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Final Environmental Impact Statement

NEVADA TEST SITE

Nye County, Nevada

Energy Research & Development Administration

Responsible Official:

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DISCLAIMER

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SECTION I

SUMMARY

A. SCOPE

This environmental statement has been prepared by the Energy Research and Development Administration (ERDA) in accordance with the requirements of Title 10, Part 711, of the Code of Federal Regulations which prescribes the procedures to be followed for implementation of the National Environmental Policy Act of 1969.

The Treaty on the Limitation of Underground Nuclear Weapon Tests, commonly known as the Threshold Test Ban Treaty, and its companion Treaty on Underground Nuclear Explosions for Peaceful Purposes have been signed and introduced to the U.S. Senate for ratification. These treaties limit individual underground nuclear tests to 150 KT. In the interim, pending their entry into force, the United States has announced its intention to abide by the yield limits of the treaties. However, the capability to conduct larger nuclear tests at the Nevada Test Site (NTS) remains unchanged.

As has been done in the preparation of environmental statements in the past for the testing activities at the Nevada Test Site (References 1, 2, 3, and 4), this environmental statement considers underground nuclear detonations with yields of one megaton or less, along with the preparations necessary for such detonations. The testing activities considered also include other continuing and intermittent activities, both nuclear and nonnuclear, which can best be conducted in the remote and controlled area of the Nevada Test Site.

Specifically, this environmental statement does not include consideration of:

Nuclear detonations for excavation purposes,
Underground nuclear detonations planned above one megaton in yield, or
Nuclear detonations conducted away from the Nevada Test Site.

Tests in these three categories will be covered by separate environmental impact assessments or statements if and when such activities are contemplated.

I. SUMMARY (Cont.)

In addition, geologic formations at the Nevada Test Site are being studied for possible use in the ERDA program for management of commercially generated high-level radioactive wastes. If the Nevada Test Site is selected as a storage site, a separate site-specific environmental statement will be prepared for that activity.

The ongoing activities as described in this statement are quite similar to those described in past environmental statements, and it is not expected that the future activities at the Nevada Test Site will differ substantially in nature or degree. This environmental statement is intended to provide for the continuation of these activities in future years until there is some significant change in the character of the planned programs or some significant change in the understanding of the environmental effects which are expected.

B. BRIEF DESCRIPTION OF THE CONTINUING NTS TESTING PROGRAM

National policy supports a vigorous nuclear weapons research and development program as part of the national defense posture. Since the signing of the Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and Underwater, known as the Limited Test Ban Treaty, in 1963, the Atomic Energy Commission conducted a continuing program of underground nuclear testing at the Nevada Test Site, a site dedicated to this purpose. Under the Energy Reorganization Act of 1974, the Energy Research and Development Administration* became responsible for carrying out this research and development on the basis of nuclear weapons requirements developed by the Department of Defense. Nuclear weapon testing is planned to continue at the Nevada Test Site as a vital part of this research and development program, until the U.S. goal of an international agreement for discontinuance of test explosions is achieved. These tests, or experiments, support the Lawrence Livermore Laboratory, the Los Alamos Scientific Laboratory, and the Sandia Laboratories in the development of nuclear weapons in response to Department of Defense requirements and the development by ERDA of nuclear explosives for peaceful applications. Test site activities also support the Department of Defense testing of weapons effects.

* References to ERDA throughout this document also imply the Atomic Energy Commission (AEC) for actions prior to January 20, 1975.

I. SUMMARY (Cont.)

As of January 1, 1977, there have been 289 announced underground nuclear detonations at the Nevada Test Site since the signing in August 1963 of the Limited Test Ban Treaty. (Note: Not all of the tests conducted at the NTS during this time period have been announced.) It is expected that the underground nuclear testing program will continue at essentially this same pace. It is anticipated that the Threshold Test Ban Treaty will not materially influence the number of underground nuclear tests which are conducted each fiscal year.

The Nevada Test Site Containment Evaluation Panel (CEP) will continue to review each proposed test before emplacement of the device. The CEP is composed of individuals with extensive experience in nuclear testing. Members of the CEP are furnished by the Los Alamos Scientific Laboratory, Lawrence Livermore Laboratory, Department of Defense, U.S. Geological Survey, and Sandia Laboratories. Independent consultants in hydrology and phenomenology also participate in proceedings of the CEP. The CEP examines each factor which may contribute to unwanted escape of radionuclides to the atmosphere during or after the detonation. Such reviews consider the device yield, the depth of burial, the geology, the hydrology, the geologic medium properties, the location of the emplacement site (including the proximity to and the success of previous test locations), the phenomenology, the closure systems, the stemming design, and the drilling and construction history. This review is done to detect, where possible, man-made openings, natural weaknesses, or discontinuities in the medium or overlying rock which could compromise containment of the radioactive materials underground.

Since tests are conducted in a nonhomogeneous medium and involve complex phenomenology, there is no way of providing absolute assurance that no radioactivity will be released to the atmosphere. The chance of there being any substantial radioactive release is very small as has been demonstrated by recent experience. Even so, actions will be planned on each test to protect workers and the public in case any release does occur.

The Test Controller, designated by the Manager of the Nevada Operations Office, will continue to utilize the Test Controller's Advisory Panel made up of specialists in nuclear weapons testing, meteorology, radiation medicine, and biological effects, along with containment and other

I. SUMMARY (Cont.)

specialists as necessary, to provide advice about onsite or offsite effects which might be postulated to arise from each test. The Advisory Panel always meets the day before the planned detonation to review in detail the conditions of readiness and the preparations for onsite and offsite safety and population control. The Advisory Panel meets again a few hours prior to the detonation time for each test and continues in session until after completion of the test. A situation is hypothesized for each test which utilizes a model based upon a well-documented dynamic venting of radioactive material from the test cavity. If, under these assumed conditions, the meteorological parameters are such that it appears some population segment could be exposed to radiation exceeding the guidelines approved for underground nuclear test operations, the test is delayed until acceptable meteorological conditions prevail.

Closed areas will continue to be designated on the NTS for each nuclear test from which all personnel will be excluded except those few test-related personnel specifically authorized and assigned to manned stations by the Test Controller.

As a safety precaution, mobile radiation monitors will continue to be deployed offsite in those areas predicted to be downwind from the nuclear detonation in the unlikely event that radioactivity does escape. These monitors will continue to be prepared to take protective action if needed. Aerial surveillance will continue to be exercised above the test site to track any radioactive clouds.

As has been the case in previous years, the activities at the Nevada Test Site will continue to include a variety of both nuclear and nonnuclear projects and experiments wherein the ERDA laboratories and ERDA contractors, as well as other government organizations and their contractors, take advantage of the facilities available, the climate, the remoteness, and the controlled access of the Nevada Test Site. It is expected these will include:

I. SUMMARY (Cont.)

1. High-explosive tests (chemical explosives, nonnuclear) by the Department of Defense and others.
2. The Cane Springs Test Range continues to be used as a calibration range for experimental radiation detection systems.
3. Controlled releases of radionuclides will continue to be a necessary part of the experimental programs conducted at the ERDA farm on NTS by the Environmental Protection Agency.
4. The prompt critical nuclear reactor operated by the LLL (the "Super Kukla" reactor) will continue to be used periodically for irradiating materials and weapons components with short bursts of neutrons.
5. An exercise to test the national capability to respond to a nuclear accident.
6. The use of lasers will continue at the NTS primarily as a construction tool and particularly for alignment purposes. It is expected that other activities involving lasers will also be conducted.
7. NASA and LASL will continue to plan for tests of a uranium hexafluoride gas core reactor, probably contained within the Reactor Maintenance, Assembly and Disassembly (R-MAD) facility in Area 25, formerly known as the Nuclear Rocket Development Station (NRDS).
8. Experiments pointed toward the retrievable storage of commercial radioactive wastes deep underground in specific geological media will continue. These experiments are not to be confused with the actual storage of commercial high-level radioactive wastes at a designated facility.
9. Experiments leading toward the demonstration of the surface or near surface retrievable storage of unreprocessed spent fuel assemblies will be initiated in FY 1978. Initial demonstration of the storage of a small number of actual fuel assemblies will begin during the latter part of FY 1978. These experiments, R and D in nature, could be expanded to a prototype facility containing some 100 to 200 fuel assemblies in 1981, if the earlier demonstration program is successful.

I. SUMMARY (Cont.)

10. ERDA's Division of Biomedical and Environmental Research sponsors a CETO organization (acronym for Civil Effects Test Organization) on the Nevada Test Site. Individual- and team-sponsored investigators, primarily from a number of universities, have established over a hundred research areas scattered over the Nevada Test Site in the past 15 years. Ecological studies of the indigenous plant and animal life are conducted in these areas under both radiation and nonradiation conditions. These studies will continue.

The size, climate, and remoteness of the controlled areas of the Nevada Test Site and the Nellis Air Force Range, plus the presence of support organizations, appeal to a number of managers conducting programs through the government. From time to time, organizations investigate the suitability of the Nevada Test Site for other selected activities. For instance, ERDA presently is investigating the suitability of the Nevada Test Site for the interim storage of high-level commercial radioactive waste. This subject is discussed briefly in Section III.

C. PROBABLE ENVIRONMENTAL IMPACTS AND EFFECTS

The probable impact on the environment due to continued underground nuclear testing at the NTS will be small in comparison with the impacts of earlier testing in the atmosphere. This statement is based, in part, upon the experience gained from underground nuclear tests executed before and since the signing of the Limited Test Ban Treaty in 1963.

A large amount of radioactive material will continue to be created in the underground cavities formed by the nuclear detonations. In many cases, the ground above this cavity collapses, and, as a result, a subsidence crater forms on the surface above the detonation point. Cracking of the ground surface will also result, particularly in and around the subsidence crater. In the past, small displacements have occurred along zones of weakness in the rock (faults) resulting in visible steps at the surface. The main fault in Yucca Valley, the Yucca fault, has at one location experienced 0.46 meters (18 inches) of differential vertical displacement along with some smaller horizontal displacement at the surface since 1973. Motion at depth is unknown, but is expected to

I. SUMMARY (Cont.)

be smaller. The Carpetbag fault at northern Yucca Flat has experienced about 2 1/2 meters (eight feet) of differential vertical movement over about a hundred meters (330 feet) of its length in the same time frame. For some high-yield events, minor vertical movements have been noted along the faults at distances as much as a few kilometers away. Such offsets are not expected to extend offsite.

Since 1971, the nuclear testing program has maintained a satisfactory degree of competency and consistency for containing radioactivity underground both during and following the nuclear detonations. There have been no prompt ventings of radioactivity from test explosions since the BANEBERRY test, December 18, 1970. Other than seepage through diffusion of very minor amounts of noble gases, there have been no inadvertent releases of gaseous radioactivity which have been detected offsite since the DIAGONAL LINE event, November 24, 1971.

Ground shock waves emanate from underground nuclear explosions. These will be detected by sensitive seismic instruments hundreds and sometimes even thousands of miles away. At nearby communities, the ground motion from the high-yield detonations will be strong enough to cause some annoyance to people and minor nonstructural damage to property, such as plaster cracking and, in some cases, cracked windows. There have been three instances in which claims have been honored from detonations having an energy equivalent as low as 100 kilotons. Since the beginning of underground nuclear testing in 1961 and through December 1976, the cumulative total for valid damage claims from NTS testing has been $114,616.

Motion at the ground surface will be amplified at the upper stories of high-rise buildings which act as resonant vibrational systems. The number of high-rise buildings (nine stories and higher) in Las Vegas has been consistently increasing. Projecting ahead, it is expected that Las Vegas will have about 70 high-rise buildings by FY 1978 and the number probably will grow at a rate of near five per year thereafter. Many of these new buildings will have multiple high-rise towers.

The number of low-rise commercial and residential structures is presently increasing at the rate of about 550 per year. With this increase in exposure, the number of damage claims will probably increase in the future.

I. SUMMARY (Cont.)

The question of triggering damaging earthquakes through premature release of natural energy stored in the ground has been examined. The larger tests at the NTS produce seismic aftershocks, but these will be small in magnitude, and confined within about 14 kilometers of the explosion itself, and have no offsite damage potential. The likelihood of triggering an earthquake, which would represent a hazard to persons or property, is very remote.

As reported in previous environmental statements, substantial areas within the government-controlled land, comprising the Nevada Test Site and the Nellis Air Force Range, are contaminated with radioactive nuclides from atmospheric tests performed before the Limited Test Ban Treaty of 1963 and from nuclear cratering tests conducted prior to 1969. The nature and distribution of this radioactivity are discussed in Section II of this statement. It is not anticipated that test activities in FY 1978 and beyond will contribute radioactivity of any significance to this existing surface contamination inventory.

The vast preponderance of the radioactivity resulting from nuclear tests at the Nevada Test Site remains in deep underground locations. Subsequent to device detonation, one or more reentry holes are usually drilled back into the underground radioactive debris formed by the explosion. Samples of the debris will continue to be brought to the surface for radiochemical analysis to determine the device performance. During this sample recovery, small quantities of volatile radionuclides will be brought to the surface along with the debris sample. Several hundred curies of radioactive noble gases (primarily xenon-133) have been released per year in the past during routine drillback operations and tunnel ventilations. When possible, these gases will continue to be passed through high-efficiency filters and activated charcoal systems to trap particulate debris and radioiodine before being released to the atmosphere. Over the past two years, the xenon-133 concentrations detected offsite have been less than 0.01 percent of the Radiation Concentration Guides.

Noble gases such as krypton-85 may slowly seep to the surface from sites of underground explosions. Normally such seepage is not discernible within the variability of the low-level world background of krypton-85 produced by nuclear fuel reprocessing and by nuclear weapons testing which has taken place in the atmosphere.

I. SUMMARY (Cont.)

Tritium concentrations in local ponds on the NTS containing water removed or drained from tunnel operations where nuclear explosions have occurred will continue to be monitored in tne future. Typical tritium levels in the tunnel ponds are less than 10^{-3} microcuries per milliliter, the level given in the Radiation Protection Guide for drinking water for the general public. Air sampling data resulting from the operation of sample stations onsite have continued to show that the principal particulate radioactivity collected is due to natural sources and worldwide fallout. Annual average concentrations of all fission products in air samples are expected to be less than 1 percent of the Radiation Protection Guide for inhalation for the occupational populations involved.

Nevada Test Site background radioactivity from all sources in the principal work areas generally averages no more than 250 millirem per year (whole body). Typically, other areas in the southwestern United States average 130 millirem per year. There are presently 55 radiation exclusion areas (RADEX areas) on the Nevada Test Site which are fenced to limit access by employees. All areas where exposure rates could be greater than five millirem per hour are designated as RADEX areas.

Radioactive wastes will continue to be generated primarily from the decontamination and cleanup activities that follow the drillback activities during postshot operations. Other radioactive wastes will result from controlled releases of radionuclides at the NTS Experimental Farm, induced radioactivity from materials irradiated at the Super Kukla Burst Reactor Facility, and from disassembly of test elements and the decontamination of facilities after the proposed uranium hexafluoride gas core reactor tests. Radioactive materials and wastes generated from activities at some other ERDA and ERDA contractor installations will continue to be sent to the Nevada Test Site for storage or burial, whichever is appropriate. Such wastes will continue to be generated in the future and will be placed in dedicated and controlled waste disposal and storage areas as they have been in the past.

The amount of radioactivity existing in populated areas will continue to be monitored. That work currently is done by the Environmental Protection Agency's Environmental Monitoring and Support Laboratory (EMSL).

I. SUMMARY (Cont.)

Neither offsite nor onsite drinking water supplies have been or are expected to be contaminated by radioactivity from NTS activities. The buried radioactive waste inventory at each underground test site requires long-term surveillance and control. An extensive network of groundwater sampling points, both onsite and offsite, with modifications as necessary, will continue to be sampled on periodic schedules into the indefinite future. Except for those wells intentionally located in or very close to nuclear chimneys so as to intercept groundwater containing radionuclide debris, water samples from the long-term hydrologic network have shown no indications of radioactivity attributable to nuclear testing.

The underground nuclear testing program has little effect upon the terrestrial ecosystem. In addition to those already in existence, the subsidence sinks and ground cracks, described earlier, will cause some local disturbance to the vegetation by tearing the roots of some plants. These local disturbances provide sites for pioneer species, both native and exotic, to begin invasion in the disturbed areas. In some locations, these subsidence sinks act as catchment basins for rainfall and surface drainage water. This causes local soil changes due to erosion and accumulation of salts. The effects of these soil changes have not influenced the vegetation to any marked degree. Some of the larger events may cause rockfalls from the cliff faces of the mesas on the Nevada Test Site, which can affect the nearby vegetation, animals, and microorganisms. The animal investigation program, conducted for ERDA by the Environmental Protection Agency, will continue in the future. This program samples mule deer and other wild animals along with beef cattle from the herd maintained on the test site. Actually, the levels of certain radionuclides found in the animal tissue, such as cesium-137 and strontium-90 are lower than those found in animals in wetter climates.

Construction activities, which attend the fielding of underground nuclear tests and other testing activities, will disturb some hundreds of hectares per year of the surface terrain of the dry, sparsely vegetated Nevada Test Site. Temporary disturbances to the surface terrain of the NTS result from conventional engineering operations such as constructing access roads to test areas, drilling of emplacement holes, laying of cable runs, and installing and operating equipment to record conditions and effects of the detonations. In addition, the vegetation is occasionally damaged by accidental brush fires. Such features as roads, buildings, parking areas, and drill pads replace habitat formerly available to plants and animals in those

I. SUMMARY (Cont.)

localities. Most habitat disturbances, including those resulting from detonation and subsidence, as well as those associated with construction activities, will occur in areas disturbed by earlier tests. Temporary surface effects are minimized by removal of reusable and salvage value equipment, supplies, and structures. Disposal of construction debris and refuse in engineered sanitary landfills is accomplished in compliance with Federal air, land, and water pollution abatement requirements, so as to leave the testing areas clean and free of such materials. Following test operations, the affected surface areas slowly revegetate through the natural return of plant species.

D. UNAVOIDABLE ADVERSE ENVIRONMENTAL EFFECTS

The probable adverse environmental effects that cannot be avoided have been mentioned earlier. The important effects are the creation of additional subsidence craters and underground pockets of intense radioactivity onsite and the initiation of ground motion that may be felt offsite. While the ground motion from high-yield tests may cause some slight damage to offsite property, it is unlikely that the structural integrity of offsite structures would be degraded.

E. ALTERNATIVES

The possible alternatives to continued testing at the NTS are to stop, curtail, or delay testing; relocate all or part of the testing to another site; or acquire required information in other ways such as computer simulation. Stoppage, curtailment, or delay of the testing program would inhibit the development of nuclear weapons as a means for the maintenance of our national security, and the development of peaceful applications of nuclear explosives. The 1963 Limited Test Ban Treaty precludes alternatives such as testing in the atmosphere, ocean, or outer space. The development of another site for all or part of the underground testing of nuclear weapons in the yield range covered by this statement would not be practicable or desirable since the NTS is already well suited for and committed to this use. While computer simulation techniques are being used, it is not yet within scientific capability to do complete test simulation.

I. SUMMARY (Cont.)

Pursuance of any of these alternatives would not alter the requirement that there be controlled access to the NTS and continued exclusion of the public because of the health and safety aspects of existing radioactivity. If and when the Threshold Test Ban Treaty is ratified, it will provide for a yield limitation of 150 KT for individual underground nuclear tests. This limitation will not change the basic conditions under which nuclear testing is conducted, although it would reduce the potential for environmental impact due to the seismic motions generated by the detonations.

F. RELATIONSHIP BETWEEN SHORT-TERM USES AND LONG-TERM PRODUCTIVITY

Relationships between local short-term uses and long-term productivity are anticipated to remain essentially unchanged for the foreseeable future. The use of NTS for prospecting, mining, and some cattle grazing, as sporadically occurred prior to the advent of testing in 1951, has been stopped and would have to remain curtailed to some extent even if testing were terminated. No economically recoverable mineral resources have been found in those areas of NTS where testing has or will take place. There are no unresolved conflicts concerning alternative uses of available resources. No official request for public use of the NTS has been made, nor is such a request presently anticipated. This would not be prudent in the future for health and safety reasons.

G. IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

The presence of underground pockets of intense radioactivity and the formation of subsidence craters in those areas of NTS where testing has taken place will subject those areas to rigorous access control and use for the indefinite future. As a result of the test program, there is an expenditure of nuclear source materials. While it may be possible by expenditure of large amounts of time and money to restore some of the subsidence areas, at present there is no practical way known to remove the underground pockets of radioactivity or to recover source material. The curtailment in the use of these NTS areas for other purposes should cause no adverse impact on local or national needs for the foreseeable future. Potential mineral resources are not in NTS areas where testing has or will take place. It is not anticipated that any such potential resources will be irreversibly committed to NTS activities or become irretrievable in the future.

I. SUMMARY (Cont.)

H. COST/BENEFIT ANALYSIS

The environmental impacts discussed in Section IV translate to costs in terms of subsidence craters, pockets of underground radioactivity, direct ground motion, and contamination by plutonium and other radionuclides in isolated areas. In addition, 1,350 square miles of land are denied for other uses.

These environmental costs are balanced against the contribution made by nuclear testing to the established policy of the United States to maintain a strong nuclear force to discourage attack by any potential aggressor. In addition, underground nuclear testing contributes to the development of nuclear explosives which may be utilized for peaceful purposes.

Benefits derived from other activities conducted on the NTS are contributions to high-explosive technology, nuclear detection capabilities, the knowledge of disposal techniques for radioactive wastes, and the knowledge of the effects of radioactivity on man, his food chains, and his environment.

SECTION II

BACKGROUND

A. NEED FOR NUCLEAR WEAPONS TESTING

In order to provide for the nation's common defense and security, it is the policy of the United States to maintain a strong nuclear force to discourage attack by any potential aggressor. The first section of the U.S. Atomic Energy Act of 1946 (amended in 1954) stipulates:

> "The development, use, and control of atomic energy shall be directed so as to make the maximum contribution to the general welfare, subject at all times to the paramount objective of making the maximum contribution to the common defense and security."

Under the Atomic Energy Act the Atomic Energy Commission (AEC) was responsible for conducting experiments and doing research and development work relative to nuclear weapons, and for producing nuclear weapons. The AEC carried out these responsibilities on the basis of nuclear weapons requirements developed by the Department of Defense (DOD) in support of stated United States policies and in accordance with prerequisite Presidential direction and approval. Under the Energy Reorganization Act of 1974, the Energy Research and Development Administration (ERDA) officially established on January 19, 1975, is now responsible for carrying out this research and development program, and continues to do so based upon nuclear weapons requirements developed by the Department of Defense.

It is within the framework of national policy that ERDA continues with an active research and development program on various nuclear weapons systems. Clearly, the maintenance of an assured deterrent against a nuclear attack on our country has long been recognized as our first defense priority.

In August 1963, during the ratification of the Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outerspace, and Underwater (i.e., the Limited Test Ban Treaty), the Chairman of the Senate Foreign Relations Committee was given assurance from the President that four safeguards to the national security would be implemented under the joint responsibility of the Atomic Energy Commission and the DOD (Reference 5). In their entirety, these four safeguards were as follows:

II. A. NEED FOR NUCLEAR WEAPONS TESTING (Cont.)

Safeguard A

"The conduct of comprehensive, aggressive, and continuing underground nuclear test programs designed to add to our knowledge and improve our weapons in all areas of significance."

Safeguard B

"The maintenance of modern nuclear laboratory facilities and programs in theoretical and exploratory technology which will attract, retain, and insure the continued application of our human scientific resources to these programs on which continued progress in nuclear technology depends."

Safeguard C

"The maintenance of the facilities and resources necessary to institute promptly nuclear tests in the atmosphere should they be deemed essential to our national security or should the treaty or any of its terms be abrogated by the Soviet Union."

Safeguard D

"The improvement of our capability, within feasible and practical limits, to monitor the terms of the treaty, to detect violations, and to maintain our knowledge of Sino-Soviet nuclear activity, capabilities, and achievements."

The United States program to maintain the capability expressed in Safeguard C above has recently been modified as follows: "The maintenance of the basic capability to resume nuclear testing in the atmosphere should that be deemed essential to national security." The modification reflects the fact that the urgency associated in 1963 with a need to resume promptly our then curtailed atmospheric test plan has been gradually, but substantially, moderated by successful underground testing, expanded simulation programs, improved international relationships, and changing national priorities.

II.A. NEED FOR NUCLEAR WEAPONS TESTING (Cont.)

These safeguards are closely interrelated. Without testing, an effective weapons laboratory program could not be maintained; likewise, without a modern laboratory program, it would be difficult, if not impossible, to maintain an effective testing program.

The DOD is responsible for establishing nuclear weapons criteria, developing and producing delivery vehicles, obtaining military effects data, and defending the United States against nuclear attack. A principal point of field coordination between ERDA and the DOD is the Nevada Test Site (NTS). The Test Directorate, Field Command, Defense Nuclear Agency (DNA), represents the DOD, and the Nevada Operations Office (NV) represents ERDA in the field for the planning and execution of all tests, whether at the NTS or other designated test locations within the United States. Each of these organizations' primary interest is the field testing of nuclear weapons.

Weapon systems do not remain static. The technology utilized continually changes. The continuing advancement of the United States' technology has been the direct result of the efforts of three laboratories established by the AEC for the specific purpose of conducting research and development activities relating to nuclear weapons: two nuclear laboratories are the Los Alamos Scientific Laboratory (LASL) at Los Alamos, New Mexico, and the Lawrence Livermore Laboratory (LLL) at Livermore, California, both of which are operated by the University of California; the third is the Sandia Laboratories (SL), with major facilities at Albuquerque, New Mexico, and Livermore, California, operated by the Western Electric Company, where weapon systems research and development work mainly relates to nonnuclear portions of nuclear weapons.

These laboratories, as separately established research and development entities, employ independent approaches to weapons development. These approaches are responsive to the basic guidance the laboratories receive from ERDA Headquarters, which in turn is responsive to the expressed needs of the DOD, and provide the necessary flexibility to adjust schedules and priorities with particular emphasis on promising areas of endeavor and on problem areas as the need arises.

All research and development organizations engage in some form of experimentation as a means of verifying theories and concepts. In the weapons development program, most of the experiments are

II.A. NEED FOR NUCLEAR WEAPONS TESTING (Cont.)

nonnuclear and are done at the laboratories' own facilities. The nuclear test must be regarded as an endpoint in a particular experimental chain for which no alternatives exist. As such, it is an essential component of the chain, but it is no more essential than the nonnuclear tests which have preceded it. (See Figure II-1.)

Without nuclear tests, some weapons systems would be infeasible and compromises would have to be made in the design of others. Pressures, temperatures, radiation fluxes, and other characteristics of nuclear explosions cannot be determined solely by laboratory experiments or by computer calculation. In the past, field tests have revealed or permitted evaluation of defects which otherwise could have led to serious doubts about the reliability of the national weapons stockpile.

In addition to the testing of nuclear weapons, the testing of nuclear explosives for peaceful purposes is provided for under Section 31 of the Atomic Energy Act of 1954. Research on the use of peaceful explosion technology is now a part of ERDA's Nuclear Explosive Applications program, formerly known as the Plowshare program. This program is consistent with United States undertakings under Article V of the Treaty on the Nonproliferation of Nuclear Weapons.

Future underground nuclear detonations may be conducted in new locations at the Nevada Test Site where the geologic medium is different from that of previous tests. Agreements made with regard to the exchange of information with the Soviet Union under the terms of the Threshold Test Ban Treaty may require the United States to provide specific information about such tests, such as location, yield, depth of burial, and properties of geologic media. These tests would serve to calibrate international teleseismic stations used to verify compliance with the treaty provisions.

The National Policy supports a vigorous nuclear weapons research and development program as part of the national defense posture. Under the Energy Reorganization Act of 1974, the Energy Research and Development Administration (ERDA) is responsible for carrying out this research and development on the basis of nuclear weapons requirements developed by the Department of Defense.

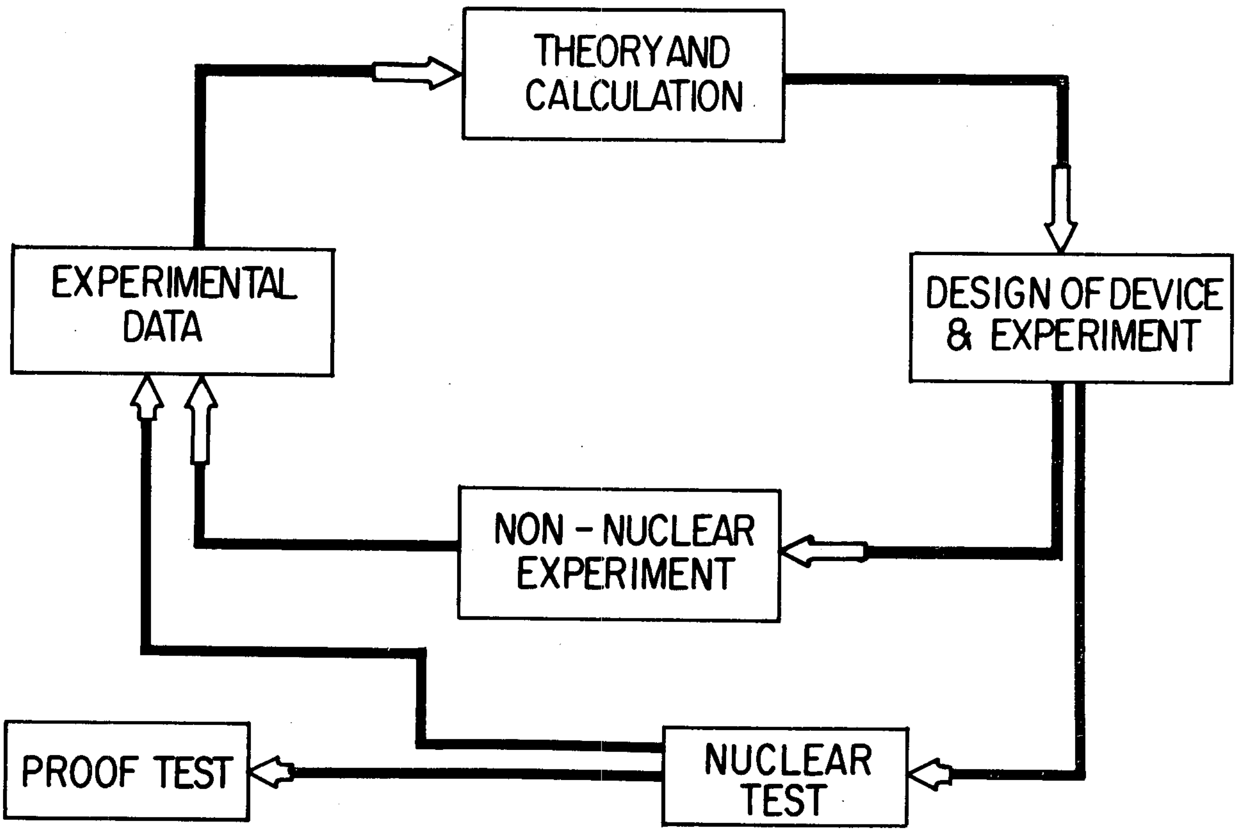

FIGURE II-1 WEAPONS DESIGN LOOP

II.A. NEED FOR NUCLEAR WEAPONS TESTING (Cont.)

Nuclear weapons testing will continue to be conducted at the Nevada Test Site as a vital part of this research and development program until the U.S. goal of an international agreement for discontinuance of test explosions is achieved. Whenever possible, a single nuclear test will be used to achieve several goals or to obtain information relevant to several different weapons programs of related design, so as to reduce the number of tests that will be necessary.

The continuing goals of ERDA's nuclear weapons program are: to develop new nuclear weapons to meet specific Defense Department requirements; to foster continuing advancement in nuclear weapons technology so that alternatives for meeting new military circumstances will be available; to contribute to the maintenance of a viable stockpile of weapons that can be stored and handled safely; to further the understanding of nuclear explosion effects; and to aid in the analysis of the threat from other nations' capabilities. These goals can only be achieved through a comprehensiv program of research and development. Nuclear tests are an integral part of the current nuclear weapons research and development process, and ERDA believes they continue to be essential to the achievement of its goals.

As of January 1, 1977, there had been 289 announced underground nuclear detonations at the Nevada Test Site since the signing in August 1963 of the Limited Test Ban Treaty. Based on current policy, it is expected that the underground nuclear testing program in FY 1978 and beyond will continue at essentially the same level of testing. The Treaty on the Limitation of Underground Nuclear Weapons Tests, commonly known as the Threshold Test Ban Treaty, was signed by President Nixon and General-Secretary Brezhnev on July 3, 1974. This treaty, if and when ratified by the U.S. Senate, will preclude individual weapons tests having a yield greater than 150 kilotons (KT). On May 28, 1976, President Ford and General-Secretary Brezhnev signed a companion treaty imposing the same 150-KT limit on individual underground nuclear explosions for peaceful purposes and a total of 1.5 megatons (Mt) for any group of individual explosions. In the interim, the United States has announced its intention to abide by the yield limits of the treaties pending their entry into force. However, the capability to test nuclear devices up to one megaton in yield at the Nevada Test Site remains unchanged. It is not anticipated that the Threshold Test Ban Treaty will materially influence the total number of tests which are conducted.

II.B. LOCATION

B. LOCATION

The Nevada Test Site is located in Nye County in southern Nevada, with its southernmost point about 100 kilometers (65 miles) northwest of Las Vegas. (See Figure II-2.) The site contains 3,500 square kilometers (1,350 square miles) of Federally owned land with restricted access, and varies from 46-56 km (28-35 miles) in width (east-west) and from 64-88 km (40-55 miles) in length (north-south).

It is significant to note that the Nevada Test Site is bordered on three sides by 10,700 square kilometers (4,120 square miles) of land comprising the Nellis Air Force Range*, another Federally owned, restricted area (see Figure II-2). This restricted area provides a buffer zone to the north and east between the test areas and public lands: this buffer zone varies from 24-104 km (15-65 miles) between the test area and land that is open to the public. A northwestern portion of the Nellis Air Force Range is occupied by the Tonopah Test Range, an area of 1,615 square kilometers (624 square miles). This government-owned facility is operated for ERDA by the Sandia Laboratories primarily for airdrop tests of ballistic shapes (Reference 6). The combination of the Tonopah Test Range, the Nellis Air Force Range, and the Nevada Test Site is one of the largest unpopulated land areas in the United State, comprising some 14,200 square kilometers (5,470 square miles).

Figure II-3 shows the general layout of the Nevada Test Site, and identifies some of the areas within the site referred to in this statement. The shaded areas indicate principal areas used for underground testing.

Mercury is the main base camp at NTS and is shown in Figure II-4. The camp provides general support facilities and overnight accommodations for 960 persons.

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* The official name is: The Air Force Tactical Fighter Weapons Center Range Complex. It is also known as the Nellis Bombing and Gunnery Range.

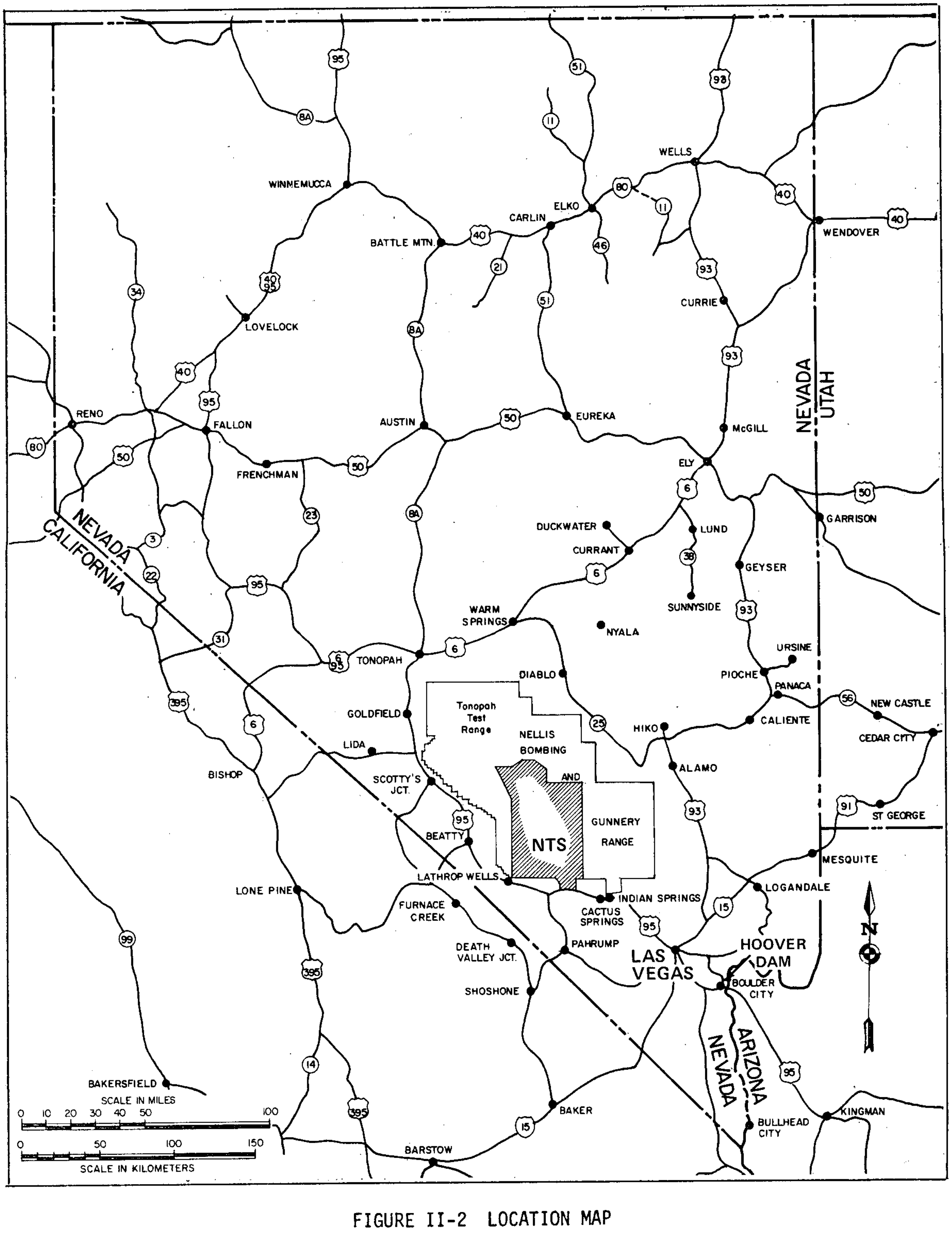

FIGURE II-2 LOCATION MAP

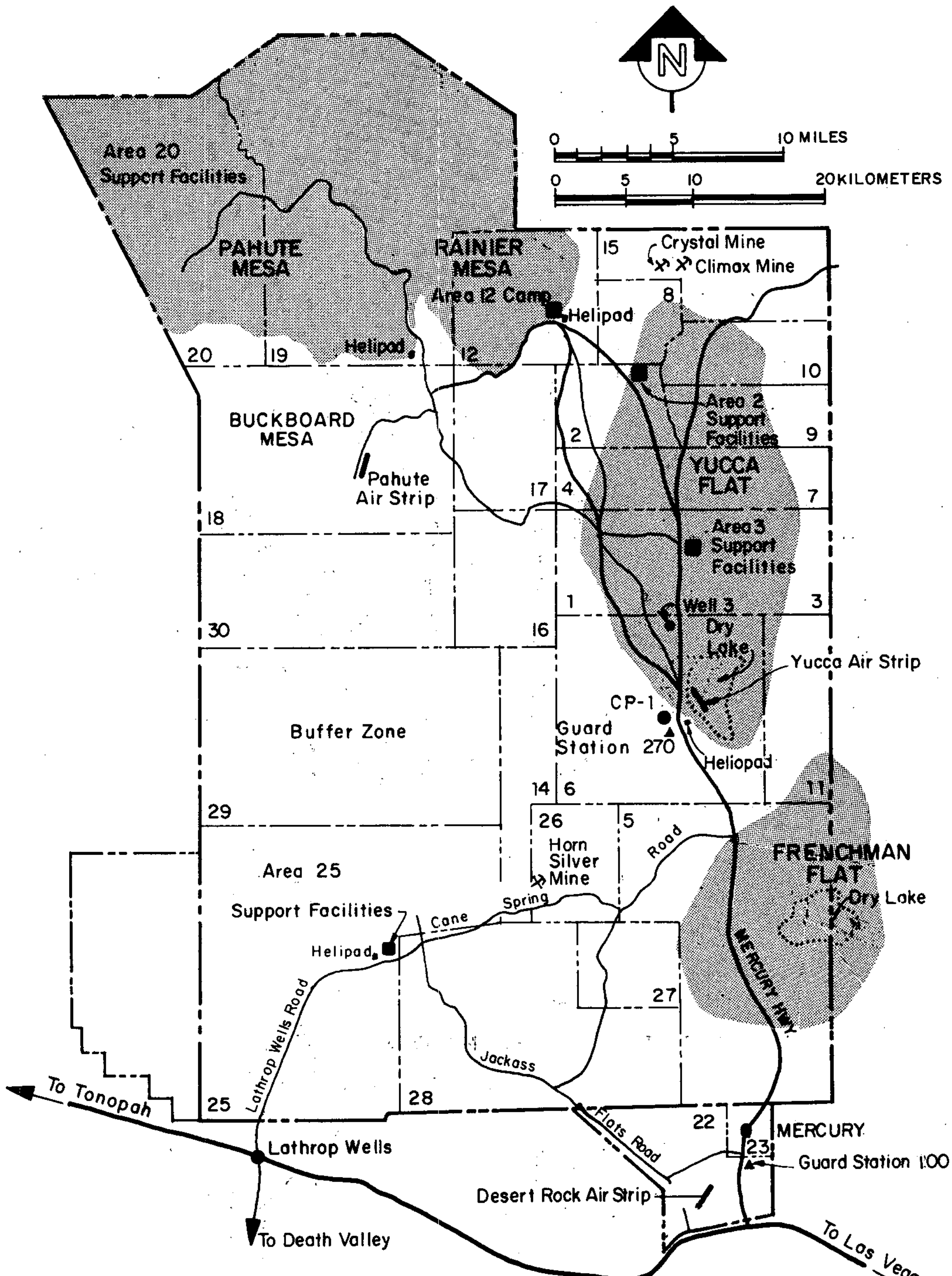

FIGURE II-3 NEVADA TEST SITE

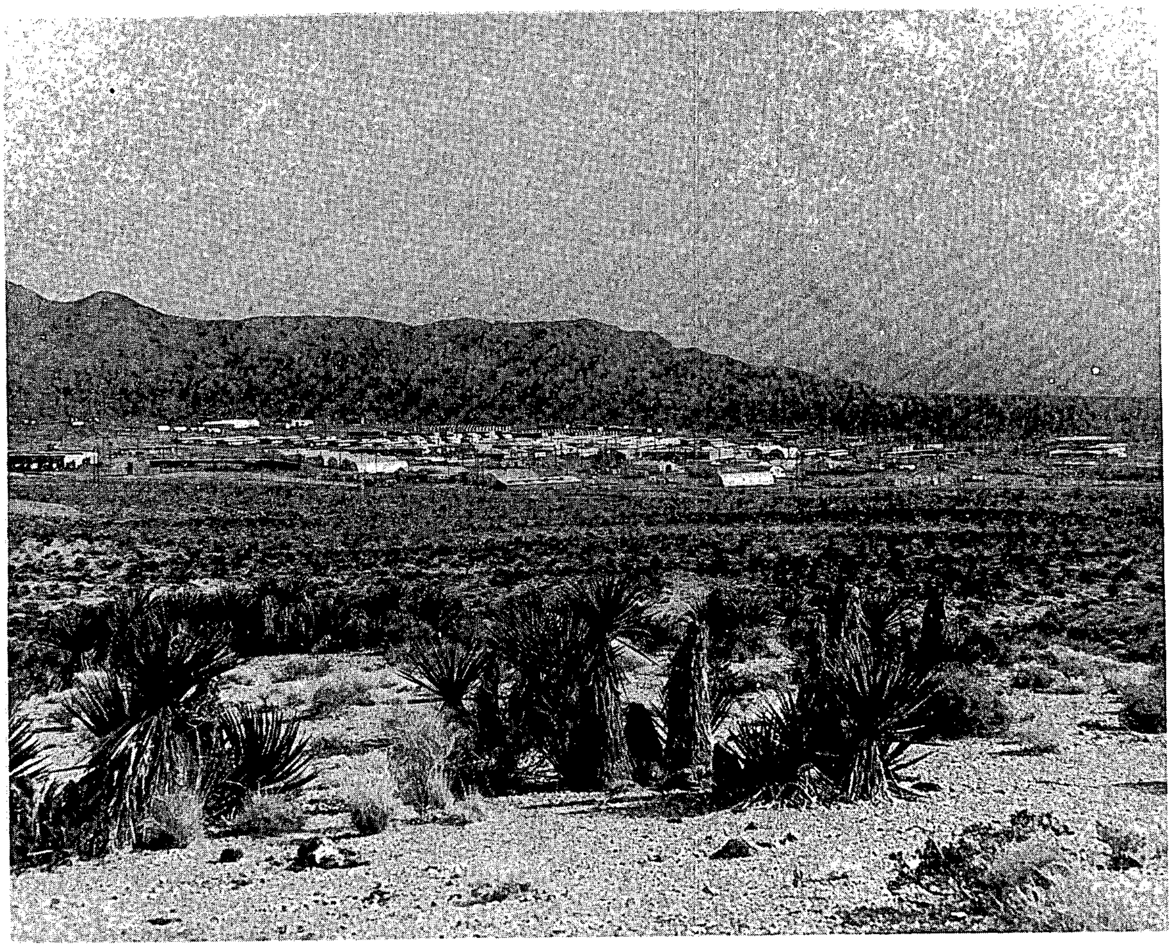

FIGURE II-4 MERCURY, NTS MAIN BASE CAMP

II.C. HISTORICAL BACKGROUND OF NTS

C. HISTORICAL BACKGROUND OF NTS

A review of the history of the Nevada Test Site is valuable both as a tool to assist in establishing the present environmental conditions and for predicting environmental disturbances in the future at the site.

1. Pre-1951

Use of the NTS areas prior to 1951 mainly comprised mining, grazing, and hunting. Two inactive mining districts, Oak Spring and Wahmonie, lie wholly or partially within the borders of the NTS. Oak Spring District occupied part of the northeast corner of the test site and included at least two onsite properties, the Climax Mine and the Crystal Mine, when the NTS was established (Area 15, Figure II-3). Prospecting and exploration started before 1905, and numerous small pits, shafts, and tunnels at higher elevations remain as evidence of sporadic activity which continued until NTS was established. Most of the prospects are at locations showing slight mineralization and low values in copper, lead, silver, gold, or mercury.

In 1937, low-grade tungsten ore was found in the Oak Spring mining district near the northeast corner of NTS. This small deposit was outlined as Climax and Crystal ore bodies (Figure II-3) by drilling and exploration conducted in 1940. Significant production of ore did not occur until 1956 when high tungsten prices permitted economic extraction of most of the ore. After 10 years of co-use during the period of atmospheric testing at the NTS, the mining claims were acquired by the government through routine condemnation procedures and the owners reimbursed. The workings have since remained in disuse.

The Wahmonie District, located in south central NTS, was prospected about 1905 for gold and silver ores. No production occurred until 1928 when a high grade silver-gold ore was rediscovered at the Horn Silver mine located in Area 26 (Figure II-3). This resulted in minor shipments of ore and caused an influx of 1500 people into Wahmonie. However, after several shafts and extensive prospecting in the area revealed no additional ore finds, interest rapidly waned and the town was abandoned by the summer of 1929.

II.C. HISTORICAL BACKGROUND OF NTS

1. Pre-1951 (Cont.)

In addition to these developments, there is evidence of sporadic prospecting throughout the Nevada Test Site. Disruption of the landscape by mining and prospecting was locally severe, but the total impact of these activities on the environment has been slight. Extensive geologic investigations made by the U.S. Geological Survey using samples taken from exploratory drill holes, emplacement holes, and tunnels in the areas used for nuclear testing have revealed no mineral deposits which would be economically recoverable considering today's mineral requirements. Other areas of the test site have been extensively mapped and investigated by the Geological Survey, but other than the deposits in the mining districts mentioned above, no additional qualifying mineral deposits have been found.

The NTS area was used for cattle grazing, and waterholes were developed and cabins and corrals built at several points on the site. Water and grazing rights of two ranches operating on what is now NTS were acquired by the government in 1955 by negotiated purchase. Impact of the grazing industry on the environment, prior to the establishment of the NTS, was evidently small and is now indiscernible.

2. Selection of NTS

In the years immediately following World War II, nuclear weapons tests were conducted in the atmosphere or underwater. Before 1951, all of this work was done at remote Pacific island sites in order to minimize any damage to property or to man. Testing at those distant sites required an extensive logistic effort and an inordinate amount of time. When weapons development was accelerated in 1949 and 1950 in response to the national defense policy it became increasingly clear that, if nuclear weapons could be tested safely within the continental boundaries, weapons development lead times would be reduced and considerably less expense incurred. This would be true particularly for the smaller nuclear weapons. At that time, a number of sites throughout the continental United States, including Alaska, were considered on the basis of low population density, safety, favorable year-round weather conditions, security, available labor sources, reasonable accessibility including transportation routes, and favorable geology. Of all the factors, public safety was considered the most important. After review of known

2. Selection of NTS

information about fallout, thermal, and blast effects, it was determined that under careful controls, an area within what is now the Nellis Air Force Range could be used for relatively low-yield nuclear detonations with full assurance of public safety.

Originally, 1,760 square kilometers (680 square miles) were withdrawn under Public Land Order 805 dated February 19, 1952, for nuclear testing purposes from an area used by the Air Force as a bombing and gunnery range. This resulted in the formation of approximately the eastern half of the present Nevada Test Site. The predominant features of this area are the closed drainage basins of Frenchman Flat and Yucca Flat where the early atmospheric tests were conducted. The main Control Point was located and remains on the crest of Yucca Pass between these two basins (Figure II-3). Additional land withdrawals in 1958, 1961, and 1964 added to the site, and with the use of Pahute Mesa area aquired by Memorandum of Agreement with the Department of Defense in 1967, provide its present size of about 3,500 square kilometers (1,350 square miles)."

Although the NTS was originally selected to meet criteria for atmospheric tests, it also has proved satisfactory for underground tests. In the years before the selection of the NTS, there had been searches for other areas suitable as alternative sites. For tests of the yields considered in this environmental statement up to one megaton and for those of somewhat higher yield, the NTS continues to be the most suitable area and provides an established facility in a location remote from population centers. The geologic media at the explosion sites permit the placement of nuclear devices at sufficient depth for proper containment and control of radiation. The water table is relatively deep and water movement is very slow. Weather conditions permit a year-round testing program.

3. Post-1951

Construction of the Nevada Test Site facilities began on January 1, 1951. Operation RANGER was the first series of tests for which the Nevada Test Site was utilized. The first test was of a one-kiloton device which was airdropped and detonated on January 27, 1951, in Frenchman Flat.

II.C. HISTORICAL BACKGROUND OF NTS

3. Post-1951 (Cont.)

Subsequently, there were various nuclear tests, mostly in the atmosphere, fired at the NTS. Some tests were positioned for firing by airdrop, but steel towers were used for many Nevada tests at heights ranging from 100 to 700 feet above the ground surface. In 1957 and 1958, helium-filled balloons, tethered to precise heights and locations (450 to 1,500 feet above ground), provided a simpler, quicker, and less-expensive method for the above ground testing of many experimental devices.

After 1951, nuclear test series were carried out alternately at the Nevada Test Site and at Pacific test locations. Testing at that time was conducted on an intermittent task force basis at both the Nevada Test Site and in the Pacific and continued in that mode until October 1958.

On October 31, 1958, the United States and Russia entered into a voluntary test moratorium which lasted until the U.S.S.R. resumed testing on September 1, 1961. After resuming the U.S. test program at the NTS on September 15, 1961, the Atomic Energy Commission revised its mode of operations from an intermittent annual activity to a continuing year-round program.

From 1951 until early 1962, all nuclear tests at the NTS were under the management of the AEC's Albuquerque Operations Office. Because of the significantly increased activities resulting from the resumption of weapons testing in the fall of 1961, the Nevada Operations Office (NV) was established in Las Vegas on March 6, 1962. NV was assigned the AEC's responsibilities for nuclear detonation programs at the NTS, as well as at all other United States test sites. The Nevada Operations Office is now a part of the Energy Research and Development Administration.

Since the establishment of the Nevada Test Site in 1951 up until the beginning of January 1977, there have been 472 announced nuclear tests conducted at the Nevada Test Site. All atmospheric tests and Plowshare program tests conducted at the Nevada Test Site have been announced. Underground nuclear tests that may cause significant ground motion are announced in advance to news media as a safety precaution, so that persons in communities nearby may avoid being in a hazardous location at the time of detonation. Other tests are announced after they have been conducted. Some tests with low yields are not announced.

II.C. HISTORICAL BACKGROUND OF NTS

3. Post-1951 (Cont.)

Eighty-four of the 472 announced tests were atmospheric detonations conducted before the signing of the Limited Test Ban Treaty (LTBT) in August 1963. If cratering experiments are excluded, all but four (small surface tests) of the atmospheric detonations occurred prior to the 1958 moratorium. The first full-scale nuclear detonation, which was designed to contain all radioactivity underground, was fired at the Nevada Test Site in 1957 in a sealed tunnel. Since late 1962, the United States has conducted all of its nuclear weapons tests underground.

A nuclear cratering device, code named DANNY BOY, was detonated on Buckboard Mesa on the western portion of the test site in 1962 as a military experiment for the Department of Defense. Three of the four small atmospheric (surface) tests mentioned above were also conducted on the flats just to the east of Buckboard Mesa and one, SMALL BOY, was conducted in Frenchman Flat for the DOD in 1962. Thereafter, nuclear cratering tests were conducted as part of the peaceful applications (Plowshare) program. There have been six such experiments (Reference 7), three of which are mentioned here. The first and largest was SEDAN, a 100-kiloton explosion on July 6, 1962, which created a huge crater in the alluvium of Area 10 roughly 340 meters (1,115 feet) across and 98 meters (320 feet) deep. The BUGGY experiment, conducted to the south of Buckboard Mesa in Area 30 in 1968, employed five nuclear devices, each having a yield of about one kiloton, fired simultaneously to produce a ditch (simulated canal) 77 meters (254 feet) across, 261 meters (855 feet) long, and 20 meters (65 feet) deep. One small device (SULKY) with a yield equivalent to 92 tons of TNT (not kilotons), buried 90 feet in basalt, failed to produce a crater.

Except for the atmospheric tests and the cratering tests such as those mentioned above, the remaining announced tests have all been designed to be contained underground in tunnels and drilled holes (see Section III.A.1.). These have been detonated for a variety of reasons. Three have been detonated in support of the Vela Uniform program to improve long-range seismic detection techniques. Six were jointly conducted US-UK tests of United Kingdom devices. Fourteen have been device development tests for potential peaceful applications (Plowshare program). Some were for research to collect scientific data to better understand the physical principles involved in nuclear explosions. New and untried designs for a given weapon concept have been explored. More advanced development has occurred, such as determining the interaction between two or more demonstrated components. Proof testing of actual warhead designs has been carried out to determine the reliability before such designs are added to the national stockpile.

II.C. HISTORICAL BACKGROUND OF NTS

3. Post-1951 (Cont.)

Safety tests were conducted on certain designs to test the vulnerability to possible accidents. Weapons effects tests have been conducted for the Department of Defense (for the most part in tunnels) to determine the effects produced by specific weapon outputs upon various military systems and components. Often, one nuclear experiment can be designed to serve two or more purposes. The broad scope of the nuclear experiments conducted in the past typified the character of the necessary research, development, and proof testing program.

Although the major effort at the Nevada Test Site has been in nuclear weapons-related testing, the activities have included a variety of both nuclear and nonnuclear projects wherein the ERDA laboratories, ERDA contractors, as well as other government agencies and their contractors have taken advantage of the facilities available, the climate, the remoteness, and the controlled access of the test site. Many of these programs are continuing and will be described further in Section III.

The 465 meters (1,527 feet) BREN (Bare Reactor Experiment--Nevada) Tower located in Area 28 at the NTS comprises a flexible radiation study facility where a variety of experiments have been performed since 1962. The facility consists of a guyed, open-framed steel tower, and is used to position a radiation source for use in studies done for the AEC's Division of Biology and Medicine (now ERDA's Division of Biomedical and Environmental Research). This facility has been used to conduct neutron and gamma ray interactions over a variety of geometric configurations in air, ground, shielding materials, shielded vehicles; and with tissue equivalent simulations, electronic components, and live organisms. A 14-MeV neutron generator was once mounted on the side of the BREN Tower. It was capable of being hoisted to seven different levels where power and control cable hookup stations are located. A control bunker housed the accelerator controls and instrumentation for the various experiments. Access to the upper levels of the tower is provided by a two-man personnel cage on an eight-ton capacity freight elevator. In the past, meteorological sensors have been installed at various elevations in support of both operational and research activities. The tower also has been the site of laser scintillation experiments, small missile launch tests, and a complex series of sonic boom experiments. The Air Force Cambridge Research Laboratories have calibrated acoustic sounding equipment by comparison with weather instrumentation mounted on the BREN Tower. This experimental acoustic sounder would remotely measure low-level atmospheric parameters.

II. C. HISTORICAL BACKGROUND OF NTS

3. Post-1951 (Cont.)

As a part of the program to develop methods for predicting building response to ground motion, two identical four-story reinforced concrete test structures were constructed in Area 1. Between 1966 and 1973, structural response measurements were recorded for 42 underground nuclear experiments. These structures were also subjected to a series of low-amplitude dynamic tests for gathering engineering data on the response of structures to ground motion both with and without nonstructural infill walls and partitions (References 8, 9, 10, and 11). By 1973, after sufficient low-amplitude data had been accumulated, high-amplitude, destructive-level testing was conducted on one of these structures. These tests were carried out in 1974 and the results published in Reference 12.

A herd of range cattle has been maintained onsite since the mid-1950's and an experimental dairy farm in Area 15 has been operated since the early 1960's. Levels of radionuclides in these experimental herds are monitored as part of the routine radiological surveillance program. Data from experiments with animals taken from these herds are being used to improve human-dose prediction models and to furnish information on the effectiveness of protective actions which may be taken to reduce the amounts of radionuclides getting into human food under various contaminating situations.

In addition to its other responsibilities, beginning in FY 1974, the Nevada Operations Office became responsible for the custody and administration of the geographical area and the facilities at the former Nuclear Rocket Development Station (NRDS) which had been administered by the Joint NASA-AEC Space Nuclear Systems Office. The NRDS occupied the southwest corner of the Nevada Test Site, and is now known as Area 25. (See Figure II-3). Area 25 contains some $140 million of specialized facilities: (1) nuclear reactor/engine/nuclear furnace test stands (known as ETS-1, Test Cell C, and Test Cell A), (2) engine maintenance, assembly, and disassembly building (known as E-MAD), (3) reactor maintenance, assembly, and disassembly building (known as R-MAD), (4) radioactive material storage facility (known as RMSF), and (5) other support facilities.

Twenty experimental reactor/nuclear engine/nuclear furnace tests have been conducted in this area since 1959. A more complete description of the test history, the facilities, and the environmental considerations is given in the environmental statement for NRDS (WASH-1508) (Reference 13). The program activity under NASA terminated in 1973.

Residual and partially expended nuclear fuel elements from the NRDS test program were part of the inventory that was turned over to the custody of the Nevada Operations Office, in addition to the radioactive waste storage areas. The nuclear rocket engine test program was terminated and no future engine tests are contemplated. The primary activities in Area 25 accomplished by the Nevada Operations Office included the disassembly of residual reactors, nuclear engines, and the preparation of fuel elements for shipment to the Idaho Nuclear Engineering Laboratory (INEL).

In Area 26 (also known as Area 401), the Lawrence Livermore Laboratory conducted six experimental tests involving development of a nuclear reactor for a ramjet engine as a part of Project Pluto. Between 1961 and 1964, four tests of the so-called Tory II-A and two tests of the Tory II-C nuclear reactors were conducted. A radioactive leach field was constructed adjacent to the disassembly building to handle radioactive liquids resulting from these tests. This field is some 250 feet by 260 feet. occupying an area of about 6,300 square meters, and appropriately fenced and marked. Some remaining materials from these tests are currently stored in the E-MAD and R-MAD buildings in Area 25. The radioactive fuel elements are to be shipped to the Idaho Nuclear Engineering Laboratory. This effort will extend into FY 1978 and is further mentioned in Section III.

Those facilities not being used for the expended fuel recovery program are presently held in caretaker status, pending determination of future use. Section III of this environmental statement includes three such proposed uses for these facilities.

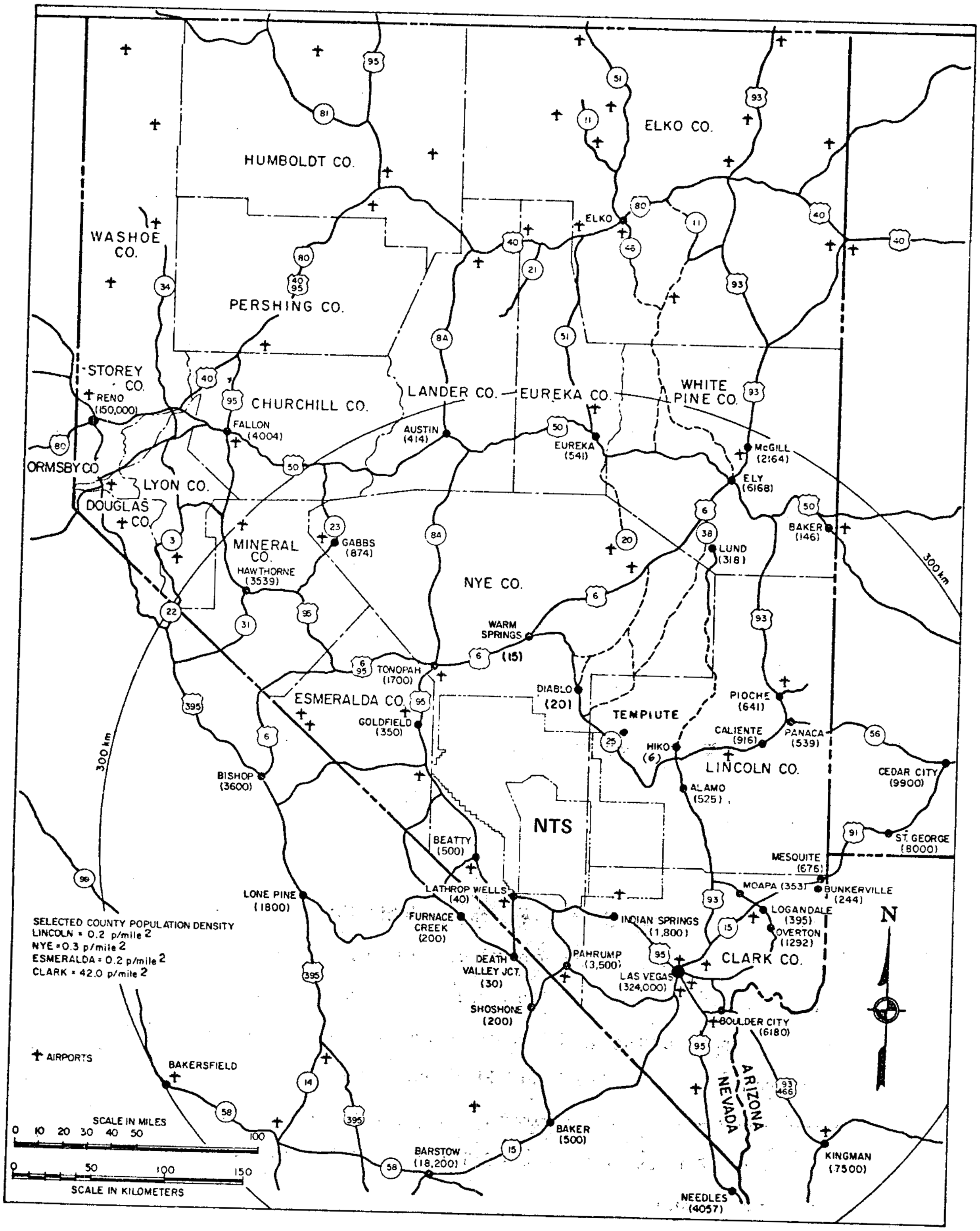

FIGURE II-5 POPULATION MAP

II.D. THE EXISTING ENVIRONMENT

D. THE EXISTING ENVIRONMENT

1. Surrounding Environs

a. Population Distribution

Figure II-5 indicates the populations in and around the cities, towns, and settlements Surrounding the NTS. The population figures used herein are 1975 estimates based upon earlier censuses. With the exception of Las Vegas and vicinity, there are no major population centers within 300 kilometers (186 miles) of the site. There are about 540,000 people living within the total area described by a 300 kilometer radius, including parts of California; about three-fifths of these live in the Las Vegas greater metropolitan area. If greater Las Vegas is not considered in determining population density, there are about 0.7 people per square kilometer (1.8 people per square mile) within the 300-kilometer radius of the NTS Control Point. For comparison, the United States (50 states) has a population density of 22 people per square kilometer and the overall Nevada average is 1.5 people per square kilometer (3.9 people per square mile).

The closest offsite areas within about 80 kilometers (50 miles) of the NTS are predominantly rural. A number of small communities are located within this area, the three largest being Indian Springs, Beatty, and Pahrump Valley. Pahrump Valley is a rural community with an estimated population of about 3,500 and is located about 72 kilometers (45 miles) south of the NTS. Indian Springs, with a population of 1,800, is located on Highway 95 near Indian Springs Air Force Auxiliary Field and is only 24 kilometers (15 miles) from the nearest border of the NTS. Beatty, with a population of about 500, is located about 30 kilometers (18 miles) west of the NTS boundary. (Beatty Township has a population of about 1,100.)

In the adjacent states, the Mojave Desert of California, which includes Death Valley National Monument, lies along the southwestern border of Nevada. The population within the Monument boundaries varies considerably from season to season, with fewer than

II.D. THE EXISTING ENVIRONMENT

1. Surrounding Environs - a. (Cont.)

200 permanent residents and tourists in the area during any given period in the summer months. However, during the winter, as many as 12,000 tourists and campers can be in the area on any particular day during the major holiday periods. The largest town in this general area is Barstow, California, located 233 kilometers (145 miles) south-southwest of the NTS, with a population of about 18,200. Baker, California, with a population of about 500, lies directly south of NTS, about 160 kilometers (100 miles). The Owens Valley, where numerous small towns are located, lies about 100 kilometers (60 miles) west of Death Valley. The largest town in Owens Valley is Bishop, California, located 225 kilometers (140 miles) west-northwest of the NTS, with a population of about 3,600.

The extreme southwestern region of Utah is more developed than the adjacent part of Nevada. The largest town, in that area, Cedar City, with a population of approximately 9,900, is located 265 kilometers (165 miles) east-northeast of the NTS. St. George, located 217 kilometers (135 miles) east of the NTS, has a population of about 8,000.

The extreme northwestern region of Arizona is mostly undeveloped range land, with the exception of that portion in the Lake Mead National Recreational Area. The Hoover Dam/Lake Mead complex is about 160 kilometers (100 miles) southeast of the NTS. Several small retirement communities are found south along the Colorado River below Hoover Dam within the Lake Mead Recreational Area, primarily at Lake Mojave. The largest town in the area is Kingman, located 265 kilometers (165 miles) southeast of the NTS, with a population of about 7,500.

b. Anticipated Population Growth

The Clark County Regional Planning Council, using data from a variety of state and local sources, has made projections for the population growth of Clark County to the year 2000. The Nevada State Engineer's office has made similar projections for other counties in Nevada in the Water Planning Report (Reference 14). The projections for the counties closest to the Nevada Test Site are shown in the following table:

II. D. THE EXISTING ENVIRONMENT

1. Surrounding Environs (Cont.)

	POPULATION PROJECTIONS		
	1975	1980	1990
Clark County	374,000	435,000	600,000
Esmeralda County	629	700	750
Lincoln County	2,500	2,700	2,800
Nye County	5,600	7,000	8,500

Clark County is expected to show continuing, rapid growth. Some have estimated a million people by the year 2000. The principal area of growth within Clark County is known as the Las Vegas Valley, which comprises Las Vegas itself, North Las Vegas, and Henderson, along with some of the intervening unincorporated areas. Another area of substantial estimated population growth (23,000 people by the year 2000) is Searchlight Township, which lies southward along the Colorado River, below Hoover Dam. The Boulder City area is expected to double in size to 15,000 people by the year 2000.

c. Land Use of NTS Environs (Reference 15)

Figure II-6 is a map showing general land use. A wide variety of uses, such as farming, grazing, mining, camping, fishing, and hunting, exist due to the varied terrain. For example, within a 300-kilometer (186-mile) radius west of the NTS, elevations range from below sea level in Death Valley to 4,420 meters (14,500 feet) above mean sea level in the Sierra Nevada Range (Mount Whitney). Additionally, parts of two valleys of major agricultural importance (the Owens and San Joaquin) are included. The areas south of the NTS are more uniform since the Mojave Desert (midlatitude desert) comprises most of this portion of Nevada, California, and Arizona. The areas east of the NTS primarily lie in the Basin and Range physiographic province, with some of the older river valleys, such as the Virgin River Valley, supporting small-scale but intensive farming and producing a variety of crops by irrigation. Grazing is also common in this area, particularly to the northeast. The area north of the NTS is also

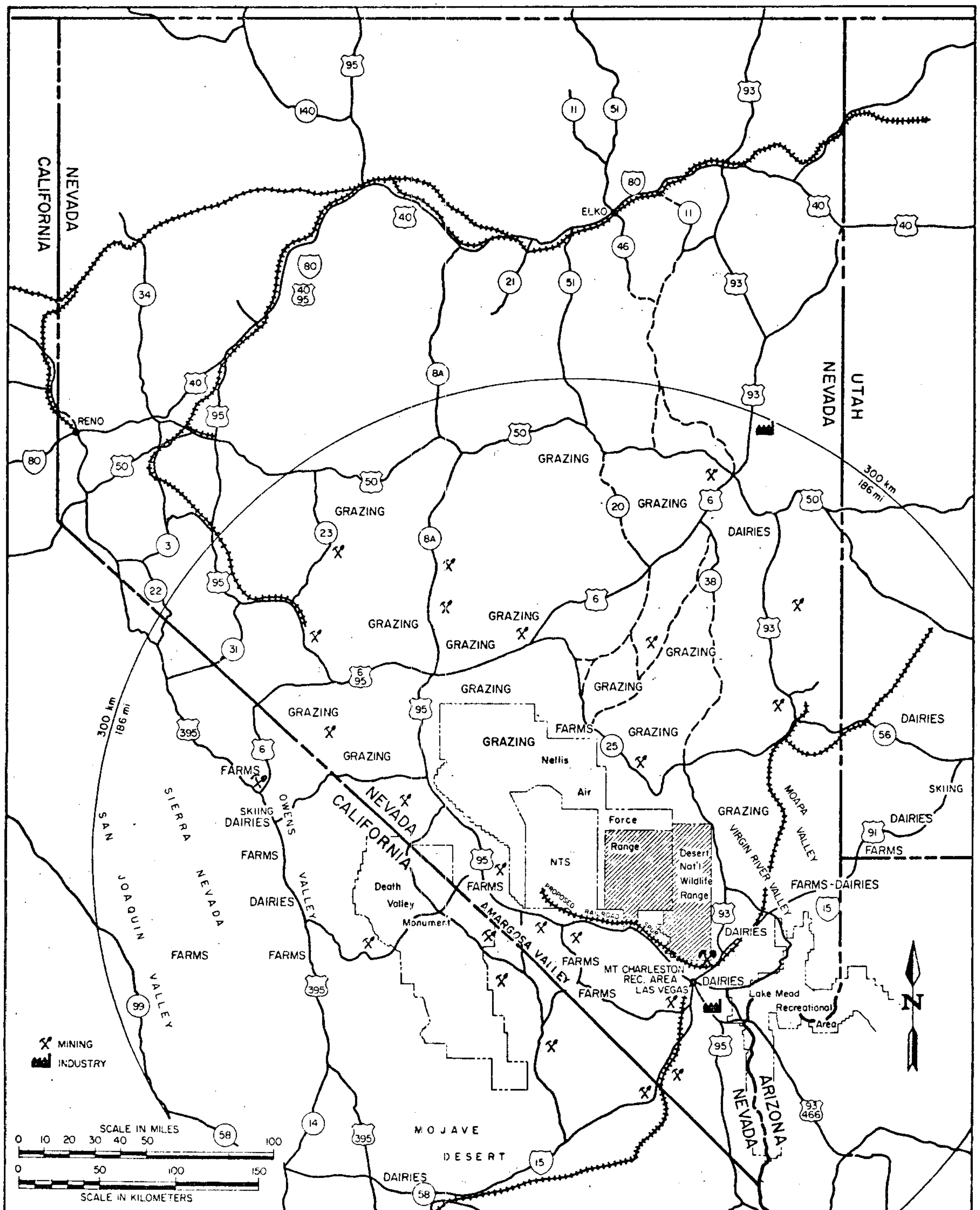

FIGURE II-6 GENERAL LAND USE MAP

II.D. THE EXISTING ENVIRONMENT

1. Surrounding Environs - c. (Cont.)

Basin-Range desert where the major agricultural-related activity is grazing of both cattle and sheep. Only areas of minor agricultural importance, primarily for production of alfalfa hay, are found north of the NTS in this portion of Nevada within a distance of 300 kilometers (186 miles).

In the summer of 1974, a brief survey of home gardens in areas surrounding the NTS found that a major portion of the local residents grow or have access to locally grown fruits and vegetables. Approximately two dozen of the surveyed gardens within 30 kilometers (18 miles) of the NTS were selected for sampling. These gardens produce a variety of root, leaf, seed, and fruit crops. The Amargosa Farm area has a population of about 300 and is located about 50 kilometers (30 miles) southwest of the center of the NTS. The Spring Meadows Farm area is a relatively new development consisting of approximately 40 square kilometers (15 square miles) with a population of somewhat more than 60. This area is about 55 kilometers (34 miles) south-southwest of the NTS.

Dairy farming is not extensive within the 300-kilometer radius area under discussion. From a survey of milk cows in the area, made during 1975, a total of 12,721 dairy cows and 1,174 family cows were located. The family cows are found in all directions around the test site. With reference to the NTS, dairy cows are primarily located (1) southeast (Moapa River Valley, Nevada; Virgin River Valley, Nevada; and Las Vegas, Nevada); (2) northeast (Hiko and Alamo, Nevada, area); (3) west-northwest (near Bishop, California); and (4) southwest (near Barstow, California).

The major body of water located 160 kilometers (100 miles) southeast of the NTS is Lake Mead, a man-made lake supplied with water by the Colorado River. Lake Mead is the source for about 40 percent of the water used locally for domestic and industrial purposes in the Las Vegas Valley. The Southern Nevada Water System utilizes a pumping and treatment facility at Lake Mead in addition to an extensive underground distribution system throughout Las Vegas Valley. The remaining water comes from local wells. Lake Mead is also the source for a portion of the water used by Southern California.

II.D. THE EXISTING ENVIRONMENT

1. Surrounding Environs - c. (Cont.)

Smaller reservoirs and lakes located in the area are primarily for irrigation and for livestock. In California, 130 kilometers (80 miles) to the west, the Owens River feeds into the Los Angeles Aqueduct, a major source of domestic water for the Los Angeles area.

d. Industrial Complexes

The nearest industrial enterprises which might be classified as a major industrial complex are at Henderson, Nevada, some 110 kilometers (68 miles) to the southeast. There are several chemical processing plants located in an industrial park at Henderson which normally employ about 1,000 workers (the number varies), largely for the chemical refining of metals.

It must be borne in mind, however, that in Las Vegas, the gaming and resort hotel businesses are considered major industries. There are, of course, a considerable number of associated commercial activities including small manufacturing in the Las Vegas Valley area. The gaming and resort structures in Las Vegas include a number of high-rise buildings. Ground motion associated with underground nuclear tests induces a response motion in high-rise structures in the same way that earthquakes do. At the beginning of 1976, there were 36 separate high-rise building complexes (nine through 29 stories). Many have two or more towers, resulting in a total of 57 high-rise towers. A conservative growth projection over the next few years suggests that with additions to existing buildings and new building complexes, the number of high-rise towers will increase to about 70 in 1978 and continue to grow at a rate near five per year. Some new buildings probably will be higher than now exist. The total replacement value of existing high-rise buildings is in excess of a billion dollars.

It has been estimated that there are about 85,000 low-rise residential and commercial buildings within a radius of 200 kilometers (125 miles) of the test site. About

II.D. THE EXISTING ENVIRONMENT

1. Surrounding Environs - d. (Cont.)

74,000 of these are located in the Las Vegas Valley and the balance in smaller communities including Tonopah, Beatty, Goldfield, Lathrop Wells, Indian Springs, and Alamo, Nevada. The normal projected growth rate in Las Vegas is 550 units per year. The replacement value of existing low-rise buildings in Las Vegas is between 2.5 and 3.0 billion dollars. The total replacement value in the smaller communities is placed at 200 million dollars.

There are 25 active mines within 300 kilometers (186 miles) of the NTS. The majority of the mining operations involve less than 10 workers per mine and at several of the smaller mines, the work force consists of one or two men. However, a few operations employ up to 150 workers. A new mill to process high-grade tungsten ore is being built at the site of the old mining town of Tempiute. It is expected the mill will employ about 200 people who will commute to the mill daily, mainly from the surrounding towns. The Kennecott Copper Corporation operates its large open-pit mine near Ely in White Pine County just at the periphery of the 300-kilometer circle. Kennecott's ore-processing plant is at McGill. The combined operations employ over 1,000 people. There are 14 mines situated within 50 kilometers (31 miles) of the test site boundaries. Of these, five are worked on a regular or continuous basis and the others are worked intermittently in response to the mineral market. Of the five active mines, three are now or will soon be open-pit operations.

e. Recreational Areas (see Figure II-6)

The use of both national and state recreational facilities within a 300-kilometer radius of the NTS (186 miles) has increased significantly during the past decade. The more popular of these sites are briefly described below.

II.D. THE EXISTING ENVIRONMENT

1. Surrounding Environs - e. (Cont.)

(1) Hoover Dam/Lake Mead

Hoover Dam is one of the world's largest hydroelectric installations and began commercial operation on October 26, 1936. More than 36 billion cubic meters (27 million acre-feet) of water, three years of average annual Colorado River flow, are stored behind the dam and released in a regulated, year-round flow to farms, homes, and factories downstream. Passing through the turbines, the water generates low-cost electricity which is distributed to markets in Nevada, Arizona, and California. (Hoover Dam was the first of the Bureau of Reclamation's present-day, large, multiple-purpose developments.)

Lake Mead, the largest man-made body of water in the western hemisphere, extends 175 kilometers (110 miles) upstream into the lower end of Grand Canyon and has a shoreline of 880 kilometers (550 miles). A 12-month season attracts more than 4.5 million visitors each year for swimming, boating, water skiing, fishing, and camping. The lake and surrounding area are administered by the National Park Service as part of the Lake Mead National Recreational Area. This area also includes Lake Mojave, which extends from the tailrace of Hoover Dam 110 kilometers (67 miles) downstream to Davis Dam.

(2) Valley of Fire

The Valley of Fire State Park (Nevada's oldest state park, dedicated in 1935) is the largest state park in southern Nevada and encompasses 138 square kilometers (53 square miles) of land area. It is located adjacent to and just west of the upper arm of Lake Mead. This recreational and geological area derives its name from the many brilliant red sandstone formations which were formed from shifting sand dunes during the Jurassic Period, 150 million years ago. Complex uplifting and faulting of the region, followed by extensive erosion, have created the present topography and other exposed geologic features including petrified logs.

II.D. THE EXISTING ENVIRONMENT

1. Surrounding Environs - e. (Cont.)

Prehistoric Indian rock art (petroglyphs) may be viewed at several locations in the park.

The Pueblo Grande Nevada-Lost City Museum of Archaeology, located in nearby Overton, houses displays of artifacts and reconstructions of the original pit dwellings and pueblos found in the Moapa Valley.

(3) Red Rock Canyon

Located 32 kilometers (20 miles) west of Las Vegas, the 1,340 square kilometers (517 square miles) Red Rock Canyon Recreation Area is jointly managed by the state and the Bureau of Land Management. The beauty and grandeur of the multicolored rock formations are the primary attractions of this area. The Nevada State Park Service administers the northern 73 square kilometers (28 square miles) with improved roads and recently completed public use facilities.

About eight kilometers (5 miles) to the south the Nevada State Park Service has recently opened the Spring Mountain Ranch facilities to the public for recreational use. Dating back to 1867, there is an unusual atmosphere and considerable historical lore associated with the ranch. The project is partially funded by the Bureau of Outdoor Recreation as well as by the state.

(4) Charleston Park/Lee Canyon

The Mount Charleston area, about 32 kilometers (20 miles) southeast of the NTS, is part of the Toiyabe National Forest, and administered by the Las Vegas Ranger District. This popular recreational area is heavily used by local residents throughout the year. Charleston Peak, at an elevation of 3.633 meters (11,918 feet), is the central focus of a scenic location for various summer and winter outdoor activities.

II.D. THE EXISTING ENVIRONMENT

1. Surrounding Environs - e. (4) (Cont.)

Charleston Peak comprises an area used for picnicking, camping, and hiking. Nearby Lee Canyon is southern Nevada's only winter sports area. Recently installed ski resort facilities include a 900-meter (3,000-foot) double chairlift. Homesites and cabins occupy privately owned holdings along the main valley floors, and a small community exists at Charleston Park, which supports an elementary school and fire protection services.

(5) Death Valley National Monument

Death Valley National Monument, established in 1933 and administered by the National Park Service, is the closest major recreational area to the NTS, i.e., about 19 kilometers (12 miles) air distance west.

The monument covers almost 7,700 square kilometers (3,000 square miles) and is located in the rugged desert region east of the Sierra Nevada Range in eastern California and southwestern Nevada. The valley itself is about 225 kilometers (140 miles) long and ranges from 6 to 48 kilometers (4 to 30 miles) in width. Nearly 1,400 square kilometers (550 square miles) of the valley floor are below sea level; the lowest land in the western hemisphere is in the vicinity of Badwater, 86 meters (282 feet) below sea level.

Death Valley National Monument is open to travel all year; however, the regular season is from late October to early May when the valley climate is usually very pleasant. Most of the recreational and visitation facilities are clustered in the central portion of the monument, with Death Valley Scotty's Ranch and Castle (northwest of Beatty) being the major exception. The recorded history of Death Valley dates from the gold-rush days of 1849. Considerable prospecting followed, leading to the large-scale recovery of borax freighted over the desert in huge high-wheeled wagons drawn by 20-mule teams.

II. D. THE EXISTING ENVIRONMENT

1. Surrounding Environs - e. (5) (Cont.)

An isolated 16-hectare (40-acre) tract in Nevada, administered as part of the Death Valley National Monument, includes Devils Hole, a sinkhole habitat for the endangered desert-pupfish species "Cyprinodon diabolis." The site, which is about 38 kilometers (24 miles) southwest of Mercury, is visited infrequently, mainly by scientists and National Park Service personnel interested in protecting this small pupfish.

Ghost mining camps in the vicinity include Panamint, Skidoo, Harrisburg, Keane, Wonder, and Leadfield in California, and Rhyolite and Bullfrog in Nevada.

(6) Desert National Wildlife Range/Desert Wilderness Area

The U.S. Fish and Wildlife Service (USF&W) administers the Desert National Wildlife Range which was established in 1936 primarily for the protection and preservation of the resident population of desert bighorn sheep. The range, one of the largest wildlife conservation areas in the United States, now comprises 6,430 square kilometers (2,480 square miles) of land extending from close to the city limits of Las Vegas northwestward to the eastern edge of the Nevada Test Site. Part of the Nellis Air Force Range overlaps the Wildlife Range and is jointly used. (By agreement, U.S. Air Force and ERDA activities on the Wildlife Range are coordinated with USF&W authorities.)

Land elevations vary from 730 meters (2,400 feet) to nearly 3,000 meters (10,000 feet), and both the climate and vegetation vary with the elevation. In addition to the estimated 1,000 desert bighorn sheep on the Wildlife Range, a wide variety of other wildlife species is supported. The Sheep Range Mountains located within the Range contain a well-developed coniferous forest and one of the four bristlecone pine forests in the state. The Desert National Wildlife Range administrative headquarters is in Las Vegas, with a field station at Corn Creek Springs, 37 kilometers (23 miles) northwest of Las Vegas.

II.D. THE EXISTING ENVIRONMENT

1. Surrounding Environs - e. (6) (Cont.)

Because of the extreme sensitivity of desert bighorn sheep to any disturbance to their natural habitat, most of the Wildlife Range (5,840 square kilometers or 2,250 square miles) has been proposed for designation as a unit of the National Wilderness Preservation System. The proposed Desert Wilderness Area consists of seven separate wilderness units varying from 166 to 1,780 square kilometers (64 to 690 square miles) in size. (An environmental impact statement has been filed by the Department of Interior concerning this proposal, but no Congressional action has taken place. If the Range should be designated as a Wilderness Area pursuant to the National Wilderness Act of 1964, a number of restrictions will be effected; for example, a mineral study will be required, and vehicular use of roads and trails by the public will be greatly curtailed.)

Contiguous to and at the northeastern corner of the Desert National Wildlife Range is the relatively small Pahranagat National Wildlife Refuge in Pahranagat Valley. It was established in 1964 and contains approximately 22 square kilometers (8.4 square miles). The name "Pahranagat" given the valley by early Indians, means "many waters."

