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FINDING OF NO SIGNIFICANT IMPACT
FORMERLY UTILIZED MED/AEC SITES REMEDIAL ACTION PROGRAM:
BAYO CANYONS, NEW MEXICO

Under the Formerly Utilized Sites Remedial Action Program (FUSRAP), the U.S. Department of Energy (DOE) has proposed to carry out remedial action at a site located in Bayo Canyon, Los Alamos County, New Mexico. Although the site as partially decontaminated and decommissioned in the 1960s, there remain above-background amounts of radionuclides.

DOE has determined that strontium-90 in excess of DOE's proposed remedial-action criteria exists in subsurface materials underlying an area of about 0.6 ha (1.5 acres) at the Bayo Canyon site. The proposed action is to demarcate this area and restrict its use to activities that will not disturb this subsurface contamination until the activity has decayed to acceptable levels (about 160 years). The proposed action would allow unrestricted use of the balance of the formerly utilized site. Alternatives to the proposed action include no action and complete decontamination and restoration of the site.

The proposed remedial action will be minor and, thus, will cause negligible disruption of the socioeconomic or environmental systems in which the sites exist. The action will not threaten any legally protected species of flora or fauna, nor will it threaten any legally protected cultural or historical resources. Because the local populace is familiar with radiation and has expressed no concern to date, it is expected that future public concern will be minor. DOE is ensuring that county authorities remain aware of all proposed remedial activities in the area.

The DOE has completed an Environmental Assessment in order to determine the need for further documentation of environmental impacts. The Environmental Assessment has resulted in the conclusion that the proposed action will adequately protect the public from added radiological risk and will have no other consequences that will significantly harm the public health on welfare. The DOE has determined that the proposed action does not constitute major Federal actions that may significantly affect the quality of the human environment within the meaning of the National Environmental Policy Act of 1969 [42 U.S.C. 4321 et seq.]. Therefore, no Environmental Impact Statement is required prior to the initiation of the remedial action under consideration.

The principal environmental consequences of the proposed actions will be as follows.

Land Use--The immediate and direct consequences of the action on future use of the formerly utilized site will be negligible because of the small size of the restricted area (0.6 ha or 1.5 acres).

Socioeconomics--Negligible impacts to demography, economics and employment, housing, transportation, utilities, other community services, or esthetics are expected as a consequence of this remedial action because of the small size of the work force required and the small scale of the project relative to the economy and work force of the area as a whole. It is unlikely that cultural and historical resources will be affected because none have been found at the site during surveys of the area.

Geology and Soils--In Bayo Canyon, erosion of the surface materials from the site will not be accelerated by the proposed actions because surface vegetation will remain intact and no excavation activities will be required.

Hydrology--During heavy thunderstorms or during periods of snowmelt, some water may infiltrate the soil over the waste site and reach the buried waste leading to dispersal of materials that the proposed action leaves in place. However, because the majority of water entering the soil is evapotranspired back to the atmosphere, little migration of dissolved wastes through the soil and alluvium is expected.

Ecology--The placement of boundary markers to demark the restricted area will involve only minor field work, which will have inconsequential impacts to the biota of the site.

Health and Safety--It is not anticipated that the proposed action will result in any direct or indirect nonradiological health or safety hazards beyond normal, everyday activities. Activities for involved personnel will not differ in nature from those they would otherwise be doing, and the added risk from the proposed action will be negligible.

Radiological--The highest expected dose to a long-term resident of Bayo Canyon is 3 mrem/yr to the bone lining. This value is 0.2% of the 1500 mrem/yr recommended maximum dose to bone lining. The background dose to bone lining is about 120 mrem/yr, including contributions from cosmic radiation, external terrestrial radiation, and radiation from internally deposited nuclides. The dose to a resident due to radioactive residues is a small fraction of this background, i.e., 3 mrem/yr is 2.5% of 120 mrem/yr.

DOE/EA--0197

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ENVIRONMENTAL ASSESSMENT

FORMERLY UTILIZED MED/AEC SITES REMEDIAL ACTION PROGRAM: BAYO CANYON, NEW MEXICO

July 1982

Oak Ridge Operations Office
U.S. Department of Energy
Oak Ridge, Tennessee

EXECUTIVE SUMMARY

Under the Formerly Utilized Sites Remedial Action Program (FUSRAP), the U.S. Department of Energy (DOE) has proposed to carry out a remedial action at a site located in Bayo Canyon, Los Alamos County, New Mexico. Although the site was partially decontaminated and decommissioned in the 1960s, there remain above-background amounts of radionuclides in the area.

The DOE has determined that strontium-90 in excess of its proposed remedial action criteria exists in materials underlying an area of about 0.6 ha (1.5 acres) at the Bayo Canyon site. The proposed action is to demarcate this area and restrict its use to activities that will not disturb this subsurface contamination. The proposed action would allow unrestricted use of the balance of the formerly utilized site.

The proposed remedial action will be minor and, thus, will cause negligible disruption of the socioeconomic or environmental systems in which the site exists. The action will not threaten any legally protected species of flora or fauna, nor will it threaten any legally protected cultural or historical resources. Because the local community is familiar with radiation and has expressed no concern to date, it is expected that future public concern will be low. The DOE is ensuring that county authorities remain aware of all proposed remedial activities in the area.

This environmental assessment has resulted in the conclusion that the proposed action will adequately protect the public from added radiological risk and will have no other environmental consequences greater than those expected for the alternative actions.

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1. PROPOSED ACTION

1.1 BACKGROUND AND NEED

In 1976, the U.S. Energy Research and Development Administration (now the U.S. Department of Energy) identified an area in Bayo Canyon, Los Alamos County, New Mexico, as MED/AEC sites possibly requiring remedial action (U.S. Dep. Energy 1980; Ramsey 1981). In 1976, personnel of Los Alamos Scientific Laboratory (currently Los Alamos National Laboratory) began a resurvey for possible residual contamination. The radiological survey was completed in 1977, and the final report of survey results was issued in June 1979 (Los Alamos Sci. Lab. 1979). The results of this survey led the Department of Energy (DOE) to consider the Bayo Canyon site for remedial action under its Formerly Utilized Sites Remedial Action Program (FUSRAP).

1.1.1 Setting

Bayo Canyon is located in Los Alamos and Santa Fe counties, north-central New Mexico, (Figure 1.1). The 120-m (390-ft) deep canyon is one of many canyons dissecting the Pajarito Plateau (Figure 1.2). The formerly utilized site is located within Township 20N, Range 6E, Sections 12 and 13, in Los Alamos County--approximately 5 km (3 mi) east of the center of the town of Los Alamos, 40 km (25 mi) to the northwest of Sante Fe, and 100 km (60 mi) to the north-northeast of Albuquerque. Several smaller towns and Native American pueblos exist within a 100-km radius of the site.

The 140-ha (350-acre) site encompasses an undeveloped canyon floor containing an ephemeral streambed (Figure 1.3). Residential development has occurred along the mesa tops on both sides of Bayo Canyon, and the canyon floor is used for occasional recreational purposes (e.g., hiking, horseback riding, and motorcycling). The county of Los Alamos envisions eventual use of the floor of Bayo Canyon for residential or recreational development (Brown 1981; Los Alamos Natl. Lab. 1981b; Taylor 1982). Final decisions await resolution of the radiation risks via the remedial action program of DOE.

1.1.2 Background

Under sponsorship of the Manhattan Engineer District (MED), facilities for experiments with conventional high explosives were constructed in Bayo Canyon during 1943 (Los Alamos Sci. Lab. 1979; Ford, Bacon & Davis Utah Inc. 1981). From 1944 to 1961, the federal government studied blast diagnostics of conventional high explosives containing uranium and other radiation sources. The radiation sources used as tracers in the blast-diagnostics tests contained from several hundred to several thousand curies of lanthanum-140 per test shot; this material contained smaller amounts of strontium-90. Explosions scattered radioactive materials around two firing points, TA-10-13 and TA-10-15 (Figure 1.3). The lanthanum-140 has decayed to nonradioactive products, but

