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Long Term Hydrological Monitoring Program:

Amchitka, Alaska
2001

Long Term Hydrological Monitoring Program

Amchitka, Alaska
2001

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NOTICE

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ABSTRACT

Surface water samples were collected on the island of Amchitka, Alaska, from July 31 through August 4, 2001, as part of the Environmental Protection Agency's Long Term Hydrological Monitoring Program. The samples were scanned for the presence of gamma-ray emitting radionuclides, and analyzed to determine tritium concentrations. Both conventional and enrichment tritium analytical methods were used. No man made gamma-ray emitters were detected, and results of the tritium analyses are consistent with historical values. Trends in decreasing concentration levels of tritium appear to be due to radioactive decay as well as dilution.

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ACRONYMS AND ABBREVIATIONS

DCG	Derived Concentration Guide
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
g	gram
^3H	tritium
$^3H+$	enriched tritium
HpGe	high purity germanium gamma detector
IAG	Interagency Agreement
keV	kilo electron volts = thousand electron volts
kg	kilogram, 1000 grams
kt	kiloton (TNT equivalent)
L	liter
LTHMP	Long-Term Hydrological Monitoring Program
m	meter
MDC	minimum detectable concentration
MeV	million electron volts
min	minute
mL	milliliter = one thousandth of a liter
MT	Megaton = 1,000,000 tons equivalent TNT
ORIA	Office of Radiation and Indoor Air
pCi/L	picocuries per liter = 10^{-12} curies per liter = 1/1,000,000,000,000 curies per liter
PHS	U.S. Public Health Service
R&IE	Radiation and Indoor Environments National Laboratory
SGZ	surface ground zero
SOP	standard operating procedure
USGS	U.S. Geological Survey

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INTRODUCTION

Under an Interagency Agreement (IAG) with the DOE, the EPA's Radiation and Indoor Environments National Laboratory (R&IE) located in Las Vegas, NV, conducts a Long Term Hydrological Monitoring Program (LTHMP) to measure radioactivity concentrations in water sources near the sites of underground nuclear explosions. The results of the LTHMP provide assurance that radioactive materials from the tests have not migrated into drinking water supplies. This report presents the results for the samples collected from July 31 through August 4, 2001, on Amchitka Island, Alaska.

History

Three nuclear detonations were conducted on Amchitka Island in the Aleutian Island chain of Alaska. See Figure 1 for location of Amchitka Island, Alaska. Project Longshot, conducted on October 29, 1965, was an 85-kt yield test emplaced at 2359 ft depth. It was a Vela Uniform Program, designed to investigate seismic phenomena. Project Longshot resulted in some surface contamination, even though the chimney did not extend to the surface. Project Milrow, conducted on October 2, 1969, was an approximately 1-MT "calibration test" of the seismic and environmental responses to the detonation of large-yield nuclear explosives. The emplacement depth of Project Milrow was 3990 ft. Project Cannikin, conducted on November 6, 1971, was a proof test of the Spartan antibalistic missile warhead with less than a 5-MT yield emplaced at 5875 ft depth. See Figures 2, 3, & 4 for sampling locations.

Amchitka Island is composed of several hundred feet of permeable tundra overlaying tertiary volcanics. The ground water system consists of a freshwater lens floating on seawater; estimates of the depth to the saline freshwater-interface range from 3900 to 5250 ft (Chapman and Hokett, 1991). It is likely that any migration from the test cavities would discharge to the nearest salt water body, Project Milrow to the Pacific Ocean, and Projects Longshot and Cannikin to the Bering Sea (Chapman and Hokett, 1991). The sampling locations on Amchitka Island are shallow wells and surface sampling sites. Therefore, the monitoring network for Amchitka Island is restricted to monitoring of surface contamination and drinking water supplies.

Sampling

Sample collection on Amchitka was conducted between July 31 and August 4, 2001. Field collection procedures and sampling locations are described in standard operating procedure (SOP) *CER-203,* and the *Amchitka, Alaska Long Term Hydrologic Monitoring Plan.*

All samples were collected with the exception of several wells that were plugged or mud pits that were filled. However, samples were taken at or near the original sample location. The samples will provide background information for future sampling efforts.

