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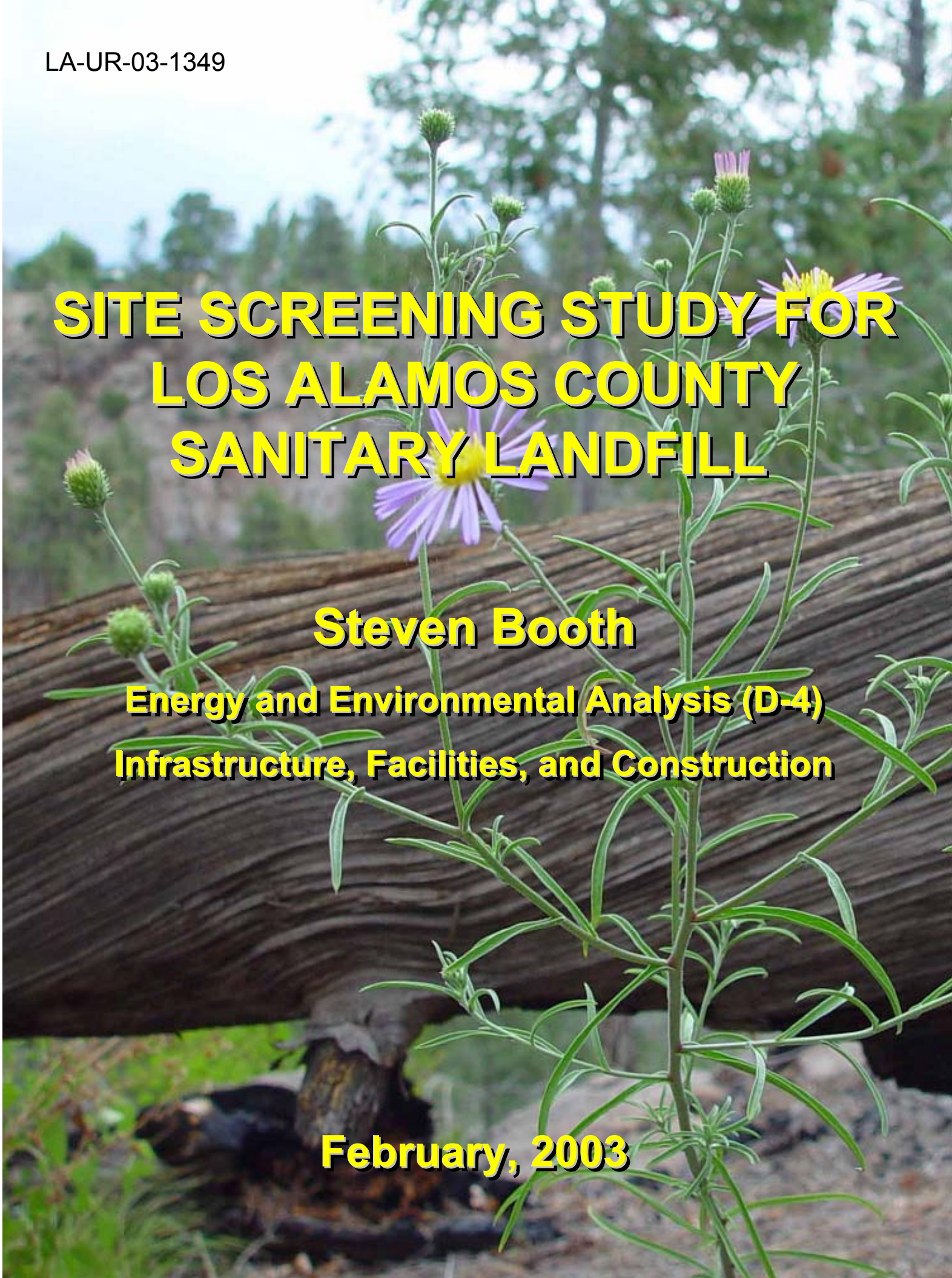

SITE SCREENING STUDY FOR LOS ALAMOS COUNTY SANITARY LANDFILL

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Energy and Environmental Analysis (D-4)

Infrastructure, Facilities, and Construction

February, 2003

Illustrations:
Front Cover – Blue Aster in bloom at TA-60 site, Summer 2002.

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Introduction

The Los Alamos County sanitary landfill is currently under interim regulatory status with the New Mexico Environment Department. In lieu of bringing the landfill up to modern permit standards, the County filed a Closure Plan with the state with a closure date of June 30, 2004.

The County pursued various off-site landfill options for about ten years. Options considered included participation in a regional landfill at Ojo Caliente and off-site shipping to the Caja del Rio (Santa Fe) or Waste Management Inc. (Rio Rancho) landfills. The County was unsuccessful in finding an adequate off-site shipping location. The problem appears to be related to the County's proximity to LANL: there is a perception that waste from Los Alamos County is especially dangerous and outside counties are reticent to accept our waste for the long-term.

In response to a County request, LANL and DOE agreed to consider a new County-operated municipal landfill on DOE property. Official memoranda to this effect were sent in mid-February, 2002. LANL named a project leader for this effort April 15, 2002, and a Landfill Site Screening Team including representatives from LANL, DOE, and the County was established. See Table 1. The kick-off meeting for this team occurred on May 9, 2002.

The goal of the Site Screening Team was to identify possible sites that LANL/DOE could consider providing for a new county landfill. This report details the results of this evaluation. The site screening process began by applying published NMED landfill criteria to maps of the county and LANL to identify possible areas worthy of further study. Next the team set up a decision analysis model with 18 evaluation criteria and weighting factors. To gather necessary data, team members toured the potential sites, interviewed potentially impacted LANL groups and divisions, and identified security, infrastructure, and other issues.

TABLE 1
Roster of Landfill Site Screening Team Members

Name	***Affiliation***	***Phone Number***	***E-mail Address***
Steven Booth (lead)	LANL	667-0990	sbooth@lanl.gov
Richard Filemyr	Solid Waste Mngt Board (SWMB)	665-3497	filemyr@lanl.gov
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Kurt Beckman	SWMB	667-6261	kurtb@lanl.gov
John Fellers	FWO-CFS	667-9607	jdf@lanl.gov
Ray Romero	DOE/OLASO	667-4662	rlromero@doeal.gov
John Stetson	DOE/OLASO/PWT	667-0575	jsteson@doeal.gov
Pradip Badheka	DOE/OLASO	665-0171	pbadheka@doeal.gov
Ray Sisneros	LA County	662-8050	sisnerosr@lac.losalamos.nm.us
Wayne Kohlrust	LA County	662-8116	kohlrustw@lac.losalamos.nm.us
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Jim Mork	LANL/PM-1	665-1331	jmork@lanl.gov
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Initial Site Screen

The first step taken in the site screening process was to apply the NMED municipal landfill siting criteria to county and LANL maps. See Table 2. This step was used as a "Go/No Go" filter to make sure the selected sites can comply with the state requirements. In addition, we first looked for large sites that would provide a 100-year landfill, i.e., over 75 acres in size.

The sites included in the 1989 "Sanitary Landfill Site Locations Study[1]" were considered and many were rejected because of small size or violation of NMED criteria (see Table 3 and Figure 1). The participants also suggested other sites around the County and LANL. TA-66 was eliminated because Pajarito Road is expected to be closed some time soon, thereby denying access to TA-66. TA-72 (south side of Truck Route) and TA-5 were denied because of airport proximity. Rendija Canyon was rejected because 1) large truck traffic would be a problem on the residential access roads and 2) the difficulty of permitting a canyon landfill. The White Rock land transfer site across from Metzger's would be too close to residences. Overlook Park area is too narrow and has residences and canyons too near. North Mesa where the FEMA temporary housing was installed is already planned as a recreation-only zone and is too close to residences. The top of Sigma Mesa (TA-60) is fully committed to other industrial-type uses. The wildlife preserve that runs along the top of the canyon bordering TA-33 and limited size eliminate that site. The TA-8 and TA-69 areas outside of the hazard zone are too small, and already have new construction on them (e.g., the Emergency Operations Center).

Six sites in TA-49, TA-70, TA-71, and TA-36 complied with the initial criteria. See Figure 2.

The Landfill Site Screening Team met several times during August and September 2002 to select additional site alternatives beyond the original six under relaxed Go/No Go conditions. Specifically, our *Proximity to Airport* evaluation criterion (the five mile limit) was relaxed because we now believe an exemption for a landfill nearer the Los Alamos Airport is possible through an New Mexico Aviation Division appeal to the Federal Aviation Administration's Albuquerque office. The second criterion that was relaxed was the 75 to 150 acre requirement. OLASO has come to the conclusion that a site similar in size to the existing landfill (~50 acres) would be a better option for DOE/NNSA.

Given these new parameters, four additional sites were identified for further examination: TA-60 East Sigma Mesa Shelf, TA-61 Borrow Pit, TA-72 at SR4 and East Jemez Road, and TA-58 Two Mile Mesa. See Figure 2.

[1] Facilities Engineering Division Planning Group, ENG-2 and ICF Kaiser Engineers, "Sanitary Landfill Site Locations Study for Los Alamos National Laboratory and Incorporated County of Los Alamos," November, 1989.

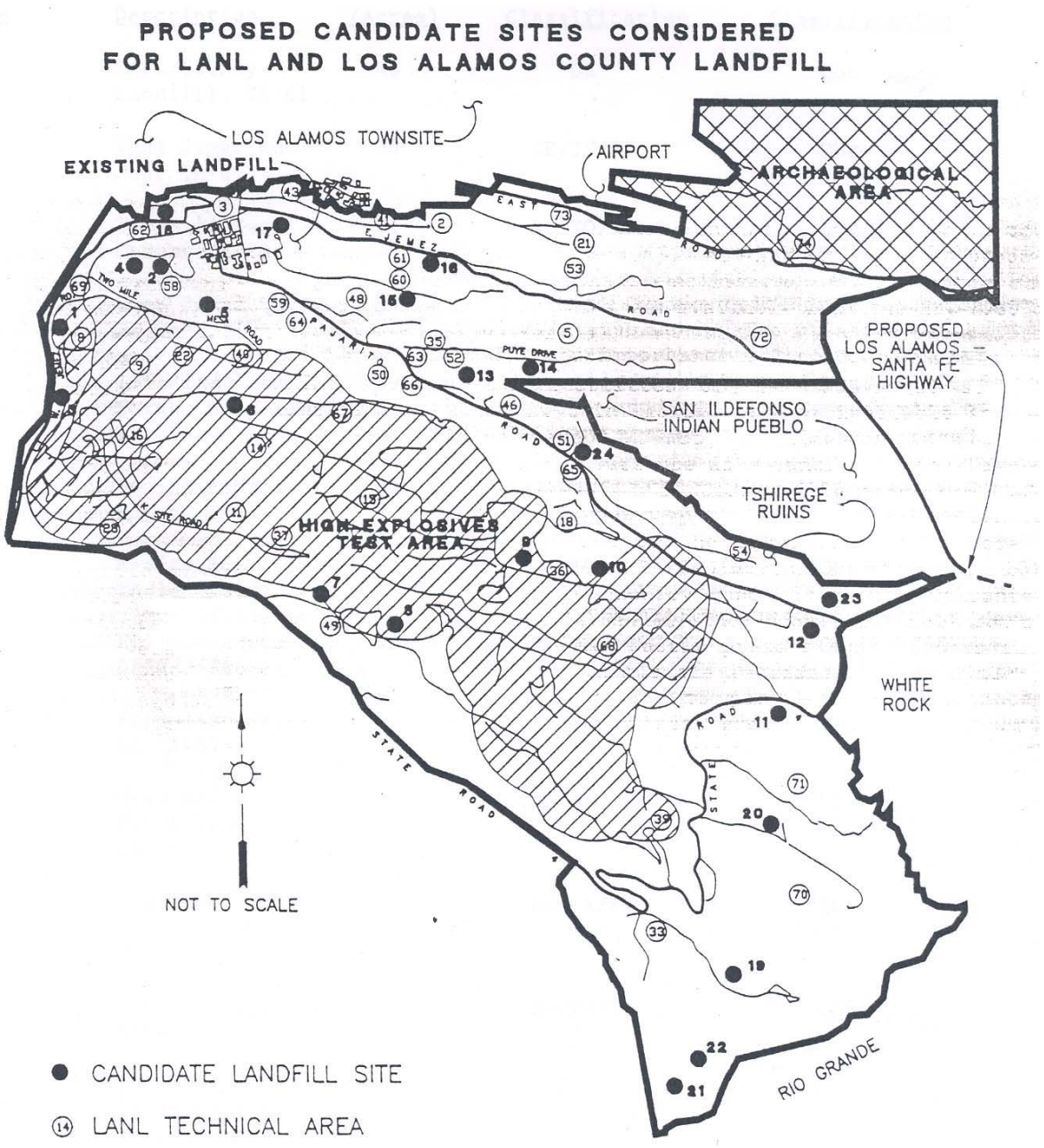

Figure 1: Twenty-four sites were examined as part of the 1989 "Sanitary Landfill Site Locations Study." Many of these were rejected during our evaluation because of small size, incompatibility with NMED requirements, or proximity to LANL operations and hazard zones.

Source: Facilities Engineering Division Planning Group, ENG-2 and ICF Kaiser Engineers, "Sanitary Landfill Site Locations Study for Los Alamos National Laboratory and Incorporated County of Los Alamos," November, 1989, p. 3-2.

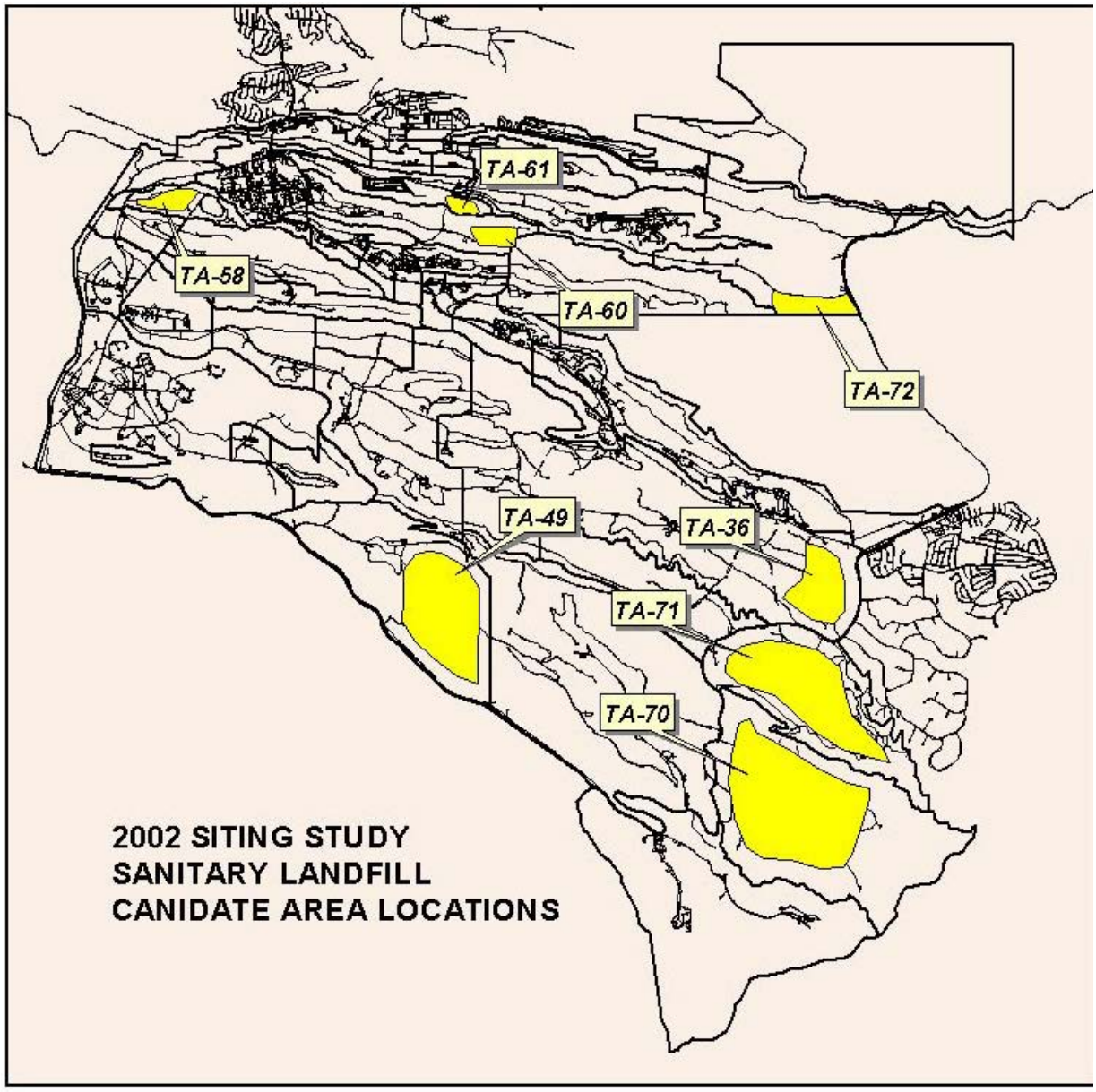

Figure 2: Ten candidate sites passed the Go/No Go criteria of the NMED (three sites are located within TA-49). The large site alternatives are on the perimeter of DOE property, whereas the smaller sites tend to be more centrally located.

