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BACKGROUND

In 1978 Congress expanded the boundaries of Redwood National Park (RNP) by approximately 48,000 acres, and authorized the establishment of a watershed rehabilitation program. Prior to park expansion, these lands were the site of intense timber harvest activities and related road construction. Studies indicate these activities cause unnatural and excessive erosion that result in adverse impacts to riparian habitat, anadromous fisheries, and amphibian species (Corn and Bury, 1989; House and Boehne, 1987; Cedarholm et al., 1980; Narver, 1971). The primary goals of the rehabilitation program are to minimize human-induced erosion and speed the natural revegetation process by restoring the hillslope hydrology to conditions that existed prior to human influence.

Since the establishment of the watershed rehabilitation program at RNP, the concept and techniques of reclaiming disturbed lands has evolved. The process of watershed restoration quickly shifted from revegetation efforts to removing potential sediment sources. As more information was gathered concerning sediment sources, the restoration focus was directed at roads as the primary erosion source.

Earlier efforts were aimed at reducing erosion and letting nature take care of the rest. Studies have shown that the complete excavation of stream crossing fill is the most cost effective use of time and funds (Weaver and Sonnevile, 1983). Building on the in-house studies and guided by National Park Service directives, the rehabilitation program has focused on a simple yet fundamental approach in its techniques. By restoring the basic, physical parameters that act as a foundation for the forest ecosystem (at a minimum, the hydrologic patterns, topsoil and stable slopes), much of the natural healing process has been taken care of.

Much of the terminology used throughout this report has been derived, created or borrowed through a combination of trades, disciplines and experiential moments during the rehabilitation program's evolution. The terms outsloping and recontouring are used simultaneously, meaning a fully recontoured slope following excavation of road fill. When referring to the recovery of topsoil, it is inferred that the topsoil was buried by sidecast or end hauled fill during road construction. The buried topsoil becomes the latent boundary for the excavation. Organics can be either exhumed logs, rootwads and slash or trees and brush that was stockpiled during clearing of the site.

PROJECT DESCRIPTION

Watershed Rehabilitation Unit 96-1 represents the upper half of the area logged using the 230 road. Within the 180 acres of unit 96 - 1, 0.5 miles of haul and approximately 0.25 miles of skid roads were identified as significant resource threats to forest stand health and Streelaw and Prairie Creek aquatic systems. The prescribed treatment called for the removal of all fill and debris from haul road and associated skid road stream crossings and the recontouring of unstable road fills. Approximately 8.5 acres was recontoured to near natural topography with original topsoil being exposed or scattered on about half of all treated surfaces. An additional 80 - 90 acres was mapped, but not included in unit 96 -1. Four haul road stream crossings, eight skid road stream crossings and two large landings were identified as being in need of treatment in the untreated portion of the 230 road area. However, due to budget constraints, treatment was limited to construction of rolling dips at the haul road stream crossings.

The half mile of haul road in Unit 96-1 was predominately haul road stream crossing removal prescriptions. There were 6 haul road stream crossings. Five of the haul road stream crossings

had additional fill excavated up or downstream of the main haul road fill due to adjacent skid road crossings, lay outs, or spur skid roads. The fill from these stream excavations was used to recontour adjacent, otherwise untreated, sections of full cut or through cut road between stream crossings. Some full cut or through cut skid roads were recontoured in a like manner.

Two segments of haul road (not crossing stream channels) were identified as being unstable. A total of five hundred feet of road bench was fully recontoured; this included removing road fill from a spring and a headwater swale. Approximately one hundred and fifty feet of the 230 road ended up untreated due to an unanticipated change in slope morphology that created a fill deficit at that site.

Location:

The 230 road is located on north and east facing slopes along the west side of Prairie Creek , and south of Streelow Creek (figures 1 and 2). The 230 road is 1.5 miles from Davison road via the 200 road through the H.A. Blankenship truck shop (formerly the Arcata Redwood Co. cat shop). The 230 road begins at an elevation of 90 feet and then climbs to 500 feet at station 00+00. Streams draining the portion of the 230 road from station 00+00 to 25+00 flow directly into Streelow Creek with the remainder of channels flowing into Prairie Creek. The slopes typically range from 30% to 70%, are densely vegetated with predominantly 35 year old second growth redwood, alder and Douglas fir trees.

