

REDWOOD NATIONAL PARK

WATERSHED RESTORATION PROJECT

UNIT 89-3: LOST MAN CREEK UPPER DAM REMOVAL

SUMMARY REPORT

By
Darci Short
May, 1991
Rev. July, 1994

ABSTRACT

The Upper Dam on Lost Man Creek in Redwood National Park was removed by heavy equipment in August 1989. The dam had been built in 1936 by the civilian conservation Corps as a water source for the Prairie Creek Fish Hatchery. The structure was abandoned in 1955 when it had become filled with sediment and was replaced by another structure closer to the Hatchery. By 1989, the Upper Dam was in disrepair, posing a visitor safety hazard. The structure was also a partial barrier to chinook salmon.

Dam removal consisted of the removal of the concrete structure, associated wing walls and stilling basins and approximately 2500 cubic yards of channel sediment trapped behind the dam. Total heavy equipment costs to remove the dam were \$12,734. Additional costs for materials, labor, diversion ditch, and supervision and documentation brought the total project cost to \$31,901.

INTRODUCTION

Background

Lost Man Creek Upper Dam was located in Redwood National Park on Lost Man Creek, 0.8 miles upstream from the confluence with Prairie Creek (figures 1 and 2). The concrete dam structure was built in 1936 to impound water for diversion to the Prairie Creek Fish Hatchery downstream. The dam and diversion system were abandoned after filling in with sediment during flooding in 1955 and was replaced by another dam lower on Lost Man Creek. The lower dam served the fish Hatchery until 1992 when the hatchery ceased operations.

By 1989 the upper dam was in disrepair, creating a visitor safety hazard. The abandoned structure was also in conflict with National Park Service Guidelines for Dams and Appurtenant Structures that call for the removal of all such structures which are no longer necessary. The dam was a partial barrier to chinook salmon and other anadromous fish.

An Environmental Assessment was prepared, public input solicited and a Finding of No Significant Impact was issued in 1989 for the removal of the dam. Redwood National Park implemented Alternative 1 of the Environmental Assessment: removal of the dam and much of the channel stored sediment in one season.

The concrete dam structure spanned 57 feet of stream, was 7 feet tall and had wing walls on each side extending 86 feet on the south side and 67 feet on the north side (Appendix). The former water intake basin was located adjacent to the south side of the dam at the terrace edge and consisted of two cement-lined sumps, each five to eight feet deep.

After the dam was abandoned in 1955, water for the Fish Hatchery was later supplied from sources further downstream. At some unknown time later, a fish ladder was constructed along the south bank of the dam in an effort to provide passage for migrating salmonids.

Physiography

Lost Man Creek drains 12.4 square miles of moderately steep forested terrain in Redwood National Park. The creek flows into Prairie Creek, the largest tributary to Redwood Creek (figure 1). The Lost Man Creek basin ranges in elevation from 60 feet (msl) to 224 feet in the headwaters. The dam was located 0.8 miles upstream from the confluence of Lost Man with Prairie Creek. Two broad terraces flanked both sides of the dam. Each were was proposed to be impacted by the dam removal project.

Geology

The geology of the Lost Man Creek basin is chiefly Mesozoic unmetamorphosed mudstones, sandstones, and pebble conglomerates of the Franciscan Complex. The Franciscan rocks are locally overlain by the Plio-Pleistocene Prairie Creek Formation, which is composed of unconsolidated sands and gravels. Remnants of the Prairie Creek Formation occur as deposits along ridge tops in the Lost Man Creek Basin (Harden, et al., 1981; Kelsey and Trexler, 1989).

Hydrology and channel morphology

Stream flows can reach 3125 cfs in the winter with summer low base flows of 0.36 cfs. Channel grades through the lower reaches of Lost Man Creek ranged from 0.0047 below the

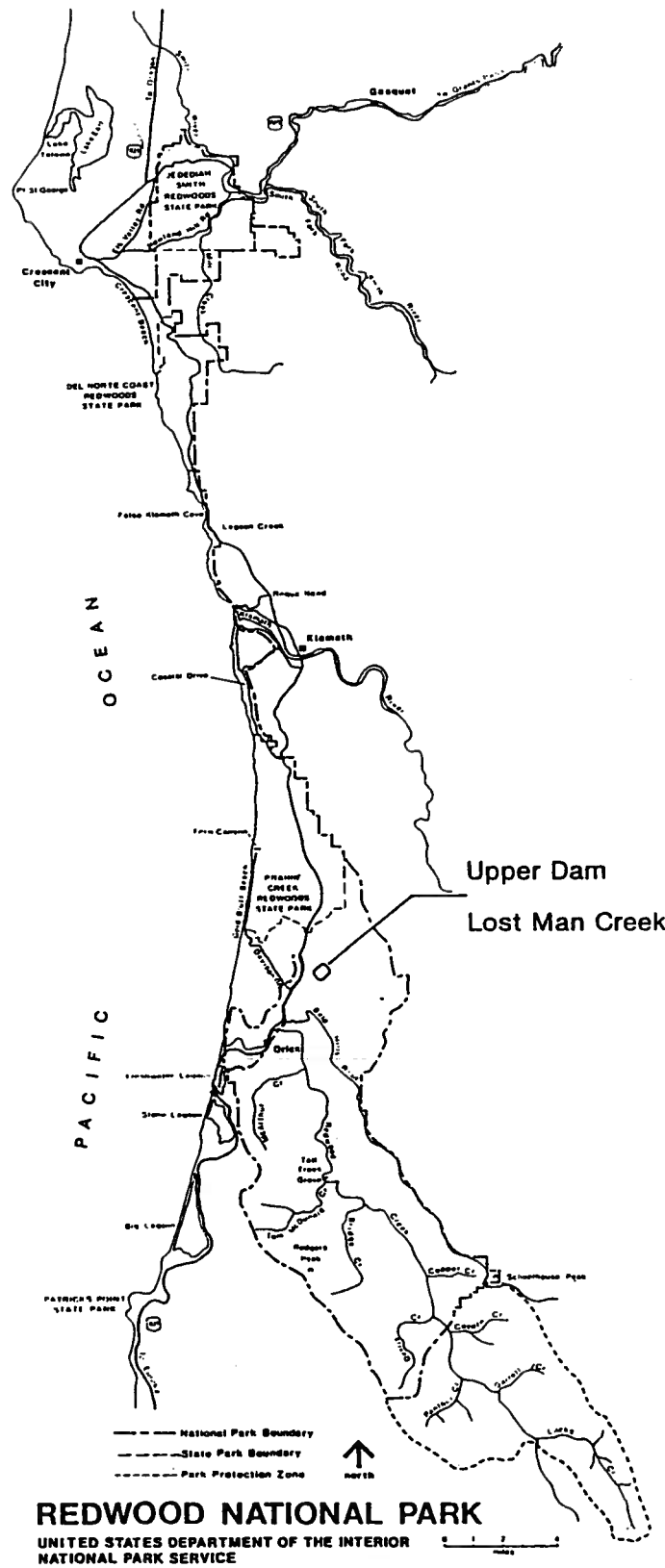


Figure 1. Location of Upper Dam on Lost Man Creek Rehabilitation Site, Redwood National Park, California.