TABLE 2
Municipal Solid Waste Landfill Siting Criteria

1. The facility size cannot exceed 500 acres.
2. The facility cannot be located in a floodplain area.
3. The facility cannot be located within 500 feet of a designated wetlands area.
4. The facility cannot be located within 200 feet of a watercourse.
5. The proposed bottom of the fill area cannot be closer than 100 feet to the seasonal high water table depth.
6. The facility cannot be located in an area where registered subsurface mines are considered a problem.
7. The facility cannot be located within 200 feet of a fault with a recorded displacement within the Holocene (11,000 years) time period. This regulation can be bypassed with a demonstration of structural integrity with a less than 200 foot setback.
8. The facility cannot be located in an area with archaeologically significant sites, unless in compliance with the Cultural Properties Act and the Prehistoric Sites Preservation Act.
9. The facility cannot be located within 1000 feet of a public or private well pumping 100 gpm or more.
10. The facility cannot be located within 350 feet of a public or private well that pumps less than 100 gpm.
11. The facility cannot be located in an area within the minimum distance to airports as set forth by the Federal Aviation Administration. Currently, this is listed in SWMR-4-201-B6 as 5 miles.
12. The landfill cannot be located within 50 feet from the property boundaries and 500 feet from actual structures of permanent residences, schools, hospitals, institutions, or churches. The landfill cannot be located in an active alluvial fan. Active is defined as those currently aggraded by either permanent or intermittent streams.
13. The landfill cannot be located in an area where critical habitat of endangered or threatened species is identified by 50 CFR Part 17 or by the Handbook of Species Endangered in New Mexico.
14. The landfill cannot be located in seismic impact zones or unstable areas. This regulation can be bypassed with a suitable determination of no significant impact to structural integrity submitted to the Department.

Source: http://www.nmenv.state.nm.us/NMED_regs/swb/20nmac9_1.html

TABLE 3
Landfill Sites Considered in the "1989 Study"

Site	*Site Description*	*Area (Acres)*	*Status*
1	West Jemez Rd. near TA-8	39	Rejected
2	Two Mile Mesa North, TA-58	61	Included
3	West Jemez Rd, TA-16	39	Rejected
4	Two Mile Mesa North, West Jemez Rd, TA-58	49	Included
5	Two Mile Mesa South, TA-6	60	Rejected
6	R-Site Road, TA-14	53	Rejected
7	Frijoles Mesa Dr., TA-49	40	Included
8	Frijoles Mesa, SE, TA-49	50	Included
9	Mesa del Potrillo, TA-36	17	Rejected
10	Mesa del Potrillo, TA-36	16	Rejected
11	West of Pajarito Acres, TA-71	91	Included
12	Intersection State Rd 4 & Pajarito Rd, TA-36	41	Included
13	La Canada del Buey, TA-46	44	Rejected
14	Pajarito Mesa/Puye Dr., TA-5	17	Rejected
15	Sigma Mesa East, TA-60	33	Rejected
16	Quarry, East Jemez Rd., TA-61	37	Included
17	Sandia Canyon, TA-60	18	Rejected
18	Los Alamos Canyon, TA-3	25	Rejected
19	TA-33	38	Rejected
20	East of SR 4, TA-70	276	Included
21	South Mesa, S. TA-33	68	Rejected
22	North Mesa, S. TA-33	59	Rejected
23	Pajarito Canyon, TA-54	12	Rejected
24	Mesita Del Buey, TA-54	19	Rejected

Source: Facilities Engineering Division Planning Group, ENG-2 and ICF Kaiser Engineers, "Sanitary Landfill Site Locations Study for Los Alamos National Laboratory and Incorporated County of Los Alamos," November, 1989, pp. 3-3 to 3-4.

Site Descriptions

The organization of this section follows a counter-clockwise pattern around the map in Figure 1, beginning with TA-49, proceeding with TA-70, and so on.

TA-49 Sites

This section captures notes, thoughts, and interview information about the possible landfill sites at TA-49. It provides data for the site ranking/evaluation model. The top choice at TA-49 from a landfill siting study in 1994[1] is designated as "TA-49A" in this report to differentiate it from other possible sites in the tech area. The Siting Team walked the two other ravines to the south of TA-49A on June 13 to check on their feasibility. The three TA-49 sites are shown in Figure 3.

The first source interviewed for operational issues related to TA-49 (as well as other sites) was Mike Smith, the Deputy Facility Manager at DX (7-6237). He has excellent background on the siting issues because, in addition to his FM duties, he also worked with Craig Bachmeier on the previous landfill siting effort in the early 1990s. On June 14, 2002, Steven Booth met with Ainslie Young (NIS-10), Ray Jermance (NIS-DO), Scott Alexander (NIS-FMU-75), Gene Darling (S-8), and Tom Turner (DX-3) to discuss operational impacts with respect to each of our potential sites. Tom described DARHT and PHERMEX issues.

LANL Operational Issues Related to TA-49 Sites

TA-49 is a very active site, and one that must be closed down often to allow special operations to occur. These include high-energy radio frequency tests, hazardous material training, and suspicious package/bomb demolition. In addition, much of TA-49 lies within blast zones of PHERMEX, DARHT, and various TA-36 and TA-39 firing sites.

The west end of TA-49 has potential release sites (PRSs) of contamination and so was not considered in the 1994 landfill study. Now that area houses fire mitigation activities and a helicopter pad for fire fighters and rapid responders.

The 1994 siting study chose the TA-49A site to keep it away from the Bandelier National Monument. The team was able to show the park officials that there would be no line-of-sight problems to the TA-49A ravine.

The current access loop to TA-49A may be undesirable as landfill access because it circles areas with underground contamination (see Figure 4). An especially sensitive area is at the northeast corner of the loop. We saw the environmental cap behind fences as we drove the loop during our tour. Consequently, we might have to construct a landfill bypass road to the north or south of the loop. The loop road lies up-gradient from TA-49B, which is a serious limitation for building a landfill at that site.

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[1] CDM Federal Programs Corporation, "Sanitary Landfill Site Selection at Los Alamos National Laboratory, Revision 1," DCN: 5102-001-RT-AAJG, January 27, 1994.

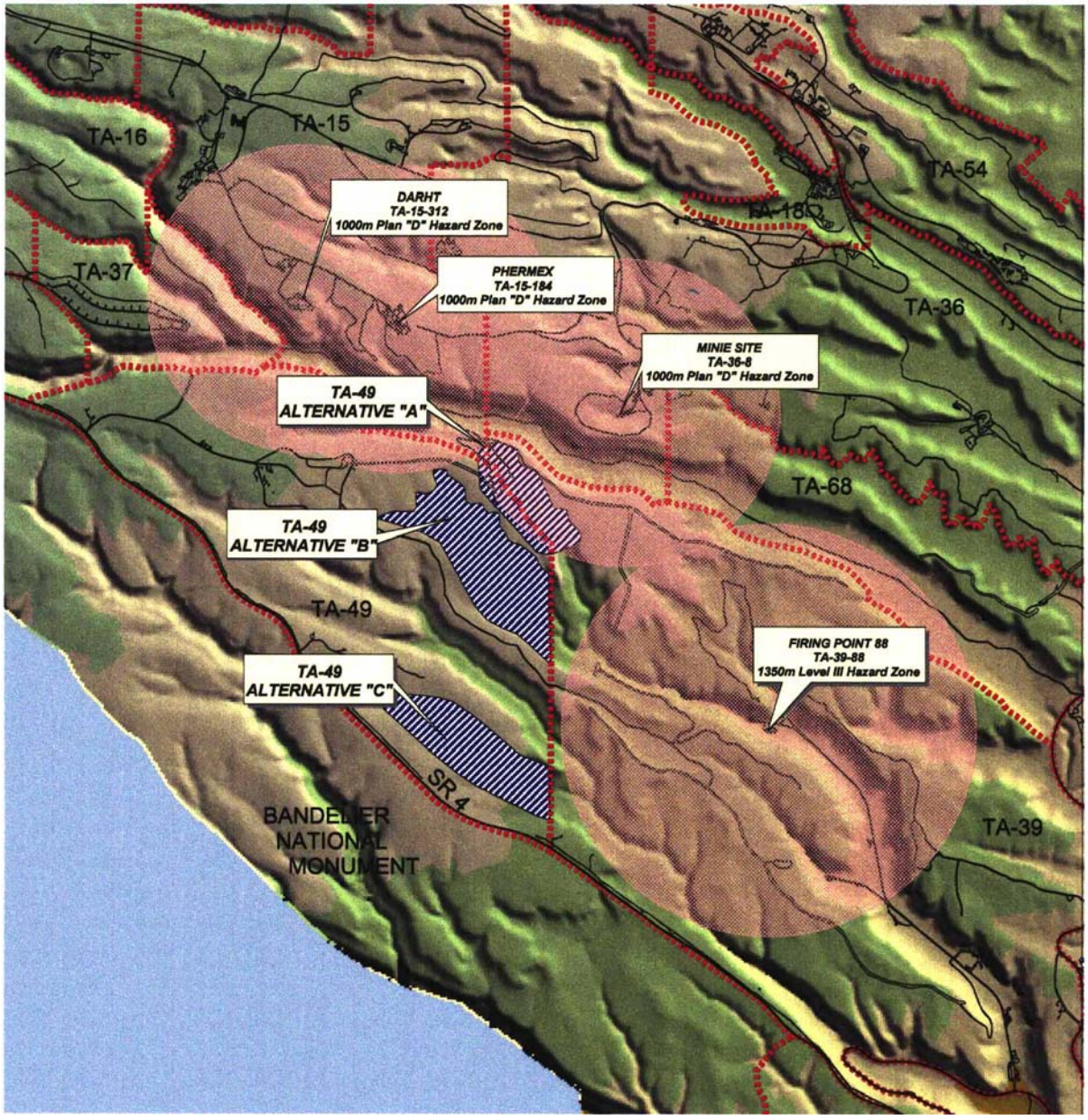

Figure 3: This map shows the blast zones associated with activities surrounding TA-49 landfill tracts: PHERMEX, DARHT, TA-39-88, 36-8.

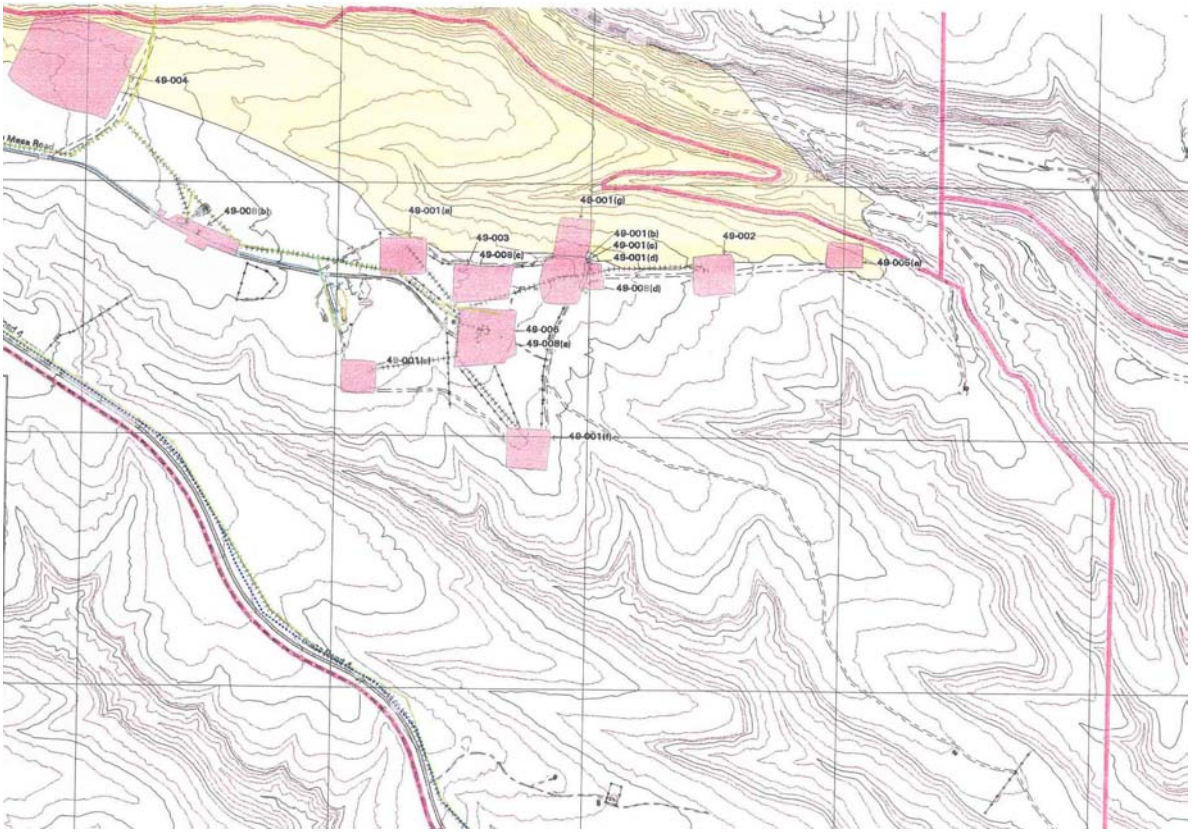

Figure 4: Several potential release sites at TA-49 lie upgradient of Tract 49B.

At one time there was talk of putting SHEBA at TA-49. That idea still may be under consideration. Point 6 in TA-39 is inactive now, and so has no bearing on the landfill decision.

The blast zones are developed from probability models that measure the risk of a lethal fragment. So the zone boundary really is not the limit of where fragments could fly, just that the probability of a lethal hit is sufficiently low beyond it. The blast zones on our maps show the 1000m limit of the "Plan D hazard zone," which is the most conservative and safest scenario. The peak over-pressure level for this zone is 0.14 psi, which is still a shock high enough to break glass. See Figure 3. This is appropriate for our analysis. Just because our sites are in ravines does not provide blast protection since the fragments fall from high up. Any time a shot will occur, the blast zone areas must be cleared of all personnel. Since the zone covers the current TA-49 access road, unless we build a new road, it is impossible to enter the site on "shot days" using the road. Therefore, an important factor in judging operational impact of a landfill is the number of shots that occur, and how often access to the site will be shutdown.

PHERMEX and DARHT. There are two types of shots at PHERMEX and DARHT: "big" shots that include complex, integrated diagnostics, and "small" shots that do not. Both shots use similar amounts of high explosives, so the hazard zone is the same in both cases. DARHT and PHERMEX each explode about one big shot and one small shot per month. These shots alternate between sites, so this means on average about one shot per week occurs at one of the facilities. When a shot occurs, the site is generally vacated for the whole day. Also, often shots are delayed, so the site closure extends one or even more days.

When the second axis of DARHT is commissioned in June 2004, PHERMEX is planned to be shut down. However, there are no guarantees that this will happen because there still seems to be interest among sponsors for experiments there. Shutting PHERMEX would remove its blast zone from the TA-49A site, but that of DARHT would still remain, covering Frijoles Mesa Drive, the current access to the landfill site. Also, some special experiments can close TA-49 in its entirety.

Overall, DARHT and PHERMEX appear to create significant problems with operating a landfill, and will close off the access road and perhaps Tract 49A for about one day per week. A potential solution may be to construct another access, outside of the blast zone. (Source: Tom Turner.)

High Energy Test Facility. The radio frequency experiment at TA-49 runs a minimum of six times per year. While operating, the experiment requires that all equipment be removed from the "flight path," since the RF is strong enough to damage it. See Figure 5. After a set up period, the experiments generally run for about one week. So for at least six one-week periods per year, landfill truck deliveries will not be allowed. (Source: Ainslie Young.)

TA-36, Minie Firing Site. The "Minie" firing site (TA-36-8) is located about 1,500 feet north of Tract A. This is an active site, which averages about two days per week when shots occur. (Source: Tom Turner.) The hazard areas for TA-36-8 Minie Site are the same as for DARHT:

Plan "A" = 250m (820 ft)
Plan "B" = 500m (1640 ft)
Plan "C" = 750m (2460 ft)
Plan "D" = 1000m (3280 ft).[2]

TA-39, Point 88. Point 88 of TA-39 is located southeast of Tracts A and B. This site can handle large high explosive tests that have a blast zone extending westward up to the TA-49 border. During our tour of Tracts B and C we heard such a blast; Figure 6 shows the dust plume immediately afterward. Large explosions only occur a couple of times per year. Smaller shots with 5 to 150 pounds of explosives occur on a weekly basis. The Level III hazard zone of Point 88 is 1350m (see Figure 3). This will probably not impact any of the TA-49 landfill sites.

Explosives Destruction and Hazardous Materials Training. TA-49 serves the lab as the location for destruction of suspicious packages or explosive devices. The HE limit is low, only two pounds, but during these events the TA-49 loop road is shut down and the gates are closed. Such closures can potentially once a week. In addition, Haz-Mat training is done at TA-49, during which time the site is closed. These training episodes occur about two days per month on varying days. Classes that last all week happen about once a quarter.

Overall, there are many LANL activities at TA-49 that require the site to close. Adding together all the days per year that TA-49 could be closed to landfill operations under current LANL activity levels, we get 178 days (50 days from DARHT/PHERMEX, 30 days from RF tests, 2 days from TA39-88, and 96 days from Haz-Mat; Minie shots were not counted.)

Miscellaneous Operations at TA-49. Near Tract 49C there is meteorological tower operated by RRES-Meteorology and Air Quality. See Figure 7. No problem is expected with the construction and operation of a new landfill since the tower is at the edge of the landfill's buffer zone.[3] Also an aluminum covered board that serves as a calibration target for LIDAR tests is located along the dirt road to Tract C. See Figure 8. A CO2 laser beam of medium long-wave infrared is sent from TA-33 to the board. Because there is about 7km of distance to the laser, there is no safety issue with respect to the landfill at Tract C. Personnel from C-Physical Chemistry and Applied Spectroscopy need access to the board about once a year for maintenance. There should be no conflict with landfill operations.[4]

[2] Jerry Vacilik, e-mail July 9, 2002.
[3] Scot Johnson, RRES-MAQ, personal communication, July 22, 2002.
[4] Joe Tiee, C-PCAS, personal communication, July 26, 2002.

