

ANIMAL INVESTIGATION PROGRAM 1970 ANNUAL REPORT

by  
D. D. Smith and K. R. Giles  
Farm and Animal Investigation Branch  
Monitoring Systems Research and Development Laboratory  
National Environmental Research Center

U. S. ENVIRONMENTAL PROTECTION AGENCY  
Las Vegas, NV 89114

Published January 1974

This study performed under a Memorandum  
of Understanding No. AT(26-1)-539  
for the  
U. S. ATOMIC ENERGY COMMISSION

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## ABSTRACT

This report presents the radionuclide contents of tissues collected during 1970 from cattle, deer, desert bighorn sheep, and other wildlife on or near the Nevada Test Site (NTS).

Gamma emitting radionuclides were infrequently detected in the tissues of animals living on or around the NTS. However,  $^{131}\text{I}$  was detected in the thyroids of all beef animals sampled during October. The probable source of the  $^{131}\text{I}$  was a non-U. S. atmospheric test conducted on October 14, 1970.

Elevated levels of  $^{131}\text{I}$ ,  $^{106}\text{Ru}$ , and  $^3\text{H}$  were detected in the tissues of wildlife that drank from drainage ponds that collect runoff waters from the mines used for testing activities. A man, eating 311 g of the flesh on one chukar sampled, would ingest 34.2 nCi of  $^{131}\text{I}$  and 53  $\mu\text{Ci}$  of  $^3\text{H}$ .

The average  $^{90}\text{Sr}$  levels detected in the bones of three ruminant species sampled on and around the NTS ranged from 2.4 to 5.6 pCi/g of ash. These levels are lower than those reported during 1969 and reflect the downward trend observed since the cessation of atmospheric testing.

No gross or microscopic lesions were detected that could be directly attributed to the effects of ionizing radiation.

Details of special studies of wildlife utilizing the contaminated runoff waters, of cattle grazing in the Schooner fallout area, and surveillance activities associated with Project Rulison are also presented.

Other activities of the Animal Investigation Program including claim investigation, public information displays, etc., during 1970 are described.

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## INTRODUCTION AND HISTORY

The predecessor of the Animal Investigation Program was the Off-Site Animal Investigation Project which was inaugurated in July of 1957 by the U. S. Atomic Energy Commission under the direction of an U. S. Army Veterinarian attached to the Nevada Operations Office<sup>(1)</sup>. This responsibility was transferred to the National Environmental Research Center, Las Vegas (NERC-LV) (formerly the Southwestern Radiological Health Laboratory), on June 1, 1964.

At that time the scope of the program was broadened to include the present objectives of:

1. The determination of tissue concentrations of fresh and/or aged fission and activation products in biological samples obtained from cattle on the NTS and from off-site ranches, if required.
2. The development and conduction of wildlife studies on and near the NTS in cooperation with state and federal wildlife agencies in order to assess the radionuclide burden in tissues collected from various edible wildlife species.
3. The gross and microscopic examination of tissues collected from domestic and wild animals for the detection of pathological changes, possibly due to the tissue concentrations of the radionuclides.
4. The maintenance of veterinary relations with the off-site population.
5. The investigation of alleged damage to domestic animals from the activities the Atomic Energy Commission conducts.

This report details the analytical data collected and progress made in meeting the above objectives during 1970.

## THE NEVADA TEST SITE BEEF HERD

The NTS beef herd has been in existence since 1957. The herd history and animal husbandry details have been described previously<sup>(2)</sup>. Also published are range<sup>(3)</sup> and soil<sup>(4)</sup> surveys of the grazing area (Area 18) utilized by the herd.

In the last few years, through natural increase, the herd became too large for efficient management; therefore, in November of 1970, 38 animals were surplused and transferred to the University of Nevada, Reno. Following this transaction, the herd consisted of 71 animals as follows:

2 bulls; 16 aged cows (5 years and older); 5 four-year-old cows; 8 three-year-old cows; 1 three-year-old steer; 11 two-year-old heifers; 4 two-year-old steers; 6 yearling heifers; 2 yearling steers; eight 1970 heifer calves and eight 1970 steer calves. The 1970 calving percentage was 80% (36 calves from 45 breeding females). The average rate of gain of the nursing calves was 1.1 pounds per day during the 100-day period between May 19 and August 26. They received no supplemental feed during this period.

As part of the surveillance activities of the Animal Investigation Program, six animals from the herd are sacrificed semiannually and selected tissues are collected for radioanalysis and histopathological examination. These sacrifices took place on May 20 and October 30. The vital statistics of the sacrificed animals are presented in Table 1. Unless otherwise noted, each sacrificed animal spent its entire life grazing on the Area 18 range of the NTS. The fall collection included samples from a seventh animal, as one of the cows was accidentally killed while loading her in a trailer during the August roundup. In addition to the samples collected from the range animals sacrificed for this purpose, samples were collected from three corralled animals (two dairy cows, one fistulated steer) that died from natural causes.



Table 1. Vital Statistics of Nevada Test Site Cattle Sampled During 1970

ID Number	Date Sacrificed or Date Died	Breed	Sex	Age (a)	Wt. (kg)	Remarks
BOV-1-NTS-70	20 May	Hereford	M	2	300	
BOV-2-NTS-70	20 May	Hereford	M	1	190	
BOV-3-NTS-70	20 May	Hereford	F	4	431	Infantile genitalia-- a "freemartin".
BOV-4-NTS-70	20 May	Hereford	M	3	375	Fibrin foreign body in abdominal cavity.
BOV-5-NTS-70	20 May	Hereford	M	3	505	Thickened urinary bladder.
BOV-6-NTS-70	20 May	Hereford	M	1	225	
BOV-7-NTS-70	26 Aug	Hereford	F	5	320	Accidentally strangled during roundup. No histopathology samples collected.
BOV-8-NTS-70	29 Oct	Hereford	F	1	234	
BOV-9-NTS-70	29 Oct	Hereford	F	6	384	Pregnant 3.5-month-old fetus.
BOV-10-NTS-70	29 Oct	Hereford	M	3	523	
BOV-11-NTS-70	29 Oct	Hereford	F	14+	400	One of the original cows in herd. Pregnant 2-month-old fetus.
BOV-12-NTS-70	29 Oct	Hereford	M	1	320	
BOV-13-NTS-70	29 Oct	Hereford	M	1	305	
AHU-44-NTS-70	14 Jan	Holstein	F	10	880	Euthanized. Terminal lymphosarcoma with secondary emphysema.

Table 1. Vital Statistics of Nevada Test Site Cattle Sampled During 1970 (cont'd)

ID Number	Date Sacrificed or Date Died	Breed	Sex	Age (a)	Wt. (kg)	Remarks
AHU-903-NTS-70	9 May	Hereford	M	7	800	Fistulated steer. Died from cardiac failure. Kept in Well 3 corrals, except for one day a month for last four years.
AHU-36-NTS-70	13 Aug	Holstein	F	5.5	570	Died of tympanites. Was in milking string at Area 15 farm.

Each sacrificed animal was killed by firing a 0.243 caliber bullet into the brain. Immediately after death the animal was necropsied and all pathological conditions were noted. Samples of adrenals, eyes, heart, kidneys, liver, lungs, muscle, spleen, thyroid, and gonads of each animal were taken and tissue sections were prepared and submitted to a pathologist for microscopic examination. A summary of the histopathological findings is presented in Appendix I.

Tissues routinely collected for radioanalysis included rumen content, liver, lung, muscle, thyroid, blood or urine, fetus, if present, and bone from the femur. Quantitative analysis of the soft tissues by gamma spectroscopy was made for  $^{187}\text{W}$ ,  $^{144}\text{Ce}$ ,  $^{140}\text{Ba}$ ,  $^{137}\text{Cs}$ ,  $^{131}\text{I}$ ,  $^{106}\text{Ru}$ ,  $^{95}\text{Zr}$ ,  $^{54}\text{Mn}$ , and K as determined by the 40K fraction. Urine or blood was analyzed for  $^3\text{H}$ . Bone was analyzed for  $^{89}\text{Sr}$ ,  $^{90}\text{Sr}$ , and  $^{239}\text{Pu}$ . Selected soft tissues were also analyzed for plutonium content.

The soft tissues of sufficient volume were prepared for gamma analysis by grinding and placing in 1000-ml polyethylene Marinelli beakers. Those of smaller volume, i.e., thyroid, kidneys, etc. were prepared for analysis by macerating in a blender and then suspended in agar in a 400-ml container. The samples were then counted for 100 minutes on a 4-inch by 4-inch NaI(Tl) crystal connected to a 400-channel pulse height analyzer calibrated to a 10 keV/channel.

Tissues for  $^{89}\text{Sr}$ ,  $^{90}\text{Sr}$ , and plutonium analyses were prepared by low temperature ashing. An aliquot of animal tissues was dissolved and the plutonium was separated by adsorption and selective elution from an anion exchange resin (5). Plutonium was then electroplated and counted on a solid state alpha spectrometer. The recovery was determined by use of  $^{236}\text{Pu}$  as an internal standard.

Other analytical procedures used at the NERC-LV were described in another publication<sup>(6)</sup>. The minimum detectable activities established at the NERC-LV are listed in Appendix II and are expressed in the analytical data tables as less than a minimum detectable activity (MDA) in the total sample analyzed. All data reported are at the 95% confidence level and are corrected to time of collection.

The analytical results of tissues from the NTS cattle are summarized in Tables 2, 3, and 4. The rumen contents showed the widest variety of radionuclides detected. Cerium-144 was found in the rumen contents of nearly all range animals but appeared in the livers of only three animals. Zirconium-95 and <sup>106</sup>Ru were not detected in any tissues, as they are not readily absorbed through the gut but are passed out of the animal in the feces. Levels of radionuclides found in the ingesta of the range animals (Tables 2 and 3) were significantly higher than those of the corralled animals (Table 4).

Air samples, from the Routine Air Surveillance Network Stations located throughout the West, were collected from October 19 to October 26 and showed concentrations of fresh fission products including <sup>131</sup>I. These concentrations were attributed to a non-U. S. atmospheric test that was conducted on October 14, 1970. Iodine-131 was found in the thyroids of all animals sacrificed on October 29 (Table 3). These levels probably came from the same source and emphasize the value of grazing animals as biological "fallout" monitors.

