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Title: Emergency Rehabilitation Efforts Resulting From the Cerro Grande Fire at the Los Alamos National Laboratory

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INTRODUCTION

On May 4, 2000, in the late evening, fire personnel at Bandelier National Monument, National Park Service, ignited a prescribed fire with an approved plan. Firing and line control occurred during the early morning of May 5. Sporadic wind changes caused some spot fires within the contained area on the upper eastern fire line to spread. Because of these spot fires, the prescribed fire was declared a wildfire during the afternoon of May 5. On May 7 winds increased significantly from the west and resulted in major fire activity and ultimately caused the fire to move out of control to the east on the Santa Fe National Forest.

In its most extreme state on May 10, the Cerro Grande Prescribed Fire was carried by very high winds, with embers blowing a mile or more across the fire lines to the north, south, and east, entering Los Alamos Canyon towards Los Alamos, New Mexico. The towns of Los Alamos and White Rock were in the fire's path and more than 18,000 residents were evacuated. By the end of the day on May 10, the fire had burned 18,000 acres, destroying 235 homes, and damaging many other structures. The fire also spread towards the Los Alamos National Laboratory (LANL), and although fires moved onto the Facility's lands, all major structures were secured and no releases of radiation occurred. The fire also burned other private lands and portions of San Ildefonso Pueblo and Santa Clara Pueblo. The total acreage burned during this catastrophe is 47,650 acres.

CERRO GRANDE FIRE AFTERMATH

Many residents of Los Alamos were allowed to return to their homes on May 18th, after being displaced for over a week. The damage was substantial to the western and northern portions of town, and the community was in shock. Most of the residents had never experienced a disaster of this proportion in their lifetime, and the amount of work to cleanup, rehabilitate and stabilize what remained was staggering. The incredible effort to complete these tasks was performed in concert with several local, state and federal government agencies. A Burned Area Emergency Rehabilitation (BAER) Team was tasked with helping the community address the severe impact to the Santa Fe National Forest directly west of Los Alamos. A Forest Service led BAER team immediately began assessments of the surrounding Forest Service land as well as collaborating with the Laboratory to coordinate rehabilitation and flood mitigation efforts. The Laboratory focused on Laboratory assessments and protective actions while the BAER team focused on mitigation activities on Forest Service land. An unprecedented local volunteer effort also played a key role in completing rehabilitation work within the Los Alamos town site.

At first, only a few people were allowed on-site to begin the assessment of the damage to Laboratory property. The buildings, infrastructure and potentially contaminated sites had to be assessed for health and safety issues, burn severity and erosion. Soon thereafter, an Emergency Rehabilitation Team (ERT) was established to address the impacts within the Laboratory's 43 square mile boundary.

It is important to realize that when a fire destroys a large portion of land within a mountain setting, the flood damage potential is great. The Cerro Grande Fire occurred one month prior to the seasonal monsoons in Northern New Mexico; therefore, the urgency of installing appropriate run-on and runoff controls within the National Forest and the Los Alamos National Laboratory has been very high. The Army Corp of Engineers has played a large role in helping address the potential flood problems by installing several retention structures, weirs and other flood control devices.

BURNED AREA EMERGENCY REHABILITATION (BAER)

"BAER Teams are formed after major fires to assess damage caused by the fire and to implement a rehabilitation plan that will prevent loss of life and property and reduce further natural resource damage. BAER Teams are composed of highly skilled wildlife biologists, archaeologists, soils scientists, landscape architects, geologists, ecologists, engineers, foresters, botanists, GIS and GPS specialists and other disciplines from all over the Nation" (BAER Team Homepage).

A multi-agency team was formed to begin emergency rehabilitation for the Cerro Grande fire. The BAER team arrived on Monday, May 15, and began a preliminary assessment of the fire area. BAER team members include personnel from the U.S. Forest Service, Bureau of Land Management, National Park Service, United States Geological Survey and LANL. The Multi-Agency Coordination (MAC) team, which also was formed on May 15, included representatives from all the landowner agencies and acted as the umbrella organization during the assessment and rehabilitation. The goal of the MAC is to provide inter-agency communications and minimize red tape.

Following an assessment to evaluate the overall severity of the burn, short-term rehabilitation measures were initiated. The primary objectives were to prevent the loss of life and property and reduce further resource damage. The BAER team's focus is the potential for accelerated erosion and runoff from loss of vegetation and charred soils.

"One thing we look at is the hydrophobicity of the burned soils, the way water can be repelled by the soil," said Judy Hallisey, a forest hydrologist with the Forest Service. "We're concerned with the potential for flooding from rains and how that will impact infrastructure, roads and sediment transport, among other things."

