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ROADSIDE ECOLOGY

OF THE

PAJARITO PLATEAU AND JEMEZ MOUNTAINS



A Real or Virtual Tour

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Ecology Group

A Cooperative Effort between Ecology and Water Quality and Hydrology

ROADSIDE ECOLOGY OF THE PAJARITO PLATEAU AND JEMEZ MOUNTAINS

Driving the Loop from Bradbury Science Museum, State Route 501 to State Route 4 to State Route 502. (Views of forests burned by the Cerro Grande and La Mesa fires and Rehabilitation Efforts).

View 1: 15th and Central to the Mesa Public Library

View 2: West Jemez Road (501); from Ski Hill turn-off to State Route 4

View 3: State Route 4 to entrance to Bandelier National Monument from intersection with 501

View 4: Entrance to Bandelier National Monument to White Rock

View 5: White Rock to Bradbury Science Museum via 502

A Brief History of the Area

Geology and Hydrology of the Pajarito Plateau

Side Trip up the Ski Hill Road

State Route 501 to the Valle Grande within Valles Caldera National Preserve

Pajarito Road from State Route 4 to Technical Area 3

Other Links:

Bradbury Science Museum
http://www.lanl.gov/worldview/museum

Road Geology of selected sections of the Pajarito Plateau and the Jemez Mountains
http://geont1.lanl.gov/roadgeology/RoadGeology.html

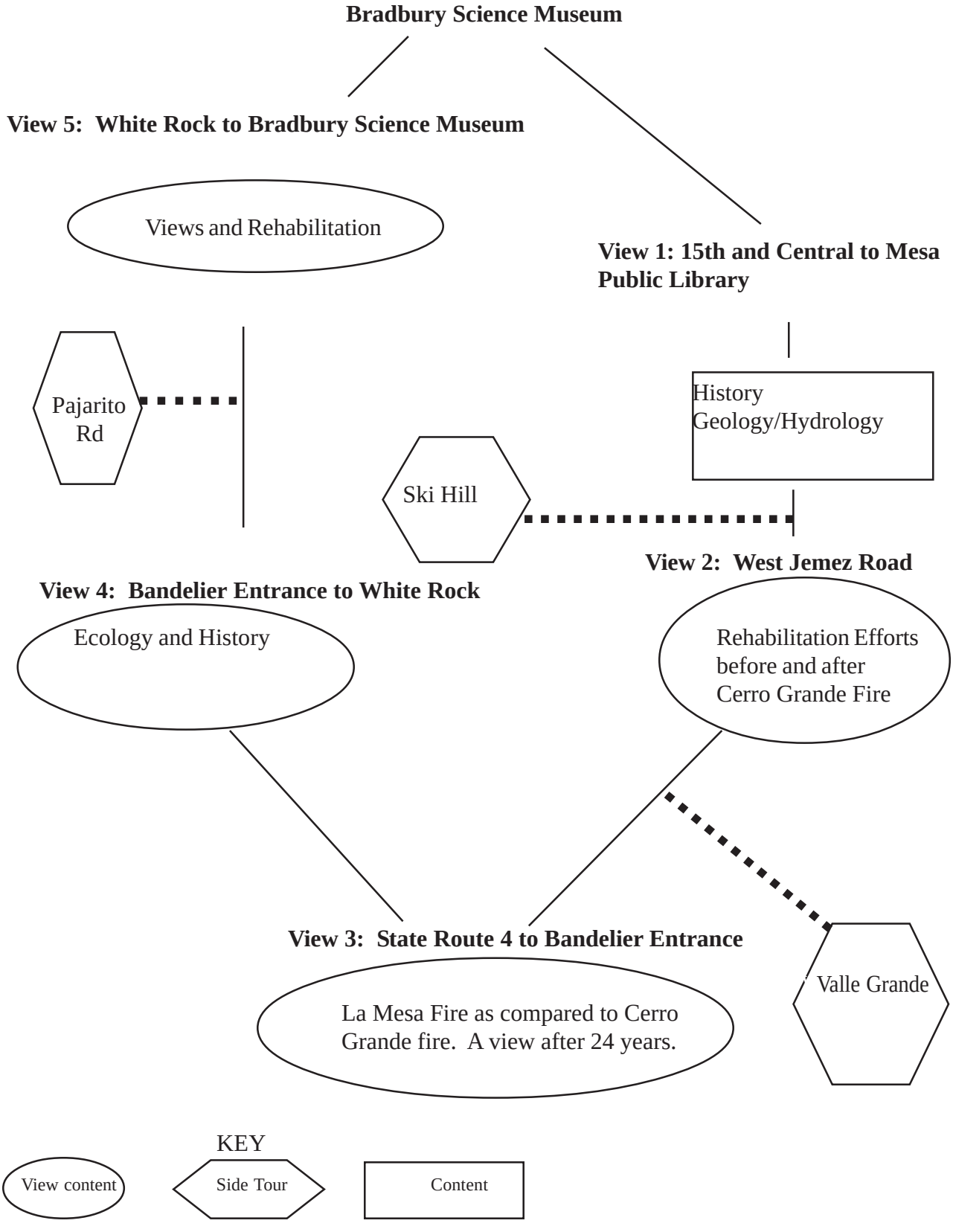
The Rio Grande Rift
http://tapestry.wr.usgs.gov/28riogrande.html

Valles Caldera National Preserve
http://www.fs.fed.us/r3/sfe/valles/

Trail Guides for the Mitchell Trail
http://www.esh.lanl.gov/%7Eesh20/pdfs/Mitchellhh.pdf

and American Springs Road and Trail
http://www.esh.lanl.gov/%7Eesh20/pdfs/AmericanSprings.pdf

DRIVING TOUR SCHEMATIC



PURPOSE OF THE TOUR

This driving tour has been developed for two purposes:

The first is to acquaint you with some of the ecology of the Pajarito Plateau on which Los Alamos National Laboratory sits. This tour can be used in conjunction with an auto driving tour established by Bradbury Science Museum in 1995 and a virtual tour they have developed on their web site (http://www.lanl.gov/worldview/museum/visiting.shtml).

The second is to share with you some major changes in the ecosystem of the plateau resulting from the Cerro Grande fire. The Cerro Grande fire began on May 4, 2000, as a controlled burn but escaped and burned 43,000 acres of the eastern slopes of the Jemez Mountains. Approximately one-third of the area was of high-intensity burn, that is, all the tree canopy was consumed. Since the fire occurred at an urban-forest interface, various rehabilitation efforts were done to prevent erosion. This tour will point out both pre- and post-fire mitigation efforts related to fire.

We have developed this both as a virtual tour and a driving tour. If you would like to take this material with you and drive to the locations specified, simply print it out.

Bradbury Science Museum has displays on the history of the Los Alamos area. For more information see their website at www.lanl.gov/worldview/museum/about.shtml.



Entrance to Bradbury Science Museum on 15th and Central.

THE BEGINNING

Bradbury Science Museum: We begin our journey from Bradbury Science Museum at 15th Street and Central Avenue.

VIEW I:

Ashley Pond and the Los Alamos Historical Museum: Travel west from the museum (take a right out of the parking lot) down Central to Oppenheimer Road. After you pass the post office on the right (north), you will see Fuller Lodge. This historic building was part of the Los Alamos Ranch School started by Ashley Pond in 1918. Today the Lodge is used for community functions and provides a reminder of the past. Next to the Lodge is the Los Alamos Historical Museum, which is also on the original Ranch School campus. In fact, all of the buildings along the road behind the museum were once part of the school.

To the left (south across Central Avenue) you will see Ashley Pond (named after Ashley Pond, the founder of the Los Alamos Ranch School) (Figure 1.1) This once was a muddy watering hole for domestic animals and a favorite swimming hole for Ranch School students. It remained a drab and unappealing place until it was landscaped in the 1960s. Today it provides a gathering place for feeding ducks, picnicking, and major community functions. To the west (right) side of the pond is the Los Alamos County Administration Building.

For further information on the history of the area go to A Brief History of the Jemez Mountains and Pajarito Plateau.

View of the Jemez Mountains from the Mesa Public Library Parking Lot: The Mesa Public Library is at the corner of Oppenheimer and Central. As you are driving down Central from the Bradbury Science Museum, turn right onto Oppenheimer into the parking lot of the library. Here you get a view of the mountains behind the townsite and Laboratory.

The extent of the results of the Cerro Grande fire behind the townsite of Los Alamos can be viewed from this spot. Pajarito Mountain is the tallest mountain in this view. Separating Pajarito watershed from Rendija and Guaje Mountains is Los Alamos Canyon (Figure 1.2). The mesas and canyons to the south (left) of Los Alamos Canyon are part of Los Alamos National Laboratory. Areas to the north (right) of the canyon are the townsite of Los Alamos.

Note how different the burn patterns are on either side of Los Alamos Canyon. The intense crown fire in areas behind Los Alamos is attributed to weather, wind, and pre-fire forest conditions.

Notice the greening of the mountain. Shrubs such as oak and seeded and native grasses provide the green tinge to the landscape (Figure 1.3).

