

Summary Report

WATERSHED REHABILITATION UNIT 98-3

M-Line/Redwood Creek Trail

Phase I: Forty-four Creek to C-12

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Introduction

Redwood Creek drains a 280-square-mile watershed in the mountainous, coastal region of northwestern California. The watershed is characterized by high relief, steep unstable slopes, and narrow valley bottoms. Redwood Creek and its tributary streams are subject to frequent flooding from winter storms, and basin soils are naturally unstable and highly erodible. Landslides and earthflows are widespread, and even under natural conditions streams swelled by winter rains transport large volumes of sediment. With over 90% of the forests in the basin harvested, and _ of the basin in active timber management, sediment levels in Redwood Creek are twice the mean annual erosion rates for the north coast (U.S. Congress, House, Committee on Government Operations 1976).

Redwood National Park (RNP) is located in the lower 1/3 of the Redwood Creek watershed. Redwood National Park was established "in order to preserve significant examples of the primeval coastal redwood (*Sequoia sempervirens*) forests and the streams and seashores with which they are associated for purposes of public inspiration, enjoyment, and scientific study" (Public Law 90-545). Original boundaries protected a ½-mile wide corridor of forest along the lower _ of Redwood Creek. Lands located upslope and upstream of this corridor remained in private ownership. Prior to the establishment of the park, much of these lands were forested with old growth mix conifer forests. Subsequent to the park's establishment, these lands were subject to aggressive timber harvesting. This timber harvesting and the related road construction adversely influenced erosion rates, sediment deposition and water quality within the entire basin. Studies indicated these activities caused unnatural and excessive erosion that resulted in adverse impacts to riparian habitat, anadromous fisheries, and amphibian species (Narver, 1971). The existence of several hundred miles of major haul roads and thousands of miles of tractor trails created severe erosion problems. The cutting of logging roads into steep slopes often resulted in massive slope failures, causing sediment to be delivered directly into perennial and intermittent stream channels. Surface runoff was intercepted and concentrated by inboard ditches along these roads, and often discharged onto slopes that had no natural drainage channels, resulting in severe gullyng. During major storms, culverts and inboard ditches often became blocked, and water was diverted onto road surfaces, causing new gullies and saturating road fills, which in turn led to slope failures. Natural deep-seated mass movements in the prairies in the watershed were also greatly aggravated by roads. Road construction across unstable prairie grasslands altered natural drainage patterns, often resulting in deep gullies. The altering of drainage patterns, the resulting loss of top soil, soil compaction, and destruction of ground cover,

combined with increase runoff rates were among the results of logging activities in the Redwood Creek basin. These factors led to increased sedimentation, increased streamside slope failures, greater bank erosion and loss of anadromous fish-spawning habitat. These events led to a general degradation of the watershed, including damage to the aquatic and riparian environments of the Redwood Creek corridor.

"In order to protect existing irreplaceable Redwood National Park resources from damaging upslope and upstream land uses, to provide a landbase sufficient to insure preservation of significant examples of the coastal redwood in accordance with the original intent of Congress, and to establish a more meaningful Redwood National Park for the use and enjoyment of visitors," Congress enacted the expansion legislation of 1978 (Public Law 95-250). The boundaries of Redwood National Park were expanded by approximately 48,000 acres, and Congress directed the National Park Service to undertake a watershed rehabilitation program. The primary goals of the rehabilitation program are to minimize man-induced erosion and speed the natural revegetation process by restoring the hillslope hydrology to conditions that existed prior to man's influence.

It is National Park Service policy to "actively seek to understand and preserve the soil resources of parks and to prevent, to the extent possible, the unnatural erosion, physical removal, or contamination of the soil, or its contamination of other resources..." It is also Park Service policy that "Terrain and plants may be manipulated where necessary to restore natural conditions on lands altered by human activity. Management activities may include, but will not be restricted to, removing constructed features, restoring natural gradients, and revegetating with native park species..." (National Park Service Management Policies, 1988). Management objectives of Redwood National Park are "to restore and/or maintain the natural ecosystems of the park" and "to continue with biological and physical restoration of park lands severely impacted by past land-use practices" (Redwood National Park, Statement for Management, 1992). These policies and objectives provided the guidance and direction for the removal of this portion of the M-Line.

Project Background and Description

The M-Line, constructed in the early 1950s by Georgia Pacific Timber Company, is the only major haul road remaining in Redwood National Park that lies immediately adjacent to Redwood Creek. Approximately 8 1/2 miles of the M-Line, from the downstream park boundary up to the Tall Trees Grove, the preeminent treasure of Redwood National Park, is used as the Redwood Creek Trail. This section of the M-Line is located within the inner gorge of Redwood Creek in some of the most unstable and erodible terrain in the entire park. This terrain is characterized by soils that are prone to gullying and landscapes that exhibit large scale mass wasting. This terrain has the greatest potential for slope instabilities where roads and skid trails cross steep slopes and wet soils located in headwater swales or along inner gorge slope positions. This project was the second phase in a multi-phase project to treat and remove erosion problems associated with the 1 1/2 miles of the M-Line between Fortyfour and Tom McDonald creeks. This project began treating erosion problems associated with the 1/2 mile of the M-Line located immediately north of Tom McDonald Creek.

