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IDAHO NATIONAL ENGINEERING AND ENVIRONMENTAL LABORATORY SITE ENVIRONMENTAL REPORT CALENDAR YEAR 2001

ENVIRONMENTAL SURVEILLANCE, EDUCATION AND RESEARCH PROGRAM

U.S. DEPARTMENT OF ENERGY IDAHO OPERATIONS OFFICE

DECEMBER 2002

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1780 First Street
Idaho Falls, ID 83401

Idaho National Engineering and Environmental Laboratory's Environmental Policy

It is the policy of the Department of Energy to conduct research, environmental remediation, and operations at the INEEL in a manner that protects human health and the environment and is in full compliance with environmental laws and regulations.

We achieve this by integrating environmental requirements and pollution prevention into our work planning and execution and by taking actions to minimize the environmental impacts of our operations. Through employee involvement and management commitment to environmental excellence, we will:

- Protect the unique natural, biological, and cultural resources of the INEEL.
- Conduct operations and manage hazardous and radioactive materials and wastes in a safe, compliant, and cost-effective manner. We do this by establishing and communicating environmental responsibilities, by providing environmental training to our workforce, and by implementing controls to mitigate environmental hazards.
- Conduct environmental remediation to address contamination from legacy activities and minimize impacts on human health and the environment.
- Develop and deploy new and enhanced environmental technologies and share this expertise with other DOE sites, the local community, and external customers.
- Integrate pollution prevention into project planning, design, and construction to minimize toxicity and volume of waste generated, conserve natural resources and energy, and minimize environmental impacts.
- Conserve natural resources by reusing and recycling materials, purchasing recycled materials, and using recyclable materials.
- Promptly identify noncompliant conditions and encourage full disclosure and open discussion regarding compliance issues. Aggressively work to resolve identified issues.
- Establish documented environmental objectives and milestones, and update them as necessary to reflect the changing needs, missions, and goals of the INEEL.
- Consider the input of our stakeholders when weighing options.
- Measure our environmental performance and monitor our impact on the environment, and communicate the results to our employees and stakeholders.
- Continuously improve our environmental management system through self-assessment and corrective action.

This policy applies to all business units and all employees. Every employee and subcontractor is expected to follow this policy and to report environmental concerns to management. Managers shall promote environmental stewardship, take prompt action to address concerns and issues, and have zero tolerance for noncompliance.

INEEL
Idaho National Engineering and Environmental Laboratory
BECHTEL BWXT IDAHO, LLC

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[a] Brennon Orr is currently with North Wind Environmental.

PREFACE

Every person in the world is exposed to ionizing radiation, which has sufficient energy to remove electrons from atoms, damage chromosomes, and cause cancer. There are three general sources of ionizing radiation: 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 general source 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 altitude at which the person resides. When such exposures are substantially higher than the average, they are considered to be elevated.

The second general source includes a variety of natural sources from which the radiation has been increased by human actions. For example, radon is a radioactive gas, which comes from the natural decay of uranium and is found in nearly all soils. Concentrations of radon inside buildings may be elevated due to the type of soil and rock upon which they are built and may be enhanced by cracks and other holes in the foundation. Another example is the increased exposure to cosmic radiation that airplane passengers receive when traveling at high altitudes.

The third source includes a variety of exposures from human-made 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 episodic events caused by human 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 in the nuclear industry generally are very small compared to exposures from natural sources [Reference P-1].

To verify that exposures resulting from operations at U.S. Department of Energy (DOE) nuclear facilities remain very small, each site where nuclear activities are conducted operates an environmental surveillance program to monitor the air, water, and other pathways whereby radionuclides from operations might conceivably reach workers and members of the public. Environmental surveillance and monitoring results are reported annually to DOE Headquarters.

This report presents a compilation of data collected in 2001 for the environmental surveillance programs conducted on and around the Idaho National Engineering and Environmental Laboratory (INEEL). During 2001, the Environmental Surveillance, Education and Research (ESER) Program was performed by a team led by the S. M. Stoller Corporation. This team collected 2001 data and prepared this report. During 2001, the INEEL was operated by Bechtel BWXT Idaho, LLC (BBWI). This report refers to BBWI as the Management and Operating (M&O) contractor. The M&O organization responsible for operating each facility conducted effluent and facility monitoring. The U.S. Geological Survey performed groundwater monitoring both onsite and offsite. The M&O contractor also conducted some onsite groundwater monitoring. The National Oceanic and Atmospheric Administration collected meteorological data.

Separate monitoring programs were maintained by Argonne National Laboratory-West and the Naval Reactors Facility (NRF). Both programs collect much the same data as the M&O and ESER

contractors, but the data are specific to these two facilities. The INEEL Oversight Program, under the Idaho Department of Environmental Quality, also continued to maintain independent sample locations and analysis capabilities both on and around the INEEL in 2001.

This report, prepared in accordance with the requirements in DOE Order 5400.1, is not intended to cover the numerous special environmental research programs conducted at the INEEL [Reference P-2]. Facilities operated under the Naval Nuclear Propulsion Program, like the NRF, are exempt from the provisions for preparing an annual site environmental report. The Naval Nuclear Propulsion Program maintains a separate environmental protection program to ensure 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, data from onsite monitoring programs at NRF are referenced in this report.

EXECUTIVE SUMMARY

Each year the U.S. Department of Energy (DOE) publishes the Idaho National Engineering and Environmental Laboratory (INEEL) site environmental report to summarize environmental data, information, and highlight major environmental programs and efforts. The results of the monitoring programs for 2001 presented in this report indicate that radioactivity from current INEEL operations could not be distinguished from worldwide fallout and natural radioactivity in the region surrounding the INEEL. Radioactive material concentrations in the offsite environment were below state of Idaho and federal health protection guidelines. Potential doses to the maximally exposed individual and to the surrounding population were estimated to be well below the applicable regulatory limit and far less than doses resulting from background radiation.

Organization of the Report

Individual chapters of the report are designed to:

- Provide an overview of the INEEL site, mission, and history (*Chapter 1*);
- Summarize the status of INEEL compliance with environmental regulations (*Chapter 2*);
- Describe major activities and milestones in environmental restoration, waste management, and other environmental programs and review INEEL environmental surveillance programs (*Chapter 3*);
- Present and evaluate environmental monitoring results of airborne constituents (*Chapter 4*);
- Present and evaluate environmental monitoring results of waterborne constituents (*Chapter 5*);
- Present and evaluate environmental monitoring results of constituents in other media (*Chapter 6*);
- Discuss the potential radiation dose to the public from INEEL activities during calendar year 2001 (*Chapter 7*); and
- Discuss programs used to ensure environmental data quality (*Chapter 8*).

Compliance with Environmental Regulations in 2001

Table ES-1 presents a brief summary of the INEEL's status of compliance with federal acts in 2001. Chapter 2 provides a detailed discussion of the INEEL's compliance with environmental regulations.

Table ES-1. Compliance with federal acts in 2001.

Act	What it Addresses	2001 Activities
Comprehensive Environmental Response, Compensation, and Liability Act	This act provides specific procedures to assess and remediate areas where the release or potential of a release of hazardous substances has occurred.	Work on these sites was in compliance with CERCLA requirements and met all enforceable cleanup milestones scheduled in the Federal Facility Agreement and Consent Order signed in 1991 by DOE, state of Idaho, and U.S. Environmental Protection Agency (EPA).
Resource Conservation and Recovery Act	This act establishes regulatory standards for the generation, transportation, storage, treatment, and disposal of hazardous waste.	In August 2000, DOE received a Notice of Violation (NOV) from the Idaho Department of Environmental Quality (DEQ). A Consent Order to resolve this NOV was signed in January 2001. The EPA and Idaho DEQ issued a second NOV in 2001. A Consent Order to resolve this NOV was signed in December 2001.
Federal Facility Compliance Act	This act requires the preparation of site treatment plans for the management of mixed wastes stored or generated at DOE facilities.	The Annual Site Treatment Plan report was submitted to and consequently approved by the state of Idaho.
Clean Air Act	This act sets the standards for ambient air quality and for emission of hazardous air pollutants.	Compliance with the Idaho air quality program was primarily administered through the permitting process. The 2001 National Emission Standards for Hazardous Air Pollutants report documented a maximum annual individual dose to a member of the public from INEEL releases of 0.035 mrem/yr, well below the regulatory limit of 10 mrem/yr.
Clean Water Act	This act establishes goals to control pollutants discharged to surface waters of the U.S.	All discharges were within permit limits in 2001. The annual Spill Prevention, Control, and Countermeasures Plan evaluation identified deficiencies in the existing plans. Updates are due for completion in 2002.
Safe Drinking Water Act	This act establishes primary and secondary standards for drinking water systems.	All drinking water systems were in compliance with drinking water standards.
Toxic Substances Control Act	This act regulates industrial chemicals currently produced or imported into the U.S.	Compliance is directed through management of polychlorinated biphenyls (PCBs). Currently, radioactively contaminated PCBs are stored at the INEEL.
National Environmental Policy Act	This act requires federal agencies to consider and evaluate potential environmental impacts as a result of federal activities and requires the study of alternatives to mitigate those impacts.	Incorporation of public and agency comments received by DOE on the draft Idaho High-Level Waste and Facilities Disposition Environmental Impact Statement (EIS) continued throughout 2001. The final EIS should be complete in 2002. Preparation of an Environmental Assessment (EA) to evaluate wildfire planning, response, and post-fire restoration was initiated in 2001. A draft EA will be available in 2002. An EA for the deactivation, decommissioning, and dismantlement of the CPP-603 basins was issued for public comment in 2001. Additional data collection has postponed the issuance of the final EA until 2002.

Table ES-1. Compliance with federal acts in 2001 [Continued].

Regulation	What it Addresses	2001 Status
Endangered Species Act	The purposes of this act are to protect threatened and endangered species and to provide a means to conserve their ecosystems. All federal agencies are to protect species and preserve their habitats.	INEEL activities complied with the requirements of this act. No threatened or endangered species were documented at the INEEL in 2001.
Emergency Planning and Community Right-to-Know Act	This act provides the public with information about hazardous chemicals and establishes emergency planning and notification procedures to protect the public from chemical releases.	The EPCRA Section 311, 312, and 313 Reports were issued as required in 2001.

Radiological Environmental Monitoring Results

The Environmental Surveillance, Education and Research (ESER) Program contractor and the Management and Operating (M&O) contractor for the DOE Idaho Operations Office conducted radiological environmental surveillance programs in 2001. As part of the ESER and M&O contractor programs, samples of air, water, agricultural products, and animal tissue were collected at distant, INEEL boundary, and onsite locations. Environmental radiation measurements were also taken at these locations. Table ES-2 summarizes the environmental monitoring and surveillance results.

Table ES-2. INEEL radiological environmental monitoring results for 2001.

Media	Sample Type	Analysis	Results
Air	Charcoal cartridge	Radioiodine	Iodine-131 (^{131}I) was detected in one sample well below DOE's Derived Concentration Guide (DCG) for radiation protection.
	Particulate filter	Gross alpha and gross beta activity, gamma-emitting radionuclides, strontium-90 (^{90}Sr), and specific actinides.	In general, gross alpha and gross beta activities showed levels and seasonal variations not attributable to INEEL releases. Fifteen of 300 gross beta results showed statistical difference. In all cases, the offsite result was higher than the corresponding onsite value indicating that the differences were attributed to natural variation. All measurements of specific radionuclides were well below the DOE DCG for radiation protection.
	Atmospheric moisture	Tritium	Tritium was detected in 30 of 44 ESER contractor samples. Measurements were well below the DCG and within background concentrations.
	Precipitation	Tritium	Tritium was detected in 24 of 38 samples. Measurements were well below the DCG and within background concentrations.
Water	Surface water	Gross alpha and gross beta activity and tritium	All measured gross alpha activities were below the EPA Maximum Contaminant Level (MCL). The gross beta measurements were within background levels. Tritium was detected in 5 of 14 samples. The highest level measured was below the EPA MCL.
	Drinking water	Gross alpha and gross beta activity and tritium	All measured gross alpha activities were below the EPA MCL. The gross beta measurements were below the EPA screening level and within background levels. Tritium was detected in 11 of 28 drinking water samples well below the EPA MCL.

Table ES-2. INEEL radiological environmental monitoring results for 2001 [Continued].

Media	Sample Type	Analysis	Results
Agricultural products	Milk, lettuce, wheat, potatoes, and sheep	^{90}Sr, Iodine-131, and Gamma-emitting radionuclides	Cesium-137 and ^{90}Sr were detected in samples at levels consistent with fallout. Iodine-131 was detected in six milk samples at levels below the DCG.
Game animals	Ducks, mule deer, elk, and pronghorn	Iodine-131, ^{90}Sr, Gamma-emitting radionuclides, and specific actinides.	Cesium-137 was detected in muscle samples of mule deer, elk, and pronghorn at levels consistent with fallout. Anthropogenic (human-made) radionuclides were detected in at least one muscle tissue in 7 of 14 ducks collected from INEEL wastewater ponds. The potential dose from consumption of ducks with the highest concentrations was calculated to be 0.08 mrem (0.02% of 355 mrem from background sources).
Soil	Soil composite samples and surface surveys.	Gamma-emitting radionuclides, ^{90}Sr, and the same actinides analyzed in particulate filters	Offsite soil samples are collected every other year, or on even numbered years. Offsite soils were not collected in 2001. Onsite soil samples were collected and soil surface surveys were performed.
Radiation exposure	Thermoluminescent dosimeters	Gamma radiation	Exposures at boundary and distant locations using environmental dosimeters were similar and showed levels consistent with previous years and background.

Nonradiological Environmental Monitoring Results

As in most previous years, particulate concentrations in the air were generally higher at distant and boundary locations than at onsite locations. Agricultural activities are a major source of suspended particulates in eastern Idaho. The differences in particulate concentrations are probably due to the limited soil disturbance on the INEEL. Concentrations of fine particulates (particulate matter less than 2.5 microns), nitrogen dioxide, and sulfur dioxide measured on the INEEL were all well within air quality standards. During 2001, only two potential storm water discharges from INEEL facilities needed to be sampled, both at the Radioactive Waste Management Complex (RWMC).

Groundwater Monitoring Results

The U.S. Geological Survey uses over 125 wells that tap the Snake River Plain Aquifer to monitor groundwater at the INEEL. Results from a number of special studies of the properties of the aquifer and the water within it were published during 2001. Several purgeable organic compounds continue to be found in monitoring wells, including drinking water wells at the INEEL. Concentrations of organic compounds were below the EPA MCLs for these compounds except for two wells at the RWMC where concentrations of carbon tetrachloride slightly exceeded the MCL during certain months. (Throughout this report, measured concentrations of contaminants in groundwater and surface water are compared to the EPA drinking water standards as benchmarks. Concentrations at or below the MCLs are presumed to be safe for human consumption.)

Contractors operating facilities at the INEEL also conducted routine monitoring of groundwater. Elevated levels of tritium and ^{90}Sr continue to be measured in the groundwater under the INEEL. Neither of these radionuclides has been detected off the INEEL since the mid-1980s. A maximum effective dose equivalent of 0.5 millirem per year (mrem/yr) (0.005 millisievert per year [mSv/yr]), 8 times less than the 4 mrem/yr EPA standard for public drinking water systems, was

calculated for workers at the Central Facilities Area on the INEEL in 2001. Monitoring indicated this location had the highest tritium concentration in drinking water.

Trichloroethylene concentrations in four water samples from the Test Area North drinking water wells during 2001 remained below the MCL.

Airborne Effluent Monitoring Results

An estimated total of 16,833 curies (1.68×10^{13} becquerel) of radioactivity, primarily in the form of short-lived noble gas isotopes, was released as airborne effluents. Nonradiological pollutants, including nitrogen dioxide and particulates, were monitored in airborne effluents at INEEL facilities. Monitoring results of liquid effluent streams indicated that all were below applicable guidelines.

Potential Radiological Doses from INEEL Operations in 2001.

Potential radiological doses to the public from INEEL operations were evaluated to determine compliance with pertinent regulations and limits. Two different computer models were used to estimate doses: CAP-88 and the mesoscale diffusion (MDIFF) air dispersion model. CAP-88 is required by EPA to demonstrate compliance with the Clean Air Act. The National Oceanic and Atmospheric Administration Air Resources Laboratory–Field Research Division developed MDIFF to evaluate dispersion of pollutants from the INEEL. The maximum calculated dose to an individual by either of the methods was well below the applicable radiation protection standard of 10 mrem/yr. The maximum potential population dose to the approximately 229,920 people residing within an 80-kilometer (km) (50-mile [mi]) radius of any INEEL facility was estimated using MDIFF to be well below that expected from exposure to background radiation. Table ES-3 summarizes the dose estimates.

Table ES-3. Summary of annual effective dose equivalents due to INEEL operations (2001).

	Maximum Dose to an Individual[a]		Population Dose
	CAP-88[b]	MDIFF[c]	MDIFF[c]
Dose	0.035 mrem 3.5×10^{-4} mSv	0.074 mrem 7.4×10^{-4} mSv	0.59 person-rem 5.9×10^{-3} person-Sv
Location	Frenchman's Cabin	8.7 km (~5.5 mi) northwest of Mud Lake, Idaho	Area within 80 km (50 mi) of any INEEL facility
Applicable radiation protection standard[d]	10 mrem (0.1 mSv)	10 mrem (0.1 mSv)	No applicable standard
Percentage of standard	0.35 %	0.74%	-
Natural background	355 mrem (3.6 mSv)	355 mrem (3.6 mSv)	43,600 person-rem (436 person-Sv)
Percentage of background	0.01 %	0.02 %	0.001 %

a. Hypothetical dose to a maximally exposed individual residing near the INEEL.
b. Effective dose equivalent calculated using the CAP-88 code.
c. Effective dose equivalent calculated using the MDIFF air dispersion model.
d. Although the DOE standard for all exposure modes is 100 mrem/yr 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/yr.

HELPFUL INFORMATION

Scientific Notation

Scientific notation is used to express numbers that are very small or very large. A very small number is 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 (6, in this case). 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 can be written as 1.0×10^{6}.

Unit Prefixes

Units for very small and very large numbers are often expressed with a prefix. One common example is the prefix kilo (abbreviated k), which means 1,000 of a given unit. One kilometer is, therefore, equal to 1,000 meters. Other prefixes used in this report are listed in the box below.

Unit Prefixes Used in This Report.

Prefix	Abbreviation	Meaning
mega-	M	1,000,000 (1×10^{6})
kilo-	k	1,000 (1×10^{3})
centi-	c	1/100 (1×10^{-2})
milli-	m	1/1,000 (1×10^{-3})
micro-	µ	1/1,000,000 (1×10^{-6})
nano-	n	1/1,000,000,000 (1×10^{-9})
pico-	p	1/1,000,000,000,000 (1×10^{-12})

Units of Radioactivity, Radiation Exposure, and Dose

The basic unit of radioactivity used in this report is the curie (abbreviated Ci). The curie is historically based on the number of disintegrations that occur in 1 gram of the radionuclide radium-226, which is 37 billion nuclear disintegrations per second. For any other radionuclide, 1 Ci 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.

The concentration of radioactivity in air samples is expressed in units of microcuries per milliliter (µCi/mL) of air. For liquid samples, such as water and milk, the units are in picocuries per liter (pCi/L). Radioactivity in agricultural products is expressed in nanocuries per gram (nCi/g) dry weight. 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 1 nuclear disintegration per second. The number of curies must be multiplied by 3.7×10^{10} to obtain the equivalent number of becquerels. Radiation dose may also be expressed using the Système International unit sievert (Sv), where 1 Sv equals 100 rem.

Uncertainty of Measurements

There is always an uncertainty associated with the measurement of environmental contaminants. For radioactivity, a major source of uncertainty is 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 results with a "±" (uncertainty) term. This report follows convention in reporting the uncertainty as a 95 percent confidence limit (or interval). That means there is 95 percent 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 in radiation measurements when the measured result is less than a preestablished average background level for the particular counting system and procedure used. These values are reported as negative, rather than as "not detected" or "zero," 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 below.

Radionuclide	Symbol
Americium-241	^{241}Am
Antimony-125	^{125}Sb
Argon-41	^{41}Ar
Barium-137	^{137}Ba
Carbon-14	^{14}C
Cesium-137	^{137}Cs
Cobalt-60	^{60}Co
Europium-152	^{152}Eu
Europium-154	^{154}Eu
Gallium-67	^{67}Ga
Iodine-129	^{129}I
Iodine-131	^{131}I
Krypton-85	^{85}Kr
Krypton-85m	^{85m}Kr
Niobium-95	^{95}Nb
Plutonium-238	^{238}Pu
Plutonium-239	^{239}Pu
Plutonium-239/240	$^{239/240}$Pu
Plutonium-240	^{240}Pu
Plutonium-241	^{241}Pu
Potassium-40	^{40}K
Radium-226	^{226}Ra
Radium-228	^{228}Ra
Strontium-90	^{90}Sr
Tellurium-125m	^{125m}Te
Thorium-232	^{232}Th
Tritium	^{3}H
Uranium-234	^{234}U
Uranium-238	^{238}U
Xenon-133	^{133}Xe
Xenon-135	^{135}Xe
Yttrium-90	^{90}Y
Zinc-65	^{65}Zn

The letter 'm' after a number denotes a metastable (transitional isotope normally with very short half-lives) isotope.

ACRONYMS

AAO	Argonne Area Office (DOE-CH)
AEC	Atomic Energy Commission
ANL-W	Argonne National Laboratory-West
ARA	Auxiliary Reactor Area
ATSDR	Agency for Toxic Substances and Disease Registry
BBI	Bechtel Bettis, Inc.
BBWI	Bechtel BWXT Idaho, LLC
BNFL	British Nuclear Fuels Limited
BOD	Biological Oxygen Demand
BORAX	Boiling Water Reactor Experiment
CAA	Clean Air Act
CEDE	Collective Effective Dose Equivalent
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CDC	Centers for Disease Control and Prevention
CERT	Controlled Environmental Radioiodine Test
CFA	Central Facilities Area
CFR	Code of Federal Regulations
CMS	Community Monitoring Station
COD	Chemical Oxygen Demand
CWA	Clean Water Act
D&D	Decontamination and Decommissioning
DCG	Derived Concentration Guide
DEQ	(Idaho) Department 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
EA	Environmental Assessment
EAL	Environmental Assessment Laboratory
EBR-I	Experimental Breeder Reactor - No. 1
EDF	Experimental Dairy Farm
EFS	Experimental Field Station
EIS	Environmental Impact Statement
EM	Environmental Management
EML	Environmental Measurements Laboratory
EMS	Environmental Management System
EOMA	Environmental Oversight and Monitoring Agreement
EPCRA	Emergency Planning and Community Right-to-Know Act
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
ESER	Environmental Surveillance, Education and Research (Program)
ESP	Environmental Surveillance Program
FAA	Federal Aviation Administration
FFA/CO	Federal Facility Agreement and Consent Order
FFCA	Federal Facility Compliance Act
FY	Fiscal Year

HLW	High-Level (radioactive) Waste
ICDF	INEEL CERCLA Disposal Facility
IDAPA	Idaho Administrative Procedures Act
IMPROVE	Interagency Monitoring of Protected Visual Environments
INEEL	Idaho National Engineering and Environmental Laboratory
INTEC	Idaho Nuclear Technology and Engineering Center (formerly Idaho Chemical Processing Plant)
ISMS	Integrated Safety Management System
ISO	International Standards Organization
ISU	Idaho State University
LLW	Low-Level (radioactive) Waste
LMITCO	Lockheed Martin Idaho Technologies Company
LTS	Long-Term Stewardship
MDC	Minimum Detectable Concentration
MEI	Maximally Exposed Individual
M&O	Management and Operating (contractor)
MCL	Maximum Contaminant Level
MDIFF	Mesoscale Diffusion Model
MSC	Monitoring and Surveillance Committee
NAGPRA	Native American Graves Protection and Repatriation Act
NEPA	National Environmental Policy Act
NESHAPs	National Emission Standards for Hazardous Air Pollutants
NHPA	National Historic Preservation Act
NIOSH	National Institute of Occupational Safety and Health
NIST	National Institute of Standards and Technology
NOAA	National Oceanic and Atmospheric Administration
NOAA ARL-FRD	National Oceanic and Atmospheric Administration Air Resources Laboratory – Field Research Division
NO	Nitrogen Oxide
NO_2	Nitrogen Dioxide
NO_x	Oxides of Nitrogen
NOV	Notice of Violation
NPDES	National Pollutant Discharge Elimination System
NRF	Naval Reactors Facility
NRTS	National Reactor Testing Station
NSNFP	National Spent Nuclear Fuel Program
NTP	National Transportation Program
PBF	Power Burst Facility
PCBs	Polychlorinated Biphenyls
PE	Performance Evaluation
$PM_{2.5}$	Particulate Matter less than 2.5 microns
PM_{10}	Particulate Matter less than or equal to 10 microns
PSD	Prevention of Significant Deterioration
PTC	Permit to Construct
RI/FS	Remedial Investigation/ Feasibility Study
RCRA	Resource Conservation and Recovery Act

RESL	Radiological and Environmental Sciences Laboratory
RML	Radiological Measurements Laboratory (INEEL)
ROD	Record of Decision
RWMC	Radioactive Waste Management Complex
SDA	Subsurface Disposal Area
SDWA	Safe Drinking Water Act
SESP	Site Environmental Surveillance Program
SMC	Specific Manufacturing Capability
SNF	Spent Nuclear Fuel
SRPA	Snake River Plain Aquifer
STF	Security Training Facility
SWEPP	Stored Waste Examination Pilot Plant
TAN	Test Area North
TLD	Thermoluminescent Dosimeter
TRA	Test Reactor Area
TRIPS	Transuranic Reporting, Inventory, and Processing System
TRU	Transuranic (waste)
TSA	Transuranic Storage Area
TSCA	Toxic Substances Control Act
TSF	Technical Support Facility
TSS	Total Suspended Solids
USGS	U.S. Geological Survey
WAG	Waste Area Group
WERF	Waste Experimental Reduction Facility
WIPP	Waste Isolation Pilot Plant
WLAP	Wastewater Land Application Permit
WMSP	Waste Management Surveillance Program
WROC	Waste Reduction Operations Complex

UNITS

Btu	British thermal unit
Bq	becquerel
cfm	cubic feet per minute
Ci	curie
cm	centimeter
cpm	counts per minute
d	day
dl	detection limit
dpm	disintegrations per minute
ft	feet
g	gram
gal	gallon
ha	hectare
hr	hour
in.	inch
KeV	kilo-electron-volts
kg	kilogram
L	liter
lb	pound
m	meter
mi	mile
min	minute
mL	milliliter
µCi	microcurie (10^{-6} curies)
µg	microgram
µm	micrometer
µS	microsiemens
mmhos/cm	millimhos per centimeter
mR	milliroentgen
mrem	millirem
mSv	millisievert
ng	nanogram
oz	ounce
pCi	picocurie (10^{-12} curies)
ppb	parts per billion
qt	quart
rem	roentgen equivalent man
R	roentgen
sec	second
Sv	seivert
x^2	unit squared
x^3	unit cubed
yd	yard
yr	year
<	less than
>	greater than

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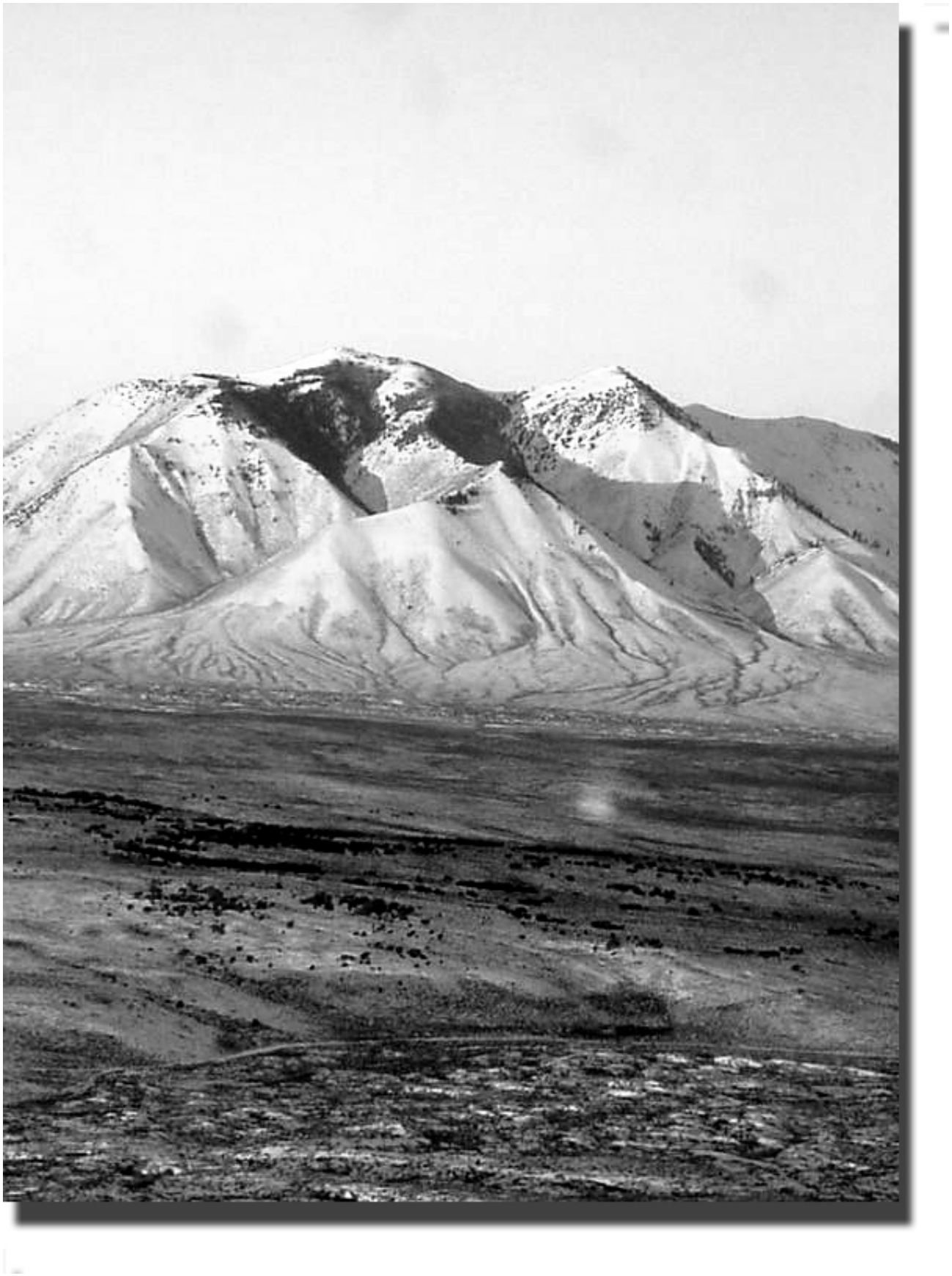


Chapter 1

Introduction

1. INTRODUCTION

This report presents the monitoring results and activities of organizations performing environmental monitoring on the Idaho National Engineering and Environmental Laboratory (INEEL) and surrounding areas for calendar year 2001. Environmental monitoring results are transmitted to the U.S. Department of Energy Idaho Operations Office (DOE–ID) and other government agencies.

The INEEL, is owned by DOE and administered through its Idaho Operations Office. The INEEL Site occupies approximately 2,300 km^2 (890 mi^2) of the upper Snake River Plain in southeastern Idaho (Figure 1-1). It is roughly equidistant from Salt Lake City, Utah (328 km [205 mi]); Butte, Montana (380 km [236 mi]); and Boise, Idaho (450 km [281 mi]). The communities closest to the INEEL are Atomic City (population 25), Arco (population 1,026), Howe (population 20), Monteview (population 10), Mud Lake (population 270), and Terreton (population 100). The larger population centers of Idaho Falls (population 50,730), Blackfoot (population 10,419), and Pocatello (population 51,466) are at least 35 km (22 mi) from the nearest INEEL boundary (Figure 1-2). Ten Idaho counties are located in part or entirely within 80 km (50 mi) of the INEEL (Figure 1-2). The INEEL includes portions of five counties (Bingham, Bonneville, Butte, Clark, and Jefferson).

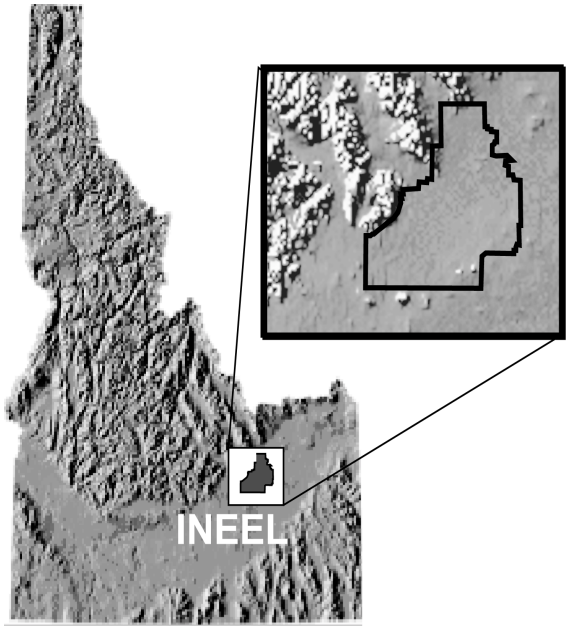


Figure 1-1. Location of the INEEL.

1.1. INEEL MISSION AND FACILITIES

The INEEL's vision is to serve as a multiprogram national laboratory that delivers science and engineering solutions to the world's environmental, energy, and security challenges. The mission of the INEEL can be divided into four core areas:

- Deliver science-based, engineered solutions to the challenges of DOE's mission areas, other federal agencies, and industrial clients.
- Complete environmental cleanup responsibly and cost effectively using innovative science and engineering capabilities.
- Provide leadership and support to optimize the value of Environmental Management (EM) investments and strategic partnerships throughout the DOE complex.
- Enhance scientific and technical talent, facilities, and equipment to best serve national and regional interests [Reference 1-1].

Over the years, various Management and Operating (M&O) contractors operated the INEEL. During 2001, the INEEL M&O contractor was Bechtel BWXT Idaho, LLC (BBWI). The University of Chicago's Argonne National Laboratory, Bechtel Bettis, Inc. (BBI), and British Nuclear Fuels Limited, Inc. (BNFL) operate other facilities.

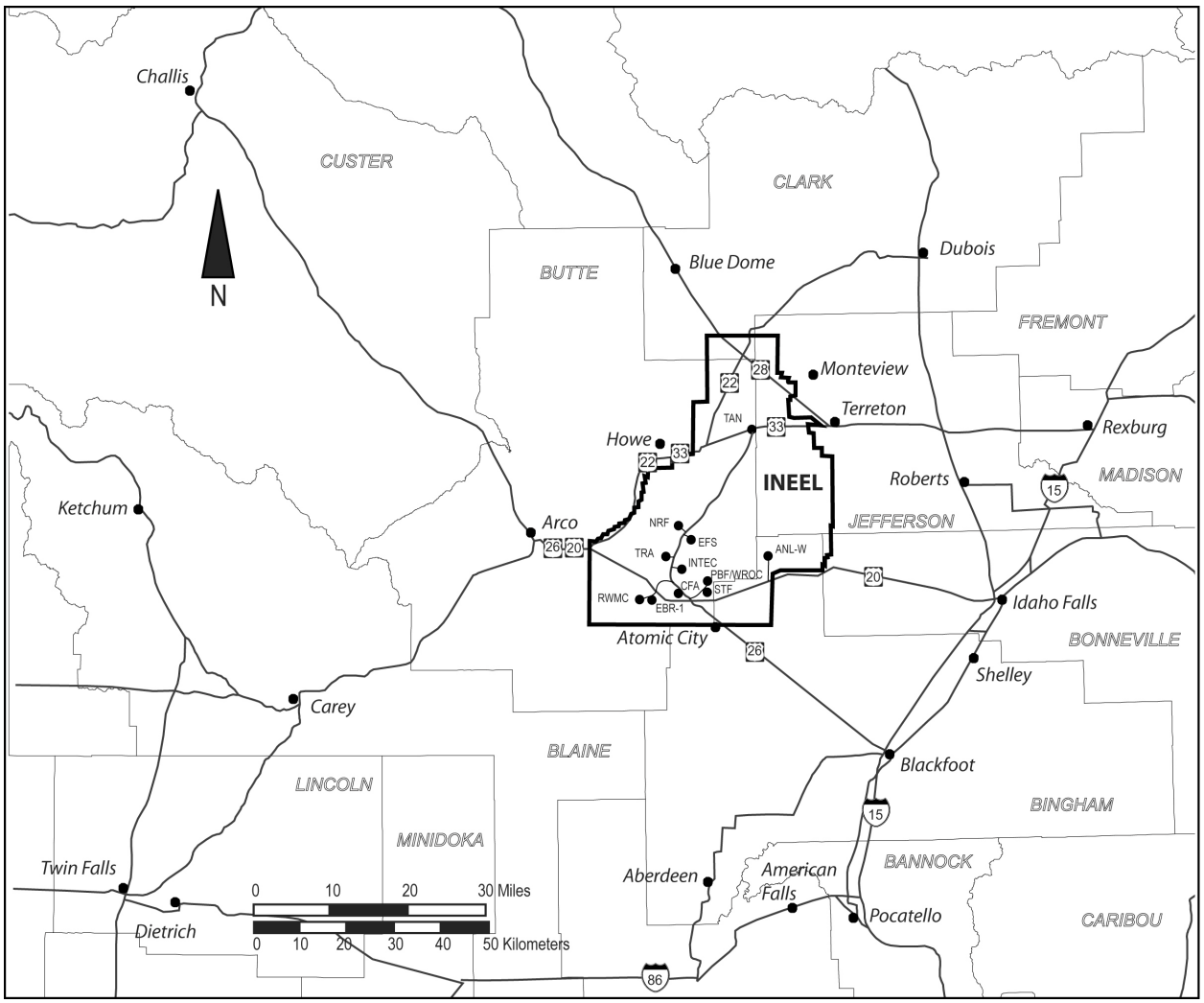


Figure 1-2. Map of INEEL and surrounding area showing facilities, counties, and cities.

The INEEL operates facilities at the Site and in Idaho Falls, Idaho. There are nine primary facility areas and three smaller secondary facilities at the INEEL and in Idaho Falls (Figure 1-2). These facility areas are outlined below.

Argonne National Laboratory-West

Argonne National Laboratory-West (ANL-W) is the prime testing center in the United States for demonstration and proof-of-concept of nuclear energy technologies. Research is focused on areas of national concern relating to energy, nuclear safety, nonproliferation, decommissioning and decontamination, and remote handling of nuclear materials. The University of Chicago operates ANL-W for the DOE Chicago Operations Office (DOE-CH). The DOE-CH Argonne Area Office (AAO) supports local operations.

Central Facilities Area

The Central Facilities Area (CFA) provides centralized support for the INEEL, including administrative offices, research laboratories, medical services, warehouses, crafts, vehicle support, and a cafeteria.

Idaho Falls Facilities

Idaho Falls facilities include the INEEL Research Center, where researchers conduct fundamental and applied research in science and engineering areas crucial to DOE's national missions. Additional support personnel for the facilities at the INEEL are housed at the Willow Creek Building, Engineering Research Office

Building, two DOE buildings, and other office buildings.

Idaho Nuclear Technology and Engineering Center

The primary mission of the Idaho Nuclear Technology and Engineering Center (INTEC) is to safely store spent nuclear fuel and prepare it for shipment to an offsite repository. The facility also develops technology for the safe treatment of high-level liquid radioactive wastes.