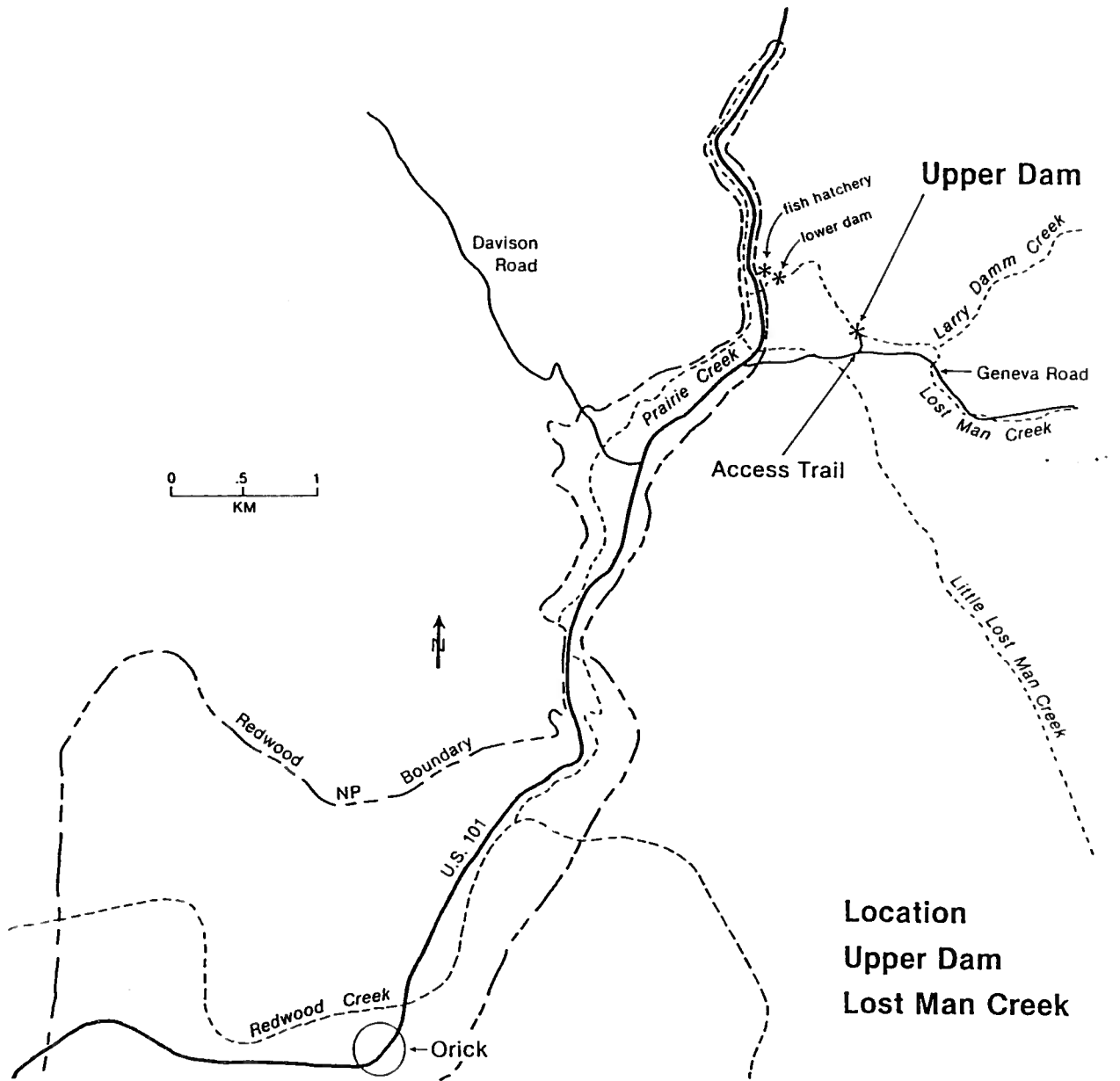


Figure 2. Detail location of Upper Dam on Lost Man Creek, Redwood National Park, showing Lost Man Creek, Upper Dam site, lower dam, fish hatchery, Geneva Road and access trail.

dam site to 0.0064 above the influence of the dam. Average grade for the lower Lost Man Creek is 0.0064. Sediment storage behind the dam was estimated from channel surveys to be approximately 5000 cubic yards, extending approximately 800 feet upstream of the dam.

Fish Resources

Lost Man Creek supports runs of chinook and coho salmon along with steelhead trout. Cutthroat trout, lamprey and sculpin are also found in the creek. Spawning surveys and a fish habitat study in the late 1980's revealed significantly more carcasses and redds below the upper dam than above the dam, indicating that many salmonids (especially chinook salmon) were unable to get above the dam to where there was much available spawning habitat.

Alternative Methods of Removal considered and investigated

Various approaches for dam and sediment removal were suggested. These ideas included dredging channel stored sediment, blasting the dam structure, trucking the sediment to Geneva Road Rock Pit, placing sediment retention structures upstream of the dam and various combinations of all the approaches.

Dredging

An initial idea was to dredge the sediment from behind the dam. This idea was attractive, as it greatly minimized impact on the riparian vegetation. The proponents of this idea felt it was also less expensive than using heavy equipment to remove the sediment. The procedure had been used successfully in stream channel restoration projects by California department of fish and Game (CDF&G).

This option was discussed with Harry Rectinwald of CDF&G and with various private dredging firms. Mr. Rectinwald recommended not using a dredge as he feels they are too slow and expensive and are meant more for back country work inaccessible to heavy equipment. He suggested the use of an excavator with water pumps to remove ponded water. He felt that a dredging operation would be far more expensive than heavy equipment. Discussions with dredge operators confirmed the high costs of dredging, estimated at between six dollars and thirty dollars per cubic yard of sediment moved.

Dredging equipment in the area is used for gold exploration and supports either 3 inch diameter hose or 6 inch diameter hose. The equipment can move sediment that is about one-half the diameter of hose and lift effectively about 10 feet. Engine size and length of hose affect lift. Site conditions at Lost Man Creek require lifting the sediment about 15 feet and running the hose across the terrace to a storage site or to a place for equipment to load the sediment into dump trucks. Dredge operators were skeptical their equipment was sufficient for site conditions. Operators estimated they could move about 50 cubic yards of material per day. Two local operators both felt that if an excavator could get to the site, it would be far more costs effective than dredging.

Partial sediment removal with Sediment Retention Structures

A "drop structure" (constructed of 1 - 1 ½ ton rock cabled and glued together and placed mid channel) was suggested to help provide habitat diversity and provide sediment retention within the sediment storage reach. The structure would also help to minimize costs associated with excavation of sediment stored behind the dam. The opposing argument to this was that cable in a stream channel is a bad legacy to leave for future generations and this type of project should

not be encouraged in Redwood National Park. No other structures for the channel were suggested or recommended.

Fillsite Location

The fillsite for sediment excavated from behind the dam that was identified in the Environmental Assessment was located at the rock quarry site in Little Lost Man Creek. The quarry is on the north side of Geneva Road, a couple thousand feet from the dam site. The use of the rock quarry would require dump trucks or wheeled loaders to haul the material and upgrading the access road to the dam site for large wheeled vehicle use. Dump trucks and road upgrading would be expensive and therefore, other less costly ideas were explored.

It was suggested that the spoils from the dam site be stored on one of the adjacent terraces to the dam, eliminating the need for dump trucks completely. The right bank terrace (north site) was the least vegetated with standing trees and appeared to be best suited for storing fill. The terrace was inventoried by REDW, vegetation management staff and was found not to be a wetland, allowing use of the site without the need for permits or mitigation.

Blasting

The design and composition of the dam were unknown until after heavy equipment began excavating. Because of this uncertainty, the possibility of blasting the dam was explored. Gary Sherwood of Death Valley National Monument was contacted for his expertise on the matter. Gary was certified by the Park Service as a blaster for Redwood National Park when a concrete bridge pier was blasted on Redwood Creek in 1984. Gary's license had since expired, but he provided very useful information of Park regulations and blasting feasibility in a creek setting. Upon Gary's recommendation, the Regional Blaster for NPS was contacted at Sequoia - Kings Canyon NP. He visited to the dam site while here on personal business and was able to outline the needs for blasting. Most importantly, a Blasting Plan as described in NPS-65, "Explosives Use Policy and Blasting Program Guideline" was required.

Upon further investigation, it was also found that storing and transporting the explosives was much more straightforward with a licensed local blaster. CDF&G offered to be available to perform the blasting. They had a licensed blaster with assistants located in Red Bluff and were more available due to closer proximity than the NPS blaster. A drill and compressor were rented and were on hand to drill the cement to set the charges if it was found necessary.

Other State and Federal Agency Jurisdiction

The Army corps of Engineers has jurisdiction of all projects located with waters of the United States. To move sediment within the stream channel requires an individual permit that generally takes a full year to acquire from the Corps. Redwood National Park did not contact the Corps about the permit until the spring of 1989 (about six months prior to the anticipated start of equipment work). Without acquiring an individual permit, we could work in the channel under a Nation Wide permit, which could be issued quickly. The National Wide No. 26 permit allowed the removal of sediment from the channel, but not movement of sediment within the channel. This meant that a cofferdam of sediment could not be built and that sandbags could not be used within the channel. These limitations led to the final design and approach.

California Department of Fish and Game also had jurisdiction over the dam removal activities and provided the necessary agreements. CDF&G was interested in the project from a habitat enhancement perspective and visited the site to observe and make suggestions regarding the

project as it progressed. Their comments mainly regarded limiting turbidity during the project and minimizing subsequent bank erosion during higher flows. They also provided support as need for blasting. Funding assistance for the project was requested from CDF&G with negative results.

California Regional Water Quality Control Board waived the need to apply for a waste discharge permit.

Conclusions of Planning and Scoping

After extensive discussion with dredging companies, blasters and local stream restorationists, it was determined that the best approach at Lost Man Creek would be to use heavy equipment to remove a large portion of the volume of stored sediment and dam rubble. It was also decided that since the internal structure of the dam was unknown, it would be best to have a team available on stand-by to blast the dam if necessary. The northern terrace adjacent to the dam was selected as the best sediment and dam rubble storage site. This sediment storage location eliminated the need for dump trucks and for upgrading the access road to the nearby rock pit, thereby greatly reducing expenses.

