

Summary Report  
WATERSHED RESTORATION UNIT 99-2  
A120 and A100 Road Reconstruction

Becca Smith  
Redwood National Park  
November, 2000

TABLE OF CONTENTS

**INTRODUCTION ..... 4**

    BACKGROUND ..... 4

    SITE DESCRIPTION ..... 4

    GEOLOGY ..... 6

    TIMBER HARVEST HISTORY ..... 8

    EROSIONAL FEATURES ..... 8

    THREATENED AND ENDANGERED SPECIES CONCERNS AND WORK SCHEDULE ..... 8

**RECONSTRUCTION WORK..... 9**

    PROJECT IMPLEMENTATION ..... 9

    HEAVY EQUIPMENT PHASE ..... 11

*Stream Crossing Excavations and Culvert Installations..... 11*

*Culvert Installations..... 12*

*Miscellaneous Work Items..... 14*

*Non-Work Items ..... 15*

    LABOR INTENSIVE PHASE ..... 15

    DOCUMENTATION PHASE ..... 15

**DISCUSSION ..... 16**

**REFERENCES ..... 20**

LIST OF FIGURES

1. Project Location ..... 5

2. Site Locations and Site Specific Treatments ..... 10

LIST OF TABLES

1. Reconstruction Work Cost Summary for Unit 99-2, A120/A100 Roads ..... 7

2. Stream Crossing Excavation Costs and Production Rates for Unit 99-2, A120/A100  
Road Reconstruction ..... 17

3. Culvert Installation Costs for Unit 99-2, A120/A100 Road Reconstruction ..... 17

4. Miscellaneous Work Item Costs for Unit 99-2, A120/A100 Road Reconstruction ..... 18

5. Non-Work Item Costs for Unit 99-2, A120/A100 Road Reconstruction ..... 19

## INTRODUCTION

### *Background*

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 2/3 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) manages the lower 1/3 of the Redwood Creek watershed.

Public Law 95-250 (March 27, 1978) directed that a watershed restoration program be developed for lands that had been timber harvested prior to becoming part of Redwood National Park. Timber harvesting and road construction that occurred on these lands before they were added to the park had adversely influenced erosion rates, sediment deposition, and water quality within the entire basin. These problems are being addressed in the restoration program. The purpose of the restoration program is to minimize human-induced erosion within Redwood National Park, encourage the return of a natural pattern of vegetation, and protect redwood groves and aquatic communities. Ultimately, these efforts should result in the restoration of natural ecosystems to conditions similar to what would have existed without disturbance by humans. (Redwood National Park, Watershed Rehabilitation Plan, 1981)

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).

### *Site Description*

The project area is located approximately five miles northeast of Orick at an elevation ranging from approximately 850 to 1740 feet above sea level (Figure 1). The A100 and A120 were haul roads constructed prior to 1954. They are located on the east side of the Redwood Creek basin within the Lost Man Creek watershed.