Hydrophobicity can result from burning litter (organic matter = leaves and needles) which contains compounds such as lignin and other waxy compounds that vaporize. After the heat diminishes and the soil cools, the gases from the waxy compounds recondense forming waxy coatings on soil particles. This creates hydrophobic conditions where water absorption into the soil is greatly diminished.

Soil scientists and hydrologists toured the area of the burn from the air, and also conducted a digital color infrared study to develop burn severity maps. Preliminary review of the Los Alamos and White Rock areas indicated that road drainage culverts were inadequate to handle runoff anticipated from the burn area.

There are a variety of rehabilitation techniques that the BAER team recommended. Reseeding of ground cover, construction of straw bale dams for small streams, placement of fallen trees to catch sediments on steep slopes and digging of below-grade pits to catch runoff and sediments are the primary techniques used by the BAER team. The team also assessed the need to modify drainage structures such as installing debris traps, enlarging culverts, installing standup inlet pipes to allow drainage to flow if culverts become plugged, adding additional culverts and constructing emergency spillways to keep roads from washing out during floods.

Aerial Hydro Mulching

Colorado-based Western States Reclamation and Clovis, New Mexico-based Aero Tech, Inc. completed aerial hydro mulching on 1600 acres of the Cerro Grande burned area around Los Alamos, New Mexico. The hydro mulch and hydro seeding effort was a continuation of the Burned Area Emergency Rehabilitation Project. Hydromulching by air was completed on hillsides that have a grade

of 60% or more. This application is designed to speed up environmental recovery and reduce erosion of severely burned areas. Approximately 200 flights a day from the Los Alamos Airport applied close to 2,000 pounds of hydro mulch per acre. Hydro mulch is a mixture of water, mulch, fertilizer, seed and a tackifier. The mixture adheres to steep slopes and retains moisture to speed seed germination.

The National Park Service issued a contract in a multi-agency effort to apply additional rehabilitation treatments. Funding from the U.S. Forest Service, Department of Energy, and Bureau of Indian Affairs allowed aerial hydromulching to be completed on National Forest, Los Alamos National Laboratory and Santa Clara Pueblo lands. The Los Alamos National Laboratory received two applications on 150 acres, equaling a total of 300 acres.

The single engine air tankers (SEATs) were originally designed for crop dusting, but have also been used to drop fire retardant as well as aerial hydro mulching and seeding. Each plane carries about 800 gallons of mulch, which weighs from 7,000 to 8,000 pounds. It takes the ground crew a minute to load and fuel an air tanker. The pilots taxi the plane for a minute landing and minute for take-off. They average about nine minutes flying time for a total of 12 minutes for each run.

The pilots travel at 200 mph to the drop point. The hydromulch mixture is released at approximately 115 mph and an altitude of 100 feet. Each aircraft is outfitted with the SAT-LOC (satellite lock) system that uses the global positioning system (GPS) to track and document its entire flight path and location. Each drop path is about 27 feet wide.

Aero Tech used at least four 802 Air Tractor air tankers. The yellow, one-seater aircraft flew successive flights throughout July. Around 7000 flights were required to complete the work. Large water and mixing tanks were temporarily placed at the airport to support the operation. Aero Tech was also contracted to apply aerial seed on the burned area immediately following the fire (Los Alamos Monitor, July 2000)

LOS ALAMOS NATIONAL LABORATORY EFFORTS

Subsequent to the early formation of a rehabilitation steering team and five focus teams, Laboratory Director John Browne announced June 2 the establishment of a Laboratory Emergency Rehabilitation Team (ERT). The ERT directed an aggressive program to address potential impacts of increased runoff resulting from the Cerro Grande fire and to look at potential long-term issues arising from the fire.

The three primary goals of the ERT are:

- Protect human life
- Minimize the movement of contamination off Laboratory property
- Protect Laboratory facilities and infrastructure

To achieve these goals, the Laboratory took actions that will prevent water from rushing down the canyons and (where possible) prevent significant erosion.

Advice From Outside Experts

In addition to the BAER team, the Laboratory has been closely consulting with outside experts to determine how to best approach this problem. In particular, the U.S. Army Corps of Engineers has studied the watersheds and the land and is recommending engineering solutions to slow down the flow

of water to protect facilities and infrastructure and to minimize the potential for the movement of contaminated sediments downstream.

