Department of Energy
Idaho Operations Office
850 Energy Drive
Idaho Falls, Idaho 83401-1563
August 10, 1994

Report Recipients

SUBJECT: Transmittal of *Idaho National Engineering Laboratory Site Environmental Report for Calendar Year 1993* (OPE/SP-94-222)

Dear Recipient:

The goal of the Department of Energy (DOE) is to comply with all environmental regulations, and it is DOE policy to operate in a safe manner that protects human health and the environment. The enclosed *Idaho National Engineering Laboratory Site Environmental Report for Calendar Year 1993* documents that the impacts of INEL operations on the offsite environment were negligible. Calculated radiation doses to members of the public were well below EPA and DOE radiation protection standards.

The report discusses environmental surveillance programs, significant environmental activities, effluent monitoring results, and quality assurance programs. Environmental compliance issues at the INEL occurring between January 1993 and January 1994 are included in the report with a few references to activities which occurred in the early part of 1994.

If you have any questions or comments on this report, please contact Diana Hoff of DOE-ID at (208) 526-2160.

Sincerely,

J. M. Wilcynski
Acting Manager

Enclosure

The Idaho National Engineering Laboratory Site Environmental Report for Calendar Year 1993

Russell G. Mitchell
Environmental Science and Research Foundation

July 1994

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PREFACE

Every person living in the United States (or the world) is exposed to sources of ionizing radiation--radiant energy that produces ions as it passes through cells. There are three general types of radiation sources: those of natural origin unaffected by human activities, those of natural origin but enhanced by human activities, and those produced by human activities (manmade).

The first group includes terrestrial radiation from natural radiation sources in the ground, cosmic radiation from outer space, and radiation from radionuclides naturally present in the body. Exposures to natural sources may vary depending upon the geographical location and even the altitude at which a person resides. When such exposures are substantially higher than the average, they are considered to be elevated.

The second group includes a variety of natural sources from which the radiation has been increased by human actions. For example, radon exposures in a given home may be elevated because of natural radionuclides in the soil and rock on which the house is built; however, the radon exposures of occupants may be enhanced by characteristics of the home, such as extensive insulation. Another example is the increased exposure to cosmic radiation that airplane passengers receive when traveling at high altitudes.

The third group includes a variety of exposures from manmade materials and devices such as medical x-rays, radiopharmaceuticals used to diagnose and treat disease, and consumer products containing minute quantities of radio-active materials. Exposures may also result from radioactive fallout from nuclear weapons testing, accidents at nuclear power plants, and other such episodic events caused by man's activities in the nuclear industry. Except for major nuclear accidents, such as the one that occurred at Chernobyl, exposures to workers and members of the public from activities at nuclear industries are very small compared to exposures from natural sources[a].

To verify that exposures resulting from operations at the Department of Energy (DOE) nuclear facilities remain very small, each site at which nuclear activities are underway operates an environmental surveillance program to monitor the air, water and any other pathway whereby radionuclides from operations might conceivably reach workers or members of the public[b]. Environmental surveillance and monitoring results are reported annually to the DOE-Headquarters. This report presents data collected in 1993 for the routine environmental surveillance program conducted by the Radiological and Environmental Sciences Laboratory (RESL) of DOE and the U. S. Geological Survey (USGS) at the Idaho National Engineering Laboratory (INEL) Site, and presents summaries of effluent monitoring data collected by INEL contractors. The report, prepared in accordance with the requirements in DOE Order 5400.1, is not intended to cover the numerous special environmental research programs being conducted at the INEL by RESL, USGS, and others.

Section 9.g of DOE 5400.1 exempts the Naval Nuclear Propulsion Program's Naval Reactors Facility (NRF) from the provisions of this order and preparation of the Annual Site Environmental Report since the Naval Nuclear Propulsion Program separately maintains an environmental protection program which assures compliance with all applicable environmental laws and regulations. However,

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[a] Paraphrased from National Council on Radiation Protection and Measurements, *Ionizing Radiation Exposure of the Population of the United States*, NCRP Report No. 93, September 1, 1987, p. 1.

[b] DOE Order 5400.1, "General Environmental Protection Program", November 9, 1988.

for completeness, the NRF data from sitewide program monitoring (e.g. the RESL environmental surveillance and the USGS ground-water monitoring) are included in this report. In addition, monitoring data and information specific to NRF, similar to that of this report, is provided in a separate annual environmental report issued by NRF.

The Idaho National Engineering Laboratory Site Environmental Report for Calendar Year 1993 was prepared by the Environmental Science and Research Foundation under DOE Contract DE-AC97-94ID13268.

Helpful Information for the General Reader

Scientific Notation

Scientific notation is used to express numbers which are very small or very large. A very small number will be expressed with a negative exponent; e.g., 1.3×10^{-6}. To convert this number to the more commonly used form, the decimal point must be moved left by a number of places equal to the exponent (in this case 6). The number thus becomes 0.0000013.

For large numbers, those with a positive exponent, the decimal point is moved to the right by the number of places equal to the exponent. The number 1,000,000 (or one million) can be written as 1.0×10^{6}.

Unit Prefixes

Units for very small or very large numbers are commonly expressed with a prefix. One example is the prefix *kilo* (abbreviated k), which means 1,000 of a given unit. A kilometer is therefore equal to 1,000 meters. Other prefixes used in this report are:

Prefix	Abbreviation	Meaning
Mega	M	1,000,000 ($=1 \times 10^{6}$)
centi	c	1/100 ($=1 \times 10^{-2}$)
milli	m	1/1,000 ($=1 \times 10^{-3}$)
micro	μ	1/1,000,000 ($=1 \times 10^{-6}$)
nano	n	1/1,000,000,000 ($=1 \times 10^{-9}$)
pico	p	1/1,000,000,000,000 ($=1 \times 10^{-12}$)

Units of Radioactivity and Radiation Exposure and Dose

The basic unit of radioactivity used in this report is the curie (abbreviated Ci). The curie is based on the radionuclide Radium-226, of which one gram decays at the rate of 37 billion disintegrations per second. For any other radionuclide, one curie is the amount of that radionuclide that decays at this same rate.

Radiation exposure is expressed in terms of the Roentgen (R), the amount of ionization produced by gamma radiation in air. Dose is given in units of "Roentgen equivalent man" or rem, which takes into account the effect of radiation on tissues.

Radionuclide Nomenclature

Radionuclides are expressed with the one- or two-letter chemical symbol for the element. Radionuclides may have many different isotopes, which are shown by a superscript to the left of the symbol. This number is the atomic weight of the isotope (the number of protons and neutrons in the nucleus of the atom). Radionuclide symbols used in this report are shown in the following table.

Radionuclide Nomenclature

Radionuclide	Symbol	Radionuclide	Symbol
Tritium	^{3}H	Cesium-137	^{137}Cs
Beryllium-7	^{7}Be	Cesium-138	^{138}Cs
Carbon-14	^{14}C	Barium-139	^{139}Ba
Sodium-24	^{24}Na	Cesium-140	^{140}Cs
Potassium-40	^{40}K	Xenon-140	^{140}Xe
Argon-41	^{41}Ar	Cerium-144	^{144}Ce
Chromium-51	^{51}Cr	Thallium-208	^{208}Tl
Manganese-54	^{54}Mn	Lead-212	^{212}Pb
Iron-55	^{55}Fe	Bismuth-212	^{212}Bi
Cobalt-58	^{58}Co	Lead-214	^{214}Pb
Cobalt-60	^{60}Co	Bismuth-214	^{214}Bi
Zinc-65	^{65}Zn	Radon-220	^{220}Rn
Krypton-85	^{85}Kr	Radon-222	^{222}Rn
Krypton-87	^{87}Kr	Actinium-228	^{228}Ac
Krypton-88	^{88}Kr	Thorium-232	^{232}Th
Rubidium-88	^{88}Rb	Uranium-234	^{234}U
Rubidium-89	^{89}Rb	Uranium-238	^{238}U
Strontium-90	^{90}Sr	Plutonium-238	^{238}Pu
Yttrium-91	^{91}Y	Plutonium-239/240	$^{239/240}Pu$
Technetium-99	^{99}Tc	Americium-241	^{241}Am
Ruthenium-103	^{103}Ru	Curium-242	^{242}Cm
Antimony-125	^{125}Sb	Curium-244	^{244}Cm
Iodine-129	^{129}I		
Iodine-131	^{131}I		
Iodine-132	^{132}I		
Iodine-133	^{133}I		
Xenon-133	^{133}Xe		
Xenon-135	^{135}Xe		

ACRONYMS

ANL-W	Argonne National Laboratory-West
B&W	Babcock & Wilcox Idaho, Inc.
CAA	Clean Air Act
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFA	Central Facilities Area
CFR	Code of Federal Regulations
CFSGF	Coal-Fired Steam Generating Facility
CTF	Containment Test Facility
CWA	Clean Water Act
DEQ	(Idaho) Division of Environmental Quality
DOE	U.S. Department of Energy
DOE-ID	Department of Energy, Idaho Operations Office
DOE-HQ	Department of Energy, Headquarters
DWR	(Idaho) Department of Water Resources
EBR-I	Experimental Breeder Reactor-I
EBR-II	Experimental Breeder Reactor-II
EFS	Experimental Field Station
EIS	Environmental Impact Statement
EML	Environmental Measurements Laboratory
EPA	Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
ERP	Environmental Restoration Program
ICPP	Idaho Chemical Processing Plant
INEL	Idaho National Engineering Laboratory
INWMIS	INEL Nonradiological Waste Management Information System
ISU	Idaho State University
MCL	Maximum Contaminant Level
NCRP	National Council on Radiation Protection and Measurements
NEPA	National Environmental Policy Act
NESHAPS	National Emission Standards for Hazardous Air Pollutants

ACRONYMS (Cont.)

NIST	National Institute of Standards and Technology
NOAA/ARL	National Oceanic and Atmospheric Administration/Air Resources Laboratory
NPS/ IMPROVE	National Park Service/Interagency Monitoring of Protected Visual Environments
NPDES	National Pollution Discharge Elimination System
NRF	Naval Reactors Facility
NWCF	New Waste Calcining Facility
PBF	Power Burst Facility
QAP	Quality Assessment Program
RCRA	Resource Conservation and Recovery Act
RESL	Radiological and Environmental Sciences Laboratory
RI/FS	Remedial Investigation/Feasibility Study
RWMC	Radioactive Waste Management Complex
RWMIS	Radioactive Waste Management Information System
SARA	Superfund Amendment and Reauthorization Act
SDWA	Safe Drinking Water Act
SWPPP	Storm Water Pollution Prevention Plan
TAN	Test Area North
TLD	Thermoluminescent Dosimeter
TRA	Test Reactor Area
TSF	Technical Services Facility
USGS	U.S. Geological Survey
VANB	Van Buren Avenue
WEC	Westinghouse Electric Corporation
WINCO	Westinghouse Idaho Nuclear Company
WLAP	Wastewater Land Application Permit
WMP	Waste Management Program
WRRTF	Water Reactor Research Test Facility

EXECUTIVE SUMMARY OF THE ENVIRONMENTAL SURVEILLANCE PROGRAM

The results of the various monitoring programs for 1993 indicated that most radioactivity from the Idaho National Engineering Laboratory (INEL) operations could not be distinguished from worldwide fallout and natural radioactivity in the region surrounding the INEL Site. Although some radioactive materials were discharged during Site operations, concentrations and doses to the surrounding population were of no health consequence and were far less than State of Idaho and Federal health protection guidelines. Chapter 2 of the report summarizes INEL activities related to compliance with environmental regulations and laws for Calendar Year 1993. The major portion of the report summarizes results of the environmental surveillance program conducted by the DOE Radiological and Environmental Sciences Laboratory, which includes the collection of foodstuffs at the INEL boundary and distant offsite locations, and the collection of air and water samples at onsite locations and offsite boundary and distant locations. The report also compares and evaluates the sample results to appropriate federal regulations and standards and discusses implications, if any. The U.S. Geological Survey (USGS) ground-water monitoring program is briefly summarized and data from USGS reports are included in maps showing the spread of contaminants. Effluent monitoring and nonradiological drinking water monitoring performed by INEL contractors are discussed briefly and data are summarized in tables.

Gross beta measurements, which are used as a screening technique for air sampler filters, were investigated by making statistical comparisons between onsite or boundary location concentrations and the distant community group concentrations. In none of those comparisons in which a statistical difference existed (9% of the total number of comparisons made) was there any evidence that gross beta concentrations increased due to INEL operations. Gross beta concentrations also show trends for natural and manmade radionuclides.

Air samples were also analyzed for specific radionuclides. Some radionuclides were detected at offsite locations, but their presence was attributable to natural sources, worldwide fallout, or statistical variations in the analyses rather than to Site operations. The annual concentrations of all specific nuclides detected at all locations were well below the derived concentration guides for radiation protection.

Tritium was reported in one onsite precipitation sample but in no offsite samples. Although no clear evidence of INEL operations information could be linked to the presence of tritium in this sample, it was assumed to be due to Site activities since none was detected in offsite samples.

Approximately 15% of all drinking water samples collected during 1993 contained detectable concentrations of gross alpha activity and about 5% contained detectable gross beta activity. All concentrations of both types of activity were near the minimum detectable concentration and were probably due to natural radioactivity or to statistical variation in the analyses. Annual averages for all onsite and offsite drinking water samples were below the Environmental Protection Agency (EPA) maximum contaminant level for community drinking water systems. No offsite water samples contained detectable tritium concentrations. Five onsite production (drinking water) wells contained measurable concentrations of tritium. An effective dose

equivalent of 0.7 mrem/yr was estimated for INEL workers at the Central Facilities Area (CFA), the location with the highest tritium concentration in drinking water. Concentrations of volatile organic compounds measured in production wells at Test Area North (TAN) that were slightly above the EPA maximum contaminant levels in 1987, have been in compliance through 1993 after appropriate remedial action was taken.

None of the milk samples contained detectable concentrations of I-131 or tritium. One sample contained a concentration of Sr-90 that was consistent with levels seen in samples nationwide as reported by the EPA. Some lettuce samples contained small amounts of Sr-90. The presence of Sr-90 in food samples is probably due to its deposition on soil as a result of worldwide fallout. Low concentrations of Cs-137 were found in liver tissue of one pronghorn antelope. The levels were consistent with the concentrations from game animals both onsite and offsite in recent years.

Ionizing radiation measured simultaneously at the Site boundary and distant locations showed only natural background levels.

For details on monitoring results, see the appropriate sections that summarize results of radioactive, nonradioactive, and ground-water monitoring and surveillance programs.

A measurable amount of radioactivity, primarily in the form of noble gases and tritium, is released into the atmosphere annually from various plant facilities and is subsequently carried offsite. Upon reaching the Site boundary, this radioactivity is in such a low concentration that its effect on direct radiation levels cannot be measured; but its potential contribution to offsite dose equivalents is nevertheless calculated.

The hypothetical maximum individual effective dose equivalent was found to occur near Mud Lake and was calculated to be 0.03 mrem (3×10^{-4} mSv) using the MESODIF air dispersion model. The calculation considered continuous submersion in and inhalation of radioactivity in air, ingestion of radioactivity in leafy vegetables, and exposure to radioactive particulates deposited on the ground surface at that location. This calculated effective dose equivalent is about 0.009% of the natural background radiation effective dose equivalent of approximately 340 mrem per year in this area. The 1993 effective dose equivalent to the maximally exposed individual (who was assumed to live at all offsite receptor points simultaneously), calculated using the CAP-88 computer code that is required to demonstrate compliance with EPA regulations, was 0.011 mrem (0.003% of background). (See the section entitled "Maximum Individual Dose--Airborne Emissions Pathway" for a complete discussion of the two different computer models used) The maximum calculated dose to an individual by either of the methods is clearly in compliance with the applicable radiation protection standards.

The maximum potential population dose from submersion, ingestion, inhalation, and deposition to the approximately 121,000 people residing within an 80-km (50-mi) radius from the geographical center between the Test Reactor Area (TRA) and the Idaho Chemical Processing Plant (ICPP) facilities of the INEL Site was estimated to be 0.3 person-rem (3×10^{-3} person-Sv) using the MESODIF air dispersion model. This population dose is less than 0.001% of the estimated 42,500 person-rem (425 person-Sv) population dose from natural background radioactivity. These calculations and their implications are discussed in the section "Evaluation of Potential Dose to the Public."

Calculations indicate that the maximum potential 50-year dose commitment to an individual from ingestion of wild game animals is about 2% of the DOE radiation protection standard for individuals at points of maximum probable exposure.

The Idaho State University (ISU) Environmental Monitoring Group continued its independent program of collecting and analyzing air, water, and milk samples at selected locations matching some of the RESL environmental surveillance program locations. Comparisons of ISU and RESL data were well within the ranges expected when two different laboratories using different instruments and analytical methods analyze duplicate samples.

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FIGURES

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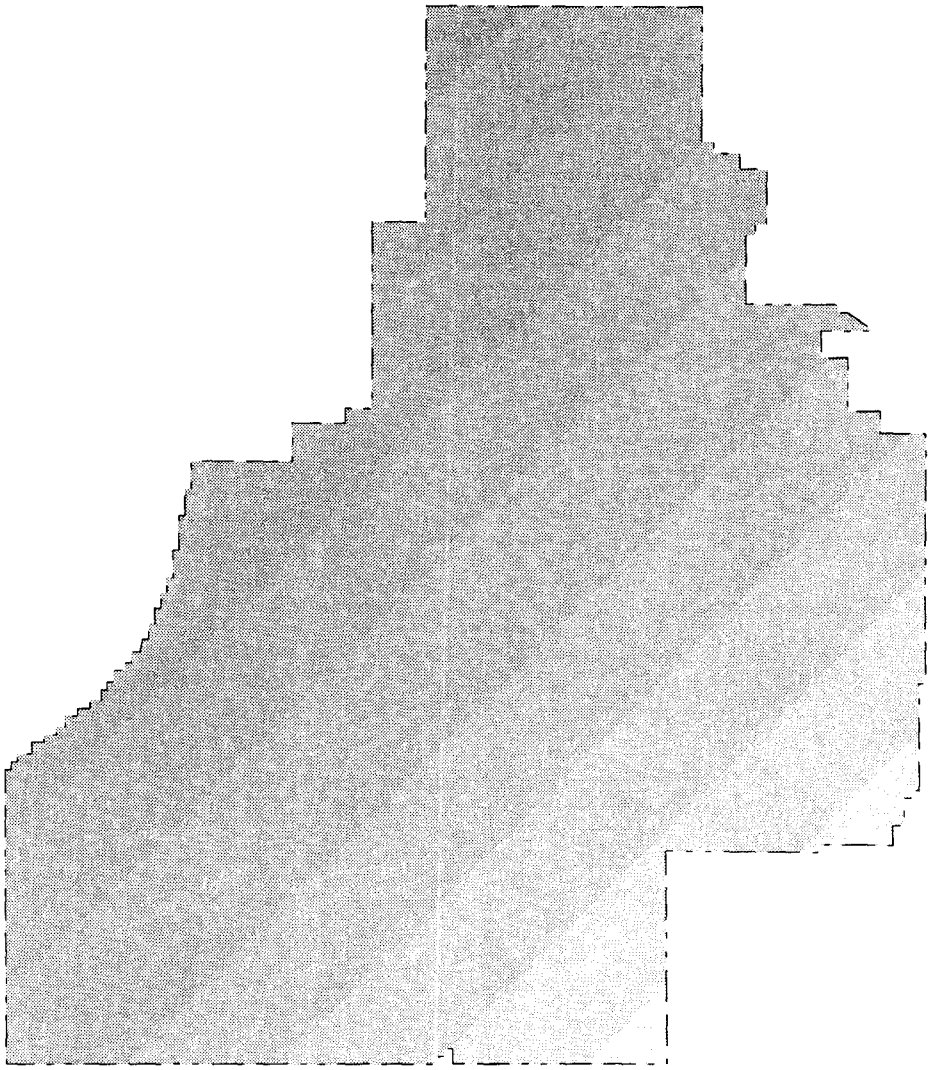
1. INTRODUCTION



1. INTRODUCTION

1.1 SITE DESCRIPTION

History

The Idaho National Engineering Laboratory (INEL) of the U.S. Department of Energy (DOE) was established as the National Reactor Testing Station on the southeastern Idaho desert in 1949 to conduct research and further the development of nuclear reactors (Figure 1.1). Prior to that time, the area was known as the Naval Proving Grounds and was used as a testing range for naval guns from the U.S. Naval Ordnance Station in Pocatello, Idaho.

The first reactor built at the INEL, the Experimental Breeder Reactor-I achieved initial criticality in December 1951. The Site expanded rapidly in the 1950s with the establishment of the Test Reactor Area, the Naval Reactors Facility, and the Idaho Chemical Processing Plant, and with the development of the Aircraft Nuclear Propulsion program at the current Test Area North. In July, 1955 one of the reactors (BORAX III) became the first to light an American town [Arco, Idaho].

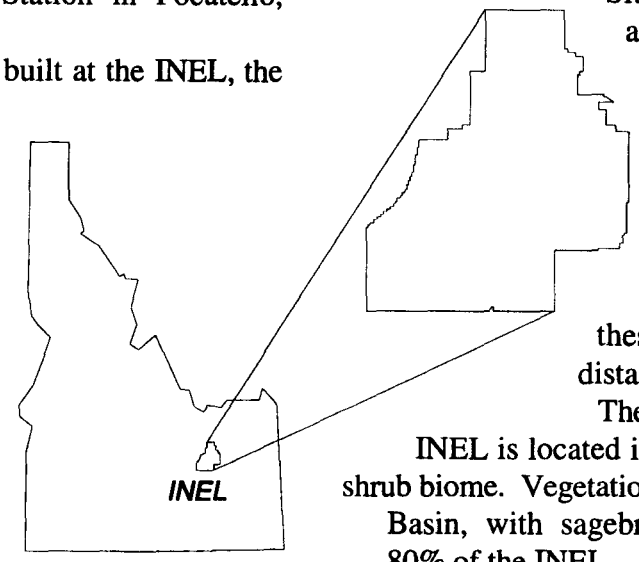


Figure 1.1 Location of INEL

In 1974, the name was changed from the National Reactor Testing Station to the INEL to better reflect current projects, which include non-nuclear as well as nuclear projects. To date, 52 reactors have been built at the INEL and 12 are still operable.

Physical Description

The INEL is situated on the eastern Snake River Plain in southeastern Idaho at an average elevation of 1500 m (4900 ft). The Site encompasses 2300 km^2 (890 mi^2); it extends 63 km (39 mi) from north to south and is about 58-km (36-mi) wide at its broader southern part. Land immediately beyond the boundaries of the Site is either desert or agricultural. Most of the nearby farming is concentrated northeast of the INEL. Large areas of agricultural land are farmed in the valleys adjacent to the Snake River, but these regions are more distant from the Site.

The plain on which the INEL is located is part of a cool, desert-shrub biome. Vegetation is typical of the Great Basin, with sagebrush conspicuous over 80% of the INEL.

The surface of the eastern Snake River Plain is composed of a sequence of basaltic lava flows extruded over the past two million years, partially covered by a veneer of sedimentary deposits. The sediment includes gravel and sand deposited by streams (as alluvial fans, channel fillings, and deltas), windblown sand, and silt and clay deposited in playa lakes. During the last glacial period, an

ancient lake known as Lake Terreton covered approximately 233 km^2 (35 mi^2) of the northern INEL[a].

Underlying the plain is the Snake River Plain Aquifer. Ground-water underflow from the Henry's Fork of the Snake River supplies a significant amount of water to the Snake River Plain Aquifer below the INEL. Additional recharge to the aquifer comes from the Big and Little Lost Rivers and Birch Creek drainages. These streams originate in the mountains to the northwest of the INEL. The Big Lost River and Birch Creek flow onto the INEL during wet years and sink into the porous soils. The underground water moves laterally at an average rate of 1.5 to 6 m/d (5 to 20 ft/d) to the south and west, and emerges in springs along the Snake River between Milner (located to the west of Burley) and Bliss, Idaho. Discharge volumes from typical springs in this region are approximately 4.3 x 10^9 m^3 (3.5 x 10^6 acre-ft) per year. Both the ground and surface waters of the Snake River Plain are used for crop irrigation.

Average annual temperature at the INEL Central Facilities Area is 5.6°C (42°F), with extremes of 38°C (101°F) and -44°C (-47°F). Annual precipitation in the area has averaged 22 cm (8.7 in.) over the past 15 years, peaking in late spring. Winds are predominantly along the southwest-northeast axis of the plain, with the most frequent and strongest winds from the southwest. The northeast winds are mostly nocturnal. Spring is the windiest time of the year, while winter has more calm periods and more nighttime temperature inversions[b].

The nearest INEL boundaries are 35 km (22 mi) west of Idaho Falls, 37 km (23 mi) northwest of Blackfoot, 71 km (44 mi) northwest of Pocatello, and 11 km (7 mi) east of Arco, Idaho (Figure 1.2). With a population of about 1100[c], Arco is the largest boundary community in the area surrounding the Site. Approximately 121,500 people reside within a radius of 80 km (50 mi) of the Site's operational center, the TRA-ICPP area (Figure 1.3). There are no residents within 16 km (10 mi) of that center with Atomic City (population 25) being the closest boundary community.

1.2 INEL MISSION AND FACILITIES

Mission

The mission of the INEL is to develop, demonstrate, and deploy advanced engineering technology and systems to improve U.S. competitiveness and security, the efficient production and use of energy, and the quality of life and the environment worldwide[d].

Facilities

Major facilities are operated by Argonne National Laboratory-West (ANL-W), EG&G Idaho, Inc. (EG&G), Babcock and Wilcox, Idaho, Inc. (B&W), Westinghouse Electric Corporation (WEC), and Westinghouse Idaho Nuclear Company (WINCO). Facilities are located both in Idaho Falls and at eight operating areas on the INEL (Figure 1.3). Major facilities include:

ANL-W. ANL-W is testing the Integral Fast Reactor, a new generation of breeder reactor that has advantages in safety and waste

[a] S.J. Miller, *INEL Management Plan for Cultural Resources*, DOE/ID-10361, March 1993.

[b] K.L. Clawson, G.E. Start, and N.R. Ricks, *Climatography of the Idaho National Engineering Laboratory, 2nd Edition*, DOE/ID-12118, December 1989.

[c] 1990 Census Report.

[d] U.S. Department of Energy, Idaho Operations Office; *1994 INEL Site-Specific Plan*, DOE/ID-12053, 1993.

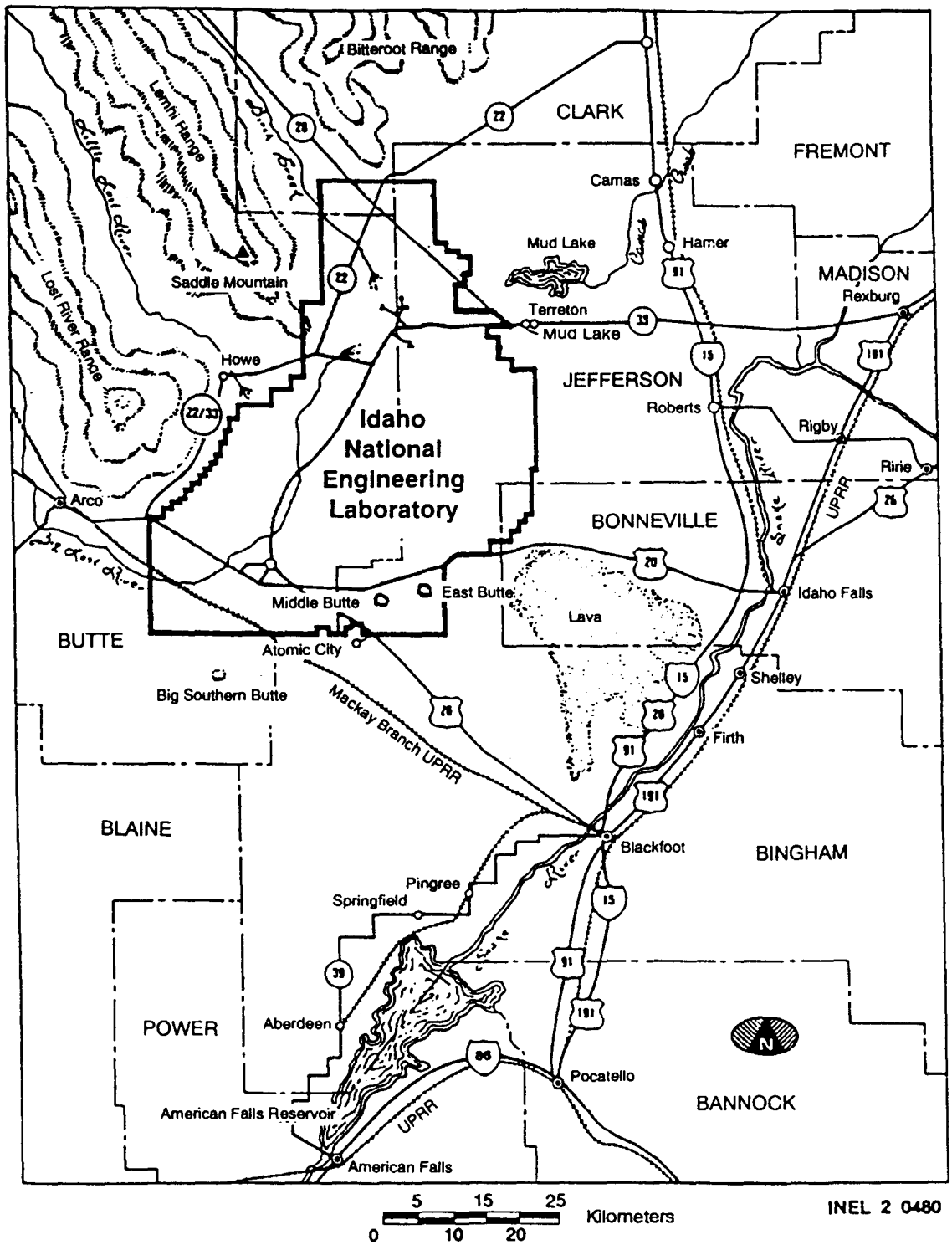


Figure 1.2 INEL Vicinity

reduction. The facility is operated by University of Chicago's Argonne National Laboratory under contract to the DOE Chicago Field Office.

ICPP. The Idaho Chemical Processing Plant (ICPP), operated by WINCO, receives and stores nuclear fuels from the U.S. Navy and other activities. Technologies for treatment and disposal of high-level waste are being developed. High-level wastes are being treated and will ultimately be prepared for disposal in a permanent repository.

TAN. The largest program currently at the Test Area North (TAN) is the Specific Manufacturing Capability Project operated by B&W, which produces armor for the M1A1 Abrams tank. Other research conducted at the area includes testing fuel storage casks and studying the Three Mile Island core debris.

TRA. The Test Reactor Area (TRA) has studied the effects of radiation on materials, fuels, and equipment for nearly 40 years. The Advanced Test Reactor can conduct nine environmentally controlled experiments simultaneously.

PBF. The Power Burst Facility (PBF) area contains the Waste Experimental Reduction Facility which processes low-level waste to reduce waste volume through incineration, sizing of metallic waste, and compaction. The Mixed Waste Storage Facility is also located at the area.

NRF. The Naval Reactors Facility (NRF) is operated by WEC for DOE's Pittsburgh Naval Reactors Office.

RWMC. The Radioactive Waste Management Complex (RWMC) is a center for studying waste storage, processing, and disposal. The Stored Waste Examination Pilot Plant is used to nondestructively examine waste before it is sent to the Waste Isolation Pilot Plant in New Mexico. Pit 9 and Pad A are the sites for major ongoing cleanup efforts using new high-technology strategies.

CFA. Support services and laboratories for environmental monitoring and analytical chemistry are located at the Central Facilities Area (CFA).

Idaho Falls. Idaho Falls facilities include the INEL Research Center, featuring a plasma research center, biotechnical center, and a materials research laboratory. The INEL Supercomputing Center offers a wide range of computer systems, among them a CRAY X-MP/216 supercomputer.

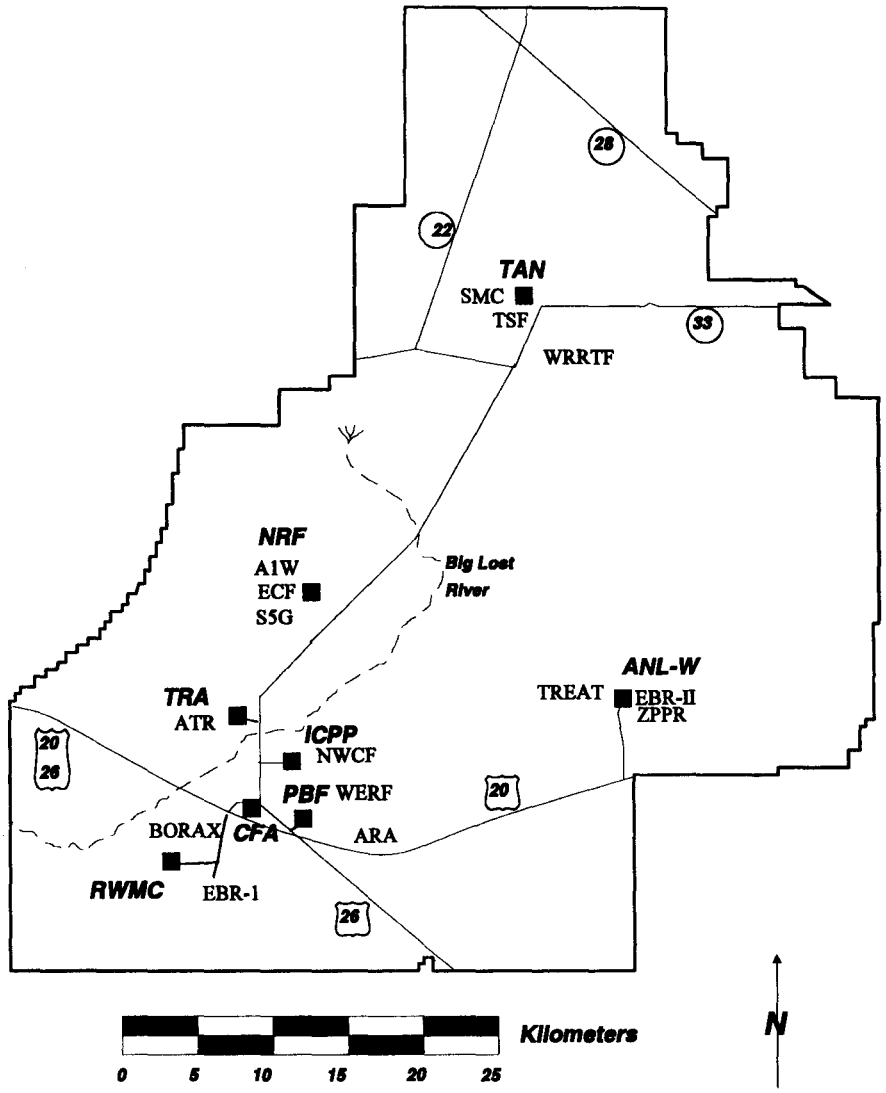


Figure 1.3 INEL Facilities

2. ENVIRONMENTAL COMPLIANCE SUMMARY

2. ENVIRONMENTAL COMPLIANCE SUMMARY

The INEL is committed to operating in compliance with all environmental laws, regulations, Executive Orders, DOE Orders, and compliance agreements with the Environmental Protection Agency (EPA) and State of Idaho agencies. The following is a summary of the INEL's current compliance status with major environmental statutes for the period January 1993 through December 1993. Environmental statutes are listed in Appendix A, Environmental Standards and Regulations.

2.1 COMPLIANCE STATUS

Comprehensive Environmental Response, Compensation & Liability Act (CERCLA)

The CERCLA requires that specific procedures be used to assess inactive waste sites for the release of hazardous substances. There are three tiers of activity: 1) preliminary assessment; 2) remedial investigation/feasibility studies; and 3) remedial actions. The INEL was placed on the National Priorities List on November 29, 1989. Environmental restoration activities are being conducted in accordance with the Federal Facilities Agreement and Consent Order signed on December 9, 1991 in consultation with the State of Idaho and EPA Region 10. By the end of 1993, determinations were made as to resolution of 63% of the Track 1 sites identified in the agreement. The Track 1 process is used for potential release sites that are unlikely to require further field data collection before a decision can be made to clean up the site, to expand the investigation, or to take no further action. Costs for this streamlined process are much lower because existing data are used, and major investigations such as Remedial Investigation/Feasibility Studies that can cost several million dollars are minimized. More information is presented in Section 3.1, Environmental Restoration Program.

CERCLA Continuous Release Reporting. In March 1993, DOE-ID performed a sitewide effluent review in an effort to identify any releases that could qualify as CERCLA continuous releases. Questionnaires were completed by INEL contractors and reviewed to identify any releases possibly exceeding CERCLA or Emergency Planning and Community Right-to-Know Act Reportable Quantities. The effort identified no known releases which could qualify as CERCLA continuous releases.

Emergency Planning and Community Right-to-Know Act (EPCRA)

The EPCRA provides the public with information about hazardous chemicals on the INEL and establishes emergency planning and notification procedures to protect the public

from a release. Subtitle A of the Act calls for the creation of state emergency response commissions to guide planning for chemical release emergencies. Subtitle B contains requirements for periodic reporting on hazardous chemicals stored and/or used on the Site to provide the public with the basis for emergency planning.

The INEL complies fully with the EPCRA reporting requirements. Quarterly updates to the INEL hazardous substance list, as required by Superfund Amendments and Reauthorization Act (SARA) Title III Section 311, are submitted to the Local Emergency Planning Committees, the State Emergency Response Commission, and the local fire departments on January 1, April 1, July 1, and October 1 of each year.

The Emergency and Hazardous Chemical Inventory (Tier II) Reports, as required by SARA Title III, Section 312, were transmitted to the emergency response organizations by March 1, 1993, as required.

The Toxic Chemical Release Inventory Report (SARA Title III Section 313) was required for two INEL subcontractors in 1993. The reporting threshold was met for nitric acid. The reports were prepared and submitted to the EPA by July 1, 1993. Additionally, voluntary revisions to the 1990 and 1991 nitric acid reports were submitted to EPA by WINCO. An assessment of the main stack at ICPP made it necessary to adjust the amounts of nitric acid reported as released in the 1990 and 1991 Toxic Chemical Release Inventory Reports.

On August 3, 1993, Executive Order 12856 was signed. It requires all Federal Agencies to comply with EPCRA and commits the Federal Government to participate in the EPA 33/50 program, which requests the government to reduce its releases of 17 priority Toxic Chemical Release Inventory chemicals by 50% before the end of 1999.

For reporting year 1993, the INEL exceeded the threshold level for only one of EPA's 33/50 Reporting Program 17 priority chemicals, methyl isobutyl ketone. Compared to the base year of 1991, releases of methyl isobutyl ketone were down by 43% in 1993 (Appendix B). This decrease was primarily due to a reduction in operation of the process at the INEL which uses the chemical.

Natural Resource Trusteeship & Natural Resources Damage Assessment

Executive Order 12580, Section 2(d), appoints the Secretary of Energy as the primary Federal Natural Resource Trustee for natural resources located on, over, or under land administered by DOE. Natural resource trustees act on behalf of the public when natural resources may be injured, destroyed, lost, or threatened as a result of a release of a hazardous substance. Federal agencies, states, and Indian tribes are designated as natural resource trustees by National Contingency Plan Sections 300.600(b), 300.605, and 300.610, respectively. In the case of the INEL, other potential natural resource trustees with possible jurisdiction over trust resources are the State of Idaho, Department of Interior (Bureau of Land Management and U.S. Fish and Wildlife Service), and Shoshone-Bannock Tribes.

Past releases of hazardous substances resulted in INEL's placement on the National Priorities List. These same releases create the potential for injury to natural resources. Therefore, in accordance with CERCLA, Section 104(b)(2) and National Contingency Plan 300.15(j), DOE-ID formally notified the other natural resource trustees of potential injury to natural resources in a letter dated July 7, 1992. A meeting was held on March 17, 1993 to discuss coordination between trustees and a proposal for formalizing a protocol

addressing natural resource injury was mailed by DOE-ID to the other trustees on April 2, 1993.

In May 1994, EG&G Idaho published the Preliminary Draft of EGG-ER-11321, *Guidance Manual for Conducting Screening Level Ecological Risk Assessments at the INEL.* This document presents reference material for conducting screening level ecological risk assessments at waste area groups at the INEL. Included in this document are discussions of the objectives and processes of conducting ecological risk assessments, previous investigations, stressor characterization, ecological effects, pathways of contaminant migration, assessment endpoints, the conceptual site model, measurement endpoint selection, analysis guidance, and risk characterization guidance.

Clean Air Act (CAA)

The CAA sets standards for ambient air quality and for air emission of hazardous air pollutants. EPA is the federal regulatory agency of authority, but states may administer and enforce CAA provisions by obtaining EPA approval of a State Implementation Plan. The primary tool for enforcing most provisions of the CAA for point source emissions is the permitting process. The EPA established the Prevention of Significant Deterioration program to protect air quality while still allowing a margin for future growth. Each proposed new point source with the potential to release air pollutants at the INEL must apply for a construction permit and a Prevention of Significant Deterioration permit. Existing or newly constructed sources must apply for an operating permit. When issued, the permit contains specific requirements to ensure the point source operates within the limits of the permit.

The State of Idaho submitted their Title V Operating Procedures to EPA in November 1993. These procedures will be followed in preparing the sitewide INEL Operating Permit Application. There will be one operating permit for the INEL with a separate section for each facility. The contractors are currently working on their applications. DOE-ID and the State of Idaho have agreed to a submission date of July 31, 1995. This date is based on EPA approval of the Idaho Procedures in November 1994.

Fuel Storage Area permit. In July 1993, the State of Idaho sent a letter stating they were suspending the processing of the Fuel Storage Area air permit application. While this action was a result of the ruling in U. S. vs. Andrus, it may be inconsistent with plans/requirements for moving out of ICPP Building 603 [Spent Fuel Storage Building]. The Air Permit for the Fuel Storage Area-Rack Reconfiguration Project will not be pursued pending the Record of Decision for the Department of Energy Programmatic Spent Nuclear Fuel Management Environmental Impact Statement.

Coal-Fired Steam Generating Facility Permit. At the time the Coal-Fired Steam Generating Facility (a fluidized-bed boiler) was granted a permit in 1981, emission factors for this type of boiler were not available. Reported releases were based on emission factors developed by EPA for nitrogen oxides from various fuel types, using what was perceived to be a similar boiler[a]. Revisions made in 1993 to the emission factors included factors for fluidized-bed, coal-fired boilers. Calculations using the new factors indicated emissions of carbon

[a] U.S. Environmental Protection Agency, *Compilation of Air Pollutant Emission Factors, AP-42, Part A,* August 1982, p. 1.3-2.

monoxide were significantly higher than permitted. Subsequently, stack sampling confirmed the emission calculations based on the new factors. The situation was reported to State of Idaho Division of Environmental Quality and EPA Region 10. EPA Region 10 retained jurisdiction of the permit since EPA issued the original permit. EPA required an application for a modification to the existing permit to correct the situation. The permit application was submitted on November 30, 1993 and approved by EPA on February 14, 1994.

Fuel Processing Restoration Permit. This permit imposes emission limitations on the now defunct Fuel Processing Restoration project, the New Waste Calcining Facility, as well as existing fuel-burning sources (boilers) throughout the INEL. DOE-ID personnel met with the State of Idaho to discuss the status of the permit. As a result of the meeting, emission limitations for existing boilers must remain as is because these fuel-burning sources serve as the baseline for future Prevention of Significant Deterioration permitting.

An application requesting modification of the Fuel Processing Restoration permit was submitted on December 6, 1993. Modifications include eliminating reference to the Fuel Processing Restoration project, eliminating the Nitrogen Oxide Abatement project, and increasing hourly emissions of nitrogen oxides from the New Waste Calcining Facility operations based on the maximum quantity specified in the permit application as long as the annual total does not exceed the 1700 tons/yr currently permitted. The State of Idaho declared the application incomplete pending receipt of additional information.

RWMC Sewage Pond Air Permit. The State of Idaho Department of Environmental Quality determined that the RWMC sewage pond did not require an air permit for construction.