Naval Reactors Facility

From 1953 through May 1995, Naval Reactors Facility (NRF) prototypes were used to train Navy personnel who serve aboard nuclear-powered submarines and warships. At the Expended Core Facility, NRF conducts research, inspection, and examination of Naval spent nuclear fuel. BBI operates the NRF for the Office of Naval Nuclear Propulsion.

Radioactive Waste Management Complex

The Radioactive Waste Management Complex (RWMC) is used to manage solid transuranic and low-level radioactive waste. The facility supports research projects dealing with waste retrieval and processing technology and provides temporary storage and treatment of transuranic waste destined for the Waste Isolation Pilot Plant (WIPP) in New Mexico. BNFL, Inc. is currently constructing the Advanced Mixed Waste Treatment Facility. This facility will retrieve mixed transuranic waste in temporary storage, treat the waste to meet disposal criteria, and package the waste for shipment to WIPP.

Test Area North

Located at the north end of the INEEL, Test Area North (TAN) was originally built to house the nuclear powered airplane project during the 1950s. Currently, the TAN facilities support two projects. The Specific Manufacturing Capability (SMC) Project manufactures protective armor for the U.S. Army M1-A1 and M1-A2 Abrams tanks. TAN personnel are also researching technologies for the cleanup of environmental contamination from prior operations. This research includes such alternatives as a biological remediation technique for destroying organic solvents in groundwater.

Test Reactor Area

The Test Reactor Area (TRA) is dedicated to nuclear technology research. The Advanced Test Reactor is used to study the effects of radiation on materials, test nuclear fuels, and to produce rare and valuable medical and industrial isotopes.

Power Burst Facility/Waste Reduction Operations Complex

The Power Burst Facility and Waste Reduction Operations Complex (PBF/WROC) provide for the safe treatment, storage, and recycling of the INEEL's mixed and low-level radioactive wastes.

The three secondary facilities at INEEL are described in the following sections.

Experimental Breeder Reactor No. 1

The Experimental Breeder Reactor No. 1 (EBR-I) is a Registered National Historic Landmark located at the INEEL off U.S. Highway 20/26.

At 1:50 p.m., on December 20, 1951, the first usable amount of electricity from a nuclear power reactor was generated. EBR-I's real mission was not to show that electricity could be generated by a nuclear reactor, but it was to determine whether scientists' theoretical calculations on fuel breeding could actually be achieved.

Experimental Field Station

The Experimental Field Station (EFS), first called the Experimental Dairy Farm (EDF), was established to conduct Controlled Environmental Radioiodine Tests (CERTs). The first CERT at EDF was conducted on September 2, 1964. The CERTs at EDF ended in 1970. The EFS was established in 1973 as a major environmental monitoring site with high- and low-volume air samplers. Since that time, the EFS has served as a field station for various experiments, the longest running

being the Protective Cap/Biobarrier Experiment.

Security Training Facility

The Security Training Facility (STF) area has been used since 1983 for security force practice maneuvers, including small arms target practice in a berm approximately 76 m (250 ft) northeast of the former STF-601 building. The berm was used from approximately 1983 to 1990.

1.2. PHYSICAL SETTING OF THE INEEL

The INEEL is located in a large, relatively undisturbed expanse of sagebrush steppe habitat. Approximately 94% of the land on the INEEL is open and undeveloped. The Site has an average elevation of 1,500 m (4,900 ft) above sea level, and it is bordered on the north and west by mountain ranges and on the south by volcanic buttes and open plain (Figure 1-1). Lands immediately adjacent to the INEEL are open rangeland, foothills, or agricultural fields. Agricultural activity is concentrated in areas northeast of the INEEL. Sixty percent of the INEEL is open to livestock grazing.

The climate of the high desert environment of the INEEL is characterized by sparse precipitation (less than 22.8 cm/yr [9 in./yr]), hot summers (average daily temperature of 15.7°C [60.3°F]), and cold winters (average daily temperature of -5.2°C [22.6°F]) [Reference 1-2]. The altitude, intermountain setting, and latitude of the INEEL combine to produce a semiarid climate. 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 terrain before 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.

Basalt flows, which produce a rolling topography, cover most of the plain. Vegetation is visually dominated by big sagebrush (*Artemisia tridentata)*. Beneath these shrubs are grasses and flowering plants, most adapted to the harsh climate. A recent inventory counted 409 plant species on the INEEL [Reference 1-3]. Vertebrate animals found on the INEEL include small burrowing mammals, snakes, birds, and several game species. Published species counts include five fishes, one amphibian, nine reptiles, 159 birds, and 37 mammals [Reference 1-4].

The Big Lost River on the INEEL flows toward the northeast, ending in a playa area on the northwest portion of the Site. Here it evaporates or infiltrates into the subsurface. Surface water does not move offsite. The fractured volcanic rocks under the INEEL, however, form a portion of the eastern Snake River Plain Aquifer, which stretches 267 km (165 mi) from St. Anthony, Idaho, to Bliss, Idaho, and stores one of the most bountiful supplies of groundwater in the nation. An estimated 200 to 300 million acre-ft of water is stored in the aquifer's upper portions. The aquifer is primarily recharged from waters of the Henry's Fork and the South Fork of the Snake River, as well as the Big Lost River, the Little Lost River, Birch Creek, and irrigation. Beneath the INEEL, the aquifer moves laterally to the southwest at a rate of 1.5 to 6 m/d (5 to 20 ft/d) [Reference 1-5]. The Snake River Plain Aquifer emerges in springs along the Snake River between Milner and Bliss, Idaho. The primary use of both surface water and groundwater on the Snake River Plain is crop irrigation.

1.3. HISTORY OF THE INEEL

The geologic events that have shaped the modern Snake River Plain on and near the INEEL took place during the last 2 million years [References 1-5 and 1-6]. The plain, which arcs from far eastern Oregon across southern Idaho to Yellowstone National Park, marks the passage of the earth's crust over a plume of melted mantle material pressing upward. The resultant rhyolite volcanics are oldest in the western portion of the Snake River Plain and youngest on the Yellowstone Plateau,

which overlies the thermal plume today. The plain is a 640-km (400-mi) trail made by the passage of the continent over this "hot spot." (The basalts that are visible on much of the plain today are usually younger than the rhyolites they surround or cover.)

Humans first appeared on the Upper Snake River Plain approximately 11,000 years ago, likely descendants of people who crossed the Bering Strait land bridge. Tools recovered from this period indicate these earliest human inhabitants were almost certainly hunters of large game. The ancestors of the present-day Shoshone and Bannock people came north from the Great Basin around 4,500 years ago [Reference 1-6].

The earliest exploratory visits by European descendants came between 1810 and 1840. Trappers and fur traders were some of the first to make their way across the plain seeking new supplies of beavers for pelts. Between 1840, by which time the fur trade was essentially over, and 1857, an estimated 240,000 immigrants passed through southern Idaho on the Oregon Trail. By 1868, treaties had been signed forcing the native populations onto the reservation at Fort Hall. The 1870s saw miners entering the surrounding mountains, followed by ranchers grazing cattle and sheep in the valleys.

A railroad was opened between Blackfoot and Arco, Idaho, in 1901. By this time, a series of acts—the Homestead Act of 1862, the Desert Claim Act of 1877, the Carey Act of 1894, and the Reclamation Act of 1902—provided sufficient incentive for homesteaders to attempt to build diversionary canals to claim the desert. Most of these canal efforts failed due to the extreme porosity of the gravelly soils and underlying basalts.

During World War II, large guns from U.S. Navy warships were retooled at the U.S. Naval Ordnance Station in Pocatello, Idaho. These guns needed to be tested, and the nearby uninhabited plain was put to use as a gunnery range, then known as the Naval Proving Ground. The Army Air Corps also used the area as a bombing range.

After the war ended, the nation turned to the peaceful uses of atomic power. DOE's predecessor, the Atomic Energy Commission (AEC) needed an isolated location with an ample groundwater supply on which to build and test nuclear power reactors. The relatively isolated Snake River Plain was chosen as the best location. The Naval Proving Ground, thus, became the National Reactor Testing Station (NRTS) in 1949.

By the end of 1951, a reactor at the NRTS (EBR-I) became the first to produce useful electricity. The Site evolved into an assembly of 52 reactors, associated research centers, and waste handling areas. The NRTS was renamed the Idaho National Engineering Laboratory in 1974 and Idaho National Engineering and Environmental Laboratory in January 1997. The AEC was renamed the Energy Research and Development Agency in 1975 and reorganized to the present-day DOE in 1977.

1.4. REGIONAL ECONOMIC IMPACT

Approximately 8,000 people work at the INEEL, making it the largest employer in eastern Idaho and one of the top five employers in the State. This number includes about 400 federal employees, most of who work for DOE-ID. The majority of the other 7,600 employees work for the M&O contractor at the INEEL. Other employees work for contractors at facilities operated by other DOE organizations, such as BBI at NRF and the University of Chicago at ANL-W.

The INEEL has a tremendous economic impact on eastern Idaho. The following statistics for 2001 demonstrate why the INEEL is an integral component of Idaho's economy and society:

- The INEEL infused more than $750 million to the Idaho economy.
- About $130 million worth of goods and services were purchased by the INEEL from vendors in Idaho.

- $1.4 million in corporate funding was disbursed for economic diversification and community development.
- $3.5 million in education and development grants were provided to Idaho public and private institutions.
- Altogether, INEEL families and retirees contributed an estimated $78 million in state and local taxes.

DOE and INEEL contractors consistently give their time and energy to the community through various civic activities. In 2001, INEEL employees and their households contributed over 1 million volunteer hours to community concerns, church affiliations, educational activities, political and issue-related causes, youth, and other areas of interest.

Chapter 2

Environmental Compliance Summary

2. ENVIRONMENTAL COMPLIANCE SUMMARY

The purpose of this chapter is to report the regulatory compliance status of the Idaho National Engineering and Environmental Laboratory (INEEL), document any releases of nonpermitted hazardous materials to the environment, and summarize the permits issued to the INEEL that are required under specific environmental protection regulations. Section 2.1 discusses the compliance status of the INEEL with respect to major environmental acts, agreements, and orders. Section 2.2 discusses environmental occurrences, which are nonpermitted releases that require notification of a regulatory agency outside of Department of Energy (DOE). Section 2.3 presents a summary of environmental permits for the INEEL site. The programs in place to attain compliance with major acts, agreements, and orders are discussed in Chapter 3.

2.1. COMPLIANCE STATUS

Operations at the INEEL are subject to numerous federal and state environmental statutes, executive orders, and DOE orders. These are listed in Appendix A. This section presents a brief summary of the INEEL's compliance status with those regulations. Table 2-1 shows how the discussion is organized.

Table 2-1. Environmental compliance status.

Radiation Protection	• Order DOE 5400.1, "General Environmental Protection Program" • Order DOE 5400.5, "Radiation Protection of the Public and the Environment"
Environmental Remediation and Protection	• Comprehensive Environmental Response, Compensation, and Liability Act • Emergency Planning and Community Right-to-Know Act • National Environmental Policy Act • Endangered Species Act • Executive Order 11988 – Floodplain Management • Executive Order 11990 – Protection of Wetlands
Waste Management	• Resource Conservation and Recovery Act • Federal Facility Compliance Act • Toxic Substances Control Act • Order DOE 435.1, "Radioactive Waste Management" • State of Idaho Wastewater Land Application Permits • Idaho Settlement Agreement
Air Quality and Protection	• Clean Air Act
Water Quality and Protection	• Clean Water Act • Safe Drinking Water Act
Cultural Resources	• National Historic Preservation Act • Native American Graves Protection and Repatriation Act

DOE Order 5400.1, "General Environmental Protection Program"

This order requires that DOE sites conduct an environmental monitoring program. Program requirements, authorities, and responsibilities for assuring compliance with applicable federal, state and internal DOE policies are established by the order. The order also establishes requirements for notification and followup of environmental occurrences and for routine reporting, including the annual site environmental report.

The INEEL monitoring programs conducted to comply with DOE Order 5400.1 are described in Section 3.1.

The Site Environmental Report for Calendar Year 2001 satisfies the order's annual site environmental report requirement.

DOE Order 5400.5, "Radiation Protection of the Public and the Environment"

This order establishes standards and requirements for operations of DOE sites with respect to protection of members of the public and the environment against undue risk from radiation. The standards and guides provided by DOE Order 5400.5 are presented in Appendix A. Concentrations of radionuclides measured by the INEEL environmental programs in 2001 were well below concentration guides established by this order (see Chapters 4, 5, and 6). Potential doses to members of the public in the vicinity of the INEEL were also estimated to be well below the dose limits established by this order (see Chapter 7).

Comprehensive Environmental Response, Compensation, and Liability Act

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) provides specific procedures to assess and remediate areas where the release of hazardous substances has occurred. Nuclear research and other operations at the INEEL left behind contaminants that pose a potential risk to human health and the environment. The INEEL was placed on the National Priorities List under CERCLA on November 29, 1989. Environmental restoration activities at the INEEL are being conducted by the Management and Operating (M&O) contractors' Environmental Restoration Program in accordance with the Federal Facility Agreement and Consent Order (FFA/CO) signed in December 1991 by the DOE Idaho Operations Office (DOE-ID), the state of Idaho, and the U.S. Environmental Protection Agency (EPA) Region 10. Activities performed by the Environmental Restoration Program are discussed in Section 3.2. Program achievements made in 2001 are summarized below.

Field investigations are used to evaluate many potential release sites when existing data are not expected to indicate that a site needs no further action or where limited field data collection are necessary. After each investigation is completed, a determination is made whether a no further action listing is possible or if it is appropriate to proceed with an interim cleanup action or further investigation using a remedial investigation/feasibility study (RI/FS). Results from the RI/FS form the basis for assessment of risks and alternative cleanup actions. After reviewing public comments, the DOE-ID, EPA, and the State reach a final decision, which is documented in a Record of Decision (ROD). Cleanup activities then can be designed, implemented, and completed.

The INEEL is divided into ten Waste Area Groups (WAGs) containing 25 areas for conducting environmental investigations as a result of the FFA/CO. By the end of 2001, 21 investigations were complete. The remaining investigations to be completed include

- A combined investigation of the Experimental Breeder Reactor No. 1 (EBR-I)/Boiling Water Reactor Experiment area and contaminated surface areas outside facility boundaries;

- Buried waste at the Radioactive Waste Management Complex (RWMC);
- Snake River Plain Aquifer contamination from the INEEL; and
- Soil and groundwater contamination at the Idaho Nuclear Technology and Engineering Center (INTEC) tank farm.

All eight FFA/CO enforceable milestones were met, but no new RODs were signed in 2001. DOE went to formal dispute with the state of Idaho and EPA over outyear milestones for WAG 7 (RWMC). The total number of cleaned up areas at the end of 2001 was 11. Cleanup actions are in progress at ten other areas.

Natural Resource Trusteeship and 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, and 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 natural resource trustees with jurisdiction over trust resources are the state of Idaho, U.S. Department of Interior (Bureau of Land Management and the U.S. Fish and Wildlife Service), and the Shoshone-Bannock Tribes.

Past releases of hazardous substances resulted in the INEEL's placement on the National Priorities List. These same releases created 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 M&O contractors' Environmental Restoration Program coordinates with DOE-ID as co-trustees on any INEEL Natural Resources Damage Assessment issues arising as a result of the comprehensive RI/FS study for each WAG.

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 natural resource issues. Executive Order 12580 allows for this substitution [Reference 2-1]. Ecological risk assessments at the INEEL have been conducted using the established guidance manual for conducting screening level ecological risk assessments [Reference 2-2].

Emergency Planning and Community Right-to-Know Act

The purpose of the Emergency Planning and Community Right-to-Know Act (EPCRA) is to provide the public with information about hazardous chemicals at a facility (such as the INEEL) and to establish emergency planning and notification procedures to protect the public from chemical releases. EPCRA also contains requirements for periodic reporting on hazardous chemicals stored and/or used at a facility. Executive Order 13148, "Federal Compliance with Right-to-Know Laws and Pollution Prevention Requirements," requires all federal facilities to comply with the provisions of EPCRA.

311 Report

EPCRA Section 311 reports were submitted quarterly for those chemicals that met the reporting threshold. These reports were sent to local emergency planning committees, the State Emergency Response Commission, and to local fire departments for each quarter in calendar year 2001. These quarterly reports satisfied the 90-day notice requirement for new chemicals brought onsite.

312 Report

Local and State planning and response agencies received the Emergency and Hazardous Chemical Inventory (Tier II) Report for 2001 by March 1, 2002. This report identified the types, quantities, and locations of hazardous and extremely

hazardous chemicals stored at INEEL facilities that exceeded:

- 10,000 pounds (for Occupational Safety and Health Act hazardous chemicals);
- 500 pounds (for Extremely Hazardous Substances as defined in Title 40 Code of Federal Regulations, Part 355 [40 CFR 355]); or
- the Threshold Planning Quantity,

whichever is less.

313 Report

The Toxic Chemical Release Inventory Report was transmitted to the EPA and the state of Idaho by July 1, 2002. The report identifies quantities of 313-listed toxic chemicals available on the INEEL that exceeded a threshold value. Once a threshold value is exceeded (for manufacturing, processing, or otherwise used), an EPA 313 Form R report must be completed for each specific chemical. These reports describe how the chemical is released to the environment. Releases under EPCRA reporting include transfers to offsite waste storage and treatment, air emissions, recycling, and other activities. Three reports were prepared at the INEEL during 2001 for ethylbenzene, lead, and nitric acid. The 313 reports vary year-to-year depending upon the chemical processes at the Site.

National Environmental Policy Act

The National Environmental Policy Act (NEPA) requires federal agencies to consider and analyze potential environmental impacts of proposed actions and explore appropriate alternatives to mitigate those impacts, including a "no action" alternative. Agencies are required to inform the public of the proposed actions, impacts, and alternatives and consider public feedback in selecting an alternative. DOE implements NEPA according to procedures in 10 Code of Federal Regulations (CFR) 1021 and assigns authorities and responsibilities according to DOE Order 451.1B, "National Environmental Policy Act Compliance Program." Processes specific to DOE-ID are set forth in its NEPA Planning and Compliance Program Manual, ID M 451.A-1. The DOE-ID NEPA Compliance Officer and NEPA Planning Board implement the process.

The DOE-ID issued the Annual NEPA Planning Summary in January 2001. This summary is a requirement of DOE Order 451.1B, and it is prepared as a means of informing the public and other DOE elements of:

- The status of ongoing NEPA compliance activities;
- Environmental assessments (EAs) expected to be prepared in the next 12 months;
- Environmental impact statements (EISs) expected to be prepared in the next 24 months; and
- The planned cost and schedule for completion of each NEPA review identified.

The Annual NEPA Planning Summary can be accessed on the INEEL web page at http://www.inel.gov/publicdocuments/.

Idaho High-Level Waste and Facilities Disposition Environmental Impact Statement

This EIS evaluates potential environmental impacts of various alternatives for managing high-level radioactive waste and related radioactive wastes and facilities at the INTEC. DOE received and considered agency and public comments on the draft EIS. In response to those comments and updated information, DOE incorporated changes into the final EIS. The final EIS should be available to the public in the fall of 2002. The ROD for the EIS will be available no sooner than 30 days after the announcement of the Notice of Availability of the final EIS.

Wildland Fire Management Plan Environmental Assessment

In January 2001, the DOE-ID Manager signed a determination to prepare an EA to evaluate prefire planning, fire response, and postfire restoration alternatives. Actions to be analyzed include firebreak construction and maintenance, dust suppression, habitat rehabilitation, and impacts on cultural resources. The draft EA is expected to be made available for public review and comment in mid-2002.

Deactivation, Decommissioning, and Dismantlement of the CPP-603 Basin Environmental Assessment

In November 2000, the DOE-ID Manager signed a determination to prepare an EA for this proposed action, which would deactivate the spent nuclear fuel storage basins in a portion of the Fuel Storage and Receiving Facility (building CPP-603) at INTEC. The proposed action also involves dismantlement of the Fuel Element Cutting Facility and other equipment associated with spent nuclear fuel storage operations. The draft EA was made available for a 30-day public review and comment period beginning in June 2001, which was subsequently extended to September 23, 2001. Due to additional data gathering that indicated radioactive "hot spots" in the sludge at the bottom of the basin, the EA was placed on hold until further characterization of the hot spots could be completed. The final EA should be issued after further characterization is complete and evaluated.

Endangered Species Act

The purposes of the Endangered Species Act are to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved; to provide a program for the conservation of such endangered species and threatened species; and to take such steps as may be appropriate to achieve the purposes of the international treaties and conventions on threatened and endangered species. It requires that all federal departments and agencies shall seek to conserve endangered species and threatened species and shall utilize their authorities in furtherance of the purposes of this act.

The Environmental Surveillance, Education and Research Program conducts ecological research, field surveys, and NEPA evaluations regarding ecological resources on the INEEL. Particular emphasis is given to threatened and endangered species and species of special concern identified by the U.S. Fish and Wildlife Service and Idaho Fish and Game Department.

Two federally protected species may occasionally spend time on the INEEL: the threatened Bald eagle (*Haliaeetus leucocephalus*) and the Gray wolf (*Canis lupus*). Gray wolves found in the geographical region that includes the INEEL are identified as an experimental/ nonessential population and treated as a threatened species. Bald eagles occasionally winter on part of the INEEL and there have been unsubstantiated sightings of Gray wolves. Ute's ladies tresses *(Spiranthes diluvialis)*, which is a threatened species, may occur on the INEEL, but they have never been reported. It is, however, unlikely that suitable habitat (wet meadows) exists on the INEEL long enough each year to support this threatened species. Research and monitoring continued on several species of special biological, economic, and social concern, including Townsend's big-eared bat (*Corynorhinus townsendii*), sage grouse (*Centrocercus urophasianus),* elk (*Cervus elaphus*), and pronghorn antelope (*Antilocapra americana*).

Executive Order 11988 – Floodplain Management

Executive Order 11988—Floodplain Management requires each federal agency to issue or amend existing regulations and procedures to ensure that the potential effects of any action it may take in a floodplain are evaluated and that its

planning programs and budget requests reflect consideration of flood hazards and floodplain management. It is the intent of this executive order that federal agencies implement floodplain requirements through existing procedures such as those established to implement NEPA. The Code of Federal Regulations (10 CFR 1022) contains DOE policy and floodplain environmental review and assessment requirements through the applicable NEPA procedures [Reference 2-3]. In those instances where impacts of actions in floodplains are not significant enough to require the preparation of an EIS under NEPA, alternative floodplain evaluation requirements are established through the INEEL environmental checklist process.

For the Big Lost River, the DOE-ID has directed that all proposed actions be reviewed to identify their location relative to the elevation of the 100-year flood indicated in *Flood Routing Analysis for a Failure of Mackay Dam* for purposes of the NEPA compliance [Reference 2-4]. This direction is considered to be interim and remains in effect until DOE-ID issues a final determination of the 100- and 500-year Big Lost River flood elevations. In 2001, a project began to delineate the Big Lost River 100-year through 10,000-year floodplains using geomorphological models to characterize and estimate the frequency and magnitude of Big Lost River floods on the INEEL.

For facilities at Test Area North (TAN), the 100-year floodplain has been delineated in *Simulation of Water-Surface Elevations for a Hypothetical 100-Year Peak Flow in Birch Creek at the Idaho National Engineering and Environmental Laboratory, Idaho* [Reference 2-5].

Other regulatory requirements for floodplain management include 40 CFR 264, Subpart B, and 40 CFR 761, Subpart D [References 2-6 and 2-7]. The 40 CFR 264, Subpart B statute requires hazardous waste storage, treatment, and disposal facilities located in the 100-year floodplain to be designed, constructed, operated, and maintained to prevent washout of any hazardous waste by a 100-year flood. The 40 CFR 761, Subpart D statute requires that any facilities used for storage of polychlorinated biphenyls (PCBs) and PCB items designated for disposal shall not be located at a site that is below the 100-year flood water elevation.

Executive Order 11990 – Protection of Wetlands

Executive Order 11990 – Protection of Wetlands requires each federal agency to issue or amend existing regulations and procedures to ensure wetlands are protected in decision-making. It is the intent of this executive order that federal agencies implement wetland requirements through existing procedures such as those established to implement NEPA. The 10 CFR 1022 statute contains DOE policy and wetland environmental review and assessment requirements through the applicable NEPA procedures. In those instances where impacts of actions in wetlands are not significant enough to require the preparation of an EIS under NEPA, alternative wetland evaluation requirements are established through the INEEL environmental checklist process. Activities in wetlands considered waters of the U.S. or adjacent to waters of the U.S. may also be subject to the jurisdiction of Section 404 and 402 of the Clean Water Act.

The only area of the INEEL identified as jurisdictional wetlands is the Big Lost River Sinks. The U.S. Fish and Wildlife Service National Wetlands Inventory map is used to identify potential jurisdictional wetlands and nonregulated sites with ecological, environmental, and future development significance. In 2001, no actions took place or had an impact on jurisdictional wetlands on the Site, and, to date, no future actions are planned that would impact wetlands. However, private parties may conduct cattle grazing in the Big Lost River Sinks area under Bureau of Land Management permits.

Resource Conservation and Recovery Act

The Resource Conservation and Recovery Act (RCRA) established regulatory standards for generation, transportation, storage, treatment, and disposal of hazardous waste. The Idaho Department of Environmental Quality (DEQ) is authorized by EPA to regulate hazardous waste and the hazardous component of mixed waste at the INEEL. Mixed waste contains both radioactive and hazardous materials. The Atomic Energy Act, as administered through DOE orders, regulates radioactive wastes and the radioactive part of mixed wastes.

Notice of Violation

The DOE-ID received a Notice of Violation (NOV) from Idaho DEQ in August 2000. The alleged violations stem from inspections in April 2000. Idaho DEQ alleged ten violations with a fine of $55,300. In January 2001, DOE-ID and Idaho DEQ negotiated a consent order to resolve the alleged violations with a final fine amount of $42,700, which was be used for a Supplemental Environmental Project to provide Idaho DEQ employees with RCRA training.

A multimedia inspection by Idaho DEQ and EPA in July 2001 resulted in the issuance of a NOV alleging 27 violations of the Idaho Hazardous Waste Management Act. Fines of $156,050 were assessed against the INEEL and Argonne National Laboratory-West (ANL-W). Negotiations to resolve the NOV began in December 2001.

RCRA Closure Plans

The state of Idaho approved the closure plan for the Waste Experimental Reduction Facility in April 2001.

RCRA Reports

As required by the state of Idaho, INEEL submitted the Idaho Hazardous Waste Generator Annual Report for 2001. The report contains information on waste generation, treatment, recycling, and disposal activities at INEEL facilities.

DOE-ID submitted the INEEL 2001 Affirmative Procurement Report to the EPA, as required by Section 6002 of RCRA and Executive Order 13101. This report provides information on the INEEL's procurement of products with recycled content.

The INEEL RCRA permit for the Hazardous Waste Storage Facility at the Central Facilities Area and some areas at ANL-W requires submittal of an annual certification to Idaho DEQ that the INEEL has a waste minimization program in place to reduce the volume and toxicity of hazardous waste. The certification was submitted by July 1, 2001.

Federal Facility Compliance Act

The Federal Facility Compliance Act requires the preparation of site treatment plans for the treatment of mixed wastes stored or generated at DOE facilities. Mixed waste contains both hazardous and radioactive components. 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, called the "backlog," and provided a preliminary analysis of potential offsite mixed low-level waste treatment capabilities.

The INEEL Proposed Site Treatment Plan formed the basis for negotiations between the state of Idaho and DOE-ID on the consent order for mixed waste treatment at the INEEL. The Federal Facilities Compliance Act Consent Order and Site Treatment Plan were 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: (1) DOE reserved its right to challenge the approval authority of the State over offsite wastes, and (2) both parties

agreed to immediately modify the plan's schedules to be consistent with the Settlement Agreement and court order issued in October 1995 in the Spent Nuclear Fuel and INEEL Environmental Impact Statement litigation.

Toxic Substances Control Act

The Toxic Substances Control Act (TSCA), which is administered by EPA, requires regulation of production, use, or disposal of chemicals. TSCA supplements sections of the Clean Air Act, the Clean Water Act, and the Occupational Safety and Health Act. Since the INEEL does not produce chemicals, compliance with TSCA at the INEEL is primarily directed toward management of PCBs.

DOE Order 435.1, "Radioactive Waste Management"

DOE Order 435.1, "Radioactive Waste Management," was issued to ensure that all DOE radioactive waste is managed in a manner that protects the environment and worker and public safety and health. This order, effective July 1, 1999, replaces DOE Order 5820.2A, "Radioactive Waste Management," and includes the requirements that DOE facilities and operations must meet in managing radioactive waste. The order is being implemented at the INEEL, as documented in Reference 2-8. Section 3.3 contains a discussion of the types of radioactive waste managed and radioactive waste management activities conducted at the INEEL.

State of Idaho Wastewater Land Application Permits

DOE-ID has applied for state of Idaho Wastewater Land Application Permits for all existing land application facilities. Renewal permits have been submitted for the Central Facilities Area (CFA) Sewage Treatment Plant, existing INTEC Percolation Ponds, INTEC Sewage Treatment Plant, and TAN/Technical Support Facility Sewage Treatment Plant. Until the renewal permits are finalized, Idaho DEQ has authorized continued use of these facilities under the terms and conditions of the original permits.

In 2001, Idaho DEQ issued a final permit for the new INTEC percolation ponds. The new ponds will provide a continued means for disposal of INTEC service wastewater. Currently, INTEC service wastewater is discharged to the existing percolation ponds, which will cease operation by December 2003 as required by the ROD. Because of some requirements related to monitoring of radioactivity, DOE-ID filed a formal appeal with Idaho DEQ. The appeal will be resolved in 2002.

The Idaho DEQ is reviewing permit applications for the Process Ponds at TAN, the Test Reactor Area Cold Waste Ponds, the Naval Reactors Facility Industrial Waste Ditch, and the ANL-W industrial and sanitary waste ponds.

Idaho Settlement Agreement

On October 16, 1995, DOE, the U.S. Navy, and the state of Idaho entered into an agreement that will guide management of spent nuclear fuel and radioactive waste at the INEEL for the next 40 years. The agreement makes Idaho the only state with a federal court-ordered agreement limiting shipments of DOE and Naval spent nuclear fuel into the state and setting milestones for shipments of spent nuclear fuel and radioactive waste out of the State. The Settlement Agreement milestones scheduled for 2001 were met as follows:

- Begin calcining sodium-bearing high-level waste currently located at INEEL. The milestone was due June 1, 2001, and was met on February 20, 1998, three years ahead of schedule.
- Complete moving Three-Mile Island fuel into dry storage. The milestone was due June 1, 2001, and was met on April 20, 2001, six weeks ahead of schedule.

As part of the Settlement Agreement, the state of Idaho received another $6 million from DOE for economic

development in eastern Idaho. Idaho awarded grants to the Regional Development Alliance and State universities and colleges to reduce economic dependence on the INEEL. Awards to date have totaled $30,000,000 and created more than 2,600 jobs.

Clean Air Act

The Clean Air Act is the law that forms the basis for the national air pollution control effort. Basic elements of the act include national ambient air quality standards for major air pollutants, hazardous air pollutant standards, state attainment plans, motor vehicle emissions standards, stationary source emissions standards and permits, acid rain control measures, stratospheric ozone protection, and enforcement provisions.

The 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. If emissions are determined to be significant, several actions may occur:

- Permitting determinations demonstrate that the project/process either is below emission thresholds or listed as exempted source categories in state of Idaho regulations allowing self-exemption;
- Submittal of an application for a Permit to Construct (PTC). If emissions are deemed major under Prevention of Significant Deterioration (PSD) regulations, then a PSD analysis, as described in the regulations, must be completed. If not deemed significant per PSD, an application for only a PTC without the additional modeling and analyses is needed. All PTCs are applied for using the state of Idaho air regulations and guidelines.

Permitted sources of air pollutants at the INEEL are listed 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 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 revised INEEL Title V Air Operating Permit Application was submitted to Idaho DEQ in March 2001. The application included ten volumes: one for each of the nine operating areas at the Site and a Sitewide volume that contains information and standards applicable to all areas. A regulatory technical review of the application is not anticipated to begin until 2002.

National Emission Standards for Hazardous Air Pollutants

DOE-ID submitted the *2001 INEEL National Emission Standards for Hazardous Air Pollutants-Radionuclides* report to EPA, DOE Headquarters, and state of Idaho officials in June 2002. This statute requires the use of the CAP-88 computer model to calculate the hypothetical maximum individual effective dose equivalent to a member of the public resulting from INEEL airborne radionuclide emissions. The 2001 calculations for this code are discussed further in Chapter 7, “Dose to the Public.”

Clean Water Act

The Clean Water Act (CWA), passed in 1972, established goals to control pollutants discharged to U.S. surface waters. Among the main elements of the CWA are effluent

limitations, set by the EPA, for specific industry categories and water quality standards set by states. The CWA also provided for the National Pollutant Discharge Elimination System (NPDES) permit program, requiring permits for discharges from a point source into surface waters.

The INEEL complies with four CWA permits through the implementation of procedures, policies, and best management practices. The four permits are

- NPDES General Permit for Storm Water Discharges from Industrial Activities provides protective requirements for facilities located within the INEEL storm water corridor [Reference 2-9];
- NPDES General Permit for Storm Water Discharges from Construction Activities provides protective requirements for construction activities located within the INEEL storm water corridor [Reference 2-10];
- Section 404 Permit for dredge and fill activities at Spreading Area B located southwest of the RWMC requires elimination of pollutant discharges and reclamation in the area; and
- Discharges from Idaho Falls facilities to the City of Idaho Falls publicly owned treatment works.

Clean Water Act Section 404 Permits

In October 1994, the U.S. Army Corps of Engineers granted a 10-year Section 404 permit that allows DOE-ID to dispose of material associated with the excavation of soil in Spreading Area B to the surrounding spreading area. This area is located southwest of the RWMC. Fill removal activities have since ceased in this area.

National Pollutant Discharge Elimination System Permits

The City of Idaho Falls is authorized by the NPDES permit program to set pretreatment standards for nondomestic discharges to publicly owned treatment works. This program is set out in the Municipal Code of the City of Idaho Falls regulations in Chapter 1, Section 8. Industrial Wastewater Acceptance Forms are obtained for facilities that discharge process wastewater through the City of Idaho Falls sewer system. Twelve Idaho Falls facilities have associated Industrial Wastewater Acceptance Forms for discharges to the city sewer system.

The Industrial Wastewater Acceptance Forms for these facilities contain special conditions and compliance schedules, prohibited discharge standards, reporting requirements, monitoring requirements, and effluent concentration limits for specific parameters. All discharges from INEEL Idaho Falls facilities in 2001 were within compliance levels established on the acceptance forms.

Storm Water Discharge Permits for Industrial Activity

Revised requirements for the NPDES general permit for the discharge of storm water from industrial activities became effective in 2000. The INEEL met the requirements to continue operations under this general permit. A modified NPDES Storm Water Multi-sector General Permit for industrial activities was also published in 2000. The original *INEEL Storm Water Pollution Prevention Plan for Industrial Activities* (DOE/ID-10431) was implemented in 1993. The most recent revision was completed in January 2001 [Reference 2-11]. This plan provides for baseline and tailored controls and measures to prevent pollution of storm water from industrial activities at the INEEL. The storm water pollution prevention plan team conducts annual evaluations to determine compliance with the plan and the need for revision. The Environmental Monitoring Unit of the M&O contractor monitors storm water in accordance with the permit requirements. Results from this monitoring in 2001 are provided in Chapter 5, Section 5.7.

The National Oceanic and Atmospheric Administration Air Resources Laboratory-Field Research Division 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 Permits for Construction Activity

INEEL's General Permit for Storm Water Discharges from Construction Sites was issued in June 1993. The permit has been renewed twice since issuance. The *INEEL Storm Water Pollution Prevention Plan for Construction Activities* was most recently revised in 1998 [Reference 2-12]. The plan provides for measures and controls to prevent pollution of storm water from construction activities at the INEEL. Worksheets are completed for construction projects and are appended to the plan. Inspections of construction sites are performed in accordance with permit requirements.

Spill Prevention, Control, and Countermeasure Plans

Only the TAN, INTEC, and RWMC require Spill Prevention, Control, and Countermeasure Plans. These INEEL facilities were evaluated in 2001 in accordance with 40 CFR 112. As a result of this evaluation, the current plans were found to lack present requirements. Updates to the appropriate plans are due for completion in 2002.

Safe Drinking Water Act

The Safe Drinking Water Act was reauthorized on August 6, 1996. It establishes primary standards for water delivered by systems supplying drinking water to 15 or more connections or 25 individuals for at least 60 days per year. The INEEL drinking water supplies meet these criteria for public water systems and are classified as either nontransient noncommunity or transient noncommunity systems. The INEEL operates 12 active public water systems, two of which serve the Naval Reactors Facility and ANL-W. All INEEL facilities performed sampling of drinking water as required by the State and EPA. See Chapter 5, Section 5.5 for details on drinking water monitoring results.

National Historic Preservation Act

Preservation of historic properties on lands managed by DOE is mandated under Section 106 of the National Historic Preservation Act and amendments. The act requires that for any federal project that may have an adverse effect on historic property, the agency in charge of the project must take actions to mitigate those adverse effects. This is usually done through an agreement with the State Historic Preservation Officer.

A comprehensive Historic Context of the INEEL was prepared in 1997. This Historic Context contains a historic evaluation of all properties built on the INEEL under the DOE-ID's authority and provides the background with which to assess their historic significance. It is used to guide a more comprehensive approach to managing the preservation and documentation of buildings scheduled to be modified or dismantled. Draft Tribal Consultation Procedures were developed in partnership with the Shoshone-Bannock Tribes. These procedures provide clarity and guidance to ensure continued good communication between the Tribes, DOE-ID, and the M&O contractor regarding cultural resource management on the INEEL. The procedures are also an integral component of the Agreement-in-Principle, signed in 2000, between DOE-ID and the Tribes.

Native American Graves Protection and Repatriation Act

The INEEL is located on the aboriginal territory of the Shoshone and Bannock people. 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 (NAGPRA) 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 Tribes with whom they are culturally affiliated.

During a 1989 test excavation, Idaho State University researchers removed a human hair bundle from Aviator's Cave on the INEEL. It was determined that the hair bundle was most likely used in an American Indian mourning ceremony and is considered to be a sacred object as defined in NAGPRA. In 2001, the Shoshone-Bannock Tribes requested that the hair bundle be repatriated to Aviator's Cave. DOE-ID is working with the Tribes and Idaho State University to honor the Tribes' request.

2.2. ENVIRONMENTAL OCCURRENCES

Several small spills occurred at the INEEL during 2001 that were not reportable to external agencies under environmental regulations. Four releases were determined to be reportable to external agencies and are discussed in the following paragraphs. Release notifications were conducted in accordance with DOE, EPA, and state of Idaho requirements.

A Union Pacific locomotive released between 0.94 L (1 qt) and 7.6 L (2 gal) of motor oil to the soil, 4.8 km (3 mi) southwest of RWMC. The oil was not cleaned up within 24 hours of discovery, which made the spill reportable.

At CFA, bead blasting fines that were disposed of in the CFA landfill were estimated to have exceeded the 4.5 kg (10 lb) reportable quantity for cadmium-containing waste. It was estimated that there were 39 disposals of cadmium-containing waste, estimated at 6.8 kg (15 lb) each. Also at CFA, hydraulic fluid from a track-mounted excavator, estimated at 7.6–11.4 L (2–3 gal), was released to the soil. The fluid was not cleaned up within 24 hours of discovery, which made the release reportable.

Legacy soil stains at INTEC and CFA were not cleaned up within 24 hours of discovery. It was estimated that the CFA soil was stained by less than 1.8 L (2 qt) of motor oil. It was originally estimated that the INTEC soil was stained by 18.9–37.8 L (5–10 gal) of fuel oil. However, the extensive excavation necessary to remove the stained soil indicates that the oil release may have exceeded 37.8 L (10 gal).