You are viewing a portion of the east Jemez Mountains, which are a result of volcanism. Over a million years ago a 12,000-ft-high volcano erupted and spewed ash as far as Oklahoma. The ash formed a skirt at the base of the erupting mountain and is known as the Pajarito Plateau. This flat table-like plateau was eroded by forces of water, wind, and weather through the ages. Deep canyons separated by finger-like mesas were carved from the volcanic tuff. The area where the volcano once was subsided into a giant bowl shape, called a caldera, rimmed with remnants of the volcano. The mountains you see from the library parking lot are the rim of that caldera and are called the Sierra de Los Valles or the Jemez Mountains. These moutains range from over 9,000 ft in elevation. Tschicoma, the tallest, is over 10,000 ft. For more information on geology and hydrology of the area, go to Geology and Hydrology of the Pajarito Plateau, and for a geological tour go to http://geont1.lanl.gov/roadgeology/RoadGeology.html. The latter site provides a driving tour through the Pajarito Plateau and the Jemez Mountains, explaining some of the geologic formations.

These mountains were covered with thick forests of ponderosa pine and other conifers, including Douglas fir, white fir, Englemann spruce, and limber pine. Interspersed in the conifer forests are aspen stands, evidence of past fire. The tops of the moutains have meadows on the south-facing slopes created by weather patterns and historically maintained by fire.

Before 1900, fire was a frequent occurrence in the mountains of the area. Lightning was the primary ignition source, and tree ring studies have shown that the average fire frequency was one fire every five to ten years at any one location and larger fires every 20 years. After 1900, because of the settlement changes, impact from large herds of domestic animals, and development of urban-forest interfaces, fire was prevented or immediately extinguished, and many areas have not had fire for over 100 years. The forest systems were adapted to frequent fire and, when fire was excluded, the forests became dense and more fire prone. With increasing litter buildup and laddering, the forests are now prone to large, hot wildfires. Such was what occurred in May of 2000. After several years of drought, many years of fire suppression, and weather conditions, a massive, hot, and rapidly moving fire burned the area you are viewing. The fire not only burned the mountain with an intensity that reduced the forest to standing sticks but also burned into the community, dispossessing over 400 families of their homes.

For more information about fire and forest conditions in the Jemez Mountains, go to the following publications.

Out of the Ashes, A Story of Natural Recovery, LALP-00-20,
http://lib-www.lanl.gov/la-pubs/00367049.pdf

Fuels Inventories in the Los Alamos National Laboratory Region: 1997, LA-13572-MS,
http://lib-www.lanl.gov/la-pubs/00326553.pdf

Forest Surveys and Wildfire Assessment in the Los Alamos Region: 1998-1999, LA-13714-MS
http://lib-www.lanl.gov/la-pubs/00393579.pdf

For more information on the Cerro Grande fire, go to Cerro Grande Fire Recovery Information,
http://www.lanl.gov/worldview/news/fire

For walks you can take to see recovery of the area see trail guides to Mitchell Trail,
http://www.esh.lanl.gov/%7Eesh20/pdfs/Mitchellhh.pdf

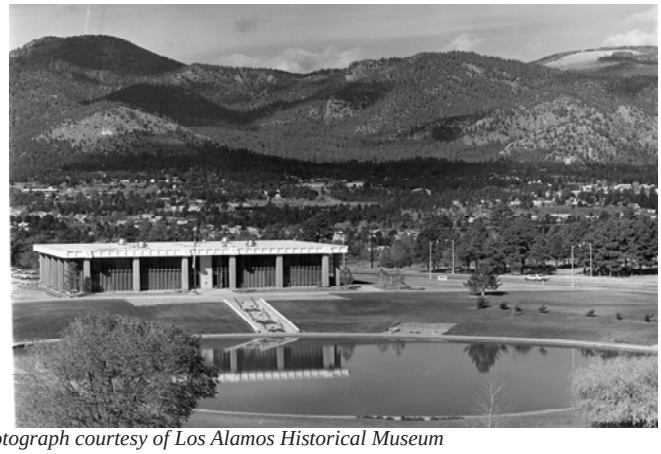
and American Springs Road and Trail,
http://www.esh.lanl.gov/%7Eesh20/pdfs/AmericanSprings.pdf

Figure 1.1: Historic pictures of Ashley pond.



Photograph courtesy of Los Alamos Historical Museum

a. Ashley Pond during the Ranch School Days.



Photograph courtesy of Los Alamos Historical Museum

b. Ashley Pond during the 1960s. (Note the pine-covered mountains in the background.)



c. Ashley Pond during the 1980s.

Figure 1.2: Mountain view from the library. Pictures taken July 2000.



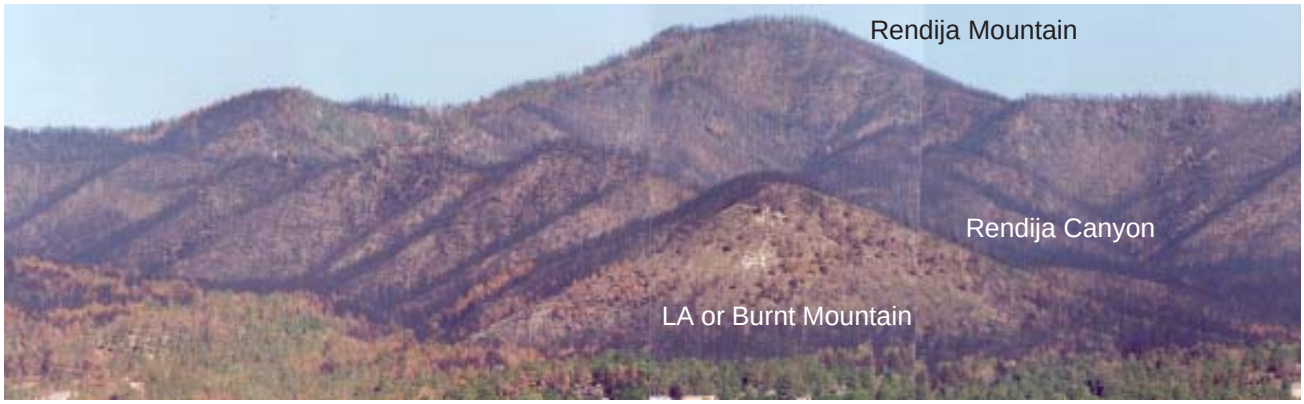




Figure 1.3: Greening of the mountain.



a. View of LA, or Burnt, Mountain.



b. Closer view, note shrubs.



c. Close-up view showing the sprouting shrubs.



d. Oak two months after the Cerro Grande fire.

VIEW 2: WEST JEMEZ ROAD (FROM SKI HILL ROAD TO STATE ROUTE 4):

Library to the Stoplight at Diamond and Trinity: As you leave the library parking lot, cut across Central and travel down Oppenheimer to Trinity (stoplight at Oppenheimer and Trinity). At the stoplight turn right and travel approximately one mile. At this point there is a stoplight and you will want to be in the left-side turning lane. Turn left and cross the bridge that spans Los Alamos Canyon. (This bridge was completed in the 1950s.) Get into the right lane. At the southern end of the bridge make a right-hand turn onto West Jemez Road. On the left along West Jemez Road you will see the administrative area for Los Alamos National Laboratory. Continue along West Jemez Road for approximately one mile. At this point there is a road to the right that provides access to Pajarito Mountain Ski Hill. If you wish to drive up this road, access information in this driving tour under Ski Hill Road.

Pre-fire Forest Treatment: Historically, ponderosa pine forests were a mosaic of open savannas with no more than 100 to 150 trees per acre in small, dense stands. The open forest was maintained by periodic and frequent fires. After fire suppression, most of the ponderosa pine forest grew into dense stands with 400 to 1,000 trees per acre. Characteristically, fire in the less dense stands would provide a cleansing of the understory and would not reach into the crowns of the trees. However, dense forested stands provide conditions for fires to reach into the tree canopy. Such fires crown into the tree tops and are hot and fast moving. After the 1996 Dome fire, there was a concerted effort to thin areas along State Route 501 and around many critical buildings within the Laboratory (Figure 2.1). All along West Jemez Road you will see the results of the thinning action. Laboratory land extends across the road for about 100 ft, and most of this four-mile stretch was thinned in 1998 and 1999 before the Cerro Grande fire. Forest Service lands west of the thinned area have had logging, previous fire (1954), and previous controlled burns. These thinned areas provided a critical barrier to Laboratory lands in the early days of the Cerro Grande fire. The fire did escape into the Laboratory near Water Canyon, an area previously burned by the La Mesa fire in 1977, but now shrub-laden and unthinned.

Rehabilitation After Fire: The forest and its understory vegetation provide a sink for water flowing from the mountains after rain storms. When the forest has been destroyed by high-intensity wildfires or other deforesting actions, the meliorating effect of the forest canopy is removed and water is no longer slowed. The water increases in velocity as it flows down the denuded mountain slopes, collecting into canyons and gullies and resulting in flash floods with volumes of water up to 900 cubic feet per second (cfs). The water collects soil, boulders, and debris off the slopes as it moves swiftly downhill. The force of the water can move boulders as large as trucks. Being in areas where the water accumulates, such as canyons and gullies, during these flash flood events is extremely dangerous. Figure 2.2 shows such an event in Rendija Canyon. Recently, someone found a sign from Rendija Canyon in Cochiti Reservoir as a result of such flood events. Discharges in Rendija measured 900 cfs. Guaje Canyon above the mouth of Rendija Canyon measured 1,350 cfs on August 27, 2000.

Hydrophobic Soils and After-Fire Rehabilitation: After fire, in areas of high-intensity burn, soil becomes hydrophobic, meaning it repels water. These soils cannot absorb water, instead, the water sheets off. The soils are eventually broken down by raindrops, animal hoof action, and natural decay of the crust. However, this may take one to two years. To protect the community of Los Alamos and Los Alamos National Laboratory, people helped rehabilitate the burned area to reduce the risk of flash floods.