The only significant difference observed that might be attributable to age was the <sup>239</sup>Pu content of tissues from an aged cow (>14 years) sacrificed in the fall. The respective levels in her femur and lungs were found to be  $27 \pm 4$  pCi/kg and  $89 \pm 7$  pCi/kg. The average plutonium levels found in the femurs of the younger animal sampled at this time was 3.7 pCi/kg with a range of 1.1 to 8 pCi/kg. The only other lung submitted for plutonium analysis was from a 5-year-old cow and the level reported was 1.7 pCi/kg. During 1971, the lungs, tracheo-bronchial lymph nodes, liver, and femur from all sacrificed cattle will be analyzed for <sup>239</sup>Pu content.

Table 2. Summary of Analytical Results of Tissues from Six Range Animals - Spring 1970

Isotope	Rumen Content	Liver	Lung	Muscle	Thyroid	Bone Femur wet wt.	Bone Femur ash	Blood
K g/kg	0.8(6) 0.5-1.0	1.2(6) 0.9-1.5	1.0(6) 0.5-1.8	1.7(6) 1.4-1.9	<0.3	NA	NA	NA
<sup>89</sup> Sr pCi/g	NA	NA	NA	NA	NA	0.45 (3) 0.4-0.5	1.8(3) 1.5-2.5	NA
<sup>90</sup> Sr pCi/g	NA	NA	NA	NA	NA	0.9(6) 0.8-1.1	3.9(6) 3.0-4.5	NA
<sup>95</sup> Zr pCi/kg	120(5) 50-170	<25	<25	<25	<25	NA	NA	NA
<sup>106</sup> Ru pCi/kg	500(3) 450-500	<250	<250	<250	<250	NA	NA	NA
<sup>131</sup> I pCi/g	<25	<25	<25	<25	<25	NA	NA	NA
<sup>137</sup> Cs pCi/kg	<25	60(2) 25-100	<25	40(5) 25-60	<25	NA	NA	NA
<sup>144</sup> Ce pCi/kg	500(5) 250-650	<250	<250	<250	<250	NA	NA	NA
<sup>181</sup> W pCi/kg	800(5) 500-1400	900(5) 400-2000	975(2) 850-1100	<300	<300	NA	NA	NA
<sup>239</sup> Pu pCi/kg	NA	NA	2.0(6) 1.0-4.0	NA	NA	0.8(3) 0.5-1.2	NA	NA
<sup>3</sup> H nCi/l	NA	NA	NA	NA	NA	NA	NA	0.5(5) 0.5-0.8

First number is average, number in parenthesis is number of samples greater than MDA, third set of numbers is the range.

NA = Not analyzed.

Table 3. Summary of Analytical Results of Tissues from Seven Range Animals - Fall 1970

Isotope	Rumen Content	Liver	Lung	Muscle	Thyroid	Bone Femur wet wt.	Bone Femur Ash	Blood
K g/kg	0.8(7) 0.5-1.9	1.6(7) 1.0-2.5	1.3(7) 1.0-1.9	1.9(7) 1.1-3.7	<0.3	NA	NA	0.5(4) 0.3-0.6
<sup>89</sup> Sr pCi/g	NA	NA	NA	NA	NA	<1.5	<5.0	NA
<sup>90</sup> Sr pCi/g	NA	NA	NA	NA	NA	1.0(7) 0.4-1.9	4.3(7) 1.5-8.3	NA
<sup>95</sup> Zr pCi/kg	45(5) 45-50	<25	<25	<25	<25	NA	NA	<25
<sup>106</sup> Ru pCi/kg	250(2) 200-300	<250	<250	<250	<250	NA	NA	<250
<sup>131</sup> I pCi/g	<25	<25	<25	<25	6.2(6) 4.3-9.7	NA	NA	<25
<sup>137</sup> Cs pCi/kg	<25	80(1)	230(1)	45(3) 30-50	<25	NA	NA	<25
<sup>144</sup> Ce pCi/kg	500(7) 300-800	300(3) 200-400	<250	<250	<250	NA	NA	<250
<sup>181</sup> W pCi/kg	<300	<300	<300	<300	<300	NA	NA	<300
<sup>239</sup> Pu pCi/kg	NA	NA	See below <sup>1</sup>	NA	NA	25.2 (4) 1.1-89.7	NA	NA

First number is average, number in parenthesis is number of samples greater than MDA, third set of numbers is the range.

NA = Not analyzed.

<sup>1</sup>Lung tissues analyzed for <sup>239</sup>Pu were from BOV-7 (1.7 pCi/kg) and BOV-11 (89.7 pCi/kg). BOV-11, an aged cow, also had elevated <sup>239</sup>Pu in the femur (27 pCi/kg).

Table 4. Summary of Analytical Results of Tissues from Three Corralled Cattle that Died from Natural Causes During 1970.

Isotope	Rumen Content	Liver	Lung	Muscle	Thyroid	Bone Femur wet wt.	Bone Femur ash	Urine
K g/kg	1.3(3) 1.0-1.5	1.6(3) 1.0-2.1	1.6(3) 0.7-3.0	2.8(2) 1.5-4.0	<0.3	NA	NA	NA
<sup>89</sup> Sr pCi/g	NA	NA	NA	NA	NA	0.08 ±0.06 AHU 44 only	0.35 ±0.26 AHU 44 only	NA
<sup>90</sup> Sr pCi/g	NA	NA	NA	NA	NA	0.56(3) 0.2-1.0	1.9(3) 0.7-3.4	NA
<sup>95</sup> Zr pCi/kg	<25	<25	<25	<25	<25	NA	NA	NA
<sup>106</sup> Ru pCi/kg	<250	<250	<250	<250	<250	NA	NA	NA
<sup>131</sup> I pCi/g	<25	<25	<25	<25	<25	NA	NA	NA
<sup>137</sup> Cs pCi/kg	<25	300- Cow 36 only	<25	<25	<25	NA	NA	NA
<sup>144</sup> Ce pCi/kg	<250	<250	<250	<250	<250	NA	NA	NA
<sup>181</sup> W pCi/kg	<300	<300	<300	<300	<300	NA	NA	NA
<sup>239</sup> Pu pCi/kg	NA	NA	1.4 ±0.3 Cow 36 only	NA	NA	3 ±2 Cow 36 only	NA	NA
<sup>3</sup> H nCi/l	NA	NA	NA	NA	NA	NA	NA	0.8 AHU 903 only

First number is average, number in parenthesis is number of samples greater than MDA, third set of numbers is the range.

NA = Not analyzed.

The  $^{90}\text{Sr}$  content of the femurs continued the downward trend of recent years (Figure 1). That of the range animals averaged 4.1 pCi/g of ash this year, as compared to 5.4 pCi/g of ash during 1969<sup>(7)</sup>.



From 1964 on, the number of bone samples from each species is listed at the top of each column.

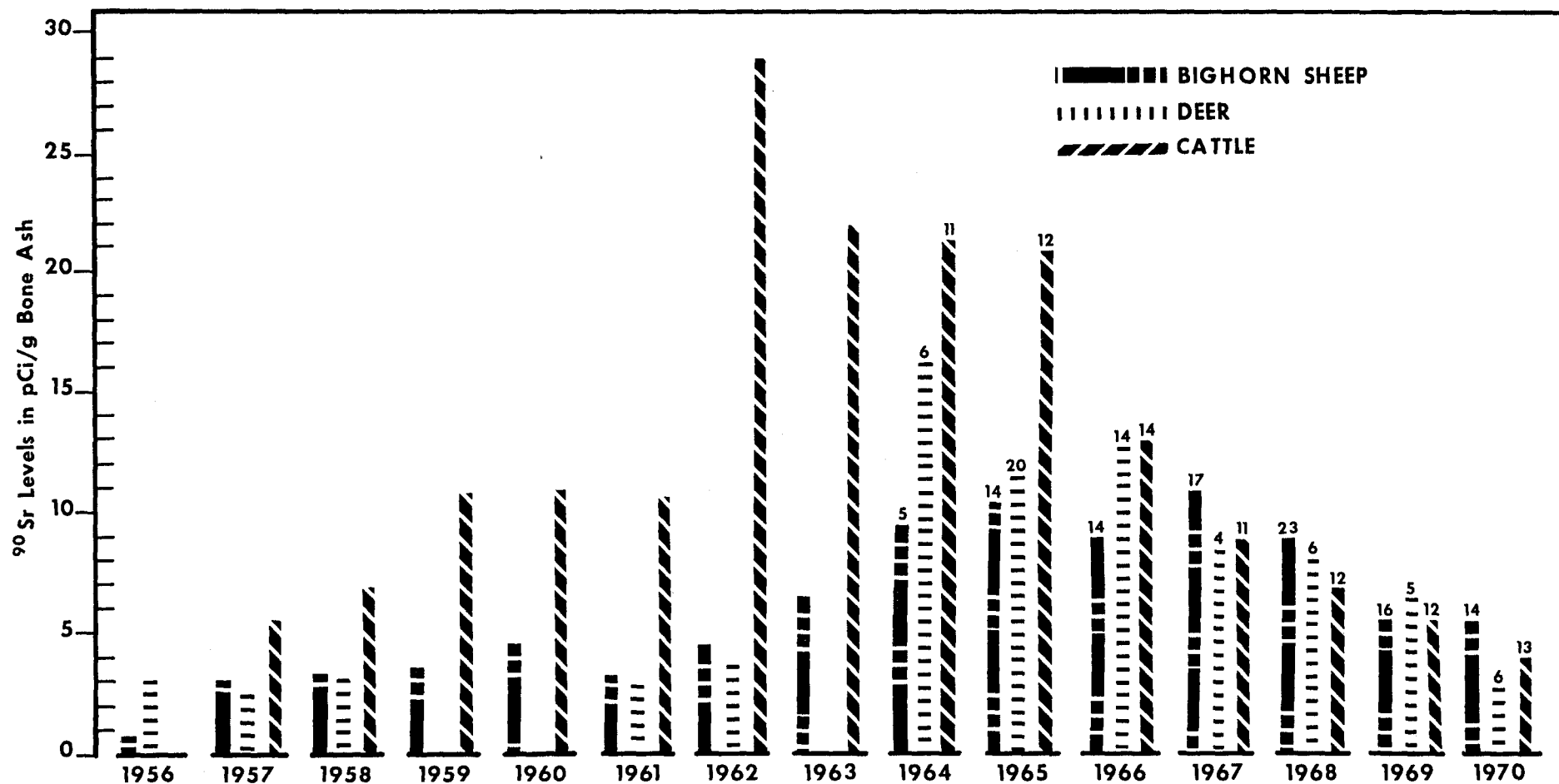


Figure 1. Comparison of  $^{90}\text{Sr}$  in Bones of Bighorn Sheep, Deer, and Cattle

## WILDLIFE STUDIES

### Mule Deer

As part of the wildlife studies, at least one mule deer (*Odocoileus hemionus*) per quarter was collected from the NTS. (See Table 5 for vital statistics.) Three deer were collected by hunting and three were collected as a result of motor vehicle collisions.

