INTERAGENCY STATE
BURNED AREA EMERGENCY RESPONSE
(BAER) REPORT

RICE FIRE

Affecting Watersheds in the
County of San Diego
CALIFORNIA
Non-Confidential

DRAFT

November 11, 2007

Purpose and Background

Burned Area Emergency Response (BAER) operations are conducted to prioritize post-fire damage prevention and mitigation efforts in the following way:

- Identify immediate threats to human life resulting from the fire.

- Identify immediate threats to property resulting from the fire.

- Identify threats to resources. Such threats include: erosion, reduced water quality, wildlife and fisheries, botanical values, and cultural resources.

Technical specialist reports in the Appendices should be reviewed thoroughly before any decisions are made on treatments to be carried out.

Acknowledgements

This effort represents the first time the State of California has undertaken large scale BAER operations as part of a post-fire program. This report is a combined effort by personnel from several departments within The Resources Agency. The following departments were represented: Forestry and Fire Protection (CAL FIRE), Water Resources (DWR), Fish and Game (DFG), and California Geological Survey (CGS). Several additional federal, state, and local government agencies also participated with and provided information to the state BAER Team. They include: Natural Resources Conservation Service (USDA), Bureau of Land Management (BLM -Dept. of Interior), California Department of Transportation (CAL TRANS), San Diego Regional Water Quality Control Board (SDRWQCB), County of San Diego Public Works (SDPW), County of San Diego Planning and Land Use (SDPLU), San Diego County Flood Control District (SDFC), North County Fire Department (NCFD), Fallbrook Public Utilities District (FPUD), and Rainbow Municipal Water District (RMWD).

The Team members are:

- John Melvin, CAL FIRE, Team Leader/Forester
- Andy Whitlock, CAL FIRE, Safety Officer/Forestry
- Pete Cafferata, CAL FIRE, Watershed Technical Specialist
- Gerrit Fenenga, CAL FIRE, Archaeologist
- Lori Gustafson, CAL FIRE, GIS Technical Specialist
- Anna Kolakowski, DWR, Hydrology/Engineering
- Joe Tapia, DWR, Civil Engineer
- Dan Blankenship, DFG, Wildlife Biologist
- L. Breck McAlexander, DFG, Environmental Scientist/Botany
- Mike Fuller, CGS, Geologist

Additionally, many other entities were consulted in the process of field evaluation and report preparation. They are represented in the table below.

Additional Contacts Made By Team 8				
NAME	**AGENCY**	**EXPERTISE**	**PHONE**	**Contact in person?**
Vic Smothers*	NRCS	Soils	(760) 207-5802	Y - participatory
Greg Hill	BLM		(760) 251-4800	Phone 11/8 - referred to Dan Westermeyer
Dan Westermeyer*	BLM	BLM Rep.	(760) 774-1391	phone 11/8 @ 1100, phone 11/9
Tim Brownson*	CAL TRANS		(619) 688-3391	Y - participatory
Ben Neill*	SDRWQCB	Water Quality	(858) 467-2983	Y - participatory
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Jason Cavender*	Fallbrook Public Utilities District	Systems Operator	(760) 497-4103	Y - participatory
Chuck Smead*	Raindow Municipal Water District	Operations Manager	(760) 685-6694	Y - participatory
Joe Destefano*	County of SD Planning & Land Use	Watershed	(858) 694-3692	11/8 @ 1520, 11/9 -received their report
Todd Snyder*	County of SD Planning & Land Use	Watershed	(858) 694-3482	phone 11/8 @1520, 11/9 email for report
Cid Tesoro	County of SD Flood Control	Manager	858.694.3672	phone 11/8 - Jason Smith Represents
Nathan Roth	County of SD OES		(858) 565-3490	phone msg 11/8@1425
Charlie Glasgow	North County Fire District	Assistant Chief	(760) 644-1102	phone 11/8@1400 hrs
Sid Morel*	North County Fire District	Fire Marshall	(760) 723-2015	Y - participatory
Thom Porter*	CAL FIRE - MVU	Unit Forester	(619) 851-0445	Phone 11/8@1000 hrs - provided some info
Wende Cornelius	CA Firesafe Council		(619) 733-5579	Phone on 11/8 @ 1000 hrs., to FEMA PIO Desk
Christine La Grua	Los Willows Resort/Wedding Place	General Manager	(760) 71-9400	Phone on 11/9 @ 1000 hrs. while on their site
Troy Conner	Kendall Farms (Pvt. Landowner -Ag)	General Manager	(760) 731-0681	Direct contact with Pete Cafferata on 11/8

* = wants report when complete.

The team members who prepared this report worked very well as a team and shared information and expertise without reservation. It is their hope that this document will be of use to public agencies and private land owners in preventing further threats to life and property following the wildfire, and that it will additionally be useful in helping to protect the natural resources within this burned area for the next generation.

The analysis by this BAER team focused on areas of moderate and high burn severity with closely correlated potential threats to life and property. Other locations and situations were noted and recommendations made when they were observed.

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BAER Report

General Area Description and Resource Conditions Assessment

The Rice Fire burned 9,472 acres between October 22, 2007 and October 29, 2007 in and around the northwestern San Diego County unincorporated community of Fallbrook. There were 206 structures damaged in this fire.

The two Hydrologic Unit Classification 6 (HUC 6) watersheds represented in the burn area are the Santa Margarita River/Sandia Canyon and San Luis Rey River. Both will be marginally impacted by the Rice Fire. The highest degree of impact is expected to occur in three tributary watersheds: Rainbow Creek, Stewart Canyon, , Rice Canyon. Rice Canyon will be affected to a lesser degree than Stewart Canyon and Rainbow Creek, due to the relatively small percentage of the basin impacted. Additionally, a small unnamed tributary that includes Red Mountain Reservoir will also be adversely impacted.

The macro-vegetative resource in the burned area consists of several vegetation types, including chaparral, chaparral with widely scattered oaks, sage scrub, riparian oak-sycamore woodland, and grass land.

The burn area contains near-urban areas including highly diverse landscaping choices by property owners. Nearly the entire burn area would be considered wildland-urban interface (WUI). The area also contains large amounts of agricultural vegetation including floricultural species, avocado, citrus, and small amounts of other agricultural resources.

Topography is highly varied in the burn area, ranging from flat areas, to rolling hills, to canyons and mountains. The elevation ranges from 320-1,617 feet above sea level. Some of the slopes are very steep, rarely in excess of 100 percent. The burn area contains mostly granitic and similar rock with minor metamorphic inclusions. The rock is heavily weathered, broken, and friable. Soils, though quite shallow in most locations, are deeper in some areas within the burn, including areas of alluvial and colluvial deposits. The majority of the soils have similar properties to decomposed granite.

The weather in the burn area is sunny approximately 265 days of the year. Average annual precipitation is approximately 16 inches. Coastal fog extends into the area somewhat regularly. The average annual low temperature for the closest climate data station (Escondido) is 37.7 degrees Fahrenheit, with the average annual high temperature being 88.0 degrees Fahrenheit. Temperatures do get much higher in the area in the summer months, often in excess of 100 degrees Fahrenheit. Freezing conditions are fairly rare, with the majority of years never experiencing a freeze at the elevations represented in the burn area.

On-The-Ground Survey Findings

The Rice Fire had highly variable burn severity. Much of the burn area burned at low to moderate severity, with some areas burning at high severity. Overall, only one third of the fire perimeter area burned at moderate or high severity.

This finding was very similar to the Burn Area Reflectance Classification (BARC) map provided. The team only noted two specific areas that required changes to the BARC map. Both areas burned at significantly higher severity than shown on the BARC map.

Soil hydrophobicity was tested in several locations in the burn area. For those areas of moderate and high severity burn, it was highly variable, but generally found to have high hydrophobicity at the mineral soil surface, with less hydrophobicity at a mineral soil depth of 1-2 inches.

Emergency Determinations

1. Red Mountain Reservoir
2. Several home locations listed by address

Treatments To Mitigate Emergencies

1. Refer to the Geology, Hydrology and Engineering reports for specific treatments.
2. Refer to the Geology, Hydrology and Engineering reports for treatment recommendations at each address identified.

Discussion/Summary/Recommendations

Refer to individual reports for discussions and general recommendations to avoid redundancy. Each report concisely summarizes their findings and recommendations.

Appendices

Appendix A.

Assessing Fire Damaged Trees

Rice Fire
November 2007
Andy Whitlock - CAL FIRE - MEU

I. Potential values at risk
- A. Life
- B. Property
- C. Resources

II. Resource Condition Assessment
- A. Resource Setting
  - 1. The Rice Fire occurred partly in Coast Live Oak *(Quercus agrifolia*), California Sycamore (*Platanus racemosa*) and Southern California Black Walnut (*Juglans californica Wats. var. californica*) stands, all of which are native to this area. The different species grow along fish bearing water bodies, tributaries to the fish bearing water bodies and amongst residences throughout the Fallbrook area.
  - 2. Homeowners, Local and State agencies and arborists assess fire damaged trees throughout the area, s/he should accurately evaluate the extent of fire damage, and the likelihood for continued survival. The native trees contribute to the overall aesthetic beauty of Fallbrook, provide stabilization of the soils especially on steep hillsides, add property value to home sites, and contribute to wildlife habitat value.

- B. Finding of the On-The-Ground Survey
  - 1. Resource condition resulting from the fire
    - A. Majority of the native hardwood trees will sprout back.

    - B. May need to prune dead wood once the tree shows sign of recovery to reduce the risk of injury.

    - C. Ornamental trees did not fair as well as the native species. Some ornamentals have already been identified as dead, other trees may take time to see the full effect from the fire.

    - D. Most native oaks are well adapted to normal fire intensities. Oaks in general have thicker bark therefore have a much higher tolerance to heat.

2. Consequences of the fire on values at risk

A. Safety is number one. Any doubt as to the safety and durability of the trees, get a professional opinion.

B. Pay particular attention in freezing conditions. Branches and/or trees already weakened by fire, are very susceptible to freezing temperatures.

C. Strong winds against fire weakened trees pose a higher than usual threat to life and property.

III. Emergency Determination

A. There are no known sites currently considered as an emergency. Winter will more than likely change the current determination depending upon the conditions received.

IV. Treatments to Mitigate the Emergency

A. Treatment Type

1. Monitoring should be done periodically throughout the first year.

V. Discussion/Summary/Recommendations

A. As a landowner, it would be wise to seek professional assistance to help evaluate damage to trees, followed-up by pruning if necessary, and continue monitoring tree health.

B. A professional arborist is trained in tree biology, tree identification and selection, tree-soil-water relations, tree nutrition and fertilization, tree planting and establishment, pruning concepts and techniques, cabling, bracing and lightning protection, problem diagnosis and management, tree preservation on construction sites, climbing and safe work practices, and tree risk assessment. A certified urban forester or Registered Professional Forester also may possess the required knowledge.

C. Type of professional that can assist, guide and recommend options

1. Certified Arborists (International Society of Arboriculture)
2. Registered Consulting Arborist (American Society of Consulting Arborists).
3. Certified Urban Forester (CA Urban Forests Council)
4. Registered Professional Forester (State of California)

Appendix B

BAER SURVEY SPECIALIST REPORT

Engineering
Rice Fire
November 2007

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I. Potential Values-at-Risk (identified prior to on-the-ground survey)

An inspection of the burn region indicated the following sites that were considered in need of evaluation to determine risk due to increased runoff:

- Five water supply reservoirs located within the fire perimeter
- Several houses or other structures located on steep, burned slopes
- State and County highways located throughout the fire area

Lives and property are potentially at risk at sites located in flood prone areas, or on roads where flash flooding causes washouts due to runoff in excess of culvert capacity. Water quality of regional water supply is potentially at risk due to loss of control of water on hill slopes.

II. Resource Condition Assessment

A. Resource Setting

The Rice Fire burned in Southern California from October 22, 2007 through October 29, 2007. The fire is located in both the Santa Margarita River watershed to the north and the San Luis Rey River watershed to the south. Large parts of the burned area are utilized for agriculture, with avocadoes being the primary crop destroyed. The fire burned very rapidly and produced mostly low and moderate burn severity, with large areas of unburned areas within the fire perimeter. Overall for the entire fire area of 9,472 acres, 6.9% was rated as high burn severity, 26.0% as moderate severity, 19.8% as low severity, and 47.3% was unburned (within the burn perimeter). Slight modifications were

made to the original Burned Area Reflectance Classification (BARC) maps produced at the Remote Sensing Applications Center in Salt Lake City for rating burn severity.

The main large sub-watersheds burned were Rice Canyon and Stewart Canyon, which drain to the south into the San Luis Rey River watershed, and Rainbow Creek, which flows to the northwest into the Santa Margarita River basin. Rapid modeling of estimated changes in peak discharge rates and surface soil erosion pre and first year post-fire were generated to provide context for expected impacts to identified values-at-risk and are provided in the Hydrology specialist report.

B. Findings of the On-The-Ground Survey

1. Resource conditions resulting from the fire

The state Burned Area Emergency Response (BAER) team assigned to the Rice Fire inspected the burned area November 6, 2007 through November 8, 2007, both as an entire team (first day) and with specialist groups (second and third days). All the significant portions of the burn area were observed for potential impacts to soil and water resources, as well as identified values-at-risk. Areas inspected included the Red Mountain Reservoir and its surrounding watershed, the Rainbow Public Utilities District storage reservoirs, the Rainbow Creek watershed, the northern and northwestern parts of fire along the Santa Margarita River, the Rice Canyon watershed, and the Stewart Canyon watershed. The sites visited all had drainage facilities in place to handle storm runoff under normal conditions. Watershed response to precipitation events is expected to increase in the regions inspected during the recovery period. Additionally, ash and sediment could be entrained and mobilized with initial precipitation events compounding flooding due to blockage of hydraulic structures such as drains and culverts.

2 Consequences of the fire on values at risk

The main consequence of the fire is expected to be flooding due to overwhelming of on site drainage facilities not only due to increased runoff, but also due to increased sediments. The flooding also could affect water quality at specific sites and downstream along the draining waterway creating significant secondary concerns. The BAER team engineering specialist determined that the areas with highest potential risk to values were the Red Mountain Reservoir and the offices of Kendall Farms in the Stewart Canyon region. Hill slope conditions at these sites will be addressed in the geologist specialist report.

Red Mountain Reservoir-The Red Mountain Reservoir is owned and operated by the Fallbrook Public Utilities District. This 1300 acre-feet reservoir serves approximately 10,000 domestic and agricultural connections in the Fallbrook area. The reservoir sits in an area surrounded by high ground, including Red Mountain, which suffered considerable burning. Approximately 0.25 mi^2 drains down into the reservoir. The main concern due to the fire is water quality impacts to the reservoir if initial storms in the near term are intense events with significant

precipitation. Such events could overwhelm the facilities drainage system due to runoff, particularly increased runoff due to hydrophobic soils containing sediment. The current drainage facility has sufficient capacity to handle a one hundred year precipitation event under normal conditions, however increased runoff due to hydrophobic soil conditions could strain the system (Appendix i). The water quality impacts to the reservoir would include sediment, nutrients and turbidity. Because the reservoir is currently at a low level of storage, there is little danger of overtopping the dam this winter. Fallbrook Pubic Utilities District staff that since the reservoir operates as offsite storage, it was designed to account for failure of the aqueduct serving the reservoir.

A secondary concern determined at this site would be downstream impacts due to runoffs with sediments. The impacts could be increased sediment, nutrients and turbidity in the drainage from the reservoir which could lead to water quality impacts and contribute to local flooding. The drainage system of the Red Mountain Reservoir discharges into a natural waterway that eventually meets with the San Luis Rey River.

Stewart Canyon-The Stewart Canyon region suffered approximately 45% burn. The region is mainly east of Interstate 15 and is drained by the Stewart Canyon creek. This creek drains south until it meets with the San Luis Rey River. The area inspected is predominately agricultural with little housing. The main concern was to flooding of the region along the Stewart Canyon Creek near the Kendall Farms office. This site had approximately 50% of the watershed above it burned to some extent. The creek at this location has undergone alterations to allow for road crossings at various sites throughout the farm. Generally, circular steel culverts have been placed to allow for drainage of the creek through the road crossings. A hydraulic analysis of the location indicates that flooding likely will occur during high precipitation events, which was confirmed by Troy Conner, General Manager of Kendall Farms (Appendix ii). This occurrence could be compounded by increased runoff due to hydrophobic soils, along with higher loadings of ash and sediment. Other concerns are water quality impacts to Stewart Canyon, including sediment, nutrients and turbidity due to increased runoff, and flooding of local roads.

III. Emergency Determination - The sites inspected do not qualify as immediate threats, however that might change if storm events of high intensity were to occur during initial precipitation. An emergency to human life, property, and water quality could occur due to the loss of control of water, increased runoff, and sedimentation.

IV. Treatments to Mitigate the Emergency

Red Mountain Reservoir

A. Treatment Type: Perform maintenance of drainage channels
Objective: To insure that the current drainage channels are clear of obstructions prior to a storm event.

Description: Fallbrook PUD maintenance staff should inspect all drainage facilities such as curbs, canals, culverts and drain inlets. Any obstructions or debris should be removed and any repairs scheduled for completion should be performed

B. Treatment Type: Monitor after every event.
Objective: To insure that the drainage channels are clear after a storm event in anticipation of the next one.
Description: After every significant storm event, staff can inspect all drainage facilities to note for any obstructions or damage to the system. Maintenance and repair can then be scheduled before the next storm event.

Stewart Canyon

A. Treatment Type: Perform maintenance of drainage channels
Objective: To insure that the current drainage channels are clear of obstructions prior to a storm event.
Description: Kendall Farms maintenance staff should inspect all drainage facilities such as curbs, canals, culverts and drain inlets. Any obstructions or debris should be removed and any repairs scheduled for completion should be performed

B. Treatment Type: Monitor after every storm event.
Objective: To insure that the drainage channels are clear after a storm event in anticipation of the next one.
Description: After every significant storm event, staff should inspect all drainage facilities to note for any obstructions or damage to the system. Maintenance and repair can then be scheduled before the next storm event.

C. Treatment Type: Upgrade Culvert Crossings
Objective: To add capacity to the drainage channel at road crossings.
Description: Evaluate the culverts at the office and at the major road crossings by standard engineering practices and determine if upgrades or replacements are necessary to reduce the risk of flooding at sensitive areas.

V. Discussion/Summary/Recommendations

Two engineering-related values at risk were identified by the post-fire assessment team. The above mentioned treatment recommendations are available for implementation before the first post fire runoff producing storm. Further hydraulic assessment is recommended to provide more specific and in-depth analysis. Caltrans and the County of San Diego is currently addressing many issues related to highways regarding potential flooding from steep hill slopes that suffered considerable burning of vegetation.

References:

Waananen, A.O., and J.R. Crippen. 1977, Magnitude and frequency of floods in California: U.S. Geological Survey Water-Resources Investigations Report 77-21, 96 p.

Average Annual Precipitation of San Diego County, County of San Diego, Department of Public Works, Flood Control Section

Appendix i
Hydraulic Calculations for Drainage at the Red Mountain Reservoir

The Red Mountain Reservoir has storm water drainage facilities located along the perimeter of the reservoir. On the east side, there is an underground 60 inch concrete pipe to collect and convey runoff. The west side of the reservoir has a series of dirt ditches that combine into a concrete "V" ditch near the front of the reservoir. Both drainage systems flow into the reservoir spill way and flow downstream in an unnamed creek.

Determination of 100 Year Flood Flow

The USGS Magnitude and Frequency Method was utilized to determine the flood flow at the Red Mountain reservoir location (Waananen and Crippen 1977). The 100 year flow equation used was for the South Coast Region:

$$Q_{100} = 1.95\ A^{0.83}\ P^{1.87}$$

Where: Q_{100} = predicted 100 year peak runoff event in cfs
A = drainage area in square miles = 0.25 square miles
P = mean annual precipitation in inches per year = 16 inches

With the above cited inputs, the 100 year runoff flow was calculated at 110.2 cfs.

East Side Drainage
The eastside of the reservoir is drained by a 60 inch concrete pipe. The capacity of this pipe was estimated using the Mannings equation.

$$Q = 1.49/n\ (A)(R)^{2/3}(S)^{1/2}$$

Where: Q = Calculated flow
A = Flow area = 19.6 ft^2
R = Hydraulic Radius = 1.25 ft/ft
S = Slope = 0.0033

The resultant capacity is 139.6 cfs

West Side Drainage

The Westside of the reservoir is drained by a series of dirt canals that drain into a V ditch of 3 foot height with 1:1 side slopes. The capacity of this pipe was estimated using the Mannings equation.

$$Q = 1.49/n\ (A)(R)^{2/3}(S)^{1/2}$$

Where: Q = Calculated flow
A = Flow area = 9 ft^2
R = Hydraulic Radius = 1.06 ft/ft
S = Slope = 0.0033

The resultant capacity is 58.7 cfs

The combined drainage capacity of both channels is 198.6 cfs.

Appendix ii
Hydraulic Calculations for Drainage at the Kendall Farms Offices

The offices of Kendall Farms are located along the Stewart Canyon creek. The creek has a crossing near the office that appeared to be in potential danger of flooding at high storm events. This observation was confirmed by Troy Conner, General Manager of Kendall Farms. Mr. Conner stated that he has seen overland flow at the crossing during past high storm events.

Determination of 100 Year Flood Flow

The USGS Magnitude and Frequency Method was utilized to determine the flood flow at the Kendall Farms office location (Waananen and Crippen 1977). The 100 year flow equation used was for the South Coast Region:

$$Q_{100} = 1.95\ A^{0.83}\ P^{1.87}$$

Where: Q_{100} = predicted 100 year peak runoff event in cfs
A = drainage area in square miles = 0.91 square miles
P = mean annual precipitation in inches per year = 16 inches

With the above cited inputs, the 100 year runoff flow was calculated at 321.9 cfs. If the burn area is taken into account, the 100 year runoff flow was determined to increase to 382.3 cfs (see Hydrologists Specialist Report for procedure details).

Capacity of Crossing Culverts

There are 4-36 inch circular steel culverts under the road crossing near the Kendall Farms office. The capacities of these pipes were estimated using the Mannings equation.

$$Q = 1.49/n\ (A)(R)^{2/3}(S)^{1/2}$$

Where: Q = Calculated flow

A = Flow area = 7.07 ft^2 for each culvert
R = Hydraulic Radius = 0.75 ft/ft for each culvert
S = Slope = 0.009

The resultant capacity for all 4 culverts is 219.9 cfs indicating that flooding of the culverts would occur during a 100 year storm event.

Capacity of the Stewart Canyon Creek

The capacity of the creek near the Kendall Farms office was indirectly determined by using HEC-RAS to model the water surface elevation for the given channel geometry at the 100 year flow of 321.3 cfs and at the increased flow of 382.3 cfs when taking into account the intensity of the burned watershed. The simulation indicated that at 321.3 cfs, the water surface elevation exceeded the near side bank by 0.08 feet. At the increased flow of 382.3 cfs, the overflow of the near bank was 0.82 feet. Any overflow would flow toward the Kendall Farms offices and the warehouse potentially damaging the two structures.

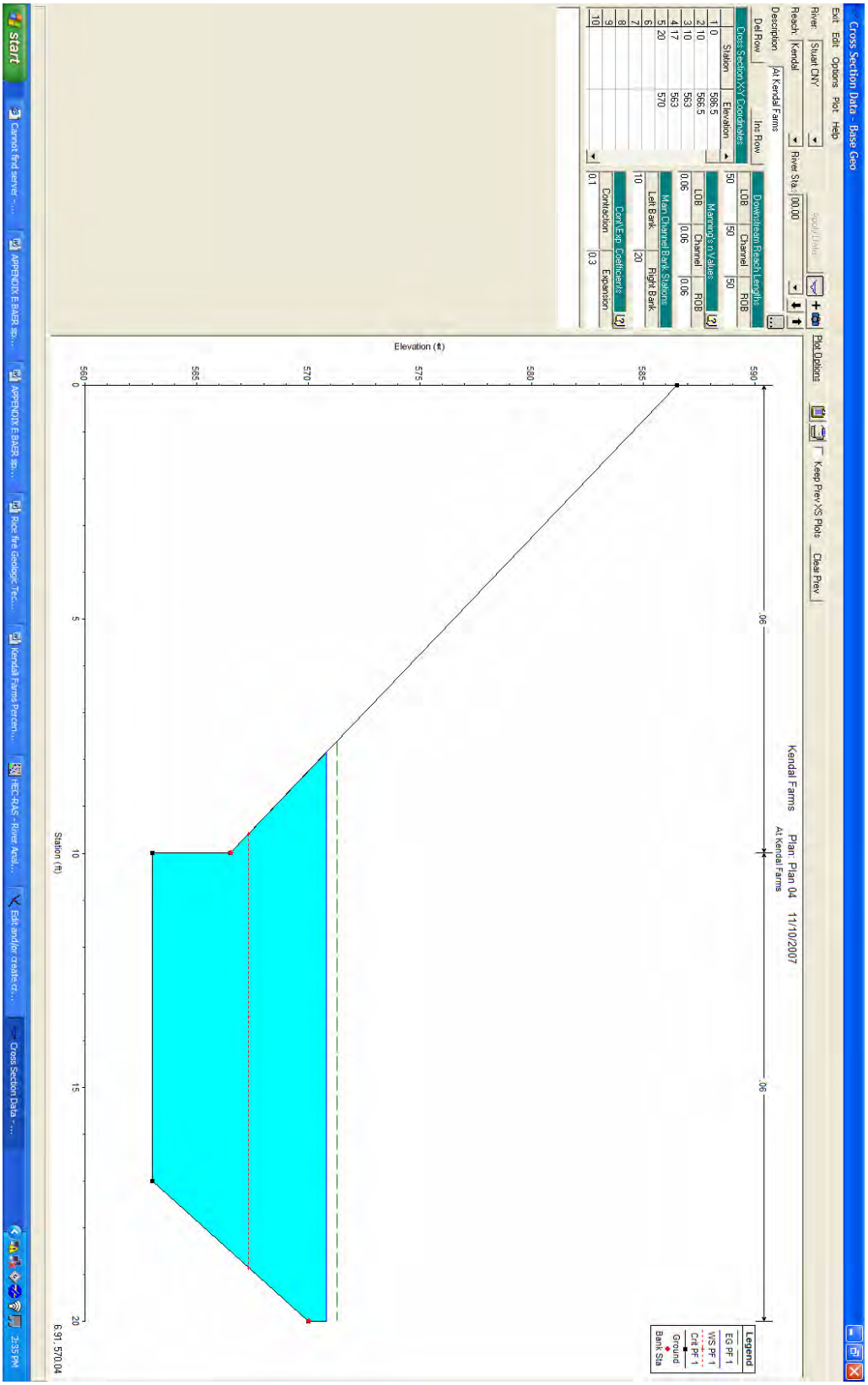

Figure 1: HEC-RAS Model Simulation at 100 year Storm Flow of 321.0 cfs

Appendix C

Report on Archaeological and Historic Resources
Rice Fire (CA-CDF-000764)

November 2007

Gerrit L. Fenenga, Ph.D.
Cal Fire Archaeologist
Sacramento Headquarters

Note These appendices contain confidential information regarding archeological site locations, so have been removed from public copies of this report in accordance with the policy of the Office of Historic Preservation as adopted by the State Historical Resources Commission under the authority of Public Resources Code 5020.4.