Facility & Waste Operations Division – Environmental, Safety & Health Division Efforts

The Facility & Waste Operations Division (FWO) is responsible for overall management of the fire rehabilitation effort within the Laboratory. Several Groups within the Environmental, Safety & Health Division supported the implementation of rehabilitation efforts. The following table details the treatments performed to-date within LANL;

Table 1. Treatment Details (approximate values)

Treatment	Acres	Amount	Total
Arial Seeding	650	36 lb/acre	13000 lb
Arial Hydro mulching	150		
Hydro mulch		2000 lb/acre	300000 lb
Tackifier		240 lb/acre	36000 lb
Seed		72 lb/acre	10800 lb
Truck Hydro mulching	125		
Hydro mulch		2000 lb/acre	250000 lb
Tackifier		240 lb/acre	30000 lb
Seed		35 lb/acre	4375 lb
Rehabilitation by Hand	654		
Hand Seeding	350	35 lb/acre	12250 lb
Wattles	654	125,000 linear ft	125000 linear ft
Straw Bails	620	3200 bales	3200 bails
Raking	350	NA	NA
Contour Tree Felling (besides hand rehab above)	100	NA	NA
Total Acreage*	**1300**	NA	NA

*Note: The acreage listed above is per unit treated. Several of the units required a combination of treatments.

Aerial and hand seeding were done using the BAER seed mix. This mix includes both annual and perennial seed (30% annual rye grass, 30% mountain brome, 30% slender wheat grass and 10% barley). Hydro mulching by air was completed on LANL property along specified canyon walls in Pajarito and Water Canyons and on areas that were steep and inaccessible by road. Land hydro mulching was done on ground that was steep but had easy road access. The hydro mulching application includes seed, hydro mulch, water and tackifier.

The land treatment done by the rehabilitation crews included removal of hazard trees, contour falling, contour raking, seeding, straw mulching, placement of straw wattles on contour (20' biodegradable mesh tubes filled with straw), log structures and rock check dams. The mulch (hydro mulch or straw mulch) is used to cover the raked and seeded areas in order to provide a place for seed germination. Land rehabilitation treatment such as tree felling, raking, wattle placement, log structures and rock check dams are all done on the contour in order to decrease erosion caused by water runoff. The treatment descriptions are as follows (BAER Technical Reference Guide, Cerro Grande Fire):

Seeding - BAER seed mix was applied by rehabilitation crews using hand-seeders set to apply seed at a rate of 35 lbs/acre.

Contour raking – Was performed to increase precipitation infiltration rates on hydrophobic soils.

Straw mulching - Straw mulch was applied where the fire consumed the pre-burn ground cover and the expected overland runoff would threaten areas at risk. First year effectiveness includes, stabilizing ashes onsite, preventing loss of topsoil, improving infiltration rate and replacing organic litter consumed by the fire. Burn areas are usually flood source areas and therefore mulching has a secondary benefit of controlling flood peaks to an acceptable level.

Straw wattles - Placed on slopes to act as terraces to prevent slope erosion and to facilitate revegetation. Straw wattles act as grade control structures in stream channels with flatter gradients, finer streambed materials or in streams with uneven bottoms.

Log structures and Rock check dams - Used as stream channel control structures. Their purpose is to reduce water velocity, thereby reducing the in-channel erosive force to prevent down cutting and to capture sediment of the stream-flow.

Contour tree felling - The contour tree felling was done on two types of slope conditions. Situation 1: Moderately sloping to steep slopes that have hydrophobic soil conditions (moderate/high burn severity), and there are few down trees or surface rock to protect soil surface. The sites must also have adequate standing tree size (6-14 inch d.b.h.), and adequate tree numbers per acres (30 to 40). Steep to very steep slopes where erodable soils occur, few down trees are present, standing tress number/size are present, and putting the minimum personnel on the slope due to safety concerns is a priority.

Environmental Restoration Project Activities to Reduce Potential Movement of Contamination

Established in 1989 as part of a Department of Energy nation-wide program, the LANL Environmental Restoration Project is designed to find out if hazardous chemical and/or radioactive wastes are present as a result of past LANL operations. Those sites where such materials are still found and that require remediation are being cleaned up in order to protect public health and the environment, in accordance with the requirements of LANL's Hazardous Waste Facility Permit.

In general, the contaminants found in potential release sites were deposited during the 1940s and 1950s. Over the course of the last 50 years, soil and other materials have been deposited on top of the contaminants, putting them at least 12 -18 inches below the surface at most of the sites. Initial reports indicate that the fire burned only the top 3 inches of the ground in most places. Thus, it may be unlikely that contaminants would have been released from most sites that were burned.