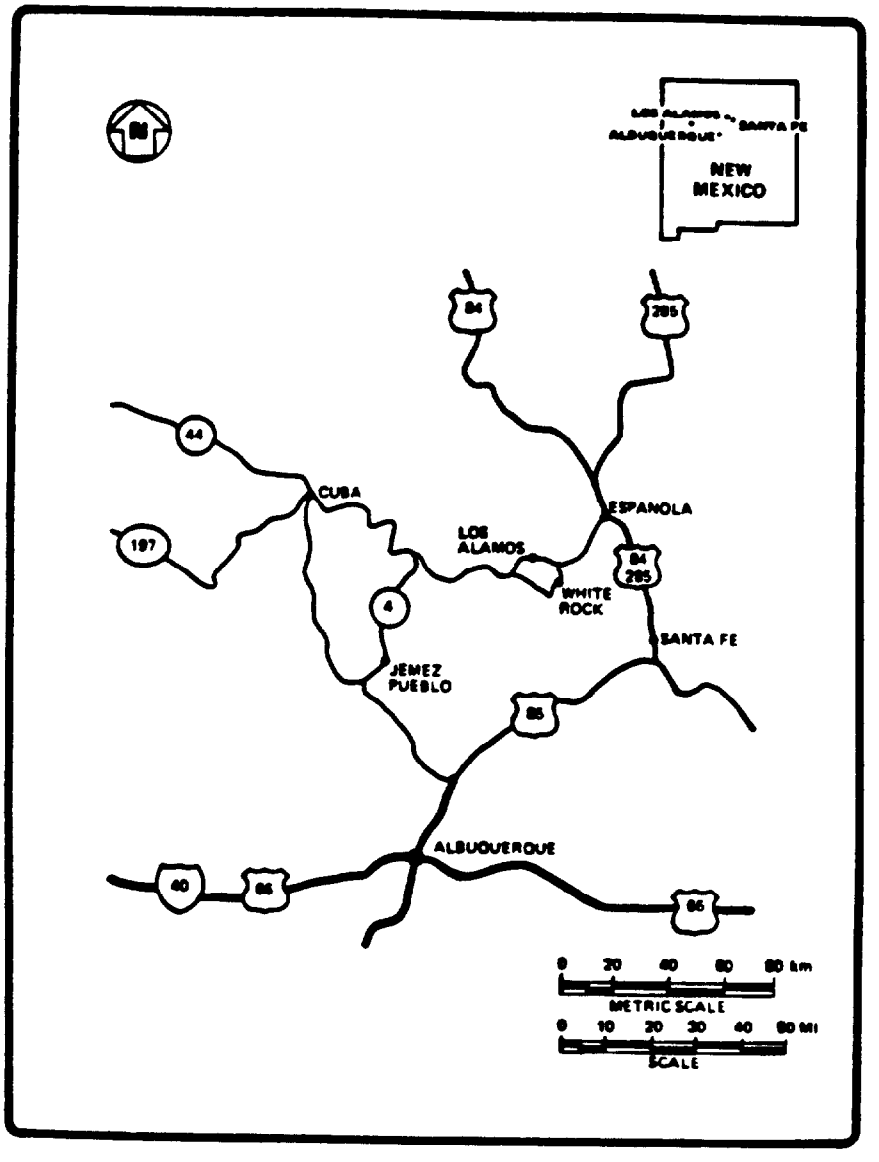

Figure 1.1. Regional Setting of the Los Alamos Area. Source: Ford, Bacon & Davis Utah Inc. (1981).

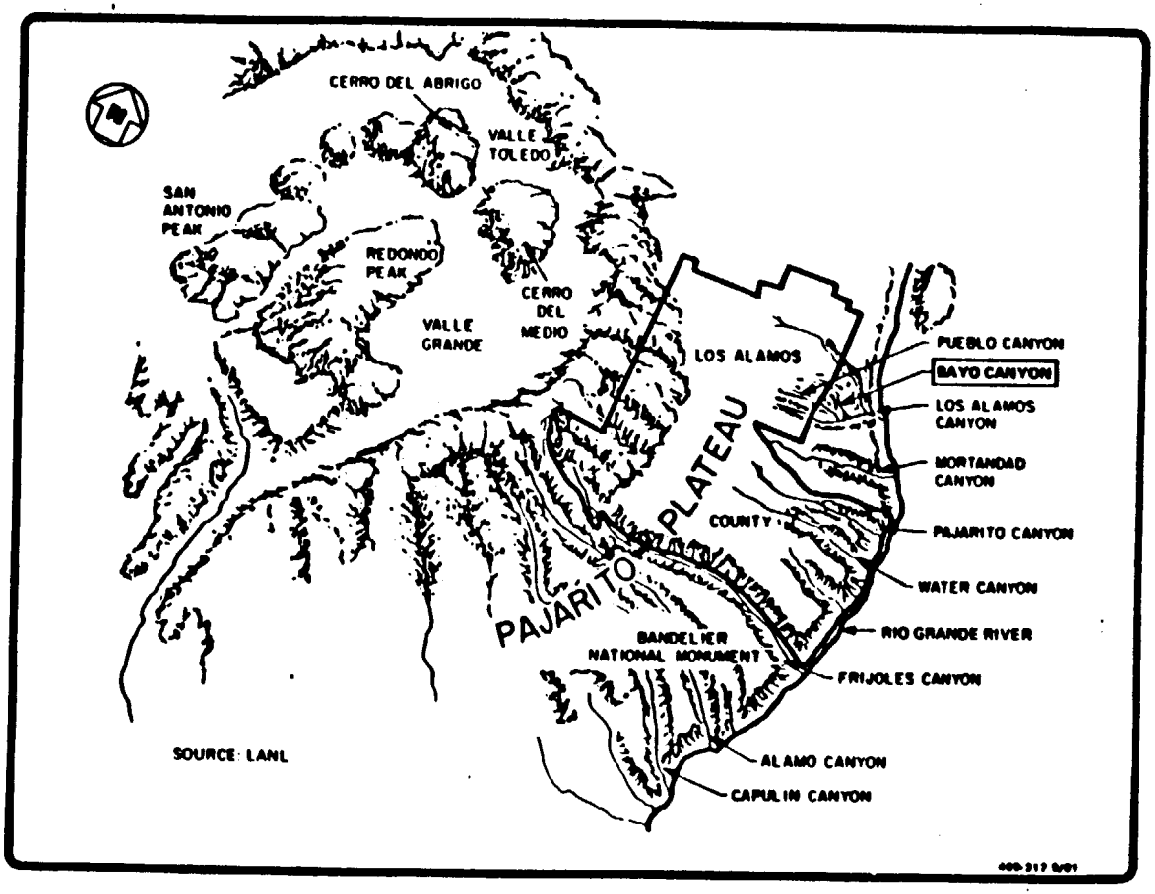

Figure 1.2. Physiographic Setting of Bayo Canyon. Source: Los Alamos Scientific Laboratory (1979).

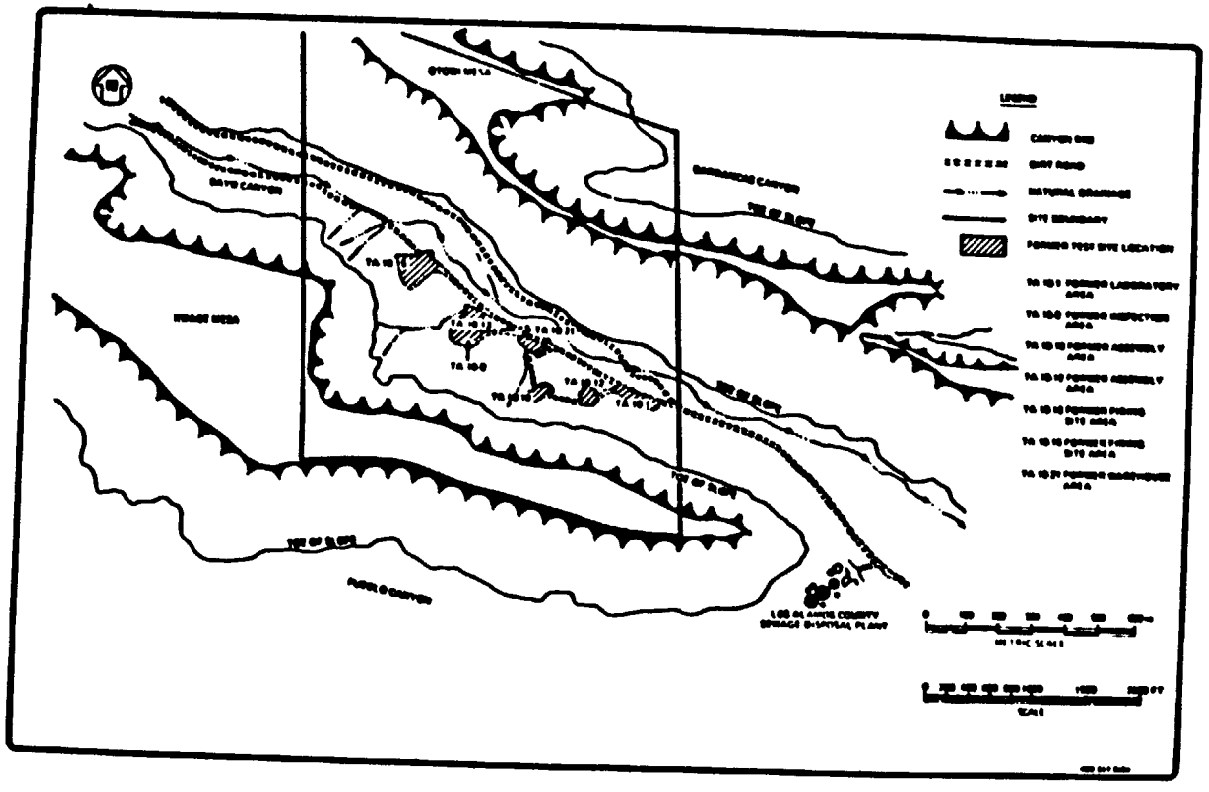

Figure 1.3. Descriptive Map of the Bayo Canyon Site. Source: Ford, Bacon & Davis Utah Inc. (1981).

measurable radioactive contamination remains in the form of strontium-90 and uranium (Los Alamos Sci. Lab. 1979; Los Alamos Natl. Lab. 1981b). In addition, there are contaminated areas on the southeastern end of the formerly utilized site where radioactive liquids and solid wastes were disposed; these waste pits were located near the radiochemistry laboratory, TA-10-1 (Figure 1.3).