National forest lands around the NTS in addition to the nearby Mount Charleston area include elements of the Toiyabe National Forest to the north, the Inyo National Forest to the west, Humboldt National Forest to the northeast, and Dixie National Forest in southwestern Utah to the east.

In addition to those recreational areas noted above, there are a number of other state-sponsored projects. Lincoln County contains five state parks or recreation areas--Cathedral Gorge, Kershaw-Ryan, Beaver Dam, Echo Canyon, and Spring Valley--all of which are northeast of the NTS. To the north of the test site in Nye County is the Berlin-Ichthyosaur State Park where fossil remains are on display. These include mammoth sea reptiles from prehistoric times, some of which weighed over 45 metric tons (50 tons). There are two state-managed wildlife refuges--the Wayne-Kirch Wildlife Management Area at Adams-McGill Reservoir in eastern Nye County and the Overton Wildlife Management Area in Clark County just east of the Valley of Fire State Park. The Ward Charcoal Ovens Historic State Monument in White Pine County is the site of six excellently constructed ovens used during the 1870's-80's

II.D. THE EXISTING ENVIRONMENT

1. Surrounding Environs (Cont.)

to make charcoal for use in the smelters of nearby mines. Similar kilns, the Tybo Charcoal Kilns, are located in Hot Creek Valley north of the Nellis Air Force Range.

f. Airspace Control

The airspace above the Nevada Test Site lies within what is identified as Special Use Airspace by Federal Aviation Authority regulations (see Reference 16). The airspace above the Nevada Test Site has been designated R-4808 and is contiguous with restricted airspace designations R-4806, R-4807, and R-4809 which cover all of the Nellis Air Force Range and the Tonopah Test Range. This entire airspace is a restricted area over which the flight of aircraft, while not wholly prohibited, is subject to limitations. Clearance must be obtained from the controlling agency. Agencies having a requirement to overfly or penetrate R-4808 are required to contact the ERDA Operations Coordination Center (OCC), at the NTS Control Point (CP), providing the type of aircraft, organization, and the purpose of the flight penetration. The OCC approves or denies the request depending upon the activities programmed at the time on the NTS. The Air Operations Center (AOC), which is manned and operated by Air Force personnel under an ERDA-Air Force agreement, assists the OCC in obtaining clearances from controlling agencies and in coordinating flights associated with the Nellis Air Force Range and the Tonopah Test Range.

g. Air Transportation (see Figure II-5)

There are a total of 38 airports in the four-county region surrounding the Nevada Test Site. These range from small, unpaved landing strips at ranches and other remote locations, up to the size of McCarran International Airport. Most of the airports are unpaved with few or no facilities or services. The table below lists those closest to the site and the most favorable landing strips in the NTS-Las Vegas area.

II. D. THE EXISTING ENVIRONMENT

1. Surrounding Environs - g. (Cont.)

	Air Distance From NTS Boundary km	mi	Current No. of Annual Operations	Remarks
Desert Rock	Onsite		1,300	ERDA Control
Yucca Lake	Onsite		36	ERDA Control
Pahute Strip	Onsite		None	ERDA Control
Lathrop Wells	5	3	100	General Public
Indian Springs AFAF	27	17	180	Air Force Control
Beatty	31	19	120	General Public
North Las Vegas	85	53	170,000	General Public
McCarran International	95	59	265,000	Commercial
Nellis AFB	98	61	64,000	Air Force Control

The Yucca Lake landing strip has a capability to handle C-54's. The Desert Rock airstrip has a capability for dual tandem wheel loads of 8,500 pounds. Both of these airstrips are primarily used in support of the Nevada Test Site. The Yucca Lake airstrip is used only for special shipments, while Desert Rock has regularly scheduled government charter flights and may be used by private aircraft. Desert Rock is an open field lying just outside (south) of Restricted Airspace R-4808.

The nearest offsite airstrip at Lathrop Wells is also designated as an open field (there are no attendants). It is an old, abandoned military auxiliary field and can accommodate C-54 aircraft. It is presently utilized for daylight operations of private aircraft (no lighting available).

The airport near Beatty is a civil airdrome equipped with navigational aids, including a rotating beacon. Its 91-meter (300-foot) wide asphalt runway is 1,700 meters (5,500 feet) long and is equipped with runway and taxi strip lighting. The airport will support C-130 or equivalent aircraft.

Indian Springs AFAF is an auxiliary airfield assigned to Nellis AFB, which, in turn is a major installation assigned to the Tactical Air Command of the USAF. Indian Springs has three paved runways, the longest of which is 2,330 meters (7,650 feet) long and has a capability for C-141's. It is used primarily as an auxiliary landing strip for

II.D. THE EXISTING ENVIRONMENT

1. Surrounding Environs - g. (Cont.)

operational and training missions over the Nellis Air Force Range. In addition to the number of fixed-wing aircraft operations shown in the table, helicopters are staged out of Indian Springs in support of the ERDA underground testing programs at the Nevada Test Site. It is closed to civilian traffic. Nellis AFB, located 72 kilometers (45 miles) from Indian Springs, has virtually an unlimited capability for aircraft. The number of operations shown for Nellis AFB and Indian Springs AFAF in the above table does not include touch-and-go training flights.

The North Las Vegas Airport has a capability for DC-3's. It is primarily used for general aviation. The McCarran International Airport is the air traffic center used by major and trunk airlines.

Detailed information concerning these airports and others in the area may be found in the Airman's Information Manual (see Reference 17).

h. Highways

U.S. Highway 95 from Las Vegas to Tonopah (Figure II-5) essentially forms the boundary for the small part of the Nevada Test Site south of Mercury, and skirts both the southern boundary of the test site through Lathrop Wells and the western boundary of the Nellis Air Force Range. There are three entrances to the Nevada Test Site from Highway 95; the main entrance, most frequently used, is the entrance into Mercury. Five kilometers (three miles) west is the turnoff to the Jackass Flats road which is presently barricaded. Another 34 kilometers (21 miles) west is the entrance to the Lathrop Wells road leading to Area 25. Highway 95 is a four-lane, dual highway from Las Vegas to the Jackass Flats turnoff, beyond which it becomes a two-lane highway.

U.S. Highway 93, a two-lane highway from Las Vegas to Ely, Nevada, and points north, lies just east of the Desert Game Range some 75 kilometers (46 miles) from the test site boundary. State Highway 25 from Hiko, Nevada, to Warm Springs through Diablo lies

II.D. THE EXISTING ENVIRONMENT

2. Topography (Cont.)

and Rainier Mesa, 2,345 meters (7,694 feet) above sea level. The lowest elevations are in Frenchman Flat and Jackass Flat, both at approximately 910 meters (3,000 feet) above sea level. These are near the extremes; a large portion of the Nevada Test Site is better described as ranging from about 910 to 1,370 meters (3,000 to 4,500 feet) in the valleys to the south and east, rising to 1,700 to 2,100 meters (5,500 to 6,900 feet) in the high country toward the northern and western boundaries. The slopes on the upland surfaces are steep and dissected, whereas the slopes on the lower surfaces are gentle and alluviated with rock debris from the adjacent highlands.

There are three principal valleys within the test site: (1) Yucca Flat, a north-south elongated closed basin with a dry lake (playa) at the southern end, (2) Frenchman Flat, an oval-shaped closed basin with a playa at the center, and (3) Jackass Flats, a valley that drains off the test site at its southwest corner. Pahute Mesa, Rainier Mesa, Timber Mountain, and Shoshone Mountain are prominent highland areas that dominate the test site landscape.

The principal effect upon the terrain from past nuclear testing has been the creation of numerous craters. A few craters have been caused from tests conducted on or near the surface during the past days of atmospheric testing. There have been tests buried at shallow depths deliberately designed to produce throw-out craters, such as some of the Plowshare tests mentioned earlier. Most underground nuclear tests designed to be contained normally produce subsidence craters caused when the overburden above the nuclear cavity collapses or "chimneys" to the surface. This is particularly common in the Yucca Flat, where most of the underground testing has occurred. Figure II-8 shows a view of Yucca Flat. The "pockmarks" are subsidence craters. In the past, the astronauts have used the test site for training missions prior to their journeys to the moon.

3. Climate and Meteorology

The climate varies significantly over short distances in response to complex orographic influences and with pronounced variations from one year to the next. Extremes of climate are exemplified by conditions on the high plateaus in contrast to the dry lake beds.

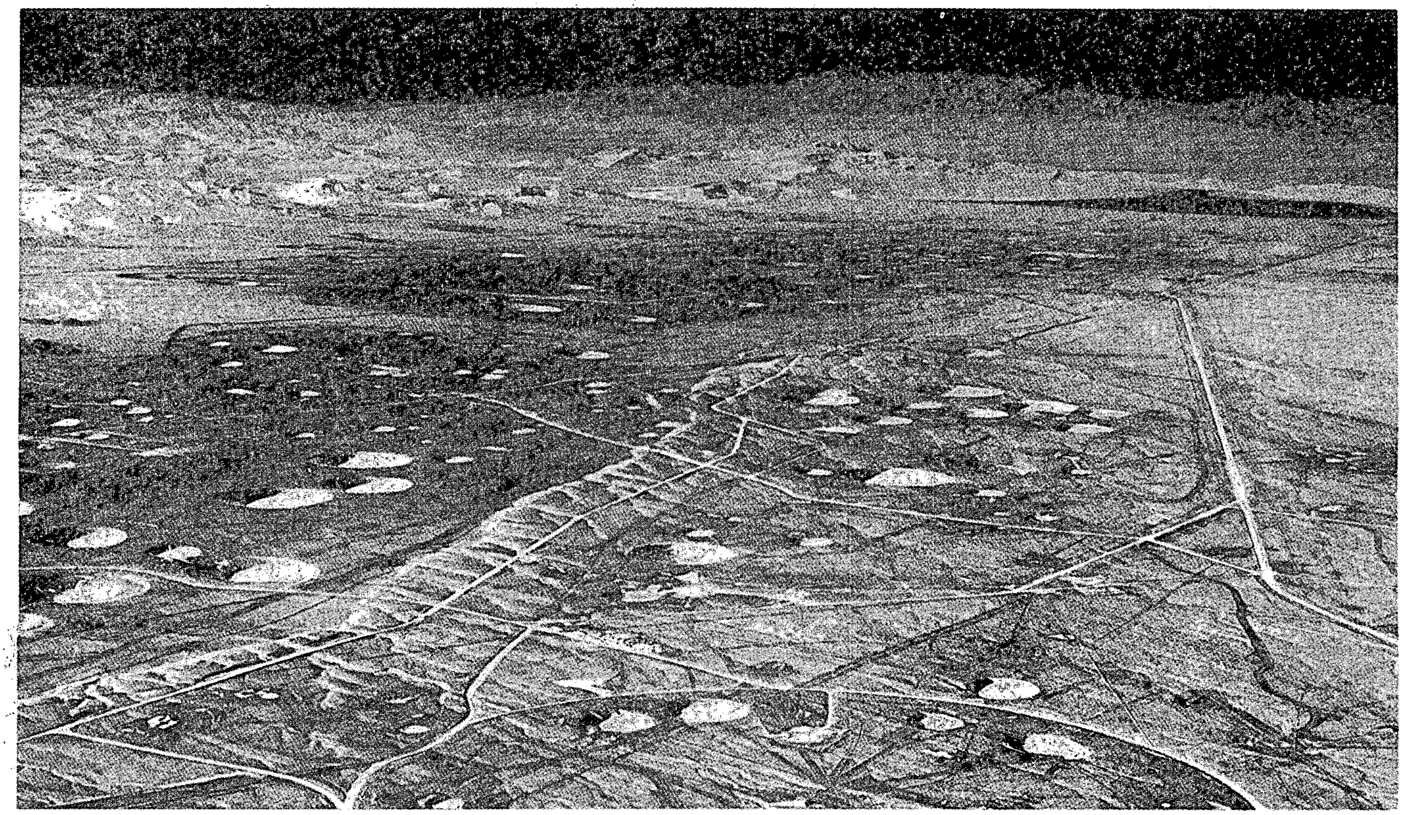

FIGURE II-8 SUBSIDENCE CRATERS ("POCKMARKS") IN YUCCA FLAT

II.D. THE EXISTING ENVIRONMENT

1. Surrounding Environs (Cont.)

northeast of the test site about 34 kilometers (22 miles) away. The northern entrance to the test site is accessible from this hoghway (Figure II-2 and II-3). North of the Nevada Test Site, Highway 6 from Tonopah through Warm Springs passes within about 89 kilometers (55 miles) of the test site boundary.

The major interstate highway, I-15, passing through Las Vegas from Salt Lake City to Southern California has its closest approach distance of about 90 kilometers (56 miles) to the east.

i. Railroads

The closest mainline railroad is the Union Pacific which serves Las Vegas, connecting southern California with points east (see Figure II-6).

There is a short, nine-mile, standard guage railroad within Area 25. That facility was equipped so that the rolling stock could be remotely operated. It served to interconnect the facilities located in this area when the NRDS was in operation.

The construction of a railroad spur has been proposed to interconnect both Area 25 and Mercury with the Union Pacific Railroad. The recommended rail spur route, most likely to enjoy public acceptance, avoids the city of Las Vegas and ties into the existing rail lines at the Dike Siding located 16 kilometers (10 miles) northeast of Las Vegas.

2. Topography (see Figure II-7)

The topography of the Nevada Test Site is typical of much of the Basin and Range physiographic province in Nevada, Arizona, and Utah. There are numerous north-south trending, linear, rugged mountain ranges separated by broad, flat-floored and gentle-sloped valleys. On the test site the higher elevations are on Pahute Mesa, approximately 2,205 meters (7,235 feet)

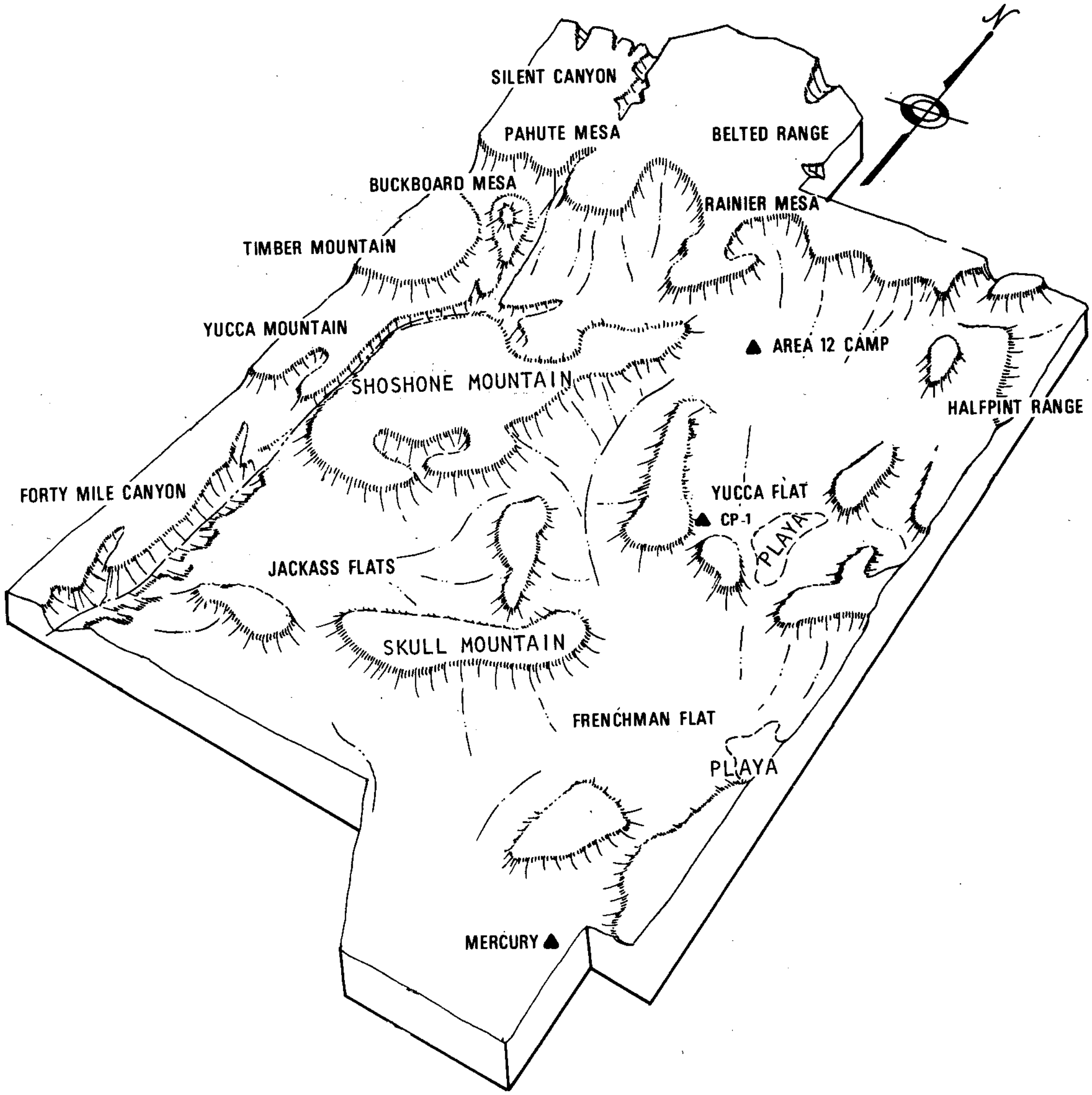

FIGURE II-7 TOPOGRAPHY

II. D. THE EXISTING ENVIRONMENT

3. Climate and Meteorology (Cont.)'

Annual precipitation depends mainly on elevation and varies on the average from about 10 centimeters (4 inches) at an elevation of 910 meters (3,000 feet) in Frenchman Flat to about 30 centimeters (12 inches) at an elevation of 2,150 meters (7,000 feet) on Pahute Mesa. The annual precipitation cycle displays a double maximum, with the primary maximum in winter and a secondary maximum in summer. Winter precipitation often falls as snow at the higher elevations; however, snow cover is intermittent and seldom persists for more than a few weeks at one time. Summer precipitation occurs in association with thunderstorms which are intense enough at times to produce localized flash flooding.

Temperature over the valley floors is characterized by a large daily range. Average temperatures for the warmest and coldest hours in Frenchman Flat in January are 12° and minus 3° C. (53° and 26° F.). Corresponding temperatures in July are 36° and 17° C. (97° and 62° F.). The daily temperature oscillation on the high plateaus contrasts with that of the dry lake beds. Data on Rainier Mesa show corresponding temperatures of 3° and minus 3° C. (37° and 27° F.) in January and 25° and 16° C. (77° and 61° F.) in July. Temperature extremes of minus 34° and 46° C. (minus 30° and 115° F.) have been observed on the NTS. Nocturnal air drainage has a pronounced influence on nighttime temperatures. Average daily minimum temperatures on sloping terrain are from 3-6 degrees (on the Celsius scale) warmer than on the valley floors with a corresponding reduction in the average daily range. A more detailed description of the climate of the NTS has been published in ESSA Technical Memorandum, ERLTM-ARL-7 (Reference 18).

4. Geology

Investigations of the geology of the Nevada Test Site, including detailed studies of numerous drill holes and tunnels, have been in progress by the U.S. Geological Survey and other organizations since 1951, shortly after the test site was established. The geologic studies were expanded in the late 1950's and early 1960's as underground tests became the established mode for testing nuclear explosives. In the early 1970's, geologic investigations were intensified at all underground explosion sites as part of the determined effort to better understand and effect the containment of all nuclear explosions beneath the ground. It is probably correct to describe the Nevada Test Site as the geologically best-known large area within the United States (see References 19 and 20).

The general geology (see Figures II-9 and II-10) of the test site can be simply described as being comprised of three major rock units--(1) complexly folded and faulted sedimentary rocks of Paleozoic age overlain at many places by (2) volcanic tuffs and lavas of Tertiary age, which in the valleys are covered by (3) alluvium of late Tertiary and Quaternary age, which was derived from erosion of the nearby hills of Tertiary and Paleozoic rocks. The volcanic rocks in the valleys are downdropped and tilted along steeply dipping normal faults of late Tertiary age; the alluvium is rarely faulted. Compared to the Paleozoic rocks, the Tertiary rocks are relatively undeformed and dips generally are gentle.

The sedimentary rocks of Paleozoic age are many thousands of feet thick and comprise mainly carbonate rocks (dolomite and limestone) in the upper and lower parts, separated by a middle section of clastic rocks (shale and quartzite).

The volcanic rocks of Tertiary age are predominantly tuffs which erupted from various volcanic centers, and lavas, mostly of rhyolitic composition. The aggregate thickness of the volcanic rocks is many thousands of feet, but at most places the total thickness of the section is far less because of erosion or nondeposition. These materials erupted before the collapse of large volcanic centers known as calderas. The Timber Mountain caldera near the west-central border of the test site, and the Silent Canyon caldera, now buried beneath Pahute Mesa, are two of the better studied calderas on the test site (Figure II-9).

Alluvial materials fill the intermontane valleys and cover the adjacent slopes. They attain thicknesses of 600 to 900 meters (2,000 to 3,000 feet) in the central portions of the valleys. The alluvium in Yucca Flat is vertically offset along the prominent north-south-trending Yucca fault. The geologically recent offset along the Yucca fault is marked by a conspicuous topographic scarp in northern and central Yucca Flat.

4. Geology (Cont.)

When an underground nuclear explosive is detonated, the energy release almost instantaneously produces extremely high temperature and pressure that vaporizes the nuclear device and surrounding rock. Within a fraction of a second after detonation, a generally spherical cavity is formed at the emplacement position. As the hot gases chill, a lining of molten rock forms over the cavity walls and puddles at the cavity bottom. Figure II-11 shows the wall of a tunnel dug into the vicinity of the cavity of an underground nuclear explosion. The dark areas (arrows) are injected melt that has been quenched in cracks within cold country rock.

After a period of minutes to hours, as the gases in the cavity cool, the pressure subsides, and the weight of the overburden causes the cavity roof to collapse producing a vertical, rubble-filled column known as a rubble chimney. This sequence is illustrated in Figure II-12.

Commonly the rubble chimney extends to the ground surface forming a subsidence crater. Numerous subsidence craters are present at the test site. Subsidence craters generally are bowl-shaped depressions with a diameter ranging from about 60 to 600 meters (200 to 2,000 feet), and a depth ranging from a few to 60 meters (200 feet) depending upon the depth of burial and the explosive energy yield.

Some deeply buried explosions of low yield form cavities that do not collapse to the surface and consequently do not create subsidence craters. Formation of a sufficiently strong arch is required to prevent collapse to the surface. In the case of the GNOME detonation at Carlsbad, New Mexico, in 1961, chimney collapse did not reach the surface. Entry to the cavity was made five months later as shown in Figure II-13. The man standing on the rubble pile indicates the scale.

Past underground nuclear tests in Yucca Flat and Pahute Mesa have fractured the ground surface above the explosions and have caused displacement of the surface along preexisting faults adjacent to explosion sites. Figure II-14 shows typical surface effects at the U2bs (Starwort) site. STARWORT was an 85-kiloton device detonated in April 1973. At most

FIGURE II-11 SOLIDIFICATION OF ROCK MELTED BY A NUCLEAR DETONATION

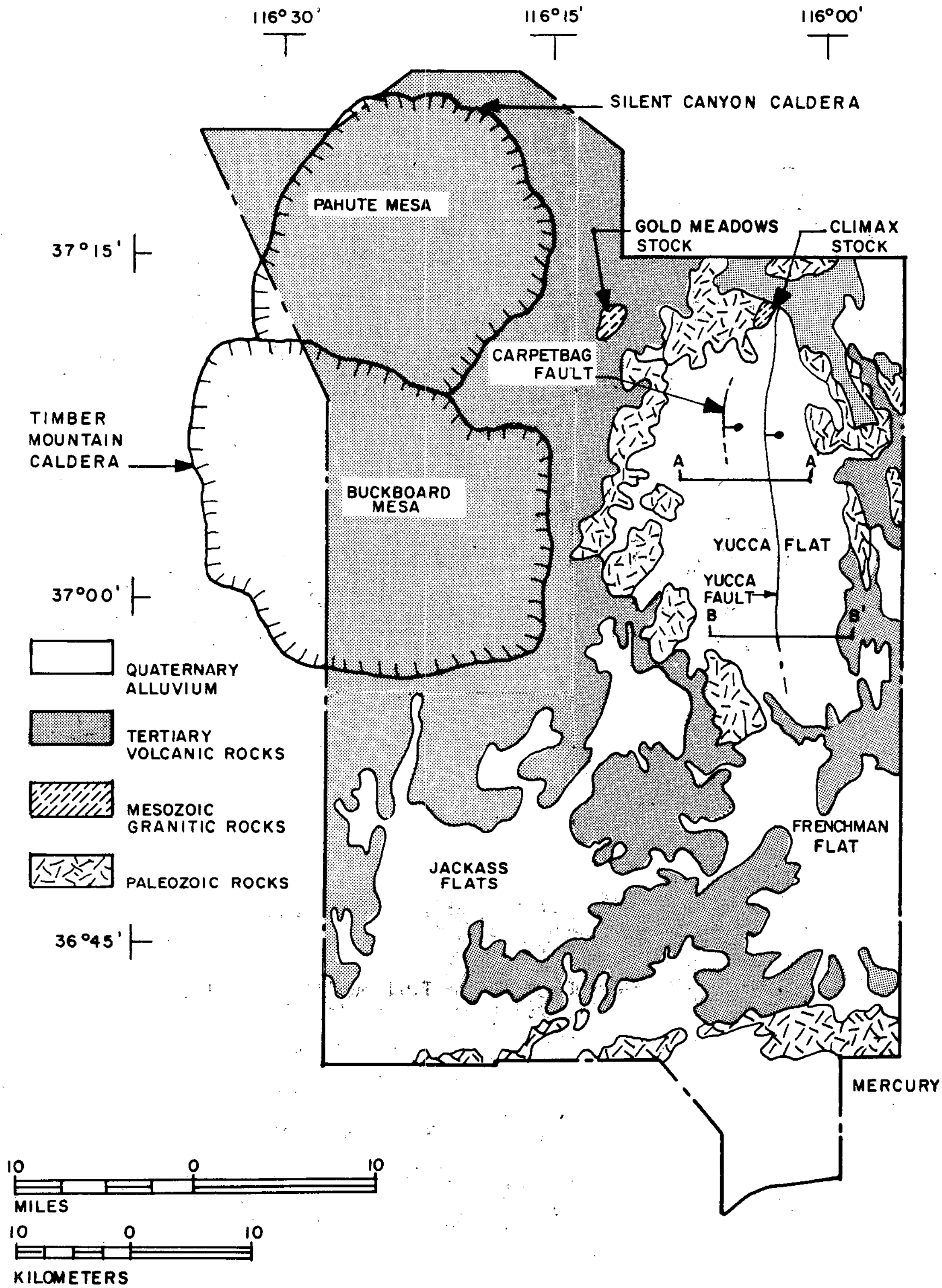

FIGURE II-9 PRINCIPAL ROCK TYPES OF THE NEVADA TEST SITE

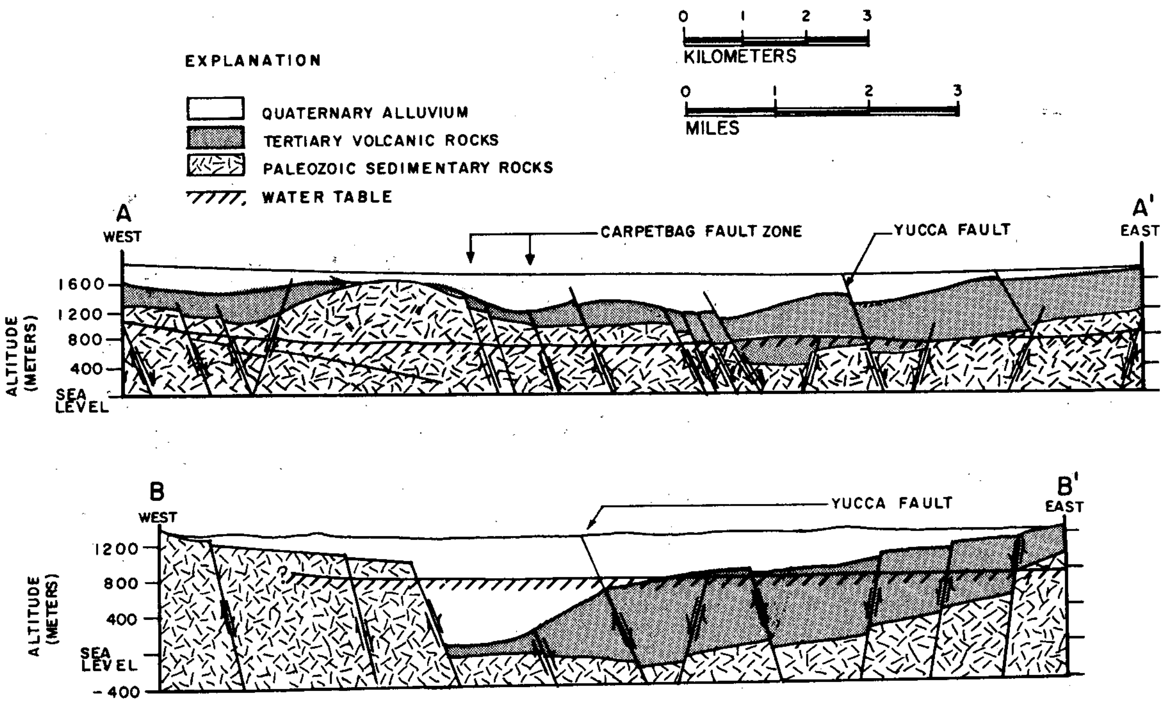

FIGURE II-10 EAST-WEST CROSS SECTIONS ACROSS YUCCA FLAT

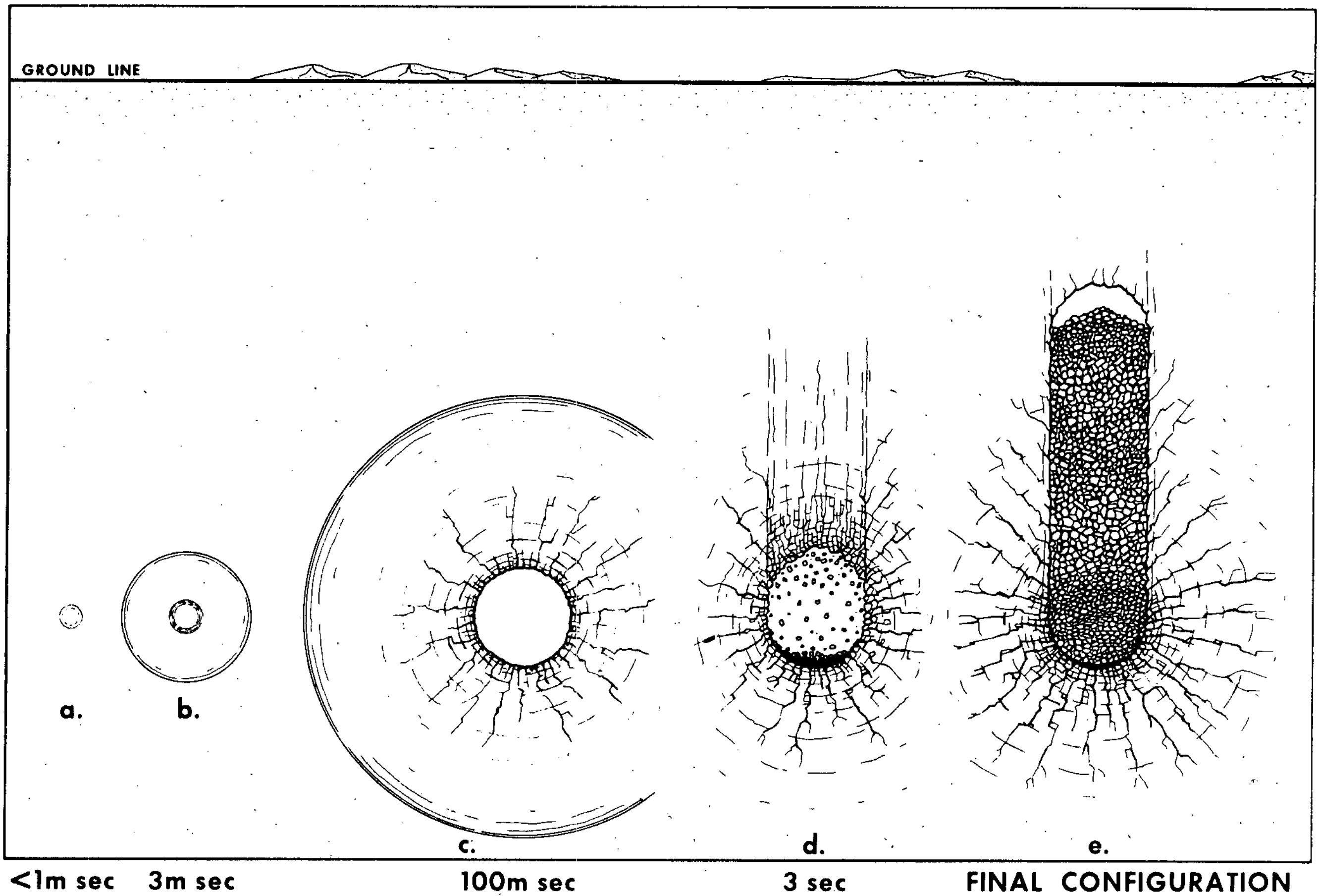

FIGURE II-12 RUBBLE CHIMNEY FORMATION

FIGURE II-13 CAVITY FORMED BY UNDERGROUND NUCLEAR EXPLOSION

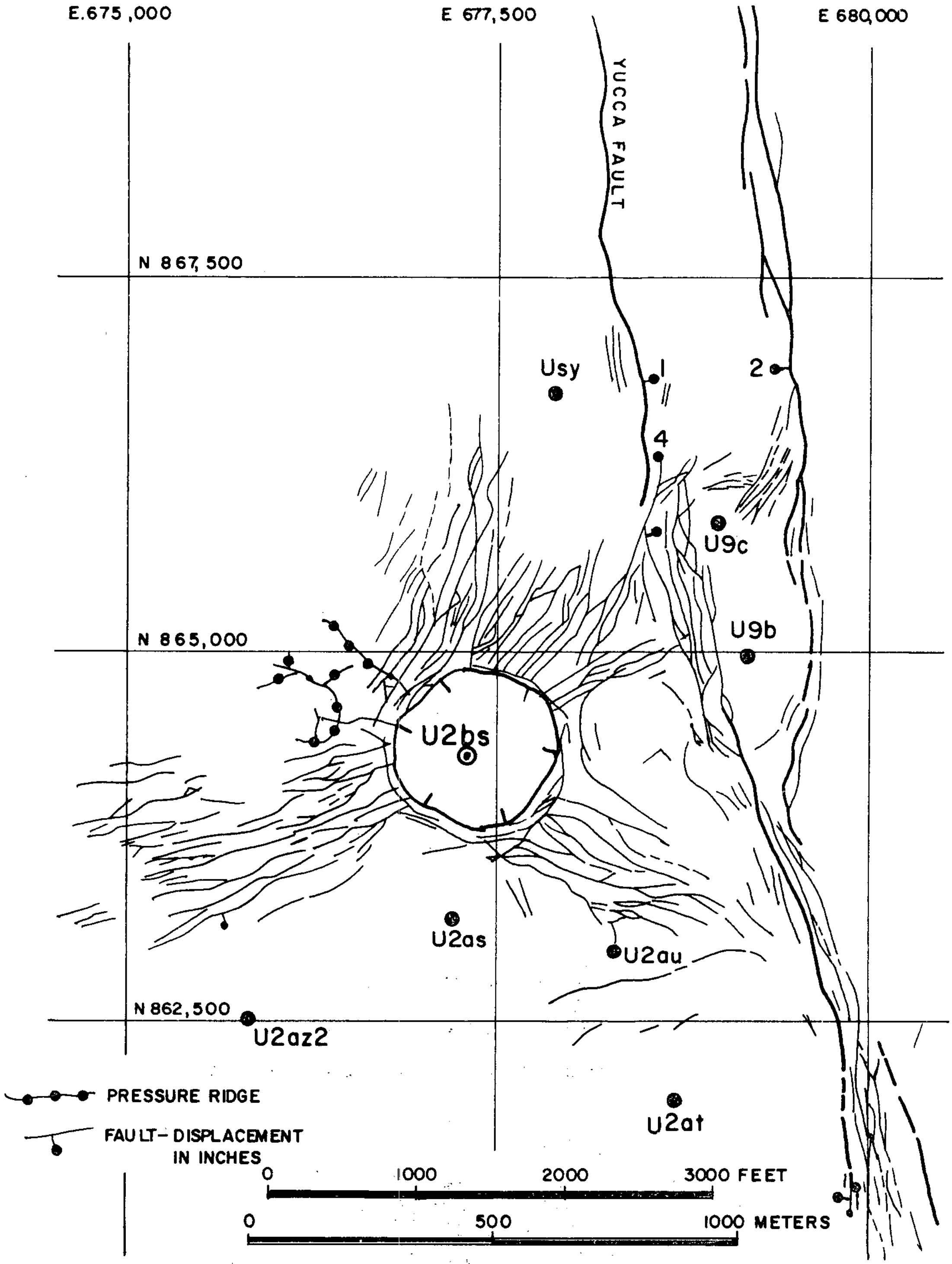

FIGURE II-14 SURFACE EFFECTS FROM THE U2bs (STARWORT) TEST subsurface nuclear explosions, the ground surface is cracked within the subsidence crater and for several tens of meters outside the crater rim; these cracks are radial and circumferential and are related to uplift of the ground surface at the time of the explosion and to the subsequent collapse forming the subsidence crater (Reference 21).

Underground nuclear explosions adjacent to preexisting faults generally cause minor displacements of the rocks along the faults. The prominent Yucca fault in Yucca Flat has ground-shock-induced displacement by nuclear explosions along most of its length of 25 kilometers (15 miles). The vertical displacement of the Yucca fault at the ground surface is mostly less than 0.3 meters (one foot), but at a few places it is displaced as much as 0.46 meter (1 1/2 feet). The largest resultant vertical displacement is along the Carpetbag fault in northwest Yucca Flat where the vertical displacement is about 2 1/2 meters (eight feet) along a distance of about a hundred meters (325 feet). Preexisting faults on Pahute Mesa characteristically exhibit displacement from nuclear explosions, resulting in vertical offsets of about 0.3 meter (one foot) or less for distances along the fault of as much as five kilometers (three miles). The characteristic subsidence and the radial and circumferential fracture pattern developed in the alluvial surface for Yucca Flat explosions are not observed for Pahute Mesa explosions, because there is well-consolidated volcanic rock instead of alluvium at the surface on Pahute Mesa. None of the displacements along reactivated faults has extended beyond the boundaries of the test site and none has produced any significant environmental effect insofar as present or foreseeable uses of the test site are concerned.

5. Hydrology

The hydrology of NTS has been studied intensively since the mid-1950's, and water quality in and around the site has been monitored since underground nuclear testing began. The U.S. Geological Survey, the Environmental Protection Agency (formerly the U.S. Public Health Service), and the Desert Research Institute of the University of Nevada have conducted most of these studies. Recently, LASL and LLL have participated actively in studies of radionuclide content and mobility in groundwater.

5. Hydrology (Cont.)

Surface Water

Precipitation on NTS results in surface-water runoff only during unusually intense or persistent storms. Rainfall typically infiltrates quickly into the moisture-deficient soil or runs off in normally dry channels, where it seeps into permeable sands and gravels. During extreme conditions, however, flash floods may occur. Runoff in the eastern half of NTS ulitimately collects in the lake beds (playas) of the closed basins, Yucca Flat and Frenchman Flat, shown in Figure II-15. Typically, this water stands on the playas for a few days to a few weeks before it is lost, mainly by evaporation. Similar playas in Kawich Valley and Gold Flat collect and dissipate the runoff from the northern part of Pahute Mesa.

The western half and southernmost part of NTS have integrated channel systems which carry runoff beyond NTS boundaries during infrequent, very intense storms. Fortymile Canyon is the largest of these systems, originating on Pahute Mesa in the northwestern part of NTS and draining into the normally dry Amargosa River channel about 32 kilometers (20 miles) southwest of NTS. Death Valley, California, is the ultimate destination of the Amargosa River channel. Within NTS, the Fortymile Canyon channel and its tributaries are restricted to well-incised canyons, but in the Amargosa Desert, the channel splits into several tributaries. Like the Amargosa River, these channels are typically dry for many months at a time.

The other major NTS tributaries to the Amargosa River are Topopah Wash, which runs southwesterly from Jackass Divide in south-central NTS into the Amargosa Desert near Lathrop Wells, and Rock Valley, which drains from southernmost NTS westward and then southward to Ash Meadows in east-central Amargosa Desert. Both are similar to Fortymile Canyon in hydrologic aspects.

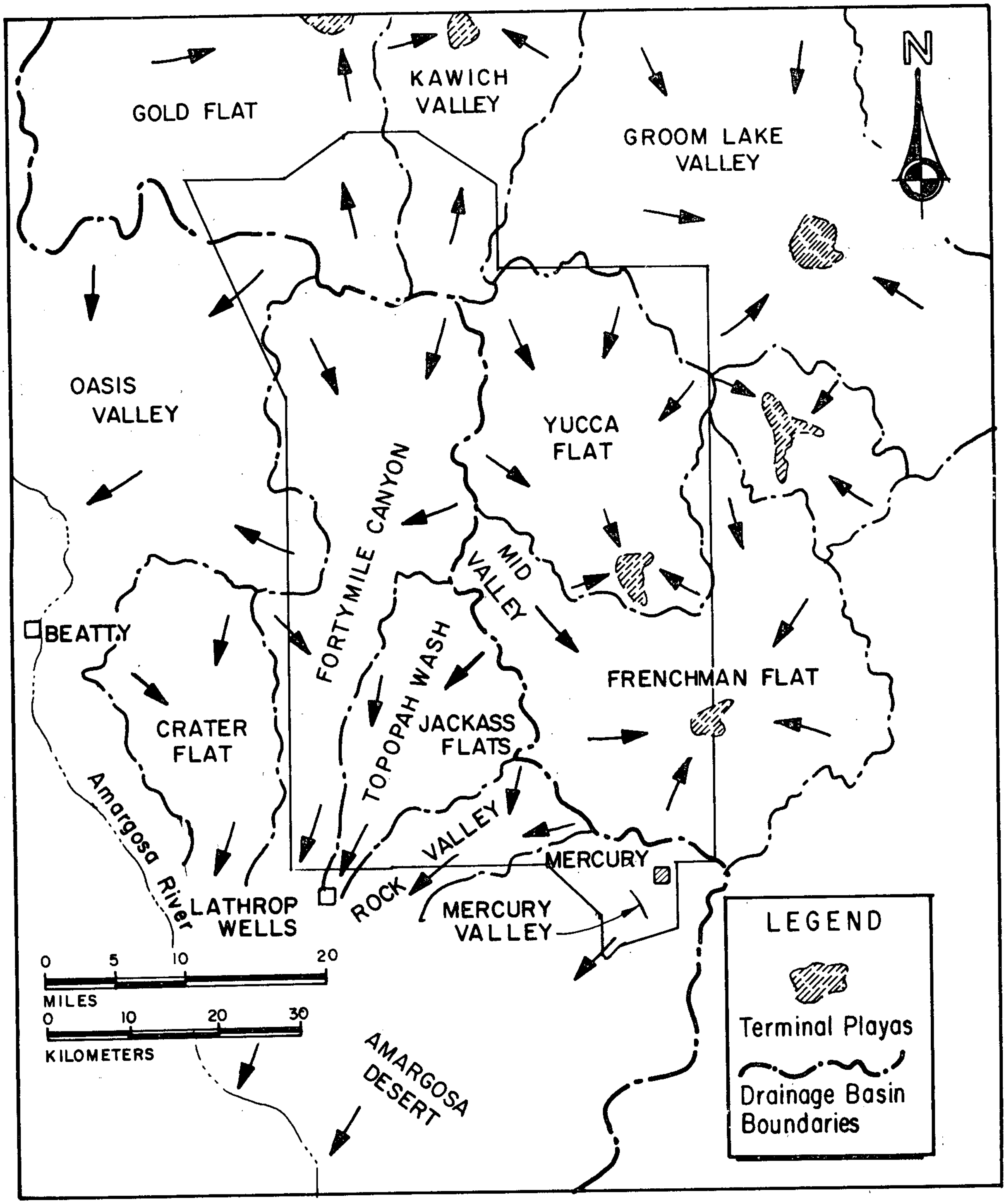

FIGURE II-15 BOUNDARIES OF BASINS AND DIRECTIONS OF SURFACE DRAINAGE

Timber Mountain (see Figure II-17). The top of the flow system, the water table, has an irregular configuration with higher surfaces coinciding with the higher elevations, the local sources of recharging water.

Depths to groundwater beneath NTS vary from about 200 meters (660 feet) beneath valleys in the southern part of the test site to more than 500 meters (1,640 feet) beneath part of Pahute Mesa. The water table depth and configuration are best known in central Yucca Flat and Pahute Mesa where extensive drilling has provided a large number of known levels. Elsewhere within and around the test site, data are relatively scarce, and features of the water table are estimated by various methods. The latest such technique begins with the concept that above certain elevations, precipitation and recharge to groundwater increase with altitude. In addition the relatively low vertical transmissivity of the underground media retards the flow of groundwater beneath the higher elevations. For these reasons, the water table is higher in altitude beneath uplands than beneath valleys. A computer program has been developed which subdues the land-surface contours and adjusts the contours to match known points on the water table. Figure II-17 shows the surface resulting from a recent application of this technique to the NTS area by the Desert Research Institute (Reference 25). At the centers of the recharging areas, highs on the water table, water tends to flow vertically downward changing to lateral flow with depth. Away from centers of recharge, water immediately below the water table tends to flow in the direction of the water table gradient, parallel to the water table.

In eastern NTS, the water table occurs generally in alluvium and volcanic rocks above the regional carbonate aquifer. The flow in the shallower parts of the groundwater body is generally toward the major valleys (Yucca Flat and Frenchman Flat), where it deflects downward to join the regional drainage in the carbonate aquifer to the southwest. In the Pahute Mesa system, however, there is no deeply underlying aquifer similar to the carbonate aquifer. The strata beneath the mesa consist of a complex series of interbedded volcanic rocks with extreme contrasts in hydraulic conductivity both laterally and vertically. Much of the water beneath Pahute Mesa is laterally moving underflow from recharge regions to the north through interconnected zones of high hydraulic conductivity.

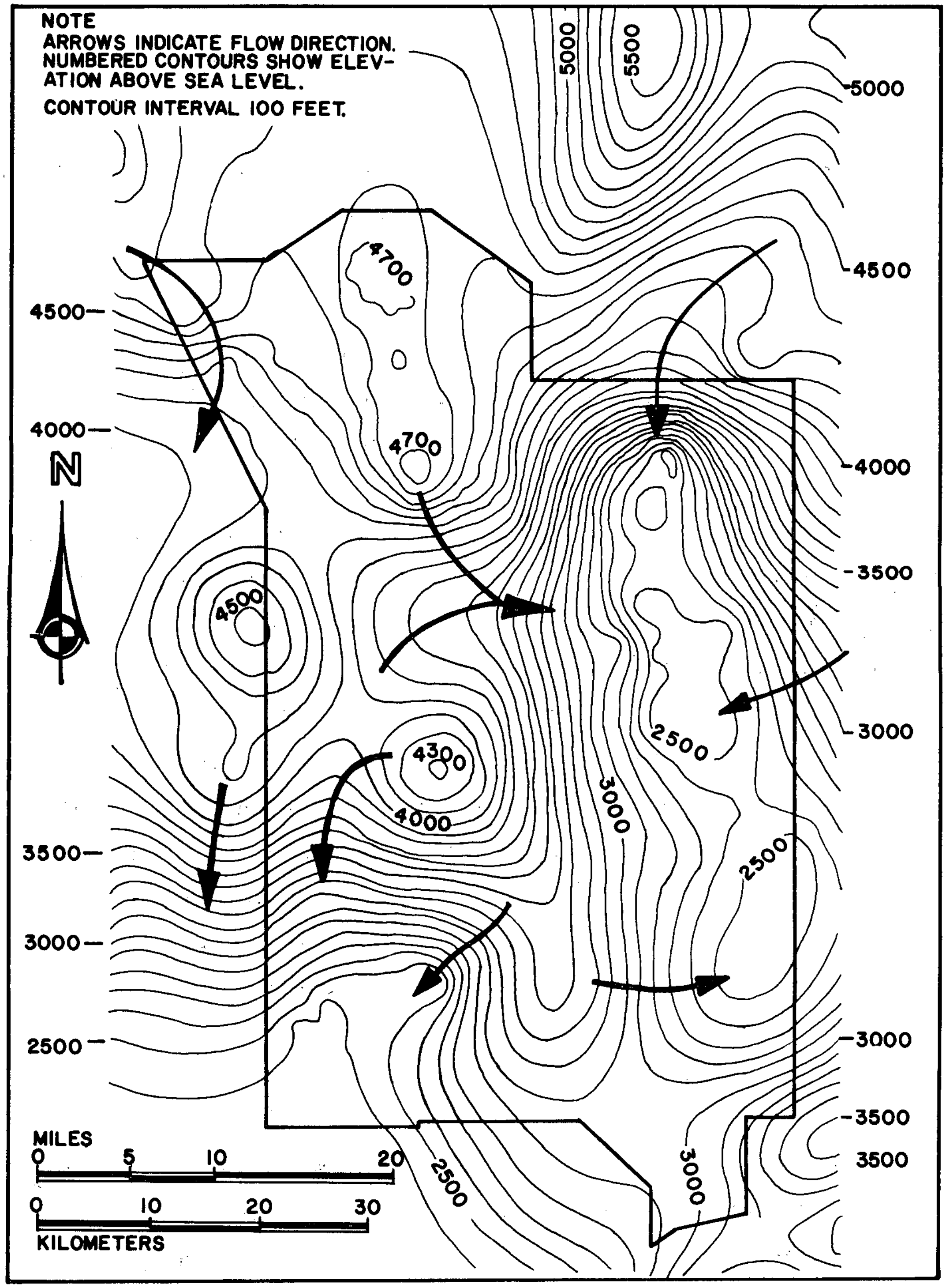

FIGURE II-17 COMPUTER SIMULATED WATER TABLE MAP OF THE NEVADA TEST SITE AND VICINITY

Groundwater

The Amargosa Desert is also the direction of drainage for the two regional groundwater systems present beneath NTS. The eastern two-thirds of NTS are within the Ash Meadows groundwater system, which also drains a vast area to the north and east (Figure II-16). Groundwater in this system generally moves downward through alluvium and volcanic rocks to the Paleozoic carbonate rocks, in which it then flows generally southwestward to discharge at the large springs in Ash Meadows, about 40 kilometers (25 miles) southwest of Mercury (Reference 22).

The Pahute Mesa groundwater system encompasses the western one-third of NTS as well as an extensive area to the west and north. Water in this system in part moves southward beneath Pahute Mesa, Fortymile Canyon, and Crater Flat (west of NTS) toward the Amargosa Desert, and in part flows southwestward to Oasis Valley near Beatty. Groundwater in Oasis Valley moves southward into the Amargosa Desert through gravels and sands of the ancestral Amargosa River channels and probably also through the underlying fractured rocks (Reference 23).

Most of the annual discharge from the two groundwater systems--about 21 million cubic meters (17,000 acre-feet) from the Ash Meadows system and 12 million cubic meters (10,000 acre-feet) from the Pahute Mesa system--is transpired by plants or evaporated from soil and playas in the Amargosa Desert (Reference 24). Less than one million cubic meters (a few hundred acre-feet) yearly may continue southward through the Amargosa channel deposits, while as much as 6 million cubic meters (5,000 acre-feet) yearly may flow westward from the Amargosa Desert to discharge at springs in Death Valley.

The water recharging the NTS region ultimately flows toward the southwest in the regional groundwater flow systems. The flow system extends from the water table to a depth where the hydraulic conductivity of the rocks is extremely small. That depth is perhaps in excess of 1,500 meters (5,000 feet) in the area of the NTS. Recharge to the regional systems tends to be localized in the areas of higher elevation such as Pahute Mesa, the Belted Range, and

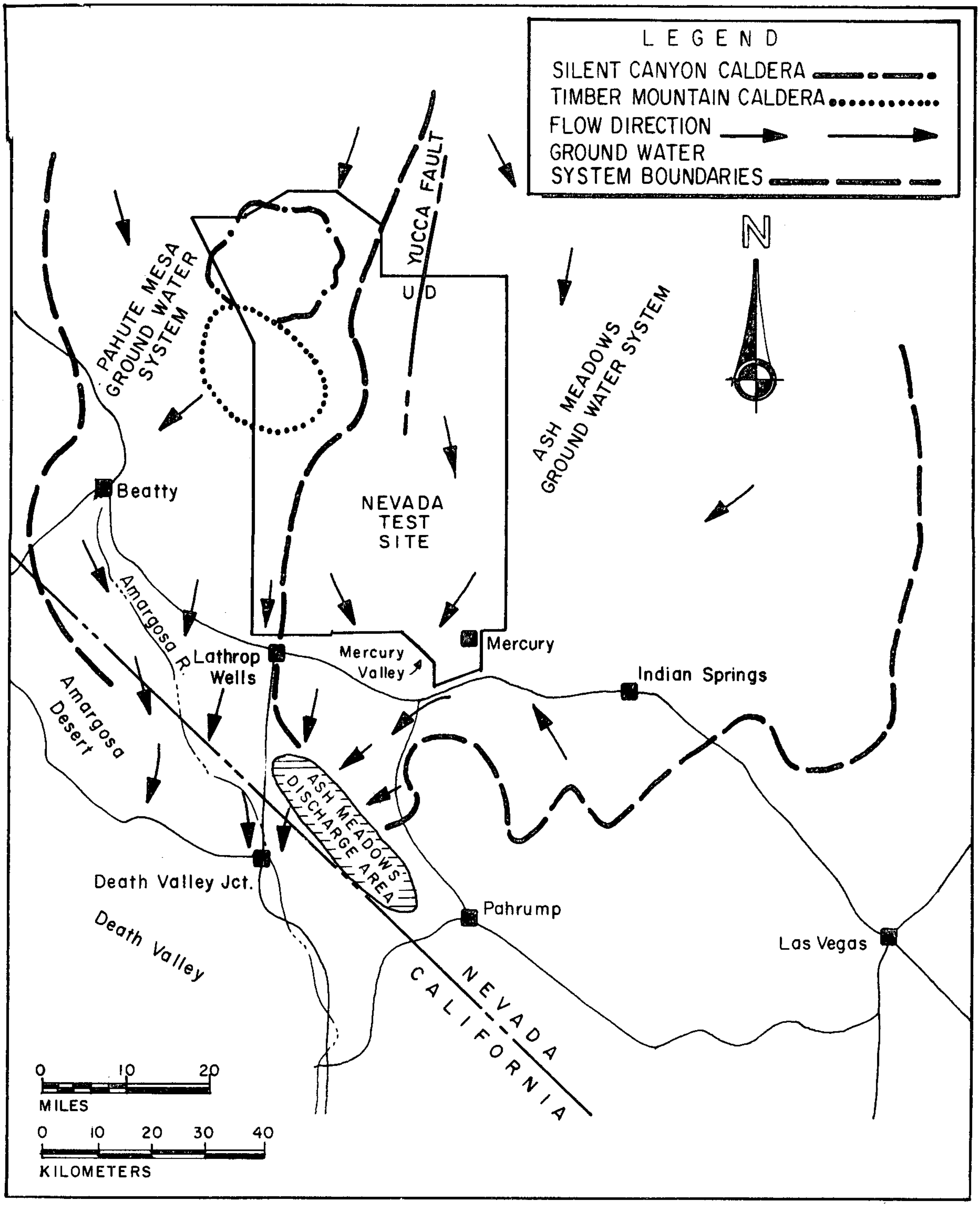

FIGURE II-16 REGIONAL GROUND WATER FLOW SYSTEMS

Flow in both regional groundwater systems occurs mainly through fractures in the massive carbonate and volcanic rocks. The relative volume of fracture openings (fracture porosity) in fractured aquifers is difficult to measure or even to estimate, and calculations of groundwater velocity are extremely sensitive to this elusive parameter. Average groundwater velocity (v) within the lower carbonate aquifer beneath central Yucca Flat was estimated through use of the standard equation: $v = Q/A \cdot P$. Of the variables, the volume of flow through the aquifer, Q, and the cross-sectional area of flow, A, are reasonably well known. However, the magnitude of the effective porosity, P, may be as large as one or two percent or as low as 0.01 percent. Thus, a two order of magnitude variation is possible. The area of underflow used in the equation was assumed to be 16 kilometers (10 miles) wide and 1,500 meters (5,000 feet) thick. The quantity of water moving through the lower carbonate aquifer probably is less than 430,000 cubic meters (350 acre-feet) per year. Utilizing the cited values, the estimated average velocity in central Yucca Flat ranges from 2 to 180 meters (6 to 600 feet) per year (Reference 22). Although the exact stratigraphic positions of the two sampling points are not known, carbon-14 analyses of water from Well 2, a primary industrial supply well in northern Yucca Flat, and from Well C-1, a primary potable water supply well in southern Yucca Flat, suggest a velocity near the lower value (Reference 26). Using even the higher value as an average velocity, however, the transit time for water to reach Frenchman Flat from central Yucca Flat is more than a century.

Similar calculations for the much greater discharge through a restricted section of the carbonate aquifer in western Mercury Valley result in velocities from 180 to 18,000 meters (600 to 60,000 feet) per year. Such high velocities are unlikely to prevail for more than the very short distances in which the aquifer is laterally restricted by older clastic, less permeable rocks. Beneath Frenchman Flat and Mercury Valley, the discharge of the Ash Meadows system is enhanced by mixing with flow from the east, and groundwater velocity is intermediate between the values cited above for Yucca Flat and western Mercury Valley.

Vertical flow through the volcanic rocks beneath Yucca Flat and Frenchman Flat is retarded by the bedded and zeolitized tuffs, which have interstitial hydraulic conductivities of less than 0.0002 meter per day (0.0007 foot per day) as determined from laboratory tests on cores. These confining beds limit downward flow to rates of less than 0.05 meter (0.2 foot) per year (Reference 22). Assuming that the tuff aquitard beneath Yucca Flat has an average saturated thickness of 305 meters (1,000 feet), the fastest time for water to move vertically from the top to the bottom of the tuff aquitard is about 6,000 years.

Groundwater velocity beneath Pahute Mesa was estimated using the same equation that was applied to flow in the carbonate aquifer beneath Yucca Flat. The area of underflow (A) used in the computation was 24 kilometers (15 miles) wide and 1,070 meters (3,500 feet) thick. The quantity of water (Q) moving through this area was estimated at 9.9 million cubic meters (8,000 acre-feet) per year. For effective porosities (P) ranging from 0.5 to 20 percent, the estimated velocities beneath the mesa ranged from 2 to 76 meters (7 to 250 feet) per year. Low-permeability blocks between fractures may result in velocities that vary as much as two or three orders of magnitude over short distances. A median value of 10 percent porosity probably is the most acceptable value, assuming that most groundwater movement occurs along interconnected fractures with less movement through interstices. Computations using this value of porosity yield velocities of about 5 meters (15 feet) per year (Reference 23).

These calculations indicate that water from some explosion sites on Pahute Mesa could travel to the boundary of the NTS in about 20 years if a maximum possible rate of travel is assumed everywhere. However, it would require a century or more before the groundwater could move from the contiguous government-controlled land of the Nellis Air Force Range. At the more probable groundwater velocities for the area, water from sites of Pahute Mesa tests could not leave government-controlled land for more than 1,000 years.

Preliminary data from a single well tracer test (a new technique being developed) using Well J-12 at Jackass Flats suggest a groundwater velocity of about 52 meters (170 feet) per year. This is consistent with velocities calculated by Blankennagel and Weir (Reference 23) for similar fracture tuffs beneath Pahute Mesa.

Water Supply

Groundwater from as many as 17 wells has supplied the demands of NTS operations. Since 1961, wells in Yucca Flat, Frenchman Flat, and Mercury Valley have produced a total of about 1.2 million cubic meters (1,000 acre-feet) annually from the Ash Meadows groundwater system (Reference 27). Withdrawals from the Pahute Mesa system are less well known, but pumping from Wells J-12 and J-13 in western Jackass Flats is estimated to have provided between 370,000 and 680,000 cubic meters (300 and 550 acre-feet) annually to the Nuclear Rocket Development Station during the 1960's. Pumping from Pahute Mesa supply wells probably peaked in 1967, when 420,000 cubic meters (342 acre-feet) were pumped in addition to the production in Jackass Flats.

The quality of water available to NTS is generally good for most purposes. Wells producing from the Pahute Mesa system yield water containing between 150 and 200 milligrams of dissolved solids per liter. Somewhat higher values, between 275 and 450 milligrams per liter, characterize most water from the Ash Meadows groundwater system. Water from Wells C and C-1 in southern Yucca Flat slightly exceeds recommended limits (500 milligrams per liter) for dissolved solids, having about 650 milligrams per liter. About half of the wells throughout NTS will produce water having fluoride concentrations that are approximately at or exceed guidelines for continuous-use supplies (Reference 22). These water supplies are used by an adult population and only on an intermittent basis. Therefore, fluoride-caused tooth discoloration is not considered of serious concern.

Effects of Past Nuclear Tests

The pressure of cavity growth during an underground nuclear explosion compresses the rocks surrounding the explosion site and raises the land surface over a wide area. If these rocks are saturated with water, the loss of porosity by compaction causes a fluid-pressure mound centered on the explosion site. With the collapse of the rubble chimney, however, the new void space in the rubble is initially lacking in or devoid of water. Consequently, the early postexplosion hydraulic condition at the site of an event beneath the water table includes a pressure mound around the explosion site with a pressure depression in the center causing groundwater flow toward and into the unsaturated rubble and the interstitial spaces within the rubble chimney. For periods ranging from about 1 year to more than 10 years, groundwater moves toward the cavity and chimney from all directions until equilibrium is reached. Until equilibrium occurs, waterborne radioactivity cannot leave the rubble chimney. In comparison with the long times required for groundwater at NTS to move beyond Federally controlled lands, the period of chimney filling is of minor significance.

Permanent physical effects immediately surrounding the detonated device are porosity changes in the rock media and minor increases in groundwater infiltration due to the entrapment of surface runoff by the subsidence sink (if a sink is formed). There has been no evidence of open, explosion-produced fractures extending further than a few cavity radii that might increase water-transport velocities in the tuff aquitard. More than 300 records of water-level and water-pressure response to explosions at NTS have been collected from dozens of observation wells. Beyond a distance of ten kilometers (six miles) from even the largest of NTS events, only transient (hydroseismic) changes have been observed. However, pressure changes that were sustained for periods of days to weeks occurred in three wells within eight kilometers (five miles) of the Handley event, a 1970 test with a yield of about one megaton. These changes were mainly pressure increases and apparently resulted from closing of pre-existing fractures under the test-produced compressive stress (Reference 28).

Investigations have been carried out since 1957 to define the hydrology of NTS and to evaluate the effects of nuclear testing on the hydrologic system. Particular emphasis has been directed toward determining if radionuclides have been introduced into the groundwater systems. The primary source of radioactivity at the NTS is the combination of fission products, neutron-induced radioactivity in surrounding materials, and unburned nuclear fuel remaining from each underground test. This creates a large, buried radioactive waste inventory at each detonation site, which is--in the practical sense--irretrievable and which requires long-term surveillance. This surveillance has included the sampling and analysis of water from drill holes completed in the sites of explosions beneath the water table, from test wells drilled and pumped in an attempt to draw water from nearby explosion sites, from water-supply wells and springs throughout the test site and adjacent areas, and from water-producing holes drilled for other purposes.

After ratification of the Limited Test Ban Treaty in August 1963, which prohibited atmospheric testing, and in the early days of underground testing which followed, there was emphasis on learning about contamination of the Paleozoic carbonate aquifer beneath Yucca Flat. In September 1963, the BILBY event was detonated in tuffs below the water table but close enough to the Paleozoic interface to cause concern. Subsequently, a monitoring hole (U3cn5) was drilled immediately adjacent to the rubble chimney and completed in the underlying Paleozoic carbonate aquifer about 100 meters (328 feet) below the explosion cavity. Its purpose was to determine if contamination had occurred. During the following decade, approximately 300,000 cubic meters (80 million gallons) of water were pumped from the aquifer without producing detectable explosion-produced radioactivity. No waterborne nuclides, not even tritium, could be induced to penetrate downward from the cavity into the Paleozoic aquifer.

Four other similar underground events have been detonated near the water table: CUP (1965) detonated in tuff just above the water table and estimated to be close to the Paleozoic interface; CORDUROY (1965) detonated below the water table in bedded tuff, again close to the Paleozoic interface; NASH and BOURBON (1967) both detonated within the Paleozoics (dolomite and limestone, respectively) above but close to the water table. Since 1971, there have been no nuclear events detonated (1) within the Paleozoics less than a cavity radius above the water table, or (2) below the water table less than a cavity radius above the Paleozoic interface.

Water has been recovered from drill holes completed at the sites of events where the cavity formed extended below the water table. Analyses have shown the most abundant radionuclides identified in the water from these sites have been tritium (hydrogen-3) and decay products (such as strontium-90 and cesium-137) of radioactive gases produced during nuclear detonations.

The FAULTLESS event was conducted in tuffaceous sediments and zeolitized nonwelded tuffs in Hot Creek Valley in Central Nevada at a depth of 975 meters (3,200 feet) on January 19, 1968. Sheared casing in the reentry hole prevents direct access to chimney water but the cased hole serves as a standpipe to measure the water level and to provide samples of water entering the chimney as it fills. Although water level fluctuations occurred, continuously increasing levels did not begin until September 1974--almost seven years after the event. By November 1976, the water level had risen to 562 meters (1,843 feet), still about 400 meters (1,300 feet) below the preevent level. Tritium concentrations, measured in August 1976, varied with depth of sample from 920,000 pCi/ml (920 RCG)* at 789 meters (2,590 feet) to 2.2 pCi/ml (0.002 RCG) at 576 meters (1,890 feet). It is expected that for FAULTLESS, radionuclides will not leave the immediate site area until preevent equilibrium has been reestablished--now estimated on the basis of cavity fill rates to take at least 20 years.

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*One picocurie (pCi) is one millionth of one millionth of a curie (10^{-12} curie). One curie is that amount of radioactivity decaying at a rate of 3.7×10^{10} disintegrations per second (dps). The Radiation Concentration Guide (RCG) used for tritium was 1,000 pCi/ml as taken from ERDAM 0524 (Reference 29). ERDAM 0524 details the radiation protection standards used by ERDA, which in turn are based upon the radiation concentration guides (RCG) recommended by the National Council on Radiation Protection and Measurements (NCRP) and other agencies.

II.D. THE EXISTING ENVIRONMENT

5. Hydrology (Cont.)

The CANNIKIN event was detonated November 6, 1971, on Amchitka Island, Alaska, at a depth of 1,791 meters (5,875 feet) below the land surface in submarine and subaerially deposited clastic rocks of volcanic origin. The CANNIKIN cavity/chimney complex filled in about one year by partly capturing water flow from a surface stream. The maximum amount of radioactivity found in water samples taken from the cavity was (Reference 30):

Gross Alpha	100 picocuries per liter (10 RCG)*
Gross Beta	2,900 picocuries per liter (29 RCG)*
Tritium	2,400 microcuries per liter (2,400 RCG)**

The STARWORT event was conducted at 562 meters (1,845 feet) below Yucca Flats, NTS, in April 1973. By May 1974, water had risen in the chimney to 655 meters (2,150 feet) and remained essentially at this level until the well was destroyed by a nearby nuclear detonation in December 1975. Analyses of water samples taken from the cavity region showed (Reference 31):

Gross Alpha	4 picocuries per liter (0.4 RCG)
Gross Beta	6,800 picocuries per liter (68 RCG)
Tritium	290 microcuries per liter (290 RCG)

Water samples taken at selected horizons from the chimney of the CAMBRIC event, a 1965 nuclear detonation in the alluvium of Frenchman Flat, have shown the following concentrations:

Strontium-90	3×10^{-6} microcuries per milliliter (30 RCG)***
Cesium-137	1×10^{-6} microcuries per milliliter (0.05 RCG)***
Tritium	6,000 microcuries per liter (6,000 RCG)

*RCG taken as 10 picocuries per liter (pCi/l) for gross alpha, and 100 picocuries per liter for gross beta (ERDAM 0524).

**One microcurie (μCi) is one millionth of a curie (10^{-6} curie).

***RCG for strontium-90 taken as 1×10^{-7} μCi/ml. RCG for cesium-137 taken as 2.0×10^{-5} μCi/ml (ERDAM 0524).

II.D. THE EXISTING ENVIRONMENT

5. Hydrology (Cont.)

The total quantity of tritium remaining at this site indicates that little, if any outflow has occurred even though hydraulic equilibrium may have been reestablished several years ago. As a part of this study, an attempt is under way to pump contaminated water from a second well (RNM-2s) drilled 91 meters (300 feet) from the explosion site. The first breakthrough of tritium activity was detected in September 1976. By the end of November about 681,374 cubic meters (180 million gallons) of water had been pumped from the well, and the breakthrough of tritium was confirmed. Pumping in RNM2s started in October 1975. Note that it required about a year of pumping to move tritium a distance of 91 meters (300 feet) under an induced hydrologic gradient many hundreds of times the natural hydrologic gradient. The pumping has continued and, as of June 1977, the highest level observed was 3.6×10^{-7} microcuries per milliliter. No explosion-related radioactivity other than tritium has been detected thus far.

Another event, code-name ALMENDRO, was detonated at a depth of 1,064 meters (3,490 feet) in igneous rock on Pahute Mesa in June 1973. The cavity has remained too hot to obtain a reliable bottom-hole temperature, strongly indicating that filling by groundwater is progressing very slowly.

The above studies, although not definitive in documenting the rate at which radionuclides can be induced to migrate in groundwater, suggest that the radioactive nuclides remain in the vicinity of the explosion site.

However, the presence of tritium, at levels above those occurring naturally, has been found in groundwater of the tuff and alluvium beneath Area 2 in northwestern Yucca Flat. Tritium was first found by LLL in groundwater inflow to a chamber mined in partly welded tuff beneath Area 2 in April 1974 (Reference 32). The level of tritium activity in the water rose to 1.1×10^{-2} microcuries per milliliter by September 1974. The chamber was expended in nuclear testing shortly thereafter. The maximum tritium level exceeded the RCG for public drinking water by about a factor of eleven. No gamma-emitting isotopes were detected in the one sample that was checked. Therefore, it is presumed that soluble nuclides such as cesium-137, antimony-125, and ruthenium-106 were retarded in flow toward the chamber, by sorption processes, so that they had not yet reached the sampling point.

Liquid samples bailed from an exploratory hole, about 1,000 meters (3,300 feet) south of the chamber cited above, were obtained in May 1975. These were found to have tritium levels less than the RCG but well in excess of the naturally occurring tritium concentration of Yucca Flat water.

Each of the holes from which these samples were taken were within the range of 360 and 770 meters (1,200 and 2,600 feet) of two past nuclear events detonated below the water table in volcanic rock.

The presence of tritium also has been observed below the water table in ground water samples taken from the Paleozoic rocks in Area 2. The most likely source is from a nuclear device expended in January 1967. The tritium was observed in water pumped from an exploratory hole in May 1977. The exploratory hole had been drilled some 600 feet away from the expended device. The highest level of tritium observed was 180 pCi/ml (0.18 RCG).

Tritium has also been found below the water table in tuff in Area 4 in April 1977. The highest level observed just at the static water level was 4.5×10^{-3} μCi/ml (4.5 RCG). The closest nuclear device expended in that vicinity was one detonated in February 1974 740 feet away in tuff.

The effects expected from this migration of tritium are discussed in Section IV.A.4.

II. D. THE EXISTING ENVIRONMENT

5. Hydrology (Cont.)

A Long-Term Hydrologic Monitoring Program for the Nevada Test Site and vicinity (Reference 33) has been designed to provide surveillance at points of public use, at "early warning" locations close to and down gradient from the centers of testing, and at points of groundwater exit from the Nevada Test Site. Sampling points were selected which are representative of the various components of the groundwater flow systems and where care can be exercised so that samples are free from contamination by surface water and atmospheric fallout. The groundwater sampling points are differentiated on the basis of sampling frequency into two networks--one is sampled monthly and one semiannually. Twelve stations (all deep wells) are sampled monthly and 20 stations (3 springs and 17 wells) are sampled semiannually forming a combined network of 32 stations (Figure II-18). Except for those wells mentioned in the preceding paragraphs, which were deliberately drilled into or near nuclear chimneys, the levels of radioactivity are low--up to 1.5×10^{-8} microcuries of tritium per milliter. Two wells in Area 6 used earlier in a tritium-migration study do produce water having about 1.5×10^{-7} microcuries per milliliter, or 0.00015 of the RCG for public drinking water.

A computer flagging system to detect anomalous analytical results and make appropriate notification is operational on a routine basis. Incoming analytical results are compared by computer with historical results. In the event that one or more of the programmed parameter limits is exceeded, the computer prints all existing information on that sample point including all previous analytical results.

The Desert Research Institute has recently initiated studies to investigate water movement and contamination transport through the unsaturated zone. The unsaturated zone, the region between the ground surface and the water table, is made up of three zones: the capillary zone, the intermediate zone, and the soil moisture zone. Under certain saturation and infiltration conditions, transport through the unsaturated zone may take place at a higher velocity, with a higher concentration of radionuclides in the water than through the saturated zone. Eighty-five percent of all nuclear testing on NTS has taken place in this zone. Radioactivity from testing in the unsaturated zone and any contamination from waste storage or disposal on NTS would have to migrate downward through this unsaturated zone before it could enter the groundwater systems.

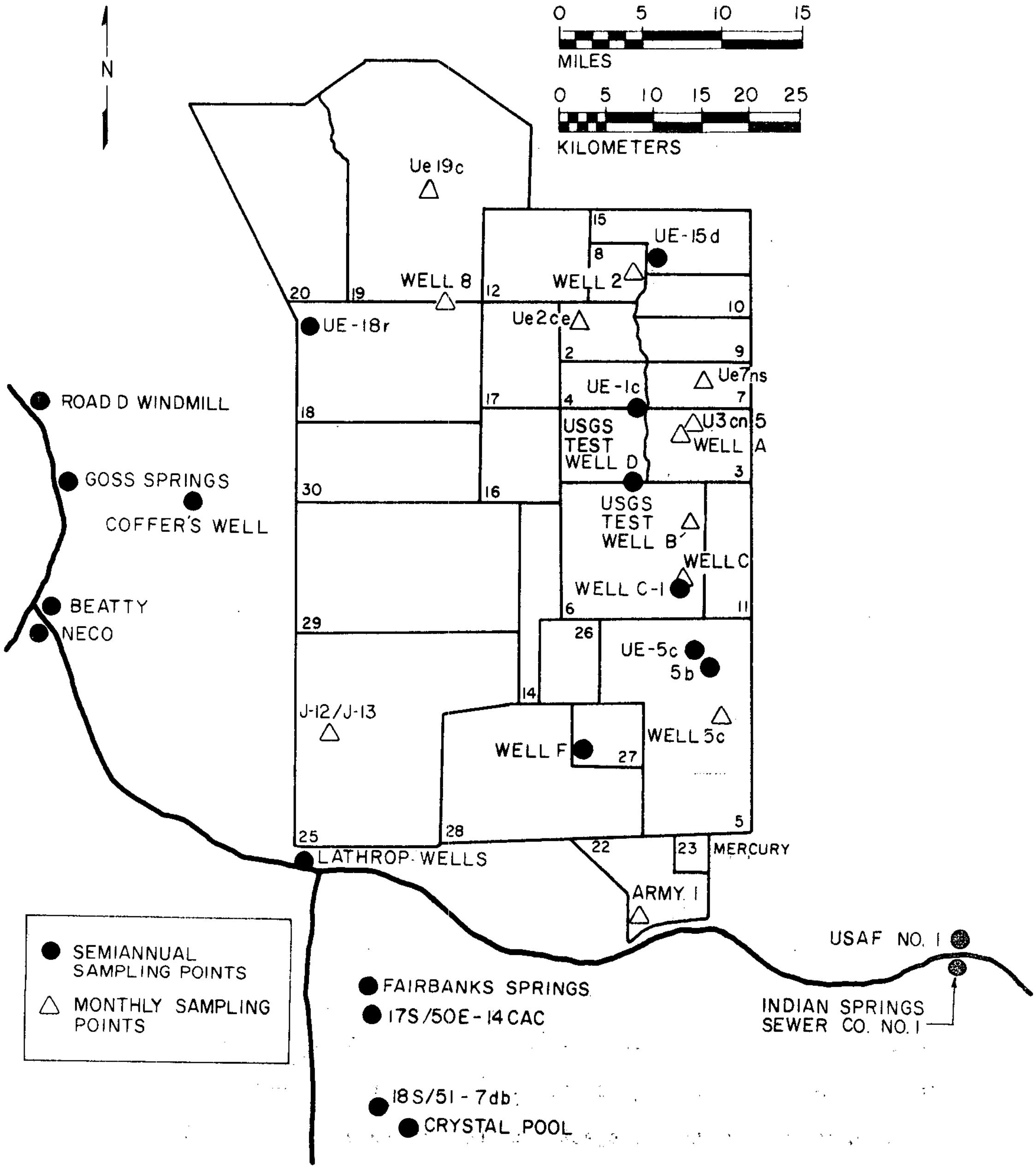

FIGURE II-18 MONITORING NETWORK - NTS AND VICINITY

II.D. THE EXISTING ENVIRONMENT

5. Hydrology (Cont.)

Another study concerns what may be a considerable quantity of direct recharge through the unsaturated zone. The southern part of Yucca Flat is a playa having a flat bed of clay-sized sediment. In 1961 and again in 1969 the playa developed cracks about two kilometers long and up to three meters wide at the surface. These features are believed not to be related to nuclear testing since traces of cracks appear on earlier (pre-testing) aerial photographs of the lake bed. After moderate to intense precipitation, water on the playa pours into the open 1969 crack at rates of several thousand liters per minute. A measurement system was installed and has been operational since 1974 to measure this amount of recharge.

At various times in the past, claims have been made by private, municipal, and industrial owners that their water wells have been damaged by explosions at NTS. Investigations of these claims can only rarely be conclusive, but in most cases, allegations of declining yield or deteriorating quality appear to correlate better with areas in which overdevelopment has dewatered the freshest and most productive aquifers.

Sudden failures of casing in some wells in Las Vegas Valley and elsewhere similarly seem more related to land subsidence caused by overdraft pumping. Detailed field experiments between 1968 and 1972 confirmed that fluid-pressure oscillations caused by seismic waves do result in surging of water into and out of wells, often causing temporary increases in turbidity of the water. Wells so affected, however, pump measurably turbid water under normal conditions, indicating improper screening in unconsolidated deposits. Experience with the 17 supply wells at NTS, some of which have been subjected to the severe effects of explosions less than 1.6 kilometers (1 mile) away without damage, indicates that properly constructed wells are not damaged by effects of distant explosions alone.

6. Ground Motion and Structural Response

An unavoidable consequence of underground nuclear testing is the generation of ground motion. In 1963, concern over the possible effects this might have on communities located near the test site and especially on structures within those communities prompted the AEC to initiate an

II.D. THE EXISTING ENVIRONMENT

6. Ground Motion and Structural Response (Cont.)

extensive program to document and analyze ground motion and the response of structures to that motion. The objectives have been to develop theories and methods to accurately predict the ground motion expected from a detonation and the response of structures to the seismic load.

When a nuclear explosion occurs underground, most of the explosion energy is expended in the formation of a cavity. The sequence of phenomena resulting from this is discussed in IV.A.1.a. Early in the explosion history, a strong compressional shock wave is formed and moves outward from the explosion, vaporizing and melting the rocks during the late stages of cavity growth. When the available energy has diminished to a level where cavity growth ceases, the shock wave breaks away from the cavity wall and continues to move outward in all directions. The energy, now less than 5 percent of the total explosion energy, is rapidly dissipated in crushing the rocks out to a distance of several cavity radii. By now, the shock wave has decayed to a longitudinal elastic wave (P) containing less than one percent of the explosion energy. As the P wave encounters discrete geologic interfaces within the earth, a shear component of motion (S) is added through the processes of reflection and refraction. At the free surface, these same processes cause the transformation of some of the P and S wave energy into surface waves (Rayleigh and Love) which will be propagated only at the surface.

Thus, the initial compression-rarefaction shock wave is altered into a complex elastic wave train which at distances beyond 50 kilometers (30 miles) will resemble a natural earthquake. For a more comprehensive discussion of the generation of seismic signals, see Reference 34. The amplitudes of the free surface motions attenuate rapidly with increasing distance from the explosion site. The free surface motions are resolved into three orthogonal components by seismic instruments and the strength of the motion is typified by the observed peak particle acceleration, velocity, and displacement.

By carefully measuring and analyzing the seismic motions from a large number of tests, it has been possible to identify those parameters which influence the characteristics of the ground motion. The geologic environment in which a nuclear explosion is emplaced has a major

II. D. THE EXISTING ENVIRONMENT

6. Ground Motion and Structural Response (Cont.)

influence on the strength of the resulting seismic signal. In general, a dense, hard rock is more efficient in coupling energy into the ground than a porous material. Coupling efficiency is enhanced in porous media if they are saturated with water. The depth of burial of the explosion influences the distribution of the available seismic energy into the various wave modes of the signal. An explosion that is very deeply buried will enhance the high-frequency components more than the low-frequency components.

Because the elastic waves were initially propagated in all directions away from the explosion, there are an infinite number of paths along which the energy is transmitted. Each path is different from all the others owing to the local and regional geology encountered and consequently, the seismic signal will be slightly different in terms of frequency and amplitude characteristics along each path. Furthermore, at a given point on the earth's surface the total seismic signal is made up of a combination of waves which have traveled along a variety of paths including those following the earth's surface. It is necessary to use statistical analysis of observed data to develop methods for predicting ground motion as a function of yield, burst location, and range. It is also known that the local geology at any point on the earth's surface will influence the ground motion characteristics at that point which in turn may impact on any facility located there. A loose, poorly consolidated alluvium layer at the surface will amplify the ground motion in selective frequencies, depending upon the thickness of the layer, and will increase the duration of ground shaking.

Research conducted on these variables of explosion-generated ground motion by the Computer Sciences Corporation (formerly the Environmental Research Corporation) has resulted in procedures and techniques for accurately predicting median values and statistical variations of frequency spectra and amplitudes of ground motion observed at stations around the NTS for underground nuclear tests (Reference 35).

Ground motion effects in terms of acceleration amplitudes, expressed in units of gravity (g), can be broadly ordered as follows:*

*In determining actual ground motion effects, acceleration, velocity, and displacement each must be taken into consideration.

II.D. THE EXISTING ENVIRONMENT

6. Ground Motion and Structural Response (Cont.)

0.00005 g--imperceptible except to seismic instruments

0.0005 g --human perception on high-rise building

0.005 g --human perception on ground

0.05 g --slight damage to structures

0.5 g --severe damage to structures

These levels are not precise owing to the subjective nature of human perception of motion and the wide variety of types of structures encountered. The manner in which the structural elements and materials are arranged and connected, and the height of the structure above ground level, determines the nature of the building response and whether damage may occur.

Ground motion from tests in the megaton yield range can be perceived by persons a few hundred kilometers distant--particularly by persons on the upper floors of high-rise buildings where ground motions generally will be amplified by the structure itself. Slight response motions have been instrumentally recorded in high-rise buildings in San Francisco from events of this yield range on the NTS.

When the base of a structure is suddenly moved, the aboveground portion will not respond immediately but will lag behind because of the inertia and the flexibility of the structure. Flexibility is related to the engineering design, the construction materials used, and how the materials are fastened together. These factors, along with other physical paramters parameters such as the dimensions of the base and the height, determine the fundamental period free vibration at which the structure will oscillate in response to ground motion. The amplitude of the structural response motion is dependent upon the spectral composition and duration of the ground motion. When a tall structure is subjected to seismic motions, it exhibits a resonating behavior and the displacement amplitude at the roof is several times greater than the displacement amplitude at the ground level. For example, an event in the one-megaton yield range produced a horizontal displacement amplitude of 0.5 centimeters at the base of a 250-foot-high Las Vegas hotel; the roof was dynamically displaced 1.24 centimeters.

II.D. THE EXISTING ENVIRONMENT

6. Ground Motion and Structural Response (Cont.)

Structural response research over the past decade by URS/John A. Blume & Associates, Engineers, a NV contractor, has led to the development of techniques for predicting the amount and character of building response motions, the amount and kind of architectural damage that may result, and the maximum levels of motion to which a building may be subjected before structural damage occurs (Reference 36).

Actually the damage caused in surrounding communities due to ground motion has not been an acute problem. Experience has shown that damage to engineered structures such as dams, bridges, transmission towers, and surfaced highway facilities has been negligible despite repeated exposures to ground motion. Transmission towers and highways on the NTS are relatively invulnerable to very strong motions. Offsite, there is a small risk of some moderate architectural damage to a few identified structures near the NTS from tests of yields near one megaton. These are few in number because of the small number of buildings near the test site and because offsite motion is not sufficiently severe to damage most structures. Occasionally, special precautions are exercised at some old stone or adobe buildings. For example, the Exchange Club at Beatty, Nevada, a two-story adobe-wood structure, has been cleared of persons for several large tests although no damage has ever been observed.