2.3. PERMITS

Table 2-2 summarizes permits applied for, and granted to, the INEEL through year-end 2001.

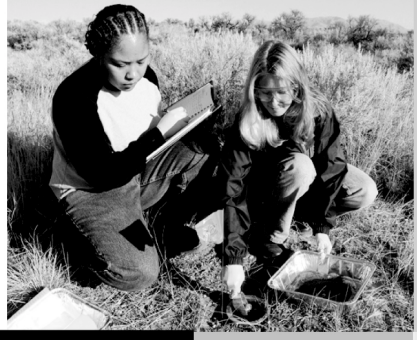
Table 2-2. Permit summary for the INEEL (2001).

Media/Permit Type	Issuing Agency	Active	Granted or Amended	Pending
Air[a]				
Permit to Construct	State of Idaho	18	2	4
NESHAPs (Subpart H)[b]	EPA Region 10	1		0
Operating Permit	State of Idaho	0		1
Groundwater				
Injection Well	State of Idaho	8		0
Well Construction	State of Idaho	1		0
Surface Water				
Wastewater Land Application Permit	State of Idaho	4		3
404 Permit	Corps of Engineers	1		0
Industrial Waste Acceptance	City of Idaho Falls	15		0
RCRA				
Part A	State of Idaho	1		0
Part B[c]	State of Idaho	7[c]		5[c]

a. Air permits do not include permits for the Naval Reactors Facility.

b. NESHAPs = National Emissions Standards for Hazardous Air Pollutants (40 CFR 61, Subpart H, National Emissions Standards for Emissions of Radionuclides Other Than Radon from Department of Energy Facilities).

c. Part B permit is a single permit comprised of several volumes.



Chapter 3

Environmental Program Information

3. ENVIRONMENTAL PROGRAM INFORMATION

This chapter highlights the Idaho National Engineering and Environmental Laboratory (INEEL) environmental programs that help implement the Environmental Compliance Policy for the INEEL (see page iii of this report). Much of the regulatory compliance activity is performed through the environmental monitoring programs (Section 3.1), the Environmental Restoration Program (Section 3.2), and the Waste Management Program (Section 3.3). Other significant INEEL environmental programs and activities are summarized in Sections 3.4 through 3.9.

3.1. ENVIRONMENTAL MONITORING PROGRAMS

The term environmental monitoring describes two separate activities: effluent monitoring and environmental surveillance. Effluent monitoring is the measurement of the waste stream before 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 present or measurable in environmental media and, if present, in what concentrations they are found.

Effluent monitoring is conducted by various INEEL organizations. Airborne effluent measurements and estimates, required under the Idaho State Implementation Plan, are the responsibility of the regulated facilities. At the INEEL, these facilities include Argonne National Laboratory-West (ANL-W), Central Facilities Area (CFA), Idaho Nuclear Technology and Engineering Center (INTEC), Naval Reactors Facility (NRF), Power Burst Facility/Waste Reduction Operations Complex (PBF/WROC), Radioactive Waste Management Complex (RWMC), Test Area North/Specific Manufacturing Capability (TAN/SMC), and Test Reactor Area (TRA). Descriptions of the airborne effluent monitoring programs are beyond the scope of this document and not discussed in this report. The Liquid Effluent Monitoring Program and Storm Water Monitoring Program, conducted by the Management and Operating (M&O) contractor, are designed to demonstrate compliance with the Clean Water Act and associated permits under the authority of the state of Idaho.

Environmental surveillance is the major environmental monitoring activity conducted at the INEEL. As such, much of the report concentrates on this task.

The remainder of this section summarizes environmental monitoring program objectives; the history of environmental monitoring at the INEEL; and information on monitoring of specific environmental media (air, water, agricultural products, animal tissue, and soil), direct radiation, and meteorology.

Results of the environmental monitoring programs for 2001 and additional information on major programs can be found in Chapter 4 (air), Chapter 5 (water), and Chapter 6 (other media).

Objectives of Environmental Monitoring

Operations of INEEL facilities have the potential to release materials, which may include both radioactive and nonradioactive contaminants, into the environment. These materials can enter the environment through two primary routes: into the atmosphere as airborne effluents and into surface water and groundwater 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.

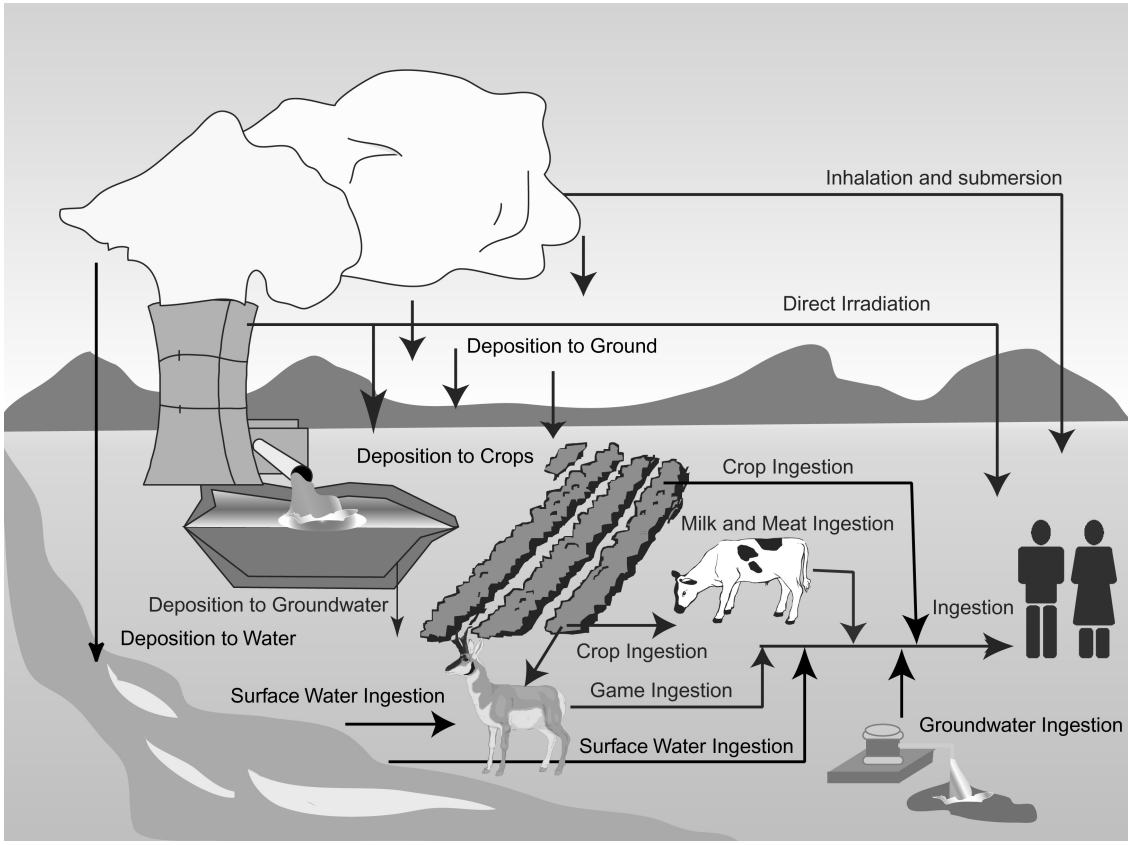


Figure 3-1. Potential exposure pathways to humans from the INEEL.

The major objectives of the various environmental monitoring programs conducted at the INEEL are to identify the key pollutants released to the environment, to evaluate different pathways through which contaminants move in the environment, and to determine the potential effects of these pollutants on the public and on the environment.

As discussed previously, monitoring also provides the information to verify compliance with a variety of applicable environmental protection laws, regulations, and permits, described in Chapter 2. The establishment and conduct of an environmental monitoring program at the INEEL is specifically required by the DOE Order 5400.1 [Reference 3-1].

The various environmental monitoring programs are also used to detect, characterize, and report unplanned releases; evaluate the effectiveness of effluent treatment, control, and pollution abatement programs; and determine compliance with commitments made in environmental impact statements, environmental assessments, safety analysis reports, or other official DOE documents.

History of Environmental Monitoring

Environmental monitoring has been performed at the INEEL by the DOE and its predecessors, the Atomic Energy Commission and Energy Research and Development Agency, as well as by other federal agencies, various contractors, and State agencies since its inception in 1949.

The organization of environmental monitoring programs remained fairly constant throughout much of the history of the INEEL. The Atomic Energy Commission's Health Services Laboratory,

later named the DOE's Radiological and Environmental Sciences Laboratory (RESL), was responsible for conducting most environmental surveillance tasks from the early 1950s to 1993 both on and off the INEEL Site. Contractors operating the various facilities were responsible for monitoring activities performed within the facility boundaries and for effluent monitoring.

Early monitoring activities focused on evaluating the potential of exposing the general public to a release of radioactive materials from INEEL facilities. Radionuclides were the major contaminants of concern because the INEEL was heavily involved in testing nuclear facilities. The DOE and its predecessor agencies sampled and analyzed environmental media that could be affected by atmospheric releases. During those early years, the various M&O contractors conducted sampling of liquid and airborne effluents from facilities to develop waste inventory information.

Throughout the history of the Site, the U.S. Geological Survey (USGS) has monitored groundwater quantity and quality in the Snake River Plain Aquifer. The National Oceanic and Atmospheric Administration (NOAA) has also monitored weather conditions since the Site's inception.

At the end of 1993, the DOE environmental monitoring program was divided into separate onsite and offsite programs. Responsibility for the onsite program was transferred to the M&O contractor. During 2001, Bechtel BWXT Idaho, LLC (BBWI) was the prime M&O contractor at the INEEL.

The offsite monitoring program was transferred to the Environmental Surveillance, Education and Research (ESER) Program contractor. During 2001, the ESER contractor and offsite monitoring activities were performed by a team led by the S. M. Stoller Corporation.

Air Monitoring

Historical Background

Low-volume air samplers have been operated on and in the vicinity of the INEEL since 1952. Table 3-1 shows the areas where samplers have been located and the dates of operation for these samplers [Reference 3-2]. Before 1960, radiation detection devices, such as a Geiger-Műller tube, were used to record the amount of radioactivity on the filters. Gross beta measurements were made starting in 1960, and by 1967 the present series of analytical measurements were being performed.

High-volume air samplers were operated at the Experimental Field Station (EFS) and CFA from 1973 until October 1996. In 1996, a program evaluation determined that the cost of operating the high-volume samplers was not commensurate with the data being collected, and operations were suspended. Also in 1973, a high-volume sampler began operation in Idaho Falls as part of the U.S. Environmental Protection Agency's (EPA's) nationwide Environmental Radiation Ambient Monitoring System.

Tritium in atmospheric moisture has been measured at a minimum of two locations since at least 1973. Some limited monitoring may have been performed before this time.

One monitoring location at CFA collected samples of noble gases with specific interest in krypton-85 (^{85}Kr) from approximately 1984 until 1992. This station was used to monitor releases of this radionuclide from the INTEC during periods when fuel processing was taking place.

Nitrogen dioxide and sulfur dioxide were first monitored for a 9-week period at five onsite locations in 1972. A nitrogen dioxide sampling station operated from 1983 to 1985 to monitor waste calcining operations at INTEC. A sulfur dioxide sampler was also used from 1984 to 1985. The two sampling locations were reactivated in 1988

Table 3-1. Historical air sampling locations and dates of operations.

Sampling Location	Dates of Operation
Distant Locations	
Aberdeen	1952-1957, 1960-1970
American Falls	1970
Blackfoot	1968-2001
Blackfoot Community Monitoring Station	1983-present
Carey	1961-1970
Craters of the Moon[a]	1973-present
Dubois	2001-present
Dietrich	1961-1970
Idaho Falls	1953-1955, 1956-present
Jackson	2001-present
Minidoka	1961-1970
Pocatello	1969-1980
Rexburg Community Monitoring Station	1983-present
Spencer	1953-1956
Boundary Locations	
Arco	1968-present
Atomic City	1953-1957, 1960-1970, 1973- present
Butte City	1953-1957, 1960-1973
Blue Dome	2001-present
Federal Aviation Administration Tower	1981-present
Howe	1958-present
Monteview	1958-present
Mud Lake	1958-present
Reno Ranch/Birch Creek	1958-2001
Roberts	1960-1970
Terreton	1953-1956, 1964-1965
INEEL Locations	
Argonne National Laboratory-West	1961-present
Aircraft Nuclear Propulsion Program	1953-1955, 1961-1963
Auxiliary Reactor Area	1966-present
Central Facilities Area	1953-present
East Butte	1953-1955
Experimental Breeder Reactor No. I	1952-1956, 1958-present
Experimental Field Station	1972-present
Fire Station #2	1958-1963
Gas-Cooled Reactor Experiment	1961-1963
Idaho Nuclear Technology and Engineering Center	1953-1956, 1958-1970, 1981- present
Main Gate	1976-present
Mobile Low Power Reactor No. 1	1961-1963
Naval Reactors Facility	1956, 1958-present
Organic Moderated Reactor Experiment	1957-1963
Power Burst Facility	1958-present
Radioactive Waste Management Complex	1973-present
Rest Area, Highway 20	2000-present
Stationary Low-Power Reactor No. I	1961-1963
Test Area North	1953-1955, 1956-present
Test Reactor Area	1953-1956, 1958-present
Van Buren Avenue	1976-present

a. Designated as a boundary location 1973-1981.

for nitrogen dioxide, and one station has operated since 1989 for sulfur dioxide.

The National Park Service, in cooperation with other federal land management agencies, began the Interagency Monitoring of Protected Visual Environments (IMPROVE) program in 1985. This program was an extension of an earlier EPA program to measure fine particles of less than 2.5 µm in diameter ($PM_{2.5}$). These particles are 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. Each of the two samplers collected two 24-hour $PM_{2.5}$ samples a week. Analyses were performed for mass, optical absorption, hydrogen, carbon, nitrogen, and oxygen plus elements from sodium through lead on the periodic table. EPA removed the CFA sampler from the nationwide network in May 2000.

Current Programs

Both the ESER and M&O contractors maintain a network of low-volume air samplers to monitor for airborne radioactivity (Figure 3-2). The ESER contractor operates 12 samplers at offsite locations and 3 onsite samplers. The ESER contractor added a 13th offsite sampler in June 2001 at Jackson, Wyoming. They also moved samplers to two new locations in July 2001. The sampler in Blackfoot was moved to Dubois and the sampler in Reno Ranch/Birch Creek was moved to Blue Dome. The M&O contractor maintains 13 onsite and 4 offsite sampling locations. The M&O contractor added the 13th onsite sampler in August 2000 at the U.S. Highway 20 Rest Area to perform monitoring following the Tin Cup range fire of July 27, 2000.

Each low-volume air sampler maintains an average airflow of 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 particulates.

Filters from the low-volume air samplers are collected and analyzed weekly. Charcoal cartridges are analyzed for iodine-131 (^{131}I) either individually or in batches of up to nine cartridges. During batch counting, if any activity is noted in a batch, each cartridge in that batch is recounted individually.

Particulate filters are analyzed weekly using a proportional counting system. Filters are analyzed after waiting a minimum of 4 days to allow naturally occurring radon progeny to decay. Gross alpha and beta analyses are used as a screening technique to provide timely information on levels of radioactivity in the environment.

Specific radionuclide analyses are more sensitive than gross alpha and gross beta analyses for detecting concentrations of anthropogenic (human-made) 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 specific transuranic radionuclides (americium-241 [^{241}Am] plutonium-238 [^{238}Pu], plutonium-239/240 [$^{239/240}Pu$]), and strontium-90 (^{90}Sr). The analyses for alpha-emitting radionuclides use chemical separation techniques followed by alpha spectrometry; for ^{90}Sr, the chemical separation is followed by beta counting.

Measurements of suspended particulates are performed on the 1.2-µm pore membrane filters from the low-volume air samplers. The M&O contractor weighs these filters weekly before and after sampling to determine the amount of material collected. The ESER contractor also weighs these filters before and after use weekly. In both cases, the amount of material collected is determined by subtracting the presampling (clean filter) weight from the postsampling (used filter) weight. The concentration of suspended particulates is calculated by dividing the amount of material collected on the filters by

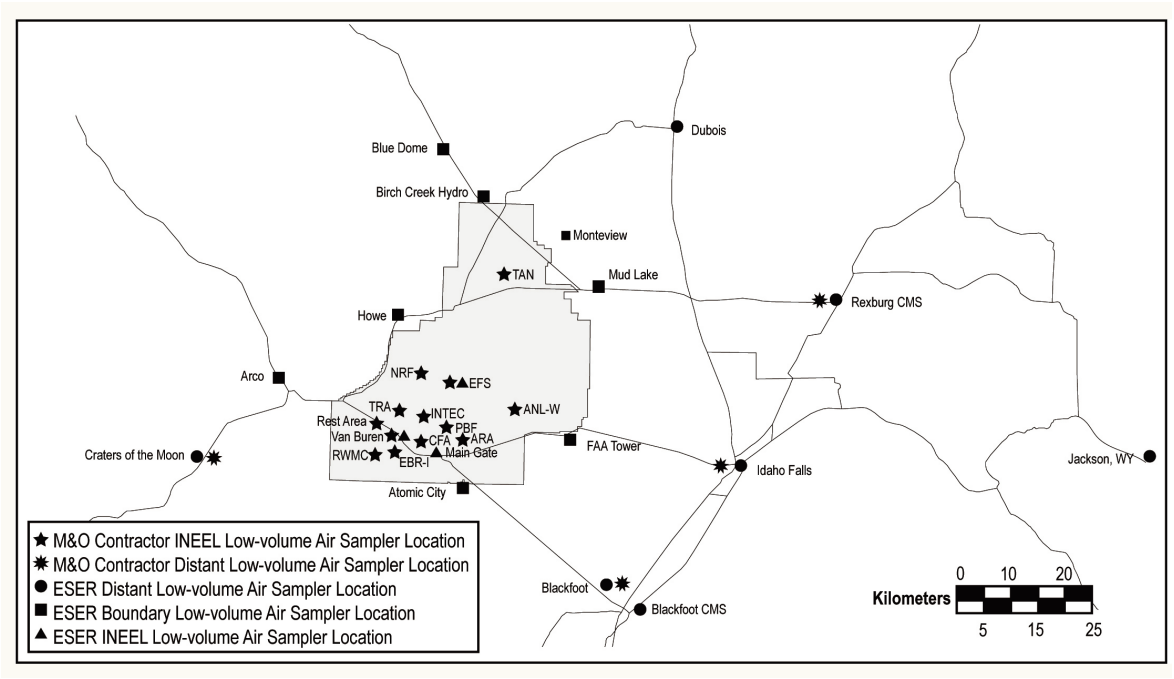


Figure 3-2. ESER and M&O contractor low-volume air sampling locations.

the total volume of air that passed through the filters.

Samplers for tritium in atmospheric moisture are located at two onsite and four offsite locations. In these samplers, air is passed through a column of either silica gel or molecular sieve material at 0.3–0.5 L/hr (0.6–1.0 ft^3/hr). The material in the column absorbs water vapor. Columns are changed when sufficient moisture to obtain a sample is absorbed (typically from one to three times per quarter). Tritium concentrations are then determined by liquid scintillation counting of the water extracted from the columns.

Tritium is also monitored using precipitation samples collected on the INEEL monthly at CFA and weekly at the EFS. A monthly sample is also obtained offsite in Idaho Falls. A portion of each precipitation sample is submitted for tritium analysis by liquid scintillation counting.

Nitrogen dioxide continues to be monitored at two stations (Van Buren Boulevard and EFS) on the INEEL. Sulfur dioxide is monitored at one station (Van Buren Boulevard). Use of the IMPROVE sampler at CFA was discontinued in May 2000 when the station was removed by EPA from the nationwide network. The station at Craters of the Moon continues to operate.

Water Monitoring

Historical Background

The USGS has conducted studies of groundwater at the INEEL since the Site's inception in 1949. The USGS was initially tasked to characterize water resources of the area and has since maintained a groundwater quality and water level measurement program on the INEEL to support research and monitor the movement of radioactive and chemical constituents in the Snake River Plain Aquifer. The first well, USGS 1, was completed and monitored in December 1949. An INEEL Project Office has been located at CFA since 1958 [Reference 3-3].

In 1993, the DOE Idaho Operations Office (DOE-ID) initiated a program to integrate all of the various groundwater monitoring programs on the INEEL. This

resulted in the development of the *INEL Groundwater Monitoring Plan* and the *INEL Groundwater Protection Management Plan*. The monitoring plan described historical conditions and monitoring programs, and it included an implementation plan for each facility. The protection management plan established policy and identified programmatic requirements [Reference 3-4].

Sampling and analysis of drinking water both onsite and offsite began in 1958. Analysis for tritium began in 1961. Up to 28 locations were sampled before increased knowledge of the movement of groundwater beneath the INEEL led to a decrease in the number of sampling locations.

A program to monitor lead and copper in drinking water in accordance with EPA regulations has been in place since 1992. Three successive years of monitoring lead and copper levels in drinking water were concluded in 1995. Since regulatory values were not exceeded, this monitoring has been reduced to once every 3 years beginning in 1998.

As one of the requirements of the National Pollutant Discharge Elimination System General Permit effective October 1, 1992, the INEEL was obligated to develop a storm water monitoring program. Sampling of snowmelt and rain runoff began in 1993, and it included up to 16 sites at eight INEEL facilities. Samples were collected from storms of at least 0.25 cm (0.1 in.) of precipitation preceded by a minimum of 72 hours without precipitation [Reference 3-5].

In September 1998, the EPA issued the "Final Modification of the National Pollutant Discharge Elimination System Storm Water Multi-Sector General Permit for Industrial Activities" [Reference 3-5]. The permit required sample collection and laboratory analysis every four years (last collected in 1999) at 18 potential discharge locations. The permit also required continued annual monitoring from coal piles at INTEC whenever there was a discharge to the Big Lost River System. In addition, quarterly visual monitoring was required at all other designated locations.

Current Programs

USGS personnel collect samples from 177 observation or production wells and auger holes and have them analyzed for selected organic, inorganic, and radioactive substances. Sampling is performed on schedules ranging from monthly to annually. These samples are submitted to the RESL at CFA for analysis of radioactive substances and to the USGS National Water Quality Laboratory in Lakewood, Colorado, for analysis of organic and inorganic substances. The USGS also records water levels at 205 selected wells on schedules ranging from monthly to annually.

The USGS also conducts special studies of the groundwater resources of the Eastern Snake River Plain. The abstract of each study published in 2001 is provided in Appendix C. These special studies provide more specific geological, chemical, and hydrological information on the characteristics of the aquifer and the movements of chemical and radiochemical substances in the groundwater. One special USGS investigation of particular interest is the ongoing annual sampling effort in the area between the southern boundary of the INEEL and the Hagerman area, known as the Magic Valley Study. This study was prompted by public concern that radiochemical and chemical constituents generated by INEEL facilities could migrate through the SRPA to the Snake River in the Twin Falls-Hagerman area. Current results of this study are summarized in USGS Open File Report 01-358 [Reference 3-6].

The M&O contractor conducts groundwater monitoring in support of state of Idaho Wastewater Land Application Permit requirements at INTEC, CFA, TAN, and TRA as well as surveillance monitoring at INTEC. In 2001, this included collecting 234 groundwater samples yielding 482 parameter results. ANL-W also

performs groundwater monitoring in support of state of Idaho Wastewater Land Application Permit requirements as well as surveillance monitoring.

The M&O contractor's Drinking Water Program monitors production and drinking water wells for radiological, chemical, and bacteriological contaminants at all their INEEL facilities. Currently, 17 wells and 10 distribution systems are 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. The NRF maintains a separate program for sampling drinking water at that facility. Radiological and bacteriological samples from ANL-W are sent to the M&O contractor for analysis. ANL-W conducts a separate program for chemical monitoring.

M&O personnel collect quarterly onsite drinking water samples from active systems for radiological analysis. Paragon Laboratory, located in Fort Collins, Colorado, performed these analyses during 2001. 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 CFA and INTEC because some water quality monitoring data indicate this water may contain ^{90}Sr concentrations above background levels.

The Environmental Hygiene Laboratory operated by the M&O contractor analyzes potable water at the INEEL for coliform bacteria monthly. If indications of contamination by bacteria are found in a sample, that particular drinking water system is taken out of service until it can be disinfected, resampled, and tested again until it is clear of bacteria. Corrective action to purify the water may vary among facilities.

The M&O contractor's Drinking Water Program also samples drinking water from wells and distribution systems at INEEL facilities for volatile organic compounds. Chlorinated drinking water systems are also monitored for total trihalomethanes (bromoform, bromodichloromethane, chloroform, and dibromochloromethane). Additional sampling is conducted for a variety of inorganic constituents, including metals, nitrates, and dissolved solids.

Storm water from the coal piles at INTEC did not discharge to the Big Lost River System in 2001; therefore, analytical monitoring was not required. Thus, monitoring in 2001 consisted only of quarterly visual monitoring at 18 locations and analytical monitoring at two RWMC locations.

The ESER contractor collects drinking water samples semiannually from boundary and distant communities. Surface water samples are collected from springs in the Twin Falls area and the Snake River at Idaho Falls and Bliss. Each water sample is analyzed for gross alpha- and beta-emitting radionuclides, as well as for tritium.

Agricultural Products and Vegetation Monitoring

Historical Background

Milk was the first agricultural product to be monitored beginning in at least 1957. The number of samples collected per year has been relatively constant since about 1962. Because of improvements in counting technology, the detection limit for ^{131}I has decreased from about 15,000 pCi/L in early sampling to the current detection level of about 2 pCi/L.

Wheat was first sampled as part of the radioecology research program in about 1962. The current monitoring program dates back to 1963. Potatoes were first collected in 1976 as part of an ecological research project. Regular potato sampling was resumed in 1994 in response to public concern. Lettuce has been collected since 1977.

Current Programs

Milk samples are collected from both commercial and single-family dairies. A 2-L (0.5-gal) sample is 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.

Wheat samples are collected from grain elevators in the region surrounding the INEEL. All wheat samples are analyzed for ^{90}Sr and gamma-emitting radionuclides.

Potato samples are collected from storage warehouses in the INEEL vicinity, with three to five samples from distant locations. The potatoes, with skins included, are cleaned and weighed before processing. All potato samples are analyzed for ^{90}Sr and gamma-emitting radionuclides.

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.

The M&O contractor annually collects perennial and grass samples from around the major waste management facilities. These samples are analyzed for gamma-emitting radionuclides. ANL-W also collects vegetation samples annually from around the Industrial Waste Pond and along the Industrial Waste Ditch. These samples are analyzed for alpha, beta, and gamma radionuclides.

Animal Tissue Monitoring

Historical Background

Monitoring of game animals has focused on research into the movement of radionuclides through the food chain. Rabbit thyroids and bones were first sampled in 1956. In 1973, routine sampling of game animal tissues was instituted; the first studies on waterfowl that were using radioactive waste disposal ponds occurred the following year. Waterfowl studies have covered the periods 1974–1978,1984–1986, and 1994–present. In 1998, the collection of waterfowl became part of the regular surveillance program.

Mourning doves were collected in 1974 and 1975 as part of a radioecology research project. Routine dove sampling as part of the environmental surveillance program was initiated in 1996. In 1998, sampling of yellow-bellied marmots was added to the sampling program.

Sheep that have grazed onsite have been part of the routine monitoring program since a special study was conducted in 1975. Beef cattle were also monitored biennially during the period 1978 to 1986.

Current Programs

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 before gamma spectrometry analysis.

Waterfowl samples are collected from waste disposal ponds at four facilities on the INEEL. 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.

Mourning doves are collected from the vicinity of INTEC and TRA and from a control area distant to the INEEL. Because of the small size of a typical dove, muscle tissues from several doves are composited into one sample. Samples are analyzed for gamma-emitting radionuclides, ^{90}Sr, and transuranic radionuclides.

Yellow-bellied marmots are collected from the RWMC and a control location distant to the INEEL. All marmot samples are analyzed for gamma-emitting radionuclides, with randomly selected samples also analyzed for ^{90}Sr and transuranic radionuclides.

Samples of tissue (muscle, liver, and thyroid) are collected from sheep grazing on the INEEL. Sheep are collected after having been on the INEEL for a minimum of 2 weeks. Control samples are collected from a location distant to the INEEL. The muscle and liver are processed and analyzed by gamma spectrometry. The thyroid is placed in a vial and analyzed specifically for ^{131}I.

Soil Monitoring

Historical Background

Soil sampling has been included as part of routine monitoring programs since the early 1970s, although some limited soil collection was performed around various facilities as far back as 1960. Offsite soil sampling at distant and boundary locations was conducted annually from 1970 to 1975, then every 2 years starting in 1978. Soil samples in 1970, 1971, and 1973 represented a composite of five cores of soil 5-cm (2-in.) in depth from a 1-m^2 (~10-ft^2) area. In all other years, the five cores were collected from two depths 0-5 cm (0-2 in.) and 5-10 cm (2-4 in.) within a 100-m^2 (~1076-ft^2) area.

A soil sampling program began in 1973 around onsite facilities. Soils at each facility were sampled every 7 years. In 2001, all locations were sampled as the frequency was increased to every 2 years.

Current Programs

Twelve offsite locations are sampled in even numbered years. Following collection, soil samples are dried for at least 3 hours at 120°C (250°F) and sieved. Only soil particles less than 500 microns in diameter (35 mesh) are analyzed. All offsite samples are analyzed for gamma-emitting radionuclides, ^{90}Sr, and transuranic radionuclides.

In preparation for a change in sampling schedule from a 7-year rotation to a 2-year rotation, the M&O contractor sampled all 277 sites in 2001. All sites are analyzed in-situ for gamma emitting radionuclides and ^{90}Sr. Approximately 10 percent of the sites have a sample collected for laboratory analysis of gamma-emitting and transuranic radionuclides. Samples are collected from 0–5 cm (0–2 in.) and sieved at the sample site with the 35-mesh fraction being collected. The M&O contractor also performs annual sampling of the CFA sewage treatment plant irrigation spray field to show compliance with the Wastewater Land Application Permit.

ANL-W collects soil samples annually at locations along the major wind directions and at crosswind locations. Samples are analyzed for low-level alpha-, beta-, and gamma-emitting radionuclides.

Direct Radiation Monitoring

Historical Background

Measurements of radiation in the environment have been made on the INEEL since 1958. The technology used for radiation measurements at fixed locations has evolved from film badges to thermoluminescent dosimeters (TLDs). In addition to these locations, surveys using hand-held and vehicle-mounted, radiation instruments have been conducted since at least 1959. Aerial radiological surveys were also performed in 1959, 1966, 1974, 1982, and 1990.

Current Programs

Environmental dosimeters, known as TLDs, are used to measure ambient ionizing radiation exposures. The TLDs measure ionizing radiation exposures from all external sources. External sources include 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 holder containing four individual chips is placed 1 m (3 ft) above ground level. The M&O contractor maintains dosimeters at 13 offsite locations and 135 locations on the INEEL. The ESER contractor has dosimeters at 14 offsite locations. The dosimeter card at each location is changed semiannually, and cumulative gamma radiation is measured by the M&O contractor Dosimetry Unit.

In addition to TLDs, the M&O contractor uses a mobile global positioning system radiometric scanner arrangement to conduct gamma radiation surveys. The scanner is mounted on a four-wheel drive vehicle, which is driven at approximately 8 km/hr (5 mi/hr). Two plastic scintillation detectors are used, and radiometric and global positioning system data are continuously recorded.

Meteorological Monitoring

Historical Background

The NOAA Air Resources Laboratory-Field Research Division (NOAA ARL-FRD) began work at the INEEL in 1948 as a Weather Bureau Research Station. The first meteorological observation station established to support the Site began operation in 1949 at CFA. The network of stations expanded in the 1950s to provide more closely spaced data. The current mesonet was designed and constructed in the 1990s.

Current Programs

NOAA ARL-FRD currently maintains a network of 34 meteorological stations in the vicinity of the INEEL. These stations provide continuous measurements of a variety of parameters, including temperature at two or three elevations, wind direction and speed, relative humidity, and precipitation. In addition, continuous measurements are taken using a wind profiling radar system and a radio acoustic sounding system located on the INEEL. Data are transmitted via radio to the NOAA ARL-FRD Idaho Falls facility, where they are stored in a computerized archive.

Monitoring Summary

Tables 3-2 through 3-4 present a summary of the environmental surveillance programs conducted by the ESER contractor, the M&O contractor, and the USGS, respectively, in 2001.

3.2. ENVIRONMENTAL RESTORATION PROGRAM

Overview

Since the Federal Facility Agreement and Consent Order (FFA/CO) was signed in December 1991, the INEEL has cleaned up sites containing asbestos, petroleum products, acids and bases, radionuclides, unexploded ordnance and explosive residues, polychlorinated biphenyls (PCBs), heavy metals, and other hazardous wastes. The INEEL Environmental Restoration Program has maintained significant progress in accomplishing its goals. As of December 2001, a tally of environmental restoration activities at the INEEL showed:

- Twenty-one Records of Decision (RODs) have been signed and are being implemented;
- Four Remedial Investigation/Feasibility Studies (RI/FSs) are under development; and
- More than 60% of Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) actions are complete.

Comprehensive RI/FSs have been completed for Waste Area Groups (WAGs) 1, 2, 3, 4, 5, 8, and 9. Comprehensive RI/FSs are being developed for WAGs 7 and 10. The RI/FS for the INTEC Tank Farm is also being developed. The comprehensive RI/FSs, which take an average of 40 months to complete, accomplish the following:

- Determine the cumulative risks for an entire WAG by assessing the combined impact of all release sites within that group;

Table 3-2. ESER environmental surveillance program summary (2001).

Medium Sampled	Type of Analysis	Locations and Frequency		Minimum Detectable Concentration
		Onsite	Offsite	
Air (low volume)	Gross alpha	3 weekly	14 weekly	1×10^{-15} µCi/mL
	Gross beta	3 weekly	14 weekly	3×10^{-12} µCi/mL
	Specific gamma	3 quarterly	14 quarterly	4×10^{-10} µCi/mL
	^{238}Pu	1-2 quarterly	7 quarterly	2×10^{-18} µCi/mL
	$^{239/240}$Pu	1-2 quarterly	7 quarterly	2×10^{-18} µCi/mL
	^{241}Am	1-2 quarterly	7 quarterly	2×10^{-18} µCi/mL
	^{90}Sr	1-2 quarterly	7 quarterly	1×10^{-6} µCi/mL
	^{131}I	3 weekly	14 weekly	4×10^{-15} µCi/mL
	Total Particulates	3 quarterly	14 quarterly	10 µg/m^3
Air (PM_{10})	Weighing filter	None	3 weekly	Not Applicable
Air (atmospheric moisture)	Tritium	None	4 locations, 2 to 4 per quarter	4×10^{-12} µCi/mL
Air (precipitation)	Tritium	1 weekly/ 1 monthly	1 monthly	3×10^{-7} µCi/mL
Drinking Water	Gross alpha	None	13 semiannually	3×10^{-9} µCi/mL
	Gross beta	None	13 semiannually	2×10^{-9} µCi/mL
	Tritium	None	13 semiannually	3×10^{-7} µCi/mL
Surface Water	Gross alpha	None	5 semiannually	3×10^{-9} µCi/mL
	Gross beta	None	5 semiannually	2×10^{-9} µCi/mL
	Tritium	None	5 semiannually	3×10^{-7} µCi/mL
Animal Tissue (sheep)[a]	Specific gamma	4 annually	2 annually	5×10^{-9} µCi/g
	^{131}I	4 annually	2 annually	3×10^{-9} µCi/g
Animal Tissue (game)	Specific gamma	Varies annually[b]	Varies annually	5×10^{-9} µCi/g
	^{131}I			3×10^{-9} µCi/g
Agricultural Products (milk)	^{129}I	None	1 weekly	3×10^{-9} µCi/mL
	^{131}I	None	1 weekly/ 9 monthly	3×10^{-9} µCi/mL
	^{90}Sr	None	9 annually	5×10^{-9} µCi/mL
	Tritium	None	9 annually	3×10^{-7} µCi/mL
Agricultural Products (potatoes)	Specific gamma	None	8 annually	1×10^{-7} µCi/g
	^{90}Sr	None	8 annually	2×10^{-7} µCi/g
Agricultural Products (wheat)	Specific gamma	None	11 annually	1×10^{-7} µCi/g
	^{90}Sr	None	11 annually	2×10^{-7} µCi/g
Agricultural Products (lettuce)	Specific gamma	None	9 annually	1×10^{-7} µCi/g
	^{90}Sr	None	9 annually	2×10^{-7} µCi/g
Soil	Specific gamma	None	12 biennially	1×10^{-9} µCi/g
	^{238}Pu	None	12 biennially	5×10^{-9} µCi/g
	$^{239/240}$Pu	None	12 biennially	1×10^{-7} µCi/g
	^{241}Am	None	12 biennially	5×10^{-9} µCi/g
	^{90}Sr	None	12 biennially	5×10^{-8} µCi/g
Direct Radiation Exposure (TLDs)	Ionizing radiation	None	14 semiannually	5 mR

a. Onsite animals grazed onsite for at least 2 weeks before being sampled. Offsite animals have never grazed onsite and serve as controls.

b. Only game animals that are victims of road-kills or natural causes are sampled onsite. No controls are generally collected except for specific ecological studies.

Table 3-3. M&O contractor site environmental surveillance program summary (2001).

Medium Sampled	Type of Analysis	Locations and Frequency		Minimum Detectable Concentration
		Onsite	Offsite	
Air (low volume)	Gross alpha	13 weekly	4 weekly	1×10^{-15} µCi/mL
	Gross beta	13 weekly	4 weekly	5×10^{-15} µCi/mL
	Specific gamma	13 quarterly	4 quarterly	—[a]
	^{238}Pu	13 quarterly	4 quarterly	2×10^{-18} µCi/mL
	^{241}Am	13 quarterly	4 quarterly	2×10^{-18} µCi/mL
	^{90}Sr	13 quarterly	4 quarterly	2×10^{-14} µCi/mL
	Particulate matter	13 quarterly	4 quarterly	10 µg/m^3
Air (atmospheric moisture)	Tritium	1 to 2 per quarter	—[b]	1×10^{-11} µCi/mL
Air	Nitrogen oxides	Continuous	—	NA[c]
Air	Sulfur dioxide	Continuous	—	NA
Soil	Specific gamma	Varies annually[d]	—	1×10^{-7} µCi/g
	Pu isotopes	Varies annually	—	3×10^{-9} µCi/g
	^{241}Am	Varies annually	—	3×10^{-9} µCi/g
	^{90}Sr	Varies annually	—	6×10^{-8} µCi/g
Vegetation	Specific gamma	Varies annually[d]	—	1×10^{-7} µCi/g
	^{238}Pu	Varies annually	—	1.2×10^{-8} µCi/g
	$^{239/240}Pu$	Varies annually	—	6×10^{-10} µCi/g
	^{241}Am	Varies annually	—	1.2×10^{-8} µCi/g
	^{90}Sr	Varies annually	—	1.2×10^{-8} µCi/g
Drinking Water	Gross alpha	12 Quarterly	—	1 pCi/L
	Gross beta	12 Quarterly	—	4 pCi/L
	Tritium	12 Quarterly	—	1,000 pCi/L
	^{90}Sr	4 Quarterly	—	2 pCi/L
	Other radionuclides	12 Quarterly	—	[a]
	Volatile organics	10 Annually/ 4 Quarterly	—	0.5 ppb
	Semivolatile organics	12 triennially	—	0.5 ppb
	Inorganics	12 triennially	—	0.5 ppb
Direct Radiation Exposure (TLDs)	Ionizing radiation	135 semiannually	13 semiannually	5 mR
Direct Radiation Exposure (mobile radiation surveys)	Gamma radiation	Facilities and INEEL Roads[e]	—	NA

a. Minimum detectable concentration for gamma spectroscopic analyses varies depending on radionuclide.

b. Denotes that the M&O contractor does not collect samples from offsite locations for this parameter.

c. NA = not applicable. This information is recorded as an instrument reading at the time of inspection.

d. Onsite soil sampling is performed each year at different onsite facilities on a rotating 2-year schedule.

e. Surveys are performed each year at different onsite facilities on a rotating 3-year schedule. All INEEL roadways over which waste is transported are surveyed annually.

