Shackleford-Mill Road Erosion Reduction Project

98-JITW-27
Agreement #14-48-11333-8-J161

Final Report

Completed by,

The Siskiyou Resource Conservation District

Funded by,
USFWS – Klamath River Restoration Act

2/15/03

Siskiyou Resource Conservation District
Gary Black –Project Coordinator
PO Box 268
Etna, CA 96027
530 467-3975
530 467-5617

Abstract:

The Shackleford/Mill Creek sub-basin is a major tributary to the Scott River. The Shackleford/Mill Road Erosion Reduction Project is a physical project aimed at eliminating road-related sediment sources that can impact anadromous populations. The basis for selecting sites for treatment was largely a product of a sediment assessment project, the Shackleford/Mill Road Erosion Assessment Project. The assessment identified landslides and compiled data pertaining to erosion volumes on road caused erosion sites. The data identified road reaches that were of varying priorities for treatment based on contribution volumes. There were many road segments in the Shackleford drainage identified as moderate to high priorities. Given that we had nearly $200,000 (funds and in-kind contribution) to reduce road related sediment, it was decided that all the road systems of Shackleford Creek drainage would be treated under the Shackleford Mill Road Erosion Reduction Project.

The Shackleford/Mill Road Erosion Reduction Project treated 30 miles of road. 6.9 miles were hydrologically decommissioned, while the remaining road-segments were improved to reduce sediment contribution. An estimated 73,000 cubic yards of potential road related sediment sources has been treated. The property owner, Fruit Growers Supply Company, Inc. (FGS)agreed to match each dollar funded by the USFWS in implementation of the project. Much of FGS's contribution was accounted for in equipment time as the FGS road crew completed the work. The Siskiyou Resource Conservation District is pleased with the completed product and will continue to work with FGS to monitor and maintain the project area.

Background:
The Siskiyou Resource Conservation District (RCD) is a special district run by a board of property owners who are working to address resource issues within the Scott River watershed. For over a decade, the Siskiyou RCD and the Scott River Watershed Council (SRWC) have worked together to develop and implement numerous projects that conserve the use of resources as well as improve management of resources in the Scott River watershed.

The Siskiyou RCD and the SRWC have focused on the protection and enhancement of anadromous fisheries in the Scott River watershed. The Siskiyou RCD implements projects and administers contracts, while the Scott River Watershed Council provides public outreach and community planning. Together the RCD and SRWC have developed and implemented numerous projects that coincide with watershed plans. Project types implemented in the watershed include: construction of fish screens, riparian planting, instream enhancement, bank stabilization, fencing, condition monitoring, development of efficient irrigation and livestock watering systems, upland erosion assessments, and road sediment reduction work.

In 1996, the Siskiyou RCD and SRWC decided to focus on several tributaries to conduct coarse holistic protection and enhancement measures to improve habitat. Due to its historical and current significance as a major fishery production stream, the Shackleford Creek sub-basin was selected as one of the tributaries to focus on. The Shackleford Creek sub-basin is a major tributary to the Scott River. It is known to support habitats used by Chinook salmon, Coho salmon, steelhead trout and native rainbow trout. Shackleford Creek meets with the Scott River at the base of Scott Valley, just above the Scott River canyon reach.

Mill Creek is a major tributary to Shackleford Creek and is the main source of flow in the summer months. Mill Creek is heavily used by Coho salmon and steelhead. Mill Creek enters Shackleford Creek approximately 3 miles from its confluence with the Scott River. Mill Creek constant cool flows throughout the summer months and supports high densities of anadromous juveniles.

Like many of the drainages in the Scott River watershed, Shackleford and Mill Creek quickly descend from 7000 feet at their headwaters to 2900 feet elevation, where the gradient flattens out as it enters Quartz Valley. Both streams flow through Quartz Valley, where they connect approximately 3 miles from the confluence with the Scott River. The upper extent of anadromous use in both streams is in forest lands at locations where stream gradient is higher then 5% for an extended length. Strong populations of native trout reside in the stream reaches above 5%.

Quartz Valley has been under agricultural production for over a century. Much of the agricultural practices in Quartz Valley are based on pasture production for cattle. Agricultural lands give way to forest lands as the gradient of the slope increases with the elevation. Upland alteration has also occurred over the past century. In 1955, a major fire burned into Mill Creek. This fire was followed by a 30 year flood event that winter. Road building and logging on the steep slopes of the Mill and Shackleford drainages began in the 1960s. Failure of early roads caused significant sediment contribution to the streams and added additional material to the alluvial fan deposits. Road densities and placement in the steep uplands of the drainages have been an issue of concern, especially during high flow events. Many of the road systems received significant damage in the 1955, 1964 and 1997 floods.

A coarse assessment of the drainage in 1996 identified three anadromous habitat protection measures that needed to occur to improve conditions: riparian protection, installation of more fish screens, and assessment/correction of upland sediment sources. As of the fall of 2002, nearly all the riparian areas have been protected by riparian fencing, all unscreened diversions have been funded and the implementation of the Shackleford/Mill Road Erosion Reduction project has been successfully completed for two years.

Project Implementation:
The SRWC and RCD worked with the funding sources and property owner, Fruit Growers Supply Company, Inc. (FGS) to develop a program to identify and reduce road related sediment sources. The scope of the project included property owned by FGS in both Shackleford and Mill Creek drainages. Excluding wilderness, the project area included over 90% of the watershed in forest lands. A road related sediment inventory of the project scope was funded by the California Department of Fish and Game (CDFG) in 1997. SHN Consulting Engineers and Geologists, Inc. (SHN) performed the sediment inventory. The product, *Road Erosion Inventory: Shackleford and Mill Creek Watersheds*, surveyed 110 miles of road in the project area. The objectives of the inventory included: An erosion inventory of road related sediment sources including location, nature and sediment volumes of sites prioritization of sites, and treatment recommendations for each site. The inventory provided us the ability to determine the volume of work required to reduce sediment sources.

In 1998, the Siskiyou RCD received funding from the U.S. Fish and Wildlife Service (USFWS) – Klamath Restoration Act to address road related sediment sources in the Shackleford/Mill Creek drainage. The project was titled the Shackleford/Mill Road Erosion Reduction Project. The scope of the project was to reduce road related sediment based on the findings of the inventory by either improving or decommissioning roads in the project scope. The inventory combined sites into road segments in order to provide a better tool for road treatment based on future maintenance. Using the inventory, some road segments became obvious major contributors of sediment while others appeared to be less of a concern (Exhibit A). The inventory placed a treatment priority on road segments based on proximity to a fish-bearing stream, volume of sediment delivered to stream, and likelihood of future contribution. Large flow events appeared to be the source of most of the road failures. Significant erosion occurred under high flow scenarios, because some of the culverts were either undersized or became chocked with sediment and debris. When this occurred during heavy flow events, the drainage would reroute at road crossings, run down the road, then cut through road fill and create a new channel back to the original channel. We found numerous sites where this occurred over time.

Development of scope:
The development of the scope of work to be conducted under the Shackleford/Mill Road Erosion Reduction Project was carried out by a core group of the entities involved. The core group included Jennifer Silveria, USFWS contract administrator, Gary Black, Siskiyou RCD Project Coordinator, Tom Shorey, FGS Forester and Clyde Franklin, FGS road crew foreman.