Experience has shown that tests above 100 kilotons yield may cause minor architectural damage in nearby communities. Since the start of the underground nuclear testing program through December 1976, AEC and ERDA have acknowledged 316 cases of credible damage to offsite structures and has paid a total of $114,616 in claims. The vast majority of claims are for nonstructural damage to low-rise and residential structures. This damage is principally in the form of new and aggravated cracks in dry wall and plaster interior walls. Other damage consists of cracks in stucco and masonry exterior walls, cracked concrete slabs, cracks in swimming pools, broken windows, broken bric-a-brac, and misalignment of mobile homes.

Minor nonstructural damage has been acknowledged at four high-rise structures in Las Vegas. The damage consisted of minor cracking in architectural partition walls, cracked sliding glass doors, cracks in a masonry sun screen, and dislodgment of decorative marble fascia.

II.D. THE EXISTING ENVIRONMENT

6. Ground Motion and Structural Response (Cont.)

There are 14 metal and nonmetal mines situated within 50 kilometers (31 miles) of the test site boundaries. Of these, generally about five are worked on a regular or continuous basis and the others are worked intermittently in response to the mineral market. Three of the mines are open-pit operations and the rest are underground mines. The damage to mines has been the subject of a continuing program by the U.S. Bureau of Mines for over a decade. That program consists of pre- and postshot detailed examinations of mines within 50 kilometers (31 miles) to determine the nature and extent of any damage that could result from ground motion produced by underground nuclear tests. To date, there has not been a single credible case of damage to offsite mines.

The Climax Tungsten Mine, located in the northeast corner of the NTS, acquired by the government after high tungsten prices in 1956 had permitted economic extraction of most of the ore body. An inspection of that mine in 1964 revealed that an adit on the mine property had partially collapsed because the adit was in badly decomposed granite. Another inspection was done by the USBM on June 28, 1966, following PILE DRIVER, a 56-kiloton test in granite on June 2, 1966, about 750 meters (2,500 feet) south of the Climax Mine. At that close range, ground acceleration had been in excess of ten times the acceleration of gravity. That inspection revealed that the same adit showed additional spalling. For other tests as close as 5 kilometers (3 miles), there has been no further evidence of spall or other damage.

Early in the underground nuclear testing program, there was concern about the vulnerability of Hoover Dam. Because of the distance involved (approximately 210 kilometers (130 miles) from Pahute Mesa), the largest acceleration measured at the dam was 0.0034 g. Early investigations found that such small seismic disturbance would have no significant effect upon the massive structure involved. More recently, concern has been expressed about the effects test induced ground motion might produce upon the Southern Nevada Water System. The System employs pumping stations, treatment plants, tunnels, vertical shafts, storage reservoirs, surge chambers, and an extensive underground distribution system. No damage has been observed at any of these facilities even from the largest underground nuclear test.

II. D. THE EXISTING ENVIRONMENT

7. Natural and Stimulated Seismicity

The southern Nevada region is generally characterized as an area of moderate seismic activity. However, it is influenced by two zones of continuous high seismicity--the San Andreas fault system extending along the entire California coast from the Gulf of California to San Francisco, and a fault system extending from southern California to north-central Nevada (Reference 37). Because of its proximity to these seismically active zones, the region lies astride the Zone 2-Zone 3 boundary of the 1969 NOAA Seismic Risk Map (see Figure II-15 in Reference 38).

There have been some 4,000 earthquakes recorded between 1900 and 1974 within an area of approximately 246,000 square kilometers (95,000 square miles), an approximate 5° grid, centered about the NTS (Reference 39). Most of these earthquakes were small, inconsequential events. Only 21 had magnitudes of 5.5 or larger (Figure II-19 and Table II-1) and the closest event to the test site had a magnitude of 5.6 and occurred about 132 kilometers (82 miles) to the west on February 11, 1949. The largest event on record was the Owens Valley earthquake of 1872. The event had a magnitude estimated at 8.3 and the epicenter was located about 160 kilometers (100 miles) west of NTS.

The earliest recorded earthquake whose epicenter could be located on the NTS was in January 1935. During the next 26 years to September 1961 (marking the resumption of weapons testing following the self-imposed moratorium of 1958) there were 23 seismic events located on the NTS (less than one event per year), all with magnitudes less than 4.5. From September 1961 to December 1973, there were 390 recorded seismic events located on the NTS. The vast majority of this activity was the result of nuclear tests and aftershocks related to those tests. During this period, there were 322 announced tests conducted at the test site.

It must be realized, however, that prior to World War II, there were few, if any seismograph stations located in this region and detection of earthquakes for the southwestern United States was dependent upon a network operating in California. It was not until the early 1960's

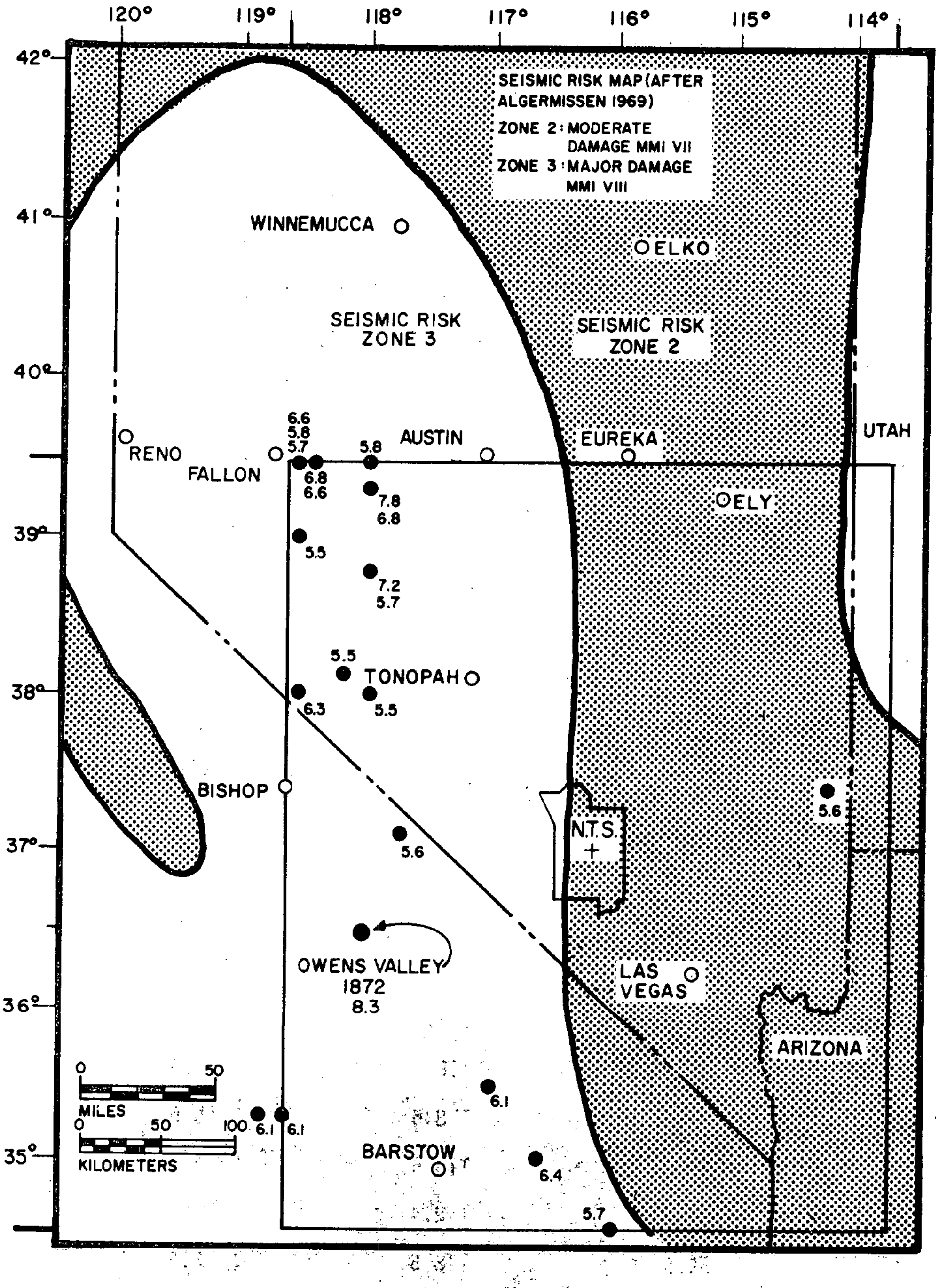

FIGURE II-19 SEISMIC EVENTS OF MAGNITUDE GREATER THAN 5.5 LOCATED IN THE VICINITY OF THE NTS

II. D. THE EXISTING ENVIRONMENT

7. Natural and Stimulated Seismicity (Cont.)

Table II-1

MAGNITUDE 5.5 AND LARGER EARTHQUAKES
OCCURRING NEAR THE NTS SINCE 1900*
(WITHIN A 5^{o} GRID)

Date	Latitude	Longitude	Magnitude	km Distance From NTS Center
11/10/16	35.5	117.0	6.1	177
12/21/32	38.75	118.0	7.2	248
1/5/33	38.75	118.0	5.7	248
1/30/34	38.0	118.5	6.3	227
5/11/39	38.0	118.0	5.5	190
8/9/43	38.2	118.2	5.5	217
7/18/46	34.5	116.0	5.7	277
4/10/47	35.0	116.6	6.4	222
2/11/49	37.1	117.75	5.6	132
7/23/52	35.3	118.6	6.1	281
7/29/52	35.3	118.8	6.1	294
7/6/54	39.5	118.4	6.6	336
7/6/54	39.0	118.5	5.5	297
7/6/54	39.5	118.5	6.6	341
8/24/54	39.5	118.4	6.8	336
8/31/54	39.5	118.5	5.8	341
9/1/54	39.5	118.5	5.7	341
12/16/54	39.3	118.0	7.8	299
12/16/54	39.3	118.0	6.8	299
12/16/54	39.5	118.0	5.8	318
8/16/66	37.4	114.2	5.6	189

* The Owens Valley earthquake March 26, 1872, was of an estimated magnitude of 8.3.

II.D. THE EXISTING ENVIRONMENT

7. Natural and Stimulated Seismicity (Cont.)

that seismograph stations were established in this region--generally in support of the underground nuclear test program. Therefore, the seismic data of record may not reflect a true picture of the regional seismicity.

An underground nuclear explosion produces an initial seismic signal which has characteristics similar to those of an earthquake and which can be detected worldwide with appropriate seismometers. In general, an event of 20-kiloton yield or less will produce a seismic signal of body wave magnitude (m_b) of 4.8 or less; an event within the range of 20-kiloton to 200-kiloton yield will produce a signal between 4.8 and 5.7 m_b; and for an event between 200 kilotons and 1,000 kilotons, the signal will be between 5.7 and 6.3 m_b.

All underground nuclear explosions are followed by a sequence of small earthquakes which may persist from hours and days upwards to several months. During the period prior to cavity collapse, most of the seismicity correlates with the deterioration of the explosion cavity. After collapse occurs, the aftershock sequence for smaller-yield events usually ceases completely. For high-yield events, aftershocks will continue to occur in the media surrounding the shot point. In such cases, there is an apparent alignment of aftershock hypocenters with subsurface geologic structures. At one time as many as 34 high-gain seismometers located on and adjacent to Pahute Mesa were utilized in the study of the seismicity preceding and following megaton explosions (Reference 40). These studies have produced the following observations:

a. Ninety-five percent of the stimulated earthquake activity is confined to within 14 kilometers (8.7 miles) of ground zero and to within 5 kilometers (3 miles) of the surface.

b. The distribution of aftershocks appears to be controlled by preexisting geologic structures.

c. The aftershock sequence decays to a background level within a period of several weeks although bursts of activity have occurred several months after some events with yields of about a megaton. In addition, the strongest aftershock is usually two or more magnitude units less than the explosion.

A comparison of the seismic signals recorded from large and small explosions indicate that many intermediate- to high-yield explosions are accompanied by a simultaneous release of natural tectonic stress (Reference 41 and 42). The energy release is postulated to be in the form of triggered movement along preexisting faults within the immediate vicinity of the explosion site. In all reported cases of prompt tectonic release, the magnitude of its seismic signal is much less than the magnitude of the signal from the initiating explosion. Studies on Pahute Mesa subsequent to the high-yield test activity ending in March 1970 indicated that while the series of megaton range tests had prematurely released natural tectonic stress, the seismic activity had returned to a level judged to be normal within two years of the last test--HANDLEY (Reference 37).

The mechanism by which explosions stimulate earthquake activity is not fully understood but within the limits of testing experience, the regional tectonics beyond the immediate test location do not appear to be involved. Small strain alterations have been observed out to distances of about 150 kilometers (93 miles) from most of the low megaton explosions on Pahute Mesa. However, this does not appear to have had any effect on naturally active fault zones which are situated within that range. Beyond 150 kilometers, the observed strain step is comparable in amplitude to the natural earth tide resulting from the gravitational attraction of the sun and moon.

II. D. THE EXISTING ENVIRONMENT

7. Natural and Stimulated Seismicity (Cont.)

It had been suggested that tests in the one-megaton range affect seismicity at distances of hundreds of kilometers (Reference 43). To examine this possibility, the USGS conducted a seismic monitoring program at several areas of known seismic activity located from 100 to 250 kilometers (62 to 155 miles) from the NTS during the execution of several one-megaton range tests. The Fairview Peak area in west-central Nevada located 250 kilometers (155 miles) northwest was monitored during BENHAM; the Silver Peak-Clayton Valley area located 100 kilometers (62 miles) northwest and the Railroad Valley-Grant Range located 100 kilometers (62 miles) northeast were monitored during JORUM (Reference 44).; and the Fishlake Valley area located 100 kilometers (62 miles) west of the test site, just north of Death Valley, was monitored during the HANDLEY event (Reference 45). In none of these cases was there evidence of earthquake stimulation in the active seismic areas observed, following the underground tests.

A comprehensive study (see Reference 37) completed in 1974 examined the regional seismicity and tectonics of the NTS from 1952 through 1973. The results of this study "showed that the underground nuclear testing program did not produce any detectable influence on the natural pattern of earthquake activity except in the immediate areas of the shots."

II. D. THE EXISTING ENVIRONMENT

8. Radiologic Environment

a. Onsite Radioactivity

As explained later in Section II.D.8, a number of contaminated areas have been created by programs at the Nevada Test Site. Because of this situation, an environmental surveillance program was established at the NTS in 1955 by the AEC. In 1966, this program was redefined and reconstituted to reflect the need for data to identify, monitor, and evaluate ambient radioactivity within the NTS in air and water. That intensified program of environmental monitoring and surveillance continues today.

Background whole-body radiation levels from all sources in the southwestern United States, and outside the NTS, typically average 130 millirem per year. In comparison, the general NTS background radioactivity from all sources has increased as a result of testing since 1951. Even so, the resultant exposure rate generally averages no more than 250 millirem per year (excluding RADEX* areas). Currently, there are 55 RADEX areas within the NTS comprising an estimated total of about 23 square kilometers (nine square miles). Areas having high plutonium concentrations have been included in order to minimize the possibility of plutonium uptake by onsite workers. RADEX areas are resurveyed on a quarterly basis if they are less than one year old or once per year if older than one year. This resurvey frequency is maintained so long as radiation levels of 5 millirem per hour or greater exist.

In 1974, a three-phase program was initiated to investigate more thoroughly the atmospheric weapons test areas. The first phase was a historical study to assemble pertinent available information on each event site. The second phase was a preliminary sampling effort along the main downwind transects to locate fallout patterns, determine

*RADEX areas are "radiation exclusion areas," fenced to control access by employees. All areas where radiation levels average five millirem per hour or greater have been designated as such.

the mixture of radionuclides still present, determine plutonium to americium ratios, delineate the concentration of plutonium in soil, and examine the depth distribution. The third phase is planned to more comprehensively sample each area and determine the distribution and inventory of radionuclides present. The program is completed through Phase 2, with one area well into Phase 3.

In areas which have been disturbed mechanically, plutonium has been found to depths of about a meter (3 feet) with the greater plutonium concentrations on the order of one μCi per gram of soil, along with substantial amounts of beta-gamma emitting radionuclides. However, the plutonium in most of the undisturbed areas in on or near the soil surface; concentrations are in the nanocurie or picocurie per gram range. The extent of plutonium distribution in most of these areas in only roughly known; the definition of these distributions still remains to be determined, and only after expenditures of considerable money and time will the distribution and inventory be understood with a reasonable degree of confidence.

Urine bioassay samples from selected NTS workers whose jobs involve a potential for ingestion or inhalation of radionuclides are routinely collected and analyzed. Sampling frequencies are based upon a continuing assessment of the exposure potential. Sampling frequencies vary from annually, quarterly, or monthly to daily in some cases. Urine samples collected are analyzed for one or more specific radionuclides depending upon the nature of the radiological conditions at the work site. Typical analyses involve measurement of gross beta-gamma emitting radionuclides, tritium, and plutonium.

Air sampling data resulting from the operation of the onsite surveillance stations continue to show that the particulate radioactivity collected is primarily due to natural sources and worldwide fallout with the exception of some NTS-related effects in 1971 (residual from BANEBERRY). A network of approximately 23 air sampling stations (Figure II-20) has been operating continuously at the NTS since 1966, primarily at living and major work sites. Analyses of filter media from these stations, collected on a

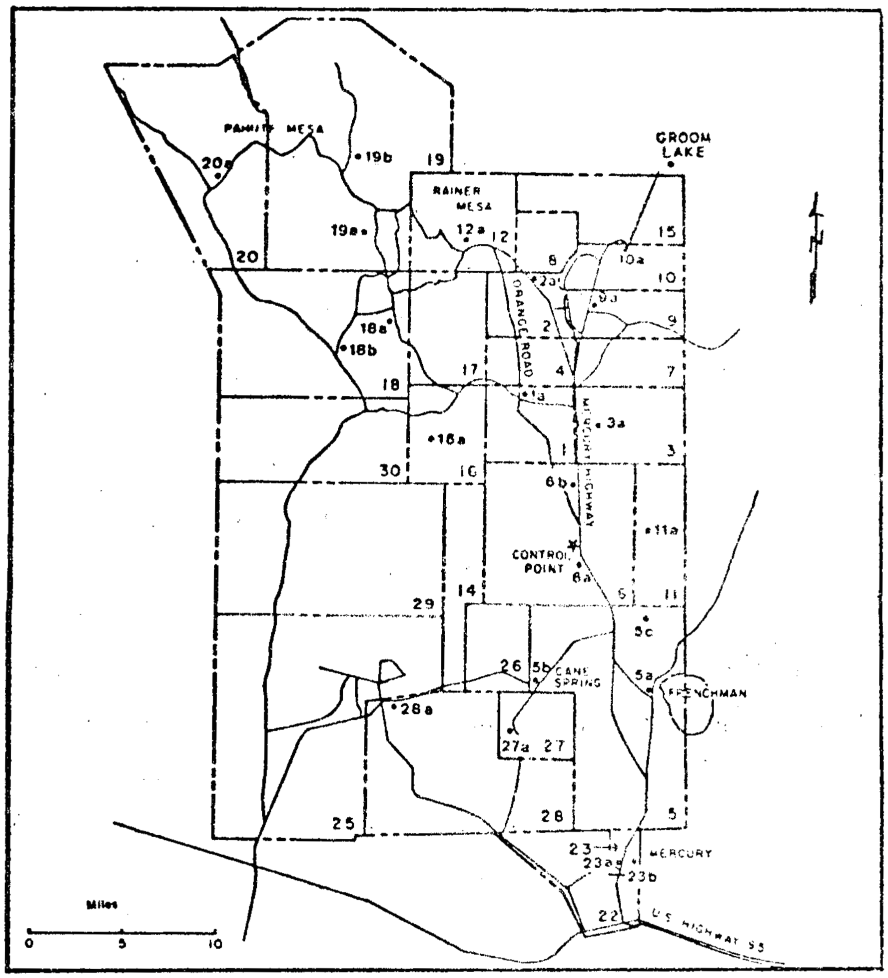

FIGURE II-20 AIR SAMPLING STATION LOCATIONS

Area	Sample Station Location	Map Code
1	Gravel Pit	1a
2	Camp Compound	2a
3	North of Cafeteria	3a
5	East of Well 5B Reservoir	5a
	Guard Station 250	5b
6	Maintenance Complex	5c
6	Air Station	6a
	Well 3 Complex	6b
9	9-300 Bunker	9a
10	Guard Station 700	10a
11	Guard Station 293	11a
12	Changehouse	12a

Area	Sample Station Location	Map Code
16	Tunnel Site Maintenance	16a
18	East of Cafeteria	18a
	North of Cafeteria	18b
19	Echo Peak	19a
	Stake 19C-10	19b
20	West of Aid Station	20a
23	Building 214	23a
	Health & Safety Building Rooftop	23b
27	West of Dispensary	27a
28	Project HENRE	28a
	Groom	
	Lake East of Station 1	

II.D. THE EXISTING ENVIRONMENT

8. Radiologic Environment (Cont.)

weekly basis, have shown no upward trends in particulate radioactive materials and have remained at low levels.

The air sampling stations operate continuously except for a few minutes each week while the filters are changed at which time they are inspected. They are not inspected more often unless there is reason to suspect that a release has occurred onsite. Since onsite activities are under close monitoring at the location of the particular operation, there is nothing to be gained and considerable expenditures saved by the weekly schedule without any sacrifice in safety.

Figure II-21 graphically portrays the trend of the annual means for 1971 thru 1976 period. Sample activity results are compared with an established "alert level." The determination of the alert level is based on the Radiation Concentration Guide (RCG) for unknown radionuclides in air for continuous exposure (168 hours per week) as outlined in ERDAM 0524. The alert level for beta activity is established at 1.0×10^{-11} µCi/ml of air analyzed after a five-day period, to allow for decay of naturally occurring radionuclides.

Water samples for radiological safety testing purposes have been collected from 66 locations at the NTS on weekly, monthly, or quarterly schedules to monitor levels of radioactivity in potable water supplies, supply wells, open reservoirs, natural springs, contaminated ponds, and effluent ponds. The location of these radiological safety sampling points are shown in Figure II-22. These water samples are to be differentiated from those samples which are taken to monitor the radioactivity in groundwater, as mentioned previously in Section II.D.5., Hydrology. Great care is taken in the sampling of groundwater to see that no surface water or worldwide fallout can contaminate the groundwater sample. (Most of the water samples analyzed for radiological safety purposes have been found to be so contaminated.)

Potable water samples have been collected weekly from an average of nine locations within the NTS. These locations consist of cafeterias, rest rooms, fire stations, and dispensaries. Figure II-23 graphically portrays the trend of the data.

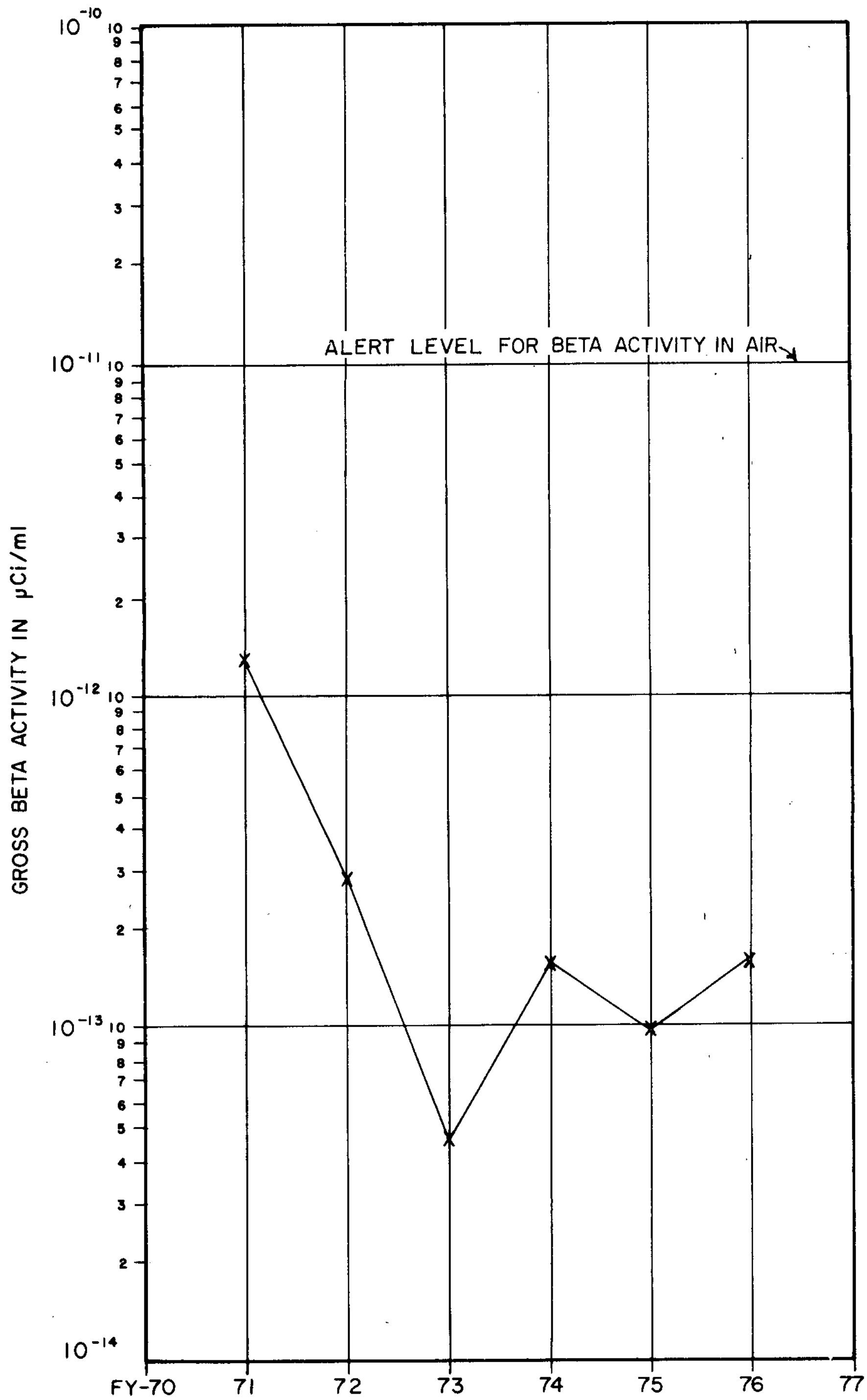

FIGURE II-21 ANNUAL MEANS OF NTS ENVIRONMENTAL AIR SAMPLE RESULTS

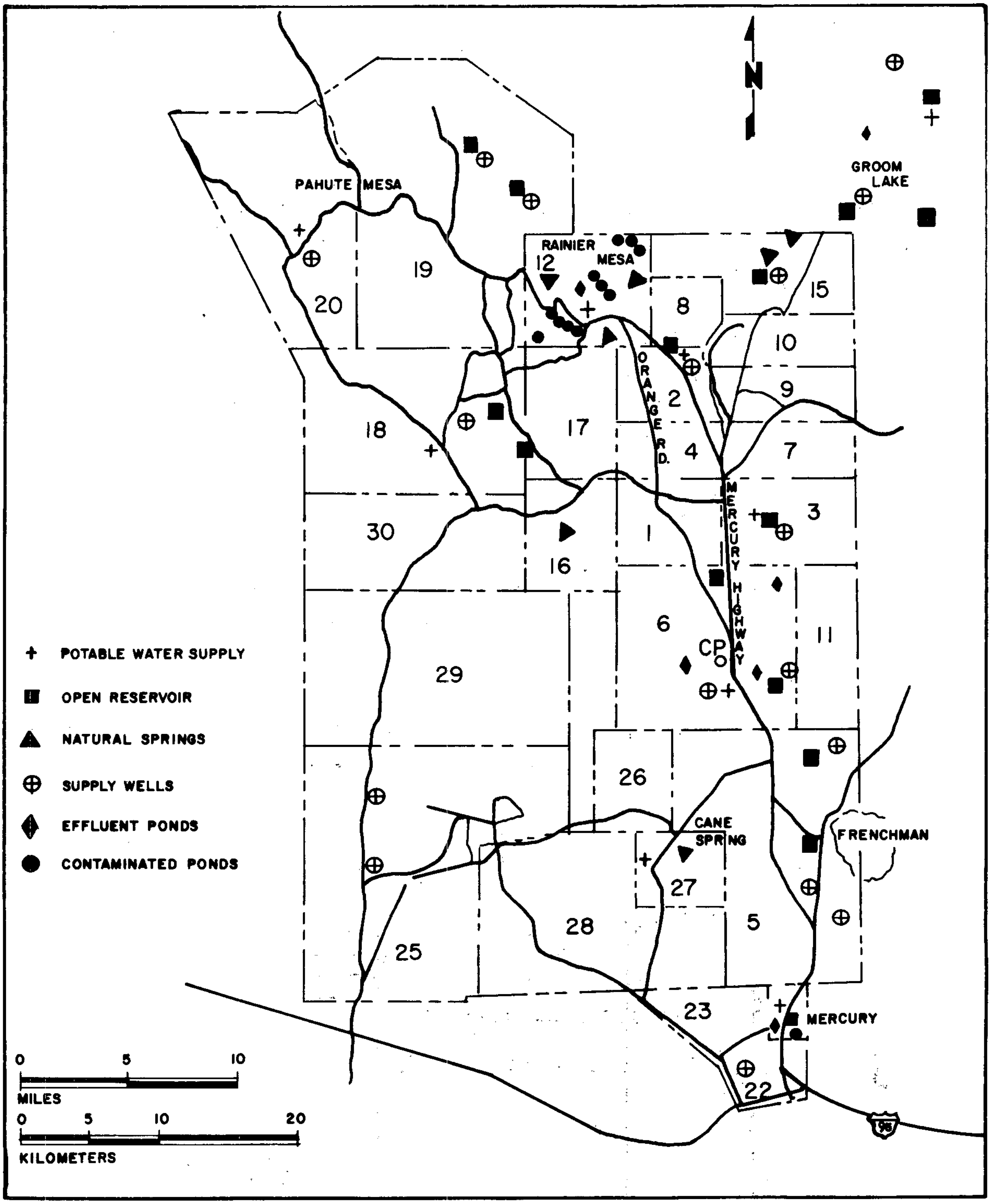

FIGURE II-22 ENVIRONMENTAL/RADIOLOGICAL SAFETY WATER SAMPLING LOCATIONS

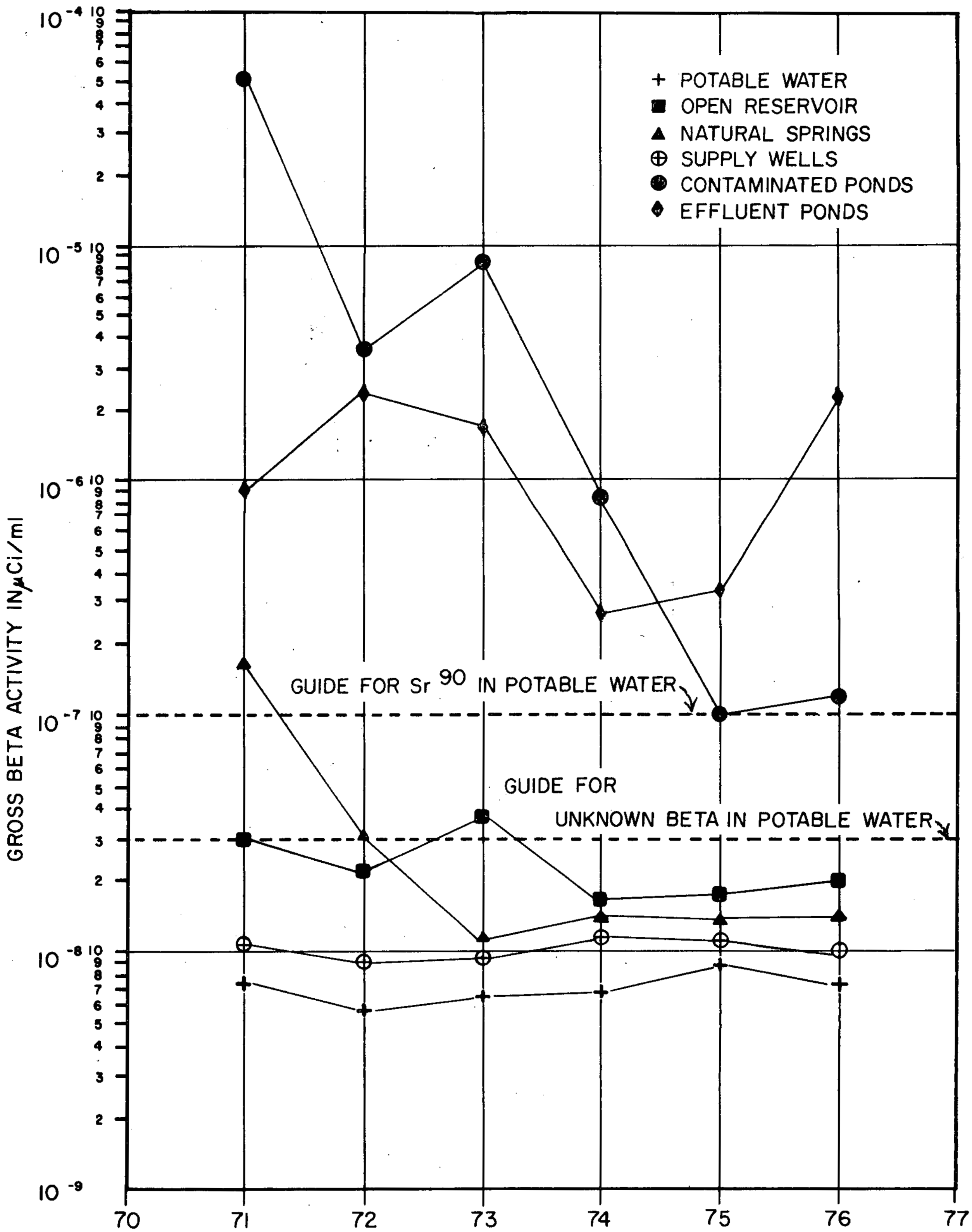

FIGURE II-23 ANNUAL MEANS OF NTS ENVIRONMENTAL WATER SAMPLING RESULTS

II. D. THE EXISTING ENVIRONMENT

8. Radiologic Environment (Cont.)

The term "natural springs" encompasses most of the naturally occurring spring-fed pools located within the NTS. Although these springs may be used occasionally as drinking water by some individuals, they are considered as a separate classification from potable water sources. In an effort to adequately represent surface water conditions at the NTS, seven sampling locations have been selected, and all of these are sampled monthly. A graphic display of the trend of these data is also shown on Figure II-23.

NTS open reservoir data are also displayed in Figure II-23. Open reservoirs have been created throughout the NTS to furnish a ready supply of water for various industrial purposes. Fifteen of these reservoirs have been selected as monthly sampling locations.

Figure II-23 also presents the results of NTS supply well water samples. Seventeen supply wells were sampled on a monthly basis. Water from these and other wells throughout the NTS is used for a variety of purposes ranging from sanitary water supply to drilling mud preparation. The criteria for selecting the particular wells to be sampled were based upon their potential use for human consumption, and also to indicate the possible movement of radioactivity through the groundwater aquifer. Most of these wells are located in areas where the movement of water in the aquifer is from known contaminated test areas. To date, the available data have not indicated movement of contamination through the aquifer.

Figure II-23 also summarizes the latest available data from contaminated and effluent ponds for the shown period. Eighteen locations were sampled to determine the trends in the levels of radioactivity in these storage ponds.

The existing average levels of gross beta radioactivity in NTS potable water samples are considerably less than the most restrictive radioactivity concentration guides in ERDAM 0524. The concentration guide for gross radioactivity in potable water and supply wells is taken as 3×10^{-8} μCi/ml.

II. D. THE EXISTING ENVIRONMENT

8. Radiologic Environment (Cont.)

In addition to the data discussed above, additional types of samples have been collected over the years as part of a routine environmental surveillance program. Since the sample locations have varied considerably, condensed summaries of these data cannot be presented. However, the results observed from various soil, vegetation, and ion-chamber measurements of air samples over the years indicate no radiological hazards to employees on the NTS.

Tritium is present onsite in tunnel drainage ponds containing water removed from tunnels where nuclear explosions have taken place. Tritium concentrations in these ponds fluctuate, but have decreased approximately 20 percent in the last five years. Very little test-related contaminated liquid has been added to these ponds during this period; the decrease in levels is due to evaporation, decay, and dilution. Typical tritium levels in these drainage tunnel ponds are less than 10^{-3} μCi/ml. (The Radiation Concentration Guides (ERDAM 0524) for tritium for an average of samples from water suitable for the general public is 1×10^{-3}μCi/ml.)

Tritium levels in drinking water from wells at the NTS are similar to tritium levels in public water supplies throughout the United States and are less than 0.01 percent of the Radiation Concentration Guides (ERDAM 0524). The highest level of airborne tritium concentrations at the NTS is much less than 1 percent of this concentration guide.

The vast preponderance of the radioactivity resulting from nuclear tests at the Nevada Test Site remains in deep underground locations. Subsequent to device detonation, one or more reentry holes are usually drilled back into the underground radioactive debris formed by the explosion. Samples of the debris are brought to the surface for radiochemical analysis to determine the device yield. During this sample recovery, small quantities of volatile radionuclides are brought to the surface along with the debris sample. Several hundred curies of radioactive noble gases (primarily xenon-133) have been released per year in the past during routine drillback operations and tunnel

II.D. THE EXISTING ENVIRONMENT

8. Radiologic Environment (Cont.)

ventilations. To minimize the release of the volatile radioactivity to the atmosphere, the testing laboratories have developed effluent control equipment which either forces the gases back down into the ground or filters the gases through high-efficiency filters and activated charcoal systems to trap particulate debris and radioiodine before the gases are released to the atmosphere. When radioactive gases are detected in a tunnel following a tunnel detonation, a comparable system of filters is used when the tunnel is ventilated for safety purposes prior to reentry. Over the past two years, the concentrations detected offsite have been less than 0.01 percent of the Radiation Protection Guide.

The amounts of noble gases, and particularly of krypton-85, environmentally present worldwide have been increasing steadily due to a variety of sources. (The present world inventory of airborne krypton-85 is estimated at about 100 mega-curies.) Diffusion-type seepage of noble gases from past underground test sites is making a relatively small contribution to this inventory. While radioactive noble gases are detectable in air within and around the NTS, those levels are not statistically different from levels reported from elsewhere throughout the United States (about 17 pCi/m^3). In turn, these worldwide concentrations are low compared to the Radiation Protection Guides and, although not considered a health hazard, they are monitored by the Environmental Protection Agency and others.

Government vehicles and facilities are surveyed on a quarterly basis supplemented by spot checks using portable radiation detection instruments. Alert levels have been established for fixed beta-gamma emitters at 0.4 millirad per hour, as measured with Geiger-Mueller-type instruments with a detector window thickness of less than seven milligrams per cm^2. For fixed alpha emitters, the alert level is set at 1,000 disintegrations per minute (DPM)* over 100 cm^2 of surface. Dry swipes are collected

*1,000 dpm is equal to 450 picocuries (pCi).

II. D. THE EXISTING ENVIRONMENT

8. Radiologic Environment (Cont.)

for loose contaminants and the alert levels are established at 1,000 dpm for beta-gamma emitters and 100 dpm for alpha emitters for 100 cm^2 of area swiped.

Residual radioactivity also exists at the Area 25 facilities as a result of past nuclear rocket engine testing programs. In total, there are 14 fenced areas which are identified and marked in Area 25. These are controlled in the same manner as the RADEX areas already identified on other parts of the NTS.

b. Safety Tests

Safety tests have been performed since 1955 to determine the behavior of nuclear weapons in conventional explosive accidents during handling, storage, and transport operations. Plutonium or uranium and mixtures of the two are the major elements utilized in these tests. The major purpose of most of these safety tests is to ensure that if nuclear weapons are involved in an accident, they will not produce nuclear explosions as a result. Before 1963, the tests were done at or near ground surface at locations within government-controlled land on the NTS, the Nellis Air Force Range, and the Tonopah Test Range.

Prior to 1963 there were also safety tests to determine the size and distribution of plutonium particles which might result from fires and conventional explosive accidents involving nuclear weapons. Associated with some of these safety tests were experiments to determine biological uptake of plutonium by various species of animals positioned downwind from locations at which plutonium particles were dispersed. These biological experiments were intended to study the health physics aspects of dispersed plutonium oxide. Another series of experiments, which was designed to examine rapid physical changes in various plutonium configurations subjected to chemical explosions, led to the dispersal of small quantities of plutonium.

II. D. THE EXISTING ENVIRONMENT

8. Radiologic Environment (Cont.)

The areas where the early safety tests were performed are unique in that the contamination which remains there is for the most part plutonium and uranium with very little contribution from fission products. Americium and other transuranic elements are also present. Fission products are present in some areas due to the fact that some of the safety experiments were intended to establish benchmarks between non-nuclear explosive accidents and accidents in which some nuclear explosive energy was released. Some safety tests in the latter category did produce small amounts of fission. Fallout from atmospheric weapons tests conducted on other parts of the test site during the atmospheric testing days and worldwide fallout also contribute to the fission product inventory. Following is a brief description of the testing done in the five safety shot areas as depicted on Figure II-24:

In the GMX area, 22 experiments, each utilizing relatively small quantities of plutonium, were conducted during 1962. These experiments were so-called "equation-of-state" studies where "instantaneous" changes in the physical properties of plutonium materials subjected to detonations from conventional explosives were measured. These experiments were conducted on or very near one place so that essentially the source can be considered to be at one site.

In Area 11, Plutonium Valley, contamination resulted from four safety tests in 1956 at sites separated by a few hundred feet, but with considerable overlap of "fallout" from the tests among the test sites. The quantities of plutonium and uranium deposited there were typical of nuclear weapons and hence were large, with from one to ten kilograms of plutonium dispersed by each test.

Contamination in Area 13 was deposited by one test in 1957. A relatively large amount of plutonium was used for the test.

Tests at the Roller Coaster sites on and near the Tonopah Test Range each utilized moderately high amounts of plutonium or plutonium combined with uranium. There

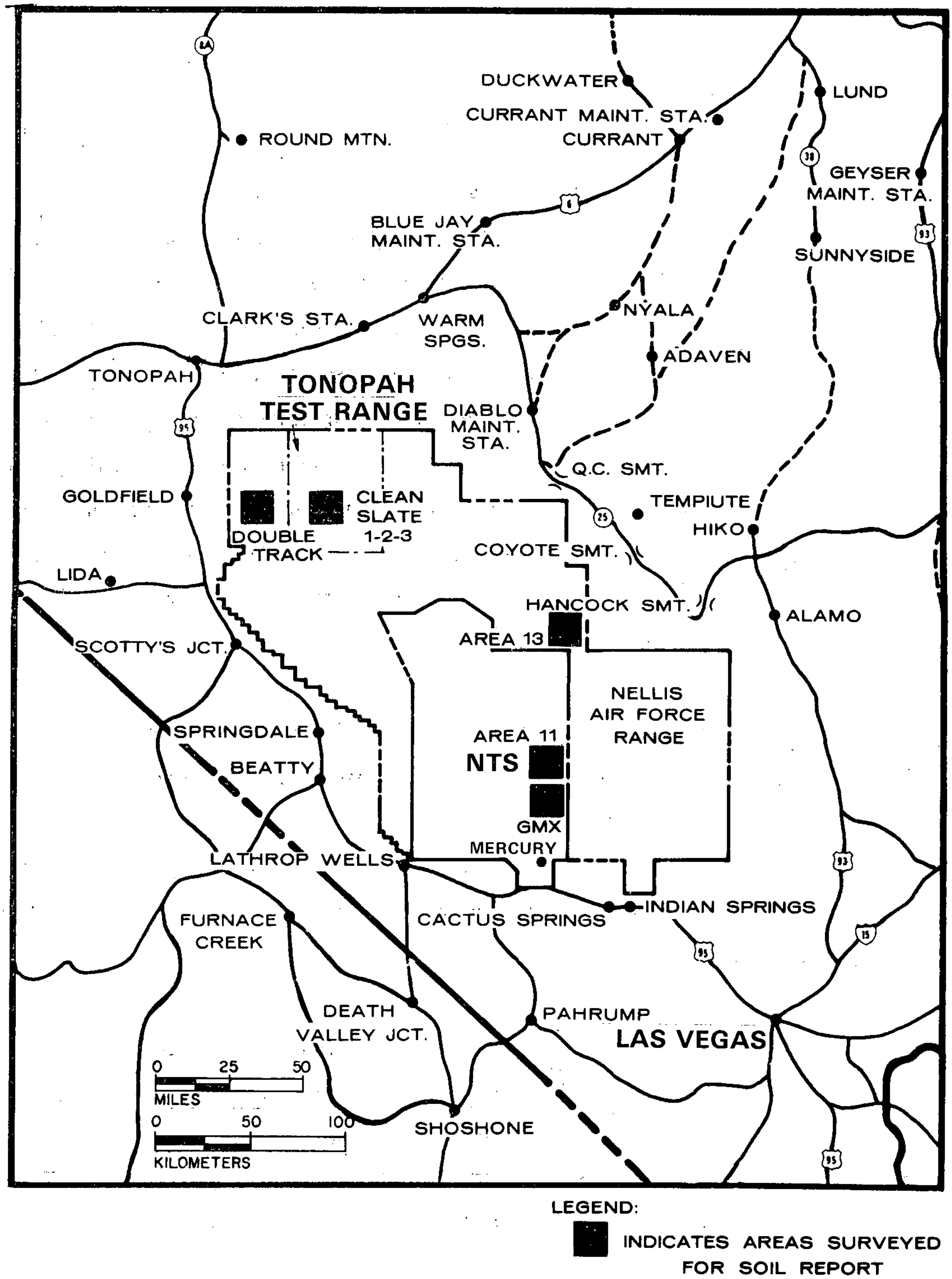

FIGURE II-24 SAFETY-SHOT AREAS STUDIED

were four tests, each consisting of one event: Double Track and Clean Slates 1, 2, and 3. The Clean Slate sites are separated from each other by several hundred feet, and the Double Track site is several miles from those sites, so that these can be considered four separate sites.

Safety tests were also conducted in Areas 3, 7, and 9 in 1957 and 1958, resulting in some plutonium contamination in these areas. Contamination from plutonium and other radionuclides also persists in other areas on the Nevada Test Site where atmospheric weapons tests and near-surface Plowshare tests have been conducted in the past.

Safety tests are no longer conducted aboveground; all tests, including those for determining safety, are detonated underground in emplacements that are designed so that the maximum yields that could conceivably be expected will be contained, and so that radioactive materials will not reach aboveground environments.

c. Ecological Studies of Plutonium and Other Radionuclides

The aboveground areas where safety experiments have been conducted in the past offer unique sites for studies of the behavior of plutonium in the natural desert environment. Recognizing this, the Nevada Operations Office intentionally has preserved these sites. Since 1970, there have been interdisciplinary studies of the behavior of plutonium in the NTS environment. That interdisciplinary studies program is conducted by the Nevada Applied Ecology Group (NAEG), which includes principal investigators from 16 organizations:

Environmental Protection Agency's Environmental Monitoring and Support Laboratory
University of California at Los Angeles
Oak Ridge National Laboratory
University of Nevada, Las Vegas
Reynolds Electrical & Engineering Co., Inc.
LFE Environmental
EG&G

II.D. THE EXISTING ENVIRONMENT

8. Radiologic Environment (Cont.)

McClellan Central Laboratory (McClellan AFB)
Eberline Instrument Corporation
Los Alamos Scientific Laboratory
Lawrence Livermore Laboratory
Battelle Northwest Laboratories
Battelle Columbus Laboratories
Air Resources Laboratory
Desert Research Institute
Holmes & Narver

Details of the studies of this interdisciplinary group and related information have been presented elsewhere (References 46 through 51). However, a brief summarization of information from these studies follows. Also, such topics as "Onsite Radioactivity" (Section II.D.8.a), "Offsite Radioactivity" (Section II.D.8.e), and "Bioenvironment" (Section II.D.9) in this Environmental Statement are related closely to these ecological studies, and results from all of these efforts are incorporated into evaluations of distribution, movements, and impact of radionuclides on and near NTS.

The studies on the surface safety-shot areas are designed to provide data on the movement of plutonium and other radionuclides through living and nonliving components in varied sites in Mojave and Great Basin desert environments on NTS. These sites have been exposed to natural environments and weathering processes for 13-20 years.

An intensive soil sampling program has been done in some of the areas referred to previously. As an example of the results, Table II-2 gives inventories of plutonium in soil based on surface soil samples (top 5 cm) and on random profile samples. Figure II-25, showing radioactivity contour estimates for a close-in area at Area 13, is an example of the characteristic decrease of plutonium deposition with distance from ground zero.

Another area of study has been the transport of plutonium through entrainment or "resuspension" in air. Throughout the world small amounts of radioactive materials, including particulate plutonium, are found suspended in the air. At the NTS, resuspension measurements of radioactive materials in the air show that on the average extremely low quantities (on the order of a billionth) of these surface materials are being resuspended in air above the study sites. The techniques and instrumentation used in these

II. D. THE EXISTING ENVIRONMENT

8. Radiologic Environment (Cont.)

TABLE II-2

INVENTORIES OF PLUTONIUM IN SOIL

Site	Area of Study Sites (Hectares	(Acres)	Estimated Pu* (Curies ± 1σ)	Concentrations Near Ground Zeros (μCi/m^2 ± 1σ)
DOUBLE TRACK	30.1	74.3	5.0 ± 1.4	2,800 ± 1,000
CLEAN SLATE I	22.2	54.8	5.2 ± 1.6	120 ± 39
CLEAN SLATE II	79.4	196.1	29 ± 6.2	260 ± 65
CLEAN SLATE III	136.4	337.1	30 ± 4.9	370 ± 190
AREA 13	362.6	896.0	44 ± 8.8	820 ± 340
AREA 11	483.1	1,193.7	39 ± 4.4	6,200 ± 2,800
GMX	24.3	60.0	2.5 ± 0.3	4.6 ± 1.6
TOTAL	1,138.1	2,812.0	154.7	

* One Curie equals 16 grams of plutonium 239.

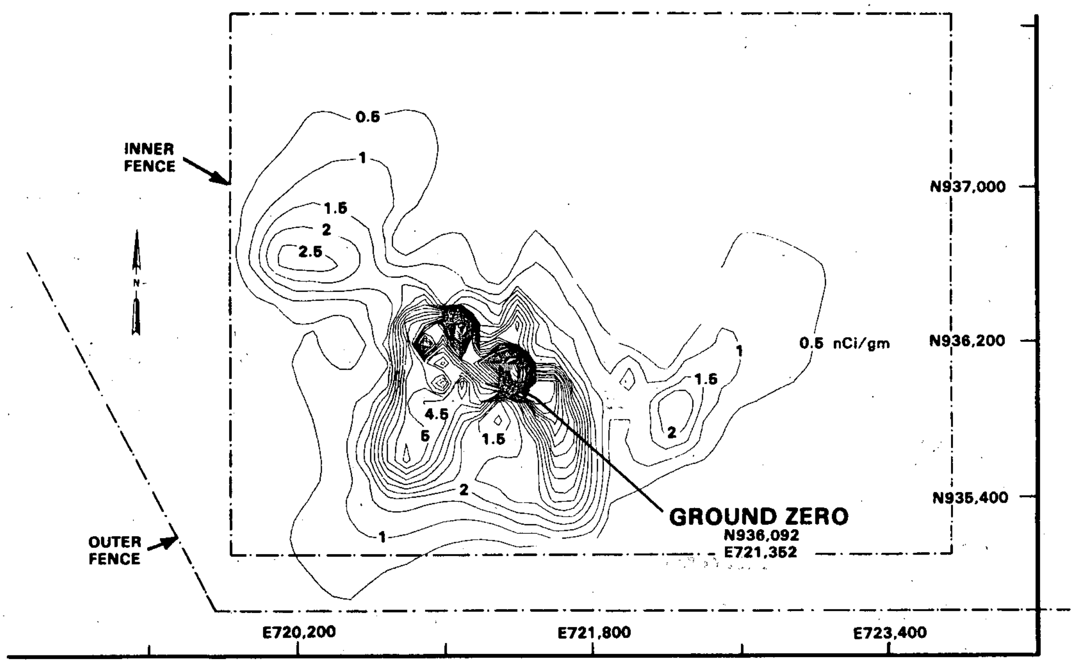

FIGURE II-25 ESTIMATED ISOPLETH LINES OF $^{239-240}Pu$ BASED ON RANDOM SOIL SAMPLES - AREA 13

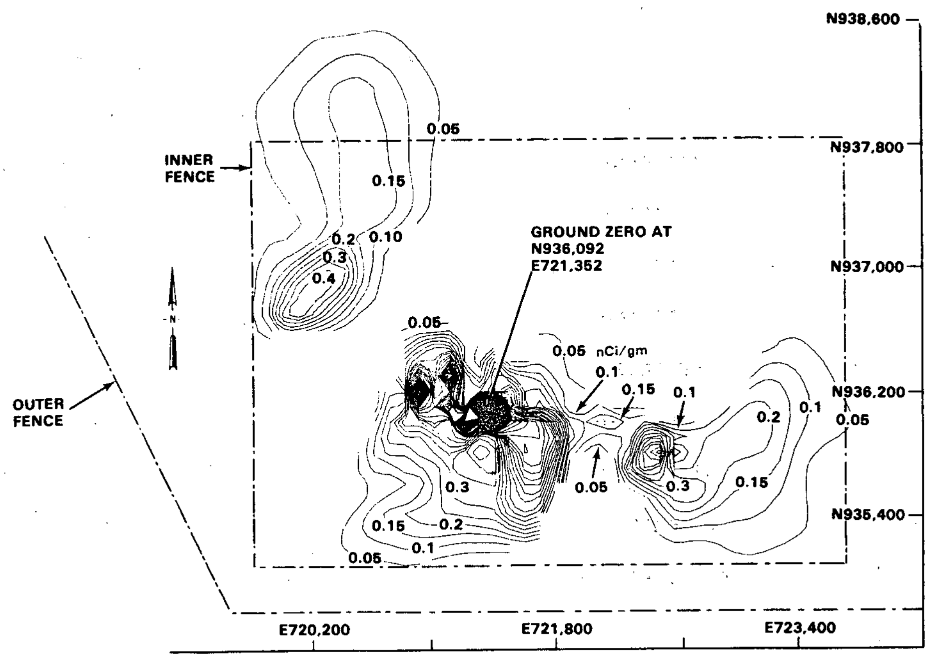

FIGURE II-26 ESTIMATED ISOPLETH LINES OF $^{239-240}Pu$ BASED ON RANDOM VEGETATION SAMPLES - AREA 13 measurements are discussed in References 46 and 47, in articles prepared by P. L. Phelps and L. R. Anspaugh, respectively. Possibly these levels are particularly low because the areas are vegetated and have stable soil surfaces, thus allowing little soil erosion by wind, even at high wind speeds. Concentrations of radioisotopes in air decrease by orders of magnitude within a few thousand feet, as the suspended particulate settles to the ground. (Figure II-27 is an example of the decrease at one study area). For most places on the NTS and for all offsite locations, air concentrations are close to worldwide levels. Offsite measurements show no radioisotope concentrations which are statistically above those measured for many years. These observations appear to indicate that no detectable quantities of radioactive material now are leaving the site via atmospheric resuspension (see Section II.D.8.e, "Offsite Radioactivity"). Biota residing in the study areas and being measured for radionuclide concentrations include vegetation, microorganisms, and large and small vertebrates. Radionuclide levels in and on vegetation correlate relatively well with levels in soil (compare, for example, Figure II-26 with Figure II-25). The greatest amount of radionuclides measured for vegetation is contributed by radioactive dust <u>on</u> the vegetation rather than by radioisotopes taken up into the plants through the roots. The discrimination ratio against plutonium being absorbed <u>into</u> the plants by way of root uptake, for instance, is of the order of 10^{-5} as compared to the amount in the soil. Radioactivity levels on various species of plant surfaces can vary by four orders of magnitude, depending mainly on the ability of external surfaces of the plants to retain particles. The inventory of plutonium for plants in the study areas, in comparison to the inventory for soils, is very small. For example, the inventory of plutonium for plants in Area 13 is only 0.00264 curies, compared with the Area 13 soil inventory of 44 curies.

Microorganisms appear capable of absorbing radionuclides to relatively high levels. Spores of soil fungus, *Aspergillus niger*, accumulated about three times more plutonium from nitrate and citrate forms of plutonium than from plutonium dioxide. Moreover, concentrations of plutonium in the spores was only about one order of magnitude less than the concentrations in the culture media, regardless of chemical form or acidity.

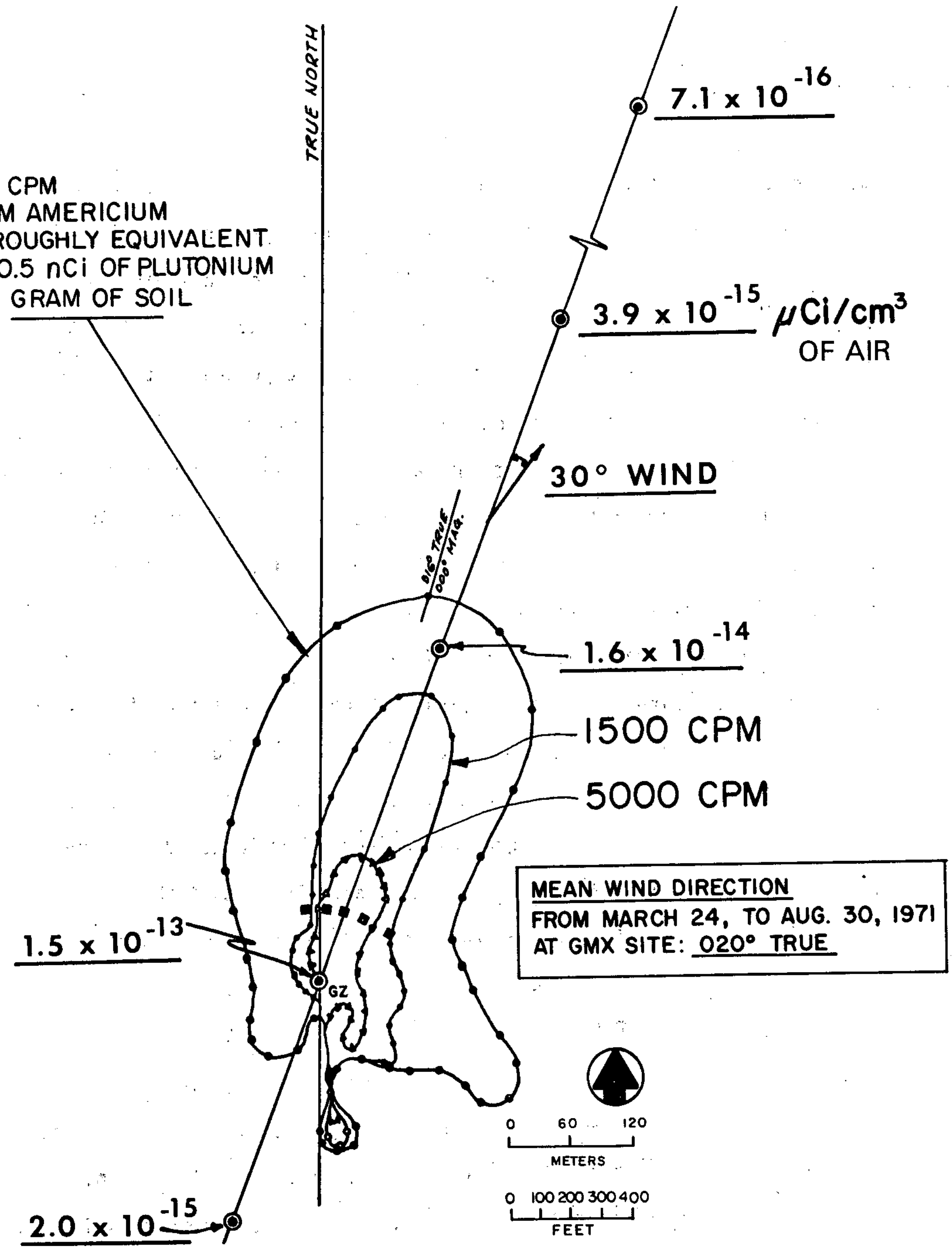

FIGURE II-27 PLUTONIUM RESUSPENDED IN AIR

Typical measurements made June 13, 1973, along mean wind direction.

II.D. THE EXISTING ENVIRONMENT

8. Radiologic Environment (Cont.)

Radioactivity levels in vertebrates vary considerably with species, their habitats, and residence time on the areas. In general, however, the quantities of radionuclides on external surfaces (skin and hair) and in the gastrointestinal (GI) tracts correlate well with the contaminated environments in which the vertebrates reside. Radioactivity levels of plutonium on external surfaces and in the GI tracts are at about the same level or one order of magnitude less than in the soil (on a dry-weight basis). Plutonium levels in tissues range from about three to five orders of magnitude less than the levels in soil. These low levels of plutonium in tissues again are explicable because of the high discrimination against plutonium (and other transuranics of interest here) being absorbed from lungs or GI tracts.

Correlative experiments with transuranic elements at the ERDA farm on the NTS, and results for a beef herd grazing on Area 18 and for wildlife from NTS, also demonstrate high discriminations (10^{-4}-10^{-5}) against transuranics. Figure II-28 illustrates the high discrimination against plutonium dioxide chronically fed to cattle in a carefully controlled experiment at the farm; as shown, all but an extremely small quantity of the oral dose is excreted rapidly via feces.

Additional discussion of radionuclide distribution around the NTS is included in Section II.D.8.e, "Offsite Radioactivity."

After evaluation of present knowledge of potential hazards of plutonium and other radionuclides disseminated into the natural environments examined so far at NTS, the degree of hazard appears to be extremely low, in comparison with hazards alleged in some publications wherein recent scientific data from actual contaminated environments were not available. Even so, there should be concerns about releasing substantial quantities of radioisotopes into environments, especially those radioisotopes with long physical half-lives which will accumulate in environments receiving even low-level chronic inputs of those materials.

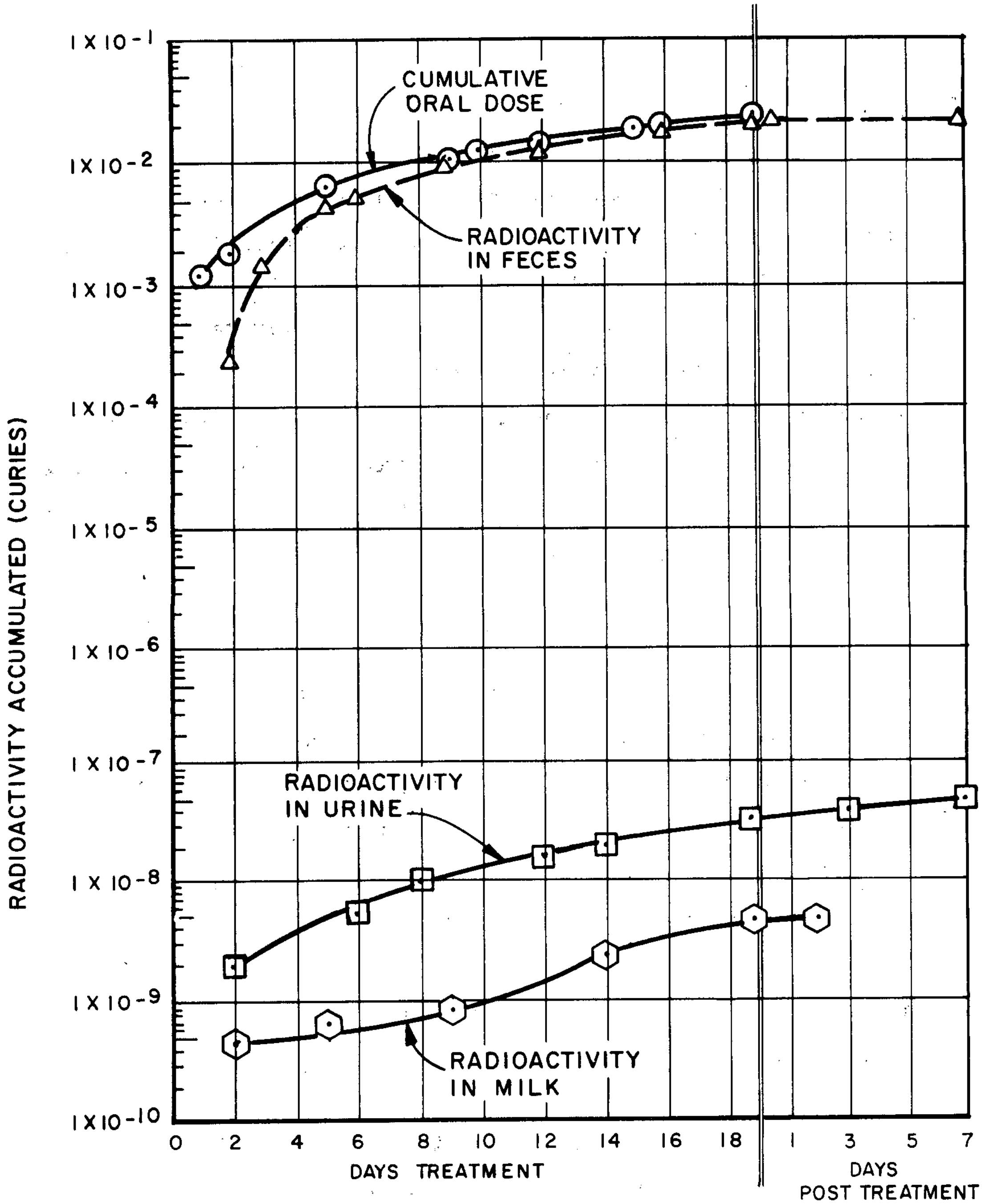

FIGURE II-28 PLUTONIUM FED TO AND ACCUMULATED BY CATTLE
Oral dose of 1 x 10^{-3} Ci plutonium dioxide fed per day for 19 days.

II. D. THE EXISTING ENVIRONMENT

8. Radiologic Environment (Cont.)

d. Radioactive Wastes

Sources

While by far most of the radioactivity at the NTS remains at the locations deep underground where nuclear tests have been conducted, there are a variety of sources which contribute to radioactive wastes on the surface. These include:

(1) Radioactivity remaining from atmospheric tests conducted during earlier years, including that from safety tests mentioned earlier.

(2) Radioactivity resulting from such activities as drilling back into nuclear explosion cavities to obtain samples of the radioactive test debris.

(3) Radioactivity removed from equipment and facilities during decontamination.

(4) Radioactive waste generated by radiochemical laboratory operations.

(5) Radioactive waste generated by and remaining from experiments and projects conducted at the Nevada Test Site not related to underground nuclear testing, such as at the NTS Experimental Farm, the Super Kukla reactor, the nuclear rocket engine testing, and the "Pluto Program."

(6) Radioactive materials in tailing piles and in debris from postshot tunnel reentry and rehabilitation activities; and, as mentioned earlier, radioactively contaminated water (primarily tritium) which has been collected in tunnel drainage ponds.

(7) Radioactive materials and wastes generated in small quantities by activities at certain other ERDA and ERDA contractor locations (also from other government agencies, such as the Department of Defense and the Environmental Protection Agency) are sent to the NTS for storage or burial.

Radioactive Waste Management

In managing radioactive waste, the burial or storage methods are appropriate to the types of wastes involved. For example, bulky hardware items which become activated or contaminated during their use, are transported to designated storage sites and held until they can be either decontaminated or buried. As another example, the tailing piles and debris resulting from tunnel reentry and tunnel rehabilitation activities primarily contain low-level radioactivity and are accumulated in segregated sites convenient to the point of mining. Later this material is covered with suitable amounts of noncontaminated soil. Highly contaminated waste derived from tunnel reentry operations is not brought out of the tunnels, but, instead, is placed in posted unused drifts to be sealed off later. Periodically, serviceable uncontaminated materials are segregated and are reused or sold as surplus property.

Retired Sites

On the NTS there are 27 radioactive waste storage sites identified on the map (Figure II-29) which have been retired from use. These sites are fenced with barbed wire and are marked with appropriate warning signs. Programs are underway to reduce the number of retired surface storage sites by consolidation of waste at burial locations.

In addition, there are six drilled holes (not shown) ranging in depth from 15 to 60 meters (50 to 200 feet) so located that the bottoms of the holes are at least 305 meters (1,000 feet) above the groundwater table. These holes are partially steel cased to diameters of up to 1.4 meters (54 inches). The wastes placed into these holes consists of mixed fission and activation products in the form of core samples of weapon debris recovered during postshot drilling. No liquid wastes were placed in these six waste disposal holes and all are plugged and secured by welded or locked steel covers.

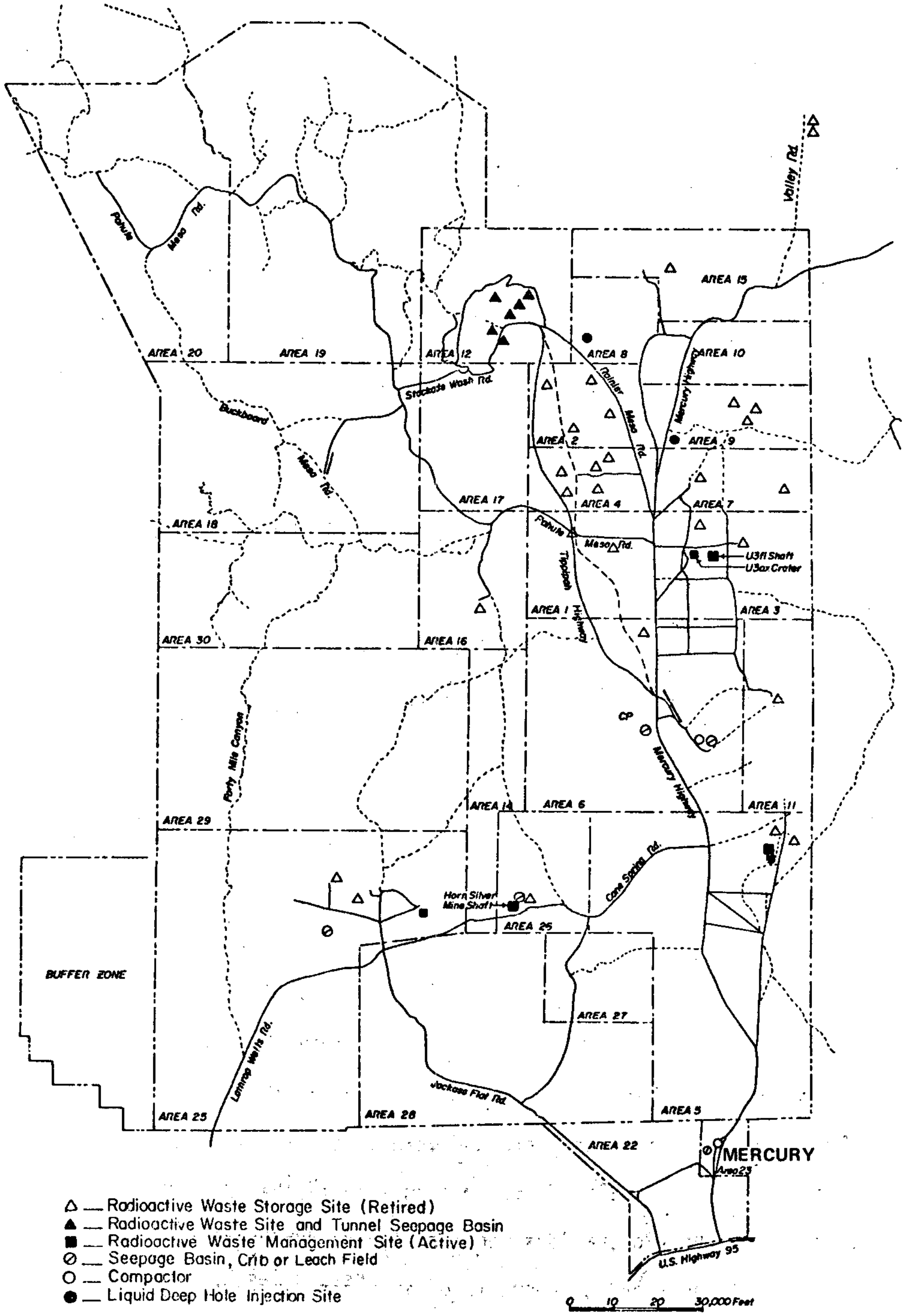

FIGURE II-29 NTS RADIOACTIVE WASTE AREA LOCATIONS

II. D. THE EXISTING ENVIRONMENT

8. Radiologic Environment (Cont.)

In the past, some radioactive debris resulting from drillback operations was buried on location a few feet beneath the surface. Many of these locations were not recorded in the past and are not known today. This practice has been discontinued, and instead, radioactive wastes are either returned to the drill hole from which they came or transported to designated waste management areas.

Active Waste Management Sites

Liquid transuranic waste generated at the ERDA Experimental Farm in Area 15 is collected in a 90 cubic meter (24,000-gallon) closed holding tank, transferred to 15 cubic meter (4,000-gallon) tankers, and transported to Area 8 where it is pumped more than 305 meters (1,000 feet) down into the underground cavity from an expended underground nuclear explosion.

Contaminated waste storage and burial sites are surrounded with barbed wire fencing and are marked with appropriate warning signs. The locations of contamination and of contaminated waste areas are recorded on site maps (see Figure II-29).

A waste treatment facility is located in NTS Area 6. There, heavy construction equipment, critical tolerance instruments, and work clothing are processed to reduce the level of radioactive contamination. In the course of removing the contaminants (primarily by washing with detergents and water), the runoff liquids from the laundry and the decontamination facilities drain into a settling pond. Contaminated waters from post-test drillback operations and from tunnel drainage are retained in other ponds in the operating areas. An onsite environmental monitoring program has continuously obtained water samples from these locations, normally on a monthly basis. These samples are analyzed for radioactivity and a continuous record is kept of the results and trends. The ponds are unlined earth excavations within fenced areas posted with appropriate radiation warning signs. Because evaporation is continuous in this low-humidity, high-temperature environment, the residual radioactivity is concentrated in these ponds. Ultimately, the dried-up evaporation ponds are covered with the appropriate depth of clean dirt, posted, and protected as other low-level waste management areas.

II.D. THE EXISTING ENVIRONMENT

8. Radiologic Environment (Cont.)

Dry waste compactors are located at the loading platform of the Area 6 Laundry Facility and within the Radioactive Materials Control Facility in Mercury. These units compact approximately 1.13 cubic meters (40 cubic feet) of dry, low-level wastes* into a 55-gallon metal drum. After each drum is sealed, it is held in aboveground storage until enough drums are filled to make a truckload. Subsequently, these drums are buried in designated radioactive waste burial sites.

Low-level liquid radioactive wastes** are generated at the Radiochemistry Laboratory at Mercury. These wastes result from preparation of various air, water, bioassay, soil, vegetation and other samples submitted to the laboratory for analysis of radioactivity. Designated sinks within the facility are piped directly to an underground sump which is further attached to a leach field. Normally, only low-level wastes are handled and are further diluted with water or chemical solutions before disposal. Periodic samples are obtained from the sump and analyzed to maintain a record of the activity level of wastes being discharged into the leach field.

There are four active radioactive waste management sites which have been designated as burial sites. In Area 5, 3.6-meter (12 foot x 12-foot) trenches are used. Sealed drums along with tools, equipment, steel pipe, and assorted hardware are accumulated in these trenches and are ultimately covered with at least three feet of earth. As contaminated waste burial trenches are filled and covered, they are marked with appropriate monuments with metal plaques stating the nature and location of the waste. In Area 3, an unused, cased emplacement hole with a locked steel cover, designated U3fi, is presently being used to accumulate cores and contaminated debris resulting from drillback operations.

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*Low-level waste in this instance is defined as packaged waste resulting in less than 500 mrem per hour at the surface of the drum.

**Liquids containing less than 3×10^{-3} µCi/ml are considered low-level liquid wastes.

These are placed down the hole to be later filled and sealed. In Area 3, the U3ax subsidence crater is also used to accumulate bulky radioactive debris, and alternate layers of waste, and dirt cover are placed in the crater. The Horn Silver mine shaft in Area 26 is also used to accumulate radioactive wastes from the local area. It is classified as a waste burial site primarily because the wastes there are stored underground. The radioactive wastes at these sites are presently classified as nontransuranic wastes. Table II-3 indicates the amounts of wastes which have been placed in these sites over the years.

Beginning in 1974, wastes containing greater than 10 nCi per gram of transuranics were separated from other lower-level wastes being accumulated, and these are being stored as retrievable transuranic waste. Most of these wastes are shipped to the Nevada Test Site from the Lawrence Livermore Laboratory and are stored on the surface in sealed drums in Area 5. Table II-3 shows the amounts of these wastes which have been stored through 1975.

e. Offsite Radioactivity

Background

The Environmental Protection Agency, through its Environmental Monitoring and Support Laboratory-Las Vegas (EMSL-LV), has performed radiological monitoring in the NTS offsite area since 1954. From 1954 to 1958, all such monitoring was specifically test-series related. Since 1958, continuous monitoring has been performed to determine the levels of radioactivity present. Samples of air, water, and milk are routinely collected and external gamma exposures are measured at both fixed stations and for individual residents. Sample collection frequency has usually been a function of the type of testing program and anticipated offsite effects. Since 1958, all operating air sampling stations have operated 24 hours a day. Until 1973, samples were changed daily. Since then they have been chanaed three times per week. The longer sampling times are required to detect the lower levels of background radioactivity which now

II. D. THE EXISTING ENVIRONMENT

8. Radiologic Environment (Cont.)

TABLE II-3

BURIAL OF NONTRANSURANIC WASTES

Period	Volume (ft.^{3})	Curies
1961	600	0.05
1962	6,000	0.2
1963	11,000	3.8
1964	5,000	0.4
1965	14,000	15.3
1966	16,000	3.5
1967	117,000	1,239.
1968	27,000	108.
1969	14,000	2,487.
1970	14,000	2,003.
1971	20,000	5.9
1972	74,000	611.
1973	14,000	38.
1974	17,000	3.9
1975	12,000	5.3
TOTALS	360,000	6,524.

RETRIEVABLE TRANSURANIC WASTES

Period	Volume (ft.^{3})	Curies
1974	356	114
1975	1,872	354
TOTALS	2,228	468

II.D. THE EXISTING ENVIRONMENT

8. Radiologic Environment (Cont.)

exist. If a release of radioactivity occurs at NTS, samples are collected more frequently. Milk samples are collected quarterly to maintain current background information. Samples would be collected more frequently (as often as daily) following a release of radioactivity to accurately assess radiation doses via the cow-milk pathway to offsite populations. Prior to 1974, water samples were collected monthly. Based on the results obtained, offsite samples are now collected semiannually or annually. These samples have confirmed predictions that no radioactivity is being transported offsite via groundwater.

Samples of other environmental media are collected during special studies to characterize the distribution and availability of radioactive materials in the total environment. The EMSL-LV whole-body counter is periodically used to determine body burdens of gamma-emitting radionuclides in selected volunteer offsite residents.

A general pattern of steadily decreasing levels of man-made radioactivity has been observed since the cessation of atmospheric testing. Since early 1971, with several minor exceptions, the surveillance networks have measured only the expected ambient levels of radioactivity. On several occasions, low levels of airborne radioactive gases, possibly originating from the NTS, have been detected on the offsite monitoring network. Xenon-133 has been detected offsite during May 1972 at Beatty and Diablo; June 1972 at Hiko; October 1973 at Las Vegas, Hiko, Diablo, and Death Valley Junction; June 1974 at Beatty; August 1974 at Beatty; November 1974 at Diablo, Indian Springs, and Las Vegas; and November 1975 at Diablo and Hiko. As an example, the November 1974 increased readings of Xenon-133 occurred during a time of a known drillback release at NTS. It is assumed that the slight increased offsite readings were a result of this drillback release. However, at other times, increased levels of Xenon detected offsite could not be attributed to any NTS activity and may have been the result of foreign nuclear testing or industrial releases. Foreign nuclear testing has occasionally resulted in short-term increases in the observed airborne concentrations of radionuclides. The existing state of environmental radioactivity is described in more detail in the following discussion.

II.D. THE EXISTING ENVIRONMENT

8. Radiologic Environment (Cont.)

External Exposures

A widespread dosimetry network around the NTS employs gamma exposure rate recorders to document exposure rate versus time and thermoluminescent dosimeters (TLD) to record total exposure doses. In general, the annual exposures off the NTS are below 110 millirem per year, while the typical average value for the southwestern states is 130. For the areas to the north-northwest and northeast of the NTS, the annual exposures do reach approximately 130 millirem per year. The slightly higher levels in these areas are believed to be due to a combination of higher natural background in those mountainous areas and higher levels of close-in residual fallout. It has been observed that exposures measured at offsite stations nearest to the NTS are decreasing with time. (Reference 15.) This decrease is believed to result from radioactive decay of fallout deposited mainly during periods of atmospheric testing and to a lesser extent from releases from previous underground tests.

Plutonium in Soil

Plutonium is present in small quantities off the NTS, both on the Nellis Air Force Range and on the public domain beyond the Range. The EPA has sampled both the vertical and areal distribution of plutonium in soil within the area believed to have been affected. Vertical profile sampling has shown that for 86 percent of the locations sampled, 90 percent or more of the plutonium burden resides within the top 3 cm of soils. Sampling to define areal distribution has shown that the current distribution of plutonium remains where it was deposited as immediate fallout. The highest plutonium value reported from a 5-cm deep surface sample taken from the public domain near the northeast boundary of NTS was 96 nanocuries per square meter (nCi/m^2).* The normal background from worldwide fallout plutonium is from one to two nCi/m^2. The highest value detected within the controlled area of the Nellis Air Force Range is 570 nCi/m^2, exclusive of those areas where safety tests have been conducted as discussed earlier. The results of the entire survey are best illustrated by two overlapping log-

*One nanocurie (nCi) is equal to one billionth of a curie (10^{-9} curie). One square meter equals 1.196 square yards.

normal distributions whose means are 3.5 nCi/m^2 and 41 nCi/m^2 (see References 52 and 53). The former distribution is derived from 86 percent of the data; the latter from 14 percent; indicating that the majority of sample results are very near the ambient plutonium background of approximately one to two nCi/m^2 for the southwest United States.

Analyses for plutonium have been performed on a number of air filter samples collected around the NTS to assess the potential hazard due to airborne resuspension of fallout plutonium. To date, any resuspension has been of such a low level that none has been detected.

Special soil sampling programs have been conducted in three areas around NTS to determine the extent, if any, of hydraulic movement of fallout plutonium by surface runoff. The areas studied were a mountain valley southeast of Frenchman Flat, a canyon area northeast of NTS, and the delta at the mouth of Fortymile Canyon which drains the western part of NTS. In no case was any significant increase noted in the lower elevations or areas receiving drainage which would indicate any movement of plutonium by runoff water.

Airborne Radioactivity

Continuous samplers monitor for radioactive particulates, gaseous iodines, noble gases, and tritium in the atmosphere. The only particulate or iodine radioactivity detected above ambient levels since the BANEBERRY event of December 1970 resulted from atmospheric nuclear tests conducted by the People's Republic of China. Due to radioactive decay and scavenging from the stratospheric reservoir, the average ambient concentration (background level) of particulate radioactivity has decreased to about 0.05 picocuries per cubic meter (pCi/m^3) of air (gross beta).* As a result of the decrease in airborne radioactivity, gamma-emitting radionuclides were below detectable levels during 1975.

*One picocurie (pCi) is equal to one millionth of a curie (10^{-12} curie).

II.D. THE EXISTING ENVIRONMENT

8. Radiologic Environment (Cont.)

Because of continuing releases of krypton-85 from nuclear fuels from worldwide reactors, the atmospheric concentration is gradually increasing. At present, the concentration averages about 17 picocuries per cubic meter (pCi/m^3)* with an observed range of about 10 to 25 pCi/m^3. During the four years of monitoring for noble gas radioactivity, no evidence of krypton-85 related to the NTS had been found until December 1975. During that month, samples containing up to 30 pCi/m^3 of krypton-85 were collected offsite and up to 38 pCi/m^3 onsite. The maximum value observed was equal to 0.038 percent of the Radiation Concentration Guide set forth in the ERDAM 0524. These increases during the middle two weeks of December possibly resulted from trapped krypton being released by the ground motion from several high-yield tests conducted during the end of 1975. Another noble gas, xenon-133, with a theoretical ambient concentration near zero, has been observed in a few samples above the detection limit of about five pCi/m^3. The positive samples were apparently related to the NTS activities, although it is conceivable that the ^{85}Kr may have originated from releases from reactor fuels unrelated to NTS activities.

Monitoring for atmospheric tritium (T) is designed to measure the concentrations in three chemical forms as water vapor (HTO), hydrogen gas (HT), and methane (CH_3T). On only a few occasions has tritium as methane been above the detection limit of five pCi/m^3 of air. There is no indication that these detectable concentrations resulted from NTS activities. The average concentration as hydrogen is about 2 pCi/m^3 of air with maximum observed concentrations on the order of 10 pCi/m^3. No indications of increased concentrations of tritium as hydrogen as a result of NTS activities have been observed. Ambient concentrations of tritium as HTO (water) in the NTS offsite area average about 0.5 pCi per milliliter (pCi/ml) of water with a range of from less than 0.2 pCi/ml to about 1.5 pCi/ml. Because of the variability of humidity, the observed range in the atmosphere concentration of tritium as HTO is from less than 0.25 pCi/m^3 of air to about 6 pCi/m^3. The Radiation Concentration Guide for tritium

*One picocurie (pCi) is equal to one millionth of a curie (10^{-12} curie).

in air is 67,000 pCi/m^3. On several occasions, tritium concentrations above the expected range in water vapor have been measured. In general, however, the associated airborne concentration has been within the range expected.