Multiple timber harvests were conducted during the early 50's and 60's in the project area. The predominant use of tractors for yarding timber resulted in a dense skid road network and major disruption of natural hydrologic conditions, including large gullies and slope failures due to diversions of surface and stream flows, reactivation of dormant mass wasting features, and in a number of failing roads and road-stream crossings. These conditions have led to an increase in hillslope erosion and sedimentation in Redwood Creek, threatened and destroyed irreplaceable park resources, and left indelible scars within view of the Tall Trees Grove.

The Redwood Creek Trail, located on this section of the M-Line, is one of the most highly used trails in Redwood National Park. This trail provides access to some of the most beautiful territory in the park. It is also plagued with many erosional problems. Many of these have created disturbing impacts to the very resources visitors come to appreciate. Combating these impacts has required a continued high level of maintenance due to upslope and downslope erosion and sedimentation and the size and age of the road. During periods of heavy rainfall and runoff,

large quantities of organic debris and sediment have been transported, and inboard ditches were frequently plugged and overwhelmed. Plugged ditches caused flow to be diverted by the M-Line, often resulting in considerable gullying downslope. Poorly draining inboard ditches also allowed water to pond and overflow, often resulting in saturated road fill and subsequent fill failures. Large scarps formed from debris flows, block slides and sidecast fill failures have posed safety hazards to visiting public and often required the construction of protective railings and pedestrian foot bridges. Continued erosion of many of these features has destroyed many trail infrastructures, including portions of the remaining road bench, several footbridges and protective railings. Continuing erosion will require construction of larger, more expensive infrastructures and rerouting the trail around road failures. Woody debris incorporated in the road fill is decaying and undermining the integrity of the fill prism increasing the likelihood of fill failure. As the road ages, the rate of deterioration increases creating an exponential increase in maintenance needs. Adequately maintaining the M-Line (now approaching 50 years in age) and the Redwood Creek Trail in a stable condition has continually drained maintenance and resource management resources and diverted limited funds from other critical problem areas in the park.

Prior to 1997, treatment of the erosion problems associated with the M-Line was considered to be of low priority. This prioritization was initially based upon results of a road inventory conducted between 1990 and 1993 on the remaining roads located in the Redwood Creek basin of Redwood National Park. However, the decision to remove this portion of the M-Line resulted from the damage incurred during the New Years storm of 1997. This storm event caused significant amounts of resource damage due to catastrophic fill failures and debris flows associated with many of the remaining roads in the Redwood Creek basin of Redwood National Park. The total estimated volume of material eroded by this storm was on the order of 600,000 yds³. Road failures occurred predominately on the west side of Redwood Creek, on lands underlain by the Redwood Creek schist. Many of the failures were debris flows which occurred along road segments located within headwater swales or regions where roads had become saturated due to poorly drained or non-functioning inboard ditches. Few of the failures and a minimal amount of the eroded material were the result of failing road-stream crossings. The failures and damage due to this storm further justified the necessity of treating the entire road segments.

Watershed Rehabilitation Unit 98-3 is located on the west side of Redwood Creek, approximately 12 miles southeast of Orick, California (Figure 1). Unit 98-3 is the second of a multi-phase project to remove the segment of the M-Line between Tom McDonald and Forty-four Creeks and treat erosion problems along the slopes adjacent to this section of the M-Line. This project planned on addressing accelerated erosion problems along the 0.55 miles of the M-Line located immediately north of Tom McDonald Creek. Additionally, erosion problems along 0.22 miles of the M-10, a secondary haul road, and 0.11 miles of spur roads were to be treated. Restoration focused primarily on stabilizing side cast fill, and restoring natural hillslope topography and drainage patterns altered by the M-Line. Recovered organic and nutrient rich side cast was returned to the surface in order to help speed recovery of native vegetation. Vegetation disturbed during excavation was stockpiled and dispersed along the finished surface in order to provide habitat and simulate natural forest litter. This project had a designed excavation of over 51,500 yds³ of fill material, including 32,000 yds³ associated with outslipping, 12,200 yds³ associated with export outslipping and 7,000 yds³ of stream crossing excavations. Methodology for road removal was consistent with past rehabilitation projects, employing heavy equipment for all excavations. Excavations were executed through IFB Contract (CX# 1443CX8530-98-009), and work was performed by Barber Construction Company of Blue Lake, California. Project costs are summarized in Table 1.

