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AMCHITKA RADIOBIOLOGICAL PROGRAM PROGRESS REPORT

JANUARY 1979 TO DECEMBER 1979

By

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ABSTRACT

The objective of the Amchitka Radiobiological Program for the period 1970-1979 was to determine the extent of radionuclide contamination from world-wide atmospheric fallout and from the detonation of three underground nuclear blasts on Amchitka Island. The objective is achieved, by the collection and radiological analyses of biological and environmental samples and by background radiation measurements. Leakage of radionuclides from the underground sites of the Amchitka nuclear detonations would be suspected if the contamination was significantly greater than would be expected from world fallout. An account of the program from July 1970 to December 1978 has been given in nine previous reports from the Laboratory of Radiation Ecology to the Nevada Operations Office of the U.S. Department of Energy. This report is an account of the program for calendar year 1979.

Results of analyses for samples collected in September and October 1979 have been added to the tables of Tornberg and Nakatani (1979) which summarize the Amchitka program from 1970 to 1978 and include analyses for: (1) gamma-emitting radionuclides in freshwater, birds, lichens, marine alga, marine invertebrates, fish, aufwuchs and freshwater moss and plants; (2) strontium-90 in rats, birds and soil; (3) plutonium-239,240 in sand, soil, marine alga and fish; (4) tritium in seawater, freshwater and organisms; and (5) background radiation levels at selected island sites.

The results of analyses of the samples collected in 1979 lead to the same conclusions as in previous years, i.e., there is no evidence that the radionuclide contamination at Amchitka Island is greater than would be expected from world fallout except for a slight contamination of the Long Shot Mud Pits with tritium.

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1. INTRODUCTION

The present Amchitka radiobiological program began in 1970 but was preceded by the Long Shot radiobiological program in 1965. A relevant description of the present program is given in the 1972 Progress Report (Held et al., 1973), and selected portions from that report follow.

"The present Amchitka Radiobiological Program was initiated in July, 1970, by the University of Washington's Laboratory of Radiation Ecology at the request of the U.S. Atomic Energy Commission, Nevada Operations Office. The program is designed to provide a periodic documentation of radionuclides, both naturally occurring and man-made, in biological and environmental samples from Amchitka and its environs. Seafoods and radionuclides potentially available to man through the food web are emphasized. However, organisms other than food organisms are also collected and analyzed. These indicator organisms are species that significantly concentrate one or more radionuclides. Concentrations of radionuclides other than those potentially hazardous to man are measured as a means of providing clues to the origin of radionuclides at Amchitka. Unexpected combinations or concentrations of radionuclides would indicate the presence of newly added radionuclides to the environment, presumably from fresh fallout, nuclear-powered vessels, or from nuclear detonations at Amchitka Island.

The first two Amchitka Radiobiological Program Progress Reports covered the period July 1970 to February 1972. These reports have been summarized by Held (1972), who concluded, "Artificial or man-made radionuclides (found at Amchitka) did not originate at Amchitka except for tritium, which has previously been reported to be present in pond water and test holes near the Long Shot SGZ site."

The third to ninth progress reports reiterated the above conclusion and extended the account of the program through December 1978. Major conclusions of the ninth report, as stated by Tornberg and Nakatani (1979) are as follows:

a. "Two natural radionuclides, ^{7}Be and ^{40}K, were the most abundant radionuclides in most samples.

b. "Some fission products, induced radionuclides and plutonium have been detected in quantities that range from the limits of detection to a few pCi/g of dry sample."

c. "Peaks of abundance of fission product radionuclides occurred in 1970-71, 1974 and 1977 and followed major Chinese nuclear detonations."

d. "Values for ^{95}Zr and ^{95}Nb in freshwater moss and algae from Amchitka Island and the Columbia River were similar in amounts and peaks of abundance.

e. "The radioactivity from fallout radionuclides, generally, was greater for freshwater than for marine organisms."

f. "There is no strong evidence from the gamma spectrum analysis that the radioactivity of the samples is related to the collection location on Amchitka Island."

g. "There has been no increase in ^{3}H, ^{90}Sr, or $^{239,240}Pu$ values. Tritium is a potential radionuclide indicator of radionuclide leakage from underground sites."

h. "The background radiation survey meter readings were at or near the lower limits of detection for the instrument."

i. "The laboratory detection and measurement system for the radiological analyses of the samples was sensitive to small perturbations in the amounts and species of radionuclides in the environment."

j. "The results of analyses of the 1978 samples complemented the results of analyses of samples collected previously and did not reveal any unexpected information."

In this, the tenth progress report, the format is the same as for the ninth progress report except that the new data from the analyses of samples collected in September and October 1979, were added to the appropriate tables of the previous report. Figure 1 of this report shows the geographical location of Amchitka Island. Figure 2 shows the general collection sites for the radiobiological program, while Figures 3 through 6 present the specific collection sites for the shaded areas shown in Figure 2. Peak years of fallout radionuclides are shown in Figure 7.

2. METHODS

Most samples collected prior to July 1972, and fish, marine invertebrates, and birds collected through 1977 were analyzed by gamma spectrometry with systems using 3 x 3 inch or 4 x 5 inch NaI crystals and 200-channel, pulse-height analyzers. Samples (except fish, marine invertebrates and birds as noted above) collected since July 1972 have been analyzed with systems using Ge(Li) diode detectors and 4096-channel, pulse-height analyzers. To determine the ^{90}Sr content of selected samples, ^{90}Y was chemically separated from ^{90}Sr, collected on filter paper and counted with a low-level beta counting system. Plutonium was extracted by ion exchange, electroplated on platinum discs and analyzed by alpha spectrometry with systems using surface barrier detectors and pulse height analyzers. Chemical yield was determined by use of ^{242}Pu as a tracer. Tritium in seawater and freshwater samples was determined by vacuum distillation of the samples and liquid scintillation counting of

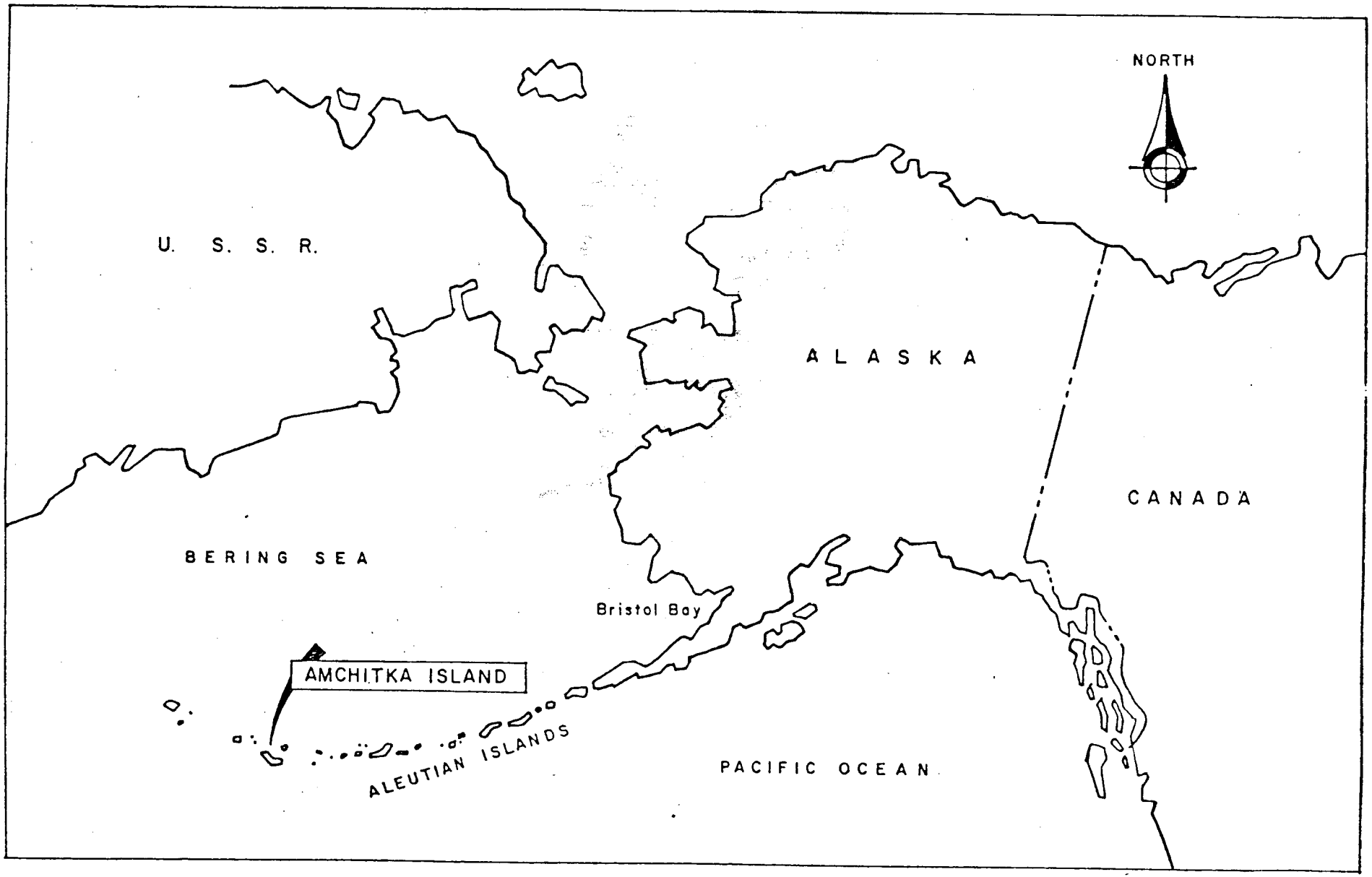

FIGURE 1. Location Map

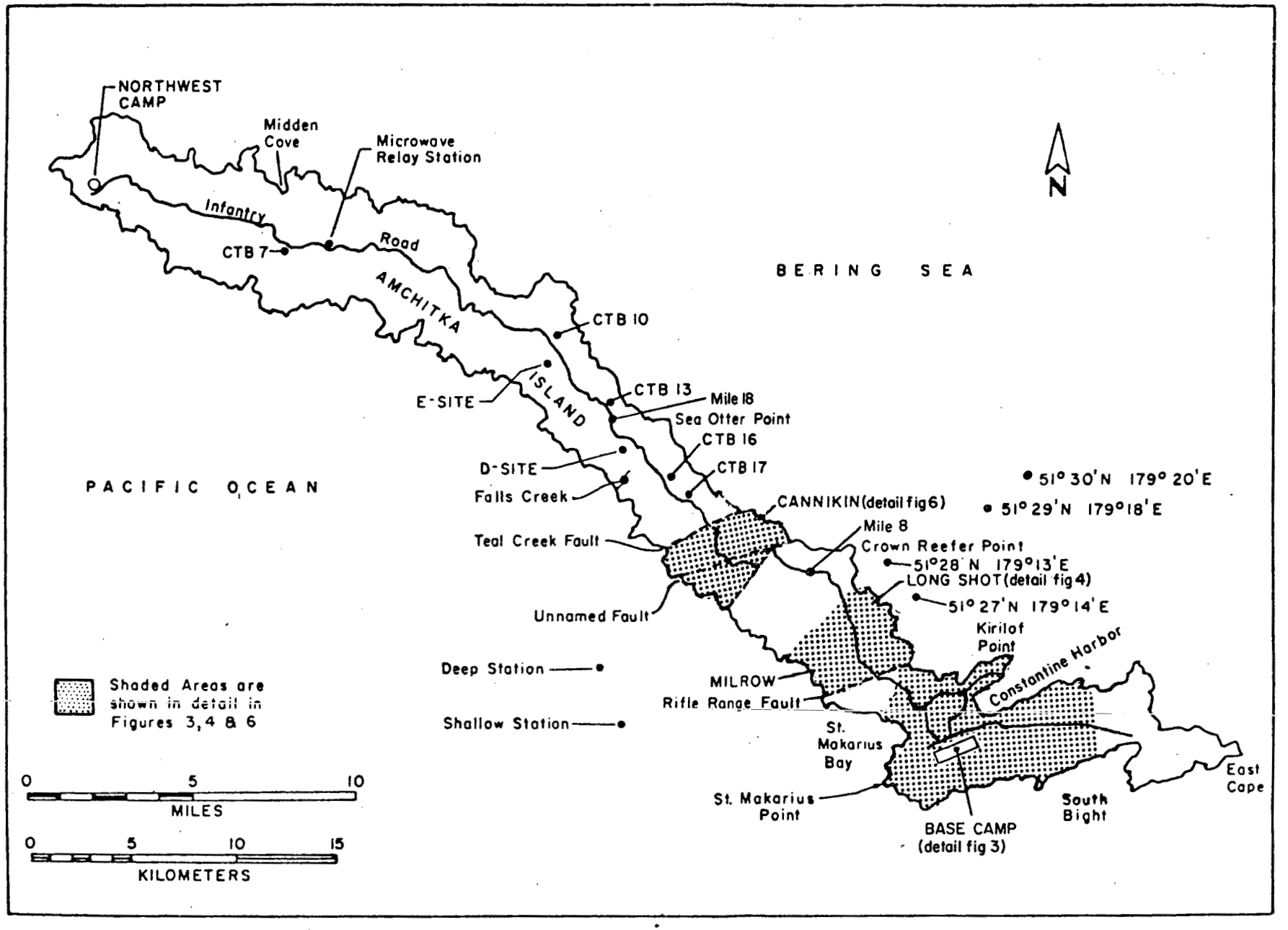

FIGURE 2. Location of Collection Sites on and near Amchitka Island, Alaska

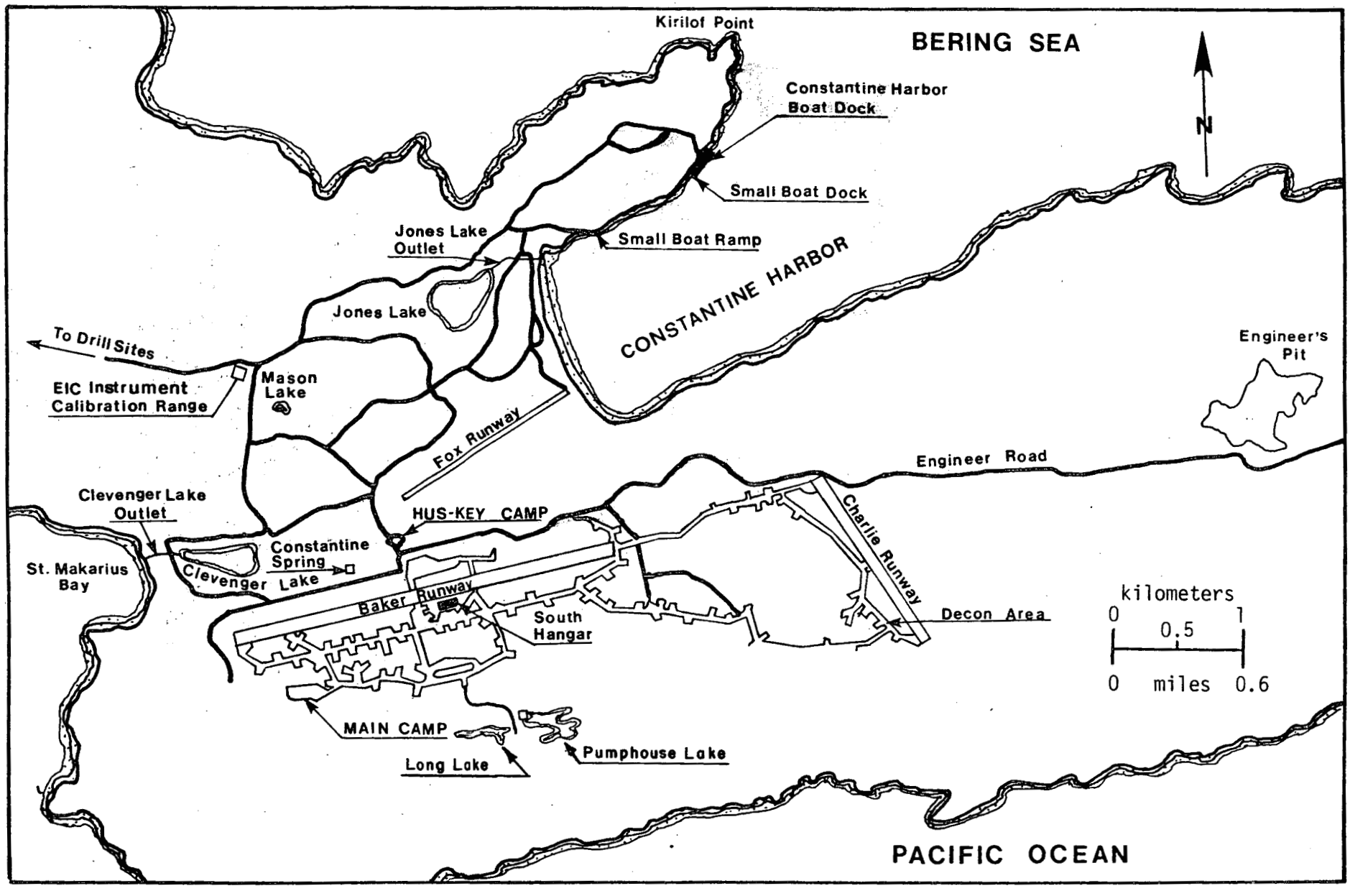

FIGURE 3. Collection Sites and Other Prominent Features in the Amchitka Island Base Camp Area