Table 3-4. U.S. Geological Survey monitoring program summary (2001).

Constituent	Frequency	Groundwater		Surface water		Minimum Detectable Concentration
		Number of Sites	Number of Samples	Number of Sites	Number of Samples	
Gross alpha	Semiannually	43	86	4	8	3×10^{-9} µCi/mL
Gross beta	Semiannually	43	86	4	8	4×10^{-9} µCi/mL
Tritium	Quarterly	30	120	—[a]	—[a]	4×10^{-7} µCi/mL
	Semiannually	95	190	7	14	
	Annually	39	39	—	—	
Specific gamma	Quarterly	5	20	—	—	—[b]
	Semiannually	58	116	4	8	
	Annually	26	26	—	—	
Strontium-90	Quarterly	25	100	—	—	5×10^{-9} µCi/mL
	Semiannually	60	120	—	—	
	Annually	33	33	—	—	
Americium-241	Quarterly	5	20	—	—	5×10^{-11} µCi/mL
	Semiannually	13	26	—	—	
	Annually	3	3	—	—	
Plutonium isotopes	Quarterly	5	20	—	—	4×10^{-11} µCi/mL
	Semiannually	13	26	—	—	
	Annually	3	3	—	—	
Conductivity	Quarterly	30	120	—	—	Not applicable
	Semiannually	96	192	7	14	
	Annually	39	39	—	—	
Sodium ion	Quarterly	2	8	—	—	1×10^{-1} mg/L
	Semiannually	46	92	—	—	
	Annually	98	98	—	—	
Chloride ion	Quarterly	30	120	—	—	1×10^{-1} mg/L
	Semiannually	95	190	7	14	
	Annually	39	39	—	—	
Nitrates (as nitrogen)	Semiannually	42	84	—	—	5×10^{-2} mg/L
	Annually	67	67	—	—	
Sulfate	Quarterly	2	8	—	—	1×10^{-1} mg/L
	Triennially	3	9	—	—	
	Semiannually	10	20	—	—	
	Annually	103	103	—	—	
Chromium (dissolved)	Quarterly	4	16	—	—	5×10^{-3} mg/L
	Semiannually	71	142	—	—	
	Annually	17	17	—	—	
Purgeable Organic Compounds[c]	Monthly	1	12	—	—	2×10^{-3} mg/L
	Quarterly	4	16	—	—	
	Semiannually	17	34	—	—	
	Annually	7	7	—	—	
Total Organic Carbon	Annually	42	42	—	—	1×10^{-1} mg/L
Trace elements	Semiannually	9	18	—	—	varies

a. No samples collected at this frequency.

b. Minimum detectable concentration for gamma spectroscopic analyses varies depending on radionuclide.

c. Each purgeable organic compound water sample is analyzed for 60 volatile organic compounds.

- Review assumptions used in each previous investigation, including "No Further Action" sites, Track 1 and 2 limited field investigations, RI/FSs, and interim actions;
- Identify data gaps and recommend actions, such as field sampling or historical document research, to resolve questions;
- Perform feasibility studies to evaluate remedial alternatives for the entire WAG;
- Develop proposed plans presenting the alternatives and recommending a preferred alternative; and
- Develop RODs selecting the alternative and resolving public comments.

The general procedure for all comprehensive investigations begins with developing a work plan outlining 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. Only four investigations remain to be completed:

- Buried waste at the RWMC (WAG 7);
- Soil contamination at the INTEC Tank Farm (WAG 3, Operable Unit 3-14);
- Miscellaneous sites, including Experimental Breeder Reactor No. 1 (EBR-I)/Boiling Water Reactor Experiment (BORAX) (WAG 10, Operable Unit 10-4); and
- Snake River Plain Aquifer contamination (WAG 10, Operable Unit 10-8).

Waste Area Group 1 – Test Area North

Waste Area Group 1 – Groundwater Remediation

Cleanup of the TAN injection well began in 1993. The well was used from 1953 until 1972 to inject liquid wastes into the fractured basalt of the Snake River Plain Aquifer. The wastes included organic and inorganic compounds and low-level radioactive waste (LLW) combined with industrial and sanitary wastewaters. The resulting plume contaminated some of the drinking water wells used by TAN workers. A well that meets drinking water standards is used to supply drinking water to TAN workers, and untreated groundwater is not accessible to workers or the public.

The TAN groundwater final remedial action ROD was approved in August 1995. The Groundwater Treatment Facility, designed and constructed under a 1994 interim action, has been in continuous operation since November 1996. The Groundwater Treatment Facility is a pump and treat unit that uses air strippers and filters to remove contaminants. More than 32.1 million L (8.5 million gal) of contaminated groundwater was treated in 2001.

In 1999, new innovative technologies, such as in-situ bioremediation and in-situ chemical oxidation, were evaluated to determine if there was a more effective technology than pump and treat. The evaluation showed that in-situ bioremediation was a better alternative for the area around the old injection well (also called the “hot spot”), and that monitored natural attenuation was a better alternative for the distal portion of the plume. The evaluation showed that pump and treat was still the best alternative for the medial zone of the plume. As a result, a Proposed Plan was distributed for public comment proposing that the remedy be changed to in-situ bioremediation at the hot spot and monitored natural attenuation in the distal zone. Pump and treat would remain the technology for the medial zone.

Waste Area Group 1 – Comprehensive RI/FS

Ten operable units, including tanks containing PCBs, hazardous, and radioactive wastes (the V-tanks), were evaluated during the final investigation. A ROD for the comprehensive investigation was signed at the end of 1999. Remediation efforts continued at eight contaminated sites identified in the ROD.

The V-tanks and burn pits were sampled in 2001 to determine the best course of action for remediating those areas. The V-tanks' contents were scheduled to be shipped offsite to a commercial facility for treatment, but the vendor has closed. An alternative is being developed for this waste.

Waste Area Group 2 – Test Reactor Area

Waste Area Group 2 – Perched Water System

Perched water under the TRA is a zone of groundwater standing 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 wastewater disposal ponds. Routine compliance monitoring continued in 2001 to aid regulatory agencies in comparison of predicted and actual contaminant concentrations in the perched water.

Waste Area Group 2 – Newly Identified Sites

Six potentially contaminated sites were identified since the original RI/FS report. These sites contain either contaminated soils, abandoned underground acid pipelines, or abandoned underground fuel oil pipelines. Two of the sites, consisting of buried fuel lines, have been determined to require no further action and will be monitored under institutional controls. The other sites continue to be investigated.

Waste Area Group 2 – Comprehensive RI/FS

Remediation has been completed at eight sites identified in the 1997 ROD. Sites include the Warm Waste Pond, Chemical Waste Pond, and Sewage Leach Pond. Cleanup actions at the three ponds consisted of covering them with intrusion-resistant soil barriers, implementation of institutional controls for access, and use restrictions to protect current and future users. Some of the remediated sites, totaling almost 3.2 ha (8 acres), were replanted.

Waste Area Group 3 – Idaho Nuclear Technology and Engineering Center

Waste Area Group 3 – Tank Farm

The RI/FS to investigate contaminated soils and the aquifer beneath the INTEC Tank Farm began in January 2001. The Tank Farm consists of 20 underground stainless steel tanks, and associated equipment for waste transfer, used to store the radioactive liquid waste generated during the reprocessing of spent nuclear fuel (SNF). Approximately 95 percent of the existing environmental contamination at the Tank Farm is the result of leakage from transfer lines and valve boxes. The tanks themselves have not leaked. This investigation will gather information on the distribution, quantities, and concentrations of contaminants related to the Tank Farm soil. Once the investigation phase is complete, a separate ROD will be prepared to detail cleanup actions.

Waste Area Group 3 – New Wastewater Disposal Ponds

One of the actions under the approved ROD for WAG 3 is to reduce contributions to perched water beneath the INTEC that might be contributing to contaminant migration. A large part of this task includes curtailment of the use of the current wastewater disposal ponds (percolation ponds). Construction of two new percolation ponds, at a distance of almost 3.2 km (2 mi) from the facility, was completed in 2001. The ponds are scheduled to be placed into service in 2002.

Instruments have been installed around the new ponds to allow scientists to observe water movement in the vadose zone as the ponds fill. The understanding gained from this work will be applied to other areas across the INEEL.

Waste Area Group 3 – INEEL CERCLA Disposal Facility

The INEEL CERCLA Disposal Facility (ICDF) was selected as a remedy in the 1999 ROD for INTEC to address Sitewide soil contamination. The purpose of the

facility is to consolidate INEEL wastes generated from CERCLA cleanup actions at a single engineered onsite facility.

In 2001, construction was started for the ICDF. The facility will have a disposal capacity of 389,000 m^3 (509,000 yd^3) and cover 16 ha (40 acres), including a landfill; evaporation ponds; and a staging, storage, sizing, and treatment facility where contaminated debris can be broken down into smaller parts for disposal. The ICDF is scheduled to open in 2003.

Waste Area Group 3 – Comprehensive RI/FS

The major source of contamination at INTEC is high-level radioactive waste (HLW) generated from past SNF reprocessing activities that is stored in underground storage tanks. The INTEC also has contaminated groundwater from a now sealed injection well, contaminated soils around and beneath buildings, and waste disposal ponds. The chief contaminants are radionuclides. A total of 101 sites of known or suspected contaminant releases were evaluated in the comprehensive RI/FS (December 1997) and summarized in a Proposed Plan (October 1998). Sixty-one of the 101 sites require cleanup; the majority of these sites were addressed in the ROD finalized in October 1999.

The ROD also included a large, onsite disposal facility at INTEC for cleanup-related waste from INEEL (see previous discussion of the ICDF). DOE, EPA, and the State approved remedial action work plans for the Tank Farm Interim Action, Perched Water, and Snake River Plain Aquifer. Remedial actions were begun in 2000 for the Tank Farm Interim Action, Perched Water, Snake River Plain Aquifer, and Gas Cylinder sites.

Waste Area Group 4 – Central Facilities Area

Waste Area Group 4 – Comprehensive RI/FS

A total of 13 operable units and 52 potential release sites were examined during this investigation. The main sources of contamination are landfills, a waste disposal pond, a wastewater drain field, and underground storage tanks. Major contaminants are metals, radionuclides, and nitrates. A final ROD for the CFA was signed July 2000 addressing surface contamination at three sites, including a now dry waste disposal pond, a sewage treatment plant drain field, and a transformer yard. Remediation initiated at the transformer yard was completed in 2001. The fieldwork for the sewage treatment plant drainfield cover and the disposal pond remediation will be completed in 2002 and 2003, respectively.

The comprehensive RI/FS was near completion in 1999 when nitrates were detected in two wells in the area in excess of drinking water standards. During 2000, analysis of monitoring data and computer modeling indicated that levels of nitrates would fall below the drinking water standard within 10 to 15 years. DOE, EPA, and the State agreed that continued monitoring was the only action necessary to address this contamination issue.

Waste Area Group 5 – Power Burst Facility/Auxiliary Reactor Area

Waste Area Group 5 – Comprehensive RI/FS

The comprehensive RI/FS report was published in 1999. This report covered 13 operable units and 55 potential release sites. Contaminants include heavy metals, radionuclides, and organic chemicals originating from such sources as underground tanks, hot cells, waste disposal ponds, a sewage system, and buried reactor debris. The comprehensive investigation identified seven sites that require cleanup: three evaporation ponds, a

large contaminated surface soil area, soil beneath now dismantled hot cells, a sanitary waste system, and an underground storage tank. The remaining sites require no remediation and 8 of the 48 sites will remain under institutional controls.

A ROD was signed in February 2000 to remediate the seven sites identified in the RI/FS. Remediation began in June 2000 on the sanitary waste system and tank and one of the five contaminated soil sites. Additional sampling was performed at a second contaminated soil site demonstrating that remediation as defined by the ROD was not necessary. Approximately 60 m^3 (78.4 yd^3) of debris was removed for disposal offsite.

In 2001, remediation was completed at the underground storage tank site, where piping was excavated and sludge was prepared for offsite treatment and disposal. The sludge was dewatered to the extent practicable with the liquid stabilized and shipped to the Staging and Storage Annex awaiting disposal in the ICDF. The tank was removed and the tank and piping placed in appropriate containers, encapsulated in grout, and shipped to the Staging and Storage Annex for eventual disposal in the ICDF. The contaminated soil site that encompassed the Auxiliary Reactor Area facility hot cell was also remediated, including the demolition of the hot cell with the resulting waste shipped to RWMC for disposal.

In addition to the sanitary waste system, underground storage tank, and contaminated soil sites remediated in the 2000-2001 timeframe, closure of four sanitary waste systems was completed. Remediation of the remaining three soil sites, including the largest soil site (23.5 ha [58 acres]), will be coordinated with completion of the ICDF, where the soil will be disposed.

Waste Area Group 6 – Boiling Water Reactor Experiment

Waste Area Group 6 – Comprehensive RI/FS

This comprehensive investigation is being conducted in combination with the WAG 10 comprehensive RI/FS.

Waste Area Group 7 – Radioactive Waste Management Complex

Waste Area Group 7 – Remedial Action of Organic Contamination in the Vadose Zone

The ROD to use the vapor vacuum extraction with treatment as the remediation technology for the vadose zone in the Subsurface Disposal Area (SDA) at the RWMC became final on December 2, 1994. The vadose zone is the area between the land surface and the top of the water table. Organic vapors were released into the vadose zone as buried drums containing volatile organic compounds, such as degreasers and solvents, deteriorated over time.

The full-scale extraction/treatment system consists of three treatment units that extract vapors from three wells and break down the majority of organic compounds chemically to form carbon dioxide, hydrogen chloride, and water. The system began operation in January 1996 and as of 2001, over 43,810 kg (96,585 lb) of total volatile organic compounds has been removed from the vadose zone. The system will continue to extract and treat organics from the SDA in 2002.

Waste Area Group 7 – Pit 9 Interim Action

The staged interim action, a three-stage approach agreed to by the DOE, EPA, and the State, has three main objectives:

- Remediate contamination to a level that protects human health and the environment;
- Provide information to support the final remedial decision for the RWMC SDA; and

- Generate information to support the RI/FS for the RWMC SDA.

The first stage of the staged interim action will provide information on specific subsurface conditions, including whether, how far, and which contaminants have migrated. This information is necessary to support the transport modeling and baseline risk assessment activities for WAG 7. Stage I will also include a limited treatment technology evaluation. Stage II activities include construction, soil treatment studies, and retrieval of buried material from an area of the pit selected during Stage I. Stage III will complete the remediation of Pit 9.

In 2001, Stage I investigations included installation of additional probes within Pit 9 and other areas of the SDA. A total of 314 probes have been installed to help characterize the buried waste and surrounding conditions, including subsurface moisture and temperature; soil water tension and gas content; water sample collection; and remote visual examination of the waste and soil.

In 2001, the State and EPA denied DOE-ID's request for extension of the Pit 9 schedule, leading to a dispute resolution process that is expected to continue into 2002.

Waste Area Group 7 – Comprehensive RI/FS

The Work Plan Addendum, detailing how the comprehensive investigation will be performed, was finalized in August 1998. The addendum reflects schedule and scope changes that resulted from significant delays in the Pit 9 interim action, and it describes additional scope to be completed. However, the outcome of the Pit 9 dispute resolution is likely to further influence scope and schedule for the comprehensive investigation.

Groundwater and perched water samples continue to be collected quarterly in and around the RWMC to assess potential migration of contaminants from the site.

Waste Area Group 8 – Naval Reactors Facility

Waste Area Group 8 – Naval Reactors Facility Remediation

DOE, EPA, and the state of Idaho signed a ROD for ten sites at NRF in 1994. Three of these sites were landfills that were capped with native soil covers in 1996. The agencies agreed the other sites (the Industrial Waste Ditch and six other landfills) required no further action. During 2001, monitoring and maintenance continued at the landfills.

Waste Area Group 8 – Comprehensive RI/FS

A ROD for the comprehensive investigation of the NRF was signed in September 1998. It addressed 64 sites, including nine sites with potentially unacceptable risk to human health or the environment. Fifty-five sites were determined to not require additional actions. Remediation continued in 2001 at the nine sites of concern. The effort includes excavating and consolidating soils contaminated with low levels of radionuclides.

Waste Area Group 9 – Argonne National Laboratory-West

Waste Area Group 9 – Comprehensive RI/FS

In 1998, DOE, EPA, and the state of Idaho signed the comprehensive investigation ROD for ANL-W, which identified five sites requiring cleanup. The ROD identified phytoremediation (the use of plants to extract contaminants through their root systems) as the preferred method for removing contaminants from the soil at these five sites, except for portions of two sites. These two sites have additional contamination on which phytoremediation would not be effective. Remediation of these two sites was performed in 2000 with the excavation and disposal of 69 m^3 (90 yd^3) of soil.

At WAG 9, phytoremediation involves using koscia and willows to extract

contaminants. The plants are periodically harvested, dried, packaged, and disposed at an appropriate facility. The phytoremediation project began in 1999 and continued through 2001. Results of analysis on plants at the end of the second year showed that contaminants of concern should meet risk levels by the 6-year deadline. New willows were planted in the spring of 2001 for another 2-year growing cycle.

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

Waste Area Group 10 – Comprehensive RI/FS

This comprehensive investigation will address WAG 6 and 10 sites and the Snake River Plain Aquifer, as well as conducting the Sitewide ecological risk assessment. The scope is collectively referred to as Operable Unit 10-04. A new Operable Unit, 10-08, was created in 1999 to evaluate new contamination release sites that have been and will continue to be identified at the INEEL in the future and to perform a Sitewide cumulative groundwater assessment. The comprehensive Sitewide ecological risk assessment and a comprehensive investigation of contaminated areas of the land surface within the INEEL, including all areas outside facility fences as well as the EBR-I/ BORAX area, was completed in 2000. This investigation encompassed impacts of INEEL activities upon surface water, surface soils, and air. A Proposed Plan based on the comprehensive investigation was issued in 2001.

3.3. WASTE MANAGEMENT PROGRAM

Overview

The mission of the Waste Management Program at the INEEL is to provide safe, compliant, and cost-effective management services for facility waste streams. Safe operations and compliance with federal, State, and local regulations are the highest priorities along with meeting the commitments made in the Idaho Settlement Agreement and the INEEL Site Treatment Plan. The goals of the program are to ensure that workers and the public are protected and 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, and volume;
- Storing wastes awaiting development of new disposal and treatment options; and
- 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. The Waste Management Program continues to provide presentations to the INEEL Citizens Advisory Board to explain issues related to the program. The Waste Management Program continues to promote openness with stakeholders in regard to these issues and works closely with the INEEL Oversight Program and the Idaho Congressional delegation. Stakeholders were also notified of the timeframes for regulatory-required public comment periods and where documents could be found for their review. In addition, stakeholders participated in several tours of the INEEL that featured the mission and accomplishments of the Waste Management Program. Information on surveillance activities specific to waste management facilities is discussed in later chapters.

Federal Facility Compliance Act

The Federal Facility Compliance 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.

In accordance with the final Site Treatment Plan, the INEEL began receiving offsite mixed waste for treatment in January 1996. The INEEL has received mixed waste from other sites within the DOE complex including Hanford, Los Alamos, Paducah, Pantex, Sandia, and six locations managed by the Office of Naval Reactors. The INEEL stopped receiving offsite mixed waste for treatment at the Waste Experimental Reduction Facility in 2000. The INEEL is storing the "backlog" of mixed waste at WROC and INTEC Resource Conservation and Recovery Act-permitted storage. Disposal of the backlog mixed waste will occur by no later than 2006.

Treatment of the majority of the offsite waste was performed at the WROC until fiscal year 2000 using incineration, stabilization, neutralization, and carbon absorption technologies. Disposition of INEEL-generated mixed waste will be obtained from offsite commercial treatment and disposal vendors. Other offsite mixed wastes may be treated at the Advanced Mixed Waste Treatment Facility planned to begin operation at the INEEL in 2003.

In November 2001, the annual Site Treatment Plan report was submitted to the State for review and final approval, and the State approved the report in January 2002. In fiscal year 2001, the INEEL dispositioned 1,337 m^3 (1,749 yd^3) of mixed waste from onsite sources. INEEL also dispositioned 4.5 m^3 (5.9 yd^3) of waste resulting from the high-efficiency particulate air filter leach process.

Advanced Mixed Waste Treatment Project

The overall goal of the Advanced Mixed Waste Treatment Project is the treatment of alpha-containing low-level mixed and transuranic (TRU) wastes for final disposal by a process that minimizes overall costs while ensuring safety. This will be accomplished through a private sector treatment facility with the capability to treat specified INEEL waste streams and the 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.

A contract for treatment services was awarded to BNFL, Inc. in December 1996. The facility is scheduled to treat 65,000 m^3 (85,020 yd^3) of retrievably stored waste managed as TRU starting in 2003, with completion by 2015 but no later than 2018.

High-Level Waste and Facilities Disposition

In 1953, reprocessing of SNF began at the INTEC, resulting in the generation of HLW, including radioactive liquid waste and sodium-bearing liquid waste. Those wastes were placed into interim storage in underground tanks at the INTEC Tank Farm. Treatment of those wastes began in 1963 through a process called calcining. The resultant waste form, known as calcine, was placed in storage in stainless steel bins, known as bin sets, at the Calcine Solids Storage Facility. Processing of SNF was curtailed in 1992. The INEEL completed calcining of all nonsodium-bearing liquid HLW on February 20, 1998, four months ahead of the June 30, 1998 Idaho Settlement Agreement milestone. Calcining of sodium-bearing liquid waste began on February 20, 1998, more than three years ahead of the Settlement Agreement milestone. Per that agreement, all such waste is required to be calcined by the end of the year 2012.

The calciner was placed in standby before the extended deadline of June 1, 2002, per the 1999 Modification to Notice of Noncompliance Consent Order, while DOE determines whether to upgrade and permit the facility to current standards or develop a new method of treating the remaining stored liquid HLW. Treatment alternatives for the remaining liquid and calcined wastes are being evaluated in the Idaho High-Level Waste and Facilities Disposition Environmental Impact Statement. By the

end of 2001, 3,500,000 L (924,602 gal) of sodium-bearing liquid waste in the tank farm, and 4,400 m^3 (5,755 yd^3) of calcined HLW in the bin sets, remained in storage at INTEC.

Low-Level Radioactive Waste

Significant accomplishments were achieved during 2001 in the disposal of LLW stored and generated at the INEEL. Activities at the RWMC Subsurface Disposal Area (SDA) were highlighted by the disposal of over 4,090 m^3 (5,350 yd^3) of legacy and newly generated LLW, and approximately 1,000 m^3 (1,308 yd^3) of LLW was volume-reduced at WROC and at offsite commercial facilities in 2001.

Transuranic Waste

The TRU Program accomplished several major goals in 2001. The INEEL shipped 694 m^3 (908 yd^3) of TRU waste to the Waste Isolation Pilot Plant (WIPP) in Carlsbad, New Mexico. A total of 3,100 m^3 (4,055 yd^3) of stored TRU waste must be shipped to WIPP by December 31, 2002, to meet a Settlement Agreement milestone. Approximately 60 percent of DOE's current inventory of contact-handled TRU waste is stored at the RWMC. The Settlement Agreement requires that all of INEEL's stored TRU waste, currently estimated to be about 64,300 m^3 (84,104 yd^3), must be shipped to WIPP by a target date of 2015 but no later than 2018.

A key certification was received in May 2001 that allows the INEEL to access the majority of TRU waste in storage at the RWMC for shipment to WIPP. The certification allows immediate access to over 60 percent (approximately 9,000 drums) of the stored TRU waste that is categorized as inorganic homogenous solids. INEEL also received a Closing the Circle award from the White House for its waste tracking system, TRIPS (Transuranic Reporting, Inventory, and Processing System). TRIPS is an electronic database tool used to manage and ship TRU waste to WIPP, which relies on a digital signature technology to reduce paperwork and ensure integrity.

Waste Minimization/Pollution Prevention

The mission of the INEEL Pollution Prevention Program is to reduce the generation and release of wastes and pollutants by implementing cost-effective pollution prevention techniques, practices, and policies. Pollution prevention is also required by various federal edicts, including but not limited to, the Pollution Prevention Act, Resource Conservation and Recovery Act (RCRA), Executive Order 12856, and Executive Order 12873 (Federal Acquisition, Recycling, and Waste Prevention).

It is the policy of the INEEL to incorporate pollution prevention into every activity. Pollution prevention is one of the key underpinnings of the INEEL Environmental Management System (see Section 3.4). It functions as an important preventive mechanism because generating less waste reduces waste management costs, compliance vulnerabilities, and the potential for releases to the environment. The INEEL is promoting the inclusion of pollution prevention into all planning activities as well as the concept that pollution prevention is integral to mission accomplishment.

In 2001, the INEEL reported 43 pollution prevention projects, which resulted in a waste reduction of 6,971 m^3 (9,118 yd^3) and decreased the cost of operations by $15.1 million. Noteworthy pollution prevention accomplishments in 2001 include:

- INEEL CFA Landfill Operations awarded a subcontract to a local food manufacturer to burn wood chips for fuel in their wood-fired boiler. Over 982 metric tons (1,082 tons) of wood chips have been burned, providing an avoided waste disposal cost of $1.7 million. Another subcontract awarded to a local speedway to use 766 metric tons (844 tons) of wood chips contaminated with gravel for road

maintenance and erosion control resulted in avoided waste disposal costs of $1.3 million.

- INEEL reduced the volume of LLW for disposal by using soft-sided bags in place of wooden boxes at the RWMC for a total waste reduction of 1,134 m^3 (1,483 yd^3) and a savings of $1.5 million.

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/volumetric survey for free release) as allowable; and
- Provide the means for generators to disposition mixed waste lead.

To date, 91.6 m^3 (119.8 yd^3) of lead waste have been processed through the cask dismantlement activity, including 4 m^3 (5.2 yd^3) in 2001 in accordance with the Site Treatment Plan.

3.4. ENVIRONMENTAL MANAGEMENT SYSTEM

DOE-ID and the INEEL M&O contractor continued to make progress on the effort initiated in 1997 to develop and implement an INEEL-wide Environmental Management System (EMS). The EMS will meet the requirements of International Standards Organization (ISO) 14001, an international voluntary standard for environmental management systems. This standard is being vigorously embraced worldwide and within the DOE complex. The INEEL's goal for certification under ISO 14001 demonstrates continued commitment to improved environmental performance to regulators, the public, and the international business community.

An EMS provides an underlying structure to make the management of environmental activities more systematic and predictable. The EMS focuses on three core concepts: pollution prevention, environmental compliance, and continuous improvement. The primary system components are (1) environmental policy, (2) planning, (3) implementation and operation, (4) checking and corrective action, and (5) management review. DOE-ID is pursuing an EMS enhancement development initiative for the Idaho workforce, and the M&O contractor is working on a parallel effort for the INEEL.

In 2001, efforts continued on schedule toward implementing the elements of the EMS based on the ISO 14001 standard in support of the contractual requirement to achieve ISO 14001 registration by June 2002. Specific actions taken include

- Completion of an overall project plan for ISO 14001 registration;
- Issuance of an improved, more comprehensive INEEL environmental management policy;
- Successful integration of environmental protection into the Integrated Safety Management System (ISMS) and completion of all ISMS milestones related to the implementation of the INEEL EMS;
- Updates to strengthen INEEL documents to ensure full integration of environmental requirements flow-down into the work planning processes;
- Development of a communication plan for ISO 14001 registration;
- Consolidation of functional Environmental Safety and Health support services in order to provide efficiency;
- Increased emphasis on incorporating pollution prevention and environmental

protection within the ISMS and environmental awareness programs; and

- Strengthen the management review process through use of the Integrated Executive Council, which serves as a single decision-making body for INEEL management.

During the period of September 10 to 18, 2001, INEEL Independent Oversight and M+A Environmental Consultants, Inc. performed an audit of the INEEL's EMS. The purpose of the audit was to assess conformance of the EMS to ISO 14001. This audit was performed at the request of the M&O contractor Environmental Affairs Directorate in preparation for an ISO 14001 registration audit scheduled for early 2002. The audit resulted in 24 concerns and ten observations (four positive and six negative). Conclusions from this audit are

- Many of the elements of an ISO 14001-conforming EMS are in place and operational;
- The M&O contractor's EMS does not entirely conform with the requirements of ISO 14001;
- The need for improvement in virtually every EMS element was identified; and
- One element, "Management Review," has not been developed and implemented.

3.5. INEEL LONG-TERM STEWARDSHIP PROGRAM

Completing the remediation activities at the INEEL in compliance with the regulatory agreements governing them will result in residual contamination remaining at some locations onsite. The sites where residual contaminants remain will require long-term stewardship to prevent unacceptable contact between waste residue and the public and to initiate subsequent cleanup activities in the event of an unforeseen increase in contaminant transport through the soil or groundwater. The term long-term stewardship (LTS) refers to all activities necessary to protect human health and the environment following completion of remediation, disposal, or stabilization of a site or a portion of a site. The INEEL considers the scope of LTS to also include the conservation of ecological and cultural resources, and maintaining awareness of changes in technology, regulations, and policy affecting these stewarded sites.

While LTS activities such as monitoring groundwater, conducting surveillance of remedies and maintenance of caps and landfills, and restricting access to residually contaminated sites have been conducted for years at the INEEL under the auspices of several different programs, DOE recognized that management advantages could be gained by consolidating these similar activities into one program. In fiscal year 2000, DOE developed a schedule for creating an INEEL LTS Plan, which would describe the strategic and tactical elements of a consolidated LTS Program at the INEEL. Creation of an LTS Program represents a management consolidation of postremediation responsibilities, regardless of what law or agreement governs the remedy. Consolidating these activities does not change any agreed-upon obligations for the operation, maintenance, monitoring, institutional control, or post-closure care identified in RODs, Hazardous Waste Management Act/Resource Conservation and Recovery Act closure plans, or other agreements. Rather, creation of the INEEL LTS Program is a way to implement postremediation responsibilities agreed to under a variety of regulations in a more efficient and focused manner.

Development of INEEL LTS Plan

The INEEL LTS Plan consists of two parts: (1) a strategic portion, in which the overall vision, mission, objectives, and goals of the program will be captured and (2) a tactical portion, which will document the specific activities and schedules necessary to achieve the vision, mission, objectives, and goals. The INEEL LTS Strategic Plan will be developed in fiscal year 2002 and incorporate stakeholder, regulator, and

Tribal comments and suggestions provided from two public reviews of the draft document. The INEEL LTS Implementation Plan, identifying the tactical activities necessary for achieving the strategic elements, will be developed in fiscal year 2003. Combined, the two documents will constitute the INEEL LTS Plan.

3.6. ENVIRONMENTAL RISK REDUCTION

Decontamination, Decommissioning, and Demolition Activities

Decontamination, decommissioning, and demolition activities at the INEEL are primarily concerned with the safe and compliant decontamination and decommissioning of inactive facilities. These facilities fall under two broad categories: (1) structures potentially suitable for reuse and (2) structures not suitable for reuse. In the last four years more than 100 buildings have been demolished. Specific projects at various facilities are described below.

Test Reactor Area

Decontamination and dismantlement of the Continuous Aerosol Collection System Test Platform in TRA Building 654 was completed in December 2001.

Building 660 (TRA-660) at TRA houses two 100-kilowatt water-cooled nuclear research reactors: the Advanced Reactivity Measurement Facility reactor and the Coupled Fast Reactivity Measurement Facility reactor, with an interconnecting water canal. During 2001, workers drained approximately 113,562 L (30,000 gal) of contaminated water and removed the reactors. The empty canal was then cleaned and filled with gravel to create a neutron experiment area, which will be used to test variations of the Portable Isotopic Neutron Spectroscopy system.

Idaho Nuclear Technology and Engineering Center

A draft environmental assessment was prepared for the planned decontamination, decommissioning, and demolition of the CPP-603 spent nuclear fuel storage basins. The 1950s era concrete basins have no liners or leak detection system and are not up to current standards for wet storage of spent fuel.

Test Area North

Decontamination and dismantlement of the 1,300 m^2 (13,993 ft^2) Initial Engine Test Facility building was completed in January 2001. The project eliminated potential safety hazards and returned the site to its original condition.

Other Areas

Decontamination and dismantlement of the 1,814 m^2 (19,526 ft^2) Security Training Facility (STF-601) was completed in June 2001. Safety hazards were eliminated, the site was returned to its original condition, and it was opened for unrestricted use.

3.7. NATIONAL PROGRAMS MANAGED BY DOE-ID

National Spent Nuclear Fuel Program

DOE-ID manages the National Spent Nuclear Fuel Program (NSNFP). The NSNFP mission is to provide the technology and guidance needed to ensure safe, efficient handling, characterization, and disposition of DOE SNF. In completing this mission, the NSNFP, while working with stakeholders, will protect the environment and the health and safety of workers and the public while fully complying with applicable federal, state, Tribal, and local laws, orders, and regulations.

The NSNFP provides technology solutions and guidance for safe, efficient management at DOE SNF operating sites. It supports the repository program by providing the analyses and research needed to include all DOE SNF in the license application for the proposed

geologic repository in Yucca Mountain, Nevada. Located at the INEEL, the program collaborates with other DOE laboratories to develop and deploy technologies that address DOE SNF management needs. By coordinating common needs for research, technology development, and testing programs, the NSNFP is achieving cost efficiencies and eliminating gaps and redundant activities.

The NSNFP is divided into technical elements that address repository analysis, materials analysis, and packaging and transportation. Major 2001 accomplishments are identified below as part of these elements.

Repository Analysis

- Provided all the data and analyses necessary for inclusion of all DOE SNF into the Yucca Mountain Site Recommendation document.
- Identified the definitions and logic to be used for information on the DOE SNF that would be necessary to support repository design, licensing basis, and certification approach.

Materials Analysis

- Developed applications and deployment opportunities for two different neutron absorbers.
- Completed engineering tests supporting the standardized canister development and advanced neutron absorber development to form the basis for the DOE SNF safety case for the repository license application.

Packaging and Transportation

- Evaluated the Foster-Wheeler shield plug proposal for the standardized canister.
- Developed specifications for an Environmental Management-SNF transportation cask system.

National Transportation Program

The National Transportation Program (NTP) serves as the corporate center of packaging and transportation expertise within the DOE Office of Environmental Management. It supports infrastructure and coordinates transportation activities for all nonclassified shipments of hazardous materials, including radioactive and mixed wastes and other commodities such as coal, other fuels, maintenance materials, and supplies.

The NTP is responsible for ensuring the availability of safe, secure, and economical transport services; consistency in regulatory implementation; and coordinated outreach for DOE. A corporate team, comprised of personnel from the DOE Headquarters, DOE Idaho, and DOE Albuquerque offices, manages the NTP. NTP Idaho is uniquely responsible for transportation planning and integration activities in support of the DOE Office of Environmental Management disposition programs.

Nuclear Reactor Technology Lead Laboratories

The Secretary of Energy designated the INEEL and Argonne National Laboratory as lead laboratories for nuclear reactor technology for the DOE's Office of Nuclear Energy, Science, and Technology in 1999. Both Argonne and INEEL were pioneers in the development of safe commercial nuclear power. Argonne's EBR-I, located at the INEEL, produced the first usable quantities of nuclear energy in 1951. In 1955, Arco, Idaho, was the first community in the world lighted by nuclear power, using electricity generated by INEEL's BORAX-III reactor. A total of 52 nuclear reactors have been designed, built, and operated at the INEEL over the last 50 years. The lead laboratories are chartered to:

- Maintain world-class staff and key facilities to pursue advanced nuclear reactor technology;
- Maintain a living knowledge base;
- Evaluate and integrate the results of research and development and propose new research;

- Stay abreast of developments associated with nuclear energy-related research; and
- Organize national and international forums to address key issues.

The lead laboratories were chosen for their complementary expertise and facilities. The INEEL has extensive expertise in light water and gas-cooled nuclear systems, design, development, and testing. The INEEL serves needs for nuclear regulatory and safety technical support, probabilistic risk analysis, nuclear engineering and design, nuclear fuels development and testing, and radiation measurements. Argonne has extensive expertise in liquid metal-cooled reactors and fuel-cycle analysis. Argonne serves needs for safety analysis, nuclear engineering and design, fuels and fuel-cycle development, and nonproliferation.

Current activities of the lead labs are

- Development of the Generation IV Technology Roadmap for advanced reactor design; and
- Research and development to support the advancement of nuclear reactor safety for current operating reactors and advanced designs.

Sagebrush Steppe Ecosystem Reserve

In 1999, DOE signed a Memorandum of Understanding with the Bureau of Land Management, the U.S. Fish and Wildlife Service, and the Idaho Fish and Game Department to establish the INEEL Sagebrush Steppe Ecosystem Reserve. The Reserve includes approximately 30,000 ha (74,000 acres) of high-desert land within the INEEL boundaries that are used by 270 animal species and 400 plant species and compose one of the last undisturbed sagebrush steppe ecosystems in the U.S. It was part of a complex-wide effort by DOE to identify, protect, and conserve environmentally significant parcels of land in partnership with federal and state agencies. The agreement charters the Bureau of Land Management to develop a management plan that will provide management direction to DOE for continuance of this unique habitat for scientific study and the benefit of future generations.

3.8. ADDITIONAL ENVIRONMENTAL PROGRAMS

Public Involvement 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, newspaper inserts, newsletters, displays, and opportunities to request INEEL information are made available to interested persons. News releases and other contacts with journalists spread INEEL messages to much wider audiences. Through a toll-free telephone number (1-800-708-2680), anyone can call the INEEL to ask questions and request copies of documents. Many documents can also be accessed on the Internet at http://www.inel.gov/ under “About us.”

American Indian Programs

DOE-ID is currently focusing on expanding and strengthening the government-to-government relationship with the Shoshone-Bannock Tribes of Fort Hall, Idaho. The Tribes are close neighbors of the INEEL and are potentially affected by INEEL operations. They have a vested interest in the INEEL, as they have inhabited the Snake River Plain continuously for the past 4,500 years. DOE-ID has developed an Agreement-in-Principle with the Tribes that addresses DOE-Indian policy and Shoshone-Bannock Tribal objectives. DOE-ID also funds programs and projects through a cooperative agreement, sponsored by the DOE Headquarters Office of Environmental Management, intended to enhance Tribal awareness, capabilities, and participation in INEEL activities. The core program addresses environmental management

activities including National Environmental Policy Act, transportation, environmental monitoring and training, cultural resources management, and emergency response and management.

3.9. OTHER MAJOR ENVIRONMENTAL ISSUES AND ACTIVITIES

Health Studies

In August 1996, DOE and the Department of Health and Human Services revised a Memorandum of Understanding under which agencies of the Department of Health and Human Services conduct and manage epidemiological studies at DOE facilities. The studies, including historical dose reconstruction and worker epidemiology, are financially supported by DOE and conducted by the Centers for Disease Control and Prevention (CDC), the Agency for Toxic Substances and Disease Registry (ATSDR), and the National Institute of Occupational Safety and Health (NIOSH). The INEEL also conducts its own studies related to worker health. All of these studies are discussed below.

INEEL Medical Surveillance

The INEEL has a medical surveillance program to monitor the health of current workers. The program is based on routinely collected health data, such as recordable injuries and illnesses specified by the Occupational Safety and Health Administration. The program will help identify emerging health issues at the INEEL.