When the core group reviewed the Shackleford/Mill Road Erosion Inventory and spent time in the field, we quickly confirmed that we did not have funds available to treat all the road systems included in the inventory. Therefore we needed to develop a strategy to treat as many high priority sediment sources as possible in a cost effective manner. Rather then treating individual sites based on priority, we choose to treat all sites within road segments containing high priority sites. We looked for opportunities to treat high priority road segments which were near each other, so available funds were not wasted in expensive equipment mobilization costs. Beyond financial considerations, reasoning for treating by priority road segments rather then scattered sites included: better maintenance scheduling in the future, assurance that complete drainage consideration occurred in storm proofing crossings, and better monitoring of success of project effectiveness.

When selecting road segments to treat, we followed the inventory recommendations closely. The inventory did not attempt to consider the cumulative impacts of "stacked roads" under a high flow event. We use the term "stacked roads" to describe the scenario when numerous roads or road segments are located on the same hill slope. Often stacked roads occur on hillside contours at routine intervals and a single drainage may have numerous road crossings over it. In major storm events, a high elevation road crossing can fail and threaten road crossings below the failure. We found that we could not solely concentrate on priority road segments without considering the condition of crossings on road segments above the site. We cross-referenced each site to ensure we considered the function of the drainage in relation to road crossing condition and construction consideration. We gave drainages with numerous crossings higher priority then those with one or two crossings. There were two drainages (tributaries to Big Meadows Creek) that had more then eight road crossings on them. They were treated as high priority, and numerous culverts throughout these drainages were upgraded, replaced, and/or provided with alternative crossings and safe outlets.

Based on our decision to treat roads segments we developed a cost estimate for moderate to high priority segments in the Shackleford Creek drainage. When beginning the project, FGS agreed match each dollar granted by USFWS to the project, using their road crew and equipment to implement the project. With FGS having a trained in-house road crew and equipment available for the project, our cost estimates were lower then expected and allowed us to consider treating all road segments in the Shackleford drainage. There were over 30 miles of road within the Shackleford Creek Drainage. Using the inventory, there were 73,000 yards of potential sediment to be delivered at 219 sites. Prior to construction, FGS committed to treating all of the Shackleford Creek drainage even if they had to expend more then previously agreed to.

Project Implementation:
After we identified the project scope, the core group moved into project implementation in the summer of 1999. Work began on the northeast side of Shackleford Creek and moved around to the southeast portion. FGS had several dump trucks, a road grader, excavator, loader, dozer and water truck on site. In an effort to be efficient, FGS road crew split up to treat road segments that were in varying stages of completion. The Shackleford/Mill Road Erosion Reduction Project was both a significant commitment by the property owner, FGS Company and a significant project to oversee for the RCD. Because the project lasted for months and the FGS road crew operated in several locations at once, we soon found we needed to develop treatment type standards to ensure we considered all variables involved in reducing road sediment sources at each site. We developed standards for the five most repeated treatment types. The standards were followed and sites were checked during and after construction for compliance. The standards were developed using plans from the Natural Resources Conservation Service (NRCS) and CDFG. Input for the standards also came from FGS resources that recently developed a draft of their own standards just prior to the project. The basic standards are a combination of many sources and are attached as Exhibit B.

Shortly into the construction phase we ran into a different scenario where construction efforts to eliminate a majority of the sediment source and storm proof the site were cost effective but efforts to eliminate all of the potential sediment source were not. We had to decide to either treat 100% of the potential sediment source or treat a majority of the source and leave small, rather inconsequential parts of the site. For example, a common scenario in reducing erosion at the outlet of a culvert was to construct a rock basin to absorb energy without eroding the banks. Usually, much of the construction of the energy absorbing basin was cost effective and could be done from one position with the equipment. However, in some cases portions of the basin were hard to reach unless vegetation was removed and the equipment was repositioned. We concluded it was neither cost effective nor rationally sound to create equal or greater disturbance in re-positioning the equipment to treat the insignificant areas. We developed an understanding of what was cost effective and integral to the treatment of the site and what was not cost effective and insignificant to the function of the treatment. Construction work of all the road segments lasted late into the fall of 2000 and continued again for over a month the following spring.

While the *Road Erosion Inventory: Shackleford and Mill Creek Watersheds*, estimated significant amounts of potential sediment would be removed by treating sites, it did not consider the improvement of out-sloped roads and road prism drainage between sites.

There were many locations between sites where overland flows were allowed to collect and create sheet and rill erosion on the road surface and rills over the fill side. We out-sloped roads and removed relevant fill side through-cut material to improve drainage and reduce collection of water on the road. We emphasized storm proofing crossings on the west side of Shackleford Creek where stream drainages were much longer and signs of failure were more prevalent. In our opinion, the road systems are in much better condition to withstand a flood event. The volume of potential sediment from a debris torrent is difficult to estimate, but we feel our efforts reduced road related/caused potential of such events. In the event a culvert plugs or is inundated with flow, fail-safe berms were constructed to keep flows in line with natural drainage and fill was protected with large rock on the slope.

The project was an excellent opportunity that opened several doors of opportunity for the Council and the RCD. The project allowed the RCD and Council to successfully expand their activities to include upland issues. The effort was a successful joint effort between the funders, property owner and the RCD. We are confident the project was successfully implemented and has significantly reduced the volume of sediment in Shackleford Creek. According to the inventory, the 219 sites treated had a potential of delivering an estimated 73,000 cubic yards of road related sediment. We feel our work, including the treatment of inventoried sites and the implementation of flood event protections, significantly exceeded the potential volume identified in the inventory. After completion of the work, we hoped the project would receive a significant precipitation event to evaluate our work. The past two seasons have been very dry, and the project area did not receive a rain on snow event or a significant thunder storm.

The contribution of FGS exceeded the previously agreed upon dollar for dollar match. In fact, FGS road crew, equipment time and materials purchased exceeded the match amount by an estimated 18,000 dollars. This project does not include any work associated with timber harvest plans (THPs). FGS demonstrated commitment by working with the RCD to develop a long term maintenance agreement for the scope of the project. Since completion of this project, the RCD and FGS have continued to work together on other upland inventory and sediment reduction projects. We continue to use inventory protocols and project type construction standards similar to those developed from this project, which makes this project an important stepping stone toward the protection of Scott River watershed.

SISKIYOU RESOURCE CONSERVATION DISTRICT
P.O. Box 268 Etna, CA 96027
(530) 467-3975 FAX (530) 467-5617
sisqrcd@sisqtel.net

Darla Eastman
U.S. Fish & Wildlife Service
1829 S. Oregon
Yreka, Ca 96097

Shackleford / Mill Road Erosion Reduction Project
Agreement # 11333-8-161
Project # 98-JITW-27
(RCD ref.# 54)

	Estimated Budget	Revised Budget	In-kind services By Fruit Growers	Actual Total Cost
a. Salaries (including benefits)	85,670.00	84,027.60	99,234.00	183,261.60
Subcontractors = 80,000.				
b. Travel and transportation (including per diem)	1,600.00	473.90		473.90
c. Expendable equipment, materials, supplies	10,300.00	10,141.00		10,141.00
Subtotal	97,570.00	94,642.50		193,876.50
d. General and Administrative Expenses (overhead @ 5 %)	1,951.00	4,878.50		4,878.50
Total	99,521.00	99,521.00	99,234.00	198,755.00