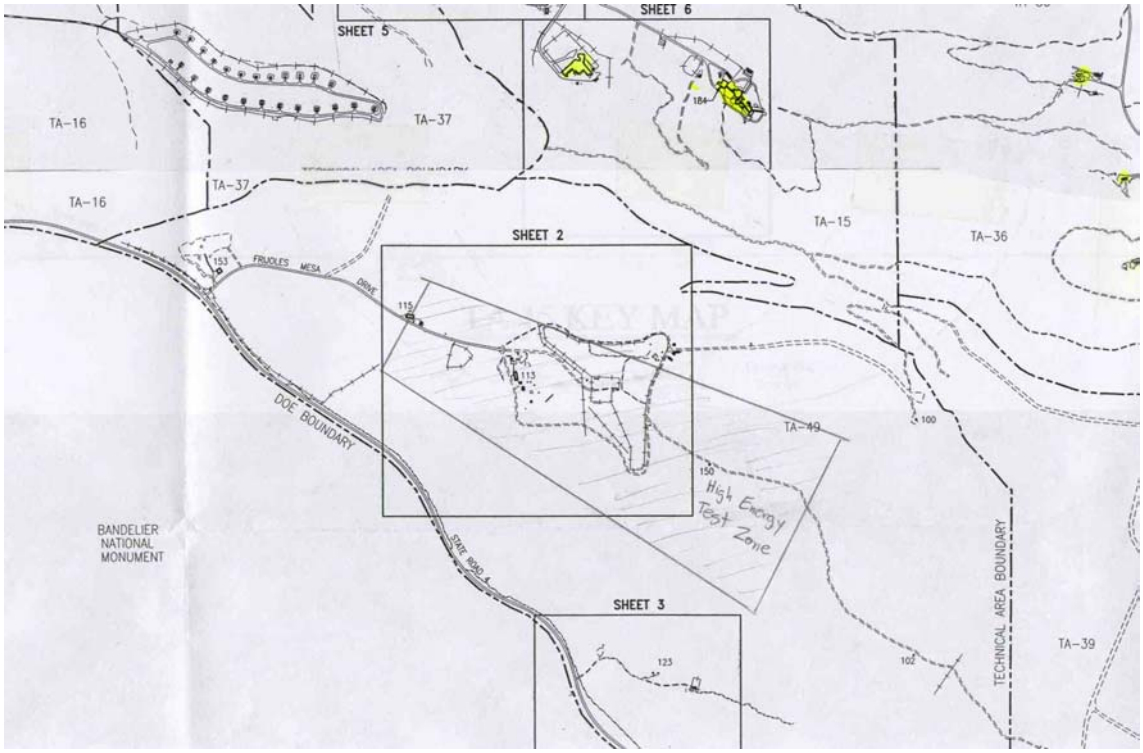

Figure 5: The RF High Energy Test Facility creates an exclusion zone that includes parts of Tracts 49A and 49B, and access roads.

Figure 6: Immediately after an explosive test at Point 88 of TA-39, this plume of dust was visible from the dirt road west of Tract 49C.

Figure 7: A meteorological tower operated by RRES-MAQ is located near the buffer zone of Tract 49C.

Figure 8: This aluminum-covered board is used to calibrate a CO2 laser LIDAR system located at TA-33. It is located along the dirt road to Tract 49C.

Photographic Tours of TA-49 Landfill Sites

Eight members of the Site Screening Team toured the TA-49 site selected in 1994 (Tract 49A) on May 30, 2002. The team toured Tracts 49B and 49C on June 13, 2002. See Figure 9. Photos from the tours follow.

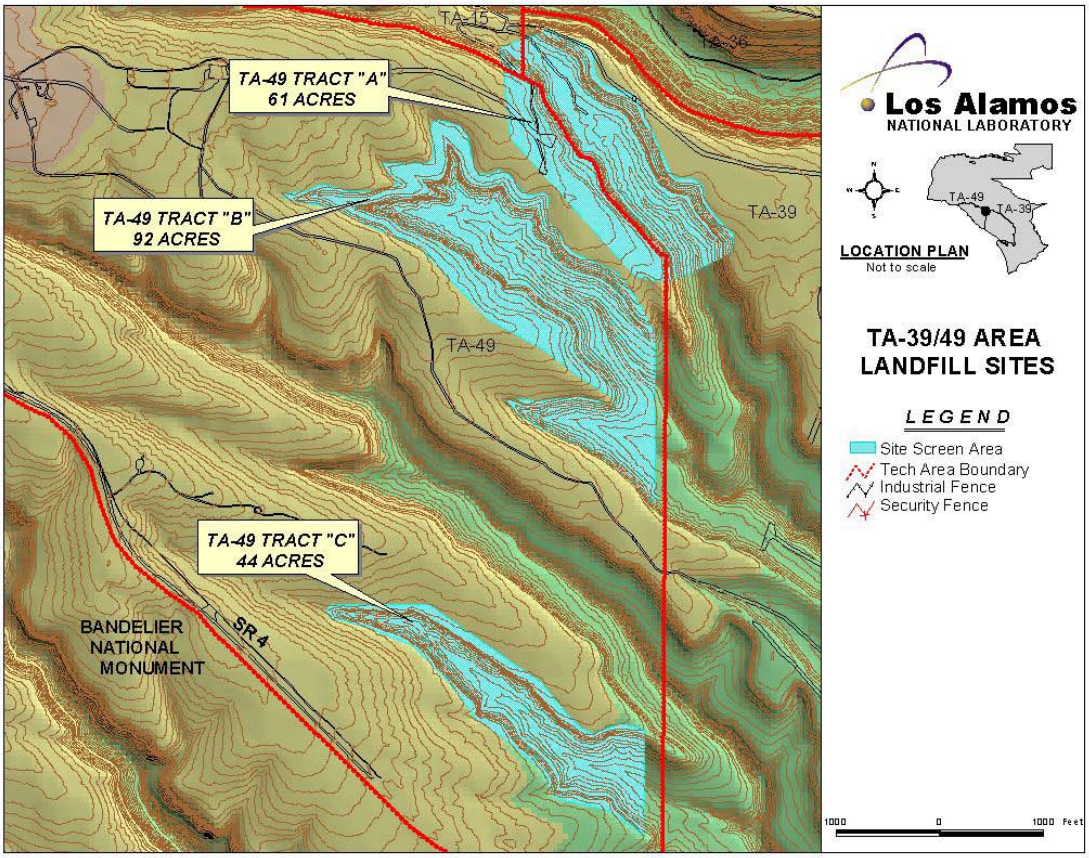

Figure 9: Map of the general vicinity of the three TA-49 landfill alternative tracts. The head of the third ravine to the NE of SR4 is Tract 49A, the preferred option of the 1994 siting study. Our Tract 49A tour entered the ravine from the dirt road that begins at the cul-de-sac located in the upper-right of the map. Disregard the acreage shown for Tract 49C. See Figure 10 for a more accurate lay out of this site.

Tract 49A Photo Tour

Photo 49A-1: The road on top of the mesa before entering the ravine is built on tuff and is relatively flat.

Photo 49A-2: The road entering the ravine from the south is steep and cut into tuff.

Photo 49A-3: A view down the ravine from the side of the south wall, looking east.

Photo 49A-4: A view up the ravine from the side of the south wall, looking NW.

Photo 49A-5: A view down ravine from south wall, from a location near the head.

Photo 49A-6: A view from north wall toward the south. Note the road cut coming down the south wall face into the head of the ravine.

Photo 49A-7: Some archeological sites are present at TA-49 as indicated by this pottery shard found in the road on the south face of the ravine.

Tract 49B Photo Tour

Photo 49B-1: View looking east from the head of the shallow ravine.

Photo 49B-2: The ravine gets deeper toward the east. This photo faces east from the top of a approximately 15 foot drop off that has some evidence of a water fall.

Photo 49B-3: View looking east from about the mid-point of the proposed site, one can see the ravine is now quite broad, with steep sides.

Photo 49B-4: View toward the northeast from the south wall of the approximate mid-point of the tract.

Photo 49B-5: View looking west at the mid-point of the tract.

Photo 49B-6: A view of the lower ravine looking east from the south side.

Photo 49B-7: A view to the west of the lower end of the tract.

Photo 49B-8: Archeological sites are present near the landfill tract.

Photo 49B-9: A zoomed view to the east from the south side of the landfill tract shows the telescope dish at TA-33.

Tract 49C Photo Tour

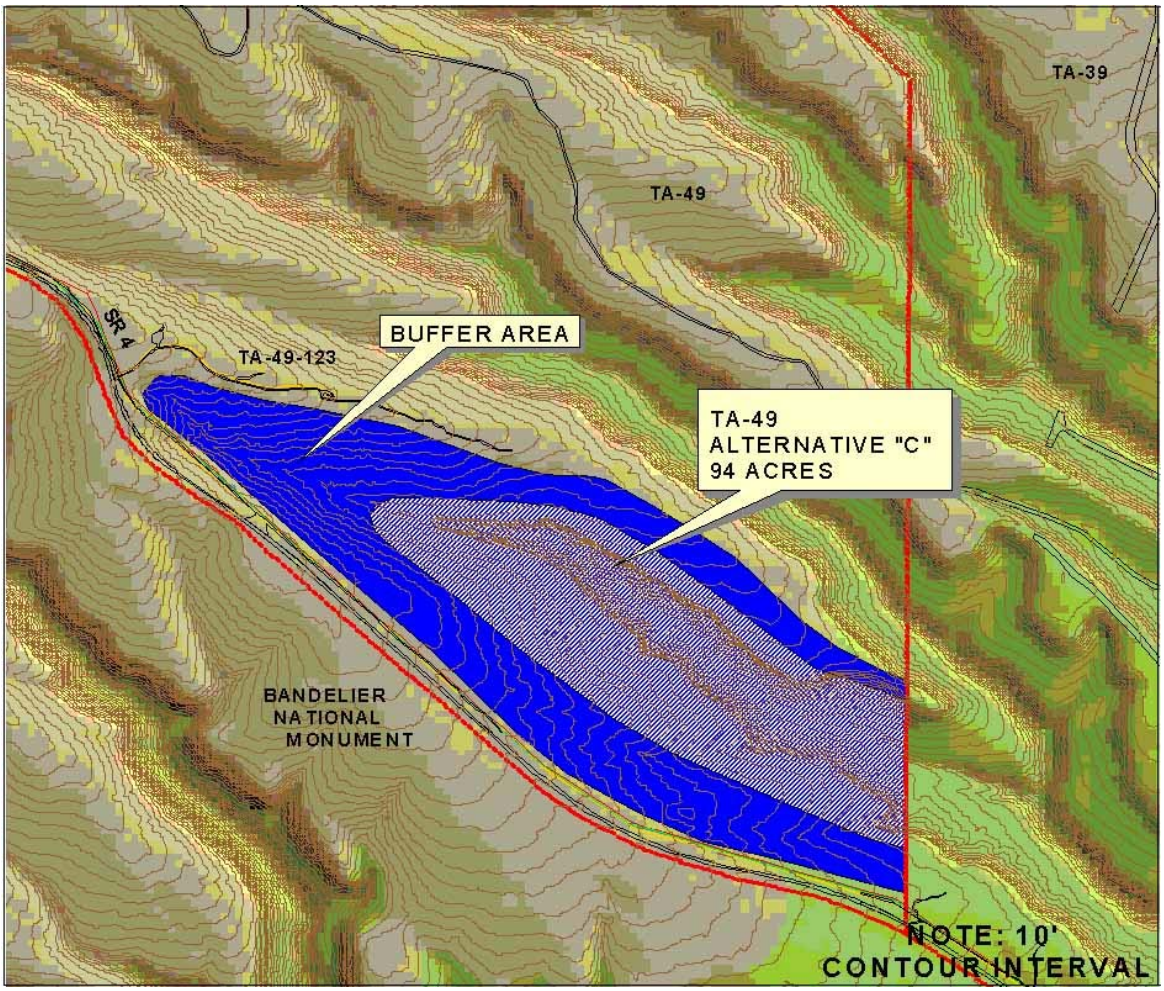

Figure 10: As drawn, Tract 49C has 94 acres plus a significant buffer area for visibility mitigation.

Photo 49C-1: From the head of the Tract 49C ravine looking southwest one can clearly see SR4 with Bandelier National Monument on the opposite side of the road.

Photo 49C-2: Another view from the head of the ravine, looking to the south east.

Photo 49C-3: A mid-ravine view to the southwest from the north ravine wall. SR4 runs along the tree-lined ridge visible in the left side of the photo.

Photo 49C-4: Mid-ravine view toward the southeast, from the north wall.

TA-70 Site

TA-70 serves as a buffer area for LANL. No activities at TA-33 or other areas would interfere with a landfill constructed at TA-70. The map in Figure 30 shows a possible landfill area of about 176 acres, but to avoid archeological and cultural sites a smaller landfill would be required.

Photographic Tour of TA-70 Site

The team toured TA-70 the morning of May 29, 2002. Photos follow.

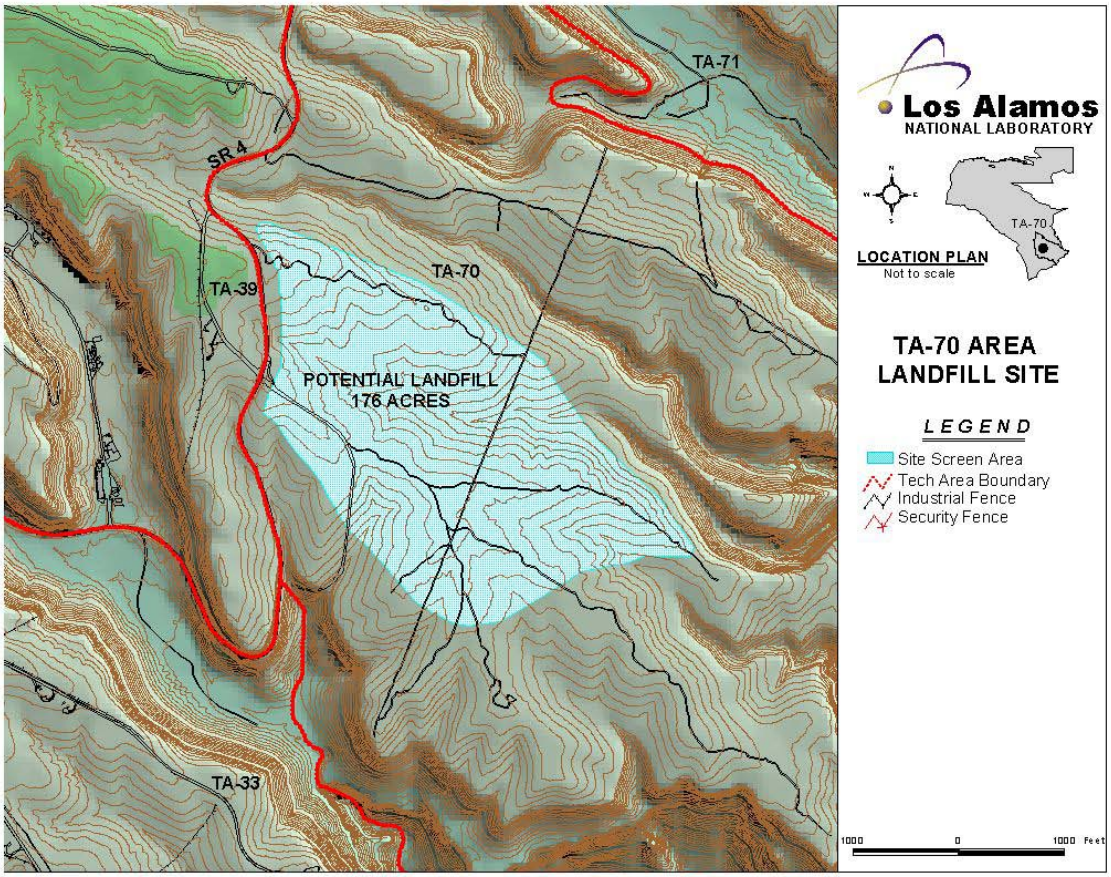

Figure 11: Map of vicinity of landfill site. Tour entered on northern dirt road that runs east from SR4, preceded to the power line (running roughly north-south across center of map), then returned to SR4 via the southern dirt road. The ravine crossed by the power line is featured in one photo below.

Photo 70-1: View to the NE along the power lines that cut Water Canyon at the intersection of the northern dirt road.

Photo 70-2: View along power lines toward SW. Near intersection of power lines and northern dirt road. The ravine can be seen ahead of the people, the low point of the site.

Photo 70-3: The topography of the site area is generally flat, with juniper and pinon trees. This is a view to the west from the northern dirt road.

Photo 70-4: The ravine is about thirty feet deep near where the power lines cross. Tour members had to travel up-gradient along the north wall to find a place to cross.

Photo 70-5: The head of the ravine where it crosses SR4 has a metering station that can provide flow data.

Photo 70-6: Looking east across Water Canyon from the northern dirt road it is possible to see houses in Pajarito Acres.

TA-71 Sites

Originally two small sites were delineated for TA-71, Tracts A and B. (See Figure 12.) To obtain adequate acreage, the two were combined.

Operational Issues Related to TA-71 Sites

There are no operations of DX division on TA-71. However, the drainage of firing sites from TA-39 and TA-36 run through TA-71. This was a significant issue that eliminated TA-71 from the land transfer process. "Special studies performed adjacent to and within the TA-70 and TA-71 site show occasional instances of sediment and water contaminated with depleted uranium."[1]

TA-71 is one of the few large areas available for major new LANL development.