The same samples for histopathology and radionuclide analysis were collected as from the beef cattle with the exception that the bone was taken from the hock joint instead of the femur. Because of the time lapse and advanced postmortem changes, histopathologic samples were usually not collected from the accident victims. The results of the histopathological examination are found in Appendix I.

In general, the analytical results shown in Table 6 paralleled those found in the beef cattle, except that the tissues from mule deer 3 and 4 showed slightly elevated levels of  $^{131}\text{I}$ ,  $^{106}\text{Ru}$ , and  $^3\text{H}$ . These animals probably drank from ponds that were contaminated with runoff waters from several tunnels in Area 12 of the NTS that were utilized for testing. These ponds are discussed in the Special Studies sections which begin on page 18. The only gamma emitting radionuclides detected in MD-1-LinCo-70 were 50 pCi/kg of  $^{95}\text{Zr}$  and 640 pCi/kg of  $^{144}\text{Ce}$  within the rumen contents.

Strontium-89 levels in the hock bones were below minimum detectable activities. Strontium-90 levels continue their decline observed in recent years. Analytical results on six hock bone samples averaged 2.4 pCi/g of ash this year compared to 6.8 of last year (see Figure 1)<sup>(7)</sup>. The strontium levels in the hock of the deer collected off the NTS (MD-1-LinCo-70) were  $2.5 \pm 0.9$  pCi/g of ash.

Plutonium-239 was found in the hock bones of two animals. The sample from MD-3-NTS-70 contained  $47 \pm 7$  pCi/kg of wet weight and that from MD-5-NTS-70 had  $1.2 \pm 0.5$  pCi/kg wet weight. The lung burden of  $^{239}\text{Pu}$  found in MD-3-NTS-70 ( $0.5 \pm 0.2$  pCi/kg wet weight) was the highest found in mule deer during 1970. The lungs from the off-site animal (MD-1-LinCo-70) did not contain detectable activities of plutonium.

Table 5. Vital Statistics of Mule Deer Collected in 1970

Number	Sex	Estimated Age (a)	Estimated Wt. (kg)	Date Collected	Remarks
MD-1-NTS-70	M	1	45	15 Apr	Collected by hunting, Gold Meadows, Area 12, NTS.
MD-2-NTS-70	M	3	60	17 Jun	Collected by hunting, Rainier Mesa Road, Area 18, NTS.
MD-3-NTS-70	M	2	50	24 Sep	Collected by hunting, Kawich Valley Road, 1/2 mile north of intersection of Rainier Mesa Road, Area 12, NTS.
MD-4-NTS-70	M	4-5	55	7 Nov	Road kill on Pahute Mesa Road, Area 17, NTS
MD-5-NTS-70	--	--	--	21 Nov	Road kill, Area 2. Most of the carcass eaten by coyotes. Only hock and thyroid samples collected.
MD-1-Lin Co-70	M	3 1/2	77	29 Oct	Road kill, 13 miles north of Pioche, Nevada, on Highway 93.

Table 6. Summary of Analytical Results of Tissues from Six Mule Deer - 1970

Isotope	Rumen Content	Liver	Lung	Muscle	Thyroid	Bone Femur wet wt.	Bone Femur ash	Urine
K g/kg	1.3(5) 1.1-1.4	1.6(5) 1.1-2.8	1.7(5) 1.2-2.3	1.8(5) 1.5-2.1	<0.3	NA	NA	NA
<sup>89</sup> Sr pCi/g	NA	NA	NA	NA	NA	<1.5	<5.0	NA
<sup>90</sup> Sr pCi/g	NA	NA	NA	NA	NA	0.7(6) 0.2	2.4(6) 3.9-3.5	NA
<sup>95</sup> Zr pCi/kg	70(3) 50-90	<25	<25	<25	<25	NA	NA	NA
<sup>106</sup> Ru pCi/kg	530(3) 250-730	825(2) 450-1200	1200(1) MD-4 only	730(1)	<250	NA	NA	NA
<sup>131</sup> I pCi/g	<25	<25	<25	0.12 (1) MD-4 only	1.1-560*	NA	NA	NA
<sup>137</sup> Cs pCi/kg	<25	<25	<25	45(2) 30-60	<25	NA	NA	NA
<sup>144</sup> Ce pCi/kg	675(4) 300-1200	<250	<250	<250	<250	NA	NA	NA
<sup>181</sup> W pCi/kg	<300	<300	<300	<300	<300	NA	NA	NA
<sup>239</sup> Pu pCi/kg	NA	NA	0.3(4) 0.2-0.5	NA	NA	24.0(2) 1.2-47	NA	NA
<sup>3</sup> H nCi/l	NA	NA	NA	NA	NA	NA	NA	2.2(3) 1.1-4.3

First number is average, number in parenthesis is number of samples greater than MDA, third set of numbers is the range.

NA = Not analyzed.

\*MD-3 = 1.1 pCi/g

MD-4 = 560 pCi/g

### Desert Bighorn Sheep

Through the cooperation of the U. S. Fish and Wildlife Service, hock joint samples were collected from desert bighorn sheep (*Ovis canadensis nelsoni*) killed during the fall and winter special hunts. See Table 7 for vital statistics of desert bighorn sheep from which samples were collected. The  $^{90}\text{Sr}$  results from 14 hock joints collected in December of 1969 and January of 1970 averaged 5.6 pCi/g of ash with a range of 2.7 to 9.1 pCi/g of ash. The  $^{90}\text{Sr}$  results decreased from that reported for 1968-1969 which averaged 9.1 pCi/g of ash (see Figure 1). Since the cessation of atmospheric testing in 1962, there has been a gradual decrease in the  $^{90}\text{Sr}$  content of the bones.

Only four hock samples had detectable amounts of  $^{89}\text{Sr}$  and they ranged from 1.6 to 2.4 pCi/g of ash with an average of 2.0 pCi/g of ash. Two of four hock samples selected for plutonium analysis contained detectable levels of  $^{239}\text{Pu}$ . The values reported were  $2.3 \pm 1.6$  and  $3.2 \pm 3.0$  pCi/kg wet weight. One of two lung samples from penned sheep contained  $0.4 \pm 0.2$  pCi  $^{239}\text{Pu}$  per kg of wet weight.

Necropsies were performed on three desert bighorn sheep that died in the pens at Corn Creek (see Appendix I). The gamma spectrum of all the tissues collected from these animals was below the minimum detectable activities.

### Other Wildlife

Small animals and birds are also collected periodically from the NTS. During 1970 other species collected were chukar partridge, sparrows, coyotes, and jackrabbits. The gamma emitting radionuclide content of tissues from these species, except from those animals collected near Haines Ponds (see next section), was below the minimum detectable activities of the analytical instruments of NERC-LV.

During the fall of 1970, water samples were collected from seven locations on the Desert National Wildlife Range. The gamma emitting radionuclide and tritium content of all samples was below the Center limits of minimum detectable activities.

Table 7. Vital Statistics of Desert Bighorn Sheep Collected 1969-1970.

Number	Sex	Estimated Age (a)	Estimated Wt. (kg)	Date Collected	Remarks
DB-1-DGR-69	M	6	90	11/25/69	Wild sheep. Hunter killed. Cabin Spring area of Desert National Wildlife Range.
DB-2-DGR-69	M	5	85	12/23/69	Wild sheep. Hunter killed. Pintwater Range of Desert National Wildlife Range.
DB-3-DGR-69	M	8	120	11/23/69	Wild sheep. Hunter killed. White Rock Spring of Desert National Wildlife Range.
DB-4-DGR-69	M	11	77	12/4/69	Wild sheep. Hunter killed. Desert National Wildlife Range.
DB-5-DGR-69	M	12	69	12/30/69	Wild sheep. Hunter killed. White Sage Gap area of Desert National Wildlife Range.
DB-6-DGR-69	M	7	90	12/6/69	Wild sheep. Hunter killed. White Rock Spring area of Desert National Wildlife Range. Hock sample collected.
DB-7-DGR-69	M	7	70	12/1/69	Wild sheep. Hunter killed. Saw Mill Canyon area of Desert National Wildlife Range. Hock sample collected.
DB-8-DGR-69	M	4	130	12/29/69	Wild sheep. Hunter killed. Heaven Well area of Desert National Wildlife Range, Unit 27A. Hock sample collected.
DB-9-DGR-69	M	9	80	12/10/69	Wild sheep. Hunter killed. Desert National Wildlife Range. Hock sample collected.

Table 7. Vital Statistics of Desert Bighorn Sheep Collected 1969-1970 (cont'd)

Number	Sex	Estimated Age (a)	Estimated Wt. (kg)	Date Collected	Remarks
DB-10-DGR-69	M	7	70	12/27/69	Wild sheep. Hunter killed. Pintwater Range area of Desert National Wildlife Range. Hock sample collected.
DB-11-DGR-69	M	8	95	12/12/69	Wild sheep. Hunter killed. Desert National Wildlife Range. Hock sample collected.
DB-12-DGR-69	M	12+	65	12/23/69	Wild sheep. Hunter killed. Pintwater Range area of Desert National Wildlife Range. Hock sample collected.
DB-13-DGR-69	M	7	70	12/24/69	Wild sheep. Hunter killed. Sand Spring area of Desert National Wildlife Range. Hock sample collected.
DB-14-DGR-69	M	11	80	12/3/69	Wild sheep. Hunter killed. Desert National Wildlife Range. Hock sample collected.
DB-1-DGR-70	F	2	10	8/19/70	Penned sheep. Died from pneumonia. Samples not collected for radioanalysis.
DB-2-DGR-70	M	2	73	12/4/70	Penned sheep. Died from shock associated with fractured metatarsus. Histopathological samples not collected.
DB-3-DGR-70	F	16	60	12/5/70	Penned sheep. Died from geriatric complications.