Decommissioning of the test area began in 1960 with the demolition of several buildings. In 1963, the remaining buildings were demolished, the sewer systems removed, the contaminated waste pits excavated, and the surface debris removed within a radius of about 760 m (2500 ft) around the detonation control buildings. Debris was removed from the site and disposed at a burial site for radioactive wastes located on the grounds of Los Alamos Scientific Laboratory (LASL) (currently Los Alamos National Laboratory [LANL]).

After decommissioning, the site ownership was transferred from the U.S. Government to Los Alamos County by quit claim deed on July 1, 1967. It was recognized at the time of decommissioning that some radioactive materials probably remained in the canyon. Consequently, several follow-up radiological surveys were subsequently conducted (Los Alamos Sci. Lab. 1979).

1.1.3 Need

The areas of the Bayo Canyon site to be considered for remedial action have been determined by using contaminated soil cleanup criteria proposed by LANL (Healy et al. 1979; Ford, Bacon & Davis Utah Inc. 1981; Los Alamos Natl. Lab. 1981b). These limits are 100 pCi/g for strontium-90 and 40 pCi/g for uranium as uranium-238. These proposed criteria were derived by assuming a whole-body dose of ≤ 500 mrem/yr received from near-surface contamination via external exposure, inhalation of contaminated air and particles, and ingestion of contaminated food and water (Healy et al. 1979). Healy et al. believe that these criteria are conservatively low and actual received doses would be less than 500 mrem/yr for contamination at the prescribed limits.

Concentrations of uranium were not found to exceed the proposed guidelines for cleanup, although they do exist in excess of background levels in the 0- to 30-cm (0- to 1-ft) soil layers over the 140-ha (350-acre) site (Los Alamos Sci. Lab. 1979). Contamination exceeding the criterion for strontium-90 exists in the vicinity of the former radiochemistry laboratory at depths below 120 cm (4 ft) (Los Alamos Sci. Lab. 1979; Ford, Bacon & Davis Utah Inc. 1981; Los Alamos Natl. Lab. 1981b). The existing strontium-90 is contained in the residue of wastes that were disposed in the waste pits located near the radiochemistry laboratory, TA-10-1 (Figure 1.3).

1.2 AGENCIES INVOLVED

Primary authority for remedial action in Bayo Canyon resides in the Formerly Utilized Sites Remedial Action Program (FUSRAP), administered by the Oak Ridge Operations Office of the U.S. Department of Energy (U.S. Dep. Energy 1980). Because of the site's former involvement with Los Alamos Scientific Laboratory (now Los Alamos National Laboratory), DOE's Los Alamos Area Office, Albuquerque Operations, has a vested interest in remedial actions at these sites. Other federal land managers in the vicinity of the site include the U.S. Bureau of Land Reclamation, U.S. Forest Service, U.S. Bureau of Indian Affairs, and U.S. National Park Service (U.S. Dep. Energy 1979).

The governing authority for the Bayo Canyon formerly utilized site is the county of Los Alamos. This body is responsible for zoning land use for the area surrounding the site.

The site is within the jurisdiction of the state of New Mexico. The New Mexico Health and Environmental Department, Environmental Improvement Division, bears the authority to regulate the use, transport, and disposal of radioactive materials.

Further discussion of institutional controls upon the sites may be found in Sections 2.1 and 2.2.

1.3 DESCRIPTION OF THE PROPOSED ACTION

The proposed remedial action at the Bayo Canyon site is a minimal action that effectively limits public exposure to radioactive sources by prohibiting disturbance of the subsurface material that exceeds the proposed 100 pCi/g criterion for strontium-90 (Ford, Bacon & Davis Utah Inc. 1981). The area in which this contamination is located is referred to as the "designated restricted area" (Figure 1.4). This designated area of about 0.6 ha (1.5 acres) encompasses the former radiochemistry laboratory and the former solid- and liquid-waste-disposal sites. The source of the excess contamination is strontium-90 remaining from lanthanum-processing wastes that were disposed at these sites (Los Alamos Sci. Lab. 1979).

The designated restricted area will be controlled to prevent the construction of housing, sewer lines, etc., until such time that radioactivity on the site has decayed to below-guideline levels. This restrictive covenant will last for approximately 160 years, the time estimated for the strontium-90 to decay to <100 pCi/g (Ford, Bacon & Davis Utah Inc. 1981; Los Alamos Natl. Lab. 1981b). Government ownership and control will be required to ensure that the restricted area is used only for purposes that will not lead to disturbance of subsurface contamination. Four monument markers will be emplaced in the corners and one at the midpoint of each edge of the designated restricted area to denote the presence of subsurface radioactivity. A crew of four will require from 5 to 10 days to complete the remedial action. Finally, radiological surveys will be required before, during, and after remedial activities to ensure that the planned goals have been accomplished. The proposed activities are summarized in Tables 1.1 and 1.2.

1.4 ALTERNATIVE ACTIONS

Three alternatives for remedial action have been identified for the remedial action sites: (1) "no action", (2) "minimal action", and (3) "decontamination/restoration" (Ford, Bacon & Davis Utah Inc. 1981; Los Alamos Natl. Lab. 1981b). Table 1.2 contains a summary of the salient characteristics of the proposed action and of the alternative actions for Bayo Canyon.

1.4.1 No Action

In the no-action alternative for the Bayo Canyon site, the property would remain unchanged. No action would result in no restrictive covenants being placed upon the 0.6-ha (1.5-acre) designated area (Figure 1.4). This area