The boundaries for the mapped area, (including watershed rehabilitation Unit 96-1), follow the boundaries of the original clear cut unit associated with the 230 road. These boundaries roughly follow the 220 road along the ridge to the north and west. The eastern boundary follows Streelow Creek. The southern boundary is the 200 road (the main arterial road for the west side of Prairie

Creek from Wolf Creek to the B Mill or highway) which runs along the western bank of Prairie Creek.

Land use:

No land disturbances were observed, other than the 200, 210 and 220 roads, in the 1958 aerial photo series. In the 1962 photos, the 230 road had been constructed with the surrounding slopes recently clear cut and tractor yarded.

The 230 road was constructed by Arcata Redwood Company as a haul road for timber harvesting operations in that unit. The unit was logged primarily with D9's using arches (personal communication, Lloyd Tangen). The use of arches required larger skid roads. In contrast to the 210 / 220 unit, the 230 unit was clear cut with relatively few snags left standing. The 230 road was used again for hauling the logs from the unit located to the west that was harvested in the late 1960's.

Geology:

The area is underlain by rocks of the Franciscan Assemblage, capped in part by sediments of the Prairie Creek Formation. The Grogan Fault crosses the 200 road between the Davison Ranch and Blankenship truck shop. The fault trends north-northwest, separating Redwood Creek schist to

the west from Franciscan sedimentary rocks to the east. The 230 road is to the east of the fault and the basement rocks here are predominately Franciscan mudstone. No exposures of the Prairie Creek Formation were observed along the 230 road.

For more detailed information on soils, refer to the in-house documents 'Soils of the 230 Road' by Jim Popenoe, May 1994 or 'Soils of the 210, 220 and 230 Roads' by Jim Popenoe and Jennifer Rice, March, 1995.

Erosional Characteristics:

The primary erosion processes of concern along the 230 road are the deteriorating stream crossings and a number of failing road fills along the hillslopes. The 1992 draft RNP remaining road inventory listed possible debris torrent potential for some the crossings along the north facing slope. The most frequently observed erosion processes were similar to those seen along the 210 and 220 roads, typically, the continuing collapse of buried, rotting organics resulting in the failure of road fills in or near stream channels.

WILDLIFE CONCERNS

During the previous season, U.S. Fish and Wildlife Service personnel had visited the 230 road and indicated that there was no suitable habitat for spotted owls or marbled murrelets (both species considered threatened on the federal list). Since the unit had been clear cut, the present

stand conditions of an even aged, dense thicket of young conifers, prevent the habitation of birds that utilize the internal spaces of a forest. A stand of old growth redwood located within a quarter mile (although across highway 101) required a late start up date. Although there was no suitable forage habitat, noise was still an issue. The equipment start date was set for no earlier than August 1, to avoid working during the noise restriction time for owls.

REHABILITATION WORK

Project implementation

Approximately one third of the watershed area for the 230 road was originally mapped by Bo Dame with help from Peter Armato during 1994 and 1995. The remaining portion of the area was mapped and prescribed by Neal Youngblood in 1996. Surveying was completed by Barry Hill, Neal Youngblood, Becca Smith, Darlene Buckskin and Keith Richey. Most of the mapping and all of the excavation surveys in preparation for Unit 96-1 were accomplished between Feb. 1 to June 15 of 1996. Fillsites were not surveyed due to their relative abundance.

Primary treatments

There were 6 stream crossings along the 230 haul road (figure 3.). An associated 5 skid road stream crossings were also excavated, typically located immediately above or below a haul road crossing. All crossings were excavated to original ground surfaces (as close as possible). All

woody material (logs, rootwads, large slash..) exhumed during excavation along with trees cleared before excavation, were scattered across the finished surface or placed in the finished stream channel.

Two segments of the road prism were treated with outslope prescriptions. From station 14+50 to station 16+50 and from station 21+00 to station 24+75 the road was completely recontoured using inplace topsoil layers, stumps and extrapolating natural topography to establish the extent of excavation.

Secondary treatments:

No secondary treatments for erosion control were prescribed for this contract. The disbursement of woody debris on the finished slope could theoretically be considered a secondary treatment. The wood scattering was prescribed for multiple reasons including, but not limited to: erosion control, salamander and small mammal habitat, diversity of microclimatic factors for revegetation and a more natural aesthetic.