There are no utility services at the site. No water, gas, sewer, or telephone. The services (e.g., underground telephone lines) come down SR4 from the Back Gate to TA-33 and TA-39 in Ancho Canyon.

TA-71 currently provides a buffer zone to the hazard zones for DX explosives tests.[2] A note on Hazard Zones:

> "…because the throwing of fragments is a statistical process, the DoD procedure defines the maximum radius as that point beyond which there is a probability of only one lethal fragment for any 25 sq. m. area. Fragments are, on occasion, thrown past the perimeter of the hazard area and fragments have been observed in these areas from past experiments. For this reason, a buffer zone is required outside the hazard area for explosive and material testing firing sites. … The TA-70 site provides a major portion of the actual hazard area for the TA-33 and TA-39 firing sites. The TA-70 site provides the buffer zone for TA-39 and the TA-70 and -71 sites provide the buffer zone for TA-33."[3]

Photographic Tour of TA-71 Sites

On Thursday, May 23, 2002, the Landfill Site Screening Team toured the TA-71 area. Photos follow.

[1] "Land Transfer Issues for the DX Division and the TA-70 and -71 Sites, DX Division report, January 1998, p. 2.
[2] Ibid.
[3] Ibid., p. 22.

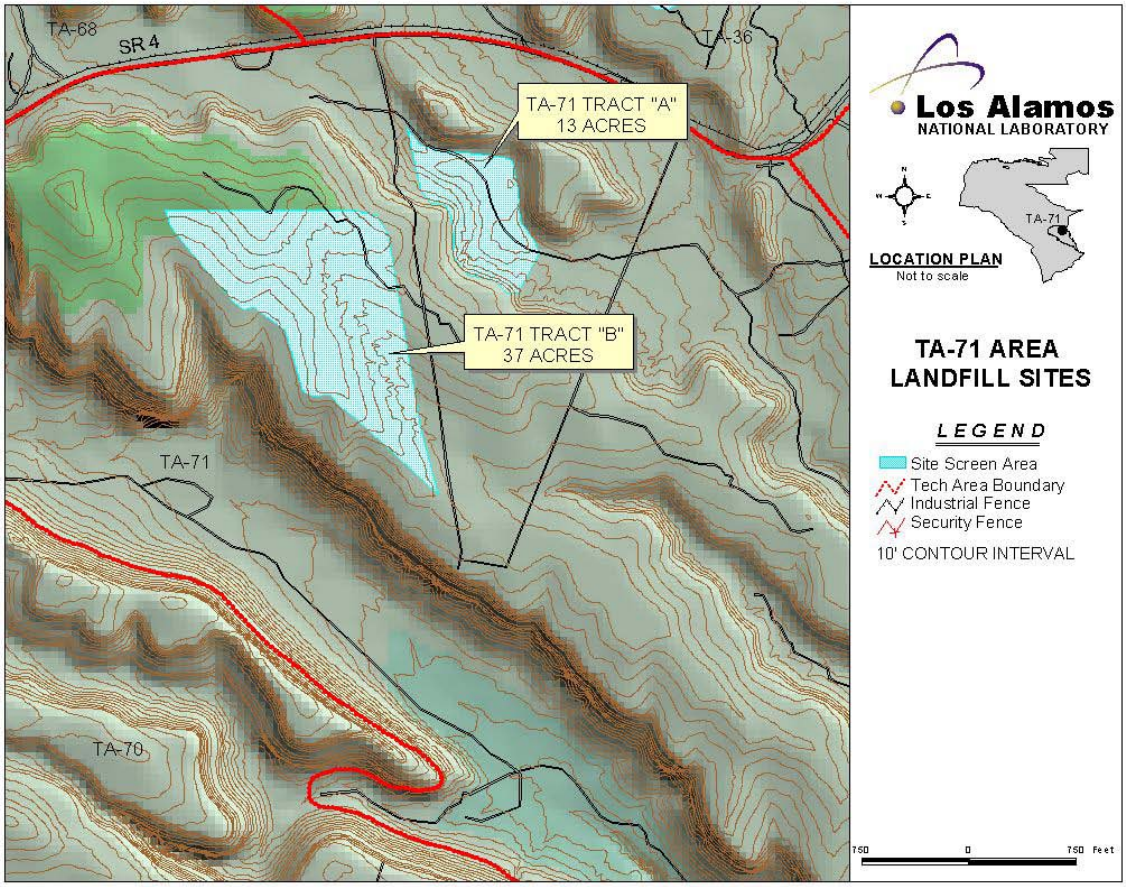

Figure 12: We began the tour by climbing the knoll directly to the north of Tract 71A. This gave us a good view of Tract 71A. We next walked west to the top of the bench above Water Canyon. This is Tract 71B.

Photo 71-1: View of Tract 71A (Borrow Pit) to the west. This shows the up-gradient end of the site, with a power line defining the western border. The 115kv power line runs approximately north-south. This borrow pit is the planned location for a new substation; new power lines will follow the existing line from the south (from the left side of the photo), then turn west from the borrow pit.

Photo 71-2: The view to the east from the knoll shows the proximity of Pajarito Acres. Visibility to the landfill may be an issue if sited at TA-71A.

Photo 71-3: Tract 71B is characterized by juniper and piñon forest, with relatively flat topography.

Photo 71-4: Archeological sites may be a significant issue on Tract 71B.

TA-36 Site

Information contained in a DX report[1] prepared for the Land Transfer project is summarized here. See Figure 13.

LANL Operational Issues Related to TA-36 Landfill Site

Our landfill site in TA-36 currently provides part of the buffer zone for TA-36 firing sites. (Remember the difference between "hazard zones" and "buffer zones." The hazard zone must be physically cleared of all personnel.) In addition, the planned extension to the 1000 foot sled at TA-36:12 will extend the hazard zone an additional 1000 feet toward SR4, further impinging on the landfill site. This means the landfill operation would have to shut down when shots were taking place at TA-36:12.

"Welded Bandelier Tuff underlies TA-36 except for the bottom of the canyons, which is underlain by alluvium. … Over 600 feet of unsaturated tuff and volcanic rock separate the surface from the aquifer."[2]

"Because of its location within the canyon walls the TA-36:12 firing site has a higher explosive limit for open air testing than the mesa top facilities like PHERMEX and DAHRT."[3]

Photographic Tour of TA-36 Landfill Site

This section contains photos from the tour taken by the Landfill Site Screening Team on Friday, June 6, 2002. We were accompanied by DX escorts: Jerry Vasilik, Franco Sisneros, and Mike Smith.

[1] "Land Transfer Issues for TA-36 and the University Site," DX Division, October 10, 1997.
[2] Ibid., p. 3.
[3] Ibid., p. 7.

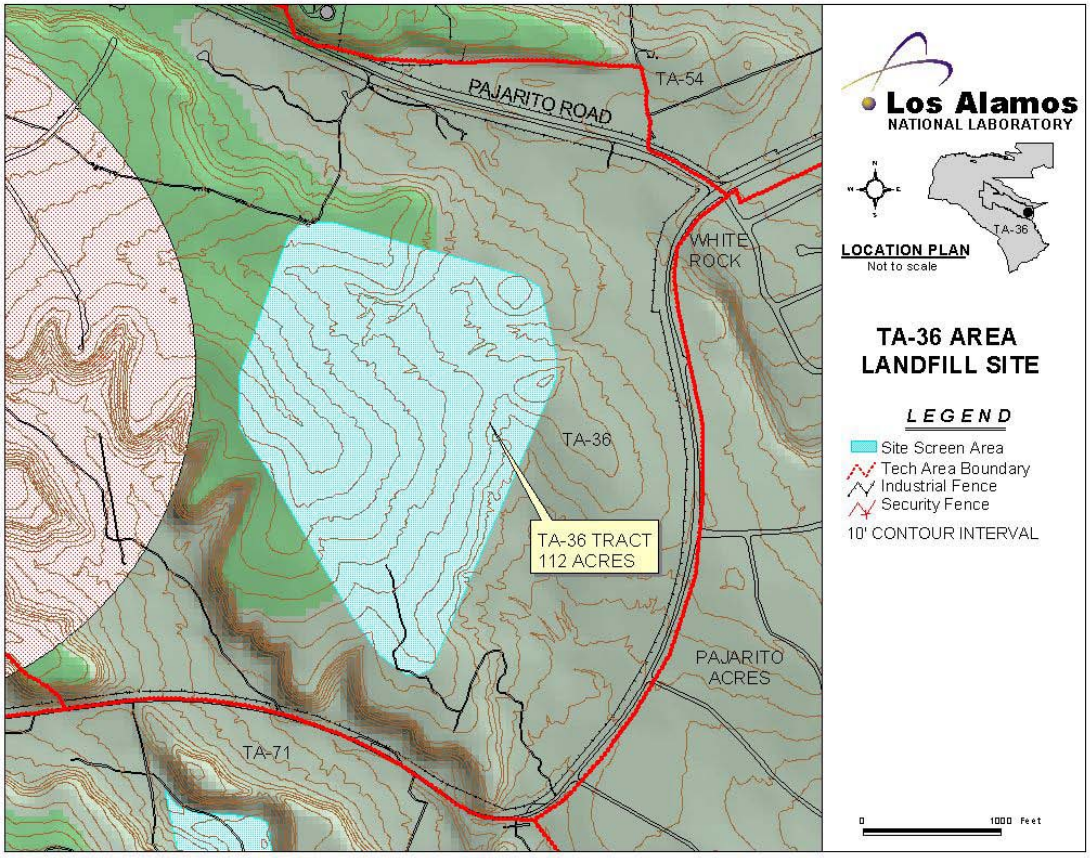

Figure 13: Topographic view of the possible landfill area of 112 acres. The hazard zone shown to the west of the tract is from the TA-36:12 firing site, and assumes the 1000 foot sled extension is in effect.

Photo 36-1: The view to the north along the communication line corridor shows the relatively flat topography of the tract. This line represents the eastern extent of the landfill tract.

Photo 36-2: From some locations on the TA-36 tract, one can clearly see houses in Pajarito Acres.

Photo 36-3: The TA-36 tract has many prominent archeological sites that would make it difficult to obtain a permit for landfill construction.

TA-72 Site

The TA-72 landfill site is located at the southwest corner of the East Jemez Road (Truck Route)/SR4 intersection. The site is bounded by the Truck Route to the north, SR4 to the east, and San Ildefonso property to the south. See Figure 14. Directly to the northeast is Bandelier National Monument's Tsankawi Ruin, a popular hiking and tourist location for the County. The land is generally flat with juniper and piñon trees.

Because the site lies on a major highway, truck access should not be a problem. East Jemez Road is designed to handle the truck shipments to and from the laboratory. A major issue with this site is its proximity to neighbors: San Ildefonso Pueblo and Bandelier National Monument. Property of both these entities lies essentially at the doorstep of the landfill site. Unavoidable clear vistas of the landfill will occur from these properties.

An airport exemption might be more difficult to obtain for this site because it lies within the approach pattern for Albuquerque flights. A final issue is the fact that the site is located at the base of Sandia and Mortandad canyons, but not within the 100-year flood plain. (See Figure 15.) The proximity of the flood plain may make permitting more difficult.

LANL Operational Issues Related to TA-72 Landfill Site

As shown in Figure 15, LANL is planning a distribution center along East Jemez Road just to the west of the landfill site. The truck inspection station is to the north of the site. Also, the County is planning to move their warehousing operations here.

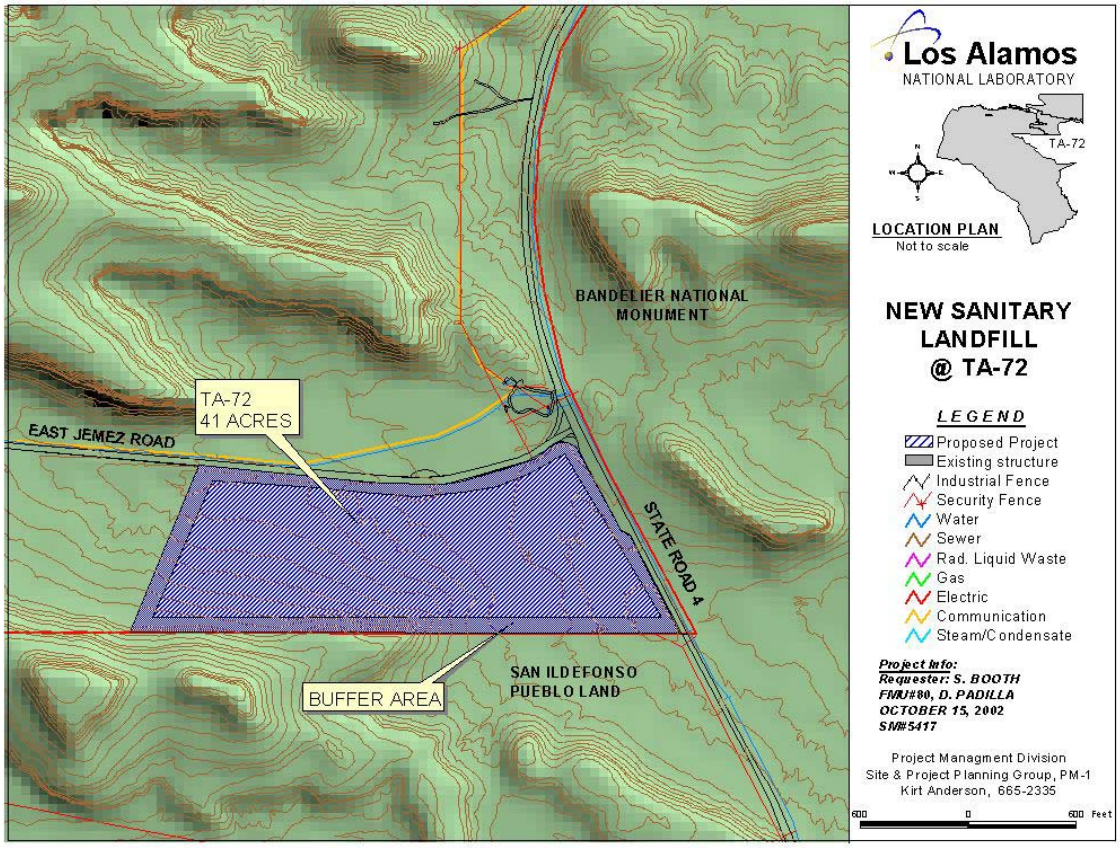

Figure 14: Map of site with buffer zones.

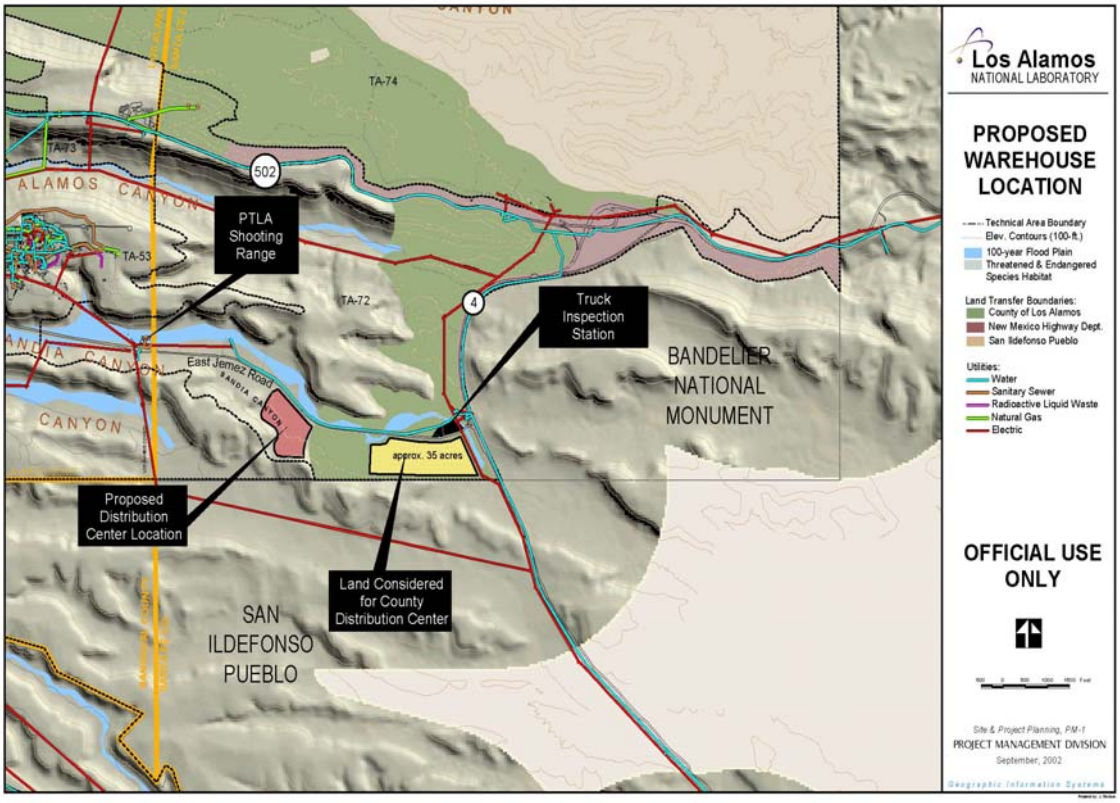

Figure 15: The new County Distribution Center is proposed for the same area of the landfill site. The 100-year flood plain is just to the north of the site.