- The majority of the sites have been evaluated and a large percentage was found to contain no contamination or insignificant quantities of chemical or radioactive contamination. The sites are called "potential release sites," or PRSs, because they may or may not contain contamination.
- After the fire, New Mexico Environment Department and Laboratory crews evaluated all PRSs located in the burned area to see which ones had been touched by flame. The joint crews determined that 315 PRSs had been touched by flame in the fire. They then evaluated the 315 sites to determine which ones needed erosion control measures, called Best Management Practices, or BMPs.
- A review of previously completed Surface Water Site Assessments was performed to assess the "pre-fire" erosion potential of each of these PRSs (see "*Ranking Sites' Erosion Potential at Los Alamos*

National Laboratory", April 2000 Issue of Erosion Control Magazine for details of the assessment). Of the 315 PRSs affected by the fire, 91 were recommended for BMPs.

- Laboratory field teams have completed the placement of BMPs at the 91 PRSs. BMPs include the placing of protective jute matting, hand reseeding, rock check dams, log-silt barriers and straw wattles, as well as other actions to control runoff and erosion.

The issue with these sites is not the fire, but the aftermath of the fire. Soil and sediment will be displaced when rains begin to wash down the canyons. Soil erosion experts predict much heavier runoff in the canyons than before the fire. This is due to the inability of the soil and vegetation on the hillsides to absorb rainwater runoff that would have normally slowed its course into and through the canyons.

Rainwater runoff can displace these contaminated soils and sediments and transport them down the canyons and potentially off LANL property. LANL scientists are working together with the US Forest Service to evaluate this situation, and are now planning work to minimize the impacts of the expected floods prior to the beginning of the summer monsoons.

US ARMY CORP OF ENGINEERS

The U.S. Army Corps of Engineers is a major Army command with a broad set of missions and capabilities. One of its missions is to provide assistance, within its authorities, when natural disasters or other emergencies occur. Emergency preparedness and response is primarily a state and local responsibility. However, in instances when the nature of the disaster exceeds the capabilities of state and local interests, the Corps of Engineers may provide help to save human life, to prevent immediate human
suffering or mitigate property damage.

The geographically diverse location of Corps of Engineers offices nationwide assures an immediate response to disasters in any area. The Corps is divided by drainage basins into regional divisions. The divisions are subdivided by smaller drainage basins into districts. Personnel are also assigned to various field offices scattered throughout each district. During disasters, personnel in any locale may be quickly mobilized to assist in response and recovery work.

The following flood control projects are being completed by the Army Corps of Engineers within Los Alamos County (Army Corps of Engineers Website):

Low-Head Filter Weir Los Alamos Canyon – Construct low-head weir to retain sediment during high water flows.

Retention Dam in Pajarito Canyon– Installation of a, Roller Constructed Concrete (RCC) flood retention structure in Pajarito Canyon. One 42-inch culvert will extend through the base of the structure at the streambed, outflow will be restricted to less than 400 cfs.

Emergency Road Hardening– To protect the Hwy 501 crossing of Water, Two-Mile and Pajarito Canyons by hardening embankments using shotcrete.

LA Reservoir Drainage – The existing Los Alamos Canyon Reservoir was drained to accommodate the expected large volumes of runoff, ash and debris from the upper watershed. The dam embankment was hard armored.

Diamond Drive Crossing – Protect the Diamond Drive crossing of Pueblo Canyon by installing, "jacking and boring" a 432-foot, 86-inch steel pipe culvert through the existing embankment.

CONCLUSION

The Cerro Grande Fire was the largest and most destructive in New Mexico history. The devastation to the community, the forest and the Laboratory will not soon be forgotten. But there is a cause for optimism; the massive rehabilitation effort by volunteers, local/state/federal government agencies and the Los Alamos National Laboratory have been implemented before any substantial flooding has occurred. There may be additional setbacks along the way to recovery, but the community is beginning a long healing process.

