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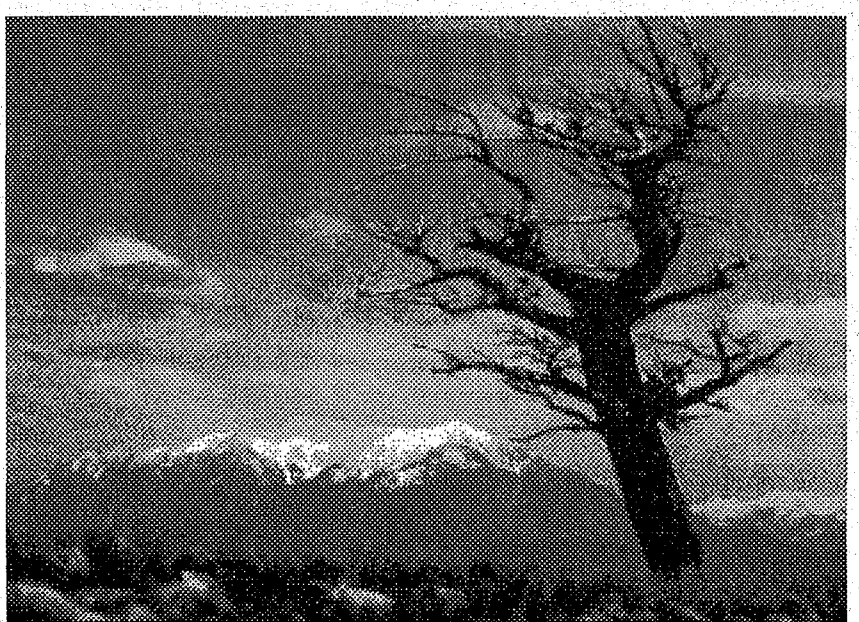
Idaho National Engineering and Environmental Laboratory Site Environmental Report for Calendar Year 1996

Environmental Science and Research Foundation, Inc.

August 1997



INEEL

IDAHO NATIONAL ENGINEERING & ENVIRONMENTAL LABORATORY

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Idaho National Engineering and Environmental Laboratory Site Environmental Report for Calendar Year 1996

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August 1997

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PREFACE

Every person in 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 (anthropogenic).

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 on 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 radioactive 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 in 1986, exposures to workers and members of the public from activities at nuclear industries are very small compared to exposures from natural sources [Reference P-1].

To verify that exposures resulting from operations at Department of Energy (DOE) nuclear facilities remain very small, each site at which nuclear activities are conducted 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. Environmental surveillance and monitoring results are reported annually to the DOE-Headquarters.

This report presents a compilation of data collected in 1996 for the routine environmental surveillance programs conducted on and around the Idaho National Engineering and Environmental Laboratory (INEEL). During 1996, the offsite surveillance program was conducted by the Environmental Science and Research Foundation. Onsite surveillance was performed by Lockheed Martin Idaho Technologies Company. Effluent monitoring and facility monitoring were conducted by the contractor responsible for operating each facility. The U.S. Geological Survey performed ground-water monitoring both on and offsite, and Lockheed Martin Idaho Technologies Company conducted facility and onsite ground-water monitoring. Air pathways were characterized by the National Oceanic and Atmospheric Administration.

This 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 INEEL by the Environmental Science and Research Foundation, Lockheed Martin Idaho Technologies Company, the U. S. Geological Survey, and others [Reference P-2].

Section 9.g of DOE Order 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. The Naval Nuclear Propulsion Program separately maintains an environmental protection program to assure compliance with all applicable environmental laws and regulations. Monitoring data and information specific to NRF are provided in a separate annual environmental report issued by NRF. For completeness, however, some information from onsite monitoring programs at NRF is included in this report.

The Idaho National Engineering Laboratory Site Environmental Report for Calendar Year 1996 was prepared by the Environmental Science and Research Foundation under DOE Contract DE-AC97-94ID13268.

EXECUTIVE SUMMARY

The results of the various monitoring programs for 1996 indicated that radioactivity from the Idaho National Engineering and Environmental Laboratory (INEEL) operations could generally not be distinguished from worldwide fallout and natural radioactivity in the region surrounding the INEEL. Although some radioactive materials were discharged during INEEL operations, concentrations and doses to the surrounding population were far less than State of Idaho and federal health protection guidelines.

Chapter 2 of the report summarizes INEEL activities related to compliance with environmental regulations and laws, describes various environmental issues and activities, and summarizes INEEL permits for 1996. Chapter 3 provides a description of major activities and milestones in the waste management, environ-mental restoration, and other environmental programs.

Chapter 4 discusses results from radiological environmental surveillance programs conducted by the Environmental Science and Research Foundation, an independent nonprofit organization, and the Lockheed Martin Idaho Technologies Company (LMITCO), the INEEL's M&O contractor. As part of these programs, samples of air, water, foodstuffs and soil are collected at distant locations, INEEL boundary locations and onsite locations. Environmental radiation measurements are also made at these locations.

Gross alpha and gross beta measurements, which are used as a screening technique for air filters, were investigated by making statistical comparisons between onsite or boundary location concentrations and the distant community group concentrations. No statistical differences were found in gross alpha concentrations. Statistical differences were noted in about 1% of the comparisons made between monthly gross beta concentrations at boundary locations and gross beta concentrations at distant locations. For comparisons of monthly gross beta concentrations at INEEL locations and those at distant locations, statistical differences were found in about 6% of the comparisons. At least some of these statistical differences may have been related to operations at the INEEL, but no source was identified.

Air samples were also analyzed for specific radionuclides. Some manmade radionuclides were detected at offsite locations, but most were near the minimum detectable concentration and their presence was attributable to natural sources, worldwide fallout, or statistical variations in the analytical results rather than to INEEL operations. One onsite sample containing detectable ^{131}I likely resulted from a leak in a shipment of volatile iodine that was received at an INEEL facility for an experiment.

Americium-241 found at one onsite location was attributed to activities at the INEEL. The annual concentrations of all specific nuclides detected at all locations were well below the DOE's derived concentration guides for radiation protection.

Tritium was detected in some atmospheric moisture and precipitation samples, but concentrations were similar at distant, boundary, and onsite locations indicating its presence was likely due to natural and fallout sources, or analytical variations, rather than to INEEL activities.

Gross alpha and gross beta activity were measured in offsite drinking and surface water samples. Concentrations were within the range expected for natural radioactivity. Four offsite water samples contained tritium concentrations just above the minimum detectable concentration, attributable to fallout sources or statistical variations.

One milk sample contained ^{131}I just above the minimum detectable concentration. Tritium was found in two samples of milk, with similar concentrations reported for distant and boundary locations. Eight samples contained detectable concentrations of ^{90}Sr. These concentrations were consistent with levels seen in samples nationwide, as reported by the Environmental Protection Agency (EPA). Some food samples (lettuce, wheat, and potatoes) contained small amounts of ^{137}Cs and ^{90}Sr, two radionuclides resulting from worldwide fallout found in soil.

Low concentrations of ^{137}Cs and ^{60}Co were found in muscle tissue and liver of some game animals and sheep. However, the levels were mostly consistent with background concentrations measured in animals sampled onsite and offsite in recent years. One game animal collected near the Test Reactor Area had elevated concentrations of radionuclides that may have resulted from consumption of contaminated plants near the facility. Some anthropogenic radionuclides were also found in above background concentrations in waterfowl and doves collected near the Test Reactor Area. The potential dose to a hunter consuming game with the highest concentration of radionuclides was calculated to be approximately 0.06 mrem, or 0.02% of annual natural background radiation.

Radionuclides found in offsite soil samples were consistent with those expected from worldwide fallout. Ionizing radiation measured simultaneously at the INEEL boundary and distant locations using environmental dosimeters were similar and showed only natural background levels.

Both the Environmental Science and Research Foundation and LMITCO also perform environmental surveillance for nonradiological substances. Chapter 5 presents a summary of air and storm water sampling results from the INEEL and offsite locations.

Total suspended particulate concentrations in air were higher at distant and boundary locations than at onsite locations. Agricultural activities are generally considered to be the major source of particulates in eastern Idaho. Particulate concentrations were somewhat elevated during the third quarter following fires that burned large areas in the INEEL vicinity.

Fine particulates, nitrogen dioxide, and sulfur dioxide measured on and in the vicinity of the INEEL were all well within air quality standards. Some onsite storm water samples exceeded drinking water standards, but these appeared to be likely due to suspended sediments in the samples.

Ground-water monitoring was performed at the INEEL by the USGS using over 125 wells that tap the Snake River Plain Aquifer, as described in Chapter 6. Results of a number of special studies of the properties of the aquifer and the water within it were published during 1996. Five purgeable organic compounds were found in wells at the INEEL, including one well used for drinking water. Concentrations of organic compounds were below EPA maximum contaminant levels for these compounds, with the exception of carbon tetrachloride at the Radioactive Waste Management Complex in December.

Routine monitoring of ground water was also conducted by contractors operating facilities at the INEEL. Elevated concentrations of gross beta were seen in water samples from an onsite facility during June sampling. Five onsite production (drinking water) wells contained measurable concentrations of tritium. An effective dose equivalent of 0.8 mrem/yr, within the EPA standard for community drinking water, was calculated for INEEL workers at the Central Facilities Area, the location with the highest tritium concentration in drinking water. Production wells in the vicinity of the Idaho Chemical Processing Plant, where ^{90}Sr monitoring is performed regularly because this radionuclide is known to be present, did not contain detectable levels of ^{90}Sr in 1996.

Water samples taken from the wellhead at one Test Area North well showed purgeable organic

compounds were above the maximum contaminant level for trichlorethylene. At Test Area North, an aerating system known as a sparger is used to volatize the trichloroethylene and remove it prior to the water entering the distribution system. This has resulted in organic compounds remaining within drinking water standards in the distribution system.

Chapter 7 presents a description of the monitoring of airborne and liquid effluents released from INEEL facilities during 1996. A total of 3,048 Curies of radioactivity, primarily in the form of noble gases, were measured in airborne effluents. Approximately 73 Curies of radioactivity, mostly tritium, were released to onsite disposal ponds during the year.

A total of 218 metric tons of oxides of nitrogen, consisting of nitrogen oxide and nitrogen dioxide, and 118 metric tons of sulfur dioxide were released from INEEL facilities. Nitrogen dioxide and sulfur dioxide concentrations, calculated for the INEEL boundary using meteorological models and measured at onsite locations, were well below air quality regulatory limits. Monitoring of liquid effluent streams indicated that all were below applicable guidelines.

Chapter 8 describes the potential dose to members of the public from INEEL activities. The calculated 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 MDIFF, a computer model developed to evaluate dispersion of pollutants from INEEL facilities. The calculation considered continuous submersion in and inhalation of radioactivity in air, ingestion of radioactivity in leafy vegetables and milk, and exposure to radioactive particulates deposited on the ground surface at that location. This calculated dose is about 0.008% of the natural background radiation dose in this area from all sources, including cosmic radiation, radioactive material in soil, natural radioactive potassium in the body, and exposure to radon.

The 1996 effective dose equivalent to the maximally exposed individual, calculated using the CAP-88 computer code that is required to demonstrate compliance with EPA regulations, was 0.03 mrem (0.008% of background). The model predicted the maximally exposed individual resided at Frenchman's Cabin, located at the INEEL's southern boundary. This location is currently inhabited only during portions of the year. The section entitled "Maximum Individual Dose—Airborne Emissions Pathway" includes a discussion of the two different computer models used. The maximum calculated dose to an individual by either of the methods was in compliance with the applicable radiation protection standards of 10 mrem per year.

The maximum potential population dose from submersion, ingestion, inhalation, and deposition to the approximately 121,500 people residing within an 80-km (50-mi) radius from the geographical center of the INEEL was estimated to be 0.2 person-rem (2×10^{-3} person-Sv) using the MDIFF air dispersion model. This population dose is less than 0.0005% of the estimated 42,500 person-rem (425 person-Sv) population dose from natural background radioactivity.

In Chapter 9, the methods used to ensure the quality of data generated by contractors performing environmental monitoring at the INEEL are described. Data from quality control samples, including duplicate samples (two similar samples collected at the same time) and spike samples (samples containing a known amount of a contaminant) are provided. Comparisons are also provided between data collected by the Environmental Science and Research Foundation, LMITCO and the State of Idaho INEEL Oversight Program at locations where the three groups conduct similar sampling.

HELPFUL INFORMATION FOR THE GENERAL READER

Scientific Notation

Scientific notation is used to express numbers which are very small and very large. A very small number will be expressed with a negative exponent, for example, 1.3×10^{-6}. To convert this number to the more commonly used form, the decimal point must be moved left by the 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 and 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, Radiation Exposure and Dose

The basic unit of radioactivity used in this report is the curie (abbreviated Ci). The curie was historically based on the radionuclide Radium-226, of which one gram decays at the rate of 37 billion nuclear disintegrations per second. For any other radionuclide, one curie is the amount of the 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. For the types of environmental radiation generally encountered, the unit of Roentgen is approximately numerically equal to the unit of rem. A person-rem is the sum of the doses received by all individuals in a population.

Concentration of radioactivity in air samples and liquid samples such as water and milk is expressed in units of microcuries per milliliter (μCi/mL) of air or liquid. Radioactivity in foodstuffs is expressed in

microcuries per gram (μCi/g). Radioactivity in soil samples is expressed in terms of both the sample dry weight and the ground surface area represented by the sample: picocuries per gram (pCi/g) and nanocuries per square meter (nCi/m^2). Annual human radiation exposure, measured by environmental dosimeters, is expressed in units of milliRoentgens (mR). This is sometimes expressed in terms of dose as millirem (mrem), after being multiplied by an appropriate dose equivalent conversion factor.

The Système International is also used to express units of radioactivity and radiation dose. The basic unit of radioactivity is the Becquerel (Bq), which is equivalent to one nuclear disintegration per second. The number of Curies must be multiplied by 3.7×10^{10} to obtain the equivalent number of Becquerels. Doses may also be expressed using the Système International unit Sievert (Sv), where 1 Sievert equals 100 rem.

Uncertainty of Measurements

Due to a variety of factors, there is always an uncertainty associated with the measurement of environmental contaminants. For radioactivity, the predominant source of uncertainty is due to the inherent statistical nature of radioactive decay events, particularly at the low activity levels encountered in environmental samples. The uncertainty of a measurement is denoted by following the result with a "±" (uncertainty) term. This report follows convention in reporting the uncertainty as a 95% confidence limit (or interval). That means there is about 95% confidence that the real concentration in the sample lies somewhere between the measured concentration minus the uncertainty term and the measured concentration plus the uncertainty term.

Negative Numbers as Results

Negative values occur when the measured result is less than a preestablished average background level for the particular counting system and procedure used. These values, rather than "not detectable" or "zero," are reported to better enable statistical analyses and observe trends or bias in the data.

Radionuclide Nomenclature

Radionuclides are frequently 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	Symbol	Radionuclide	Symbol
Tritium	^{3}H	Chromium-51	^{51}Cr
Beryllium-7	^{7}Be	Manganese-54	^{54}Mn
Carbon-14	^{14}C	Iron-55	^{55}Fe
Sodium-24	^{24}Na	Manganese-56	^{56}Mn
Potassium-40	^{40}K	Cobalt-57	^{57}Co
Argon-41	^{41}Ar	Cobalt-58	^{58}Co
Scandium-46	^{46}Sc	Iron-59	^{59}Fe

Radionuclide Nomenclature (Cont.)

Radionuclide	Symbol	Radionuclide	Symbol
Cobalt-60	^{60}Co	Xenon-133	^{133}Xe
Zinc-65	^{65}Zn	Cesium-134	^{134}Cs
Krypton-85	^{85}Kr	Xenon-135	^{135}Xe
Krypton-87	^{87}Kr	Cesium-137	^{137}Cs
Krypton-88	^{88}Kr	Cesium-138	^{138}Cs
Rubidium-88	^{88}Rb	Xenon-138	^{138}Xe
Strontium-90	^{90}Sr	Barium-140	^{140}Ba
Yttrium-90	^{90}Y	Cerium-144	^{144}Ce
Niobium-94	^{94}Nb	Europium-152	^{152}Eu
Niobium-95	^{95}Nb	Hafnium-181	^{181}Hf
Zirconium-95	^{95}Zr	Radium-226	^{226}Ra
Technetium-99	^{99}Tc	Radium-228	^{228}Ra
Ruthenium-103	^{103}Ru	Thorium-232	^{232}Th
Ruthenium-106	^{106}Ru	Uranium-234	^{234}U
Antimony-125	^{125}Sb	Uranium-238	^{238}U
Iodine-129	^{129}I	Plutonium-238	^{238}Pu
Iodine-131	^{131}I	Plutonium-239/240	$^{239/240}Pu$
Iodine-132	^{132}I	Americium-241	^{241}Am
Iodine-133	^{133}I	Curium-244	^{244}Cm

ACRONYMS

AEC	Atomic Energy Commission
ANL-W	Argonne National Laboratory–West
ARA	Auxiliary Reactor Area
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CDC	Centers for Disease Control
CFA	Central Facilities Area
CFR	Code of Federal Regulations
CFSGF	Coal Fired Steam Generating Facility
CMS	Community Monitoring Station
CWA	Clean Water Act
DEQ	(Idaho) Division of Environmental Quality
DOE	U.S. Department of Energy
DOE-CH	U.S. Department of Energy–Chicago Operations Office
DOE-ID	U.S. Department of Energy–Idaho Operations Office
DOE-HQ	U.S. Department of Energy–Headquarters
EAL	Environmental Assessment Laboratory
EBR–I	Experimental Breeder Reactor–I
EFS	Experimental Field Station
EML	Environmental Measurements Laboratory
EMS	Environmental Management System
EPCRA	Emergency Planning and Community Right-to-Know Act
EPA	Environmental Protection Agency
ICPP	Idaho Chemical Processing Plant
IMPROVE	Interagency Monitoring of Protected Visual Environments
INE(E)L	Idaho National Engineering (and Environmental) Laboratory
LMAES	Lockheed Martin Advanced Environmental Systems
LMITCO	Lockheed Martin Idaho Technologies Company
MCL	Maximum Contaminant Level
MSDS	Material Safety Data Sheet
NCRP	National Council on Radiation Protection and Measurements
NEPA	National Environmental Policy Act
NERP	National Environmental Research Park
NESHAPs	National Emission Standards for Hazardous Air Pollutants
NIST	National Institute of Standards and Technology

ACRONYMS (Cont.)

NOAA	National Oceanic and Atmospheric Administration
NOV	Notice of Violation
NPDES	National Pollutant Discharge Elimination System
NRF	Naval Reactors Facility
NRTS	National Reactor Testing Station
PBF	Power Burst Facility
PCBs	Polychlorinated Biphenyls
PFA	Plutonium Focus Area
QAP	Quality Assessment Program
RCRA	Resource Conservation and Recovery Act
RESL	Radiological and Environmental Sciences Laboratory
RWMC	Radioactive Waste Management Complex
RWMIS	Radioactive Waste Management Information System
SMC	Specific Manufacturing Capability
SWPPP	Storm Water Pollution Prevention Plan
TAN	Test Area North
TLD	Thermoluminescent Dosimeter
TRA	Test Reactor Area
TRU	Transuranic
TSF	Technical Support Facility
USGS	U.S. Geological Survey
WERF	Waste Experimental Reduction Facility
WIPP	Waste Isolation Pilot Plant

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Summary of Chapter 1
Introduction

The Idaho National Engineering and Environmental Laboratory (INEEL), a 2,300-km^2 U.S. Department of Energy site on the Snake River Plain of Idaho, employs 8,000 people. They work on nationally important nuclear energy, systems engineering, and environmental technology problems. The INEEL was founded in 1949 and occupies a mostly undeveloped site of sagebrush desert. This chapter describes the INEEL's environment (*Section 1.1*), mission (*Section 1.2*), history (*Section 1.3*), economic impact (*Section 1.4*), and facilities (*Section 1.5*).

1. INTRODUCTION

1.1 LOCATION AND DESCRIPTION OF THE SITE

In Idaho, the U.S. Department of Energy (DOE) owns and administers the Idaho National Engineering and Environmental Laboratory (INEEL). Located in the southeastern portion of the state, the INEEL occupies 2,308 km^2 (570,415 acres) on the upper Snake River Plain and represents an important example of the sagebrush-steppe biome [Reference 1-1]. The INEEL site extends 63 km (39 miles) from north to south and is about 58 km (36 miles) across at its broadest east-west extent (Figure 1-1). Average elevation across the INEEL is approximately 1,500 m (4,900 ft) above sea level. The Site is bordered on the north and west by three basin-and-range fault block mountain ranges and on the south by three buttes of volcanic origin. Lands immediately beyond the boundaries of the INEEL are desert, foothills or agricultural fields. Most of the nearby farming is concentrated northeast of the INEEL. Large areas of agricultural land are farmed adjacent to the Snake River, but these regions are more distant from the INEEL.

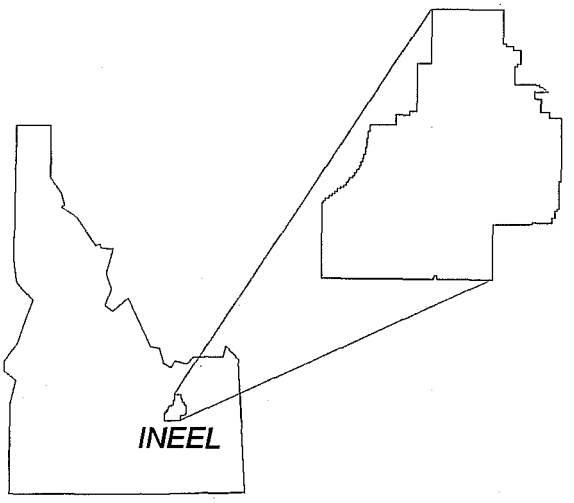


Figure 1-1. Location of INEEL

The altitude, intermountain setting, and latitude of the INEEL combine to produce a semi-arid climate [Reference 1-2]. Prevailing weather patterns are from the southwest, moving up the Snake River Plain. Air masses, which gather moisture over the Pacific Ocean, traverse several hundred miles of mountainous land prior to reaching southeastern Idaho. The result is frequently dry air and little cloud cover. Solar heating can be intense with extreme day-to-night temperature fluctuations.

The climate of the cold desert environment of the INEEL is characterized by sparse precipitation, hot summers, and cold winters. The Site's climate and mostly alkaline soils support plant communities and animal populations able to cope with both dryness and temperature extremes. Most of the plain is covered by basalt flows, which produce a rolling topography. Vegetation is visually dominated by big sagebrush. Beneath these shrubs is found an array of grasses and flowering plants, most adapted to the harsh climate. A recent plant inventory counted 409 species on the INEEL [Reference 1-3]. Vertebrate animals are represented by suites of small burrowing mammals, snakes, birds of prey, and several game species. Species counts include six fishes, two amphibians, 11 reptiles, 224 birds and 44 mammals [Reference 1-4]. Sixty percent of the INEEL is open to livestock grazing.

Within the plain, and its ample basalt flows interceded with sedimentary deposits, is a productive aquifer. The eastern Snake River Plain Aquifer stores one of the most bountiful supplies of ground water in the nation. An estimated 200 to 300 million acre-feet are stored in the aquifer's upper portions. Significant recharge of the aquifer beneath the INEEL comes from waters of the Henry's Fork of the Snake River, as well as the South Fork of the Snake River, Big Lost River, Little Lost River, and Birch Creek drainages. In this century, irrigation recharge has come to account for as much as 60% of the water returning to the aquifer. The Big Lost River and Birch Creek flow onto the INEEL during wet

periods. There, they sink into porous soils. Beneath the INEEL, the aquifer moves laterally to the southwest at a rate of 1.5 m to 6 m/day (5 to 20 ft/day). The eastern Snake River Plain Aquifer emerges in springs along the Snake River between Milner and Bliss, Idaho. On the Snake River Plain, the preponderant use of both surface water and ground water is for crop irrigation.

The INEEL consists of several primary facility areas located on an expanse of otherwise undeveloped terrain. Most buildings and structures on the INEEL are situated within facilities, leaving about 94% of the Site undeveloped and open land [Reference 1-5]. Such an expanse of sagebrush steppe offers important ecological characteristics, with representative suites of native animals and plants functioning without major human disturbances from agriculture and recreation.

1.2 INEEL'S MISSION

The DOE Idaho Operations Office (DOE-ID) has stated its mission in this way: "through world class applied engineering, we will clean up the cold war legacy, execute multi-program missions, and leverage INEEL's expertise with merging technology to meet the Nation's needs." The INEEL is dedicated to restoring and protecting our environment and now reflects that emphasis by adding the words "and Environmental" to the Laboratory's name to more closely represent the site's missions.

In addition to this stated mission, DOE-ID is committed to providing a safe and healthy workplace for its employees, protect public health and safety, and protect the environment. The INEEL was designated the second of seven National Environmental Research Parks (NERP) in 1975. NERPs are used to assist in scientific endeavors to evaluate the environmental consequences of energy use and development as well as the strategies to mitigate such effects [Reference 1-6].

About 60% of the INEEL's funding is devoted to environmental restoration and waste management activities. The INEEL's environmental program is laid out over the next 40 years through the spent fuel settlement agreement with the State of Idaho, the Site Treatment Plan for Mixed Wastes and the cleanup agreement among the DOE, the State of Idaho, and the Environmental Protection Agency. These legally-enforceable agreements are geared toward assessing and remediating past contamination of the Site, and putting wastes now stored at the Site in more stable forms "road ready" for disposal when permanent repositories become available. The other 40% of the INEEL budget funds ongoing programs like the Advanced Test Reactor, and research into a wide range of fields, including energy efficiency, renewable energy, technology development, systems engineering and other areas. "Finish the 60, grow the 40" is shorthand for INEEL's two strategic priorities [Reference 1-7].

1.3 HISTORY OF THE SITE

The geologic events that have shaped the modern Snake River Plain on and near the INEEL took place during the last two million years [References 1-8 & 1-9]. The plain, which arcs across eastern Oregon and southern Idaho, marks the passage of the earth's crust over a dome of mantle material pressing up from the super-heated center of the planet. The resultant lava flows are oldest in the west and youngest at the Yellowstone Plateau, where the thermal upwelling is most evident today. The plain is a 650 km (400 mile) trail made by the passage of the continent over the "hot spot."

Human use of the upper Snake River Plain, and especially of the lands of the INEEL, seems to have always been sporadic and nomadic since humans appeared in the area 10,000 to 12,000 years ago. The Shoshone and Bannock people lived in socially fluid groups travelling among the mountains, plains, and river bottoms as their

seasonal needs changed. From the plain, game animals were taken in late summer. Obsidian and other useful stones were quarried at Big Southern Butte. Plants, from camas to dogbane, were gathered. A prime route between the Fort Hall area and the Camas Prairie passed across the plain near the three buttes, and across what became the INEEL.

The earliest exploratory visits by European descendants came in the 1810s, '20s, and '30s. Trappers scrounged over the plain seeking new supplies of beavers for pelts. Their impressions discouraged potential settlers, and the pioneers using the Oregon Trail avoided lingering in the high desert. The second half of the 1800s saw valuable ores mined in the surrounding mountains and cattle and sheep beginning to be grazed in the valleys. More lines of transportation—stock trails and stage routes—pressed across the plain. A railroad opened between Blackfoot and Arco in 1901. There was by then sufficient enticement for homesteaders to attempt to win a section of land on the plain. The Carey Land Act of 1894 and the Desert Reclamation Act of 1902 are credited as setting the stage for Idaho's irrigation-based farming economy. The heart of the plain remained immune to irrigation attempts, however. The porosity of its soils could not be overcome and water drained out of the bottom of newly-built canals faster than it could be carried to crops and stock. A broad swath of the eastern plain is still sparsely inhabited.

World War II brought Pocatello a plant, where large guns from the U.S. Navy ships were retooled. The U.S. Naval Ordnance Station was one of two such installations. This factory was located inland for fear of being too enticing of a target for enemy bombs along a coast. Retooled guns must be tested, and the nearby, uninhabited plain was put to use as a gunnery range. In the aftermath of the war, as the nation moved to learn how to tame the newly-released powers within atoms, the Naval Proving Ground caught the eye of the Atomic Energy Commission (AEC). On the AEC's drawing boards were plans for an isolated facility with ample water supply at which to build, test, and perfect nuclear reactors. The plain was chosen as the best location.

Arco's proving ground became the National Reactor Testing Station (NRTS) in 1949, under the Atomic Energy Commission, predecessor to the DOE. The station's administrative offices were situated in Idaho Falls, then a city of less than 20,000. By the end of 1951, a reactor at the NRTS produced useful electricity. The facility evolved into an assembly of 52 reactors, associated research centers, and waste handling areas. Only two reactors operate today. The NRTS had a technological mission that required both of the defining characteristics of the Snake River Plain, desert land and ample ground water. The NRTS was renamed the Idaho National Engineering Laboratory in 1974 and Idaho National Engineering and Environmental Laboratory in January 1997 [Reference 1-10].

The human population, based on 1990 census figures, living within 80 km (50 miles) of the INEEL's operational center is 121,500 [Reference 1-11]. There are no permanent residents within 16 km (10 miles) of that center (Figure 1-2). Atomic City (population 25) is the closest community to the INEEL's center. Other boundary communities include Arco (population 1,106), Howe (population 20), Monteview (population 10), Mud Lake (population 179), and Terreton (population 100). The larger population centers of Idaho Falls (population 49,928), Blackfoot (population 10,769), and Pocatello (population 50,588) are at least 35 km (22 miles) from the nearest INEEL boundary.

1.4 REGIONAL ECONOMIC IMPACT

Approximately 8,000 people work at the INEEL, making it the largest employer in eastern Idaho. This number includes about 400 federal employees, most of whom work for DOE's Idaho Operations Office. The vast majority of the other 7,500 work for Lockheed Martin Idaho Technologies Company (LMITCO). Others work for contractors such as Westinghouse Electric

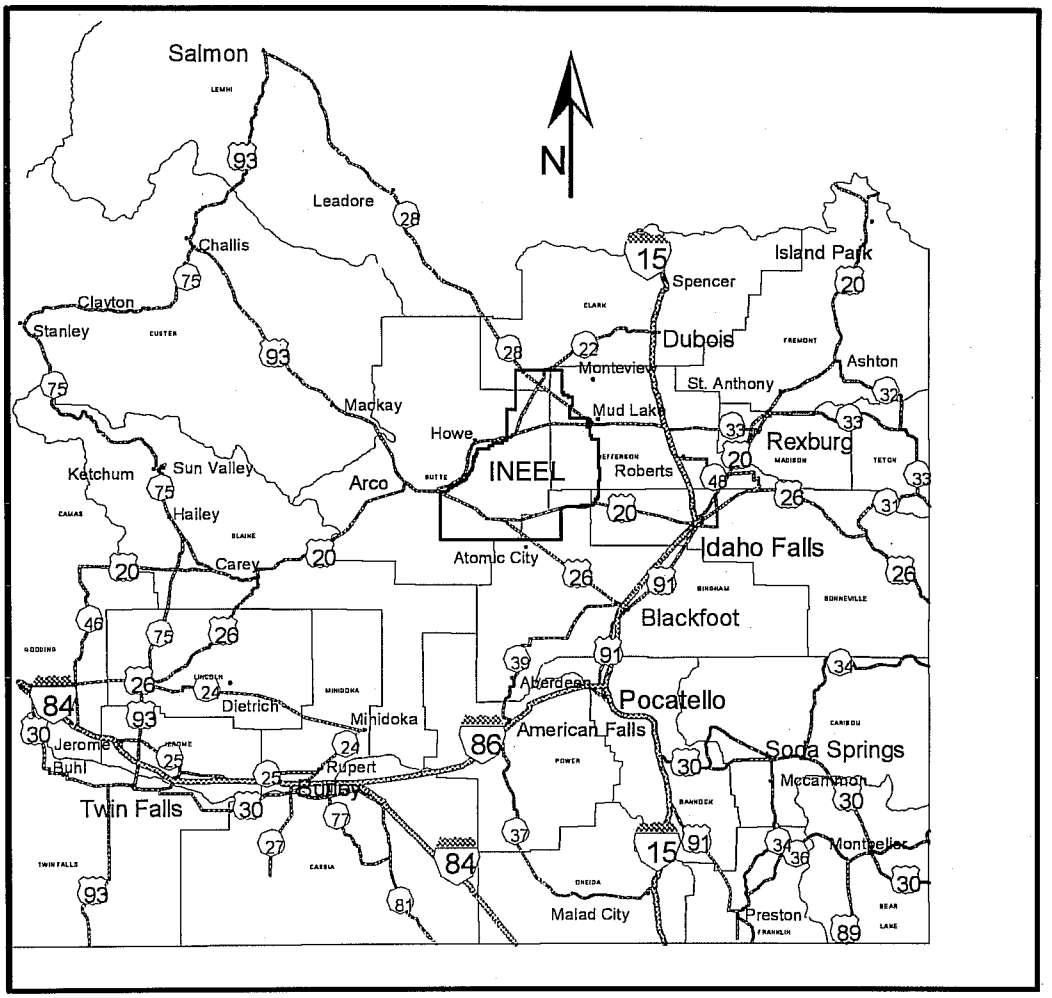


Figure 1-2. INEEL Vicinity

Corporation, University of Chicago's Argonne National Laboratory and various contractors and subcontractors.

With an overall annual budget of about $750 million, the INEEL has a tremendous economic impact. Idaho State University's Center for Business Research conducts a study each year of the impacts of INEEL on the state and regional economy [Reference 1-12]. The most recent study, which was completed in 1997 and looked at 1996 impacts, shows:

- INEEL employees paid an estimated $20.6 million in state income tax, $15.1 million in sales tax, and $7.7 million in local property taxes.
- Wages and salaries for INEEL employees totaled $398 million, while non-wage benefits (pension and retirement contributions, educational benefits, medical coverage) totaled $133 million.
- The INEEL awarded $96.8 million in subcontracts to Idaho businesses, paid out

$6.9 million to employees who voluntarily left their positions at the laboratory, donated $3.9 million worth of equipment to Idaho schools and other agencies, and paid state sales tax of $2.1 million.

- The INEEL employed 8,134 local residents in 1996, which was estimated to generate an additional 7,963 jobs in the local economy.

In addition to monetary contributions, INEEL employees are extraordinarily active in their communities, contributing an estimated 560,000 hours of volunteer service in 1996 alone. For example, INEEL employees contributed 119,000 hours to youth activities like Scouting and organized sports, 224,000 hours to community activities like United Way, voter registration, tutoring and civic fundraising, and more than 216,000 hours to church activities.

1.5 FACILITIES

The Idaho National Engineering and Environmental Laboratory is operated for the U.S. Department of Energy by LMITCO. Additional facilities are operated by Westinghouse Electric Corporation and the University of Chicago's Argonne National Laboratory. Facilities are located in the city of Idaho Falls and at eight operating areas on the INEEL (Figure 1-3). Major facilities, and their current missions, are listed in the following sections.

Argonne National Laboratory-West (ANL-W)

This facility is operated by the University of Chicago's Argonne National Laboratory under contract to the DOE-Chicago Operations Office. The present mission of the laboratory is research into spent nuclear fuel, nuclear proliferation, and waste reduction and cleanup technologies.

Idaho Chemical Processing Plant (ICPP)

The ICPP 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 at the plant. High-level wastes are being treated and will ultimately be prepared for disposal in a permanent repository.

Test Area North (TAN)

Located at the north end of the INEEL, TAN was built to house the program to develop a nuclear-powered airplane during the 1950s. Facilities include one of the world's largest "hot shops," which more recently supported research into the Three Mile Island accident. The largest program currently at TAN, the Specific Manufacturing Capability Project, produces armor for the M1A2 Abrams tank for the U.S. Army.

Test Reactor Area (TRA)

The TRA has studied the effects of radiation on materials, fuels, and equipment for over 40 years. The Advanced Test Reactor is currently used for the production of important isotopes used in medicine, research and industry.

Power Burst Facility (PBF)

The PBF area contains the Waste Experimental Reduction Facility, which processes low-level waste to reduce waste volume through sizing of metallic waste, compaction and incineration.

Naval Reactors Facility (NRF)

The NRF is operated by Westinghouse Electric Corporation for DOE's Pittsburgh Naval Reactors Office. From 1953 through May 1995, NRF prototypes served as a site for training Navy personnel who serve aboard nuclear-powered submarines and warships. At the Expended Core Facility, NRF also tests and examines naval reactor fuel components to improve current designs and to monitor the performance of existing reactors.

Radioactive Waste Management Complex (RWMC)

The RWMC's mission is to manage the disposal of low-level radioactive waste and the temporary storage of transuranic waste in an environmentally sound manner. The facility studies various strategies for the storage, processing and disposal of radioactive wastes. The Stored Waste Examination Pilot Plant is used to nondestructively examine waste before it an be sent to the Waste Isolation Pilot Plant in New Mexico.

Central Facilities Area (CFA)

The CFA is headquarters for services at the INEEL. The area contains environmental monitoring, radiochemistry, radiation protection, quality assurance and calibration laboratories, vehicle and equipment pools, a cafeteria, fire and emergency medical facilities, warehouses, various craft shops, and a security facility.

Idaho Falls

Idaho Falls facilities include the INEEL Research Center, featuring programs in materials science, physical science, biotechnology, environmental science, and geotechnology. The Engineering Research Office Building, Willow Creek Building, Woodruff Avenue Complex, two DOE buildings, and other buildings house support personnel for the facilities at the INEEL.

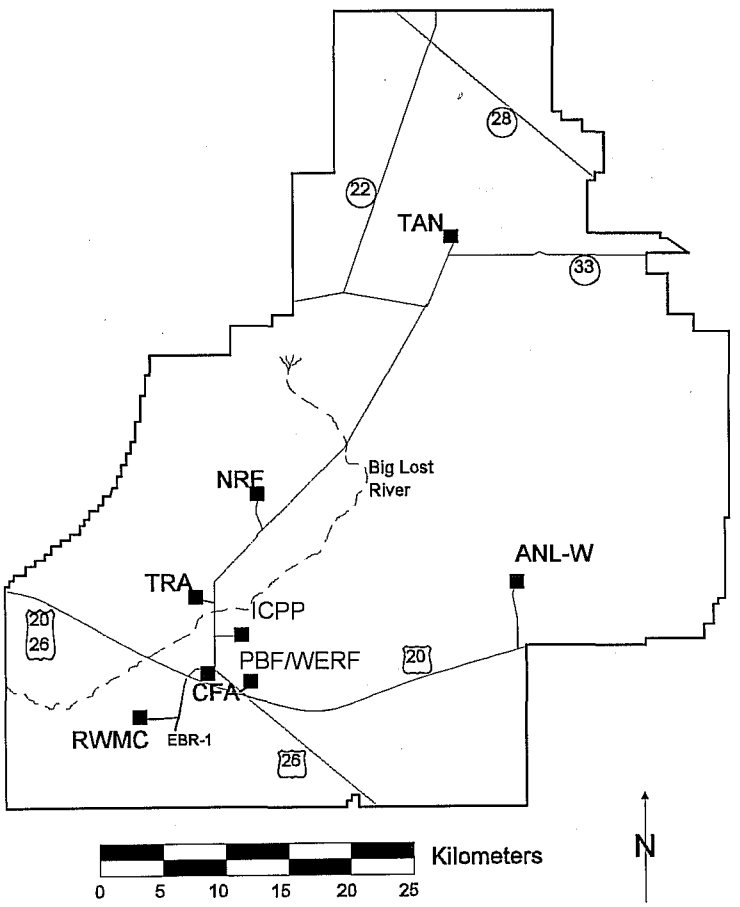


Figure 1-3. INEEL Facilities

Summary of Chapter 2
Environmental Compliance Summary

The Idaho National Engineering and Environmental Laboratory (INEEL) is committed to operating in compliance with all environmental laws, regulations, Executive Orders, U.S. Department of Energy (DOE) Orders, and compliance agreements with the Environmental Protection Agency (EPA) and the State of Idaho. This chapter provides a summary of the INEEL's current compliance status with major environmental statutes for the period January through December 1996 (*Section 2.1*) and summarizes major environmental issues and activities (*Section 2.2*). The current status of various permits are also described in this chapter (*Section 2.3*).

2. ENVIRONMENTAL COMPLIANCE SUMMARY

2.1 COMPLIANCE STATUS

Comprehensive Environmental Response, Compensation & Liability Act (CERCLA)

This act provides the specific procedures to assess and remediate inactive waste sites where the release of hazardous substances has occurred. The INEEL was placed on the National Priorities List under CERCLA on November 29, 1989. Environmental restoration activities at the INEEL are being conducted in accordance with the Federal Facilities Agreement and Consent Order signed in December 1991 in consultation with the State of Idaho and EPA Region 10.

During 1996, investigations under the processes outlined in the 1991 Consent Order continued to be streamlined. Limited field investigations, termed Track 1 or Track 2, are used in lieu of the more extensive remedial investigation/feasibility study to evaluate many potential release sites. A Track 1 designation is used for potential release sites where existing data are expected to demonstrate that a site needs no further action. Track 2 denotes that limited field data collection is necessary. After each limited investigation is completed, a determination is made by the Consent Order Project Managers that no further action is necessary or that proceeding with an interim cleanup action or further investigation under a remedial investigation/feasibility study is appropriate.

Three cleanup milestones were missed during 1996—the Comprehensive Remedial Design and the Remedial Action Work Plan for Pit 9 and the Remedial Design/Remedial Action Work Plan for TAN. A request for a schedule extension for TAN was submitted to the EPA and was denied. This resulted in a dispute between the parties. The dispute was later resolved with a revised scope and schedule. All other milestones were met on or ahead of schedule.

Emergency Planning and Community Right-to-Know Act

The purpose of this act is to provide the public with information about hazardous chemicals on the INEEL and to establish emergency planning and notification procedures to protect the public from chemical releases. It also contains requirements for periodic reporting on hazardous chemicals stored and/or used at the facilities. Executive Order 12856, "Federal Compliance with Right-to-Know Laws and Pollution Prevention Requirements," requires all federal facilities to comply with the provisions of this act (Table 2-1).

311 Report. Quarterly 311 reports were submitted to Local Emergency Planning Committees, the State Emergency Response Commission, and to local fire departments by January 1, April 1, July 1, and October 1 in 1996. These quarterly reports satisfy the 90-day notice requirement for new chemicals brought onsite.

312 Report. The Emergency and Hazardous Chemical Inventory (Tier II) Report for 1996 was transmitted to the planning and response agencies before March 1, 1997. This report identifies the types, quantities, and locations of hazardous and extremely hazardous chemicals stored at INEEL facilities that exceed CERCLA and Emergency Planning Act reporting thresholds.

313 Report. The Toxic Chemical Release Inventory Report was transmitted to EPA and the State of Idaho by July 1, 1996. The report identified quantities of toxic chemicals released to the environment by the INEEL during calendar year 1995. Reports were prepared for five toxic chemicals, including benzene, methyl tert-butyl ether, nitric acid, toluene, and xylene in 1996.

33/50 Report. Executive Order 12856 requires all federal agencies to comply with the EPA 33/50 program, requiring release reductions of 17

TABLE 2-1. INEEL 1996 EMERGENCY PLANNING AND COMMUNITY RIGHT-TO-KNOW ACT (EPCRA) UPDATE

EPCRA 302-303: Planning Notification	Yes [ ]	No [ ]	Not Required [X]
EPCRA 304: EHS Release Notification	Yes [ ]	No [ ]	Not Required [X]
EPCRA 311-312: MSDS[a]/Chemical Inventory	Yes [X]	No [ ]	Not Required [ ]
EPCRA 313: Toxic Release Inventory Reporting	Yes [X]	No [ ]	Not Required [ ]

[a] Material Safety Data Sheet

priority Toxic Chemical Release Inventory chemicals by 50% before the end of 1999. To reach the 50% reduction goal by December 31, 1999, DOE must achieve an overall 1.1 million kg (2.3 million lb) reduction in reported releases of toxic chemicals to the environment and transfers of toxic chemicals for treatment and disposal. To achieve this reduction, DOE is focusing efforts on the specific chemicals and sites which contribute the largest amounts to the complex-wide total each year.

DOE was recognized for its success in meeting the 33% of toxic chemical release reduction goals under EPA's 33/50 Pollution Prevention Program. In March 1996, DOE, along with 20 participating corporations, was presented with the "Environmental Champions" award from McGraw Hill and EPA. DOE was the only federal agency to participate in this nationwide voluntary reduction program, and in September 1996 received the National Performance Review "Hammer" award from Vice President Gore.

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 the release of hazardous substances. In the case of the INEEL, 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 the INEEL's placement on the National Priorities List. These same releases create the potential for injury to natural resources. DOE is liable under CERCLA for damages to natural resources resulting from releases of hazardous substances to the environment. The Environmental Restoration Program is attempting to coordinate with DOE-ID co-trustees on any INEEL Natural Resource Damage Assessment issues arising as a result of the comprehensive remedial investigation/feasibility study for each Waste Area Group.

In April 1995, Lockheed Martin Idaho Technologies Company (LMITCO) published a guidance manual for conducting screening level ecological risk assessments [Reference 2-1]. The manual was developed to streamline and standardize the ecological assessment process at the INEEL, and it supports DOE schedules and milestones in the Federal Facilities Agreement/Consent Order for carrying out remedial investigation/feasibility study activities at the INEEL. Integrating the natural resource

concerns with these activities will provide for efficiency of efforts and more cost-effective remediation of sites at the INEEL. Although the ecological risk assessment is a separate effort from the Natural Resources Damage Assessment, it is anticipated that the ecological assessment performed for CERCLA remedial actions can be used to help resolve many natural resource issues among trustees as well. The regulation allows for this substitution [Reference 2-2].

DOE-ID met with the potential co-trustees in May, July and September of 1996 to acquaint them with the INEEL and the areas where CERCLA hazardous substances have been released. To better use trustee resources, the co-trustees agreed to review CERCLA documents concerning Waste Area Group 1 (Test Area North), Waste Area Group 3 (Idaho Chemical Processing Plant), Waste Area Group 7 (Radioactive Waste Management Complex) and Waste Area Group 10 (comprehensive INEEL evaluation). These areas were determined by the co-trustees to be the areas on the INEEL having the most potential for significant resource injury. Documents from all four Waste Area Groups have been submitted to the co-trustees.

Clean Air Act

The Clean Air Act 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 provisions of the act by obtaining EPA approval of a State Implementation Plan. Idaho has been delegated such authority.

The Idaho air quality program is primarily administered through the permitting process. Potential sources of air pollutants are evaluated against regulatory criteria to determine if the source is specifically exempt from permitting requirements, and if the source's emissions are significant or insignificant.

Significance determination will result in several actions:

- Self-certify that emissions are below any trigger level necessitating action by a regulatory agency.
- Request a permit applicability determination from the regulatory agency.
- Request a Permit to Construct.
- Request a Permit to Construct for sources of significant emissions through a Prevention of Significant Deterioration analysis.

Permitting actions for potential sources of air pollutants are discussed in Section 2.3.

Title V Operating Permit. Title V of the 1990 Clean Air Act Amendments required the EPA to develop a federally enforceable operating permit program for air pollution sources to be administered by the state and/or local air pollution agencies. The EPA promulgated regulations in July 1992 that defined the requirements for state programs. Idaho has promulgated regulations and EPA has given interim approval of the Idaho Title V Operating Permit program.

The INEEL Title V Air Operating Permit Application was submitted to the Idaho Division of Environmental Quality on July 28, 1995. The permit application was declared "administratively complete" on December 22, 1995. The regulatory technical review of the application is not anticipated to begin until late 1998, with a permit issued in 1999. An emission inventory of sources of air pollutants has been and will continue to be conducted with the inventory submitted to the regulatory agency annually.

Air Permitting vs. Environmental Restoration (CERCLA) Activities. Discussions are continuing both within the INEEL and among the agencies as to the relationship of CERCLA and the Clean Air Act, specifically air permitting. Clearly, CERCLA activities are not required to obtain air permits but are required to meet the substantive requirements of permits. However, CERCLA activities could impact other INEEL

sources via impacts to the ambient air quality. Such an analysis would normally include the proposed action in addition to the existing permitted sources. It appears the analyses can be independent if compliance has been demonstrated. Independent analyses protect the division between CERCLA and the Clean Air Act and between the management and operating contractor and the Environmental Restoration contractor.

Fuel Storage Area permit. The October 1995 agreement between DOE, the State of Idaho and the U.S. Navy related to spent nuclear fuel shipments to Idaho and temporary storage at the INEEL allows installation of new fuel racks for the reconfiguration project upon receipt of a Permit to Construct from the State. The State of Idaho held a public comment period between January 18 and February 16, 1996. The Permit to Construct the Fuel Storage Area Rack Reconfiguration Project was received from the State of Idaho on April 5, 1996.

Procurement of new racks for the Fuel Storage Area facility proceeded as allowed under the U.S. District Court's December 1993 amended court order. All fuel storage racks for this project have been received and are in storage at the Idaho Chemical Processing Plant (ICPP). The new racks, which are 1.5 m (5 ft) taller than the existing racks, will increase and optimize the underwater storage capacity of fuel at ICPP. A November 14, 1995 agreement between DOE-ID and the Governor of Idaho will allow dry storage of fuels that are not compatible with long-term underwater storage. Some of these fuels have significant corrosion problems in an underwater environment. This agreement increases the amount of storage available in the facility in which the reconfiguration project is scheduled.

National Emission Standards for Hazardous Air Pollutants

In June 1996, DOE-ID submitted the 1995 INEEL National Emission Standards for Hazardous Air Pollutants—Radionuclides report to EPA, DOE-Headquarters, and State of Idaho officials. Using the CAP-88 computer model, the hypothetical maximum individual effective dose equivalent to a member of the public resulting from 1995 INEEL airborne radionuclide emissions (monitored, unmonitored, and diffuse sources) was 0.018 mrem/yr. This dose was 0.18% of the regulatory standard of 10 mrem/yr. The 1996 calculations with this code are discussed in Chapter 8, Dose to the Public.

In addition to the radiological program, LMITCO operates an asbestos program. All renovations or demolitions of structures that involve asbestos must satisfy requirements of 40 CFR 61, Subpart M. During 1996, there were 146 renovation operations involving nonscheduled operations in which amounts were less than the EPA threshold. There were 40 scheduled renovation or demolition operations that required EPA notifications (amounts above the EPA threshold). Argonne National Laboratory–West had three scheduled asbestos removals and 19 removals below reporting level.

Clean Water Act

The Clean Water Act, passed in 1972, establishes goals to control pollutants discharged to U.S. surface waters. Among the main elements of the act are effluent limitations set by the EPA for specific industry categories and water quality standards set by states. The Clean Water Act also provided for the National Pollutant Discharge Elimination System (NPDES) permit program, requiring permits for discharges from a point source into surface waters. An expansion of the NPDES program was instituted with the issuance of storm water discharge permits to medium and large municipalities and sites with industrial activity. DOE was issued NPDES storm water general permits for the discharge of storm water from industrial and construction activities at the INEEL in 1993. These permits will expire in 1997.

Clean Water Act Section 404 Permits. DOE-ID sent a joint request in May 1994 to the U.S. Army Corps of Engineers and the Idaho Department of

Water Resources for a Clean Water Act Section 404 permit to authorize work in Spreading Area B near the Radioactive Waste Management Complex. Spreading Area B is one of four depressions where water is diverted from the Big Lost River for flood control. In October 1994, the Army Corps of Engineers granted a 10-year Section 404 permit that authorizes DOE-ID to discharge dredged and fill material associated with the excavation of soil material in Spreading Area B. The permit prohibits construction activity at sites eligible for listing on the National Register of Historic Places.

A determination of where Waters of the United States may reasonably be expected to occur in the historic Birch Creek Playa was completed August 30, 1996. The boundary was established as the lower portion of Playa 4 at an elevation of 1,456 m (4,778 ft). In another area of the INEEL, the Army Corps of Engineers decided in August 1994 that the Birch Creek Playa at Test Area North does not require a Section 404 permit for construction work and other borrow and fill work.

Spill Prevention Control and Counter-measure Plans. Evaluations were conducted in 1993 to determine which INEEL facilities are required to have a Spill Prevention Control and Countermeasure Plan. Determinations were made as to which facilities required plans, and plans were prepared and updated for those facilities. Plans and determinations were documented in the INEEL Spill Prevention Control and Countermeasure Plans and Exemptions in September 1994. Facilities reviewed their status in July 1996 and made changes where necessary.

National Pollutant Discharge Elimination System Point Source Discharge Permits

All INEEL facilities were inventoried for process point source discharges to Waters of the United States in 1992 and 1993. As a result, a National Pollutant Discharge Elimination System permit application is on file with EPA Region 10 for minor discharges from the ICPP production wells to the Big Lost River. ICPP is required to comply with Idaho Water Quality Standards for these discharges.

Storm Water Discharge Permits for Industrial Activity. The General Permit for Storm Water Discharges Associated with Industrial Activity was issued in February 1993. The INEEL Storm Water Pollution Prevention Plan (SWPPP) for Industrial Activities [DOE/ID-10431] was implemented in 1993. This plan provides for baseline and tailored controls and measures to prevent pollution of storm water. Annual evaluations are conducted by the SWPPP Team to determine compliance with the plans and the need for revision. The LMITCO Environmental Monitoring Unit monitors storm water in accordance with the permit requirements and with DOE Orders. Results from this monitoring in 1996 are provided in Chapters 4 and 5. The National Oceanic and Atmospheric Administration (NOAA) Air Resources Laboratory provides identification and notification of storm events. Storm water pollution prevention training is provided to INEEL personnel in accordance with the permit requirements.

Storm Water Discharge Permit for Construction Activity. The General Permit for Storm Water Discharges from Construction Sites was issued in June 1993. The INEEL Storm Water Pollution Prevention Plan for Construction Activities (DOE/ID-10425) was distributed in January 1994. The plan provides for measures and controls to prevent pollution of storm water. Worksheets are completed for construction projects and appended to the plan. Inspections of construction sites are performed in accordance with permit requirements. The NOAA Air Resources Laboratory provides identification and notification of storm events. Under the permit for construction activities, storm water monitoring is not a requirement. Storm water pollution prevention training is provided to INEEL personnel and subcontractors as needed.

Executive Order 11990—Protection of Wetlands

A plan was developed, and funding allocated, to identify and field-verify regulated wetlands at the INEEL. Potential sites were evaluated in 1994 and 1995. Sites delineated on the 1993 U.S. Fish and Wildlife Service INEEL National Wetlands Inventory map were included in the process. The only areas identified as jurisdictional wetlands were in the area of the Big Lost River Sinks.

The U.S. Fish and Wildlife Service National Wetlands Inventory map is used as a source of information to identify potential jurisdictional wetlands or nonregulated sites with ecological, environmental, and future development significance. Currently, there are no identified operations at the INEEL that have a significant impact on jurisdictional wetlands. The spreading areas south of RWMC are not jurisdictional wetlands. However, Spreading Area A is classified as "Waters of the United States." Present and future excavation for borrow soil in Spreading Area A is performed under a Section 404 permit with the Army Corps of Engineers.

Executive Order 11988—Floodplain Management

In the fall of 1993, DOE-ID developed stereographic aerial photographic coverage of INEEL site areas judged to contain the 100-year/500-year floodplains of the Big Lost River and Birch Creek as an initial step in the production of a map of INEEL floodplains. The aerial photographs have been used to produce detailed topographic maps, an important prerequisite to mapping the floodplains. Early in 1994, DOE-ID gave approval to the U.S. Geological Survey (USGS) to conduct the 100-year floodplain evaluations for the streams. Personnel from the Boise Office of the USGS began mapping tasks for the floodplain study in 1994. Maps of the 100-year floodplains of the Big Lost River and Birch Creek, and a report documenting the floodplain study, are expected to be completed in 1997. Presently, the modeling has been completed for the Big Lost River and Birch Creek and is under review.

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 INEEL having a 1% or greater chance of being flooded in any given year. Specifically, the study does not include areas that may be prone to flooding caused by runoff from local drainage basins. Such studies will be conducted separately. However, the detailed topographic maps produced by the current project will support such studies if they are within the areas mapped. Detailed contour maps have been completed for all major INEEL facilities. The 100-year/500-year floodplain evaluations have been completed for the RWMC, and maps have been developed for delineating the 100-year and 500-year floodplains. DOE-ID is attempting to obtain funding to conduct additional studies on a sitewide basis. However, at this time, these studies will be conducted only on an as-needed basis. In addition, the NOAA Air Resources Laboratory has expanded and updated its computations of annual, extreme, and return period precipitation to further support these studies [Reference 2-3].

State of Idaho Wastewater Land Application Permits

DOE-ID is applying for State of Idaho Wastewater Land Application Permits for all existing and future land application facilities (e.g. percolation ponds and sewage treatment irrigation systems). Applications for Wastewater Land Application Permits have been submitted to the Idaho Division of Environmental Quality for the Water Reactor Research Test Facility Sewage and Process Ponds at Test Area North (TAN) and the Test Reactor Area (TRA) Chemical Waste and Cold Waste Ponds. The Argonne National Laboratory-West (ANL-W) Industrial Waste Pond and Conveyance Ditches application was submitted by DOE Chicago Operations Office to the State of Idaho, and an application for the Naval Reactors Facility (NRF) Industrial Waste

Ditch has also been submitted to the State for review.

Final Wastewater Land Application Permits were issued in July 1994 for the Central Facilities Area (CFA) Sewage Treatment Plant, in September 1995 for the ICPP Percolation Ponds and ICPP Sewage Treatment Plant Rapid Infiltration Trenches, in May 1996 for the TAN/TSF Sewage Treatment Plant, and in July 1997 for temporary land application at the TRA Sewage Treatment Plant.

Resource Conservation and Recovery Act (RCRA)

This act establishes regulatory standards for the generation, transportation, storage, treatment and disposal of hazardous waste. The State of Idaho is authorized by EPA to regulate hazardous waste and the hazardous component of mixed waste at the INEEL. Mixed wastes contain both radioactive and hazardous materials. Radioactive wastes not containing hazardous materials are regulated by the Atomic Energy Act as administered through DOE Orders.

RCRA Inspection. Officials from the Idaho Department of Environmental Quality (DEQ) arrived at the INEEL on January 29, 1996, to begin the annual RCRA Inspection. The areas inspected during this visit were the Waste Experimental Reduction Facility (WERF), ICPP, TAN, TRA and ANL-W. A Notice of Violation (NOV) was received on March 21, 1996.

RCRA Notices of Violation. On October 25, 1995, DOE-ID received an NOV for an inspection conducted in June 1995. This inspection covered ANL-W and the Hazardous Waste Storage Facility at CFA, both RCRA permitted units. The NOV contained fines, all of which were assessed against ANL-W. A consent order to resolve this NOV was signed in May 1996. All LMITCO issues at CFA were resolved prior to the signing of the consent order.

On March 21, 1996, DOE received an NOV from the January 29 inspection containing 61 violations and a fine of $317,000. The violations covered four general area of regulations—record keeping, management of waste containers, decontamination of lead, and criminal dumping of waste samples. A negotiation team, led by DOE but including contractor personnel, met with the State on several occasions to resolve this NOV. After negotiation, several violations were dismissed. The remaining violations were placed into two categories: those violations where DOE agrees with the finding and those violations where DOE and the State disagree on the finding, but do agree with the final solution. The total fine was reduced to $163,000 of which LMITCO paid $87,000. The negotiation team was able to resolve this NOV in less than one year of negotiations, much less time than past negotiations. The consent order was signed on January 14, 1997.