PROJECT IMPLEMENTATION

Baseline Monitoring

Baseline studies were implemented beginning in 1987 to document potential changes in channel morphology, fish habitat, etc. The studies consisted of fish habitat typing and inventory, and stream channel morphology mapping and surveying. These studies will continue to monitor the effects of the dam removal on fish habitat and channel morphology. Reports are on file at Redwood National Park, Orick and Arcata.

The heavy equipment phase of the rehabilitation project was implemented in August 1989 for a total cost of \$31,901. Costs are outlined in tables 1, 2 and 3.

Table 1. Rehabilitation work cost summary, Unit 89-3: Lost Man creek Upper Dam Removal.

	COSTS	TOTAL COSTS
HEAVY EQUIPMENT WORK		
Dam and Sediment Removal	7,436	
Diversion Ditch	1,224	
Access Road Outslope	203	
Rock Quarry Improvements	772	
Miscellaneous	961	
Standby with Operator	336	
TOTAL		\$12,734
MATERIALS		5,370
TECHNICAL WORK		
Preparation	5,247	
Supervision and Maintenance	2,745	
Resources Management Support Crew	5,048	
Documentation	757	
TOTAL		<u>13,797</u>
PROJECT TOTAL		\$31,901

Table 2. Heavy equipment cost summary Unit 89-3: Lost Man Creek Upper Dam Removal.

	EXCAVATOR ¹		DOZER ²		TOTAL EQUIPMENT COST
	Hours	Costs ³	Hours	Costs ⁴	
Dam and Sediment Removal	28.00	\$3,780.00	29.25	3,656.25	\$7,436.25
Diversion Ditch	6.75	911.25	2.50	312.50	1,223.75
Access Road Outslope	1.50	202.50	0	0	202.50
Rock Quarry Improvements	2.25	303.75	3.75	468.75	772.50
Miscellaneous	5.50	742.50	1.75	218.75	961.25
Standby with Operator	2.00	155.00 ⁵	2.50	181.25 ⁶	336.25
Move in / Move out		1,062.75		739.05	1,801.80
TOTAL EQUIPMENT COSTS					\$12,734.30

1 Case 220 hydraulic excavator. 2 ½ cubic yard bucket, 38 ft. max. horiz. reach at ground level.

Owned and operated by Wendel Larkin, Arcata

2 Cat D8H dozer with U-blade and winch. Owned by Twin Parks Lumber Co., Arcata and operated by Ernie Larkin, Arcata.

3 Hourly rate \$135.00/hour

4 Hourly rate \$125.00/hour

5 Standby with Operator Hourly Rate \$77.50/hour

6 Standby with Operator Hourly Rate \$72.50/hour

Table 3. Materials cost summary, Unit 89-3: Lost Man Creek Upper Dam Removal.

	COST	TOTAL COST
FILTER FENCES		
Hog wire	\$143.64	
Filter fabric	300.00	
Fence Posts/wire	71.52	
TOTAL		\$515.16
DIVERSION DITCH		
Pipe	3,211.40	
Hog Wire	51.00	
Sand Bags	55.00	
TOTAL		3,317.40
PUMPS		
Pump Rental	738.00	
Fuel	69.60	
TOTAL		807.60
STRAW		
35 bales	140.00	
TOTAL		140.00
STANDBY EQUIPMENT NOT USED		
Drill (for blasting)		
SPC absorbent pads (for fuel spills)	74.80	
TOTAL		589.90
MATERIALS TOTAL		\$5,370.06

Tree Removal and Slough Sedge Salvage

Because the site is adjacent to a park road accessing Lost Man Picnic Area and is open to the public, park management felt it important the project site be aesthetically pleasing upon completion. All alder and other standing trees which were in the impacted area were felled prior to the arrival of heavy equipment, bucked for firewood and hauled to Wolf Creek Outdoor School. It was anticipated that the restoration site would become a picnic area after the area undergoes a few years of revegetation and recovery.

The slough sedge was removed from the site prior to heavy equipment work and held in a makeshift nursery on site until after removal of the dam.

Silt Fences

Prior to heavy equipment work, silt fences were installed in the channel downstream of the dam site to minimize turbidity beyond the work area. The fences were installed, in series, 135 and 195 downstream of the dam face. Both fences were constructed of fence posts pounded two feet into the channel bottom about 5 feet apart across the full width of the stream and onto the banks. The "wings" on the bottom of the posts were removed to allow easier retrieval of the post when the project was completed. Hog-wire fencing was attached to the upstream side of the fence posts with bailing wire for the full width of the fence. Filter cloth (poly-filter GB, a palmered geotextile woven of monofilament polypropylene yarns) was then attached to the upstream side of the fence. Straw bales were placed on the upstream face of the fence to help hold the cloth to the channel bottom and to help slow the current to allow for the settling of fine sediment.

Heavy Equipment

Heavy equipment was secured under rental agreement with Twin Parks Lumber Co. of Arcata, California. A Case 220 Hydraulic Excavator with a 2.5 cubic yard bucket was operated by Wendell Larkin and a Caterpillar D8H dozer with U-blade and winch was operated by Ernie Larkin. Complications with securing low boy transportation and a newly implemented route for oversized loads traveling north on Highway 101 caused the heavy equipment to arrive late and not in the sequence as planned. The excavator arrived a full day ahead of the dozer, although it was scheduled to arrive after the dozer. A quick reassessment of approach was discussed and equipment was used to its fullest with no standby time accrued as a result of the rescheduling. Time and costs of the heavy equipment, for various phases of the project, are shown in table 2.

Diversion Trench

To effectively remove the dam with minimal impact on downstream turbidity, it was necessary to divert all stream flow away from the work site. The diversion trench location provided for some interesting challenges. The diversion needed to go around the project without interfering with equipment access. The first location chosen for the diversion was far along the northern edge of the right bank (northern) terrace at the base of the hillslope. This route proved to be very long, which meant it would be expensive and highly impacting to an area that would otherwise be unimpacted by the dam removal activities. An alternate route along the left bank was shorter and would impact an area that was already destined to be damaged by the removal project. The concern with a diversion trench on the left bank was that it would cut off equipment and walking access to the creek during the project.

The diversion ditch was constructed beginning 150 feet upstream of the dam site on the left bank, discharging immediately downstream of the spillway into the existing plunge pool. The

200 foot long ditch, excavated by the excavator was one bucket width wide (42') and was routed through the left bank (south terrace). The trench was kept at a 1 % grade over the full distance. At its deepest, the trench reached 8.5 feet deep, and averaged six to seven feet.

It was necessary to line the ditch to minimize any increase in the sediment load of the diverted water. ADS plastic pipe was chosen as it could be handled easily by people as it is relatively light weight and simple to connect. We chose 18-inch diameter pipe, which has a capacity of about 5-cfs at a grade of 1 %. This size pipe is also the minimum size recommended for road culverts, thus increasing the likelihood of using it in the future of road repair projects within the park. The pipe was connected on the terrace surface along the trench and rolled in after being fully connected. Sandbags were placed surrounding the entrance of the pipe and covered with plastic to provide wing walls into the pipe.

Many of the couplings leaked and water was ponded inside the trench. The drop of 8 feet into the trench no doubt contributed to the weak coupling of the pipe sections. However, overall the ADS pipe worked well, with most of the water discharged through the outlet, and all the leaking water contained or absorbed by the trench walls. The trench walls consisted of fine silts and sands which during the course of the project continued to collapse and slough off. The trench was not shored and all staff on site were instructed in proper safety procedures near the open trench.

For safety, a boundary fence of posts and flagging was installed along each side of the trench. A bridge of 2X6's and plywood was constructed to allow safe foot passage across the trench at a key location.

The trench was further excavated out into the channel at the upper end allowing the stream to flow into the diversion pipe. An impermeable fence constructed of fence posts, hog wire, and plastic was built diagonally across the channel to prevent water from flowing down the existing stream channel into the work site. Ideally, a berm within the channel, constructed of sand bags or of stream gravels, would have been built. However, the U.S. Army Corps of Engineers required that permits be obtained to place gravel or sandbags in the channel. The permit process requires a full year, precluding it as an option for this project.

After completion of dam and sediment excavation, flow to the diversion was closed off, and the flow was directed back into the channel. The pipe was then retrieved from the trench with the excavator. The pipe and collars were hauled to Wolf Creek Fire Cache for storage and later use in culvert repairs and replacements within the park.