Some of the rehabilitation actions after the fire were breaking up the soil crusts by contour raking, spreading grass seed by hand and air, mulching with straw by hand, and hydromulching by air and truck. Severely burned areas were contour raked to break up the hydrophobic soil conditions, straw wattles and log erosion barriers were placed to capture sediment and slow surface water run off, areas were seeded by hand and mechanical spreaders and mulched with a three-inch straw layer. Over 1,600 acres of LANL property received treatments from professional fire recovery teams and Laboratory volunteers.

Along this approximate four-mile stretch of highway from the intersection with the Ski Hill Road to the intersection of West Jemez Road and State Route 4, you will observe several actions that were used to rehabilitate the mountains (Figure 2.3).

Concrete Barriers: Concrete barriers have been constructed at the canyon crossings to stablilize the road-canyon interface from the erosion potential of fast-moving water (Figure 2.3a).

Straw Wattles: Straw wattles and log erosion barriers were placed to capture sediment and slow surface water run off. A good place to view the wattles is at the corner of West Jemez Road and State Route 4 (Figure 2.3b).

Seeding of Grasses: Both aerial and hand seeding of four grass species were done throughout the burn area. Two annual grasses, annual rye and barley, were abundant in many areas in 2001. There was some evidence of germination of the perennial slender wheatgrass and brome.

Gaging Stations: Stream gaging stations along State Route 502 and in other areas of the Laboratory and Los Alamos County were built to determine storm water flows on and off the Laboratory. The purpose was to monitor the potential for contaminant transport. Some of the gaging stations had to be rebuilt because of damage by fire and flooding. Gaging stations, such as the station in Cañon de Valle along State Route 502 (West Jemez Road), have been rebuilt to their current size and scale to accomodate the predicted large storm water flows (Figure 2.4). For information about stream flows, you can review “Precipitation Events and Storm Water Runoff Events at Los Alamos National Laboratory after the Cerro Grande Fire,” LA-13894-MS, http://lib-www.lanl.gov/la-pubs/00818493.pdf

Natural Regeneration: In addition to the rehabilitation efforts, nature has been healing quickly. Along this stretch of the highway, natural regeneration of oak and native grass can be observed. Most of the trees are alive.

Oak and other sprouting shrubs and trees recover quickly if the growth tissues are not damaged. Many sprouting shrubs have mechanisms within the plant that suppress sprouting from the roots until the top of the plant is gone (Figure 2.5). Then, within hours after a fire, the plant begins to sprout. The thick bark of the ponderosa pine will protect the tree if the fire does not go into the crown. In the thinned area, the trees are still alive because the fire did not go into the crown of the trees but stayed on the ground surface.

Figure 2.1: Thinned area along State Route 501.



Photo courtesy of Patrick Valerio

a. Thinning crew along State Route 501 reducing the tree density, one year before the Cerro Grande fire.



b. View of the thinned area along State Route 501. Note how the trees are spaced.

Figure 2.2: Flooding events are common after mountain slopes are denuded of vegetation.



Photo by Water Quality and Hydrology

a. A flood event in Rendija Canyon. Note the fast-moving and spreading water.



Photo by Water Quality and Hydrology

b. Starmer’s Gulch flooded near TA-22. The drainage area is less than a mile square and the highest discharge after the fire was 180 cfs.

Figure 2.3: Rehabilitation activities along West Jemez Road (State Route 501).



a. Stablization of canyon crossings.



b. Straw wattles placed in gullies and canyons to slow storm water. They will deteriorate with time after vegetation is established.



c. Raking, mulching, and seeding.

Figure 2.4: Gaging stations in Cañon de Valle.



Photos taken by Water Quality and Hydrology

a. Size of the station before the Cerro Grande fire.



Photos taken by Water Quality and Hydrology

b. Size of the station after the Cerro Grande fire. Note the difference in height to accomodate increased flows.

Figure 2.5: Natural regeneration after fire.



a. Regrowth of shrubs one year after the fire. The inset shows sprouting mountain mahogany one month after the Cerro Grande fire.



b. Note how the tallest trees survived because the fire did not get into the tree tops.

VIEW 3: FROM INTERSECTION OF STATE ROUTE 501 AND STATE ROUTE 4 TO BANDELIER NATIONAL MONUMENT

The intersection of State Route 501 and State Route 4 is a T. A right turn leads into the Jemez Mountains where you can view the upper portions of the Cerro Grande fire and the Valles Caldera National Preserve. See Side Trip Into the Jemez Mountains and the Valles Caldera National Preserve. A left turn will continue our tour.

Approximately two-tenths of a mile from this intersection will be Ponderosa Campground to the right. The 1977 La Mesa fire began on Mesa del Rito above Alamo Canyon on Santa Fe National Forest in June 1977. It burned over 15,000 acres of Bandelier National Monument, Santa Fe National Forest, and Los Alamos National Laboratory. Near this campground the fire jumped the road and entered into the Laboratory through Water Canyon and into S-Site.

For the next five miles or so the ecology on both sides of the road will be influenced by the 1977 La Mesa fire. Only a short section on the north (left) side of the road was burned in the Cerro Grande fire. The La Mesa fire area will give a glimpse of what areas burned by the Cerro Grande fire will look like in 25 years. This portion of the original Ramon Vigil Grant was once part of the Laboratory but was given to the National Park Service in a land exchange in the 1960s. You will also see portions of the area burned by the Dome fire in Bandelier National Monument and the Santa Fe National Forest in 1996 (the distant mountaintops to your right).



Tree Planting: For the next 1.4 miles, on the north (left) side you can view the tree planting that occurred after the La Mesa fire. The area was salvaged of burned timber by people collecting firewood. Then the area was planted with two-year-old ponderosa pine. Unfortunately, these trees were plantation planted and are now dense stands of 300 to 400 trees per acre that need to be thinned. In some areas the Cerro Grande fire did burn the trees, and small groves are now dead (Figure 3.1).

On the south (right) side of the road, Bandelier National Monument did a different type of management. They did not salvage timber but allowed the trees to fall naturally. This took approximately eight years. The only replanting was by Boy Scouts in an area near the Ponderosa Campground. In areas of natural regeneration, we have found no more than 80 to 100 trees per acre. The replanting and natural reestablishment of trees from the few remaining seed trees also have created a dense stand of ponderosa pines approximately 10 to 12 feet tall.

View of the La Mesa Fire: At approximately 5.8 miles from Bradbury Science Museum and approximately one mile from Ponderosa Campground there is a turnout to the south (right) side of the road. This is not the most panoramic view of the La Mesa fire area, but it is one area where you can safely pull off the road and look around (Figure 3.2). All along this stretch you will see similar views. Most of the site has come back in shrubs (oak and New Mexico locust). Few trees remain standing except for scattered snags. These snags provide habitat for various tree-dwelling species, such as bluebirds and flickers. Figure 3.3 shows the succession of tree fall through the years.

You can turn around here or continue along the tour circle.

Burnt Mesa: The road to Burnt Mesa is 6.7 miles from the stoplight on Diamond and Trinity. A nice walk can be taken through the area burned by the La Mesa fire on Burnt Mesa (Figure 3.4). This area is on National Park Service land and you should contact Bandelier National Monument about hiking. Remember, when hiking you should take care to have plenty of water and follow outdoor safety rules.

A hike along Burnt Mesa will take you through areas that were once densely forested and will give you panoramic views of the mesas and Boundary Peak, Rabbit Hill, and areas burned by the 1996 Dome fire. Aerial maps and tree-ring data indicate this area had been burned periodically and had open meadows bounded by dense forest. The dense forested areas were severely burned in the La Mesa fire, and the whole area is now meadow-like, attracting elk and deer. Controlled burns done in 1998 by the National Park Service have reduced most of the dead and down timber to ash. There are now large patches of lupines, which attract blue butterflies in large numbers. Grasses and wildflowers abound at certain times of the year (Figure 3.5).



TA-49: Across State Route 4 from Burnt Mesa is TA-49. Although not visible from the road, TA-49 is the home of the interagency fire cache that can be used for fighting fires of the area. There are a helicopter pad and storage areas. This fire cache was part of the activities of the Interagency Fire Management Team established after the 1996 Dome fire.

On the south side of the road from TA-49 to the end of the La Mesa fire area, you will see the results of a high-intensity fire in a piñon-juniper woodland. Unlike ponderosa pine, piñon and juniper are killed by fire. They have a thin bark that does not protect the tree from the heat of the fire. Throughout the area, oak dots the landscape and, along the roadside, little bluestem with its reddish tinge waves in the breeze created by your moving car.

Figure 3.1: Tree planting along State Route 4.