TRA Pond. A meeting between DOE-ID personnel and the State of Idaho was held to discuss the Permit to Construct requirements. Concerns that would potentially delay operation of the pond to August of 1993 were raised. One was resolved by a letter from EPA to the State of Idaho stating that 40 CFR 61.93, which refers to point sources rather than area sources, did not apply. Another concern was related to the interpretation of the permit language concerning fluctuation in water level of the pond. EG&G was to write their procedures based on their interpretation of the language in the Permit to Construct and submit them to the State for approval.

The most difficult concern was related to the monthly limit of 27.1 curies of radioactivity in effluent, derived by dividing the annual limit of 324.3 by 12. EG&G felt they would exceed the 27.1 curies for several months at the June 1993 operation level. This could result in shutdown of the facility to avoid exceeding the permit limits. All concerns were resolved, and the new lined pond at TRA was put into operation during August 1993.

National Emission Standards for Hazardous Air Pollutants (NESHAPs)

In June 1993, DOE-ID submitted the NESHAPs Annual Report for Calendar Year 1992. The airborne radionuclide emissions (monitored, unmonitored, and diffuse sources) from INEL operations in 1992 were calculated to result in a maximum individual effective dose equivalent to a member of the public of 0.0018 mrem/yr (1.8×10^{-5} mSv/yr) using the CAP-88 computer code. This dose was 0.02% of the 40 CFR 61 Subpart H, regulatory standard of 10 mrem/yr. The 1993 calculations

are discussed in Chapter 4, Environmental Radiological Program Information. The INEL has developed a Periodic Confirmatory Measurements program as required by NESHAPs. This measurements program, which applies to all air emission pathways that do not require continuous monitoring, was implemented during calendar year 1993. Information about this program will be included in the 1993 NESHAPs Annual Report to be published in June 1994.

Clean Water Act (CWA)

The CWA, originally passed in 1972, established goals to control pollutants discharged to U.S. surface waters. Among the main elements of the Act were effluent limitations set by the EPA for specific industry categories and water quality standards set by states. The CWA also provided for the National Pollutant Discharge Elimination System permit program, requiring permits for discharges from a point source into surface waters. An expansion of the National Pollutant Discharge Elimination System is now underway with the issuance of storm water discharge permits to medium and large municipalities and sites with industrial activity.

Waters of the U.S. Delineation. To assist in ensuring CWA compliance, areas on the INEL that are potential "Waters of the U.S." (as defined in 40 CFR 122.2) were mapped and the maps were presented to EPA Region 10 in 1993. These areas encompass what is called the Big Lost River system, which includes the Little Lost River, Birch Creek, the Big Lost River, and connecting tributaries and playas. In November 1993, the Army Corps of Engineers also designated the INEL Spreading Areas A and B near RWMC as Waters of the U.S.

Clean Water Act Section 404 Permits. DOE-ID has applied for a CWA Section 404 permit for the removal of material from the INEL Spreading Areas A and B near the RWMC. These activities will become subject to Section 404 permitting requirements August 23, 1994 as the result of promulgation of regulations which modified the definition of "discharge of dredged materials."

Spill Prevention Control and Countermeasures Plans. Evaluations were conducted in 1993 to determine which INEL facilities are required under 40 CFR 112 to have a Spill Prevention Control and Countermeasure Plan. These plans for identified facilities are currently being revised to meet the requirements and will be completed by September 30, 1994.

Oil Pollution Abatement. Evaluations were conducted to determine applicability of a proposed Oil Pollution Abatement rule revision published in the Federal Register (58 FR 8824 February 17, 1993). The proposed rule requires preparation and submittal of facility response plans for facilities determined to be "substantial harm" facilities. Based on the evaluations, it was determined that there are none of these facilities at the INEL, and that the INEL, as a whole, is also not a "substantial harm facility. " A certification of no substantial harm will be prepared during fiscal year 1994 and kept on file at the INEL.

National Pollutant Discharge Elimination System (NPDES) Point Source Discharge Permits

General. All INEL facilities were inventoried for point source discharges to Waters of the U.S. in 1992 and 1993. In October 1993, information obtained from Phase I of the INEL Liquid Effluent Inventory and from evaluations conducted as part of the INEL Storm Water

Pollution Prevention Plan for Industrial Activities was examined to identify any potential point source discharges. None were identified with the exception of the previously identified pressure relief discharges from ICPP production well pump stations to the Big Lost River.

An NPDES permit application for the ICPP discharges was submitted to EPA Region 10 in 1992. EPA concluded that the pollutant discharges were minor, and that they would not issue a permit at this time due to higher permitting priorities. EPA indicated that ICPP is expected to comply with Idaho Water Quality Standards until a permit is issued at some time in the future.

NPDES Storm Water Discharge Permits for Industrial Activity. The INEL applied for coverage under the General Permit for Storm Water Discharges Associated with Industrial Activity on September 28, 1992. An INEL Storm Water Pollution Prevention Plan (SWPPP) was completed on April 1, 1993 for all applicable areas and was implemented by October 1, 1993. Major facility area subsections are included in the INEL SWPPP. These plans will be kept on file and updated as necessary due to General Permit requirements. Annual inspections will be conducted by the SWPPP Team to determine compliance with the plans and the need for revision. Storm Water monitoring will be conducted at all facilities by the EG&G Environmental Support Group in accordance with the permit requirements and with DOE Orders. Procedures have been implemented with the NOAA/ARL for identification and notification to DOE and contractor officials of storm events.

NPDES Storm Water Discharge Permit for Construction Activity. INEL submitted a Notice of Intent for coverage under the General Permit, and a generic INEL SWPPP for construction activities was prepared. The SWPPP affects any construction activity at the INEL after October 1, 1992 or any construction activity that has not received final stabilization by October 1, 1992. Construction includes clearing, grading, or excavation but does not include industrial activities. Facility area-specific SWPPPs are in preparation and will list specific requirements for construction projects in a major facility area. Projects outside the major area are required to prepare a project-specific SWPPP. Again, procedures have been implemented with the NOAA/ARL for identification and notification of storm events.

Executive Order 11990--Protection of Wetlands

A plan will be developed, and funding requested, to identify and field verify regulated wetlands at the INEL. This will include a prioritized schedule of areas or potential sites to be evaluated from fiscal year 1994 through fiscal year 1998. About 20 sites will be evaluated per year. Sites delineated on the 1993 U.S. Fish and Wildlife Service INEL National Wetlands Inventory map will be included in the prioritization process. Other information gathered from previous field investigations will also be used to establish the prioritized schedule. Proximity to facility operational areas, or sites that are currently being used, will be given the highest priority.

The U.S. Fish and Wildlife Service National Wetlands Inventory map will be used as a source of information to identify potential wetlands or non-regulated sites with ecological, environmental, or future development significance. National Wetlands Inventory sites that are clearly not wetlands will be eliminated from INEL inventory maps with the concurrence of the U.S. Fish and Wildlife Service. A DOE-ID

policy will be developed delineating how National Wetlands Inventory sites will be managed at the INEL. Regulated wetlands will be added to the maps and will be identified in a manner that will clearly differentiate "regulated wetlands" from "non-regulated wetlands." Currently there are no identified operations at the INEL that are impacting regulated wetlands.

Executive Order 11988--Floodplain Management

In the fall of 1993, DOE-ID obtained stereographic aerial photographic coverage of INEL site areas judged to lie within the 100-yr floodplains of the Big Lost River and Birch Creek as an initial step in the production of a map of INEL floodplains. Early in 1994, DOE-ID gave approval to proceed with the remaining tasks in the floodplain mapping project. One early project task is using the aerial photographs to produce detailed topographic maps, an important prerequisite to mapping the floodplains. The U.S. Geological Survey will carry out the remaining technical tasks making up the floodplain study. Maps of the 100-yr floodplains of the Big Lost River and Birch Creek, and a report documenting the floodplain study, are expected to be finished near the end of fiscal year 1996.

Although the floodplains of the Big Lost River and Birch Creek will be delineated by the present project, the project will not account for all areas on the Site having a one-percent or greater chance of being flooded in any given year. Specifically, the study will not include areas which may be prone to flooding caused by runoff from local drainage basins. Such studies will have to be conducted separately. However, the detailed topographic maps to be produced by the current project will support such studies. In addition, the National Oceanic and Atmospheric Administration/Air Resources Laboratory (NOAA/ARL) is expanding and updating its computations of annual, extreme, and return period precipitation to further support these studies.

State of Idaho Wastewater Land Application Permits

DOE-ID will obtain State of Idaho Wastewater Land Application Permits (WLAPs) for existing and future land application facilities (i.e. percolation ponds and sewage treatment irrigation systems). Draft WLAPs were issued in November 1993 by the State for the ICPP percolation ponds and Sewage Treatment Plant Rapid Infiltration Trenches. DOE-ID is currently negotiating the conditions of the draft ICPP permits. A draft permit was issued by the State for the proposed CFA Sewage Treatment Plant and irrigation system and a final permit is expected in 1994.

Applications for WLAPs are being prepared and are expected to be submitted to the State by December 15,1995 for the following: Technical Service Facility Disposal Pond at TAN, TRA Chemical Waste Pond, ANL-W Industrial Waste Pond, and the NRF Industrial Waste Ditch. It is unclear whether a permit is needed for the Water Reactor Research Test Facility Pond at TAN. Other discharges to the land surface identified in the INEL Liquid Effluent Inventory will be evaluated to determine Wastewater Land Application Permit applicability by December 1, 1995.

Resource Conservation and Recovery Act (RCRA)

The RCRA establishes regulatory standards for the generation, transportation, storage, treatment, and disposal of hazardous waste. The State of Idaho is fully authorized by

EPA to regulate hazardous waste and the hazardous component of radioactive mixed waste at the INEL. Strictly radioactive wastes are regulated by the Atomic Energy Act as administered through DOE orders.

Consent Order Status. Progress on the requirements of the Hazardous Waste Consent Orders of October 7, 1992 and April 3, 1992 is on schedule. The April 1992 Consent Order was recently modified on March 17, 1994 based upon the Idaho District Court's amended order in United States of America v. Andrus, dated December 22, 1993. The Consent Order for the 1992 State of Idaho RCRA inspection of the INEL has been finalized and all alleged violations have been resolved.

RCRA Closures of Interim Status Units. The State of Idaho approved RCRA closure plans for the Reactives Storage and Treatment Facility, The ICPP Hot Shop Storage Tank, and the Intermediate-Level Transuranic Facility. Closure of those facilities is on schedule.

RCRA Permitting Accomplishments. The INEL received its first Hazardous Waste Partial Permit, which became effective January 24, 1994. The permit is for the Hazardous Waste Storage Facility at CFA, the Radioactive Sodium Storage Facility at ANL-W, and the Radioactive Scrap and Waste Facility at ANL-W.

The INEL submitted three additional RCRA Part B applications (for eight RCRA facilities) to the State of Idaho.

RCRA Reports. As required by the State of Idaho, DOE-ID submitted the Idaho Hazardous Waste Generator Quarterly Reports for 1993. The reports contain information on waste generation, treatment, recycling, and disposal activities at all INEL facilities during 1993.

As required by Sections 3002 and 3004 of RCRA, DOE-ID submitted the INEL 1993 Hazardous Waste Report and the INEL Research Center 1993 Hazardous Waste Report to the State of Idaho on February 28, 1994. The reports contain information on waste generation, treatment, and minimization activities at the INEL and INEL Research Center during 1993. Because the INEL Research Center was temporarily classified as a large quantity generator during 1993, the facility was required to file a report for that year.

As required by Section 6002 of RCRA and Executive Order 12780, DOE-ID submitted the INEL 1993 Affirmative Procurement Report to DOE-HQ on December 8, 1993. The report contains information on DOE-ID's procurement, to the maximum extent possible, of items composed of recovered materials.

As required by the variance to Land Disposal Restrictions, a progress report titled "INEL Report for the Renewal of the Hazardous Debris Case-by-Case Capacity Variance Extension" was sent to EPA by August 1993.

Federal Facilities Compliance Act

This Act, which amends RCRA, requires the preparation of site treatment plans for the cleanup of mixed wastes at the INEL. During 1993, the mixed waste inventory for the INEL and the Conceptual Site Treatment Plan were completed. Both documents were forwarded to the State of Idaho in October 1993 and to EPA Region 10.

National Environmental Policy Act (NEPA)

Federal regulations require NEPA documentation showing that federal agencies have considered the environmental impacts of, and public commentary on, proposed actions. This

information must then be included in federal decision making. NEPA documentation can include either an Environmental Assessment or an Environmental Impact Statement.

Activities to ensure compliance with NEPA are ongoing at the INEL. A draft Environmental Impact Statement (EIS) has been prepared for programmatic spent nuclear fuel management and for INEL-specific environmental restoration, waste management, and spent nuclear fuel management activities. A Notice of Intent to prepare the INEL Environmental Restoration and Waste Management EIS was published October 5, 1992 and scoping meetings were held during November 1992. In September 1993, the public was notified that the scope of this EIS would be expanded to include the transportation, receipt, processing, and storage of spent nuclear fuel from throughout the DOE complex and from other sources. These other sources include naval vessels and prototype reactors, the Fort St. Vrain reactor in Colorado, university research reactors in the United States, and foreign research reactors. This expansion of scope was in response to public comments and a court order signed in June 1993. The name of the EIS has been changed to the EIS for Programmatic Spent Nuclear Fuel Management and INEL Environmental Restoration and Waste Management. The EIS Implementation Plan was distributed to the public in November 1993. The public comment period began July 1, 1994 and will continue until September 30, 1994.

DOE-ID is also participating as a cooperating agency on an EIS named the "Southeast Regional Wastewater Treatment Plant Facilities Improvements Project and Geysers Effluent Pipeline Project" in Lake County, California. The Notice of Intent was published March 13, 1993, in the Federal Register and the draft EIS is expected to be distributed during the summer of 1994.

Four Environmental Assessments with Findings of No Significant Impact were approved during 1993 for DOE-ID operations. Another ten proposals have been determined to require Environmental Assessments, and the documents were being prepared or were in some stage of review at the end of 1993.

Safe Drinking Water Act (SDWA)

The SDWA establishes primary drinking water standards for water delivered by a public water supply system, defined as a system that supplies drinking water to either 15 or more connections or 25 individuals for at least 60 days per year. The INEL drinking water supply meets these criteria and is referred to as a noncommunity, nontransient system because persons who use the water do so five days per week but do not live at the Site.

Beginning October 1, 1993, the State of Idaho instituted the assessment of fees for all public water systems. The purpose of the fees was to help the Idaho Division of Environmental Quality (DEQ) fund the drinking water program in the State because the Idaho legislature did not fully fund the program and asked DEQ to find ways to fund their program. The INEL has eleven active public water systems with a fee of $100 per nontransient-noncommunity or transient-noncommunity water system.

In early June, a meeting with DEQ led to the information that to qualify for the reduced sampling regimen in the Chaffee Amendment to the Safe Drinking Water Act authorized by Congress earlier in the year, the INEL needed to sample drinking water supplies for volatile organic chemicals and synthetic organic chemicals once during fiscal year 1993. By conducting the sampling during 1993, resampling would not be needed until 1996 rather

than yearly as was required prior to the Amendment. All INEL facilities performed the recommended sampling during 1993. The State of Idaho was petitioned individually by each public water system to grant waivers for dioxin sampling because the chemical is not used at the INEL and for asbestos sampling based on previous analytical data showing the water is not contaminated. The State of Idaho DEQ has granted each of the waivers requested.

On July 15, 1993 the water system serving personnel at TAN tested positive for coliform bacteria during routine sampling. The water system was posted to prevent personnel from drinking the water and bottled water was provided for drinking. The water system was disinfected and additional samples collected as required by Idaho regulations. There have been multiple incidents of drinking water contamination at TAN during the last two years. A continuous chlorination program has been instituted to provide a lasting solution to bacterial contamination of the area drinking water supply.

During September and October of 1993, while the TAN personnel were using bottled water for the bacterial contamination problem, the sparger (an aerating device) that treats the drinking water for volatile organic compound contamination (specifically trichloroethylene and tetrachloroethylene) was taken out of service for repair and preventive maintenance. The TAN drinking water systems and the sparger unit were put back in service in November 1993.

Personnel at the Power Burst Facility used bottled water following the appearance of coliform bacteria in January 1993 until the system was cleaned and put back online in November 1993.

A new potable water well at the ICPP was drilled in 1993 but has not been placed in service because construction of the well is not complete. Some upgrades to the existing potable water well at ICPP took place during 1993 and the well was brought into compliance with construction standards. This well has met water quality standards since it was put online in the ICPP drinking water system but did not fully comply with construction standards until the upgrade was completed.

The Idaho DEQ signed a waiver request for the installation of a diesel fuel tank for an emergency generator at PBF. The waiver allows for the tank to be located closer than 50 feet to the public water system well serving PBF after the State determined that secondary containment of the diesel fuel tank would provide equivalent protection of the public water system.

Toxic Substances Control Act (TSCA)

The TSCA statute, which is administered by EPA, requires testing and regulation of chemical substances that enter the environment. TSCA supplements sections of the Clean Air Act, the Clean Water Act, and the Occupational Safety and Health Act. Compliance with TSCA and the INEL is primarily directed toward management of polychlorinated biphenyls (also known as PCBs).

DOE-ID continues to store radioactively contaminated polychlorinated biphenyls at the INEL and is in the process of developing a draft Compliance Agreement for negotiations with EPA Region 10. EPA Region 10 has been aware of the situation since their inspection in 1989. Negotiation issues include characterization, inspections, labeling, and one-year storage requirements.

Federal Insecticide, Fungicide, and Rodenticide Act

This Act governs the registration and use of pesticides (i.e. fungicides, herbicides,

insecticides, and rodenticides. The INEL complies with the Act's requirements pertaining to storage and application of pesticides. There were no major activities or issues at the INEL with respect to this statute during 1993.

National Historic Preservation Act

Preservation and management of prehistoric, historic and cultural resources on lands administered by DOE are mandated under Sections 106 and 100 of the National Historic Preservation Act. The Act requires that before undertaking any project, federal agencies must adopt measures to mitigate the potential adverse effects of that project on sites, structures, or objects eligible for inclusion in the National Register of Historic Places. During 1993, an agreement was signed with the State Historical Preservation Officer permitting the decontamination and decommissioning of historically significant buildings at the Auxiliary Reactor Area-I, -II, and -III facilities.

Endangered Species Act

Various federal statutes, such as the Endangered Species Act and Executive Orders, govern the protection of ecological and biological resources at the INEL. Several species that occur on the INEL are currently on various state and federal agency sensitive lists or have been declared candidates for endangered and threatened listing. Through 1993, the Environmental Sciences Branch of RESL at DOE-ID periodically conducted research and participated in surveys to determine the status of these species on the INEL. Beginning in April 1994, these studies and surveys are being performed by the Environmental Science and Research Foundation. The Foundation will contact the U.S. Fish and Wildlife Service every six months to update INEL threatened and endangered species list (which includes candidate species and sensitive species lists). In addition, the Foundation conducts NEPA field evaluations of proposed project sites on the INEL that include assessment of the impacts on threatened and endangered species.

The Environmental Science and Research Foundation will continue to conduct the National Wildlife Federation mid-winter bald eagle count for the state zone that includes the INEL. These surveys have been instrumental in identifying seasonal and geographic use of the INEL by bald eagles, the only endangered species that predictably occurs here. The eagle surveys have been intensified to record all raptors (birds of prey) wintering on the INEL. Two sightings of peregrine falcons (an endangered species) were made during 1993 in conjunction with a raptor research project.

A study was completed in 1993 on the occurrence and microhabitat selection of the Townsend's big eared bat, a candidate threatened and endangered species, on the INEL. Another study was initiated in January 1994 on the pygmy rabbit, also a candidate threatened and endangered species.

There were two potential sightings of wolves reported on the INEL during the winter of 1992-1993. In the fall of 1993, one potential sighting of four wolves occurred on the INEL. Foundation employees are involved in training sessions on wolf identification and reporting with the U.S. Fish and Wildlife Service, Bureau of Land Management, Idaho Fish and Game Department, and the INEL Aviation Operations personnel.

2.2 OTHER MAJOR ENVIRONMENTAL ISSUES AND ACTIVITIES

Fort St. Vrain Litigation

On December 22, 1993, the U.S. District Court issued its order approving the stipulation previously agreed to by the State of Idaho, the Secretary of the Navy, and the Secretary of Energy. The order was entered by the Court after the Ninth Circuit Court of Appeals held that the trial court had abused its discretion by modifying the terms of the stipulation in an earlier order. The latest order allows a limited number of shipments of spent fuel to enter the INEL pending completion of the EIS. In addition, the order sets accelerated milestones for the preparation of the EIS; removal of spent fuel from ICPP Building 603 and placement in ICPP Building 666; and treatment, storage and disposal of high-level radioactive wastes. The order also requires DOE to work with the State of Idaho, the Eastern Idaho Economic Development Council, and the consolidated contractor to encourage economic development.

To support these economic activities, DOE is required to provide the sum of $500,000.00 in grant funds to the State of Idaho or its designee. With the filing of this order, the litigation over spent fuel could come to an end barring any further disagreements with the State over interpretation and/or execution of the terms of the order.

Ground-Water Monitoring Program Activities

The INEL Ground-Water Monitoring Plan, written in accordance with DOE Order 5400.1, was completed in June 1993. The plan establishes the framework for ensuring compliance with all regulatory and DOE standards which require ground-water monitoring. The plan documents the INEL's regional and facility area-specific ground-water monitoring needs and documents the ground-water monitoring networks and sampling programs that must be developed to meet those needs. Implementation of the plan was initiated in 1993 with the collection of ground-water samples from existing monitoring networks at the ICPP and ANL-W, and the construction of a ground-water monitoring network at the Special Training Facility. Evaluations are being conducted in 1994 to further evaluate unit or facility specific ground-water monitoring needs. It is anticipated that the plan will be fully implemented by the year 2004.

In 1993, a physical survey of all wells at the INEL was completed and each wellhead was evaluated and, where necessary, upgraded. A "fitness" evaluation of all wells at the INEL was completed to determine whether the wells meet applicable state and federal well construction standards. This evaluation will be used as the basis for prioritizing deficient wells for upgrade or abandonment.

Tiger Team Assessment Corrective Actions

In June 1989, the Secretary of Energy announced an initiative to strengthen safety, environmental protection, and waste management activities at DOE production, research, and testing facilities. A Tiger Team assessment was conducted at the INEL during June and July of 1991 and the team's report listed a number of concerns and findings in four major areas: 1) Environmental; 2) Management and Operations; 3) Occupational safety and health; and 4) Overall safety and health. No findings were characterized as representing an imminent danger.

The DOE-ID and its contractors developed corrective action plans to address findings and concerns and have worked on closing activities as time and resources permit. DOE-ID and contractor personnel continue to carefully track progress on closeout and interim milestones of these plans, and any delinquent actions have been analyzed by program and plan managers to ensure there is no environmental or safety impact resulting from delinquency in closure. A few plans that were no longer applicable to operations at the INEL were canceled.

Progress Assessment Team Visit

The Progress Assessment Team visited the INEL during July 1993 to evaluate progress on the action plans written in response to the Tiger Team audit findings. Feedback from team members was generally positive during interviews, and DOE-ID and contractor presentations. The draft Progress Assessment Team report was reviewed for factual accuracy in August 1993 and the INEL response to the final report was issued January 27, 1994. There were noteworthy practices and a number of concerns listed in the final report, but none of the concerns were considered urgent.

Environmental Occurrences

The Clean Air Act of 1990 made ethylene glycol releases greater than one pound reportable under CERCLA. In 1993, releases between 1 quart and 5 quarts of ethylene glycol occurred at the INEL on January 1, January 7, March 11, May 13, June 29, July 28, September 24, October 7, October 18, and November 5. The releases were absorbed and disposed of. Proper notifications were made in all cases.

Summary of 1993 ER&WM Activities

The following items represent a capsulized summary of events and activities at the INEL related to the Environmental Restoration and the Waste Management Programs for 1993. For a more complete discussion of these items, see Sections 3.1 and 3.2 of this report.

- Completion of Volume 2 of the Draft EIS on June 30, 1994
- Remedial Investigation/Feasibility Study at Pad A of RWMC completed March 1993. Record of Decision signed February 17, 1994
- Vapor Vacuum Extraction tests concluded in September 1993. Remedial Investigation/Feasibility Study planned for RWMC area in future
- CFA Motor Pool Record of Decision--no action decision
- Record of Decision at Pit 9 at RWMC followed by proof-of-process tests by two potential contractors
- Remediation activities at TRA Warm Waste Pond begun in October 1993 and completed in March 1994
- Clean up activities begun on the TAN Injection Well
- Unexploded ordnance interim project completed by the end of 1993
- Three removal actions (short-term projects to respond to situations that could potentially pose a health or environmental threat) completed during 1993

- Significant progress or completion on five decontamination and decommissioning projects

- Conceptual Site Treatment Plan for Federal Facilities Compliance Act submitted to the State of Idaho in October 1993

- Four new remote, robotic, cleanup technologies demonstrated in July 1993 by Buried Waste Integrated Demonstration Program drew comments of interest from other DOE laboratories and private companies

- Public meetings: two on Environmental Restoration Program status, one on proposed plan for Pad A at the RWMC, and one on the Remedial Investigation/Feasibility Study for CFA Landfills II and III

2.3 PERMITS

Ground-water Permits

In November 1993, the Idaho Department of Water Resources granted Underground Injection Control permits allowing the continued operation of seven deep injection wells (defined as Class V under 40 CFR 144.6) at the INEL. These wells are used for draining excess surface water runoff. One permit application (TAN Drainage Disposal Well #4) was denied based on the well's close proximity to a bulk fuel storage area. DOE-ID agreed to abandon this well in accordance with the State of Idaho well abandonment regulations. The well was sealed with grout on May 25, 1994.

Summary

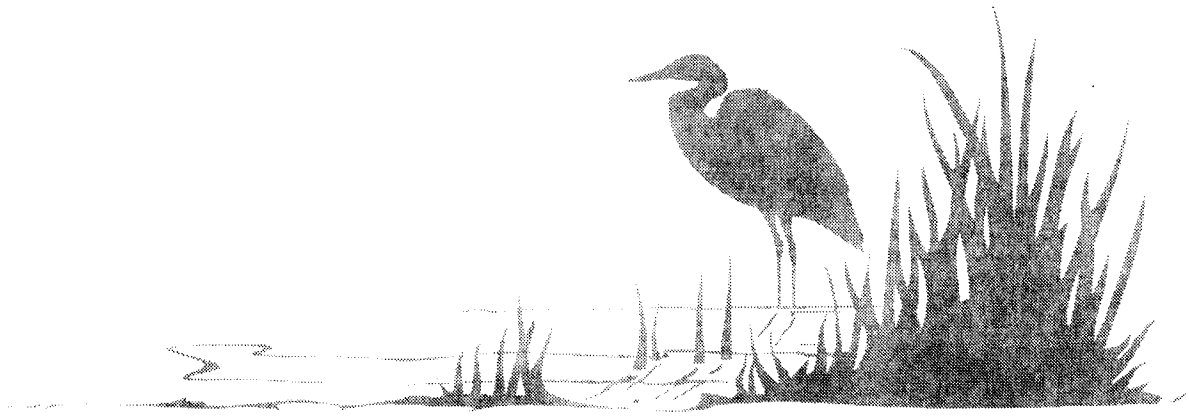
Permits that have been granted to the INEL and those for which applications have been submitted are summarized in Table 2.1. The RCRA units now operating with a RCRA Hazardous Waste Partial Permit include: the Hazardous Waste Storage Facility at CFA, the Radioactive Sodium Storage Facility at ANL-W, and the Radioactive Scrap and Waste Facility at ANL-W.

Table 2.1
Permit Summary for the INEL (1993)

Permit Type	Issuing Agency	Granted	Pending
Air			
PTC/PSD[a]	Idaho DEQ[b]	24	3
BRC[c]	Idaho DEQ	41	2
NESHAP	EPA Region 10	27	0
Operating Permit	Idaho DEQ	0	1
Water			
NPDES	EPA Region 10	2	2
Injection Well	Idaho DWR[d]	7	3
WLAP	Idaho DEQ	0	3
RCRA			
Part A	State of Idaho	1	0
Part B[e]	State of Idaho	2	7

a. Permit to Construct/Prevention of Significant Deterioration.
b. Division of Environmental Quality.
c. Below Regulatory Concern.
d. Department of Water Resources.
e. Part B permit is a single permit composed of several volumes. To date, seven volumes have been submitted to EPA.

3. ENVIRONMENTAL PROGRAM INFORMATION



3. ENVIRONMENTAL PROGRAM INFORMATION

3.1 ENVIRONMENTAL RESTORATION PROGRAM (ERP)

General Information

A common public perception of environmental restoration activities is that all investigations are expensive and time-consuming. However, by streamlining the investigation process at the INEL, DOE-ID, EPA, and the State of Idaho have saved taxpayers millions of dollars. By the end of 1993, the agencies had investigated and made determinations on 91 of the 144 (63%) Track 1 sites identified in the Action Plan of the Federal Facilities Agreement/Consent Order.

Track 1 sites at the INEL range from locations where contaminants were thought to have been disposed (either intentionally or unintentionally) to locations where there were confirmed releases to the environment. The Track 1 process is used for sites that are unlikely to require further field data collection before a decision can be made to take immediate cleanup action, to expand the investigation, or to take no further action. Costs for this process are much lower because existing data are used. Major investigations such as Remedial Investigation/Feasibility Studies (RI/FS), which can cost several million dollars and take several years to complete, are minimized.

Remedial Investigation/Feasibility Studies (RI/FS)

ANL-W. ANL-W is accelerating its comprehensive RI/FS study because preliminary data suggest the scope of the investigation can be completed sooner and be more cost-effective. No contaminants have been discovered in the Snake River Plain Aquifer attributable to ANL-W activities and no perched water zones have been detected.

Pad A. The Pad A RI/FS Study was completed in March 1993 and finalized by DOE-ID, EPA, and the State of Idaho. A proposed remediation plan was drafted and meetings took place during the summer of 1993. A Record of Decision was signed February 17, 1994. Remedial Design is currently underway.

Vapor Vacuum Extraction. A process that extracts hazardous vapors from soil was demonstrated to be successful in removing volatile organic compounds such as carbon tetrachloride, trichloroethylene, tetrachloroethylene, and 1,1,1-trichloroethane from basalt beneath the INEL. Five months of vapor vacuum extraction tests were concluded in September 1993, providing information for a CERCLA environmental investigation of the RWMC vadose zone. (Vadose zone is the geological term for the soil and rock that lie between the land surface and the top of the water table.) In 1991 DOE-ID conducted a preliminary health and environmental risk assessment to evaluate potential risks posed by the contaminated vadose zone under the RWMC. While there is no immediate threat to human populations (including INEL workers), the RWMC drinking water well contains small concentrations of volatile organic compounds well below drinking water standards. DOE-ID, EPA, and the State of Idaho decided to proceed

with an RI/FS to determine whether cleanup actions are needed under the Superfund law.

Records of Decision

No Action Decisions. During December 1992, DOE-ID, EPA, and the State of Idaho agreed to take no action at two INEL waste sites--the TRA Perched Water System and the Auxiliary Reactor Area Chemical Evaporation Pond. Remedial investigations to determine the extent of contamination were conducted at the sites. The investigation reports, which included risk assessments, indicated the contaminants present at the two sites do not pose an unacceptable risk to human health or the environment.

In January 1993, DOE-ID, EPA, and the State of Idaho agreed to take no action at the CFA Motor Pool Pond. This is an unlined evaporation pond located in an abandoned borrow pit where wastes from two sumps were discharged between 1951 and 1985. In late 1985, discharges to the Motor Pool Pond ceased because the wastes were diverted through an oil/water separator to a sanitary sewer line connected to the Sewage Treatment Plant. Soil samples collected at the CFA Motor Pool Pond in 1989 indicated that pond sediments contained metals, chemicals, volatile organic compounds, and low concentrations of the radionuclides ^{241}Am, ^{137}Cs, and $^{239/240}Pu$. A polychlorinated biphenyl compound was detected in a ditch leading to the pond. The remedial investigation to determine the extent of contamination at the site indicated the contaminants do not pose an unacceptable risk to human health or the environment.

Pit 9 Decision. During 1993, the U.S. Department of Energy, EPA and State of Idaho officials signed a Record of Decision for Pit 9 at the RWMC. Pit 9 is an inactive disposal pit covering about 1 acre. About two-thirds of the waste buried in Pit 9 between November 1967 and June 1969 was generated at the Rocky Flats Plant and consists of sludge, drums of assorted solid waste, and cardboard boxes containing empty contaminated drums. About one-third of the waste buried in Pit 9 came from waste generators at the INEL. Past shipping records indicated the pit contains about 20 kg (44 pounds) of plutonium and 650 g (1.5 pounds) of americium, along with trichloroethylene, carbon tetrachloride, and other wastes.

Based on shipping records for the entire RWMC facility, an estimated 366 kg (807 pounds) of plutonium were shipped from Rocky Flats to the INEL. However, recent examination of DOE Rocky Flats records indicates that more plutonium than previously estimated may have been sent to the INEL and buried at the RWMC between 1954 and 1970 giving current estimates between 600 to 900 kg (1,320 to 1,980 pounds) more plutonium than previously calculated. (This is in addition to the 366 kg above.) Waste received after 1970 from Rocky Flats was stored above-ground. The increased amount of plutonium and other nuclear materials (uranium and americium) in the buried waste at Pit 9 and other RWMC areas is not expected to create a greater threat to the aquifer or additional risk to workers.

Using public input, the three agencies decided to use a combination of physical separation, chemical extraction, and stabilization as the remediation method for the contaminated Pit 9 materials. DOE-ID has determined the Pit 9 interim action will not have a significant adverse impact on the environment, will expedite the overall remediation of the RWMC, and will reduce the risks associated with potential migration of Pit 9 wastes to the underlying Snake River Plain Aquifer.

Based on responses to the Request for Proposals to remediate Pit 9, two companies

were selected by DOE to undergo the proof-of-process test. This is the first project phase and requires a company to demonstrate how well the critical aspects of its proposed remediation processes work. The Pit 9 Proof-of-Process tests were completed by the Lockheed Corporation and Waste Management Environmental Services, Inc. in December 1993 and are currently being evaluated by EG&G Idaho and DOE-ID.

Remediation/Restoration Activities

Power Burst Facility Evaporation Pond. The draft Remedial Design Work Plan was submitted to the EPA and the State of Idaho Department of Health and Welfare in 1993. Sampling of the Power Burst Facility Evaporation Pond was completed in April which refined the design criteria.

TRA Warm Waste Pond. Radioactive wastewater was discharged to the unlined pond near TRA between 1952 and 1993. The pond sediments became contaminated with chromium and various radionuclides, primarily ^{60}Co and ^{137}Cs. The Record of Decision listed the preferred cleanup remedy as physical separation/chemical extraction. However, laboratory tests showed that not all contaminants could be removed from the sediments without increasing the estimated cost by an order of magnitude and increasing the volume of waste to be managed. Therefore, DOE-ID, EPA, and the State of Idaho agreed to implement a modification to the contingency remedy allowed in the Record of Decision by placing a soil cover over the contaminated sediments of the pond to reduce the potential for airborne release (by windborne resuspension) and radiation exposure. Contaminated sediments were consolidated to reduce the "footprint" of contamination by about 50%. The sediments were then covered with clean fill and the remainder of the pond was backfilled to grade with clean fill material. Cleanup field activities at the pond started in October 1993, and were completed in March 1994.

TAN Injection Well. Cleanup activities were begun on the TAN Injection Well that was used from 1953 to 1972 to discharge liquid wastes into the fractured basalt of the Snake River Plain Aquifer. Those wastes included organic, inorganic, and low-level radioactive wastewaters that were added to industrial and sanitary wastewaters. The drinking water used by TAN workers is treated in order to meet drinking water standards, and untreated water is not accessible to workers or the general public. However, an interim action is necessary to remove sources of contamination that could further impact the Snake River Plain Aquifer. A subcontract was awarded for the design, construction, and operation of a treatment facility to reduce contamination in the well. A separate remedial investigation/feasibility study is scheduled for completion in 1994 to investigate groundwater contamination in areas beyond the injection well.

Unexploded Ordnance Interim Action. Unexploded ordnance items at the INEL were the result of past activities associated with the former Naval Proving Ground. Prior to 1949, the Navy conducted aerial bombing practice, naval artillery testing, explosives storage bunker testing, and ordnance disposal at a large portion of what is now the INEL.

The interim action project to locate and detonate unexploded ordnance items found on the INEL was completed by the end of 1993, and well over 100 ordnance devices had been located at six areas of the INEL. The project was undertaken because the ordnance items presented a hazard to personnel who frequented

those areas. A majority of the devices found were non-explosive. Those which were explosive were detonated, and soils contaminated as a result of past and recent detonations were transported to an EPA-approved incineration facility in Arkansas.

ICPP Removal Actions. Two removal actions, short-term projects undertaken to respond to situations that could potentially pose a threat to health or the environment, were completed during 1993 at the ICPP. WINCO personnel removed contaminants from a plugged, abandoned-vessel off-gas line associated with the calcine pilot plants and capped two drain lines from the top of a calcine storage bin. The drain lines had discharged radioactively contaminated water to the underlying soil, so the second removal action included removing the contaminated soil at the end of the drain lines and capping the lines on both ends. The capped lines will be replaced by new drainage lines.

ANL-W Removal Action. A removal action at the abandoned Experimental Breeder Reactor-2 Leach Pit at ANL-W was completed in late September 1993. About 11.6 m^3 (387 ft^3) of radioactively contaminated sludge was removed, solidified, and transported to the RWMC as low-level waste. This action was taken to prevent migration of the contaminants through the basalt fractures of the leach pit that had received radioactive liquid wastes from the early 1960s to 1975.

Decontamination/Decommissioning Activities

CFA Hot Laundry Facility. Decontamination and decommissioning of the CFA Hot Laundry facility will be completed in 1994. In 1993, the contaminated roof and the noncontaminated boiler were removed from the facility.

Other D&D Activities. Other decontamination and decommissioning activities completed during 1993 included: the Stationary Low Power Reactor-I Crane Yard, Special Power Excursion Reactor Test-IV Tank Area, asbestos removal at the Waste Calcining Facility at ICPP, completion of an environmental assessment report for Auxiliary Reactor Area II and Auxiliary Reactor Area III, and removal of vent stacks and underground pipe and tank remediation at Auxiliary Reactor Area III.

Public Involvement in Environmental Restoration Program Activities

A focus group was formed to evaluate and comment on the draft INEL Community Relations Plan. Comments were very helpful in determining what should be included in the document before a public comment period is scheduled.

Two public Environmental Restoration Program status meetings were held in May and September to give an update of cleanup projects that had received earlier public input. Public meetings were also held to address the Pad A proposed plan and the CFA Landfills II and III RI/FS. More public involvement opportunities are planned during 1994 for Environmental Restoration Program activities.

3.2 WASTE MANAGEMENT PROGRAM (WMP)

General

The goals of the waste management program are to manage wastes at the INEL, ensuring that workers and the public are

protected and that the environment is not further impacted. INEL waste management activities consist of (a) reducing the total amount of wastes generated; (b) treating wastes already generated by reducing their toxicity, mobility, or volume; (c) disposing of wastes; and (d) storing wastes awaiting disposal that have no treatment or disposal options available.

Key approaches to meeting WMP goals are waste minimization and pollution prevention programs. Strategies at the INEL have been developed which integrate pollution prevention into all aspects of all waste generating processes. The essential elements of the strategies are to empower organizations to develop and administer the Pollution Prevention Program; prioritize waste streams to be reduced, and develop a method for tracking the performance and progress of the program.

Some current activities of the waste minimization and pollution prevention programs at the INEL include: (a) identifying, screening and analyzing options to reduce the generation of waste; (b) listing unused and excess chemical and materials in the Material Exchange Program as available for use by other companies or programs; (c) examining the database on which hazardous solvents are tracked to identify and substitute nonhazardous solvents when possible; (d) practicing sitewide recycling of paper, wood, glass, metal, plastic, cardboard, beverage cans, used oil, electronic components, antifreeze, some solvents, and batteries; (e) substituting reusable and nonhazardous materials for hazardous and disposable materials when possible in the site equipment and vehicle maintenance programs; (f) sharing pollution prevention lessons learned at the INEL with surrounding communities and industry; and (g) examining production processes within the INEL to determine whether improvements in process efficiency can result in significant source reduction of wastes.

Another challenge faced in managing wastes at the INEL is involving the citizens of Idaho in the search for answers and resolutions to significant waste management issues. During 1993, the DOE-ID Waste Management Program attempts to inform and involve the public included regular articles in the INEL Reporter, a publicly available newsletter; tours at the ICPP, RWMC, and Waste Experimental Reduction Facility; mall displays; presentations to schools and civic organizations by the Public Affairs Speakers Bureau; and holding semiannual briefings and open houses in communities not often targeted for information dissemination.

Waste Management Program Accomplishments for 1993

General. The Federal Facility Compliance Act, which amends RCRA, requires the preparation of site treatment plans for the clean up of mixed wastes containing both radioactive and nonradioactive hazardous materials at the INEL in three phases. The "Conceptual Site Treatment Plan," detailing the current INEL mixed waste inventory in terms of treatment capacities, technology needs, and options for facilities to meet land disposal restriction standards was submitted to the State of Idaho in October 1993. A "Draft Plan" must be submitted by August 1994, and a "Final Proposed Plan" is due by February 1995. The schedule is designed with the goal of having all plans in the DOE complex in place by October 1995.

Several activities related to permitting of hazardous wastes at the INEL are discussed under the RCRA title in the "Environmental Compliance Summary" section of this report.

Buried Waste Integrated Demonstration Program. The Buried Waste Integrated Demonstration Program demonstrated four

buried waste cleanup technologies that drew comments of interest from other DOE labs and private companies in July 1993. The systems were:

- Remote Characterization System, a remotely guided vehicle that carries sensors for locating and evaluating or characterizing waste
- Remote Excavation System, a modified U.S. Army excavator that can remotely retrieve waste, including containers and large buried objects, with a front-end loader and a backhoe
- Contamination Control Unit, which operates from a trailer and can spread dust-control products over an area being cleaned up to minimize the spread of contaminants
- Rapid Transuranic Monitoring System, which can rapidly analyze air and soil samples to detect contamination spread during operations.

The remote, robotic design of the deployed technologies improves the safety of workers by reducing their exposure to contaminants or hazardous materials during cleanup operations.

3.3 ENVIRONMENTAL MONITORING

General

During normal operation of the facilities at the INEL, some materials (both radioactive and nonradioactive) are released to the environment. Potential pathways by which such materials could be transported from the INEL to nearby populations are shown in Figure 3.1.

To evaluate these exposure pathways, and to verify compliance with applicable environmental protection laws and regulations, DOE Order 5400.1 requires an environmental monitoring program. Environmental monitoring consists of two separate activities: effluent monitoring and environmental surveillance. Effluent monitoring is the measurement of the waste stream prior to its release to the environment. Environmental surveillance is the measurement for the presence or absence and the concentrations (or the extent) of pollutants in the environment. Further defined by the DOE:

- *Effluent monitoring* is the collection and analysis of samples, or measurements of liquid and gaseous effluents for the purpose of characterizing and quantifying contaminants, assessing radiation exposures of members of the public, providing a means to control effluents at or near the point of discharge, and demonstrating compliance with applicable standards and regulations.
- *Environmental surveillance* is the collection and analysis of samples, or direct measurements, of air, water, soil, foodstuff, biota, and other media from DOE sites and their environs for the purpose of determining compliance with applicable standards and permit requirements, assessing radiation exposures of members of the public and assessing the effects, if any, on the local environment[a].