RCRA Closure Plans. The State of Idaho approved the closure certifications and removal of the following units from the Part A permit:

- Fluorinel Dissolution Process Waste Tanks VES-FA-141 and VES-FA-142 in May 1996.
- Army Re-entry Vehicle Facility Site/Sodium Potassium Storage Unit in September 1996.
- Initial Engine Test Mercury Storage Unit in December 1996.
- Test Area North 681 Evaporator Unit in December 1996.

RCRA Reports. As required by the State of Idaho, DOE-ID submitted the Idaho Hazardous Waste Generator Annual Report for 1996. The report contains information on waste generation, treatment, recycling, and disposal activities at INEEL facilities for 1996.

DOE-ID submitted the INEEL 1996 Affirmative Procurement Report to EPA by

December 1, 1996, as required by Section 6002 of RCRA and Executive Order 12780. This report provides information on the INEEL's procurement of products containing recovered, rather than virgin, materials.

The INEEL RCRA permit for the Hazardous Waste Storage Facility at CFA and some areas at ANL-W requires submittal of an annual certification to the DEQ that the INEEL has a waste minimization program in place to reduce the volume and toxicity of hazardous waste. The certification was submitted on July 1, 1996.

The Annual Reports on Treatability Studies for Calendar Year 1996 were submitted to the DEQ in March 1997. Reports were submitted for the INEEL and the INEEL Research Center. Treatability Studies, as defined by the regulation [Reference 2-4], are those in which a hazardous waste is subjected to a treatment process to determine:

- Whether the waste is amenable to the treatment process.
- What pretreatment, if any, is required.
- The optimal process conditions needed to achieve the desired treatment.
- The efficiency of a treatment process for a specific waste or wastes.
- The characteristics and volumes of residuals from a particular treatment process.

The annual reports describe the types of studies performed on both hazardous waste and mixed waste, and the quantities of waste used in the studies for the previous calendar year. The reports also provide a brief description of studies planned for the current calendar year. A "treatability study" is not a means to commercially treat or dispose of hazardous waste.

Federal Facilities Compliance Act

The Federal Facilities Compliance Act, which amends RCRA, requires the preparation of site treatment plans for the treatment of mixed wastes at DOE facilities that store or generate mixed wastes. Mixed waste contains both hazardous and radioactive components. *The INEL Proposed Site Treatment Plan* formed the basis for State of Idaho and DOE-ID consent order negotiations for mixed waste treatment at the INEEL. The Federal Facility Compliance Act Consent Order and Site Treatment Plan was finalized and signed by the State of Idaho on November 1, 1995. See Section 3.2 for more information.

In November 1996, the annual report and update was submitted to the State for review, public review, and final approval. In December 1996, the State approved the update and report. The INEEL Site Treatment Plan Update has been distributed to all interested parties.

National Environmental Policy Act (NEPA)

NEPA and the Council on Environmental Quality Regulations at 40 CFR 1500 require each federal agency to consider every significant aspect of the environmental impacts of its proposed actions, inform the public that the agency considered environmental concerns in its decision making process, and inform the agency decision maker of the environmental impacts and public concern associated with a proposed action. DOE's NEPA implementing procedures are at 10 CFR 1021 as amended. DOE Order 451.1 assigns authorities and responsibilities for the NEPA process within DOE. DOE-ID specific processes are set forth in its NEPA Internal Scoping Procedures, Quality Program Plan and Public Participation Plan. The DOE-ID NEPA Compliance Officer and NEPA Planning Board implement the process. A handbook has been developed to provide a primer on NEPA, to describe DOE-ID's NEPA process, and to provide

step-by-step instructions to project and program managers. The handbook is available electronically from twitchrl@inel.gov.

Environmental Assessments. An environmental assessment was completed for the TAN Pool Stabilization and a Finding of No Significant Impact was signed by the Manager of DOE-ID on May 6, 1996. Copies of the documents were mailed to public reading rooms, the State of Idaho, Indian Tribes, and the Snake River Alliance.

The environmental assessment for the Closure of the Waste Calcining Facility at ICPP was completed and the Finding of No Significant Impact was signed by the Manager of DOE-ID on July 15, 1996. Public notification of availability of the completed documents was made on August 7, 1996

Safe Drinking Water Act

The Safe Drinking Water Act establishes primary standards for drinking water delivered by systems that supply drinking water to 15 or more connections or 25 individuals for at least 60 days per year. The INEEL drinking water supplies meet those criteria and are classified as nontransient noncommunity or transient noncommunity systems because persons who use the water do so four or five days per week, but do not live at the Site.

The INEEL operates 12 active public water systems. All INEEL facilities performed sampling of drinking water for parameters required by the Safe Drinking Water Act.

The bacteriological program for drinking water at the INEEL involves monthly and/or quarterly testing for coliform bacteria. The TAN drinking water distribution system was found to be contaminated with coliform bacteria during 1993 and 1994. Four deep wells are used for drinking water at TAN. In 1995, the TAN Chlorination Project started installation of a chlorine unit at the Technical Support Facility, and the installation was completed in 1996.

Bacteriological contamination was found in the drinking water supply at TRA and Power Burst Facility (PBF) during 1996. A plan to install a permanent disinfectant system for the two systems was submitted to the DEQ. The State granted permission to install and test a mixed oxidant system developed in Los Alamos, New Mexico. Following successful testing, work on certification and approval of the system by all necessary agencies has begun. The system serving TRA is operational. Plans to install a unit at PBF have been submitted to the DEQ, and installation is expected to occur in early spring 1997.

Toxic Substances Control Act

The Toxic Substances Control Act, which is administered by EPA, requires testing and regulation of chemical substances that enter the environment. The act supplements sections of the Clean Air Act, the Clean Water Act, and the Occupational Safety and Health Act. Compliance with the act at the INEEL is primarily directed toward management of polychlorinated biphenyls (PCBs).

Storage of PCB-Contaminated Materials. DOE-ID continues to store radioactively contaminated PCBs at the INEEL. Negotiations between DOE and EPA have resulted in a complex-wide agreement, signed on May 8, 1996, for storage longer than one year. DOE-ID and EPA Region 10 are in the process of developing an agreement for issues other than one-year storage of these materials. A package with a draft agreement and background information was sent to EPA Region 10 on April 25, 1996. Negotiation issues include characterization, inspections, and labeling.

Under the Federal Facilities Compliance Act INEEL Site Treatment Plan, the INEEL has received small quantities of mixed wastes from Mare Island Naval Shipyard. A concern was raised that these wastes might be contaminated with PCBs, and the INEEL could be perceived as a commercial storer under the Toxic Substances Control Act. The Naval Nuclear Propulsion Program sent DOE-ID a letter stating that the

waste is owned by DOE because it was generated as part of the Propulsion Program. The INEEL cannot be considered a commercial storage facility for wastes that are owned by DOE.

PCB Treatability Study. During 1994, DOE-ID submitted a permit application for a study to determine if PCBs can be destroyed by high-energy gamma radiation. Tests using the TRA fuel cells as the gamma radiation source successfully reduced the concentration of PCB congeners (similar compounds) in hydraulic oil by an order of magnitude—from 5,000 ppm to 556 ppm. The 1994 study results were promising—the treatment destroyed PCBs, did not generate any additional waste, and was relatively inexpensive when a source of gamma radiation was available. On September 15, 1995, EPA issued the Toxic Substances Control Act permit for this study. On August 20, 1996, DOE-ID submitted a final report on the project to EPA Region 10.

Federal Insecticide, Fungicide, and Rodenticide Act

The Federal Insecticide, Fungicide, and Rodenticide Act governs the registration and use of pesticides (i.e. fungicides, herbicides, insecticides, and rodenticides). The INEEL complies with the act's requirements pertaining to storage and application of pesticides. There were no activities or issues at the INEEL with respect to this statute during 1996.

National Historic Preservation Act

Preservation of historic properties on lands managed by DOE is mandated under Section 106 of the National Historic Preservation Act. The act requires that when any federal undertaking will have an adverse effect on an historic property, the cognizant federal agency must enter into an agreement with the State Historical Preservation Officer for the purpose of mitigating those adverse effects.

During 1996, seven Memoranda of Agreement were signed by DOE and the State Historical Preservation Officer. Six were for decontamination and decommissioning of historically significant buildings and one was for a land transfer to the General Services Administration.

The INEEL Historic Preservation Programmatic Agreement, which was scheduled to be finalized during 1996, was not signed. This agreement between the INEEL and the State Historical Preservation Officer would eliminate the need for separate Memoranda of Agreement for each decontamination and decommissioning project. The agreement has been revised to meet the needs of NRF and ANL-W and is now scheduled to be finalized during 1997.

Draft Tribal Consultation Procedures were developed in partnership with the Tribes. These procedures provide clarity and guidance on how communication between the Tribes, DOE and LMITCO should occur, and ensure continued good communication between the three entities regarding cultural resource management on the INEEL.

Native American Grave Protection and Repatriation Act

The INEEL is located on the aboriginal territory of the Shoshone people, and the Shoshone-Bannock Tribes are major stakeholders in INEEL activities. They are particularly concerned with how the remains of their ancestors and culture are treated by DOE-ID and its contractors. The Native American Graves Protection and Repatriation Act provides for the protection of Native American remains and the repatriation of human remains and associated burial objects. Repatriation refers to the formal return of human remains and cultural objects to the culturally affiliated tribes to whom they belong.

Human remains were discovered at the Waste Experimental Reduction Facility during the summer of 1996; however, cultural affiliation could not be determined. DOE-ID and the Tribes are working closely and carefully to determine how to proceed. Resolution is still in process.

The State Historic Preservation Office and DOE-ID have been working closely to develop protocols based on the repatriation efforts for human remains found on the INEEL in 1995. Draft procedures have been formulated to assist in future repatriations in the Idaho, and are being used effectively.

Endangered Species Act

The Environmental Science and Research Foundation conducts ecological research, field surveys, and NEPA evaluations regarding ecological resources. Particular emphasis is given to threatened and endangered species and species of special concern (Table 2-2). Ute's ladies tresses (*Spiranthes diluvialis*) was added to the INEEL list this year. This is a threatened species that only recently was found to occur in the upper Snake River Plain. It has never been found on the INEEL, and it is not known if suitable habitat–wet meadows–exists long enough each year to support this species.

2.2 OTHER MAJOR ENVIRONMENTAL ISSUES AND ACTIVITIES

Litigation Issues

Fort St. Vrain Litigation. On February 9, 1996, DOE and the Public Service Company of Colorado signed a settlement that allows continued safe storage of spent nuclear fuel from the Fort St. Vrain power reactor near Platteville, Colorado, until a permanent repository becomes available. The agreement meets one of the requirements of the October 1995 spent fuel agreement between DOE, the State of Idaho, and the U.S. Navy. Under the agreement, spent nuclear fuel from Fort St. Vrain can only be shipped to the INEEL if a permanent repository or interim storage facility located outside Idaho has been opened and is accepting fuel from the INEEL. In that case, spent nuclear fuel from Fort St. Vrain could be shipped to the INEEL for the purpose of preparing it for disposal or storage out-of-state.

The out-of-court settlement between DOE and the Public Service Company resolves the company's claims against DOE emanating from the 1965 contract. The Public Service Company claimed the contract obligated DOE to receive spent nuclear fuel from the Fort St. Vrain reactor for storage. However, DOE was unable to fulfill the contract because of the legal challenges to spent nuclear fuel storage at the INEEL. The utility company subsequently constructed and now operates a Nuclear Regulatory Commission-licensed fuel storage facility located adjacent to the former Fort St. Vrain power plant. In lieu of accepting the spent nuclear fuel for storage in Idaho, DOE has taken title to the spent fuel and will pay the Public Service Company $16 million to settle the claim. Public Service Company personnel will continue to manage the fuel for DOE under its current storage license until the license has been transferred to DOE. At that time, DOE will take title to the facility and begin managing it.

Improper Sample Disposal by INEEL Employees. An internal audit begun by EG&G, Inc. during 1994 and continued by LMITCO after they assumed operation in October 1994, resulted in some potentially serious findings related to sample disposal. In March 1995, the Inspector General became involved in the investigation. In July 1995, DOE-ID requested that LMITCO management make a detailed evaluation of the sample monitoring activities of the two LMITCO employees involved. DOE-ID specifically asked if any Environmental Restoration or RCRA programmatic decisions made at the INEEL during the past five years were suspect as a result of the two employees' actions.

LMITCO issued a formal report "Review of Environmental Monitoring Sample Collection-

TABLE 2-2. LISTED THREATENED AND ENDANGERED SPECIES AND OTHER SPECIES OF CONCERN ON OR POSSIBLY OCCUPYING THE INEEL

Species	Classification	Occurrence on the INEEL
Bald Eagle (*Haliaeetus leucocephalus*)	Listed: Threatened	Winter visitor most years
Gray wolf (*Canis Lupus*)	Listed: Endangered, Experimental population	Several sightings since 1993
Ute's Ladies tresses (*Spiranthes diluvialis*)	Listed: Threatened	Found near but not on INEEL
Long-eared Myotis (*Myotis evotis*)	Former C2 species	Limited onsite distribution
Small-footed Myotis (*Myotis subulatus*)	Former C2 species	Relatively common
Townsend's big-eared bat (*Corynorhinus townsendii*)	Former C2 species	Year round resident
Pygmy Rabbit (*Brachylagus idahoensis*)	Former C2 species	Limited onsite distribution
Merriam's shrew (*Sorex merriami*)	State protected species	Limited onsite distribution
Ferruginous hawk (*Buteo regalis*)	Former C2 species	Widespread summer resident
Long-billed curlew (*Numenius americanus*)	Former C2 species	Limited summer distribution
Northern Sagebrush Lizard (*Sceloperous graciosus*)	Former C2 species	Widespread distribution
Painted milkvetch (*Astragalus ceramicus* var *apus*)	Former C2 species	Common in sandy areas
King's bladderpod (*Lesquerella kingii* var *cobrensis*)	INPS[a] monitor list	Uncommon
Nipple cactus (*Lesquerella kingii* var *cobrensis*)	INPS monitor list	Uncommon
Sepal-tooth dodder (*Cuscuta denticulata*)	INPS Category 1	Near but not known onsite
Lemhi milkvetch (*Astragalus aquilonius*)	INPS Sensitive species	Limited distribution
Winged-seed evening primrose (*Camissonia pterosperma*)	INPS Sensitive species	Rare and limited
Spreading gila (*Ipomopsis* [=*Gilia*] *polycladon*)	INPS Category 2	Limited to western foothills
Tree-like oxytheca (*Oxytheca dendroidea*)	INPS Sensitive species	Uncommon but widespread

[a] Idaho Native Plant Society

MSL-36-95" on September 7, 1995, that concludes, in part, that the data associated with the drinking water and liquid effluent monitoring programs did not affect programmatic decisions, and the improper employee actions were generally related only to a disregard of safety requirements and appropriate procedures in the management and disposal of sample residues. Correct techniques for collection and analysis of samples were followed. There is no indication that public health was ever at risk due to the actions of the employees.

In September and October 1995, a DOE-ID team conducted a formal review of the LMITCO Environmental Monitoring Unit, for which the two employees worked, to see if effective management systems were in place. Based on DOE-ID and LMITCO reviews, DOE-ID concluded that the unit was generally sound and supportive of waste management and programmatic decisions. The problems in the INEEL Environmental Monitoring Unit did not go beyond the independent actions of the two individuals. On February 13, 1996, both individuals were indicted by a grand jury on multiple felony and misdemeanor charges related to the sample problems. One individual, a staff scientist, pled guilty to one count of making false statements and is no longer employed by LMITCO. The other individual, a senior technician, was acquitted after a jury trial. This individual still works for LMITCO, but was transferred out of the Environmental Monitoring Unit.

In summary, the problems were generally limited to sample disposal and safety procedure violations (not sample collection and analysis), and these personnel did not collect samples for projects affecting major programmatic decisions. LMITCO continues to seek opportunities for improvement in this important area, and investigations and improvements are currently underway related to management of sample storage and procedures and practices for proper disposal of samples. Both DOE-ID and LMITCO will continue to closely monitor important environmental matters and to identify and address environmental program deficiencies as they occur.

Ground-water Monitoring Program Activities

The INEEL Groundwater Monitoring Plan establishes a programmatic framework for ensuring compliance with all state, federal, and DOE ground-water related standards. In accordance with DOE Order 5400.1, the plan documents local and regional hydrologic regimes, known and potential sources of ground-water contamination at the INEEL, and the monitoring networks and sampling programs necessary to evaluate the effects of the INEEL's activities on the local and regional ground-water resources.

The INEEL Groundwater Monitoring Program was designed using a three-tiered approach which integrates "Regional," "Area-specific" and "Unit-/Facility-specific" monitoring networks. These networks are being installed and ground-water monitoring schedules are being implemented using a phased approach. The regional monitoring network is mostly in place and is being implemented by the USGS as part of their ongoing program which has been conducted since 1949. The development of area-specific monitoring networks was initiated in 1993 and networks have been completed at the Auxiliary Reactor Area, Special Training Facility, PBF, and ICPP. Area-specific monitoring networks are being installed in accordance with the INEEL Groundwater Monitoring Plan implementation schedule. Unit-/facility-specific monitoring networks were designed to provide leak detection, where necessary, and where required by federal or state regulations or permits. These wells are designed, installed, and monitored on an as-needed basis.

In 1996, compliance ground-water monitoring was implemented regionally, as well as at TAN and ICPP. It is anticipated that the compliance monitoring program will be fully functional by 2004. In addition, observational ground-water monitoring was conducted by the USGS in accordance with its Memorandum of Agreement with DOE-ID, and ground-water monitoring and characterization were conducted by the Environmental Restoration program in accordance with the INEEL Federal Facility Agreement and Compliance Order.

Health Studies

In December 1991, the Secretary of Energy and the Secretary of the Department of Health and Human Services signed a Memorandum of Understanding which transferred authority for the conduct and management of all epidemiological studies at DOE facilities to the Department of Health and Human Services. The Memorandum

of Understanding was revised in August 1996. Two studies, dose reconstruction and worker epidemiology, are discussed below. The Centers for Disease Control and Prevention (CDC) has established a public advisory group, the INEEL Health Effects Subcommittee.

The Subcommittee met in March, June, September, and December of 1996 at Boise, Pocatello, Twin Falls, and Idaho Falls, respectively. This group will provide recommendations to the CDC and the Agency for Toxic Substances and Disease Registry regarding all three INEEL health studies performed under the Memorandum of Understanding: the INEEL Environmental Dose Reconstruction Project; the INEEL worker epidemiology study; and health studies connected with CERCLA activities.

INEEL Dose Reconstruction Study. The INEEL Environmental Dose Reconstruction Project is being conducted by the National Center for Environmental Health of the CDC. Phase 1, completed in 1994, identified and evaluated the documents and data at the INEEL pertinent to a historical dose reconstruction. Phase 2 began in 1996 with the start of a task to determine the feasibility of estimating doses to the offsite public from toxic chemicals released from the INEEL.

Epidemiological Study of Workers at the INEEL. The INEEL Epidemiological Study of Workers, which will evaluate patterns of mortality in all workers at the INEEL since 1949, is being conducted by the National Institute for Occupational Safety and Health (NIOSH) of the CDC.

The primary objective of this study is to assess potential associations between exposures to ionizing radiation and/or other toxic elements in the INEEL worksite and mortality in the workforce. To meet this objective, NIOSH is conducting an all-cause epidemiological cohort mortality study and will evaluate the feasibility of a prospective cancer incidence study among INEEL employees. Detailed exposure histories will be compiled for all workers using records from health physics and industrial hygiene at the INEEL.

Environmental Occurrences

Several small spills occurred at the INEEL during 1996 that were not reportable under environmental regulations. These included small releases of diesel fuel, sulfuric acid, nitric acid, and oil.

On November 4, 1996, approximately 5,700 L (1,500 gal) of wastewater with a pH of 1.45 was released to the soil from a 114,000 L (30,000 gal) above-ground tank serving as an Elementary Neutralization Unit at TRA. Notifications to the National Response Center, state, and local agencies were made in accordance with DOE and CERCLA requirements. Immediate actions were taken by the facility to control the situation. These included transferring the contents of the tank, removing the leaking tank from service, and testing the pH of the surrounding soil to confirm acidic conditions were not present.

Environmental Oversight & Monitoring Agreement

The Environmental Oversight and Monitoring Agreement between DOE-ID, DOE-Naval Reactors Idaho Branch Office, and the State of Idaho maintains the State's program of independent oversight and monitoring established under the agreement first creating the INEEL Oversight Program. The main objectives as established under the second five-year agreement are to:

- Assess the potential impacts of present and future DOE activities in Idaho.
- Assure citizens of Idaho that all present and future activities in Idaho are protective of the health and safety of Idahoans and the environment.
- Communicate the findings to the citizens of Idaho in a manner that provides them the

opportunity to evaluate potential impacts of present and future DOE activities in Idaho.

The State Oversight Program activities produced many accomplishments in 1996, due in large part to a coordinated working relationship with DOE, the INEEL contractors, the Shoshone-Bannock Tribes, USGS, NOAA, and Idaho State University.

Environmental Surveillance Program. The Environmental Surveillance Program is intended to verify and supplement existing surveillance programs operated by DOE contractors. The program's approach is designed to accomplish emergency response as well as environmental verification.

A research study regarding atmospheric tritium measurements was initiated in 1996 in conjunction with Idaho State University and LMITCO, and will continue through 1997. The study will evaluate and attempt to improve current methods of field sampling and laboratory analysis for environmental levels of atmospheric tritium. The results of this study will enable the State Oversight Program to enhance its current sampling methods and ensure comparable results with other INEEL monitoring programs.

Emergency Response and Preparedness Program. The agreement requires assistance to local authorities with emergency preparedness. DOE has assisted the State Oversight Program in establishing a statewide Interagency Planning Group. The group provides a process for coordination of emergency preparedness issues and concerns among the various state agencies as well as increased communication among the various organizations. A five-phase radiological emergency response plan and emergency response training has been cooperatively established with the State Oversight Program to assist the local governments to meet local emergency response needs.

Impact Assessments Program. The Impacts Assessment Program produces scientific validation through independent risk assessment of current and future operations specific to Idaho. A collaborative effort improves and scientifically validates DOE's processes. The activity allows the State and DOE to more effectively and efficiently plan future needs in surveillance and emergency response.

Reviews of the hazard assessments of TRA, ANL-W, and ICPP were conducted and comments submitted to DOE. A one-year pilot project on Transportation Risk Assessment was completed in 1996. The focus of this project was shipments of ^{137}Cs from Colorado and Virginia across Idaho to the Hanford Site in Washington. A project report has been published, and copies are available from the State Oversight Program Public Information Office.

The Straddle-packer Research Project. Conducted from 1992 to 1995, this study included staff from the University of Idaho, Idaho State University, Boise State University, the USGS, LMITCO, previous INEEL contractors, and the INEEL Oversight Program. The straddle-packer was used to sample ground water at differing depths in the aquifer by isolating water at various intervals from other levels in the aquifer. As studies are completed and published, the information will provide interested scientists and citizens with more information regarding the Snake River Plain Aquifer.

The Idaho Water Resources Research Institute published a report in 1996 which contained results and analysis of hydrogeologic data collected during the project [Reference 2-5]. Another 1996 report summarizes the water quality data collected during the project [Reference 2-6]. In addition, two theses have been completed by University of Idaho students. One thesis has been completed by a graduate student at Boise State University.

Citizens Advisory Board

The INEEL Citizens Advisory Board, formerly called the Site Specific Advisory Board, was formed in March 1994. Its charter is to provide

input and recommendations on environmental management strategic decisions that impact future use, risk management, economic development, and budget prioritization activities.

During 1996, five members rotated off the board and were replaced with five new members. A new chair and vice-chair were also elected.

Five recommendations were submitted to DOE-ID in 1996 which are addressed in detail in the Citizens Advisory Board INEL Annual Report 1996:

- INEL Ten-Year Plan;
- INEL Low-Level Waste Program;
- INEL Spent Nuclear Fuel Management Plan Document; and
- Environmental Management Fiscal Year 1998 Integrated Budget Prioritization.

2.3 PERMITS

Permits that were granted to the INEEL in 1996 and those for which applications have been submitted are summarized in Table 2-3. In 1996, the RCRA units with Hazardous Waste Permits included:

- Hazardous Waste Storage Facility at CFA;
- Radioactive Sodium Storage Facility at ANL-W;
- Radioactive Scrap and Waste Facility at ANL-W;
- Hazardous Chemical Waste Handling and Neutralization Facility at ICPP;
- Intermediate-Level Transuranic Storage Facility, Pad 2 at RWMC;
- Waste Storage Facilities (Type I and Type II) at RWMC; and
- Stored Waste Examination Pilot Plant at RWMC.

Wastewater Land Application Permits were granted in May 1996 for the TAN/TSF Sewage Treatment Plant. The INEEL received one blanket Well Construction Permit from the Idaho Department of Water Resources in 1996, covering eight wells.

The Idaho Department of Water Resources has granted Underground Injection Control permits allowing the continued operation of eight deep injection wells, defined as Class V under 40 CFR 144.6, at the INEEL. Seven are located at the INEEL and are used for draining excess surface water runoff to avoid facility flooding. The eighth well is located at the INEEL Research Center and is a closed-loop heat exchange system.

TABLE 2-3. PERMIT SUMMARY FOR THE INEEL (1996)

Permit Type	Issuing Agency	Granted	Pending
Air			
Self-Certify	None	14	0
Permit to Construct	DEQ	7	3
Exempt/PAD[a]	DEQ	19	6
NESHAPs[b]	EPA Region 10	27	0
Operating Permit	DEQ	0	1
Ground Water			
Injection Well	Dept. of Water Resources	8	0
Well Construction	Dept. of Water Resources	1	0
Surface Water			
NPDES-Point Source	EPA Region 10	0	1
NPDES-Storm Water	EPA Region 10	2	1
Wastewater Land Application	DEQ	4	5
404 Permit	Corps of Engineers	1	0
Industrial Waste Acceptance Form	City of Idaho Falls	16	1
RCRA			
Part A	State of Idaho	1	0
Part B[c]	State of Idaho	7	13

[a] Permit Applicability Determination
[b] National Emissions Standards for Hazardous Air Pollutants.
[c] Part B permit is a single permit composed of several volumes.

Summary of Chapter 3
Environmental Program Information

This chapter describes activities and milestones within major environmental programs at the Idaho National Engineering and Environmental Laboratory (INEEL). The U.S. Department of Energy (DOE) is developing an environmental management system for the INEEL, based on an international standard known as ISO 14001 (*Section 3.1*). The Environmental Restoration Program section (*Section 3.2*) describes the activities within the 10 Waste Area Groups, ranging from limited field investigations to major remedial investigation/feasibility studies. The goal of the Waste Management Program (*Section 3.3*) is to manage wastes at the INEEL in such a manner as to ensure that workers and the public are protected, and that there is no further impact to the environment.

Other programs at the INEEL contain environmental components (*Section 3.4*). Public education programs and the publications designed to inform the public about the INEEL activities are also discussed in this section.

Several groups perform environmental monitoring of various pathways by which members of the public could potentially be impacted by operations at the INEEL (*Section 3.5*). During 1996, major environmental surveillance activities at the INEEL were performed by the Environmental Science and Research Foundation, Lockheed Martin Idaho Technologies Company (LMITCO), the U.S. Geological Survey (USGS), the National Oceanic and Atmospheric Administration (NOAA), and the State of Idaho.

3. ENVIRONMENTAL PROGRAM INFORMATION

3.1 ENVIRONMENTAL MANAGEMENT SYSTEM (EMS)

DOE-ID is actively pursuing the development of an EMS that conforms to international consensus standard ISO 14001, "Environmental Management Systems." This initiative is being promoted by DOE-ID because a comprehensive EMS will help DOE and the INEEL attain its strategic objective of becoming the nation's premier environmental laboratory while instilling a culture of pollution prevention and excellent environmental stewardship.

DOE-ID and LMITCO have each established groups to implement the EMS in 1997 and are working jointly to achieve alignment and to proceed in a collaborative fashion. When fully implemented, the EMS will encompass all INEEL activities that may have an environmental impact. In addition to full regulatory compliance with zero tolerance for noncompliance, emphasis will also be placed on pollution prevention and continuous improvement.

3.2 ENVIRONMENTAL RESTORATION PROGRAM

General Information

A common perception of environmental restoration investigative and remedial activities at DOE and other government sites is that all parts of the process are expensive and time-consuming. However, during recent years, streamlining environmental restoration activities at the INEEL by DOE, the Environmental Protection Agency (EPA), and the State of Idaho has saved millions of dollars. This streamlining was possible due to the flexibility and management principles established under the Federal Facilities Agreement and Consent Order such as:

- Making cleanup decisions as soon as sufficient data are present.
- Using existing data whenever possible.
- Avoiding duplication of analyses and documentation.
- Matching the level of investigation to the level of complexity of each release site.

During the five years since the agreement was signed, the INEEL has cleaned up sites containing asbestos, petroleum products, acids and bases, radionuclides, unexploded ordinance and explosive residues, PCBs, heavy metals and other hazardous wastes. The INEEL Environmental Restoration Program has maintained significant progress in accomplishing its goals. As of December 1996, a tally of environmental restoration activities at the INEEL showed:

- 14 Records of Decision have been signed;
- 13 removal actions were completed;
- nine major investigations were in progress;
- four interim actions were completed; and
- five final actions were completed.

Comprehensive remedial investigation/ feasibility studies are under way in all Waste Area Groups. The comprehensive investigations, which take an average of two years to complete, accomplish the following:

- Determine the cumulative risks for an entire Waste Area Group by assessing the combined impact of all release sites within that group.
- Review assumptions used in each previous investigation of "No Further Action" sites,

Track 1 and 2, remedial investigation/ feasibility studies and interim actions.

- Identify data gaps and recommend actions such as field sampling or historical document research to resolve questions.

- Perform a feasibility study and recommend remedial alternatives for the entire Waste Area Group.

The general procedure for all comprehensive investigations begins with developing a Work Plan that outlines potential data gaps and release sites that may require more field sampling. When the investigation is complete, DOE, EPA and the State hold public comment meetings on the proposed cleanup alternative. The first proposed plan for cleanup resulting from a comprehensive remedial investigation/ feasibility study was released for public comment on March 9, 1997. Following the evaluation of public comments, the agencies will sign a Record of Decision for the Waste Area Group documenting the final cleanup decision. The status of each Waste Area Group was given in the March/April 1996 edition of the INEEL Reporter Supplement: Citizen's Guide. Major Environmental Restoration Program accomplishments for 1996 are described in the following sections.

Waste Area Group 1–Test Area North (TAN)

TAN Ground-Water Remediation. In 1993, cleanup activities were begun on the TAN Injection Well used from 1953 to 1972 to discharge liquid wastes into the fractured basalt of the Snake River Plain Aquifer. Those wastes included organic and inorganic compounds and low-level radioactive wastes that had been added to industrial and sanitary waste waters. The resulting waste plume contaminated some of the drinking water wells that had been used by TAN workers. Since discovery of the contamination, drinking water has been treated to meet drinking water standards, and untreated water is not accessible to workers or the public.

An interim action was necessary to remove the sources of contamination and prevent further impact to the aquifer in the region. A subcontract was awarded for the design, construction, and operation of a Ground-Water Treatment Facility, and the interim action began in March 1994. The objective was to pump and treat the TAN injection well water to remove the primary contaminant of concern—trichloroethylene. However, after operating the treatment facility for several months, the agencies (DOE-ID, EPA, and the State of Idaho) learned that levels of contaminants were higher than previously known, other contaminants of potential concern were present and the treatment facility was not designed to treat some of these additional contaminants. The agencies temporarily suspended operation of the facility to consider expanding the preferred remedial alternative for the ground-water contamination by adding three new tasks: . sampling and analysis of the injection well water for better characterization, testing to confirm removal of ^{137}Cs and other radionuclides, and alternately pumping and emptying the injection well to remove the buildup of material injected into the well.

A separate remedial investigation/feasibility study addressing the organic contamination plume beyond the injection well was completed in 1994. The TAN ground-water final remedial action Record of Decision was officially approved by representatives of the EPA and State of Idaho in August 1995. The treatment facility used in the earlier interim action was purchased from the subcontractor by DOE and has been operated to surge and stress the injection well since soon after the Record of Decision was signed. During 1996, the treatment plant reached continuous operation. The area of highest contaminant concentrations immediately surrounding the injection well will be contained and the ground water treated to reduce contamination levels. The decision also prescribes that new, innovative technologies, such as in-situ bioremediation and in-situ chemical oxidation, be evaluated to determine whether there is any benefit to using them rather than the traditional air stripping and ion exchange processes to treat the

ground water. Innovative technologies were evaluated during this year to determine applicability to these circumstances.

Plans for 1997 include continuing hydraulic containment and surge and stress at the injection well, and evaluating bioremediation and chemical oxidation as possible enhancements or replacements to pumping and treating the water.

Waste Area Group 1 Comprehensive Remedial Investigation/Feasibility Study. This investigation began during 1995. DOE-ID submitted the draft Final Work Plan to EPA and the State of Idaho on January 24, 1996. Eleven operable units and 94 potential release sites, including the V-tanks (tanks containing hazardous, PCB, and radioactive wastes) will also be evaluated during this final investigation. Activities planned for 1997 include completing the remedial investigation/feasibility study and conducting treatability studies on the V-tank contents.

Waste Area Group 2–Test Reactor Area (TRA)

Perched-Water System. The perched water under TRA is a zone of ground water that is "perched" on a relatively impermeable layer of clay 100 m (330 ft) above the Snake River Plain Aquifer. It was formed over time by percolation from the TRA waste water disposal ponds. The INEEL Project Office of the USGS has monitored perched water in the TRA area for many years. LMITCO personnel began routine compliance monitoring following closure of the TRA Radioactive Waste Pond in 1993. The agencies will use the monitoring data to determine whether contaminant concentrations are behaving as predicted in the perched water.

Waste Area Group 2 Comprehensive Remedial Investigation/Feasibility Study. Activities performed in 1996 related to the comprehensive investigation for Waste Area Group 2 included completing the remedial investigation and much of the feasibility study. The entire remedial investigation/feasibility study will be completed in 1997. The proposed plan will be completed and released for public comment in the first quarter of 1997. The Record of Decision is scheduled for completion in October 1997.

Waste Area Group 3–Idaho Chemical Processing Plant (ICPP)

Waste Area Group 3 Comprehensive Remedial Investigation/Feasibility Study. The draft comprehensive investigation/baseline risk assessment report was submitted to the EPA and the State of Idaho in August for their review and comment. Their comments were received in October 1996. The results of the groundwater modeling and the baseline risk assessment will be used to identify both the release sites that require further evaluation in the feasibility study and removal actions that may be necessary to prevent further migration of contaminants to the Snake River Plain Aquifer. The draft Remedial Investigation/baseline risk assessment and the draft feasibility study are scheduled to be submitted to the EPA and the State of Idaho in June 1997 for their review and comment.

Waste Area Group 4–Central Facilities Area (CFA)

Simulated Calcine/Mercury-Contaminated Soil Removal Action. Treatment of simulated calcine and mercury-contaminated soil was completed in early 1996. The remainder of the year was devoted to safely storing and evaluating disposal options for the treated materials and residual wastes. The materials treated were excavated from a dry pond used in the 1950s and 1960s to dispose of materials from the Chemical Engineering Laboratory during development of a nuclear waste calcining process. The excavation, treatment, storage, and disposal are being performed under a Comprehensive Environmental Response, Compensation and Liability Act removal action associated with the Operable Unit 4-05 Track 2 investigation.

Miscellaneous Sites 1996 Removal Action. Petroleum and lead contaminated materials, mostly soils, were cleaned up at three sites during 1996.

Petroleum contamination was cleaned up in the area of a fueling rack and fuel delivery fittings associated with a petroleum fuels tank farm that is no longer used. Approximately 1797 m^3 (2,350 yd^3) of contaminated material were excavated and transported to the CFA Land Farm for treatment. Before the excavation was backfilled, confirmation samples were taken to ensure that cleanup goals had been met.

Lead contamination was cleaned up at two sites. One site consisted of an area outside a lead shop, where lead scrap awaiting processing was stored on the ground. Another consisted of the portion of a fenced storage yard where lead objects were also kept on the ground. Approximately 410 m^3 (540 yd^3) of lead-contaminated materials (soil, asphalt, etc.) were excavated, placed in roll-off containers similar to large dumpsters used at construction sites, and shipped offsite for treatment and disposal. Confirmation samples were collected and analyzed after excavation was complete to ensure cleanup goals had been met. Contamination at a third site was checked and confirmed to be below the cleanup goal already.

Landfills I, II, and III Remedial Action. Most of the construction for this remedial action was completed in 1996, with some minor work to be performed in the spring of 1997. As specified in the Record of Decision for the CFA Landfills I, II, and III, Operable Unit 4-12, the remedy consisted of native soil covers, access controls such as fencing and signs, and environmental monitoring. Minimizing infiltration of water through the wastes that could facilitate migration of contaminants to the Snake River Plain Aquifer is the main purpose of the soil covers, which also mitigate direct contact with the wastes in the landfills.

Used as recently as 1984, the landfills accepted municipal-type and industrial wastes generated from INEEL operations. Wastes disposed to the landfills included cafeteria garbage, trash sweepings, weeds, grass, asphalt, asbestos, scrap lumber, and metal. DOE-ID, EPA, and the State agreed to take action to reduce any potential of ground-water contamination from the landfills and risks associated with exposure to the waste.

Waste Area Group 4 Comprehensive Remedial Investigation/Feasibility Study. This investigation for CFA began in 1996. DOE held scoping meetings with EPA and the State of Idaho and finalized the Scope of Work. The work plan drafted in 1996 will be finalized and the field investigation conducted in 1997. In total, 13 operable units and 52 potential release sites will be examined during this investigation.

Waste Area Group 5–Power Burst Facility (PBF)/Auxiliary Reactor Area (ARA)

Stationary Low-Power Reactor-1/Boiling Water Reactor Experiment-I. Although these two reactor burial sites are located in different Waste Area Groups, similarities led to combining them for the investigative and remedial processes.

The Stationary Low-Power Reactor-1 facility was a small nuclear power plant designed for the military to generate electric power and heat for remote installations. It accidentally achieved a critical reaction on January 3, 1961, resulting in a steam explosion that destroyed the reactor and killed the three operators on duty. To minimize radiation exposure to site workers and the public, a reactor burial ground was built for the contaminated debris near the original reactor site. Disposing of the material onsite was preferable to transporting the radioactive debris over 26 km (16 mi) of public highway to the Radioactive Waste Management Complex.

The Boiling Water Reactor Experiment-I facility was a small reactor for testing boiling water reactor technology. It was intentionally destroyed in 1954 after completion of its mission. The destruction of the reactor contaminated about 0.8 ha (2 acres) of surrounding terrain. Much of the reactor debris was buried in place, and the area was covered with about 15 cm (6 in) of gravel to reduce radioactivity levels.

The remedial investigation tasks for both sites included searching historical records, reviewing past sampling and radiological survey data, and performing computer modeling to estimate types and concentrations of radionuclides buried at the sites. Risk calculations were made and presented during a public comment period completed in May 1995.

The Record of Decision was signed in January 1996. The selected remedy for the two sites is to cap them with natural materials. The goal is to inhibit migration of the contaminants and to prevent direct exposure to ionizing radiation. Other major components of the selected remedy include recontouring and grading the surrounding terrain to direct surface water runoff away from the caps, inspecting and maintaining the caps, conducting periodic radiological surveys of the areas, restricting access and restricting land use to industrial applications for at least 100 years following installation of the caps. Construction of the caps was completed in the summer and fall of 1996 with final work on the surrounding areas to be performed in the spring of 1997.

ARA. A Time Critical Removal Action was conducted at the ARA-I facility in September and October 1996. Contaminated sludge was removed from aging septic tanks and placed in waste drums. The drums are currently kept in monitored compliant storage awaiting shipment for offsite treatment. The removal action was critical because the ability of the septic tanks to contain the waste could not be substantiated, and a release to the environment would lead to costly evaluation and clean-up.

Waste Area Group 5 Comprehensive Remedial Investigation/Feasibility Study. This investigation began in February 1995. Waste Area Group 5 has 13 operable units and 54 potential release sites. Activities for 1996 included finalization of the Scope of Work document and preparation of the draft work plan for the comprehensive remedial investigation/feasibility study. A campaign of ground-water level monitoring was conducted to aid in developing an accurate understanding of the hydraulic gradient below Waste Area Group 5. Activities planned for 1997 include finalization of the work plan, as well as sampling and analysis to support the remedial investigation and the baseline risk assessment.

Waste Area Group 6–Boiling Water Reactor Experiment

Boiling Water Reactor Experiment I. Remediation of this reactor burial site is discussed under Waste Area Group 5 with the SL-1 burial ground discussion.

Waste Area Group 6 Comprehensive Remedial Investigation/Feasibility Study. The comprehensive investigation for Waste Area Group 6 is being conducted in combination with the Waste Area Group 10 comprehensive remedial investigation/feasibility study.

Waste Area Group 7–Radioactive Waste Management Complex (RWMC)

Remedial Action of Organic Contamination in the Vadose Zone. The Record of Decision signed by DOE, EPA and the State of Idaho agreeing to use the vapor vacuum extraction with treatment as the remediation technology for the vadose zone at RWMC became final on December 2, 1994. The vadose zone is the area between the land surface and the top of the water table into which organic vapors were released when buried drums containing volatile organic compounds, such as degreasers and solvents, deteriorated over time. The three agencies agreed to take action because small quantities of the contaminants had already reached the Snake River Plain Aquifer.

The full-scale extraction/treatment system was installed during 1995 and became operational January 11, 1996. It consists of three treatment units that extract vapors from five wells. Extracted vapors are then treated using a state-of-the-art process called "Recuperative Flameless Thermal Oxidation." When the vapors reach the

optimum oxidation temperature inside the treatment units, the majority of organic compounds break down chemically to form carbon dioxide, hydrogen chloride and water. As of March 1997, approximately 10,000 kg (22,000 lb) of total volatile organic compounds have been removed from the vadose zone. Extensive modeling of air emission impacts was performed to determine ambient and occupational air quality impacts from the project. Actual emission levels are measured periodically to ensure compliance with requirements and to ensure safety of workers and the public.

Pit 9 Interim Action. During 1993, DOE, 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 0.4 ha (1 acre). Most of the waste in the pit originated at the Rocky Flats Plant in Colorado and the INEEL. The remediation subcontract for Pit 9 was awarded by LMITCO to Lockheed Martin Advanced Environmental Systems (LMAES) in October 1994.

LMAES proposed a three-stage process for Pit 9: physical separation, chemical treatment, and thermal stabilization. They will use remote retrieval technologies to safely remove soils and waste from Pit 9, chemically separate radionuclides and hazardous chemical wastes from soils, destroy the organics, and transform the remaining waste into a glass-like material which meets waste disposal requirements.

Site preparation and grading for the Pit 9 treatment facility began in December 1994. The Pit 9 Remedial Design/Remedial Action Scope of Work update to reflect LMAES' project approach and schedule was finalized by the agencies (DOE, EPA, State of Idaho) in January 1995.

LMAES began sampling soil to characterize the Pit 9 overburden in July 1995. These soil samples, taken from about 90 different locations, were analyzed for organic compounds and radioactive isotopes to determine whether the soil is contaminated above background levels. Construction of the facilities at Pit 9 began in the spring of 1995, and LMAES estimates construction will be completed by the end of 1997.

In early 1996, LMAES announced that due to safety and operational problems associated with the chemical treatment system during testing, it was abandoning the system. Instead, the company proposed to develop a radiological soil sorting system to perform the same function as the original process. LMAES is working with LMITCO and the agencies to develop a technical baseline for the project and to define system and design requirements.

Following completion of construction and preoperational systems testing, LMAES will conduct a limited production test to process a small amount of simulated and actual Pit 9 waste. If the test is successful, LMAES will be allowed to proceed with full-scale remediation. LMAES' 1996 project schedule estimates cleanup of Pit 9 will be completed in 2000.

Pad A. Pad A at the RWMC received packaged mixed wastes from 1972 to 1978 primarily from the Rocky Flats Plant in Colorado. Hazardous wastes included evaporator salts, primarily sodium nitrate and potassium nitrate, while radioactive wastes included plutonium, americium and uranium. Pad A was used for disposal of 10,000 m^3 (13,000 yd^3) of wastes.

The Record of Decision for Pad A was signed by DOE-ID, EPA, and the State of Idaho in February 1994. The selected alternative involved placing plywood and/or polyethylene over many of the containers and covering them with a 0.9-m (3-ft) soil layer. Recontouring of the pad cover was finished in late 1995.

The INEEL has now entered into the post-Record of Decision maintenance of the pad cover and monitoring. As part of this activity, personnel will monitor soil, surface water, air and existing ground-water wells. Monitoring will continue for five years, then the data will be evaluated to verify the protectiveness of the

remedial action. Monitoring information is being included in the Waste Area Group 7 comprehensive investigation.

Waste Area Group 7 Comprehensive Remedial Investigation/Feasibility Study. The investigation to evaluate Waste Area Group 7 in its entirety was initiated in 1995 to collect data and evaluate the cumulative impacts of the buried waste and the historical release from the Transuranic Storage Area. The work plan was finalized in March 1996. The plan was included in the Administrative Record where it, along with other public information pertaining to the comprehensive investigation, is available to the public.

Waste Area Group 8–Naval Reactors Facility (NRF)

Naval Reactors Facility Remediation. The DOE, EPA, and State of Idaho signed a Record of Decision for 10 sites at the NRF in 1994. Three of these sites were landfills, which the agencies agreed should be capped with a native soil cover. These actions were completed in 1996. The agencies agreed the other sites (the industrial waste ditch and six other landfills) required no further action.

Waste Area Group 8 Comprehensive Remedial Investigation/Feasibility Study. The work plan for the Waste Area Group 8 comprehensive investigation was finalized in November 1995. The work plan was submitted to the Administrative Record, where it, along with other public information pertaining to the comprehensive investigation, is available to the public. Supporting data were collected during 1996 for this investigation. The hydrogeological study, and the baseline and ecological risk assessments used to evaluate the impacts of human health and the environment of 17 potential release sites at NRF, is in draft form and will be finalized as part of the investigation in 1997.

Waste Area Group 9–Argonne National Laboratory–West (ANL-W)

Radioactive Liquid Waste Transfer Line Best Management Practice. Pipe from a lift station (sump) that leads to the ANL-W Leach Pit was sampled and is awaiting shipment to RWMC for disposal. It is suspected the pipe contains low levels of radioactive contamination.

Waste Area Group 9 Comprehensive Remedial Investigation/Feasibility Study. ANL-W began its comprehensive investigation for Waste Area Group 9 in June 1995. Preliminary data were collected in the fall of 1994 for this investigation. The scope of work and work plan are completed. The remedial investigation/baseline risk assessment that evaluates the impacts to human health and the environment of 19 potential release sites at ANL-W was completed in March 1997. The draft remedial investigation/feasibility study report is currently undergoing comment by EPA and the State of Idaho. Slightly elevated chloride levels are the only contaminants attributable to ANL-W activities that have been found in the Snake River Plain Aquifer.

Waste Area Group 10–Miscellaneous Sites/Snake River Plain Aquifer

Unexploded Ordnance Projects. Prior to the inception of the INEEL in 1949, the U.S. Navy conducted aerial bombing practice, naval artillery testing, explosives storage bunker testing, and ordnance disposal at the site. These naval activities resulted in the unexploded ordnance areas that are being addressed in this removal action. Ordnance found to date include artillery shells, partially exploded bombs, anti-tank mines, anti-personnel mines, depth charges, smokeless powder, and dummy bombs with spotting charges. Unexploded ordnance and explosive residues from four areas of the INEEL are being removed in a $3 million, time-critical removal action.

Allied Technology Group was subcontracted to locate, detonate and clear unexploded ordnance and explosive residues from four sites. These included a land mine fuse burn area, a site east of TRA, an area where railroad cars were detonated with explosives and a site adjacent to the rail car explosion area. This action will be completed in 1997.

The INEEL has removed hundreds of unexploded ordnance devices and disposed of contaminated soil and explosive chunks of TNT and RDX during the last four years in similar cleanup actions. Unexploded ordnance or explosive residues identified in this removal action are being transported to the Mass Detonation Area located east of NRF, where they will be detonated or destroyed. If items are determined to be unsafe to move, they will be detonated in place. All nonexplosive scrap may be recycled.

Radionuclide-Contaminated Soils Removal Action. On May 4, 1995, DOE, EPA Region 10, and the Idaho Department of Health and Welfare determined that seven of the Waste Area Group 10 radionuclide-contaminated soil sites were to be remediated through removal actions. The INEEL removed, consolidated and contained approximately 7,650 m^3 (10,000 yd^3) of radionuclide-contaminated soils that resulted from spills, storage, surface-contaminated materials, and wind blown contamination from these seven locations. Primary contaminants at the locations included ^{137}Cs, ^{90}Sr and ^{152}Eu. The excavated soil was collected and transported by truck to TRA where it was stored within the 1957 cell of the old Warm Waste Pond.

In 1996, soil removal activities continued at the TRA North Storage Area, and approximately 1,950 m^3 (2,550 yd^3) were removed and placed in the TRA Warm Waste Pond.

Excavation at one of the seven locations near TAN showed that contamination was widespread in several areas and could not be completely remediated through this soil removal action. Further assessment of that contamination is being conducted, and it may be appropriate to address this problem in the final TAN comprehensive remedial investigation/feasibility study. The excavated areas were recontoured and reseeded.

Waste Area Group 10 Comprehensive Remedial Investigation/Feasibility Study. The investigation for Waste Area Group 10 began in August 1996. This investigation is addressing potential release sites in Waste Area Groups 6 and 10 and the Snake River Plain Aquifer. Sampling activities will be conducted in 1997 to provide information for the baseline risk assessment.

Decontamination/Dismantlement/Demolition Activities

Decontamination, dismantlement, and demolition activities at the INEEL are primarily concerned with the safe decontamination of existing structures that can be reused and the demolition and disposal of surplus facilities. Eleven buildings were identified for dismantlement and demolition in 1996. Ten more are scheduled for 1997.

Pollution Prevention. All INEEL dismantlement and demolition projects are required to implement the precepts of pollution prevention. Waste volume reduction is accomplished by processing incinerable and compactible wastes at the Waste Experimental Reduction Facility (WERF) prior to disposal at RWMC. Reuse and reclamation of equipment and materials is a major goal of all facility disposition activities. In 1996, the program recycled 30,930 kg (68,200 lb) of scrap metal. The INEEL Portable Crushing Plant, utilized to reuse concrete debris, was loaned to Los Alamos National Laboratory and generated a savings across the DOE complex of $318,000.

Several decontamination, dismantlement, and demolition projects at INEEL facility areas were completed during the year and are summarized in the following paragraphs.

Army Re-entry Vehicle Field Station Bunker. Demolition, disposal, and soil recontouring of the bunker were completed this year. The bunker, a below grade metal arch structure, was used to store radioactively contaminated sodium-potassium waste until its removal for processing in 1995.

ARA-I. Demolition and disposal of three ARA-I area buildings were completed, and decontamination and equipment removal activities in Building ARA-626 were initiated. The ARA-626 Hot Cell Facility contains two radiologically contaminated, concrete hot cells. Demolition of the hot cell facility and the area guard house should be completed in 1997, completing the project.

ARA-III. Demolition and disposal of two buildings were completed, and a septic tank was removed. The remaining warehouse and service buildings will be demolished in 1997.

Boiling Organic Reactor Experiment. The cleanup of the reactor pits, septic system, and underground piping at this facility was completed. Hazardous and mixed waste was removed from the basement, facility entombment actions were completed, and the basement shielding block covers were reinstalled. This completes the project pending the final determination of the type of permanent cover to be placed over the foundation. This decision will be made through the Operable Unit 10-04 remedial investigation/ feasibility study estimated to be completed in the year 2000.

CFA. Three storage and maintenance buildings were demolished and removed.

ICPP. Characterization and planning for demolition of the Service Waste Diversion Facility was completed. Demolition and disposal will be completed in 1997.

TRA. The Experimental Test Reactor Cooling Tower Basin was demolished and entombed. The associated pumphouse is scheduled for demolition in 1997.

3.2 WASTE MANAGEMENT PROGRAM INFORMATION

General Information

The goals of the Waste Management Program are to manage wastes at the INEEL, ensuring that workers and the public are protected, and that the environment is not further impacted. INEEL waste management activities consist of:

- Reducing the total amount of wastes generated.
- Treating wastes already generated by reducing their toxicity, mobility, or volume.
- Storing wastes awaiting development of new disposal or treatment options.
- Disposing of wastes.

Another challenge faced in managing wastes at the INEEL is involving the citizens of Idaho in the search for solutions to significant waste management issues. A variety of methods are used to keep the public informed about INEEL activities and involved in making decisions. Some of these are discussed in Section 3.4.

Accomplishments of the Waste Management Program

The Federal Facility Compliance Act. This act requires the preparation of site treatment plans for the cleanup of mixed wastes, those containing both radioactive and nonradioactive hazardous materials, at the INEEL. The INEEL Proposed Site Treatment Plan was submitted to the State of Idaho and EPA on March 31, 1995. Copies of the plan were also sent to various reading rooms throughout Idaho, the INEEL Citizens Advisory Board, and the Shoshone-Bannock Tribes. This plan outlined DOE-ID's proposed treatment strategy for INEEL mixed waste streams and provided a preliminary analysis of potential offsite mixed low-level waste treatment capabilities.

The final INEEL Site Treatment Plan formed the basis for State of Idaho and DOE consent order negotiations for mixed waste treatment at the INEEL. The Federal Facility Compliance Act Consent Order and Site Treatment Plan was finalized and signed by the State of Idaho on November 1, 1995. Two changes to the administrative sections of the plan were negotiated to resolve issues between the State and DOE-ID: DOE reserved its right to challenge the approval authority of the State over offsite wastes, and both parties agreed to immediately modify the plan's schedules to be consistent with the Governor's Settlement Agreement and Court Order issued in October 1995 in the Spent Nuclear Fuel and INEEL Environmental Impact Statement litigation.

Public involvement activities in the Federal Facilities Compliance Act planning process at the INEEL were integrated into the overall public participation program already in place for environmental restoration and waste management activities. Public focus group meetings were held on the Conceptual Site Treatment Plan in 1993; briefings on the Draft Site Treatment Plan were held in 1994 in Twin Falls, Boise, Moscow and Idaho Falls to solicit public opinion early in the process. DOE-ID also briefed the INEEL Site Specific Advisory Board on the proposed plan, and responded to its comments and concerns.

In accordance with the INEEL Site Treatment Plan, the INEEL began receiving offsite mixed waste for treatment in January 1996. The shipments of offsite mixed waste were the result of two Department of Defense naval base closures: the Mare Island Naval Shipyard and the Charleston Naval Shipyard. The INEEL also expects to receive mixed waste shipments from other sites within the DOE complex including Los Alamos, Rocky Flats, Savannah River and Lawrence Livermore National Laboratories.

Storage and treatment of the majority of the offsite waste will be performed at the Waste Reduction Operations Complex using technologies of incineration, mercury retort, macroencapsulation, stabilization in Portland cement, neutralization, and carbon absorption. Additional offsite mixed wastes will be treated at the Advanced Mixed Waste Treatment Facility planned for construction at the INEEL.

Advanced Mixed Waste Treatment Project. The initial Request-for-Proposal for the Advanced Mixed Waste Treatment Project was issued in January 1996. The overall vision for the INEEL project is to treat alpha low-level mixed and transuranic waste for final disposal by a process that provides the greatest value to the government. This will be accomplished through a private sector treatment facility with the capability to treat specified INEEL waste streams, and with flexibility to treat other INEEL and DOE regional and national waste streams. The services will treat waste to meet the most current requirements, reduce waste volume and life-cycle cost to DOE, and perform tasks in a safe, environmentally compliant manner. An unclassified preproposal conference and tour of the RWMC was held in early March 1996.

Four corporate teams prepared proposals for the initial Request-for-Proposal, and at the completion of evaluations by the Source Evaluation Board, one team was eliminated from the competition. At the end of 1996, the three remaining teams had submitted their Best and Final Offers. British Nuclear Fuels Limited was awarded the contract in December 1996.

As a result of this privatization effort for the treatment of alpha and transuranic low-level mixed wastes, a task team comprised of representatives from DOE-Headquarters, DOE-WIPP, DOE-ID, and LMITCO, reviewed pertinent information regarding the need for the Waste Calcining Facility.

Plutonium Focus Area (PFA). In May 1994, the Defense Nuclear Facilities Safety Board issued Recommendation 94-1 expressing concern that the halt in weapons production froze the manufacturing pipeline, leaving it in a state that "...for safety reasons, should not be allowed to persist unremediated." In the recommendation, the

board expressed concern about certain liquids and solids containing unstable fissile materials and other radioactive substances stating "...imminent hazards could arise within two to three years unless certain problems are corrected." In response to board concerns, PFA was chartered (October 1995) to implement the 94-1 Research and Development Plan—identifying, developing, and deploying technologies for the stabilization, characterization, packaging, transportation, and interim storage of plutonium residues.

PFA is a multi-year (i.e., 1995-2002), complex-wide project that includes collaboration on technology ventures with Russian scientists as part of the U.S.-Russian non-proliferation program. PFA research and development projects for 1997 include:

- Development of 3,013 containers from radioactively contaminated scrap metal.
- Advanced plutonium stabilization technology development.
- Demonstration of integrated plutonium monitoring and surveillance system.
- Development of cold ceramification process.
- Development of plutonium packaging and transportation systems.
- Development of a plutonium stabilization verification system.
- Collaboration on Russian stabilization technologies.
- Continuation of complex-wide integration functions.

Mixed Waste Focus Area. DOE-HQ announced in December 1994 that the INEEL had been selected as the lead laboratory for mixed waste technology development. DOE-ID, supported by LMITCO, formed a group called the Mixed Waste Focus Area that is coordinating the national effort to treat mixed waste. At the INEEL alone, there is enough mixed waste to fill about 600 railroad boxcars.

In 1996, an Integrated Technical Baseline was prepared, which evaluated the characterization and treatment alternatives for all the mixed waste on the Mixed Waste Inventory Report. Technology deficiencies that prevent a treatment system from being implemented were identified and prioritized, and became the principal emphasis of the focus area. Thirty deficiencies for the implementation of thermal and non-thermal treatment systems were identified. An Integrated Master Schedule, reflecting the commitments made by Site Treatment Plans, was prepared and identifies when technology deficiencies must be resolved for the technologies to satisfy the site consent orders.

Some significant technical accomplishments in 1996 include the commercialization of Polymer Macroencapsulation by Envirocare of Utah. A cooperative agreement between Envirocare and the DOE will result in 235,000 kg (520,000 lb) of radioactively contaminated lead being transported to Envirocare, where it will be treated and disposed. The Transportable Vitrification System completed surrogate testing at Clemson University, and was disassembled and shipped to the Oak Ridge K-25 site. At Oak Ridge, it was reassembled for testing, and ultimately for the treatment of Oak Ridge waste water treatment sludges. The Plasma Hearth Process, Radioactive Bench Scale system, located at ANL-W initiated operations by treating surrogate waste materials. Demonstration of Chemically Bonded Phosphate Ceramics was accomplished by the Argonne National Laboratory, a room temperature stabilization technology based on natural analogues. Fifteen quick win projects were selected for funding that demonstrated technologies, and will also treat 93 m^3 (121 yd^3) of mixed waste.