## SPECIAL STUDIES

### Haines Ponds Study

In May of 1970, Hudson Moon, a Department of Defense nuclear test device, was detonated in E-tunnel which had been mined into the face of Rainier Mesa in Area 12 of the NTS. Haines Ponds are a series of three ponds which are located in a canyon below E-tunnel portal and were intended to collect runoff waters from the tunnel. Following the Hudson Moon Event, the runoff waters draining the ES drift of E-tunnel contained certain radionuclides. The Environmental Sciences Department of the Reynolds Electric and Engineering Company reported the following activity levels in water samples collected at the Haines Ponds.

Table 8. Activity Levels in Haines Ponds Samples

Source	Date	$^{131}\text{I}$ $\mu\text{Ci/l}$	$^3\text{H}$ $\mu\text{Ci/l}$
Makeup water from ES drift to first pond	7/8/70	23	500
Lower Haines pond	7/8/70	85	13

Following receipt of this information, a water sampling survey was made of the Haines Ponds and of the runoff ponds below T-tunnel to establish the current activity levels, and of the natural springs and water wells in adjacent areas to determine if these waters were also contaminated. The analytical data are listed in Table 9.

As feral horses, mule deer, chukar, rabbits, coyotes, and numerous small birds in the area frequently used these ponds as a water source, wildlife were collected to determine the tissue burdens. Chukar, sparrows, a coyote, and a rabbit were collected and sampled. The analytical data are presented in Table 10.



Table 9. Analytical Results of Water Samples Collected on the Nevada Test Site During 1970.

Location	Date Sampled	$^{131}\text{I}$ nCi/l	$^{106}\text{Ru}$ nCi/l	$^3\text{H}$ nCi/l
Haines Ponds below E tunnel	7/28	$3.0 \times 10^3$	$8.0 \times 10^3$	$2.6 \times 10^2$
Ponds below T tunnel	7/28	$4.6 \times 10^2$	$5.6 \times 10^3$	$4.0 \times 10^4$
Area 5 Pond	7/29	<.01	<0.4	1.3
White Rock Spring	7/29	<.01	<0.4	<0.4
Tub Spring	8/5	<.01	<0.4	<0.4
Well 8 Pond	8/5	<.01	<0.4	<0.4
Panute CP Pond	8/5	<.01	<0.4	<0.4
Well 3 Pond	9/16	<.01	<0.4	<0.4
Area 15 Farm Irrigation Reservoir	9/24	<.01	<0.4	0.5
Captain Jack Spring	11/17	<.01	<0.4	<0.4
Ponds below N tunnel	11/18	<.01	<0.4	$2.3 \times 10^2$
Ponds below G tunnel	12/03	<.01	$1.6 \times 10^2$	$1.4 \times 10^5$

Table 10. Analytical Results of Tissues From Wildlife Collected Near Haines Ponds

Sample Type	Date Collected	Area Collected	$^{131}\text{I}$ pCi/g	$^{106}\text{Ru}$ pCi/g	$^3\text{H}$ $\mu\text{Ci/l of H}_2\text{O}$
Composite of muscle from two chukar	7/28/70	Haines Ponds	110	70	260 $\mu\text{Ci/l of H}_2\text{O}$ or 170 $\mu\text{Ci/kg of tissue}$ (66.3% moisture)
Composite of Viscera from two chukar	7/28/70	Haines Ponds	930	$4.3 \times 10^3$	NA
Heads and necks of two chukar	7/28/70	Haines Ponds	770	570	NA
Sparrows - whole body	7/29/70	Haines Ponds	$1.3 \times 10^3$	390	NA
Coyote blood	7/29/70	0.2 miles E of Haines Ponds	NA	NA	1.5
Coyote thyroid	7/29/70	0.2 miles E of Haines Ponds	$1.1 \times 10^6$	$3 \times 10^4$	NA
Coyote muscle	7/29/70	0.2 miles E of Haines Ponds	13	<1.0	NA
Coyote liver	7/29/70	0.2 miles E of Haines Ponds	140	<1.0	NA
Coyote lung	7/29/70	0.2 miles E of Haines Ponds	50	<1.0	NA
Coyote stomach contents	7/29/70	0.2 miles E of Haines Ponds	920	150	NA
Rabbit muscle	7/28/70	At ponds below U-12 T tunnel	1	1	0.07 $\mu\text{Ci/l}$ or 0.05 $\mu\text{Ci/kg}$ (74% moisture)

Table 10. Analytical Results of Tissues from Wildlife Collected Near Haines Ponds (cont'd)

Sample Type	Date Collected	Area Collected	<sup>131</sup> I pCi/g	<sup>106</sup> Ru pCi/g	<sup>3</sup> H μCi/l of H <sub>2</sub> O
Rabbit thyroid	7/28/70	At ponds below U-12-T tunnel	100	<1	NA
Rabbit viscera	7/28/70	At ponds below U-12-T tunnel	<0.2	1.6	NA

The National Committee on Radiation Protection<sup>(8)</sup> has published radionuclide concentration guides in air and water for occupational exposure during a 40-hour week. These guides allow up to 100  $\mu\text{Ci}$  of  $^3\text{H}$  and  $6 \times 10^{-2}$   $\mu\text{Ci}$  of  $^{131}\text{I}$  per liter of water. The level of tritium in the Haines Ponds water on July 28, 1970, was reported to be 0.26  $\mu\text{Ci/l}$ , which would be approximately 1/500 of the guide. The  $^{131}\text{I}$  level on the same date was 3  $\mu\text{Ci/l}$  or 50 times greater than the guide for occupational exposure.

Each gram of muscle tissue, from chukar drinking from Haines Ponds, contained 110 pCi of  $^{131}\text{I}$  and 0.17  $\mu\text{Ci}$  of  $^3\text{H}$ . If 311 grams (approximately 3/4 pound) of this tissue were consumed by a man, his ingestion of  $^{131}\text{I}$  would be 34.2 nCi which, on the basis of 5.5 rem/ $\mu\text{Ci}$ <sup>(9)</sup> in a 20-gram thyroid, and assuming 0.2 as the fraction of iodine going to the thyroid, would result in a dose of 38 mrem to the thyroid. However, this area is not open to hunting and therefore the chukar are not available for consumption by man.

There would be 53  $\mu\text{Ci}$  of  $^3\text{H}$  present as free water in a meal of 311 grams of the chukar flesh, which on the basis of 0.17 mrem/ $\mu\text{Ci}$ <sup>(9)</sup> would correspond to a whole body dose of 8.9 mrem. Additional tritium present in the chukar flesh as tritiated organic compounds would increase the actual dose somewhat. The estimate of this increase is difficult but would certainly not exceed a factor of two.

Goldfish were placed in the U-12-E pond to determine if they could survive and be used as a biological monitor. Goldfish from the Area 5 reservoir were transplanted but they survived only 4-1/2 to 5 hours, as the dissolved oxygen content of the water was less than 2.5 parts per million.

## Fistulated Steer Surveillance Study of Schooner Fallout in the Queen City Summit Area

Project Schooner, part of the continuing Plowshare program, was a nuclear cratering detonation executed in a tuffaceous medium at the NTS.

Schooner was detonated at 0800 PST on December 8, 1968, and resulted in a release of radioactive debris into the atmosphere. The portion of the cloud containing the highest levels of gamma emitting radionuclides passed over the Queen City Summit area<sup>(10)</sup>. Considerable deposition of fallout debris was observed by monitors in this area.

As privately owned cattle routinely graze in this area, it was decided to use fistulated steers to collect monthly samples of the native vegetation ingested by these animals. These samples were analyzed for radionuclide content and for botanical makeup. Cattle native to the area were purchased and sacrificed during the spring and fall. Tissues from the animals were analyzed for radionuclide content and rumen contents were analyzed as above.

Once a month from April through September 1970, (except May, when the sacrificed animal served as the botanical sample) two or three fistulated steers were placed on the range and allowed to graze freely for 6-8 hours. Prior to placement on the range, the animals were fasted for 24 hours and the rumen was completely emptied<sup>(11)</sup>. After the grazing period, the freshly consumed vegetation was removed from the rumen, placed in 400-ml plastic containers, weighed, labeled and submitted for 100-minute gamma spectroscopy. At this time a sample was also collected for botanical analysis<sup>(12)</sup>. After the gamma scan and botanical analysis were completed, the samples were composited and submitted for <sup>239</sup>Pu analysis. The analytical data are presented in Table 11 and the botanical data are presented in Table 12.

In May and again in October, one aged cow grazing in the area was purchased, sacrificed, necropsied and sampled. Both animals lived in the Queen City Summit area for the major portion of their lives. The sacrifice and necropsies were performed under field conditions. Tissue samples collected were placed in plastic bags and were later ground, placed in 1000-ml Marinelli

Table 11. Analytical Results of Rumen Contents of Bovine Grazing the Queen City Summit Area.

Date Collected	Animal Sampled	<sup>3</sup> H Blood pCi/ml	<sup>95</sup> Zr pCi/kg	<sup>106</sup> Ru pCi/kg	<sup>137</sup> Cs pCi/kg	<sup>144</sup> Ce pCi/kg	<sup>181</sup> W pCi/kg	<sup>239</sup> Pu Analysis pCi/kg (wet wt.)
4/8	901	1.7	<25	<250	<25	<250	<300	NA
4/8	903	1.5	<25	<250	<25	<250	<300	NA
4/8	905	1.4	<25	<250	<25	<250	<300	NA
5/6	BOV-1-N16	<0.4	<25	<250	<25	<250	<300	110 ± 10
6/11	901	0.6 ± 0.3	70	<250	<25	<250	1.0 x 10 <sup>4</sup>	170 ± 20 (composite of 901 and 905 rumen samples)
6/11	905	0.9 ± 0.3	<25	<250	300	<250	1.9 x 10 <sup>4</sup>	same as above
7/16	901	NA	<25	<250	<25	<250	1.4 x 10 <sup>3</sup>	42 ± 4 (composite of 901 and 905 rumen samples)
7/16	905	NA	100	<250	<25	<250	1.1 x 10 <sup>4</sup>	same as above
8/19	901	NA	200	700	<25	<250	1.8 x 10 <sup>4</sup>	13 ± 2 (composite of 901 and 905 rumen samples)
8/19	905	NA	30	700	<25	<250	4.9 x 10 <sup>3</sup>	same as above
9/18	901	0.9 ± 0.3	40	<250	<25	<250	3.2 x 10 <sup>3</sup>	46 ± 5 (composite of 901, 902 and 905 rumen samples)
9/18	902	0.6 ± 0.3	50	<250	<25	<250	3.7 x 10 <sup>3</sup>	same as above
9/18	905	0.5 ± 0.3	80	<250	<25	<250	4.8 x 10 <sup>3</sup>	same as above
9/18	Water Well 3 corral	<0.4	<25	<250	<25	<250	<300	NA
10/23	BOV-2- N16	0.4 ± 0.3	30	<250	<25	900	3.3 x 10 <sup>3</sup>	160 ± 100

Table 12. Botanical Analysis of Rumen Contents of Bovine Grazing the Queen City Summit.