Water Pumps

Once stream flow was diverted through the pipe, the excavator dug a pond immediately behind the dam to intercept the inner-gravel flow water so that it could be pumped out. The pumped water was heavy with sediment and was discharged into the thickly vegetated terrace for dispersal. The pumps ran continuously during the day to keep up with incoming flow. Two, three inch diaphragm pumps were required, with a rated capacity of 5000-6000 gallons per minute.

There were technical difficulties with the pumps and the 150 feet of discharge fire hose that ran into the forest required frequent realignment. The continual pulses of heavy sediment in the water caused the hoses to jerk around and eventually they would end up in some unwanted

locations. The hoses were secured as well as feasible with ropes, strapping the hose to long sections of downed alder trunks. A better design would have helped, however with the many other tasks at hand the hose was a relatively small nuisance.

Fillsite Preparation

After the stream flow diversion was complete, the dozer with winch arrived and began preparing the fillsite on the right (north) terrace (initially, the dozer was planned to complete the fillsite preparation prior to the excavator arrival). The dozer scraped all vegetation from the fillsite area avoiding the few stands of large alder trees. All vegetation was pushed into one pile. The dozer then removed the upper 1 – 2 feet of soil and pushed it to another location for storage, to be used as the top layer when finished. Next, the dozer excavated a large hole in the middle of the cleared area for burial of the sediment and rubble from the dam.

Channel Excavation and Dam Removal

The excavator began by removing sediment form immediately behind the concrete dam structure. Upon removing this material, the structure of the dam became visible. The dam was composed of a vertical wall of concrete approximately 18 inches thick sitting directly on channel gravels. It was at this point that it was recognized that blasting would not be necessary and equipment began to remove channel-stored sediment upstream of the dam.

The excavator and dozer worked together throughout the removal of the channel-stored sediment with the excavator digging and passing the sediment to the dozer which then pushed it to the fillsite. The equipment removed a large portion of the channel stored sediment before beginning removal of the dam. The dam functioned as a retention structure for fine sediment, suspended in the ponded water, while the equipment worked upstream.

The longest sustained pulse of turbid water was released when the final portions of the dam rubble were removed. Even though the steam flow was diverted and the inner-gravel (sub-surface) flow was directed to pumps, not all water could be removed from the work site. It was this small volume of water that became very turbid from the equipment work. Turbidity was not visually detectable downstream of the silt fences for most of the project, except for about two hours immediately following the removal of the dam rubble. Sediment samples were not taken to measure the sediment load released.

Finish work

After completing removal of the channel-stored sediment, dam and wing walls, the diversion fence was removed and the excavator trenched the channel to allow flow back into the natural stream channel. The diversion pipe was lifted from the trench using a chain attached to the bucket of the excavator. Additional sediment from upstream of the diversion, which was prescribed for removal, was excavated and placed into the diversion ditch. The diversion ditch was further backfilled with the stored spoils from the ditch excavation.

Large boulders that were exhumed at the foot of the dam were placed at the old diversion trench entrance for bank protection. Additional large boulders were placed intermittently along areas of the bank for bank protection and diversity.

At the fill site on the right terrace (northern), the dozer recovered the upper one to two feet of soil which had been set aside, and distributed it evenly over the fill area, smoothing and

shaping to blend with the surrounding topography. After completion of shaping and smoothing the disturbed area on both terraces, the dozer was released from duty.

Access Road Outslope

The excavator remained on site to decompact the equipment paths with the bucket teeth and to remove the access road. The access road sidecast fill was excavated and placed against the cutbank and blended with the surrounding topography to obscure the cutbank as much as possible. A four foot bench of the original road surface was left as an access trail down to the restoration site for future development of a proposed picnic area.

Rock Quarry Improvements

Improvement of a nearby rock pit was accomplished concurrent with dam and sediment removal. This work was done by the heavy equipment during times when only one piece was able to efficiently work at the damsite. During these lag times the idle piece of equipment was sent to the rock pit to work.

At the rock pit, the equipment redistributed and reshaped the unattractive soil and rock piles at the base of the rock face, developing a free flowing surface with no ponds and resembling a more natural talus slope. The equipment also attempted pampas grass eradication, but it was soon discovered that the equipment engine fans spread more seed than the number of plants being eradicated, and therefore, work on the pampas grass was immediately suspended.

Surface Erosion Control and Revegetation

Labor intensive work followed the completion of the heavy equipment and included two phases. The first phase consisted of straw mulch (certified weed free) application to minimize surface erosion during the first winter and brush cleanup along the access trail. Straw was retrieved from the silt fences and spread over disturbed areas at the work site by Redwood National Park Resource Management Support Crew. The second phase consisted of transplanting the salvaged slough sedge that was removed from the site prior to heavy equipment work in the disturbed channel banks and terraces. Transplanting was done by YCC crews and a volunteer Boy Scout troop. The transplanting was followed with watering from firepumps drawing from the river to help the stressed plants through the late hot summer months for the first year.