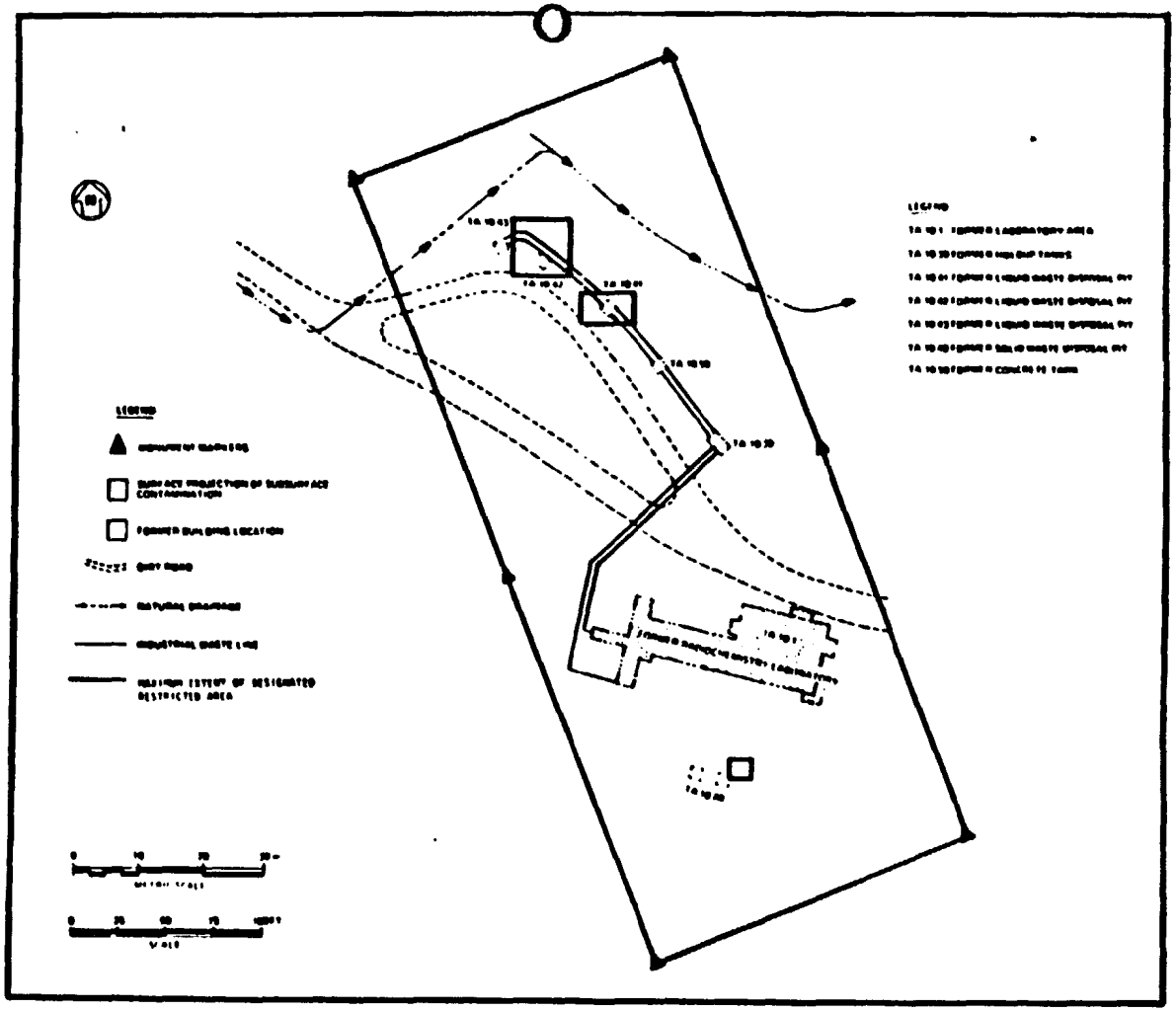

Figure 1.4. Approximate Extent of Designated Area of the Bayo Canyon Site Under the Proposed Remedial Action. Modified from Ford, Bacon & Davis Utah Inc. (1981).

Table 1.1. Activities Associated with the Proposed Remedial Action for the Bayo Canyon Formerly Utilized Site

- Implement health-physics precautions during installation of monuments.
- Maintain government control over the designated restricted area (0.5 ha).
- Control land use such that subsurface disturbance does not occur for approximately 160 years.
- Provide for periodic surveillance to ensure restricted use of the designated area.

Table 1.2. Summary of Alternative Remedial Actions Proposed for the Bayo Canyon Formerly Utilized Site

Characteristic	Proposed Action	No Action	Decontamination/ Restoration
Proposed restriction	Restrict commercial/ residential development for ~ 160 years	None	None after decontamination
Area of restriction	0.6 ha (1.5 acres)	None	None
Area of disturbance	None	None	0.7 ha (1.8 acres)
Volume of excavation	None	None	1160 m^3 (1520 yd^3)
Duration of effort	5-10 days	None	55-65 days
Work force effort	20-40 person-days	None	550-650 person-days
Expense	$63,000	None	$461,000
Decontaminated waste transport	None	None	20 km (12 mi) to disposal site

Data from Ford, Bacon & Davis Utah Inc. (1981).

could then be developed in a manner similar to the remainder of the formerly utilized site, and such development could result in intrusion into the subsurface contamination.

1.4.2 Decontamination/Restoration

Under the decontamination/restoration alternative, decontamination to meet the proposed criteria for strontium-90 would be completed in the designated area (Table 1.2). Excavation would be required to a depth of approximately 7.5 m (25 ft) at former solid-waste pit TA-10-48, to a depth of approximately 9 m (30 ft) at the nearby former liquid-waste pit TA-10-41, and to a depth of approximately 12 m (40 ft) at former liquid-waste pit TA-10-42 (Figure 1.4).

Excavation would be performed with conventional earth-moving equipment. The sides of the excavations would be sloped at approximately 45 degrees to provide equipment access to the excavation site. Contaminated material would be transported by truck approximately 20 km (12 mi) to the LANL waste-disposal site. The in-situ volume of contaminated materials is estimated to be approximately 1160 m^3 (1520 yd^3). Although this is a relatively small volume, it would be necessary to excavate approximately 12,000 m^3 (16,000 yd^3) of uncontaminated soil material to accomplish the removal of the contaminated material.

Uncontaminated material that was stockpiled during excavation would be returned to the resulting pits and compacted. Additional fill material would be obtained from areas as close to the site as possible. The area disturbed by excavation and stockpiling operations would be revegetated if immediate development was not planned. It is estimated that approximately 2800 m^2 (30,000 ft^2) would be disturbed by excavation and that approximately 4200 m^2 (45,000 ft^2) of the canyon floor would be disturbed by stockpiling the uncontaminated soil. Little topsoil exists near the site, and revegetation would be accomplished directly on the backfill material. This approach was used successfully when the site was decommissioned. A crew of approximately 10 would require about 55 to 65 working days to complete the remedial action.

After restoration, the site could be released for unrestricted use, and consequently neither U.S. Government control or ownership nor periodic surveillance or monitoring would be necessary.

1.4.3 Comparison of Environmental Impacts of Alternative Actions

The no-action alternative involves leaving the site as it exists, with no restrictions upon land development in the area and no further cleanup of contaminated materials. Thus, there would be no impacts associated with excavation activities, and there would be no further expenditure of funds beyond costs of releasing the site. Maximum possible exposure to surface radioactive contamination would not differ from the proposed action; however, the likelihood of such exposure would be higher. Under the no-action alternative, it is anticipated that individual residents of the area would receive maximum, annual doses of about 3 mrem to bone lining. The major pathway for these estimated doses is via ingestion of vegetables and crops grown in soils containing radioactivity equivalent to that found in the 0- to 30-cm (0- to 1-ft) portion of soils in the area of the formerly utilized site (Los Alamos Natl. Lab. 1981b, Table II). However, within the 0.6-ha (1.5-acre) designated area, excavation of the subsurface is possible under the no-action alternative.

This could bring to the surface material containing in excess of 1100 pCi/g strontium-90 (Los Alamos Sci. Lab. 1979, p. 41). If excavation is assumed to result in dispersal of this contamination into areas subsequently used for vegetable gardening, estimated doses received by residents would be well in excess of 500 mrem/yr. Doses received by transients would be lower due to shorter periods of exposure.

In the event that the no-action alternative were implemented and Bayo Canyon were subsequently developed, it is expected that several structures might be built in the designated area over a period of a few years. During home building, construction workers would be exposed to radiation from both surface and contaminated subsurface soils because there would be no restriction on disturbance of subsurface soils within the designated area. For the no-action scenario, the 50-year dose commitments, or cumulative doses for the 50 years following exposure to surface (< 30 cm or 1 ft) contamination, were calculated as 0.1 mrem to bone lining and 0.3 mrem to lung of construction workers (Los Alamos Natl. Lab. 1981b, Table II). Construction workers building homes would also be exposed to radiation from strontium-90 if they excavated below 122 cm (4 ft) into the limited region of elevated subsurface contamination near the waste pits (Figure 1.4). For this case, the calculated 50-year dose commitments are 0.04 mrem to bone lining and 0.03 mrem to lung (Los Alamos Natl. Lab. 1981b, Table II). The exposure scenario assumes that exposure to higher levels of contamination would occur for a shorter period than exposure to surface contamination and, hence, dose estimates are correspondingly lower.

Decontamination and restoration of the formerly utilized site is expected to have the largest environmental impact (Table 1.2). Decontamination would make the designated area available for development as a residential or commercial site with a lowered risk of exposure to long-term radioactive contamination. However, approximately 0.7 ha (1.8 acres) of land would be disturbed, increasing the possibility for increased losses of soil due to wind and water erosion and disrupting an area that currently contains an open stand of ponderosa pine (Los Alamos Natl. Lab. 1981b). The activities associated with excavation and backfilling could disrupt foraging in Lower Bayo Canyon by endangered peregrine falcons that are known to occur in the area.

Excavation would require the transportation of wastes about 20 km (12 mi) to the waste-disposal site at LANL. Transport of the wastes could have minor effects on the traffic patterns along the route to the waste-disposal site, exacerbating current traffic problems (Section 2.2.5). In addition, it may not be possible to accommodate the extra waste disposal at the current disposal site (Section 2.2.6). The impacts of decontamination/restoration on the local economy and on availability of the work force would not be expected to be measurable because of the small size of the operation in comparison to the economy and work force of the area as a whole.

If a transportation accident were to occur during decontamination, the maximum radiation doses are expected to be 0.9 mrem to bone lining for drivers of waste-hauling trucks and 0.02 mrem to bone for the general public (Los Alamos Natl. Lab. 1981b, Table XIV). After decontamination, maximum doses would be expected to be lower, i.e., 0.01 mrem to bone and 0.001 mrem to bone lining for workers installing sewer lines or other subsurface facilities (Los Alamos Nat. Lab. 1981b). Estimated doses received by residents would be anticipated to be the same as those received under a scenario of gardening in

- soils containing surface (0- to 30-cm; 0- to 1-ft) contamination at levels that currently exist. This exposure would occur over most of the site because even under this alternative, only the area around the former waste pits would be decontaminated.