I. Potential Values at Risk

An archaeological records search at the South Coastal Information Center (SCIC) of the California Historical Resources Information System (CHRIS). Historically, the region was occupied by a significant number of Native American people who belonged to several different tribal groupings. Many of the descendants of the various groups survived into modern times, and today there are a number of Federally-recognized tribes with tribal land holdings, as well as other people who identify themselves as local Native Americans. These people have considerable interest and concern over archaeological resources in the region utilized by their ancestors. Native populations left a considerable record of their presence in the form of a variety of different kinds of archaeological remains including village and camp sites, resources procurement and processing sites, ritual and ceremonial locations, rock art sites, mythological locations of importance, and so on. Any of these kinds of sites are potentially at risk as a consequence of the fire, fire suppression activities, and post-fire effects such as looting and erosion.

Historical use of the area of the Rice Fire created another layer of cultural resources across the landscape. Much of this use is not reflected in the records available from the SCIC. Of the historic resources identified prior to field survey, the standing architecture is at greatest potential risk. The remaining identified historic locations consisted of minor trash scatters, building foundations, and piles of field stones associated with field clearing for agricultural purposes, and other features such as well holes or privy holes that are not likely to be affected by the fire or its consequences.

II. Resource Condition Assessment

A. Resource Setting

Historic use of the area has left a significant record across the landscape, with much of it dating to the past 50 years and hence not technically “historic” or requiring assessment. Most of the historic use of this area has been for ranching or agricultural and horticultural purposes. There also has been some exploration for mineral resources and there is a potential for finding historic prospects and other mining features. Today, recreational use of undeveloped areas, or those set aside as reserves, is common and material evidence of that activity may occur any where in those settings.

B. Consequences of the Fire on Resources at Risk

Cultural resources are at risk from the fire itself, from fire suppression activities, and from post-fire exposure that may reveal archaeological sites previously hidden in vegetation to artifact predation and other forms of vandalism. Standing historical buildings are obviously susceptible to destruction by fire. Prehistoric archaeological remains of Native village sites, or other kinds of archaeological sites, may seem less at risk, but these too can be adversely affected. Native Americans regularly engaged in fire ecology, annually burning the landscape for increasing yield of economic plants, improved hunting, and water management. This practice probably resulted in fuel regimes completely unlike modern conditions which produce catastrophic wild fires. There also are a variety of other effects such as alteration of soil chemistry, introduction of recent carbon into midden deposits, and potential alteration of obsidian artifacts limiting their use for sourcing of obsidian hydration dating.

III. Emergency Determination

There are no emergency situations relating to Archaeological or Historical properties within the Rice Fire burn area.

IV. Summary and Recommendations

This is an unusually low number for this area and this size of a land parcel. Site density might be lower here than elsewhere in San Diego County, but it is more likely that this figure reflects a lack of survey work. It also is apparent from my own survey work associated with this fire that a considerable amount of the land that would have been suited for Native American land use purposes has been modified by modern agrarian practices and by housing developments. In spite of these factors, there

still is some potential for unknown sites to occur here that have not been identified.

Based on the above observations, the following recommendations are suggested.

1) The larger public partials of land within and adjacent to this fire need to be systematically inventoried for archaeological and historical resources. Those agencies that own and manage such properties can not be acting as responsible stewards of their resources without knowledge of their presence or significance. This recommendation applies especially to the Utility District and SDSU lands along the Santa Margarita River drainage.
2) Those resources identified under the "Treatments" section of the attached Rice Fire Cultural Resource data matrix as having either no site record or an incomplete site record need this to be corrected. The existing records for several of these sites are completely inadequate and not up to modern standards. The three sites identified during survey work associated with this fire (Ida Howell Site, 1880's Railroad Grade, and the Trailer Park Site) should be formally recorded with the SCIC. Those sites with incomplete or incorrect information should be updated. For example, the registered historical property listed at 405 Roger Road is actually located at 405 Ranger Road.
3) Efforts should be made to monitor activity on and around archaeological locations that have been exposed by the removal of vegetation. This may be done by the agencies that own them, or by concerned neighbors who are aware of the potential problem.
4) The trailer park at 3090 Reche Road appears to have been built atop an Indian village site, as cultural artifacts and bedrock milling features have been identified around its margins. The burned debris will have to be removed from this location, and perhaps additional activity may occur here that could adversely effect any portions of the site that may still exist underneath the development. Any work in this area that may expose intact sediments with ground disturbing equipment or activities has the potential of exposing undiscovered remains of this site. It is recommended that someone with archaeological training be present when material is removed from this site.
5) Any future involvement with the Native American sites here, such as additional survey and site identification work should involve consultation with local Native American tribal representatives. The sites in this area are of great concern to them and they are aware of many locations that may be intangible to non-Native people, but which are of significance to tribal members. Cal Fire maintains a current list of appropriate local Native American contacts for San Diego and Riverside Counties on its website. To obtain a contact, go to the Resource Management link, and then the Archaeology Program link at www.fire.ca.gov.

Appendix D

Burned Area Emergency Report
Resource: Geology
DRAFT FINAL TECHNICAL SPECIALIST'S REPORT

Burned Area Emergency Report
Resource: Geology
Fire Name: Rice Fire **Month/Year**: November 2007

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I. Resource Condition Assessment

A. Resource Setting

The 9472-acre Rice Fire burn area is underlain by Cretaceous gabbroic, tonalitic, and granitic plutonic rock and minor metamorphic inclusions. The gabbroic rock is dark colored, fragmented, and deeply weathered. It decomposes to a reddish brown sandy-clayey soil. Surficial soil deposits of alluvium and colluvium overlie most of the bedrock. The tonalitic and granitic rock consists of hard, boulder-sized, core-stones in a matrix that is heavily weathered, broken, and friable. As the matrix decomposes, the core-stones become conspicuous as fields of boulders in coarse, sandy, tan-colored soil of decomposed granite (DG) that is locally thick and gullied, and prone to rapid erosion and slope failure. The Elsinore Fault lies approximately 5 miles to the northeast. Appendix 1 (Geologic Map Legend) includes a description of the geologic units within the Canyon fire area.

Topography within the burn area ranges from gentle alluvial valleys to very steep headwater basins. Topographic relief is moderate. Only one third of the burn area burned at moderate to high severity. The burn area lies below the elevation generally subject to rain-on-snow events, although snow may occasionally fall near the higher peaks. Although the climate is generally dry; intense rainfall and especially wet years repeatedly occur and usually result in mudflows and flooding.

The values at risk are 1) possible loss of life and property due to slope-generated landslides, debris flows, rock fall, and associated slope movement and 2) drinking and agricultural water reservoirs.

B. Survey Methods

To evaluate the risk to life and property, road and foot reconnaissance inspections were conducted on November 5-9, 2007. Most public roads within the burn area were driven to identify where high-value sites may be present that need additional on-site reviews, concentrating on developed residential areas and drinking water facilities. Road-related features, such as culverts and bridges, were not surveyed.

The California Geological Survey inspected houses and other high-value sites within and down-slope of the burn area to evaluate potential risks from debris flow and other geologic hazards that may not be identified in a regional hydrologic evaluation that we understand is being undertaken by the CAL FIRE hydrologist. The survey was rapid, limited to easily accessible areas, and based on incomplete and preliminary information. We estimated risk to prioritize sites to expedite the implementation of preventative measures. Closer inspection at some sites may reveal conditions different from our initial estimates. The sites identified as having potential risks to lives or property are listed and briefly described below and summarized in Appendix 2 to this report. Other sites with similar concerns probably exist but may have been missed through this rapid survey. **Follow-up efforts to identify issues and to implement remedies are essential to protect the public.**

San Diego County hired a consultant, Scientech, Inc. to survey slope hazards along county roads and recommend treatments. We were provided with draft copies by the Department of Public Works. During the course of our field work, we were provided with draft Scientech findings and found them to be generally consistent with our observations. We refer to the Scientech findings to supplement our findings and to avoid needless duplication of effort.

C. Emergency Determination

The values at risk considered in this assessment include the possible loss of life and property due to landsliding, debris flow, rock fall, debris torrents, and flooding from increased surface water runoff. In general, the risk from landslides, debris flows and rock falls are possible where roads, residences or other development are located on alluvial fans, colluvial footslopes and debris cones. As such these locations can be pre-identified and map prior to emergencies such as wild fire. Flooding and in-stream debris torrent activity adjacent to canyon stream channels may also pose a risk to high-value features that are near to those channels. As such, the information provided in the attached summary sheets must be used in combination with the hydrologists' assessments to understand more completely the magnitude of risks to high-value sites in the area.
It should be noted that these hazards are part of the natural processes in this environment, and that these risks were present under pre-fire conditions. Many existing structures in the burn area have been and will continue to be at risk from these hazards. The potential for these

processes to be exacerbated by fire is primarily dependent upon burn severity and slope steepness, both of which are variable in the Rice Fire area. Risks to cultural, soils and biologic assets are covered in other specialist reports. Areas with moderate to high potential risks to life and property from slope instabilities exist elsewhere in the vicinity of the Rice Fire, but the assessment of sites that were not affected by the fire is beyond the scope of this evaluation.

II. Observations

A. General observations

The principal concern with the Rice Fire is an increase in the potential for in-channel floods, hyperconcentrated floods, debris torrents, debris flows and headward expansion of gullies. Houses are present in drainage swales at the bottoms of canyons where debris flows and flash floods would be a threat. Several houses occupy steep ridgetops directly above major swales and gullies where headward erosion can undermine foundations. **The magnitude of post-fire damage will be determined by the intensity and duration of storms that impact the area.**

The colluvial and alluvial spoils are the weathered and transported products of long-term bedrock disintegration. Water is the chief agent of erosion. The chaparral vegetation typically slows erosion by removing water through interception and evapotranspiration, reducing the force of raindrop impacts, and by providing a network of roots to hold soil in place. Due to the loss of vegetation, runoff is likely to be higher than background conditions until vegetation is re-established. This may result in accelerated erosion especially in the severely burned areas and the most erodible soils. Intense fires may also create hydrophobic soils where waxy substances released by plant materials during hot fires follow thermal gradients into the soil and congeal as semi-impervious surfaces.

The increased runoff and erosion will result in higher than usual peak flows along stream channels. Numerous houses occupy floodplains (i.e., Stewart Canyon Creek) below burned watersheds and are consequently are at a higher risk of flood and sediment damage until vegetation is re-established.

Specific houses and other high-value features that were identified by our rapid, survey are documented below.

As discussed above, there may also be an increase risk from floods, hyperconcentrated floods, and in-stream debris flows that are beyond the scope of the CGS survey.

B. Specific Observations

1. Red Mountain Reservoir
   The now burned natural slopes and cutslopes surrounding the reservoir appear to have been affected by past instabilities. An engineered drainage system of subdrains and lined V-ditches conduct normal runoff

away from the reservoir. Barring a catastrophic failure the 20-ft wide perimeter road that separates the reservoir from the base of slopes appears to be sufficient to catch rock falls and other cutslope failures. The chief engineer of the facility was advised of these observations and stated that the drainage system was built for 100-year flows. Engineers from the Department of Water Resources accompanied the BAER team and also visited this site.

2. Houses located on erodible slopes:
   a. Vista Del Rio:
      This house adjacent to a gullied watercourse channel below the county road watercourse crossing could potentially be undermined as a result of increased runoff and sediment transport as a result of the Rice Fire.
   b. Vista Del Rio:
      The slope above this house is steep (~65%), burned, denuded of chaparral, and contains boulders that may fall toward the house. Rock falls may occur even under dry conditions prior to winter rain. The existing 1-2 ft wide drainage swale above the house appears to be inadequate to stop a significant rock fall.
   c. Vista Del Rio:
      The foundation of the house directly above the head of a severely burned gully could be potentially be undermined by increased erosion associated with post-fire headward gully expansion.
   d. Red Mountain Heights:
      This house is perched atop an unstable ridge of crumbling, broken rock. The house may be undermined if the slope continues to slough or slides.
3. Houses located in drainages below burned slopes
   a. Daisy Lane
      This house is currently under construction and is adjacent a steep swale that drains a burned slope. A recently constructed 10-ft high dam (a landscaping feature) may not be adequate to impound sediment and runoff from the burn slopes. In the event that flows spill over the dam, flow may divert down the driveway and into the garage of this house.
   b. North Stagecoach Lane (propane tank, 1 absent owner)
      This and the neighboring two houses occupy are close to the access of a swale that drains a steep, burned slope. Numerous small boulders and large cobbles collected in the swale could move down the swale and could be mobilized as a debris slide that would follow the swale. A propane tank is especially at risk.

c. Stewart Canyon Road

The hillside above the county road is burned. The bare soil is loose and subject to mass wasting into (and perhaps across) the road toward the homes. A spoil pile from a fire break blocks a drainage above a culvert that underlies the road. Slide debris or hyperconcentrated flows along the stream channel could block the culvert and could potentially affect properties near the road. The original grading for the resort narrows the stream channel and may result in higher stream flows adjacent to the resort. Flooding could impact the parking lot but is unlikely to affect homes.

d. Pala Mesa Resort, Pala Mesa Drive

    i. A set of residences lie at the base of a burned, steep, bowl-shaped slope. The burn was of light to moderate intensity. Accumulations of rock and soil in the steep headwall area are minor. A deposit of rocks from a past rockfall lies immediately uphill of the residences but is stable. Runoff from the bowl is conducted through the resort via a culvert system. Debris from the slope may plug the culvert.

e. Puerto del Mundo

    i. The house is located at the base of a rock slope which was burned to low intensity. The increased risk is low.

f. Tecolte Drive

    i. The house is at the base of a burned slope with boulders evident toward the crest. A 2.5-ft wide inceptor swale is approximately 50-feet uphill of the house. The swale may be inadequate to catch large falling rocks.

4. Buildings adjacent to creek channels
    a. Kendall Farms warehouse facility
    Grading and channel modifications have narrowed the stream channel and may result higher flood flows. The steep watershed was moderately burned and is highly erodible. A watercourse crossing upstream from the warehouse may plug due to excessive debris, which could potentially flood the office and warehouse area. In the event of heavy rainfall, the roads leading into the canyon may wash out. Evacuation during heavy or prolonged rain may be unsafe due to slippery or damaged road conditions.

    A hydrologist member of the BAER team also visited this location and has prepared findings and recommendations.

b. Stewart Canyon Road
These homes occupy the floodplain of Stewart Canyon Creek. The watershed is burned. Peak flows and flood risk are expected to be increased.

c. Skyline Circle
The basin above this house was burned and is drained by a under fit swale. During a significant storm, runoff and sediment movement in the swale may divert out of the channel and flow toward this house.

5. State Highway 15
CALTRANS crews and contractors were actively hydro-seeding and installing rolled straw as erosion control on affected road cuts and embankments. The treatments appear to be appropriate.

4. County Roadways
SynTech Inc. prepared erosion control plans for portions of county roads that will likely be impacted by sediment off of burned areas. They identified portions of Stewart Canyon Road, Mission Road, Old Highway 395, and Highway 15. Their recommendations appear to be appropriate. Because there are no direct threats to life and property other than the road, we did not evaluate these independently. Impacts to the road may create hazards to motorists.

III. Recommendations

A. General Recommendations:

- The sites identified in Appendix ii should be evaluated by Professional Geologists or Professional Engineers with experience in slope stability and debris flow hazard identification and mitigation to fully document the scope of the problems at each site.
- The existing road drainage systems should be inspected by the appropriate controlling agency to evaluate potential impacts from floods, hyperconcentrated floods, debris torrents, debris flows and sedimentation resulting from winter rains.
- The local flood control districts, Department of Public Works and Fire Department, San Diego State University, the Bureau of Land Management, the State Department of Transportation, the Office of Emergency Services, the Natural Resources Conservation Service, and any other responsible party should be made aware of the potential hazard to lives and property in the fire area.
- Houses within or alongside drainage channels that drain steep, burned watersheds should anticipate higher than usual flows until vegetation is re-established. The flows may carry significant loads of wood and sediment debris that could plug various waterways and pipes. Emergency response personnel should inspect and maintain the

drainage systems and should consider keeping sandbags on-hand for rapid deployment.

- Steep and small, upper watersheds are likely to experience flashy flows that could limit the time to respond and evacuate. Emergency agencies should consider of the ALERT early warning rain gauge system.
- Evacuation routes may be damaged and unpaved roads may be slippery. Emergency agencies should consider developing a data base of pre-identified alternative routes.
- Owners of houses and other critical structures that are situated below steep hillsides that have burned and now reveal loose rock and boulders should evaluate the use of control measures to stabilize the rock or to divert or catch falling rock. This evaluation should be conducted by Professional Engineers or Professional Geologists experienced in slope stability.
- Houses and other critical structures located adjacent to or on erodible slopes should be monitored for slope instability. Gullies, thick perched soils, loose rock accumulations, and steep crumbly slopes may be indicators of slope instability. This evaluation should be conducted by Professional Engineers or Professional Geologists experienced in slope stability.
- California Geological survey Note 33, hazards from "Mudslides"…Debris Avalanches and debris flows in hillside and wildfire areas describes important safety information for residents of houses at risk. This document should be distributed to houses at risk.

B. Specific Recommendations:

1. Red Mountain Reservoir

   a. The operators of the reservoir should conduct storm patrols to ensure proper functioning of the drainage system as the sediment yield may be high. A sandbag wall may be useful to enhance the protection of the water in the reservoir.

   b. Refer to the hydrology and engineering reports.

2. Houses located on erodible slopes

   a. Vista Del Rio
      The County Department of Public Works should be immediately notified of this condition. They should make an evaluation and implement remedies prior to heavy rain. The County should notify the residents of the situation immediately.
      Monitoring of the slope is advised. Slope stakes and photo monitoring by licensed professionals are advised.

   b. Vista Del Rio
      The stability of the boulders should be immediately inspected by a. Professional Geologist or Professional Engineer with experience in

slope stability. Unstable boulders should be removed or anchored under the direction of the geologist or engineer. If unstable boulders can not be removed or anchored, alternative measures to protect the house should be considered.

c. Vista Del Rio
A Professional Geologist or Professional Engineer with experience in slope stability should inspect the slope prior to rains. Their recommendations should be implemented prior to continued occupancy.

Monitoring of the slope is advised. Slope stakes and photo monitoring are advised.

d. Red Mountain Heights
A Professional Geologist or Professional Engineer with experience in slope stability should inspect the slope prior to rains. Their recommendations should be implemented prior to continued occupancy.

e. Daisy Lane
Public officials with authority over dam design should be notified of the dam and evaluate its design prior to approving occupancy of the house.

f. North Stagecoach Lane
County officials should immediately notify the residents of the houses neighboring 2477 Stagecoach Lane of potential risks to their properties.

At a minimum, the at-risk propane tank should be evaluated and appropriately protected.

Houses bordering the swale may potentially be protected by installing deflection walls in areas where flows and falls could escape the channel. A Professional Engineer will need to determine the need for and the appropriate design of any installation.

g. Stewart Canyon Road (the Los Willows Resort)
The County Department of Public Works should be immediately notified of this condition. They should evaluate and implement appropriate remedies prior to any heavy rain. The County should notify residents of the situation immediately.

Please refer to the hydrologist's report for this site.

h. Pala Mesa Resort, Pala Mesa Drive

    i. Erosion control measures should be employed along the slope to control sediment and water runoff from the bowl area. A Professional Engineer or Professional Geologist should evaluated the need, design, and implementation, if needed, for treatment to control potential debris flow hazard.

i. Puerto del Mundo

   i. Monitor hillslope conditions. If ravel or drainage increases, contact a Professional Geologist or Professional Engineer for an inspection.

j. Tecolate Drive

   i. The stability of the boulders should be immediately inspected by a Professional Geologist or Professional Engineer with experience in slope stability. Unstable boulders should be removed or anchored under the direction of the geologist or engineer. If unstable boulders can not be removed or anchored, alternative measures to protect the house should be considered.

[redacted]

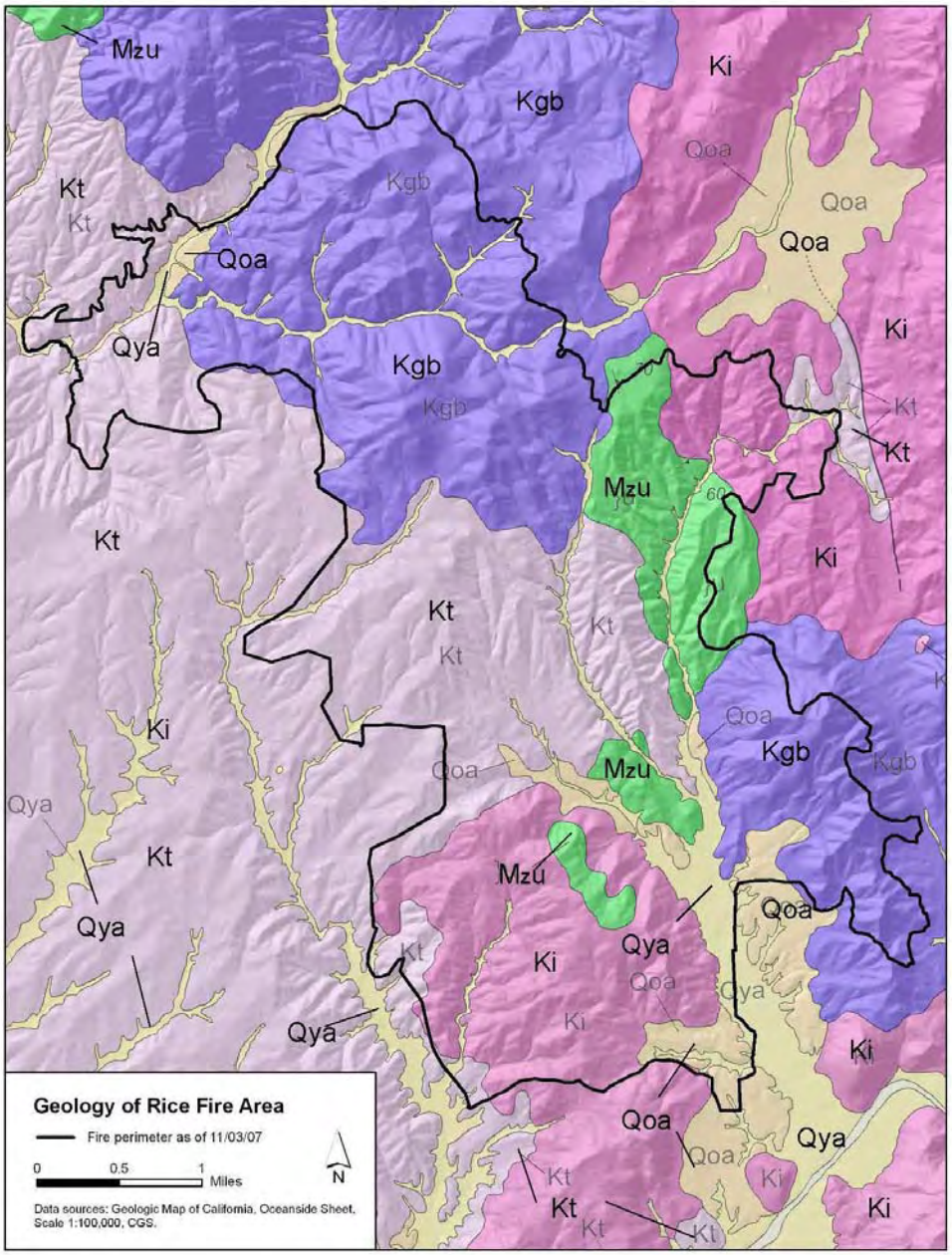
- [redacted] should remove personnel from the warehouse and office area if heavy or prolonged rain is predicted. Kendall Farms should identify a safe evacuation route and instruct all personnel accordingly. An ALERT early warning rainfall detection system could be installed as a part of a safety and evacuation plan.
- A professional engineer may consider installing a trash rack several feet in front of the culvert inlet to capture debris. Periodic clearing of debris should be done to keep the channel clear.
- Sand bags may be reasonable to minimize flood flows from moving toward the structures.
- Plastic culverts were destroyed by the fire. A complete inventory of culverts should be conducted and damaged ones replaced.
- Sediment basins should be cleaned out as needed.
- Refer to the hydrologist's and engineer's report.

3. Skyline Circle
   A Professional Engineer should evaluate measures to protect the structure from flows that may affect this slope

4. The county should implement the recommendations immediately.

References

Kennedy and Tan, 2007, Geologic Map of the Oceanside 30' X 60" Quadrangle, Oceanside Sheet, California Geological Survey, scale 1:100,000.


Geology of Rice Fire Area
Fire perimeter as of 11/03/07
0
0.5
1
Miles
N
Data sources: Geologic Map of California, Oceanside Sheet, Scale 1:100,000, CGS.
Mzu
Kgb
Ki
Qoa
Kt
Qya

Appendix i: Legend to Geologic Index Map, Rice Fire (Kennedy and Tan, 2007)

Qya	Young alluvial fan deposits	Unconsolidated sediments contained within major stream courses; of Holocene age.
Qoa	Older alluvium	Unconsolidated to weakly consolidated alluvial sediments; dissected where elevated; of Late Pleistocene age.
Kt	Tonalite	Light-colored granitic rock largely consisting of sodium plagioclase and quartz of Mesozoic age.
Ki	Granite of Indian Mountain	Crystalline igneous rock largely consisting of quartz and orthoclase or microcline of Mesozoic age.
Kgb	Gabbro	Massive, coarse grained, dark-gray and black biotite-hornblende-hypershene gabbro of Mesozoic age.
M**z**u	Metamorphic and Medisedimentary rocks	Undivided metamorphosed volcanic and sedimentary rock of Mesozoic age.