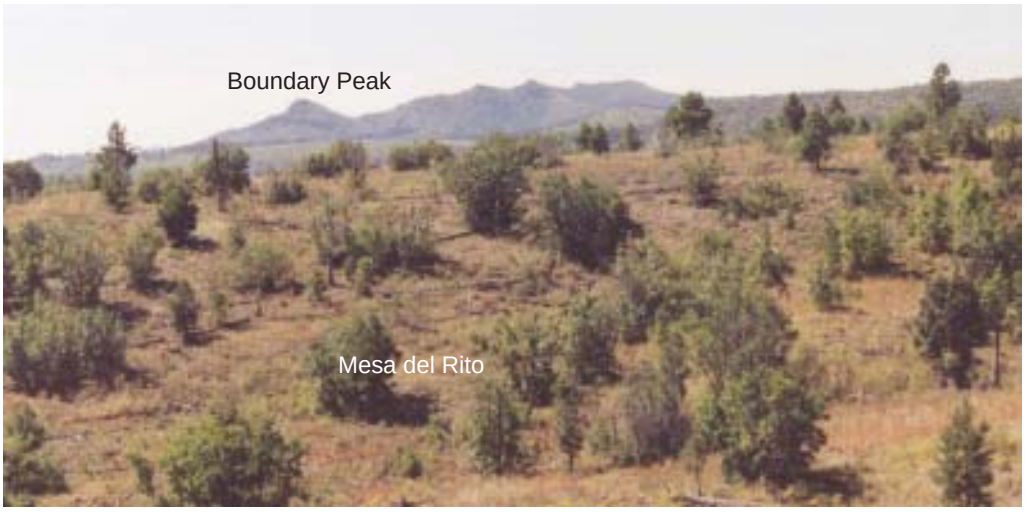


a. State Route 4 traveling west toward the Jemez. Note the differences in each side of the road. Bandelier had limited plantings; the Laboratory planted two-year-old trees.

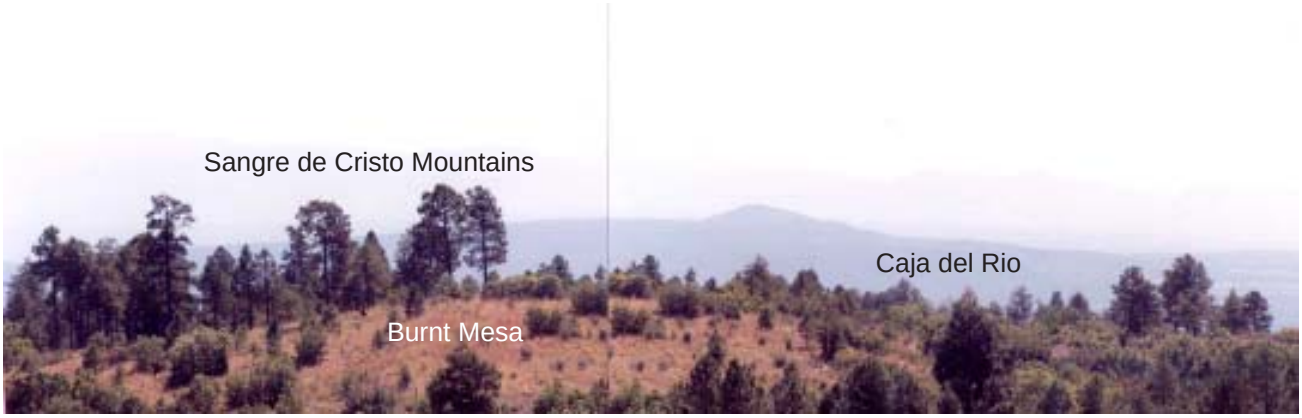


b. Two-year-old pine trees were planted in the Laboratory about 1985. The trees per acre are over 300 and need to be thinned. Some trees were burned by the Cerro Grande fire.

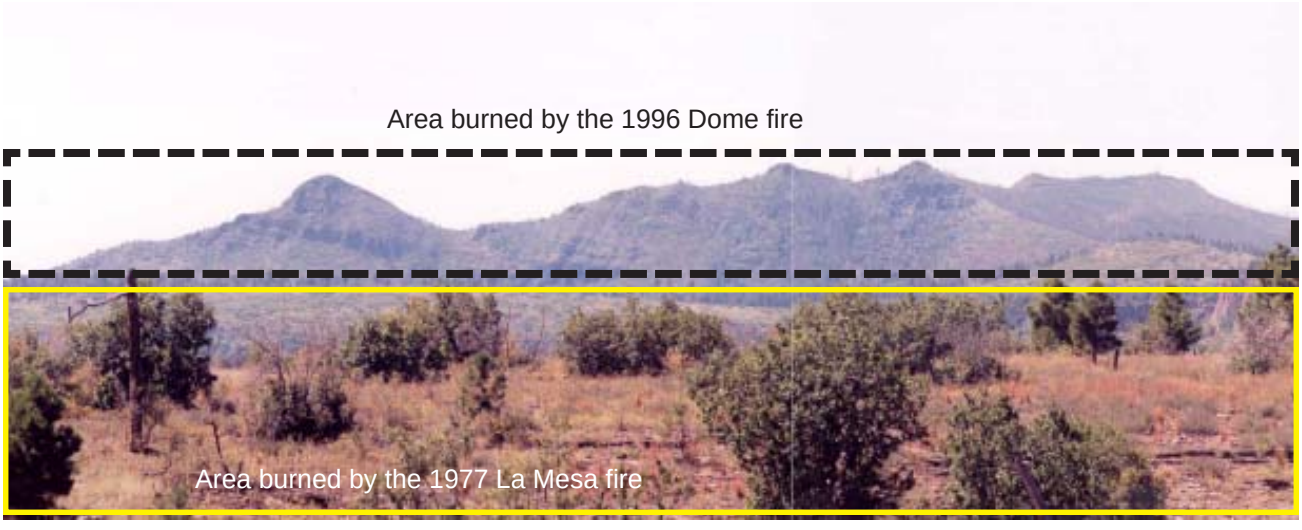
Figure 3.2: Views of the area of the La Mesa fire and vistas.



a. View of Boundary Peak and Escobas Mesa to the southwest.

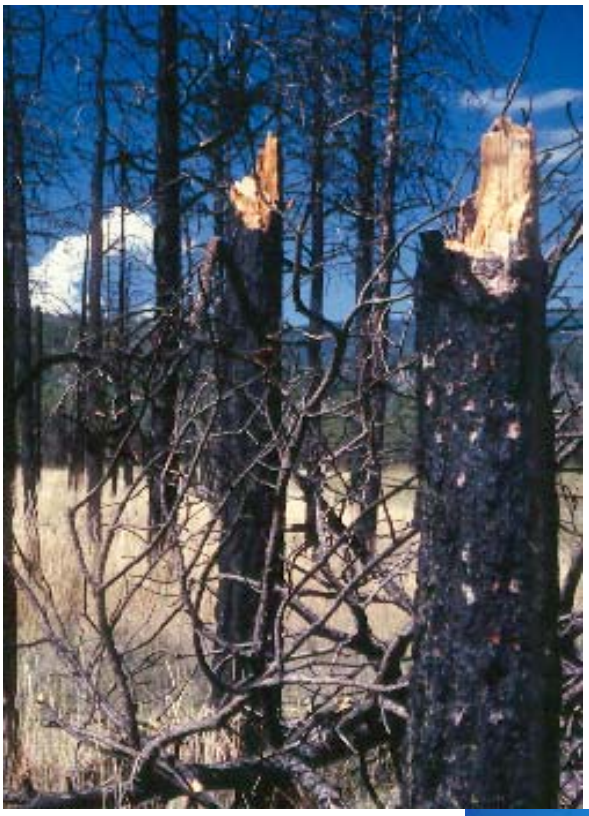


b. View of the Sangre de Cristo Mountains to the east.



c. Looking southwest from the view point. On the picture is noted the area burned by the La Mesa and the Dome fires.

Figure 3.3: The successional process of tree fall. What you see today is 24 years post-fire. Note the grasses, shrubs, and trees that cover the landscape.



a. Trees had not fallen at five years after the La Mesa fire, but they had broken at five to six feet from the ground. A similar pattern will probably be seen in the Cerro Grande fire area, depending on wind and other factors.



b. Most trees had fallen at about eight years after the La Mesa fire. Until the downed trees began to decay, the area looked like pick-up sticks.

Figure 3.4: Burnt Mesa, a nice place to hike.



a. There are trails and remnants of old roads on this mesa. Permits are required from Bandelier National Monument to hike the area.



b. There is evidence from tree-ring dating that Burnt Mesa had frequent fires until 1900. Before the La Mesa fire, large meadows were interspersed within the densely forested mesa top. Note how the fire has pruned the lower branches on the large trees around the meadow.

Figure 3.5: Successional process in high-intensity burn study plots established on Burnt Mesa after the La Mesa fire.



a. One month after the La Mesa fire.



b. One year after the La Mesa fire.



c. Eight years after the La Mesa fire.



d. Twenty-two years after the La Mesa fire.

VIEW 4: FROM BANDELIER NATIONAL MONUMENT ENTRANCE TO WHITE ROCK:

The entrance to Bandelier National Monument is 10.6 miles from the stoplight at Diamond and Trinity.

Bandelier National Monument is a wonderful place to visit. The shaded Frijoles stream has picnic tables on the banks, and trails provide glimpses of past habitation by native peoples of the area. There is an entrance fee, but this may be a nice stop along your journey.

At the entrance to the Monument, you will note dead and burned trees. This burned area is not part of the La Mesa, Dome, or Cerro Grande fires but is an area of prescribed burn. The burn was done in 1998 to reduce the density of the forest. Before 1900, the pinon-juniper woodlands were known to be more open. Studies have shown that reducing the canopy of the woodland helps in controlling erosion. Fire frequencies were also five to ten years and, over the years, the increased density of trees has contributed to arroyo cutting as well as increased fire hazards. Experiments with thinning by cutting and also by fire have shown a positive change in arroyo cutting.



Sign at the entrance of Bandelier National Monument

Ancho Canyon: As you drive toward White Rock on State Route 4, you ascend into Ancho Canyon. At the top, an overlook will allow you to view the canyon and the dense unburned ponderosa pine forest to the west. You can see box elder maple in the moister areas of the canyon, as well as ponderosa pine (Figure 4.1).