DOE Accreditation Programs. The Radiological and Environmental Sciences Laboratory (RESL) at the INEEL is the national lead laboratory for two major laboratory accreditation programs. The

DOE Laboratory Accreditation Program for personnel dosimetry has operated since 1986. The bioassay portion of that program is being developed at RESL, and the draft handbook for the DOE Laboratory Accreditation Program for Radiobioassay has been distributed.

The second program is the Mixed Analyte Performance Evaluation Program. The program distributes samples containing known quantities of specific analytes to participating laboratories for analyses. During 1996, the entire Mixed Analyte program (sample preparation, distribution and reporting) was relocated to RESL.

National Low-level Waste Management Program. The INEEL provided technical support for commercial low-level waste disposal siting and disposal facility development in several states including Nebraska, California, Texas, Pennsylvania, and North Carolina. Work began with the DOE Office of Civilian Radioactive Waste to establish the Yucca Mountain, Nevada, repository as the final resting place for waste that does not meet Nuclear Regulatory Commission criteria for shallow land burial disposal. This is waste referred to as "Greater-Than-Class-C." DOE is responsible for the disposition of this waste. The National Low-level Waste Program is working with the Office of Civilian Radioactive Waste Management to permanently dispose of the nations's Greater-Than-Class-C waste.

Waste Minimization/Pollution Prevention

Key approaches to meeting Waste Management Program goals are waste minimization and pollution prevention programs. Current INEEL activities of these programs include:

- Identifying and analyzing options to reduce the volume of waste generated.
- Listing unused and excess chemicals and materials in the Material Exchange Program as available for use in other projects or facilities.
- Maintaining a database in which hazardous solvents are tracked to identify and substitute nonhazardous solvents when possible.
- Practicing sitewide recycling of as many materials as possible.
- Substituting reusable and nonhazardous materials for hazardous and disposable materials in the equipment and vehicle maintenance programs when possible.
- Sharing pollution prevention lessons learned with surrounding communities and industry.
- Examining production processes at the INEEL to determine whether improvements in process efficiency can result in a significant source reduction of wastes.

In a May 3, 1996 memorandum, the Secretary of Energy demonstrated the Department's continued commitment to pollution prevention by setting additional complex-wide goals to be achieved by December 31, 1999. These goals include a 50% reduction in releases and transfers of Toxic Release Inventory chemicals as well as new goals for a 50% reduction in the generation of radioactive, low-level mixed and hazardous wastes from routine operations; a 33% reduction in the generation of sanitary waste; recycling 33% of sanitary waste; and increasing procurement of EPA designated products to 100%.

On September 21, 1996, DOE participated in Idaho Falls' first annual Household Chemical Collection Day. The purpose of the event is to ensure safe disposal of household wastes that might otherwise end up in the city sewer or rivers.

On September 18, 1996, the INEEL was recognized by the Idaho Division of Environmental Quality for reducing the amount of hazardous waste generated at the Site. The INEEL received an award for reporting minimization of hazardous waste generated as reported in the 1991, 1993, and 1995 biennial reports.

Recycling and Re-use of Excess Materials

In November 1996, a paper pelletizer project was brought on-line and began converting the nonradioactive office waste at the ICPP into fuel for the INEEL Coal Fired Steam Generation Facility. During the month of November alone, 398 m^3 (520 yd^3) of ICPP waste was pelletized with an avoidable waste cost of $11,700. This translates to 80% of the ICPP office waste going to the pelletizer, and ultimately to fuel, rather than to the landfill. Beginning January 21, 1997, all INEEL old combustible waste began being diverted from the landfill to the paper pelletizer. Current projects show that disposal of INEEL nonradioactive waste to the landfill will be reduced by 65%, saving disposal costs of $1,646,000 annually. This project has generated interest world-wide and numerous tours have been performed. The paper pelletizer has also turned out to be a very cost effective method of handling the INEEL's security papers, resulting in a significant cost savings in the handling of the material. In addition to the cost savings, the mixture of coal and pellets burns cleaner and more efficiently than the present fuel. Burning pellets at the Coal Fired Steam Generation Facility will reduce sulfur and nitrogen oxide emissions and heavy metal releases.

Lead Management Program. The intent of the INEEL Lead Management Program is to minimize new lead purchases, evaluate lead substitutes, maximize reuse of contaminated lead for shielding, protect lead from contamination, reduce the accumulation of contaminated lead, recycle contaminated lead to the scrap metal market by decontamination and surface and volumetric survey for free release, and provide the means for generators to disposition mixed waste lead. The Lead Management Program completed sampling and inventory of all the mixed waste lead brick, shot, chunks and slabs in storage at the RWMC and the Mixed Waste Storage Facility. The total mixed lead sampled and inventoried was approximately 360,000 kg (800,000 lb).

The dismantlement of lead casks and devices continued. The cask dismantlement backlog treatment schedule was submitted to the State of Idaho in December 1996. Ten casks had been dismantled by the end of the fiscal year, and another eight devices are scheduled for dismantlement in 1997.

The INEEL shipped 12,000 kg (26,000 lb) of contaminated lead to Oak Ridge to fabricate lead shielded containers for storage of remotely handled transuranic waste at the INEEL. The lead had previously been in storage.

Alternative-fueled Vehicle Program

Regulations from the Clean Air Act and Executive Orders list specific requirements for 1995 to 1998, with respect to ensuring efficient and effective fleet operations at DOE facilities. These requirements include reducing gasoline and diesel fuel consumption and converting operations to alternate-fueled vehicles. The INEEL started conversion to bi-fuel vehicles that are able to operate on either natural gas or gasoline in 1995.

Six liquified natural gas-fueled buses were used to transport NBC dignitaries at the 1996 Summer Olympic Games in Atlanta. The buses were accepted by the Olympic Committee because of the good match with the Olympic theme for energy alternatives.

The INEEL installed a mobile liquid natural gas fueling station in 1995 at the new CFA Transportation Complex. Plans are to replace the mobile station with a permanent station, and move the mobile station to Idaho Falls. The permanent fueling station is expected to be installed and operational by May 1997.

Waste Treatment Accomplishments

Offsite Low-Level Waste Treatment. The INEEL is marketing the capacity to treat DOE mixed low-level waste by incineration at the Waste

Experimental Treatment Facility (WERF). Under provisions proposed in the INEEL Site Treatment Plan, any offsite waste received at the INEEL must be treated within six months of receipt, and all treatment residues sent out of Idaho within six months of treatment.

In June 1996, the INEEL received 51 drums of approximately 10,000 L (2,750 gal) of mixed low-level waste from the Los Alamos National Laboratory. This was the first DOE to DOE facility shipment of offsite waste to the INEEL. The shipment tested the system for receipt of offsite waste to see if the established time frames could be met. Six drums of ash, treatment residues from the incineration of the mixed low-level waste, were shipped to Envirocare in Utah for permanent disposal in March 1997. All time frames were met.

To date, the INEEL has received shipments of mixed low-level waste for incineration from Norfolk, Charleston, Mare Island, Pearl Harbor, Puget Sound and Newport News Naval Shipyards, Knolls and Bettis Atomic Power Laboratories, as well as Los Alamos National Laboratory.

WERF Restart Program. WERF personnel completed the incineration of a backlog of mixed low-level waste not reserved for other commitments. Eighty percent of the waste was incinerated, and the remaining 20% has been set aside for RCRA Part B trial burn scheduled for May 1997. WERF incinerated 482 m^3 (630 yd^3) of mixed waste.

WERF also conducted processes, including cutting and compaction, during 1996 to reduce the quantity of wastes. WERF cut 612 m^3 (800 yd^3) and compacted 514 m^3 (672 yd^3) of low-level waste.

Dry Rod Consolidation Technology-disposition Project. Project personnel began segmenting and packaging non-fuel bearing components of radioactive fuel assembly skeletons stored in the TAN pool and separating them into either Class C waste or Special Case waste. The Class C waste was to be disposed at RWMC and the Special Case waste was to be stored at RWMC for future disposition. Shearing of the 10 drums of Class C waste and the six drums of Special Case waste was completed in December 1995. Shipping of the Class C waste to RWMC was completed in April 1996, and shipping of the Special Case waste was completed in October 1996.

Sodium/Potassium Wastes. In September 1995, 680 L (180 gal) of Sodium/Potassium waste was moved from the Army Reentry Vehicle Facility Site Bunker, where it had been in storage for over 40 years, to ANL-W for treatment. The treatment process included reacting the waste material with water, neutralizing the resulting solution, and solidifying the neutralized solution. The treatment of the waste was completed in 1996, and the solid radioactive waste resulting from the treatment process was sent to the RWMC for disposal. Following the removal of the waste from the bunker, the bunker was administratively closed under RCRA, and subsequently removed. The location was planted with native vegetation.

In December 1995, the TAN Operations group reprioritized the removal of the S1G sodium tank from the TAN-647 RCRA storage area to ANL-W for treatment and disposal. The task was completed in 1996. This closes an issue with the State of Idaho concerning a RCRA Notice of Violation item related to the roll-up door at the TAN-647 building

Scrap Metal and Incinerable Low-level Waste Shipped Offsite. The INEEL has sent five shipments totaling 392,000 kg (865,000 lb) of low-level waste to Scientific Ecology Group in Oak Ridge, Tennessee. Scientific Ecology uses incineration, then ash compaction or ash solidification, to treat the low-level waste. The residue from the low-level waste is sampled, analyzed for hazardous and radiological constituents, packaged and returned to the INEEL for disposal at RWMC. Treatment to achieve volume reduction of 260:1 to 470:1 helps extend the life of the disposal area. Processing the waste also converts the waste to a more stable form,

minimizing void spaces and future settling. The incinerable low-level waste shipped to Oak Ridge contains short-lived radionuclides that can be handled directly by personnel without shielding. The low-level waste consists of materials such as rags, plastic, protective clothing, and scrap wood routinely generated as a result of work in radiologically-controlled areas.

The INEEL also transported approximately 21,000 kg (46,000 lb) of radiologically contaminated recyclable scrap metal to Scientific Ecology for metal melt and beneficial reuse. The metal is melted and custom molded into high-density ingots that will be transported to Los Alamos National Laboratory and reused as radiological shielding blocks. Approximately 5% by weight will be removed as slag, analyzed for hazardous and radiological constituents, packaged and returned to the INEEL for disposal.

Waste Storage Accomplishments

Dry Fuel Storage Agreement. DOE-ID presented its case to the State for storage of certain CPP-603 fuels in the Irradiated Fuel Storage Facility. However, the State did not agree that the facility is adequate for safe storage, due to seismic vulnerabilities of the facility. Based on the use of the facility for longer-term interim storage (possibly for 40 more years) and on discussions with the Defense Nuclear Facilities Safety Board, upgrades to the facility are planned. Another agreement has been prepared for signature by DOE-ID and the State that will allow DOE to store fuel from CPP-603 in the facility during the facility upgrades. Further seismic analyses of the facility are in progress that will be the basis for the upgrades. The agreement will be needed by about July 1, 1997. Technical issues on the agreement have been resolved. No fuel from CPP-603 has been stored in alternate facilities to date.

The Idaho Settlement Agreement. On October 16, 1995, a settlement agreement was signed by DOE, the U.S. Navy and the State of Idaho to resolve issues surrounding a court order that prohibited the receipt of spent nuclear fuel for storage at the INEEL. As part of the settlement agreement, the INEEL has been designated DOE's lead laboratory for spent fuel. As the lead laboratory for spent fuel, the INEEL will direct the research, development and testing of treatment, shipment and disposal technologies for all DOE spent fuel, and coordinate and integrate all such DOE activities under the direction of the DOE-ID Manager. The INEEL has also initiated the budget process for appropriations requests to the Executive Office of the President for funds necessary for DOE to initiate procurement of dry storage at the INEEL to replace wet, below ground facilities.

As a result of the settlement agreement, the Fort St. Vrain contract was modified to implement an Agreement In Principle for the purchase of the Fort St. Vrain Independent Spent Fuel Storage Installation by the DOE on February 9, 1996. This gives DOE immediate title to the Fort St. Vrain fuel, pays Public Services Company of Colorado $16 million, and provides for the continued management of Fort St. Vrain spent nuclear fuel stored there under Nuclear Regulatory Commission license.

The INEEL began operating offsite mixed waste treatment processes under the settlement agreement schedule restrictions. The agreement commitments are to treat any and all offsite treatable waste shipped into the State of Idaho within six months of receipt at the treatment facility and to have those same wastes shipped outside Idaho for storage or disposal within six months following treatment.

Initial operation of the new High-level Liquid Waste Evaporator occurred on June 1, 1996, five months ahead of the agreement milestone. Since the start of operation, the evaporator has processed approximately 2.9 million L (757,000 gal) of liquid waste feed (including the non-sodium bearing liquid) from the tank farm.

The agreement provides the State of Idaho beginning in fiscal year 1996, and continuing thru 1997-2000, a total amount of $30 million for

community transition purposes, or any other purpose mutually acceptable to the parties.

In December 1996, DOE awarded a procurement contract to British Nuclear Fuels, Limited for the Advanced Mixed Waste Treatment Project. This was six months ahead of the milestone in the settlement agreement.

Waste Disposal Accomplishments

Although it is DOE's goal to eliminate the generation of wastes, ongoing operations result in the creation of waste ultimately requiring disposal, and in some cases, permanent isolation from people and the environment. Currently, only industrial and low-level radioactive wastes are being disposed at the INEEL. Other waste types are being stored for eventual disposal at the Site or elsewhere or until treatment technologies are available.

Low-level Radioactive Waste. Approximately 40% of low-level wastes, but no hazardous wastes, generated at the INEEL are buried at RWMC in shallow pits. The remaining 60% will be buried at RWMC following treatment for volume reduction. The compacting and sizing processes at WERF reduce the volume of wastes before disposal. Additionally, some low-level wastes are shipped offsite to be incinerated, and the residual ash is returned to the INEEL for disposal. The RWMC is expected to be filled to capacity by the year 2030. Future disposal of low-level waste is being evaluated by DOE, the State and other regulators.

Transuranic Waste. All consent order and settlement agreement milestones related to management of transuranic (TRU) waste were met in 1996. Reconfiguration of accessibly stored TRU waste was completed in November 1996, six weeks ahead of schedule. In addition, the contract for the Advance Mixed Waste Treatment Facility was awarded in December 1996, six months ahead of schedule.

The TRU Waste Characterization Program will ensure TRU waste is properly characterized to meet the WIPP Waste Acceptance Criteria. Intrusive characterization at ANL-W and non-intrusive characterization at the RWMC are proceeding according to schedule. Integration of two systems, which will improve the accuracy of characterization data, occurred in 1996. Start-up and certification of the Analytical Chemistry Laboratory, to increase analysis capability, was also completed. The concept for a container/data management system called the Transuranic Reporting Inventory and Processing System, was developed in order to handle the critical data requirements identified by WIPP.

The Technical Support Program assists the DOE-Carlsbad office in their efforts to provide scientific evidence to the EPA and the State of New Mexico in support their Compliance Certification Application and RCRA Part B permit. The INEEL is providing actual waste characterization data to support modeling efforts, which are proceeding on schedule. The EPA has approved the use of the Fourier Transform Infrared Spectroscopy system, which will allow real-time head space gas sampling. Construction of a prototype mobile gas sampling and venting system was completed.

A program was initiated to determine the accuracy required of equipment to meet the WIPP Waste Acceptance Criteria and Quality Assurance Program Plan requirements. Efforts in support of the Matrix Depletion Program were continued to provide scientific evidence to support the reduction of WIPP Waste Acceptance Criteria transportation requirements. The INEEL assisted in the development and execution of the Performance Demonstration Program, which certifies that equipment across the complex is operating satisfactorily and provides assurances to the regulators of WIPP that waste is being properly characterized. The WIPP Waste Information System was completed in 1996 and turned over to the Carlsbad office.

The TRU project supported efforts to examine the effectiveness of the Waste Inspection Tomography and the Active and Passive Neutron

Examination and Assay systems. This is a joint venture between DOE, academia and private industry to improve characterization of TRU waste.

A joint effort between the INEEL and Oak Ridge National Laboratory resulted in the shipment of 11,800 kg (26,000 lb) of TRU-contaminated lead to Oak Ridge, where the lead was manufactured into shielded overpacks for return to the INEEL. The shielded overpacks will allow remote-handled TRU waste to be managed and stored as contact-handled TRU waste, resulting in an annual cost savings of $80,000.

Offsite Disposal. The INEEL successfully shipped 38 rail cars of soil with radioactive contamination to Envirocare, a licensed disposal facility in Utah. The soils, originating at ICPP and NRF, were contaminated as a result of maintenance, construction, and environmental restoration activites. A total of 1937 m^3 (2,533 yd^3) of soil was disposed at the Envirocare facility rather than RWMC. All shipments met Department of Transportation requirements, and notifications of shipments were given to the State of Idaho and the Shoshone-Bannock Tribes. These shipments represent the first time a significant amount of INEEL-generated radioactive waste was disposed off the INEEL site.

Waste-related Research and Development

A wide variety of research projects are conducted at the INEEL to benefit major DOE-ID program. The Environmental Science and Research Foundation and its University affiliates primarily conduct ecological and radioecological research. LMITCO conducts a wide range of projects including methods of waste characterization and disposal, robotics, alternate-fuel vehicles, and bioremediation of wastes.

Environmental Science and Research Foundation Program. The Environmental Science and Research Foundation, an independent nonprofit organization, conducts a variety of waste-related research for DOE-ID on the INEEL. Much of this work is performed through a network of university affiliates from local and regional academic institutions.

The Protective Cap/Biobarrier Experiment was designed to rigorously test the performance of four protective cap configurations for low-level buried wastes in semi-arid to arid climates. The ultimate objective of the experiment is to confidently recommend an effective, economical soil-plant cover system for interred wastes at the INEEL and climatically similar repositories. During the first three years, baseline data were collected on plant establishment, rooting depths, patterns of soil water storage and depletion. Burrowing ants were introduced to the plots in 1996, and borrowing rodents will be introduced in the spring of 1997. Current plans call for application of excess irrigation until cap failure occurs (drainage through the entire cap) in the sixth year. Results from these manipulations will allow the prediction of the amount and seasonal distribution of precipitation that could fall on the site before a particular cap configuration would fail, and whether burrowing organisms will significantly affect cap performance under high levels of precipitation.

The intrusion of burrowing mammals into hazardous waste areas and the subsequent transport of waste off the burial area has been shown to be a problem on older waste areas and continues to be a concern regarding future closure of current waste areas. The objective of one study is to determine the effectiveness of three types of material in preventing the burrowing of small mammals into waste areas. An additional objective was to determine if creating such a biobarrier in the presence of burrowing mammals might alter soil moisture patterns and compromise the integrity of the waste cap.

Various EPA and DOE regulations require that shallow-land burial sites for low-level radioactive wastes remain effective for at least 100 years. Primary to the success of a waste management site is the capability to keep wastes isolated from water. At the INEEL, most of the

annual soil moisture recharge results from precipitation that occurs during the months when plants are dormant (October - March). Improvements in management practices since 1952 at the RWMC have resulted in differences in soil covers, thickness, land contours, vegetation types, and proximity of buried wastes to roads and ditches. Each of these factors influences soil moisture dynamics in the protective soil caps. Since 1988, the Foundation has measured soil moisture on eight study sites within the RWMC, mostly during the late winter, early summer, and fall. Throughout that period, precipitation during the non-growing season ranged from 46.6% to 135.5% of normal. Soil moisture recharge was generally less than 40 cm (16 in) deep for all areas and years except for 1989, 1993, and 1995. During those years maximum infiltration was recorded at depths of up to 1.4 m (4.5 ft).

Research is being conducted to determine the fate of radionuclides released as liquid effluent to two double-lined evaporation ponds at TRA. In order to determine the fate of radionuclides at the TRA ponds, it is necessary to quantify all inputs to, and losses from, those systems. Emphasis was placed on determining potential radionuclide transport from the ponds, especially transport to humans via waterfowl which have spent time on the ponds. During 1996, 112 samples were taken to quantify radionuclide concentrations in the pond components and in bird species potentially transporting radionuclides from the ponds. A total of 317 analyses were conducted on those samples. Results from the analysis of waterfowl and mourning doves are presented in Chapter 4, and an evaluation of the potential dose to humans is provided in Chapter 8 [Reference 3-1].

Subsurface Contaminants Focus Area. In early 1996, the Landfill Stabilization Focus Area and Plumes Focus Area were combined to form the new Subsurface Contaminants Focus Area, led by DOE's Savannah River Site. The mission is to contain, control, and/or remediate waste site source terms and contaminant plumes to environmentally acceptable levels. The INEEL has taken an active role in the management team through its leadership of the Source Term Remediation Product Line, featuring a suite of technologies related to location, characterization, retrieval, stabilization, and disposal of buried wastes.

The INEEL has been successful in achieving applications, or deployments, of several of these technologies to actual buried waste sites at the INEEL and other DOE facilities, including the Savannah River Site and the Mound facility. Partnerships have been formed with other DOE offices, private industry, and universities for development and deployment of these technologies.

Other Subsurface Contaminants Focus Area projects at the INEEL include development of technologies that address remediation of the TAN Injection Well plume, and emplacement of subsurface barriers under existing waste pits. The INEEL also provides systems engineering and integration services for the focus area and has created the Decision Analysis for Remediation Technology System, an interactive database that includes complex-wide subsurface remediation needs and applicable technologies.

3.4 ADDITIONAL ENVIRONMENTAL PROGRAMS

Public Involvement in INEEL Program Activities

During 1996, the INEEL Citizens Advisory Board (consisting of 15 citizens from around the state, and three ex-officio members from DOE-ID, EPA, and the State of Idaho INEEL Oversight Program) met every two months to review and discuss INEEL programs and activities. The board considered official recommendations and received briefings and updates on such projects as the spent fuel Settlement Agreement between the State of Idaho, DOE, and the U.S. Navy; INEEL Environmental Management Ten-Year Plan; environmental restoration activities at the RWMC, TAN, and ICPP; and issues related to waste minimization, storage, treatment, and disposal.

In the summer of 1996, DOE conducted a public comment period on a new planning and budget document called the INEEL Environmental Management Ten-Year Plan. This draft plan was released for public comment, and was the topic of discussion at a public meeting where the Assistant Secretary of DOE Environmental Management met with citizens. An updated discussion draft of the plan is expected to be released in mid-1997.

In late 1996, a focus group of eight citizens was convened by DOE-ID to review and update the May 1995 INEEL Community Relations Plan. The State of Idaho and the EPA also participated in the discussions. The focus group was briefed on the status of environmental restoration activities at the site and the comprehensive remedial investigation/feasibility study underway at Waste Area Group 2 (TRA). The focus group and the agencies jointly agreed to have focus group members review and comment on a draft fact sheet and draft proposed cleanup plan the agencies were preparing for distribution to the public in early 1997.

Articles in the *INEEL Reporter* bimonthly newsletter, distributed to more than 6,000 readers, also provided details on the status of cleanup projects. Additional information was distributed to the public via two *INEEL Reporter* supplements called Citizens' Guides that summarized annual environmental restoration and waste management program activities. In addition, "kick-off" and update fact sheets were distributed to readers to keep them informed of cleanup progress being made. These publications were available in Information Repositories and via the Internet.

Members of the public may call 1-800-708-2680 to request specific documents. These documents are also available on the Internet by typing http://www.inel.gov to call up the INEEL Homepage. The *INEEL Reporter* is found under "What's New."

Public Communication and Education Activities

To foster public understanding of environmental issues involving the INEEL, concerted communication and education efforts are made by DOE-ID and its contractors. A wide array of tours, speaking engagements, newsletters, and opportunities to request INEEL information are made available to interested persons. These efforts provided information directly to about 50,000 people in 1996. News releases and other contacts with journalists spread INEEL messages to much wider audiences.

LMITCO Public Affairs. Though the LMITCO Public Affairs Department communicates about all INEEL activities, its broad focus includes environmental matters. LMITCO Public Affairs is responsible for INEEL facility tours, the Experimental Breeder Reactor I (EBR-I) historic landmark, INEEL news media relations, INEEL's speakers bureau, and a toll-free telephone service for information requests. For all these activities, LMITCO Public Affairs reported 44,331 contacts during 1996.

Almost 11,000 people toured the INEEL in 1996. A total of 4,492 persons in 273 groups took day-long tours of the Site. Tours are individually arranged to visit facilities that suit the interests of each group. Most tours include a stop at EBR-I and a viewing of the spent fuel storage pools inside ICPP. EBR-I, a National Historic Landmark where electricity was first produced from atomic energy, is open to walk-in visitors from Memorial Day to Labor Day. A total of 6,334 individuals visited the EBR-I facility. Visitors gain not only a historical perspective on the development of nuclear reactors, but also an overview of research at the INEEL and the flora and fauna of the sagebrush steppe. Since 1979, when EBR-I opened for tours, about 200,000 persons, from every state and dozens of countries, have visited the facility.

In news media relations, LMITCO Public Affairs recorded 2,254 contacts with journalists. This activity includes the writing and distribution of 140 news releases and the arrangement of 512 interviews with INEEL personnel.

The INEEL Speakers Bureau facilitated 640 talks to a total of 30,538 persons by INEEL engineers and scientists during 1996. Common audiences were schoolchildren, civic groups, and scientific meetings.

Through a toll-free telephone number (800-708-2680), anyone can call the INEEL to ask questions and request copies of documents. During 1996, 713 calls were handled. These calls resulted in 498 filled information requests and the distribution of 1,119 documents.

Environmental Science and Research Foundation Communication Programs. The Environmental Science and Research Foundation, as a DOE-ID contractor for environmental monitoring, ecological research, and environmental services on the INEEL, aims to improve public understanding of the INEEL's environment through an environmental public education program. This program employs two community monitoring stations; news releases; presentations; interpretive signs, posters, and displays; publications; an INEEL travelers' information radio station; and a newsletter. The content of these communication strategies incorporates a recognition of the INEEL's environmental legacy of radioactive materials, which must be properly managed, with plenty of information about the wealth of Idaho's natural heritage present on the Site. As a much smaller organization than LMITCO, the Foundation's communication and education activities are not as extensive. They do, however, concentrate solely on INEEL environmental matters.

One of the primary responsibilities of the The INEEL Offsite Environmental Surveillance Program is to communicate environmental data to the public. The data, along with easy-to-follow interpretations and explanations of their underlying concepts, are incorporated into reports, report summaries, fact sheets, multimedia presentations, and a portable display. The Foundation's portable display describes the environmental surveillance program, and was made available to libraries and other public institutions throughout Idaho. It appeared at 11 locations: Hailey, Twin Falls, Rupert, Fort Hall, Pocatello, Arco, Carey, Terreton, Boise, Rexburg, and Rigby.

New educational tools for the environmental surveillance program, a pair of community monitoring stations (CMSs) were established at Madison Middle School in Rexburg and Mountain View Middle School in Blackfoot. These stations monitor radioactivity and particulates in the air, environmental radiation levels, and weather conditions, providing some real-time measurements and collection of samples for laboratory analysis. The stations provide community involvement and educational opportunities, as well as actual environmental surveillance data. Data from the stations, along with other data collected within the surveillance program, are being incorporated into the science and mathematics curricula.

As part of the two new CMSs, permanent displays were constructed. At each CMS, signs explaining the basis for environmental monitoring, explaining INEEL Environmental Surveillance Program findings, and featuring real-time display of data were installed. These signs also contain a bulletin board where the science teachers who manage the stations can display messages and student work.

The Foundation issued 25 news releases about the INEEL's environment to a mailing list containing 212 news media outlets. During 1996, the Foundation personnel gave 49 presentations to professional peers, students, civic leaders, and other audiences. More than 1,500 persons attended Foundation presentations.

During 1996, 10 reports were published by the Foundation. Notable among these publications were *Plant Communities, Ethnoecology, and*

Flora of the Idaho National Engineering Laboratory, a compilation of 50 years worth of vegetation studies on and around the Site, and the *Idaho National Engineering Laboratory Site Environmental Report for Calendar Year 1995*. In addition to Foundation published reports, Foundation researchers had 15 technical, peer-reviewed articles and reports published, in-press, or submitted during 1996.

A Foundation-operated INEEL travelers' information radio station broadcast continuously during 1996. Located at the intersection of U.S. Highways 20 and 26, the low-powered transmitter broadcasts on a frequency of 530 AM and is available to persons in the 800,000 vehicles driving on these highways each year. Fourteen messages discussed the environment, natural history, and cultural history of the INEEL and the southeastern Idaho desert. To provide future messages, as well as an educational opportunity, a contest was held for area high school students. Awards were presented to 16 students.

The *Foundation Focus* newsletter reached an expanded audience. Circulation grew to 1,024 in 1996. The final issue of this volume was significant in introducing an in-depth series of articles entitled, "The Site, the Plain, the Aquifer, and the Magic Valley." The newsletter's value as a direct voice of an independent non-profit organization is significant in highlighting important environmental work at the INEEL.

Shoshone-Bannock Tribes Cooperative Agreement. DOE-ID, through an existing Cooperative Agreement, is supporting the establishment and maintenance of a Community Monitoring Station on the Fort Hall Indian Reservation as a collaborative effort between NOAA, the INEEL Oversight Program, DOE and the Shoshone-Bannock Tribes. The Fort Hall CMS will be linked to the State monitoring station network and contains air monitoring and meteorological equipment. The CMS became operational in early 1997.

INEEL-sponsored Academic Programs

During the past four summers, the INEEL has hosted teams of high school teachers and students who performed research projects that supported DOE program initiatives as well as various entities outside the INEEL/DOE system. Many of the projects conducted by these Science Action Teams were in the areas of environmental restoration and waste management with LMITCO and Environmental Science and Research Foundation scientists as mentors. The teams consisted of bright and progressive junior- and senior-high school students and math or science teachers. They performed their research at the INEEL over an eight-week period.

By hosting these teams, the INEEL supports math, science and research education. Using INEEL facilities and mentors to lead a research activity results in providing useful data to the funding program at a minimal cost. Another benefit is in a future workforce that has been exposed to real world problems and the process required to address those problems. Additionally, most of the end products are of interest to local business communities, government agencies, and universities.

In previous years, the INEEL developed partnerships with local universities, cities, school districts, and federal and state agencies. These partners provide resources (supplies, equipment, databases, technical expertise, and time) to support the research topic that individually interests them. Last year's teams:

- Identified, collected, and consolidated numerous federal and State of Idaho databases containing environmental information into an accessible and user friendly database. This consolidated database is easy to update and compatible with current PC software.

- Retrofitted a stripped vehicle with electric components and will enter the car into an

electric vehicle competition to be held in Phoenix, Arizona in 1997.

- Built, tested and monitored stream side incubators to increase the number of salmon and trout in Idaho streams.

- Studied the recovery of the plant community and associated animals, including insects, following two large wildland fires on the INEEL—the 1994 Butte City fire and the 1995 Argonne fire. Studies included a comparison of the recovery of an area planted with winter wheat in an effort to reduce blowing dust with naturally recovering sites.

- Grew a silver scurf fungus on Idaho potatoes to test potential silver scurf eradication techniques for the fungus. Silver scurf has been an increasing problem for Idaho farmers over the past 10 years.

- Utilized tissue culture techniques to grow a large number of potato seed plants in a very short period of time without introducing genetic defects.

- Worked to develop a bioremediation technique to clean up potato processing waste for a major potato processor.

- Studied the possibility of using computer programs to analyze data and form neural networks.

- Tested a sophisticated piece of ultrasonic equipment and then developed dimensional animations of the equipment to enable prospective customers to see what the equipment looks like and how it can be used.

- Created multiple web sites and developed smart sensing software and hardware to protect containers while in storage and while being transported.

- Created a computer program that prospective isotope customers will use to determine power and energy (neutron) flux levels by clicking on an animated picture of the reactor core port and clicking at a point in the port.

- Determined multiple cost effective uses for a privately owned geothermal source located in southern Idaho.

3.5 ENVIRONMENTAL MONITORING

Purpose and Organization of Monitoring Programs

Routine operation of INEEL facilities releases some materials, which may include both radioactive and nonradioactive contaminants, into the environment. There are two primary routes by which these materials can enter the environment—into the atmosphere as airborne effluents and into surface and ground waters as liquid effluents. Through a variety of exposure pathways (Figure 3-1), contaminants can be transported away from INEEL facilities, where they could potentially impact the surrounding environment and the population living in these areas.

The primary purpose of the various environmental monitoring programs conducted at the INEEL is to evaluate these different exposure pathways, and determine what effects may be occuring in the environment. In addition, monitoring provides the information to verify compliance with a variety of applicable environmental protection laws and regulations described in Chapter 2. DOE Order 5400.1 also requires DOE sites to conduct an environmental monitoring program.

The term *environmental monitoring* is used to describe two separate activities. Effluent monitoring is the measurement of the waste stream prior to its release to the environment, such as the monitoring of stacks or discharge pipes. Environmental surveillance is the measurement of pollutants in the environment. Surveillance involves determining whether or not pollutants are

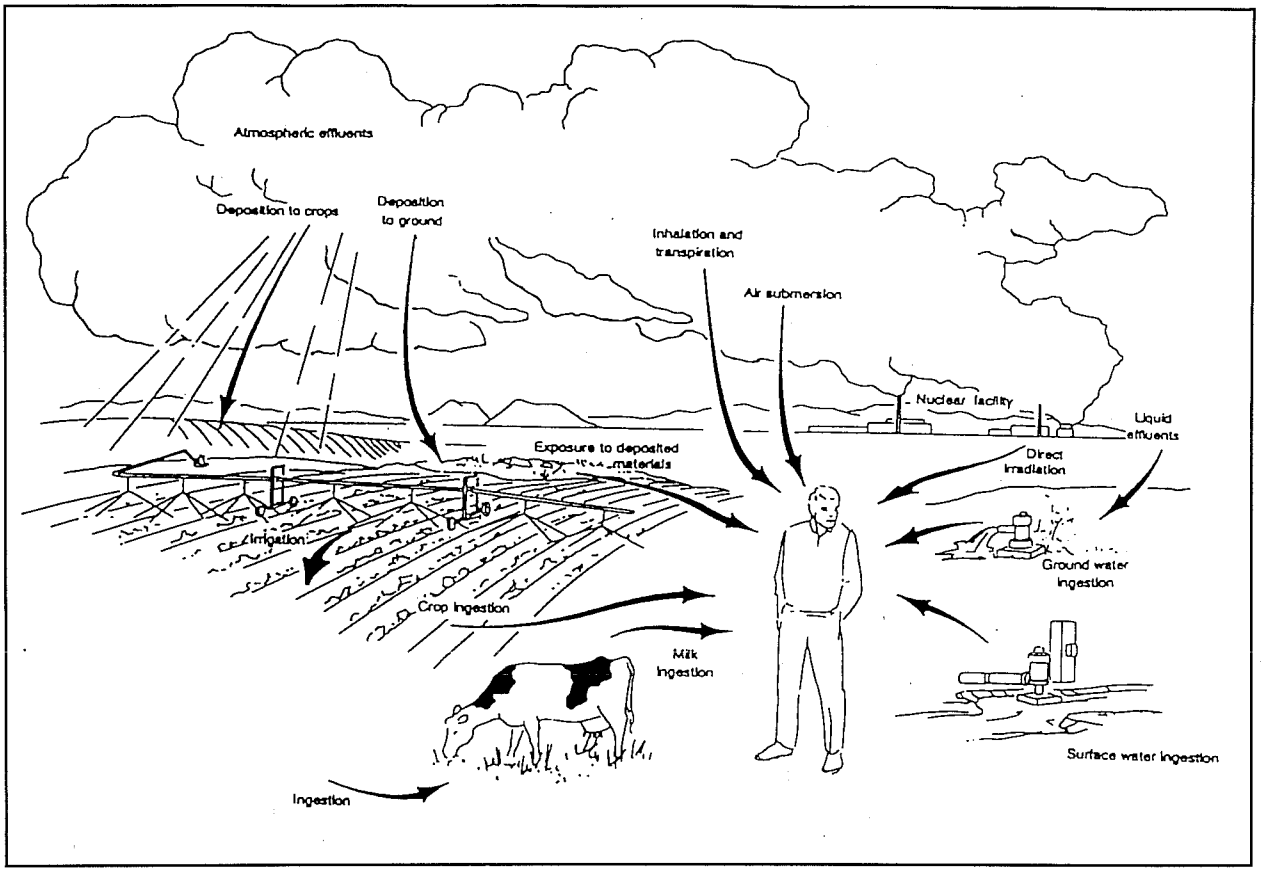


Figure 3-1. Potential Pathways from the INEEL to Humans

present or measurable, and if present, in what concentrations they are found.

At the INEEL, environmental monitoring is a collective effort involving a number of different organizations and groups. The remainder of this section provides a brief summary of the various environmental monitoring activities currently being conducted.

Effluent Monitoring Programs

Radiological Effluents. Radionuclides in airborne effluents released to the environment were monitored by the contractor responsible for operating each facility. There are currently five airborne emission points for which continuous monitoring for radionuclides is required under the National Emission Standards for Hazardous Air Pollutants. Of these five points, two are at ANL-W, one is at ICPP, and two are at WERF. Other emission points are monitored to verify that they remain below the threshold at which continuous monitoring is required, or for general facility information.

Data from each of these release points are reported monthly to a centralized database, the Radioactive Waste Management Information System, operated by LMITCO. An annual report of the results of the effluent monitoring organizes the data by month, facility, and radionuclide.

Radioactive liquid effluents are also monitored at release points and compiled in the Radioactive Waste Management Information System. Most liquid radioactive effluents are discharged into ponds. No radioactive liquids are released to offsite surface waters, or to streams on the INEEL.

Nonradiological Effluents. Nonradiological airborne effluents originate from the following primary sources at the INEEL:

- Calcination of high-level radioactive liquid waste at the New Waste Calcining Facility.
- Combustion of coal for steam generation at the Coal Fired Steam Generating Facility.
- Combustion of fuel oil used for heating INEEL facilities.
- Combustion of fuel in engines operating generators.
- Motor vehicle exhaust.
- Fugitive dusts from a number of activities, including construction and waste burial.

Emissions of nitrogen dioxide are routinely monitored at the New Waste Calcining Facility, and sulfur dioxide, nitrogen dioxide, and carbon oxides are monitored at the Coal Fired Steam Generating Facility. Monitoring data for these sources are published in the INEEL Nonradiological Waste Management Information System quarterly reports. Sulfur dioxide emissions from heating oil usage are calculated from the sulfur content and the quantity of fuel used. Emissions of nitrogen dioxide from fuel oil are calculated using EPA emission factors [Reference 3-2] and the amount and type of oil used at each facility. Motor vehicle exhausts and fugitive dusts are not monitored at the source.

At ANL–W, the Experimental Breeder Reactor II auxiliary boilers are monitored monthly as an efficiency check, and to ensure emissions of nitrogen oxides and sulfur dioxide remain below the State of Idaho's emission limits. A portable stack emission monitor provides a direct printout of ambient and stack temperature, carbon monoxide, carbon dioxide, sulfur dioxide, nitrogen oxides, and oxygen.

Routine direct disposal of wastes to the Snake River Plain Aquifer ceased in 1984. Liquid wastes are now disposed to sewage lagoons, seepage ponds, industrial waste ponds, industrial waste ditches, and sewage treatment facilities. The liquid effluent monitoring program is presently operated by LMITCO for effluent streams at CFA, ICPP, RWMC, TAN, and TRA. In addition, monitoring is performed by the program for INEEL-related facilities located in the city of Idaho Falls. A total of 27 discharge points were routinely monitored for nonradiological parameters in 1996.

ANL–W monitors the Industrial Waste Pond and the Primary Sanitary Lagoon monthly for nonradiological constituents when these ponds are not frozen or dry.

Facility Monitoring Programs

Several INEEL facilities conduct environmental surveillance within, and around the perimeters, of their facilities. The scope of each of these programs varies with the nature of the facility being monitored. One such program, the Radiological Environmental Surveillance Program, monitors LMITCO waste management facilities including RWMC and WERF. Samples are taken of air, water, soil, and vegetation. Environmental radiation measurements are also made, and visual inspections of the facilities are conducted. Other monitoring programs are in place at ANL-W, ICPP, and the Specific Manufacturing Capability facility located at TAN.

Drinking Water Programs

The LMITCO Drinking Water Program monitors production and drinking water wells for radiological, chemical and bacteriological contaminants at all INEEL facilities operated by the company. Currently, 19 wells and 10 distribution systems are routinely monitored. All analyses for the program are conducted using laboratories certified by the State of Idaho or

laboratories certified in other states, where this certification is accepted by the State of Idaho. NRF maintains a separate program for sampling drinking water at that facility. Radiological and bacteriological samples from ANL-W are sent to LMITCO for analysis. ANL-W conducts a separate program for chemical monitoring.

Radiological Monitoring. Onsite drinking water samples are collected quarterly for radiological analysis from production wells in use at active LMITCO facilities. Analyses were performed by Accu-Lab, Inc. during the first half of 1996 and Paragon Laboratory during the second half. Each water sample is submitted for gross analyses for alpha and beta-emitting radionuclides. Tritium analyses are also performed on all drinking water samples. Strontium-90 analyses are performed on quarterly samples from drinking water wells in the ICPP area, because monitoring data indicates these wells may be affected by a ^{90}Sr plume.

Bacteriological Monitoring. Potable water at the INEEL is monitored for coliform bacteria monthly by the LMITCO Environmental Hygiene Laboratory. If indications of contamination by bacteria are found in a sample, that particular drinking water system is cleaned, resampled, and tested again, until it is clear of bacteria. Corrective action to purify the water may vary among facilities.

Chemical Monitoring. The LMITCO Drinking Water Program routinely samples drinking water from wells and distribution systems at facilities at the INEEL for volatile organic compounds. A program to monitor lead and copper in drinking water in accordance with EPA regulations has been in place since 1992. The year 1995 concluded three successive years of monitoring lead and copper levels in drinking water. Since regulatory values were not exceeded, and in accordance with regulations, this monitoring has been discontinued until 1998. Chlorinated drinking water systems are also monitored for total trihalomethanes (bromodichloromethane, bromoform, chloroform, and dibromochloromethane). Additional sampling is conducted for a variety of inorganic constituents, including metals, nitrates, and dissolved solids.

Storm Water Monitoring Program

As one of the requirements of the National Pollutant Discharge Elimination System General Permit effective October 1, 1992, the INEEL was required to develop a storm water monitoring program. Sampling of snow melt and rain runoff began in 1993, and in 1996 included 21 sites at nine INEEL facilities. Four sites must be sampled at least twice per year if discharge to Waters of the U.S. occurs to meet permit requirements. The program attempts to sample all locations at least three times per year—during snow melt, a spring rain event, and a fall rain event.

Samples are collected from storms of at least 0.25 cm (0.1 in) of precipitation preceded by a minimum of 72 hours without precipitation. Collection, preservation, and analysis of storm water samples are performed in accordance with the National Pollutant Discharge Elimination System Storm Water Sampling Guidance Document and 40 CFR 136.

The general permit does not contain numeric limitations for analytical parameters, except for the runoff from coal piles at ICPP. These are required to have a pH within the range of 6 to 9. Other parameters are compared to maximum contaminant levels from the Safe Drinking Water Act, not as regulatory requirements, but to help evaluate the quality of storm water discharges.

Site Environmental Surveillance Program

General Information. LMITCO and EG&G, its predecessor as INEEL operating contractor, have conducted the Site Environmental Surveillance Program since January 1994. The program has overall responsibility for sampling of air and soil, and measurement of environmental radiation at onsite locations. For comparison purposes, some sampling is also performed at distant locations. A summary of the program in 1996 is provided in Table 3-1.

TABLE 3-1. LMITCO SITE ENVIRONMENTAL SURVEILLANCE RADIOLOGICAL PROGRAM SUMMARY (1996)

Medium Sampled	Type of Analysis	Number of Locations and Frequency		~Minimum Detectable Concentration[a]
		Onsite	Offsite	
Air (Low-Volume)	Gross alpha	12 weekly	4 weekly	1×10^{-15} µCi/mL
	Gross beta	12 weekly	4 weekly	5×10^{-15} µCi/mL
	Specific gamma	12 quarterly	4 quarterly	1 to 10×10^{-15} µCi/mL
	Pu	12 quarterly	4 quarterly	2×10^{-18} µCi/mL
	Am	12 quarterly	4 quarterly	2×10^{-18} µCi/mL
	^{90}Sr	12 quarterly	4 quarterly	3.5×10^{-17} µCi/mL
	Particulate matter	12 quarterly	4 quarterly	10 µg/m^3
Air (High-Volume)[b]	Gross gamma	2 daily	-----	N/A[c]
	Specific gamma	2 monthly	-----	1 to 10×10^{-16} µCi/mL
Air (Tritium Samplers)	^{3}H	2 at 1 to 2/quarter	-----	1×10^{-11} µCi/mL
Soil	Specific gamma	Varies annually[d]	-----	1×10^{-7} µCi/g
	Pu	Varies annually	-----	3×10^{-9} µCi/g
	Am	Varies annually	-----	3×10^{-9} µCi/g
	^{90}Sr	Varies annually	-----	6×10^{-8} µCi/g
Direct Radiation Exposure (Thermoluminescent Dosimeters)	Ionizing Radiation	135 semiannually	13 semiannually	5 mR
Direct Radiation Exposure (Radiation Surveys)	Gamma Radiation	Facilities[e] INEEL Roads[f]	-----	N/A

[a] Approximate minimum detectable concentration.
[b] Sampling discontinued in September 1996.
[c] Not applicable.
[d] Onsite soil sampling is performed each year at different onsite facilities on a rotating seven-year schedule.
[e] Surveys are performed each year at different onsite facilities on a rotating three-year schedule.
[f] All INEEL roadways over which waste is transported are surveyed annually.

Analyses for the Site Environmental Surveillance Program were performed primarily by the Radiological Measurement Laboratory located at TRA. A database containing sampling and analytical information is maintained by LMITCO through the computer support group. Data validation is conducted by the Sample Management Office.

High-volume Air Samplers. LMITCO operated high-volume air samplers at the Experimental Field Station (EFS) and CFA through the end of September. At the beginning of October, this sampling was discontinued.

High-volume air samplers pulled approximately 1,400 L/min (50 ft^3/min) through a 10-cm (4-in) diameter filter. Filters were collected each workday and returned to the laboratory for gross gamma counting.

The high-volume sampler filters were analyzed in a sodium iodide well counter immediately following collection and again after approximately

6 and 24 hours. At the end of the third count, the net counts/min and time since collection were plotted on graph paper. The resulting decay curve can be used to distinguish between naturally-occurring radionuclides, which generally decay rapidly, and manmade radionuclides that have relatively long half lives and so do not decay as rapidly. If the graph indicates the possible presence of activity from other than natural sources, the filter can then be submitted for specific gamma-emitting nuclide analysis.

Low-volume Air Samplers. Airborne particulate radioactivity is monitored continuously on the INEEL by LMITCO using a network of low-volume air samplers (Figure 3-2). LMITCO collects air at 12 locations onsite, and at four offsite locations for comparison purposes. Locations of onsite samplers give adequate coverage in the event of releases of radioactivity from INEEL facilities. Each low-volume air sampler maintains an average air flow of about 50 L/min (2 ft^3/min) through a set of filters consisting of a 1.2-μm pore membrane filter followed by a charcoal cartridge. The filters are 99% efficient for airborne particulate radioactivity and iodides.

The particulate filters from the low-volume air samplers are collected and analyzed weekly. All the charcoal cartridges are evaluated individually each week for ^{131}I by gamma spectrometry. Particulate filters are analyzed after waiting a minimum of four days to allow the naturally occurring, short-lived radon and thoron daughters to decay. Analyses for gross (nonspecific) alpha and gross beta activity are performed on a Tennelec proportional counter.

Specific radionuclide analyses are more sensitive than gross alpha and gross beta analyses for detecting concentrations of manmade radionuclides in air. The particulate filters of the low-volume samplers are composited by location at the end of each quarter, and all composites are analyzed for specific radionuclides by gamma spectrometry. Composites are then submitted for analyses for alpha-emitting radionuclides (^{238}Pu, $^{239/240}Pu$, and ^{241}Am) and ^{90}Sr. The analyses for alpha-emitting nuclides use chemical separation techniques followed by alpha spectrometry; for ^{90}Sr, the chemical separation is followed by beta counting.

Atmospheric Moisture Samplers. Samplers for tritium in water vapor in the atmosphere are located at the EFS and Van Buren locations on the INEEL. In these samplers, air is passed through a column of silica gel at a rate of approximately 0.3 L/min (0.01 ft^3/min). Water vapor in the air is absorbed by the gel in the column; columns are changed when the gel absorbs sufficient moisture to obtain a sample. Tritium concentrations are then determined by liquid scintillation counting of the water extracted from the silica gel columns.

Nitrogen Dioxide/Sulfur Dioxide Monitoring. To fulfill one of the conditions specified in the Permit to Construct, Idaho Chemical Processing Plant Nitrogen Oxide Sources, two nitrogen oxide monitoring stations (which measure NO and NO_2, collectively called NO_x) are operated by LMITCO. These are located near the intersection of U.S. Highway 20/26 and Van Buren Boulevard and at EFS. The analyzers used are designated as EPA equivalent methods. One EPA equivalent method sulfur dioxide analyzer is operated at the Van Buren location in addition to the nitrogen dioxide analyzer.

Environmental Dosimeters. Environmental dosimeters, known as thermoluminescent dosimeters (TLDs), are used to measure ionizing radiation exposures. The TLDs measure ionizing radiation exposures from natural radioactivity in the air and soil, cosmic radiation from space, fallout from nuclear weapons tests, radioactivity from fossil fuel burning, and radioactive effluents from INEEL operations and other industrial processes.

At each location, a dosimeter card containing five individual chips is placed 1 m (3 ft) above ground level. LMITCO maintained dosimeters at 13 offsite locations and 135 locations on the INEEL. The dosimeter card at each location is

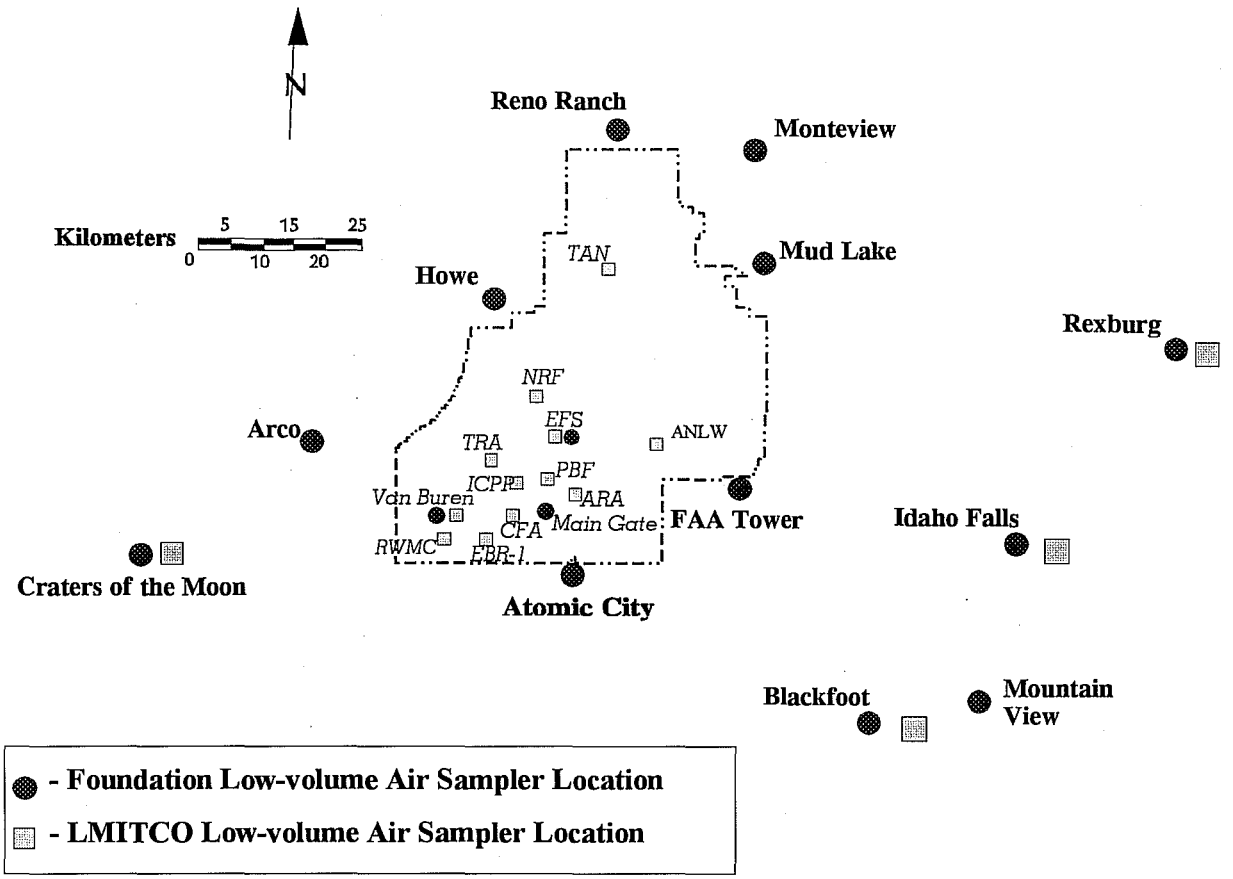


Figure 3-2. Low-volume Air Sampler Locations

changed semiannually, and cumulative gamma radiation is measured by the LMITCO Dosimetry Unit.

INEEL Offsite Environmental Surveillance Program

General Information. The Environmental Science and Research Foundation is an nonprofit organization that conducts environmental monitoring, ecological research, and environmental services independent of the M&O contractor at the INEEL. The Foundation has, since April 1994, performed the INEEL Offsite Environmental Surveillance Program for DOE-ID [Table 3-2].

The Foundation uses independent offsite laboratories to perform analyses for the environmental surveillance program. The majority of radiological analyses, including gross alpha/gross beta, tritium, and gamma spectrometry analyses, are conducted by the Idaho State University Environmental Assessment Laboratory. Radiochemical analyses, such as ^{90}Sr and transuranics, are performed at Quanterra, Inc., an independent commercial laboratory. Analyses for the Interagency Monitoring of Protected Visual Environments (IMPROVE) program are performed at the University of California, Davis Crocker Nuclear Laboratory. The University of Toronto's IsoTrace Laboratory conducted ^{129}I analyses in 1996.

TABLE 3-2. ENVIRONMENTAL SCIENCE AND RESEARCH FOUNDATION ENVIRONMENTAL SURVEILLANCE RADIOLOGICAL PROGRAM SUMMARY (1996)

Medium Sampled	Type of Analysis	Number of Locations and Frequency		~Minimum Detectable Concentration
		Onsite	Offsite	
Air (Low-Volume)	Gross alpha	3 weekly	11 weekly	2×10^{-15} µCi/mL
	Gross beta	3 weekly	11 weekly	5×10^{-15} µCi/mL
	Specific gamma	3 quarterly	11 quarterly	~5×10^{-15} µCi/mL
	Pu	1-2 quarterly	4 quarterly	7×10^{-18} µCi/mL
	Am	1-2 quarterly	4 quarterly	8×10^{-18} µCi/mL
	^{90}Sr	1-2 quarterly	4 quarterly	7×10^{-17} µCi/mL
	Particulate matter	3 quarterly	11 quarterly	10 µg/m^3
Air (Tritium Samplers)	^{3}H	None	2 to 4/quarter	3×10^{-13} µCi/mL
Air (Precipitation)	^{3}H	1 weekly/ 1 monthly	1 monthly	3×10^{-7} µCi/mL
Drinking Water	Gross alpha	None	13 semiannually	2×10^{-9} µCi/mL
	Gross beta	None	13 semiannually	3×10^{-9} µCi/mL
	^{3}H	None	13 semiannually	3×10^{-7} µCi/mL
Surface Water	Gross alpha	None	6 quarterly	2×10^{-9} µCi/mL
	Gross beta	None	6 quarterly	3×10^{-9} µCi/mL
	^{3}H	None	6 quarterly	3×10^{-7} µCi/mL
Animal Tissue (Sheep)[a]	Specific gamma	4 annually	2 annually	7×10^{-9} µCi/g
Animal Tissue (Game)	Specific gamma	Varies annually[b]	-----	7×10^{-9} µCi/g
Foodstuffs (Milk)	^{131}I	None	1 weekly	2×10^{-9} µCi/mL
	^{131}I	None	10 monthly	2×10^{-9} µCi/mL
	^{90}Sr	None	10 annually	5×10^{-10} µCi/mL
	^{3}H	None	10 annually	3×10^{-7} µCi/mL
Foodstuffs (Wheat)	Specific gamma	None	10 annually	4×10^{-9} µCi/g
	^{90}Sr	None	10 annually	4×10^{-9} µCi/g
Foodstuffs (Lettuce)	Specific gamma	None	8 annually	2×10^{-7} µCi/g
	^{90}Sr	None	8 annually	8×10^{-8} µCi/g
Soil	Specific gamma	None	12 biennially	4×10^{-8} µCi/g
	Pu	None	12 biennially	2×10^{-9} µCi/g
	Am	None	12 biennially	3×10^{-9} µCi/g
	^{90}Sr	None	12 biennially	9×10^{-8} µCi/g
Direct Radiation Exposure (Thermoluminescent Dosimeters)	Ionizing Radiation	None	13 semiannually	5 mR

[a] "Onsite" animals grazed onsite for at least four weeks before being sampled. "Offsite" animals have never grazed onsite and serve as controls.

[b] Only road-killed game animals are sampled onsite. No controls are generally collected except for specific ecological studies.

Low-volume Air Samplers. The Foundation maintains a network of low-volume air samplers (Figure 3-2) to monitor for airborne radioactivity. Eleven samplers are located at offsite locations; a 12th sampler was added in October at the Mountain View Middle School Community Monitoring Station in Blackfoot. In addition, three samplers are operated on the INEEL for comparison purposes. Each low-volume air sampler maintains an average air flow of about 50 L/min (2 ft^3/min) through a set of filters consisting of a 1.2-µm pore membrane filter followed by a charcoal cartridge. The filters are 99% efficient for airborne particulate radioactivity and iodides.

The particulate filters from the low-volume air samplers are collected and analyzed weekly. Charcoal cartridges are evaluated in batches of up to eight cartridges for ^{131}I using gamma spectrometry. If any activity is noted in a batch, each filter in the batch can then be recounted individually.

Particulate filters are analyzed weekly for gross alpha and gross beta concentrations using a Canberra automatic proportional counting system. Filters are analyzed after waiting a minimum of four days to allow the naturally occurring radionuclides to decay. Gross alpha and gross beta analyses are used as a screening technique, to provide timely information on levels of radioactivity in the environment.

The particulate filters from the low-volume samplers are composited by location at the end of each quarter and analyzed for specific radionuclides. All composites are analyzed for specific gamma-emitting nuclides by gamma spectrometry. Selected composites are then submitted for analyses for transuranic radionuclides (^{238}Pu, $^{239/240}Pu$, and ^{241}Am) or ^{90}Sr. The analyses for transuranic nuclides use chemical separation techniques followed by alpha spectrometry; for ^{90}Sr, the chemical separation is followed by beta counting.

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

Atmospheric Moisture. Samplers for tritium in water vapor in the atmosphere are located in Idaho Falls and Atomic City. In October, a third sampler was added at the Madison Middle School Community Monitoring Station in Rexburg. In these samplers, air is passed through a column of silica gel at a rate of approximately 0.3 L/min (0.01 ft^3/min). Water vapor in the air is absorbed by the gel in the column; columns are changed when the gel absorbs sufficient moisture to obtain a sample. Tritium concentrations are then determined by liquid scintillation counting of the water extracted from the silica gel columns.

