

Summary of Erosion Control Work

Unit 83-1
Devils Creek Basin

Redwood National Park
Orick, Ca

written and compiled
by

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South Operations Center

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Introduction

Description

Unit 83-1 is located in the Devils Creek basin 35 miles southwest of Orick, CA (see plate I). The Devils Creek watershed drains some 18 km² (4,450 acres) into the Redwood Creek system. It is the southernmost westside tributary located within the 1978 Redwood National Park expansion area and is characterized as one of the relatively few low relief, redwood dominated tributaries to Redwood Creek.

Site boundaries include 266 acres on the northwest slope of the basin, ranging from 1,350 to 1,650 feet in elevation. Of these 266 acres, only 68 were harvested by the time of park expansion in 1978. Project boundaries were drawn in conjunction with Unit 82-3, eliminating the lower two-thirds of the slope from the rehabilitation schedule. Removal of 2.5 miles of the M-2-1 road, the 0.5 mile Y-3 road, and a 0.5 mile section of the Y-line was accomplished by an Invitation for Bid contract.

Restorative treatments focused on the major haul road and were relatively easily delineated in a contract format. Three of the 3.5 miles of haul road was constructed in 1977 and 1978 and most of the slope remains unharvested. Erosional problems, for the most part, were incipient in nature.

Primary restorative treatments included removal of 18,360 cubic yards of material from 16 road crossings, outslipping 1.6 miles of potentially unstable landings and road segments, and construction of 3,848 ft. of drain. Secondary treatments entailed placement of 1,327 cubic yards of erosion control rock in 13 of the 16 excavated channels, and application of some 53 tons of straw mulch on the site.

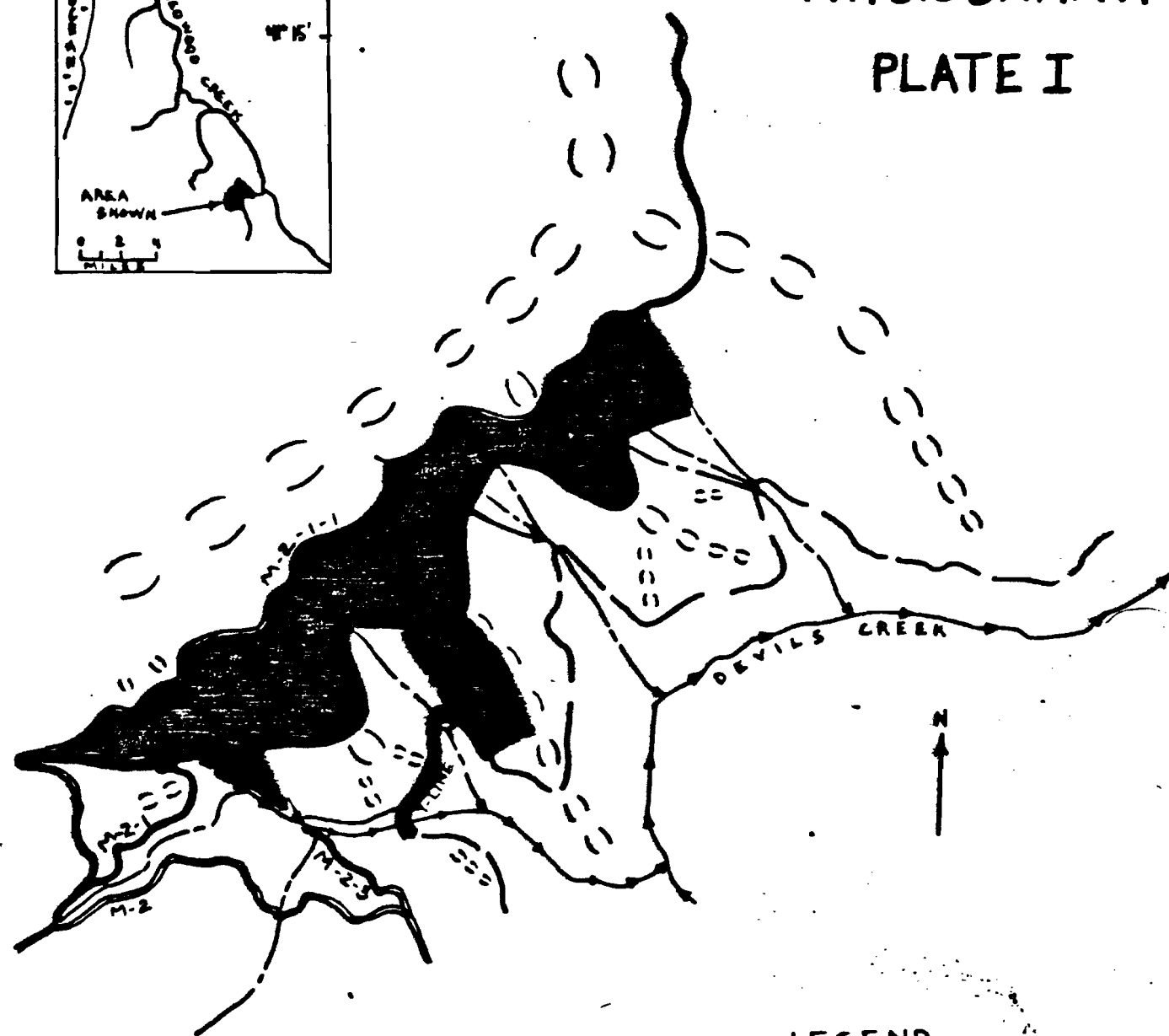
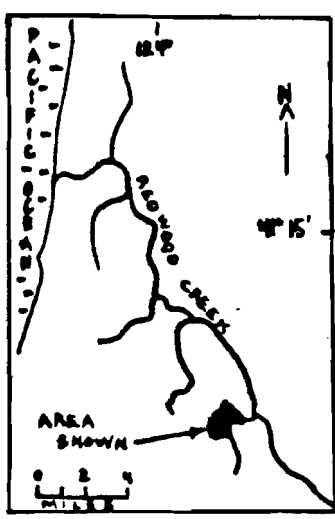
History

During the 1930's and 1940's much of the timber was harvested on the relatively gentle topography on the M-line ridge using steam donkeys and earliest tractor methods. During the 1950's access into Devils Creek basin was established (see plate II).

The M-2 road led into the basin through Devils Pass. Here, several roads spurred off the M-2 road. By 1956 large areas adjacent to Devils Pass had been logged by tractor. A small (18 acres) amount of this acreage is included within unit 83-1 boundaries. These early roads were unsurfaced and lacked culverts. Many major, low gradient skid roads were associated with the M-2 spur roads, but were abandoned after initial logging took place. 1956 cutblocks employed "seed tree leave" regeneration methods, though apparently few seed trees were left after harvest.

Beginning in 1973, accelerated timber harvest and associated road construction were characteristic in Devils Creek basin until park expansion in 1978. Of the 266 acres within the 83-1 site boundary, 18 acres were cut before 1960,

LOCATION AND PHYSIOGRAPHY PLATE I



LEGEND

APPROXIMATE SCALE = 1:24000

-  PROJECT ROAD
-  REMOVED ROAD
-  EXISTING ROAD
-  PERENNIAL STREAM
-  INTERMITTENT STREAM
-  TOPOGRAPHIC RIDGE
-  SITE 88-1

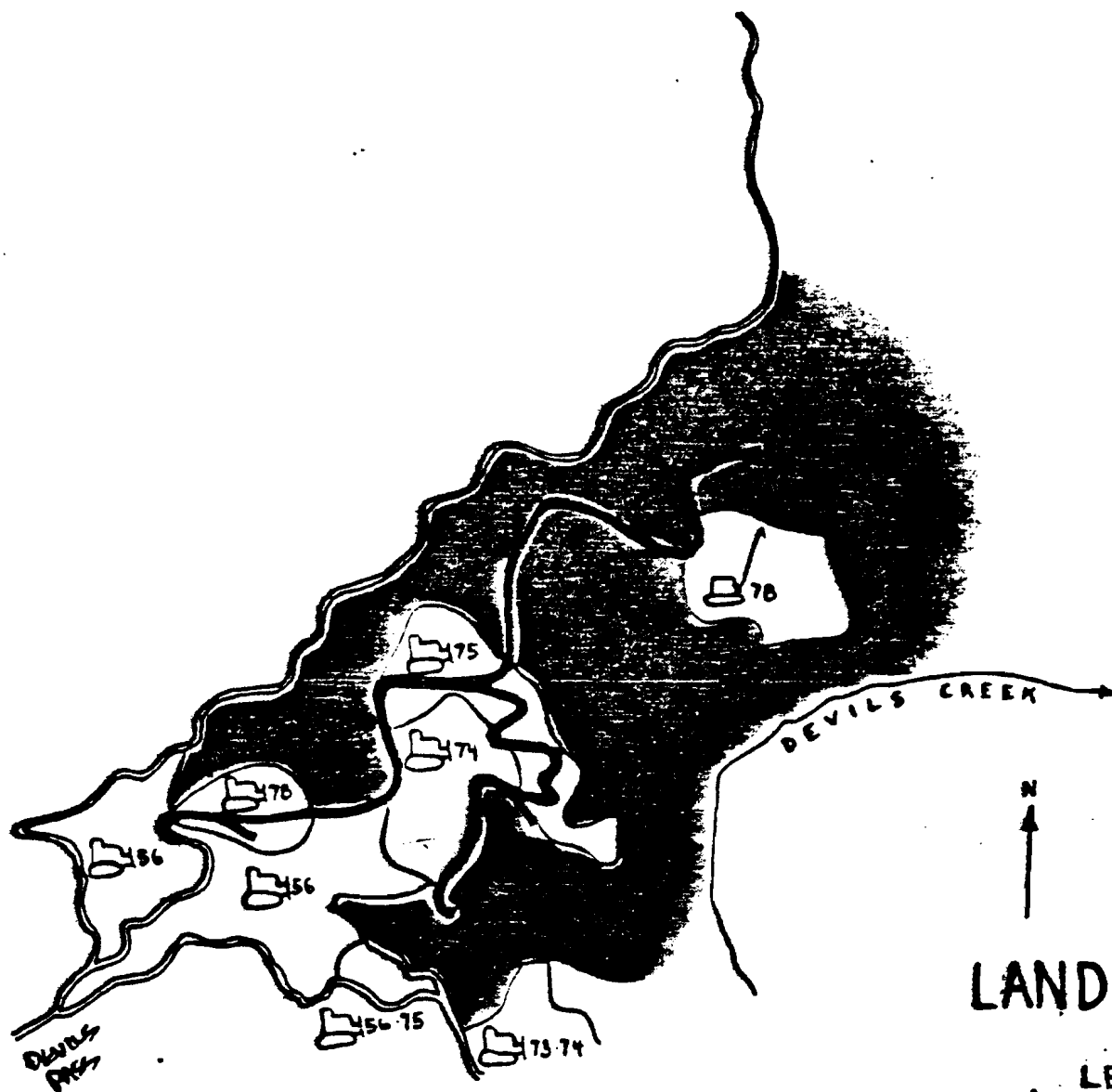


PLATE 1 LAND USE MAP

LEGEND

-  HIGH LEAD CABLE YARDED
YEAR COMPLETE
-  TRACTOR YARDED
YEAR COMPLETE
-  UNCUT OLD GROWTH TIMBER

COMPILED FROM PHOTO MOSAIC
SCALE APPROXIMATELY 1/12,000

and 50 acres were cut between 1974 and 1978. The remaining 198 acres became accessible from roads built in this time period.

Y-line development in 1973 began with establishing the Y-line rock pit #2, which provided surfacing for many of the older, established roads, as well as for the Y-line. In 1974 the Y-line was extended through the project boundaries, and by 1976 was complete. The M-2-3 road, apparently abandoned in 1956 after logging activities, was reopened at this time, and then abandoned the following year. Also in 1974, a large, tractor clearcut unit was accessed from the Y-line. The 1974 clearcut was expanded in 1975 to include the entire slope from the Y-line to the future alignment of the M-2-1-1, and includes the broad ridge that became the Y-3 alignment. At the upper extent of this cutblock, skid trail systems were developed but trees were left unharvested. Much of this cutblock lies within the project boundary.

In 1977 and 1978, the M-2-1 road was extended from the Devils Pass area for 2.5 miles, upslope and parallel to the Y-line. It ends in a short pioneered road section past a 1978 cutblock. The cutblock is a highly visible cable unit, much to the consternation of groups working towards park expansion at that time. Another cutblock was completed at the beginning of the M-2-1 extension.

The Y-3 road was also completed in 1977 and 1978 and connects the Y-line to the M-2-1 road. The Y-3 road climbs upslope along a broad ridge in a series of switch backs through the 1974/75 clearcut unit.

The Y-3 road was surfaced with rock from a quarry developed just upslope of the M-2-1 road. Total area of the rock pit is about 4 acres. Rock surfacing for the M-2-1 and Y-line was provided by the Y-line rock pits.

EROSIONAL FEATURES

Introduction

Unit 83-1 lies within the upper one-half to two-thirds of the northwest slope above Devils Creek. Fluvial development is modified by large scale mass movement processes. Slopes range from 80% to over 100% within deeply incised stream channels (inner gorge) but may be locally gentle on hummocky, mass movement controlled ridges and slopes. Geomorphic expression is typical of Franciscan terrain.

Bedrock is complex. It is composed of schist, sheared to various degrees during tectonic derivation and further modified by recent tectonics. Soils reflect bedrock composition and have developed according to slope position and moisture levels.

Due to the minimal cutting history, young age of the roads, and relatively mild winter storms since construction, many erosional problems were incipient in nature. Blue line erosion maps are on file in the Arcata and Orick offices.

Types of Features

Sediment sources are twofold. First, road fill in stream channels contained sediment available directly to streams. In addition, flow diversion instigated by culvert failure was a potential source of erosion of natural ground. Second, fill failure and accelerated mass movement resulted as road construction across steep or wet slopes concentrated and redistributed intercepted flow and redistributed hillslope mass. Massive failures, rilling and gully-ing, resulted or were incipient erosional problems.

Y-Line Road ('A' Road)

There are six stream crossings located on this .5 mile section of the Y-line. Contributing hydrologic areas range from 503 to less than five acres. Combined fill volumes were estimated at approximately 9,000 cubic yards on the crossings. All crossings used metal culvert pipes ranging from 24" to 48" in size.

Two small drainages were combined at A164+40 during Y-line construction in 1974. Some aggregation has occurred on the smaller drainage where a berm was used to divert the stream 120' downstation resulting in its present configuration. Each other drainage had its own road crossing.

All crossings were intact, and all trash racks clear. Lower ends (outlets) were often equipped with half rounds and/or energy dissipation rock. Culverts were set close to the natural stream gradient at the upper ends. Lower ends ranged from two to 12 feet above straight line channel grade. Several crossings (A147+10, A148+70, A160+40) appear to have been constructed at major kickpoints in the channels.

Several of the streams had potential to divert flow. At RXA148+70, flow had partially diverted downstation to the next culvert without significant erosion. At DDA164+40*, flow diversion would lubricate a translational slide which was located 300 feet upstation. (Excavation of road fill in the slide area was carried out in project 82-3.) At DDA160+55 the road grade is six percent upstation towards RXA163+00, and diversion would have caused downcutting along the inboard ditch.

Other crossings had no potential to erode natural ground, but failure of the road itself would have contributed large amounts of sediment to the system. Maintenance of culverts was essential to prevent erosion of road fills. In 1974/75, about 150 yds³ of sediment was removed at RXA163+00 to maintain flow through the culvert. Failure of a crossing upstream, on the M-2-3 road, probably had contributed much of the material.

Perched fill was extensive along landings and road reaches on the Y-line. Some of the fill was located on steep slopes (70-90%) above stream channels. Trend and riser topography was incorporated in landings where steep slope breaks were extended with slash and fill to enlarge deck areas. At A152, for example, 1/2 to 1 1/2 foot scarps developed that physically extended during the winters of 1982 and 1983.

Slopes adjacent to the Y-line road reach were incorporated in unit 82-3, and treatments were carried out in 1982.

* read deep dish A164+40; a type of stream crossing excavation



A "channelization" was constructed in 1982 that carries flow across slope from DDA147+10 to RX148+70. Significant downcutting (2-3 feet) has occurred along the trench.

Further discussion of these areas is found in the 82-3 report.

Y-3 Road and M-2-1 Road (E Road)

The M-2-1 road crosses 15 hydrologic basins. Five are crossed at headwater areas where contributing drainage area is between one and 10 acres and channel development is poor. Hydrologic areas of the remaining streams range from 11 to 115 acres. Total fill volume was estimated at 10,000 cubic yards.

Two crossings were partially constructed (pioneered) at the time of Redwood National Park expansion and without culvert pipes. Subsequent erosion of these crossings left little fill intact.

All other crossings were furnished with 18" to 36" culvert pipes, trash racks, and frequently had half rounds and rock energy dissipators at culvert outlets. Culverts were intact and functioning, except at E142+65. This pipe had been choked with rock and had separated at the base of the fillslope. Although flow was carried through the pipe, back pressure created an artesian situation at the break during high flows.

Culverts were set near to channel grade in all larger drainages. In several of the crossings (E46+50, E55+20, E56+88, E113+44, E115+12), road cuts intersected channel gradient at the upper end of the crossings, creating headcuts ranging from one to five feet. Migration of these kickpoints in the short time since road construction was not obvious.

Potential for stream diversion was present at many of the crossings. However, it is unlikely that large volumes of natural ground would have eroded. Diverted flow would be captured by low gradient inboard ditches and usually would have arrived at adjacent culverted stream channels within a few hundred feet. With several blockages, erosion of the stream channel fills themselves would most likely have occurred.

Mass movement activity consisted of localized failures of perched fill and massive failures involving natural ground. Many fill failures began as localized failures and progressed into natural ground (E31+00 - 35+00 for example).

Large scale mass movement is often a dominating factor controlling morphology throughout the site. For example, an ancient, multiple scarp slump is crossed by the M-2-1 at E132 to E140. The feature totals about 100 acres in area. Headscarps are located well above the M-2-1 road. A well developed drainage was interrupted at E137+28, and a considerably younger channel now carries its flow at DDE142+65.

The hummocky topography crossed by the M-2-1 from E46 to E60 lies within the Bridge Creek lineament. Severe slope breaks, immature drainages, and multiple groundwater discharge points characterize the reach. Similar morphology exists between E10 and E20.

Active mass movement features along the M-2-1 road include ongoing fill failures, debris torrents, and compound (multiple scarp) slumps.

At E24 to E26, scarps developed in perched fill material. Slopes range to 47 degrees below the road. At E25+00 one large (3 acre) "scree" (ravel) slope has developed, although it may have initially been formed during road construction. "Calving" of perched fill at the outboard edge of the road in the reach has also buried the culvert outlet at E26. In contrast to the other active mass movement areas, this site is quite dry.

Much of the reach from E142 to E152 is steep (100% slope) and very wet. Deep soils and/or locally sheared (incoherent) bedrock is associated with two failures of perched fill in the area. The larger, at E144, fell 170 feet to the stream channel below. Motion was dominantly translational. Much of the material has been moved by stream transport. A second debris torrent occurred at E146, and deposited material on a skid road bench 100' downslope (i.e. road 'S'). Smaller (.5 to 1.0 foot) scarps had developed along much of the reach.

One of the few off-road erosional problems associated with Unit 83-1 was a 700' section of skid trail below E145 to E152 (Road 'S'). As previously described, deep colluvial soils and/or sheared bedrock, steep slopes, and high water content combine to make this slope unstable. Road 'S' is also subject to undercutting by a large stream (115 drainage acres). Failures had already occurred at 'S'0 through 'S'4.

At E59, the road bench and landing are built overhanging a large break in slope which corresponds to the general location of the Bridge Creek lineament. One half to 1.5 foot scarps developing in the fill show further failure was imminent. Similar situations were encountered at E15 and E160 without scarp development.

At E31 to E35, a 350' arcuate scarp developed one foot of vertical offset and intersects original ground at the inboard ditch of the M-2-1 road. The scarp is the uppermost hillslope expression of a roughly 30 acre, translational slide that has progressively affected the hillslope beginning at the Y-line, located 800 feet in elevation below the M-2-1 road. Except for the M-2-1 and Y-line corridors, the area is unharvested old growth timber. Although the comprehensive impact of road building on slope equilibrium is unknown, interruption of normal groundwater circulation and re-distribution of hillslope mass has probably encouraged movement. The feature became active in 1976 during Y-line construction. Accelerated movement closed the Y-line in 1981/82, when slumping deposited hillslope debris on the road, and into the tributary stream below.