Geology

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

Deformation from tectonic emplacement, likely by subduction, and from brecciation along high angle faults, has resulted in intense fracturing and pervasive shearing. The intensity and style of this deformation seems to be the rock characteristic that most influences differences in the erosion rates and landforms (Janda, unknown). This region is subject to high erosion rates due to geologically rapid tectonic uplift, the pervasively sheared and faulted condition of the underlying lithologies and the imprint of complex, highly disruptive land use activities (Janda and others, 1975).

Rehabilitation Unit 98-3 is situated on the west side of the Redwood Creek basin, immediately adjacent to Redwood Creek (Figure 2). It is entirely underlain by the intensively sheared and complexly folded Redwood Creek schist. Considerable variations in mineralogy, texture, structure, and lithology occur within this unit. However, the intense shearing and complex folding have precluded mapping subunits within the schist.

Within the schist terrane in the Redwood Creek basin, there are a large number of “trough-shaped” first-order drainages ranging in area from a few hectares to over a square kilometer. These appear to have been formed by mass-movement rather than fluvial processes. Creep and blocksliding that occur over large, undefined portions of hillslopes have been shown to be important mass-movement processes on areas underlain by schist bedrock (Sonnevil et. al., 1985). Active blocksliding is most common in areas where the bedrock consists predominately of sheared black schist. The morphology of Watershed Rehabilitation Unit 98-3 is characteristic of the schist terrane; this morphology is represented by an undulating surface of first-order basins.

Land Use History

The project area has been dominated by only one style of land use, timber harvesting, which began in the early 1950's. The extensions of the M-Line and the C-Line into the Redwood Creek basin, apparent in air-photos dating to 1954, provided a direct access from the west to timber in the lower Redwood Creek basin. The M-Line was a major haul road originating from Georgia Pacific mills located at Crannell, in the Little River basin. The C-Line was a major haul road originating from Georgia Pacific mills located along Big Lagoon. By 1954, the C-Line and the M-Line were connected by the secondary haul road, the C-12.

The logging history within Unit 98-3 is characterized by a succession of multiple entries of selective harvesting. The first entry began in the early 50's, likely coincident with the construction of the M-Line. During this entry, selective harvesting and seed-tree-leave method were utilized. Most of the timber harvesting concentrated on the lands bounded between the M-Line and Redwood Creek. Minimal amount of land above the M-Line was harvested; this was restricted to a very narrow corridor immediately adjacent to the M-Line. All timber harvesting was tractor yarded.

Between 1954 and 1962, timber harvesting and road construction accelerated substantially. Predominate road construction included the secondary haul road, the M-10, which extended up into Tom McDonald creek. All timber harvesting was selective and seed-tree-leave method and all was tractor yarded. Lands harvested were bounded by the M-Line, downslope, the M-10, to the south, and the C-12, located along the ridge. No lands below the M-Line were harvested. Additionally, a spur road was constructed from the M-Line down to redwood Creek. This road was located near the junction of the M-Line and the C-12. This road's primary purpose was to gain access to redwood Creek for mining river run rock to surface roads.

Between 1962 and 1968, timber harvesting concentrated on removing the majority of the seed trees left in 1962. This activity revisited lands harvested between 1954 and 1962. No lands below the M-Line were harvested. All timber harvesting was tractor yarded.

In 1968, the park was created and the entire hydrologic boundary of the unit area fell within the original park boundary. None of these lands were harvested again.

After the creation of the park in 1968, the M-Line was relegated to becoming a very impressive and rather statuesque

“trail.” Hence, the M-Line went from being a major haul road to a trail. (Bureaucratic rehabilitation at its apex!) After the establishment of the M-Line as a trail, all major road-stream crossings (Tom McDonald, Forty-four, Bond, and Elam creeks) were removed. Additionally, culverts used for ditch relief and minor road-stream crossings were removed and replaced with cross road drains.

Erosional Features

The M-Line/Redwood Creek Trail and slopes adjacent to it have had a marked history of erosion, both natural and management related. Naturally, the landscape is defined by a number of “trough-shaped”, first-order drainages characteristic of the schist terrane of Redwood Creek. These drainages have the appearance of having been created by mass-movement rather than fluvial processes. The most prominent mass-movement process in this area is the result of large-scale (several hectares to over a square kilometer) block-sliding.

Superimposed on this naturally unstable setting is the signature associated with road building and timber management. Historically, the M-Line has had some impressive bouts with both fluvial and mass-wasting processes. The most prominent of these is the mass-wasting associated with large fill-failures. Within the unit area, five significant fill failures were directly associated with the M-Line. Three of these failures were significant enough to have direct deposition into Redwood Creek. All of these failures were associated with the proximity of the M-Line constructed through headwater swales of “trough-shaped”, first-order drainages. Additionally, no drainage structures existed in any of these drainages.