Appendix ii:

California Geological Survey Burn Site Evaluation Summary
Fire Name :

Bold where risks are high											
Site		At-risk		GPS location		Hazard	Likeli-	Risk to lives		Risk to property	
number		Feature		Latitude N	Longitude W		hood	fire	pre-exist	fire	pre-exist
	101	Reservoir				Sediment pollution	Mod	low	low	mod	low
	102	House				Slope failure	Mod	mod	low	mod	**low**
	103	**House**				**Rock fall, slope failure**	**mod**	**high**	**mod**	**high**	**mod**
	104	House				Slope failure	mod	mod	mod	mod	mod
	105	**House**				**Slope failure**	**mod**	**high**	**mod**	**high**	**mod**
	106	House				Sedimentation, flood	low	low	low	mod	low
	107	House				Rock fall, debris flow	mod	mod	low	mod	low
	108	Houses				Sedimentation, flood	mod	low	low	mod	low

Bold where risks are high											
Site number		At-risk Feature	Street address	GPS location		Hazard	Likeli-hood	Risk to lives		Risk to property	
				Latitude N	Longitude W			fire	pre-exist	fire	pre-exist
	109	Buildings				Flood	mod	low	low	mod	low
	110	Houses				flood	mod	low	low	mod	low
	111	House				debris flow, flood	high	low	low	mod	low
	112	Road				erosion, cutslope failure, plugged drains	mod	low	low	low	low
	113	Road				erosion, cutslope failure, plugged drains	mod	low	low	low	low
	114	Houses				debris flow, flood	mod	high	mod	mod	mod
	115	**House**				**rock fall**	**mod**	**high**	**mod**	**high**	**low**
	116	House				rock fall	low	mod	mod	mod	mod

Appendix E

BAER SURVEY SPECIALIST REPORT

Hydrology
Rice Fire
November 2007
Anna Kolakowski (DWR) and Pete Caffereta (CAL FIRE)

I. Potential Values-at-Risk (identified prior to and during on-the-ground survey)

1. Red Mountain Reservoir
2. Rainbow Municipal Water District Reservoirs
3. Houses located on erodable slopes
    a. Vista Del Rio
    b. Red Mountain Heights
4. Houses located in drainages below steep, burned slopes
    a. Daisy Lane (berm constructed across drainage adjacent to home under construction)
    b. 2 Homes neighboring North Stagecoach Lane (propane tank, 1 absent owner)
5. Buildings adjacent to creek channels
    a. Kendall Farms warehouse facility in Stewart Canyon
    b. Stewart Canyon Road
    c. Skyline Circle
6. State Highway 15
7. County Roadways
8. Water quality impacts—particularly to Rainbow Creek watershed (a TMDL watershed listed as impaired by U.S. EPA under Section 303(d) of the Clean Water Act)
9. Soil resources

II. Resource Condition Assessment

C. Resource Setting

The Rice Fire burned in Southern California from October 22, 2007 through October 29, 2007. The fire area is located in both the Santa Margarita River watershed to the north and the San Luis Rey River watershed to the south (HUC 6th field watersheds). Major sub-watersheds include Rice Canyon, Stewart Canyon, and Rainbow Creek. Large parts of the burned area are utilized for agriculture, with avocadoes being the primary crop affected. The fire burned very rapidly and produced mostly low and moderate burn severity,

with large areas of unburned areas within the fire perimeter. Overall for the entire fire area of 9,472 acres, 6.9% was rated as high burn severity, 26.0% as moderate severity, 19.8% as low severity, and 47.3% was unburned (within the fire perimeter). Slight modifications were made to the original Burned Area Reflectance Classification (BARC) map produced at the Remote Sensing Applications Center in Salt Lake City for rating burn severity.

The main large sub-watersheds burned were Upper Rice Canyon and Stewart Canyon, which drain to the south into the San Luis Rey River watershed, and Rainbow Creek, which flows to the northwest into the Santa Margarita River basin. Riparian vegetation is largely unimpaired along the two major rivers and is in good condition along many of the smaller drainages. Rapid modeling of estimated changes in peak discharge rates and surface soil erosion before the fire, and first year post-fire, were generated to provide context for expected impacts to identified values-at-risk.

B. Hydrologic and Erosion Response

Peak flows increase following wildfire as a result of reduced surface cover and the formation of water repellent soils. The most intense peaks occur during intense, short duration rainfall events on watersheds with steep slopes (Neary et al. 2005). Estimated changes in post-fire peak flows were patterned after efforts that have been conducted for past federal BAER work in southern California using data provided in Rowe et al. 1949.[1] Pre-fire peak flow estimates were first produced by using the south coast USGS regional regression equations for 2, 10, and 100 year recurrence interval discharges (Waananen and Crippen 1977) for the Upper Rice Canyon, Stewart Canyon, and Rainbow Creek sub-watersheds. These results were compared to actual peak flow data recorded from 1962 through 1973 for a small unregulated tributary (0.52 mi^2) to the Santa Margarita River near Fallbrook (USGS Station No. 11044600). Use of the USGS PEAKFQ software program for a flood frequency analysis revealed that estimates for 2, 5, 10, 25, 50, and 100 year discharges were relatively similar to those produced by the USGS south coast regression equations, particularly for 2, 5, and 10 year flows. Generally, at least 20 years of data from a stream gauging station is required to have a record sufficient to produce a statistically valid flood frequency analysis. Therefore, we used the equations provided in Waananen and Crippen 1977 to predict pre-fire flows rather than the limited data available for the Santa Margarita River tributary.

To determine the impact of the fire on first year peak flows, increases were based on Rowe et al. (1949) projections for the Pechanga Creek drainage (Table 28; drainage area equals 10 square miles). Pechanga Creek is a

[1] Examples of past use of data provided in Rowe et al. (1949) include the Las Pilitas, Highway 41, and Highway 58 Fires in San Luis Obispo County; Bridge Fire in Los Angeles County; and the Old and Grand Prix Fires in San Bernardino County.

tributary to the Santa Margarita River located approximately four miles northwest of the Rice Fire boundary. For 2, 10, and 100 year return interval events, discharges for high burn severity watersheds that were completely burned were estimated to increase approximately 3.1, 2.3, and 1.9 times over the pre-fire flow rate, respectively. These estimates were modified by utilizing "fire intensity factors" that were originally used for the 1985 Las Pilitas Fire and have been used several times for post-fire rehabilitation efforts that occurred in later years.[2]

For high intensity burned areas, the percent of the watershed burned is multiplied by a factor of 1, which is then multiplied by the Rowe et al. (1949) first year post-fire rate and the Q_2, Q_{10}, and Q_{100} discharge. For moderately burned areas, the percent of the area burned is multiplied by 0.7 and the Q_2, Q_{10}, and Q_{100} discharge, which is multiplied by the Rowe first year post-fire rate. For low intensity burn areas, the calculated unburned rate is multiplied by 1.15, which is then multiplied by the percent of the area burned at this rate and the Q_2, Q_{10}, and Q_{100} discharge. The high, moderate, low, and unburned discharge rates are then all added together to provide a weighted average for the watershed. No bulking factor was included in our analysis, but bulking by sediment can be extremely important during the first post-winter period. For example for the Cedar Fire in San Diego County, the federal DOI BAER team estimated that in addition to projected increases in peak flows, flood flow volumes can increase an additional 2.1 times due to bulking (J. Frazier, USFS Stanislaus National Forest, personal communication). This is considered to be a very conservative estimate and it is more likely that bulking could increase flood flows another 30 to 50 percent during very infrequent, severe winter storm events.

Due to the fact that the Rice Fire rapidly burned through the various watersheds leaving large areas unburned within the fire perimeter and produced mostly low to moderate burn severity, changes in peak flows in the moderately sized Upper Rice Canyon, Stewart Canyon, and Rainbow Creek watersheds are not extreme. The percentage of the Upper Rice, Rainbow, and Stewart watersheds burned are 1, 17, and 46 percent, respectively. For peak discharges that occur on average every two years, flow rates are estimated to increase 1.0, 1.2, and 1.5 times for these three watersheds, respectively (Table 1). Clearly, much smaller subwatersheds (i.e., less than 250 acres) that were entirely burned with moderate to high severity are expected to have a two year peak discharge rate elevated closer to the 3.1 times factor referred to above.[3] It is commonly stated as a rough estimate that flows will approximately double the first winter following severe wildfire covering entire drainages in southern California (assuming a two year return

[2] This factors were originally suggested by Mr. Robert Blecker, Forest Hydrologist, USFS Los Padres National Forest (retired).

[3] Neary et al. (2005) state that post-fire changes in peakflows are probably greatest out of smaller sized watersheds less than 0.4 mi^2 (~250 ac).

interval runoff event). For example, this increase was projected for small drainages in the San Gabriel Mountains during a federal BAER effort for the Bridge Fire in 1999.

Background sediment data was estimated with a relatively new computer program denoted as ERMiT (Erosion Risk Management Tool) developed by the USFS Rocky Mountain Research Station (Robichaud et al. 2006, 2007). Predicted sediment yields are calculated from the estimated probabilities for different storms, burn severity patterns, and soil characteristics (Larson et al. 2007). ERMiT is considered to be an improved version of the Disturbed WEPP (Water Erosion Prediction Project) erosion model that has been in use for several years, since it uses probabilities rather than providing one a single, deterministic value. In other words, unlike past erosion models, the model's stochastic component allows users to work on a risk basis. Limited validation work has shown that ERMiT provides reasonable estimates of post-fire sediment yields in California (T. Ellsworth, USFS Inyo National Forest, personal communication).[4] Larson et al. (2007) have recently reported that ERMiT produces realistic estimates of sediment reduction for post-fire hillslopes treated with straw mulch.

We modeled a burned hillslope in the upper Stewart Canyon sub-watershed with ERMiT. The soil series was determined to be a Cieneba very rocky coarse sandy loam on 30-75% slopes (NRCS 1973), formed from decomposed grandodiorite.[5] Rock content was assumed to be 5-10% based in information from the soil survey work. Climate data was assumed to be similar to that developed for Escondido, located approximately 20 miles to the south of Fallbrook. The middle slope was modeled at 50%, with the toe slope at 30%. Slope length was assumed to be 300 feet and low, moderate, and high burn severity were modeled. Pre-fire hillslope vegetation was assumed be 80% chaparral and 20% bare ground. ERMiT estimated that the pre-fire erosion rate was 0.5 tons/acre. Low, moderate, and high severity first year post-fire sediment yields were predicted to be 7.6, 8.9, and 9.6 tons/acre, with only a 10% probability that these sediment yields will be exceeded (Figure 1). With mulching and moderate burn severity, first year post-fire estimated sediment yield is modeled to be 1.4 ton/acre (assuming mulching at a rate of 0.5 t/ac). This is approximately an 80% reduction is sediment yield. Seeding is modeled as ineffective for the first winter, with sediment yield equaling 8.9 tons/acre (unchanged). This is consistent with results from past monitoring work that has shown that grass seeding rarely

[4] ERMiT was used to model sediment reduction with production following for the Angora Fire in the Lake Tahoe Basin by the USFS BAER team in 2007. ERMiT was found to under predict sediment yields for untreated sites in the Colorado Front Range (Dr. Lee MacDonald, Colorado State University, electronic communication).

[5] Significant gullies were evident across the basin where concentrated flow had occurred in the past without adequate energy dissipators.

reduces surface erosion the first post-fire winter period (Booker and Dietrich 1998, Beyers et al.1998, Wohlgemeuth et al.1998, Robichaud et al. 2000).

Post-fire erosion was estimated for three sub-watersheds draining the Rice Fire area using the sediment yield estimates produced with the ERMiT model. Using the GIS-determined acreages for low, moderate, and high burn severity, first year post-fire erosion was estimated to be 1.9 t/ac for Rainbow Canyon, 4.3 t/ac for Stewart Canyon, and 0.6 t/ac for Upper Rice Canyon. These estimates are 3.9, 8.5, and 1.2 times higher than the normal sediment production rate for these basins.

Numerous post-fire monitoring studies have documented that a significant percentage of sediment can be expected to occur immediately following the fire (MacDonald et al. 2004). Rice (1975) stated that approximately 70 percent of long-term sedimentation can be expected to occur during the first year after the fire. ERMiT predicts that roughly half of the additional sediment will occur during the first overwintering period (Figure 1).

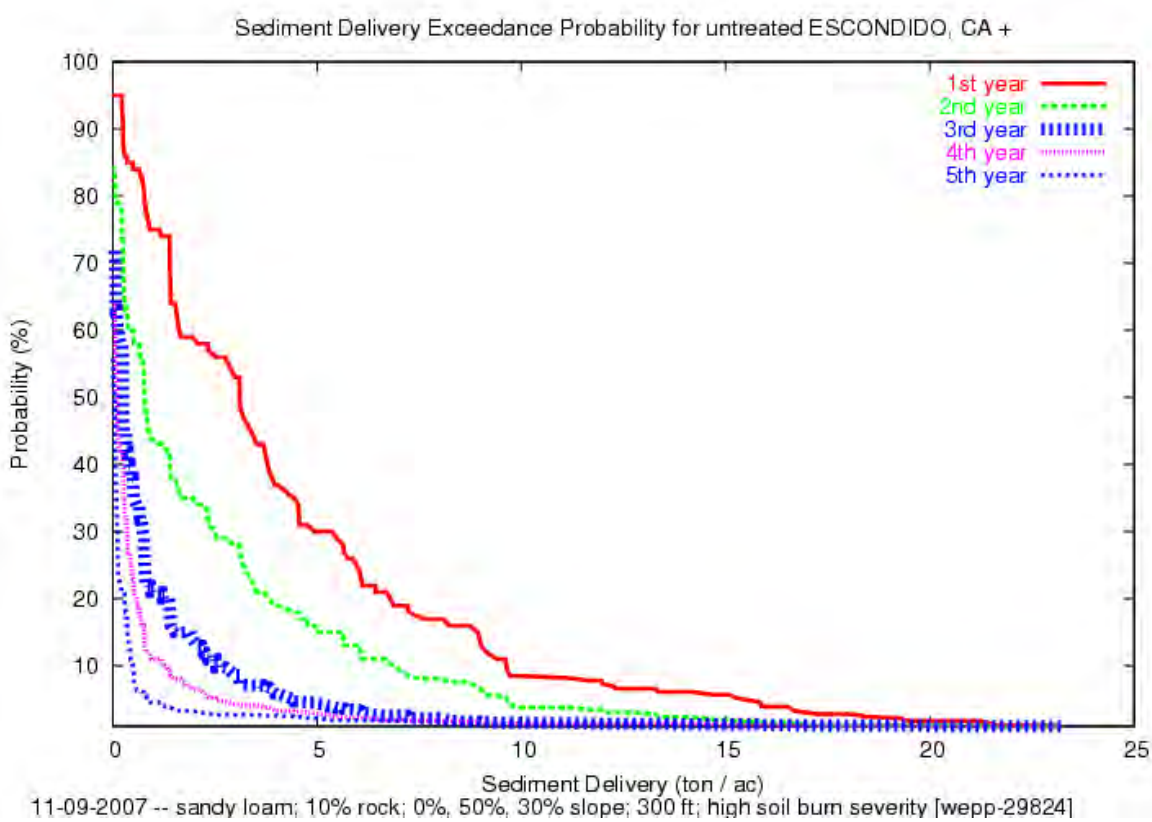


Figure 1. Modeled sediment yield using the ERMiT software program.

Rice Fire Sub-Watersheds-Discharge (cfs)	2-yr Pre-Fire Peak Flow	10-yr Pre-Fire Peak Flow	100-yr Pre-Fire Peak Flow	2-yr Post-Fire Peak Flow	10-yr Post-Fire Peak Flow	100-yr Post-Fire Peak Flow	2 yr Peak Flow X Normal	10 yr Peak Flow X Normal	100 yr Peak Flow X Normal
Upper Rice Canyon	16	103	451	16	104	454	1.0	1.0	1.0
Rainbow Creek	73	556	2649	86	616	2837	1.2	1.1	1.1
Stewart Creek	32	227	1034	47	285	1205	1.5	1.3	1.2

Table 1. Peak discharges for pre and post-fire conditions.

B. Findings of the On-The-Ground Survey

The state Burned Area Emergency Response (BAER) team assigned to the Rice Fire inspected the burned area November 6, 2007 through November 8, 2007, both as an entire team (first day) and with specialist groups (second and third days). All the significant portions of the burn area were observed for potential impacts to soil and water resources, as well as identified values-at-risk. Areas inspected included the Red Mountain Reservoir and its surrounding watershed, the Rainbow Public Utilities District storage reservoirs, the Rainbow Creek watershed, the northern and northwestern parts of fire along the Santa Margarita River, Upper Rice Canyon watershed, and the Stewart Canyon watershed.

2. Resource conditions resulting from the fire

Numerous hydrophobic soil tests were conducted in the Red Mountain Reservoir watershed, western part of Upper Rice Canyon in a burned citrus grove, and the upper part of Stewart Canyon. The general procedure utilized was to scrape the upper layer of ash away with a trowel and test soil for hydrophobicity at the bare mineral soil surface in several locations within a three square foot area. Several additional tests were then conducted at a depth of one to two inches into the soil profile (NRCS 2000). The tests generally revealed high variability in hydrophobic conditions at the soil surface, with high hydrophobicity (water drops remaining on the surface for more than 40 seconds are rated as high and 10 to 40 seconds are considered moderate—Frazier 2002). For several of the sites tested, there was much less severe hydrophobicity at depth.

Hydrophobic soil conditions are commonly produced following wildfire, particularly where coarse textured soils are found. Usually only a thin layer of soil at or below the mineral soil surface becomes hydrophobic after intense heating. The hydrophobic layer is produced when a waxy substance derived

from plant material burned during a hot fire penetrates into the soil as a gas and forms a waxy coating around soil particles (NRCS 2000). Hydrophobic soils repel water, reducing the amount infiltration that can occur into the soil profile, resulting in increased winter peak storm flows and significant soil erosion. Depending on the intensity of the fire, hydrophobic layers can persist for a number of years, especially if they are relatively thick (thicker layers will persist for more than a year). The hydrophobic layer is generally ½ inch to 3 inches beneath the soil surface and is commonly as much as 1 inch thick. On a site specific basis with relatively level or gentle slopes, it is possible to rake or hoe the upper few inches of the soil to break up the water-repellant layer and allow water to penetrate the soil.

3. Consequences of the fire on values at risk are listed below:

    a. Red Mountain Reservoir stores imported water for the community water supply that is isolated and protected from the watershed runoff by existing drainage structures that direct runoff flows around and then away from the reservoir. Steep cut slopes remaining from the reservoir construction are on the east side, and steep natural slopes are on the west side of the reservoir. The watershed that is tributary to the reservoir drainage system (0.25 mi^2) was completely burned with moderate to high severity. If the existing drainage system becomes blocked with sediment and/or debris carried by excess runoff or by slide material from the steep east side slopes during a significant storm, runoff water could back up and overflow into the reservoir. The water supply provided by the reservoir would thereby become polluted by burn area runoff.
    b. Four hilltop reservoirs owned by the Rainbow Municipal Water District were inspected. Erosion on burned embankment slopes was identified as a potential consequence of the fire.
    c. Houses located on erodable slopes and/or adjacent to gullies may be impacted by erosion from increased post-fire runoff.
    d. Residences located within drainages below steep burned slopes may be affected by excess runoff carrying sediment. Falling rocks may become a hazard as soil becomes saturated and erodable.
    e. Kendall Farms warehouse facilities located adjacent to a man-made constriction in the upper Stewart Canyon streambed may be vulnerable to flooding as excess streamflows carrying sediment and/or debris congest the existing upstream culvert and the man-made constriction. Identified residences could be affected by increased flood risk due to burned watershed.
    f. Caltrans Interstate 15 embankments may erode and existing drainages may become overwhelmed as excess inflows resulting from the fire damaged areas carry sediment and/or debris from outside as well as within the Caltrans right-of-way easements.
    g. County-owned roadways such as Old Highway 395, Mission Road, Stewart Canyon Road, and Pankey Road may be subject to inundation

in some areas due to existing drainage structures becoming overwhelmed by increased streamflows carrying sediment and/or debris. The roads could also be impacted by rock falls and earth slides originating from slopes immediately above the roads.

h. Water quality will be affected by polluted water runoff containing ash and soil, as well as hazardous waste runoff from burned homes, vehicles, and public facilities.
i. Increased erosion potential caused by excess runoff from hydrophobic soil conditions and reduced vegetative cover will deplete soil resources.

II. Emergency Determination – An emergency exists to human life, property, water quality, and soil resources, due to increased runoff, sedimentation, and erosion, and decreased control of water.

III. Treatments to Mitigate the Emergency (Type, Objective, Description, Cost) at each Value at Risk

A. Red Mountain Reservoir — possible emergency
   a. Type: Silt fencing, straw bale dikes, sand bagging, K-rails. Trash rack protection at pipe/culvert intakes. Monitor and maintain drainage structures and channels free of debris before, during, and after rainstorm events.
   b. Objective: Protect drainage facilities from sediment/debris obstruction and prevent runoff flows from entering the reservoir.
   c. Description: Place silt fencing, straw bale dikes, filled sandbags, and K-rails to direct sediment/debris flows away from drainage structures and deflect excess runoff from entering the reservoir. Installation direction is provided in NRCS publications that are attached to this report (www.ca.nrcs.usda.gov). Trash rack protection upstream of drainage pipes and culverts should deny entry of debris large enough to lodge within the pipe or culvert. Crews should be dedicated to monitoring and maintaining the drainages free of obstruction.
   d. Cost: Cost will vary depending on method used. Judgment is needed to provide effective choice and placement of mitigation measures and needs may vary over the site. Monitoring and maintaining the drainage facilities free of obstruction are to be provided by the Fallbrook PUD (owner) forces.

B. Rainbow Municipal Water District Reservoirs — not an emergency
   1. Type: Jute netting, fiber rolls, hydromulching.
   2. Objective: Prevent erosion of dam embankment slopes.
   3. Description: Place jute netting, fiber rolls, hydromulching on burned slopes to prevent erosion. Installation direction is provided in

NRCS publications that are attached to this report (www.ca.nrcs.usda.gov).

4. Cost: Cost will vary depending on method used and area covered.

C. Houses located on erodable slopes — some locations are an emergency—see Appendix D (Geologist Report) for specific information

1. Type: Sand bags, straw bale dikes, v-ditching, diversion ditching, fiber rolls, jute netting, coconut fiber mats, retaining walls, deflector walls, riprap, mulching, hydromulching. Use of San Diego County Flood Control District system ALERT rain gages for early warning from severe storm events.[6]
2. Objective: Prevent soil loss and erosion and/or slope instability that may lead to undermining the structure foundation.
3. Description: Place sand bags, straw bale dikes, v-ditching, diversion ditching, and deflector walls to control excess runoff. Place straw bale dikes, fiber rolls, jute netting, coconut fiber mats, riprap, mulching hydromulching to prevent progressive erosion on slopes. Installation direction is provided in NRCS publications that are attached to this report (www.ca.nrcs.usda.gov).
4. Cost: Cost will vary depending on site and slope conditions, area covered, and pre-existing conditions.

D. Houses located in drainages below steep, burned slopes — some locations are an emergency — see Appendix D (Geologist Report) for specific information

1. Type: Obtain professional assessment of landslide risk. Awareness of the hazard and evacuation plan. Retaining walls, deflection walls, sand bags, straw bale dikes, v-ditching, diversion ditching, fiber rolls, jute netting, coconut fiber mats, debris fences, mulching, hydromulching. Removal/modification of hazardous obstructions in drainages.
2. Objective: Prevent soil loss and runoff, erosion, and/or slope instability that may affect the structure. Protect the structure from runoff, debris slide, mudflow, or landslide.
3. Description: Be prepared, place erosion and landslide deflection devices as prescribed by a hired state-licensed engineering geologist, and the NRCS or California Geological Survey (CGS) publications (see

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[6] San Diego County Flood Control District operates two ALERT rain gages in the Fallbrook area. ALERT systems are used to provide real-time flood warning to local communities at risk from flooding threat. Changes in rainfall levels throughout San Diego County are transmitted by radio to mountaintop repeaters, which in turn relay the transmission to the District Flood Warning office in Kearny Mesa. The radio signals are intercepted and also relayed by independent radio repeaters to the National Weather Service in San Diego.

attached CGS Note 33). Evaluate man-made obstructions in drainages.

4. Cost: Cost will vary depending on existing conditions and professional assessment.

E. Buildings in and adjacent to creek/flood channels — possible emergency

1. Type: Early warning devices such as San Diego County operated ALERT rain gauges. Trash rack protection of drainage culverts/pipes. Monitor and maintain drainage and debris catchment structures before and after storm events to keep them clear of sediment and debris. Evacuation plan and recognition of potential hazards. Other measures developed by the appropriate public emergency services. See Engineer's Report (Appendix B).
2. Objective: To the extent possible, prevent loss of life and property in flood channels.
3. Description: Utilize existing early warning devices (ALERT rain gauges) in the Fallbrook area during the rainy season per professional assessment and have an evacuation plan. Design and install trash racks and sediment/debris catchment basins per professional assessment. Develop evacuation plans and educate the public regarding potential flood hazards. Involvement of appropriate public emergency services is recommended.
4. Cost: Unknown, but potentially significant.

F. Interstate Highway 15 — possible emergency — currently being addressed by Caltrans

1. Type: Fiber rolls, hydroseeding/hydromulching. Trash rack protection of drainage culverts/pipes. Monitor and maintain drainage and debris catchment structures before and after storm events to keep them clear of sediment and debris. Recognition of potential hazards to the public and a highway closure plan. Other measures developed by the appropriate public emergency services organizations. Public education to reduce sediment/debris impacts from outside the Caltrans easement.
2. Objective: Prevent erosion and debris slides affecting the highway and easements, and minimize sediment/debris runoff (bulking) impacts to the highway drainage systems. Prevent potential hazards to the public in case of debris slides and drainage system failure.
3. Description: Install erosion control measures, and sediment/debris control structures per professional assessment. If not already in place, develop highway closure plan if potential hazards are identified.
4. Cost: Variable depending on the area size and number of affected drainage structures. Cost will be significant due to the large area affected.

G. County Roadways possible emergency currently being assessed and addressed by San Diego County Public Works Department

1. Type: Fiber rolls, hydroseeding/hydromulching, K-rails, sandbagging. Trash rack protection of drainage culverts/pipes. Monitor and maintain drainage and debris catchment structures before and after storm events to keep them clear of sediment and debris. Recognition of potential hazards to the public and a road closure plan. Other measures developed by the appropriate public emergency services organizations. Public education to reduce sediment/debris impacts from outside the roadway easements.
2. Objective: Prevent erosion and debris slides affecting the roads and easements, and minimize sediment/debris runoff (bulking) and overflow impacts to the road drainage systems. Prevent potential hazards to the public in case of debris slides and drainage system failure.
3. Description: Install erosion control measures, and sediment/debris control structures per professional assessment. If not already in place, develop road closure plans if potential hazards are identified.
4. Cost: Variable depending on the area size and number of affected drainage structures. Cost will be significant due to the large area affected.

H. Water Quality Impacts

1. Type: Public education regarding removal of burned hazardous waste, erosion protection, water control, public services support for removal of hazardous waste (San Diego County is a resource for this). Other measures developed by the appropriate public services.
2. Objective: Protect water quality to the extent possible from polluted water runoff containing ash and earth, as well as hazardous waste runoff from burned homes, vehicles, and public facilities, particularly in the 303(d) listed Rainbow Creek drainage.[7]
3. Description: To the extent possible reduce water quality impacts by providing education and support to the public in this regard.
4. Cost: Unknown.

I. Soil Resources

1. Type: Public education regarding erosion protection, water control, removal of burned hazardous waste, and public services support for

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[7] The California Regional Water Quality Control Board, San Diego Region (Regional Board) has adopted Total Maximum Daily Loads (TMDLs) for Total Nitrogen and Total Phosphorus to address water quality impairments in Rainbow Creek. A TMDL allocates pollution control responsibilities among pollution sources in a watershed, and is the basis for taking the actions needed to restore a water body.

removal of hazardous waste (San Diego County is a resource for this). Other measures developed by the appropriate public services. NRCS will be an invaluable resource for protection of soil resources.

2. Objective: Protect soil resources to the extent possible from excess runoff, pollution, and erosion.
3. Description: To the extent possible reduce impacts to soil resources by providing education and support to the public.
4. Cost: Unknown.