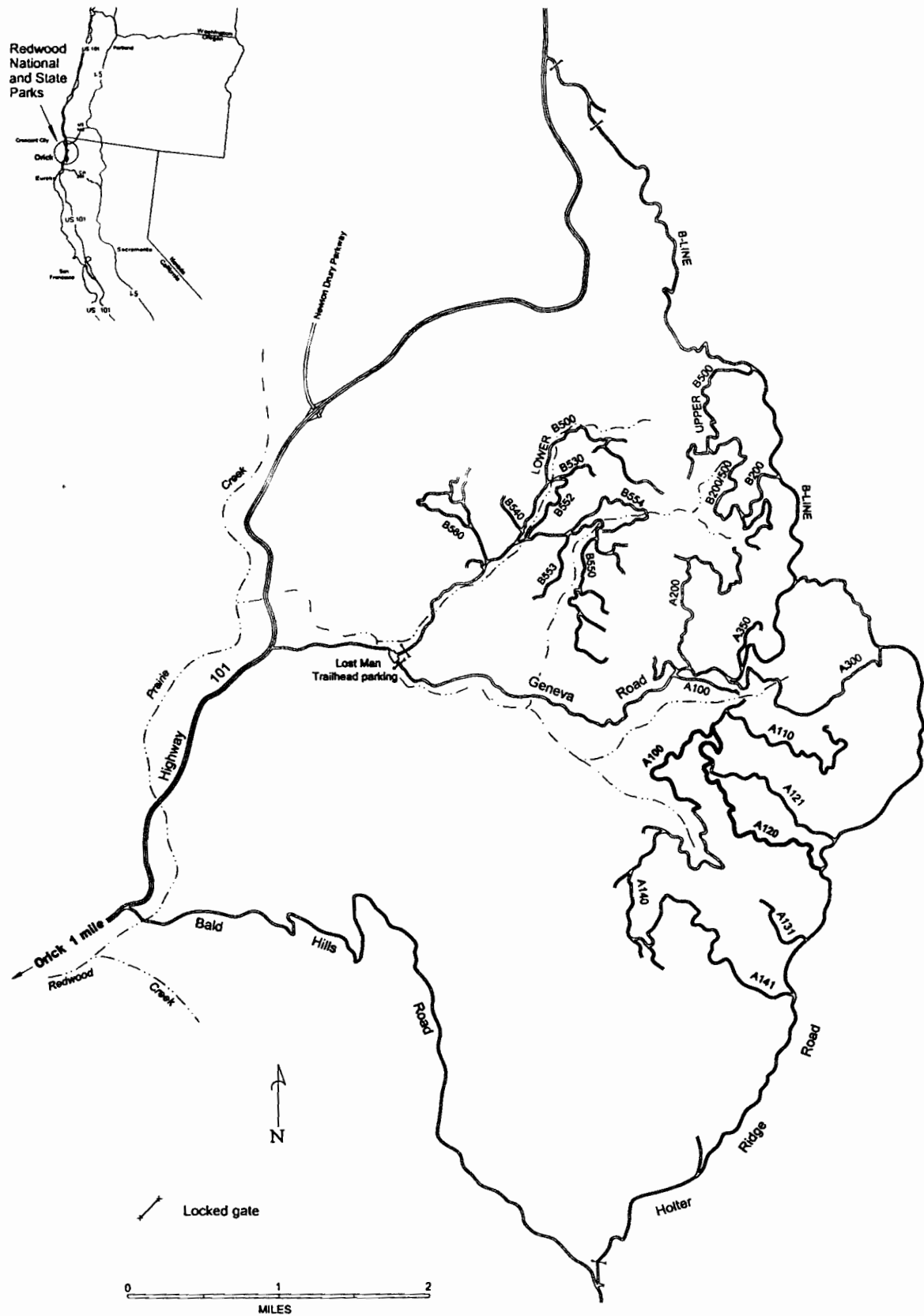


**Figure 1: Project Location**

On January 1, 1997, an eleven-year storm hit northern California, including the Redwood Creek basin, after three months of above average precipitation. This storm caused numerous failures along the roads in Redwood National Park. Four stream crossings on the A100 and A120 in this project area failed causing the roads to be undrivable. Redwood National Park received \$7.5 million from the Emergency Supplemental Appropriations Act for Recovery from Natural Disasters (PL 105-18) and \$0.5 million from the Federal Highway Administration's Emergency Relief for Federally Owned Roads (ERFO) to remove roads that had been damaged during the storm. Other roads that were public access or long term administrative access roads also received funds for repair. The A100 and A120 were two of the roads to be removed. However, before these roads could be removed, they had to be repaired in order to allow equipment access. This project involved reconstruction of portions of these two roads and excavation of portions of two stream crossings.

The total cost for this project was \$62,288 (see Table 1 for cost summary). The heavy equipment cost of \$49,450 was funded from the Emergency Supplemental Appropriations Act. The salary cost of \$12,838 for implementation was funded by RNP's base operating funds and the Emergency Supplemental Appropriations Act.

Road reconstruction focused on culvert installation, rolling dip construction, inboard ditch cleaning, and road blading. As part of the culvert installation at two of the sites, portions of the stream crossing fill were excavated to restore more natural hillslope topography and drainage patterns interrupted by the roads. The excavation of the stream-crossing fill uncovered the natural channel bed and banks, and excavated fill was used to re-create the natural topography. Trees removed during excavation were dispersed along the finished surface in order to provide habitat and simulate natural forest litter.

### *Geology*

The Redwood Creek basin is almost entirely underlain by the Jurassic-Cretaceous Franciscan formation. Exposures of these rocks typically show closely spaced fractures and/or pervasive shearing. Fractures seem to have resulted from deformation from tectonic emplacement, likely by subduction, and from brecciation along high angle faults. The intensity and style of this disruption seems to be the rock characteristic that most influences differences in the erosion rates and landforms (Janda, unknown). The Grogan fault, which has a surface trace roughly coincident with the valley of Redwood Creek, separates two major lithologies of the Franciscan formation. In general, rocks on the west side of the basin consist of quartz-mica schist, whereas unmetamorphosed sedimentary rocks are found on the east side. The Grogan fault is more linear than other major NNW trending faults in the region which suggests a near vertical dip (Hardin et al., 1982).

The north-northwest trend of these units and the younger faults that cut them is a signature of the overall tectonic structure of the northwest. This structure is dominated by north-northwest trending, imbricated thrust faults that dip to the east and accounts for the prominent north-northwest trend of many of the ridges and rivers in the northern Coast Ranges as well as the obvious shearing. The overall amount of shearing in the major units can usually be predicted by

| TABLE 1<br>RECONSTRUCTION WORK COST SUMMARY FOR UNIT 99-2, A120/A100 ROADS |                        |              |             |                       |                                     |                    |                       |
|----------------------------------------------------------------------------|------------------------|--------------|-------------|-----------------------|-------------------------------------|--------------------|-----------------------|
| Treatment                                                                  | Quantity               | # of<br>Jobs | Total Costs |                       | % of Grand<br>Total using<br>Actual | Average Unit Costs |                       |
|                                                                            |                        |              | Actual      | H.E.R.E. <sup>a</sup> |                                     | Actual             | H.E.R.E. <sup>a</sup> |
| Heavy Equipment                                                            |                        |              |             |                       |                                     |                    |                       |
| Stream Crossing                                                            | 4,500 yds <sup>3</sup> | 2            | \$20,800    | \$17,049              | 33                                  | \$4.62             | \$3.79                |
| Culvert Installation                                                       |                        | 7            | \$18,490    | \$11,801              | 30                                  |                    |                       |
| Misc. Work Items                                                           |                        | 7            | \$10,160    | \$7,924               | 16                                  |                    |                       |
| Misc. Non-Work Items                                                       |                        |              | \$0         | \$2,100               | 0                                   |                    |                       |
| Subtotal                                                                   | 4,500 yd <sup>3</sup>  |              | \$49,450    | \$38,874              | 79                                  |                    |                       |
| Project Implementation <sup>b</sup>                                        |                        |              |             |                       |                                     |                    |                       |
| Planning                                                                   | 26.75                  | NA           | \$598       |                       | 1                                   |                    |                       |
| Mapping                                                                    | 71.25                  | NA           | \$1,562     |                       | 3                                   |                    |                       |
| Prescriptions and<br>Layout                                                | 45.50                  | NA           | \$747       |                       | 1                                   |                    |                       |
| Surveying                                                                  | 75.50                  | NA           | \$1,434     |                       | 2                                   |                    |                       |
| Environmental<br>Compliance                                                | 44.50                  | NA           | \$1,043     |                       | 2                                   |                    |                       |
| Contract Preparation                                                       | 88.25                  | NA           | \$2,068     |                       | 3                                   |                    |                       |
| Heavy Equipment<br>Supervision                                             | 172.25                 | NA           | \$4,290     |                       | 7                                   |                    |                       |
| Photo Documentation                                                        | 23.00                  | NA           | \$393       |                       | 1                                   |                    |                       |
| Report Writing                                                             | 27.00                  | NA           | \$703       |                       | 1                                   |                    |                       |
| Subtotal                                                                   | 574.00                 | NA           | \$12,838    |                       | 21                                  |                    |                       |
| Grand Total                                                                |                        |              | \$62,288    | \$51,712              | 100                                 |                    |                       |