[a] DOE Order 5400.1, November 9, 1988, p. 8

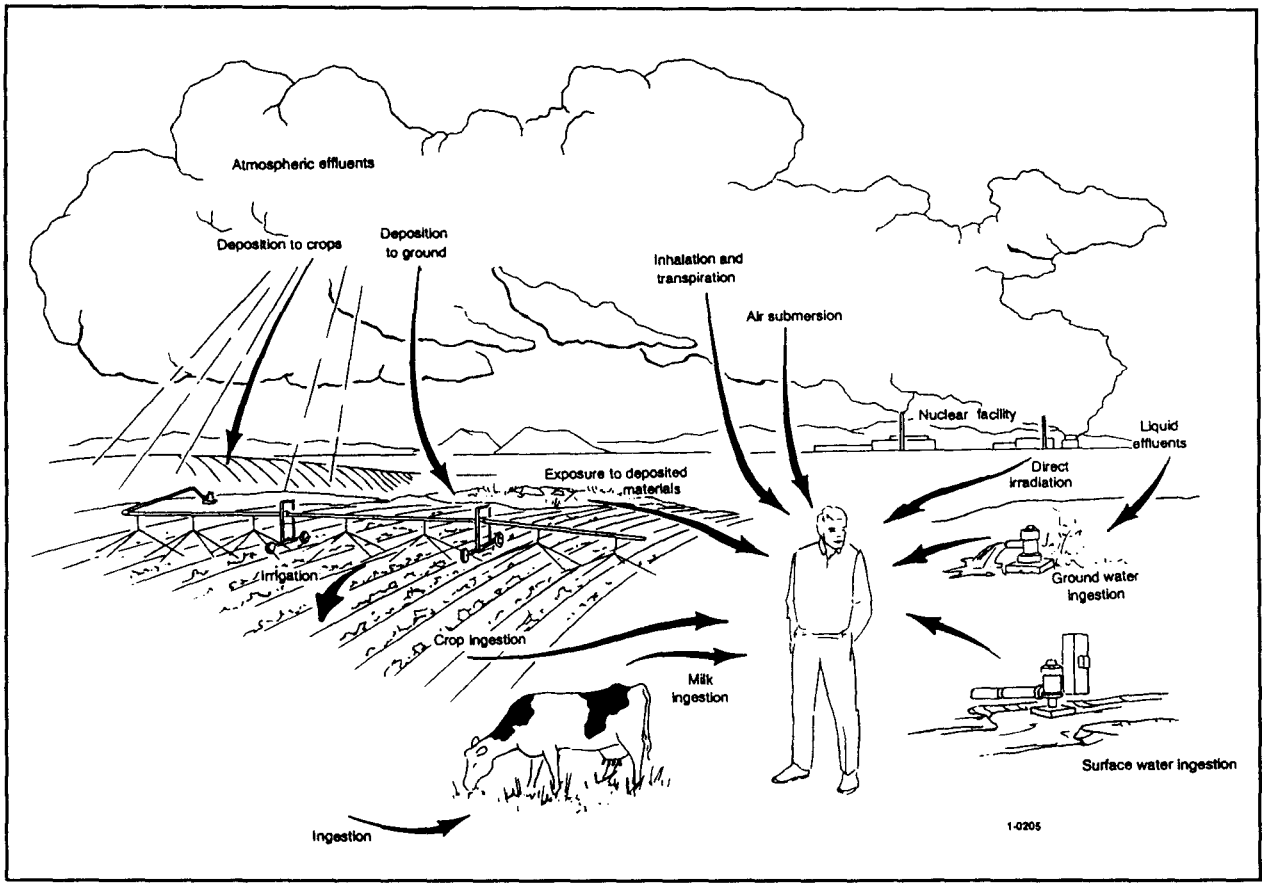


Figure 3.1 Potential pathways from the INEL to humans

Organization of Monitoring in 1993

The operating contractors at each INEL facility were responsible for monitoring the effluents (releases) from their facilities and for any ambient monitoring or surveillance performed within their facility fences. Results of these programs are reported annually by each organization.

The overall environmental surveillance program for the INEL was conducted by a division of DOE-ID, the Radiological and Environmental Sciences Laboratory (RESL), in 1993. Table 3.1 shows the radiological portion of the program. More detailed descriptions of the routine program are given in Chapter 4 (Environmental Radiological Program Information) and Chapter 6 (Environmental Nonradiological Program Information).

Ground-water surveillance was conducted largely by the U.S. Geological Survey (USGS). A description of this program and a summary of data collected in 1993 are given in Chapter 5, Ground Water. A program summary is presented in Tables 3.2 and 3.3.

Air pathways were characterized by the National Oceanic and Atmospheric Administration/Air Resources Laboratory (NOAA/ARL) using data from the INEL meteorological measuring network. These data were used in part to compute doses to members of the public (see Section 4.4).

TABLE 3.1
RESL ENVIRONMENTAL SURVEILLANCE RADIOLOGICAL PROGRAM SUMMARY (1993)

Medium Sampled	Type of Analysis	Number of Locations and Frequency		Minimum Detectable Concentration
		Onsite	Offsite	
Air (Low-Volume)	Gross alpha	4 weekly	4 weekly	3×10^{-16} µCi/mL
	Gross beta	12 weekly	11 weekly	8×10^{-15} µCi/mL
	Specific gamma	12 quarterly	11 quarterly	1 to 10 x 10^{-15} µCi/mL
	Pu	6 quarterly	4 quarterly	6×10^{-18} µCi/mL
	Am	6 quarterly	4 quarterly	8×10^{-18} µCi/mL
	^{90}Sr	2 quarterly	4 quarterly	1×10^{-16} µCi/mL
	Particulate matter	12 quarterly	11 quarterly	10 µg/m^3
Air (High-Volume)	Gross gamma	2 daily	-----	N/A[a]
	Specific gamma	2 monthly	-----	1 to 10 x 10^{-16} µCi/mL
Air (Tritium Samplers)	^{3}H as HTO	2 at 1 to 2/quarter	1 to 2/quarter	1×10^{-11} µCi/mL
Air (Precipitation)	^{3}H as HTO	1 weekly/ 1 monthly	1 monthly	4×10^{-7} µCi/mL
Drinking Water	Gross alpha	26 monthly	13 semiannually	3×10^{-9} µCi/mL
	Gross beta	26 monthly	13 semiannually	4×10^{-9} µCi/mL
	^{3}H as HTO	26 monthly	13 semiannually	4×10^{-7} µCi/mL
	^{90}Sr	2 monthly	-----	5×10^{-10} µCi/mL
Animal Tissue (Sheep)[b]	Specific gamma	4 annually	2 annually	7×10^{-9} µCi/mL
Animal Tissue (Game)	Specific gamma	Varies annually[c]	-----	7×10^{-9} µCi/mL
Foodstuffs (Milk)	^{131}I	None produced	1 weekly	1×10^{-9} µCi/mL
	^{131}I	None produced	10 monthly	1×10^{-9} µCi/mL
	^{90}Sr	None produced	10 annually	2×10^{-9} µCi/mL
	^{3}H as HTO	None produced	10 annually	4×10^{-7} µCi/mL
	^{129}I	None produced	3 annually	3×10^{-10} µCi/mL
Foodstuffs (Wheat)	Specific gamma	None produced	10 annually	4×10^{-9} µCi/g
	^{90}Sr	None produced	10 annually	4×10^{-9} µCi/g
Foodstuffs (Lettuce)	Specific gamma	None produced	8 annually	2×10^{-7} µCi/g
	^{90}Sr	None produced	8 annually	8×10^{-8} µCi/g
Soil	Specific gamma	Varies annually[d]	12 biennially	4×10^{-8} µCi/g
	Pu	Varies annually	12 biennially	2×10^{-9} µCi/g
	Am	Varies annually	12 biennially	3×10^{-9} µCi/g
	^{90}Sr	Varies annually	12 biennially	9×10^{-8} µCi/g
Direct Radiation Exposure (Thermoluminescent Dosimeters)	Ionizing Radiation	135 semiannually	13 semiannually	5 mR
Direct Radiation Exposure (Radiation Surveys)	Gamma Radiation	Varies annually[e]	-----	N/A

a. Not applicable.
b. "Onsite" animals grazed onsite for at least four weeks before being sampled. "Offsite" animals have never grazed onsite and serve as controls.
c. Only road-killed game animals are sampled onsite. No controls are generally collected except for specific ecological studies.
d. Onsite soil sampling is performed each year at different onsite facilities on a rotating 7-year schedule,
e. Surveys are performed each year at different onsite facilities on a rotating 3-year schedule.

TABLE 3.2
USGS GROUND-WATER RADIOLOGICAL MONITORING PROGRAM SUMMARY

		Ground Water		Surface Water		≈Minimum Detectable Concentration
Constituent	Frequency	Number of Sites	Number of Samples	Number of Sites	Number of Samples	(µCi/mL)
Gross alpha	Semiannual	3	6	4	8	3×10^{-9}
Gross beta	Semiannual	3	6	4	8	4×10^{-9}
Tritium	Quarterly	37	148	4	16	4×10^{-7}
	Semiannual	83	166	5	10	4×10^{-7}
	Annual	20	40	----	----	4×10^{-7}
Specific gamma	Quarterly	7	28	----	----	1 to 10×10^{-8} [a]
	Semiannual	21	42	4	8	1 to 10×10^{-8}
	Annual	27	27	----	----	1 to 10×10^{-8}
^{90}Sr	Quarterly	35	140	----	----	5×10^{-9}
	Semiannual	32	64	----	----	5×10^{-9}
	Annual	17	17	----	----	5×10^{-9}
Americium	Quarterly	5	20	----	----	5×10^{-11}
	Semiannual	5	10	----	----	5×10^{-11}
	Annual	3	3	----	----	5×10^{-11}
Plutonium	Quarterly	5	20	----	----	4×10^{-11}
	Semiannual	5	10	----	----	4×10^{-11}
	Annual	3	3	----	----	4×10^{-11}
^{129}I (na[b])	≈5 years	20-35	20-35	----	----	1×10^{-10}
^{129}I (ams[c])	≈5 years	20-35	20-35	----	----	1×10^{-15}

a. Varies depending upon radionuclides present in the sample.
b. Formerly used neutron activation method of analysis.
c. Accelerator mass spectrographic method of analysis used for 1990-91 sample collection period.

Independent surveillance of operations at the INEL was performed by Idaho State University (see Chapter 7, Quality Assurance) and the State of Idaho INEL Oversight Program.

Changes in Monitoring for 1994

In March of 1993, a decision was made within DOE-ID to transfer the environmental surveillance functions previously performed by RESL from the federal to the private sector. Most of the onsite portion of the RESL program was assumed by the EG&G Environmental Monitoring Unit; effective date of this transfer was January 3, 1994.

The offsite Environmental Surveillance Program was transferred to the Environmental Science and Research Foundation on April 11, 1994. The Foundation also assumed responsibility for the environmental research programs formerly administered by RESL, and is active in increasing awareness of INEL environmental programs through public relations/education.

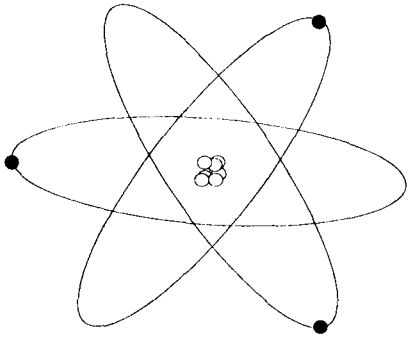
In January 1994, the State of Idaho's INEL Oversight Program took over the independent verification program operated by Idaho State University (ISU) since 1989 (see Chapter 7, Quality Assurance). ISU will continue to perfom radiological analyses for the State program.

TABLE 3.3
USGS GROUND-WATER NONRADIOLOGICAL MONITORING PROGRAM SUMMARY

		Ground Water		Surface Water		≈Minimum Detectable Concentration
Constituent	Frequency	Number of Sites	Number of Samples	Number of Sites	Number of Samples	(mg/L)
Conductance	Quarterly	42	168	----	----	N/A[a]
	Semiannual	85	170	5	10	N/A
	Annual	20	20	----	----	N/A
Sodium ion	Quarterly	5	20	----	----	5
	Semiannual	1	2	----	----	5
	Annual	128	128	----	----	5
Chloride ion	Quarterly	22	88	----	----	5
	Semiannualy	86	172	6	12	5
	Annual	22	22	----	----	5
Nitrates (as N)	Annual	82	82	----	----	0.5
Chromium (total)	Quarterly	13	52	----	----	0.05
	Semiannual	41	82	----	----	0.05
Purgeable Organic Compounds[b]	Monthly	1	12	----	----	0.0002
	Quarterly	5	20	----	----	0.0002
	Semiannual	2	4	----	----	0.0002
	Annual	1	1	----	----	0.0002
Trace elements	Annual	varies	varies	----	----	varies

a. Not applicable.
b Each sample is analyzed for 36 compounds.

4. ENVIRONMENTAL RADIOLOGICAL PROGRAM INFORMATION



4. ENVIRONMENTAL RADIOLOGICAL PROGRAM INFORMATION

In this chapter, individual analytical results for radiological data are presented with plus or minus (±) two analytical standard deviations (2s), where all analytical uncertainties have been estimated, and "s" is an estimate of the population standard deviation "σ." Many of the results were less than or equal to 2s (and, in fact, some were negative), which means that they were below the minimum detectable concentration.

If the result lies in the range of two to three times its estimated analytical uncertainty (2s to 3s), and assuming that the result belongs to a Gaussian distribution, detection of the material by the analysis may be questionable because of statistical variations within the group of samples. If the result exceeds 3s, there is confidence that the material was detected (or, that the radionuclide was present in the sample). Further information may be found in Appendix C.

Unpaired t-tests were used to determine whether the annual means for the INEL or boundary stations were greater than the annual means for the distant stations. All statistical tests used a level of significance of 5% ($\alpha = 0.05$). More information on statistical tests may be found in Appendix C.

4.1 ENVIRONMENTAL SURVEILLANCE PROGRAM DESCRIPTION

High-Volume Air Samplers

Two high-volume air samplers were in operation at the Experimental Field Station (EFS) and Central Facilities Area (CFA). Both samplers pulled approximately 1,160 liters/minute (50 ft^3/min) through a 10-cm diameter polyester needled-felt filter. Filters were collected each workday and returned to RESL for counting.

The high-volume sampler filters were counted for 10 minutes in a sodium iodide well counter immediately following collection and again after approximately six hours and 24 hours. At the end of the third count, the net counts per minute were plotted on graph paper vs. hours after collection. Examination of the resulting decay curve characteristics allows staff to distinguish between the rapid decay of daughter products of ^{222}Rn (^{214}Pb and ^{214}Bi), the approximate 10.6-hr effective half-life of ^{220}Rn daughters (^{212}Pb, ^{212}Bi and ^{208}Tl), all of which are natural radionuclides, and the generally long half-life (compared to 10.6 hours) of any fission-products mixture. These data provide timely information in the event of an INEL release. If the graph indicated the possible presence of activity from other than natural sources and background fallout, the filter was submitted for specific gamma-emitting nuclide analysis on the High-Purity Germanium system.

Low-Volume Air Samplers

Airborne particulate radioactivity was monitored continuously by a network of 12 air samplers within the INEL and 11 air samplers outside the INEL boundaries at the locations shown in Figure 4.1. Locations of onsite samplers were selected to give adequate coverage in the event of facility releases of radioactivity. Seven offsite air samplers were located near the INEL boundary and four samplers were located at the distant communities of Blackfoot, Craters of the Moon National Monument, Idaho Falls, and Rexburg. Distant locations were used to provide background measurements for comparison with data from boundary or onsite samplers that might be affected by INEL operations. The

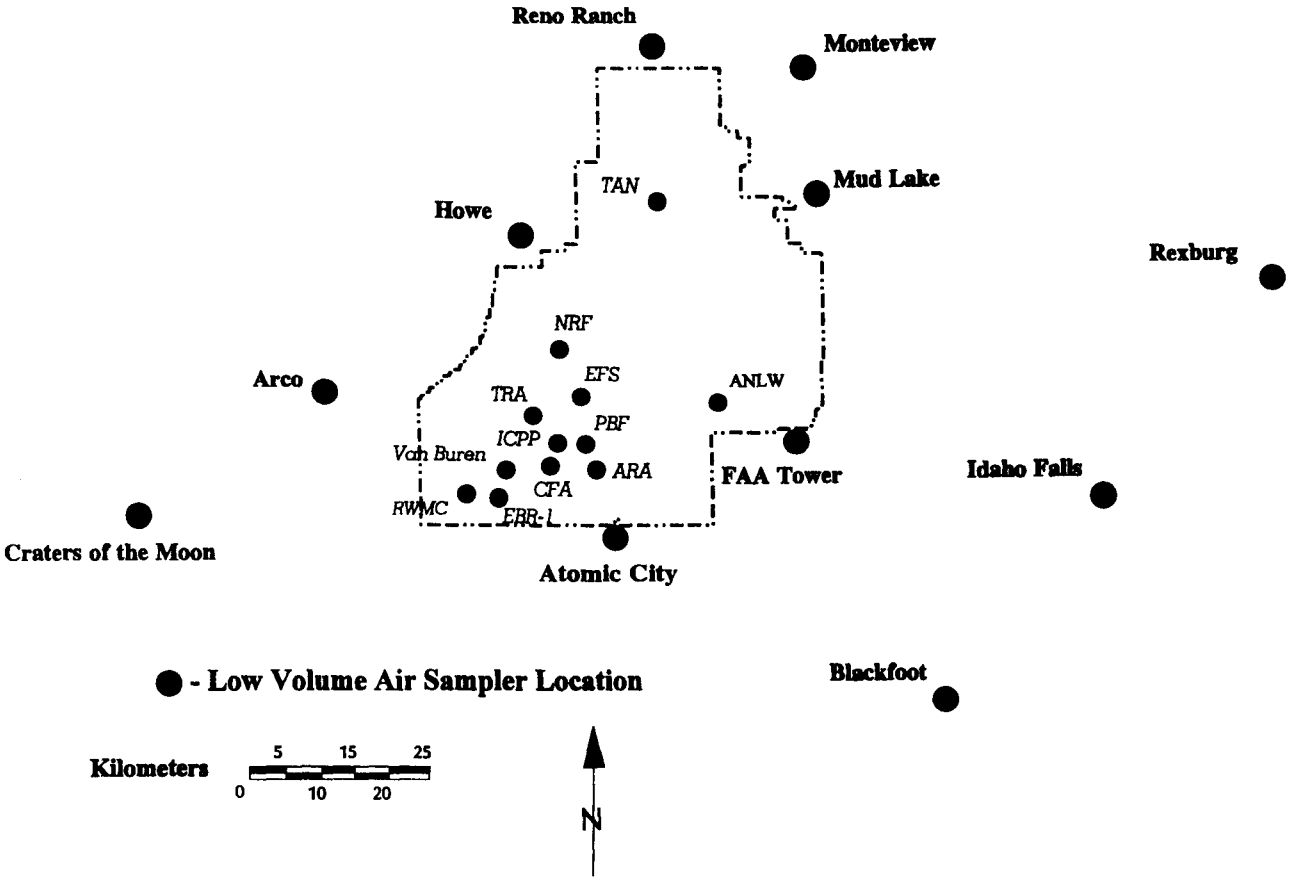


Figure 4.1 Low-volume air sampler locations

whole network provides comprehensive surveillance of particulate atmospheric radioactivity and makes it possible to differentiate INEL releases from worldwide fallout and long-lived natural radioactivity.

Each low-volume air sampler maintained an average air flow of about 50 liters/min (2 ft^3/min) through a set of filters consisting of a 1.2 micrometer pore membrane filter followed by a charcoal cartridge filter. The filters are 99% efficient for airborne particulate radioactivity and airborne iodides.

Low-volume Filter Analyses

The particulate filters from the low-volume air samplers were collected weekly. The charcoal cartridges were screened for gross (or nonspecific) gamma activity weekly with a large well-type thallium-activated sodium iodide detector. The filters were counted either individually or as a stack of four filters. The counting efficiency was experimentally derived by the RESL analytical laboratory specifically for this ^{131}I screening procedure. Initially, all

gross gamma activity observed (which includes natural radon daughter products) is attributed only to ^{131}I; therefore, the screening result represents the maximum ^{131}I activity that can be present on the cartridge. A number of filters were also counted each week specifically for ^{131}I by gamma spectrometry using a High-Purity Germanium detector to determine the ^{131}I component, if any.

Particulate filters were analyzed after waiting a minimum of four days to allow the naturally occurring, short-lived radon and thoron daughters to decay. Analyses for gross alpha activity were performed on filters from Blackfoot, Craters of the Moon, Arco, Mud Lake, ANL-W, EFS, and RWMC. Filters from TAN were also analyzed during the fourth quarter.

Analysis for gross beta activity was performed weekly on filters from all 23 locations in a low background beta counter.

Specific Radionuclide Analyses

Specific radionuclide analyses are more sensitive indicators than gross beta analyses of concentrations of manmade radionuclides in air. Therefore, the membrane filters of the low-volume samplers were composited according to location at the end of each quarter, and all composites were analyzed for specific radionuclides by gamma spectrometry. Selected composites were then submitted for analyses for alpha-emitting radionuclides (plutonium and americium) or ^{90}Sr on a rotating schedule. The analyses for alpha-emitting nuclides used chemical separation techniques followed by alpha spectrometry; for ^{90}Sr, the chemical separation was followed by beta counting. Because both of the follow-up analyses consume the entire sample, only one of the two types can be performed on a given composite.

Atmospheric Tritium Samplers

Samplers for tritium in water vapor in the atmosphere were located in Idaho Falls and at the EFS and Van Buren (VANB on Figure 4.1) locations on the INEL. In these samplers, air was passed through a column of silica gel at a rate of approximately 0.3 liters/min (0.65 ft^3/h). Water vapor in the air was adsorbed by the gel in the column; columns were changed when the gel had adsorbed sufficient moisture to obtain a sample. Tritium concentrations were then determined by liquid scintillation counting of the water extracted from the silica gel columns.

Precipitation Samplers

Monthly precipitation samples were collected on the INEL at CFA and at the offsite location of Idaho Falls. In addition, weekly samples were collected at EFS (when available). A portion of each precipitation sample was submitted for tritium analysis by liquid scintillation counting.

Water Sampling Program Description

Water monitoring on the INEL included sampling of ground water and surface water inflow.

Onsite drinking water samples were collected monthly from production (drinking water) wells in use at active INEL facilities by the contractor responsible for each facility. RESL collected drinking water from boundary and distant communities and Snake River water samples semiannually. In addition, quarterly drinking water and surface water samples were collected from the Magic Valley area (Figure 4.2). Each quarterly sample was collected simultaneously with one by the ISU Environmental Monitoring Program for

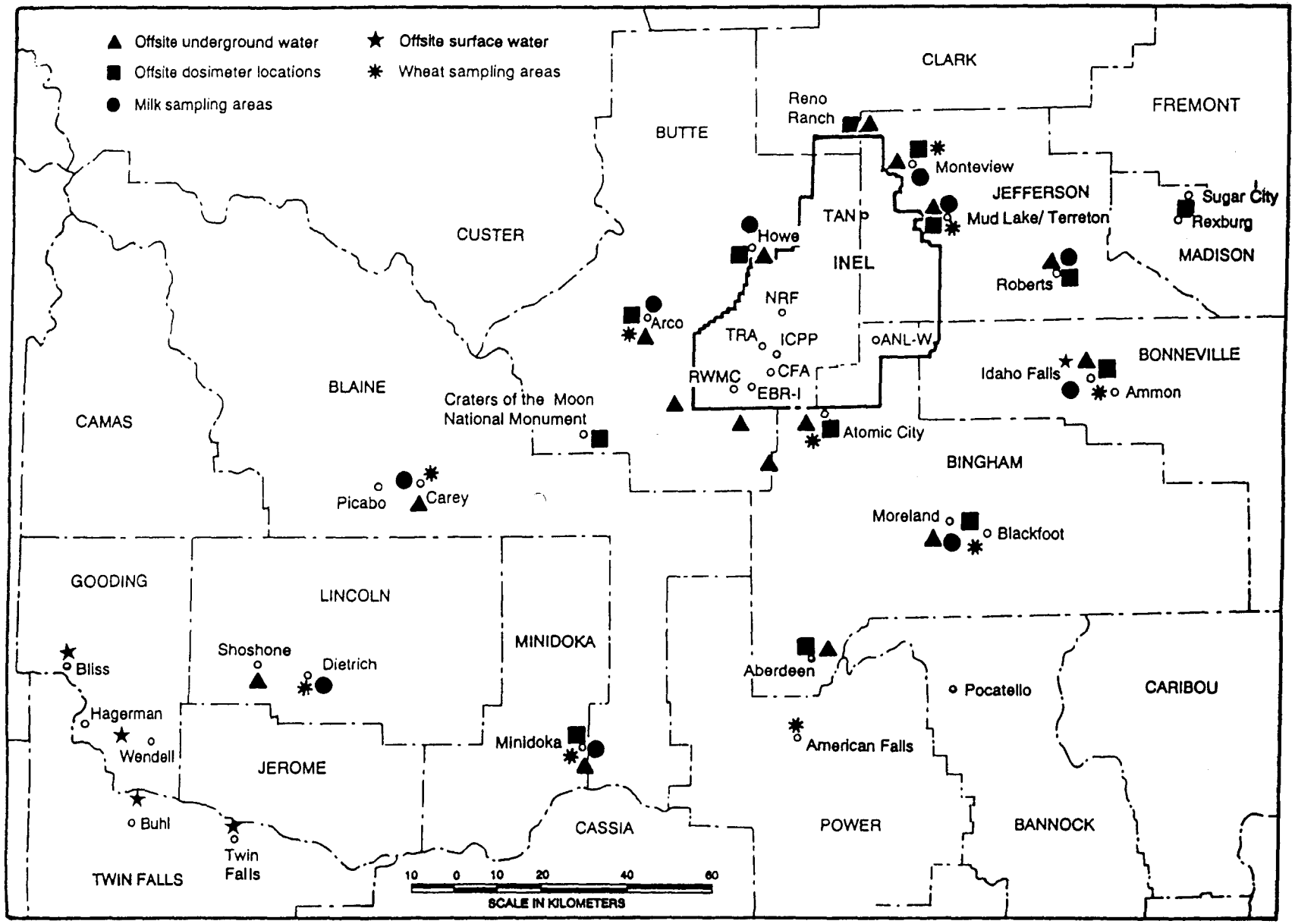


Figure 4.2 Water, foodstuff, and environmental dosimeter sampling locations

comparison to their independent environmental surveillance program. RESL data are compared to ISU data for these water samples in Chapter 7, Quality Assurance.

In addition to the production well monitoring, the USGS conducted an extensive ground-water surveillance program on the INEL Site. A description of the USGS portion of the water surveillance program and maps showing locations of their sampling wells are included in Chapter 5, Ground Water.

Water Sample Analyses

Each RESL water sample was submitted for gross (nonspecific) analyses for alpha and beta-emitting radionuclides that might be present in the water. For gross alpha analysis, a portion of the sample was evaporated on a stainless steel planchet and counted with a scintillation counter system. For gross beta activity, a portion was evaporated and counted in a low-background beta counter. The minimum detectable concentrations for gross alpha and gross beta were approximately 3×10^{-9} and 4×10^{-9} μCi/mL, respectively, or about 10% and 4% of the DOE derived concentration guides for radiation protection of the public (see Appendix A). These minimum detectable concentrations are also 20% and 8%, respectively, of maximum contaminant levels for community drinking water listed by the EPA in 1993.

Tritium analyses were performed on all of the drinking and surface water samples collected, and ^{90}Sr analyses were performed each month on samples from drinking water wells in the ICPP area because two of these wells lie within the ^{90}Sr waste plume as determined by the USGS.

Concentrations of tritium were determined by using a liquid scintillation counter. Strontium-90 was separated from the sample chemically and, after an ingrowth period, its ^{90}Y decay product was separated chemically and counted in a low-background beta counter to determine the amount of ^{90}Sr initially present in the sample. The minimum detectable concentrations for tritium and ^{90}Sr are 4×10^{-7} and 5×10^{-10} μCi/mL, or about 0.02% and 0.05%, respectively, of the DOE derived concentration guides for radiation protection of the public. These minimum detectable concentrations are about 2% and 6%, respectively, of maximum contaminant levels for community drinking water listed by the EPA in 1993.

Foodstuff Sampling Program

General. Samples of milk, wheat, and leafy garden lettuce from locations near the INEL boundary and at distant locations were collected. Tissues were also obtained from game animals killed on the INEL. Wheat and lettuce were chosen for sampling because they are part of the typical American diet and represent a potential pathway to the public for radionuclides from fallout or from INEL operations. Game animals represent a potential pathway to members of the public who might consume animals that have spent time on the INEL.

Milk. Milk samples were collected from both commercial and single-family dairies (Figure 4.2). A four-liter (one-gallon) sample was obtained from each location monthly, except in Idaho Falls where a sample was collected weekly. All milk samples were passed through an anion exchange resin, which was then analyzed for ^{131}I by gamma spectrometry. Milk from each location was analyzed for ^{90}Sr and tritium once during the year.

Lettuce. Lettuce samples were obtained from private gardens in communities in the vicinity of the INEL. Samples were washed to remove any soil (as in normal food preparation), dried, reduced to a powdered form, and weighed. All lettuce samples were analyzed for ^{90}Sr and gamma-emitting radionuclides.

Wheat. Wheat samples were collected from grain elevators in the INEL vicinity (Figure 4.2). A portion of each sample was placed in a plastic container and weighed. All wheat samples were analyzed for ^{90}Sr and gamma-emitting radionuclides.

Game Animals. Selected tissues (muscle, liver, and thyroid) were collected from game animals killed on INEL roads. Thyroid samples were placed in vials and analyzed by gamma spectrometry. Muscle and liver samples were processed, placed in a plastic container, and weighed prior to gamma spectrometry.

Soil Sampling Program

To establish background levels of natural and fallout radioactivity in surface soil and to assess any potential buildup of radioactivity from INEL operations, soil samples were collected annually from distant and boundary locations from 1970-78 (except 1972 and 1977). The biennial soil sampling program was established in 1978 for offsite locations (Figure 4.3). A rotating seven-year schedule is used to sample onsite soils around major INEL facilities.

Soil samples collected in 1970, 1971, and 1973 represented a composite of five cores of soil from a 1-m^2 area. Each core was a cylinder 10 cm in diameter and 5 cm in depth. In all other years, the five cores were collected from a 100-m^2 area. A number of samples from the 5- to 10-cm depth were also collected.

Concentrations of natural radioactivity in the surface soil were previously reported[a]. The ^{238}U and ^{232}Th activities were determined from those of the progeny radionuclides, ^{214}Pb and ^{228}Ac. Data indicates that the average concentrations of uranium, thorium, and ^{40}K in the earth's upper crust, when translated from ppm to pCi/g are 0.9, 1.1, and 17 pCi/g, respectively[b]. The local soils averaged about 1.5, 1.3 and 19 pCi/g, respectively, values that are slightly higher in natural radioactivity than earth crustal averages. Although much of the surface rock on the Snake River Plain is basalt, the local soil is largely derived from silicic volcanics, which have higher uranium and thorium concentrations than basalt.

Estimates of the average external dose equivalent received by a member of the public from ^{238}U plus decay products, ^{232}Th plus decay products, and ^{40}K in average area soil were calculated to be 21, 28, and 27 mrem/yr, respectively, for a total of 76 mrem/yr. Because heavy snow cover can reduce the effective dose equivalent Idaho residents receive from the soil of the area, a correction must be made each year for snow cover (see Table 4.9).

The soils were dried at least three hours at about 120° C and sieved. Only soil particles less than 500 micrometers in diameter (35 mesh) were analyzed.

Environmental Dosimeters

Thermoluminescent dosimeters (TLDs) were used to measure ionizing radiation exposures (beta energies greater than 200 keV and gamma energies greater than 10 keV). The

a. U.S. Energy Research and Development Administration, Idaho Operations Office, *1976 Environmental Monitoring Report*, IDO-12082(76), May 1977, p. 27.

b. D. T. Oakley, *Natural Radiation Exposures in the United States*, U.S. Environmental Protection Agency, ORP/STD 72-1, 1972, p. 16.

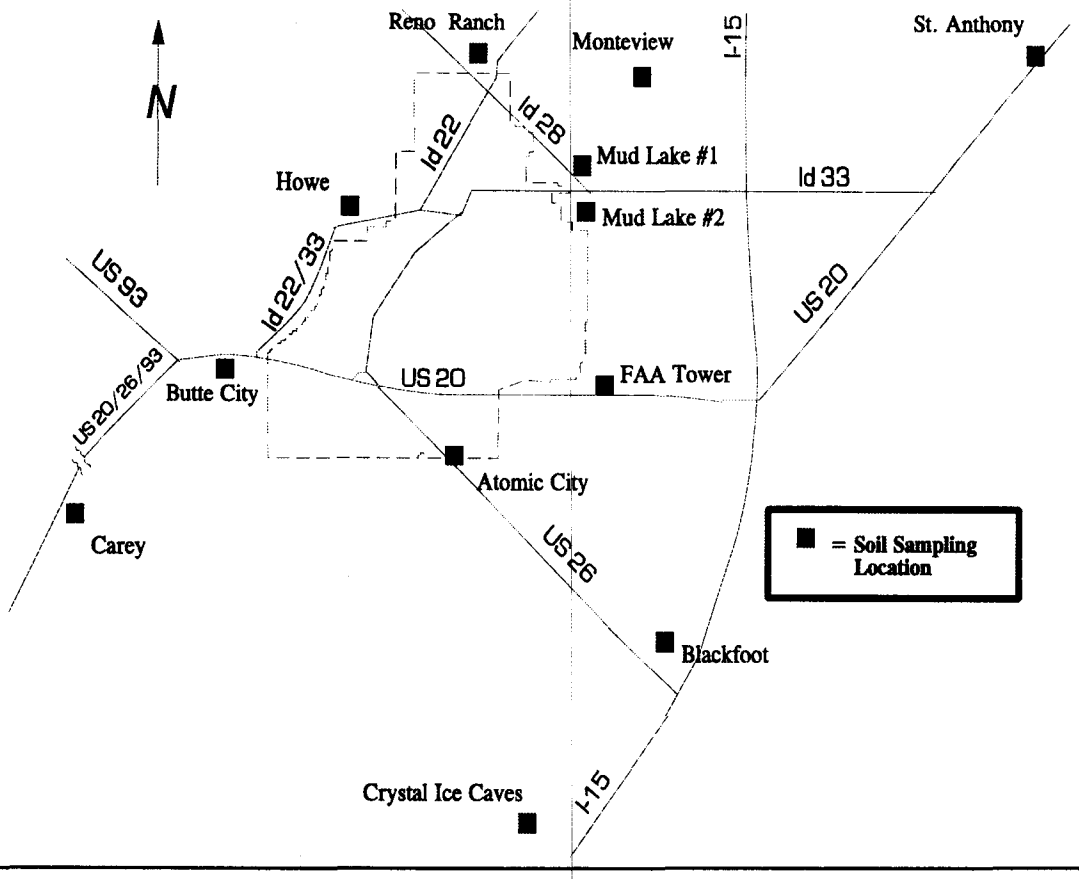


Figure 4.3 Offsite soil sampling locations

TLDs measure ionizing radiation exposures from natural radioactivity in the air and soil, cosmic radiation from outer space, fallout from nuclear weapons tests, radioactivity from fossil fuel burning, and radioactive effluents from Site operations and other industrial processes.

At each location, a dosimeter card containing five individual chips was placed one meter above ground level. The dosimeter card at each location was changed semiannually. There were 7 distant community locations, 6 boundary locations (Figure 4.2), and 135 locations on the INEL.

4.2 ENVIRONMENTAL SURVEILLANCE PROGRAM RESULTS

High-Volume Samplers

Individual filters from the following dates and locations were submitted for gamma spectrometry following gross gamma analyses: January 21 to January 25 from CFA, March 4 to March 5 from EFS, and April 14 to April 15 from EFS. No manmade radionuclides were detected on any of these filters.

Beryllium-7, a naturally-occurring radionuclide produced by the interaction of cosmic radiation and nitrogen in the atmosphere, was detected in all of the samples

of the monthly composites. No manmade radionuclides were detected on any of the 24 composites analyzed by gamma spectrometry.

Low-Volume Charcoal Cartridge ^{131}I Analyses

A total of 187 cartridges were analyzed specifically for ^{131}I following gross gamma screening during 1993. No detectable concentrations of ^{131}I were found in any of the charcoal cartridges analyzed.

Low-volume Gross Alpha

Gross alpha concentrations are usually greater at the distant location of Blackfoot than at the other locations because of contributions from non-INEL sources. Gross alpha data for 1993, however, indicated that the boundary mean was higher than the distant or onsite means (Table 4.1). Monthly gross alpha concentrations were found to be statistically higher than the distant mean gross alpha concentration at Arco in June, July, and August; ANL-W in August; EFS in July; and the onsite group in July. Annual statistical differences were noted for Arco and the boundary group. The onsite group was not statistically higher than the distant group for the year, however.

Low-Volume Gross Beta

Weekly gross beta concentrations ranged from a low of $(5 \pm 4) \times 10^{-15}$ µCi/mL at NRF during the week of April 9 to April 16 to a high of $(1.17 \pm 0.14) \times 10^{-13}$ µCi/mL at TAN during the week of January 29 to February 5. Figure 4.4 indicates a typical annual pattern for gross beta concentrations with higher values

TABLE 4.1
GROSS ALPHA ACTIVITY IN AIR (1993)

			Concentration ($\times 10^{-15}$ µCi/mL)	
Group	Location	Number of Samples	Range of Samples	Annual Mean[a]
Distant	Blackfoot	52	0.1-4.1	1.8 ± 0.2
	Craters of the Moon	51	0.4-2.5	1.3 ± 0.2
			Grand Mean[a]	1.5 ± 0.1
Boundary	Arco	51	0.3-4.1	1.9 ± 0.2
	Mud Lake	50	0.4-3.9	1.7 ± 0.2
			Grand Mean[a]	1.8 ± 0.2
INEL	ANL-W	52	0.6-3.9	1.6 ± 0.2
	EFS	50	0.3-3.9	1.5 ± 0.2
	RWMC	50	0.2-4.4	1.5 ± 0.2
	TAN	12[b]	0.9-3.4	2.1 ± 0.5
			Grand Mean[a]	1.6 ± 0.1

a. Arithmetic mean with the 95% confidence interval for the mean.
b. Measurements made in the Fourth Quarter only.

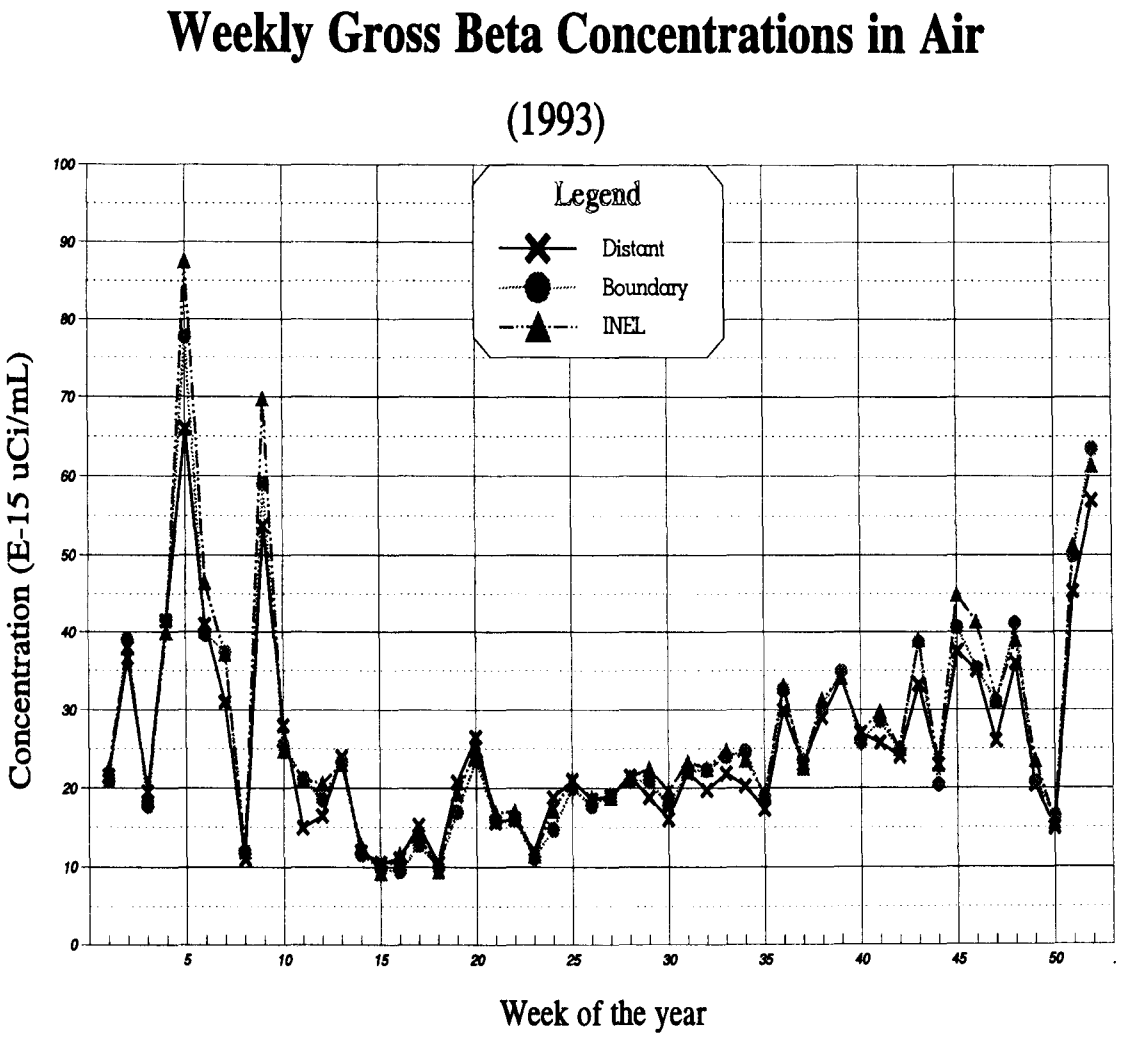


Figure 4.4 Weekly gross beta concentrations in air (1993)

occurring at the beginning and end of the year, particularly during inversion conditions like those existing during the fifth week of 1993 (January 29 to February 5).

Statistical comparisons were made between monthly mean gross beta concentrations at each individual location and the distant group mean gross beta concentration. Statistical differences were noted in 5 of 84 (6%) comparisons involving boundary locations and 16 of 144 (11%) comparisons involving onsite locations (Table 4.2). When statistical differences like these are found, the results of specific nuclide analyses (discussed in the following section) are examined to try to pinpoint a possible INEL cause for the differences. Since the only radionuclides found were near the minimum detectable concentration and were only seen at isolated locations, it is difficult to draw firm conclusions

TABLE 4.2
GROSS BETA STATISTICAL COMPARISON TABLE (1993)[a]

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Arco													
Atomic City													
FAA Tower													
Howe							■	■					
Monteview													
Mud Lake	■									■	■		■
Reno Ranch													
Boundary Group								■					
ANL-W								■					
ARA													
CFA													
EBR-1										■	■		
EFS								■					
ICPP								■					
NRF							■	■	■	■	■		■
PBF							■	■	■	■			■
RWMC													
TAN	■												■
TRA													
Van Buren							■						■
INEL Group							■	■					■

a. A shaded block in the matrix indicates that the mean gross beta concentration for that location was statistically greater than the mean gross beta concentration for the distant group for the given time period. The statistical test used was an unpaired t-test ($\alpha = 0.05$).

as to their effect on the statistical variations. Gross beta concentrations can vary widely from location to location as a result of a number of factors such as diverse local meteorological conditions.

Statistical comparisons were also made between the mean gross beta concentration of the boundary group (or onsite group) and the distant group mean gross beta concentration. The boundary group was found to be statistically higher in the month of August; the onsite group was statistically greater than the distant group in July and August. Monthly gross beta concentrations for the distant, boundary, and INEL groups are shown in Figure 4.5. Gross beta concentrations peaked dramatically after the Chernobyl accident in April 1986. The distant location vs. INEL graph also shows the effects of ^{125}Sb releases from the Fluorinel Dissolution and Fuel Storage Facility at ICPP during late 1986 to mid-1988.

