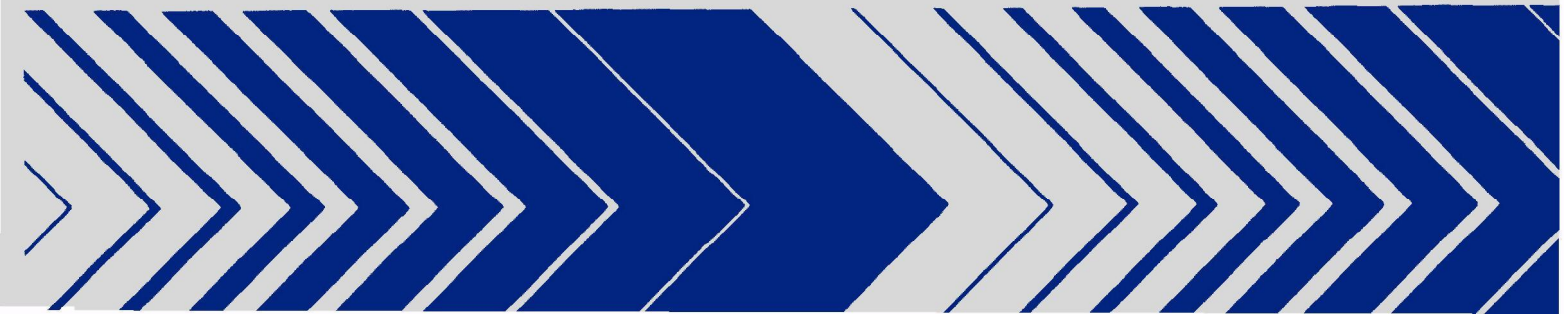




Animal Investigation Program 1980 Annual Report:

Nevada Test Site and vicinity

prepared for the
U.S. Department of Energy
under Interagency Agreement
Number DE-AI08-76DP00539



Available from the
National Technical Information Service
U.S. Department of Commerce
Springfield, VA 22161

Price Code: Paper copy, A04
Microfiche, A01

ANIMAL INVESTIGATION PROGRAM 1980 ANNUAL REPORT
Nevada Test Site and Vicinity

D. D. Smith, K. R. Giles
Nuclear Radiation Assessment Division
Environmental Monitoring Systems Laboratory

D. E. Bernhardt
Office of Radiation Programs, Las Vegas Facility
U. S. Environmental Protection Agency
Las Vegas, Nevada 89114

prepared for the
U.S. Department of Energy
under Interagency Agreement
Number DE-AI08-76DP00539

ENVIRONMENTAL MONITORING SYSTEMS LABORATORY
OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY
LAS VEGAS, NEVADA 89114

DISCLAIMER

This report has been reviewed in accordance with the U.S. Environmental Protection Agency's peer and administrative review policies and approved for publication. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

ABSTRACT

Data are presented from the radioanalyses of tissues collected from cattle, mule deer, desert bighorn sheep, rabbits, and a horse that resided on or near the Nevada Test Site during 1980. Routine and special activities of the Animal Investigation Program are also discussed.

Other than the naturally occurring potassium-40, gamma-emitting radionuclides were detected infrequently. Iodine-131 was found in the thyroid of a deer 3 weeks after a nuclear test by the People's Republic of China.

Strontium-90 concentrations in bones from deer, cattle, and desert bighorn sheep were similar to those of recent years. Plutonium levels in all tissues from all species showed little variation from those levels in samples collected in recent years. Radionuclide concentrations were generally higher in the tissues of animals residing in Area 15 than in similar animals collected from other Nevada Test Site areas. Surface soil samples from the Area 15 farm contained plutonium-238 and -239 in nanocurie per kilogram concentrations.

Hypothetical annual dose estimates to man were calculated on the basis of the daily consumption of 0.5 kilogram of liver or muscle from animals that contained peak radionuclide levels. The highest postulated dose was 0.4 millirems to whole body for cesium-137 in muscle obtained from cattle. This dose is about 0.1 percent of the 500 millirems per year radiation protection guide for individuals in the general population. All other postulated doses for consumption of tissues containing other radionuclides were less than 0.1 percent of the standard.

Gross and microscopic lesions found in necropsied animals were similar to those found in animals in other areas of the U.S. and would not be attributable to ionizing radiation exposure.

The movements of 26 mule deer fitted with collars containing a radio transmitter unit were monitored weekly. By mid-December, all deer had left their summer range on the mesas of the Nevada Test Site. In general, deer captured on Pahute Mesa spend the winter in the 40-Mile Canyon and Timber Mountain area with some movement off the NTS toward Beatty, while those captured on Rainier Mesa winter in the Shoshone Mountain area. A deer captured in December 1979 was observed in July and August 1980 in the Barley Creek area of Nye County, which is approximately 160 kilometers from its capture point. NTS mule deer population estimates were made for 1978, 1979 and 1980 through the Peterson-Lincoln index based on weekly sightings.

CONTENTS

	<u>Page</u>
Abstract.	iii
Figures	vi
Tables.	vii
 Introduction.	 1
Sample Collection	2
Analytical Procedures and Methods	7
Results and Discussion.	9
Quality assurance samples.	9
Nevada Test Site cattle.	9
Nevada Test Site mule deer	11
Desert bighorn sheep	11
Nevada Test Site horse	12
Nevada Test Site rabbits	12
Area 15 soil	13
Nevada Test Site spring waters	13
Necropsy and histopathological examinations.	14
Hypothetical dose estimates.	14
Other Activities.	18
Deer migration study	18
Deer census.	22
Beef herd.	23
Area 15 farm	23
Public information	24
Special studies.	24
Investigations	24
References.	25
List of Appendix Tables	28

FIGURES

<u>Number</u>		<u>Page</u>
1	Sampling sites on the Nevada Test Site.	3
2	Approximate collection sites of 1980 desert bighorn sheep	6
3	Annual averages of strontium-90 in bones of cattle, deer, and desert bighorn sheep, 1956-1980	10
4	Mule deer capture and wintering areas, 1980	21

TABLES

<u>Number</u>		<u>Page</u>
1	Sampling Information for Nevada Test Site Cattle, 1980.	2
2	Sampling Information for Nevada Test Site Animals, 1980	4
3	Sampling Information for Desert Bighorn Sheep, 1980	5
4	Plutonium Concentrations in Soil from the Area 15 farm, 1980. . . .	13
5	Tritium and Gamma Analyses of Nevada Test Site Spring Waters, 1980	13
6	Summary of Peak Radionuclide Concentrations in Selected Tissues from Nevada Test Site Animals, 1980	15
7	Postulated Dose to Man Following Ingestion of Selected Tissues for 1 year.	17
8	Deer Capture Information, 1980.	19
9	Deer Population Estimates by the Peterson-Lincoln Index Method for 1978, 1979, and 1980	22

INTRODUCTION

Since 1964, the U.S. Environmental Protection Agency's (USEPA) Environmental Monitoring Systems Laboratory at Las Vegas (EMSL-LV) has conducted the Animal Investigation Program (AIP) for the Nevada Operations Office of the U.S. Department of Energy. During 1980, the major objectives of the AIP continued to be:

1. To conduct surveillance of domestic and wild animals on and around the Nevada Test Site (NTS) in order to assess the radionuclide burden present in their tissues and to detect pathological effects from the burdens.
2. To investigate alleged damage to domestic animals and wildlife resulting from the activities of the Nevada Operations Office of the U.S. Department of Energy.
3. To provide public information through education and veterinary advice to the offsite population.
4. To conduct special ad hoc investigations.

Progress during 1980 in achieving these objectives and summaries of the data collected are presented in this report. Previously published reports (Fountain 1961; Smith and Giles 1970, 1974, and 1975; and Smith et al. 1976, 1977a, 1977b, 1978a, 1978b, 1979, 1980, and 1981) have detailed the history, evolution, and accomplishments of the AIP since its beginning in 1957.

SAMPLE COLLECTION

Nevada Test Site animals sampled during 1980 included cattle, mule deer, rabbits and a horse. Desert bighorn sheep that range the mountainous areas to the south and east of the NTS were also sampled. Animals sampled included those that died from natural causes or through accidents, those collected through the cooperation of licensed hunters, and those that were sacrificed as part of the routine sampling activities of the program.

Animals collected by rifle or shotgun fire were necropsied immediately after death and any gross pathological conditions noted. Animals collected by other means were also necropsied if a prosector was available. If advanced postmortem changes had not occurred, the adrenals, eyes, heart, kidneys, liver, lungs, muscle, spleen, thyroid, gonads, and gross lesions (if any) were sampled and prepared for histopathological evaluation. Tissues collected from large animals for radioanalyses included rumen or stomach contents, liver, lungs, tracheobronchial lymph nodes, muscle, thyroids, blood, kidneys, fetus (if present), and bone (femurs or hock). Tissues collected from the rabbits for radioanalyses included bone from the entire skeleton, muscle, skin, entire gastrointestinal tract, and composited internal organs (liver, lungs, kidneys, and spleen).

Six beef cattle from the NTS herd were sampled during 1980. Sampling information is presented in Table 1. Except for a brief weaning period, when the calves were maintained at the Area 15 farm, each animal sampled spent its entire life grazing on the Area 18 range of the NTS (Figure 1). The management of the beef herd and soil and range surveys of the Area 18 grazing area have been published previously (Smith 1970, Leavitt 1970, and Brown and Mason 1968).

TABLE 1. SAMPLING INFORMATION FOR NEVADA TEST SITE CATTLE, 1980

Animal Number	Sex	Age (years)	Weight (kg)	Date Sampled	Remarks
1	M	1	302	05/14	Bull in good condition
2	F	3	323	05/14	Cow in fair condition
3	F	2 weeks	50	05/14	Calf in good condition, Dam was Animal No. 2
4	F	7.5	523	10/08	Beginning ocular squamous cell carcinoma
5	F	7.5	500	10/08	Advanced ocular squamous cell carcinoma--pregnant
6	M	0.5	175	10/08	Bull calf in good condition

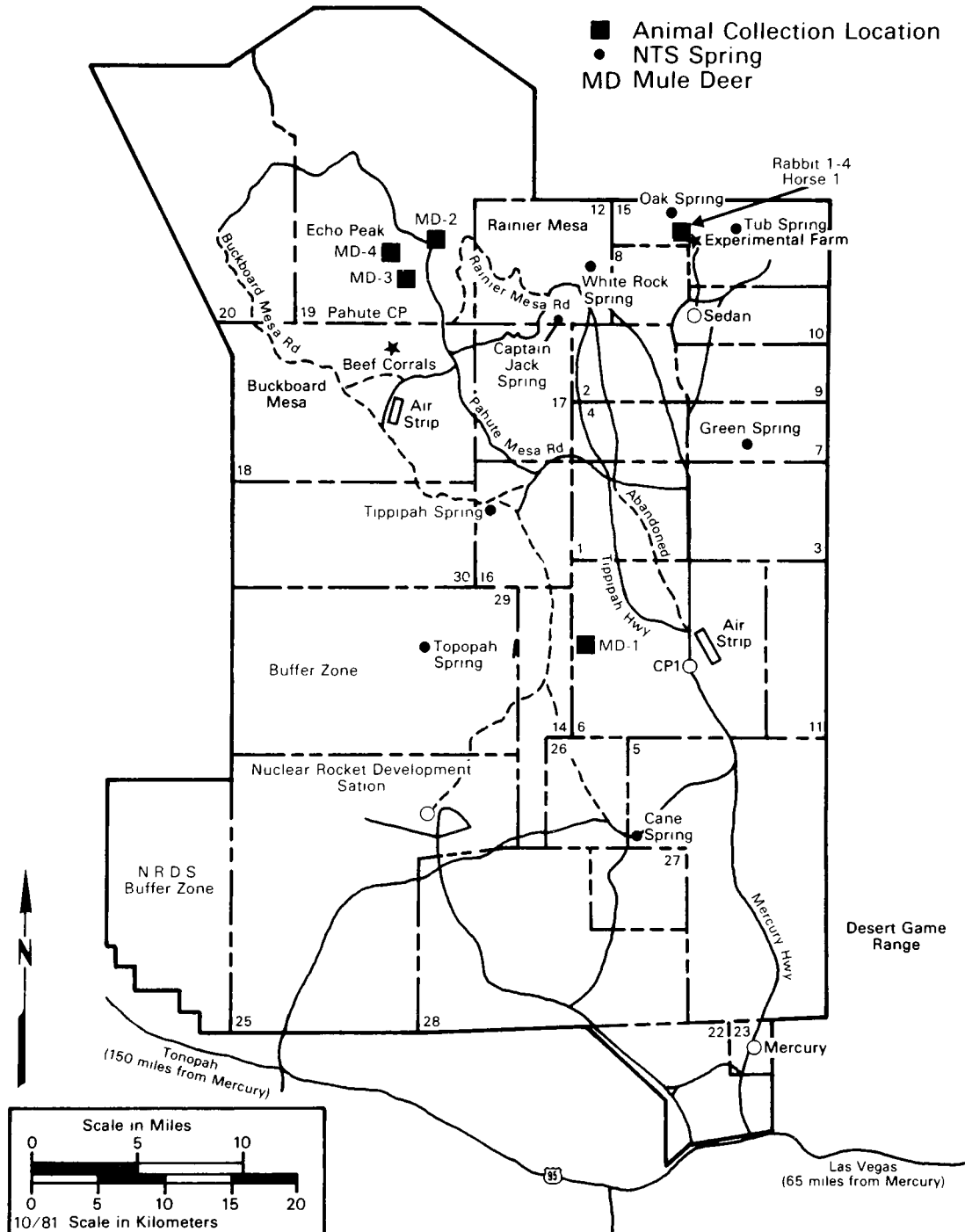


Figure 1. Sampling sites on the Nevada Test Site.

AIP investigators collected tissue samples from four NTS adult mule deer (Odocoileus hemionus). Four jackrabbits (Lepus californicus) were collected at the Area 15 experimental farm. Also a horse (Equus caballus) from the NTS was sampled. Collection locations are noted on Figure 1 and sampling information is listed in Table 2.

Through the cooperation of State and Federal wildlife officials and participating hunters, bone and kidney samples were collected from 14 mature desert bighorn sheep rams (Ovis canadensis nelsoni) during the annual hunt.