IV. Discussion/Summary/Recommendations

The Rice Fire burned at relatively low intensity through an area in northern San Diego County with wildlands, agriculture, and housing developments. Expected changes in peak discharges are fairly small for the larger subwatersheds modeled, but can be considerably higher for much smaller basins (250 acres) that burned with at least moderate severity. Sediment yields for the first winter are projected to be significantly increased, even for two of the three larger subwatersheds. If localized hillslope sediment reduction is attempted, straw mulch application is recommended.

A number of values-at-risk were identified by the BAER team assigned to the Rice Fire burn area. The most concern centered on the Red Mountain Reservoir and the upper Stewart Canyon area occupied by Kendall Farms. The team recognizes that, in some cases, some treatments may not be implemented in a manner timely enough to reduce the risk human life and property, water quality, and soil resources. Most of the values-at-risk are not an immediate threat to lives or property. However, several houses were located that do present a substantial risk and are addressed in considerable detail in the Geologist's report.

The state BAER team recognizes that a continuing effort is being undertaken by the County to identify specific values at risk, several of which are addressed in this overview report. Both the County and Caltrans have already taken steps identified above, and perhaps additional steps, to mitigate the impacts of the Rice Fire.

References

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Beyers, J.L., P.M. Wohlgemuth, C.D. Wakeman, and S.G. Conard. 1998. Ryegrass seeding for postfire erosion control in chaparral—does it work? Fire Management Notes. 58: 30-34.

Booker, F.A. and W.E. Dietrich. 1998. Landscape and management response to wildfires in California. Draft Final Report submitted to the California Department of Forestry and Fire Protection for Contract No. 8CA98629. Sacramento, CA. 34 p.

Frazier, J. 1989. Burn severity criteria. USDA Forest Service - Burned Area . Unpublished USFS note. 1 p.

Larsen, I.J., L.H. MacDonald, P.R. Robichaud, and W.J. Elliot. 2007. Predicting post-fire sediment yields on a probabilistic basis: Testing the Erosion Risk Management Tool (ERMiT) in the Colorado Front Range. Unpublished draft paper. 41 p.

MacDonald, L. H., D.B. Coe, and S.E. Litschert, 2004. Assessing cumulative watershed effects in the central Sierra Nevada: hillslope measurements and catchment-scale modeling, pp 149-157. IN Murphy, D. D. and P. A. Stine Editors. 2004. Proceedings of the Sierra Nevada Science Symposium; 2002 October 7-10; Kings Beach, CA; Gen. Tech. Rep. PSW_GTR-193. Albany, CA. Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture; 287 p.

Natural Resources Conservation Service (NRCS). 2000. Soil quality resources: hydrophobicity. Soil Quality Information Sheet. United States Department of Agriculture. http://soils.usda.gov/sqi/files/SQIShydrophob.pdf

Neary, D.G.; Ryan, K.C.; DeBano, L.F., eds. 2005. Wildland fire in ecosystems: effects of fire on soils and water. Gen. Tech. Rep. RMRS-GTR-42-vol.4. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 250 p.

Parsons, A. 2003. Burned area emergency rehabilitation (BAER) soil burn severity definitions and mapping guidelines. USDA Forest Service unpublished document. 12 p.

Rice, R.M. 1975. Sowing ryegrass on burned watersheds may be a mistake. Unpublished paper. 18 p.

Robichaud, P.R., J.L. Beyers, and D.G. Neary. 2000. Evaluating the effectiveness of postfire rehabilitation treatments. Gen. Tech. Rep. RMRS-GTR-63. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 85 p. http://www.fs.fed.us/rm/pubs/rmrs_gtr63.html

Robichaud, P.R.; Elliot, W.J.; Pierson, F.B.; Hall, D.E.; Moffet, C.A. 2006. Erosion Risk Management Tool (ERMiT) Ver. 2006.01.18. [Online at <http://forest.moscowfsl.wsu.edu/fswepp/>.] Moscow, ID: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station.

Robichaud, P.R.; Elliot, W.J.; Pierson, F.B.; Hall, D.E.; Moffet, C.A.; Ashmun, L.E. 2007. Erosion Risk Management Tool (ERMiT) user manual (version 2006.01.18). Gen. Tech. Rep. RMRS-GTR-188. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 24 p.

Rowe, P.B., C.M. Countryman, and H.C. Storey. 1949. Probable peak discharges and erosion rates from southern California watersheds as influenced by fire. USDA Forest Service. California Forest and Range Experiment Station, Berkeley, California. 305 p.

Waananen, A.O., and J.R. Crippen. 1977, Magnitude and frequency of floods in California: U.S. Geological Survey Water-Resources Investigations Report 77-21, 96 p.

Wohlgemeuth, P.M., J.L. Beyers, C.D. Wakeman, and S.G. Conard. 1998. Effects of fire and grass seeding on soil erosion in southern California chaparral. In: Proceedings, nineteenth annual forest vegetation management conference: wildfire rehabilitation, January 20-22, 1998. Redding, CA: Forest Vegetation Management Conference: 41-51.

Appendix F

BIOLOGICAL RESOURCES
RICE FIRE

NOVEMBER 2007
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I. Potential Values at Risk

The Rice Fire burned approximately 9,500 acres near the town of Fallbrook in northeast San Diego County. Two HUC 6 watersheds were within the burn area. In the northern area of the burn the Santa Margarita/Sandia HUC 6 watershed drains into the Santa Margarita River and in the southern area of the burn the San Luis Rey HUC 6 watershed drains into the San Luis Rey River. The initial review of biological resources included producing a Cal Veg GIS map, a California Natural Diversity Database (CNDDB) map of sensitive species occurrences within the burn area, and a fire severity map. Maps were provided by Cal Fire GIS specialists and CDFG GIS specialists. The Biological Information Observation System (BIOS) was referenced on line by CDFG staff (CNDDB information). The Cal Veg vegetation community map when integrated with the fire polygon map illustrated that approximately 2,200 acres burned of California sagebrush (this classification includes coastal sage scrub), 1,500 acres burned of northern mixed chaparral, 250 acres burned of mixed riparian hardwood, 400 acres burned of coast live oak, 120 acres burned of willow, 4 acres burned of coastal bluff scrub, 600 acres burned of annual grass/forb, as well as agricultural lands (approximately 3,400 acres burned) and Eucalyptus stands (approximately 8 acres) burned during the Rice Fire (see Rice Fire Vegetation Map). These vegetation communities support a host of wildlife and plant species, including Sensitive species. San Diego County has a Natural Community Conservation Plan that is being drafted for the north county called North County Multi-species Conservation Plan (NCMSCP). This Draft Sub-Area Plan (SAP) has a list of sensitive species within its purview. The species on this list are called covered species and were included in the assessment. Records for 14 sensitive plants and animals were identified by the CNDDB and the NCMSCP within the Rice Fire polygon.

II. Resource Condition Assessment

A. Resource Setting

On 22 October 2007, a fire started that consumed approximately 9,5000 acres in North East San Diego County east of the town of Fallbrook, California. The Rice

Fire burn site is located 10 to 12 miles inland and varies in elevation from approximately 300 to 1,550 ft.. The location has average annual rainfall of approximately 16 inches. Temperatures vary from 35 degrees F to the low l00s. The area has a Mediterranean climate with hot summers and mild winters with some maritime influence.

The area supports several upland and lowland riparian types ranging from xeric to mesic and freshwater communities (see Rice Fire Vegetation Map). The vegetative community types that occur within the boundaries of the Rice Fire include both upland and lowland types. Upland types are those at higher and dryer locations (generally more fire prone) that contain plants of a more xeric nature (i.e., those that are adapted for drought during part of their life cycles). They include coastal sage, mixed chaparral, oak scrub, oak forest, oak woodland, other woodland, and grassland communities. Most impacts to these habitats are expected to be direct and will depend on tolerance to fire (e.g., resprouting potential or geophytic or fossorial habit that may have insulated some plants and animals from the fire; or mobility to avoid the direct effects). Indirect effects to animals in this type are expected to be mostly a function of loss of habitat.

There is a large suite of wildlife and plants that reside in upland habitat types. However, this burn assessment will only list Sensitive species (as defined by the CNDDB and the NCMSCP list of covered species) that occurred within the burn.

The Sensitive species of coastal sage scrub (CSS) is California gnatcatcher (*Polioptila californica californica*)(FT/CSC/-/1). Species that may be found in CSS but also intergrade into mixed chaparral, oak scrub, and grassland communities are: rufous-crowned sparrow (*Aimiophila ruficepis canescens*); (FSC/CSC/-/1); red diamond rattlesnake (*Crotalus rubber rubber*)(FSC/CFC/-/2); coast horned lizard (*Phrysnosoma coronatum*)(FSC/CFC/-/2); orange-throated whiptail (*Cnemidophorus hyperythrus*)(FSC//-/2); California pocket mouse (*Chaetodipus californicus femoralis*) and; rosy boa (*Chorina trivirgata*).

Sensitive upland plants within the reach of the fire include: yellow pincushion (*Chaenactis glabruscula orcuttiana*)(-/-/1B-), Rainbow manzanita (*Arctostaphylos rainbowensis*)(-/-/1B/A), Orcutt's brodiaea (*Brodiaea orcutti*)(FSC/-/1B/ A); and Parry's tetrococcus (*Tetracoccus dioicus*)(FSC/-/1B/A).

Lowland types are habitats that consist of wetter or more mesic, lower elevation environs associated with watershed drainages, such as riparian woodland, riparian scrub, and freshwater marsh. They are expected to show primarily indirect effects because direct effects to the habitats, in general, where more minimal due to less flammability of vegetation and so there was less outright loss of habitat. However, indirect affects will occur, subsequently, due to runoff and erosion and will be concentrated in the downslope drainage basins.

There is a large suite of animals and plants that reside in lowland environments for a least part of their life cycles. Only the list of Sensitive species , from the CNDDP and NCMSCP list of covered species, for this habitat type follows: least Bell's vireo (FE/CE/-/1), arroyo toad (*Bufo californicus*) and, arroyo chub (*Gila orcutti*).

Federal Listing Status	State Listing Status	California Native Plant Society	Sensitive Animals, County of San Diego
FE Federal Endangered FT Federal Threatened FSC Federal Species of Concern	CE California Endangered CT California Threatened CFP California Fully Protected CSC California Species of Special Concern CR California Rare CSP California Specially Protected	1B Considered rare, threatened, or endangered in California	1 Animals of high sensitivity 2 Animals declining

It appears that the Rice Fire is entirely contained within the boundaries of the NCMSCP. This Natural Community Conservation Plan (NCCP) is subdivided into areas that are designated for present or future conservation and are defined in relation to the Pre-Approved Mitigation Areas (PAMA). Types of conservation zoning that occur within the burn area are identified by the following categories: Existing Agriculture important for Preserve Design, Existing Agriculture Outside PAMA, Hardlined Preserve Area, Natural Upland Habitats outside PAMA, Natural Habitats within PAMA, Riparian/Wetland Habitat outside PAMA, Riparian/Wetland Habitat inside PAMA and Open Space Easement Outside PAMA (NCMSCP). These areas are specified in relation to their biological preservation value.

B. Findings of the Ground Surveys

1. Resource Condition Resulting from the Fire

The Rice Fire burned primarily with low to moderate intensity. Some of the areas that burned at high intensity will require post fire monitoring to evaluate native plant regeneration, soil erosion rates, and exotic plant species invasion. Many of the native plant communities within the burn area have evolved under a fire regime and will regenerate naturally within 2-3 years to a moderately functioning condition. The wildlife habitat lost in the Rice Fire has caused mobile wildlife species to be displaced. As vegetation communities re-colonize following a natural succession of regeneration, wildlife species will reoccupy the burned area. Plant communities with a variety of age classes arranged in a mosaic throughout the landscape, often caused by how fires burn over a landscape, provide for high plant and animal diversity.

2. Consequences of the Fire on Values at Risk

Many plant communities burned during the Rice Fire will naturally regenerate over time because they are adapted to fire. Most of the Rice Fire burned with a low to moderate intensity that will allow successful natural plant regeneration both from seeds left in the seed bank within the soil and from root-crown sprouting. Areas that burned severely are at risk of poor natural plant regeneration and may have high rates of soil erosion. These areas need to be monitored and erosion control actions need to be implemented if these conditions are observed. Also, invasive plant species expansion is common following disturbances such as fire. For example, within some perennial drainages, the above ground plant material of *Arundo donax* was observed burned to a high degree, yet the below ground rhizomes, left untreated, have potential to regenerate robust stands that will further expand. There is an opportunity to control *Arundo donax* with post-burn treatment methods as provided by NRCS and San Diego County. Native riparian vegetation has been shown to be less restrictive to flow events than exotic vegetation stands such as Arundo as well as providing valuable wildlife habitat resources.

Ash and other sediment/nutrient loads will be washed and blown into ephemeral and perennial streams. This will increase the Total Maximum Daily Loads (TMDLs) for total nitrogen and phosphorus, Total Dissolved Solids (TDS), Total Suspended Solids (TSS) within the water courses and will cause short term water quality impacts that could impact aquatic species. Rainbow Creek and Santa Margarita River support resident fish populations of arroyo chub (*Gila orcutti*) which are California Species of Special Concern (CSC), as well as native amphibians that may be impacted by excessive nutrient loads (WQCB 2006). San Luis Rey River supports a population of arroyo toad and may be impacted by excessive nutrient levels as well.

Most of the riparian habitat within and along streams burned at a lower intensity during the Rice Fire and many of these habitats will recover within 2-3 year time frame to a moderately functional level. As upland vegetation regenerates within the watersheds, the native plant associations will again act to filter and hold sediments and water quality will improve. Areas that were identified as severely burned should be monitored and adaptively managed to ensure native plant regeneration. If areas are identified during the post fire monitoring program that are not naturally regenerating due to a lack of seed source or damaged top soils, erosion control measures such as hydro mulching are recommended.

III. Emergency Determination

There has been a loss of native plant communities and associated wildlife within the Rice Fire but the impacts should be of a temporary nature only. Emergency actions are not recommended for natural resource conservation at this time. Actions taken to mitigate erosion and sediment flows to protect lives and property

will be designed to include plant regeneration measures in order to hasten stability of watersheds within the Rice Fire area. In order to facilitate winter rain containment, perennial and ephemeral streams that will require vegetation removal, should be coordinated through San Diego County and NRCS staff. These streambed remedial activities will require expedited Streambed Alteration Agreement (SAA) processing through the CDFG Southcoast Region 5 Office. Guidelines and Best Management Practices (BMPs) are currently being developed by CDFG in order to process Emergency Exemptions for SAA Permits and California Endangered Species Act (CESA) incidental take permits (858-467-4201).

IV. Treatments to Mitigate the Emergency

A. Treatment Type

Post Fire Monitoring: The following areas were identified during the post-fire assessments as at-risk of poor native plant regeneration due to burn severity and may exhibit high rates of erosion and were recommended as areas for monitoring: (1) Red Mountain adjacent to the reservoir; (2) Northern Stewart Canyon Road, Kendall Farms; (3) Southern Stewart Canyon Road, western facing slopes adjacent to Interstate Hwy 15. (4) Northern slopes draining into the Santa Margarita River along Stage Coach Rd.; (5) Rainbow Valley south facing slopes along Willow Glenn Rd.; (6) Tecolate Dr., south and west slopes east of trailer park; (7) Southern Monserate Mountain, west of Rice Canyon Rd, along road up to water tank.

B. Treatment Objective

Identify areas having poor native plant regeneration and showing signs of excessive soil erosion. Identify areas of increased exotic plant cover. Identify areas that exhibit below normal seasonal water quality standards.

C. Treatment Description

Monitor side-slopes using ocular plant cover estimates and plant species composition on a site specific basis to identify areas of poor plant regeneration and areas showing signs of excessive soil erosion. These areas may benefit from hydro-mulching to stabilize soils on slopes. Remedial actions should be initiated through the San Diego County Environmental Office and the Natural Resource Conservation Service (NRCS). We recommend monitoring monthly and immediately following significant rainfall events. At the end of an initial monitoring period an evaluation should be made to determine the course of action.

Water quality should be monitored at intervals along and down stream of the burn perimeter of the Santa Margarita River, Stewart, Rainbow, and Rice Creeks,

and at the confluence of Stewart Creek and the San Luis Rey River. Monitoring should be coordinated through the Regional Water Quality Control Board.

V. Discussion/Summary/Recommendations

In summary, the Rice Fire consumed approximately 9,500 acres including valuable upland and lowland habitat types that supported 14 Sensitive species. Most of the vegetation communities that were affected by the Rice Fire and associated wildlife have evolved with periodic fires and will naturally regenerate within a few years. Our preliminary assessment suggests that due to the magnitude of this fire plants or animal species have not been impacted to the extent necessary to cause significant harm to populations and species.

Three primary categories of threats to wildlife and habitats were identified within the Rice Fire that prompted recommendations for monitoring and adaptive management. They are the following: (1) Direct affects of erosion. (2) Siltation and nutrient loads. (3) Exotic plant invasions. We have incorporated monitoring and adaptive management recommendations to mitigate the negative impacts of the burn on sensitive habitats and wildlife.

VI. References

BIOS, Biological Information Observation System, California Department of Fish and Game, Sacramento, California.

California Natural Diversity Database, California Department of Fish and Game, Sacramento, California.

California Regional Water Quality Control Board San Diego Region. 2006. Basin Plan Amendment and Final Tech. Rpt. TMDLs for Rainbow Creek.

Draft North San Diego County Multi-Species Conservation Plan. 2007. San Diego County, California.

Peter R.Robichaud, Jan L. Beyers, and Daniel G. Neary. 2005. USDA Forest Service Gen. Tech. Rep. RMRS-GTR-42-vol.4. 2005

VII. Maps

Cal Veg Map attached.

Rice Fire Representative Photos

Photo 1. Red Mountain Reservoir, storage tank, and upper watershed.

Photo 2. Red Mountain Reservoir, tank, and west side watershed.

Photo 3. The Red Mountain Reservoir watershed was completely burned. BAER team on site.

Photo 4. Houses at risk below burned steep slope drainage above North Stagecoach Road and the Santa Margarita River.

Photo 5. Low burn severity in the Santa Margarita River Canyon below burned slopes.

Photo 6. View of a portion of the Santa Margarita watershed showing mosaic of low to high severity burns.

Photo 7. The Kendall Farms warehouse facility adjacent to a constriction in the Stewart Canyon drainage.

Photo 8. Interstate Highway 15. Caltrans has installed straw waddles and hydroseed for erosion control on highway embankments.

Photo 13. Upper Stewart Canyon.

What Is ALERT?

ALERT systems are used around the world to provide real-time flood warning to local communities at risk from flooding threat.

An ALERT system is characterized by its real-time nature, accomplished by the instantaneous transmission of weather events primarily by radio transmission, and to a lesser extent by satellite, telephone, and cell phone transmission. Changes in rainfall, stream, weather and lake levels throughout San Diego County are transmitted by radio to mountaintop repeaters, which in turn relay the transmission to our District Flood Warning office in Kearny Mesa. In Kearny Mesa, the radio signals are intercepted and also relayed by independent radio repeaters to the National Weather Service (NWS) in San Diego. This data is received by ALERT computers which check the data for validity, check against established warning criteria for that data, update any displayed maps, then place the data into a database. If any warning criteria are met, the computers will put out a visible, audible, and/or pager warning.

In San Diego County, a partnership has evolved between the Flood Control District (FCD), the NWS, and the County Office of Emergency Services (OES). The FCD is responsible for the maintenance and operation of the ALERT Flood Warning System. When flooding conditions develop, the FCD evaluates the flooding potential presented by the ALERT data and advises the NWS and OES on possible flooding in the County. The NWS will complete the assessment of flooding potential using their resources and will issue a forecast update, special weather statement, flash flood watch, or flash flood warning. OES will pass along the NWS warnings and watches to relevant agencies within San Diego County and will coordinate Disaster Relief Operations whenever necessary.

Because of its nature, the ALERT system can monitor anything that provides a contact closure, a voltage range of 0-5 volts, or a current range of 4-20 mA. This makes it ideal not only to provide real-time flood warning, but can also monitor water resource parameters such as: winds, temperature, humidity, barometric pressure, groundwater levels, soil moisture, fuel moisture, water temperature, water quality, and evaporation. ALERT field transmitters with control capability can also perform physical functions such as activating low water crossing flood warning gates and signals, raising flood control barriers, or setting off warning sirens.

Protecting Your Property From Soil Erosion

Early Action Plan: Best Management Practices (BMPs) for Post-Fire Runoff, Erosion, and Sediment Control

Many property owners in San Diego County are working to protect their homes from mudslides and flooding. Planning ahead goes a long way toward preventing property damage.

The purpose of an **Early Action Plan** is to implement runoff, sediment, and erosion control measures to provide interim protection from the first runoff-producing rains following a fire. **Early Action Measures** – also known as **Best Management Practices (BMPs)** - are those practices that can be implemented using available work force crews (primarily manual labor), and which focus on sediment and debris control. These measures are intended to provide practical, preliminary protection in critical areas while a more comprehensive area Phase I Hazard Mitigation Plan is implemented on the surrounding area.

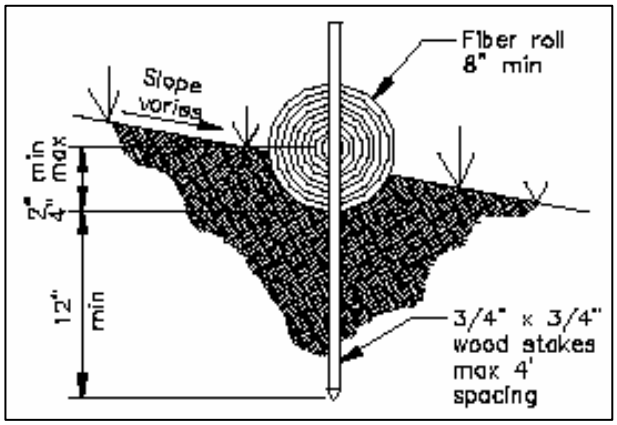
The County of San Diego has compiled a list of Early Action Measures that can be implemented by property owners immediately after a fire when rains are imminent. The description, installation, and operation of these practices are adapted from the Caltrans Stormwater Quality Handbooks: *Construction Site Best Management Practices (BMPs) Manual.* These Early Action Measures should be considered as tools that can be selected for the most appropriate runoff, sediment, and erosion control based on site conditions.

One of the most appropriate BMPs following a wildfire is preservation of existing vegetation. Whether ***burned or unburned****, the roots of vegetation hold the soil together. Tree removal activities in the fall and winter following a fire will disturb soil at a time of the year when it is most vulnerable to erosion. Unless trees or shrubs pose an imminent hazard to health and safety, it is recommended that property owners leave them in place.*

It is also important that public and volunteer laborers who wish to implement BMPs have an understanding of how to properly install and maintain them.

Straw Fiber Rolls consist of straw that is compacted into plastic netting to form a tube, usually with standard dimensions of 9 inches in diameter by 25 feet long. Fiber rolls have a number of applications:

- Across slope faces to shorten slope length, reduce runoff velocity, and retain sediment;
- Along the toe and top of slopes to spread runoff as sheet flow;
- As check dams in channels and drainage ways; and
- Along the perimeter of fire-affected lots to retain ash and sediment.



There are a few keys to fiber roll installation:

1) They should be trenched according to the manufacturer's instructions;
2) They should be held in place using wooden stakes;
3) They should be inspected when rain is forecast;
4) They should be repaired or replaced when split or torn; and
5) Ash and sediment should be removed when it reaches ¾ of the roll height.

Straw Mulching consists of placing a uniform layer of weed-free straw on the surface of the soil to prevent erosion. Straw is a temporary cover that reduces rainfall impact, conserves moisture, and moderates temperature – all things that are beneficial for plant growth.

Usually, 2-3 inches of mulch is a sufficient depth and approximates around 2 tons per acre. The fibers can be held in place by "punching" them into the ground with a spade.

Sand Bag Barriers are constructed of plastic, geo-textile bags filled with sand. A sand bag barrier is a temporary linear sediment barrier consisting of stacked sandbags designed to intercept and divert flow away from property and infrastructure.

Sand bags ***should not*** be placed on slopes as a substitute for fiber rolls or around foundations where free drainage is required (see gravel-filled burlap bags below).

Gravel Bag Berms (SC-06) consist of a single row of gravel-filled burlap bags, installed end-to-end to form a barrier across a slope or to intercept runoff, reduce its velocity, and settle out sediment and ash. Gravel bags can also be used where flows are moderately concentrated, such as ditches and swales.

The most common use of gravel bags in fire-affected urban areas is to retain debris within a property or foundation to enable demolition and to keep materials from clogging municipal storm drains.

Gravel bags should be filled 1/3 full with ¾ inch angular rock with the loose flap of fabric folded over in the direction of water flow.

For more information or assistance about erosion and sediment control measures, call the County Stormwater Hotline:
1-888-846-0800
Or visit our website at www.sdcountyrecovery.com

California Geological Survey

CGS Note 33

Hazards From "Mudslides"...Debris Avalanches and Debris Flows in Hillside and Wildfire Areas

- ***The single most important action that should be taken by residents on rainy nights is NOT to sleep in lower-floor bedrooms on the sides of houses that face hazardous slopes.***
- ***More than 100 Californians have been killed by debris flows during the past 25 years.***
- ***Most of these 100 deaths occurred when debris flows buried persons who were sleeping in lower-floor bedrooms that were adjacent to hazardous slopes.***

Sudden "mudslides" gushing down rain-sodden slopes and gullies are widely recognized by geologists as a hazard to human life and property. Most "mudslides" are localized in small gullies, threatening only those buildings in their direct path. They can burst out of the soil on almost any rain-saturated hill when rainfall is heavy enough. Often they occur without warning in localities where they have never been seen before.

The ashy slopes left denuded by wildfires in California are especially susceptible to "mudslides" during and immediately after major rainstorms.

Those who live downslope of a wildfire area should be aware of this potential for slope failure that is present until new vegetation rebinds the soil.

What Are Debris Avalanches and Debris Flows?

Debris avalanches and debris flows (both popularly called "mudslides") are shallow landslides, saturated with water, that travel rapidly downslope as muddy slurries. The flowing mud carries rocks, bushes, and other debris as it pours down the slopes.

A debris avalanche (Figure 1) is a fast-moving debris flow that travels faster than about 10 mph or approximately 25 yards in about 5 seconds. Speeds in excess of 20 mph are not uncommon, and speeds in excess of 100 mph, although rare, do occur locally.