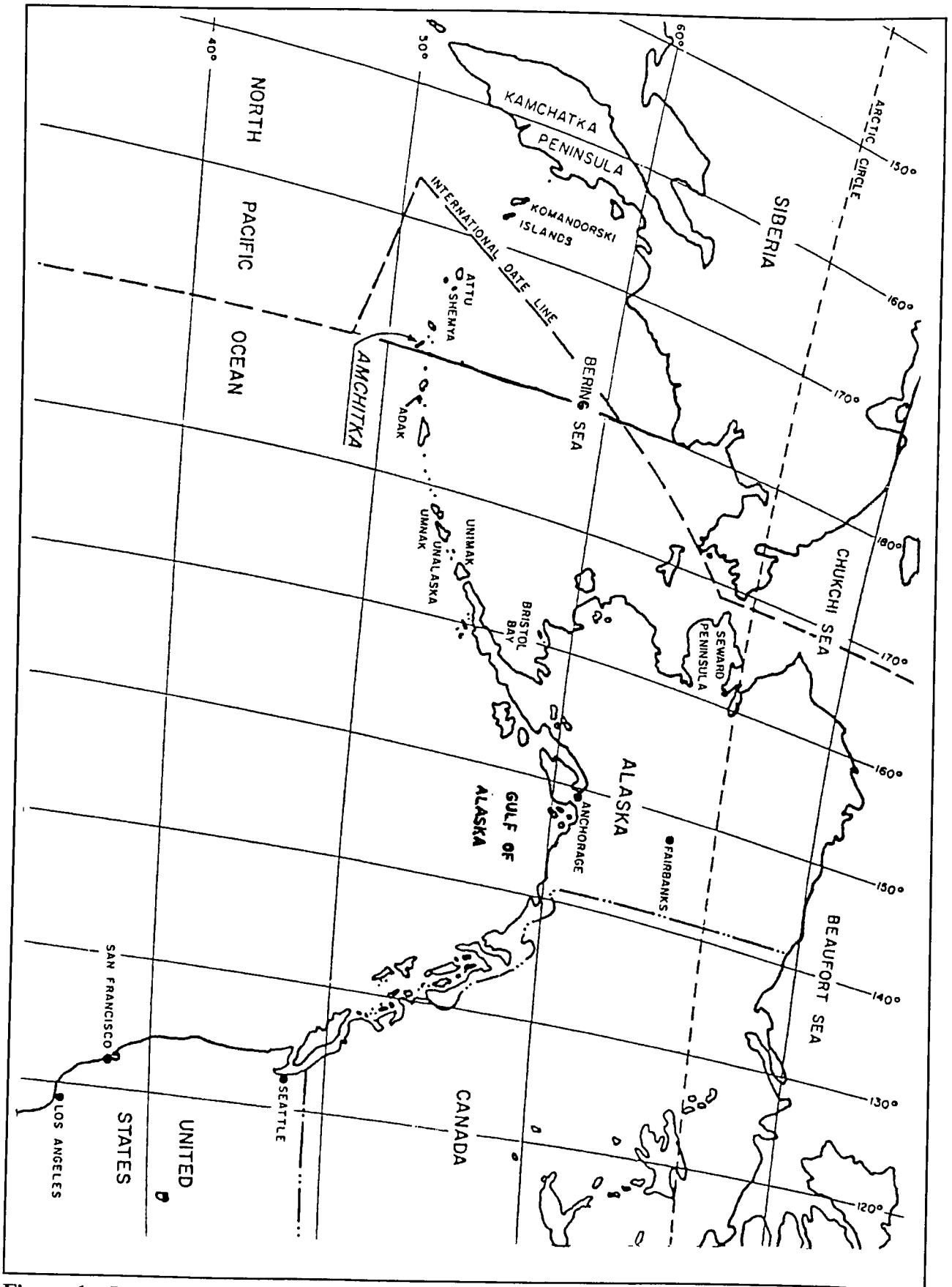

Figure 1. Location of Amchitka Island, Alaska

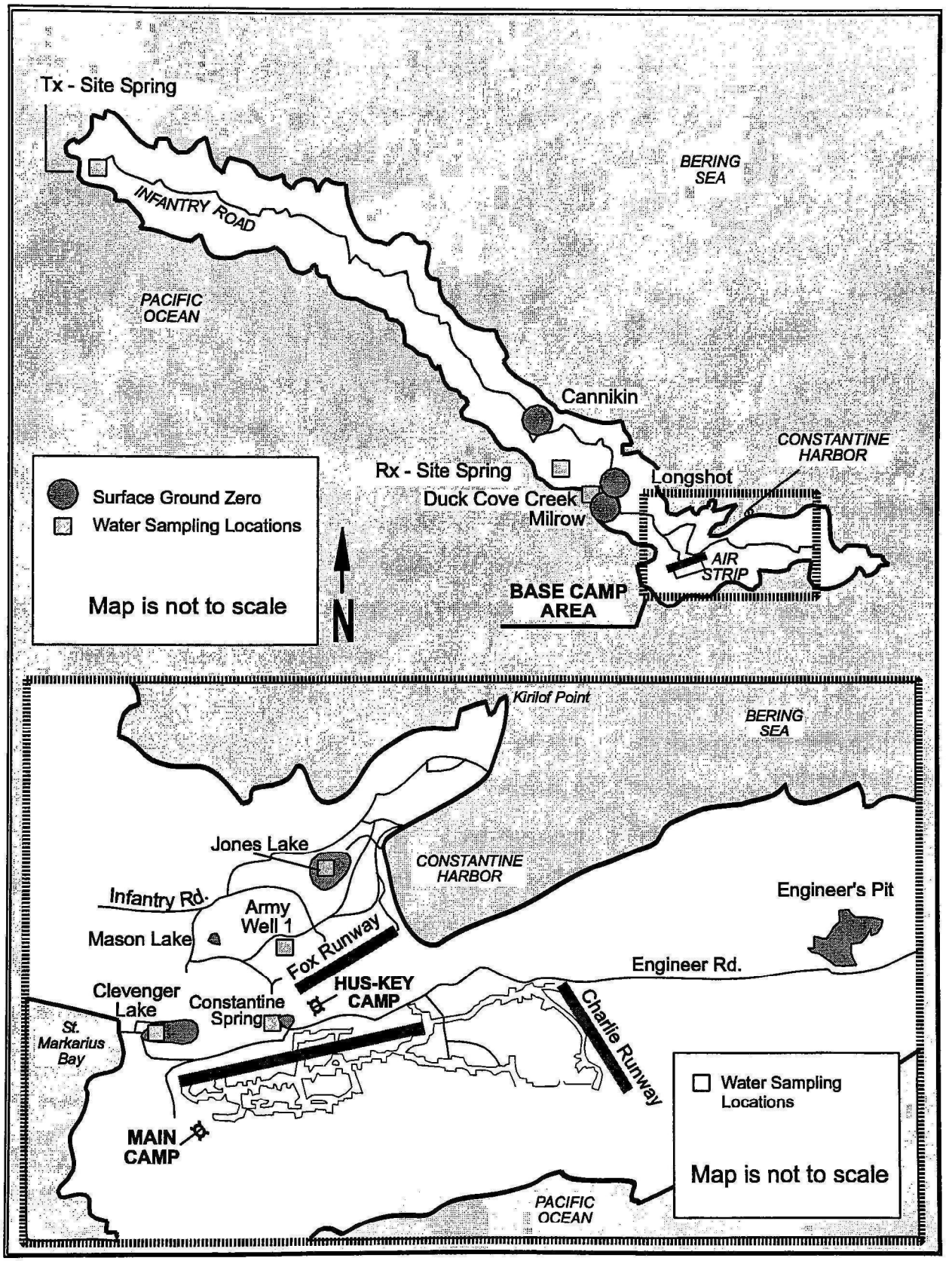

Figure 2. Amchitka Island and Camp Area

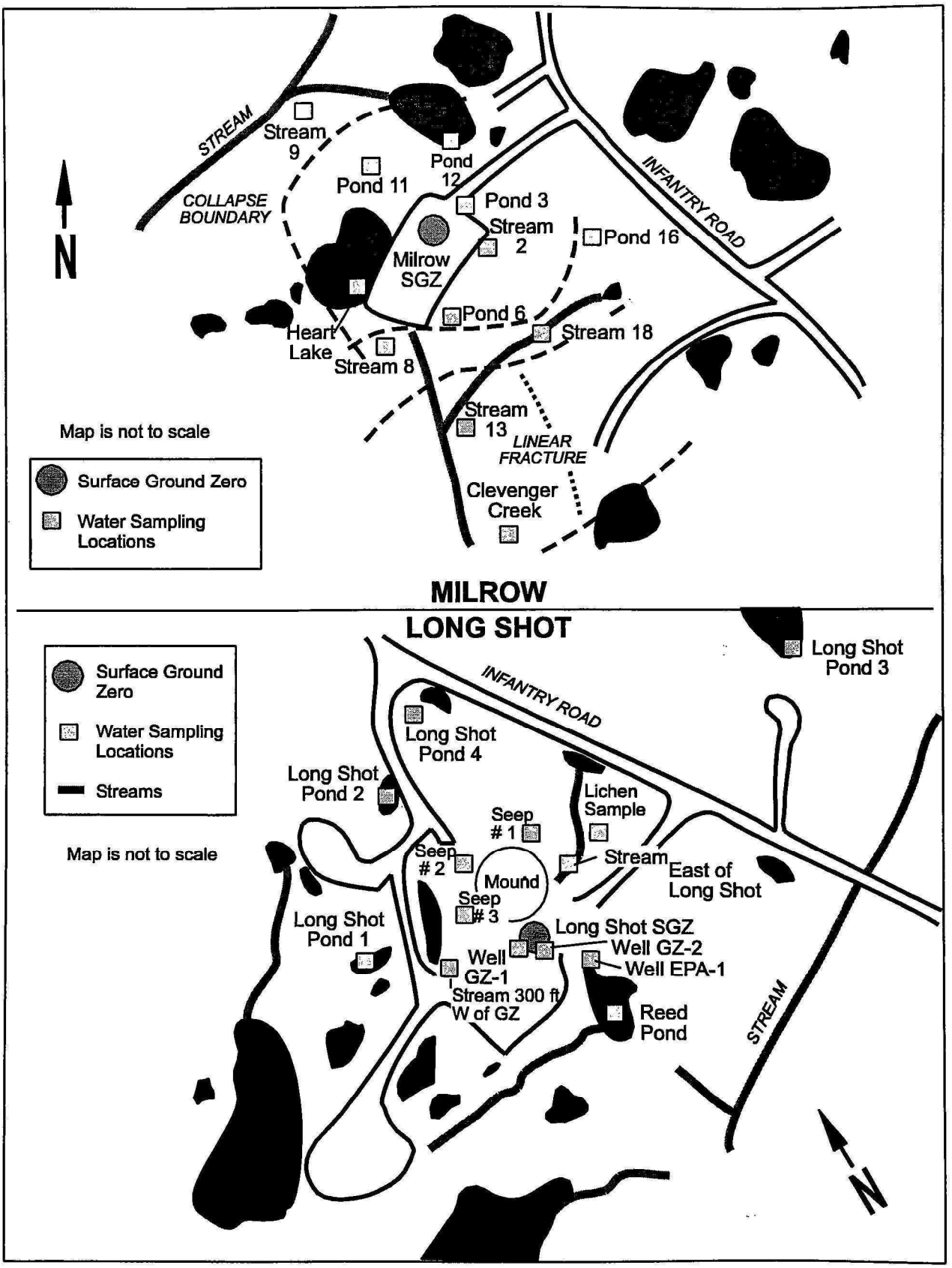

Figure 3. Longshot/Milrow Surface Ground Zero Area

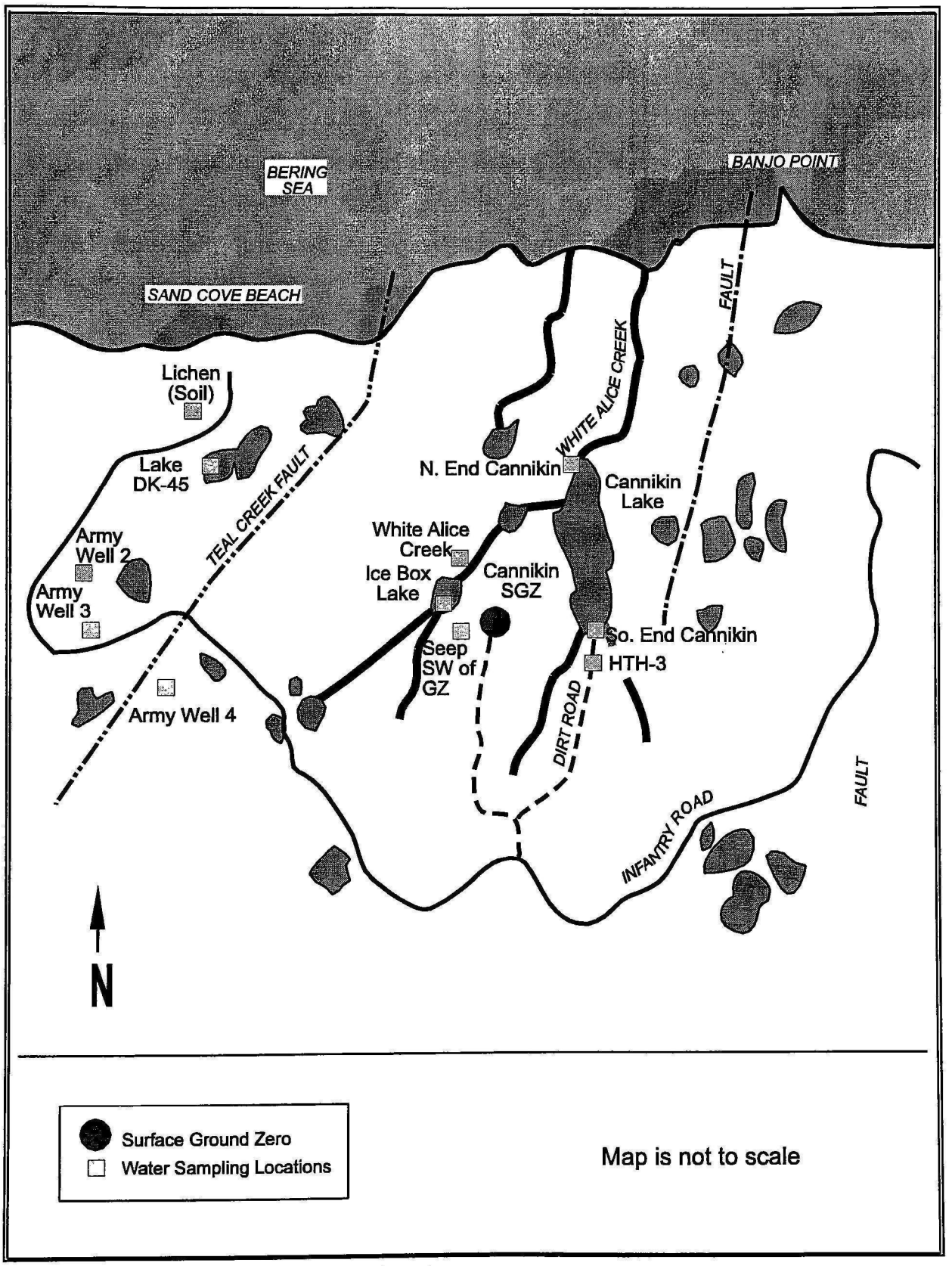

Figure 4. Cannikin Surface Ground Zero Area

Sample Analysis

Radiochemical laboratory procedures used to analyze the samples collected for this report are summarized in R&IE's SOPs listed in Appendix A, and for procedures summary see Appendix B. These include standard methods to identify natural and man-made gamma-emitting radionuclides, tritium, plutonium, strontium, and uranium in water samples.

Two types of tritium analyses were performed: conventional and electrolytic enrichment. The enrichment method lowers the minimum detectable concentration (MDC) from approximately 300 pCi/L to about 5 pCi/L. An upper limit of activity of 700 - 800 pCi/L has been established for the tritium enrichment method because sample cross-contamination becomes a problem at higher levels.

In late 1995, it was decided that a maximum of 25 percent of all samples collected would be analyzed by the low-level enrichment method. This decision was based on the time required for analysis, budgetary constraints, and an assessment of past results. Under the current sampling and analysis protocol for the site, all samples are initially screened for tritium activity by the conventional method, and selected samples are enriched. At this time, only sampling locations that are in position to show migration are selected for enrichment. Sufficient sample is collected from new sampling locations to perform all routine analyses, and a full suite of other radiochemical determinations including assays for strontium-90, plutonium, and uranium.