TABLE 2. SAMPLING INFORMATION FOR NEVADA TEST SITE ANIMALS, 1980

Animal Number	Sex	Estimated Age (years)	Estimated Weight (kg)	Date Sampled	Remarks
Mule Deer-1	M	5	80	03/27	Collected at Mine Mountain, had been tracked with radiotelemetry, collar applied in June of 1977
Mule Deer-2	F	3-4	60	07/28	Accident victim Area 19, lactating doe
Mule Deer-3	M	1-2	50	09/10	Killed during capture attempt, Echo Peak region of Area 19
Mule Deer-4	M	1.5	55	11/06	Collected Trap Site, Area 19
Horse-1	M	25	420	10/08	Aged domestic horse that was euthanized
Rabbit-1-A15	M	1-2	2.2	03/05	Jackrabbit, collected Area 15 farm
Rabbit-2-A15	M	<2	2.3	03/05	Jackrabbit, collected Area 15 farm
Rabbit-3-A15	F	<2	2	03/05	Jackrabbit, collected Area 15 farm
Rabbit-4-A15	M	1-2	2.2	03/05	Jackrabbit, collected Area 15 farm

Sampling information for these animals is presented in Table 3 and the collection sites are shown in Figure 2. The majority of the sheep were collected from Clark County in southern Nevada, with five coming from the Desert National Wildlife Range (DNWR). Two animals were collected from the Silver Peak and Lone Mountain areas which are north and west of the NTS.

TABLE 3. SAMPLING INFORMATION FOR DESERT BIGHORN SHEEP, 1980

Animal Number	Sex	Estimated Age (years)	Date Collected	Remarks
1	M	9	11/19	Killed at DNWR, Area 76*
2	M	6	12/07	Killed North Eldorado Range, Area 85*
3	M	5	11/21	Killed Arrow Canyon Range, Area 79*
4	M	8	11/15	Killed Cathedral Mountain in Black Mountains, Area 81*
5	M	8	11/23	Killed Joe May Canyon, Sheep Range DNWR, Area 77*
6	M	5	11/21	Killed Gass Peak, Area 78*
7	M	5	11/16	Killed Mormon Mountains, Area 80*
8	M	5	11/22	Killed North Eldorado Range, Area 85*
9	M	5	11/22	Killed Area 71*
10	M	6	11/10	Killed White Rock Spring, DNWR, Area 77*
11	M	8	11/10	Killed McCullough Range, Area 84*
12&13	M	9	11/17	Killed East DNWR, Area 75*. Duplicate samples were collected from the same animal and identified as No. 12 and No. 13.
14	M	6	11/26	Killed Newberry Range, Area 86*
15	M	10	11/25	Killed Rhyolite Ridge, Silver Peak Range, Area 70*

DNWR = Desert National Wildlife Range

*Nevada Wildlife Department Bighorn Sheep Management Area

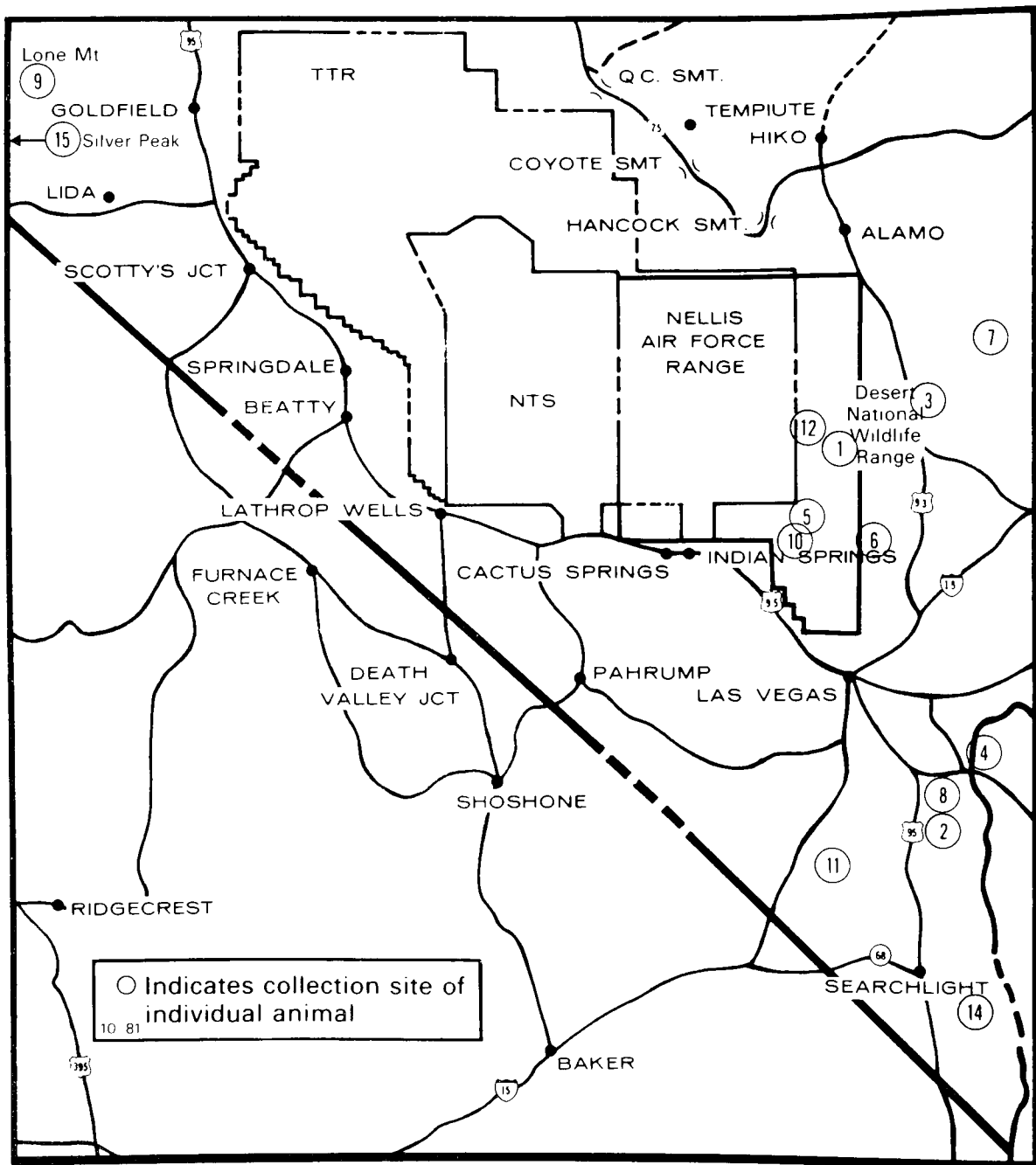


Figure 2. Approximate collection sites of 1980 desert bighorn sheep.

ANALYTICAL PROCEDURES AND METHODS

Gamma-emitting radionuclides in samples of soft tissues and rumen contents were analyzed by gamma spectrometry. A sample of blood or of tissue was collected from each animal and analyzed for tritium. Bone samples were analyzed for strontium-89 and -90 and plutonium-238 and -239. Selected soft tissues were also analyzed for plutonium content. The EMSL-LV performed all of the analyses for tritium and the gamma-emitting radionuclides. The Environmental Sciences Department of the Reynolds Electrical and Engineering Company, Inc. (REECo), Mercury, Nevada, performed the plutonium and strontium analyses.

Rumen contents and soft tissues of sufficient volume were placed in 300-milliliter aluminum containers with a 10-percent Formalin® solution as a preservative. The containers were then sealed and stored for gamma analysis. Those tissues of smaller volume, i.e., thyroid gland, tracheo bronchial lymph nodes, etc., were first macerated in a blender and then brought to a standard volume by suspending in agar. These samples were also sealed in 300-milliliter aluminum containers. Muscle, liver, lungs, kidneys, and fetal samples were counted for approximately 1,200 minutes on lithium-drifted germanium detectors calibrated at approximately 0.5 kilo-electronvolts (keV) per channel in the 60-KeV to 2-mega-electronvolts (MeV) range. These detectors are connected to a Nuclear Data 6620 computerized gamma spectral accumulation and analysis system. Other tissue samples such as thyroid, tracheobronchial lymph node, skin, and gonad, as well as rumen or stomach and gastrointestinal contents, were counted for 1,000 minutes using a 4- by 4-inch NaI(Tl) crystal also connected to the Nuclear Data 6620 for spectral accumulation. This spectrometer is calibrated at 10 KeV per channel in the 60-KeV to 2-MeV range. The data reduction of the spectra was performed using a least squares program resident on a CDC-6400 computer.

Tissues collected for strontium and plutonium analyses were placed in plastic bags and kept frozen until submitted to the analytical laboratory. The samples were prepared for analyses by ashing and radiochemical separation. Plutonium was analyzed by alpha spectrometry using plutonium-236 as an internal tracer. Details of the analytical procedures used by REECo are proprietary information but are similar to those described by Talvitie 1971, 1972; Wish and Rowell 1956; Mitchell 1960; Hagan and Arrhenius 1963; and Major et al. 1975. The EMSL-LV radionuclide analytical procedures were those described by Johns et al. (1979).

All data are reported with the 95 percent confidence interval based on counting statistics and are corrected to time of sample collection. The minimum detectable activity (MDA) is defined as 3.3 times the standard

deviation of the background counts. Results which show a net sample activity less than the MDA are reported as such. The approximate MDAs and analytical procedures are summarized in Appendix A.

The activity values for plutonium-239 listed in this report are actually the sums of the individual isotopic activities of plutonium-239 and -240. The alpha emissions of these two isotopes cannot be separately identified (resolved) by alpha spectrometric analysis.

Quality assurance samples were included in each group of samples submitted for plutonium analyses. These were either liver, muscle or bone samples purchased at a local meat market and to which a known amount of plutonium was added, or they were duplicate samples collected from sacrificed animals and submitted for analyses under blind identification numbers. The purchased bone samples were ashed prior to spiking. The data from the quality assurance samples are presented in Appendix B.

Tissue and lesion samples collected for histopathological examination were fixed with a 10-percent Formalin solution and delivered to a pathologist for interpretation.

RESULTS AND DISCUSSION

QUALITY ASSURANCE SAMPLES

As shown in Appendix B, the strontium-90 and plutonium-239 analytical data from a duplicate bighorn sheep bone sample indicate a precision of analyses of 4 percent and 27 percent, respectively. The accuracy of analysis, expressed as bias, is also shown in Appendix B. Based on the precision and bias data for strontium-90 analyses, the 95 percent confidence interval for the true value was calculated to range from 1.68 to 1.84 times the reported value in bone and from 1.07 to 1.23 times the reported value in soft tissue. The 95 percent confidence interval of the true value for plutonium-239 in bone ranged from 0.98 to 2.05 times the reported value while that for soft tissue ranged from 0.95 to 2.03 times the reported value. These confidence intervals were considered when conclusions were drawn from the data.

NEVADA TEST SITE CATTLE

The analytical results from tissues collected from the Area 18 beef cattle are presented in the tables of Appendix C.

Naturally occurring potassium-40 was the only gamma-emitting radionuclide consistently detected in both the May and October samples. Cesium-137 was occasionally detected in the ingesta or soft tissue samples. If detected, the cesium-137 levels were within a narrow range of activity; for example, five of six muscle samples contained detectable levels ranging from 15 to 37 picocuries per kilogram (pCi/kg) wet weight.

Tritium was not detected in the blood of any of the cattle sampled during 1980.

Strontium-90 concentrations in the femur samples from the Area 18 cattle ranged from 2.4 to 3.1 picocuries per gram (pCi/g) of ash with an average of 2.8. As shown in Figure 3, this average value is similar to those reported in recent years, except for that of 1979 which was significantly lower. As explained previously (Smith et al. 1981a) the 1979 average was thought to be due to bias in the analyses by the analytical laboratory. Strontium-89 was not detected in any of the 1980 bone samples. It was planned to limit plutonium analyses to those tissues collected during the spring, because of budgetary restraints and the consistent findings of previous years. However, a power outage in June at the Area 15 farm resulted in the loss of all frozen samples. Because of this, the fall samples were submitted for plutonium and strontium analyses. Ingesta samples were not collected as the cattle were maintained on purchased alfalfa hay for several days prior to death.

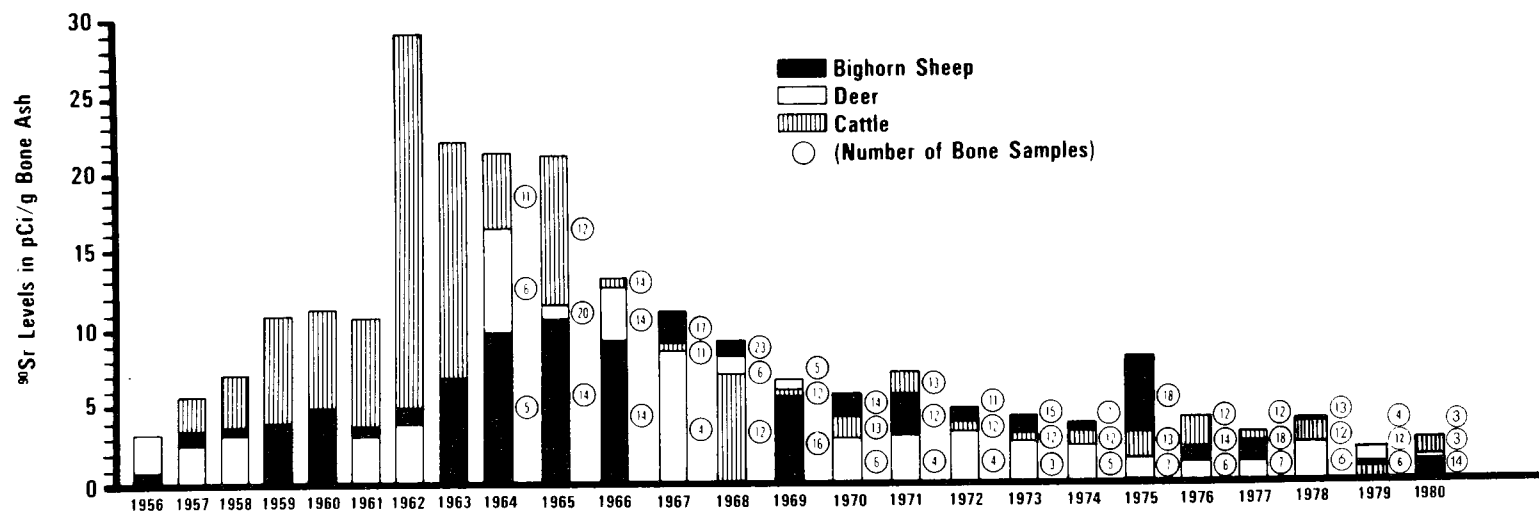


Figure 3. Annual averages of strontium-90 in bones of cattle, deer, and desert bighorn sheep, 1956-1980.