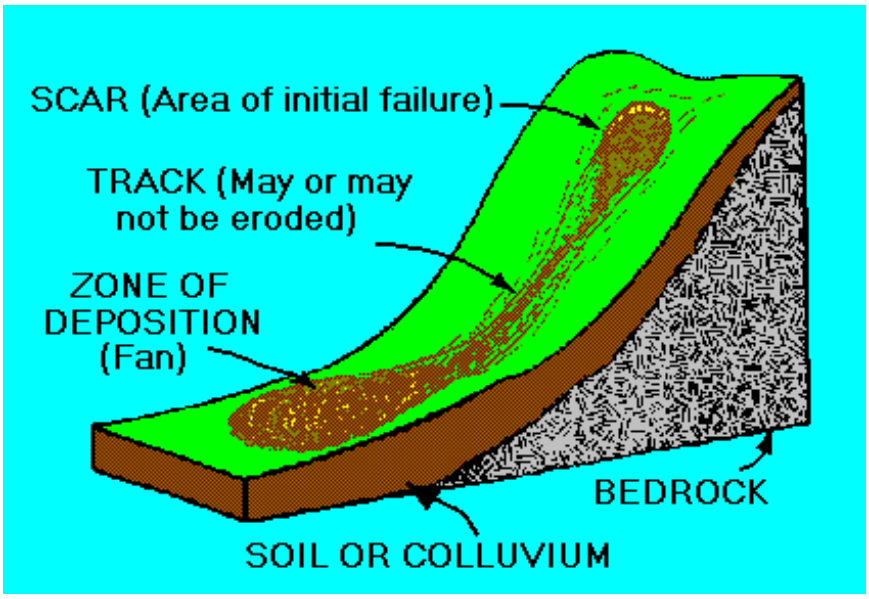


Figure 1. Sketch of a typical debris avalanche scar and track. Although this figure shows the "zone of deposition" as quite near the source, debris avalanches can travel thousands of feet or, in exceptional cases, miles from the point of origin. Original drawing by Janet K. Smith.

What Dangers Are Posed by Debris Avalanches?

Debris avalanches pose hazards that are often overlooked. Houses in the path of debris avalanches can be severely damaged or demolished. Persons in these structures can be severely injured or killed.

Most rainstorms are of such low intensity that they do not trigger debris avalanches. Some intense storms may trigger only a few debris avalanches. However, when the ground is already saturated from previous rain, even relatively short high-intensity rainstorms may trigger debris avalanches. For example, in January 1982, an intense rainstorm triggered literally tens of thousands of debris avalanches in the San Francisco Bay Area. These 1982 debris avalanches caught people unaware and caused 14 deaths and many injuries and destroyed or damaged several hundred homes and other structures.

What Causes Debris Avalanches and Debris Flows?

The most common cause of debris avalanches and debris flows is the combination of heavy rainfall, steep slopes, and loose soil. Most fairly steep slopes have enough soil and loose rock for potential landslides. Although "stable" when dry, such slopes can produce local debris flows, often without warning.

Normally the source of the excess water is intense rainfall, although broken water pipes or misdirected runoff concentrated by roads, roofs, or large paved areas may trigger, or help to trigger, debris avalanches and debris flows. In California, most debris flows occur during wet winters.

Where Do Debris Flows and Debris Avalanches Occur?

Debris avalanches occur all over the world. They are particularly common in mountainous areas underlain by rocks that produce sandy soils. Debris avalanches have been noted in southern California during at least nine rainy seasons since 1915. They have occurred in northern California during at least 14 rainy seasons since 1905.

Debris flows are known to start on slopes as low as 15 degrees, but the more dangerous, faster moving flows (debris avalanches) are more likely to develop on steeper slopes. About two-thirds of all debris avalanches start in hollows or troughs at the heads of small drainage courses. Typically, a debris avalanche bursts out of a hillside and flows quickly downslope, inundating anything in its path. Because the path of a debris flow is controlled by the local topography just like flowing water, debris avalanches and debris flows generally follow stream courses.

Slopes burned by range and forest fires are especially susceptible to debris avalanches and debris flows because of the absence of vegetation and roots to bind the soil. The areas directly downslope are especially subject to damage from debris flows.

What Can Be Done to Avoid or Reduce the Hazard Posed by Debris Avalanches?

To be safe, assume that all drainages in steep, hilly, or mountainous areas are capable of carrying debris flows, especially if relatively loose, sandy soils are present in the watershed. Areas that have been burned by regional fires are especially vulnerable.

Avoid building sites at the bottoms and mouths of steep ravines and drainage courses. These areas are the most likely to be inundated by debris flows. The outer "banks" of bends along such ravines also should be avoided because swiftly flowing debris avalanches can "ride up" out of the bottom of the stream channel where it bends.

Avoid building on or below steep slopes. In general, the steeper the slope the greater the risk. If these areas must be used, consult with a soils engineer and an engineering geologist. These specialists will be able to evaluate the potential for mudslide problems and give advice on the best way to minimize the risk to life and property.

The hazard from debris flows that occurs in modified slope cuts can be decreased by: 1) limiting the height and slope of cuts and fills; 2) properly compacting fills and keying them into bedrock; and 3) properly controlling the flow of water onto slopes.

If steep cuts or fills occur below the discharge points of runoff water from streets, downspouts, or similar drainage facilities onto a slope, it may be wise to obtain advice from an engineering geologist or erosion control specialist.

In some cases, walls can be built to deflect potential mudflows away from or around structures (Figure 2). To be effective, diversion walls must be properly designed and regularly maintained.

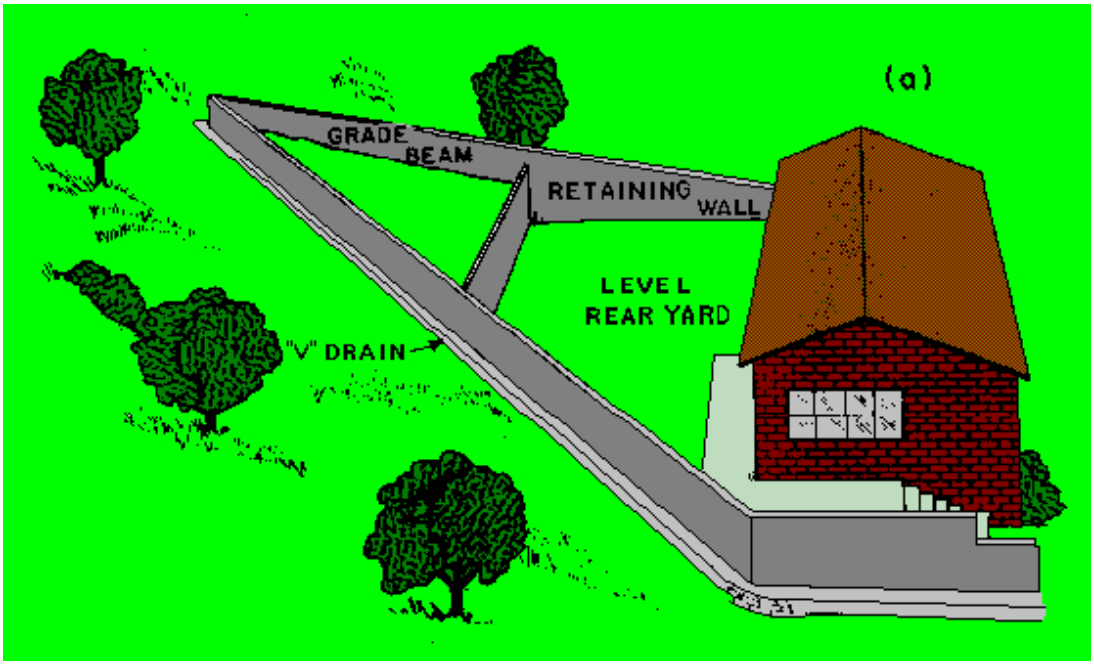


Figure 2. Methods to reduce the hazard from debris avalanches include construction of a) deflection walls and b) debris fences. Because of the extreme force of impact associated with debris flows, these and similar structures should be carefully engineered and constructed. The specifics of these designs will vary from site to site (After Hollingsworth and Kovacs, 1981.)

"Mud Floods" and "Debris Floods" Pose Hazards, Too

Residents living directly downslope of mountainous wildfire areas should be aware that, in addition to life-threatening potential debris flows and other forms of mass movement, there is another, perhaps deadlier hazard-- debris flooding or mud flooding at and near the mouths of channels that drain burned-over, ashy slopes. Studies have shown that, in the first year following a wildfire, sediment yields and peak discharges or such streams can increase up to 35-fold. Thus occupants of dwellings near such drainage channels could be endangered by floods that incorporate enormous amounts of debris and mud washed off the burned hillsides.

Tips and Clues That May Save Your Life...

- Mitigation of hazards from debris flows and debris avalanches through construction of permanent engineering measures takes considerable time and money. In the meantime, preparation for rapid evacuations should be made.

- Before and during rains, frequent inspection of the slopes (above vulnerable sites) for extension cracks and other symptoms of downslope movements of slope materials can be a guide to impending failure and a warning to evacuate. In particular, watch for new springs or seeps on slopes; cracks in snow, ice, soil, or rock; bulges at the base of slopes; the appearance of holes or bare spots on hillsides; tilting trees; or increased muddiness of streams. Any sudden increase in runoff is cause for concern.

- Listen for unusual rumbling sounds or noises that may indicate shifting bedrock or breaking vegetation or structures.

- Stay alert to the amount of rain falling locally during intense rainstorms. Buy a rain gauge (an inexpensive plastic one will suffice) and install it where it can be checked frequently.

- Whenever rainfall has exceeded 3 or 4 inches per day or ¼ inch per hour, the soil may be waterlogged and more rain can trigger mudflows.

- Again, the single most important action that should be taken by residents on rainy nights is NOT to sleep in lower-floor bedrooms on the sides of houses that face hazardous slopes. More than 100 Californians have been killed by debris flows during the past 25 years. Most of these 100 deaths occurred when debris flows buried persons who were sleeping in lower-floor bedrooms that were adjacent to hazardous slopes.

Where Can More Information Be Obtained?

For general information about debris avalanches and other kinds of landslides, contact your city or county geologist, or any office of the California Geological Survey.

For an assessment of the landslide risk to an individual property or homesite, obtain the services of a state-licensed engineering geologist (see the Yellow Pages of the telephone directory). The California Geological Survey does not perform individual site assessments or recommend particular consultants.

For more information about the design and construction of debris basins, debris fences, deflection walls, or other protective works, consult your city or county engineer, local flood control agency, or the U.S. Department of Agriculture, Natural Resources Conservation Service (NRCS).

REFERENCES

Booker, F.A., Dietrich, W.E., and Collins, L.M., 1993, Runoff and Erosion after the Oakland Firestorm, Expectations and Observations: CALIFORNIA GEOLOGY, v. 46, no. 6, p. 159-173. *This paper offers a critical review of the potential effectiveness of erosion control measures in the wake of the Oakland Hills Fire of 1991. Citation added 11/03.*

California Department of Conservation, Division of Mines and Geology Staff, 1979, Landslides in the Los Angeles region, California— Effects of the February-March 1978 rains: Division of Mines and Geology Open-File Report 79-4LA. *This report summarizes the effects of debris flows resulting from some storms in southern California.*

Campbell, R.H., 1975, Soil slips, debris flows, and rainstorms in the Santa Monica Mountains and vicinity, southern California: U.S. Geological Survey Professional Paper 851, 51 p. *This paper describes the causes and effects of debris flows and avalanches.*

Cannon, S.H. and Ellen, S.D., 1985, Rainfall conditions for abundant debris avalanches, San Francisco Bay region, California: CALIFORNIA GEOLOGY, v. 38, no. 12, p. 267-272. *The authors describe how to use a rain gauge to determine the threshold of risk for a debris avalanche.*

Ellen, S.D., and Wieczorek, G.F., editors, 1988, Landslides. floods, and marine effects of the storm of January 3-5, 1982, in the San Francisco Bay region, California: U.S. Geological Survey Professional Paper 1434, 310 p. *Most relevant are the six chapters on debris flows and other landslides.*

Hollingsworth, R. and Kovacs, G.S., 1981, Soil slips and debris flows, prediction and protection: Bulletin of the Association of Engineering Geologists, v. 18, no. 1, p. 17-28. *This paper provides information about deflection walls and similar structures.*

Irvine, P..J., 1996, Debris Flows Resulting from January 1995 Rainstorms, Fillmore, Ventura County, California: CALIFORNIA GEOLOGY, v. 49, no. 5, p. 129-134. *Citation added 11/03*.

Smith, T.C. and Hart, E.W., 1982, Landslides and related storm damage, January 1982, San Francisco Bay region: CALIFORNIA GEOLOGY, v. 35, no. 7, p. 139-152. *This article summarizes the effects of debris avalanches triggered by a storm in northern California*.

Weber, F.H., Jr. and Treiman, J.A., 1979, Slope instability and debris flows, Los Angeles area: CALIFORNIA GEOLOGY, v. 32, no. 1, p. 3-5. *This article describes the effects of debris flows in southern California.*

DMG NOTE 13 was written by Alan Barrows and Ted Smith
November, 2003 version slightly modified by Julia Grim, USDA-NRCS

NRCS Natural Resources Conservation Service

FACT SHEET

America's Private Lands Conservation Agency

TEMPORARY EROSION CONTROL AROUND THE HOME FOLLOWING A FIRE

SANDBAG PROTECTION

What is it?

An inexpensive, **temporary** barrier, or wall, one to two feet high, that is constructed by stacking sand-filled or earth-filled sandbags and placing them to divert mud and other debris flows away from buildings. **These barriers do not provide protection from high debris flows.**

When is it used?

These barriers are used to protect building sites vulnerable to **low mud debris flows** from steep, erodible slopes that are partially or completely void of vegetation due to wildfire burns. This is an inexpensive, temporary protection method that can be used by homeowners before predicted rainfall.

Sandbags deteriorate when exposed to continued wetting and drying for several months . If the bags need to be used for more than a few months, cement can be mixed with the sand. The cement and sand mixture will harden when the bags dry.

Methods and Materials:

These barriers are easy to construct. Burlap bags, sand, plastic, lumber, cement and plywood are readily available at local lumber yards. Some fire stations and other emergency centers can help with materials too. Often times, volunteers are available to provide assistance in assembling and placement of sandbags.

Begin by trying to direct debris flows away from buildings, pools and other structures. Clear a path for the debris. **Do not try to dam it or stop it.**

Protect your most valuable property first. Debris can enter a building through doors and windows. They should be boarded up and waterproofed with plastic sheets. **Sandbags will not seal out water.**

Work with your neighbors and be prepared to use your property to provide good protection for the community.

Filling Bags:

Fill sandbags one-half full. Use sand, if available, or, local soil. Fold the top of the sandbag down and place the bag on its folded top (see illustration).

Placing Bags:

Refer to the illustration. Place each sandbag as shown, finishing each layer before starting the next. **Limit placement to two layers unless they are stacked against a building or sandbags are pyramided.**

It is important to place the bags with the folded top in the upstream or uphill direction facing the flow of water to prevent them from opening when water runs by.

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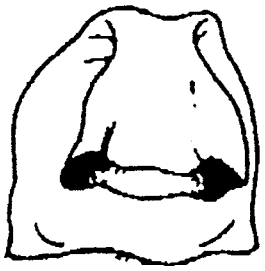
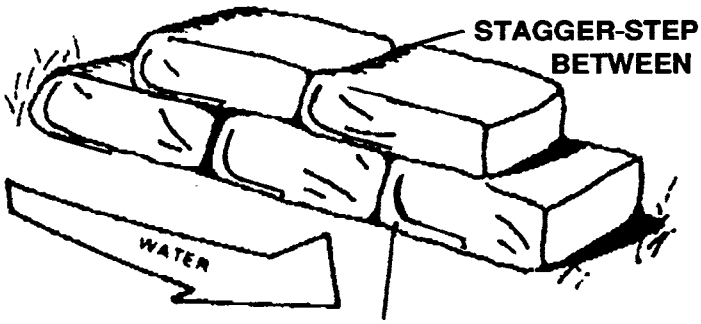
SANDBAG FILLING AND PLACEMENT

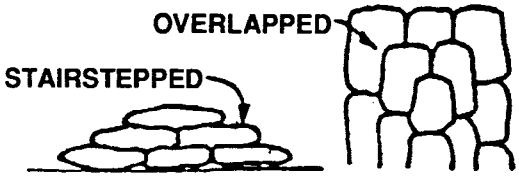


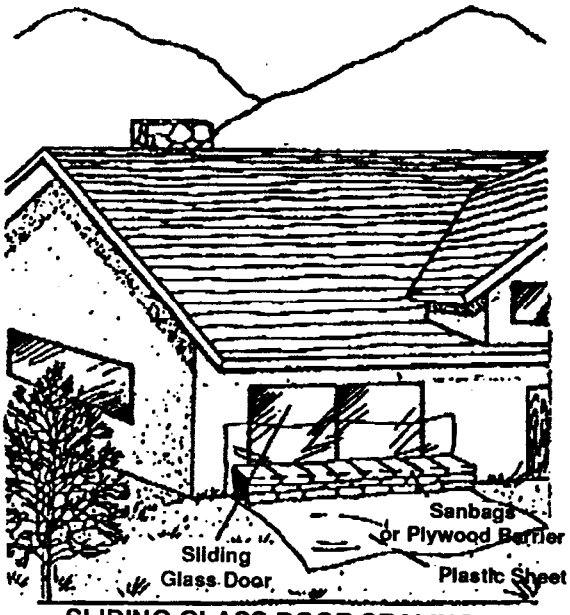
FILL HALF FULL
FOLD TOP UNDER



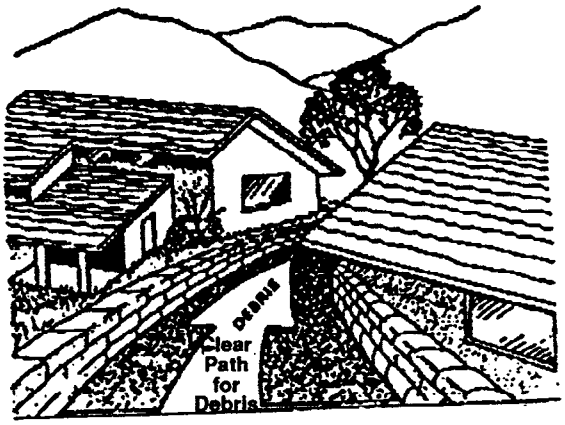
STAGGER-STEP BAGS
BETWEEN ROWS

PLACE BAG WITH FLAP
UNDER BAG

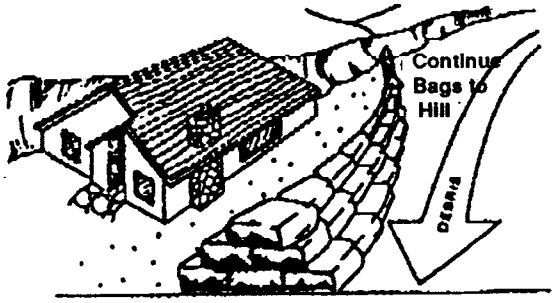




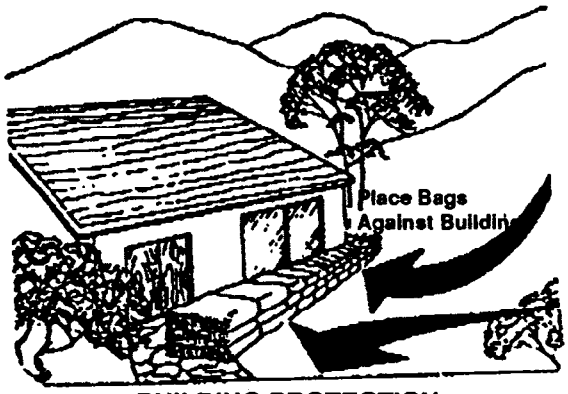
SLIDING GLASS DOOR SEALING
Control of Flows to prevent
seeping into sliding glass door



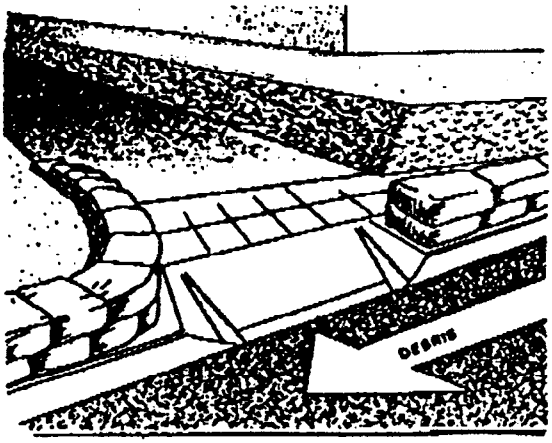
DIRECTING FLOWS BETWEEN BUILDINGS



DIRECTING DEBRIS AWAY FROM BUILDINGS



BUILDING PROTECTION



CONTROLLING DEBRIS/STORM FLOWS IN STREETS

NRCS Natural Resources Conservation Service

FACT SHEET

America's Private Lands Conservation Agency

TEMPORARY EROSION CONTROL AROUND THE HOME FOLLOWING A FIRE

STRAW BALE DIKE

What is it?
A temporary sediment barrier constructed of straw bales located downslope of a disturbed area or around a storm drainage outlet to redirect debris flows or trap debris materials.

When is it used?
Usually installed in areas requiring protection from sedimentation expected from predicted rainfall events that will cause erosion and are intended to provide protection for a limited time period (less than 3 months).

Planning Criteria:
Straw Bale Dikes drainage area limits are as follows:

Slope	Maximum Drainage Area	Maximum Slope Length
0-15 percent	1acre	200 feet
>15 percent	1/2 acre	100 feet

Methods and Materials:
Bales should be bound with wire or nylon twine. Twine bound bales are less durable. Bales should be placed in a row with ends tightly abutting the adjacent bales. **Do not place bales with wire or twine touching~ the soil (see illustration).** Some loose straw should be compressed between adjacent bales to close voids. The tops of bales should all be level and set at the same elevation.

Anchorage:
Each bale should be embedded in the soil a minimum of 4 inches. Drive 2x2 stakes or rebar through the bales and into the ground 1 1/2 to 2 feet for anchorage. The first stake in each bale should be driven toward a previously laid bale to force the bales together. Please refer to the drawings on the back side of this sheet.

Maintenance:
Inspect the bale dike and provide necessary maintenance following each storm period. It is important to assure that loose straw does not enter storm drain facilities. Remove the bales once permanent drainage and stabilization is reestablished. Used straw can be used as mulch in other areas.

Where to Get Help:
Technical assistance is available from your local USDA Natural Resources Conservation Service office or your local Resource Conservation District regarding the use and installation of straw bale dikes and other treatments.

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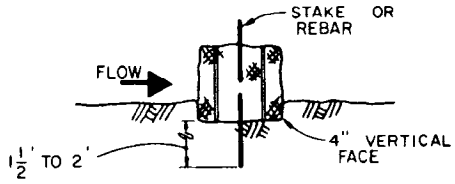

EMBEDDING DETAIL
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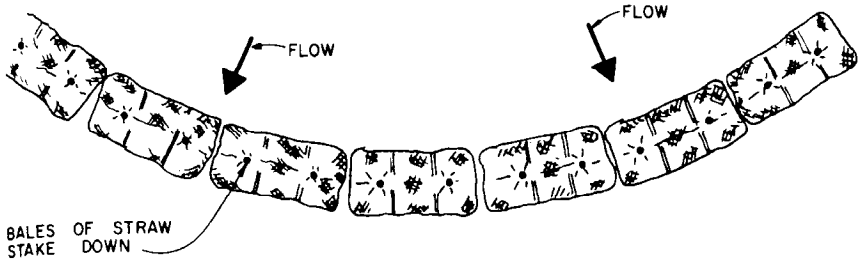
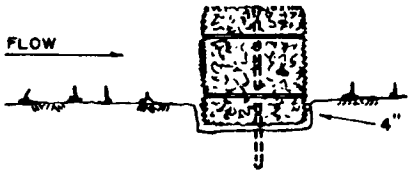


PLAN
N.T.S.

ELEVATION
N.T.S.

STRAW BALE DIKE



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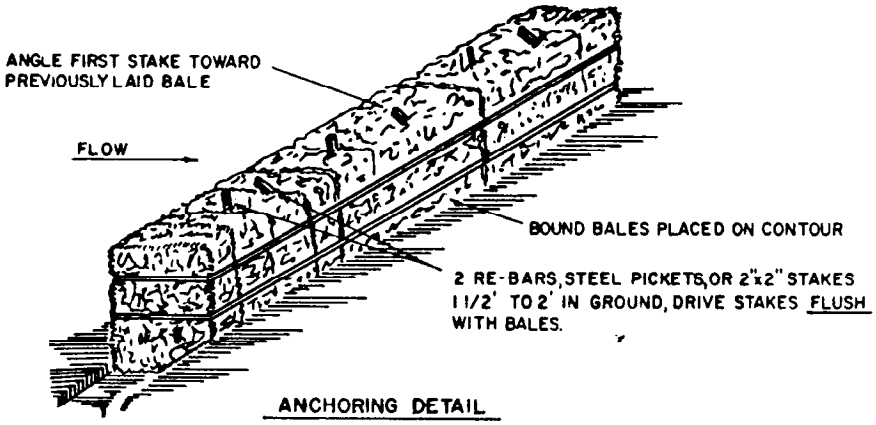

ANCHORING DETAIL

NRCS Natural Resources Conservation Service

FACT SHEET

America's Private Lands Conservation Agency

TEMPORARY EROSION CONTROL AROUND THE HOME FOLLOWING A FIRE

SILT FENCE

What is it?
This is a temporary barrier made of woven wire and fabric filter cloth that is used to catch sediment-laden runoff from small areas of disturbed soil such as following a fire.

Silt fences are easy to construct, and materials are available from hardware stores, nurseries, and lumber yards.

When is it used?
Silt fences are used for specific situations. Major considerations are slope, slope length, and the amount of drainage area from which the fence will catch runoff. Here are some design considerations:

Slope Steepness	Maximum Slope Length
2:1 = 50%	50 feet
3:1 = 33%	75 feet
4:1 = 25%	125 feet
5:1 = 20%	175 feet
<5:1 = <20%	200 feet

For longer slopes, add additional silt fences.

Drainage Area:
The area that contributes runoff to be caught by the silt fence should not be greater than 1/2 acre for 100 feet of fence.

Type of Runoff:
Silt fences are designed to catch runoff that is in the form of "sheet flow" and not "concentrated flow." Sheet flow differs from concentrated flow in that the runoff is spread evenly over the ground surface (like a sheet) rather than concentrated in small rills or gullies.

Methods and Materials:

Fence Posts:
Posts should be at least 36 inches long. Wood posts should be of hardwood with a minimum cross sectional area of 3 inches. Steel posts should be standard "T" or "U" section and should weigh no less than 1 pound per linear foot.

Wire:
Wire fence should be at least 14 gage with openings no larger than 6 inches by 6 inches.