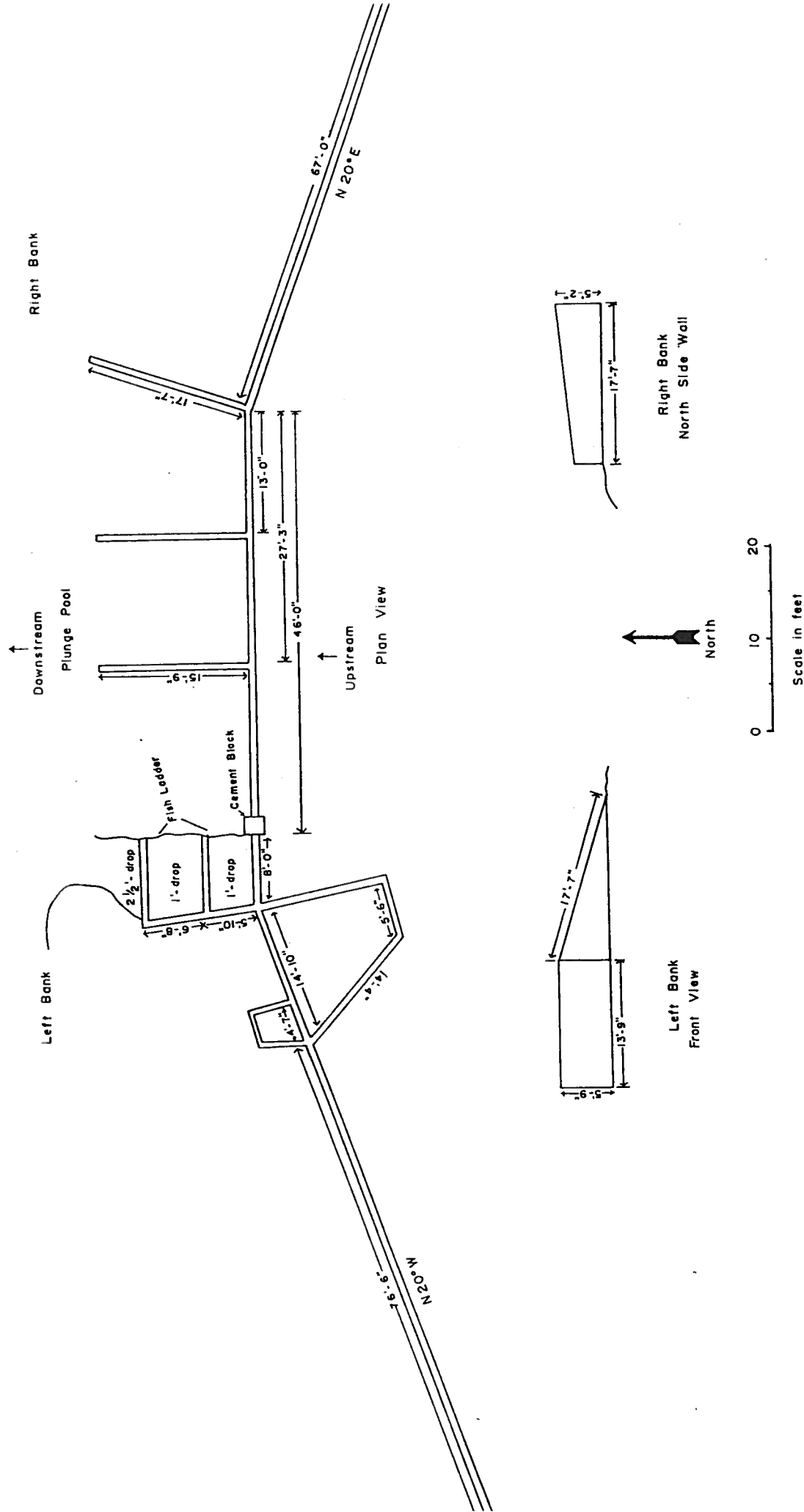
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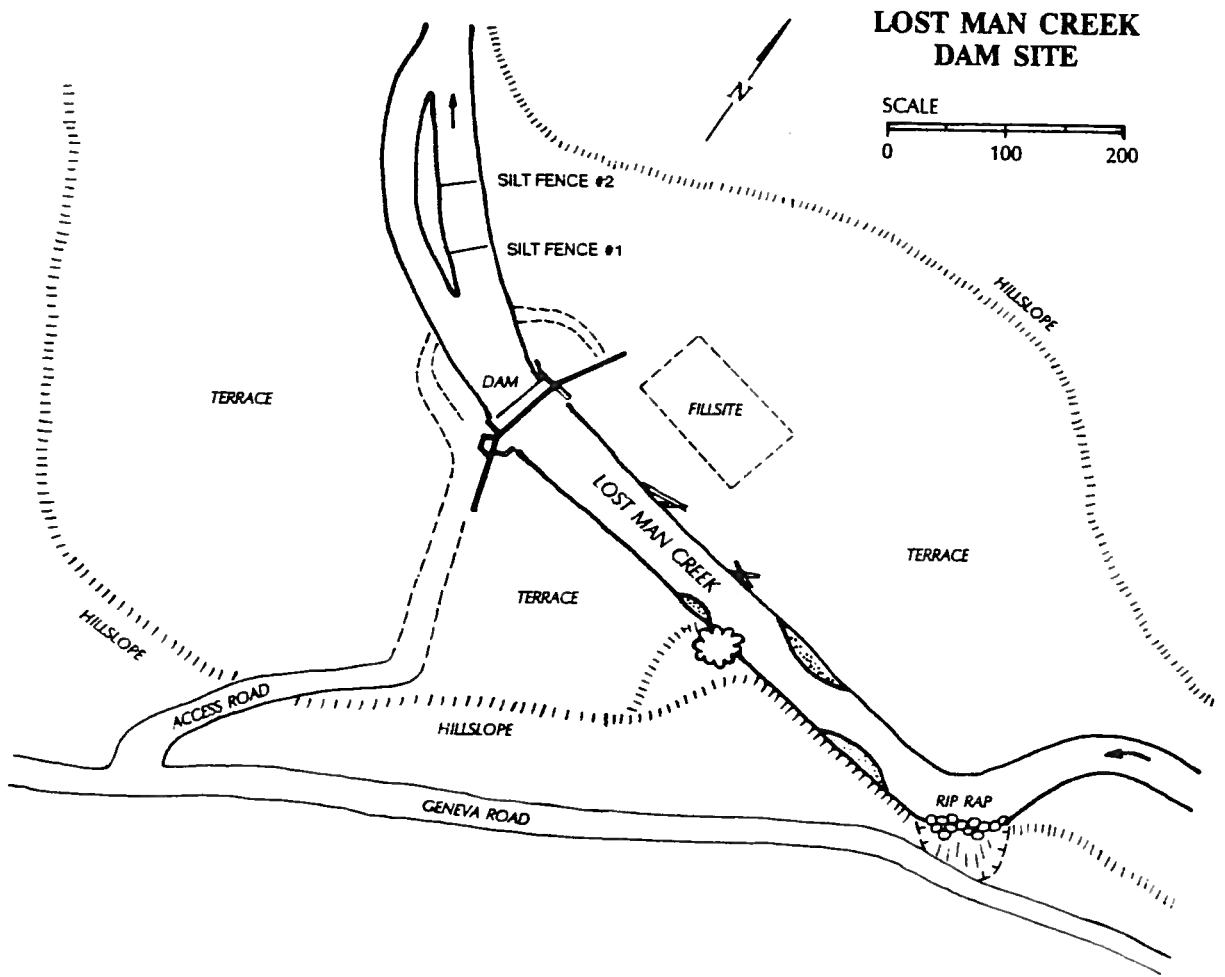
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Watershed Rehabilitation Unit 89-3: Lost Man Creek Dam Removal.

LOST MAN CREEK DAM



As built drawing of Lost Man Creek Upper Dam. Measured by J. Sacklin and A.K. Smith, spring, 1989.
Drawing by T. Hardt.



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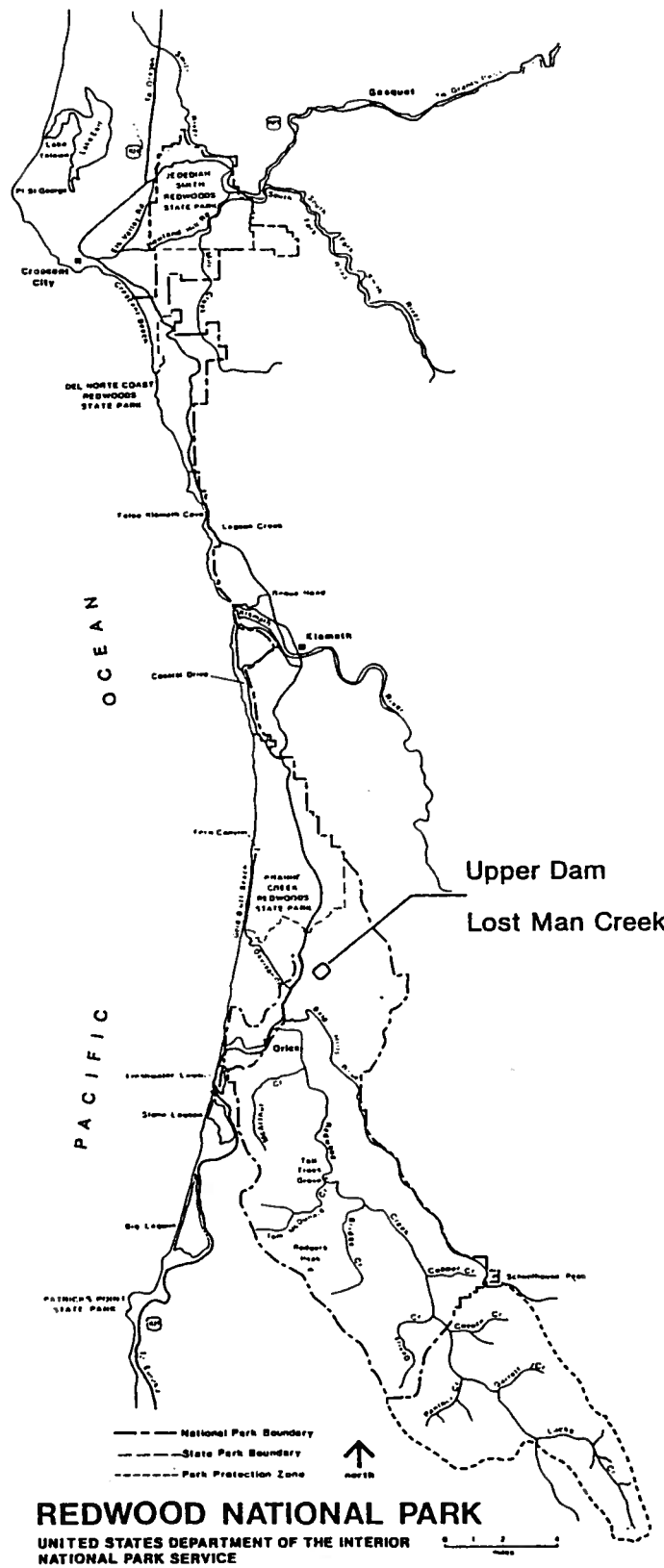