Date Collected	Animal Sampled	Botanical Analysis
4/8	901	<i>Salsola kali</i> - 74% <i>Orhyzopsis hymenoides</i> - 26%
4/8	903	<i>Orhyzopsis hymenoides</i> - 97% <i>Salsola kali</i> - 3%
4/8	905	<i>Orhyzopsis hymenoides</i> - 99% <i>Salsola kali</i> - 1%
5/6	BOV-1-N16	<i>Hilaria jamesii</i> - 88% <i>Eriogomuna</i> - trace <i>Orhyzopsis hymenoides</i> - 12% <i>Ephedra nevadensis</i> - trace <i>Atriplex centrifolia</i> - trace
6/11	901	<i>Orhyzopsis hymenoides</i> - 47% <i>Sitanion hystrix</i> - 41% <i>Hilaria jamesii</i> - 10% <i>Bromus tectorium</i> - 1% <i>Forb spp.</i> - 1%
6/11	905	<i>Hilaria jamesii</i> - 53% <i>Orhyzopsis hymenoides</i> - 20% <i>Sitanion hystrix</i> - 17% <i>Eurotia lanata</i> - trace <i>Eriogonum spp.</i> - trace <i>Euphorbia spp.</i> - trace
7/16	901	<i>Orhyzopsis hymenoides</i> - 62% <i>Sitanion hystrix</i> - 37% <i>Hilaria jamesii</i> - 1% <i>Forb spp.</i> - trace
7/16	905	<i>Sitanion hystrix</i> - 54% <i>Orhyzopsis hymenoides</i> - 45% <i>Hilaria jamesii</i> - 1% <i>Forb spp.</i> - trace
8/19	901	<i>Hilaria jamesii</i> - 76% <i>Orhyzopsis hymenoides</i> - 18% <i>Sitanion hystrix</i> - 5% <i>Eriogonum spp.</i> - 1%
8/19	905	<i>Orhyzopsis hymenoides</i> - 45% <i>Sitanion hystrix</i> - 36% <i>Hilaria jamesii</i> - 18% <i>Forb spp.</i> - 1%
9/18	All Animals	Samples not analyzed

Table 12. Botanical Analysis of Rumen Contents of Bovine Grazing the Queen City Summit.  
(continued)

Date Collected	Animal Sampled	Botanical Analysis
10/23	BOV-2-N16	<i>Hilaria jamesii</i> - 59% <i>Orhizopsis hymenoides</i> - 36% <i>Atriplex canescens</i> - 3% <i>Eriogonum</i> spp. - 2% <i>Euratia lanata</i> - trace



beakers and analyzed by gamma spectroscopy and radiochemical methods. The analytical data are presented in Table 13. Histopathological examinations were made of selected tissue samples (see Appendix I).

There was little rainfall between April and October; hence, the vegetation growth was sparse. This resulted in scanty samples from the fistulated steers who grazed only for limited periods. These factors make the validity of radionuclide analysis somewhat questionable. However, the rumen samples from the sacrificed animals should have been quite representative of what the native herd was ingesting.

Radionuclides of interest found in the rumen contents included  $^{181}\text{W}$  and  $^{239}\text{Pu}$ . Tissue levels of  $^{181}\text{W}$  were found in the liver and lungs of the sacrificed animals and  $^{239}\text{Pu}$  was found in the lungs and bones. Iodine-131 was detected in the thyroid of the animal sacrificed on October 23. This probably came from a non-U. S. atmospheric test conducted on October 14, 1970.

Table 13. Analytical Results of Tissues Collected from Two Cows that Grazed the Queen City Summit Area.

Animal Number	Tissue Type	$^3\text{H}$ pCi/ml $\text{H}_2\text{O}$	$^{131}\text{I}$ pCi/kg	$^{137}\text{Cs}$ pCi/kg	$^{181}\text{W}$ pCi/kg	$^{89}\text{Sr}$ pCi/g ash	$^{90}\text{Sr}$ pCi/g ash	$^{238}\text{Pu}$ pCi/kg	$^{239}\text{Pu}$ pCi/kg
BOV-1-N16	Liver	NA	<25	<25	<300	NA	NA	NA	NA
BOV-2-N16	Liver	NA	<25	40	$2.6 \times 10^3$	NA	NA	NA	NA
BOV-1-N16	Lung	NA	<25	<25	900	NA	NA	$0.2 \pm 0.1$	$7.8 \pm 0.5$
BOV-2-N16	Lung	NA	<25	<25	700	NA	NA	$0.7 \pm 0.3$	$22 \pm 20$
BOV-1-N16	Muscle	NA	<25	30	<300	NA	NA	NA	NA
BOV-2-N16	Muscle	NA	<25	<25	<300	NA	NA	NA	NA
BOV-1-N16	Thyroid	NA	<25	<25	<300	NA	NA	NA	NA
BOV-2-N16	Thyroid	NA	$3 \times 10^3$	<25	<300	NA	NA	NA	NA
BOV-1-N16	Blood	<0.4	NA	NA	NA	NA	NA	NA	NA
BOV-2-N16	Blood	<0.4	NA	NA	NA	NA	NA	NA	NA
BOV-1-N16	Bone	NA	NA	NA	NA	$6.2 \pm 2.6$	$8.8 \pm 1.7$	<0.1	$3.0 \pm 0.7$
BOV-1-N16	Bone	NA	NA	NA	NA	<5	$5.1 \pm 1.0$	<0.1	$2.0 \pm 0.1$

BOV-1-N16 was sacrificed 05/06/70 and BOV-2-N16 was sacrificed 10/23/70.

## Project Rulison Study

Project Rulison's purpose was to study the economic and technical feasibility of using underground nuclear explosives to stimulate production of natural gas from the low productivity, gas-bearing Mesa Verde formation in the Rulison field in Garfield County, Colorado.<sup>(13)</sup>

A biological sampling program was initiated in August 1969 in order to document the background levels of radionuclides in the tissues of domestic animals and wildlife in the Rulison area. The Project Rulison post-shot plans and evaluation document<sup>(14)</sup> directed the Animal Investigation Program to continue to collect biological samples from domestic animals, deer and other wildlife, prior to drill-back, and at intervals during and after operational activities at the Rulison site. Selected organs were to be analyzed for mixed fission products and for tritium. Table 14 lists the time schedule of the various Project Rulison post-shot activities.

Table 14. Project Rulison Post-Shot Activities

Activity	Date and Time Begun		Date and Time Ended	
Detonation	9/10/69	1500 MDT		
Drill-back	4/28/70		7/28/70	
Initial Flarings	8/1/70	2020 MDT	8/1/70	2050 MDT
	8/18/70	1137 MDT	8/18/70	1157 MDT
	8/22/70	1021 MDT	8/22/70	1107 MDT
Calibration Flaring	10/4/70	0630 MDT	10/7/70	1315 MDT
High Rate Flaring	10/26/70	1430 MST	11/3/70	1417 MST
Intermediate Rate Flaring	12/1/70	1240 MST	12/20/70	1403 MST

There was no detectable increase in tritium levels found in the tissue samples collected from domestic animals and wildlife of the area following any of the Rulison activities. Levels of gamma emitting radionuclides in these tissues remained below the minimum detectable activities for the Laboratory's analytical systems.

The analytical results of all tissues sampled are reported in Appendix III. Surveillance activities near the Rulison site will continue during 1971.

#### Baneberry Studies

The Baneberry Event, detonated December 18, 1970, in Area 8 of the NTS, resulted in the accidental release of significant amounts of radioactivity from the test site. The Animal Investigation Program initiated a special surveillance study that included collecting tissue samples from dairy calves at the Area 15 farm, from bovine grazing on the Tonopah Test Range, from bovine grazing in Kawich Valley and from sheep grazing in Coal Valley. Wildlife from several areas in the state was also collected. The analytical results from these collections will be published in a special report.

## PUBLIC INFORMATION AND EDUCATION

During 1970, there were 40 tours of the National Environmental Research Center, Las Vegas facilities on the NTS. Approximately 1300 visitors on these tours were briefed on the Animal Investigation Program activities. These tour groups represented a wide range of interests and technical background varying from NTS workers, students from the University of Nevada (both Reno and Las Vegas campuses), Nevada Chamber of Commerce, American Nuclear Society Symposium attendees, Utah, Texas, and Wyoming state officials and foreign visitors from Germany, Nigeria, and Australia.

Details of the Animal Investigation Program were also presented to attendees of the training session of the United States Department of Agriculture Defense Board which was held in Reno, Nevada, on March 5 and 6, 1970.

On April 9, 1970, a paper<sup>(15)</sup> summarizing the necropsy findings in the desert bighorn sheep was presented to the 1970 Desert Bighorn Council Meeting in Bishop, California.

"Big Sam," a fistulated steer, was exhibited on the grounds of the Dallas Health and Science Museum during the State Fair of Texas, October 10-25, 1970. He was visited by approximately 30,000 people and viewed by an estimated 150,000 others. Approximately 15,000 brochures and fact sheets (see Appendix IV) were distributed to interested visitors.

Representatives from the press were briefed on the Animal Investigation Program activities on several occasions. Articles that featured or mentioned these activities appeared in the St. Louis Dispatch, Las Vegas Review Journal, Las Vegas Sun, and the Los Angeles Times.

## INVESTIGATIONS AND CLAIMS

No formal livestock radiation damage claims were received during 1970. An investigation was made of one incident of possible damage. The findings of this investigation eliminated radiation as a causative agent.