SPECIAL THANKS

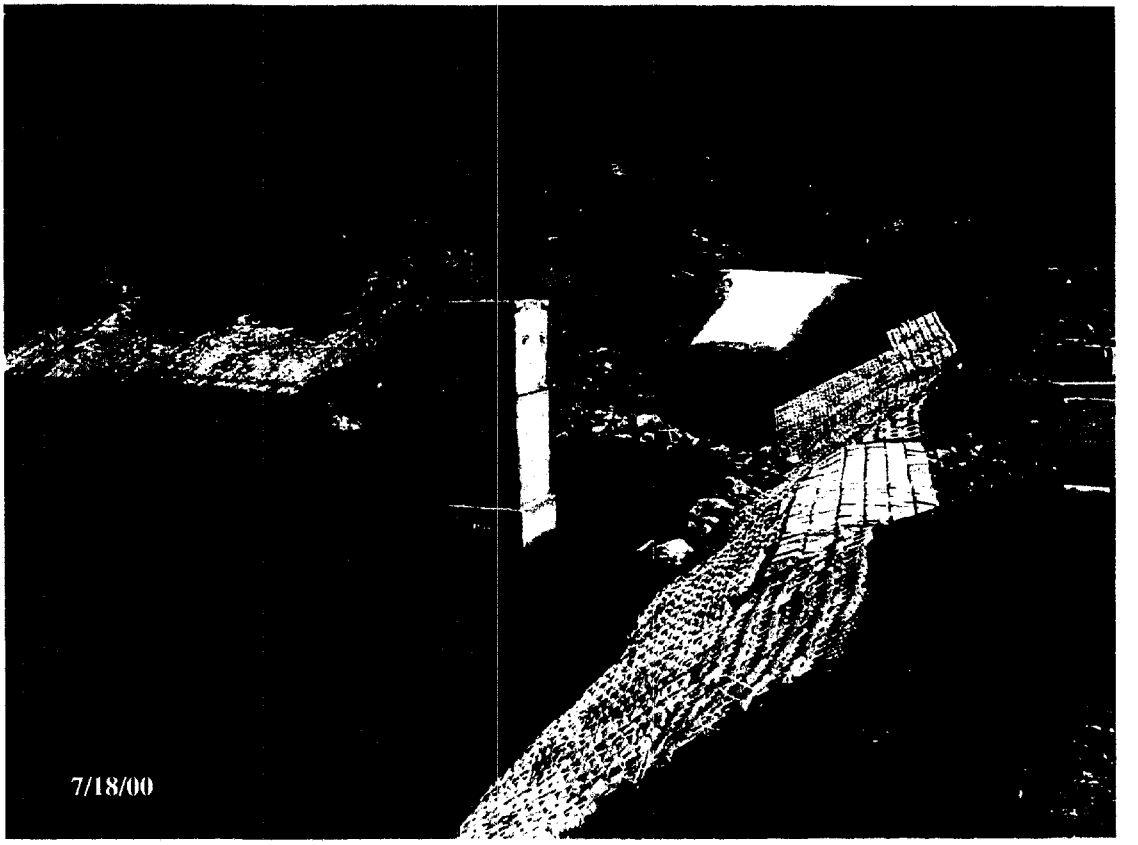
Several individuals deserve to be recognized for their efforts during the Cerro Grande Fire Rehabilitation. It is impossible to mention everyone who contributed to this major effort but all individuals, contractors and supporting agencies involved also deserve a special thank you.

Steve Mee
Mike Alexander
Jeff Walterscheid
Manny L'Esperance
Orlando Archuleta
Robin Reynolds
Mike Saladen
Deborah Apodaca
Kevin Buckley
James Covey
Tori George
Ken Mullen
Ed Hoth
Steve Rae
Sam Lofton