The hillslopes below the M-Line were also plagued by a number of fill failures associated with smaller skids and layouts constructed during timber harvesting. Many of these features were untreatable. The damage had occurred and there was little possibility for rectifying conditions.

The spur road constructed down to Redwood Creek also had a history of fill failures, several that eliminated access to the lower half of the road. The lower stretch of the road is located immediately above Redwood Creek and the failures resulted in 100% delivery of sediment to Redwood Creek. The final phase of treatment along the remaining stretch of this portion of the M-Line will address the lower half of the road.

Fluvial erosion along the M-Line and the adjacent hillslopes was predominately gully erosion. This gully erosion was predominately caused by the concentration of runoff by the M-Line and the subsequent diversion by cross road drains and ditch relief culverts. None of the existing gullies were treated, instead treatment concentrated on dispersing runoff and eliminating diversions.

No road-stream crossings were treated during this project.

Wildlife Concerns and Work Schedule

The U.S. Fish & Wildlife Service (FWS), as administrator of the Endangered Species Act, has set noise restriction guidelines for management projects that do not remove or degrade suitable habitat for both the northern spotted owl and the marbled murrelet. These noise restrictions are designed to reduce human impact to nesting sites during the breeding season and apply to management projects that are located within a ¼ mile radius of suitable habitat.

Project 98-3 was located entirely inside of the ¼ mile radius for suitable habitat. Therefore heavy equipment work was restricted from beginning before September 15th. On September 3, the contract was awarded to Lambert's Excavating Service of Arcata, California and the contractor was notified to proceed with work on September 23. The contractor began moving equipment onto the site that day. On September 29, the contractor moved an excavator on site and began excavating that afternoon. The contractor typically used only 2 pieces of equipment to complete the contract. There were 3 days near the end of the equipment season of 1997 where a third piece of equipment was brought on site.

The contractor, Larry Lambert, was the operator for the excavator. Ernie Larkin, Jay Franke, and Paul Curtright were sub-contractors and all operated bulldozers.

Heavy equipment typically operated six days a week, weather permitting. Hours of operation were typically sunrise to sunset, approximating 12 hours per day.

Contractor worked until November 20 when National Marine Fisheries Service (NMFS) issued a mandatory suspension on all excavations. The contractor winterized the site on November 21 and a seasonal suspension was issued. The contractor removed all equipment from the site during the winter.

On September 10, 1998, the contractor resumed operations and completed the final phase of the contract on September 21, 1998.

Project Implementation

The geologist for this project was M. Sanders. It was the project geologist's responsibility to perform all evaluation and formulation of rehabilitation prescriptions, complete the surveying and photo-documentation, generate plansheets and technical specifications for contracting, oversee heavy equipment operations as the contracting officer's technical representative, and complete final documentation.

Watershed Rehabilitation Unit 98-3 addressed accelerated erosion problems along the 2717 feet of the M-Line located between Forty-four Creek and the C-12 road. Additionally, erosion problems along 1963 feet of secondary haul roads were treated. This project involved the excavation of over 76,500 yds³ of fill material, including 47,931 yds³ associated with export outslowing and 30,493 yds³ associated with outslowing.

On the M-Line, 1313 feet of road was outslowed and 25,072 yds³ of fill excavated. Additionally, 1168 feet of road was export outslowed and 42,195 yds³ of fill excavated. For the secondary haul roads, 1160 feet was outslowed and 5,421 yds³ of fill excavated. Additionally, 803 feet of road was export outslowed and 5,736 yds³ of fill excavated (Fig 4).

Export Outslowing

Export outslope (EOS) treatments are performed where the road fill needs to be endhauled to a stable fillsite. All endhauling on this project was performed either by dozer (in which case the material is pushed) or loader. Eight EOS treatments were performed on project 98-3. Costs for these treatments are summarized in Tables 1 and 2.

The EOS prescription was used to treat sections of road constructed through first-order drainages.

Outslowing

Outslowing (OS) treatments are used to reconstruct the original contours along a road corridor. This involves the removal of fill from the outboard edge of a road and placing it along the cutbank. Recontouring restores natural drainage patterns and results in the recovery of original side cast soil elements. Recovering the original sidecast topsoil from the outboard edge of the road and distributing it across the finished excavation enhances the process of revegetation dramatically (Popenoe and Martin, 1990). In addition, the dispersal of organics (i.e. trees, sidecast logs and rootwads, etc.) along the finished slopes is believed to provide additional organic material for revegetation as well as provide suitable habitat for wildlife.