2. DESCRIPTION OF THE AFFECTED ENVIRONMENT

2.1 LAND USE

Most land in the area surrounding the formerly utilized site is owned and managed by county or federal governments--with the exception of privately owned industrial, commercial, and residential land in the communities of Los Alamos and White Rock (U.S. Dep. Energy 1979; Los Alamos Natl. Lab. 1981b, 1982). The Bayo Canyon site is owned by Los Alamos County.

Currently undeveloped, Bayo Canyon land is used for hiking, horseback riding, and other recreational activities. The area is now zoned for recreational use and for the possibility of private ownership, a status that could allow construction of residences or facilities such as clubhouses or rodeo grounds (Los Alamos Co. Plan. Dep. 1976b; Los Alamos Co. 1981; Taylor 1982). The upper end of the canyon is steep-sided and accessible only by foot or horseback. Residential development has occurred on the mesa on the north side of this section of the canyon. On the south side are the county rodeo grounds and facilities. The lower, wider end of the canyon is bordered by mesas that are not now zoned for development (Los Alamos Co. Plan. Dep. 1976a, 1976b; Brown 1981, 1982; Los Alamos Co. 1981; Payne 1981; Los Alamos Natl. Lab. 1981b, 1982).

In the vicinity of the town of Los Alamos, land for residential development is limited (Los Alamos Co. Plan. Dep. 1976a; U.S. Dep. Energy 1979; Brown 1981). Until recently, employment growth in the area and the resulting population influx made limited residential land the most pressing issue for the county. Although demand for land from developers and for housing has declined in the past year (Brown 1981; Payne 1981), county plans still call for use of about 80 ha (200 acres) of the lower part of Bayo Canyon for either residential and commercial development or as the site of new rodeo grounds; the latter would make land that is now being used for rodeo facilities available for residential development (Brown 1981; Los Alamos Natl. Lab. 1981b; Payne 1981).

2.2 SOCIOECONOMICS

2.2.1 Demography

The estimated 1980 population of Los Alamos County was 17,600 persons, distributed between two population centers: the towns of Los Alamos and White Rock (Los Alamos Natl. Lab. 1982). Projections for the future indicate only slight growth from in-migration, historically a major growth factor, because of (1) the reduction in new employment opportunities in the area (see Section 2.2.2) and (2) the lack of vacant housing and developable residential land (see Section 2.2.3).

2.2.2 Economics and Employment

The primary employer in the Los Alamos area is Los Alamos National Laboratory (LANL). The combined work force of LANL and associated operations (e.g., local consultants, construction subcontractors) accounts for about 70% (about 10,000 persons) of the total employment in Los Alamos County (U.S. Dep. Energy 1979; Brown 1981; Los Alamos Natl. Lab. 1981b, 1982). Forty percent of the workers for these firms (including the Laboratory) live outside Los Alamos County (Brown 1981). Employment was growing until recently, but it has leveled off in the past year due to cutbacks at LANL (Payne 1981). The commercial sector (about 1000 employees) is indirectly dependent on these employees and on tourism for its existence (U.S. Dep. Energy 1979; Brown 1981). Unemployment is low, between 3 and 4%; it is even less in the summer months because of increased student employment at LANL (Brown 1981).

2.2.3 Housing

Housing is in short supply in Los Alamos County due to the lack of developable residential land combined with population growth due to migration into the area (Los Alamos Co. Plan. Dep. 1976a; U.S. Dep. Energy 1979; Brown 1981; Los Alamos Natl. Lab. 1981b, 1982). The official vacancy figure on April 1, 1980, was 5.7%; however, much of the vacant housing is reserved for temporary, summer employees at LANL (Brown 1981). Construction of new residences has slowed because of stable employment at LANL and the tighter financial market (Payne 1981).

2.2.4 Institutional

Los Alamos County owns both the Bayo Canyon and Acid/Middle Pueblo Canyons FUSRAP sites and has the authority to regulate their future use (U.S. Dep. Energy 1979; Los Alamos Natl. Lab. 1981b; Payne 1981). The county has zoning regulations, a zoning map, and a comprehensive plan--all of which have been revised and adopted within the last six years (Los Alamos Co. Plan. Dep. 1976a, 1976b, 1979; Los Alamos Natl. Lab. 1981b, 1982; Brown 1981). If either of the sites were to be developed for residential use, county subdivision regulations would apply (Los Alamos Co. Plan. Dep. 1979). These regulations call for county coordination on all development plans and impose minimum standards for many aspects of residential areas (e.g., 1.2 ha [3 acres] of parkland and 0.2 ha [0.5 acre] for schools per 100 dwelling units, with locations for both determined by the County Planning Commission).

2.2.5 Transportation

The Los Alamos area is accessible by U.S. Highway 285 and State Route 4, which connect with larger highways to Santa Fe and Albuquerque (Figure 2.1). The local housing shortage combined with an increasing work force at LANL (until 1980) has led to considerable traffic problems because employees commute from more distant population centers (Paul C. Box Assoc. 1976; Brown 1981). The County Comprehensive Plan identified similar traffic problems, primarily at peak commuting hours. To relieve the congestion on intercounty roads and intersections, the county proposed building a road through Bayo Canyon (including the formerly utilized site) to connect Diamond Drive and State Route 4 and a road over Pueblo Canyon to connect Trinity Drive and San Ildefonso Road (Los Alamos Co. Plan. Dep. 1976a).

Currently, vehicular access to the Bayo Canyon floor is limited to authorized vehicles via an unimproved road (Los Alamos Natl. Lab. 1981b). The rough dirt road connects to State Road 4, and access is controlled by a locked gate.

Diamond Drive and Pajarito Road (Figure 2.1) are very heavily used, particularly at peak commuting hours because they are major access routes between LANL, the towns of Los Alamos and White Rock, and other areas where laboratory workers live (Los Alamos Co. Plan. Dep. 1976a; Paul C. Box Assoc. 1976; Los Alamos Natl. Lab. 1982).

2.2.6 Utilities and Other Community Services

All utility systems are adequate to serve existing needs and could accommodate future growth. Water for the county is taken from a series of 60- to 180-m (200- to 600-ft) wells located in three fields on the Pajarito Plateau, upgradient and at some distance from the formerly utilized sites (Section 2.5).

One of the two local sewage-treatment facilities is located near the depression of the mesa between Lower Pueblo and Bayo Canyons and is reached via the same unimproved road used to reach Bayo Canyon and the FUSRAP site from Alternate State Route 4 (U.S. Dep. Energy 1979; Los Alamos Natl. Lab. 1981b, 1982). A county sewage line connecting residential areas on the mesas at the head of Pueblo Canyon to this facility runs down the canyon along the stream channel (Los Alamos Natl. Lab. 1982).

2.2.7 Esthetics

Bayo Canyon for the most part remains in its natural state, with low shrubs, grasses, scattered ponderosa pines and other trees, and some exposed boulders. The walls of the canyon consist of exposed rock and soil and vary in the degree of steepness.

Only a few traces of the original building sites in Bayo Canyon remain--primarily in the form of small, sparsely vegetated spots that are slowly regaining natural vegetative cover.

The canyon floors and walls and the formerly utilized sites are visible from the adjacent mesas and to recreational visitors using the canyons. A portion of the east end of Bayo Canyon forms a dramatic view from a scenic overlook off Alternate State Route 4, although the site in Bayo Canyon is not visible from Alternate State Route 4.

2.2.8 Public Attitudes and Perceptions

Because of the influence of LANL, the communities of Los Alamos and White Rock have acquired an understanding of radiation that has created a climate of relative sophistication about radiation health hazards. The designation of the formerly utilized sites has not been a critical issue thus far (Payne 1981), although newspaper articles about the discovery of areas with some radioactive contamination have appeared in local and Albuquerque newspapers (England 1981; Schomisch 1981). In addition, county authorities are being kept informed of DOE's plans for remedial actions in the area.