Removal of overburden during quarry operations above E105 produced point sources of groundwater discharge in the headwaters contributing to DDA147+10. Flow from these point sources concentrated on a skid trail system and eventually reached a culvert located at E104+50. Outfall from the culvert was directed towards a series of poorly drained skid trails on the slope beneath the Y-3 road. Slumping of original ground and associated skid trail benches was progressive, probably beginning with culvert installation in 1977/78.

The Y-3 road switchbacks down a broad ridge from the M-2-1 to the Y-line. Rilling and gullying by concentrated ditch flow from the Y-3 was present, but was not considered to be a significant sediment source.

EROSION CONTROL WORK

Introduction

Procedures

Rehabilitation efforts on Unit 83-1 may be divided into phases including site evaluation, prescription of restorative treatments, site preparation, contract (document) preparation, and prescription implementation.

Evaluation

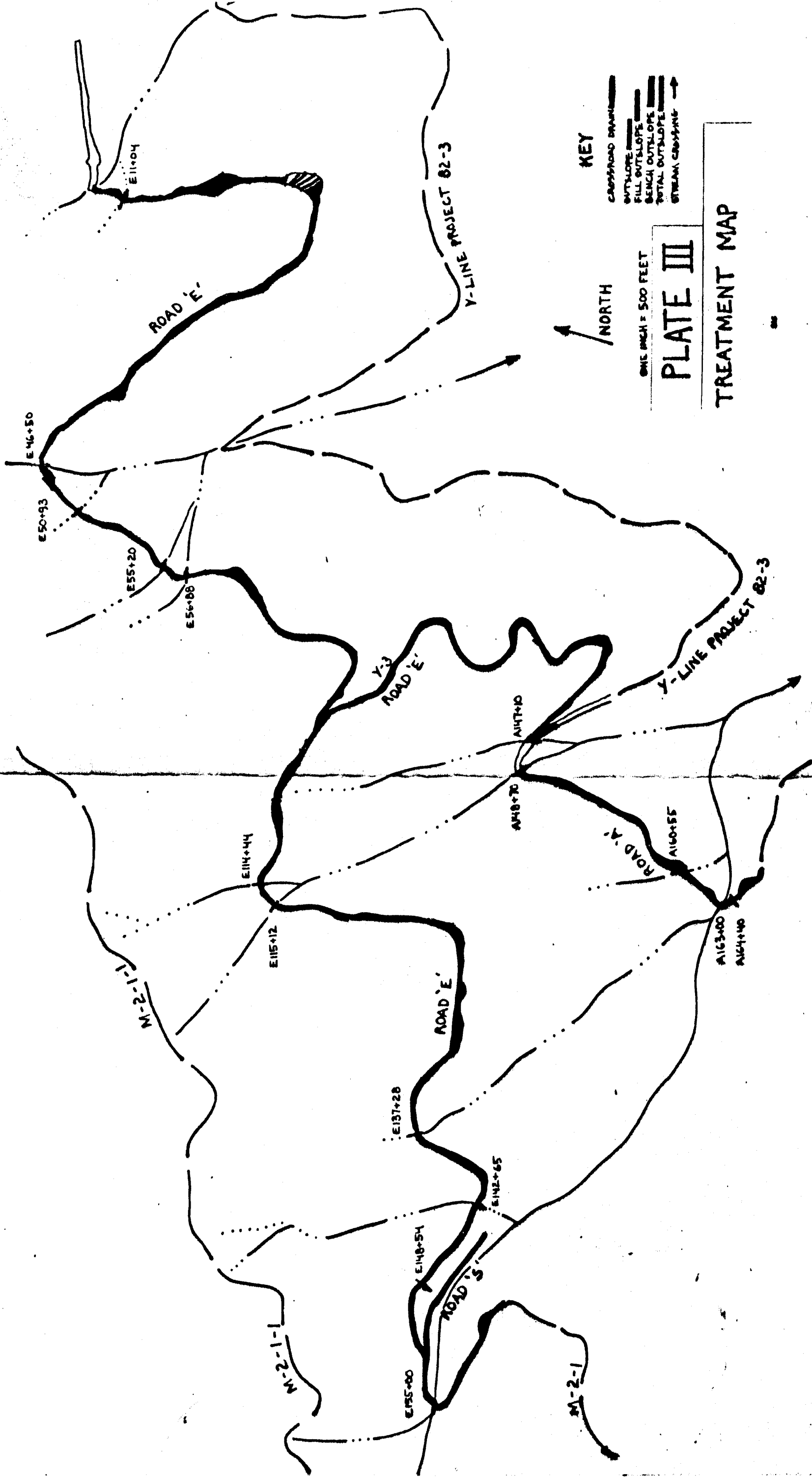
Rehabilitation efforts in preparation of Unit 83-1 began in 1981 with the evaluation of sediment sources and erosional problems associated with the Y-line. Although treatment of much of the area was accomplished in 82-3, a segment (.5 miles) of the Y-line went without treatment, but was left accessible via the M-2-1 and Y-3 roads. Identification of site 83-1 centered on treatment of high priority sediment sources remaining on the Y-line, and removal of the M-2-1 and Y-3 roads. A contract was anticipated due to the relative ease of delineating, accessing, and quantifying heavy equipment and labor intensive treatments where erosional problems are directly attributable to major haul road corridors. Off-road problems in cut units adjacent to the Y-line were addressed in 82-3. Off-road work associated with the M-2-1 and Y-3 roads was minimal.

Reconnaissance mapping of the basin was carried out in 1981. Large scale mapping (1" = 100') followed, using aerial photo enlargements as base maps. All cut over areas or impacted areas were mapped in detail. Areas adjacent to the Y-line originally detail mapped in 1981, were reviewed in 1982, concurrent with detail mapping of the remainder of the unit. Areas of extensive old growth cover were not mapped in detail, except along stream channels within the project area. Blue line maps are on file in the Arcata and Orick Redwood National Park offices.

Prescription

Prescriptive treatments for erosion control were assigned to one of several categories. Prescriptions that did not fall into a category were, on the whole, avoided. Frequent changes between categories were also avoided. Simplicity and uniformity were goals in prescription application. Prescription categories include several types of outslowing, stream channel excavations, installation of cross road drains and dissaggregation, and rock and straw mulch placement. General treatment types for Unit 83-1 are seen in Plate III.

Outslowing categories include regular (cut and fill) outslope carried to various extents. Type I outslowing produces a finished grade of about 3:1 in cross section while Type II outslowing produces a 2.3:1 finished grade. Type IV outslowing uses a percentage of the Type I fill height from 25% to 125% of the original height. Type III outslowing is used to allow for sub-standard cutbank angles, for volume compensation. This system was adopted to allow for as much variability within an outslope reach as possible.



KEY

- CROSSROAD DRAINAGE
- OUTSLOPE
- FILL OUTSLOPE
- BENCH OUTSLOPE
- TOTAL OUTSLOPE
- STREAM CROSSING

ONE INCH = 500 FEET

PLATE III

TREATMENT MAP

NORTH

without changing prescription categories.

Total outsloping involved end hauling of fill material and left a finished grade varying from 6:1 to 3:1 across the road bench in cross section. Bench outsloping is similar, but leaves the inboard 10 feet of the road intact (except for drains placed across it) and finished grade of the cut area is as great as 2:1. Fill outsloping is regular outsloping at a fill site where imported fill is placed and a local cut is desired.

Site Preparation

Layout

Layout consisted of surveying, staking (slope stake placement) and establishing photo documentation locations.

Surveying

Surveying was accomplished using tape, clinometer and compass, and also used the stadia rod and level. Staking was completed using a variety of methods.

Outstanding work from last year's project on the Y-line used the "R-X" format for stream crossing excavations on major channels, while all other crossing excavations used a "deep dish" format. RX formats use multiple X-sections with slope stakes at each cross section. Grade and stake placement is determined from drafting the cross sections and thalweg (centerline) profile. "Deep Dish" formats, where cross sections are standardized (2:1 sideslopes tangential to a 30-foot radius vertical curve), use newly innovated nomograms (see Appendix 1 "The System") to determine cross sectional limits and volume estimates. Grade is determined in the field from centerline (thalweg) excavation limits, yielding the maximum cut depth which, in turn, gives maximum cross sectional width. With limits staked, planned excavation volume can be estimated and fillsites can be considered. Cross sections are not used. Instead, the centerline profile is extended laterally at each point on the profile.

Where roads bend into the crossing limits, some error is introduced in stake placement width. Volume, we suspect, is not affected by the radius of the turn. It is imagined that the effect is the same as bending a deck of cards around an axis - no matter how tightly they are folded around the axis, the volume they displace does not change.

The nomograms were used in combination with rod and level for staking outsloped road reaches. Vertical distances for stake placement may be read from the nomograms using a minimum of parameters. These are: cutbank and fill-slope angles, road width and road length, and designated fill height (or cut depth). Staking is permitted directly from these measurements.

Fillsites are staked in a similar manner as outslopes are staked. After compensating for imported fill, local outslope cut was superimposed.

Station lathes were used to locate worksites on Site 83-1. Lathes were placed above the cutbank every 100' along the roadways' travel path. Station

lathe are useful in double end area calculations for fillsites and outslloping volumes, and for figuring endhaul distances. It must be pointed out, however, that cross sections (identified by station) were not parallel, but were perpendicular to the roadway at each point. Therefore some error in double end area calculations was anticipated.

Grade checking was important in control of work in progress as well as in assessment of completed work. Methods of grade control commonly used during channel excavations were grade checks from the lower end stake (benchmark) or from the excavated (straight line gradient) thalweg. Sideslopes and channel widths at deep dish excavations could be checked at any perpendicular since all cross-sections are standardized. Final excavated volumes at all stream crossings were determined by completing a thalweg profile and several surveyed cross-sections and tied to the pre-equipment surveys with (rebar) benchmarks. Grade control on outslope and fillsite reaches used the cut or fill stake as a benchmark and grade was checked for evenness and angle.

Photopoints

Photopoint locations were established prior to equipment work after NPS employees had brushed the site. Photopoint locations were chosen to exhibit overall changes produced by heavy equipment work. Most are expected to be useful for several years until the eventual encroachment of vegetation occurs.

Plansheets and Contract Preparation

Preparation of plansheets that depict controlling parameters at sequential worksites was abridged from the plansheet format used in past projects. Control points usually lack visual representations (cross-sections) but include shorthand for cut depth, fill height, slope percent, accumulated volumes, and endhaul distances. Reach totals include equipment projections and volume estimates. Stream crossings are graphically represented by longitudinal profiles, along with maximum cut depth, width, grade percent, mean endhaul distance, and rock prescription information. All information for grade checks is included on the plansheets.

Section B and C of the actual contract document was produced in a joint effort with the contracting officer. Section B divided prescriptive categories into bid items to form the bid, or payment, schedule. Section C dealt with descriptions and specifications of the contract. Prescriptive definitions are included in this section along with explanation of the plansheets. General expectations made of the contractor and specific limitations regarding rehabilitation treatments were outlined in this section of the contract. Section C of the contract document may be found in Appendix 2.

Implementation

Prescriptions were implemented by an invitation for bid contract agreement. Four bids were received by the contracting officer. The lowest bid received was from Kjer and Sons, and was accepted through normal bidding procedures. The COR, E.P. Wosika, and his representative, M. Sandeck, were responsible for establishing final road crossing excavation limits and grade, working closely with the contractor as excavations progressed. Demonstration of grade control methods, evaluation of removed volumes, and approval of completed bid

items while contract work progressed were also the responsibility of the C.O.R.

Objectives

An important aspect in identifying Unit 83-1, in delineating site boundaries, and in prescribing restorative treatments, is consideration of the relatively pristine conditions that exist in Devils Creek basin. Recency of basin development (timber harvest) has restricted erosional problems to road corridors themselves and left large stands of old growth redwood and Douglas-fir intact. Treatment objectives addressed mainly incipient erosion. A balance between cost effectiveness and physical limits was desired.

Plate III is a general prescriptive category map. Details of prescriptive types may be found in the plansheets on file in the Arcata and Orick offices.

Y-Line (Road A)

Major objectives on the Y-line were removal of stream crossing fills and addressing sections of road susceptible to mass movement. Disaggregation of thick rock surfacing was incorporated to encourage normal circulation of ground water and improve infiltration. Large amounts of mulch were employed to aid revegetation on fillsites, outsloped reaches, and crossing sideslopes. Rock armor was used to protect excavated stream channels.

Removal of all stream crossing fills and local placement of the fill was desired. One stream at A164+40 was left in its diverted alignment to allow room for a major fillsite. Base level of the stream was physically lowered to lessen aggregation at the point of diversion.

Two large road fills at A163+00 and A148+70 were completely removed. The well-incised stream at A163+00 drains 503 acres and was rocked heavily to protect the excavated reach during heavy flows. At A148+70, in a moderately mature drainage with a 118-acre hydrologic area, rock was placed in several "aprons" across the channel. Objectives in using the aprons were to create artificial knickpoints in the excavated reach and thereby reduce downcutting while using the smallest rock volume possible.

Smaller crossings were excavated to stable base levels. These steep, poorly to moderately developed drainages were sometimes not completely excavated (i.e. A160+60, A164+40) and rock was used to protect upstream headcut migration through the excavation.

Objectives in treatment of mass wasting were to remove perched fill and unstable road sections in order to stabilize hillslopes. A variety of outslope prescription types were employed. Outsloping with local fill placement (OS) was designated in areas where fill was perched above stream channels and extended into areas where protection of old growth was desired. The fillsite at A152 was not outsloped to allow more room for fill volume. The trade-off was plausible because there was a stable bench below the landing. Also, scarps developing there did not affect original ground. Bench outsloping (BOS) is applied where a large cut is desired (e.g. A150) to remove perched fill where local placement is prohibited. In addition, a bench is left to catch material from cutbank failures. A total outslope (TOS) was employed where free drainage across the road was desired and a major cut was not required (A157, A146). Fill is exported in the TOS and BOS formats.

Decompaction of aggregate surfaces was prescribed to restore infiltration, improve groundwater circulation, and enhance vegetation.

Large amounts of mulch were applied in all impacted areas except crossroad drain reaches. Mulch was applied at about 6,000 lbs per acre.

Y-3 Road (E74 to E104)

Objectives on the Y-3 were 1) decompaction of aggregate road surfacing to allow infiltration and promote revegetation, 2) breakup of concentrated flow to the west side of this broad ridge and 3) to direct surface runoff into the headwaters of a channel on the east side of the ridge. The latter two objectives were accomplished by installation of cross road drains and long ditches (up to 540 feet).

Skid Trail (Road 'S')

Proximity to a major stream channel led to outslope of 300 feet of this perched road reach. Implementation of the prescription without spillage into the channel was desired.

Two small drainages were accommodated by cross road drain installation. A drain was necessary to handle flow below DDE148+54 to avoid avulsion onto the fillsite which was located below the worksite on the skid trail.

The road was ripped to encourage normal hydrologic circulation and encourage regrowth. Mulch placement on the fillsite and outslope reach was incorporated.

M-2-1 (Road E)

Main objectives on the M-2-1 road were stream crossing fill removal, out-sloping unstable road reaches and landings, decompaction of aggregate surfacing, direction of flow by installation of cross road and other drains, and encouragement of revegetation by strategic fill placement and mulching.

Removal of several culverted stream crossing fills on poorly to well-incised stream channels was a major goal in road removal. Bands, or aprons of rock were used to create knickpoints in excavated reaches in all but the smallest drainages (i.e. except E11+89, E50+93, E148+54). Bands were typically 30' in width, 20' in centerline length, and two feet in thickness. Wide bands were used to prohibit peak flows from eroding sidebanks beyond the rock limits.

Several bands were used on longer, steeper excavated channel reaches. Rock was also placed to armor upstream migration of headcuts at the upper end of E46+50, E55+20, E50+93, and E148+54.

Two channels on the pioneered section of the M-2-1 (E6+00, E10+00) had little fill volume. After eroding for several years, rebuilding would have been required for access. No treatment was, therefore, applied.

Outsloping was applied where fill was perched above stream channels and where the M-2-1 road bench adversely affected hillslope dynamics.

Regular outslipping (Type I) and steeper (Type II) outslipping was prescribed to remove perched fill above stream channels. Frequently, a reach beginning with Type I outslipping would be stepped up to Type II outslipping to remove more fill from the outboard edge of the road as the channel was approached (e.g. E55+20, E148+54, and E155+00).

At E17 and E59, large, inactive landslide headscarps formed severe slope breaks. Outslipping of perched fill built out onto the slope break was desired to avoid reactivation of the scarps.

In addition, regular outslipping was used in old growth settings for aesthetic value.

Removal of large amounts of fill in the reach from E143 to E149, and at E157, was accomplished by using several outslope types. Limitations on local fill placement were imposed by abundant, high discharge springs and unstable cutbanks. Bench outslipping and deep, total outslipping was used in the wet areas, and steep (Type II) regular outslipping was used in drier segments.

Fillsite landings were outslipped with two objectives that are accomplished by use of one of two methods. First, where perched fill was encountered to a significant depth (e.g. E59+50, and E125), a total outslope was applied along the landing edge. Second, where drainage was the concern and fill was relatively shallow, a fill outslope prescription was used to apply a shallow cut (E11+00, E38+00, for example).

Decompaction of aggregate surfaces was desired for fill placement areas to provide normal ground water circulation. Ripping to a depth of 24" was warranted to break up thick rock surfacing. In crossroad drain reaches ripping was needed to improve percolation and vegetative regrowth.

Crossroad drains were used to break up flow concentrated in inboard ditches or to drain point sources across the road bench or into crossing excavations. At E46+70, drains were placed from a large spring on the right side of the channel into the top of the excavation. Cutbank instability warranted placement of a second drain for backup. Another drain was placed in the rock pit area above E109 to drain springs into the headwaters of DDA147+10, thereby reducing flow that aggravated slope stability below E101 on the Y-3 road.

At E24, the road bench was used as a fillsite for revegetative purposes. Likewise, the landing at E21 to E22 was cut and filled in order to provide a growing medium. In both cases the objective was to obscure high bedrock cutbanks, visible from as far away as Bald Hills Road.

Mulch, spread at about 6,000 lbs per acre, was prescribed for all reaches (except cross road drain reaches) to protect disturbed ground and encourage revegetation.

Summary Costs

Summary costs for Unit 83-1 are presented in Table 1. Total cost for the project is \$174,876 with \$33,136 acquired as in-house costs, and the

TABLE 1: Summary Costs Unit 83-1*

		Redwood National Park Costs (\$)				Contract Costs(\$)	% Total Cost	Total Cost(\$)
		Employees		Heavy Equip. Rental	Materials			
		Hydrologist/PST	Laborer					
Secondary Treat- ments	mapping, prescription, surveying plansheet preparation	23,380				800 (timekeeping)	14	24,180
	Brushing		3,350					
	Move-in, move-out			450		2,000	3	5,800
	Crossings					49,509		
	XRDS					2,559		
	Reg outslope					16,748		
	Total outslope					5,370	52	91,169
	Bench outslope					8,901		
	Fill outslope					5,322		
	Misc. outslope					2,756		
Secondary Treat- ments	Rock			960		21,286	13	22,246
	Straw		670		4,326	22,935	16	27,931
	Haul CMP's Misc.					2,550 1,000	2	3,550
SUBTOTAL		23,380	4,020	1,410	4,326	141,740		
TOTAL		33,136			141,740		\$174,876	

*Costs for placement of a french drain and some rock quarrying and hauling costs were not included in this report, but were included in costs for Unit 82-3.

remainder, about \$141,740, paid directly to the contractor.

Not included in the summary costs were salaries for RNP employees involved in mapping, surveying, prescription, and plansheet preparation for the A' road (Y-line) which were attributed to Unit 82-3 costs. Also, some rock quarrying costs and hauling costs for rock at two Y-line excavations were attributed to Unit 82-3 and not included in the summary costs for Unit 83-1. In addition, a french drain was installed during project 82-3 that was needed for a fillsite used in 83-1.

It should be noted that the original contract bid amount was altered as work progressed. Several supplemental agreements were filed, owing to: 1) actual excavation limits differing from prescribed limits and volumes at crossing excavations; 2) occurrence of bedrock ledges in outsloping reaches; 3) re-evaluation of double end area calculations for non-standard road configurations; 4) inadequate straw coverage with the prescribed number of bales; 5) simple transcription errors for rock volumes, and; 6) additional payments to the contractor stemming from the lack of adequate amounts of government supplied rock during the initial stages of work.

Areas one through five were anticipated by the writers of the contract. Ten percent of all crossing payments were withheld in anticipation of natural channel bottoms, sideslopes, and other original ground differing from the prescribed excavation dimensions. Likewise original ground was desired as the cut off point in outslope excavations, although payment was not automatically withheld. Survey and transcription errors were anticipated, although careful rechecking eliminated most of these.