Excavation rates for outslope treatments are summarized in Table 4. Variations in excavation rates along OS reaches were the result of site specific conditions. Production rates were the highest when the D9H could retrieve the bulk of the fill, the 245 pulled the remainder and the D6D finished the slopes. Where a piece of equipment was restricted, production rates fell. The lower rates were attributed to limited access of the D9H to the bulk of fill or to stretches of the K&K that had steep sideslopes. In these cases, the excavator not only retrieved the sidecast fill but also was used to dress up the finished slope.

Miscellaneous Bid Items

Miscellaneous bid items on this project included Move In and Move Out costs. All of these miscellaneous bid items were Lump Sum items. Table 5 provides a cost breakdown for miscellaneous bid items.

Non-Bid Items

Non-bid items are categorized as jobs that result in non-recoverable costs on the part of the contractor. These items are distinguished by requiring time that is not directly attributable to any specific bid item. Times for non-bid items are recorded to compare the costs of contract with that of hourly rentals. Table 6 provides a cost breakdown for Non-bid items.

Discussion time is defined as periods of time where equipment operations were interrupted by discussions lasting more than 15 minutes. Typically the operators would stop to discuss the progress of a particular phase of a bid item or develop a strategy for the work. Other times would include the contractor discussing the operations of the equipment. On occasion, the C.O.T.R. or site inspector would interrupt the operators to make sure that the specifications of the contract are understood and would be met.

Downtime occurred when equipment was unable to perform in its expected capacity. Downtime was most often the result of mechanical failure, predominately the rupturing of a hydraulic line. Downtime also included time equipment was either stuck or assisting in the rescuing of stuck equipment.

Fueling equipment and routine servicing were also included as a non-bid item. These times are a given necessity for the operations of equipment but could not be attributed to a specific job item. Consequently, these are also looked upon as an inherent cost to the contractor.

Idle time for equipment was recorded as a non-bid item but is markedly different than the previous items. Idle time represents the time a piece of equipment was inactive while work proceeded. Idle time differs from downtime in that the equipment operable but the contractor or operator chooses not to use it (see Table 6).

Discussion

The removal of this portion of the M-Line and associated secondary roads was the action most consistent with National Park Service Management Policies, PL 95-250 Section 101(6), 1980 General Management Plan, 1992 Statement for Management, and the 1981 Watershed Rehabilitation Plan. The implementation of this project greatly reduced the threat associated with unnatural sedimentation associated with the road and disturbed hillslopes. Diversion potentials were eliminated through the restoration of natural hillslope topography and drainage patterns. This restoration minimized the potential for both hillslope and sidecast failures and delivery of unnaturally large quantities of sediment to Redwood Creek and its tributaries. The recovery of nutrient and organic-rich soil should greatly speed the recovery of native vegetation. The thorough treatment of this portion of the M-Line and surrounding hillslopes has reduced the impacts to downstream resources in the Redwood Creek watershed, eliminated the costly drain on maintenance resources, and enhanced the visitor experience in this easily accessible portion of

Redwood National Park.

Success of this project did not come about without setbacks. In spite of the contractor's diligence, several factors seemed to create delays in completing this contract in a timely manner. To begin with, the contractor had difficulty securing an excavator. This was believed to be a consequence of the large number of construction projects that resulted from the damages of the New Years storm of 1997. No sooner had the contractor secured an excavator and work began, the forecasted rains of El Nino began. The rains of El Nino proved rather relentless and plagued the contractor throughout the equipment season of 1997. In spite of these rains, the contractor and his subcontractor were able to perform quite remarkably in the adverse conditions.

The conditions resultant by these rains also created additional headaches for the contractor. The main headache was the access road (the C-12). Because this road was unrocked, travel during rain resulted in the road surface becoming a mire of mud. This required the contractor to divert the dozer on occasion to blade off the mud to make the road passable.

One of the most adverse incidents that cost the contractor a large quantity of time was the mechanical failure of his Caterpillar D8H bulldozer. On the 7th day of equipment operations, the dozer began to run very poorly. Ernie Larkin thought that there may have been water in the fuel filters and went through a cursory check. However, all diagnosis failed to turn up a cause for the poor performance. Not until Ernie got more into the engine did he discover that the dozer had broke a valve lifter. To fix this, Ernie needed to get the dozer up to his equipment yard in Arcata. However, the work he did to discover the problem left the dozer inoperable. This required the contractor to tow the dozer up to a spot where it could be loaded onto a lowboy.

In order to tow a dozer, you need to have a dozer!! So the contractor was stuck between the proverbial rock and a hard spot. First, Larry needed to secure another dozer. He was able to get a dozer from Wendell Larkin. However, one of the setbacks with Wendell's dozer was the grouse on the pads were greatly worn. These would need to be replaced before the dozer could be used to its full capability. In the meantime, he had Wendell's D8H dozer hauled out to the C-Line. He then used it to tow his own dozer back up the hill to the lowboy. However, the towing was a major challenge.