Detectable plutonium-238 concentrations were not found in any of the soft tissue samples and in only one bone sample. Liver and lung samples generally contained detectable plutonium-239 concentrations while muscle, fetal and gonad tissues did not. The lung and liver concentrations and those in the femurs (which ranged from 1.5 to 4.2 pCi/kg wet weight), were not significantly different from concentrations reported in recent years.

NEVADA TEST SITE MULE DEER

The analytical results from tissues of the NTS mule deer are presented in the tables of Appendix D. As was the case for the NTS cattle, naturally occurring potassium-40 was the only gamma-emitting radionuclide that was consistently detected. Cesium-137 was detected in one kidney sample. The thyroid from deer No. 4, collected on November 6, 1980, contained 22 ± 1.9 pCi of iodine-131 per gram (wet weight). The source of this iodine is thought to be airborne fallout from a nuclear test conducted by the People's Republic of China on October 15, 1980 (Smith, et al. 1981b).

Tritium concentrations in the blood or kidneys of the deer ranged from <330 to 470 pCi/l. These levels are well within the range found in atmospheric moisture at Beatty, Nevada (Smith, et al. 1981).

Strontium-90 concentrations in hock bones ranged from 0.95 to 2.2 pCi/g of ash with an average of 1.7 pCi/g ash (Figure 3). Strontium-89 was not detected in any of the bone samples.

Plutonium-238 and -239 were found in measurable amounts only in the rumen content samples, one bone sample, and one gonad sample. The plutonium-239 concentration of 1.2 ± 0.52 pCi/kg in the gonads from mule deer No. 3 is very similar to a value reported in 1979 (Smith, et al. 1981a). The plutonium-239 content of all lung and liver samples was below the MDA, contrary to the results of previous years (Smith, et al. 1980, 1981a). This may have been caused by the use of a different analytical laboratory for this year's samples.

DESERT BIGHORN SHEEP

Analytical data from bone and kidney samples are listed in Appendix E. The average strontium-90 concentration in the hock bones was 1.5 pCi/g of ash (Figure 3). Detectable levels of strontium-89, plutonium-238 and -239 were not present in any of the animals sampled. Detectable levels of plutonium-239 have generally been reported in 10 to 25 percent of the bone samples analyzed during the last few years.

Cesium-137 concentrations ranging from 31 to 91 pCi/kg wet weight were detected in the kidneys of only two of the sheep. Tritium was not found in any of the kidney samples.

NEVADA TEST SITE HORSE

An aged domestic horse from the Area 15 farm was euthanized and sampled in October. The analytical data from the samples are listed in Appendix F. Naturally occurring potassium-40 was the only gamma-emitting radionuclide detected. A blood sample contained less than 400 pCi of tritium per liter.

The bone ash contained 3.5 ± 0.5 picocuries of strontium-90 per gram of ash. Net strontium-89 activities were not reported. Net plutonium-239 activities were found in the liver and lung samples with 13 ± 1.4 and 4.7 ± 0.56 picocuries per kilogram of wet weight, respectively.

NEVADA TEST SITE RABBITS

Four jackrabbits from the Area 15 experimental farm were collected and sampled in March. Analytical data from analyses of their tissues are summarized in the tables of Appendix G. Cesium-137 and potassium-40 were present in all soft-tissue samples. Cesium-137 concentrations in muscle tissues ranged from 82 to 130 pCi/kg wet weight with a median value of 93 pCi/kg, while the values in skin ranged from 130 to 250 pCi/kg with a median value of 170 pCi/kg. The gastrointestinal sample from rabbit No. 3 contained 130 pCi of cobalt-60 and rhodium-102m, 2,300 pCi of cesium-137, and 4,300 pCi of plutonium-239 per kilogram of fresh tissue. However, the concentrations of gamma-emitting radionuclides and plutonium found in the soft tissues and bones of this animal were not significantly higher than those reported from the other three rabbits sampled.

Tritium concentrations in the aqueous portion of the Area 15 rabbit tissues were all above the lower limit of detection with a median value of 4,700 pCi/l and a range of 1,200 to 6,500 pCi/l. The tritium source is believed to be the Sedan Crater which is approximately 1 mile south of the farm.

Strontium-90 values in bone ranged from 1.5 to 3.5 pCi/g of ash with a median value of 1.5 pCi/g. Strontium-89 was not detected in the bone samples. Plutonium-239 was detected in 2 of 4 muscle samples and all three of the internal organ samples. These activities reported were generally higher than those found in other NTS animals sampled during 1980.

Plutonium concentrations in those samples subject to external contamination, i.e., the gastrointestinal tract and the skin, were markedly higher than the internal tissues. Plutonium concentrations detected in the rabbit muscle tissue were usually higher than those reported for the cattle.

These findings and similar ones noted for Area 15 animals in previous reports (Smith et al. 1977b, 1978a, 1978b, 1979, 1980 and 1980a) indicated that the environs of Area 15 contain elevated levels of tritium and plutonium when compared to other NTS areas that are frequently sampled by the AIP.

AREA 15 SOIL

In view of the above findings, surface soil samples (0 to 5 cm) from the Area 15 farm were collected and analyzed for plutonium content by the Environmental Sciences Department of REECo. As shown in Table 4, all soil samples contained plutonium with higher levels present in samples from the undisturbed soil. These findings indicate that the apparently elevated plutonium concentrations reported for the gastrointestinal tract and skin samples from the Area 15 rabbits are reasonable.

TABLE 4. PLUTONIUM CONCENTRATIONS IN SOIL FROM THE AREA 15 FARM, 1980

Soil Type	Plutonium-239 (nCi/kg)	Plutonium-238 (nCi/kg)
Plowed	4.8 ± 0.67	0.57 ± 0.098
Plowed	2.7 ± 0.4	0.42 ± 0.075
Plowed	2.9 ± 0.38	0.34 ± 0.054
Unplowed	5.3 ± 0.64	1.3 ± 0.19
Unplowed	7.5 ± 1.4	0.71 ± 0.16
Unplowed	5.8 ± 1.1	0.72 ± 0.1
Unplowed	5.3 ± 1.0	1.1 ± 0.16

NEVADA TEST SITE SPRING WATERS

Several natural springs that serve as a source of water for wildlife were sampled during 1980. The spring locations are shown in Figure 1. The waters were analyzed for gamma-emitting radionuclides and tritium. The results are shown in Table 5. Detectable levels of gamma-emitting radionuclides were not found in any of the waters and the tritium levels were below detectable concentrations.

TABLE 5. TRITIUM AND GAMMA ANALYSES OF NEVADA TEST SITE SPRING WATERS, 1980

Spring Name	Date Sampled	Water Analysis	
		Gamma Analysis	Tritium pCi/l
Cane	5/7	GSN*	<310
Topopah	5/7	GSN	<310
Tippipah	5/7	GSN	<310
Green	5/7	GSN	<310
White Rock	5/7	GSN	<310
Oak	5/7	GSN	<310
Tub	5/7	GSN	<310

*GSN = Gamma Spectrum Negligible

NECROPSY AND HISTOPATHOLOGICAL EXAMINATIONS

Sacrificed animals were necropsied and selected tissue and lesion samples were collected for histopathological evaluation. The gross and microscopic pathologies observed are summarized in Appendix H.

Sarcocystis spp. were detected in the skeletal and cardiac muscles of both cattle and deer. This is a ubiquitous protozoan parasite found in warm- and cold-blooded vertebrates and is usually considered to be of low pathogenicity and seldom has any clinical significance (Merck and Company 1973).

The ocular squamous cell carcinomas observed in two cows (No. 4 and 5) were not unusual. Ocular carcinoma is the most common neoplasm of cattle and is especially prevalent in aged Hereford cattle subjected to high levels of sunlight (Merck and Company 1973).

The most unusual lesions noted were the numerous calcified parasitic nodules found in the liver and lungs of the aged horse. Other occasionally observed histologic findings; e.g., hemosiderosis of the spleen, mild liver and kidney changes, and myositis, were felt to be within normal levels by examining pathologist. No pathology, gross or microscopic, was observed that could be attributed to ionizing radiation.

HYPOTHETICAL DOSE ESTIMATES

Although meat from animals living on the Nevada Test Site is not available for consumption by people, the various doses to a standard man based on postulated consumption of the edible tissues has been calculated. The dose estimates are not presented as an implication of potential doses, but rather to place the reported radionuclide concentrations in perspective. The dose estimates are based on the techniques and parameters of the International Commission for Radiological Protection (1959, 1968, 1977) and Dillman (1969). The estimates were calculated using the maximum observed concentrations of the radionuclides in edible tissues of the cattle, deer, and rabbits sampled (summarized in Table 6). It was assumed that 500 grams (about 1 pound) of the meat were consumed each day for a year, and that the radionuclide concentration remained constant for that time. The minimum detectable values of Table 6 were used in the dose calculations when they were the maximum value for a given tissue.

Although doses are calculated for ingestion of tissues from a rabbit, these doses are not compared to the dose guide. Furthermore, these doses are not used in discussing the maximum hypothetical doses because it is doubtful that enough similar tissue could be obtained to provide the 1-year intake quantities.

The International Commission for Radiological Protection (1959) and the U.S. Department of Energy (1977) present different dose criteria for various parts of the body, based on estimates of relative radiosensitivity. The

TABLE 6. SUMMARY OF PEAK RADIONUCLIDE CONCENTRATIONS IN SELECTED TISSUES FROM NEVADA TEST SITE ANIMALS, 1980

Nuclide	Radionuclide Concentrations (pCi/kg Wet Weight)						Area 15 Rabbits
	Area 18 Cattle			NTS Mule Deer			
	Muscle	Liver	Blood (pCi/l)	Muscle	Liver	Blood (pCi/l)	
Plutonium-238	0.048 ± 0.073**	0.039 ± 0.06**	NA	0.051 ± 0.093**	0.066 ± 0.31**	NA	0.00 ± 0.14
Plutonium-239	0.12 ± 0.35**	0.64 ± 0.12	NA	0.053 ± 0.081**	0.13 ± 0.25**	NA	0.88 ± 0.21
Cesium-137	37 ± 12	14 ± 8.8	NA	ND	ND	NA	130 ± 20
Tritium	NA	NA	<390	NA	NA	470 ± 250	6,500 ± 340*

NA = Not analyzed

ND = Not detected

* = pCi/l - aqueous portion of kidney or muscle

** = Counting error exceeds reported activity

National Council on Radiation Protection and Measurements (NCRP 1971) recognizes this philosophy, but recommends simplifying the guides for the general population, and uses the minimum guide (0.5 rem per year to the whole body for an individual in an uncontrolled area) for all body organs. The NCRP emphasizes that this is a simplifying administrative decision, rather than a reduction of the guides based on new technical information.

The indicated confidence intervals in Table 6 are twice the standard deviation (2s) based on counting statistics. The total analytical uncertainties at two standard deviations for the plutonium results are estimated to be about 0.2 pCi/kg for results of several tenths of a pCi/kg, or several times the indicated counting uncertainties. Thus, differences between values, when the values are under several tenths of a pCi/kg, have limited statistical significance given the total analytical uncertainties of the results.

Table 7 lists postulated doses based on the data summarized in Table 6. The column on the right shows the respective fraction of the radiation protection guide of 500 millirems per year for the various postulated doses. The doses from plutonium and, to a lesser extent, cesium-137 are not delivered in 1 year. For practical purposes, however, the integrated doses for a 1-year ingestion period are related to the yearly guide.

The highest postulated dose (other than for rabbit), 0.4 millirems (mrem), would result from ingesting cattle muscle. This dose is 0.1 percent of the guide of 500 mrem per year. All of the other postulated doses are about 0.2 mrem or less and are similar to or lower than those estimated for 1979 (Smith et al. 1981a).

TABLE 7. POSTULATED DOSE TO MAN FOLLOWING INGESTION OF SELECTED TISSUES FOR 1 YEAR

Nuclide	Human Organ for Which Dose was Calculated	Animal Tissue Containing Maximum Concentration	pCi/kg (wet weight) or pCi/l of Tissue Water	Dose Factor mrem:pCi/da (1-year ingestion)*	Dose (mrem)	Percent of 500 mrem
Tritium†	Body water	NTS mule deer, blood	470 ± 250	3.6 x 10 ⁻⁵	0.01	<0.1
Tritium†	Body water	Area 15 rabbits, muscle	6,500 ± 340	3.6 x 10 ⁻⁵	0.12	‡
Cesium-137	Whole body tissue	Area 15 rabbit, muscle	130 ± 20	0.022	1.4	‡
Cesium-137	Whole body tissue	Area 18 cattle, muscle	37 ± 12	0.022	0.4§	0.1
Plutonium-238	Bone	NTS mule deer, liver	0.066 ± 0.31	0.54	<0.1	<0.1
Plutonium-238	Bone	Area 18 cattle, liver	0.64 ± 0.12	0.63	0.2	<0.1

* The doses from plutonium-238 and -239, and to a lesser extent cesium-137, are not delivered within the 1-year ingestion period, but, for simplification, the doses have been related to the guide for 1 year. The doses for plutonium are actually for a 50-year period, but it should be recognized that the doses are resulting from ingestion over a 1-year period. The dose factors are based on a quality factor (QF) of 1 for tritium and cesium-137 and 20 for plutonium-238 and -239 (ICRP, 1977). The QF of 20 used for plutonium is twice the value used in reports for the program prior to 1979 (Smith et al. 1978b, 1979, 1980).

†The reported tritium concentrations are for muscle and kidney tissue. It is assumed that the concentration in edible tissues (water plus organic) is equal to that of the reported results.

‡The percent of the 500 mrem dose guide is not calculated for these tissues because it is not reasonable to assume that someone could consume 500 g of meat per day from NTS rabbits.

§Since the analytical counting error term is much larger than the mean, the postulated dose is calculated for the mean plus the error term and is stated as a "less than" value.

OTHER ACTIVITIES

DEER MIGRATION STUDY

A sizeable mule deer herd resides in the mountainous regions of the NTS during the summer. If they move to unrestricted lands, these deer may be hunted by members of the public. A study to determine migration patterns of the herd through tracking of individual deer fitted with collars containing miniature radio transmitters was begun in 1975 and continued through 1980.