Water Analysis Results

The gamma-ray spectrometric analysis results indicate that no man-made gamma-ray emitting radionuclides were detected in any samples collected from the three sites: Cannikin, Longshot, and Milrow. Tritium concentrations above normal background at Longshot ranged from 542 ± 10 pCi/L at GZ #2 to 16 ± 4 pCi/L at Pond #3. The level at GZ #2 is well below the 20,000 pCi/L level defined in the U.S. EPA Drinking Water Regulation (40 CFR 141). Long term trends in tritium concentrations on Amchitka Island, Alaska, follow a decreasing trend established from prior LTHMP sampling. Tritium values for the samples are given in Tables 1, 2, 3, and 4.

Conclusions

Tritium concentrations on Amchitka Island, Alaska, follow a decreasing trend established from prior LTHMP sampling. At locations around the Longshot SGZ where contamination is known to exist, concentrations continue to decrease faster than would be expected from tritium decay alone, indicating that dilution is also an important factor.

Table 1. Sampling Locations Established at the Longshot Site (Figure 3).

Sample Location	Collection Date	Enriched Tritium pCi/L ± 2 SD (MDC)	Tritium [a] pCi/L ± 2 SD (MDC)	Gamma Spectrometry [b] pCi/L (MDC)
WL-1	7/31/01		18 ± 135 (222)	ND (1.6)
WL-2	7/31/01		69 ± 136 (222)	ND (1.8)
GZ-1	8/03/01		Gamma only	ND (1.6)
GZ-2	8/03/01	542 ± 10 (7.0)		ND (1.9)
EPA-1	7/31/01		32 ± 136 (222)	ND (1.9)
Surface Locations				
Reed Pond	8/03/01		Gamma only	ND (1.6)
Mud Pit No. 1 Stream[c]	8/03/01		96 ± 137 (222)	ND (1.9)
Mud Pit No. 2 Spring[c]	8/03/01		Gamma only	ND (1.5)
Mud Pit No. 3 Spring[c]	8/03/01	14 ± 4.1 (6.3)		ND (1.6)
Stream East of Longshot	8/03/01		110 ± 136 (221)	ND (1.9)
Stream West of GZ	8/03/01	11.5 ± 4.0 (6.0)		ND (1.5)
LS Pond No. 1	8/03/01		36 ± 135 (221)	ND (1.8)
LS Pond No. 2	8/03/01		110 ± 136 (221)	ND (1.9)
LS Pond No. 3	8/03/01	16 ± 4.0 (6.0)		ND (1.7)
LS Pond No. 4	8/03/01		123 ± 142 (230)	ND (1.6)
Vegetation	8/01/01		118 ± 142 (230)	

(a) Indicates results are less than MDC.
(b) No gamma radionuclides detected above MDC.
(c) (Seep or spring , grab sample at or near original sampling location. Sampling locations have been removed or plugged.
(ND) Non-detected MDC for gamma represents ^{137}Cs.

Table 2. Sampling Locations Established at the Milrow Site (Figure 3).

Sample Location	Collection Date	Enriched Tritium pCi/L ± 2 SD (MDC)	Tritium [a] pCi/L ± 2 SD (MDC)	Gamma Spectrometry[b] pCi/L (MDC)
W-1	8/02/01	Sample from stream (well plugged) Gamma only		ND (1.6)
W-2 Stream[c]	8/02/01		-14 ± 135 (222)	ND (1.8)
W-3 Pond[c]	8/02/01		18 ± 135 (222)	ND (1.6)
W-4		Well Removed (No Sample)		
W-5		Well Removed (No Sample)		
W-6 Pond[c]	8/02/01		50 ± 136 (222)	ND (1.5)
W-7		Well Removed (No Sample)		
W-8 Stream[c]	8/02/01		9 ± 135 (222)	ND (1.7)
W-9 Stream[c]	8/02/01		73 ± 136 (222)	ND (1.8)
W-10		Well Removed (No Sample)		
W-11 Pond[c]	8/02/01	Well Plugged	69 ± 136 (222)	ND (1.6)
W-12	8/02/01		9.0 ± 135 (222)	ND (1.6)
W-13 Stream[c]	8/02/01		4.6 ± 134 (221)	ND (1.6)
W-14		Well Removed (No Sample)		
W-15		Well Removed (No Sample)		
W-16 Pond[c]	8/02/01		14 ± 134 (221)	ND (1.5)
W-17		Well Removed (No Sample)		
W-18	8/02/01		-23 ± 133 (221)	ND (1.6)
W-19		Well Removed (No Sample)		
Surface Locations				
Heart Lake[c]	8/02/01	Well Plugged (Gamma only)		ND (1.8)
Duck Cove Creek	8/01/01		-18 ± 134 (222)	ND (1.6)
Clevenger Creek	8/01/01		41 ± 136 (222)	ND (1.5)