<sup>a</sup> Heavy Equipment Rental Equivalent (H.E.R.E.) is the cost to complete each job based on the actual hours worked. These rates were calculated using the Caltrans hourly rental rate of each machine (or a comparable machine), added to Bacon-Davis operator wages for each machine, then that total multiplied by 1.4 to account for a 40% overhead. Overhead includes maintenance, fuel, profit, insurance, etc. These rates are: Caterpillar D8H dozer @ \$165/hr and John Deere 892D excavator @ \$160/hr.

<sup>b</sup> Project implementation costs are the total number of hours that Redwood National Park employees worked on the project multiplied by their hourly rates. Several employees making different hourly rates worked on this project, so the total hourly rate is not consistent.

the topography because the amount of shearing strongly influences both type and abundance of landslides.

The project area is situated on the east side of the Redwood Creek basin, and is underlain by the Coherent unit of Lacks Creek (Hardin et al., 1982). This rock unit consists primarily of coherent sandstone and interbedded sandstone and mudstone with minor amounts of conglomerate, chert, and volcanic rock. The sandstone is predominately lithic graywackes and quartzofeldspathic graywackes. The rhythmic bedding and internal sedimentary structures of sandstone-mudstone sequences are typical of turbidites. However, individual beds cannot be traced laterally for more than 100m due to complex folding and faulting within this unit. Sandstone occurs as massive beds up to 10m thick, but most beds are between 0.1m and 3m thick with thinner mudstone interbeds. Mudstone comprises a noticeably lower percentage of the coherent unit of Lacks Creek than of the incoherent unit of Coyote Creek. The graywackes within this unit contain abundant fine volcanic detritus, but large blocks of volcanic rocks and chert are not found.

High sandstone content, presence of massive beds, and less intense shearing and fracturing result in steeper, straighter hillslopes in areas underlain by the coherent unit compared to those in the remainder of the basin (Janda, 1979). Uniformly sharp ridge crests, steep slopes, and narrow V-shaped tributary canyons are characteristic of the landscape developed in this unit. (Hardin et al., 1982).

### ***Timber Harvest History***

The 1954 air photos covering Lost Man Creek show that the A100 and A120 had been constructed and that much of the timber on the hillslopes above and below the roads had been harvested. Most of the area below the A120 and A100 was cable yarded, while the area above the A120 was tractor yarded. By 1962 the remainder of the area to be harvested below the upper portion of the A120 had been cut using tractor-yarding techniques. Seed-tree leave was the dominant silvicultural practice used. Between 1962 and 1968, no large-scale harvesting was done in the project area. No additional timber harvesting was performed after 1968 when Redwood National Park acquired the land.

### ***Erosional Features***

The most dominant erosional features are partially failed stream crossings. Only one stream crossing had a culvert in it. All the other stream crossings were Humboldt or fill crossings. The stream crossings on the A120 at stations 12+60 and 71+80 and on the A100 at Site B and Site D were partially blown out.

### ***Threatened and Endangered Species Concerns and Work Schedule***

Two bird species that are listed as threatened under the Endangered Species Act occupy areas in or near the project area: the northern spotted owl and the marbled murrelet. On May 6, 1997, coho

salmon were also listed as a threatened species. Because old-growth forests serve as critical habitat for these species, Redwood National Park is considered a critical conservation area for their survival.

The U.S. Fish & Wildlife Service (USFWS), as administrator of the Endangered Species Act for the northern spotted owl and marbled murrelet, has set noise and habitat modification restriction guidelines designed to reduce human impact, especially to nesting sites during the breeding season.

The National Marine Fisheries Service (NMFS) is responsible for administering the Endangered Species Act for protection of the coho salmon.

In July, 1998, Biological Assessments (BA) and Biological Opinions (BO) to determine the effects of 1997 Storm restoration projects on threatened and endangered species and their critical habitats were completed by RNP, USFWS, and NMFS. The purpose of the BA/BOs was to meet the criteria for formal consultation with the USFWS and NMFS as required under Section 7 of the Endangered Species Act of 1973, as amended. The BA/BOs determined that the majority of the project area was not in either northern spotted owl or marbled murrelet habitat. However, a 23-acre area of marbled murrelet habitat was located within ¼ mile of the upper A120. The BA/BOs stated that work could not begin in this area until September 1. This habitat area was surveyed for marbled murrelets in July, 1999. There were no detections, so it was determined that work done in 1999 could begin at any time after the surveys were completed.

## RECONSTRUCTION WORK

### *Project Implementation*

Reconstruction work focused on repairing the roads to a drivable condition to permit access to future road removal sites. During installation of two culverts, the upper portions of these stream crossings were restored to natural conditions and a smaller scale road reconstructed over the culverts. Reconstruction work included culvert installation, rolling dip construction, inboard ditch cleaning, and road blading (Figure 2).