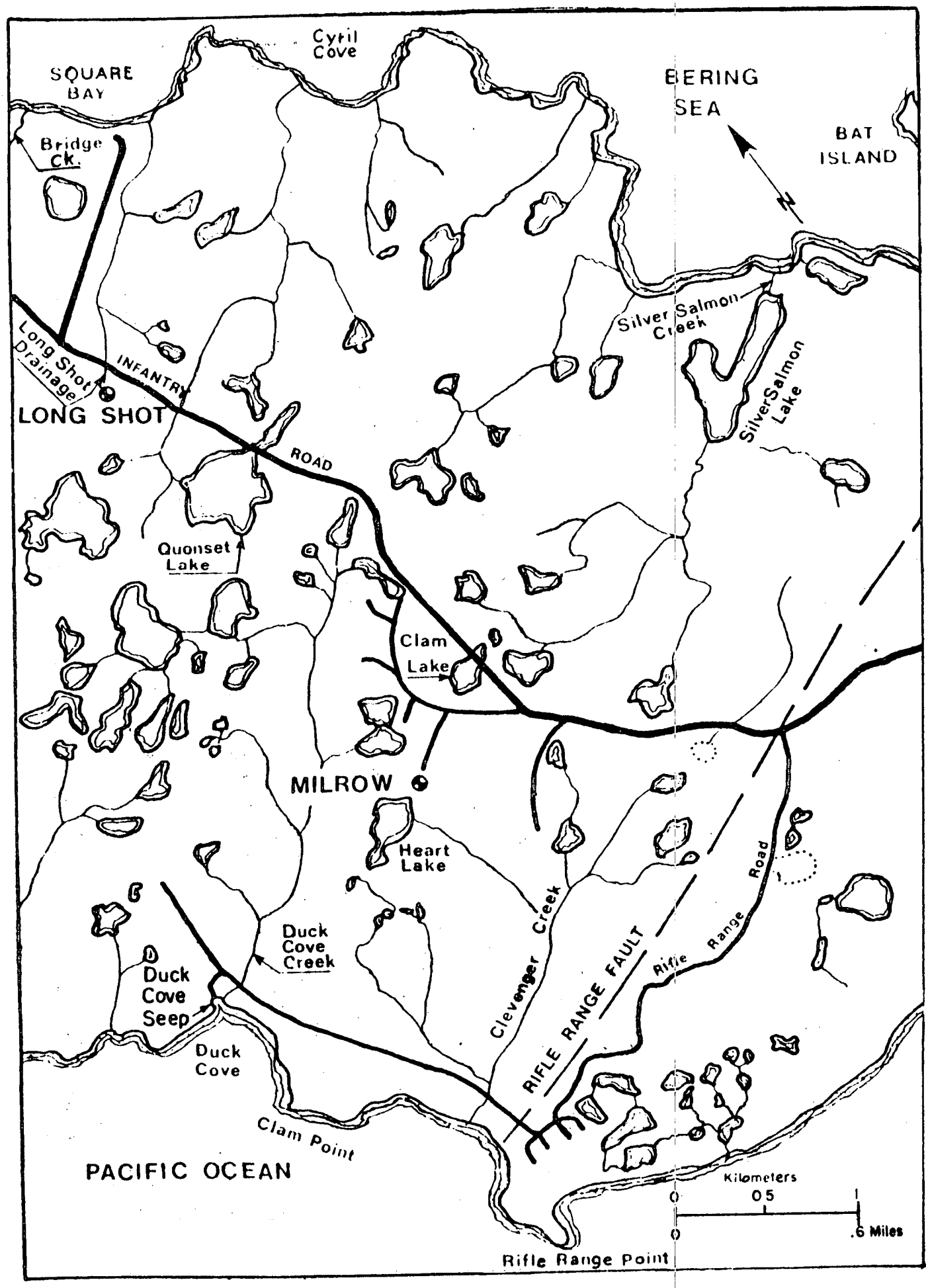

FIGURE 4. Collection Sites and Other Prominent Features in the Milrow Area.

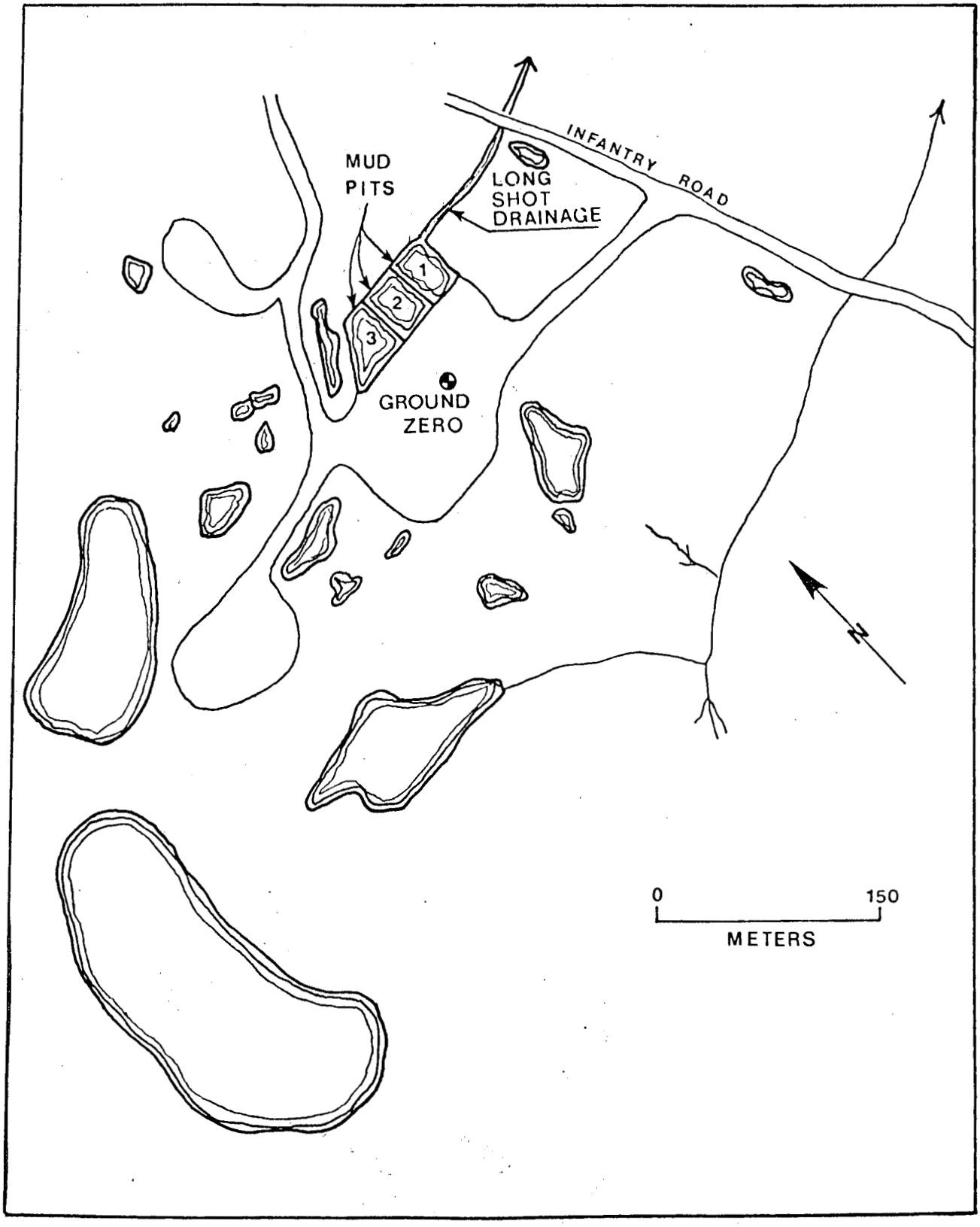

FIGURE 5. Collection Sites and Other Prominent Features in the Long Shot Ground Zero Vicinity.

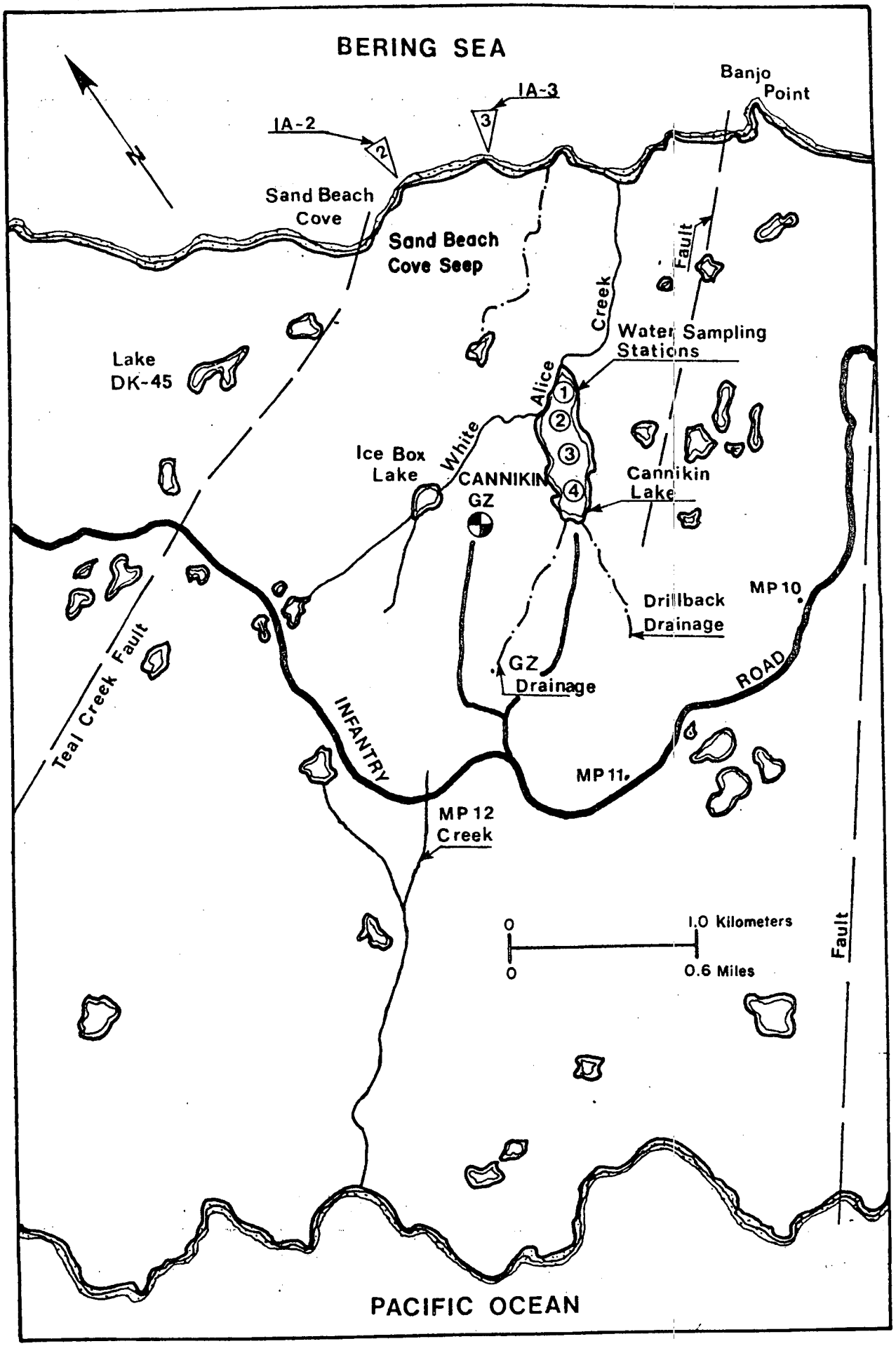

FIGURE 6. Collection Sites and Other Prominent Features in the Cannikin Area

the distillate, or by azeotropic distillation and liquid scintillation counting. The free tritium in samples from fish, ptarmigan and aquatic plants was determined by freeze-drying the samples, azeotropic distillation and liquid scintillation counting. Freshwater samples (34 liters or more) for analyses of radionuclides other than tritium were evaporated on the island and the residue was later counted for gamma emitting radionuclides using the Ge(Li) detectors.

All data presented in the tables have been corrected to the date of collection; this correction will introduce little or no error in the calculated values except for ^{95}Nb if the ^{95}Zr in the sample was produced at various unknown times and is not in equilibrium with its daughter, ^{95}Nb. In this case, an accurate decay correction factor cannot be made for ^{95}Nb, and the application of the standard decay correction factor for ^{95}Zr to the amount of ^{95}Nb present at the time of the counting gives an estimate of the maximum possible amount of ^{95}Nb present at the time of collection. The problems of ^{95}Zr-^{95}Nb analysis have been discussed in Held et al. (1973).

The error term in radionculide concentration values for single samples is the combined counting error for the background, standard, and sample: hence, the term "propagated error". The error limits for the gamma-emitting radionuclides in single samples are "two-sigma" or two-standard deviation counting errors while for the ^{3}H data, error limits are one-standard deviation counting errors. Errors for ^{90}Sr and all Pu analyses are two-sigma counting errors. The error term for the mean of more than one sample is one-standard deviation of the mean.

Limits of detection are important since they govern the amount of a radionuclide that can be detected if it is present in a sample. Many factors influence the limit of detection, including the type of detector and analyzer, the presence of other radionuclides, the duration of the counting period, the size and density of the sample and the geometry relationship of the sample and detector. Hence, the actual limits of detection can vary considerably for various radionuclides and types of samples, but can be summarized by stating that the detection limits were approximately as follows:

By gamma detection	
^{40}K	2.1 pCi/g or less
^{7}Be, ^{103}Ru, ^{106}Ru, ^{144}Ce, ^{228}Th, ^{238}U	0.41 pCi/g or less
^{95}Nb, ^{95}Zr, ^{125}Sb, ^{137}Cs, ^{155}Eu, ^{226}Ra	0.12 pCi/g or less
By beta detection	
^{3}H	48 pCi/liter or less
^{90}Sr	0.2 pCi/g or less
By X-ray detection	
^{55}Fe	0.04 pCi/g or less

By alpha detection

$^{239,240}Pu$	0.02 pCi/g or less

In addition to the radiometric analyses made on the biological and environmental samples, environmental radiation surveys of selected areas on Amchitka Island have been conducted since August, 1974. An Eberline survey meter, Model E-410, and a pancake probe with a <2 mg/cm^2 window was used in the surveys.

4. RESULTS AND DISCUSSION

The results of the analyses of the samples collected in 1979 are presented in Tables 2 through 18. These tables also summarize the results of analyses from previous years although more detail can be found in earlier progress reports. An excellent summary of the radiobiological studies at Amchitka from 1965 to 1975 can be found in Chapter 24, "Radionuclides in Air, Water and Biota"(Seymour and Nelson, 1977), of the book, The Environment of Amchitka Island (Merritt and Fuller, eds., 1977). Other chapters of the book provide additional information about the Amchitka environment based on extensive studies by many investigators.

The samples collected in August 1979 were of the same type and from the same locations as in previous years and included biological indicator species, water, soil or sand from freshwater, terrestrial and marine environments. The only change in the 1979 schedule of sample collections and analyses were as follows:

a. A sample of water was collected 100 meters above Square Bay in the Long Shot Drainage to further document the flow of water contaminated with tritium from the Long Shot Mud Pits.

b. Seven samples of Ranunculus were collected from the Long Shot drainage system and analyzed for tritium.

Most of the samples were analyzed by gamma spectrometry for both natural and fission product radionuclides. In addition, selected samples were analyzed for tritium, strontium-90 and plutonium-239,240. The results of radiological analyses are presented in Tables 2-19.

The results of gamma spectrum analysis for three vascular or nonvascular plants collected in freshwater are given in Tables 2-4. The sample types were Fontinalis (a moss), Ranunculus (vascular)and aufwuchs (bottom adhering micro-organisms) with filamentous algae. Samples were collected at seven stations. The data from the tables indicate that the values for naturally occurring beryllium-7 (^7Be) and potassium-40 (^{40}K) generally are greater than the values for the fission products and that there is a distinct "year of collection" effect with peak years in 1970-71, 1974 and 1977.

Seymour and Johnson (1978) investigated the "year of collection" effect by comparing the values for the amount of zirconium-95 (^{95}Zr) plus niobium-95 (^{95}Nb) in Fontinalis from Amchitka with the amount of ^{95}Zr plus ^{95}Nb in freshwater moss and algae samples from Columbia River stations on the Oregon shoreline. These ^{95}Zr plus ^{95}Nb values were correlated with the schedule of atmospheric detonation of nuclear devices of 20 kiloton or greater fission yields in China. The source of information about the Chinese nuclear detonations was Telegadas (1977) and Carter (1979). The data for the years 1970 through 1979 are presented in Figure 7.

The variables in Figure 7 were selected for the following reasons: ^{95}Zr and ^{95}Nb are indicators of fresh fallout radionuclides and were the most abundant fission products in the Amchitka samples; Fontinalis was selected as an excellent biological indicator species; moss and algae from the Columbia River were selected as comparable samples to Amchitka Fontinalis samples from a location at approximately the same latitude as Amchitka; and the schedule of Chinese nuclear detonations was selected for comparison with the ^{95}Zr plus ^{95}Nb values because this is the probable source of fallout radionuclides in the samples from both areas. The results of analyses of Columbia River samples (a moss, Callierogonella cuspidata and/or an alga, Cladophora) were provided by Toombs (1978, 1979, 1980). The Columbia River samples were collected monthly and it should be noted in Figure 7 that the results of analyses have been smoothed by a moving average of three. Also, the Columbia River samples were reported in terms of wet weight and for this reason the Amchitka samples in Figure 7 also are given in terms of wet weight. Prior to 1978 the wet weight values were calculated from the wet weight-dry weight ratio of 8.1 as determined from the measurements of 15 samples in 1977. The wet weight-dry weight ratio for samples collected in 1978 and 1979 used the measured ratio of each individual sample. The Amchitka Fontinalis data for 1979 are derived from 16 samples collected in September and October. No samples were available for other months. The concentrations of ^{95}Zr plus ^{95}Nb in Fontinalis and in Cladophora samples collected at Amchitka Island and at Goble, Rainier and Prescott, Oregon in 1979 were less than the minimum detectable limits of $\sim$0.1 picocuries per gram of wet weight.

Inspection of Figure 7 provides evidence for the following comments (Seymour and Johnson, 1978): (1) the trends for the Amchitka and Columbia River values are similar; (2) the peaks in the curves occur after Chinese nuclear detonations of 20 kiloton or greater fission yeild; (3) there is a "year of collection" effect with peaks in 1970-71, 1974 and 1977; and (4) the detection and measurement systems are sensitive to small perturbations in the amounts of fallout radionuclides in the environment.