A medical surveillance program for former workers at the INEEL was initiated in 1997. The program, required by Section 3162 of Public Law 102-484, will evaluate the long-range health conditions of former employees who may have been subjected to significant health risks from exposure to hazardous substances as a result of their employment at the INEEL.

A Phase I pilot project was completed in October 1998 by a group of investigators consisting of the Paper, Allied-Industrial, Chemical, and Energy Workers International Union; Mt. Sinai School of Medicine; the University of Massachusetts at Lowell; and Alice Hamilton College. The pilot project resulted in findings that former INEEL workers have had significant exposure to pulmonary toxins, carcinogens, renal toxins, neurotoxins, hepatotoxins, and noise. The study also concluded that epidemiological studies at the INEEL are lacking, workers are concerned about previous exposures, and workers are interested in medical screening and education programs

The findings supported initiation of Phase II, a targeted medical surveillance program that included medical examinations and educational workshops. Efforts are ongoing to add to the existing former worker roster, particularly from Site contractor lists. Current exposure assessment efforts rely on both construction of a job exposure matrix and on the development of building/job classification categories for the INEEL. Medical screening protocols have been developed. This is being conducted by the Paper, Allied-Industrial, Chemical, and Energy Workers International Union in conjunction with Queens College of New York.

INEEL Health Effects Subcommittee

The Department of Health and Human Services established a public advisory group, the INEEL Health Effects Subcommittee, to provide recommendations to CDC and ATSDR regarding INEEL health studies. The Subcommittee is comprised of Idaho citizens and meets twice a year, usually in different cities in Idaho. All meetings are open to the public. More information about the INEEL Health Effects Subcommittee can be accessed at http://www.cdc.gov/nceh/radiation/ineel/ ineel_health_effects subcommittee.htm.

INEEL Dose Reconstruction Study

The CDC is conducting the INEEL Dose Reconstruction Project. Phase II began in 1996 with the start of a task to determine the feasibility of estimating exposures to the offsite public from toxic chemicals released

from the INEEL. A final report was issued in 1999 concluding that none of the chemical releases from past INEEL operations were of sufficient quantities to have caused health effects to the offsite public and, therefore, did not justify inclusion in a dose reconstruction. A similar task for radionuclides began near the end of 1997 and a draft report was issued in 2001. More information can be found at the INEEL Dose Reconstruction website at http://www.cdc.gov/nceh/radiation/brochure/profile_ineel.htm.

Epidemiological Study of Workers at the INEEL

The NIOSH is conducting several studies of INEEL workers. The INEEL Epidemiological Study of Workers will evaluate patterns of mortality in all workers at the INEEL since 1949 by using an all-cause cohort mortality to evaluate the feasibility of a prospective cancer incidence study among INEEL employees. Exposures of interest are external ionizing radiation and a variety of chemicals.

The first phase of the study, analysis of standardized mortality ratios, was completed in 2001. Under a NIOSH cooperative agreement, the INEEL was part of a complexwide epidemiological evaluation of childhood leukemia and paternal exposure to ionizing radiation. The results indicated no correlation between childhood leukemia and paternal exposure to ionizing radiation. More information about NIOSH studies of the INEEL can be found at http://www.cdc.gov/niosh/2001-133. html - contents.

CERCLA Public Health Assessment

The ATSDR is conducting a public health assessment of the INEEL as required by CERCLA for all sites on the National Priorities List. The focus of the public health assessment is to provide information that will further the goal of preventing and mitigating exposures to hazardous substances released to the environment. A draft of the Public Health Assessment was submitted to DOE for review in December 2001.

Environmental Oversight and Monitoring Agreement

The Environmental Oversight and Monitoring Agreement (EOMA) between DOE-ID, DOE Naval Reactors Office, Idaho Branch Office, and the state of Idaho maintains the State's program of independent oversight and monitoring established under the first agreement creating the state of Idaho INEEL Oversight Program. The main objectives as established under the current 5-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 DOE activities in Idaho are protective of the health and safety of Idahoans and the environment; and
- 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.

INEEL Oversight Program activities produced many accomplishments in 2001, due in large part to a well-coordinated working relationship with DOE, INEEL contractors, the Shoshone-Bannock Tribes, USGS, NOAA, and Idaho State University.

Monitoring and Surveillance Committee

The INEEL Monitoring and Surveillance Committee (MSC) was formed in March 1997 and holds bimonthly meetings to coordinate activities between groups involved in INEEL-related onsite and offsite environmental monitoring. This standing committee brings together representatives of DOE (Idaho, Chicago, and Naval Reactors); INEEL contractors; ANL-W; NRF; Shoshone-Bannock Tribes; Idaho INEEL Oversight Program; NOAA; and USGS. The MSC has served as a valuable forum to review monitoring, analytical, and quality assurance methodologies; to

coordinate efforts; and to avoid unnecessary duplication.

Oversight Environmental Surveillance Program

The INEEL Oversight Environmental Surveillance Program is intended to verify and supplement existing surveillance programs operated by INEEL contractors. The program's approach is designed to provide independent assessments of potential contaminants resulting from DOE activities at the INEEL. It monitors multiple environmental media that have been or potentially could be contaminated by INEEL activities, including: air, soil, milk, surface water, groundwater, and external gamma radiation. Results are reported annually in the INEEL oversight program environmental surveillance report. They are not reported in the annual site environmental report.

Emergency Response and Preparedness Program

The EOMA requires emergency preparedness assistance to local authorities. DOE has assisted the INEEL Oversight Program in establishing a Statewide Interagency Planning Group. The group provides a process for coordinating emergency preparedness issues and concerns among the various State agencies as well as increased communication among the organizations. A five-phase radiological emergency response plan and emergency response training has been cooperatively established with the INEEL Oversight Program to assist the local governments to meet local emergency response needs. The community monitoring stations have helped enhance the monitoring parameters and locations of meteorological conditions for use in emergency planning as well as emergency response. This information is available to the state of Idaho as well as the local emergency response personnel for use in actual emergencies, drills, and exercises.

Impact Assessment Program

The Impact 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.

Citizens Advisory Board

The INEEL Citizens Advisory Board, one of the Environmental Management Site Specific Advisory Boards, was formed in March 1994. Its charter is to provide input and recommendations on DOE Environmental Management's strategic decisions that impact future use, risk management, economic development, and budget prioritization activities.

The Citizens Advisory Board has produced 87 recommendations through December 2001. In 2001, eight recommendations were made on the following:

- Proposed Plan for Remediation of Contaminated Groundwater Plume at Test Area North;
- Idaho Hazardous Waste Management Act/ Resource Conservation and Recovery Act Closure Plan for INTEC Tanks WM-182 and WM-183;
- INEEL Institutional Plan, Fiscal Years 2001-2005;
- Wildfire Management Plan Environmental Assessment;
- Deactivation, Decommissioning, and Dismantlement of CPP-603 Basin Project
- Yucca Mountain Preliminary Site Suitability Evaluation;
- Proposed Relocation of Technical Area 18 Capabilities and Materials at the Los Alamos National Laboratory; and
- Stakeholder Forum on Alternative Technologies to Incineration.

Chapter 4

Environmental Monitoring Programs - Air

4. ENVIRONMENTAL MONITORING PROGRAMS – AIR

This chapter presents the results of both radiological and nonradiological analyses performed on airborne effluents and ambient air samples taken at both onsite and offsite locations. Results from sampling conducted by the Management and Operating (M&O) contractor and the Environmental Surveillance, Education and Research Program (ESER) contractor are all presented here. Results are compared to both the U.S. Environmental Protection Agency (EPA) health-based levels established in environmental statutes and/or the U.S. Department of Energy (DOE) Derived Concentration Guide (DCG) for inhalation of airborne contaminants (Appendix A).

4.1. PURPOSE AND ORGANIZATION OF AIR MONITORING PROGRAMS

The facilities operating on the Idaho National Engineering and Environmental Laboratory (INEEL) release both radioactive and nonradioactive constituents into the air. Various pathways (such as air, soil, plants, animals, and groundwater) may transport radioactive and nonradioactive materials from the INEEL to nearby populations. These transport pathways have been ranked in terms of relative importance [Reference 4-1]. The results of the ranking analysis indicate that air is the most important transport pathway. The INEEL environmental surveillance programs, conducted by the M&O contractor and the ESER contractor, emphasize measurement of airborne radionuclides because air has the potential to transport a large amount of activity to a receptor in a relatively short period and can result in direct exposure to offsite receptors. Table 4-1 summarizes the air monitoring activities conducted by each organization at the INEEL.

The M&O contractor monitors airborne effluents at individual INEEL facilities and ambient air outside the facilities to comply with applicable statutory requirements and DOE orders. The M&O contractor collected approximately 3,500 air samples, primarily on the INEEL Site, for analyses in 2001.

The ESER contractor collects samples from over an approximately 23,309-km^2 (9,000-mi^2) area of southeastern Idaho at locations on, around, and distant to the INEEL. The ESER contractor collected approximately 2,600 air samples, primarily off the INEEL Site, for analyses in 2001.

Section 4.2 presents both radiological and nonradiological air results from the M&O contractor and ESER contractor. Section 4.3 is a discussion of air sampling performed by the M&O contractor in support of waste management activities. Section 4.4 is a summary of selected air results.

Unless specified otherwise, the radiological analytical results presented in the following sections are those that are greater than two times the associated analytical uncertainty (see Appendix B for information on statistical methods). Each individual result is reported as the measurement plus or minus two standard deviations (± 2s) uncertainty for that radiological analysis.

4.2. AIR SAMPLING

Airborne effluents are measured at regulated facilities as required under the Idaho State Implementation Plan. Monitoring or estimation of effluent data is the responsibility of programs associated with the operation of each INEEL facility and not the environmental surveillance programs.

Environmental surveillance of air pathways is the responsibility of the M&O contractor (specifically, the Site Environmental Surveillance Program) and

Table 4-1. Air monitoring activities by organization.

Area/Facility	Airborne Effluent Monitoring Programs	Environmental Surveillance Programs										
	Airborne Effluents[a]	Low-Volume Charcoal Cartridges (iodine-131)	Low-volume Gross Alpha	Low-volume Gross Beta	Specific Radionuclides[b]	Atmospheric Moisture	Precipitation	Suspended Particulates	Fine Particulates	Nitrogen Dioxide	Sulfur Dioxide	IMPROVE samplers
Argonne National Laboratory-West												
ANL-W	●				●							
Management and Operating Contractor												
INTEC	●									●	●	
TAN	●											
PBF/WROC	●											
Sitewide		●	●	●	●	●		●	●			
Naval Reactors Facility												
NRF[c]	●											
Environmental Surveillance, Education and Research Program												
INEEL/Regional		●	●	●	●	●	●	●	●			●
National Oceanic and Atmospheric Administration												
INEEL/Regional						●	●	●	●			

a. Facilities with stacks that require continuous monitoring or calculation of stack effluents for compliance with 40 CFR 61, Subpart H, "National Emissions Standards for Hazardous Air Pollutants" (NESHAPs) regulation. The exception is NRF. See footnote c.

b. Gamma-emitting radionuclides and strontium-90, plutonium-238, plutonium-239,-240, and americium-241.

c. NRF is not required to continuously monitor any stack for NESHAPs compliance. However, NRF has a number of stacks and vents with emissions that are monitored and calculated by NRF for confirmation that emissions continue to be below regulatory limits. The NRF source terms are included in the INEEL's calculation of the annual dose to the public for NESHAPs compliance (Chapter 7).

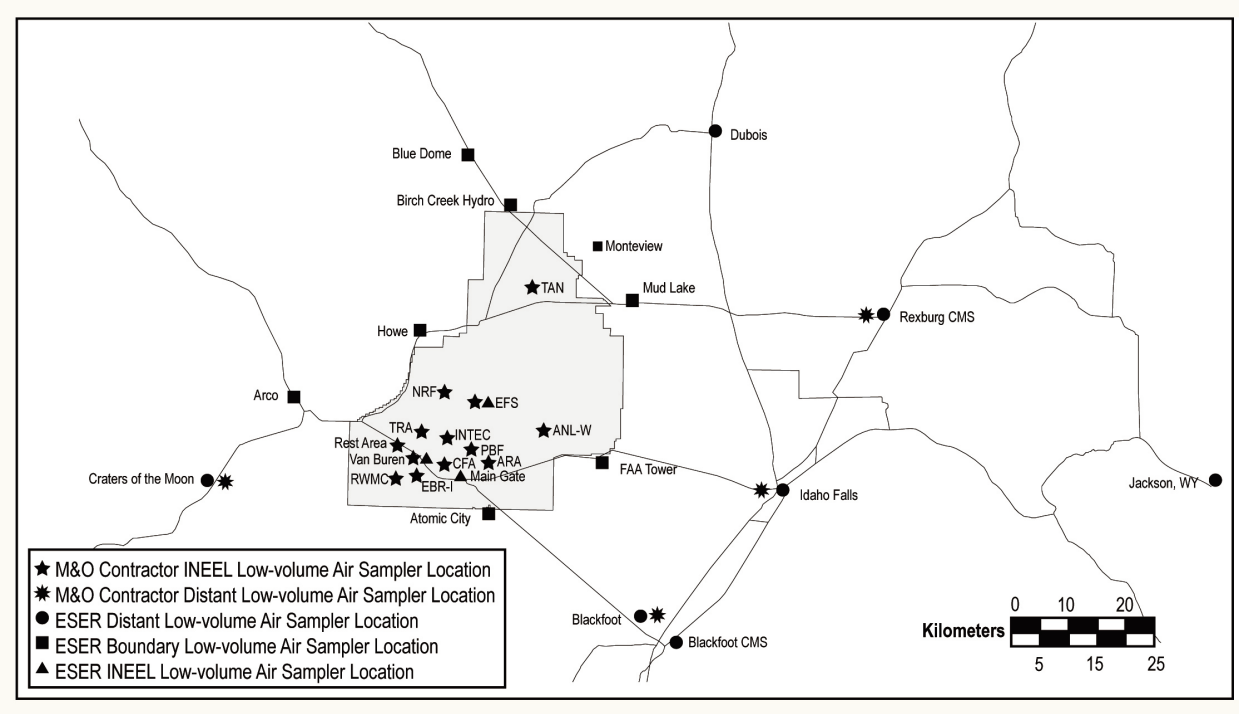


Figure 4-1. INEEL environmental surveillance air sampling locations.

the ESER contractor. Figure 4-1 shows the surveillance air monitoring locations for the INEEL environmental surveillance programs.

The INEEL environmental surveillance program contractors collect filters from a network of low-volume air samplers weekly. Air flows at an average of about 57 L/min (2 cfm) through a set of filters consisting of a 5-cm (2-in.) 1.2-µm pore membrane filter followed by a charcoal cartridge. The membrane filters are analyzed weekly for gross alpha and gross beta radiation and are composited quarterly by location. The composite samples are analyzed for gamma-emitting radionuclides using gamma spectrometry and for specific alpha- and beta-emitting radionuclides using radiochemical techniques. In addition to the membrane filter samples, charcoal cartridges are collected and analyzed weekly specifically for iodine-131 (^{131}I) using gamma spectrometry.

There is no requirement to monitor the dust burden at the INEEL, but it is monitored by both the M&O and the ESER contractor to provide comparison information to other monitoring programs and to the DOE Idaho Operations Office (DOE-ID). The suspended particulate dust burden is monitored with the same low-volume filters used to collect the particulate samples for radioactive analyses by weighing the filters before and after their use in the field.

Nitrogen oxides are monitored by the M&O contractor at Van Buren Boulevard and the Experimental Field Station (EFS) following an EPA-equivalent method as implemented by the *Ambient Nitrogen Dioxide Monitoring Plan for the INEL* [Reference 4-2]. This monitoring fulfills one of the conditions specified in the "Permit to Construct, Idaho Chemical Processing Plant Nitrogen Oxide Sources."

Sulfur dioxide measurements are recorded to confirm that the INEEL does not release significant amounts of sulfur dioxide with respect to national ambient air quality standards. Sulfur dioxide is monitored by the M&O contractor at the Van Buren Boulevard location.

Tritium in water vapor in the atmosphere is monitored by the M&O contractor and ESER contractor using samplers located at two onsite locations (EFS and Van Buren Boulevard) and four offsite locations (Atomic City, Blackfoot Community Monitoring Station (CMS), Idaho Falls, and Rexburg CMS). Air passes through a column of molecular sieve material. The molecular sieve material absorbs water vapor in the air. Columns are changed when the molecular sieve material absorbs sufficient moisture to obtain a sample. Water is extracted from the material by distillation and collected. Tritium concentrations are then determined by liquid scintillation counting of the water extracted from the molecular sieve columns.

Airborne Effluents

During 2001, a reported 16,833 Ci of radioactivity was released to the atmosphere from all INEEL sources. *The National Emissions Standards for Hazardous Air Pollutants (NESHAPs) – Calendar Year 2001 INEEL Report for Radionuclides* [Reference 4-3] describes three categories of airborne emissions. The first category includes sources that require continuous monitoring under the NESHAPs regulation. The second category consists of releases from other point sources. The final category is nonpoint, or diffuse, sources. These include radioactive waste ponds and contaminated soil areas. The NESHAPs document only reports the first category results, whereas all three categories are included in Table 4-2 of this report.

The largest facility contributions to the total emissions came from the Idaho Nuclear Technology and Engineering Center (INTEC) at over 80 percent, (Table 4-2), Test Area North (TAN) at 10 percent, and Test Reactor Area (TRA) at 8 percent. Approximately 88 percent of the radioactive effluent was in the form of noble gases (argon, krypton, and xenon). Most of the remaining 12 percent was tritium.

Low-volume Charcoal Cartridges

Both the ESER and M&O contractors collected charcoal cartridges weekly and analyzed them for gamma-emitting radionuclides. Charcoal cartridges are used primarily to collect gaseous radioiodines. If traces of any anthropogenic (human-made) radionuclide were detected, the filters were individually analyzed. During 2001, the M&O contractor analyzed a total of 985 cartridges, looking specifically for ^{131}I. No ^{131}I was detected in any of the M&O samples. The ESER contractor analyzed 889 cartridges. Iodine-131 was measured in one batch of ten cartridges at a concentration slightly greater than their respective ± 2s uncertainty. However, immediate reanalysis of each individual cartridge yielded results below the 2s values, indicating that ^{131}I was not detected.

Low-volume Gross Alpha

Particulates filtered from the air were sampled from 29 locations weekly as part of the INEEL environmental surveillance program (see Figure 4-1). All were analyzed for gross alpha radioactivity and gross beta radioactivity. Gross alpha concentrations found in ESER contractor samples, both on and offsite, tended to be higher than those found in M&O contractor samples at common locations. Reasons for differences in concentrations measured at the same locations are likely due to differences in laboratory analytical techniques and instrumentation, as different analytical laboratories were used. Both sets of data indicated gross alpha concentrations at distant locations were generally equal to or higher than at boundary and onsite locations.

Weekly gross alpha concentrations in ESER contractor samples that exceeded their ± 2s uncertainty ranged from a minimum of $(0.6 \pm 0.5) \times 10^{-15}$ µCi/mL at the Rexburg CMS in February to a maximum of $(7.4 \pm 5.0) \times 10^{-15}$ µCi/mL during September at Monteview. Concentrations measured by the M&O contractor ranged from a low of $(0.8 \pm 0.7) \times 10^{-15}$ µCi/mL in June at TRA to

Table 4-2. Radionuclide composition of INEEL airborne effluents (2001). [a]

Effluent Type[b]	Radionuclide	Half-Life	Airborne Effluent (Ci)								
			ANL-W	CFA	INTEC	RWMC	PBF	NRF	TAN	TRA	Total
Noble gases	^{85}Kr	10.7 yr	81.1	--[c]	12,100[d]	--	1.0×10^{-6}	0.67	1,580	--	**13,761**
	^{41}Ar	1.83 h	--	--	--	--	--	--	--	985.2	**985.2**
	^{135}Xe	9.10 h	--	--	--	--	--	--	--	21.9	**21.9**
	^{133}Xe	5.25 d	--	--	--	--	--	--	--	12.0	**12.0**
	^{85m}Kr	4.4 h	--	--	--	--	--	--	--	1.57	**1.57**
Particulates	^{67}Ga	77.9 h	--	--	--	--	--	--	--	85.95	**85.95**
	^{60}Co	5.27 yr	--	--	2.72×10^{-5}	--	--	6.2×10^{-7}	--	0.026	**0.026**
	^{90}Sr/^{90}Y	28.6 yr	--	--	1.86×10^{-3}	--	2.13×10^{-6}	1.1×10^{-4}	7.66×10^{-5}	1.37×10^{-3}	**3.42×10^{-3}**
	^{137}Cs/^{137}Ba	30.2 yr	--	--	2.27×10^{-3}	--	9.04×10^{-5}	1.7×10^{-5}	2.40×10^{-4}	1.97×10^{-4}	**2.81×10^{-3}**
	^{125}Sb/^{125m}Te	2.73 yr	--	--	--	--	--	--	--	2.29×10^{-3}	**2.29×10^{-3}**
	^{241}Pu	13.2 yr	--	--	7.77×10^{-4}	--	--	--	--	--	**7.77×10^{-4}**
	^{154}Eu	16 yr	--	--	--	--	--	--	--	1.02×10^{-4}	**1.02×10^{-4}**
	^{152}Eu	12.7 yr	--	--	--	--	--	--	--	9.10×10^{-5}	**9.10×10^{-5}**
	^{241}Am	458 yr	--	--	3.83×10^{-5}	--	--	--	--	--	**3.83×10^{-5}**
	^{239}Pu	2.4×10^{4} yr	--	--	2.11×10^{-5}	--	--	5.3×10^{-6}	2.40×10^{-6}	8.70×10^{-6}	**3.75×10^{-5}**
	^{240}Pu	6,580 yr	--	--	1.11×10^{-5}	--	--	--	--	--	**1.11×10^{-5}**
	^{238}Pu	87.7 yr	--	--	6.83×10^{-6}	--	1.10×10^{-7}	--	--	--	**6.94×10^{-6}**
Tritium, ^{14}C, and Iodine Isotopes	Tritium	12.3 yr	0.73	3.38	1,500	57.0	0.0192	0.009	160	242	**1,963**
	^{14}C	5,700 yr	--	--	--	0.86	3.22×10^{-4}	0.28	--	--	**1.14**
	^{129}I	1.6×10^{7} yr	--	--	0.0209	--	9.85×10^{-6}	--	0.014	--	**0.035**
	^{131}I	8.04 d	--	--	--	--	--	1.3×10^{-6}	--	0.0288	**0.029**
Total			**81.8**	**3.38**	**13,600**	**57.9**	**0.02**	**1.04**	**1,740**	**1,349**	**16,833**

a. Radioactive release information provided by Bechtel Babcock and Wilcox, Idaho, LLC. June 2002.

b. Includes only those radionuclides with releases greater than 1×10^{-7} Ci.

c. A double dash signifies the radionuclide was not released to air from that facility during the calendar year.

d. The large release was an unplanned, ground-level release from the Independent Spent Fuel Storage Installation at INTEC.

a high of (5.1 ± 1.7) x 10^{-15} µCi/mL at Rexburg in March.

Figure 4-2 displays the average weekly gross alpha concentrations for the ESER and M&O contractors at INEEL, boundary, and distant station groups. Each weekly average was computed using all measurements, including those less than their associated ± 2s uncertainties. These data are typical of the annual natural fluctuation pattern for gross alpha concentrations in air. The highest mean weekly concentration of gross alpha occurred for the distant group in the third quarter of 2001 (Figure 4-2). The maximum mean weekly gross alpha concentration was (3.6 ± 2.7) x 10^{-15} µCi/mL and is below the DCG for the most restrictive alpha-emitting radionuclide in air (americium-241 [^{241}Am]) of 20.0 x 10^{-15} µCi/mL.

Annual mean gross alpha concentrations calculated by the ESER contractor (Table 4-3) ranged from 1.4 x 10^{-15} µCi/mL at Blue Dome and Craters of the Moon to 2.1 x l0^{-15} µCi/mL at Mud Lake and the Blackfoot CMS. M&O contractor data indicated an annual mean range of 0.1 x 10^{-15} µCi/mL at the Craters of the Moon to 1.5 x 10^{-15} µCi/mL at Rexburg (Table 4-3). Confidence intervals are not calculated for annual means.

Gross alpha concentrations were generally higher during late spring and summer months due to resuspended dust from previously burned areas. Gross alpha concentrations for other times of the year were, in general, typical of those measured previously and natural fluctuations.

Low-volume Gross Beta

As with gross alpha, gross beta concentrations in ESER contractor samples were consistent with those found in M&O contractor samples.

Weekly gross beta concentrations in ESER contractor samples that exceeded their ± 2s uncertainty ranged from a low of (7.3 ± 1.8) x 10^{-15} µCi/mL during November at the Blackfoot CMS to a high of (85.7 ± 4.4) x 10^{-15} µCi/mL at Idaho Falls in January. Concentrations measured by the M&O contractor ranged from a low of (5.7 ± 1.9) x 10^{-15} µCi/mL at the RWMC to a high of (70.0 ± 4.0) x 10^{-15} µCi/mL at Idaho Falls.

Figure 4-3 displays the average weekly gross beta concentrations for the ESER and M&O contractors at INEEL, boundary, and distant station groups. These data are typical of the annual natural fluctuation 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 highest mean weekly concentration of gross beta was detected in the first quarter of 2001 (Figure 4-3). Each average value was calculated using all measurements, including those less than their associated ± 2s uncertainties. The maximum gross beta concentration was 87.2 x 10^{-15} µCi/mL and is significantly below the DCG of 3,000 x 10^{-15} µCi/mL for the most restrictive beta-emitting radionuclide in air (radium-228 [^{228}Ra]).

Annual average gross beta concentrations are shown in Table 4-4. ESER contractor annual mean gross beta concentrations ranged from 26.0 x 10^{-15} µCi/mL at Craters of the Moon to 32.9 x 10^{-15} µCi/mL at Idaho Falls. M&O contractor data indicated an annual mean range of 22.3 x 10^{-15} µCi/mL at the RWMC to 40.4 x 10^{-15} µCi/mL at Experimental Breeder Reactor – No. 1 (EBR-I).

In general, the levels of airborne radioactivity for the three groups (i.e., INEEL, boundary, and distant locations) tracked closely throughout the year. This is an indication that the pattern of fluctuations occurred over the entire sampling network, is representative of natural conditions, and is not caused by a localized source such as a facility or activity at the INEEL.

Statistical Comparisons

Gross beta concentrations can vary widely from location to location as a result of a variety of factors, such as local soil type

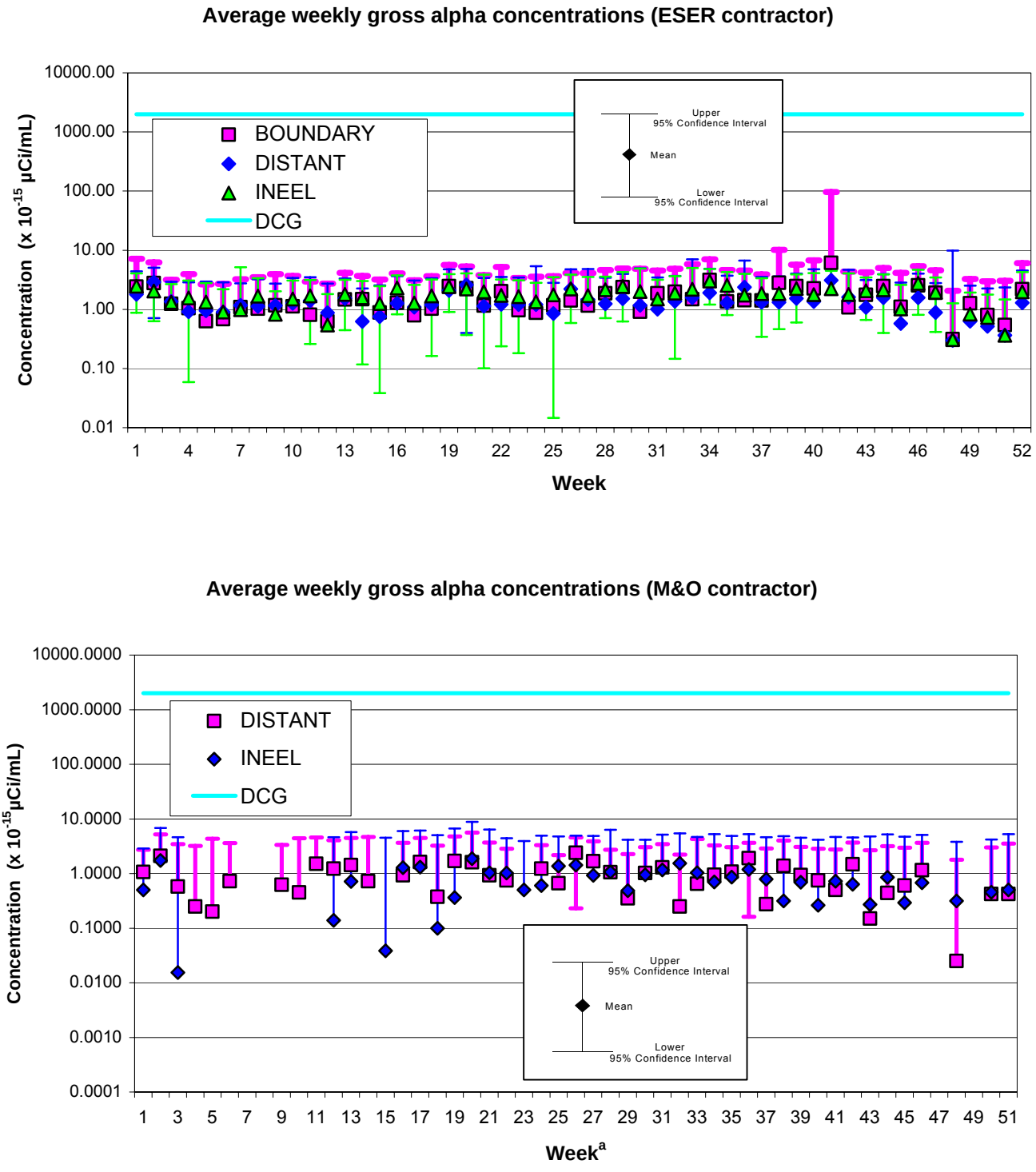


Figure 4-2. Average weekly gross alpha concentrations in air (2001).

a. The M&O contractor collected only 51 weeks of low-volume air samples. No samples were collected during the shutdown week of 12/23/01.

Table 4-3. Gross alpha radioactivity in air (2001).[a]

ESER Contractor Data			Concentration[b]	
Group	**Location**	**No. of Samples**	**Range of Samples**	**Annual Mean**
Distant	Blackfoot[c]	26	-0.3 – 2.9	1.7
	Blackfoot CMS[d,e]	52	0.0 – 6.4	2.1
	Craters of the Moon	52	0.0 – 3.5	1.4
	Idaho Falls	52	0.1 – 5.5	2.0
	Rexburg CMS [e]	52	0.2 – 4.1	2.0
	Dubois[c]	26	-7.8 – 2.9	1.4
	Jackson[f]	28	0.0 – 2.8	1.7
			Grand Mean	**1.8**
Boundary	Arco	52	0.2 – 3.4	1.8
	Atomic City	52	0.3 – 3.9	1.8
	Blue Dome[g]	26	-0.1 – 3.0	1.4
	FAA[h] Tower	52	0.0 – 4.4	1.6
	Howe	52	0.1 – 4.0	1.8
	Monteview	52	0.3 – 7.4	1.9
	Mud Lake	52	0.3 – 5.6	2.1
	Reno Ranch/Birch Creek[g]	26	0.6 – 2.4	1.5
			Grand Mean	**1.7**
INEEL	EFS	52	0.2 – 3.7	1.8
	Main Gate	52	0.2 – 3.0	1.8
	Van Buren	52	0.1 – 3.6	1.7
			Grand Mean	**1.8**
M&O Contractor Data			**Concentration[b]**	
Group	**Location**	**No. of Samples**	**Range of Samples**	**Annual Mean**
Distant	Blackfoot	50	-1.9 – 3.7	0.8
	Craters of the Moon	51	-3.0 – 2.3	0.1
	Idaho Falls	48	-3.0 – 2.9	0.7
	Rexburg	52	-1.8 – 5.1	1.5
			Grand Mean	**0.8**
INEEL	ANL-W	52	-2.5 – 3.7	0.4
	ARA	49	-1.0 – 3.6	1.1
	CFA	53	-2.0 – 4.5	0.8
	EBR-I	50	-2.0 – 2.1	0.4
	EFS	50	-2.6 – 2.6	0.3
	INTEC	52	-5.0 – 2.5	0.3
	NRF	52	-1.9 – 2.1	0.4
	PBF	52	-2.2 – 2.1	0.5
	Rest Area	18	-2.2 – 2.4	0.4
	RWMC	52	-2.0 – 4.5	0.7
	TAN	53	-1.9 – 2.7	0.5
	TRA	49	-5.0 – 2.9	0.5
	Van Buren	51	-1.8 – 3.0	0.6
			Grand Mean	**0.5**

a. All values are x 10^{-15} microcuries per milliliter (µCi/mL).
b. All measurements, including those less than two times their analytical uncertainty, are included in this table and in computation of annual means. A negative result indicates that the measurement was less than the laboratory background measurement.
c. The sampler located at the Blackfoot NOAA enclosure was moved to Dubois on June 27, 2001. The Blackfoot sampler was redundant with the Blackfoot CMS and Dubois provided a distant location in the predominant wind direction (from the southwest).
d. CMS = Community Monitoring Station.
e. The Blackfoot CMS is located at Mountain View Middle School, the Rexburg CMS is located at Madison Middle School.
f. On June 13, 2001, a sampler was placed in Jackson, Wyoming, because of local concerns.
g. On June 27, 2001, the sampler located at Reno Ranch/Birch Creek was moved to a NOAA enclosure near Blue Dome because the Reno Ranch/Birch Creek landowner planned construction at the sampler location.
h. FAA = Federal Aviation Administration.

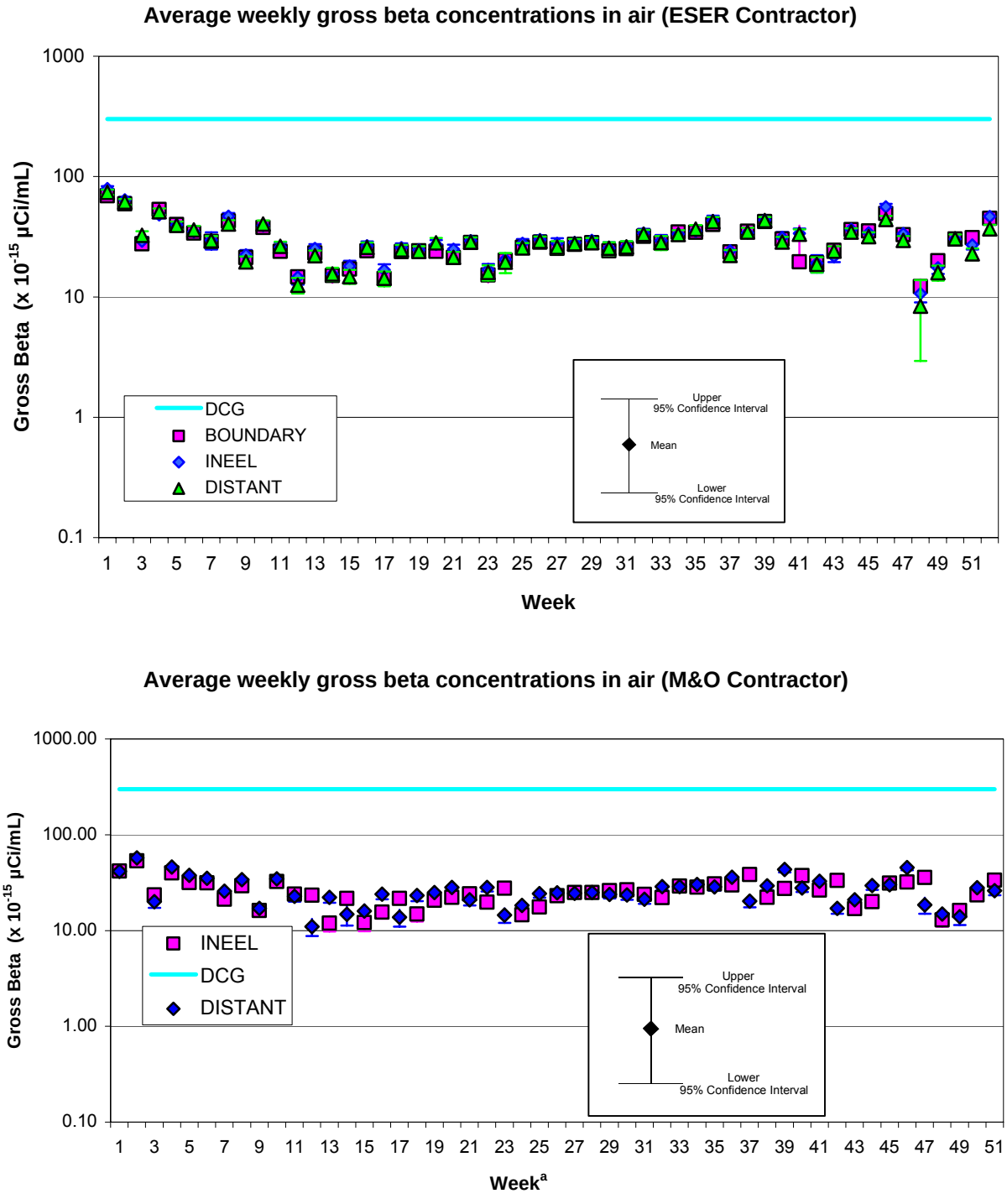


Figure 4-3. Average weekly gross beta concentrations in air (2001).

a. The M&O contractor collected only 51 weeks of low-volume air samples. No samples were collected during the shutdown week of 12/23/01.