RCD ref. # 54

EXHIBIT A

Shackleford / Mill Road
Erosion Inventory
Specific Work Products

Road Segment	Site #	Priority	Future Vol.	Crossing Type	Treatment	Length
US1E	1	ml	20	Gully	Decommission	
US1E	2	m	13	Gully	Decommission	
US1E	3	m*	200	Gully	Decommission	
US1E	4	ml	4	Gully	Decommission	
US1E	5	ml*	84	Rd. fill mass mvmnt	Decommission	
US1E	6	m*	1333	Rd. fill mass mvmnt	Decommission	
US1E	7	ml	44	Rd. fill mass mvmnt	Decommission	
US1E	8	m*	1111	Rd. fill mass mvmnt	Decommission	
US1E	9		0	Bridge	Decommission	
US1E	10	m*	20000	Rd. fill mass mvmnt	Decommission	
US1E	11	ml*	261	Crossing W/ Culvert	Decommission	
US1E	12	ml	44	Rd. fill mass mvmnt	Decommission	
US1E	13	ml	0	Crossing W/ Culvert	Decommission	
US1E	14	mh*	13889	Rd. fill mass mvmnt	Decommission	
US1E	15	mh*	13333	Rd. fill mass mvmnt	Decommission	
US1E	16	mh	8	Crossing W/ Culvert	Decommission	
US1E	17	ml*	556	Rd. fill mass mvmnt	Decommission	
US1E	18	mh	52	Rill erosion	Decommission	
Total	**18**		**50952**			**3.3**
LS1A	1	l	0	Crossing w/culvert	Clean inlet/improve drianage	
LS1A	2	l	0	Crossing w/culvert	Clean inlet/improve drianage	
LS1A	3	ml*	0	Crossing w/culvert	Clean inlet/improve drianage	
LS1A	4	l	0	Crossing w/culvert	Clean inlet/improve drianage	
LS1A	5	l	0	Crossing w/culvert	Clean inlet/improve drianage	
LS1A	6	h*	0	Crossing w/culvert	Replace culvert	
LS1A	7	ml*	0	Crossing w/ no culvert	Install culvert	
LS1A	8	ml*	0	Crossing w/ no culvert	improve drianage	
LS1A	9	h*	594	Crossing w/culvert	Replace culvert	
LS1A	10	mh	0	Crossing w/ no culvert	Install culvert	
LS1A	11	h*	27	Crossing w/culvert	Replace culvert	
Total	**11**		**621**			**1.4**
LS9	1	l	50	Crossing w / culvert	Replace culvert	
LS9	2	l	0	Crossing w/ culvert	improve drianage	
LS9	3	l	0	Crossing w / no culvert	Install Culvert	
LS9	4	l	0	Crossing w / culvert	improve drianage	
LS9	5	m	0	Crossing w / culvert	Replace culvert	
LS9	6	l	0	Crossing w / culvert	Clean inlet	
LS9	7	l	1333	Rd. Fill Mass Movement	improve drianage	
Total	**7**		**1383**			**1.4**

* Priority one sites based on, professional data interpretation, potential sediment contribution from failure.

* Priority two sites based on, professional data interpretation, potential sediment contribution from failure.

*** Priority three sites based on, professional data interpretation, potential sediment contribution from failure.

Road Segment	Site #	Priority	Future Vol.	Crossing Type	Treatment	Length
LS7	1	mh***	119	Gully	Improve Drainage	
LS7	2	h***	57	Crossing w / culvert	Clean inlet/outlet	
LS7	3	l	0	Crossing w / culvert	Clean inlet/outlet	
LS7	4	l	0	Crossing w / no culvert	Install culvert	
LS7	5	l	10370	Mass Mvmnt deep slide	Improve Drainage	
LS7	6	mh	0	Crossing w / no culvert	Install culvert	
LS7	7	mh**	97	Crossing w / culvert	Clean inlet	
LS7	8	m	0	Crossing w / no culvert	Install culvert	
LS7	9	ml	0	Spring	Improve drainage	
Total	**9**		**10643**			**1.5**
LS	1	1	0	Crossing w / culvert	Clean inlet/outlet	
LS	2	m*	0	Crossing w / culvert	Replace culvert	
LS	3	m	6	Gully	Improve Drainage	
LS	4	1	0	Crossing w / culvert	Clean inlet/outlet	
LS	5	1	0	Crossing w/ no culvert	Install culvert	
LS	6	1	0	Crossing w / culvert	Clean inlet/outlet	
LS	7	1	0	Crossing w / culvert	Clean inlet/outlet	
LS	8	ml	0	Crossing w / culvert	Clean inlet/outlet	
LS	9	m	12	Crossing w / culvert	Replace culvert	
LS	10	1	0	Crossing w / culvert	Clean inlet/outlet	
LS	11	1	0	Crossing w / culvert	Clean inlet/outlet	
LS	12	1	0	Crossing w / culvert	Clean inlet/outlet	
LS	13	1	0	Crossing w / culvert	Clean inlet/outlet	
LS	14	1	194	Mass Movement Rd. Fill	Improve Drainage	
LS	15	1	0	Crossing w / culvert	Clean inlet/outlet	
LS	16	m*	116	Crossing w / culvert	Clean inlet/outlet	
LS	17	h*	76	Crossing w / culvert	Clean inlet/outlet	
LS	18	1	0	Crossing w / culvert	Clean inlet/outlet	
LS	19	h	0	Crossing w / culvert	Clean inlet/outlet	
LS	20	h	2	Crossing w / culvert	Clean inlet/outlet	
LS	21	1	10	Crossing w / culvert	Clean inlet/outlet	
LS	22	1	0	Crossing w / culvert	Clean inlet/outlet	
LS	23	1	0	Crossing w / culvert	Clean inlet/outlet	
LS	24	1	0	Crossing w / culvert	Clean inlet/outlet	
LS	25	1	0	Crossing w / culvert	Clean inlet/outlet	
LS	26	1	0	Crossing w / culvert	Replace culvert	
LS	27	1	0	Gully	Improve Drainage	
LS	28	1	0	Crossing w / culvert	Clean inlet/outlet	
LS	29	1	0	Crossing w/ no culvert	Install culvert	
LS	30	m	0	Crossing w / culvert	Clean inlet/outlet	
LS	31	1	0	Gully	Improve Drainage	
LS	32	1	0	Crossing w / culvert	Clean inlet/outlet	
LS	33	mh	0	Crossing w/ no culvert	Install culvert	
LS	34	1	0	Crossing w / culvert	Clean inlet/outlet	
LS	35	m	13	Gully	Install culvert	
Total	**35**		**429**			**1.6**

* Priority one sites based on, professional data interpretation, potential sediment contribution from failure.

* Priority two sites based on, professional data interpretation, potential sediment contribution from failure.