From comments(1) and(2) above, the obvious conclusion is that the source of radionuclides at Amchitka is world fallout, principally from the Chinese nuclear detonations. Another method of determining the source of the radionuclides is to determine the date of origin of the radionuclides and/or

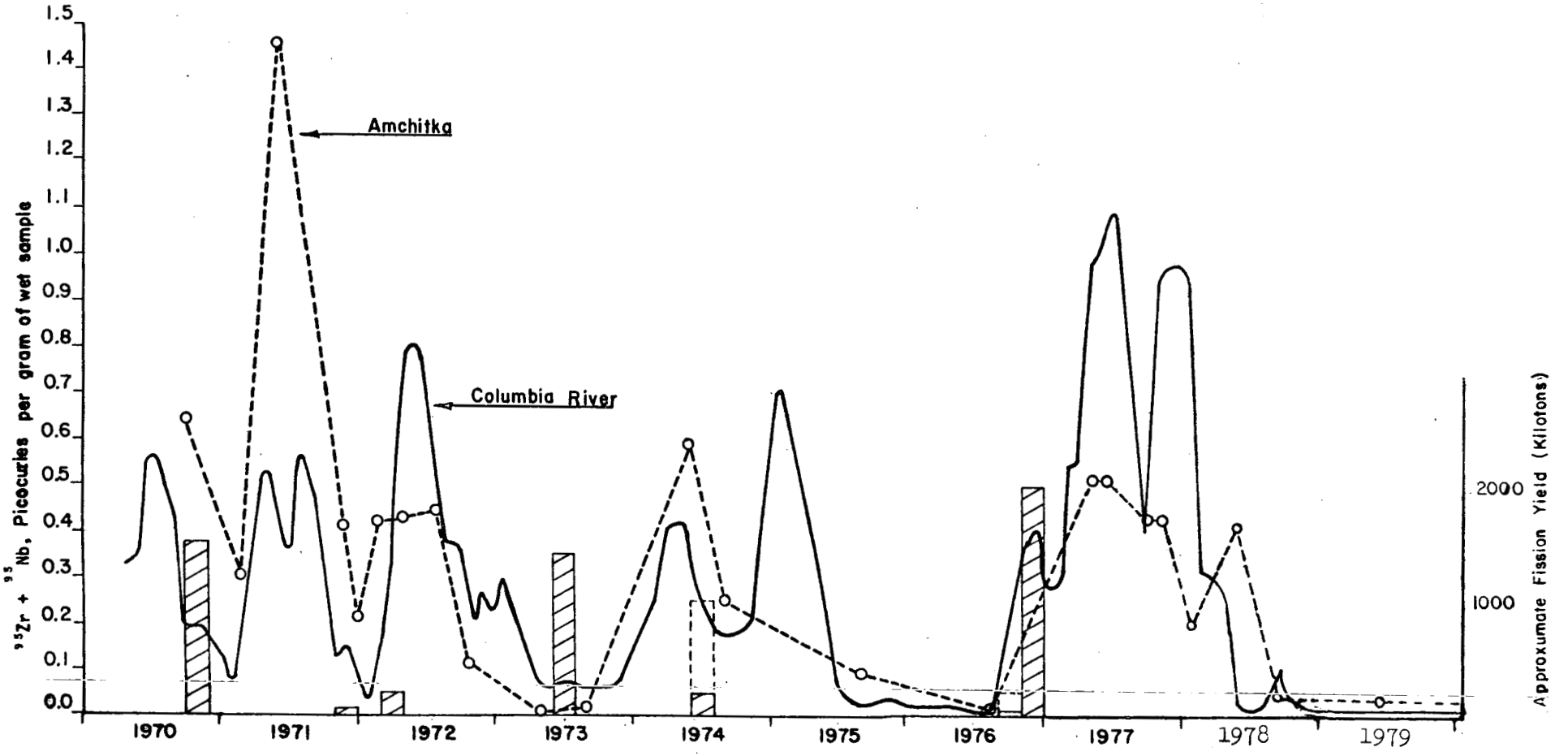

Figure 7. Zirconium-95 plus niobium-95 in freshwater vegetation from Amchitka Island and from the Columbia River and the fission yield of Chinese atmospheric nuclear detonations, 1970 to 1979. The Amchitka samples were the moss, Fontinalis. The Columbia River samples were the moss Calliergonella cuspidata, the algae Cladophora sp., or a combination of the two species collected at Goble, Oregon in 1970-71, at Rainier, Oregon in 1972-77, and at Goble, Rainier, and Prescott, Oregon in 1978-1979. The three locations are ten miles apart. The Oregon samples were collected monthly and the values smoothed by a moving average of three. The fission yield of Chinese detonations greater than 20 kiloton are shown as bars (Telegadas, 1977).

the presence of short half lived fallout radionuclides in the samples. The date of origin of radionuclides can be determined from the ratio of fission product radionuclides if the parent radionuclide is known, little or no fractionation of any kind occurs, and reliable fission product radionuclide ratios can be established. For the Amchitka data, there was insufficient information to calculate date of origin by the radionuclide ratio method. However, the presence of short half life ^{95}Zr and ^{95}Nb (65 and 35 days respectively) as the dominant fission product radionuclides in the samples means that these radionuclides are of more recent origin than the last nuclear detonation at Amchitka (November 1971) and hence originate from world fallout.

There has been no strong evidence from the radiological data for a "collection location" effect, i.e., the radioactivity of the sample is related to the collection location on Amchitka Island.

Radionuclide values for Ranunculus are given in Table 3, for aufwuchs in Table 4 and for lichens in Table 5. Ranunculus, a freshwater plant, and aufwuchs, bottom adhering micro-organisms, are good biological indicator species but are not present at as many locations as Fontinalis. The concentrations of ^{7}Be, ^{40}K, ^{106}Ru, ^{137}Cs and ^{244}Ce were similar for Ranunculus, aufwuchs, and Fontinalis. The average concentrations of naturally occurring ^{7}Be and ^{40}K were always greater than 1.0 pCi/g, dry weight and the average concentrations of the fallout radionuclides, ^{106}Ru, ^{137}Cs, and ^{144}Ce were always less than 1 pCi/g, dry. Lichens are well known for the collection and retention of fallout radionuclides and are the single, best indicator species for the terrestrial environment. The average lichen values for ^{137}Cs and ^{144}Ce in 1979 (2.5 and 2.7 pCi/g, dry, respectively) are greater than for the freshwater indicator species but all other radionuclide values are similar.

Samples of the marine alga, Fucus (Table 6), had no measurable fallout radionuclide values in 1979. The only detectable radionuclide found in Fucus was ^{40}K which ranged in concentration from 31 to 39 pCi/g, dry weight.

Maximum radionuclide values for the green sponge, Halichondria panicea, were 13 and 0.31 pCi/g, dry for ^{40}K and ^{144}Ce respectively (Table 7). Potassium-40 was present in each of the three samples collected in 1979. Cerium-144 was the only detectable fallout radionuclide identified and it was found in only one sample.

Naturally occurring ^{40}K and fission-produced ^{137}Cs were the two radionuclides most commonly detected in fish (Tables 8-10). Cesium-137 was found in the muscle and/or viscera of Pacific halibut, greenling and Dolly Varden in concentrations which ranged from 0.06 to 1.9 pCi/g, dry. Muscle from a coho salmon caught at Clevenger Lake had a ^{40}K concentration of 17 pCi/g, dry and an undetectable amount of ^{137}Cs. Potassium-40 was the predominant radionuclide in all fish samples in all years and in marine fishes was usually present in concentrations 50 or more times greater than ^{137}Cs.

Potassium-40 and ^{137}Cs also were the predominant gamma-emitting radionuclides in rock ptarmigan, Lagopus mutus, samples for all years (Table 11) and as for fish, the ^{40}K values were significantly greater than the ^{137}Cs values. The values for ^{40}K and ^{137}Cs in rock ptarmigan ranged from 11-12 and 0.15-0.53 pCi/g, dry, respectively.

The samples analyzed for ^{90}Sr were the bones of rats and ptarmigan, and soils (Table 12). In samples collected since 1971 the ^{90}Sr values for rat bones have ranged from the limits of detection to 5.8 pCi/g, dry. The concentration of ^{90}Sr in ptarmigan bones for the same period is significantly higher (9.6-27 pCi/g, dry) but in recent years there has been a definite trend in the reduction of ^{90}Sr in ptarmigan bones. Soil samples from Main Camp and the Cannikin area have been collected and analyzed for ^{90}Sr since 1975. All values for ^{90}Sr in soils were 1 pCi/g, dry, or less.

Environmental samples which have been collected for gamma spectrum analysis include sand, soil and water (Tables 13 and 14). The surface (0 - 2.5 cm) soil samples were collected at Main Camp and in the Cannikin area; the surface sand samples were from Constantine Harbor and Sand Beach Cove. The radionuclide present in the largest amount was ^{40}K. Other radionuclides which were present in trace amounts (<1 pCi/g, dry) included ^{226}Ra, ^{228}Th, ^{238}U and the fallout radionuclides, ^{137}Cs, ^{141}Ce and ^{144}Ce. Freshwater samples have been collected for gamma spectrum analysis since 1970-71 at four sites - Jones Lake, Heart Lake, Cannikin Lake and Long Shot Mud Pit No. 1, and at Constantine Springs, Sand Beach Cove Seep and Long Lake since 1977. In addition, a rain water sample has also been collected annually since 1977. All sites were sampled in 1978 and 1979 except the Sand Beach Cove Seep. The results of analyses of the residue from the evaporation of 34 to 50 liter samples are presented in Table 14. Radionuclides detected in the September and October 1979 samples included ^{7}Be, ^{40}K, ^{137}Cs and ^{144}Ce. The values for ^{137}Cs ranged from 0.03 pCi/liter to a maximum of 0.12 pCi/liter. Cerium-144 was detected only in the rain water sample.

The concentration of tritium (^{3}H) in seawater and freshwater samples from all areas except Long Shot mud pits and drainage systems are recorded in Table 15. Tritium concentrations in seawater and freshwater have steadily declined from maximum values of 103 and 298 pCi/liter in 1970-71. Average tritium concentrations in seawater from 7 collection locations in 1979 was 37±30pCi/ℓ. Average tritium concentration freshwater from 28 collection locations was 70±26 pCi/ℓ. As for 1978, precipitation samples collected during 7 months of 1979 have a seasonal tritium input. Tritium concentrations in precipitation were low (∿35 pCi/liter) for January and February and peaked at 226 pCi/liter in April. The concentration of tritium in precipitation declined in May through July and then increased to 129 pCi/liter in September.

The water samples collected from the Long Shot Mud Pits for ^{3}H analysis have always been considered separately from other samples because this area was found to be slightly contaminated with ^{3}H a few months after the Long Shot nuclear detonation in 1965. The extent of the contamination has been well documented in previous progress reports and in other publications (see Nelson, 1975; Merritt and Fuller, 1977; and Seymour and Nelson, 1977.

Table 16 records the values for tritium in water samples from Long Shot Drainage for the years 1970-1979. During this period the average ^{3}H values for water samples from the three mud pits have declined from 11.3×10^{3} to 1.7×10^{3} pCi/liter. These values are well below the Maximum Permissible Concentration for ^{3}H in water (MPC_w) for occupational exposure. The MPC_w value as established by the International Commission on Radiological Protection (ICRP, 1959,1964)and the U.S. National Committee on Radiation Protection (NCRP, 1959) is 3×10^{7} pCi/liter. For an individual member of the population in an uncontrolled area, the Radiation Protection Guide (RPG) value is one-tenth the MPC for occupational exposure, or 3×10^{6} pCi/liter (U.S. Energy Research and Development Administration, 1975) The MPC_w for the general population is 10^{6} pCi/liter (ICRP, 1959). The 1.6 km course of the drainage stream has been sampled annually since 1975 for tritium analysis. The ^{3}H values have decreased from values comparable to the Mud Pit values to values near the mouth of the stream which are slightly greater than the 1979 ^{3}H values in freshwater samples from other areas of Amchitka Island. The contribution of ^{3}H from Long Shot Mud Pits to the ocean is insignificant.

The results of ^{3}H analysis of free water extracted from biological samples are presented in Table 17. Twenty-six samples from the marine, freshwater and terrestrial environments were measured for tritium during 1979. Fucus, greenling muscle and ptarmigan muscle had ^{3}H values which were near the limits of detection. Ranunculus and Fontinalis were the best indicators for ^{3}H. The average tritium concentration in these organisms from collection sites other than the Long Shot drainage system was 112 pCi/liter. During the September and October field trip of 1979, 12 samples of Ranunculus and Fontinalis were collected from the Long Shot mud pits and drainage system. The maximum tritium concentration of 3317 pCi/liter occurred in Ranunculus growing in Mud Pit #3. Tritium concentrations in the aquatic plants were consistently higher than water samples collected at the same site but decreased in concentration as distance from the mud pits increased. Tritium values in aquatic plants near the mouth of the stream were less than 50 pCi/liter.

Samples of soil, sand and Fucus and greenling muscle were analyzed for $^{239,240}Pu$ and the results of these analyses are given in Table 18. The general conclusions from inspection of the table were that the maximum value was 0.015 pCi per gram, dry for a soil sample and that there were no obvious differences related to year of collection. The $^{239,240}Pu$ values at Amchitka were compared with the results of analyses of comparable samples from the Atlantic Coast (Noshkin et al., 1973), California (Wong et al., 1972), and Washington (Nelson and Seymour, 1975) and were found to be similar, i.e., some of the Amchitka values were slightly less, some slightly greater than the values found in other areas (Nelson and Seymour, 1977). For this reason the source of $^{239,240}Pu$ at Amchitka is believed to be the same as for other areas, i.e., world fallout.

In 1974 a background radiation survey program with a Geiger-Muller detector (window thickness <2mg/cm^2) was initiated and the results of the survey for the last five years are presented in Table 19. Observations were made at 14 locations and in no instance was the average value greater than 0.04 mR per hour, although occasionally pulses of radiation would momentarily deflect the needle on the dial to values as much as 0.07 mR per hour. The survey meter reading for all years are similar and if there were annual differences, the instrument which was operating near the lower limits of detection was insensitive to the changes in background radiation.

5. SUMMARY AND CONCLUSIONS

The objective of the program is to determine the extent of radionuclide contamination on Amchitka Island. The objective is achieved, principally, by the collection and radiological analyses of biological and environmental samples but also by background radiation measurements. If the contamination was significantly greater than would be expected from world fallout, then leakage of radionuclides from the underground sites of the Amchitka nuclear detonations would be suspected. The results of analyses of the samples collected in September and October 1979 and the background radiation measurements of that date lead to the same conclusions as in previous years, i.e., there is no evidence that the radionuclide contamination at Amchitka Island is greater than would be expected from world fallout except for a slight contamination of the Long Shot Mud Pits with tritium.

Following are summary statements from which the conclusion is made that there is little radionuclide contamination at Amchitka Island and what is there, with the exception of tritium seeping into the Long Shot Mud Pits and drainage system, is of world fallout origin.

a. Two natural radionuclides, ^{7}Be and ^{40}K, were the most abundant radionuclides in most samples.

b. Some fission products, induced radionuclides, and plutonium have been detected in quantities that range from the limits of detection to a few pCi/g of dry samples.

c. Values for ^{95}Zr and ^{95}Nb in freshwater moss and algae from Amchitka Island and the Columbia River were similar in amounts and peaks of abundance.

d. Peaks of abundance of fission product radionuclides occurred in 1970-71, 1974 and 1977 and followed major Chinese nuclear detonations.

e. There is no strong evidence from the gamma spectrum analysis that the radioactivity of the samples is related to the collection location on Amchitka Island.

f. The radioactivity from fallout radionuclides, generally, was greater for freshwater than for marine organisms.

g. There has been no significant increase in ^{3}H, ^{90}Sr or $^{239,240}Pu$ values. Tritium is a potential radionuclide indicator of radionuclide leakage from underground sites.

h. The background radiation survey meter readings were at or near the lower limits of detection for the instrument.

i. The laboratory detection and measurement system for the radiobiological analyses of the samples was sensitive to small perturbations in the amounts and species of radionuclides in the environment.

j. The results of analyses of the 1979 samples complemented the results of analyses of samples collected previously and did not reveal any unexpected information.

Table 1. Scientific and common names and wet weight to dry weight ratios of some Amchitka Island organisms.

Species	Tissue	Wet/Dry Ratio	Standard Deviation
	VERTEBRATES		
MAMMALS			
Rattus norvegicus Rat	Bone		
FISH[a]			
Salvelinus malma Dolly Varden	Muscle	3.62	0.70
	Viscera	4.20	0.42
Oncorhynchus gorbuscha Pink Salmon	Gonad	4.51	
	Muscle	4.71	0.81
	Liver	4.49	0.69
Hippoglossus stenolepis Pacific Halibut	Muscle	4.01	0.58
	Liver	3.63	0.04
Hexagrammos lagocephalus Rock Greenling	Liver	3.43	0.41
	Muscle	4.83	0.14
	Viscera	2.13	0.04
BIRDS			
Lagopus mutus Rock Ptarmigan	Liver	3.52	0.32
	Muscle	3.54	0.08
	INVERTEBRATES		
Halichondria panicea Sponge (green)	Entire	4.55	0.91
	MARINE ALGAE		
Fucus distichus Marine algae	Entire	4.94	1.40
	FRESHWATER VEGETATION		
Cladophora sp. Filamentous algae	Entire	7.82	3.51
Fontinalis sp. Moss	Entire	8.10	0.89
Ranunculus sp. Freshwater plant	Entire	12.2	4.10

Table 1.(continued) Scientific and common names and wet weight to dry weight ratios of some Amchitka Island organisms.

Species	Tissue	Wet/Dry Ratio	Standard Deviation
	AUFWUCHS		
Periphyton & other organisms	Entire	7.27	2.40
	TERRESTRIAL VEGETATION		
Cladonia sp. Lichens	entire	3.75	0.87

a. Names are from "Common and Scientific Names of Fishes from the United States and Canada" (Third Edition), 1970 American Fisheries Society Special Pub. No. 6.