In all negotiated payment items, the contracting officer met with both the contractor and the C.O.R. to resolve a modification of the payment schedule to afford changes in the contract work. In all cases except for area six, changes in work were linked to payment proportionately. Volumes of fill could be surveyed and a reasonable payment made. However, in this last case, payment hinged on the governments provision of rock, to be used throughout the contract. In short, the contractor was paid, in amendment #86, to "generate 800 cu. yd. rock". In reality, the dispute centered on the responsibility of the contractor (vs. the C.O.R.) in notifying the government that adequate rock was not available, as claimed in the contract specifications. A delay was caused, according to the contractor, while a (rental) dozer was brought in by the government to make suitable rock.

A payment was eventually made to cover the contractors claim for \$11,844. The negotiated payment amounted to \$7,817. This payment increases the over-all cost of rock by 48%, and represents a 6% increase over the original contract bid. In fact, this increased amount exceeds the amount of the next lowest, low bid, submitted by Whitey Brown, at \$139,382.

This was not the only claim for additional monies made by the contractor. In fact, the contractor also purported that gross errors were made in assessing all crossing volumes and asked that a licensed surveyor be employed to evaluate removed volumes. This claim was denied. However, one worksite was re-evaluated in response to the claim.

Although the question of applicability of contracts in rehabilitation work is moot, having been given a mandate to perform a number of these contracts, one cannot help but wonder if similar adjustments will be made in future

IFB's and what effect these adjustments will have on unit costs.

Heavy Equipment Phase

Equipment

A large excavator and crane were used primarily for excavation of crossing fills and for rock placement. A D-8 ripper cat was used for most outslowing. Backup equipment used with the excavator and crane were a small (850B) cat for handling crossing fills at the fillsites, one to two 12 yd. dumptrucks, a backhoe, and a large, rubber tired loader. Equipment specifications are found in Table 2 and Appendix 3.

Both the excavator and crane were owned and operated by the contractor. The small dozer and one dumptruck were also owned by the contractor, although an operator was hired for each. Equipment rented by the contractor was the loader, the D-8, and the truck/backhoe combination.

Recordkeeping

Equipment times were kept by the contractor in fulfillment of a bid item. The complexity of timekeeping involving several pieces of equipment proved to be difficult for the contractor. Several weeks into the contract, flaws in beginning and ending times in the record were noted. The contractor was notified and an agreement was reached that cleared up obvious discrepancies. Overall, times are approximate. General trends may be relied on, but details of equipment performance are suspect. Tables 3 and 4 list hours for equipment at each worksite.

Equipment Use

Crossings were most often dug completely by crane and/or excavator. Slow progress of crossing excavations was tolerated while the D-8 finished downstation work. The D-8 was often in greatest demand. Work done most effectively by D-8 was sometimes augmented or completed by other, idle equipment. Short truck endhauls were preferred over D-8 push. Excavation equipment was also intermittently idled while truck(s) strove to catch up.

The D-8 operator worked on a similar project last year (Site 82-3), and was familiar with rehabilitation work and slope staking.

The D-8 was used for ripping the entire site, and for much of the outslowing work. Crossroad drains were often placed by the dozer when no other equipment was immediately available. Because this was the only ripper cat on site, ripped areas were often ripped out of sequence while the dozer was available, then backbladed for truck travel. These areas were seldom re-ripped.

Production figures for the D-8 (Tables 8, 10) are lower than those of last year. Average yd^3/hour dropped from 105 to 87 yd^3 but is based on very few entries. The lack of usable entries is largely due to non-exclusive work (i.e. work augmented by other equipment). The excavator was often used to

Table 2

Unit 83-1

Heavy Equipment Used

<u>Type</u>	<u>Description</u>	<u>Owner</u>
Excavator	Bucyrus Erie BE 300H	Carl Kjer & Sons
Crane	Bucyrus Erie BE 25	Carl Kjer & Sons
Bulldozer	U-blade, ripper Cat D8H	Tim Crowley
Bulldozer	Winch Case 850B	Carl Kjer & Sons
Backhoe	MF	Laroy Hake
Dumptruck	12 yd	Laroy Hake
Dumptruck	12 yd	Carl Kjer & Sons

Table 3 Equipment Hours-Stream Crossings*

Stream Crossing and Station	Excavation Equipment Hours							Rocking Equipment Hours					
	BE-300	25B	D-8	850B	DT	175B	BH	BE-300	25B	D-8	850B	DT	175B
E11+89	3.5		.7										
E46+50	47.5		1.5	20.0	73.5	7.5		6.0					6.0
E50+93	9.5			12.2	11.5								
E55+20	24.0			19.7	44.0			1.5				1.0	
E56+88	19.0			41.8	37.0			1.0				1.0	
E113+44	6.3	15.5		11.6	41.6			2.0	4.5				
E115+12	8.0	6.0		17.6	28.0			0.2	1.5				
E137+28	3.0			0.3				1.0					
E142+65	4.0	9.8	0.5	19.8	13.5			3.0			1.0		
E148+54	4.0		1.0										
E155+00	6.5	14.9	3.6	7.3	40.0			2.0	2.0			2.0	
A164+40		16.0		16.0	3.5				4.0		4.0		
A163+00		67.0	6.5	62.0	4.5	8.0			15.5		4.0		11.5
A160+55		5.0	6.2		1.6		2.0		1.5				1.5
A148+70	1.5	36.0	12.9	10.0	1.6		6.5		4.5		1.5		
A147+10	16.0	13.5	22.0	5.5				4.3	3.0	1.3	1.3		
Total Hours*	153.8	183.7	55.0	243.7	300.3	15.5	8.5	21.0	36.5	1.3	11.8	4.0	19.0

* Excludes rock production and hauling, culvert hauling.

Table 4 Equipment Hours-All Treatments

Treatment and Reach	BE-300	25-B	D-8	850-B	DT	175B	BH.
Fillsite out- slope/Total	11.8	21.0	31.4	13.0	0		
E11+04-11+62	0.5						
E12+43-11+62			0.8				
E15+00-16+30	0.8		0.3				
E109+35-111+00	2.5		3.0				
E139+80-141+65	4.0		0.5				
E153+65-154+65		0.5	1.3				
E159+30-161+00	4.0	3.0	7.5	1.0			
A167+00-164+72		16.0		12.0			
A162+46-160+89			7.5				
A160+19-158+00		1.5	10.0				
A145+80-143+00			0.5				
Regular Out- slope/Total	51.5	3.5	120.6	4.0	0		
E16+30-17+52	9.5		15.5				
E25+82-35+00			22.0				
E40+20-45+64			19.0				
E50+35-54+73	6.0		0.5				
E57+31-59+20	3.0		0.5				
E105+50-109+35	6.0	2.0	13.3	0.5			
E111+00-124+70	9.5		24.3	3.5			
E142+85-143+75	2.5	1.5					
E144+62-145+70	5.5		0.3				
E146+65-148+20			5.3				
E148+88-149+80	0.5		2.8				
E151+15-153+65	3.0		4.0				
E157+10-159+30	3.5		0.3				
E161+00-161+50	1.0		0.7				
A157+00-155+00			11.9				
S0+00-3+00	0.5		0.1				
S3+70-4+50	1.0		0.1				

Table 4 Equipment Hours-All Treatments
(Continued)

Treatment and Reach	BE-300	25-B	D-8	850-B	DT	175B	BH
Total Outslope/ Total	9.4	9.8	19.7	18.1	14.0		
E10+55-11+04	1.8						
E12+16-12+43	0.3		1.0				
E14+10-15+00			3.0				
E35+00-38+00			11.5				
E59+20	2.5			5.4			
E124+70	0.3		0.8	10.2			
E143+75-144+62	3.5	9.8	0.4	2.5	14.0		
A158+00-157+00			3.0				
A146+56-145+80	1.0						
Benched Outslope/ Total	11.3	23.3	10.4	11.1	39.5		
E145+20-146+65	2.0	13.4	0.6	4.2	22.5		
E155+43-157+10	8.5	1.9	0.9	6.9	17.0		
A151+30-148+95	0.8	8.0	8.9				
Crossroad Drains/ Total	11.0	0	14.7	5.8	0		
E17+52-21+60			1.5				
E47+28-50+35			1.5				
E63+55-73+00				4.5			
E75+50-105+50	5.0		4.5	0.3			
E128+00-139+80	3.0		4.3	1.0			
E149+18-151+15	1.0		1.0				
A155+00-152+60			1.5				
S3+00-3+70	0.5		0.1				
S4+50-7+00	1.5		0.3				
Rock Hauling *1 *2	0	0	0	20.5	161.0	89.5	0
Crossing Total (from Table)	153.8	183.7	55.0	243.7	300.3	15.5	8.5
Culvert Hauling	2.5	0	0	0	35.5	0	27.0
Grand Total Hours	272.3	277.8	253.1	328.0	554.3	124.0	35.5

*1 time includes contractor production time

*2 RNP rock production time not included (time incurred during project 82-3 plus 12 hours of Komatsu D85E dozer in 1983).

begin outsloping by creating a notch for the dozer to push against, and sometimes to dig around stumps. Excavator and crane would work on outslopes in their extra time so that the D-8 could keep up. D-8 production level may have decreased due to the steepness of some of the outsloping work, which approached 2.7:1 grade. Another probable factor in the decrease is the different auxiliary equipment on the D-8. The rippers on this machine made it heavier and less maneuverable than the winch cat used for a large part of 82-3's data base.

The U-blade on the D-8 was an asset in distance pushing, but a hindrance to maneuverability due to its extra size and weight. Crossroad drains were difficult to excavate with the larger blade. An available combination is the U-blade/ripper set up in a D-8. A U-blade in combination with a winch is unheard of.

Both excavator and crane were used for excavation and rocking of channel reaches and to help the D-8 in outsloping. The excavator also built some crossroad drains.

Although larger than the rental equipment commonly used in the rehabilitation program, the BE300 assumed a similar, conventional role. Narrow road segments (15-20 feet) were outsloped by the excavator without backup equipment. Crossings were excavated in a stair step pattern, with each "stair" rocked as the excavator progressed up the channel.

Larger excavations were handled by the crane. The crane had a longer reach than the excavator and could retrieve and place fill or rock further from the machine. Intuitively, production by the crane was similar to that of the excavator on this site. Slow swing time was balanced by large bucket capacity. Logs and slash tended to slow the loading of the dragline bucket, but many road fills were clean. The clamshell bucket was used only briefly for rock placement at A163.

Other equipment used on the site were a loader, a backhoe, and a dozer. The loader was used exclusively for loading and handling rock. The backhoe was used to excavate shallow pipes. The dozer (850B) was used for fill shaping at the fillsites, and miscellaneous chores.

Heavy Equipment Costs

Table 5 is a summary of average prescription costs and includes costs for straw mulch placement. The contractor, in preparing a final bid, may compensate for undercharging on one bid item by overcharging for another bid item. The most outstanding example of this is the bid for straw mulch placement. Although \$15 per bale was charged, the contractor subcontracted this work for \$3.50 per bale, thereby assuming \$17,583 in monies that may be redistributed to other unit costs. This report, however, is limited to a discussion of actual bid costs, ignoring interpretation of unit costs with regard to bale costs. Tables 5 through 12 reflect unit costs for the various heavy equipment treatments.

Table 5 Summary of Average Unit Costs

<u>Treatment</u>	<u># of</u>	<u>Total Quantity</u>	<u>Total Cost</u>	<u>Average Cost/Site</u>	<u>Average Cost/Quantity</u>	<u>Range in Cost</u>
Road Crossings	16 sites	18,714 Yd ³	\$49,509.43	\$ 3,094.34/site	\$2.65/Yd ³	\$1.00-3.50/Yd ³
Outsloping	1.69 miles of road	27,538 Yd ³	\$39,070.67	\$23,118.74/mi. of road	\$1.42/Yd ³	\$1.00-3.55/Yd ³
Cross Road Drain	1.23 miles of road	4,128 ft of drain (39 drains)	\$ 2,559.36	\$ 2,080.78/mi. of road	\$.62/ft. of drain	\$24.03-288.92/drain
Haul Culvert Pipes	9 sites	380 ft of pipe	\$ 2,550.00	\$ 283.33/site	\$6.71/ft. of pipe	\$50-250.00/site
Straw Mulch	17.84 acres	1,529; 70# bales	\$27,931.00 ^{*1}	\$ 1,565.64/acre	\$18.27/bale	-0-
Rock ^{*4}	13 sites	1,327 Yd ³	\$22,841.00	\$ 1,757.00/site	\$17.21/Yd ³	\$5.00-17.21/Yd ³
Misc.			\$ 3,000.00 ^{*2}	TOTAL TREATMENT COST: Primary		
				Secondary		
				Misc.		
				GRAND TOTAL ^{*3}		
						\$ 93,689.46
						50,627.10
						<u>3,000.00</u>
						\$147,316.56

*1 Straw includes purchase price.

*2 Misc. covers move-in, move-out and a bid item entitled "miscellaneous".

*3 Does not include Redwood National Park employee salaries.

*4 Does not include some quarrying and hauling costs included in Unit 82-3.

Table 6 Stream Crossing Excavations

Stream Crossing and Station	Final Excavated Volume Yd ³	Average Endhaul Distance (feet)	Contract Bid Cost(\$) Per Yd ³	Contract Bid Cost(\$) Per Site	Total Cost(\$) of Rock	Total Site Cost(\$) Including Rock	Total Cost(\$) Per Excavated Yd ³	% Cost Increase With Rock Added
E11+89	86	138	1.33	114.38	0	114.38	1.33	N/A
E50+93	263	1,017	3.50	920.50	0	920.50	3.50	N/A
E137+28	314	50	1.00	314.00	100.00	414.00	1.32	32
E142+65	439	195	2.50	1,097.50	592.71	1,690.21	3.85	54
A160+55	469	65	1.00	469.00	449.02	918.02	1.96	96
E148+54 ^{*1}	583	130 ^{*2}	1.33	775.39	0	775.39	1.33	N/A
A164+40	702	100	1.33	933.66	1,706.28	2,639.94	3.76	183
E115+12	732	1,080	3.00	2,196.00	718.43	2,914.43	3.98	33
E55+20	1,090	590	3.00	3,270.00	1,347.07	4,617.07	4.24	41
E155+00	1,214	420	3.00	3,642.00	1,400.95	5,042.95	4.15	38
E113+44	1,295	275	3.00	3,885.00	2,011.62	5,896.62	4.55	52
E56+88	1,339	422	3.00	4,017.00	564.03	4,581.03	3.42	14
A148+70	1,882	300	2.50	4,705.00	2,514.52	7,219.52	3.84	54
A147+10	2,249	270	2.50	5,622.50	1,993.26	7,615.16	3.39	36
E46+50	2,405	989	3.50	8,417.50	2,586.36	11,003.86	4.58	31
A163+00	3,652	256	2.50	9,130.00	6,858.41	15,988.41	4.38	75
	18,714	423	2.64	49,509.43	22,841.10	72,350.53	3.87	47

*1 Includes 130' drain *2 Push is downhill

Table 7 Rock Production, Distribution, and Placement

	Contract Costs				Non Contract Costs			
	Transportation				Quarrying			
Unit	Trans. Cost(\$) Per Site Bid	Trans. Cost(\$) Per Yd ³ Bid	Added*4 Trans. Per Site(\$)	Total Trans. Cost(\$) Site	Total Trans. Cost(\$) Per Yd ³	Quarry Cost(\$) Per Site *1	Quarry Cost(\$) Per Yd ³ *1	Total Cost(\$) Per Site
60		8.40	861.24	2,070.84	14.38	155.52	1.08	2,586.36
		8.40	448.57	1,078.57	14.38	81.00	1.08	1,347.07
		9.24	179.43	456.63	15.22	32.40	1.08	564.03
		8.40	669.86	1,610.66	14.38	120.96	1.08	2,011.62
		8.40	239.23	575.23	14.38	43.20	1.08	718.43
		0	0	0	0	0	0	100.00
		8.40	197.37	474.57	14.38	35.64	1.08	592.71
		8.40	466.51	1,121.71	14.38	84.24	1.08	1,400.95
		8.40	568.18	1,366.18	14.38	102.60	1.08	1,706.28
		6.61	2,535.89	5,340.49	12.64	457.92	1.08	6,858.41
		8.40	149.52	359.52	14.38	27.00	1.08	449.02
		8.40	837.32	2,013.32	14.38	151.20	1.08	2,514.52
		8.40	663.88	1,595.88	14.38	119.88	1.08	1,993.26
		\$7.59	\$7817.00	\$18,063.60	\$13.36	\$1410.00	\$1.06	\$22,841.10

3

st is not incorporated in Unit 83-1 costs.
tracting Officer.

Table 8 Regular Outslope (Cut and Fill)

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Reach	Contract Bid Cost(\$)	Contract Bid Cost(\$)/Yd ³	Total Yds ³	Linear Ft. of road	Yds ³ Per Lin. Ft.	Yd ³ Per Dozer Hr.
E16+30 -17+52	1,647.87	1.33	1,239	122	10.2	
E25+82 -35+00	2,064.84	1.21	1,707	918	1.9	78
E40+20 -45+64	2,542.00	1.22	2,081	544	3.8	110
E50+35 -54+73	623.00	1.00	623	352	1.8	
E105+50 -109+35	2,411.29	1.33	1,813	385	4.7	
E111+00 -124+70	3,519.18	1.33	2,646	1,198	2.2	
E142+85 -143+75	279.00	1.00	279	90	3.1	
E144+62 -145+70	512.00	1.00	512	108	4.7	
E146+65 -148+20	464.00	1.00	464	155	3.0	88
E148+88 -149+80	325.00	1.00	325	92	3.5	
E151+15 -153+65	607.81	1.33	457	250	1.8	
E157+10 -159+30	415.00	1.00	415	220	1.9	
E161+00 -161+50	83.00	1.00	83	50	1.7	
A157+00 -155+00	561.26	1.33	422	200	2.1	
S0+00 -3+00	301.00	1.00	301	300	1.0	
S3+70 -5+50	62.00	1.00	62	80	0.8	
TOTAL OR AVERAGE	\$16,749.25	\$1.22	13,760	5,253	2.9	95

Table 9 Fill Outslope

Reach	Contract Bid Cost(\$)	Contract Bid Cost(\$)/Yd ³	Total Yds ³ Local Cut	Linear Ft. Of Fillsite	Yds ³ Per Lin. Ft. Fillsite
E11+04 -11+62	31.92	1.33	24	58	0.4
E12+43 -14+10	95.76	1.33	72	167	0.4
E15+00 -16+30	418.95	1.33	315	130	2.4
E109+35 -111+00	432.25	1.33	325	165	2.0
E139+80 -141+65	203.00	1.00	203	185	1.1
E153+65 -154+65	136.00	1.00	136	100	1.4
E159+30 -161+00	1,252.86	1.33	942	170	5.7
A167+00 -164+72	1,267.49	1.33	953	228	4.2
A162+46 -160+89	855.19	1.33	643	157	4.1
A160+19 -158+00	585.00	1.00	585	219	2.7
A145+80 -143+00	44.00	1.00	44	280	0.2
TOTAL OR AVERAGE	\$5,322.42	\$1.25	4,242	1,859	2.3

Table 10 Total Outslope (Fill Exported)

Reach	Contract Bid Cost(\$)	Contract Bid Cost(\$)/Yd ³	Total Yds	Linear Ft. of road	Yds ³ Per Linear Ft.	Average Endhaul Distance	Yds ³ Per D-8 Hour
E10+55 -11+04	82.46	1.33	62	49	1.3	66	
E12+66 -12+43	57.19	1.33	43	27	1.6	99	
E14+10 -15+00	214.50	1.50	143	90	1.6	110	48
E35+00 -38+00	1,561.50	1.50	1,041	300	3.5	260	91
E59+20	530.00	1.00	530	109	4.9	50	
E124+70	225.00	1.00	225	60	3.8	50	
E143+75 -144+62	1,988.00	3.50	568	87	6.5	1,750*	
A158+00 -157+00	359.10	1.33	270	100	2.7	150	90
A146+56 -145+80	323.00	1.00	323	76	4.3	70	
TOTAL OR AVERAGE	\$5,340.75	\$1.66	3,205	898	3.6	150 ft.	87

*Original bid is based on distance of 4,646 ft. This entry not used for average.

Table 11 Bench Outslope (Fill Exported)

Reach	Contract Bid Cost(\$)	Contract Bid Cost(\$)/Yds ³	Total Yds ³	Linear Ft. of Rd.	Yds ³ Per Lin. Ft.	Average Endhaul Distance
E145+20	3,343.40	3.55	943	95	9.9	1,575*
-146+65						
E155+43	2,654.20	2.01	1,323	167	7.9	389
-157+10						
A151+30	2,904.17	1.38	2,109	235	11.7	180
-148+95						
TOTAL OR AVERAGE	\$8,901.77	\$2.03	4,375	497	10.1	261 ft.