The project geologist, Becca Smith, evaluated the condition of the roads, prescribed reconstruction treatments, surveyed the volumes and culvert alignments where necessary before and after excavation, prepared the contract, oversaw heavy equipment operations as the contracting officer's technical representative (COTR), photo documented the work, and wrote the final report. Phil Freiberg assisted with mapping and layout and Aileen Stuart and Kristine Leep assisted with layout and surveying.

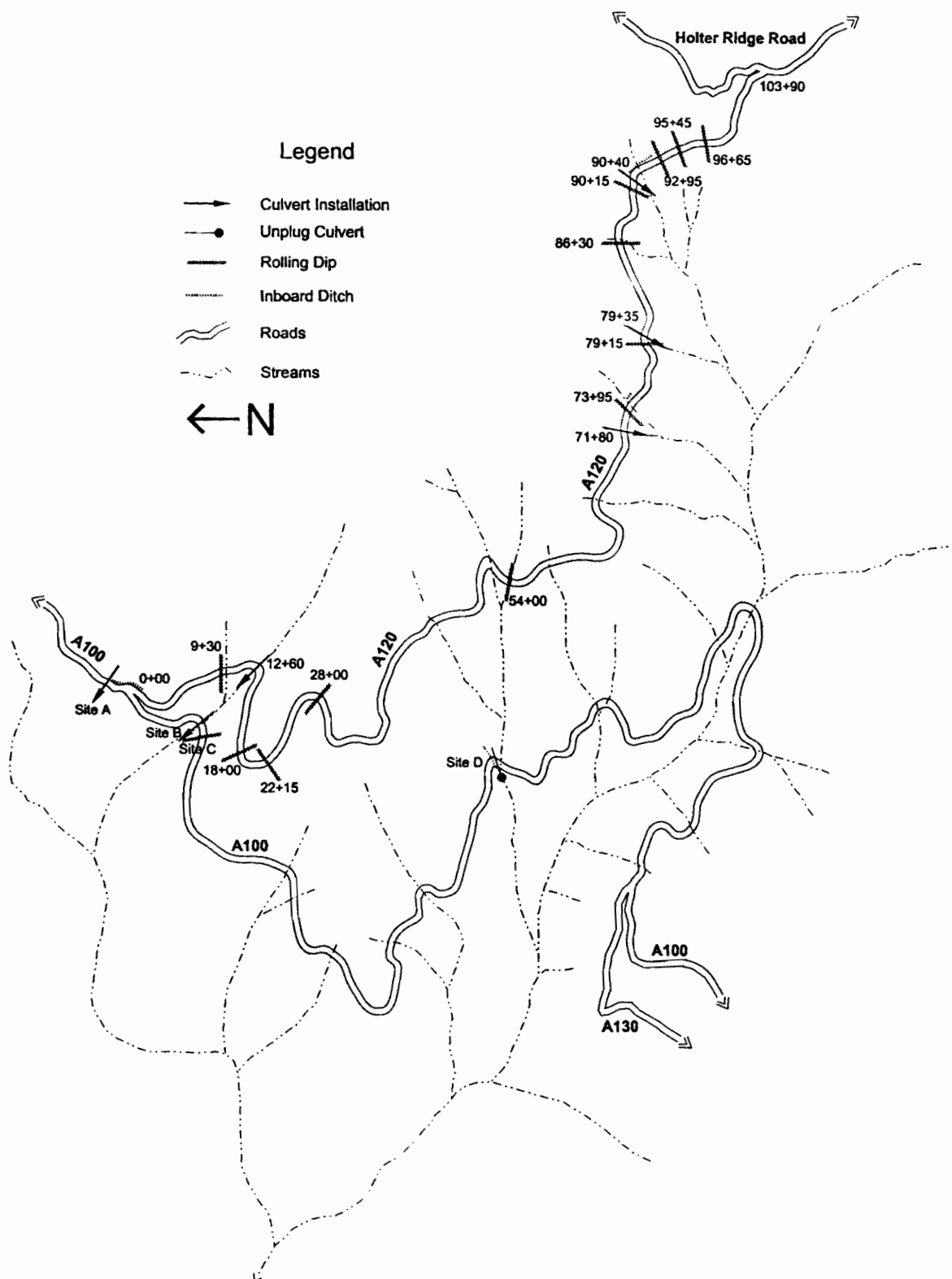


Figure 2. Site Locations and Site Specific Treatments

### *Heavy Equipment Phase*

The heavy equipment phase included completion of all primary reconstruction and restoration treatments. A total of 6 culverts and one drop inlet were installed, 13 rolling dips were constructed, 860 feet of inboard ditch was cleaned, portions of the roads were bladed, and 4500 yds<sup>3</sup> of material were excavated from two stream crossings for a total heavy equipment cost of \$49,450.

The heavy equipment phase was done by "request for proposal – indefinite quantity/indefinite delivery" contract. Proposals were due July 6, 1999 and contracts were awarded to three contractors on July 28, 1999. The delivery order for the A120 and A100 was issued to Lambert's Excavating Service (Larry Lambert) on August 23, 1999. Larry Lambert had another job (99-5, L-2-2-1) running at the same time, so he hired additional employees to work on the A120/A100 project. The heavy equipment work on this project began on August 24, 1999 and all work was completed on September 13, 1999.

The following equipment was used: a John Deere 892D-LC excavator with thumb and a Caterpillar D8H dozer with winch. The equipment operators were Jay Chamberlain on the 892 and Paul Cartright Sr., Bill Garlinghouse, Paul Cartright Jr., and Joe Romanini on the D8H.

### *Stream Crossing Excavations and Culvert Installations*

A summary of stream crossing excavation costs and production rates is shown in Table 2. A narrative of the excavation of the crossings follows.