(a) Indicates results are less than MDC.
(b) No gamma radionuclides detected above MDC.
(c) Seep or spring , grab sample at or near original sampling location. Sampling locations have been removed or plugged.
(ND) Non-detected MDC for gamma represents ^{137}Cs.

Table 3. Sampling Locations Established at the Cannikin Site (Figure 4).

Sample Location	Collection Date	Enriched Tritium pCi/L ± 2 SD (MDC)	Tritium[a] pCi/L ± 2 SD (MDC)	Gamma Spectrometry[b] pCi/L (MDC)
HTH-3	7/31/01	13.6 ± 4.0 (6.3)		ND (1.8)
Surface Locations				
Cannikin Lake, north	7/31/01	15 ± 4.2 (6.5)		ND (1.5)
Cannikin Lake, south	7/31/01	13.5 ± 4.6 (7.0)		ND (1.9)
Ice Box Lake	8/01/01	15 ± 4.2 (6.5)		ND (1.9)
Stream SW Cannikin GZ[c]	8/01/01		59 ± 136 (222)	ND (1.6)
DK-45 Lake	8/01/01		-59 ± 133 (221)	ND (1.5)
DK-45 Veg	8/01/01		208 ± 144 (230)	
Decon Pump		Well Removed (No Sample)		
Decon Sump		Well Removed (No Sample)		
Constantine Spr Pumphouse		Removed (No Sample)		
RX-Site Spr[c]	8/04/01	Removed (No Sample)		ND (1.5)
TX-Site Spr	8/04/01		9.0 ± 136 (221)	ND (1.8)
TX-Site Water Tank House		Well Removed (No Sample)		
White Alice Creek	8/01/01	13 ± 4.2 (6.5)		ND (1.5)

(a) Indicates results are less than MDC.
(b) No gamma radionuclides detected above MDC.
(c) Seep or spring , grab sample at or near original sampling location. Sampling locations have been removed or plugged.
(ND) Non-detected MDC for gamma represents ^{137}Cs.

Table 4. Sampling Locations Established to Provide Background Data.

Sample Location	Collection Date	Enriched Tritium pCi/L ± 2 SD (MDC)	Tritium[a] pCi/L ± 2 SD (MDC)	Gamma Spectrometry[b] pCi/L (MDC)
Army Well No. 1	8/04/01		41 ± 135 (221)	ND (1.9)
Army Well No. 2	8/02/01		41 ± 135 (221)	ND (1.6)
Army Well No. 3		Well Removed (No Sample)		
Army Well No. 4	8/01/01		82 ± 136 (221)	ND (1.7)
Site E Hydro		Well Removed (No Sample)		
Site D Hydro		Well Removed (No Sample)		
Surface Locations				
Jones Lake	8/04/01		87 ± 137 (222)	ND (1.6)
Constantine Spr	8/04/01	17 ± 4.2 (6.4)		ND (1.9)
Clevenger Lake	8/02/01		64 ± 135 (221)	ND (1.6)
Rain Sample	8/03/01		41 ± 135 (221)	
Rain Sample	8/04/01		133 ± 137 (221)	

(a) Indicates results are less than MDC.
(b) No gamma radionuclides detected above MDC.
(ND) Non-detected MDC for gamma represents ^{137}Cs.

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GLOSSARY OF TERMS

Background Radiation

The radiation in man's environment, including cosmic rays and radiation from naturally-occurring and man-made radioactive elements, both outside and inside the bodies of humans and animals. The usually quoted average individual exposure from background radiation is 125 millirem per year in mid-latitudes at sea level.