*** Priority three sites based on, professional data interpretation, potential sediment contribution from failure.

Road Segment	Site #	Priority	Future Vol.	Crossing Type	Treatment	Length
LS4	1	mh*	667	Gully	Install culvert	
LS4	2	m*	27	Crossing w / culvert	Clean inlet/outlet	
LS4	3	m*	37	Crossing w/ no culvert	Install culvert	
LS4	4	ml*	20	Crossing w/ no culvert	Install culvert	
LS4	5	h*	136	Crossing w/ no culvert	Install culvert	
Total	**5**		**887**			**1.1**
US	1	1	1	Crossing w/ no culvert	Improve Drainage	
US	2	ml*	0	Crossing w / culvert	Clean inlet/outlet	
US	3	1	0	Rill Erosion	Improve Drainage	
US	4	1	0	Crossing w / culvert	Clean inlet/outlet	
US	5	mh	688	Crossing w / culvert	Replace culvert	
US	6	ml*	69	Rill Erosion	Improve Drainage	
US	7	ml*	69	Rill Erosion	Improve Drainage	
US	8	ml	3	Crossing w/ no culvert	Improve Drainage	
US	9	ml*	80	Crossing w / culvert	Replace Culvert	
US	10	ml	1	Gully	Improve Drainage	
US	11	mh*	56	Crossing w/ no culvert	Install culvert	
US	12	m*	628	Crossing w / culvert	Replace culovert	
US	13	m*	39	Gully	Improve Drainage	
US	14	ml*	0	Crossing w / culvert	Replace culvert	
US	15	m	30	Crossing w/ no culvert	Rock crossing	
US	16	m*	231	Gully	Improve Drainage	
US	17	m*	119	Gully	Improve Drainage	
US	18	m*	278	Gully	Improve Drainage	
US	19	h*	587	Crossing w / culvert	Replace culvert	
US	20	mh	0	Crossing w/ no culvert	Improve Drainage	
US	21	m*	70	Crossing w/ no culvert	Install culvert	
US	22		0	Bridge		
US	23	ml*	0	Crossing w / culvert	Clean inlet/outlet	
US	24	m	0	Rill Erosion	Improve Drainage	
US	25	mh	7	Crossing w/ no culvert	Install culvert	
US	26	m	11	Crossing w/ no culvert	Improve Drainage	
US	27	m*	833	Mass Movement - Rd Fill	Improve drianage/stabilize	
US	28	1	0	Crossing w / culvert	Clean inlet/outlet	
Total	**28**		**3800**			**6.4**
LS1	1	m*	10	Crossing w/ no culvert	Rock crossing	
LS1	2	ml	100	Gully	Improve Drainage	
LS1	3	1	0	Crossing w / culvert	Clean inlet/outlet	
LS1	4	1	0	Crossing w / culvert	Clean inlet/outlet	
LS1	5	ml	0	Crossing w/ no culvert	Install culvert	
LS1	6	1	25	Crossing w / culvert	Clean inlet/outlet	
LS1	7	1	0	Crossing w / culvert	Clean inlet/outlet	
LS1	8	1	0	Crossing w / culvert	Clean inlet/outlet	
LS1	9	1	0	Crossing w / culvert	Clean inlet/outlet	
LS1	10	1	11	Gully	Improve Drainage	
LS1	11	1	0	Crossing w / culvert	Clean outlet	
LS1	12	m	4	Gully	Improve Drainage	
LS1	13	h*	120	Crossing w / culvert	Replace culvert	
Total	**13**		**270**			**1.7**

* Priority one sites based on, professional data interpretation, potential sediment contribution from failure.

* Priority two sites based on, professional data interpretation, potential sediment contribution from failure.

*** Priority three sites based on, professional data interpretation, potential sediment contribution from failure.

Road Segment	Site #	Priority	Future Vol.	Crossing Type	Treatment	Length
US6	1	ml*	3	Crossing w/ no culvert	Decommission	
US6	2	mh*	0	Crossing w/ no culvert	Decommission	
US6	3	1	0	Crossing w/ no culvert	Decommission	
US6	4	1	0	Crossing w/ no culvert	Decommission	
US6	5	1*	11	Crossing w / culvert	Decommission	
US6	6	1	0	Gully	Decommission	
US6	7	1	0	Crossing w/ no culvert	Decommission	
US6	8	1	2	Surface erosion	Outslope road	
US6	9	1*	0	Crossing w/ no culvert	Decommission	
US6	10	h*	11	Crossing w/ no culvert	Decommission	
US6	11	h*	11	Crossing w/ no culvert	Decommission	
US6	12	h*	11	Crossing w/ no culvert	Decommission	
US6	13	1*	0	Crossing w/ no culvert	Decommission	
US6	14	1	0	Gully	Decommission	
Total	**14**		**49**			**2.3**
US1C	1	1	0	Crossing w / culvert	Clean inlet/outlet	
US1C	2	mh*	11	Gully	Improve Drainage	
US1C	3	1	0	Crossing w / no culvert	Improve Drainage	
US1C	4	1	0	Crossing w / culvert	Clean inlet/outlet	
US1C	5	mh	2	Gully	Improve Drainage	
US1C	6	1	0	Crossing w / culvert	Clean inlet/outlet	
US1C	7	1	0	Crossing w / no culvert	Improve Drainage	
US1C	8	1	0	Crossing w / culvert	Improve Drainage	
US1C	9	m	0	Gully	Improve Drainage	
US1C	10	m**	6	Gully	Improve Drainage	
US1C	11	1	0	Crossing w / culvert	None	
US1C	12	1	0	Crossing w / culvert	Clean inlet/outlet	
US1C	13	1	0	Crossing w / no culvert	Improve Drainage	
US1C	14	1	0	Crossing w / culvert	Improve Drainage	
US1C	15	mh**	8	Gully	Improve Drainage	
US1C	16	mh	4	Gully	Improve Drainage	
US1C	17	m	0	Crossing w / culvert	Clean inlet/outlet	
US1C	18	mh**	11	Gully	Improve Drainage	
US1C	19	mh**	13	Gully	Improve Drainage	
US1C	20	ml	0	Crossing w / culvert	Clean inlet/outlet	
US1C	21	1	37	Mass Movement - Rdcut	Shape cut	
US1C	22	1	15	Mass Movement - Rdcut	Shape cut	
Total	**22**		**107**			**1.1**

* Priority one sites based on, professional data interpretation, potential sediment contribution from failure.

* Priority two sites based on, professional data interpretation, potential sediment contribution from failure.