#### Xing 71+80

A skid road crossing was present above the haul road crossing. The skid road crossing was still intact, but the haul road crossing had failed. There were no culverts in either crossing, nor any Humboldt logs. A large hole (approximately 10' deep) had formed in the haul road, leaving only about a 2' strip of the original road left on the outboard edge. Also, immediately up road of this site, the entire road bed had slumped 3'. The skid road crossing was completely excavated. A culvert was installed under the haul road and a minimal road reconstructed over the culvert.

The fill material was very rocky and sandy which meant that the stream flow drained down to the channel bottom and the fill was extremely dry during excavation. There was no topsoil either in the channel bottom or on the sideslopes. The material in the bottom of the channel was yellow in color. There were no logs in the fill. The only real clue of original ground was bedrock and a few stumps. Excavation began at the top of the crossing with water flowing down the channel, but there was never a problem with the water ponding – it just went right through the base of the rocky fill.

The culvert was 24" in diameter and designed to be 60' long. The pipe needed to be longer and we had some odd lengths of pipe to work with, so the culvert ended up being 82' long.

### Xing Site B

This was a Humboldt crossing that had plugged up. The basin upstream of the crossing had mostly filled in with sediment to road level. There was a small 6' deep pond on the inboard side of the road. The stream flowed year round. When the flow was low, water went into this pond and flowed through the fill. When the flow was higher, water would overflow the pond and flow across the road. As a result of this, the outboard edge and most of the road itself had failed into the creek. Most of the crossing was excavated, with the upper portion being excavated to original ground. A culvert was placed in the base of the fill and a minimal road rebuilt across the culvert.

The majority of the fill material was very wet which created several problems. The fill would not stack up in the fillsite so the dozer had to keep pushing it further and further down the road and leave it in low piles against the cutbank. Water was flowing into the top of the excavation and into the pond as the excavation progressed. A pump was not on site from the beginning nor was the water being diverted around the work site. We allowed the water to flow into the pond and then would periodically suction the water out of the pond with 4" flex pipe. This was cumbersome, slow, and sometimes ineffective. Also we had to let the water flow down the upper part of the crossing to the pond before we could pipe it over the road. Part way through the excavation we decided that we needed to get a pump so that we could divert the water from the top of the crossing around the work site. This helped a lot, however, some water continued to flow through the fill keeping the fill wet. There was a lot of slash and logs in the fill. There were two very long (~80') Humboldt logs along the channel. The length of the logs made them difficult to remove, but we managed to get one out by breaking it into pieces.

The culvert was 48" in diameter and designed to be 40' long. The fill over the top of the culvert needed to be deep enough so that the grades of the approaches to the culvert weren't too steep. As the excavation progressed, it became apparent that 40' of pipe wouldn't be long enough. One section of plastic 48" pipe had been delivered to the site at the beginning of the project. No more 48" plastic sections were available locally. Two 48" steel sections were acquired and combined with the plastic section and installed.

The excavation of the upper portion of the channel turned out very well despite the wet working conditions. There was a group of 12" redwoods on the right bank just above the culvert inlet. The COTR felt that these redwoods were close to original ground and decided to leave them. During the 1999-2000 winter, a small amount of material (~10 yd<sup>3</sup>) failed just downstream of the redwoods, flowed through the culvert and deposited at the culvert outlet. A stump was exposed in this failure. The COTR recommends that when the culvert is pulled and the remainder of the crossing is excavated, that the small amount of fill left on the right bank by the culvert inlet be excavated.

### *Culvert Installations*

All culverts installed as part of this contract, with the exception of the drop inlet, were semi-permanent culverts designed to remain in place for one to three years. Culverts were aligned with the natural stream channel and placed at the base of the fill at the grade of the original streambed.

The culverts were backfilled with the best local material available, free of rocks, clay and organic material. Flared inlets and rip rap were not required. The culverts were double walled plastic, with the exception of two sections of the culvert at Site B and the drop inlet. Culverts were sized for the 100-year storm. Rolling dips were constructed at or immediately downroad of each culvert to prevent diversions. A summary of culvert installation costs is shown in Table 3. A narrative of the culvert installations follows.

#### Culverts 90+40 and Site A

These were ditch relief pipes (24", 30' at 90+40 and 18", 40' at Site A). Both pipes drained wet sections of road where water seeped from the hillslope into the ditch or onto the road. The culvert at station 90+40 drains a bowl where several headwater swales discharged water onto the road. There was no inboard ditch, so the water had been saturating the road bench. An inboard ditch was also constructed to collect the water and direct it to the culvert.

Site A was an old landslide. Water seeped from the cutbank into a ditch that had no outlet. The water used to pond in the ditch. The existing inboard ditch was extended to capture all of the water and direct it to the culvert.

Observations during the winter of 1999-2000 indicated that the inboard ditches collected and directed the water, but the flow was generally insufficient to make it all the way to the culverts (especially at Site A). Instead the water seeped into the fill through the ditch.

#### Culvert 79+35

No culvert existed at this small crossing. The water had been flowing across the road without causing much erosion. A 24", 30' long pipe was installed. As the pipe was shallow, installation only took about one hour. Unfortunately, the dozer subsequently hit and destroyed the inlet end of the pipe, which had to be dug out and replaced.

#### Culvert 73+95

This crossing contained a 12" metal pipe. The inlet had plugged and water had flowed across the road contributing to a slump downroad. Since this culvert existed and was intact, a new culvert was not installed. The inboard ditch from the center of the crossing to the culvert inlet was improved.

#### Culvert 12+60

This was a humboldt crossing. The humboldt had begun deteriorating with fill collapsing into the channel. A collapse-hole gully had formed across the road making the road undrivable. The humboldt was removed and a 36", 60' culvert installed.