From this overlook you ascend into the canyon, passing Ancho Canyon Site (TA-39). As the road climbs out of the other side of the canyon you will see the old road that provided acess to that portion of the Pajrito Plateau in the 1920s. Until the 1930s, access to Bandelier's ruins and Mrs. Frey's guest house was down the steep Frey trail. In the 1930s, the road was extended into the canyon from the mesa top (Figure 4.2a, b).

Pinon-Juniper Plant Community: As the road tops the mesa, the vast expanse of pinon-juniper woodland can be seen on both sides of the road (Figure 4.3). The plant community is a mix of two tree species: one-seed juniper and Colorado pinon. The area is called a woodland because the trees are short with a spreading canopy. The large seed of the pinon was and is a favorite nut collected in years of high crop yield. The pinon-juniper woodland receives about eight inches of rain a year and is more drought tolerant than the upper-elevation species. The woodland extends to the rim of White Rock Canyon.

Stream Gages in Water Canyon and Canada del Buey: The stream gages used for measuring runoff can be observed in Water Canyon and Canada del Buey. There are 23 gages that cover most of the Laboratory property. Gages near State Route 501 measure incoming flows, and gages near State Route 4 measure flows leaving the Laboratory (Figure 4.4).

Canada del Buey intersects State Route 4 near Sherwood Avenue. A substantial arroyo dissects the community of White Rock from State Route 4 to the White Rock Canyon Overlook and was sandbagged for erosion protection after the fire. The maximum stream flow was not associated with the Cerro Grande fire but occurred September 8, 1995, with a discharge of 17 cfs. Most of the time there are no flows. A new walking trail follows the arroyo from Rover Boulevard to Meadow Lane.

In Water Canyon, the stream gages registered a minimal flow before the Cerro Grande fire. Since the fire, several large storm events resulted in significant flow. On June 28, 2000, there was a maximum discharge of 306 cfs.

Figure 4.1: Ancho Canyon and a view of the mountains.



View of Ancho Canyon looking toward the Jemez Mountains. Note the ponderosa pine and riparian species that dominate the canyon floor. Also observe the tuff cliffs along the walls of the canyon.

Figure 4.2: Old and the new roads to Bandelier.



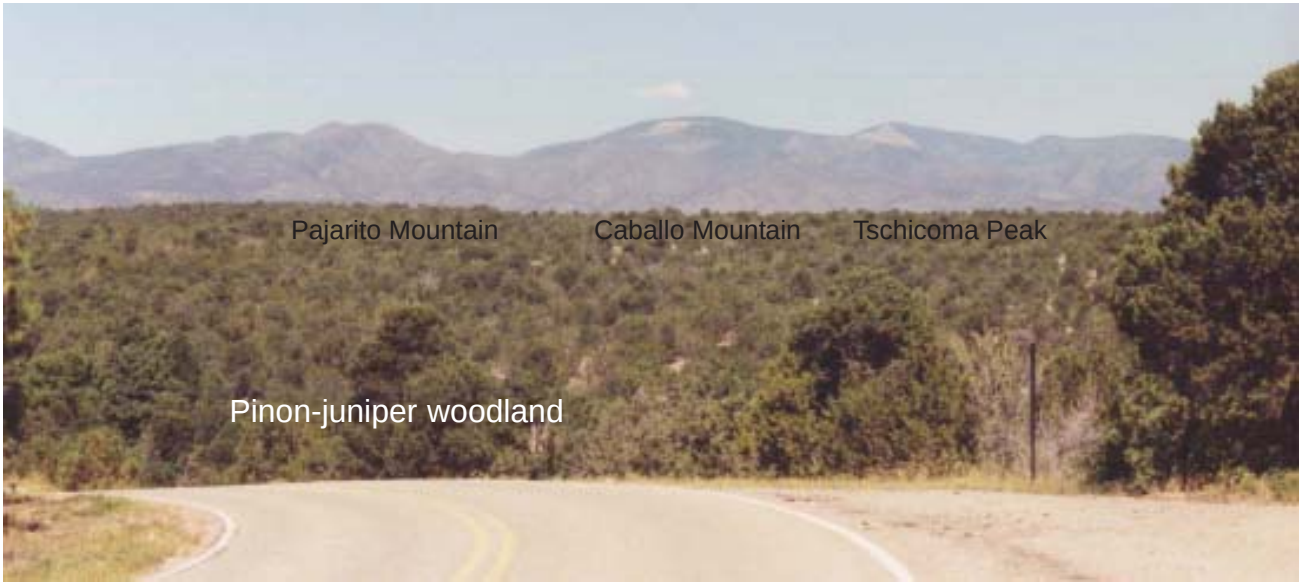
a. View of Ancho Canyon in the 1990s.



b. View of Ancho Canyon in 1920s.

Photo courtesy of Los Alamos Historical Museum

Figure 4.3: Views of the pinon-juniper woodlands and the mountains.



As you drive along State Route 4 between Ancho Canyon and White Rock, views of extensive pinon-juniper woodlands can be seen. The plant community extends from 6,500 ft to approximately 7,000 ft in elevation where the ponderosa pine plant community becomes dominant. This is also a good place to view the three large mountains in the Jemez: Pajarito (10,441 ft), Caballo (10,496 ft), and Tschicoma Peak (11,950 ft). Some watch the snow melt on the meadows of Caballo as an indication of a warm or cold winter and late or early spring.



The Laboratory is thinning along the perimeter to provide a fire break and for public safety. The trees are being thinned to have about 25 ft in between (50 to 60 trees per acre).

Figure 4.4: Stream gage in Canada del Buey.



Stream gages have been placed on the upper and lower boundaries of the Laboratory. This gage is in Canada del Buey where the canyon intersects State Route 4. Gages provide information as to stream flow through the Laboratory. Stream gages in Water Canyon measured 21 cfs August 29, 1995. After the Cerro Grande fire, the stream gage measured 274 cfs on June 28, 2000.

VIEW 5: WHITE ROCK TO BRADBURY SCIENCE MUSEUM

Los Alamos Canyon Weir: The Los Alamos Canyon low-head weir located at the intersection of State Route 4 and State Road 502 was built to provide sediment control and retention and deceleration of storm water flow. The weir has a large shallow basin that serves as a sediment catch basin and a sediment retention structure. The detention basin is approximately 500 ft long by 100 ft wide by 10 ft deep. The weir is constructed of rock-filled gabion baskets. The disturbed soils around the basin were seeded with native perennials and quick-growing annuals and covered with excelsior erosion-control blankets. Two species of cottonwood and one species of willow have been planted along the interior perimeter of the basin. Total affected area is four acres (Figure 5.1).

Anderson Overlook: Travel from White Rock towards Santa Fe to the White Rock Y weir site and take the left turn towards Los Alamos on the Main Hill Road. Approximately halfway up this winding road, which was called *camino de la culebra* in the early days (Figure 5.2), is the Anderson Overlook. Across from the overlook is the original road up the mesa. From the Anderson Overlook, to the east, there is a spectacular view of the Sangre de Cristo Mountains and the valley below. To the west, portions of the Jemez Mountains can be seen (Figure 5.3).

View from the Airport: This wonderful view of the mountains has been viewed by inhabitants of the plateau for centuries (Figure 5.4). In the summer months wildflowers can be seen blooming along the runway. The county tries to mow when the flowers have ceased blooming but have Federal Aviation Administration standards to adhere to. During the Ranch School years, the area of the airport was a field where hay and other crops were raised. Until 2000, the airport area provided a view of the tree-covered slopes of the mountains. Today it is an airport where private planes can lift off to places unknown and the view is of burned slopes. There are times when the shadows are such that the burned slopes are not visible and the outline of the mountain is as it has always been. In the future the lower slopes will be covered by oak and other shrubs and the upper slopes by aspen. Small trees planted in the burned area will grow about one foot a year.

Although the trees are gone, the exposed rock formations result in interesting patterns as snow melts in the winter months. The north-facing slopes retain the snow longer giving the mountain a striped appearance. The slope directions will make a difference in plant recovery with north-facing slopes being moister than south-facing slopes.

THE TOUR ENDS: Route 502 becomes Trinity Drive and, at the Hill Top House Motel, Trinity veers left and Central intersects Trinity. Traveling down Central will bring you back to the Bradbury Science Museum.