From August through November 1980, 31 NTS mule deer (Table 8) were captured, either by chemical restraint of free-ranging animals (Smith et al. 1978a) or by trapping at a water site (Giles 1979). Ten deer were fitted with collars containing new radio transmitters, ear tags, and reflective numbers. Two deer were fitted with re-conditioned radio transmitter collars that had been recovered from deer captured prior to 1980. These 12 newly installed transmitters brought to 26 the total number of working transmitters in the field (14 from previous years). AIP personnel monitored the movements of the deer weekly with hand-held receivers and directional antenna. Nineteen other deer were captured but were unsuitable for collaring and were released after visible markers (ear tags and reflective collars) had been attached.

Twenty-four of the deer were captured at the Area 19 trap site at Echo Peak and immobilized with M-99® (etorphine). The other seven deer were free ranging animals (three on Rainier Mesa in Area 12 and four along the Pahute Mesa Road in Area 20) and were immobilized with Sernylan® (phencyclidine hydrochloride), and acepromazine maleate (Ayerest Laboratories, Inc.) injected via a syringe-dart fired from a Cap Chur™ gun (Palmer Chemical Company).

Deer captured in Areas 19 and 20 remained there until the end of December when winter storms forced them onto their wintering areas. By mid-January of 1981, nearly all the radio collared deer had moved south to the Timber Mountain in Areas 29 and 30 or to the 40-Mile Canyon area (Figure 4). From there they scattered to the Yucca Mountain and Beatty Wash areas. However, there were two exceptions to this migration pattern. A buck moved west from the NTS onto the Nellis Bombing and Gunnery Range in the vicinity of Black Mountain north of Beatty, Nevada and a doe moved to the northern edge of Area 19 and stayed there through the entire winter. By mid-April 1981 the deer had all moved back onto the 1980 summer ranges in Areas 19 and 20.

By mid-December of 1980, two of the three radio-equipped deer captured on Rainier Mesa moved to Shoshone Mountain in Areas 16, 29 and 14. The remaining marked deer, a young buck, along with several unmarked deer of both sexes remained in Area 12 in the vicinity of N tunnel and Captain Jack Spring all winter long. All of the deer captured on Rainier Mesa returned there by early June 1981.

TABLE 8. DEER CAPTURE INFORMATION, 1980

I.D.	Age Estimate (years)	Sex	Weight Estimate (kg)	Date Captured	Location	Comments
1 Green	2-3	F	45	7/22	Area 19, Trapsite	Old No. F-1; Green Transmitter Collar (GTC)
2 Green	1	F	28	8/5	Area 19, Trapsite	Young doe lactating, GTC
3 Green	3-4	F	38	8/6	Area 19, Trapsite	Lactating doe in fair condition, GTC; Dead Cat Canyon, Area 30, Nov. 27. Radio not recovered.
4 Green	4-5	F	46	8/6	1 mile west of U19C reservoir	Lactating doe with 1 fawn; given ear tags GTC
5 Green	2-3	F	40	8/7	Area 19, Trapsite	Lactating doe in fair condition, GTC
6 Green	1-2	F	40	8/27	Area 19, Trapsite	Non-lactating doe in good condition, GTC
7 Green	1-2	M	51	8/28	Rainier Mesa 1/4 mile past Holmes Rd. turnoff	Young buck in good condition, 2 x 2 antlers; spent winter in Area 12, N. Tunnel and Capt. Jack Spring, GTC
8 Green	1-2	M	50	9/12	Echo Peak repeater in Area 19	Young buck in good condition, 2 x 2 antlers, GTC
9 Green	4-5	M	90	9/16	Area 19, 1/4 mile east of U19F turnoff on Pahute Mesa Rd.	Large buck, 3 x 3 antlers, excellent condition, GTC
10 Green	5-6	M	90	9/18	Area 19, Trapsite	Large buck, 4 x 4 antlers, excellent condition, GTC
3 Blue	1-2	F	55	8/29	Rainier Mesa by U19R bunker	Non-lactating doe in good condition, reconditioned blue transmitter collar
1 Red	1-2	M	68	10/2	Area 19, Trapsite	Buck in good condition, 2 x 2 antlers, reconditioned red transmitter collar
T	1-2	M	74	8/30	Area 19, Trapsite	Buck in good condition 2 x 2 antlers, ear tags, reflective No. only
D-1	3-4	M	74	8/30	Area 19, Trapsite	Buck in good condition 4 x 4 antlers, ear tags and reflective No. only
E-1	5-6	M	76	9/12	Rainier Mesa, Holmes Rd. turnoff	Buck in excellent condition, 4 x 4 antlers, ear tags and reflective No. only
L-1	fawn	M	1.8	9/16	Area 19, Trapsite	Fawn in good condition, antler nubs on head, ear tags only

(continued)

TABLE 8. (Continued)

I.D.	Age Estimate (years)	Sex	Weight Estimate (kg)	Date Captured	Location	Comments
J-1	3-4	M	70	9/30	Area 19, Trapsite	Buck in good condition, 4 x 4 antlers, given ear tags and reflective No. Only
H-1	2-3	M	70	10/1	Area 19, Trapsite	Buck in good condition, 3 x 3 antlers, given ear tags and reflective No. only
K-1	fawn	M	2	10/1	Area 19, Trapsite	Fawn in good condition, 1-inch antler nubs on head, ear tags only
M-1	2-3	M	78	10/2	Area 19, Trapsite	Buck in good condition, 3 x 2 antlers, given ear tags and reflective No. only
G-1	1-2	M	67	10/16	Area 19, Trapsite	Buck in good condition, 2 x 2 antlers, given ear tags and reflective No. only
N-1	6-7	M	98	10/9	Area 19, Trapsite	Buck in excellent condition, 4 x 4 antlers, ear tags only -- too large for reflective No.
P-1	6-7	M	83	10/16	Area 19, Trapsite	Buck in excellent condition, 6 x 5 antlers, ear tags and reflective No. only
A	4-5	M	90	11/6	Area 19, Trapsite	Buck in excellent condition, 4 x 4 antlers, ear tags and reflective No. only
Z	1-2	M	41	11/7	Area 19, Trapsite	Buck in good condition, 2 x 2 antlers, ear tags and reflective No. only
X	fawn	M	18	11/6	Area 19, Trapsite	Fawn given ear tags only
K-G	6-7	M	92	11/5	Area 19, Trapsite	Buck in excellent condition, 5 x 4 antlers, ear tags and reflective No. only
S-1	5-6	M	90	11/19	Area 19, Trapsite	Buck in excellent condition, 7 x 5 antlers, ear tags and reflective No. only
T-1	2-3	M	54	11/18	Area 19, Trapsite	Buck in excellent condition, 3 x 3 antlers, given ear tags and reflective No. only
F-1	3-4	M	82	11/19	Area 19, Trapsite	Buck in good condition, 3 x 2 antlers, given ear tags and reflective No. only
C-G	2-3	F	68	12/4	Area 19, Trapsite	Doe in good condition, given ear tags and reflective No. only

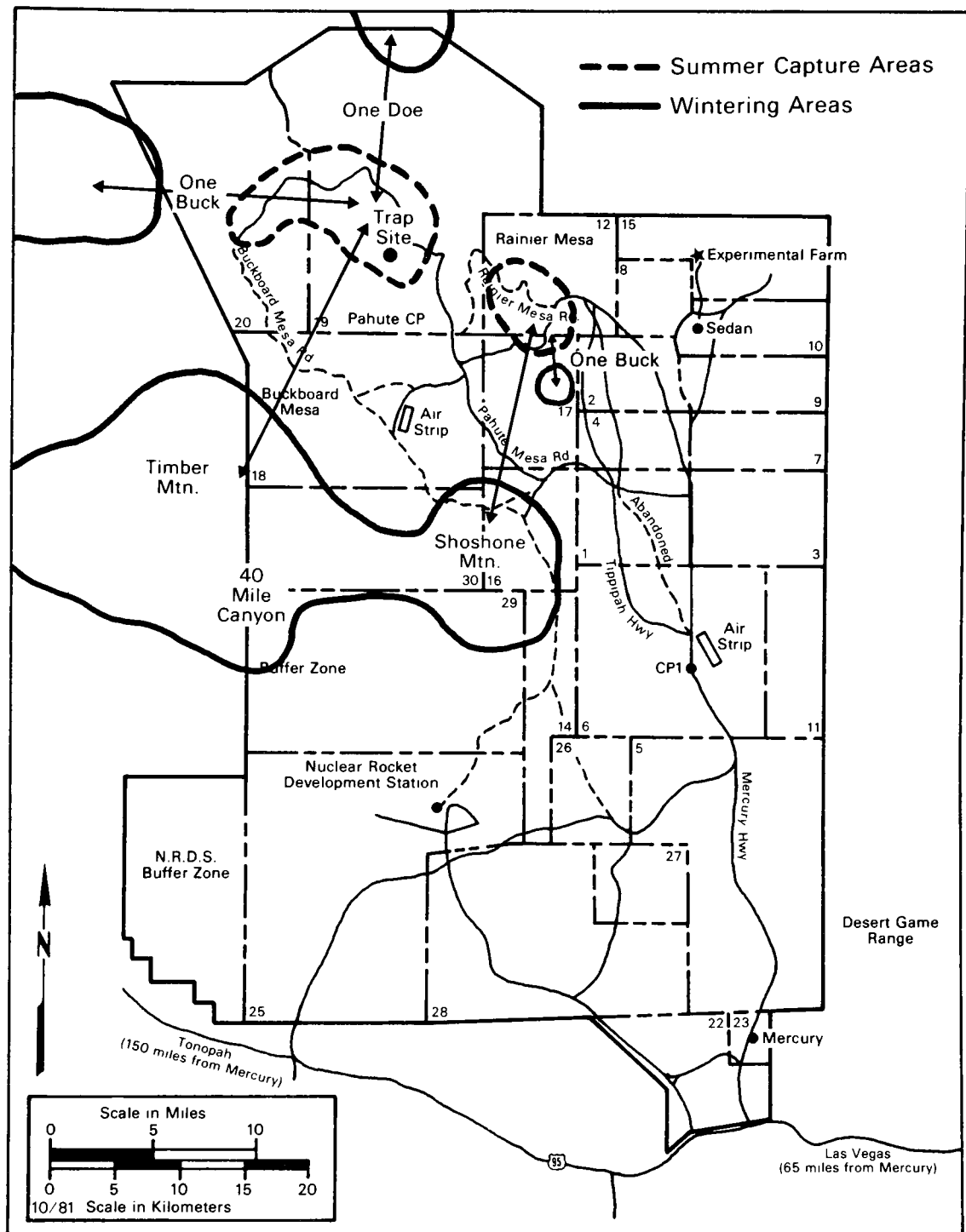


Figure 4. Mule deer capture and wintering areas, 1980.

The 1980 summer and winter ranges of the NTS deer are shown in Figure 4. A doe tagged in December 1979 at the Echo Peak trap site was observed in the Barley Creek area of Nye County during June and August 1980. This deer migrated over 160 km within 6 or 7 months.

DEER CENSUS

As a result of the deer migration study, there now exists on the NTS a sizeable number (approximately 125 animals marked since 1975) of identifiable deer. This base population provided the means for a statistical estimate of the deer population in certain areas of the NTS.

Weekly sightings of both marked and unmarked deer during 1978, 1979, and 1980 were recorded and provided to Dr. Robert Kinnison, Battelle Pacific Northwest Laboratories, Richland, Washington, for statistical analysis. The method used was the annual weighted average of the weekly Peterson-Lincoln index estimates using capture-recapture sampling plans (Mosby 1963). The inverse of the weekly variance estimates were used as weights for averaging. These annual estimates are listed in Table 9.

TABLE 9. DEER POPULATION ESTIMATES BY THE PETERSON-LINCOLN INDEX METHOD FOR 1978, 1979, AND 1980

Year	Echo Peak Section Area 19		Dead Horse Flats Section Area 19		Area 20		Rainier Mesa Section Area 12	
	Bucks	Does	Bucks	Does	Bucks	Does	Bucks	Does
Mean	49	15	11	8	7	8	15	21
C.I. 1978	41-56	10-20	5-17	5-11	5-9	1-15	11-20	15-28
S.D.	14	8	6	2	2	4	7	10
S.S.	13	11	5	3	6	1	9	11
Mean	47	25	6	5	28	5	8	9
C.I. 1979	32-62	17-33	4-8	2-7	16-39	2-8	6-11	5-13
S.D.	29	15	4	3	15	4	4	5
S.S.	14	14	9	6	7	6	9	6
Mean	97	32	8	14	6	11	15	27
C.I. 1980	63-131	25-39	3-13	9-19	2-10	6-15	8-22	18-37
S.D.	48	10	6	6	6	5	9	12
S.S.	8	9	7	6	7	6	6	6

Mean - Yearly mean.

C.I. - 95% confidence interval of the yearly means.

S.D. - Population standard deviation.

S.S. - Sample size--number of weeks observation data available.

The population estimates were based on weekly sightings during the period of August through November and were restricted to areas readily accessible to vehicular traffic and where marked deer were present. However, it seems logical that these population estimates could be extrapolated to other NTS areas with similar water sources and habitat.

In general, the population sizes appear to be either stable or slightly increasing. Population concentrations are dependent upon the availability of water. As there are no known natural springs in Areas 19 and 20, the deer are dependent on precipitation or man-made water supplies such as water reservoirs, pipeline leaks, etc. The availability of these sources fluctuate with the levels of construction and testing activities carried on within these areas.

BEEF HERD

All animals of the beef herd were maintained on the Area 18 range for the entire year except for the 1980 calves which were weaned at the Area 15 farm during November and December. While on the range all animals subsisted on the native vegetation supplemented with cottonseed oil meal during the winter months.

The herd was rounded up in May and October. At each roundup, all captured animals were identified, weighed and sprayed for ectoparasites. Health problems were treated. Selected animals were removed from the herd for sacrifice, weaning, or transfer. Following the October roundup, 35 cattle were declared surplus to the needs of the AIP and transferred to Iowa State University (ISU) Ames, Iowa. In return, ISU supplied a registered Hereford bull for use as a herd sire.

A quarter horse was purchased in October for use in the semiannual roundups.

AREA 15 FARM

The Area 15 farm, in addition to its major function as a research facility, also served as the field station for the NTS operations of the AIP. As such it provided the facilities for the maintenance of the horses, rumen-fistulated steers, and beef bulls; weaning of calves; and production of alfalfa hay. Lloyd Enterprises, a contractor, operated the farm, maintained the beef herd and supplied support for studies conducted at the farm.

The 16 acres of croplands produced 65 tons of alfalfa hay during 1980. This production was achieved despite severe depredation of the alfalfa by jackrabbits. The rabbits were controlled by intensive hunting. The hay production was also reduced as the alfalfa was not irrigated for a 2-week period in May when the deep-well pump had to be replaced after being damaged by a lightning strike.