The towing of a dozer is no small feat. Realize that to begin with a Caterpillar D8H bulldozer weighs in at a mere 96,000 pounds (48 tons). So not only does it take a big 'horse' but also a pretty strong 'rope.' Well, Wendell's bulldozer solved the 'horse' problem. The 'rope' was a number of chokers and straps. The contractor connected one end of the choker to the hook under the belly pan of the broken dozer; the other to the tow hitch on Wendell's dozer. The next task was just to pull. Well, that worked for about 20 feet when the first choker broke! So another one was used and it lasted until the dozer was hauled to the C-12. There the sharp bend at the intersection was more than the choker could tolerate and it broke. Ernie then straightened out the broken dozer by knocking it with the good dozer, another choker connected and then started hauling up the C-12. While hauling up the hill, Larry followed in the excavator to act as a brake should the dozer break free. The next choker broke at Forty-four Horse Camp. The next choker made it mid-way between the contractor's camp and the G-6-1. The final choker was connected and the towing commenced.

Shortly up the road, the road took a slight jog to the left. To prevent snapping the last choker, Ernie wanted to get a side pull on the broken dozer so he backed down and saddled over to the left. When he realized tension on the choker, it slipped off the hook on the belly pan of the broken dozer. This left the broken dozer on a steep incline with no brakes and no tow line. The consequence of this was that the dozer started to run down towards Larry. Larry was able to use the excavator bucket as a chockstone and stopped the dozer from continuing down the hill. Had it gotten free it probably would have continued all the way down to Redwood Creek!!

The choker was reconnected and towing continued up to the C-Line. Here the sharp bend at the intersection of the C-12 and the C-Line was too much for the choker and it broke. Ernie then got behind the broken dozer and pushed it

the final distance to the lowboy. With a little finesse, Ernie was able to push the dozer onto the lowboy.

There were a few difficulties that resulted in getting the dozer out of the park but through perseverance the dozer was dropped off at Ernie's equipment yard that afternoon.

Wendell's dozer was functional but the lack of decent grousers greatly affected its performance. So the next task for the contractor was to replace the pads and grousers. It took 2 weeks for a new set of pads to arrive at Peterson tractor. It took an additional 2 days to install those pads. At that time, Wendell's D8H bulldozer proved to be a very valuable piece of equipment!!

The combined lost time to the contractor was on the order of 10-14 days. This time is based on actual down time, time spent removing the broken dozer, the time lost due to Wendell's dozer not operating efficiently and replacing the pads. Considering the contract started September 23rd, time was of the essence.

As for the actual performance on the contract, there were many inherent difficulties. The most obvious was the amount of vegetation and large woody debris that needed to be handled. Considering that much of the roadway was overgrown with trees that were at least 30 years old, handling this material was no simple task. Fortunately, Larry and Ernie were able to formulate a very efficient method. Ernie would start the process of brushing the work area and then push the material down the road, out of the way of the worksite. Once the earthwork was completed, he would then push a batch of material back and Larry would spread it around the finished worksite. This caused material to be handled several times but it proved to be much more efficient due to the large worksites and the amount of woody debris.

The actual excavations were problematic too. Much of the problem was the result of the nature of the excavated material. This site was very wet; much of the fill excavated was in varying degrees of saturation. Depending on the degree of moisture in the fill, there was severe limitations to the dozer's ability to actually move the material. This often required the excavator to handle the material several times before the dozer could push the material to a fillsite. While this is one of the inherent uncertainties of the nature of this work, there was one jobsite where it was realized that the design and the actual were substantially different. This was the case on EOS2.

EOS2 was the second in a series of export outslipping prescriptions. This job was also the site of a major debris flow that resulted from the New Years 1997 storm. Excavation of this site was immediately hampered due to the level of saturation of the material. Shortly after excavation began, the dozer was unable to push material due to the likelihood of getting stuck. This required the excavator to handle almost all the material, often times having to double or triple bale the material to a location that the dozer could then push it to a suitable fillsite.

As excavation progressed, it became painfully obvious that the bounds of the swale were much greater than the design envisioned. This was mainly the result of the swale having a large trough-shaped morphology instead of a designed channel morphology. This caused the excavation to go both wider and longer than design.

The other job sites were not without variations from design. However, these variations were not as extreme as that of EOS2. The only jobsites worth mentioning were the last two of the contract. These were EOS5 and EOS S2-1. As with EOS2, these two jobsites required the excavation of a very large trough-shaped drainage. Additionally, the available fillsite for the endhailed material was a considerable push distance of 400+ feet. These two jobsites were begun at the latter part of the equipment season of 1997.

It should be noted that near the end of the season, National Marine Fisheries Service (NMFS) became concerned that equipment was operating in the middle of November. Consequently, NMFS issued a mandatory cessation of equipment operations by November 20th.