* Bid is based on original distance of 4,488 ft. This entry not used for average.

Table 12 Crossroad Drains and Disaggregation

Reach or Location	Contract Bid Cost*	Contract Bid Cost Per Ft. of Drain	Contract Bid Cost Per Ft. of Road	Ft. of Drain	Linear Ft. of Road	# of Drains	Cost (\$) Per Drain
E17+52 -21+60	105.40	.62	51.47	170	408	3	35.13
E47+28 -50+35	133.92	.62	68.40	216	307	4	33.48
E63+55 -73+00	181.04	.62	39.68	292	945	5	36.21
E75+50 -105+50	1,155.68	.62	46.16	1,864	3,000	4	288.92
E128+00 -139+80	442.68	.62	113.18	714	1,138	9	49.19
E149+80 -151+15	96.10	.62	234.07	155	135	4	24.03
S3+70 -3+00	43.40	.62	95.71	70	70	1	43.30
S4+50 -7+00	126.48	.62	80.40	204	250	4	31.62
A155+00 -152+60	101.06	.62	87.50	163	240	3	33.69
A152+60	31.00	.62	N/A	50	N/A	1	31.00
Rock Pit	142.60	.62	N/A	230	N/A	1	142.60
TOTAL OR AVERAGE	\$2,559.36	\$0.62	\$65.64	4,128 ft.	6,493 ft.	39	\$ 65.62

* Bid Cost includes ripping road reach and placement of drains.

Labor Intensive Phase

Labor intensive treatments on Unit 83-1 were restricted to distribution and spreading straw mulch on much of the disturbed ground affected by heavy equipment treatment. All crossing sideslopes, outsloped areas, and fill-sites were covered with straw, applied at about 6,000 lbs per acre. Cross-road drain reaches were not covered.

Approximately 1,529 bales were spread at a total cost of \$27,931 (16% of project total). Bid costs amounted to \$22,935 or \$15 per bale while the work was subcontracted to Jack Naylor at \$3.50 per bale. Direct profit to the primary bidder, then, accumulated to \$17,583. Although this profit may be re-distributed to other unit costs, the task, although viable, is beyond the scope of this report.

A record shows Mr. Naylor spent about 276 hours at the site, distributing and spreading about 5 1/2 bales per hour on the average. At this rate, the subcontractor was averaging \$19.25 per hour. A motorized bale carrier was used to assist in distribution of bales.

Conclusion

Unit cost analyses presented in this report are of a cursory nature. Unit costs developed from bid prices fail to incorporate complexities caused by overcompensating in the bid schedule, on the part of the contractor, for bid items where: 1) evaluation of a worksite is beyond his expertise, or 2) the work is subcontracted, or 3) costs vary from the anticipated range for unknown reasons.

Comparisons made to rental rates depend on equipment work hours supplied by the contractor. In 83-1, these are known to be suspect in terms of accuracy, or are based on owner operated equipment whose application differed from that of equipment leased by the contractor.

Overall, contract application was appropriate to Unit 83-1; more so than to sites that involve off-road prescriptions. Long reaches of outsloping and relatively easily defined stream fills lend themselves to the contract format developed in the past years at Redwood National Park.

Problems with contract implementation may also influence cost effectiveness on future rehabilitation units. These problems are difficult to evaluate by normal methods, and can lead to significant expenditures.

Post script

A post equipment evaluation of Unit 83-1, as seen in spring 1984, shows that the site is experiencing minor thalweg adjustments at excavated stream crossings, and virtually no sidebank failures. Rock aprons seem to be effective in creating stable knickpoints in low and moderate gradient channels, although high gradient channels are more difficult to "key in" during placement.

The evaluation also showed that mass movement had not accelerated with rainfall accumulation, as it had in past years. Visual impact of long reaches of outsloped road will, at the very least, add to the aesthetic appeal of Devils Creek Basin in the future.

Appendix 1

THE SYSTEM: Part I

Outsloping and XRD

By Ed Wosika

November 30, 1982

THE UNIFIED ROAD OUTSLOPING SYSTEM

Introduction

For some time now, the lack of adequate road outsloping prescription techniques has led to a dearth of outsloping data in our reports. Until now, the only alternative has been to survey and draft a complete road cross section for every 100 feet of road to be outsloped. This took too much time and yielded poor quality control (complex grade checking procedure), but did yield useable data. Thus the choice was between doing a job by "feel" (and having poor grade control) or spending too much time (and still having poor grade control). Some choice! It is little wonder that the first choice was taken in most cases. The following method gives all needed parameters with only one measurement and required only a single two minute visit to each cross section. This method, hereafter called THE SYSTEM, was developed empirically from the Y-Line outsloping data.

Outsloping Types Treated

The 3:1 outsloping done on the Y-Line is used as a standard in THE SYSTEM. This is termed Type I outsloping. In addition, a 2.3:1 outsloping style (Type II) is included for those places requiring the steepest practical outslope. Both of these types assume that: 1. a -40° fill slope is typical; 2. a $+45^\circ$ cut bank; 3. the expansion ratio is around 1.5:1. These values were attained by averaging many Y-Line cut bank and fill slope angles. The range of these values was surprisingly small. Type I outsloping should suffice for at least 90 percent of all outsloping you will do.

Occasionally a road will have a much steeper or shallower cut bank angle. These cases are handled by Type III outsloping. The following cutbank angles cover all normal situations: 20° ; 33° ; 45° (Types I & II); and 75° (Type I only). These angles were chosen because smaller gradations yield no significant change in the resultant data. For example, Type I data works well for CB angles of from 38° to 60° . Just choose the angle that most closely compares with your cutbank's angle, then use the Type III nomogram to get your correctional coefficients to apply to your standard Type I or II data (based upon the same road width). This method is quite accurate, but remember that 10 to 15 feet to either side of your road station, the angle will be different, so use Type III only when a pronounced and consistent difference from the standard (45°) angle occurs (CB angle is more than 60° or less than 38°).

Once in a while it is necessary to choose a non standard fill height (i.e.: cutbank is not tall enough; springs halfway up the cutbank; incised gully mouth part way up the cutbank; etc.). Type IV outsloping provides for a range of fill heights of from 25 to 128 percent of the standard Type I fill height for your road width. Again, choose the percentage that most closely approximates the desired height, then use the Type IV nomogram to obtain your prescription and performance correctional coefficients.

The Nomogram Sheet...How To Use It

Type I Standard Outsloping:

Use the lower graph line of the Type I & II nomogram (reads "Type I - 3:1"). Measure your road's width, then find that value on the abscissa (use nearest 5 feet interval or interpolate... instructions are for 5 feet intervals). Lets say your road is 20 feet wide (from IBD to outer edge of fill slope). Follow the vertical line up to the Type I graph line. To the left, along the faint solid line is your road reading from a 5 feet HI (instrument height). The value is 10.6 ft. The rod man (Phill. Road) holds the rod on the road C (centerline), while the instrumentman moves up the cutbank until a level shot reads 10.6 feet on the rod (height of center of clinometer is 5 feet above ground... monopod adjusted accordingly beforehand). Once the indicated height is surveyed in, place a stake reading "Fill To Here" (FTH) at the location of the monopod base. The notes need only contain: 1. the road station number; 2. the road width; 3. the type of outsloping; 4. and the rod height. The note should look like this "(200 ft.) (I) FTH @ Sta 21+36 -- rod = 10.6". The following parameters can be done (with the nomogram) back in the office: finished slope length (parameter 1) is 33 feet.; cut and fill (resp.) are 4.8 ft. and 5.6 ft.; volume factor is .778 yd³/foot of road; the D-8 should proceed at 113 ft. of road per hour; for 6,000 pounds of straw per acre, you will need 6.5 bales/100 ft. or 15 ft/bale (data for 4000 ppa is 4.3/100 ft. or 23 ft/bale). Thus all needed data, plus stake positioning is achieved through a single, easy measurement (road width).

Type II - Heavy Outsloping:

Heavy outsloping is rarely needed, since Type I outsloping is already fairly heavy. However it is laid out exactly like the Type I model. Measure your road width as usual, but use the upper graph line (titled "Type II-2.3:1") to obtain your stake placement and prescription data. Note that the faint horizontal reference lines for Type II are dashed, while those for Type I are solid. The same road reading scale is used for both types, but parameters 1 through 6 are on the right side of each vertically scaled parameter line for Type II and on the left for Type I. These are two separate scales placed back to back, not one continuous scale. The scale on either side give values only for even 5 foot road widths. Intermediate values must be interpolated, but the vertically adjacent values are close enough in value that one need only do an eyeball interpolation (or easier yet, just choose the closest one).

Type III - Non Standard Cut Bank Angles:

This should be used only when necessary, as previously described. For the field portion, set your stake just as you would for a standard Type I or II outslope, but label it "III: X° C.B.; II base)" or "(III: X° C.B.: I base)" in your notes, depending upon whether you are using a Type I or II base model (X° = either 20°, 33°, or 75°, whichever is closest). In the office, use the "Type III Coefficients" nomogram (in upper left corner of sheet) to find your correctional coefficients. Note that the coefficients used depend upon which base you are using. For example, if you want a Type I profile base, but have a 20° cut bank and a 20 ft. wide road, your prescription data would be found as follows (Type I data for your road width is multiplied or divided by the appropriate 20° coefficient):

(20° coeff. for Type I param. #3, & 4 = .787)

$$Yd^3/ft \text{ of Rd.} = .787 \times .778 = .612 \text{ yd}^3/ft$$

$$D-8 \text{ speed} = 113/.787 = \underline{144 \text{ ft/hr}}$$

(20° coeff. for param. #1, 5, & 6 = 1.21)

$$\text{Finished slope length} = 1.21 \times 33 = \underline{40 \text{ ft}}$$

$$\text{Straw (6,000 ppa)} = 1.21 \times 6.5 = \underline{7.9 \text{ bales/100 ft}}$$

$$\text{Bale Separ. (6,000 ppa)} = 15/1.21 = \underline{12 \text{ to } 13 \text{ ft.}}$$

(20° coeff (I) for slope = 1.50; always multiply by the constant 3.00 regardless of base I or II)

$$\text{Slope} = 1.5 \times 3.00 = \underline{4.5:1}$$

(20° coeff for (I) cut = .649)

$$\text{cut} = .649 \times 4.8 = \underline{3.1 \text{ ft.}}$$

$$\text{fill} = \text{same as Type I} = \underline{5.6 \text{ ft.}}$$

Type II data may not be used as a reference base for cutbanks much steeper than standard (45°), since the finished slope would be extremely steep. Thus there are no listed coefficients in the Type III nomogram for 75° cutbank.

Type IV - Non Standard Fill Height (it happens even in the best of families):

This variation is handled in just the same way as for the Type III, using the upper nomogram, but referring to the ordinate on the RIGHT side (titled "Cutbank (% of Type I height)") and using the coefficients on the RIGHT side of the (vertical) coefficient scales. Only a Type I data base may be used. Choose the height of fill you want and place a "Fill To Here" stake there. Record all the normal data in your notebook, but label it "(IV: X%)". Remember that X% is the percentage of your normal FILL HEIGHT (not rod reading).

$$X\% = ((\text{rod reading} - 5^0)/\text{Type I fill height}) \times 100$$

Choose from 128, 75, 50, or 20 percent (whichever is closest to your actual percentage) and enter the Type IV nomogram with the percentage. [For your information, Type I = 100% and Type II = 155% of the normal fill height for your road's width.] For example what if you had a road station where springs were emerging 30 ft above the road surface and your road was 20 feet wide.. (you are in an outsloping reach and do not want to get fancy by changing to a short XRD section). Place the FTH stake at the base of the springs and shoot a rod shot from that location. The road reads 80 ft., so fill is $8-5=3$ feet. Notebook reads:

"(20' rd)(IV: %) FTH @ Sta 36+24 ---rod=80 --springs on CB"

Office work:

$$\text{fill height} = 8-5 = \underline{3^0 \text{ ft}}$$

$$X\% = (30/20' \text{ Type I fill ht}) \times 100$$

$$= 3.0/5.6 \times 100 = 53.6\%, \text{ so USE } 50\% \text{ (fill in blank space in notes to read "IV:50\%")}$$

$$Yd^3/ft = .461 \times .778 = .359 \text{ yd}^3/ft$$

$$D-8 \text{ ft/hr} = 113/.461 = 245 \text{ ft/hr}$$

$$\text{Slope Length} = .790 \times 33 = 26 \text{ ft}$$

$$\text{bales (6000 ppa)} = .790 \times 6.5 = 5.1 \text{ bales/100 ft}$$

$$\text{bales sep. ("')} = 15/.790 = 19 \text{ ft.}$$

$$\text{slope} = 1.67 \times 3.00 = 5:1$$

$$\text{cut} = .494 \times 4.8 = \underline{2^4 \text{ ft.}}$$

$$\text{fill (you already know)} = \underline{3^0 \text{ ft.}}$$

Type III/IV Combinations:

The Type III and IV coefficients can NOT be multiplied together to estimate the data for (say) a cross section with a fill height of 50 percent of normal and a 20° cutbank. Just pick the type which most closely approximates your cross section and go with it...it will be very close to the actual values derived from laborious surveying.

Uses Of The Data

Obviously it is essential to know how much fill will be moved and what the completed profile will look like, but some less obvious uses are quite valuable. The D-8 ft/hr data is based on a very conservative 88 yd³/hr figure (our average value on the Y-Line was 105 yd³/hr), so if your operator does less than the predicted rate of progress, then he is really flakey and you can not only prove it, but tell him how much faster percentage wise he will have to work in order to just qualify. If you do have trouble with an operator, the contracting officer will appreciate having some hard data to work with... hopefully it won't be necessary, but at least now we are prepared. You can accurately predict the amount of straw you will need and prescribe its spacing and stockpiling locations. The newly designed straw carrying poles permit you to stockpile the exact number of bales needed at either end of each outslowing section (no lugging bales up cutbanks anymore) and have them carried in AFTER the work. Placement is quicker than with the old method, plus you may outslope as steeply as desired, without reference to difficult bale placement.

Why "Fill To Here" Stakes?

Many factors effect the actual resulting outslope parameters, and not all factors work in the same direction (some are mutually opposing). FTH stakes are the only way to go since setting the elevation of the top of the fill results in the least variability. For example, if the expansion ration is 1.8:1 (assumed value of 1.5:1 yields a 3:1 outslope), then a slightly less steep finished slope will develop. The amount of overspill is also minimized on contracts, since the operator knows he needs to place as great a percentage of his dirt as possible in the fill area (CB), since any overspill simply means he must dig deeper to bring the fill up to the prescribed level and produce the required straight slope. The stakes are highly visible to the operator and do not tend to be destroyed during excavation.

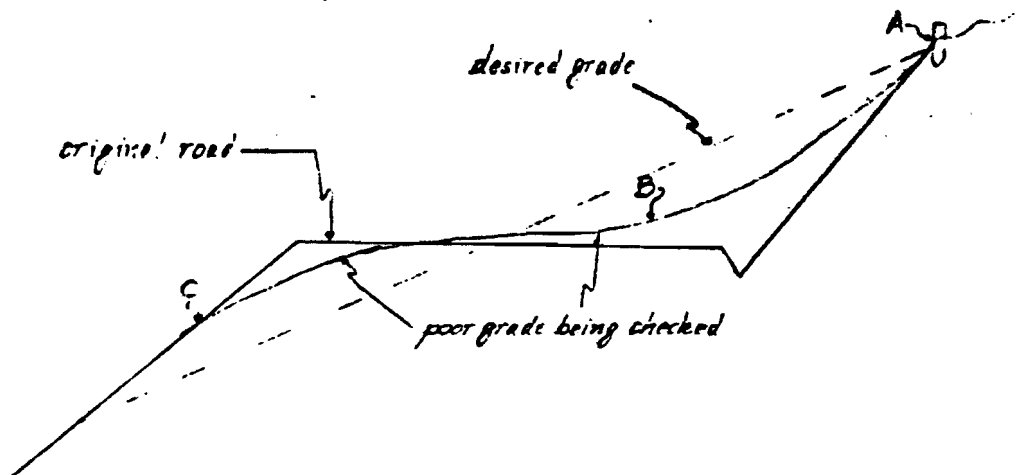
Grade Checking

Only a clinometer is necessary for grade checking. Look down the road $\frac{1}{2}$ of a newly completed outslope section. If the slope is a straight line and the fill reaches the bottom of the stakes, no further checking is necessary (no post survey either). If the profile is either concave or convex up, or has a horizontal "S" shape, then check as follows:

1. Stand at the top of the fill and shoot eye-to-eye with someone standing in the non-straight part.
2. Shoot another eye-to-eye shot with the helper at the outboard edge of the fill.

3. If the two angles are equal, O.K. If not, the operator has made an error and should redo his work (free on a contract but more expense for rental equipment).

The tendency is to produce the following profile:



Obviously the shot from point A to B and C will show the degree of error. Once an operator knows you watch for this, you will have no further problems especially on a contract. Do not be concerned with the final slope angle, only that it is a straight slope, and that the fill reaches the base of the FTH stake.

Road Stations

Road stations are essential to outsloping calculations and save a great deal of time in general layout of all prescription types used (crossings, fill sites, etc.), since road distances never have to be measured again and locations can be accurately located on all rehabilitation sites. The access route to all off road worksites can easily be controlled by merely stating the station number of the access point and the distance along the route chosen, then flagging the route off the road. This means that even slope crossing locations can be succinctly described (contract or no contract).

To facilitate the layout of station laths, I have ordered a rough-country style Roll-O-Tape wheel. One merely zeroes the device at the beginning of work (station 0 + 00) and drops a numbered station lath at every indicated 100 ft (i.e.: station 53 + 00 is 20 ft more than a mile from the beginning and is the 54th lath from the start). The laths are then placed well up the cut-bank. The process is worth the effort. Anyone (laborer, visitor, VIP, veggie, etc.) can find any specific point on such a rehabilitation site without even having a site map. This is extremely helpful when you have a crew of laborers placing straw, as you can vary your bale separation prescription very easily... just give the crew leader a list showing the number of feet between bales for all strawed section by station number. The "Veggies" have found that the station laths provide them with a valuable set of reference points in laying out the planting prescriptions and contracts, especially when adjustments must be made later due to the number of plants available. The usual arbitrary worksite naming system is very unwieldy. I encourage you to upgrade to the use of station laths (as if you hadn't guessed).

D-8 Techniques

Outsloping with a single D-8 ripper cat was tried successfully on the Y-Line. In fact D-8's did roughly 80 percent of all the work. To begin an outsloping section, the cat cuts out a divot approximately five feet deep at the outboard side of the road. Starting from the bottom of the divot, the cat outslopes the road as follows:

1. A cut is made along the outboard edge (leaving no berm) until the resistance of the non outsloped portion is felt. This cut is made at around 1/2 throttle, and the blade is canted slightly toward the outboard side of the road. This spills a small amount of dirt...no problem.
2. A laterally cutting turn is made, using the power of the outboard track alone, until the cat is facing 45° inboard across the road. The cutting turn takes off between .5 and 1.5 feet, giving 1/4 to 1/3 of a blade full.
3. The cut proceeds along the 45° inboard angle (uphill) taking off 1 to 1.5 feet of the berm with each pass. This is done at full throttle. The material is dumped on the cutbank from the top of the material piled there from previous cuts, so that the majority of it falls into the inboard ditch. Thus the fill pile leads the outboard cut and both proceed at equal speed down the road. The blade should be completely filled by the time it reaches the top of the fill pile on each pass.
4. The cut is made deep enough so that the fill pile ends up at the prescribed level. Only a single pass is necessary, no having to go back and "take some more off to reach grade". No berm is permitted at either the top or the bottom of the slope. The top of the fill pile is faired into the native ground, and the small berm (usually non existant) at the base of the cut is pushed over the edge. Proper technique eliminates the need for this later step.

This technique works on virtually any width of road. If a large buried stump is hit along the outboard edge (or a live tree you wish to save), then the process is merely begun again on the far side, after which the cat can attach the fill inboard of the stump/tree from the other side. Quite a few stumps/trees were encountered along the Y-Line. The 88 yd³/hr figure used in making the nomogram is conservative, even considering these obstructions (any operator that is not slacking off will beat this figure).

The Case Of The Killer Cutbank (or how to avoid getting a monopod stuck where it will do you the least good)

THE SYSTEM requires that the top of the fill pile be marked, but not necessarily with a stake. In many cases, cutbanks are too steep or dangerous to climb, usually where outsloping is needed the most (this is a hydrological corollary to Murphy's Law). In that case:

1. Find the AVERAGE cutbank angle (θ) by placing a clinometer on your surveying rod (which is placed at the IBD and held to the visually average angle).