### Drop Inlet Site D

This site presented numerous challenges both in the design and construction phases. The stream flowed year round. When the flow was low, the water would infiltrate the fill on the inboard side of the road and flow through the fill. When the flow was higher, water would flow across the road. As a result of this, the outboard edge of the road had failed into the creek. A 24", 100-foot long culvert was present in the crossing, but the inlet was buried under 19' of sediment.

The crossing had a 76-acre drainage area which meant that one 60" culvert or two 36" culverts were necessary to pass the 100-year discharge. The channel gradient was steep and concave in shape. Nearly all of the crossing fill would have to be excavated in order to install a 60" pipe on grade. Installing two above ground 36" pipes was considered but deemed unfeasible. This crossing was expected to be removed the following year (2000) as part of a road removal project. In order to improve the existing condition and decrease the potential for erosion along with the knowledge that the pipe was expected to remain in place for only one more winter, we decided to utilize the intact 24" pipe by excavating the inlet and installing a 90° elbow and 20' drop inlet.

The fill material was extremely saturated and water continued to flow out of the fill and into the excavation. The fill would not stack up because it was so wet, so the dozer pushed it down the road and left it against the bank and on the road. The culvert was composed of 2' sections riveted together. This was handy because as we dug through the fill to find and expose the inlet, the pipe was damaged. A two-foot section was then simply pulled off to expose an undamaged inlet.

Installing the drop inlet posed several logistical and engineering challenges. The end of the twenty-foot long drop inlet was hung from the excavator bucket on a chain in order to position it over the elbow. This worked well to fasten the drop inlet to the elbow, but a problem was recognized when the chain could not be removed to disconnect the pipe from the excavator because the end of the pipe with the chain on it was now twenty feet off the ground. Several attempts resulted in a satisfactory pipe positioning and chaining approach that allowed the chain to be removed and the pipe and elbow to remain in place. Dry fill was placed around the elbow and the base of the drop inlet. Slots were cut into the drop inlet to allow water to flow into the pipe. The end result is that the drop inlet bears a striking resemblance to the Leaning Tower of Pisa, but is functioning adequately.

### *Miscellaneous Work Items*

A summary of miscellaneous work item costs is shown in Table 4. All miscellaneous work items were lump sum items, except inboard ditches which were paid by the foot of ditch constructed. The equipment was dropped off at the Bald Hills / Holter Ridge junction. Lowboys could not drive to the A120 because of the weight limit on the bridges over Lost Man Creek and the narrow winding section of road at the beginning of Holter Ridge Road. The start up and miscellaneous move out costs were to walk the equipment in and out of the site from the Bald Hills Road. Blading was done to smooth out sections of the road to make it drivable. Thirteen rolling dips (one on the A100 and twelve on the A120) were constructed either to prevent stream diversions or

disperse water that might flow down the roadbed. Three sections of inboard ditch were constructed or improved to collect water and direct it to the nearest culvert inlet.

### *Non-Work Items*

Non-work 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 generally not directly attributable to any specific work item. Non-work item times were recorded to compare the costs of the contract with that of an hourly rental. Table 5 provides a cost breakdown for non-work items.

“Discussion time” is defined as periods of time where equipment operations were interrupted by discussions lasting 15 minutes or more. Several shorter discussion periods were sometimes combined into one when they added up to approximately 15 minutes (time was recorded in 15 minute intervals). Most of the discussion time recorded was when the operators and COTR would stop to discuss the progress of a particular phase of a work item or develop a strategy for the work. On occasion, the COTR or site inspector would interrupt the operators to make sure that the specifications of the contract were understood and would be met.

“Down time” occurred when equipment was unable to perform at its expected capacity. Down time was most often the result of mechanical failure.

“Idle time” represents the time a piece of equipment was inactive while work proceeded. Idle time differs from down time in that the equipment could be used but the contractor or operator chose not to use it.

### *Labor Intensive Phase*

Labor intensive restoration and erosion control work usually includes all secondary treatments for surface erosion which, in the past, have typically involved the application of straw mulch to critical areas on finished rehabilitation worksites. Straw mulch was not applied on unit 99-2 for several reasons. Logs and brush were placed on the surface of the stream crossing excavations, which helped protect them from surface erosion. After restoration work was completed, redwood fronds and alder leaves naturally dropped from the surrounding second-growth forest onto the finished surface. Natural revegetation, especially initial alder growth, is expected to be excellent. Previous studies indicate that straw may not be good in forest settings since it alters the soil to be more like that of a grassland and it may also introduce exotic species.

No labor-intensive work was done on this project.

### *Documentation Phase*

The final restoration phase is the documentation process. This includes post-heavy equipment volumetric surveys, photo point documentation, cost data compilation, and writing the restoration

project report. This work was done by Becca Smith with help from Kristine Leep, and was completed in November 2000.

## DISCUSSION

Project 99-2 was primarily a road reconstruction rather than a watershed restoration project. However, installing culverts and excavating two stream crossings met the goals of the watershed restoration program by reducing human-caused potential erosion and sedimentation from roads into creeks and onto hillslopes. Road fill was removed from two stream crossings, culverts installed and a minimal road bench rebuilt. Topsoil was uncovered where possible. Woody debris was spread on the finished slopes. A total of 4,500 surveyed yds<sup>3</sup> were excavated from the two crossings and moved to stable fillsites at a heavy equipment cost of \$20,800 which equates to an overall average of \$4.62/yds<sup>3</sup>. In addition, four other culverts and one drop inlet were installed at crossings that did not have functioning culverts.

This was the first year that indefinite quantity / indefinite delivery type contracts were used for road removal work. These contracts allowed the park to select contractors based on their past experience and past performance as well as price. The contracts were not automatically awarded to the lowest bidder. In addition, the contracts can be renewed for two additional years, eliminating the need to put contracts out to bid each year. This contracting method proved essential to completing this project. The project was selected to be contracted at the last minute. The indefinite quantity contracts were flexible enough to accommodate this road reconstruction project. An additional delivery order was simply awarded to one of the contractors who had been awarded the original contracts.