Table 4-4. Gross beta radioactivity in air (2001). [a]

ESER Contractor Data			Concentration[b]	
Group	**Location**	**No. of Samples**	**Range of Samples**	**Annual Mean**
Distant	Blackfoot[c]	26	11.8 – 74.2	28.6
	Blackfoot CMS[d,e]	52	7.3 – 84.1	29.7
	Craters of the Moon	52	7.8 – 48.7	26.0
	Idaho Falls	52	11.4 – 85.7	32.9
	Rexburg CMS [e]	52	10.0 – 77.9	29.3
	Dubois[c]	26	-4.1 – 43.4	28.6
	Jackson[f]	28	15.9 – 46.7	29.2
			Grand Mean	**29.2**
Boundary	Arco	52	9.9 –67.7	28.3
	Atomic City	52	10.3 – 71.0	29.9
	Blue Dome[g]	26	9.9 – 44.8	28.4
	FAA[h] Tower	52	9.0 – 56.2	27.6
	Howe	52	12.5 – 80.0	31.4
	Monteview	52	12.3 – 78.7	30.8
	Mud Lake	52	15.5 – 83.1	32.6
	Reno Ranch/Birch Creek[g]	26	13.8 – 60.0	27.7
			Grand Mean	**29.6**
INEEL	EFS	52	11.7 – 79.6	31.0
	Main Gate	52	11.3 – 85.2	31.0
	Van Buren	52	8.9 – 73.1	30.5
			Grand Mean	**30.8**
M&O Contractor Data			**Concentration[b]**	
Group	**Location**	**No. of Samples**	**Range of Samples**	**Annual Mean**
Distant	Blackfoot	50	10.0 – 62.0	27.6
	Craters of the Moon	51	9.3 – 47.0	22.8
	Idaho Falls	48	7.0 – 70.0	28.6
	Rexburg	52	11.0 – 50.0	27.2
			Grand Mean	**26.6**
INEEL	ANL-W	52	9.0 – 49.0	25.8
	ARA	49	11.0 – 54.0	28.4
	CFA	53	11.7 – 56.0	27.2
	EBR-I	50	13.0 – 61.0	40.4
	EFS	50	8.0 – 68.0	27.6
	INTEC	52	9.0 – 54.0	25.4
	NRF	52	9.0 – 53.0	25.6
	PBF	52	10.2 – 48.0	25.2
	Rest Area	18	9.0 – 45.0	23.8
	RWMC	52	5.7 – 37.0	22.3
	TAN	53	10.4 – 67.0	24.5
	TRA	49	12.0 – 50.0	25.8
	Van Buren	51	11.0 – 62.0	28.2
			Grand Mean	**26.9**

a. All values are x 10^{-15} microcuries per milliliter (µCi/mL).
b. All measurements, including those less than two times their analytical uncertainty, are included in this table and in computation of annual means. A negative result indicates that the measurement was less than the laboratory background measurement.
c. The sampler located at the Blackfoot NOAA enclosure was moved to Dubois on June 27, 2001. The Blackfoot sampler was redundant with the Blackfoot CMS and Dubois provided a distant location in the predominant wind direction (from the southwest).
d. CMS = Community Monitoring Station.
e. The Blackfoot CMS is located at Mountain View Middle School, the Rexburg CMS is located at Madison Middle School.
f. On June 13, 2001, a sampler was placed in Jackson, Wyoming, because of local concerns.
g. On June 27, 2001, the sampler located at Reno Ranch/Birch Creek was moved to a NOAA enclosure near Blue Dome because the Reno Ranch/Birch Creek landowner planned construction at the sampler location.
h. FAA = Federal Aviation Administration.

and meteorological conditions. When statistical differences are found in gross beta activity, specific radionuclide analyses are examined to identify the possible radionuclide(s) that may have contributed to the elevated concentrations and to identify a possible INEEL cause, if any exists, for the differences.

Statistical comparisons were made using the gross beta radioactivity data collected from the onsite, boundary, and distant locations (see Appendix B for a description of statistical methods). Figure 4-4 is a graphical comparison of all gross beta concentrations measured during 2001 by the ESER contractor. The results are grouped by location (INEEL, boundary, and distant stations). Visually, there appeared to be no difference between locations. The figure also shows that the largest measurement was well below the DCG for the most restrictive beta emitting radionuclide (^{228}Ra) in air of 3,000 x 10^{-15} µCi/mL. If the INEEL were a significant source of offsite contamination, concentrations of contaminants would be statistically greater at boundary locations than at distant locations. There were no statistical differences between boundary and distant station concentrations collected during 2001.

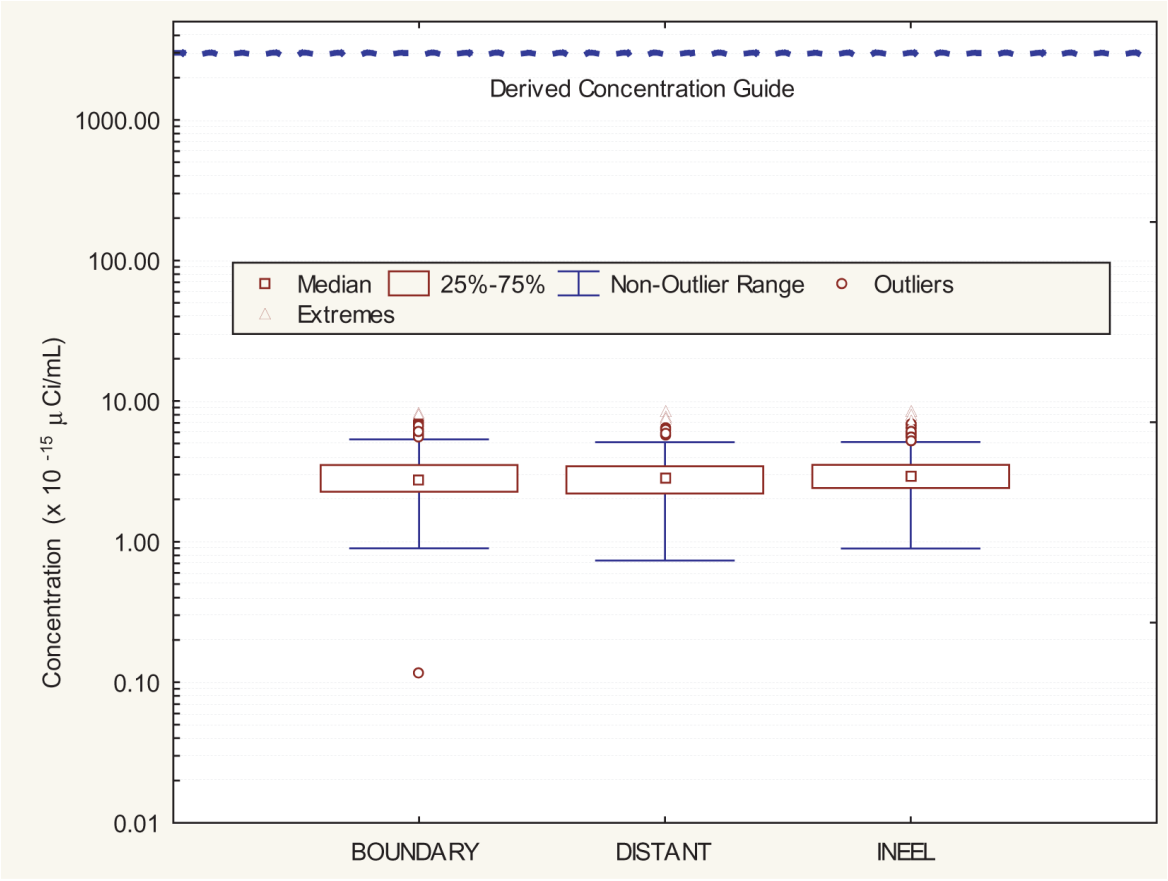


Figure 4-4. Comparison of gross beta concentrations measured in air at distant, boundary, and INEEL locations by the ESER contractor (2001) (terms are defined in Appendix B).

The M&O contractor data were grouped into INEEL and distant data sets. There were no statistical differences between data obtained from INEEL and distant locations.

Specific Radionuclides in Air

Anthropogenic (human-made) radionuclides were observed in some ESER contractor quarterly composite samples (Table 4-5). Most of these values were in the range where actual detection is questionable (they exceeded their respective ± 2s values). No anthropogenic radionuclides were detected in quarterly samples collected by the M&O contractor.

Since mid-1995, the ESER contractor has detected ^{241}Am in air samples, although there has been no discernable pattern with respect to time or location. Americium-241 was again detected in some 2001 quarterly composite samples at levels substantially below the ^{241}Am DCG of 20,000 x 10^{-18} µCi/mL.

Plutonium-238 (^{238}Pu) was detected in six samples at very low concentrations. Levels were significantly below the DCG of 30,000 x 10^{-18} µCi/mL. Plutonium-239/240 ($^{239/240}$Pu) was also detected in two of the same samples that showed ^{238}Pu. It was also detected in an additional three samples. All $^{239/240}$Pu levels were significantly below the DCG for both ^{239}Pu and ^{240}Pu of 20,000 x 10^{-18} µCi/mL. Plutonium is a residual of nuclear fission. The concentrations measured in ESER samples are consistent with worldwide levels related to atmospheric nuclear weapons testing.

Cesium-137 (^{137}Cs) was detected in one sample collected at the Howe (QA-2) location. The result is far below the DCG for ^{137}Cs of 4 x 10^{-10} µCi/mL.

Strontium-90 (^{90}Sr) was also detected in 12 samples. The highest value measured is much below the DCG for ^{90}Sr (9,000,000 x 10^{-18} µCi/mL).

Atmospheric Moisture

During 2001, the ESER contractor collected a total of 44 atmospheric moisture samples from four locations, including Atomic City, Blackfoot, Idaho Falls, and Rexburg. Table 4-6 presents the range of values for each station that were greater than their respective 2s value by quarter.

Tritium was detected in 30 of the samples. Samples that exceeded their respective ± 2s values ranged from a low at Idaho Falls of (1.3 ± 0.5) x 10^{-13} µCi/mL in the second quarter of 2001, to a high of (20.0 ± 5.1) x 10^{-13} µCi/mL at Atomic City in the fourth quarter of 2001.

These detected concentrations were all very low and similar at distant and boundary locations. This similarity suggests that the detections probably represent tritium from natural production in the atmosphere by cosmic ray bombardment, residual weapons testing fallout, and possible analytical variations, rather than tritium from INEEL operations. The highest observed tritium concentration (from the fourth quarter at Atomic City) is over nine orders of magnitude below the DCG for elemental tritium in air of 2 x 10^{-2} µCi/mL.

The M&O contractor also collected atmospheric moisture samples at the EFS and at Van Buren Boulevard on the INEEL. They collected from one to three samples at each location each quarter. Laboratory analyses indicated that all samples were below the detection limit of 1 x 10^{-11} µCi/mL.

Precipitation

The ESER contractor collects precipitation samples weekly at the EFS and monthly at the Central Facilities Area (CFA) and offsite in Idaho Falls. Tritium was detected in 24 of 38 precipitation samples collected during 2001 from the three sites. Tritium concentrations ranged from 65.9 ± 63.7 pCi/L to 269.5 ± 65.8 pCi/L. Table 4-7 shows the maximum concentration by quarter for each location. The highest radioactivity was from a sample collected at the EFS and is well below the DCG level for tritium in water of 2.0 x 10^6 pCi/L. The concentrations are well within the normal range observed worldwide in recent years from the natural production

Table 4-5. Anthropogenic radionuclides detected in ESER and M&O[a] contractor air samples (2001).[b]

ESER Contractor Samples				
Location	**^{241}Am**	**^{238}Pu [$^{239/240}$Pu][c]**	**^{137}Cs**	**^{90}Sr**
First Quarter 2001				
FAA Tower[d]	2.2 ± 2.0	No Detections	No Detections	No Detections
Howe	3.6 ± 2.4	No Detections	No Detections	No Detections
Monteview	4.7 ± 2.7	No Detections	No Detections	No Detections
Rexburg CMS	1.6 ± 1.3	No Detections	No Detections	No Detections
Second Quarter 2001				
Arco (QA-1)	2.3 ± 2.0	No Detections	No Detections	No Detections
Atomic City	3.9 ± 2.8	No Detections	No Detections	No Detections
Blackfoot	3.3 ± 2.5	No Detections	No Detections	No Detections
Blackfoot CMS	No Detections	[3.4 ± 2.5]	No Detections	No Detections
Blank A	1.1 ± 1.0	No Detections	No Detections	No Detections
FAA Tower	No Detections	No Detections	No Detections	61.4 ± 55.0
Howe (QA-2)	No Detections	No Detections	No Detections	47.0 ± 41.0
Main Gate	1.9 ± 1.4	[1.4 ± 1.3]	No Detections	No Detections
Mud Lake	2.2 ± 1.8	No Detections	No Detections	No Detections
Third Quarter 2001				
Atomic City	No Detections	No Detections	No Detections	125 ± 60
Arco	No Detections	No Detections	No Detections	89.2 ± 44.0
Arco (QA-1)	No Detections	No Detections	No Detections	88.4 ± 52.0
Blue Dome	No Detections	No Detections	No Detections	60.0 ± 57.0
Craters of the Moon	No Detections	4.8 ± 3.0	No Detections	No Detections
Dubois	No Detections	No Detections	No Detections	93.4 ± 49.0
EFS	3.8 ± 2.8	No Detections	No Detections	No Detections
FAA Tower	No Detections	9.3 ± 4.7 [2.7 ± 2.5]	No Detections	No Detections
Howe	No Detections	4.8 ± 3.4 [3.5 ± 2.9]	No Detections	No Detections
Jackson, Wyoming	No Detections	No Detections	No Detections	71.2 ± 51.0
Main Gate	No Detections	No Detections	No Detections	72.2 ± 53.0
Monteview	2.5 ± 2.4	3.0 ± 2.3	No Detections	No Detections
Mud Lake	No Detections	No Detections	No Detections	159 ± 60
Rexburg CMS	No Detections	5.3 ± 4.1	No Detections	No Detections
Van Buren	No Detections	10.4 ± 5.5	No Detections	No Detections
Fourth Quarter 2001				
Arco	2.4 ± 2.2	No Detections	No Detections	No Detections
Blackfoot CMS	3.8 ± 3.2	No Detections	No Detections	No Detections
Blank A	1.3 ± 1.0	No Detections	No Detections	No Detections
Blue Dome	3.3 ± 3.1	[3.5 ± 2.7]	No Detections	No Detections
EFS	No Detections	No Detections	No Detections	60.6 ± 48.0
Howe (QA-2)	No Detections	No Detections	1408.9 ± 1250.1	No Detections
Van Buren	No Detections	No Detections	No Detections	53.9 ± 43.0

a. No anthropogenic radionuclides were detected in any samples collected by the M&O contractor. Thus no results are presented

b. A result greater than its associated uncertainty of 2 standard deviations is considered to be detected.

c. Concentrations shown are result x 10^{-18} µCi/mL air ± 2 standard deviations.

d. FAA = Federal Aviation Administration.

Table 4-6. Tritium concentrations in ESER contractor atmospheric moisture samples (2001).

	Range[a]			
Location	**First Quarter**	**Second Quarter**	**Third Quarter**	**Fourth Quarter**
Atomic City	4.2 ± 1.2 – 8.8 ± 1.4	7.1 ± 2.2	1.4 ± 1.1 – 1.9 ± 0.7	5.2 ± 1.7 – 20.0 ± 5.1
Blackfoot	2.4 ± 1.3 – 2.9 ± 0.8	3.5 ± 1.3 – 11.4 ± 2.5	6.0 ± 2.2 – 8.4 ± 4.7	4.9 ± 0.8
Idaho Falls	—[b]	1.3 ± 0.5	3.3 ± 0.9 – 13.1 ± 3.8	2.0 ± 1.7 – 13.6 ± 2.0
Rexburg	1.7 ± 0.7	4.4 ± 1.0 – 9.5 ± 2.0	6.4 ± 3.0 – 18.9 ± 3.7	4.3 ± 1.8

a. All values are x 10^{-13} µCi/mL of air ± 2 standard deviations.
b. No samples exceeded their respective 2s value.

Table 4-7. Maximum tritium concentrations detected in ESER contractor precipitation samples (2001).

	Maximum Concentration[a]			
Location	**First Quarter**	**Second Quarter**	**Third Quarter**	**Fourth Quarter**
CFA	88.7 ± 62.9	—[b]	125 ± 63.7	258.8 ± 65.9
EFS	165.2 ± 63.9	142.7 ± 63.1	—	269.5 ± 65.8
Idaho Falls	125.1 ± 59.4	112.7 ± 62.6	71.8 ± 58.5	117.7 ± 63.8

a. All values are in picocuries per liter ± 2 standard deviations.
b. No results greater than ± 2 standard deviations.

of tritium in the upper atmosphere and nuclear weapons testing.

Suspended Particulates

In 2001, both the ESER and M&O contractors measured concentrations of suspended particulates using filters collected from the low-volume air samplers. The filters are 99 percent efficient for collection of particles greater than 0.3 µm in diameter. Unlike the fine particulate samplers discussed in the next section, these samplers do not selectively filter out particles of a certain size range, so they collect the total particulate load greater than 0.3 µm in diameter.

Particulate concentrations from ESER contractor samples ranged from 0.05 µg/m^3 at Blue Dome to 1.19 µg/m^3 at the Blackfoot CMS. Particulate concentrations were generally higher at distant locations than at the INEEL stations. Overall, concentrations were within the range of values observed in the past 10 years (Figure 4-5). This figure shows suspended particulate concentrations from all groupings (INEEL, boundary, and distant) for both the ESER and M&O contractors.

The annual means of total suspended particulate concentrations ranged from 1.3 µg/m^3 at the EFS to 40.2 µg/m^3 at the Big Lost River Rest Area. With the exception of the Rest Area, sample particulate concentrations are generally higher at distant locations than at the INEEL stations. The high value for the Rest Area is related to resuspension of soils from the surrounding area that was burned in 2000.

The 2001 quarterly suspended particulate concentrations are shown in Figure 4-6. Higher suspended particulate

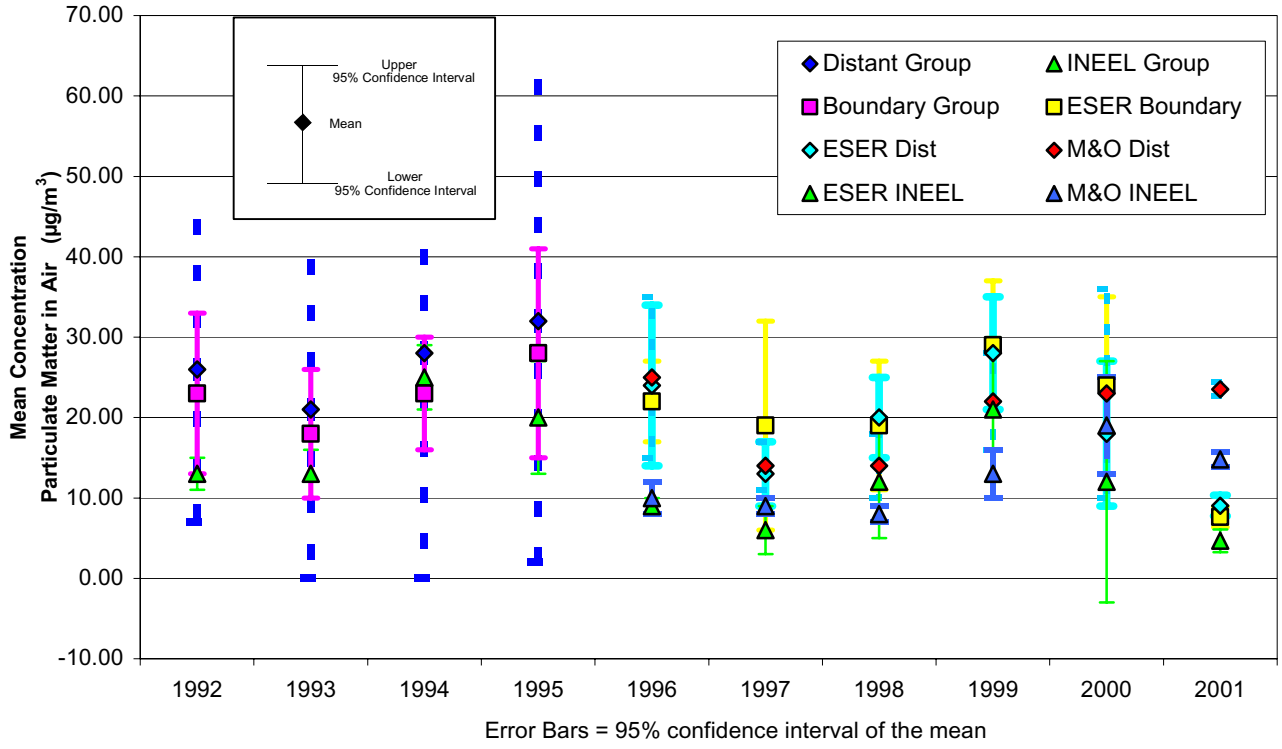


Figure 4-5. Ten-year summary of total particulate matter concentrations (1992-2001).

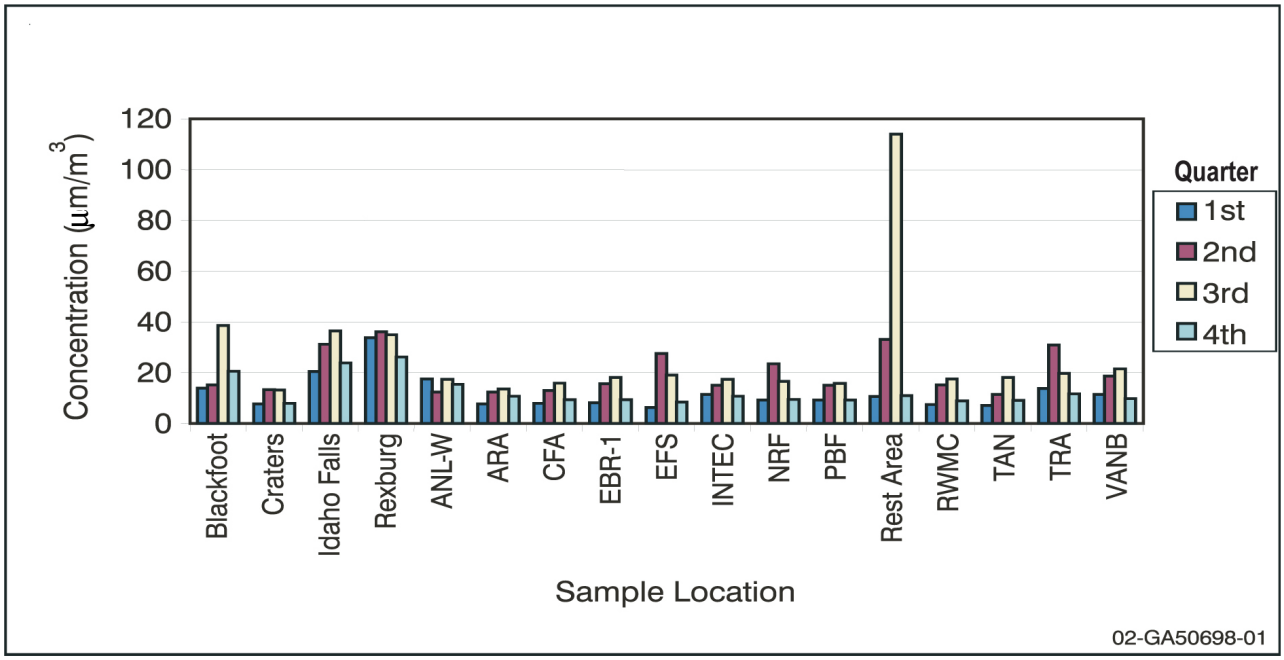


Figure 4-6. Quarterly suspended particulate matter concentrations (2001).

concentrations were found at the locations near the burned areas, in particular the Big Lost River Rest Area and TRA. The largest source of airborne particulates on the INEEL in 2001 was resuspended dust from the area that burned in the 2000 Tin Cup fire.

Fine Particulates

The EPA uses a standard for concentrations of particles with an aerodynamic diameter less than or equal to 10 microns (PM_{10}) [Reference 4-4]. Particles of this size can reach the lungs and are considered to be responsible for most of the adverse health effects associated with airborne particulate pollution. The air quality standards for PM_{10} are an annual average of 50 $\mu g/m^3$, with a maximum 24-hour concentration of 150 $\mu g/m^3$.

The ESER contractor collected 47 valid samples at the Rexburg CMS from January through December 2001. A valid sample is one that has run for the proper length of time (24 hours continuously) and that has a beginning weight less than the ending weight (does not yield a negative weight). Concentrations of PM_{10} particulates ranged from 6.1 $\mu g/m^3$ (3.3 ppb) to 188.7 $\mu g/m^3$ (102.1 ppb), with a mean of 22.8 $\mu g/m^3$ (12.3 ppb). At the Blackfoot CMS, 57 valid samples were collected from January through December. Concentrations ranged from 2.2 $\mu g/m^3$ (1.2 ppb) to 77.8 $\mu g/m^3$ (42 ppb). The mean concentration was 20.8 $\mu g/m^3$ (11.3 ppb). At Atomic City, 59 valid samples were collected from January through December. Concentrations ranged from 1.1 $\mu g/m^3$ (0.6 ppb) to 47.1 $\mu\mu g/m^3$ (25.4 ppb), with a mean of 15.6 $\mu g/m^3$ (8.4 ppb).

Nitrogen Dioxide

The M&O contractor monitored ambient nitrogen dioxide on a continuous basis at Van Buren Boulevard and the EFS throughout 2001. At Van Buren Boulevard, quarterly mean concentrations ranged from 0.6 $\mu g/m^3$ (0.6 ppb) to 1.3 $\mu g/m^3$ (1.2 ppb), with an annual mean of 1.1 $\mu g/m^3$ (1.1 ppb). These concentrations are significantly lower than the EPA national primary ambient air quality standard of 100 $\mu g/m^3$ (54 ppb) [Reference 4-5]. The maximum 24-hour concentration measured was 11.7 $\mu g/m^3$ (3.9 ppb) on December 10.

Quarterly means at EFS ranged from 1.5 $\mu g/m^3$ (1.5 ppb) in the first quarter to 2.4 $\mu g/m^3$ (2.4 ppb) in the third quarter. Due to equipment failure, no data were collected in the fourth quarter of 2001. For the three quarters collected, the mean concentration was 1.8 $\mu g/m^3$ (1.8 ppb), again well below the EPA standard of 100 $\mu g/m^3$ (54 ppb). The maximum 24-hour average concentration was a value of 4.1 $\mu g/m^3$ (4.1 ppb) on September 7.

All quarterly concentrations in 2001 remained below 50 percent of the annual standard throughout the time period of monitoring.

Sulfur Dioxide

Sulfur dioxide is measured at the Van Buren Boulevard monitoring location. For sulfur dioxide, there are three separate EPA standards [Reference 4-6]: (1) an annual primary air quality standard of 80 $\mu g/m^3$ (61 ppb), (2) a second primary air quality standard for the maximum 24-hour concentration of 365 $\mu g/m^3$ (279 ppb), not to be exceeded more than once per year, and (3) a secondary ambient air quality standard. The secondary standard refers to the maximum 3-hour concentration, which cannot exceed 1,300 $\mu g/m^3$ (994 ppb) more than once per year.

Ambient sulfur dioxide was not measured during 2001 due to equipment failure.

IMPROVE Samplers

Interagency Monitoring of Protected Visual Environments (IMPROVE) samplers began continuous operation at Craters of the Moon National Monument and CFA

during the spring of 1992. The EPA removed the CFA sampler from the national network in May 2000, when the location was determined to be no longer necessary. The most recent data available for the station at Craters of the Moon are through November 2001.

The IMPROVE samplers measure several elements, including aluminum, silicon, calcium, titanium, and iron. These elements are derived primarily from soils and show a seasonal variation with lower values during the winter when the ground is often covered by snow. Potassium is also measured and may be derived from soils, but it 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 0.1 ng/m^3 range at Craters of the Moon and 0.2 ng/m^3 at CFA, is a tracer of emissions from coal-fired plants. At Mammoth Cave in Kentucky, annual selenium concentrations of 1.4 ng/m^3 from natural sources have been reported.

Fine particles with a diameter less than 2.5 microns ($PM_{2.5}$) 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 409 to 25,103 ng/m^3 with a mean of 3,443 ng/m^3.

4.3. WASTE MANAGEMENT SURVEILLANCE MONITORING

In addition to site surveillance, the M&O contractor also conducts environmental surveillance in and around waste management facilities (e.g., Radioactive Waste Management Complex, Waste Experimental Reduction Facility [WERF], and TAN) for compliance with DOE Order 435.1, "Radioactive Waste Management." The basis for the Waste Management Surveillance Program differs from the Site Environmental Surveillance Program in that it is more facility- or source-specific.

The Waste Management Surveillance Program collects particulate material on 102-mm (4-in.) membrane filters using two types of air samplers: one for particulate matter with a nominal size of 10 µm (PM_{10}) or larger and one for suspended particulates. The PM_{10} monitors are designed to admit particles that can be inhaled into the lungs, and the suspended particulate air monitors admit larger particles. The PM_{10} particulate materials include the range of particle sizes that can be suspended in air for long periods and may be readily transported to offsite locations by wind.

Filters are collected and analyzed twice a month for gross alpha and gross beta radioactivity, and monthly composites of each location are analyzed quantitatively for gamma-emitting radionuclides. Filters from each sample location are also composited quarterly and are analyzed for specific alpha- and beta-emitting radionuclides.

Gross alpha and gross beta concentration data were obtained from PM_{10} monitors for most ambient air measurement locations during 2001. Five of the locations with PM_{10} monitors also had suspended particulate monitors in place. Suspended particulate monitors were used exclusively at locations in the TAN/Specific Manufacturing Capability (SMC) area.

Measurement values were compared by analyzing the paired data for each monitor type from the five locations with both PM_{10} and suspended particulate monitors. These five locations included one at the RWMC Subsurface Disposal Area (SDA), one at the WERF, and three at the RWMC Stored Waste Examination Pilot Plant (SWEPP). Based on these paired data, the average 2001 gross alpha and beta concentrations measured by suspended particulate

monitors are still larger than those measured by PM_{10} monitors.

For the PM_{10} monitors, the gross alpha averages ranged from 1.09 x 10^{-15} µCi/mL of air at the SWEPP Control to 1.29 x 10^{-15} µCi/mL at WERF Control. Similarly, the suspended particulate averages ranged from 1.19 x 10^{-15} µCi/mL at the SDA to 1.45 x 10^{-15} µCi/mL at TAN/SMC (Table 4-8).

Gross beta averages for the PM_{10} monitors ranged from 18.80 x 10^{-15} µCi/mL to 21.48 x 10^{-15} µCi/mL at SWEPP Control and WERF Control, respectively. The suspended particulate gross beta average was lowest at SWEPP (18.64 x 10^{-15} µCi/mL) and highest at SMC Control (23.19 x 10^{-15} µCi/mL) (Table 4-9).

The mean difference in gross alpha concentration measured by the suspended particulate monitors as compared to paired values measured by the PM_{10} monitors was 0.13 x 10^{-15} µCi/mL. For gross beta measurements, the mean difference was 0.12 x 10^{-15} µCi/mL. The 2001 mean differences in gross alpha and gross beta concentrations were 0.21 x 10^{-15} µCi/mL and 1.78 x 10^{-15} µCi/mL, respectively. The difference in the gross alpha measurements for 2001 was statistically significant using a paired t-test (see Appendix B for a discussion of statistical methods).

Trend Analysis

Trends in gross alpha concentrations for both suspended particulate and PM_{10} monitors (Figures 4-7 and 4-8) increased and decreased during the year, as shown by the third order polynomial best fit line, but they ended the year generally lower than at the start of the year. Gross beta concentrations from both monitor types (Figures 4-9 and 4-10) reported the lowest activity during the summer, as shown by the second order polynomial best-fit line. End-of-year concentrations for suspended particulate monitors were close to those at the start of the year, while end-of-year concentrations from PM_{10} monitors were slightly higher than those at the start of the year.

Comparisons by Facility

As with past analysis of gross alpha values, facility groupings varied little during 2001. Median suspended particulate monitor concentrations slightly decreased from 2000 to 2001 for all facility groupings except WERF, which slightly increased.

Table 4-8. Summary of gross alpha concentrations from M&O contractor air measurements (2001). [a]

Monitor Type	Facility	No. of Samples	Average	Median	Minimum	Maximum
Suspended Particulate	SDA	24	1.19	1.15	0.40	2.10
	SMC Control	24	1.36	1.25	0.40	3.10
	SWEPP	48	1.24	1.10	0.40	3.20
	SWEPP Control	25	1.28	1.30	0.30	3.70
	TAN/SMC	93	1.45	1.40	0.40	4.10
	WERF	25	1.30	1.20	0.60	2.20
PM_{10}	SDA	138	1.24	1.20	-1.40	3.40
	SWEPP	139	1.17	1.10	-4.00	3.20
	SWEPP Control	23	1.09	1.00	0.40	3.10
	WERF	68	1.14	1.10	-0.20	3.10
	WERF Control	23	1.29	1.20	0.40	3.00

a. All concentrations are x 10^{-15} µCi/mL air.

Table 4-9. Summary of gross beta concentrations from M&O contractor air measurements (2001). [a]

Monitor Type	Facility	No. of Samples	Average	Median	Minimum	Maximum
Suspended Particulate	SDA	24	19.13	16.40	9.60	46.20
	SMC Control	24	23.19	22.05	11.70	49.50
	SWEPP	48	18.64	16.35	9.40	38.60
	SWEPP Control	25	20.92	19.20	12.60	44.20
	TAN/SMC	93	23.06	20.10	4.60	71.00
	WERF	25	20.41	18.80	10.50	35.50
PM_{10}	SDA	138	21.35	20.25	2.80	43.20
	SWEPP	139	21.17	19.70	6.00	45.30
	SWEPP Control	23	18.80	17.30	9.30	34.80
	WERF	68	20.33	18.50	6.90	44.30
	WERF Control	23	21.48	19.80	1.80	51.10

a. All concentrations are x 10^{-15} µCi/mL air.

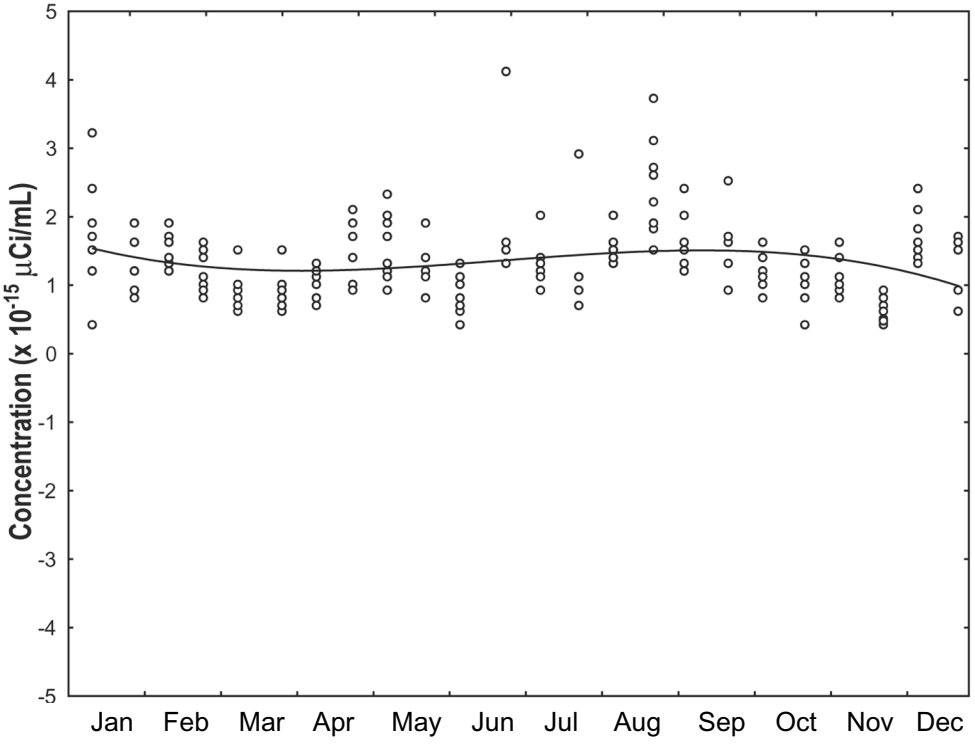


Figure 4-7. Gross alpha concentrations from suspended particulate monitors (2001).

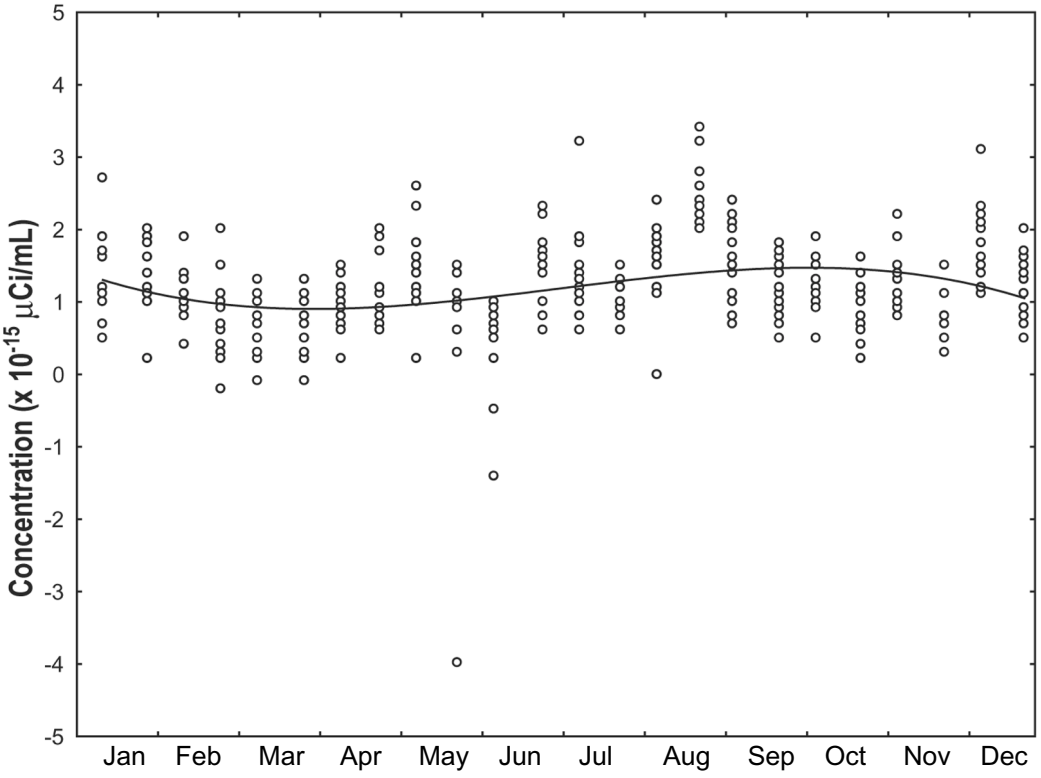


Figure 4-8. Gross alpha concentrations from PM_{10} monitors (2001).

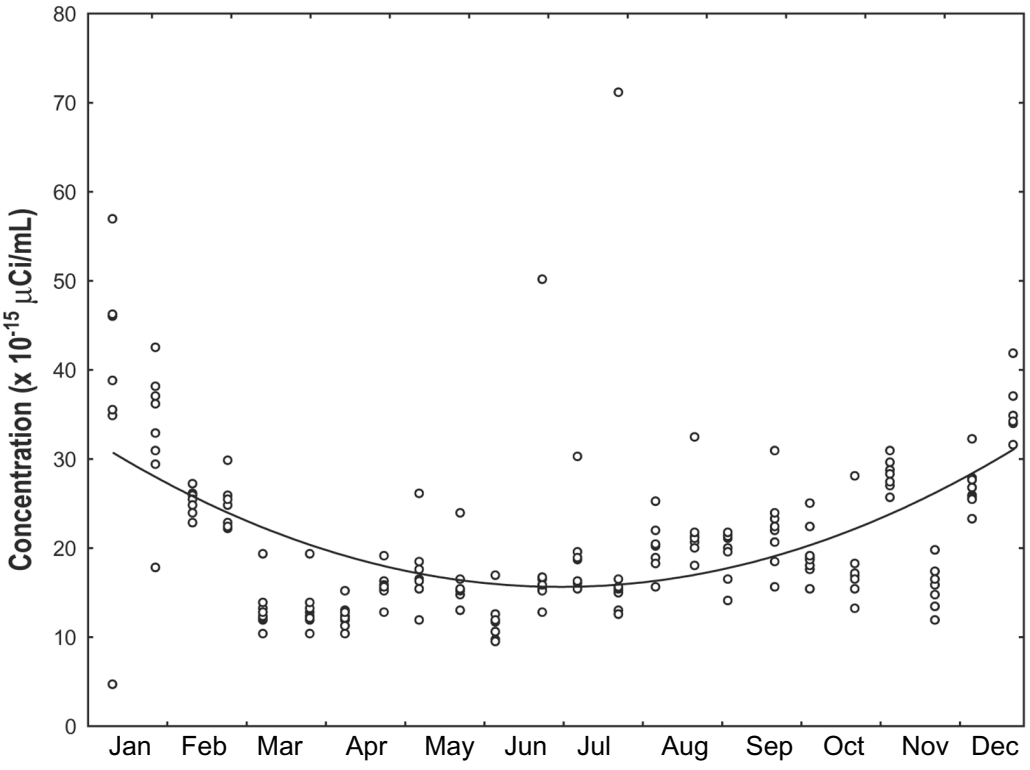


Figure 4-9. Gross beta concentrations from suspended particulate monitors (2001).