*** Priority three sites based on, professional data interpretation, potential sediment contribution from failure.

Road Segment	Site #	Priority	Future Vol.	Crossing Type	Treatment	Length
US1C	23	1	0	Crossing w / culvert	Decommission	
US1C	24	1	0	Crossing w / culvert	Decommission	
US1C	25	1	0	Crossing w / culvert	Decommission	
US1C	26	1	0	Crossing w / culvert	Decommission	
US1C	27	1	0	Crossing w / culvert	Decommission	
US1C	28	1	31	Crossing w / culvert	Decommission	
US1C	29	h**	24	Crossing w / culvert	Decommission	
US1C	30	ml	0	Gully	Decommission	
Total	**8**		**55**			**0.6**
US1	1	1	0	Crossing w / culvert	Clean inlet/outlet	
US1	2	1	0	Crossing w / culvert	Clean inlet/outlet	
US1	3	1	0	Crossing w / culvert	Clean inlet/outlet	
US1	4	1	0	Crossing w / culvert	Clean inlet/outlet	
US1	5	m**	6	Gully	Improve Drainage	
US1	6	1	0	Crossing w / culvert	Clean inlet/outlet	
US1	7	mh	3	Gully	Improve Drainage	
US1	8	m	2	Gully	Improve Drainage	
US1	9	1	35	Crossing w / culvert	Replace culvert	
US1	10	1	0	Crossing w / culvert	Clean inlet/outlet	
US1	11	h	5	Rill Erosion	Improve Drainage	
US1	12	1	0	Crossing w / culvert	Clean inlet/outlet	
US1	13	1	0	Crossing w / culvert	Clean inlet/outlet	
US1	14	m	0	Crossing w / culvert	Clean inlet/outlet	
US1	15	1	0	Crossing w / culvert	Clean inlet/outlet	
US1	16	ml	9	Gully	Improve Drainage	
US1	17	ml	0	Crossing w / culvert	Clean inlet/outlet	
US1	18	mh	17	Crossing w / no culvert	Install culvert	
US1	19	h	22	Gully	Install culvert	
Total	**19**		**99**			**2.2**
LS3	1	mh	36	Crossing w / culvert	Clean inlet/safe out	
LS3	2	mh	28	Crossing w / culvert	Clean inlet/safe out	
LS3	3	ml	30	Gully	install culvert	
LS3	4	1	0	Gully	improve drainage	
LS3	5	mh	42	Crossing w / culvert	Clean inlet/safe out	
Total	**5**		**136**			
LS5	1	1	0	Crossing w / no culvert	improve drainage	
LS5	2	1	6	Crossing w / no culvert	improve drainage	
Total	**2**		**6**			
LS6	1	1	0	Crossing w / no culvert	improve drainage	
LS6	2	1	0	Crossing w / no culvert	improve drainage	
LS6	3	ml	167	Mass Movement - cut	plant	
LS6	4	1	27	Crossing w / no culvert	install culvert	
Total	**4**		**194**			
* Priority one sites based on, professional data interpretation, potential sediment contribution from failure.						
* Priority two sites based on, professional data interpretation, potential sediment contribution from failure.						
*** Priority three sites based on, professional data interpretation, potential sediment contribution from failure.						

Road Segment	Site #	Priority	Future Vol.	Crossing Type	Treatment	Length
US8B	1	h***	237	Crossing w / no culvert	Pull crossing	0.5
US8B	2	mh***	100	Crossing w / no culvert	Pull crossing	
US8B	3	mh***	320	Crossing w / no culvert	Pull crossing	
Total	**3**		**657**			**0.5**
US8A	1	mh***	1778	Crossing w / no culvert	Pull fill	0.4
Total	**1**		**1778**			**0.4**
US8	1	mh*	50	Crossing w / no culvert	Install Culvert	2.2
US8	2	m*	40	Gully	Install Culvert	
US8	3	mh*	60	Crossing w / no culvert	Install culvert	
US8	4	mh*	80	Crossing w / no culvert	Install Culvert	
US8	5	mh	0	Crossing w / no culvert	Install Culvert	
Total	**8**		**230**			**2.2**
US8C	1	m	0	Crossing w / no culvert	Decommission	0.15
US8C	2	1	6	Crossing w / no culvert	Decommossion	
Total	**2**		**6**			**0.15**
US5	1	1	0	Crossing w / culvert	Clean inlet/outlet	0.1
Total	**1**		**0**			**0.1**
Total	**219**		**73066**			**29.95**

* Priority one sites based on, professional data interpretation, potential sediment contribution from failure.

* Priority two sites based on, professional data interpretation, potential sediment contribution from failure.

*** Priority three sites based on, professional data interpretation, potential sediment contribution from failure.

Exhibit B

Construction Specifications

Construction Standards: All sites shall be done in accordance with the best current standards as described by treatment type below. Any deviation from treatment type described below shall be discussed with Contractor and Sub-Contractor before implementation. Treatment types to be used in scope of work include, but are not limited to the following:

*Sites which alter from the above specifications shall be monitored/maintained for five years or after significant events which cause significant damage in a regional location. Alternate designs will be reconstructed to current standards, if determined they are not properly functioning.

Construction Types:

1.) Fill erosion at crossings or points where unavoidable flow breaks off road surface:

- a.) Construct a safe outlet over the crossing by dipping out road surface.
- b.) Excavate bench on fill slope that is eroding and install fabric.
- c.) Place or dump rock over bank to limit flood damage potential. Placed rock should be 18" or over, dumped rock should be a mix of from 6" –2'. Rock should be placed at 18"-24" deep.
- d.) At culvert outlet, either: flume to a stable area and dissipate energy with rock or place rock dissipater directly underneath culvert, depending on length of fill and culvert placement.
- e.) All disturbed soil shall be faced with crossing rock or seeded and mulched.
- f.) Sites shall be monitored for maintenance needs on routine basis

2.) Hydrological Decommission of crossing:

- a.) Excavate crossing to near original grade and remove culvert if needed. Place spoils at safe location and seed/mulch
- b.) Pull road prism back until grade is at angle of repose.
- c.) Place rock in bottom of channel 2 feet above scout mark. Ensure capacity meets or exceeds natural channel capacity. Placed rock should be 18" or over, dumped rock should be a mix of from 6" –2'. Rock should be placed at 18"-24" deep.
- d.) All disturbed soil shall be faced with crossing rock or seeded and mulched.

3.) Culvert crossings

a.) All newly installed culverts shall be placed at or near grade of channel and shall be sized for 100-year events.
b.) Safe outlet dips shall be placed over all culverts to direct flow into original channel. If fill is of significant depth or deemed unstable by project coordinator and FGS, rock armoring shall be placed on fill from road surface to bottom of fill. Rock shall be sized accordingly based on size of channel, depth of fill, and conditions above site (stacked roads, clear cut or increased potential of debris slide/torrent.
c.) Energy dissipaters will be considered at each site. Dissipater may be rock armored plunge area or flumed to stable location in channel.
d.) All disturbed soil shall be faced with crossing rock or seeded and mulched.
e.) Sites shall be monitored for maintenance needs on routine basis

4.) Rock Fords and French Drains

a.) Rock base in road surface shall be constructed of large boulders sized so they will not move during large flow events.
b.) Channel will be shaped so boulders can be placed so flow will not be diverted from structure.
c.) Filter fabric shall be placed over boulders to provide porosity and prevent crossing rock from plugging voids in boulders.
d.) Crossing rock shall be placed across entire crossing area, including 30 feet on either side of channel.
e.) Fill side shall be anchored with large boulder placed so they are locked together.
f.) Energy dissipation shall be considered at fill side to prevent down cutting
g.) Safe outlet dips shall be placed over all crossing to ensure flow remains in original channel. If fill is of significant depth or deemed unstable by project coordinator and FGS, rock armoring shall be placed on fill from road surface to bottom of fill. Rock shall be sized accordingly based on size of channel, depth of fill, and conditions above site (stacked roads, clear cut or increased potential of debris slide/torrent.
h.) All disturbed soil shall be faced with crossing rock or seeded and mulched.
i.) Sites shall be monitored for maintenance needs on routine basis

5. Road shaping

a.) Where possible roads shall be out sloped to increase drainage and reduce collection of flows. Out sloping shall be at 1%-2% grade.
b.) Berms shall be removed where possible.
c.) When out sloping is not possible, drainage breaks shall be installed at frequent intervals. Interval rate shall be determined by road gradient, road width, soil type and road history
d.) Side casting shall be kept to a minimum, an not permitted at wet crossings,
e.) Mulch and seeding shall take place at active erosion sites on cut and fill slopes where determined by project coordinator and FGS.
f.) Segments of road treated shall be monitored for maintenance on routine basis.