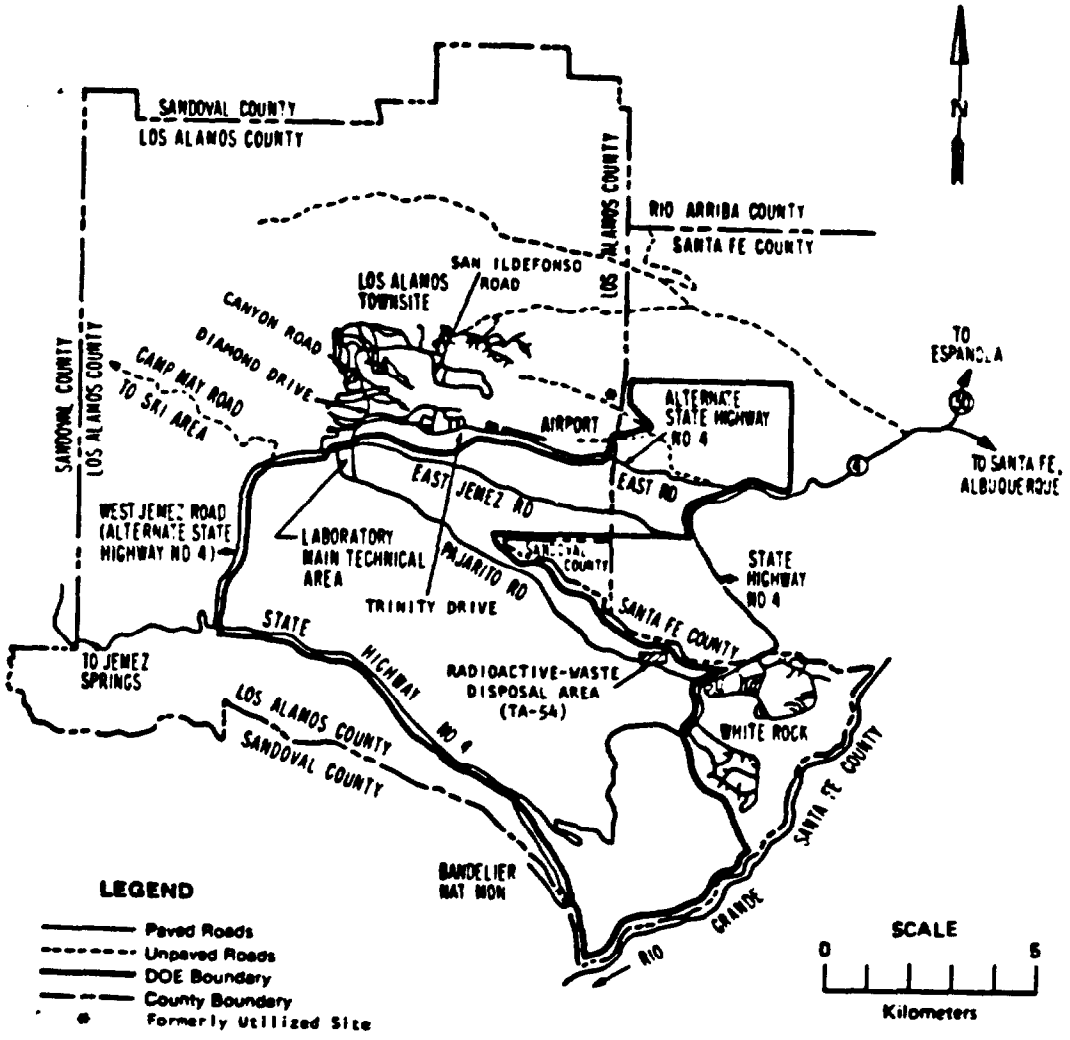

Figure 2.1. Transportation Routes in the Bayo Canyon Area. Adapted from U.S. Department of Energy (1979).

2.3 CULTURAL AND HISTORICAL RESOURCES

Many signs of prehistoric Native American life have been found in the general region of LANL, indicating extended use of the area for over 100,000 years. Three major ruins on LANL land as well as numerous other small ruins have been identified (Steen 1977; U.S. Dep. Energy 1979; Los Alamos Natl. Lab. 1981b). The three major sites and many of the minor ones have been proposed for inclusion in the National Register of Historic Places (Los Alamos Natl. Lab. 1981b).

In Bayo Canyon, one small site has been identified west of the major Otowi Ruins about 2 km (1.2 mi) from the formerly utilized site (Los Alamos Natl. Lab 1981b).

2.4 GEOLOGY AND SOILS

The Pajarito Plateau forms a topographic high area along the western part of the Rio Grande depression in north-central New Mexico. The plateau is formed by a series of Pleistocene ashfalls and ashflows of Bandelier Tuff and is dissected by numerous canyons. At the Bayo Canyon site, the vertical or near-vertical walls of the canyon are formed by the upper Tshirege Member, composed of moderately welded to nonwelded tuff. The canyon floors are formed by the lower part of the Otowi Member, a mass of nonwelded tuff about 42-m (140-ft) thick at the Bayo Canyon site. The lower Guaje Member, a pumice fall 9-m (30-ft) thick at the site, underlies the Otowi Member and overlies the Puye Formation (Purtymun 1979).

Seismic activity in the Los Alamos area is estimated to be low, and the sites are not located near any known active faults. Based on limited data, Sanford (1976) suggests that seismic risk may be on the order of a magnitude-5.5 earthquake once every 100 years somewhere in the Rio Grande depression from Albuquerque to Questa.

Alluvium in the canyons is derived from weathered and eroded Bandelier Tuff and is composed mainly of clay, silts, sands, and gravels with few cobbles or boulders. Downstream from the Bayo Canyon site, where the stream channel cuts into the Puye Formation, the cobble- and boulder-sized materials form a large percentage of the streambed sediments. The alluvium, thin in the upper reaches of the canyons, thickens towards the east becoming as much as 10-m (33-ft) thick in the lower reaches of Bayo Canyon (Purtymun 1979) and as much as 3- to 5-m (10- to 15-ft) thick in Acid/Middle Pueblo Canyons.

The canyon walls of Bayo Canyon are steep outcrops of volcanic tuff. The south-facing walls of these canyons are generally steep and have little or no soil material or vegetation, although weathering of the north-facing walls has created areas of very shallow, dark-colored soils.

Clayey soils derived from weathering of Bandelier Tuff cover most of the fingerlike mesas of the Pajarito Plateau. According to a recent soil survey, the soils of Bayo Canyon belong to the Puye series (Nyhem et al. 1978). The Puye series consists of deep, well-drained, sandy-loam soils formed in the level to gently sloping canyon bottoms. Permeability of soils in this series is moderately rapid, runoff is very slow, and the erosion hazard is low.

2.5 HYDROLOGY

Surface flows through Bayo Canyon originate in the Pajarito Plateau and drain into the lower reach of Los Alamos Canyon, which in turn drains eastward into the Rio Grande. Water runoff in the canyons is ephemeral, occuring only after heavy rainfalls or snowmelts. The largest amounts of runoff occur during heavy summer thunderstorms. At times, these storms may generate heavy runoff in local canyons that can cause scouring of the canyon bottoms (Purtymun 1979).

The average annual precipitation of 45 cm (18 in.) is divided between warm-weather convective rainshowers and cold-season migratory storms. On the average, approximately 70% of the yearly moisture falls between the months of May and October, and 40% of the annual moisture total falls in a few hours during August in localized heavy thunderstorms (Los Alamos Natl. Lab. 1981a). Winter precipitation falls primarily as snow, with accumulations of about 130 cm (51 in.).

The stream channel floodplains occupy substantial portions of the canyon bottoms, including portions of the formerly utilized Bayo Canyon site. The sandy alluvium in the canyons is quite permeable in contrast to the underlying volcanic tuff and sediments. Intermittent runoff infiltrates the alluvium until its downward movement is impeded by the less permeable Otowi Member of the Bandelier Tuff, but perched water is thought to be of limited extent in both canyons. Water that is not immediately lost by evapotranspiration and movement into the underlying volcanic units may move downgradient as a shallow, alluvial groundwater body (Purtymun 1979; Los Alamos Natl. Lab. 1981a). The volume of water in the alluvium aquifers is largest during the spring snowmelt period and in the early summer when storm runoff is largest.

Available data suggest that no hydrologic connection is likely between any Bayo Canyon surface water and the main aquifer in the Tesuque Formation and the lower part of the Puye Formation (Section 2.4). The main aquifer is isolated from alluvial and perched water found in many areas of the plateau by approximately 240 m (790 ft) of Bandelier Tuff and sediments of the Puye Formation (Los Alamos Natl. Lab. 1981a). Few joints are present in the non-welded ashflows of the Otowi Member, which underlies the sites (Purtymun and Kennedy 1971) and through which alluvial water could flow towards the underlying aquifer. Shallow test holes drilled at the Bayo Canyon site in 1961 were dry, with no indication of (1) water being present in the channel alluvium, (2) perched water, or (3) excessive moisture in the tuff above the Puye Formation fanglomerate (Purtymun 1979).