Precipitation. Monthly precipitation samples are collected on the INEEL at CFA and at the offsite location of Idaho Falls. In addition, weekly samples are collected at EFS when available. A portion of each precipitation sample is submitted for tritium analysis by liquid scintillation counting.

Fine Particulates. The Foundation established samplers that selectively measure the concentration of fine particulates less than 10 μm in diameter, known as PM_{10} samplers, as part of the Community Monitoring Stations in Rexburg and Blackfoot. Sampling began at Rexburg in August, and at Blackfoot in October. An additional sampler began operation in Atomic City during March 1997.

Fine particulate samplers operate for 24 hours, midnight to midnight, every sixth day. Clean quartz fiber filters are weighed before and after sampling to determine the amount of material collected.

IMPROVE Samplers. The National Park Service, in cooperation with other federal land managment agencies (U.S. Forest Service, U.S. Fish & Wildlife Service, Bureau of Land Management) began the IMPROVE program in 1985. This program was an extension of an earlier Environmental Protection Agency program to measure fine (<2.5 μm) particles, the largest cause of visibility degradation.

In May 1992, one IMPROVE sampler was established at CFA on the INEEL and a second was located at Craters of the Moon National Monument, as part of the nationwide network. The two samplers each collect two 24-hour samples weekly of fine particulates <2.5 μm in diameter. Analyses are performed for mass, optical absorption, hydrogen, carbon, nitrogen,

and oxygen plus elements from sodium through lead on the periodic table.

Water. The Environmental Science and Research Foundation collects semiannual drinking water samples from boundary and distant communities, and surface water samples from the Snake River at Idaho Falls and Bliss. In addition, quarterly drinking water and surface water samples are collected from the Magic Valley area. Each water sample collected is submitted for gross analyses for alpha and beta-emitting radionuclides, as well as for tritium analysis using liquid scintillation.

Milk. Milk samples are collected from both commercial and single-family dairies (Figure 3-3). A 4-L (1-gal) sample was obtained from each location monthly, except in Idaho Falls where a sample is collected weekly. Milk from each location is analyzed for ^{131}I, and one analysis for ^{90}Sr and tritium at each location is performed during the year.

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

Wheat. Wheat samples are collected from grain elevators in the region surrounding the INEEL. A portion of each sample is placed in a plastic container and weighed. All wheat samples are analyzed for ^{90}Sr and gamma-emitting radionuclides.

Potatoes. Potato samples are collected from storage warehouses in the INEEL vicinity. The samples, with cleaned skins included, are processed and weighed. All potato samples are analyzed for ^{90}Sr and gamma-emitting radionuclides.

Sheep. Samples of tissue (muscle, liver, and thyroid) are collected from sheep grazing on the INEEL. Control samples are collected from Blackfoot. The muscle and liver are processed and analyzed by gamma spectrometry. The thyroid is placed in a vial and analyzed specifically for ^{131}I.

Game Animals. Selected tissues (muscle, liver, and thyroid) are collected from game animals accidentally killed on INEEL roads. Thyroid samples are placed in vials and analyzed by gamma spectrometry specifically for ^{131}I. Muscle and liver samples are processed, placed in a plastic container, and weighed prior to gamma spectrometry analysis.

Fish are obtained from the Big Lost River during years when the river is flowing. Fish samples are analyzed for gamma-emitting radionuclides.

Samples are collected of waterfowl using waste disposal ponds at four facilities on the INEEL to evaluate the potential for exposure to members of the public who might consume these game animals. Control samples are also taken in areas distant from the INEEL. Waterfowl samples are separated into an external portion (consisting of the skin and feathers), edible portion (muscle tissue), and remainder portion. All samples are analyzed by gamma spectrometry. Selected samples are also analyzed for ^{90}Sr and transuranic radionuclides.

Soil. To establish background levels of natural and fallout radioactivity in surface soil and to assess any potential buildup of radioactivity from INEEL operations, soil samples were collected annually from distant and boundary locations from 1970-78, except 1972 and 1977. A biennial soil sampling program was then established in 1978 for offsite locations, and samples are collected in each even-numbered year. 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.

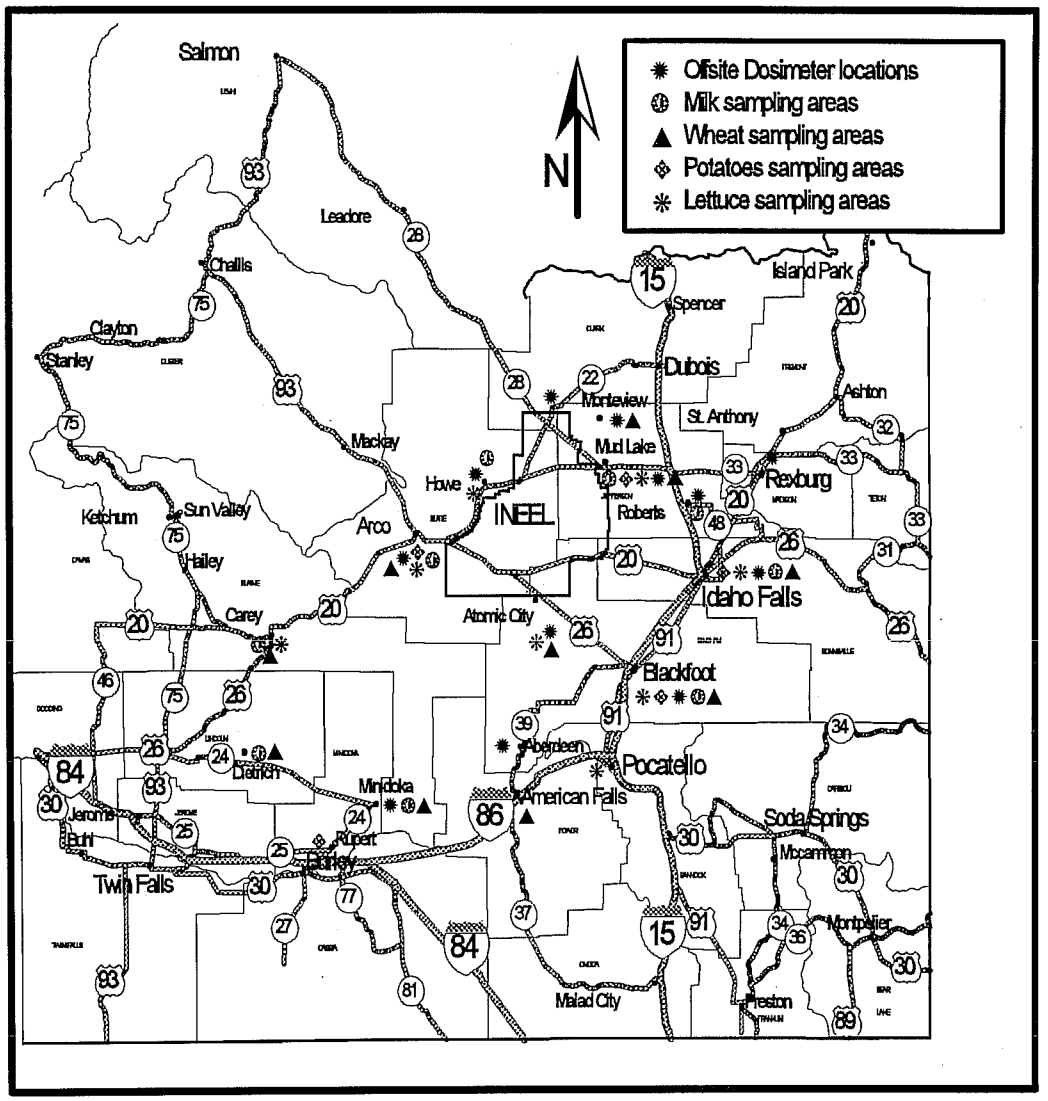


Figure 3-3. Offsite Foodstuff Sampling and Environmental Dosimeter Locations

Following collection, the soils are dried at least three hours at about 120° C (250° F) and sieved. Only soil particles less than 500 μm in diameter (35 mesh) are analyzed. All offsite samples are analyzed for gamma-emitting radionuclides, ^{90}Sr and transuranic radionuclides.

Environmental Dosimeters. Environmental dosimeters, commonly called thermoluminescent dosimeters (TLDs), are used to measure ionizing radiation exposures at offsite locations. The TLDs measure ionizing radiation exposures from all sources, including natural radioactivity, cosmic radiation, fallout from nuclear weapons tests, radioactivity from fossil fuel burning, and radioactive effluents from INEEL operations and other industrial processes.

At each location, a dosimeter card containing five individual chips is placed 1 m (3 ft) above ground level. Dosimeters are changed twice per year at each of the 13 sampling locations (Figure 3-3).

USGS Ground-water Monitoring Program

The USGS INEEL Project Office has conducted ground- and surface water monitoring at the Site since 1949. The USGS currently maintains 125 aquifer observation wells on or near the INEEL. An additional 45 wells are available for sampling perched ground-water bodies. In addition, more than 120 auger holes have been drilled to monitor shallow perched ground-water bodies (see Chapter 6).

USGS monitors water levels in wells, and radiological and nonradiological substances in water from their observation wells and auger holes on schedules ranging from monthly to annually [Table 3-3]. The USGS also conducts special studies of the ground water of the Snake River Plain. A summary of these studies is provided in Chapter 6 of this report. 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.

Chemical Monitoring. Water samples from onsite production wells and ground-water monitoring wells are collected by USGS personnel on schedules ranging from monthly to annually. These samples are submitted to the USGS National Water Quality Laboratory in Arvada, Colorado, for analysis of 60 purgeable organic compounds. Sampling for trace elements is also performed by the USGS. Other parameters in ground water are measured based on the needs of special studies that are being conducted by the organization. Results for these studies are published in Water Resources Investigation Reports and Open-File Reports periodically.

Meteorological Monitoring Program

Meteorological monitoring began at the INEEL in 1949. The NOAA Air Resources Laboratory, located in Idaho Falls, currently maintains a network of 30 meteorological stations in the vicinity of the Site. These stations provide continuous measurement of a variety of parameters, including temperature at two or three levels, wind direction and speed, relative humidity, and precipitation. In addition, continuous measurements are also made using a wind-profiling radar system and radio acoustic sounding system located on the INEEL. Data are transmitted via radio to the NOAA Idaho Falls facility, where they are stored in a computerized archive.

INEEL Oversight Program

Introduction. Since 1990, the State of Idaho has operated an environmental surveillance program as part of the INEEL Oversight Program. This program includes the collection and analysis of air, precipitation, atmospheric moisture, water, soil and milk samples on and around the INEEL. In addition, the program has a network of pressurized ion chambers and environmental dosimeters. Many of these samples are taken simultaneously with other organizations performing environmental surveillance, or are at sites colocated with other organizations. All radiological analyses are performed by the Idaho State University Environmental Monitoring Laboratory. The Oversight Program recently completed a report detailing results for the first two years of the program, and plans to produce annual reports for subsequent years [Reference 3-3].

TABLE 3-3. U.S. GEOLOGICAL SURVEY GROUND-WATER MONITORING PROGRAM SUMMARY

Constiuent	Frequency	Ground Water		Surface Water		Minimum Detectable Concentration[a]
		Number of Sites	Number of Samples	Number of Sites	Number of Samples	
Gross alpha	Semiannually	43	86	4	8	3×10^{-9}
Gross beta	Semiannually	43	86	4	8	4×10^{-9}
Tritium	Quarterly	30	120	—	—	4×10^{-7}
	Semiannually	96	192	7	14	
	Annually	39	39	—	—	
Specific gamma	Quarterly	5	20	—	—	1 to 10×10^{-9}[b]
	Semiannually	58	116	4	8	
	Annually	26	26	—	—	
^{90}Sr	Quarterly	25	100	—	—	5×10^{-9}
	Semiannually	60	120	—	—	
	Annually	33	33	—	—	
Americium	Quarterly	5	20	—	—	5×10^{-11}
	Semiannually	13	26	—	—	
	Annually	3	3	—	—	
Plutonium	Quarterly	5	20	—	—	4×10^{-11}
	Semiannually	13	26	—	—	
	Annually	3	3	—	—	
Conductance	Quarterly	30	120	—	—	Not applicable
	Semiannually	96	192	7	14	
	Annually	39	39	—	—	
Sodium ion	Quarterly	2	8	—	—	0.1
	Semiannually	46	92	—	—	
	Annually	99	99	—	—	
Chloride ion	Quarterly	30	120	—	—	0.1
	Semiannually	96	192	7	14	
	Annually	39	39	—	—	
Nitrates (as nitrogen)	Semiannually	42	84	—	—	0.05
	Annually	68	68	—	—	
Sulfate	Quarterly	2	8	—	—	0.1
	Triennially	3	9	—	—	
	Semiannually	10	20	—	—	
	Annually	104	104	—	—	
Chromium (dissolved)	Quarterly	4	16	—	—	0.005
	Semiannually	72	144	—	—	
	Annually	17	17	—	—	
Purgeable organic compounds[c]	Monthly	1	12	—	—	0.0002
	Quarterly	4	16	—	—	
	Semiannually	17	34	—	—	
	Annually	7	7	—	—	
Total organic carbon	Annually	42	42	—	—	0.1
Trace elements	Semiannually	9	18	—	—	varies

[a] Minimum detectable concentration in µCi/mL for radiological parameters and mg/L for nonradiological parameters.
[b] Vaires depending on radionuclide.
[c] Each sample is analyzed for 60 compounds.

Summary of Chapter 4
Environmental Radiological Program Results

The Environmental Science and Research Foundation and Lockheed Martin Idaho Technologies Company (LMITCO) conduct environmental surveillance programs on and around the Idaho National Engineering and Environmental Laboratory (INEEL) to monitor potential pathways by which radionuclides could reach members of the public and workers at the INEEL. These programs collect samples of a variety of media, including air, water, soil, and foodstuffs such as milk, wheat, lettuce, potatoes, livestock, and game animals. Direct measurements of radiation in the environment are also made. This chapter provides the results obtained during 1996 for these environmental media, with tables and graphs used to illustrate trends in these data over the past several years. When appropriate, results collected from samples taken on or near the INEEL are compared to results from distant locations to determine if there may be any effect on the environment from INEEL operations.

Section 4.1: One onsite air sample near the Test Reactor Area indicated airborne ^{131}I due to a release of less than 1 mCi of ^{131}I from a leaking container of methyl iodide received from an out-of-state shipment to the facility. Some INEEL and boundary monitoring locations exhibited elevated levels of gross alpha and gross beta during the third calendar quarter. This is attributed to increased airborne particulates from range fires in the area during that time. Statistical tests indicated annual concentrations of gross beta were statistically greater than for distant locations at three locations on the INEEL, and at the boundary location of Mud Lake, though no radionuclides from specific INEEL sources could be identified. Atmospheric moisture and precipitation samples indicated no apparent effects from INEEL operations.

Section 4.2: Offsite drinking and surface water samples indicated no concentrations of radionuclides above background levels. Some onsite storm water samples contained elevated concentrations of gross alpha, gross beta, and $^{226}Ra + ^{228}Ra$, likely due to sediment in the samples.

Section 4.3: No impact from INEEL operations was detected in offsite foodstuff samples. One large game animal, accidentally killed on the INEEL, contained elevated concentrations of radionuclides possibly attributed to ingestion of plants and soil from a contaminated soil area on the INEEL. Waterfowl and doves collected from INEEL waste ponds contained elevated concentrations of several radionuclides from ingestion of food, sediment, and water from the waste disposal ponds.

Section 4.4: Offsite soil samples indicated no impact from INEEL operations. The radionuclides, ^{137}Cs and ^{90}Sr, originating from nuclear fallout, continue to show a slow but steady decrease in concentrations.

Section 4.5: Offsite environmental (ionizing) radiation measurements indicated no impact from INEEL operations. Onsite measurements indicated elevated levels of environmental radiation in the vicinity of several facilities due to radioactive materials storage areas and contaminated soils.

4. ENVIRONMENTAL RADIOLOGICAL PROGRAM RESULTS

4.1 AIR

High-volume Samplers

Two onsite high-volume air monitors, located at the Central Facilities Area (CFA) and Experimental Field Station (EFS), continuously sampled the air for particulate airborne radioactivity. All decay curves appeared normal and no special analyses were conducted on daily filters during 1996.

Beryllium-7, a naturally-occurring radionuclide produced by the interaction of cosmic radiation and nitrogen in the atmosphere, was detected on most of the monthly composites. No manmade gamma-emitting radionuclides were found.

Low-volume Charcoal Cartridges

LMITCO analyzed a total of 984 cartridges specifically for ^{131}I. This radionuclide was found just above the minimum detectable concentration on two cartridges. The highest ^{131}I concentration of $(4.3 \pm 2.4) \times 10^{-14}$ µCi/ml, at the Test Reactor Area (TRA) during the week of February 21 to February 28, was 0.01% of the derived concentration guide. During this week, an out-of-state shipment of ^{131}I in the form of volatile methyl iodide was received at TRA for an experiment. Upon opening the shipment in a laboratory fume hood, it was found that one of the glass ampules containing ^{131}I was broken. Less than 1 mCi of ^{131}I was released. Two laboratory personnel received small doses from the incident, but these doses were well within radiation protection standards.

The Foundation analyzed a total of 861 charcoal cartridges. No ^{131}I was detected on any cartridge at a minimum detectable concentration of 4×10^{-15} µCi/ml.

Low-volume Gross Alpha

Gross alpha concentrations obtained by LMITCO, both onsite and offsite, were consistently lower than those obtained by the Foundation at common locations (Table 4-1). This difference is likely due to differences in laboratory analytical techniques and instrumentation. Both sets of data indicated, however, that gross alpha concentrations were generally higher at distant locations than at boundary and onsite locations. There were no locations with gross alpha concentrations that were statistically greater than the background group mean gross alpha concentration.

Low-volume Gross Beta

Analysis of gross beta concentrations in air samples collected by the Foundation and those collected by LMITCO at common locations indicated that the results were similar (Table 4-2). Chapter 9 includes a comparison table of weekly gross beta concentrations obtained by LMITCO and the Foundation at common locations.

Weekly gross beta concentrations in air samples collected by the Foundation ranged from a low of $(-6 \pm 4) \times 10^{-15}$ µCi/mL at Monteview during the month of July to a maximum of $(74 \pm 6) \times 10^{-15}$ µCi/mL at the FAA Tower, also during July. LMITCO results ranged from $(-1 \pm 2) \times 10^{-15}$ µCi/mL at EFS during April to $(65 \pm 6) \times 10^{-15}$ µCi/mL at PBF and Van Buren during the first week in January.

Foundation annual mean gross beta concentrations ranged from 20×10^{-15} µCi/mL at Mountain View Middle School (Blackfoot), Idaho Falls, and Arco to 25×10^{-15} µCi/mL at Mud Lake (Table 4-2). LMITCO data indicated a range of 19×10^{-15} µCi/mL at RWMC to 24×10^{-15} µCi/mL at PBF, EBR-1, and EFS. The annual concentration at Mud Lake was 0.9% of the derived concentration guide for gross beta.

TABLE 4-1. GROSS ALPHA ACTIVITY IN AIR (1996)

Environmental Science and Research Foundation Data

Group	Location	No. of Samples	Concentration ($\times 10^{-15}$ µCi/mL) Range of Samples	Annual Mean[a]
Distant	Blackfoot	51	-0.2 - 3.4	1.7 ± 0.2
	Mountain View	13[b]	0.2 - 4.4	2.1 ± 0.7
	Craters of the Moon	51	-0.2 - 3.7	1.2 ± 0.2
	Idaho Falls	50	-0.3 - 3.2	1.4 ± 0.2
	Rexburg	52	-0.2 - 4.4	1.7 ± 0.3
			Grand Mean[a]	1.6 ± 0.1
Boundary	Arco	52	0.0 - 3.6	1.3 ± 0.2
	Atomic City	52	0.0 - 4.1	1.3 ± 0.2
	FAA Tower	52	-0.1 - 3.6	1.3 ± 0.3
	Howe	52	-0.5 - 3.8	1.2 ± 0.2
	Monteview	52	-0.9 - 3.7	1.2 ± 0.2
	Mud Lake	52	0.1 - 4.0	1.5 ± 0.2
	Reno Ranch	50	0.1 - 4.4	1.3 ± 0.3
			Grand Mean[a]	1.3 ± 0.1
INEEL	EFS	52	-0.2 - 4.0	1.3 ± 0.3
	Main Gate	52	-0.6 - 3.4	1.3 ± 0.3
	Van Buren	52	-0.4 - 4.8	1.3 ± 0.3
			Grand Mean[a]	1.3 ± 0.2

LMITCO Data

Group	Location	No. of Samples	Concentration ($\times 10^{-15}$ µCi/mL) Range of Samples	Annual Mean[a]
Distant	Blackfoot	51	-0.6 - 4.6	1.4 ± 0.3
	Craters of the Moon	51	-1.6 - 2.4	0.7 ± 0.2
	Idaho Falls	48	-0.7 - 2.7	0.9 ± 0.2
	Rexburg	50	-0.3 - 3.8	1.6 ± 0.3
			Grand Mean[a]	1.2 ± 0.1
INEEL	ANL-W	52	-0.8 - 3.3	1.0 ± 0.3
	ARA	46	-1.9 - 4.8	0.6 ± 0.4
	CFA	51	-1.3 - 3.8	1.1 ± 0.3
	EBR-1	51	-1.0 - 6.0	0.9 ± 0.4
	EFS	52	-0.6 - 2.9	1.0 ± 0.2
	ICPP	50	-1.0 - 2.6	1.0 ± 0.2
	NRF	51	-0.6 - 4.4	0.9 ± 0.3
	PBF	52	-0.8 - 5.8	0.8 ± 0.4
	RWMC	50	-0.4 - 2.4	0.7 ± 0.2
	TAN	52	-1.3 - 5.3	1.0 ± 0.3
	TRA	51	-1.2 - 2.8	0.9 ± 0.2
	Van Buren	50	-1.4 - 4.1	1.1 ± 0.3
			Grand Mean[a]	0.9 ± 0.1

[a] Arithmetic mean with the 95% confidence interval for the mean.
[b] New station started in October in Blackfoot.

TABLE 4-2. GROSS BETA ACTIVITY IN AIR (1996)

Environmental Science and Research Foundation Data

Group	Location	Number of Samples	Concentration (x 10^{-15} µCi/mL) Range of Samples	Annual Mean[a]
Distant	Blackfoot	51	8 - 39	21 ± 2
	Mountain View	13[b]	8 - 33	20 ± 6
	Craters of the Moon	51	4 - 39	21 ± 2
	Idaho Falls	50	4 - 40	20 ± 3
	Rexburg	52	9 - 39	23 ± 3
			Grand Mean[a]	21 ± 1
Boundary	Arco	52	6 - 38	20 ± 2
	Atomic City	52	5 - 41	22 ± 3
	FAA Tower	52	8 - 74	21 ± 3
	Howe	52	10 - 42	23 ± 2
	Monteview	52	-6 - 43	21 ± 3
	Mud Lake	52	2 - 47	25 ± 3
	Reno Ranch	50	9 - 53	23 ± 3
			Grand Mean[a]	23 ± 1
INEEL	EFS	52	8 - 62	24 ± 3
	Main Gate	52	6 - 37	23 ± 3
	Van Buren	52	1 - 47	22 ± 2
			Grand Mean[a]	23 ± 2

LMITCO Data

Group	Location	Number of Samples	Concentration (x 10^{-15} µCi/mL) Range of Samples	Annual Mean[a]
Distant	Blackfoot	51	8 - 38	22 ± 2
	Craters of the Moon	51	3 - 40	20 ± 2
	Idaho Falls	48	3 - 51	21 ± 3
	Rexburg	50	7 - 49	20 ± 2
			Grand Mean[a]	21 ± 1
INEEL	ANL-W	52	5 - 51	20 ± 2
	ARA	47	5 - 49	21 ± 3
	CFA	51	9 - 52	22 ± 2
	EBR-1	51	8 - 57	24 ± 3
	EFS	52	-1 - 47	24 ± 3
	ICPP	49	6 - 55	22 ± 3
	NRF	51	10 - 48	23 ± 2
	PBF	52	8 - 65	24 ± 3
	RWMC	50	8 - 46	19 ± 2
	TAN	52	9 - 52	22 ± 2
	TRA	52	7 - 45	23 ± 2
	Van Buren	50	4 - 65	21 ± 3
			Grand Mean[a]	22 ± 1

[a] Arithmetic mean with the 95% confidence interval for the mean.
[b] New station started in October in Blackfoot.

Figure 4-1 indicates the average weekly gross beta concentrations for the INEEL, boundary, and distant station groups. These data are typical of the annual pattern for gross beta concentrations in air, with higher values generally occurring at the beginning and end of the calendar year during winter inversion conditions. The peak showing at the first week of the year is reflected at all locations for both Foundation and LMITCO data, and is due to meteorological conditions.

An analysis of the correlation among the distant, boundary, and INEEL data groups indicated the fluctuations shown in Figure 4-1 are highly linearly correlated (r values range from 0.93 to 0.95). This means that, in general, the levels of airborne radioactivity for the three groups track each other closely throughout the year. This is an indication that generally the pattern of fluctuations occurred over the entire sampling network, and therefore were not caused by a localized source such as a facility or activity at the INEEL.

Historic monthly gross beta concentrations for the distant, boundary, and INEEL groups are shown in Figure 4-2. The distant location vs. INEEL graph shows the effects of ^{125}Sb, released as one of the effluents of the fuel dissolution process from the Fluorinel Dissolution and Fuel Storage Facility at ICPP during 1987 and the first half of 1988. The effect is also seen, but to a lesser degree, in the distant vs. boundary graph in Figure 4-2. This indicates the ability of the low-volume air sampling network to detect radioactive airborne releases from the INEEL.

Statistical Comparisons. Statistical comparisons were made between monthly mean gross beta concentrations at each onsite location and the distant group mean gross beta concentration, and between monthly mean gross beta concentrations at each boundary location and the distant group mean gross beta concentration. Foundation data indicated statistical differences in two of 36 (6%) comparisons involving INEEL locations and one of 84 (1%) comparisons involving boundary locations (Table 4-3). For LMITCO samplers, statistical differences were found in 9 of 144 (6%) comparisons made for the INEEL locations. 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 for each month. For Foundation data, neither the INEEL or the boundary group was found to be statistically higher during any month. The INEEL group gross beta concentration obtained by LMITCO was statistically greater than background during July and September.

All of the statistical differences found for monthly LMITCO onsite data occurred in the third quarter. During that quarter, extensive wild fires burned on and around the site. These fires were followed by an increase in blowing dust from the burned areas. Elevated gross beta concentrations may have been due to the increase in airborne particulates from windblown ash and fine soil particles trapped in the filters. These particles may contain naturally occurring and fallout-produced radionuclides.

Statistical comparisons were made between annual gross beta mean concentrations at individual onsite and boundary locations and the mean annual background gross beta concentration (Table 4-3). For the Foundation, the annual gross beta concentrations for Mud Lake and EFS were statistically greater than the distant mean annual gross beta concentration. In addition, the annual gross beta concentration for the INEEL group was statistically greater than the distant mean annual gross beta concentration. For LMITCO, the mean annual gross beta concentrations at EBR-1, EFS, and PBF were statistically greater than the distant mean annual gross beta concentration. The INEEL group as a whole was not statistically greater than background.

Results of the above statistical tests may indicate some detectable effects on the environment from INEEL operations at the onsite locations of EBR-1, EFS, and PBF, and offsite at Mud Lake. However, gross beta concentrations can vary widely from location to location as a result of a number of factors such as diverse local soil and meteorological conditions. Thus, when statistical differences are found, the results of specific

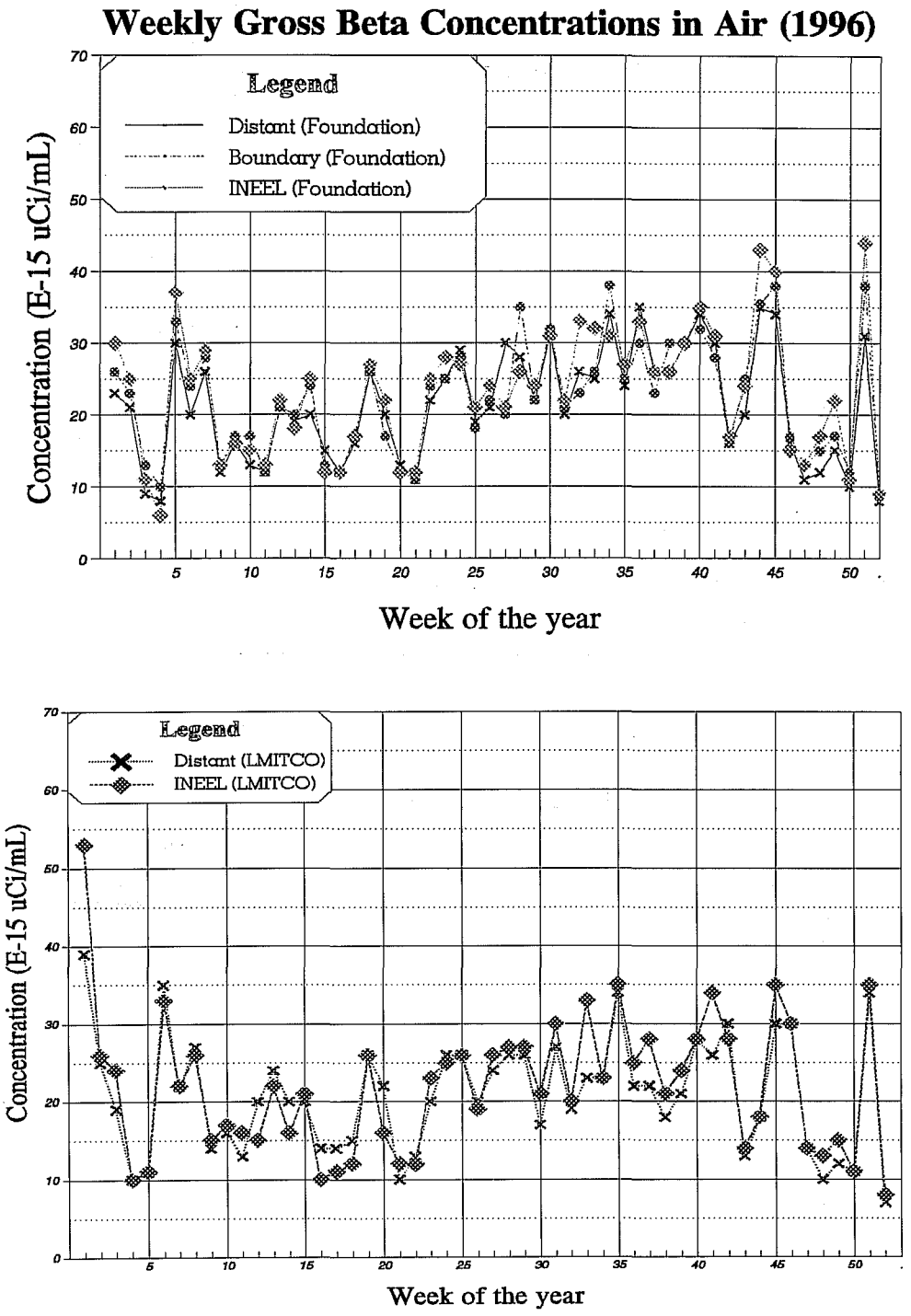
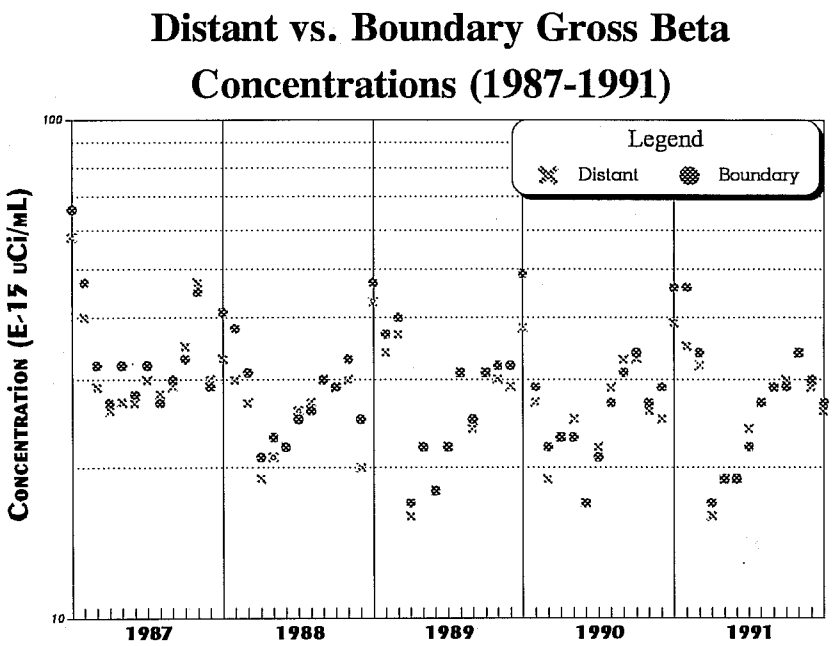


Figure 4-1. Weekly Gross Beta Concentrations in Air (1996)



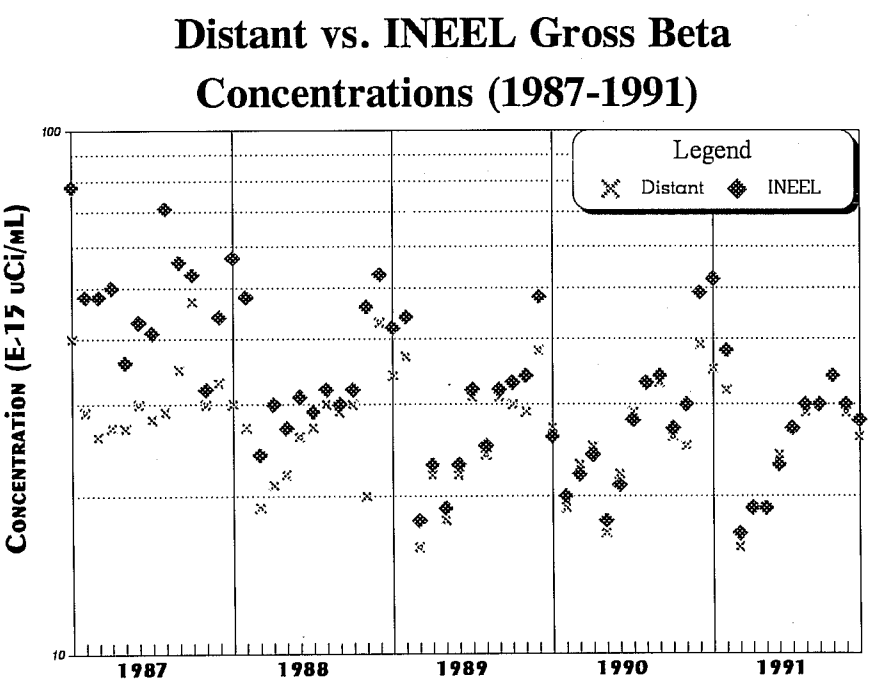
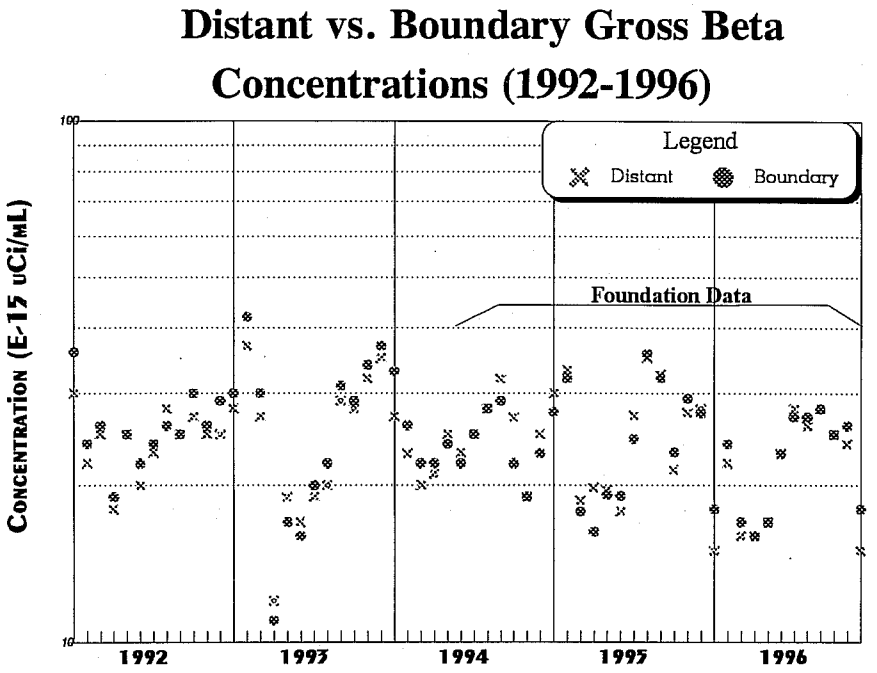


Figure 4-2. Monthly Gross Beta Concentrations (1987-1991)



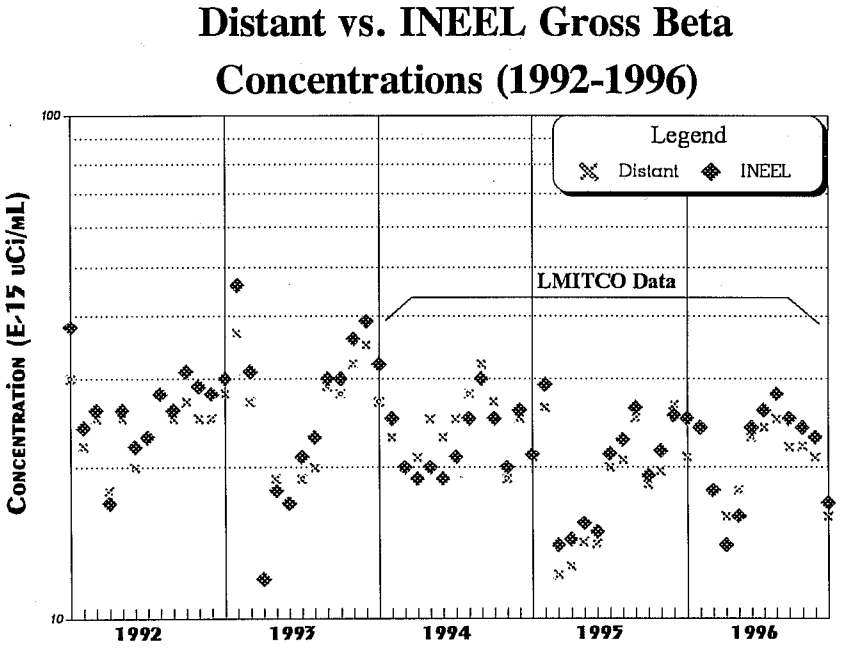


Figure 4-2. (Continued) Monthly Gross Beta Concentrations (1992-1996)

TABLE 4-3. STATISTICAL COMPARISON TABLE OF GROSS BETA CONCENTRATIONS IN AIR AT DISTANT, BOUNDARY, AND INEEL LOCATIONS (1996)[a]

Environmental Science and Research Foundation Data

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													
EFS													
Main Gate													
Van Buren													
INEEL Group													

LMITCO Data

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
ANL-W													
ARA													
CFA													
EBR-1													
EFS													
ICPP													
NRF													
PBF													
RWMC													
TAN													
TRA													
Van Buren													
INEEL 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, single-tailed t-test (α=0.05).

nuclide analyses discussed in the following section are examined to try to pinpoint the possible specific radionuclide(s) that may have contributed to the elevated concentrations, and to identify a possible INEEL cause, if any, for the differences.

Low-volume Specific Radionuclides

Beryllium-7, a naturally-occurring radionuclide produced from cosmic ray interactions, was found in nearly all the quarterly composites analyzed. Manmade radionuclides were observed in both Foundation and LMITCO data (Tables 4-4 and 4-5), but most were in the range of concentrations were detection is considered questionable (see Appendix B). The locations and time period of detectable results can be compared to the gross beta statistical test results in Table 4-3 to determine if an INEEL origin for the radionuclides is likely.

TABLE 4-4. MANMADE RADIONUCLIDES IN FOUNDATION AIR SAMPLES (1996)

Radionuclide	Calendar Quarter	INEEL Location	Boundary Location	Distant Location	Concentration ± 2s ($\times 10^{-15}$ µCi±mL)	DCG[a] ($\times 10^{-15}$ µCi/mL)
^{90}Sr	First			Rexburg	0.07 ± 0.05	9,000
	First		Atomic City		0.09 ± 0.04	
	First		Mud Lake		0.20 ± 0.06	
	Third		Atomic City		0.06 ± 0.05	
	Fourth		Arco		0.05 ± 0.04	
^{137}Cs	Third		EFS		0.3 ± 0.3	400,000
^{241}Am	First	Main Gate			0.002 ± 0.002	20
	Fourth	EFS			0.04 ± 0.01	
	Fourth		Mud Lake		0.006 ± 0.003	
	Fourth			Mtn. View	0.009 ± 0.003	

[a] The derived concentration is an annual guide that, although not strictly applicable to quarterly values, is provided here for comparison purposes.

TABLE 4-5. MANMADE RADIONUCLIDES IN LMITCO AIR SAMPLES (1996)[a]

Radionuclide	Calendar Quarter	INEEL Location	Distant Location	Concentration ± 2s ($\times 10^{-15}$ µCi±mL)	DCG[b] ($\times 10^{-15}$ µCi/mL)
$^{239/240}Pu$	First		Blackfoot	0.0033 ± 0.0032	
	Second	ANL-W		0.0034 ± 0.0030	
	Third	TAN		0.0027 ± 0.0025	
	Third	RWMC		0.0055 ± 0.0037	

[a] Table does not include ^{90}Sr results, which are considered suspect. See text for explanation.
[b] The derived concentration is an annual guide that, although not strictly applicable to quarterly values, is provided here for comparison purposes.

For Foundation data, detectable radionuclides were found at each of the locations where statistical differences were found. Strontium-90 was found at Mud Lake during the first quarter, consistent with the time of a statistically significant gross beta concentration at this location. However, this radionuclide was also found at the distant location of Rexburg, although at a lower concentration.

Americium-241 has been consistently detected by the Foundation at various locations since mid-1995. Detectable concentrations have been found at INEEL, boundary, and distant locations. A concentration of ^{241}Am somewhat outside the normal range of these detections was measured in the fourth quarter sample from EFS (Table 4-4). A reanalysis verified the original result. No source has been identified, but it is assumed to have resulted from INEEL operations since it is outside the usual range of concentrations and was found at an onsite location.

During 1996, an unusually high number of detectable concentrations of ^{90}Sr were reported in various LMITCO sample types. For quarterly low-volume air samples, detectable concentrations were found on 12 sets of composites, ranging from $4 \pm 4 \times 10^{-17}$ µCi/mL to $2.4 \pm 2.0 \times 10^{-16}$ µCi/mL. The relatively large number of detectable results triggered an investigation of the analytical laboratory's sample preparation and data handling

procedures. Additional samples of air, water, and soil were collected and analyzed with blind quality assurance and blank samples. The laboratory concluded the possible cause of the increased number of ^{90}Sr detections may be due to accumulation of very short-lived radon daughter products on the samples resulting from laboratory preparation methods. This was indicated by the presence of ^{90}Sr on field and laboratory blanks. As a result of the investigation, laboratory procedures have been modified to ensure credibility of ^{90}Sr data.

Plutonium-239/240 detected at RWMC in the third quarter is likely the result of disturbance of slightly contaminated soil by construction activities. This radionuclide has been consistently detected in RWMC composites during periods when the ground is not covered by snow.

Atmospheric Moisture

A total of 21 samples were collected in 1996, 10 onsite and 11 offsite. No tritium was found in any of the onsite samples. A somewhat lower detection limit was achieved for the offsite samples analyzed by the Foundation. Two contained a detectable concentration of tritium, both from distant locations. The highest concentration, from Idaho Falls, was $(1.0 \pm 0.8) \times 10^{-13}$ µCi/mL. This is 0.0001% of the derived concentration guide. It is likely the tritium originates from the worldwide inventory of tritium due to historic nuclear weapons testing, nuclear reactor operations, spent nuclear fuel handling, and natural atmospheric processes.

Precipitation

A total of 35 precipitation samples were collected and analyzed. Tritium was detected in eight of the samples at concentrations ranging from $(1.3 \pm 1.0) \times 10^{-7}$ µCi/mL to $(3.6 \pm 1.0) \times 10^{-7}$ µCi/mL. The highest concentration was at the distant location of Idaho Falls. Tritium attributable to INEEL operations has been found in isolated precipitation samples during the previous few years, but the higher concentration of tritium at the background sampling location indicates it is more likely these tritium concentrations originate from the worldwide inventory of tritium due to historic nuclear weapons testing, nuclear reactor operations, spent nuclear fuel handling, and natural atmospheric processes. These results are also consistent with those previously reported by the EPA [Reference 4-1].

4.2 WATER

This section contains results from radiological analyses performed on drinking water and surface water samples taken at offsite locations by the Environmental Science and Research Foundation. In addition, results of radiological analyses of onsite storm water monitoring by LMITCO are presented. Radiological results from onsite production well sampling may be found in Chapter 6, "Ground Water," with results from additional sampling conducted by the LMITCO Drinking Water Program.

Offsite Water Sampling

Gross Alpha. In 1996, the Foundation collected 52 offsite samples, including replicate samples. Of these, 33 were drinking water samples and 19 were surface water samples. One sample, from Monteview, had a detectable gross alpha concentration of $(3 \pm 2) \times 10^{-9}$ µCi/ml. For perspective, this concentration is 10% of the annual derived concentration guide and about 20% of the Environmental Protection Agency (EPA) maximum contaminant level (MCL). The offsite gross alpha activity is unlikely to be due to alpha-emitting wastes from INEEL operations, which have not migrated far from their source. In addition, Monteview is northeast of the INEEL, whereas water in the aquifer moves primarily to the southwest. The probable source of gross alpha activity is natural radioactivity from uranium and thorium chain radionuclides that occurs in the Snake River Plain Aquifer.

Gross Beta. Gross beta activity above the minimum detectable concentration was present in

32 of the 52 offsite water samples. Detectable concentrations ranged from $(1.8 \pm 1.4) \times 10^{-9}$ μCi/mL to $(8 \pm 2) \times 10^{-9}$ μCi/mL. Concentrations for all samples were within the expected concentration range for natural radioactivity. The highest concentration represents about 8% of the DOE derived concentration guide and 16% of the EPA maximum contaminant level.

Tritium. Tritium was found above the minimum detectable concentration in four offsite drinking water samples. It was not detected in offsite surface water samples. The highest concentration, $(0.16 \pm 0.10) \times 10^{-6}$ μCi/mL from Blackfoot in May, was 0.008% of the DOE derived concentration guide and 0.8% of the EPA maximum contaminant level.

The present detection limit is within the range of environmental concentrations of tritium resulting from a variety of sources [Reference 4-1]. These sources include historic nuclear weapons testing, nuclear reactor operations, spent nuclear fuel handling, and natural atmospheric processes.

Storm Water Sampling

During 1996, radiological analyses were performed on samples taken from 17 of 21 INEEL monitoring points. Four points were not sampled due to lack of flow at the monitoring location. While these samples are not subject to standards for drinking water, the averages are compared to these standards to evaluate water quality of storm runoff water. Three samples were greater than the 15 pCi/L MCL for gross alpha (Table 4-6). The maximum value of 140 ± 38 pCi/L was measured at a CFA monitoring point in February. This CFA sample also exceeded the 50 pCi/L MCL for gross beta, having a measured gross beta concentration of 230 ± 50 pCi/L, and the 5 pCi/L MCL for $^{226}Ra + ^{228}Ra$, with a value of 22 pCi/L. The reason for these elevated concentrations appears to be the presence of radionuclides in suspended sediment in the sample.

More detailed information and data on storm water monitoring will be included in the *1996 Compliance Monitoring Annual Report*, INEEL-97/0255(96), due to be published in August 1997.

4.3 FOODSTUFFS

Milk. Of the 148 milk samples collected during 1996, one from Howe in September contained ^{131}I just above the minimum detectable concentration at $(4.4 \pm 4.1) \times 10^{-9}$ μCi/mL.

Tritium was detected in one of the four milk samples analyzed in May, and in one of the five samples analyzed in November. Concentrations were similar at distant and boundary locations, and

TABLE 4-6. SELECTED RADIOLOGICAL STORM WATER MONITORING DATA (1996)

Radionuclide	Monitoring Point	Sample Date	Measured Concentration[a]	Drinking Water Standard[b]
Gross Alpha	CFA-3/2	02/13	140	15
	RWMC-2/1	04/02	33	
	TSF-1/2	09/17	32	
Gross Beta	CFA-3/2	02/13	230	50
	TSF-1/2	02/13	61	
$^{226}Ra + ^{228}Ra$	CFA-3/2	02/13	22	5

[a] Concentrations in pCi/L.
[b] Data selected are those concentrations above drinking water standards. These standards are used for comparison purposes only.

were similar to environmental levels of tritium found in offsite water and precipitation samples. The highest concentration was $(1.5 \pm 1.0) \times 10^{-7}$ μCi/mL, reported in the sample from the boundary location of Arco.

Eight of nine samples analyzed for ^{90}Sr had detectable concentrations ranging from $(0.9 \pm 0.6) \times 10^{-10}$ μCi/mL at the Arco location to $(2.2 \pm 1.1) \times 10^{-9}$ μCi/mL at Dietrich. All levels of ^{90}Sr in milk were consistent with those previously reported by the EPA as resulting from worldwide fallout deposited on soil, then taken up by ingestion of grass by cows [Reference 4-1].

Lettuce. Of nine samples collected, two distant samples contained detectable ^{137}Cs concentrations and two samples contained ^{90}Sr, one from a boundary location and one from a distant location. Three samples were lost during the ^{90}Sr analyses. The maximum ^{90}Sr concentration (Table 4-7) was found at the distant location of Blackfoot. Both ^{137}Cs and ^{90}Sr are present in soil from above-ground nuclear weapons testing that took place primarily in the 1950s and 1960s.

Wheat. No manmade gamma-emitting radionuclides were found above the minimum detectable concentration in 1996 wheat samples. Measurable concentrations of ^{90}Sr were seen in some of the samples from both distant and boundary locations (Table 4-8). The concentrations were similar to those detected in recent years.

Potatoes. Three distant and two boundary locations were sampled. No gamma-emitting radionuclides or ^{90}Sr were observed at any of the five locations sampled.

Sheep. Cesium-137 was detected in the muscle tissue of two of the four onsite sheep and none of

TABLE 4-7. STRONTIUM-90 CONCENTRATIONS IN GARDEN LETTUCE (1992-1996)

	^{90}Sr Concentration (10^{-9} μCi/g dry weight)[a]				
Sample Location	**1992**	**1993**	**1994**	**1995**	**1996**
Distant Group:					
Blackfoot	----[b]	-30 ± 60	160 ± 80	740 ± 200	270 ± 240[e]
Carey	200 ± 40	-70 ± 50	130 ± 40	-50 ± 180	----
Idaho Falls	230 ± 40	-80 ± 50	120 ± 40	60 ± 30	----
Pocatello	80 ± 40	180 ± 140	----	----	----
Mean[c]	170 ± 200	0 ± 190	140 ± 50	250 ± 1050	270 ± ---[f]
Boundary Group:					
Arco	50 ± 40	90 ± 90	50 ± 40	140 ± 50	200 ± 200[e]
Atomic City	210 ± 60	-80 ± 60	200 ± 60	300 ± 120	120 ± 100
Howe	80 ± 40	NS[d]	NS	NS	100 ± 160
Monteview	NS	210 ± 80	110 ± 40	100 ± 90	NS
Mud Lake/Terreton	150 ± 40	40 ± 70	70 ± 60	80 ± 40	160 ± 360[e]
Mean[c]	120 ± 110	70 ± 190	110 ± 100	160 ± 160	140 ± 70

[a] Analytical results ± 2s. Approximate minimum detectable concentration of ^{90}Sr in lettuce is 80×10^{-9} μCi/g dry weight.
[b] Sample destroyed 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.
[e] Low chemical yield (<20%).
[f] 95% confidence interval cannot be determined for only one sample.

TABLE 4-8. STRONTIUM-90 CONCENTRATIONS IN WHEAT (1992-1996)

Sample Location	^{90}Sr Concentration (10^{-9} µCi/g dry weight)[a]				
	1992	1993	1994	1995	1996
Distant Group:					
American Falls	11 ± 2	2 ± 2	7 ± 2	8 ± 4	7 ± 5
Blackfoot	7 ± 2	2 ± 4	7 ± 2	4 ± 4	6 ± 6
Carey	10 ± 2	2 ± 4	2 ± 2	11 ± 7	5 ± 6
Dietrich	NS[b]	-1 ± 4	3 ± 2	NS	5 ± 5
Idaho Falls	9 ± 2	0 ± 3	6 ± 2	9 ± 5	9 ± 18[d]
Minidoka	7 ± 2	4 ± 4	6 ± 2	3 ± 5	8 ± 5
Mean[c]	9 ± 2	2 ± 2	5 ± 2	7 ± 4	7 ± 2
Boundary Group:					
Arco	10 ± 2	-1 ± 3	4 ± 2	3 ± 5	16 ± 40[d]
Monteview	9 ± 2	1 ± 4	7 ± 3	4 ± 4	3 ± 4
Mud Lake	4 ± 2	2 ± 4	5 ± 2	4 ± 5	5 ± 5
Tabor	8 ± 2	0 ± 6	8 ± 2	12 ± 6	10 ± 6
Terreton	3 ± 2	1 ± 2	5 ± 2	7 ± 5	8 ± 6
Mean[c]	7 ± 4	1 ± 1	6 ± 2	6 ± 5	8 ± 6

[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.
[d] Low chemical yield (<20%).

the two offsite (control) sheep. The maximum concentration, found in a sheep that grazed in the eastern portions of the INEEL, was (3.2 ± 2.5) x 10^{-9} µCi/g. All ^{137}Cs concentrations were similar to those found in both onsite and offsite sheep samples during recent years. One of the onsite sheep liver samples showed a detectable concentration of ^{60}Co at (2.8 ± 2.1) x 10^{-9} µCi/ml. Iodine-131 was not detected in any of the six sheep thyroid gland samples. The presence of the radionuclides is attributed to the world-wide inventory of fallout from historic nuclear weapons testing.

Game Animals. A total of eight large game animals were sampled during 1996—seven mule deer and one pronghorn. No ^{131}I was found in any of the thyroid gland samples. Cesium-137 was found in the muscle tissue of five animals and in the liver of three animals. The highest level of ^{137}Cs in muscle was (13 ± 4) x 10^{-9} µCi/g, and in liver was (20 ± 6) x 10^{-9} µCi/g. These samples were from a mule deer collected near TRA during the fourth quarter. It is possible this deer may have ingested some soil or plants growing in areas of contaminated soil around the facility. One mule deer accidentally killed near the INEEL contained a detectable concentration of ^{60}Co at (3.3 ± 2.9) x 10^{-9} µCi/g. Some of the manmade radionuclides detected likely come from fallout due to historic nuclear weapons testing. With the exception of the deer collected near TRA, ^{137}Cs concentrations in all other game tissues collected in 1996 were similar to those seen in offsite sheep tissue samples collected in recent years.

Fish were collected onsite from the Big Lost River during early summer when the river was flowing. Several small fish were composited into one sample. The sample contained no detectable concentrations of manmade gamma-emitting radionuclides.

Thirteen ducks were collected from the following areas: three control ducks from Fort Hall and Heise, four from the radioactive waste

ponds at the TRA, and three each from historic radioactive waste ponds at Test Area North (TAN) and the Idaho Chemical Processing Plant (ICPP). Detectable concentrations of a variety of manmade gamma-emitting radionuclides, ^{90}Sr, and transuranics were measured in the edible portions of ducks collected from the TRA, ICPP, and TAN ponds (Tables 4-9 and 4-10). Control ducks had measurable concentrations of some of the radionuclides, but generally at levels close to the minimum detectable concentrations. The highest concentrations were generally seen in waterfowl from the TRA pond. The highest concentrations of radionuclides, relative to control samples, were for ^{60}Co, ^{65}Zn, ^{137}Cs, and ^{90}Sr. Elevated levels of radionuclides are attributed to the ingestion of food, sediment, and water by the waterfowl from the contaminated ponds where they were collected. A preliminary analysis indicated diving ducks had higher radionuclide concentrations than surface ducks. See chapter 8 for a radiation dose estimate for humans ingesting these contaminated waterfowl.

In August, 13 doves were collected from the radioactive waste ponds at TRA. In September, four control doves were collected from Rigby. Some of the maximum concentrations in the dove samples indicated detectable concentrations of radionuclides in samples from the control location as well as at the TRA waste ponds (Table 4-11). The mean values, however, indicated detectable concentrations of radionuclides (^{90}Sr and ^{137}Cs) only in samples from the TRA waste ponds. The predominant radionuclide was ^{137}Cs. See chapter 8 for a radiation dose estimate for humans ingesting these doves.

4.4 SOIL

Each soil sample collected at offsite locations was analyzed for gamma-emitting radionuclides. The surface samples (0-5 cm, or, equivalently, 0-2 in) were also analyzed for ^{90}Sr, a beta-emitter, and selected alpha-emitting transuranics (Table 4-12). 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 cross-sectional area (0.039 m^2, or, equivalently, 60 in^2) of the sample. Since the conversion from pCi/g to nCi/m^2 involves the sample mass, which varies from sample to sample, there is no strong correlation between the pCi/g results and the nCi/m^2 results from year to year. Experience has shown that due to the statistical distribution of background concentrations of radionuclides in soil samples, the geometric mean, rather than the arithmetic mean, is the appropriate describer of mean concentrations.

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. 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 due to disturbance of the sampling locations from activities such as farming, erosion, and vehicular traffic. These sampling locations, plus the location at Monteview, were re-evaluated and moved in 1986 to more representative undisturbed locations.

The 1996 boundary group average concentrations were not statistically greater than the distant group concentration for any radionuclide. The manmade radionuclides detected are present as a result of worldwide nuclear fallout. The shorter-lived radionuclides (^{137}Cs and ^{90}Sr) continue to show a slow but steady decrease in concentrations.

4.5 ENVIRONMENTAL DOSIMETERS

The measured cumulative radiation exposure for offsite locations for the time period from November 1995 to November 1996 is shown in Table 4-13 for the duplicate set of dosimeters maintained by the Foundation and LMITCO. For purposes of comparison, annual exposures from 1992-95 are also included for each location.