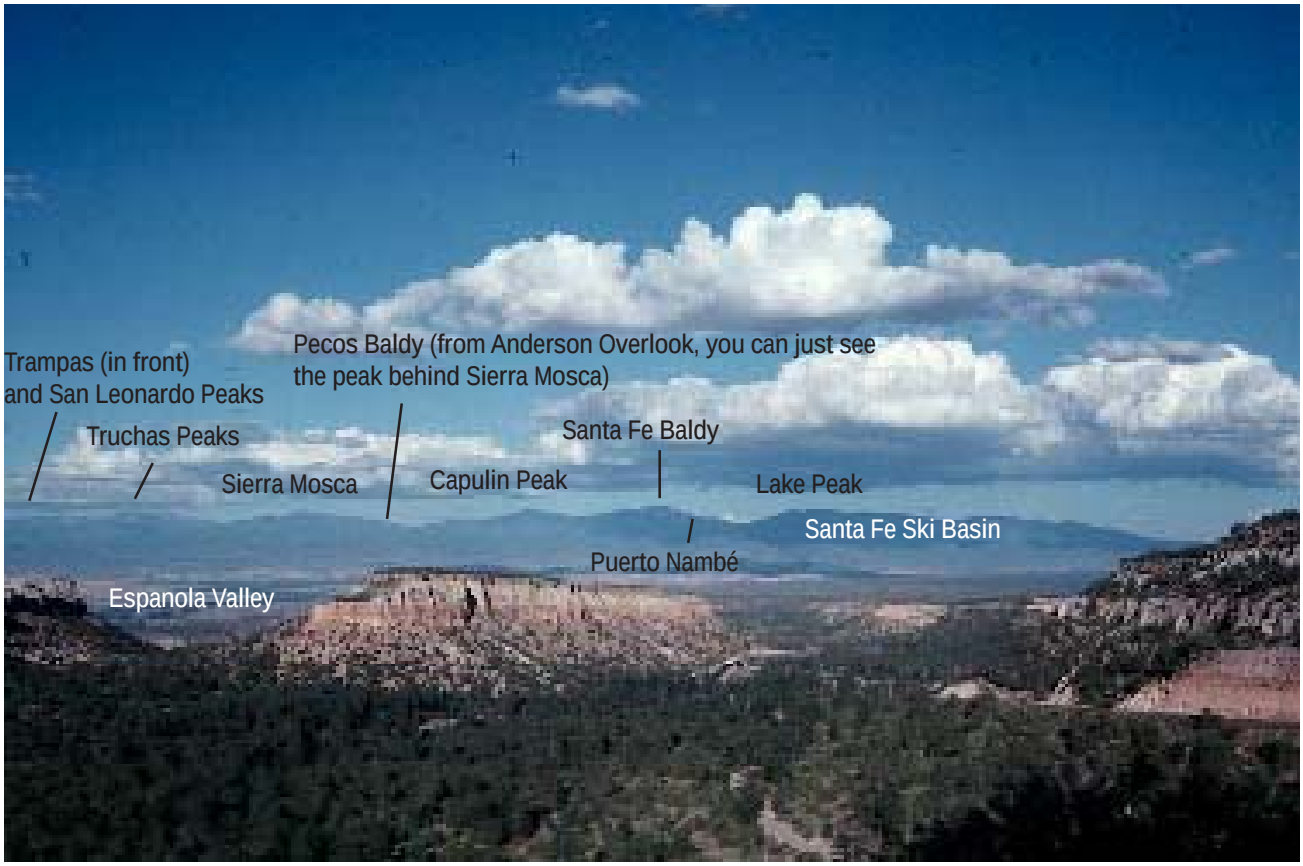
Figure 5.1: Los Alamos Canyon Wier



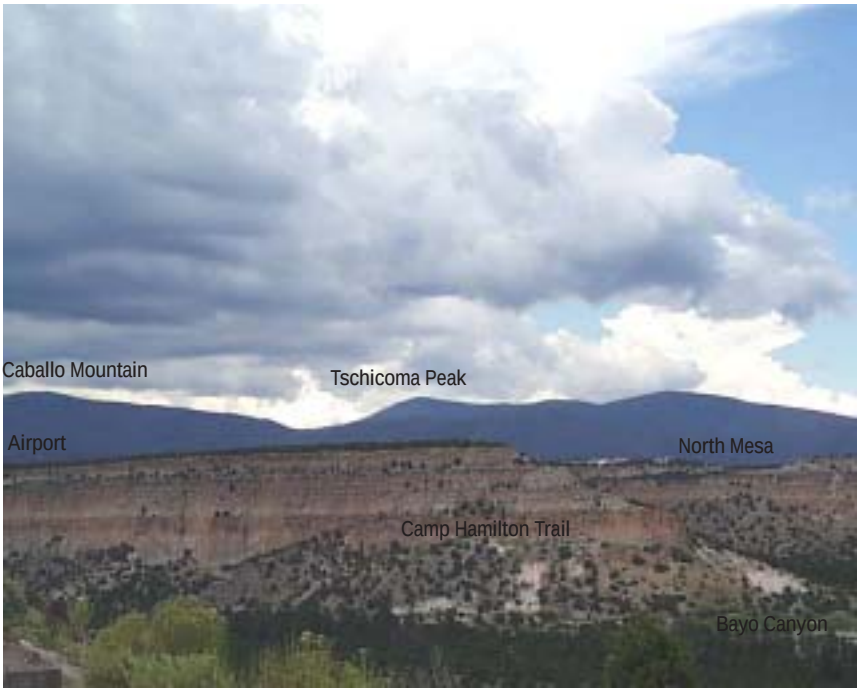
Figure 5.2: *Camino de la culebra.*



Figure 5.3: Views from Anderson Overlook.

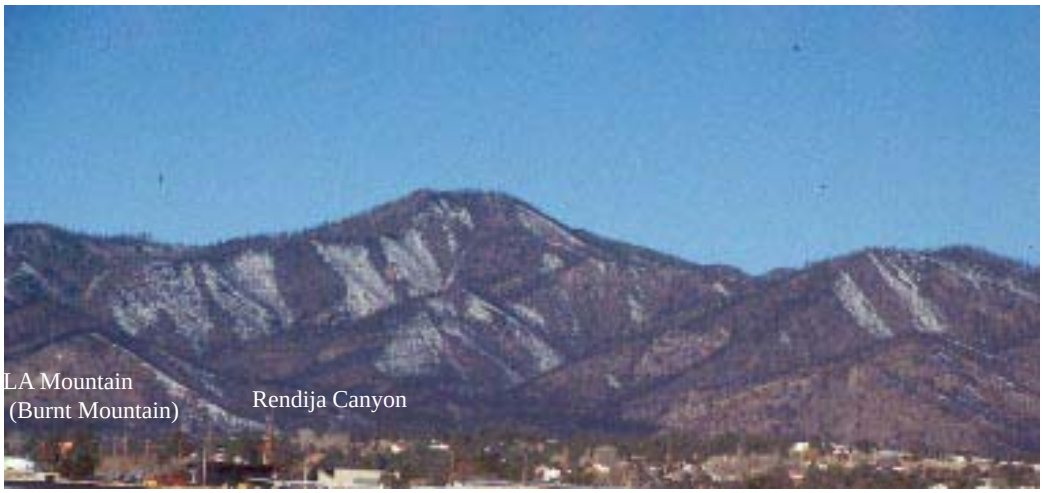


a. View looking toward Sangre de Cristo Mountains.



b. View looking west at the Jemez Mountains.

Figure 5.4: View of the mountains from the airport section of State Route 502.



a. A view of the mountains in January 2001. Note the snow has not melted on the north-facing slopes.



b. The pattern on the uppermost slope, created by rock formations where the snow melts more quickly, has been called a “fire child” or a child with a dog. Students at Piñon Elementary wrote stories about the formation. Some said it looked like a dragon, a coyote, a mermaid, a fire bird. What do you think it looks like? If you look across the valley at the Sangre de Cristo Mountains, you will see the shape of a thunderbird, created by rock formations and tree patterns.

A Brief History of the Jemez Mountains and Pajarito Plateau

A BRIEF HISTORY OF THE JEMEZ MOUNTAINS AND PAJARITO PLATEAU

The ecology of an area cannot be separated from its history. Some important changes that have influenced the ecology of the Pajarito Plateau include homesteading, urbanization, grazing, logging, and fire. Each activity changed the plant communities by removing or introducing plants within the ecosystem.

The Pajarito Plateau was largely uninhabited, except for occasional hunter-gatherers, until the 1100s when the mesas and canyons were settled by the ancestors of the present-day Pueblo peoples. From the 1100s to the 1500s these inhabitants farmed, hunted, and lived in pueblos on the flat, sloping mesa tops and in dwellings along the canyon walls. About 1500, drought or other conditions caused them to abandon their plateau homes and move to their present-day sites. Along with these inhabitants came plants used for food or medicine (Figure 1).

The Spanish arrived in the Espanola Valley in 1598, first establishing a settlement near the present-day San Juan Pueblo. They came with domestic animals and favorite wild or medicinal plants that became established, particularly in disturbed area (Figure 2). The era of small pastoral herds and subsistence farms with a few cattle, sheep, horses, and goats began on the plateau in 1742 when Pedro Sanchez was given a Spanish Land Grant (later known as the Ramon Vigil Grant). For over 100 years the Grant remained within the Sanchez family. Then, in 1862, the *Homestead Act* opened the area up to permanent settlement. Any bonafide settler could obtain quarter-sections of land if they remained in residence for five years. In the 1940s, 32 homesteads existed when they were bought and the land was used for the secret Manhattan Project during World War II (Figure 3).

At the close of the 19th century and into the early 20th century, one of the biggest influences was the development of a narrow-gage railroad in White Rock Canyon (Figure 4). This railroad provided a means to get products to wider markets. Development of a system of roads and the railroad provided access to larger herds of animals, primarily sheep, until the late 1800s when cattle raising became more lucrative (Figure 5). For a short period (1885 to 1887), 3000 head of cattle ranged the 32,000-acre Grant. This was severe overstocking. Today, a liberal estimate of range stocking would be 100 acres per cow per year.

In 1897, the owners of the Ramon Vigil Grant sold timber rights to H. S. Buckman, who removed lumber from the area until 1903. He built the town of Buckman on the Rio Grande as a railway station (Figure 6). He constructed a road linking the railstop to his sawmill, which was probably near the present-day S-Site (thus named because of a very large sawdust pile). His contract allowed him to cut all trees greater than 8 inches in diameter. Buckman is estimated to have cut 36,000,000 board-feet on the 32,000-acre Grant. In addition to Buckman's cutting, areas adjacent to the Ramon Vigil Grant yielded 17,319,000 board-feet of saw-log timber.