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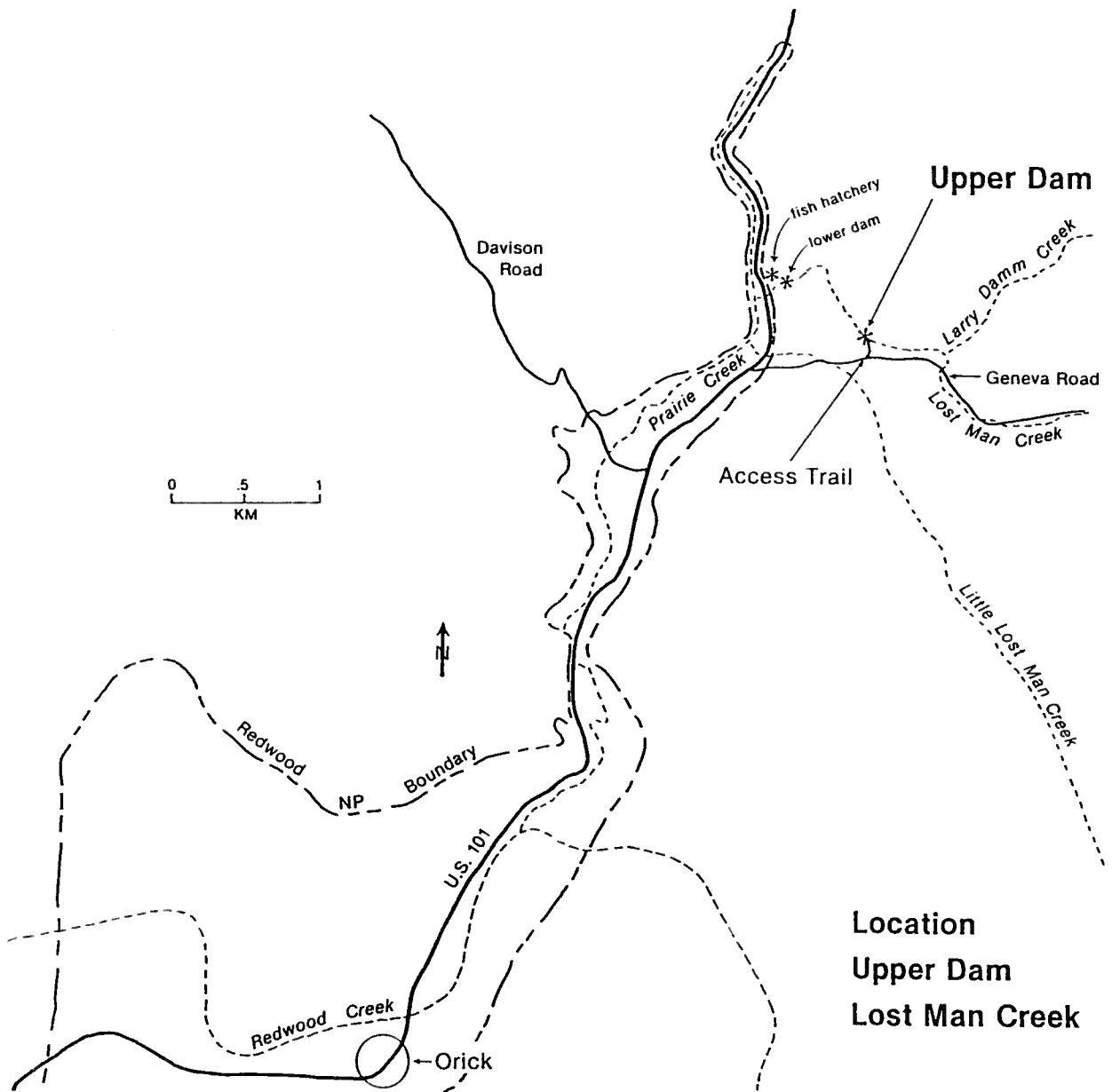


Figure 2. Detail location of Upper Dam on Lost Man Creek, Redwood National Park, showing Lost Man Creek, Upper Dam site, lower dam, fish hatchery, Geneva Road and access trail.

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Various approaches for dam and sediment removal were suggested. These ideas included dredging channel stored sediment, blasting the dam structure, trucking the sediment to Geneva Road Rock Pit, placing sediment retention structures upstream of the dam and various combinations of all the approaches.

Dredging

An initial idea was to dredge the sediment from behind the dam. This idea was attractive, as it greatly minimized impact on the riparian vegetation. The proponents of this idea felt it was also less expensive than using heavy equipment to remove the sediment. The procedure had been used successfully in stream channel restoration projects by California department of fish and Game (CDF&G).

This option was discussed with Harry Rectinwald of CDF&G and with various private dredging firms. Mr. Rectinwald recommended not using a dredge as he feels they are too slow and expensive and are meant more for back country work inaccessible to heavy equipment. He suggested the use of an excavator with water pumps to remove ponded water. He felt that a dredging operation would be far more expensive than heavy equipment. Discussions with dredge operators confirmed the high costs of dredging, estimated at between six dollars and thirty dollars per cubic yard of sediment moved.

Dredging equipment in the area is used for gold exploration and supports either 3 inch diameter hose or 6 inch diameter hose. The equipment can move sediment that is about one-half the diameter of hose and lift effectively about 10 feet. Engine size and length of hose affect lift. Site conditions at Lost Man Creek require lifting the sediment about 15 feet and running the hose across the terrace to a storage site or to a place for equipment to load the sediment into dump trucks. Dredge operators were skeptical their equipment was sufficient for site conditions. Operators estimated they could move about 50 cubic yards of material per day. Two local operators both felt that if an excavator could get to the site, it would be far more costs effective than dredging.

Partial sediment removal with Sediment Retention Structures

A "drop structure" (constructed of 1 - 1 ½ ton rock cabled and glued together and placed mid channel) was suggested to help provide habitat diversity and provide sediment retention within the sediment storage reach. The structure would also help to minimize costs associated with excavation of sediment stored behind the dam. The opposing argument to this was that cable in a stream channel is a bad legacy to leave for future generations and this type of project should

not be encouraged in Redwood National Park. No other structures for the channel were suggested or recommended.

Fillsite Location

The fillsite for sediment excavated from behind the dam that was identified in the Environmental Assessment was located at the rock quarry site in Little Lost Man Creek. The quarry is on the north side of Geneva Road, a couple thousand feet from the dam site. The use of the rock quarry would require dump trucks or wheeled loaders to haul the material and upgrading the access road to the dam site for large wheeled vehicle use. Dump trucks and road upgrading would be expensive and therefore, other less costly ideas were explored.

It was suggested that the spoils from the dam site be stored on one of the adjacent terraces to the dam, eliminating the need for dump trucks completely. The right bank terrace (north site) was the least vegetated with standing trees and appeared to be best suited for storing fill. The terrace was inventoried by REDW, vegetation management staff and was found not to be a wetland, allowing use of the site without the need for permits or mitigation.

Blasting

The design and composition of the dam were unknown until after heavy equipment began excavating. Because of this uncertainty, the possibility of blasting the dam was explored. Gary Sherwood of Death Valley National Monument was contacted for his expertise on the matter. Gary was certified by the Park Service as a blaster for Redwood National Park when a concrete bridge pier was blasted on Redwood Creek in 1984. Gary's license had since expired, but he provided very useful information of Park regulations and blasting feasibility in a creek setting. Upon Gary's recommendation, the Regional Blaster for NPS was contacted at Sequoia – Kings Canyon NP. He visited to the dam site while here on personal business and was able to outline the needs for blasting. Most importantly, a Blasting Plan as described in NPS-65, "Explosives Use Policy and Blasting Program Guideline" was required.

Upon further investigation, it was also found that storing and transporting the explosives was much more straightforward with a licensed local blaster. CDF&G offered to be available to perform the blasting. They had a licensed blaster with assistants located in Red Bluff and were more available due to closer proximity than the NPS blaster. A drill and compressor were rented and were on hand to drill the cement to set the charges if it was found necessary.

Other State and Federal Agency Jurisdiction

The Army corps of Engineers has jurisdiction of all projects located with waters of the United States. To move sediment within the stream channel requires an individual permit that generally takes a full year to acquire from the Corps. Redwood National Park did not contact the Corps about the permit until the spring of 1989 (about six months prior to the anticipated start of equipment work). Without acquiring an individual permit, we could work in the channel under a Nation Wide permit, which could be issued quickly. The National Wide No. 26 permit allowed the removal of sediment from the channel, but not movement of sediment within the channel. This meant that a cofferdam of sediment could not be built and that sandbags could not be used within the channel. These limitations led to the final design and approach.

California Department of Fish and Game also had jurisdiction over the dam removal activities and provided the necessary agreements. CDF&G was interested in the project from a habitat enhancement perspective and visited the site to observe and make suggestions regarding the

project as it progressed. Their comments mainly regarded limiting turbidity during the project and minimizing subsequent bank erosion during higher flows. They also provided support as need for blasting. Funding assistance for the project was requested from CDF&G with negative results.

California Regional Water Quality Control Board waived the need to apply for a waste discharge permit.

Conclusions of Planning and Scoping

After extensive discussion with dredging companies, blasters and local stream restorationists, it was determined that the best approach at Lost Man Creek would be to use heavy equipment to remove a large portion of the volume of stored sediment and dam rubble. It was also decided that since the internal structure of the dam was unknown, it would be best to have a team available on stand-by to blast the dam if necessary. The northern terrace adjacent to the dam was selected as the best sediment and dam rubble storage site. This sediment storage location eliminated the need for dump trucks and for upgrading the access road to the nearby rock pit, thereby greatly reducing expenses.