### Hot Creek Ranch Investigation

In the early spring of 1970, cattle from the Hot Creek Ranch (both at the home ranch and at the Wine Cup Ranch in Wells, Nevada) were reported to have hairless areas which the owner suspected was caused by radiation. Some of the affected animals were examined on February 26, 1970.

The owner provided the following history. Approximately 30% of both herds were affected. The number of animals involved was  $200 \pm 50$  at the Hot Creek Ranch and  $300 \pm 50$  at the Wine Cup Ranch. The condition first appeared three or four months before the investigation and gradually progressed until a few animals had lost one-third of their body hair. The condition affected all ages, but was especially prevalent in the four-to eight-year-old cows.

The three animals examined had irregularly shaped, hairless patches scattered over the body with most of the lesions located on the lateral side of the neck. The patches ranged in size from 0.5 by 1 inch to 2 inches by 8 inches. There was no discoloration or loss of pigment in the hair. The denuded skin appeared normal with occasional increased scaling. Some of the denuded areas were sun-burned and showed signs of trauma that might be associated with scraping or rubbing. All animals were in good flesh.

Skin scrapings, hair samples, and blood samples were collected from each animal. Sucking lice (*Linognathus vituli*) were noted on two of the animals. A skin biopsy was taken from the most extensive lesion. The lesions were documented by photographs.

The lateral location, large size, and irregular shape of these lesions, plus the lack of depigmentation refuted beta particles as an etiological agent. Skin scrapings were negative for mange mites. Complete blood cell counts were within normal limits.

The histopathologic report of the skin biopsy stated that: "Morphologic characteristics are not compatible with those expected in beta burns of three or four months duration. Etiology of the alopecia described is not apparent in the sections."

*Trichophyton* (an etiological agent of ringworm), *rhodotorula* and *rhizopus*, species of fungus were isolated and identified on mycology cultures of hair samples prepared by the Nevada Animal Disease Laboratory, Reno, Nevada.

Both ringworm and lice (because of feeding habits) cause pruritus that the animals relieve by rubbing, hence the loss of body hair. The location of lesions and history supported the diagnosis of mycosis and pediculosis.

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## APPENDIX I. Gross and Microscopic Pathology\* Found in Necropsied Animals

### Bovine

BOV-1-NTS-70	No gross lesions observed Histopathological Report: No significant lesions.
BOV-2-NTS-70	No gross lesions observed. Histopathological Report: Sarcosporidiosis.
BOV-3-NTS-70	No gross lesions observed. Ovaries and uterus were infantile characteristic of a "freemartin." Histopathological Report: No significant lesions.
BOV-4-NTS-70	No gross lesions observed. Free floating mass of fibrin in peritoneal fluid. Histopathological Report: One section contains a mass composed of eosinophilic granular and fibrillar material which resembles fibrin.
BOV-5-NTS-70	Urinary bladder somewhat thickened. Histopathological Report: Kidney. There are a few mineralized tubules in the renal medulla.
BOV-6-NTS-70	No gross lesions observed. Histopathological Report: Sarcosporidiosis.
BOV-7-NTS-70	Gross lesions seen were associated with asphyxiation as animal was accidentally strangled while capturing. No histopathology samples collected.
BOV-8-NTS-70	No gross lesions observed. Histopathology Report: <u>Ovaries</u> . Large follicles old corpora lutea are seen. <u>Lung</u> . The pleura is very thick in some areas.

APPENDIX I. Gross and Microscopic Pathology\* Found in Necropsied Animals  
(cont'd)

Bovine

Heart. Twenty-one sarcocysts are seen.

Skeletal muscle. Occasional fibers are swollen and pale green (artifact?)

Thyroid. The thyroglossal duct is seen.

Diagnosis: Normal.

BOV-9-NTS-70

Animal is 3-1/2 months pregnant. The lungs are emphysematous from agonal struggling.

Histopathology Report:

Spleen. Numerous neutrophils are seen in perifollicular areas.

Lungs. Areas of hemorrhage (terminal) are seen.

Heart. A few foci of lymphocytes are seen in the myocardium.

Kidney. A few lymphocytic foci are seen. Several small foci of calcification are seen in the medulla.

Ovaries. Several large follicles are present. A large corpus luteum is present on other ovary.

Diagnosis: Normal

BOV-10-NTS-70

Histopathology Report:

Lung. Some terminal areas of hemorrhage.

Spleen. Neutrophils are adjacent to follicles.

Liver. Liver cell nuclei along portal areas seem enlarged.

Heart. One sarcocyst is seen.

Kidney. A few lymphocytes are seen around two large arteries.

Diagnosis: Normal.

BOV-11-NTS-70

Aged cow. Uterus contained a 2-month-old fetus.

APPENDIX I. Gross and Microscopic Pathology\* Found in Necropsied Animals  
cont'd

Bovine

Histopathological Report:

Lung. One lobe is hemorrhagic (due to manner of death)

Kidney. There are casts in some tubules, a few foci of mononuclear cells are seen in the cortex, in these areas, small vessels are thickened.

Adrenal. Sinusoids in cortex are congested.

Ovaries. A few large follicles are seen, but most of the tissue is old corpora lutea and stroma. A large corpus luteum seen on other ovary.

Kidney. Similar to other, but more focal collections of lymphocytes, capsules of some glomeruli are thickened, interstitial fibrosis in some areas, occasional shrunken sclerosed glomerulus.

Spleen. Diffuse hemosiderosis.

Lung. Areas of acute hemorrhage, one lymphoid nodule is under bronchial epithelium.

Diagnosis: a) Normal, b) Mild chronic interstitial nephritis.

Comment: Kidney lesions are mild and focal and seem to be oriented around small arterioles.

BOV-12-NTS-70 No gross lesions observed.

Histopathological Report:

Heart. Several sarcocysts are seen, no other lesions.

Diagnosis: Normal

BOV-13-NTS-70 No gross lesions observed.

Histopathological Report:

Heart. Several sarcocysts are seen. There are also a few focal areas of lymphoreticular cells within the myocardium.

Lung. Alveoli in some areas are dilated greatly with air, probably terminal.

Spleen. No significant lesions. Lymphoid follicles are normal.

APPENDIX I. Gross and Microscopic Pathology\* Found in Necropsied Animals  
(cont'd)

Bovine

Kidney. a few arterioles seem hyalinized in the outer cortex and a few inflammatory cells are adjacent to them.

Diagnosis: Normal.

Comment: No lesions are observed that could be attributed to the effects of ionizing radiation.

AHU-44-NTS-70

Cow euthanized because of extreme respiratory distress.

Gross lesions included:

1. Subcutaneous emphysema of chest wall and esophagus
2. emphysematous lungs
3. swollen epiglottis
4. enlarged pulmonary lymph nodes with central caseous necrosis
5. necrotic foci on tricuspid valve of heart
6. lymphoid infiltration of cardiac muscle
7. lymphoid infiltration behind right eye
8. cysts on kidneys
9. omentum is edematous and emphysematous
10. inflamed gall bladder

Thyroid. Seems toughened and gritty.

Diagnosis: Bovine lymphosarcoma with secondary emphysema caused by restriction of air passage from lymphoid infiltration of the epiglottis.

Histopathological Examination: Morphological characteristics are compatible with those of bovine lymphosarcoma. Accumulations of usually mature lymphocytes form a monotonous pattern in many locations including the heart and the retrobulbar mass in the orbit. There are foci of interstitial nephritis. The renal cysts are not remarkable. There is equivocal sclerosis of the interfollicular tissue in the thyroid, but definitive changes to account for the "gritty sensation" noted at necropsy are not found. Fibrosis of interalveolar septa and moderate hyperplasia of the media of arterial walls are in the lung. Sarcosporidia are present. There may have been lenticular degeneration in the left eye; however, the specimen is inadequate for definitive determination.

AHU-903-NTS-70

Treated for clinical leptospirosis two weeks before death.

Gross lesions included:

1. Enlarged, dilated heart with ecchymotic hemorrhages
2. areas of myocardial degeneration

APPENDIX I. Gross and Microscopic Pathology\* Found in Necropsied Animals  
(cont'd)

Bovine

3. lungs are distended and contain numerous encapsulated abscesses which are 2 cm in diameter
4. left diaphragmatic lobe of lung contains an 8-10 cm cavitation filled with decaying blood.

Diagnosis: Acute cardiac dilatation and failure, probably as result of combination of high fever (108°F) associated with previous illness, toxins produced by lung pathology and the increased respiratory workload from impaired gaseous transfer in the lungs (reduced viable tissue).

Histopathological Report:

Peribronchial active, subacute to chronic inflammation. Active chronic pulmonary abscesses. There are numerous immature and organized thrombi of which some of the latter contain foci of active inflammation. The predominant microorganism is a gram positive coccobacillus. Acid fast organisms are not found.

Focal subacute interstitial nephritis and nephrosis with casts and degenerate epithelial cells in the urinary tubules. Special stains for the presence of spirochetes were negative.

There is moderate periportal fibrosis in the liver. A bacterial colony is in a central vein.

AHU-36-NTS-70 Cow found dead with no history of illness.

Gross lesions included:

1. Rumen, omasum, abomasum and intestinal tract greatly distended with gas
2. thoracic organs compressed into apex of chest cavity
3. froth and foam observed in rumen contents which consisted of approximately 50 gallons of fresh alfalfa green chop.

Diagnosis: Tympanites.

No histopathology samples collected because of advanced post mortem changes.

BOV-1-N16-70 Cow grazed Sand Spring Valley Range

Liver. Seemed fibrotic.

APPENDIX I. Gross and Microscopic Pathology\* Found in Necropsied Animals  
(cont'd)

Bovine

Histopathological Report:

Sarcosporidiosis  
Splenic hemosiderosis

BOV-2-N16-70      Aged cow in extremely poor condition. Unable to rise.  
Very lousy.

Gross lesions included:

1. Incisors worn away;
2. peritonitis with ascites;
3. abscess in left kidney;
4. serous atrophy of all fatty deposits;
5. emphysematous lungs.

Diagnosis: Animal suffering from advanced starvation  
complicated by traumatic pericarditis

Histopathological Report:

Kidneys. Mostly normal, one lobule has mild interstitial  
fibrosis, dilated tubules, some perivascular collections  
of lymphocytes in association with some fibrosis.