It was thought that most of the road failures occurring along the 230 were due to the rotting of buried organics. By burying the organics, as had been done in earlier restoration work in the park, we would be perpetuating small slope instabilities. The presence of woody debris on the surface aids in the re-establishment of native plant and animal species, facilitating a quicker recovery of the ecosystem - our goal. Should this go with BACKGROUND

Three rolling dips were constructed at the lower stream crossings along the 230, above the 200 road. These dips will reduce the chances of stream flow leaving the natural stream course and diverting down the roadway when the crossing structure fails in upcoming storm events.

narrative of the disappearance of the 230 road

NARRATIVE OF EXCAVATION WORK

The Contractor, Barber Construction Inc. had moved on site a D9H (straight blade with a single shank ripper), D6D (straight blade / winch), 988 (5yd bucket) and 245 (3+yd bucket & thumb) for the purposes of completing the road removal work as described in the contract 14431B8480-96-0001. They brought in a 229 excavator for the lower reach of RX6 for one day. The equipment began moving on site on the 22 of August. Actual excavation work began on August 26, at RX1 (bid item 3). Equipment work was completed with the rolling dips (bid item 11) on the 23 of September.

Barber Construction typically had three operators on site during peak production periods. Randy Moore operated the 245 and the 229 and acted as the contractors' representative in Rich Barber's absence. Oscar "Butch" Brundine operated the D9H or the D6D when necessary. Mike Moore operated the D6D or the 988. During the last stream crossing excavation (RX6), while Randy was running the 229, Rich ran the 245.

RX1:

The Humboldt style stream crossing at RX1 was a deep hair pin alignment with a corduroy road built up the channel that tied into the 220 road atop the ridge. On the left side of the crossing there were three skid roads (available as fillsites) and two spur roads(also fillsites). The stream

channel appeared to come down a relatively narrow, low gradient v-shaped valley form, dropping into a broader and somewhat steeper valley form at the location of the road. The right edge of RX1 adjoined up to the left edge of RX2.

The D9 was down for repairs for the first few days. The lack of the big dozer may have been negligible due to the presence of a spring at RX2 which was located on the right bank of RX1. The contractor began RX1 by having the 245 start at the heart of the crossing fill. The excavator then moved to the downstream end of the road fill on the left bank. The excavator began by uncovering a stump near the downstream extent of the excavation boundary. As it turned out, the excavator ended up tying into original ground and working back 30 to 40 feet short of the estimated boundary. While the excavator was busy on the left bank, Barber had the D6 start dishing down the soft spot at RX2. As the excavator worked up the road, they decided to bring both the loader and the D6 over to the left side to place fill into the skid roads designated as fillsites above the left bank. This decision required that RX2 be filled back in to provide access for the loader. The combination of the loader and D6 packing the fillsite was only somewhat affective. The machines were able to move fill onto the skid roads, but as the fillsite approached the natural slope conditions the loader became useless. The D6 had to finish the fillsites to the best of its ability achieving a relatively natural surface flow pattern but not a complete recontouring of the hillslope and leaving a significant volume of potential fillsite unutilized. With the left side of the crossing eliminated from the potential fillsite list, the remaining fill had to be end hauled by the 988 up the 230 road to an intersection of many skid roads near station 6+00. The 988 was just about compatible with the 245 for moving the fill. After awhile of running over the mush known as RX2, it became impractical for the loader to continue driving across the muck zone. They brought in the D6 again for the short push across RX2 to solid

ground, feeding the 988. This system was used for probably 90% of the fill removal from RX1, which might help explain the slightly lower production rate.

After finishing the upper part of the channel, the 245 dove into the lower portion of the channel work. They built a short push out the slope between RX1 and RX2 which did require the disturbance of in place topsoil, but was the least impacting route for getting equipment in and out of the hole. For the most part, the excavator had to double or triple bucket material up from the bottom to close enough to the push road for the D6 to get the fill to the loader. The 245 needed help getting out of the hole from the winch cat on a regular basis.

RX2:

The stream crossing at RX2 was more of a swale with a year round spring flow initiating approximately 50 feet above the road alignment. The fill was relatively wet with a steep outboard edge. No culvert existed, causing the spring to flow over the road surface.

After having been dished out a couple of times in the previous days, RX2 was attacked primarily with the 245. The excavator had to do a single step down to adequately reach the bottom of the fill. A large lobe of material existed on the upper left bank, generated by a steep skid road that dropped onto the 230 road at RX2. The left lobe was nice, dry material, allowing the D6 to get some high production push action for about an hour.