The abattoir area of the barn was divided into separate high level ("hot") and low level ("cold") radioisotope work rooms. The "hot" area (16 feet x 18 feet) is adjacent to the metabolism room and was designed to maintain a negative pressure with absolute filtration on the heating and cooling system. All AIP sampling was conducted in the "cold" area (20 feet x 20 feet x 22 feet). Both areas have their own overhead hoists and rail systems.

Other farm improvements during 1980 included repainting of the barn's interior, landscaping of the parking area, removal and relocation of out-buildings, modification of the main barn's heating and water systems, and repair and relocation of corral pens.

Five surplus dairy heifers were transferred to Iowa State University in October. Eleven African Pygmy goats were transferred to the farm from the laboratory at EMSL-LV. The Area 15 farm served as a training site for participants in the Radiological Emergency Response Course sponsored by the Nuclear Regulatory Commission, Office of State Programs. This course, taught by REEC Co for DOE, NVO, was presented on an approximate biweekly basis.

PUBLIC INFORMATION

The offsite public information program continued by direct contact with ranchers, and by briefings of groups touring the EMSL-LV or the NTS Experimental Farm. During 1980, the objectives and findings of the AIP were presented to 970 NTS visitors in 42 different tour groups. Approximately 200 additional drop-in visitors to the farm received informal briefings.

"Big Sam", the rumen-fistulated steer, was a featured exhibit at the December 6 grand opening of the Nevada Cooperative Extension Services' Holly Park Field Laboratory in Pahrump, Nevada. Approximately 200 people visited the exhibit and were briefed on the activities and findings of the AIP.

SPECIAL STUDIES

During October, November and December, the Comparative Animal Research Laboratory (CARL), Oak Ridge, Tennessee, conducted an actinide metabolism study with weaner domestic swine in the metabolism portion of the barn. Fifty young pigs were administered, via gavage, 5 mCi of americium-241 and sacrificed over a 3-month period for tissue uptake, cytogenic and spermatogenesis studies. The results of this study will be published at a later date by CARL.

INVESTIGATIONS

There were no offsite livestock damage claims that required investigation during 1980. AIP personnel participated in the investigation of alleged plant and animal health effects purported in the Three Mile Island area of Pennsylvania (Gears et al. 1980) and assisted in preparing the report.

REFERENCES

- Brown, K. W. and B. J. Mason. 1968. Range Survey, Area 18, Nevada Test Site. SWRHL-52r. U.S. Department of Health, Education, and Welfare, Southwestern Radiological Health Laboratory, Las Vegas, Nevada. 42 pp.
- Dillman, L. T. 1969. "Radionuclide decay schemes and nuclear parameters for use in radiation-dose estimation." Medical Internal Radiation Dose Committee. J. Nucl. Med. Supplement No. 2.
- Fountain, E. L. 1961. Offsite Animal Investigation Project. Fourth Annual Report. U.S. Atomic Energy Commission, Nevada Operations Office, Las Vegas, Nevada. 32 pp.
- Gears, G. E., G. LaRouche, J. Cable, B. Jaroslow, and D. Smith. 1980. Investigations of Reported Plant and Animal Health Effects in the Three Mile Island Area. NUREG-0738, EPA 600/4-80-049. U.S. Environmental Protection Agency. Environmental Monitoring Systems Laboratory, Las Vegas, Nevada. 33 pp.
- Giles, K. R. 1979. A summer trapping method for mule deer. EMSL-LV-0539-27. U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Las Vegas, Nevada. 5 pp.
- Hagan, V. I. and G. Arrhenius. 1963. "Ion exchange in mixed solvent." Talanta 10:865.
- International Commission on Radiological Protection. 1959. Report of Committee II on Permissible Dose for Internal Radiation. ICRP Report No. 2.
- International Commission on Radiological Protection. 1968. Evaluation of Radiation Doses to Body Tissues from Internal Contamination Due to Occupational Exposure. ICRP Report No. 10.
- International Commission on Radiological Protection. 1977. Recommendations of the International Commission on Radiological Protection. ICRP Report No. 26.
- Johns, F. B., P. B. Hahn, D. J. Thomé and E. W. Bretthauer. 1979. National Environmental Research Center - Las Vegas Handbook of Radiochemical Analytical Methods. EMSL-LV-539-17. U.S. Environmental Protection Agency, Environmental Monitoring Systems Laboratory, Las Vegas, Nevada. 109 pp.

- Leavitt, V. D. 1970. Soil Survey of Area 18, Nevada Test Site. SWRHL-74. U.S. Department of Health, Education, and Welfare, Southwestern Radiological Health Laboratory, Las Vegas, Nevada. 119 pp.
- Major, W. J., K. D. Lee, and R. A. Wessman. 1975. "Analysis of ^{239}Pu and ^{241}Am in NAEG Large-Sized Bovine Samples." NVO-153. In: The Radioecology of Plutonium and Other Transuranics in Desert Environments. M. G. White and P. B. Dunaway (eds.). U.S. Atomic Energy Commission.
- Merck and Company, Inc. 1973. The Merck Veterinary Manual. Fourth Edition. O. H. Siegmund (ed.). Merck and Company, Inc., Rahway, New Jersey. 1,618 pp.
- Mitchell, R. F. 1960. "Electrodeposition of actinide elements at tracer concentrations." Anal. Chem. 32:326.
- Mosby, H. S., editor. 1963. Wildlife Investigational Techniques. Second edition. The Wildlife Society. Blacksburg, Virginia. 419 pp.
- National Council on Radiation Protection and Measurements. 1971. Basic Radiation Protection Criteria. Report No. 39.
- Smith, D. D. 1970. Management History of the AEC Beef Herd - 1 June 1964 - 1 June 1969. SWRHL-80r. U.S. Department of Health, Education, and Welfare, Southwestern Radiological Health Laboratory, Las Vegas, Nevada. 26 pp.
- Smith, D. D. and K. R. Giles. 1970. Animal Investigation Program 1969 Annual Report. SWRHL-102r. U.S. Department of Health, Education, and Welfare, Southwestern Radiological Health Laboratory, Las Vegas, Nevada. 20 pp.
- Smith, D. D. and K. R. Giles. 1974. Animal Investigation Program 1970 Annual Report. NERC-LV-539-16. U.S. Environmental Protection Agency, National Environmental Research Center, Las Vegas, Nevada. 53 pp.
- Smith, D. D. and K. R. Giles. 1975. 1971 Animal Investigation Program Annual Report. NERC-LV-539-20. U.S. Environmental Protection Agency, National Environmental Research Center, Las Vegas, Nevada. 39 pp.
- Smith, D. D., K. R. Giles, and D. E. Bernhardt. 1976. Animal Investigation Program 1972 Annual Report. NERC-LV-539-35. U.S. Environmental Protection Agency, National Environmental Research Center, Las Vegas, Nevada. 82 pp.
- Smith, D. D., K. R. Giles, and D. E. Bernhardt. 1977a. Animal Investigation Program 1973 Annual Report: Nevada Test Site and Vicinity. EMSL-LV-0539-3. U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Las Vegas, Nevada. 31 pp.
- Smith, D. D., K. R. Giles, D. E. Bernhardt, and K. W. Brown. 1977b. Animal Investigation Program 1974 Annual Report: Nevada Test Site and Vicinity. EMSL-LV-0539-10. U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Las Vegas, Nevada. 37 pp.

- Smith, D. D., K. R. Giles, D. E. Bernhardt, and K. W. Brown. 1978a. Animal Investigation Program 1975 Annual Report: Nevada Test Site and Vicinity. EMSL-LV-0539-14. U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Las Vegas, Nevada. 48 pp.
- Smith, D. D., K. R. Giles, D. E. Bernhardt, and K. W. Brown. 1978b. Animal Investigation Program 1976 Annual Report: Nevada Test Site and Vicinity. EMSL-LV-0539-20. U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Las Vegas, Nevada. 111 pp.
- Smith, D. D., K. R. Giles, D. E. Bernhardt, A. B. Crockett, and R. R. Kinnison. 1979. Animal Investigation Program 1977 Annual Report: Nevada Test Site and Vicinity. EMSL-LV-0539-26. U.S. Environmental Protection Agency, Environmental Monitoring Systems Laboratory, Las Vegas, Nevada. 90 pp.
- Smith, D. D., D. E. Bernhardt, and K. R. Giles. 1980. Animal Investigation Program 1978 Annual Report: Nevada Test Site and Vicinity. EPA-600/3-80-096, DOE/DP/0059-038. U.S. Environmental Protection Agency, Environmental Monitoring Systems Laboratory, Las Vegas, Nevada. 65 pp.
- Smith, D. D., K. R. Giles, and D. E. Bernhardt. 1981a. Animal Investigation Program 1979 Annual Report: Nevada Test Site and Vicinity. EPA-600/3-81-035, DOE/DP/00539-042. U.S. Environmental Protection Agency, Environmental Monitoring Systems Laboratory, Las Vegas, Nevada. 65 pp.
- Smith, D. D., R. F. Grossman, W. D. Corkern, D. J. Thom , R. G. Patzer, and J. L. Hopper. 1981b. Offsite Environmental Monitoring Report: Radiation Monitoring Around United States Nuclear Test Areas, Calendar year 1980. EPA-600/4-81-047, DOE/DP/00539-043. U.S. Environmental Protection Agency, Environmental Monitoring Systems Laboratory, Las Vegas, Nevada. 101 pp.
- Talvitie, N. A. 1971. "Radiochemical determination of plutonium in environmental and biological samples by ion exchange." Anal. Chem. 43:1827-1830.
- Talvitie, N. A. 1972. "Electrodeposition of actinides for alpha spectrometric determination." Anal. Chem. 44:280-282.
- U.S. Department of Energy. 1977. "Standards for Radiation Protection Manual." U.S. Department of Energy Transmittal Notice. Chapter 0524.
- Wish, L. and M. Rowell. 1956. Sequential Analysis of Tracer Amounts of Np, U, and Pu in Fission-Product Mixtures by Anion Exchange. USNRDL-TR-117. Naval Radiological Defense Laboratory, San Francisco, California. 34 pp.

LIST OF APPENDIX TABLES

<u>Table</u>	<u>Page</u>
A-1 Summary of Analytical Procedures and Minimum Detectable Activities.	30
B-1 Quality Assurance Results	31
C-1 Plutonium Concentrations in Lungs and Tracheobronchial Lymph Nodes, Beef Cattle, Area 18, NTS, October 1980.	33
C-2 Plutonium Concentrations in Muscles and Livers, Beef Cattle, Area 18, NTS, October 1980.	34
C-3 Plutonium Concentrations in Gonads and Fetus, Beef Cattle, Area 18, NTS, October 1980.	35
C-4 Plutonium and Strontium Concentrations in Femurs, Beef Cattle, Area 18, NTS, 1980.	36
C-5 Gamma-Emitting Radionuclide and Tritium Concentrations in Selected Tissues, Beef Cattle, Area 18, NTS, May 1980	37
C-6 Gamma-Emitting Radionuclide and Tritium Concentrations in Selected Tissues, Beef Cattle, Area 18, NTS, October 1980	38
D-1 Plutonium Concentrations in Muscles and Livers, Mule Deer, NTS, 1980	39
D-2 Plutonium Concentrations in Lungs and Gonads, Mule Deer, NTS, 1980	40
D-3 Plutonium Concentrations in Rumen Contents, Mule Deer, NTS, 1980	41
D-4 Plutonium and Strontium Concentrations in Hock Bones, Mule Deer, NTS, 1980.	42
D-5 Gamma-Emitting Radionuclide and Tritium Concentrations in Selected Tissues, Mule Deer, NTS, 1980.	43
E-1 Plutonium and Strontium Concentrations in Bones, Desert Bighorn Sheep, 1980	44

LIST OF APPENDIX TABLES (Continued)

<u>Table</u>	<u>Page</u>
E-2 Gamma-Emitting Radionuclide and Tritium Concentrations in Kidneys, Desert Bighorn Sheep, 1980	46
F-1 Plutonium, Strontium, and Gamma-Emitting Radionuclide Concentrations in Selected Tissues, NTS Horse, 1980	47
G-1 Plutonium Concentrations in Selected Tissues, Rabbits, Area 15, NTS, 1980.	48
G-2 Plutonium and Stontium Concentrations in Bones, Rabbits, Area 15, NTS, 1980.	50
G-3 Gamma-Emitting Radionuclide and Tritium Concentrations in Selected Tissues, Rabbits, Area 15, NTS, 1980	51
H Gross and Microscopic Pathology Found in Necropsied Animals, 1980	52

TABLE A-1. SUMMARY OF ANALYTICAL PROCEDURES AND MINIMUM DETECTABLE ACTIVITIES

Type of Analysis	Analytical Equipment	Counting Period (min)	Analytical Procedures	Sample Size	Minimum Detectable Activities (pCi/total sample)*
Gamma Spectrometry	Lithium-drifted germanium detectors calibrated at approximately 0.5 KeV per channel input to 4096 channels resident in the core of the Nuclear Data 6620 computer-based gamma spectrometry system.	1,200	Radionuclide concentrations quantitated from gamma spectrum by Nuclear Data 6620 computer-based gamma spectrometry system using vendor supplied software.	300-ml aluminum cans	For: ^{54}Mn , ^{60}Co , ^{95}Zr , ^{103}Ru , ^{124}Sb , ^{132}Te , ^{131}I , ^{134}I , ^{137}Cs , ^{140}Ba - 7 pCi For: ^{125}Sb , ^{141}Cs , - 30 pCi For: ^{65}Zn , ^{106}Ru , ^{144}Ce - 20 pCi For: ^{181}W - 85 pCi For: ^7Be - 45 pCi
	or by				
	10-cm-thick by 10 cm-diameter NaI (Tl-activated) crystal with input to Nuclear Data 6620 calibrated at 10 keV per channel in the 60 keV to 2 MeV range.	1,000	Radionuclide concentration quantitated by CDC-6400 computer using Least Squares Technique.	300-ml aluminum cans	For: ^{241}Am - 35 pCi For: ^{22}Na - 4 pCi For: K - 0.08 g
$^{89-90}\text{Sr}$	Low-background thin-window, gas-flow proportional counter with a 2.54-cm diameter window (900 $\mu\text{g}/\text{cm}^2$).	200	Chemical separation by Sr $(\text{NO}_3)_2$ precipitation and $\text{Fe}(\text{HO})_3$ scavenge $^{89-90}\text{Sr}$ was counted as SrCO_3 . ^{90}Sr was determined by ^{90}Y counting. Purity was checked by two successive counts at 14-day intervals for $^{89-90}\text{Sr}$ and 3 separate counts at 24-hour intervals for ^{90}Y .	10 g of ash	For: ^{89}Sr - .5 pCi ^{90}Sr - .3 pCi
^3H	Automatic liquid scintillation counter with output printer.	200	Sample prepared by distillation.	5 ml	0.4 pCi/ml H_2O
$^{238-239}\text{Pu}$	Alpha spectrometer with silicon surface barrier detectors operated in vacuum chambers.	1,000	Ash sample is digested with acid, purified by ion exchange, electroplated on stainless steel planchet, and counted by alpha spectrometer.	0.1-1 kg wet weight 1-10 g of ash	For all isotopes - 0.04 pCi

* The minimum detectable activities in terms of total activity per sample for standard geometries and counting times are defined as those activities which equal 3.29 times the standard deviation based on counting only [Environmental Measurements Laboratory (EML-formerly HASL) Procedures Manual, HASL-300, pages D-08-02 through D-08-06, August 1974]. These values are approximations and are applicable to ideal conditions and simple complexes of nuclides. Complex spectra or spectra showing naturally occurring radionuclides can raise the minimum detectable activities considerably.