Ovaries. Dense connective tissues, vessels only, few ova,  
one large follicle, two old hyalinized C.L.S.

Lung. Alveolar emphysema, bronchioles are constricted,  
fibrous thickening of pleura.

Adrenal. Foci of lymphocytes are seen at cortico-  
medullary junction.

Spleen. Some focal fibrosis is seen on capsule, marked  
hemosiderosis.

Liver. A foci of liver cell necrosis with neutrophils  
are seen, some foci of lymphocytes are seen.

Heart. No visible lesions. Numerous bacteria appear on  
surface of fat adjacent to heart.

Adrenal. Melanin in capsule, and in *Z. glomerulosa*.

Diagnosis:

1. Traumatic pericarditis and reticuloperitonitis;



APPENDIX I. Gross and Microscopic Pathology\* Found in Necropsied Animals  
(cont'd)

Bovine

2. renal abscess;
3. serous atrophy of fat;
4. chronic interstitial nephritis (mild);
5. focal hepatic necrosis (mild);

Comment: The first three diagnoses are made from gross findings. Bacteria found on pleural and peritoneal surfaces may be post mortem invaders. There is no inflammatory reaction to them.

Mule Deer

- MD-1-NTS-70      No gross lesions observed.
- Histopathological Report:
- No significant lesions.
- MD-2-NTS-70      No gross lesions observed.
- Histopathological Report:
- Sarcosporidiosis
- Mild, focal interstitial nephritis
- MD-3-NTS-70      No gross lesions observed.
- Histopathological Report:
- Results not received.
- MD-4-NTS-70      Trauma associated with vehicular collision.
- Histological samples not collected as there are advanced post mortem changes.
- MD-5-NTS-70      No autopsy performed as carcass nearly destroyed by force of vehicular collision and by scavengers. Histological samples not collected as there are advanced post mortem changes.
- MD-1-Lin Co-70    Trauma of femur, spleen, liver and lungs from vehicular collision.
- Histopathological Report:
- Kidney. There are areas of congestion, a lymphoid nodule is seen alongside a vessel, two lymphocytic foci in medulla.
- Testes. Autolytic, no visible lesions.

APPENDIX I. Gross and Microscopic Pathology\* Found in Necropsied Animals  
(cont'd)

Mule Deer

Kidney. Several focal areas of interstitial chronic inflammation.

Lung. Pleura is thickened and bluish in some areas. Some smooth muscle in alveolar tips is bluish in color.

Thyroid. Follicles are very large.

Diagnosis:

1. Normal
2. Mild chronic focal pleuritis

Desert Bighorn  
Sheep

DB-1-BGR-70 Two-month-old lamb that died at Corn Creek Station/  
Desert National Wildlife Range.

Gross lesions included:

1. Pleural adhesions;
2. all lobes of lungs contain numerous small abscesses (0.2-0.5 cm in diameter);
3. phytobezor in rumen;
4. ecchymotic hemorrhages on border of spleen.

Diagnosis: Diffuse bacterial pneumonia

Histopathological Report:

Liver. no lesions are seen.

Spleen. There is atrophy of the lymphoid follicles.

Kidney. no lesions.

Spleen. atrophy of follicles.

Lung. There is atelectasis, filling of alveoli with fluid, neutrophils and macrophages. Alveolar walls appeared lined by hyperplastic cells in some areas. Perivascular cuffs are also noted. Airways are plugged with cells, debris and fluid.

Diagnosis: Pneumonia.

APPENDIX I. Gross and Microscopic Pathology\* Found in Necropsied Animals  
(cont'd)

DB-2-DGR-70 Two-year-old ram maintained at Corn Creek Station/Desert National Wildlife Range. Compound fracture of metatarsus. Died from shock from the trauma and anesthetic associated with fracture repair.

Histopathology samples not collected as there were advanced post mortem changes.

DB-3-DGR-70 Sixteen-year-old ewe, spent entire life in pens at Corn Creek Station/Desert National Wildlife Range.

Gross lesions noted included:

1. Tapeworm in bile duct,
2. ecchymotic hemorrhage on edges of spleen,
3. contusions of hips and pelvis.

Diagnosis: Geriatric complications

Histopathological Report:

Lung. There are areas of congested vessels and perivascular edema. A few possible areas of emphysema are observed.

Liver. No lesions are seen.

Ovary. Only one follicle is noted. Stroma is prominent.

Adrenal. Congested.

Kidney. Areas of interstitial inflammation and fibrosis are seen. The kidneys are congested. There is brown pigment in some tubule cells. Hyaline and hemoglobin casts are seen in some tubules.

Heart. One sarcocyst is observed.

Spleen. Nodules on surface contain hemosiderin, and brown pigment. A large area of hemorrhage is observed on the surface.

Diagnosis: Lower nephron nephrosis (hemoglobinurio).

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\*As reported by Dr. James N. Shively and Dr. Jerrold M. Ward, Division of Biological Effects, Bureau of Radiological Health, 12720 Twinbrook Parkway, Rockville, Maryland 20852.

APPENDIX II. Minimum Detectable Activities for Radionuclide Analyses.  
 Technical Support Laboratory, National Environmental  
 Research Center, Las Vegas, Nevada.

The minimum detectable activities (MDA's) in terms of total activity per sample for standard geometries and counting times are based on a combination of a number of technical experiments and operational experience. By means of experimentation the MDA has been defined as that activity which produced a  $\pm 100\%$  deviation at the 95% confidence level. These values are applicable to ideal conditions and simple complexes of nuclides. Complex spectra and spectra showing naturally occurring radionuclides can raise the MDA's considerably.

Minimum Detectable Activities in pCi for Total Sample

Isotope	10 Min. Count		40 Min. Count		100 Min. Count	
	Planchet	Planchet	400 ml	3.5 liter	400 ml	1000 ml Marinelli
$^{181}\text{W}$					300	300
$^{144}\text{Ce}$	500	250	400	350	250	250
$^{131}\text{I}$	50	25	40	35	25	25
$^{106}\text{Ru}$	500	250	400	350	250	250
$^{65}\text{Zn}$	500	250	400	350	250	250
$^{137}\text{Cs}$	50	25	40	35	25	25
$^{95}\text{Zr}$	50	25	40	35	25	25
$^{54}\text{Mn}$	50	25	40	35	25	25
$^{140}\text{Ba}$	50	25	40	35	25	25
$^{40}\text{K}^*$	0.5	0.3	0.4	0.4	0.3	0.3
$^{239}\text{Pu}$	0.01 pCi per gram of ash					
$^3\text{H}$	0.4 pCi per ml of $\text{H}_2\text{O}$					
$^{90}\text{Sr}$	2 pCi total sample of ash					
$^{89}\text{Sr}$	5 pCi total sample of ash					

\* grams of potassium.

APPENDIX III. Analytical Results of Biological Samples Collected for  
Project Rulison

Sample Description	Date Collected	pCi/g of ash		<sup>3</sup> H pCi/ml H <sub>2</sub> O	Remarks
		<sup>89</sup> Sr	<sup>90</sup> Sr		
Mule deer	8/16/69				One-year-old male. A hunter kill in High-tower area of Dike Creek. Gamma spectra indicated that radionuclide concentrations in the muscle and thyroid were less than the minimum detectable activities.
Muscle		NA	NA	0.8 ± 0.7	
Hock bone		10.0 ± 4.6	6.0 ± 1.5	NA	
Mule deer	8/17/69				Two-year-old male. A hunter kill from Uncompahgre Plateau, west of Delta, Colorado. Gamma spectra indicated that radionuclide concentrations in the muscle and thyroid were less than the minimum detectable activities.
Muscle		NA	NA	0.8 ± 0.7	
Hock bone		5.4 ± 4.0	5.7 ± 1.3	NA	
Mule deer	8/19/69				Five-year-old male. A hunter kill at Hubbard Creek, Colorado. Gamma spectra indicated that radionuclide concentrations in the muscle and thyroid were less than the minimum detectable activities.
Muscle		NA	NA	0.9 ± 0.7	
Hock bone		3.4 ± 4.0	6.4 ± 1.3	NA	
Mule deer	8/27/69				Female fawn. Road kill, 3 miles south of Mesa, Colorado, Highway 65. Gamma spectra indicated that radionuclide concentrations in the abomasum contents, abomasum tissue, liver, lungs, muscle, thyroid, and rumen contents were less than the minimum detectable activities.
Muscle		NA	NA	1.0 ± 0.7	
Hock bone		6.9 ± 3.1	3.8 ± 1.2	NA	

APPENDIX III. Analytical Results of Biological Samples Collected for  
Project Rulison (cont'd)

Sample Description	Date Collected	pCi/g of ash		<sup>3</sup> H pCi/ml H <sub>2</sub> O	Remarks
		<sup>89</sup> Sr	<sup>90</sup> Sr		
Mule deer	8/29/69				Four-year-old male. A hunter kill, 21 miles south of Carbondale, Colorado, Highway 133. Gamma spectra indicated that radionuclide concentrations in the muscle and thyroid were less than the minimum detectable activities.
Muscle		NA	NA	<0.4	
Hock bone		3.7 ± 3.5	7.7 ± 1.4	NA	
Bovine	9/2/69				Yearling steer from Gregg Coffman Ranch, Carbondale, Colorado. No detectable gamma emitters.
Thyroid		NA	NA	0.8 ± 0.7	
Bovine	9/2/69				Yearling steer from Gary Aldridge ranch, Silt, Colorado. No detectable gamma emitters.
Thyroid		NA	NA	1.9 ± 1.0	
Bovine	9/2/69				Yearling steer from Connie Carpenter, Debeque, Colorado. No detectable gamma emitters.
Thyroid		NA	NA	0.9 ± 0.7	
Bovine	9/2/69				Yearling steer from Don Mackey, Debeque, Colorado. No detectable gamma emitters.
Thyroid		NA	NA	1.0 ± 0.7	
Bovine	9/2/69				Yearling steer from Doug McDonald, Rifle, Colorado. No detectable gamma emitters.
Thyroid		NA	NA	0.8 ± 0.7	
Bovine	3/19/70				Two-year-old bull from Mrs. John Savage, Graham Mesa, Rifle, Colorado. No detectable gamma emitters.
Muscle		NA	NA	1.2 ± 0.4	

APPENDIX III. Analytical Results of Biological Samples Collected for  
Project Rulison (cont'd)