The contractor on this job, Lambert's Excavating, was also doing another contract (99-5, L-2-2-1) at the same time as this project. Larry Lambert initially hired two equipment operators to work on the A120/A100 project (Jay Chamberlain on the 892 and Paul Cartright Sr. on the D8H and as contractor's representative). Larry and Paul Cartright Jr. were on site the first two days of the project to get Paul Sr. and Jay started. After that, Larry pretty much left the operators on their own. Neither of the equipment operators had worked in the park nor done road removal work before. Jay Chamberlain was an experienced excavator operator. He learned the goals and intent of the stream crossing excavation work and how to identify original ground very quickly. He went on to work on the C-Line South (99-1) project after completing this project. He is a very competent new equipment operator to the restoration program. Paul Cartright Sr. did not appear to have much dozer operating experience. Paul Sr. worked for four days, then there was one day without a dozer operator, Joe Romanini ran the dozer for one day, then Bill Garlinghouse ran the dozer for the rest of the job. Joe and Bill were both good dozer operators although neither had worked in the park or done road removal work before. Not having the contractor or a contractor's representative on the site for much of the job (after Paul Sr. left) caused several difficulties. There was no one on site to coordinate the work, the operators, equipment repair, or the delivery of materials (culverts and fuel). There was little communication between Larry and the equipment operators.

**TABLE 2**  
**Stream Crossing Excavation Costs and Production Rates for Unit 99-2, A120/A100 Road Reconstruction**

| Worksite            | Volume<br>(yds <sup>3</sup> ) | Heavy Equipment Hours |                    | Total Costs     |                                    | Unit Costs                      |                                    | Original<br>Price<br>(\$/yd <sup>3</sup> ) | Average<br>Fillsite<br>Dist. (ft.) | Excav.<br>Rate<br>(yds <sup>3</sup> /hr) |
|---------------------|-------------------------------|-----------------------|--------------------|-----------------|------------------------------------|---------------------------------|------------------------------------|--------------------------------------------|------------------------------------|------------------------------------------|
|                     |                               | Cat.<br>D8H           | John Deere<br>892D | Actual          | H.E.R.E.*<br>(\$/yd <sup>3</sup> ) | Actual<br>(\$/yd <sup>3</sup> ) | H.E.R.E.*<br>(\$/yd <sup>3</sup> ) |                                            |                                    |                                          |
| Xing 71+80          | 500                           | 6.50                  | 8.50               | \$2,000         | \$2,433                            | \$4.00                          | \$4.87                             | \$4.00                                     | 100                                | 33                                       |
| Xing Site B         | 4000                          | 37.00                 | 42.00              | \$18,800        | \$12,825                           | \$4.70                          | \$3.21                             | \$4.00                                     | 350                                | 51                                       |
| Xing Site B - labor |                               | 6.25                  | 4.75               | \$0             | \$1,791                            |                                 |                                    |                                            |                                    |                                          |
| <b>Total/Ave.</b>   | <b>4,500</b>                  | <b>49.75</b>          | <b>55.25</b>       | <b>\$20,800</b> | <b>\$17,049</b>                    | <b>\$4.62</b>                   | <b>\$3.79</b>                      |                                            |                                    | <b>43</b>                                |

**TABLE 3**  
**Culvert Installation Costs for Unit 99-2, A120/A100 Road Reconstruction**

| Worksite             | Heavy Equipment Hours |                    | Total Costs     |                                     |
|----------------------|-----------------------|--------------------|-----------------|-------------------------------------|
|                      | Cat.<br>D8H           | John Deere<br>892D | Actual          | H.E.R.E.*<br>Equipment<br>Materials |
| Culvert 90+40        | 1.00                  | 1.25               | \$1,810         | \$365                               |
| Culvert 79+35        | 3.00                  | 2.50               | \$1,810         | \$895                               |
| Culvert 71+80        | 3.50                  | 7.25               | \$2,320         | \$1,738                             |
| Culvert 71+80 labor  | 0.50                  | 0.25               | \$0             | \$123                               |
| Culvert 12+60        | 0.75                  | 6.25               | \$3,090         | \$1,124                             |
| Culvert 12+60 labor  | 1.25                  | 1.75               | \$0             | \$486                               |
| Culvert Site A       | 0.25                  | 1.00               | \$2,160         | \$201                               |
| Culvert Site A labor | 0.75                  | 0.50               | \$0             | \$204                               |
| Culvert Site B       | 2.25                  | 6.00               | \$5,000         | \$1,331                             |
| Culvert Site B labor | 6.25                  | 0.50               | \$0             | \$1,111                             |
| Culvert Site D       | 9.00                  | 12.50              | \$2,300         | \$3,485                             |
| Culvert Site D labor | 3.75                  | 0.75               | \$0             | \$739                               |
| <b>Total/Ave.</b>    | <b>32.25</b>          | <b>40.50</b>       | <b>\$18,490</b> | <b>\$11,801</b>                     |

\* Heavy Equipment Rental Equivalent (H.E.R.E.) is the cost to complete each job based on the actual hours worked. These rates were calculated using the Caltrans hourly rental rate of each machine (or a comparable machine), added to Bacon-Davis operator wages for each machine, then that total multiplied by 1.4 to account for a 40% overhead. Overhead includes maintenance, fuel, profit, insurance, etc. These rates are: Caterpillar D8H dozer @ \$165/hr and John Deere 892D excavator @ \$160/hr.