We had anticipated that the remaining fill in RX2 would fill the remaining road surface between RX2 and the skid roads near 6+00. As the excavator followed original ground, we ended up short

of fill. Approximately 150 feet of full cut road bench was left as is. Since it is a full bench cut, unstable fill problems are not expected in the future.

RX3:

The stream crossings at RX3 include the main 230 haul road and a large spur road dropping in from upslope to the landing at 6+00. A large through cut on the right side of the upper crossing was designated as a critical fillsite to prevent concentrated road surface runoff into the channel excavation. A vast skid road network heading upslope on the left edge of the upper crossing was available as a fillsite. A large spur road, accessing the ridge below the lower (230) crossing initiated from the centerline of the survey profile. The lower spur and its associated skid roads were available for fillsites as well as the remaining 230 road surface. A short reach of channel existed between the upper and lower crossings that was cluttered with debris and sidecast fill. The entire channel was purged through both large crossings, down past the terminus of a small skid road.

The excavation of RX3 was begun at the top of the upper crossing. As the through cut to the right was filled by the 245 (double bucketing because it was too steep for the dozers), the D6 began to push material up into the skid network on the left side. The D9 was busy dishing down the lower crossing while the upper crossing was coming out. Most of the dished out material went onto the remaining 230 road surfaces on either the right or left sides.

As the original channel grade was re-exposed during excavation, stream flow was liberated. When the excavator reached the remaining plug of fill that used to be the 230 road crossing, the plan changed to coming up from the bottom. By going to the bottom, they could better utilize

the lower fillsites. The only problem was the newly liberated flowing water that formed a good sized pond above the plug of fill. As the 245 began pulling the final plug, the saturated fill mobilized. A viscous flow of approximately 20 to 30 cubic yards began to migrate down stream. Fortunately, there had been large rootwads and logs in the crossing fill that could be used for the 245 to walk onto the goo with (the 245 weighs 160,000+ pounds). After a series of these attempts, the bulk of the escaped fill was recovered and laid to rest in the fillsite and the channel finished to specifications.

RX4

The stream crossing at RX4 was the only crossing to have a culvert. There was a 12” corrugated metal pipe placed relatively high in the crossing fill. It seems likely, from the placement and size, that the pipe was installed for the second entry when they logged the western side of the hill in the late sixties. There was a small, partially blown out skid road crossing with a significant amount of fill accumulated above it. Available fillsites were on both sides on the remaining 230 road bench, a large through cut skid dropping down onto the left edge at the 230 road and the skid road to the left side of the lower skid road crossing. This was the only channel with surface water flowing before the excavation began.

As the D9 began dishing down RX4, a chunk of in-place bedrock became exposed at the uppermost right edge of the excavation with a lens of topsoil exposed farther to the right. At this point, we determined there had probably been a small ridge on the right side of the channel that had been cut down in the road building process. There was good evidence for a large swale feature to the right of the small ridge. Both the D9 and the 245 had great difficulty working in the swale and channel fills due to high soil moisture conditions. An attempt was made to dam up

the flow above the excavation during the day, and then release it at night. For the most part, the dam was effective in keeping the flowing water off the working site. The dam did create other problems at the final exit.

Once the D9 had removed as much fill as it could (maybe 10 - 15%), the lighter D6 came in. The excavator began working its way down the outboard edge of the crossing fill. As the original slopes became exposed, it appeared that the channel would be too steep for the excavator to climb out under its own power. Since they had been able to pull the 245 out of RX1 with the D6, we figured that the 245 could go to the bottom and work its way back to where the D6 could pull it up. As it turned out, the 245 managed to get so stuck that instead of being pulled out, it pulled the D6 into the hole. The only way out was to have the equipment go down to the skid road crossing and walk out to the left. As they were making their way down, they blew right past the skid road and stopped at a lower road below the bounds of excavation. We agreed that the disturbed area would be cleaned up to specifications on the way out as mitigation for exceeding the bound of the site. The lower road that they ended up on, tied into the left side of RX5, where they proceeded to exit. The only feasible option for completing RX4 was to send the 245 back into the hole and drag the fill (becoming muck) downhill to the lower road, cleaning the channel on the way down. It did not take long to see that he had accumulated far too much material to clean it all out in one pass. The excavator built a pile nearly 20 feet high within the first 40 feet of moving down the 150 foot reach. As he decided to make a rough pass and then do a second loop to finish the channel, the 245 got hopelessly stuck. The next day, they brought in some rigging and tried to pull the 245 out the top. The stump that was being used for a tail hold began to pull out of the ground, ending the prospects of an upward escape. Getting out of the bottom was successful but time consuming. The second attempt down the channel was more effective and

produced an acceptable channel. The final pulling of the plug (what was left of the dam) released a slug of milkshake like material, most of which was recovered.