Annual statistical comparisons were also made between gross beta mean concentrations at individual locations and the mean background gross beta concentration (Table 4.2). Statistical differences were found at Mud Lake, NRF, PBF, TAN, and Van Buren. The INEL group mean gross beta concentration was

TABLE 4.3
GROSS BETA ACTIVITY IN AIR (1993)

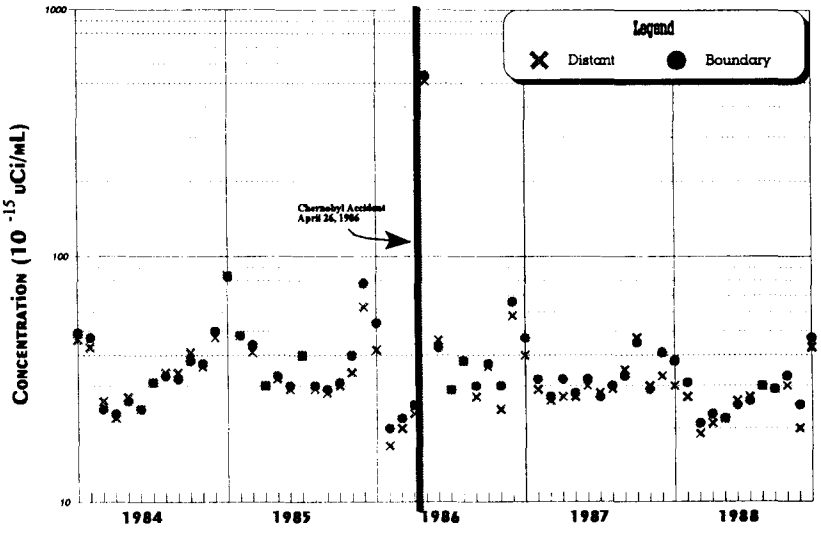
Group	Location	Number of Samples	Concentration (x 10^{-15} µCi/mL) Range of Samples	Annual Mean[a]
Distant	Blackfoot	52	7-87	27 ± 4
	Craters of the Moon	51	9-54	23 ± 3
	Idaho Falls	45	9-72	24 ± 4
	Rexburg	50	10-65	26 ± 3
			Grand Mean[a]	25 ± 2
Boundary	Arco	51	9-61	26 ± 4
	Atomic City	52	7-78	26 ± 4
	FAA Tower	50	10-82	25 ± 4
	Howe	52	10-104	29 ± 5
	Monteview	52	7-74	24 ± 4
	Mud Lake	50	7-81	29 ± 5
	Reno Ranch	49	10-67	25 ± 4
			Grand Mean[a]	26 ± 2
INEL	ANL-W	52	10-92	28 ± 4
	ARA	52	9-77	26 ± 4
	CFA	50	10-85	28 ± 4
	EBR-1	51	6-72	27 ± 4
	EFS	50	7-90	27 ± 5
	ICPP	49	9-73	27 ± 4
	NRF	52	5-102	30 ± 5
	PBF	50	12-95	29 ± 4
	RWMC	50	7-87	25 ± 4
	TAN	52	9-117	31 ± 6
	TRA	52	9-71	24 ± 4
	Van Buren	52	7-97	29 ± 5
			Grand Mean[a]	28 ± 1

a. Arithmetic mean with the 95% confidence interval for the mean.

also statistically greater than the distant mean gross beta concentration. As described earlier, more reliance is generally placed on the results of specific nuclide analyses than on gross beta concentrations, and these were not conclusive in pinpointing a source for the statistical differences.

Annual mean gross beta concentrations ranged from 2.3 x 10^{-14} µCi/mL at Craters of the Moon to 3.1 x 10^{-14} µCi/mL at TAN (Table 4.3). These concentrations are 0.8% and 1.0% of the annual derived concentration guide for gross beta, respectively.

Distant vs. Boundary Gross Beta Concentrations (1984-1988)



Distant vs. INEL Gross Beta Concentrations (1984-1988)

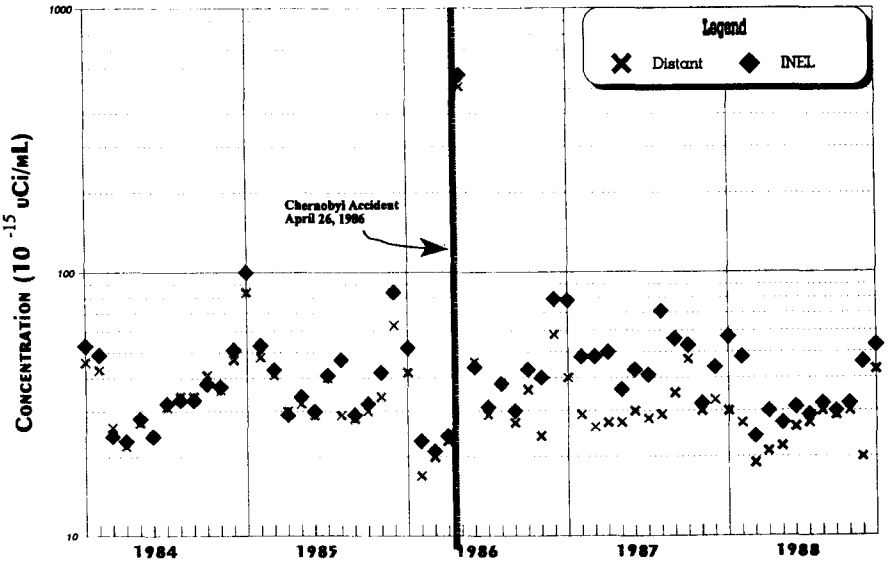
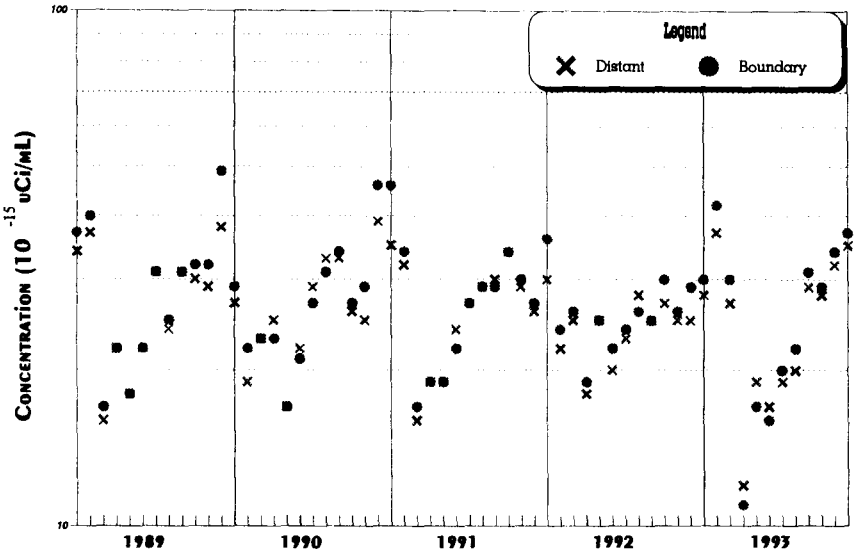


Figure 4.5 Monthly gross beta concentrations (1984-1988)

Distant vs. Boundary Gross Beta Concentrations (1989-1993)



Distant vs. INEL Gross Beta Concentrations (1989-1993)

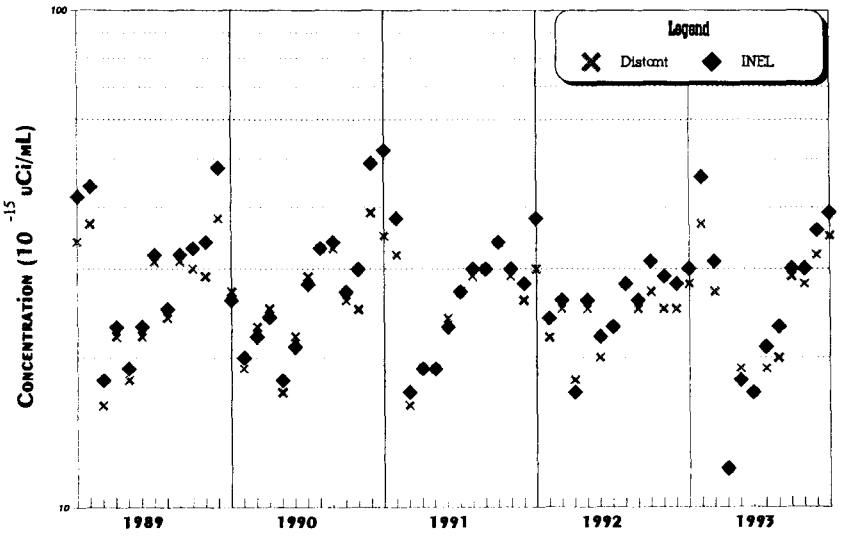


Figure 4.5 (Continued) Monthly gross beta concentrations (1989-1993)

Low-Volume Specific Nuclides

Naturally occurring ^{7}Be was reported in all of the quarterly composites analyzed. Two radionuclides were indicated on the second quarter composite from NRF, both near the minimum detectable concentration. These were ^{54}Mn at $(1.1 \pm 0.8) \times 10^{-15}$ µCi/mL and ^{103}Ru at $(3.6 \pm 3.2) \times 10^{-15}$ µCi/mL.

No ^{90}Sr was detected on any of the 26 sets of quarterly composites analyzed.

No ^{238}Pu was detected on any of the 41 sets of composites analyzed for actinides. Two radionuclides, ^{241}Am in the second quarter and $^{239/240}Pu$ in the third quarter, were indicated on composites from RWMC at concentrations of $(5 \pm 4) \times 10^{-18}$ µCi/mL and $(4.2 \pm 3.2) \times 10^{-18}$ µCi/mL, respectively. Detection of these two radionuclides, although near the minimum detectable concentration, may be a result of airborne suspension of soil known to have above-background concentrations of plutonium and americium. Construction activities occurred in the area near the air sampler in 1993.

In addition, $^{239/240}Pu$ was also indicated near the minimum detectable concentration on two fourth quarter composites from boundary locations. A reported concentration of $(3.1 \pm 2.4) \times 10^{-18}$ µCi/mL was given for Atomic City and $(4 \pm 3) \times 10^{-18}$ µCi/mL for Mud Lake.

Atmospheric Tritium

Five samples were collected for each location covering the following time periods: November 6, 1992 to January 29, 1993; January 29 to April 30; April 30 to July 2; July 2 to October 1; and October 1 to December 30. Tritium was not detected in any of the samples.

Precipitation

A total of 46 precipitation samples were collected and analyzed for tritium. Only one sample had a detectable concentration of tritium, a sample from EFS from the period March 30 to April 6. The concentration measured in the sample was $(9 \pm 2) \times 10^{-7}$ µCi/mL. Because tritium is not generally greater than the minimum detectable concentration in precipitation samples, and no other significant source of tritium exists, this is assumed to have resulted from INEL operations.

Water Sampling Results

The DOE Order governing preparation of Annual Site Environmental Reports (DOE 5400.1) recommends using units of µCi/mL for concentrations of radionuclides in water. However, 40 CFR 141 gives the EPA maximum contaminant levels in units of pCi/L. For the reader's convenience, concentrations of radionuclides in water samples will be shown with exponents that allow easy conversion to EPA units:

1×10^{-9} µCi/mL = 1 pCi/L

1×10^{-6} µCi/mL = 1000 pCi/L.

Gross Alpha

Forty-six offsite samples were collected in 1993. Three had gross alpha concentrations above the minimum detectable concentration. The highest reported value of $(2.4 \pm 2.2) \times 10^{-9}$ µCi/mL was 8% of the derived concentration guide.

Of the 305 onsite production well samples collected during 1993, a total of 49 samples contained gross alpha above the minimum detectable concentration (Figure 4.6), the highest of which was $(3.1 \pm 2.4) \times 10^{-9}$ µCi/mL. This value is 10% of the derived concentration guide for gross alpha.

All gross alpha concentrations were within the expected concentration range for naturally occurring alpha activity in the aquifer underlying the INEL and surrounding areas. According to USGS reports, alpha-emitting wastes from Site operations have not migrated far from their entrance into the aquifer near ICPP. The offsite gross alpha activity is unlikely to be due to migration of wastes from Site operations, and all onsite drinking water wells lie outside the migration plumes for alpha-emitting nuclides.

Gross Beta

Gross beta activity was only above the minimum detectable concentration in two of the offsite samples. An August sample from Alpheus Spring (in the Twin Falls area) had a concentration of $(7 \pm 4) \times 10^{-9}$ µCi/mL or 7% of the derived concentration guide. One other sample, the August sample from Clear Spring Trout Farm north of Buhl, had a reported concentration near the minimum detectable concentration at $(5 \pm 4) \times 10^{-9}$ µCi/mL. This

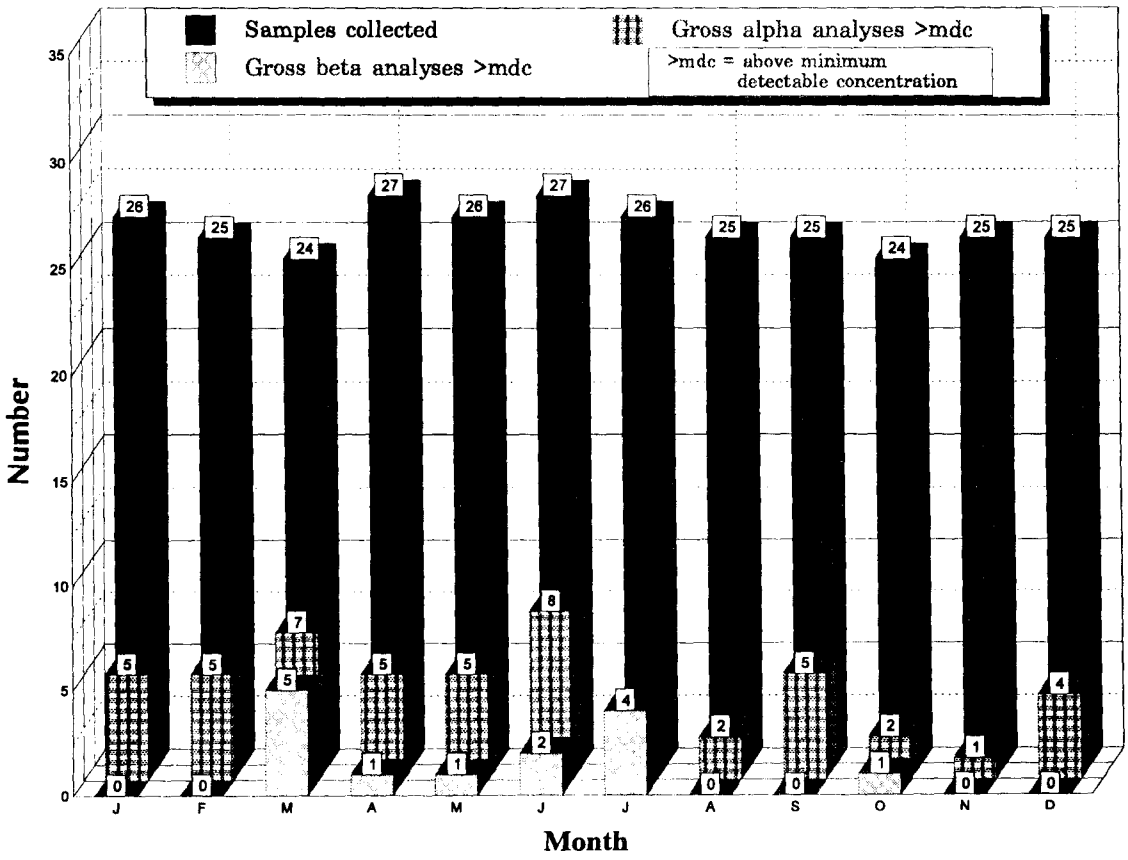


Figure 4.6 Water samples with detectable gross alpha and gross beta concentrations (1993)

value is 5% of the derived concentration guide for gross beta.

Fourteen of the 305 onsite production well samples had a concentration of gross beta that was above the minimum detectable concentration (Figure 4.6). All of these detected concentrations were either $(6 \pm 4) \times 10^{-9}$ µCi/mL (6% of the derived concentration guide) or $(5 \pm 4) \times 10^{-9}$ µCi/mL (5% of the derived concentration guide).

Natural radioactivity is found in the Snake River Plain aquifer in areas upgradient, parallel to, and distant from the INEL. Natural radioactivity is the probable source of the presence of low concentrations of gross alpha and gross beta activity.

Tritium

None of the offsite water samples contained a detectable concentration of tritium.

Water from four of the onsite production wells that were routinely sampled showed detectable concentrations of tritium each month (Table 4.4). Figure 4.7 shows five years of tritium data for these wells along with data from a production well at the Organic Moderated Reactor Experiment (OMRE on Figure 4.7) facility that is no longer in use.

In addition to the above four production wells, one sample from ICPP Well #4 taken in December had an indicated tritium concentration of $(0.5 \pm 0.4) \times 10^{-6}$ µCi/mL, or near the minimum detectable concentration.

Strontium-90

Concentrations of ^{90}Sr above the minimum detectable concentration were found in four of the six samples from ICPP #1 during 1993. Concentrations reported were consistent with those of previous years (Figure 4.8), ranging from 0.5% to 0.9% of the derived concentration guide. None of the 6 samples from ICPP #2 or 12 samples from ICPP #4 showed a detectable concentration of ^{90}Sr.

TABLE 4.4
TRITIUM CONCENTRATIONS IN INEL PRODUCTION WELLS (1993)

Well Code	# of Samples[b]	Tritium Concentration ($\times 10^{-6}$ µci/mL)[a] Minimum[c]	Maximum[c]	Mean[d]	% DCG
CFA[e]	12	14.0 ± 1.0	16.7 ± 1.0	15.2 ± 0.6	0.7
CFA #1	11	13.1 ± 1.0	16.7 ± 1.0	15.4 ± 0.8	0.8
CFA #2	12	14.1 ± 1.0	17.9 ± 1.0	15.2 ± 0.6	0.7
Rifle Range	12	3.8 ± 0.6	4.4 ± 0.6	4.17 ± 0.13	0.2
RWMC	12	1.3 ± 0.4	1.6 ± 0.4	1.48 ± 0.08	0.07

a. Equivalent to pCi/mL.
b. Samples taken only from wells in use at collection time.
c. Tritium concentration ± 2s.
d. Arithmetic mean with the 95% confidence interval for the mean.
e. Samples collected from the CFA distribution system.

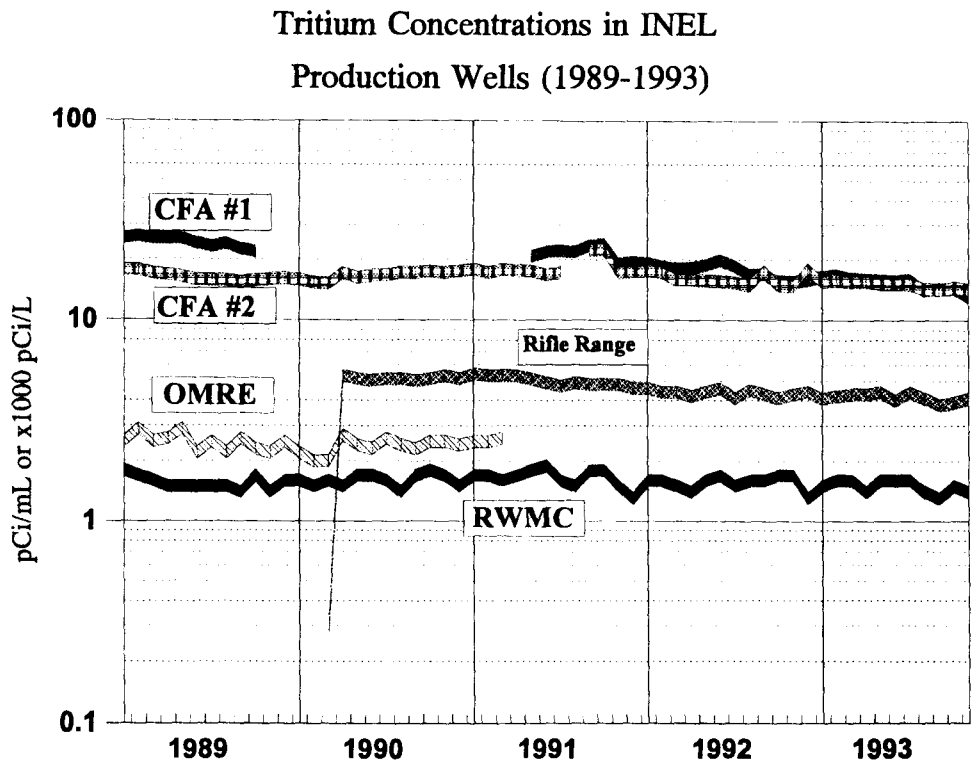


Figure 4.7 Tritium concentrations in INEL production wells (1989-1993)

CFA Worker Dose

The potential effective dose equivalent to a worker at CFA from radioactivity in water was calculated. CFA was selected because the tritium concentrations found in these wells were the highest of any drinking water wells. The 1993 calculation was based on

- Average tritium concentration for the CFA production well for 1993 as shown in Table 4.4
- Data from a 1990-91 USGS study for ^{129}I using the accelerator mass spectrographic analytical technique which indicated that water from CFA #1 contained ^{129}I at a concentration of 0.26 x 10^{-9} µCi/mL (average of two samples) and water from CFA #2 had a concentration of 0.14 x 10^{-9} µCi/mL (also the average of two samples). For perspective, the proposed EPA drinking water standard for ^{129}I is 21 x 10^{-9} µCi/mL.
- Water usage information for 1993 showing CFA #2 was used for approximately 96% of drinking water and CFA #1 was used for only 4%.

For the 1993 dose calculation, the assumption was made that each worker's total water intake came from the CFA drinking water distribution system. This assumption overestimates the dose because workers typically consume only about half their total intake during working hours and typically work

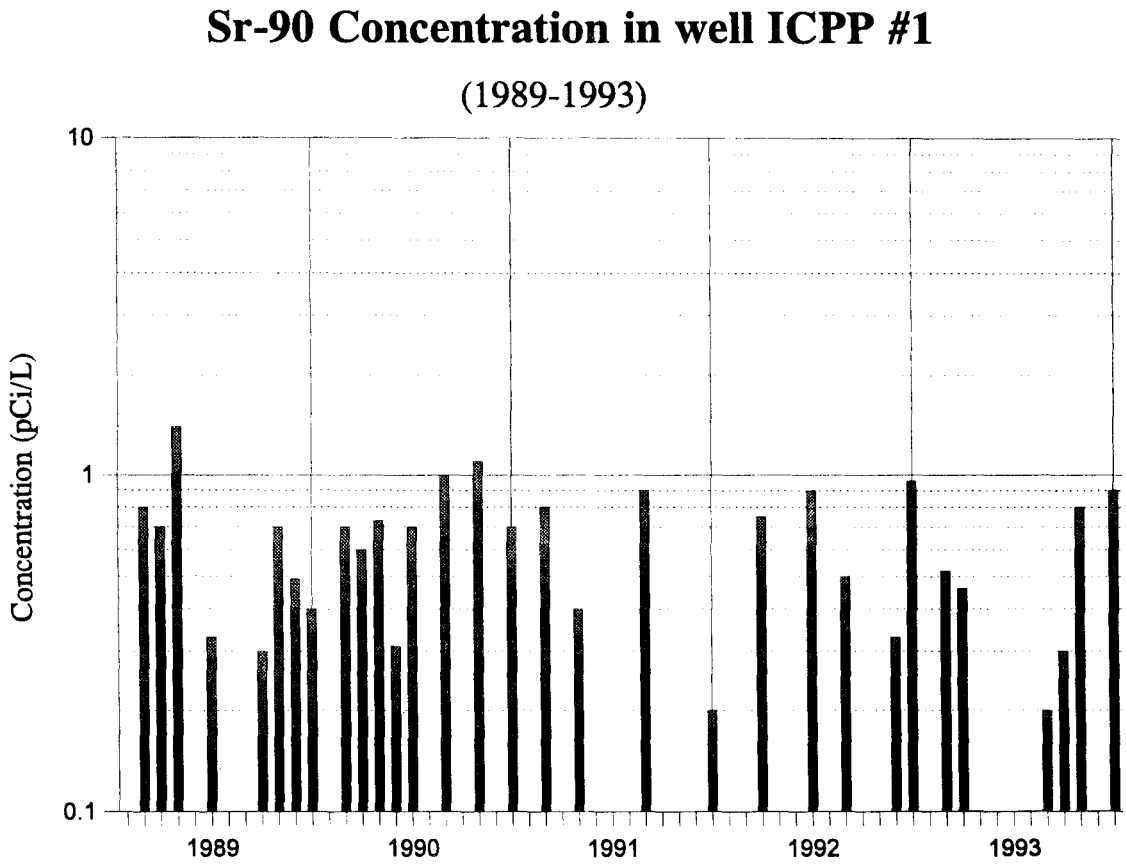


Figure 4.8 ^{90}Sr concentration in well ICPP #1 (1989-1993)

only 240 days rather than 365 days per year. The estimated effective dose equivalent to a worker from consuming all drinking water at CFA during 1993 was 0.7 mrem, 18% of the EPA standard of 4 mrem for community drinking water systems.

Foodstuff Sampling Results

Milk. None of the 153 milk samples collected during 1993 contained a detectable concentration of ^{131}I. Tritium was not detected in any of the ten samples analyzed for that radionuclide.

None of the four samples from boundary locations had a detectable concentration of ^{90}Sr, but it was detected in one of the six samples from distant locations, a Roberts sample, at a concentration of (1.6 ± 0.5) x 10^{-9} μCi/mL. Group means for the distant and boundary locations were 0.3 and 0.5 x 10^{-9} μCi/mL, respectively. All levels of ^{90}Sr in milk were consistent with those reported by the EPA as resulting from world-wide fallout deposited on soil, then taken up by consumption of grass by cows[a].

a. U.S. Environmental Protection Agency, Environmental Radiation Data Reports 70-73, 1993.

Lettuce. No gamma-emitting radionuclides were detected in any of the eight samples collected. Two of the samples, one from a distant location and one from a boundary location, had a ^{90}Sr concentration above the minimum detectable concentration (Table 4.5). There was no statistical difference between mean ^{90}Sr concentrations at the distant and boundary locations. The detectable concentrations found were likely from wordlwide fallout.

Wheat. No manmade gamma-emitting radionuclides or ^{90}Sr were found above the minimum detectable concentration in 1993 wheat samples. No differences have been seen in ^{90}Sr concentrations at distant and boundary locations over the past several years (Table 4.6). Concentrations of this radionuclide found in some years are likely due to worldwide fallout.

Game. Three game animals, all pronghorn antelope, were sampled in 1993. Two were killed in the vicinity of NRF and one in the ICPP area. No manmade radionuclides were detected in thyroid or muscle samples. The pronghorn collected near the ICPP had a ^{137}Cs concentration just above the minimum detectable concentration at $(2.5 \pm 2.4) \times 10^{-9}$ µCi/g in the liver.

The Big Lost River contained water on the INEL for the first time since 1986, running for a period of approximately one month, but no fish were collected during this time.

Table 4.5
^{90}Sr Concentrations in Garden Lettuce (1989-1993)

Sample Location	^{90}Sr Concentration ($\times 10^{-9}$ µCi/g dry weight)[a]				
	1989	1990	1991	1992	1993
Distant Group:					
Blackfoot	170 ± 60	150 ± 60	170 ± 80	-----[b]	-30 ± 60
Carey	140 ± 60	180 ± 40	210 ± 80	200 ± 40	-70 ± 50
Idaho Falls	60 ± 60	-----[b]	170 ± 100	230 ± 40	-80 ± 50
Pocatello	130 ± 40	210 ± 60	190 ± 40	80 ± 40	180 ± 140
Mean[c]	125 ± 75	180 ± 70	190 ± 30	170 ± 200	0 ± 190
Boundary Group:					
Arco	110 ± 60	50 ± 40	80 ± 40	50 ± 40	90 ± 90
Atomic City	210 ± 80	140 ± 40	310 ± 120	210 ± 60	-80 ± 60
Howe	70 ± 60	50 ± 40	50 ± 40	80 ± 40	NS[d]
Monteview	NS	NS	NS	NS	210 ± 80
Mud Lake/Terreton	190 ± 80	90 ± 60	170 ± 80	150 ± 40	40 ± 70
Mean[c]	110 ± 110	80 ± 70	150 ± 160	120 ± 110	70 ± 190

a. Analytical results ± 2s. Approximate minimum detectable concentration for ^{90}Sr in lettuce is 80×10^{-9} µCi/g dry weight.
b. Sample lost in preparation or analysis.
c. Arithmetic mean with the 95% confidence interval for the mean.
d. No sample was collected at this location during the year.

Table 4.6
^{90}Sr Concentrations in Wheat (1989-1993)

Sample Location	^{90}Sr Concentration (x 10^{-9} μCi/g dry weight)[a]				
	1989	1990	1991	1992	1993
Distant Group:					
American Falls	3 ± 2	10 ± 3	10 ± 4	11 ± 2	2 ± 2
Blackfoot	9 ± 3	21 ± 4	10 ± 3	7 ± 2	2 ± 4
Carey	NS[b]	NS	NS	10 ± 2	2 ± 4
Dietrich	7 ± 3	9 ± 3	6 ± 3	NS	-1 ± 4
Idaho Falls	11 ± 3	13 ± 4	9 ± 3	9 ± 2	0 ± 3
Minidoka	8 ± 3	12 ± 4	8 ± 4	7 ± 2	4 ± 4
Mean[c]	8 ± 4	13 ± 6	8 ± 2	9 ± 2	2 ± 2
Boundary Group:					
Arco	5 ± 3	13 ± 4	10 ± 3	10 ± 2	-1 ± 3
Monteview	6 ± 2	9 ± 3	3 ± 3	9 ± 2	1 ± 4
Mud Lake	12 ± 3	7 ± 3	9 ± 3	4 ± 2	2 ± 4
Tabor	8 ± 3	10 ± 3	15 ± 4	8 ± 2	0 ± 6
Terreton	5 ± 2	12 ± 3	5 ± 3	3 ± 2	1 ± 2
Mean[c]	7 ± 4	10 ± 3	8 ± 6	7 ± 4	1 ± 1

a. Analytical results ± 2s. Approximate minimum detectable concentration of ^{90}Sr in wheat is 4 x 10^{-9} μCi/g dry weight.
b. No sample was collected at this location during the year.
c. Arithmetic mean with the 95% confidence interval for the mean.

Soil

In 1992, all offsite soil samples were analyzed for gamma-emitting radionuclides. All offsite surface samples (0-5 cm) were also analyzed for ^{90}Sr and alpha-emitting radionuclides (Table 4.7). The data are reported in units of activity per gram of soil (pCi/g dry weight) and also in units of areal activity (nCi/m^2), which is the total activity in each soil sample divided by the surface area (0.039 m^2) of the sample. Data from 1992 are included in the 1993 report because the ^{90}Sr results were not available for the 1992 report.

Surface soil concentrations of ^{137}Cs, ^{90}Sr, ^{238}Pu, $^{239/240}Pu$, and ^{241}Am, as measured from 1970-75, are compared to biennial samples since 1978. The 1976 data are not included because the sampling locations used that year are not considered to be representative of the area. Three samples from 1984, Mud Lake No. 1, Mud Lake No. 2, and Crystal Ice Caves, were excluded from 1984 data because the concentrations were uncharacteristically low compared to previous years. This may have been caused by disturbance (farming, erosion, vehicular traffic, etc.) of the sampling locations. These sampling locations, plus the location at Monteview, were re-evaluated and moved to more representative undisturbed locations in 1986.

The 1992 boundary group average concentrations were not statistically greater than the distant group concentrations for any radionuclide. It is concluded the manmade radionuclides detected are present as a result of worldwide fallout.

TABLE 4.7
RADIONUCLIDES IN OFFSITE SURFACE (0-5 cm. DEPTH) SOIL (1970-1992)

		pCi/g		nCi/m²			~MDC[a]	
Nuclide	Year	Geometric Mean	95% Confidence Interval	Geometric Mean	95% Confidence Interval	Number of Samples	pCi/g	nCi/m²
^{137}Cs	1970-75[b]	0.94	0.78-1.1	54	49-59	60	0.01	1
	1978	0.94	0.72-1.2	58	44-75	10		
	1980	0.64	0.46-0.90	41	29-57	10		
	1982	0.90	0.64-1.2	44	31-62	10		
	1984	0.69	0.49-0.97	43	31-60	7		
	1986	0.81	0.54-1.2	48	34-67	13		
	1988	0.66	0.34-1.3	47	46-48	12		
	1990	0.73	0.54-0.99	43	33-56	12		
	1992	0.78	0.56-1.09	42	31-57	12		
^{90}Sr	1970-75	0.54	0.43-0.59	34	31-37	55	0.09	10
	1978	0.52	0.40-0.68	32	23-45	10		
	1980	0.35	0.25-0.49	22	15-33	10		
	1982	0.37	0.26-0.52	18	11-29	10		
	1984	0.45	0.32-0.63	28	20-39	7		
	1986	0.52	0.43-0.62	30	25-37	13		
	1988	0.38	0.28-0.53	23	17-31	12		
	1990	0.30	0.22-0.40	17	13-23	12		
	1992	0.26	0.17-0.41	14	9-21	12		
^{238}Pu	1970-75	0.0028	0.0023-0.0034	0.15	0.13-0.18	55	0.002	0.1
	1978	0.0010	0.0005-0.0020	0.06	0.03-0.11	10		
	1980	0.0007	0.0005-0.0009	0.05	0.04-0.07	10		
	1982	0.0011	0.0007-0.0017	0.05	0.03-0.08	10		
	1984	0.0015	0.0008-0.0027	0.08	0.04-0.15	7		
	1986	0.0021	0.0010-0.0027	0.12	0.06-0.27	13		
	1988	0.0014	0.0009-0.0024	0.09	0.05-0.14	12		
	1990	0.0006	0.0003-0.0012	0.04	0.02-0.09	12		
	1992	0.0013	0.0009-0.0019	0.07	0.05-0.10	12		
$^{239/240}Pu$	1970-75	0.020	0.017-0.024	1.06	0.96-1.17	54	0.002	0.1
	1978	0.018	0.013-0.025	1.09	0.78-1.53	10		
	1980	0.010	0.006-0.017	0.63	0.37-1.07	10		
	1982	0.022	0.016-0.031	1.06	0.76-1.48	10		
	1984	0.016	0.011-0.022	1.02	0.73-1.43	7		
	1986	0.018	0.012-0.027	1.05	0.70-1.58	13		
	1988	0.021	0.015-0.029	1.22	0.91-1.65	12		
	1990	0.024	0.017-0.035	1.43	1.01-2.03	12		
	1992	0.021	0.013-0.033	1.52	0.74-1.70	12		
^{241}Am	1970-75	0.004	0.003-0.005	0.24	0.20-0.29	37	0.003	0.2
	1978	0.006	0.004-0.009	0.38	0.29-0.49	10		
	1980	0.003	0.002-0.0004	0.20	0.14-0.28	10		
	1982	0.004	0.003-0.006	0.21	0.13-0.34	10		
	1984	0.004	0.002-0.007	0.26	0.15-0.44	7		
	1986	0.004	0.002-0.007	0.23	0.12-0.41	13		
	1988	0.005	0.004-0.008	0.31	0.22-0.45	12		
	1990	0.005	0.003-0.008	0.27	0.16-0.45	12		
	1992	0.004	0.002-0.006	0.19	0.12-0.31	12		

a. Approximate minimum detectable concentration.
b. Excluding 1972 in which no samples were taken.

Environmental Dosimeters

The measured cumulative exposure for offsite locations for the time period from November 1992 to November 1993 is shown in Table 4.8. For purposes of comparison, annual exposures from 1989-92 are also included for each location.

The mean annual exposures for distant and boundary community locations in 1993

TABLE 4.8
ENVIRONMENTAL RADIATION EXPOSURES (1989-1993)

Location	Annual Exposure (mR)[a] 1989	1990	1991	1992	1993
Distant Group:					
Aberdeen	114 ± 6	114 ± 4	126 ± 5	-----[b]	99 ± 3
Blackfoot	117 ± 8	118 ± 5	122 ± 6	122 ± 4	111 ± 4
Craters of the Moon	123 ± 7	116 ± 4	131 ± 10	132 ± 6	110 ± 7
Idaho Falls	-----[c]	126 ± 4	127 ± 6	138 ± 9	116 ± 4
Minidoka	108 ± 6	99 ± 4	103 ± 4	129 ± 6	-----[d]
Rexburg	114 ± 5	110 ± 4	113 ± 5	109 ± 4	107 ± 4
Roberts	127 ± 6	125 ± 5	137 ± 8	136 ± 6	124 ± 4
Mean[e]	117 ± 7	115 ± 9	123 ± 11	128 ± 11	111 ± 9
Boundary Group:					
Arco	117 ± 5	114 ± 4	123 ± 9	134 ± 6	117 ± 4
Atomic City	125 ± 6	121 ± 4	117 ± 9	132 ± 5	125 ± 4
Howe	117 ± 6	-----[f]	114 ± 8	126 ± 4	114 ± 4
Monteview	120 ± 6	110 ± 4	128 ± 4	120 ± 5	116 ± 4
Mud Lake	125 ± 6	121 ± 6	124 ± 6	138 ± 4	126 ± 4
Reno Ranch	105 ± 6	110 ± 4	120 ± 8	112 ± 4	107 ± 4
Mean[e]	118 ± 8	115 ± 7	121 ± 5	127 ± 10	118 ± 7

a. Annual exposure ± 2s.
b. Dosimeter missing at November 1992 collection time.
c. Dosimeter missing at November 1989 collection time.
d. Dosimeter missing at May and November 1993 collection times.
e. Arithmetic mean with the 95% confidence interval for the mean.
f. Dosimeter missing at May 1990 collection time.

were 111 ± 9 mR and 118 ± 7 mR, respectively, as measured by thermoluminescent dosimeters (TLDs). The average exposures of the offsite groups are approximately equivalent to 114 and 122 mrem, when a dose equivalent conversion factor of 1.03[a] was used to convert from mR to mrem in tissue.

Table 4.9 summarizes the calculated effective dose equivalent an individual receives on the Snake River Plain from various background radiation sources. The terrestrial portion of this value, which is based on soil sampling for natural radionuclides in 1976, varies from year to year, depending on the amount of snow cover[b]. For 1993, this resulted

a. R. C. Yoder, et al., *Confirmation of Conversion Factors Relating Exposure and Dose-Equivalent Index Presented in ANSI N13.11*, NUREG/CR-1057, PNL-3219: Pacific Northwest Laboratory, Richland, WA, 1979.

b. National Council on Radiation Protection and Measurements, *Ionizing Radiation Exposure of the Population of the United States*, NCRP Report No. 93, September 1, 1987.

in about a 21% dose reduction due to the extremely heavy snow cover, which reached a recorded INEL maximum of 54 cm (30 in).

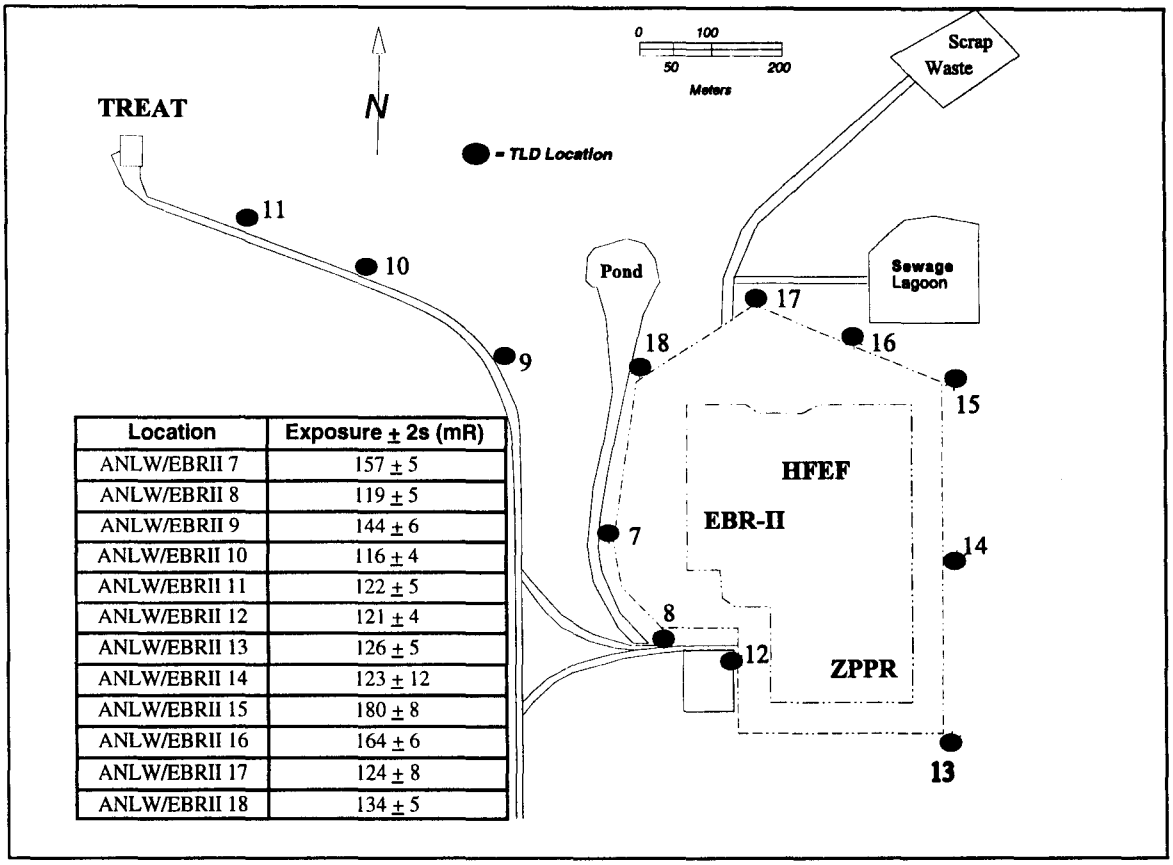
The cosmic component varies primarily with altitude. The average annual dose equivalent of 26 mrem at sea level essentially doubles with each 2000 m (6560 ft) increase in altitude[a]. The INEL Site altitude is approximately 1500 m (4900 ft). The sum of the estimated terrestrial and cosmic components for 1993 is 98 mrem, which is lower than the 111 mrem measured by TLDs at distant locations. The component of natural background dose that varies the most is that of inhaled radionuclides. According to the National Council on Radiation Protection, the major radionuclides contributing to this component are short-lived decay products of radon, and the amount of radon in buildings and ground water depends, in part, upon the natural radionuclide content of the soil and rock of the area. There is also variation between buildings of a given geographic area depending upon the materials each contains, the amount of ventilation and air movement, and other factors. The U.S. average of 200 mrem has been used in Table 4.9 for this component of the total background dose because no specific estimate for southeastern Idaho has been made, and measurements in homes in this area are few. Therefore, the effective dose equivalent from natural background radiation for residents in the INEL vicinity may actually be higher or lower than the total estimated natural background dose of about 340 mrem shown in Table 4.9 and will vary from one location to another.