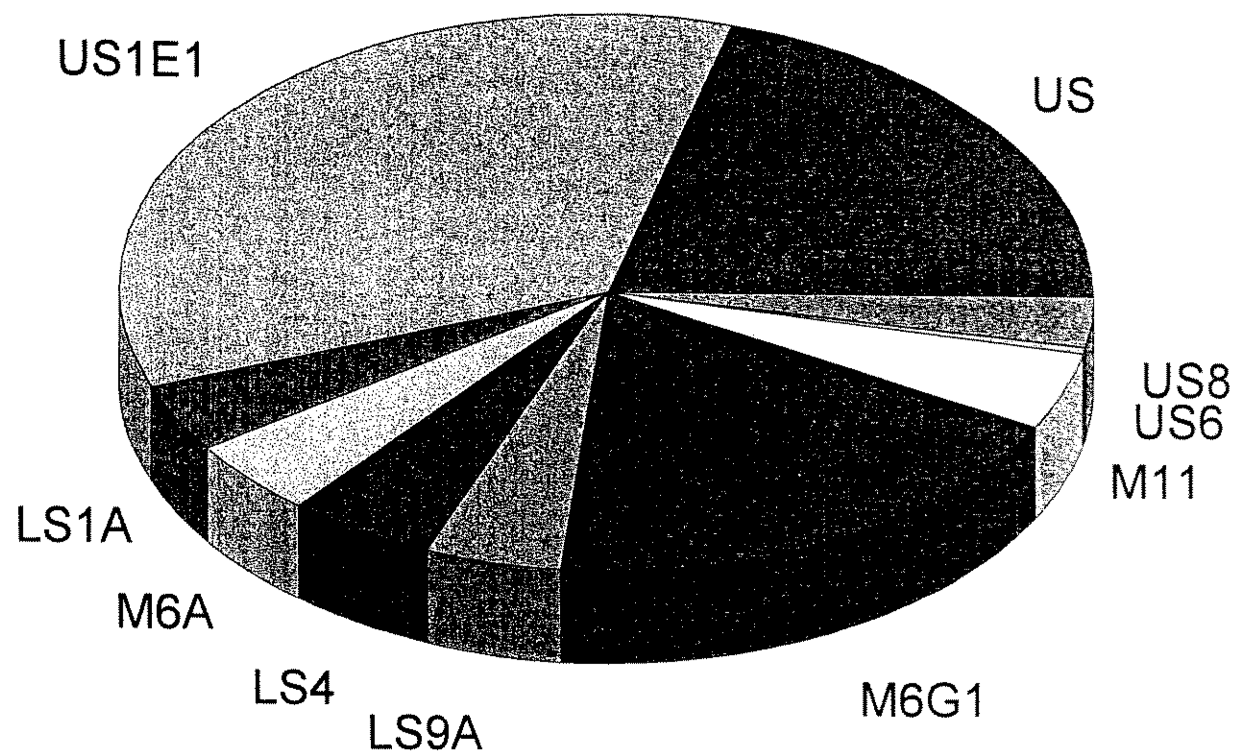
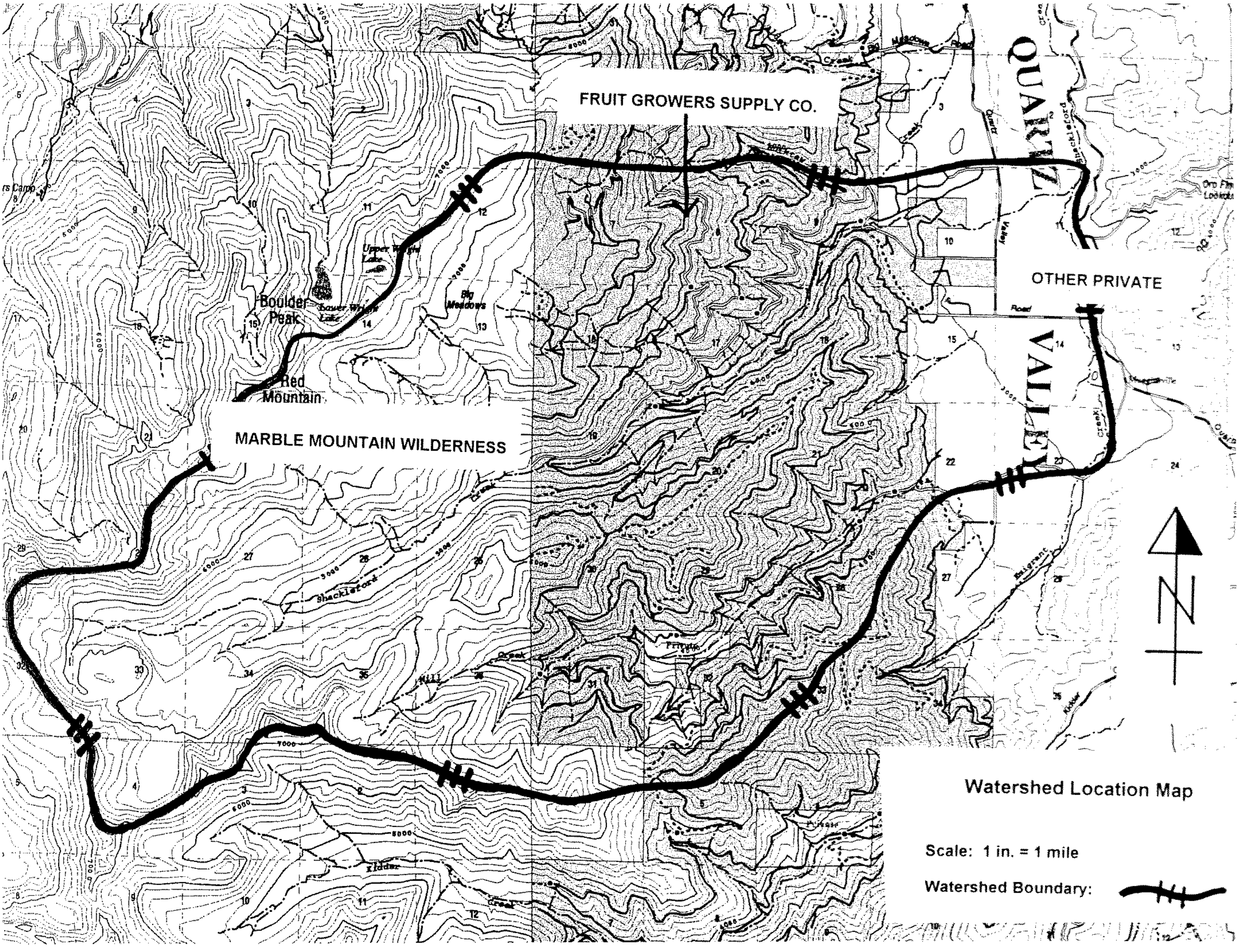
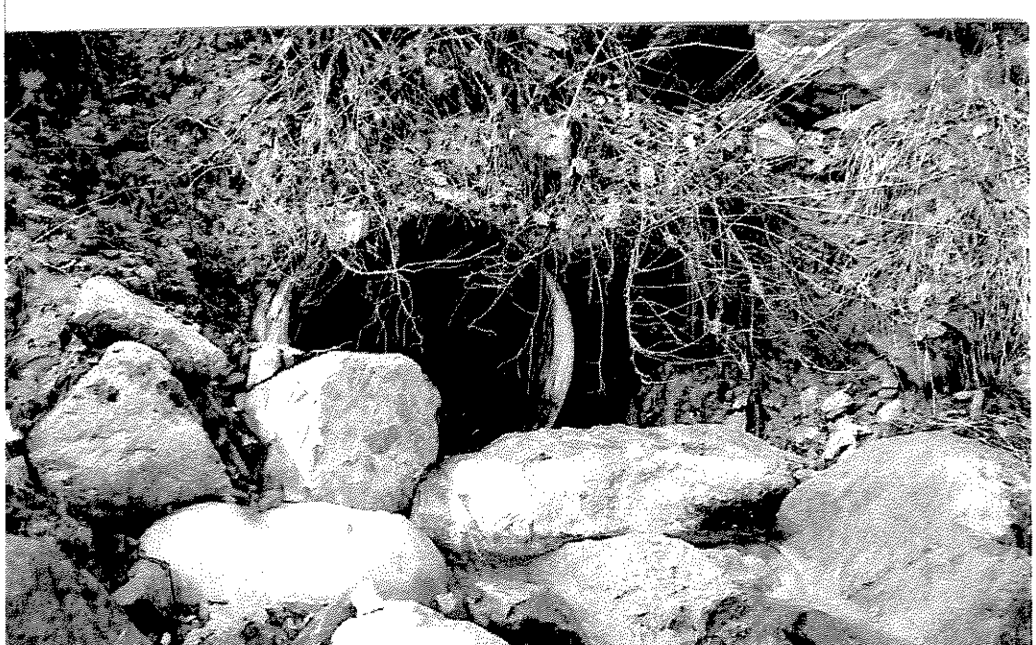