Table 2. Some gamma-emitting radionuclides in the freshwater moss, Fontinalis sp., collected at Amchitka Island

Location and Date	n	Radionuclides pCi/g, dry [a]									
		^{7}Be	^{40}K	^{95}Zr	^{95}Nb	^{103}Ru	^{106}Ru	^{125}Sb	^{137}Cs	^{144}Ce	^{155}Eu
Clevenger Creek											
1970-71[b]	4	8 ± 4	5.8±3.0	1.4 ±1.0	2.9 ±2.3	0.28±0.54	3.2 ±1.2	1.4 ±0.6	4.0 ±1.5	NA	NA
1971-72	5	2.7± 4.3	6.2±2.1	0.6 ±0.3	2.0 ±2.0	0.67±0.87	0.54±0.75	0.18±0.4	1.9 ±1.2	1.1 ±1.6	---
1973	2	4.5± 1.1	5.4±0.2	---	0.15±0.21	0.07±0.10	0.74±0.18	0.23±0.03	2.3 ±1.1	0.84±0.37	0.22±0.01
May '74	1	17 ±11	3.9±1.8	2.4 ±1.2	3.4 ±0.8	---	3.1 ±0.9	0.55±0.16	1.2 ±0.1	2.8 ±0.3	0.26±0.10
Aug '74	1	4.3±1.9	5.7±1.4	0.7 ±0.3	1.5 ±0.2	---	2.5 ±0.5	0.31±0.10	1.5 ±0.1	3.9 ±0.3	0.27±0.06
Aug '75	1	4.2±2.0	6.3±1.4	---	0.44±0.18	---	0.88±0.47	0.17±0.09	0.7 ±0.1	2.3 ±0.3	0.08±0.06
Aug '76	3	4.0±2.4	9.2±3.2	---	---	0.21±0.36	0.15±0.27	---	1.2 ±0.8	0.52±0.21	0.05±0.08
April '77	1	20 ±1.3	5.5±1.4	1.5 ±0.2	3.0 ±0.2	1.2 ±0.2	0.78±0.43	0.23±0.12	2.9 ±0.1	1.5 ±0.2	0.28±0.09
May '77	1	12 ±7.7	4.7±1.6	2.3 ±0.9	3.7 ±0.9	---	1.4 ±0.8	---	1.7 ±0.2	1.1 ±0.4	---
Aug '77	1	---	4.8±2.3	0.83±0.37	1.6 ±0.4	---	---	0.28±0.15	0.75±0.12	2.2 ±0.4	0.18±0.14
Sept '77	3	3.9±1.8	5.1±2.3	---	1.4 ±0.19	---	0.92±0.84	0.28±0.19	0.8 ±0.3	2.0 ±0.6	---
Feb '78	1	7.0±5.8	4.4±1.4	---	1.2 ±0.42	---	1.6 ±0.58	0.18±0.11	1.8 ±0.11	2.9 ±0.32	---
May '78	1	3.3±2.5	6.3±1.5	0.50±0.26	0.59±0.22	---	2.3 ±0.51	0.27±0.10	2.8 ±0.13	3.4 ±0.28	---
Aug '78	3	2.1±1.8	5.8±0.83	0.07±0.13	0.11±0.10	---	1.8 ±0.74	0.06±0.10	1.1 ±0.22	1.9 ±0.56	0.13±0.12
Nov '78	1	4.7±1.3	4.4±2.0	---	---	---	1.4 ±0.58	---	1.7 ±0.13	1.2 ±0.3	0.13±0.12
Sept '79	3	3.6±1.6	6.7±0.88	---	---	---	0.41±0.37	---	1.5 ±0.26	0.62±0.42	---
Bridge Creek											
1970-71[b]	3	10 ±5	7.3±3.2	1.7 ±1.4	3.9 ±3.1	---	4.4 ±2.5	1.2 ±0.8	4.1 ±3.0	NA	NA
1971-72	5	6.2±2.8	6.8±1.0	1.0 ±0.6	2.2 ±1.5	0.6 ±0.8	1.1 ±1.3	0.4 ±0.6	3.3 ±1.3	0.52±1.2	---
1973	2	5.1±1.4	5.8±0.4	---	0.08±0.11	---	---	0.14±0.19	2.3 ±1.9	1.1 ±0.5	0.11±0.15
May '74	1	5.2±0.9	7.9±1.6	2.1 ±0.2	4.4 ±0.2	0.24±0.10	3.5 ±0.6	0.33±0.11	1.9 ±0.1	4.5 ±0.3	0.18±0.06
Aug '74	1	3.6±2.5	5.2±1.8	1.0 ±0.3	2.1 ±0.3	---	2.3 ±0.7	0.20±0.15	1.0 ±0.1	4.6 ±0.4	0.23±0.09
Aug '75	1	3.3±2.2	5.8±1.7	0.3 ±0.3	0.6 ±0.23	---	1.7 ±0.7	0.25±0.14	1.1 ±0.1	3.1 ±0.4	0.10±0.08
Aug '76	2	5.2±0.6	6.0±0.3	---	0.10±0.13	0.24±0.34	0.4 ±0.6	0.08±0.11	1.4 ±0.4	0.9 ±0.6	0.08±0.11
April '77	1	21 ±1.6	5.5±1.2	1.2 ±0.2	2.6 ±0.2	1.1 ±0.2	0.71±0.42	0.24±0.12	5.1 ±0.2	1.3 ±0.2	0.14±0.07
May '77	1	12 ±9.3	5.7±1.8	---	2.3 ±0.8	---	0.93±0.78	0.33±0.16	2.3 ±0.2	1.5 ±0.5	0.16±0.10
Aug '77	1	3.9±3.3	2.3±1.7	1.5 ±0.4	3.0 ±0.5	0.53±0.49	2.0 ±0.8	0.38±0.18	2.7 ±0.2	3.0 ±0.5	0.14±0.10
Sept '77	3	3.5±0.3	6.9±1.4	1.5 ±0.4	2.3 ±1.4	---	1.7 ±0.8	0.26±0.16	1.6 ±0.3	2.3 ±0.7	0.24±0.15
Feb '78	1	---	3.0±1.1	---	1.3 ±0.50	---	2.7 ±0.65	0.28±0.14	3.2 ±0.17	4.2 ±0.43	0.19±0.07
May '78	1	11 ±2.7	6.1±1.6	0.85±0.29	1.4 ±0.27	0.65±0.53	4.7 ±0.72	0.44±0.11	1.4 ±0.10	5.0 ±0.34	0.14±0.11
Aug '78	3	2.4±0.76	5.5±1.4	---	0.28±0.03	---	1.9 ±0.11	0.16±0.14	1.1 ±0.17	3.3 ±0.73	0.04±0.08
Nov '78	1	3.7±1.3	5.6±1.6	---	---	---	1.4 ±0.58	---	1.7 ±0.16	1.9 ±0.33	0.11±0.07
Sept '79	3	4.2 ±0.47	6.8±0.90	---	---	---	---	---	1.6 ±0.49	0.44±0.39	---

Table 2 (continued) Some gamma-emitting radionuclides in the freshwater moss, Fontinalis sp., collected at Amchitka Island.

Location and Date	n	Radionuclides pCi/g, dry [a]									
		^{7}Be	^{40}K	^{95}Zr	^{95}Nb	^{103}Ru	^{106}Ru	^{125}Sb	^{137}Cs	^{144}Ce	^{155}Eu
Duck Cove Creek											
1970-71[b]	3	8 ±3	6.6±2.6	1.3 ±1.1	2.7 ±2.3	0.5 ±0.6	2.8 ±1.5	1.4 ±0.5	2.6 ±1.1	NA	NA
1971-72	5	6.4±5.4	6.1±0.8	0.5 ±0.2	1.3 ±0.8	0.9 ±1.2	1.2 ±1.0	1.1 ±0.5	1.7 ±0.9	0.32±0.72	---
1973	2	7.1±7.0	6.4±0.4	---	---	---	0.65±0.92	0.32±0.23	1.2 ±0.5	0.9 ±1.3	0.09±0.13
May '74	1	7.4±1.0	5.4±1.2	1.6 ±0.2	3.5 ±0.2	0.36±0.11	3.4 ±0.6	0.53±0.13	2.2 ±0.1	5.7 ±0.3	1.16±0.05
Aug '74	1	1.4±0.8	<6	---	0.21±0.08	---	0.29±0.19	---	0.8 ±0.1	0.34±0.1	---
Aug '75	1	1.9±1.2	5.4±1.1	0.2 ±0.2	0.65±0.15	---	0.69±0.44	0.26±0.09	0.8 ±0.1	2.4 ±0.26	0.09±0.05
Aug '76	1	4.7±2.2	7.0±1.3	---	---	---	---	0.18±0.09	1.4 ±0.1	---	---
Sept '77	1	---	3.6±2.1	---	1.1 ±0.4	---	---	---	1.0 ±0.2	1.5 ±0.4	---
Aug '78	1	2.9±0.88	4.1±2.0	---	0.14±0.09	---	0.93±0.62	---	0.86±0.11	1.1 ±0.28	---
Sept '79	1	1.8±1.4	7.6±1.6	---	---	---	0.46±0.50	---	0.66±0.09	---	---
Long Shot Drainage											
Aug '75	1	4.4±1.2	4.0±1.3	0.2 ±0.1	0.61±0.13	---	2.3 ±0.4	0.27±0.01	1.2 ±0.1	3.2 ±0.2	0.2 ±0.08
Aug '76	1	4.7±1.6	5.3±1.2	---	---	---	---	0.12±0.09	0.7 ±0.1	0.26±0.21	0.10±0.05
Sept '77	2	4.2±0.1	4.8±0.04	0.8 ±0.3	1.1 ±0.7	---	1.3 ±0.7	---	0.7 ±0.1	1.4 ±1.1	---
Aug '78	2	2.2±0.05	5.7±1.8	---	0.18±0.05	0.05±0.07	1.4 ±1.1	0.27±0.19	1.3 ±0.46	2.0 ±0.9	0.05±0.07
Oct '79	3	7.4±8.6	7.6±2.4	---	---	---	---	---	0.58±0.41	0.76±0.67	---
MP-12 Creek											
1973	2	9.0±8.6	4.7±2.0	---	0.17±0.23	---	0.7 ±0.9	0.12±0.17	2.0 ±1.2	1.4 ±0.8	0.09±0.12
May '74	1	13 ±1.0	6.0±1.1	1.4 ±0.13	3.4 ±0.18	0.20±0.05	4.1 ±0.6	0.23±0.10	2.1 ±0.1	6.0 ±0.3	0.16±0.04
Aug '74	1	4.5±2.0	5.8±1.2	0.8 ±0.3	1.3 ±0.3	---	1.9 ±0.6	---	0.7 ±0.1	3.9 ±0.3	0.13±0.06
Aug '75	1	6.5±1.8	4.5±1.7	0.3 ±0.2	0.67±0.18	---	2.7 ±0.7	---	0.5 ±0.1	5.2 ±0.3	0.21±0.11
Aug '76	1	8.7±1.9	5.3±1.5	0.3 ±0.3	---	---	1.6 ±0.5	0.15±0.10	0.9 ±0.1	1.7 ±0.2	0.16±0.09
Sept '77	1	5.9±4.1	6.4±2.7	1.2 ±0.5	3.4 ±0.6	---	2.8 ±1.0	---	1.1 ±0.2	4.4 ±0.5	---
Aug '78	1	6.6±1.4	5.6±2.0	---	0.32±0.14	0.12±0.11	4.3 ±1.1	---	1.1 ±0.16	7.1 ±0.61	---
Ice Box Lake Inlet											
1973	2	4.1±0.8	5.7±1.0	---	0.08±0.11	---	0.5 ±0.9	0.28±0.06	1.5 ±0.6	0.87±0.12	0.17±0.08
May '74	1	3.7±0.6	5.0±1.0	0.70±0.09	1.2 ±0.11	---	1.0 ±0.4	0.20±0.09	3.1 ±0.1	2.4 ±0.21	0.13±0.04
Aug '74	1	2.3±0.8	5.9±0.5	0.17±0.14	0.6 ±0.1	---	0.9 ±0.3	0.23±0.08	1.0 ±0.1	1.6 ±0.2	---
Aug '75	1	---	4.7±1.3	---	0.27±0.16	---	0.7 ±0.5	0.20±0.11	1.3 ±0.1	1.8 ±0.3	0.09±0.07
Aug '76	3	4.8±1.8	4.0±0.8	0.15±0.26	---	---	0.2 ±0.4	0.21±0.08	1.4 ±0.5	0.75±0.13	0.13±0.05
Sept '77	3	3.0+2.9	4.8+1.6	---	1.9 +0.8	1.4 +1.0	1.3 +1.1	---	1.4 +0.7	2.5 +1.6	---
Aug '78	3	2.0±0.66	4.1±3.6	---	0.46±0.79	---	0.89±0.79	0.05±0.08	0.81±0.19	2.0 ±0.7	0.04±0.08
Sept '79	3	1.5±1.3	6.7±2.6	---	---	---	---	---	0.68±0.06	0.45±0.47	---

Table 2 (continued) Some gamma-emitting radionuclides in the freshwater moss, Fontinalis sp., collected at Amchitka Island.

Location and Date	n	Radionuclides pCi/g, dry[a]									
		^{7}Be	^{40}K	^{95}Zr	^{95}Nb	^{103}Ru	^{106}Ru	^{125}Sb	^{137}Cs	^{144}Ce	^{155}Eu
Cannikin Lake Outlet											
1973	2	7.3±0.5	6.2±0.7	0.09±0.12	0.16±0.23	0.07±0.09	0.6 ±0.8	0.30±0.18	3.9 ±4.6	1.1 ±0.4	0.15±0.21
May '74	1	10 ±1.0	2.4±0.6	1.2 ±0.12	2.7 ±0.15	0.24±0.13	2.2 ±0.3	0.29±0.05	1.1 ±0.1	6.3 ±0.2	0.13±0.03
Aug '74	1	---	4.2±0.6	1.2 ±0.15	2.3 ±0.17	0.21±0.11	2.6 ±0.5	0.33±0.12	1.6 ±0.1	6.4 ±0.3	---
Aug '75	1	7.9±1.9	5.1±1.1	---	0.52±0.16	---	1.8 ±0.5	0.24±0.09	2.0 ±0.1	2.1 ±0.3	---
Aug '76	3	3.8±0.6	3.6±0.3	---	---	0.15±0.27	0.3 ±0.3	0.05±0.09	1.0 ±0.4	---	0.06±0.05
Sept '77	3	19.5±0.5	5.3±1.8	3.1 ±0.2	6.6 ±1.1	0.66±0.35	4.0 ±1.7	0.23±0.20	1.0 ±0.2	9.0 ±0.7	0.37±0.21
Aug '78	3	13 ±4.3	3.2±0.62	---	0.19±0.03	---	1.7 ±0.5	0.25±0.09	1.3 ±0.47	3.6 ±1.5	0.08±0.09
Sept '79	3	14 ±0.32	4.5±2.6	---	---	---	0.27±0.23	---	0.65±0.13	0.30±0.28	---

a. Radionuclide values for a single sample (n=1) are a single count of the sample ± the two sigma, propagated, counting error. The radionuclide value shown for more than one sample is the mean ± one standard deviation of two or more single sample counts. Dashes in the table indicate the sample count is not significant and NA indicates the radionuclide was not included in the analyses.

b. Pre-Cannikin.

Table 3. Some gamma-emitting radionuclides in the freshwater plant, Ranunculus sp., collected at Amchitka Island

Location and Date	n	Radionuclides pCi/g, dry[a]									
		^{7}Be	^{40}K	^{95}Zr	^{95}Nb	^{103}Ru	^{106}Ru	^{125}Sb	^{137}Cs	^{144}Ce	^{155}Eu
Clevenger Creek											
1970-71[b]	4	4.1 ±4.7	21 ±4	0.6 ±0.8	1.3 ±1.6	---	1.9 ±1.8	0.3 ±0.6	1.7 ±1.1	NA	NA
1971-72	5	5.0 ±8.7	16 ±1.6	0.36±0.49	0.99±0.96	0.54±0.53	0.6 ±0.8	0.5 ±0.54	1.6 ±0.7	NA	NA
1973	2	1.9 ±2.7	22 ±3.5	---	---	---	---	---	0.8 ±0.5	0.3 ±0.4	---
May '74	1	3.1 ±0.6	24 ±1.6	0.80±0.10	1.8 ±0.1	0.12±0.08	1.0 ±0.4	0.14±0.09	0.87±0.07	2.3 ±0.2	---
Aug '74	1	1.4 ±1.4	15 ±1.3	---	---	---	---	---	0.24±0.07	0.5 ±0.3	---
Aug '75	1	---	19 ±2.3	---	---	---	---	---	0.52±0.09	0.34±0.3	---
Aug '76	3	1.2 ±1.0	17 ±2.3	---	---	0.09±0.16	---	---	0.39±0.15	---	---
Sept '77	3	---	22 ±3.8	---	0.51±0.12	---	---	---	0.34±0.13	0.69±0.36	---
Aug '78	3	---	15 ±1.5	---	---	---	---	---	0.64±0.11	0.51±0.49	---
Sept '79	3	---	17 ±3.8	---	---	---	---	---	0.43±0.18	---	---
Bridge Creek											
1970-71[b]	3	8.4 ±5.8	17 ±3	1.0 ±0.4	2.3 ±1.0	---	2.1 ±0.5	0.5 ±0.5	3.2 ±0.2	NA	NA
1971-72	5	3.6 ±5.0	21 ±7.6	0.36±0.22	0.78±0.48	0.19±0.30	0.62±0.91	0.3 ±0.4	2.2 ±1.4	NA	NA
1973	1	4.7 ±1.5	29 ±2.3	---	---	---	---	---	1.2 ±0.1	0.7 ±0.2	0.15±0.10
May '74	1	3.8 ±0.8	19 ±2.5	1.1 ±0.2	2.4 ±0.2	0.15±0.09	1.5 ±0.6	0.23±0.12	1.6 ±0.1	3.4 ±0.3	---
Aug '74	1	2.0 ±0.8	19 ±0.8	0.4 ±0.1	0.7 ±0.1	---	0.94±0.32	0.16±0.08	0.85±0.06	1.7 ±0.2	---
Aug '75	1	2.5 ±1.2	21 ±2.2	---	0.35±0.13	---	0.67±0.46	---	1.2 ±0.1	1.0 ±0.23	---
Aug '76	3	0.9 ±1.6	19 ±0.6	---	---	---	---	0.04±0.08	1.8 ±0.6	0.3 ±0.2	---
Sept '77	2	---	25 ±0.1	---	0.74±0.30	---	0.71±0.58	---	0.28±0.18	1.0 ±0.1	---
Aug '78	2	0.69±0.97	19 ±1.4	0.09±0.13	---	---	---	---	0.40±0.20	1.0 ±0.1	---
Sept '79	3	---	19 ±2.6	---	---	---	---	---	1.30±0.32	0.21±0.37	---
Duck Cove Creek											
1970-71[b]	2	4.0 ±3.5	15 ±8	0.41±0.15	0.86±0.32	---	1.0 ±1.0	0.7 ±0.5	1.3 ±0.4	NA	NA
1971-72	5	6.2 ±8.9	20 ±5	0.42±0.24	0.94±0.57	0.52±0.66	0.87±0.80	0.6 ±0.4	1.6 ±0.9	NA	NA
1973	1	6.0 ±1.5	20 ±1.5	---	---	---	---	0.26±0.09	2.9 ±0.1	0.9 ±0.2	0.14±0.08
May '74	1	3.1 ±0.7	14 ±1.5	0.46±0.09	1.2 ±0.1	0.16±0.08	0.81±0.36	---	4.0 ±0.2	1.8 ±0.2	---
Aug '74	1	---	21 ±2	---	0.47±0.19	---	---	---	0.67±0.08	0.78±0.22	---
Aug '75	1	---	13 ±1.8	---	---	---	0.63±0.43	---	1.6 ±0.13	0.85±0.24	---
Aug '76	1	3.5 ±2.9	18 ±2.3	---	---	---	---	---	1.5 ±0.1	0.25±0.24	---
Sept '77	1	sample lost									
Aug '78	1	---	12 ±2.4	---	---	---	---	0.18±0.13	0.11±0.12	0.61±0.25	---
Sept '79	1	---	21 ±2.0	---	---	---	---	---	0.43±0.07	---	---

Table 3 (continued) Some gamma-emitting radionuclides in the freshwater plant, Ranunculus sp., collected at Amchitka Island.