Table 4.9
Estimated Natural Background Effective Dose Equivalent (1993)

Source of Radiation Dose Equivalent	Total Average Annual Effective Dose Equivalent (mrem)	
	Estimated	Measured (TLD)
External		
Terrestrial	59	--------
Cosmic	39	--------
Subtotal	98	111
Internal		
Cosmogenic	1	
Inhaled radionuclides	200	
^{40}K and others	39	
Subtotal	240	
Total	338	

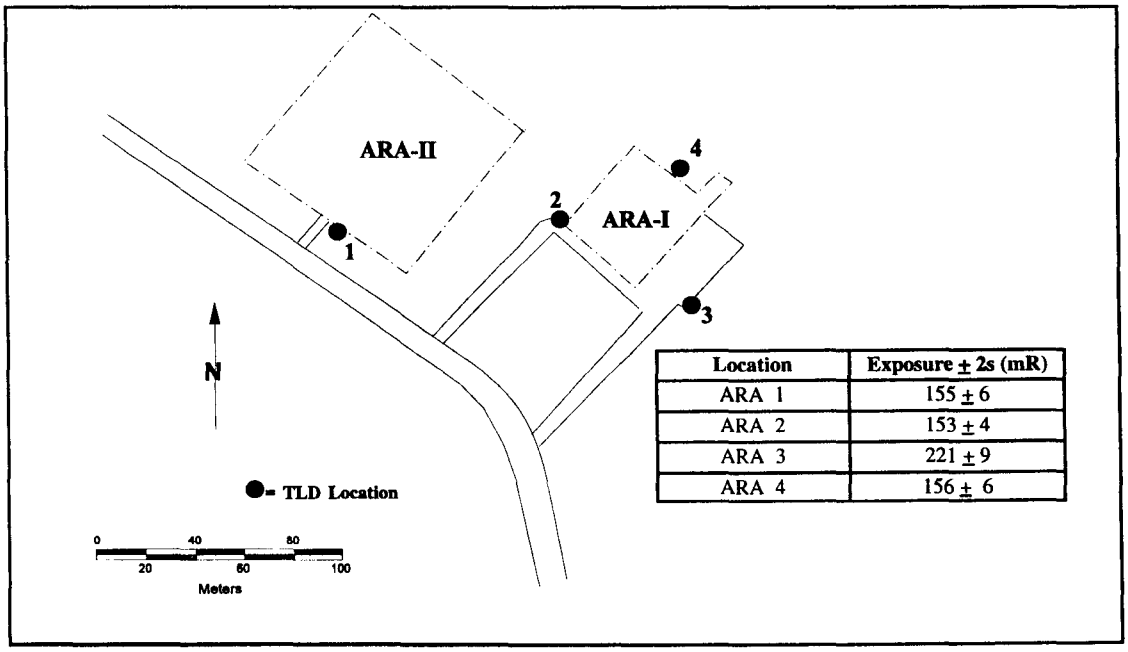
Annual exposure ± two standard deviations (2s) for onsite TLDs representing the same exposure period as the offsite dosimeters are shown in Figures 4.9 through 4.18. Onsite dosimeters were placed on facility perimeters, concentrated in areas likely to show the highest gamma radiation readings. At TRA, for example, dosimeters #3, #4, and #5 are adjacent to the former radioactive disposal pond which has been drained and covered by clean soil as described in Chapter 2. Other dosimeters (e.g., ICPP #21 and #22, TRA #7, and ANL-W #15) are located in the vicinity of radioactive material storage areas. At some facilities, particularly ARA and ICPP, slightly elevated exposures result from soil contamination.

a. National Council on Radiation Protection and Measurements, *Exposure of the Population in the United States and Canada from Natural Background Radiation*, NCRP Report No. 94, December 30, 1987.



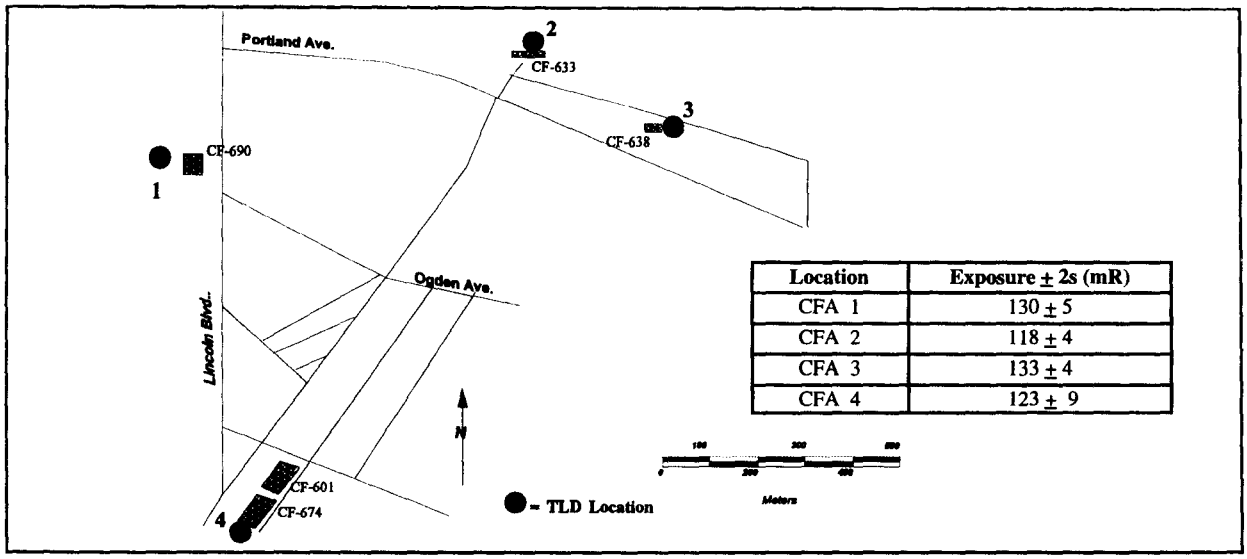
Location	Exposure ± 2s (mR)
ANLW/EBRII 7	157 ± 5
ANLW/EBRII 8	119 ± 5
ANLW/EBRII 9	144 ± 6
ANLW/EBRII 10	116 ± 4
ANLW/EBRII 11	122 ± 5
ANLW/EBRII 12	121 ± 4
ANLW/EBRII 13	126 ± 5
ANLW/EBRII 14	123 ± 12
ANLW/EBRII 15	180 ± 8
ANLW/EBRII 16	164 ± 6
ANLW/EBRII 17	124 ± 8
ANLW/EBRII 18	134 ± 5

Figure 4.9 Environmental dosimeter measurements at ANL-W (1993)



Location	Exposure ± 2s (mR)
ARA 1	155 ± 6
ARA 2	153 ± 4
ARA 3	221 ± 9
ARA 4	156 ± 6

Figure 4.10 Environmental dosimeter measurements at ARA (1993)



Location	Exposure ± 2s (mR)
CFA 1	130 ± 5
CFA 2	118 ± 4
CFA 3	133 ± 4
CFA 4	123 ± 9

Figure 4.11 Environmental dosimeter measurements at CFA (1993)

Location	Exposure ± 2s (mR)
ICPP 1	150 ± 8
ICPP 9	191 ± 9
ICPP 14	144 ± 6
ICPP 15	150 ± 6
ICPP 16	137 ± 4
ICPP 17	138 ± 5
ICPP 18	128 ± 5
ICPP 19	132 ± 5
ICPP 20	190 ± 6
ICPP 21	154 ± 4
ICPP 22	193 ± 6
ICPP 23	149 ± 5
ICPP 24	126 ± 4
ICPP 25	125 ± 5
ICPP 26	135 ± 6
TREE FARM 1	179 ± 6
TREE FARM 2	157 ± 5
TREE FARM 3	163 ± 5
TREE FARM 4	191 ± 9

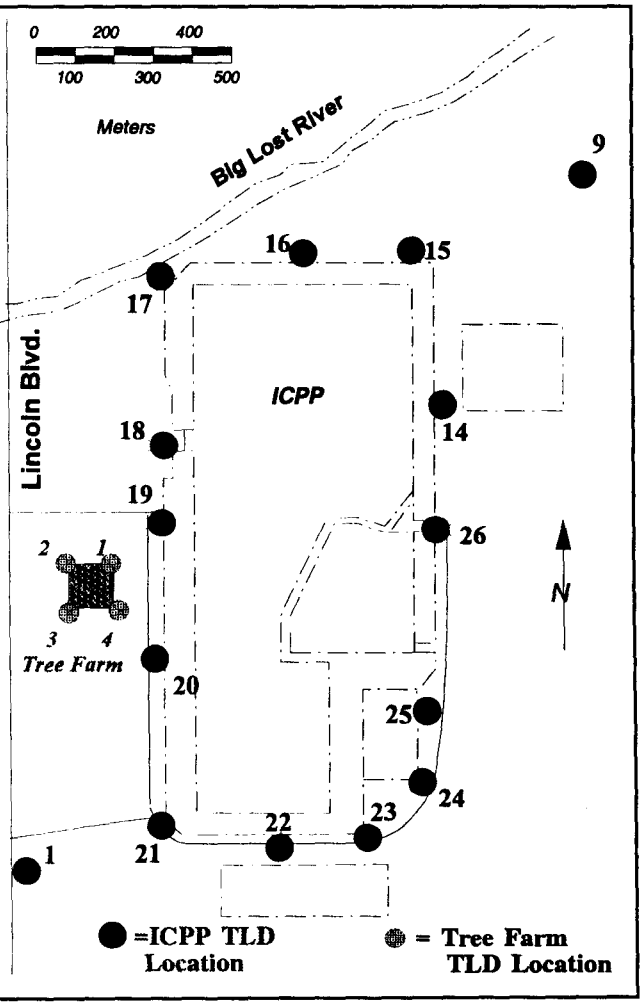


Figure 4.12 Environmental dosimeter measurements at ICPP (1993)

Location	Exposure ± 2s (mR)
NRF 4	135 ± 6
NRF 5	146 ± 5
NRF 11	135 ± 5
NRF 12	146 ± 6
NRF 13	132 ± 6
NRF 16	133 ± 4
NRF 17	132 ± 6
NRF 18	133 ± 4
NRF 19	134 ± 4
NRF 20	136 ± 4
NRF 21	133 ± 5

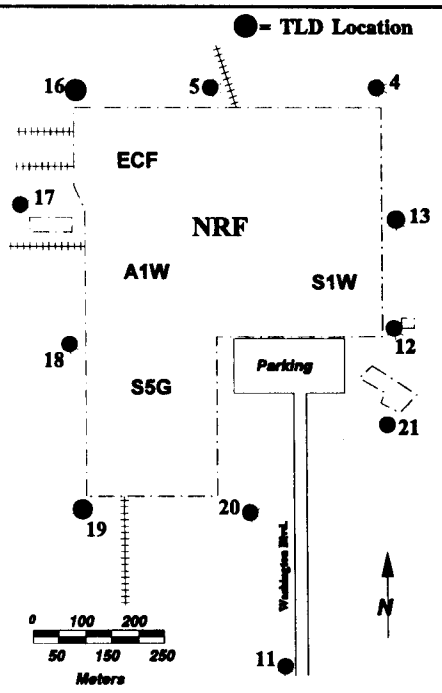


Figure 4.13 Environmental dosimeter measurements at NRF (1993)

Location	Exposure ± 2s (mR)
PBF/SPERT 1	123 ± 4
PBF/SPERT 2	133 ± 4
PBF/SPERT 3	135 ± 5
PBF/SPERT 4	142 ± 5
PBF/SPERT 5	132 ± 5
PBF/SPERT 6	137 ± 6
PBF/WERF 1	125 ± 4
PBF/WERF 2	120 ± 6
PBF/WERF 3	127 ± 4
PBF/WERF 4	131 ± 6
PBF/WERF 5	127 ± 6
PBF/WERF 6	125 ± 5
PBF/WERF 7	128 ± 7

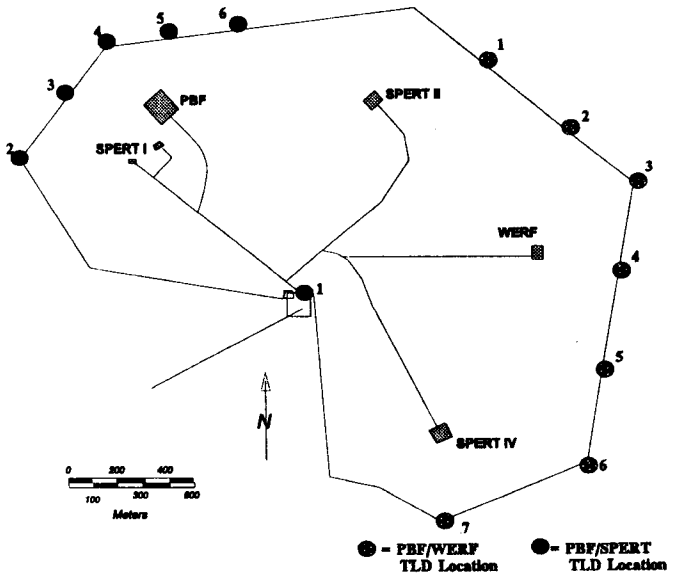
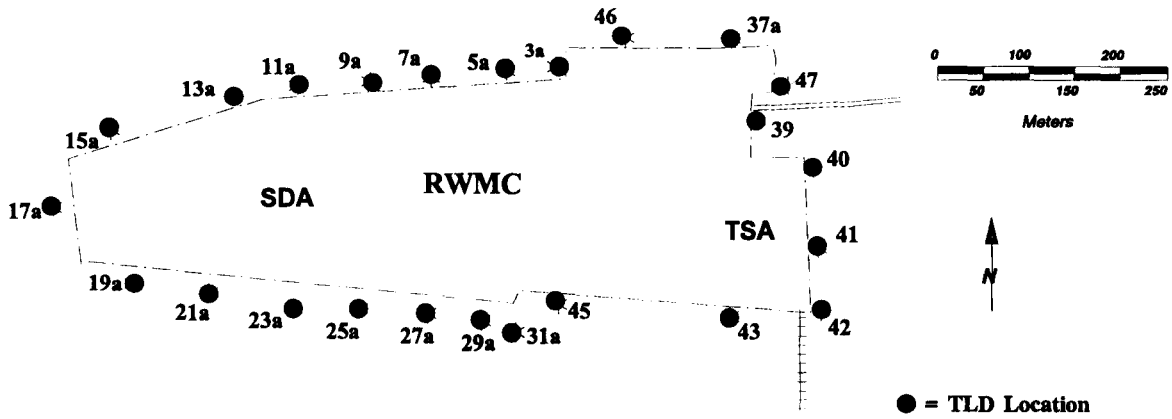


Figure 4.14 Environmental dosimeter measurements at PBF (1993)



Location	Exposure + 2s (mR)
RWMC 3a	154 ± 5
RWMC 5a	170 ± 5
RWMC 7a	163 ± 6
RWMC 9a	146 ± 5
RWMC 11a	135 ± 4
RWMC 13a	130 ± 6
RWMC 15a	131 ± 4
RWMC 17a	131 ± 4
RWMC 19a	126 ± 5
RWMC 21a	130 ± 7
RWMC 23a	129 ± 4
RWMC 25a	131 ± 4

Location	Exposure + 2s (mR)
RWMC 27a	----[a]
RWMC 29a	146 ± 6
RWMC 31a	142 ± 4
RWMC 37a	132 ± 12
RWMC 39	158 ± 5
RWMC 40	130 ± 4
RWMC 41	----[a]
RWMC 42	125 ± 4
RWMC 43	128 ± 4
RWMC 45	141 ± 5
RWMC 46	137 ± 4
RWMC 47	132 ± 4

a. TLD missing at collection time.

Figure 4.15 Environmental dosimeter measurements at RWMC (1993)

Location	Exposure + 2s (mR)
TAN/TSF 1	----[a]
TAN/TSF 2	138 ± 4
TAN/TSF 3	129 ± 5
TAN/TSF 4	119 ± 5
TAN/LOFT 1	137 ± 4
TAN/LOFT 2	158 ± 5
TAN/LOFT 3	122 ± 5
TAN/LOFT 4	121 ± 4
TAN/LOFT 5	126 ± 8
TAN/LOFT 6	143 ± 4
TAN/LOFT 7	131 ± 6
TAN/WRRTF 1	137 ± 5
TAN/WRRTF 2	123 ± 5
TAN/WRRTF 3	125 ± 4
TAN/WRRTF 4	118 ± 4

a. Dosimeter missing at collection time.

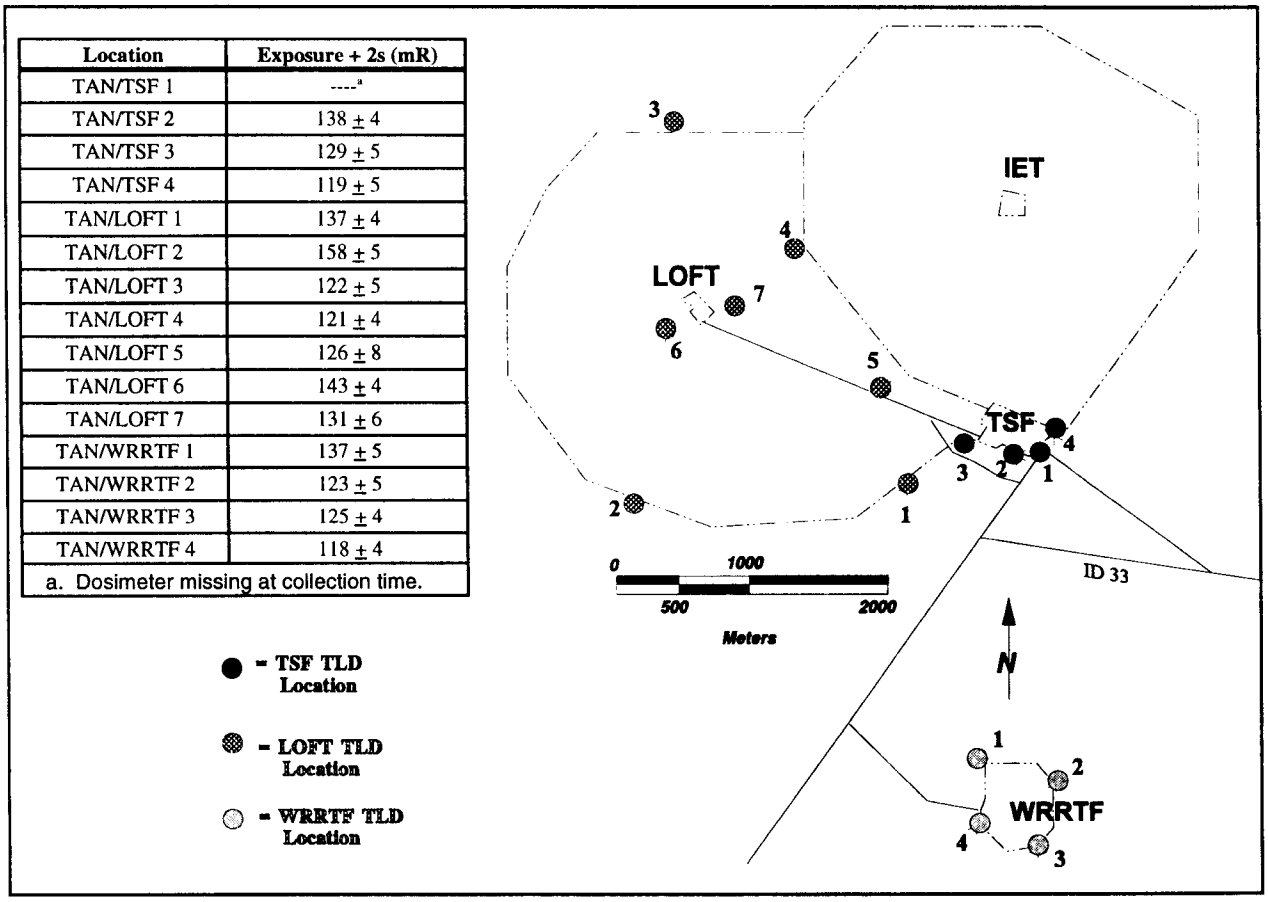


Figure 4.16 Environmental dosimeter measurements at TAN (1993)

Location	Exposure ± 2s (mR)
TRA 1	168 ± 5
TRA 2	463 ± 16
TRA 3	3091 ± 90
TRA 4	1527 ± 43
TRA 5	1513 ± 43
TRA 6	222 ± 6
TRA 7	193 ± 5
TRA 8	199 ± 6
TRA 9	149 ± 5
TRA 10	153 ± 5
TRA 11	141 ± 4
TRA 12	139 ± 6
TRA 13	134 ± 4

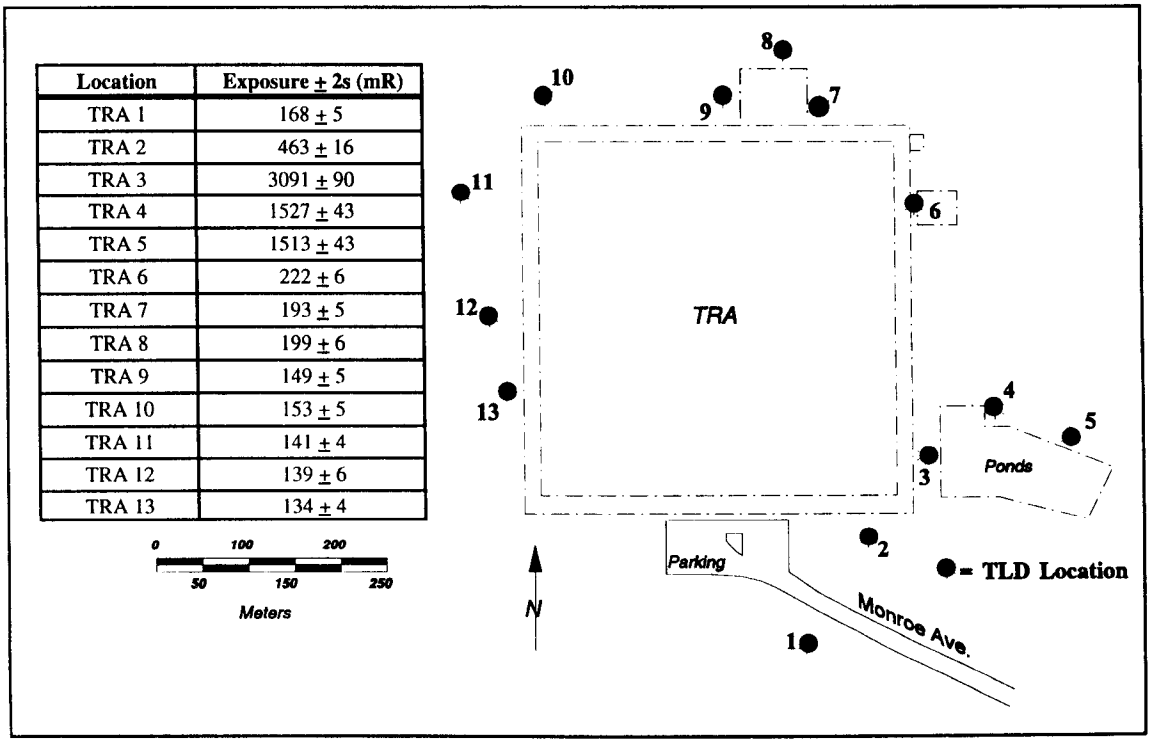
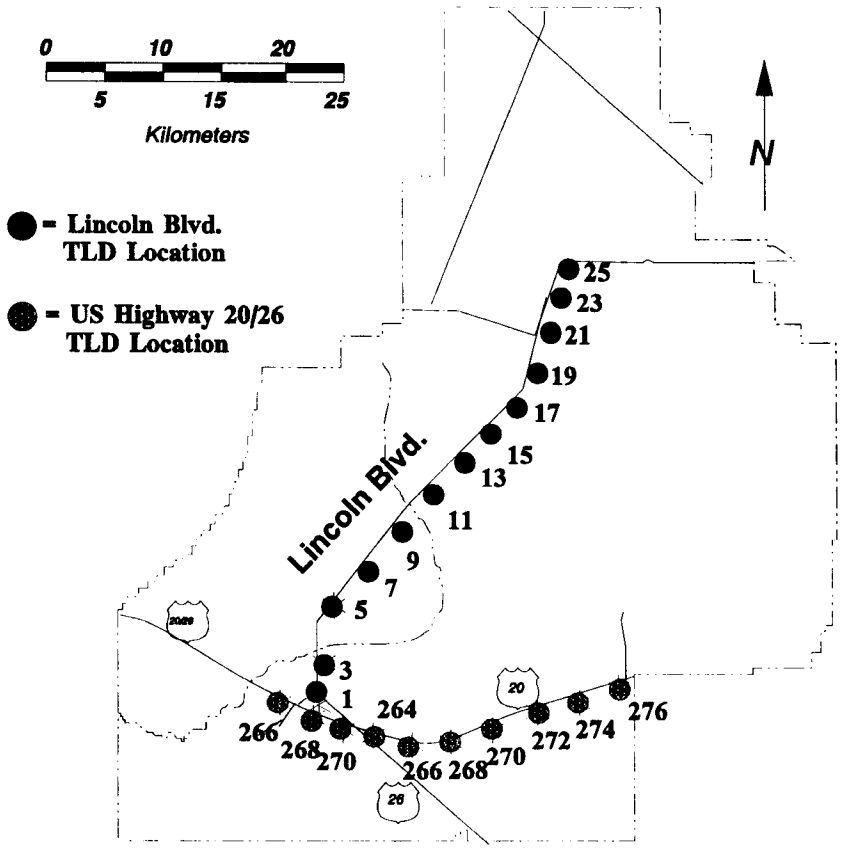


Figure 4.17 Environmental dosimeter measurements at TRA (1993)



Location	Exposure ± 2s (mR)
LINCOLN BLVD. 1	122 ± 4
LINCOLN BLVD. 3	143 ± 5
LINCOLN BLVD. 5	136 ± 4
LINCOLN BLVD. 7	137 ± 4
LINCOLN BLVD. 9	140 ± 4
LINCOLN BLVD. 11	133 ± 5
LINCOLN BLVD. 13	136 ± 5
LINCOLN BLVD. 15	136 ± 7
LINCOLN BLVD. 17	138 ± 4
LINCOLN BLVD. 19	136 ± 6
LINCOLN BLVD. 21	131 ± 4
LINCOLN BLVD. 23	140 ± 6
LINCOLN BLVD. 25	137 ± 7

Location	Exposure ± 2s (mR)
HIGHWAY 26 mile 266	129 ± 6
HIGHWAY 26 mile 268	128 ± 4
HIGHWAY 26 mile 270	124 ± 5
HIGHWAY 20 mile 264	122 ± 4
HIGHWAY 20 mile 266	118 ± 5
HIGHWAY 20 mile 268	120 ± 4
HIGHWAY 20 mile 270	120 ± 5
HIGHWAY 20 mile 272	113 ± 4
HIGHWAY 20 mile 274	104 ± 4
HIGHWAY 20 mile 276	113 ± 4

Figure 4.18 Environmental dosimeter measurements along Lincoln Blvd. and US Highways 20 and 26 (1993)

4.3 RADIOACTIVE EFFLUENT MONITORING

General

Radionuclides in airborne and liquid effluents released to the environment were monitored at potentially significant release points. INEL contractors monitor stacks and liquid effluent streams as required by state and federal regulations, and data were reported to the Radioactive Waste Management Information System, which published quarterly reports of the results of the effluent monitoring by month, facility, and radionuclide.

Air

An estimated total of 2800 Ci of radioactivity was released to the atmosphere from INEL facilities in 1993 (Table 4.10). More than 99% of this total was in the form of noble gases. The ANL-W and TRA facilities were the source of about 96% of the total radioactivity released to the atmosphere. Because of radioactive decay of the short-lived radionuclides, the actual activity that would reach offsite areas is less than the value indicated in the table.

Air emissions from non-point, or diffuse, sources such as radioactive waste ponds (TRA and ICPP) and known contaminated soil areas on the INEL were evaluated as part of the dose calculation using the CAP-88 computer code described in the following section. The total of the doses from all such sources for 1993 was 7.4×10^{-5} mrem (7.4×10^{-7} mSv). Of this total, TRA was the largest contributor with 6.7×10^{-5} mrem (6.7×10^{-7} mSv).

The total annual airborne radioactive effluent varies from year to year, depending on which processes are active at INEL facilities. The total shown for 1993 is considerably less than for the years 1987 through 1992. In those years, the actual amount of ^{85}Kr released was classified information and an overestimated value was used. This was no longer the case beginning in 1993. The overestimation of ^{85}Kr releases for classification reasons masks trends, if any, in airborne effluent totals.

Liquid

No liquids were released directly to the offsite environment. Onsite releases are summarized in Table 4.11. No radioactive liquids were released onsite at NRF. Most liquid radioactive effluents were discharged into seepage ponds. The effluent listed for CFA is discharged through a sewage treatment facility.

The liquid effluent reported for the ICPP in 1993 was substantially reduced over previous years, particularly for tritium. This resulted from operation of a new Liquid Effluent Treatment and Disposal facility.

At TRA, a new liquid effluent pond lined with the plastic hypalon was constructed and placed into service in August 1993. The former TRA radioactive waste ponds were drained and the sediments were covered with clean soil (part of a CERCLA Interim Action as described in Chapter 3).

TABLE 4.10
RADIONUCLIDE COMPOSITION OF AIRBORNE EFFLUENTS (1993)

Effluent Type	Radionuclide	Half-life	Airborne Effluent (Curies)[a] ANL-W	ICPP	NRF	TRA	Total[b]
Noble Gases	^{41}Ar	1.83 h	17	--	0.32	1300	1300
	^{133}Xe	5.25 d	490	--	--	4.1	500
	^{135}Xe	9.10 h	310	--	--	28	340
	^{138}Xe	14.2 min	22	--	--	71	93
	^{88}Kr	2.84 h	58	--	--	24	82
	^{85}Kr	10.7 yr	70	--	--	--	70
	^{87}Kr	1.27 h	38	--	--	25	63
	^{85m}Kr	4.48 h	44	--	--	8	52
	^{140}Xe	13.6 sec	30	--	--	--	30
	^{135m}Xe	15.3 min	11	--	--	14	25
Particulates	^{140}Cs	1.06 min	29	--	--	--	29
	^{89}Rb	15.4 min	--	--	--	0.73	0.73
	^{138}Cs	32.2 min	--	--	--	0.69	0.69
	^{88}Rb	15.4 min	1.3×10^{-3}	--	--	0.52	0.52
	^{139}Ba	1.39 h	--	--	--	5.4×10^{-2}	5.4×10^{-2}
	^{137}Cs	30.2 yr	1.7×10^{-8}	7.5×10^{-3}	--	6.1×10^{-6}	7.5×10^{-3}
	^{24}Na	15.0 h	--	--	--	5.2×10^{-3}	5.2×10^{-3}
	^{51}Cr	27.8 d	--	--	--	3.8×10^{-3}	3.8×10^{-3}
	^{99m}Tc	6.01 h	--	--	--	2.2×10^{-3}	2.2×10^{-3}
	^{91m}Y	58.8 d	--	--	--	1.6×10^{-3}	1.6×10^{-3}
	$^{90}Sr + D$[c]	28.6 yr	--	1.1×10^{-3}	--	2.2×10^{-6}	1.1×10^{-3}
	^{106}Ru	372 d	--	1.0×10^{-3}	--	--	1.0×10^{-3}
	^{125}Sb	2.73 yr	--	7.3×10^{-5}	--	--	7.3×10^{-5}
	Pu (total)	--	--	2.5×10^{-9}	--	--	2.5×10^{-9}
Tritium, ^{14}C, and Iodine Isotopes	^{3}H	12.3 yr	34	67	6.7×10^{-2}	--	101
	^{14}C	5700 yr	--	9.6×10^{-3}	0.91	--	0.92
	^{129}I	1.6×10^{7} yr	--	9.8×10^{-2}	--	--	9.8×10^{-2}
	^{132}I	83 min	--	--	--	1.1×10^{-3}	1.1×10^{-3}
	^{133}I	20.8 hr	--	--	--	4.3×10^{-4}	4.3×10^{-4}
	^{131}I	8.04 d	--	--	4.6×10^{-6}	1.1×10^{-4}	1.1×10^{-4}
All others		--	1.2×10^{-3}	1.0×10^{-4}	2.8×10^{-5}	7.4×10^{-4}	2.1×10^{-3}
Totals		--	1200	69	0.55	1500	2800

a. Preliminary radioactive release information provided by the 1993 RWMIS. The table includes all radionuclides with total releases greater than 1×10^{-3} Ci (1×10^{-4} for isotopes of iodine). Some radionuclides of special concern (^{125}Sb and Pu) are also included. Values are not corrected for decay after release.

b. Totals include small amounts from facilities not listed.

c. Parent-daughter equilibrium assumed.

TABLE 4.11
RADIONUCLIDE COMPOSITION OF LIQUID EFFLUENTS RELEASED ONSITE (1993)

Radionuclide	Half-Life	Liquid Effluent (Curies)[a]				
		ANL-W	CFA	ICPP	TRA	Total[b]
^{3}H	12.3 yr	7.9×10^{-2}	1.2×10^{-4}	--	120	120
^{60}Co	5.26 yr	--	--	1.0×10^{-3}	2.1	2.1
^{51}Cr	27.8 d	--	--	--	1.8	1.8
^{24}Na	15.0 yr	--	--	--	0.24	0.24
$^{90}Sr + D$	28.6 yr	--	5.2×10^{-8}	2.7×10^{-3}	0.22	0.22
^{137}Cs	30.2 yr	--	--	2.2×10^{-3}	7.9×10^{-2}	7.9×10^{-2}
^{65}Zn	243.8 d	--	--	--	7.7×10^{-2}	7.7×10^{-2}
^{58}Co	70.9 d	--	--	--	2.9×10^{-2}	2.9×10^{-2}
^{54}Mn	312.2 d	--	--	--	1.1×10^{-2}	1.1×10^{-2}
Pu (total)	--	--	--	4.8×10^{-5}	--	4.8×10^{-5}
All Others	--	--	2.5×10^{-7}	5.7×10^{-3}	1.6	1.6
Grand Totals	--	7.9×10^{-2}	1.2×10^{-4}	1.2×10^{-2}	130	130

a. Preliminary radioactive release data provided by the 1993 RWMIS. Values are not corrected for decay after release.

b. Total includes small amounts from facilities not listed.

4.4 EVALUATION OF POTENTIAL RADIATION DOSE TO THE PUBLIC

General Information

Usually, the radiological impact of INEL operations on the resident public surrounding the Site has been too small to be measured by the routine monitoring program. Therefore, the radiological impact of INEL operations by the air pathway has traditionally been estimated using the known amounts of various radionuclides released during the year from Site facilities and appropriate air dispersion models, described in the next section, to determine the concentrations at selected locations in the vicinity. During 1993, this was done for the radionuclides released from INEL facilities to the atmosphere as summarized in Table 4.10.

The following values were determined: 1) the effective dose equivalent to the maximally exposed individual residing offsite using the EPA-required CAP-88 model; 2) the effective dose equivalent to the maximally exposed individual residing offsite using dispersion calculations from the MESODIF model[a]; and 3) the collective effective dose equivalent (population dose) within an 80-km (50-mi) radius of the operations center of the Site (TRA and ICPP) using the MESODIF dispersion model.

For simplicity, the term *dose* will mean effective dose equivalent in the following dose assessment sections, unless

[a] G.E. Start and L.L. Wendell, Regional Effluent Dispersion Calculations Considering Spatial and Temporal Meteorological Variations; NOAA Technical Memorandum ERL ARL-44, May 1974.

another term is specifically stated. The effective dose equivalent was calculated by summing the committed dose equivalents to organs, each multiplied by a weighting factor that is proportional to the organ's radiosensitivity. The effective dose equivalent includes doses received from both external and internal sources and represents the same risk as if an individual's whole body were irradiated uniformly. DOE dose conversion factors and a 50-yr integration period are used for internally deposited radionuclides[a] and for radionuclides deposited on ground surfaces[b] in calculations with both air dispersion models. Because the hypothetical effective dose equivalent to the maximally exposed individual residing near the INEL is so low, no allowance was made for shielding by housing materials or residence time in the community in any of the calculations using the MESODIF dispersion model. The CAP-88 code, which is used by all sites regardless of the magnitude of the hypothetical dose, does include a factor to allow for shielding and occupancy time.

The possible exposure pathways by which radioactive materials from Site operations could be transported to offsite environs are shown diagrammatically in Figure 4.19. Atmospheric transport is the principal potential exposure pathway from the Site as radionuclides from the INEL have not been found in drinking water wells offsite. The air pathway is evaluated in the section "Maximum Individual Dose--Airborne Emissions Pathway".

[a] U.S. Department of Energy, *Internal Dose Conversion Factors for Calculation of Dose to the Public*, DOE/EH-0071, July 1988.

[b] U.S. Department of Energy, *External Dose Conversion Factors for Calculation of Dose to the Public*, DOE/EH-0070, July 1988.

Several indirect exposure pathways are being studied at the INEL to determine their effect, if any, on the highest possible dose that could have been received by a member of the public. The principal indirect exposure pathway involves eating animals of game species that have spent time on the Site. Radioactivity present in game species depends upon the length of residence at each onsite location, the time elapsed since migration from the Site, and the metabolism of the animal. Estimates of the maximum potential dose to a person consuming meat from different game animals is described in the section "Maximum Individual Dose--Game Ingestion Pathway."

Maximum Individual Dose--Airborne Emissions Pathway

CAP-88. During 1993, EPA regulations, the National Emission Standards for Hazardous Air Pollutants (NESHAPs) 40 CFR 61 [Subpart H], were in effect that limited the amount of airborne radionuclides released from any nuclear facility to that which will produce an effective dose equivalent of 10 mrem/yr to any member of the public. The EPA has specified that the CAP-88 computer code be used to demonstrate compliance unless an alternate model has been approved by the Administrator of the EPA.

Because the INEL operations are spread over a wide area, the potential offsite doses occur at a variety of receptor (nearest resident, school, or business) locations. For the NESHAPs report, the offsite dose was calculated for the nearest resident to each INEL facility that reported airborne releases in 1993. The doses from all facilities were then summed. This method is conservative (it

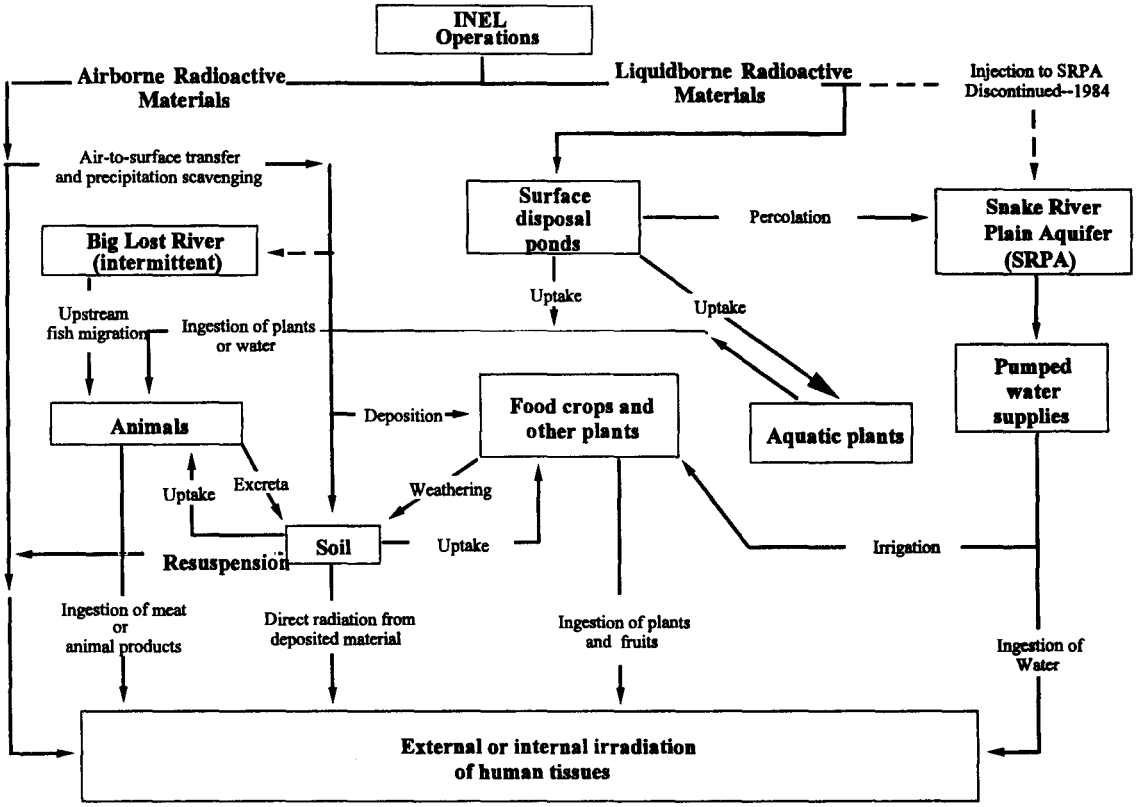


Figure 4.19 Potential exposure pathways from the INEL to members of the public

overestimates the dose) because the maximum exposed individual was assumed to live at all of these maximum receptor locations simultaneously. Using the CAP-88 code and INEL facility emissions, a 1993 hypothetical effective dose equivalent of 0.011 mrem (1.1×10^{-4} mSv) was calculated for a member of the public. This dose is 0.11% of the EPA radiation protection standard. A thorough discussion of the NESHAPs calculations will appear in the 1993 INEL NESHAPs annual report to be submitted to EPA by June 30, 1994.

MESODIF. The MESODIF air dispersion model has been used for 20 years to calculate doses to members of the public residing near the INEL. The MESODIF diffusion curves, developed from tests at the INEL and Hanford desert environments, appear to be more appropriate for the INEL Site than the EPA-required model. MESODIF uses a more complicated puff Gaussian plume model than the straight-line Gaussian plume model in CAP-88. Although the doses calculated with the MESODIF model are usually somewhat higher than doses using CAP-88, the doses

and offsite concentrations calculated using both models were compared to actual monitoring results at offsite locations in 1986, 1987, and 1988. Concentrations and doses calculated using the MESODIF model showed good agreement with those from actual measurements at several locations. Differences between the two air dispersion models were discussed in detail in the 1986 annual report[a]. The effective dose equivalent calculated using the MESODIF model is included in this report as well as the value calculated using the EPA-required CAP-88 model.

The mesoscale map (Figure 4.20) shows the calculated 1993 concentrations normalized to a unit release rate for the INEL and vicinity. This map has been prepared by the NOAA/ARL using the MESODIF model and data gathered continuously at meteorological stations on and around the Site. To make the display easier to read, the dispersion coefficient values are given in whole numbers and must be multiplied by 10^{-9} h^2/m^3. To obtain the average air concentration (Ci/m^3) for a radionuclide released from TRA or ICPP along any dispersion coefficient isopleth in Figure 4.20, the value of the 1993 average dispersion coefficient (e.g., 30 x 10^{-9} h^2/m^3) was multiplied by the number of curies of the radionuclide released during 1993 and divided by the number of hours in a year squared (7.67×10^7).

The MESODIF model predicts that the highest concentrations of radionuclides in air for an inhabited area would have occurred near Mud Lake, Idaho in 1993. The maximum hypothetical dose was calculated for an adult resident of that location from inhalation of air, submersion in air, ingestion of radioactivity on leafy vegetables, ingestion of milk, and exposure due to deposition of particulates on the ground surface. The calculation was based on data presented in Table 4.10 and Figure 4.20. Using a calculated value of 27 x 10^{-9} h^2/m^3 (the dispersion coefficient value at the highest point which is inhabited) and allowing for radioactive decay during the 53-km (33-mi) transit of the radionuclides from the TRA/ICPP facilities to the Mud Lake location, the potential effective dose equivalent from all radionuclides released was calculated to be 0.03 mrem (3 x 10^{-4} mSv) (Table 4.12). This dose is 0.03% of the DOE radiation protection standard for a prolonged period of exposure to a member of the public from all pathways and 0.3% of the EPA standard for the airborne pathway only. Figure 4.21 illustrates the proportion of specific nuclides comprising the maximum individual dose for 1993. For comparison, the proportions of individual radionuclides contributing to the maximally exposed individual effective dose equivalents for 1989 through 1992 are also shown (Figure 4.22).

As discussed earlier, there are differences in the atmospheric dispersion portions of the MESODIF and CAP-88 air dispersion codes, and RESL has chosen to use the MESODIF doses for comparison to most standards and to calculated doses from previous years. The calculated maximum dose resulting from INEL operations is very small (0.03%) compared to the measured 111 mrem average dose individuals in southeastern Idaho received from cosmic and

[a] D. L. Hoff, E. W. Chew, and S. K. Rope, *1986 Environmental Monitoring Program Report for the Idaho National Engineering Laboratory Site*, DOE/ID-12082(86), May 1987 .