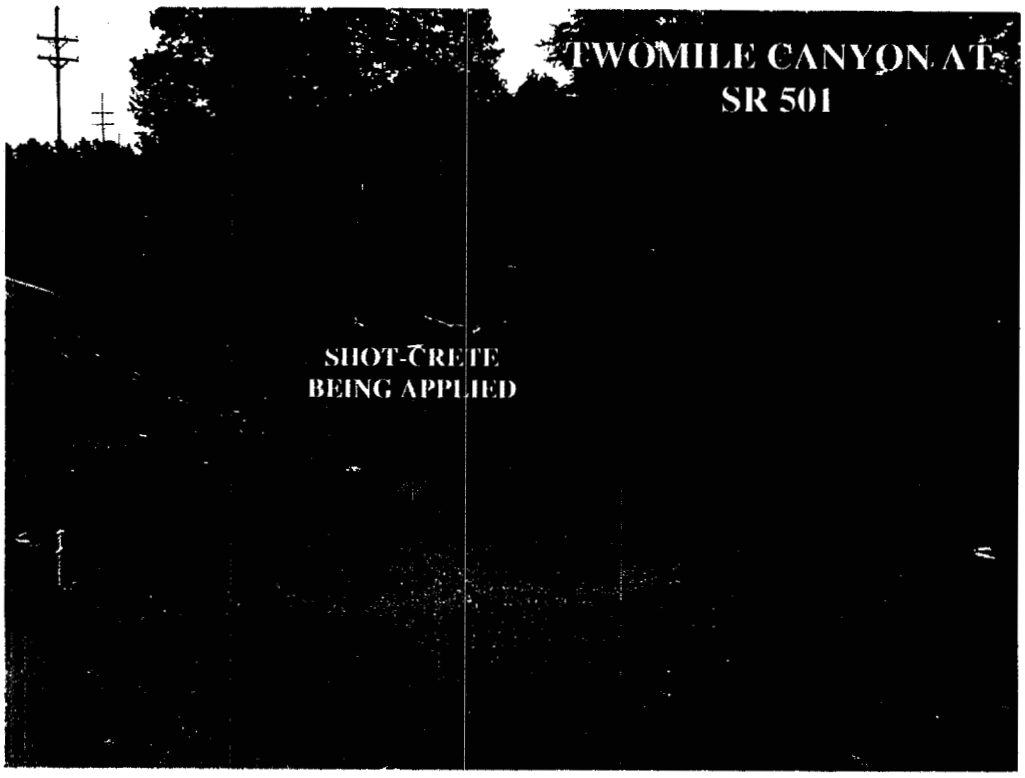
WEBSITES TO OBTAIN INFORMATION ON THE CERRO GRANDE FIRE

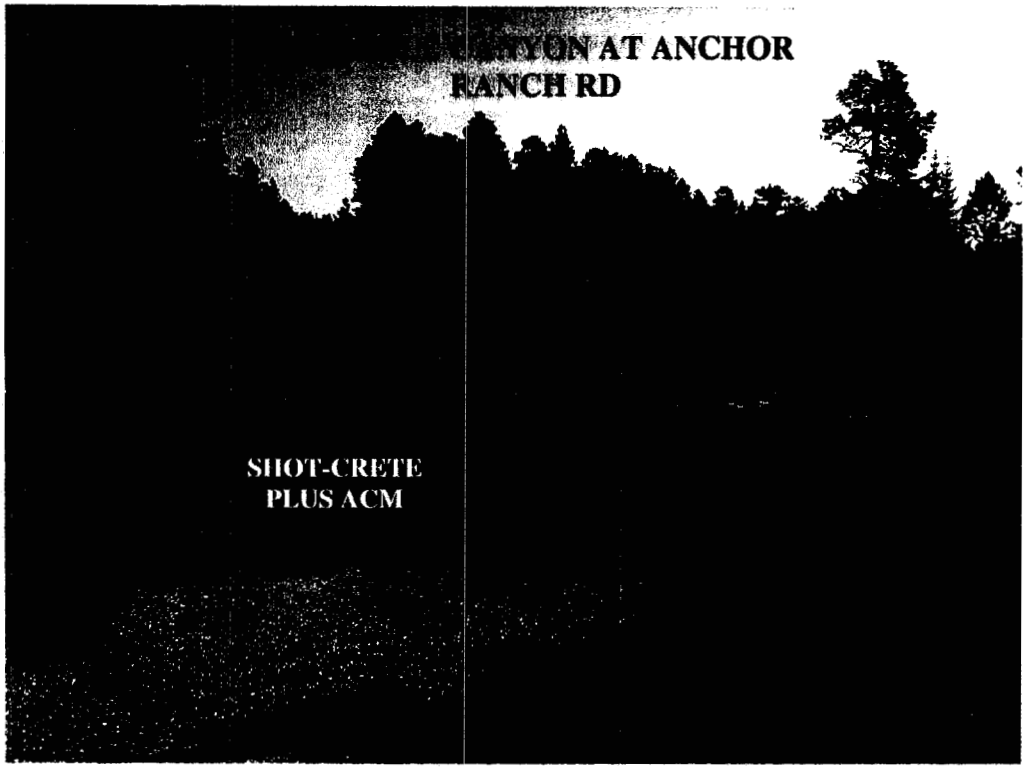
http://www.baerteam.org/cerrogrande/
http://www.nps.gov/cerrogrande/
http://www.lanl.gov/worldview/news/fire/ert/
http://www.spa.usace.army.mil/