Location and Date	n	Radionuclides pCi/g, dry[a]									
		^{7}Be	^{40}K	^{95}Zr	^{95}Nb	^{103}Ru	^{106}Ru	^{125}Sb	^{137}Cs	^{144}Ce	^{155}Eu
Clevenger Lake Outlet											
1970-71[b]	2	2.5± 2.2	5.3±3.5	0.39±0.07	0.81±0.16	0.4 ±0.5	0.5 ±0.6	0.6 ±0.1	0.6 ±0.8	NA	NA
1971-72	5	12 ±14	10 ±9	0.78±0.86	2.5 ±2.4	0.9 ±1.3	1.2 ±0.4	0.1 ±0.2	1.1 ±0.1	NA	NA
1973	1	3.4± 1.0	20 ±2.1	---	---	---	---	---	0.3 ±0.1	---	---
Aug '74	1	---	24 ±1.1	0.45±0.20	0.80±0.19	---	---	---	0.7 ±0.1	1.4 ±0.3	---
Aug '75	1	1.9±0.7	18 ±1.5	---	0.07±0.07	---	0.5±0.3	---	0.8 ±0.1	0.6 ±0.2	---
Long Shot Drainage											
Aug '75	1	5.3±2.4	19 ±3.0	---	0.42±0.26	---	1.3±0.8	---	1.0 ±0.1	1.4 ±0.4	---
Aug '76	2	1.8±2.5	26 ±5	---	---	---	---	---	0.6 ±0.3	0.2 ±0.3	---
Sept '77	1	---	18 ±2.8	0.72±0.50	0.91±0.31	---	---	---	0.69±0.11	0.87±0.33	---
Aug '78	3	4.3±4.8	16 ±2.7	---	0.11±0.10	---	1.3±1.1	---	0.57±0.26	1.9 ±0.78	---
Oct '79	3	3.3±5.7	20 ±6.6	---	---	---	---	---	0.53±0.24	0.30±0.53	---
Cannikin Lake Outlet											
May '74	1	13 ±1.2	17 ±1.8	1.6 ±0.2	3.9 ±0.2	0.45±0.13	3.4± 0.6	---	1.3 ±0.1	6.4± 0.3	0.20±0.06
Aug '74	1	3.5±1.3	28 ±3.3	0.31±0.19	0.60±0.16	---	1.2± 0.8	---	1.4 ±0.1	2.0± 0.3	---
Aug '75	1	2.3±0.9	10 ±1.5	---	0.18±0.09	---	---	0.22±0.1	2.9 ±0.2	1.5± 0.2	0.14±0.06
Aug '76	1	---	11 ±1.9	---	---	---	---	---	1.8 ±0.1	---	---

a. Radionuclide values for a single sample (n = 1) are a single count of the sample ± the two-sigma, propagated, counting error. The radionuclide value shown for more than one sample is the mean ± one standard deviation of two or more single sample counts. Dashes in the table indicate the sample count is not significant and NA indicates the radionuclide was not included in the analyses.

b. Pre-Cannikin

Table 4. Some gamma-emitting radionuclides in freshwater aufwuchs and filamentous algae collected at Amchitka Island[a]

Location and Date	n	Radionuclides pCi/g, dry[b]								
		^{7}Be	^{40}K	^{95}Zr	^{95}Nb	^{103}Ru	^{106}Ru	^{125}Sb	^{137}Cs	^{144}Ce
Long Shot Mud Pit #3										
1970-71[c]	7	15 ±12	9 ±4	3.1 ±1.9	6.7 ±3.9	2.1 ±2.7	5.8 ±4.1	1.5 ±0.9	1.8 ±0.9	NA
1971-72	5	3.2± 3.4	10 ±1.4	0.8 ±1.0	2.2 ±2.9	0.39±0.56	0.2 ±0.4	0.4 ±0.3	0.5 ±0.1	1.1 ±1.6
1973	2	3.7± 2.1	9.8±0.4	---	0.9 ±0.12	---	---	---	0.27±0.02	0.42±0.26
May '74	1	26 ± 9	4.9±1.4	---	4.6 ±1.0	---	2.5 ±0.8	0.39±0.13	0.40±0.07	7.7 ±0.6
Aug '74	1	3.4± 1.0	9.4±0.8	0.55±0.15	0.92±0.14	---	1.3 ±0.4	0.24±0.09	0.34±0.05	1.2 ±0.2
Aug '75	1	2.8± 1.8	9.8±1.6	---	0.28±0.19	---	---	0.21±0.09	0.19±0.05	1.4 ±0.3
Aug '76	1	1.8± 1.4	8.6±1.6	---	---	---	---	0.16±0.08	0.25±0.05	---
Sept '77	1	---	10 ±2.7	---	0.72±0.37	0.54±0.51	0.69±0.63	---	---	1.5 ±0.4
Aug '78	1	---	7.5±2.5	---	---	---	---	---	0.09±0.07	0.31±0.29
Oct '79	1	---	13 ±2.2	---	---	---	---	---	0.12±0.08	---
MP-12 Creek										
July '72	1	7.8± 1.7	5.2±0.5	3.5 ±0.4	6.4 ±0.5	1.7 ±0.3	0.76±0.28	---	2.0 ±0.2	3.8 ±0.4
Aug '73	1	8.3± 0.9	9.6±1.6	0.29±0.11	0.34±0.08	0.24±0.09	---	---	2.7 ±0.1	0.36±0.17
May '74	1	9.1± 1.1	8.9±1.6	4.0 ±0.2	7.6 ±0.3	0.28±0.13	2.9 ±0.7	0.79±0.13	2.5 ±0.2	12 ±0.5
Aug '75	1	13 ± 1.2	6.2±1.5	0.36±0.11	0.97±0.12	---	2.3 ±0.5	0.26±0.10	2.3 ±0.1	3.2 ±0.2
Sept '77	1	7.8± 2.8	5.1±2.3	2.5 ±0.4	5.3 ±0.5	---	2.4 ±1.0	---	1.7 ±0.2	3.0 ±0.4
Aug '78	1	8.9± 1.5	6.1±2.2		0.21±0.11	---	2.2 ±0.72	0.30±0.15	1.8 ±0.16	2.7 ±0.35
Sept '79		10 ± 2.0	13 ±1.0	---	---	---	---	---	0.89±0.06	---

Table 4. (Con't.) Some gamma-emmitting radionuclides in fresh water aufwuchs and filamentous algae collected at Amchitka Island[a].

Location and Date	n	Radionuclides pCi/g, dry[b]								
		^{7}Be	^{40}K	^{95}Zr	^{95}Nb	^{103}Ru	^{106}Ru	^{125}Sb	^{137}Cs	^{144}Ce
White Alice Inlet to Cannikin Lake										
Aug '73	1	23 ± 1.5	6.1±1.4	0.59±0.13	1.1 ±0.14	0.91±0.15	---	---	0.72±0.09	1.4 ±0.2
Aug '74	1	12 ± 1.2	9.8±0.6	0.99±0.14	2.0 ±0.15	0.43±0.08	1.7 ±0.4	---	1.1 ±0.08	4.3 ±0.2
Aug '75	1	3.8± 0.9	5.1±1.3	---	0.2 ±0.08	---	0.89±0.4	0.16±0.09	0.75±0.09	2.0 ±0.3
Aug '76	1	3.3± 1.9	10 ±1.7	---	---	---	---	---	0.17±0.04	0.23± .20
Aug '78	1	---	21 ±20	---	---	---	---	---	1.6 ±0.69	---
Sept '79	1	---	8.5±6.9	---	---	---	---	---	2.3 ±0.28	---
Drillback Drainage to Cannikin Lake										
Sept '77	1	36 ± 5.1	4.8±3.0	4.1 ±0.62	8.7 ±0.80	---	5.0 ±1.3	---	1.0 ±0.17	9.1 ±0.7
Aug '78	1	10 ± 1.4	3.3±2.4	---	0.17±0.11	---	---	0.30±0.13	0.83±0.10	---
Sept '79	1	6.2± 1.5	2.1±0.72	---	---	---	---	---	0.35±0.05	0.47±0.16
Duck Cove Seepage										
Aug '78	1	1.7± 0.67	16 ±2.2	---	---	0.09±0.08	0.44±0.39	---	0.06±0.05	1.2 0.23
Sept '79	1	---	5.0±1.3	---	---	---	---	---	0.14±0.04	---

a. Aufwuchs samples were collected from Long Shot Pond, MP-12 Creek, and Drillback Drainage to Cannikin Lake and the algae samples from White Alice Inlet to Cannikin Lake and from Cliff Seepage at Duck Cove.

b. Radionuclide values for a single sample (n = 1) are a single count of the sample ± the two-sigma, propagated, counting error. The radionuclide value shown for more than one sample is the mean ± one standard deviation of two or more single sample counts. Dashes in the tables indicate the sample count is not significant and NA indicates the radionuclide was not included in the analyses.

c. Pre-Cannikin.

Table 5. Some gamma-emitting radionuclides in lichens collected at Amchitka Island

Location and Date	n	Radionuclides pCi/g, dry [a]									
		^{7}Be	^{40}K	^{95}Zr	^{95}Nb	^{103}Ru	^{106}Ru	^{125}Sb	^{137}Cs	^{144}Ce	^{155}Eu
Clam Lake											
1970-71b	7	15 ±6.1	4.5±6.4	1.0 ±1.0	2.1±1.9	1.5 ±3.1	5.4±3.2	5.6 ±7.2	37±39	NA	NA
1971-72	5[c]	9.7±8.2	6.2±5.5	0.7 ±0.7	1.7±1.4	0.5 ±0.7	3.6±3.8	3.4 ±3.5	27±23	9 ±0.4	1.5 ±0.14
1973	3	5.3±0.5	3.5±0.3	0.03±0.05	0.1±0.1	0.03±0.06	1.1±0.2	0.60±0.12	7±6.9	3.7±1.3	0.56±0.32
May '74	1	4.5±0.9	2.4±0.9	0.48±0.09	1.2±0.1	---	1.4±0.5	0.56±0.11	12±0.3	4.0±0.3	0.38±0.05
Aug '74	1	5.2±1.2	3.7±0.4	0.23±0.18	0.9±0.1	---	1.3±0.4	0.33±0.09	9±0.2	4.1±0.2	0.33±0.09
Aug '75	1	4.6±1.7	2.5±1.1	---	0.5±0.1	---	1.0±0.6	0.28±0.14	6±0.2	5.5±0.4	0.23±0.08
Aug '76	1	8.0±1.5	2.0±1.5	---	---	---	0.6±0.4	0.41±0.11	7±0.2	2.0±0.3	0.11±0.10
Sept '77	1	8.1±3.3	1.9±1.4	1.1 ±0.4	2.4±0.5	---	2.1±0.8	0.36±0.19	2.8±0.2	6.2±0.6	0.18±0.10
Aug '78	1	6.5±1.5	---	0.28±0.18	0.17±0.11	---	1.9±0.69	0.35±0.14	3.9±0.25	10±0.63	0.24±0.10
Sept '79	1	6.0±2.6	2.6±2.6	---	---	---	---	---	2.0±0.14	2.7±0.48	---
Ice Box Lake											
Oct '72	1	---	2.8±1.2	0.7 ±0.1	1.4±0.3	3.8 ±2.0	---	2.6 ±0.7	14±0.2	NA	NA
1973	2	5.7±0.3	0.6±0.8	---	---	---	1.3±0.1	0.86±0.12	16±0.7	4.3±1.1	0.63±0.18
May '74	1	8.6±1.1	1.4±0.9	0.80±0.12	2.1±0.2	---	2.1±0.5	0.59±0.13	13±0.3	8.1±0.4	0.40±0.06
Aug '74	1	5.7±1.5	1.3±0.5	0.49±0.19	0.8±0.1	---	2.2±0.5	0.64±0.13	9±0.2	6.0±0.3	0.43±0.07
Aug '75	1	5.2±1.5	1.9±1.6	---	0.4±0.1	---	1.5±0.6	0.48±0.14	11±0.3	5.4±0.3	0.38±0.13
Aug '76	1	8.1±3.7	---	---	0.2±0.2	---	0.87±0.55	0.56±0.13	11±0.3	2.1±0.3	0.48±0.12
Sept '77	1	14 ±3.8	1.7±1.3	1.5 ±0.4	3.8±0.6	---	2.0±0.9	0.37±0.17	3.6±0.3	10±0.7	---
Aug '78	1	8.3±2.0	---	0.32±0.14	0.39±0.14	---	2.2±0.80	---	9.5±4.2	9.0±0.66	0.18±0.12
Sept '79	1	8.9±0.7	0.5±0.4	---	---	---	0.72±0.26	---	3.0±0.08	2.8±0.09	---
Cannikin Lake											
July '72	1	5.3±1.7	2.0±0.7	0.7 ±0.1	1.6±0.1	0.6 ±0.3	---	0.2 ±0.4	21±0.2	NA	NA
1973	2	5.3±1.3	2.3±0.1	---	---	0.07±0.09	1.3±0.1	0.90±0.06	16±0.7	4.1±1.6	0.73±0.17
May '74	1	6.7±0.6	1.6±0.6	0.62±0.07	1.6±0.1	0.09±0.06	1.6±0.3	0.65±0.08	11±0.2	5.8±0.2	0.39±0.03
Aug '74	1	5.1±1.3	2.5±0.6	0.30±0.15	0.7±0.1	---	1.7±0.5	0.34±0.12	8±0.2	4.3±0.3	0.30±0.06
Aug '75	1	6.1±2.1	---	---	0.4±0.2	---	1.4±0.5	0.40±0.10	7±0.2	4.6±0.3	0.26±0.11
Aug '76	1	6.4±1.6	1.4±1.0	---	---	---	0.52±0.45	0.40±0.11	5±0.2	2.4±0.3	0.19±0.07
Sept '77	1	13 ±3.6	---	1.3 ±0.4	3.6±0.5	---	2.0±0.7	0.38±0.15	3.5±0.2	7.6±0.5	---
Aug '78	1	7.3±1.4	---	---	0.32±0.12	---	1.6±0.65	0.52±0.14	4.0±0.23	7.5±0.46	0.23±0.14
Sept '79	1	9.6±1.7	1.6±1.3	---	---	---	0.8±0.48	---	2.5±0.12	2.6±0.36	---

a. Radionuclide values for a single sample (n = 1) are a single count of the sample ± the two-sigma, propagated, counting error. The radionuclide value shown for more than one sample is the mean ± one standard deviation of two or more single sample counts. Dashes in the table indicate the sample count is not significant and NA indicates the radionuclide was not included in the analyses.

b. Pre-Cannikin

c. n equals 1 for ^{144}Ce and ^{155}Eu.

Table 6. Some gamma-emitting radionuclides in the marine alga Fucus distichus collected at Amchitka Island.

Location and Date	n	Radionuclides pCi/g, dry[a]					
		^{7}Be	^{40}K	^{95}Zr	^{95}Nb	^{137}Cs	^{144}Ce
Constantine Harbor							
1970-71[b]	3	0.52±0.18	25±6	0.10±0.08	0.21±0.17	0.05±0.02	NA
1972	4	2.5 ±2.0	34±2	0.04±0.04	0.07±0.08	---	---
1973	2	---	34±0.7	---	---	0.03±0.04	---
May '74	1	1.0 ±0.04	32±2.0	0.36±0.04	0.73±0.09	0.05±0.03	1.5±0.2
Aug '75	1	1.7 ±1.3	32±2.3	---	---	0.04±0.04	---
Aug '76	1	---	28±2.2	---	---	0.05±0.04	---
Sept '77	1	---	23±3.2	---	---	---	0.38±0.26
Aug '78	1	0.66±0.47	28±2.3	---	---	---	0.38±0.18
Sept '79	1	---	33±1.2	---	---	---	---
Duck Cove[b]							
1970-71	3	0.8 ±0.3	23±2	0.07±0.04	0.15±0.10	0.04±0.02	NA
1971-72	5	1.9 ±1.5	35±4.5	0.05±0.03	0.10±0.07	0.01±0.03	---
1973	3	0.47±0.41	35±9.9	---	---	0.03±0.05	0.08±0.14
May '74	1	---	38±1.2	0.08±0.06	0.22±0.05	0.07±0.02	0.91±0.10
Aug '74	1	---	36±2.3	---	---	0.07±0.04	0.35±0.21
Aug '75	1	---	33±2.3	---	---	---	---
Aug '76	1	---	30±2.2	---	0.13±0.10	---	---
Sept '77	1	---	32±3.4	---	0.24±0.11	---	---
Aug '78	1	---	30±2.2	---	---	---	---
Sept '79	1	---	38±2.2	---	---	---	---
Square Bay							
Aug '75	1	---	38±2.4	---	---	---	---
Aug '76	1	---	22±2.0	---	---	---	---
Sept '77	1	---	31±3.4	---	0.34±0.12	---	0.69±0.27
Aug '78	1	0.90±0.45	19±1.7	---	---	0.08±0.04	0.27±0.14
Sept '79	1	---	31±1.2	---	---	---	---

Table 6. (Con't.) Some gamma-emitting radionuclides in the marine alga Fucus distichus collected at Amchitka Island.