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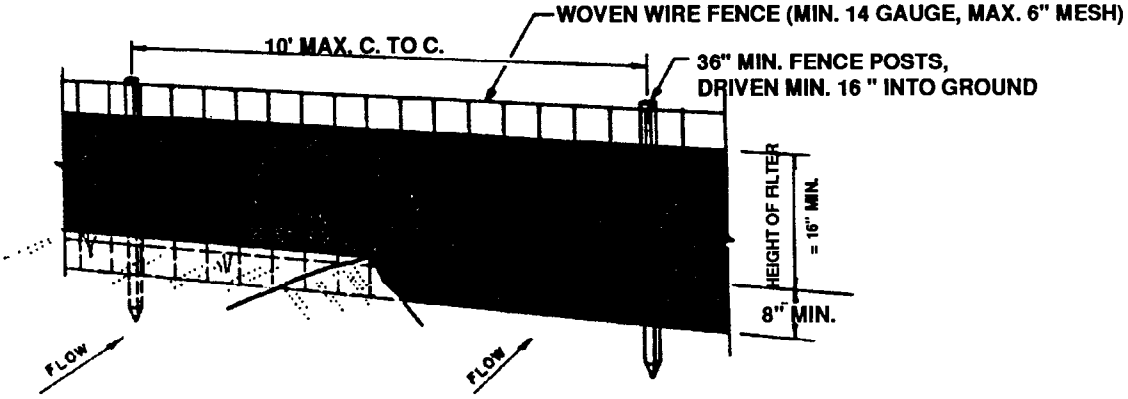
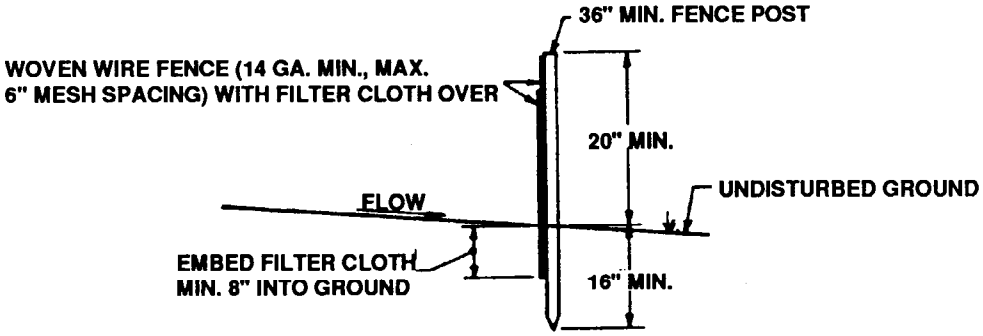
Fabric Properties:
Filter fabric properties should be as follows (hardware store personnel can help you with these):

Fabric Property	Minimum Acceptable Value	Test Method
Grab tensile strength (LBS)	90	ASTM D1682
Elongation at Failure (%)	50	ASTM D1682
Mullen Burst Strength (PSI)	190	ASTM D3786
Puncture Strength (lbs)	40	ASTM D751 (mod)
Slurry flow Rate (gal./min/sf)	0.3	
Equivalent Opening Size	40-80	US Std Sieve
Ultraviolet Rad. Stability	90	ASTM-G-26

Perspective View:



Section View:



CONSTRUCTION NOTES FOR FABRICATED SILT FENCE

1. WOVEN WIRE FENCE TO FASTENCED SECURELY TO FENCE POSTS WITH WIRE TIES OR STAPLES.

2. FILTER CLOTH TO BE FASTENED SECURELY TO WOVEN WIRE FENCE WITH TIES SPACES EVERY 24" AT TOP AND MID SECTION.

3. WHEN TWO SECTIONS OF FILTER CLOTH ADJOIN EACH OTHER THEY SHALL BE OVER-LAPPED BY SIX INCHES AND FOLDED.

4. MAINTENANCE SHALL BE PERFORMED AS NEEDED AND MATERIAL REMOVED WHEN "BULGES" DEVELOP IN THE SILT FENCE...

POST: STEEL EITHER OR U TYPE OR 2' HARDWOOD

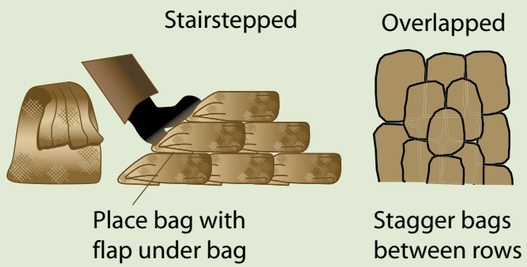
FENCE: WOVEN WIRE, 14 GA., 6" MAX. MESH OPENING

FILTER CLOTH: FILTER X, MIRAFI 100X, STABILINKA T140 OR APPROVED EQUAL

PREFABRICATED UNIT: GEOFAB, ENVIROFENCE, OR APPROVED EQUAL.

Where to get help?
Technical assistance is available from your local USDA Natural Resources Conservation Service office of your local Resource Conservation District regarding the use and installation of straw bale dikes and other treatments.

How to Use Sandbags



Filling

Filling sandbags is best done with two people. Fill half full with sand if available or local soil.

Stacking

Fold top of sandbag down and rest the bag on its top on the stack. Top should be facing upstream. Stamp the bag into place. Complete each layer before starting the next layer. Stagger the layers. Stack no more than three layers high unless they are against a building or stacked pyramid-style.

Sandbag diversion

Sandbags will redirect water away from property but will not seal out water. Place sandbags with the folded top toward the upstream or uphill direction. Sandbags are temporary and will deteriorate after several months.

DO'S AND DON'TS

Do:

- Contact your local Flood Control Agency or Public Works Authority- *Installing these erosion control devices on your property may not be sufficient to thwart extreme flows.*
- Try to direct debris flows away from your property to a recognized drainage device or to the street.
- Clear a path for debris.
- Place protective measures to divert debris, not dam it.
- Board up windows facing the flow
- Work with your neighbors.

Don't:

- Under-estimate the power of debris flows.
- Walk or drive across swiftly flowing water.
- Wait until storms arrive to make a plan.
- Try to confine the flows more than is necessary.
- Direct flow to neighbor's property.

Don't Forget to Plan for Erosion Control ALL YEAR ROUND

Preventing runoff during the spring and summer is equally as important as preventing erosion. A major source of dry season pollution of lakes and streams near urban areas is runoff from landscape watering. This water carries oil and gasoline residue from roadways, fertilizers, pesticides, and other undesirable material as it flows away from our homes and drains into streams and lakes.

Irrigating on slopes can be tricky. Emitters are preferred but require monthly inspections to detect clogging. The freeze/thaw cycle at higher elevations can also damage tubing. Bubblers require less maintenance than drip emitters and may be highly effective. New plants should have earthen dams or watering basins around them to capture the water they receive.

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www.ca.nrcs.usda.gov

Prevent Soil Erosion on your Property

A homeowner's guide to erosion control

Soil erosion can happen slowly, gradually washing away top soil, or it can happen quickly in heavy rain events. In either scenario, the land is stripped bare of valuable natural resources.

In an effort to help landowners protect their property, professional NRCS Conservationists developed erosion control practices for areas where trees have been removed.

In this Homeowner's Guide to Erosion Control, you will find common NRCS practices that can be implemented to protect your property and prevent mudslides. Expanded fact sheets are also available at: www.ca.nrcs.usda.gov/programs/ewp

NRCS Natural Resources Conservation Service

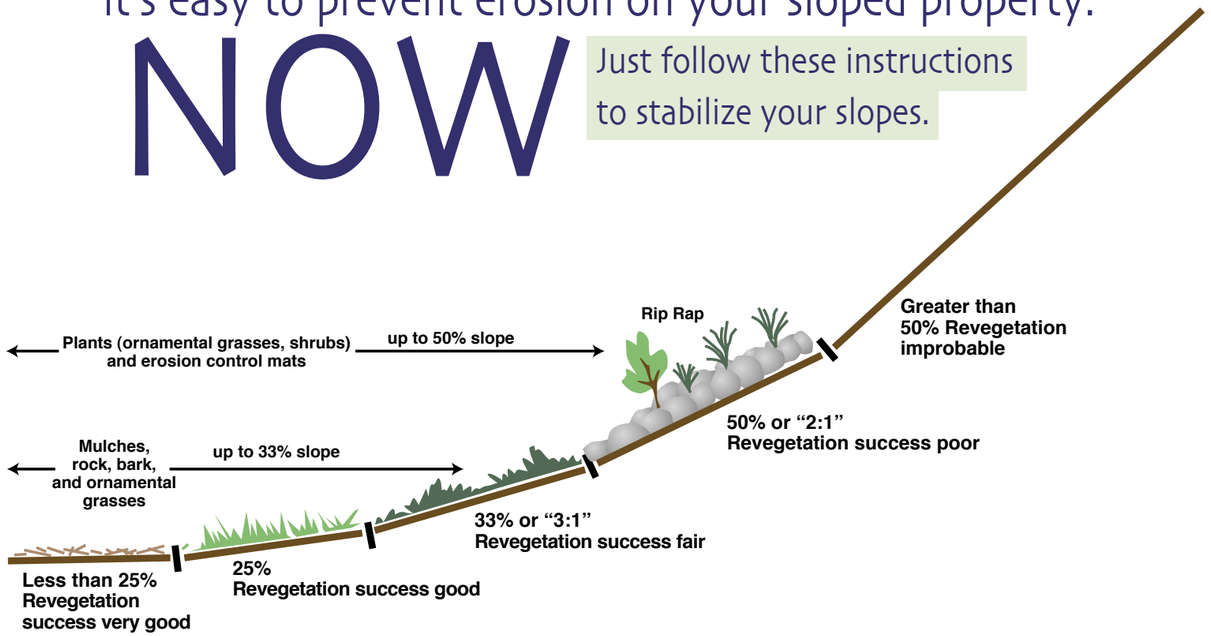
California Watershed Recovery Project

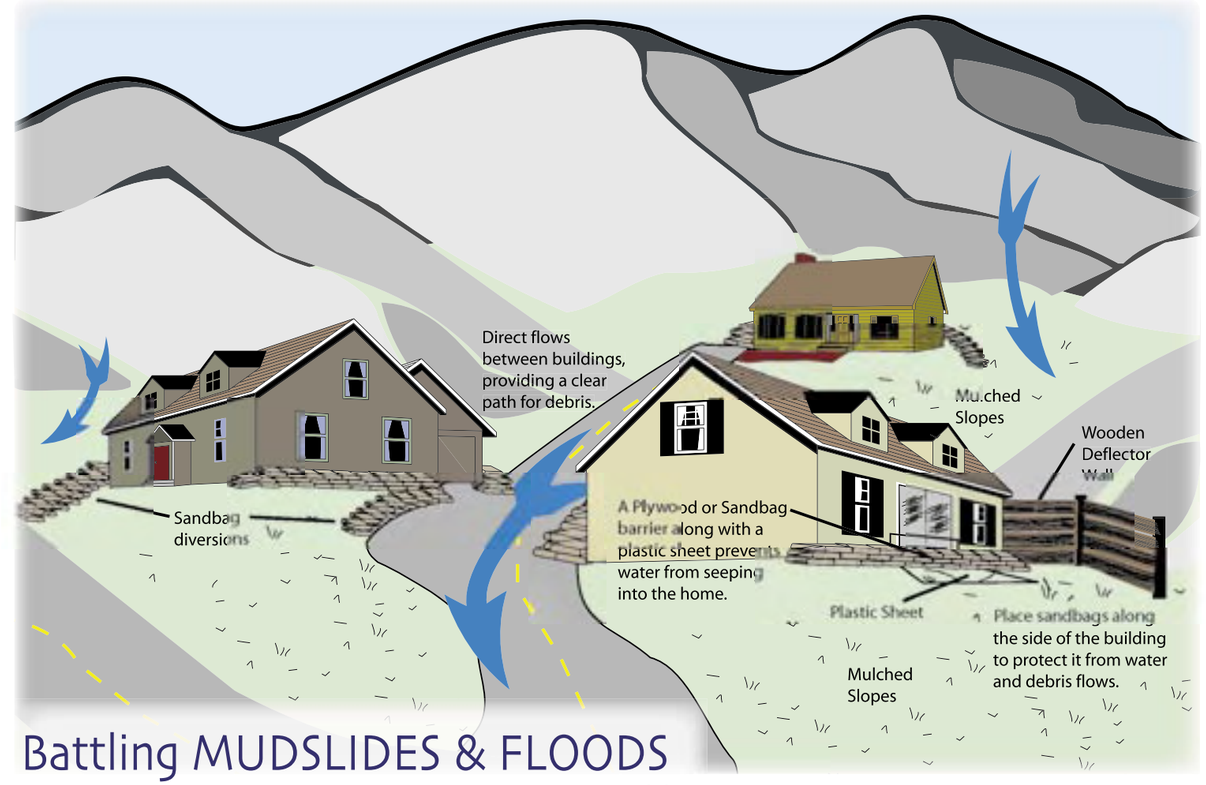
Prevent Erosion

it's easy to prevent erosion on your sloped property.

NOW

Just follow these instructions to stabilize your slopes.





What Kind of SLOPES Do You Have?

Take a look at your slopes. How steep they are will tell you what will work.

Moderate slopes (less than 33%) have a good chance of success at controlling runoff using plant materials and mulch.

Cover bare soils with mulch of bark chips, pine needles, wood chips, and even stones or river rock. Up to two inches of bark, wood chips or pine needles will not create a fire hazard.

When landscaping, select plants for slope stabilization and use bubblers or drip emitters for irrigation. When watering season starts again, watch the length of time you water and the amount of water delivered. Make sure the plants get only what will soak in.

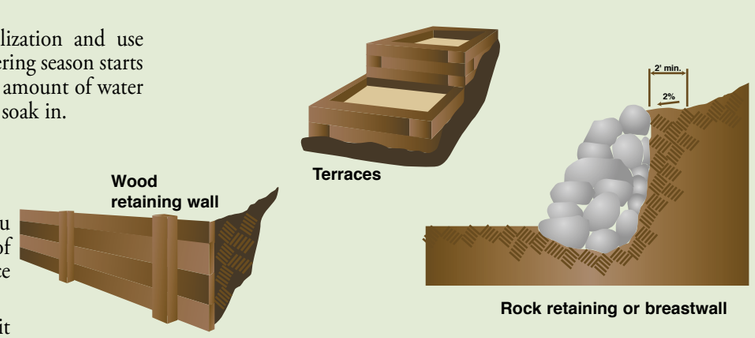
Slopes between 33% and 50% require special care.

Plant on slopes that are this steep, but be aware you may need to use an erosion control blanket, mats of coconut fiber, or jute netting to hold slopes in place until plants can become established.

Once established, the roots of the plants will knit together to hold soils in place. Their limbs, leaves and branches will diffuse the force of rain and wind. These steep slopes require irrigation systems that will not create runoff.

Slopes over 50% will require structures or special techniques for stabilization.

Techniques for steep slopes include wood retaining walls, interlocking concrete blocks, rock retaining walls, riprap (loose rock) areas, and terracing. If you choose wood, make sure the wood is treated with a wood preservative to prevent rotting. Terraces and wood retaining walls require approval by government agencies; please contact your local Building and Safety office.



Battling MUDSLIDES & FLOODS

If you have removed vegetation, dead or dying trees from your property, you need to take defensive measures to protect against flooding and mudslides. When too much protective material is removed, soil is left bare and vulnerable to erosion. Defensive measures for your property can provide protection in the form of mulch, deflection walls, diversion ditches, and sandbag diversions.

Materials

The materials needed are readily available and inexpensive and can be installed with normal household tools: sandbags, sand, lumber and plywood.

Paved driveways are often an important factor in controlling erosion.

Paving prevents erosion resulting from snow removal, vehicle traffic in and out of your driveway and soils unable to absorb moisture because they have been compacted by vehicle weight. Small ditches or swales that capture runoff and return precipitation to your landscape should border your driveway. Semi-permeable coverings such as gravel can also be effective if slopes are not too steep.

Choose plants for slope stabilization.

Contact your local NRCS office for a list of plants and trees suitable for your area.

Mulching

A mulch consisting of two inches of wood chips, oak leaves and pine needles should be spread across burnt or baren areas of soil. This will:

- help to protect and keep soil in place
- increase water penetration
- keep soil cool and maintain moisture
- increase organic content of soil (you may want to add nitrogen if mulch is applied around existing vegetation, since the break down of mulch utilizes some nitrogen)

Protecting windows and doors

In areas where mudslides are possible use plywood to board up windows and doors. Overlap windows, vents or doors at least three inches on each side. Secure plywood with four or more nails, screws or bolts.

Wooden deflector walls

Use lumber for walls. Drive stakes to at least half their length into the ground for proper anchorage. Place deflectors on solid, level soil to prevent erosion. Earth packed behind the deflector will make it stronger. Contact your local NRCS office for more information.

Diversion ditches

Dig a small ditch close to the upper edge of the property to slow water movement. Provide for the ditch to drain into a drainage device, street pavement or a well-vegetated area.

United States Department of Agriculture

NRCS Natural Resources Conservation Service

Wildfire Risk Reduction and Recovery Tips For Homeowners

USDA-NRCS, Tucson, AZ June 2002

As more homeowners move into rural areas to get away from crowded urban areas, they can unknowingly place themselves in harm's way.

Building homes in wooded and/or brushy areas is aesthetically pleasing, but homeowners need to be aware of the potential dangers from wildfire and how to protect their homesites from wildfires.

Homes that are even far away from a fire can still be impacted. Slopes left denuded by range or forest fires are especially susceptible to accelerated soil erosion, flash flooding, and debris flows because of the absence of vegetation and roots to bind the soil. Homesites near waterways or on slopes that are downstream from a fire could be subjected to the above-mentioned flooding events.

This publication contains some techniques, practices, and information homeowners can use for new or existing homesites to reduce their susceptibility to damage from wildfires and related flooding events.

The Natural Resources Conservation Service (NRCS) and your local conservation district are available to answer your questions and provide assistance as you recover from the aftermath of a wildfire or prepare your homesite to reduce potential damage from a wildfire.

Prevention

Step one: Plan your home site location to reduce the risk of damage caused by wildfires.

Check with local officials regarding the availability of fire protection for your location. Evaluate your site for fire protection equipment accessibility. Place your home on a level area, rather than on a slope. Ensure clear identification of access roads and of your homesite.

Develop a fire escape plan that details escape routes and a meeting location outside the home. Rehearse your plan so all family members know what to do and where to go in an emergency.

Step two: Work with your architects, contractors, and local fire officials during construction to create a home that is firewise and aesthetically pleasing.

Use fire resistant roofing and wall materials, and keep flammable vegetation, woodpiles, and other debris at a safe distance from the home and other buildings. If your home has a fireplace, make sure the fireplace is an approved unit and the chimney has noncombustible wire mesh screening. Windows should have thick tempered safety glass. Double pane windows may be appropriate, but contact your local fire officials to determine what is most suitable.

Step three: Maintain the landscape and create a defensible space or safety zone around your home.

This zone can be created by selecting fire resistant landscape plants and by mowing or clipping the herbaceous vegetation at least 30 feet around your home to a 3-4 inch height. Waiting to mow until the plants have set seed (early or mid-summer to fall) will help maintain the vigor of your grasses and forbs. Mowing around trees and shrubs, up to and beyond 100 feet, will create mulch to help reduce soil erosion and reduce a fire's ability to climb into trees and brush.

As the slope of your lot increases, you may need to extend your safety zone beyond 100 feet. Consult with local fire officials on the creation and maintenance of your safety zone.

Clean roofs, gutters, and eaves regularly. Stack firewood away from the house and other buildings.

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Recovery

Vegetation is one of the most important factors influencing soil erosion. It helps control erosion by shielding the soil from the impact of raindrops, maintaining a soil surface capable of absorbing water, and slowing the amount and velocity of runoff.

There is a good chance that native seeds on your property are still alive and will germinate. Old and new vegetation will help protect the soil from erosive rains. In severely burned areas, seeding may be required.

Your first step is to field check the burned area and map out areas that have burned intensively and, thus, may have very little seed under the ash.

White ash shows where the fire was very hot and seeds were most likely destroyed. Burned areas that had thick brush, without a grass understory, will not have enough seed.

For large fires on federal lands, seed survey teams examine areas as soon as possible, and before significant rainfall events, to confirm which parts of the potential treatment area do not have an adequate amount of viable seed. They establish transects across the treatment area and collect one square foot of the soil surface to a one-inch depth at five points along the transect. The soil samples are then placed in shallow propagation flats, placed in a greenhouse, and lightly irrigated for 10 days. The seedlings present in 10 days provide an indication of seed viability per square foot of soil and how much viable seed is immediately available for erosion control when the first rain occurs.

Desirable seeds are grasses and forbs. The minimum amount to seed is an aggregate of 25 viable seeds per square foot when drill seeded and 50 viable seeds per square foot when broadcast seeded.

Exposed earth areas such as new roads, firebreaks, and steep embankments, including cut and fill slopes, should also be planted.

Species Selection

Contact your local NRCS field office or Plant Materials Center for a suggested list of species that are adapted to your specific area. The phone number of the nearest field office can be found in the Federal Government Offices White Pages of your phone directory. Look under United States Department of Agricultural **or** Natural Resources. Field offices can be found under "Natural Resources Conservation Information and Technical Assistance."

Additional information regarding NRCS, the Plant Materials Program, and requesting assistance from NRCS can be obtained at: **http://nrcs.usda.gov** or **http://Plant-Materials.nrcs.usda.gov.**

Methods of Seeding

Seeds can be broadcast by hand, with a hand-operated seeder, hydroseeder, drilled, or air seeded.

Most homeowners and small landowners will find broadcasting to be the most economical method. Hydroseeding requires roads for equipment access and a nearby water supply. Use drill seeding when possible or aerial seeding on large acreages.

Seed Specifications

The total amount of seed purchased should equal the acres burned multiplied by the recommended seeding rate per acre. Include any roads and firebreaks in the burned acreage.

If the seed is coated by the supplier or is less than 80% Pure Live Seed (PLS), then adjust the amount of seed purchased. Check seed tags for each species to determine the percent germination and purity. PLS = % germination x % purity.

Obtain seed supplies of each species in separate bags and keep cool and dry.

Low PLS Adjustment

Example: When the recommended seeding rate is **10 pounds per acre** and your seed has a 90% purity and a 70% germination rate, then your PLS = (90% x 70%) 63% PLS. Since the PLS is less than the recommended 80%, you need to adjust your seeding rate. An adjustment factor is calculated by dividing the suggested PLS (80%) by your actual PLS (63%). In this example, the adjustment factor is 1.3 (80÷ 63 =1.3). To calculate your actual seeding rate multiply the adjustment factor by the recommended seeding rate (1.3 x 10 lbs/acre = **13 pounds per acre**).

If the supplier coats the seed with inoculant, then the seeding rate for the coated seed should be adjusted. No adjustment is needed when you inoculate alfalfa (alfalfa is an example species and may not be recommended in your mix) or other legume seeds.

Recommended seeding rates are based on un-coated seed and need to be adjusted, as shown in the following example, after making any adjustment for low PLS.

Example: Coated alfalfa seed or other small seeded legumes with a suggested seeding rate of 6 pounds per acre. The adjustment factor = 1.5 and the adjusted seeding rate is (1.5 x 6 lbs/acre) **9 lbs/acre**.

Equipment and Materials Needed

Equipment and materials should be ready before you start. This list of items will minimize disruptions and let you finish seeding in one day for small areas.

- 1 hand operated cyclone seeder for each person doing the seeding
- Weight scale, at least 20-pound capacity
- At least 2 plastic buckets
- Seed targets. At least 2 pieces of 2x2-foot soft cloth or cardboard with corrugations exposed, nailed to a small wood frame, or at least 4 pieces of 1x1-foot soft cloth attached to an open wire frame
- 4 paper grocery bags and 2 marker pens
- Inoculant. Specific type for each legume. Omit if supplier coats seed.

Getting Started

Inoculating legumes enables them to "fix" nitrogen that improves the health of the plant and provides additional fertility for other plants.

Inoculate alfalfa and other legume seeds (if the supplier has not) the evening before or early on seeding day so the seed will dry by seeding time. Re-inoculate seed coated over 30 days ago or seed that has not been kept cool and dry.

Seeding Specifications

Divide seed of each species into equal amounts and label bags. Keep cool and dry. When seeding a mixture, broadcast each species separately, if possible, to get good uniform seed distribution.

Adjust the seeder according to the manufacturer's instructions based on half the seeding rate when seeding in arid areas. Base it on the full seeding rate when doing a simple once-over seeding. Set out two seed targets 10 feet apart and offset 10 feet. With the hand-operated seeder half full, start broadcasting and walk between the two seed targets. Stop and check the seed count at each target. Adjust the seeder and repeat until the number of seeds per square foot agrees with your approximate target of 50 minimum seeds per square foot.

Broadcast in two directions to achieve a uniform distribution of seed. Use half the seed of a given species; broadcast the seed as you walk across the slope, starting at the top of the burn area. Notice how far the seed is thrown. When you reach the other edge of the burn area, move downslope a distance equal to the width of throw.

Continue broadcasting and walk back across the slope, trying to avoid gaps. Repeat this process all the way to the bottom edge. When several people are seeding, move across the slope together. Adjust your walking pace so you have enough seed to finish.

Using the remaining half of the seed, repeat the procedure going up and downslope. However, on steep slopes, it is best to broadcast only walking downslope because you need to maintain the same walking speed used to calibrate the seeder. Using several people will make this easier.

Broadcast in one direction if conditions do not allow seeding in two directions. Broadcast the remaining seed in the same direction across the slope while walking midway between your previous lines of travel.

Repeat the above process for each species.

What are Hydrophobic Soils?

Definition: Wildfires burn dead and living vegetation that accumulates on the soil surface. Burning produces volatile hydrophobic substances that can penetrate the soil up to a depth of six inches. When these substances penetrate the cool soil, they condense and coat the soil particles, making the soil hydrophobic or water repellent.

Soils that are water repellent exhibit a decreased water infiltration rate and an increased water runoff rate, creating extreme soil erosion potential.

Initially, rain or irrigation water will run off hydrophobic soils instead of infiltrating and promoting germination of seed and growth of roots. This makes it difficult to establish a stand of vegetation.

Water repellent soils will be the worst where vegetation was thickest and burn temperatures were extreme, especially under trees, thick brush and around buildings that burned to the ground.

Field Check

Field check for water repellent soil conditions by digging a shallow trench with a vertical wall and applying water droplets from the surface down in 1-centimeter increments.

- If water sits as a ball on the soil for 10-to-40 seconds, it is moderately hydrophobic.
- If more than 40 seconds, it is strongly hydrophobic.

Treatment

On gentle slopes, chisel the soil a few inches deep, perpendicular to the slope, to break up the hydrophobic layer. This will allow water to penetrate the soil surface for seed germination and root growth.

On steeper slopes, lightly spray the soil surface with a soil wetting product (surfactant). This will break up the hydrophobic substances coating the soil particles the way dishwashing detergent breaks up grease. Then water can penetrate the soil readily. Soil wetting products can be purchased at lawn and garden stores.

Hazards from Debris Flows

Debris flows are shallow landslides, saturated with water that travel rapidly downslope as muddy slurries, carrying rocks and debris.

Even moderate precipitation can cause major flooding on a wildfire damaged watershed due to the lack of vegetation and roots to bind the soil. Areas directly downslope are especially subject to damage.

What can be done to avoid or reduce the hazard of debris flows? To be safe, assume that all drainages in steep, hilly areas are capable of carrying debris flows and are especially vulnerable after a wildfire.

Avoid building at the bottoms and mouths of steep ravines and drainage courses. These areas are the most likely to be inundated. The outer banks of bends along such ravines should also be avoided, because swiftly flowing debris avalanches can "ride" up and out of the stream channel.