Photographic Tour of TA-72 Landfill Site

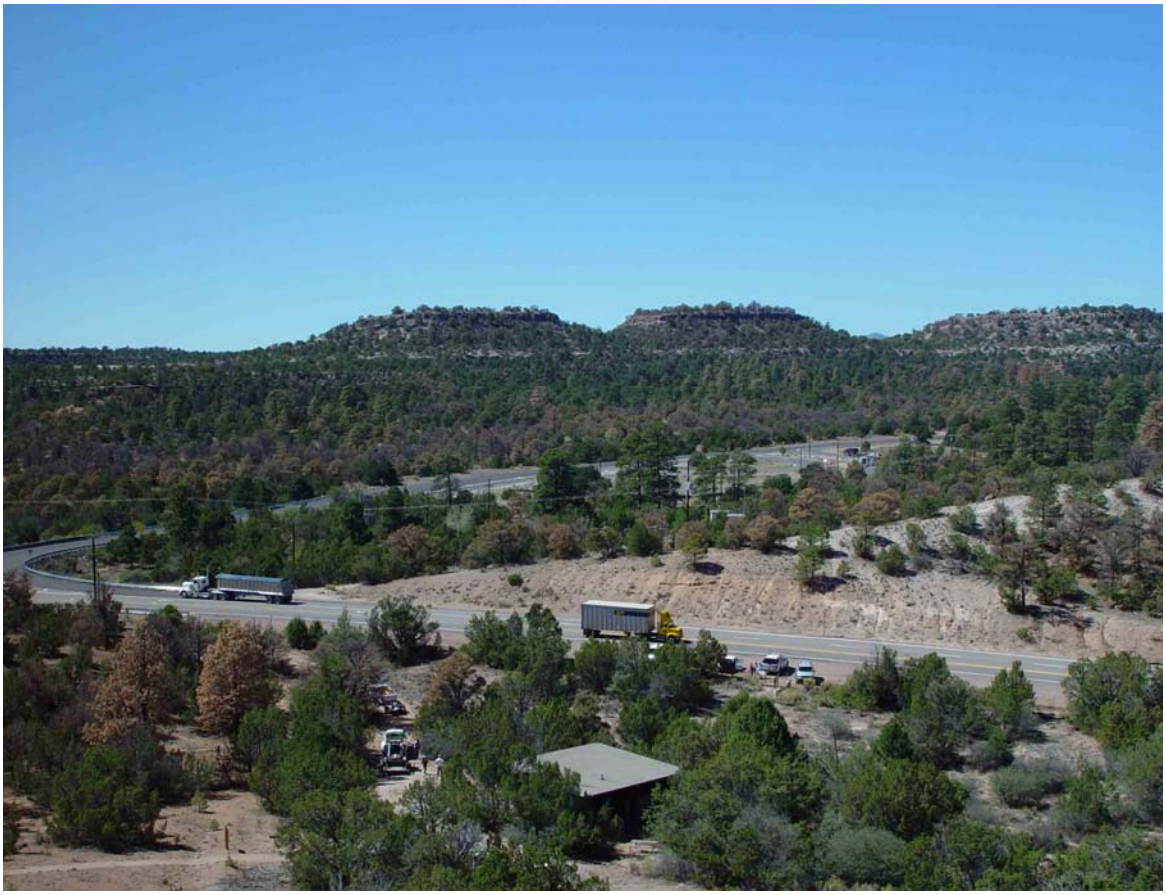

Photo 72-1: This view from Tsankawi provides an overall perspective of the location. On the horizon, the three small mesas or knolls oriented in a east-west line are part of San Ildefonso property. The landfill site lies in the foreground of these knolls along East Jemez Road, extending west approximately to the mid-line of the second knoll. A Bandelier National Monument building is seen in the foreground of the photo.

Photo 72-2: The fence line of San Ildefonso property marks the south edge of the site.

Photo 72-3: The TA-72 site is only 1000 feet from Tsankawi ruins, a popular tourist spot within Bandelier National Monument. The site can be clearly seen from the higher vantage points of the park.

TA-60 East Sigma Mesa Shelf Site

This site is located off the east end of Sigma Mesa on a shelf or bench that lies about fifty feet lower than the mesa top. The mesa extends in the form of knolls to the north and south of the landfill site, which provide visibility and wind protection. A gentle gradient to the east characterizes the site.

LANL Operational Issues Related to TA-60 Landfill Site

There do not seem to be any operational issues for this site. Potential impact of the landfill on the LANSCE expansion for the Advance Hydrodynamic Facility (AHF) was discussed with the project leader. Jeff Paisner had his A/E firm (Holmes and Narver) check into the landfill issue on his behalf. "Based on their evaluation, the location of the proposed landfill will not impact AHF project development."[1]

With regard to the Utilities and Grounds master plan, there are no problems with the TA-60 site. Eniwetok Drive will be improved to handle truck traffic that is expected for the relocation of several industrial/support operations such as the "brown palace" for the support contractor, the FWO building, and the Roads and Grounds shop. In addition, the construction rubble and debris recycling area will be on this road as well.[2] There should be no problem with either safety or security of using Eniwetok Drive for shipment of sanitary bales to the new landfill.[3] The SCC cooling tower water conservation project will have collection ponds along the drive, but without any impact on the landfill site. There should be no problem with water wells, since none are nearby.[4]

The RRES-R Industrial Sites Team Leader evaluated this site for environmental restoration issues. There are no possible release sites (PRSs) within the boundary of the proposed site.[5]

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[1] Jeffrey A. Paisner, LANSCE-Advanced Hydrotest Facility, e-mail to Steven Booth, September 9, 2002.
[2] It may be possible to combine County and LANL debris recycling and crushing operations at the Eniwetok site.
[3] Ross Griechen, S-1 Security Plans and Programs, personal communication, December 3, 2002
[4] Charles Trujillo, FWO-Utilities and Infrastructure, personal communication, September 30, 2002.
[5] Gabriela Lopez Escobedo, RRES-Industrial Sites Team Leader, e-mail to Steven Booth, September 10, 2002.

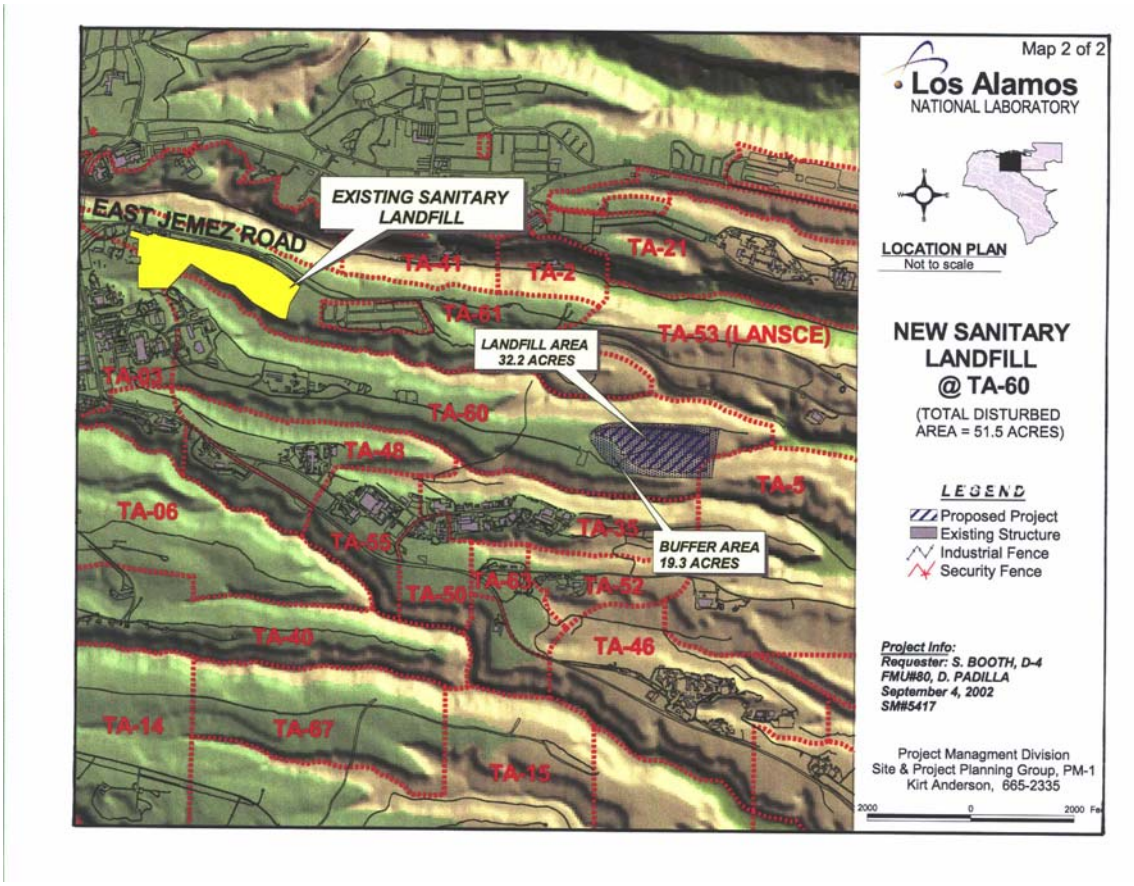

Figure 16: Within two miles of the TA-60 landfill site is the existing County landfill, shown here in yellow. One possible transportation option is a bridge over Sandia Canyon combined with some road construction would allow trucks to shuttle between the baling/recycle operations at the existing site and the new bale-fill, minimizing traffic on East Jemez Road and Eniwetok Drive.

Geology, Archeology, Cultural, Threatened and Endangered Species Issues

The following information comes from Phil Noll in an e-mail to Steve Booth dated September 3, 2002.

- The area is within core and buffer habitat for the Spotted Owl. To construct a landfill here would require a formal consultation with the US Fish and Wildlife Service and the preparation of a Formal Biological Assessment. Even so, it is very likely that we would be allowed to proceed with the landfill. We just need to cross all t's and dot all i's.
- There are 7 cultural sites present. On the edge of the mesa (western edge of the proposed landfill) there are two field houses. These would need to be avoided. On the northeast corner of the proposed landfill there are two artifact scatters. These would likely need to be

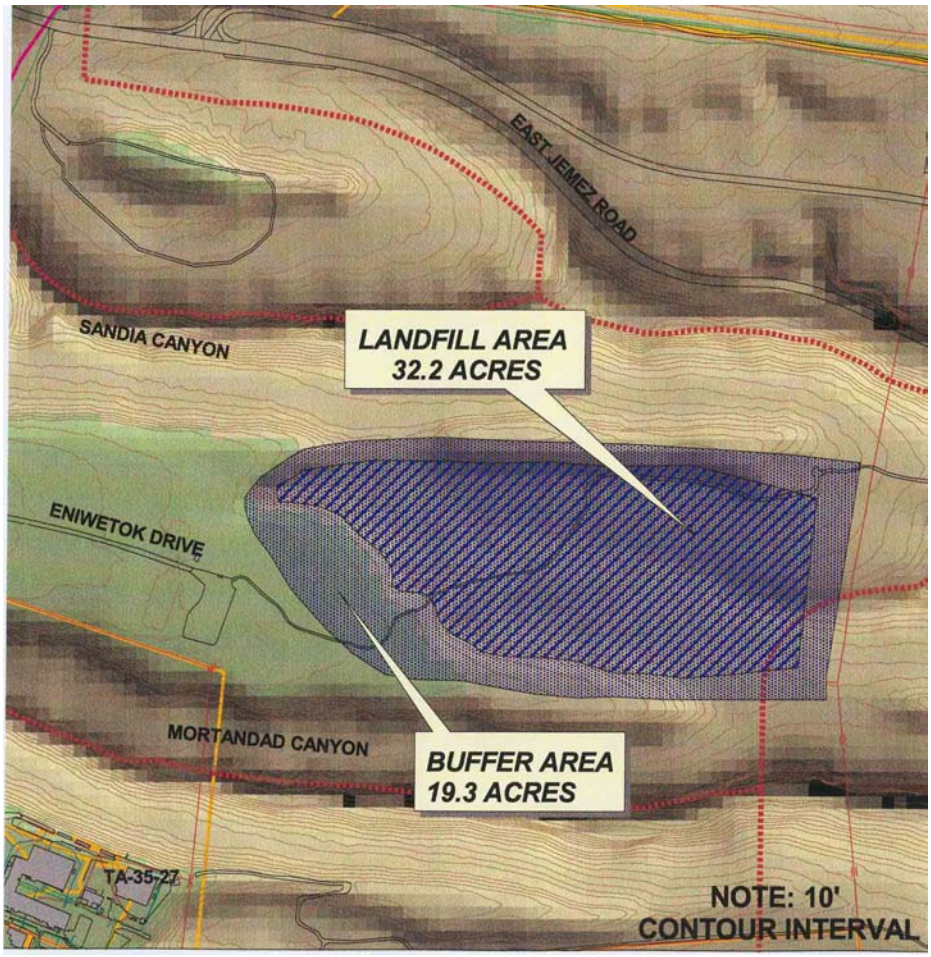

Figure 17: The TA-60 site located on a shelf about 50 feet lower than the top of eastern Sigma Mesa. The site benefits from knolls on both the north and the south, which together shield the site from view. Essentially a bowl, it also experiences less wind than the top of the mesa.

excavated. On the southern edge of the proposed landfill there is a rock ring and a trail/stair. These would need to be recorded photographically and geographically. The rock ring would need to be excavated. On the southwest corner of the proposed landfill, near the mesa edge is a rock feature. This would need to be avoided. The excavations would require a formal consultation with the State Historic Preservation Office and preparation of a Data Recovery Plan. This should not be a "big deal" and I think cultural issues are your least concern for this site.

- There is a known small wetland immediately north of the proposed landfill in Sandia Canyon. There are other wetlands downstream in Sandia Canyon. Mortandad Canyon would have to be field surveyed for wetlands. If water is diverted from the mesa top into Mortandad and/or Sandia, then Best Management Practices (BMPs) would have to be followed to ensure no increase in erosion of the mesa edge/slope and no increase in sediment load in the canyons. A Floodplain/Wetland Assessment would be recommended.
- Groundwater percolating through the landfill could introduce contaminants into Sandia and/or Mortandad Canyons which could, in turn, affect T&E species, wetlands, and surface and ground water quality. Diversion of stormwater runoff from the mesa top west of the proposed landfill into Sandia or Mortandad Canyons is expected to have no detrimental effects to surface or groundwater. You would have to show how contaminants would not be leached out of the landfill.
- Geology of the area is composed of Units 2 and 3 of the Tshirege Member of the Bandelier Tuff. (Unit 3 is the mesa top and Unit 2 is below.) A report by Dransfield and Gardner (1985) show possible faults in the area of the proposed landfill. This, along with jointing in Units 2 and 3 could provide pathways for groundwater to enter the landfill and eventually end up in Sandia or Mortandad canyon. The locations of faults should be identified via field surveys. Seismicity is not likely a problem. Unit 2 may be slightly more permeable to groundwater than unit 3.
- I haven't looked into the soils in this area but I can't believe there would be anything regarding soils that would prohibit the landfill. (The soils here are likely bare rock to colluvium [slope deposits] derived from the rock).

Considering a possible widening/improving of the road down Sigma Mesa to the proposed landfill and the crossing of upper Sandia Canyon from the existing landfill to the road to the new landfill:

- There are additional cultural sites along Sigma Mesa and the existing dirt road. Improvements to the road will need to be coordinated with RRES-ECO's Cultural Resources team to avoid cultural sites.
- If a connector road is built from the existing landfill, across Sandia Canyon to the Sigma Mesa dirt road, a Floodplains/Wetland Assessment will need to be prepared as Upper Sandia Canyon contains an extensive wetland.

- The road along Sigma Mesa also traverses buffer habitat for the Spotted Owl. Improving this road will require a Biological Assessment.
- It's best if we consider the project as a whole (i.e., the landfill, plus the road to the landfill). Based on this quick preliminary look at the environmental issues with this proposed site, I do not see any show stoppers. All of these things would be looked at in detail in an Environmental Assessment if one were requested by DOE for this project.

Photographic Tour of TA-60 Landfill Site

Photo 60-1: The head of the site looking west. The head of the site is a western "finger" that protrudes into the side of Sigma Mesa. This is shown in the middle of the photo, where a fallen tree is located. Control of water entry to the landfill from the mesa top would occur at this point. The initial waste bale cells would be constructed just to the east of this point, with the leachate collection ponds just down-gradient.

Photo 60-2: Looking west from the about the middle of the site, one sees the northern knoll on the right. This knoll is about fifty feet high and forms the northern side of the natural bowl in which the site is located, providing excellent visibility protection from the town site.

Photo 60-3: Looking east from the same location as the previous photo, one sees the northern knoll on the left. The base of the "bowl" is relatively flat, with a gradient toward the east.

Photo 60-4: From the top or the north bluff, one can view the town site of Los Alamos to the northwest. East Jemez Road lies at the base of the canyon in the center of the photo, screened by trees.

Photo 60-5: Looking west across the bowl from the north knoll. The south knoll is covered with trees and forms the horizon in this photo.

TA-61 Borrow Pit Site

The TA-61 Truck Route Borrow Pit is currently used for soil/rubble storage and pick up. It is located on the south side of East Jemez Road (Truck Route) across from the entrance to LANSCE. See Figure 18. Its location is about two miles from the existing county landfill, and is across Sandia Canyon from the TA-60 East Sigma Mesa Shelf landfill tract. The Borrow Pit is bounded by East Jemez Road to the north and Sandia Canyon to the south. The existing borrow pit visibility screen provided by the knoll would be eliminated to allow adequate acreage of about 43 acres.