RX5

The stream crossing at RX5 had a fairly narrow channel above and a broad, ambiguous reach of predominately large woody debris below. A small skid road crossing was located immediately below the 230 crossing. Fillsites for RX5 were located on a skid network heading up the ridge on the left side of the channel, on the skid road bench that remained from the lower crossing, on a skid network heading down the ridge on the right side of the channel and the remaining road benches the 230 road.

The D9 was able to push most of the fill out of both crossings. In the mid reach portion between the two crossings, the D9 did manage to get stuck as he got closer to the muck. The actual excavation ended up being much shallower than estimated. The channel below the lower crossing proved to be a broad swale that apparently flowed subsurface originally according to the topsoil evidence. Otherwise the excavation proceeded without incident.

RX6

The stream crossing at RX6 was one of the most complex in this contract. The upper crossing at the 230 road was very deep and narrow with a number of large stumps. Below the bulk of the crossing fill was some blocky sandstone and some schist with a significant increase in moisture content. From that point to the lower skid road crossing (150') the channel aggraded, causing a

broad marshy flat. The lower skid road crossing was approximately 15 feet deep at the outboard edge.

The D9 was able to dish out most of the upper (230) crossing, and the D6 was able to get a little more. As the excavator moved down to begin the lower portion of the channel, The bucket sunk into the marshy area and immediately filled with water. That was the end of that plan. After pulling the 245 out of the hole again, it was agreed that a smaller excavator would be necessary to work in the lower section of the crossing/aggraded fill.

Barber found a 229 (like a 225 with a wider undercarriage) within a couple of days, so we proceeded. With the 229 and the 245, they headed to the bottom using the lower skid road that accessed the lower skid road crossing. The 229 used logs and debris to crawl out onto the muck and began passing fill back to the 245. This process seemed to work very well. The D9 pushed the fill back up the skid road until the fill became too mucky causing the D9 to loose traction or sink, then they switched to the D6. When the 229 had finished the lower extent of the channel, it went to the mid section leaving the 245 to finish the bulk of the fill near the skid road.

For the excavation of the left bank through the mid section of the channel length, the 245 approached from a skid road running along the bank. The skid road was designated as a fillsite and therefore available for use within the bounds of excavation. The remainder of the channel excavation was For excavation of the left bank through the mid section of the channel length, the 245 approached from a relatively straight forward. Topsoil continued to be easy to identify and follow.

DISCUSSION

Following post excavation surveys, four of the six haul road stream crossings were less than 85% of the estimated excavation volume (RX1, RX3, RX5 & RX6). The Contractor chose to negotiate on all four of these bid items (bid items 3,5,8 & 9). Of the stream crossings that were over estimated, RX3 was actually 80% of the estimate, while the others were all about half of the original estimate. An overestimation of excavation volume had been anticipated, but the magnitude was greater than expected.

The original layouts used to survey the excavation volumes, focused on the contact between fill material and original ground surface. The computer program used by the Park assumes a straight line between the 'edge' or contact and the corresponding edge of the channel bottom. From the excavations done in Rehabilitation Unit 95-4, we saw that channel banks tended to roll into an inner gorge, with a relatively narrow channel width. This kind of morphology, causes the computer program to overestimate the cross-sectional areas. Since the volume had not changed too much during the previous years excavations, a verbal acknowledgment of the condition was felt to be satisfactory.

Other factors that influenced the reduced volume were onsite reductions of excavation made by the COTR during equipment work. The boundaries or edges of the excavations were reduced in some cases due to limitations of the equipment in particular situations. Some of the surveyed areas included what turned out to be thin veneers of fill across relatively steep slopes. The large size of the excavator prohibited its ability to work on steep slopes and reduced its capacity for finer detailed finish work. While the operator(s) were willing and able to attempt all requested

excavations, the process of accessing certain fills required destruction of buried topsoil layers.