TABLE B-1. QUALITY ASSURANCE RESULTS

Sample and Shipment No.	Nuclide	Activity Added (pCi/g Ash)	Activity Reported (pCi/g Ash)	Percent Bias*
<u>Bone Ash Samples</u>				
179960 No. 3	⁹⁰ Sr ²³⁹ Pu	0 0	1.3 ± 0.18 <0.013	- -
179961 No. 3	⁹⁰ Sr ²³⁹ Pu	1.5 0.022	1.3 ± 0.35 <0.0075	100 100
179962 No. 3	⁹⁰ Sr ²³⁹ Pu	1.5 0.022	1.8 ± 0.25 <0.0082	73 100
179963 No. 3	⁹⁰ Sr ²³⁹ Pu	12.0 0.088	5.4 ± 0.73 0.045 ± 0.0079	67 62
179964 No. 3	⁹⁰ Sr ²³⁹ Pu	12.0 0.088	6.7 ± 0.9 0.037 ± 0.0062	56 58
221119 No. 9	⁹⁰ Sr ²³⁹ Pu	0 0	1.4 ± 0.2 0.0076 ± 0.0181	- -
221120 No. 9	⁹⁰ Sr ²³⁹ Pu	3.0 0.044	1.2 ± 0.18 0.041 ± 0.009	100 33
221121 No. 9	⁹⁰ Sr ²³⁹ Pu	2.9 0.044	1.8 ± 0.25 0.043 ± 0.009	86 28
221147 No. 13	⁹⁰ Sr ²³⁹ Pu	0 0	1.6 ± 0.27 0.024 ± 0.0086	- -
221148 No. 13	⁹⁰ Sr ²³⁹ Pu	7.3 0.055	5.3 ± 0.27 0.076 ± 0.017	47 -17

Duplicate Bone Samples for Bighorn Sheep No. 12

				Precision of Analysis**
221115 No. 9	⁹⁰ Sr ²³⁹ Pu	0 0	1.3 ± 0.18 0.0069 ± 0.0078	
221116 No. 9	⁹⁰ Sr ²³⁹ Pu	0 0	1.2 ± 0.17 0.012 ± 0.012	0.04 0.27

(continued)

TABLE B-1. (Continued)

Sample and Shipment No.	Nuclide	Activity Added (pCi/kg†)	Activity Reported (pCi/kg†)	Percent* Bias
<u>Muscle Tissue Samples</u>				
179949	⁹⁰ Sr	56.0	46.0 ± 8.8	19
No.3	²³⁹ Pu	8.4	4.0 ± 0.54	53
179954	⁹⁰ Sr	130.0	120.0 ± 16.0	8.1
No.3	²³⁹ Pu	13.1	6.7 ± 1.8	49
179956	⁹⁰ Sr	0	0.51 ± 0.11	-
No.3	²³⁹ Pu	0	<0.009	-
179958	⁹⁰ Sr	24.0	29.0 ± 4.3	-19
No.3	²³⁹ Pu	2.4	1.2 ± 0.22	51
<u>Liver Tissue Samples</u>				
179950	⁹⁰ Sr	140.0	83.0 ± 11.0	41
No.3	²³⁹ Pu	13.0	6.4 ± 0.9	51
179955	⁹⁰ Sr	0	<2.0	-
No.3	²³⁹ Pu	0	<0.028	-
179957	⁹⁰ Sr	25.0	23.0 ± 3.8	12
No.3	²³⁹ Pu	2.5	1.7 ± 0.57	33
159959	⁹⁰ Sr	48.0	36.0 ± 5.2	17
No.3	²³⁹ Pu	7.2	3.1 ± 0.66	58

*Bias (B) = 1 - Recovery where Recovery is average recovery $\left(\frac{x_i}{u}\right)$

where x_i = net activity reported
u = activity added

**Precision (C_V) = $\frac{x_1 - x_2}{x_1 + x_2}$

where x_1 = first value
 x_2 = second value

The formulas for 95% confidence interval limits:

L upper = $x_i (1 + B + 2C_V)$
L lower = $x_i (1 + B - 2C_V)$

†Wet weight

TABLE C-1. PLUTONIUM CONCENTRATIONS IN LUNGS AND TRACHEOBRONCHIAL LYMPH NODES, BEEF CATTLE, AREA 18, NTS, OCTOBER 1980

Animal Number	Plutonium-238 (pCi/g Ash) (pCi/kg*)	Plutonium-239 (pCi/g Ash) (pCi/kg*)	Ash (%)
<u>Lungs</u>			
4	0.0063 ± 0.012** 0.055 ± 0.11**	0.14 ± 0.026 1.2 ± 0.23	0.88
5	0.0007 ± 0.00032** 0.006 ± 0.028**	0.17 ± 0.027 1.5 ± 0.24	0.88
6	0.0062 ± 0.029** 0.029 ± 0.13**	0.057 ± 0.099** 0.26 ± 0.46**	0.46
Median	0.0062** 0.029	0.14 1.2	0.88
Range	0.0007** - 0.0063** 0.006** - 0.055**	0.057** - 0.17 0.26** - 1.5	0.46 - 0.88
<u>Tracheobronchial Lymph Nodes</u>			
4	0.021 ± 0.097** 0.12 ± 0.55**	2.8 ± 0.53 15 ± 3.0	0.56
5	-0.13 ± 0.26** -2.8 ± 5.9**	0.15 ± 0.29** 3.3 ± 6.4**	2.2
6	0.01 ± 0.049** 0.12 ± 0.57**	0.042 ± 0.097** 0.49 ± 1.1**	1.2
Median	0.01** 0.12**	0.15 3.3	1.2
Range	-0.13** - 0.021** -2.8** - 0.12**	0.042** - 2.8 0.49** - 15	0.56 - 2.2

* Wet weight

** Counting error exceeds reported activity.

TABLE C-2. PLUTONIUM CONCENTRATIONS IN MUSCLES AND LIVERS,
BEEF CATTLE, AREA 18, NTS, OCTOBER 1980

Animal Number	Plutonium-238 (pCi/g Ash) (pCi/kg*)	Plutonium-239 (pCi/g Ash) (pCi/kg*)	Ash (%)
<u>Muscles</u>			
4	0.00044 ± 0.002** 0.0037 ± 0.017**	0.00044 ± 0.002** 0.0037 ± 0.017**	0.85
5	0.0061 ± 0.0094** 0.048 ± 0.073**	0.016 ± 0.045** 0.12 ± 0.35**	0.78
6	0.00055 ± 0.0025** 0.0044 ± 0.02**	0.0077 ± 0.01** 0.062 ± 0.081**	0.81
Median	0.00055** 0.0044**	0.0077** 0.062**	0.81
Range	0.00044** - 0.0061** 0.0037** - 0.048**	0.00044** - 0.016** 0.0037** - 0.12**	0.78 - 0.85
<u>Livers</u>			
4	0.0021 ± 0.0057** 0.021 ± 0.057**	0.056 ± 0.016 0.56 ± 0.16	1
5	0.0048 ± 0.0073** 0.039 ± 0.06**	0.08 ± 0.015 0.64 ± 0.12	0.81
6	0.0013 ± 0.003** 0.013 ± 0.03**	0.013 ± 0.0043 0.13 ± 0.043	1
Median	0.0021** 0.021**	0.056 0.56	1
Range	0.0013** - 0.0048** 0.013** - 0.039**	0.013 - 0.08 0.13 - 0.64	0.81 - 1

* Wet weight

** Counting error exceeds reported activity.

TABLE C-3. PLUTONIUM CONCENTRATIONS IN GONADS AND FETUS,
BEEF CATTLE, AREA 18, NTS, OCTOBER 1980

Animal Number	Plutonium-238 (pCi/g Ash) (pCi/kg*)	Plutonium-239 (pCi/g Ash) (pCi/kg*)	Ash (%)
<u>Gonads</u>			
4	0.015 ± 0.034** 0.55 ± 1.3**	0.029 ± 0.048** 1.1 ± 1.8**	3.8
5	-0.069 ± 0.12** -0.6 ± 1.1**	0.02 ± 0.065** 0.17 ± 0.56**	0.87
6	0.0027 ± 0.0042** 0.03 ± 0.047**	0.0006 ± 0.002** 0.0067 ± 0.022**	1.1
Median	0.0027** 0.03**	0.02** 0.17**	1.1
Range	-0.069** - 0.015** -0.6** - 0.55**	0.0006** - 0.029** 0.0067** - 1.1**	0.87 - 38
<u>Fetus</u>			
5	0.0069 ± 0.013** 0.12 ± 0.22**	0.0012 ± 0.0054** 0.02 ± 0.092**	1.7

* Wet weight

** Counting error exceeds reported activity.

TABLE C-4. PLUTONIUM AND STRONTIUM CONCENTRATIONS IN FEMURS, BEEF CATTLE, AREA 18, NTS, 1980

Animal Number	Plutonium-238 (pCi/g Ash) (pCi/kg*)	Plutonium-239 (pCi/g Ash) (pCi/kg*)	Strontium-89 (pCi/g Ash) (pCi/kg*)	Strontium-90 (pCi/g Ash) (pCi/kg*)	Ash (%)
4	0.00041 ± 0.0019** 0.14 ± 0.67**	0.012 ± 0.0045 4.2 ± 1.6	12 ± 18** 4,200 ± 6,300**	2.4 ± 0.35 840 ± 120	35
5	0.0072 ± 0.0031 1.8 ± 0.78	0.0059 ± 0.0069** 1.5 ± 1.7**	11 ± 20** 2,800 ± 5,000**	3 ± 0.42 750 ± 105	25
6	0.0007 ± 0.0033** 0.14 ± 0.66**	0.016 ± 0.00034 3.2 ± 0.68	17 ± 26** 3,400 ± 5,200**	3.1 ± 0.49 620 ± 98	20
Median	0.0007** 0.14**	0.012 3.2	12 3,400	3 750	25
Range	0.00041** - 0.0072 0.14** - 1.8	0.0059** - 0.016 1.5** - 4.2	11** - 17** 2,800** - 4,200**	2.4 - 3.1 620 - 840	20 - 35

Frozen samples from animals 1-3 were lost because of a power outage at 16 Area 15 farms.

* Wet weight

** Counting error exceeds reported activity.

TABLE C-5. GAMMA-EMITTING RADIONUCLIDE AND TRITIUM CONCENTRATIONS IN SELECTED TISSUES,
BEEF CATTLE, AREA 18, NTS, MAY 1980

Animal Number	Muscles K (g/kg*) ¹³⁷ Cs(pCi/kg*)	Lungs K (g/kg*)	Livers K (g/kg*) ¹³⁷ Cs(pCi/kg*)	Thyroids K (g/kg*)	Kidneys K (g/kg*) ¹³⁷ Cs(pCi/kg*)	Rumen Contents K (g/kg*) ¹³⁷ Cs(pCi/kg*)	Blood ³ H (pCi/l)
1	6.4 ± 0.29 37 ± 12	16 ± 1.5	Sample Lost	41 ± 3.6	4.1 ± 0.33 <27	3.3 ± 0.33 36 ± 17	<320
2	6.1 ± 0.32 21 ± 12	7.6 ± 0.64	3.8 ± 0.22 14 ± 8.8	35 ± 2.6	5.1 ± 0.28 29 ± 12	2.6 ± 0.3 <37	<320
3**	6.0 ± 0.3 33 ± 12	7.2 ± 0.4	5.4 ± 0.31 <24	GSN	8.2 ± 0.61 81 ± 26	Not Sampled	<320
Median	6.1 33	7.6	4.6 <19	39	5.1 29	3.0 <37	<320
Range	6.0 - 6.4 21 - 37	7.2 - 16	3.8 - 5.4 14 - <24	35 - 41	4.1 - 8.2 <27 - 81	2.6 - 3.3 36 - <37	<320 - <320

* Wet weight

** Thymus was sampled; only K at 7.3 ± 0.8 g/kg was detected.

TABLE C-6. GAMMA-EMITTING RADIONUCLIDE AND TRITIUM CONCENTRATIONS IN SELECTED TISSUES,
BEEF CATTLE, AREA 18, NTS, OCTOBER 1980

Animal Number	Muscles K (g/kg*) ¹³⁷ Cs(pCi/kg*)	Lungs K (g/kg*)	Livers K (g/kg*)	Thyroids K (g/kg*)	Kidneys K (g/kg*)	Rumen Contents**	Blood ³ H (pCi/l)
4	3.5 ± 0.26 <25	6.8 ± 0.43	4.7 ± 0.37	22 ± 3.4	4.1 ± 0.25	Not Sampled	<390
5	6.2 ± 0.27 15 ± 9.2	7.9 ± 0.77	4.5 ± 0.29	9.6 ± 1.4	4.4 ± 0.26	Not Sampled	<390
6	5.8 ± 0.28 24 ± 8.8	4.2 ± 0.33	4.8 ± 0.28	4.1 ± 0.56	3.4 ± 0.24	Not Sampled	<390
Median	5.8 24	6.8	4.7	9.6	4.1		<390
Range	3.5 - 6.2	4.2 - 7.9	4.5 - 4.8	4.1 - 22	3.4 - 4.4		<390 - <390

* Wet weight

** Rumen Contents not sampled as animal maintained on alfalfa hay for several days prior to death.

TABLE D-1. PLUTONIUM CONCENTRATIONS IN MUSCLES AND LIVERS,
MULE DEER, NTS, 1980

Animal Number	Plutonium-238 (pCi/g Ash) (pCi/kg*)	Plutonium-239 (pCi/g Ash) (pCi/kg*)	Ash (%)
<u>Muscles</u>			
1	-0.0012 ± 0.0037** -0.013 ± 0.059**	0.013 ± 0.004 0.13 ± 0.042	1
2	-0.0015 ± 0.0071** -0.0095 ± 0.044**	0.0061 ± 0.014** 0.038 ± 0.09**	0.63
3	0.0051 ± 0.0093** 0.051 ± 0.093**	0.0051 ± 0.0093** 0.051 ± 0.093**	1
4	0.00059 ± 0.0028** 0.0044 ± 0.021**	0.0072 ± 0.011** 0.053 ± 0.081**	0.74
Median	-0.0003** -0.0026**	0.0067** 0.052**	0.87
Range	-0.0015** - 0.0051** -0.0095** - 0.051**	0.0052** - 0.013 0.038** - 0.13	0.63 - 1
<u>Livers</u>			
1	0.0031 ± 0.0054** 0.039 ± 0.069**	0.012 ± 0.0048 0.15 ± 0.06	1.3
2	0.0013 ± 0.0061** 0.021 ± 0.1**	0.0078 ± 0.015** 0.13 ± 0.25**	1.6
3	0.006 ± 0.028** 0.066 ± 0.31**	0.006 ± 0.028** 0.066 ± 0.031**	1.1
4	0.0019 ± 0.009** 0.018 ± 0.087**	0.0039 ± 0.013** 0.038 ± 0.13**	0.97
Median	0.0022** 0.036**	0.0069** 0.098**	1.2
Range	0.0013** - 0.006** 0.018** - 0.039**	0.0039** - 0.012 0.038** - 0.15	0.97 - 1.6

* Wet weight
** Counting error exceeds reported activity.