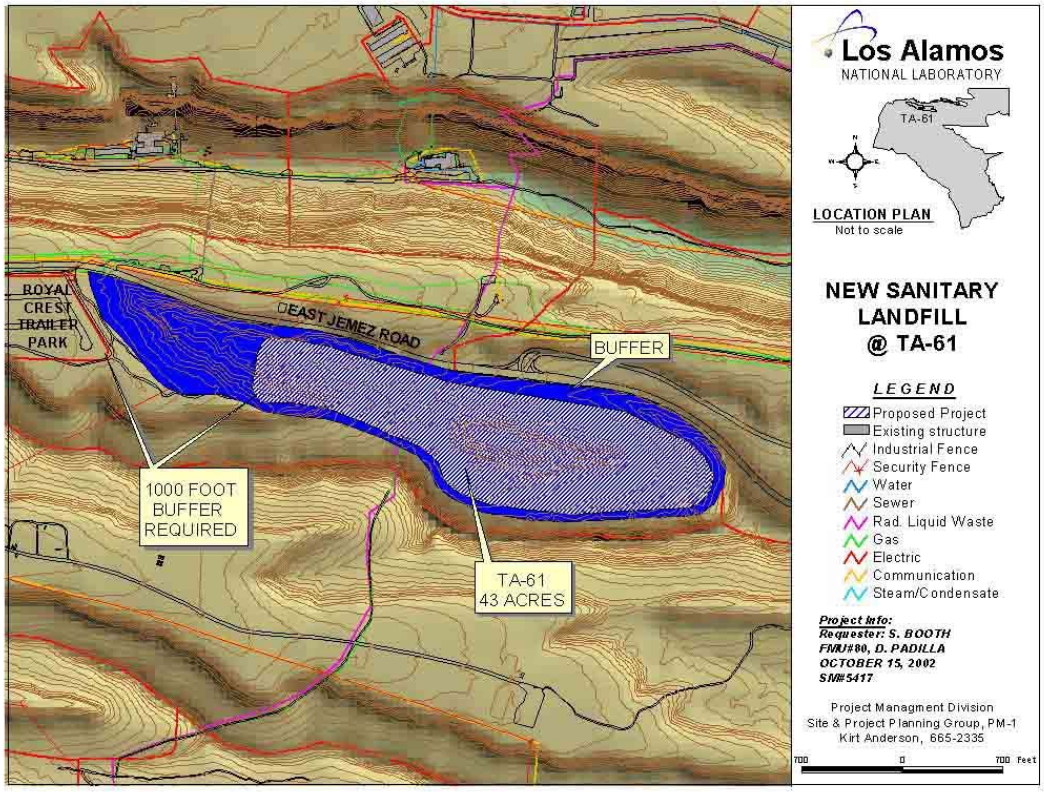

Figure 18: The buffer for residential set back and drainage control abuts the Royal Crest Trailer Park.

LANL Operational Issues Related to TA-61 Site

A landfill at the TA-61 would displace the current borrow pit activities. No utilities issues would limit the landfill. Transportation would not be a large problem given the current trucks that use the pit, although the bale trucks are most likely larger than the dump trucks. Overall, this landfill site has few operational problems for LANL.

Photographic Tour of TA-61 Landfill Site

Photo 61-1: View to the east, showing the flat nature of the site.

Photo 61-2: View to the north shows the knoll that provides a visibility shield from East Jemez Road. This knoll would have to be removed to provide adequate acreage for a landfill.

Photo 61-3: A view to the south. The tractor in the background lies close to the edge of the canyon, and shows the approximate southern limit of the landfill site. The trees on the horizon are located on Sigma Mesa (TA-60), across Sandia Canyon.

TA-58 Site

Two Mile Mesa (TA-58) lies directly to the west of the SM-30 warehouse and south and east of West Jemez Road. See Figure 19.

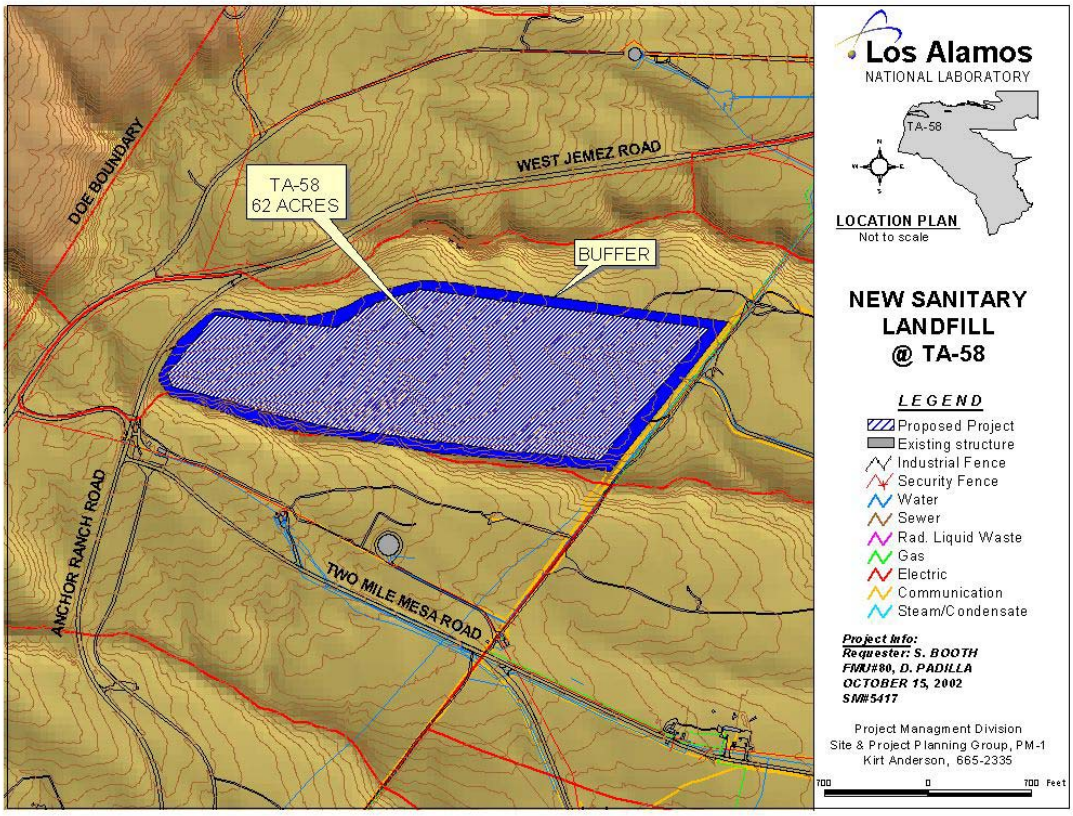

Figure 19: Map of buffer zone and landfill for TA-58.

LANL Operational Issues Related to TA-58 Site

Two-Mile Mesa is strategically located near TA-3, the heart of LANL. This, combined with its relatively large size, proximity to utilities, and topography favorable for construction, make this a prominent site in LANL expansion plans. For example, the Associate Director for Strategic Research (Tom Meyer) has pursued this area for a new campus to consolidate all of SR activities. It is a popular hiking and fitness area located near the Wellness Center.

Photographic Tour of TA-58 Landfill Site

Photo 58-1: The site is split by a utilities corridor running north to south. This is a view to the south.

Photo 58-2: A view to the north along the utilities corridor shows the shallow ravine that drains the site toward the east.

Photo 58-3: A view to the west shows the gentle up-gradient along the road. A Ponderosa pine forest characterizes the site.

Photo 58-4: The site is popular with laboratory employees as an exercise area for hiking and running.

Decision Analysis

The alternative landfill sites were evaluated using multicriteria decision analysis. The team relied on a software package called Criterium DecisionPlus[1] to build the model and calculate the results. The Analytical Hierarchy Process (AHP) was used to organize the model. Figure 20 shows the analysis steps used in the evaluation. My discussion below is organized along these steps also.

During the first step of the process, "Brainstorming," the team defined the goal of the exercise (*Select Landfill Site*) and discussed a multitude of possible evaluation criteria. We were careful to define each criterion to make it independent of the others.

After narrowing the list of criteria, the team built the hierarchy. In this step the structure of the model is produced as shown in Figure 21. The goal of selecting a landfill site is on the left side. Next are listed the four top-level criteria that help attain the goal. Each of these criteria has three to six independent sub-criteria that are used to score the alternative sites. The right side of the hierarchy chart lists the ten possible sites. Note that each site alternative is connected through the eighteen sub-criteria to the goal. This shows graphically that the alternatives are scored against all of these sub-criteria.

Definitions

Each component of the model is clearly defined to facilitate accurate scoring of alternatives.

Goal: Select Landfill Site

The task is to select one or more sites that can be approved by LANL's AD-Operations and recommended to DOE/LASO for possible special use permitting as a landfill developed by the County. Since our team's effort was internal to the Lab, we weighted more heavily LANL's operational issues than public or environmental issues. We recognize that the NEPA process will emphasize those aspects.

Environmental/Physical Sub-Criteria

Geology and Soils. Considers site stability, such as faults, seismic impact zones, and soil suitability to prevent groundwater contamination.

Topography and Drainage. Considers water drainage patterns, ponding, runon and runoff potential, and flooding. Slope between four and eight percent is preferred.

Surface Water Protection. Considers wetlands, proximity to watercourses and flood plains, and recharge of groundwater aquifers. Preferred sites are those where surface water can be controlled and/or diverted from site.

[1] Infoharvest, Inc., Seattle, WA, www.infoharvest.com.

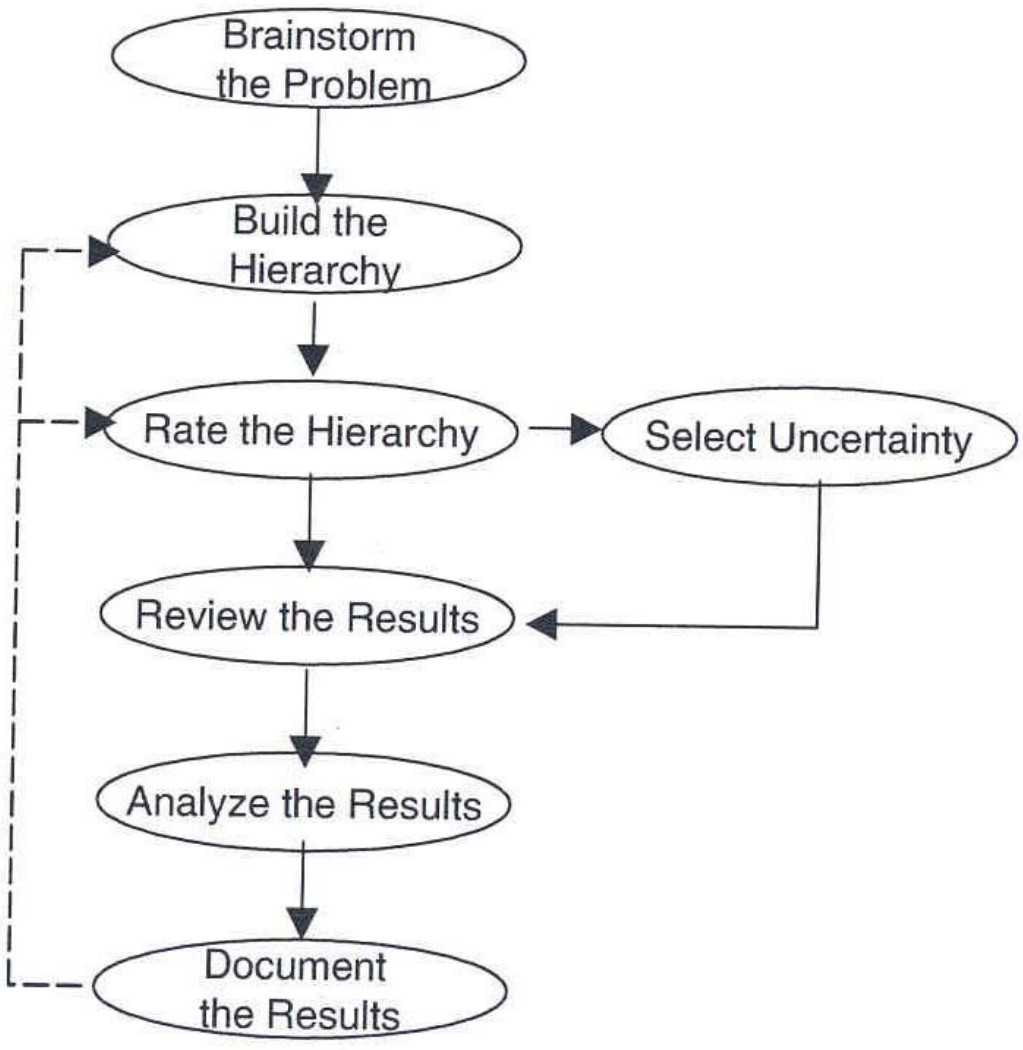

Figure 20: Landfill site evaluation followed standard decision analysis steps.

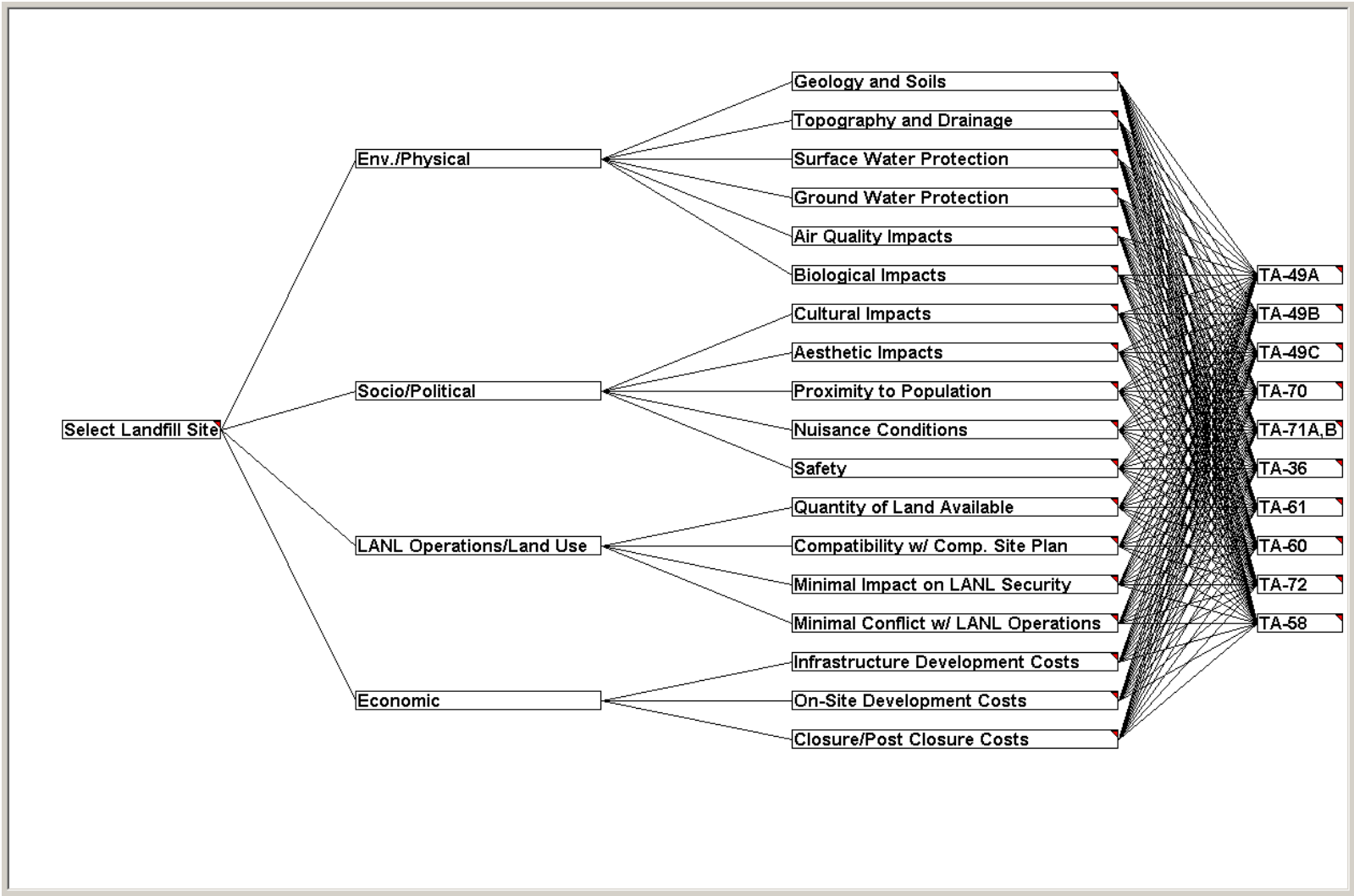

Figure 21: The model's hierarchy shows the goal at the left and the alternatives to achieve that goal on the right, with the evaluation criteria in between.

Ground Water Protection. Considers the distance to water table and the absence of fractured media, such as basalt, and the presence of protective media, such as tuff and clays. Low permeability soil is preferred.

Air Quality Impacts. Considers site attributes that minimize air quality impacts and violations of the Clean Air Act. This includes regulatory impacts rather than odors, which are captured under "Nuisance Conditions."

Biological Impacts. Considers plant or animal impacts (invasion), and known endangered species or their habitat at the site.

Socio/Political Sub-Criteria

Cultural Impacts. Considers the presence of historical sites, both ancient and homestead eras.

Aesthetic Impacts. Considers the presence of buffer zones for noise/odor abatement, vegetation and topography for visual shielding.

Proximity to Population. Considers how close the site is to populated areas, such as technical areas, residential areas, and the town site.

Nuisance Conditions. Considers potential impacts of dust, noise, odors, and other public health hazards on surrounding area.

Safety. Considers the increased risk of vehicle accidents caused by bale and rubble trucks to landfill. Even though only a few trucks per day are expected, this topic will be important to the public and should be included explicitly in our ratings.