Location and Date	n	Radionuclides pCi/g, dry[a]					
		^{7}Be	^{40}K	^{95}Zr	^{95}Nb	^{137}Cs	^{144}Ce
Sand Beach Cove							
1970-71[b]	5	0.09±0.09	26±6	0.08±0.06	0.17±0.14	0.06±0.03	NA
1971-72	6	3.8 ±3.2	26±4.6	0.22±0.20	0.45±0.43	0.01±0.02	---
1973	2	---	35±2.1	---	---	---	0.16±0.23
May '74	1	0.61±0.45	39±2.3	0.23±0.09	0.34±0.08	---	0.92±0.19
Aug '74	1	---	27±1.4	---	---	---	0.25±0.19
Aug '75	1	---	34±2.2	---	0.16±0.12	0.04±0.04	---
Aug '76	1	---	24±2.1	---	---	---	---
Sept '77	1	0.95±0.79	25±3.2	0.20±9.19	---	---	0.66±0.27
Aug '78	1	---	23±2.9	---	---	0.07±0.04	0.21±0.18
Sept '79	1	---	39±1.2	---	---	---	---

a. Radionuclide values for a single sample (n=1) are a single count of the sample ± the two-sigma, propogated, counting error. The radionuclide value shown for more than one sample is the mean ± one standard deviation of two or more single sample counts. Dashes in the table indicate the sample count is not significant and NA indicates the radionuclide was not included in the analyses.

b. Pre-Cannikin.

Table 7. Some gamma-emitting radionuclides in the green sponge, Halichondria panicea, collected at Amchitka Island.

Location and Date	n	Radionuclides pCi/g, dry [a]				
		^{7}Be	^{40}K	^{95}Zr	^{95}Nb	^{144}Ce
Duck Cove						
1971-72	4	2.7±2.7	11 ±3	0.05±0.07	0.11±0.14	NA
1973	2	1.5±0.6	9.8±0.1	---	---	0.42±0.04
May '74	1	1.0±0.4	10 ±1.5	0.16±0.07	0.36±0.07	1.1 ±0.17
Aug '74	1	---	7.2±1.3	---	---	1.2 ±0.23
Aug '75	1	---	7.7±1.4	---	---	0.73±0.20
Aug '76	1	4.3±4.2	20 ±1.3	---	---	---
Sept '77	1	---	8.2±1.5	0.41±0.34	0.45±0.16	1.1 ±0.2
Aug '78	1	0.9±0.6	10 ±1.5	---	---	1.1±0.20
Oct '79	1	---	9.5±2.0	---	---	---
Sand Beach Cove						
June '72	1	---	6.8±1.7	0.24±0.13	0.54±0.28	NA
April '73	1	---	12 ±1.7	---	---	0.31±0.17
May '74	1	1.1±0.4	9.0±1.5	0.10±0.07	0.26±0.07	0.60±0.16
Aug '74	1	---	9.6±1.4	---	---	1.2 ±0.2
Aug '75	1	---	10.0±1.6	---	---	0.56±0.2
Aug '76	1	1.0±0.7	8.5±1.4	---	---	0.22±0.16
Sept '77	1	---	7.4±2.3	---	0.40±0.26	1.0 ±0.3
Aug '78	1	1.1±0.58	11 ±1.5	---	---	1.1 ±0.19
Oct '79	1	---	13 ±1.0	---	---	---
Square Bay						
1973	2	0.7±0.9	9.7±0.5	---	---	0.35±0.12
Aug '75	1	1.2±0.9	9.5±1.7	---	0.11±0.09	0.61±0.20
Aug '76	1	---	10 ±1.7	---	---	0.21±0.18
Sept '77	1	---	7.8±2.3	---	0.48±0.25	1.2 ±0.3
Oct ' 79	1	---	10 ±0.8	---	---	0.31±0.14

a. Radionuclide values for a single sample (n = 1) are a single count of the sample ± the two-sigma, propagated, counting error. The radionuclide value shown for more than one sample is the mean ± one standard deviation of two or more single sample counts. Dashes in the table indicate the sample count is not significant and NA indicates the radionuclide was not included in the analyses.

Table 8. Potassium-40 and cesium-137 in Pacific halibut collected off Amchitka Island.

Location and Date	Tissue	n[b]	Radionuclides pCi/g, dry[a] ^{40}K	^{137}Cs
Bering Sea				
Off C-Site				
1971[c]	Muscle	4/4	18 ±1.7	0.06±0.08
1971-72	"	9/9	17 ±1.7	0.02±0.03
1973	"	5/5	18 ±1.1	0.11±0.02
Aug '75	"	1/1	18 ±1.6	0.06±0.04
1971[c]	Liver	4/4	13 ±5.9	0.27±0.28
1971-72	"	8/8	6.7 ±2.1	---
1973	"	5/5	6.9 ±1.3	0.04±0.05
Aug '75	"	1/8	11 ±1.5	0.05±0.03
Constantine Harbor				
Aug '74	Liver	5/5	7.5 ±2.6	0.06±0.07
Sept '77	"	1/1	---	---
Aug '78	"	1/1	7.7 ±2.7	---
Oct '79	"	1/6	6.8 ±0.40	---
Sept '77	Muscle	1/1	18 ±2.8	0.07±0.06
Aug '78	"	1/1	12 ±1.6	0.08±0.04
Oct '79	"	1/6	20 ±2.2	---
Midden Cove				
Aug '75	Muscle	2/2	19 ±1.9	0.05±0.04
Aug '75	Liver	4/4	10 ±1.5	---
Square Bay				
Aug '76	Muscle	1/1	18 ±0.5	0.05±0.03

a. Radionuclide values for a single sample ($n = 1$) are a single count of the sample ± the two-sigma, propagated, counting error. The radionuclide value shown for more than one sample is the mean ± one standard deviation of two or more single sample counts. Dashes in the table indicate the sample count is not significant.

b. Number of samples/total number of fish in all samples.

c. Pre-Cannikin

Table 9. Potassium-40 and cesium-137 in greenling collected off Amchitka Island.

Location and Date	Tissue	n[b]	Radionuclides pCi/g, dry[a] ^{40}K	^{137}Cs
Constantine Harbor				
1971[c]	Muscle	2/19	16 ± 0.7	0.37 ± 0.42
1971-72	"	15/29	15 ± 1.3	0.04 ± 0.04
1973	"	2/9	17 ± 2.8	0.05 ± 0.06
May '74	"	1/5	18 ± 1.5	0.06 ± 0.03
Aug '74	"	1/5	16 ± 0.8	0.07 ± 0.05
Aug '75	"	1/4	21 ± 2.5	0.49 ± 0.07
Aug '76	"	1/4	9.8 ± 0.8	---
Sept '77	"	1/6	15 ± 2.7	0.08 ± 0.06
Aug '78	"	1/4	18 ± 2.8	0.07 ± 0.06
Sept '79	"	1/4	16 ± 1.0	---
1971[c]	Viscera	2/19	13 ± 0.7	0.15 ± 0.05
Dec '71	Liver	1/10	13 ± 1.6	0.21 ± 0.12
1973	Viscera	1/4	9.1 ± 0.6	---
May '74	"	1/5	15 ± 1.0	0.03 ± 0.02
Aug '74	"	1/5	9.2 ± 0.8	---
Aug '75	"	1/4	11 ± 2.2	0.06 ± 0.05
Aug '76	"	1/4	10 ± 0.9	0.20 ± 0.06
Sept '77	"	1/6	7.9 ± 3.5	---
Aug '78	"	1/4	17 ± 2.6	---
Sept '79	"	1/4	17 ± 1.1	0.07 ± 0.03
Sand Beach Cove				
1971[c]	Muscle	3/27	15 ± 1.2	0.07 ± 0.02
1971-72	"	15/26	15 ± 1.6	0.03 ± 0.05
1973	"	2/12	17 ± 1.4	0.05 ± 0.06
May '74	"	1/5	21 ± 1.9	0.05 ± 0.04
Aug '74	"	1/4	15 ± 0.7	---
Aug '75	"	1/8	25 ± 2.7	0.08 ± 0.06
Aug '76	"	1/8	18 ± 0.8	---
Sept '77	"	1/7	15 ± 2.5	---
Aug '78	"	1/4	18 ± 2.8	---
Sept '79	"	1/4	19 ± 2.2	---
1971[c]	Viscera	3/27	13 ± 0.6	0.02 ± 0.02
1972	Liver	1/6	21 ± 2.9	---
1973	Viscera	1/6	11 ± 0.4	---
1973	Liver	1/6	13 ± 0.6	---
May '74	Viscera	1/5	9.1 ± 1.1	---

Table 9 (continued) Potassium-40 and cesium-137 in greenling collected off Amchitka Island.

Location and Date	Tissue	n[b]	Radionuclides pCi/g, dry[a] ^{40}K	^{137}Cs
Sand Beach Cove				
Aug '74	Viscera	1/4	8.1 ±2.1	---
Aug '75	"	1/8	6.3 ±1.4	0.06 ± 0.04
Aug '76	"	1/8	9.6 ±0.4	---
Sept '77	"	1/7	9.0 ±2.4	---
Aug '78	"	1/4	15 ±4.2	---
Sept '79	"	1.4	13 ±0.9	---
Square Bay				
Aug '75	Muscle	1/5	16 ±1.6	---
Aug '76	"	1/6	18 ±0.9	---
Sept '77	"	1/5	16 ±2.8	---
Aug '78	"	1/5	14 ±2.1	0.04 ± 0.04
Sept '79	"	1/4	15 ±2.2	---
Aug '75	Viscera	1/5	7.8 ±1.4	0.07 ± 0.04
Aug '76	"	1/6	11 ±0.8	0.10 ± 0.05
Sept '77	"	1/5	9.1 ±2.6	---
Aug '78	"	1/5	10 ±2.4	0.10 ± 0.06
Sept '79	"	1/4	13 ±1.9	---
Duck Cove				
1972	Muscle	8/14	16 ±1.1	0.06 ± 0.06
1973	"	2/8	15 ±2.8	0.08 ± 0.01
May '74	"	1/3	18 ±1.6	0.06 ± 0.03
Aug '74	"	2/6	15 ±1.8	0.07 ± 0.02
Aug '75	"	1/6	17 ±1.8	0.09 ± 0.04
Aug '76	"	1/8	18 ±0.4	0.07 ± 0.02
Sept '77	"	1/6	13 ±2.7	---
Aug '78	"	1/4	19 ±2.9	0.09 ± 0.06
1973	Viscera	1/4	12 ±0.5	0.13 ± 0.03
May '74	"	1/3	7.7 ±0.8	0.04 ± 0.02
Aug '74	"	2/6	9.5 ±0.1	0.15 ± 0.05
Aug '75	"	1/6	9.5 ±1.2	0.04 ± 0.03
Aug '76	"	1/8	9.6 ±0.4	---
Sept '77	"	1/6	11 ±2.5	0.08 ± 0.06
Aug '78	"	1/4	9 ±2.0	0.09 ± 0.05

a. Radionuclide values for a single sample (n = 1) are a single count of the sample ± the two-sigma, propagated, counting error. The radionuclide values shown for more than one sample is the mean ± one standard deviation of two or more single sample counts. Dashes in the table indicate the sample count is not significant.

b. Number of samples/total number of fish in all samples.

c. Pre-Cannikin.

Table 10. Potassium-40 and cesium-137 in muscle of Dolly Varden collected at Amchitka Island.

Collection Date	Collection Location	n[b]	Radionuclides pCi/g, dry[a] ^{40}K	^{137}Cs
1971[c]	Jones Lake	1/1	15 ± 0.8	0.35 ± 0.05
1972	DK-45 Lake	3/8	16 ± 1.0	5.7 ± 3.9
1973	Jones L., Bridge Cr., Silver Salmon L. Outlet	3/7	16 ± 0.6	0.18 ± 0.09
1974	Jones L., Cannikin L., Duck Cove	6/28	15 ± 1.7	0.28 ± 0.08
1975	Jones L., Cannikin L., Bridge Cr., Duck Cove, Clevenger Cr.	5/19	12 ± 4.4	0.17 ± 0.12
Aug '76	Jones L., Cannikin L., Duck Cove	3/17	15 ± 0.58	0.17 ± 0.06
Sept '77	Jones L., Duck Cove, Clevenger L. Outlet	3/6	14 ± 2.1	0.27 ± 0.17
Aug '78	Jones L. Outlet, Cannikin L., Duck Cove, Clevenger Creek	4/15	14 ± 1.0	0.23 ± 0.20
Oct '79	Jones Lake Watershed	1/4	17 ± 1.2	1.9 ± 0.08
Oct '79	Cannikan Lake	1/5	15 ± 2.6	0.35 ± 0.09
Sept '79	Clevenger Lake	1/3	15 ± 2.6	0.06 ± 0.09

[a]Radionuclide values for a single sample (n=1) are a single count of the sample ± the two-sigma, propagated counting error. The radionuclide values shown for more than one sample is the mean ± one standard deviation of two or more single sample counts.

[b]Number of samples/total number of fish in all samples.

[c]Pre-Cannikin.

Table 11. Potassium-40 and cesium-137 in rock ptarmigan collected at Amchitka Island.

Collection Date	Collection Location	Tissue	Number of Birds	Radionuclides pCi/g, dry[a] ^{40}K	Radionuclides pCi/g, dry[a] ^{137}Cs
1970-71[b]	South Bight	Liver	1	---	---
Aug '74	Cannikin Area	Viscera	1	13 ± 1.2	1.6 ± 0.8
1970-71[b]	South Bight	Muscle	4	11 ± 0.5	1.0 ± 0.6
1971-72	Cannikin Area	"	3	11 ± 1.6	0.70 ± 0.04
1973	Cannikin Area[c]	"	5	11 ± 0.8	0.43 ± 0.25
May '74	Cannikin Area	"	2	11 ± 1.2	0.42 ± 0.05
Aug '74	"	"	4	11 ± 1.5	0.90 ± 0.35
Aug '75	"	"	4	14 ± 2	3.4 ± 0.2
"	Mile 8	"	2	11 ± 2	1.4 ± 0.1
"	Milrow Area	"	2	12 ± 2	1.8 ± 0.6
Aug '76	Cannikin Area	"	4	12 ± 0.5	1.7 ± 0.1
"	Milrow/Long Shot	"	3	10 ± 4.5	<0.3
"	Camp Area	"	1	10 ± 0.6	1.5 ± 0.1
"	Mile 18	"	1	9.4 ± 0.6	0.75 ± 0.04
Sept '77	Cannikin Area	"	4	11 ± 2.5	2.1 ± 0.18
"	Long Shot	"	4	8.8 ± 1.0	0.37 ± 0.08
"	Camp Area	"	5	12 ± 2.5	0.55 ± 0.10
Aug 78	Cannikin Area	"	4	9.1 ± 2.3	0.39 ± 0.08
"	Milrow/Long Shot	"	7	9.6 ± 1.8	0.90 ± 0.08
"	Camp Area	"	4	9.4 ± 1.5	0.30 ± 0.04
Sept '79	Milrow/Long Shot	"	4	11 ± 1.6	0.53 ± 0.07
"	Camp Area	"	3	11 ± 2.8	0.15 ± 0.10
"	Cannikan Area	"	4	12 ± 1.6	0.32 ± 0.07

[a]Values for radionuclides in samples collected from 1970 through 1973 are given as a mean ± one standard deviation of two or more single sample counts. Values for radionuclides in birds collected from 1974 to 1977 are from a single count of a sample of one or more birds ± a two-sigma, propagated counting error. The dashes in the body of the table indicate the sample counts were not significant.

[b]Pre-Cannikin.

[c]One each from Mason Lake, Cannikin area, and Mile 16; two from Mile 5.

Table 12. Strontium-90 in bone samples from rats and ptarmigan and in soil samples collected at Amchitka Island.

Collection Date	n[a]	Collection Location	Sample Type	pCi ^{90}Sr/g, dry[b]
1971[c]	2	Sand Beach Cove	Rat, bone	1.6 ± 1.3
1971	2	"	"	5.8 ± 5.9
1973	1	"	"	1.9 ± 2.0
1975	1	"	"	0.5 ± 0.2
1976	1	"	"	<1.3
1977	1	"	"	<0.78
1978	1	"	"	0.63 ± 0.04
1979	1	"	"	<0.11
1973	1	Other Sites[d]	Rat, bone	1.8 ± 0.4
1974	2	"	"	1.6 ± 1.1
1975	2	"	"	1.4 ± 0.3
1976	5	"	"	<1.3
1977	3	"	"	<0.80
1978	3	"	"	2.1 ± 5.2
1979	3	"	"	1.1 ± 1.1
1971	1	Cannikin Area	Ptarmigan, bone	31.0 ± 3.6
1975	1	"	"	13.0 ± 1.0
1976	1	"	"	14.0 ± 2.6
1977	1	"	"	17.0 ± 1.4
1978	1	"	"	13.0 ± 1.0
1979	1	"	"	13.0 ± 1.0
1971[c]	1	Milrow/Long Shot	Ptarmigan, bone	27.0 ± 3.2
1973	1	"	"	11.0 ± 0.8
1975	1	"	"	14.0 ± 1.4
1976	1	"	"	19.0 ± 2.4
1977	1	"	"	16.0 ± 1.2
1978	1	"	"	9.6 ± 0.6
1979	1	"	"	9.7 ± 1.2

Table 12. (Con't.) Strontium-90 in bone samples from rats and ptarmigan and in soil samples collected at Amchitka Island.

Collection Date	n[a]	Collection Location	Sample Type	pCi ^{90}Sr/g, dry[b]
1971	2	Other Sites[e]	Ptarmigan, bone	27.0 ± 12.0
1973	1	"	"	14.0 ± 0.8
1974	1	"	"	16.0 ± 9.2
1975	1	"	"	19.0 ± 2.8
1976	2	"	"	26.0 ± 0.4
1977	1	"	"	15.0 ± 1.4
1978	1	"	"	10.0 ± 0.8
1979	1	"	"	9.6 ± 1.2
1975	1	Main Camp	Soil	0.03 ± 0.02
1976	3	"	"	<0.03
1977	1	"	"	<0.14
1978	1	"	"	0.06 ± 0.10
1979	1	"	"	0.13 ± 0.12
1975	1	Cannikin Area	Soil	<0.16
1976	3	"	"	<0.04
1977	3	"	"	<0.14
1978	3	"	"	0.21 ± 0.26
1979	1	"	"	0.11 ± 0.08

a Each bone sample obtained from 2 to 4 individuals.

b Radionuclide values for single samples (n=1) are a mean of a repeated count of the sample ± two sigma, propagated, counting error. The radionuclide values for more than one sample is the mean ± one standard deviation of those individual sample values. Since 1976 a correction was made for reagent contaminants and, in 1977, an additional correction for residual sample contaminants. The maximum net effect of these correction on sample values, in terms of pCi per gram of sample, is about 0.5 for rat samples (3 g) 0.3 for ptarmigan (5 g) and 0.03 for soils (50 g).

c Pre-Cannikin.

d Main dump, Duck Cove, Constantine Harbor, Camp Area, Bridge Creek and Clevenger Creek (mouth).

e Main camp, mile post 8, Silver Salmon Lake, mile 18.