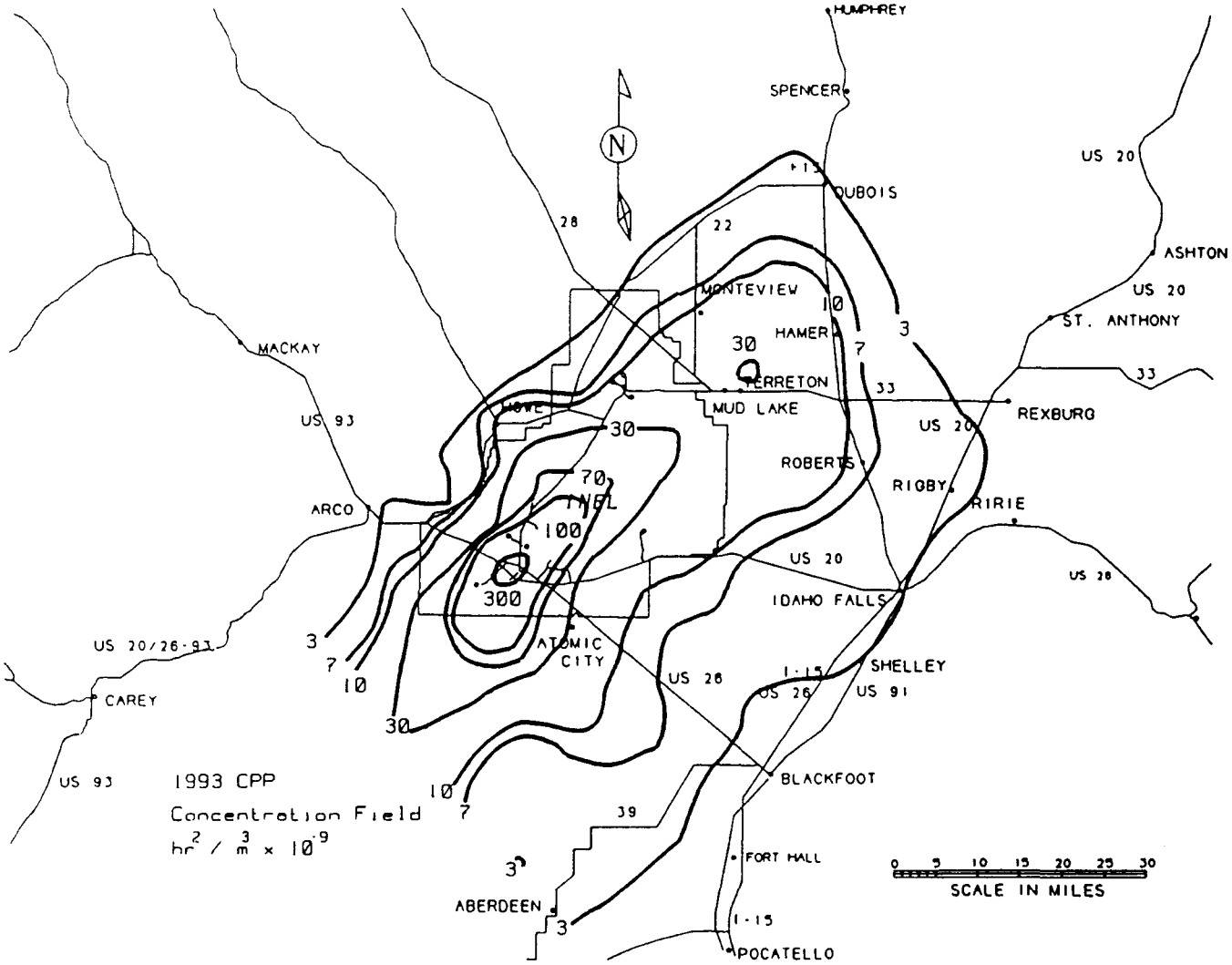


Figure 4.20 1993 average of mesoscale dispersion isopleths of air concentrations at ground level, normalized to unit release rate

TABLE 4.12
MAXIMUM INDIVIDUAL EFFECTIVE DOSE EQUIVALENT (1993)

Radionuclide	Maximum Offsite Concentration	Maximum Effective Dose Equivalent	
		mrem	mSv
^{129}I	3.7×10^{-17}	2.6×10^{-2}	2.6×10^{-4}
^{41}Ar	2.1×10^{-13}	1.4×10^{-3}	1.4×10^{-5}
$^{88}Kr + D$	1.8×10^{-14}	2.9×10^{-4}	2.9×10^{-6}
$^{90}Sr + D$	4.0×10^{-19}	1.4×10^{-4}	1.4×10^{-6}
$^{137}Cs + D$	2.8×10^{-18}	1.4×10^{-4}	1.4×10^{-6}
^{135}Xe	1.1×10^{-13}	1.3×10^{-4}	1.3×10^{-6}
^{133}Xe	1.8×10^{-13}	3.2×10^{-5}	3.2×10^{-7}
^{87}Kr	7.0×10^{-15}	3.1×10^{-5}	3.1×10^{-7}
$^{138}Xe + D$	5.1×10^{-17}	2.2×10^{-5}	2.2×10^{-7}
^{3}H	3.7×10^{-14}	1.9×10^{-5}	1.9×10^{-7}
^{85m}Kr	1.4×10^{-14}	1.1×10^{-5}	1.1×10^{-7}

a. Table includes only radionuclides which contribute a dose of 1.0×10^{-5} mrem (1×10^{-7} or more). When indicated (+D), the contribution of daughter decay products was also included in the dose calculations.
b. Estimate of radioactive decay using the distance to the Mud Lake area and the 1993 average wind speed in that direction. For radionuclides where parent-daughter equilibria were used in dose calculations, concentration of the parent is shown.
c. Effective dose equivalent using dose conversion factors for submersion and deposition given in DOE/EH-0070 and dose conversion factors for inhalation and ingestion given in DOE/EH-0071.

terrestrial radiation during 1993. The calculated dose is even smaller compared to the total estimated effective dose equivalent from natural background radiation of about 340 mrem (see Table 4.9). For perspective, the calculated dose may also be compared to the approximately 30 mrem average dose received from medical diagnostic procedures, the 4 mrem average dose received from highway and road construction materials, and the 0.04 to 0.1 mrem received from luminous watches and clocks[a]. Another source has estimated that the average five-hour jet flight contributes a dose of about 0.7 mrem to passengers, and that the average television viewer receives about 0.05 to 0.1 mrem annually[b].

Maximum Individual Dose--Game Ingestion Pathway

Potential dose to an individual from occasional ingestion of meat from game animals continues to be investigated. One group of studies involves the calculation of potential doses to individuals who might eat ducks that reside briefly upon liquid waste ponds used for the disposal of low-level reactor effluent. In one study, conducted in

[a] National Council on Radiation Protection and Measurements, *Ionizing Radiation Exposure of the Population of the United States*, NCRP Report No. 93, September 1, 1987.

[b] *United Nations Scientific Committee on the Effects of Atomic Radiation Sources and Biological Effects*, United Nations: New York, 1982.

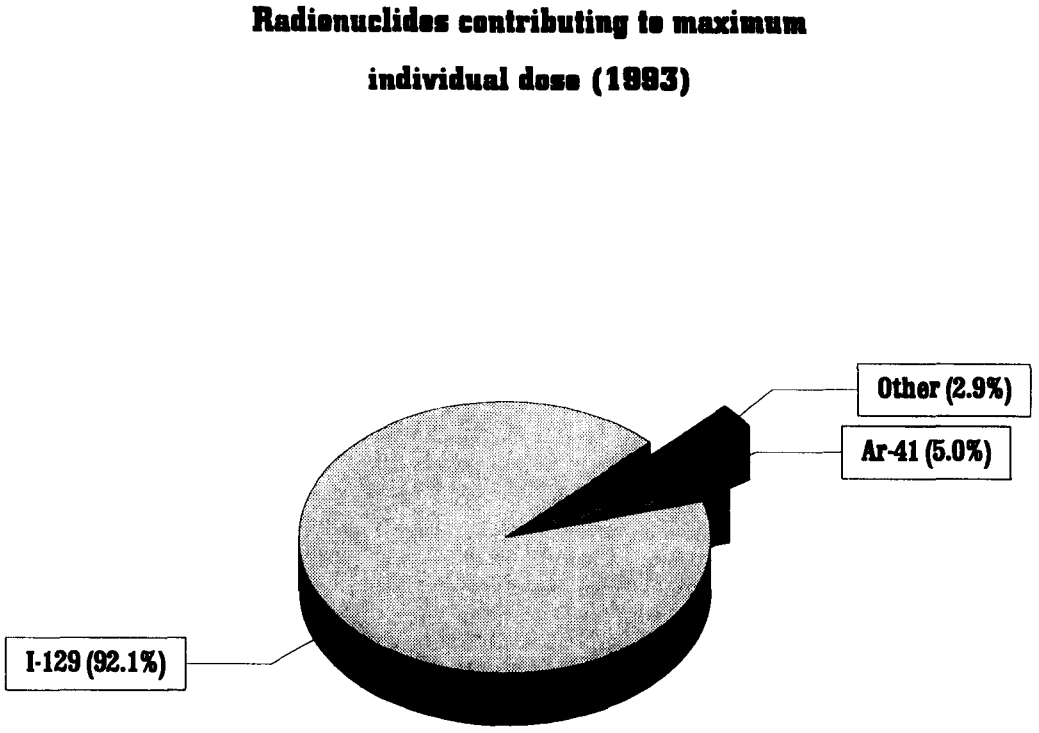


Figure 4.21 Radionuclides contributing to maximum individual dose (1993)

1974-1978, wild ducks using liquid waste ponds at TRA were collected. The average potential whole-body dose equivalent from gamma emitters due to consumption of the meat of cooked ducks (not including the juices in the pan) was calculated to be 10 mrem[a].

In another study, wing-clipped mallards were released on the TRA pond for 56-188 days before collection. Various tissues were analyzed for concentrations of ^{90}Sr, ^{238}Pu, $^{239/240}Pu$, ^{241}Am, ^{242}Cm, and ^{244}Cm. The potential effective dose equivalent to a human consuming the entire muscle and liver mass of one experimental duck with average nuclide concentrations was 0.046 mrem from those specific nuclides[b]. In the most recent study, migratory waterfowl were collected from several ponds on the INEL ranging from the sewage disposal pond at NRF to the radioactive waste pond at TRA[c]. Several tissues from these birds were analyzed for gamma-emitting radionuclides. The predicted committed effective dose equivalent to an

[a] D. K. Halford et al., "Radionuclide Concentrations in Waterfowl Using a Liquid Radioactive Disposal Area and the Potential Radiation Dose to Man," *Health Physics, 40,* February 1981, pp. 173-181.

[b] O. D. Markham, D. K. Halford, S. K. Rope, and G. B. Kuzo, "Plutonium, Am, Cm, and Sr in Ducks Maintained on Radioactive Leaching Ponds in Southeastern Idaho," *Health Physics, 55,* 3, pp. 517-524.

[c] R. C. Morris, S. K. Rope, and O. D. Markham, Transport of Radionuclides by Waterfowl Using Wastewater Ponds at the Idaho National Engineering Laboratory, submitted to *Health Physics,* May 1993.

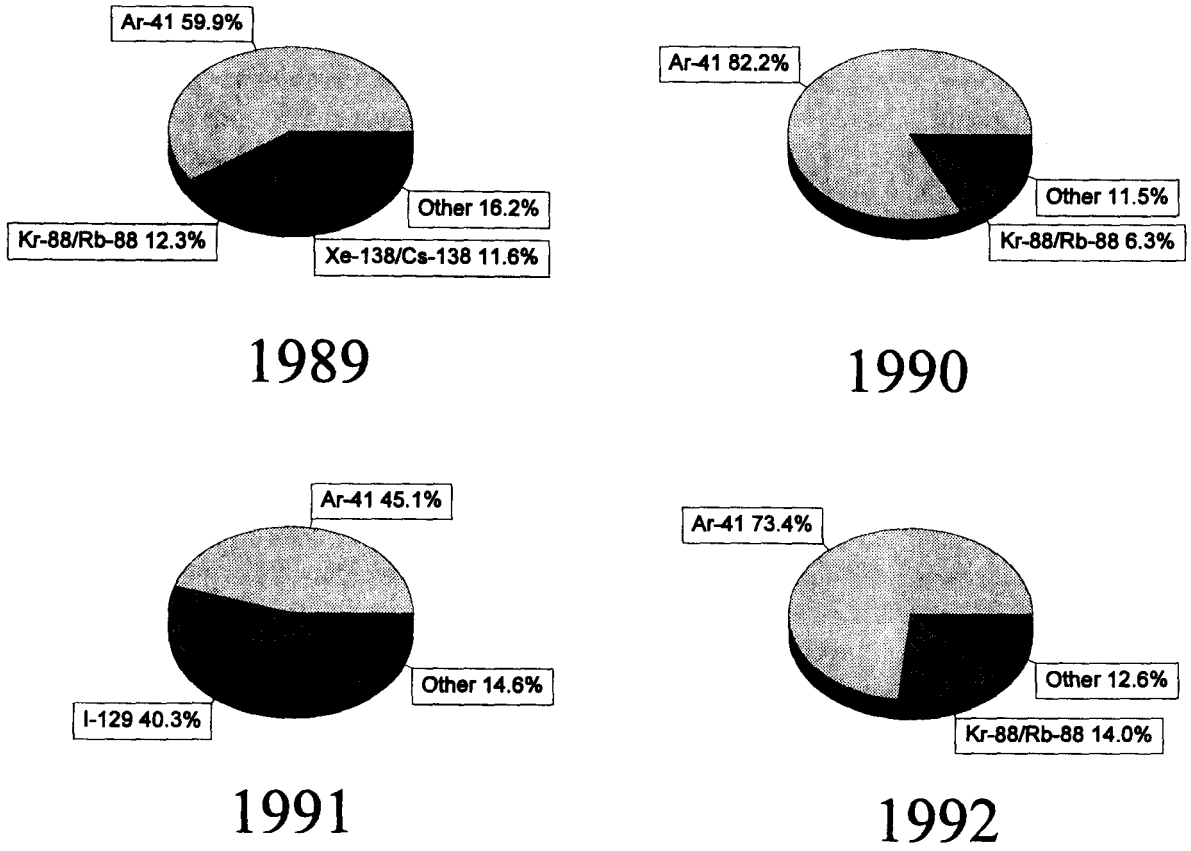


Figure 4.22 Radionuclides contributing to maximum individual dose (1989-1992)

individual eating the entire muscle and liver mass of the most contaminated duck (collected from the TRA radioactive waste pond) was 4.0 mrem (0.040 mSv). The median committed effective dose equivalent, based on all waterfowl in the study, was 0.0027 mrem (2.7×10^{-5} mSv).

The most recent estimates (based on banding data from nearby wildlife refuges) indicate that about 7.7% of the waterfowl which visit the TRA and ICPP radioactive waste ponds each year are harvested by Idaho hunters. In 1984-1985, this was approximately 61 ducks. Because a small number of people are exposed, the population dose associated with this pathway is very small.

The individual and population doses from eating contaminated waterfowl are likely to be even lower for several reasons. The TRA radioactive waste ponds have been

drained as part of a CERCLA Interim Action. A new, hypalon-lined pond has been constructed near the location of the old pond and, at least initially, the new pond will be contaminated at lower levels than the old pond. In addition, since other less-contaminated ponds have been constructed nearby, the number of ducks visiting the radioactive waste ponds has most likely decreased since the 1984-85 time period. The doses calculated above are based on the unlikely assumption that the duck would be killed and eaten immediately after leaving the pond, so a lower dose would be more realistic due to biological elimination of the radioactivity. For example, the largest contributor to the dose, ^{137}Cs, has an effective half-life in mallard ducks of 11.2 days[a]. This means that half of the ^{137}Cs present when a given duck leaves the pond would be eliminated in 11.2 days. At the end of the next 11.2 days, half of the remaining radioactivity (or one-fourth of the original activity) would be eliminated, and so on until the amount of ^{137}Cs present in the duck's tissues can no longer be detected.

The highest estimated potential whole-body dose equivalent to a person eating the entire muscle mass of a sage grouse that summered near the TRA-ICPP area was 2 mrem[b]. The maximum whole-body dose equivalent from consumption of sage grouse from other onsite locations and offsite areas ranges from 0.01 to 0.04 mrem.

The maximum potential whole-body dose equivalent to a person eating the muscle tissue of one mourning dove from the TRA pond area was 0.3 mrem. The average whole-body dose equivalent to people consuming doves migrating from onsite to offsite areas was 0.01 mrem, which was the same as for control birds collected far from the INEL[c].

A conservative (or high) estimate of the potential whole-body dose equivalent which could be received by a single individual eating the entire muscle and liver mass of an antelope (collected on the INEL after August 1975) with the highest levels of radionuclides was 0.2 mrem[d]. Game animals collected on the INEL during the past few years have shown much lower concentrations of radionuclides than in 1975, resulting in a reduced potential dose from this pathway.

80-Kilometer Population Dose

An estimate was made of the collective effective dose equivalent (population dose) from inhalation, submersion, ingestion, and deposition that could have been received by all members of the public within an 80-km (50-mi) radius of the TRA/ICPP facilities. This population dose (person-rem) was calculated by a computer program that multiplies the population number in each square mile by the dispersion coefficient at that point (h^2/m^3) and the normalized dose received at the location of the maximally

[a] D. K. Halford, "Effect of Cooking on Radionuclide Concentration in Waterfowl Tissues," *Idaho National Engineering Laboratory Radioecology and Ecology Programs*, 1983 Progress Report, DOE/ID-12098, June 1983.

[b] J. W. Connelly and O. D. Markham, "Movements and Radionuclide Concentrations of Sage Grouse in Southeastern Idaho," *Journal of Wildlife Management, 47*, 1, January 1983, pp. 169-175.

[c] O. D. Markham and D. K. Halford, "Radionuclides in Mourning Doves Near a Nuclear Facility Complex in Southeastern Idaho," *The Wilson Bulletin, 94*, 2, June 1982, pp. 185-195.

[d] O. D. Markham and D. K. Halford, "Effects of Decreased Effluents from Nuclear Fuel Reprocessing on Cs-137 Concentrations in Wildlife," *Northwest Science, 59*, 3, August 1985.

exposed individual (rem per year/h^2 per m^3)[a]. The calculation overestimates dose, however, because radioactive decay of the isotopes was not calculated during transport over distances greater than the 19 km (12 mi) from the TRA/ICPP facilities to the Mud Lake maximum location. Idaho Falls, for example, is about 66 km (41 mi) from TRA/ICPP. Neither residence time nor shielding by housing was considered when calculating the MESODIF dose upon which the collective dose is based.

The 1993 MESODIF population dose within each census division was obtained by summing the results from appropriate areas contained within those divisions (Table 4.13). The total 80-km (50-mi) population dose was the sum of population doses for the various census divisions. The estimated potential population dose was 0.3 person-rem (3 x 10^{-3} person-Sv) to a population of about 121,500. When compared with an approximate population dose of 42,500 person-rem (425 person-Sv) from natural background radiation, this represents an increase of only about 0.0007%. The dose of 0.3 person-rem can also be compared to the following estimated population doses for the same size population: 3600 person-rem for medical diagnostic procedures, about 480 person-rem from exposure to highway and road construction materials or 6 to 12 person-rem for television viewing[b].

TABLE 4.13
80-KM POPULATION DOSE (1993)

Census Division	Population[a]	Population Dose	
		Person-rem	Person-Sv
Aberdeen	2,760	1.04×10^{-2}	1.04×10^{-4}
Alridge (part)	160	9.00×10^{-5}	9.00×10^{-7}
American Falls (part)	200	3.02×10^{-4}	3.02×10^{-6}
Arco	2,600	4.41×10^{-3}	4.41×10^{-5}
Atomic City (city)	25	5.22×10^{-4}	5.22×10^{-6}
Atomic City (division)	2,300	1.65×10^{-3}	1.65×10^{-5}
Blackfoot	12,450	7.29×10^{-3}	7.29×10^{-5}
Carey (part)	120	3.23×10^{-5}	3.23×10^{-7}
Challis (part)	10	6.23×10^{-6}	6.23×10^{-8}
Firth	3,050	3.69×10^{-3}	3.69×10^{-5}
Fort Hall (part)	3,920	1.01×10^{-3}	1.01×10^{-5}
Hamer	2,400	4.15×10^{-2}	4.15×10^{-4}
Howe	325	2.77×10^{-3}	2.77×10^{-5}
Idaho Falls	63,500	1.44×10^{-1}	1.44×10^{-3}
Idaho Falls West	1,750	1.32×10^{-3}	1.32×10^{-5}
Leadore (part)	15	1.11×10^{-5}	1.11×10^{-7}
Lewisville-Menan (part)	2,700	5.53×10^{-4}	5.53×10^{-6}
Mackay	1,200	2.44×10^{-4}	2.44×10^{-6}
Moreland	8,150	1.96×10^{-2}	1.96×10^{-4}
Rigby	1,000	2.31×10^{-3}	2.31×10^{-5}
Roberts	1,430	1.22×10^{-2}	1.22×10^{-4}
Shelley	6,400	1.31×10^{-2}	1.31×10^{-4}
Ucon	4,900	1.11×10^{-2}	1.11×10^{-4}
West Clark (part)	90	1.22×10^{-2}	1.22×10^{-4}
Totals	121,465	3.01×10^{-1}	3.01×10^{-3}

a. Population based on the 1990 Census Report for Idaho.

Summary

Table 4.14 summarizes the calculated annual effective dose equivalents from 1993

[a] D. L. Hoff, E. W. Chew, and S. K. Rope, *1986 Environmental Monitoring Program Report for the Idaho National Engineering Laboratory Site*, DOE/ID-12082(86), May 1987.

[b] National Council on Radiation Protection and Measurements, *Exposure of the Population in the United States and Canada from Natural Background Radiation*, NCRP Report No. 94, December 30, 1987.

INEL operations using both CAP-88 and MESODIF air dispersion models and compares these doses to the EPA airborne pathway standard and to the estimated effective dose equivalent from natural background.

The contribution of game animal consumption to the population dose has not been calculated because a small percentage of the population hunts game, few of the animals killed have spent time on the INEL, and most of the animals that do migrate from the INEL have background concentrations of radionuclides in their tissues. The total population dose contribution from these pathways would, realistically, be less than the sum of population doses from inhalation of air, submersion in air, and deposition on soil.

TABLE 4.14
SUMMARY OF ANNUAL EFFECTIVE DOSE EQUIVALENTS DUE TO INEL OPERATIONS (1993)

	Maximum Dose to an Individual[a]		Collective Dose to Population within 80 km
	MESODIF[b]	CAP-88[c]	MESODIF
Dose	0.03 mrem (3×10^{-4} mSv)	0.011 mrem (1.1×10^{-4} mSv)	0.3 person-rem (3×10^{-3} person-Sv)
Location	Mud Lake area	All offsite receptor points	Area within an 80-km circle
Applicable Radiation Protection Standard[d]	10 mrem (0.1 mSv)	10 mrem (0.1 mSv)	-----
Percentage of Standard	0.3%	0.11%	-----
Natural Background	340 mrem (3.4 mSv)	340 mrem (3.4 mSv)	42,500 person-rem (425 person-Sv)
Percentage of Background	0.009%	0.003%	0.0007%

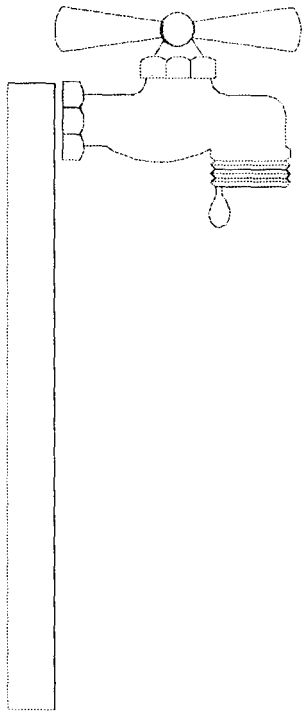
a. Hypothetical dose to the maximally exposed individual residing near the INEL.

b. Effective dose equivalent calculated using the MESODIF air dispersion model. MESODIF calculations do not consider occupancy time or shielding by buildings.

c. Effective dose equivalent calculated using the CAP-88 code.

d. Although the DOE standard for all exposure models is 100 mrem/y as given in DOE Order 5400.5, DOE guidance states that DOE facilities will comply with the EPA standard for the airborne pathway of 10 mrem/y.

5. Ground Water



5. GROUND WATER

5.1 USGS PROGRAM INFORMATION

USGS Program Description

No streams or rivers flow from within the INEL to locations outside the boundaries. Water monitoring includes onsite and offsite ground-water monitoring plus samples from the Snake River and other surface streams and tributaries in the INEL vicinity, some of which flow onto the Site and sink into its porous soils. A brief description of the hydrogeology of the INEL and the movement of water in the Snake River Plain aquifer is given in Chapter 1. Further information may be found in USGS publications. The Snake River Plain aquifer, which lies beneath the INEL, serves as one of the primary sources for drinking water and crop irrigation in the Snake River Basin. The USGS has an extensive monitoring program to maintain surveillance of the aquifer, and perched water bodies above it, on the INEL and at a few locations beyond the southern and western boundaries. The USGS maintains more than 120 aquifer observation wells on or near the INEL, and 45 wells are available for sampling perched ground-water bodies. In addition, more than 120 shallow auger holes have been constructed to monitor shallow perched ground-water bodies. Figures 5.1 and 5.2 show USGS sampling locations. Water levels in wells and various radiological and nonradiological substances in water from the aquifer are monitored. The reports referenced above contain maps showing the frequency of water level measurements and water sample collections, as well as information on the shape and extent of waste plumes (i.e., the spread of various contaminants in the water of the aquifer and perched water from INEL facilities) as they were between 1982 and 1988. Figures 5.3 and 5.4 show plumes for tritium and ^{90}Sr as they existed in 1988[a]. An update to this report is expected at the end of 1994. Changes which have occurred in the INEL ground water over the six-year period from 1982 to 1988 can be seen in figures and text of these two references.

The USGS routine ground-water surveillance program was summarized in the chapter "Environmental Program Information." In 1993, the routine program included collection of 368 samples for radionuclides and inorganic constituents (mostly sodium and chloride), 193 samples for trace elements (mostly for chromium), 166 samples for nutrients (nitrates), and 76 samples for organic compounds.

The USGS also conducts special studies of the ground water of the Snake River Plain that are not included in this summary. These special studies provide more specific geological and hydrological information on the flow and recharge of the aquifer and the movements of radioactive and nonradioactive substances in the ground water. Most of the information from these studies is published in USGS reports.

Results of monitoring or surveillance activities that are published in USGS reports are generally summarized in this annual site environmental report the year of publication but may refer to sampling programs that took place in earlier years. USGS results and information for securing copies of their reports are available upon request from the USGS INEL Project Office at CFA.

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a. Modified from B. R. Orr and L. D. Cecil, *Hydrologic Conditions and Distribution of Selected Chemical Constituents in Water, Snake River Plain Aquifer, Idaho National Engineering Laboratory, Idaho, 1986 to 1988*, U.S. Geological Survey, Water Resources Investigation Report 91-4047, DOE/ID-22096, March 1991.

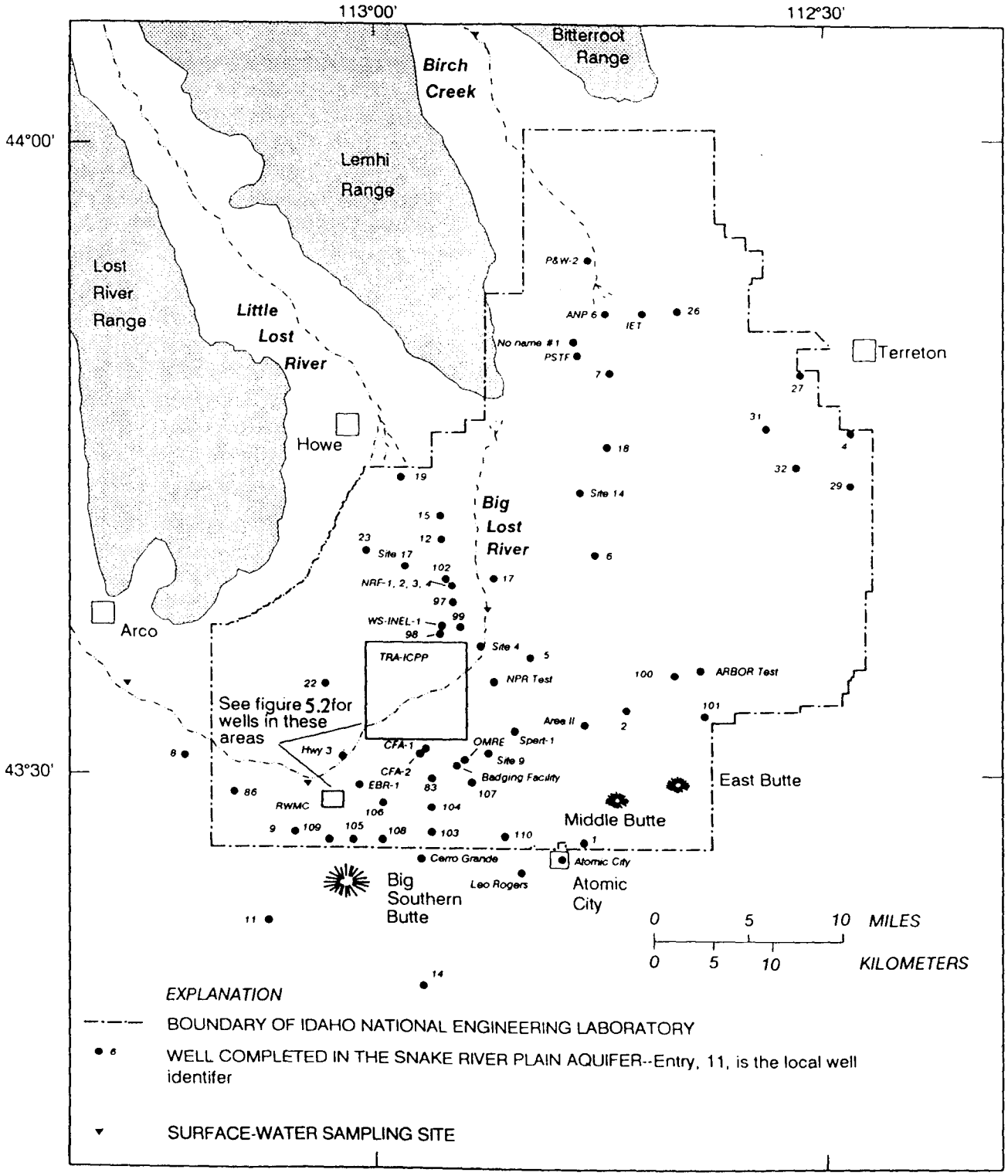


Figure 5.1 USGS Well Locations

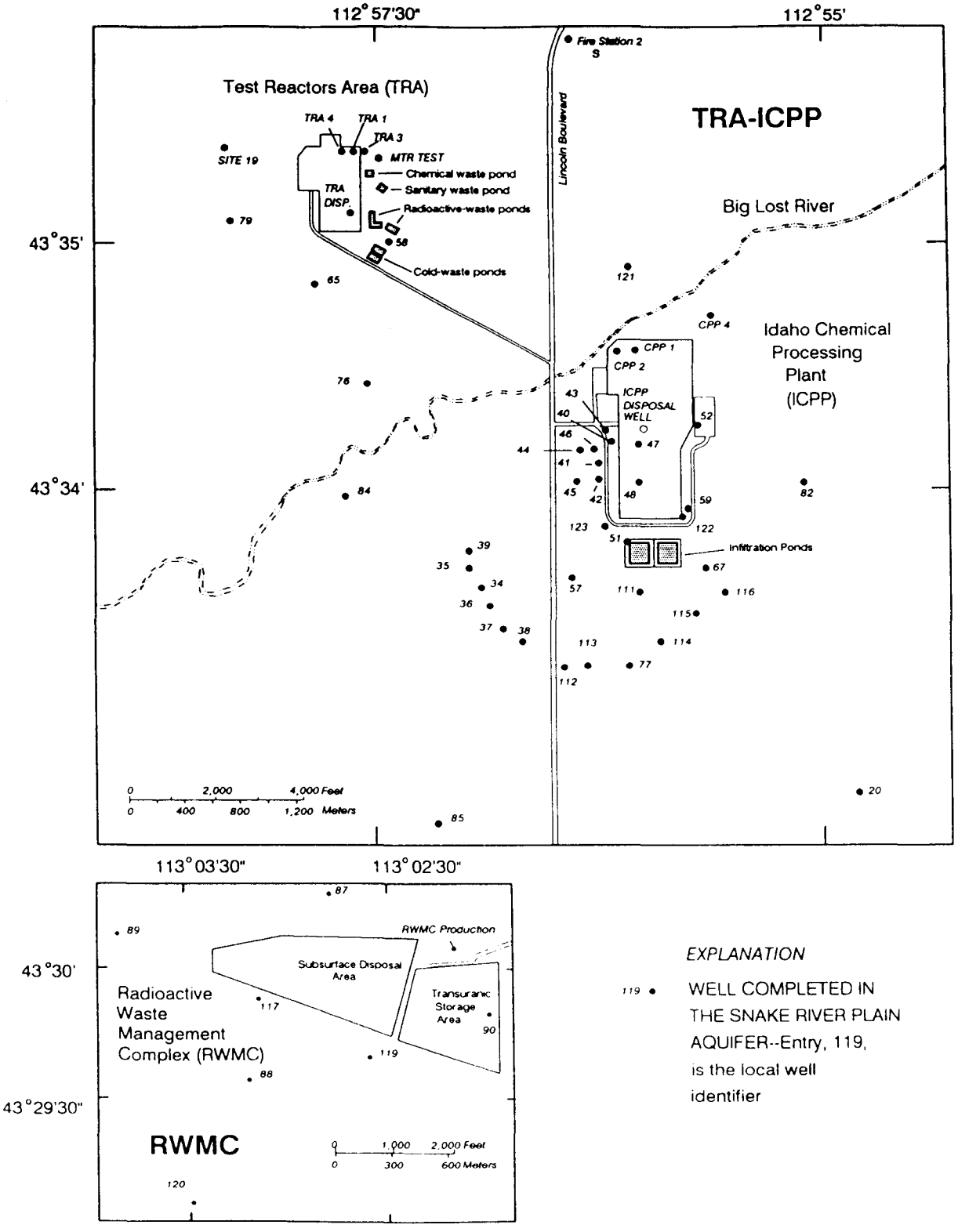


Figure 5.2 USGS well locations at ICPP-TRA and RWMC

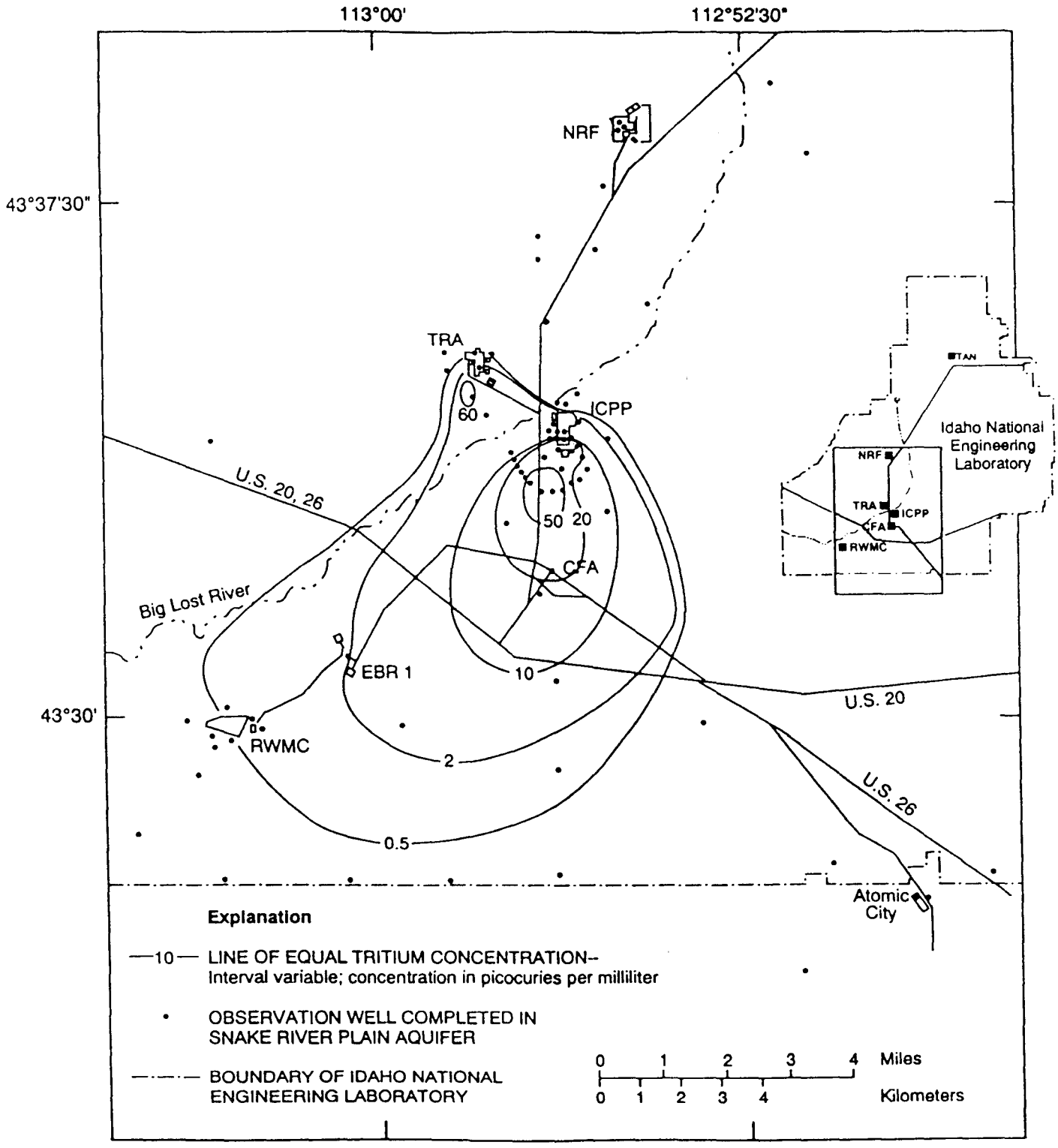


Figure 5.3 Distribution of tritium in the Snake River Plain Aquifer on the INEL, 1988

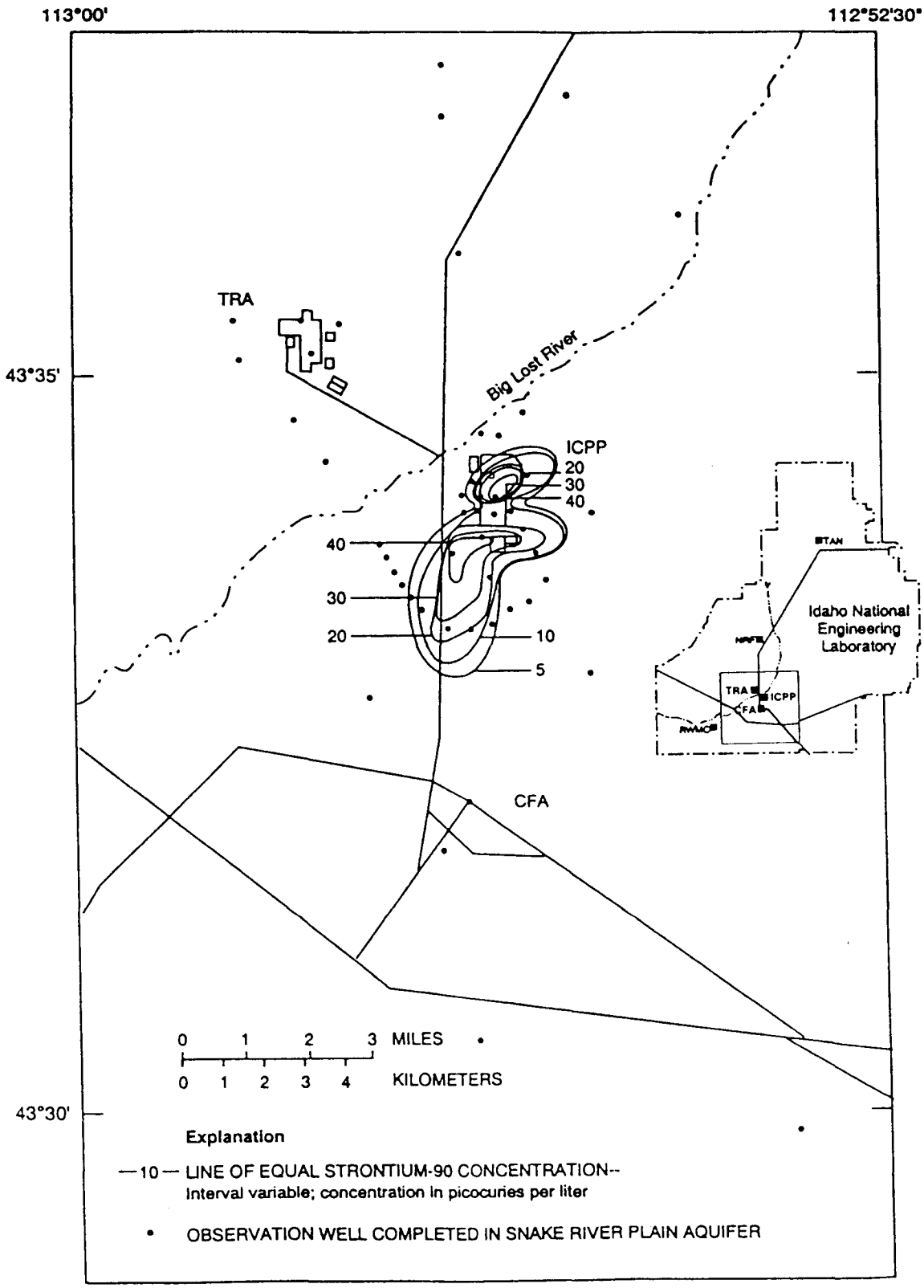


Figure 5.4 Distribution of ^{90}Sr in the Snake River Plain Aquifer on the INEL, 1988

USGS Special Studies

Chlorine-36. Results of a USGS study on ^{36}Cl were published in 1993[a]. The study used an extremely sensitive accelerator mass spectrometry technique to investigate the origins of this radionuclide in ground water, where it is present from both natural and manmade sources. Measurements of the ^{36}Cl/stable Cl ratio allowed the authors to distinguish between ^{36}Cl occurring naturally and that produced from nuclear fuel reprocessing operations like those conducted at the ICPP.

The report concluded that although not a radiological hazard (the highest ^{36}Cl value measured was 0.2% of the EPA drinking water standard) concentrations of ^{36}Cl could be clearly identified from the point of injection in the ICPP-TRA area to the southern INEL boundary. The report also suggests the value of using ^{36}Cl as a tracer for water in the Snake River Plain aquifer beneath the INEL.

Trace elements. Data for trace element concentrations in water samples from 177 ground- and surface-water sites collected between 1988 and 1991 were reported by the USGS[b]. Analyses were performed for total recoverable trace elements aluminum, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, nickel, selenium, silver, and zinc. Dissolved concentrations of these elements and bromide, fluoride, lithium, molybdenum, strontium, thallium, and vanadium were obtained from filtered water samples.

Except for chromium, all reported concentrations of trace elements were below the EPA maximum contaminant levels for drinking water. Chromium was found to be above the maximum contaminant level at 12 water-quality monitoring wells, none of which are used for drinking water.

Naval Reactors Facility. The USGS, in response to a request from DOE's Pittsburgh Naval Reactors Office, Idaho Branch Office, sampled wells in the NRF vicinity as part of a long-term project to monitor water quality of the Snake River Plain aquifer in the vicinity of the NRF facility on the INEL. The 1989-90 data were reported in June 1992[c] and a followup report was published in January 1993[d].

Water samples during the 1990-91 period were analyzed for manmade contaminants and natural constituents. Sixty samples were collected from eight ground-water monitoring wells and four production wells.

Most of the samples contained reportable concentrations of total sodium and dissolved anions. The predominant category of nitrogen-bearing compounds was nitrite plus nitrate as nitrogen. Concentrations of total organic carbon ranged from less than 0.1 to 2.2 mg/L. Total phenols in 52 of 69 samples ranged from 1 to 8 μg/L. Extractable acid and base/neutral organic compounds were detected in water from 16 of 69 samples. Pesticides were not detected in any wells.