TABLE 4-9. MANMADE GAMMA-EMITTING RADIONUCLIDES IN EDIBLE PORTIONS OF WATERFOWL (1996)

			Concentration (x 10^{-6} µCi/g)		
Radionuclide	Location	# Ducks Analyzed	Minimum[a]	Maximum[a]	Mean[b]
^{54}Mn	Control	3	<mdc[c]	0.03 ± 0.03	0.03 ± 0.03
	ICPP	4	<mdc	<mdc	-----[d]
	TAN	3	<mdc	<mdc	-----
	TRA	3	<mdc	0.26 ± 0.13	0.06 ± 0.14
^{58}Co	Control	3	<mdc	<mdc	-----
	ICPP	4	<mdc	<mdc	-----
	TAN	3	<mdc	0.13 ± 0.11	0.02 ± 0.11
	TRA	3	<mdc	0.26 ± 0.17	0.12 ± 0.11
^{60}Co	Control	3	<mdc	<mdc	-----
	ICPP	4	<mdc	<mdc	-----
	TAN	3	<mdc	<mdc	-----
	TRA	3	<mdc	9.0 ± 1.0	4.6 ± 4.8
^{65}Zn	Control	3	<mdc	<mdc	-----
	ICPP	4	<mdc	<mdc	-----
	TAN	3	<mdc	<mdc	-----
	TRA	3	<mdc	4.7 ± 0.7	1.5 ± 2.2
^{95}Nb	Control	3	<mdc	<mdc	-----
	ICPP	4	<mdc	0.23 ± 0.20	0.02 ± 0.25
	TAN	3	<mdc	<mdc	-----
	TRA	3	<mdc	<mdc	-----
^{95}Zr	Control	3	<mdc	<mdc	-----
	ICPP	4	<mdc	<mdc	-----
	TAN	3	<mdc	<mdc	-----
	TRA	3	<mdc	0.49 ± 0.24	0.17 ± 0.21
^{134}Cs	Control	3	<mdc	<mdc	-----
	ICPP	4	<mdc	<mdc	-----
	TAN	3	<mdc	0.03 ± 003	0.02 ± 0.02
	TRA	3	<mdc	0.09 ± 0.08	0.03 ± 0.04
^{137}Cs	Control	3	<mdc	0.03 ± 0.03	0.01 ± 0.02
	ICPP	4	<mdc	0.05 ± 0.04	0.03 ± 0.03
	TAN	3	<mdc	<mdc	-----
	TRA	3	<mdc	7.3 ± 0.8	2.1 ± 3.4
^{140}Ba	Control	3	<mdc	<mdc	-----
	ICPP	4	<mdc	17.8 ± 12.8	3.5 ± 15.6
	TAN	3	<mdc	<mdc	-----
	TRA	3	<mdc	4.7 ± 3.6	3.7 ± 2.6
^{181}Hf	Control	3	<mdc	0.10 ± 0.08	-0.04 ± 0.20
	ICPP	4	<mdc	<mdc	-----
	TAN	3	<mdc	<mdc	-----
	TRA	3	<mdc	<mdc	-----

[a] Concentration ± 2 standard deviations.
[b] Mean with 95% confidence interval.
[c] Less than minimum detectable concentration.
[d] There were no detectable concentrations for this radionuclide at this location.

TABLE 4-10. STRONTIUM-90 AND TRANSURANICS IN EDIBLE PORTIONS OF WATERFOWL (1996)

Radionuclide	Location	# Ducks Analyzed	Concentration (x 10^{-6} µCi/g) Minimum[a]	Maximum[a]	Mean[b]
^{90}Sr	Control	2	<mdc[c]	0.02 ± 0.01	0.02 ± 0.01
	ICPP	1	<mdc	<mdc	-----[d]
	TAN	1	<mdc	<mdc	-----
	TRA	3	0.03 ± 0.01	0.65 ± 0.13	0.19 ± 0.31
^{238}Pu	Control	2	<mdc	<mdc	-----
	ICPP	1	<mdc	0.011 ± 0.003	0.01[e]
	TAN	1	<mdc	<mdc	-----
	TRA	3	<mdc	<mdc	-----
$^{239/240}Pu$	Control	2	<mdc	0.0007 ± 0.0009	0.0004 ± 0.0007
	ICPP	1	<mdc	<mdc	-----
	TAN	1	<mdc	<mdc	-----
	TRA	3	<mdc	<mdc	-----
^{241}Am	Control	2	<mdc	<mdc	-----
	ICPP	1	<mdc	<mdc	-----
	TAN	1	<mdc	<mdc	-----
	TRA	3	<mdc	0.006 ± 0.003	0.002 ± 0.004

[a] Concentration ± 2 standard deviations.
[b] Mean with 95% confidence interval.
[c] Less than minimum detectable concentration.
[d] There were no detectable concentrations for this radionuclide at this location.
[e] No confidence interval is calculated with one sample.

The mean annual exposures for distant and boundary community locations in 1996 were 123 ± 9 mR and 124 ± 10 mR, respectively, as measured by the Foundation's environmental dosimeters, and 127 ± 9 mR and 125 ± 16 mR, respectively, as measured by environmental dosimeters collected by LMITCO. Using the average of both sets of data, the average exposure of the distant group was approximately equivalent to 129 mrem, when a dose equivalent conversion factor of 1.03 was used to convert from mR to mrem in tissue [Reference 4-2].

Table 4-14 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 is based on concentrations of naturally occurring radionuclides found in soil samples collected in 1976. Data indicated the average concentrations of ^{238}U, ^{232}Th, and ^{40}K were 1.5, 1.3, and 19 pCi/g, respectively. These are very long-lived radionuclides and soil concentrations remain, on the average, constant over many years. 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 based on the above average area soil concentrations were calculated to be 21, 28, and 27 mrem/yr, respectively, for a total of 76 mrem/yr. Because snow cover can reduce the effective dose equivalent Idaho residents receive from the soil, a correction factor must be made each year to the above estimate of 76 mrem/yr. For 1996, this resulted in about a 4% dose reduction due to snow cover, which reached a maximum depth of 28 cm (11 in) for a few days in January.

The cosmic component varies primarily with altitude increasing from about 26 mrem at sea level to about 48 mrem at the elevation of the INEEL at approximately 1500 m (4900 ft.) [Reference 4-3]. This may vary slightly due to solar cycle fluctuations and other factors.

The estimated sum of the terrestrial and cosmic components for 1996 is 121 mrem. This is

TABLE 4-11. MANMADE RADIONUCLIDES IN BREAST MEAT OF MOURNING DOVES (1996)

			Concentration (x 10^{-6} µCi/g)		
Radionuclide	Location	# Doves Analyzed	Minimum[a]	Maximum[a]	Mean[b]
^{54}Mn	Control	4	<mdc[c]	<mdc	-----
	TRA	13	<mdc	0.09 ± 0.09	0.01 ± 0.03
^{58}Co	Control	4	<mdc	0.13 ± 0.07	0.05 ± 0.08
	TRA	13	<mdc	0.13 ± 0.10	-0.01 ± 0.03
^{65}Zn	Control	4	<mdc	<mdc	-----
	TRA	13	<mdc	0.22 ± 0.20	0.02 ± 0.08
^{90}Sr	Control	3	<mdc	<mdc	-----
	TRA	5	<mdc	0.03 ± 0.02	0.02 ± 0.01
^{95}Nb	Control	4	<mdc	0.16 ± 0.09	0.03 ± 0.11
	TRA	13	<mdc	<mdc	-----
^{95}Zr	Control	4	<mdc	0.17 ± 0.16	0.02 ± 0.16
	TRA	13	<mdc	<mdc	-----
^{103}Ru	Control	4	<mdc	<mdc	-----
	TRA	13	<mdc	0.19 ± 0.17	0.01 ± 0.05
^{134}Cs	Control	4	<mdc	<mdc	-----
	TRA	12	<mdc	0.08 ± 0.07	0.02 ± 0.02
^{137}Cs	Control	4	<mdc	<mdc	-----
	TRA	13	<mdc	0.25 ± 0.05	0.13 ± 0.06
^{140}Ba	Control	4	<mdc	1.4 ± 0.5	0.6 ± 0.7
	TRA	13	<mdc	<mdc	-----
^{181}Hf	Control	4	<mdc	<mdc	-----
	TRA	13	<mdc	0.16 ± 0.16	0.03 ± 0.04

[a] Concentration ± 2 standard deviations.
[b] Mean with 95% confidence interval.
[c] Less than minimum detectable concentration.

comparable to the value of 129 mrem measured by thermoluminescent dosimeters (TLDs), after conversion from mR to mrem, 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 4-14 for this component of the total background dose because no specific estimate for southeastern Idaho has been made, and few specific measurements have been made of radon in homes in this area. Therefore, the effective dose equivalent from natural background radiation for residents in the INEEL vicinity may actually be higher or lower than the total estimated natural background dose of about 360 mrem shown in Table 4-14 and will vary from one location to another.

Onsite TLDs representing the same exposure period as the offsite dosimeters are shown in Figures 4-3 through 4-12. The results are expressed in mR ± 2s. Onsite dosimeters were placed on facility perimeters, concentrated in areas likely to show the highest gamma radiation readings. At TRA, for example, dosimeters #2, #3, #4, and #5 are adjacent to the former radioactive disposal pond which has been drained and covered by clean soil.

Other dosimeters (e.g., ICPP #20 through #22, TRA #7 and #8, and ANL-W #15) are located in

TABLE 4-12. RADIONUCLIDES IN OFFSITE SURFACE (0-5 cm. DEPTH) SOIL (1970-1996)

		pCi/g		nCi/m²			~MDC[a]	
Nuclide	Year	Geometric Mean	95% Confidence Interval[b]	Geometric Mean	95% Confidence Interval[b]	Number of Samples	pCi/g	nCi/m²
^{137}Cs	1970-75[c]	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		
	1994	0.75	0.55-1.03	36	28-47	12		
	1996	0.63	0.42-0.95	32	22-47	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		
	1994	0.36	0.29-0.46	18	14-24	11		
	1996	0.23	0.17-0.31	12	9-16	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		
	1994	0.0013	0.0009-0.0019	0.06	0.05-0.09	12		
	1996	0.0014	0.0006-0.0029	0.07	0.03-0.15	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		
	1994	0.021	0.013-0.033	1.01	0.67-1.53	12		
	1996	0.022	0.017-0.030	1.14	0.86-1.49	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		
	1994	0.004	0.002-0.006	0.17	0.11-0.28	12		
	1996	0.009	0.007-0.011	0.44	0.35-0.56	12		

[a] Approximate minimum detectable concentration.
[b] The 95% confidence interval for the geometric mean.
[c] Excluding 1972 in which no samples were taken.

TABLE 4-13. ENVIRONMENTAL RADIATION EXPOSURES (1992-1996)

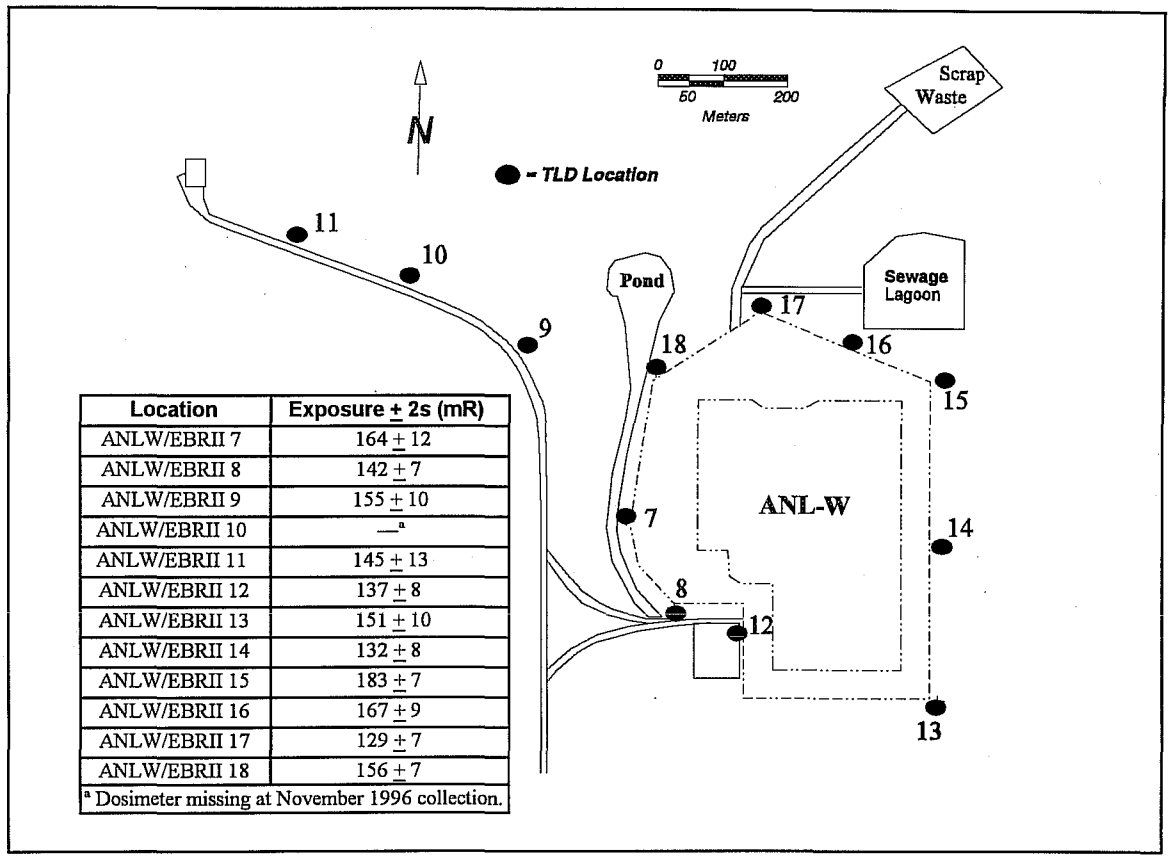
Location	Annual Exposure (mR)[a] 1992	1993	1994	1995 Foundation	1995 LMITCO	1996 Foundation	1996 LMITCO
Distant Group:							
Aberdeen	----[b]	99 ± 3	120 ± 4	108 ± 3	110 ± 4	----	----
Blackfoot	122 ± 4	111 ± 4	125 ± 5	117 ± 4	118 ± 4	120 ± 8	132 ± 7
Craters of the Moon	132 ± 6	110 ± 7	133 ± 10	114 ± 4	109 ± 4	117 ± 4	122 ± 6
Idaho Falls	138 ± 9	116 ± 4	----	120 ± 5	122 ± 6	120 ± 5	120 ± 6
Minidoka	129 ± 6	----	120 ± 6	105 ± 2	-----	118 ± 5	121 ± 4
Rexburg	109 ± 4	107 ± 4	120 ± 6	109 ± 3	114 ± 4	122 ± 4	125 ± 11
Roberts	136 ± 6	124 ± 4	138 ± 4	118 ± 5	126 ± 6	140 ± 9	141 ± 9
Mean[c]	128 ± 11	111 ± 9	126 ± 3	113 ± 5	117 ± 7	123 ± 9	127 ± 9
Boundary Group:							
Arco	134 ± 6	117 ± 4	127 ± 6	118 ± 3	121 ± 7	131 ± 6	130 ± 4
Atomic City	132 ± 5	125 ± 4	134 ± 8	124 ± 5	126 ± 5	136 ± 6	144 ± 14
Howe	126 ± 4	114 ± 4	121 ± 4	112 ± 4	108 ± 4	117 ± 8	122 ± 6
Monteview	120 ± 5	116 ± 4	120 ± 7	118 ± 4	120 ± 6	122 ± 4	108 ± 4
Mud Lake	138 ± 4	126 ± 4	130 ± 8	117 ± 7	-----	129 ± 6	139 ± 9
Reno Ranch	112 ± 4	107 ± 4	126 ± 11	113 ± 4	117± 8	110 ± 4	109 ± 6
Mean[c]	127 ± 10	118 ± 7	126 ± 2	117 ± 5	118 ± 8	124 ± 10	125 ± 16

[a] Annual exposure ± 2s.
[b] Dosimeter missing or damaged.
[c] Arithmetic mean with the 95% confidence interval for the mean.

the vicinity of radioactive material storage areas. At some facilities, particularly ARA and ICPP, slightly elevated exposures result from areas of soil contamination around the perimeter of these facilities.

TABLE 4-14. ESTIMATED NATURAL BACKGROUND EFFECTIVE DOSE EQUIVALENT (1996)

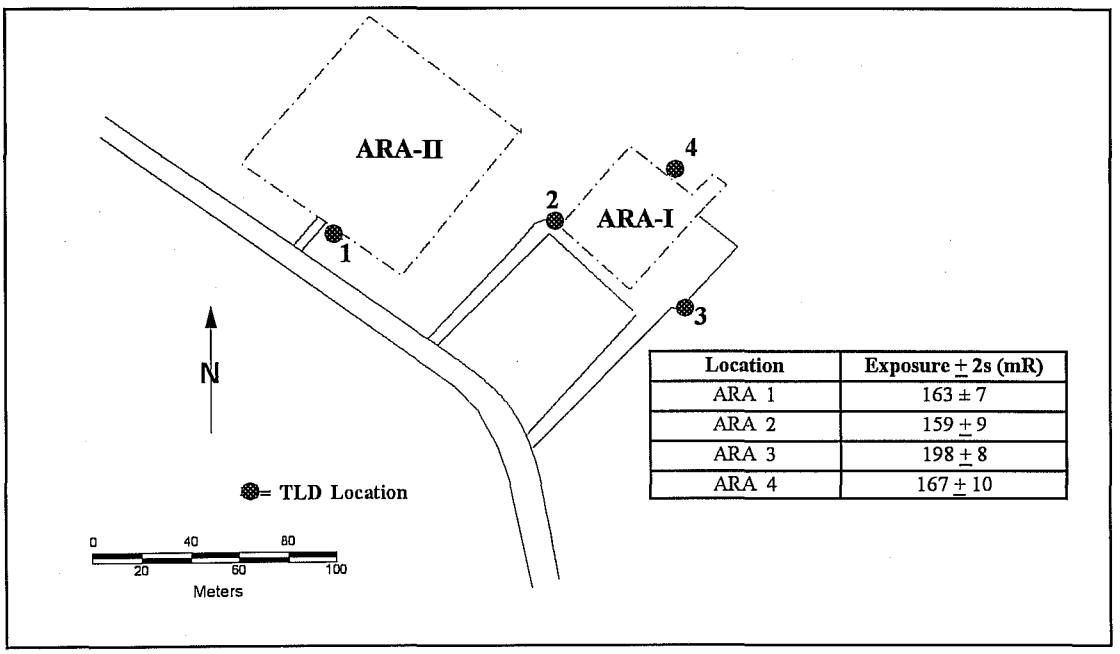
Source of Radiation Dose Equivalent	Total Average Annual Effective Dose Equivalent (mrem) Estimated	Measured (TLD)
External		
Terrestrial	73	-------
Cosmic	48	-------
Subtotal	121	129
Internal		
Cosmogenic	1	
Inhaled radionuclides	200	
^{40}K and others	39	
Subtotal	240	
Total	361	



Location	Exposure ± 2s (mR)
ANLW/EBRII 7	164 ± 12
ANLW/EBRII 8	142 ± 7
ANLW/EBRII 9	155 ± 10
ANLW/EBRII 10	—[a]
ANLW/EBRII 11	145 ± 13
ANLW/EBRII 12	137 ± 8
ANLW/EBRII 13	151 ± 10
ANLW/EBRII 14	132 ± 8
ANLW/EBRII 15	183 ± 7
ANLW/EBRII 16	167 ± 9
ANLW/EBRII 17	129 ± 7
ANLW/EBRII 18	156 ± 7

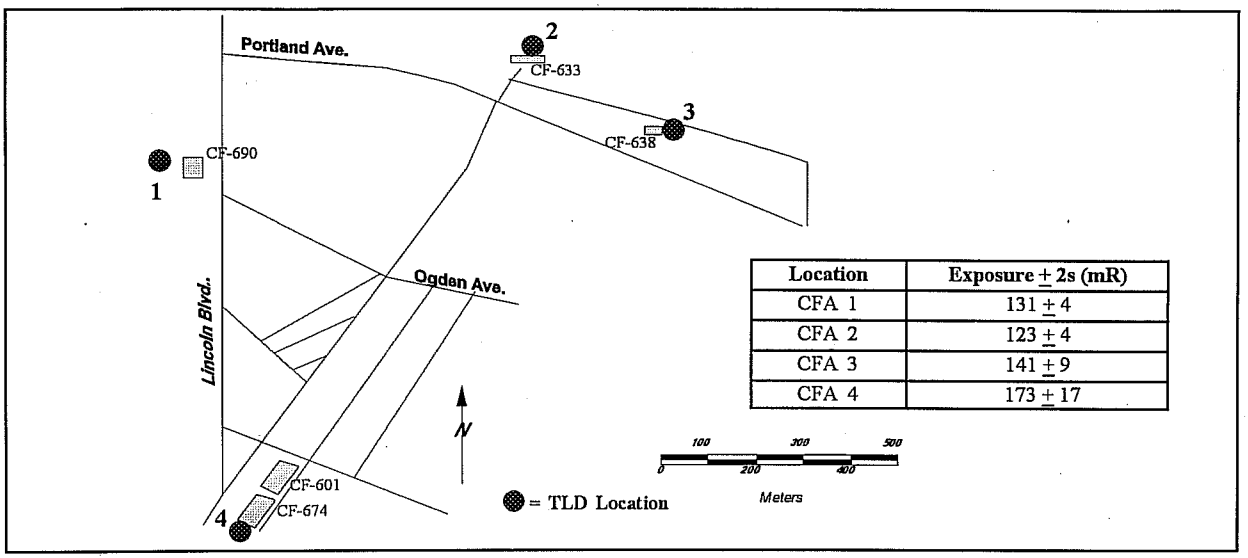
[a] Dosimeter missing at November 1996 collection.

Figure 4-3. Environmental Dosimeter Measurements at ANL-W (1996)



Location	Exposure ± 2s (mR)
ARA 1	163 ± 7
ARA 2	159 ± 9
ARA 3	198 ± 8
ARA 4	167 ± 10

Figure 4-4. Environmental Dosimeter Measurements at ARA (1996)



Location	Exposure ± 2s (mR)
CFA 1	131 ± 4
CFA 2	123 ± 4
CFA 3	141 ± 9
CFA 4	173 ± 17

Figure 4-5. Environmental Dosimeter Measurements at CFA (1996)

Location	Exposure ± 2s (mR)
ICPP 1	168 ± 9
ICPP 9	283 ± 18
ICPP 14	155 ± 12
ICPP 15	163 ± 15
ICPP 16	144 ± 10
ICPP 17	155 ± 7
ICPP 18	-----[a]
ICPP 19	134 ± 6
ICPP 20	251 ± 13
ICPP 21	170 ± 15
ICPP 22	215 ± 12
ICPP 23	157 ± 10
ICPP 24	155 ± 17
ICPP 25	-----[a]
ICPP 26	-----[a]
Tree Farm 1	214 ± 15
Tree Farm 2	169 ± 8
Tree Farm 3	167 ± 9
Tree Farm 4	210 ± 8

[a] Dosimeter missing at Nov. 1996 collection

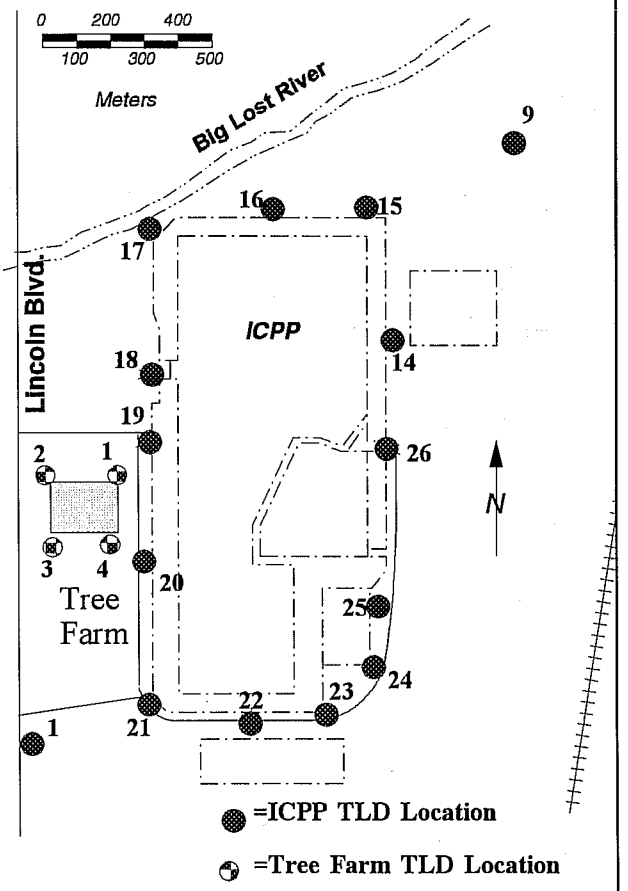


Figure 4-6. Environmental Dosimeter Measurements at ICPP (1996)

Location	Exposure ± 2s (mR)
NRF 4	-----[a]
NRF 5	143 ± 8
NRF 11	135 ± 7
NRF 12	138 ± 10
NRF 13	143 ± 10
NRF 16	131 ± 4
NRF 17	136 ± 7
NRF 18	135 ± 8
NRF 19	145 ± 7
NRF 20	133 ± 6
NRF 21	143 ± 6

[a] Dosimeter missing at Nov. 96 collection.

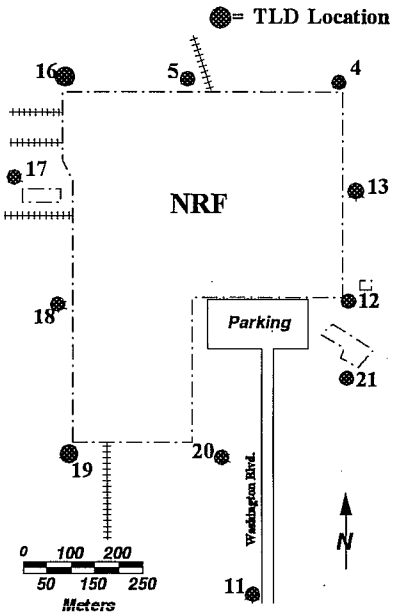


Figure 4-7. Environmental Dosimeter Measurements at NRF (1996)

Location	Exposure ± 2s (mR)
PBF/SPERT 1	124 ± 6
PBF/SPERT 2	158 ± 7
PBF/SPERT 3	133 ± 7
PBF/SPERT 4	129 ± 5
PBF/SPERT 5	130 ± 6
PBF/SPERT 6	145 ± 4
PBF/WERF 1	131 ± 5
PBF/WERF 2	116 ± 5
PBF/WERF 3	124 ± 8
PBF/WERF 4	147 ± 10
PBF/WERF 5	127 ± 6
PBF/WERF 6	128 ± 4
PBF/WERF 7	138 ± 9

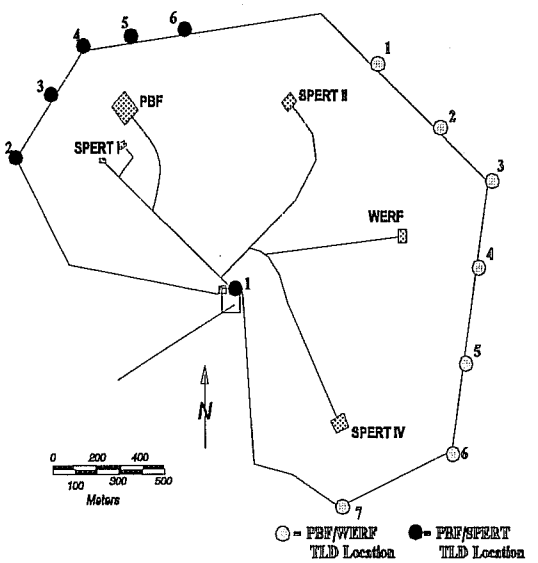
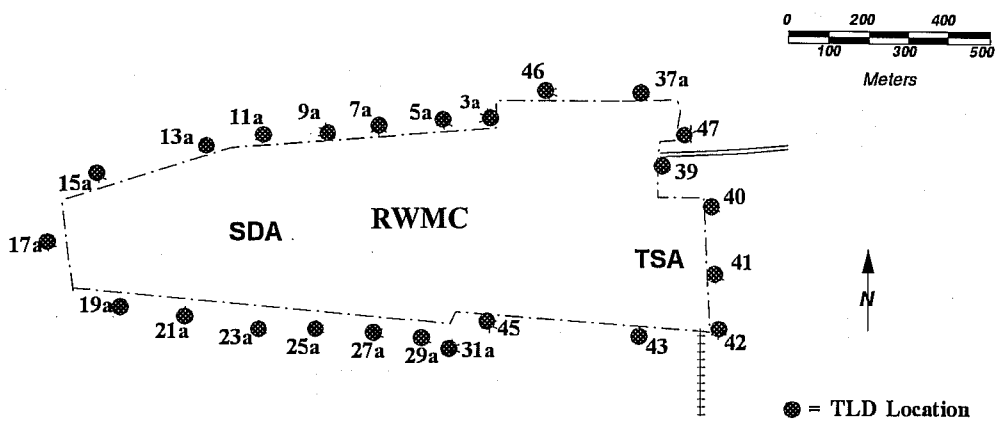


Figure 4-8. Environmental Dosimeter Measurements at PBF (1996)



Location	Exposure ± 2s (mR)
RWMC 3a	-----[a]
RWMC 5a	152 ± 8
RWMC 7a	-----[a]
RWMC 9a	173 ± 8
RWMC 11a	148 ± 5
RWMC 13a	156 ± 9
RWMC 15a	145 ± 7
RWMC 17a	157 ± 6
RWMC 19a	142 ± 5
RWMC 21a	149 ± 9
RWMC 23a	301 ± 24
RWMC 25a	163 ± 6

Location	Exposure ± 2s (mR)
RWMC 27a	216 ± 6
RWMC 29a	276 ± 13
RWMC 31a	196 ± 6
RWMC 37a	143 ± 9
RWMC 39	143 ± 4
RWMC 40	163 ± 5
RWMC 41	302 ± 13
RWMC 42	146 ± 7
RWMC 43	147 ± 6
RWMC 45	158 ± 4
RWMC 46	158 ± 9
RWMC 47	161 ± 9

[a] TLD missing at May 1996 collection time.

Figure 4-9. Environmental Dosimeter Measurements at RWMC (1996)

Location	Exposure ± 2s (mR)
TAN/TSF 1	153 ± 8
TAN/TSF 2	147 ± 12
TAN/TSF 3	----[a]
TAN/TSF 4	130 ± 8
TAN/LOFT 1	132 ± 6
TAN/LOFT 2	143 ± 4
TAN/LOFT 3	110 ± 6
TAN/LOFT 4	119 ± 4
TAN/LOFT 5	115 ± 6
TAN/LOFT 6	140 ± 9
TAN/LOFT 7	147 ± 7
TAN/WRRTF 1	127 ± 6
TAN/WRRTF 2	125 ± 9
TAN/WRRTF 3	140 ± 17
TAN/WRRTF 4	116 ± 4

[a] Dosimeter missing at Nov. 96 collection.

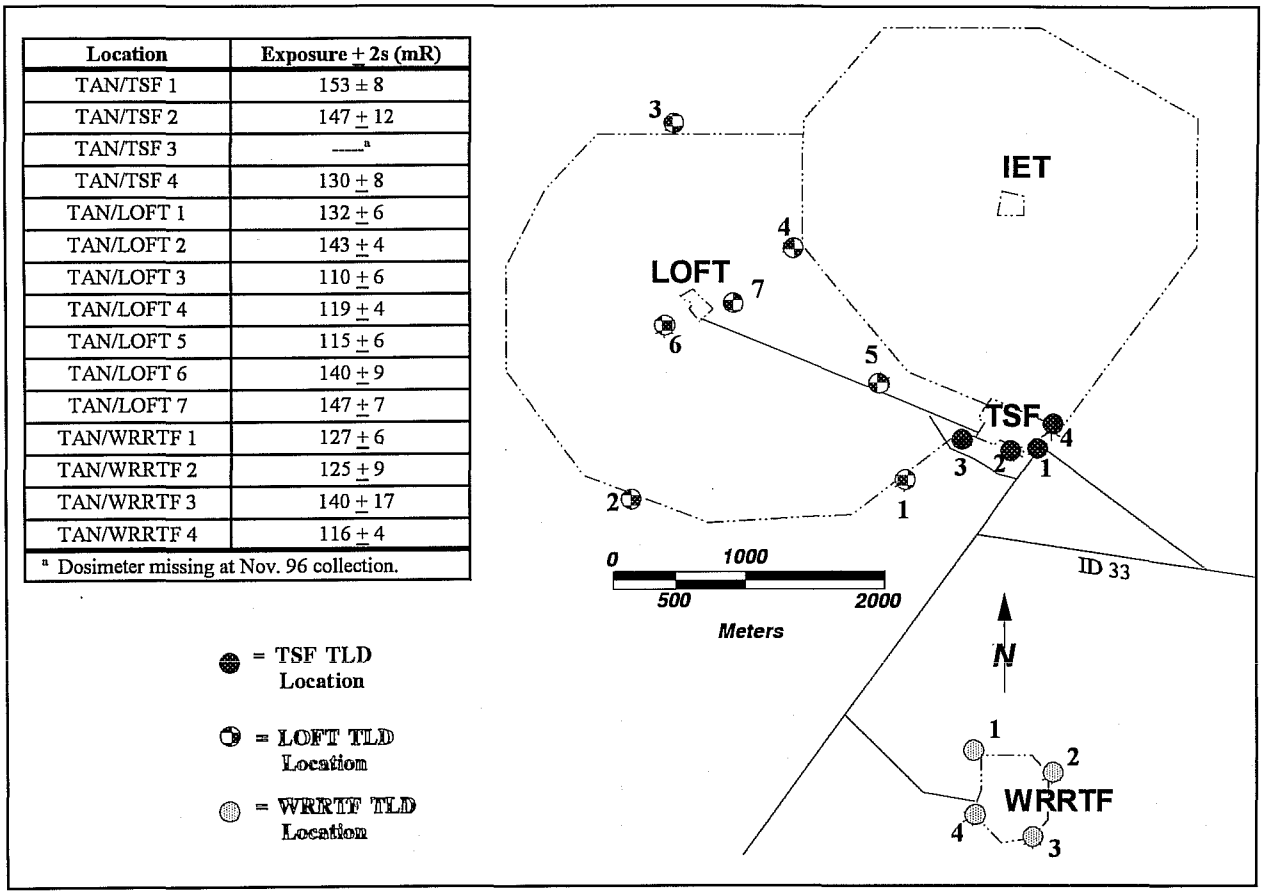


Figure 4-10. Environmental dosimeter measurements at TAN (1996)

Location	Exposure ± 2s (mR)
TRA 1	172 ± 13
TRA 2	270 ± 10
TRA 3	345 ± 16
TRA 4	255 ± 10
TRA 5	179 ± 7
TRA 6	154 ± 8
TRA 7	165 ± 6
TRA 8	196 ± 9
TRA 9	152 ± 6
TRA 10	165 ± 7
TRA 11	194 ± 6
TRA 12	147 ± 6
TRA 13	143 ± 8

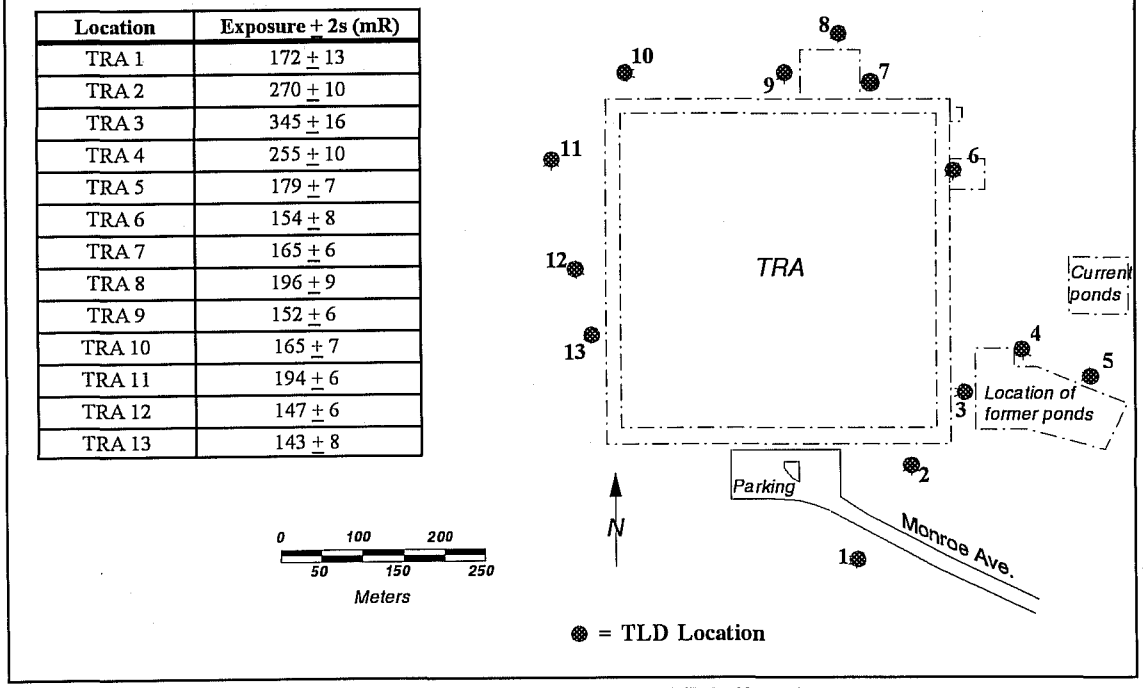
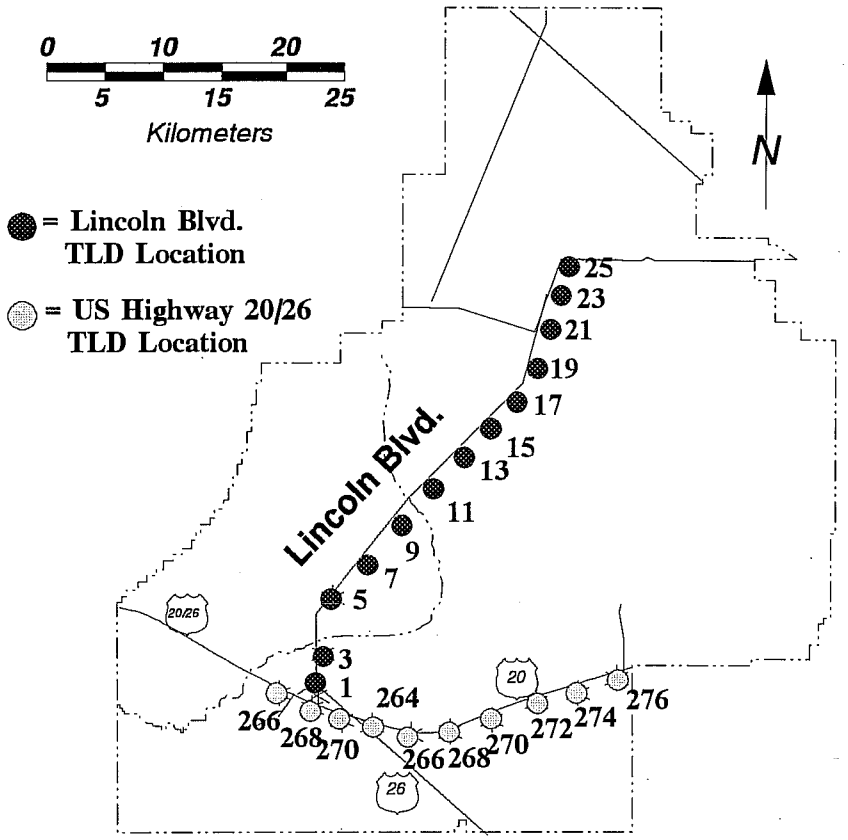


Figure 4-11. Environmental Dosimeter Measurements at TRA (1996)



Location	Exposure ± 2s (mR)
LINCOLN BLVD. 1	130 ± 7
LINCOLN BLVD. 3	155 ± 10
LINCOLN BLVD. 5	145 ± 6
LINCOLN BLVD. 7	138 ± 9
LINCOLN BLVD. 9	143 ± 8
LINCOLN BLVD. 11	151 ± 11
LINCOLN BLVD. 13	141 ± 5
LINCOLN BLVD. 15	135 ± 4
LINCOLN BLVD. 17	160 ± 5
LINCOLN BLVD. 19	136 ± 6
LINCOLN BLVD. 21	128 ± 8
LINCOLN BLVD. 23	131 ± 7
LINCOLN BLVD. 25	146 ± 12

Location	Exposure ± 2s (mR)
HIGHWAY 26 mile 266	138 ± 7
HIGHWAY 26 mile 268	133 ± 7
HIGHWAY 26 mile 270	137 ± 9
HIGHWAY 20 mile 264	------[a]
HIGHWAY 20 mile 266	129 ± 9
HIGHWAY 20 mile 268	115 ± 6
HIGHWAY 20 mile 270	110 ± 6
HIGHWAY 20 mile 272	102 ± 3
HIGHWAY 20 mile 274	------[a]
HIGHWAY 20 mile 276	187 ± 23

[a] Dosimeter missing at Nov. 96 collection.

Figure 4-12. Environmental Dosimeter Measurements along Lincoln Blvd. and US Highways 20 and 26 (1996)

Summary of Chapter 5
Nonradiological Environmental Monitoring Results

The Environmental Science and Research Foundation and Lockheed Martin Idaho Technologies Company (LMITCO) monitored air and storm water for nonradiological parameters at the Idaho National Engineering and Environmental Laboratory (INEEL). Concentrations of airborne particulates were measured in three different size fractions: the total amount of particulates collected on low-volume air filters, the amount less than 10 micrometers in diameter (PM_{10}), and the amount of very fine material less than 2.5 micrometers in diameter ($PM_{2.5}$). As part of a nationwide National Park Service program, additional monitoring was performed for several different parameters that can contribute to visibility impairment. Nitrogen dioxide and sulfur dioxide measured at onsite locations were substantially below air quality standards for these parameters set by the U.S. Environmental Protection Agency (EPA).

Storm water runoff from snowmelt and precipitation events was collected and analyzed for a variety of nonradiological substances. Comparisons were made between concentrations of these substances in storm water and EPA drinking water standards in order to assess the water quality of these discharges. Levels of one or more pollutants in storm water were above the drinking water standards at 15 sampling sites, but most of these appeared to result from sediment in the samples.

5. NONRADIOLOGICAL ENVIRONMENTAL MONITORING RESULTS

5.1 TOTAL SUSPENDED PARTICULATES

Concentrations of total suspended particulates were measured in 1996 by both the Environmental Science and Research Foundation and LMITCO using filters from low-volume air samplers. The filters are 99% efficient for collection of particles greater than 0.3 μm in diameter. Unlike the fine particulate samplers discussed in Section 5.2, these samplers do not selectively filter out particles of a certain size range, and so measure the total amount of particulate matter.

The annual mean of total suspended particulate concentrations ranged from 4 $\mu g/m^3$ at Craters of the Moon to 56 $\mu g/m^3$ at Idaho Falls (Table 5-1). The particulate concentration at Idaho Falls was undoubtedly affected by road construction on U.S. Highway 20 adjacent to the sampling location throughout the summer.

Particulate concentrations were generally higher at distant and boundary locations than at the INEEL stations. The largest source of particulates in eastern Idaho is considered to be suspended dust from agricultural activities. Third quarter concentrations were higher than during other quarters at most of the locations. This was likely due in part to the large fires that occurred in the vicinity of the INEEL at this time, followed by an increase in windblown dust from the burned areas. In addition, dry soils and field burning contribute to particulate levels during this quarter. Overall, however, annual onsite particulate concentrations were lower than in other recent years (Table 5-2).

Two INEEL locations had particulate concentrations that were somewhat higher than other onsite locations. At Argonne National Laboratory–West (ANL–W), this followed a July fire that burned a large area near the facility. Throughout late summer and early fall, ANL-W was occasionally impacted by dust storms from the burn. Particulate concentrations at the Radioactive Waste Management Complex were likely elevated by ongoing construction activities.

5.2 FINE PARTICULATES (PM_{10})

The EPA began using a new standard for concentrations of airborne particulate matter in 1987. The new standard refers only to "particles with an aerodynamic diameter less than or equal to a nominal 10 micrometers" [Reference 5-1]. Particles of this size, which can reach the lungs, are considered to be responsible for most of the adverse health effects associated with airborne particulate pollution. The air quality standards for fine particulates, generally referred to as PM_{10}, are an annual average of 50 $\mu g/m^3$, with a maximum 24-hour concentration of 150 $\mu g/m^3$.

Seventeen samples were collected at Rexburg by the Foundation from September through December. Concentration of fine particulates ranged from -11 $\mu g/m^3$ to 73 $\mu g/m^3$, with a mean of 23 ± 3 $\mu g/m^3$. At Mountain View Middle School in Blackfoot, where sampling began in November, the range of the eight samples collected was 4 $\mu g/m^3$ to 41 $\mu g/m^3$. The mean concentration at this location was 14 ± 10 $\mu g/m^3$.

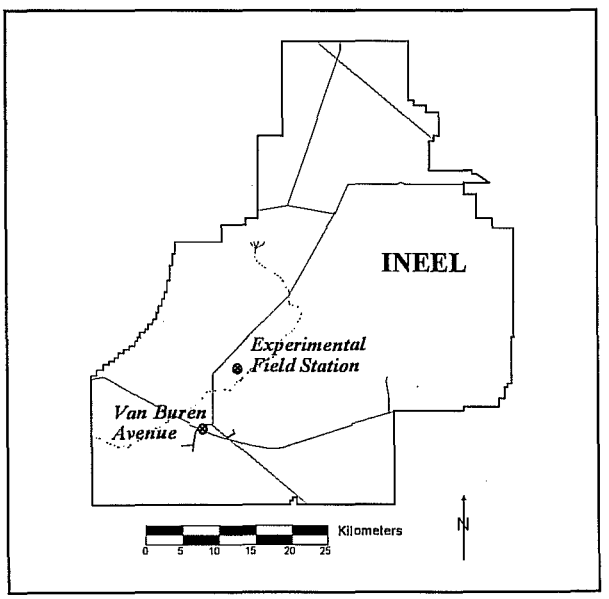


Figure 5-1. Nitrogen/Sulfur Dioxide Monitoring Locations

TABLE 5-1. PARTICULATE MATTER CONCENTRATIONS IN AIR (1996)

Environmental Science and Research Foundation Data

		Concentration (µg/m³)	
Group	**Location**	**Range[a]**	**Mean[b]**
Distant	Blackfoot	10–31	19 ± 14
	Craters of the Moon	0–13	4 ± 15
	Idaho Falls	14–102	56 ± 62
	Mountain View[c]	18	18
	Rexburg	20–27	24 ± 4
		Grand Mean[b]	24 ± 10
Boundary	Arco	37–89	51 ± 41
	Atomic City	7–16	12 ± 6
	FAA Tower	4–45	17 ± 31
	Howe	7–36	18 ± 21
	Monteview	6–37	20 ± 21
	Mud Lake	14–33	24 ± 15
	Reno Ranch	6–13	10 ± 6
		Grand Mean[b]	22 ± 5
INEEL	EFS	5–18	10 ± 9
	Main Gate	6–12	8 ± 5
	Van Buren	5–13	9 ± 5
		Grand Mean[b]	9 ± 1

LMITCO Data

		Concentration (µg/m³)	
Group	**Location**	**Range**	**Mean[a]**
Distant	Blackfoot	5–32	16 ± 18
	Craters of the Moon	4–17	9 ± 11
	Idaho Falls	10–93	53 ± 62
	Rexburg	15–32	21 ± 12
		Grand Mean[b]	25 ± 10
INEEL	ANL-W	8–37	21 ± 22
	ARA	3–13	6 ± 7
	CFA	3–13	10 ± 7
	EBR1	3–13	8 ± 6
	EFS	2–18	7 ± 11
	ICPP	4–12	6 ± 6
	NRF	3–13	7 ± 8
	PBF	5–15	10 ± 8
	RWMC	10–35	22 ± 17
	TAN	3–10	6 ± 5
	TRA	3–13	7 ± 7
	VANB	5–16	11 ± 7
		Grand Mean[b]	10 ± 2

[a] Range of quarterly concentrations.
[b] Arithmetic mean with the 95% confidence interval for the mean.
[c] Station operated in fourth quarter only

TABLE 5-2. TEN-YEAR SUMMARY OF PARTICULATE MATTER CONCENTRATIONS (1987-1996)

	Group Mean Concentration ($\mu g/m^3$)[a]		
Year	Distant Group	Boundary Group	INEEL Group
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
1994	28 ± 28	23 ± 7	25 ± 4
1995	32 ± 30	28 ± 13	20 ± 7
1996 (Foundation)	24 ± 10	22 ± 5	9 ± 1
1996 (LMITCO)	25 ± 10	---	10 ± 2

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

5.3 NITROGEN DIOXIDE

Nitrogen dioxide was monitored at Van Buren Avenue and the Experimental Field Station (EFS) (Figure 5-1) throughout 1996. At Van Buren, quarterly mean concentrations ranged from 2.6 $\mu g/m^3$ to 3.2 $\mu g/m^3$, with an annual mean of 3.1 $\mu g/m^3$ (1.6 ppb). This annual concentration is 3% of the EPA air quality standard of 100 $\mu g/m^3$ for nitrogen dioxide. The maximum 24-hour concentration measured was 10.2 $\mu g/m^3$ (5.4 ppb) on July 20. Data were obtained at the Van Buren station for 97% of the year.

Quarterly means at EFS ranged from 2.1 $\mu g/m^3$ during the second quarter to 19.2 $\mu g/m^3$ during the third quarter. Above-normal concentrations of nitrogen dioxide were found during the brush fires that occurred on, and in the vicinity of, the INEEL during late summer. For the year, the mean concentration was 8.1 $\mu g/m^3$ (4.3 ppb), or 8% of the EPA standard. The maximum 24-hour concentration occurred on August 3, when a value of 71.5 $\mu g/m^3$ (37.4 ppb) was recorded. Data were obtained at the EFS location for 79% of the year.

When operating, the New Waste Calcining Facility at the Idaho Chemical Processing Plant (ICPP) is the largest single source of nitrogen dioxide at the INEEL. A graph of nitrogen dioxide at the two sampling locations may indicate some effect from this facility on ambient concentrations of nitrogen dioxide, particularly at EFS located approximately 5 km (3 miles) in the prevailing wind direction from ICPP (Figure 5-2). All quarterly concentrations have remained below 50% of the annual standard throughout the time period of monitoring. The New Waste Calcining Facility did not operate from October 1993 until mid-1997. Further information on airborne nitrogen dioxide effluents released during 1996 is provided in Chapter 7.

5.4 SULFUR DIOXIDE

Sulfur dioxide was measured at the Van Buren Avenue monitoring location, and the analyzer operated satisfactorily for 97% of the year. For sulfur dioxide, there are three separate EPA standards [Reference 5-2]. The mean sulfur dioxide concentration for 1996 was 4.0 $\mu g/m^3$ (1.5 ppb), or 5.0% of the annual primary air quality standard of 80 $\mu g/m^3$. There is a second primary air quality standard for the maximum 24-hour concentration, not to be exceeded more than once per year. The maximum recorded 24-hour concentration at Van Buren was 20.7 $\mu g/m^3$ (7.8 ppb) on November 17, which did not approach the standard of 365 $\mu g/m^3$.

In addition to the primary standards, there is a secondary ambient air quality standard. The

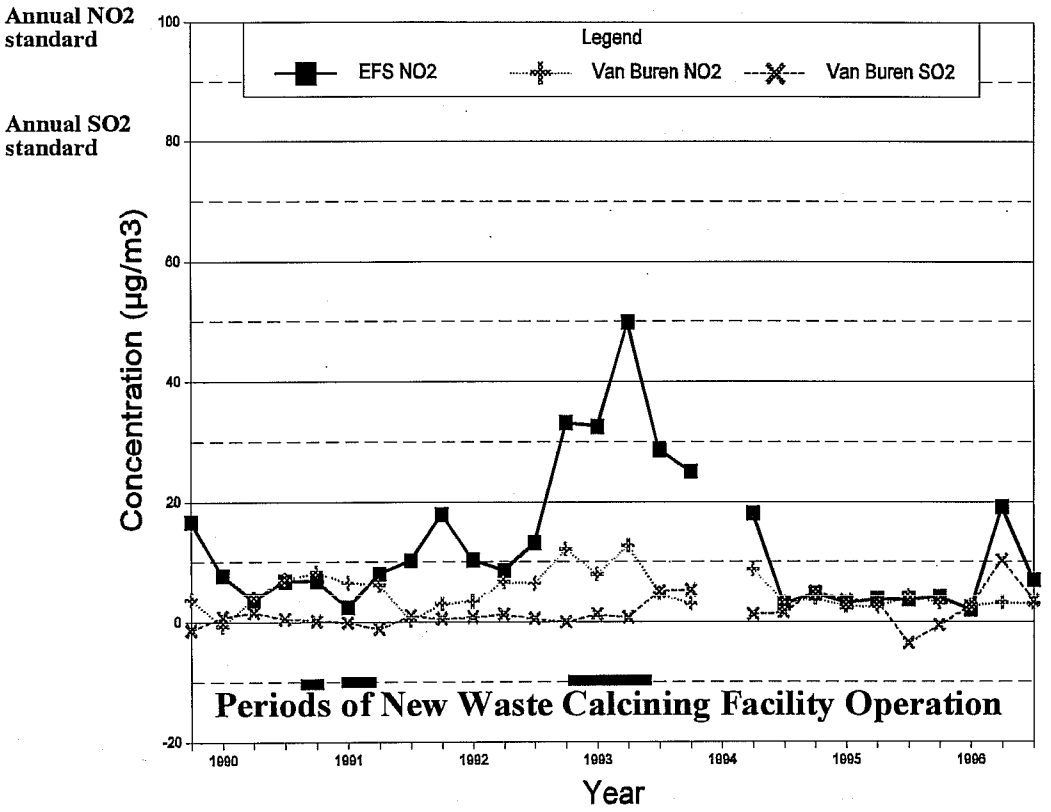


Figure 5-2. Nitrogen Dioxide and Sulfur Dioxide Concentrations at the INEEL (1988-1996)

secondary standard refers to the maximum 3-hour concentration, which can not exceed 1300 $\mu g/m^3$ more than once per year. The highest measured 3-hour concentration of 24.0 $\mu g/m^3$ (9.0 ppb) was less than 2% of the secondary standard.

5.5 IMPROVE SAMPLERS

Interagency Monitoring of Protected Visual Environment (IMPROVE) samplers have operated continuously at Craters of the Moon National Monument and Central Facilities Area (CFA) since the spring of 1992. The most recent data available are through February 1996. A summary of the data for hydrogen and elements sodium through lead on the periodic table are shown in Table 5-3.

Several elements measured, including aluminum, silicon, calcium, titanium, and iron, are derived from soils, and show a seasonal variation with lower values during the winter when the ground is often covered by snow. Potassium may be derived from soils, but is also a component of smoke.

Other elements are considered tracers of various industrial and urban activities. Lead and bromine, for example, result from automobile emissions. Annual concentrations of lead at IMPROVE sites in the mid-Atlantic states are commonly in the range of 2 to 6 ng/m^3, or up to 10 times higher than at the two southeast Idaho sites. Selenium, in the 0.2 ng/m^3 range at Craters of the Moon and CFA, is a tracer of emissions from coal-fired plants. At Mammoth Cave in Kentucky, annual selenium concentrations of 1.4 ng/m^3 have been reported [Reference 5-3].

TABLE 5-3. DATA FOR IMPROVE SAMPLERS AT CFA AND CRATERS OF THE MOON NATIONAL MONUMENT (MAY 1992 - FEBRUARY 1996)[a]

	% Detected[b]		Range		Mean[c]	
Constituent	CFA	Craters	CFA	Craters	CFA	Craters
Hydrogen	100	100	24 - 1256	19 - 1339	168 ± 14	139 ± 11
Sodium	51	63	<dl[d] - 214	<dl - 257	35 ± 4	40 ± 4
Magnesium	40	32	<dl - 399	<dl - 145	18 ± 4	13 ± 2
Aluminum	74	75	<dl - 1146	<dl - 965	58 ± 12	53 ± 8
Silicon	99	99	<dl - 2869	<dl - 2115	167 ± 30	133 ± 16
Phosphorus	17	11	<dl - 101	<dl - 103	5.4 ± 1.0	4.0 ± 0.8
Sulfur	100	100	23 - 1509	16 - 617	198 ± 14	163 ± 10
Chlorine	6	7	<dl - 37	<dl - 15	2.7 ± 0.3	2.4 ± 0.1
Potassium	99	99	<dl - 432	<dl - 298	41 ± 6	37 ± 4
Calcium	99	97	<dl - 880	<dl - 295	51 ± 7	39 ± 4
Titanium	77	80	<dl - 75	<dl - 48	4.6 ± 0.7	3.9 ± 0.4
Vanadium	39	34	<dl - 7.0	<dl - 5.0	1.3 ± 0.1	1.1 ± 0.1
Chromium	25	26	<dl - 4.1	<dl - 3.1	0.8 ± 0.1	0.78 ± 0.04
Manganese	46	50	<dl - 15	<dl - 11	1.3 ± 0.2	1.2 ± 0.1
Iron	100	100	1 - 706	1 - 410	38 ± 7	32 ± 4
Nickel	16	16	<dl - 0.4	<dl - 1.1	0.066 ± 0.004	0.07 ± 0.01
Copper	93	90	<dl - 5.9	<dl - 6.4	0.6 ± 0.1	0.5 ± 0.1
Zinc	100	100	0.1 - 29	0.1 - 20	1.8 ± 0.2	1.6 ± 0.1
Arsenic	40	44	<dl - 1.7	<dl - 4.1	0.18 ± 0.02	0.20 ± 0.03
Lead	84	94	<dl - 3.0	<dl - 4.4	0.58 ± 0.04	0.58 ± 0.04
Selenium	85	73	<dl - 2.3	<dl - 1.3	0.22 ± 0.02	0.16 ± 0.01
Bromine	100	100	0.2 - 8.3	0.2 - 4.8	1.5 ± 0.1	1.3 ± 0.1
Rubidium	63	54	<dl - 1.4	<dl - 1.1	0.12 ± 0.02	0.11 ± 0.01
Strontium	74	74	<dl - 3.2	<dl - 2.0	0.25 ± 0.03	0.24 ± 0.02
Zirconium	21	17	<dl - 2.0	<dl - 1.7	0.15 ± 0.01	0.15 ± 0.01
Molybdenum	6	5	<dl - 3.3	<dl - 3.8	1.3 ± 0.1	1.3 ± 0.1

[a] Units expressed in nanograms/m^3.
[b] Percentage 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.

Fine particles with a diameter less than 2.5 micrometers, $PM_{2.5}$, are the size fraction most commonly associated with visibility impairment. At Craters of the Moon, $PM_{2.5}$ has ranged over the period of sampler operation from 0.4 to 25 $\mu g/m^3$ with a mean of 3.6 $\mu g/m^3$. Concentrations at CFA during the same time period varied from 0.5 to 28 $\mu g/m^3$, with a mean of 4.5 $\mu g/m^3$. In general, the highest levels of very fine mass have been seen during the late summer and early fall, particularly in 1994, when smoke from western forest fires covered the Snake River Plain (Figure 5-3). Elevated very fine mass concentrations are also found occasionally during wintertime inversion conditions, most notably during January 1993 at CFA.

5.6 STORM WATER MONITORING

Seventeen of the 21 storm water monitoring points were sampled during 1996. The only permit-required limits are for pH in runoff from the coal piles at the Idaho Chemical Processing Plant, and in 1996 all of the samples from these monitoring locations had pH values within the 6 to 9 limits.

Nonradiological parameters measured in the discharges were also compared to maximum contaminant levels from the Safe Drinking Water Act. While compliance with drinking water standards is not required, this information is used to determine the water quality of storm discharges.