PROJECT IMPLEMENTATION

Baseline Monitoring

Baseline studies were implemented beginning in 1987 to document potential changes in channel morphology, fish habitat, etc. The studies consisted of fish habitat typing and inventory, and stream channel morphology mapping and surveying. These studies will continue to monitor the effects of the dam removal on fish habitat and channel morphology. Reports are on file at Redwood National Park, Orick and Arcata.

The heavy equipment phase of the rehabilitation project was implemented in August 1989 for a total cost of \$31,901. Costs are outlined in tables 1, 2 and 3.

Table 1. Rehabilitation work cost summary, Unit 89-3: Lost Man creek Upper Dam Removal.

	COSTS	TOTAL COSTS
HEAVY EQUIPMENT WORK		
Dam and Sediment Removal	7,436	
Diversion Ditch	1,224	
Access Road Outslope	203	
Rock Quarry Improvements	772	
Miscellaneous	961	
Standby with Operator	336	
TOTAL		\$12,734
MATERIALS		5,370
TECHNICAL WORK		
Preparation	5,247	
Supervision and Maintenance	2,745	
Resources Management Support Crew	5,048	
Documentation	757	
TOTAL		<u>13,797</u>
PROJECT TOTAL		<u>\$31,901</u>

Table 2. Heavy equipment cost summary Unit 89-3: Lost Man Creek Upper Dam Removal.

	EXCAVATOR ¹		DOZER ²		TOTAL EQUIPMENT COST
	Hours	Costs ³	Hours	Costs ⁴	
Dam and Sediment Removal	28.00	\$3,780.00	29.25	3,656.25	\$7,436.25
Diversion Ditch	6.75	911.25	2.50	312.50	1,223.75
Access Road Outslope	1.50	202.50	0	0	202.50
Rock Quarry Improvements	2.25	303.75	3.75	468.75	772.50
Miscellaneous	5.50	742.50	1.75	218.75	961.25
Standby with Operator	2.00	155.00 ⁵	2.50	181.25 ⁶	336.25
Move in / Move out		1,062.75		739.05	1,801.80
TOTAL EQUIPMENT COSTS					\$12,734.30

1 Case 220 hydraulic excavator. 2 ½ cubic yard bucket, 38 ft. max. horiz. reach at ground level.

Owned and operated by Wendel Larkin, Arcata

2 Cat D8H dozer with U-blade and winch. Owned by Twin Parks Lumber Co., Arcata and operated by Ernie Larkin, Arcata.

3 Hourly rate \$135.00/hour

4 Hourly rate \$125.00/hour

5 Standby with Operator Hourly Rate \$77.50/hour

6 Standby with Operator Hourly Rate \$72.50/hour

Table 3. Materials cost summary, Unit 89-3: Lost Man Creek Upper Dam Removal.

	COST	TOTAL COST
FILTER FENCES		
Hog wire	\$143.64	
Filter fabric	300.00	
Fence Posts/wire	71.52	
TOTAL		\$515.16
DIVERSION DITCH		
Pipe	3,211.40	
Hog Wire	51.00	
Sand Bags	55.00	
TOTAL		3,317.40
PUMPS		
Pump Rental	738.00	
Fuel	69.60	
TOTAL		807.60
STRAW		
35 bales	140.00	
TOTAL		140.00
STANDBY EQUIPMENT NOT USED		
Drill (for blasting)		
SPC absorbent pads (for fuel spills)	74.80	
TOTAL		589.90
MATERIALS TOTAL		\$5,370.06

Tree Removal and Slough Sedge Salvage

Because the site is adjacent to a park road accessing Lost Man Picnic Area and is open to the public, park management felt it important the project site be aesthetically pleasing upon completion. All alder and other standing trees which were in the impacted area were felled prior to the arrival of heavy equipment, bucked for firewood and hauled to Wolf Creek Outdoor School. It was anticipated that the restoration site would become a picnic area after the area undergoes a few years of revegetation and recovery.

The slough sedge was removed from the site prior to heavy equipment work and held in a makeshift nursery on site until after removal of the dam.

Silt Fences

Prior to heavy equipment work, silt fences were installed in the channel downstream of the dam site to minimize turbidity beyond the work area. The fences were installed, in series, 135 and 195 downstream of the dam face. Both fences were constructed of fence posts pounded two feet into the channel bottom about 5 feet apart across the full width of the stream and onto the banks. The "wings" on the bottom of the posts were removed to allow easier retrieval of the post when the project was completed. Hog-wire fencing was attached to the upstream side of the fence posts with bailing wire for the full width of the fence. Filter cloth (poly-filter GB, a palmered geotextile woven of monofilament polypropylene yarns) was then attached to the upstream side of the fence. Straw bales were placed on the upstream face of the fence to help hold the cloth to the channel bottom and to help slow the current to allow for the settling of fine sediment.

Heavy Equipment

Heavy equipment was secured under rental agreement with Twin Parks Lumber Co. of Arcata, California. A Case 220 Hydraulic Excavator with a 2.5 cubic yard bucket was operated by Wendell Larkin and a Caterpillar D8H dozer with U-blade and winch was operated by Ernie Larkin. Complications with securing low boy transportation and a newly implemented route for oversized loads traveling north on Highway 101 caused the heavy equipment to arrive late and not in the sequence as planned. The excavator arrived a full day ahead of the dozer, although it was scheduled to arrive after the dozer. A quick reassessment of approach was discussed and equipment was used to its fullest with no standby time accrued as a result of the rescheduling. Time and costs of the heavy equipment, for various phases of the project, are shown in table 2.

Diversion Trench

To effectively remove the dam with minimal impact on downstream turbidity, it was necessary to divert all stream flow away from the work site. The diversion trench location provided for some interesting challenges. The diversion needed to go around the project without interfering with equipment access. The first location chosen for the diversion was far along the northern edge of the right bank (northern) terrace at the base of the hillslope. This route proved to be very long, which meant it would be expensive and highly impacting to an area that would otherwise be unimpacted by the dam removal activities. An alternate route along the left bank was shorter and would impact an area that was already destined to be damaged by the removal project. The concern with a diversion trench on the left bank was that it would cut off equipment and walking access to the creek during the project.

The diversion ditch was constructed beginning 150 feet upstream of the dam site on the left bank, discharging immediately downstream of the spillway into the existing plunge pool. The

200 foot long ditch, excavated by the excavator was one bucket width wide (42') and was routed through the left bank (south terrace). The trench was kept at a 1 % grade over the full distance. At its deepest, the trench reached 8.5 feet deep, and averaged six to seven feet.

It was necessary to line the ditch to minimize any increase in the sediment load of the diverted water. ADS plastic pipe was chosen as it could be handled easily by people as it is relatively light weight and simple to connect. We chose 18-inch diameter pipe, which has a capacity of about 5-cfs at a grade of 1 %. This size pipe is also the minimum size recommended for road culverts, thus increasing the likelihood of using it in the future of road repair projects within the park. The pipe was connected on the terrace surface along the trench and rolled in after being fully connected. Sandbags were placed surrounding the entrance of the pipe and covered with plastic to provide wing walls into the pipe.

Many of the couplings leaked and water was ponded inside the trench. The drop of 8 feet into the trench no doubt contributed to the weak coupling of the pipe sections. However, overall the ADS pipe worked well, with most of the water discharged through the outlet, and all the leaking water contained or absorbed by the trench walls. The trench walls consisted of fine silts and sands which during the course of the project continued to collapse and slough off. The trench was not shored and all staff on site were instructed in proper safety procedures near the open trench.

For safety, a boundary fence of posts and flagging was installed along each side of the trench. A bridge of 2X6's and plywood was constructed to allow safe foot passage across the trench at a key location.

The trench was further excavated out into the channel at the upper end allowing the stream to flow into the diversion pipe. An impermeable fence constructed of fence posts, hog wire, and plastic was built diagonally across the channel to prevent water from flowing down the existing stream channel into the work site. Ideally, a berm within the channel, constructed of sand bags or of stream gravels, would have been built. However, the U.S. Army Corps of Engineers required that permits be obtained to place gravel or sandbags in the channel. The permit process requires a full year, precluding it as an option for this project.

After completion of dam and sediment excavation, flow to the diversion was closed off, and the flow was directed back into the channel. The pipe was then retrieved from the trench with the excavator. The pipe and collars were hauled to Wolf Creek Fire Cache for storage and later use in culvert repairs and replacements within the park.

Water Pumps

Once stream flow was diverted through the pipe, the excavator dug a pond immediately behind the dam to intercept the inner-gravel flow water so that it could be pumped out. The pumped water was heavy with sediment and was discharged into the thickly vegetated terrace for dispersal. The pumps ran continuously during the day to keep up with incoming flow. Two, three inch diaphragm pumps were required, with a rated capacity of 5000-6000 gallons per minute.