Concentrations of dissolved gross alpha- and gross beta-particle radioactivity in all samples were near the laboratory's reportable

a. T.M. Beasley, L.D. Cecil, P. Sharma, P.W. Kubik, U. Fehn, L.J. Mann, and H.E. Gove, "Chlorine-36 in the Snake River Plain Aquifer at the Idaho National Engineering Laboratory: Origin and Implications"; *Ground Water;* 31, April 1993, pp. 302-310.

b. M. J. Liszewski and L. J. Mann, *Concentrations of 23 Trace Elements in Ground Water and Surface Water at and near the Idaho National Engineering Laboratory, Idaho, 1988-91*; DOE/ID-22110, USGS Open-File Report 93-126, 1993.

c. L. L. Knobel, R. C. Bartholomay, L. D. Cecil, B. J. Tucker, and S. J. Wegner; *Chemical Constituents in the Dissolved and Suspended Fractions of Ground Water from Selected Sites, Idaho National Engineering Laboratory, Idaho, 1989*; DOE/ID-22101; USGS Open-File Report 92-51; March 1992.

d. R.C. Bartholomay, L.L. Knobel, and B.J. Tucker; *Chemical Constituents in Water from Wells in the Vicinity of the Naval Reactors Facility, Idaho National Engineering Laboratory, Idaho, 1990-91*; DOE/ID-22106, USGS Open-File Report 93-34; January 1993.

level [minimum detectable concentration]. Radium-226 concentrations were reported in 63 of 68 samples with concentrations ranging from 0.016 to 0.975 x 10^{-9} μCi/mL. Radium-228 was reported in five of the 69 samples at concentrations ranging from 0.16 to 0.54 x 10^{-9} μCi/mL. Both are naturally occurring radionuclides.

CFCs. One study used concentrations of chlorofluorocarbons (CFCs) in ground water to determine the recharge age of the waters[a]. The study found that most ground waters had ages of 14 to 30 years; major sources of recharge were the Big Lost River, Birch Creek, the Little Lost River, the Mud Lake-Terreton area, and wells drilled into the Snake River Plain aquifer at the INEL. The study also reported a plume of elevated CFC concentrations orginating at TRA, ICPP, and RWMC extending to the south similar to the tritium plume shown in Figure 5.3.

Snake River Plain Aquifer. The USGS and the Idaho Department of Water Resources, in response to a request from DOE, sampled 18 sites in 1991 as part of an ongoing long-term project to monitor water quality of the Snake River Plain aquifer from the southern boundary of the INEL to the Hagerman, Idaho area. A report on the data generated was published in 1993[b]. Water samples were collected and analyzed for manmade pollutants and naturally occurring constituents from six irrigation wells, seven domestic wells, two springs, one stock well, one dairy well, and one observation well.

None of the radionuclides, inorganic constituents, or organic compounds for which the samples were analyzed exceeded the established maximum contaminant levels for drinking water. Most of the radionuclide and inorganic constituent analyses, and all of dissolved organic carbon analyses, exceeded the reporting level. (Compounds with values below the reporting level are considered not to be present in the sample.) Only one of the 36 purgeable organic compounds measured exceeded the reporting level--1,1,1 trichloroethane, found in two samples at less than 0.2% of the maximum contaminant level. Samples were also analyzed for insecticides, herbicides, and polychlorinated compounds. Of these, only one (the herbicide 2,4-D), was at or above the reporting level. One sample had a fecal coliform bacteria count of nine colonies per 100 mL; therefore, this sample exceeded the maximum contaminant level which is based on the presence (greater than zero colonies per 100 mL) of total coliform bacteria.

Purging effects. A study examined the effects of purging one, two, and three borehole volumes of water on tritium and ^{90}Sr concentrations[c]. No apparent differences were found during the investigation. Prior to implementation of the USGS quality assurance plan in 1989, three borehole volumes of water were not consistently purged before sampling so data were needed comparing the concentrations of constituents after purging different volumes.

Chemical Monitoring

According to a USGS report on background concentrations of chemical

a. E. Busenberg, E.P. Weeks, L.N. Plummer, and R.C. Bartholomay; Distribution of chlorofluorocarbons (CCl_2F and CCl_3F_2) in ground water and unsaturated-zone air, Snake River Plain aquifer, Idaho National Engineering Laboratory; USGS Water-Resources Investigations Report 93-4054 (DOE/ID-22107).

b. R. C. Bartholomay, D. D. Edwards, and L. J. Campbell; *Radionuclides, Inorganic Constituents, Organic Compounds, and Bacteria in Water from Selected Wells and Springs from the Southern Boundary of the Idaho National Engineering Laboratory to the Hagerman Area*, Idaho, 1991; DOE/ID-22108; USGS Open-File Report 93-102; 1992.

c. R. C. Bartholomay; *Concentrations of Tritium and Strontium-90 in Water from Selected Wells at the Idaho National Engineering Laboratory After Purging One, Two, and Three Borehole Volumes*; USGS Water-Resources Investigation Report 93-4201; 1993.

constituents, operations at the INEL have probably locally affected concentrations of several purgeable organic compounds including carbon tetrachloride, 1,1,1-trichloroethane, trichloroethylene, tetrachloroethylene, chloroform, and 1,1-dichloroethylene in the aquifer under the INEL[a]. However, the INEL has apparently had no effect on the concentrations of other purgeable organic compounds, pesticides, or fluoride. In the trace elements group, operations have not affected concentrations of arsenic, barium, cadmium, mercury, or silver; but they may have had a slight effect on the concentrations of dissolved chromium, lead, and selenium.

Sampling for purgeable organic compounds in ground water was conducted by the USGS at the INEL Site during 1993. Water samples from one onsite production well and eight ground-water quality monitoring wells that tap the Snake River Plain aquifer were collected by USGS personnel and submitted to the USGS National Water Quality Laboratory in Arvada, Colorado, for analysis for 60 purgeable organic compounds. A USGS report on the purgeable organic compounds sampling program describes in detail the methods used to collect the water samples and to ensure sampling and analytical quality[b]. In the 1993 USGS set of samples from the INEL, five purgeable organic compounds were reported at concentrations above the laboratory reporting level of 0.2 µg/L: carbon tetrachloride, chloroform, 1,1,1-trichloroethane, trichloroethylene, and tetrachloroethylene (Table 5.1). The only drinking water well sampled by the USGS in 1993 containing purgeable organic compounds was the RWMC production well. All detected concentrations were well below the EPA maximum contaminant levels for each compound (Table IV in Appendix A).

a. B. R. Orr, L. D. Cecil, L. L. Knobel, *Background Concentrations of Selected Radionuclides, Organic Compounds, and Chemical Constituents in Groundwater in the Vicinity of the Idaho National Engineering Laboratory,* U.S. Geological Survey, Water-Resources Investigations Report 91-4015, DOE/ID-22094, February 1991.

b. M. J. Liszewski and L. J. Mann, *Purgeable Organic Compounds in Ground Water at the Idaho National Engineering Laboratory, Idaho--1990 and 1991,* DOE/ID-22104, USGS Open-File Report 92-174, DOE/ID-22089, July 1992.

5.2 INEL CONTRACTOR PROGRAM INFORMATION

Bacteriological Monitoring

Potable water at the INEL was monitored for coliform bacteria monthly by contractor personnel and analyzed by the EG&G Idaho Environmental Hygiene Laboratory. Between 48 and 104 samples per month were collected from the active drinking water systems at INEL facilities. While "total coliform" bacteria may occasionally be detected in drinking water samples, concern arises only if *Escherichia coli (E. coli)* is present. Although most strains of *E. coli* are not dangerous and are normally found in human and animal intestines, the presence of this organism indicates possible contamination of the water by fecal waste. If even one colony of *E. coli* is found in a sample by the laboratory, that particular drinking water system is cleaned, re-sampled, and tested again, until it is clear of bacteria. Corrective action to purify the water may vary somewhat from one facility to another.

In 1993, there were a number of instances where coliform bacteria were found at TAN during July, August, and September, but there were no cases in which *E. coli* were detected. In July, four positive samples were from a distribution system that was out of service. Six others were from a distribution system being placed back into service, but all resamples were negative. In August and

Table 5.1
Purgeable Organic Compounds in USGS Well Samples (1993)[a]

Well ID	Date	Carbon Tetra-chloride	Chloroform	1,1,1-trichloro-ethane	Tetrachloro-ethylene	Trichloro-ethylene
87	01/19	1.2	0.2	0.2	<dl[b]	0.3
	04/15	0.7	<dl	<dl	<dl	0.3
	07/15	1.3	<dl	0.2	<dl	0.3
	10/18	1.0	<dl	0.2	<dl	0.3
88	01/20	2.4	0.5	0.3	<dl	<dl
	04/20	1.3	0.5	0.2	<dl	<dl
	07/26	1.5	0.4	0.3	<dl	<dl
	10/5	1.4	0.4	0.2	<dl	<dl
89	04/21	<dl	<dl	0.2	<dl	<dl
90	05/3	1.3	<dl	0.3	<dl	0.5
	10/4	1.3	<dl	0.2	<dl	0.4
120	01/20	0.5	<dl	<dl	<dl	<dl
	04/20	0.4	<dl	<dl	<dl	<dl
	06/23	0.9	<dl	0.2	<dl	<dl
	10/6	0.9	<dl	0.2	<dl	<dl
RWMC[c]	01/19	2.6	0.5	0.4	<dl	1.2
	02/18	3.1	0.4	0.5	0.2	1.4
	03/15	2.0	0.4	0.4	<dl	1.1
	04/15	2.0	0.3	0.4	<dl	1.1
	05/19	2.8	0.3	0.5	<dl	1.3
	06/15	2.1	0.4	0.5	<dl	1.1
	07/15	2.4	0.3	0.4	<dl	1.1
	08/18	1.6	0.2	0.3	<dl	0.9
	09/15	2.3	0.3	0.5	<dl	1.0
	10/18	2.1	0.4	0.4	<dl	1.0
	11/15	2.5	0.3	0.4	<dl	1.2
	12/16	2.2	0.3	0.4	<dl	1.1
EPA maximum contaminant level		5	100	200	5	5

a. Concentrations expressed in μg/L. Only values which exceed the detection limit are included.
b. Analytical result less than detection limit.
c. Samples from RWMC Production Well.

September, samples and re-samples from the latter system were positive; the system was tagged out and chlorinated before being placed back into service.

Coliform bacteria were detected in the PBF water system in November, but again *E. coli* were not present. This system was taken out of service and chlorinated. After three consecutive days of sampling indicated the water no longer contained coliform bacteria, the system was returned to service.

Single samples were positive for total coliform bacteria at NRF in June, RWMC in November, and TRA in December, but re-samples were negative in each of these cases.

Radiological Monitoring

All INEL contractors with liquid effluent streams containing radionuclides sample the waste streams and report the results of analyses on a monthly basis to the Radioactive Waste Management Information System operated by EG&G Idaho. Each quarter a report is published showing the monthly radiological releases at each INEL facility. In the past, each major contractor sampled drinking water wells at their facilities on a quarterly basis one out of every four years and submitted these samples for gross alpha, gross beta, and tritium analyses to an analytical

laboratory either certified by the State of Idaho or by a state whose certification is accepted by the State of Idaho. Currently, the RESL laboratory is certified by the State of Idaho for radiological analyses of drinking water, and the RESL program serves as a substitute for the earlier contractor programs. Results of this program were discussed in Chapter 4 as part of the routine environmental surveillance program.

ANL-W. ANL-W samples its seepage pond monthly when it is unfrozen and analyzes the water for gross alpha, gross beta, tritium, and gamma-emitting radionuclides. None were reported above the detection limit in 1993.

Chemical Monitoring

ANL-W. No volatile organic compounds were found in ANL-W production well samples in 1993.

EG&G. The EG&G Idaho Environmental Monitoring Unit routinely samples drinking water from wells and distribution systems at EG&G Idaho facilities at the INEL for volatile organic compounds. At the Technical Service Facility at TAN (TAN/TSF), the production wells and distribution systems are sampled more frequently since the discovery in 1987 that the trichloro-ethylene concentrations in samples collected at the wellhead exceeded the maximum contaminant level. (Drinking water samples from the TAN/TSF distribution system did not exceed the regulatory levels.) A corrective action plan was implemented by installing an aerating device (sparger system) at the point of entry to the distribution system to remove the volatile trichoroethylene from the drinking water in the system. The routine monitoring program, which samples the water at the wellhead and in the distribution system has indicated the aeration system works well; and a plan for remedial action to address the localized contamination in the aquifer was developed. Monitoring and treatment will continue as long as is necessary to follow the contaminants present in the water.

Data for volatile organic compounds in 1993 EG&G Idaho samples are shown Table 5.2. Concentrations of trichloroethylene in samples from the Water Reactor Research Test Facility (WRRTF) distribution system occasionally rise above the maximum contaminant level, because the sparger system is effective only at the TSF area. Bottled water is used by personnel at this facility, so the elevated concentrations of trichloroethylene are not of health concern to WRRTF employees. In October, concentrations of trichloroethylene were above the maximum contaminant level in the TSF distribution system. This was during the period when the system was out of service due to the bacteria detections described in a previous section. Concentrations of trichloroethylene were below the maximum contaminant levels after it was placed back into service.

Chlorinated drinking water systems must also be monitored for total trihalomethanes. Concentrations from the CFA distribution system in 1993 ranged from 4 to 6 μg/L , which are 4% and 6% of the EPA maximum contaminant level of 100 μg/L.

During 1992, EG&G Idaho initiated a semiannual monitoring program for lead and copper levels in drinking water in accordance with EPA regulation 40 CFR 141.80-141.91. None of the drinking water samples from EG&G facilities exceeded the regulatory action level of 1.3 mg/L for copper. One sample from CFA 652 was above the action level of 0.015 mg/L for lead at 0.025 mg/L. More detailed information and data presentation will be included in the *Drinking Water Program 1993 Annual Report*, EG&G-2678(93) which is due to be published in August 1994.

Table 5.2 Organic Compounds [µg/L] in INEL Drinking Water (1993)

Trichloroethylene Maximum contaminant level = 5 µg/L		
CFA651	March	0.6
	September	0.7
CFA642	March	1.0
	September	0.8
CFA641	March	0.8
	September	0.7
	November	0.7
RWMC WMF603	March	1.0
	September	0.9
RWMC WMF604	March	0.6
	September	0.8
	November	0.8
TAN612	January	1.0
	February	0.9
	April	0.8
	May	0.8
	June	0.7
	July	1.1
	August	1.3
	September	1.7
	October	1.4
	November	1.4
	December	1.1
TAN613	January	1.7
	March	1.4
	April	1.7
	May	2.6
	June	1.8
	July	2.9
	August	4.7
	September	3.2
	October	5.4
	November	3.0
	December	2.8
TAN610	January	3.2
	February	2.4
	March	3.1
	April	1.1
	May	1.4
	June	1.3
	July	4.5
	August	2.0
	October	5.3
	November	2.2
	December	2.3
WRRTF (TAN645)	March	8.9
	September	9.3

Tetrachloroethylene Maximum contaminant level = 5 µg/L		
TAN612	January	2.3
	February	2.2
	March	2.1
	April	2.0
	May	1.8
	June	2.0
	July	2.8
	August	3.5
	September	4.2
	October	3.1
	November	3.5
	December	2.6
TAN613	April	0.6
	May	0.8
	June	0.6
	July	0.9
	August	1.2
	September	0.9
	October	1.3
	November	0.8
	December	0.8
TAN610	January	0.6
	March	0.6
	July	1.1
	October	1.1
WRRTF (TAN645)	March	3.0
	September	3.5
Chloroform Maximum contaminant level = 100 µg/L		
CFA651	March	7.2
	September	7.8
CFA690	March	0.5
Bromoform Maximum contaminant level = 100 µg/L		
CFA641	March	2.0
	September	1.2
	November	1.4
CFA609	May	4.0
CFA660	September	2.0
CFA690	March	4.0
CFA681	December	3.0
TAN610	August	6.0
Dibromochloromethane No maximum contaminant level		
CFA609	May	0.9
CFA660	September	0.6

Dibromochloromethane (Cont.)		
CFA690	March	1.2
CFA681	December	0.8
Total trihalomethanes Maximum contaminant level =100 µg/L		
CFA609	May	5.0
CFA690	March	6.0
CFA681	December	4.0
1,1,1-Trichloroethane maximum contaminant level = 200 µg/L		
Fire Station #2	September	1.7
Main Gate (603)	March	1.1
	November	1.2
Main Gate (605)	September	1.2
TAN613	July	0.5
Chloromethane No maximum contaminant level		
CFA641	March	0.5
Dichloromethane No maximum contaminant level		
TAN613	June	0.6
TAN610	June	0.8
\Ethylbenzene Maximum contaminant level =700 µg/L		
CFA614	January	0.9
	February	0.9
	March	0.8
	April	0.6

Chlorodibromomethane Maximum contaminant level =100 µg/L		
CFA641	September	0.5
Toluene Maximum contaminant level =1000 µg/L		
CFA614	January	0.7
	February	0.7
	March	0.6
Xylenes (total) Maximum contaminant level =10000 µg/L		
CFA614	January	6.4
	February	6.0
	March	5.9
	April	4.3
p-Dichlorobenzene Maximum contaminant level =75 µg/L		
CF614	January	2.0
	February	2.0
	March	2.1
	April	2.9
Carbon Tetrachloride Maximum contaminant level =5 µg/L		
RWMC (WMF603)	March	1.8
	September	2.0
RWMC (WMF604)	March	0.9
	September	1.6
	November	1.6

NRF. Drinking water samples were collected from source water prior to entering the distribution system and monitored for volatile organic compounds, synthetic organic compounds, nitrates, and nitrites. No volatile or synthetic organic compounds were found above the minimum detectable levels established for the analyses of these compounds. Concentrations of nitrates and nitrites were well below regulatory limits.

Lead and copper monitoring of the NRF drinking water system was initiated in 1993 in accordance with applicable state and federal regulations. No action levels for copper were exceeded. Initial monitoring identified three sampling locations which exceeded the action level for lead (15 parts per billion). Exceeding the action level for lead prompted additional monitoring of source water and treated drinking water for water-quality parameters such as pH, alkalinity, calcium, conductivity, and water temperature. Follow-up sampling and monitoring at other locations throughout the distribution system is currently underway, as is evaluation of alternatives to ensure lead concentrations in drinking water are minimized.

WINCO. Water from the production and potable wells at the ICPP facility were analyzed monthly for a number of parameters (Table 5.3). None of these constituents were above the EPA maximum contaminant levels or State of Idaho drinking water limits during 1993.

TABLE 5.3
INORGANIC CHEMICALS IN ICPP POTABLE AND PRODUCTION WELLS (1993)[a]

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MCL[b]
Potable Well													
Arsenic	<dl[c]	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	0.05
Barium	0.08	0.09	0.09	0.09	0.09	0.09	0.09	0.08	0.09	0.09	0.09	0.09	2
Cadmium	0.0009	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	0.005
Chromium	0.006	0.007	0.006	0.005	0.006	<dl	0.006	0.007	0.005	0.005	0.007	0.005	0.1
Lead	0.003	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	0.05
Selenium	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	0.003	0.007	0.05
Silver	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	2
Sodium	8.1	7.4	7.3	8.6	7.5	7.8	7.1	7.6	7.7	8.1	6.5	7.7	N/A
Chloride	19.0	17.3	18.6	19.7	16.9	17.9	18.5	18.2	18.8	17.9	20.9	17.7	N/A
Fluoride	0.23	0.22	0.22	0.20	0.20	0.20	0.19	0.23	0.21	0.21	0.21	0.22	4
Nitrate	4.65	4.41	4.97	5.00	3.83	4.80	4.61	4.58	4.91	4.70	4.55	4.68	10
Phosphate	<dl	<dl	<dl	0.72	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	N/A
Sulfate	25.4	24.4	28.1	27.3	26.3	24.8	25.7	27.1	25.7	26.9	25.8	25.1	N/A
Production Well[d]													
Arsenic	<dl	<dl	<dl	<dl	<dl	0.001	<dl	0.002	<dl	<dl	<dl	<dl	0.05
Barium	0.08	0.08	0.09	0.08	0.08	0.09	0.09	0.09	0.09	0.09	0.09	0.09	2
Cadmium	0.0018	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	0.005
Chromium	0.006	0.007	0.006	0.005	0.005	0.004	0.006	0.003	0.005	0.005	0.007	0.005	0.1
Lead	0.02	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	0.05
Selenium	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	0.004	<dl	0.05
Silver	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	N/A
Sodium	7.3	7.4	7.3	8.2	7.7	7.7	7.3	7.5	7.2	8.1	6.6	8.0	N/A
Chloride	19.0	18.3	16.7	19.2	18.5	18.8	19.1	17.8	20.1	18.6	18.2	18.4	N/A
Fluoride	0.22	0.22	0.20	0.21	0.20	0.22	0.20	0.23	0.22	0.22	0.21	0.22	4
Nitrate	4.37	4.31	4.58	4.65	4.49	4.57	4.47	4.58	4.58	5.00	4.52	4.68	10
Phosphate	<dl	<dl	<dl	0.72	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	N/A
Sulfate	25.9	24.9	23.5	27.1	27.1	26.0	26.5	26.9	26.2	26.1	24.3	23.4	N/A

a. Concentrations reported in mg/L by WINCO.

b. EPA maximum contaminant level for noncommunity, nontransient drinking water systems. N/A indicates no MCL established.

c. Concentration below detection limit.

d. Samples taken from whichever production well (#1 or #2) was in use.

6. ENVIRONMENTAL NONRADIOLOGICAL PROGRAM INFORMATION

6. ENVIRONMENTAL NONRADIOLOGICAL PROGRAM INFORMATION

6.1 ENVIRONMENTAL SURVEILLANCE PROGRAM DESCRIPTION

Total Suspended Particulates

Measurements of total suspended particulates were performed on the particulate filters from the low-volume filters described in Chapter 4. Clean filters were weighed at the beginning of each quarter and filter composites were weighed at the end of the quarter. The concentration of total suspended particulates was calculated by dividing the amount of material collected on the filters by the total volume of air passing though the filters.

The EPA primary and secondary standard for particulate matter is 50 $\mu g/m^3$, but it applies only to "particulates with an aerodynamic diameter less than or equal to a nominal 10 micrometers." Measurements of total suspended particulates will overestimate particulate concentrations in the 10 μm and below size range in comparison with the new standard. This is because the standard applies only to particles on the filter with diameters of 10 μm or less, but many of the particles on the low-volume filters are actually larger than that size because there is no device on the samplers to screen out the larger particles. Particles larger than 10 μm are not considered by the EPA to be respirable by humans because they do not usually enter the lungs with inhaled air. The larger particles usually fall out before they reach the nose, are trapped by nasal hairs, or are impacted on tissues of the nasopharynx and passed through the body via the digestive system.

IMPROVE Samplers

In May of 1992, one sampler for nonradiological parameters in air was established at CFA and a second was located at Craters of the Moon National Monument, operated under a Memorandum of Understanding between the DOE and the National Park Service. These samplers were developed by the Crocker Nuclear Laboratory of the University of California at Davis, for the NPS/IMPROVE (National Park Service/Interagency Monitoring of Protected Visual Environments) aerosol network, which has been in operation since March 1988 at national parks, monuments, and wilderness areas across the United States.

The two samplers, comprised only of Module A of the four-module IMPROVE sampler, each collected two 24-hr samples weekly of fine particulates (<2.5 μm in diameter). Analyses were performed by Crocker Nuclear Laboratory at the University of California in Davis, California for mass, optical absorption, hydrogen, carbon, nitrogen, and oxygen plus elements from sodium through lead on the Periodic Table.

Nitrogen Dioxide/Sulfur Dioxide Monitoring

To fulfill one of the conditions specified in the Permit to Construct the Fuel Processing Restoration facility, two nitrogen oxide monitoring stations (which measure NO and NO_2, collective called NO_x) were operated. These were located near the intersection of US Highway 20/26 and Van Buren Boulevard

(VANB) and at EFS. The analyzers used are EPA equivalent methods.

One sulfur dioxide (SO_2) analyzer (also designated as an EPA equivalent method) was operated at the VANB location in addition to the nitrogen dioxide analyzer.

6.2 ENVIRONMENTAL SURVEILLANCE PROGRAM RESULTS

Total Suspended Particulates

Results for 1993 indicated total suspended particulate concentrations ranged from 6 $\mu g/m^3$ at Craters of the Moon and the Auxiliary Reactor Area to 38 $\mu g/m^3$ at Idaho Falls (Table 6.1). The onsite mean total suspended particulate concentration of 13 $\mu g/m^3$ was lower than the distant mean of 21 $\mu g/m^3$ and the boundary mean of 18 $\mu g/m^3$. The largest source of airborne particulates in the vicinity of the INEL is considered to be resuspended dust from agricultural operations. Total suspended particulate concentrations for 1984-1993 are provided in Table 6.2.

IMPROVE Samplers

Data were available for the period June 1992 through November 1993. A summary of results is shown in Table 6.3.

Nitrogen Dioxide

The New Waste Calcining Facility at ICPP, the largest single source of nitrogen dioxide on the INEL, operated approximately two-thirds of 1993. Mean nitrogen dioxide concentrations for 1993 were 9.4 $\mu g/m^3$ (5.0 parts per billion) at VANB and 36.0 $\mu g/m^3$ (19.1 parts per billion) at EFS, lower than the EPA national primary ambient air quality standard of 100 $\mu g/m^3$. Data recovery for the year was about 94% at Van Buren and 97% at EFS.

Sulfur Dioxide

The mean SO_2 concentration for 1993 was 1.8 $\mu g/m^3$ (0.68 parts per billion), or 2% of the annual primary air quality standard. The maximum daily concentration of 25.6 $\mu g/m^3$ (9.6 parts per billion) on August 11 was 7% of the primary standard for a 24-hour period. The maximum recorded three-hour average of 102 $\mu g/m^3$ (38.4 parts per billion), also on August 11, was 8% of the EPA secondary standard. The analyzer operated satisfactorily for about 88% of the year.

6.3 NONRADIOLOGICAL AIRBORNE EFFLUENTS

Summary

Nonradioactive airborne effluents originate from five primary sources at the INEL: (a) calcination of high-level radioactive liquid waste at the New Waste Calcining Facility (NWCF); (b) combustion of coal for steam generation at the Coal-Fired Steam Generating Facility (CFSGF); (c) combustion of fuel oil for heating at all INEL facilities; (d) motor vehicle exhausts; and (e) fugitive dusts from waste burial and construction activities.

Nitrogen oxide emissions are routinely monitored by WINCO at the NWCF, and sulfur dioxide, nitrogen oxides, and carbon oxides are monitored at the CFSGF. (Both facilities are located at ICPP.) These monitoring data are published in the INEL Nonradiological Waste Management Information System (INWMIS) quarterly reports.

TABLE 6.1
PARTICULATE MATTER CONCENTRATIONS IN AIR (1993)

Group	Location	Concentration ($\mu g/m^3$) Range	Mean[a]
Distant	Blackfoot	13-20	17 ± 7
	Craters of the Moon	0-10	6 ± 7
	Idaho Falls	14-60	38 ± 31
	Rexburg	20-30	24 ± 4
		Grand Mean[a]	21 ± 21
Boundary	Arco	2-40	32 ± 32
	Atomic City	7-20	15 ± 10
	FAA Tower	6-9	8 ± 3
	Howe	11-20	17 ± 9
	Monteview	18-30	22 ± 7
	Mud Lake	18-20	20 ± 2
	Reno Ranch	7-14	10 ± 5
		Grand Mean[a]	18 ± 8
INEL	ANL-W	11-20	16 ± 10
	ARA	3-9	6 ± 4
	CFA	7-16	10 ± 6
	EBR-1	8-10	9 ± 2
	EFS	11-30	20 ± 13
	ICPP	9-20	14 ± 10
	NRF	3-30	14 ± 22
	PBF	10-11	11 ± 1
	RWMC	5-30	18 ± 16
	TAN	11-20	15 ± 7
	TRA	7-12	8 ± 3
	VANB	2-15	9 ± 10
		Grand Mean[a]	13 ± 3

a. Arithmetic mean with the 95% confidence interval for the mean.

RESL calculates the maximum sulfur dioxide and nitrogen dioxide concentrations at the INEL boundary each year using the total annual discharges as reported by the INWMIS and the MESODIF air dispersion model. The calculational method is essentially the same as described in the section "Evaluation of Potential Radiation Dose to the Public," using mass units for releases instead of radioactivity units.

Emissions of sulfur dioxide from heating oils are calculated from sulfur content and the amount of fuel used at all INEL facilities and are reported to the INWMIS. RESL calculates emissions of nitrogen oxides from fuel by using emission factors developed by the EPA and the amount and type of fuel burned at each facility as reported by the INWMIS. Motor vehicle exhausts and fugitive dusts are not monitored at their sources.

Total sulfur dioxide released in 1993 was about 139 megagrams (Mg) (Table 6.4). A Mg is sometimes referred to as a metric ton and

TABLE 6.2
TEN-YEAR SUMMARY OF PARTICULATE MATTER CONCENTRATIONS (1984-1993)

	Group Mean Concentration ($\mu g/m^3$)[a]		
Year	Distant Group	Boundary Group	Onsite Group
1984	41 ± 31	20 ± 2	23 ± 9
1985	55 ± 29	33 ± 12	32 ± 9
1986	39 ± 17	31 ± 9	23 ± 6
1987	45 ± 16	34 ± 8	28 ± 8
1988	50 ± 20	35 ± 9	32 ± 13
1989	40 ± 14	30 ± 7	17 ± 2
1990	36 ± 12	32 ± 8	20 ± 9
1991	30 ± 20	28 ± 12	18 ± 3
1992	26 ± 19	23 ± 10	13 ± 2
1993	21 ± 21	18 ± 8	13 ± 3

a. Arithmetic mean with the 95% confidence interval for the mean.

is equivalent to 2200 pounds. The maximum concentration of sulfur dioxide at the southern INEL boundary, where the MESODIF model predicted the highest concentration, was 0.4 $\mu g/m^3$, which is 0.5% of the national primary ambient air quality standard of 80 $\mu g/m^3$.

The releases of nitrogen oxides during 1993 are also shown in Table 6.4. When the nitrogen oxide was converted to nitrogen dioxide, the total released equaled about 600 Mg. The calculated maximum Site boundary concentration of nitrogen dioxide was 1.8 $\mu g/m^3$ from all INEL sources. This concentration is 1.8% of the national primary ambient air quality standard of 100 $\mu g/m^3$.

ANL-W

At ANL-W, the Experimental Breeder Reactor II Auxiliary Boilers do not require continuous monitoring because they are below the State of Idaho's 250 million BTU/hr monitoring limit. The boiler emissions are monitored monthly as an efficiency check and to ensure that NO_x and SO_2 levels are below State-imposed emission limits. Personnel use a portable stack emission monitor that gives a direct printout of ambient and stack temperature, carbon monoxide, carbon dioxide, sulfur dioxide, nitrogen oxides, and oxygen. If any parameter is measured outside prescribed

TABLE 6.3
DATA FOR IMPROVE SAMPLERS AT CFA AND CRATERS OF THE MOON NATIONAL MONUMENT (JUNE 1992 - NOVEMBER 1993)[a]

	% Detected[b]		Range		Mean[c]	
Constituent	CFA	Craters	CFA	Craters	CFA	Craters
Hydrogen	100	100	42 - 1256	37 - 601	174 ± 23	141 ± 12
Sodium	50	61	<dl[d] - 214	<dl - 169	42 ± 7	49 ± 6
Magnesium	37	33	<dl - 15	<dl - 65	13 ± 2	13 ± 2
Aluminum	74	73	<dl - 251	<dl - 965	45 ± 8	54 ± 15
Silicon	100	99	8 - 625	<dl - 2115	136 ± 21	147 ± 33
Phosphorus	15	6	<dl - 35	<dl - 46	3.6 ± 0.8	2.9 ± 0.7
Sulfur	100	100	42 - 1509	45 - 617	224 ± 28	188 ± 17
Chlorine	6	5	<dl - 35	<dl - 8	2.5 ± 0.6	2.3 ± 0.1
Potassium	100	100	2 - 432	4 - 298	39 ± 8	33 ± 6
Calcium	100	100	3 - 241	3 - 295	46 ± 7	43 ± 7
Titanium	80	83	<dl - 18	<dl - 48	3.3 ± 0.5	4.0 ± 0.7
Vanadium	22	19	<dl - 5.1	<dl - 2	0.8 ± 0.1	0.82 ± 0.04
Chromium	26	21	<dl - 1.3	<dl - 1.6	0.60 ± 0.03	0.66 ± 0.03
Manganese	49	58	<dl - 5	<dl - 11	0.9 ± 0.1	1.1 ± 0.2
Iron	100	100	2 - 147	2 - 410	29 ± 5	33 ± 7
Nickel	10	24	<dl - 0.4	<dl - 1.1	0.07 ± 0.01	0.08 ± 0.02
Copper	98	96	<dl - 6	<dl - 6	0.7 ± 0.1	0.6 ± 0.1
Zinc	100	100	0.1 - 30	0.1 - 20	1.8 ± 0.4	1.5 ± 0.3
Arsenic	33	31	<dl - 0.7	<dl - 4	0.17 ± 0.02	0.2 ± 0.1
Lead	99	99	<dl - 2.1	<dl - 4	0.6 ± 0.1	0.6 ± 0.1
Selenium	86	65	<dl - 1.2	<dl - 0.7	0.18 ± 0.03	0.14 ± 0.02
Bromine	100	100	0.2 - 5	0.2 - 4	1.3 ± 0.1	1.1 ± 0.1
Rubidium	64	61	<dl - 0.5	<dl - 1.1	0.12 ± 0.01	0.14 ± 0.02
Strontium	80	78	<dl - 0.8	<dl - 2	0.22 ± 0.03	0.25 ± 0.04
Zirconium	35	35	<dl - 1.3	<dl - 1.3	0.16 ± 0.02	0.18 ± 0.03
Molybdenum	10	10	<dl - 1.9	<dl - 4	1.33 ± 0.04	1.5 ± 0.1

a. Units expressed in nanograms/m^3.
b. % of samples analyzed that were greater than the detection limit for that parameter.
c. Arithmetic mean with the 95% confidence interval for the mean.
d. At least one value was below the detection limit for that parameter.

limits, the boiler is checked for improper operation and corrective action is initiated. During 1993, the NO_x analyses ranged from 43 to 72 mg/m^3 (23 to 38 parts per million) and SO_2 ranged between 3 and 93 mg/m^3 (1 and 35 parts per million).

B&W Idaho

At the Specific Manufacturing Capability facility, nonradiological airborne effluents include particulate matter, nitrogen oxides, sulfur dioxide, carbon monoxide, volatile organic compounds and toxic air pollutants. B&W Idaho personnel have determined that particulate matter originates from combustion sources, manufacturing processes, emergency generators, welding sources, an incinerator and a carpenter shop. Emissions of NO_x, SO_2 and carbon monoxide, are generated primarily from boiler and generator operations. In addition, an acid-etch process also produces some NO_x emissions that pass through a scrubber and filter system, which removes some of the pollutants before they enter the environment. During 1993, procedures required one NO_x grab sample per day using a Draeger tube during operation of the acid-etch process. The acid-etch system operated for about 57 days, and the average hourly concentration of NO_x during operations was 184 parts per million. When extrapolated

TABLE 6.4
SUMMARY OF NO_2 AND SO_2 EMISSIONS AND AMBIENT MONITORING RESULTS (1989-1993)

Facility	Mg NO_2					Mg SO_2				
	1989	1990	1991	1992	1993	1989	1990	1991	1992	1993
ANL-W	5	4	3	5	6	11	6	8	10	13
CFA	1	2	1	1	2	2	4	3	3	5
CTF	---	---	---	---	---	---	1	---	---	---
ICPP (CFSGF)	112	83	22	107	87	23	18	5	17	9
ICPP (oil)	5	1	13	2	6	34	6	86	14	44
ICPP (main stack)	11	71	501	5	467	---	---	---	---	---
NRF	22	18	17	17	18	84	52	10	45	40
PBF	---	---	---	---	---	1	1	1	1	---
SMC	---	---	---	3	5	---	---	---	8	11
TRA	3	4	3	3	3	8	11	10	10	7
TSF	14	7	4	3	4	64	23	11	8	9
WRRTF	4	---	1	1	---	10	1	1	1	1
Totals	176	189	566	147	598	239	122	135	117	139
Ambient Monitoring ($\mu g/m^3$)										
EFS	3.6	8.7	7.2	12.5	36.0	---	---	---	---	---
VANB	5.5	3.7	5.2	4.9	9.4	---	0.4	0.0	0.8	1.8

throughout the year, the annual hourly average concentration was 12 parts per million. This concentration equates to about 0.6 ton/y of nitrogen dioxide released from acid-etch operations, which is well below the Prevention of Significant Deterioration permitted value of 5.73 ton/y[a].

6.4 NONRADIOLOGICAL LIQUID EFFLUENTS

Summary

Nonradioactive liquid effluents are disposed of primarily to a waste ditch at the NRF; seepage ponds at the Contained Test Facility, TAN, TRA, ICPP, and WRRTF; an industrial waste pond at ANL-W; and sewage treatment facilities at various locations.

Routine direct disposal of wastes to the Snake River Plain aquifer ceased in 1984. The only other injection wells on the INEL are used for storm water runoff. No waste streams, other than storm water runoff, are discharged directly to the Big Lost River, the only surface stream on the INEL that might conceivably accept waste water. As described in Chapter 2, the INEL has initiated a storm-water monitoring program.

Other waste effluents are calculated from the amounts of chemicals used for water treatment, corrosion control, and demineralization; as cleansers, and algicides;

a. D. H. Janke, *1993 Environmental Monitoring Report for the SMC Project* (Rev. 0), BWI-1382, April 1994.

processed by treatment facilities is monitored for biochemical oxygen demand, dissolved oxygen, settleable solids, and pH. Results of monitoring sanitary waste streams for these parameters at all INEL facilities are reported quarterly by the INWMIS.

ANL-W

During 1993, personnel at ANL-W monitored the Industrial Waste Pond at their facility for pH, cadmium, temperature, total suspended solids, biological oxygen demand, and dissolved oxygen.

B&W Idaho

Most radioactive and hazardous liquid wastes at B&W Idaho's Specific Manufacturing Capability facility are recycled or processed through a drum evaporator with the final residue disposed as solid waste. Other hazardous, mixed hazardous, and radioactive wastes are containerized at Satellite Accumulation Areas within the facility, characterized, and transported to appropriate INEL storage facilities for final preparation and disposal to an offsite facility.

Boiler effluent and sanitary wastewater were released to the TAN 750 evaporation pond. A sampling program was established at the Specific Manufacturing Capability facility to collect baseline data for liquid effluent releases beginning in September 1992. Sanitary wastewater samples were collected during each month and analyzed for 7 conventional pollutants, 6 organics, 5 inorganics, 12 heavy metals, total uranium, and approximately 100 semivolatile and volatile compounds. Boiler wastewater was analyzed for the same parameters except the semivolatile and volatile compounds.

As a result of analyses, B&W determined that, beginning in 1994, the number of analytes measured each month could be reduced without risk to the environment. A complete set of analyses would be performed twice per year[a].

EG&G

EG&G Idaho instituted a Nonradiological Liquid Effluent Monitoring Program in fiscal year 1986 to provide environmental monitoring for nonradioactive parameters and pollutants in liquid waste effluents generated within its facilities at the INEL. The program involves sampling, analysis, and data interpretation carried out under a rigorous quality assurance program. A more complete description of the program--effluent stream descriptions, sampling regimes, analytical methods, and presentation and interpretation of the data--are published annually by EG&G Idaho.

NRF

At NRF, the sewage waste stream is monitored for more parameters than appear in the INWMIS reports. Results for 1993 are shown in Table 6.5.

WINCO

The extent of effluent monitoring for liquid waste streams varies depending on the nature of the effluents. The largest INEL effluent stream, the service waste at the ICPP, is monitored by monthly composite samples analyzed for arsenic, barium, cadmium, chromium, lead, mercury, selenium, silver, chloride, fluoride, nitrate, sulfate, conductivity, total dissolved solids, and pH (Table 6.6). All analytical results for 1993 were less than concentrations defined as hazardous waste in 40 CFR 261.24.

a. D. H. Janke, *1993 Environmental Monitoring Report for the SMC Project* (Rev. 0), BWI-1382, April 1994.

TABLE 6.5
NRF SEWAGE LAGOON WASTE STREAM ANALYSES (1993)

Parameter	Concentration[a] Minimum	Maximum	Mean[b]	Toxicity Limit[c]
Antimony	N/A[d]	N/A	<0.30	---
Arsenic	N/A	N/A	<0.005	5
Barium	0.012	0.038	0.025 ± 0.009	100
Beryllium	N/A	N/A	<0.005	---
Biochemical Oxygen Demand	18	67	28 ± 14	---
Cadmium	N/A	N/A	<0.010	0.5
Chloride	88	110	100 ± 9	---
Chromium (total)	<0.02	<0.02	<<0.02	5
Copper	N/A	N/A	0.011	---
Cyanide (total)	N/A	N/A	<0.005	---
Lead	<0.10	<0.10	<<0.10	5
Mercury	<0.0002	0.0003	<0.0002	0.2
Nickel	N/A	N/A	<0.04	---
Nitrate-Nitrite as Nitrogen	<0.1	<0.1	<<0.1	---
Oil and Grease	<5	44	<12	---
Dissolved Oxygen	0.6	21.4	9.2 ± 6.8	---
pH	7.9	11.3	9.7 ± 0.8	2 to 12.5
Selenium	N/A	N/A	<0.005	1
Silver	<0.010	<0.010	<<0.010	5
Sodium	157	235	199 ± 28	---
Sulfate	64	140	89 ± 23	---
Sulfide	N/A	N/A	<1	---
Thallium	N/A	N/A	<0.5	---
Total Dissolved Solids	530	790	668 ± 88	---
Total Suspended Solids	21	110	69 ± 35	---
Vanadium	N/A	N/A	<0.05	---
Zinc	N/A	N/A	0.11	---

a. Concentrations in mg/L except pH.
b. Mean ± 1 standard deviation. Mean values preceded by " < " contained at least one value less than the minimum detectable level for that parameter. Mean values preceded by " < < " contained all values less than the minimum detectable value.
c. Sampled and analyzed for only once. Therfore, no minimum or maximum values or mean standard deviation available.
d. EPA maximum concentration of contaminant for the toxicity characteristic from 40 CFR 261.24. A "---" means no limit has been established.

TABLE 6.6
ICPP SERVICE WASTE INORGANIC MONITORING DATA (1993)[a]

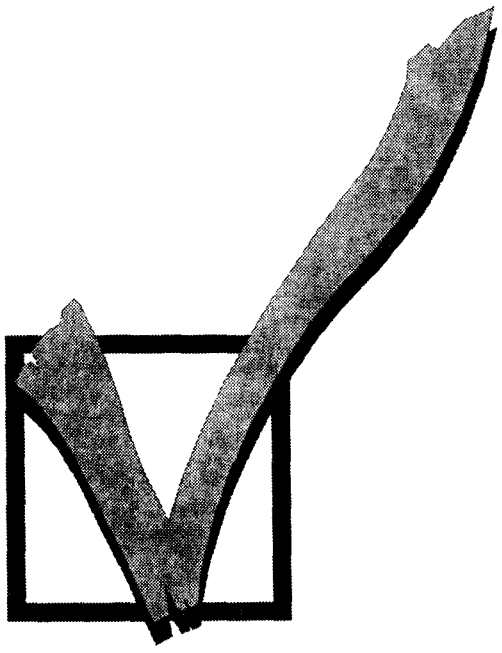
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Toxicity Limit
Arsenic	<dl[b]	<dl	<dl	<dl	0.0011	<dl	<dl	<dl	<dl	<dl	<dl	<dl	5
Barium	0.10	0.09	0.10	0.07	0.08	0.09	0.09	0.09	0.10	0.10	0.09	0.10	100
Cadmium	0.015	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	1
Chromium	<dl	<dl	<dl	<dl	0.010	<dl	<dl	<dl	<dl	<dl	<dl	0.02	5
Selenium	<dl	<dl	0.002	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	1
Silver	<dl	<dl	<dl	<dl	0.003	<dl	<dl	<dl	<dl	<dl	<dl	0.003	5
Sodium	17	15	18	18	18	15	18	16	18	17	17	15	N/A
Chloride	285	262	269	291	283	287	271	277	302	284	290	290	N/A
Fluoride	0.24	0.22	0.25	0.21	0.21	0.23	0.23	0.22	0.21	0.21	0.23	0.22	N/A
Nitrate	5.35	5.23	5.13	4.68	4.7	4.6	4.6	4.9	4.8	8.7	5.00	9.5	N/A
Phosphate	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	N/A
Sulfate	26.7	28.3	27.3	27.0	27.6	27.3	28.6	28.6	27.3	26.9	28.5	26.8	N/A
TDS[c]	670	680	670	710	690	710	720	700	700	750	680	690	N/A
Conductivity	1100	1200	1200	1200	1300	1300	1300	1300	1300	1400	1300	1300	N/A
pH	8.5	8.4	8.4	8.2	8.5	8.2	8.2	8.2	8.4	8.2	8.1	8.2	2 to 12.5

a. Concentration reported in mg/L by WINCO.

b. Concentration was below detection limit.

c. Total dissolved solids.