Avoid building on or below steep slopes. In general, the steeper the slope, the greater the risk. If these areas must be used, consult with a soil engineer and engineering geologist. They will be able to evaluate the potential for problems and give advice on the best way to minimize the risk to life and property.

Limit the height and slope of cuts and fills in human-modified slope cuts. Properly compact fills, key them into bedrock, and properly control the flow of water onto slopes.

Stay alert to the amount of rain falling in your area during rainstorms. Concerns for flooding and debris flows are based on moderate to high amounts of moisture over short periods. Minimal precipitation rates, especially after previous storms, could possibly trigger flooding and debris movement events.

For Additional Information

For additional information on wildfire risk reduction, please visit the following websites:

http://www.firewse.org
http://www.usfa.fema.gov/wildfire/
http://www.extension.unr.edu/FIRE/FrontPage.html
http://www.psw.fs.fed.us

Fact sheets and other additional information regarding specific practices and or wildfire related hazards can be found at:

http://www.ca.nrcs.usda.gov/pa/ewp.html.
http://www.mt.nrcs.usda.gov/pas/fires/firemt.html.

Additional information regarding floods, debris flows, and erosion control can be found at:

http://ladpw.org/pln/HomeOwners/index.cfm
http://www.consrv.ca.gov/dmg/pubs/notes/33/index.htm.

This brochure adapted from *"Wildfire Recovery Tips"* brochure, produced by USDA-NRCS, Boise, Idaho, July 2000.

Bruce Munda
Arizona Plant Materials Specialist
Tucson, AZ

June 2002

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Hydroseeding and Hydromulching

The terms hydroseeding and hydromulching are often used interchangeably.

- **Hydroseeding** is applying a slurry of water, wood fiber mulch, seed, and fertilizer to the soil surface to prevent soil erosion and provide an environment conducive to plant growth.

- **Hydromulching** is applying a slurry of water, wood fiber mulch, and often a tackifier to a slope to prevent soil erosion.

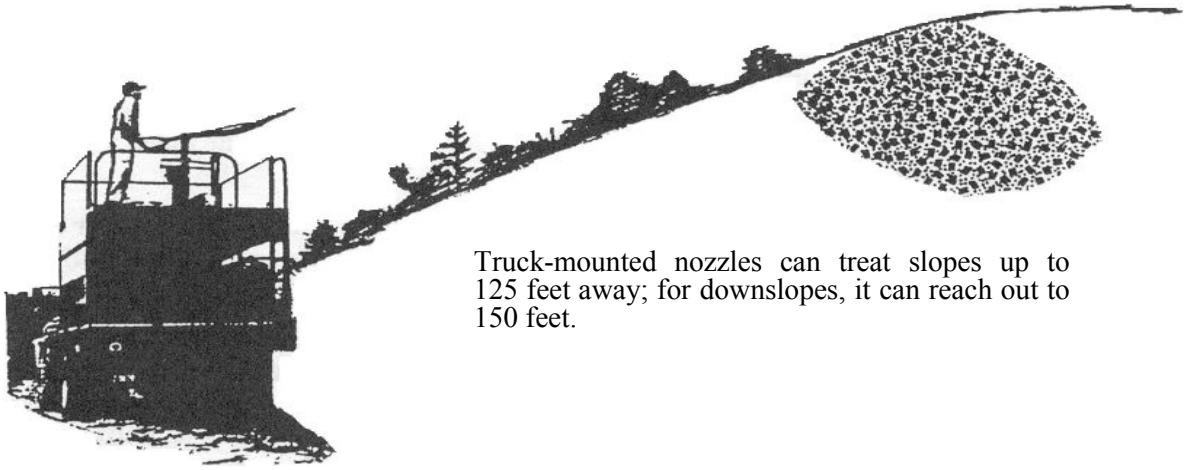
When to Use

General recommendation: On steep, highly erosive slopes that have been partially or completely denuded of vegetation due to fire, apply seed to the site first and then hydromulch over the seed to keep the seed from washing off the slope.

This is a fairly expensive erosion control method that is often reserved for areas close to roads, bridges, homes, and other structures. Use is sometimes restricted due to lack of access roads and adequate water supplies. Slope lengths of 125-225 feet can be treated.

For small landowners, this technique will need to be hired out. Check the listings under "Landscape contractors," "Erosion Control," or "Seeding Contractors" in the yellow pages of your telephone directory.

Hydroseeding and Hydromulching

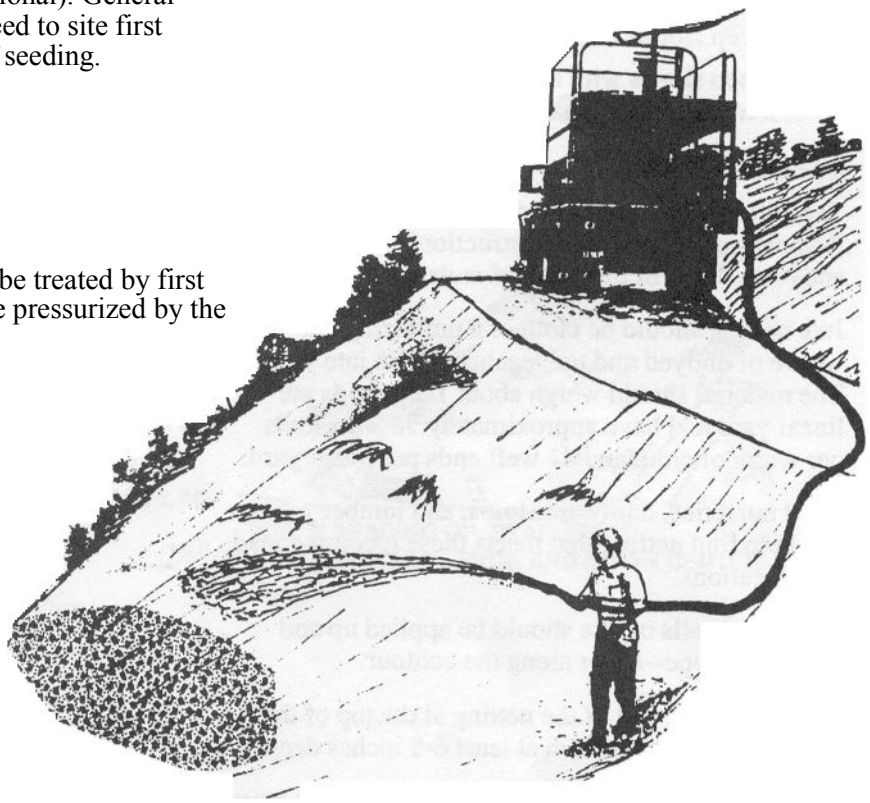


Truck-mounted nozzles can treat slopes up to 125 feet away; for downslopes, it can reach out to 150 feet.

Hydromulching: Tank mix includes water, wood fiber, and tackifier (optional).

Hydroseeding: Tank mix includes water, wood fiber, seed, fertilizer, (optional after fire) and tackifier (also optional). General recommendation: Apply seed to site first then hydromulch on top of seeding.

200 to 225 feet of slope can be treated by first using 100 to 150 feet of hose pressurized by the tank truck



Jute Netting

Netting made of jute can be laid and anchored over straw or other mulch to help protect the soil from wind and water damage. Netting helps reduce soil erosion and provides a good environment for vegetative regrowth.

Jute is a biodegradable material that will eventually decompose and is not a threat to the environment or wildlife.

When to Use

Jute netting can be used on areas that may erode near structures such as homes, roads, and bridges or on small, steep, disturbed areas.

Netting can also be applied alone (without mulch) as an alternative to straw or wood mulches on flat sites for dust control and seed germination enhancement.

It should not be used alone where runoff quantities are expected to be high.

The use of jute netting is not appropriate in all situations. Examples of when it may not be appropriate:

- Steep slopes with sandy soils
- Steep slopes with many rocks on the surface
- Steep slopes with a significant amount of fire burned vegetation remaining
-

Specifications

The soil surface should be reasonably smooth. Remove rocks and other obstructions that rise above the level of the soil or mulch.

Jute netting should be cloth of a uniform plain weave of undyed and unbleached single jute yam. The materials should weigh about 1.2 pounds per linear yard and have approximately 78 warp ends per width of cloth and 41 weft ends per linear yard.

Most nurseries, hardware stores, and lumber yards can help find netting that meets these recommended specifications.

Individual rolls of jute should be applied up and down the slope--never along the contour.

Bury the upper end of the netting at the top of the disturbed area in a trench at least 6-8 inches deep.

Lay out rolls so edges overlap each other by at least 4 inches.

Extremely important: When more than one roll is required going down slope, the ends going down the slope should overlap by at least 3 feet.

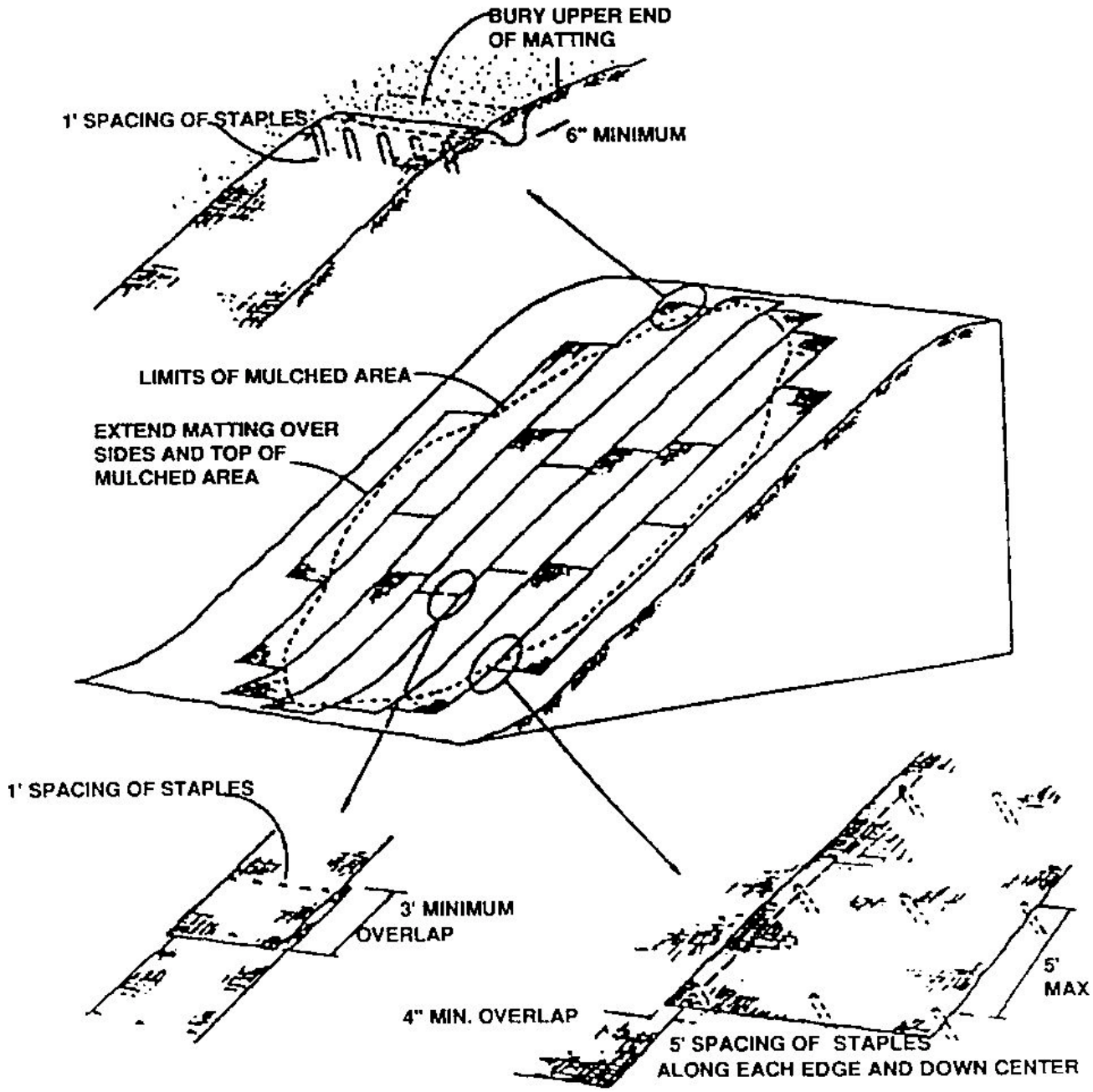
Anchor the netting to the soil surface with anchor pins or staples. Anchor pins are made of rigid 0.12–inch diameter or heavier galvanized wire with a minimum length of 10 inches for hook or “J” type pins. Staples should be of wire .09 inch in diameter or greater and should have “U” shaped legs that are at least 6 inches long. Longer staples are needed for sandy soils.

Staples or anchor pins need to be driven perpendicular into the slope face and should be spaced about 5 feet apart down the sides and center of the roll.

Spacing between staples at the upper end of a roll and at the end overlap of 2 rolls should not be greater than 1 foot.

The netting should go beyond the edge of the mulched or seeded area at least 1 foot at the sides and 3 feet at the bottom. If there is vegetation at the boundaries of the area, the netting should be continued into the stable vegetated area or to the edge of a structure.

Jute Netting



Sandbag Protection

An inexpensive temporary barrier or wall, 1 to 2 feet high, can be constructed by stacking sand-filled or earth-filled sandbags. They can be placed to divert mud and other debris flows away from buildings. They will not, however, provide protection from high debris flows.

When to Use

- To protect building sites vulnerable to low mud debris flows from steep, erodible slopes that are partially or completely void of vegetation due to wildfire burns.

- As an inexpensive, temporary protection method for home before predicted rainfall.

Note: Sandbags deteriorate when exposed to continued wetting and drying for several months. If the bags need to be used for more than a few months, cement can be mixed with the sand. The cement and sand mixture will harden when the bags dry.

Methods and Materials

Sandbag barriers are easy to construct. Burlap bags, sand, plastic, lumber, cement and plywood are readily available at local lumberyards. Some fire stations and other emergency centers can also help with materials.

Place filled sandbags to direct debris flows away from buildings, pools, and other structures. Clear a path for the debris. Do not try to dam or stop debris flows.

Protect your most valuable property first. Debris can enter a building through doors and windows, so they should be boarded up and waterproofed with plastic sheets. **Remember:** Sandbags will not seal out water.

Work with your neighbors and be prepared to use your property to provide good protection for the community.

How to Fill Bags

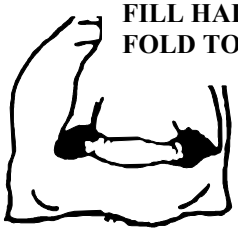
Fill sandbags one-half full. Use sand, if available, or, local soil. Fold the top of the sandbag down and place the bag on its folded top (see illustration).

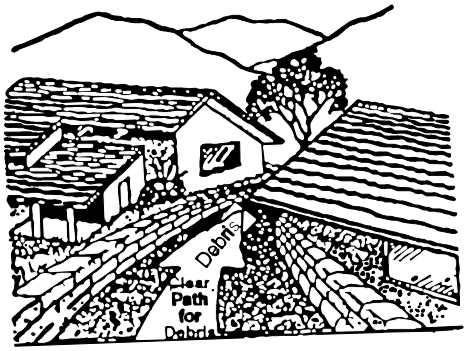
How to Place Bags

Refer to illustration. Place each sandbag as shown finishing each layer before starting the next. Limit placement to two layers unless they are stacked against a building or pyramided.

It is important to place bags with the folded top in the upstream or uphill direction facing the flow of water to prevent them from opening when water runs by.

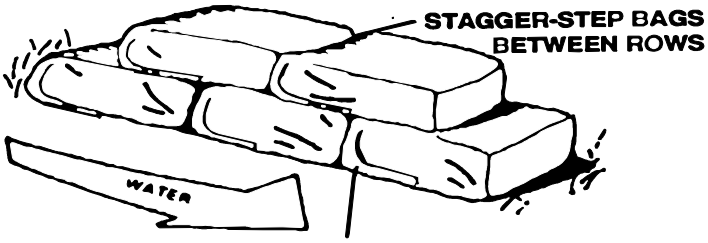
Sandbag Protection



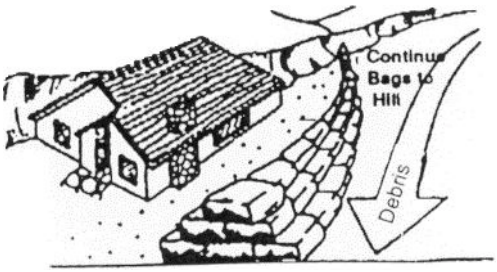


Sliding glass door sealing

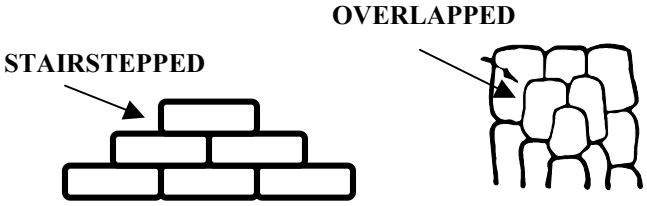
Directing flows between buildings

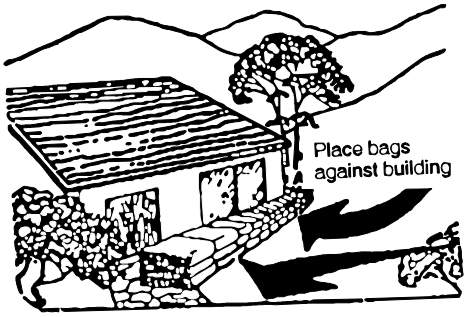


PLACE BAG WITH FLAP UNDER BAG

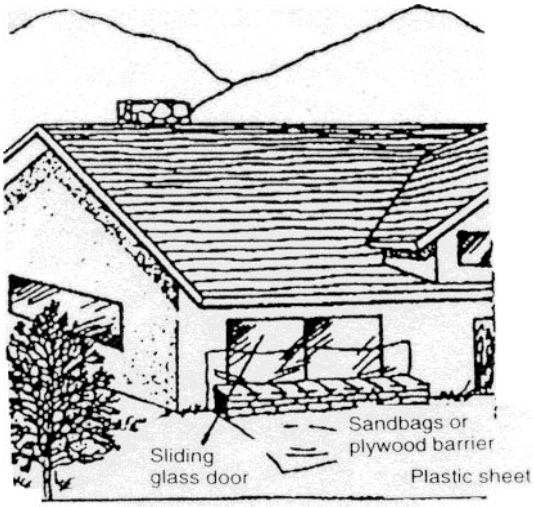


Directing debris away from buildings

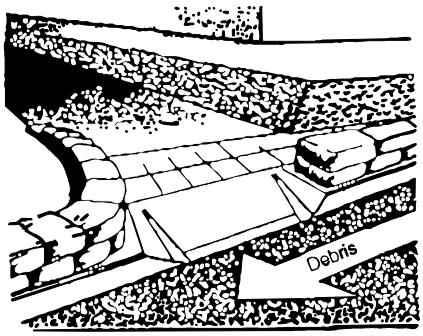




Building protection



Sliding glass door sealing



Controlling debris/storm flows in streets

Silt Fence

A silt fence made of woven wire and fabric filter cloth is a temporary barrier that can be used to catch sediment-laden runoff from small areas of disturbed soil.

Silt fences are easy to construct. Materials are available from hardware stores, nurseries, and lumber yards.

When to Use

Major considerations for use of silt fences are slope, slope length, and the amount of drainage area from which the fence will catch runoff.

Here are some design considerations:

Slope Steepness	Maximum Slope Length
2:1 = 50%	50 feet
3:1 = 33%	75 feet
4:1 = 25%	125 feet
5:1 = 20%	175 feet
<5:1 = <20%	200 feet

For longer slopes, add additional silt fences.

Drainage Area

The area that contributes runoff to be caught by the silt fence should not be greater than .5 acre for every 100 feet of fence.

Type of Runoff

Silt fences are designed to catch runoff that is in the form of "sheet flow," not "concentrated flow."

Sheet flow differs from concentrated flow in that the runoff is spread evenly over the ground surface, like a sheet, rather than concentrated in small rills or gullies.

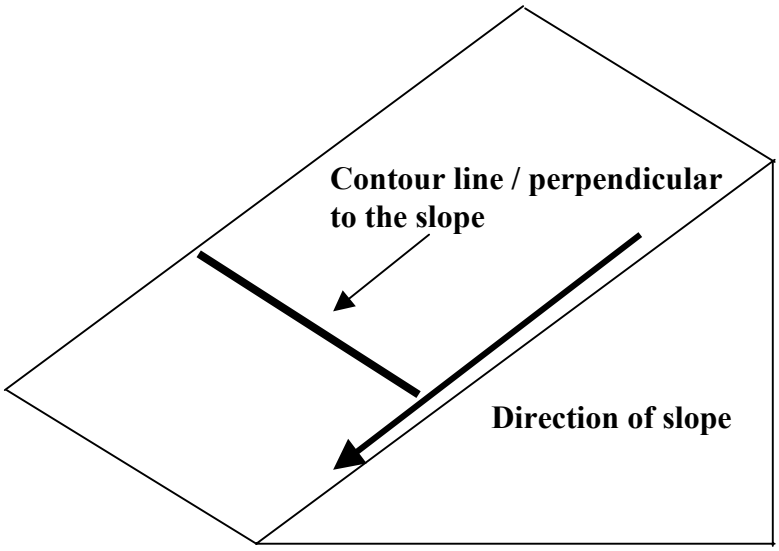
Methods and Materials

Fence Posts: Posts should be at least 36 inches long. Wood posts should be of hardwood with a minimum cross sectional area of 3 inches. Steel posts should be standard "T" or "U" section and should weight no less than 1 pound per linear foot.

Wire: Wire fence should be at least 14 gauge with openings no larger than 6x6 inches.

Extremely Important: Bury the fence at least 8 inches below ground level and install the fence following the contour (perpendicular to the slope).

Silt Fences are not permanent structures and **must** be maintained and/or inspected on a regular basis. Debris that is trapped behind the fence should be removed when the fence shows signs of bulges.

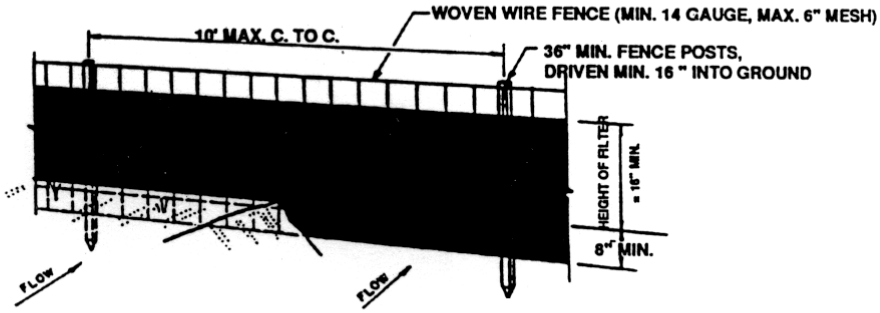


Silt Fence

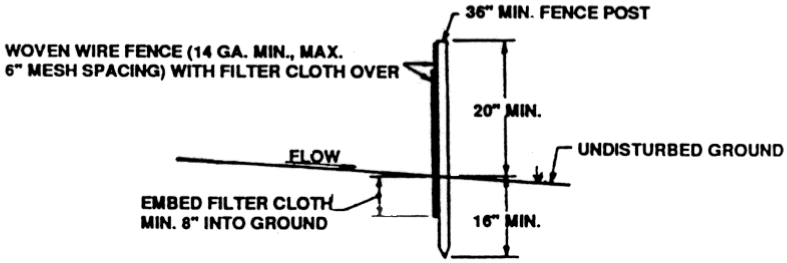
Fabric Properties:
Filter fabric properties should be as follows (hardware store personnel can help you with these):

Fabric Property	Minimum Acceptable Value	Test Method
Grab tensile strength (LBS)	90	ASTM D1682
Elongation at Failure (%)	50	ASTM D1682
Mullen Burst Strength (PSI)	190	ASTM D3786
Puncture Strength (lbs)	40	ASTM D751 (mod)
Slurry flow Rate (gal./min/sf)	0.3	
Equivalent Opening Size	40-80	US Std Sieve
Ultraviolet Rad. Stability	90	ASTM-G-26

Perspective View



Section View



Construction Notes

1. Woven wire fence to be fastened securely to fence posts with wire ties or staples.
2. Filter cloth to be fastened securely to woven wire fence with ties spaced every 24" at top and midsection.
3. When 2 sections of filter cloth adjoin each other, they shall be overlapped by 6" and folded.
4. Maintenance shall be performed as needed and material removed when "bulges" develop in the silt fence.

Straw Bale Check Dams

Straw bale check dams are temporary sediment barriers constructed of straw bales located across small drainages. They are temporary structures used to slow debris flows in small channels. They are not intended to provide protections from large storm events nor to control debris flows in water bodies such as creeks, streams, or rivers.

Planning Criteria

0-15% slope:
Maximum drainage area: 1acre
Maximum slope length between check dams: 200 feet

15 – 20% slope:
Maximum drain area: .5 acre
Maximum slope length between check dams: 100 feet

Greater than 20% slope
Not recommended

Methods and Materials

Bales should be bound with wire or nylon string. Jute twine bound bales are less durable. Place the bales in rows with ends tightly abutting adjacent bales. Bales should be made from clean weed free straw.

Downstream Row (see illustration): Dig a trench across the small channel, wide enough and deep enough so the top of the row of bales placed on their long wide side is level with the ground.

The tops of bales across the center of the channel should all be level and set at the same elevation. Place the bales in position and stake them according to the instructions that follow.

Upstream Row: Dig another trench across the small channel, upstream and immediately adjacent to the first row of bales. This trench should be wide enough to accommodate a row of bales set vertically on their long edge. It should be deep enough so that at least 6 inches of each bale is below ground, starting with the bale in the channel bottom.

The trench should be as level as possible so the tops of the bales across the center of the channel are level and water can flow evenly across them.

Continue this trench up the side slopes of the small channel to a point where the unburied bottom line of highest bale (point "C" in illustration) is higher than the top of the bales that are in the center of the channel (point "D" in illustration).

Staking

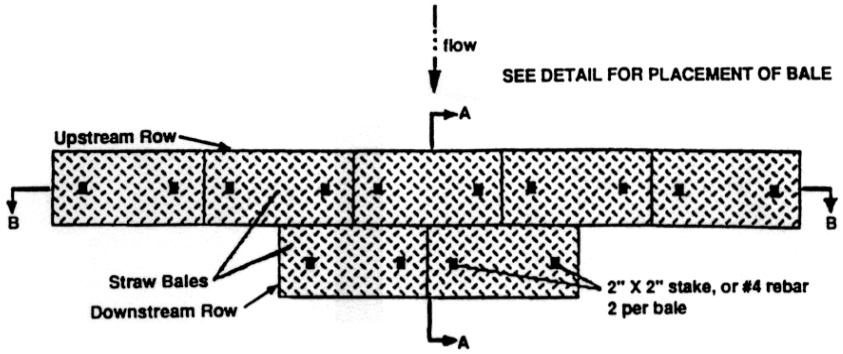
Drive 2x2 stakes or #4 rebar through the bales and into the ground 1.5 to 2 feet for anchorage. The first stake in each bale should be driven toward a previously laid bale to force the bales together (see illustration).