2. Using the measured road width, find the appropriate FILL height (parameter 2-denominator) for Type I only (if it is too steep to climb, then it is too steep for a Type II). This is value F.
3. Measure back 100 from the base of the cutbank and take a shot on the cutbank (using a 50 ft HI) using the positive angle θ (derived below):

$$\theta = \tan^{-1} ((F-50)/(100 + (F/\tan \theta)))$$
 The point intersected on the cutbank is the top of the fill (see me for derivation, if desired).
4. Mark the top-of-fill location using a standard forester's paint pellet pistol (extremely accurate to 50 ft.). Mark only solid objects that are dry. I have one of these on order.
5. Place a "Fill To Mark" (FTM) stake at the base of the cutbank. Carry several of these along with your standard FTH stakes. During inclement weather, merely record the FTM, road width, desired fill height, and asterisk it (means "incomplete field work"). Figure the angle in the office, then fire the marks on the next sunny day. Simple!

Putting It All Together (or have you hugged your plan sheet today?)

The sample blueprinted plan sheet gives examples of every type of outsloping prescription, plus a sample reach of cross road drains (XRD), showing the preferred format. Note #5 shows typical field notes for cross road drains. Of course, all notes are made directly on the plan sheet. The use of surveyed stations, plus this plan sheet layout greatly reduces the volume of notes required and automatically organizes the work by station number. Notes #1 & 2 show how field notes are made in outsloped road sections and include a sample equipment speed check. All checks should be made on a yd³/hr basis, since that parameter automatically excludes speed variations due to road width. The parameter "D-8 ft/hr" given on the nomogram is useful only for quick and dirty speed checks on short road sections of uniform road width. Its main use is to calculate the total predicted D-8 time between FTH or FTM stakes. Good speed checks usually involve the length of road covered by at least two stakes (merely add the yd³ and divide by the time used then find the percentage of 88 yd³/hr).

For becoming familiar with THE SYSTEM, concentrate only on the section covered by Notes #3 & 4 (Sta. 95 + 31 to 110 + 80). All cross sections in this reach have the same road width, but the cut bank's angle and the fill height are varied. Read this entire report, then practice working THE SYSTEM until you can easily derive identical answers for all the parameters in this section (see me if you have any trouble). At that point, you are ready to apply it to your own site. Note that a full mile of OS prescriptions fit on a single plan sheet!

Many plan sheet arrangements have been tried. The one shown is by far the best. Here's how it is done and why:

1. Plan sheet layout is from bottom to top, starting with the left page half, then up the right page half. This arrangement places "upstation" (higher station numbered) cross sections progressively further away from the reader, mimicking their sequence in the field during work. Vertical spacing on the sheet is .6 inches between lines (minimum), as shown.
2. Cut and Fill as well as Slope and Slope Length describe the values at that station only, so their values are always taken directly from the nomogram. All other values describe the area between that station and the next one downstation. Thus the cut/fill (C60 / F70), slope and slope length (3:1 & 41 ft. = standard therefore not shown on plan sheet) at station 56 + 00 apply to that location only, while the other values (vol/time = 122 yd³/1.4 hrs; 8 bales @ 120) refer to the area from sta 55 + 00 to and including sta 56 + 00.
3. If the road width values at two successive cross-sections differ by 10 feet or less, no double end area (DEA) work is necessary. Just read the values from the nomogram and derive your figures, based upon the road reach length. If more than 10 ft. (rd. width difference between cross-sections) then all values (excl. cut/fill & slope/slope length) are averaged (DEA) with those of the preceding station. Then derive the reaches figures based on the road reach length.
4. For non-DEA cross section pairs the separating distance (ft.) is placed between the two station numbers (see blueprint). For DEA reaches (> 100 ft width change), it is listed in the left margin between the lines of station data and preceded by "DEA=". This convention is extremely helpful for telling you at a glance the separation (avoids subtraction) and whether or not it was a DEA reach or not. Straw bales in a DEA reach must NOT be equally spaced, so the bale separation value is replaced by "space bales for even cover". The laborers can eyeball the spacing (avoids a ROYAL PIA geometric progression for each DEA reach= prescription overkill).
5. Cross sections are located 100 to 160 ft. apart or at major break points in either road width or CB angle, thus the maximum spacing is 1600. This maximum represents a good balance between the opposing desires of max. equipment operator guidance and min. cross section frequency. If cross sections are not placed at obvious road width break points, then all volume, time, and straw values will be way off.
6. Box in all summation data, special notes and changes of prescription type on the plan sheet. The LAST cross section in a reach of OS road should be placed 10 to 30 feet downstation from the end. Its volume, time, and straw values cover from the previous (downstation) cross section through to the end of the OS reach (calculate in two sections if the end tapers to no cut as a wedge or to a point then add the values). [The volume, time, and straw values cover clear through to the end, rather than just between stations.] The FIRST cross section in a reach is placed 10 to 30 feet from the start, and the values represent the road reach to that point (not beyond). Useful factors for doing DEA calculations required at both ends of an OS reach:

- a. if OS tapers to zero cut/fill like a pyramid (i.e.: Δ to XRD): $1/3 \times \text{vol.}$; $3 \times \text{speed}$; $1/3 \times \text{bales}$ (bales spaced by eye for even cover),
 - b. if OS tapers to a wedge (i.e.: to and from "total OS"): $1/2 \times \text{vol.}$; $2 \times \text{speed}$; $1/2 \times \text{bales}$ (bales spaced by eye for even cover),
 - c. OS remains full section (i.e.: to and from DD or crossing): all values same as nomogram...no DEA needed.
7. Single underline the prescription type (I, II, III, IV, FTH, FTM) and the station number. Place two more lines under all non standard prescriptions (II, III, IV, FTM, ODD SLOPES AND SLOPE LENGTHS). List odd slopes and their lengths (Types III & IV only = ones not found on the main nomogram).
 8. Cross road drain prescriptions need only list the station at the IBD end, the length, and the grade (shoot eyeball to eyeball from both ends using clinometer). Indent all XRD prescriptions from the left margin used for OS prescriptions (make them easy to find on the plan sheets). Special XRD cross sections can be specified easily on the plan sheet or in the technical specifications (contract).
 9. "Width Of Road" = the level distance from the IBD across the traveled roadway to the point on the outboard fill edge where the mean plane of the fill slope intersects the horizontal extension of the roadway plane (done by eyeball, or with the assistance of a hand level or clinometer). One person holds the tape reel over the IBD $\&$ at an elevation permitting the tape to be stretched level to the outboard edge, while the other person (carrying the tape end) steps over the edge, onto the fillslope and positions the tape end at the planar intersection described above. The IBD person reads off the value. The elevation of the outboard edge of the road (rel. to the roadway) will vary from cross section to cross section, but it all averages out in the long run. The only alternative (: full survey; drafting; planimetry; slope stake marking and organizing; extra trips to the field to set stakes; long involved calculations; etc.) is totally incompatible with our work load, but it can be done on those rare cross sections where THE SYSTEM just won't work.

Advantages Of THE SYSTEM (road OS and XRD)

1. Yieldstruly professional plans for either contract or in-house work.
2. Your work can be carried out by anyone familiar with THE SYSTEM, should you and/or your assistant be incapacitated just prior to contract or in-house rehabilitation. This is not possible with the "I have it in my head and spread through two notebooks" approach which also precludes contracting as an option.
3. NO DRAFTING!!!
4. All required parameters are available from a single easily attained measurement (in most cases, but never more than two).
5. DEA calculations are minimized.

6. Accurate field checks of D-8 performance are done quickly on site while the heavy equipment is there to remedy it, assuring high performance relative to both speed and grade.
7. Long, tedious note taking is minimized, since all notes are made directly on the plan sheets. Extra notes (where necessary) can be written on the back of the plan sheet (reference required on the plan sheet face).
8. All prescriptions, field notes, etc., end up as a single package automatically organized by station number, greatly facilitating report writing and providing a complete, legible, permanent record for future study by yourself or any interested party (useable even if you are no longer working here).
9. There is no significant difference between plan sheets for in-house and contract work. Contracts are far easier to manage (given quality plans like these) than in-house work is to perform. [Why do it the hard way? Since the plans give you excellent control, with no loopholes, contract work is by far the best choice.]
10. Bid control of contracts is maximized, since the bidder knows how long you would take to do the job. He knows that your cost will have to be beat if there is to be a contract, since this is stated clearly and prominently in the contract (standard clause permits the government to ignore any or all bids which exceed the in-house cost...this is usually buried in the "boiler plate", so you state it clearly in a part of the contract that the bidder will read: the technical specifications). All bidders will read the T.S. section, since otherwise the whole contract reads like Greek (pardon me, Greg). A suitable statement would be: "The time specification for D-8 work given at each outsloping cross section is not binding upon the contractor. It is provided for the convenience of the government in case the work must be done in-house. The government reserves the right to ignore bids whose total cost exceed the projected cost for in-house work. In the event that no qualified bidder can beat the in-house cost, then the contract will be eliminated and the work will be done using rental equipment." All intelligent bidders will immediately get to work organizing (probably) a coalition of equipment owners whose equipment is sitting idle or is paid off. The bid base for such equipment will have a much lower \$/hr value than any available through the park's equipment rental program, yet the contractor can still make a good profit. [The best cat skinner on my site had been out of work for 1 1/2 years...think of the incentive to the owner/operator to bid low!] This does NOT exclude the use of rental equipment or hired operators, it merely takes advantage of the free-market principle of focused free competition. The money saved by this type of approach can fund additional in-house work, especially if a number of sites are done by contract method.
11. Plan sheets are merely transcriptions of field notes and Nomogram data into a standard, functional format, providing far better organization and using less time than any presently used system (and a ten times speed increase over my old system).

12. THE SYSTEM requires only a two person crew (although its development required a minimum three person crew).
13. The normally onerous task of supervising straw placement and spacing (for in-house work) is eliminated, since a simple list can be typed up directly from the plan sheets specifying "Between Stations" (distance not necessary, just station numbers), "total bales", and "spacing". Space is provided (blank columns) on the list to note "time (person hours) to drop off/date", "emplacement time/date" (covers time used to carry bales onto finished OS sections), "spreading time/date". Another column leaves space for crew make-up (RNP, CETA, RWU), and total hours worked. You merely make up the beast to give you all the data you will want (see sample), so that the labor crew leader has only to fill in the blanks each day. The columns are bracketed by station number for each work type each day, providing an accurate depiction of work accomplished (helps control goofing off, as the work MUST be done in order to be checked off). The crew leader is then required to give you a verbal report on his progress weekly, plus a copy of the list at that stage of completion (provides record security). This trick greatly increases the time available for your other work during the rehabilitation season. Giving the responsibility of the straw work to your laborers tends to help build morale and esprit de corps. Any goofing off is immediately obvious from the records they themselves must keep. Since record falsification would be obvious, it will not occur. Of course this is all unnecessary if a contract is used, as the contractor does the straw spreading. A standard bid item on all contract will be the recordkeeping of such things, as described by you in the technical specifications.
14. When THE SYSTEM is used by everybody then actual cost comparisons are possible since wide ranging variations in techniques and format are eliminated. The disturbing lack of "yd³/ft", "\$/yd³", and "D-8 ft/hr" data is also eliminated.

All 98 bales for sta 52+80 to 63+20 are stashed at sta 52+60

Stash: Date _____ hrs/worker _____ Crew: RNP _____ CETA _____ RWU _____

Note: "SEC"=space for even coverage

Station Number	# bales	feet between bales	PLACING hrs per worker/ # workers			Date	Begin and End Time	SPREADING hrs per worker/ # workers			Date	Begin and End Time
			RNP	CETA	RWU			RNP	CETA	RWU		
52+80-53+00	1	middle										
53+00-53+90	8	SEC										
53+90-55+00	11	10'										
55+00-56+00	8	12'										
56+00-56+50	5	SEC										
56+50-58+00	27	5'-6'										
58+00-58+38	5	SEC										
58+38-59+54	9	SEC										
59+54-61+00	9	16'										
61+00-62+50	12	12'-13'										
62+50-63+20	3	20'										

Notes on this section of strowing: _____

Timekeeper _____

signature _____

Well, here it is folks.... the rest of THE SYSTEM. Remove the draft of section II from the jacket I gave it to you in and replace it with this final stuff. Relable the jacket "Parts II and III". You will want to read the new section on total outslaping (end of Part II) and all of Part III.....if not, do it anyway as there will be a meeting within a week to go over how this thing works and give examples and answere questions people might have. Please turn in to Ken the best day for you (next week) for this meeting, so he can schedule with the greatest convenience for everyone. Over half of ~~the~~^{the} site for this year has been finish-prescribed using this method. By the end of today, the plan sheets should be ready for all work surveyed so far.....all ready for contract. Its fast and gives all the data you could plsibly need.

Thanks a bunch.....

Ed

THE SYSTEM - - - PART II

Determining the Extent and Volume of Endhailed Excavations (Stream Crossings
and Total Outslopes)

by

Ed Wosika

INTRODUCTION

Estimates of volumes to be excavated then endhauled by blade or truck (20 feet or 20 miles) are critical, since these yardages will have by far the greatest unit cost on your site. In addition, both the extent of excavation and the extent and type of fill site must be planned. Normally one does preliminary surveying of the excavation site and the proposed fill site, then drafts it up to find the volume, plus the vertical and horizontal distance to grade from a given datum reference line (stream for crossings; IBD for total out-slopes), and the carrying capacity of the fill site (hopefully it is big enough, if not then an additional trip is necessary). Then (on the second trip to the site), the excavation and fill site are flagged and/or staked. No specific prescriptions can be given to the adjacent treatment areas until all this is done, since you can't know where the excavation and fill site begin and end till the paper-work is done. This leads to the inefficient practice of surveying and laying out all the excavations and fill sites first, then working on the areas in between (OS & XRD reaches). With all these trips to the field, much can get lost or left undone, as the process is so disjointed. With a given budget, you don't know how much your project will cost until it is all done; usually the final estimate is in excess of the available funding so you start cutting back. It is a wonder we don't get ulcers! What if you could lay it all out on the first trip to the field, so that you knew the lateral limits, depth, channel gradient, and volume of a crossing, so that you knew the finished grade and volume of a total out-slope, so that all stakes were set and all in place and all that was left was to put it on the plan sheet? If that could be done, then you could proceed down the road completing section after section for all prescription types in the order they will be done by the equipment. A concurrent running total could be kept of estimated costs, so that the prescription work could be stopped right at the point where the budget runs out. This would greatly add to the time available for other needed work in preparation for the equipment season. After all, why prescribe way ahead until all is ready for this season's work? The number of field trips would be lessened too. THE SYSTEM -- PART II enables you to do all of the above. The first section covers regular stream crossings, while the second section treats total out-sloping.

Deep Dishing Stream Crossings

The Deep Dish (DD) style of stream crossing was developed so as to standardize the stream crossing prescription, and to provide a cross section that was compatible with high production volume equipment (big cats). It has proven itself to be adequate for most applications and yields an exceptionally low unit cost. Standardizing the cross section permits us to predict all relevant parameters fairly accurately without preliminary surveying and office work.

Nomogram sheets 2 and 3 cover Type I and Type II deep dishes, respectively. The cross sections for these are shown on the accompanying blueline sheet (Plate I), at a scale of 1 inch = 10 feet (use 10 scale). Type I can be used bare for watersheds covering up to 20 acres (maximum channel gradient = 30%; 1 foot maximum flow depth for $T_p = 25$ years; maximum mean flow velocity = 1.5 feet/second) and if rocked, for watersheds up to 150 acres (any channel gradient that will

hold rocks; 3 foot maximum flow depth on top of 1.5 foot rocking depth; 1.5 feet/second maximum mean flow velocity assumed, though higher is okay). Its form in cross section is merely 2:1 side slopes tangential to a 30 foot vertical radius channel bottom. Type II deep dishes have the same form as Type I, but the 30 foot radius bottom has been split in the middle and separated (widened) by 10 feet. These can be used bare for watersheds up to 43 acres, or rocked for watersheds up to 260 acres (same assumptions as for Type I).

The cross sectional profile is designed to centralize low flow as well as to provide an easily attained shape for a D-8 working by itself (no excavator). Flat bottom channels are absolutely out, since they encourage lateral cutting and thus sidebank instability and erosion. An excavator is only needed in those crossings where the working area at the lower end is too restricted to maneuver the big cat, or where water problems are expected. In most cases where an excavator/loader (or excavator/cat) combination is needed, it only has to handle around 10 percent of the crossing volume, and can be restricted to work around the outlet. Really wet crossings must be handled as the situation dictates. Formulas for estimating equipment time are given on the back side of Nomogram Sheet #2. These two Nomogram Sheets (#2 and 3) are designed to give you a close estimate of critical crossing data in the field. They do not take the place of the normal office calculations of width, volume, etc. They do permit you to continue with finish staking and prescription work on down the road, so that the office work can be done in large station-sequential batches, rather than piecemeal. Speedy volume calculations (in the office) are facilitated by Plates I and II. If a different cross section is desired for general use, then you will need to make up your own nomogram. Be warned, though, that each sheet requires the calculation of all parameters for over 100 separate crossings!!

Before doing prescription work, determine the contributing area for each crossing you will have, then decide which style of crossing is most appropriate (Type I or II DD). In the field, decide where the top and bottom of the excavation will be. Place wooden stakes labeled "Top of DD" and "Bottom of DD" in these locations, respectively. In line with this but well outside the limits of excavation place your Upper and Lower End Stakes (ues and les, respectively). Preferably these are made from brightly painted 1/2" rebar. Do your tape and clinometer longitudinal profile as usual, noting the location of these four stakes. In addition, also obtain the following data (circled and labeled), by shooting from the at the outboard edge of the road: (1) D_{10} = number of feet of slope distance rod-to-rod (rtr) to the base of the "Bottom of DD" stake; (2) θ_{10} = negative angle of D_{10} ; (3) D_{h1} = number of feet of slope distance (rtr) to the base of the "Top of DD" stake; (4) θ_{h1} = negative angle of D_{h1} . Enter the appropriate Nomogram Sheet (I or II) as follows. The sheet is divided into 9 separate sections, arranged in three columns and rows. The columns of sections increase in θ_{10} value to the right, while the rows increase in θ_{h1} value down the page. Find the section that pertains to your crossing, then find your D_{10} value on the ordinate and follow it across until you are on the column corresponding to your D_{h1} . Your four data values are shown there:

Volume (yd ³)	Width/2
Max. depth	channel gradient (%)

Interpolation for intermediate values (if needed) is done as follows:

[1] Within a given section (of the 9 shown), direct interpolation is possible between vertically, horizontally or diagonally adjacent values. The greatest differences are between columns (usually a 2X difference), so this is the most commonly needed interpolation. A simple linear interpolation (or even a visual estimate thereof) is usually close enough; [2] between sections horizontal, vertical, or diagonally adjacent sections) interpolations are handled in the same way as in [1]; [3] for combinations of [1] and [2], first determine the value within each section, then between sections. Option [3] is seldom needed. Accuracy of the nomogram is $\pm 10\%$ for "normal" crossings.

In cases where θ_{hi} and D_{hi} cannot be determined directly due to absence of a direct line of sight (i.e., depth of inboard fillslope causes the road to occlude a direct shot), obtain the road width (R_w), then stand on the $\mathcal{C}$ at the inboard edge of the road and shoot the slope distance and vertical angle to the "Top of DD" stake, obtaining values D_ϕ and ϕ , respectively. Find θ_{hi} and then D_{hi} using the following formulas (need calculator):

$$\theta_{hi} = \tan^{-1} [D_\phi \cdot \sin \phi / (D_\phi \cdot \cos \phi + R_w)]$$

$$D_{hi} = (R_w + D_\phi \cdot \cos \phi) / \cos \theta_{hi}$$

(TI-30 hint: find $[D_\phi \cdot \cos \phi + R_w]$ and store in memory, then invert and multiply by D_ϕ and $\sin \phi$, then take the inverse Tan; now you have θ_{hi} . Hit Exchange to bring back the stored value and store θ_{hi} . Hit "divide" and then "recall", "Cos", and "=". D_{hi} is displayed and θ_{hi} is in memory. It takes just over a minute to do it all. This formula is provided on the back of sheet #2 [Type I DD sheet].)

The formula for straw mulch needs is provided along the left margin of both DD sheets. The equipment time estimate guidelines are given on the back of sheet #2. Use these only for your final volumes as determined by office work, unless you are doing a "quicky" estimate. Deep dish combinations not shown on the sheets (left blank) are either impossible or improbable. If they do occur, office work will be needed prior to continuing. Sheets 2 and 3 cover: crossing volumes from 40 to 2060 cubic yards, width/2 values from 14.5 to 68 feet, maximum depth values from 3.6 to 24 feet, and channel gradients from 0.9 % to 62%. "Max depth" is the depth to grade at the outboard road edge. "Width/2" is the maximum excavation width from the $\mathcal{C}$ (along the outboard edge of the road). If you don't know what "channel grade %" is, you are in deep trouble!