LANL Operations/Land Use Sub-Criteria

Quantity of Land Available. Considers the size and capacity of a given site. The goal is to find 50 to 150 acres; larger is better.

Compatibility with Comprehensive Site Plan. Considers possible conflicts with current LANL site plans. Land that is already committed to other uses, depending on how far along those commitments are, will be downgraded.

LANL Security Impacts. Considers potential impacts on LANL security. Potential mitigations include badging county workers, building alternative entry routes to avoid sensitive areas, or restricting entry to non-operational times of the week.

LANL Operations Impacts. Considers potential impact on on-going and future Lab operations. Divisions that "own" the land in question were interviewed to understand these issues. Hazard and buffer zones were defined. Mitigation strategies may be negotiable with impacted divisions.

Economic Sub-Criteria

Infrastructure Development Costs. Considers the cost of installing required infrastructure up to the landfill's gate. Includes utilities, roads, water, natural gas/propane, and telephone/communications.

On-Site Development Costs. Considers cost of building the actual landfill, and includes the construction of the waste cells, buildings, roads and utilities inside the landfill gate.

Closure/Post-Closure Costs. Considers the costs of landfill closure, with required capping, fencing and monitoring, once site is closed.

Rating the Hierarchy

The next step in the decision analysis process is to rate the hierarchy, i.e., apply weights to the criteria based on relative importance, and score the alternatives against each sub-criterion. The basic algorithm is to multiply how each alternative scores against each sub-criterion by the relative importance of that sub-criterion (i.e., its weight). Those products are then summed over all the sub-criteria to provide a total decision score, thus serving as a measure of how well that alternative fits our decision model.

Weights

The weights of the criteria with respect to the goal were chosen by the Siting Team based on a descriptive scale with points attached: *Critical* (100 points), *Very Important* (75 points), *Important* (50 points), *Unimportant* (25 points), and *Trivial* (0 points). The four top-level criteria are weighted to align with the Site Selection Team's mission, emphasizing the critical nature of Laboratory Operational Impacts (see Table 4).

Although the eighteen sub-criteria are all weighted as *Important* with a value of 50 points, the normalized weights can be different as shown in Table 5. This is because the normalization takes account of the number of sub-criteria under each top-level criterion. For example as shown in Table 5, Environmental/Physical has six sub-criteria that all are valued with 50 points. Each sub-criterion's normalized weight is calculated as $50/(6 \times 50) = 0.167$. In a sense, the influence of Environmental/Physical is divided into six "sub-influences" represented by the sub-criteria. On the other hand, the top-level criterion *Economic* only has three sub-criteria. Therefore its influence on the total is split into only three components, leading to a weight of 0.333 for each sub-criterion.

TABLE 4
Computing Normalized Weights for Top Four Criteria

Criterion	*Descriptor*	*User Scale Value (0 to 100)*	*Normalized Scale Value (0 to 1.0) [1]*
Environmental/Physical	Important	50	0.222
Socio/Political	Important	50	0.222
LANL Operations/Land Use	Critical	100	0.444
Economic	Unimportant	25	0.111

Note 1: This scale adds to 1.0. Computed by dividing the single criterion's weight by the total of all weights, e.g., 50/(50 + 50 + 100 + 25) = .222.

The software automatically calculates the accumulated weight for each path in the hierarchy that connects the alternative to the goal. This is done by multiplying the top-level criterion's normalized weight by that of the sub-criterion along the path. For example, Geology is a sub-criterion of Environmental/Physical. The top-level weight is 0.222 and the sub-criterion weight is 0.167, so the accumulated weight along that path of the hierarchy is 0.037 (0.222 x 0.167). The total of the eighteen accumulated weights is 1.0.

Scores

Each sub-criterion was scored with respect to the ten alternative sites using a descriptive scale ranging from 100 to zero: *Finest* (100 points), *Excellent* (83.3 points), *Above Average* (66.7 points), *Average* (50 points), *Below Average* (33.3 points), *Poor* (16.7 points), and *Unsatisfactory* (0 points). The reasoning behind these scores is described below; the scores are listed in Table 6.

Environmental/Physical Sub-Criteria

Geology and Soils. All TA-49 sites are very similar in soils. The presence of tuff is considered "excellent" in score. Alluvial soil is easier to excavate. TA-49 sites in ravines mean less digging to excavate for waste bales. There is 800 feet to reach basalt for TA-49 sites and they score "excellent." At TA-70 the basalt is less than 200 feet deep; could be less than 100 feet in some areas. TA-70 will be a "below ground" facility, so having basalt so close to the surface is an important factor in downgrading it to "average." At the TA-71 site the basalt is less than 100 feet from the surface. At TA-71A we would be working right at the basalt level. The overall score for TA-71AB is "below average." TA-36 gets the same score as TA-71. TA-61 is a disturbed site, with a very steep and deep canyon right next to it. Geology is the upper part of Bandelier Tuff. A landfill would have to be offset from the edge of Sandia Canyon. East Jemez Road

TABLE 5
Weights of Sub-Criteria

Criterion	*Descriptor*	*User Scale Value (0 to 100)*	*Normalized Scale Value (0 to 1.0)*	*Accumulated Value*
Geology	Important	50	0.167	0.037 [1]
Topography and Drainage	Important	50	0.167	0.037
Surface Water Protection	Important	50	0.167	0.037
Ground Water Protection	Important	50	0.167	0.037
Air Quality Impacts	Important	50	0.167	0.037
Biological Impacts	Important	50	0.167	0.037
Cultural Impacts	Important	50	0.2	0.044 [2]
Aesthetic Impacts	Important	50	0.2	0.044
Proximity to Population	Important	50	0.2	0.044
Nuisance Conditions	Important	50	0.2	0.044
Safety	Important	50	0.2	0.044
Quantity of Land Available	Important	50	0.25	0.11 [3]
Compatibility Comp. Plan	Important	50	0.25	0.11
Security Impacts	Important	50	0.25	0.11
LANL Operations Impacts	Important	50	0.25	0.11
Infrastructure Devel. Costs	Important	50	0.333	0.037 [4]
On-Site Devel. Costs	Important	50	0.333	0.037
Closure/Post-Closure Costs	Important	50	0.333	0.037

Note 1: The accumulated weight for the six sub-criteria under Env/Physical is 0.167 x 0.222 = 0.037.
Note 2: The accumulated weight for the five sub-criteria under Socio/Political is 0.2 x 0.222 = 0.044.
Note 3: The accumulated weight for the four sub-criteria under LANL Operations is 0.25 x 0.444 = 0.11.
Note 4: The accumulated weight for the three sub-criteria under Economic is 0.333 x 0.111 = 0.037.

TABLE 6
Scores for the Ten Landfill Alternatives

Sub-Criterion	*TA-49A*	*TA-49B*	*TA-49C*	*TA-70*	*TA-71A,B*	*TA-36*	*TA-61*	*TA-60*	*TA-72*	*TA-58*
Geology and Soils	83.33	83.33	83.33	50	33.33	33.33	66.67	83.33	33.33	83.33
Topography and Drainage	100	66.67	83.33	100	33.33	100	50	100	0	66.67
Surface Water Protection	50	50	50	100	66.67	83.33	66.67	50	16.67	83.33
Ground Water Protection	83.33	83.33	83.33	66.67	66.67	66.67	83.33	83.33	66.67	83.33
Air Quality Impacts	66.67	66.67	66.67	50	50	50	50	66.67	50	50
Biological Impacts	16.67	33.33	100	83.33	100	83.33	16.67	16.67	100	100
Cultural Impacts	16.67	33.33	50	0	0	0	100	50	0	100
Aesthetic Impacts	100	83.33	33.33	50	16.67	0	16.67	100	0	83.33
Proximity to Population	83.33	83.33	83.33	66.67	16.67	0	16.67	66.67	50	33.33
Nuisance Conditions	100	100	33.33	50	0	0	33.33	83.33	0	50
Safety	83.33	83.33	83.33	50	33.33	33.33	16.67	100	83.33	33.33
Quantity of Land Available	50	83.33	66.67	100	33.33	83.33	16.67	33.33	33.33	100
Compatibility w/ Comp. Site Plan	83.33	83.33	83.33	50	16.67	33.33	33.33	83.33	16.67	0
Minimal Impact on LANL Security	16.67	16.67	66.67	83.33	100	50	100	16.67	100	16.67
Minimal Conflict w/ LANL Operations	0	0	0	100	83.33	16.67	16.67	83.33	100	83.33
Infrastructure Development Costs	33.33	33.33	100	50	50	66.67	33.33	83.33	100	50
On-Site Development Costs	66.67	66.67	50	50	50	33.33	50	66.67	33.33	33.33
Closure/Post Closure Costs	33.33	33.33	33.33	66.67	50	66.67	33.33	33.33	33.33	66.67

is the other edge. The canyon-bottom stream takes jog right at the landfill site, so armoring would be needed. Lots of faults are nearby. Good tuff combined with bad faults and near cliff scores "above average." TA-60 is bowl-shaped and sheltered. Geology shows similar tuff to TA-61, but fewer faults. Soils are similar to TA-61, but it has more protection from canyons; better score than TA-61, "excellent." TA-72 site is in the Otowi member of the Bandelier Tuff. This is a more uniform, porous, permeable tuff. Under this is the Puye conglomerate with gravels, which is very permeable, and is not far from basalt. TA-72 is similar to TA71AB, and so scores "below average." TA-58 Two Mile Mesa: Located right in middle of the Pajarito Fault Zone, and in the upper portion of Bandelier Tuff. Overall score, "excellent."

Topography and Drainage. TA-49 sites all would be canyon fills but are different with respect to slope and water control. TA-49A starts at a saddle, so it scores higher than TA-49B and -49C. TA-49C is second best, and TA-49B is third best because it is so close to the loop road and its contamination. If we must stay away from that road, then TA-49B will face more trouble trying to control drainage. TA-70 does not include the local ravine, so it is comparable to TA-49A in score. TA-71A is a pit and not at the canyon headwaters, making drainage harder to control, so its score by itself would be "poor/below average." TA-71B is near the edge of Water Canyon, on a mesa top, pretty flat. The score for the combined 71AB is "below average." TA-36 has a good slope and drainage, with no ponding. It is comparable with TA-70 in score ("excellent"). TA-61 is very good because it is on top of a mesa; but being close to canyon causes trouble. It is a small site that is enclosed by a canyon, road, and natural gas line (to the west), which means it will be harder to engineer a water control system. Score is "average." TA-60: easy to control water and drainage because it is at head of a bowl; good slope for drainage and leachate collection; scores like TA-49A, "excellent." TA-72 site is at the bottom of two major canyons, Mortandad and Sandia, directly upstream of Bandelier N.M., next door to San Ildefonso property. While not in the 100-year flood plain, psychological image and permit troubles should be expected. Score: "unsatisfactory." TA-58 is similar to other mesas, but has steep slope west of Route 501 with the potential of mud or rocks slides since the Cerro Grande fire. It would be important to protect against the danger of water coming off that slope directly across Route 501 into a landfill. Scores same as TA-61, "above average."

Surface Water Protection. In reviewing geologic maps, it appears that wetlands (and floodplains) are not an issue with any of the site alternatives with the exception of TA-49B. A requirement in a ravine landfill is to control water at the head waters. A mesa top is better than a ravine for this criterion. TA-49B is in a 100-year flood plain according to geology maps.

TA-49 has more recharge to groundwater because it is closer to mountains than other sites and has more rainfall. TA-49 sites score "average," and TA-70 is "finest." TA-71 is a combination of pit and mesa, so scores "above average." TA-36 is on a mesa top and there is a wetland to the north, so it receives a score of "excellent." TA-61: "above average." TA-60 is at the head of a bowl/bench, and gets the same score as TA-49A: "average." TA-72 is not in 100-year flood plain, but at the bottom of canyon; "poor." TA-58 is on top of a mesa, but stream beds on north and south of site mean we would need to keep water and leachate out of there; scores "excellent."

Ground Water Protection. TA-49 distance to ground water is about 1000 feet. TA-70 distance is about 850 feet; both TA-36 and -71 are 750 feet. Tuff is more permeable than the basalt at TA-70 and -71. The liner will protect against seepage, but if it leaks, low permeability soil is fallback protection. But tuff is actually more desirable than basalt beneath a landfill because tuff acts as a sponge to capture any leakage, which delays the effluent from reaching ground water. Basalt is generally fractured and provides easier transport of liquids. In our scoring, we weight heavier the distance to ground water than permeability. Sites at TA-49 score higher ("excellent") than TA-70, -71, and -36 ("above average") because of combined large distance to ground water and tuff. PM-1 says there is a plan for a new groundwater well in Water Canyon that might be about 2500 feet from TA-49A, and would have no impact. TA-61 is 1300 ft. to the aquifer and has tuff. TA-60 is similar, as is TA-58. TA-72 is 850 ft. to aquifer.

Air Quality Impacts. Less excavation means fewer particulate air emissions during construction, so canyons score a bit better.

Biological Impacts. TA-70: bald eagle habitat comes close to the landfill site, but has no overlap and is not a problem; "finest." TA-49 has problems: TA-49A is the worst for spotted owl because it lies within both the buffer and core zones ("poor"); TA-49B is not so bad because it is in the buffer ("below average"); TA-49C is the best of the TA-49 sites, located outside of both the buffer and core zones ("finest"). TA-36 is close but outside of willow flycatcher habitat ("excellent"). TA-71 has no issues with biology: "finest." TA-61 is in the middle of core and buffer area for spotted owl ("poor"). TA-60 is within core and buffer for spotted owl ("poor"). TA-58 has no T&E issues ("finest"), nor does TA-72 ("finest").

Socio/Political Sub-Criteria

Cultural Impacts. Based on information from Phil Noll and LANL archeologists: most everything at LANL has been completely surveyed for cultural sites, except for about 10 percent of TA-71. TA-36, -70, and -71 each have multiple pueblos of 20 – 30 rooms, and some have "plaza

pueblos" with 50 – 60 rooms with open plazas. Carefully modifying the location of the landfill site could improve the scores, but as drawn, the archeologists would rate TA-36, -70, and -71 sites as "unsatisfactory," TA-49A as "poor," TA-49B as "below average," and TA-49C as "average." If TA-49A were moved off the mesa top and only went up to the ravine edge, then it would avoid a large plaza pueblo. If TA-36, -70, or -71 were chosen, we could expect a San Ildefonso complaint. TA-61: no cultural issues within the site ("finest"). TA-60: seven cultural sites are present. On the edge of mesa there are two field houses that would have to be avoided. Two artifact scatters on northeast corner that would have to be excavated. Overall, the TA-60 site would require a formal consultation with the State Historic Preservation Office and preparation of a Data Recovery Plan; but this should not be a "big deal" and not a show stopper. Score of "average." TA-58: no cultural sites ("finest"). TA-72: two artifact scatters, but it is right next to San Ildefonso expecting the same negative reaction as with TA-36 ("unsatisfactory").

Aesthetic Impacts. TA-49A is best because it is well hidden ("finest"). TA-36 is the worst because it is in full view of White Rock and houses across SR4 ("unsatisfactory"). TA-71 is across SR4 from White Rock also and will be hard to screen, but it is a little better than TA-36 because part is in the borrow pit ("poor"). TA-49C is similar to TA-71 because it is close to SR4, but people are driving by TA-49 rather than living near it. Also, being in a ravine, TA-49C will be easier to screen than TA-71AB ("below average"). TA-70 is scored as "average." TA-70 has a lot more space, so a screen is more effective. But it can be seen from the backcountry of Bandelier. TA-61: in its current form the borrow pit is sheltered from view. But because of its small size, a landfill would have to cut right to East Jemez Road, which causes a low score ("poor"). TA-60 is in a natural bowl and is not visible ("finest"). TA-58 can be screened from road view, so scores "excellent." TA-72 is "unsatisfactory" because it lies below the Tsankawi hiking area and is impossible to screen from view. It would be the first thing people see as they enter the county via the Truck Route; thousands use that intersection each day as part of their commute to work.

Proximity to Population. This criterion focuses on where people live, work, and function, not how close to a road the site is. TA-36 is closest to residences ("unsatisfactory"). TA-49A is best. TA-49A and -49C are farthest from loop road, but TA-49A is closer to DARHT. All TA-49 sites are scored as "excellent." TA-71AB is a bit better than TA-36 so is scored as "poor." TA-70 is even farther from population so scores "above average." TA-61 is located near LANSCE and Royal Crest, so it scores "poor." TA-60 is at the far end of an industrial area of lab and out of view, so has the same score as TA-70 "above average." TA-58 is near Wellness Center and hiking/jogging trails, plus near Anchor Ranch site so

scores “below average.” (People don't live there, but lots of foot and vehicle traffic.) TA-72 is near truck stop and warehouse, “average.”

Nuisance Conditions. TA-36 and TA-71 are both upwind of population and score “unsatisfactory.” TA-49A and -49B are isolated and are in ravines which can help minimize noise pollution and odors (“excellent”). TA-49C is in a ravine that is quite shallow near SR4, so some noise and odor may escape (“below average”). TA-70 scores “average.” TA-61 will require removal of the buffer bluff and it will be along a busy road, so it scores “below average.” TA-60 is “excellent” because of secluded and shielded location in an industrial zone. TA-72 site is across street from a popular National Monument location and next door to San Ildefonso reservation. Noise and dust will be very hard to hide from these areas--scores “unsatisfactory.” TA-58 can have adequate shielding of odors and dust, and scores “average.”