Radioactivity in Milk

Milk samples are periodically collected from family cows and producing dairies in the vicinity of NTS. The samples are analyzed for gamma-emitting radionuclides, strontium-89 and-90, and, in some cases, tritium. Because of the dry desert environment, observed concentrations of fission products are generally lower than those found in milk produced in other parts of the United States. Because of its relatively short half-life, strontium-89 is currently below the detection limit of two picocuries per liter* (pCi/l) of milk. Strontium-90 concentrations range from less than one pCi/l to about five pCi/l of milk, with the average at about 1.5 pCi/l. Concentrations of tritium reflect the concentrations observed in atmospheric moisture and fall in a range of from less than 200 pCi/l of milk to about 1,000 pCi/l.

Radioactivity in Water

Groundwater samples are collected at a number of locations offsite, with emphasis on those areas identified by the U.S. Geological Survey as being down-gradient from the underground test areas. No evidence of transport of test-related radioactivity from the NTS has been found. The only radionuclides positively identified have been ones which occur naturally. (See Hydrology, Section II.D.5.)

Population Body Burdens

Offsite residents from 14 locations around the NTS participate in a program of whole-body radioactivity counting at the EMSL-LV. The only fission product radioactivity identified by gamma spectroscopy has been cesium-137. The measured concentrations range from less

*One liter equals 1,000 milliliters (ml) or 1.057 quarts.

II.D. THE EXISTING ENVIRONMENT

8. Radiologic Environment (Cont.)

than 5×10^{-9} microcuries per gram (μCi/g)* to about 5×10^{-8} μCi/g of body weight, with an average for those with measurable amounts of about 1.4×10^{-8} μCi/g. Essentially the same results have been reported for other groups measured at other locations in the country. The range of concentrations are randomly distributed around the NTS and do not appear to be related to such factors as old fallout patterns from atmospheric tests.

9. Bioenvironment

The forward test area of NTS contains vast desert vistas and a surprising amount of vegetation and wildlife (see FIGURE II-30).

The fact that the NTS spans a section of the transition zone between the northern edge of the Mojave Desert and the southern portion of the Great Basin Desert makes it a natural laboratory of great interest to ecologists; it is in such transitional zones that the effects of environmental factors influencing biotic communities are often most readily identified and investigated.

O'Farrell and Emery (Reference 54) have summarized the results of ecological studies carried out at NTS to date, based on published research papers and reports; they list 334 such publications. Many of these deal with the effects of nuclear tests on biota, but a considerable number are devoted to describing the composition and dynamics of natural biotic communities, or communities disturbed in one way or another by testing operations.

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*One microcurie is equal to one millionth of a curie (10^{-6} curie).

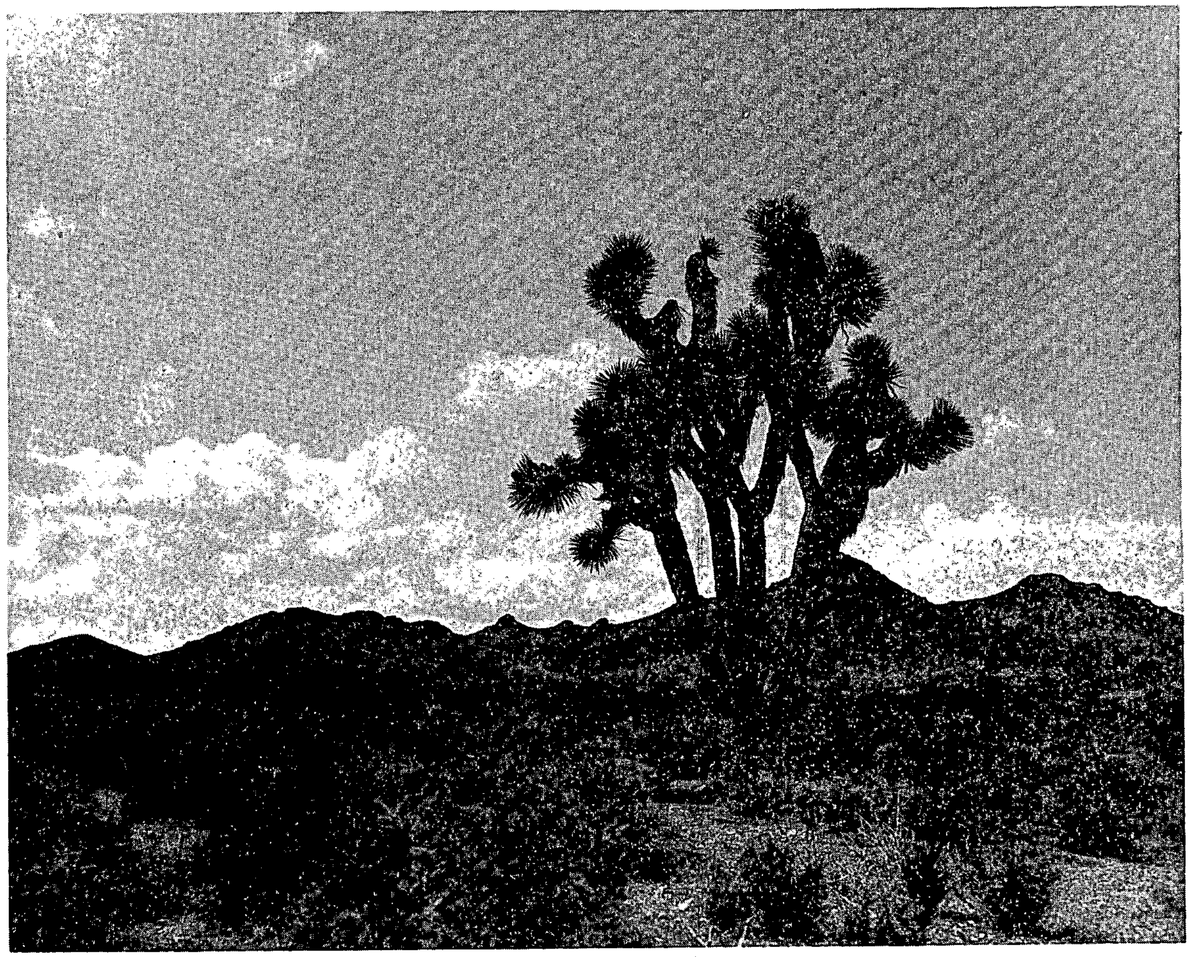

FIGURE II-30 FORWARD AREA OF NTS

Environmental Determinants

Many factors interact to determine the distribution and composition of the plant communities of NTS. Vegetation, in turn, has an important role in determining the composition, density, and distribution of faunal populations. The most important determinants influencing plant communities are precipitation (total amount and seasonal distribution), temperature, and soil characteristics.

The pattern of seasonal distribution of precipitation plays a major role in growth cycles of desert vegetation, especially at the lower elevations, where rainfall is lowest. The wide fluctuations in the amount of precipitation, from year to year and from place to place (within the NTS), impose severe stresses on desert plants and on the aminals that depend on them for subsistence.

Two of the valley basins on the Nevada Test Site, Frenchman Flat, and Yucca Flat, have no external drainage. Each contains a dry lake bed, or playa, which is occasionally water covered for short periods after heavy rains and is characterized by the lack of vegetation cover. In these closed basins, nighttime air temperatures just above the valley floor, i.e., where they exert an effect on the low-growing shrub vegetation, are considerably lower than would be anticipated on the basis of elevation alone (see Section II.D.3., "Climatology"). Beatley (References 55 and 56) has concluded that there is a relationship between the phenomenon of drainage of colder air into the closed basins, and the distribution of certain plant associations, in the transition desert zone.

II.D. THE EXISTING ENVIRONMENT

9. Bioenvironment (Cont.)

The soils of NTS form a mosaic of great complexity, but all are alluvial in nature, and comprise the valley floors and the bajadas, washes, and alluvial fans that slope downward from the mountains and mesas. Water transport of the alluvium from higher to lower elevations results in a sorting process, leaving coarser materials (cobbles and gravel) nearer the mountains where the slopes are steeper, and carrying the finer materials (sand, silt, and clay) farther out onto the valley floor. Hardpans of varying degrees of permeability are found in many areas, but may be absent locally, as in washes. Carbonate caliche is usually present at a depth of 30 to 70 centimeters (12 to 28 inches) when the parent material is calcareous, as at the base of limestone mountains.

An important feature of the soils in the desert shrub associations, which cover a large part of the test site, is the difference in soil properties under shrubs or shrub clumps, as compared to bare areas between the shrubs (see Reference 57). Soils beneath shrubs generally have better-developed uppermost horizons, higher levels of organic matter, nitrogen, phosphorus, and soluble salts. The pH of soils in bare areas between shrubs is generally 8.0 to 9.0, while under shrubs it may be as low as 7.5 to 8.0. Hardpans may be partially broken down beneath shrubs, and there is usually an accumulation of wind-transported fine material (loess) around the bases of the shrubs.

<u>Vegetation</u>

A total of 706 taxa of vascular plants, distributed among 67 families, has been collected within or near the boundaries of NTS. About one-third of the species are accounted for by three families: Compositae or sunflower family; Gramineae or grass family, and Polygonaceae or buckwheat family (Reference 54).

II.D. THE EXISTING ENVIRONMENT

9. Bioenvironment (Cont.)

The greater part of NTS is vegetated by various associations of desert shrubs, representative of the Mojave or Great Basin Deserts, or the zone of transition desert between these. At higher elevations, especially in the northern and western parts of the test site, there are areas of desert woodland (pinyon-juniper). But even there, typical Great Basin shrubs, principally sagebrushes (*Artemisia* spp.), are a conspicuous component of the vegetation, so this type of cover might better be described as desert shrub/woodland. Beatley (References 55, 56, and 58) has provided the most detailed analysis available to date of the plant associations of NTS, as well as annotated checklists of the vascular flora. Figure II-31, a generalized map of the most important plant associations, is adapted from Beatley (Reference 55).

Typically, desert shrub associations consist of scattered individual plants or, more often, clumps of plants, with large areas of bare soil or rock ("desert pavement" in some cases) between. The shrub clumps commonly consist of two or more species growing intermingled so as to appear as a single plant. Coverage of the soil surface by shrubs rarely exceeds 50 percent, and is more often in the range of 15-30 percent. Percent coverage by shrubs varies directly with precipitation, and species composition of the cover also changes with change in total precipitation (Reference 55).

Although shrubs, or shrubs and small trees, are the dominant forms that determine the aspect of all undisturbed plant associations on the test site, herbaceous plants are well represented in the flora and play an important role in supporting animal life. Herbaceous plants are predominantly winter annuals or perennials. Most of them are associated with shrub clumps, which afford a favorable microhabitat. But when growing conditions are favorable, the usually bare areas between clumps may support dense populations of herbaceous forms.

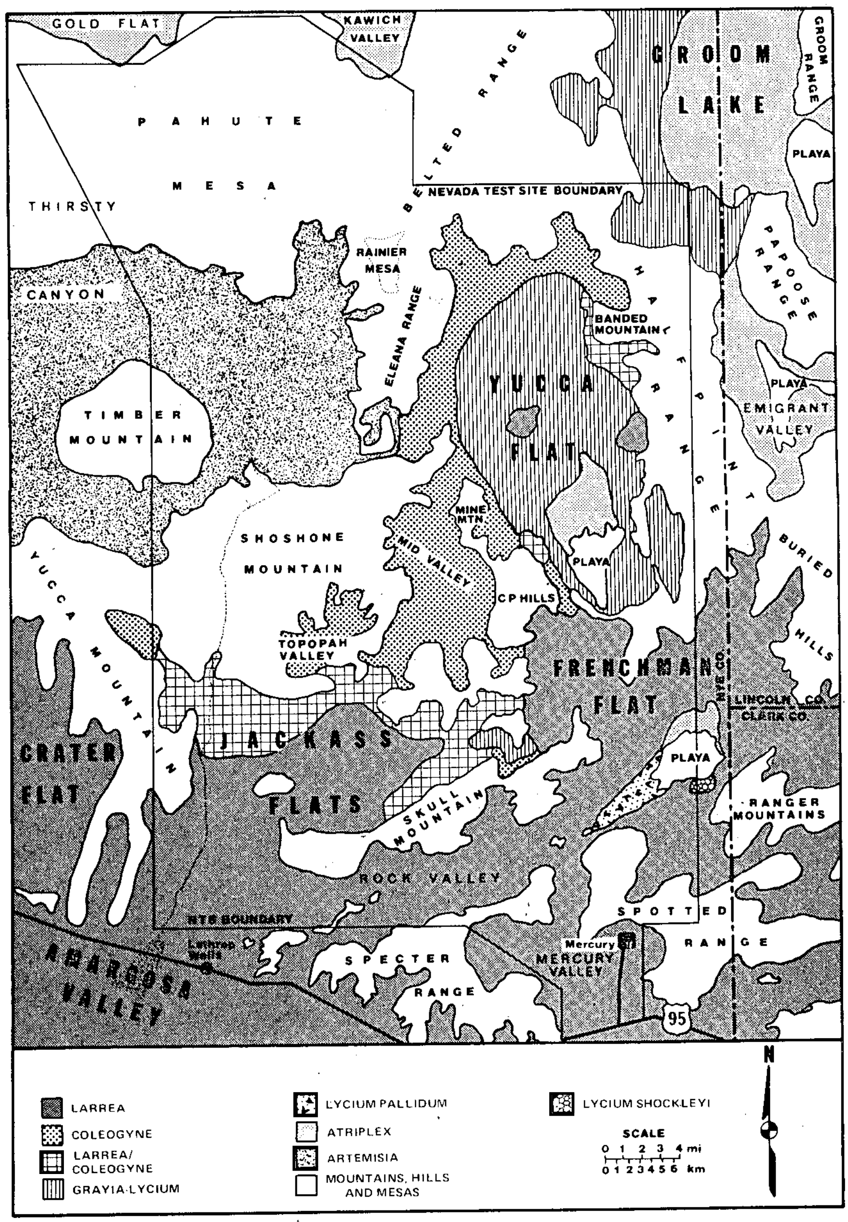

FIGURE II-31 VEGETATION TYPES NEVADA TEST SITE

Redrawn by Desert Research Institute from material prepared by Dr. Janice C. Beatley.

II. D. THE EXISTING ENVIRONMENT

9. Bioenvironment (Cont.)

In Mojave Desert associations, precipitation between late September and early December is the most important factor controlling growth and productivity (Reference 58). Relatively heavy and general rainfall during this period is followed by vigorous vegetative growth and reproduction by shrubs and herbaceous species during winter and spring. In general, for Mojave and Transitional zone plants, physiological activity is greatest during fall, winter, and spring, while summer is a period of dormancy for most species. However, Wallace and Romney (Reference 60) show that temperatures interact with precipitation to cause marked shifts in onset of growth from year to year. And the normal summer dormancy of some species can be broken in seasons of high summer rainfall.

Primary production in shrub associations is contributed mainly by the shrub component, but herbaceous winter annuals can make a significant contribution, especially in Mojave and Transitional types, when favorable moisture and temperature conditions combine to produce a flush of growth. In Rock Valley (Mojave Desert shrub vegetation), a three-year study showed wide variations in the relative amounts of primary production by shrubs and herbaceous species, as well as in total production (Reference 39). In 1965-1966 and 1967-1968, when fall/winter precipitation was high, herbaceous production made up 27 percent and 36 percent, respectively, of the total annual productions of 672 and 678 kilograms per hectare (600 and 605 pounds/acre). But in 1966-1967, when total precipitation was low, and especially during fall/winter, herbaceous production made up only 13 percent of the total. The total in this season amounted to only 350 kilograms per hectare (312 pounds/acre).

Biomass production by winter annuals, though relatively less than that of shrubs, nevertheless is an important factor for desert animal populations supported by the shrub associations. Beatley (Reference 61) concluded, on the basis of a five-year study at NTS, that reproductive success in desert rodent populations was correlated with winter annual production. When critical rains failed to come and production of winter annuals was negligible, reproduction in rodent populations was sharply reduced.

II. D. THE EXISTING ENVIRONMENT

9. Bioenvironment (Cont.)

Fauna

The diverse habitats of NTS are occupied by a wide variety of animal species, representing faunal elements from both Mojave and Great Basin Deserts. Most animals on the NTS are small, secretive (often nocturnal in habit), and hence not often seen by casual observers.

Sport hunting is not permitted on NTS, so that at the present time most animal populations are generally affected by human activity only to the extent that some areas of habitat are disturbed by test operations, or that small numbers of individuals are collected by scientists in the course of their investigations. During the earlier period of atmospheric testing, some populations were subjected to ionizing radiation, and some controlled experiments on the effects of radiation on wild animal populations are still in progress in the Rock Valley area of the test site. Only a limited amount of pest control effort is practiced in areas regularly occupied by NTS workers. So over much of NTS, faunal populations are regulated only by the natural controls imposed by their environment, including normal predator/prey relationships.

O'Farrell and Emery (Reference 54) have summarized the number of species of different faunal groups now known from NTS, as follows:

II. D. THE EXISTING ENVIRONMENT

9. Bioenvironment (Cont.)

Table II-4
NTS Faunal Groups

Invertebrates

Group(s)	No. of Species
Crustaceans	2
Centipedes and Millipedes	10
Spiders, Scorpions, Sun Spiders, and Harvestmen	135
Mites and Ticks	67
Insects	814
Total	1,028

Vertebrates

Group	No. of Species
Fish	1 (introduced by workers into reservoirs)
Reptiles	32 (including 3 species of poisonous snakes)
Birds	188 (mostly migrants or seasonal residents)
Mammals	45 (includes feral horses, burros, and domestic cattle)
Total	266

The species lists for vertebrates are probably complete or nearly so, but the invertebrate fauna of the NTS is still far from adequately known. For taxonomic groups that have been collected and studied intensively, numerous species new to science have been identified. Discovery of many other heretofore unknown species can be expected as other groups are investigated in depth.

Biotic Communities

Allred, Beck, and Jorgensen (Reference 62) developed a classification scheme for NTS plant communities somewhat like that of Beatley (see Figure II-31) as a basis for describing the distribution of fauna on the test site. Their breakdown, which emphasizes general habitat characteristics rather than the fine structure of plant associations, is used here to show distribution of vertebrate fauna by "biotic communities." Their classification, with

II. D. THE EXISTING ENVIRONMENT

9. Bioenvironment (Cont.)

additional descriptive notes, follows:

*Larrea-Franseria** (Creosote Bush-Burrobush. See *Larrea* type of Figure II-31 .)

This community belongs to the Mojave Desert flora. It covers wide areas in Frenchman and Jackass Flats, Rock Valley, and Mercury Valley, and corresponds to the *Larrea* vegetation type of Figure II-31 . Within this extensive area, creosote bush is found in association with a number of other desert shrub species and a wide variety of annual and perennial herbaceous plants. Beatley (Reference 58) says that "*Larrea* communities, especially those on the bajadas below the limestone ranges, are those of the greatest floristic diversity in the region." This type of cover ranges in elevation from about 910 meters (3,000 feet) on valley floors up to 1,220 meters (4,000 feet) on the upper bajadas.

Grayia-Lycium (Spiny Hop Sage-*Lycium* spp.)

This community is assigned by Beatley (Reference 55) to the Transitional Desert type of vegetation. It occurs in a wide zone on the bajadas around Yucca Flat, generally at elevations of 1,220-1,370 meters (∿4,000-4,500 feet).

Coleogyne (Blackbrush)

Nearly pure stands of blackbrush occupy large areas in Mid-Valley and the lower slopes of mountains and mesas in the north-central part of NTS, at elevations of 1,220 to 1,520 meters (4,000 to 5,000 feet). Blackbrush often occurs in association with Mojave Desert species (i.e., *Larrea*) or Great Basin Desert types (*Artemisia* spp.). It is designated as a Transitional Desert type.

**Ambrosia* in current nomenclature.

II.D. THE EXISTING ENVIRONMENT

9. Bioenvironment (Cont.)

Atriplex-Kochia (Saltbush-Red Molly; *Atriplex* type of Figure II-31)

Pure stands of saltbush, or saltbush in association with red molly or winterfat (*Eurotia lanata*), are found around the playas in the closed basins of Frenchman and Yucca Flats. Species of saltbush (*Atriplex canescens* and *A. confertifolia* also occur with other shrubs as dominants or co-dominants on saline or calcareous soil, at elevations up to >1,520 meters (5,000 feet). *Atriplex* associations belong to the Great Basin Desert floristic unit.

Pinyon-Juniper (*Pinus monophylla-Juniperus osteosperma*; includes part of *Artemisia* type of Figure II-31)

This community is better identified as "*Artemisia* Pinyon-Juniper" (Reference 58). Sagebrush (mainly *Artemisia arbuscula* or *A. tridentata*) become important dominants in shrub associations above 1,520 meters (5,000 feet), with pinyon and juniper occurring only sparingly. Above 1,830 meters (6,000 feet), the desert woodland aspect is more evident, but sagebrushes continue as important components of the shrub understory, along with botterbrush (*Purshia* spp.) and cliff rose (*Cowania mexicana*).

The *Artemisia*-Pinyon-Juniper community is a Great Basin Desert type. Smith and Giles (Reference 63) show that this type of cover is an important habitat for mule deer (*Odocoileus hemionus*). Analysis of rumen contents of mule deer collected from the NTS mesa showed that bitterbrush (stems and leaves) comprised over one-half of the dietary components during late spring, summer, and early fall. Cliff rose (stems and leaves) made up almost the entire dietary intake during the winter.

II. D. THE EXISTING ENVIRONMENT

9. Bioenvironment (Cont.)

Other Habitats (Mixed)

Several disparate habitat types are grouped under this catch-all category: "mountainous areas, natural springs, reservoirs, and playas." Exclusive of the "mountainous areas," which were not sampled intensively (Reference 62), the one feature common to these habitat types is the presence of surface water during all or part of the year, an important determinant of faunal distribution in the desert environment of NTS.

Salsola (Russian Thistle or Tumbleweed)

Salsola spp. as well as certain grasses and other herbaceous forms, are the primary invaders of disturbed areas, especially where ground motion or subsidence has cracked and loosened the soil, or where the native shrub vegetation has been destroyed. *Salsola* spp. usually germinate during late spring to early summer, and grow through summer and fall. Under favorable conditions, *Salsola* may produce large, dense stands on disturbed soils. As Beatley (Reference 64) points out, the *Salsola* community identified by Allred, Beck, and Jorgensen (Reference 62) is limited to highly disturbed areas in Yucca Flat, and the animal populations found to be associated with it are not greatly different from those occurring in native desert shrub associations in the same area.

Table II-5 shows the distribution, by community type, of the vertebrate species that Allred, Beck, and Jorgensen (Reference 62) identify as "predominant species," although that term is not precisely defined by the authors. (For lists of invertebrates given the same designation, the referenced source may be consulted.)

Previous Habitat Disturbances

Since the NTS was established in 1951, the then existing habitats have been modified to a considerable degree by construction activities, nuclear testing, and by a few extensive

TABLE II-5

Predominant Vertibrate Species

	Plant Community (as defined in footnote*)						
	La-Fr	Gr-Ly	Co	At-Ko	Pi-Ju	Mixed	Sa
REPTILES							
SNAKES							
Chionactis occipitalis (Western Shovel-nosed Snake)	X	X					
LIZARDS							
Callisaurus draconoides (Zebra-tailed Lizard)	X	X	X	X		X	
Cnemidophorus tigris (Western Whiptail)	X	X	X	X		X	X
Phrynosoma platyrhinos (Desert Horned Lizard)	X	X	X	X		X	X
Sceloporus occidentalis (Western Fence Lizard)			X		X		X
Uta stansburiana (Side-blotched Lizard)	X	X	X	X	X	X	X
BIRDS							
Alectoris chukar (Chukar)					X	X	
Amphispiza belli (Sage Sparrow)	X	X	X	X		X	X
A. bilineata (Black-throated Sparrow)	X	X	X	X	X	X	X
Carpodacus mexicanus (House Finch)	X	X	X	X	X	X	X
Erimophila alpestris (Horned Lark)	X	X	X	X	X	X	X
Gymnorhinus cyanocephala (Pinyon Jay)	X	X	X	X	X	X	
Junco oreganus (Oregon Junco)					X	X	
Zenaidura macroura (Mourning Dove)	X	X	X	X	X	X	X

TABLE II-5 (Cont.)

Predominant Vertibrate Species

	Plant Community*						
	La-Fr	Gr-Ly	Co	At-Ko	Pi-Ju	Mixed	Sa
MAMMALS							
RODENTS							
Ammospermophilus leucurus (White-tailed Antelope Squirrel)	X̲	X̲	X̲	X	X	X	X̲
Dipodomys merriami (Merriam's Kangaroo Rat)	X̲	X̲	X̲	X		X̲	X̲
D. microps (Great Basin Kangaroo Rat)	X̲	X̲	X̲	X̲	X	X̲	X̲
D. ordii (Ord Kangaroo Rat)	X	X	X			X	X̲
Eutamias dorsalis (Cliff Chipmunk)					X̲	X	
Peromyscus maniculatus (Deer Mouse)	X	X	X̲	X	X̲	X	X
Perognathus formosus (Long-tailed Pocket Mouse)	X̲	X	X	X	X̲	X	X
P. longimembris (Little Pocket Mouse)	X̲	X̲	X̲	X		X̲	X
RABBITS							
Lepus californicus (Black-tailed Jackrabbit)	X	X̲	X	X̲	X	X	X
DEER							
Odocoileus hemionus (Mule Deer)			X		X̲		
CARNIVORES							
Canis latrans (Coyote)	X	X	X	X		X	X
Vulpes macrotis (Kit Fox)	X̲	X		X		X	X

Distribution of "predominant" vertebrate species among plant communities of NTS.

*La-Fr = *Larrea-Franseria*; Gr-Ly = *Grayia-Lycium*; Co = *Coleogyne*; At-Ko = *Atriplex-Kochia*; Pi-Ju = Pinyon-Juniper, Mixed = "mountainous areas, springs, reservoirs, and playas"; Sa = *Salsola*.

X in community column means species is found there; X̲ means species is found there in relatively high abundance.

brush fires (most of them due to natural causes). Atmospheric testing above the desert surface also burned the surrounding vegetation, damaged vegetation by way of airblast, caused some scouring of surface soils, and subjected the soils and vegetation to high initial fluences of radiation as well as subsequent, high levels of residual radiation from fission products, induced radioactivity, and unburned nuclear fuels from the nuclear explosives. The foregoing discussion of the environmental setting is concerned largely with the natural biotic communities, and thus does not truly describe the setting as it is at the start of the actions proposed in this statement.

Disturbed Plant Cover

The roads, power and communication lines, and other permanent installations built to support testing activities are described in Section II.D.11. They account for about 70 square kilometers (27 square miles), or about 2 percent of the total area of the test site. This amount of habitat can be considered as essentially removed from production of vegetation or use by wildlife. Some additional amount of plant cover has been less severely disturbed in a diffuse pattern by off-road vehicular traffic. On the other hand, construction of surface reservoirs* and improvement of springs have made water available to animals, particularly wide-ranging mammals and birds, in areas where only ephemeral water supplies existed before. This type of modification is considered an improvement of habitat for certain faunal populations.

Some indication of the extent of the disturbances directly attributable to nuclear testing can be seen in Figure II-8, which shows a portion of Yucca Flat where both atmospheric and underground testing has been intensive.

A total of 84 atmospheric tests were carried out in the early years of the test program. These tests, principally airdrops, tower, or balloon shots, were done mainly in Yucca Flat, over areas

*A total of 18, widely dispersed, in Frenchman and Yucca Flats, on Pahute Mesa, and in Area 25.

II. D. THE EXISTING ENVIRONMENT

9. Bioenvironment (Cont.)

covered with desert shrub vegetation. Typically, an atmospheric test completely denuded an area of about 2 square kilometers (0.75 square miles), centered on ground zero, and caused varying degrees of damage to plants over an additional area of 2.5 to 5 square kilometers (one to two square miles) (Reference 65). No good estimate of the total area disturbed by atmospheric testing can be computed from these data, since affected areas often overlapped, and, in many instances, the same areas were used for more than one test.

In areas wholly denuded of vegetation, there has been little recovery of the shrub component of the plant community. Such areas have instead been revegetated by annual and perennial grasses and forbs. Shrub seedlings have been observed on the formerly denuded sites, but these generally have failed to survive browsing by rabbits and rodents. In zones where shrubs were not entirely killed, there has been some recovery of the shrubs by crown sprouting (Reference 66).

Underground testing has further disturbed the terrain and plant cover of the NTS. Most underground tests have been conducted in Yucca Flat, many on sites previously impacted by atmospheric tests. They have added to the intensity of disturbance, and have also increased to some extent the total area of disturbed habitat. A number of the underground tests were conducted on Pahute Mesa, under Rainier Mesa, and in Shoshone Mountain (Area 16) at sites not affected by the atmospheric testing. Several hundred subsidence craters from deep underground tests, and throw-out craters from Plowshare shots, now dot Yucca Flat and, in a more dispersed pattern, Frenchman Flat and Pahute and Buckboard Mesas.

Close-in areas around cratering shots were completely denuded, or the vegetation was smothered under ejecta from the crater. In Yucca Flat, revegetation in such areas has followed much the same pattern as that in areas denuded by atmospheric shots, i.e., annual and perennial forbs and grasses have largely replaced the native shrub cover. For cratering tests on Pahute Mesa, the initial revegetation pattern has been similar to that observed in Yucca Flat. But native shrubs are reestablishing themselves on even the most disturbed areas, a fact that probably presages an eventual return to the original shrub or shrub woodland cover (Reference 66).

II.D. THE EXISTING ENVIRONMENT

9. Bioenvironment (Cont.)

Habitat disturbance from deep underground tests has resulted both from preshot operations (site preparation, drilling, etc.) and from postshot subsidence. In some instances, e.g., for tests on Pahute Mesa, ground motion from the detonation has caused localized damage to plants through rockfalls or root shearing along fault lines. Habitat disturbance by underground nuclear testing is estimated to have affected about 8 to 26 hectares (20-65 acres) per test from all causes. The type and rate of recovery of plant cover has varied with the degree of disturbance, and has generally followed much the same course as that described for sites distrubed by atmospheric or cratering tests.

Brushfires, many of them lightning-set, are known to have modified the plant cover over sizable areas of NTS, since the test site was first used by AEC/ERDA. The most extensive recent fire damage occurred during a period of severe thunderstorm activity, between June 18 and July 1, 1959. Five separate fires, the largest of which were on Shoshone Mountain and Buckboard Mesa, burned over about 65 square kilometers (25 square miles) of habitat.* Smaller brushfires are known to have occurred in widely scattered areas on the test site, but no complete record of these is available. Burned-over areas in desert shrub or *Artemisia*-Pinyon-Juniper communities were initially revegetated as grass communities. Nonindigenous winter and annual grasses, *Bromus rubens* or *B. tectorum*, were the principal invading species, and the dense stands of these grasses created a strong potential for reburning, with consequent hazards to adjacent unburned vegetation (Reference 67). With time, perennial grasses and, ultimately, native shrubs or shrubs and trees will become reestablished in the community (Reference 68).

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*Personal communication, L. V. Martin, Fire Chief, NTS

II.D. THE EXISTING ENVIRONMENT

9. Bioenvironment (Cont.)

Effects on Fauna

There is no clear-cut evidence that the various types of habitat disturbance described above have had significant effects on any faunal populations, although this question has not been studied intensively. As Table II-5 shows, vertebrate species on NTS are generally found in more than one, often in several, types of habitat, i.e., the populations are well dispersed. Any effects resulting from a single nuclear test would be localized, affecting only a small fraction of a widely scattered population, and therefore would likely be transient. Plant cover on disturbed areas, while differing in species composition from the native cover it has replaced, is believed to provide almost as much biomass production to support animal life as did the original vegetation.

Endangered* and Threatened** Species

a. Plants

On July 1, 1975, the Director of the U.S. Fish and Wildlife Service (FWS) published in the Federal Register a list of vascular plants considered to be possibly endangered or threatened within the United States (Reference 69). The list, based on a report submitted to the U.S. Congress by the Smithsonian Institution, comprised over 3,000 species, 21 of which (9 listed

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*Endangered Species

The term "endangered species" means any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range (pest insects excluded).

**Threatened Species

The term "threatened species" means any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

II.D. THE EXISTING ENVIRONMENT

9. Bioenvironment (Cont.)

as endangered and 12 as threatened) were believed to occur on NTS. The list published in Reference 69 was not final. It was intended to alert the public, the scientific community, commercial interests, and any other persons that these plants were being considered for addition to the lists of endangered and threatened species under the Endangered Species Act of 1973 (P.L. 93-205), and to seek from such persons any data, advice, opinions, or other information relevant to the listing.

On June 16, 1976, the Director of FWS published in the Federal Register a proposed rule that would designate approximately 1,700 native U.S. plant taxa as endangered species (Reference 70). (The question of species to be designated as threatened was presumably reserved for later consideration). The taxa included in this list were selected on the basis of comments received by FWS from the scientific community, various states, Federal agencies, industry groups, other special interest groups, and the general public. Again, the list was not final, and Reference 70 solicited comments and suggestions from all who might be interested. Nine of the plant species listed as candidates for designation as endangered occur, or have occurred in the past, on NTS (or, in one instance, very close to the NTS boundary).

In the spring of 1976, before publication of Reference 70, ERDA initiated a survey of the status of those species on NTS listed in Reference 69 as endangered or threatened. The survey was intended to update and augment existing knowledge concerning NTS species tentatively proposed for protection under the provisions of the Endangered Species Act of 1973. Pending final action by the Department of the Interior on the list proposed in Reference 70, ERDA proposes to treat those species that appeared on the list as de facto endangered species. Nevertheless, in the discussion that follows, recommendations will be presented for considering two of the listed species as threatened rather than endangered, and for adding two taxa to the proposed endangered species list. These recommendations are based on the survey that started in the spring of 1976 mentioned above, and which continued. Results are reported in detail in Reference 72.

II.D. THE EXISTING ENVIRONMENT

9. Bioenvironment (Cont.)

For seven of the plant taxa involved, a location on NTS represents the "type locality" for the species or subspecies, i.e., the site from which the first specimens for taxonomic identification were collected. Populations growing in a type locality are of more than ordinary interest to the taxonomist and ecologist.

Those plants that occur on NTS and have been proposed for endangered status are listed below, with descriptions of their known distributions on and near the test site. As indicated, only seven are species whose "type locality" is on the NTS. The map in Figure II-32 and accompanying descriptions further indicate where they occur (information on distributions is drawn from References 71 and 72). Numerals refer to the species listed below.

1. *Astragalus beatleyae*; a perennial found as scattered plants in *Artemisia nova*, north and east Pahute Mesa, 1,860-2,070 meters (6,100-6,800 feet) (type locality).

2. *A. nyensis*; a rare and local annual, found on calcareous gravel knolls, below 1,370 meters (4,500 feet) (type locality is in the Spotted Range toward Frenchman Flat). The type locality for this species, now believed extirpated from NTS, was not described with sufficient precision to permit showing more than an approximate area. The plant has not been found on the NTS since 1941.

3. *Lathyrus hitchcockianus*; a perennial, not known to occur on NTS, but reported from a site below Yucca mountain, about 2.2 kilometers (1.4 miles) west of the NTS western boundary. In *Artemisia tridentata* or lower *Artemisia*-Pinyon-Juniper, 1,370-1,580 meters (4,500-5,200 feet). Also in central Bullfrog Hills, (the type locality) some 42 kilometers (26 miles) west of NTS.*

*Although this species was not found on NTS during the 1976 survey, it is considered possible that it may occur within the western boundary of NTS near the site of the earlier off-NTS collection (Reference 71).

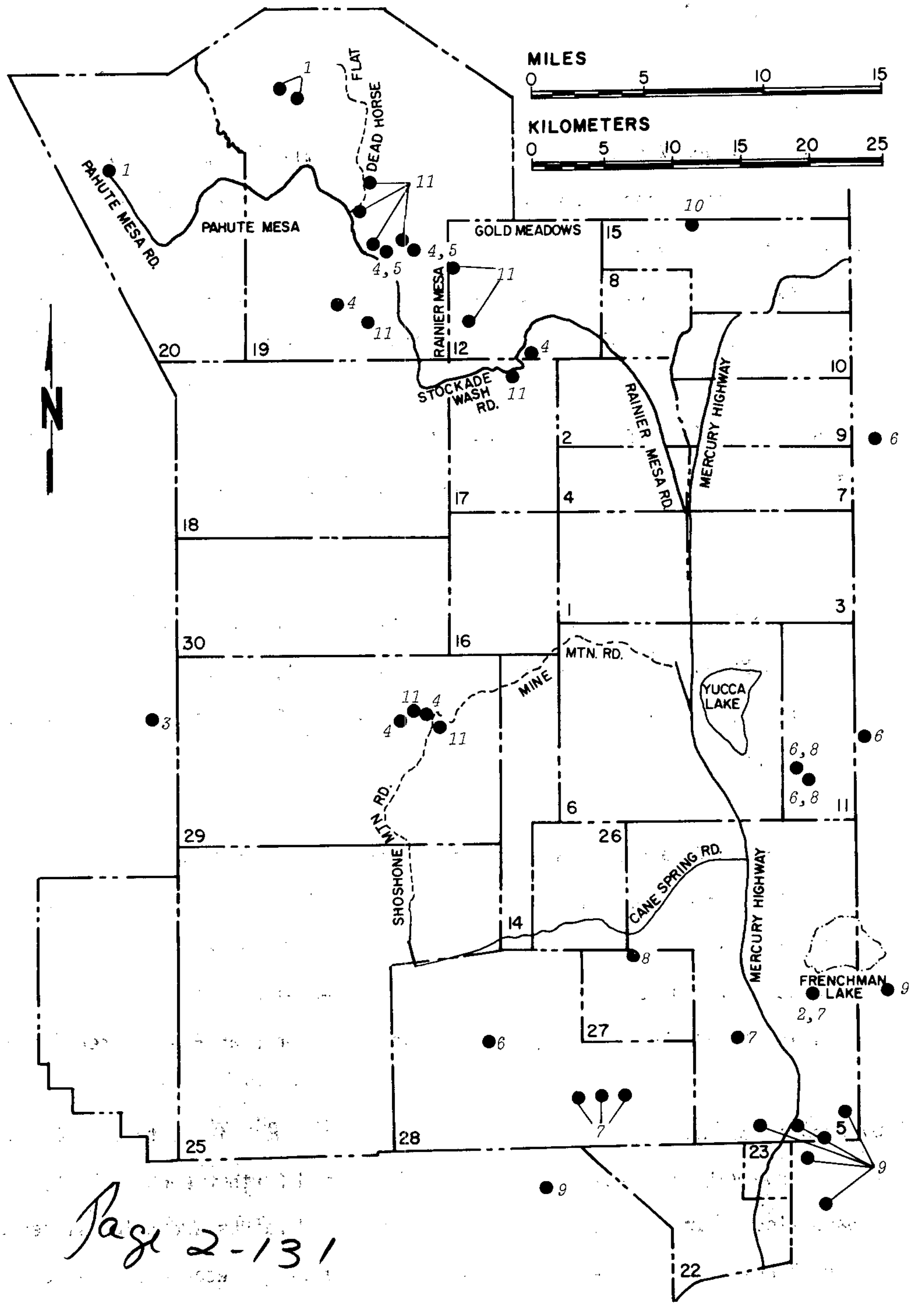

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FIGURE II-32 LOCALITIES OF NTS POPULATIONS OF ENDANGERED PLANT SPECIES CANDIDATES

II.D. THE EXISTING ENVIRONMENT

9. Bioenvironment (Cont.)

4. *Trifolium andersonii* spp. *beatleyae*; a locally common to abundant perennial, around volcanic flatrock areas and washes in *Artemisia nova* and *Artemisia*-Pinyon-Juniper, south and east slopes of Shoshone Mountain (type locality, Tippipah Spring); Eleana Range (near Capt. Jack Spring); and southeast rim of Pahute Mesa, where it occurs over many acres, 1,770-2,225 meters (5,800-7,300 feet) (also found below White Blotch Spring, off NTS).

5. *Frasera pahutensis*; a perennial occurring in a large population near southeast rim of Pahute Mesa, in *Artemisia*-Pinyon-Juniper, 2,200-2,230 meters (7,200-7,300 feet) (type locality).

6. *Phacelia beatleyae*; a winter annual, locally abundant along certain washes and nearby loose tulus below French Peak (north Frenchman Flat), in *Atriplex hymenelytra*, 1,220-1,370 meters (4,000-4,500 feet) (type locality), on Skull Mountain, and west of NTS in Lincoln County.

7. *Phacelia parishii*; a winter annual, first collected on what is now NTS in May 1941, below west Spotted Range (Mercury Ridge) near playa of south Frenchman Flat, 980 meters (3,200 feet), and until recently, known only at NTS from that first collection (Reference 71). In 1976, populations of this species were found at a number of locations on NTS, in eastern Rocky Valley and southwestern Frenchman Flat (Reference 72).*

8. *Camissonia megalantha*; a spring-germinating annual, occasional to locally common on soils derived from volcanic rock in two areas of west and north Frenchman Flat; bare soil of seepage slope near Cane Spring (type locality), and washes and talus slopes of canyons of French Peak, 1,220-1,340 meters (4,000-4,400 feet). Because of the possibility that

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*Not listed in Reference 70. Recommended for designation as an endangered species, on the basis of what is known about its distribution and degree of endangerment (Reference 72).

this species may be determined as a synonym for *C. heterochroma*, a widespread species not threatened, these NTS populations might later be removed from the endangered list (Reference 72).

9. *Arctomecon merriamii*; a perennial, occasional populations in *Larrea-Ambrosia* and *Atriplex*, often on ground terraces and sometimes as a weed of disturbed soils, Specter Range, west Spotted Range (including Mercury Ridge), Ranger Mountains, 670-1,460 meters (2,200-4,800 feet). Also found off NTS in mountains on east side of Stewart Valley, and in Ash Meadows).*

10. *Galium hilendiae*, ssp. *kingetonense*; a perennial, found on south Belted Range (cliff at head of Butte Wash below Oak Spring Butte) in *Artemisia*-Pinyon-Juniper, 1,880 meters (5,600 feet).**

11. *Penstemon pahutensis*; a perennial, common in areas of occurrence, in *Artemisia*-Pinyon-Juniper, canyons of South Shoshone Mountain, Eleana Range, south Belted Range, south Pahute Mesa (type locality below northwest face of Rainier Mesa) 1,770-2,290 meters (5,800-7,500 feet) (also found off NTS, on Stonewall Mountain, in western Nye County).*

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*It is being recommended to FWS that these species be removed from consideration as endangered species, and be designated instead as threatened (Reference 72). The recommendation is based on the size and distribution of populations of the species, and the lack of significant endangerment.

**Listed in Reference 71 as endangered in California, but not so listed for Nevada. Recommended for designation as an endangered species in Nevada, on the basis of what is known about its distribution and degree of endangerment (Reference 72).

II. D. THE EXISTING ENVIRONMENT

9. Bioenvironment (Cont.)

As noted above, a number of plant species were proposed by the Smithsonian Institution for designation as "threatened species." The Department of Interior is presently evaluating the suitability of the list of candidates for designation as "threatened." Appropriate consideration will be given by ERDA to the status of those plants occurring on the NTS which are on the Smithsonian list of threatened species. Data on such species will be published after ongoing surveys are completed.

Detailed maps showing known locations of populations of endangered or threatened plant species candidates, and their critical habitats when ascertained, will be distributed to appropriate planning and operational personnel of NTS. They will provide information for planning and carrying out test site operations in a manner designed to avert adverse effects on these populations and their habitats.

b. Animals

No animals occurring on the NTS are presently on the U. S. Department of the Interior list of endangered or threatened wildlife. However, the State of Nevada, through the State Board of Fish and Game Commissioners, has placed the following animals in the "protected" classification under Nevada game laws (Reference 54):

> Kit Fox; Spotted Bat; all Eagles, Falcons, Hawks, and Owls (14 species in all on NTS); Osprey; Turkey Vulture; Belted Kingfisher; White Pelican; White-Faced Ibis; Common Nighthawk; Lesser Nighthawk; Roadrunner; and Desert Tortoise.

The prohibitions against sport hunting on NTS, plus restriction of access to NTS except by authorized personnel, probably ensure that these species are more adequately protected on NTS than in areas of the state where control of access is not so strict.

Although no species of endangered animals are resident on the NTS, the only known surviving wild population of the endangered Devils Hole pupfish, *Cyprinodon diabolis*, lives in a single,

II.D. THE EXISTING ENVIRONMENT

9. Bioenvironment (Cont.)

spring fed, sinkhole pool in Ash Meadows, Nye County, Nevada, between Death Valley and NTS. This location is about 38 kilometers (24 miles) southwest of Mercury or about 72 kilometers (45 miles) south-southwest of the center of the nuclear test area in Yucca Flat. Surface motions from some of the larger underground nuclear tests at NTS have on some occasions produced transient water level fluctuations (sloshing) of three to six inches in the water of the Devil's Hole pool. The small population (about 200 fish) is threatened by a declining water level caused by nearby pumping for irrigation (Reference 73). The U.S. Supreme Court has recently enjoined the irrigators from lowering the water table below a level to be set by the Federal District Court in Las Vegas that will ensure adequate water for survival of the pupfish. **(Also see Reference 74.)**

The Animal Investigation Program

Since 1955, AEC, and more recently ERDA, has sponsored an "Animal Investigation Program" in conjunction with nuclear test activities conducted at the NTS. Initially, the program was conducted by a U.S. Army veterinarian, but in recent years it has been performed for the Nevada Operations Office by the U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory in Las Vegas.

The current objectives of this program are:

a. The determination of tissue concentrations of selected radionuclides in biological samples obtained from cattle grazing on the Nevada Test Site and from cattle grazing off-site areas when indicated.

b. The development and conduct of wildlife studies on and near the Nevada Test Site in cooperation with state and Federal wildlife agencies, particularly to assess the radionuclide burden in tissues collected from various edible wildlife species.

c. The gross and microscopic examination of tissues collected from these domestic and wild animals for the detection of pathological changes and to ascertain if such changes might possibly be due to the presence of radionuclides.

d. The maintenance of veterinary relations with the off-site population.

e. The investigation of alleged damage to domestic animals resulting from the activities of the Nevada Operations Office of the Energy Research and Development Administration.

The principal activity in this program has centered on maintenance of a beef herd on the NTS where 75 to 100 head of cattle are allowed to graze freely in areas where nuclear tests were conducted in the past. The herd is managed in conformance with conventional range conservation practices in order to avoid overgrazing of the native forage.

Twice each year, the herd is inspected by a veterinarian and six animals are sacrificed for radiological and histopathological analyses. Four times a year, a mule deer is similarly sampled; often the samples are obtained from road kill accidents. Small numbers of other species of wildlife such as rabbit, chukar partridge, and coyote are sampled on a seasonal or opportunistic basis. Also, a long-term cooperative study has been conducted since 1956 in conjunction with the U. S. Fish and Wildlife Service on the Desert National Wildlife Range located to the east of NTS. Each winter, a controlled sport hunt for desert bighorn sheep is held on the range. Tissue specimens are taken from hunter kills and analyzed for radionuclides.

Levels of certain radionuclides in animal tissues, such as ^{137}Cs and ^{90}Sr, are lower than those found in animals living in wetter climates. Some radionuclides have been observed in animal tissues that have been above normal background concentrations, especially following Plowshare cratering experiments. With the exception of some beta-burns which occurred to livestock grazing near the test site during atmospheric testing, and to animals intentionally exposed in experiments, no test-related effects on animals have been observed in this program (References 75, 76, and 77).

The Experimental Farm

The NTS Experimental Farm complex is operated for the Nevada Operations Office by EPA/ EMSL-LV. This facility was originally established in 1964 to study the problem of radioiodine in the agricultural food chain to man. It has also been used in studies of other radionuclides in the environment and at the present time is being used in a series of plutonium uptake and retention experiments. The remote location of the farm (160 kilometers northwest of Las Vegas) makes it admirably suited for experiments employing large doses of radionuclides, heavy elements, or other toxicants that may be considered too hazardous to perform near populated areas.

The farm occupies 12 hectares (30 acres) in Area 15 at the northern end of Yucca Flat (see Figure II-33). It consists of 6 hectares (15 acres) under cultivation as forage crops; an irrigation system with a 3,800-cubic-meter (1,000,000-gallon) reservoir and well; a milking herd of about 25 Holstein cows; a dairy barn and milking parlor; cow pens; and 0.8 hectares (2 acres) of microplots and a greenhouse for controlled studies of radionuclide movement in the soil and uptake in vegetable and grain crops. Metabolism stalls and a slaughter house for cattle, equipped to safely handle animals containing radionuclides, along with a fully contained liquid radioactive waste storage system, are also located there.

10. Archaeological and Historical Values

Human occupation of what is now the NTS has extended from perhaps as early as 10,000 B.C. to the present time. Early occupation by small hunting and gathering groups was probably

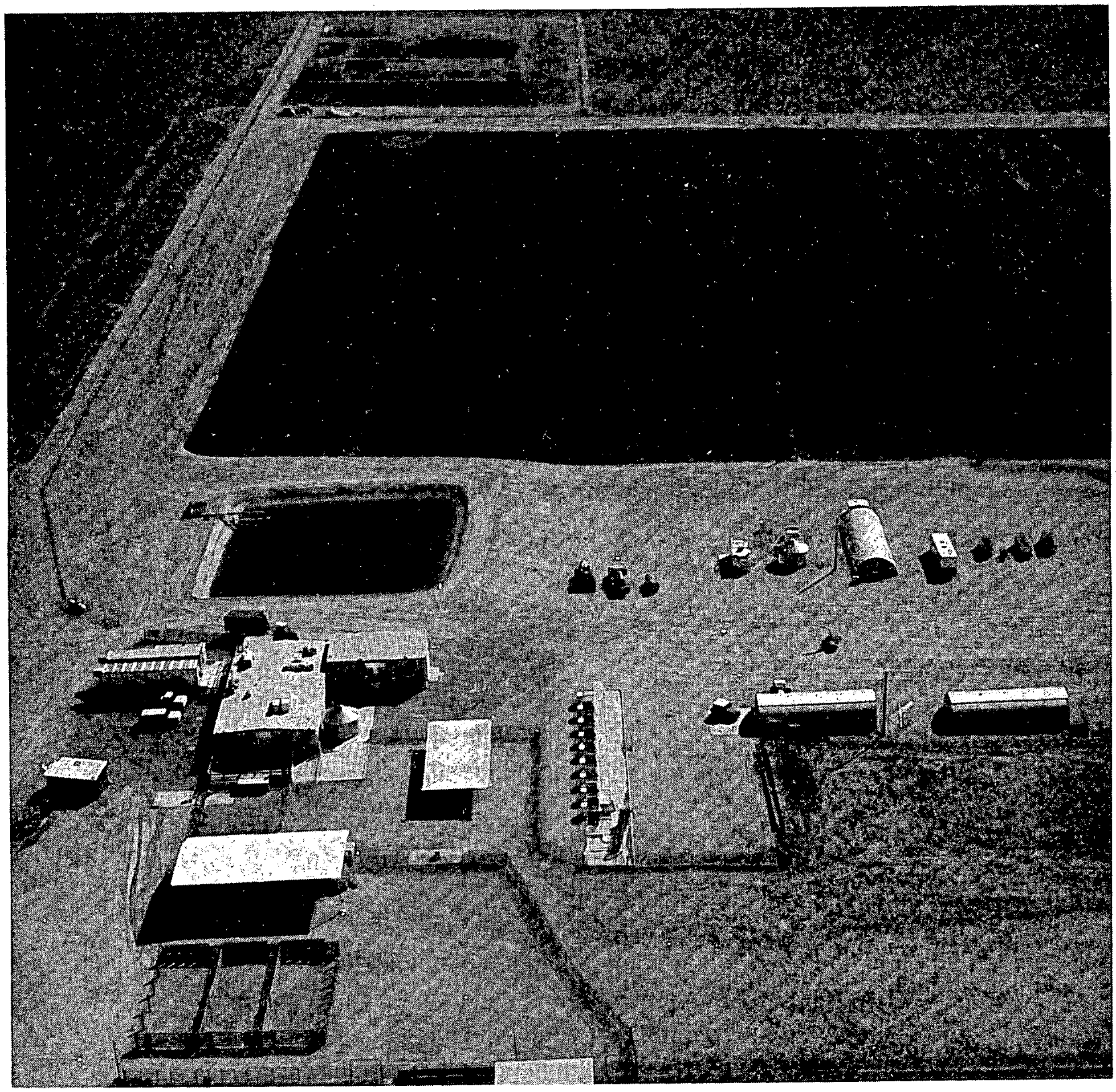

FIGURE II-33 NTS FARM

II. D. THE EXISTING ENVIRONMENT

10. Archaeological and Historical Values (Cont.)

sporadic and sparse, and had little influence on the environment. Various aboriginal cultures occupied the area over this extended period as evidenced by the presence of artifacts at many surface sites, and more substantial deposits of cultural material in several rockshelters on the NTS. The area was occupied by Paiute Indians at the time of the first known outside contact in 1849. This period of aboriginal occupation was sustained primarily by a hunting and gathering economy, based on using temporary campsites and shelters. Aside from the artifactual remains left behind, the presence of prehistoric man in the area probably had only a superficial and transient impact on the environment.

The archaeological and historical features of the Nevada Test Site have been investigated. Working in consultation with the Nevada State Museum, Desert Research Institute of the University of Nevada, Las Vegas, Dr. Frederick Worman of the Los Alamos Scientific Laboratory (now deceased) identified 17 known archaeological sites on the Nevada Test Site and has documented these in References 78, 79, and 80. These sites are located on the map shown in Figure II-34.

These documents were published and made available to the National Park Service in 1969 in compliance with Public Law 93-291. These sites have been recorded in the Nevada State Museum's Site Record File. None of the known sites on the Nevada Test Site is listed in the National Register of Historic Places.

Neither the Nevada State Museum, the National Park Service, nor the Nevada State Historical Preservation Officer has identified any of these known sites as meeting the criteria for nomination for inclusion on the National Register list.

In his most complete discussion of these matters in Reference 80 Worman calls attention to several sites of historical interest, and 17 sites of archaeological interest. Because the ready availability of surface water was the most important single determinant governing the location of human occupation, historic sites are often associated with prehistoric ones, both being situated near springs. As a consequence of this superposition of historic

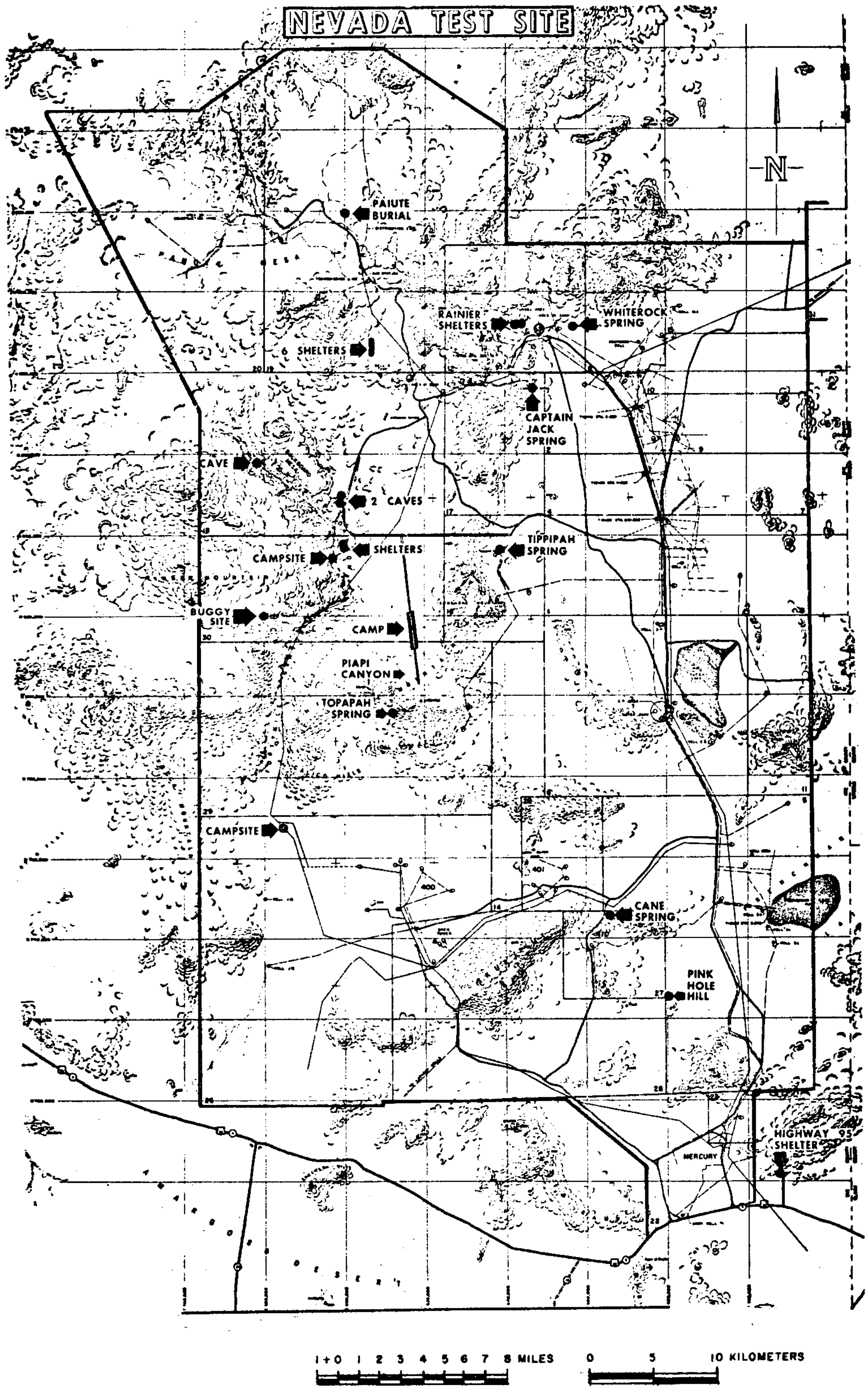

FIGURE II-34 ARCHEOLOGICAL SITES

occupation on the prehistoric, disturbance of certain aboriginal sites by modern man occurred long before use of the area by AEC/ERDA began.

In addition to the archaeological sites discussed above, there are also some sites of historical interest. The principal ones include: (1) the remains of primitive stone cabins, with nearby corrals, at Tippipah Spring, Cane Spring, and White Rock Spring; (2) a natural cave containing prospector's paraphernalia, in Cat Canyon in Area 30; and (3) crude remains of early mining and smelting activities, e.g., the cinnibar retort on Mine Mountain Road in Area 6.

Archaeological remains include artifacts found on or just below the surface at campsites and in natural caves or rockshelters in canyons and cliff faces. The artifacts comprise flakes and ground stone tools, pottery (mostly shards), and occasionally trade items, such as glass beads, indicative of postcontact occupation. One rockshelter, located just outside the NTS boundary, also yielded fragments of basketry and cordage. Petroglyphs are found in a few areas, e.g., Cat Canyon.

In addition to the 17 numbered sites, Worman, in Reference 80 lists 15 "general areas" on which surface finds of artifacts have been made. Artifacts in the possession of private collectors are described and figured in Reference 80. Most such collections were made in the early days of NTS operation, before measures were adopted to protect antiquities. One private collection has been turned over to the museum of the Desert Research Institute of the University of Nevada, Las Vegas.

As noted above, sites of both historic and prehistoric occupation on NTS are located around springs, in canyons, or on or near the bases of mountains and mesas. In contrast, the larger valleys show little or no evidence of occupation. Worman, in Reference 80 characterizes most of NTS operational Areas 2, 3, 4, 5, 6, 7, 9, 10, 11, 14, and 25 as "Areas of no archaeological interest--no building or testing restrictions." These areas together comprise almost the entire floors of Yucca, Frenchman, and Jackass Flats. Yucca Flat (especially

10. Archaeological and Historical Values (Cont.)

Areas 2, 3, 7, 9, and 10) was the site of much of the atmospheric testing during the early days of NTS operation, and of a large percent of the underground testing carried on since 1961. Thus, testing and associated operational activities have generally been most intense in those parts of NTS where archaeological and historic sites are absent. Even sites on the periphery of Yucca Flat, close to the area of repeated underground testing, seem to have been little affected by ground motion from the tests, For example, during a site visit in January 1976, the condition of the stone cabin at Tippipah Spring, less than ten miles from the site of numerous underground tests, was found to be essentially unchanged as compared to its condition as shown in a photograph made eight years earlier (shown in Reference 80).

Formal investigation of the archaeological and historical features of NTS has consisted largely of the reconnaissance and spot sampling efforts reported by Worman. Worman also carried out an officially authorized salvage investigation, in 1962, of two rockshelters thought to be potentially threatened by ground motion from proposed tunnel shots. The shelters are located on the south slope of Rainier Mesa, in Area 12. The results of this salvage operation are reported in Reference 78. Materials recovered, which were all of the late prehistoric and postcontact eras, were deposited, with the records, in the Museum of Natural History at the University of Nevada, Las Vegas. Currently, the Desert Research Institute of the University of Nevada is pursuing an investigation to identify and inventory additional archaeological and historic cultural sites on NTS. It is expected that this investigation will be conducted over a number of years.

Guidelines and operating procedures have been developed at the Nevada Test Site to protect known sites of potential archaeological and historical interest in compliance with the Federal Antiquities Act of 1906 (16USC Sections 431, 432, 433), the Historic Sites Act of 1935 (16USC Sections 461 and 467), and the National Historic Preservation Act of 1966 (16USC Section 470). These procedures are established in the standard operating procedure for the Nevada Test Site (NTSO-6003--Reference 81), which specifies the responsibilities and procedures to be used with regard to preservation of antiquities and historic sites within

II.D. THE EXISTING ENVIRONMENT

10. Archaeological and Historical Values (Cont.)

the Nevada Test Site. It also establishes procedures for reporting and confirming new "finds" of archaeological and historical interest. Sites and locations on the Nevada Test Site that had been identified as having archaeological or historical interest have been marked with appropriate signs. As new sites of historical interest are identified, these will be similarly marked and protected. If necessary, the standard operating procedures will be modified.

On January 3, 1976, a high-yield event detonated on Pahute Mesa caused concern for National Park Service properties within Death Valley. The ground motion caused by this event was distinctly felt at Scotty's Castle and there was concern on the part of the National Park Service that some damage might also have been caused. Scotty's Castle and the surrounding Scotty's Ranch are not listed in the National Register of Historical Places, but they are considered eligible for consideration by the Secretary of the Interior.

The Nevada Operations Office has been in contact with the Historic Preservation Coordinator for the state of California with regard to this incident. In addition, inquiries have been made of the State Historic Preservation Officers (SHPO) of California and Nevada to ascertain if there are any other historic sites which are eligible for inclusion in the National Register, and which are close enough that they might experience adverse effects from ground motion from NTS activities (see Figure II-35). Currently, the structural response contractor, URS/John A. Blume and Associates, is consulting with these SHPOs and other interested historical entities to locate additional historic structures and to assess the potential effects of ground motion. Historical sites in Utah and Arizona will not be affected because of the greater distances involved.

11. On-Site Facilities

Onsite facilities at NTS vary from highly specialized test structures to general utility structures. For the purposes of this statement, an installation or structure is considered permanent which has been in place for four years and is expected to be in use for four additional years.

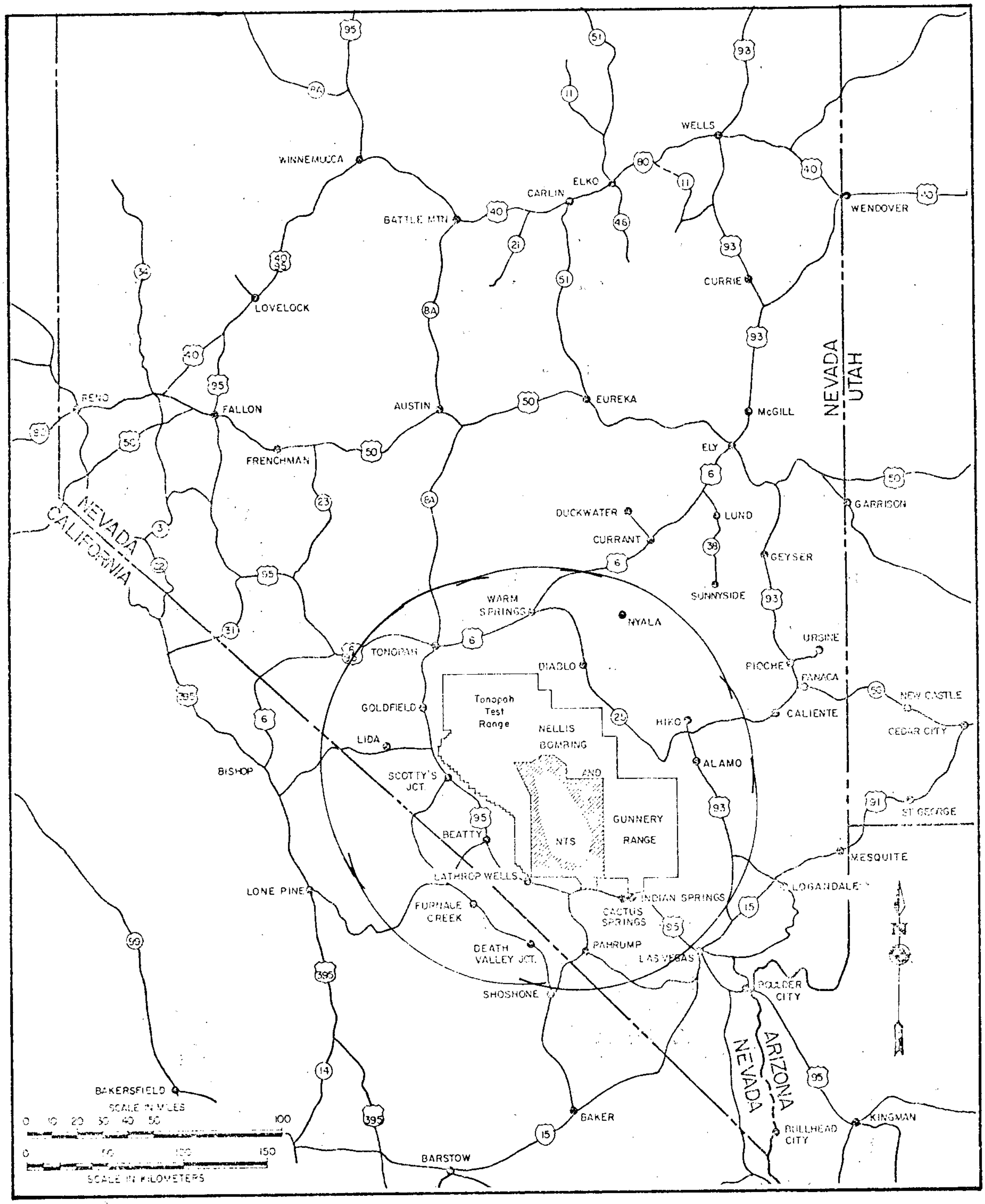

FIGURE II-35 AREAS OF POSSIBLE GROUND MOTION INDUCED DAMAGE TO HISTORICAL SITES

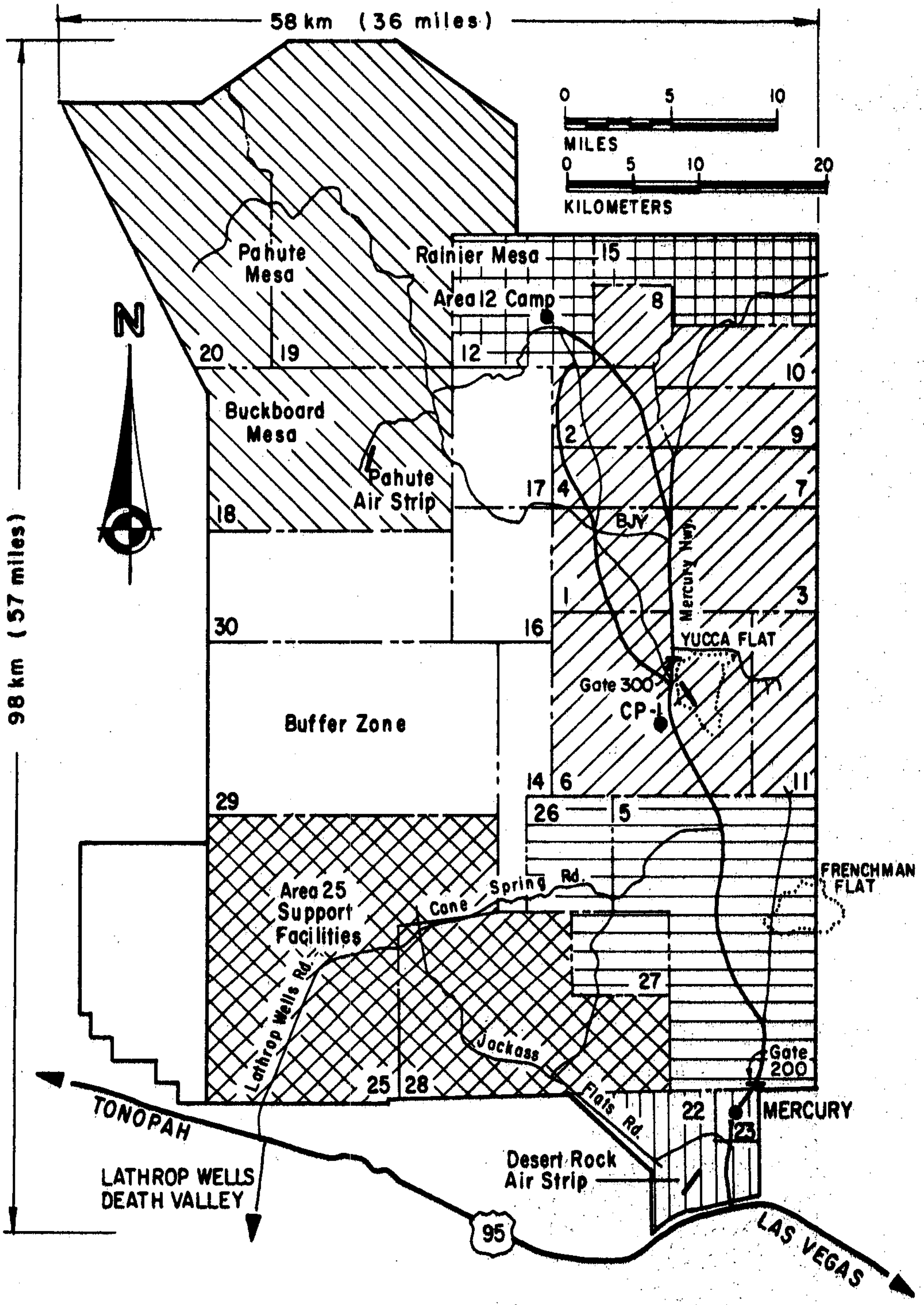

FIGURE II-36 NEVADA TEST SITE REGIONS

II.D. THE EXISTING ENVIRONMENT

11. On-Site Facilities (Cont.)

At the NTS, there are residential areas, administrative centers, major construction complexes, as well as various other facilities and installations strategically positioned in the forward areas. They are interconnected by a primary and secondary road net, buried utility systems, and surface-strung high-power lines. Although normally considered as permanent, roads, power, and utility nets are often constructed and abandoned in response to the needs of the testing program.

At present (1976), there are 705 kilometers (438 miles) of open, paved roads and 111 kilometers (69 miles) of unpaved secondary roads at NTS. In addition, there are 368 kilometers (229 miles) of abandoned and permanently barricaded paved and unpaved roads, for a total of 1,184 kilometers (736 miles) of roadway at the site. In many instances, utility systems and power lines closely parallel the road networks; therefore, using 50 meters as the average combined width of these features, 59 square kilometers (23 square miles) of land are estimated to be permanently utilized for this purpose.

To facilitate the general description of the permanent onsite features, the test site has been divided into six regions as shown on Figure II-36. The features range in use from the major administrative center at Mercury, with a more or less permanent population of 475, to forward areas such as Pahute Mesa, utilized only for experimental purposes and with little or no overnight population (Reference 82).

a. In the Mercury vicinity there are centralized facilities to house and support most of the activities at the NTS.

b. The Frenchman Flat vicinity is wholly utilized for experimental projects.

c. The Yucca Flat vicinity furnishes the site for most of the underground tests, the location of the testing Control Point, and the forward location for some test support activities.

II.D. THE EXISTING ENVIRONMENT

11. On-Site Facilities (Cont.)

d. The Rainier Mesa vicinity is the location of underground tests for the DoD. There is also an experimental farm in that vicinity.

e. The Pahute Mesa vicinity provides a site for higher yield underground tests.

f. Areas 25 and 28 contain buildings and facilities that remain from former activities.

g. The remaining areas of the NTS have no permanent facilities other than some paved and unpaved roads.

The general distribution of facilities at the NTS is indicated in Table II-6.

There are 27 numbered areas comprising the Nevada Test Site and 10 of these areas have no permanent facilities or installations. These ten areas total 1,100 square kilometers (424 square miles) and have an effective permanent usage factor of zero. In the remaining 17 areas, comprising 2,350 square kilometers (904 square miles), about 70 square kilometers or 27 square miles have been covered with "permanent" constructions of installations for a total NTS usage factor of 3 percent.

12. Safeguards and Security

No significant amounts of special nuclear materials (SNM) are located continuously at the Nevada Test Site. SNM is occasionally situated at specific locations on a temporary basis while being prepared for testing. In accordance with established ERDA guidelines, NTS has established a Safeguards Security System.

a. There are three types of special nuclear materials (SNM) which may be located at the Nevada Test Site:

TABLE II-6

DISTRIBUTION OF FACILITIES AT NTS

Area Designations	Mercury	Frenchman Flat	Yucca Flat	Rainier Mesa	Pahute Mesa		Other
Areas	22,23	5,26,27	1,2,3, 4,6,7, 8,9,10, 11	12,15	18,19,20	25,28	14,16, 17,29,30
Area (kilometers²)	92	366	714	104	684	586	954
Airstrip	•		•		•		
Housing	•		•	•			
Laboratories	•	•	•	•		•	
Shop Areas	•		•	•		•	
Offices	•	•	•	•		•	
Yards and/or Warehouses	•		•	•		•	
Permanent Buildings	170	42	114	32		92	
Non-permanent Buildings*	•	•	•	•		•	
Support Facilities and Utilities	•	•	•	•		•	

*The number of non-permanent structures in an area of the NTS will vary according to the activities there.

II.D. THE EXISTING ENVIRONMENT

12. Safeguards and Security (Cont.)

(1) Nuclear weapons or weapons components which are shipped to NTS to be tested as part of the underground weapons test program.

(2) Reactor fuel for the Super Kukla reactor; a fast burst reactor used for testing of weapons components.

(3) Irradiated reactor fuel from the Tory reactor. This fuel is presently in the process of dissembly for shipment to a reprocessing facility in Idaho for recovery of the SNM.

The NTS Safeguards and Security Program is generally designed to provide protection in accordance with, but greater than, required by ERDA Manual Chapters 2401, 2405, and 7401.

b. Safeguards and Security Program

The objective of the NV Safeguards and Security Program are:

(1) To prevent theft of SNM by outsiders.

(2) To protect against theft or diversion of SNM by insiders.

(3) To protect against sabotage.

(4) To protect against espionage.

II.D. THE EXISTING ENVIRONMENT

12. Safeguards and Security (Cont.)

To accomplish these objectives, NV has designed a system using the traditional elements of:

- Physical protection.
- Personnel clearances.
- Material control procedures.
- Material accountability systems.

The Physical Protection System includes an Early Warning System, an immediate assessment capability, techniques to delay an attack or intrusion attempt, and adequate protection forces to respond to such an attempt.

The Protective Security System is designed to allow access to only those persons having the appropriate clearance and an operational need, and to detect, assess, and prevent any attempt at unauthorized entry to SNM areas.

The guard force is the backbone for the security provided for the Nevada Test Site. Wackenhut Services, Incorporated (WSI), provides this guard force under contract to the Nevada Operations Office.

The area of the Nevada Test Site is considerably larger than that found at most ERDA installations, and the operations conducted at the site call for a high degree of protection. The guard force normally is comprised of from 150 to 200 guards, and is necessarily one of the largest contingents of protective personnel to be found at ERDA installations.

II.D. THE EXISTING ENVIRONMENT

12. Safeguards and Security (Cont.)

The perimeter of the NTS area is not fenced, but is posted as a restricted area, and access is prohibited other than at designated entrances. The buffer zone, provided by the Nellis Air Force range, further restricts access to NTS, particularly in the forward areas. Road access to the Nevada Test Site is restricted by guard stations and barricades. A guard station exists at the Mercury entrance and at the northern entrance from Highway 25. The Lathrop Wells road leading to the NRDS area is opened only for morning and evening traffic. The Jackass Flats road is presently barricaded between Highway 95 and the turnoff leading to Mercury.

All personnel on the NTS are required to be badged (identification and film badges).* Generally, workers at the NTS are required to have a security clearance.

Mobile patrols are one of the more effective methods employed to provide security over the large area. The guard force in a typical year utilizes over a hundred government vehicles and travels over 3 million kilometers (2 million miles).

Certain sensitive areas on the test site call for special security controls. Chain link fencing, protective alarms, closed-circuit TV, and secure communications systems are utilized. Teams of heavily armed guards are available to respond to emergency situations. and to escort the movement of nuclear explosives within the NTS. Such response teams are equipped with armored vehicles capable of moving cross-country at high speed.

Temporary roadblocks are established when needed to control access to designated testing areas in connection with the detonation of underground nuclear devices. The designated forward areas usually include all areas north of the Control Point, and these areas are "swept by guard patrols to assure that all personnel have withdrawn to a safe designated location. Helicopters and light aircraft are available to the security force and are normally used to check perimeter barricades and other remote locations in the forward test areas as part of this sweeping action.

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*The film in a "film badge," when developed, indicates the amount of radiation received.

II.D. THE EXISTING ENVIRONMENT

12. Safeguards and Security (Cont.)

Guard personnel are required to meet rigid physical standards. The NTS is equipped with a modern pistol and rifle range in Area 23 where the guards maintain their proficiency in the use of weapons. Certain guards used for sensitive assignments are also trained in the operation of weapon-equipped armored vehicles.

All locations on the NTS containing special nuclear material are designated as special security areas and utilize a combination from among the following to provide adequate security:

- Hardened facilities
- Security fences
- Internal alarms
- External alarms
- Closed circuit television (CCTV)
- Guards
- Response capability

Access Controls

The NTS is a controlled access area. Although it does not require a security clearance to enter the site, access is controlled and restricted to those personnel who have been properly identified and badged.

The security areas onsite have more stringent controls, requiring appropriate security clearances and an operational need before unescorted access is allowed. Others having a need for access are escorted.

c. Personnel Clearances

All personnel having access to SNM at NTS must either have security clearance in accordance with ERDA regulations or be escorted by personnel who do possess the proper clearance.

II.D THE EXISTING ENVIRONMENT

12. Safeguards and Security (Cont.)

d. Material Control Procedures

All SNM is assigned to specific areas, each of which has specific operational and security controls.

All SNM at NTS is under a two-man concept; that is, it requires two equally responsible individuals to enter an area where SNM is maintained. In the case of weapons, the two individuals must be together in constant attendance. At Super Kukla material, it requires two to open the facility. The same two must inventory and close up together. In the case of Tory fuel, operating procedures require that no less than two personnel be involved in any operations and that any person exiting from the operational area be monitored by radiation safety personnel.

All vehicles and packages exiting a security area are subject to search by the guards.

e. Material Accountability

Accountability for material at NTS is under the control of two different organizations. Accountability for Super K material is by Lawrence Livermore Laboratory (LLL) of the University of California under the cognizance of the San Francisco Operations Office.

There have been no inventory differences in either the weapons program or the Super Kukla Program at NTS. There have been inventory differences related to the reactor fuel which is being disassembled and shipped to Idaho for recovery. However, this difference has been determined to be reactor burnings, experimental loss, loss in disassembly, operating and measuring difference as a result of the differences in the capability of measuring equipment between the time the reactor fuel was fabricated and the time it was disassembled for recovery.

II.D. THE EXISTING ENVIRONMENT

12. Safeguards and Security (Cont.)

SNM are inventoried monthly, routinely, and upon special request. There have been no inventory differences for materials except as indicated above.

f. Assessments

The ERDA-HQ Division of Safeguards and Security performs an annual assessment of the NV Security and Safeguards System. To date, findings and recommendations have been minor and they have judged NTS to have an adequate Safeguards and Security Program.

13. Economy and Work Force

The average work force employed in Nevada alone by ERDA and its contractors is about 5,500 people. This represents an annual expenditure of about 140 million dollars for salaries and related expenses, and rates as the fourth largest "industry" in the area. Gaming, the largest of all local industries, produced a revenue over $845 million in Clark County during 1976. The tourist-convention activity accounts for the next largest industry (comprised of room accommodations, restaurant expenditures, and nightclub entertainment). There were 9.7 million visitors in 1976.

Nellis Air Force Base and Range is the biggest single employer in the area, currently employing a total of about 8,500 military and civilian personnel. The combined payroll alone amounts to nearly $104 million. This compares to a $92 million payroll associated with the Nevada Test Site.

II.D. THE EXISTING ENVIRONMENT

14. Public Information

The Nevada Operations Office conducts a public information program to inform citizens in areas surrounding the Nevada Test Site of the current aspects of Energy Research and Development Administration projects carried out by NV. Emphasis is placed on informing the public of safety measures and environmental effects concerning these projects.

The NV Office of Public Affairs maintains close contact with local, regional, and national news media to provide prompt release of information on NTS and other ERDA programs that may be of interest to the public.

Visits to the NTS are conducted for about 1,000 members of the public per year. Included are news media representatives; state, local, and federal government officials; and private citizens. Special public and news media observer programs for nuclear tests are conducted periodically. A live "countdown" is broadcast on commercial radiostations in Las Vegas for all underground tests which may cause ground motion that would be felt off the NTS.

Unclassified reports and other publications concerning the underground nuclear testing and other NTS programs are available at the public reading room in the Nevada Operations Office at 2753 South Highland Drive in Las Vegas. Many of these reports and publications describing other ERDA energy and national security programs are sent to public and university libraries in Nevada and adjoining states. NV also participates in an ERDA-wide speakers' bureau and other information programs designed to give direct response to public requests for information on all ERDA programs.

All information programs conducted by NV comply with the Freedom of Information Act and the Privacy Act of 1974.

SECTION III

DESCRIPTION OF PROPOSED ACTIVITY

A. UNDERGROUND NUCLEAR TESTING

1. General Description of Testing

As mentioned previously in Section II.C.3, the United States conducts all of its nuclear weapons tests underground in accordance with the terms of the Limited Test Ban Treaty. Hence, complete containment of all nuclear weapons tests is a dominant consideration in nuclear test operations.

Various techniques are used for emplacing nuclear test weapons so that the explosion will be contained. The most common method is to emplace a test device at the bottom of a vertically drilled hole. Another technique is to emplace a test device within a tunnel that has been mined horizontally to a location that is sufficiently deep to provide containment. The preparation of such holes and tunnels constitutes a major part of the activity carried on at the NTS.

There are many considerations which enter into the judgment of acceptability for the selection of suitable locations. These include:

a. The results from past experience in the immediate vicinity.

b. The distances to nearby expended and open test emplacement sites.

c. The relative location, strike, and dip of faults and significant surface lineations.

d. The physical and mechanical properties of the geologic media as interpreted from data collected from nearby holes (e.g., the porosity, water content, and the degree of saturation; the gas-filled porosity; the bulk and grain densities, sonic velocities, clay content, and type).

e. The proximity of discontinuities in the geologic media which would act as reflecting surfaces for shock waves.

f. The results available from geophysical logs taken in the vicinity.

g. The likelihood of CO_2 production from rocks containing carbonates.

III.A. UNDERGROUND NUCLEAR TESTING

1. General Description of Testing (Cont.)

h. The depth of the water table.

A considerable body of information already exists concerning various aspects of containment, and that data continues being developed. In particular, a vast amount of geologic knowledge about the Nevada Test Site has been assembled and is utilized in determining the best test locations for use. In instances where there is not sufficient data to make this judgment, exploratory drilling is accomplished and observations are made to obtain such information.

After suitable sites have been selected, the emplacement holes are drilled. (See Figure III-1). During the actual drilling operation, well-site geologists monitor the media properties. This is done by taking representive samples from the geologic formations being penetrated (core samples) and from drill cuttings or by additional geophysical logging of the hole. These results establish a correlation between the actual and expected geologic parameters. Often, but not always, during the drilling operation, the emplacement holes are lined with steel casing cemented in place. Primarily this is done to assure the integrity of the hole, but it also provides for more convenient access.

Geologists also monitor the mining of tunnels and tunnel drifts, documenting the physical and mechanical properties of the penetrated geologic media; however, in the tunnels the geologists have the opportunity to observe the geologic matrices in place, so that faults and other discontinuities are more obvious.

An inventory of drilled holes or partially completed holes is maintained at the Nevada Test Site to the extent feasible, so that tests can be conducted without hole preparation delays.