Given the above data, you can set your two wooden "Edge" stakes (along the out-board road edge at a position "Width/2" feet from the $\mathcal{C}$) and take the volume figure and enter the Fill Outsloping Nomogram, to lay out your fill area. Note down the station numbers of the crossing $\mathcal{C}$ and both "Edge" stakes. Your fill site usually starts at the edge of the excavation. You now have the station number it begins at.

Refer now to the sample DD prescription shown on the back of the Type I DD Nomogram Sheet (drawn at standard 1 inch to 10 feet scale - takes very little room). In the office, lay out all work on the plan sheet up to the downstation "Edge" stake. Draw in the $\mathcal{C}$ profile between ues and les at a scale of 1 inch = 10 feet (10 scale). Label all the stakes (Top, Bottom, les, ues). Draw in the channel grade (straight line between "Top of DD" and "Bottom of DD" stakes). Find and label on the plan sheet the maximum depth's location (below the out-board road edge) and value, as well as the channel gradient. Make a mark ("+") a scaled 5 feet above both end stakes and put down rod-to-ground (rtg) grade checks from each endstake (use drafting machine to measure from the "+" mark to the desired ground position. List target location, distance, and $\pm$ angle). Give checks from each endstake to the Top, Bottom, and Max points. Also list DD station # (underline), volume, width/2, mean endhaul distance and type (blade or truck), design flow capacity ($T_r = 25$ years) and flow depth, and rock prescriptions if needed (number of cubic yards, thickness, height, length). For even a rocked crossing, this should take only 20 to 30 minutes. Besides, you were going to do it anyway on a separate sheet of paper. Now you get much more for your efforts as you have a plan to use in the field, complete with grade checks and it is contract-compatible with no change required. Go to the back of Sheet #2 (or use your own data) and figure the total hours required to complete each equipment piece's work. Note this on the plan sheet:

<u>excavating</u>	D-8: 5 hours
	excavator/loader: 1 hour
<u>rocking</u>	excavator/loader: 1 hour

Your width/2 and volume figures are determined from Plate I (blue line sheet). Plate II is for Double End Area (DEA) calculations. DEA calculations are greatly simplified, requiring only the depth to grade at any point to yield the cross sectional area - simple! Check your width/2 value with the field estimate. It should be very close. If it is off more than 1 foot, then readjust the "Edge" stakes on your next field trip (no adjustment to the fill site is required).

The normal double end area formula works quite well between cross sections of similar size, but gives poor results with pronounced tapers. Trapezoids do not fit well into rounded cross sectional profiles and thus are out. The solution lies in the use of the following formula for figuring the volumes of the tapered ends of your crossings, where they go from full profile to zero cut (but have a definite width still, equal the natural channel width):

$$Yd^3 = \frac{A_w \cdot L}{((W-w)/W) + 2} \cdot 27$$

Where: A_w = cross sectional area at the beginning of the taper (get from the blue-lined graph of depth versus area)

L = the map distance between A_w and the zero-cut location

W = excavation width (not channel width) at A_w (get from the blue-lined cross sectional template)

w = the excavation width at the zero-cut point (= natural channel width)

Yd^3 = total cubic yards for that DEA pair

With all the figures at hand, the above takes around 30 seconds to output the volume. A twin formula for heavy taper DEA calculations of intermediate cross sections is shown with Plate II.

During excavation, grade checks entail only setting your 5 foot HI Jacobs staff at the chosen endstake (les or ues), stretching the specified length of tape from the top of the staff to the ground, along the α , and shooting the vertical angle to that point. The information from this rod to ground (rtg) shot can be used to determine the remaining depth to grade as follows:

$$\text{Remaining Depth } (\pm) = (\text{Sin } \alpha_g - \text{Sin } \alpha) \cdot (L)$$

Where: α_g = prescribed vertical angle to grade (from grade checks on plans)

α = present vertical angle

L = prescribed rtg tape length

If the sign is positive, you are above grade; if negative, you are below grade and didn't do your grade check soon enough.

Often you will have a limited fill capacity and/or wish to outslope at the fill site as well as store fill there. Beware that the cat operator will usually give you a shallower (3:1) sideslope than the prescribed value of 2:1 if left to his own devices. This greatly increases your fill volume. Once you get him "broken in" (or in worse cases "broken down") to the standard sideslope grade, you will have no further trouble. A real help is to note the position of each edge stake relative to some object on the cutbank and point this out to the cat operator. He can refer to these once the "Edge" stakes are wiped out, thus keeping overexcavation within bounds. Soon he will do this for himself.

Crossings greater than 2000 cubic yards in volume should be surveyed separately, as the 10 percent error margin takes on a relatively large significance.

Your TI-30 (or similar trigonometrically capable beast) is an essential tool for all phases of THE SYSTEM. If you will wrap it in saran wrap (clingy, tight sealing stuff), you can use it even in the heaviest rain. It is best to "modify"

(butcher) your plastic carrying case for this by removing the zipper (tears saran wrap) and wrapping a length of duck or strapping tape around it half way down. This tape band keeps the beast from falling out. I have yet to lose one. Be sure to provide a drainage hole or two in the base of your carrying case if you don't have one there now. Use the alkaline batteries (and carry a packaged spare) to avoid having to wrap and unwrap the unit for charging each night and morning. These last for around 20 hours of intermittent calculation (about 3 weeks of steady surveying). These calculators only cost \$13 each now, and they can take quite a bit of punishment if kept dry (mine sure has!).

Total Outsloping

Often a short section within an OS road reach will have conditions precluding the placement of fill on the cutbank (CB). In other cases the local instability indicators (tension cracks, scarps, etc.) show that the most probable failure surface extends clear back to the IBD or into the CB. If the need to outslope exists, then it is obvious that the only solution is to export the removed material. The Total Outsloping (TOS) prescription consists of a straight line cut beginning at the IBD and proceeding outboard at a specified grade to the fillslope, with all material being push-endhauling or (very rarely) truck endhauling. Sheet #4 is a table giving all necessary parameters for the field layout and staking, plus prescription data (office work) for three degrees of TOS on roads of from 10 to 40 feet in width.

In laying out a TOS road reach, you have two objectives. The first is to delineate the reach of the TOS and put in the grade control stakes. The second is to obtain the total expanded yardage removed so that the fill site can be laid out immediately. Both objectives are achieved simultaneously through sheet #4.

Determine the station numbers at both ends of the TOS reach and place a "Begin TOS" and "End TOS" stake on the CB at the lower and upper ends, respectively. You will need to delineate the cut at these locations as well as at any place in between where the road width changes significantly (this rarely occurs). The first cross section is done right below the "Begin TOS" stake. There will be two stakes to delineate the final cut plane. The first is labeled "TOS" and goes in the IBD. This shows the top of the cut and warns the (informed) operator to look over the edge of the road to find the Cut to Here (CTH) stake which marks the lower end of the cut plane. To install the CTH stake, first measure and record the road width, then enter sheet #4 at the corresponding road width. Look at the three figures for total cut (column 2) representing the 9:1, 6:1, and 4:1 finished slope options and choose the degree of cut suitable for the entire TOS reach. This figure tells you how many feet below the road your cut plane will emerge on the fill slope.

The 9:1 option is standard, while the 6:1 option gives a heavier cut roughly the same as a Type I OS and the 4:1 option yields a heavy cut similar to that of a Type II OS. Choose the smallest cut option feasible, as the volume per

foot of road is much greater per foot of cut than with standard outslloping. Now find the rod reading (in column R) corresponding to your chosen cut. The rod-person moves down the fillslope until a level shot (50 HI) from the road cuts the rod at that figure. Place a "CTH" stake on the fillslope at the base of the rod. The expanded fill volume per foot of road is shown in column X. You need record only the following for each cross section (# = a number you will insert): (#:1) TOS @ STA # + ##: ## ft. rd. width; $yd^3(exp)/ft = \#.\#$. Proceed to the next cross section (usually the "End TOS" stake) and perform the same function, using the same chosen degree of cut (9:1, 6:1, or 4:1). For finding the total expanded volume between each sequential pair of TOS stakes, multiply the road length (obtained by subtracting STA numbers) by the mean value from column X (=expanded) yd^3/ft . Record this value in the notes ("Exp. vol. = ### yd^3 ") for the higher STA #d cross section, then figure the volume between that cross section and the next (if there is one). The last volume is thus recorded in the data for the "End TOS" location. Sum the volumes and record this ("Total exp. vol. = ###") with the "End TOS" notes. Since normally you will have only two cross sections for the TOS reach, the two figures are usually equal.

You may now lay out the fill site using the technique described in Part III of THE SYSTEM. The TOS prescription is quick, simple, and foolproof. A typical plan sheet TOS prescription is shown below:

End TOS @ Sta 3+31

Totals: Vol = 324 yd^3 ; Bales = 7; D-8 hrs = 2.2 hrs; 700 ft of TOS

(35' Rd) TOS = 6:1 @ Sta 3+31: $C7^4$; Vol = 324 yd^3 ; 7 Bales (space for even cover)

(20' Rd) TOS = 6:1 @ Sta 2+31: $C4^3$

Begin TOS @ Sta 2+31

All fill goes upstation
between 3+31 and 4+90.
Mean push-endhaul=130 ft.

BEGIN HERE AND READ UP THE PAGE

The volume (unexpanded) and bale values are obtained through averaging the values for each cross section's column 3 and 5 values, then multiplying by the road separation. Expanded volumes are not included on the plan sheet as their only purpose is to lay out the fill site. Bale separation values (column 6) may be given only when the road width differs by 5 feet or less between sections. Otherwise specify "space for even cover". In standard OS work this difference can be as much as 10 feet between sections, but the finished slope length (which

controls mulched area) varies much more rapidly with road width in TOS work. Note also that the first cross section has no value or bale figure attached to it, since it represents the very beginning of the TOS reach and each prescription line represents the totals between it and the preceeding line. The first OS section is placed several tens of feet into the OS reach, while the first TOS section is placed at the very start of the TOS reach, thus it has no totals.

The big cats can move earth MUCH faster on a total outslope prescription than in standard outslowing since they are not pushing steeply uphill and don't have to make quartering turns. Also the cats can build up push-berms after a few passes so that they can push a much greater volume per pass. Considering these factors plus the fact the volume per foot of road varies so quickly with road width on the TOS prescription, it is inadvisable to give estimates for D-8 time for short portions of a TOS reach. It is better to just work with the total cubic yard (unexpanded) and total feet of road values in making your time estimate. A special guide for this is provided on the back of sheet #4. Place the resulting D-8 time estimate in the "Totals" section of the plan sheet for your TOS reach (as shown in the example). Please keep good records of all TOS work, as our data base is rather scanty at present. I would appreciate any and all results you obtain regardless of equipment used so that an improved guide can be generated for various equipment types and conditions.

In summarizing the approaches to fill-exporting worksites, bear in mind that with both crossings and TOS sites, you first calculate the total unexpanded volume of fill, then use the guide on the back of the appropriate sheet (sheet 2 or 4) to find the appropriate cubic yard/hour value for determining your equipment time. By contrast, the regular OS work has an equipment time estimate for each pair of cross sections.

THE SYSTEM: PART III

"Fill-Outsloping" . . . How to Handle Imported Fill Material

by

Ed Wosika

2/10/83

Introduction

The layout of fillsites is usually one of the most challenging aspects of our work, since often the fillsite requires treatment such as outslowing in addition to serving as a fillsite. The ideal solution is to emplace as much imported fill as possible while still leaving enough room for the local cut/fill work (if needed). Further complications arise when some parts of the intended fillsite need extensive outslowing, while other parts need none at all, thus eliminating uniform prescriptions. There is no way to achieve anything approaching an optimal solution when this work is done by feel. Part III of THE SYSTEM provides a method for rapidly prescribing an optimal solution which is customized to meet the local needs of each part of the fillsite. The work is all accomplished in the field and finish staked, ready for work. The far end of the fillsite is a known point, so prescriptions beyond that point can be made without regard to possible complications from imported fill and no intervening trips to the office are necessary to determine the extent of the fillsite prior to further upstation prescriptions. This work is achieved using sheet #5.

Types of Fill Outslowing and Stakes

Sheet #5 is set up to handle four categories of fill-outslowing. The categories are based upon the percent of each cross section which is composed of imported fill (the remainder being local fill): 0%, 33%, 66%, and 100%. The 0% category is the same as Type I standard outslowing. The value is used at each cross section (regardless of category) for placing the Fill to Here (FTH) stake which shows the top of the final fill. A Fill Outslowing (FOS) stake is placed a certain distance below the FTH stake. The FOS stake marks the top of the imported fill prism, which is placed prior to local outslowing. The imported fill is placed at the same grade as that of the final (overlying) grade. Since no local fill is created with the 100% category, the FTH and FOS stakes stand side by side. Local areas where no imported fill will be placed (0% category) have the FOS stake in the inboard ditch. Field layout of the fillsite is discussed in the next section. The grade for the imported fill (in % slope) should be marked on the FOS stake. This is the only on-the-stake mark that needs to be done in the field.

Laying Out a Fillsite

In all cases, you will need the total expanded yardage you will be importing. Part II of THE SYSTEM shows how to obtain this value in the field. Normally, you will be proceeding in an upstation direction away from your fill source (a crossing or TOS reach), but you may work in both directions if desired. If you think you will need to fill-outslope in a downstation direction, you should stop your field prescription layout well downstation of the fill source, then survey the fill source, then lay out your downstation fillsite before completing the rest of your downstation work. This precludes any overlapping of prescription types (wasted effort).

The example used here will be one where the fillsite proceeds upstation from the edge of a fill source.

Place a "Begin FOS" stake on the CB at the beginning of your FOS reach (the downstation end of your fillsite). Look at the road and determine what category of FOS your first uniform section of road can handle (0%, 33%, 66%, or 100% IMPORTED FILL) based on the degree of local OS needed. Proceed upstation a maximum of 160 feet or until conditions change (road widens, or a different FOS category is needed). This is the site of your first cross section. Let's say the road was 30 feet wide and we wanted a 66 percent TOS and we were placing our first stake 100 feet upstation from the beginning. To set our stakes, we enter sheet #5 at the 30 foot road width. Column A shows that our ROD READING (shot from the CB using a 5⁰ HI) for the FOS stake is 10⁰, while that for the FTH stake is 13². We set our stakes on the CB and mark the FOS grade (29%) on the FOS stake. This should take only a couple of minutes. Column B shows that we have prescribed placing 2.17 cubic yards of expanded fill per foot of road. Our notes would read:

Begin FOS @ Sta. 3+00 total exp. yd³=600

(30 ft. rd.) 66%FOS=3.5:1(29%) @ STA 4+00: . . . 600 yd³ - (100 x 2.17) = 383 yd³ to go.

We merely proceed thus upstation until it is obvious that the remaining imported fill will be consumed somewhere within the next road section. Let's say we have 110 cubic yards left to handle and that the next road stretch looks to be about 130 feet long and is 40 feet wide. We have chosen the 33 percent option, since major local outsloping work is indicated. How far do we go with our FOS prescription? Our volume figure for this option (column B) is 1.70 cubic yards per foot:

$$110 \text{ yd}^3 = (1.70 \text{ yd}^3/\text{ft}) \times (? \text{ ft})$$

$$101/1.70 = 60 \text{ feet yet to go.}$$

Thus our last FOS section is 60 feet down the road. We place an "END FOS" stake beside the FTH stake (where it won't get destroyed) and proceed with our prescription of normal outsloping.

All other parameters are obtained in the office in a similar manner to the Type I OS. If the cubic yard of fill per foot of road is fairly constant through the FOS reach, then the mean push-endhaul distance is obtained by merely subtracting the station number of the fill source from the mean station number of the FOS reach, otherwise the moment mean of the FOS reach should be used in the subtraction. The mean push-endhaul value should be included on the plan sheet. A typical plan sheet sample is shown below (different from last example). Note that all equipment time for imported fill placement is billed to the fill source, so the information to the right of the colon in each line deals with the local work which is done after fill placement.

END FOS/BEGIN OS @ STA 7+85

Local Totals: Vol=205 yd³; D-8 time = 2.4 hrs; Bales = 21; 185 ft of TOS

(40'Rd) 66%FOS=3.5:1(29%grd.) @ STA 7+85: C5⁶; F11²; Vol/Time=121 yd³/1.4 hrs;
11 bales @ 9'

(30'Rd) 66%FOS=3.5:1(29%grd.) @ STA 7+10: C4²; F8⁵; Vol/Time=84 yd³/1.0 hr;
10 bales @ 11'

BEGIN FOS @ STA 6+00

mean push-endhaul = 150 ft.

Total Fill Imported = 350 yd³ unexpanded
= 525 yd³ expanded

Rip entire road surface, then outslope fill
from DD 5+60 to the base of the FOS stakes,
then complete local outslowing.

DD 5+60 blah....blah....blah....(this is the fill source)

The total fill (F) values are obtained by subtracting 5⁰ from the FTH rod reading in column A. Follow Type I OS procedures for parameter calculations and (if road width varies more than 10⁰ between sections) DEA calculations. Your brief field notes plus sheet #5 make for rapid final plansheet layout for this usually difficult prescription type. Again the use of station numbers greatly simplifies your calculations and specifications.

Top
Left
Right
Bottom

Approximate Space For Type I AD
(use for field layout of stakes & galleto)

Edwards 12/102

Slope Distance (D _s)		Lower Slope Distance (D _L)		Lower Slope Distance (D _L)	
for	for	for	for	for	for
$\theta = 30^\circ; \theta = 30^\circ; Type I$	$\theta = 30^\circ; \theta = 30^\circ; Type I$	$\theta = 30^\circ; \theta = 30^\circ; Type I$	$\theta = 30^\circ; \theta = 30^\circ; Type I$	$\theta = 30^\circ; \theta = 30^\circ; Type I$	$\theta = 30^\circ; \theta = 30^\circ; Type I$
15	15	15	15	15	15
25	25	25	25	25	25
35	35	35	35	35	35
45	45	45	45	45	45
55	55	55	55	55	55
65	65	65	65	65	65
75	75	75	75	75	75
85	85	85	85	85	85
95	95	95	95	95	95
105	105	105	105	105	105
115	115	115	115	115	115
125	125	125	125	125	125
135	135	135	135	135	135
145	145	145	145	145	145
155	155	155	155	155	155
165	165	165	165	165	165
175	175	175	175	175	175
185	185	185	185	185	185
195	195	195	195	195	195
205	205	205	205	205	205
215	215	215	215	215	215
225	225	225	225	225	225
235	235	235	235	235	235
245	245	245	245	245	245
255	255	255	255	255	255
265	265	265	265	265	265
275	275	275	275	275	275
285	285	285	285	285	285
295	295	295	295	295	295
305	305	305	305	305	305
315	315	315	315	315	315
325	325	325	325	325	325
335	335	335	335	335	335
345	345	345	345	345	345
355	355	355	355	355	355
365	365	365	365	365	365
375	375	375	375	375	375
385	385	385	385	385	385
395	395	395	395	395	395
405	405	405	405	405	405
415	415	415	415	415	415
425	425	425	425	425	425
435	435	435	435	435	435
445	445	445	445	445	445
455	455	455	455	455	455
465	465	465	465	465	465
475	475	475	475	475	475
485	485	485	485	485	485
495	495	495	495	495	495
505	505	505	505	505	505
515	515	515	515	515	515
525	525	525	525	525	525
535	535	535	535	535	535
545	545	545	545	545	545
555	555	555	555	555	555
565	565	565	565	565	565
575	575	575	575	575	575
585	585	585	585	585	585
595	595	595	595	595	595
605	605	605	605	605	605
615	615	615	615	615	615
625	625	625	625	625	625
635	635	635	635	635	635
645	645	645	645	645	645
655	655	655	655	655	655
665	665	665	665	665	665
675	675	675	675	675	675
685	685	685	685	685	685
695	695	695	695	695	695
705	705	705	705	705	705
715	715	715	715	715	715
725	725	725	725	725	725
735	735	735	735	735	735
745	745	745	745	745	745
755	755	755	755	755	755
765	765	765	765	765	765
775	775	775	775	775	775
785	785	785	785	785	785
795	795	795	795	795	795
805	805	805	805	805	805
815	815	815	815	815	815
825	825	825	825	825	825
835	835	835	835	835	835
845	845	845	845	845	845
855	855	855	855	855	855
865	865	865	865	865	865
875	875	875	875	875	875
885	885	885	885	885	885
895	895	895	895	895	895
905	905	905	905	905	905
915	915	915	915	915	915
925	925	925	925	925	925
935	935	935	935	935	935
945	945	945	945	945	945
955	955	955	955	955	955
965	965	965	965	965	965
975	975	975	975	975	975
985	985	985	985	985	985
995	995	995	995	995	995

Grade Checks (α and L = vert. & end tape length to grade; α = vert. & you have α & L):

$$\text{Remaining Depth To Grade (Z)} = (\sin \alpha - \sin \alpha) \cdot (L)$$

Included Backsight Formula To Obtain Q_1 and Q_2 Indirectly:

(1) Obtain: roadwidth along the DD L ($= R_w$); vertical angle ($= \theta$) and slope distance ($= D_p$) from inboard road edge to "Top of DD" stake.