In the early part of the 20th century, the Ramon Vigil Grant was sold to Frank Bond of Espanola who used it as pasture and a way-station for moving cattle and sheep to and from the Valle Grande.

Anthropologists and archaelogists such as Adolph Bandelier and Edgar Hewett studied and excavated archaeological sites during the late 1800s and early 1900s. Soon extensive ruins in Bandelier were open to visitation, and visionaries like Ashley Pond saw the plateau as a place of commerical interest to visitors. In 1916, Bandelier National Monument was established to protect the archaeological treasures. And, after a failed venture to develop a dude ranch in Pajarito Canyon, Pond established the Los Alamos Ranch School (1918), which existed until the World War II effort caused its closing.

What is now called Los Alamos National Laboratory had its beginnings in the early years of World War II. Searching for a place to carry out the secret Manhattan Project, Robert Oppenheimer and General Leslie Groves settled on the Pajarito Plateau as a place of security and isolation. For a few years scientists from around the country and the world worked at development of the first atomic bombs used in Japan in 1945. After World War II, the Laboratory remained and its mission changed, depending on the world situtation. Today Los Alamos is approximately 18,000 in population, including the lower-elevation community of White Rock.

From the early days of the Ranch School to today, landscape and ecology have attracted many people to the area.



Figure 1: Pale wolfberry is considered a “camp follower” because it was used by early inhabitants, has its origin in South America, and is often found around archaeological ruins.





Figure 2: Mullein is a common roadside plant that was introduced by the Spanish. Leaves of the young plants were used as a medicinal for lung disorders; the dead stalks were used for candles, thus, it is sometimes called “candelaria.” This biennial plant sends up a rosette of fuzzy leaves the first year and then blooming stalks the second year after which it dies.

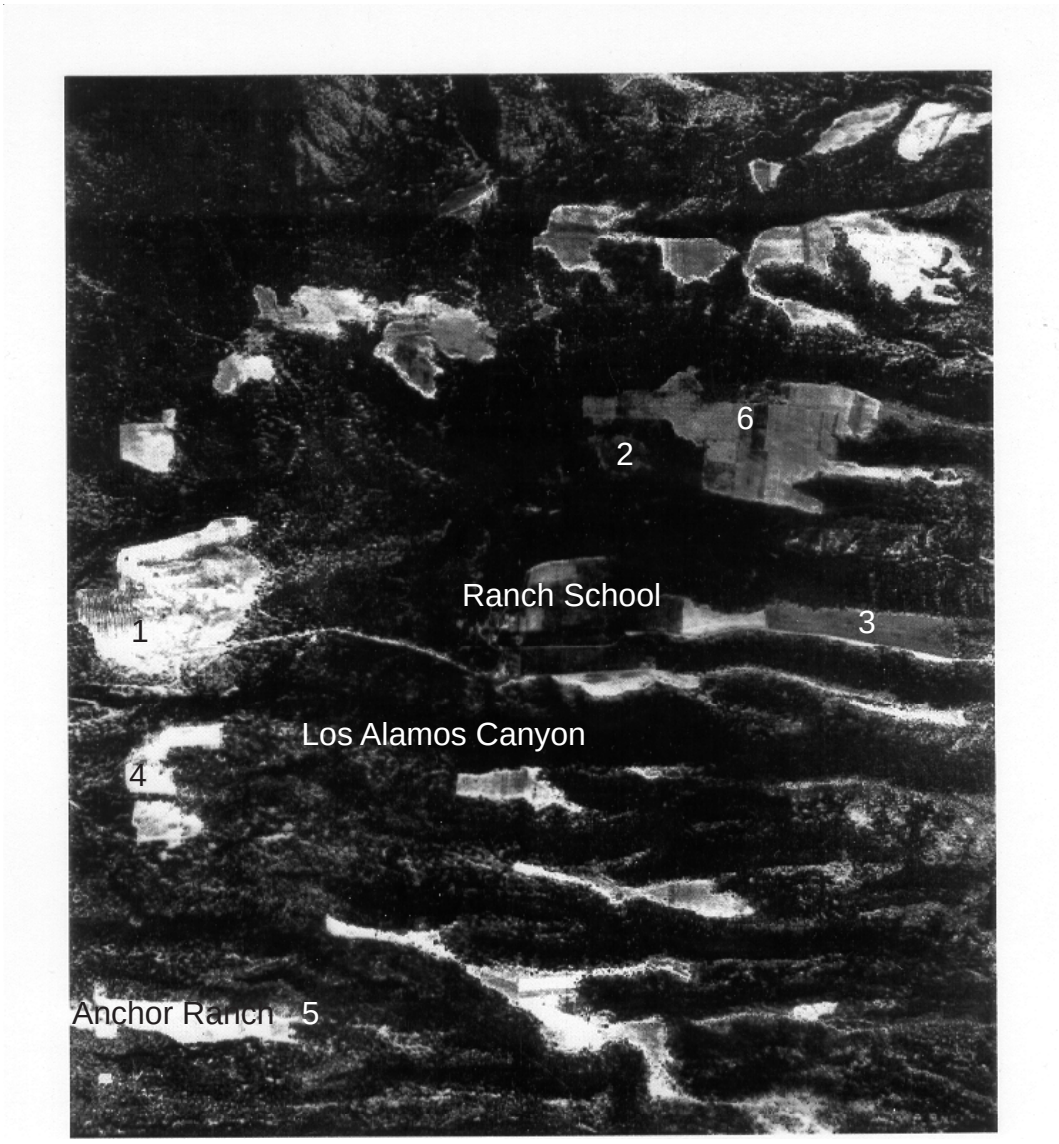


Figure 3: A 1932 aerial map showing some of the homesteads on the plateau.

1) Present-day Western Area
2) Ashley Pond
3) Present-day airport
4) Present-day TA-3
5) Present-day TA-8 and -9
6) North Mesa



Photo courtesy of Los Alamos Historical Museum

Figure 4: The Chili Line locomotive.





Photos courtesy of Los Alamos Historical Museum

Figure 5: Stock grazing on the Pajarito Plateau.

Figure 6: Buckman from White Rock Overlook.



a. Buckman in 1990s.



Photos courtesy of Los Alamos Historical Museum.

b. Buckman in early 1900s.



Picture (a) shows the area as it is seen today. Picture (b) shows the bridge still spanning the Rio Grande. Note that the vegetation is still different than the surrounding area even 100 years later.

GEOLOGY AND HYDROLOGY

OF THE

PAJARITO PLATEAU

GEOLOGY AND HYDROLOGY OF THE PAJARITO PLATEAU

The Laboratory lies at the western boundary of the Rio Grande rift, a major North American tectonic feature. Three major local faults constitute the modern rift boundary, and each is potentially seismogenic. Recent studies indicate that the seismic surface rupture hazard associated with these faults is localized. Most of the finger-like mesas in the Los Alamos area are formed from Bandelier Tuff, which includes ashfall, ashfall pumice, and rhyolite tuff. The tuff is more than 1,000 ft thick in the western part of the plateau and thins to about 260 ft eastward above the Rio Grande. It was deposited by major eruptions in the Jemez Mountains' volcanic center about 1.2 to 1.6 million years ago.

On the western part of the Pajarito Plateau, the Bandelier Tuff overlaps onto the Tschicoma Formation, which consists of older volcanics that form the Jemez Mountains. The tuff is underlain by the conglomerate of the Puye formation in the central plateau and near the Rio Grande. The Cerros del Rio Basalts interfinger with the conglomerate along the river. These formations overlie the sediments of the Santa Fe Group, which extend across the Rio Grande valley and are more than 3,300 ft thick.

Surface water in the Los Alamos area occurs primarily as short-lived or intermittent reaches of streams. Perennial springs on the flanks of the Jemez Mountains supply base flow into upper reaches of some canyons, but the volume is insufficient to maintain surface flows across the plateau before they are depleted by evaporation, transpiration, and infiltration.

Groundwater in the Los Alamos area occurs in three modes: (1) water in shallow alluvium in canyons, (2) perched water (a body of groundwater above a less permeable layer that is separated by an unsaturated zone), and (3) the regional aquifer of the Los Alamos area.

The regional aquifer of the Los Alamos area is the only aquifer in the area capable of serving as municipal water supply. Water in the regional aquifer is under artesian conditions under the eastern part of the Pajarito Plateau near the Rio Grande. The source of most recharge to the aquifer appears to be infiltration of precipitation that falls on the Jemez Mountains. The regional aquifer discharges into the Rio Grande through springs in White Rock Canyon (Figure 1) between Otowi Bridge and the mouth of Rito del los Frijoles, which receives an estimated 4,300 to 5,500 acre-feet annually from the aquifer.

Figure 1: The regional aquifer discharges into the Rio Grande through various springs.



a. Springs in Ancho Canyon.



b. Pajarito Falls below springs in Pajarito Canyon.



c. View of the Rio Grande at Ancho Canyon looking toward Chaquehui Canyon.