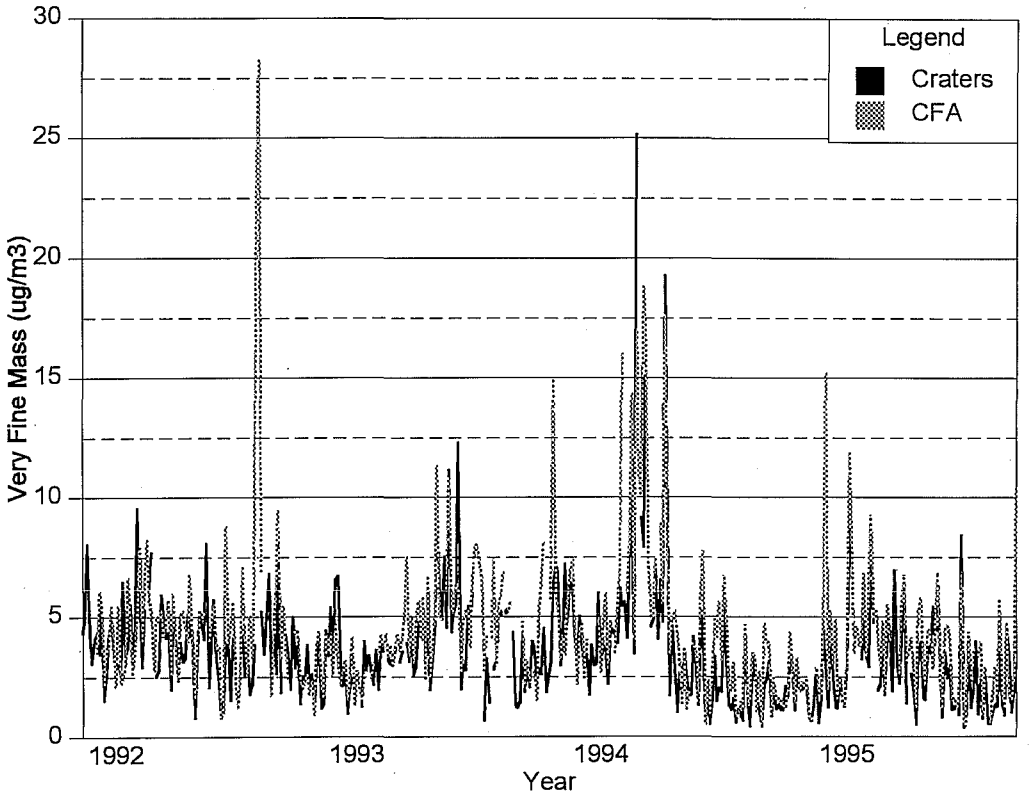


Figure 5-3. Very Fine Mass ($PM_{2.5}$) Concentrations at Craters of the Moon and CFA (1992-1996)

There were a total of 11 parameters that exceeded the maximum contaminant level in one or more samples (Table 5-4). Of these, lead accounted for the largest number. In the National Urban Runoff Program study, nationwide average lead concentrations were reported at 238 µg/L, compared to a drinking water standard of 15 µg/L [Reference 5-4]. Lead concentrations at the INEEL during1993 through 1996 have been approximately 8% of those reported in the nationwide study.

Concentrations of other metals were above the drinking water limit primarily in samples with high total suspended sediment content. This was particularly true of the February 13 sample from monitoring point CFA-3/2, which exceeded the maximum contaminant level for seven metals. It is likely that the metals found were derived from background concentrations of soil.

TABLE 5-4. SELECTED NONRADIOLOGICAL STORM WATER MONITORING DATA (1996)[a]

Parameter	Monitoring Point	Sample Date	Measured Concentration	Drinking Water Standard[b]
Antimony	CFA-3/2	02/13	60	6
Arsenic	CFA-3/2	02/13	54	50
Barium	CFA-3/2	02/13	3200	2000
Cadmium	CFA-3/2	02/13	13	5
	RWMC-2/1	04/02	5.7	
Chromium	CFA-3/2	02/13	210	100
	RWMC-2/1	04/02	115	
Iron	TSF-1/2	09/17	2200	300
Lead	ANLW-1/2	05/16	24.2	15
		09/16	31.0	
	ANLW-2/2	05/16	36.7	
		09/16	23.6	
	CFA-1/2	02/08	21.3	
		05/16	22.0	
	CFA-3/2	02/13	480	
	CTF[c]-1/2	02/20	27.6	
		09/16	26.2	
	ICPP-1/1	05/16	38.7	
	RWMC-2/1	04/02	88	
	TSF-1/2	02/13	54	
Manganese	CFA-3/2	02/13	3700	50
	PBF-2/2	02/12	89	
	PBF-3/2	02/12	96	
	TSF-1/2	02/13	920	
	TSF-3/2	02/20	120	
Thallium	TSF-3/2	02/20	210	2
pH	CFA-1/2	09/16	8.68	6.5-8.5
	CTF-1/2	09/16	8.82	
	ICPP-2/2	02/08	6.48	
		09/16	8.88	
	RWMC-1/2	09/16	9.36	
	RWMC-2/1	02/13	8.80	
		04/02	9.13	
	RWMC-3/2	09/16	8.66	
		09/17	8.95	
Total Dissolved Solids	ANLW-2/2	02/08	673	500
	CTF-1/2	02/20	833	
	RWMC-1/2	02/08	603	
	RWMC-2/1	04/02	690	
	SMC[d]-1/2	02/13	927	

[a] Concentrations in µg/L, except pH which has no units and total dissolved solids which is in mg/L. Data selected are those concentrations exceeding drinking water standards.
[b] Used for comparison purposes only.
[c] Contained Test Facility located at Test Area North.
[d] Specific Manufacturing Capability facility located at Test Area North.

Summary of Chapter 6
Ground Water

The Snake River Plain Aquifer, a primary source for drinking water and crop irrigation in southeastern Idaho, flows beneath the Idaho National Engineering and Environmental Laboratory (INEEL). The U.S. Geological Survey (USGS) maintains observation wells in the INEEL vicinity to monitor the movement of radiochemical and chemical substances in the Snake River Plain Aquifer, perched aquifers, and surface water bodies (*Section 6.1*). Lockheed Martin Idaho Technologies Company (LMITCO) also conducts ground-water monitoring at the INEEL. The status of the tritium and ^{90}Sr contaminant plumes is updated based on data collected during 1992-95. The extent of the tritium contaminant plume, originating from the Test Reactor Area (TRA) and the Idaho Chemical Processing Plant (ICPP), remained about the same as it was in 1991. However, concentrations in well water within the plume significantly decreased. This is attributed to radioactive decay and a decrease in tritium disposal rates (*Section 6.1*). The extent of the ^{90}Sr contaminant plume, originating from ICPP, as well as the concentrations of ^{90}Sr have remained essentially constant since 1991. This is attributed to a lack of ground water recharge from the Big Lost River and to chemical changes in the ground water due to the disposal of chemicals in the ICPP infiltration ponds (*Section 6.1*).

In addition to routine monitoring, the USGS publishes the results of a variety of special studies detailing characteristics of and conditions in the aquifer. Some of the documents issued during 1996 included reports on long-term studies of the aquifer, both on the INEEL and in the region between the INEEL and the Hagerman area; a report detailing the continuing study of the stratigraphy of the rocks that make up the aquifer; and a report that estimates the 100-year peak flows and flow volumes of streams entering the INEEL. These reports are summarized in *Section 6.1* of this chapter.

The USGS and contractors who operate the various facilities at the INEEL perform routine monitoring of the ground water under and adjacent to the site. Results of ground water monitoring conducted during 1996 are summarized in this chapter. Elevated concentrations of several purgeable (volatile) organic chemicals continue to be present in some wells in the vicinity of INEEL facilities (*Section 6.2*). One distribution system at Test Area North, where concentrations of trichloroethylene at the wellhead have been greater than drinking water standards, maintained trichloroethylene levels below the Environmental Protection Agency maximum contaminant level during 1996.

All gross alpha and gross beta concentrations in onsite production wells were within drinking water standards (*Section 6.3*). Tritium concentrations at two production wells and three drinking water distribution systems continued to be detected, but concentrations met drinking water standards and are decreasing. Strontium-90, occasionally detected in production wells at one INEEL facility, was not found in 1996 samples. Coliform bacteria was detected in some samples at three INEEL facilities. Each system was purified by chlorination. (*Section 6.4*)

6. GROUND WATER

6.1 AQUIFER STUDIES

Program Information

USGS. The USGS is responsible for conducting ground-water monitoring, analyses, and studies of the Snake River Plain Aquifer under and adjacent to the INEEL. This is done through an extensive network of strategically placed observation wells on and near the Site (Figures 6-1 and 6-2). The Snake River Plain Aquifer, which travels beneath the INEEL, serves as one of the primary sources for drinking water and crop irrigation in the Snake River Basin. A brief description of the hydrogeology of the INEEL and the movement of water in the Snake River Plain Aquifer was given in Chapter 1. Further information may be found in USGS publications.

The USGS has investigated hydrologic conditions at the INEEL since the Site's origination, and currently conducts an extensive monitoring program for the aquifer and perched water bodies above it. This program includes collection of samples on the INEEL and at locations beyond the southern and western boundaries. The USGS routine ground-water surveillance program was summarized in Chapter 3. In 1996, the routine program included collection of 374 samples for radionuclides and inorganic constituents including trace elements, and 66 samples for purgeable organic compounds. In addition, as part of the 1996 NRF sampling program, the USGS collected 58 samples from 13 NRF wells sampled quarterly for radioactivity, inorganic constituents, and purgeable organic compounds.

Various USGS reports contain maps showing the frequency of water level measurements and water sample collections. Recent information has also been published on the shape and extent of contaminant plumes (the spread of various contaminants in the water of the aquifer and perched water from INEEL facilities) between 1992 and 1995 [Reference 6-1]. A summary of this information is presented below in this section.

The USGS also conducts special studies of the ground water of the Snake River Plain. A summary of these studies is provided below in this section. These special studies provide more specific geological, chemical, and hydrological information on the flow and recharge of the aquifer and the movements of radiochemical and chemical substances in the ground water. Most of the information from these studies is published in USGS reports.

Results of recently published monitoring or surveillance activities are summarized in the *Annual Site Environmental Report* during 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 INEEL Project Office.

LMITCO. LMITCO conducts ground-water monitoring in support of Wastewater Land Application Permits requirements at ICPP and TAN, as well as surveillance monitoring at ICPP. More detailed information and data will be included in the *1996 Compliance Monitoring Annual Report*, INEEL-97/0255(96), due to be published in August 1997.

Contaminant Plumes

Historic waste disposal practices have produced localized plumes of radiochemical and chemical contaminants in the Snake River Plain Aquifer at the INEEL.. Of principal concern over the years have been the movements of the tritium and ^{90}Sr plumes.

The tritium plume has developed from the disposal of wastewater at the INEEL since the

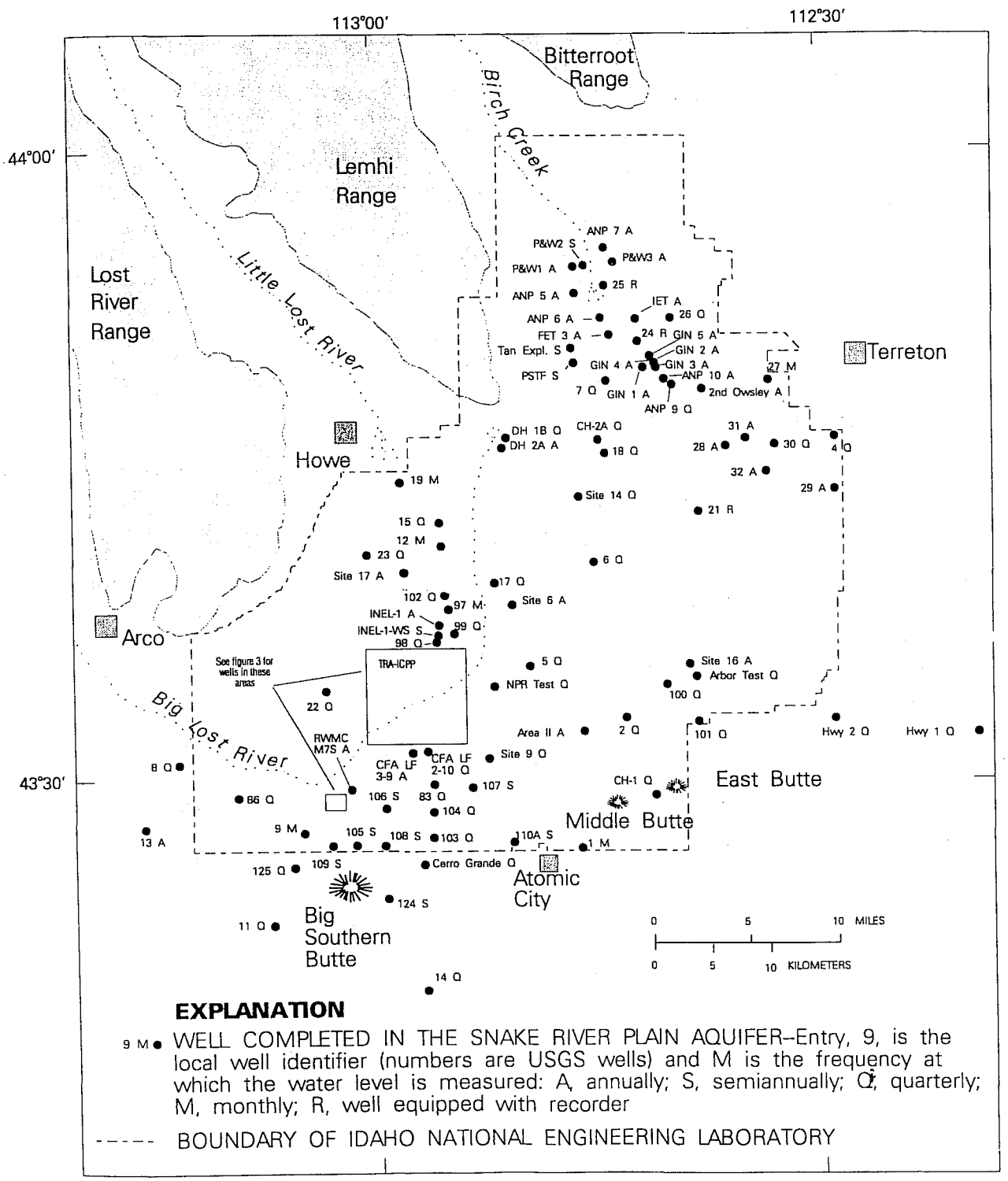
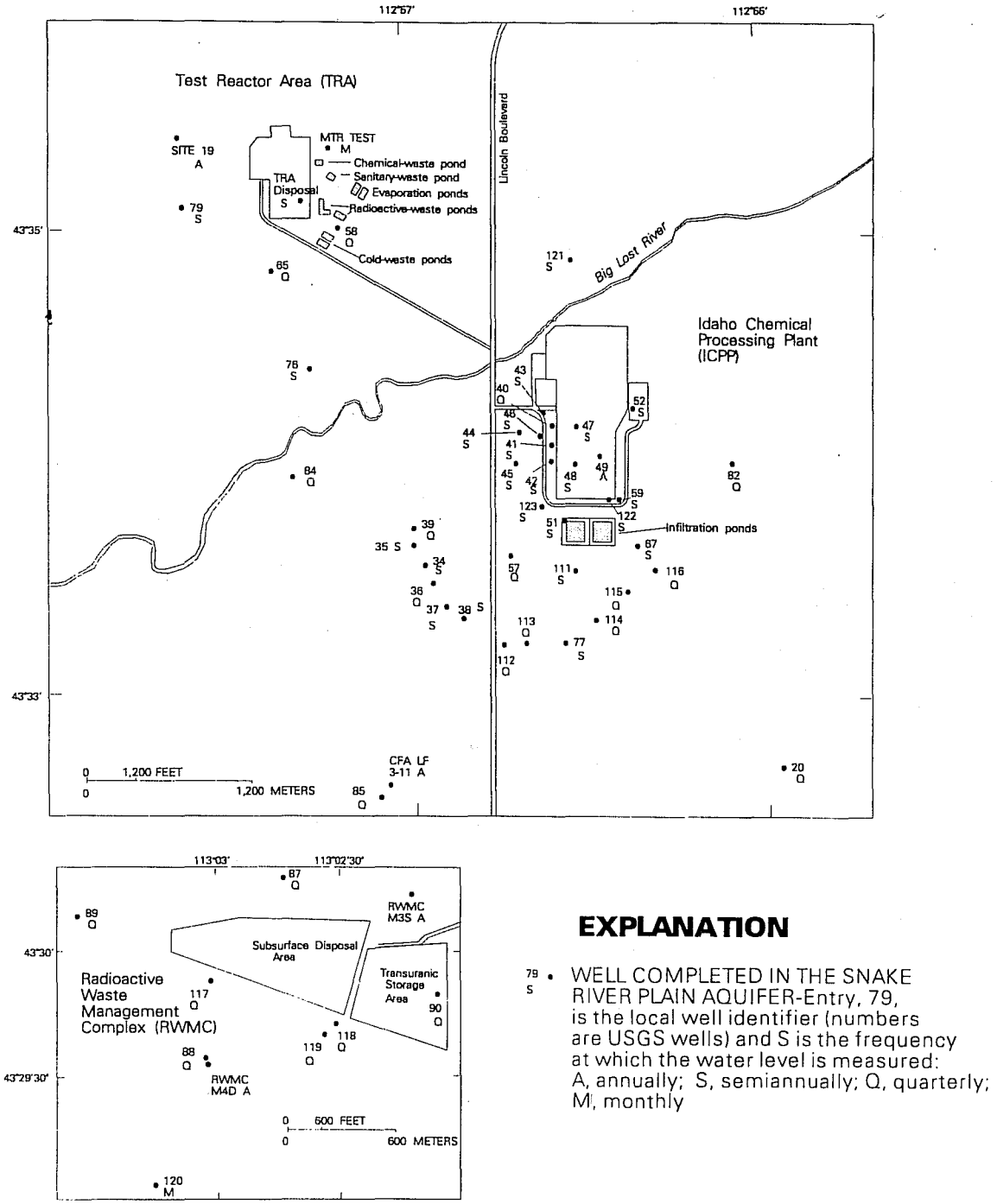


Figure 6-1. USGS Well Locations



EXPLANATION

79 S • WELL COMPLETED IN THE SNAKE RIVER PLAIN AQUIFER-Entry, 79, is the local well identifier (numbers are USGS wells) and S is the frequency at which the water level is measured: A, annually; S, semiannually; Q, quarterly; M, monthly

Figure 6-2. USGS well locations at ICPP-TRA and RWMC

1950s. About 31,750 Ci of tritium have been discharged to wells and ponds since 1952. The main sources of tritium contamination of ground water have been the injection of wastewater through the ICPP disposal well and the discharge of wastewater to the infiltration ponds at the ICPP and TRA. Since 1984 wastewater has been discharged only to the infiltration ponds.

The configuration and extent of the tritium plume, based on the latest data, is shown in Figure 6-3 [Reference 6-1]. The area of the plume within the 0.5 pCi/mL contour line decreased from about 115 km^2 (45 mi^2) in 1988 to about 102 km^2 (40 mi^2) in 1991 [Reference 6-2]. In 1995, the area was about the same as it was in 1991. However, the higher concentration contour lines have moved closer to their origins at ICPP and TRA as well concentrations of tritium generally decreased. The higher contour lines near the Central Facilities Area (CFA) are due to the CFA-1 well which had concentrations exceeding 20 pCi/mL. This area of elevated concentrations may represent a slug of higher tritium concentrations originating at ICPP some years earlier when larger amounts of tritium were disposed. However, quarterly samples taken by LMITCO in 1996 at well CFA-1 did not confirm the elevated tritium concentration (see Table 6-4 in Section 6.3). There is no source of tritium contamination of ground water at CFA.

The tritium concentration in well 65 near TRA (Figure 6-2) decreased from 37.8 ± 0.8 pCi/mL in 1991 to 21.2 ± 0.9 pCi/mL in 1995; the tritium concentration in well 77 south of ICPP (Figure 6-2) decreased from 41.7 ± 0.9 pCi/mL in 1991 to 25.1 ± 1.0 in 1995. The EPA maximum contaminant level (MCL) for tritium is 20 pCi/mL. These decreased tritium concentrations over the long term are due to radioactive decay (tritium has a half-life of 12.3 years) and a decrease in tritium disposal rates. The average combined rate of tritium disposal at the TRA and ICPP during 1952-83 was 910 Ci/yr; during 1984-91, 280 Ci/yr; and during 1992-95, 107 Ci/yr.

During 1952-95, about 93 Ci of ^{90}Sr were disposed at TRA and about 57 Ci were disposed at ICPP. However, only at ICPP was an injection well used for disposal directly to the aquifer of some of the ^{90}Sr. This practice was discontinued in the 1980s. During 1992-95, about 0.1 Ci of ^{90}Sr were disposed to the TRA infiltration ponds. These ponds were replaced by hypalon plastic-lined evaporation ponds in August 1993.

The configuration and extent of the ^{90}Sr contaminant plume, based on the latest data, is shown in Figure 6-4 [Reference 6-1]. The plume originates from the ICPP. There is no ^{90}Sr contaminant plume in the vicinity of TRA. This is because injection wells for waste disposal were not used and because of the interception of contaminants by perched ground water zones below TRA. The area of the ^{90}Sr contaminant plume is approximately the same as it was in 1991. Concentrations of ^{90}Sr in the wells have remained relatively constant since 1991. The concentrations during 1992-95 ranged from 2.6 ± 0.7 pCi/L to 76 ± 3 pCi/L. The MCL for ^{90}Sr in drinking water is 8 pCi/L.

Prior to 1989, ^{90}Sr concentrations had been decreasing because of changes in waste disposal practices and radioactive decay, diffusion, dispersion, and dilution from natural ground water recharge [Reference 6-3]. The relatively constant ^{90}Sr concentrations in the wells sampled from 1992 to 1995 is thought due, in part, to a lack of recharge from the Big Lost River that would act to dilute the ^{90}Sr. Also, an increase in the disposal of other chemicals into the ICPP infiltration ponds may have affected the adsorption, via ion-exchange, of ^{90}Sr to soil and rock surfaces, allowing more ^{90}Sr to exist in the liquid phase [Reference 6-1].

Summary of USGS Special Studies

Study of the Snake River Plain Aquifer South of the INEEL. This document summarizes the results of some of the water samples taken from

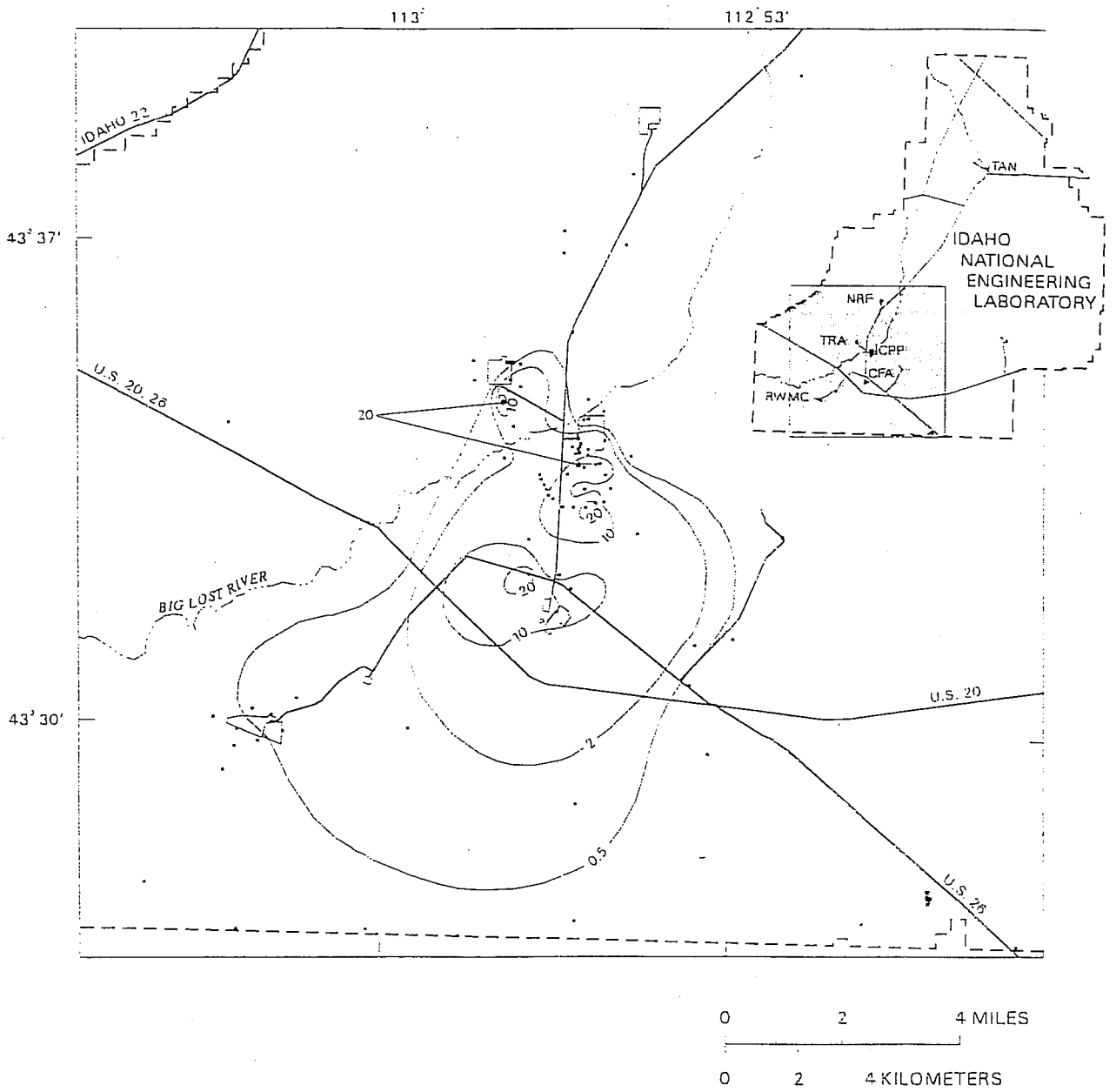


Figure 6-3. Distribution of tritium in the Snake River Plain Aquifer on the INEEL, 1995

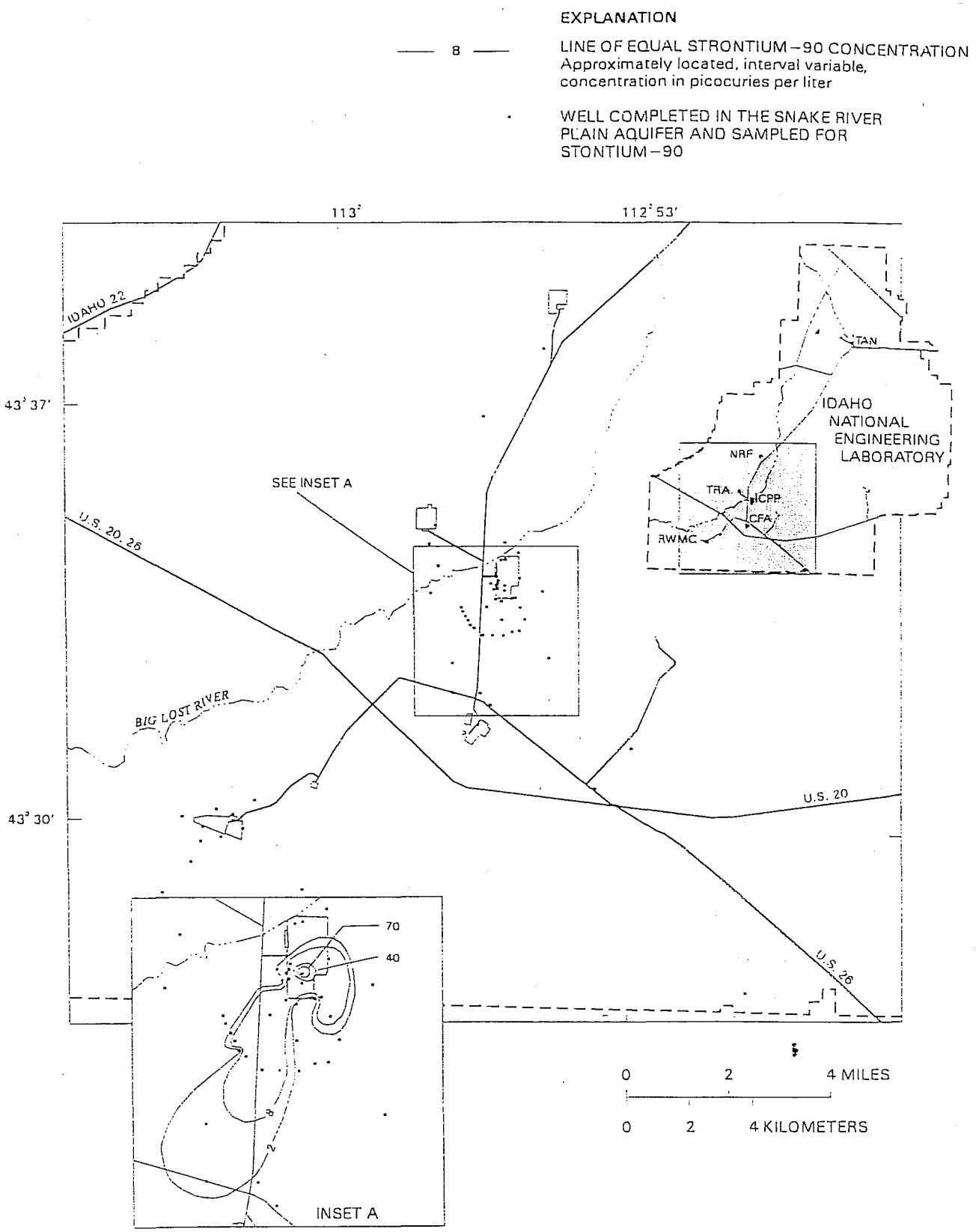


Figure 6-4. Distribution of ^{90}Sr in the Snake River Plain Aquifer on the INEEL, 1995

the area hydrologically downgradient from the INEEL, south to the Hagerman area [Reference 6-4]. This is part of a long-term study, begun in 1989 by the USGS in cooperation with the Idaho Department of Water Resources and the Department of Energy (DOE), to determine any impacts on ground water south of the Site due to activities at the INEEL.

The report summarizes the data collected from the final phase of the second round of sampling begun in 1993. The final phase included samples from 17 of the 55 initial well sites taken during June-July 1995. Water samples were collected from irrigation wells, domestic wells, two springs, a stock well, and a public supply well. Samples were analyzed for selected radionuclides, stable isotopes of hydrogen, oxygen, carbon, sulfur, and nitrogen, inorganic constituents, and organic compounds.

While many of the radionuclide and inorganic constituent concentrations exceeded the USGS reporting levels (results greater than the 3σ uncertainty of the measurement), none exceeded the EPA's maximum contaminant levels for drinking water. Some water samples, analyzed by a sensitive enrichment and gas counting technique, contained tritium concentrations above the reporting level ranging from 1.3 ± 0.6 pCi/L to 60 ± 3.8 pCi/L. This compares to background concentrations of tritium in the Snake River Plain aquifer that generally range from 0 to about 40 pCi/L [Reference 6-5]. Concentrations of ^{90}Sr and ^{137}Cs were less than the reporting levels in all water samples. All samples analyzed for dissolved organic carbon had concentrations greater than the reporting level.

Additional studies will continue to be performed by the USGS to monitor for any changes in radiochemical and chemical concentrations in offsite ground water which could be attributed to INEEL activities.

Stratigraphy of the Snake River Plain Aquifer. Historic liquid waste disposal at the INEEL has resulted in detectable concentrations of several waste constituents in the Snake River Plain Aquifer. Numerous studies of the subsurface at the INEEL have been performed due to public concern about the potential migration of radiochemical and chemical wastes in the unsaturated zone and aquifer. This document [Reference 6-6], following three earlier reports, describes a data base containing stratigraphic units in 333 wells that make up the unsaturated zone and the Snake River Plain Aquifer at and near the INEEL. A stratigraphic unit, as used in this document, is defined as the smallest layer of rock sequence that can be subdivided and correlated using the data available as of December 1993. Although the previous reports contain important geologic information, relationships among stratigraphic units and names identifying those units discussed in those reports are superseded by this document.

This report describes a variety of stratigraphic units including basalt-flow groups, sedimentary interbeds, andesite-flow groups, and one rhyolite dome. These units were identified and correlated using data from numerous outcrops, continuous cores, and natural-gamma logs. The main body of data in this document includes names, types, altitudes, depths, and thicknesses of the stratigraphic units.

100-year Peak Flows and Volumes. The Big Lost River and Birch Creek flow onto the eastern Snake River Plain and terminate in playas (temporary, shallow desert lakes), sinks, and spreading areas at the INEEL. Although flooding events involving these streams rarely occur, peak flows and flow volumes from these rare events of high streamflow need to be calculated so the boundaries of the flood plain can be predicted to evaluate the potential severity of floods at INEEL facilities. This document [Reference 6-7] estimates the 100-year peak flows and flow volumes that could enter the INEEL area from these streams.

Estimated peak flow from Big Lost River, the most likely source of flooding at the INEEL, for a flood event likely to occur once in 100 years was

7,260 cubic feet per second. The estimated volume of flow for a 60-day period from a flood event likely to occur once in 100 years was 390,000 acre-feet. For Birch Creek, the estimated peak flow entering the INEEL was 700 cubic feet per second; the estimated volume of flow was 10,600 acre-feet.

In the next phase of this study to determine the extent of the 100-year flood-plain at the INEEL, a simulated 100-year peak flow, using a computer model, will be routed downstream to spreading areas and playas on the INEEL.

6.2 CHEMICAL MONITORING

USGS

Sampling for purgeable (volatile) organic compounds in ground water was conducted by the USGS at the INEEL during 1996. Water samples from two onsite production wells and 27 ground-water monitoring wells were collected and submitted to the USGS National Water Quality Laboratory in Arvada, Colorado, for analysis of 61 purgeable organic compounds. A USGS report describes the methods used to collect the water samples and ensure sampling and analytical quality [Reference 6-8]. Concentrations above the laboratory reporting level of 0.2 µg/L were detected for five purgeable organic compounds: carbon tetrachloride, chloroform, 1,1,1-trichloroethane, tetrachloroethylene, and trichloroethylene (Table 6-1). The only production well sampled by the USGS in 1996 containing detectable concentrations of purgeable organic compounds was the Radioactive Waste Management Complex (RWMC) production well. For this well, concentrations of these compounds increased slightly from 1995 levels. Carbon tetrachloride concentrations exceeded the MCL at the end of 1996 (Table 6-1).

One of two water samples taken from well 119 at RWMC, near the subsurface disposal area, had a toluene concentration of 0.6 µg/L. The EPA MCL for toluene is 1000 µg/L.

High levels of some purgeable organics were found in two monitoring wells that had not been sampled since the late 1980s because they have been dry. Well 24 (Figure 6-1), at Test Area North (TAN) and located within the trichloroethylene contaminant plume described in the next subsection, was sampled once and had a trichloroethylene concentration of 990 µg/L and a tetrachloroethylene concentration of 46 µg/L. The MCL for both is 5 µg/L. The previously reported trichloroethylene concentration was 1600 µg/L [Reference 6-9]. Water from this well, as for all other USGS wells, is used for monitoring purposes only.

The other monitoring well which had not been sampled since the late 1980s was well 92, located at RWMC. It samples a perched aquifer at a depth of about 65 m (215 ft). One sample was obtained from this well during 1996. The highest concentrations were for those purgeable organics listed in Table 6-1: 1800 µg/L for carbon tetrachloride, 920 µg/L for chloroform, 170 µg/L for 1,1,1-trichloroethane, 180 µg/L for tetrachloroethylene, and 1400 µg/L for trichloroethylene. The MCLs for these purgeable organics are given in Table 6-1. For comparison, previous results were 1400 µg/L for carbon tetrachloride and 1100 µg/L for trichloroethylene [Reference 6-9].

LMITCO

The LMITCO Environmental Monitoring Unit routinely samples drinking water from wells and distribution systems at INEEL facilities for volatile organic compounds. At the TAN Technical Support Facility (TSF), the production wells and distribution systems are sampled more frequently since the discovery in 1987 that trichloroethylene concentrations in samples collected at one well exceeded the EPA MCL. For TSF well #1, concentrations at the well exceeded maximum contaminant levels for each of the three samples collected during 1996 (Table 6-2).

Results from the routine monitoring program, which samples water at the wells and distribution

TABLE 6-1. PURGEABLE ORGANIC COMPOUNDS IN USGS WELL SAMPLES (1996)[a]

Well ID	Date	Carbon Tetra-chloride	Chloroform	1,1,1-trichloro-ethane	Tetrachloro-ethylene	Trichloro-ethylene
34	04/02	<dl[b]	<dl	0.2	<dl	<dl
	10/24	<dl	<dl	0.2	<dl	<dl
38	04/16	<dl	<dl	0.3	<dl	<dl
	10/25	<dl	<dl	0.3	<dl	<dl
65	04/10	<dl	<dl	0.4	<dl	<dl
	10/21	<dl	<dl	0.4	<dl	<dl
77	04/04	<dl	<dl	0.4	<dl	<dl
	10/17	<dl	<dl	0.4	<dl	<dl
87	01/16	1.8	<dl	<dl	<dl	0.5
	04/10	1.9	<dl	<dl	<dl	0.5
	07/17	1.9	<dl	0.2	<dl	0.5
	10/08	2.3	<dl	0.2	<dl	0.5
88	01/10	2.1	0.5	0.2	<dl	0.9
	04/09	2.0	0.5	0.2	<dl	0.7
	07/17	2.0	0.5	0.2	<dl	0.8
	10/09	2.1	0.5	0.2	<dl	0.8
90	01/11	2.4	0.2	0.3	<dl	1.0
	04/17	2.6	0.3	0.4	<dl	1.0
	08/01	2.8	0.4	0.4	<dl	1.3
	10/23	2.6	0.3	0.4	<dl	1.2
	01/17	1.6	<dl	0.2	<dl	0.4
120	04/23	0.9	<dl	<dl	<dl	<dl
	07/17	1.2	<dl	<dl	<dl	0.3
	10/21	0.5	<dl	<dl	<dl	<dl
RWMC[c]	01/16	4.4	0.7	0.6	<dl	2.3
	02/13	4.7	0.7	0.7	<dl	2.5
	03/14	4.8	0.8	0.7	0.2	2.6
	04/10	4.6	0.8	0.7	0.2	2.3
	05/14	4.6	0.7	0.6	0.2	2.3
	06/13	4.8	0.7	0.6	0.2	2.4
	07/17	4.6	0.7	0.6	0.2	2.3
	08/14	4.7	0.7	0.6	<dl	2.1
	09/11	5.0	0.8	0.6	0.2	2.2
	10/15	3.4	0.4	0.5	<dl	1.5
	11/13	4.6	0.7	0.6	0.2	2.1
	12/16	5.1	0.8	0.7	0.2	2.5
EPA maximum contaminant level		5	100	200	5	5

[a] Concentrations expressed in µg/L. Only samples for which one or more value exceeded the detection limit are included.
[b] Analytical result less than detection limit of 0.2 µg/L.
[c] Production well.

system, indicate the aeration system, which volatilizes trichloroethylene, works well. Since its installation in 1988, drinking water samples from the TSF distribution system have generally not exceeded regulatory levels. During 1996, the TSF distribution system was in compliance. Drinking water is obtained only through the distribution systems, not from the wells.

Chlorinated drinking water systems must also be monitored for total trihalomethanes (bromodichloromethane, bromoform, chloroform, and dibromochloromethane). The concentration of trihalomethanes in the Rifle Range distribution well remained significantly below the reporting level. The concentration in water from the CFA distribution system averaged about 4.6 µg/L, or 4.6% of the EPA maximum contaminant level of 100 µg/L.

During 1992, the INEEL prime contractor initiated a semiannual monitoring program for lead and copper levels in drinking water in accordance with EPA regulations (40 CFR 141.80-141.91).

TABLE 6-2. PURGEABLE ORGANIC COMPOUNDS [µg/L] IN INEEL DRINKING WATER (1996)

Well	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Tetrachloroethylene (maximum contaminant level=5 µg/L)												
TSF Dist.	0.6	---[a]	---	---	---	---	0.5	0.8	0.9	0.4	0.4	0.3
TSF #1	---	---	1.5	---	1.3	---	---	---	3.1	---	---	---
TSF #2	---	---	---	---	0.5	---	---	---	0.7	---	---	---
Trichloroethylene (maximum contaminant level=5 µg/L)												
CFA Dist.	---	---	---	---	---	---	---	---	---	0.2	---	---
CFA #1	---	---	---	---	---	---	---	---	0.1	---	---	---
RWMC #1	---	---	1.6	---	2.0	---	---	1.8	---	1.3	---	---
RWMC Dist.	---	---	1.1	---	0.9	---	---	1.5	---	1.2	---	---
TSF Dist.	---	---	1.1	0.9	0.6	1.0	2.1	3.7	4.5	1.9	1.8	0.8
TSF #1	---	---	6.0	---	5.5	---	---	---	15.0	---	---	---
TSF #2	---	---	1.4	---	1.4	---	---	---	2.2	---	---	---
Total Trihalomethane (maximum contaminant level=100 µg/L)												
CFA Dist.	---	---	3.4	5.7	---	---	---	2.9	---	---	5.0	6.2
CPP Dist.	---	---	1.0	7.1	---	---	---	2.9	---	---	0.7	---
TSF Dist.	---	---	---	1.0	---	---	---	2.0	---	---	1.6	---
Rifle Range Dist.	---	---	1.0	1.0	---	---	---	0.1	---	---	---	---
Ethylbenzene (maximum contaminant level=700 µg/L)												
CFA Dist.	---	---	---	---	---	---	---	---	---	0.2	---	---
CPP Dist.	---	---	---	---	---	---	---	0.2	---	---	---	---
Total Xylenes (maximum contaminant level=10,000 µg/L)												
CFA Dist.	---	---	---	---	---	---	---	---	---	1.8	---	---
CPP Dist.	---	---	---	---	---	---	---	1.0	---	---	---	---
p-Dichlorobenzene (maximum contaminant level=75 µg/L)												
RWMC Dist.	---	---	---	---	---	---	---	---	---	0.1	---	---
Carbon Tetrachloride (maximum contaminant level=5 µg/L)												
RWMC #1	---	---	2.8	---	4.2	---	---	4.1	---	3.3	---	---
RWMC Dist.	---	---	1.9	---	1.8	---	---	2.9	---	2.4	---	---
1,1,1-Trichloroethane (maximum contaminant level=200 µg/L)												
Main Gate Dist.	---	---	---	---	---	---	---	---	1.1	---	---	---
RWMC #1	---	---	---	---	0.6	---	---	0.5	---	0.4	---	---
RWMC Dist.	---	---	---	---	---	---	---	0.4	---	0.3	---	---

[a] Table includes only those samples in which the parameter was above the reporting level.

Action levels are determined based on "90th percentile" values. An action level is exceeded if more than 10 percent of water samples collected during a six-month monitoring period exceed the regulatory values of 1.3 mg/L for copper and 0.015 mg/L for lead. In 1995, the 90th percentile value was not greater than the regulatory values for either contaminant. The year 1995 concluded three successive years of monitoring lead and copper levels in drinking water. Since regulatory values were not exceeded, and in accordance with regulations, this monitoring will be discontinued until 1998.

Additional sampling was conducted in 1996 for a variety of inorganic constituents, including metals, nitrates, dissolved solids. There were no instances where the maximum contaminant levels were exceeded. More detailed information and data will be included in the *1996 Compliance Monitoring Annual Report*, INEEL-97/0255(96), due to be published in August 1997.

Water from the production and potable wells at ICPP and other facilities were analyzed monthly for a number of parameters (Table 6-3). None of these constituents were above the EPA maximum

contaminant levels or State of Idaho drinking water limits in 1996.

Argonne National Laboratory - West (ANL-W)

The Safe Drinking Water Act implementing regulations required only monitoring for nitrites, nitrates, and inorganic chemicals in ANL-W production wells during 1996. All parameters were well below applicable standards.

Naval Reactors Facility (NRF)

Drinking water samples were collected prior to entering the distribution system and monitored for volatile organic compounds, inorganic constituents, and water quality parameters. These samples were drawn from a sampling port immediately downstream from the NRF water softening treatment system. No volatile organic compounds were detected above minimum detection levels established for the analyses of these compounds. Concentrations of inorganic analytes and water quality parameters were all below regulatory limits.

Lead and copper monitoring of the NRF drinking water system continued in 1996 in accordance with applicable state and federal regulations. Concentrations of lead and copper at NRF were below regulatory action levels.

In 1996, NRF, with the assistance of USGS, began sampling from an improved ground water monitoring well network established around the NRF (Figure 6-5). Six new wells were designed and drilled specifically to evaluate potential chemical impacts of NRF operations on ground water. Specifics regarding this monitoring are published annually in a separate report prepared and issued by NRF as described in the preface of this report.

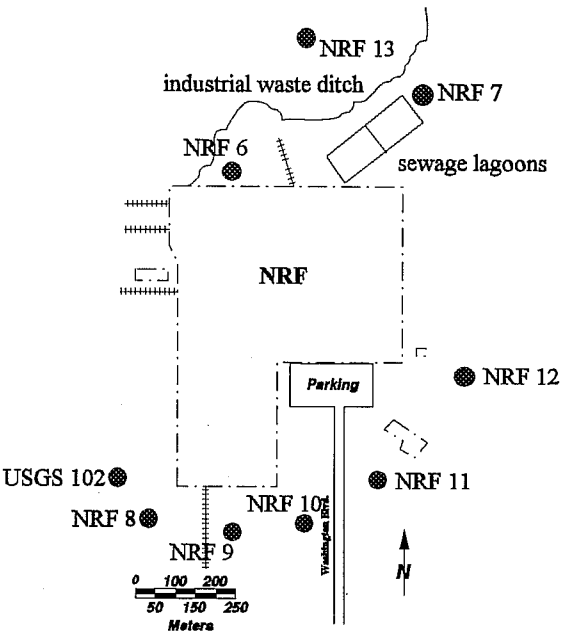


Figure 6-5. Monitoring Wells Around NRF.

6.3 RADIOCHEMICAL MONITORING

In the past, major contractors sampled drinking water wells at their facilities each quarter during one of every four years. These samples were then submitted for gross alpha, gross beta, and tritium analyses to an analytical laboratory that was either certified by the State of Idaho or certified by a state whose certification is accepted by the State of Idaho. In 1996, Accu-Lab Research and Paragon Analytics, Inc. were certified by the State of Idaho for radiological analyses of drinking water. The drinking water program fulfilled the compliance requirements for radiochemical monitoring of ground water at the INEEL.

USGS

A summary of the ongoing sampling of radiochemicals in the aquifer is included above in section 6.1.

TABLE 6-3. INORGANIC CHEMICALS IN INEEL POTABLE AND PRODUCTION WELLS (1996)[a]

	ICPP #5	ICPP #1	CFA #1	RWMC #1	TRA #1	MAIN GATE	MCL[b]
Barium	0.09	0.08	0.08	0.04	0.05	0.03	1
Cadmium	<dl[c]	<dl	<dl	<dl	<dl	<dl	0.01
Chromium	0.01	0.01	0.01	0.02	<dl	0.01	0.05
Lead	<dl	<dl	<dl	<dl	<dl	<dl	0.15
Mercury	<dl	<dl	<dl	<dl	<dl	<dl	0.002
Selenium	0.007	<dl	<dl	<dl	<dl	<dl	0.01
Silver	0.01	<dl	<dl	<dl	<dl	<dl	2
Chloride	19.7	18.5	75.6	16.9	8.5	18.0	N/A
Fluoride	0.21	0.19	---[d]	0.20	0.16	0.21	4
Nitrate	1.05	1.10	3.14	0.74	1.01	0.67	10
Sulfate	27.4	26.3	29.6	26.5	17.2	22.9	N/A

[a] All analytes, except nitrate, reported in units of mg/L; nitrate reported in units of mg-N/L. All wells analyzed once during 1996 for each analyte.
[b] EPA maximum contaminant level for noncommunity, nontransient drinking water systems. N/A indicates no MCL established.
[c] Concentration below detection limit.
[d] No sample collected.

LMITCO

Gross Alpha. Of the 62 onsite production well samples analyzed for gross alpha, a total of 18 samples contained gross alpha above the minimum detectable concentration. The highest concentration was in a sample from CFA well #2 at $(5 \pm 3) \times 10^{-9}$ µCi/mL. This value is 33% of the EPA MCL of 15×10^{-9} µCi/mL for gross alpha in drinking water.

All gross alpha concentrations were within the expected concentration range for naturally-occurring alpha activity in the aquifer underlying the Snake River Plain, including the INEEL. According to USGS reports, alpha-emitting wastes (^{238}Pu, $^{239/240}$Pu, and ^{241}Am) from INEEL operations have not migrated far from their entrance into the aquifer near ICPP [References 6-1 through 6-4]. All onsite drinking water wells lie outside the migration plumes for alpha-emitting nuclides.

Gross Beta. Of the 63 onsite production well samples analyzed for gross beta, 31 had concentrations of gross beta that were above the minimum detectable concentration. All were within the range typically found for background concentrations from natural radioactivity that occurs in the Snake River Plain Aquifer, except for two samples from the ICPP taken in June, the highest of which was $(19 \pm 18) \times 10^{-9}$ µCi/mL. This value is 38% of the EPA MCL of 50×10^{-9} µCi/mL for gross beta in drinking water.

Tritium. Water from two of the onsite production wells and three drinking water distribution systems that were routinely sampled showed detectable concentrations of tritium each month (Table 6-4). Figure 6-6 shows five years of tritium data for two of the production wells and two distribution systems. In addition, two samples from ICPP well #1 contained detectable concentrations of tritium. There were no detectable concentrations of tritium in the ICPP distribution system samples. The detectable results for ICPP samples averaged about $(0.5 \pm 0.4) \times 10^{-6}$ µCi/ml. No other onsite drinking water samples contained detectable tritium concentrations.

Strontium-90. Because of the presence of the localized plume of ^{90}Sr in the ground water near ICPP, sampling from several production wells at ICPP is routinely performed. While samples have historically contained detectable levels of ^{90}Sr, none of the 1996 samples indicated detectable concentrations of ^{90}Sr with a minimum detectable concentration of approximately 2×10^{-9} µCi/mL.

TABLE 6-4. TRITIUM CONCENTRATIONS IN INEEL PRODUCTION WELLS AND DISTRIBUTION SYSTEMS (1996)

Well Code	# of Samples[b]	Tritium Concentration ($\times 10^{-6}$ µCi/mL)[a] Minimum[c]	Maximum[c]	Mean[d]	%MCL[e]
CFA[f]	4	13.9 ± 0.9	18.0 ± 0.5	16.2 ± 2.8	81
CFA #1	4	12.9 ± 0.8	19.0 ± 0.5	16.3 ± 4.4	82
CFA #2	4	11.8 ± 0.8	15.0 ± 0.5	13.6 ± 2.1	68
Rifle Range[g]	4	2.8 ± 0.2	3.5 ± 0.3	3.2 ± 0.6	16
RWMC[h]	4	1.3 ± 0.1	1.6 ± 0.2	1.5 ± 0.3	8

[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] EPA drinking water MCL (maximum contaminant level) for tritium is 20 x 10^{-6} µCi/mL.
[f] Samples collected from the Central Facilities Area distribution system.
[g] Samples collected from the Rifle Range distribution system.
[h] Samples collected from the Radioactive Waste Management Complex distribution system.

CFA Worker Dose. The potential effective dose equivalent to a worker at CFA from radioactivity in water was calculated. CFA was selected because tritium concentrations found in these wells were the highest of any drinking water wells. The 1996 calculation was based on:

- Mean tritium concentration for the CFA distribution system in 1996 as shown in Table 6-4.
- Data from a 1990-91 USGS study for ^{129}I using the accelerator mass spectrographic analytical technique that indicated water from CFA #1 contained ^{129}I at a concentration of $(0.26 \pm 0.05) \times 10^{-9}$ µCi/mL (the average of two samples) and water from CFA #2 had a concentration of $(0.14 \pm 0.03) \times 10^{-9}$ µCi/mL (also the average of two samples). For perspective, the proposed EPA drinking water standard for ^{129}I in drinking water is 21×10^{-9} µCi/mL.
- Water usage information for 1996 showing CFA #1 was used for approximately 87% of the drinking water and CFA #2 was used for 13% of the drinking water.

For the 1996 dose calculation, the assumption was made that each worker's total water intake came from the CFA drinking water distribution system. This assumption over-estimates the dose because workers typically consume only about half their total intake during working hours and typically work 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 1996 was 0.8 mrem, 20% of the EPA standard of 4 mrem for community drinking water systems.

ANL-W

During 1996, ANL-W analyzed four quarterly samples for gross alpha, gross beta, and tritium from the entrance to the distribution system in accordance with State of Idaho guidance. The maximum gross alpha concentration was 5 ± 3 pCi/L (33% of the maximum contaminant level); the maximum gross beta concentration was 7 ± 5

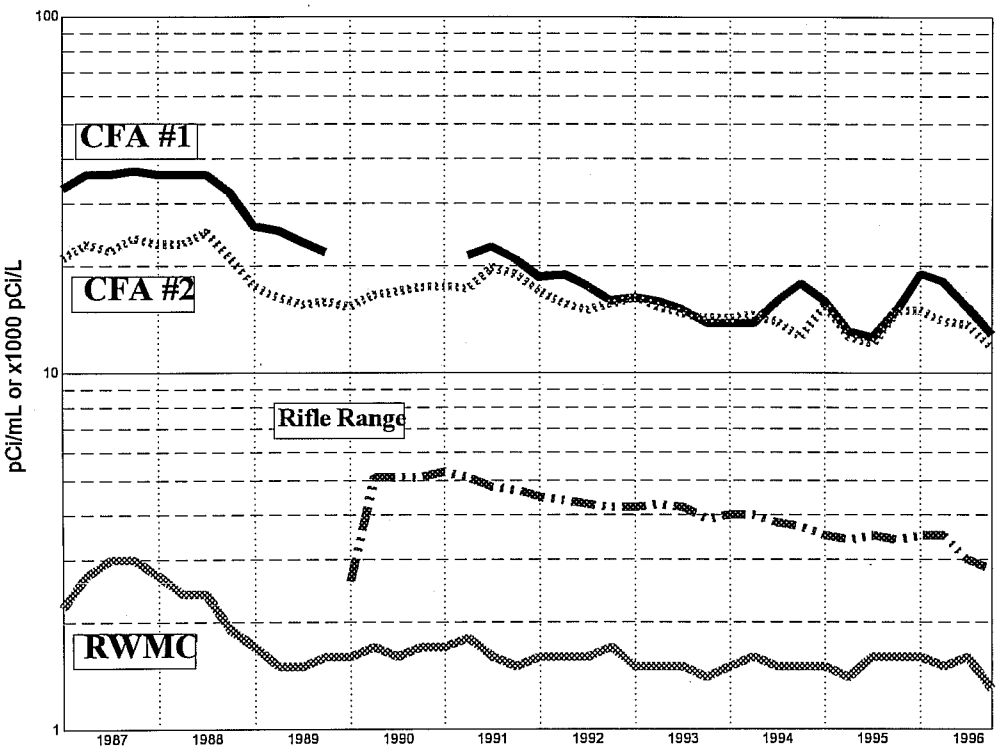


Figure 6-6. Tritium Concentrations in INEEL Production Wells and Distribution Systems (1987-1996)

pCi/L (14% of the maximum contaminant level). No samples contained detectable concentrations of tritium.

ANL-W sampled its Industrial Waste Pond and Secondary Sanitary Lagoon monthly when these ponds were not frozen or dry. The water samples were analyzed for gross alpha, gross beta, tritium, and gamma-emitting radionuclides. No gross alpha, tritium, or gamma-emitting radionuclides were detected in either pond. Gross beta activity was regularly detected in the Secondary Sanitary Lagoon with values ranging from 26×10^{-9} to 89×10^{-9} μCi/mL. No gross beta activity was detected in the Industrial Waste Pond.

NRF

As mentioned above in section 6.2, an enhanced ground-water monitoring well network was established in 1996. Analysis of water collected from NRF ground-water wells did not detect any gross alpha or gross beta radioactivity in excess of natural background concentrations. Measurements of tritium were at least two orders of magnitude below drinking water standards. Specifics regarding this monitoring are published annually in a separate report prepared and issued by NRF, as described in the preface to this report.

6.4 BACTERIOLOGICAL MONITORING

LMITCO

Potable water at the INEEL was monitored for coliform bacteria quarterly or monthly by contractor personnel and analyzed by the LMITCO Environmental Hygiene Laboratory.

While no samples from any of the INEEL facilities during 1996 indicated the presence of *E. coli*, some samples showed positive results for coliform bacteria. TRA showed positive results in

August and October; the Power Burst Facility showed positive results in February, May, and September through December; and TAN showed positive results for January, August, and November. Each system underwent corrective action to purify the potable water by chlorination, and then was retested to check the effectiveness of the purification process.

NRF

Drinking water samples were collected monthly and analyzed for the presence of coliform bacteria. Frequency and sample locations met the requirements of applicable state and federal regulations. All sample results confirmed the absence of coliform bacteria in the NRF drinking water supply system.

ANL-W

ANL-W conducted monthly bacteriological sampling, with analysis performed by the LMITCO Environmental Hygiene Laboratory. No detections were found in 1996.

Summary of Chapter 7
Effluent Monitoring

Certain facility operations at the Idaho National Engineering and Environmental Laboratory (INEEL) have the potential to release airborne and liquid radioactive effluents (*Section 7.1*). The quantity of airborne radioactive effluents released during calendar year 1996 increased slightly over the totals released during the previous three years. The radionuclides comprising the vast majority of radioactive airborne releases for 1996 are discussed, and year to year comparisons are provided. The quantity of liquid radioactive effluents released during 1996 was slightly less than the amount released during 1995.

Section 7.2 summarizes the nonradioactive airborne and liquid effluents released in 1996 from INEEL facilities. Tables summarizing effluent components, amounts released, and year to year comparisons accompany discussion of effluent monitoring by each INEEL facility of concern.

7. EFFLUENT MONITORING

7.1 RADIOACTIVE EFFLUENTS

General

In compliance with state and federal regulations, radionuclides released to the environment during 1996 via airborne and liquid effluents were monitored at potentially significant release sites. These sites included stacks and liquid effluent streams, monitored at the relevant facilities by INEEL contractors. Monitoring results were reported to the Radioactive Waste Management Information System (RWMIS) administered by Lockheed Martin Idaho Technologies Company (LMITCO). Effluent information from the RWMIS is used to produce annual reports summarizing effluent monitoring by month, facility and radionuclide.

Airborne

During calendar year 1996, an estimated total of 3,048 Curies (Ci) of radioactivity were released to the atmosphere from monitored INEEL sources [Reference 7-1]. Of this total, the Test Reactor Area (TRA) contributed 1,854 Ci, and Argonne National Laboratories-West (ANL-W) contributed 1,049 Ci. These and other totals from monitored sources are summarized in Table 7-1. Nearly 95% of the total radioactivity released during 1996 was from radioisotopes of noble gases. Noble gases are the elements from Group 8 on the periodic table of the elements, and by their stable nature, are generally not reactive. The primary exposure concern is external, as noble gases generally do not transport through food chains or concentrate in biological tissues [Reference 7-2].

Year to year fluctuations in airborne radioactive effluent releases are dependant on which processes are active at INEEL facilities. The total for 1996 is somewhat higher than the total for 1995, due partially to the 1,038 Ci of ^{85}Kr released from ANL-W. Krypton-85 was released from ANL-W as part of a reactor fuel refining project titled the Electrometallurgical Treatment Research and Demonstration Project in the Fuel Conditioning Facility. Figure 7-1 shows the total Ci of airborne radioactivity released from the INEEL from 1993 through 1996. Although the 1996 total was the highest of these four years, it was still considerably less than the totals for 1987 through 1992. During these years, the six-year average amount of ^{85}Kr released from the ICPP was less than 60,000 Ci, although the actual amount was classified information and an overestimated value was used.