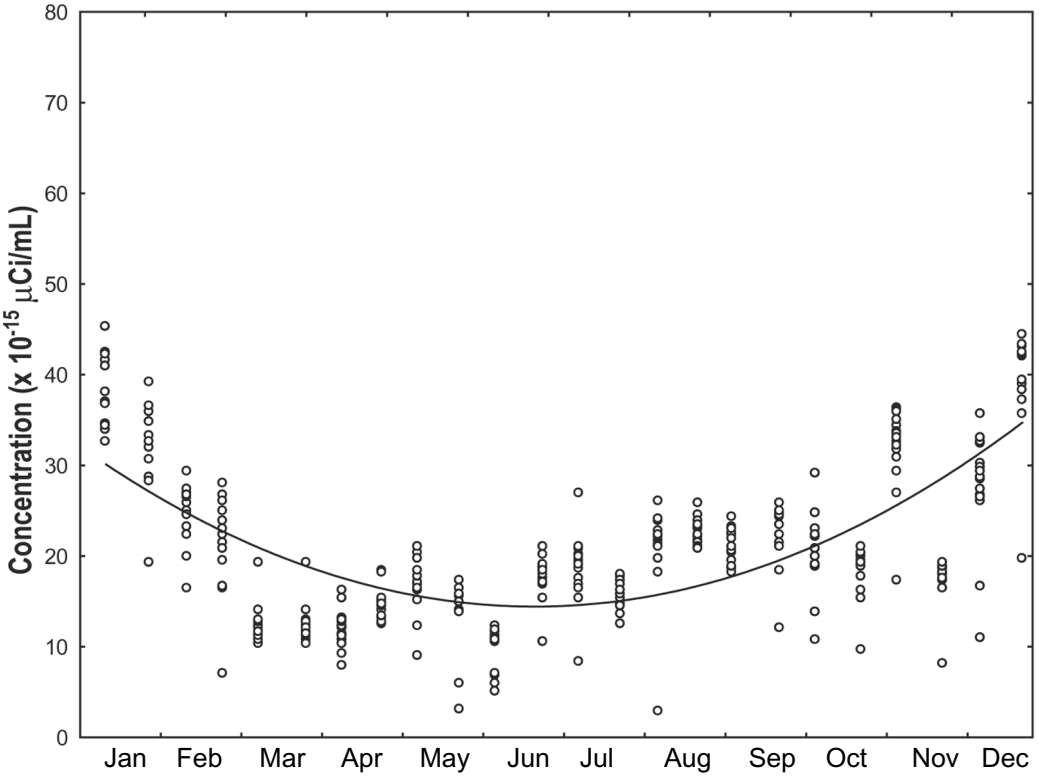


Figure 4-10. Gross beta concentrations from PM_{10} monitors (2001).

For the PM_{10} monitors, the median concentrations decreased for SWEPP, SWEPP control, and WERF control groupings; increased for the SDA grouping; and remained the same for the WERF grouping. To test for statistical significance of the variations in medians of gross alpha concentrations from 2000 to 2001, the Kruskal-Wallis significance test was performed on data from each facility grouping. Only the changes in median values from 2000 to 2001 for the gross alpha suspended particulate monitors at the SDA were statistically significant at the 95 percent confidence level. For the remaining facility/monitor type groupings, the changes in gross alpha median values from 2000 and 2001 were not statistically significant.

Facility groupings' median gross beta concentrations from suspended particulate monitors changed slightly from 2000 to 2001 for most location groupings (SWEPP control and WERF remained the same). Median gross beta concentrations from PM_{10} monitors increased for all the location groupings, except for the WERF control location, which decreased slightly. For PM_{10} monitors, these changes were significant at the 95 percent confidence level for the SDA, while none of the changes in suspended particulate monitor gross beta concentrations from 2000 to 2001 were significant.

No anthropogenic alpha or beta-emitting radionuclides were above the laboratory-stated detection. Cesium-137 and ^{60}Co were the only anthropogenic gamma-emitting radionuclides detected in 2001 (Table 4-10).

4.4. SUMMARY

The M&O, and ESER contractors sampled a variety of media in 2001 to assess if operations at the INEEL are releasing contaminants to the environment in significant levels. Assessment of the 2001 air data indicates that, although some contaminants were detected, they could not

be directly linked to operations at the INEEL. Furthermore, the maximum levels for the contaminants found were all well below regulatory health based limits for protection of human health and the environment.

Table 4-10. Anthropogenic gamma-emitting radionuclides detected by Waste Management Surveillance air measurements (2001).

Detection	No. of Samples	Location	Collection Date	Maximum[a]	DCG[b]
Cesium-137	4	TAN 101	April	5.1 ± 1.8 [c]	4×10^{-10}
		Howe	April		
		RWMC location:			
		SDA 11.3	June		
		SWEPP 21.3	September		
Cobalt-60	3	Northeast corner of the SDA:		7.0 ± 2.0	8×10^{-11}
		SDA 6.3	April		
		SDA 11.3	June		
		SWEPP 22.3	September		

a. Values shown are result x 10^{-16} μCi/mL $\pm$ 2 standard deviations.

b. Values are in microcuries per milliliter (μCi/mL).

c. Near the stated detection limit.

Chapter 5

Environmental Monitoring Programs - Water

5. ENVIRONMENTAL MONITORING PROGRAMS – WATER

Operations at facilities located on the Idaho National Engineering and Environmental Laboratory (INEEL) release both radioactive and nonradioactive constituents into the environment. This chapter presents results from both radiological and nonradiological analyses performed on liquid effluent, drinking water, groundwater, surface water, and storm water samples taken at both onsite and offsite locations. Results from sampling conducted by the Management and Operating (M&O) contractor; the U.S. Geological Survey (USGS); and the Environmental Surveillance, Education and Research (ESER) contractor are all presented here. Results are compared to both the U.S. Environmental Protection Agency (EPA) health-based maximum contaminant levels (MCL) for drinking water and/or the U.S. Department of Energy (DOE) Derived Concentration Guide (DCG) for ingestion of water.

5.1. ORGANIZATION OF MONITORING PROGRAMS

The M&O contractor monitors liquid effluents, drinking water, groundwater, and storm water runoff at the INEEL to comply with applicable laws and regulations, DOE Orders, and other requirements.

The ESER contractor monitors drinking water and surface water at offsite locations and collected 70 water samples for analyses in 2001.

The USGS INEEL Project Office performs groundwater monitoring, analyses, and studies of the Snake River Plain Aquifer (SRPA) under and adjacent to the INEEL. This is done through an extensive network of strategically placed observation wells on the INEEL (Figures 5-1 and 5-2) and at locations throughout the Eastern Snake River Plain. The USGS routine groundwater surveillance program is summarized in Chapter 3. In 2001, USGS personnel collected 2,458 samples for radionuclides and inorganic constituents including trace elements and 69 samples for purgeable organic compounds.

In addition, through an interagency agreement, the USGS performs groundwater monitoring activities for the Naval Reactors Facility (NRF). As part of the 2001 NRF sampling program, the USGS performed quarterly sampling from nine NRF wells and four USGS wells, collecting a total of 60 samples. Samples were analyzed for radionuclides, inorganic constituents, and purgeable organic compounds.

This chapter is organized according to the following sections:

- 5.2 – Liquid Effluent Compliance Monitoring;
- 5.3 – Liquid Effluent Characterization Monitoring;
- 5.4 – Drinking Water Monitoring;
- 5.5 – Groundwater Monitoring;
- 5.6 – Surface Water and Storm Water Monitoring; and
- 5.7 – Summary.

Table 5-1 presents the various water-related monitoring activities performed on and around the INEEL.

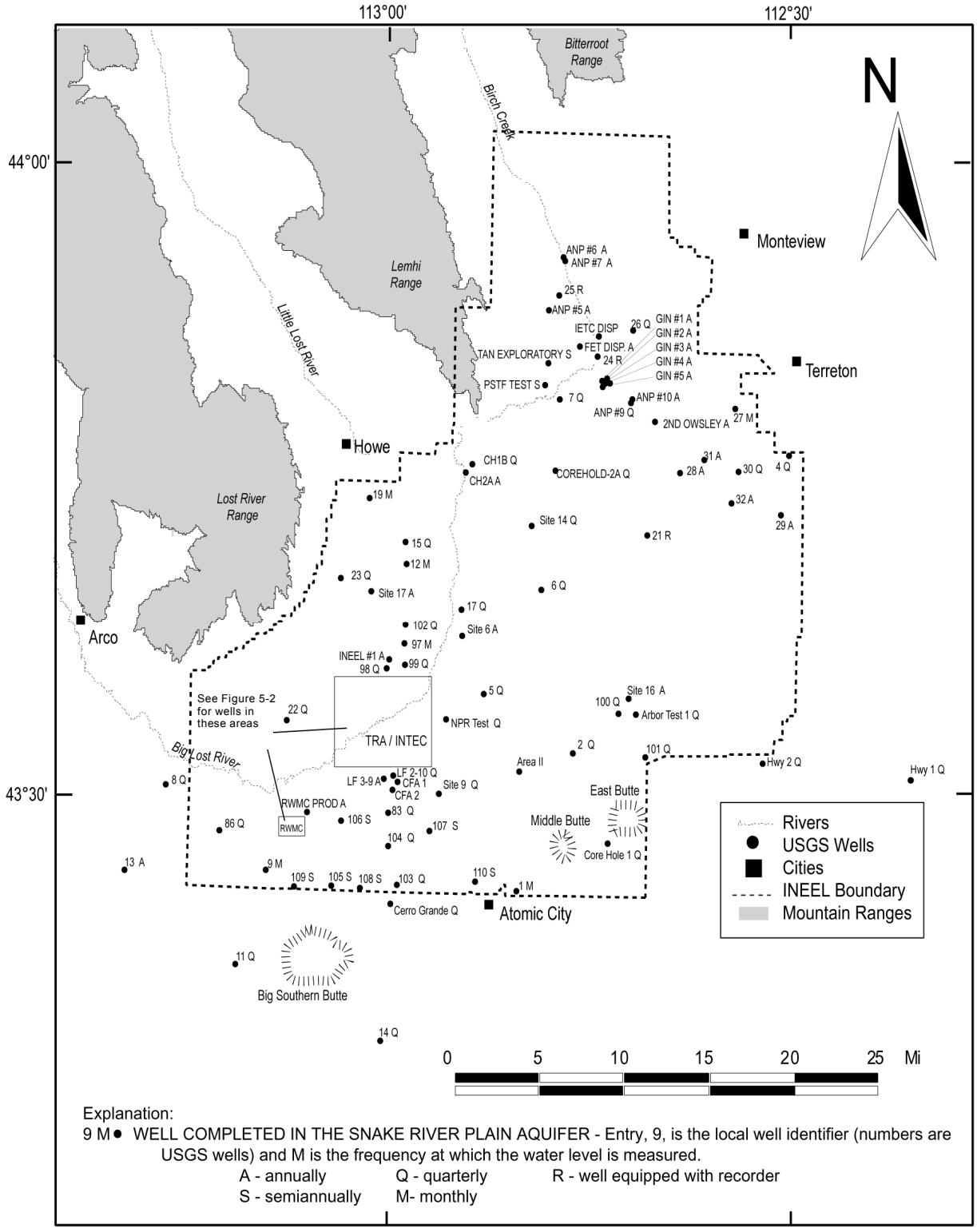


Figure 5-1. USGS well locations [Reference 5-1].

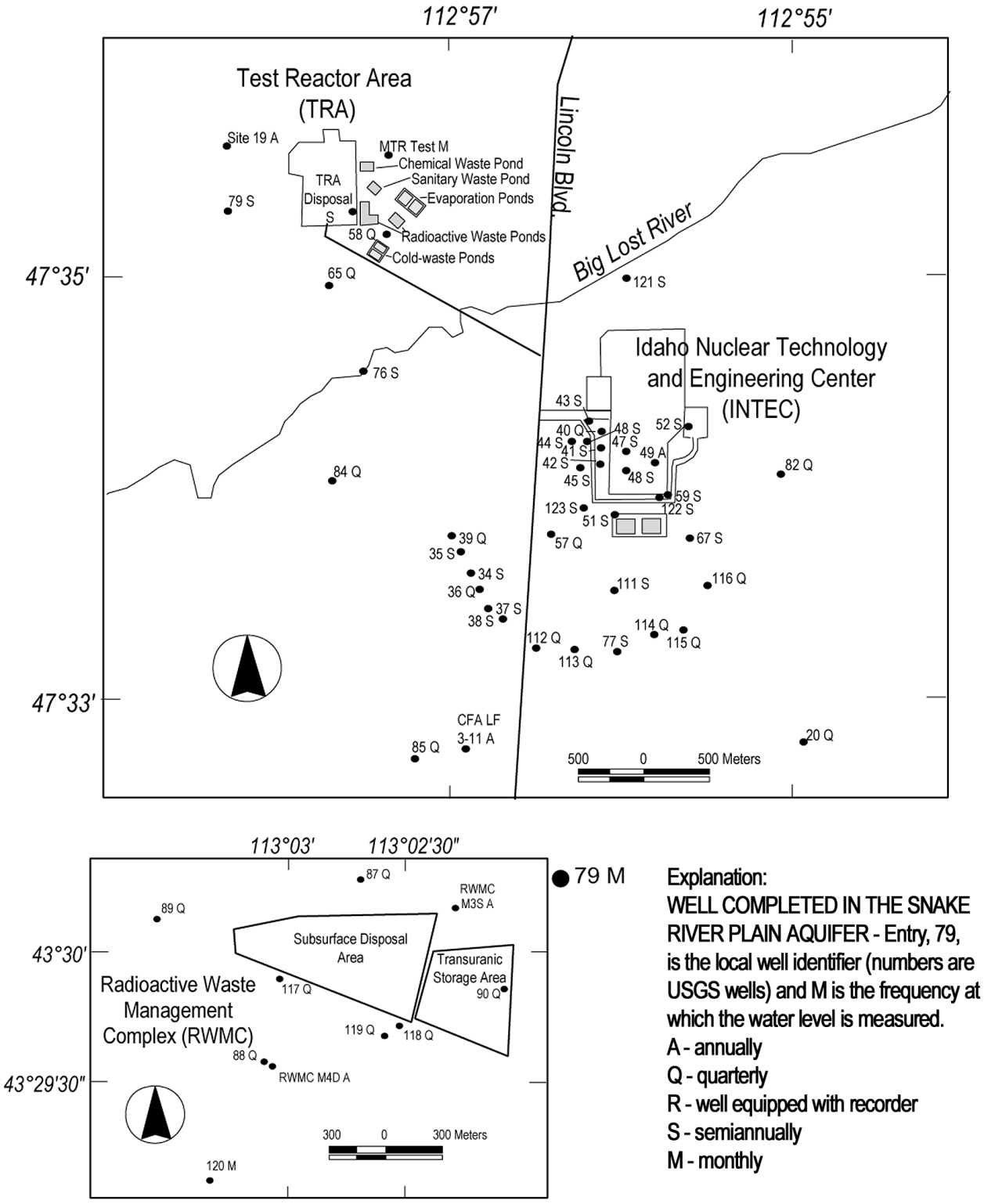


Figure 5-2. USGS well locations at the Idaho Nuclear Technology and Engineering Center, Test Reactor Area, and Radioactive Waste Management Complex [Reference 5-1].

Table 5-1. Liquid effluent and water-related monitoring at the INEEL and surrounding area.

Area/Facility	Media						
	Liquid Effluent (Permitted)	Liquid Effluent (Characterization)	Drinking Water	Groundwater (radiological)	Groundwater (Nonradiological)	Surface Water	Storm Water
Argonne National Laboratory-West							
ANL-W[a]		●	●	●	●		
Management and Operating Contractor							
CFA	●	●	●	●	●		
INTEC	●	●	●	●	●		●
TRA	●	●	●	●	●		
TAN	●	●	●	●	●		
RWMC	●	●	●	●	●	●	●
PBF/WROC	●	●	●			●	●
WCB[b]	●						
IRC[c]	●						
Naval Reactors Facility							
NRF		●	●	●	●		
Environmental Surveillance, Education and Research Program							
INEEL/Regional			●			●	
U.S. Geological Survey							
INEEL/Regional				●	●	●	
INEEL Oversight Program							
INEEL/Regional			●	●	●	●	

a. ANL-W = Argonne National Laboratory-West
b. WCB = Willow Creek Building.
c. IRC = INEEL Research Center.

5.2. LIQUID EFFLUENT COMPLIANCE MONITORING

Discharge of wastewater to the land surface is regulated under Idaho Wastewater Land Application Permit (WLAP) rules [Reference 5-2]. An approved WLAP will normally require monitoring of nonradioactive parameters in both the influent waste, effluent waste, and groundwater. The Liquid Effluent Monitoring Program conducted by the M&O contractor and Argonne National Laboratory-West (ANL-W) monitors for nonradioactive parameters in liquid waste effluents and groundwater. This monitoring program supports WLAP requirements for INEEL facilities that generate liquid waste streams covered under WLAP rules. Table 5-2 lists the six facilities operated on by the M&O contractor that require WLAPs and the current status of each permit.

The WLAPs generally require compliance with the Idaho groundwater quality standards in specified downgradient groundwater monitoring wells [Reference 5-3]. The Permits specify annual discharge volume and application rates and effluent quality limits. As required, an annual report is prepared and submitted to the Idaho Department of Environmental Quality (DEQ).

During 2001, the INEEL M&O contractor conducted monitoring as required by the Permits for each of the six facilities listed in Table 5-2. The following subsections present wastewater and groundwater monitoring results by facility. Additional parameters specified in the Idaho groundwater quality standards are also monitored. The results of this additional monitoring are discussed on a facility basis in Section 5.3. This additional monitoring is performed in support of characterization or surveillance activities.

Table 5-2. Current M&O contractor Wastewater Land Application Permits.

Facility	Status	Explanation
Central Facilities Area Sewage Treatment Plant	WLAP expired	Idaho DEQ issued letter authorizing continued operation under the terms and conditions of original permit until a new permit is issued.
Idaho Nuclear Technology and Engineering Center (INTEC) Percolation Ponds	WLAP expired	Idaho DEQ granted an extension until December 2003.
INTEC New Percolation Ponds	WLAP issued	Idaho DEQ originally issued the WLAP on September 10, 2001. The permit was subsequently modified and a new permit issued on March 28, 2002, and expires on April 1, 2007.
INTEC Sewage Treatment Plant	WLAP expired	Idaho DEQ issued letter authorizing continued operation under the terms and conditions of original permit until a new permit is issued.
Test Area North/ Technical Support Facility Sewage Treatment Plant	WLAP expired	Idaho DEQ issued letter authorizing continued operation under the terms and conditions of original permit until a new permit is issued.
Test Reactor Area Cold Waste Pond	WLAP application submitted to Idaho DEQ	Idaho DEQ has not issued a WLAP. Idaho DEQ authorized INEEL to operate the wastewater land application facility under the conditions and terms of state of Idaho WLAP rules and Idaho DEQ's Handbook for Land Application of Municipal and Industrial Wastewater until a permit is issued. [Reference 5-4].

The majority of industrial wastewater discharged at the INEEL is to the ground surface through infiltration ponds at the following areas: an industrial waste pond at ANL-W; an industrial waste ditch at NRF; seepage ponds at the Idaho Nuclear Technology and Engineering Center (INTEC) and Test Reactor Area (TRA); sewage treatment facilities at various locations on the INEEL; and City of Idaho Falls sewer system from in-town facilities. At the Central Facilities Area (CFA), a sprinkler irrigation system is also used during the summer months to land-apply treated sanitary wastewater.

Idaho Falls Facilities

DESCRIPTION – The City of Idaho Falls is authorized by the Clean Water Act National Pollutant Discharge Elimination System to set pretreatment standards for nondomestic discharges to publicly owned treatment works. Industrial Wastewater Acceptance Forms are obtained for facilities that discharge process wastewater through the City of Idaho Falls sewer system. The INEEL Idaho Falls facilities are required to comply with the applicable regulations in Chapter 1, Section 8 of the Municipal Code of the City of Idaho Falls. Twelve INEEL-related Idaho Falls facilities have associated Industrial Wastewater Acceptance Forms for discharges to the City sewer system.

The Industrial Wastewater Acceptance Forms for these facilities contain special conditions and compliance schedules, prohibited discharge standards, reporting requirements, monitoring requirements, and effluent concentration limits for specific parameters. Two of the facilities, the INEEL Research Center and the Willow Creek Building, have specific monitoring requirements.

WASTEWATER MONITORING RESULTS – Semiannual monitoring was conducted at the Willow Creek Building and INEEL Research Center in April 2001. However, due to changes in the work activities, the monitoring requirements for the Willow Creek Building were discontinued in July 2001. Table 5-3 summarizes the 2001 semiannual monitoring results.

Central Facilities Area Sewage Treatment Plant

DESCRIPTION – The CFA Sewage Treatment Plant (STP) serves all major facilities at CFA. It is southeast of CFA, approximately 671 m (2,200 ft) downgradient of the nearest drinking water well.

A 1,500-L/min (400-gal/min) pump applies wastewater from a 0.2-ha (0.5-acre) lined, polishing pond to 30 ha (74 acres) of native desert rangeland through a computerized center pivot system. The Permit limits wastewater application to 25 acre-in./acre/yr from March 15 through November 15 and limits leaching losses to 8 cm/yr (3 in./yr).

WASTEWATER MONITORING RESULTS – The permit requires influent and effluent monitoring, as well as soil sampling and vegetation density/species evaluation in the application area (see Chapter 6 for results pertaining to soils and vegetation). Influent samples were collected monthly from the lift station at CFA (prior to Lagoon No. 1) during 2001. Effluent samples were collected from the pump pit (prior to the pivot) starting in June 2001 and continued through the month of September 2001 (months of pivot operation). All samples collected were 24-hour composites, except the pH and coliform samples, which were collected as grab samples. Tables 5-4 and 5-5 show the results.

Daily influent flows averaged less than 477,000 L/d (126,000 gal/d). Total influent flow volume was approximately 174 million L (46 million gal) for the 2001 calendar year. Discharge to the pivot averaged less than 647,000 L/d (171,000 gal/d) when it operated. A total of 55 million L (15 million gal) was discharged through the pivot for 2001.

Table 5-3. Semiannual monitoring results for INEEL Research Center and Willow Creek Building (2001).[a]

	INEEL Research Center		Willow Creek Building	
Parameter	**April 2001**	**October 2001**	**April 2001**	**Limit**
Cyanide	0.005 U[b]	0.005 U	0.005 U	1.04
Silver	0.00125 U	0.00125 U	0.0126	0.43
Arsenic	0.00125 U	0.00125 U	0.00125 U	0.04
Cadmium	0.00025 U	0.00025 U	0.00025 U	0.26
Chromium	0.00125 U	0.00125 U	0.00125 U	2.77
Copper	0.0263	0.0326	0.0969	1.93
Mercury	0.0001 U	0.0001 U	0.0001 U	0.002
Nickel	0.00125 U	0.00125 U	0.0028	2.38
Zinc	0.0231	0.0265	0.179	0.90
Lead	0.00075 U	0.00075 U	0.002	0.29
Conductivity (µS) (max/avg.)[c]	547.5/504.6	702/562	957/689	N/A
pH (standard units) (max/avg.)[c]	8.74/8.18	7.96/7.9	8.77/8.66	5.5-9.0

a. All values are in milligrams per liter unless otherwise noted.
b. U flag indicates that the result was below the detection limit; half the detection limit is shown and used in summaries.
c. Values represent the maximum and average for the four samples taken over an 8-hr period during semiannual monitoring.

Table 5-4. CFA Sewage Treatment Plant influent monitoring results (2001).[a]

Parameter	**Maximum**	**Average**	**# Samples**	**# Detections[b]**
Biological Oxygen Demand (5-day)	223.0	48.9	12	12
pH (standard units) (grab)	8.40	7.77	12	12
Chemical Oxygen Demand	217.0	101.0	12	12
Nitrogen, Nitrate+Nitrite (mg-N/L)	1.87	0.74	12	12
Total Kjeldahl Nitrogen	27.5	16.0	12	12
Total Suspended Solids	80.6	40.6	12	12

a. All values are in milligrams per liter unless otherwise noted.
b. # Detections indicates the number of samples with results greater than the minimum detectable limit for that constituent.

Table 5-5. CFA Sewage Treatment Plant effluent monitoring results (2001).[a]

Parameter	Maximum [b]	Average [b]	# Samples	# Detections
Biological Oxygen Demand (5-day) [c]	27.10	11.17	3	2
pH (standard units) (grab)	9.91	9.79	4	4
Chemical Oxygen Demand	41.20	33.60	5	5
Nitrogen, Nitrate + Nitrite (mg-N/L)	0.022	0.01[d]	5	1
Total Phosphorus	0.17	0.13	5	5
Total Kjeldahl Nitrogen	1.78	1.35	5	5
Total Suspended Solids	4	2[e]	5	1

a. All values are in milligrams per liter unless otherwise noted.

b. Duplicate samples collected in June, July, and September are included in the summaries.

c. July and August data were rejected during data validation and not included in the summaries.

d. Sample results for June, July, and August were less than detection levels. Half the detection limit was used when calculating the summary.

e. Sample results for June, July, and September were less than detection levels. Half the detection limit was used when calculating the summary.

Removal efficiencies for biochemical oxygen demand, chemical oxygen demand, total suspended solids, and total nitrogen were calculated to estimate treatment in the lagoons. During the 2001 calendar year, all average removal efficiencies were within the historical ranges, and treatment in the lagoons was sufficient to produce a good quality effluent for land application.

The 2001 annual total chemical oxygen demand loading for the CFA STP (56 lb/acre/yr) was less than the previous year and was substantially less than the State guidelines of 50 lb/acre/d (which is equivalent to 18,250 lb/acre/yr).

The annual total phosphorus loading rate of 0.241 lb/acre/yr was well below the projected maximum loading rate of 4.5 lb/acre/yr. The small amount of phosphorus applied was probably removed by sorption reactions in the soil and used by vegetation, rather than lost to leaching.

Soil and weather conditions, combined with the relatively low volume of wastewater applied, resulted in no leaching loss for the year, compared to the Permit limit of 8 cm/yr (3 in./yr). As a result, land application of wastewater had a negligible impact on soils and groundwater. The impact to vegetation in the application area continues to suggest that the sagebrush steppe community is more susceptible to change as a result of wastewater application than other communities.

GROUNDWATER MONITORING RESULTS— The WLAP does not require groundwater monitoring at the CFA STP.

Idaho Nuclear Technology and Engineering Center Existing and New Percolation Ponds

DESCRIPTION – The INTEC generates an average of 3.8 to 7.6 million L/d (1 to 2 million gal/d) of nonhazardous process wastewater during normal operations. This wastewater, commonly called service waste, is discharged to the existing percolation ponds via the service waste system. In the event of unusual circumstances, the percolation ponds could accommodate up to 18.9 million L/d (5 million gal/d).

The percolation ponds receive only nonhazardous wastewater. Wastewater with the potential to contain hazardous

constituents is disposed of in accordance with applicable Resource Conservation and Recovery Act regulations. Sanitary wastes from restrooms and the INTEC cafeteria are either discharged to the INTEC Sewage Treatment Plant or directed to onsite septic tank systems.

The service waste system serves all major facilities at INTEC. This process-related wastewater from INTEC operations consists primarily of steam condensates, noncontact cooling water, reverse osmosis products, water softener and demineralizer regenerate, and boiler blowdown wastewater.

All service waste enters building CPP-797, the final sampling and monitoring station, prior to discharge to the percolation ponds. In CPP-797, the combined effluent is measured for flow rate and monitored for radioactivity, and samples are collected for analyses. No radioactivity is expected; however, if radioactivity is detected above normal operating levels, all contaminated waters are directed to a diversion tank rather than discharged to the percolation ponds. Two sets of two pumps transfer the wastewater from CPP-797 to the percolation ponds.

In 2001, construction was completed on new percolation ponds that, when operational, will replace the existing ponds. More information on the new ponds can be found in Chapter 3 of this report in the discussion of Waste Area Group 3.

WASTEWATER MONITORING RESULTS – The WLAP for the existing percolation ponds requires influent and effluent monitoring, as well as groundwater sampling. A 24-hour flow-proportional composite sample is collected monthly from the sample point located in CPP-797 and analyzed. Table 5-6 presents the effluent results from the existing INTEC percolation ponds.

Based upon analytical results, the quality of wastewater discharged to the percolation ponds in 2001 is consistent with previous years. The Permit does not specify concentration limits for effluent to the ponds; however, concentrations were compared to the applicable state of Idaho primary or secondary groundwater standards. Yearly average effluent concentrations for all constituents met these standards. The yearly average concentration for total dissolved solids has continued to decrease since the Permit was issued and fell below the secondary groundwater standard of 500 mg/L this Permit period.

The flow volumes to the percolation ponds were recorded daily from the flow meter located in CPP-797. The majority of the flow (1.97×10^9 L of the 2.06×10^9 total L [519.8×10^6 gal of the 544×10^6 total gal]) was discharged into Percolation Pond No. 1. Percolation Pond 2 was only used during June 2001 for a short period. Total flow during the 2001 permit year increased over that of the previous year, but it was well below the Permit limit of 345×10^9 L/yr (912 million gal/yr).

GROUNDWATER MONITORING RESULTS— To measure potential percolation pond impacts to groundwater, the WLAP requires that groundwater samples be collected semiannually from four monitoring wells:

- One background aquifer well (USGS-121) upgradient of INTEC;
- One aquifer well (USGS-048) immediately upgradient of the percolation ponds; and
- Two aquifer wells (USGS-112 and -113) downgradient of the percolation ponds, which serve as points of compliance (Figure 5-2).

Analytical results for 2001 were very similar to those of previous years. No Permit levels were exceeded at either compliance well during the calendar year (Table 5-7). Chloride, total dissolved solids, and sodium concentrations continued to be elevated in wells USGS-112 and -113 compared to USGS-048. These elevated concentrations resulted from the ongoing

Table 5-6. INTEC existing percolation pond effluent monitoring results (2001).[a]

Parameter	Maximum	Average[b]	# Samples	# Detections
pH (standard units) (composite)	8.31	8.21	11	11
pH (standard units) (grab)	8.62	8.23	12	12
Chloride	405.0	153.0	12	12
Fluoride	0.23	0.20	12	12
Nitrogen, as Nitrite (mg-N/L)[c]	0.0070	0.0027	12	0
Nitrogen, as Nitrate (mg-N/L)	1.10	0.91	12	12
Total Dissolved Solids	820.0	464.0	12	7
Total Kjeldahl Nitrogen[c]	0.135	0.113	12	0
Silver	0.0011	0.0008	12	1
Aluminum	0.0138	0.0061	12	5
Arsenic[c]	0.0031	0.0018	12	0
Cadmium[c]	0.0004	0.0002	12	0
Chromium	0.0064	0.0055	12	12
Copper	0.0057	0.0034	12	10
Iron	0.0364	0.0174	12	9
Mercury[c]	0.0001	0.0001	12	0
Manganese	0.0012	0.0008	12	10
Sodium	258.0	111.1	12	12
Selenium[c]	0.0024	0.0018	12	0

a. All values are in milligrams per liter unless otherwise noted.

b. Annual average is determined from the average of the monthly values. Half the reported detection limit was used in the yearly average calculation for those data reported as below the detection limit.

c. All data were reported as below the detection limit. Half of the highest reported detection limit for a particular parameter is used for the annual maximum concentration.

Table 5-7. INTEC existing percolation pond groundwater results for April and October (2001).

	USGS-048		USGS-112		USGS-113		USGS-121		PCS/SCS[a]
Depth to Water[b]	460.66	462.45	416.64	477.96	476.82	468.79	455.97	453.74	
Sample Date/Parameter[c]	4/25/01	10/10/01	4/24/01	10/10/01	4/25/01	10/10/01	4/24/01	10/10/01	
Total Kjeldahl Nitrogen	0.219	0.1 U[d]	0.1 U	0.1 U	0.322	0.1 U	0.1 U	1.0 U	NA[e]
Chloride[f]	26.1 [27]	27.4	102 [101]	105	173 [173.8]	176	11.6 [11.4]	11.7	250 (350)[g]
Total Dissolved Solids	303	270	455	362	623	506	258	197	500 (800)[g]
Sodium	14.7	14.9	49.5	45.3	78.9	67.6	7.1	7.47	NA
Nitrate (NO_3)	3.2	3.33	3.1	3.42	2.4	2.27	0.75	0.80	10
Nitrite (NO_2)	0.0035 U	0.10 U	0.003 U	0.10 U	0.003 U	0.10 U	0.004 U	0.10 U	1
NO_2 +NO_3	3.22	3.23	3.25	3.37	2.39	2.32	0.757	0.82	10
Arsenic	0.0025 U	0.003 U	0.0025 U	0.003 U	0.0025 U	0.003 U	0.0025 U	0.003 U	0.05
Cadmium	0.0005 U	0.001 U	0.0005 U	0.001 U	0.0005 U	0.001 U	0.0005 U	0.001 U	0.005
Chromium	0.0059	0.0068	0.0055	0.0059	0.0056	0.0062	0.0041[h]	0.0053[h]	0.1
Mercury	0.0002 U	0.00022	0.0002 U	0.00013	0.0002 U	0.00011	0.0002 U	0.00017[i]	0.002
Selenium	0.0025 U	0.004 U	0.0025 U	0.004 U	0.0025 U	0.004 U	0.0025 U	0.004 U	0.05
Silver	0.0025 U	0.002 U	0.0025 U	0.002 U	0.0025 U	0.002 U	0.0025 U	0.002 U	0.1
Fluoride[f]	0.2 U [0.21]	0.20	0.2 U [0.25]	0.20	0.215 [0.22]	0.20	0.2 U [0.21]	0.20	4
Iron	0.0125 U	0.0366	0.121	0.0931	0.0125 U	0.015 U	0.0125 U	0.0345	0.3
Manganese	0.0025 U	0.001 U	0.0025 U	0.0013	0.0025 U	0.001 U	0.0025 U	0.001 U	0.05
Copper	0.0027	0.002	0.0031	0.0015	0.0025 U	0.001 U	0.0025 U	0.0016	1.3
Aluminum	0.005 U	0.049 U	0.0121	0.049 U	0.0072	0.049 U	0.005 U	0.049 U	0.2
pH (standard units)	7.93	7.74	8.29	8.01	7.91	7.85	8.23	7.87	6.5–8.5

a. Primary constituent standards (PCS) and secondary constituent standards (SCS) in groundwater referenced in Idaho Administrative Procedure Act 58.01.11.200.01.a and b.
b. Depth to water table in feet.
c. All values are in milligrams per liter unless otherwise noted.
d. U flag indicates that the result was reported as below the detection limit.
e. NA = not applicable.
f. Where available, duplicate results are presented in brackets.
g. The Permit specifies exceptions for chloride and total dissolved solids limits of 350 mg/L and 800 mg/L, respectively.
h. Duplicate chromium results were 0.0044 mg/L for April and 0.0045 mg/L for October.
i. A duplicate mercury result was reported as 0.0001U mg/L.

operation of the water softening and treatment processes at INTEC, which introduces chloride, total dissolved solids, and sodium into the service waste system and eventually to the percolation ponds.

The WLAP for the new percolation ponds requires characterization of groundwater quality in the perched water formation prior to startup of the ponds using three perched water monitoring wells specified in the Permit. However, if there is no flow in the Big Lost River or no perched water formations occur prior to startup, then water quality characterization is not required. Since issuance of the WLAP on September 10, 2001, there has been no flow in the Big Lost River. Inspection of the perched wells in the vicinity of the new percolation ponds prior to Permit issuance indicated that the wells were dry. Monitoring of water levels in the three perched wells is planned for 2002 to determine if they can be characterized prior to startup.

Idaho Nuclear Technology and Engineering Center Sewage Treatment Plant

DESCRIPTION – The INTEC STP treats and disposes of sanitary and other related wastes (cafeteria and building water softeners) using natural biological and physical processes (digestion, oxidation, photosynthesis, respiration, aeration, and evaporation). The INTEC STP consists of

- Two aerated lagoons (Cell Nos. 1 and 2);
- Two quiescent, facultative stabilization lagoons (Cell Nos. 3 and 4);
- Six control stations; and
- Four rapid infiltration trenches.

The six control stations direct the wastewater flow to the proper sequence of lagoons and infiltration trenches. Automatic flow-proportional composite samplers are located at control stations CPP-769 (influent) and CPP-773 (wastewater from the STP to the rapid infiltration trenches). The composite samplers are connected to flow meters, thus, allowing collection of flow-proportional samples.

WASTEWATER MONITORING RESULTS – The WLAP requires that the influent and effluent be sampled and analyzed monthly. Influent samples were collected from control station CPP-769 and effluent samples were collected from control station CPP-773. The WLAP sets effluent limits at CPP-773 for total nitrogen (total Kjeldahl nitrogen plus nitrite/nitrate nitrogen) and total suspended solids. Current permit-required influent and effluent monitoring results are presented in Tables 5-8 and 5-9, respectively.

Except for the monthly total coliform grab sample, all samples were collected as 24-hour flow-proportional composites. Monthly average effluent total suspended solids concentrations remained below the Permit limit of 100 mg/L, with an annual average of 34 mg/L. During 2001, the average monthly total nitrogen exceeded

Table 5-8. INTEC Sewage Treatment Plant influent monitoring results (2001).[a]

Parameter	Maximum	Average	# Samples	# Detections
Biological Oxygen Demand (5-day)[b]	217.0	119.4	18	18
Nitrogen, Nitrate + Nitrite (mg-N/L)[b]	2.650	0.214	18	13
Total Phosphorus	9.1	5.7	12	12
Total Kjeldahl Nitrogen[b]	78.1	51.9	18	18
Total Suspended Solids[b]	460.0	171.0	18	18

a. All values are in milligrams per liter (mg/L) unless otherwise noted.

b. Average value was calculated from two samples per month collected during April, May, June, July, August, and September.

Table 5-9. INTEC Sewage Treatment Plant effluent monitoring results (2001).[a,b,c]

Parameter	Maximum[d]	Average[d]	# Samples	# Detections
Biochemical Oxygen Demand (5-day)[e]	29.9	17.3	16	16
Conductivity (µS) (composite)	1,023.0	976.5	8	8
Conductivity (µS) (grab)[e]	1,053.0	954.3	15	15
Chloride[f,g]	197.0	154.0	10	10
Nitrogen, Nitrate+Nitrite (mg-N/L)[e]	4.4	1.0	16	16
Total Phosphorus[f]	7.75	3.99	11	11
Total Dissolved Solids[f,g]	653.0	565.0	10	10
Nitrogen, Total Kjeldahl[e]	30.3	13.1	16	16
Total Suspended Solids[e]	92.4	34.0	16	16

a. No effluent sample was collected in January 2001 due to the shear gate replacement project.

b. Samples in addition to permit-required monthly samples were collected on 6/6/2001, 7/10/2001, 8/15/2001, and 9/26/2001. The samples were analyzed for biochemical oxygen demand, conductivity (grab), nitrogen, nitrate + nitrite, total Kjeldahl nitrogen, and total suspended solids. The results were included in the summary calculations.

c. A duplicate sample was collected on 9/6/2001 and analyzed for biochemical oxygen demand, chloride, nitrogen, nitrate + nitrite, total phosphorus, total dissolved solids, total Kjeldahl nitrogen, and total suspended solids.

d. All values are in milligrams per liter unless otherwise noted.

e. Data from a special sample collected on April 11, 2001, were used in the summary calculations for these parameters.

f. The compliance sample scheduled for the week of April 23, 2001, was not taken due to ongoing work on the shear gate replacement project; therefore, there were no data for the month of April for these parameters factored into the summary.

g. Sample for chloride and total dissolved solids was not collected during November 2001.

the monthly average limit of 20 mg/L during February, March, and April. Typically, the highest nitrogen concentrations occur during the colder months. However, due to work being performed on the shear gate, the potential for both total suspended solids and total nitrogen exceedances existed until the treatment system had time to stabilize.