Safety. Low traffic flow west of Bandelier entrance means TA-49 sites score “excellent.” (Because SR4 is a narrow road and has recreational uses, the score cannot be “finest.”) TA-36 and -71 are close to White Rock and Pajarito Acres and score “below average.” TA-70 entrance is beyond Pajarito Acres are so scores “average.” TA-61 site is rated “poor” for safety because the entry point is on a steep hill of high-traffic East Jemez Rd. TA-60 site score “finest” because entry will be on road designed for heavy trucks and industrial activities. This depends on the LANL Bypass road or a new connecting road from the existing landfill being built. Currently the Eniwetok/Diamond intersection is difficult for heavy truck traffic. TA-72 scores “excellent” because it is on a flat section of the Truck Route. The heavy commuter traffic at the intersection is its one drawback. TA-58 will have some difficulty in finding safe entry point to West Jemez Road because the slopes, curves, and traffic. Score is “below average.”

LANL Operations/Land Use Sub-Criteria

Quantity of Land Available. TA-49A is 61 acres (“average”), TA-70 is 176 acres (“finest”), TA-71AB is 50 acres (“below average”), TA-49C is 84 acres (“above average”), TA-49B is 119 acres (“excellent”), TA-36 is 112 acres (“excellent”). TA-72 (41 acres), TA-61 (43 acres), and TA-60 (32 acres) score “poor.” TA-58 has lots of acreage (“finest”). Although DOE is looking at sites of about 50 acres, larger sites should still receive a higher score. Even if the DOE does not choose to lease the whole area, the extra land could provide additional buffer space.

Compatibility with Comprehensive Site Plan. TA-71AB scores “poor” because of a planned electrical substation in the TA-71A borrow pit and a planned evacuation route through TA-71. Site at TA-36 scores “below average” because of a DX-planned sled extension. TA-70 is planned for

recreational uses and so scores "average." The three TA-49 sites score "excellent." TA-61 Borrow Pit is currently active for rubble and soils, and will remain so in the future. Therefore a landfill there would force the current operations to go elsewhere; TA-61 scores "below average." A Bypass road is important for the industrial development of Sigma Mesa and would facilitate locating the landfill there. TA-60 is well aligned with Comprehensive Plans for Sigma Mesa; score is "excellent." TA-72 site is already planned for a County warehouse operation; thus a landfill there creates a major planning conflict; score is "poor." TA-58 is prime developable land near TA-3. Many competing interests have desires for this area as expansion of scientific campus of LANL, including the SR Directorate: score is "unsatisfactory."

LANL Security Impacts. Security impact is pretty bad for TA-49A and -49B because landfill users must enter through restricted areas ("poor"). TA-49C is more open and has a separate access road ("above average"). TA-36 is the most restrictive site from an operations standpoint; to tour the site our team needed escorts and Form 1812 for uncleared visitors. Per Ross Griechen of S-1, security issues are minimal at TA-36. We have to be sure that entrance to landfill would be off SR4 rather than to-be-access-controlled Pajarito Road ("average"). TA-70 and TA-71 have little or no security issues. TA-71 is better than TA-70, because of occasional TA-33 activities that could force the clearance of TA-70. TA-71 scores "finest" and TA-70 scores "excellent." TA-61 is along a public road and should have no security issues ("finest"). TA-60 is in an industrial area where contractor delivery trucks will pass. Should not have a problem in controlling access via badging. But the footprint of the landfill site will be in the interior of the lab rather than on the outskirts ("poor"). TA-72 is on the edge of lab property with no security issues nearby ("finest"). TA-58 is near TA-3 and DX and ESA operations ("poor").

LANL Operations Impacts. The site description section for TA-49 shows over 170 days per year of site shutdown for TA-49A and the access road to TA-49B. LANL's blast zones are drawn to combine PT88 with Minie shots. So TA-49A is right in middle of the hazard zones. Only using the landfill on Saturdays and Sundays could possibly mitigate this, but this would be a burden for the County. Site TA-49B is down-gradient of major possible contaminant sites. *Per AD-Operations management: because of the past activities TA-49, all sites at TA-49 are scored as "unsatisfactory" for this criterion. This precludes their transfer to the county for a landfill site.* The TA-36 sled blast zone is close to landfill site. TA-36 site serves as buffer zone, so it is down graded to "poor." The TA-71 and -70 sites are outside of hazard zones and only serve as buffer areas. TA-70 is highest rated at "finest," TA-71 as "excellent" because of the substation conflict. TA-61 is in conflict with current lab operation of a borrow pit (score is "poor"). TA-60 site is not currently in a hazard zone, but it is

interior to the lab footprint. Score is "excellent" instead of "finest" because of possible expense associated with Authorization Basis (AB) of TA-55 and Be Technology Facility. Bruce Letellier (D-11) reports that this site would cause a slight change in the probabilistic dosage calculations that may not be significant. The current landfill is not considered as the "public" for these calculations, so status quo would say the new landfill would be treated the same, and no impact would occur. TA-72 is on the outside perimeter of the lab and does not have any lab operations ("finest"). TA-58 appears to be outside hazard zones for DX and ESA, but also has possible AB impacts as with TA-60. Ignoring any Wellness Center conflicts, score is "excellent."

Economic Sub-Criteria

Infrastructure Development Costs. Propane tanks will be adequate; no natural gas supply is needed at landfill. A more remote site is scored lower. Being close to a state road rather than a private road scores higher. All sites will require a transfer/recycle station located elsewhere.

WATER[2]: a water line runs down SR4 past TA-49 and serves TA-33 and TA-39. So sites TA-49A, -49B, and -49C have easy water access. The TA-36 site can access water from the south side of the intersection of Pajarito Road and SR4 without much expense. TA-70 and -71AB face the biggest problems with obtaining water.

ELECTRICITY[3]: TA-49 has access to electricity. The 13,800 power line that runs across TA-71, -70, and -36 provides relatively easy access to those sites.

COMMUNICATIONS[4]: TA-49A and -49B have the most economical access. TA-49C is next best, requiring a longer length cable than TA-49A or TA-49B. TA-36 would need a fiber cable from TA-18. TA-70 would get communications from TA-39 using buried copper cable.

ROADS[5]: Trucks should not have a problem on SR4 at TA-49 or TA-70 because of the low volume of vehicles. TA-36 and TA-71 landfill sites encounter more traffic. To gain entrance to the landfill, all sites will require a feeder road. TA-49C and TA-36 are best for this, TA-71 and -70 more expensive, and TA-49A and -49B are more expensive if we must build a new road entrance to avoid LANL operational conflicts. The steep ravine between SR4 and TA-49B will make it hard to build an alternative road. TA-49C is ranked highest because it is close to utilities and has easy access to SR4 ("finest"). TA-36 scores "above average." TA-70 and

[2] David Padilla, personal communication, June 25, 2002.
[3] Ibid.
[4] Per Phil Bove, CCN-4.
[5] Padilla, June 25, 2002.

-71AB are good for roads, but not so good for utilities ("average"). TA-49A and -49B sites have utilities close, but face expensive road construction to avoid operational conflict with LANL ("below average").

Cost is high to build a road entrance to TA-61[6] given that the site is near a steep hill and there is no room for an acceleration lane. The site has easy access to gas (a line crosses from Sigma Mesa on the way to LANSCE). An 8-inch water line runs on top of the LANSCE mesa and would have to be brought across E. Jemez Road to the TA-61. Poor road and water access scores "below average." TA-60 should have easy extension of communications down Sigma Mesa. A 12-inch water line extends to the rack facility, and a 2-inch line to the pesticide storage shed, TA-60-29, about 6,000 feet from the landfill site. Bringing water from this source would not be too expensive since it is a gravity feed. An alternative water supply would be the E. Jemez Road line, which entails crossing Sandia Canyon and pumping water up gradient. Power lines run across the east end of the landfill site, and access is easy. There is a high-pressure 6-inch steel gas line that crosses the mesa west of the landfill site. Not expensive to tap it. The road should be excellent if a TA-3 bypass road gets built, and the score would be "excellent." I have been informed that only a small bypass project for security only is being planned, so the score dropped to "average" because of road building expense. TA-72 is close to current operations, with all utilities easily available and a good road/intersection designed for trucks ("finest"). TA-58 intersection along highway will be expensive because of the grade and curves ("average"). Utilities are located in the corridor that runs just to the east of the landfill site: a 6-inch water line, 12-inch gas line, and electricity.

On-Site Development Costs. There is not a big spread of scores for this criterion. Canyon sites are better for excavation costs, don't have spoils management problems, but may have less cover material ("above average"). Water diversion in canyons is more expensive than mesa tops. The TA-36 site will face visibility-screening expenses ("below average"). TA-61 must armor the bend in Sandia Canyon, so score is "average." TA-60 has natural screening and a bowl to reduce cell construction costs, good natural slope for leachate collection ("above average"). TA-72 needs water protection because it is at the base of two canyons, so lower score than TA-70 ("below average"). TA-58 is on mesa with slope and requires visual screening, same score as TA-36 ("below average").

Closure/Post-Closure Costs. Canyons are a little harder to maintain drainage in perpetuity, so will be more expensive; TA-49 sites get scores of "below average." TA-70 and -36 sites score as "above average" and TA-71AB receives an intermediate score of "average" since it has both a canyon and a mesa.

[6] Charles Trujillo, personal communication, October 22, 2002.

Results

The weights for the criteria and the scores of the alternatives are combined to create the final results of the decision model. The scores described above and in Table 6 are normalized in a similar fashion to what is done with the weights. That is, the scores of the ten landfill alternatives against one sub-criterion are recomputed so that the ten scores add to unity. For each sub-criterion this is done by dividing each alternative's score by the sum of the ten scores. For example, the (rounded) scores against Geology and Soils are: TA-49A (83), TA-49B (83), TA-49C (83), TA-70 (50), TA-71AB (33), TA-36 (33), TA-61 (67), TA-60 (83), TA-72 (33), and TA-58 (83). The sum of the ten scores is 631. Therefore, the normalized score for TA-49A, TA-49B, TA-49C, TA-60, and TA-58 is 83/631 = 0.13, and that of TA-70 is 50/631 = 0.079, and so on. These scores are listed in Table 7.

The decision score is found by computing the weighted sum of the scores of each alternative. The information needed for this calculation is shown in Table 7. The column for each alternative has the normalized scores for each sub-criterion. The right-hand column has the accumulated weights (*Model Weights*). The sum of an alternative's scores against all the sub-criteria multiplied by their appropriate weights is the total score shown in the bottom row. The chart in Figure 22 shows these results.

Eight of the alternatives have red bars in Figure 22, which signify a violation of one or more rules in the model. Rules are defined to highlight important sub-criteria where a score of *Unsatisfactory* indicates a major problem with that alternative. In this model seven rules are defined, as shown in Table 8. Even though an alternative may score very high against many sub-criteria and have a high total score, a violation of a rule indicates a major potential problem exists in developing a landfill at that site. In coloring the score bar red in Figure 22, the reader can see the final score but also the fact that a potential "show-stopper" issue exists. Alternatives TA-49A, TA-49B, TA-49C violate the rule "Minimal Conflict with LANL Operations." Alternatives TA-70 and TA-71AB both violate the rule "Cultural Impacts." Alternatives TA-36 and TA-72 violate two rules: "Cultural Impacts" and "Aesthetics." TA-58 violates the rule "Compatibility with Comprehensive Site Plan."

Because of rule violations, only two alternatives are deemed worthy of further consideration as possible sites for a County municipal landfill: TA-60 and TA-61. East Sigma Mesa Bench (TA-60) scores very high, the second overall behind TA-70. Jemez Road Borrow Pit (TA-61) has a relatively low score, second from last.

TABLE 7
Normalized Scores for the Ten Landfill Alternatives

Sub-Criterion	*TA-49A*	*TA-49B*	*TA-49C*	*TA-70*	*TA-36*	*TA-71A,B*	*TA-61*	*TA-60*	*TA-72*	*TA-58*	*Model Weights*
Geology and Soils	0.13	0.13	0.13	0.08	0.05	0.05	0.11	0.13	0.05	0.13	0.04
Topography and Drainage	0.14	0.1	0.12	0.14	0.14	0.05	0.07	0.14	0	0.1	0.04
Surface Water Protection	0.08	0.08	0.08	0.16	0.14	0.11	0.11	0.08	0.03	0.14	0.04
Ground Water Protection	0.11	0.11	0.11	0.09	0.09	0.09	0.11	0.11	0.09	0.11	0.04
Air Quality Impacts	0.12	0.12	0.12	0.09	0.09	0.09	0.09	0.12	0.09	0.09	0.04
Biological Impacts	0.03	0.05	0.15	0.13	0.13	0.15	0.03	0.03	0.15	0.15	0.04
Cultural Impacts	0.05	0.1	0.14	0	0	0	0.29	0.14	0	0.29	0.04
Safety	0.14	0.14	0.14	0.08	0.06	0.06	0.03	0.17	0.14	0.06	0.04
Aesthetic Impacts	0.21	0.17	0.07	0.1	0	0.03	0.03	0.21	0	0.17	0.04
Proximity to Population	0.17	0.17	0.17	0.13	0	0.03	0.03	0.13	0.1	0.07	0.04
Nuisance Conditions	0.22	0.22	0.07	0.11	0	0	0.07	0.19	0	0.11	0.04
Quantity of Land Available	0.09	0.15	0.12	0.18	0.15	0.06	0.03	0.03	0.03	0.18	0.11
Compatibility w/ Comp. Site Plan	0.17	0.17	0.17	0.1	0.07	0.03	0.07	0.17	0.03	0	0.11
Minimal Conflict w/ LANL Operations	0	0	0	0.21	0.03	0.17	0.03	0.17	0.21	0.17	0.11
Minimal Impact on LANL Security	0.03	0.03	0.12	0.15	0.09	0.18	0.18	0.03	0.18	0.03	0.11
Infrastructure Development Costs	0.06	0.06	0.18	0.09	0.12	0.09	0.06	0.09	0.18	0.09	0.04
On-Site Development Costs	0.13	0.13	0.1	0.1	0.07	0.1	0.1	0.13	0.07	0.07	0.04
Closure/Post Closure Costs	0.07	0.07	0.07	0.15	0.15	0.11	0.07	0.07	0.07	0.15	0.04
Results	**0.1**	**0.11**	**0.11**	**0.13**	**0.08**	**0.09**	**0.08**	**0.12**	**0.09**	**0.11**	

Note: Each criterion row adds to 1.0. Normalized scores are computed by dividing the single alternative's score by the total of all alternative scores, e.g. for TA-49A against Geology and Soils, 83/(83 + 83 + 83 + 50 + 33 + 33 + 67 + 83 + 33 + 83) = 0.13.

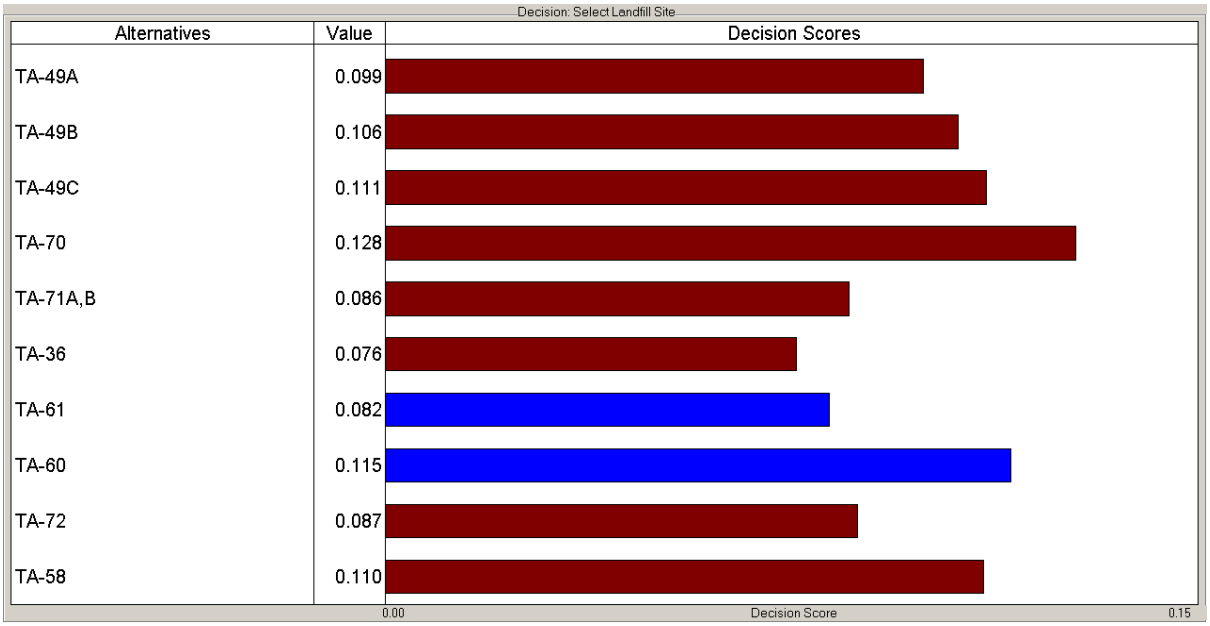

Figure 22: There are two possible sites for a new county landfill on NNSA property, shown in blue in the decision analysis ranking chart. Red bars signify that the alternative scored "unsatisfactory" on one or more important rating criteria.

TABLE 8
Rules for Important Sub-Criteria

Rule Name	***Definition***
Size	**Quantity of Land Available** must be better than *Unsatisfactory*.
Lab Operations	**Minimal Conflict with LANL Operations** must be better than *Unsatisfactory*.
Surface Water	**Surface Water Protection** must be better than *Unsatisfactory*.
Geology	**Geology and Soils** must be better than *Unsatisfactory*.
Aesthetics	**Aesthetic Impacts** must be better than *Unsatisfactory*.
Cultural Impacts	**Cultural Impacts** must be better than *Unsatisfactory*.
Compatibility with Comp. Site Plan	**Compatibility with Comp. Site Plan** must be better than *Unsatisfactory*.