Liquid

Radioactive liquid effluents released onsite are summarized in Table 7-2. During 1996, more than 99% of the INEEL's total liquid radioactive effluent was released from TRA into two hypalon plastic lined evaporation ponds which have been in use since August 1993. These ponds serve to prevent contaminant percolation into the ground thus confining contaminant dispersal to a minimum. No radioactive liquid effluent was released to the offsite environment from INEEL facilities during 1996. Routine injections of radioactive liquid effluents into the Snake River Plain Aquifer ceased in 1984.

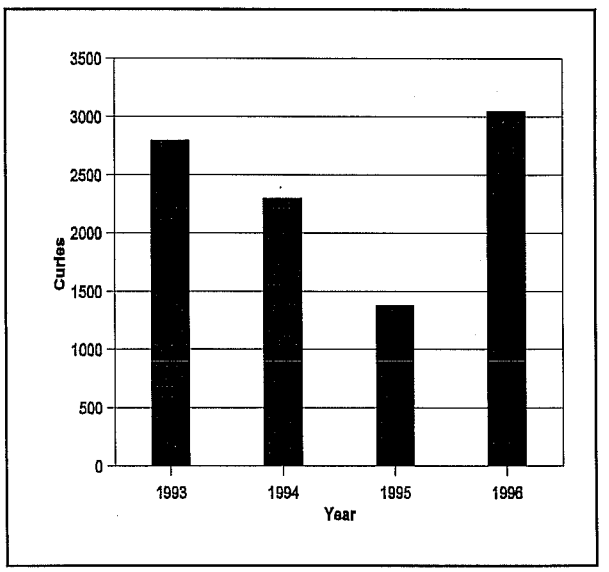


Figure 7-1. INEEL Airborne Radioactive Effluent

TABLE 7-1. RADIONUCLIDE COMPOSITION OF AIRBORNE EFFLUENTS (1996)

Effluent Type	Radionuclide	Half-life	Airborne Effluent (Ci)[a] ANL-W	ICPP	NRF	TRA	Total[b]
Noble Gases	^{41}Ar	1.83 h	2.4	--	--	1,802	1,804
	^{85}Kr	10.7 yr	1,038	--	4.5×10^{-2}	--	1,038
	^{135}Xe	9.10 h	--	--	--	26.5	26.5
	^{88}Kr	2.84 h	--	--	--	7.1	7.1
	^{85m}Kr	4.48 h	--	--	--	4.6	4.6
	^{133}Xe	5.25 d	--	--	--	3.0	3.0
	^{87}Kr	1.27 h	--	--	--	2.2	2.2
	^{138}Xe	14.2 min	--	--	--	1.7	1.7
	^{135m}Xe	15.3 min	--	--	--	1.4	1.4
Particulates	^{88}Rb	15.4 min	--	--	--	3.1	3.1
	^{138}Cs	32.2 min	--	--	--	1.6	1.6
	^{51}Cr	27.8 d	--	--	--	1.4	1.4
	^{24}Na	15.6 h	--	--	--	5.9×10^{-3}	5.9×10^{-3}
	^{56}Mn	2.6 h	--	--	--	1.4×10^{-3}	1.4×10^{-3}
	^{137}Cs	30.2 yr	--	2.4×10^{-4}	--	2.8×10^{-6}	2.4×10^{-4}
	^{125}Sb	2.73 yr	--	3.6×10^{-5}	--	--	3.6×10^{-5}
	$^{90}Sr + D$[c]	28.6 yr	--	2.1×10^{-5}	--	9.6×10^{-6}	3.1×10^{-5}
	^{238}Pu	87.7 yr	--	6.3×10^{-6}	--	--	6.3×10^{-6}
	^{239}Pu	2.4×10^{4} yr	--	1.3×10^{-7}	--	--	1.3×10^{-7}
Tritium, ^{14}C, and Iodine Isotopes	^{3}H	12.3 yr	8.9	144	8.2×10^{-3}	--	153
	^{14}C	5,700 yr	--	---	1.1	--	1.1
	^{129}I	1.6×10^{7} yr	--	5.5×10^{-2}	--	--	8.6×10^{-2}
	^{131}I	8.04 d	--	--	2.4×10^{-5}	7.6×10^{-4}	8.0×10^{-4}
	^{132}I	83 min	--	--	--	5.4×10^{-4}	5.4×10^{-4}
	^{133}I	20.8 h	--	--	--	3.5×10^{-4}	3.5×10^{-4}
All others		--	6.8×10^{-13}	2.5×10^{-6}	2.2×10^{-6}	1.0×10^{-3}	1.0×10^{-3}
Totals		--	1,049	144	1.2	1,854	3,048

[a] Preliminary radioactive release information provided by the 1996 Radioactive Waste Management Information System. 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, ^{90}Sr, and Pu) are also included. Values are not corrected for decay after release.

[b] Rounded totals include small amounts from facilities not listed.

[c] Parent-daughter equilibrium assumed.

7.2 NONRADIOACTIVE EFFLUENTS

Airborne

Nitrogen and sulfur dioxide releases are determined for onsite facilities (Table 7-3). Two oxides of nitrogen, nitrogen oxide (NO) and nitrogen dioxide (NO_2), are collectively referred to as NO_x. For the years 1992 through 1995, the data in Table 7-3 were based on data from the INEL Industrial Waste Management Information System. Emissions of nitrogen and sulfur dioxides from fuel were calculated using emission factors developed by the Environmental Protection Agency, and the amount of fuel used at each facility. For the years 1992 through 1995, data were reported as NO_2. Data for 1996 were obtained from the INEEL Air Emission Inventory [Reference 7-3], where the data are reported as total nitrogen oxides, NO_x.

TABLE 7-2. RADIONUCLIDE COMPOSITION OF LIQUID EFFLUENTS RELEASED ONSITE (1996)

Radionuclide	Half-Life	Liquid Effluent (Ci)[a] ICPP	TRA	Total[b]
^{3}H	12.3 yr	--	70.5	70.5
^{51}Cr	27.8 d	--	1.5	1.5
^{60}Co	5.27 yr	--	0.2	0.2
^{24}Na	15.0 yr	--	6.1×10^{-2}	6.1×10^{-2}
^{181}Hf	42.4 d	--	5.5×10^{-2}	5.5×10^{-2}
^{90}Y	64.1 h	--	1.7×10^{-2}	1.7×10^{-2}
^{90}Sr	28.6 yr	1.7×10^{-4}	1.7×10^{-2}	1.7×10^{-2}
^{137}Cs	30.2 yr	5.8×10^{-4}	9.4×10^{-3}	1.0×10^{-2}
^{238}Pu	87.7 yr	3.0×10^{-6}	--	3.0×10^{-6}
All Others	--	5.0×10^{-4}	0.3	0.3
Grand Totals	--	1.3×10^{-3}	72.7	72.7

[a] Preliminary radioactive release data provided by the 1996 Radioactive Waste Management Information System. Table includes all radionuclides with total releases greater than 1×10^{-2} Ci. Values are not corrected for decay after release.
[b] Rounded totals include small amounts from facilities not listed.

In 1996, the total NO_2 released was 218 Megagrams (Mg) and the total SO_2 released was 118 Mg. A Megagram is also referred to as a metric ton which equals approximately 2,200 pounds.

Wind direction and speed are constantly monitored on the INEEL. Because of this, it can be determined where along the INEEL boundary the maximum concentrations of NO_2 and SO_2 would occur. For NO_2, the boundary concentration was calculated to be 0.29 $\mu g/m^3$, a value less than 0.3% of the 100 $\mu g/m^3$ national primary ambient air quality standard. The boundary concentration for SO_2 was 0.16 $\mu g/m^3$, a value 0.2% of the 80 $\mu g/m^3$ national primary ambient air quality standard.

ANL-W. Emissions from the Experimental Breeder Reactor II Auxiliary Boilers do not require continuous monitoring because they are below the State of Idaho's 250 million BTU/hour emission limit. Monitoring occurs monthly with a portable stack emission monitor as an efficiency check and to ensure NO_x and SO_2 emissions are below state-imposed standards. During 1996, the NO_x emissions ranged from 252 to 300 mg/m^3 (134 to 159 parts per million) and SO_2 emissions ranged from 10 to 240 mg/m^3 (4 to 90 parts per million).

Liquid

In 1986, a Nonradiological Liquid Effluent Monitoring Program was instituted to provide environmental monitoring for nonradioactive parameters and pollutants in liquid wastes generated by INEEL facilities. From 1986 to 1993, a report detailing program description, effluent stream descriptions, sampling regimes, analytical methods, and presentation and interpretation of the data was produced by EG&G Idaho, the primary INEEL contractor at that time. This report is now produced by LMITCO for the facilities under their direction.

Nonradioactive liquid effluents are disposed primarily to the following areas on the INEEL: an industrial waste ditch and evaporative sewage lagoon at the Naval Reactors Facility; lined sewage lagoons at the Specific Manufacturing Capability Facility; seepage ponds at the Technical Support Facility, Test Reactor Area, Idaho Chemical Processing Plant, and Water Reactor Research Test Facility; an industrial waste pond at Argonne National Laboratory-West; and sewage

TABLE 7-3. SUMMARY OF NO_x AND SO_2 EMISSIONS AND AMBIENT MONITORING RESULTS (1992-1996)[a]

	Mg[b] NO_2				Mg NO_x	Mg SO_2				
Facility	**1992**	**1993**	**1994**	**1995**	**1996**	**1992**	**1993**	**1994**	**1995**	**1996**
ANL-W	5	6	5	6	7	10	13	15	17	23
CFA	1	2	1	1	5	3	5	3	2	10
ICPP (CFSGF)	107	87	57	91	68	17	9	4	9	15
ICPP	2	6	10	2	12	14	44	71	18	4
ICPP (main stack)	5	467	---	---	---	---	---	---	---	---
NRF	17	18	13	10	7	45	40	60	39	25
PBF	---	---	---	0.3	1	1	---	---	1	1.8
RWMC	---	---	---	---	13	---	---	---	---	2.6
TAN	7	9	14	8	7	17	21	28	15	24
TRA	3	3	2	3	72	10	7	7	9	12
Other Stationary Sources	---	---	---	---	27	---	---	---	---	1.8
Totals	147	598	102	122	218	117	139	188	110	118
Ambient Monitoring (NO_2 µg/m³)										
EFS	12.5	36	15.4	4	8.1	---	---	---	---	---
VANB	4.9	9.4	4.9	3.8	3.0	0.8	1.8	2.7	2.1	4.0

[a] Data for 1992 through 1995 calculated from fuel usage data from the Industrial Waste Management Information System. Data for 1996 reported in the INEEL Air Emissions Inventory.
[b] Mg = megagram = 1 metric ton = 2200 lbs.

treatment facilities at various locations. Injection wells and the Big Lost River are not used as repositories for any liquid wastes, except for storm water runoff.

ANL-W. During 1996, the Industrial Waste Pond at ANL-W was monitored for iron, sodium, mercury, chloride, fluoride, sulfate, phosphate, and pH. The Secondary Sanitary Lagoon was monitored for biological oxygen demand, total suspended solids, iron, sodium, chloride, fluoride, sulfate, and pH.

TRA. Nonradioactive liquid effluents are discharged from TRA into three types of ponds: the Cold Waste Pond, Chemical Waste Pond, and two sewage lagoons. The Cold Waste Pond receives primarily secondary cooling water from the Advanced Test Reactor. Table 7-4 summarizes the nonradiological monitoring data for effluents released into the Cold Waste Pond from TRA during 1996. The Chemical Waste Pond receives neutralized water from chemical treatment processes at the TRA demineralizer facility.

Further information on effluent monitoring at TRA, and other LMITCO facilities, will be available in the *1996 Compliance Monitoring Annual Report*, INEEL-97/0255 (96), due to be published in August 1997.

ICPP. Service waste water monitoring results for analytes of interest are summarized in Table 7-5. Levels measured for each parameter were below the concentrations defined as hazardous waste [Reference 7-4]. At present, the only source of liquid effluent from ICPP is cooling water, which falls far below the concentrations which would define it as radioactive or hazardous effluent. The current volume of discharge is approximately 6.8 million L (1.8 million gal) per day.

Naval Reactors Facility (NRF). At NRF, nonradioactive liquid effluents are disposed to an industrial waste ditch and to an evaporative

TABLE 7-4. TRA LIQUID EFFLUENT INORGANIC MONITORING DATA FOR THE COLD WASTE POND (1996)

	Concentration[a]				
Parameter	**February**	**May**	**August**	**November**	**Toxicity Limit[b]**
Conductivity	413	420	313	822	---
pH	7.6	7.5	8.1	6.7	2 to 12.5
Chemical Oxygen Demand	<dl[c]	<dl	<dl	11.3	---
Biochemical Oxygen Demand	32	<dl	9.0	1.0	---
Total Organic Carbon	1.0	1.3	<dl	1.8	---
Total Dissolved Solids	847	850	249	847	---
Total Suspended Solids	<dl	<dl	<dl	<dl	---
Chloride Ion	32.1	30.1	13.6	37.6	---
Fluoride Ion	0.4	0.4	0.1	0.4	---
Nitrate as Nitrogen	2.7	ND[d]	1.2	2.9	---
Total Kjeldahl Nitrogen	<dl	<dl	<dl	<dl	---
Total Phosphorus	1.7	1.9	0.1	1.8	---
MBAS[e]	<dl	<dl	<dl	<dl	---
Silver	<dl	<dl	<dl	<dl	5
Arsenic	0.016	<dl	<dl	<dl	5
Barium	<dl	<dl	<dl	0.12	100
Beryllium	<dl	<dl	<dl	<dl	---
Calcium	138	136	45	127	---
Cadmium	<dl	<dl	<dl	<dl	1
Cobalt	<dl	<dl	<dl	<dl	---
Chromium	0.011	<dl	<dl	0.009	5
Copper	<dl	<dl	<dl	0.010	---
Iron	<dl	0.29	<dl	0.08	---
Mercury	<dl	<dl	<dl	<dl	0.2
Potassium	11.9	9.9	<dl	8.7	---
Magnesium	52.3	48.0	16.9	47.5	---
Manganese	<dl	<dl	<dl	0.003	---
Sodium	25.7	26.7	7.8	24.6	---
Nickel	<dl	<dl	<dl	<dl	---
Lead	<dl	<dl	<dl	<dl	5
Antimony	<dl	<dl	<dl	<dl	---
Selenium	<dl	<dl	<dl	<dl	1
Thallium	<dl	<dl	<dl	<dl	---
Zinc	<dl	<dl	<dl	0.009	---

[a] Concentrations in mg/L except Specific Conductance (µS) and pH (no units).
[b] EPA maximum concentration of contaminants for the toxicity characteristic from 40CFR 261.24. A blank (---) in this column means no limit has been established.
[c] Concentration below the detection limit.
[d] No data available for this sampling event.
[e] MBAS represents an analysis for surfactants.

sewage lagoon. Liquid effluent monitoring at NRF confirmed that all liquid effluents discharged from NRF in 1996 were controlled in accordance with applicable federal and state laws. Specifics regarding this monitoring are published annually in a separate report prepared and issued by NRF as prefaced in this report.

TABLE 7-5. ICPP SERVICE WASTE INORGANIC MONITORING DATA (1996)[a]

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Toxicity Limit
Aluminum	<dl[b]	<dl	0.037	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	N/A
Arsenic	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	5
Cadmium	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	1
Chromium	0.005	0.008	0.005	<dl	0.004	<dl	0.004	0.005	<dl	0.003	<dl	0.005	5
Copper	0.006	0.01	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	N/A
Mercury	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	0.2
Selenium	0.03	<dl	0.004	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	1
Silver	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	5
Sodium	192	166	178	167	136	177	170	177	145	151	157	139	N/A
Chloride	349	294	265	342	210	286	329	276	206	247	280	256	N/A
Fluoride	<dl	<dl	<dl	0.21	<dl	0.24	0.24	0.25	0.24	0.29	0.24	0.23	N/A
Iron	0.06	0.02	0.02	0.02	0.02	0.02	0.01	0.008	0.03	0.009	0.02	0.02	N/A
Manganese	0.003	0.004	0.003	<dl	<dl	0.002	0.001	0.001	0.001	0.002	0.002	0.002	N/A
Nitrate	4.21	5.72	4.60	5.40	5.10	5.10	4.43	5.38	4.30	5.40	4.90	5.30	N/A
Nitrite	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	0.33	0.33	N/A
TDS[c]	698	566	655	632	549	686	704	670	560	473	664	628	N/A
pH	8.5	8.5	8.4	8.5	8.3	8.6	8.7	8.6	8.4	8.5	8.6	8.6	2-12.5
TKN[d]	<dl	<dl	<dl	<dl	<dl	<dl	<dl	0.28	<dl	<dl	0.12	0.23	N/A

[a] Concentration reported in mg/L by LMITCO.
[b] Concentration was below detection limit.
[c] Total dissolved solids.
[d] Total Kjeldahl Nitrogen.

Summary of Chapter 8
Dose to the Public

In the course of some operations at the Idaho National Engineering and Environmental Laboratory (INEEL), radioactive materials may be released to the environment. These radioactive materials have the potential to provide a dose to individuals that live and work at offsite locations. Potential doses may result from the immersion, ingestion, and inhalation of radioactive materials released into the atmosphere and transported offsite (*Section 8.1*).

This chapter presents an evaluation of the potential doses received from INEEL operations by the public. Two separate computer models are used to determine the hypothetical maximally exposed individual (*Section 8.2*), based on the amount of radioactivity released to the air and meteorological data. In 1996, one model predicted this individual would reside at Frenchman's Cabin at the southern INEEL boundary, and would have received a dose of 0.03 mrem. The other model also predicted a dose of 0.03 mrem to the maximally exposed individual, who would have resided south of Mud Lake, Idaho. These numbers can be compared to the approximately 360 mrem dose received by residents of southeast Idaho from natural sources during the year.

A second potential exposure pathway to the population residing near the INEEL is through ingestion of game animals that migrate across or live on the Site (*Section 8.3*). This pathway was evaluated for waterfowl and mourning doves in 1996. A potential dose from manmade radionuclides of 0.06 mrem was calculated for the duck with the highest concentration of these radionuclides in edible tissues. This duck was collected from a radioactive waste disposal pond at the Test Reactor Area. For doves, a potential dose of 0.0003 mrem was calculated, also from a bird taken from the Test Reactor Area. Both of the calculated doses were significantly lower than those obtained in previous studies of INEEL waste ponds.

A computer model and census data were used to calculate the theoretical dose to the population that lives within 80 km (50 mi) of the INEEL's center of operations (*Section 8.3*). For 1996, a calculated dose of 0.24 person-rem was obtained using the model for a population of approximately 121,500. This same population received an estimated dose of 42,500 person-rem from natural sources during the year.

8. DOSE TO THE PUBLIC

8.1 GENERAL INFORMATION

Typically the radiological impact of INEEL operations on the public surrounding the INEEL has been too small to be measured by routine monitoring programs. Because of this, radiological impacts resulting from INEEL operations have been estimated using the reported amounts of radionuclides released during the year from INEEL facilities and appropriate air dispersion models to estimate the concentrations of radionuclides at selected locations surrounding the INEEL. During 1996, this was accomplished for the radionuclides summarized in Table 7-1. The following estimates were calculated: the effective dose equivalent to the maximally exposed individual residing offsite using the CAP-88 model; the effective dose equivalent to the maximally exposed individual residing offsite using dispersion calculations from the MDIFF (mesoscale diffusion) model [Reference 8-1]; and the collective effective dose equivalent (population dose) within an 80-km (50-mi) radius of the operations center of the Site—the Test Reactor Area (TRA) and Idaho Chemical Processing Plant (ICPP)—using the results from the MDIFF air dispersion model calculation for the maximally exposed individual.

In this chapter, the term *dose* will refer to effective dose equivalent unless another term is specifically stated. Dose was calculated by summing the committed dose equivalents to organs, each multiplied by a weighting factor proportional to each organ's sensitivity to radiation. Effective dose equivalent includes doses received from both external and internal sources and represents the same risk as if an individual's body were uniformly irradiated. U.S. Department of Energy (DOE) dose conversion factors and a 50-year integration period were used for internally deposited radionuclides [Reference 8-2] and for radionuclides deposited on ground surfaces [Reference 8-3] in calculations with both air dispersion models. Because the hypothetical dose to the maximally exposed individual residing near the INEEL is so low, no allowance is made in the MDIFF model for shielding by housing materials, which is estimated to reduce the dose by about 30%, or occupancy time in the community. The CAP-88 model, used by all sites regardless of the magnitude of the hypothetical dose, includes a factor to allow for shielding by housing materials and occupancy time.

Of the potential exposure pathways by which radioactive materials from INEEL operations could be transported offsite, atmospheric transport is likely to be the principal potential pathway. This is the likely exposure pathway since radionuclides from the INEEL have not been found in drinking water wells offsite. Because of this, the maximally exposed individual dose is determined through the use of models using the airborne emissions pathway.

8.2 MAXIMUM INDIVIDUAL DOSE - AIRBORNE EMISSIONS PATHWAY

CAP-88 Model

During 1996, U.S. Environmental Protection Agency (EPA) regulations were in effect that limit quantities of airborne radionuclides released from any nuclear facility. The standard required the dose received by any member of the public must be less than 10 mrem/yr, determined using the CAP-88 computer model.

For the 1996 calculations at the INEEL, approximately 60 potential maximum locations were evaluated. The CAP-88 model predicted the highest location would be Frenchman's Cabin, located at the southern boundary of the INEEL. Although this location is only inhabited during portions of the year, it meets the EPA definition of a residence. At Frenchman's Cabin, a hypothetical dose of 0.03 mrem (3×10^{-4} mSv) was calculated. The largest contributions to this dose came from ^{129}I from ICPP, which accounted for about 55%, and diffuse sources of tritium at the Radioactive

Waste Management Complex, accounting for about 30%. The dose of 0.03 mrem is 0.3% of the EPA radiation protection standard.

MDIFF Model

The MDIFF (formerly known as MESODIF) air dispersion model has been in use for over 20 years to calculate doses to members of the public residing near the INEEL. The MDIFF diffusion curves, developed from tests in desert environments (i.e. INEEL and the Hanford Site in eastern Washington) may be more appropriate for the INEEL than CAP-88. In previous years, doses calculated with the MDIFF air dispersion model have been somewhat higher than doses calculated using CAP-88. Differences between the two models were discussed in detail in the 1986 annual report [Reference 8-4]. The offsite concentrations calculated using both models were compared to actual monitoring results at offsite locations in 1986, 1987, and 1988. Concentrations calculated for several locations using the MDIFF model showed good agreement with concentrations from actual measurements, with the model generally predicting concentrations higher than those measured [Reference 8-5].

The mesoscale map (Figure 8-1) shows the calculated 1996 concentrations normalized to a

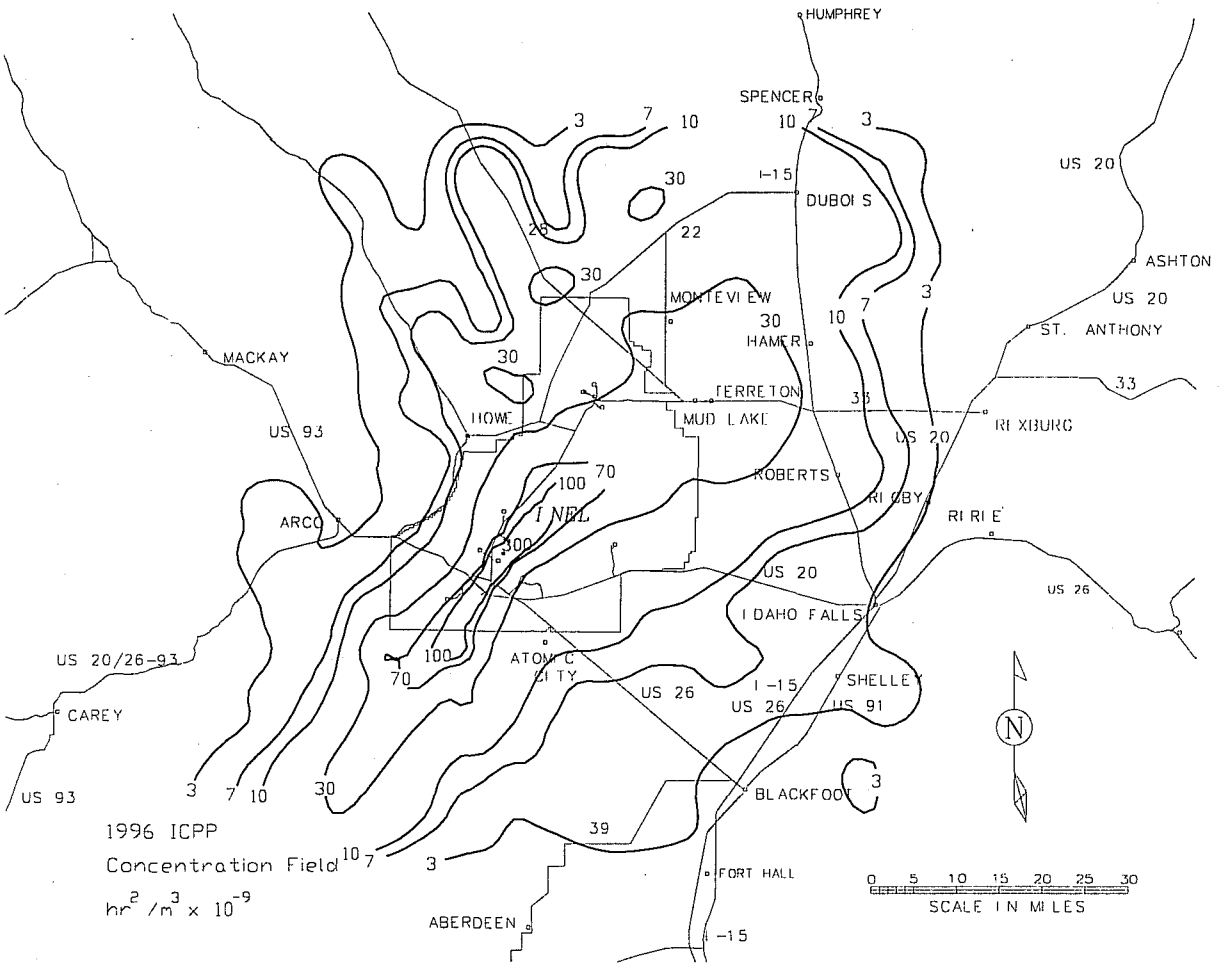


Figure 8-1. Average Mesoscale Dispersion Isopleths of Air Concentrations at Ground Level, Normalized to Unit Release Rate for TRA/ICPP

unit release rate for the TRA and ICPP. A second map (Figure 8-2) shows the calculated 1996 concentrations normalized to a unit release rate for Argonne National Laboratory-West (ANL-W). These maps were prepared by the National Oceanic and Atmospheric Administration Air Resources Laboratory using the MDIFF model and data gathered continuously at meteorological stations on and around the INEEL. To obtain the average air concentration (Ci/m^3) for a radionuclide released from TRA or ICPP along any dispersion coefficient isopleth (line of equal air concentration) in Figure 8-1, the value of the 1996 average dispersion coefficient is multiplied by the number of curies of the radionuclide released during 1996 and divided by the square of the number of hours in a year (7.67×10^7).

The MDIFF model predicts that the highest concentrations of radionuclides in the air at an inhabited area would have occurred approximately 3 km (2 mi) south of Mud Lake, Idaho in 1996. 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 radioactive particles on ground surfaces. The calculation was based on data presented in Table 7-1 and in Figure 8-1.

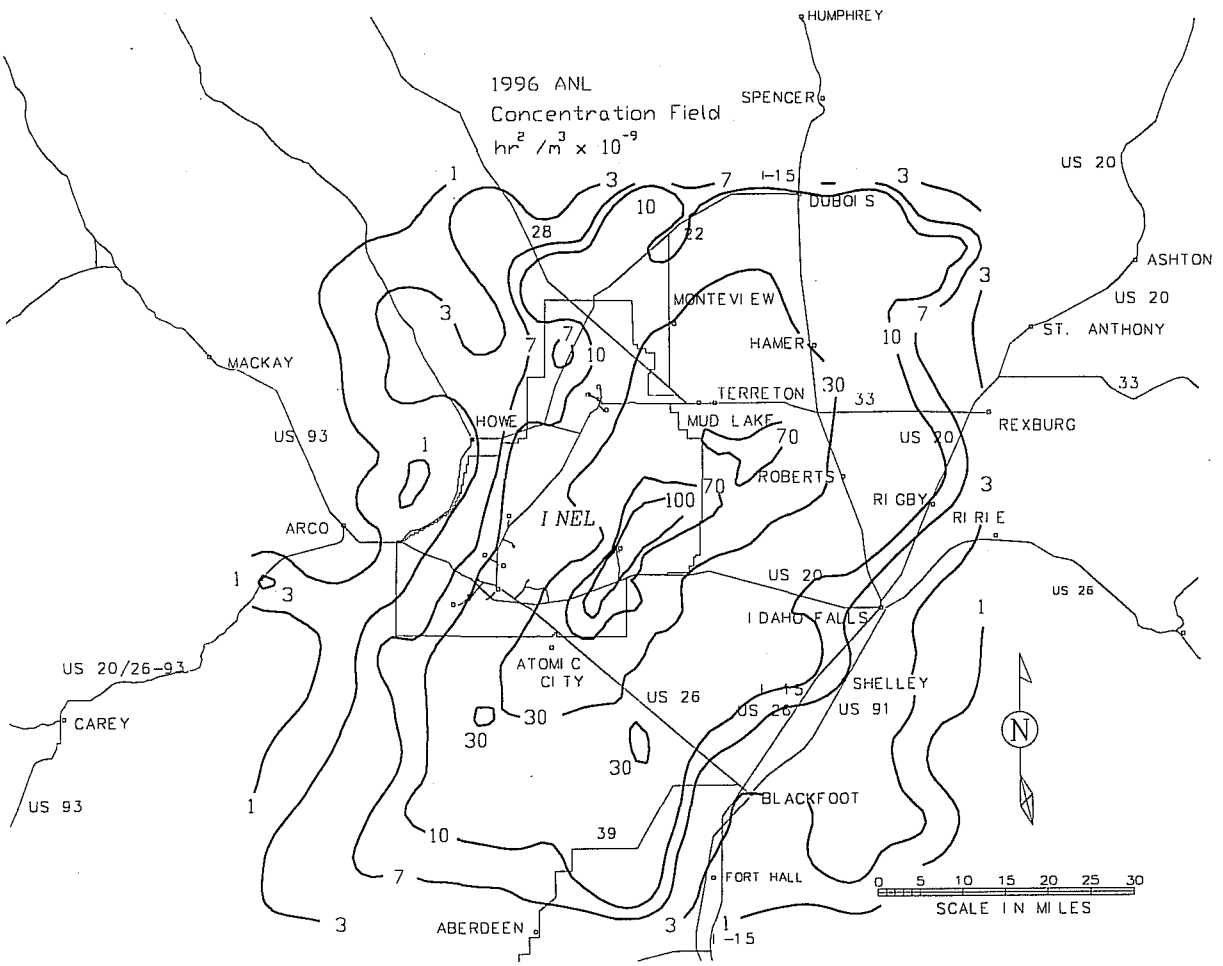


Figure 8-2. Average Mesoscale Dispersion Isopleths of Air Concentrations at Ground Level, Normalized to Unit Release Rate for ANL-W

TABLE 8-1. MAXIMUM INDIVIDUAL EFFECTIVE DOSE EQUIVALENT (1996)

Radionuclide[a]	Maximum Offsite Concentration (μCi/mL)[b]	Maximum Effective Dose Equivalent[c]	
		mrem	mSv
^{129}I	3.0×10^{-17}	2.4×10^{-2}	2.4×10^{-4}
^{41}Ar	5.8×10^{-13}	3.9×10^{-3}	3.9×10^{-5}
^{51}Cr	1.5×10^{-15}	6.1×10^{-5}	6.1×10^{-7}
^{3}H	8.7×10^{-14}	4.6×10^{-5}	4.6×10^{-7}
$^{88}Kr + D$	2.7×10^{-15}	3.1×10^{-5}	3.1×10^{-7}
^{125}Xe	1.3×10^{-14}	1.6×10^{-5}	1.6×10^{-7}
^{85}Kr	1.4×10^{-12}	1.5×10^{-5}	1.5×10^{-7}
^{88}Rb	6.3×10^{-15}	1.4×10^{-5}	1.4×10^{-7}
^{238}Pu	6.9×10^{-21}	1.3×10^{-5}	1.3×10^{-7}
^{14}C (organic)	6.2×10^{-16}	1.1×10^{-5}	1.1×10^{-7}
^{131}I	8.5×10^{-19}	7.9×10^{-6}	7.9×10^{-8}
$^{137}Cs + D$	2.7×10^{-19}	6.6×10^{-6}	6.6×10^{-8}
$^{90}Sr + D$	3.3×10^{-20}	6.0×10^{-6}	6.0×10^{-8}
^{60}Co	6.7×10^{-20}	3.3×10^{-6}	3.3×10^{-8}
^{87}Kr	5.5×10^{-16}	2.5×10^{-6}	2.5×10^{-8}
^{85m}Kr	2.0×10^{-15}	1.6×10^{-6}	1.6×10^{-8}
^{138}Cs	2.1×10^{-16}	1.6×10^{-6}	1.6×10^{-8}

[a] Table includes only radionuclides which contribute a dose of 1.0×10^{-6} mrem (1.0×10^{-8} mSv) or more. When indicated (+D), the contribution of progeny decay products was also included in the dose calculations.
[b] Estimate of radioactive decay using the distance to the Mud Lake area and the 1996 average wind speed in that direction. For radionuclides where parent-progeny 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.

Due to an increase in ^{85}Kr releases from a new process at ANL-W, calculations were also performed for ANL-W using similar data and Figure 8-2. However, the dose resulting from ANL-W releases were small, compared to those from TRA/ICPP. Using the calculated dispersion coefficients of 42×10^{-9} and 60×10^{-9} hr^2/m^3 (the largest dispersion coefficient values at a location that is inhabited by a full-time resident from TRA/ICPP and from ANL-W, respectively) and allowing for radioactive decay during the 53-km (33-mi) transit of the radionuclides from TRA/ICPP and the 47-km (29-mi) transit of radionuclides from ANL-W facilities to the Mud Lake location, the potential effective dose equivalent from all radionuclides released was calculated to be 0.029 mrem (2.9×10^{-4} mSv) (Table 8-1). This dose is 0.029% of the DOE radiation protection standard for a prolonged period of exposure to a member of the public from all pathways and 0.29% of the EPA standard for the airborne pathway only.

Of the dose received, the ingestion pathway accounted for 79% of the total, with the immersion pathway accounting for 14%. Figure 8-3 illustrates the contribution of the most significant radionuclides to the maximum individual dose for 1996. For comparison, the contribution of individual radionuclides to the maximally exposed individual dose for 1992 through 1995 are also shown (Figure 8-4). The potential doses for these years were 0.004 mrem, 0.03 mrem, 0.007 mrem, and 0.008 mrem.

There are differences in the atmospheric dispersion portions of the MDIFF and CAP-88 air dispersion codes. The calculated maximum dose resulting from INEEL operations is very small compared to the average dose received by

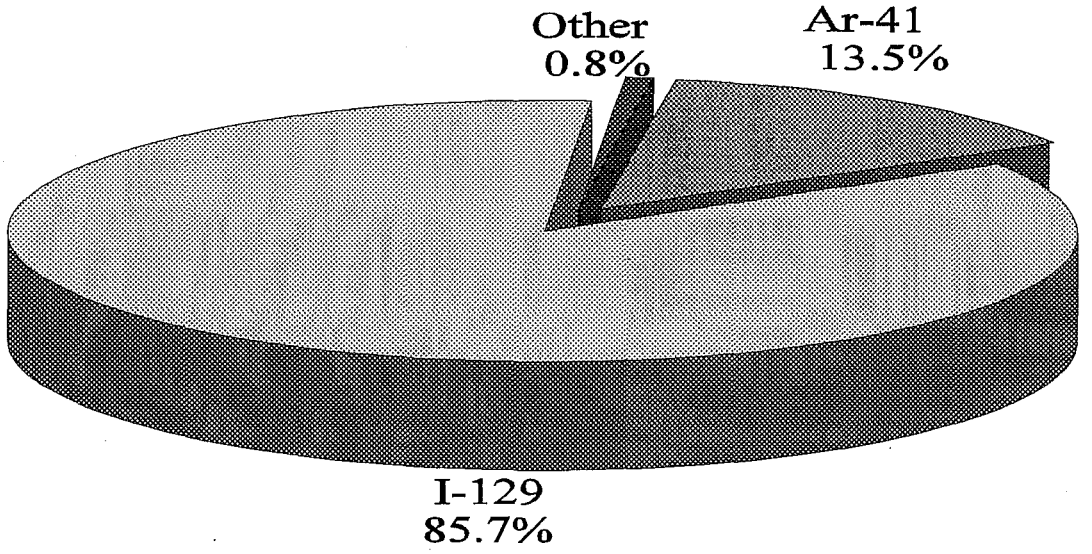


Figure 8-3. Radionuclides contributing to Maximum Individual Dose (1996)

individuals in southeastern Idaho from cosmic and terrestrial sources of naturally-occurring radiation found in the environment.

8.3 MAXIMUM INDIVIDUAL DOSE - GAME INGESTION PATHWAY

The potential dose an individual may receive from the occasional ingestion of meat from game animals continues to be investigated at the INEEL. Such studies include the potential dose to individuals who may eat waterfowl that reside briefly at waste ponds used for the disposal of low-level radioactive wastes and dose to individuals who may eat game birds or game animals which may migrate across the INEEL. Following the construction of two hypalon-lined evaporation ponds at TRA and the closure of the percolation ponds formerly used for disposal of wastes at this facility, the Environmental Science and Research Foundation initiated a study in 1994 to obtain current data on potential doses from game animals using the ponds.

During 1996, 10 waterfowl were collected from radioactive waste disposal ponds at TRA and ICPP and a pond at Test Area North (TAN) previously used for low-level waste disposal. Three control samples were also collected from the Fort Hall area and from the South Fork of the Snake River near Heise. Radionuclide concentrations in the edible portion of the ducks reported in Table 4-9 and 4-10 were used to estimate the potential dose to an individual consuming waterfowl from each facility. Estimated doses are based upon the assumption that ducks are killed and eaten immediately after leaving the ponds. A lower dose would be more realistic due to the biological elimination of the radioactivity. For example, a significant contributor to the dose, ^{137}Cs, has an effective half-life in mallard ducks of 11.2 days [Reference 8-6]. This means that half of the ^{137}Cs present in the muscle tissue of the duck 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 remaining.

Among the doses from manmade radionuclides, the highest values were found in waterfowl collected at TRA, where a dose of 0.055 mrem was calculated (Table 8-2). This can be compared to a dose of 0.0006 mrem estimated for the control location. The largest anthropogenic contributors to dose were ^{60}Co, ^{65}Zn, ^{90}Sr, and ^{137}Cs. The

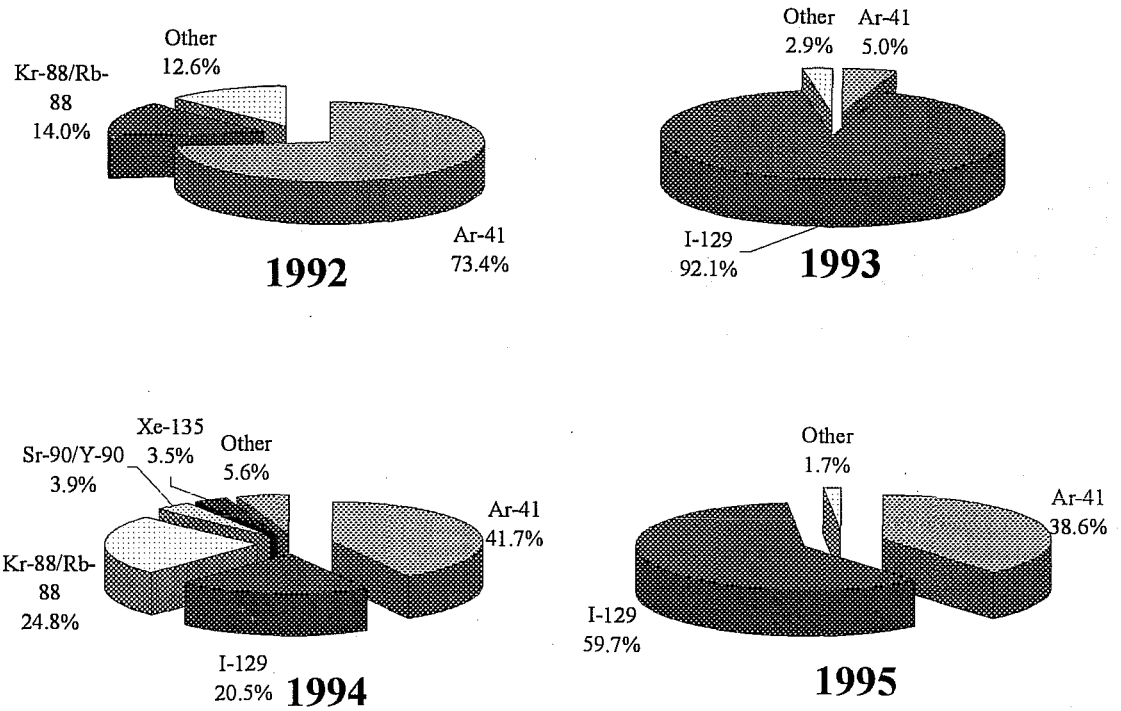


Figure 8-4. Radionuclides Contributing to Maximum Individual Dose (1992-1995)

potential doses from the current pond are substantially reduced from the 10 mrem average whole-body dose equivalent from gamma-emitting radionuclides estimated during a 1974 to 1978 study at the former TRA percolation pond [Reference 8-7], and from the 4.0 mrem estimated for the most contaminated duck taken from the percolation pond in 1984 to 1986 [Reference 8-8].

During 1996, 13 mourning doves were collected from the evaporation ponds at TRA. Four control samples were also collected near Rigby, Idaho. Manmade radionuclide concentrations in the edible portion of the doves reported in Table 4-11 were used to estimate the potential dose resulting from the ingestion of 30 g (1 oz) of the edible portion of the mourning doves (Table 8-3). The potential dose from a dove at TRA was calculated to be 0.0003 mrem, compared to 0.0002 mrem in the control dove. The largest anthropogenic contributors to the dose were ^{90}Sr and ^{137}Cs. The highest estimated potential whole-body dose equivalent to a person eating the entire muscle mass of a mourning dove from the former TRA percolation pond was 0.3 mrem in 1974-1977 [Reference 8-9].

A conservative (or high) estimate of the potential whole-body dose that could be received from an individual eating the entire muscle and liver mass of an antelope with the highest levels of radioactivity found in these animals was estimated at 0.2 mrem in 1975 [Reference 8-10]. Game animals collected at the INEEL during the past few

TABLE 8-2. DOSE FROM INGESTION OF MUSCLE TISSUE OF WATERFOWL USING INEEL WASTE DISPOSAL PONDS (1996)[a]

Radionuclide[b]	TRA Evaporation Ponds	TAN TSF Pond	ICPP Percolation Pond	Control (Fort Hall and S. Fork Snake River)
^{54}Mn	<0.0001	0	0	0
^{58}Co	0.0001	0	0	0
^{60}Co	0.0129	0	0	0
^{65}Zn	0.0048	0	0	0
^{90}Sr	0.0058	0	0	0.0004
^{95}Zr	0.0001	0	0	0
^{134}Cs	0.0004	0.0003	0	0
^{137}Cs	0.0227	0	0.0003	0.0002
^{140}Ba	0.0078	0	0.0073	0
^{181}Hf	0	0	0	<0.0001
^{238}Pu	0	0	0.0021	0
^{241}Am	0.0003	0	0	0
Total	0.0550	0.0003	0.0098	0.0006

[a] Doses given in mrem. Assumes the consumption of 225 g (8 oz) of muscle tissue from each location.
[b] Doses are calculated for manmade radionuclides only.

years have shown much lower concentrations than in 1975. Based on the highest concentration of radionuclides found in a game animal during the past several years, the potential dose is now approximately 0.03 mrem.

The potential dose for the consumption of a sage grouse from the TRA-ICPP area was estimated at 2 mrem in 1977-1980 [Reference 8-11]. Following the covering of the former percolation pond at TRA by clean soil, radionuclide concentrations in soil around that facility are substantially lower now than when the earlier studies took place. Therefore, the values for potential doses from sage grouse are likely lower now than in 1980, as shown by the decreased estimated dose resulting from the ingestion waterfowl and mourning doves from TRA.

8.4 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 exposed individual ($rem/yr/h^2/m^3$). This gives an approximation of the dose received by the entire population in a given census division.

The average dose received per person is obtained by dividing the collective effective dose equivalent by the population in that particular

TABLE 8-3. DOSE FROM INGESTION OF MUSCLE TISSUE OF MOURNING DOVES USING WASTE PONDS AT THE TEST REACTOR AREA (1996)[a]

Radionuclide[b]	Control (Rigby)	TRA Evaporation Ponds
^{65}Zn	0	<0.00001
^{90}Sr	0	0.0001
^{134}Cs	0	<0.00001
^{137}Cs	0	0.0002
^{140}Ba	0.0002	0
Total	0.0002	0.0003

[a] Doses given in mrem. Assumes the consumption of 30 g (1 oz) of muscle tissue from each location.
[b] Doses calculated for manmade radionuclides only.

census division. This calculation overestimates dose because the model (conservatively) does not account for radioactive decay of the isotopes during transport over distances greater than 52-km (32-mi) from the TRA/ICPP facilities to the residence of the maximally exposed individual located near Mud Lake. 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 MDIFF dose upon which the collective dose equivalent is based. The calculation also tends to overestimate the population doses because they are extrapolated from the dose computed for the location of the potential maximally exposed individual. This individual is potentially exposed through ingestion of contaminated leafy vegetables from his garden and ingestion of milk from cows grazing solely upon contaminated pasture grass.

The 1996 MDIFF population dose within each census division was obtained by summing the results from appropriate areas contained within those divisions (Table 8-4). 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 0.235 person-rem (0.00235 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 0.0005%. The dose of 0.235 person-rem can also be compared to the following estimated population doses for the same size population: 3,600 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. The largest collective doses are found in the Idaho Falls and Hamer census divisions. Idaho Falls is relatively high because of the relatively high population and Hamer because it lies in the predominant downwind direction from the INEEL.

TABLE 8-4. 80-KILOMETER POPULATION DOSE (1996)

Census Division	Population	Population Dose	
		Person-rem	Person-Sv
Aberdeen	2,760	1.28×10^{-3}	1.28×10^{-5}
Alridge (part)	160	4.35×10^{-4}	4.35×10^{-6}
American Falls (part)	200	1.74×10^{-5}	1.74×10^{-7}
Arco	2,600	4.66×10^{-3}	4.66×10^{-5}
Atomic City (city)	25	2.09×10^{-4}	2.09×10^{-6}
Atomic City (division)	2,300	8.09×10^{-4}	8.09×10^{-6}
Blackfoot	12,450	9.45×10^{-3}	9.45×10^{-5}
Carey (part)	120	2.43×10^{-5}	2.43×10^{-7}
Challis (part)	10	6.75×10^{-7}	6.75×10^{-9}
Firth	3,050	8.29×10^{-3}	8.29×10^{-5}
Fort Hall (part)	3,920	2.44×10^{-3}	2.44×10^{-5}
Hamer	2,400	5.11×10^{-2}	5.11×10^{-4}
Howe	325	4.02×10^{-3}	4.02×10^{-5}
Idaho Falls	63,500	9.31×10^{-2}	9.31×10^{-4}
Idaho Falls, west	1,750	1.40×10^{-3}	1.40×10^{-5}
Leadore (part)	15	9.38×10^{-5}	9.38×10^{-7}
Lewisville-Menan (part)	2,700	6.35×10^{-3}	6.35×10^{-5}
Mackay	1,200	1.88×10^{-4}	1.88×10^{-6}
Moreland	8,150	1.60×10^{-3}	1.60×10^{-5}
Rigby	1,000	2.48×10^{-3}	2.48×10^{-5}
Roberts	1,430	1.47×10^{-2}	1.47×10^{-4}
Shelley	6,400	1.74×10^{-2}	1.74×10^{-4}
Ucon	4,900	1.22×10^{-2}	1.22×10^{-4}
West Clark	90	2.86×10^{-3}	2.86×10^{-5}
Totals	121,465	2.35×10^{-1}	2.35×10^{-3}

[a] Population based on 1990 Census Report for Idaho

8.5 SUMMARY

Table 8-5 summarizes the calculated annual effective dose equivalents from 1996 INEL operations using both CAP-88 and MDIFF air dispersion models. A comparison is shown between these doses and the EPA airborne pathway standard, and to the estimated dose from natural background. The contribution of game animal consumption to the population dose has not been calculated because only a percentage of the population hunts game, few of the animals killed have spent time on the INEEL, and most of the animals that do migrate from the INEEL would have reduced concentrations of radionuclides in their tissues by the time they were harvested. 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 8-5. SUMMARY OF ANNUAL EFFECTIVE DOSE EQUIVALENTS DUE TO INEEL OPERATIONS (1996)

	Maximum Dose to an Individual[a]		Population Dose
	MDIFF[b]	CAP-88[c]	MDIFF
Dose	0.029 mrem (3×10^{-4} mSv)	0.031 mrem (3.1×10^{-4} mSv)	0.24 person-rem (2.4×10^{-3} person-Sv)
Location	Mud Lake area	Frenchman's Cabin	Area within an 80-km circle
Applicable Radiation Protection Standard[d]	10 mrem (0.1 mSv)	10 mrem (0.1 mSv)	-----
Percentage of Standard	0.29%	0.31%	-----
Natural Background	360 mrem (3.6 mSv)	360 mrem (3.6 mSv)	43,700 person-rem (437 person-Sv)
Percentage of Background	0.008%	0.009%	0.0005%

[a] Hypothetical dose to the maximally exposed individual residing near the INEEL.
[b] Effective dose equivalent calculated using the MDIFF air dispersion model. MDIFF 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.

Summary of Chapter 9
Quality Assurance

The Environmental Science and Research Foundation, Lockheed Martin Idaho Technologies Company (LMITCO) and the United States Geological Survey (USGS) perform environmental monitoring at the Idaho National Engineering and Environmental Laboratory (INEEL). Each of these contractors maintains a quality assurance program which includes many quality control elements to ensure results are accurate and reliable (*Section 9.1*). Laboratories performing analyses for these programs maintain their own quality assurance programs. One part of a laboratory's quality assurance program is participation in a variety of intercomparison programs (*Section 9.2*), including those administered by the U.S. Department of Energy (DOE) Environmental Measurements Laboratory (EML), the National Institute of Standards and Technology (NIST), and the Environmental Protection Agency (EPA).

Another measure of the precision of data generated by environmental programs is gained through the use of duplicate samples. This chapter provides the results of duplicate samples collected by the Environmental Science and Research Foundation and Lockheed Martin Idaho Technologies Company (LMITCO) (*Section 9.3*). Data collected simultaneously at the same locations by three different organizations (the Foundation, Lockheed, and the State of Idaho) are also provided for comparison. In addition, the USGS compares data with the State of Idaho on the analysis of ground-water samples collected simultaneously.

9. QUALITY ASSURANCE

9.1 QUALITY ASSURANCE PROGRAMS

Quality control and assurance programs were maintained by contractors conducting environmental monitoring, and by laboratories performing environmental analyses, to ensure accurate and reliable results and to maximize data completeness. Elements of typical quality control programs include the following:

- Adherence to peer-reviewed written procedures for sample collection and analytical methods.
- Documentation of program changes.
- Periodic calibration of instruments with standards traceable to the NIST.
- Chain of custody procedures.
- Equipment performance checks.
- 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 during analysis.
- Analysis of blind spike samples (samples containing a known amount of a contaminant) to verify the accuracy of a measurement.
- Internal and external surveillance to verify quality elements.
- Data verification and validation programs.

9.2 LABORATORY INTERCOMPARISON PROGRAMS

General Information

Radiological data reported in this document were obtained from several commercial, university, government, and government contractor laboratories, including Accu-Labs Research, Inc., the Idaho State University Environmental Assessment Laboratory (EAL), the Lockheed Martin Idaho Technologies Company Radiological Measurements Laboratory, Paragon Analytics, Inc., the DOE Radiological and Environmental Sciences Laboratory (RESL), and Quanterra, Inc. These laboratories participate in a variety of programs to ensure the quality of their analytical data.

Quality Assessment Program (QAP)

The QAP is administered by DOE's EML in New York. EML prepares 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 twice per year in which the identities of participating laboratories, their results, and comparison to EML results are presented. Results from the QAP are presented in Tables 9-1 to 9-5 for laboratories used during 1996.

NIST

RESL participates in a traceability program administered through NIST. NIST prepares several alpha-, beta-, and gamma-emitting standards, generally in liquid media, for analysis by RESL.

TABLE 9-1. ENVIRONMENTAL MEASUREMENTS LABORATORY (EML) QUALITY ASSESSMENT PROGRAM RESULTS FOR ACCU-LABS RESEARCH INC. LABORATORY [1996]

			Accu-Lab		EML[a]		Accu-Lab /EML[b]	
Medium	Units	Radionuclide	Value	Error	Value	Error	Ratio	+/-
			June Distribution					
Air	Bq/filter	Gross alpha	1.54	0.03	1.62	0.15	0.95	0.09
		Gross beta	1.50	0.03	1.77	0.15	0.85	0.07
		^{54}Mn	3.0	0.2	3.4	0.4	0.87	0.11
		^{57}Co	7.1	0.3	8.9	0.9	0.80	0.09
		^{60}Co	27.1	0.9	29.5	2.9	0.92	0.10
		^{90}Sr	0.7	0.2	1.06	0.03	0.69	0.18
		^{106}Ru	10	1	12	1	0.89	0.16
		^{125}Sb	10.1	0.9	9.8	1.0	1.03	0.14
		^{134}Cs	13.0	0.6	14.7	1.5	0.88	0.10
		^{137}Cs	6.0	0.3	6.6	0.7	0.90	0.11
		^{144}Ce	32	2	33	3	0.97	0.12
		^{238}Pu	0.10	0.01	0.10	0.01	1.01	0.13
		^{239}Pu	0.09	0.01	0.09	0.01	0.98	0.14
		^{241}Am	0.18	0.01	0.19	0.01	0.93	0.08
		^{234}U	0.06	0.01	0.05	0.01	1.16	0.21
		^{238}U	0.06	0.01	0.05	0.01	1.04	0.20
		U BQ	0.12	0.02	0.11	0.01	1.08	0.14
	µg/filter	U UG	4.40	0.06	4.31	0.10	1.02	0.03
Soil	Bq/kg	^{40}K	369	22	465	30	0.79	0.07
		^{90}Sr	1340	60	1340	113	1.00	0.10
		^{137}Cs	327	11	359	10	0.91	0.04
		^{238}Pu	44	3	43	2	1.03	0.10
		^{239}Pu	11.3	1.7	9.2	0.4	1.22	0.19
		^{241}Am	2.3	0.3	3.7	0.5	0.63	0.11
		^{234}U	38	3	34	4	1.11	0.15
		^{238}U	32	3	36	4	0.89	0.12
		U BQ	70	5	72	4	0.97	0.08
	µg/g	U UG	2.34	0.03	2.90	0.29	0.81	0.08
Vegetation	Bq/kg	^{40}K	746	38	1030	33	0.72	0.04
		^{60}Co	44.1	2.6	59.7	1.0	0.74	0.05
		^{90}Sr	202	6	1300	52	0.16	0.01
		^{137}Cs	854	28	944	16	0.91	0.03
		^{238}Pu	0.60	0.07	0.82	0.10	0.74	0.13
		^{239}Pu	8.1	0.2	9.8	1.2	0.82	0.11
		^{241}Am	5.6	0.3	5.6	0.2	1.00	0.06
		^{244}Cm	4.4	0.2	4.4	0.2	0.99	0.07
Water	Bq/L	Gross alpha	1820	200	1850	185	0.98	0.15
		Gross beta	528	66	744	74	0.71	0.11
		^{3}H	224	9	251	11	0.89	0.05
		^{54}Mn	44	4	38	1	1.15	0.10
		^{60}Co	36.9	2.6	33	0.6	1.13	0.08
		^{90}Sr	1.52	0.19	1.45	0.03	1.05	0.13
		^{137}Cs	45.60	3.60	38.30	.088	1.19	0.10
		^{238}Pu	0.85	0.12	0.98	0.07	0.87	0.14
		^{239}Pu	0.84	0.12	0.77	0.06	1.09	0.17
		^{241}Am	0.80	0.11	0.77	0.01	1.05	0.15
		^{234}U	0.33	0.04	0.27	0.02	1.20	0.17
		^{238}U	0.32	0.04	0.28	0.02	1.16	0.18
		U BQ	0.65	0.06	0.56	0.05	1.16	0.14
	µg/mL	U UG	25.70	1.10	0.02	0.00	****	****
			December Distribution					
Air	Bq/filter	Gross alpha	1.97	0.09	1.15	0.11	1.71	
		Gross beta	0.48	0.03	0.50	0.05	0.96	
		^{54}Mn	6.6	0.3	6.4	0.3	1.05	
		^{57}Co	15.6	0.7	14.8	0.8	1.05	
		^{60}Co	9.3	0.4	8.6	0.4	1.07	
		^{90}Sr	0.55	0.25	0.53	0.04	1.05	
		^{106}Ru	6.3	1.4	10.8	1.1	0.58	
		^{125}Sb	11.7	0.6	10.8	0.5	1.08	
		^{134}Cs	11.4	0.5	10.8	0.4	1.06	
		^{137}Cs	8.6	0.4	8.5	0.4	1.01	
		^{238}Pu	0.11	0.03	0.12	0.01	0.95	
		^{241}Am	0.14	0.05	0.22	0.02	0.61	
		^{234}U	0.08	0.03	0.08	0.01	0.95	
		^{238}U	0.05	0.02	0.08	0.01	0.64	
		U BQ	0.12	0.03	0.16	0.01	0.80	
	µg/filter	U UG	5.0	0.5	6.4	0.5	0.78	

TABLE 9-1. (Cont.) ENVIRONMENTAL MEASUREMENTS LABORATORY (EML) QUALITY ASSESSMENT PROGRAM RESULTS FOR ACCU-LABS RESEARCH INC. LABORATORY [1996]

			Accu-Lab		EML[a]		Accu-Lab /EML[b]	
Medium	Units	Radionuclide	Value	Error	Value	Error	Ratio	+/-
Soil	Bq/kg	^{40}K	314	24	300	25	1.05	
		^{90}Sr	56	5	70	5	0.80	
		^{60}Co	5.3	0.9	2.9	0.2	1.81	
		^{137}Cs	1650	50	1550	22	1.07	
		^{238}Pu	1.5	0.5	1.1	0.2	1.36	
		^{239}Pu	21	2	22	1	0.98	
		^{241}Am	7.6	1.6	13.5	0.5	0.56	
		^{244}Cm	0.22	0.18	0.31	0.06	0.71	
		^{234}U	41	10	39	2	1.05	
		^{238}U	38.1	9.2	41.6	0.6	0.92	
		U BQ	82	14	82	3	1.00	
	µg/g	U UG	2.05	0.07	3.36	0.30	0.61	
Vegetation	Bq/kg	^{40}K	1120	60	992	29	1.13	
		^{60}Co	15.2	2.6	10.9	0.7	1.39	
		^{90}Sr	596	48	1390	12	0.43	
		^{137}Cs	240	10	190	7	1.26	
		^{239}Pu	1.8	0.4	2.0	0.3	0.91	
		^{241}Am	1.0	0.2	1.2	0.4	0.79	
		^{244}Cm	0.8	0.2	0.8	0.1	0.98	
Water	Bq/L	Gross alpha	1190	100	1210	121	0.98	
		Gross beta	435	46	540	54	0.81	
		^{3}H	465	12	587	58	0.79	
		^{54}Mn	70.8	2.9	60.5	0.6	1.17	
		^{60}Co	70.6	3.1	61.0	0.7	1.16	
		^{90}Sr	2.9	0.4	2.7	0.2	1.08	
		^{137}Cs	107	4	90	2	1.20	
		^{238}Pu	1.85	0.17	1.91	0.07	0.97	
		^{239}Pu	0.91	0.12	0.84	0.03	1.09	
		^{241}Am	1.06	0.11	1.08	0.04	0.98	
		^{234}U	0.65	0.10	0.48	0.04	1.35	
		^{238}U	0.99	0.09	0.48	0.37	1.02	
		U BQ	1.16	0.14	0.97	0.07	1.20	
	µg/mL	U UG	0.04	0.01	0.04	0.01	1.08	

[a] The EML value is the mean of replicate determinations for each radionuclide. The EML error is the standard error of the mean.
[b] The ratio error was not given in the December report.