Table 13. Some gamma-emitting radionuclides in sand and soil collected at Amchitka Island.

Location and Date	Sample Type	n	Radionuclides pCi/g, dry[a]						
			^{40}K	^{137}Cs	^{141}Ce	^{144}Ce	^{226}Ra	^{228}Th	^{238}U
Main Camp									
Aug '75	Soil	1	8.0±1.2	---	0.20±0.13	0.14±0.13	0.18±0.04	0.14±0.05	---
Aug '76	"	3	11 ±1.0	0.82±0.60	0.27±0.24	---	0.26±0.06	0.11±0.04	0.17±0.30
Sept '77	"	1	15 ±2.2	0.24±0.07	---	0.29±0.21	0.29±0.07	0.27±0.08	0.85±0.69
Aug '78	"	1	21 ±1.6	0.38±0.05	---	0.22±0.13	0.39±0.04	---	0.67±0.42
Sep '79	"	1	14 ±0.7	0.15±0.02	---	---	0.40±0.05	0.41±0.04	0.13±0.26
Cannikin Area									
Aug '75	Soil	1	11 ±1.3	0.32±0.05	0.22±0.15	0.97±0.18	0.11±0.05	0.08±0.04	---
Aug '76	"	3	10 ±2.5	0.34±0.21	---	0.09±0.12	0.21±0.03	0.11±0.02	0.64±0.18
Sept '77	"	5	8.8±3.0	0.21±0.15	---	0.42±0.02	0.20±0.05	0.19±0.08	---
Aug '78	"	3	9.0±3.8	0.47±0.08	---	0.60±0.15	0.16±0.05	---	---
Sep '79	"	2	13.0±1.2	0.27±0.19	---	0.06±0.08	0.07±0.09	0.17±0.05	0.13±0.18
Constantine Harbor									
Aug '75	Sand	1	13 ±1.2	0.07±0.03	---	---	0.18±0.04	0.09±0.04	0.44±0.36
Aug '76	"	1	16 ±1.6	0.22±0.04	---	---	0.28±0.05	0.11±0.05	0.80±0.47
Sept '77	"	1	15 ±2.1	0.05±0.04	---	---	0.19±0.06	0.09±0.07	---
Aug '78	"	1	15 ±2.2	---	---	---	0.20±0.05	---	---
Sep '79	"	1	8.3±0.4	0.03±0.01	---	---	0.13±0.03	0.08±0.02	0.05±0.10
Sand Beach Cove									
Aug '75	Sand	1	9.8±1.1	0.06±0.03	---	0.2 ±0.1	0.22±0.04	0.11±0.03	0.48±0.20
Aug '76	"	1	8.6±1.1	---	---	---	0.28±0.04	0.13±0.04	0.64±0.33
Sept '77	"	1	4.7±1.1	---	---	---	0.08±0.05	0.07±0.04	---
Aug '78	"	1	7.8±1.8	---	---	---	0.28±0.06	---	0.71±0.62
Sep '79	"	1	9.8±0.4	0.01±0.01	---	---	0.24±0.03	0.22±0.03	---

[a]Radionuclide values for a single sample (n=1) are a single count of the sample ± the two-sigma, propagated counting error. The radionuclide value shown for more than one sample is the mean ± one standard deviation of two or more single sample counts. Dashes in the table indicate the sample count is not significant.

Table 14. Some gamma-emitting radionuclides in freshwater samples collected at Amchitka Island[a].

Location and Date	Liters; Range	Fraction	n	Radionuclides pCi/liter[b] ^{7}Be	^{95}Zr	^{95}Nb	^{137}Cs	^{144}Ce
Jones Lake								
1971[c]	83-477	Particulate	4	---	0.05 ± 0.04	0.11 ± 0.08	0.02 ± 0.04	NA
"	"	Soluble	4	---	0.01 ± 0.01	0.02 ± 0.02	0.02 ± 0.02	NA
1971-72	53-619	Particulate	5	0.2 ± 0.3	0.008± 0.011	0.02 ± 0.02	0.004± 0.009	NA
"	"	Soluble	5	1.3 ± 2.9	0.07 0.15	0.16 ± 0.33	0.05 ± 0.10	NA
1973	152-193	Particulate	2	---	---	---	0.042± 0.015	NA
"	"	Soluble	2	---	---	---	---	NA
May '74	53	Particulate	1	---	0.084± 0.062	0.19 ± 0.06	0.039± 0.029	0.44 ± 0.14
"	"	Soluble	1	---	---	---	---	---
Aug '74	413	Particulate	1	---	---	---	---	---
"	"	Soluble	1	---	---	---	---	---
Aug '75	56	Entire	1	1.1 ± 0.3	---	0.05 ± 0.03	0.12 ± 0.03	---
Aug '76	50	Entire	1	1.9 ± 0.5	---	---	0.08 ± 0.04	---
Sept '77	50	Entire	1	1.6 ± 0.6	0.29 ± 0.09	0.42 ± 0.09	0.13 ± 0.04	0.44 ± 0.17
Aug '78	50	Entire	1	---	---	---	0.11 ± 0.05	0.23 ± 0.22
Sept '79	50	Entire	1	---	---	---	0.09 ± 0.02	---
Heart Lake								
Aug '75	52	Entire	1	2.3 ± 0.4	0.09 ± 0.05	0.15 ± 0.04	0.25 ± 0.04	0.24 ± 0.11
Aug '76	48	Entire	1	1.9 ± 0.5	---	---	0.13 ± 0.05	---
Sept '77	50	Entire	1	---	---	---	---	0.90 ± 0.30
Aug '78	50	Entire	1	1.8 ± 1.3	---	---	0.10 ± 0.04	---
Sept '79	50	Entire	1	2.6 ± 1.0	---	---	0.14 ± 0.02	---
Cannikin Lake								
1972	9-10	Particulate	2	---	0.17 ± 0.23	0.34 ± 0.48	---	NA
1973	72-95	Particulate	2	---	---	---	0.04 ± 0.057	NA
"	"	Soluble	2	---	---	---	0.08 ± 0.11	NA
May '74	314	Particulate	1	---	0.20 ± 0.04	0.25 ± 0.03	0.019± 0.013	0.41 ± 0.07
"	"	Soluble	1	---	---	---	---	---
Aug '74	99	Particulate	1	---	---	---	---	---
"	"	Soluble	1	---	---	---	---	---
Aug '75	53	Entire	1	---	---	---	0.21 ± 0.04	---
Aug '76	50	Entire	1	---	---	---	0.10 ± 0.04	0.24 ± 0.15
Sept '77	50	Entire	1	0.93± 0.78	---	0.46 ± 0.13	0.10 ± 0.06	0.35 ± 0.25
Aug '78	50	Entire	1	---	---	---	0.05 ± 0.03	---
Sept '79	50	Entire	1	---	---	---	0.05 ± 0.02	---

Table 14. (Continued) Some gamma-emitting radionuclides in freshwater samples collected at Amchitka Island[a].

Location and Date	Liters; Range	Fraction	n	Radionuclides pCi/liter[b] ^{7}Be	^{95}Zr	^{95}Nb	^{137}Cs	^{144}Ce
Long Shot Mud Pit No. 1								
1970-71[c]	62-950	Particulate	6	4.0 ± 4.7	0.4 ± 0.6	0.9 ± 1.2	0.02 ± 0.03	NA
"	"	Soluble	6	11.0 ± 18.0	0.002 ± 0.003	0.006 ± 0.009	0.08 ± 0.18	NA
1971-72	29-108	Particulate	5	1.2 ± 1.3	0.25 ± 0.29	0.48 ± 0.55	0.03 ± 0.07	NA
"	"	Soluble	5	0.44 ± 0.98	---	---	---	NA
1973	32-38	Particulate	2	2.0 ± 1.0	---	---	0.04 ± 0.06	NA
"	"	Soluble	2	---	---	---	---	NA
May '74	48	Particulate	1	4.0 ± 0.7	1.3 ± 0.1	2.7 ± 0.2	0.034 ± 0.028	4.9 ± 0.3
"	48	Soluble	1	---	---	---	---	---
Aug. '74	189	Particulate	1	0.7 ± 0.2	0.06 ± 0.03	0.14 ± 0.02	---	---
"	189	Soluble	1	---	---	0.21 ± 0.10	---	---
Aug. '75	50	Entire	1	1.2 ± 0.3	---	---	0.08 ± 0.03	---
Aug. '76	52	Entire	1	1.3 ± 0.4	---	---	0.05 ± 0.03	---
Sept. '77	50	Entire	1	1.7 ± 0.8	0.44 ± 0.14	0.91 ± 0.19	0.14 ± 0.06	0.31 ± 0.24
Aug. '78	50	Entire	1	1.3 ± 1.2	---	---	0.12 ± 0.05	---
Sept. '79	50	Entire	1	---	---	---	0.03 ± 0.02	---
Constantine Springs								
Sept. '77	50	Entire	1	---	---	---	---	---
Aug. '78	50	Entire	1	0.75 ± 0.62	---	---	0.05 ± 0.03	---
Sept. '79	50	Entire	1	---	---	---	---	---
Long Lake								
Sept. '77	50	Entire	1	1.1 ± 0.7	0.55 ± 0.15	0.61 ± 0.14	0.11 ± 0.06	0.41 ± 0.24
Aug. '78	50	Entire	1	---	---	---	0.10 ± 0.05	0.30 ± 0.20
Sept. '79	50	Entire	1	---	---	---	0.05 ± 0.02	---
Sand Beach Cove Seepage								
Sept. '77	34	Entire	1	1.1 ± 1.0	0.30 ± 0.29	0.33 ± 0.14	---	---
Rain Water								
Sept. '77	50	Entire	1	28.0 ± 1.5	4.9 ± 0.2	9.4 ± 0.3	0.40 ± 0.06	2.8 ± 0.3
Aug. '78	50	Entire	1	3.3 ± 2.2	0.24 ± 0.23	0.28 ± 0.23	0.41 ± 0.06	3.7 ± 0.26
Sept. '79	50	Entire	1	14.0 ± 1.4	---	---	0.12 ± 0.02	0.27± 0.06

a. ^{40}K, ^{103}Ru, ^{106}Ru, ^{125}Sb, ^{140}Ba, ^{214}Bi, ^{226}Ra and ^{228}Th also present in some samples.

b. Radionuclide values for a single sample (n=1) are a single count of the sample ± the two sigma, propagated counting error. The radionuclide value shown for more than one sample is the mean ± one standard deviation of two or more single sample counts. Dashes in the table indicate the sample count is not significant and NA indicate the radionuclide was not included in the analyses.

c. Pre-Cannikin

Table 15. Tritium concentration in water samples collected at sites other than Long Shot Drainage, Amchitka Island, 1970-1979.

Collection Date	Collection Location	Number of Samples	Tritium Units[a]	pCi/liter[b]
I Seawater				
1970-71[c]	d	10	32 ± 19	103 ± 61
1972	d	16	28 ± 25	90 ± 81
1973	d	6	22 ± 13	71 ± 42
1974	d	6	<13	<42
1975	d	6	<15	<48
1976	d	6	<15	<50
1977	d	4	<13	<42
1978	d	8	17 ± 10	55 ± 32
Sep '79	Constantine Harbor	1	< 9	<29
Sep '79	Square Bay	1	<10	<32
Sep '79	Sand Beach Cove	1	< 8	<26
Sep '79	Duck Cove	1	< 9	<29
Sep '79	St. Makarius Bay	1	< 9	<29
Sep '79	Near Mouth of Long Shot Creek	1	<10	<32
Sep '79	Near Mouth of Bridge Creek	1	24 ± 10	77 ± 32
II Freshwater, Except Long Shot Area				
1970-71[c]	d	12	92 ± 46	298 ±149
1972	d	18	49 ± 14	158 ± 45
1973	d	46	50 ± 17	162 ± 55
1974	d	44	32 ± 18	103 ± 58
1975	d	29	34 ± 14	110 ± 45
1976	d	33	30 ± 12	97 ± 39
1977	d	44	28 ± 9	90 ± 29
1978	d	45	26 ± 13	84 ± 42
1979	d	45	20 ± 9	65 ± 29

Table 15. (Con't.) Tritium concentration in water samples collected at sites other than Long Shot Drainage, Amchitka Island, 1970-1979.

Collection Date	Collection Location	Number of Samples	Tritium Units[a]	pCi/liter[b]
Jan '79	Camp Area Precipitation	2	12 ± 4	39 ± 13
Feb '79	"	2	10 ± 2	32 ± 6
Apr '79	"	2	70 ± 3	226 ± 10
May '79	"	2	25 ± 2	81 ± 6
Jun '79	"	2	20 ± 1	65 ± 3
Jul '79	"	2	11 ± 3	36 ± 10
Sep '79	"	1	40 ± 9	129 ± 29
Feb '79	Clevenger Creek	2	<10	<32
May '79	"	2	13 ± 4	42 ± 13
Sep '79	"	2	22 ± 1	71 ± 3
Feb '79	Bridge Creek	2	18 ± 11	58 ± 36
May '79	"	2	33 ± 3	107 ± 10
Sep '79	"	2	15 ± 8	48 ± 26
Sep '79	Constantine Spring	1	23 ± 9	74 ± 29
Sep '79	Long Lake	1	36 ± 9	116 ± 29
Sep '79	Pump House	1	27 ± 9	87 ± 29
Oct '79	Decontamination Facility	1	24 ± 9	78 ± 29
Sep '79	Jones Lake Outlet	1	<10	<32
Oct '79	Clevenger Lake Outlet	1	9 ± 8	29 ± 26
Sep '79	Duck Cove Creek	1	27 ± 9	87 ± 29
Sep '79	Seep Area from Cliffs at Duck Cove	1	20 ± 9	65 ± 29
Sep '79	Clam Lake	1	18 ± 9	58 ± 29
Sep '79	Heart Lake	1	13 ± 9	42 ± 29
Sep '79	Quonset Lake	1	27 ± 9	87 ± 29
Sep '79	Quonset Creek	1	28 ± 9	90 ± 29
Sep '79	Ice Box Lake Inlet[e]	1	54 ± 10	174 ± 32
Sep '79	Ice Box Lake Outlet	1	18 ± 10	58 ± 32

Table 15. (Con't.) Tritium concentration in water samples collected at sites other than Long Shot Drainage, Amchitka Island, 1970-1979.

Collection Date	Collection Location	Number of Samples	Tritium Units[a]	pCi/liter[b]
Sep '79	Cannikin Lake Inlet from Ground Zero	1	<10	<32
Sep '79	Cannikin Lake Inlet from Drillback	1	<10	<32
Sep '79	White Alice Inlet to Cannikin Lake	1	30 ± 11	97 ± 36
Sep '79	Cannikin Lake Surface and Bottom	9	14 ± 6	45 ± 19
Sep '79	Cannikin Lake Outlet	3	21 ± 11	84 ± 13
Sep '79	MP-12 Creek	1	24 ± 9	78 ± 29
Sep '79	DK-45 Lake	1	24 ± 9	78 ± 29
Sep '79	Sand Beach Cove Seep	2	23 ± 3	74 ± 10

a Radionuclide values for single samples (n = 1) are a mean of a repeated count of the sample ± a one-sigma, propagated, counting error. The radionuclide value shown for more than one sample is the mean ± one standard deviation of those individual sample values.

b One TU equals 3.23 pCi/liter.

c Pre-Cannikin.

d Mean of all collection sites.

e A small lake formed in the north fork of White Alice Creek after surface subsidence occurred at the Cannikin site.

Table 16. Tritium concentration in water samples collected at Long Shot drainage, Amchitka Island, 1970-1979.

Collection Location	Collection Date	Number of Samples	Tritium Units[a]	pCi/liter[b]
Spring Draining into Mud Pit #3	1978	1	792 ± 23	2558 ± 74
	1979	1	54 ± 9	174 ± 29
Long Shot Mud Pit				
Mud Pit #3	1970-71[c]	3	3500 ± 460	11300 ±1500
	1974	1	2900 ± 460	9400 ± 160
	1975	1	867 ± 19	2800 ± 61
	1976	1	1150 ± 23	3710 ± 74
	1977	1	915 ± 23	2956 ± 74
	1978	1	704 ± 21	2274 ± 68
	1979	1	654 ± 20	2112 ± 65
Mud Pit #2	1976	1	1140 ± 23	3680 ± 74
	1977	1	731 ± 20	2361 ± 65
	1978	1	623 ± 20	2012 ± 65
	1979	2	501 ± 20	1618 ± 65
Mud Pit #1	1970-71[c]	3	1800 ± 260	5800 ± 840
	1972	4	2050 ± 240	6600 ± 780
	1973	2	1900 ± 420	6100 ±1400
	1974	2	1300 ± 250	4200 ± 810
	1975	1	122 ± 11	395 ± 36
	1976	2	716 ± 12	2310 ± 39
	1977	2	681 ± 27	2200 ± 87
	1978	1	492 ± 18	1589 ± 58
	1979	1	383 ± 15	1237 ± 48
Long Shot Mud Pit Drainage 3 Meters below Mud Pit #1	1975	1	872 ± 19	2820 ± 61
	1976	1	739 ± 18	2390 ± 58
	1978	1	529 ± 18	1709 ± 58
	1979	2	406 ± 4	1311 ± 13

Table 16. (Con't.) Tritium concentration in water samples collected at Long Shot drainage, Amchitka Island, 1970-1979.