(2) $F = (D_p \cdot \cos \theta) \cdot R_w$

(3) $Q_1 = \tan^{-1}(D_p \cdot \sin \theta / F)$

$Q_2 = F / \cos Q_1$

Universal Sign Convention For THE SYSTEM

All signs are relative to gear position, and never relative to any L , IBD, L-R bank, etc. Face the outboard road edge, then:

Inboard = " $-$ "	;	Outboard = " $+$ "
Left = " L "	;	Right = " R "
Up Angle = " $+$ "	;	Down Angle = " $-$ "
Up Elev. = " $+$ "	;	Down Elev. = " $-$ "

Sample DD Layout & Description (standard 1:10 scale): Note that the Type 2 Shingreen provided the following: Vol = 562 yd^3 ; Width = 30' 2"; max depth = 15' 4"; gradient = 28.5'.....

Note 1: ch marks (8 ft) from left reference line, 4 ft from right side when blue band is

↳ this one requires slight "edge" stake adjustment (total 28.5')

Sta 22+53 → 25+33 = Fill Site w/508 OS

Note: stop @ channel rock depth, if encountered.

grade checks fly w/508 OS:

- from nos 2: top = +15' @ -23.3°
- " " nos = +44' @ -21.0°
- " " bottom = +70' @ -18.7°
- " nos 2: " = -10' @ -13.7°
- " " nos = -35' @ +6.9°
- " " top = -64' @ +20.4°

Depth = 15' 4"
width = 30' 2"

Fillsite = directly upstream from 28+00
Main Elevation (Grade) = 240.2

Stream Aulch (600ppm)
= 4 holes ... store on upper left bank

drainage area = 10.5 acres

depth to floor = 7.5 ft

Volume = 571 yd^3

Time: 0-8 = 0.3 hours

Ex. 10.5' @ 10' 10' 10'

Channel along a 10' 10' 10' 10'

Drop Disk 22+16
Type 2
unworked

Sta. 21+79: End XRD/Begin DD

Volume Coefficients for Equipment Time Estimates:

SYSTEM Style:

DD yd^3/hr where 0-8 during 00-100% of DD volume

normal dig of 150' pull and haul = 234 yd^3/hr (100% vol.)

deep dig " " " = 100 "

" " w/ 50' 10' " = 50 "

For 116 yd^3/hr Excavator & 274 yd^3/hr Truck Loader

cleanup work (10-20% of DD vol) = 40 yd^3/hr

primary excavation (no 0-8) = 65 "

Bandras Style (deep, narrow, & real loads....)

0-7 does first 40-70%, then Excavator 20-4 excavate stepwise w/ crew pushing of remaining 20-60% of volume = the hard part)

1st part = 0-7 @ 70 yd^3/hr

2nd part = Exc 20-4 @ 50 yd^3/hr

Kos	WGLA
Val	WGLA
WGLA	WGLA
WGLA	WGLA

[illegible]

18-2-3
7-2-15

the in fold for sitting.
 "End to third stroke (on
 full slope) and drawing
 volume of expanded
 (expanded) full.
 ⑦ refers and not to with.

Total Outgoing Table

Total Outlaying Table

Procedure choice of 1 step: 910 - usual light TOS; 6:1 cut to Type I OS; 4:1-14 heavy cut seen. to Type II OS.

Directions: ① Set TOS stake in SSB; ② Color hole @ your side with a note ③ a ⑤ your chosen run-out shape (see map); ④ Also ⑤ to set your CTH stake on the file. ⑥ Multiply ③ by the # of feet since last CTH a huge running total of this org. yardage for file to work; ⑦ An steps 1-4 for most stakes in the TOS much. Pl. "Type TOS" a "Lead TOS" stake @ end of TOS much. Do steps 1-4 @ both ends a where

10.9	18.5	5.34	8.74	46	87	5.9	4.8	3.34	6.44	D-8 ft/l. See Table On Back Of This Sheet For This and haul. Runmeter.. Use Total Unexpanded yd.					2.0	9.1	6.1	4.4	4.8	10.1	17	18	11	9
9.6	16.2	5.34	8.74	46	87	5.9	4.8	3.34	6.44						2.0	9.1	6.1	4.4	4.8	10.1	17	18	11	9
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9.6	16.2	5.34	8.74	46	87	5.9	4.8	3.34	6.44						2.0	9.1	6.1	4.4	4.8	10.1	17	18	11	9
9.6	16.2	5.34	8.74	46	87	5.9	4.8	3.34	6.44						2.0	9.1	6.1	4.4	4.8	10.1	17	18	11	9
9.6	16.2	5.34	8.74	46	87	5.9	4.8	3.34	6.44						2.0	9.1	6.1	4.4	4.8	10.1	17	18	11	9
9.6	16.2	5.34	8.74	46	87	5.9	4.8	3.34	6.44						2.0	9.1	6.1	4.4	4.8	10.1	17	18	11	9
9.6	16.2	5.34	8.74	46	87	5.9	4.8	3.34	6.44						2.0	9.1	6.1	4.4	4.8	10.1	17	18	11	9
9.6	16.2	5.34	8.74	46	87	5.9	4.8	3.34	6.44						2.0	9.1	6.1	4.4	4.8	10.1	17	18	11	9
9.6	16.2	5.34	8.74	46	87	5.9	4.8	3.34	6.44						2.0	9.1	6.1	4.4	4.8	10.1	17	18	11	9
9.6	16.2	5.34	8.74	46	87	5.9	4.8	3.34	6.44						2.0	9.1	6.1	4.4	4.8	10.1	17	18	11	9
9.6	16.2	5.34	8.74	46	87	5.9	4.8	3.34	6.44						2.0	9.1	6.1	4.4	4.8	10.1	17	18	11	9
9.6	16.2	5.34	8.74	46	87	5.9	4.8	3.34	6.44						2.0	9.1	6.1							

(201.24)
 174 1/2
 174 1/2
 174 1/2
 174 1/2

1974

50-02-1
מגיד פז

~~5/27/22~~

⑥ Red Roosting Pigeon
Nesting has started
(up to 50 nests)

Finished Skape
Length (ft)

② Local Gas Station
(get type of road)

10/10/10
 10/10/10
 10/10/10

PL 86-360-2-55
U S GOVERNMENT PRINTING OFFICE

[illegible]

Appendix 2

SECTION C - DESCRIPTION/SPECIFICATIONS

1. General

This contract is set up so as to provide the bidder with the volume of earth to be removed at each worksite. For worksites which require endhauling of the excavated material, the distance to the fillsite and the desired shape of the final fill profile are specified. The amount of data provided for each worksite requires that a form of "shorthand" be used. The "Description Specifications" section deals with this shorthand format as well as giving a general description of each of the prescription types. In addition, suggested techniques are outlined in a separate section.

2. Description of Prescription Types

There are three general prescription types: 1) excavations involving no endhauling; 2) excavations requiring endhauling by truck or blade; 3) worksites at which imported fill is placed and where some local excavation may also be done. All work is located by "station numbers."

3. Stations

All work is laid out using the standard engineering "station" method. A station is a 100-foot interval. Station laths are installed every 100 feet along the road, starting from the beginning of a road, and labeled with their station number. Thus the point on the "E" road that is 800 feet from the beginning has a lath on the cutbank labeled "E8+00." Locations between station laths are labeled as follows: "E8+88" is a point 33 feet beyond the E8+00 lath, or 833 feet from the beginning of the road. Similarly, the point "E52+80" is one mile from the beginning of the "E"-road. Work is usually laid out so that one proceeds toward higher station numbers. "Upstation" means "in the direction of higher station numbers," while "Downstation" means "in the direction of lower station numbers." This simple system permits one to exactly pinpoint any location on the contracted roads. The "A"-road work is laid out backwards...one works from higher station numbers to lower station numbers.

4. Excavation Involving No Endhauling

The first prescriptive type in this group is "OutSloping (of roads)" (OS). This consists of removing the loose fill on the outboard edge of the road and placing it against the cutbank. Grade stakes are provided at intervals along each stretch of road to be outsloped. Two types of stakes may be encountered: "Fill To Here" (FTH); and "Fill To Mark" (FTM) stakes. FTM stakes are carefully surveyed into place on the cutbank at a predetermined elevation above the road. The earth on the outboard edge of the road is excavated and piled up against the cutbank until a straight line gradient is achieved from the base of the stake outboard to the newly-excavated edge of the fillslope. This results automatically in an excavated volume equal to that specified in the contract. Any resulting berm at the upper or lower edge of the resultant slope is faired into the existing terrain, except locally at the FTH stake. The FTH stake will not be disturbed or buried. No more than 10 percent of the excavated volume shall be permitted to spill onto the fillslope at any given location....., though up to 30 percent of this volume may be lost at the very start of an outsloped reach (see "Suggested Techniques" section). The inboard half of the road bench shall be ripped thoroughly to a 2-foot depth prior to any fill being placed thereon. The top of the finished grade proceeds along the cutbank in a straight line from the base of each FTH stake to the next one up the road. These stakes are placed not more than 170 feet apart. FTM stakes function just like FTH stakes, except that the desired grade elevation on the cutbank is marked with a spot of paint rather than a stake. FTM stakes are located at the base of the cutbank and will be buried during work, but the paint spots are treated just as the FTH stakes (not buried). The reference paint spot is located on the cutbank directly above the FTM stake. The following diagrams are representative road cross-sections before and after outsloping.

5. Excavations Involving the Endhauling of Material

Stream crossing excavations are the first type in this class. There are two types of stream crossings: 1) Deep Dish (DD); and Road Crossing (R/X). The only difference between these is that the R/X format provides more grade stakes than the DD format and involves varying cross-section profile shapes. The volumes shown on the plan sheets represent the tentative final grade. In all cases, the fill is removed from the stream crossing down to the tentative grade line (shown

5. Excavations Involving the Endhauling of Material (continued)

on the plan sheets) and this spoil is moved to the specified fillsite and shaped to grade. The final grade line is determined on-site by the C.O.R. as the planned grade is reached (see Section G, paragraph (d)). This will sometimes involve more or less excavation than shown in the plan sheets. No material will be removed beyond the vertical and horizontal limits of the excavation. No overexcavation is permitted, as the fill site capacity is very limited in most cases. Straw mulch shall be spread evenly at both the stream crossing and at the fillsite, with the number of bales of straw being specified on the plan sheet. Both the DD and the R/X formats define the limits and grade of the excavation using grade stakes. The DD format is simplest, as it uses a standard cross-sectional profile (see bluelines cross-section template included with plan sheets) that is uniform along the length of the crossing. This profile is designed to be easy to excavate using a large bulldozer (such as a D-8). DD's have a simple stake layout. A pair of 1/2" diameter rods are located on the crossing centerline (L) upstream and downstream of the excavation limits. They are called the Upper End Stake (ues) and the Lower End Stakes (les) and are used for grade checking. These stakes will not be disturbed. "Top" and "Bottom" stakes are located on the L at the upper and lower limits of channel excavation, respectively. The planned channel bottom is a straight line between the bases of these two stakes. "Edge" stakes are placed at the outboard edge of the road to define the lateral limits of the excavation at its widest point. Remove the "Edge" stakes prior to excavation and place them on the cutbank so that a continual reference point is maintained during digging, so as to prevent overexcavation laterally. Vertical control is provided by "Grade Checks" printed on the plans. The use of these Checks will be explained, as needed, in the field. They permit grade control of the channel bottom to within ± 0.1 foot in most cases, though the grade tolerance is ± 0.3 feet (vertical) for all channel excavations. A longitudinal stream profile (scale: 1" = 10') is provided for each DD, showing the locations of the ues, Top, Bottom, and les stakes as well as the present ground surface, planned (tentative) channel grade, and rocking sites (if present).

The R/X type stream crossing prescription is used where conditions do not permit the use of the DD format. Specific cross-sections are provided, as well as a longitudinal section (both at a scale of 1" = 10') and a plan view (at 1" = 20').

5. Excavations Involving the Endhauling of Material (continued)

The use of the ues and les stakes is retained, but a different type of grade stake is used than in the DD type. Please refer to the plan sheet labeled "Road A; Sheet 4" (upper right corner of the plan sheet), showing the cross-sections for R/X A163+00. Look at cross-section B (second from the bottom). The stake controlling the top-of-cut on the right bank is labeled "SSB_{R-1}". The inscription on the stake is:

SS
C26⁷
1:79:1
54⁵
ditch
20⁰

This means: From the base of this Slope Stake (SS), make a cut for 26.7 feet of elevation (C26⁷) following a 1.79:1 slope (1.79:1 or 56%) 54.5 feet long (54⁵), then cut a level ditch bottom (Ditch... = channel bottom) 20.0 feet wide (20⁰). This is the cut shown on the right bank of the B cross plans and in the field. The cut line connects between successive cross-sections. As with DDs, the grade checking procedures will be explained as needed in the field.

The next type of fill-exporting prescription is the Total Outslope (TOS). This involves straight line cut extending from the bottom of the inboard ditch and increasing to the full prescribed cut at the fillslope with all material being removed to a specified fillsite. The fillsite is shaped to a prescribed grade using this fill (part of the TOS bid price). Grade stakes define the upper and lower limits of the TOS cut. A "TOS" stake is placed above the inboard ditch and a "CTH" (Cut To Here) stake is set to the bottom-of-cut on the fillslope. These pairs of stakes define the cut plane throughout the TOS road reach. It is difficult to judge exactly at what point the cut will emerge on the fillslope using only the TOS stake and indicated slope gradient, thus a CTH stake is surveyed in on the fillslope at the desired point of emergence of the cut. Thus one need only cut down to the CTH stake on a straight line grade from the bottom of the inboard ditch (IBD), then carry this cut down the road by adjusting the cut gradually between stakes locations so as to produce a straight gradient on the fillslope between CTH stakes. Most CTH stakes will be lost during excavation.

5. Excavations Involving the Endhauling of Material (continued)

The last type of prescription in this class is the Benched Outslope (BOS). It is very similar to the TOS, except that the top of the cut is begun 10 feet outboard of the base of the cutbank/inboard ditch intersection (measured at road level). The CTH stake is used, but there is no stake placed at the top of the cut, since it would impeded traffic. The BOS stake is placed on the cutbank to show the location of a controlled point (and where to look for a CTH stake over the side).

6. Fill Handling

The Fill OutSloping (FOS) format is used to control the grade at fillsites. Two stakes are provided. The imported fill is piled up against the cutbank to the elevation of the lower FOS stake. This format permits some local outsloping also. Where local outsloping cuts are to be made, the local work is done after the imported fill is placed and is piled up (straight line) to the base of the higher (FTH) stake. The same grade (slope) is used for both profiles...imported and final fill with local material. This grade is specified on the plan sheets. Since the expense of handling the imported fill is part of the bid for the fill source (DD, R/X, TOS, or BOS), only the local cut volume is listed for a FOS site. There are few "Custom FOS" reaches. These are provided with full cross-sections showing the fill and local cuts desired. In all cases FTH and CTH stakes are used to control grade for all FOS sites.

7. Special Prescriptions

There are a few isolated locations where the prescribed work does not fit into any of the above classifications. These are covered in adequate detail on the plan sheets.

8. Roads Involved in the Contract

The contract covers: most of the M-2-1 road (contract label is "E" road); part of the Y-Line road (contract label is "A" road); and all of a short skid trail off the "E" road (contract label is "S" road). The "A"-road and the "S"-road must be completed before access is eliminated. The "S"-road in its entirety is poorly suited for some types of equipment due to its narrowness.

9. Plan Sheets

The plan sheets are laid out in station-sequential order, by road. Each sheet has its sheet number and road letter ("E," "A," or "S") in the upper right hand corner. Do NOT be disturbed by the seemingly complexity of the plan sheets, as the codes are easy to understand and simple to follow. The reading (and work) sequence starts with the lower left hand side of the sheet. One reads upward to the top of the page, then starts at the lower right hand side of the page and reads upward to the right hand top of the page. This provides the reader with a page reading sequence that mimics the field work layout...the further (up the page) the item is, the further away (along the road) the worksite is. This is particularly helpful where odd station number sequences are encountered ("A"-road), providing the Contractor with a visualization of the work sequence. The information on excavated volume and bales of straw for mulching provided in each station-specific line of prescription data (control point) refer to the road reach from that station back to the last prescribed station (control point). For example (refer to plan sheet "Road "E"; Sheet 5") the prescription at the bottom right hand side of the page is an outsloping (OS) prescription for station E119+25 (called "Sta E119+25" on the sheet). It says that 57 yd³ of material have been moved and 3 bales of straw spread since the last prescription point (Sta. E119+00, at the top left side of the sheet). Local specifications for this station are as follows (for OS @ Sta E119+25): Cut 2.2 feet from the outboard side of the road (C2²); filled to height of 2.8 feet above the road level (F2^B) = height of base of FTH stake); the resulting straight slope has a steepness of 9.1:1 and is 46 feet long; the road was 40 feet wide before work. Notice the "25⁰" beneath the prescription line....this means you have proceeded 25.0 feet since the last prescription point (@ Sta. E119+00). The "75⁰" above the prescription line shows you that your next control point is 75.0 feet upstation. In all cases the top of the fill follows the cutbank on a straight line between successive FTH stakes (or the equivalent point mark if an FTH stake is used). Keep piling the fill up until it is to grade (base of FTH stake and a straight slope to the bottom of the cut), then proceed on a straight fill gradient so as to connect the bases of each successive FTH stake with the top of the fill. Follow the stakes with the top-of-fill line. Bale separation and total bale number specifications will be followed carefully.

TOS reaches are equally simple to excavate (refer to plan sheet labeled "Road E; Sheet 1," lower left side of the sheet, at the TOS reach from Sta E10+55 to E11+04). The total cut and grade are given for each control point as well as the yardage and bale count from that point to the preceding control point. Note that the first control point (Sta. E10+55) has no volume or bale information, since it is located at the start of the TOS reach (there is no downstation volume nor is there a cut area there to cover with straw). Since all TOS control points have CTH stakes on the fillslope, merely take a straight line cut from the IBD down to the CTH stakes, then proceed down the road connecting the CTH stakes with the bottom-of-cut line, then space the bales (use tape measure) and spread the straw. The fillsite (FOS reach) for all TOS reaches is prescribed and the mean endhaul and suggested style of endhaul (push with cat, or load and truck) are given.

BOS reaches are handled in the same way as TOS reaches, with the following exceptions: the cut starts 10 feet outboard of the cutbank (CB) base; the inboard ditch (IBD) is not filled in; and cross road drains are placed every 15 feet, with the first drain at the very beginning of the BOS reach. Each prescription reach (BOS, FOS, OS, etc.) is provided with a summary section (on the plan sheet) at the end of the reach. The summary section is always boxed in. The equipment and estimated hours given in the plan sheets are for Government use only. These are for the convenience of the Government and are based upon previous experience.

10. Wet Crossings

Several of the stream crossings will have some flowing water during excavation. These are indicated on the plan sheets, along with the maximum expected flow rate. The diversion of these flows will be sequenced to ensure that the fill prism will be dried out prior to work. The following suggestions are made for stream diversion, based upon previous experience. Comments will be directed toward R/X 163+00 primarily (this stream carries a significant summer flow), but the techniques are useful anywhere. Stream diversion dams may be made from sand bags. Fill the bags with local fine-grained material with an even sprinkling of Bentonite pellets included. Bentonite is "Driller's Mud" and expands to fill available pore space, thus providing an improved seal. It is available from drilling suppliers and (occasionally) well drillers in pellet or powder form. A cup of Bentonite per cubic foot is usually sufficient. An overflow pipe (pvc or

10. Wet Crossings (continued)

corrugated plastic pipe (CPP is suggested) should be built into the dam near its top. The overflow pipe may be sealed (as the bags are laid) by potter's clay, modeling clay, or something similar. The flow is carried by the CPP to the downstream limit of this excavation during non-working hours. Most streams can be diverted high enough in elevation from the crossing that the pipe can be routed around the crossing excavation limits. This stream has a very low gradient, thus one cannot do this. It is suggested that the flow be carried in a 10" or 12" CPP at night and pumped (using portable pumps such as used for fire fighting) during the excavation work, from the dam up to the through-cut skid trail shown in the plans on the upper right bank of the crossing, then direct the flow into DD164+40.