FIGURE 4-6
FUTURE EROSION CONTRIBUTION
(Including Mass Movement Sites)
MILL AND SHACKLEFORD WATERSHEDS
MUGGINSVILLE, CALIFORNIA


FRUIT GROWERS SUPPLY CO.
QUARTZ
VALLEY
OTHER PRIVATE
MARBLE MOUNTAIN WILDERNESS
Boulder Peak
Red Mountain
Big Meadows
Shackleford
N
Watershed Location Map
Scale: 1 in. = 1 mile
Watershed Boundary:

Top: US-19 before treatment

Bottom: US-19 after treatment

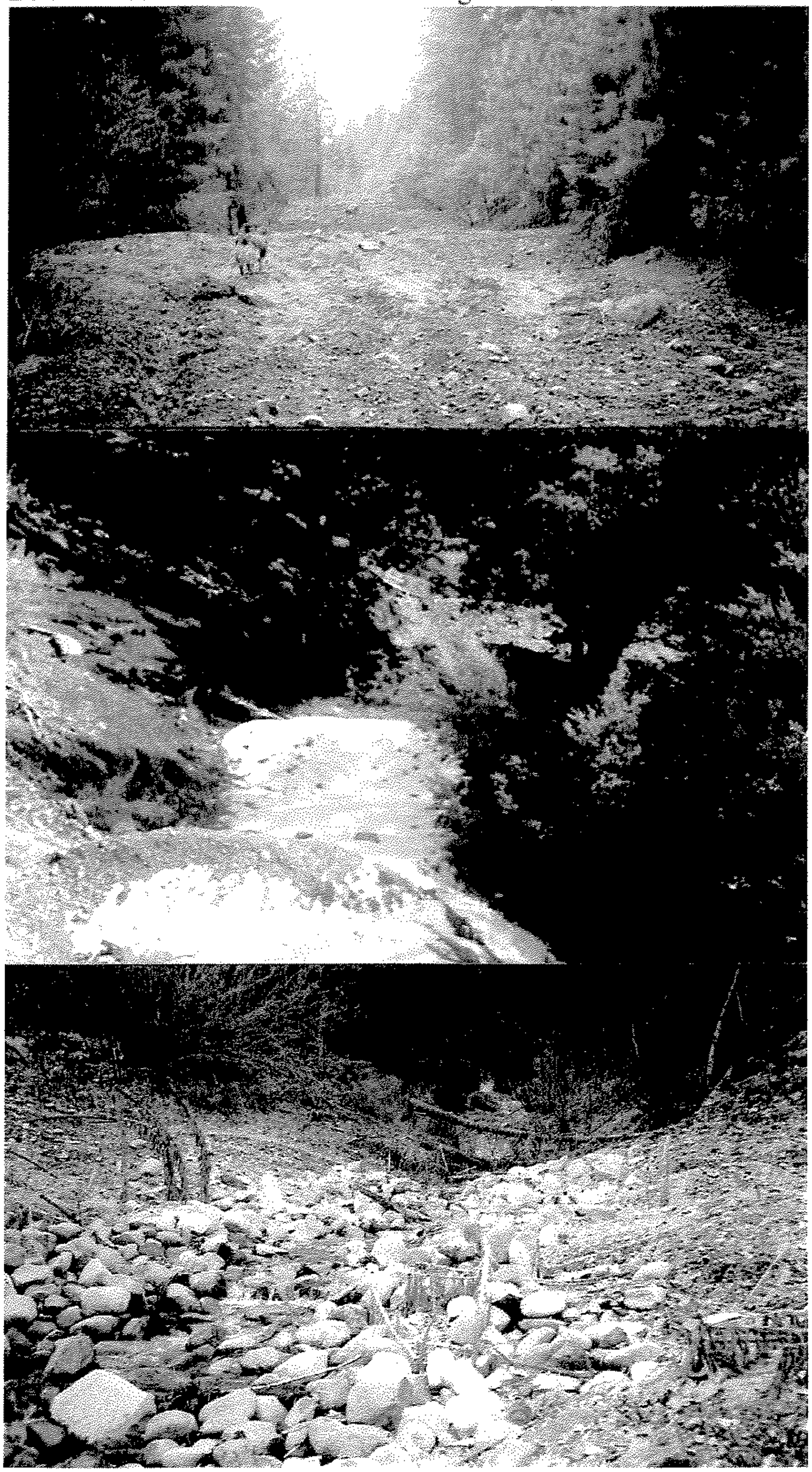


Top: Site US-3 Before treatment
Bottom: Site US-3 After treatment

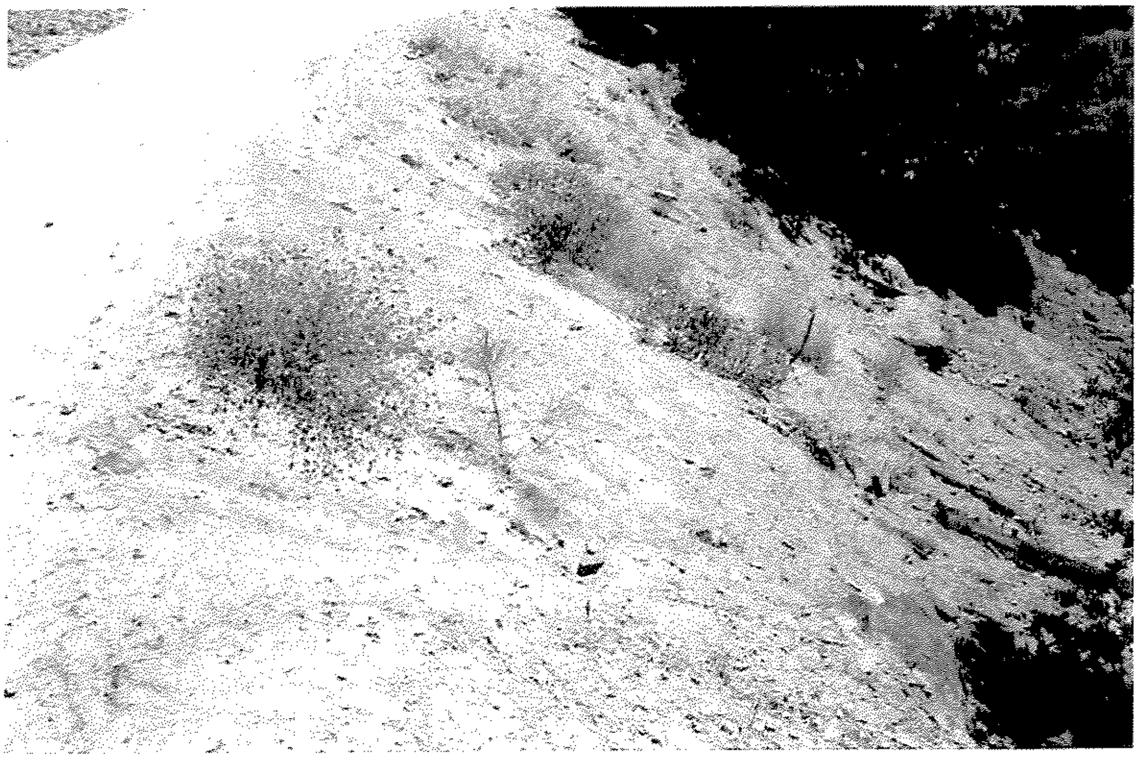
Site US-5 before treatment

Site US-5 after treatment

Top and middle: Decommission of road base
Bottom: Decommission of stream crossing US6-13

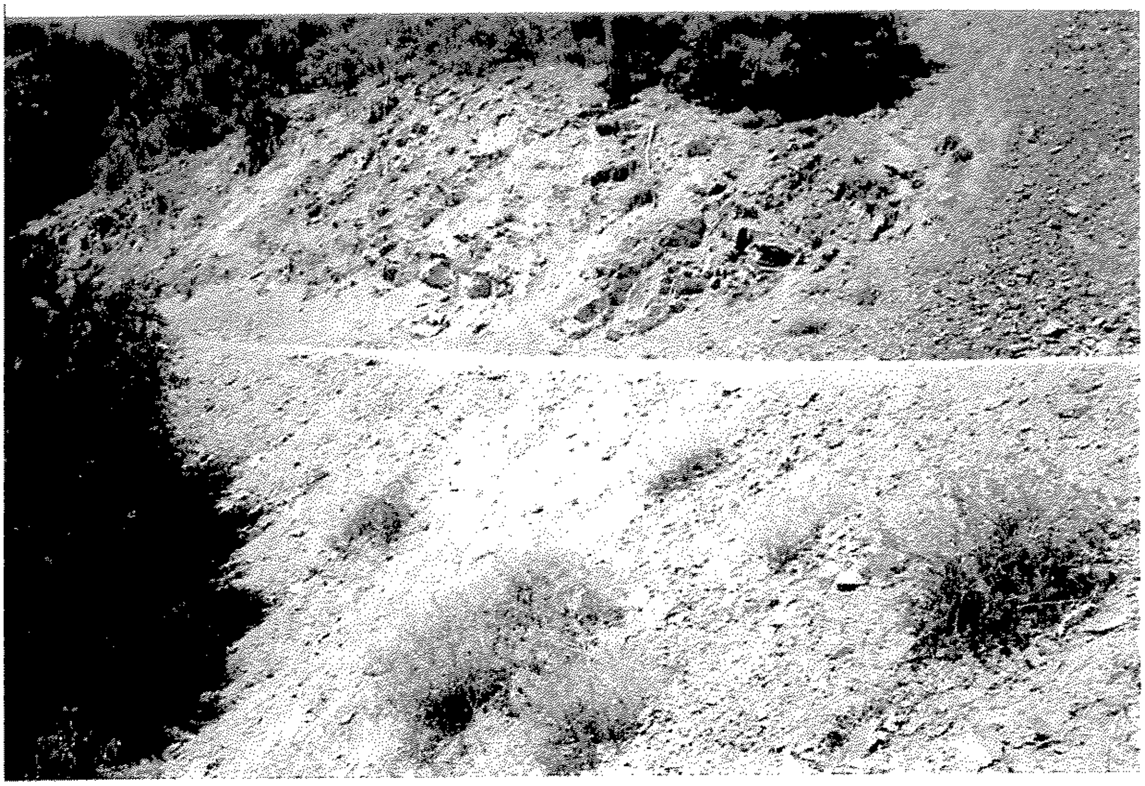


Top: US-7 before treatment
Bottom: US-7 after treatment

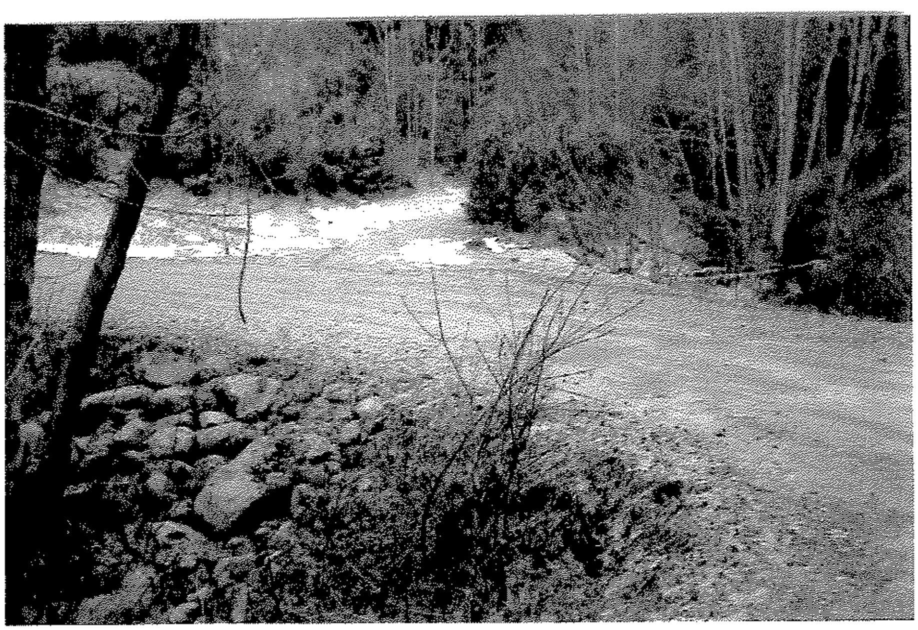


Top: Site US-8 before treatment

Bottom: Site US-8 after treatment



Top: Site US-9 before and after
Bottom: Overview photo of Site US-9 showing armored fill slope and safe outlet



Top: US-19 before treatment

Bottom: US-19 after treatment

Top: Site US-18 before treatment
Bottom: Site US-18 after treatment

Both photos: Site US20 at source. Vegetation/Debris placed in gully by EUHS students to successfully limit erosion.


Top: US-23 before treatment

Bottom US-23 after treatment

Top: Site US-25 before treatment

Bottom: US-25 after treatment – culvert installation

Left: US1-14 fill side before treatment

Right: US1-14 fill side after treatment

Left: Site US1-12 fill side before treatment

Right: Site US-12 fill side after treatment

Left: Site US1-19 After treatment

Right: Site US1-19 Before treatment