2.6 ECOLOGY

2.6.1 Terrestrial Ecology

The region surrounding Los Alamos has a semiarid, continental mountain climate. Daytime summer temperatures rarely exceed 32°C (88°F)--dropping to the 12-15°C (53-60°F) range at night as a result of the high altitude, light winds, clear skies, and low humidity. Winter temperatures typically range from -10 to 5°C (14 to 40°F) (U.S. Dep. Energy 1979; Los Alamos Natl. Lab. 1981b).

The elevational gradients in the Los Alamos area and in the many canyons dissecting the base of the Jemez Mountains have resulted in a diversity of ecosystems in the area of Bayo Canyon (U.S. Dep. Energy 1979; Los Alamos Natl. Lab. 1981b, 1982). The canyons contain vegetation communities of pinyon-juniper on the mesa tops, pine-fir on the more mesic slopes, and ponderosa pine on the canyon floor (Los Alamos Natl. Lab. 1981b, 1982). The vegetation within the Bayo Canyon site boundaries contains species characteristic of disturbed sites in the region, including chamisa or rabbit brush, filaree, and Russian thistle.

The fauna of the formerly utilized site is composed of characteristic species for the region (Los Alamos Natl. Lab. 1981b). Mule deer is the most common big game species found in the Los Alamos area. A diversity of bird species (over 90) use the area, and about 45 species are considered permanent residents (U.S. Dep. Energy 1979). Generally, the larger mammals and birds are wide-ranging and occupy commensurately large habitats, from the dry mesa-canyon country at lower elevations to the high mountain tops west of LANL. The smaller mammals, reptiles, invertebrates, and vegetation are generally confined to smaller habitats. No species of flora or fauna likely to occur in the canyons is restricted to the immediate environs of the formerly utilized sites nor is any dependent upon that area for the continued survival of the species.

2.6.2 Aquatic Ecology

The nearest natural, permanent aquatic ecosystems are approximately 5 km (3 mi) downstream of the Bayo Canyon site, in the Rio Grande (U.S. Dep. Energy 1979). Flow through Bayo Canyon itself is restricted to only portions of the year (see Section 2.4), and extant aquatic ecosystems have developed near the formerly utilized site under conditions of ephemeral flow regimes.

2.6.3 Sensitive Species

There are seven species of plants protected under New Mexico Statute 45-11 that may occur in Bayo Canyon (Los Alamos Sci. Lab. 1979; Foxx and Tierney 1980; Los Alamos Natl. Lab. 1981b). There are no species currently on or proposed for the federal list of threatened and endangered species that are likely to occur in canyon habitats (Los Alamos Natl. Lab. 1979b; Nagy and Calef 1980; U.S. Fish Wildl. Serv. 1981). One species under review for that list, grama grass cactus, is known to occur in Bayo Canyon but is unlikely to occupy habitat near the remedial action sites because it is generally found on drier mesa tops at lower elevations.

Several species of mammals and birds listed as sensitive species by either the U.S. Fish and Wildlife Service or the state of New Mexico are known to occur in the Los Alamos region (New Mexico Dep. Game Fish 1978; Los Alamos Sci. Lab. 1979; U.S. Fish Wildl. Serv. 1981). Of these species, the red-headed woodpecker and zone-tailed hawk are not documented as occurring in Bayo Canyon but are likely to use habitat found in the area of the formerly utilized site (Los Alamos Sci. Lab. 1979; Los Alamos Natl. Lab. 1981b, 1982). The endangered peregrine falcon is known to forage in Bayo and a falcon aerie is located in Lower Pueblo Canyon near the sewage treatment plant (Los Alamos Natl. Lab. 1981b, 1982).

2.7 RADIOLOGY

The current radiological environment of Bayo Canyon results from a combination of natural and anthropogenic sources that, for the purposes of this report, may be placed into three categories: (1) subsurface radioactivity at depths of > 30 cm (1 ft), (2) surface radioactivity at depths of 0 to 30 cm (0 to 1 ft), and (3) ambient external gamma radiation.

Elevated subsurface soil radioactivity is essentially anthropogenic and is found in a limited area within 10 m (33 ft) of the radiochemistry laboratory site and its acid-waste system (Figure 1.3). Samples taken at depths of from 30 to 600 cm (1 to 20 ft) contained concentrations of strontium-90 that ranged from < 1 to > 1100 pCi/g (Los Alamos Sci. Lab. 1979). Uranium concentrations were found to be at background levels.

Samples of surface soil were analyzed for strontium-90 and uranium. Average concentrations of strontium-90 did not exceed 2 pCi/g, and average uranium concentrations were 4-5 μg/g (equivalent to 15-20 pCi/g of gross alpha radiation). For comparison, surface concentrations of strontium-90 from fallout (due to atomic bomb tests in the 1950s) range from 0.2 to 0.4 pCi/g; uranium occurs naturally in concentrations of about 3-4 μg/g. Statistical analysis of the surface soil data for strontium-90 and uranium concentrations indicates that there is little probability (<< 2.5%) of undetected surface concentrations exceeding the proposed criteria of 100 pCi/g strontium-90 and 40 pCi/g uranium-238 (Los Alamos Natl. Lab. 1981b).

External penetrating radiation in Bayo Canyon and the surrounding area exhibits a high degree of spatial variation, due mainly to: (1) variations in the soil concentrations of naturally occurring radionuclides, (2) differences in the local topography from one location to the next (a site located in the canyon would receive radiation from the canyon walls as well as the floor, whereas a location on a mesa top would only receive radiation from the material beneath it), and (3) differences in the level of cosmic radiation between the canyon floor and mesa top because of the 120-m (400-ft) change in elevation. The average radiation exposure rate in the canyon bottom is 21 ± 2 μR/h, with somewhat higher values observed on the talus slopes. The exposure rate at the formerly utilized site does not show a statistically significant, instrumentally measurable difference from other parts of the canyon. The canyon as a whole exhibits levels about 13% greater than those observed in the townsite areas. Theoretical estimates can be made of penetrating radiation caused by strontium and uranium debris deposited on soil in the formerly utilized site. Estimates show that the increments of exposure rate attributable to the residual contaminants are less than the spatial and temporal variations in natural background (Los Alamos Natl. Lab 1981b).

The background external radiation dose rate in Bayo Canyon from charged particles and photons is about 170 mrem/yr. The annual cosmic neutron radiation dose is approximately 10 mrem, so that the total external radiation dose rate is about 180 mrem/yr.

3. ENVIRONMENTAL CONSEQUENCES OF THE PROPOSED ACTION

3.1 LAND USE

The immediate and direct consequences of the action on future use of the FUSRAP site will be negligible because of the small size of the restricted area (0.6 ha or 1.5 acres) (Figure 1.4). However, if the county acts to convert the formerly utilized site from its current status to either rodeo grounds or residential development (Section 2.1), use of that area would be constrained by the remedial action. Plans for either kind of development would have to preclude disturbance of the subsurface within the restricted area for about 160 years (Section 1.3). Because both potential uses would include fields or parks (Section 2.2.4) that require only surface activity and because county regulations require some parkland within residential areas (Section 2.2.4), this constraint will not be burdensome. This form of passive institutional control, i.e., no active guarding, cannot be guaranteed to prevent subsurface activity for the full 160 years. Changes in the residential development pattern that made open space more valuable, coinciding with a loss of records as to why the land was not built on initially, could lead to construction or other activity on the site. These changes would increase the likelihood of human interference before the 160-year period is over (see Section 3.7). However, the County is aware of DOE's proposed remedial action and finds the proposal compatible with the County's plans for the future (Taylor 1982).

Official county policy is one of cooperation with current FUSRAP policies (Brown 1981). Because of the close cooperation and interdependence of the town, county, and LANL, such cooperation could be expected to extend to working within the minor land-use constraints imposed by the action. FUSRAP authorities will help to ensure this by including county and LANL representatives in their planning.

3.2 SOCIOECONOMICS

No direct impacts to demography, economics and employment, housing, transportation, utilities, other community services, or esthetics are expected as a consequence of this remedial action because of the small size of the work force required and the small scale of the project (Table 1.2) relative to the economy and work force of the area as a whole (Sections 2.1 and 2.2). It is unlikely that cultural and historical resources will be affected because none have been found at the site during surveys of the area (Section 2.3).

Subsequent to a remedial action in Bayo Canyon, the county may move forward with plans to encourage development of the area by private owners for more organized recreational use or for housing. Either plan would help to ease the problem of the short supply of housing and developable land in the area (Section 2.2.3). However, public concern may be aroused as to the safety of the land for development, particularly for housing, if the site is not

excavated and a minor health hazard remains. Under these circumstances, there is a small probability that the justification for the proposed action may be examined carefully and possibly challenged by concerned groups. The current lack of expressed concern over the presence of contaminated material in Bayo Canyon and the knowledge of the public about radioactivity and related health hazards (Section 2.2.8) suggest that strong public opposition to the action is unlikely.