It should also be noted that while weather and ground conditions had deteriorated significantly, work was not

occurring in live stream courses nor in areas where sediment could be easily transported to a live stream. I then deferred the decision to continue to the contractor. He and Ernie discussed the matter and felt that they could complete the job by the mandatory shutdown.

Work on these jobsites began on November 13th. As work progressed, both Larry and Ernie realized they needed additional help. Hence, Larry subcontracted Jay Franke to help with the excavation. On November 18th, Jay walked his Caterpillar D8L (Da King) down to the site and joined in on the excavation. Work continued until the afternoon of the 20th when the site was winterized and all excavations were suspended until the following equipment year. The following day, equipment was walked up to the C-Line and the C-12 was winterized.

Equipment operations resumed on September 10th, 1998, and the contract was completed September 21st, 1998.

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TABLE 1							
REHABILITATION WORK COST SUMMARY FOR UNIT 96-2: REMOVAL OF A PORTION OF THE K&K ROAD, PHASE VII							
TREATMENT	QUANTITY	# of JOBS	TOTAL COSTS		% OF GRAND TOTAL USING H.E.R.E. ^(a)	UNIT COSTS	
			CONTRACT	H.E.R.E. ^(a)		CONTRACT	H.E.R.E. ^(a)
HEAVY EQUIPMENT							
STREAM CROSSINGS	0	0	\$0	\$0	0.0	\$0	\$0
EXPORT OUTSLOPING	47931	8	\$134,952.90	\$79,453		\$2.82	\$1.66
OUTSLOPE	30493	7	\$56,941.20	\$36,420		\$1.87	\$1.19
MISC. BID ITEMS ^(b)	---	2	\$14,000	\$0	0.0		
MISC. NON-BID ITEMS ^(c)	---	7	\$0	\$59,730			
SUB-TOTAL:			\$205,894.10	\$175,603			
LABOR INTENSIVE ^(d)							
SUB-TOTAL:			\$0		0.0		
PROJECT IMPLEMENTATION ^(e)							
MAPPING	146 hrs	---	\$1,530				
PRESCRIPTIONS AND LAYOUTS	21 hrs	---	\$1,224				
SURVEYING ^(f)	118 hrs	---	\$2,772				
CONTRACT PREP	68 hrs	---	\$1,206				
HEAVY EQUIPMENT SUPERVISION	576	---	\$1,908				
PHOTO DOC	12 hrs	---	\$432				
REPORT	hrs	---	\$0				
CONTRACT ADMINISTRATION	130 hrs	---	\$1,116				
SUB-TOTAL:	496 hrs	---	\$10,188				
		GRAND TOTAL:		\$76,083	\$51,386	100.0	

**Table 1: Summary Sheet for Volumes, Times, Heavy Equipment Rental Equivalent and Contract Costs, and Production Rates
Watershed Rehabilitation Project 97-3, Removal of a portion of the M-Line/Redwood Creek Trail**

Bid Item	Name	Original Bid	Volume (yds³)	Equipment Hours				Production (yds³/hr)	Totals Costs		
				D8H	690	D8L	892		H.E.R.E.	Actual	
1	Move In	\$7,000.00	1	N/A	N/A	N/A	N/A	N/A	\$0	\$7,000.00	
2	Move Out	\$7,000.00	1	N/A	N/A	N/A	N/A	N/A	\$0	\$7,000.00	
3	EOS 1	\$2.50	1876	8.3	14.6	0.0	0.0	81.9	\$3,035	\$4,690.00	
4	OS 1	\$1.80	4441	24.7	17.3	0.0	0.0	105.7	\$5,633	\$7,993.80	
5	OS 2	\$2.00	2886	7.3	9.9	0.0	0.0	167.8	\$2,287	\$5,772.00	
6	EOS 2	\$2.80	4230	41.9	48.6	0.0	0.0	46.7	\$12,058	\$16,920.00	
7	OS 3	\$2.00	5898	9.8	24.2	0.0	0.0	173.5	\$4,489	\$11,796.00	
8	EOS 3	\$2.50	12436	76.6	50.5	0.0	0.0	97.8	\$17,059	\$31,090.00	
9	OS 4	\$1.80	11847	67.4	62.5	0.0	0.0	91.2	\$17,359	\$21,324.60	
10	EOS 4	\$3.00	1760	8.1	10.8	0.0	0.0	93.1	\$2,514	\$5,280.00	
11	EOS 5	\$2.80	21893	139.8	16.6	19.6	69.0	89.4	\$35,868	\$61,300.40	
12	OS S1-1	\$1.80	2826	15.1	19.1	0.0	0.0	82.6	\$4,552	\$5,086.80	
13	EOS S1-1	\$2.50	2345	7.3	7.5	0.0	0.0	158.4	\$1,975	\$5,862.50	
14	OS S1-2	\$1.80	1110	1.0	5.8	0.0	0.0	163.2	\$891	\$1,998.00	
15	EOS ST1	\$1.50	242	0.5	2.3	0.0	0.0	86.4	\$368	\$363.00	
16	OS S2-1	\$2.00	1485	0.0	9.3	0.0	0.0	159.7	\$1,209	\$2,970.00	
17	EOS S2-1	\$3.00	3149	7.8	28.6	0.0	11.4	65.9	\$6,576	\$9,447.00	
---	Brush	N/A	N/A	27.9	13.7	0.0	1.5	N/A	\$5,839	N/A	
---	Idle	N/A	N/A	62.0	118.7	3.0	17.7	N/A	\$27,274	N/A	
---	Down	N/A	N/A	47.0	16.6	0.0	0.0	N/A	\$8,597	N/A	
---	Discussion	N/A	N/A	5.4	3.8	0.0	3.7	N/A	\$1,815	N/A	
---	Service	N/A	N/A	61.1	25.8	2.3	1.3	N/A	\$12,366	N/A	
---	Walk	N/A	N/A	3.9	2.4	0.0	2.8	N/A	\$1,286	N/A	
---	Winterizing	N/A	N/A	5.9	8.6	3.3	0.0	N/A	\$2,553	N/A	
TOTALS:			78424	628.8	517.2	28.2	107.4		\$175,603	\$205,894.10	