Emplacement of a test device in a drilled hole or tunnel is not accomplished until the containment design has been reviewed by the Containment Evaluation Panel (see Section

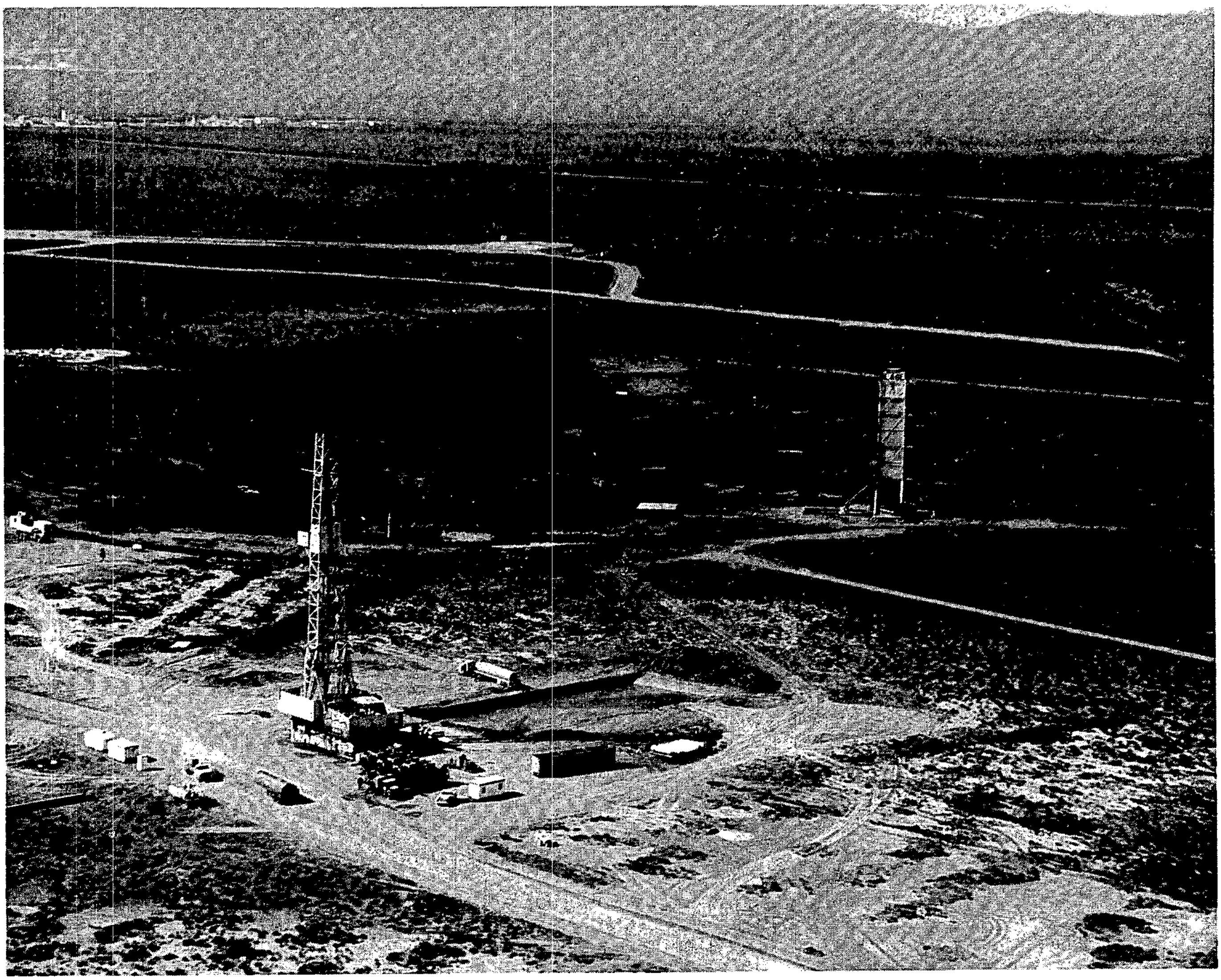

FIGURE III-1 EMPLACEMENT HOLE DRILLING

Drill rigs operate continuously at NTS preparing emplacement holes.

III.A. UNDERGROUND NUCLEAR TESTING

1. General Description of Testing (Cont.)

III.A.3.a.(1). The usual configuration for emplacing a test device is within a long cylindrical capsule or "canister" (see Figure III-2). Diagnostic systems are usually contained within the same canister and, in fact, usually constitute the greatest part of its length. The canister can be lowered into position using either certified wire rope cables or metallurgically specified drill pipe or casing under carefully controlled conditions. A considerable bundle of electrical cables is fed into the emplacement hole during this operation. These cables connect the firing systems and the diagnostic systems to the surface instrumentation.

After the devices and related diagnostic equipment are lowered into the hole or emplaced in the tunnel in the proper position consistent with the containment design, the emplacement hole or tunnel is provided with a closure system.

The closure system for tests conducted in vertically drilled holes normally consists of backfilling the hole with standard mixes of sand and gravel (referred to as "stemming") and from one to three coal tar epoxy plugs. The stemming and plugs are used as seals against leakage of cavity gas to the atmosphere. The plugs also can serve as platforms to keep the stemming from falling downhole into explosion-produced cavities. All downhole cables passing through coal tar epoxy plugs are either protected with factory-installed gas blocks or with gas blocks installed in the field to prevent the cables from acting as conduits from the explosion-produced cavity to the surface. On rare occasions, a vertically emplaced test may include a "line-of-sight" pipe, in which case the normal stemming and plugs are used outside the pipe as well as appropriate mechanical closures within the pipe, to afford assurance of containment.

For tests detonated in tunnels, the stemming material will normally consist of rock matching grout (concrete) emplaced close to the device, backed-up by varying types, amounts, and combinations of grout and other stemming materials. Tunnel experiments generally include a horizontal line-of-sight pipe within the mined tunnel. After the detonation occurs, appropriate mechanical closures block the pipe to prevent gases from entering the open (unstemmed)

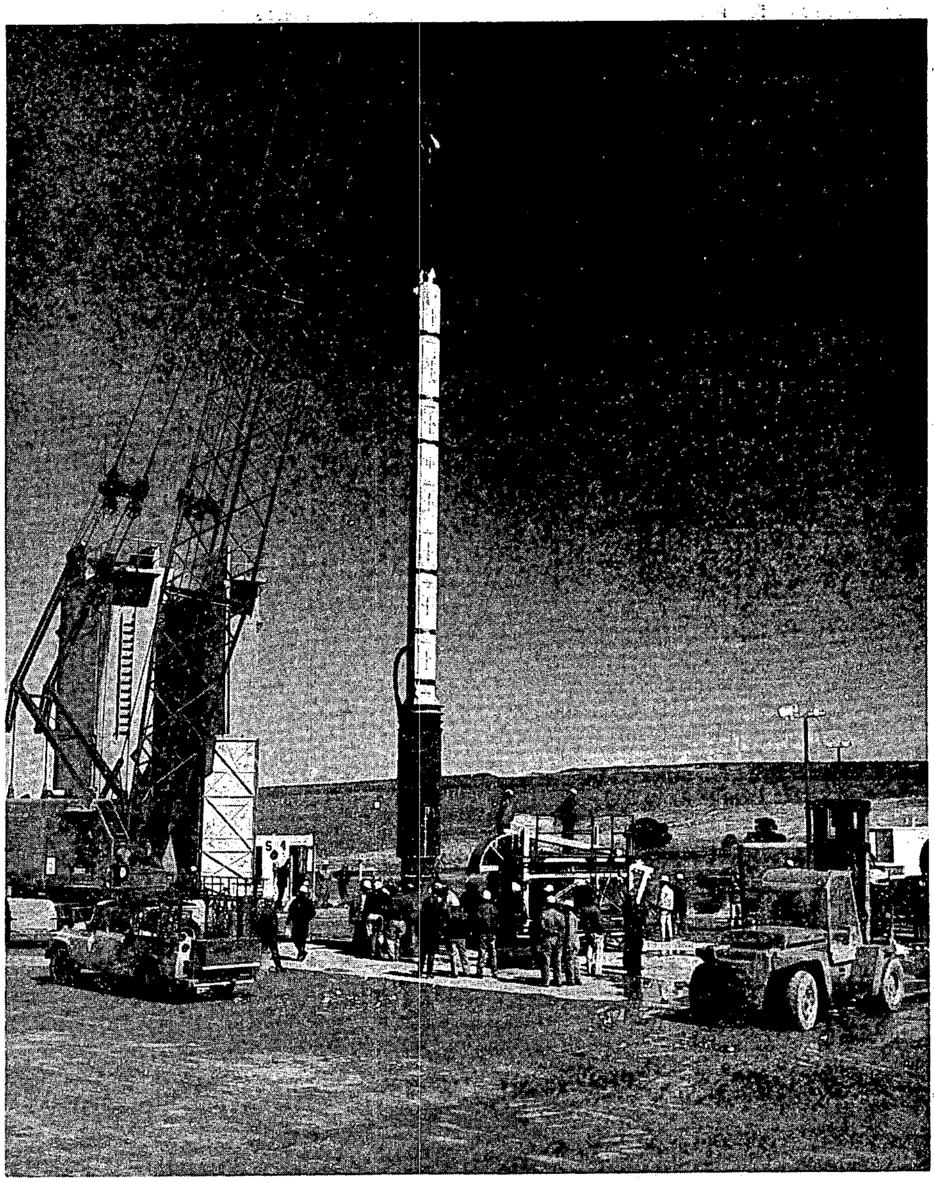

FIGURE III-2 INSERTION OF TEST DEVICE

An event canister being lowered downhole at Pahute Mesa.

III.A. UNDERGROUND NUCLEAR TESTING

1. General Description of Testing (Cont.)

portions of the tunnel. In addition, several large concrete and steel plugs block the tunnel between the experimental area and the portal (entrance) to afford added protection against the possibility of gas bypassing the stemmed area.

When all is in readiness, the test device is fired by electrical signals sent from a remote firing location called the Control Point or CP. During and following the test, diagnostic data are transmitted by cables to trailers and instrumentation shelters located at the surface outside the area of possible surface collapse.

After the test has been fired, there are other engineering operations which may be conducted relative to specific tests. Those operations and the precautionary procedures which they require are described in Section III A.3.e.

2. Areas Used (Land Use)

Currently, underground nuclear tests at the Nevada Test Site are being conducted in undisturbed media in areas which have been utilized in the past. As mentioned previously, the primary users are assigned control of certain testing areas and coordinate the various activities within their boundaries (see Figure III-3).

For testing in FY 1978 and beyond, it is expected that these same areas in Yucca Flat, Rainier Mesa, and Pahute Mesa will continue to be utilized for underground tests by the laboratories and the DoD. In addition, it is anticipated that there may be requirements to utilize other areas of the NTS for underground nuclear tests.

3. Normal Operations

a. Test Operations Review and Survey Panels

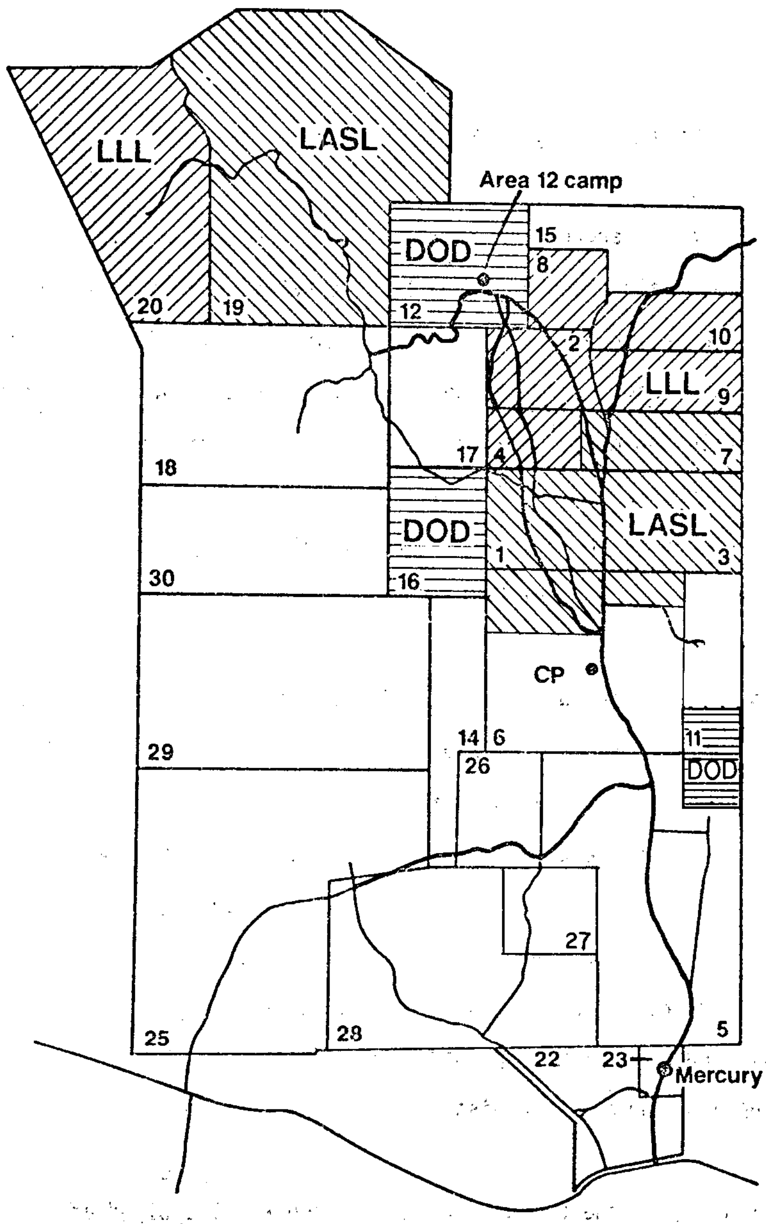

FIGURE III-3 TESTING AREA DESIGNATIONS - NTS

III.A. UNDERGROUND NUCLEAR TESTING

3. Normal Operations (Cont.)

(1) The Containment Evaluation Panel

Each proposed underground nuclear test will be thoroughly reviewed by a Containment Evaluation Panel (CEP). The CEP is composed of individuals with extensive experience in nuclear testing and associated phenomenology. The CEP assists the Manager, NV, in the review of proposed nuclear tests to ensure that each containment design is one which will (a) provide reasonable assurance of satisfactory containment of radioactivity,* or (b) release radioactivity only under controlled conditions in compliance with all treaty constraints, and under health and safety guidelines established by the Administrator of ERDA.

Panel membership includes individuals from the Los Alamos Scientific Laboratory (LASL), Lawrence Livermore Laboratory (LLL), Defense Nuclear Agency (DNA), U.S. Geological Survey (USGS), Sandia Laboratories (SL), and independent consultants. The Panel examines each factor which may contribute to unwanted escape of radionuclides to the atmosphere during or after the detonation. Such reviews consider in detail the device yield, depth of burial, geology, hydrology, medium characteristics, location of the emplacement site (including the proximity to and the success of previous test locations), phenomenology, closure methods, stemming design, and the drilling and construction history.

Establishment of the Containment Evaluation Panel evolved after a breach of containment for the BANEBERRY event detonated on December 18, 1970, resulting in the prompt venting of about three million curies** of radioactivity into the atmosphere. Because of this incident, a test moratorium was imposed. One result of the intense investigation which followed was that the "Test Evaluation Panel", which had been charged with evaluating the adequacy of test safety preparation, was reconstituted as the Containment Evaluation Panel (CEP).

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*Satisfactory containment, as defined by the Manager, NV, will result in no radioactivity measurable offsite by normal monitoring equipment and no unanticipated release of radioactivity onsite.

**The estimate is corrected to 12 hours after the event time.

III.A. UNDERGROUND NUCLEAR TESTING

3. Normal Operations (Cont.)

Among the changes made were the assignments of a USGS representative and consultants in underground phenomenology and hydrology as permanent members of the Panel. Increased emphasis was placed upon the physical properties of the geologic media; more conservative emplacement depths were emphasized; extensive emplacement site investigations were required to assure suitability of each test for the location proposed for that test; changes were made in the design and location of containment mechanisms, such as epoxy plugs and cable gas blocks; and more extensive evaluation procedures were instituted.

It is the function of the CEP to undertake this comprehensive and thorough review required by ERDA before approval can be given to proceed with the test. After reviewing and evaluating the test design, each member of the CEP provides a statement on the adequacy of the containment design. These statements are not made for public record, because they normally consist of classified information. The chairman of the panel then summarizes the views of the panel and makes a recommendation to the Manager, NV, relative to proceeding with his request for detonation authority from the Division of Military Application, ERDA/HQS, to conduct the test as designed. After the event, the CEP reviews the effectiveness of the containment design.

Since the advent of the CEP, with its heightened attention to test containment, the nuclear testing program has maintained a satisfactory record for containing radioactivity underground both during and following nuclear explosions. There have been no dynamic ventings since BANEBERRY, although there has been one release. During the DIAGONAL LINE event of November 24, 1971, about 6,800 curies* of radioactive gases (primarily xenon-133) seeped to the atmosphere. This release was detected in the atmosphere offsite by very sensitive airborne monitoring systems but was undetected offsite by ground monitoring systems.

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*The 6,800 curie estimate is corrected to 12 hours after event time.

III.A. UNDERGROUND NUCLEAR TESTING

3. Normal Operations (Cont.)

(2) The Nuclear Explosive Safety Study and Survey Group

Prior to any activity involving a nuclear explosive, a study of the proposed operation is conducted in accordance with ERDAM 0560 (Reference 83). The Nuclear Explosive Safety Study and Survey Group, as constituted for that event, reports to the Manager, NV, for nuclear explosive operations at the NTS. This group includes personnel from the Energy Research and Development Administration, Albuquerque, New Mexico (ERDA/AL); Energy Research and Development Administration, Oakland, California (ERDA/SAN); Los Alamos Scientific Laboratory (LASL); Lawrence Livermore Laboratory (LLL); Sandia Laboratories (SL); and is chaired by a representative from the ERDA/NV.

This designated group conducts detailed safety analyses of all proposed operations involving nuclear explosives prior to the beginning of any operation. These operations are: assembly, transportation, insertion, emplacement, arming, and firing. The group prepares a report which may contain safety rules or recommendations pertinent to the specific operation under study. These rules or recommendations are based on findings resulting from their safety analyses and from the physical inspection of the facilities and equipment to be used. The report from this group is reviewed for approval by the Manager, NV. Any recommendations contained in the report are resolved prior to the start of any associated nuclear explosive operations, and the ERDA Headquarters organization is so advised.

(3) The Test Controller and Advisory Panel

The Test Controller, and ERDA/NV representative designated by the Manager, NV, assumes operational control of the Nevada Test Site and the Nevada Test Site Organization (the entity of Nevada Operations Office that supports test operations) for a specifically assigned test during the test execution period. The Test Controller assures that the test is conducted in compliance with the ERDA directives, instructions, published policy, containment plans, and applicable international test treaties. An Advisory Panel is assembled to assist the Test Controller in matters pertaining to onsite and offsite safety associated with the test.

III.A. UNDERGROUND NUCLEAR TESTING

3. Normal Operations (Cont.)

The Advisory Panel is chaired by a Scientific Advisor from the sponsoring laboratory, who is familiar with the technical and scientific aspects of the test. Members of the Panel have combined expertise in the field of underground testing phenomenology, meteorology, radiation, biological effects, and other subjects influencing the safety of a specific activity.

The Test Controller and Advisory Panel meet several times in advance of a scheduled test to review preparations and developing situations. Such reviews are conducted until test completion. Specifically, on the day before a test, separate briefings are held regarding (a) containment design and as-built details, (b) experimental systems, and (c) test readiness (technical, weather, operational, and safety preparations). The Panel reviews the consequences of an accidental release of radioactive material as a result of the test and the consequences of offsite ground motion effects upon mines, buildings, and new construction. After completion of these reviews, the Advisory Panel deliberates and through the Scientific Advisor provides a formal recommendation to the Test Controller either to proceed on schedule or delay until appropriate readiness is achieved.

On the scheduled test day, the data presented at the previous readiness briefings are reexamined and the Advisory Panel again deliberates and recommends actions through the Panel Chairman (Scientific Advisor). If the test readiness is satisfactory to the Advisory Panel and the Test Controller, the Test Controller grants the Test Group Director, assigned by the sponsoring laboratory, permission to arm the device. The Test Controller, Advisory Panel, and their supporting staff continue to monitor weather and readiness developments throughout the execution of the test and beyond.

Postdetonation observations are continued to assure that the test effects are as predicted or until the Test Controller and Panel believe that workers can safely return to normal work areas and tasks.

III. A. UNDERGROUND NUCLEAR TESTING

3. Normal Operations (Cont.)

(4) Other Panels

Occasionally, potential problems arise which require specialists with disciplines other than those represented by members of the panels described above. In other cases, a detached judgment is sought from knowledgeable individuals who are independent from ERDA. NV calls together a panel of consultants for this purpose utilizing recognized authorities in such specialties as geophysics, seismology, hydrology, geology, structural engineering, soil and rock mechanics, and radiobiology, as appropriate to the specific problem at hand. Most of the scientists used as consultants were recommended by the National Academy of Sciences. Additional scientists and technical experts acting as consultants can be obtained, if needed.

A good example of how such specialists have been used in the past, and may be needed in the future, is their evaluation of the advisability of detonating a proposed nuclear device in the Paleozoic rocks which underlie the testing areas, particularly if the proposed event is to take place in the proximity of the water table. The consultant panel, after reviewing all pertinent data available to determine the likelihood of contaminating the Paleozoic carbonate aquifer, makes recommendations either as to precautions which should be taken, or as to additional geologic and hydrologic information which should be obtained in order for them to make a sound judgment. Any such special panel opinions or recommendations are included in the containment and safety considerations regarding specific tests.

(5) Safety Appraisals

ERDA requires periodic appraisals of certain key areas related to safety of operations at the Nevada Test Site. Examples of these are management overview, health protection, industrial safety and fire protection, occupational medicine,

III.A. UNDERGROUND NUCLEAR TESTING

3. Normal Operations (Cont.)

environmental protection, emergency preparedness, and nuclear explosives safety. There are also interim visits between formal appraisals. Members of the group performing these appraisals are organizationally separate from those who conduct operations at NTS. Findings and recommendations are presented to the Manager, NV.

b. Approval Authorities

There are four basic authorizations leading to the execution of nuclear experiments at the NTS. They are Programmatic Authority; Detonation Authority; Authority to Move, Emplace, and Stem; and Permission to Fire.

(1) Programmatic Authority

The proposed nuclear test series, submitted by the Administrator of ERDA, is reviewed by an interagency group under the National Security Council. The President, acting on the group's advice and recommendations, grants programmatic authority for on underground nuclear testing series for a given fiscal year. Further, specific presidential approval is required on a six months' basis for each test identified by name within that series to be conducted during that semiannual interval. Programmatic authority is granted by the President to the Administrator of ERDA and delegated to the Assistant Administrator for National Security.

(2) Detonation Authority

Before detonation authority is granted, each planned test is extensively reviewed and evaluated by the CEP, which advises the Manager, NV, on the containment aspects of the test. The Manager, NV, further evaluates the test and if he deems it appropriate, submits a request to ERDA Headquarters for detonation authority.

Authority to detonate is provided from ERDA Headquarters to the Manager, NV, by the Director, Division of Military Application, with the concurrence of the Assistant Administrator for National Security.

(3) Authority to Move, Emplace, and Stem

This authority is granted by the Manager, NV, to the Test Group Director of the sponsoring laboratory fielding the test. In requesting such approval, the Test Group Director determines and assures that recommendations from the CEP and from the Nuclear Explosive Safety Study and Survey Group have been or will be complied with. Normally, both programmatic and detonation authorities will have been received before the Manager, NV, will approve the Test Group Director's request for moving and emplacing the device, and stemming the hole.

(4) Permission to Fire

The Test Controller at the NTS, having been delegated detonation authority from the Manager, NV, and having been satisfied that all conditions are safe for execution as recommended by his Advisory Panel, issues permission to fire to the laboratory Test Group Director, who initiates the final countdown leading to detonation.

c. Safety Precautions

(1) Radiation Guidelines

All underground nuclear tests are designed for containment to assure that the probability of any release of radioactive effluent is minimized. However, since accidents are always a possibility, the radiation guidelines approved by ERDA for planning nuclear test detonations are predicated on the postulation that a venting

III.A. UNDERGROUND NUCLEAR TESTING

3. Normal Operations (Cont.)

could occur and therefore require predictions to be made for the maximum potential exposure from each test using the most appropriate hypothetical venting model. Thus, the "as low as practicable" concept for operations involving potential radiation exposure is governing, but as a safety precaution the accident model is postulated as a limiting factor. The occupational guidelines for onsite workers as specified in the Standards for Radiation Protection, ERDAM 0524, are three rem for each quarter of a year, or five rem per year, whole-body external exposure. If the predictions indicate that these exposures might be exceeded, either the test will be delayed or additional precautions will be taken to see that these guidelines are not exceeded.

Certain parts of the body may exceed these guidelines (e.g., the guideline for the hands and feet is 75 rem per year; the thyroid, 15 rem per year). Internal exposure guidelines vary with the internal body organ.

Every effort is made at the NTS to keep occupational exposures to as low as practicable. In the past five years, no one at the NTS has had an exposure to radiation greater than four rem total exposure for any year. In 1976, of the 16,827 people badged on the NTS, 98.7 percent had zero exposure, and of the remaining, there was no exposure greater than one rem.

The guidelines for offsite populations for tests at the Nevada Test Site require consideration of the event day weather conditions and selection of the most appropriate model for that specific event to estimate the offsite exposures that could result from the most probable venting. Should such estimates indicate that there are offsite populations in areas where the predicted whole body dose would exceed 0.170 rem per year and where preventive actions to reduce whole body doses are not feasible, the event shall be postponed until more favorable conditions prevail. In addition, events may only proceed where remedial actions against uptake of radionuclides in the food chain are practicable and/or indications are

III.A. UNDERGROUND NUCLEAR TESTING

3. Normal Operations (Cont.)

that average thyroid doses* to the population will not exceed 0.5 rem per year (Reference 84).

In those areas where trained rad-safe monitors are available, where communications are effective, where people can be expected to comply with recommended remedial actions, and where remedial actions against uptake of radionuclides in the food chain are practicable, events may proceed where indications are that individuals in those areas would not receive whole body and thyroid doses in excess of 0.5 rem per year and 1.5 rem per year, respectively.

Should there be any release of radioactive material which may move offsite, aircraft and ground radiation monitoring systems, along with offsite ground monitoring systems which are always operated, will be employed along with detailed meteorological data to predict radioactive cloud trajectories and potential exposure rates at downwind locations. Based upon these predictions and subsequent radiological monitoring observations, effort will be made to keep total dose commitments from both internal and external emitters to the lowest practicable levels. Remedial actions which are compatible with both a coordinated emergency action plan and the basic philosophy of the FRC Radiation Protection Guidance of July 16, 1964, and May 17, 1965, will be employed to this end.

(2) Meteorological and Radiation Predictions

Weather and radiation predictions are performed for NV by the National Oceanic and Atomspheric Administration's Weather Service Nuclear Support Office, Las Vegas, (NOAA/WSNSO-LV). A representative of NOAA/WSNSO-LV sits on the Test Controller's Advisory Panel and provides up-to-date information on these predictions.

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*See paragraph 5.4, FRC Report No. 1, for discussion on the concept of average dose to a suitable sample of the exposed population.

III.A. UNDERGROUND NUCLEAR TESTING

3. Normal Operation (Cont.)

For an underground nuclear detonation at a depth of burial determined appropriate for containment, the probability that a significant amount of radioactivity will escape into the atmosphere is small. Nevertheless, in the interest of safety, the possibility of an accidental release of radioactivity is always taken into consideration in planning and conducting an underground nuclear event. Such precautions include the preshot prediction of the downwind geographical area that would be affected and an estimate of the maximum radiation exposures which might possibly occur as a result of an unexpected release of radioactivity to the atmosphere. Before any nuclear detonation is conducted, there must be assurance that the people in the predicted downwind sector will not be exposed to radiation exceeding the guidelines approved for underground nuclear testing operation. Assuming this maximum exposure, the test will not be conducted if the guidelines enumerated above might be exceeded. The effectiveness of containment design and evaluation is reflected in the fact that no underground test at the NTS (designed for containment) has resulted in an exposure to offsite residents which exceeded the established guides. Meteorological and radiation prediction methodology is explained in more detail in Section III.A.3.d. of this statement.

(3) <u>Onsite Controls</u>

The Test Controller institutes controls during the operational period to assure that only those individuals necessary to the completion and safe conduct of the test are allowed to remain within the designated "closed" or "controlled" areas. The closed area is usually defined as that portion of the forward area north of the CP surrounding the test surface ground zero (SGZ) which will be closed at shot time to all personnel except those assigned to occupy manned stations. An area of the NTS south of the CP and portions of the Nellis Air Force Range are designated as the controlled area and act as a buffer zone between the closed and uncontrolled areas.

A limited number of manned stations within the closed area will usually be established for operations which require continuous attention. The personnel

III.A. UNDERGROUND NUCLEAR TESTING

3. Normal Operations (Cont.)

at these locations will be equipped with two different means of communications, plus primary and backup transportation. In addition to the personnel operating manned stations, two NTS security inspectors and a qualified radiation safety monitor with monitoring equipment and radiation protection gear will also be at each of these stations. All personnel will be briefed on emergency procedures and on the use of evacuation routes. Evacuation dry runs will be practiced.

The majority of test-related personnel will continue from the CP within the controlled area and in case of an inadvertent release of radioactivity or other emergency, will either take cover at established shelters or evacuate the area if necessary.

The event operations and security plans approved by the ERDA Test Controller are distributed to all participating organizations. These plans include a schedule which specifies when certain areas are to be clear of personnel. Before each nuclear test, the guard force has the task of clearing the closed and controlled areas of all but authorized test personnel. The guard force supports this effort by establishing a muster system as the areas are being cleared. This system provides a means of accounting for the personnel authorized to remain within the closed area. Temporary roadblocks and barricades are utilized by the guard force to facilitate the test area controls. Security interests within the evacuated test areas are monitored by the security control center through use of alarm systems and/or closed-circuit television. A helicopter air response team of armed guards is in standby status to respond to any security irregularity monitored in the closed areas.

(4) Offsite Controls

(a) Ground Surveillance

The Environmental Protection Agency's Environmental Monitoring and Support Laboratory, Las Vegas, (EPA/EMSL-LV) conducts the public safety program for ERDA/NV. A representative, experienced in nuclear testing, sits on the Test

III.A. UNDERGROUND NUCLEAR TESTING

3. Normal Operations (Cont.)

Controller's Advisory Panel. Depending upon the expected device yield, EPA will initially field approximately 12 to 24 mobile monitors for each nuclear test at the NTS. Other monitors may be on standby at the EMSL-LV or can be made available on short notice.

On the day prior to each test, EPA monitors check all roads and possibly inhabited locations in the near offsite areas predicted to be downwind from ground zero. During periods of special big horn sheep hunts conducted in areas immediately east of the NTS, by the Nevada Fish and Game Department, information concerning the approximate locations and numbers of hunters is obtained from the Department officials. From this, a safety plan is established which carries with it reasonable confidence that the locations of people at or shortly after event time are known.

For tests which will produce a level of ground motion expected to be felt at a range of 80 km (50 miles) from the NTS boundaries, all operators of active mines are advised by EPA monitors of the status of the test so that workers may be brought to the surface at the discretion of the operators. For those tests where the ground motion will be strongly felt, the Test Controller may request EPA monitors to arrange for evacuation of the mines. In addition, during periods of heavy snow cover in the Spring Mountain Range south of the NTS, U.S. Forest Service officials are contacted by EMSL-LV monitors to determine if avalanche conditions exist and if special safety precautions are necessary in those areas. For larger tests scheduled for firing at Pahute Mesa, one building, the Exchange Club in Beatty, Nevada, is cleared of occupants just prior to event time.

The dispatched mobile monitors are trained and equipped to make measurements of exposure rates and to collect samples of a variety of environmental media for laboratory analysis. The activities of the mobile monitors are coordinated by EPA personnel at the CP through a radio network that provides nearly 100 percent coverage over southern Nevada and adjacent portions of Utah, Arizona, and California.

III.A. UNDERGROUND NUCLEAR TESTING

3. Normal Operations (Cont.)

Each monitor is equipped with two portable gamma exposure rate recorders. The exposure rate recorders cover the range of 0.004 to 40 milliroentgens per hour (mR/h). The monitors also carry portable, battery-operated air samplers which collect particulate radioactivity on a primary filter and gaseous radioiodines on a secondary activated charcoal filter. The detection limit for individual radionuclides is about 5 picocuries per cubic meter (pCi/m^3). This supplemental equipment is intended for use in case a massive radioactivity release should occur. This has never happened and it is not envisioned as a realistic possibility; however, if a release should occur, the mobile monitors would be directed by radio where to position themselves. There would be ample time for positioning the monitors in this fashion; hence, there would be no point in prepositioning the recorders air samplers or in operating that equipment during every event. The recorders and air samplers can be set up along the trajectory "hot line" or at populated locations not covered bv routine stations. In actual use, air samples can be sent for analysis after the completion of a sample collection operation.

Each monitor is also provided with 10 thermoluminescent dosimeters (TLDs) for issuance to offsite residents so that actual personnel exposures can be measured, rather than extrapolated from exposure rate measurements. One monitor is provided with 100 TLDs which can be used, in the event of a radioactive release from a prompt (dynamic) venting, to establish a series of stations across the predicted trajectory path, for exposure profile documentation.

Having established temporary stations with the gamma exposure rate recorders and portable air samplers, the monitors are free to collect background samples of water, milk, and vegetation, and to make exposure rate measurements if required. The variety of portable survey meters carried by the monitors permits exposure rate measurements from background to 50 roentgens per hour (R/h).

III.A. UNDERGROUND NUCLEAR TESTING

3. Normal Operation (Cont.)

A mobile road scanner vehicle can be put into operation if necessary. This vehicle, equipped with an NaI(Tℓ) crystal detector coupled to an odometer-driven recorder, rapidly produces a data plot of fallout patterns. Depending on the circumstances, one mobile road scanner may range out to 1,500 km (900 miles) or more from the NTS. By comparing the recorder charts obtained to background recorder charts collected along the same roads and on file at the EMSL-LV, radiation level measurement increases on the order of 1 μR/hr can be documented. The system is not precisely calibrated, but it can be used to give an estimate of exposure rate.

The EPA mobile equipment and monitoring teams deployed prior to a planned event augment the permanent environmental monitoring networks which have been developed in the past. For example, there are at present 48 active and 73 standby Air Surveillance Network stations located in 21 western states (west of the Mississippi). In the event that an underground test should release radioactive material, the EPA could activate by telephone those parts of the air surveillance network appropriately located to measure and track the release. Each of these is equipped with a primary air filtering device for collecting particulate debris and a secondary activated charcoal filter for collecting gaseous effluents. Thirty of these, near the NTS, are also equipped with gamma exposure rate recorders. There are seven offsite and four onsite stations in the Noble Gas and Tritium Network to provide measurements of the airborne concentrations of krypton, xenon, and tritium radioisotopes. There are 70 fixed locations in the Dosimetry Network surrounding the NTS which are monitored continuously with thermoluminescent dosimeters (TLDs) in addition to 25 volunteers from the local citizenry who routinely wear TLDs. The Milk Surveillance Network consists of 23 routine sampling locations. For more complete information about these sampling networks, see Reference 15. Any of the various stations described above at appropriate locations would be activated by EPA upon verbal request from the Test Controller following a venting.

III.A. UNDERGROUND NUCLEAR TESTING

3. Normal Operations (Cont.)

Data from all of these networks and from the mobile monitors can be used to provide a record of exposure rates and can be integrated to obtain total exposures if necessary. In the future it can be expected that similar systems and networks will be operating in close coordination with the activity at NTS.

(b) Aerial Surveillance

Aerial tracking and sampling by EPA of releases of radioactivity from nuclear testing at the NTS serve two functions, with somewhat overlapping requirements. The more important of the two is to provide the earliest possible estimate of radiological impact on the offsite population and to assist in determination of the probable trajectory so that precautionary measures can be taken if necessary. The second function is to make cloud measurements and obtain samples for estimation of the release inventory, primarily for the use of the testing laboratories for refining their understanding of venting phenomenology.

For each underground test, EPA aircraft will be airborne near ground zero at event time for use as needed to track and sample a radioactive cloud and to provide airborne confirmation of predicted weather conditions.

d. Meteorological Methods

The fate of radioactive material which may be accidentally released from the site of an underground nuclear detonation depends to a large extent on atmospheric conditions. Should a radioactive cloud be formed, the height to which it ascends is important to the estimation of possible radiation exposures. Cloud height is determined in part by the vertical distribution of temperature in the atmosphere. Consequently, cloud rise estimates depend on the prediction of the atmospheric temperature structure. A mathematical procedure developed to preduct cloud rise, in conjunction with empirical data from past accidental ventings of underground nuclear detonations, has been found useful for estimating potential cloud heights. In the event of the formation of a radioactive cloud, the geographic area over which radioactive particles would be deposited is partly determined by the wind speeds and directions within the cloud layer. This downwind area, projected in the basis of predicted winds, is called the "fallout sector." Accurate wind forecasts are essential to the calculation of potential exposure levels in the downwind areas possibly affected.

The amount of radioactivity created by a given nuclear detonation is required input for radiation exposure estimates. The total radioactivity resulting from a nuclear detonation depends on the device design and on the emplacement methods and medium. The fission yield, and the induced radioactivity, in the case of a thermonuclear device, is required for external gamma exposure calculations. A knowledge of the composition of the activity is important when large quantities of induced activities are produced which can considerably alter the decay characteristics of the composite of gamma-emitting radionuclides. Information on the amount and composition of activity to be produced by the nuclear detonation is provided by the nuclear laboratory conducting the experiment.

For each nuclear detonation, the laboratory conducting the experiment provides both a design yield and a maximum credible yield. A source term based upon the maximum credible yield is routinely used in radiation exposure estimates. The total amount of activity produced by a nuclear detonation, when multiplied by an appropriate fallout fraction, determines the source term used in radioactive fallout exposure estimates. Fallout fractions assumed for underground nuclear detonations are based on past experience with various types of device emplacement configurations and containment characteristics. For example, useful estimates can be made of the fraction of the total activity produced in a nuclear excavation experiment which will be deposited in local fallout. However, fallout fractions for underground detonations designed to be completely contained are not explicitly employed. For this type of experiment,

III.A. UNDERGROUND NUCLEAR TESTING

3. Normal Operations (Cont.)

radiation exposure estimates are made on the basis of an assumed maximum credible venting, employing a well-documented massive-venting experience as an analog. The fallout fraction used in preparing estimates for a forthcoming event is assumed to be the same as that observed with the analog. Since the maximum credible yield and a fall-out fraction observed in connection with a previous massive-venting experience are used in these calculations, the subsequent estimates are conservative.

A number of models have been developed for the prediction of local fallout intensities. They employ similar fundamental considerations and contain varying degrees of sophistication. The total amount of fallout and the distribution of activity as a function of particle size and height in the initially stabilized radioactive cloud must normally be specified. The output usually includes a predicted local fallout pattern. A modification of this approach is currently being employed for underground nuclear testing. This method provides estimates of fallout centerline radiation intensities required for operational application. It is a scaling technique which does not require explicit definition of the distribution of activity as a function of particle size and height in the initial cloud. Rather, the assumption is made that an appropriate analog event can be chosen whose particle size-activity distribution would closely approximate that of the event for which estimates are being made. This scaling method consists of a ratio technique whereby the parameters which determine the centerline exposure rates and the locations of these exposure rates in their respective fallout patterns are related, and then used in conjunction with the empirical results of a previous event for prediction purposes.

Application of the scaling technique requires specific information on meteorological and radiological conditions observed in connection with the analog event. A detailed analysis of radiological monitoring data is necessary to establish the downwind locations and intensities of radioactive contamination. These results are combined

III.A. UNDERGROUND NUCLEAR TESTING

3. Normal Operations (Cont.)

with an analysis of the meteorological conditions existing during the period of cloud transport and fallout. Data resulting from these analyses are utilized as input values for the analog parameters required by the scaling method. The success of this technique depends not only on the careful analysis of exposure rate levels, observed meteorological conditions, and cloud characteristics for the analog event, but also the predicted parameters for the forthcoming detonation.

Radiation exposures considered so far are those that might result from fallout particles on the ground. There may also be some exposure at the ground directly from passage of the radioactive cloud itself. When a cloud approaches a given point, the radiation intensity at the ground starts to rise rapidly, reaching a maximum when the cloud is directly over the point. As the cloud moves away, the intensity begins to fall off. During the cloud passage, some of the radioactivity is deposited on the surface and the radiation intensity on the ground after the cloud has passed is due only to the fallout. This amount is estimated on the basis of the relative exposures observed for the analog event. Examination of data from previous massive ventings indicates that, for any specific point on the surface, the contribution of cloud passage exposure is approximately equal to half of the infinite exposure resulting from fallout.

In addition to external exposures potentially resulting from fallout and cloud passage, thyroid exposures are also possible as a result of ingestion of contaminated cows' milk following the deposition of radioiodine on pasture or dry feed. Estimates of potential thyroid exposures are made utilizing an empirical relationship observed between fallout radiation intensities and radioiodine levels measured in milk.

An evaluation has been performed to verify the ability of this scaling technique to reproduce radiological data obtained from actual releases of radioactive materials. Given accurate values of input parameters, required by any fallout model, this technique performs remarkably well for the series of events examined. The assumptions made in the development of the scaling technique appear to account for the major differences in radiation levels observed for the series of events. The technique satisfies the requirement for an operationally useful exposure estimation method that can be both rapidly and easily employed. The method requires a minimum of input information and depends realistically on the empirical results of previous detonations from which radioactive materials have been released.

e. Postevent Activities

For all postevent activities at NTS, the ERDA and the laboratories have well-defined operating procedures. These procedures are provided to preclude industrial or radiation accidents or incidents to reentry parties who will be collecting postevent data or to the public if accidental releases of radioactivity should occur.

Onsite postevent data are obtained from a Remote Area Monitoring System (RAMS). This is an array of gamma reading instruments set in a specified pattern at and around surface ground zero (SGZ) to measure radiation in this area of interest. The individual gamma detectors are connected to readout instruments displaying the data in operation centers at the CP. Increases over background readings give an indication of a leak of radioactivity to the atmosphere.

During the postevent phase, the offsite EPA monitoring positions along the projected trajectory are altered to fit the postevent weather pattern and predictions. As noted earlier, the monitors, who are prepositioned, are equipped to take various radiation measurements of the environment; the results of these measurements, negative as well as positive, are periodically reported to the CP for assistance on planning the postevent monitoring operation.

Geophones are operated to obtain recordings of the close-in seismic activity associated with the event. These geophones are located in the so-called Diagnostic Trailer Park, which is offset from ground zero at a distance projected to be outside the expected subsidence crater (see Figure III-4). The seismic information is displayed in the operation center at the CP and is followed closely through the formation of the subsidence crater, which is easily detected by these instruments. For safety purposes, the recordings and displays are maintained for at least 24 hours after the event if subsidence has occurred and even if "all is quiet." If no subsidence crater forms, the monitoring period is extended until the Test Group Director is satisfied that the area has stabilized.

After the subsidence crater is formed, or if no subsidence occurs, after it is deemed safe, teams will enter the test area to establish security and safety controls. During this radiation survey, close communication between the reentry teams and test control personnel is maintained. In this manner, a step-by-step status report of the reentry will be logged and the conditions documented prior to the initiation of work in the test area. If a subsidence crater does not form, the site, including the area expected to subside, is physically barricaded. This barricade will remain in place until a subsidence crater is formed or it is deemed safe to enter the barricaded area. Radiological surveillance remains in effect until postevent activities are complete, or until a determination has been made that continuous radiological coverage is no longer required. Postevent work is the responsibility of the Laboratory Test Group Director, who supervises the operation and will be present, or be represented, throughout any drilling and sampling activities to assure compliance with established standards and procedures.

One of the major facilities utilized during postevent operations is the so-called "Base Station" skid, which is the radiological safety base of operations during any postevent reentry drilling phase. This movable facility is continuously manned and is the sole entrance and exit for all vehicles and personnel to the area designated as the "postevent-controlled area." At the Base Station, all personnel initially entering the postevent controlled area are logged in, issued safety equipment,

FIGURE III-4 SUBSIDENCE CRATER FORMATION

III.A. UNDERGROUND NUCLEAR TESTING

3. Normal Operations (Cont.)

including a self-reading pocket dosimeter in addition to the regularly issued film badge and anticontamination clothing as required. When leaving the area, vehicles are stopped and checked (both cargo and vehicle) for radioactive contamination. Personnel leaving the area are also checked for radioactive contamination. Safety equipment and anti-contamination clothing are collected and the pocket dosimeters read and results recorded. Personnel are then logged out of the area.

A group of gamma measuring units surrounds each post-shot rig during each operation. Units are also placed in several places on the drilling rig and are installed so as to produce an audible alarm in case they detect a given low level of radiation. Other major safety systems or devices used include a gas-tight system of plumbing, valves, and ducts which either redirect any radioactive effluent brought to the surface during drillback operations back downhole, or shunt it through a series of gas and particulate filters to remove most of the radioactive material except noble gases from the effluent before it is released to the atmosphere. The effluent may be released at a controlled rate through the filter system so as not to exceed the safety criteria set by ERDA. Another safety device used during postevent drilling is a "blowout preventer." This device is placed on top of the hole being drilled, in such a manner that it may be hydraulically activated to close the uphole path to the atmosphere if the effluent pressures reach a decisive point. This device can also be manually operated if required. Immediately prior to the start of drilling operations, final tests of the operating systems are made to assure that all requirements are met and the containment and filter systems are fully functional. Only after the safety systems have been tested and there has been approval of the drillback operation by the appropriate laboratory does post-event drilling commence. During the course of the drilling phase, air sampling and radiation safety monitoring are continually maintained in sensitive work areas in order to detect any accidental leakage of radiation or other safety hazards such as toxic gases.

After the postevent drilling and sample recovery phase are completed, the drill hole is sealed. All equipment is decontaminated and a complete radiation and safety survey

III. A. UNDERGROUND NUCLEAR TESTING

3. Normal Operations (Cont.)

of the drill site is conducted. Surface contamination, if any is removed prior to the opening of the area for uncontrolled access. After each event is completed, the crater area, or the potential crater area, if collapse to the surface has not occurred, is surrounded by a permanent fence suitably marked with signs indicating any special hazards.

4. Emergency Procedures

The testing procedures described earlier in this section are carefully designed and stringently reviewed in an attempt to avert the release of radioactive materials to man's environment.

Although the resulting chance of a radiological incident or an industrial accident occurring is very small, there are capabilities to cope with a variety of emergencies should they arise. Industrial accidents associated with testing which require emergency action are usually confined to the test site and in most cases, radiological emergencies also fall in this category. The exception to this is an inadvertent release following a detonation or a controlled release during a drillback operation, of radioactive effluent that may be carried offsite by the local winds prevailing at the time.

Immediately after the detonation, an Air Force helicopter carrying radiological monitoring personnel with portable equipment flies over the area at predetermined heights and patterns to ascertain if any radioactivity has escaped as a result of the detonation. The Air Force renders this type of support to NV upon request, under an interagency agreement (AEC-DOD Memorandum of Agreement No. AT(16-1)-341 dated August 29, 1977). As noted earlier, aerial surveillance is also performed by the EPA/EMSL-LV. A similar type of aerial monitoring is also available as backup from EG&G, Inc., an ERDA contractor. Both of these organizations have sophisticated monitoring equipment mounted in aircraft to track and analyze the radioactive effluent cloud if one is formed. In addition, the U.S. Air Force maintains a cloud-tracking capability which can be called upon when necessary. This aerial surveillance is coordinated with ground monitoring crews to determine where and to what extent there may be radioactivity, and it serves as a basis for evaluating whether any corrective action is necessary to protect the public or workers.

III.A. UNDERGROUND NUCLEAR TESTING

4. Emergency Procedures (Cont.)

Obtaining cloud measurements and samples for determining the amounts and characteristics of radioactivity release is most easily performed at early times after release while the cloud is relatively small and well defined. Presently, the EPA aircraft is scheduled to be airborne 45 minutes prior to detonation to facilitate this eventuality. Its normal flight time of 3 1/2 hours allows sufficient time for early cloud definition and sample collection. Follow-up sampling and monitoring aircraft can be dispatched, if needed, to provide tracking as long as required or until the radiation is so dispersed that it can no longer be tracked. In the interim, activities and emergency actions are controlled and coordinated at the NTS Control Point by the Test Controller and the Advisory Panel, and their representatives.

EPA's offsite emergency response capability for reducing radiation exposures to the public following a venting of radioactive material from the NTS depends largely upon the potentially affected area, in terms of knowledge of the number and distribution of people in the area, and the response time available to carry out the protective plan. However, there are also other considerations which revolve around the fact that the offsite population is largely uncontrolled. Routine personnel safety measures used onsite at the NTS in advance of a test, such as closing potentially affected areas to workers, mustering workers to maintain accountability, or conducting evacuation dry runs, are not easily implemented offsite. Resources such as transportation for people who have none available to them, medical assistance to handle bed-ridden patients, or law enforcement personnel to close roads or direct the public to safety may or may not be available. As explained in Section III.A.3.c.(1), if a postulated dynamic venting could result in exceeding the radiation exposure guides in areas where protective action cannot be effectively initiated, the test will be postponed. Where protective action can be taken, EPA mobile monitoring personnel visit , before the test, the offsite area projected to be in the downwind trajectory. Expected activities by offsite residents and visitors are noted, with particular emphasis placed on the locations of ranchers and miners, along with the presence of hunters or vacationers, so that all persons who may be in an area of potential exposure can be contacted in an emergency.

Having made these extensive plans and preparations, the emergency actions taken in the event of an actual emergency would vary, depending on individual circumstances, but would include removing people from the area or asking them to remain indoors for a period of

III.A. UNDERGROUND NUCLEAR TESTING

4. Emergency Procedures (Cont.)

time. Thermoluminescent dosimeters would be issued to as many of the residents as possible to document their actual individual exposures.

Following a release of fresh fission products, iodine-131 is the radionuclide considered most liiely to reach the human food chain in concentrations that warrant protective action to reduce the projected dose. The important mode of transmission to humans is through the consumption of fresh milk. Iodine-131 can appear in milk within a few hours after its deposition on a pasture being grazed by dairy cows. The concentration in milk reaches a maximum in two to four days, after which the concentration diminishes by half every five days.

EPA has conducted, at least biennially, a census of family milk cows and Grade A dairies over the entire state of Nevada, the easternmost counties in California, and the westernmost counties in Utah. EPA conducts these surveys under a Memorandum of Understanding AT(26-1)-539 dated June 2, 1971, between the U.S. Atomic Energy Commission and Environmental Protection Agency, and carried over to ERDA and EPA-EMSL, Las Vegas, which provides that offsite services including dairy and family cow survey will be accomplished on a reimbursable basis to ERDA, NV, which determines the frequency of the surveys. This information obtained, which includes such things as the location and number of cows, feeding practices throughout the year, and where the milk is processed, is stored in a computer and can quickly be retrieved to provide a listing of all milk cow locations in any contaminated sector out to the boundaries of the survey. Within hours, EPA monitors can divert milk at those locations, should contamination by radioiodine occur.

Projected iodine doses, based on early fallout measurements, and results from early milk samples, can be compared to the ERDA guidelines. If these guidelines should be approached, some practical protective action can be implemented. At all family milk cow locations within the area of the survey, milk can either be purchased from the owner and discarded or replaced with uncontaminated milk, whichever the owner prefers.

Implementation of protective action at the Grade A dairies is somewhat more complicated. The dairy cattle can be removed from contaminated pasture and uncontaminated hay can be brought in for replacement feed, or, if the cows are being fed stacked hay, the outer bales can be

III.A. UNDERGROUND NUCLEAR TESTING

4. Emergency Procedures (Cont.)

removed to provide noncontaminated or less contaminated hay. Contaminated milk can be diverted to processed dairy products, providing time for the iodine-131 to decay to safe levels. These actions may entail government purchase and transport of alternate feed supplies into the contaminated area.

Monitoring surveys along roads in the downwind trajectory, by documenting the areas affected and the residual exposure rates, facilitate estimates of infinite exposures and future exposure rates. Follow-up surveys are made on successive days to document effective radioactive decay rates and to collect additional environmental samples. Such activities will typically extend to about 500 kilometers (300 miles) from the NTS. Collection of milk samples continues for as long as elevated levels of fresh fission products are detected.

B. OTHER ACTIVITIES AT THE NEVADA TEST SITE

The underground nuclear test program described above constitutes the primary effort at the Nevada Test Site. However, as has been the case in previous years, the experimental program will include a variety of nuclear and nonnuclear projects and experiments wherein the ERDA laboratories and ERDA contractors, as well as other government agencies and their contractors, take advantage of the facilities available, the climate, the remoteness, and the controlled access of the Nevada Test Site. Such projects and experiments are necessarily conducted on a basis not to interfere with the primary mission, and unless associated with one of the underground nuclear tests, are usually conducted in parts of the test site remote from the areas used for underground nuclear testing. Those which are expected to take place are described here. It is expected that additional experiments similar to these, but not yet identified, will also take place.

1. High-Explosive Tests (Chemical Explosives, Nonnuclear)

This category includes a wide variety of tests employing chemical explosives in one form or another, static or dynamic, inert testing or explosive testing. In the past, these have included, and are expected in the future to include, tests employing weaponry, such as small arms, artillery, guns, aircraft, armored vehicles, demolitions, rockets, bazookas, airdropped armaments, and associated electronic systems.

III.B. OTHER ACTIVITIES AT THE NEVADA TEST SITE

1. High-Explosive Tests (Chemical Explosives, Nonnuclear) (Cont.)

Chemical explosives may be employed in performance tests of the weaponry itself or they may be involved in tests of the penetration of proven weaponry through various experimental barricades and armored structures.

At times, experimental fabrication of chemical explosives may take place onsite, prior to their performance testing or prior to being loaded into experimental armaments. Detonations are usually conducted at or near the surface or they may be buried so as to create small craters.

Such high explosive testing is usually performed by the armed services or their contractors and is sponsored by the DOD through the Defense Nuclear Agency (DNA). Occasionally, the ERDA laboratories may elect to test certain chemical explosives or the high explosive components of nuclear weapons at the NTS, rather than at their own facilities.

There is no specific location on the test site dedicated to this type of testing. Rather, the site selection largely is dependent upon the type of test to be conducted. Radioactive areas are avoided.

2. The Cane Spring Test Range

The Cane Spring Test Range (CSTR) is located within the NTS to the west of the Mercury Highway between the Cane Spring Road and the Control Point. The only permanent construction consists of a single one-story building 6 by 18 meters (20 by 60 feet) surrounded by a security chain link fence with a road array to the north of the building.

The range has been in operation since June 1975 and its purpose is to provide a facility for the testing, evaluation, and calibration of nuclear radiation detection systems within a constant background environment, utilizing various standard nuclear radiation sources. The range provides for the evaluation of these detection systems whether hand-held, surface vehicle mounted, or when operated from an aircraft. All operations are performed during daylight hours only and under good weather conditions.

III.B. OTHER ACTIVITIES AT THE NEVADA TEST SITE

2. The Cane Spring Test Range (Cont.)

All radioactive sources used at the Cane Springs Test Range are received and stored in containers, specially fabricated and sealed in conformance with applied Federal regulations, are carefully controlled during the operation, and are returned to permanent NTS-secured storage facilities after each test operation. Each operation is carefully planned, a safety analysis performed, and an operational plan approved on all aspects prior to implementation.

The Cane Springs Test Range will continue to be used as a necessary part of improving and calibrating radiation detection systems.

3. Experiments at the NTS Farm

The ERDA NTS Farm is located in Area 15 near the north border of the NTS and covers about 14 hectares (35 acres). (See Figure II-28.) Activities planned at the ERDA Farm in the future will not differ greatly from those performed in previous years. Metabolism and biological transfer rates of radionuclides, heavy metals, and other environmental contaminants will be studied in both animals and plants. ERDA-sponsored studies primarily will be on transuranic metabolism in large farm animals or in poultry. EPA will also use the farm, on a cooperative basis, for EPA-funded studies. As the U.S. energy programs develop, it is anticipated that an increasing number of studies will be conducted on the environmental and physiological behavior of nonradioactive waste materials generated by various energy facilities.

Dairy cattle and goat studies will be "hot-lab" type, where the contaminated animals will be confined in metabolism stalls and all excreta collected for analyses and appropriate waste disposal. (See Figure III-5.) Cattle have been dosed with as much as 80 millicuries of plutonium in the past. Vegetation (vegetable and foliage plants) radionuclide uptake experiments will be done in hydroponic solutions or soil pots contained in an enclosed glasshouse or controlled chamber, as appropriate.

Regardless of the contaminant being studied, extreme care will be continued to minimize any possibility of loss of contaminant to uncontrolled environments or of exposure to personnel.

FIGURE III-5 DAIRY CATTLE IN METABOLISM STALLS

3. Experiments at the NTS Farm (Cont.)

Each experimental protocol will undergo extensive peer review, including the safety aspects and waste disposal. "Dry runs" will be performed before starting each experiment, and health physicists will continuously monitor both the dry runs and the actual experiments. During the actual experiments, monitoring continues until levels of the contaminants become negligible. Contaminated solid and liquid wastes will be disposed of at approved waste-disposal sites, as is present practice. (See Section II.D.8.d.)

4. Activities in Area 27 (the 410 Area)

The Lawrence Livermore Laboratory (LLL) maintains facilities in Area 27 (also known as the 410 Area) of NTS. OPerations at some of these facilities have the potential for serious accidents which may have some environmental impact. However, these facilities have been constructed are operated so that accident probabilities and consequences are minimized (see Figure III-6).

The facilities are grouped at three sites (Super Kukla, Baker, and Able) within Area 27. Safety Analysis Reports (SARs) are being prepared for Able and Baker sites. An existing SAR for Super Kukla is being rewritten. The following discussion is an abstract of the SARs to allow evaluation of the environmental impact of LLL's activities in Area 27 (the 410 Area).

a. The Super Kukla Reactor

Super Kukla is an all-metal prompt burst reactor housed in a shielded containment bunker. The reactor is designed to serve as a source for the irradiation of a wide variety of test specimens or samples, many of which include fissile materials. Samples may be irradiated either in an internal cavity of the reactor or outside the reactor.

The reactor is basically an annular shell, with optional end reflectors. The wall thickness is 150 mm (6 inches) and the outer diameter is 760 mm (30 inches). The height, which is variable, is nominally 940 mm (37 inches) at critical. This shell is built of rings of a ten percent molybdenum alloy of enriched uranium (20 percent uranium-235). The mass of the assembled reactor is approximately 4.5 metric

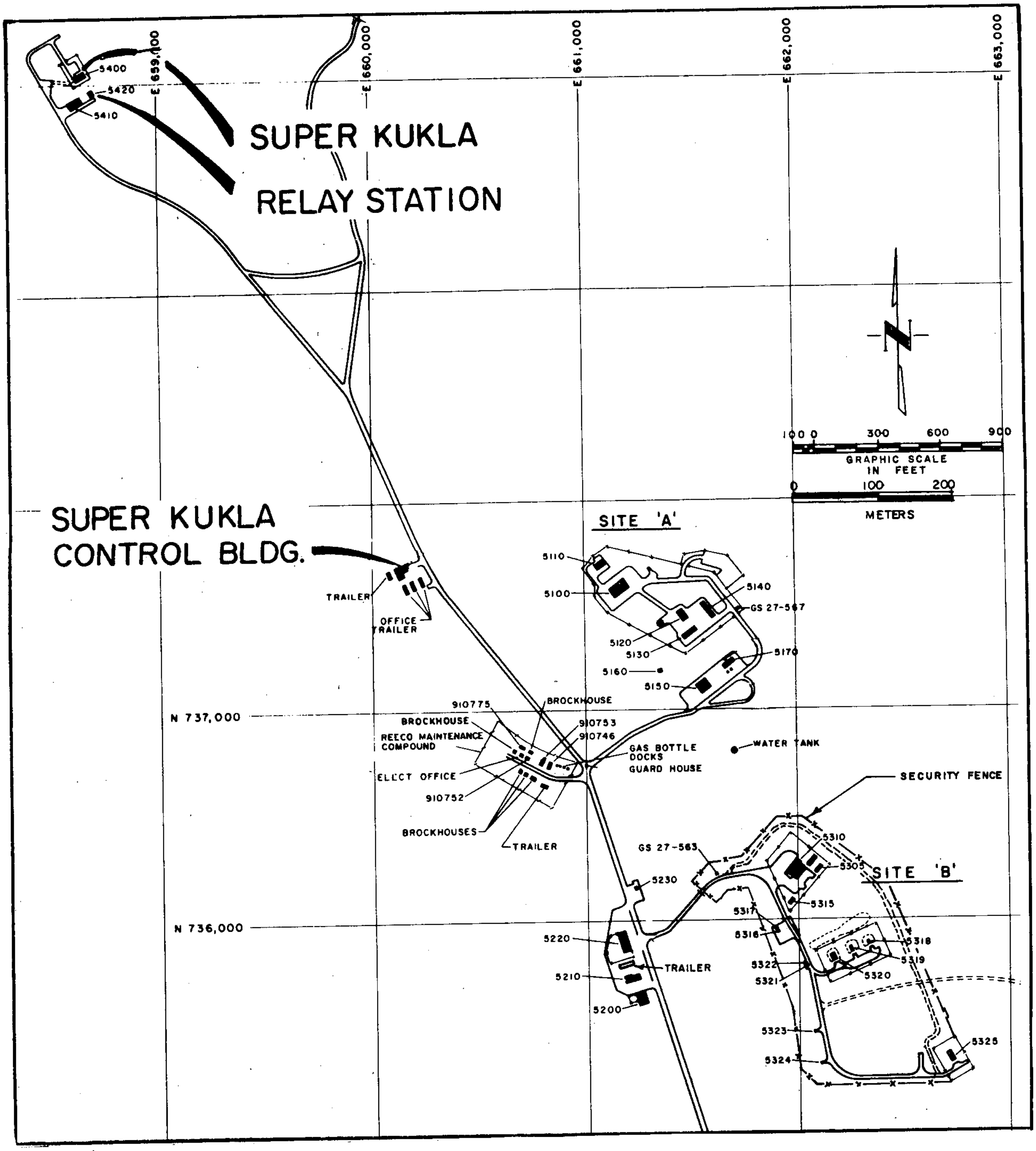

FIGURE III-6 AREA 27 (410) SITE MAP

III.B. OTHER ACTIVITIES AT THE NEVADA TEST SITE

4. Activities in Area 27 (the 410 Area) (Cont.)

tonnes (5.0 tons). The axial cavity is 460 mm (18 inches) in diameter and 940 mm (37 inches) high without end reflectors. A 150 mm (6 inches) thick tungsten plate is attached to the sample container and serves as the top reflector of the reactor when desired.

Fine reactivity control is exercised by varying the insertion of six individually controlled fuel rods into holes in the core. A similar system of six ganged fuel rods may be inserted rapidly into the core to provide a step reactivity change for burst generation. Shutdown is accomplished by separating the core into two roughly equal segments.

Data obtained to date indicate that a maximum yield burst will generate approximately 5×10^{18} fissions in the core. This will expose a sample in the cavity to about 2×10^{15} neutrons/cm^2. Such a burst is about 550 ns full-width at half-maximum, and causes a measured peak core temperature rise of about 300 degrees on the Celsius scale (540 degrees on the Fahrenheit scale). Burst repetition rate is limited by core cooling time to one burst per day when the measured core temperature rise exceeds 120 degrees on the Celsius scale (216 degrees on the Fahrenheit scale).

The reactor operating staff consists of permanent LLL-Nevada personnel. Technical direction is from LLL-Livermore.

The reactor has operated without significant incident for approximately 10 years. Experiments are being conducted intermittently at present. The reactor is run approximately four times per year to train operating personnel and maintain equipment.

(1) <u>General Facility Description</u> (See Figure III-7.)

The Super Kukla Reactor is housed in an underground concrete containment bunker. A steel-frame building for experiment assembly and handling is located on top of the bunker. This building is commonly called High Bay. The High Bay is

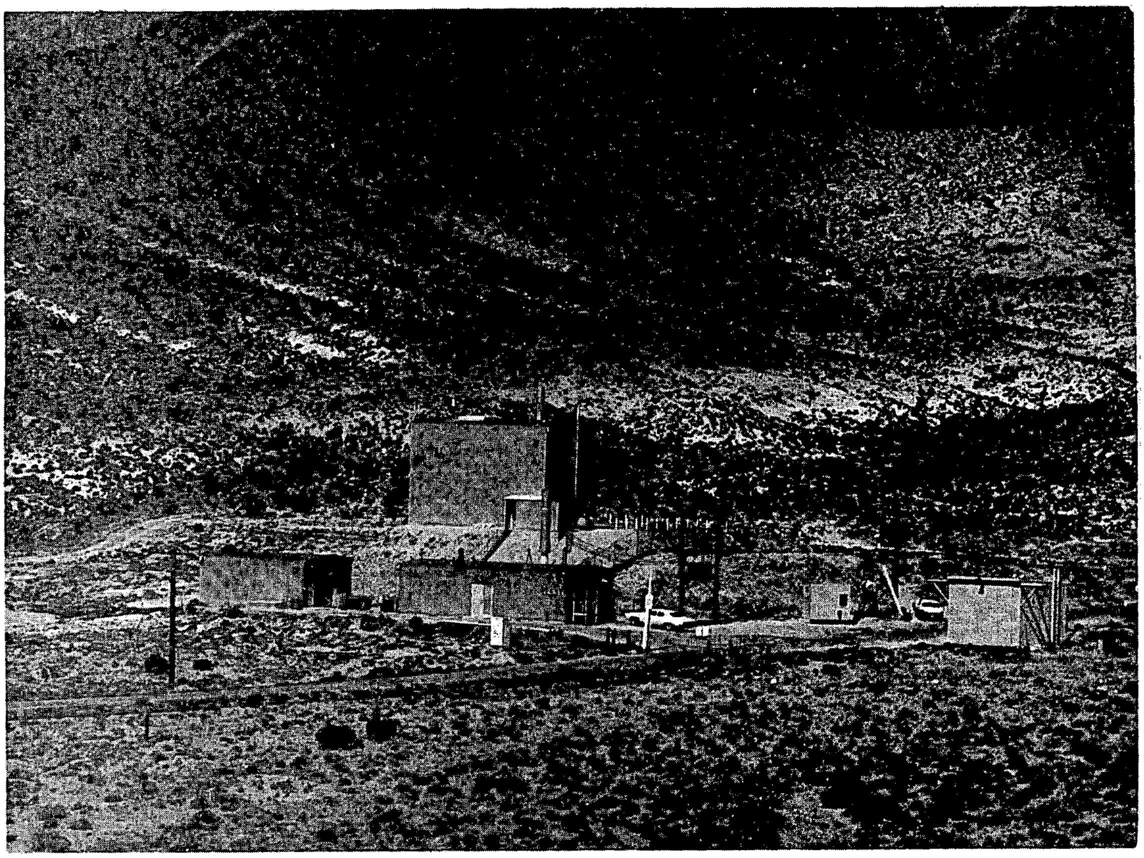

FIGURE III-7 SUPER KUKLA REACTOR FACILITY connected to the bunker by an access hole that is sealed during reactor operations. Two steel-frame buildings referred to as the Mechanical Equipment Building and the Electronics Relay Station are located adjacent to the bunker.

The Reactor Control Building is a steel-frame building located 850 m (930 yards) from the Reactor Containment Bunker. Buried instrumentation and control cables run from the Reactor Area to the Control Building in three earth-filled trenches. All control of the reactor is done remotely at the Control Building. The Reactor Area and the area between the Control Building and the reactor are cleared of personnel before every burst to provide complete radiation protection to operating personnel.

(2) Operational Procedures

Authorization and Regulation of Operations

The experimental program is conducted within the framework described in the following documents.

The Safety Analysis Report (Reference 85), which requires approval by the LLL Plant Manager, by ERDA-SAN, and by ERDA-HQ, Washington.

The Technical Specifications, which require approval by the LLL Plant Manager and by ERDA-SAN.

The Operating Manual, which requires approval by the LLL Plant Manager and by the LLL-N Resident Manager.

The Authorized Operating Personnel List, which requires approval by the LLL-N Resident Manager and by the LLL Plant Manager.

III. B. OTHER ACTIVITIES AT THE NEVADA TEST SITE

4. Activities in Area 27 (the 410 Area) (Cont.)

Standards Rules and Policies

A pre-startup checklist is used to verify that the reactor safety system is in proper operating condition whenever a startup is to be made after a shutdown of the facility. The completed pre-startup checklist must be approved by the Reactor Supervisor before operations begin.

During reactor operations, at least two authorized operating personnel must be in the reactor control room. During burst-generation and rod-calibration procedures, one of the authorized operating personnel must be the Reactor Supervisor. A list of authorized operating personnel is kept at the reactor control console.

Burst-generation procedures are carried out using a "burst form" which is a combination checklist procedure and data form. This form is filled out by the reactor operator at the control console as the operation progresses, and is checked by the Reactor Supervisor.

Burst Operations

Design calculations and operating experience indicate that some samples of interest will decrease the core reactivity. Other sample types will cause positive reactivity changes. When the sample is changed, it is necessary to shim the reactor to adjust the core reactivity to obtain an acceptable reactor criticality configuration. Following any such change, the shim and burst rods are calibrated before a burst is attempted.

Super Kukla Safety Committee

The Super Kukla Safety Committee consists of LLL personnel who have experience in monitoring the operation of prompt-burst reactors. The purpose of this committee is to review normal reactor operations and special operational problems. Meetings are called by the Super Kukla Project Supervisor when needed.

(3) Operating Hazards

Basis for Operating Limits

The nuclear and mechanical design of Super Kukla was based on results calculated by CONEC, a coupled neutronic/elasticity-theory computer code, which is applicable to spherical, bare systems. The actual reactor system is neither spherical nor bare, and the operating characteristics of the reactor reflect these differences. The differences are in the safe direction--they show that CONEC results form a conservative basis for hazards analysis. Therefore, the original basis for the operating limits is still considered valid.

Accident Conditions

The maximum credible accident for the Super Kukla Reactor, as described in the existing Safety Analysis Report, is a burst of 10^{20} fissions during an experiment involving 1 kg (2.2 pounds) of plutonium-239. The building containment is also assumed to fail (although it is designed to contain such an accident). Ten percent of the fission products and ten percent of the plutonium are assumed to be released to the atmosphere.

The accident analyses performed for the 5300 Complex (which follows) estimate the consequences of the complete release of 15 kg (33 pounds) of plutonium and the results of a 1.4×10^{22} fission (0.1-kt) explosion.

Because the consequences of the 5300 Complex maximum credible accident are more severe than the consequences of the Super Kukla maximum credible accident, the

III.B. OTHER ACTIVITIES AT THE NEVADA TEST SITE

4. Activities in Area 27 (the 410 Area) (Cont.)

5300 Complex accident analysis will be used to demonstrate the maximum credible environmental impact of the 410 Area operations.

b. The 5300 Complex (Baker Site)

(1) General Facility Description

The 5300 Complex is engaged in the assembly, disassembly, and modification of nuclear explosives, nonnuclear explosives, and assemblies containing special nuclear material.

The Complex consists of four buildings and six storage magazines. One building houses radiographic equipment and x-ray equipment used in the assembly area. Magazines are specially constructed for storing or holding hazardous materials including explosives, special nuclear materials, and parts. They are located away from the other buildings at Baker Site.

(2) Operations

Quantities and Types of Materials to Be Handled or Stored

The quantities and types of materials found at Baker Site are covered in detail in the LLL-Nevada Health and Safety Manual (Reference 86). Work station and storage mass limits are provided for the fissionable isotopes and for high explosives. The Baker Site frequently houses kilogram quantities of plutonium and hundred-kilogram quantities of high explosives of many types. All isotopes of uranium may be present at various times, as well as smaller amounts of actinide oxides. Light isotopes and metal hydrides are frequently part of the inventory. All radioactive or fissionable materials at Baker Site, with the exception of uranium, are enclosed in inert-metal shells and are handled as sealed sources.

III.B. OTHER ACTIVITIES AT THE NEVADA TEST SITE

4. Activities in Area 27 (the 410 Area) (Cont.)

Material Flow

Baker Site is the staging point for the manufactured components of the nuclear device. They are shipped to the site from various parts of the United States. These shipments may involve air, train, or truck transportation but are always packaged, shipped, and handled in accordance with Department of Transportation requirements, as well as other Federal and state regulations. When all parts are on hand, the components are transferred to a common work area where the experimental nuclear devices are assembled.

All radioactive materials movements into or out of the Baker Site are supervised by the Assembly Facility Coordinator.

Before the parts for an assembly are received, a detailed assembly procedure is compiled and reviewed by the Nuclear Explosives Engineering/Weapons Engineering Division, the LLL-N Resident Manager, Baker Site personnel, the LLL Criticality Group, and H.E. Chemistry personnel. This procedure lists all parts, the steps to be performed in sequence, and all special handling equipment. During an assembly operation, each step is signed off by the Device Enginner.

(3) Accident Analysis

Plutonium Dispersal

No more than 70 KG (54 pounds) of high explosives can be present in an assembly bay with concurrent activity involivng explosives in an adjacent bay. No more than 15 KG (33 pounds) of plutonium can be present in any assembly bay. As a postulated worst-case accident the detonation of 70 kg (154 pounds) of high explosives in Building 5310 involving the complete dispersion of 15 KG (33 pounds) of plutonium has been analyzed.

III.B. OTHER ACTIVITIES AT THE NEVADA TEST SITE

4. Activities in Area 27 (the 410 Area) (Cont.)

Based on the amounts of plutonium and high explosive which have been handled at one time within this assembly facility, the postulated accident describes an upper bound for this type of accident.

Low-Order Nuclear Yield

The consequences of a 0.1-kiloton fission yield have been calculated to demonstrate the upper bound of any conceivable environmental impact from the operations at the 5300 Complex. This will be treated in Section IV.B. of this environmental statement.

c. The 5100 Complex (Able Site)

(1) General Facility Description

The 5100 Complex (Able Site) consists of several buildings that were constructed in 1960. Explosives were handled at the 5100 Complex in the past, but this is no longer permitted. One building is used for the storage of spare Super Kukla fuel elements.

(2) Operational Procedures

Operations at the 5100 Complex are governed by the LLL-Nevada Health and Safety Manual (Reference 86).

(3) Accident Analysis

The maximum credible accident for the 5100 Complex involves a fire in the building which houses the spare Super Kukla fuel elements. The consequences of such an accident are minimal since the storage array will remain subcritical even when flooded with water.

III.B. OTHER ACTIVITIES AT THE NEVADA TEST SITE

5. Nuclear Accident Response Test

It is anticipated that the Nevada Test Site may be used for an exercise to test the national capability to respond to a nuclear accident. Such exercises are necessary to maintain the viability of the emergency response teams involved and to improve their effectiveness by incorporating the latest technology into their methods and procedures. The coordination between the response teams also needs to be exercised as well as the modes of intercommunication between responsible agencies. The results will provide the basis for updating existing interagency agreements for the handling of emergency situations involving radioactivity (Reference 87).

The scenario for such an exercise would include an accident or incident involving a nuclear weapon or spent nuclear fuels, and be designed to represent an airplane crash, a highway or railway wreck, or an incident resulting from terrorist activities. A catastrophic nuclear reactor accident can also be simulated. The simulated accident could utilize selected short-lived radionuclides chosen to represent the longer-lived radiation from fissionable material or from fission products, scattered about by the collisions, fire, or high-explosive detonations associated with such a hypothesized accident.

A remote area on the Nevada Test Site would be selected, for example, Buckboard Mesa, or the higher mountain terrain, depending upon the environment required for the particular scenario chosen. The area easily can be isolated so that only the participating emergency crews (and umpires) would have access. The participants in such an exercise would include the armed forces; the local, state, and Federal law enforcement agencies; civil defense agencies; and health, safety, and environmental agencies.

6. Lasers

The use of lasers at the NTS is expected to continue but the application of these instruments is minimal and restricted to low- or medium-power systems. Lasers are used largely as construction tools, primarily for alignment purposes in tunnels or in emplacement holes.

6. Lasers (Cont.)

Most lasers are used underground. Occasionally a few are used for laboratory bench-type equipment alignment, while others are used outdoors for measurement purposes. There are no high-power lasers in use. None are contemplated for use in laser research or development programs.

It is the policy of the Nevada Operations Office (NV) to control laser operations at the Nevada Test Site through established Standard Operating Procedures (Reference 88). These procedures outline the responsibilities, radiation exposure criteria, and describe the administrative requirements related to the Nevada Test Site laser activity.

As each laser operation at the NTS must receive the approval of the Assistant Manager for Operations prior to implementation, the initial request by the using agency must include a laser safety plan outlining an adequate description of the proposed laser usage with considerations given to hazard control. Upon approval, the using agency must register any laser over two milliwatts peak power with the Operations Coordination Center. An Operations Permit must be granted prior to the use of the laser.

7. Gas Core Reactor Tests

The National Aeronautics and Space Administration (NASA) is interested in conducting research to investigate the feasibility of a gas core reactor system which may have large potential benefits for certain applications in space. The LASL, under NASA sponsorship, is conducting critical experiments on low-power gas core systems at this time. It is anticipated that these experiments will lead to higher-power tests as the work progresses, and that ultimately tests will be needed at high powers of 0.1 to 10 megawatts. It will not be feasible to conduct such tests within the confines of the Critical Experiments Facility at Los Alamos, and hence, planning is under way for these tests to be conducted at the NTS.

III.B. OTHER ACTIVITIES AT THE NEVADA TEST SITE

7. Gas Core Reactor Tests (Cont.)

The existing R-MAD* building in Jackass Flats (see Figure III-8) is a suitable structure in which these initial higher-power tests would be performed. Use of this facility is also consistent with a congressional directive to NASA to effect as much benefit as possible from the investment made over a number of years in the Nuclear Rocket Propulsion Program. Modification of the R-MAD facility to accept these tests is planned to begin in 1978 based upon the actual tests being under way in 1980 (Budgets permitting). The testing would be conducted in the major shielded bay area of the R-MAD building. The apparatus would consist of the reactor reflector assembly, a uranium hexafluoride (UF6) gas canister inserted in the reflector, and a gas recirculation system attached to the canister (see Figure III-9). The test would involve operation of the reactor at power for a few minutes to observe the behavior of certain system parameters.

Such tests would occur more than a week apart. Performance of these tests inside the disassembly bay represents the major containment precaution taken, in that the disassembly bay affords a high assurance of confinement of any radioactive constituents if an untoward equipment failure were to occur and result in the release of gas from the reactor system. The bay has a tight, closed, high-efficiency filtered air system, which provides retention of gases within the hot bay for sufficiently long times (days) so that radioactive products can decay to acceptably low levels before release.

Postoperational procedures will be to disassemble the reactor components with the remote manipulators, examine the components, decontaminate those components required for reuse, package the remaining "hot" items in suitable containers, and store them in the existing radioactive waste storage area adjacent to the R-MAD building.

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*The R-MAD (Reactor Maintenance, Assembly, and Disassembly) building is one of the facilities used as part of the nuclear rocket engine test program which was terminated in 1973.

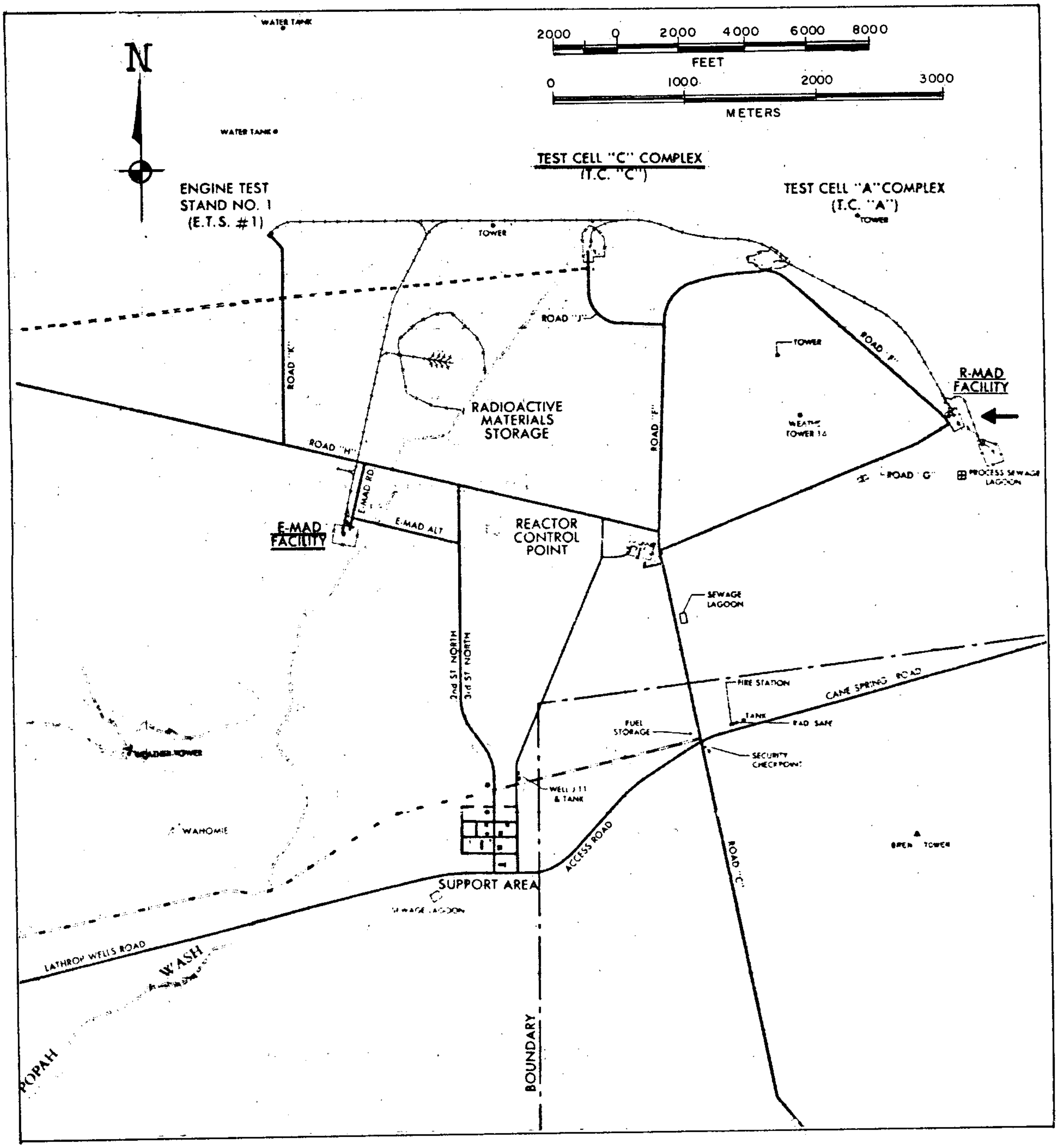

FIGURE III-8 FACILITIES IN AREA 25

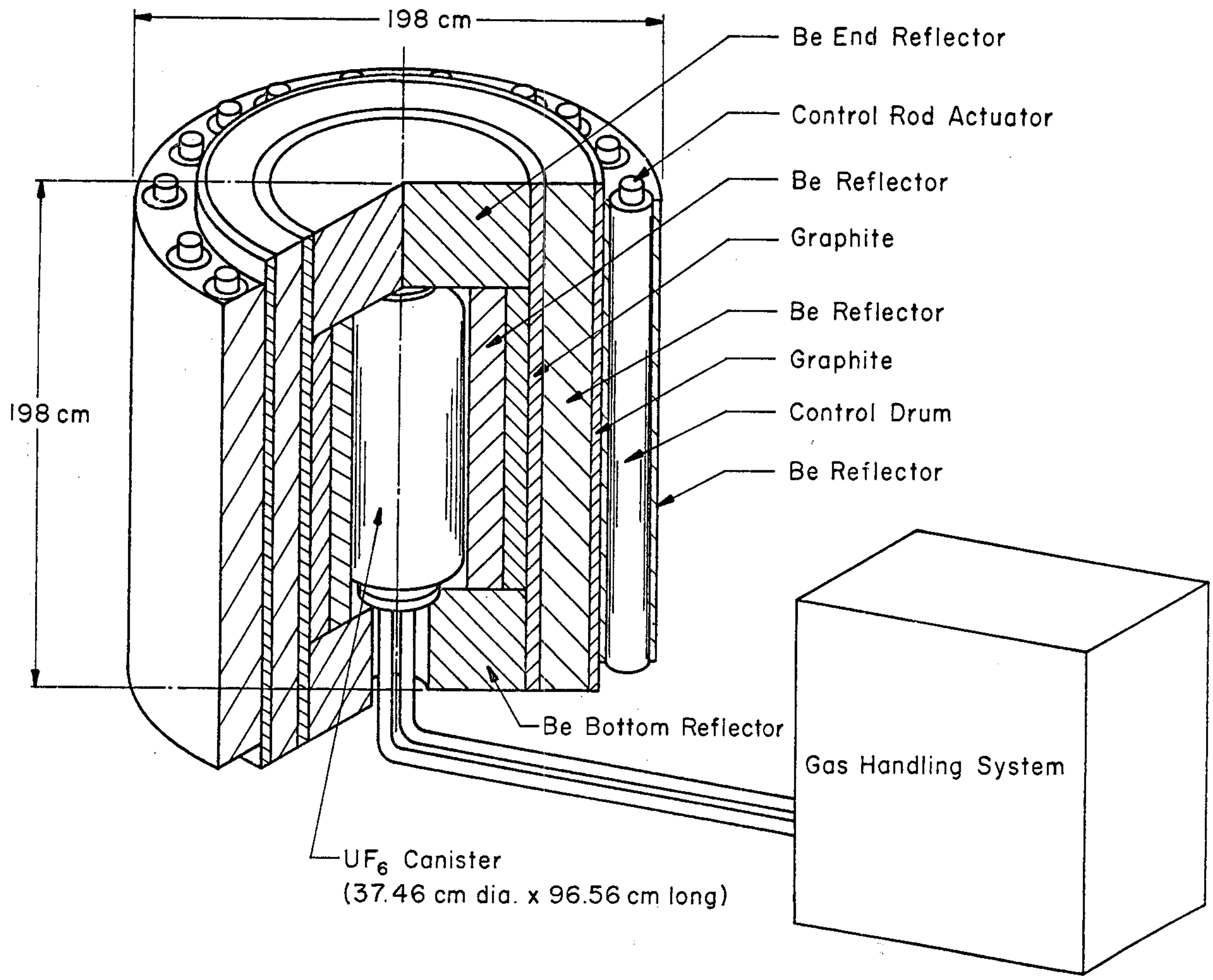

FIGURE III-9 GAS REACTOR EXPERIMENT

III.B. OTHER ACTIVITIES AT THE NEVADA TEST SITE

8. Commercial Radioactive Waste Disposal Experiments

Recent projections of growth in the use of commercial nuclear power reactors and recent Federal policy decisions concerning the commercial nuclear fuel reprocessing plant availability indicate significant delays for the anticipated production of high-level radioactive wastes. As a result, priorities for managing radioactive wastes have been reoriented to include retrievable surface storage as an adjunct to terminal disposal in geologic formations. The program of geologic investigations has been expanded beyond salt formations to include both argillaceous and crystalline rock formations.