Collection Location	Collection Date	Number of Samples	Tritium Units[a]	pCi/liter[b]
Infantry Road	1975	1	666 ± 16	2150 ± 52
	1976	1	342 ± 14	1100 ± 45
	1977	1	454 ± 16	1466 ± 52
	1978	1	394 ± 15	1273 ± 48
	1979	1	329 ± 14	1063 ± 45
100 meters below road	1975	1	424 ± 15	1370 ± 48
	1976	1	278 ± 14	898 ± 45
	1977	1	148 ± 13	478 ± 42
	1978	1	279 ± 13	901 ± 42
	1979	1	229 ± 12	740 ± 39
200 meters below road	1976	1	252 ± 13	814 ± 42
	1977	1	84 ± 12	271 ± 39
	1978	3	272 ± 90	879 ±291
	1979	1	214 ± 12	691 ± 39
400 meters below road	1976	1	103 ± 12	333 ± 39
	1977	1	57 ± 12	184 ± 39
	1978	2	168 ± 18	543 ± 58
	1979	1	78 ± 10	252 ± 32
500 meters below road	1975	1	82 ± 13	264 ± 42
	1976	1	53 ± 11	171 ± 36
	1978	1	70 ± 10	226 ± 32
	1979	1	45 ± 9	145 ± 29
200 meters above Square Bay	1975	1	121 ± 13	390 ± 47
	1976	1	48 ± 11	155 ± 36
	1977	1	41 ± 12	132 ± 39
	1978	2	92 ± 17	297 ± 55
	1979	1	64 ± 9	207 ± 29

Table 16. (Con't.) Tritium concentration in water samples collected at Long Shot drainage, Amchitka Island, 1970-1979.

Collection Location	Collection Date	Number of Samples	Tritium Units[a]	pCi/liter[b]
100 meters above				
Square Bay	1979	1	54 ± 9	174 ± 29
20 meters above				
Square Bay	1975	1	107 ± 13	347 ± 42
	1976	1	27 ± 11	87 ± 36
	1977	1	16 ± 12	52 ± 39
	1978	2	62 ± 5	200 ± 16
	1979	1	37 ± 10	120 ± 32

a Radionuclide values for single samples (n=1) are a mean of a repeated count of the sample ± a one-sigma, propagated, counting error. The radionuclide value shown for more than one sample is the mean ± one standard deviation of those individual sample values.

b One TU equals 3.23 pCi/liter.

c Pre-Cannikin.

Table 17. Tritium in free water from biological samples collected at Amchitka Island.

Sample Type, Tissue & Collection Location	Collection Date	n[a]	Tritium Units[b]	pCi/liter[c]
Fucus, entire				
Constantine Harbor	Aug '75	2	<35 ± 18	<110 ± 58
	Aug '76	1	35 ± 11	110 ± 36
	Sept'77	1	23 ± 10	74 ± 32
	Aug '78	1	15 ± 9	48 ± 29
	Sept'79	1	< 8	<26
Square Bay	Aug '75	3	<26 ± 12	<84 ± 39
	Aug '76	2	25 ± 3	81 ± 10
	Sept'77	1	38 ± 11	122 ± 36
	Aug '78	1	53 ± 19	171 ± 61
	Sept'79	1	15 ± 9	48 ± 29
Sand Beach Cove	Aug '75	2	<21 ± 1	<68 ± 3
	Aug '76	3	31 ± 4	100 ± 13
	Sept'77	1	28 ± 11	90 ± 36
	Aug '78	1	< 9	<29
	Sept'79	1	13 ± 9	42 ± 29
Duck Cove	Aug '76	3	23 ± 3	74 ± 10
	Sept'77	4	<13	<42
	Aug '78	1	< 9	<29
Greenling, muscle				
Constantine Harbor	May '74	2	48 ± 4	155 ± 13
	Aug '75	1	<14	<45
	Aug '76	1	<21	<68
	Sept'77	2	<13	<42
	Aug '78	1	< 9	<29
	Sept'79	1	14 ± 9	45 ± 29
Square Bay	Aug '75	4	<20 ± 2	<65 ± 6
	Aug '76	1	<19	<62
	Sept'77	1	17 ± 10	55 ± 32
	Aug '78	1	< 9	<29
	Sept'79	1	<10	<32

Table 17. (Con't.) Tritium in free water from biological samples collected at Amchitka Island.

Sample Type, Tissue & Collection Location	Collection Date	n[a]	Tritium Units[b]	pCi/liter[c]
Greenling, muscle				
Sand Beach Cove	May '74	3	94 ± 39	304 ± 126
	Aug '75	2	< 20 ± 1	65 ± 3
	Aug '76	3	20 ± 7	65 ± 23
	Sept'77	1	<12	<39
	Aug '78	1	<10	<32
	Sept'79	1	28 ± 9	90 ± 29
Duck Cove	Aug '76	1	<46	<150
	Sept'77	1	<13	<42
	Aug '78	1	16 ± 9	52 ± 29
Dolly Varden, muscle				
Ice Box Lake	Oct '72	3	45 ± 9	145 ± 29
White Alice Creek	Aug '73	2	162 ± 52	523 ± 168
Bridge Creek (Intertidal area of Creek)	Aug '73	4	64 ± 3	207 ± 10
	Aug '75	2	16 ± 2	51 ± 6
Duck Cove	Aug '76	2	43 ± 9	140 ± 29
	Sept'77	1	<11	<36
	Aug '78	1	< 9	<29
Jones Lake	May '74	3	68 ± 54	220 ± 174
	Aug '75	4	26 ± 16	85 ± 52
	Aug '76	1	58 ± 13	190 ± 42
	Sept'77	1	38 ± 11	123 ± 36
	Aug '78	1	< 9	<29
	Oct '79	1	25 ± 11	81 ± 36
Cannikin Lake	Aug '75	1	39 ± 12	130 ± 39
	Aug '76	1	72 ± 17	230 ± 55
	Aug '78	1	22 ± 9	71 ± 29
	Oct '79	1	<10	<32

Table 17. (Con't.) Tritium in free water from biological samples collected at Amchitka Island.

Sample Type, Tissue & Collection Location	Collection Date	n[a]	Tritium Units[b]	pCi/liter[b]
Ranunculus, entire				
Duck Cove Creek	Aug '73	2	68 ± 35	220 ± 113
White Alice Creek	Aug '73	2	89 ± 28	228 ± 90
Bridge Creek	Aug '76	2	<67	<220
	Aug '78	3	25 ± 4	81 ± 13
	Sept'79	1	13 ± 9	42 ± 29
Clevenger Creek	Aug '78	2	31 ± 1	100 ± 3
Long Shot Mud Pit #3	Aug '78	2	787 ± 7	2542 ± 23
	Oct '79	1	1027 ± 30	3317 ± 97
Long Shot Mud Pit #1	Oct '79	1	413 ± 17	1334 ± 55
Long Shot at Infantry Road	Oct '79	1	383 ± 18	1237 ± 58
Long Shot-200 m below Infantry Road	Oct '79	1	270 ± 15	872 ± 48
Long Shot-250 m below Infantry Road	Aug '78	1	143 ± 11	462 ± 36
Long Shot-400 m below Infantry Road	Aug '78	1	72 ± 10	233 ± 32
	Oct '79	1	105 ± 12	339 ± 39
Long Shot-500 m below Square Bay	Oct '79	1	53 ± 10	171 ± 32
Long Shot-100 m above Square Bay	Oct '79	1	309 ± 15	998 ± 48
Fontinalis, entire				
Clevenger Creek	Aug '76	4	102 ± 6	329 ± 19
	Sept'77	1	27 ± 16	87 ± 52
	Aug '78	3	38 ± 6	123 ± 19
	Nov '78	1	37 ± 9	120 ± 29
	Sept'79	1	46 ± 11	149 ± 36
Ice Box Lake Inlet	Aug '76	3	37 ± 16	120 ± 52
	Sept'77	2	54 ± 9	174 ± 29
	Aug '78	3	32 ± 1	103 ± 3

Table 17. (Con't.) Tritium in free water from biological samples collected at Amchitka Island.

Sample Type, Tissue & Collection Location	Collection Date	n[a]	Tritium Units[b]	pCi/liter[b]
Fontinalis, entire				
White Alice Creek (Cannikin Lake Drainage)	Aug '75	2	39 ± 28	126 ± 91
	Aug '76	5	71 ± 15	229 ± 48
	Sept'77	3	32 ± 9	103 ± 29
	Aug '78	3	32 ± 4	103 ± 13
	Sept'79	1	35 ± 11	113 ± 36
Bridge Creek	Feb '78	1	<10	<32
	Aug '78	1	< 9	<29
	Sept'79	1	44 ± 11	142 ± 36
Long Shot Mud Pit #2	Oct '79	1	721 ± 24	2329 ± 78
Long Shot-200 m above Square Bay	Aug '75	2	85 ± 14	275 ± 45
	Sept'77	1	107 ± 12	346 ± 39
	Aug '78	1	95 ± 10	307 ± 32
	Oct '79	1	87 ± 12	281 ± 39
Long Shot-20 m above Square Bay	Aug '76	1	150 ± 15	480 ± 48
	Sept'77	1	62 ± 11	200 ± 36
	Aug '78	1	97 ± 11	313 ± 36
	Oct '79	1	49 ± 9	158 ± 29
Ptarmigan, muscle				
Camp Area	Aug '76	2	<21	<68
	Sept'77	1	21 ± 10	68 ± 32
	Aug '78	1	17 ± 9	55 ± 29
	Sept'79	1	<10	<32
Milrow/Long Shot	Aug '76	2	40 ± 17	130 ± 55
	Sept'77	2	35 ± 5	113 ± 16
	Aug '78	1	< 9	<29
	Sept'79	1	15 ± 10	48 ± 32
Cannikin Area	Aug '76	1	36 ± 18	120 ± 58
	Aug '78	1	10 ± 10	32 ± 32
	Sept'79	1	16 ± 10	52 ± 32

a n equals the number of free water samples from a single tissue sample.

b Radionuclide values for single samples (n=1) are a mean of a repeated count of the sample ± a one-sigma, propagated, counting error. The radionuclide value shown for more than one sample is the mean ± one standard deviation of these individual sample values.

c One TU equals 3.23 pCi/liter.

Table 18. Plutonium-239, 240 in Fucus, greenling, sand and soil samples collected at Amchitka Island.

Sample Type	Collection Location	Collection Date	pCi/g, dry[a]
Fucus, entire	Sand Beach Cove	Aug '75	0.006 ± 0.002
		Aug '76	0.003 ± 0.002
		Sept'77	0.002 ± 0.002
		Aug '78	0.003 ± 0.0008
		Sept'79	0.004 ± 0.001
Fucus, entire	Constantine Harbor	Aug '75	0.002 ± 0.002
		Aug '76	<0.002
		Sept'77	0.002 ± 0.0006
		Aug '78	0.003 ± 0.0006
		Sept'79	0.001 ± 0.0004
Fucus, entire	Square Bay	Aug '76	0.003 ± 0.002
		Sept'77	0.005 ± 0.002
		Aug '78	0.003 ± 0.001
		Oct '79	0.002 ± 0.001
Fucus, entire	Duck Cove	Sept'77	0.002 ± 0.0008
		Aug '78	0.003 ± 0.001
		Sept'79	0.003 ± 0.0008
Greenling, muscle	Sand Beach Cove	Aug '75	<0.002
		Aug '76	<0.002
		Sept'77	0.001 ± 0.0004
		Aug '78	<0.001
		Sept'79	<0.0005
Greenling, muscle	Constantine Harbor	Aug '75	<0.003
		Aug '76	<0.002
		Sept'77	<0.0001
		Aug '78	<0.001
Sand, surface[b]	Sand Beach Cove	Aug '75	0.004 ± 0.002
		Aug '76	<0.001
		Sept'77	0.001 ± 0.0006
		Aug '78	<0.001
		Sept'79	0.004 ± 0.001

Table 18. (Con't.) Plutonium-239, 240 in Fucus, greenling, sand and soil samples collected at Amchitka Island.

Sample Type	Collection Location	Collection Date	pCi/g, dry[a]
Sand, surface	Constantine Harbor	Aug '75	<0.002
		Aug '76	0.003 ± 0.002
		Sept'77	0.005 ± 0.002
		Sept'79	0.003 ± 0.001
Soil, surface	Cannikin Area Drillback #1	Aug '75	0.015 ± 0.004
		Aug '76	0.008 ± 0.002
		Sept'77	0.005 ± 0.006
		Aug '78	0.003 ± 0.002
		Sept'79	0.007 ± 0.004
Soil, surface	Cannikin Area Drillback #2	Aug '76	<0.002
		Sept'77	0.002 ± 0.0008
		Aug '78	0.005 ± 0.001
		Sept'79	0.001 ± 0.001
Soil, surface	Cannikin Area Drillback #3	Aug '76	0.009 ± 0.005
		Sept '77	0.001 ± 0.0001
		Aug '78	0.004 ± 0.001
Soil, surface	Camp Area	Aug '75	0.001 ± 0.001
		Aug '76	<0.002
		Aug '76	0.005 ± 0.003
		Aug '76	0.006 ± 0.004
		Sept '77	0.004 ± 0.002
		Aug '78	0.004 ± 0.001

a The radionuclide value for these single samples is a single count of the sample ± the two sigma, propagated, counting error.

b Surface samples were the 0 to 2.5 cm layer.

Table 19. Background radiation at selected sites on Amchitka Island.

Location	Average Reading - Radiation Level[a], mR/hr					
	1974	1975	1976	1977	1978	1979
Decon Facility	0.01	0.01	0.01	0.01	0.02	0.03
Inside "D" Barracks	0.01	<0.01	0.01	0.01	0.01	0.03
Husky Camp	<0.01	0.01	0.01	0.01	0.02	0.03
Jones Creek Effluence	<0.01	<0.01	0.01	0.01	0.01	0.03
EIC Calibration Range	<0.01	0.01	0.01	0.01	0.02	0.04
Rifle Range Target Area	0.01	0.01	0.01	0.01	0.02	0.03
Duck Cove	<0.01	<0.01	0.01	0.01	0.02	0.03
Milrow SGZ & Vicinity	<0.01	0.01	0.01	0.01	0.01	0.02
Long Shot SGZ & Vicinity	0.01	0.01	0.01	0.01	0.02	0.03
Cannikin SGZ & Vicinity	0.01	0.01	0.01	0.01	0.01	0.04
Cannikin Drillback	0.01	0.01	0.01	0.01	0.01	0.04
Sand Beach Cove	<0.01	<0.01	0.01	0.01	0.02	0.03
D-Site	0.01	<0.01	0.01	0.01	0.02	0.03
E-Site	0.01	<0.01	0.01	0.01	0.02	0.03

a Eberline G-M detector, Model E-510, probe window thickness less than 2 mg/cm^2.

Table 19. (Con't.) Background radiation at selected sites on Amchita Island.

Location	Maximum Reading - Radiation Level[a], mR/hr					
	1974	1975	1976	1977	1978	1979
Deacon Facility	0.05	0.04	0.03	0.04	0.03	0.06
Inside "D" Barracks	0.04	0.04	0.04	0.05	0.03	0.06
Husky Camp	0.04	0.05	0.04	0.05	0.05	0.06
Jones Creek Effluence	0.04	0.04	0.03	0.04	0.03	0.06
EIC Calibration Range	0.04	0.04	0.05	0.05	0.03	0.05
Rifle Range Target Area	0.04	0.05	0.04	0.06	0.03	0.06
Duck Cove	0.03	0.04	0.04	0.05	0.03	0.06
Milrow SGZ & Vicinity	0.04	0.04	0.06	0.05	0.02	0.06
Long Shot SGZ & Vicinity	0.05	0.05	0.05	0.04	0.04	0.06
Cannikin SGZ & Vicinity	0.04	0.04	0.04	0.04	0.04	0.06
Cannikin Drillback	0.05	0.04	0.05	0.05	0.04	0.07
Sand Beach Cove	0.04	0.04	0.04	0.06	0.03	0.06
D-Site	0.05	0.03	0.04	0.05	0.03	0.05
E-Site	0.03	0.04	0.04	0.03	0.03	0.06

a Eberling G-M detector, Model E-510, probe window thickness less than 2 mg/cm^2.

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Year	Report No.	Author(s)
1970-71	NVO-269-11	Held, E. E.
1972	NVO-269-17	Held, E. E.
1972	NVO-269-19	Held, E. E., et al.
1973	NVO-269-21	Nelson, V. A., and A. H. Seymour
1974	NVO-269-23	Nelson, V. A., and A. H. Seymour
1975	NVO-269-27	Nelson, V. A., and A. H. Seymour
1976	NVO-269-31	Nelson, V. A., and A. H. Seymour
1977	NVO-269-34	Seymour, A. H., and A. F. Johnson
1978	DOE/DP00269-37	Tornberg, L. D., and R. E. Nakatani

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Clevenger Lake Outlet	3	3, 15
Constantine Harbor	2 & 3	6, 8, 9, 12, 13, 15, 17, 18
Constantine Harbor	3	15
Constantine Spring	3	14, 15
Crown Reefer Point	2 & 4	6
D-Site	2	19
Decon Area	3	19
Duck Cove	4	6, 7, 9, 10, 12, 17
Duck Cove Creek	4	2, 3, 10, 15
Duck Cove Seep	4	15
E-Site	2	19
EIC Calibration Range	3	19
Heart Lake	4	14, 15
Hus-key Camp	3	19
IA-2	6	None
IA-3	6	"
Ice Box Lake (Lake 05-46)	6	5, 15
Ice Box Lake Inlet	6	2, 15, 17
Infantry Road	2, 4-6	None
Jones Lake	3	10, 14, 15, 17, 18
Jones Lake Outlet	3	15, 19
Lake DK-45	6	10
Lake DK-45 Outlet	6	None
Long Lake	3	14, 15
Long Shot	2, 4, 5	4, 14, 15, 16, 19
Long Shot Drainage	4 & 5	2, 3, 15, 16, 17
Main Camp	3	11, 12, 13, 18, 19
Midden Cove	2	8
Mile 8	2	11, 12
Mile 18	2	11, 12
Milrow	2 & 4	11, 12, 17, 19
MP 12 Creek	6	2, 15
Quonset Creek	4	15

8. TABLE AND MAP INDEX (Cont'd)

Collection Site	Figure No. (s)	Table No. (s)
Rifle Range Target Area	4	19
Sand Beach Cove	6	6, 7, 9, 12, 13, 15, 17, 19
Sand Beach Cove Seep	6	15
Silver Salmon Lake	4	12
Small Boat Dock, Constantine Harbor	3	None
South Bight	2	13
South Hangar	3	15
Square Bay	4	6, 7, 8, 9, 15, 17
White Alice Creek	6	2, 3, 4, 15, 17

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