| TABLE 4<br>Miscellaneous Work Item Costs for Unit 99-2, A120/A100 Road Reconstruction |          |                       |                    |                 |                       |                     |                                    |                    |  |
|---------------------------------------------------------------------------------------|----------|-----------------------|--------------------|-----------------|-----------------------|---------------------|------------------------------------|--------------------|--|
| Job                                                                                   | Quantity | Heavy Equipment Hours |                    | Total Costs     |                       | Unit Costs          |                                    | Original           |  |
|                                                                                       |          | Cat.<br>D8H           | John Deere<br>892D | Actual          | H.E.R.E. <sup>a</sup> | Actual<br>(\$/unit) | H.E.R.E. <sup>a</sup><br>(\$/unit) | Price<br>(\$/unit) |  |
| Move In                                                                               | 1        | NA                    | NA                 | \$850           | \$1,500               | NA                  | NA                                 | \$850              |  |
| Start Up                                                                              | 1        | 2.00                  | 1.75               | \$975           | \$610                 | NA                  | NA                                 | \$975              |  |
| Move Out                                                                              | 1        | NA                    | NA                 | \$850           | \$1,500               | NA                  | NA                                 | \$850              |  |
| Misc. Move Out                                                                        | 1        | 1.50                  | 3.50               | \$975           | \$808                 | NA                  | NA                                 | \$975              |  |
| Blading                                                                               | 1        | 11.25                 | 2.50               | \$5,000         | \$2,256               | NA                  | NA                                 | \$5,000            |  |
| Rolling Dips                                                                          | 13       | 2.00                  | 1.25               | \$650           | \$530                 | \$50.00             | \$40.77                            | \$50               |  |
| Inboard Ditches                                                                       | 860 ft   | 0                     | 4.5                | \$860           | \$720                 | \$1.00              | \$0.84                             | \$1                |  |
| <b>Total</b>                                                                          |          | <b>16.75</b>          | <b>13.50</b>       | <b>\$10,160</b> | <b>\$7,924</b>        |                     |                                    |                    |  |

<sup>a</sup> Heavy Equipment Rental Equivalent (H.E.R.E.) is the cost to complete each job based on the actual hours worked. These rates were calculated using the Caltrans hourly rental rate of each machine (or a comparable machine), added to Bacon-Davis operator wages for each machine, then that total multiplied by 1.4 to account for a 40% overhead. Overhead includes maintenance, fuel, profit, insurance, etc. These rates are: Caterpillar D8H dozer @ \$165/hr and John Deere 892D excavator @ \$160/hr.

| TABLE 5<br>Non-Work Item Costs for Unit 99-2, A120/A100 Road Reconstruction |                       |                    |                            |  |
|-----------------------------------------------------------------------------|-----------------------|--------------------|----------------------------|--|
| Job                                                                         | Heavy Equipment Hours |                    | Total<br>H.E.R.E.<br>Costs |  |
|                                                                             | Cat.<br>D8H           | John Deere<br>892D |                            |  |
| Discussions                                                                 | 1.75                  | 5.00               | \$1,089                    |  |
| Walking Between Sites                                                       | 2.25                  | 4.00               | \$1,011                    |  |
| Subtotal                                                                    | 4.00                  | 9.00               | \$2,100                    |  |
| Down                                                                        | 4.00                  | 2.00               | NA                         |  |
| Idle                                                                        | 24.50                 | 8.00               | NA                         |  |
| Lunch/Breaks                                                                | 3.25                  | 3.00               | NA                         |  |
| Totals                                                                      | 31.75                 | 13.00              |                            |  |

<sup>a</sup> Heavy Equipment Rental Equivalent (H.E.R.E.) is the cost to complete each job based on the actual hours worked. These rates were calculated using the Caltrans hourly rental rate of each machine (or a comparable machine), added to Bacon-Davis operator wages for each machine, then that total multiplied by 1.4 to account for a 40% overhead. Overhead includes maintenance, fuel, profit, insurance, etc. These rates are: Caterpillar D8H dozer @ \$165/hr and John Deere 892D excavator @ \$160/hr.

## REFERENCES

- Harden, D. R., Kelsey, H.M., Morrison, S. D., and Stephens, T. A., 1982. Geologic Map of the Redwood Creek Drainage Basin, Humboldt County, California. U.S. Geological Survey Water Resources Investigations, Open-file Report 81-496. 1 sheet.
- Janda, R. J., Nolan, K. M., Harden, D. R., and Coleman, S. M., 1975. Watershed Conditions in the Drainage Basin of Redwood Creek, Humboldt County, California, as of 1973. U.S. Geological Survey Open-file Report 75-568. 266 p.
- United States Congress, House Committee on Government Operations, Forest Management and Redwood National Park, Hearings Before the Conservation, Energy, and Natural Resources Subcommittee, September 18, 1976. 94<sup>th</sup> Congress, 2<sup>nd</sup> Session.
- United States Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, 1998. Biological Opinion and conference Opinion: Watershed Restoration Program, Routine and Non-routine road maintenance in Redwood National and State Parks.
- United States Department of the Interior, Fish and Wildlife Service, 1998. Biological Opinion on Redwood National and State Parks' Watershed Restoration Program.
- United States Department of the Interior, National Park Service, Redwood National and State Parks, 1998. A Biological Assessment of Impacts to Aquatic Threatened and Proposed Species from the Watershed Restoration Program in Redwood National and State Parks.
- United States Department of the Interior, National Park Service, Redwood National and State Parks, 1998. A Biological Assessment of Impacts to Terrestrial Threatened and Endangered Species from the Watershed Restoration Program in Redwood National and State Parks.
- United States Department of the Interior, National Park Service, 1988. Management Policies.
- United States Department of the Interior, National Park Service, Redwood National Park, 1981. Watershed Rehabilitation Plan.
- United States Department of the Interior, National Park Service, Redwood National Park, 1992. Statement for Management.