On the NTS, large outcroppings of the Eleana Formation extend north to south through Areas 12, 16, and 17. The Eleana Formation exists beneath these areas to great depth. Exploratory excavations along with drilling and coring are presently underway at the NTS to increase our knowledge of the physical characteristics of the Eleana Formation. Further geologic field investigations will be pursued in 1977 and 1978 to better define the extent of the formation.

The experiments proposed include emplacement of electrical heat sources in holes to measure the rock's thermomechanical properties and to determine the effects of the long-term thermal loading upon the rock properties. Simulated radioactive heat sources are being proposed to determine the dual effects of both thermal loading and radiation. Later experiments, for which a site must be selected, will investigate similar effects at depths of about 300 meters (1,000 feet) under the surface. One proposal is to construct a tunnel which would include several mined test chambers. Electrical and simulated radioactive heat sources would be placed in drilled holes within these test chambers and the combined heat effects and radiation effects upon the rock media would be studied.

If these experiments demonstrate the Eleana Formation to have suitable properties, continued field surveys, drilling, and evaluations will be carried out to identify and certify a suitable site for a terminal waste storage repository.

III.B. OTHER ACTIVITIES AT THE NEVADA TEST SITE

8. Commercial Radioactive Waste Disposal Experiments (Cont.)

It is not expected that such experiments and investigations will be confined to the Eleana Formation. Other geologic media will also be investigated with similar experiments and tests in those areas of the test site where it can be shown that they will not interfere with the underground nuclear testing program. The granitic formations of the Climax Stock in Area 15 and the Gold Meadows Stock in Area 19 are examples. Other crystaline rocks, unsaturated alluvial deposits, and tuffaceous materials are also likely candidates.

Nor need such investigations be confined to the test site proper. The granitic core of the Timber Mountain Caldera extends offsite to the west on to the Nellis Air Force Range (see Figure II-9). Aero-magnetic exploration is presently being conducted in this area in an attempt to infer the extent of this granitic structure. In agreement with the U.S. Air Force, exploratory drilling will follow and if the rock properties are determined to be suitable, electrical heat experiments and radiation experiments will be conducted. Ultimately, this could also lead to mined test chambers suitable for a pilot demonstration of a terminal waste repository.

9. Spent Unreprocessed Fuel Storage Experiments

Nuclear fuel recovery activities for the Tory II-C fuel tubes occurring in the EMAD facility, in Area 25, will be completed and shipment of the recovered fuel to the Idaho Nuclear Engineering Laboratory is scheduled to occur during the first quarter of FY 1978. The EMAD building will be decontaminated in preparation for additional spent fuel handling research and development experiments.

Stated in broad terms, the objective of this proposed program is the experimental verification and demonstration of the engineering and operational principles of a generic system for the handling and interim surface storage of unreprocessed spent reactor fuel assemblies. It constitutes a demonstration program whose ultimate objective is to place a minimum of four encapsulated LWR spent fuel assemblies in a surface storage configuration near the NTS EMAD facility.

III.B. OTHER ACTIVITIES AT THE NEVADA TEST SITE

9. Spent Unreprocessed Fuel Storage Experiments (Cont.)

Dummy fuel elements will be used at first, received by truck in approved shipping casks at the EMAD facility. Alternate flow paths and techniques for receiving, handling, encapsulating, transporting, emplacing, and instrumenting will be experimentally investigated and evaluated to develop the technology. Safety procedures will be developed and evaluated. Potential malfunctions will be investigated and handling procedures developed.

It is anticipated that spent unreprocessed LWR fuel assemblies will follow and the demonstration program will begin. The actual emplacement will be instrumented with a 20-year operational design life and will be capable of interim retrieval. The sealed storage cask concept, similar to that described in Draft Environmental Impact Statement 1539 (Reference 91), and emplacements in dry wells, are to be demonstrated. Other storage concepts, such as the air-cooled vault (Reference 91), may also be demonstrated. The water basin storage concept will not be demonstrated at NTS.

Depending upon the results obtained from the demonstration of the four unreprocessed spent reactor fuel assemblies, the program could grow into a demonstration phase of a prototype handling and storage facility for some 100 to 200 spent reactor fuel assemblies.

10. CETO Program

ERDA's Division of Biomedical and Environmental Research sponsors a CETO organization (acronym for Civil Effects Test Operation) on the NTS. Individual and team-sponsored investigators, primarily from a number of universities, have established over a hundred research areas (plots) scattered over the NTS in the past 15 years.

The general purpose of the CETO study plots is to provide individually distinct and strategically located areas for the acquisition of data on plant and animal life in a desert environment. Some areas are used to provide baseline control data under natural environmental conditions and others serve as unique reserves of flora and fauna for taxonomic purposes. Other areas provide information relative to individual and species reactions to specific experimental conditions.

III.B. OTHER ACTIVITIES AT THE NEVADA TEST SITE

10. CETO Program (Cont.)

Since the CETO biological and ecological investigations were initiated at the NTS, plots have been chosen for their unusual characteristics by scientists from several universities and research organizations. Early research was directed toward assessment of nuclear testing effects on populations of desert animal and plant life, as determined by trapping surveys and observations in irradiated and nonirradiated areas. Study plots were established at critical blast locations, with physiognomy-similar, nonaffected plots used as control areas. Basic projects conducted during this period were directed to (a) compare ecological studies of native animals exposed to nuclear effects; (b) study plant communities and their environments to evaluate effects of nuclear testing; (c) collect, identify, and study the behavior of arthropods in disrupted ecosystems; (d) study radiation effects on rodents, lizards, and vegetation within the Rock Valley study area; and (e) study radionuclide cycling in plants and soils. Numerous subprojects dealing with specific species' reactions have been conducted in relation to these broader objectives.

Data relative to annual climatic conditions, analysis of communities, and their interrelationships, which were collected and documented from study plots established during the earlier period, have been used as a base for ongoing research slanted more toward investigations of the natural desert ecosystem. As plant population changes are very slow, the value of specific plots increases with time, as does the importance of maintaining their integrity.

Current projects include investigative efforts toward determinations of (a) effects of population density, winter rainfall, and predation upon the reproduction and survival of specific lizard species; (b) nature and distribution of soil arthropods in relation to plant distributions and abiotic factors; (c) energy and water metabolism of free living vertebrates; (d) various aspects of autecology (e.g., diet, behavior, water, and energy metabolism) to assess environmental factors which affect reproduction and mortality of desert rodents; (e) nitrogen, radionuclide, and mineral cycling in desert plants; (f) methods of revegetating disturbed areas including irrigation techniques; and (g) possible effects of nonnuclear contaminants on the desert ecosystem. O'Farrell and Emery (Reference 54) include a compilation of many of the reports resulting from this work.

III.B. OTHER ACTIVITIES AT THE NEVADA TEST SITE

10. CETO Program (Cont.)

The Rock Valley Study Area and some of the forward area study plots are being used by investigators associated with the U.S. International Biological Program (IBP), Desert Biome, in their analysis of an ecosystem program (Reference 90). The extensive available information on these areas has made them ideal for continued monitoring to provide an unequaled data base suitable for validating mathematical "predictive" models of desert ecosystems.

The extensive data base has been found useful by IBP workers, not only for validation (current state of the system measurements) but also for the actual construction of models based on complete histories of specific fertility, natality, mortality, and longevity rates of various species of both plant and animal life in a desert ecosystem. The DBER-sponsored CETO projects are expected to continue.

C. ACTIVE CONSIDERATIONS

The size, climate, and remoteness of the controlled areas of the NTS and the Nellis Air Force Range along with the existing support organization, appeal to program managers throughout the government. From time to time, some investigate the suitability of the NTS for selected activities. Several such investigations are under way at the present time, but it is difficult to determine if these will develop into real activities. The most significant of these are:

1. Interim Storage of High-Level Commercial Radioactive Waste

The Nevada Test Site, along with the Hanford Reservation, Washington, and the Idaho National Engineering Laboratory, Idaho, have been considered as potential sites for the interim storage of commercial high-level radioactive-contaminated waste--a proposed activity heretofore designated as a retrievable surface storage facility. The alternatives for the concept of retrievable surface storage were treated in a Draft Environmental Statement, WASH 1539 (Reference 91). This environmental statement was withdrawn in April 1975 when the program for managing radioactive waste was reoriented in favor of terminal disposal in geologic formations.

III.C. ACTIVE CONSIDERATIONS

1. Interim Storage of High-Level Commercial Radioactive Waste (Cont.)

Retrievable surface storage, however, is being held as a viable option and it may still develop that the NTS is selected for this purpose sometime in the future. While there are no plans at present to construct such a storage facility, ERDA has requested the Nevada Operations Office to prepare a study on commercial high-level waste handling and storage at NTS. The experimentation and demonstration to be accomplished at the NTS, as described in III.B.9. above, is pointed toward the readying of this technology. ERDA is also completing some testing and design work on a sealed storage cask demonstration at the Hanford Reservation which will enhance the capability for aboveground storage, should it be necessary. If and when the NTS is selected for this purpose, a license for such a facility will be sought from the Nuclear Regulatory Commission and a separate site specific environmental statement will be prepared for that activity.

2. Seafarer

The Nevada Test Site has also been examined as part of a potential site for the Navy's proposed extremely low-frequency radio, submarine communications system, the "Seafarer" System. The Navy has recently withdrawn consideration of the Nevada Test Site, but is actively considering lands of the Nellis Air Force Range and Tonopah Test Range, immediately adjacent to the NTS, as well as sites on the upper peninsula of Michigan and at the White Sands Proving Ground and Fort Bliss in New Mexico.

3. Solar Energy Research Facility

The Jet Propulsion Laboratory in Pasadena is presently investigating the Nevada Test Site along with numerous locations in California as a potential site for a solar energy research facility. A portion of the Area 25 is under consideration.

SECTION IV

ENVIRONMENTAL IMPACTS AND EFFECTS

A. EFFECTS FROM FUTURE UNDERGROUND NUCLEAR TESTING

1. Detonation Phenomena

Under the current limitation, nuclear explosive tests to be conducted in FY 1978 and beyond by the Nevada Operations Office will be executed underground. Unless proper controls are exercised, hazardous conditions can develop in association with any explosion. It is and continues to be the policy and practice of ERDA to carry out a nuclear weapons test program with full attention to making each test as safe and free of hazards and adverse environmental effects as possible. In an underground nuclear detonation, such effects can arise mainly from the extremely high pressures generated in the ground by the explosion, with its attendant shock wave, and from the radioactive residues of the nuclear device. A nuclear explosion underground starts a complex series of events that take place in times ranging from almost instantaneously to many hours.

a. Cavity Formation and Collapse

When a nuclear explosive is detonated underground, the energy released immediately produces extremely high temperatures in the device and the surrounding medium. These solid materials are vaporized, and pressures exceeding a million atmospheres are produced. An outgoing shock wave develops which is initially so strong that it vaporizes more of the surrounding medium. As the shock wave expands, its intensity weakens until the medium is melted rather than vaporized. The cavity thus formed expands until the vapor pressure in the cavity approximately balances the lithostatic pressure of the overburden. The size of the underground cavity is dependent upon the amount of energy released by the explosion, the depth of burial, and the physical properties of the medium in which it is detonated. At ranges still greater than cavity radius, the shock wave is sufficiently weak that its effect is limited to fracturing and heating of the medium. The generally spherical cavity is filled with vaporized material and lined with melted rock. After the cavity forms, the vaporized rock condenses and the molten rock flows toward the bottom, the residual gases cool, the pressure subsides, and collapse of the upper walls of the

IV.A. EFFECTS FROM UNCERGROUND NUCLEAR TESTING

1. Detonation Phenomena (Cont.)

cavity begins. The cavity collapse is commonly initiated within a few minutes to several hours of its formation. Occasionally, it may be delayed for several days or weeks, but, once started, the collapse proceeds rapidly. This collapse continues upward, producing a vertical, rubble-filled column known as a rubble chimney.

The upward progression of the rubble chimney depends on the size of the cavity, its depth, and the strength of the individual strata of overlying rock. Some chimneys do not progress to the surface. If this happens, there will remain a potential hazard with regard to the stability of the surface terrain over the underground chimney. Such a situation requires special safety precautions as discussed in "Postevent Activities," Section III.A.3.e.

b. *Surface Expression*

Following most of the nuclear tests, the overburden does not form a supporting arch over the rubble chimney, and the chimneying process will proceed upward until it reaches the ground surface. The process will terminate by the formation of a conical or bowl-shaped depression from several tens of meters to a few hundred meters in diameter and up to 60 meters deep. These depressions, called subsidence craters or "sinks," will be similar to the many (several hundred) craters now in existence on the test areas and described in Section II.D.2.

Numerous surface fractures will be visible around most craters. Those related to its formation may show concentric and radial patterns, while other linear fractures may be aligned with the existing faults and bedrock joint patterns in the underlying rocks. Ground motion from some explosions can be expected to cause displacement along preexisting faults near the explosion sites. Such motion, if strong enough, usually results in vertical offset (displacement) along the trace of the fault at the ground surface. Based upon past experience (see Section II.D.4.), it is unlikely that these vertical displacements will exceed about one meter (3.3 feet). They can extend for a

IV.A. EFFECTS FROM UNDERGROUND NUCLEAR TESTING

1. Detonation Phenomena (Cont.)

few hundred meters to a few kilometers laterally along the fault. The vertical displacement usually will decrease rapidly with distance from the explosion site. Any displacement along preexisting faults is not expected to extend beyond the boundaries of the test area and none will produce any significant environmental effect insofar as present or foreseeable uses of the test site are concerned.

2. Ground Motion and Structural Response

An underground nuclear detonation will invariably produce some detectable level of ground motion. While there are methods for decoupling or lessening the amount of the explosion energy transmitted into the ground as seismic energy, these techniques are difficult and are not practical for use on routine operations.

After many years (since 1963) of monitoring and analyzing ground motion data from a large number of underground explosions, empirical equations have been developed which define the important characteristics of the ground motion and the dynamic response of structures to that motion. The resulting equations are used to predict, with reasonable accuracy, the expected ground motion from planned underground test and the effects that motion will have upon structures.

Past experience has shown that the important parameters to be considered in predicting the ground motion at any given location include: (1) the distance from the emplacement hole, (2) the specific area on NTS where the test is to be conducted, (3) the expected yield of the nuclear device, (4) the depth of burial, and (5) the properties of the geologic media surrounding the detonation point (especially the porosity and water content of the rock). See Section II.D.6. of this statement and Reference 35 for a more extensive discussion. The predictions are stated in terms of the peak amplitudes of acceleration, velocity, and displacement, which quantitatively describe the relative signal strength at the ground stations of interest.

IV.A. EFFECTS FROM UNDERGROUND NUCLEAR TESTING

2. Ground Motion and Structural Response (Cont.)

For structural engineering studies, predictions of the spectral composition of the ground motion at specific locations on and off the test site are required. Structures respond to ground motion excitation by oscillating at fairly well-defined periods of vibration. The amount of movement experienced by a structure is dependent upon the physical parameters of the structure and the spectral composition and duration of the seismic signal. Techniques have evolved from the study of the interrelationship between these factors which permit the prediction of the magnitude of a specific building's response to the predicted ground motion. (See Reference 36.)

Many tests conducted as part of the underground test program are by nature experimental so that the energy yield is not precisely known beforehand. However, a maximum credible yield can be calculated, based upon the best performance which can reasonably be expected from the device components. Predictions of ground motion effects from any nuclear explosion will be made on the basis of this maximum credible yield. This introduces an element of conservatism into the predictions. Predictions will also be made for the expected yield of the device (the design yield), but this is not for safety reasons but rather for postevent comparison with actual ground motions. Observed motion data are processed for refinement of the data base so as to improve the ground motion prediction capability.

Seismic instruments will continue to be deployed to document the ground and building response motions to verify that actual motions are within the range of predicted motions. The magnitude of the measurement program will vary with the anticipated yield. For tests with yields above 80 kilotons, a minimum of five ground stations and ten high-rise buildings will be instrumented, while for higher-yield tests, as many as 25 ground stations and 50 high-rise buildings will be included in the program. Most of the documentation effort will be concentrated in Las Vegas, although for the high-yield tests, records may be taken as far away as Reno, Nevada; Salt Lake City, Utah; Phoenix, Arizona; and San Francisco and Los Angeles, California.

IV.A. EFFECTS FROM UNDERGROUND NUCLEAR TESTING

2. Ground Motion and Structural Response (Cont.)

In addition, large Federal and municipal facilities, such as Hoover Dam and the Colorado River Water System, will be monitored to verify that actual motions are within the range of predicted motions, and assure that adverse effects, which could result in the interruption of vital public services, are not occurring.

The successful application of the prediction techniques utilized over the years and the broad data base upon which these prediction techniques were developed gives rise to a high degree of confidence that future underground nuclear testing, in the range of yields covered by this environmental statement, will not produce ground motion significantly different from past experience. In addition, it is not expected that the response of structures to that motion will cause structural damage to existing buildings offsite. Some uncertainty relates to the future high-rise buildings projected for Las Vegas. New and innovative design concepts and building materials are being utilized in an effort to maintain an acceptable cost level for new buildings. ERDA will continue to study explosion-generated ground motion and its effects on structures in order to update and refine the prediction methodology.

There is no evidence of damage to offsite mines that could be attributed to ground motion produced by underground nuclear explosions. All mines within 50 km (31 miles) of the test site are periodically examined and photographically documented by experienced mining engineers. At the levels of motion expected from future test activities, damage to offsite mines is not expected to occur. However, the surveillance program will be continued.

Although test-related ground motions have never been reported to have caused snow dislodgment in the Spring Mountains south of the NTS, EMSL-LV monitors will continue to contact the U. S. Forest Service whenever a large test is scheduled during winters of heavy snowfall. Members of the Las Vegas Ranger District can then take any special safety precautions they deem necessary.

Because underground nuclear tests conducted at the NTS in FY 1978 and afterward are not expected to exceed in yield those conducted in the past. few claims of damage to water wells by ground motion are anticipated. As noted in Section II.D.5., for a few poorly constructed wells, increased water turbidity may have appeared somewhat earlier than it would have without nuclear testing. This will continue to be true in the future. The NV will continue to investigate claims of well damage even though the likelihood of their being related to test activity at the NTS is small.

IV.A. EFFECTS FROM UNDERGROUND NUCLEAR TESTING

3. Seismicity

Stimulated seismicity has been observed to occur following the execution of underground nuclear tests, with the aftershocks persisting for days, weeks, or months after the explosion. Studies have shown that this seismicity is confined to the approximate area of the detonation and is caused by a readjustment of the near stress field to the explosion effects and by deterioration of the cavity during chimney formation. Research has shown that the effects of underground tests on the regional seismicity are narrowly restricted both in time, area, and amplitude.

ERDA has maintained a program to document and analyze the stimulated seismicity pattern on Pahute Mesa in connection with the high-yield tests. The patterns of seismicity associated with each test do not appear to deviate significantly from event to event or from test area to test area. The differences that are noted are generally related to the proximity of the explosion to preexisting fault planes on Pahute Mesa. Furthermore, it does not appear that the frequency of testing has any obvious influence on the patterns of seismicity except that the number of aftershocks associated with each test seems to diminish with each succeeding test, provided the time between tests is a few months or less. Research into this aspect of the stimulated seismicity is continuing.

In consideration of any high-yield test activities in the future, there is no reason to expect any variation from the pattern of stimulated seismicity already reported by Hamilton (Reference 40). The seismic characteristics of high-yield testing at Pahute Mesa include:

a. Aftershock magnitudes are expected to be less than the seismic magnitude resulting from the explosion itself.

b. The vast preponderance of aftershocks will occur at shallow depths probably less than 5 kilometers (3 miles), and will be located within 14 kilometers (8.7 miles) of ground zero of the preceding explosion.

c. Explosion-stimulated earthquake activity is not expected to extend outside the test areas.

d. The spatial distribution of aftershocks will be largely influenced by the local geologic structure.

IV.A. EFFECTS FROM UNDERGROUND NUCLEAR TESTING

3. Seismicity (Cont.)

The likelihood of triggering an earthquake, which would represent a hazard to persons or property, or cause environmental damage offsite, is very remote.

4. Hydrology

This section assesses the impact of future underground testing on the hydrologic system of the NTS and adjacent areas. The primary source of radioactivity at the NTS is the combination of weapon materials, fission products, and neutron-induced radioactivity generated at each underground nuclear test location. Such tests will continue to create and add to the large buried radioactive waste inventory requiring long-term surveillance and restricted access. The mobility of the waste at each site is dependent mainly upon the proximity to local water tables and upon groundwater transport.

a. Nuclear Tests Above the Water Table

Most nuclear explosions at the NTS have been and are expected in the future to be conducted in unsaturated alluvium or tuff above the water table. Infiltration of surface runoff caught in subsidence craters will be somewhat greater than through the undisturbed preshot soil because of the increased permeability of the rubble beneath the crater. However, there is some evidence that infiltration into and around the nuclear cavity will be slowed by a layer of clay which accumulates in the bottom of many subsidence craters, by the explosion-compacted, glazed envelope surrounding the cavity itself, and because of the low natural permeability of the rock beneath the cavity. Although some stratigraphic units within the tuffs underlying NTS test areas are moderately permeable, downward hydraulic seepage is limited by the thick tuff aquitard, previously discussed in Section II.D.5., that does not maintain open fractures.

IV.A. EFFECTS FROM UNDERGROUND NUCLEAR TESTING

4. Hydrology (Cont.)

Additionally, the zeolitized zones of the tuffs, through which interstitial flow predominates, have high ion-exchange capacities because of their mineralogy and large surface areas for adsorption (Reference 92). Only tritium in the form of water can be expected to move through the system at the same rate as the groundwater, but even then its concentration will be reduced by radioactive decay, (with a half-life of 12.3 years), dispersion, and dilution during migration. Any recharge reaching the water table, therefore, may carry tritium and very dilute concentrations of other radionuclides; however, the process will take hundreds of years and must traverse a long and circuitous path to reach offsite areas. A study of the rates of movement of water and waterborne radionuclides through the unsaturated zone is a continuing program at the NTS. This matter is discussed in the following section.

b. Nuclear Tests Below the Water Table

A small percentage of nuclear tests at NTS require burial at depths greater than about 500 meters (1,650 feet) where the working point or the deepest limit of cavity growth will penetrate saturated media beneath the water table. Beneath Frenchman Flat and most of Yucca Flat, the cavities resulting from these explosions will be within alluvium or tuffs characterized by low vertical permeability and high ion-exchange capacities. As explained in Section II.D.5., water in the tuffs leaks downward into the regional carbonate aquifer (in the Ash Meadows groundwater system) at rates of less than 0.05 meter (0.2 feet) per year. The transport time of contamination in the water is increased by passage through many lithologic units having the ability to sorb radionuclides. This will act to broaden the distribution and suppress peak radionuclides concentrations.

IV.A. EFFECTS FROM UNCERGROUND NUCLEAR TESTING

4. Hydrology (Cont.)

The Nevada Operations Office plans to select occasional holes of opportunity, generally drillback holes, in appropriate locations and lithologies for continued investigation of the distribution of radioactivity in chimney water, infill rates, temperature changes, and radionuclide migration. The drillback hole into the chimney formed by the Cheshire event of February 14, 1976, has recently been converted into a radiologic and hydrologic monitoring hole and will be used for these purposes. Cheshire was detonated 476 meters (1,562 feet) below the water table on Pahute Mesa in a geological medium of rhyolite. An exploratory hole drilled in Area 7 extends below the water table and penetrates the Paleozoic carbonates. This hole will intercept groundwater in the regional system after it enters the rock under the NTS. The Bourbon event, detonated in 1967, is located 200 meters (700 feet) away. This hole will be used to investigate the Paleozoic aquifer and to study groundwater transport characteristics.

Because of the presence of tritium in Area 2 groundwater, as noted earlier in Section II.D.5., a continuous hydrologic data collection program will be conducted in the Area 2 portion of the NTS. It will consist of obtaining water level measurements and water samples for radiochemical analysis from all holes of opportunity made available through the various ongoing drilling programs.

Should radionuclides reach the regional carbonate aquifer beneath Yucca Flat, they would be transported at, or slower than, the groundwater velocity, previously stated as 2 to 180 meters (6 to 600 feet) per year. Little is known of the retardation and dispersion characteristics of the carbonate aquifer, although tests are being conducted to learn more about them. If radioactivity deposited from nuclear tests in Yucca Flats were to enter the regional groundwater in the carbonate system, on the order of one century will be required for this water to arrive beneath Frenchman Flat. Downward-moving contaminated water from past or any future tests in Frenchman Flat, itself, will arrive at the carbonate aquifer in a similar or longer time frame. Thus, any test-derived tritium in the water, be it from Yucca or Frenchman, would have decayed by a factor of about 250 in the

IV.A. EFFECTS FROM UNDERGROUND NUCLEAR TESTING

4. Hydrology (Cont.)

carbonate aquifer below Frenchman Flat. In the Ash Meadows groundwater system, the area beneath Frenchman Flat also receives flow from the east from outside the NTS boundaries. This interbasin flow from the east may be as much as an order of magnitude greater than the contribution coming from beneath Yucca Flat. The flow from Yucca Flat is thought to be about 430,000 cubic meters (350 acre-feet) annually. Dispersive mixing along the boundaries of the two volumes of water would ultimately dilute the concentration of any tritium by another factor of ten. An additional century will have passed before this water arrives under Mercury Valley, allowing time for further radioactive decay. Under Mercury Valley, the greatest proportion of Ash Meadows flow is derived from the Spring Mountain Range recharge which enters the system from the southeast. Again, dispersive mixing will occur when this large volume of water comes in contact with that which enters from under the Nevada Test Site. There remains another hundred-year journey before these waters arrive at the Ash Meadows discharge area. The combination of 300 years for radioactive decay and dispersive mixing over the long migratory path will reduce any tritium concentrations by at least an order of 10^9.

As previously stated in Section II.D.5., the annual discharge from the Ash Meadows spring line is about 21 million cubic meters (17,000 acre-feet) or about 21×10^{12} milliliters. It would take 21,000 curies of tritium in the form of water to mix with this amount of discharge to bring the concentration up to 1,000 pCi/ml, the Radiation Concentration Guide (RCG) used in Section II.D.5. in accordance with ERDAM 0524. If the reduction factor of 2×10^7 for the minimum 300-year journey due to radioactive decay referred to above is applied, more than 420 billion curies of tritium would need to be introduced into the water in the paleozoic aquifer under Yucca Flat per year in order to produce a concentration of 1,000 pCi/ml at the Ash Meadows, if all of the remaining tritium were discharged there. This amount, of course, is many orders of magnitude above all of the tritium associated with nuclear testing at the Nevada Test Site. In fact, this amounts to over 42,000 kilograms (50 tons) of pure tritium and, for example, is more tritium than the Savannah River Plant has ever produced. Thus, it is virtually impossible for nuclear testing to contaminate the groundwater with tritium in any amount that would be detectable in the outflow of groundwater from the spring line in the Ash Meadows area.

IV.A. EFFECTS FROM UNDERGROUND NUCLEAR TESTING

4. Hydrology (Cont.)

The above discussion makes it clear that tritium migration in NTS groundwater, even though the most mobile contaminant derived from nuclear testing, cannot reasonably be expected to be a future hazard at locations off the Test Site. The concentrations of other isotopes having longer half-lives will not be reduced as rapidly by radioactive decay, but they will be slowed by sorptive processes and are not anticipated to pose a future hazard. The ion-exchange capacity of the alluvium and tuffs beneath Yucca and Frenchman Flat appears to be the best defense against transport of very long-lived nuclides (Reference 92).

Calculations of average groundwater velocity, presented in Section II.D.5., show that water from sites on Pahute Mesa is unlikely to leave government-controlled land for more than 1,000 years. Dispersion along the boundaries of any volume of groundwater contaminated by testing will ultimately reduce the concentration. The flow must pass through tuffs or the detritus of eroded tuffs having sorptive capacities similar to those in Yucca Flat, further lessening the danger in public areas.

However, monitoring of groundwater at the NTS is considered necessary because of testing already concluded, as well as in the future, and that monitoring will continue until it can be further demonstrated that the migration of radioactivity in groundwater is not significant. As wells in the long-term hydrologic monitoring network (see Section II.D.5.) are destroyed or become unserviceable, and if the centers of testing shift to other areas at the NTS, additional wells will be added so that the monitoring network will continue to provide surveillance at points of public use, at "early warning" locations close to centers of testing, and at points of groundwater exit from the Nevada Test Site.

c. Effects on the Regional Water Supply Quantity

The average water pumpage at the NTS of about 1.2 million cubic meters (1,000 acre-feet) annually from the Ash Meadows groundwater system has not produced detectable effects on the regional water table or water quality during the past 15 years. Most of the withdrawal has been from Yucca Flat, an area of about 200 square kilometers (75 square miles or about 50,000 acres). An average decline of about 0.15 meter (0.5 foot) would provide for the cumulative production from Yucca Flat. This is insignificant and such a variation in water table would not be discernible. Withdrawals from Frenchman Flat also have negligible effects upon the water table altitude and the flow in the regional aquifer. Continued pumping of similar quantities of water to support nuclear tests in FY 1978 and beyond can be expected to have similar negligible effects upon the water levels. Because the thick tuffs provide effective hydraulic insulation of the regional aquifer from the alluvial valley fill, effects on regional water supply should not be discernible for centuries to come.

d. Effects on Surface Water

Slight local effects are expected upon the surface water because of local drainage into the subsidence craters. Also, as noted in Section IV.A.5.a., tritium will be present in the tunnel drainage ponds. Such local effects will have no influence upon the infrequent surface water runoff from NTS.

e. Effects of Hydrologic Investigations

Continuing investigations to improve knowledge of the natural hydrologic system and the effects of nuclear testing on this system will, in themselves, produce minor environmental impacts. The maintenance of observation wells for water level measurements and periodic sampling requires some traffic to areas that might otherwise be allowed to revert to their natural state. The disruption of the natural land surface, for this reason, however, is insignificant in comparison to that which is necessary to support the test program directly.

An important type of investigation that will be conducted for at least several years is the measurement of groundwater velocity and aquifer dispersivity by tracer tests. Large dilution factors require that radioactive tracers be used in such tests, and selection and testing of suitable tracers is a major element of the current program. Tritium itself

IV.A. EFFECTS FROM UNDERGROUND NUCLEAR TESTING

4. Hydrology (Cont.)

is an excellent tracer, but it is used on NTS only sparingly to avoid confusion with test-derived tritium. Sulfur-35 is one of the more promising tracers because of the relatively great mobility of the tagged sulfate and thiocyanate anions. It is not a fission product, emits only beta particles, and has a relatively short 88-day half-life, thereby posing no long-term danger. Tracer quantities are selected such that dilution in the groundwater will lower concentrations to RCG or less soon after injection.

Most of the current methods for tracer tests were developed offsite at a location about 24 kilometers (15 miles) southwest of Mercury. These tests were conducted by the U. S. Geological Survey under licenses granted by the Nuclear Regulatory Commission and were done with the concurrence of the State of Nevada after review of test procedures.

A short-lived (8-day half-life) gamma-emitting isotope, iodine-131, is used sparingly during infrequent hydraulic (tracejector) tests to determine aquifer distribution in drill holes. Because of the continuing need for more information on groundwater movement, more of such tests will be required in the future. Occasionally (one to three times annually), water must be pumped to open surface ponds where it will be accessible to some birds, mammals, and reptiles. Although concentrations of iodine-131 in the cumulative discharge are very low, it can be concentrated in the thyroid of animals. It is therefore conceivable that there may be effects on local small animal populations.

Investigations of radionuclide mobility in water that fills the rubble chimneys at expended sites have caused some contaminated water to be brought to the surface (see Section II.D.5.). Samples of the water are taken for analysis, but the remainder is disposed of in accordance with procedures established for other liquid wastes on NTS, as described in Section II.D.8.d. Future investigations will follow the same procedures.

IV.A. EFFECTS FROM UNDERGROUND NUCLEAR TESTING

5. Radioactivity

a. OnSite Radioactivity

While most of the radioactivity which is created at the Nevada Test Site by underground tests will remain in or near to the respective cavity locations deep underground, some radioactivity remains on the surface from atmospheric testing of weapons, nuclear cratering devices, and nuclear propulsion systems conducted during the earlier years. Other radioactivity on the surface will result from such activities as drilling back into the test explosion cavities to obtain samples of the radioactive test debris, from controlled releases of radionuclides at the NTS Experimental Farm, from the Super Kukla Burst Reactor Facility, and from such experiments as the gas core reactor tests. Where warranted, radioactivity from these sources will be treated as radioactive wastes. That matter is discussed in a next subsection (IV.A.5.b.).

Radioactive gases are expected to be released to the atmosphere during drillback operations and from tunnel ventilations, as they have been in the past. To minimize these releases, the system utilized is to either force effluent gases back down into the drill hole or to direct the effluent through prefilters and charcoal filters prior to release into the atmosphere, as explained in Section III.A.3.e. (Postevent Activities). These techniques will continue to be used in the future. On an average, several hundred curies of radioactive noble gases (primarily xenon-133) have been released per year in the past. For example, in Calendar Year 1975, this release was 22 curies and in 1976, 91 curies. The amounts released in the future will fluctuate depending upon the particular drilling and tunnel conditions.

The investigation of the distribution and inventory of the radioactivity remaining at and around the old atmospheric test areas will continue. This investigation has progressed into its third phase as described in Section II.D.8.a., and the comprehensive sampling of each area for the determination of the amounts of plutonium and other radionuclides present is anticipated to continue well into the future.

IV. A. EFFECTS FROM UNDERGROUND NUCLEAR TESTING

5. Radioactivity, a. (cont.)

The RADEX (Radiation Exclusion) areas will probably decrease in number as the radiation levels at some of the sites decay below 5 millirem per hour, and as the contaminated debris in others is moved to the new centralized waste disposal area as described in the following subsection. Only a limited number of new RADEX areas is expected.

The environmental surveillance program, active on the Nevada Test Site since 1955, will continue. The number and locations of routine sampling stations on the test site are expected to change in response to new needs as they develop, and in accordance with the significance of the accumulated data.

It is expected that the background whole-body radiation levels existing on the test site will not change significantly. The present exposure rate, outside of the designated RADEX areas, is no more than 250 millirem per year.

A routine bioassay program for selected NTS workers will continue with sampling frequencies based upon a continuing assessment of the exposure potential.

Air sampling data, resulting from the continued operation of the on-site sampling stations, is expected to show that the particulate radioactivity collected is primarily due to natural sources and worldwide fallout. Resuspension of surface radioactivity has not been and is not expected to be significant. The annual average concentrations of fission products in air samples should continue to average less than one percent of the radiation concentration guides (ERDAM 0524) for inhalation. The present network of 23 air sampling stations will be modified to some extent in response to evaluations of the data acquired.

Tritium concentrations in ponds containing contaminated water from tunnel operations will continue to fluctuate. The average tritium levels have decreased about 20 percent since 1973, a trend expected to continue. Very little test-related contaminated liquid will be added to these ponds during FY 1978 and beyond. Typical tritium levels in the tunnel ponds are now, and are expected to remain, less than 10^{-3} uCi/ml, which is lower than the radiation concentration guide for public drinking water (ERDAM 0524).

IV. A. EFFECTS FROM UNDERGROUND NUCLEAR TESTING

5. Radioactivity (Cont.)

The present network of 51 water sampling stations on the NTS will continue to be monitored for radiological safety purposes as well as for the accumulation of experience data. Again, the number of stations is expected to fluctuate, particularly if new supply wells are found necessary, or if the significance of the data accumulated should change. It is not expected that this water sampling program will indicate the presence of radioactivity from past or future weapons tests. It is expected that any radioactivity detected will continue to be from natural sources and will represent only a very small percentage of the concentration guides for drinking water specified in ERDAM 0524. As has been noted in Section IV.A.4. (Hydrology), tritium has been detected in the groundwater of Area 2. However, since the supply wells utilized on the Nevada Test Site are not located near this area, tritium levels above background are not expected to be found in supply well water. As mentioned previously, the amounts and distribution of groundwater tritium in Area 2 will be investigated as part of the long-term hydrologic monitoring program.

b. Radioactive Wastes

Sources

The primary sources of radioactivity in FY 78 and beyond will be the same as those that have been described for previous years in Section II.D.8.d. (Radioactive Wastes). The sources that contribute to radioactive waste on the surface will remain essentially the same. Soil contamination which persists from past atmospheric testing will remain unchanged as no surface soil cleanup of these areas is presently planned. It is planned, however, that any assortment of scrap materials, which exist in some of these areas, will be methodically collected and consolidated. The primary source of added radioactive waste generated on site will continue to be that which results from the decontamination and cleanup activities which follow the postevent drillback and tunnel reentry operations. It is estimated that these will continue to accumulate at a rate of about five to ten curies per year.

IV. A. EFFECTS FROM UNDERGROUND NUCLEAR TESTING

5. Radioactivity (Cont.)

Liquid wastes (transuranic and other radionuclides) will continue to be generated from experiments at the NTS Farm in amounts estimated at less than a curie per year. These will continue to be disposed of down the cased drillback hole into the U8d chimney, as mentioned in Section II.D.8.d. A similar hole for disposal of liquid waste is available in Area 9 and may be utilized if necessary.

Some five cubic meters (six cubic yards) of solid low-level radioactive waste will be generated each year at the Super Kukla reactor in addition to about three cubic meters (four cubic yards) of contaminated paper, gloves, lab coats, etc., from other activities in Area 27 (see Section IV.B.4.). These will be buried, either in the Horn Silver Mine shaft at Area 26 as they have been in the past, or in the Area 25 waste management site.

There will be some new sources of radioactive waste from other projects and experiments not related to underground nuclear testing:

(1) The small amounts (millicuries) of fission products resulting from the decontamination of the R-MAD bay, used for the gas core reactor tests, would be piped into the existing tile field near the R-MAD facility. The "hot" component hardware resulting from these tests will be packaged in suitable containers and stored in the waste management area adjacent to the R-MAD building. These experiments are presently estimated to begin in FY 1980.

(2) As mentioned in Section II.D.8.d., some radioactive materials and wastes generated from activities at other ERDA and ERDA contractor locations (also from other government agencies and their contractors, such as the Department of Defense and the Environmental Protection Agency) are sent to the NTS for storage or burial. Approximately 300 curies per year of waste, now classified as retrievable transuranic waste, have been received from LLL, Livermore, California, in the past and will continue in the future. Weapons-related waste tritium will be received from Mound

Laboratory, Miamisburg, Ohio (a contractor to ERDA/AL), for storage at the NTS. It is estimated some three megacuries will be stored in special redundant container systems in Area 5 by 1978.

Active Waste Management Sites

A new radioactive waste management plan is expected to be implemented in FY 1978 at the Nevada Test Site. The plan is based upon the expansion of the waste management facility in Area 5 to a size approximating 36 hectares (90 acres). Within this site, various subdivisions will permit segregation of radioactive wastes into the following categories:

(1) Classified Waste; where security considerations require burial or special surveillance precautions.

(2) Retrievable Transuranic Waste; which contains more than ten nanocuries per gram and requires 20-year storage.

(3) Tritium Waste; from the Mound Laboratory.

(4) Remaining Radioactive Waste; mostly contaminated or activated equipment and materials, but can include contaminated drilling mud, soils, etc.

Basically, the concept underlying the new radioactivity management plan is to collect contaminated debris from other locations on the Nevada Test Site and consolidate this debris in the New Area 5 complex, the U3ax subsidence crater, and the lined drill hole at the U3fi site (see Figure II-25). As this plan develops, the number of RADEX (Radiation Exclusion) areas and other old waste storage sites will be reduced. Useful equipment and materials, which are nonradioactive, can be disposed of as excess property. Useful contaminated equipment and materials will be processed through the Area 6 decontamination facility. (See Section II.D.8.d.)

IV. A. EFFECTS FROM UNDERGROUND NUCLEAR TESTING

5. Radioactivity (Cont.)

Surface storage pads will be provided within the new Area 5 complex for retrievable waste. The transuranic waste will be stored in 55-gallon metal drums to allow for possible recovery at a later date. The tritium from Mound Laboratory will be stored in the specially designed containers with redundant internal encasement in which they are received. Testing of these containers at Mound Laboratory has shown that the leakage from these containers will not exceed 0.0001 percent per year.

The Area 5 complex is planned to include facilities for the compaction of loose solid wastes. Much of the radioactive waste consists of laboratory coats, gloves, booties, other protective clothing, cardboard containers, and many other compactible items. Facilities are also planned for the concentration and solidification of liquid wastes. Incinerators will be provided for the reduction of organic wastes.

Wastes which are designated as non-restrictive, or which do not require special security precautions, will be accumulated in 3.6-meter x 3.6-meter (12-foot x 12-foot) trenches within the Area 5 complex and ultimately covered with at least one meter (three feet) of earth.

c. Off-Site Radioactivity

(1) <u>Contained Events</u>

The radiological environmental impact of nuclear testing at the NTS can be considered in two categories. The first category includes those effects expected from routine operations. Previous experience, particularly that since 1971, supports the contention that the successful containment of tests is by far the most likely circumstance. In such cases, the only immediate off-site effect is that from ground motion, as discussed earlier. The potential long-term effect is the transport of radionuclides in groundwater, also discussed earlier. On-site sampling for airborne tritium and noble gases has shown that average concentrations of tritium and krypton-85 are slightly higher than ambient levels off site. The tritium enters the atmosphere by evaporation from soil moisture in and around past cratering experiments, from holding ponds that receive water drained from tunnel areas, and from gas seepage and drillback operations at underground test locations. Krypton-85 may be released in small quantities as it seeps upward to the surface from underground detonation points. Postshot reentry drilling operations may release small quantities of radioactive noble gases--primarily xenon-133. On occasion, these releases have resulted in low but measurable concentrations of xenon-133 at continuously operated gas sampling stations both on and off the NTS.

The measured concentrations of tritium and xenon-133 at offsite locations, when averaged over the year, have remained less than 0.01 percent of the concentration guides for a suitable sample of the population, as set forth in ERDAM 0524. The increased average concentrations of krypton-85 onsite have been discernible only by applying statistical techniques to the data. Atmospheric dilution of the krypton-85 reduces the concentrations to the point that they are not detectable offsite. It is unlikely that testing programs in the future will produce atmospheric concentrations of gaseous radionuclides greater than those observed to date.

Radioactivity attributable to the resuspension of dust particles in the air from contaminated areas onsite has never been detected in offsite samples and is not expected to be in the future.

(2) Accidental Releases

The second category to be considered is for those events which accidentally release airborne radioactivity at the time of, or shortly after, detonation.

The radiological impact on the environment of the radioactivity accidentally released from an underground test designed for complete containment is mostly transitory. The radionuclides released primarily consist of the noble gases, krypton, and xenon, and under certain circumstances, tritium. Lesser, but important, amounts of radioiodine will escape. Short-lived fission products are primarily entrapped in the particulate

IV. A. EFFECTS FROM UNDERGROUND NUCLEAR TESTING

5. Radioactivity (Cont.)

debris. Krypton-85 has a half-life of about 11 years; tritium, 12 years; and the remaining gaseous products have shorter half-lives (hours to a few days). In general, noble gases contribute to whole-body external exposure, tritium contributes to whole-body internal dose, and radioiodines contribute to thyroid dose.

The highest radioiodine content found in milk off site from an inadvertent release of radioactivity was at a dairy near Hiko, Nevada, where a peak level of 4.8 nanocuries (nCi) of iodine-131 per liter of milk was recorded following the Pin Stripe event in April 1966 (Reference 93). As a precautionary measure to minimize any unnecessary exposures, milk cows at this dairy were put on dry feed for about three weeks. Though the levels of radioiodine in human thyroids were expected to be low, mobile thyroid scanning equipment was moved into the area and residents were invited to undergo measurements. Seventy-eight people living in the area were examined to determine their thyroid doses resulting from that event. Of the 78 people examined, 53 had body burdens measurably above background, 37 of which would result in radiation doses to the thyroid of up to 300 millirem. Sixteen of the 53 had projected thyroid doses of less than 50 millirem. (A millirem in this case is approximately equivalent to a millirad.) These exposures amount to between 3 and 20 percent of the levels listed in the Radiation Protection Standards (ERDAM 0524) for normal peacetime operations for exposures of the thyroid (1,500 millirem per year for an individual). The remaining 25 people did not take up detectable amounts of radioiodine.

Since the signing of the Limited Test Ban Treaty (LTBT), the highest estimated potential external whole-body gamma radiation exposure to offsite residents from a nuclear test designed for containment occured at Cactus Springs, Nevada (eight people), following the Pike event of March 1964. At this location, the highest estimated potential out-of-doors external gamma radiation exposure of a populated area from radioactive cloud passage and fallout was about 55 millirems, infinite dose (i.e., that dose which would accure from exposure to this specific radioactive source over an infinite period of

IV. A. EFFECTS FROM UNDERGROUND NUCLEAR TESTING

5. Radioactivity (Cont.)

time as the source decays). However, because of the short-lived nature of this debris, the vast majority of this exposure would have occurred during the first year. This exposure is about one-third of the 170 millirems per year listed in the Standards for Radiation Protection (ERDAM 0524) and is less than the annual exposure from natural background radiation (Reference 94). For comparison, Figure IV-1 is a graphic display of examples of radiation dosage under several naturally occurring and imposed levels of radiation in the environment. As reported in the September 1971 environmental statement, radioactivity release resulted from the venting of the Baneberry event on December 18, 1970. The Baneberry event was of low yield (less than 20 kilotons) and, although designed for containment, some radioactive material escaped. The effluent was carried off the NTS by the winds. The presence of the radioactive material was detected in environmental samples from central and northern Nevada and in most of the western United States.

In the September 1971 environmental statement, it was reported that the maximum estimated total external gamma exposure resulting from the Baneberry cloud passage and the deposition of fallout at a populated location was 36 milliroentgens (mR)* at Clark Station, Nevada (one resident). Further EPA evaluation of data led to a revised best estimate of 13 mR at Clark Station, Nevada (Reference 95). Based on the same evaluation, the best estimate of the maximum total external gamma exposure at a populated location was 16 mR at the Blue Jay Highway Maintenance Station, Nevada (five people). The maximum concentration of iodine-131 found in milk was 810 pCi per liter at a ranch near Beatty, Nevada, about 64 kilometers (40 miles) from surface ground zero. Hypothetically, this concentration could have resulted in an estimated time integrated thyroid dose of 130 millirems to a two-year-old child. The milk

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* One roentgen (R) is that amount of radiation which will produce one electrostatic unit of ions per cubic centimeter of standard dry air. One milliroentgen (mR) is one one-thousandth of a roentgen (10^{-3}R).

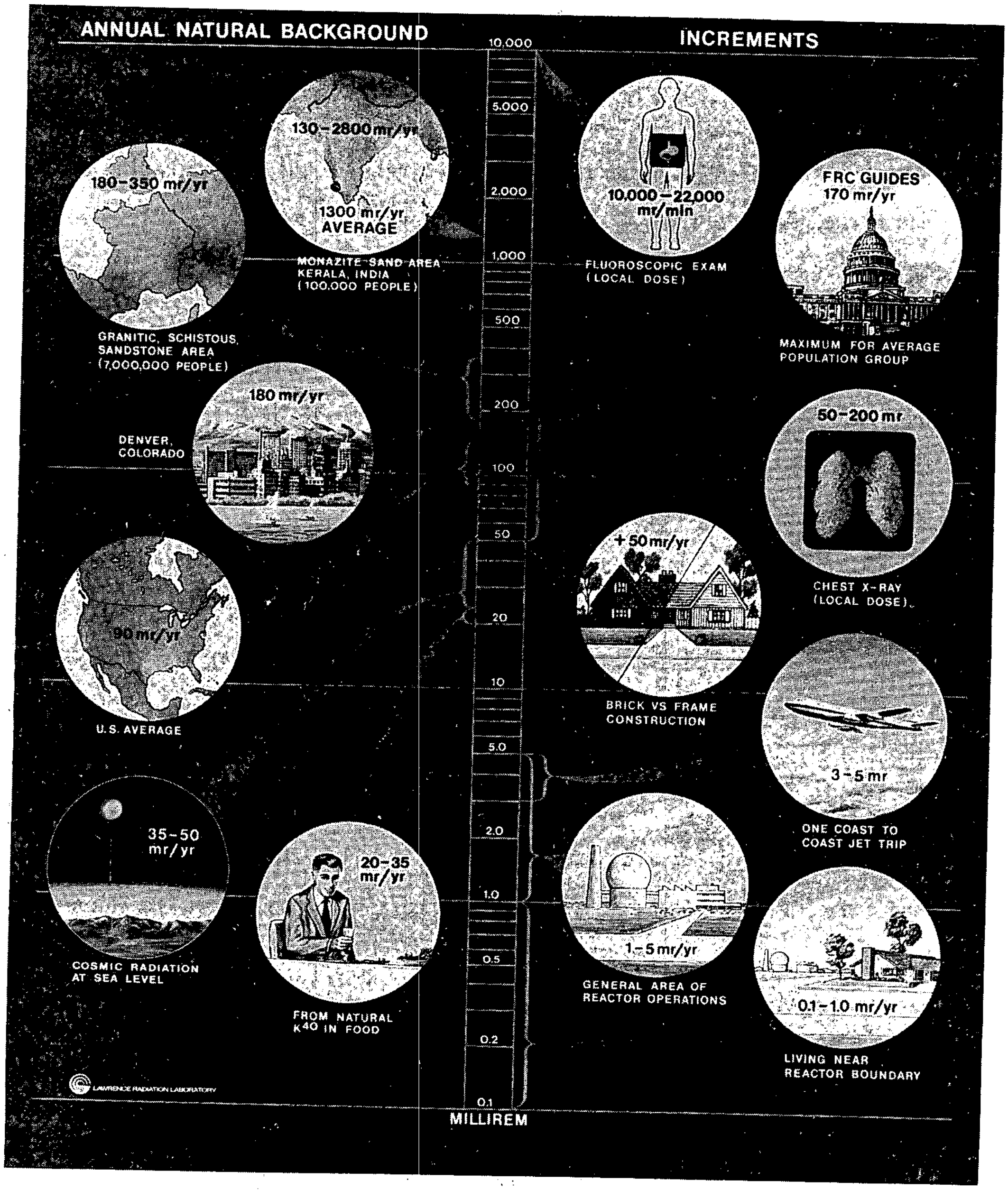

FIGURE IV-1 TYPICAL WHOLE BODY EQUIVALENT DOSES

IV. A. EFFECTS FROM UNDERGROUND NUCLEAR TESTING

5. Radioactivity (Cont.)

from this ranch was purchased by the government (and therefore not distributed) from December 31 through January 10, at which time the concentration of iodine-131 had decreased to below 100 pCi per liter and would contribute little to the total thyroid dose.

After EPA ended its environmental sampling program following the Baneberry venting, it was learned that some sheepherders in the area north of NTS where radioactivity had been measured, were using melted snow as a source of drinking and cooking water. The sheepherders, during the weeks following Baneberry, were in an area from about 50 kilometers (30 miles) east of Eureka, Nevada, on U. S. Highway 50, to south of Duckwater, Nevada. Based on sampling results and snowfall records for the general area, and on information obtained from the eight sheepherders about their locations and water consumption, EPA estimated the dose to their thyroids from radioactive iodine as about 0.5 rem. There was a factor of three uncertainty in this estimate because there was no detailed information on radioactive contamination levels where the sheepherders were located, the old snowpack was covered by new uncontaminated snow, and there was no information about distribution of the radioactivity at depth in the snowpack.

The most recent radioactive release detected off site occurred on November 24, 1971, when gaseous radioactivity from the Diagonal Line event began to seep from the ground at about four hours after detonation. Monitoring aircraft and off-site ground monitoring personnel had been released from their missions before seepage started. After on-site monitoring personnel detected the seepage, tracking aircraft were deployed. The maximum exposure rate measured outside the test site by the aircraft was 0.01 mR/h. Ground monitors were redeployed off site at 19.5 hours postevent, but neither they nor the routinely operated surveillance networks detected any ground-level radioactivity attributable to this event. The noble gas and tritium monitoring network operated off site by the EPA did not become operational until April 1972.

IV. A. EFFECTS FROM UNDERGROUND NUCLEAR TESTING

5. Radioactivity (Cont.)

(3) Future Expectations

The additional containment precautions, taken as a result of the Baneberry release in December 1970 (see Section III.A.3.a., Containment Evaluation Panel), have substantially diminished the probability of a radioactive release to the atmosphere. Even so, there cannot be absolute assurance that radioactivity will not be released in detectable amounts beyond the boundaries of the NTS. This is the reason for the safety precautions and the hypothetical radiation predictions discussed in Section III. III.A.3. (Normal Operations). If the hypothetical venting model used for off-site radiation predictions postulates a release of a million curies (calculated to 12 hours after release), past experience indicates that EPA would expect exposure rates decaying from a peak of about 10 milliroentgens per hour. This exposure could be expected to vary, depending upon the particular meteorologic conditions at the time.

In the past, no underground test at the NTS designed for containment has resulted in exposure to offsite residents which exceeded the radiation protection guidelines approved for underground nuclear testing. On the basis of past experience, it can be predicted that containment and exposure which may be expected for the future, should be comparable or better.

6. Bioenvironmental Effects

a. On-Site

Bioenvironmental effects anticipated from the type and scale of testing proposed will be those resulting from the destruction or disturbance of the terrestrial habitat by test-related operations (site preparation, drilling, etc.), by ground motion, and by postshot subsidence.

It is estimated that the amount of habitat disturbed by test-related operations, for representative low- to intermediate-yield tests in the alluvium of Yucca Flat, will range from about eight hectares (20 acres) to as much as 26 hectares (65 acres) per test. The disturbance around a test emplacement location will vary in intensity, from total destruction of the plant cover close to surface zero, to partial destruction of the vegetation around the site periphery, resulting from vehicular traffice to install and operate instrument and monitoring stations. It is to be noted that the Nevada Operations Office has promulgated a prohibition against off-road vehicular travel unless necessary for performance of an assigned task. For tests in Yucca Flat, sites will generally be in areas already disturbed by atmospheric testing, or by earlier underground tests (see Figure II-8). Operational effects thus will have a less severe ecological impact than would be the case for tests carried out in hitherto undisturbed parts of NTS.

For tests in alluvium, ground motion will produce localized cracking of the soil, accompanied by some shearing of plant roots. On-site observations suggest that in Yucca Flat, the zone of significant disturbance of this type will extend only slightly, if at all, beyond the area disturbed by operational activities.

The formation of subsidence craters, which can be expected following underground tests in Yucca Flat, will constitute an additional and severe type of local disturbance. In a narrow zone immediately around the rim of the crater, the soil will be deeply cracked and fissured, a type of disturbance that will favor the establishment of Russian-Thistle (Salsola spp.), grasses, and other pioneering species, native and introduced. These species will also invade the sides and floor of the depression, where any natural vegetation that survived site preparation and related activities will have been further disturbed by the collapse. Observation of subsidence craters resulting from shots fired eight to twelve years ago suggests that there will be some survival, or partial recovery, of native shrub vegetation on crater slopes facing north and east. In old craters, slopes facing south and west are still very thinly vegetated and often exhibit shallow erosion channels.

IV. A. EFFECTS FROM UNDERGROUND NUCLEAR TESTING

6. Bioenvironmental Effects (cont.)

Site preparation and test-related operations for tests in drilled holes on Pahute Mesa will result in somewhat more habitat disturbance per shot than that from tests in Yucca Flat, perhaps as much as 60 hectares (150 acres) per event. Moreover, ground motion from tests on Pahute Mesa or in tunnels under Rainier Mesa will produce types of habitat disturbance different from those resulting from shots in alluvium.

Ground motion from tests on Pahute Mesa or under Rainier Mesa will kill or damage some vegetation, especially shrubs and trees, whenever the motion is strong enough to cause rockfalls from cliff faces or canyon walls. Such disturbances will be scattered, and limited to plants rooted on cliff rims and sides, or below unstable rock masses. Ground motion will also kill or damage a fraction of the trees and shrubs growing directly on fault lines in the vicinity of the shot point. Apart from such scattered losses of plants--by rockfalls or on fault traces--shots in the harder rock will have little effect attributable to ground motion, even close to surface zero (References 96 and 97).

Effects of subsidence on vegetation within the crater will also be somewhat different for shots in hard rock, as compared to effects in alluvium. As much as 100 percent of the perennial vegetation may be killed in a zone around the periphery of the crater, while the plant cover remaining in the central part of the crater may exhibit little or no damage (Reference 95). Based on experience, it can be expected that not all tests on Pahute Mesa will form subsidence craters.

In summary, the on-site bioenvironmental impact of the proposed actions will, each year, damage or destroy as much as several hundred hectares of desert shrub vegetation (Yucca Flat), or desert shrub/woodland vegetation (Pahute and Rainier Mesas). Most of the habitat damaged or destroyed will be in areas that will already have been severely disturbed by earlier testing. The amount of habitat that will be adversely affected is expected to be less than 0.1 percent of the total area of NTS. This amount of habitat disturbance is not expected to have appreciable effects on the faunal populations inhabiting the test site.

IV.A. EFFECTS FROM UNDERGROUND NUCLEAR TESTING

6. Bioenvironmental Effects (Cont.)

The formation of postshot subsidence craters following most of the tests will also be an adverse effect. Formation of the craters will contribute to the reduction in amount of wildlife habitat to some degree. Perhaps more important, the craters will constitute an irreversible and readily recognizable manmade change in the landscape. The approximately 20 craters formed per year will be located among, and similar to, the more than 200 craters formed by previous tests.

b. Off-Site

As noted in Section II.D.9., the endangered Devil's Hole pupfish are located in a pool about 75 kilometers (45 miles) to the south-southwest of Yucca Flat and concern has been expressed they may be in jeopardy from ground motion and water level fluctuations resulting from the nuclear tests at NTS. Scientists of the Desert Fishes Council were worried by observations of wave action in the pool during a nuclear test in February 1976, proposing that pupfish eggs on the rockshelf immediately below the water surface might be damaged by wave-induced movement of pebbles on the shelf. (The survival of the pupfish is vitally dependent on this shelf for spawning and feeding.)

Records of the U.S. Geological Survey water-level recorder in Devil's Hole, however, indicate that water-level changes and wave action resulting from natural earthquakes are greater in amplitude and of longer duration than oscillations resulting from nuclear explosions. It is not possible to predict with certainty the possible effects of explosion-induced sloshing on the pupfish eggs and food resources, however any risk should be less than they have been experiencing from earthquakes - and from which the population has survived. Liaison has been established with the National Park Service

IV.A. EFFECTS FROM UNDERGROUND NUCLEAR TESTING

6. Bioenvironmental Effects (Cont.)

in Death Valley National Monument, and the U.S. Fish & Wildlife Service office in Las Vegas, which share responsibility for management of the pupfish to keep aware of their status and to determine if any protective measures may become appropriate.

No environmental effects outside the boundaries of NTS are anticipated from the activities proposed.

7. Archaeological Effects

It is expected that the activities proposed for the NTS will have minimal impact upon historic or archaeological features. Yucca and Frenchman Flats, the most active test areas, are essentially lacking in such features. The less active testing areas, including Pahute Mesa, Rainier Mesa, and Buckboard Mesa (and other areas) where potential construction and testing activities may occur are more likely to contain cultural features owing to the generally less hostile environment (the occasional presence of water, tree cover, and canyon protection). The program to inventory archaeological and cultural sites referred to in Section II.D.10., will identify and mark the location of these features for protection and possible future study. When there is a conflict between program requirements and the preservation of archaeological sites of interest which cannot be resolved within the guidelines set forth in NTSO-6003 (Reference 81), the Nevada State Historic Preservation Officer will be consulted for viable alternatives to mitigate possible adverse effects, and the national Advisory Council on Historic Preservation will be kept advised.

8. Nonexplosive-Related Effects

a. New Facility Construction

New facility construction includes but is not limited to those buildings or installations which have been identified as required for continued efficient operations at the NTS.

Actual construction of the presently identified structures and facilities will depend on programmatic requirements and availability of construction funds. In FY 1976 an and 1976T, five General Plant Projects (GPP) items were proposed for construction:

An Air Resources Laboratory weather station, to be located at the Desert Rock airstrip, to cover about 190 square meters (2,000 square feet).

A welding operations support facility at Yucca Lake in Area 6, estimated to cover approximately 280 square meters (3,000 square feet).

A maintenance facility in Area 6, covering an estimated 800 square meters (8,700 square feet).

A first-aid station in Area 12 to cover about 200 square meters (2,200 square feet).

The Mercury Highway will be widened between Gate 300 and the "Buster Jangle" Y intersection (BJY) (Figure II-31), estimated to affect about 2.7 hectares (6.7 acres).

In the FY 1977 time period, only two GPP Items have been identified:

A dormitory at Mercury, estimated to need about 240 square meters (2,600 square feet).

A radioactive waste management facility in Area 5 enclosing 36 hectares (90 acres).

Three line items have been tentatively identified for construction in FY 1978;

A heavy drill repair shop in Area 6, to cover about 1,000 square meters (11,000 square feet).

A vertical pull test facility for Area 2 requiring an estimated two hectares (five acres).

Construction items beyond FY 1978 have not yet been identified, but based upon past experience, it is expected that new construction will continue at substantially the same rate.

The areas of land dedicated to a new construction are insignificant when compared to the habitats disturbed by the preparation for, and the detonation of, underground nuclear tests.

IV.A. EFFECTS OF UNDERGROUND NUCLEAR TESTING

8. Nonexplosive-Related Effects (Cont.)

b. Industrial Wastes (Nonradioactive)

These wastes consist of liquid domestic sewage from offices, feeding and housing facilities, as well as miscellaneous items of waste, such as construction debris, community waste, and trash. There are, however, no industrial wastes generated from any manufacturing process.

The raw sewage is treated at several locations by a series of stabilization ponds, some of which are equipped with mechanical aerators. The dry solid wastes are collected for disposal at onsite engineered sanitary landfills. Dust suppression practices are followed; no air or water pollution results from these operations.

The current quantity of domestic sewage amounts to 500 million liters (134 million gallons) per year. The stabilization ponds designed to treat those effluents are operated at 95 percent of total capacity with a minimum holding time of 30 days during which time there is an above-average sunlight penetration, aerobic bacterial action, and volume reduction through surface area evaporation. The raw sewage treated is a weak solution containing 1.4 percent solids, having a pH range of 8.6 to 8.9 with biochemical oxygen demand loading of less than 0.2 pounds per man per day. Sampling of the effluent from the oxidation lagoons yields a total coliform count of 0-800 per 100 ml sample and zero fecal coliform per 100 ml when chlorinated. The calculations are predicated on an average population of 4,500 people at the NTS but would fluctuate directly in proportion to future populations. A chlorinated effluent from these ponds is occasionally used in road and airstrip construction and maintenance. In rare periods of runoff from the last pond in any series, the effluent may go some 220 meters (700 feet) into the adjacent desert for further evaporation loss. Soil percolation seldom exceeds 30 cm (12 inches) in depth. This effluent is fully contained within the test site.

IV.A. EFFECTS FROM UNDERGROUND NUCLEAR TESTING

8. Nonexplosive-Related Effects (Cont.)

The quantities of miscellaneous trash and construction debris disposed of during Calendar Year 1975 was 10,000 metric tonnes (11,000 tons). An active cleanup program is presently underway whereby construction debris and unserviceable equipment are being collected from a variety of past work sites on the Nevada Test Site. It is estimated this activity will essentially double the annual amount of assorted debris disposed of until the program is completed in the future. The annual disposal rate might be expected to return to the more normal rate of about 10,000 metric tonnes (11,000 tons) by FY 1978, or perhaps later depending upon the funding provided for such cleanup activities.

There are at present the following designated sanitary landfill areas:

(1) A trenching area southwest of Mercury.

(2) A trenching area, due east of CP, in Area 6.

(3) A crater in Area 3 numbered U3aus.

(4) A crater in Area 10 numbered U10c.

(5) An existing trench in Area 19 can be reactivated for landfill disposal.

These landfill areas will accommodate the industrial waste to be disposed of at the Nevada Test Site well beyond FY 1978. The same insignificant environmental effects will result from these disposal operations as would be expected for any other landfill disposal. The overall environmental effect is beneficial, resulting from the cleanup of other site areas.

c. Pest Control Management

A year-round pest management program is maintained using EPA-approved, registered pesticides in the prescribed manner for the specified targets by trained and certified personnel. The purpose is to control insects and rodents without adversely affecting people or the environment. Primary considerations are (1) to select the least hazardous concentrations or formulations of the substance which will be effective; (2) to use approved methods of application; and (3) to take all the necessary precautions for a safe operation.

It is the policy of NV to prohibit the use of chemical toxicants for the purpose of killing predatory mammals or birds. Further, the use of chemical toxicants which cause any secondary poisoning of mammals, birds, or reptiles is prohibited by Executive Order 11643.

NV cooperates fully with the Federal Working Group on Pest Management (FWGPM), submitting annually a detailed description of its proposed and current pest control programs for review and implementing any FWGPM recommendations.

d. Air Quality

The air quality of the NTS is subject to periodic disturbance brought about by routine operations and test detonations. Such activities as vehicle operations on gravel roads, drilling, backfilling, and subsidence craters do create dust hazards of short duration which do not escape the NTS and do not result in either long-term or permanent pollution.

Operations involving the discharge of air pollutants, such as the oil-fired Mercury Steam Generating Station or the Shaker Plant which prepares gravel-stemming materials, is subject to the EPA-approved Nevada State implementation plan. The Nevada Operations Office has complied with or is currently modifying all existing operational equipment to comply with applicable EPA regulations. The air quality at the interface of the NTS and its environs has not been disturbed or threatened by NTS activities from any planned activity since the onset of underground testing.

IV.A. EFFECTS FROM UNDERGROUND NUCLEAR TESTING

B. EFFECTS FROM OTHER ACTIVITIES

1. High-Explosive Tests (Nonnuclear)

Some surface effects will occur immediately surrounding the locations of surface or near-surface chemical explosions, which will result in minor water and wind-induced soil erosion and minor disturbance of habitats. Local dust clouds will result but they are not expected to be carried offsite into populated areas. These surface effects are expected to be only temporary, and to have only minimal impact on the environment.

2. Cane Spring Test Range

The occasional calibration activities on the Cane Spring Test Range involve vehicles traversing the grid as well as helicopters flying low over the area. These activities are expected to create little environmental damage, although there will be some dust created in spite of the dust control practices employed (oiled surface and water sprays).

The radioactive sources (primarily plutonium) used at the range can be as large as a kilocurie. These are transported from Areas 6 and 27 in shipping containers of the type approved by the Department of Transportation. The most common practice is to use the sources as they exist within these same containers during the calibration and sensitivity measuring activities, although on one occasion, a plutonium source within a sealed steel capsule was removed from its shipping container.

There is always the remote possibility of an accident during transportation and utilization of the sources, but the shipping containers and capsules are designed to withstand, and proof tested against, much more serious accidents than could conceivably be expected to occur on the NTS. Hence, the consequences of the worst credible accident involving transportation of sources would not result in any release of radioactivity to the environment.

IV. B. EFFECTS FROM OTHER ACTIVITIES

3. Experiments at the NTS Farm

Work at the NTS Farm should cause little adverse effects. Contaminated materials are removed to waste disposal sites, and some relative increase in waste storage area usage is to be expected. No significant residual contamination is to be expected at the farm, because of the operational precautions taken and because contaminated materials are removed.

Animals at the farm naturally consume the renewable resources of food, but wastes from uncontaminated animals are used as fertilizer on the farm. Meat and milk products from the farm animals are not made available as food, so that those products are wasted.

On the beneficial side of the ledger, the farm forms an ecological oasis, where herbivores feed on excess vegetation and predators feed on the herbivores. Consequently, jackrabbits, cottontails, coyotes, wildcats, granivorous and insectivorous birds, and raptorial birds are relatively abundant at the farm. Also, flocks of waterfowl rest and feed in the water reservoir.

The most beneficial contribution of the farm (in fact, its reason for existence) is to provide a location for studying the behavior of contaminants, so as to generate real-life data which can be directly applied to human and environmental exposure situations. Thus, this information should be of use in helping to avoid adverse effects from such contaminants on environments and people elsewhere in the world. These kinds of data are much more realistic than data obtained from calculations based on chemical similarity or from extrapolations from laboratory animal or plant studies. Use of larger experimental amounts of radionuclides or of other contaminants than those found in ordinary environments, decreases experimental and analytical errors.

IV. B. EFFECTS FROM OTHER ACTIVITIES

4. Activities in Area 27 (the old Area 410)

a. Super Kukla Reactor

(1) Normal Operations

The reactor is shielded so that the measured dose in the relay station, adjacent to the reactor bunker (see Figure III-3), is less than 100 mrem from a maximum design-yield burst. No personnel are closer than 750 meters (2,500 feet) from the reactor during a burst. This distance is sufficient to ensure that no measurable prompt dose in humans will occur from bursts of up to 10^{20} fissions (20 times the maximum permitted burst).

The exposure rate is about 500 mR/h, at a distance of one meter (three feet) from the reactor core, 48 hours after a maximum-yield burst. Samples handled for short periods of time in the high bay typically have gamma exposure rates (for surface contact) of 1 to 20 roentgens per hour (R/h).

(2) Effluents

No liquid radioactive effluents are produced at Super Kukla.

Minute quantities of radioactive gases are produced by the burst operation of the reactor. The most significant of these is xenon-138, having a half-life of 14 minutes. It decays to cesium-138 with a half-life of 32 minutes and the combined concentration in the reactor bunker would be about 20 times the 40-hour maximum permissible concentration, one hour after a maximum-yield pulse or "burst" of 5×10^{18} fissions. The reactor bunker ventilation system is operated in a recirculation mode during burst operations to prevent escape of the radioactivity to the outside environment.

Approximately five cubic meters (six cubic yards) of low-level solid radioactive waste with an aggregate activity of ∿0.5 curie is generated per year when Super Kukla is in full operation.

(3) Accident Conditions

The maximum credible accident for Super Kukla is similar to, but less than, the maximum credible accidents for the Able and Baker Sites. Treatment of the Able and Baker situations will therefore treat the maximum environmental impact from the operations in Area 27 under accident conditions.

b. Able and Baker Sites (5100 and 5300 Complexes)

The discussion which follows, though drawn specifically for the Baker Site, applies to the combined sites. Actually, the volume of work at the Able Site is low and most of the work does not involve explosive, radioactive, or toxic materials.

(1) Normal Operations

These sites have essentially no radiological impact on the environment during normal operations.

(2) Effluents

These sites generate no liquid or gaseous radiological effluents. Approximately three cubic meters (four cubic yards) per year of paper, rubber gloves, etc., which may be radioactively contaminated, are disposed of as radioactive waste.

IV. B. EFFECTS FROM OTHER ACTIVITIES

4. Area 27 Activities (Cont.)

Approximately six cubic meters (eight cubic yards) per year of chemical explosive-contaminated (nonradioactive) waste are disposed of by open air burning at Site Baker, several hundred meters from all buildings. The maximum amount of explosives destroyed by burning or detonation at one time is 23 kilograms (51 pounds).

(3) Maximum Credible Accidents

Two hypothetical accidents have been analyzed to determine the maximum potential environmental impact of LLL operations in Area 27. Both involve the atmospheric dispersion of radioactive material.

The atmospheric dispersion which would be applicable to such a hypothetical event was estimated using meteorological data from a 10-meter tower near the Super Kukla Reactor. These meteorological data, taken over the one-year period from January to December 1968, are the bases for the "worst-case diffusion" estimates used in the accident analysis. Seasonal effects are included by dividing the period into winter (October to February) and summer (March to September).

Plutonium Release

The accident as described in Section III.B.4.b. for Site Baker (the 5300 complex) is a postulated release of plutonium-239. The maximum allowable amount of high explosive (70 kilograms) (154 pounds) is assumed to detonate, dispersing the maximum allowable amount of plutonium-239 (15 kilograms) (33 pounds) in a cloud. No containment is assumed. Twenty percent of the plutonium-239 was assumed to be respirable. Worst-case estimates were made of the doses at various distances from Site Baker to the closest centers of population, if the wind were directly toward each center. The results summarized in Table IV-1 are the maximum integrated lung doses to individuals who remain directly under the centerline of the cloud during its passage.

IV. B. EFFECTS FROM OTHER ACTIVITIES

4. Area 27 Activities (Cont.)

Table IV-1. Maximum Lung Dose Estimates From H.E. Accident at Site Baker*

Location	Winter	Summer
Area 410 Guard Station	2,000	900
Mercury	60	60
Nearest Site Boundary	300	90
Lathrop Wells	30	9

*Maximum lung dose estimates (lifetime) from a plutonium release at Site Baker caused by 70 kg of high explosive with 15 kg of ^{239}Pu. Units are rem (alpha exposure).

The fallout pattern, resulting from an accident of this magnitude, assuming winds from the northeast, is shown in Figure IV-2. This wind direction was chosen because it results in the maximum dose at the NTS boundary.

Low-Order Nuclear Yield

This postulated accident is an explosion which results in a fission yield of 0.1 kiloton. Worst-case estimates were again made of the cloud passage doses at the various centers listed. The results of the integrated doses are summarized in Table IV-2. The doses shown are the beta-gamma doses accumulated from both cloud passage and deposition exposure. The infinite whole-body doses (beta-gamma) due to fallout from a 0.1-kiloton accident with a wind from the northeast are shown in Figure IV-3.

The calculation of these doses does not imply that these numbers constitute acceptable limit doses for workers and the public under accident considerations.

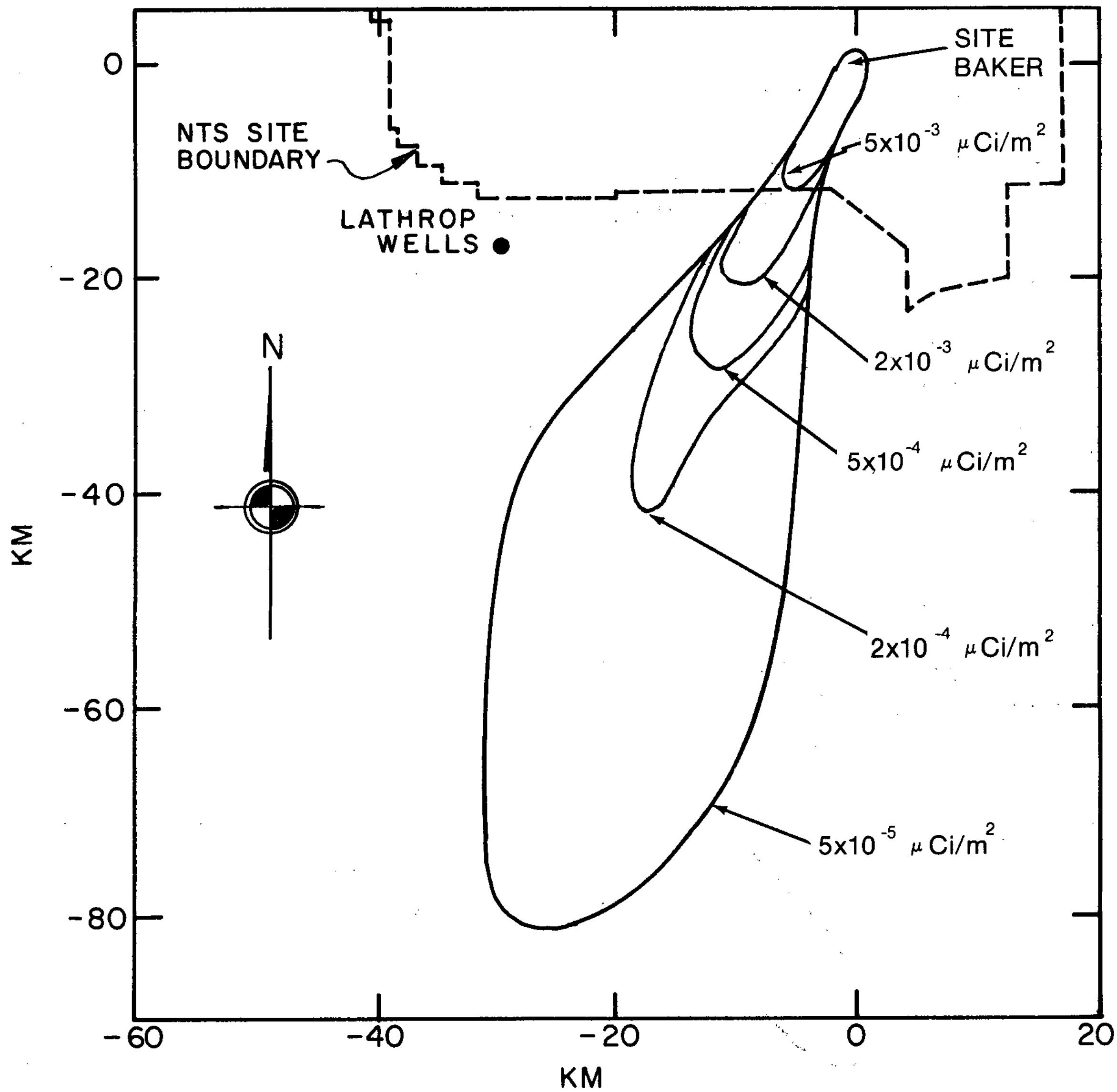

FIGURE IV-2 HYPOTHETICAL PLUTONIUM DEPOSITION PATTERN

Predicted deposition pattern following a 70 kg chemical explosion containing 15 kg of plutonium-239.

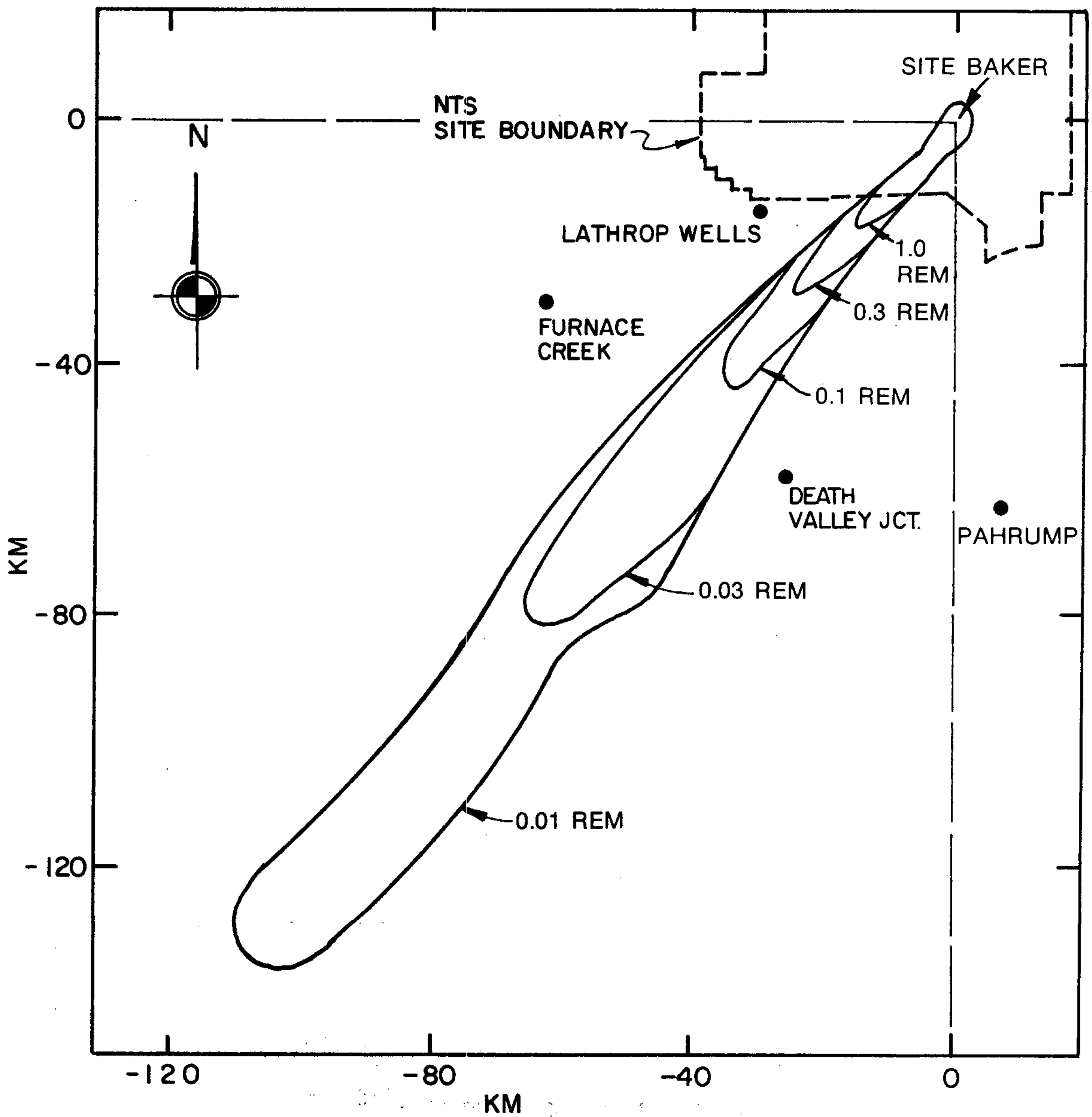

FIGURE IV-3 DOSE ISOPLETHS FROM A HYPOTHETICAL 0.1 KT FISSION ACCIDENT

Infinite whole body dose (beta gamma) from fallout resulting from a 0.1 KT fission yield accident.

IV. B. EFFECTS FROM OTHER ACTIVITIES

4. Area 27 Activities (the old Area 410) - b. (3) (Cont.)

These values are guides for evaluating site suitability and the beta-gamma doses can be compared with maximum fence-line (border) doses of 25 rem to the whole body and 300 rem to the thyroid which are used as power reactor site criteria under maximum credible accident considerations (see Reference 98). Accident lung dose criteria are not cited but the thyroid dose roughly compares to those for other internal organ doses.

Table IV-2. Estimated Maximum Dose From a 0.1 KT Fission Accident*

Location	Winter	Summer
Area 410 Guard Station	80	40
Mercury	0.5	0.7
Nearest Site Boundary	30	30
Lathrop Wells	20	30

*Maximum whole-body dose (lifetime) estimates from a 0.1-kiloton yield accident at Site Baker. Beta-gamma exposures are stated in rem.

The LLL-Nevada Health and Safety Manual Chapters (see Reference 86) contain written procedures which apply to emergencies that might arise in Area 27. They include evacuation plans, emergency response efforts, and medical assistance. They employ the assistance of other agencies, e.g., EPA, local and state police; and can be put into action and coordinated through ERDA at the CP in much the same manner as described in Section III.A.4.

5. Nuclear Accident Response Tests

There are general plans for utilizing the NTS as the location for an exercise of the national capability to respond to a nuclear accident. Such an exercise could be conducted at this

IV. B. EFFECTS FROM OTHER ACTIVITIES

5. Nuclear Accident Response Tests (Cont.)

facility within a variety of environmental settings with fewer residual impacts than at most other continental locations.

Even a simulated accident, if it is to be realistic, inevitably will cause some disturbance to the environment. It is anticipated that perhaps a few hundred individuals, consisting of members of the armed forces, civil defense, law enforcement, and regulatory and environmental agencies, will participate in the nuclear accident response exercise. Extensive use of land vehicles and aircraft will be involved to conduct inspections and emergency actions and to mitigate or control the hazards identified. Several acres will be designated as a pseudo-fallout sector and receive application of short-lived radionuclides. Additional acres will be exposed to the insult of traffic, depending upon the proximity of the accident to established roads. It is anticipated that approximately 16 hectares (40 acres) of terrain will be required for any simulated accident, or an area comparable to that normally utilized for an underground nuclear test at the NTS. The desert, canyon, or mesa environments selected will see intensive use for a few days, especially at the locations used for a bivouac area, command post, improvised emergency evacuation center, decontamination pad, hazard control centers, and staging area for support vehicles.

Since there will be off-road vehicular traffic, with disruption to the soil surface, the effect on the vegetation and faunal regimes will be similar to that which occurs during normal site preparation, drilling, and testing activities at the NTS.

The fact that the "accident" will be a designed accident offers the opportunity to plan for and mitigate a substantial portion of these environmental effects. For example:

a. The site selected for an accident involving fire can be a sparsely vegetated area to avoid unnecessary loss of plant and animal resources.

b. The radioisotopes selected to represent nuclear debris would be short-lived so as to preclude any long-term contamination of the area, and to eliminate the need to remove or dispose of large amounts of surficial materials.

IV. B. EFFECTS FROM OTHER ACTIVITIES

5. Nuclear Accident Response Tests (Cont.)

c. Debris from cleanup operations would not need to be treated as radioactive waste, but could be disposed of in ordinary landfills at the NTS.