7. Quality Assurance



7. QUALITY ASSURANCE

7.1 QUALITY ASSURANCE PROGRAMS

Quality control and assurance programs were maintained by the Radiological and Environmental Sciences Laboratory to ensure consistent and reliable monitoring results. Elements of laboratory quality control programs include the following:

- Adherence to written procedures for sample collection and analytical methods
- Documentation of program changes
- Periodic calibration of instruments with standards traceable to the National Institute of Standards and Technology (NIST).
- Equipment performance checks for background and counting rates of standards
- Routine yield determinations of radiochemical procedures
- Replicate samples to determine precision
- Analysis of blind duplicate and replicate samples
- Analysis of quality control standards in appropriate matrices to test accuracy
- Analysis of reagent blanks to verify that there is no radiochemical contamination
- Propagation of random and systematic uncertainties.

7.2 LABORATORY INTERCOMPARISON PROGRAMS

NIST

The Analytical Measurements Team of RESL has participated each year since 1974 in a Traceability Program with the NIST. Several alpha-, beta-, and gamma-emitting nuclides, generally in liquid media, are determined; and the results are reported directly to NIST. NIST issues a Report of Test in which the results are compared with the previously undisclosed NIST-certified values. The criterion for traceability is that the results agree to within 5% of the NIST values. Most results for 1993 had not yet been received by RESL, including the mixed gamma solution. Results for ^{239}Pu and ^{75}Se analysis performed early in the year were both within 2.5%.

During past years, the Analytical Measurements Team sent samples to other INEL contractors and project office laboratories who voluntarily participated in the INEL Intercomparison Test Program. Results reported by all laboratories were compared to RESL values. The Standards and Evaluation Team has assumed responsibility for the continuation of this program.

QAP

The Analytical Measurements Team has also participated each year since 1976 in the Quality Assessment Program (QAP) administered by the DOE Environmental Measurements Laboratory (EML). EML prepares the quality control samples containing various alpha-, beta-, and gamma-emitting nuclides in water, soil, air filter, vegetation, and tissue media and distributes them to numerous DOE contractor laboratories throughout the country. The program is an interlaboratory comparison in that results from the participants are compared with the experimentally determined results of EML. EML issues "QAP" Reports in which the identities of participating laboratories, their results, and comparison to EML results are presented. RESL results for 1993 compared to the EML results are reported in Table 7.1.

Other Programs

In 1993 RESL continued to participate in the EPA Intercomparison Studies Program for the measurement of radionuclides in drinking water and is currently certified by the State of Idaho for these analyses as required by the National Primary Drinking Water Regulations.

RESL may also participate in the International Atomic Energy Agency inter-laboratory comparisons on those occasions when the Agency provides sample media of the type and level of radionuclide concentrations normally analyzed in routine procedures.

As time or opportunity permits, RESL participates in the American Society for Testing Materials' round-robin testing of standard methods.

USGS

The USGS submits most ground-water samples requiring radioactive analyses to the Analytical Measurements Team. Samples requiring nonradioactive or organic analyses are submitted to the EPA-certified USGS National Water Quality Laboratory in Arvada, Colorado. The INEL USGS Project Office personnel collect, process, and handle all samples according to guidelines specified in a written quality assurance plan for quality of water activities. Quality assurance samples submitted to RESL and the NWQL consist of at least 10% of the total number of samples. Data quality is documented through the use of field logbooks, strict chain-of-custody procedures, and a data verification program for analytical results.

USGS Project Office personnel participate in the USGS's National Field Quality Assurance Program which measures the ability of field personnel to accurately measure pH, specific conductance, and alkalinity. Any deficiencies require retesting and, if necessary, corrective action. Technical reviews of the INEL Project Office water-quality program are conducted on two- to three- year intervals by personnel from USGS National Headquarters in Reston, Virginia; Regional Headquarters in Menlo Park, California; and District Headquarters in Boise, Idaho. Written notification of deficiencies are provided to the Project Chief, and corrective actions are required.

INEL Contractors

Each contractor laboratory that analyzes INEL samples operates quality assurance programs similar to the one described in Section 7.1, including participation in various

intercomparison programs. When possible, contractors send samples that cannot be analyzed onsite to commercial laboratories with State of Idaho certification or certification by another state.

Dosimetry

To verify the quality of the environmental dosimetry program, RESL has participated in eight International Environmental Dosimeter Intercomparison Studies. RESL results were within ±10% of the test exposure values on all intercomparisons. RESL staff were responsible for coordinating the tenth intercomparison, and therefore could not participate in that round.

Verification of the RESL Environmental Dosimetry program is through participation in the Measurement Quality Assurance Program every two years. An internal investigation of the RESL program in 1993 found that quality assurance measurement data may not have been within ± 2.0% of the NIST values, as previously reported. The investigation concluded that all values were within ±4.0%, however.

TABLE 7.1
DOE ENVIRONMENTAL MEASUREMENTS LABORATORY QUALITY ASSURANCE PROGRAM RESULTS COMPARISON (1993)

				RESL		EML[a]		RESL/EML	
Sample Medium	Units	Radionuclide	RESL ID#	Value	Uncertainty[b] (%)	Value	Uncertainty (%)	Ratio	+/-
Air	Bq/filter	^{54}Mn	1	14.5	4	15.4	4	0.94	0.06
		^{54}Mn	2	14.8	4	15.4	4	0.96	0.06
		^{57}Co	1	13.6	3	17.3	4	0.79	0.04
		^{57}Co	2	13.6	3	17.3	4	0.79	0.04
		^{60}Co	1	18.8	3	20.5	4	0.92	0.05
		^{60}Co	2	19.2	3	20.5	4	0.94	0.05
		^{90}Sr	1	0.784	4	0.762	4	1.03	0.07
		^{125}Sb	1	17.2	6	17.4	5	0.99	0.09
		^{125}Sb	2	16.9	8	17.4	5	0.97	0.10
		^{134}Cs	1	12.7	7	12.2	3	1.04	0.08
		^{134}Cs	2	13.1	4	12.2	3	1.07	0.06
		^{137}Cs	1	17.7	3	18.8	4	0.94	0.05
		^{137}Cs	2	17.7	3	18.8	4	0.94	0.05
		^{144}Ce	1	31.1	7	40.3	4	0.77	0.07
		^{144}Ce	2	31	8	40.3	4	0.77	0.07
		^{238}Pu	1	0.124	4	0.129	3	0.96	0.05
		^{239}Pu	1	0.081	5	0.08	3	1.01	0.06
		^{241}Am	1	0.0835	5	0.0654	10	1.28	0.15
	µg/filter	^{234}U	1	0.0687	5	0.065	4	1.06	0.07
		^{238}U	1	0.0667	5	0.065	7	1.03	0.10
Soil	Bq/kg	^{40}K	1	26.2	39	28.6	7	0.92	0.37
		^{40}K	2	28.5	33	28.6	7	1.00	0.34
		^{137}Cs	1	13.1	7	11.4	2	1.15	0.09
		^{137}Cs	2	13.2	6	11.4	2	1.16	0.08
	µg/g	^{234}U	1	23.7	3	24.8	3	0.96	0.05
		^{234}U	2	24.8	3	24.8	3	1.00	0.06
		^{234}U	3	22	3	24.8	3	0.89	0.05
		^{238}U	1	23.5	3	25.5	4	0.92	0.05
		^{238}U	2	25.6	3	25.5	4	1.00	0.05
		^{238}U	3	22.3	3	25.5	4	0.87	0.05

TABLE 7.1 (Continued)

Sample Medium	Units	Radionuclide	RESL ID#	RESL Value	RESL Uncertainty[b] (%)	EML[a] Value	EML[a] Uncertainty (%)	RESL/EML Ratio	RESL/EML +/-
Vegetation	Bq/kg	^{40}K	1	921	4	842	3	1.03	0.06
		^{40}K	2	870	4	842	3	1.03	0.06
		^{60}Co	1	5.33	15	6.45	2	0.83	0.13
		^{60}Co	2	6.85	21	6.45	2	1.06	0.23
		^{90}Sr	1	186	3	221	13	0.84	0.11
		^{137}Cs	1	88.8	4	89.2	2	1.00	0.05
		^{137}Cs	2	87.7	3	89.2	2	0.98	0.04
		^{238}Pu	1	0.418	12	0.463	4	0.90	0.12
		^{238}Pu	2	0.368	15	0.463	4	0.79	0.13
		^{239}Pu	1	0.733	9	0.965	4	0.76	0.08
		^{239}Pu	2	0.862	9	0.965	4	0.89	0.09
		^{241}Am	1	0.514	12	0.465	21	1.11	0.27
		^{241}Am	2	0.481	12	0.465	21	1.03	0.26
Water	Bq/L	^{3}H	1	262	3	170	4	1.54	0.08
		^{3}H	2	257	3	170	4	1.51	0.08
		^{54}Mn	1	119	3	109	1	1.09	0.04
		^{54}Mn	2	118	3	109	1	1.08	0.04
		^{55}Fe	1	156	1	133	5	1.17	0.07
		^{55}Fe	2	158	1	133	5	1.19	0.07
		^{60}Co	1	110	3	99.6	0	1.10	0.04
		^{60}Co	2	108	3	99.6	0	1.08	0.04
		^{90}Sr	1	24.2	12	25.2	3	0.96	0.12
		^{90}Sr	2	24.6	12	25.2	3	0.98	0.12
		^{134}Cs	1	61.1	4	56.1	1	1.09	0.05
		^{134}Cs	2	61.1	3	56.1	1	1.09	0.04
		^{137}Cs	1	85.1	3	75.5	1	1.13	0.05
		^{137}Cs	2	82.5	3	75.5	1	1.09	0.04
		^{144}Ce	1	191	7	173	0	1.10	0.09
		^{144}Ce	2	188	7	173	0	1.09	0.08
		^{238}Pu	1	1.2	4	1.14	0	1.05	0.05
		^{238}Pu	2	1.18	4	1.14	0	1.04	0.05
		^{239}Pu	1	0.31	6	0.338	5	0.92	0.08
		^{239}Pu	2	0.344	6	0.338	5	1.02	0.08
		^{241}Am	1	1.44	4	1.39	4	1.04	0.07
		^{241}Am	2	1.47	4	13.9	4	1.06	0.07
	µg/mL	^{234}U	1	1.05	4	1.06	5	0.99	0.07
		^{234}U	2	1.15	4	1.06	5	1.08	0.08
		^{238}U	1	1.03	5	1.08	2	0.95	0.05
		^{238}U	2	1.05	4	1.08	2	0.97	0.05

a. The EML value shown is the mean of replicate determinations for each radionuclide. The EML uncertainty is the standard error of the mean.

b. The RESL uncertainty is based on the 1s estimated analytical uncertainties.

7.3 INDEPENDENT VERIFICATION PROGRAM

DOE Order 5400.1 requires that an independent data verification program that covers each element of environmental monitoring and surveillance programs, be established by each field organization as a part of the quality assurance program. To meet this requirement for the RESL environmental surveillance program, DOE-ID established a contract with Idaho State University (ISU) to conduct an independent environmental surveillance program at the INEL and offsite. Personnel from the ISU Environmental Monitoring Group selected a few RESL sampling locations for air, water, milk, and soil. They collected samples from these locations at the same times that RESL personnel collect samples. The ISU group analyzed their own samples and reported their results plus comparisons to RESL data to the State of Idaho and DOE-ID. Tables 7.2 through 7.4 show both ISU and RESL 1993 results for gross alpha, gross beta, and tritium in quarterly water samples and weekly gross alpha and gross beta in air. The comparison of results shows no serious differences between the laboratories. Those differences seen (particularly with gross beta in air) are most likely due to differences in sampling and analytical methods. The two groups use different types of air samplers for collection and different types of instruments for gross beta analyses.

Table 7.2
Comparison of RESL and Idaho State University Water Monitoring Results (1993)

Location	Date	Gross Alpha (10^{-9} μCi/mL)[a]		Gross Beta (10^{-9} μCi/mL)[a]		Tritium (pCi/mL)[a]	
		RESL	ISU	RESL	ISU	RESL	ISU
Minidoka (Drinking Water)	02/93	0.0 ± 1.6	0 ± 1	-3 ± 4	-1 ± 4	0.0 ± 0.4	-0.2 ± 0.2
	05/93	0.7 ± 1.6	1 ± 1	3 ± 4	2 ± 4	0.1 ± 0.4	0.1 ± 0.2
	08/93	0.0 ± 1.6	0 ± 1	3 ± 4	0 ± 4	0.0 ± 0.3	-0.1 ± 0.2
	11/93	1.0 ± 1.8	0 ± 2	4 ± 4	4 ± 2	0.0 ± 0.3	0.0 ± 0.2
Shoshone (Drinking Water)	02/93	0.3 ± 1.6	0 ± 1	-1 ± 4	-1 ± 4	0.0 ± 0.4	0.1 ± 0.2
	05/93	2 ± 2	1 ± 1	0 ± 4	1 ± 4	-0.1 ± 0.3	0.1 ± 0.2
	08/93	1.0 ± 1.8	1 ± 1	2 ± 4	1 ± 4	0.0 ± 0.3	0.1 ± 0.2
	11/93	0.0 ± 1.6	0 ± 2	2 ± 4	1 ± 2	-0.1 ± 0.3	0.0 ± 0.2
Bill Jones Hatchery (Surface Water)	02/93	0.0 ± 1.6	0 ± 1	-1 ± 4	3 ± 4	0.0 ± 0.4	0.2 ± 0.2
	05/93	1.7 ± 1.8	1 ± 1	1 ± 4	-1 ± 4	0.0 ± 0.4	0.1 ± 0.2
	08/93	1.0 ± 1.8	1 ± 1	4 ± 4	-1 ± 4	0.0 ± 0.3	-0.2 ± 0.2
	11/93	-0.3 ± 1.4	3 ± 4	3 ± 4	4 ± 2	-0.1 ± 0.3	0.0 ± 0.2
Clear Springs (Surface Water)	02/93	0.7 ± 1.6	0 ± 1	-1 ± 4	2 ± 5	0.0 ± 0.4	0.1 ± 0.2
	05/93	0.7 ± 1.6	1 ± 1	-1 ± 4	2 ± 4	0.0 ± 0.4	-0.1 ± 0.2
	08/93	1.0 ± 1.8	0 ± 1	5 ± 4	-2 ± 4	-0.1 ± 0.3	-0.2 ± 0.2
	11/93	0.3 ± 1.6	5 ± 4	3 ± 4	-1 ± 2	0.0 ± 0.3	-0.2 ± 0.2
Alpheus Spring (Surface Water)	02/93	0.0 ± 1.6	0 ± 1	0 ± 4	1 ± 4	-0.1 ± 0.4	0.1 ± 0.2
	05/93	0.7 ± 1.6	1 ± 1	3 ± 4	3 ± 5	-0.1 ± 0.4	-0.1 ± 0.2
	08/93	2 ± 2	0 ± 2	7 ± 4	6 ± 5	0.1 ± 0.3	0.1 ± 0.2
	11/93	0.3 ± 1.6	0 ± 2	0 ± 3	4 ± 2	0.0 ± 0.3	0.0 ± 0.2

a. Result ± 2s, where s is the random analytical uncertainty.

Table 7.3 Comparison of RESL and Idaho State University Air Monitoring Results (1993)

Week	Gross Alpha (10^{-15} μCi/mL)[a]			
	Craters		EFS	
	RESL	ISU	RESL	ISU
12/31-01/08	0.7 ± 0.4	1.0 ± 0.6	0.7 ± 0.4	1.9 ± 0.8
01/08-01/15	1.7 ± 0.6	0.4 ± 0.5	1.1 ± 0.4	0.7 ± 0.6
01/15-01/22	0.6 ± 0.4	0.3 ± 0.3[b]	1.3 ± 0.8	0.6 ± 0.4
01/22-01/29	NS[c]		0.9 ± 0.6	
01/29-02/05	1.9 ± 0.6	0.8 ± 0.8	2.3 ± 0.8	0.7 ± 0.7
02/05-02/12	1.9 ± 0.6	0.9 ± 0.8	2.9 ± 0.4	0.7 ± 0.7
02/12-02/19	1.6 ± 0.6	0.3 ± 0.6	1.7 ± 0.6	1.2 ± 0.9
02/19-02/26	0.4 ± 0.3	0.2 ± 0.5	0.3 ± 0.3	0.2 ± 0.5
02/26-03/05	2.5 ± 0.6	1.9 ± 0.9	3.9 ± 1.0	0.9 ± 0.6
03/05-03/12	0.8 ± 0.4	0.3 ± 0.5	1.5 ± 0.4	0.5 ± 0.5
03/12-03/19	0.6 ± 0.4	0.0 ± 0.4	1.0 ± 0.4	-0.2 ± 0.3
03/19-03/26	0.9 ± 0.4	0.3 ± 0.5	1.2 ± 0.4	0.3 ± 0.5
03/26-04/02	1.5 ± 0.6	0.2 ± 0.5	1.4 ± 0.6	0.1 ± 0.4
04/02-04/09	0.4 ± 0.4	0.3 ± 0.5	0.5 ± 0.4	-0.2 ± 0.3
04/09-04/16	0.7 ± 0.4	0.5 ± 0.5	0.5 ± 0.4	0.3 ± 0.5
04/16-04/23	0.7 ± 0.4	NS	0.8 ± 0.4	0.4 ± 0.5
04/23-04/30	0.7 ± 0.4	0.3 ± 0.6	1.1 ± 0.6	0.5 ± 0.6
04/30-05/07	1.0 ± 0.4	1.0 ± 0.8	0.8 ± 0.4	0.5 ± 0.7
05/07-05/14	1.3 ± 0.6	1.1 ± 0.9	1.1 ± 0.6	0.1 ± 0.5
05/14-05/21	1.5 ± 0.6	1.3 ± 1.0	2.1 ± 0.8	1.1 ± 0.9
05/21-05/28	0.7 ± 0.4	0.4 ± 0.6	1.3 ± 0.6	1.3 ± 1.0
05/28-06/04	0.9 ± 0.4	0.0 ± 0.4	1.6 ± 0.6	0.1 ± 0.5
06/04-06/11	0.4 ± 0.4	-0.2 ± 0.4	0.6 ± 0.4	0.0 ± 0.4
06/11-06/18	1.1 ± 0.4	0.2 ± 1.0	1.8 ± 0.6	NS
06/18-06/25	0.8 ± 0.4	1.3 ± 1.0	1.8 ± 0.6	1.1 ± 0.9
06/25-07/02	1.2 ± 0.6	0.0 ± 0.4	0.7 ± 0.6	0.4 ± 0.7
07/02-07/09	0.6 ± 0.4	0.3 ± 0.8	1.7 ± 0.6	0.5 ± 0.9
07/09-07/16	0.9 ± 0.4	0.1 ± 0.7	1.6 ± 0.6	0.3 ± 0.9
07/16-07/23	1.2 ± 0.6	0.4 ± 1.0	1.7 ± 0.6	1.1 ± 1.2
07/23-07/30	0.9 ± 0.4	0.5 ± 0.9	1.1 ± 0.6	-0.1 ± 0.6
07/30-08/06	1.0 ± 0.4	0.9 ± 1.2	1.3 ± 0.6	1.2 ± 1.2
08/06-08/13	0.9 ± 0.4	1.0 ± 1.3	1.3 ± 0.6	0.5 ± 0.9
08/13-08/20	1.1 ± 0.6	-0.7 ± 1.2	1.1 ± 0.6	0.5 ± 0.9
08/20-08/27	0.7 ± 0.4	0.7 ± 1.0	1.5 ± 0.6	2.0 ± 1.4
08/27-09/03	1.6 ± 0.6	1.3 ± 1.2	1.0 ± 0.6	1.4 ± 1.2
09/03-09/10	2.1 ± 0.6	2.0 ± 1.5	1.8 ± 0.6	1.7 ± 1.3
09/10-09/17	1.1 ± 0.6	0.9 ± 1.1	1.9 ± 0.8	1.2 ± 1.2
09/17-09/24	1.6 ± 0.6	1.5 ± 1.3	1.7 ± 0.6	1.4 ± 1.2
09/24-10/01	2.5 ± 0.8	2.0 ± 1.4	2.3 ± 0.8	2.1 ± 1.4
10/01-10/08	2.1 ± 0.6	0.3 ± 0.6	1.8 ± 0.8	0.8 ± 0.9
10/08-10/15	1.6 ± 0.6	0.9 ± 0.8	1.1 ± 0.6	0.5 ± 0.7
10/15-10/22	1.4 ± 0.4	0.1 ± 0.5	1.7 ± 0.6	1.3 ± 0.9
10/22-10/29	2.3 ± 0.6	1.8 ± 1.2	2.2 ± 0.6	1.7 ± 1.0
10/29-11/05	1.3 ± 0.4	-2.3 ± 21.1[d]	2.4 ± 1.0	0.7 ± 0.7
11/05-11/12	2.4 ± 0.6	1.4 ± 1.0	2.6 ± 0.6	1.4 ± 0.9
11/12-11/19	2.0 ± 0.6	0.7 ± 0.7	NS	1.0 ± 0.8
11/19-11/26	1.7 ± 0.6	0.1 ± 0.4	NS	0.2 ± 0.5
11/26-12/03	2.3 ± 0.6	2.1 ± 1.2	2.1 ± 0.6	1.8 ± 1.1
12/03-12/10	1.4 ± 0.6	0.9 ± 0.9	1.1 ± 0.4	0.2 ± 0.6
12/10-12/17	0.9 ± 0.3	0.8 ± 0.8	0.9 ± 0.3	3.9 ± 4.0[d]
12/17-12/23	1.9 ± 0.6	1.4 ± 1.1	2.2 ± 0.6	1.1 ± 0.6
12/23-12/30	1.7 ± 0.6	0.8 ± 0.8	3.4 ± 0.8	1.2 ± 0.9

a. Analytical result ± 2s, where s represents random analytical uncertainty.
b. Two-week samples collected.
c. No sample collected.
d. Low volume for the week--results suspect.

Table 7.4 Comparison of RESL and Idaho State University Air Monitoring Results (1993)

Week	Gross Beta (10^{-15} μCi/mL)[a]							
	Craters		Atomic City		EFS		Van Buren	
	RESL	ISU	RESL	ISU	RESL	ISU	RESL	ISU
12/31-01/08	19 ± 3	12 ± 4	20 ± 3	13 ± 4	23 ± 4	14 ± 4	25 ± 4	8 ± 4
01/08-01/15	33 ± 4	20 ± 5	31 ± 4	18 ± 5	30 ± 4	18 ± 5	45 ± 8	15 ± 4
01/15-01/22	18 ± 4	9 ± 3	14 ± 2	14 ± 3	16 ± 6	15 ± 3	25 ± 6	10 ± 2
01/22-01/29	NS		31 ± 6		42 ± 8		41 ± 8	
01/29-02/05	43 ± 6	29 ± 5	75 ± 8	44 ± 5	84 ± 10	52 ± 6	97 ± 10	37 ± 5
02/05-02/12	32 ± 4	17 ± 5	35 ± 4	20 ± 5	51 ± 6	28 ± 5	45 ± 6	25 ± 5
02/12-02/19	33 ± 4	17 ± 5	48 ± 6	16 ± 5	38 ± 6	16 ± 5	39 ± 6	10 ± 4
02/19-02/26	13 ± 3	4 ± 5	12 ± 3	8 ± 6	7 ± 3	6 ± 5	13 ± 4	6 ± 4
02/26-03/05	54 ± 6	25 ± 5	78 ± 8	30 ± 5	90 ± 10	19 ± 5	67 ± 8	14 ± 4
03/05-03/12	20 ± 4	11 ± 5	22 ± 4	8 ± 4	25 ± 4	14 ± 5	32 ± 6	8 ± 4
03/12-03/19	14 ± 3	6 ± 5	14 ± 3	6 ± 5	22 ± 4	-1 ± 4	24 ± 4	8 ± 5
03/19-03/26	16 ± 3	8 ± 5	14 ± 3	8 ± 5	24 ± 4	6 ± 5	25 ± 6	3 ± 4
03/26-04/02	23 ± 4	15 ± 5	22 ± 4	12 ± 5	21 ± 4	12 ± 5	26 ± 4	9 ± 4
04/02-04/09	13 ± 4	9 ± 5	7 ± 4	7 ± 5	14 ± 4	10 ± 5	14 ± 6	5 ± 5
04/09-04/16	11 ± 4	6 ± 5	9 ± 4	7 ± 5	10 ± 4	5 ± 5	7 ± 6	6 ± 4
04/16-04/23	10 ± 3	NS	10 ± 3	9 ± 5	10 ± 4	7 ± 5	12 ± 6	3 ± 4
04/23-04/30	14 ± 4	9 ± 6	14 ± 4	11 ± 5	14 ± 4	10 ± 5	15 ± 6	5 ± 5
04/30-05/07	9 ± 3	6 ± 5	9 ± 4	6 ± 5	11 ± 4	6 ± 5	8 ± 6	4 ± 5
05/07-05/14	20 ± 4	10 ± 5	17 ± 4	11 ± 5	18 ± 4	11 ± 5	21 ± 6	10 ± 5
05/14-05/21	25 ± 4	22 ± 6	25 ± 4	9 ± 5	24 ± 4	15 ± 5	28 ± 6	10 ± 5
05/21-05/28	15 ± 4	12 ± 5	16 ± 4	10 ± 5	15 ± 4	11 ± 5	18 ± 6	8 ± 5
05/28-06/04	17 ± 4	11 ± 5	18 ± 4	9 ± 5	19 ± 4	10 ± 5	18 ± 6	5 ± 5
06/04-06/11	11 ± 4	6 ± 6	12 ± 4	6 ± 5	12 ± 4	7 ± 5	10 ± 6	4 ± 5
06/11-06/18	17 ± 4	5 ± 10	15 ± 4	9 ± 5	16 ± 4	NS	21 ± 6	8 ± 5
06/18-06/25	18 ± 4	7 ± 5	21 ± 4	9 ± 5	20 ± 4	11 ± 5	23 ± 6	9 ± 5
06/25-07/02	18 ± 4	10 ± 5	15 ± 4	6 ± 15	19 ± 6	6 ± 6	23 ± 6	11 ± 5
07/02-07/09	16 ± 4	8 ± 5	18 ± 4	4 ± 6	18 ± 4	5 ± 5	20 ± 6	5 ± 5
07/09-07/16	20 ± 4	12 ± 5	20 ± 4	6 ± 5	21 ± 4	12 ± 5	28 ± 6	11 ± 5
07/16-07/23	19 ± 4	7 ± 6	20 ± 4	10 ± 5	20 ± 4	13 ± 5	21 ± 6	8 ± 5
07/23-07/30	18 ± 4	9 ± 5	18 ± 4	9 ± 5	19 ± 4	6 ± 5	21 ± 6	6 ± 5
07/30-08/06	20 ± 4	6 ± 6	21 ± 4	14 ± 5	23 ± 4	16 ± 5	19 ± 6	13 ± 5
08/06-08/13	23 ± 4	4 ± 7	20 ± 4	13 ± 5	25 ± 4	10 ± 5	25 ± 6	10 ± 5
08/13-08/20	25 ± 4	6 ± 12	27 ± 6	15 ± 5	27 ± 4	12 ± 5	26 ± 6	9 ± 5
08/20-08/27	22 ± 4	17 ± 5	25 ± 4	11 ± 5	26 ± 4	37 ± 6	21 ± 4	25 ± 5
08/27-09/03	19 ± 4	13 ± 5	22 ± 4	10 ± 5	20 ± 4	9 ± 5	20 ± 6	7 ± 5
09/03-09/10	29 ± 6	20 ± 6	32 ± 6	28 ± 6	33 ± 6	20 ± 5	34 ± 6	19 ± 5
09/10-09/17	23 ± 4	11 ± 5	25 ± 4	14 ± 5	24 ± 6	14 ± 5	19 ± 4	1 ± 5
09/17-09/24	29 ± 6	20 ± 5	33 ± 6	16 ± 5	33 ± 6	12 ± 5	36 ± 6	12 ± 5
09/24-10/01	33 ± 6	20 ± 6	33 ± 6	21 ± 6	33 ± 6	19 ± 5	31 ± 6	24 ± 5
10/01-10/08	23 ± 4	9 ± 5	24 ± 4	15 ± 5	26 ± 6	9 ± 6	28 ± 6	14 ± 6
10/08-10/15	25 ± 4	17 ± 5	28 ± 4	18 ± 5	30 ± 6	14 ± 5	31 ± 6	12 ± 5
10/15-10/22	23 ± 4	17 ± 5	24 ± 4	15 ± 5	21 ± 4	10 ± 5	30 ± 6	13 ± 5
10/22-10/29	35 ± 6	26 ± 6	39 ± 6	21 ± 5	33 ± 4	17 ± 5	40 ± 6	19 ± 5
10/29-11/05	23 ± 4	249 ± 253[d]	22 ± 4	15 ± 5	24 ± 8	17 ± 5	24 ± 6	14 ± 5
11/05-11/12	40 ± 6	27 ± 5	39 ± 6	28 ± 6	38 ± 6	24 ± 5	53 ± 8	19 ± 5
11/12-11/19	35 ± 4	23 ± 5	39 ± 6	20 ± 5	NS	19 ± 5	43 ± 6	21 ± 5
11/19-11/26	28 ± 4	13 ± 6	22 ± 4	17 ± 6	NS	14 ± 6	23 ± 4	-6 ± 4
11/26-12/03	35 ± 6	26 ± 6	40 ± 6	22 ± 5	45 ± 6	19 ± 5	33 ± 6	24 ± 5
12/03-12/10	19 ± 4	14 ± 5	19 ± 4	13 ± 5	25 ± 4	14 ± 5	25 ± 4	11 ± 5
12/10-12/17	16 ± 2	12 ± 5	16 ± 3	16 ± 5	15 ± 2	78 ± 27[d]	17 ± 4	13 ± 5
12/17-12/23	39 ± 6	30 ± 6	58 ± 8	38 ± 7	54 ± 6	19 ± 3	56 ± 8	28 ± 6
12/23-12/30	30 ± 4	36 ± 6	58 ± 6	25 ± 5	62 ± 6	27 ± 5	62 ± 8	33 ± 6

a. Analytical result ± 2s, where s represents random analytical uncertainty.
b. Two-week samples collected.
c. No sample collected.
d. Low volume for the week--results suspect.

APPENDIX A
ENVIRONMENTAL STANDARDS AND REGULATIONS

The following environmental standards and regulations are applicable, in whole or in part, on the INEL Site or at the INEL Site boundary.

U.S. Environmental Protection Agency, "National Primary and Secondary Ambient Air Quality Standards," 40 CFR 50, 1993.

U.S. Environmental Protection Agency, "National Emission Standards for Hazardous Air Pollutants," 40 CFR 61, 1993.

U.S. Environmental Protection Agency, "National Interim Primary Drinking Water Regulations," 40 CFR 141, 1993.

U.S. Environmental Protection Agency, "Hazardous Waste Management System: General," 40 CFR 260, 1993.

U.S. Environmental Protection Agency, "Identifying and Listing of Hazardous Wastes," 40 CFR 261, 1993.

U.S. Environmental Protection Agency, "Standards Applicable to Generators of Hazardous Waste," 40 CFR 262, 1993.

U.S. Environmental Protection Agency, "Standards Applicable to Transporters of Hazardous Waste," 40 CFR 263, 1993.

U.S. Environmental Protection Agency, "Standards for Owners and Operators of Hazardous Waste Treatment, Storage and Disposal Facilities," 40 CFR 264, 1993.

U.S. Environmental Protection Agency, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage and Disposal Facilities," 40 CFR 265, 1993.

U.S. Environmental Protection Agency, "Interim Standards for Owners and Operators of New Hazardous Waste Land Disposal Facilities," 40 CFR 267, 1993.

Department of Health and Welfare, State of Idaho, Rules and Regulations for the Control of Air Pollution in Idaho, 1972, as amended through May 1990.

Department of Health and Welfare, State of Idaho, Idaho Regulations for Public Drinking Water Systems, November 1989.

The Derived Concentration Guides (DCGs) are based on the DOE standard[a] and have been calculated using DOE models and parameters for internal[b] and external[c] exposure. These are shown in Table I. The most restrictive guide is listed when there is a difference between the soluble and insoluble chemical forms. The DCGs consider only the inhalation of air, the ingestion of water, or submersion in air. The principal standards and guides for release of radionuclides at the INEL are those of DOE Order 5400.5, entitled "Radiation Protection of the Public and the

[a] U.S. Department of Energy Order 5400.5, "Radiation Protection of the Public and the Environment", January 7, 1993.

[b] U.S. Department of Energy, *Internal Dose Conversion Factors for Calculation of Dose to the Public*, DOE/EH-0071, July 1988.

[c] U.S. Department of Energy, *External Dose Conversion Factors for Calculation of Dose to the Public*, DOE/EH-0070, July 1988.

Environment." The DOE standard is shown in Table II along with the EPA standard for protection of the public, airborne pathway only.

Ambient air quality standards are shown in Table III. Water quality standards are dependent on the type of drinking water system sampled. Table IV is a partial list of maximum contaminant levels set by the EPA for public community drinking water systems in 40 CFR 141.

TABLE I
DERIVED CONCENTRATION GUIDES FOR RADIATON PROTECTION

Radionuclide	Derived Concentration Guide[a] (μCi/mL) In Air	In Water	Radionuclide	Derived Concentration Guide[a] (μCi/mL) In Air	In Water
Gross Alpha[b]	2×10^{-14}	3×10^{-8}	^{129}I	7×10^{-11}	5×10^{-7}
Gross Beta[c]	3×10^{-12}	1×10^{-7}	^{131}I	4×10^{-10}	3×10^{-6}
^{3}H	1×10^{-7}	2×10^{-3}	^{132}I	4×10^{-8}	2×10^{-4}
^{14}C	5×10^{-7}	7×10^{-5}	^{133}I	2×10^{-9}	1×10^{-5}
^{24}Na[d]	4×10^{-9}	1×10^{-4}	^{135}I	1×10^{-8}	7×10^{-5}
^{41}Ar	1×10^{-8}	—	^{131m}Xe	2×10^{-6}	—
^{51}Cr	5×10^{-8}	1×10^{-3}	^{133}Xe	5×10^{-7}	—
^{54}Mn	2×10^{-9}	5×10^{-5}	^{133m}Xe	6×10^{-7}	—
^{58}Co	2×10^{-9}	4×10^{-5}	^{135}Xe	8×10^{-8}	—
^{60}Co	8×10^{-11}	5×10^{-6}	^{135m}Xe	5×10^{-8}	—
^{65}Zn	6×10^{-10}	9×10^{-6}	^{138}Xe	2×10^{-8}	—
^{85}Kr	3×10^{-6}	—	^{134}Cs	2×10^{-10}	2×10^{-6}
^{85m}Kr	1×10^{-7}	—	^{137}Cs	4×10^{-10}	3×10^{-6}
^{87}Kr	2×10^{-8}	—	^{138}Cs	1×10^{-7}	9×10^{-4}
^{88}Kr	9×10^{-9}	—	^{139}Ba	7×10^{-8}	3×10^{-4}
^{88d}Rb	3×10^{-8}	8×10^{-4}	^{140}Ba	3×10^{-9}	2×10^{-5}
^{89}Rb	3×10^{-7}	2×10^{-3}	^{141}Ce	1×10^{-9}	5×10^{-5}
^{89}Sr	3×10^{-10}	2×10^{-5}	^{144}Ce	3×10^{-11}	7×10^{-6}
^{90}Sr	9×10^{-12}	1×10^{-6}	^{238}Pu	3×10^{-14}	4×10^{-8}
^{91m}Y	4×10^{-7}	4×10^{-3}	^{239}Pu	2×10^{-14}	3×10^{-8}
^{95}Zr	6×10^{-10}	4×10^{-5}	^{240}Pu	2×10^{-14}	3×10^{-8}
^{99m}Tc	4×10^{-7}	2×10^{-3}	^{241}Am	2×10^{-14}	3×10^{-8}
^{103}Ru	2×10^{-9}	5×10^{-5}			
^{106}Ru	3×10^{-11}	6×10^{-6}			
^{125}Sb	1×10^{-9}	5×10^{-5}			

a. Derived concentratrion guides (DCGs) are from DOE Order 5400.5 and are based on an effective dose equivalent of 100 mrem/yr.
b. Based on ^{241}Am, ^{239}Pu, and ^{240}Pu.
c. Based on the most restrictive beta emitter (^{228}Ra).
d. Submersion in a cloud of gas is more restrictive than the inhalation pathway.

TABLE II
RADIATION STANDARDS FOR PROTECTION OF THE PUBLIC IN THE VICINITY OF DOE FACILITIES

	Effective Dose Equivalent	
	mrem/yr	mSv/yr
DOE Standard for routine DOE activities [a] (all pathways)	100	1
EPA Standard for site operations (airborne pathway only)	10	0.1

a. The effective dose equivalent for any member of the public from all routine DOE operations including remedial activities and release of naturally-occurring radionuclides shall not exceed this value. Routine operations refers to normal, planned operations and does not include accidental or unplanned releases.

TABLE III
AMBIENT AIR QUALITY STANDARDS

Pollutant	Type of Standard[a]	Sampling Period	EPA ($\mu g/m^3$)[b]
SO_2	S	3-hour average	1300
	P	24-hour average	365
	P	Annual average	80
NO_2	S&P	Annual average	100
	S	24-hour average	150
Total Particulates[c]	S&P	Annual average	50

a. National primary (P) ambient air quality standards define levels of air quality to protect the public health. Secondary (S) ambient air quality standards define levels of air quality to protect the public welfare from any known or anticipated adverse effects of a pollutant.

b. The State of Idaho has adopted these same ambient air quality standards.

c. The primary and secondary standard to the annual average applies only to "particulates with an aerodynamic diameter less than or equal to a nominal 10 micrometers."

TABLE IV MAXIMUM CONTAMINANT LEVELS FOR NONTRANSIENT NONCOMMUNITY DRINKING WATER SYSTEMS	
Gross alpha	1.5×10^{-8} µCi/mL
Gross beta	5.0×10^{-8} µCi/mL
Manmade radionuclides	Concentrations resulting in 4 mrem total body or organ dose equivalent
Nitrate (as N)	10.0 mg/L
Fluoride	4.0 mg/L
Trihalomethanes (Chloroform)	0.100 mg/L
Carbon Tetrachloride	0.005 mg/L
Tetrachloroethylene	0.005 mg/L
Toluene	1.000 mg/L
1,1,1-trichloroethane	0.200 mg/L
Trichloroethylene	0.005 mg/L
Arsenic	0.05 mg/L
Barium	2.0 mg/L
Cadmium	0.005 mg/L
Chromium	0.10 mg/L
Lead	0.05 mg/L
Mercury	0.002 mg/L
Selenium	0.05 mg/L
Silver	0.05 mg/L

APPENDIX B ANNUAL SUMMARY REPORT OF EPA 33/50 PROGRAM INFORMATION

ANNUAL SUMMARY REPORT FOR 33/50 PROGRAM INFORMATION (LBS)
FOR THE ANNUAL SITE ENVIRONMENTAL REPORT

Site Name: U.S. DOE Idaho National Engineering Lab.
Field Office: DOE-Idaho Operations Office
Technical Contact: Laura Bingham
Base Year: 1991
Phone Number: (208) 526-7645
Reporting Year: 1993

Column #:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Chemical	Amount (M.P.O.U.) Reporting Yr	Amount (M.P.O.U.) Prior Yr	Total Air Releases	Total Water Releases	Total Land Releases	Total Releases	POTW	Off-Site Transfers	Summary Total Reporting Yr	Summary Total Base Yr	Percent Change
Benzene											
Cadmium and Compounds											
Carbon Tetrachloride											
Chloroform											
Chromium and Compounds											
Cyanides											
Dichloromethane											
Lead and Compounds											
Mercury and Compounds											
Methyl Ethyl Ketone											
Methyl Isobutyl Ketone	19,000	8	8,950	NA	NA	8,950	NA	4	8,954	15,700	0.43
Nickel and Compounds											
Tetrachloroethylene											
Toluene											
1,1,1-Trichloroethane											
Trichloroethylene											
Xylene(s)											
Total	19,000	8	8,950	NA	NA	8,950	NA	4	8,954	15,700	0.43

APPENDIX C
STATISTICAL METHODS USED BY RESL FOR THE ENVIRONMENTAL SURVEILLANCE PROGRAM

Relatively simple statistical procedures are used to analyze the data from the RESL environmental surveillance program. Environmental Surveillance Program personnel initially review field collection information and analytical results to determine whether there are identifiable errors that would invalidate or limit the use of the results. Examples of these might be power outages at air sampler locations, torn membrane filters, or evidence of laboratory cross-contamination. Data that pass this initial screening are then evaluated for statistical significance with respect to laboratory analytical uncertainties, sample locations, reported releases from INEL operations, meteorological data, and worldwide events that might conceivably have an effect on the INEL environment.

For radiological data, individual analytical results are presented in this report with plus or minus (±) two analytical standard deviations (2s), where all analytical uncertainties have been estimated, and "s" is an estimate of the population standard deviation "σ." Many of the results were less than or equal to 2s (and, in fact, some were negative), which means that they were below the minimum detectable concentration. For example, in gamma spectrometric analyses, a given radionuclide is not considered detected unless the net count in the peak is greater than three times its estimated analytical uncertainty (3s). If the result lies in the range of two to three times its estimated analytical uncertainty (2s to 3s), and assuming that the result belongs to a Gaussian distribution, detection of the material by the analysis may be questionable because of statistical variations within the group of samples. If the result exceeds 3s, there is confidence that the material was detected (or, that the radionuclide was present in the sample).

A deliberate search for specific nuclides can be made and results reported, but such results might include negative values or small positive values where the result is less than or equal to 2s. Analyses with results in the questionable range (2s to 3s) are published in this report with the understanding that there is some doubt as to whether the material was actually present.

There are many factors that can influence the result to some degree, and these factors are considered and included in the methods used to determine the estimated uncertainty of the measurement. Uncertainties in measurements near the minimum detectable concentration are primarily caused by counting statistics. For low concentrations near the minimum detectable concentration, the uncertainty in the measurement is nearly equal to the measurement itself, and the lower limit of the range of the measurement approaches "zero." Such a result might not be very reliable because the uncertainty is only an estimate and the actual probability distribution of the results is not usually known. In reality, the material being measured may not actually be present in the sample. Therefore, when analytical results show a measurement very near the minimum detectable concentration, statistical tools, meteorological data, and Site release information are all considered when interpreting and evaluating the results.

Arithmetic means were calculated using actual assay results, regardless of their being

above or below the minimum detectable concentration. The uncertainty of the mean, or the 95% confidence interval, was determined by multiplying the standard deviation of the mean (also called the standard error of the mean) or $s/(n)^{1/2}$ by the $t_{(0.05)}$ statistic. Means for which the 95% confidence interval does not include zero were assumed to indicate detectable amounts of activity. In situations where the analytical results of a group of samples are near the minimum detectable concentration, the 95% confidence interval for the mean may not include zero and thus appears to be statistically significant even though, on the basis of the 2s-to-3s criterion, it is doubtful that any individual sample contained detectable radioactivity.

Geometric means were calculated by summing the natural logarithms (ln) of the positive analytical results, dividing by the number of samples (n), and then transforming the quotient. If the result was either a negative number or a zero, the ln of the smallest positive, nonzero measurement in the group was used. The 95% confidence interval was determined by multiplying the standard deviation of the geometric mean by the $t_{(0.05)}$ statistic and then transforming the result. The actual interval is determined by dividing the transformed mean by the transformed 95% confidence interval term for the lower limit, then multiplying the mean by the confidence interval term for the upper limit.

Unpaired t-tests were used to determine whether the annual means for the Site or boundary stations were greater than the annual means for the distant stations. All statistical tests used a level of significance of 5% ($\alpha = 0.05$).

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