3.3 GEOLOGY AND SOILS

In Bayo Canyon, erosion of the surface materials from the site will not be accelerated by the proposed actions because surface vegetation will remain intact and no excavation activities will be required. However, subsequent development of the land around the 0.6-ha restricted site may lead to increased construction and a concomitant increase in erosion in the vicinity of the site. These activities could cause undercutting and gullying around the edge of the restricted area if construction activities were to coincide with periods of heavy thunderstorm/runoff activities. Proper sediment-control procedures will therefore be needed for future construction in the vicinity of the restricted area. Future plans for development of Bayo Canyon should contain measures for preventing loss of integrity of the restricted area during the 160-year period.

As noted in Section 2.4, the probability of earthquakes in the Los Alamos area is small. The consequences of an earthquake occurring at the Bayo Canyon site are also small. Under the proposed action, the damage to be expected would be ground shifting and cracking, with little vertical displacement. Surface cracking would leave openings from the surface to the wastes until the crevices were filled by material eroded during periods of surface runoff (Wheeler et al. 1977).

3.4 HYDROLOGY

During heavy thunderstorms or during periods of snowmelt, some water may infiltrate the soil over the waste site and reach the buried wastes, leading to dispersal of materials that the proposed action leaves in place. However, because the majority of water entering the soil is evapotranspired back to the atmosphere, little migration of dissolved wastes through the soil and alluvium has been detected (Los Alamos Sci. Lab. 1979).

It is possible that some radionuclides may migrate as flow through the unsaturated soil/alluvium/tuff material (Wheeler et al. 1977). No unsaturated flow studies have been made, however, for the Bayo Canyon site or for other waste-disposal sites in the Los Alamos area. Nevertheless, because of the low moisture content of the geologic units underlying the waste-disposal area as well as the depth of and lack of hydrologic connection with the main aquifer, it is expected that little or no contaminated water would reach the underlying aquifer. No contamination has been detected in recent surveys of groundwater (Los Alamos Sci. Lab 1979).

Losses of cover soil from the site could occur due to heavy summer thunderstorm activity and associated high runoff. The high permeability and low erosion hazard of the Puye and Totavi soils in the valley will maintain a low potential for loss of soil. Major storms may have more serious erosion impacts

on the Bayo Canyon waste site than has been previously recorded. However, quantification or qualification of such soil losses for the 160-year period of concern is not possible at this time.

3.5 ECOLOGY

The ecological consequences of the proposed action are not expected to be of concern. The placement of boundary markers to demark the restricted area will involve only minor field work, which will have inconsequential impacts to the biota of the site. The only sensitive species likely to be encountered on the site is the endangered peregrine falcon, which uses the Bayo Canyon floor as part of its foraging range (Section 2.6.3). Disturbance to foraging peregrines due to the activities needed to implement the proposed action will be negligible. Currently, human activities are occurring in the peregrines' foraging range and in the area of their aerie. Near their nest, the falcons are normally exposed to activities from the local airport and from recreational users of Pueblo Canyon.

The proposed action will not alter the riparian communities of the floodplain nor interfere with current patterns of flooding.

Development of Bayo Canyon after the remedial action is completed would likely alter the nature of the ecological communities in the canyon, including foraging habitat for the falcons. However, such impacts from development would not result from the action per se. In their planning, developers should take such impacts into account, particularly with regard to protection of the peregrine falcons in the area.

3.6 HEALTH AND SAFETY

It is not anticipated that the proposed action will result in any direct or indirect nonradiological health or safety hazards beyond normal, everyday activities. The activities for involved personnel would not differ in nature from those they would otherwise be doing, and the added risk from the proposed action will be negligible.

3.7 RADIOLOGICAL

The following discussion of radiological environmental consequences associated with the proposed action considered for the Bayo Canyon site is based on data provided in environmental analysis and radiological survey reports by Los Alamos National Laboratory (Los Alamos Sci. Lab. 1979; Los Alamos Natl. Lab. 1981b).

Three groups of people have been identified as possible radiation receptors after implementation of the proposed action. These groups are (1) residents--people who would be living in Bayo Canyon if it is developed, (2) transients--recreational users who venture into Bayo Canyon for such activities as hiking, picnicking, and trail riding, and (3) construction workers--people engaged in building homes in Bayo Canyon if it is developed.

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3.7.1 Doses to Residents and Transients

If Bayo Canyon were developed, it is expected that several homes might be built adjacent to, but outside of, the designated area. Radiation doses to residents would result from exposure (directly or via inhalation/ingestion pathways) to radionuclides deposited in the top 30 cm (1 ft) of the soil layer. The dose to a hypothetical resident in Bayo Canyon would depend on the amount of time the resident lived in the canyon and on the amounts of locally grown vegetables and fruit that are consumed. Calculations were made for a resident who spends 100% of the time in the contaminated area for 70 years (Los Alamos Natl. Lab. 1981b). During that time, it is expected that the resident would be exposed to elevated strontium-90 and uranium levels from inhalation of the airborne dust and ingestion of fruits and vegetables from a home garden located in contaminated soil. Inhalation exposure was calculated from average radionuclide concentrations in the 0- to 5-cm (0- to 2-in.) soil layers; exposure from garden produce was calculated from concentrations in the 0- to 30-cm (0- to 1-ft) layer. The calculated highest annual radiation doses for the 70-year exposure time for both the inhalation and ingestion pathways are presented in Table 3.1. Bone lining would receive the highest dose, i.e., about 3 mrem/yr.

Table 3.1. Radiation Doses to Members of the General Public Associated with the Proposed Remedial Action

Receptor Group	Type of Dose	Unit	Above-Background Radiation Dose to†[1] Bone Lining	Red Marrow	Lung
Residents	Maximum dose rate, internal plus external, during 70 years of exposure	mrem/yr	3	2	1
Construction workers	Dose accumulated over 50 years as a result of intake during first year, internal plus external	mrem	0.1	0.1	0.3
Radiation protection recommendation†[2]		mrem/yr	1500	1500	500
Natural background radiation†[3]		mrem/yr	120	80	180

†[1] From Los Alamos National Laboratory (1981b, Table II).

†[2] From National Council on Radiation Protection and Measurements (1971).

†[3] From National Council on Radiation Protection and Measurements (1975).

Transients are expected to visit the canyon for only a few hours at a time. As such, the dose to a transient would be less than, and probably only a small fraction of, the dose to a permanent resident.

3.7.2 Doses to Construction Workers

In the event that Bayo Canyon were developed following the proposed action, it is expected that several homes might be built in the vicinity, outside of the designated area (Figures 1.3 and 1.4). In calculating doses to construction workers, a hypothetical scenario was assumed for construction of homes in the canyon. During home building, construction workers would be exposed to radiation from surface and subsurface materials surrounding the designated area. The extent of contamination is such that it would be possible for all construction to occur in areas that are contaminated to some extent, but below cleanup criteria. Since construction may take place over several years, an annual inhalation dose may be based on a 2000-h exposure time (40 h/wk for 50 wk/yr). The ambient dust concentration is expected to be about 400 $\mu g/m^3$ and the workers' breathing rate is assumed to be 43 L/min, a value typical for relatively demanding work. The airborne dust was assumed to be contaminated with strontium-90 and uranium at levels found in the 0- to 30-cm soil layer, resulting in inhalation of these radionuclides by the workers and in a subsequent dose. The estimated 50-year dose accumulations after exposure were calculated as about 0.1 mrem to bone lining and about 0.3 mrem to lung (Table 3.1).

3.7.3 Evaluation of Radiation Doses

The radiation doses to residents and construction workers may be compared to radiation protection standards and to background radiation. Because neither residents nor construction workers can be considered to be radiation workers, the standards for members of the general population would be applicable. The National Council on Radiation Protection and Measurements (1971) has recommended that individual members of the general population should not receive a whole-body radiation dose in excess of 500 mrem/yr. This recommendation is consistent with existing NRC and DOE radiation protection standards. The highest expected dose to a long-term resident of Bayo Canyon is 3 mrem/yr to the bone lining. This value is 0.2% of the 1500 mrem/yr recommended maximum dose to bone lining. The background dose to bone lining is about 120 mrem/yr, including contributions from cosmic radiation, external terrestrial radiation, and radiation from internally deposited nuclides. The dose to a resident due to radioactive residues is a small fraction of this background, i.e., 3 mrem/yr is 2.5% of 120 mrem/yr.

The variation in background radiation at a given location in the United States is commonly found to be in excess of 10 mrem/yr (Natl. Counc. Radiat. Prot. Measure. 1975). The highest cumulative dose from activities associated with the alternatives considered at Bayo Canyon is 3 mrem. Since this dose value is well within the variation in background radiation levels, it is reasonable to consider the radiological consequences of the proposed alternatives to be negligible.

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