11. Strawing Techniques

The straw may be easily and quickly carried by two people, with one pole on each shoulder and one bale slung from each pole (see plans for suggested straw-carrying device). The straw bales may be arranged in piles (counted properly for all work to the next downstation pile). As work progresses, the bales can then be carried (in pairs) on the poles right past the working equipment and spaced as per the prescriptions, then spread. An alternative method is pushing such piles downstation with a dozer. The bales tumble off the blade in a random sequence, but pushes of up to 200 feet are possible. The bales are then rearranged to proper spacing and spread. It is suggested that the grade be approved by the COR prior to spreading straw, as any reworking of the areas would destroy the mulch, which must be replaced at the Contractor's expense. Most control points contain a spacing prescription (i.e.: "6 Bales @ 7'"). The sample just given would mean: "the stretch from the last control point to this one requires 6 bales, spaced at 7-foot intervals." In all cases the first bale is ~~placed at the very beginning of the controlled reach~~ (i.e.: at the location of the previous control point). ~~Whenever a pronounced taper in the finished slope~~ width is to be produced, the bale prescription looks like "6 Bales (S.E.C.)"...meaning "Space and spread the six bales so that the resulting Coverage is Even between this control point and the previous one." This work is spaced by eye to achieve a uniform mulch cover.

2. Access

No access or any kind will be permitted over a completed work unit. However, access by motorcycle shall be maintained to the most distant uncompleted site for monitoring purposes.

13. Special Tools Required

The special tools listed in Section H will enable the Contractor to check grades. The jacob staffs shall have spring clips attached (bolted) at their top. The clinometer is held by its lower edge in this spring slip and the overall-height from the ground to the center of the clinometer is adjusted to 5.0 feet. A target (2" x 4" x 1/2" plywood, painted flourescent red or orange) is slipped to the top of the second staff. Telescoping photographic monopods are recommened. Attach a large spring clip to the top by drilling a hole in the clip. The monopod's bolt is passed through the drilled hole, then a nut secures the clip to the top of the pod. The COR will instruct the Contractor in the use of these tools as needed.

14. Suggested Techniques

The following paragraphs reflect the most efficient known techniques and estimated production rates.

Outsloping (OS) may be done with a LARGE ripper cat. First rip the inboard half of the road in the outslope reach, then work at one end (lets assume the work is in the upstation direction). To start, scallop out the outboard edge of the road locally to the approximate depth of the cut shown in the plan sheets, placing the fill on the inboard edge of the road. This provides a long slope with adequate working room even on the untouched (upstation) fill prism which is to be outsloped. Start out with the cat on the outboard edge of the preliminary cut and parallel with the road. Prop the blade and run into the uncut fill with the outboard half of the blade. Then initiate a cutting turn, taking off around 1 foot of material (laterally), then proceed cutting uphill along a lone 45 degrees to the road. The amount of lateral cut is adjusted so that a totally full blade is achieved by the time the cutbank is reached. The fill is dropped and the process is repeated (cutting turn, then 45 degrees climbing cut). The work is

14. Suggested Techniques (continued)

adjusted so that maximum throttle is used for as much of the push as possible. Adjust the depth of cut to bring the top of the fill to the base of the successive FTH stakes AND produce a straight line gradient to the bottom edge of the cut. A small berm is often produced at the bottom of the cut...this is backbladed. No more than 10 percent of the volume shall be lost over the bank at any location, though up to 30 percent may be lost during the scalloping cut that starts the DS reach. Of course any material that is lost is material that cannot go to make up the required grade, so must be dug over again, thus minimum spillage is an advantage. Time estimates given for outsloping on the plan sheets are based on a conservative 88yd³/hour excavation rate.

Total outsloping and Bench outsloping go much faster (per yd³), since no quartering turn is necessary..the cats merely push slightly uphill toward the loading equipment or FOS. Push-endhauling may be done by following the inboard edge of the road, which acts to retain the extra-full blade load. The material that spills off the outboard edge of the blade rapidly forms a berm, thus the fill is pushed down a trench and large bladefulls can be pushed quickly over long distances (up to 600 feet) in second or third gear. Again FULL THROTTLE should be used as much as possible.

Deep Dishes and R/X crossings may be excavated mostly with a large cat. The inaccessible portions of the work may be done by a large hydraulic excavator (such as a Case 980B), at an estimated rate of 40 yd³/hour. The excavator can place rock at an estimated rate of 30 yd³/hour. The excavator can load a 10 yd³ dump truck in an estimate 10 minutes, while a Cat 977 track loader can do the same job in an estimated 3 minutes. Mean truck speed has averaged 5 mph on the roads.

Local conditions may cause production rates less than those given, but the figures provided take into account an average over many types of conditions.

15. Culverts

5. Culverts (continued)

16. Sign Conventions

Left and Right (on the crossing) are determined by facing downstream. The direction toward the outboard side of the road is taken as positive, the inboard direction negative. Positive and negative vertical angles are above level and below level, respectively.

17. Rock Specifications

All rock (except as noted otherwise) shall be obtained at the #1 rock pit on the Y-Line road (see map), which is accessed via the M-Line haul road. Abundant rock is available at the rock pit, requiring only minimal gathering by heavy equipment prior to loading onto trucks. Mean distances to the rock pit are provided for each rock-work site on the plan sheets. Draped width is the width as measured across the channel (rocked) with a fiberglass tape loosely draped across the tops of the rock. "Length" is the length of stream channel covered (slope distance).

ABBREVIATIONS

&	= And
@	= At
Bottom	= Bottom of channel excavation
BOS	= Bench Outslope
C	= Excavation cut on fillslope
cfm	= Cubic feet per minute
cfs	= Cubic feet per second
CL	= Centerline
CMP	= Corrugated metal pipe
CPP	= Corrugated plastic pipe
CTH	= Cut to here
DD	= Deep dish excavation
dia.	= Diameter
dr. area	= Drainage area
(ea)	= Each
Excav.	= Excavator
F	= Height of fill (on cutbank or other place)
ft	= Feet
FTH	= Fill to here
FTM	= Fill to paint mark
FOS	= Fill-outslope
HI	= Height of instrument
hr	= Hour
I.B.D.	= Inboard ditch
ie	= Such as
Left	= Left side of road as determined when facing upstation along the road.
l.e.s.	= Lower endstake of channel
Indg	= Landing
LRR	= Lower rocked reach
L.T.	= Left bank of channel as determined when facing downstream
max.	= Maximum
mi	= Mile
min.	= Minimum
MRR	= Middle rocked reach

OS = Outslope

Outsloping (Contractor knowledge of types is not necessary...they are government reference numbers only)

I = Type 1 Outslope

II = Type 2 Outslope

III = Type 3 Outslope

IV = Type 4 Outslope

p.p.a = Pounds per acre

Rd = Road

Right = Right side of road as determined when facing upstation along the road.

rox = Rock

R.P. = Rock pit #1

Rt. bank = Right bank of channel as determined when facing downstation

r.t.g. = Angle is taken rod to ground (use a 5.0 ft HI)

r.t.r. = Angle is taken rod to rod

S.E.C. = Space for even coverage

SS = Slope stake

Sta. = Station

T25 = Time of concentration of rainfall for a 25-year storm
(used in stream crossing design)

Top = Top of channel excavation

TOS = Total outslope

u.e.s. = Upper endstake of channel

URR = Upper rocky reach

vol. = Volume

w/ = with

w/o = without

XRD = Cross road drain

yds³ = Cubic yards

1st = First

% = Percent

20% = Twenty percent slope

20° = Twenty degrees

20¹ = 20.1 feet

20' = 20 feet

(+) = Outboard direction

(-) = Inboard direction

Appendix 3

SUPPLEMENTAL QUESTIONNAIRE

Type of Equipment (Maintained and Operated): _____

Make: 988Model: 87AYear: 1966Serial Number: 87A 1496Owner: Paul JohnsonContractor: Paul JohnsonBusiness phone: 488-2395Home phone: sameOperator: Paul JohnsonPhone: 488-2395Contractor's Comments: The machine can be used with either leg loading forks with clamps or 7yd standard bucket.Present Location of Equipment: Orick - CalifRate per hour is \$ 75⁰⁰ (equipment rate + operator rate)Contractor or Operator rate per hour is \$ 15⁰⁰

Safety Equipment:

Seat belts: Yes _____ No XFire extinguisher: Yes X No _____Back up alarm: Yes X No _____Roll protection: Yes X No _____Spark arrestor: Yes X No _____

General:

Capable of self-transportation between sites? Yes _____ No _____

Maximum working slope - uphill 15 % downhill 15 % sideslope 10 %Maximum traveling slope - uphill 25 % downhill 60 % sideslope 10 %

Road surface requirements _____

What is cruising speed?

(OVER)

Equipment Specifications:Weight: 80,000Horsepower: 300Wheel Mounted: X or Track Mounted: _____ Grouser Height: _____Blade:

Type & Size: Straight _____ feet U-Blade _____ feet Angle _____ feet

Maneuverability: 2 way _____ 4 way _____ 6 way _____ 8 way _____

Digging Depth: _____ inches

Lift: Height _____ feet

Tilt: Hydraulic _____ Manual _____ Degrees or inches _____

Angle: Hydraulic _____ Manual _____ Degrees or inches _____

Pitch: Hydraulic _____ Manual _____ Degrees or inches _____

Buckets:Type: Standard X 4-in-1 _____ Clamshell _____Size: (yd³) Standard 7 yd 4-in-1 _____ Clamshell _____

Reach: _____ feet (from centerpin)

Working reach: _____ feet

Boom length: _____ feet

Miscellaneous:

Rippers: Yes _____ No _____, ripping depth _____ feet. Number of rippers _____

Winch: Yes _____ No _____

Length of winch line _____ feet, cable diameter _____

Tilting House: Yes _____ No _____

Bed Type: Box _____ or trough (rock) _____ Capacity _____ yd³

Are you willing to haul rock? Yes _____ No _____

Transmission: If track mounted, does it have power shift? Yes X No _____

Other: _____

SUPPLEMENTAL QUESTIONNAIRE

Type of Equipment (Maintained and Operated): 988 CAT LOADER 84Make: CATModel: 988Year: 1974Serial Number: 87A9120Owner: REAROT + GINGER BARBERBusiness phone: 839 3077Home phone: SAMEOperator: REAROT BARBERPhone: 839 3077

Contractor's Comments: _____

Present Location of Equipment: HickoryvilleRate per hour is \$ 124.90 (equipment rate + operator rate)Contractor or Operator rate per hour is \$ 28.42

Safety Equipment in working order:

Seat belts: Yes ☒ No ☐Fire extinguisher: Yes ☒ No ☐Back up alarm: Yes ☒ No ☐Roll protection: Yes ☒ No ☐Spark arrestor: Yes ☒ No ☐

General:

Capable of self-transportation between sites? Yes ☒ No ☐Maximum working slope - uphill % downhill % sideslope %Maximum traveling slope - uphill % downhill % sideslope %

Road surface requirements _____

What is cruising speed? 18 mph

Equipment SpecificationsWeight: 36 tonsHorsepower: 270Wheel Mounted: x Track Mounted: Grouser Height: Track Width: Blade:Type & Size: Straight feet U-Blade feet Angle feetManeuverability: 2 way 4 way 6 way 8 way Digging Depth: inchesLift: Height 5 feetTilt: Hydraulic Manual Degrees or inches Angle: Hydraulic Manual Degrees or inches Pitch: Hydraulic Manual Degrees or inches Note:Lift means entire blade moving up and down.Tilt means top of blade curving down.Angle means side edges of blade moving out or in from bulldozer.Pitch means side edges of blade moving up or down.Buckets:Type: Standard 7yd 4-in-1 Clamshell Size: (yd³) Standard 4-in-1 Clamshell Reach: feet (from centerpin)Working reach: feetBoom length: feetHydraulically operated bucket clamp: Yes No ✓Miscellaneous:Rippers: Yes No , ripping depth feet. Number of rippers Brushrake: Yes No , Number of teeth , tooth length ,
rake width Winch: Yes No Length of winch line feet, cable diameter Tilting House: Yes No Bed Type: Box or trough (rock) Capacity yd³Are you willing to haul rock? Yes ✓ No Transmission: If track mounted, does it have power shift? Yes No Other:

SUPPLEMENTAL QUESTIONNAIRE

Type of Equipment (Maintained and Operated): Excavator

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Make: Bucyrus - ErieModel: 300HYear: 1980Serial Number: 139718Owner: Carl M. Kjer & SonsBusiness phone: 822-1663Home phone: SameOperator: Charles GienniniPhone: 725-2359Contractor's Comments: The Operator's maybe changed because of Seniority and availability.Present Location of Equipment: 420 South G Street Arcata, Calif. 95521Rate per hour is \$ 106.00 (equipment rate + operator rate)Contractor or Operator rate per hour is \$ 33.83

Safety Equipment in working order:

Seat belts: Yes ☐ No ☒Fire extinguisher: Yes ☒ No ☐Back up alarm: Yes ☐ No ☒Roll protection: Yes ☐ No ☒Spark arrestor: Yes ☒ No ☐

General:

Capable of self-transportation between sites? Yes ☐ No ☒Maximum working slope - uphill 94% downhill 45% sideslope 30%Maximum traveling slope - uphill 94% downhill 94% sideslope 50%Road surface requirements 11 FootWhat is cruising speed? 2.5 M.P.H.

Equipment SpecificationsWeight: 57,800 lbs.Horsepower: 176 Hp.Wheel Mounted: Track Mounted: X Grouser Height: 3/4" Track Width: 10'-6"Blade:Type & Size: Straight feet U-Blade feet Angle feetManeuverability: 2 way 4 way 6 way 8 way Digging Depth: 21'-0" inchesLift: Height 28'-3" feetTilt: Hydraulic Manual Degrees or inches Angle: Hydraulic Manual Degrees or inches Pitch: Hydraulic Manual Degrees or inches Note:Lift means entire blade moving up and down.Tilt means top of blade curving down.Angle means side edges of blade moving out or in from bulldozer.Pitch means side edges of blade moving up or down.Buckets:Type: Standard X 4-in-1 Clamshell Size: (yd³) Standard 1 *4-in-1 Clamshell Reach: 32'-9" feet (from centerpin)Working reach: 25' feetBoom length: 21' feetHydraulically operated bucket clamp: Yes No X*Rated Capacity
1 1/4 yd³ Heaped CapacityMiscellaneous:Rippers: Yes No X, ripping depth feet. Number of rippers Brushrake: Yes No X, Number of teeth , tooth length ,
rake width Winch: Yes No XLength of winch line feet, cable diameter Tilting House: Yes No XBed Type: Box or trough (rock) Capacity yd³Are you willing to haul rock? Yes No Transmission: If track mounted, does it have power shift? Yes X No Other:

SUPPLEMENTAL QUESTIONNAIRE

Type of Equipment (Maintained and Operated): Dragline & ClamshellMake: Bucyrus - ErieModel: 25B Heavy Duty Series IIIYear: 1972Serial Number: 13132ZOwner: Carl M. Kjer & SonsBusiness phone: 822-1663Home phone: SameOperator: Carl M. KjerPhone: Same

Contractor's Comments: _____

Present Location of Equipment: 420 South G Street Arcata, Calif.Rate per hour is \$ 110.⁰⁰ (equipment rate + operator rate)Contractor or Operator rate per hour is \$ 34.¹²

Safety Equipment in working order:

Seat belts: Yes _____ No XFire extinguisher: Yes X No _____Back up alarm: Yes _____ No XRoll protection: Yes _____ No XSpark arrestor: Yes X No _____

General:

Capable of self-transportation between sites? Yes _____ No XMaximum working slope - uphill 0 % downhill 0 % sideslope 0 %Maximum traveling slope - uphill 0 % downhill 0 % sideslope 0 %Road surface requirements 12 Ft.What is cruising speed? 1 M.P.H.

Equipment SpecificationsWeight: 66,000 lbs.Horsepower: 115 H.P.Wheel Mounted: _____ Track Mounted: X Grouser Height: _____ Track Width: 11'-2"Blade:

Type & Size: Straight _____ feet U-Blade _____ feet Angle _____ feet

Maneuverability: 2 way _____ 4 way _____ 6 way _____ 8 way _____

Digging Depth: 80' ± inchesLift: Height 60 feet

Tilt: Hydraulic _____ Manual _____ Degrees or inches _____

Angle: Hydraulic _____ Manual _____ Degrees or inches _____

Pitch: Hydraulic _____ Manual _____ Degrees or inches _____

Note:Lift means entire blade moving up and down.Tilt means top of blade curving down.Angle means side edges of blade moving out or in from bulldozer.Pitch means side edges of blade moving up or down.Buckets:

Type: Standard X 4-in-1 _____ Clamshell X
 Size: (yd³) Standard 3/4 4-in-1 _____ Clamshell 3/4
 Reach: 80' ± feet (from centerpin)
 Working reach: 80' ± feet
 Boom length: 60' feet
 Hydraulically operated bucket clamp: Yes _____ No X

Miscellaneous:

Rippers: Yes _____ No X, ripping depth _____ feet. Number of rippers _____
 Brushrake: Yes _____ No X, Number of teeth _____, tooth length _____,
 rake width _____
 Winch: Yes X No _____
 Length of winch line 100' feet, cable diameter 1"
 Tilting House: Yes _____ No X
 Bed Type: Box _____ or trough (rock) _____ Capacity _____ yd³
 Are you willing to haul rock? Yes _____ No X
 Transmission: If track mounted, does it have power shift? Yes _____ No X

Other: _____

SUPPLEMENTAL QUESTIONNAIRE

Type of Equipment (Maintained and Operated): DozerMake: CaseModel: 850BYear: 1980Serial Number: 7078751Owner: Carl M. Nier & SonsBusiness phone: 822-1663

Home phone: _____

Operator: Ted HelmPhone: 822-3349

Contractor's Comments: _____

Present Location of Equipment: 420 South G Street Arcata, Calif.Rate per hour is \$ 55.00 (equipment rate + operator rate)Contractor or Operator rate per hour is \$ 32.83

Safety Equipment in working order:

Seat belts: Yes X No _____Fire extinguisher: Yes X No _____Back up alarm: Yes X No _____Roll protection: Yes X No _____Spark arrestor: Yes X No _____

General:

Capable of self-transportation between sites? Yes _____ No XMaximum working slope - uphill 70% downhill 70% sideslope 30%Maximum traveling slope - uphill 80% downhill 80% sideslope 50%Road surface requirements 8 ft.What is cruising speed? 6.3 M.P.H.

Equipment SpecificationsWeight: 20,000 lbs.Horsepower: 85 H.P.Wheel Mounted: _____ Track Mounted: X Grouser Height: 2.06" Track Width: 107"Blade:Type & Size: Straight _____ feet U-Blade _____ feet Angle X feetManeuverability: 2 way _____ 4 way _____ 6 way X 8 way _____Digging Depth: 18" inchesLift: Height 36" feetTilt: Hydraulic X Manual _____ Degrees or inches 15"Angle: Hydraulic X Manual _____ Degrees or inches 0°-25°

Pitch: Hydraulic _____ Manual _____ Degrees or inches _____

Note:Lift means entire blade moving up and down.Tilt means top of blade curving down.Angle means side edges of blade moving out or in from bulldozer.Pitch means side edges of blade moving up or down.Buckets:

Type: Standard _____ 4-in-1 _____ Clamshell _____

Size: (yd³) Standard _____ 4-in-1 _____ Clamshell _____

Reach: _____ feet (from centerpin)

Working reach: _____ feet

Boom length: _____ feet

Hydraulically operated bucket clamp: Yes _____ No _____

Miscellaneous:Rippers: Yes _____ No X, ripping depth _____ feet. Number of rippers _____Brushrake: Yes _____ No X, Number of teeth _____, tooth length _____, rake width _____Winch: Yes X No _____Length of winch line 50' feet, cable diameter 3/4"

Tilting House: Yes _____ No _____

Bed Type: Box _____ or trough (rock) _____ Capacity _____ yd³

Are you willing to haul rock? Yes _____ No _____

Transmission: If track mounted, does it have power shift? Yes X No _____Other: _____



Unit: 83-1 Date: 6-20-1983, PP15, SOC



Unit: 83-1 Date: 10-6-1983, PP15, SOC



Unit: 83-1 Date: 6-22-1983, PP25A, SOC



Unit: 83-1 Date: 10-6-1983, PP25A, SOC, 35mm



Unit: 83-1 Date: 7-1-1983, PP25A, SOC



Unit: 83-1 Date: 6-22-1983, PP28A, SOC



Unit: 83-1 Date: 10-6-1983, PP28A, SOC



Unit: 83-1 Date: 8-13-1983, PP28A, SOC



Unit: 83-1 Date: 8-16-1983, OS E 25+82, SOC



Unit: 83-1 Date: 9-27-1983, DD E 137+28, SOC



Unit: 83-1 Date: 8-12-1983, DS E 23+20, SOC