Curie (Ci)

The basic unit used to describe the rate of radioactive disintegration. The curie is equal to 37 billion disintegrations per second, which is the equivalent of 1 gram of radium. Named for Marie and Pierre Curie who discovered radium in 1898. One microcurie (μCi) is 0.000001 Ci.

Isotope

Atoms of the same element with different numbers of neutrons in the nuclei. Thus ^{12}C, ^{13}C, and ^{14}C are isotopes of the element carbon, the numbers denoting the approximate atomic weights. Isotopes have very nearly the same chemical properties, but have different physical properties (for example ^{12}C and ^{13}C are stable, ^{14}C is radioactive).

Enrichment Method

A method of electrolytic concentration that increases the sensitivity of the analysis of tritium in water. This method can be used for samples containing less than 800 pCi/L of tritium..

Minimum Detectable Concentration (MDC)

The smallest amount of radioactivity that can be reliably detected with a probability of Type I and Type II errors at 5 percent each (DOE 1981).

Tritium

A radioactive isotope of hydrogen that decays by beta emission. Its half-life is about 12.5 years.

Type I Error

The statistical error of accepting the presence of radioactivity when none is present. Sometimes called alpha error.

Type II Error

The statistical error of failing to recognize the presence of radioactivity when it is present. Sometimes called beta error.

APPENDIX A

Standard Operating Procedures for the Center for Radioanalysis & Quality Assurance

RQA-302	Standard Operating Procedure of Gamma-Ray Detector Systems.
RQA-602	Tritium Enrichment Procedure.
RQA-603	Standard Operating Procedure for ^{89}Sr and ^{90}Sr in Water, Air Filters and Milk.
RQA-604	Standard Operating Procedure of Convention Tritium in Water.
RQA-606	Analysis of Plutonium, Uranium, and Thorium in Environmental Samples by Alpha Spectroscopy.

APPENDIX B

Summary of Analytical Procedures

Type of Analysis	Analytical Equipment	Counting Period (Min)	Analytical Procedures	Sample Size	Approximate Detection Limit[a]
HpGe Gamma[b]	HpGe detector calibrated at 0.5 keV/ channel (0.04 to 2 MeV range) individual detector. Efficiencies ranging from 15 to 35%.	100	Radionuclide concentration quantified from gamma spectral data by online computer program.	3.5 L	Varies with radionuclides.
^{3}H	Automatic liquid scintillation counter	300	Sample prepared by distillation.	5 to 10 mL	300 to 700 pCi/L
3H+ Enrichment (LTHMP samples)	Automatic liquid scintillation counter	300	Sample concentrated by electrolysis followed by distillation.	250 mL	5 pCi/L

[a] The detection limit is defined as the smallest amount of radioactivity that can be reliably detected, i.e., probability of Type I and Type II error at 5 percent each (DOE 1981).

[b] Gamma spectrometry using a high purity intrinsic germanium (HpGe) detector.

Typical MDA Values for Gamma Spectroscopy
(100 minute count time)

Geometry*	Marinelli	Model	430G
Matrix	Water	Density	1.0 g/ml
Volume	3.5 Liter	Units	pCi/L
Isotope	MDA	Isotope	MDA
		Ru-106	4.76E+01
Be-7	4.56E+01	Sn-113	8.32E+00
K-40	4.92E+01	Sb-125	1.65E+01
Cr-51	5.88E+01	I-131	8.28E+00
Mn-54	4.55E+01	Ba-133	9.16E+00
Co-57	9.65E+00	Cs-134	6.12E+00
Co-58	4.71E+00	Cs-137	6.43E+00
Fe-59	1.07E+01	Ce-144	7.59E+01
Co-60	5.38E+00	Eu-152	2.86E+01
Zn-65	1.24E+01	Ra-226	1.58E+01
Nb-95	5.64E+00	U-235	1.01E+02
Zr-95	9.06E+00	Am-241	6.60E+01

Disclaimer

The MDA's provided are for background matrix samples presumed to contain no known analytes and no decay time. All MDA's provided here are for one specific *Germanium detector and the geometry of interest. The MDA's in no way should be used as a source of reference for determing MDA's for any other type of detector. All gamma spectroscopy MDA's will vary with different types of shielding, geometries, counting times and decay time of sample.