**Table 2: Time, Production Rates, and Total Costs for Export Outslowing Prescriptions
Watershed Rehabilitation Project 97-3: M-Line/Redwood Creek Trail, Phase I**

Table 2: Time, Production Rates, and Total Costs for Export Outslping Prescriptions Watershed Rehabilitation Project 97-3: M-Line/Redwood Creek Trail, Phase I													
Bid Item	Name	Length (ft)	Volume (yds)		Equipment Hours					Production (yds/hr)		Unit Price	Total Costs
					D8H	690	D8L	892					
M-Line:													
3	EOS 1	119	1876		8.3	14.6	0.0	0.0		81.9		\$2.50	\$4,690.00
6	EOS 2	92	4230		41.9	48.6	0.0	0.0		46.7		\$4.00	\$16,920.00
8	EOS 3	294	12436		76.6	50.5	0.0	0.0		97.8		\$2.50	\$31,090.00
10	EOS 4	90	1760		8.1	10.8	0.0	0.0		93.1		\$3.00	\$5,280
11	EOS 5	573	21893		139.8	16.6	19.6	69.0		89.4		\$2.80	\$61,300.40
M-Line Totals:		1168	42195		274.7	141.1	19.6	69.0					\$119,280.40
Skid Roads:													
13	EOS S1-1	263	2345		7.3	7.5	0.0	0.0		158.4		\$2.50	\$5,862.50
15	EOS ST-1	81	242		0.5	2.3	0.0	0.0		86.4		\$1.50	\$363.00
17	EOS S2-1	459	3149		7.8	28.6	0.0	11.4		65.9		\$3.00	\$9,447.00
Skid Road Totals:		803	5736		15.6	38.4	0.0	11.4					\$15,672.50
EOS Totals:		1971	47931		290.3	179.5	19.6	80.4					\$134,952.90

**Table 3: Time, Production Rates, and Total Costs for Outsloping Prescriptions
Watershed Rehabilitation Project 97-3: M-Line/Redwood Creek Trail, Phase I**

Bid Item ^(A)	Name	Length (ft)	Volume (yds ³)		Equipment Hours					Production (yds ³ /hr)		Unit Price	Total Costs
					D8H	690	D8L	892					
M-Line:													
4	OS 1	153	441		24.7	17.6	0.0	0.0		105.7		\$1.80	\$7,993.80
5	OS 2	106	2886		7.3	9.9	0.0	0.0		167.8		\$2.00	\$5,772.00
7	OS 3	301	5898		9.8	24.2	0.0	0.0		173.5		\$2.00	\$11,796.00
9	OS 4	753	11847		67.4	62.5	0.0	0.0		91.2		\$1.80	\$21,324.60
M-Line Totals:		1313	25072		109.2	113.9	0.0	0.0					\$46,886.40
Skid Roads:													
12	OS S1-1	489	2826		15.1	19.1	0.0	0.0		82.6		\$1.80	\$5,086.80
14	OS S1-2	258	1110		1.0	5.8	0.0	0.0		163.2		\$1.80	\$1,998.00
16	OS S2-1	413	1485		0.0	9.3	0.0	0.0		159.7		\$2.00	\$2,970.00
Skid Road Totals:		1160	5421		16.1	34.2	0.0	0.0					\$10,054.80
OS Totals:		2473	30493		125.3	148.1	0.0	0.0					\$56,941.20