TABLE D-2. PLUTONIUM CONCENTRATIONS IN LUNGS AND GONADS,
MULE DEER, NTS, 1980

Animal Number	Plutonium-238 (pCi/g Ash) (pCi/kg*)	Plutonium-239 (pCi/g Ash) (pCi/kg*)	Ash (%)
<u>Lungs</u>			
1	-0.002 ± 0.009** -0.013 ± 0.062**	0.044 ± 0.014 0.3 ± 0.094	0.68
2	-0.0074 ± 0.0016** -0.088 ± 0.18**	0.003 ± 0.0097** 0.035 ± 0.12**	1.2
3	0.0015 ± 0.0071** 0.018 ± 0.085**	0.0045 ± 0.012** 0.054 ± 0.14**	1.2
4	0.0011 ± 0.005** 0.012 ± 0.055**	0.011 ± 0.018** 0.12 ± 0.2**	1.1
Median	0.0004** 0.00	0.007** 0.087**	1.2
Range	-0.0074** - 0.0015** -0.088** - 0.018**	0.003** - 0.044 0.035** - 0.3	0.68 - 1.2
<u>Gonads</u>			
3	0.014 ± 0.033** 0.2 ± 0.46**	0.088 ± 0.037 1.2 ± 0.52	1.4
4	0.0021 ± 0.0096** 0.048 ± 0.22**	0.0041 ± 0.014** 0.095 ± 0.32**	2.3

* Wet weight

** Counting error exceeds reported activity.

TABLE D-3. PLUTONIUM CONCENTRATIONS IN RUMEN CONTENTS, MULE DEER,
NTS, 1980

Animal Number	Plutonium-238 (pCi/g Ash) (pCi/kg*)	Plutonium-239 (pCi/g Ash) (pCi/kg*)	Ash (%)
1	0.0072 ± 0.0024 0.13 ± 0.044	0.038 ± 0.0063 0.69 ± 0.11	1.8
2	0.007 ± 0.0082** 0.15 ± 0.2**	0.027 ± 0.0079 0.61 ± 0.17	2.2
3	0.006 ± 0.0081** 0.09 ± 0.12**	0.034 ± 0.0085 0.51 ± 0.13	1.5
4	0.025 ± 0.0074 0.33 ± 0.096	0.23 ± 0.037 3.0 ± 0.48	1.3
Median	0.0071** 0.14**	0.036 0.65	1.7
Range	0.006** - 0.025 0.09** - 0.33	0.027 - 0.23 0.51 - 3.0	1.3 - 2.2

* Wet weight

** Counting error exceeds reported activity.

TABLE D-4. PLUTONIUM AND STRONTIUM CONCENTRATIONS IN HOCK BONES, MULE DEER, NTS, 1980

Animal Number	Plutonium-238 (pCi/g Ash) (pCi/kg*)	Plutonium-239 (pCi/g Ash) (pCi/kg*)	Strontium-89 (pCi/g Ash) (pCi/kg*)	Strontium-90 (pCi/g Ash) (pCi/kg*)	Ash (%)
1	-0.0011 ± 0.0037** -0.28 ± 0.93**	0.019 ± 0.0071 4.9 ± 1.8	450 ± 510** 110,000 ± 130,000**	2.2 ± 0.3 550 ± 76	25
2	Sample Lost				
3	0.0004 ± 0.0018** 0.088 ± 0.4**	0.0056 ± 0.007** 1.2 ± 1.5**	16 ± 16** 3,500 ± 3,500**	0.95 ± 2.0** 200 ± 440**	22
4	0.0004 ± 0.0018** 0.13 ± 0.59**	0.0004 ± 0.0018** 0.13 ± 0.69**	-176 ± 230** 58,000 ± 76,000**	1.9 ± 0.41 630 ± 140	33
Median	0.0004** 0.088**	0.0056** 1.2**	16** 3,500**	1.9 550	25
Range	-0.0011** - 0.0004** -0.28** - 0.13**	0.0004** - 0.019 0.13** - 4.9	-176** - 452** -5,8000** - 110,000**	0.95** - 2.2 200** - 630	22 - 33

* Wet weight

** Counting error exceeds reported activity.

TABLE D-5. GAMMA-EMITTING RADIONUCLIDE AND TRITIUM CONCENTRATIONS IN SELECTED TISSUES,
MULE DEER, NTS, 1980

Animal Number	Muscles K (g/kg*)	Lungs K (g/kg*)	Livers K (g/kg*)	Thyroids ¹³¹ I(pCi/g*)	Kidneys K (g/kg*) ¹³⁷ Cs(pCi/kg*)	Rumen Contents K (g/kg*)	Blood ³ H (pCi/l)
1	4.9 ± 0.33	6.9 ± 0.44	3.9 ± 0.31	<4	4.3 ± 0.32 <30	4.1 ± 0.31	<420
2	3.6 ± 0.29	4.2 ± 0.36	4.4 ± 0.36	Sample Not Collected	4.3 ± 0.33 19 15	3.6 ± 0.29	470 ± 250
43 3	4.5 ± 0.26	8.2 ± 0.47	5.0 ± 0.32	Sample Not Collected	7.4 ± 0.48 <50	5.4 ± 0.31	<330
4	5.8 ± 0.31	5.0 ± 0.43	5.3 ± 0.35	22 ± 1.9	9.5 ± 0.65 <73	5.0 ± 0.33	<420
Median	4.7	6.0	4.7	<13	5.9 <40	4.6	<420
Range	3.6 - 5.8	4.2 - 8.2	3.9 - 5.3	<4 - 22	4.3 - 9.5 19 - <73	3.6 - 5.4	<330 - 470

* Wet weight

TABLE E-1. PLUTONIUM AND STRONTIUM CONCENTRATIONS IN BONES, DESERT BIGHORN SHEEP, 1980

Animal Number	Plutonium-238 (pCi/g Ash) (pCi/kg*)	Plutonium-239 (pCi/g Ash) (pCi/kg*)	Strontium-89 (pCi/g Ash) (pCi/kg*)	Strontium-90 (pCi/g Ash) (pCi/kg*)	Ash (%)
1	0.0042 ± 0.011** 0.76 ± 2.0	0.02 ± 0.027** 3.6 ± 4.9	-1.0 ± 7.9** -180 ± 1,400	1.9 ± 0.34 340 ± 61	18
2	0.00041 ± 0.0019** 0.14 ± 0.65	0.002 ± 0.0042** 0.68 ± 1.4	0.55 ± 2.2** 190 ± 750**	0.55 ± 0.086 190 ± 30	34
3	0.0064 ± 0.011** 2.2 ± 3.7	0.0032 ± 0.0074** 1.1 ± 2.5	4.2 ± 11** 1,400 ± 3,700	2.2 ± 0.33 750 ± 110	34
4	0.0034 ± 0.0072** 1.1 ± 2.2	0.0069 ± 0.010** 2.1 ± 3.1	1.4 ± 3.8** 430 ± 1,200**	0.68 ± 0.11 210 ± 34	31
5	0.0044 ± 0.0078** 1.2 ± 2.2	0.00063 ± 0.0029** 0.18 ± 0.81	-1.1 ± 9.0** -300 ± 2,500	1.7 ± 0.27 470 ± 76	28
6	Sample Lost				
7	0.00036 ± 0.0017** 0.12 ± 0.56	0.0029 ± 0.0048** 0.96 ± 1.6	0.41 ± 8.8** 140 ± 2,900	2.1 ± 0.29 690 ± 96	33
8	0.0004 ± 0.0018** 0.1 ± 0.45	0.0056 ± 0.007** 1.4 ± 1.8	1.7 ± 3.1** 430 ± 780	0.58 ± 0.11 150 ± 28	25
9	0.00042 ± 0.0019** 0.063 ± 0.29	0.0089 ± 0.0094** 1.3 ± 1.4	-1.5 ± 5.9** -230 ± 890	1.5 ± 0.2 230 ± 30	15
10	0.00031 ± 0.0015** 0.081 ± 0.39	0.013 ± 0.0042** 3.4 ± 1.1	3.0 ± 6.5** 780 ± 1,700	1.3 ± 0.19 340 ± 49	26

(continued)

TABLE E-1. (Continued)

Animal Number	Plutonium-238 (pCi/g Ash) (pCi/kg*)	Plutonium-239 (pCi/g Ash) (pCi/kg*)	Strontium-89 (pCi/g Ash) (pCi/kg*)	Strontium-90 (pCi/g Ash) (pCi/kg*)	Ash (%)
11	0.003 ± 0.0058** 0.81 ± 1.6	0.0076 ± 0.0088** 2.1 ± 2.4	2.2 ± 4.6** 590 ± 1,200	0.84 ± 0.13 230 ± 35	27
12	0.00036 ± 0.0017** 0.094 ± 0.44	0.0069 ± 0.0078** 1.8 ± 2.0	0.71 ± 5.6** 180 ± 1,500	1.3 ± 0.18 340 ± 47	26
13 (dupli- cate No. 12)	0.0011 ± 0.0035** 0.31 ± 0.98	0.012 ± 0.012** 3.4 ± 3.4	2.4 ± 5.4** 670 ± 1,500	1.2 ± 0.17 340 ± 48	28
14	0.00056 ± 0.0026** 0.22 ± 1.0	0.00056 ± 0.0026** 0.22 ± 1.0	4.1 ± 4.4** 1,600 ± 1,700	2.8 ± 1.4 1,100 ± 550	39
15	0.0019 ± 0.0039** 0.53 ± 1.1	0.0045 ± 0.0064** 1.3 ± 1.8	0.73 ± 1.2** 200 ± 340	2.9 ± 0.4 810 ± 110	28
Median	0.00083** 0.27	0.0063** 1.4	1.1** 310	1.4 340	28
Range	0.00031** - 0.0064** 0.063 - 2.2	0.00056** - 0.02** 0.18 - 3.6	1.5** - 4.1** -300 - 1,600	0.55 - 2.9 150 - 1,100	15 - 39

* Wet weight

** Counting error exceeds reported activity.

TABLE E-2. GAMMA-EMITTING RADIONUCLIDE AND TRITIUM CONCENTRATIONS
IN KIDNEYS, DESERT BIGHORN SHEEP, 1980

Animal Number	K (g/g*)	Cesium-137 (pCi/kg*)	Hydrogen-3 (pCi/l*)
1	13 + 0.78	<84	<420
2	17 + 1.1	<112	<420
3	14 + 1.4	<123	<420
4	8 + 0.65	<51	<420
5	7.9 + 0.67	<93	<420
6	5.6 + 0.42	91 + 22	<330
7	11 + 0.64	<61	<420
8	6.1 + 0.45	<40	<330
9	8.6 + 0.69	<88	<330
10	6.1 + 0.39	31 + 18	<420
11	9.9 + 0.68	<80	<420
12	7.3 + 0.58	<50	<420
Median	8.3	<82	<420
Range	5.6 - 17	31 - <123	<330 - <420

* Wet weight

+ Aqueous portion of kidney tissue

TABLE F-1. PLUTONIUM, STRONTIUM, AND GAMMA-EMITTING RADIONUCLIDE CONCENTRATIONS IN
SELECTED TISSUES, NTS HORSE, 1980

Tissue Type	Plutonium-238 (pCi/g Ash) (pCi/kg*)	Plutonium-239 (pCi/g Ash) (pCi/kg*)	Strontium-89 (pCi/g Ash) (pCi/kg*)	Strontium-90 (pCi/g Ash) (pCi/kg*)	Ash (%)	K (g/kg*)
Bone	-0.0012 ± 0.004** -0.32 ± 1.1**	0.015 ± 0.015 3.9 ± 3.9	150 ± 515** 40,000 ± 140,000**	3.5 ± 0.5 950 ± 130	27	NA
Muscle	0.0031 ± 0.0059** 0.024 ± 0.046**	0.0057 ± 0.0081** 0.044 ± 0.063**	NA	NA	0.78	6.3 ± 0.32
Liver	0.034 ± 0.0088 0.44 ± 0.11	0.98 ± 0.11 13 ± 1.4	NA	NA	1.3	4.4 ± 0.18
Lung	0.014 ± 0.014 0.15 ± 0.15	0.42 ± 0.045 4.7 ± 0.56	NA	NA	1.1	7.2 ± 0.57
Thyroid	NA	NA	NA	NA	NA	24 ± 2.7