We felt that it was better to leave the topsoil layers intact, even when they were slightly buried, than to remove all manner of organic components from the slopes surface.

ACKNOWLEDGMENTS

Bo Dame and Mike Sanders spent time preparing ground work prior to the '95 season. Darlene Buckskin, Becca Smith, Barry Hill and Keith Ritchey helped survey the road fills and provided much education by sharing their diverse perspectives and experience. Lex Rohn, Jill Richards and Brent Shumaker all assisted with photo points. Tommy Dore helped open the road with his expert back Ho service.

The folks at H.A. Blankenship trucking deserve a case of ear plugs. Steve Frick, Dana Witaker, Flint and Kenny Frick were always helpful and patient with equipment logistics on their property. Also thanks To Tim Mason, Tim Johnson and Betty for always providing the BIG picture catalyst.

Obviously, the work would not be completed if someone didn't get in one of those big yellow pieces of tin. Thanks needs to go to Rich and Ginger Barber (even though it is business, attitude makes a big difference), Randy Moore, Mike Moore and Oscar "Butch" Brundine. Randy, Mike and Butch all managed to keep a positive attitude and work hard regardless of the circumstances. They performed their services in a most skilled and professional manner. Also, Frank, Shorty, Ed and the Peterson Guy who provide support when it was need, not when it was convenient.

Finally, the contributions made by Terry Spreiter & co. can not be over homaged. Terry always had positive input and extended patience for those times when her advice wouldn't sink in as fast as she hoped. Too often, the words "oh, that's why she wanted us to do it that way" were heard. Terry's wisdom and support make a huge difference, not only in moral, but ultimately in the quality of restoration work at Redwood and other parks.

REFERENCES

Cedarholm, C.J., L.M. Reid, and E.O. Salo, 1980. Cumulative effects of logging road sediment on salmonid populations in the Clearwater River, Jefferson County, Washington. In: Salmon-spawning gravel: a renewable resource in the Pacific Northwest? Proceedings of the conference. Seattle, Washington. Contribution No. 543, College of Fisheries, University of Washington. 35p.

Corn, P.S., and R.B. Bury, 1989. Logging in western Oregon: responses of headwater habitats and stream amphibians. *Forest Ecology and Management*. 29: 39-57.

House, R.A. and P.L. Boehne, 1987. The effect of stream cleaning on salmonid habitat and populations in a coastal Oregon drainage. *Western Journal of Applied Forestry*. 2(3):84-87

Narver, D.W., 1971. Effects of logging debris on fish production. In: Krygier, J.T. and J.D. Hall, eds. Forest land uses and stream environment; Proceedings of the symposium. Corvallis, Oregon. Oregon State University, Continuing Education Publications. P.100-111.

Tangen, L., personal communication. Arcata Redwood Company, Orick California.

Weaver, W.E., Seltenrich, M.S., Sonnevill, R.A. and Babock, E.M. 1982. The use of cost-effectiveness as a technique to evaluate and improve watershed rehabilitation for erosion control, Redwood National Park. P. 341-360, in: *Watershed Rehabilitation in Redwood National Park and Other Pacific Coastal Areas: Proceedings of a Symposium* (Arcata Calif. August 24-28, 1981). Center for Natural Resources Studies, 360 p. Sacramento Calif.

HEAVY EQUIPMENT COSTS

TREATMENT	TOTAL	NUMBER	TOTAL COSTS		UNIT COSTS
	VOLUME (yd ³)	OF SITES	CONTRACT	H.E.R.E.	CONTRACT
HAUL ROAD					
STREAM CROSSING	27057	6	\$76,300	\$43,609	\$2.50
OUTSLOPE	4500	2	\$9,000	\$9,000	\$2.00
ROLLING DIP		3	\$1,200		
MOVE IN / MOVE OUT		2	\$6,000		
total volume =	31557	contract cost =	\$92,500		

ADDITIONAL LABOR COSTS

	hours	cost
BRUSHING		
T & E SURVEYS		

PROJECT PLANNING COSTS

	hours	cost
MAPPING		
LAYOUT / SURVEYING		
CONTRACT WRITING		
CONTRACT SUPERVISION		

; (\$/yd ³)	
H.E.R.E.	
	\$1.61
	\$2.00