TABLE 9-2. ENVIRONMENTAL MEASUREMENTS LABORATORY (EML) QUALITY ASSESSMENT PROGRAM RESULTS FOR THE ENVIRONMENTAL ASSESSMENT LABORATORY (EAL) [1996]

			EAL		EML[a]		EAL/EML[b]	
Medium	Units	Radionuclide	Value	Error	Value	Error	Ratio	+/-
			December Distribution					
Air	Bq/filter	Gross alpha	0.73	0.02	1.15	0.11	0.64	
		Gross beta	0.64	0.03	0.50	0.05	1.28	
		^{54}Mn	6.66	0.31	6.35	0.27	1.05	
		^{57}Co	15.4	0.5	14.8	0.8	1.05	
		^{60}Co	9.0	0.2	8.6	0.4	1.05	
		^{106}Ru	12.0	1.1	10.8	1.1	1.11	
		^{134}Cs	12.0	0.3	10.8	0.4	1.11	
		^{137}Cs	8.6	0.4	8.5	0.4	1.00	
		^{125}Sb	11.7	0.4	10.8	0.5	1.08	
Soil	Bq/kg	^{40}K	520	40	300	25	1.73	
		^{60}Co	2.0	0.6	2.9	0.2	0.69	
		^{137}Cs	1710	32	1550	22	1.21	
Vegetation	Bq/kg	^{40}K	1630	122	992	29	1.64	
		^{60}Co	12.6	1.7	10.9	0.7	1.16	
		^{137}Cs	230	6	190	7	1.21	
Water	Bq/L	^{54}Mn	67.0	1.3	60.5	0.6	1.11	
		^{60}Co	65.8	1.0	61.1	0.7	1.08	
		^{137}Cs	100	2	90	1	1.12	

[a] The EML value is the mean of replicate determinations for each radionuclide. The EML error is the standard error of the mean.
[b] The ratio error was not given in the December report.

TABLE 9-3. ENVIRONMENTAL MEASUREMENTS LABORATORY (EML) QUALITY ASSESSMENT PROGRAM RESULTS FOR LMITCO [1996]

			LMITCO		EML[a]		LMITCO/EML[b]	
Medium	Units	Radionuclide	Value	Error	Value	Error	Ratio	+/-
			June Distribution					
Air	Bq/filter	Gross alpha	2.19	0.15	1.62	0.15	1.35	0.16
		Gross beta	2.19	0.14	1.77	0.15	1.24	0.13
		^{54}Mn	3.1	0.2	3.4	0.4	0.90	0.12
		^{57}Co	7.1	0.2	8.9	0.9	0.80	0.08
		^{60}Co	26.70	0.04	29.50	2.90	0.91	0.09
		^{106}Ru	11	1	12	1	0.94	0.16
		^{125}Sb	9.2	0.3	10	1	0.94	0.10
		^{134}Cs	13.8	0.3	15	1.5	0.94	0.10
		^{137}Cs	5.8	0.2	7	0.7	0.87	0.10
		^{144}Ce	23.4	0.8	33.3	3.3	0.70	0.07
Soil	Bq/kg	^{40}K	461	85	465	30	0.99	0.19
		^{90}Sr	9900	30	1340	113	7.39	0.62
		^{137}Cs	406	14	359	10	1.13	0.05
		^{238}Pu	41	3	43	2	0.94	0.09
		^{239}Pu	10.5	1.1	9	0.4	1.14	0.13
		^{241}Am	4.0	0.6	3.7	0.5	1.08	0.21
		^{234}U	15	2	34	4	0.43	0.07
		^{238}U	15	2	36	4	0.42	0.07
Vegetation	Bq/kg	^{40}K	1030	130	1030	33	1.00	0.13
		^{60}Co	59	5	59	1	0.99	0.09
		^{90}Sr	1250	30	1300	52	0.96	0.05
		^{137}Cs	1030	30	944	16	1.09	0.04
Water	Bq/L	^{3}H	180	30	251	11	0.72	0.12
		^{54}Mn	43	2	38	1	1.12	0.06
		^{55}Fe	62	17	83	3	0.75	0.21
		^{60}Co	34.0	2.0	32.8	0.6	1.04	0.06
		^{90}Sr	1.23	0.06	1.45	0.34	0.85	0.05
		^{137}Cs	43.0	2.0	38.3	0.9	1.12	0.06
		^{238}Pu	0.83	0.06	0.98	0.07	0.85	0.09
		^{239}Pu	0.63	0.05	0.77	0.06	0.82	0.09
		^{241}Am	0.64	0.04	0.77	0.01	0.84	0.05
		^{234}U	0.25	0.03	0.27	0.02	0.91	0.13
		^{238}U	0.24	0.03	0.28	0.02	0.87	0.13
			December Distribution					
Air	Bq/filter	Gross alpha	1.20	0.10	1.15	0.11	1.04	
		Gross beta	0.70	0.10	0.50	0.05	1.40	
		^{54}Mn	6.9	0.5	6.4	0.3	1.09	
		^{57}Co	16.4	1.2	14.8	0.8	1.11	
		^{60}Co	9.5	0.7	8.6	0.4	1.10	
		^{106}Ru	12	1	11	1	1.10	
		^{125}Sb	12.6	0.9	10.8	0.5	1.17	
		^{134}Cs	12.4	0.9	10.8	0.4	1.15	
		^{137}Cs	8.9	0.7	8.5	0.4	1.04	
Soil	Bq/kg	^{40}K	340	30	300	25	1.13	
		^{60}Co	3.2	0.6	2.9	0.2	1.10	
		^{90}Sr	77	6	70	5	1.10	
		^{137}Cs	1830	140	1550	22	1.18	
		^{238}Pu	0.4	0.3	1.1	0.2	0.35	
		^{239}Pu	21	3	22	1	0.96	
		^{241}Am	1.3	0.2	13.5	0.5	0.10	
		^{244}Cm	0.70	0.30	0.31	0.06	2.24	
		U BQ	61	4	82	3	0.75	
Vegetation	Bq/kg	^{40}K	1090	115	992	29	1.10	
		^{60}Co	11.0	2.0	10.9	0.7	1.01	
		^{90}Sr	1470	30	1390	12	1.06	
		^{137}Cs	203	15	190	7	1.07	
		^{239}Pu	1.8	0.8	2.0	0.3	0.92	
		^{241}Am	1.3	0.3	1.2	0.4	1.06	
		^{244}Cm	0.8	0.2	0.8	0.1	1.01	
Water	Bq/L	^{54}Mn	64.0	5.0	60.5	0.6	1.06	
		^{60}Co	65.0	5.0	61.1	0.7	1.06	
		^{90}Sr	2.64	0.07	2.71	0.24	0.97	
		^{137}Cs	96	7	90	1	1.07	
		^{238}Pu	1.30	0.20	1.91	0.07	0.68	
		^{239}Pu	0.52	0.09	0.84	0.03	0.62	
		^{241}Am	0.94	0.08	1.08	0.04	0.87	
		U BQ	1.09	0.06	0.97	0.07	1.12	

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

[b] The ratio error was not given in the December report.

TABLE 9-4. ENVIRONMENTAL MEASUREMENTS LABORATORY (EML) QUALITY ASSESSMENT PROGRAM RESULTS FOR PARAGON ANALYTICS, INC. [1996]

			Paragon		EML[a]		Paragon/EML[b]	
Medium	Units	Radionuclide	Value	Error	Value	Error	Ratio	+/-
June Distribution								
Air	Bq/filter	Gross alpha	1.85	0.08	1.62	0.15	1.14	0.12
		Gross beta	1.73	0.07	1.77	0.15	0.98	0.09
		^{54}Mn	2.9	0.2	3.4	0.4	0.84	0.11
		^{57}Co	7.4	0.5	8.9	0.9	0.84	0.02
		^{60}Co	27	2	30	3	0.90	0.11
		^{90}Sr	0.9	0.2	1.1	0.1	0.82	0.15
		^{106}Ru	11	2	12	1	0.98	0.20
		^{125}Sb	9.8	0.7	10	1	1.00	0.13
		^{134}Cs	15	1	15	2	0.99	0.12
		^{137}Cs	6.1	0.4	6.6	0.7	0.92	0.12
		^{144}Ce	25	2	33	3	0.76	0.09
		^{238}Pu	0.09	0.01	0.10	0.01	0.88	0.12
		^{239}Pu	0.09	0.01	0.09	0.01	0.93	0.12
		^{241}Am	0.17	0.02	0.19	0.01	0.89	0.12
		^{234}U	0.08	0.1	0.05	0.01	1.55	0.24
		^{238}U	0.07	0.01	0.05	0.01	1.28	0.19
Soil	Bq/kg	^{40}K	585	45	465	30	1.26	0.13
		^{90}Sr	1040	140	1340	113	0.78	0.12
		^{137}Cs	452	29	359	10	1.29	0.09
		^{238}Pu	41	5	43	2	0.95	0.12
		^{239}Pu	9.2	1.1	9.2	0.4	1.00	0.13
		^{241}Am	3.3	0.4	3.7	0.5	0.90	0.16
		^{234}U	31	4	34	4	0.92	0.14
		^{238}U	32	4	36	4	0.90	0.14
Vegetation	Bq/kg	^{40}K	1220	84	1030	33	1.18	0.09
		^{60}Co	62	4	60	1	1.04	0.07
		^{90}Sr	1220	220	1300	52	0.94	0.17
		^{137}Cs	1180	75	944	16	1.25	0.08
		^{239}Pu	9	1	10	1	0.96	0.16
		^{241}Am	6.2	0.7	5.6	0.2	1.10	0.14
		^{244}Cm	4.0	0.4	4.4	0.2	0.89	0.09
Water	Bq/L	Gross alpha	1850	233	1850	185	1.00	0.16
		Gross beta	474	59	744	74	0.64	0.10
		^{3}H	195	29	251	11	0.78	0.12
		^{54}Mn	40	3	38	1	1.04	0.09
		^{60}Co	32	3	33	6	0.97	0.08
		^{90}Sr	1.5	0.3	1.5	0.3	1.03	0.21
		^{137}Cs	41	3	38	9	1.06	0.09
		^{238}Pu	0.94	0.12	0.98	0.07	0.96	0.14
		^{239}Pu	0.72	0.09	0.77	0.06	0.93	0.13
		^{241}Am	0.8	0.1	0.77	0.01	1.03	0.13
		^{234}U	0.29	0.04	0.27	0.02	1.07	0.15
		^{238}U	0.28	0.04	0.28	0.02	1.03	0.16
		U BQ	0.15	0.01	0.56	0.05	0.26	0.03
December Distribution								
Air	Bq/filter	Gross alpha	0.45	0.01	1.15	0.11	0.39	
		Gross beta	0.48	0.01	0.50	0.05	0.97	
		^{54}Mn	7.9	0.5	6.4	0.3	1.25	
		^{57}Co	18.5	1.2	14.8	0.8	1.25	
		^{60}Co	9.5	0.6	8.6	0.4	1.10	
		^{90}Sr	0.55	0.10	0.53	0.04	1.05	
		^{106}Ru	12	1	11	1	1.07	
		^{125}Sb	14.1	1	10.8	0.5	1.31	
		^{134}Cs	11.5	1.0	10.8	0.4	1.07	
		^{137}Cs	10.1	0.7	8.5	0.4	1.18	
		^{238}Pu	0.12	0.02	0.12	0.01	1.02	
		^{241}Am	0.22	0.03	0.22	0.02	1.01	
		^{234}U	0.077	0.009	0.080	0.006	0.96	
		^{238}U	0.074	0.044	0.078	0.006	0.95	
		U BQ	0.16	0.01	0.16	0.01	0.97	
	µg/filter	U UG	6.8	0.9	6.4	0.5	1.06	

TABLE 9-4. (Cont.) ENVIRONMENTAL MEASUREMENTS LABORATORY (EML) QUALITY ASSESSMENT PROGRAM RESULTS FOR PARAGON ANALYTICS, INC. [1996]

			Paragon		EML[a]		Paragon/EML[b]	
Medium	Units	Radionuclide	Value	Error	Value	Error	Ratio	+/-
Soil	Bq/kg	^{40}K	373	40	300	25	1.24	
		^{60}Co	2.9	1.0	2.9	0.2	0.99	
		^{90}Sr	69	12	70	5	1.99	
		^{137}Cs	1890	121	1550	22	1.22	
		^{238}Pu	0.84	0.08	1.13	0.24	0.74	
		^{239}Pu	22.9	0.4	21.8	1.1	1.05	
		^{241}Am	14.2	2.1	13.5	0.5	1.05	
		^{234}U	24	4	39	2	0.62	
		^{238}U	25	4	42	1	0.95	
		U BQ	0.16	0.01	0.16	0.01	0.97	
	µg/g	U UG	6.8	0.9	6.4	0.5	1.06	
Vegetation	Bq/kg	^{40}K	1180	93	992	29	1.19	
		^{60}Co	11.5	2.4	10.9	0.7	1.05	
		^{90}Sr	1260	252	1390	12	0.91	
		^{137}Cs	237	16	190	7	1.25	
Water	Bq/L	Gross alpha	799	11	1210	121	0.66	
		Gross beta	208	8	540	54	0.39	
		^{3}H	216	33	587	58	0.37	
		^{54}Mn	63.5	4.3	60.5	0.6	1.05	
		^{60}Co	62.3	4.2	61.1	0.7	1.02	
		^{90}Sr	3.0	0.5	2.7	0.2	1.10	
		^{137}Cs	95	6	90	1	1.02	
		^{238}Pu	1.80	0.28	1.91	0.07	0.94	
		^{239}Pu	0.82	0.13	0.84	0.03	0.98	
		^{241}Am	0.88	0.28	1.08	0.04	0.82	
		^{234}U	0.55	0.09	0.48	0.04	1.15	
		^{238}U	0.55	0.09	0.48	0.37	1.15	
		U BQ	1.13	0.19	0.97	0.07	1.17	
	µg/mL	U UG	42	6	0.039	0.003	****	

[a] The EML value is the mean of replicate determinations for each radionuclide. The EML error is the standard error of the mean.
[b] The ratio error was not given in the December report.

TABLE 9-5. ENVIRONMENTAL MEASUREMENTS LABORATORY (EML) QUALITY ASSESSMENT PROGRAM RESULTS FOR QUANTERRA, INC. [1996]

Medium	Units	Radionuclide	Quanterra Value	Quanterra Error	EML[a] Value	EML[a] Error	Quanterra/EML[b] Ratio	Quanterra/EML[b] +/-
June Distribution								
Air	Bq/filter	Gross alpha	1.86	0.03	1.62	0.15	1.15	0.11
		Gross beta	2.99	0.07	1.77	0.15	1.69	0.15
		^{54}Mn	2.6	0.2	3.4	0.4	0.76	0.11
		^{57}Co	5.8	0.3	8.9	0.9	0.66	0.08
		^{60}Co	22.9	0.5	29.5	2.9	0.78	0.08
		^{90}Sr	1.06	0.06	1.06	0.04	1.00	0.07
		^{106}Ru	9.7	0.8	11.6	1.4	0.83	0.12
		^{125}Sb	8.24	0.3	9.8	1.0	0.83	0.09
		^{134}Cs	11.4	0.4	14.7	1.5	0.78	0.08
		^{137}Cs	5.1	0.2	6.6	0.7	0.76	0.08
		^{144}Ce	20.0	0.5	33.3	3.3	0.60	0.06
		^{238}Pu	0.091	0.006	0.096	0.002	0.95	0.07
		^{239}Pu	0.095	0.006	0.093	0.003	1.03	0.07
		^{241}Am	0.173	0.006	0.189	0.007	0.92	0.04
	µg/filter	U UG	4.7	0.6	4.3	0.1	1.09	0.15
Soil	Bq/kg	^{40}K	541	24	465	30	1.16	0.09
		^{90}Sr	1100	111	1340	113	0.82	0.11
		^{137}Cs	432	12	359	10	1.20	0.05
		^{238}Pu	31	4	43	3	0.72	0.10
		^{239}Pu	6.5	0.6	9.2	0.4	0.70	0.07
		^{241}Am	3.4	0.8	3.7	0.5	0.93	0.25
	µg/g	U UG	2.25	0.06	2.9	0.3	0.78	0.08
Vegetation	Bq/kg	^{40}K	1360	24	1030	33	1.32	0.05
		^{60}Co	73	1	60	1	1.22	0.03
		^{90}Sr	1550	19	1300	52	1.19	0.05
		^{137}Cs	1250	47	944	16	1.32	0.05
		^{239}Pu	9.0	0.6	9.8	1.2	0.92	0.13
		^{241}Am	6.2	0.2	5.6	0.2	1.10	0.05
		^{244}Cm	4.49	0.04	4.44	0.20	1.01	0.05
Water	Bq/L	Gross alpha	1680	217	1850	185	0.91	0.15
		Gross beta	886	109	744	74	1.19	0.19
		^{3}H	209	6	251	11	0.83	0.05
		^{54}Mn	47	5	38	1	1.21	0.14
		^{60}Co	37.0	3.0	32.8	0.6	1.13	0.09
		^{90}Sr	1.46	0.16	1.45	0.03	1.01	0.15
		^{137}Cs	46.2	4.1	38.3	0.9	1.21	0.11
		^{238}Pu	1.00	0.02	0.98	0.07	1.02	0.08
		^{239}Pu	0.95	0.14	0.77	0.06	1.22	0.20
		^{241}Am	0.84	0.09	0.77	0.01	1.10	0.12
	µg/mL	U UG	22.80	0.19	0.022	0.003	****	****
December Distribution								
Air	Bq/filter	Gross alpha	1.11	0.01	1.15	0.11	0.97	
		Gross beta	0.94	0.02	0.5	0.05	1.88	
		^{54}Mn	6.4	0.2	6.4	0.3	1.01	
		^{57}Co	13.7	0.7	14.8	0.8	0.93	
		^{60}Co	8.4	0.2	8.6	0.4	0.97	
		^{90}Sr	0.55	0.04	0.53	0.04	1.05	
		^{106}Ru	10.3	1.2	10.8	1.1	0.95	
		^{125}Sb	11.1	0.4	10.8	0.5	1.03	
		^{134}Cs	10.1	0.2	10.8	0.4	0.94	
		^{137}Cs	7.8	0.3	8.5	0.4	0.92	
		^{238}Pu	0.12	0.01	0.12	0.01	1.02	
		^{241}Am	0.20	0.02	0.22	0.02	0.90	
		^{234}U	0.096	0.012	0.080	0.006	1.20	
		^{238}U	0.068	0.004	0.078	0.006	0.87	
	µg/filter	U UG	8.3	0.11	6.4	0.5	1.30	
Soil	Bq/kg	^{40}K	372	39	300	25	1.24	
		^{60}Co	4.2	0.3	2.9	0.2	1.45	
		^{90}Sr	69	3	70	5	0.98	
		^{137}Cs	1990	70	1550	22	1.28	
		^{238}Pu	0.84	0.14	1.13	0.24	0.74	
		^{239}Pu	21	3	22	1	0.96	
		^{241}Am	14.5	0.9	13.5	0.5	1.07	
		^{244}Cm	0.26	0.06	0.31	0.06	0.83	
		^{234}U	40	3	39	2	1.01	
		^{238}U	37.3	3.3	41.6	0.6	0.90	
	µg/g	U UG	3.03	0.08	3.36	0.30	0.90	

TABLE 9-5. (Cont.) ENVIRONMENTAL MEASUREMENTS LABORATORY (EML) QUALITY ASSESSMENT PROGRAM RESULTS FOR QUANTERRA, INC. [1996]

			Quanterra		EML[a]		Quanterra/EML[b]	
Medium	Units	Radionuclide	Value	Error	Value	Error	Ratio	+/-
Vegetation	Bq/kg	^{40}K	1190	158	992	29	1.20	
		^{60}Co	13.5	1.8	10.9	0.7	1.24	
		^{90}Sr	1540	257	1390	12	1.11	
		^{137}Cs	245	8	190	7	1.29	
		^{239}Pu	2.7	1.4	2.0	0.3	1.38	
		^{241}Am	1.2	0.1	1.2	0.4	0.97	
		^{244}Cm	0.78	0.02	0.83	0.12	0.94	
Water	Bq/L	Gross alpha	843	56	1210	121	0.70	
		Gross beta	436	12	540	54	0.81	
		^{3}H	464	18	587	58	0.79	
		^{54}Mn	65.2	0.9	60.5	0.6	1.08	
		^{55}Fe	251	6	230	23	1.09	
		^{60}Co	65.8	2.0	61.1	0.7	1.08	
		^{90}Sr	3.00	0.06	2.71	0.24	1.11	
		^{137}Cs	96	2	90	1.4	1.07	
		^{238}Pu	1.97	0.10	1.91	0.07	1.03	
		^{239}Pu	0.88	0.04	0.84	0.03	1.05	
		^{241}Am	1.04	0.12	1.08	0.04	0.96	
		U UG	0.040	0.001	0.39	0.003	1.04	

[a] The EML value is the mean of replicate determinations for each radionuclide. The EML error is the standard error of the mean.
[b] The ratio error was not given in the December report.

EPA Intercomparison Studies Program

The EPA's Environmental Monitoring Systems Laboratory in Las Vegas, Nevada coordinates an intercomparison program for radionuclides in water. The laboratories used by contractors performing environmental monitoring at the INEEL participate in this program.

Dosimetry

To verify the quality of the environmental dosimetry program conducted by LMITCO, the Operational Dosimetry Unit has participated in 11 International Environmental Dosimeter Intercomparison Studies. The Operational Dosimetry Unit's results were within ±30% of the test exposure values on all intercomparisons. Quality control of the environmental dosimetry program is maintained through internal check measurements every month.

Blind Spikes

The Foundation purchases samples spiked with various radioactive nuclides from Analytics, Inc. and submits these spikes, disguised as samples, to the laboratories performing the Foundation's environmental analyses. The analytical results are expected to compare to the known value to within 20% or three standard deviations. Over 91% of the results met the specifications.

Other Programs

INEEL contractors participate in additional performance evaluation programs, including those administered by the International Atomic Energy Agency and the American Society for Testing and Materials. Where possible, contractors use laboratories that are certified by the State of Idaho or certified by another state whose certification is recognized by the State of Idaho.

9.3 DATA PRECISION AND VERIFICATION

Duplicate Sampling

As a measure of the quality of data collected, the Foundation, LMITCO, USGS and other contractors performing monitoring used a variety of quality control samples of different media.

Quality control samples include duplicate samples (separate samples taken at the same time), split samples (two portions of a sample that are analyzed separately), and spike samples (samples to which a known amount of a contaminant is added).

Both the Foundation and LMITCO maintained duplicate air samplers at two locations during 1996 (Table 9-6). The Foundation operated these samplers at Mud Lake and the INEEL Main Gate and the LMITCO samplers were at the Central Facilities Area (CFA) and Test Area North (TAN). Filters from these samplers were collected and analyzed in the same manner as filters from regular air samplers.

Duplicate Data Comparisons

Another measure of data quality can be made by comparing data collected simultaneously by different organizations. The Foundation, LMITCO, and the State of Idaho collected air monitoring data throughout 1996 in conjunction with the INEEL at three sampling locations, the distant location of Craters of the Moon and on the INEEL at the Experimental Field Station (EFS) and Van Buren Avenue. Data from these three sampling locations for gross alpha and gross beta are shown in Tables 9-7 and 9-8. The three organizations maintain slightly different collection and analysis schedules.

The Foundation also collects quarterly samples of drinking and surface water jointly with the State Oversight Program at five locations in the Magic Valley area. Table 9-9 contains results from analysis of 1996 samples from these locations. Also, the USGS collects ground-water samples simultaneously with the State of Idaho.

TABLE 9-6. COMPARISON OF DUPLICATE AIR MONITORING RESULTS (1996)

Environmental Science and Research Foundation Data

	Gross Alpha (10^{-15} µCi/mL)[a]				Gross Beta (10^{-15} µCi/mL)[a]			
	Mud Lake		Main Gate		Mud Lake		Main Gate	
Month	Sampler	Duplicate	Sampler	Duplicate	Sampler	Duplicate	Sampler	Duplicate
January	1.5 ± 1.3	1.3 ± 1.5	0.4 ± 0.8	0.8 ± 1.4	34 ± 28	31 ± 23	26 ± 28	24 ± 17
February	1.4 ± 1.4	1.2 ± 1.9	0.9 ± 0.6	0.8 ± 1.2	30 ± 21	30 ± 20	26 ± 13	25 ± 15
March	1.4 ± 1.1	1.3 ± 0.7	1.1 ± 0.7	0.7 ± 0.7	20 ± 8	18 ± 7	17 ± 8	16 ± 7
April	1.4 ± 1.6	1.1 ± 1.5	1.1 ± 1.5	0.8 ± 1.3	21 ± 13	19 ± 11	17 ± 11	16 ± 7
May	1.6 ± 1.1	1.7 ± 1.4	0.8 ± 1.4	0.9 ± 0.9	17 ± 9	20 ± 10	21 ± 9	19 ± 7
June	1.6 ± 0.6	1.8 ± 1.8	1.8 ± 0.4	1.2 ± 0.7	26 ± 9	28 ± 8	29 ± 5	23 ± 6
July	1.6 ± 0.7	1.3 ± 0.4	1.6 ± 1.1	0.9 ± 1.4	24 ± 2	28 ± 6	27 ± 5	23 ± 4
August	2.4 ± 0.8	2.7 ± 0.7	2.7 ± 1.2	2.4 ± 0.7	31 ± 14	32 ± 12	30 ± 5	26 ± 12
September	1.9 ± 2.4	2.3 ± 2.7	2.1 ± 2.2	2.1 ± 2.7	33 ± 16	30 ± 6	28 ± 8	25 ± 4
October	1.6 ± 0.8	2.2 ± 1.5	1.5 ± 1.2	1.3 ± 0.9	28 ± 10	23 ± 10	27 ± 9	28 ± 9
November	1.3 ± 1.3	1.5 ± 1.6	1.2 ± 0.9	1.8 ± 0.9	28 ± 25	24 ± 23	24 ± 22	24 ± 26
December	0.6 ± 1.0	1.0 ± 1.1	0.6 ± 0.8	0.3 ± 0.7	17 ± 20	20 ± 16	17 ± 13	18 ± 16
Annual	1.5 ± 0.2	1.6 ± 0.3	1.3 ± 0.3	1.1 ± 0.3	26 ± 3	25 ± 3	24 ± 3	22 ± 2

LMITCO Data

	Gross Alpha (10^{-15} µCi/mL)[a]				Gross Beta (10^{-15} µCi/mL)[a]			
	CFA		TAN		CFA		TAN	
Month	Sampler	Duplicate	Sampler	Duplicate	Sampler	Duplicate	Sampler	Duplicate
January	0.3 ± 0.9	0.0 ± 0.8	1.1 ± 1.0	0.8 ± 1.2	25 ± 20	24 ± 26	27 ± 21	30 ± 19
February	0.3 ± 1.2	0.1 ± 0.5	1.3 ± 0.9	1.1 ± 2.0	24 ± 17	19 ± 11	25 ± 13	27 ± 18
March	0.7 ± 1.9	0.3 ± 0.9	1.8 ± 2.6	0.3 ± 0.2	20 ± 8	15 ± 7	21 ± 7	19 ± 10
April	-0.5 ± 0.6	0.0 ± 0.5	-0.1 ± 1.3	0.5 ± 0.6	15 ± 8	13 ± 6	16 ± 10	15 ± 7
May	1.0 ± 0.5	0.9 ± 0.7	0.7 ± 1.1	0.5 ± 0.8	17 ± 7	14 ± 5	14 ± 7	15 ± 10
June	1.1 ± 0.2	0.7 ± 1.9	0.8 ± 1.0	0.6 ± 0.5	25 ± 2	20 ± 2	24 ± 6	18 ± 7
July	0.9 ± 1.6	1.5 ± 0.5	1.1 ± 0.6	1.9 ± 1.5	26 ± 6	22 ± 5	25 ± 6	23 ± 5
August	1.7 ± 0.8	0.7 ± 1.2	1.9 ± 0.7	1.0 ± 0.6	30 ± 16	22 ± 25	28 ± 11	23 ± 9
September	1.3 ± 1.9	1.1 ± 1.8	1.3 ± 1.7	1.5 ± 2.2	23 ± 5	23 ± 8	23 ± 4	21 ± 5
October	1.0 ± 1.1	1.4 ± 2.6	0.8 ± 1.4	1.2 ± 1.3	24 ± 9	23 ± 11	23 ± 11	21 ± 8
November	0.6 ± 1.7	0.7 ± 0.9	0.9 ± 0.8	1.2 ± 0.9	19 ± 17	27 ± 22	24 ± 20	21 ± 14
December	0.3 ± 0.2	-0.2 ± 0.3	0.5 ± 0.1	0.8 ± 0.8	17 ± 20	17 ± 22	17 ± 11	17 ± 13
Annual	0.8 ± 0.3	0.6 ± 0.3	1.0 ± 0.3	1.0 ± 0.2	22 ± 2	20 ± 3	22 ± 2	21 ± 2

[a] Monthly mean with the 95 %confidence interval of the mean.

TABLE 9-7. COMPARISON OF FOUNDATION (F), LMITCO (L) AND STATE OF IDAHO (S) AIR MONITORING RESULTS—GROSS ALPHA (1996)

Week Ending	Gross Alpha (10^{-15} µCi/mL)[a]								
	Craters of the Moon			EFS			Van Buren		
	F	L	S	F	L	S	F	L	S
1/5	0.8 ± 1.0	2.2 ± 1.6	1.3± 2.9	2.2 ± 1.3	1.6 ± 1.4	2.7 ± 3.9	3.3 ± 1.5	1.8 ± 2.0	2.8 ± 4.4
1/12	0.5 ± 1.0	-0.3 ± 1.4	0.6 ± 2.2	1.2 ± 1.0	0.2 ± 1.4	1.7 ± 3.0	0.6 ± 1.0	0.7 ± 1.8	1.8 ± 2.8
1/19	0.0 ± 0.8	0.4 ± 1.4	1.9 ± 2.4	0.7 ± 0.9	0.4 ± 1.2	1.5 ± 2.8	0.1 ± 0.8	-0.4 ± 1.6	2.0 ± 2.8
1/26	0.0 ± 0.8	0.0 ± 1.2	0.1 ± 1.5	-0.2 ± 0.6	0.7 ± 1.4	0.2 ± 2.0	0.7 ± 1.0	NS	0.7 ± 2.8
2/2	0.1 ± 0.8	0.1 ± 1.0	0.2 ± 1.9	0.0 ± 0.7	0.9 ± 1.2	1.5 ± 2.4	-0.4 ± 1.0	-0.9 ± 1.4	1.1 ± 3.2
2/9	1.5 ± 1.2	1.0 ± 1.2	0.8 ± 2.6	1.1 ± 1.1	1.3 ± 1.4	0.8 ± 3.1	1.0 ± 1.1	0.7 ± 1.8	1.4 ± 3.1
2/16	0.9 ± 1.0	-0.5 ± 1.2	1.1 ± 2.5	0.6 ± 0.9	0.5 ± 1.4	1.4 ± 2.9	0.5 ± 1.0	NS	0.8 ± 2.5
2/23	0.5 ± 1.7	0.6 ± 1.2	0.7 ± 2.2	1.7 ± 1.2	1.2 ± 1.4	NS	0.9 ± 1.1	1.3 ± 2.0	1.5 ± 2.7
3/1	0.4 ± 0.4	-0.6 ± 1.2	0.9 ± 1.9	0.4 ± 0.3	-0.6 ± 1.2	0.4 ± 2.2	0.3 ± 0.3	0.3 ± 1.8	0.7 ± 2.1
3/8	0.2 ± 0.3	0.4 ± 1.4	0.3 ± 1.9	0.5 ± 0.3	-0.2 ± 1.4	0.8 ± 2.3	0.5 ± 0.4	0.3 ± 2.0	1.0 ± 2.3
3/15	0.9 ± 0.4	-0.2 ± 1.2	1.4 ± 2.3	1.1 ± 0.4	0.4 ± 1.4	0.7 ± 2.7	0.6 ± 0.4	1.1 ± 2.0	0.6 ± 2.3
3/22	0.7 ± 0.7	1.0 ± 1.8	1.0 ± 2.3	0.7 ± 0.4	1.6 ± 1.4	0.6 ± 2.5	0.8 ± 0.4	1.6 ± 2.0	1.8 ± 2.3
3/29	1.2 ± 0.8	1.3 ± 2.6	0.9 ± 2.4	1.2 ± 0.7	1.7 ± 2.0	1.0 ± 2.7	1.5 ± 0.8	0.8 ± 2.4	0.7 ± 2.1
4/5	2.1 ± 0.7	-0.5 ± 1.8	1.2 ± 0.7	2.7 ± 0.7	0.6 ± 1.4	1.4 ± 0.7	2.8 ± 0.8	1.5 ± 2.2	1.6 ± 0.8
4/12	0.7 ± 0.7	1.3 ± 2.4	1.8 ± 1.4 [c]	0.7 ± 0.6	0.1 ± 1.6	2.0 ± 0.8	1.4 ± 0.8	-0.3 ± 2.2	1.3 ± 0.7
4/19	-0.2 ± 0.5	1.2 ± 2.0	0.3 ± 0.4	0.7 ± 0.6	0.3 ± 1.4	0.4 ± 0.5	0.2 ± 0.6	-0.3 ± 2.0	0.6 ± 0.5
4/26	0.4 ± 0.6	-1.6 ± 2.0	1.1 ± 0.7	0.1 ± 0.5	0.1 ± 1.6	1.0 ± 0.6	0.6 ± 0.6	-1.4 ± 2.0	0.9 ± 0.6
5/3	0.9 ± 0.7	2.4 ± 2.4	1.3 ± 0.7	1.2 ± 0.8	0.4 ± 1.6	1.7 ± 0.8	0.6 ± 0.7	1.5 ± 2.2	2.0 ± 0.8
5/10	2.5 ± 1.0	1.1 ± 2.4	1.5 ± 0.8	1.8 ± 0.9	2.1 ± 2.0	2.0 ± 0.8	1.8 ± 0.9	0.6 ± 2.2	2.5 ± 0.9
5/17	1.3 ± 0.8	1.7 ± 2.2	1.5 ± 0.7	1.2 ± 0.7	0.3 ± 1.4	1.4 ± 0.7	1.3 ± 0.8	0.0 ± 2.0	1.4 ± 0.7
5/24	1.0 ± 0.8	-0.1 ± 2.0	1.0 ± 0.6	0.4 ± 0.6	0.4 ± 1.2	1.1 ± 0.6	0.9 ± 0.7	2.0 ± 2.0	1.3 ± 0.7
5/31	1.1 ± 0.8	0.8 ± 1.8	1.4 ± 0.7	0.5 ± 0.6	0.8 ± 1.4	1.3 ± 0.7	0.2 ± 0.6	0.9 ± 2.0	1.4 ± 0.7
6/7	1.8 ± 0.9	1.5 ± 1.4	1.6 ± 0.7	1.6 ± 0.8	1.2 ± 1.2	1.1 ± 0.6	1.9 ± 0.9	1.9 ± 1.8	1.4 ± 0.7
6/14	1.2 ± 0.8	0.5 ± 1.2	1.9 ± 0.8	1.2 ± 0.8	1.4 ± 1.4	1.8 ± 0.8	1.7 ± 0.9	1.3 ± 1.8	1.4 ± 0.7
6/21	1.8 ± 0.9	0.6 ± 1.4	1.4 ± 0.7	1.5 ± 0.8	1.9 ± 1.6	1.3 ± 0.7	1.3 ± 0.8	1.7 ± 2.0	1.7 ± 0.7
6/28	1.1 ± 0.8	0.6 ± 1.4	1.1 ± 0.6	1.3 ± 0.8	1.0 ± 1.4	1.1 ± 0.6	1.3 ± 0.8	1.7 ± 2.2	1.4 ± 0.7
7/5	2.0 ± 0.9	1.6 ± 1.6	0.6 ± 0.6	1.7 ± 0.9	0.8 ± 1.6	1.3 ± 0.8	0.8 ± 0.7	-0.7 ± 1.8	0.8 ± 0.7
7/12	1.0 ± 1.0	1.5 ± 1.4	1.6 ± 0.7	2.7 ± 1.2	1.2 ± 1.6	2.6 ± 0.8	1.6 ± 1.1	2.1 ± 2.4	1.8 ± 0.7
7/19	1.2 ± 1.0	0.5 ± 1.2	1.3 ± 0.7	1.2 ± 0.9	1.5 ± 1.6	NS	1.3 ± 1.0	1.4 ± 1.8	1.3 ± 0.7
7/26	0.7 ± 0.8	0.8 ± 1.2	2.0 ± 0.8	0.7 ± 0.9	1.8 ± 1.6	2.3 ± 0.8	0.8 ± 0.9	1.0 ± 1.8	2.6 ± 0.9
8/2	1.1 ± 0.9	1.6 ± 1.4	2.0 ± 0.8	1.8 ± 0.9	1.2 ± 1.6	2.0 ± 0.8	1.0 ± 0.9	1.2 ± 1.8	2.4 ± 0.8
8/9	1.3 ± 0.7	1.3 ± 1.4	2.3 ± 0.9	1.9 ± 0.8	0.9 ± 1.6	2.1 ± 0.9	2.0 ± 0.8	1.6 ± 2.0	1.4 ± 0.7
8/16	1.6 ± 0.9	0.6 ± 1.4	2.7 ± 0.9	2.0 ± 1.1	2.9 ± 2.0	4.3 ± 2.3 [c]	2.7 ± 1.1	2.6 ± 2.2	3.1 ± 1.0
8/23	2.9 ± 1.1	1.9 ± 1.6	1.4 ± 0.7	3.3 ± 1.1	1.8 ± 2.0	3.4 ± 1.4	3.1 ± 1.2	2.7 ± 2.2	2.5 ± 0.9
8/30	3.7 ± 1.1	1.8 ± 1.4	2.9 ± 0.9	4.0 ± 1.1	1.2 ± 1.6	17.0 ± 8.1 [c]	3.6 ± 1.1	3.1 ± 2.0	2.2 ± 0.8
9/6	3.3 ± 1.1	1.0 ± 1.4	3.3 ± 1.0	3.2 ± 1.2	1.4 ± 2.4	3.7 ± 1.3	4.8 ± 1.3	4.1 ± 2.4	4.1 ± 1.1
9/13	2.9 ± 0.9	1.4 ± 1.4	0.8 ± 0.6	2.6 ± 0.9	1.0 ± 2.0	0.6 ± 1.1 [c]	2.6 ± 0.9	0.7 ± 1.8	0.4 ± 0.5
9/20	1.0 ± 0.6	0.1 ± 1.0	1.1 ± 0.6	1.2 ± 0.7	1.2 ± 2.0	0.7 ± 0.8	1.3 ± 0.8	1.5 ± 2.0	0.8 ± 0.6
9/27	0.9 ± 0.6	-0.2 ± 1.2	0.8 ± 0.6	1.0 ± 0.6	0.7 ± 2.0	1.2 ± 0.9	1.2 ± 0.7	0.2 ± 2.0	1.8 ± 0.8
10/4	1.7 ± 0.6	0.3 ± 1.2	2.9 ± 1.0	3.3 ± 0.8	1.3 ± 2.0	3.1 ± 1.5	2.8 ± 0.8	2.6 ± 2.2	3.1 ± 1.0
10/11	1.4 ± 0.8	1.4 ± 1.6	3.3 ± 1.1	3.2 ± 1.1	2.8 ± 2.0	2.1 ± 1.0	2.0 ± 1.0	3.2 ± 2.2	3.4 ± 1.1
10/18	1.4 ± 0.6	2.1 ± 1.8	2.4 ± 0.9	1.5 ± 0.7	0.0 ± 1.8	2.0 ± 1.0	1.9 ± 0.7	3.0 ± 2.2	1.8 ± 0.9
10/25	0.5 ± 0.7	1.0 ± 1.6	0.5 ± 0.7	0.2 ± 0.6	0.5 ± 2.0	0.8 ± 0.7	0.0 ± 0.5	-0.8 ± 1.8	1.1 ± 0.7
11/1	1.0 ± 0.5	NS	1.4 ± 0.8	1.0 ± 0.5	0.4 ± 1.8	2.7 ± 1.1	1.1 ± 0.5	-0.6 ± 1.6	2.9 ± 1.0
11/8	1.4 ± 0.8	0.0 ± 1.4	1.5 ± 0.8	1.1 ± 0.7	1.4 ± 2.0	2.8 ± 1.2	1.9 ± 0.8	0.2 ± 1.8	2.5 ± 1.0
11/15	2.2 ± 0.8	2.1 ± 1.6	1.1 ± 0.7	2.4 ± 0.9	2.9 ± 2.0	1.2 ± 0.9	2.3 ± 0.8	3.2 ± 2.2	1.1 ± 0.7
11/22	0.0 ± 0.4	0.4 ± 1.2	1.3 ± 0.8	0.3 ± 0.6	NS	0.7 ± 0.7	0.8 ± 0.6	NS	1.2 ± 0.7
11/29	0.2 ± 0.4	-0.2 ± 1.2	1.9 ± 1.0	0.6 ± 0.6	0.6 ± 1.6	2.8 ± 1.3	0.4 ± 0.5	0.5 ± 1.6	2.6 ± 1.1
12/6	0.7 ± 0.7	-0.7 ± 1.0	1.0 ± 0.6	0.6 ± 0.7	0.7 ± 1.8	0.3 ± 0.5	1.5 ± 0.7	0.5 ± 1.6	0.7 ± 0.6
12/13	0.5 ± 0.8	0.1 ± 1.0	2.3 ± 0.9	0.9 ± 0.8	1.4 ± 2.0	3.4 ± 1.1	0.7 ± 0.7	1.9 ± 2.0	0.8 ± 0.7
12/20	0.7 ± 0.7	1.1 ± 1.4	2.1 ± 0.9	0.2 ± 0.6	1.5 ± 1.8	2.7 ± 1.2	0.9 ± 0.7	0.9 ± 1.8	2.9 ± 1.0
12/27	1.2 ± 1.0	0.5 ± 1.8	1.3 ± 0.7	2.0 ± 1.6	-0.4 ± 2.0	2.0 ± 1.0	1.3 ± 0.9	2.9 ± 2.8	2.2 ± 0.9
1/3	0.3 ± 0.6	-0.2 ± 1.4	0.9 ± 0.7	0.8 ± 1.0	-0.1 ± 2.2	1.1 ± 0.8	0.3 ± 0.6	O.4 ± 1.2	NS

[a] Analytical result ± 2s, where s represents random analytical uncertainty.
[b] No sample collected.
[c] Low volume.

TABLE 9-8. COMPARISON OF FOUNDATION (F), LMITCO (L) AND STATE OF IDAHO (S) AIR MONITORING RESULTS—GROSS BETA (1996)

Week Ending	Gross Beta (10^{-15} µCi/mL)[a]								
	Craters of the Moon			EFS			Van Buren		
	F	L	S	F	L	S	F	L	S
1/5	48 ± 6	40 ± 4	37 ± 4	61 ± 6	47 ± 4	72 ± 6	66 ± 7	65 ± 6	91 ± 6
1/12	14 ± 5	17 ± 3	19 ± 3	33 ± 5	31 ± 4	40 ± 4	24 ± 5	26 ± 4	35 ± 4
1/19	23 ± 5	15 ± 3	25 ± 4	25 ± 5	27 ± 3	34 ± 4	28 ± 5	30 ± 4	34 ± 4
1/26	10 ± 5	7 ± 2	8 ± 2	10 ± 4	13 ± 3	16 ± 3	13 ± 5	NS[b]	13 ± 3
2/2	6 ± 4	9 ± 2	14 ± 3	11 ± 4	10 ± 2	25 ± 4	1 ± 6	7 ± 3	29 ± 5
2/9	33 ± 6	32 ± 3	29 ± 4	41 ± 6	38 ± 4	43 ± 5	37 ± 6	37 ± 4	44 ± 5
2/16	19 ± 5	18 ± 3	26 ± 4	21 ± 5	20 ± 3	38 ± 4	24 ± 5	NS	27 ± 4
2/23	48 ± 19	22 ± 3	21 ± 3	29 ± 5	32 ± 4	NS	33 ± 6	31 ± 4	32 ± 4
3/1	5 ± 5	13 ± 3	15 ± 3	8 ± 4	13 ± 3	20 ± 3	16 ± 5	14 ± 3	18 ± 3
3/8	11 ± 2	12 ± 3	14 ± 3	16 ± 2	19 ± 3	23 ± 3	17 ± 2	17 ± 4	24 ± 4
3/15	13 ± 3	11 ± 3	21 ± 3	15 ± 2	19 ± 3	31 ± 4	13 ± 2	11 ± 4	23 ± 3
3/22	13 ± 2	29 ± 4	22 ± 3	11 ± 2	19 ± 3	27 ± 4	14 ± 2	19 ± 4	23 ± 4
3/29	20 ± 4	24 ± 6	24 ± 4	23 ± 4	25 ± 4	30 ± 4	21 ± 4	14 ± 4	29 ± 4
4/5	15 ± 4	21 ± 4	14 ± 3	19 ± 4	18 ± 3	20 ± 3	18 ± 64	15 ± 4	22 ± 3
4/12	22 ± 5	20 ± 4	40 ± 7[c]	26 ± 4	23 ± 3	26 ± 4	24 ± 4	18 ± 4	26 ± 4
4/19	18 ± 4	14 ± 4	10 ± 3	16 ± 4	14 ± 3	19 ± 3	11 ± 4	10 ± 4	16 ± 3
4/26	11 ± 4	14 ± 4	12 ± 3	13 ± 4	11 ± 3	11 ± 3	10 ± 4	7 ± 3	12 ± 3
5/3	22 ± 5	18 ± 4	16 ± 3	19 ± 5	-1 ± 2	20 ± 3	16 ± 4	13 ± 4	18 ± 3
5/10	30 ± 5	33 ± 6	26 ± 4	31 ± 5	31 ± 4	31 ± 4	22 ± 5	24 ± 4	33 ± 4
5/17	20 ± 5	22 ± 4	20 ± 3	21 ± 4	14 ± 3	21 ± 3	18 ± 4	15 ± 4	25 ± 4
5/24	16 ± 5	12 ± 4	14 ± 3	14 ± 4	9 ± 3	16 ± 3	7 ± 4	9 ± 4	12 ± 3
5/31	17 ± 5	20 ± 4	19 ± 3	11 ± 4	15 ± 3	17 ± 3	9 ± 4	14 ± 3	14 ± 3
6/7	24 ± 5	18 ± 3	26 ± 4	27 ± 5	25 ± 3	28 ± 4	21 ± 5	19 ± 4	25 ± 4
6/14	27 ± 5	25 ± 3	27 ± 4	27 ± 5	30 ± 4	40 ± 4	23 ± 5	26 ± 4	28 ± 4
6/21	38 ± 5	23 ± 3	28 ± 4	24 ± 5	29 ± 4	32 ± 4	28 ± 5	23 ± 4	32 ± 4
6/28	26 ± 5	20 ± 3	16 ± 3	17 ± 4	18 ± 3	18 ± 3	21 ± 4	23 ± 4	20 ± 3
7/5	26 ± 5	21 ± 3	16 ± 3	23 ± 5	30 ± 4	28 ± 4	19 ± 5	20 ± 4	21 ± 4
7/12	31 ± 5	24 ± 3	28 ± 3	18 ± 5	32 ± 4	31 ± 4	22 ± 5	34 ± 6	32 ± 4
7/19	27 ± 5	22 ± 3	32 ± 4	27 ± 5	30 ± 4	NS	25 ± 5	24 ± 4	35 ± 4
7/26	26 ± 5	15 ± 3	22 ± 4	31 ± 5	25 ± 4	28 ± 4	17 ± 5	23 ± 4	26 ± 4
8/2	29 ± 5	22 ± 3	34 ± 4	33 ± 5	33 ± 4	41 ± 4	28 ± 5	27 ± 4	42 ± 4
8/9	21 ± 5	19 ± 3	20 ± 4	21 ± 5	23 ± 4	24 ± 4	19 ± 5	24 ± 4	23 ± 4
8/16	31 ± 3	31 ± 4	31 ± 4	35 ± 4	33 ± 4	41 ± 10[c]	31 ± 3	29 ± 4	36 ± 4
8/23	21 ± 3	18 ± 3	35 ± 4	34 ± 4	18 ± 4	43 ± 6	30 ± 4	27 ± 4	41 ± 4
8/30	28 ± 3	28 ± 4	37 ± 4	34 ± 3	28 ± 4	196 ± 35[c]	27 ± 3	27 ± 4	48 ± 5
9/6	22 ± 3	22 ± 4	32 ± 4	27 ± 4	32 ± 6	48 ± 6	28 ± 4	28 ± 4	38 ± 4
9/13	32 ± 3	23 ± 3	32 ± 4	32 ± 3	34 ± 6	32 ± 7[c]	32 ± 3	25 ± 4	17 ± 3
9/20	25 ± 3	18 ± 3	21 ± 3	27 ± 3	29 ± 4	33 ± 5	26 ± 3	25 ± 4	25 ± 4
9/27	25 ± 3	21 ± 3	24 ± 4	28 ± 3	25 ± 4	27 ± 5	23 ± 3	19 ± 4	28 ± 4
10/4	30 ± 3	29 ± 3	34 ± 4	31 ± 3	32 ± 4	40 ± 6	29 ± 3	32 ± 4	36 ± 4
10/11	31 ± 3	30 ± 4	34 ± 4	37 ± 4	31 ± 4	44 ± 5	34 ± 4	34 ± 6	17 ± 3
10/18	26 ± 3	28 ± 4	27 ± 4	32 ± 3	37 ± 6	29 ± 5	32 ± 3	31 ± 4	35 ± 4
10/25	17 ± 2	15 ± 3	16 ± 3	18 ± 2	12 ± 4	19 ± 3	17 ± 2	14 ± 4	16 ± 3
11/1	19 ± 2	NS	25 ± 4	26 ± 3	22 ± 4	24 ± 4	20 ± 2	15 ± 4	30 ± 4
11/8	39 ± 3	32 ± 4	34 ± 4	44 ± 4	45 ± 6	43 ± 5	47 ± 3	25 ± 4	43 ± 5
11/15	34 ± 3	26 ± 3	34 ± 4	48 ± 4	32 ± 4	49 ± 6	38 ± 3	27 ± 4	43 ± 4
11/22	11 ± 2	12 ± 3	10 ± 3	17 ± 2	NS	13 ± 3	14 ± 2	NS	11 ± 3
11/29	11 ± 2	12 ± 3	25 ± 4	16 ± 3	13 ± 4	33 ± 5	13 ± 2	13 ± 4	21 ± 4
12/6	12 ± 1	12 ± 2	11 ± 3	19 ± 2	14 ± 3	16 ± 3	16 ± 2	13 ± 3	13 ± 3
12/13	20 ± 2	9 ± 2	22 ± 4	26 ± 2	20 ± 4	33 ± 4	21 ± 2	15 ± 4	27 ± 4
12/20	11 ± 2	11 ± 3	24 ± 4	13 ± 2	11 ± 3	30 ± 5	11 ± 2	6 ± 3	22 ± 4
12/27	24 ± 2	28 ± 4	25 ± 4	62 ± 5	41 ± 6	36 ± 5	36 ± 3	20 ± 4	33 ± 4
1/3	4 ± 1	3 ± 3	7 ± 2	9 ± 2	9 ± 4	11 ± 3	9 ± 1	4 ± 2	NS

[a] Analytical result ± 2s, where s represents random analytical uncertainty.
[b] No sample collected.
[c] Low volume.

TABLE 9-9. COMPARISON OF FOUNDATION AND STATE OF IDAHO WATER MONITORING RESULTS (1996)

Location	Date	Gross Alpha (10^{-9} µCi/mL)[a]		Gross Beta (10^{-9} µCi/mL)[a]		Tritium (10^{-9} µCi/mL)[a]	
		Foundation	State	Foundation	State	Foundation	State
Minidoka (Drinking Water)	02/96	-1 ± 1	3 ± 5	2 ± 1	6 ± 2	-80 ± 100	0 ± 90
	05/96	0 ± 40[b]	-2 ± 3	8 ± 3	0 ± 2	80 ± 100	0 ± 100
	08/96	0 ± 1	-1 ± 3	6 ± 2	3 ± 2	-180 ± 110	0 ± 90
	11/96	0 ± 1	3 ± 3	4 ± 2	3 ± 2	80 ± 90	120 ± 90
Shoshone (Drinking Water)	02/96	-1 ± 1	0 ± 6	2 ± 2	6 ± 2	-30 ± 100	0 ± 90
	05/96	-2 ± 4	-2 ± 3	2 ± 2	5 ± 2	40 ± 100	-100 ± 90
	08/96	0 ± 1	1 ± 3	4 ± 2	2 ± 2	50 ± 110	0 ± 90
	11/96	0 ± 1	0 ± 3	3 ± 2	6 ± 3	60 ± 90	50 ± 100
Bill Jones Hatchery (Surface Water)	02/96	0 ± 1	0 ± 4	1 ± 1	4 ± 2	-110 ± 100	0 ± 90
	05/96	2 ± 4	-1 ± 3	2 ± 2	4 ± 2	50 ± 100	0 ± 100
	08/96	0 ± 1	1 ± 3	4 ± 2	3 ± 2	-160 ± 110	0 ± 90
	11/96	-1 ± 1	0 ± 3	4 ± 2	15 ± 3	20 ± 90	80 ± 90
Clear Springs (Surface Water)	02/96	0 ± 1	2 ± 6	1 ± 1	3 ± 2	-100 ± 100	0 ± 90
	05/96	1 ± 4	0 ± 4	2 ± 2	3 ± 2	40 ± 100	0 ± 100
	08/96	-1 ± 1	0 ± 3	4 ± 2	3 ± 2	-190 ± 110	0 ± 90
	11/96	0 ± 1	3 ± 3	4 ± 2	7 ± 3	10 ± 90	50 ± 90
Alpheus Spring (Surface Water)	02/96	0 ± 1	4 ± 6	2 ± 1	7 ± 2	20 ± 100	100 ± 90
	05/96	0 ± 5	2 ± 6	6 ± 3	9 ± 3	20 ± 100	100 ± 90
	08/96	0 ± 1	0 ± 3	6 ± 2	6 ± 3	-40 ± 110	0 ± 90
	11/96	-1 ± 1	-2 ± 3	4 ± 2	9 ± 3	40 ± 90	120 ± 90

[a] Result ± 2s, where s is the random analytical uncertainty.
[b] Large uncertainty due to high sample turbidity.

APPENDIX A
ENVIRONMENTAL STANDARDS AND REGULATIONS

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

U.S. Environmental Protection Agency, "National Primary and Secondary Ambient Air Quality Standards," 40 CFR 50, 1996.

U.S. Environmental Protection Agency, "National Emission Standards for Hazardous Air Pollutants," 40 CFR 61, 1996.

U.S. Environmental Protection Agency, "National Pollutant Discharge Elimination System," 40 CFR 122, 1996.

U.S. Environmental Protection Agency, "National Interim Primary Drinking Water Regulations," 40 CFR 141, 1996.

U.S. Environmental Protection Agency, "Hazardous Waste Management System: General," 40 CFR 260, 1996.

U.S. Environmental Protection Agency, "Identifying and Listing of Hazardous Wastes," 40 CFR 261, 1996.

U.S. Environmental Protection Agency, "Standards Applicable to Generators of Hazardous Waste," 40 CFR 262, 1996.

U.S. Environmental Protection Agency, "Standards Applicable to Transporters of Hazardous Waste," 40 CFR 263, 1996.

U.S. Environmental Protection Agency, "Standards for Owners and Operators of Hazardous Waste Treatment, Storage and Disposal Facilities," 40 CFR 264, 1996.

U.S. Environmental Protection Agency, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage and Disposal Facilities," 40 CFR 265, 1996.

U.S. Environmental Protection Agency, "Interim Standards for Owners and Operators of New Hazardous Waste Land Disposal Facilities," 40 CFR 267, 1996.

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," 16.01.8000-16.01.8999, October 1993.

The Derived Concentration Guides (DCGs) are based on the DOE standard [Reference A-1] and have been calculated using DOE models and parameters for internal [Reference A-2] and external [Reference A-3] exposure. These are shown in Table A-1. 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 INEEL are those of DOE Order 5400.5, entitled "Radiation Protection of the Public and the Environment." The DOE standard is shown in Table A-2 along with the EPA standard for protection of the public, airborne pathway only.

Ambient air quality standards are shown in Table A-3. Water quality standards are dependent on the type of drinking water system sampled. Table A-4 is a partial list of maximum contaminant levels set by the EPA for public community drinking water systems in 40 CFR 141.

TABLE A-1. DERIVED CONCENTRATION GUIDES FOR RADIATION PROTECTION

Derived Concentration Guide[a] (μCi/mL)			Derived Concentration Guide[a] (μCi/mL)		
Radionuclide	In Air	In Water	Radionuclide	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 concentration 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 A-2. 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 A-3. EPA 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 A-4. EPA 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 mg/L
Fluoride	4 mg/L
Trihalomethanes (Chloroform)	0.1 mg/L
Carbon Tetrachloride	0.005 mg/L
Tetrachloroethylene	0.005 mg/L
Toluene	1.0 mg/L
1,1,1-trichloroethane	0.2 mg/L
Trichloroethylene	0.005 mg/L
Arsenic	0.05 mg/L
Barium	2 mg/L
Cadmium	0.005 mg/L
Chromium	0.1 mg/L
Lead	0.05 mg/L
Mercury	0.002 mg/L
Selenium	0.05 mg/L
Silver	0.05 mg/L

APPENDIX B
STATISTICAL METHODS USED FOR THE ENVIRONMENTAL SURVEILLANCE PROGRAM

Relatively simple statistical procedures are used to analyze the data from the INEL 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 INEEL operations, meteorological data, and worldwide events that might conceivably have an effect on the INEEL 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 spectro-metric 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 INEEL 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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