* Wet weight

** Counting error exceeds reported activity.

NA Not Analyzed

TABLE G-1. PLUTONIUM CONCENTRATIONS IN SELECTED TISSUES, RABBITS,
AREA 15, NTS, 1980

Animal Number	Plutonium-238 (pCi/g Ash) (pCi/kg*)	Plutonium-239 (pCi/g Ash) (pCi/kg*)	Ash (%)
<u>Muscles</u>			
1	-0.0027 ± 0.0055** -0.053 ± 0.11**	0.044 ± 0.011 0.88 ± 0.21	2.0
2	-0.0011 ± 0.0052** -0.016 ± 0.073**	0.018 ± 0.021** 0.25 ± 0.3**	1.4
3	0.00 ± 0.0088** 0.00 ± 0.14**	0.037 ± 0.041** 0.59 ± 0.65**	1.6
4	-0.0029 ± 0.0066** -0.04 ± 0.093**	0.051 ± 0.013 0.71 ± 0.18	1.4
Median	-0.0019** -0.028**	0.041 0.65	1.5
Range	-0.0029** - 0.00** -0.053** - 0.00**	0.018** - 0.051 0.25** - 0.88	1.4 - 2
<u>Internal Organs</u>			
1	0.031 ± 0.012 0.43 ± 0.17	0.61 ± 0.079 8.5 ± 1.1	1.4
2	Sample Lost		
3	0.067 ± 0.028 1.0 ± 0.42	0.93 ± 0.018 14 ± 2.7	1.5
4	0.011 ± 0.016** 0.15 ± 0.21**	0.14 ± 0.027 1.8 ± 0.35	1.3
Median	0.031 0.43	0.61 8.5	1.4
Range	0.011** - 0.067 0.15** - 1.0	0.14 - 6.93 1.8 - 14	1.3 - 1.5

(continued)

TABLE G-1. (Continued)

Animal Number	Plutonium-238 (pCi/g Ash) (pCi/kg*)	Plutonium-239 (pCi/g Ash) (pCi/kg*)	Ash (%)
<u>G. I. Tract</u>			
1	0.016 ± 0.008 0.34 ± 0.12	0.38 ± 0.042 7.9 ± 0.88	2.1
2	0.038 ± 0.01 0.9 ± 0.25	0.88 ± 0.096 21 ± 2.3	2.4
3	1.5 ± 0.28 200 ± 30	33 ± 4.8 4,300 ± 630	13
4	0.017 ± 0.0063 0.32 ± 0.12	0.63 ± 0.063 12 ± 1.2	1.9
Median	0.028 0.62	0.76 17	2.3
Range	0.016 - 1.5 0.32 - 200	0.38 - 33 7.9 - 4,300	1.9 - 13
<u>Skin</u>			
1	0.28 ± 0.057 6.2 ± 1.3	10 ± 0.95 220 ± 21	2.2
2	0.33 ± 0.096 8.0 ± 2.3	16 ± 2.3 380 ± 56	2.4
3	0.46 ± 0.079 10 ± 1.8	19 ± 1.8 420 ± 40	2.2
4	0.25 ± 0.052 5.8 ± 1.2	7.8 ± 0.74 180 ± 17	2.3
Median	0.31 7.1	13 300	2.3
Range	0.25 - 0.46 5.8 - 10	7.8 - 19 180 - 420	2.2 - 2.4

* Wet weight

** Counting error exceeds reported activity.

TABLE G-2. PLUTONIUM AND STRONTIUM CONCENTRATIONS IN BONES, RABBITS, AREA 15, NTS, 1980

Animal Number	Plutonium-238 (pCi/g Ash) (pCi/kg*)	Plutonium-239 (pCi/g Ash) (pCi/kg*)	Strontium-89 (pCi/g Ash) (pCi/kg*)	Strontium-90 (pCi/g Ash) (pCi/kg*)	Ash (%)
1	-0.0012 ± 0.0039** -0.14 ± 0.48**	0.018 ± 0.0069 2.2 ± 0.86	530 ± 830** 66,000 ± 100,000**	2.6 ± 0.38 320 ± 47	12
2	0.0 ± 0.0024** 0.0 ± 0.36**	0.02 ± 0.0071 2.9 ± 1.0	170 ± 1,000** 24,000 ± 110,000**	3.5 ± 0.49 500 ± 71	14
3	0.00065 ± 0.003** 0.098 ± 0.46**	0.049 ± 0.01 7.3 ± 2.0	-140 ± 780** -22,000 ± 110,000**	2.4 ± 0.36 360 ± 55	15
4	0.0006 ± 0.0026** 0.08 ± 0.37**	0.042 ± 0.012 6.1 ± 1.8	350 ± 470** 51,000 ± 68,000**	1.5 ± 0.22 270 ± 32	14
Median	.0003** 0.04**	0.031 4.5	260** 38,000**	2.5 340	14
Range	-0.0012** - 0.00065** -0.14** - 0.098**	0.018 - 0.049 2.2 - 7.3	-140** - 530** -22,000** - 66,000**	1.5 - 3.5 220 - 500	12 - 15

* Wet weight

** Counting error exceeds reported activity.

TABLE G-3. GAMMA-EMITTING RADIONUCLIDE AND TRITIUM CONCENTRATIONS IN
SELECTED TISSUES, RABBITS, AREA 15, NTS, 1980

Animal Number	Muscles	Internal Organs	G. I. Tract	Skin
	K (g/kg*) ¹³⁷ Cs(pCi/kg) ³ H(pCi/l)		K (g/kg*) ¹³⁷ Cs(pCi/kg*) ¹⁰² mRh(pCi/kg*) ⁶⁰ Co(pCi/kg*)	
1	9.2 ± 0.57 98 ± 16 4,100 ± 310	9.3 ± 0.3 71 ± 14	4.7 ± 0.34 63 ± 16 <28 <28	13 ± 1.3 250 ± 91
2	5.7 ± 0.43 130 ± 20 1,200 ± 270	5.9 ± 0.45 90 ± 23	6.3 ± 0.44 150 ± 22 <42 <42	10 ± 1.6 200 ± 120
3	5.0 ± 6.34 82 ± 16 6,500 ± 340	4.6 ± 0.34 37 ± 18	11 ± 0.56 2,300 ± 61 130 ± 25 130 ± 13	4.9 ± 1.3 140 ± 71
4	6.0 ± 0.37 88 ± 18 5,300 ± 320	3.9 ± 0.35 46 ± 16	4.6 ± 0.34 33 ± 15 <29 <29	15 ± 1.6 130 ± 87
Median	5.9 93 4,700	5.3 59	5.5 107 <36 <36	11.6 170
Range	5.0 - 9.2 82 - 130 1,200 - 6,500	3.9 - 9.3 37 - 99	4.6 - 11 33 - 2,300 <28 - 130 <28 - 130	4.9 - 15 130 - 250

* Wet weight

TABLE H. GROSS* AND MICROSCOPIC PATHOLOGY† FOUND IN
NECROPSIED ANIMALS, 1980

AREA 18 CATTLE

1

Necropsy findings: The lungs were emphysematous from agonal struggling. Metal fragments were found in the reticulum.

Histopathological findings: No significant lesions noted. No active spermatogenesis in the testes.

Clinical diagnosis: Normal immature bull.

2

Necropsy findings: Adhesions between diaphragm and liver. Lice are present on skin.

Histopathological findings: Sarcocyst observed in cardiac muscle. There is moderate hemosiderosis of the spleen. The skin shows mild superficial dermal mononuclear infiltrate, etiology undetermined. An incidental finding was scattered tubular mineral deposits in the kidneys.

Clinical diagnosis: Normal lactating cow.

3

Necropsy findings: No gross lesions noted.

Histopathological findings: No significant lesions noted. An incidental finding was diffuse fatty changes in the liver.

Clinical diagnosis: Normal 2-week old female calf.

4

Necropsy findings: Cauliflower growth on left eye (squamous cell carcinoma). Lungs contain areas of emphysema and atelectasis probably resulting from agonal struggling.

* As reported by senior author

† As reported by Dr. Billy C. Ward, College of Veterinary Medicine,
Mississippi State University, Starkville, Mississippi.

Histopathological findings: Mild hemosiderosis of the spleen. Sarcocysts are found in the cardiac muscle and the skeletal muscle shows moderate fatty infiltration. The neoplastic mass on the cornea is composed of moderate undifferentiated squamous cells which occasionally form pearls on the corneal surface. The only significant lesion is the presence of an ocular squamous cell carcinoma.

Clinical diagnosis: Mature cow with beginning ocular squamous cell carcinoma.

5

Necropsy findings: The left eye was completely enucleated by a squamous cell carcinoma and secondary bacterial infections. Uterus contained a 3-month male fetus.

Histopathological findings: Sarcocysts are scattered throughout the myocardium. The spleen shows moderate hemosiderosis.

Clinical diagnosis: Mature cow with advanced ocular squamous cell carcinoma.

6

Necropsy findings: No gross lesions noted.

Histopathological findings: Mild peribronchial lymphoid proliferation noted in the lungs. No evidence of active spermatogenesis in the testes.

Clinical diagnosis: Normal 6-month old bull calf.

NEVADA TEST SITE MULE DEER

1

Necropsy findings: Trauma associated with bullet passage through the lungs, antlers stunted and knobby.

Histopathological findings: No significant lesions noted. Tissue samples were autolyzed.

Clinical diagnosis: Normal mature male deer.

2

Necropsy findings: Mature doe in lactation. Trauma associated with vehicular collision. Neck was broken.

Histopathological findings: Focal hemorrhage in lung. No other lesions noted. Samples showed advanced post-mortem autolysis.

Clinical diagnosis: Normal mature lactating female deer.

Necropsy findings: Fractured vertebrae from syringe fired from Cap-Chur gun.

Histopathological findings: No significant lesions. No evidence of active spermatogenesis in testes.

Clinical diagnosis: Normal immature male deer.

Necropsy findings: Trauma associated with bullet passage through lungs.

Histopathological findings: A few sarcocysts are observed in the myocardium and skeletal muscle. There are small mineralized foci in the pelvis of the kidney. No evidence of active spermatogenesis in the testes.

Clinical diagnosis: Normal immature male deer.

AREA 15 HORSE

Necropsy findings: The liver and lung surfaces and parenchyma contained numerous spherical nodules 2-5 mm in diameter. These nodules were whitish yellow in color and very hard. The urinary bladder contained several hundred cubic centimeters of a thick pustular exudate. The same exudate was found in the pelvis of the left kidney. Thyroid was very dense and hard.

Histopathological findings: There are multifocal calcific nodules scattered throughout the liver and lung parenchyma. These nodules are surrounded by dense fibrous connective tissue bands which occasionally have a few infiltrating inflammatory cells, many of which are eosinophils. The center of the nodule is composed of dense calcified tissue. There is some linear mineralization in the choroid behind the retinal epithelium. The thyroid displays marked irregularity of follicular size and of colloid content. The muscle shows some fatty infiltration. There are a variety of mild, probably age-associated lesions in the kidney. These consist of mild multifocal interstitial fibrosis with moderate accumulation of mononuclear cells associated with fibrotic lesions. There are some protein casts in dilated tubules and an occasional granular cast. Focal glomerular scarring is occasionally observed.

Clinical diagnosis: Aged horse showing the degenerative changes of advanced age. The major findings in this horse include mineralization behind the retina, mild interstitial nephritis and degenerative changes of the kidney, and mild thyroid atrophy and regeneration. The multifocal calcific nodules in the liver and lungs are probably associated with old calcified parasitic granulomas.

AREA 15 RABBITS

All of these animals were collected by shotgun fire. All were placed in a freezer until sampled. No gross lesions were noted by dissector. All were apparently normal at time of death. Samples were not collected for histopathological examination.

DESERT BIGHORN SHEEP

All of these animals were mature males that were killed by licensed hunters. Necropsies were not performed but all were apparently normal at time of death. Samples were not collected for histopathological examination.

TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

1. REPORT NO.		2.		3. RECIPIENT'S ACCESSION NO.	
4. TITLE AND SUBTITLE ANIMAL INVESTIGATION PROGRAM 1980 REPORT Nevada Test Site and Vicinity				5. REPORT DATE	
				6. PERFORMING ORGANIZATION CODE EPA/600/07	
7. AUTHOR(S) D. D. Smith, K. R. Giles and D. E. Bernhardt				8. PERFORMING ORGANIZATION REPORT NO.	
9. PERFORMING ORGANIZATION NAME AND ADDRESS Environmental Monitoring Systems Laboratory Office of Research and Development U.S. Environmental Protection Agency Las Vegas, Nevada 89114				10. PROGRAM ELEMENT NO. X6EH10	
				11. CONTRACT/GRANT NO. IA DE-AI08-76DP00539	
12. SPONSORING AGENCY NAME AND ADDRESS U.S. Department of Energy Nevada Operations Office P.O. Box 14100 Las Vegas, Nevada 89114				13. TYPE OF REPORT AND PERIOD COVERED Calendar 1980	
				14. SPONSORING AGENCY CODE	
15. SUPPLEMENTARY NOTES Performed under Interagency Agreement DE-AI08-76DP00539 for the U.S. Department of Energy					
16. ABSTRACT Data are presented from the radioanalysis of tissues collected from animals that resided on or near the Nevada Test Site (NTS). Gamma-emitting radionuclides were detected infrequently. Iodine-131 was found in the thyroids of a deer 3 weeks after a nuclear test by the People's Republic of China. Strontium-90 and plutonium concentrations in NTS animal tissues were similar to those of recent years. Radionuclide tissue concentrations were generally higher in the tissues of animals residing in Area 15. Annual dose estimates to man were calculated based on the daily consumption of 0.5 kg of tissue with peak radionuclide levels. The highest postulated dose was 0.4 millirems to the whole body from consuming cattle muscle containing 37 pCi cesium-137 per kg. This dose is about 0.1 percent of the radiation protection guide. The movements of 26 mule deer fitted with collars containing a radio transmitter unit were monitored. By mid-December, all deer had left their summer ranges. In general, deer captured on Pahute Mesa winter in the 40-Mile Canyon and Timber Mountain areas with some movement off the NTS toward Beatty, while those captured on Rainier Mesa winter in the Shoshone Mountain area. A deer captured in December 1979 was seen in July and August, approximately 160 kilometers from its capture point. NTS mule deer population estimates based on weekly sightings were made for 1978, 1979 and 1980. No gross or microscopic lesions in necropsied animals were found that could be directly attributed to the effects of ionizing radiation.					
17. KEY WORDS AND DOCUMENT ANALYSIS					
a. DESCRIPTORS		b. IDENTIFIERS/OPEN ENDED TERMS		c. COSATI Field/Group	
18. DISTRIBUTION STATEMENT RELEASE TO PUBLIC		19. SECURITY CLASS (This Report) UNCLASSIFIED		21. NO. OF PAGES	
		20. SECURITY CLASS (This page) UNCLASSIFIED		22. PRICE	