None of the effects or impacts described above would extend to the offsite environment. Were it not for possible increased construction equipment and emergency road traffic moving toward the NTS during such an exercise, local residents probably would be unaware that such an exercise was under way.

6. Laser Use at NTS

The safety procedures called for in the use of laser systems at the NTS, as referred to in Section III.B.6., are primarily designed to protect against potential hazards to personnel. Hazards to the eye and skin are emphasized.

At the present time, the lasers used at the NTS are of low and medium power. These seldom are used in the open environment and then only for operational purposes such as accurate survey measurements; hence, the environmental impacts of these lasers will be so minimal that no prediction of quantifiable effects is warranted.

If higher-powered lasers were introduced at the NTS, secondary hazards also would arise from the use of compressed gases, cryogenic materials, and toxic materials. These would be considered along with problems of noise, ionizing radiation, electrical, shock, and scintillation effects. Laser safety procedures also would provide an equivalent protection to the environment.

7. Gas Core Reactor Tests

Normal operations of the uranium hexafluoride (UF_6) Gas Core Reactor are anticipated to have no impact of any consequence. Each test, at 10 megawatts for a brief period of five minutes, would only generate millicuries of fission products (allowing for a one-half hour decay

IV. B. EFFECTS FROM OTHER ACTIVITIES

7. Gas Core Reactor Tests (Cont.)

time). During the postmortem disassembly of the reactor components, some small fraction of these fission products will contaminate the area inside the hot bay. The decontamination procedures would involve wastes which would be piped into the existing waste disposal system and thence into the tile field near the R-MAD facility.

A worst-case accident can be imagined based on an assumption that a complete gas release would occur. About 24 kilograms of UF_6 gas maintained at two atmospheres pressure in the reactor system along with the millicuries of fission products would escape into the hot bay. The air-circulating system within the hot bay normally maintains the room at a reduced relative pressure of 15 centimeters (6 inches) of water, so that any air leakage is inward. The expansion of the UF_6 gas into the volume of the hot bay would not be sufficient to overcome the negative pressure relative to the room. The UF_6 would react with moisture in the air and convert quickly to UF_4, a solid, and settle on the floor along with some of the fission products. The hydrogen-flourine byproducts will be removed by the wet scrubber to be employed as part of the filter system.

It should be recognized that the fuel inventory in this reactor test is of <u>minimal</u> amounts and already in the gaseous phase; hence, one need not be concerned with the often-assumed vaporization of solid fuel elements. Even if the gas fuel container were to be overpressurized due to a power transient, causing a vessel rupture, the expansion cooling of all gases released would prevent any overpressurization of the <u>large</u> volume disassembly bay. Except for magnitude, facility decontamination would be no different from that involved in the normal operation.

The benefit to be gained by testing this reactor system is simply a feasibility demonstration. The implication is that if this system is feasible, it will be useful as an energy source, and would have definite impact on NASA program planning.

It is not anticipated that there could be any significant adverse effects on the environment or on the long-term productive use of the R-MAD building. This use has a very favorable

IV.B. EFFECTS FROM OTHER ACTIVITIES

7. Gas Core Reactor Tests (Cont.)

cost/benefit ratio in that it would obviate construction of a second heavily shielded test facility with comparable containment properties.

8. Radioactive Waste Disposal Experiments (Commercial)

Exploratory drilling, experiments, and tests to determine the geologic suitability of formations beneath the NTS for waste disposal will disturb relatively small areas of surface terrain as a result of constructing short access roads and drill pads, laying cables, installing structures, and operating equipment to record conditions and effects. Later experiments would involve mining operations which would generate tailing piles, similar to, but of lesser magnitude than, those occuring at Rainier Mesa, in connection with underground tests.

9. Spent Unreprocessed Fuel Storage Experiments

Safety procedures for the handling of fuel assemblies will be developed utilizing dummy configurations. Therefore, when spent fuel assemblies are utilized, the potential malfunctions which could result in the escape of radioactivity will be minimal, as safety procedures will have been developed to prepare for such eventualities. Such potential malfunctions most probably could occur within the EMAD facility where decontamination procedures have been operative for years.

The transport to, and emplacement in, the selected storage area in the vicinity near the EMAD will be performed with the fuel elements encapsulated and moved in shielded configurations and within shielded transporters. The selected storage area will occupy a relatively small area of the surface terrain, and the amount of construction necessary is small. Again, there will be instrumentation cables, very shallow boreholes, and the necessary drainage construction. The heat generated from each stored container will be less than a kilowatt. Four such units will produce negligible heat effects in the surrounding environment.

IV.B. EFFECTS FROM OTHER ACTIVITIES

9. Spent Unreprocessed Fuel Storage Experiments

If the earlier demonstrations of four spent reactor fuel assemblies provies successful and the storage area is increased to demonstrate a prototype facility containing from 100 to 200 spent reactor fuel assemblies, about two hectares (5 acres) would be utilized for the storage area near the EMAD facility. This would enlarge the amount of construction necessary with access roads for the transporters between rows of sealed storage casks of shallow drilled dry wells, or both. A study of the flash flooding potential would be accomplished in order to determine the necessary drainage design for the storage area. The effects of the heat generated over the area, and the effects this heat would have upon the soils, are expected to be quite moderate. However, the quantative effects of the heat and radiation are among the research and development studies which would be investigated in such a prototype facility.

10. CETO Program

Controlled experiments on effects of radiation on plant and small animal populations in the Rock Valley Irradiation Facility are conducted using a partially shielded cesium-137 source located atop a 16-meter (50 foot) tower. The source, installed in 1963, had decayed to 25,560 curies in 1975. The irradiation plot covers approximately nine hectares (22 acres) and is completely fenced by two, one-meter (three-foot) hardware cloth fences; one at the 16-meter (50-foot) radius and the second at the 180-meter (559-foot) radius from the tower. A third fence, with a locked barricade for access control and a block house containing the source-raising mechanism, is located at the 360-meter (1,100-foot) radium. The source is shielded by lead plates in the exposed position to deliver an exposure rate of 85 mR/hr (June 1973) uniformly over the nine-hectare (22-acre) plot. The radiation level outside the 360-meter (1,100-foot) fence is less than four mR/hr. Quarterly inspections are conducted by the REECO Environmental Sciences Division at which time the source is leak tested and maintenance is performed. Operating procedures and safety plans are established and documented in the Rock Valley Ecology and Study Area and Irradiation Facility Procedure, Rock Valley Misc. Pub. 2, 1973.

IV.B. EFFECTS FROM OTHER ACTIVITIES

10. CETO Program (Cont.)

Other CETO projects conducted within the confines of the Rock Valley study area and in other areas of the test site are expected to have negligible effects on the environment. Some off-road vehicular traffic is necessary for access to study plots; however, vehicles will be confined to already established trails or washes, with minimum disturbance of the terrain occurring only as necessary to permit access to newly established plots. Generally, small animals are trapped, examined, marked, and released at the point of capture with a minimal number removed permanently in the course of investigations. Vegetation is normally examined either in place or by sampling portions of plants and their root systems.

SECTION V

PROBABLE ADVERSE ENVIRONMENTAL EFFECTS WHICH CANNOT BE AVOIDED

When the proposed activities are implemented, there will be adverse impacts on the environment which cannot be fully mitigated. The probable, unavoidable major environmental effects as discussed in Section IV, IMPACT AND EFFECTS, include the formation of new subsidence craters at the surface, the creation of additional pockets of radioactivity underground in the test areas, and the generation of ground motion which may be felt outside the boundaries of the NTS.

Simply stated, a subsidence crater is formed by slumping of the earth's surface above the point at which an underground nuclear detonation takes place. Testing experience has shown that subsidence craters will eventually result from most underground nuclear tests.

Most of the radioactive materials which are created by an underground nuclear explosion are trapped within a pocket of resolidified rock melt in the explosion cavity. Radioactive noble gases and tritium have been released to the surface by gradual seepage from expended underground tests and by escape of gases during sampling operations. The state of the art of drillhole sampling does not permit absolute control of gaseous materials during transfer of drillback samples from the tool to the gas-tight shipping container. Despite efforts to improve its capability to control the gases, NV believes that similar, small gaseous releases are likely to occur in the future.

Ground motions accompany underground nuclear explosions and for some NTS tests are felt at Las Vegas, Nevada, and elsewhere in the surrounding region. Occasionally, ground motion from the larger NTS tests may cause nonstructural damages offsite, such as plaster cracks. The larger underground tests cause perceptible motion at offsite locations, particularly in high-rise structures in Las Vegas.

The effects of subsidence and confined radioactivity on the environment persist for many years; the damage potentials of ground motions are of short duration, and the effects of ground motions are perceived immediately. Construction, drilling, and mining activities, along with the expected subsidence craters, will disturb the ecology of some hundreds of hectares per year onsite, and will have no influence offsite.

V. PROBABLE ADVERSE ENVIRONMENTAL EFFECTS WHICH CANNOT BE AVOIDED (Cont.)

As regards other activities at the NTS, for the most part effects are registered immediately and those effects are very small in comparison with the effects of underground nuclear testing. Activities such as those at the Cane Spring Test Range, the NTS Farm, and activities such as the Nuclear Accident Response Test, Laser Operations, and the CETO Program should have localized effects during the course of specific operations and almost no perceptible residual effects of a long-term nature. Operations such as the Gas Core Reactor tests, the Super Kukla Reactor operations, and the assembly/disassembly operations at Baker Site normally will have no immediate or residual effects. The consequences of the maximum credible accidents for these latter operations, as described in Section IV.B., would be minimized through the execution of those emergency actions which are planned for these contingencies. Other than the effects of mining operations, the Waste Disposal Experiments should have no adverse environmental results.

SECTION VI

ALTERNATIVES

Alternatives to the underground nuclear test program described in the previous sections include the following:

A. CESSATION OF TESTING

The inability to conduct nuclear explosions would terminate most further advancements in the technology of nuclear weapons and explosives. In the absence of a national decision to cease testing, this would directly conflict with national policy as stated in the Atomic Energy Act of 1954, as well as with specific safeguards delineated by the Senate at the time of ratification of the Limited Test Ban Treaty in 1963 (Reference **99**). The environmental impact of eliminating testing would be that no explosions would take place, no seismic-type motions would be generated, no new radioactive cavities or subsidence craters would be formed, and no possibility of new ventings would exist. This alternative, however, would not make it possible to restore the entire Nevada Test Site to other uses. Existing radioactive cavities and potential and existing subsidence craters would remain and require area control. RADEX areas will remain. Some of these could be cleaned up, but for others, particularly those contaminated with plutonium, it is speculative whether cleanup activities would do more environmental damage than if they were to be left undisturbed.

B. LESS TESTING

Testing of fewer devices would retard advancement in those areas of nuclear explosion technology for which the eliminated tests were intended. To the extent that systems essential to national policy were adversely affected or terminated in their development by adoption of this alternative, the same conflicts with delineated policy apply as in A. above, if there were no national decision to reduce the number of tests.

VI. ALTERNATIVES

B. LESS TESTING (Cont.)

If the U.S. Senate gives its advice and consent to the ratification of the Treaty on the Limitation of Underground Nuclear Tests, commonly referred to as the Threshold Test Ban Treaty, a yield limitation of 150 KT on underground nuclear tests will be imposed by the treaty's terms. This will reduce the potential for environmental impact due to induced seismic motion, although the current observation with the terms of the Threshold Test Ban Treaty and the Peaceful Nuclear Explosion Treaty yield limits has already reduced this effect. However, this limitation would not change the basic conditions under which underground nuclear testing is conducted, nor would it change the basic environmental impacts other than those from ground motion. The favorable environmental impact of testing fewer devices would be the formation of fewer underground pockets of radioactivity and fewer subsidence craters. However, the Nevada Test Site would remain an area requiring controlled access and continued isolation for reasons of public safety.

C. DELAY OF TESTING

This alternative would lead to a comparable delay in the advancement of nuclear explosion technology which, absent a national decision to do so, would conflict with the national policy as stated in the Congressional actions referred to in A. above. In all probability, such a delay would not lessen the environmental effects of the program once it was resumed.

D. TESTING AT DIFFERENT LOCATIONS

Before the Nevada Test Site was established in 1951, an extensive study for the optimum location of a continental test site was conducted. The prime consideration in the site selection was minimization of the radioactive fallout hazard to the general population. Other considerations were a large available area, sparse population, favorable operational weather year round, and remoteness combined with accessibility. Subsequently, there have been searches for sites more suitable for certain tests. While other sites have been located and used for special tests, no other location has been found with as favorable a combination of the characteristics listed above as the Nevada Test Site. With the ban on atmospheric testing commencing in 1963, the adverse environmental effects of assured fallout, air blast, and thermal radiation disappeared. The effects of induced seismic motion and groundwater contamination became of importance. The favorable

VI. ALTERNATIVES

D. TESTING AT DIFFERENT LOCATIONS (Cont.)

geology and hydrology of the Nevada Test Site, combined with its previously described characteristics, continue to show the NTS as the most suitable location for underground nuclear testing.

The environmental impact of testing at a different location would be to create at the new site the same types of environmental damage that now exist at the Nevada Test Site. At the same time, the present site would remain as an area that would require continued custody.

E. OBTAIN INFORMATION IN DIFFERENT WAYS

Nonnuclear testing (e.g., high-explosive tests) and computer simulation are extensively used in the development of nuclear explosives. To the maximum degree feasible, these techniques are utilized to reduce the requirement for actual nuclear tests. In the case of high-explosive testing, the substitution of nonnuclear for nuclear material imparts a limitation to the information acquired. Though the weapons laboratories possess probably the most modern and extensive computational facilities in the world, the inherent limitations of computer models for the complex designs being calculated, together with incomplete knowledge of the characteristics of materials in the pressure and temperature regimes encountered in nuclear explosion environments, make complete test simulation impossible within present scientific and technologic capabilities.

If this country were to rely entirely on simulation while other countries conducted actual nuclear tests, advancements in the U.S. weapons technology would be placed at a serious disadvantage. In addition, there could not be confidence in stockpiled weapons if new weapons designs had not been proved by nuclear test. If, in spite of these disadvantages, the U.S. were to become completely reliant upon simulation techniques as the source of test information, the existing craters and underground cavities would still remain and the need for continued site custody would persist.

VI. ALTERNATIVES

F. ALTERNATIVES FOR OTHER ACTIVITIES AT THE NEVADA TEST SITE

In each case, the other activities conducted at the Nevada Test Site produce less environmental effects than are produced by underground nuclear weapons testing. The extent of these effects are described in Section IV. Each of the activities could be carried out at other locations. However, these activities presently depend upon facilities and/or capabilities now available at the NTS. The commitment to continue underground nuclear testing at the Nevada Test Site provides the opportunity to conduct these other programs and experiments at a minimal incremental environmental cost.

SECTION VII

RELATIONSHIP BETWEEN LOCAL SHORT-TERM USE OF MAN'S ENVIRONMENT AND MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

The NTS area, typical of the Basin and Range physiographic province, consists of rugged low mountains and valleys which are, for the most part, topographically closed basins. The major basins contain dry lake beds with almost no vegetation. Some vegetation exists on the alluvial slopes near the mountains and on the higher mesas which provide cover for wildlife and limited forage for grazing animals.

Previous short-term use of the NTS area consisted of hunting, sporadic prospecting, and mining, as well as some cattle grazing. However, no economically recoverable mineral resources have been found in those areas of NTS where drilling, tunneling, and testing take place; hunting and domestic grazing are not permitted. Thus, the minimal uses of NTS prior to the advent of nuclear weapons testing in 1951 (it was then being used as an Air Force gunnery range) have been curtailed by the testing.

On the other hand, the area has provided, and is expected to continue to provide for the foreseeable future, a suitable nuclear testing site. Construction of roads, airstrips, buildings, and water development projects in connection with testing at NTS have in the long run had a positive economic effect on the region. The elimination of public hunting at the NTS has, in practice, created a large refuge for wildlife and a reservoir of game animals and predators which can multiply and migrate to other nearby locales and provide productive sport for Nevada hunters. Intangible benefits for people in many arid and semiarid regions are expected to result from the studies which have been and will continue to be made of the desert environment. Incident to the testing activities, scientists and others with special skills have made use of the area and its facilities to conduct detailed technical and environmental investigations which would probably not have been possible under other circumstances. A large number and wide variety of ecological studies and investigations and studies of ground motion and structural response, hydrology, geology, explosion phenomena, and radiological impact provide a data base for both short-term and longer-term uses. Much of the resulting information is applicable to areas with similar climatic and geologic conditions and serves as source material for basic desert research.

The presence of activities, other than underground nuclear testing, at the NTS has added to the

VII. RELATIONSHIP BETWEEN LOCAL SHORT-TERM USE OF MAN'S ENVIRONMENT AND MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY (Cont.)

utilization of that location, without increasing the adverse environmental effects thereon.

Considering the present condition of NTS lands and the present value of those lands for national security, balanced against the longer-term prospect for other uses such as grazing and development of mineral resources, there are strong reasons for the continued use of the NTS as the site for an underground nuclear testing program, particularly since continued use is not adding substantially to conditions which already make the area largely unsuitable for more general productivity.

SECTION VIII

RELATIONSHIP OF PROPOSED ACTION TO LAND USE PLANS, POLICIES, AND CONTROLS

The operation and function of the Nevada Test Site is not in conflict with existing plans or prosed plans for land use by the state or county governments or with known private interests.

The area comprising the Nevada Test Site was formed by a series of public land orders commencing with PLO-805 in February 1952. The co-use agreement between the United States Air Force and AEC in 1963 also provides for the use of Pahute Mesa, the area situated on the northwest corner of what is now described as the Nevada Test Site. This Federal land has been dedicated to the national nuclear weapons test program. The NTS is bounded on all sides by lands under the jurisdiction of the Federal government. To the east side, the Nellis Air Force Range overlaps the Desert National Wildlife Range and is jointly used by them. The Nellis Air Force Range forms adjoining borders with the NTS on the north and a major portion of the western boundary. The southern boundary and part of the west side adjoins the public domain administered by the Bureau of Land Management.

Except for the investigation conducted by the Navy for the Seafarer system mentioned in Section II.B.9., no known plans have been made by a Federal, state, or local agency for an alternate use of the Nevada Test Site which would conflict with the program proposed herein. None is anticipated in the future.

As previously stated in Section II, guidelines and operating procedures have been developed at the NTS for compliance with Federal regulations with regard to safety of toxic and hazardous materials, protection of the environment, and preservation of sites of archaeological and historic interest, among others.

ERDA maintains a cooperative interface with other Federal agencies and state agencies concerning land management matters of joint interest. A five-party interagency agreement has been negotiated for the purpose of managing the wildlife, wild horse, and burro populations on the Nellis Air Force Range, the NTS, and the Tonopah Test Range. The five parties involved are: U.S. Air Force, Bureau of Land Management, U.S. Fish and Wildlife Service, ERDA; and the Nevada Department of Fish and Game.

SECTION IX
IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

There are a few irreversible and irretrievable commitments of resources that would be involved should the nuclear test programs be conducted as planned. Nuclear source materials will be expended for which no recovery is practicable; once expended, they cannot be applied to other beneficial uses for man. Large amounts of nonnuclear resources, including copper, steel, petroleum products, and energy will likewise be expended. Over 6,000 man-years of effort will be applied directly to the NTS activities annually. Several hundred acre-feet of underground water will be pumped and utilized at the NTS each year, but no significant deleterious effects on the aquifer are predicted.

The addition of new underground pockets of radioactivity and the formation of subsidence craters in the test areas of NTS will deny use of those sites for other nontest-related purposes. As a result of the test program, it will be necessary to subject those test areas to rigorous control of access and limited use for an indefinite time. The additional land areas involved in the FY 1978 and beyond programs will be incremental but not a substantial portion of the existing areas for which future use is likely to be denied indefinitely. The curtailment in the use of these NTS areas for other purposes should cause no adverse impact on local or national needs. Prior to the advent of testing activities in 1951, there was no development of agricultural resources in this arid region. Grazing resources are minimal throughout and around the test site. Economically recoverable mineral resources have not been found in those areas where testing is or will be taking place.

There are a few mineralized locations at the NTS in areas not used for testing purposes which have a limited potential for economic recovery of mineral resources. However, it is not anticipated that future testing activities will cause these minor potential resources to be irretrievably or irreversibly committed to the testing program.

SECTION X
ENVIRONMENTAL TRADE-OFF ANALYSIS

The principal benefits expected from the execution of the program of underground nuclear tests at the NTS have been identified in detail in Section II.A. and Section II.A.1. Because this program has been active for several years at about the same levels as projected herein, the economic benefits and costs are known rather well. While the environmental costs cannot be precisely calculated, the estimates made in Section IV are based on years of experience from underground nuclear testing.

A. BENEFITS

Briefly stated, the goal of the proposed activity is to enhance and strengthen the nation's nuclear capability in order to maintain a strong nuclear force. Without testing of nuclear devices, the reliability of new weapons systems could not be determined. Without experimentally testing the feasibility of new concepts, improvements in weapons systems could not be assured and the technological options for meeting new threats would not be available. It appears probable that the nuclear weapons research and development program, of which nuclear testing is a vital part, has resulted in savings of several tens of billions of dollars in nuclear weapons systems costs which are of considerable benefit to the national economy. The cost of nuclear weapon development has been a relatively small part (a few percent) of the total nuclear weapon system cost. Moreover, through testing, the U.S. system capability has been achieved at much lower costs than would have been incurred without new warhead and reentry vehicle development. The principal potential benefits of the proposed activity are maintenance and improvement of the nation's security. In addition, device development tests for peaceful applications are necessary to assure that environmentally acceptable nuclear explosives are available for appropriate peaceful uses. Substantial scientific and technical benefits also accrue from the other experimental activities which take place at the NTS at minimal dollar cost. A specific example is the seismology and ground motion work. Each underground nuclear test explosion furnishes a seismic signal source where the time, depth, energy, and precise location are known; this has allowed progress to be made that would not otherwise have been possible. As the state of seismologic knowledge improves, the continuation of testing allows checking of new theories. A very tangible economic benefit to the southern Nevada area is derived from an annual expenditure of about $140 million for nuclear testing activities at the NTS.

B. COSTS

In considering the environmental impact of the proposed activity due to maintaining a viable nuclear test program and other experimental activities at the NTS, as enumerated in Sections II and IV, it is concluded that the immediate and long-term effects are such that additional adverse effects attributable to the incremental testing will be slight. With the implementation of the Threshold Test Ban Treaty, the hazards due to induced seismic motion will be reduced. Some additional test site land area, perhaps a few hundred acres of the total test site area, will be affected by the proposed activity. Rocks beneath some of the affected land will contain radioactive debris buried at a depth and beyond access of any but authorized personnel, and some additional acreage will be graded or paved for roads and other construction. No significant disruption to the ecological balance in the area is foreseen in view of past and continuing studies on the environment.

APPENDIX A

GLOSSARY OF TERMS

A

AEC: U.S. Atomic Energy Commission, dissolved January 18, 1975, and succeeded by the Energy Research and Development Administration and the Nuclear Regulatory Commission. See ERDA.

Acceleration: A parameter for measuring the rate of change in motions, principally as related to differential movement on the surface of the earth.

Aftershock: Minor seismic tremors that may follow an underground nuclear detonation. (Also the secondary tremors following the main shock of an earthquake.)

Alluvium: Unconsolidated deposits of variously sized detritus from boulders to sand, clay, and other transported material deposited by water, generally in river beds, flood plains, lakes, and fans at the foot of mountain slopes.

Americium: (Symbol, Am) A radioactive element of atomic number 95 produced by nuclear bombardment of an element of lower number.

Aquifer: An underground body of rock that contains sufficient permeable material to conduct groundwater and to produce economically significant quantities of groundwater in wells and springs.

Advisory Panel: A panel of individuals knowledgeable of nuclear testing who have combined expertise in the fields of underground nuclear testing phenomenology, meteorology, radiation dosimetry, and other disciplines. The panel deliberates on conditions and effects which can influence the safety of conducting each nuclear test.

B

Bajada: A broad continuous undulating alluvial slope or gently inclined detrital surface extending along and from the base of a mountain range out into and around an inland basin.

APPENDIX A

GLOSSARY OF TERMS (Cont.)

Basalt: A dark igneous rock of volcanic origin usually deposited on the surface in layers as in a lava flow. Common in the western United States.

Basin and Range: A geographic area including most of Nevada and portions of adjacent states which is characterized by numerous parallel mountain ranges and intervening valleys.

Beta-Gamma Emitters: Radionuclides that primarily emit beta particles (electrons) and gamma rays (similar to X rays) as their principal mode of radioactive decay.

Biomass: The weight of living organisms in an ecosystem expressed either in fresh weight or dry weight.

Biota: A collective term to describe all plants and animals occurring within a certain area.

C

CEP: Acronym for Containment Evaluation Panel. The CEP is a group of experts appointed by the Manager, Nevada Operations Office (NV), comprising representatives of each weapons laboratory, the U.S. Geological Survey, and the Defense Nuclear Agency, with consultants in hydrology and effects phenomenology. The mission of the panel is to review and evaluate each proposed underground nuclear test and advise the Manager, NV, of the technical adequacy of the containment design.

Caliche: A secondary deposit of calcareous material, usually dense and hard, found a few meters or less below the present or former buried ground surfaces. It is usually thought to have formed by deposition of calcium salts when solutions at or near the soil surface were evaporated, a process most common in arid to semi-arid regions.

Carbonate: A sedimentary rock formed of calcium carbonate (limestone), magnesium carbonate (dolomite), or calcium-iron carbonates (ankerite).

APPENDIX A

GLOSSARY OF TERMS (Cont.)

Cavity: An underground void created in the rock by the shock wave and heat from an underground nuclear detonation.

Chimney: A tall, roughly cylindrical volume of broken rock and rubble formed underground by the collapse of the overlying medium (overburden) into the cavity.

Controlled Release: A planned action which involves the understanding that there will be or may be the release of small quantities of radioactive gases to the atmosphere in a manner which assures that the amount and rate of release can be controlled. Usually involves postshot operations or reentry into chambers containing the residues of nuclear explosions.

Crater: The pit, depression, or cavity formed in the surface of the earth by an explosion. A throwout crater results from the expulsion of ground material by the expanding gases. A subsidence crater may be formed by an underground nuclear explosion if the collapse of chimney material reaches the ground surface. See subsidence sink.

Curie: (Symbol, Ci) A quantity of radioactive material which undergoes 3.7×10^{10} (37 billion) transformations (or disintegrations) per second. See microcurie, picocurie, nanocurie.

D

DOD: Department of Defense.

Device: A mechanism or apparatus, usually referred to in a nuclear context, designed to serve a special purpose or perform a special function.

Dose: An absorbed quantity of ionizing (or nuclear) radiation. In this environmental statement, dose implies a dose in rem. See rem.

APPENDIX A

GLOSSARY OF TERMS (Cont.)

Dosimetry: The measurement of the amount of radiation delivered to a specific place or the amount of radiation that was absorbed there.

E

ERDA: Energy Research and Development Administration, successor Federal agency to the AEC.

Earthquake: A shaking or trembling of the earth that results from the abrupt movement of rocks below the surface due to volcanic activity or movement along faults. See ground motion.

Ecology: The branch of science concerned with the interrelationship of organisms and their environment. The study of the structure and function of ecosystems.

Ecosystem: A basic unit of ecology; an aggregate of plants and animals occupying the same habitat, together with the environment that controls their utilization of energy and raw materials.

Elastic Wave: A movement generated in the earth's crust by an earthquake or explosion which causes a temporary displacement of the rock medium, the recovery of which is accompanied by ground vibrations.

Epicenter: In an earthquake (or detonation), the point on the earth's surface vertically above the earthquake source.

F

Fallout: The gradual return of particles (usually radioactive) to the ground from clouds formed from an uncontained nuclear explosion; also, the material itself. Local (or early) fallout occurs downwind from the explosion site within about one day after the detonation. Delayed fallout consists of very small particles that ascend to high altitudes and return to earth slowly over a large area (also called worldwide fallout).

APPENDIX A

GLOSSARY OF TERMS (Cont.)

Fallout Sector: That area over which local fallout is predicted to occur based on wind speeds and directions at various levels from the ground surface to the top of the cloud.

Fault: A fracture or a zone of closely associated fractures along which rocks on one side have been displaced in a plane parallel to the fracture with respect to those on the other side.

Fracture: Any break (crack, joint or fault) in a rock caused by mechanical failure under stress whether or not displacement has occurred.

Frequency Spectra: The entire content of an elastic wave train in terms of frequency or vibrations per second. The content of wave modes in a wave train based on the occurrence of waves of specific vibrational frequencies.

G

Ground Motion: The movement of the earth when subjected to an elastic deformation in response to an earthquake or other seismic disturbance (e.g. a nuclear detonation).

Ground Shock Wave: A strong compressional wave generated by an underground explosion which moves outward as the cavity is formed and dissipates after crushing the rocks for a distance of several cavity radii. It is the source of a complex elastic wave train which generates ground motions at locations remote from the explosion.

Groundwater: That water in the natural environment which is below the ground surface; subsurface water as opposed to surface water.

H

Hardpan: See caliche.

APPENDIX A

GLOSSARY OF TERMS (Cont.)

I

Induced Radioactivity: Radioactivity that results when certain substances absorb neutrons from a nuclear reaction.

Isotopes: Forms of the same element having identical chemical properties but differing in their atomic masses (owing to different numbers of neutrons but the same number of protons in their respective nuclei) and their nuclear properties.

Kiloton: (Symbol, kt) One thousand tons, used to express energy released in a nuclear explosion, usually as kilotons of TNT energy equivalent. (10^{12} calories or 4.2×10^{19} ergs.)

L

Line-of-Sight Pipe: A straight pipe leading from the nuclear device through the stemming material for the transmission of radiations produced in the explosion, and employing appropriate devices for rapid closure of the pipe for containment of the explosion itself.

Low-Level Waste: Wastes containing types and concentrations of radioactivity such that shielding to prevent personnel exposure is not required.

M

MEV: One million (or 10^6) electron volts.

Magnitude (Earthquake): A measure of the energy released by an earthquake, usually based on a logarithmic scale such as that devised by Dr. C. F. Richter for measuring the relative size of southern California earthquakes.

APPENDIX A

GLOSSARY OF TERMS (Cont.)

Megaton: (Symbol, Mt) One million tons or one thousand kilotons; used to express the energy released in a nuclear explosion (10^{15} calories or 4.2×10^{22} ergs).

Microcurie: (Symbol, μCi) One millionth part of a curie (10^{-6} curie). It represents the quantity of radioactive material that undergoes 2.22 million disintegrations per minute. See curie.

Millirem: (Symbol, mrem) A thousandth part of a rem. See rem.

N

Nanocurie: (Symbol, nCi) One billionth part of a curie. (10^{-9} Curie). See curie.

Neutron: (Symbol, n) An uncharged elementary particle with a mass slightly greater than a proton and found in the nucleus of every atom heavier than hydrogen.

Noble Gases: Gaseous elements (helium, neon, argon, krypton, xenon, and radon) in the periodic table which chemically are relatively inert. Certain nuclear reactions result in the production of radioactive isotopes of these gases.

Nuclear Device: A system that utilizes nuclear reactions to produce energy and radioactive residues, e.g., a nuclear reactor or a nuclear explosive.

Nuclear Explosive: An explosive based on fission or fusion of atomic nuclei.

Nuclear Radiation: Particulate or electromagnetic radiation emitted from atomic nuclei in various nuclear reactions; it may consist of alpha, beta, gamma, or neutron emissions.

Nuclear Reaction: A reaction involving a change in an atomic nucleus, such as fission, fusion, neutron capture, or radioactive decay, as distinct from a chemical reaction which is limited to changes in the electron structure surrounding the nucleus.

APPENDIX A

GLOSSARY OF TERMS (Cont.)

Nucleus: The small positively charged core of an atom. All nuclei contain both protons and neutrons except for ordinary hydrogen whose nucleus consists of a single proton.

P

Paleozoic: One of the major divisions or eras of geologic time following the Proterozoic and preceding the Mesozoic eras. Also, the group of rocks formed during the Paleozoic era.

Picocurie: (Symbol, pCi) One picocurie is one millionth of a millionth (10^{-12}) of a curie. It represents a quantity of a radioactive material that undergoes 2.22 disintegrations per minute. See curie.

Plutonium: (Symbol, Pu) A heavy, radioactive "man-made" metallic element with atomic number 94. Its most important isotope is fisionable plutonium-239, produced by neutron irradiation of uranium-238.

Prompt Venting: See venting.

Proton: An elementary nuclear particle about 1,800 times as heavy as an electron with a unit positive charge. It is physically identical with the nucleus of an ordinary hydrogen atom. All atomic nuclei contain protons.

Q

Quaternary: A geologic time period which began 2 or 3 million years ago and continues through the present time.

R

Rad: (Acronym for Radiation Absorbed Dose) The unit of absorbed energy which expresses the energy

APPENDIX A

GLOSSARY OF TERMS (Cont.)

absorbed, per gram of material, from any ionizing radiation. A dose of 1 rad means the absorption of 100 ergs of radiation energy per gram of absorbing material.

Radex Area: A "radiation exclusion area," which is fenced and posted to control access of personnel to potentially hazardous radiation on the NTS. All areas where radiation levels average 5 millirem per hour or greater are so designated.

Radioactive: Exhibiting the property of spontaneously emitting energetic particles (alpha, beta, neutrons) or radiant energy (gamma rays) by the disintegration of atomic nuclei.

RAMS: (Acronym for Remote Area Monitoring System.) A network of permanent and temporary instrument stations for monitoring gamma ray exposure rates on the ground within the Nevada Test Site.

Rem: (Acronym for roentgen equivalent man.) A unit of dose equivalent. It is numerically equal to the dose in rads multiplied by modifying factors that account for the different biological effects of the various types of nuclear radiation. One rem is approximately equal to one rad for X, gamma or beta radiation. One rem is the biological effect produced by the absorption of one roentgen of X rays.

Roentgen (Symbol R): The international unit of X ray radiation. One roentgen is that amount of radiation which will produce one electrostatic unit of ions per cubic centimeter of standard dry air.

S

Scientific Advisor: An individual from the Advisory Panel who is nominated by the sponsoring laboratory or agency for each test conducted at the Nevada Test Site to serve as Chairman of the Panel for that test.

Seepage: Slow diffusion to the atmosphere of noncondensable gases from an underground nuclear explosion.

APPENDIX A

GLOSSARY OF TERMS (Cont.)

Subsidence Sink: A depression formed at the surface of the ground by an underground nuclear explosion if the chimney collapse has progressed to the surface--generally conical or dish-shaped and of relatively shallow depth. Often called subsidence crater.

Stemming: The process of plugging or closing a hole or tunnel, in which a nuclear explosive has been placed, to prevent the escape of radioactivity into the atmosphere. Also the materials used. See contained explosion.

T

Tectonic: Pertaining to the forces involved in or the resulting structures or features of tectonics, a branch of geology dealing with large scale deformation and architecture of the upper part of the earth's crust.

Teleseismic: Pertaining to that aspect of seismology which deals with seismic phenomena at a distance greater than 1,000 kilometers (600 miles) from the observer or recording station.

Tertiary: The first period of the Cenozoic era (after the Mesozoic era and before the Quaternary period), thought to have covered a time span beginning 65 million years ago and continuing until 2 or 3 million years ago.

Test Controller: An ERDA official designated by the Manager, Nevada Operations Office, to assume responsibility for the field operations involved in conducting a nuclear test at the Nevada Test Site.

Test Group Director: An individual designated by the sponsoring laboratory as its responsible representative who will be the official contact in all matters concerning a particular test.

Thermoluminescent Dosimeter, TLD: An instrument utilizing materials that emit light upon heating after exposure to nuclear, x-ray, and gamma radiation. The quantity of light measured can be related to the accumulated radiation exposure or dose.

APPENDIX A

GLOSSARY OF TERMS (Cont.)

Transuranics: Elements listed above uranium in the periodic table, that is, with an atomic number greater than 92.

Tritium: (Symbol, ^3H) A radioactive isotope of hydrogen with two neutrons and one proton in the nucleus. It is used as a component of atomic weapons. Because of its chemical similarity to normal hydrogen in water, it is often used to trace the movement of groundwater.

Tuff: A compact layered clastic rock formed by the deposition of ash and dust expelled into the atmosphere from a volcanic vent.

V

Venting: The prompt escape to the atmosphere of gases and solid residues from an underground explosion. See seepage.

W

Worldwide Fallout: See fallout.

Y

Yield: The total energy produced by a nuclear device on detonation, usually expressed in equivalent tonnage of TNT.

Yield Ranges: Low yields include tests from between 0 and 20 kilotons; low-intermediate yields are between 20 and 200 kilotons; intermediate yields are between 200 kilotons and 1 megaton; high yields are in excess of 1 megaton.

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APPENDIX C

COMMENT LETTERS AND STAFF RESPONSES

Written comments which were received on the Draft Environmental Impact Statement which was distributed for review and comment as ERDA-1551-D on January 18, 1977, are published in this appendix along with the Energy Research and Development Administration's responses to the individual comments.

Matters of concern that were mentioned by the commenters have been addressed either in the Final Environmental Impact Statement text or in the responding letters. The major subjects to which comments were addressed included: archaeology, endangered species, international relations, land utilization, public safety, resource protection, test containment monitoring, and waste disposal.

DEPARTMENT OF TRANSPORTATION
MATERIALS TRANSPORTATION BUREAU
WASHINGTON, D.C. 20590

Mr. W. H. Pennington
Director
Office of NEPA Coordination
U. S. Energy Research and Development
Administration
Washington, D. C. 20545

Dear Mr. Pennington:

Your letters of January 18, 1977, to Mr. Martin Convisser, Director, Office of Environmental Quality forwarded three draft environmental statements (ERDA-1551-D, Nevada Test Site; ERDA-1553-D, Management of Intermediate Level Radioactive Waste, Oak Ridge National Laboratory; and ERDA-1552-D, Safety Research Experiment Facilities, Idaho National Engineering Laboratory).

We have reviewed these documents with particular regard to those sections dealing with transportation and in each case have found no areas of disagreement.

We appreciate the opportunity to review these statements.

Sincerely,

Dr. C. H. Thompson, P.E.
Acting Director
Office of Hazardous Materials
Operations

UNITED STATES
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
WASHINGTON, D.C. 20545

Dr. C. H. Thompson, P.E.
Acting Director
Office of Hazardous Materials
Operations
Materials Transportation Bureau
Department of Transportation
Washington, D.C. 20590

Dear Dr. Thompson:

Thank you for your letter of February 4, 1977, indicating that the Department of Transportation has found no areas of disagreement with regard to sections dealing with transportation of the Energy Research and Development Administration's Nevada Test Site Environmental Impact Statement, ERDA-1551-D. The Statement has been revised as a result of comments received, and a copy of the Final Statement is enclosed for your information.

Your interest in our program at the Nevada Test Site is appreciated.

Sincerely,

W. H. Pennington, Director
Office of NEPA Coordination

Enclosure:
Final Environmental Impact
Statement, ERDA-1551

cc: Mr. Martin Convisser, DOT
w/encl.

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
P. O. Box 4850, Reno, Nevada 89505

February 2, 1977

W. H. Pennington, Director
Office of NEPA Coordination
U. S. Energy Research & Development
Administration
Washington, D. C. 20545

Dear Mr. Pennington:

We have reviewed the Draft Environmental Impact Statement, ERDA-1551-D, Nevada Test Site, Nye County, Nevada (January 1977).

The statement is well written and impacts are assessed thoroughly. There are no impacts of concern to SCS. We have no other comments.

Thank you for this opportunity to review the statement.

Sincerely,

GERALD THOLA
State Conservationist - Nevada

UNITED STATES
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
WASHINGTON, D.C. 20545

Mr. Gerald Thola
State Conservationist - Nevada
Soil Conservation Service
U.S. Department of Agriculture
P.O. Box 4850
Reno, Nevada 89595

Dear Mr. Thola:

Thank you for your letter of February 2, 1977, indicating that there are no impacts described in the Energy Research and Development Administration's Environmental Impact Statement on the underground nuclear testing program at the Nevada Test Site, ERDA-1551-D, which are of concern to the Soil Conservation Service. The Statement has been revised as a result of comments received, and a copy of the Final Environmental Impact Statement is enclosed for your information.

Your interest in ERDA's program at the Nevada Test Site is appreciated.

Sincerely,

W. H. Pennington, Director
Office of NEPA Coordination

Enclosure:
Final Environmental Impact
Statement, ERDA-1551

cc: Mr. Errett Deck, USDA
w/encl.

STATE OF IDAHO
DIVISION OF BUDGET, POLICY PLANNING AND COORDINATION
BOISE, IDAHO 83720

CECIL D. ANDRUS
GOVERNOR

H. W. TURNER
ADMINISTRATOR

February 14, 1977

U. S. Energy Research and Development Admin.
Washington, D. C. 20545

Att: James L. Liverman

Dear Mr. Liverman:

The State Clearinghouse sent copies of the Summary Sheet and Draft Environmental Impact Statement, ERDA-1551-D, Nevada Test Site to the following agencies for review and comment:

Health and Welfare, Radiation Control * no comment
Idaho State University, College of Engineering
Ken Stolz, Natural and Physical Resource Planner, Div. of Budget, Policy Planning and Coordination * no comment

No comments were received.

We appreciate the opportunity to review.

Sincerely,

Michelle Liebel,
State Clearinghouse

lf

UNITED STATES
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
WASHINGTON, D.C. 20545

Ms. Michelle Liebel
State Clearinghouse
Division of Budget, Policy
Planning and Coordination
State of Idaho
Boise, Idaho 83720

Dear Ms. Liebel:

Thank you for your letter of February 14, 1977, indicating that the Idaho State Clearinghouse has no comments on the Energy Research and Development Administration's Draft Environmental Impact Statement on the Nevada Test Site, ERDA-1551-D. The Statement has been revised as a result of comments received, and copies are enclosed for your information.

Your interest in ERDA's program at the Nevada Test Site is appreciated.

Sincerely,

W. H. Pennington, Director
Office of NEPA Coordination

Enclosure:
Final Environmental Impact
Statement, ERDA-1551 (6)

cc: Honorable John V. Evans
Governor of Idaho
w/encl.

Scott M. Matheson
Governor

James Edwin Kee
State Planning Coordinator

STATE OF UTAH
Office of the
STATE PLANNING COORDINATOR
118 State Capitol
Salt Lake City, Utah 84114
(801) 533-5246

March 1, 1977

James L. Liverman
Assistant Administrator for
Environment and Safety
U.S. Energy Research and
Development Administration
Washington, D.C. 20545

Dear Mr. Liverman:

As authorized by the Governor and as the state clearinghouse, I advise you that the State of Utah offers no comment on the Draft Environmental Impact Statement (ERDA-1551-D), Nevada Test Site, Nye County, Nevada. The document was reviewed for the State by the Utah State Environmental Coordinating Committee.

Sincerely,

James Edwin Kee
State Planning Coordinator

JEK/jn

UNITED STATES
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
WASHINGTON, D.C. 20545

Mr. James Edwin Kee
State Planning Coordinator
State of Utah
118 State Capitol
Salt Lake City, Utah 84114

Dear Mr. Kee:

Thank you for your letter of March 1, 1977, indicating that the Utah State Clearinghouse has no comment on the Energy Research and Development Administration's Draft Environmental Impact Statement on the Nevada Test Site, ERDA-1551-D. The Statement has been revised as a result of comments received, and copies are enclosed for your information.

Your interest in ERDA's program at the Nevada Test Site is appreciated.

Sincerely,

W. H. Pennington, Director
Office of NEPA Coordination

Enclosure:
Final Environmental Impact
Statement, ERDA-1551 (6)

cc: Honorable Scott M. Matheson
Governor of Utah
w/encl.

UNITED STATES ARMS CONTROL AND DISARMAMENT AGENCY
WASHINGTON, D.C. 20451

March 11, 1977

Mr. W.H. Pennington
Director
Office of NEPA Coordination
U.S. Energy Research and Development Administration
Washington, D.C. 20545

Dear Mr. Pennington:

As you requested, this agency has undertaken a review of the ERDA draft environmental impact statement entitled "Nevada Test Site, Nye County, Nevada", document number ERDA-1551-D. As a result of this review we recommend that the following suggestions for change, or in some cases answers to the following questions, be included in your draft.

-- page 1-1, second paragraph, add after last sentence: "Additionally, there is a possibility that the United States will enter into an agreement to ban all nuclear testing in the near future. In this case, all nuclear explosions at NTS would cease and only the statements concerning residual radiation hazards and precautions plus the hazards of the test programs other than nuclear testing conducted at NTS would be applicable."

-- page 1-2, Section B, first paragraph; delete: "No change is foreseen in the National policy which supports a vigorous nuclear weapons research and development program as part of the National defense posture."

-- page 1-2, Section B, second paragraph, first sentence; change to read: "Unless halted by a comprehensive nuclear test ban or moratorium, nuclear weapons testing will continue to be conducted . . . development program."

-- page 1-11a, Section E, first paragraph, second sentence, change to read: "Unless the United States enters into a comprehensive test ban or moratorium, stoppage, curtailment, or delay of the testing could conflict with the current United States commitment to the . . . nuclear explosives."

-- page 2-1, last paragraph, first sentence, change to read "In September 1963, during the U.S. Senate hearings on advice and consent to ratification of the Treaty Banning Nuclear Weapons Tests in the Atmosphere, in Outer Space and Under Water (i.e., the Limited Test Ban Treaty), the Senate was informed by the Chairman of the Joint Chiefs of Staff that the following four safeguards to reduce risks to the national security would be implemented under the joint responsibility of the Atomic Energy Commission and the Department of Defense (Reference 5)."

-- page 2-4, second full paragraph, second and third sentences, change to read "Research on the use of explosion technology for peaceful purposes is now a part of ERDA's Nuclear Explosive Applications program, formerly known as the Plowshare Program. This program is consistent with United States policy in connection with the Treaty on the Non-Proliferation of Nuclear Weapons, wherein the States parties have undertaken to make available the benefits of proven applications for peaceful purposes, if and when any such benefits are ever realized."

-- page 2-4, third full paragraph, second sentence, add words "(not yet ratified)" after "Threshold Test Ban Treaty".

-- page 2-4, last paragraph, delete first sentence: "No change is forseen . . . defense posture."

-- page 2-6, first new sentence on page, delete: "Nuclear weapons testing will continue. . . development program."

-- page 2-6, final paragraph, change second sentence to read: "The underground nuclear testing program in FY 1978 and beyond may continue at essentially the same level of testing."

-- page 2-6, final paragraph, delete final sentence: "It is not . . . conducted."

-- page 2-14, first full paragraph, first sentence, change to read: "On October 31, 1958, the United States and the Soviet Union voluntarily halted nuclear testing until the U.S.S.R. resumed testing on September 1, 1961, following the initial French nuclear tests and the Berlin Wall crisis.

-- 2-79, describe conditions under which the air sampling stations referred to in the last paragraph are inspected on a daily basis, e.g., immediately after a scheduled event or drill-back operation, or if this is not the case, state why not.

-- page 2-87, middle paragraph, second sentence, add words "Release from planned drill-back operation" to beginning of sentence.

-- page 2-92, final paragraph, second sentence: by what process are these measurements made? How far do resuspended particles of Pu travel?

-- page 2-104, final paragraph, second and third sentences: What is the meaning of "continuous monitoring" and "routine collection"? How often were samples collected in the past as compared to present practice, and under what operative guidelines?

-- page 2-106, first paragraph, third sentence: when and where were the described low-levels of airborne radioactive gases detected? What was the relationship of these levels to events and/or drill-backs at NTS?

-- page 2-108, first full paragraph: define phrase "ambient levels".

-- page 2-108, last paragraph, continuing to page 2-109: Was the "trapped krypton" referred to produced during the December 1975 events? When and where were the observed samples of Xenon-133 acquired? What evidence supports the conclusion that the samples "were apparently related to the NTS activities"?

-- page 3-9, first full paragraph: indicate if the statements on the adequacy of containment design are matters of public record. Also indicate if reports on the adequacy of containment are made after the event.

-- page 3-9, second full paragraph, second sentence: is the statement "no prompt ventings" intended to convey the thought that delayed ventings have occurred? If not, delete the word "prompt."

-- page 3-16, first full paragraph: why are the off-site ground radiation monitoring systems not turned on before every event, rather than waiting until venting is detected on-site?

-- page 3-19, last paragraph, second sentence: how often is this collection data analysed? If not on a daily basis prior to and after each scheduled event or drill/back, of what value is collection at longer intervals?

-- page 3-20, first paragraph, second sentence: does the reference to "radioactive release" include releases both from scheduled events and drill-backs?

-- page 3-20, last paragraph, second sentence: by whom and on what basis are the "73 standby Air Surveillance Network stations" activated? How often are the collected data analysed?

-- page 3-25, third paragraph, last sentence: where is the RAMS postevent data published? If not, why not?

-- page 3-25, last paragraph, second sentence: what is the interval in time between the "periodic reports" referred to? Why is the monitoring operation being planned "during" the postevent phase, rather than prior to it?

-- page 3-29, third paragraph, first sentence: what is the role of the USAF at NTS? Is the "Air Force helicopter" provided under contract to ERDA or otherwise by agreement between USAF/DOD and ERDA?

-- page 3-31, second full paragraph, first sentence: is the EPA census of cows and dairies carried out under ERDA contract or otherwise by agreement between EPA and ERDA?

-- page 4-7, last paragraph, second sentence, add after "radioactive decay" the words "at a half-life rate of 12.26 years".

-- page 4-10, first paragraph, first sentence, add after word "tritium" the words "penetration of the NTS water table".

-- page 4-12, second full paragraph, last sentence, change to read: "It is therefore conceivable that there may be effects on local small animal populations."

-- page 4-13, second paragraph, sixth sentence: add figures for calendar year 1976.

-- page 4-18, final paragraph, third sentence, delete word "continued" before the word "successful".

-- page 4-19, first paragraph, second full sentence: if "postshot reentry drilling operations may release small quantities of radioactive noble gases", the ground monitoring stations should be activated in advance to determine if this possibility was realized; will these stations be activated or not prior to such operations?

-- page 5-1, third paragraph: why is the release of radioactive noble gases and tritium unavoidable during drillback activities?

-- page 6-1, first paragraph: first sentence add word "further" between words "most advancements"; second sentence delete entirely.

-- page 10-1, section A, first paragraph, second sentence: delete words "full-scale".

-- page 10-1, section A, first paragraph, fourth sentence: cite source of estimate referred to.

-- page 10-1, section A, first paragraph, seventh sentence: this sentence states a conclusion ("Thus, the principal potential benefits of the proposed activity are maintenance and improvement of the nation's security") that is unsupported by the previous discussion, which is almost exclusively devoted to economic aspects of the testing program. Either the conclusion should be deleted or the supporting discussion rewritten.

Sincerely,

Thomas Graham, Jr.
Acting General Counsel

UNITED STATES
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
WASHINGTON, D.C. 20545

Mr. Thomas Graham, Jr.
General Counsel
U.S. Arms Control and
Disarmament Agency
Washington, D.C. 20451

Dear Mr. Graham:

Thank you for your letter of March 11, 1977, with comments on the Energy Research and Development Administration's Nevada Test Site Environmental Impact Statement, ERDA-1551-D.

The ACDA comments have been reviewed and additional material has been included in appropriate sections of the Final Environmental Impact Statement, a copy of which is enclosed for your information. In addition, staff responses have been prepared and are enclosed relative to certain of the matters that were included in your comments.

We appreciate your continued interest in operations at the Nevada Test Site. Your agency has contributed a considerable effort in reviewing the Draft Environmental Impact Statement, and your comments have helped us to clarify important aspects of the statement.

Sincerely,

W. H. Pennington, Director
Office of NEPA Coordination

Enclosures:
1. Staff Responses
2. Final Environmental Impact
Statement, ERDA-1551

ERDA STAFF RESPONSES TO ACDA COMMENTS ON DRAFT ENVIRONMENTAL STATEMENT FOR THE NEVADA TEST SITE, ERDA-1551-D

Comments numbered in the order in which they appeared in the ACDA letter are briefly stated below, followed by staff responses:

1. Comment: page 1-1, second paragraph, add after last sentence: "Additionally, there is a possibility that the United States will enter into an agreement to ban all nuclear testing in the near future. In this case, all nuclear explosions at NTS would cease and only the statements concerning residual radiation hazards and precautions plus the hazards of the test programs other than nuclear testing conducted at NTS would be applicable."

3. Comment: page 1-2, Section B, second paragraph, first sentence; change to read: "Unless halted by a comprehensive nuclear test ban or moratorium, nuclear weapons testing will continue to be conducted . . . development program."

4. Comment: page 1-11a, Section E, first paragraph, second sentence, change to read: "Unless the United States enters into a comprehensive test ban or moratorium, stoppage, curtailment, or delay of the testing could conflict with the current United States commitment to the . . . nuclear explosives."

7. Comment: page 2-4, third full paragraph, second sentence, add words "(not yet ratified)" after "Threshold Test Ban Treaty."

8. Comment: page 2-4, last paragraph, delete first sentence: "No change is forseen . . . defense posture."

9. Comment: page 2-6, first new sentence on page, delete: "Nuclear weapons testing will continue . . . development program."

10. Comment: page 2-6, final paragraph, change second sentence to read: "The underground nuclear testing program in FY 1978 and beyond may continue at essentially the same level of testing."

11. Comment: page 2-6, final paragraph, delete final sentence: "It is not . . . conducted."

<u>Response to Comments 1, 3-4, and 7-11</u>

The above comments are generally of a political nature, and their inclusion in the Energy Research and Development Administration's Environmental Impact Statement, which is intended as a technical document, would appear inappropriate. Some of the statements have been changed to best reflect a changing circumstance on future treaty commitments. It is ERDA's intent that its Environmental Impact Statement accurately reflect the consequences to the environment from whatever level of nuclear testing is approved. In that way, the report will not require revision in the future as a result of any political decisions which may be made regarding nuclear testing.

2. Comment: page 1-2, Section B, first paragraph; delete: "No change is foreseen in the National policy which supports a vigorous nuclear weapons research and development program as part of the National defense posture."

Response: The sentence has been changed to read: "National policy supports a vigorous nuclear weapons research and development program as part of the national defense posture."

5. Comment: page 2-1, last paragraph, first sentence, change to read "In September 1963 (sic), during the U.S. Senate hearings on advice and consent to ratification of the Treaty Banning Nuclear Weapons Tests in the Atmosphere, in Outer Space and Under Water (i.e., the Limited Test Ban Treaty), the Senate was informed by the Chairman of the Joint Chiefs of Staff that the following four safeguards to reduce risks to the national security would be implemented under the joint responsibility of the Atomic Energy Commission and the Department of Defense (Reference 5)."

Response: The sentence has been changed to read: "In August 1963, during the ratification of the Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outerspace, and Underwater (i.e., the Limited Test Ban Treaty), the Chairman of the Senate Foreign Relations Committee was given assurance from the President that four safeguards to the national security would be implemented under the joint responsibility of the Atomic Energy Commission and the DOD (Reference 5)."

6. Comment: page 2-4, second full paragraph, second and third sentences, change to read "Research on the use of explosion technology for peaceful purposes is now a part of ERDA's Nuclear Explosive Applications program, formerly known as the Plowshare Program. This program is consistent with United States policy in connection with the Treaty on the Non-Proliferation of Nuclear Weapons, wherein the States parties have undertaken to make available the benefits of proven applications for peaceful purposes, if and when any such benefits are ever realized."

Response: We are concluding the sentence in the 5th line after the word "weapons."

12. Comment: page 2-14, first full paragraph, first sentence, change to read: "On October 31, 1958, the United States and the Soviet Union voluntarily halted nuclear testing until the U.S.S.R. resumed testing on September 1, 1961, following the initial French nuclear tests and the Berlin Wall crisis.

Response: This document is not intended to be a complete historical document. The French nuclear tests and the Berlin Wall crisis do not appear relevant to the environmental trade-off at NTS.

13. Comment: page 2-79, describe conditions under which the air sampling stations referred to in the last paragraph are inspected on a daily basis, e.g., immediately after a scheduled event or drill-back operation, or if this is not the case, state why not.

Response: The air sampling stations operate continuously except for a few minutes each week while the filters are changed at which time they are inspected. They are not inspected more often unless there is reason to suspect that a release has occurred onsite. Since onsite activities are under close monitoring at the location of the particular operation, there is nothing to be gained and considerable expenditures saved by the weekly schedule without any sacrifice in safety.

14. Comment: page 2-87, middle paragraph, second sentence, add words "Release from planned drill-back operation" to beginning of sentence.

Response: This comment was not used because it would alter the intended meaning of the paragraph in question.

15. Comment: page 2-92, final paragraph, second sentence: by what process are these measurements made? How far do resuspended particles of Pu travel?

Response: Explanatory information has been added and referenced in the Final Environmental Impact Statement. As indicated by the statements made at bottom of page 2-92 and top of page 2-95, mobility of resuspended Pu particles would be extremely limited.

16. Comment: page 2-104, final paragraph, second and third sentences: What is the meaning of "continuous monitoring" and "routine collection"? How often were samples collected in the past as compared to present practice, and under what operative guidelines?

Response: Sample collection frequency has usually been a function of the type of testing program and anticipated offsite effects.

Since 1953, all operating air sampling stations have operated 24 hours a day. Until 1973, samples were changed daily. Since then they have been changed three times per week. The longer sampling times are required to detect the lower levels of background radioactivity which now exist. If a release of radioactivity occurs at NTS, samples are collected more frequently.

Milk samples are collected quarterly to maintain current background information. Samples would be collected more frequently (as often as daily) following a release of radioactivity to accurately assess radiation doses via the cow-milk pathway to offsite populations.

Prior to 1974, water samples were collected monthly. Based on the results obtained, offsite samples are now collected semiannually or annually. These samples have confirmed predictions that no radioactivity is being transported offsite via groundwater.

17. Comment: page 2-106, first paragraph, third sentence: when and where were the described low-levels of airborne radioactive gases detected? What was the relationship of these levels to events and/or drill-backs at NTS?

Response: Xenon-133 has been detected offsite during May 1972 at Beatty and Diablo; June 1972 at Hiko; October 1973 at Las Vegas, Hiko, Diablo, and Death Valley Junction; June 1974 at Beatty; August 1974 at Beatty; November 1974 at Diablo, Indian Springs, and Las Vegas; and November 1975 at Diablo and Hiko.

The November 1974 increased readings of xenon-133 occurred during a time of a known drillback release at NTS. It is assumed that the slightly increased offsite readings were a result of this drillback release. However, at other times, increased levels of xenon detected offsite could not be attributed to any NTS activity and may have been the result of foreign nuclear testing or industrial releases.

18. Comment: page 2-108, first full paragraph: define phrase "ambient levels."

Response: This comment has been accommodated in the text by inserting the phrase "(background levels)" after the word "concentration."

19. Comment: page 2-108, last paragraph, continuing to page 2-109: Was the "trapped krypton" referred to produced during the December 1975 events? When and where were the observed samples of xenon-133 acquired? What evidence supports the conclusion that the samples "were apparently related to the NTS activities"?

Response: See answer to 17 for answer re ^{133}Xe. The hypothesis regarding possible releases of ^{85}Kr during December 1975 is that small amounts of gas are continually seeping to the surface from previous underground tests. The relatively large-scale ground motion caused by subsequent high-yield tests could possibly have resulted in an accelerated release rate of ^{85}Kr during that period, although ^{85}Kr releases from reactor fuels are also conceivable.

Also, the following clause has been added at the end of the sentence, page 109, end of first paragraph: "...although it is conceivable that the ^{85}Kr may have originated from reactor releases unrelated to NTS activities."

20. Comment: page 3-9, first full paragraph: indicate if the statements on the adequacy of containment design are matters of public record. Also indicate if reports on the adequacy of containment are made <u>after</u> the event.

Response: This comment has been accommodated by inserting the following sentence in the paragraph and modifying the remainder of the paragraph: "These statements are not made for public record, because they normally consist of classified information."

21. Comment: page 3-9, second full paragraph, second sentence: is the statement "no prompt ventings" intended to convey the thought that delayed ventings have occurred? If not, delete the word "prompt."

Response: The statement has been changed to indicate that there have been no ventings since BANEBERRY, but that there has been one release due to seepage during the DIAGONAL LINE event on November 24, 1971.

22. Comment: page 3-16, first full paragraph: why are the off-site ground radiation monitoring systems not turned on before every event, rather than waiting until venting is detected on-site?

Response: It was not intended that this paragraph would denote the absence of functioning ground monitoring stations prior to the event. The offsite ground monitoring systems (TLD's, air samplers, and gamma rate recorders) are always operating. (See Section II.D.8.e.) Referred to here are similar (and supplemental) instruments, carried by the radiation monitors in the downwind sector, which would be used to provide additional detail on radioactivity encountered in these areas should a release occur.

23. Comment: page 3-19, last paragraph, second sentence: how often is this collection data analyzed? If not on a daily basis prior to and after each scheduled event or drill-back, of what value is collection at longer intervals?

Response: The data from these recorders and air samplers, if activated, are analyzed on location or at the EPA Laboratory in Las Vegas. Analysis frequency is indicated by the operational conditions at the time of the release or suspected release of any radioactivity from NTS. Since this system is designated to obtain radiologic information immediately after shot time, the gamma rate information can be reported by radio to the Test Controller essentially in real time. This arrangement of equipment and manpower is not normally used offsite to monitor drillback operations, unless a massive radioactive release occurred which would present a hazard to the populace offsite. This has never happened, and is not envisioned as a realisitc possibility.

24. Comment: page 3-20, first paragraph, second sentence: does the reference to "radioactive release" include releases both from scheduled events and drill-backs?

Response: The "radioactive release" referred to is any that could conceivably result in a health concern offsite. It mainly refers to inadvertent ventings and not drillback releases. For the case of shot day precautions, if no venting occurs during the first hour or so after the test, the monitoring personnel return to Las Vegas. Also see the last two sentences of the answer to Comment 23 above.

25. Comment: page 3-20, last paragraph, second sentence: by whom and on what basis are the "73 standby Air Surveillance Network stations" activated? How often are the collected data analyzed?

Response: The standby ASN stations are activated by EPA upon verbal request from the Test Controller following a venting. In addition, they are activated for the first week of each calendar quarter to test operational readiness and to establish current background levels. They are also activated upon request of ERDA/NV following atmospheric nuclear tests by other nations to assess the radiological impact on this country and to maintain information on the current background. Analyses of these samples are performed at varying frequencies from several hours to days depending upon radiological conditions.

26. Comment: page 3-25, third paragraph, last sentence: where is the RAMS postevent data published? If not, why not?

Response: The RAMS postevent data for all announced tests are published annually as Onsite Radiological Safety Reports for each test series. These are available to the public through the National Technical Information Service, U.S. Department of Commerce, Springfield, Virginia 22161.

It should be noted, however, those data for unannounced events are classified for national security reasons, at ERDA/HQ direction and are not available to the public.

27. Comment: page 3-25, last paragraph, second sentence: what is the interval in time between the "periodic reports" referred to? Why is the monitoring operation being planned "during" the postevent phase, rather than prior to it?

Response: The "periodic intervals" vary with the situation at each location being monitored. In a rapidly changing radiation field, reports may be transmitted via radio every few minutes. In a stable situation, reports may be made hourly. As much pre-planning as possible is done, but only after the magnitude, actual trajectory, and approximate composition of the release are known can the most efficient use be made of the personnel and equipment in the field.

28. Comment: page 3-29, third paragraph, first sentence: what is the role of the USAF at NTS? Is the "Air Force helicopter" provided under contract to ERDA or otherwise by agreement between USAF/DOD and ERDA?

Response: This comment has been accommodated at page 3-30 in the Final Environmental Impact Statement by adding the following comment in the paragraph: "The Air Force renders this type of support to NV upon request, under an interagency agreement (AEC-DOD Memorandum of Agreement No. AT(16-1)-341 dated August 29, 1967)."

29. Comment: page 3-31, second full paragraph, first sentence: is the EPA census of cows and dairies carried out under ERDA contract or otherwise by agreement between EPA and ERDA?

30. Comment: page 4-7, last paragraph, second sentence, add after "radioactive decay" the words "at a half-life rate of 12.26 years."

31. Comment: page 4-10, first paragraph, first sentence, add after word "tritium" the words "penetration of the NTS water table."

32. Comment: page 4-12, second full paragraph, last sentence, change to read: "It is therefore conceivable that there may be effects on local small animal populations."

33. Comment: page 4-13, second paragraph, sixth sentence: add figures for calendar year 1976.

34. Comment: page 4-18, final paragraph, third sentence, delete word "continued" before the word "successful."

35. Comment: page 4-19, first paragraph, second full sentence: if "postshot reentry drilling operations may release small quantities of radioactive noble gases," the ground monitoring stations should be activated in advance to determine if this possibility was realized; will these stations be activated or not prior to such operations?

Response to Comments 29-35

These comments have been accommodated by changes made in the text of the Final Environmental Impact Statement.

36. Comment: page 5-1, third paragraph: why is the release of radioactive noble gases and tritium unavoidable during drillback activities?

Response: To accommodate this comment, the text in Section V of the Final Environmental Impact Statement has been changed to read as follows: "Radioactive noble gases and tritium have been released to the surface by gradual seepage from expended underground tests and by escape of gases during sampling operations. The state of the art of drillhole sampling does not permit absolute control of gaseous materials during transfer of drillback samples from the tool to the gas-tight shipping container. Despite efforts to improve its capability to control the gases, NV believes that similar, small gaseous releases are likely to occur in the future."

37. Comment: page 6-1, first paragraph: first sentence add word "further" between words "most advancements"; second sentence delete entirely.

Response: The first sentence has been modified to your specifications. The second sentence has been changed to read as follows: "In the absence of a national decision to cease testing, this would directly conflict...." It is reasonable to assume that, if there were a national decision to cease testing, any conflicts of policies would be resolved.

38. Comment: page 10-1, section A, first paragraph, second sentence: delete words "full-scale."

Response: This comment has been accommodated in the Final Environmental Impact Statement.

39. Comment: page 10-1, section A, first paragraph, fourth sentence: cite source of estimate referred to.

Response: The text has been modified in response to this comment, since no specific source could be cited.

40. Comment: page 10-1, section A, first paragraph, seventh sentence: this sentence states a conclusion ("Thus, the principal potential benefits of the proposed activity are maintenance and improvement of the nation's security") that is unsupported by the previous discussion, which is almost exclusively devoted to economic aspects of the testing program. Either the conclusion should be deleted or the supporting discussion rewritten.

Response: This comments has been accommodated in the Final Environmental Impact Statement.

Advisory Council on
Historic Preservation
1522 K Street N.W.
Washington, D.C. 20005

March 9, 1977

Mr. W. H. Pennington, Director
Office of NEPA Coordination
Energy Research and Development Administration
Washington, D. C. 20545

Dear Mr. Pennington:

This is in response to your request of January 18, 1977 for comments on the draft environmental statement (DES) ERDA-1551-D, Nevada Test Site, Nye County, Nevada. The Advisory Council on Historic Preservation has reviewed the DES and notes that the Energy Research and Development Administration (ERDA) has determined that the proposed undertaking will not affect properties included in or known to be eligible for inclusion in the National Register of Historic Places, within Nevada or California. However, subsequent to receipt of the DES, the Council received the comments of the California State Historic Preservation Officer (SHPO) on the DES, which indicates his office was not consulted with respect to the ERDA determination of no effect. Similarly, the DES is unclear as to whether or not the Nevada SHPO concurs in the ERDA determination of no effect.

Therefore, the Council requests ERDA to consult the California and Nevada SHPOs pursuant to the "Procedures for the Protection of Historic and Cultural Properties" (36 C.F.R. Part 800), which sets forth the steps for compliance with Section 106 of the National Historic Preservation Act of 1966 (16 U.S.C. 470f, as amended, 90 Stat. 1320), and provide adequate documentation in the final environmental statement of ERDA's determination of no effect.

ERDA is reminded, that should those consultations result in a determination that a property included in or eligible for inclusion in the National Register will be affected, it must afford the Council

Page 2
March 9, 1977
Nevada Test Site
Mr. W. H. Pennington

an opportunity to comment in accordance with the "Procedures", prior to taking any action with respect to the undertaking that will affect the cultural resources.

Should you have questions or require additional assistance in this matter, please contact Michael H. Bureman of the Council staff at P. O. Box 25085, Denver, Colorado 80225, telephone number (303) 234-4946. Your continued cooperation is appreciated.

Sincerely yours,

Michael H. Bureman
for
Louis S. Wall
Assistant Director, Office
of Review and Compliance

UNITED STATES
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
WASHINGTON, D.C. 20545

Mr. Louis S. Wall, Assistant Director
Office of Review and Compliance
Advisory Council on Historic
Preservation
1522 K Street, N.W.
Washington, D.C. 20005

Dear Mr. Wall:

Thank you for your letter of March 9, 1977, with comments on the Energy Research and Development Administration's Draft Environmental Impact Statement on the Nevada Test Site, ERDA-1551-D.

You expressed concern that there be appropriate consultation with Nevada and California to determine that operations at the Nevada Test Site would have no effect on properties included in (or known to be eligible for inclusion in) the National Register of Historic Places, within Nevada or California. ERDA has contacted the State Historic Preservation Officers (SHPO's) in both California and Nevada. While determinations of "no effect" have not yet been made, we are exercising the procedures as defined in 36 CFR, Part 800.4, to obtain the requirement determinations.

In November 1976, the Nevada Operations Office in Las Vegas assigned the task for assembling an inventory of historic structures within approximately 100 km of the test site to the John A. Blume and Associates, a seismic engineering firm based in San Francisco. The purpose of this program, which is being carefully coordinated with the various Federal, state, and local historical organizations, is to develop an inventory containing the location and condition of historic structures which are now on the National Register or may be eligible for inclusion at some future date. The Blume engineers will then apply their engineering expertise and judgment to determine what effect, if any, the ground motion from underground tests will have on the identified structures. The results of this program will be reviewed with the Nevada and California SHPO's and a determination of effect agreed upon. These determinations will be forwarded to the Advisory Council for review.

Mr. Louis S. Wall 2

We appreciate your interest in ERDA's operations at the Nevada Test Site and feel that your comments have helped us to clarify an important aspect of the effects of those operations.

Copies of the Final Environmental Impact Statement are enclosed for your information.

Sincerely,

W. H. Pennington, Director
Office of NEPA Coordination

Enclosure:
Final Environmental Impact
Statement, ERDA-1551

MIKE O'CALLAGHAN
Governor

NEVADA

NEVADA
STATE
PARK
SYSTEM

JOHN L. MEDER
Administrator

ROOM 221
NYE BUILDING
201 S. FALL STREET
CAPITOL COMPLEX
CARSON CITY,
NEVADA 89710
(702) 885-4384

In Reply Refer to:
561 ERDA

MAR - 9 1977

Mr. W. H. Pennington, Director
Office of NEPA Coordination
U.S. Energy Research
and Development Administration
Mail Station E-201
Washington, D.C. 20545

Dear Mr. Pennington:

Subject: DES NEVADA TEST SITE, ERDA-1551-D, JANUARY, 1977

We have reviewed the above named document and find that it appears to adequately address the concerns we mentioned in our previous correspondence with Mr. Elwood M. Douthett, and to you through our Governor's Office of Planning Coordination.

We are especially impressed with the willingness of ERDA to work with our office to initiate a survey and inventory of historic and cultural sites within the area of possible impact in the area surrounding the Nevada Test Site. Only through a thorough survey and inventory will it be possible to properly assess potential and/or actual effect of the testing activities on historic and cultural resources and take proper steps to mitigate any adverse effects which might be identified.

We will soon be developing a system of survey and inventory for use statewide and would like to work with ERDA to assure that any surveys they undertake are compatible with our system. As soon as we have our plans firmed up, we will contact you.

Sincerely,

John L. Meder, Administrator
(State Historic Preservation Officer)

By: John Richardson
Alternate State Historic
Preservation Officer

Administration: (702) 885-4384
Operation and Maintenance: (702) 885-4387
Planning and Development: (702) 885-4370

a division of the Department of Conservation and Natural Resourc
Norman Hall, Direct

UNITED STATES
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
WASHINGTON, D.C. 20545

Mr. John L. Meder, Administrator
Nevada State Park System
(State Historic Preservation Officer)
Room 221, Nye Building
201 S. Fall Street
Capitol Complex
Carson City, Nevada 89710

Dear Mr. Meder:

Thank you for your letter of June 9, 1977, indicating an interest in a thorough survey and inventory to assess properly potential and/or actual effects of the Nevada Test Site (NTS) testing activities on historic and cultural resources as a result of your review of the Energy Research and Development Administration's Draft Environmental Impact Statement on the NTS, ERDA-1551-D.

The ERDA Nevada Operations Office has initiated a program to inventory and catalog historic structures within about 100 km of the NTS. The purpose is to identify those historic structures and cultural resources which might be influenced by underground nuclear explosions at the test site. The John A. Blume and Associates, a San Francisco-based seismic engineering firm, is conducting the survey.

To date they have contacted nearly all of the Federal, state, and local organizations and parties in Nevada which have an interest in preserving the historic cultural resources of the area. We are encouraged by the enthusiasm and spirit of cooperation with which this program has been received by your office and others. We now expect to conclude the inventory this fall and will present our findings to your office for determination as to the eligibility for inclusion in the National Register and as to any possible impact which our proposed activities may have on these properties.

In addition, the Desert Research Institute has been commissioned to carry out a continuing archaeological study on the NTS. This is a revitalization of a program which lapsed into inactivity with the passing of Dr. Worman. The first priority of this new program will be to identify and protect archaeological sites where new testing and construction activity is contemplated. The second priority will be to develop a suitable sampling program for all of the NTS.

The Final Environmental Impact Statement reflects the above information as well as other comments received on the Draft Environmental Impact Statement.

Your interest in our operations at the Nevada Test Site is appreciated. Copies of the Final Environmental Impact Statement are enclosed for your information.

Sincerely,

W. H. Pennington, Director
Office of NEPA Coordination

Enclosure:
Final Environmental Impact
Statement, ERDA-1551 (2)

cc: Honorable Mike O'Callaghan
Governor of Nevada
w/encl.

Mr. Bruce D. Arkell
State Planning Coordinator
w/encl.

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20201

MAY 1977

Mr. W. H. Pennington
Director, Office of NEPA
Coordination
Energy Research and Development
Administration
Washington, D.C. 20545

Dear Mr. Pennington:

We have reviewed the draft Environmental Impact Statement for the Nevada Test Site, Nye County, Nevada. One general criticism is that the document does not relate the radiation standards cited in the DEIS to their original published source material. Many results are expressed as a percentage of a particular standard or guide. The reader is referenced to ERDAM 0524, a secondary rather than a primary reference. Primary sources should be cited, i.e., the occupational exposure limits referenced to NCRP 33; the "Radiation Protection Standard" or "Radiation Exposure Standard" referenced to the Radiation Protection Guidance (RPG) of the Federal Radiation Council; and the "Radiation Concentration Guide (RCG) referenced to NBS Handbook 69. The impression that these guidelines originated with ERDAM 0524 is probably unintentional. Reference to the original published guidance would provide a more solid basis for the percentage comparisons made in the document. Specific comments are as follows:

1. Data on CANNIKIN (pages 2-16) is included. This test on Amchitka Island, Alaska, does not relate directly to the NTS.

2. Evaluation of knowledge of potential hazards of plutonium are said to be incomplete. More information on this important problem is available, mainly in "Health Effects of Alpha-Emitting Particles" in "The Respiratory Tract" EPA 520/4-76-013, National Academy of Sciences, October 1976.

3. Paragraph 2, page 2-108 on airborne radioactivity is confusing. The average ambient particular radioactivity is said to be 50 uCi/m^3 of air. No gamma emitters are reported in the DEIS to have been detected in 1975. Is all the 50 uCi/m^3 thus due to pure alpha and beta emitters? We feel this is unlikely.

4. Little information is given on the magnitude and distribution of occupational exposures. Occupational exposures under accident conditions are not discussed. Some comparisons to existing guidelines in ERDAM 0524 are made but this treatment is, in our opinion, not sufficient.

5. The DEIS indicates that milk was purchased and removed from market at 810 pCi/liter, equivalent to a 130 man/rem dose to the thyroid of a 2-year old child. This purchase could be cited as setting a basis for the removal of radioactively contaminated milk from market. It adds nothing of substance to the DEIS and is not supported by the present Federal Protective Action Guides.

Thank you for the opportunity to review the document.

Sincerely,

Charles Custard
Director
Office of Environmental Affairs

UNITED STATES
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
WASHINGTON, D.C. 20545

Mr. Charles Custard, Director
Office of Environmental Affairs
Department of Health, Education,
and Welfare
Washington, D.C. 20201

Dear Mr. Custard:

Thank you for your letter of March 14, 1977, with comments on the Energy Research and Development Administration's Draft Environmental Impact Statement on the Nevada Test Site, ERDA-1551-D.

The HEW comments have been reviewed, and additional material has been included in appropriate sections of the Final Environmental Impact Statement as a result of your comments and others received. In addition, specific staff responses to certain of the matters that you raised are enclosed.

Your interest in ERDA's program at the Nevada Test Site is appreciated. Your comments have helped us to clarify important aspects of the effects of that program.

Copies of the Final Environmental Impact Statement are enclosed for your information.

Sincerely,

W. H. Pennington, Director
Office of NEPA Coordination

Enclosures:
1. Staff Responses
2. Final Environmental Impact Statement, ERDA-1551 (5)

ERDA STAFF RESPONSES TO HEW COMMENTS ON DRAFT ENVIRONMENTAL STATEMENT FOR THE NEVADA TEST SITE, ERDA-1551-D

Comments numbered in the order in which they appeared in the HEW letter are briefly stated below, followed by staff responses:

General Comment

Comment: The first paragraph of the HEW letter contains general comment suggesting the use of ERDAM 0524 as a secondary rather than primary reference.

Response: ERDA has no intention of representing ERDA 0524 as a primary reference. ERDA 0524, itself, explains its relationship with regard to primary standards. As stated in the footnote at the bottom of page 2-60 in the DEIS, ERDA 0524 is, "based upon the radiation concentration guides recommended by the National Council on Radiation Protection and Measurements (NCRP) and other agencies."

Specific Comment

1. Comment: Data on CANNIKIN (pages 2-16) is included. This test on Amchitka Island, Alaska, does not relate directly to the NTS.

   Response: The discussion of the hydrology of NTS (Section II.D.5.) was presented .o relate experience of underground tests conducted below the water table. There is limited experience on infill rates and radionuclide concentration of chimney water from the NTS due to the deep water levels. For that reason, reference was made to data obtained on two sites outside the NTS to show the variability of infill rates of nuclear chimneys for tests conducted below shallow water tables at central Nevada and Amchitka, and to demonstrate the range of concentrations of radioactivity which can occur under these circumstances. ERDA believes that these values for offsite events are of related interest to hydrologists and others and should be retained in the final statement.

2. Comment: Evaluation of knowledge of potential hazards of plutonium are said to be incomplete. More information on this important problem is available, mainly in *Health Effects of Alpha-Emitting Particles* in *The Respiratory Tract*, EPA 520/4-76-013, National Academy of Sciences, October 1976.

Response: The ERDA staff appreciates the Department's interest in calling this document to our attention.

3. Comment: Paragraph 2, page 2-108, on airborne radioactivity is confusing. The ambient particulate radioactivity is said to be 50 $\mu Ci/m^3$ of air. No gamma emitters are reported in the DEIS to have been detected in 1975. Is all the 50 $\mu Ci/m^3$ thus due to pure alpha and beta emitters? We feel this is unlikely.

Response: The Final Environmental Impact Statement has been corrected to accommodate this comment.

4. Comment: Little information is given on the magnitude and distribution of occupational exposure. Occupational exposures under accident conditions are not discussed. Some comparisons to existing guidelines in ERDAM 0524 are made but this treatment is, in our opinion, not sufficient.

Response: A paragraph has been added to page 3-15 of the Final Environmental Impact Statement to provide more information on occupational exposure.

5. Comment: The DEIS indicates that milk was purchased and removed from market at 810 pCi/liter, equivalent to a 130 man/rem [sic] dose to the thyroid of a 2-year old child. This purchase could be cited as setting a basis for the removal of radioactively contaminated milk from market. It adds nothing of substance to the DEIS and is not supported by the present Federal Protective Action Guides.

Response: At the time the milk was removed from the market, the level of contamination was not known. The action of removing this milk from market was taken strictly as a precaution to eliminate a potential public hazard, and it was not related to any Federal Protection Guide.

United States Department of the Interior

OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

ER--77/67

MAR 16 1977

Dear Mr. Pennington:

Thank you for your letter of January 18, 1977, transmitting copies of Energy Research and Development Administration's draft environmental impact statement [ERDA-1551-D] for the Nevada Test Site, Nye County, Nevada.

Our comments are presented according to the format of the statement or by subject.

General Comments

At this particular point in the continuing operation of the site, it would be helpful to provide a brief description of the prior environmental statements that have been prepared and the specific differences between the operations previously considered and those operations presently under consideration.

The summary also does not provide adequate reference to the size of the nuclear weapons proposed for testing and described in detail later in the statement.

It seems that there is a lack of coordination or at least a reference to past as well as concurrent actions involving the same tract of land. The Nellis Air Force Bombing Range withdrawal will necessitate a thorough resource study in the process of preparing the environmental statement and will include the same lands covered by this statement. The Bureau of Land Management is coordinating preparation of that statement.

We also understand that the Nevada Test Site is one of the possible locations for the Navy's Seafarer Communications System and that a draft environmental statement has been filed with CEQ. Nevertheless, if the Nevada Test Site is included as a possible Seafarer site, some mention of this possibility ought to be included in the final statement. We also call attention to the Fish and Wildlife Service final environmental statement of August 29, 1975, concerning the Desert National

Wildlife Range. These related matters should be mentioned in the final statement.

Land Status

The description of the status of the land in the Nevada Test Site on pages 2-12 and 2-13 of the draft statement could be misconstrued in that the terms "set aside" and "turned over" are used to describe the withdrawal. Actually, the withdrawal is a jurisdictional transfer in which the Department of the Interior retains responsibility for the mineral and vegetational resources, and could regain jurisdiction of all or parts of the area should the present use become no longer necessary.

In addition to the lands withdrawn under Public Land Order 805 and the additions in 1961 and 1965, our records show that the present Nevada Test Site area is comprised also of 33,400 acres from Public Land Order 1662 in 1953 and 68,533.75 acres from Executive Order 8954 in 1941.

Mineral Potential

We believe that more discussion should be made in the final statement of the mineral potential at the site, from the standpoint of the likelihood of loss of valuable minerals due to contamination. These mineral resources could conceivably be utilized in the future if the withdrawal were to be revoked.

On page 2-11 of the draft statement, the mineral potential is discussed on the basis that no economically recoverable deposits are known considering today's mineral requirements. We believe that the results of the U.S. Geological Survey's extensive investigations should be referenced in the final statement and described briefly to allow further study of the possible future value of known deposits should the economic picture change.

Surface Water

Indications are that the surface water flow into Death Valley National Monument and Devil's Hole passes through the Nevada Test Site. We are concerned with the problem of reduced flows when the water is withdrawn into cavities created by the underground explosions. There is also concern over potential concentrations of radionuclides appearing in monument water. It is not certain that the drill holes which appear later in the draft statement adequately monitor flow into the area of the monument.

Fish and Wildlife

Page 4-27 of the draft statement contains a very short discussion on Devils Hole. This paragraph in the final statement should be corrected to read that the National Park Service, Death Valley National Monument, is responsible for the management of the pupfish rather than the U.S. Fish and Wildlife Service.

Our primary concerns with the proposed actions include the potential detrimental effects on wildlife in the vicinity of the test site and the adoption of precautionary measures and monitoring programs to prevent and detect these impacts. We find that, in general, these concerns are adequately addressed in the text.

We previously commented in a March 17, 1976 letter on the Environmental Assessment and Negative Declaration for FY 77 Underground Nuclear Testing Program at the Nevada Test Site. In those comments, we expressed concern over the potential adverse impacts of the testing program on the endangered Devil's Hole pupfish, *Cyprinodon diabolis*. We reported temporary water level fluctuations of 3 to 6 inches, as recorded by water level records, and pronounced sloshing action in Devil's Hole as a result of underground tests on June 26 and October 28, 1975, and on February 12, 1976.

The draft statement briefly discusses the environmental impacts of testing on Devil's Hole, but does not report similar water level fluctuations. This section also does not assess the impacts of sloshing action and dewatering of the shallow ledge important to the pupfish for feeding and spawning. We recommend that this section in the final statement should be rechecked for accuracy and expanded to include these considerations related to the environmental impact of testing upon the pupfish.

Desert National Wildlife Range

The last sentence of the first paragraph on page 2-31 should be rewritten in the final statement to clarify potential land restrictions. President Ford, in his June 13, 1974, wilderness message to Congress recommended that wilderness designation for the Desert National Range not go forward until a mineral study by the Bureau of Mines and Geological Survey is completed. However, the interim segregation of the range on February 15, 1974, effectively closed the range to further entry under the mining law. Final withdrawal either with or without wilderness designation does not prohibit mineral exploration and development on claims located prior to the segregation notice.

Cultural Resources

The draft statement is inadequate in that it contains insufficient information concerning the extent of cultural resources found in the project area. It does not appear from the archeological reports referenced that the full extent of possible cultural resources have been located and identified.

On the basis of previous investigations, it is possible to delimit areas that may have a greater potential for the occurrence of cultural resources. Therefore, the categories defined for the purpose of dividing the test site areas may provide a useful guide for delineating archeologically sensitive areas. However, this information can in no way be considered conclusive data for predicting the presence or absence of cultural resources. The categories should be used for initially selecting an area for construction or testing. Once delineated, the area slated for project action should be intensively surveyed in order to locate cultural resources that may be affected.