ARMORING
LA RESERVOIR DAM

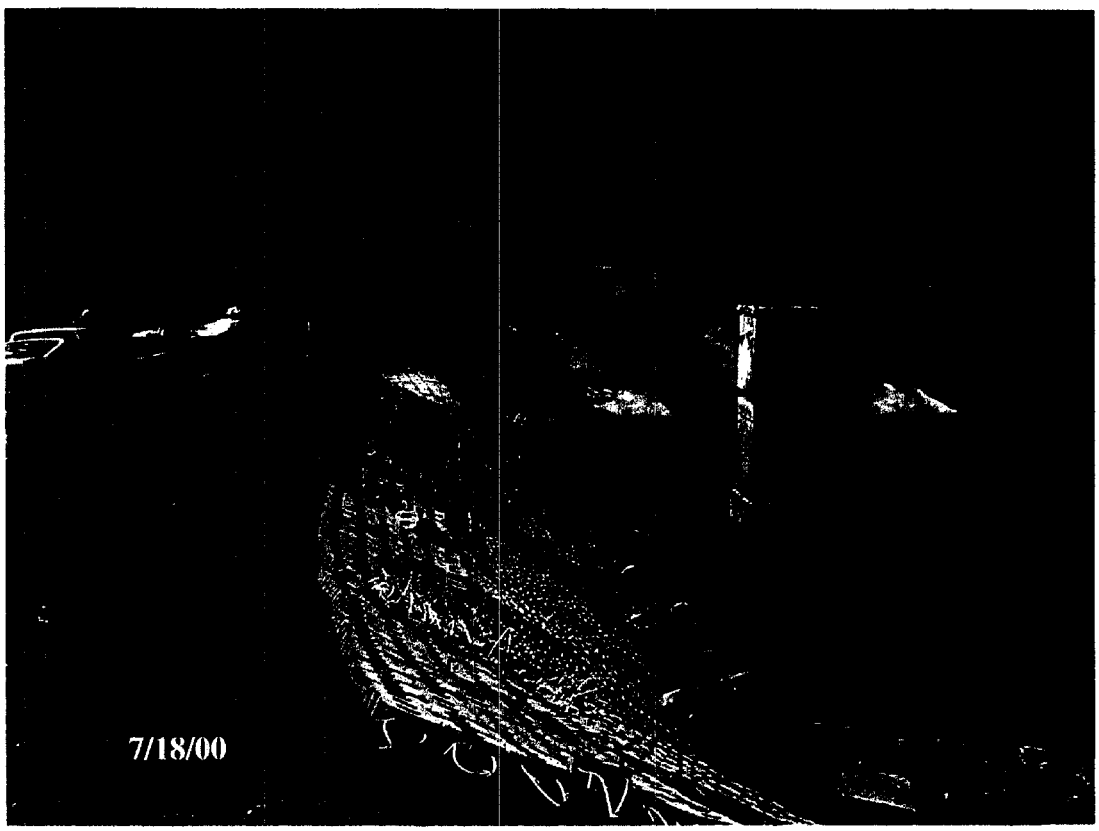


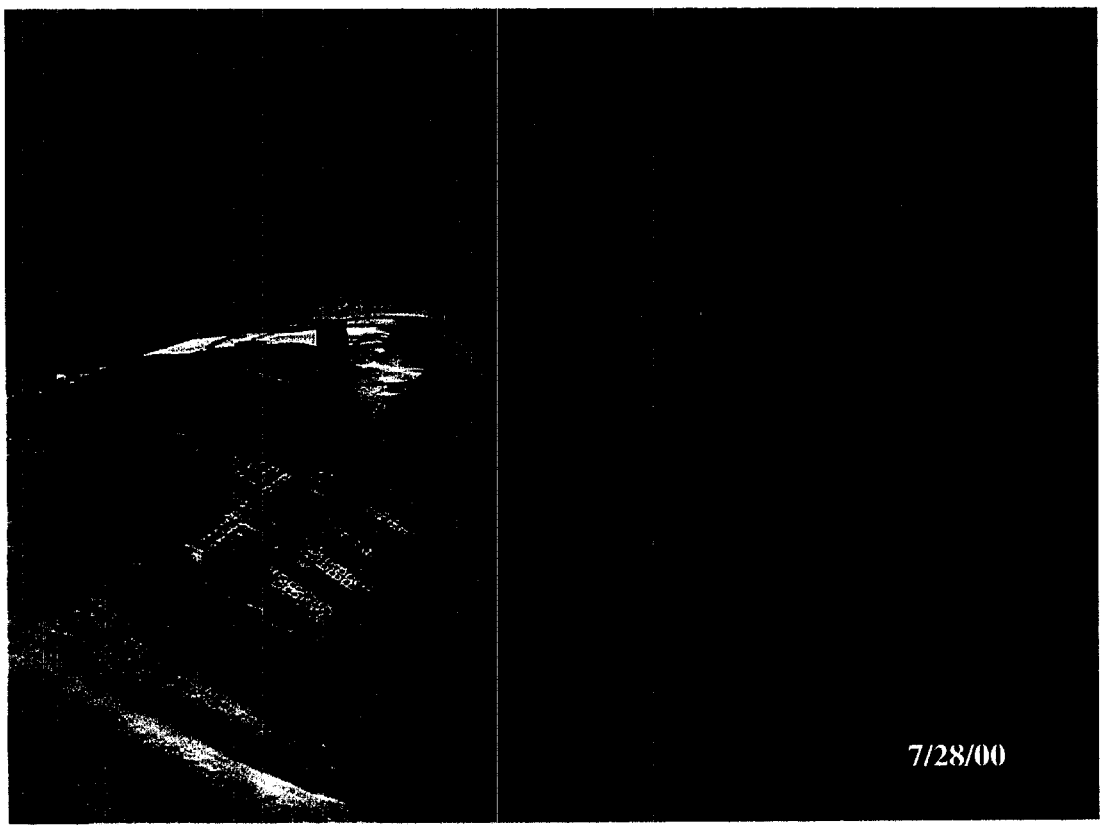
HARDENING

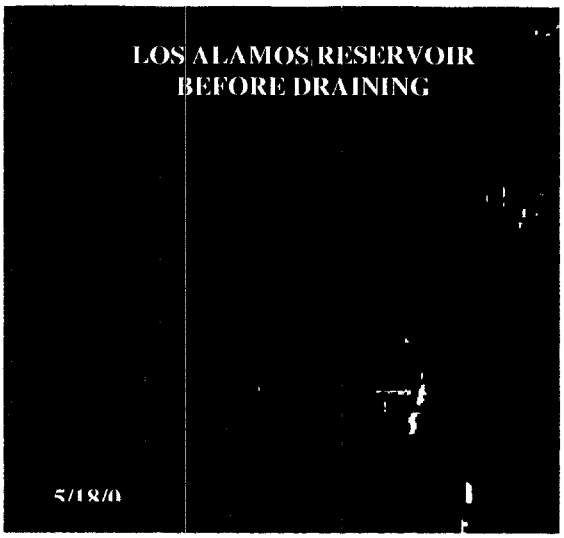

TWOMILE CANYON AT
SR 501
SHOT-CRETE
BEING APPLIED

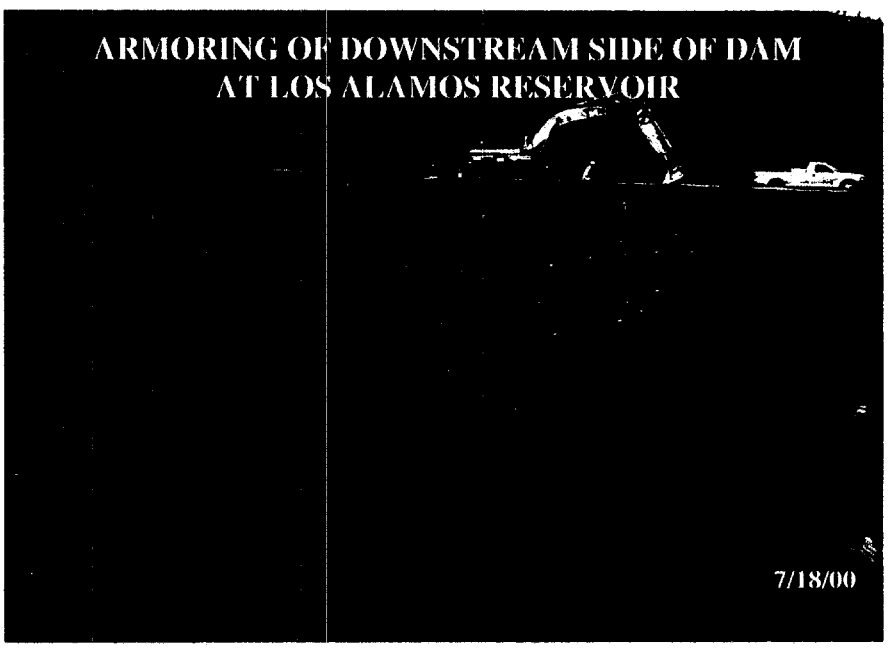

YON AT ANCHOR
RANCH RD
SHOT-CRETE
PLUS ACM

HARDENING OF LOS ALAMOS RESERVOIR DAM






LOS ALAMOS RESERVOIR
BEFORE DRAINING
5/18/0


ARMORING OF DOWNSTREAM SIDE OF DAM
AT LOS ALAMOS RESERVOIR
7/18/00


ARMORING OF UPSTREAM SIDE OF
DAM AT LOS ALAMOS CANYON
ARTICULATED
CONCRETE MATS (ACMs)
STANDING WATER FROM
STORM EVENTS
7/18/00

WEIRS/PONDS/BERMS