There were technical difficulties with the pumps and the 150 feet of discharge fire hose that ran into the forest required frequent realignment. The continual pulses of heavy sediment in the water caused the hoses to jerk around and eventually they would end up in some unwanted

locations. The hoses were secured as well as feasible with ropes, strapping the hose to long sections of downed alder trunks. A better design would have helped, however with the many other tasks at hand the hose was a relatively small nuisance.

Fillsite Preparation

After the stream flow diversion was complete, the dozer with winch arrived and began preparing the fillsite on the right (north) terrace (initially, the dozer was planned to complete the fillsite preparation prior to the excavator arrival). The dozer scraped all vegetation from the fillsite area avoiding the few stands of large alder trees. All vegetation was pushed into one pile. The dozer then removed the upper 1 – 2 feet of soil and pushed it to another location for storage, to be used as the top layer when finished. Next, the dozer excavated a large hole in the middle of the cleared area for burial of the sediment and rubble from the dam.

Channel Excavation and Dam Removal

The excavator began by removing sediment form immediately behind the concrete dam structure. Upon removing this material, the structure of the dam became visible. The dam was composed of a vertical wall of concrete approximately 18 inches thick sitting directly on channel gravels. It was at this point that it was recognized that blasting would not be necessary and equipment began to remove channel-stored sediment upstream of the dam.

The excavator and dozer worked together throughout the removal of the channel-stored sediment with the excavator digging and passing the sediment to the dozer which then pushed it to the fillsite. The equipment removed a large portion of the channel stored sediment before beginning removal of the dam. The dam functioned as a retention structure for fine sediment, suspended in the ponded water, while the equipment worked upstream.

The longest sustained pulse of turbid water was released when the final portions of the dam rubble were removed. Even though the steam flow was diverted and the inner-gravel (sub-surface) flow was directed to pumps, not all water could be removed from the work site. It was this small volume of water that became very turbid from the equipment work. Turbidity was not visually detectable downstream of the silt fences for most of the project, except for about two hours immediately following the removal of the dam rubble. Sediment samples were not taken to measure the sediment load released.

Finish work

After completing removal of the channel-stored sediment, dam and wing walls, the diversion fence was removed and the excavator trenched the channel to allow flow back into the natural stream channel. The diversion pipe was lifted from the trench using a chain attached to the bucket of the excavator. Additional sediment from upstream of the diversion, which was prescribed for removal, was excavated and placed into the diversion ditch. The diversion ditch was further backfilled with the stored spoils from the ditch excavation.

Large boulders that were exhumed at the foot of the dam were placed at the old diversion trench entrance for bank protection. Additional large boulders were placed intermittently along areas of the bank for bank protection and diversity.

At the fill site on the right terrace (northern), the dozer recovered the upper one to two feet of soil which had been set aside, and distributed it evenly over the fill area, smoothing and

shaping to blend with the surrounding topography. After completion of shaping and smoothing the disturbed area on both terraces, the dozer was released from duty.

Access Road Outslope

The excavator remained on site to decompact the equipment paths with the bucket teeth and to remove the access road. The access road sidecast fill was excavated and placed against the cutbank and blended with the surrounding topography to obscure the cutbank as much as possible. A four foot bench of the original road surface was left as an access trail down to the restoration site for future development of a proposed picnic area.

Rock Quarry Improvements

Improvement of a nearby rock pit was accomplished concurrent with dam and sediment removal. This work was done by the heavy equipment during times when only one piece was able to efficiently work at the damsite. During these lag times the idle piece of equipment was sent to the rock pit to work.

At the rock pit, the equipment redistributed and reshaped the unattractive soil and rock piles at the base of the rock face, developing a free flowing surface with no ponds and resembling a more natural talus slope. The equipment also attempted pampas grass eradication, but it was soon discovered that the equipment engine fans spread more seed than the number of plants being eradicated, and therefore, work on the pampas grass was immediately suspended.

Surface Erosion Control and Revegetation

Labor intensive work followed the completion of the heavy equipment and included two phases. The first phase consisted of straw mulch (certified weed free) application to minimize surface erosion during the first winter and brush cleanup along the access trail. Straw was retrieved from the silt fences and spread over disturbed areas at the work site by Redwood National Park Resource Management Support Crew. The second phase consisted of transplanting the salvaged slough sedge that was removed from the site prior to heavy equipment work in the disturbed channel banks and terraces. Transplanting was done by YCC crews and a volunteer Boy Scout troop. The transplanting was followed with watering from firepumps drawing from the river to help the stressed plants through the late hot summer months for the first year.

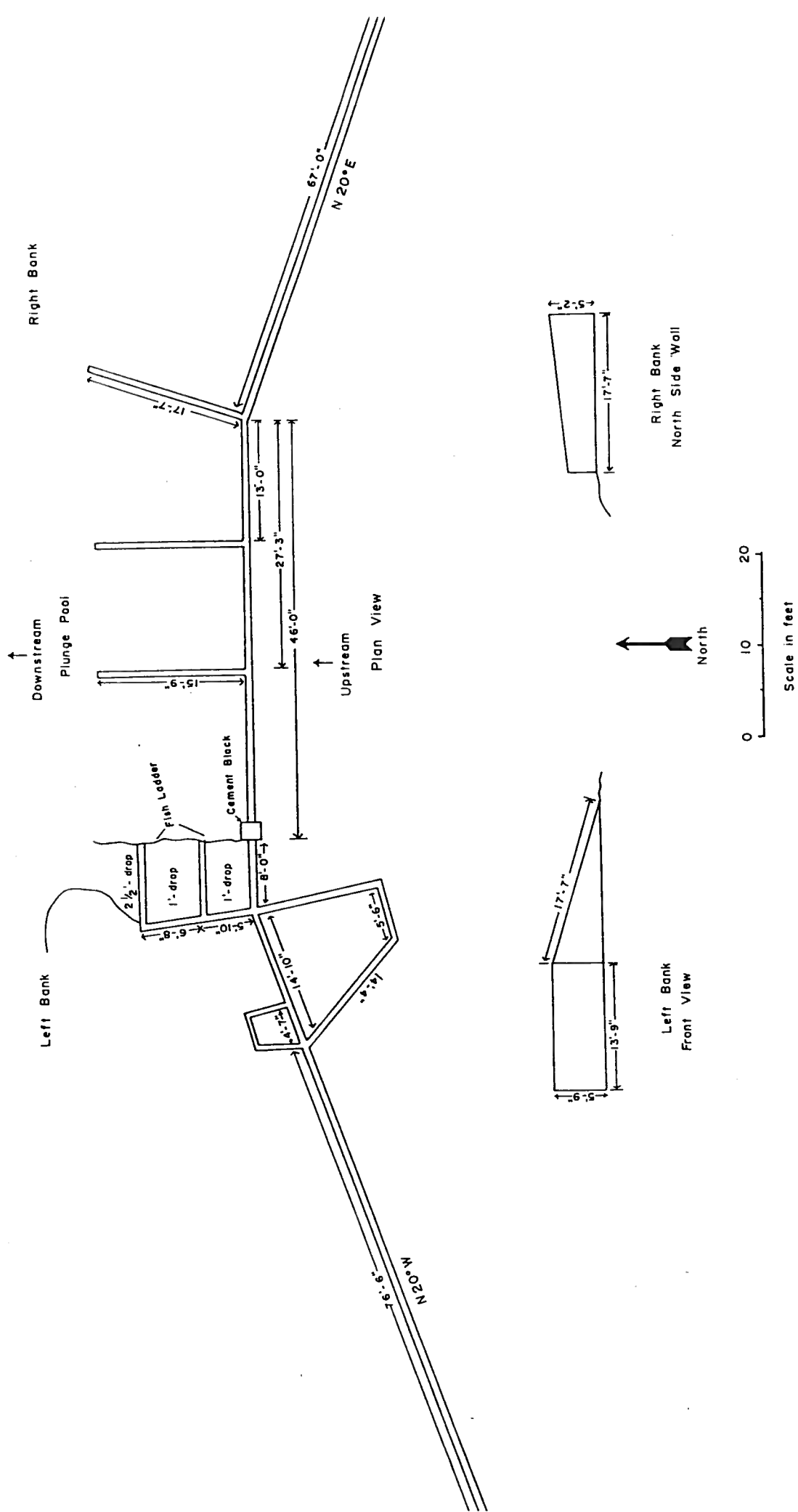
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Watershed Rehabilitation Unit 89-3: Lost Man Creek Dam Removal.

LOST MAN CREEK DAM



As built drawing of Lost Man Creek Upper Dam. Measured by J. Sacklin and A.K. Smith, spring, 1989.
Drawing by T. Hardt.