Thus, without the results of an intensive on-the-ground survey, we believe that it is premature to state on page 4-27 of the draft statement that since "actions will be carried out in parts of the test site that are essentially lacking in features of archeological and historical interest, no adverse impact on such features is foreseen." If cultural resources are identified, the State Historic Preservation Officer for the State of Nevada should be consulted to determine the National Register of Historic Places eligibility of the sites and to aid in developing appropriate mitigation measures.

Subsequent to the archeological investigations conducted at the site areas, additional Federal legislation has been developed to protect cultural resources. Without examining the document listed in the draft statement as reference 79, it is not possible to determine if the guidelines and operating procedures designed by the Nevada Test Site Office to protect cultural resources meet Federal standards. We suggest a copy of these guidelines be made available to the Western Archeological Center, National Park Service, P.O. Box 49008, Tucson, Arizona 85717, in order to facilitate a more comprehensive assessment of the final statement.

On page 2-136, the draft statement indicates that none of the known sites are listed on the National Register of Historic Places. Although the Nevada State Museum, the National Park Service and the Nevada State Historic Preservation Officer have not "identified any of these known sites as meeting the criteria for nomination," it appears from the descriptions included in the archeological report that some of the sites may qualify for inclusion on the National Register of Historic Places. The Nevada State Historic Preservation Officer should be consulted for an official determination of National Register eligibility for any sites identified in the project area. On page 2-140, the draft statement indicates that Scottys Castle is not listed on the National Register of Historic Places. The castle and ranch have been nominated for the National Register and should be considered as being on the Register.

We hope these comments will be useful to you.

Sincerely yours,

Stanley D. Doremus

Deputy Assistant Secretary of the Interior

Mr. W.H. Pennington
Director, Office of NEPA
Coordination
Energy Research and Development
Administration
Washington, D. C. 20545

UNITED STATES
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
WASHINGTON, D.C. 20545

Mr. Stanley D. Doremus
Deputy Assistant Secretary
of the Interior
U.S. Department of the Interior
Washington, D.C. 20240

Dear Mr. Doremus:

Thank you for your letter of March 16, 1977, with comments on the Energy Research and Development Administration's Draft Environmental Impact Statement on the Nevada Test Site, ERDA-1551-D.

The Department of the Interior comments have been studied by the ERDA staff, and staff responses concerning the matters addressed are enclosed. In addition, material has been incorporated or changed in the text of the Final Environmental Impact Statement where appropriate, on the basis of your comments, and copies are enclosed for your information.

Your continued interest in ERDA's operations at the Nevada Test Site is appreciated. Your comments, which reflect careful attention on the part of individuals within the Department, have helped ERDA to clarify several important aspects of the effects of operations at the Nevada Test Site.

Sincerely,

W. H. Pennington, Director
Office of NEPA Coordination

Enclosures:
1. Staff Responses
2. Final Environmental Impact Statement, ERDA-1551 (18)

ERDA STAFF RESPONSES TO
DOI COMMENTS ON DRAFT ENVIRONMENTAL STATEMENT
FOR THE NEVADA TEST SITE, ERDA-1551-D

Comments numbered in the order they appeared in the Department of the Interior letter are briefly stated below, followed by staff responses:

1. Comment: At this particular point in the continuing operation of the site, it would be helpful to provide a brief description of the prior environmental statements that have been prepared and the specific differences between the operations previously considered and those operations presently under consideration.

Response: The nuclear test programs to be conducted under the present environmental statement are consistent with and essentially the same as those described under previous statements. Other activities and related programs, such as those enumerated in Sec. III.B. consist of both new activities and ongoing activities at the NTS. All are similar in scope and effort to other activities identified in earlier environmental statements.

2. Comment: The summary also does not provide adequate reference to the size of the nuclear weapons proposed for testing and described in detail later in the statement.

Response: The size of nuclear weapons for proposed testing remains within the limitations of earlier statements; i.e., the maximum size is that having a yield equivalent to one megaton of high explosives. We believe that the reference on page 1-1 of the Summary, which states that this environmental statement considers underground nuclear detonations with yields of one megaton or less, is as definitive of the range of tests to be conducted as is possible due to the classification limitations.

3. Comment: It seems that there is a lack of coordination or at least a reference to past as well as concurrent actions involving the same tract of land. The Nellis Air Force Bombing Range withdrawal will necessitate a thorough resource study in the process of preparing the environmental statement and will include the same lands covered by this statement. The Bureau of Land Management is coordinating preparation of that statement.

Response: A portion of the Nevada Test Site consists of land withdrawn by the Air Force for operation of the Nellis Bombing and Gunnery Range, and made available to NV through an inter-agency agreement (AEC-DOD Memorandum of Agreement No. AT(16-1)-341, dated August 29, 1967). This area, known as Pahute Mesa (Areas 19 and 20), comprises 102,716 acres located in an irregular shaped block at the northwest corner of the test site. This extension is part of the land with-drawal previously effected by the Air Force with the Bureau of Land Management, and for which renewal is currently in progress by the Air Force. NV will cooperate with the Air Force and the BLM on providing information on land use and a resource summary for inclusion in the environmental statement in support of the Air Force's requested renewal.

4. Comment: We also understand that the Nevada Test Site is one of the possible locations for the Navy's Seafarer Communications System and that a draft environmental statement has been filed with CEQ. Nevertheless, if the NTS is included as a possible Seafarer site, some mention of this possibility ought to be included in the final statement.

Response: With the Department's suggestion that mention should be made of the Navy's consideration of the Nevada Test Site as a possible location for its Seafarer Communication System, we have inserted in Sec. III.C. a brief description of this installation as previously contemplated for Nevada. Currently the Navy is considering sites on the upper peninsula of Michigan, at the White Sands Proving Ground and Fort Bliss in New Mexico, and at the Nellis Air Force Range and Tonopah Test Range in Nevada. The Navy has withdrawn consideration of the Nevada Test Site.

5. Comment: We also call attention to the Fish and Wildlife Service final environmental statement of August 29, 1975, concerning the Desert National Wildlife Range. These related matters should be mentioned in the final statement.

Response: We are keenly aware of our neighbor to the east of NTS including the Desert National Wildlife Range and have collaborated on a number of areas of mutual interest. As noted in the final environmental statement, Sec. VIII speaks to the interface of ERDA with other federal agencies, including the U. S. Fish and Wildlife Service, regarding land matters and wildlife resources management. We expect these mutual activities to be closely maintained during the coming program implementation.

6. Comment: The description of the status of the land in the Nevada Test Site on pages 2-12 and 2-13 of the draft statement could be misconstrued in that the terms "set aside" and "turned over" are used to describe the withdrawal. Actually, the withdrawal is a jurisdictional transfer in which the Department of the Interior retains responsibility for the mineral and vegetational resources, and could regain jurisdiction of all or parts of the area should the present use become no longer necessary.

Response: The language of the final paragraph on page 2-12 has been revised to clarify the status of lands acquired for use in the Nevada Test Site.

7. Comment: In addition to the lands withdrawn under Public Land Order 805 and the additions in 1961 and 1965, our records show that the present Nevada Test Site area is comprised also of 33,400 acres from Public Land Order 1662 in 1953 and 68,533.75 acres from Executive Order 8954 in 1941.

Response: Our records indicate that the present NTS comprises, in addition to the Pahute Mesa portion of 102,716 acres described above, the following parcels withdrawn by Public Land Order in the acreage shown:

			SQ.MI.	ACRES
PLO	805	February 19, 1952	679.843	435,000
PLO	805	February 19, 1952	3.156	2,020
PLO	1662	June 20, 1958	60.0	38,400
PLO	2568	December 19, 1961	496,875	318,000
PLO	3759	September 2, 1964	32,981	21,108

As noted above, the acreage involved in PLO 1662 is 38,400 rather than 33,400 acres, and the date of withdrawal was 1958 rather than 1953. Executive Order 8954, dated November 27, 1941, was a withdrawal to the War Department for a Machine Gun Range and has no current bearing on ERDA's Nevada Test Site withdrawals.

Section II.C.2. has been modified to reflect this additional information.

8. Comment: We believe that more discussion should be made in the final statement of the mineral potential at the site, from the standpoint of the likelihood of loss of valuable minerals due to contamination. These mineral resources could conceivably be utilized in the future if the withdrawal were to be revoked.

On page 2-11 of the draft statement, the mineral potential is discussed on the basis that no economically recoverable deposits are known considering today's mineral requirements. We believe that the results of the U.S. Geological Survey's extensive investigations should be referenced in the final statement and described briefly to allow further study of the possible future value of known deposits should the economic picture change.

Response: With regard to loss of potential minerals due to nuclear contamination at the NTS, we believe that this is exceedingly unlikely, because the actual nuclear testing occurs either in holes in the alluvium-filled basins at Yucca and Frenchman Flats, in tunnels in tuff, or in very deep holes in various volcanic rocks at Pahute Mesa. None of these areas and rock types on the NTS have been reported as having metallogenic characteristics. Extensive geologic investigations of the testing areas have been conducted by the U. S. Geological Survey and the results of those investigations are published as open file reports and professional papers.

While the USGS studies are not intended for the purpose of mineral evaluation, any evidence of mineralization in the rocks is routinely addressed in these reports. Samples taken from exploratory drill holes, emplacement holes, and tunnel borings have revealed no economically recoverable mineral deposits in the testing areas.

The remaining area of NTS not used for testing has also been investigated and geologically mapped by the USGS. There are a few mineralized locations which might yield small quantities of sulfide ore, tungsten or precious metals.* Any potential mining activity would be small scale and dependent on fluctuating mineral markets for economic extractions. The proposed testing program at NTS will have no effect on the recovery and utilization of these minerals should the NTS lands revert to the public domain in the future.

*Nevada Bureau of Mines & Geology, Bull. 77, Mackay School of Mines, 1972

9. **Comment:** Indications are that the surface water flow into Death Valley National Monument and Devil's Hole passes through the Nevada Test Site. We are concerned with the problem of reduced flows when the water is withdrawn into cavities created by the underground explosions. There is also concern over potential concentrations of radionuclides appearing in monument water. It is not certain that the drill holes which appear later in the draft statement adequately monitor flow into the area of the monument.

Response: Although intermittent surface drainage from the western part of the NTS may eventually flow into Death Valley National Monument near its southern border, there is no surface drainage from either the Yucca Flat or Frenchman Flat nuclear test areas. Surface runoff from flash flooding in the Mercury and Rock Valley areas along the southern edge of the NTS, flows offsite to the southwest, and may enter the Amargosa River drainage. Owing to its elevation and location, Devil's Hole does not intersect these surface flows; water at this location is derived from underground sources. Wells and springs have been selected along the southern and western boundaries of the NTS (see ERDA-1551-D, Figure II-18) to monitor the groundwater which moves slowly south to southwest from the NTS. As pointed out in Sec. II.D.5, hydrology observations and samples from these monitoring sources have never shown any appreciable fluctuation in groundwater levels or any radioactivity related to testing at the NTS. ERDA believes that these wells, along with numerous onsite samples of water and soils taken periodically from wells and surface drainage areas, are adequate to warn of any unexpected flow of contaminated water onto the Monument.

It is ERDA's further belief that evidence gained from several years of hydrologic study by the U.S. Geological Survey and others clearly shows that no measurable reduction in the available groundwater supply has occurred as a result of testing activities at the NTS.

10. Comment: Page 4-27 of the draft statement contains a very short discussion on Devil's Hole. This paragraph in the final statement should be corrected to read that the National Park Service, Death Valley National Monument, is responsible for the management of the pupfish rather than the U.S. Fish and Wildlife Service.

Our primary concerns with the proposed actions include the potential detrimental effects on wildlife in the vicinity of the test site and the adoption of precautionary measures and monitoring programs to prevent and detect these impacts. We find that, in general, these concerns are adequately addressed in the text.

We previously commented in a March 17, 1976 letter on the Environmental Assessment and Negative Declaration for FY 77 Underground Nuclear Testing Program at the Nevada Test Site. In those comments, we expressed concern over the potential adverse impacts of the testing program on the endangered Devil's Hole pupfish, Cyprinodon diabolis. We reported temporary water level fluctuations of 3 to 6 inches, as recorded by water level records, and pronounced sloshing action in Devil's Hole as a result of underground tests on June 26, and October 28, 1975, and on February 12, 1976.

The draft statement briefly discusses the environmental impacts of testing on Devil's Hole, but does not report similar water level fluctuations. This section also does not assess the impacts of sloshing action and dewatering of the shallow ledge important to the pupfish for feeding and spawning. We recommend that this section in the final statement should be rechecked for accuracy and expanded to include these considerations related to the environmental impact of testing upon the pupfish.

Response: The final environmental statement has been modified in Sections II.D.9.b., Bioenvironment (Animals), and IV.A.6.b., Bioenvironment (Off Site), in response to DOI concerns expressed for the Devil's Hole pupfish. ERDA appreciates the endorsement of its precautionary measures designed to prevent and detect any detrimental impact of the NTS activities on wildlife in the vicinity.

11. Comment: The last sentence of the first paragraph on page 2-31 should be rewritten in the final statement to clarify potential land restrictions. President Ford, in his June 13, 1974, wilderness message to Congress, recommended that wilderness designation for the Desert National Range not go forward until a mineral study by the Bureau of Mines and Geological Survey is completed. However, the interim segregation of the range on February 15, 1974, effectively closed the range to further entry under the mining law. Final withdrawal either with or without wilderness designation does not prohibit mineral exploration and development on claims located prior to the segregation notice.

Response: Section II.D.1.3.(6) has been modified to more clearly state the potential land restrictions that would be effected should the Desert National Wildlife Range be designated a Wilderness Area.

12. Comment: The draft statement is inadequate in that it contains insufficient information concerning the extent of cultural resources found in the project area. It does not appear from the archeological reports referenced that the full extent of possible cultural resources have been located and identified.

On the basis of previous investigations, it is possible to delimit areas that may have a greater potential for the occurrence of cultural resources. Therefore, the categories defined for the purpose of dividing the test site areas may provide a useful guide for delineating archeologically sensitive areas. However, this information can in no way be considered conclusive data for predicting the presence or absence of cultural resources. The categories should be used for initially selecting an area for construction or testing. Once delineated, the area slated for project action should be intensively surveyed in order to locate cultural resources that may be affected.

Response: ERDA recognizes the concerns voiced by the DOI on completeness of the archeological surveys at the NTS, and has taken action to ameliorate these concerns. A contractual agreement between the Nevada Operations Office and the Desert Research Institute (DRI) has been concluded which will provide the professional capability of the DRI to assess the archeological potential of the NTS. The DRI and ERDA will then assess the potential impact of NTS activities on sites of archeological significance at the Test Site.

Briefly, the operation will consist of identifying areas of greatest potential for occurrence of cultural resources; selection of areas for detailed investigation on the ground, based on land use requirements for programmatic activities; and appropriate cataloging and inventorying of all sites having archeological importance.

13. Comment: Thus, without the results of an intensive on-the-ground survey, we believe that it is premature to state on page 4-27 of the draft statement that since "actions will be carried out in parts of the test site that are essentially lacking in features of archeological and historical interest, no adverse impact on such features is foreseen." If cultural resources are identified, the State Historic Preservation Officer for the State of Nevada should be consulted to determine the National Register of Historic Places eligibility of the sites and to aid in developing appropriate mitigation measures.

Response: If cultural resources are identified, ERDA will, according to current policy, notify the State Historic Preservation Office, and take such steps as necessary to determine eligibility of the sites for nomination to the National Register of Historic Places. In addition, should any sites or resources be subjected to damaging impacts, appropriate measures will be effected to mitigate these concerns.

14. Comment: Subsequent to the archeological investigations conducted at the site areas, additional Federal legislation has been developed to protect cultural resources. Without examining the document listed in the draft statement as reference 79, it is not possible to determine if the guidelines and operating procedures designed by the Nevada Test Site Office to protect cultural resources meet Federal standards. We suggest a copy of these guidelines be made available to the Western Archeological Center, National Park Service, P. O. Box 49008, Tucson, Arizona 85717, in order to facilitate a more comprehensive assessment of the final statement.

Response: Further, ERDA is revising its internal guidance to NTS personnel (Reference 80), Preservation of Antiquities and Historic Sites, NTSSO Chapter 6003, August 11, 1972, to reflect responsibility for conducting its activities in compliance with the law on these matters. As soon as these revisions are issued, ERDA will forward a copy of the guidelines to the Western Archeological Center National Park Service, Tucson, AZ 85717.

15. Comment: On page 2-136, the draft statement indicates that none of the known sites are listed on the National Register of Historic Places. Although the Nevada State Museum, the National Park Service and the Nevada State Historic Preservation Officer have not "identified any of these known sites as meeting the criteria for nomination," it appears from the descriptions included in the archeological report that some of the sites may qualify for inclusion on the National Register of Historic Places. The Nevada State Historic Preservation Officer should be consulted for an official determination of National Register eligibility for any sites identified in the project area. On page 2-140, the draft statement indicates that Scottys Castle is not listed on the National Register of Historic Places. The castle and ranch have been nominated for the National Register and should be considered as being on the Register.

Response: Reviews of the results from the forthcoming surveys will enable ERDA, in cooperation with the Nevada State Historic Preservation Officer, to update potential historic sites which qualify for inclusion on the National Register of Historic Places.

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
324 25th Street
Ogden, Utah 84403

8200

March 15, 1977

Mr. W.H. Pennington
Director, Office of NEPA Coordination
U.S. Energy Research and
Development Administration
Mail Station E-201
Washington, D.C. 20545

Dear Mr. Pennington:

We have reviewed the draft environmental statement prepared by the Energy Research and Development Administration (ERDA) for the Nevada Test Site. The statement does not address the possibility of ground motion causing release of snow avalanches.

The Las Vegas Ranger District, Toiyabe National Forest, is subject to major avalanches under the right conditions of snowpack. Both private and public structures have been destroyed in the past with loss of life. The changing snowpack conditions must be monitored during winters of heavy snowfall to safely predict probability of a release. We believe the Las Vegas Ranger District should be consulted in advance of test shots which create ground motion in the Spring Mountain Range. The probability for loss of human life is slight, but not impossible.

We appreciate the opportunity to comment on this environmental statement.

Sincerely,

P.M. Rees

P.M. REES
Director, Regional Planning
and Budget

UNITED STATES
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
WASHINGTON, D.C. 20545

Mr. P. M. Rees, Director
Regional Planning and Budget
Forest Service
U.S. Department of Agriculture
324 25th Street
Ogden, Utah 84403

Dear Mr. Rees:

Thank you for your letter of March 15, 1977, in which you provided a comment on the Energy Research and Development Administration's Draft Environmental Impact Statement on the Nevada Test Site, ERDA-1551-D.

You have emphasized that snowpack conditions in the Spring Mountain Range of Toiyabe National Forest must be monitored during winters of heavy snowfall to predict safely the probability of releasing an avalanche. ERDA agrees that any possibility for the loss of human life due to avalanche, even though slight, justifies the precautionary measure of consulting the Las Vegas Ranger District in advance of certain tests. Discussion of this matter had been included in Section III.A.3.c.(4), and further mention now has been added in Section IV.A.2. Additional revisions have been made as a result of other comments received.

Your interest in ERDA's program at the Nevada Test Site is appreciated.

Sincerely,

W. H. Pennington, Director
Office of NEPA Coordination

Enclosure:
Final Environmental Impact
Statement, ERDA-1551

cc: Mr. Errett Deck, USDA
w/encl.

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

MAR 2 2 1977

Mr. W. H. Pennington, Director
Office of NEPA Coordination
U. S. Energy Research and Development
Administration
Washington, D. C. 20545

Dear Mr. Pennington:

We have reviewed the Energy Research and Development Administration's (ERDA) Draft Environmental Impact Statement, ERDA-1551-D, Nevada Test Site, Nye County, Nevada (January 1977) transmitted to us by your letter of January 18, 1977. Our specific comments are provided as an enclosure to this letter.

In general, we note that the information presented in the draft statement does not have enough detail to allow a meaningful evaluation of the adequacy of the waste disposal methods. Within the context of increasing national concern over radioactive waste from all nuclear facilities, and when viewed as another element of a nationwide radioactive waste disposal program, it appears that waste disposal at the Nevada Test Site should receive the same scrutiny and meet the same requirements as any other disposal operation. While the waste management operations are not today the prime activity at the NTS, they may be singularly important in protection of public health and safety in the longer term.

We recognize that the NTS, itself, is unique in the depth to which its geophysical characteristics have been studied and are known. The combination of operations and test programs have provided extensive data useful by analogy to sites of more direct interest to NRC. And, there appears to be ample evidence that off-site impacts have been controlled for the most part and that a comprehensive continuous monitoring program should provide an alert to future difficulties.

We believe that ERDA should be encouraged to sustain a strong research program at the site such as is represented and coordinated by the Nevada Applied Ecology Group. The site is a valuable resource as a place uniquely able to provide information and data on the long term transport and fate of radionuclides in the geosphere and biosphere as characteristic of the western region of the United States.

MAR 2 2 1977

Mr. W. H. Pennington - 2 -

Thank you for the opportunity to review and comment on this draft statement.

Sincerely,

Voss A. Moore, Assistant Director
for Environmental Projects
Division of Site Safety and
Environmental Analysis

Enclosure:
Comments on Nevada
Test Site DES

cc: CEQ (5)

SPECIFIC COMMENTS OF NUCLEAR REGULATORY COMMISSION STAFF ON THE DRAFT ENVIRONMENTAL STATEMENT FOR THE NEVADA TEST SITE (ERDA-1551-D) JANUARY 1977

DES Section	Comment
I.	Summary
	The method of monitoring the amount of radioactivity existing offsite in populated areas should be indicated. Also, what are the current findings?
	The type of long-term surveillance and what is planned for the buried radioactive waste inventory at each underground test site should be indicated. As there are no existing geologic disposal sites for high-level wastes, the statement that surveillance and control would be similar to that for such sites is questionable.
II.D.1.a.	Population Distribution
	Tables appropriately keyed to a map with concentric circles divided into 16 compass sectors (referenced to true north) would provide a clearer summary of the offsite population distribution by distance and direction as well as current and projected population.
II.D.1.c.	Land Use of NTS Environs
	It is not clear whether the cited reference 15 contains a summary of vegetable, fruit, meat, and milk production for the areas surrounding the NTS. What irrigated and nonirrigated food production information was used for assessing the radiological impact in this environmental statement?
II.D.8.a.	Onsite Radioactivity
	The NTS occupational whole body radiation levels should be related to specific on-site areas.

DES Section	Comment
	The monitoring program or surveillance used to determine the extent of tritium movement from tunnel drainage ponds in the lithosphere is not identified. The reports containing surveillance results or radioactivity inventory of these ponds should be referenced in this section.
II.D.8.d.	Radioactive Wastes The radiological monitoring program for retired and active waste burial or storage sites is not identified. What reports contain surveillance results and radioactivity inventories for each NTS waste management site?
II.D.8.d.	Radioactive Waste Management Indicate the standards used for the disposal methods vs. types of waste involved. In the discussion of tailing sites and debris resulting from tunnel reentry indicate if this material contains unburned Plutonium, quantify the term "low level" and define the criteria used to determine the suitability of soil covering amount. Can this soil covering be compared to standards being developed for covering Uranium mill tailings piles or commercial shallow land burial sites? In the discussion of the 27 retired sites, the nature of the radioactive wastes buried at these sites should be indicated. Also, the method of burial should be indicated as well as any long-term surveillance monitoring. Is there any trans-uranic material buried at these locations? In the discussion of waste in drilled holes, it should be stated whether such waste is recoverable, what the surface water conditions at the holes are and the method of plugging, if any, should be indicated.

DES Section | Comment

II.D.8.d. — Active Waste Management Sites

The method of selection of designated waste management areas should be indicated. The criteria for this selection should be discussed.

For those settling ponds containing radioactive wastes, how is suspension of radioactivity in air from entrainment of water or later, of dust in winds, monitored or prevented? Does the water from drillback contain Plutonium? What levels of radioactivity occur in the ponds?

The surface and subsurface hydrologic and soil properties of the four active radioactive waste management sites should be indicated.

It is stated that wastes containing greater than 10 nCi per gram of transuranics are stored on the surface in sealed drums. The kind of drums, their method of storage, protection methods and monitoring plans should be indicated.

II.D.8.e. — Offsite Radioactivity

The offsite monitoring sample location, type, and frequency should be identified on a map or maps similar to Figure II-22 used in Section II.D.

The concentration of noble gases other than krypton-85 and xenon-133 measured in air samples should also be discussed in terms of ambient levels detected. It is not clear whether milk samples are analyzed for I-131 or what range of concentrations have been measured.

III.A.4. — Underground Nuclear Testing, Emergency Procedures

It would be appropriate to discuss offsite radiation exposure criteria and expected or planned actions to mitigate exposures to the general public in this section.

DES Section	Comment
IV.A.5.a.	Effects from Underground Nuclear Testing, On-Site Radioactivity Occupational radiation exposure experience should be indicated in at least general terms, with average and maximum annual exposures to individuals and the total man-rem per year discussed for each type of activity.
IV.A.5.b.(1)	Sources The fate of the fission products after they are piped to the tile field near the R-MAD facility should be discussed. Also, the duration of storage of "hot" hardware adjacent to the R-MAD building should be indicated.
IV.A.5.b.(2)	Active Waste Management Site For the collection and consolidation of radioactive wastes in the new Area 5 Complex, it should be stated if such procedure will involve exhuming buried wastes, and if so, will such relocation offset the exposure to workers received during the relocation?
IV.A.5.c.	Environmental Impacts and Effects - Radioactivity The radiological impact for the offsite population and individuals should be summarized in this section. The radiological considerations should include exposure pathways associated with the specific land use characteristics in the offsite vicinity of the NTS. The radiological impact or annual dose commitment for onsite workers should also be summarized in this section.

UNITED STATES
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
WASHINGTON, D.C. 20545

Mr. Voss A. Moore
Assistant Director for
Environmental Projects
Division of Site Safety and
Environmental Analysis
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Moore:

Thank you for your letter of March 22, 1977, with comments on the Energy Research and Development Administration's Draft Environmental Impact Statement on the Nevada Test Site, ERDA-1551-D.

The NRC comments have been reviewed, and some additional material which appeared appropriate has been inserted into the Final Environmental Impact Statement and a copy enclosed for your information. Also, staff responses to some of your comments are enclosed.

Your letter contains one general recommendation that there be more detail in the Environmental Impact Statement concerning waste disposal in order to allow a meaningful evaluation of the adequacy of the methods used. The Final Statement and our responses to your comments provide information concerning the specific situations where wastes generated by the weapons program are disposed of at the NTS. However, neither the ongoing program nor the program now planned for the NTS involves any nationwide program for disposal of radioactive waste. Should planning for such an activity for the NTS be instituted, another Environmental Impact Statement probably would be prepared.

Your interest in ERDA's program at the Nevada Test Site is appreciated. Your comments have assisted us in improving the Final Environmental Impact Statement in the area of discussion of radioactive wastes.

Sincerely,

W. H. Pennington, Director
Office of NEPA Coordination

Enclosures:
1. Staff Responses
2. Final Environmental Impact
Statement, ERDA-1551 (5)

ERDA STAFF RESPONSES TO NRC COMMENTS ON DRAFT ENVIRONMENTAL IMPACT STATEMENT FOR THE NEVADA TEST SITE, ERDA-1551-D

Comments in the order in which they appeared in the NRC letter are briefly stated below, followed by staff remarks:

DES Section	Specific Comments
I	Summary
Comment:	The method of monitoring the amount of radioactivity existing offsite in populated areas should be indicated. Also, what are the current findings?
Response:	As described in Section II.D.8., offsite radioactivity has been monitored since the beginning of testing activities at Nevada in 1951. Today there is continuous air monitoring and there are analyses of water, soil, milk, livestock, and vegetation samples that are collected on a periodic basis. The offsite monitoring efforts have shown slightly elevated levels of airborne radioactive gases on several occasions. However, the annual exposures to radioactivity around the NTS are approximately 130 millirem per year; levels which are typical of the southwestern states.
Comment:	The type of long-term surveillance and what is planned for the buried radioactive waste inventory at each underground test site should be indicated. As there are no existing geologic disposal sites for high-level wastes, the statement that surveillance and control would be similar to that for such sites is questionable.
Response:	NRC is correct in observing that there are no existing geologic disposal sites for high-level wastes so that there is no example after which we may pattern a long-term surveillance program. The Final Environmental Impact Statement has been corrected on this point.

DES Section | Specific Comments

II.D.1.a. Population Distribution

Tables appropriately keyed to a map with concentric circles divided into 16 compass sectors (referenced to true north) would provide a clearer summary of the offsite population distribution by distance and direction as well as current and projected population.

Response: The method of display suggested for the population distribution was attempted in an earlier draft of the environmental statement. In our judgment, this type of display was found unsatisfactory in the case where the sparse population exists in and around discrete population centers which are widely separated. The population map shown on Figure II-5, page 2-19, was considered a better method to indicate the population distribution.

II.D.1.c. Land Use of NTS Environs

It is not clear whether the cited reference 15 contains a summary of vegetable, fruit, meat, and milk production for the areas surrounding the NTS. What irrigated and nonirrigated food production information was used for assessing the radiological impact in this environmental statement?

Response: Reference 15 does not contain a detailed summary of meat, vegetable, fruit and milk production for the area. It primarily concentrates information on family and dairy cows, and goats. All food production is by irrigation including home gardens. EPA conducted fruit and vegetable studies in 1974 and 1976 in the NTS environs.

II.D.8.a. Onsite Radioactivity

The NTS occupational whole body radiation levels should be related to specific on-site areas.

DES Section | Specific Comments (Cont)

Response: NTS is generally treated as a single area for occupational exposure record purposes. Every individual entering the Test Site receives a personnel monitoring device. Operations in radiation areas (exposure rate > 5mr/h), are closely supervised with workers' exposure individually tracked. However from a general sense, craftsman move from area to area depending on work requirements, and thus each individual is tracked with an automatic management alert set at specified thresholds.

II.D.8.a. (Cont) Comment

The monitoring program or surveillance used to determine the extent of tritium movement from tunnel drainage ponds in the lithosphere is not identified. The reports containing surveillance results or radioactivity inventory of these ponds should be referenced in this section.

Response: There is no specific program to determine movement of tritium in the lithosphere; however, monthly, routine grab samples are collected and analyzed to assay radioactivity in the ponds. They are reported in the onsite radiological safety reports published by Reynolds Electrical & Engineering Co., Inc. The reference is: "Environmental Sampling Results at the Nevada Test Site, July 1970 thru June 1976," to be published.

II.D.8.d. Radioactive Wastes

The radiological monitoring program for retired and active waste burial or storage sites is not identified. What reports contain surveillance results and radioactivity inventories for each NTS waste management site?

Response: The Nevada Test Site as a whole has radiological monitoring program which includes air and water sampling. The results of these samples are included in "Environmental Sampling Results at the Nevada Test Site, July 1970 through June 1976," referred to above. Radioactive waste inventories buried or stored in waste management sites at the NTS are being reported on a quarterly basis through the ERDA Solid Waste Information Management System (SWIMS). The SWIMS data are available from USERDA, Division of Waste Management, Production, and Processing Operations Branch, M/S B-107, Washington, D. C. 20545.

DES Section | Specific Comments (Cont)

II.D.8.d. Radioactive Waste Management

Indicate the standards used for the disposal methods vs. types of waste involved.

Response: The Nevada Operations plan "Operational Radioactive Waste Management Plan for the Nevada Test Site," NVO-185, in process of publication, defines the criteria for segregating and packaging of radioactive waste materials for either long-term storage or burial, and designates those site locations at NTS that would be most suitable to long-term radioactive waste storage or burial.

II.D.8.d. (Cont) Comment

In the discussion of tailing sites and debris resulting from tunnel reentry indicate if this material contains unburned plutonium, quantify the term "low level" and define the criteria used to determine the suitability of soil covering amount. Can this soil covering be compared to standards being developed for covering uranium mill tailings piles or commercial shallow land burial sites?

Response: Radioactive tailings generated from past tunnel reentry operations contain aged fission radionuclides which in some cases can be contaminated with traces of plutonium. At present when radioactivity is initially incurred during a reentry, a soil sample is removed for radiochemical analysis. If the soil is radioactive, it is removed to an unused drift, later to be sealed when the drift is full.

For the purposes of these mining operations radioactive tailings (not containing alpha emitters) reading less than 0.4 mrad/h are considered low-level waste and may be removed to the portal tailings pile. Debris of this nature is rapidly covered with clean rock obtained from uncontaminated mining. It is estimated that less than one percent of the tailings removed from these mined areas has any radioactive contamination. The maximum potential exposure to the uncovered or covered tailing piles is considerably less than the occupational guidelines for a controlled area provided in ERDAM 0524.

DES Section

II.D.8.d. (Cont) Comment

In the discussion of the 27 retired sites, the nature of the radioactive wastes buried at these sites should be indicated. Also, the method of burial should be indicated as well as any long-term surveillance monitoring. Is there any transuranic material buried at these locations?

Response: The 27 retired sites at the NTS consist principally of piles of activated and contaminated cement and metal debris, which following the atmospheric tests of the 1950's were scraped and gathered together (at different locations that would not interfere with current operations). These locations are retired surface storage sites, not burial sites. Plutonium has been identified at some of these sites.

The long term surveillance monitoring of the sites is encompassed within the radiological monitoring program addressed in comments II.D.8.a. and II.D.8.d. above.

DES Section

II.D.8.d. (Cont) Comment

In the discussion of waste in drilled holes, it should be stated whether such waste is recoverable, what the surface water conditions at the holes are and the method of plugging, if any, should be indicated.

Response: Radioactive waste placed in these "drilled holes" mentioned on page 2-100, (these holes are steel cased and the bottoms are cement plugged) is coring debris which has been treated with Calseal (a patented material used to solidify liquids) prior to its placement into the cased hole. These wastes are classified material and are not recoverable. Whenever a waste hole is full, or of no further use, it is backfilled to the surface with cement and a steel cover welded to the casing.

The casing extends above the surface so that any surface drainage water is excluded. These holes (50 to 200 ft in depth) are well isolated from the groundwater which is some 300 meters below the surface.

II.D.8.d. Active Waste Management Sites

The method of selection of designated waste management areas should be indicated. The criteria for this selection should be discussed.

Response: During the early days of weapons testing, the locations of radioactive waste burial and storage areas at NTS were selected based on operational convenience. The new Area 5 waste management site is located on high, dry alluvial soil, free of surface water drainage areas, and more than 600 ft above the water table.

DES Section

II.D.8.d. (Cont) Comment

For those settling ponds containing radioactive wastes, how is suspension of radioactivity in air from entrainment of water or later, of dust in winds, monitored or prevented? Does the water from drillback contain plutonium? What levels of radioactivity occur in the ponds?

Response: The ERDAM 0513, "Effluent Environmental Monitoring and Reporting" requires annual reports to ERDA/HQ of any radioactive effluents from the Nevada Test Site. To provide these data for the contaminated waters of the NTS settling ponds, the concentration of radionuclides in the ponds is determined quarterly, and the evaporative losses of tritium reported. Traces of plutonium have been identified in some of these ponds ($\sim10^{-10}$ μCi/ml or $\sim10^{-6}$ RCG).

Air sampling has not indicated any detectable resuspension of radioactivity from dried settling ponds. Wind entrainment (resuspension) of radioactivity from desert flats has not been evidenced as a problem. See pages 2-92, 2-95 of the Draft Environmental Statement.

II.D.8.d. (Cont) Comment

The surface and subsurface hydrologic and soil properties of the four active radioactive waste management sites should be indicated.

Response: The surface and subsurface hydrologic and soil properties of the waste management site in Area 5 is indicated in response to a previous comment.

The U3ax crater is a subsidence crater from a past underground nuclear test, PACA, detonated on 5-7-62 at a depth of 848 feet, about 650 feet above the water table. The original subsidence crater formed in dry alluvial soil above the PACA chimney was approximately 480 feet in diameter and 60 feet deep. There is little, if any, surface water which drains into the subsidence crater from the surrounding area, however, it does act as a catchment basin for the limited rainfall. Infiltration and evaporation prevent ponding in the crater bottom.

DES Section

Response (Cont)

The U3fi drill hole is an abandoned, cased implacement hole about 1.8 meters in diameter and has been plugged with concrete below a depth of about 240 meters. The hole is drilled in alluvial soil and rock and is located on the alluvial fan north of Yucca Lake. The casing extends about a foot above the surface and is capped with locked covers for security purposes. These features prevent the entrance of surface drainage water. The water table is approximately 1500 feet below the surface.

Horn Silver mineshaft in Area 26 is an abandoned shaft mined into altered volcanic rocks which contained gold and silver ores. The shaft has been designated as a disposal site for classified radioactive waste. A concrete plug has been poured over waste in the partially filled mineshaft at a depth of about 128 meters. A concrete collar (or pad) with a steel cover and lid with a security lock has been installed at the opening to the shaft. This prevents the entrance of surface drainage water. The water table is estimated to be about 1000 feet deep.

For a more general description of the surface and subsurface hydrologic, soil, and rock properties of the NTS, see Sections II.D.4., Geology, and II.D.5., Hydrology, in the Draft Environmental Statement.

II.D.8.d. (Cont) Comment

It is stated that wastes containing greater than 10 nCi per gram of transuranics are stored on the surface in sealed drums. The kind of drums, their method of storage, protection methods and monitoring plans should be indicated.

Response: The NTS storage of transuranic waste is regulated by the Nevada Operations Office's "Operational Radioactive Waste Management Plan," referred to previously. This plan provides guidance to all waste generators at the NTS as to: various types of drums and boxes used for storage, criticality safety and security responsibility, radiological monitoring and control requirements, and related information.

DES Section

II.D.8.e. Offsite Radioactivity

The offsite monitoring sample location, type, and frequency should be identified on a map or maps similar to Figure II-22 used in Section II.D.

Response: Figures 6-20 in EMSL-LV-539-4 (reference 15) provide this information and are not appropriate for the EIS because of their large number.

II.D.8.e. (Cont) <u>Comment</u>

The concentration of noble gases other than krypton-85 and xenon-133 measured in air samples should also be discussed in terms of ambient levels detected. It is not clear whether milk samples are analyzed for I-131 or what range of concentrations have been measured.

Response: No noble gases other than krypton-85 and the xenon isotopes are measured by the analytical methods. The second sentence of the "Radioactivity in Milk" section (P2-109) states that the samples are analyzed for gamma emitters. No detectable iodine-131 has occurred in offsite milk samples since 1970. The maximum 1970 levels are referenced on page 4-21 of the Draft Environmental Statement.

III.A.4. Underground Nuclear Testing, Emergency Procedures

It would be appropriate to discuss offsite radiation exposure criteria and expected or planned actions to mitigate exposures to the general public in this section.

Response: The present radiation exposure criteria for offsite populations are those found in ERDAM 0524. The EPA has prepared detailed plans for emergency actions. It is felt that section III.A.4. contains a reasonable summary of actions to be taken.

DES Section

IV.A.5.a. Effects from Underground Nuclear Testing, On-Site Radioactivity

Occupational radiation exposure experience should be indicated in at least general terms, with average and maximum annual exposures to individuals and the total man-rem per year discussed for each type of activity.

Response: ERDA and ERDA contractor radiation exposure experience is published annually by HQ in the detail requested (e.g., see ERDA-76/119). To summarize, every effort is made at the NTS to keep occupational exposures to as low as practicable. In the past five years, no one at the NTS has had an exposure to radiation greater than four rem total exposure for any year. In 1976, of the 16,827 people badged on the NTS, 98.7 percent had zero exposure, and of the remaining, there was no exposure greater than one rem.

IV.A.5.b.(1) Sources

The fate of the fission products after they are piped to the tile field near the R-MAD facility should be discussed. Also, the duration of storage of "hot" hardware adjacent to the R-MAD building should be indicated.

Response: The nonvolatile fission products remain in the tile field area. The existing hardware adjacent to the R-MAD building is part of the FY 1978-1979 NRDS cleanup and will be moved and buried during this period. The hardware from the planned tests at R-MAD will be stored adjacent to the building as long as operationally necessary.

IV.A.5.b.(2) Active Waste Management Site

For the collection and consolidation of radioactive wastes in the new Area 5 Complex, it should be stated if such procedure will involve exhuming buried wastes, and if so, will such relocation offset the exposure to workers received during the relocation?

Response: There are no plans at present to exhume buried wastes.

DES Section

IV.A.5.c. Environmental Impacts and Effects - Radioactivity

The radiological impact for the offsite population and individuals should be summarized in this section. The radiological considerations should include exposure pathways associated with the specific land use characteristics in the offsite vicinity of the NTS. The radiological impact or annual dose commitment for onsite workers should also be summarized in this section.

Response: This subject for the offsite population is covered in detail in EMSL-LV-539-4 (reference 15). The onsite population is monitored by an extensive dosimetry system including mandatory film dosimeters for all who enter the NTS. A routine environmental surveillance program as described on pages 2-78 to 2-88.

With the advent of underground testing, exposure to onsite workers has been minimal. For example, during CY 1976; 16,827 people were film badged. Over 98% had no detectable exposure and there were no exposures exceeding 1 rem.

The Nevada State Museum

CAPITOL COMPLEX
CARSON CITY, NEVADA 89710
Telephone (702) 885-4810

February 16, 1977

W. H. Pennington
U.S. E.R.D.A.
Nevada Operations Office
P.O. Box 14100
Las Vegas, Nevada 89114

Dear Mr. Pennington:

This is written as commentary on your Draft Environmental Statement for the Nevada Test Site, Nye County, Nevada, ERDA-1551-D. I shall restrict my comments to a single section of that report that discusses archaeological and historical values, pp. 2-134 through 2-140.

We are extremely pleased to know that the Nevada Test Site will protect sites of potential archaeological and historical interest, and, indeed, has done much already to comply with existing Federal laws pertaining to such cultural resources. I do know that the Test Site had relieved Mr. Worman of 50% of his duties in a radiation monitoring laboratory in order that he could use that time to record some of the archaeological and historical values on the Test Site. Otherwise, there would be no record of such values present, as reported in the Draft Statement.

As you point out in your second paragraph on page 2-139, the "... formal investigation of the archaeological and historical features of NTS has consisted largely of the reconnaissance and spot sampling efforts of Worman." I know of no subsequent investigations and reports on Nevada Test Site cultural resources since Worman's death in 1970. Since the entire Test Site was only subjected to "spot sampling" procedures, I would suggest that continuous, systematic, intensive archaeological field work would yield a harvest of heretofore unrecorded archaeological values. Surely such resources merit the protective efforts of more than just one part time position in archaeology. In fact, I am wondering if the Nevada Test Site does now employ a full time, or even a part time, professional archaeologist?

Yours truly,

Donald R. Tuohy

Donald R. Tuohy
Curator of Anthropology

UNITED STATES
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
WASHINGTON, D.C. 20545

Mr. Donald R. Tuohy
Curator of Anthropology
The Nevada State Museum
Capitol Complex
Carson City, Nevada 89710

Dear Mr. Tuohy:

Thank you for your letter of February 16, 1977, concerning the Energy Research and Development Administration's Draft Environmental Impact Statement on the Nevada Test Site, ERDA-1551-D.

You are correct in your assessment that since the death of Dr. Worman, there have not been any formalized archaeological investigations conducted at the Nevada Test Site. However, arrangements have been made recently with the Desert Research Institute of the University of Nevada to conduct a systematic cultural resources inventory of the Nevada Test Site. The effort during Fiscal Year 1977 has been primarily to design and test a suitable sampling system. Systematic investigations of cultural resources have been made only at construction sites as they become identified.

In future years, the sampling design will be utilized to inventory systematically archaeological and historical sites on Pahute, Ranier, and Buckboard Mesas in addition to new construction sites. The Final Environmental Impact Statement has been revised to reflect this information. Other revisions have been made as a result of comments received.

Your interest in our program at the Nevada Test Site is appreciated. Your comments have helped us to clarify important aspects of the effects of that program. A copy of the Final Environmental Impact Statement is enclosed for your information.

Sincerely,

W. H. Pennington, Director
Office of NEPA Coordination

Enclosure:
Final Environmental Impact
Statement, ERDA-1551

cc w/encl:
Honorable Mike O'Callaghan
Governor of Nevada

Mr. Bruce D. Arkell
State Planning Coordinator

DEPARTMENT OF STATE

Washington, D.C. 20520

BUREAU OF OCEANS AND INTERNATIONAL
ENVIRONMENTAL AND SCIENTIFIC AFFAIRS

March 28, 1977

Mr. W. H. Pennington
Director
Office of NEPA Coordination
Energy Research and Development
Administration
Washington, D.C. 20545

Dear Mr. Pennington:

The Department of State has reviewed the Draft Environmental Statement of January 1977 for the continuation of ERDA's underground nuclear testing program and other activities at the Nevada Test Site during 1978 and beyond.

Within the Department's area of concern, we have noted several places where we would like to suggest additional, or revised wording. Most of these changes are proposed simply for the sake of clarity, but a few are designed to make the Statement more accurately reflect current U.S. policy on particular issues.

For the sake of simplicity, the proposed changes, and the rationale for each, are enclosed separately.

Sincerely,

Herbert Spielman
Acting Director
Office of Environmental Affairs

Recommended Changes
to the
Draft Environmental Statement
for the
Nevada Test Site

1. Page 1-1. We suggest that a brief statement be added early in the report setting forth why under NEPA an EIS is required for the Nevada Test Site and, in turn, why this new EIS has been prepared. Such a statement could include the period which this EIS is intended to cover.

2. Page 1-1, second paragraph. Change the third sentence to read:

"In the interim, pending their entry into force, the United States has announced its intention to abide by the yield limits of the treaties."

REASON: As currently worded, one could infer that the time of ratification and entry into force would coincide. While this may be true, we should not anticipate such a coincidence. As a separate matter, the interim policy which we have announced is to observe the yield limits, not all terms of the treaties.

3. Page 1-2, section B, second paragraph. Change the first sentence to read:

"Nuclear weapons testing will continue to be conducted at the Nevada Test Site as a vital part of this research and development program until the US goal of an international agreement for discontinuance of test explosions is achieved."

REASON: It is US policy to seek to achieve the discontinuance of all test explosions of nuclear weapons for all time, and to continue negotiations to this end. If an agreement were reached on discontinuance, nuclear weapons testing could not remain a vital part of the research and development program.

4. Page 1-7, lines 1-3. The last sentence of the top partial paragraph carried over from page 1-6 indicates that inadvertant radioactivity releases through seepage have been detected offsite. It would appear to be useful to quantify the magnitude of the amount detected offsite in assessing what implications for the environment such seepage may have.

5. Page 1-11, section E. Change the second sentence to read:

"Stoppage, curtailment, or delay of the testing program would inhibit the development of nuclear weapons as one of the elements for the maintenance of our national security and the development of peaceful applications of nuclear explosives."

REASON: If the cessation of testing were pursuant to an undertaking by the United States, its conflict with other national commitments would presumably have been resolved, thus no longer constituting a conflict. A second change to the sentence reflects that elements other than nuclear weapons may also contribute to the maintenance of our national security.

6. Page 2-4, second full paragraph. Change the last sentence to read:

"This program is consistent with United States undertakings under Article V of the Treaty on the Nonproliferation of Nuclear Weapons."

REASON: Because of the complexities of any treaty, including the NPT, it would be helpful to cite Article V, which appears to be the subject of this sentence, rather than attempt to summarize it in the text.

7. Page 2-6, lines 1 and 2. Change the first full sentence on this page to read:

"Nuclear weapons testing will continue to be conducted at the Nevada Test Site as a vital part of this research and development program until the US goal of an international agreement for discontinuance of test explosions is achieved."

REASON: See the reason for suggested change number 3 above.

8. Page 2-6, first full paragraph. Change the last sentence to read:

"Nuclear tests are an integral part of the current nuclear weapons research and development process and ERDA believes they continue to be essential to the achievement of its goals."

REASON: Accuracy and to make clear that other agencies are not assuming to judge the essentiality of underground tests to meeting ERDA's goals.

9. Page 2-6, bottom paragraph. Change the second sentence to read:

"Based on current policy, it is expected that the underground nuclear testing program..."

REASON: Our expectation of future testing levels is based on current policy. If that policy were to change, future testing levels could conceivably change.

10. Page 2-6, bottom paragraph. Change the sixth sentence to read:

"In the interim the United States has announced its intention to abide by the yield limits of the treaties pending their entry into force."

REASON: See the reason for suggested change number 2, above.

11. Page 2-76, first full paragraph following paragraph c.

It would be useful to define the general ranges in kilotons for "intermediate" and "high yield" explosions. Otherwise the reader may not be able to infer if these tests are above or below one megaton since this EIS addresses tests of one megaton or less.

12. Page 3-8, top partial paragraph. A statement should be added showing that ERDA guidelines are responsive to environmental and treaty constraints. Otherwise one could erroneously infer that ERDA may establish whatever standards it chooses.

13. Page 3-13, paragraph b(1). Change the first and second sentences to read:

"The proposed nuclear test series, submitted by the Administrator of ERDA, is reviewed by an interagency group under the National Security Council. The President acting on the group's advice and recommendations, grants programmatic authority for an underground nuclear testing series for a given fiscal year."

REASON: Accuracy

14. Page 6-1, first paragraph. Change the second sentence to read:

"In the absence of a national decision to cease testing, this would directly conflict...."

REASON: If there were a national decision to cease testing, it is reasonable to assume that in making it any conflicts of policies would be resolved.

15. Page 6-1, bottom paragraph. Change the last sentence to read:

"...the same conflicts with delineated policy apply as in A. above if there were no national decision to reduce the number of tests."

REASON: If there were a national decision to reduce the number of tests, it is reasonable to assume that in making it any conflicts of policies would be resolved.

16. Page 6-2, top paragraph. Change the first and second sentences to read:

"...commonly referred to as the Threshold Test Ban Treaty, a yield limitation of 150 kt on underground nuclear tests will be imposed by the treaty's terms. This will reduce the potential for environmental impact due to induced seismic motion although the current observation of the TTBT and PNET yield limits has already had this effect."

REASON: To reflect that the 150 kiloton limit is currently being observed with an attendant reduction in environmental impact.

17. Page 6-2, paragraph c. Change the first sentence to read:

"This alternative would lead to a comparable delay in the advancement of nuclear explosion technology which, absent a national decision to do do, would conflict with the national policy...."

REASON: If there were a national decision delay testing, it is reasonable to assume that, in making it, any conflicts of policies would be resolved.

UNITED STATES
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
WASHINGTON, D.C. 20545

Mr. Herbert Spielman, Acting Director
Office of Environmental Affairs
Bureau of Oceans and International
Environmental and Scientific Affairs
Department of State
Washington, D.C. 20520

Dear Mr. Spielman:

Thank you for your letter of March 28, 1977, with comments on and suggested changes to the Energy Research and Development Administration's Draft Environmental Impact Statement on the Nevada Test Site, ERDA-1551-D. Your suggestions have been accommodated within the enclosed Final Environmental Impact Statement.

We appreciate the Department of State's continuing interest in ERDA's underground nuclear testing program. Your carefully prepared comments have helped ERDA to make considerable improvements to the document.

Sincerely,

W. H. Pennington, Director
Office of NEPA Coordination

Enclosure:
Final Environmental Impact
Statement, ERDA-1551

Do not type to the left of dotted line.

C-83

AZ—189

COVER SHEET for FEDERAL GRANT APPLICATION/AWARD NOTIFICATION
ARIZONA Related to 75-80-0029

1 APPLICATION DATE yr mo day 19__ __ __

ITEMS 1-31 TO BE COMPLETED BY APPLICANT OR CLEARINGHOUSE DEPENDING UPON STATE PROCEDURES

3. APPLICANT – Organizational Unit	Energy Research & Development Admin.
4. ADDRESS – Street or P. O. Box	
2 FEDERAL EMPLOYER ID NO.	
5. CITY	Washington
6. COUNTY	
7. STATE	DC
8. ZIP CODE	20545
9. PROG NO./FEDERAL AGENCY	12.999 Dept. of Defense

10. TYPE OF ACTION: a [X] New; c [ ] Modification; b [ ] Continuation

TYPE OF CHANGE (Complete if 10b or 10c was checked)
11. a [ ] Increased Dollars; b [ ] Decreased Dollars
12. a [ ] Increased Duration; b [ ] Decreased Duration
13. a [ ] Other Scope Change; b [ ] Cancellation

14a. EXISTING FED GRANT ID
14b. EXISTING CLEARINGHOUSE ID 75-80-0029

15. REQUESTED FUND START yr mo 19__
16. FUNDS DURATION ____(Months)
17. EST. PROJECT START yr mo 19__
18. EST. PROJECT DURATION ____(Months)

19. APPLICANT TYPE — Enter Letter [J]
A. State; B. Interstate; C. COG; D. County; E. City; F. School District; G. Special Unit; H. Community Action Agency; I. Sponsored Organization; J. Indian; K. Other

Funds Requested At This Time

20a.	FEDERAL GRANT	( ) $ .00
20b.	FEDERAL LOAN	( ) $ .00
21.	STATE	( ) $ .00
22.	LOCAL	( ) $ .00
23.	OTHER	( ) $ 1 .00
24.	TOTAL (20,21,22,23)	( ) $ 1 .00

PART 1

25. BRIEF TITLE OF APPLICANT'S PROJECT: Nevada Test Site, Nye County, Nevada - Draft Environmental Statement - ERDA-1551-D

26. PROJECT ABSTRACT (60 Characters Per Line – 6 Lines). ALSO Attach 1 or 2 Page Project Summary For Review.
The treaty on the Limitation of Underground Nuclear Weapon Tests, commonly known as the Threshold Test Ban Treaty, and its companion Treaty on Underground Nuclear Explosions for Peaceful Purposes have been signed and introduced to the US Senate for ratification. These treaties limit individual underground nuclear tests to 150 KT.

27. AREA OF PROJECT IMPACT (Indicate City, County, State, etc.): Coconino, Mohave Counties, Arizona

28. CONGRESSIONAL DISTRICT — Of Applicant [ ] Districts Impacted By Project [03]

29. Environmental Assessment Required By State/Federal Agency? [X] Yes [ ] No — If Yes, Attach.

30. CLEARINGHOUSE(S) TO WHICH SUBMITTED: a [X] State b [X] Area Wide

31. a NAME OF CONTACT PERSON: Mr. W. H. Pennington, Director, Office of NEPA Coordination
b ADDRESS – Street or P. O. Box: Energy Research & Dev. Admin. Washington, DC 20545
c TELEPHONE NO.: 353-4241

31. d IF STATE AGENCY — WILL PROJECT, REQUIRE NEW POSITION [ ] YES [ ] NO — WILL PROJECT, SUPPORT EXISTING POSITIONS [ ] YES [ ] NO

31. e MATCHING RATIO — FEDERAL / STATE / LOCAL

ITEMS 32-38 TO BE COMPLETED BY CLEARINGHOUSE

PART 2

32. CLEARINGHOUSE ID 200 — [X] MULTIPLE CLEARINGHOUSE — 203, 204

33. a ACTION BASED ON REVIEW OF: a [ ] Notification; b [X] Application
33. b ACTION TAKEN: a [X] With Comment; b [ ] Without Comment; c [ ] Waived; d [ ] Unfavorable

34. STATE APPLICATION IDENTIFIER (SAI): State A Z — Number 7 7 8 0 0 0 0 8

35. CLEARINGHOUSE IMPACT CODE — STATE WIDE [ ] Yes [X] No — County/City Plng Area: 005, 015

36. STATE PLAN REQUIRED [ ] Yes [X] No

37. DATE AT CLEARINGHOUSE yr mo day 1977 03 09

38. FINAL CLEARINGHOUSE ACTION DATE yr mo day 1977 04 22 By Jo Youngblood — Mrs. Jo Youngblood

ITEMS 39-42 TO BE COMPLETED BY APPLICANT BEFORE SENDING FORM TO FEDERAL AGENCY

PART 3

39. CERTIFICATION – The applicant certifies that to the best of his knowledge and belief the above data are true and correct and filing of this form has been duly authorized by the governing body of the applicant.

40. a NAME (Print or Type) — b TITLE — c SIGNATURE of Authorized Representative — d TELEPHONE NUMBER

41. DATE MAILED TO FEDERAL/STATE AGENCY yr mo day 19__

42. NAME OF FEDERAL / STATE AGENCY TO WHICH THIS APPLICATION SUBMITTED

ITEMS 43-54 TO BE COMPLETED BY FEDERAL OFFICE EVALUATING AND RECOMMENDING ACTION ON THE APPLICATION

PART 4

43. GRANT APPLICATION ID (Assigned by Federal Agency)

52. Application Rec'd. yr mo day 19__

53.a Exp Action Date yr mo day 19__

Always Complete 53.a OR b

53.b Ret to Applicant yr mo day 19__

44. GRANTOR AGENCY

REVISIO — Amended Applic. Received yr mo day 19__

REVISIO — Rev Expected Action Date

54. Exp Action Revised As Of yr mo day 19__

REVISIO — Applicant

45. ORGANIZATIONAL UNIT

46. ADMINISTERING OFFICE

Northern Arizona Council of Governments

P.O. BOX 57 • FLAGSTAFF, AZ - 86001 • (602) 774-1895

WILLIAM C. WADE
EXECUTIVE DIRECTOR

Regional A-95 Review

TO: Ms. Jo Youngblood
Arizona State Clearinghouse
1700 W. Washington, Room 505
Phoenix, AZ 85007

RE: Project: Energy Research and Development Administration
Nevada Test Site, Nye County, Nevada - Draft Env. Statement
S.A.I. #: 77-80-0008

The Northern Arizona Council of Governments (NACOG) has completed its A-95 Review and Comment upon the above project. Action taken on this project notification is as follows:

☐ Proposal supported as described on the AZ-189 and any attachments.

☐ Proposal is supported with certain recommendations, provisions, etc.

X No comment on this proposal at this time.
One reviewer is concerned that (1) weapons testing is controlled and utilized by qualified, conscientious representatives of the people of the United States, and (2) activities for peaceful purposes are not at the expense or exclusion of overdue efforts to develop clean coal and solar sources of energy.

☐ Proposal is not supported.

Please be aware that NACOG reserves the prerogative of making additional comments should new information become available to the Agency.

The Northern Arizona Council of Governments has appreciated this opportunity to review and comment on this project.

Thank you.

William C. Wade
Executive Director

Date: March 29, 1977

THIS A-95 REVIEW IS SUPPORTED IN PART BY A HUD 701 PLANNING GRANT.

TO: Dr. James Schoenwetter
Center for Environmental Studies
Department of Anthropology
Arizona State University
Tempe, AZ 85281

C-85

State Application Identifier (SAI)

March 7, 1977 State AZ Number 77-80-0008

Economic Sec. Region III
Game & Fish Region IV
Ag. & Hort.
Az. Atomic Energy
Health
Water
Land
Mineral Resources
Energy Programs
Emergency Services
Renewable Natural Resources
Environmental Studies

From: Arizona State Clearinghouse
1700 West Washington Street, Room 505
Phoenix, Arizona 85007

This project is referred to you for review and comment. Please evaluate as to:

(1) the program's effect upon the plans and programs of your agency
(2) the importance of its contribution to State and/or areawide goals and objectives
(3) its accord with any applicable law, order or regulation with which you are familiar
(4) additional considerations

Please return this form to the clearinghouse no later than 15 working days from the date noted above. Please contact the clearinghouse if you need further information or additional time for review.

- [x] No comment on this project
- [ ] Proposal is supported as written
- [ ] Comments as indicated below

Comments: (Use additional sheets if necessary)

Reviewer's Signature James Schoenwetter

Date 21 Mar 77

Title

Telephone

TO: Mr. Roger Root, Acting Chief
Office of Planning
Dept. of Econ. Security
1717 W. Jefferson
Phoenix, Arizona 85007

C-86

State Application Identifier (SAI)

March 7, 1977 State AZ Number 77-80-0008

Economic Sec. Region III
Game & Fish Region IV
Ag. & Hort.
Az. Atomic Energy
Health
Water
Land
Mineral Resources
Energy Programs
Emergency Services
Renewable Natural Resources
Environmental Studies

From: Arizona State Clearinghouse
1700 West Washington Street, Room 505
Phoenix, Arizona 85007

This project is referred to you for review and comment. Please evaluate as to:

(1) the program's effect upon the plans and programs of your agency
(2) the importance of its contribution to State and/or areawide goals and objectives
(3) its accord with any applicable law, order or regulation with which you are familiar
(4) additional considerations

Please return this form to the clearinghouse no later than 15 working days from the date noted above. Please contact the clearinghouse if you need further information or additional time for review.

☐ No comment on this project
☒ Proposal is supported as written
☐ Comments as indicated below

Comments: (Use additional sheets if necessary)

Reviewer's Signature Richard L. Bronek

Date 770315

Title State Planner

Telephone 602 271-5984

Mr. Donald C. Gilbert, Exec.Dir.
Arizona Atomic Energy Comm.
1601 West Jefferson Street
Phoenix, AZ 85007

C-87

State Application Identifier (SAI)

March 7, 1977 State AZ Number 77-80-0008

Economic Sec.
Game & Fish
Ag. & Hort.
Az. Atomic Energy
Health
Water
Land
Mineral Resources
Energy Programs
Emergency Services
Renewable Natural Resources
Environmental Studies

Region III
Region IV

From: Arizona State Clearinghouse
1700 West Washington Street, Room 505
Phoenix, Arizona 85007

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- ☐ No comment on this project
- ☐ Proposal is supported as written
- ☐ Comments as indicated below

RECEIVED
MAR 11 1977
ARIZONA ATOMIC ENERGY COMMISSION

Comments: (Use additional sheets if necessary)

Reviewer's Signature: Donald C Gilbert

Date: 3-11-77

Title: Exec Dir

Telephone: 271-4845

TO:

Mr. Wesley E. Steiner,
State Water Commission
222 N. Central Ave., Suite 800
Phoenix, Arizona 85004

C-88

State Application Identifier (SAI)

March 7, 1977 State AZ Number 77-80-0008

Economic Sec.
Game & Fish
Ag. & Hort.
Az. Atomic Energy
Health
Water
Land
Mineral Resources
Energy Programs
Emergency Services
Renewable Natural Resources
Environmental Studies

Region III
Region IV

From: Arizona State Clearinghouse
1700 West Washington Street, Room 505
Phoenix, Arizona 85007

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- [x] No comment on this project
- [ ] Proposal is supported as written
- [ ] Comments as indicated below

Comments: (Use additional sheets if necessary)

Reviewer's Signature: Martin E. Wells (signature) Date: 3-21-77

Title: Planner Telephone: 258-7321

TO:

Dr. Suzanne Dandoy, Director
Department of Health Services
1740 West Adams Street
Phoenix, Arizona 85007

From: Arizona State Clearinghouse
1700 West Washington Street, Room 505
Phoenix, Arizona 85007

State Application Identifier (SAI)

March 7, 1977 State AZ Number 77-80-0008

Economic Sec.
Game & Fish
Ag. & Hort.
Az. Atomic Energy
Health
Water
Land
Mineral Resources
Energy Programs
Emergency Services
Renewable Natural Resources
Environmental Studies

Region III
Region IV

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- [x] No comment on this project
- [ ] Proposal is supported as written
- [ ] Comments as indicated below

Comments: (Use additional sheets if necessary)

Reviewer's Signature: R. Bruce Scott

Date: MAR 17 1977

Title: ASSISTANT DIRECTOR
ARIZONA DEPT OF HEALTH SERVICES
DIV. OF ENVIRONMENTAL HEALTH SERVICES

Telephone:

TO:

Mr. John Jett, Director
Mineral Resources Department
Fairgrounds, Mineral Building
1826 West McDowell Road
Phoenix, Arizona 85007

State Application Identifier (SAI)		
March 7, 1977	State AZ	Number 77-80-0008

Economic Sec. — Region III
Game & Fish — Region IV
Ag. & Hort.
Az. Atomic Energy
Health
Water.
Land
Mineral Resources
Energy Programs
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Environmental Studies

From: Arizona State Clearinghouse
1700 West Washington Street, Room 505
Phoenix, Arizona 85007

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- [x] No comment on this project
- [ ] Proposal is supported as written
- [ ] Comments as indicated below

Comments: (Use additional sheets if necessary)

Reviewer's Signature J N Jett

Date 3-15-77

Title Director

Telephone 271-3791

TO: Mr. Andrew L. Bettwy
Comm., Department of Land
1624 W. Adams St., 4th Floor
Phoenix, Arizona 85007

State Application Identifier (SAI)

March 7, 1977 State AZ Number 77-80-0008

Economic Sec.
Game & Fish
Ag. & Hort.
Az. Atomic Energy
Health
Water
Land
Mineral Resources
Energy Programs
Emergency Services
Renewable Natural Resources
Environmental Studies

Region III
Region IV

From: Arizona State Clearinghouse
1700 West Washington Street, Room 505
Phoenix, Arizona 85007

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RECEIVED MAR 11 1977 STATE LAND DEPT. 865

☐ No comment on this project
☐ Proposal is supported as written
☐ Comments as indicated below

Comments: (Use additional sheets if necessary)

3-16-77

The State Land Department, Division of Natural Resource Conservation has read the Draft Environmental Statement Nevada Test Site, Nye County, Nevada, published January 1977. The Land Department would encourage your proposed experiments on commercial radio-active waste disposal. Arizona is in the process of constructing a nuclear power plant at Palo Verde, and any contribution your work in this area could furnish us would be timely.

Reviewer's Signature: Peggy Spaw (signed) Date: 3-16-77

Title: Administrative Assistant Telephone: 271-4625

TO:

Mr. Robert Jantzen, Director
Game and Fish Dept.
2222 W. Greenway
Phoenix, Arizona 85023

State Application Identifier (SAI)		
March 7, 1977	State AZ	Number 77-80-000

Economic Sec. — Region III
Game & Fish — Region IV
Ag. & Hort.
Az. Atomic Energy
Health
Water
Land
Mineral Resources
Energy Programs
Emergency Services
Renewable Natural Resources
Environmental Studies

From: Arizona State Clearinghouse
1700 West Washington Street, Room 505
Phoenix, Arizona 85007

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- [x] No comment on this project
- [ ] Proposal is supported as written
- [ ] Comments as indicated below

Comments: (Use additional sheets if necessary)

Reviewer's Signature John U Carr — Date March 14, 1977

Title Supv. Planning & Eval. Br. — Telephone 942-300

TO: Col. George B. Jordan, Dir.
Div. of Emergency Services
5636 East McDowell Road
Phoenix, Arizona 85008

State Application Identifier (SAI)

March 7, 1977 State AZ Number 77-80-0008

Economic Sec.
Game & Fish
Ag. & Hort.
Az. Atomic Energy
Health
Water
Land
Mineral Resources
Energy Programs
Emergency Services
Renewable Natural Resources
Environmental Studies

Region III
Region IV

From: Arizona State Clearinghouse
1700 West Washington Street, Room 505
Phoenix, Arizona 85007

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☐ No comment on this project
☐ Proposal is supported as written
☐ Comments as indicated below

Comments: (Use additional sheets if necessary)

Concur in Treaty and recommend continuation of underground testing which limits underground nuclear tests to 150 K.T

Reviewer's Signature George B Jordan

Date March 14, 1977

Title Director of EMERGENCY SERVICES

Telephone 271-4671

TO:

Mr. R. K. Perry, Acting Director
Agriculture & Horticulture Dept.
421 Capitol Annex West
Phoenix, Arizona 85007

State Application Identifier (SAI)

March 7, 1977 State AZ Number 77-80-0008

Economic Sec.
Game & Fish
Ag. & Hort.
Az. Atomic Energy
Health
Water
Land
Mineral Resources
Energy Programs
Emergency Services
Renewable Natural Resources
Environmental Studies

Region III
Region IV

From: Arizona State Clearinghouse
1700 West Washington Street, Room 505
Phoenix, Arizona 85007

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☐ No comment on this project
☒ Proposal is supported as written
☐ Comments as indicated below

Comments: (Use additional sheets if necessary)

Reviewer's Signature R K Perry

Date 3/11/77

Title Acting Dir

Telephone 271-4373

TO: Tom Lynch, Chief
Energy Programs
Room 507
1700 W. Washington
Phoenix, Arizona 85007

State Application Identifier (SAI)

March 7, 1977 State AZ Number 77-80-000

Economic Sec. Region III
Game & Fish Region IV
Ag. & Hort.
Az. Atomic Energy
Health
Water
Land
Mineral Resources
Energy Programs
Emergency Services
Renewable Natural Resources
Environmental Studies

From: Arizona State Clearinghouse
1700 West Washington Street, Room 505
Phoenix, Arizona 85007

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☒ No comment on this project
☐ Proposal is supported as written
☐ Comments as indicated below

Comments: (Use additional sheets if necessary)

Reviewer's Signature T Lynch Date 3-11-77

Title Chief, energy programs Telephone 271-3303

UNITED STATES
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
WASHINGTON, D.C. 20545

Ms. Jo Youngblood
Arizona State Clearinghouse
1700 W. Washington, Room 505
Phoenix, Arizona 85007

Dear Ms. Youngblood:

Thank you for providing comments from the various agencies within the government of the State of Arizona regarding the Energy Research and Development Administration's Draft Environmental Impact Statement on the Nevada Test Site, ERDA-1551-D. The statement has been revised based on the comments received and a copy of the Final Environmental Impact Statement is enclosed for your information.

Your interest in ERDA's program at the Nevada Test Site is appreciated.

Sincerely,

W. H. Pennington, Director
Office of NEPA Coordination

Enclosure:
Final Environmental Impact
Statement, ERDA-1551 (15)

cc: Honorable Raul H. Castro
Governor of Arizona
w/encl.

STATE OF NEVADA
GOVERNOR'S OFFICE OF PLANNING COORDINATION
CAPITOL BUILDING, ROOM 45
CAPITOL COMPLEX
CARSON CITY, NEVADA 89710
(702) 885-4865

April 14, 1977

Mr. James L. Liverman
Assistant Administrator for
Environment and Safety
Energy Research and Development Administration
Washington, D.C. 20545

Re: SAI NV #77800022 - Draft EIS - Nevada Test Site

Dear Mr. Liverman:

Attached are comments from the following affected State Agencies concerning the above referenced Environmental Impact Statement:

Environmental Protection Services
Department of Fish and Game

These comments constitute the State Clearinghouse review of this proposal, and we would appreciate it if you would incorporate these comments in your final Environmental Impact Statement.

Sincerely,

Bruce D. Arkell
State Planning Coordinator

BDA/cc

Attachments

cc: Environmental Protection Services
Department of Fish and Game

STATE OF NEVADA
DEPARTMENT OF HUMAN RESOURCES
ENVIRONMENTAL PROTECTION SERVICES
CAPITOL COMPLEX
CARSON CITY, NEVADA 89710

February 28, 1977

MEMORANDUM

TO: Bruce Arkell, State Planning Coordinator

FROM: Wendell D. McCurry, Water Quality Officer

RE: SAI NV #77800022 - Draft EIS, Nevada Test Site - Nye County

In reference to the above mentioned project, we forward the following comments:

Air Quality Control

All operations must comply with Nevada Air Quality Regulations as enforced by the Environmental Protection Services. There are no comments included regarding ambient air monitoring re: fugitive dust created by processing equipment or possible sources of air contaminant other than radio-active. Why not? (Galen Flinn)

Water Pollution Control

No comment. (Wendell D. McCurry)

Solid Waste Management

No comment. (H. LaVerne Rosse)

pc

cc: Frank Holzhauer

Larry

GLEN K. GRIFFITH
DIRECTOR

MIKE O'CALLAGHAN
GOVERNOR

1100 VALLEY ROAD P.O. BOX 10678 RENO, NEVADA 89510 TELEPHONE (702) 784-6219

March 18, 1977

Mr. Bruce D. Arkell
Planning Coordinator
Governor's Office
Carson City, NV. 89701

Dear Mr. Arkell:

We have received a draft Environmental Statement from the Energy Research and Development Administration relative to the Nevada Test Site Nye County.

We have been requested to comment by the 19th of March and having not heard from your office concerning this subject, we will reply to you for response to the Energy Research and Development Administration, Nevada Operations, Box 14100, Las Vegas, Nevada 89114.

The effects of the establishment of this test site on wildlife result in loss of normal wildlife protection and management practices normally carried on by the Nevada Department of Fish and Game for the entire area. There is a direct loss to the public for normal aesthetic and consumptive use of the wildlife species associated with this area. This loss has further compressed or increased public use for outdoor recreation on the areas surrounding the Nevada Test Site.

Within the document only minor comment is made to the presence of wildlife and the wildlife values. Another indication of this would be the fact that only two pages plus a table, are utilized in describing "predominant wildlife species" in contrast with the 12 pages devoted to "flora" section.

It is understood that this area has been established for a long period of time and is considered one of major importance for National Defense; however, considerations should at least be made that a valuable wildlife resource does exist within the area and that within certain sections, possibilities may be found wherein uses for wildlife and recreation may be developed through the cooperative efforts of the Nevada Department of Fish and Game and the Energy Research and Development Administration.

Sincerely,

Glen

Glen K. Griffith
Director

UNITED STATES
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
WASHINGTON, D.C. 20545

Mr. Bruce D. Arkell
State Planning Coordinator
Governor's Office of Planning
Coordination
State of Nevada
Capitol Building, Room 45
Carson City, Nevada 89710

Dear Mr. Arkell:

Thank you for your letter of April 14, 1977, forwarding Nevada State comments on the Energy Research and Development Administration's Draft Environmental Impact Statement on the Nevada Test Site, ERDA-1551-D. Comments were also received directly from the Nevada State Park System and the Nevada State Museum. These were responded to directly.

The comments from the Nevada Department of Fish and Game have been studied by the Energy Research and Development Administration staff, and staff responses concerning the matters addressed are enclosed.

Your interest in ERDA's program at the Nevada Test Site is appreciated. Your comments have helped us to clarify important aspects of the effects of that program.

Copies of the Final Environmental Impact Statement are enclosed for your information and distribution.

Sincerely,

W. H. Pennington, Director
Office of NEPA Coordination

Enclosures:
1. Staff Responses
2. Final Environmental Impact Statement, ERDA-1551 (6)

cc: Honorable Mike O'Callaghan
Governor of Nevada
w/encls.

ERDA STAFF RESPONSES TO
STATE OF NEVADA COMMENTS ON DRAFT ENVIRONMENTAL IMPACT STATEMENT
FOR THE NEVADA TEST SITE, ERDA-1551-D

Comments numbered in the order in which they appeared in the State of Nevada letter are briefly stated below, followed by staff responses:

1. Comment: The effects of the establishment of this test site on wildlife result in loss of normal wildlife protection and management practices normally carried on by the Nevada Department of Fish and Game for the entire area.

Response: Contrary to the implication that establishment of the NTS results in loss of wildlife protection, it should be pointed out that because NTS is a closed area and is under strict security controls, this particular area gives a higher degree of protection to wildlife than they receive on uncontrolled public lands in Nevada. In addition, our security patrols enhance the closed area protection and are believed to deter molestation or unlawful acts involving the wildlife by personnel assigned to the NTS. In point of fact, the NTS is serving as a wildlife refuge.

2. Comment: There is a direct loss to the public for normal aesthetic and consumptive use of the wildlife species associated with this area. This loss has further compressed or increased public use for outdoor recreation on the areas surrounding the Nevada Test Site.

Response: It is true that there is a loss to the public for normal aesthetic and consumptive use of the wildlife species associated with this area. However, if this loss is to be properly evaluated, then the benefit to the nation should also be factored in: i.e., the NTS is the one and only land area used by the United States to test and certify nuclear weapons for the defense of the country. The importance of the site to the country's defense and the importance of defense to the nation must be weighed as the benefit that counterbalances the cost represented by the loss of this area for other possible uses.

3. Comment: Within the document only minor comment is made to the presence of wildlife and the wildlife values. Another indication of this would be the fact that only two pages plus a table, are utilized in describing "predominant wildlife species" in contrast with the 12 pages devoted to "flora" section.

Response: There are a number of plant species found on the test site that are candidates for designation as endangered or threatened status by the U.S. Fish and Wildlife Service; on the contrary, there are no known species of wildlife resident on the test site that are either on the endangered or threatened list. Therefore, since the NTS flora require more attention they received more attention in the EIS than the fauna.

4. Comment: It is understood that this area has been established for a long period of time and is considered one of major importance for National Defense; however, considerations should at least be made that a valuable wildlife resource does exist within the area and that within certain sections, possibilities may be found wherein uses for wildlife and recreation may be developed through the cooperative efforts of the Nevada Department of Fish and Game and the Energy Research and Development Administration.

Response: Earlier in 1977, a five-party interagency cooperative wildlife management agreement was signed by ERDA and the Nevada Department of Fish and Game (the other signators were the U.S. Air Force, U.S. Fish and Wildlife Service, and Bureau of Land Management). As stated in that agreement, public access to ERDA-controlled land areas is not envisioned and this, of course, rules out use of ERDA land for hunting or other forms of recreation. Therefore, the urging by Nevada Fish and Game that NTS be considered for recreation use is not consonant with the interagency agreement recently signed by our two agencies.

There are three particularly important reasons why ERDA has taken the position that hunting should not be allowed on the NTS. These are:

a. Strangers, not programmatically involved with the NTS, are not welcome as there are many locations on the Test Site where there would be safety or security problems if visitors were allowed to roam indiscriminately.

b. Stray bullets from hunters would pose an undefinable and unacceptable hazard to NTS personnel, facilities, and experiments.

c. Although the possibility of hazard is believed to be very small, we do not allow wild or domestic animals or birds to be taken from the Test Site for use as human food because of the latent possibility they might be contaminated with radionuclides.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

MAY 27 1977

Mr. W. H. Pennington
Director, Office of NEPA Coordination
U.S. Energy Research and Development
Administration
Washington, D.C. 20545

Dear Mr. Pennington:

The Environmental Protection Agency has reviewed the draft environmental impact statement for the Nevada Test Site in Nye County, Nevada (ERDA-1551-D). As stated, the statement was prepared to assess the environmental impact of the continuation of ERDA's underground nuclear testing program and other activities at the Nevada Test Site (NTS) for Fiscal Year 1978 and beyond. The statement addressed those environmental consequences that may not have been fully evaluated at the outset or at each stage of the testing program, and serves as a base for evaluating the environmental impact of future actions in relation to the existing environment at the Nevada Test Site and surrounding area. In addition, we reviewed the current ERDA radiation monitoring program to determine if contamination is presently reaching the environment and if the ERDA monitoring program has the capability to predict the present and future impact of underground nuclear testing on the environment.

Our primary conclusion is that, given the requirement for testing, the proposed underground testing program can be conducted with an acceptable environmental impact. EPA believes that the draft environmental statement (ERDA-1551-D) presents an adequate evaluation of that environmental impact. However, the final statement should include additional information on the radiation guidance which is used for the Nevada Test Site. Specifically, in Section III. A. 3. C. (pp 3-14 thru 3-16), radiation guidelines are discussed. It is indicated that measures will be taken to assure that the whole body exposure to any off-site population group does not exceed 0.170 R per year. This is discussed in the context of a single event or test. It is conceivable that a population could be exposed to radioactive materials from more than one event, wherein the projected whole body exposures could exceed 0.170 R. The ERDA policy regarding this contingency should be presented.

In addition, the identification of the applicable radiation protection guides to off-site populations should be made for "normal operations" as well as for emergency or accident conditions.

In EPA comments on the supplement to WASH-1526, submitted in August, 1975, we presented similar questions concerning the individual dose, both whole body and organ dose, and the dose commitment to the Nevada Test Site and surrounding area. These questions persist when considering the radiation exposure criteria for planned tests. The rationale or basis for ERDA's test criteria should be presented in the Final Statement to clarify this issue.

For example, EPA has protective action guidance (PAG's) under development wherein mitigating actions are to be considered or taken at exposure levels ranging from one to five R. The EPA draft PAG's are based on the fact that the likelihood of an individual receiving such a dose more than once in his lifetime is extremely low, since the probability of an event leading to such exposures is low. The most frequently considered accident case to which PAG's are applied is an accident at a LWR where extensive engineering safety features are utilized to insure that probabilities and consequences of accidents are low. When applying PAG's to underground tests, however, it is not immediately clear that the probability of accidents leading to such exposures is low. If the probability is high that individuals could receive repeated exposures in the above stated range from underground test accidents, EPA is concerned that the total exposure may be found unacceptable. In addition, we are also concerned over the relationship of these test criteria to individuals whose past exposures may be in, or may have exceeded this range.

We believe a much more detailed evaluation of the potential doses resulting from test accidents and the likelihood of these accidents occurring is needed to permit judgements to be made concerning the adequacy of the exposure criteria as presented in the draft statement.

We believe that the information which we have requested is necessary for a fuller understanding of the potential impact of the continuing underground nuclear test program. We recognize, however, that this program has been conducted in the past without major environmental problems, and believe that its continuation also can be carried out safely. In light of our review and in accordance with EPA procedure, we have rated the draft statement as Category 2 (Insufficient Information) and the proposed actions as LO (Lack of Objections). If you or your staff have any questions concerning our classification or comments, please do not hesitate to call on us.

Sincerely yours,

Rebecca W. Hanmer

Rebecca W. Hanmer
Director
Office of Federal Activities (A-104)

UNITED STATES
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
WASHINGTON, D.C. 20545

Ms. Rebecca W. Hanmer
Director
Office of Federal Activities (A-104)
U.S. Environmental Protection Agency
Washington, D.C. 20460

Dear Ms. Hanmer:

Thank you for your letter dated May 27, 1977, which provided the Environmental Protection Agency's comments on the Energy Research and Development Administration's Draft Environmental Impact Statement on the Nevada Test Site, ERDA-1551-D. The statement has been finalized, taking into account the comments received.

You commented that the ERDA statement should address the possibility of multiple exposures to radioactive materials which could lead to offsite population group exposures exceeding 0.170 R per year. As indicated in the statement, estimations are made prior to each test of the offsite exposures that could result from the most probable venting. If these estimates indicate that there are offsite population groups where the 0.170 R per year dose limitation would be exceeded in case of the worst accident, and if prevention actions to reduce whole-body doses are not feasible, the event will be postponed until more favorable conditions prevail. However, where a population group might accidentally have received some radiation exposure, the subsequent test operations would have to be controlled so that another accidental release could not lead to exposing that group to a total radiation exposure exceeding 0.170 R per year.

Your comments call for identification of the applicable radiation protection guides to offsite populations for normal operations. It must be made clear that under all but emergency conditions there are no radiation exposures to offsite populations.

Your next question is with regard to doses and dose commitments for the NTS and the offsite areas. The pertinent dose limit information can be found at pages 3-14 through 3-16. It should be noted that the radiation exposure criteria used by ERDA for its underground testing activities conform with criteria provided by the Federal Radiation Council and used throughout the United States for radiation protection. Regarding dose commitments, there would be none for normal operations; the dose commitment in the event of an accidental venting would depend upon the size of that venting and the population sector that happened to be in the path of that vented radioactivity.

The protective action guides which EPA has under development will be of interest to ERDA. If one compares EPA's guideline levels of 1 to 5 R with the 0.170 R level which has been applied in the case of accidental nuclear test ventings, the ERDA guide proves very conservative. The probability of a venting that would cause offsite exposures in excess of 0.170 R is extremely remote. No such exposure has occurred since 1962; meanwhile the containment methods have had dramatic improvements over that period.

Your next comment deals with the likelihood of the testing accidents that might cause radiation exposures. Unlike operations with nuclear reactors, underground nuclear test operations are not of a nature such that there can be quantitative evaluation of accident probabilities. Because of this situation, ERDA has elected to use the 0.170 R FRC exposure limit which has been found acceptable for protection of the general population.

Regarding EPA's evaluation that the Draft Environmental Impact Statement contained insufficient information, it is hoped that the above explanations relative to the EPA questions and additional information included in the Final Environmental Impact Statement will furnish a better understanding of the matters involved and satisfy this deficiency. Copies of the Final Environmental Impact Statement are enclosed for your information.

Sincerely,

W. H. Pennington, Director
Office of NEPA Coordination

Enclosure:
Final Environmental Impact
Statement, ERDA-1551 (2)

cc: (see attached)

3cc: EPA w/encl.

Chief
Energy Systems Analysis Branch (AW-459)
Office of Radiation Programs
Environmental Protection Agency
Room 645 East Tower
401 M Street, SW.
Washington, D.C. 20460 (3)

Director
Las Vegas Radiation Operations
Environmental Protection Agency
P. O. Box 15027
Las Vegas, Nevada 89114 (1)

Patricia Port
Environmental Protection Agency
Region IX
100 California Street
San Francisco, California 94111 (3)

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The protective action guides which EPA has under development will be of interest to ERDA. If one compares EPA's guideline levels of 1 to 5 R with the 0.170 R level which has been applied in the case of accidental nuclear test ventings, the ERDA guide proves very conservative. The probability of a venting that would cause offsite exposures in excess of 0.170 R is extremely remote. No such exposure has occurred since 1962; meanwhile the containment methods have had dramatic improvements over that period.

Your next comment deals with the likelihood of the testing accidents that might cause radiation exposures. Unlike operations with nuclear reactors, underground nuclear test operations are not of a nature such that there can be quantitative evaluation of accident probabilities. Because of this situation, ERDA has elected to use the 0.170 R FRC exposure limit which has been found acceptable for protection of the general population.

Regarding EPA's evaluation that the Draft Environmental Impact Statement contained insufficient information, it is hoped that the above explanations relative to the EPA questions and additional information included in the Final Environmental Impact Statement will furnish a better understanding of the matters involved and satisfy this deficiency. Copies of the Final Environmental Impact Statement are enclosed for your information.

Sincerely,

W. H. Pennington, Director
Office of NEPA Coordination

Enclosure:
Final Environmental Impact Statement, ERDA-1551 (2)

cc: (see attached)

3cc: EPA w/encl.

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