Sample Description	Date Collected	pCi/g of ash		<sup>3</sup> H pCi/ml H <sub>2</sub> O	Remarks
		<sup>89</sup> Sr	<sup>90</sup> Sr		
Bovine	3/27/70				
Kidney		NA	NA	0.9 ± 0.3	One and one-half-year-old cow, 1 mile south of Plateau City, Colorado. No detectable gamma emitters.
Bovine	4/1/70				
Kidney		NA	NA	1.1 ± 0.4	One-year-old steer from Alkali Creek, 5 miles southeast of New Castle, Colorado. No detectable gamma emitters.
Mule deer	4/3/70				
Muscle		NA	NA	0.6 ± 0.3	Four-year-old doe. Road kill, 1 mile west of Rifle, Colorado. Gamma spectra indicated that radionuclide concentrations in liver, thyroid, rumen contents, and muscle were less than the minimum detectable activities.
Hock bone		<2.5	<1	NA	
Bovine	4/6/70				
Kidney		NA	NA	0.8 ± 0.3	Aged bovine collected from Garfield County, Colorado. Tag No. 1103. No detectable gamma emitters.
Bovine	4/6/70				
Kidney		NA	NA	1.1 ± 0.3	Aged bovine collected from Garfield County, Colorado. Tag No. 1178. No detectable gamma emitters.
Bovine	4/6/70				
Kidney		NA	NA	0.8 ± 0.3	Aged bovine collected from Garfield County, Colorado. Tag No. 1176. No detectable gamma emitters.
Trout	4/26/70				
Whole Body		NA	NA	0.7 ± 0.3	Collected from Battlement Creek near Central Point, Colorado. No detectable gamma emitters.

APPENDIX III. Analytical Results of Biological Samples Collected for  
Project Rulison (cont'd)

Sample Description	Date Collected	$^{89}\text{Sr}$ pCi/g of ash	$^{90}\text{Sr}$	$^3\text{H}$ pCi/ml $\text{H}_2\text{O}$	Remarks
Trout	5/28/70				
Whole body		NA	NA	$1.1 \pm 0.3$	Collected from Battlement Creek near Central Point, Colorado. No detectable gamma emitters.
Chicken	7/11/70				
Eggs		NA	NA	$0.7 \pm 0.3$	Eggs collected from Dan Moore Ranch, Grand Valley, Colorado. No detectable gamma emitters.
Trout	7/22/70				
Whole body		NA	NA	$1.4 \pm 0.3$	Collected from Battlement Creek, between Central Point and Grand Zero Pad, Colorado. No detectable gamma emitters.
Chicken	7/21/70				
Eggs		NA	NA	$1.8 \pm 0.4$	Eggs collected from Tate Weir Ranch, Grand Valley, Colorado. No detectable gamma emitters.
Chicken	7/23/70				
Muscle		NA	NA	$1.5 \pm 0.3$	Collected from Don Moore Ranch, Grand Valley, Colorado. No detectable gamma emitters.
Bovine	8/17/70				
Blood		NA	NA	$1.7 \pm 0.4$	Blood drawn from five-month-old calf from A. L. McLain Ranch, Grand Valley, Colorado. No detectable gamma emitters.
Bovine	8/17/70				
Blood		NA	NA	$1.0 \pm 0.3$	Blood drawn from six-year-old Jersey cow from Donald Burtard, Rulison, Colorado. No detectable gamma emitters.
Bovine	8/17/70				
Blood		NA	NA	$1.3 \pm 0.3$	Blood drawn from five-month-old lamb from Donald Burtard, Rulison, Colorado. No detectable gamma emitters.
Porcine	10/14/70				
Kidney		NA	NA	$0.4 \pm 0.3$	One-year-old Hampshire hog from H. W. Arnett Ranch, Grand Valley, Colorado, one mile west of Rulison. No detectable gamma emitters.



APPENDIX III. Analytical Results of Biological Samples Collected for  
Project Rulison (cont'd)

Sample Description	Date Collected	$^{89}\text{Sr}$ pCi/g of ash	$^{90}\text{Sr}$	$^3\text{H}$ pCi/ml $\text{H}_2\text{O}$	Remarks
Bovine	10/27/70				
Kidney		NA	NA	$0.6 \pm 0.3$	Two-year-old cow collected one mile north of Rifle, Colorado. No detectable gamma emitters.
Elk	11/2/70				
Muscle		NA	NA	$0.8 \pm 0.3$	Two-year-old cow elk. A hunter kill from the Vega area. Gamma emitting radionuclides were within background levels of activity.
Mule deer	11/6/70				
Kidney		NA	NA	$0.7 \pm 0.3$	Hunter kill in Grand Mesa area. Samples collected by Colbran Locker Plant. No information as to age. Sex assumed to be male. No detectable gamma emitters.
Mule deer	11/6/70				
Kidney		NA	NA	$0.9 \pm 0.3$	Hunter kill in Grand Mesa area. Samples collected by Colbran Locker Plant. No information as to age. Sex assumed to be male. No detectable gamma emitters.
Mule deer	11/6/70				
Kidney		NA	NA	$0.6 \pm 0.3$	Hunter kill in Grand Mesa area. Samples collected by Colbran Locker Plant. No information as to age. Sex assumed to be male. No detectable gamma emitters.
Ovine	11/6/70				
Blood		NA	NA	$1.2 \pm 0.3$	Blood drawn from 5-6-year-old ewe from Dan Duplice Ranch, Grand Valley, Colorado. No detectable gamma emitters.
Bovine	11/6/70				
Blood		NA	NA	$1.2 \pm 0.3$	Blood drawn from 9-year-old cow from Don Burtard Ranch, Rulison, Colorado. No detectable gamma emitters.
Elk	11/6/70				
Muscle		NA	NA	$0.9 \pm 0.3$	Two-year-old cow elk. A hunter kill from Battlement Mesa. Gamma emitting radionuclides were within background levels of activity.

APPENDIX III. Analytical Results of Biological Samples Collected for  
Project Rulison (cont'd)

Sample Description	Date Collected	<sup>89</sup> Sr pCi/g of ash	<sup>90</sup> Sr	<sup>3</sup> H pCi/ml H <sub>2</sub> O	Remarks
Bovine Blood	12/21/70	NA	NA	0.4 ± 0.3	Blood drawn from six-year-old Jersey cow from Don Burtard Ranch, Rulison, Colorado. No detectable gamma emitters.
Ovine Blood	12/21/70	NA	NA	<0.4	Blood drawn from four-year-old ewe from Don Burtard Ranch, Rulison, Colorado. No detectable gamma emitters.

October 10-26, 1970

# BIG SAM AT THE STATE FAIR OF TEXAS

Big Sam, a fistulated steer from the herd of more than 70 Hereford beef cattle the U.S. Public Health Service maintains on the Atomic Energy Commission's nuclear test site in Nevada, is a featured exhibit at the State Fair of Texas being held in Dallas, October 10-25, 1970. The Public Health Service's Southwestern Radiological Health Laboratory and the AEC's Nevada Operations Office in Las Vegas brought Big Sam to Texas under sponsorship of the Dallas Health & Science Museum. The steer is displayed in his own special pen on the Museum lawn.

In a suitably deep voice, Sam tells his own story of the life he leads on the 1350-square mile test site in Nevada. "My place is right smack in the middle of the AEC's nuclear test area. A Texas-sized spread I call it," Sam says.

When Sam was a yearling, he underwent surgery to have a fistula (hole) into his rumen (forestomach) with a canula (plugged entrance to the hole) installed in his left side. "I've had it nearly all my life," says Sam, "and it doesn't hurt a bit." He and four similarly fitted corral mates then joined the herd of beef cattle that grazes the Nevada Test Site — where, from 1951 to the end of last year, some 375 nuclear explosive tests were conducted.

Sam and the other fistulated steers had a special job to do for a research project being done jointly by the University of Nevada, which owned the steers, and the U.S. Public Health Service, which has been managing the AEC's beef herd since 1954. The fistulated steers were to serve as biological samplers of the forage grazed by the herd as it ranges over the desert test site.

Once a month, a sample of the rumen contents is removed from Sam or one of his fistulated corral mates. The Radiological Research Program at the Public Health Service's Southwestern Radiological Health Laboratory (SWRHL) analyzes the samples for radioactivity and botanical species represented. The University of Nevada then relates the nutritional composition of the diet to the actual plant species ingested.

Also, the chemical and radiochemical composition of the animals' diet is determined and changes in composition of the diet are studied with relation to season, year-to-year variation, and nuclear testing events.

The beef herd has lived on the Nevada Test Site for 13 years. Twice a year, animals from the herd are slaughtered by SWRHL veterinarians, and a large number of tissue and organ samples are taken. These are analyzed for radionuclide content at the SWRHL, and samples are sent to the Armed Forces Institute of Pathology for complete microscopic examination.

In all these years, no pathology related to radiation exposure has been observed. The radiation levels in the tissues are well below allowable levels, and the meat would be quite safe for consumption. The herd had a 96% calf drop for the last 3 consecutive years — a production statistic that few herds could beat.

The AEC also has an experimental dairy farm on the Nevada Test Site developed and managed by the Southwestern Radiological Health Laboratory as a field research facility for studying the transport of radionuclides through man's environment to man. In different studies, cows or growing crops are exposed to aerosol sprays of radionuclides, or cows are fed capsules containing radionuclides. Radionuclide concentration in the forage, the milk, in certain organs, and in the excreta is measured. The data are studied to learn the influence of particle size, type of forage, feeding practices, and other parameters. The information is used to develop models by which to predict exposure to man, and to evaluate the effectiveness of various protective actions which may be taken to reduce the amounts of radionuclides getting into food materials under different contaminating situations.

Besides managing the beef herd and dairy farm, the SWRHL wildlife biologists and veterinarians collect samples from several wild species living in or near the test site as biological indicators of fallout. The SWRHL cooperates with state and federal conservation agencies in surveillance of bighorn sheep, mule deer, and other native species.

From these and other continuing and cooperative programs conducted over a period of many years, the Atomic Energy Commission and the Public Health Service gain a better understanding of the complex behavior of radioactive material in the environment and its effect on living things.

Southwestern Radiological Health Laboratory  
Bureau of Radiological Health  
Public Health Service, USDHEW  
P. O. Box 15027 - Las Vegas, Nevada 89114

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