Maintenance

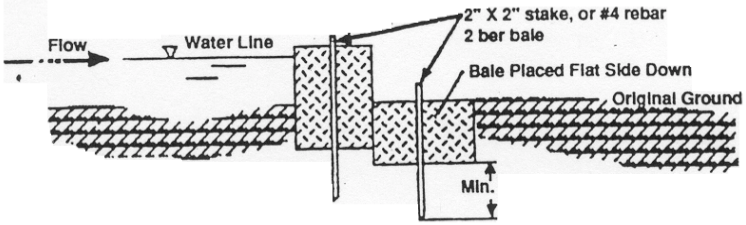
Inspect bale check dams after each storm period. Shovel work may be needed to rebuild the soil berm on the upstream side. Remove any loose straw so it does not enter storm drains.

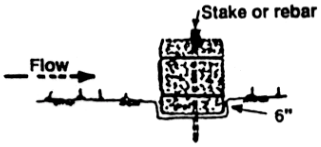
Remove the bales and stakes once vegetation, permanent drainage ways, and stabilization are re-established. Use the straw as mulch in other areas.

Straw Bale Check Dams



Section A-A

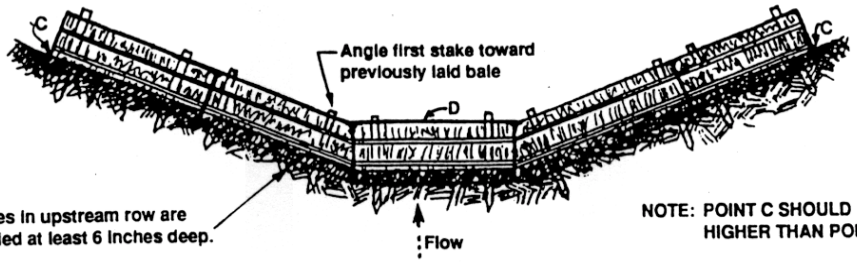




PLACEMENT DETAIL
UPSTREAM ROW

Remove #4 rebar after straw bales are no longer in place

Section B-B



NOTE: POINT C SHOULD BE HIGHER THAN POINT D

Straw Bale Dikes

Straw bale dikes are a temporary sediment barrier constructed of straw bales located downslope of a disturbed area or around a storm drainage outlet to redirect debris flows or trap debris materials.

They are usually installed in areas requiring protection from sedimentation expected from predicted rainfall events that will cause erosion.

They are intended to provide protection for a limited time, usually less than 3 months.

Installation Tips

Drainage area limits:

- **0-15% slope**: Maximum drainage area is 1 acre and maximum slope length is 200 feet.
- **More than 15% slope**: Maximum drainage area is ½ acre, maximum slope length is 100 feet.

Bind bales with wire or nylon twine (jute twine-bound bales are less durable). Bales should be made from clean weed free straw. Place bales in a row with ends tightly abutting adjacent bales. Do not place bales with wire or twine touching–see illustration. Compress some loose straw between adjacent bales to close voids. The tops of bales should all be level and set at the same direction.

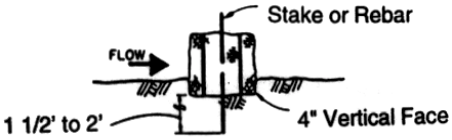
Staking

Each bale should be embedded in the soil a minimum of 4 inches. Drive 2x2 stakes or rebar through the bales and into the ground 1.5 to 2 feet for anchorage. The first stake in each bale should be driven toward a previously laid bale to force the bales together–see illustration.

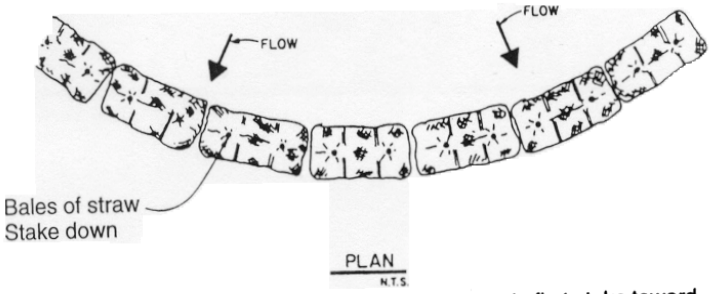
Maintenance

Inspect dikes and provide necessary maintenance following each storm event. It is important to ensure that loose straw does not enter storm drain facilities. Remove bales once permanent drainage and stabilization are re-established. Use the straw as mulch in other areas.

Straw Bale Dikes



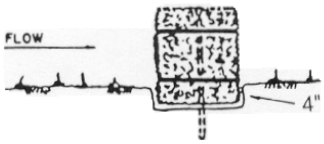
EMBEDDING DETAIL
N.T.S.



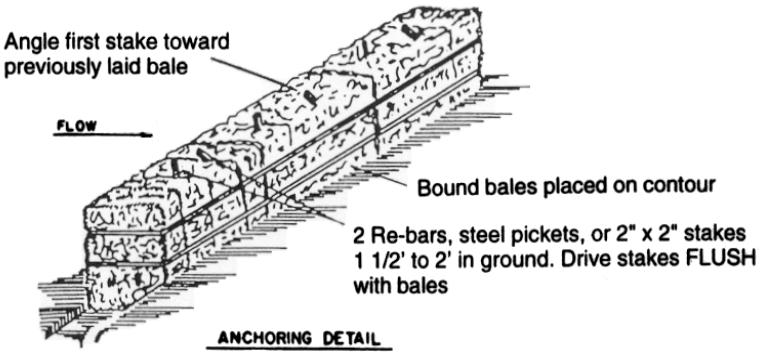
PLAN
N.T.S.

ELEVATION
N.T.S.

STRAW BALE DIKE



BEDDING DETAIL



ANCHORING DETAIL

Straw Mulching

Straw mulching should be used on slopes that have been seeded and have high potential for erosion. It will provide a protective cover to reduce erosion, increase water infiltration, and aid in revegetation.

Mulching requires some type of anchoring by matting, crimping, or other methods to prevent the straw from blowing or washing away.

Straw mulch forms a loose layer when applied over a loose soil surface. To protect the mulch from wind drifting or being moved by water, it must be covered with netting such as jute, punched into the soil with a spade, roller, or mulch tucker, or sprayed with a tacking agent.

Straw mulch should cover the entire seed or bare area and extend into existing vegetation or be stabilized on all sides to prevent wind or water damage which may start at the edges.

Methods and Materials

On gentle to moderate slopes, straw mulch can be applied by hand broadcasting to a uniform depth of 2-3 inches. On steep slopes, the straw should be blown onto the slope to achieve the same degree of cover.

When applied properly, about 5 to 10% of the original ground surface can be seen. The application rate per acre should be about 2 tons, or one 74–pound bale per 800 square feet. Straw should be clean weed free barley or wheat straw.

Anchoring

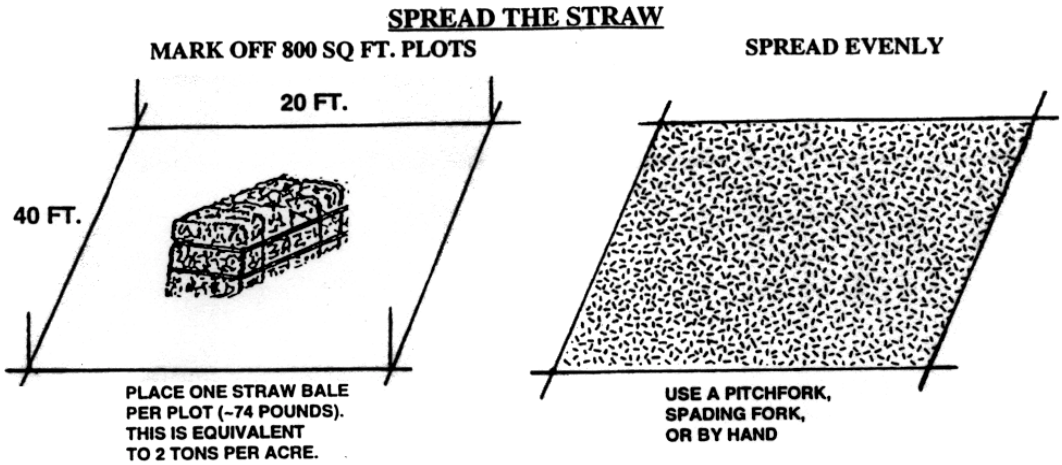
Hand Punching: Use a spade or shovel to punch straw into the slope until all areas have straw standing perpendicularly to the slope and embedded at least 4 inches into the slope. It should be punched about 12 inches apart.

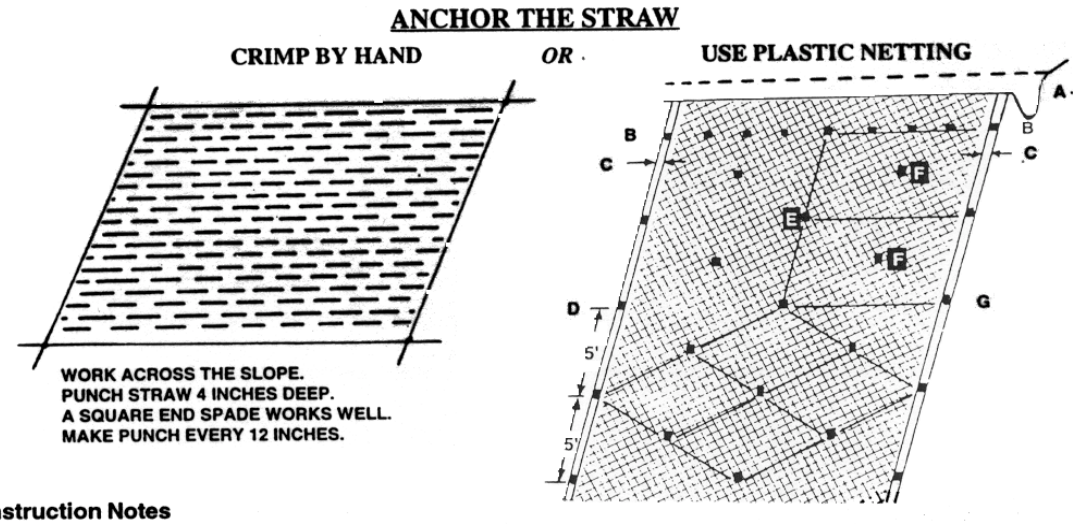
Roller Punching: A roller equipped with straight studs not less than 6 inches long, from 4-6 inches wide and about 1-inch thick, is rolled over the slope.

Crimper Punching: Like roller punching, the crimper has serrated dish blades 4-8 inches apart that force straw mulch into the soil. Crimping should be done in two directions with the final pass across the slope.

Matting: Use on large, steep areas that cannot be punched with a roller or by hand. Jute, wood excelsior, or plastic netting can be applied over unpunched straw.

Straw Mulching





Construction Notes

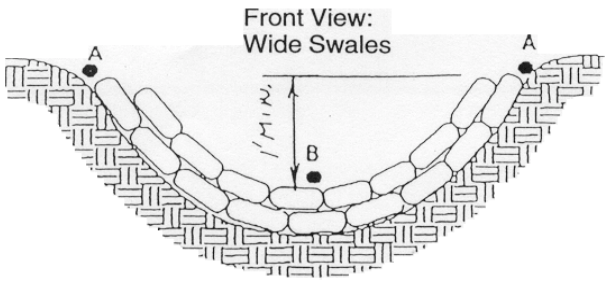
1. Lay matting in strips down the slope over the straw. Bury upper end in 6-8 inch deep and wide trench. Most netting comes in 14-17 feet wide rolls.
2. Secure the upper end with stakes every 2 feet.
3. Overlap seams on each side 4-5 inches.
4. Secure seams with stakes every 5 feet.
5. Stake down the center every 5 feet.
6. Stake middles to create diamond pattern that provides stakes spaced 4-5 feet apart.
7. Use pointed 1x2 inch stakes 8-9 inches long. Leave 1-2 inch top above netting or use "U" shaped metal pins at least 9 inches long.
8. When joining 2 strips, overlap upper strip 3 feet over lower strip and secure with stakes every 2 feet like in "B" above.

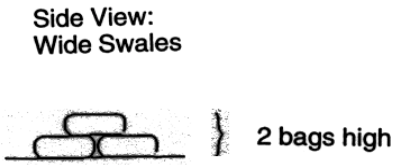
Burlap Bag Check Dams

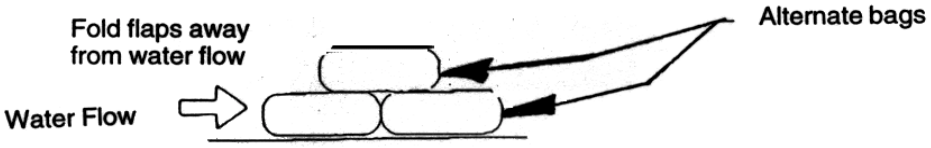
Gravel-filled bags can be used to construct sediment barriers, diversions, and basins on slopes up to 25%.

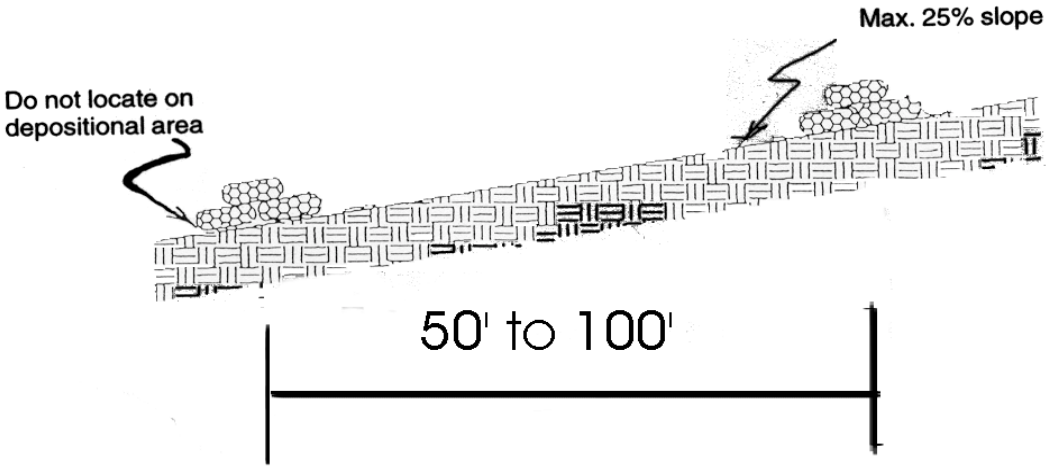
Bags should be made of burlap material. Fill material can be coarse sand or gravel.

Place the bags in layers, with each layer overlapping the joints in the previous layer, and packed tightly. Fill the bags one-half full. Tie or fold down the top of the filled bag. If folded, place the bags with the folded top in the upstream or uphill direction, facing the flow of water. Limit placement to 2 layers high.









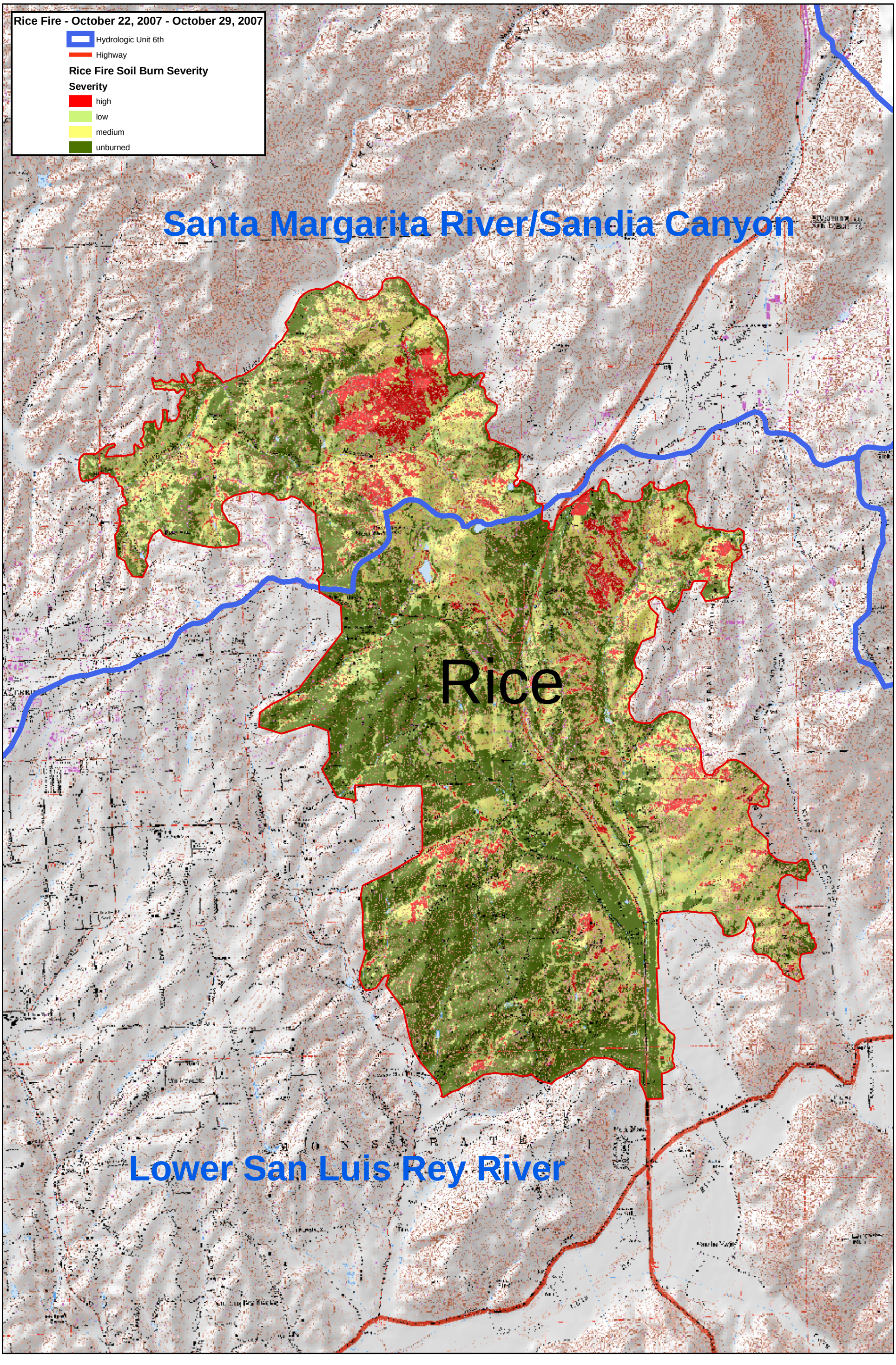
Lori Gustafson
November 10, 2007
1647 Hours
Teale Albers NAD 1927

Rice Fire: Soil Burn Severity

1:42,145

0 0.5 1 2 Miles

4



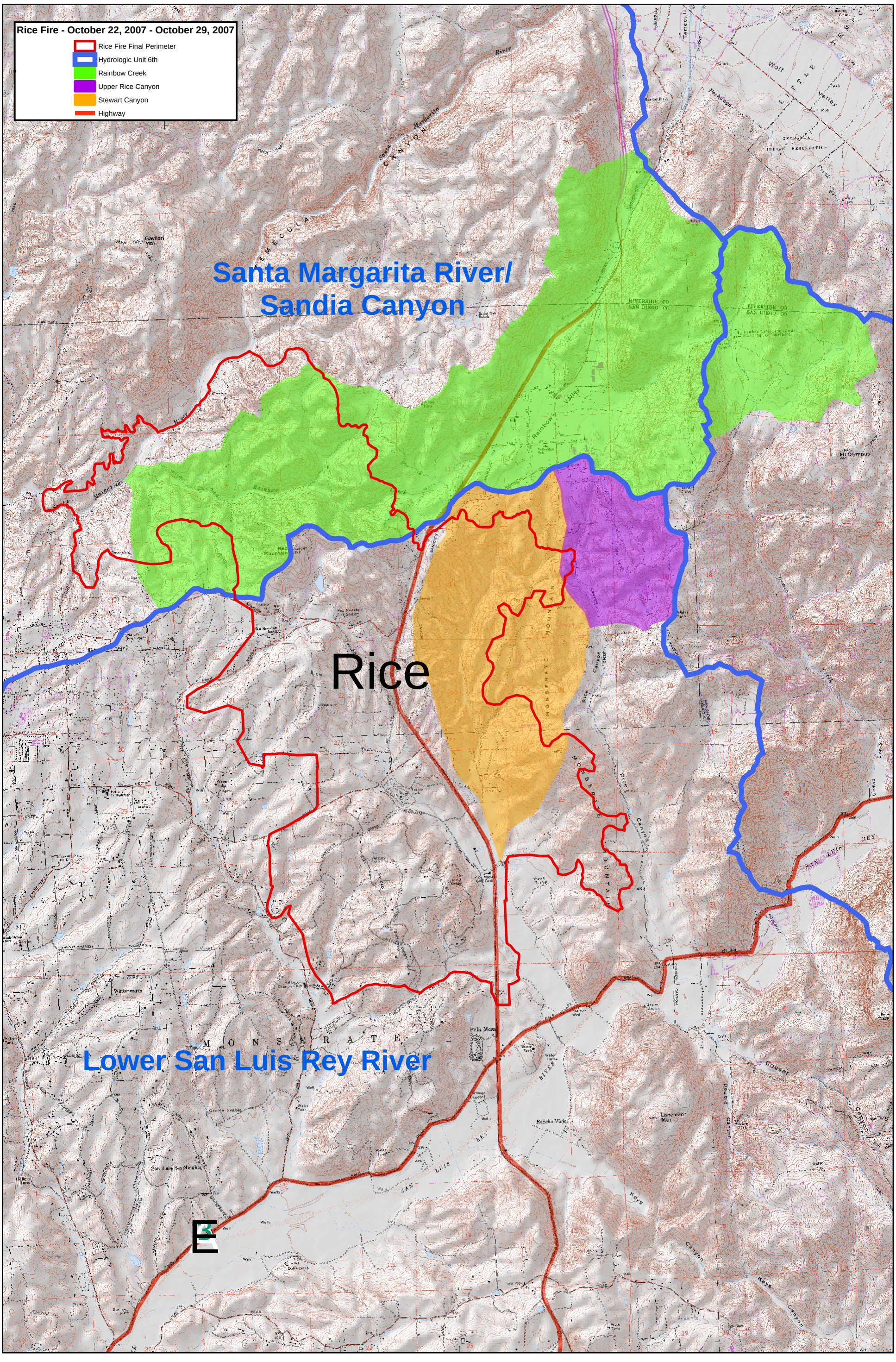
Lori Gustafson
November 10, 2007
2032 Hours
Teale Albers NAD 1927

Rice Fire: Subwatersheds of Concern

0 0.5 1 2 Miles

1:52,490

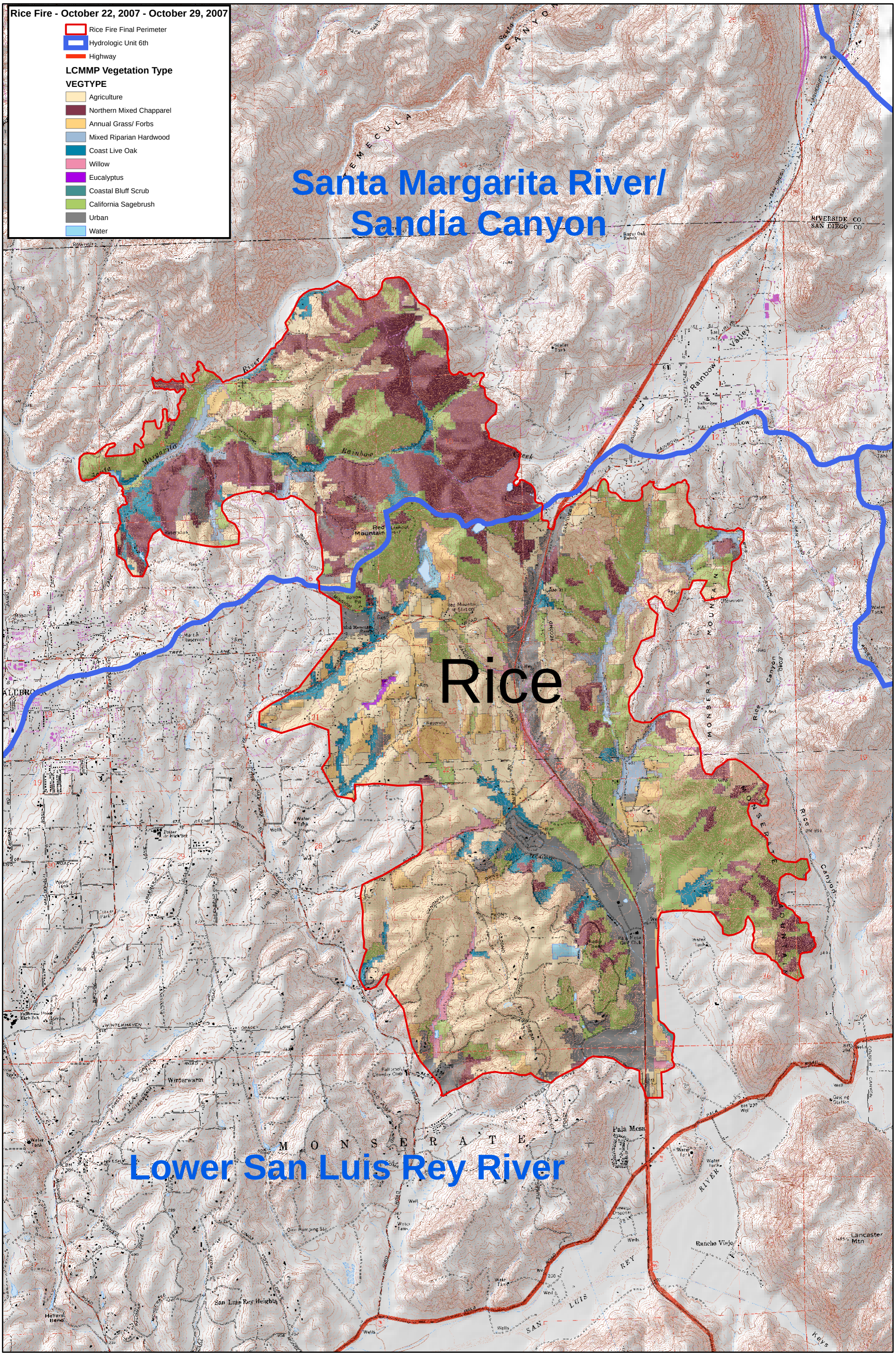
4



Lori Gustafson
November 10, 2007
1721 Hours
Teale Albers NAD 1927
LCMMP, Vegetation Data
California Dept. of Forestry and Fire Protection and
USDA Forest Service, 2005

Rice Fire: Vegetation Types

1:41,917

0 0.5 1 2 Miles

4