SKI HILL ROAD

SKI HILL ROAD

This road played a critical role in movement of the Cerro Grande fire. Backfires along this road were not able to prevent the fire from escaping across Los Alamos Canyon. As you drive toward the Pajarito Ski Area on Pajarito Mountain, you will enter a burned mixed conifer zone that includes ponderosa pine, Douglas fir, white fir, and limber pine. This coniferous forest was interspersed with aspen. As you drive along the road you will see aspen quickly regenerating. Aspen is a sprouting species that is stimulated by fire. Figures 1 and 2 show the aspen within a few months of the fire.

Some cutting of hazard trees along the road and some clearing of burnt timber has cleared the roadside of the burned trees. As the burned, standing trees begin to fall (within the next 5 to 8 years), dramatic vistas of the Pajarito Plateau will emerge. Figures 3 and 4 show some of the vistas presently visible with the tree clearing.

After the fire the rehabilitation efforts included seeding with perennial and annual grass species. In 2001, the higher elevation sites such as seen in Figure 5, have good stands of annual rye and barley. Some of the perennial slender wheatgrass and the brome are also found. Figure 6 shows new grass intermingled with new aspen.

Along these roadsides various wildflowers can be found. In early to mid summer, fireweed can be seen (Figure 7). This plant is often found in areas that have burned soon after fire. Other species such as goldeneye and purple aster brighten the fall of 2001 (Figure 8).



Ski Hill Road. Note the burned trees on either side. Picture taken in September 2001.



Figure 1: Aspen height in August of 2000, three months after the fire.



Figure 2: Aspen height in September 2000, four months after the fire.



Figure 3: View of the Pajarito Plateau from the lower Ski Hill Road, September 2001.



Figure 4: View of the Pajarito Plateau from the upper Ski Hill Road, September 2001. Note the aspen sprouts in the foreground.



Figure 5: The burned area with seeded rye and barley, September 2001.



Figure 6: The burned area with a mixture of grass and aspen.



Figure 7: Fireweed can be found along the roadside in early to mid summer. This plant can be found in disturbed or burned areas at higher elevations.



Figure 8: Purple aster along the roadside in the autumn, September 2001.

SIDE TRIP INTO THE JEMEZ MOUNTAINS

AND

THE VALLES CALDERA NATIONAL PRESERVE

THE JEMEZ MOUNTAINS AND THE VALLES CALDERA NATIONAL PRESERVE

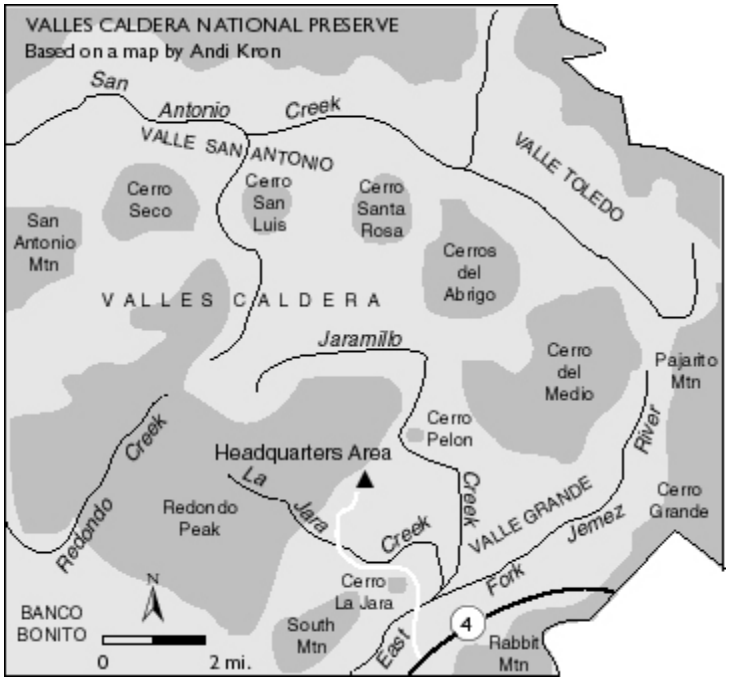
Turning right at the intersection of State Route 501 and State Route 4 will take you into the Jemez Mountains. The winding and narrow road was paved to San Ysidro in the early to mid 1960s. Until then it was a primitive road closed in the winter. However, sections of the road were part of the early trails to take livestock, both cattle and sheep, into the Valle Grande.

Along this route you can view the areas that burned early in the Cerro Grande fire. As you negotiate the first set of sharp turns, the panorama opens to the left. The large area immediately below was burned in the La Mesa fire (Figure 1). There is no turnout for this overview and may be better visible and enjoyable as you return down the mountain in the opposite direction.

Two trails begin after the first series of curves: Apache Springs and American Springs. Apache Springs trail is on the south (left) side of the road, and the American Springs trail is on the north (right) side of the road. A trail guide for the American Springs area can be viewed at http://www.esh.lanl.gov/%7Eesh20/pdfs/AmericanSprings.pdf. This walk will acquaint you with natural recovery and rehabilitation efforts at these higher altitudes.

After hiking when you continue down State Route 4 to the Dome Road turnoff, you will be at the southernmost point of the Cerro Grande fire. A few miles farther is the Valle Grande within the Valles Caldera National Preserve. Until July 2000, this vast caldera was privately owned. With the *Valles Caldera Preservation Act*, Congress designated these lands as a national preserve and outlined how they were to be managed. The Act states that the preserve is established to ". . . protect and preserve the scientific, scenic, geologic, watershed, fish, wildlife, historic, cultural, and recreation values of the Preserve and to provide for multiple use and sustained yield of renewable resources within the Preserve."

Although the Preserve is not presently open to the public, you can view some of the thousands of elk from the road turnouts (Figure 2). Binoculars and spotting scopes are helpful because the caldera is so vast. For more information on the Preserve go to http://www.fs.fed.us/r3/sfe/valles.



Map by Andi Kron

Valles Caldera National Preserve

Figure 1: Overlook of the 1977 La Mesa fire area. The overlook curve is not constructed for stopping, but slow negotiation of the curve will allow you to see the spectacular view.



a. As overlook appeared days after the La Mesa fire.



b. View of the 1977 La Mesa fire area in 2001 from State Route 4.

Figure 2: Valles Caldera National Preserve.



a. The Valle Grande from Pajarito Mountain.



b. Elk in the Valle Grande.

PAJARITO ROAD SIDE TRIP

PAJARITO ROAD

You can continue your tour by turning left at this stoplight and going up Pajarito Road or you can continue through White Rock and travel to the White Rock Y to observe the Los Alamos Canyon weir and to return to the Bradbury Science Museum via the Main Hill Road.

Archaelogical Site (Figure 1): Pajarito Road goes into Pajarito Canyon, which has a long history of habitation. Tsirege is one of the largest ruins in the area and is an ancestral site of the San Ildefonso Puebloans. This site is visible from the road on the north (right) side.

Wetlands (Figure 2): Along the south (left) side of the road are sedge-rush marshes. The wetlands in Pajarito Canyon are a result of road building and other activities in the early 1960s, along with a perched aquifer. Hewett indicates there were springs in the canyon below Tsirege during the habitation of that site. The springs were also water stations for animals being driven to the Valle Grande. Wetlands are important to flood control in that the wetland areas can slow flood waters. These wetlands support several species of frogs and tiger salamanders and are important watering areas for wildlife.

TA-18: Pajarito Canyon has some of the oldest history, both prehistoric and historic. The canyon was the headquarters for the Ramon Vigil Grant. It was also a waystation for watering livestock going to or coming from the Valle Grande and the home of a dude ranch. At the confluence of Three-mile Canyon and Pajarito Canyon sits TA-18. Now a Laboratory technical area, it was once the the home of Ashley Pond when he first came to the Pajarito Plateau. The site had been the headquarters of the Ramon Vigil Ranch but became the home of Pond's dude ranch venture (Figure 3). The Ponds moved from the site because the spring dried up.

Floodwater Retention Structure (Figure 4): Although you will not be able to view this structure, the Pajarito retention structure was built to decrease storm water flooding and flowing debris. The structure was implemented to protect the areas and facilities down Pajarito Canyon as in the case of TA-18 and the residential areas of White Rock.

The flood retention structure is constructed of rolled concrete. The structure is 390 ft wide stretching across the canyon and is 70 ft high. Water retained by the structure is allowed to drain naturally into the existing stream bed and will not be retained longer than 96 hours.

Romero Homestead Fields: Across from TA-55 is a remnant of the Romero Homestead. Until the 1980s a cabin stood in what is now part of the technical area (Figure 5). That cabin was moved to an area next to Fuller Lodge. The only remnant of the homestead is an old tree that stood next to the cabin where the Romero children had a swing (Figure 6). The open field was part of the fields associated with the homestead. For more information about this homestead see "Historical Botany of the Romero Cabin: A Family Homestead on the Pajarito Plateau," LA-13644-H, http://lib-www.lanl.gov/la-pubs/00460166.pdf.



Figure 1: View of the cavates associated with Tsirege.

Figure 2: View of the wetlands along Pajarito Road.



a. Portion of the wetlands as seen from Tsirege.



b. Sedge-rush marshes within the wetland.



c. During years with high snowpack, there is standing water in the wetlands.



Figure 3: The Pajarito Club, a dude ranch that was located where TA-18 is today.



Figure 4: Pajarito Canyon has a retention structure to protect downstream resources. This structure cannot be viewed from the road.

Figure 5: The Romero Homestead.



Photos courtesy of the Los Alamos Historical Museum

a. Romero cabin, 1967.



b. Romero cabin at Historical Museum near Fuller Lodge, 1999.





Figure 6: The pine tree that was in the front of the Romero cabin that once supported a swing.