GROUNDWATER MONITORING RESULTS— To measure potential INTEC STP impacts to groundwater, the WLAP requires that groundwater samples be collected semiannually from three monitoring wells:

- One background aquifer well (USGS-121) upgradient of INTEC;
- One perched water well (ICPP-MON-PW-024) immediately adjacent to the STP; and
- One aquifer well (USGS-052) downgradient of the STP, which serves as the point of compliance (Figure 5-2).

Contaminant concentrations in USGS-052 are limited by primary and secondary groundwater standards specified in Idaho regulations. Table 5-10 presents the monitoring results for 2001.

Groundwater samples collected from USGS-052 were in compliance with all Permit limits during 2001. Chloride and nitrate concentrations in USGS-052 were elevated compared to USGS-121, as in previous years.

Monitoring well ICPP-MON-PW-024 was completed in the perched water zone approximately 21 m (70 ft) below the surface of the infiltration trenches. Similar to previous years, total dissolved solids and

Table 5-10. INTEC Sewage Treatment Plant groundwater monitoring results (2001).

	ICPP-MON-PW-024		USGS-52				USGS-121		PCS/SCS[a]
Depth to Water[b]	62.71	63.46	454.36	454.36	453.39	453.39	455.97	453.74	
Sample Date Parameter[c]	4/24/01	10/9/01	4/25/01	4/25/01[d]	10/22/01	10/22/01[d]	4/24/01	10/10/01	
Total Kjeldahl Nitrogen	0.677	1.0 U[e]	0.1 U	0.1 U	1.0 U	1.0 U	0.1 U	1.0 U	NA[f]
Chloride[g]	82.1/81.8	126	25.6/25.9	25.1/25.9	27.7	27.9	11.6/11.4	11.7	250
Total Dissolved Solids	551	634	296	301	265	264	258	197	500
NO_3N	12.9	12.0	3.1	3.1	3.9	3.8	0.75	0.8	10
NO_2N	0.003 U	0.10 U	0.003 U	0.003 U	0.10 U	0.10 U	0.004 U	0.10 U	1
$NO_2N + NO_3N$	13.2	16	3.32	3.33	4.0	3.84	0.757	0.82	10
NH_4N	0.01 U	0.10 U	0.01 U	0.0129	0.10 U	0.10 U	0.0405	0.1	NA
Biological Oxygen Demand	2.0 U	8.0 U	2.0 U	2.0 U	3.2	2.8	2.0 U	6.4	NA
Total P	1.95	1.8	0.0197	0.0192	0.10 U	0.10 U	0.0161	0.10 U	NA
Total Coliform	Absent	6[h]	Absent	Absent	Absent	Absent	Absent	Absent	1 colonies/100 mL
Fecal Coliform	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	NA

a. Primary constituent standards (PCS) and secondary constituent standards (SCS) in groundwater referenced in Idaho Administrative Procedure Act 58.01.11.200.01.a and b.
b. Depth to water table in feet.
c. All values are in milligrams per liter unless otherwise noted.
d. Duplicate sample.
e. U flag indicates that the result was reported as below the detection limit.
f. NA = not applicable.
g. Two different samples were analyzed for chloride in April; both results are presented.
h. Coliform bacteria were speciated as *Enterobacter aerogenes*, which is a naturally occurring bacteria in soils and water.

chloride concentrations in ICPP-MON-PW-024 approximated those of the effluent. Total coliform was detected in the October 2001 sample from this well and was present also in the effluent. However, the species of bacteria detected *(Enterobacter aerogenes)* is a type of bacteria that normally occurs in soils and water.

Test Area North/Technical Support Facility Sewage Treatment Plant

DESCRIPTION – The Test Area North/ Technical Support Facility (TAN/TSF) STP was constructed in 1956. It was designed to treat raw wastewater by biologically digesting the majority of the organic waste and other major contaminants, then applying it to land for infiltration and evaporation. The STP plant consists of

- Wastewater-collection manhole;
- Imhoff tank;
- Sludge drying beds;
- Trickle filter and settling tank;
- Contact basin; and
- Infiltration disposal pond.

The TAN/TSF disposal pond was constructed in 1971. It consists of a primary disposal area and an overflow section, both of which are located within an unlined, fenced 14.2 ha (35-acre) area. The overflow pond is used only when wastewater is diverted to it for brief periods of cleanup and maintenance of the primary pond. In addition to receiving treated sewage wastewater, the TAN/TSF disposal pond also receives process wastewater, which enters the facility at the TAN-655 lift station.

The TSF sewage primarily consists of spent water containing wastes from restrooms, sinks, and showers. The sanitary wastewater goes to the TAN-623 STP, and then to the TAN-655 lift station, which pumps to the TAN/TSF disposal pond.

The process drain system collects wastewater from process drains and building sources originating from various TAN facilities. The process wastewater consists of effluent, such as steam condensate; water softener and demineralizer discharges; and cooling water, heating, ventilating, air conditioning, and air scrubber discharges. The process wastewater is transported directly to the TAN-655 lift station, where it is mixed with sanitary wastewater before being pumped to the TAN/TSF disposal pond.

WASTEWATER MONITORING RESULTS – The Permit flow limit is 129 million L (34 million gal) per year discharged to the disposal pond. Total effluent to the disposal pond for calendar year 2001 was 33 million L (10 million gal). The Permit for the TAN/TSF STP also sets concentration limits for total suspended solids and total nitrogen measured in the effluent to the disposal pond and requires that the effluent be sampled and analyzed monthly for several parameters. During 2001, 24-hour composite samples (except fecal and total coliform, which were grab samples) were collected from the TAN-655 lift station effluent monthly.

Table 5-11 shows the effluent monitoring results for calendar year 2001. Monthly concentrations of total suspended solids were well below the Permit limit (100 mg/L) throughout the entire year, with an annual average of 6.9 mg/L. All monthly total nitrogen (total Kjeldahl nitrogen + nitrite/nitrate nitrogen) concentrations were well below the Permit limit of 20 mg/L, with the maximum monthly concentration of 10.9 mg/L reported in February.

GROUNDWATER MONITORING RESULTS— To measure potential disposal pond impacts to groundwater, the WLAP for the TAN/TSF STP requires that groundwater samples be collected semiannually from four monitoring wells:

- One background aquifer well (TANT-MON-A-001) upgradient of the disposal pond; and

Table 5-11. TAN/TSF Sewage Treatment Plant effluent annual monitoring results (2001).[a]

Parameter	Maximum	Average	# Samples	# Detections
Biological Oxygen Demand (5-day)[b]	28.3	12.7	12	12
Chloride	227.0	96.0	13	13
Fluoride[c]	0.287	0.246	13	12
Nitrogen, as Ammonia	5.61	1.78	13	13
Nitrogen, Nitrate + Nitrite (mg-N/L)	5.87	3.77	13	13
Total Phosphorus	1.38	0.82	13	13
Sulfate	44.5	37.7	13	13
Total Dissolved Solids	637.0	420.0	13	13
Nitrogen, Total Kjeldahl	6.42	2.65	13	13
Total Suspended Solids[c]	10.0	6.9	13	12
Arsenic[c]	0.0035	0.0019	13	5
Barium	0.1130	0.0997	13	13
Chromium[d]	0.0052	0.0022	13	6
Iron	0.1800	0.0864	13	13
Lead[d]	0.0024	0.0009	13	1
Manganese	0.0089	0.0057	13	13
Mercury[d]	0.0001	0.0001	13	0
Selenium[d]	0.0013	0.0013	13	0
Sodium	141.0	57.2	13	13
Zinc	0.0396	0.0302	13	13

a. All values are in milligrams per liter unless otherwise noted.

b. Biological oxygen demand data for September were rejected due to the required analytical hold time being missed, as a result of sample shipment delays. September data were not used in calculating annual average.

c. Half the detection limit was used when calculating the average value when sample results were reported as less than the detection limit.

d. Duplicate sample collected in October. Data from duplicate sample were used in calculating the annual summary.

- Three aquifer wells (TAN-10A, TAN-13A, and TANT-MON-A-002) downgradient of the disposal pond that serve as points of compliance.

Contaminant concentrations in TAN-10A, TAN-13A, and TANT-MON-A-002 are limited by Idaho primary and secondary groundwater standards. Table 5-12 presents the monitoring results for 2001.

Iron concentrations exceeded the Permit standard of 0.3 mg/L in TANT-MON-A-001 (the background well) and TAN-13A in April and October, in TAN-MON-002 in April, and in TAN-10A in October. These concentrations are consistent with results of the past few years; elevated iron concentrations historically have been detected in the TAN WLAP monitoring wells.

Table 5-12. TAN/TSF Sewage Treatment Plant groundwater monitoring results (2001).

	TANT-MON-A-001		TANT-MON-A-002		TAN-10A				TAN-13A		PCS/SCS[a]
Depth to Water[b]	202.74	205.65	207.31	209.08	204.54	204.54	205.64	205.64	206.92	206.73	
Sample Date Parameter[c]	4/11/01	10/16/01	4/11/01	10/16/01	4/10/01	4/10/01[d]	10/16/01	10/16/01[d]	4/10/01	10/8/01	
TKN	0.1 U[e]	1.0 U	0.1 U	1.0 U	0.1 U	0.1 U	1.0 U	1.0 U	0.1 U	1.0 U	NA[f]
BOD	2.0 U	2.0 U	2.06	2.0 U	2.0 U	2.0 U	3.2	3.3	2.0 U	2.0 U	NA
Chloride	11.1	11.6	2.6	3.8	104	108	106	106	1.6	3.4	250
TDS	195	230	172	195	502	496	497	489	138	165	500
Total P	0.0458	0.10 U	0.0404	0.10 U	0.0723	0.0734	0.10 U	0.10 U	0.0253	0.10 U	NA
Sodium	7.32	8.12	5.99	6.54	51	51.2	46.3	46.0	5.58	4.13	NA
NO_3N	0.89	0.92	0.54	0.58	2.39	2.39	2.17	2.26	0.36	0.41	10
NO_2N	0.003 UR[g]	0.10 U	0.003 UR	0.10 U	0.003 UR	0.003 UR	0.10 U	0.10 U	0.003 UR	0.10 U	1
NO_2N +NO_3N	0.811	0.748	0.493	0.577	2.31	2.29	1.88	1.88	0.345	4.08	10
NH_4N	0.01 U	0.10	0.01 U	0.01 U	0.01 U	0.01 U	0.10 U	0.10	0.01 U	0.10 U	NA
Arsenic	0.0033	0.0075	0.0025 U	0.0034	0.0025 U	0.0025 U	0.0047	0.0054	0.0025 U	0.003 U	0.05
Barium	0.0823	0.083	0.0802	0.0839	0.231	0.231	0.245	0.243	0.0763	0.0722	2
Chromium	0.005	0.006	0.0062	0.0068	0.0025 U	0.0025 U	0.0016	0.0012	0.0038	0.0045	0.1
Mercury	0.0002 U	0.0001 U	0.0002 U	0.0001 U	0.0002 U	0.0002 U	0.0001 U	0.0001 U	0.0002 U	0.0001 U	0.002
Selenium	0.0025 U	0.0061	0.0025 U	0.004 U	0.0025 U	0.0025 U	0.0046	0.004 U	0.0025 U	0.004 U	0.05
Fluoride	0.2 U	0.20	0.2 U	0.2	0.2 U	0.2 U	0.10	0.10	0.2 U	0.2 U	4
Iron	3.42	2.97	2.52	0.188	0.142	0.151	1.32	1.33	3.24	0.346	0.3
Iron (filtered)	—	—	—	—	0.0754	0.0661	4.75	2.93	—	—	—
Lead	0.0035	0.0032	0.0029	0.002 U	0.0015 U	0.0015 U	0.002 U	0.002 U	0.0117	0.002 U	0.015
Manganese	0.0071	0.0075	0.0171	0.011	0.0055	0.0055	0.0112	0.0113	0.0101	0.0046	0.05
Sulfate	30.5	30.8	13.2	15.9	36.2	16.0	35.9	37.8	12.8	16.7	250

Table 5-12. TAN/TSF Sewage Treatment Plant groundwater monitoring results (2001) [Continued].

	TANT-MON-A-001		TANT-MON-A-002		TAN-10A				TAN-13A		PCS/SCS[a]
Depth to Water[b]	202.74	205.65	207.31	209.08	204.54	204.54	205.64	205.64	206.92	206.73	
Sample Date Parameter[c]	4/11/01	10/16/01	4/11/01	10/16/01	4/10/01	4/10/01[d]	10/16/01	10/16/01[d]	4/10/01	10/8/01	
Zinc	0.54	0.622	0.811	0.271	0.534	0.513	0.219	0.213	2.02	0.578	5
Total coliform	Absent	Absent	Absent	Absent	Absent	Absent	1[h]	Absent	Absent	Absent	1 colonies/100 mL
Fecal coliform	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	NA

a. Primary constituent standards (PCS) and secondary constituent standards (SCS) in groundwater referenced in Idaho Administrative Procedure Act 58.01.11.200.01.a and b.

b. Depth to water table in feet.

c. All values are in milligrams per liter unless otherwise noted.

d. Duplicate sample.

e. U = indicates that the result was reported as below the detection limit.

f. NA = not applicable

g. UR = The result was rejected during validation; it was below the method detection limit, and the associated spike recovery was below the acceptable range.

h. Coliform bacteria were speciated as *Klebsiella oxytoca*, which are naturally occurring bacteria in soils and water.

Analytical results showed iron concentrations above the Permit limit in all four of the wells in 1999. As a result, a corrosion evaluation was performed on the TAN wells that exhibited similar increases [Reference 5-5]. This evaluation confirmed that the riser pipes at several TAN wells were significantly corroded and attributed the increased iron concentrations to this corrosion. The riser pipes were replaced with stainless steel riser pipes in all four TAN WLAP monitoring wells during August 2001.

Video log information gathered during the well maintenance showed that the stainless steel well casings in wells TAN-13A, TANT-MON-A-001, and TAN-MON-A-002 appeared relatively free of rust to the water table. All three of these wells showed decreases in iron concentrations, based on samples collected prior to the maintenance (April 2001) and those collected after the maintenance (October 2001).

Video log information gathered on TAN-10A showed that the carbon steel well casing appeared to be rusted most of the way to the water table. During 2001, the iron concentrations in TAN-10A increased after maintenance, and iron concentrations for TAN-10A were the highest of the four wells. The condition of the well casing, coupled with the residual effects relating to the replacement of the galvanized riser pipe, may have resulted in the increased iron concentrations in TAN-10A.

The April 2001 total dissolved solids concentration from one sample collected at TAN-10A exceeded the Permit limit of 500 mg/L. The duplicate sample concentration was 496 mg/L. None of the October 2001 results for TAN-10A exceeded the limit. The high total dissolved solids levels in TAN-10A could be related to the corrosion in the well's riser pipe.

No other parameters exceeded Permit limits during calendar year 2001.

Test Reactor Area Cold Waste Pond

DESCRIPTION – The TRA Cold Waste Pond was constructed in 1982. Wastewater discharges to the Cold Waste Pond include, but are not limited to, nonhazardous and nonradioactive maintenance cleaning waste, floor drains, and yard drains. The majority of wastewater received by the Cold Waste Pond is secondary cooling water from the Advanced Test Reactor when it is in operation. Chemicals used in the cooling water are primarily commercial corrosion inhibitors and sulfuric acid to control pH.

The cold waste effluents collect at the cold well sump and sampling station (TRA-764) before being pumped to the Cold Waste Pond. The cooling tower system has a radiation monitor with an alarm that prevents accidental discharges of radiologically contaminated cooling water.

WASTEWATER MONITORING RESULTS – A letter from the Idaho DEQ authorized the continued operation of the Cold Waste Pond under the terms and conditions of the WLAP regulations [Reference 5-4]. As a result, total nitrogen and total suspended solids analyses were added in August 2001 to the list of parameters analyzed quarterly at the Cold Waste Pond. These are the only parameters required for compliance. Other parameters are sampled for surveillance purposes.

Automated samplers are used to collect quarterly 24-hour time-proportional composite samples from TRA-764. Total suspended solids and total nitrogen results are reported in Table 5-13. Additional monitoring for surveillance parameters is discussed in the next section. Total suspended solids were undetected in either sample collected during 2001. The detection level of 2 mg/L is well below the regulatory limit of 100 mg/L. The maximum total nitrogen concentration during 2001 was 2.82 mg/L, and it was significantly less then the regulatory limit of 20 mg/L.

Table 5-13. TRA Cold Waste Pond effluent monitoring results (2001).[a]

Parameter	Maximum	Average	# Samples	# Detections
Total Suspended Solids	2.0 U[b]	2.0 U	2	0
Total Nitrogen	2.82	2.70	2	2

a. All values are in milligrams per liter.

b. U flag indicates that the result was reported as below the detection limit.

GROUNDWATER MONITORING RESULTS—Currently, there are no groundwater monitoring requirements associated with the TRA Cold Waste Pond. However, groundwater monitoring is expected to be required when a permit is issued.

5.3. LIQUID EFFLUENT CHARACTERIZATION MONITORING

As stated in Section 5.2 additional parameters specified in the Idaho groundwater quality standards are also monitored. The results of this additional monitoring are discussed on a facility basis in the following sections. This additional monitoring is performed in support of characterization or surveillance activities.

Argonne National Laboratory–West

During 2001, the Industrial Waste Pond and secondary sanitary lagoon at ANL-W was monitored monthly for iron, sodium, chloride, fluoride, sulfate, pH, conductivity, total dissolved solids, turbidity, biological oxygen demand, gross alpha, gross beta, gamma spectrometry, and tritium. The Secondary Sanitary Lagoon was monitored monthly for the same constituents as the Industrial Waste Pond and total coliform. All parameters for both ponds were well below applicable standards (Table 5-14).

Central Facilities Area

The influent and effluent to the CFA STP are both monitored according to the WLAP issued for the plant. The results of the Permit-related monitoring are discussed in detail above in Section 5.2. Table 5-15 presents the additional monitoring conducted during 2001 at the CFA STP, showing those parameters with at least one detected result during the year. Additional monitoring is performed at the CFA STP from the floor drains and vehicle maintenance areas of the Transportation Complex located at CFA-696. During 2001, no corresponding limits were exceeded for any of the additional parameters monitored and all additional parameters were within historical concentration levels.

Idaho Nuclear Technology and Engineering Center

Wastewater Land Application Permits exist for the STP and the existing percolation ponds at the INTEC. The results of Permit-related monitoring are discussed in detail in Section 5.2. Table 5-16 presents the additional monitoring conducted during 2001 at INTEC, showing those parameters with at least one detected result during the year.

For the existing INTEC percolation ponds, the June 2001 barium concentration slightly exceeded the historical high concentration. However, the result was well within the applicable release limit. Other additional parameters for the existing ponds were all within applicable limits and historical concentration levels. For the INTEC STP, none of the additional parameters exceeded applicable limits, and all were within historical concentration levels.

Naval Reactors Facility

Liquid effluent monitoring confirmed all discharges to the industrial waste ditch in 2001 were controlled in accordance with applicable federal and State laws. No

Table 5-14. ANL-W industrial and sanitary waste pond monitoring results (2001).

Constituent	Industrial Waste Pond			Industrial Waste Ditch			Sanitary Waste Pond		
	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg
BOD[a]	0	16	7.1	NA	NA[b]	NA	6	77	41
TSS[c]	NA	NA	NA	NA	NA	NA	10	103	32
Coliform[d]	1	60	12.3	NA	NA	NA	121	12,000	3,156
Iron[e]	0.24	1.24	0.59	0.92	6.53	3.75	0.12	0.47	0.26
Mercury	< 0.007	< 0.007	< 0.007	< 0.007	< 0.007	< 0.007	< 0.007	< 0.007	< 0.007
Sodium	17.0	53.7	35.8	21.0	147.0	63.7	114.0	224.0	154.4
Chloride	19	68	45	29	218	89	135	215	165
Fluoride	< 1	1.4	1.2	2.1	4.5	3.3	< 1	< 1	< 1
Phosphate	< 1	< 1	< 1	< 1	< 1	< 1	3	19	8.1
Sulfate	13	45	33	18	39	23	52	82	62
Gross alpha[f]	< 5.2	< 5.2	< 5.2	< 5.2	< 5.2	< 5.2	< 5.2	< 5.2	< 5.2
Gross beta	< 16	< 16	< 16	< 16	< 16	< 16	34	3.8×10^6	4.2×10^5
Gross gamma	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Tritium	< 3,200	< 3,200	< 3,200	< 3,200	< 3,200	< 3,200	< 3,200	< 3,200	< 3,200
pH[g]	7.40	9.23	8.10	7.81	8.20	8.10	7.11	9.16	8.20

a. BOD = biological oxygen demand; values are in milligrams per liter.
b. NA = not analyzed.
c. TSS = total suspended solids; values are in milligrams per liter.
d. Coliform is reported in cultures per 100 mL liquid.
e. Values of iron through sulfate are in micrograms per milliliter.
f. Radiological values are in picocuries per liter.
g. pH values are in standard units.

Table 5-15. CFA liquid effluent characterization monitoring results (2001).[a]

	Maximum[b]	Average[b]	# Samples	# Detections
Influent to CFA Sewage Treatment Plant Pond 1				
Conductivity (µS)	1,407	991	12	12
Effluent from CFA Sewage Treatment Plant to pivot irrigation system				
Conductivity (µS)	1,314	1,299	4	4
Chloride	319	319	1	1
Fluoride	0.365	0.365	1	1
Sulfate	53.30	53.30	1	1
Total dissolved solids	915	915	1	1
Zinc	0.003	0.003	1	1
Gross beta[c]	6.54 ± 1.89	5.52 ± 1.25	2	2
Transportation Complex, CFA-696				
pH (standard units)	8.70	8.03	4	4
Conductivity (µS)	1,124	944	4	4
Total oil and grease	339	101	4	3

a. Only parameters with at least one detected result are shown.
b. All values are in milligrams per liter unless otherwise noted.
c. Gross beta values are in picocuries per liter plus or minus the uncertainty (two standard deviations).

Table 5-16. INTEC liquid effluent characterization monitoring results (2001).[a]

	Maximum[b]	Average[b]	# Samples	# Detections
INTEC Existing Percolation Ponds				
Conductivity (µS)	997	769	5	5
Sulfate	46.0	33.7	12	12
Barium	0.134	0.075	12	12
Influent to INTEC Sewage Treatment Plant				
Conductivity (µS)	1,766	909	19	19
pH (standard units)	8.68	9.93	19	19
Effluent from INTEC Sewage Treatment Plant				
Aluminum	0.0221	0.0221	1	1
Barium	0.0904	0.0904	1	1
Copper	0.0037	0.0037	1	1
Iron	0.139	0.139	1	1
Manganese	0.0255	0.0255	1	1
Sodium	88.5	88.5	1	1
Zinc	0.0198	0.0198	1	1
Gross alpha[c]	3.35 ± 2.14	1.43 ± 0.65	4	2
Gross beta[c]	15.90 ± 1.05	12.64 ± 0.76	4	4

a. Only parameters with at least one detected result are shown.

b. All values are in milligrams per liter unless otherwise noted.

c. Gross alpha and beta values are in picocuries per liter plus or minus the uncertainty (two standard deviations).

detections above these limits were seen. Specifics regarding this monitoring are published in the 2001 *Environmental Monitoring Report for the Naval Reactors Facility* [Reference 5-6].

Test Area North

The effluent to the disposal pond receives a combination of process water from various TAN facilities and treated sewage waste. The effluent is monitored monthly in support of a WLAP. The results of monitoring in support of the Permit are discussed in Section 5.2. Additional monitoring for surveillance purposes is conducted monthly for metal parameters and quarterly for radiological parameters. The results of this additional monitoring are summarized in Table 5-17 for those parameters with at least one detected result. During 2001, the concentrations of the additional parameters were within historical levels and applicable limits.

Test Reactor Area

The effluent to the disposal pond receives a combination of process water from various TRA facilities. The effluent is monitored monthly in support of a WLAP. The results of monitoring in support of the Permit are discussed above in Section 5.2. Additional monitoring for surveillance purposes is conducted monthly for metal parameters and quarterly for radiological parameters. The results of this additional monitoring are summarized in Table 5-18 for those parameters with at least one detected result. During 2001, the concentrations of the additional parameters were within historical levels and applicable limits.

The largest volume of wastewater received by the TRA Cold Waste Pond is secondary cooling water from the Advanced Test Reactor when it is in operation. During 2001, concentrations of sulfate and total dissolved solids were elevated in samples

Table 5-17. TAN liquid effluent characterization monitoring results (2001).[a]

	Maximum[b]	Average[b]	# Samples	# Detections
Conductivity (µS) (grab)	1,332	655	12	12
pH (standard units) (grab)	8.92	7.91	12	12
Aluminum	0.1270	0.0573	13	13
Boron	0.0283	0.0283	1	1
Copper	0.0414	0.0094	13	13
Magnesium	15.70	15.70	1	1
Vanadium	0.0032	0.0032	1	1
Gross alpha[c]	2.65 ± 1.04	1.47 ± 0.51	5	1
Gross beta[c]	20.60 ± 1.06	11.41 ± 0.62	5	5
Cesium-137[c]	4.77 ± 2.96	1.79 ± 1.11	5	1
Potassium-40[c]	48.50 ± 23.00	38.81 ± 19.76	2	1

a. Only parameters with at least one detected result are shown.
b. All values are in milligrams per liter unless otherwise noted.
c. Radionuclide values are in picocuries per liter plus or minus the uncertainty (two standard deviations).

Table 5-18. TRA effluent characterization monitoring results (2001).[a]

	Maximum[b]	Average[b]	# Samples	# Detections
Conductivity (µS) (grab)	1,067	881	4	4
pH (standard units) (grab)	8.05	7.81	4	4
Chloride	29.5	24.1	5	5
Fluoride	0.414	0.327	5	4
Sulfate	407	316	5	5
Total dissolved solids	836	705	5	5
Aluminum	0.0119	0.0055	5	2
Arsenic	0.0058	0.0044	5	5
Barium	0.132	0.109	5	5
Boron	0.0663	0.0663	2	2
Chromium	0.00910	0.00734	5	5
Copper	0.0055	0.0038	5	4
Iron	0.0475	0.0212	5	2
Magnesium	43.70	43.60	2	2
Molybdenum	0.008	0.008	2	2
Sodium	26.60	22.29	5	5
Antimony	0.0029	0.0013	5	3
Vanadium	0.0101	0.0101	2	2
Zinc	0.0051	0.0026	5	2
Gross alpha[c]	4.27 ± 1.82	2.88 ± 0.79	5	3
Gross beta[c]	8.13 ± 2.04	7.09 ± 0.57	5	5

a. Only parameters with at least one detected result are shown.
b. All values are in milligrams per liter unless otherwise noted.
c. Gross alpha and gross beta values are in picocuries per liter plus or minus the uncertainty (two standard deviations).

collected during reactor operation. These differences are due to the normal raw water hardness, as well as corrosion inhibitors and sulfuric acid added to control the cooling water pH. Concentrations of sulfate and total dissolved solids exceeded the risk-based release levels specific to the TRA Cold Waste Pond during periods of reactor operation but not during reactor outages.

5.4. DRINKING WATER MONITORING

Radiological Parameters

M&O Contractor

GROSS ALPHA – Of the 71 onsite production well and distribution system samples analyzed for gross alpha in 2001, 46 samples contained radioactivity above the minimum detectable concentration. The highest gross alpha concentration observed was 3.75 ± 1.05 pCi/L in a sample collected on February 13 from the INTEC distribution system. This value is below the EPA MCL of 15 pCi/L for gross alpha in drinking water.

According to USGS reports, alpha-emitting wastes (plutonium-238 [^{238}Pu], plutonium-239/240 [$^{239/240}$Pu], and americium-241 [^{241}Am]) from INEEL operations have not migrated far from their entrance into the SRPA near INTEC. This is primarily due to these radionuclides being highly sorbed onto subsurface materials (sediments and basalts).

GROSS BETA – Of the 71 onsite production well samples analyzed for gross beta in 2001, all had gross beta activities above the minimum detectable concentration. All were within the range typically found for background concentrations from natural radioactivity in the SRPA. The highest observed activity was 16.1 ± 1.6 pCi/L in a sample from the CFA #1 well on November 13. This value is below the EPA screening level of 50 pCi/L for gross beta in drinking water.

TRITIUM – Tritium concentrations in quarterly samples taken by the M&O contractor in 2001 at production wells at CFA and other facilities are given in Table 5-19. Figure 5-3 shows the most recent 11 years of tritium data for two of the production wells and two distribution systems that have continually shown the highest tritium concentrations. Concentrations in these wells and systems show a decreasing trend over time.

STRONTIUM-90 – Because of the localized presence of ^{90}Sr in the groundwater near INTEC, sampling from several production wells at INTEC is routinely performed. While samples have historically contained detectable levels of ^{90}Sr, only two of the 13 samples had detectable concentrations of ^{90}Sr in 2001. The highest concentration was observed in a sample collected on May 16 from the INTEC distribution system. The concentration of 0.33 ± 0.23 pCi/L is well below the EPA MCL for ^{90}Sr of 8 pCi/L.

CFA Worker Dose

Because of the potential impacts to downgradient workers at CFA from radionuclides in the SRPA, the potential effective dose equivalent 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 2001 calculation was based on

- Mean tritium concentration for the CFA distribution system in 2001;
- Data from a 1990-1991 USGS study for iodine-129 [^{129}I] using the accelerator mass spectrographic analytical technique that indicated water from CFA #1 contained ^{129}I at a concentration of 0.26 ± 0.05 pCi/L (the average of two samples) and water from CFA # 2 had a concentration of 0.14 ± 0.03 pCi/L (also the average of two samples). For perspective, the proposed EPA drinking water standard for ^{129}I in drinking water is 1 pCi/L; and
- Water usage information for 2001 showing CFA #1 was used for approximately 50 percent of the drinking

Table 5-19. Tritium concentrations in INEEL production wells and distribution systems (2001).

Well Code	No. of Samples[b]	Tritium Concentration[a] Minimum	Maximum	Mean	% MCL[c]
CFA # 1	4	1.05 ± 0.069	1.08 ± 0.071	1.06	53
CFA # 2	4	0.89 ± 0.059	1.10 ± 0.072	0.99	50
CFA DIST.	4	0.90 ± 0.059	1.02 ± 0.068	0.97	49
CPP WELL # 4	4	-0.026 ± 0.011	-0.006 ± 0.01	-0.02	--
CPP WELL # 5	4	-0.019 ± 0.011	-0.003 ± 0.01	-0.01	--
CPP DIST.	3	-0.031 ± 0.011	-0.0009 ± 0.01	-0.01	--
CTF DIST.	4	-0.021 ± 0.011	0.004 ± 0.01	-0.005	--
EBR-I DIST.	4	-0.024 ± 0.011	0.0008 ± 0.01	-0.007	--
GUN RANGE	3	0.153 ± 0.016	0.173 ± 0.017	0.161	0.8
MAIN GATE DIST.	4	-0.031 ± 0.011	-0.003 ± 0.01	-0.016	--
PBF DIST.	4	-0.028 ± 0.011	0.003 ± 0.01	-0.01	--
RWMC DIST.	4	0.123 ± 0.015	0.143 ± 0.02	0.134	7
RWMC WELL	4	0.115 ± 0.014	0.151 ± 0.02	0.136	7
TSF DIST.	4	-0.021 ± 0.011	0.0003 ± 0.01	-0.005	--
TRA DIST.	4	-0.017 ± 0.011	0.009 ± 0.01	-0.007	--

a. All values are x 10^4 picocuries per liter (pCi/L) plus or minus 2 standard deviations.
b. Samples taken only from wells in use at collection time.
c. EPA drinking water MCL for tritium is 2.0 x 10^4 pCi/L.

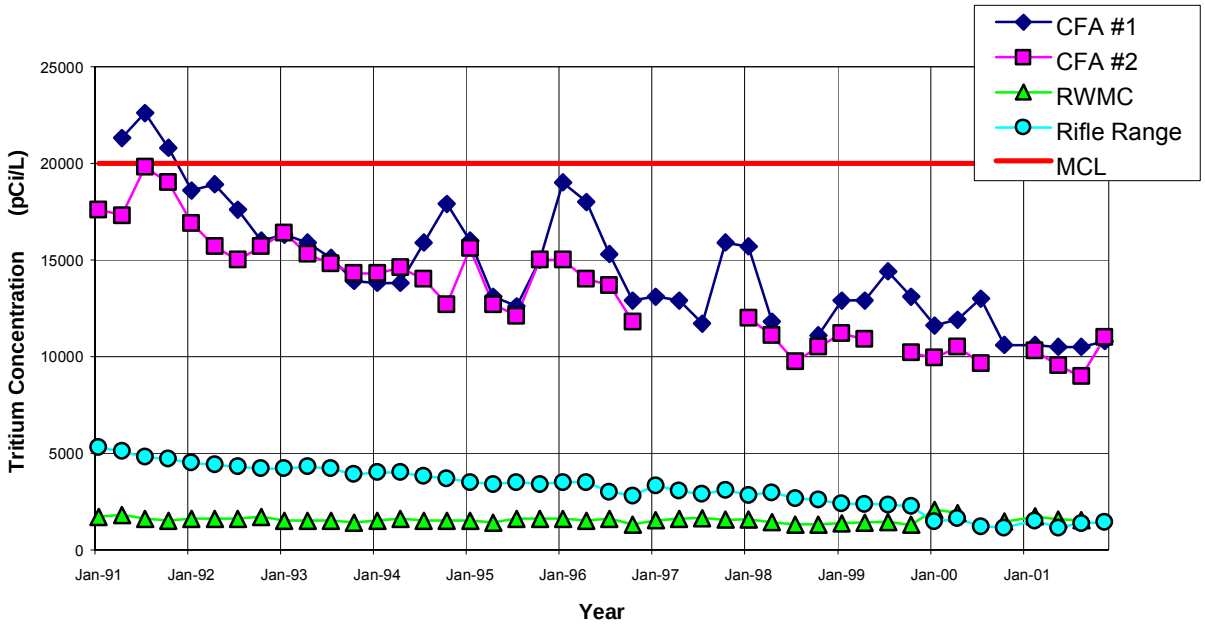


Figure 5-3. Tritium concentrations in two wells and two distribution systems at the INEEL (1991–2001).

water and CFA #2 for 50 percent of the drinking water.

For the 2001 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 2001 was 0.5 mrem/yr, 8 times below the EPA standard of 4 mrem/yr for public drinking water systems.

Argonne National Laboratory-West

During 2001, ANL-W analyzed four samples for gross alpha, gross beta, and tritium from the entrance to the drinking water distribution system in accordance with the Safe Drinking Water Act. Values for both gross alpha concentration and gross beta concentration were well below MCLs. No detectable concentrations of tritium were reported.

Naval Reactors Facility

Groundwater monitoring from NRF groundwater wells did not detect any gross alpha or gross beta activity in excess of natural background concentrations. For more information, see the *2001 Environmental Monitoring Report for the Naval Reactors Facility* [Reference 5-6].

Nonradiological Parameters

M&O Contractor

The M&O contractor Environmental Monitoring Unit regularly samples drinking water from wells and distribution systems at INEEL facilities for volatile organic compounds (Table 5-20). Chlorinated drinking water systems are monitored for total trihalomethanes (bromoform, bromodichloromethane, chloroform, and dibromochloromethane). The concentration of total trihalomethanes in each of the tested distribution systems in 2001 remained significantly below the MCL. The highest concentration of total trihalomethanes in water came from the Power Burst Facility (PBF) distribution system. This sample was collected in September and had a concentration of 11.6 µg/L, below the EPA MCL of 100 µg/L. All other measurements were less than 10 µg/L.

In 1987, concentrations of trichloroethylene in samples collected from TSF Well #1 at the TAN TSF exceeded the EPA MCL of 5 µg/L. As a result, the production wells and distribution systems at this facility are sampled more frequently.

In 1988, an aerating device (air sparger system) was installed in the storage tank between the TSF #1 Well and the point of entry to the TSF distribution system to remove trichloroethylene from TSF drinking water. In the third quarter of 1997, TSF #1 Well was placed in standby and TSF #2 Well was brought online as the primary production well. Trichloroethylene concentrations in TSF #2 Well have not exceeded the MCLs. As a result, the air sparger in the storage tank is no longer operated unless TSF #1 Well is being used. The concentration of trichloroethylene in water collected from both TSF #1 Well and TSF #2 Well remained below the MCL of 5 µg/L in the samples collected in 2001 (Table 5-20).

Water from the distribution systems at each of the facilities was sampled and analyzed in 2001 for nitrate as nitrogen (Table 5-21). None of these measurements was above MCLs or state of Idaho drinking water limits in 2001.

Naval Reactors Facility

Drinking water samples were collected prior to entering the distribution system and monitored for volatile organic compounds, inorganic constituents, and water quality parameters. These were drawn from a sampling port immediately downstream from the NRF water softening treatment system.

Table 5-20. Concentrations of volatile organic compounds in INEEL drinking water (2001).[a]

Well	FEB[b]	MAR	APR	JUN	AUG	SEP	OCT	DEC
			1,1,1-Trichloroethane				(MCL = 200 µg/L)	
MAIN GATE DIST	--[c]	0.9	--	--	--	--	--	--
RWMC DIST.	--	0.3	ND[d]	--	ND	--	ND	--
RWMC WELL	--	0.5	ND	--	ND	--	ND	--
			Bromodichloromethane					(NE)[e]
CFA DIST.	--	0.3	0.7	ND	--	ND	--	0.6
CPP DIST.	--	0.3	ND	ND	--	ND	--	ND
CTF DIST.	--	1.0	0.8	ND	--	0.6	--	ND
GUN RANGE DIST.	--	0.1	ND	ND	--	ND	--	--
PBF DIST.	--	0.6	ND	0.8	--	1.1	--	ND
TSF DIST.	--	0.2	ND	ND	ND	ND	ND	ND
			Bromoform					(NE)
CFA DIST.	--	6.8	3.4	3.3	--	6.1	--	4.7
CPP DIST.	--	0.5	ND	0.6	--	0.6	--	ND
CTF DIST.	--	0.8	1.0	0.6	--	0.8	--	0.8
GUN RANGE DIST.	--	0.2	ND	ND	--	ND	--	--
PBF DIST.	--	2.2	1.4	2.6	--	6.6	--	2.4
TRA DIST.	--	0.2	ND	1.2	--	ND	--	ND
TSF DIST.	--	0.2	ND	ND	ND	0.7	ND	0.6
			Carbon tetrachloride				(MCL = 5 µg/L)	
RWMC WELL	--	4.3	3.6	--	3.5	--	3.3	--
RWMC DIST.	--	2.4	2.6	--	2.3	--	2.3	--
			Chloroform					(NE)
CFA DIST.	--	--	1.3	ND	--	0.9	--	ND
CFA WELL #1	--	--	2.0	--	--	--	--	--
PBF DIST.	--	--	ND	ND	--	0.5	--	ND
RWMC DIST.	--	0.6	0.5	--	ND	--	ND	--
RWMC WELL	--	0.8	0.7	--	0.6	--	ND	--
TSF DIST.	--	0.5	ND	ND	ND	ND	ND	ND
			Chloroform (Trichloromethane)					(NE)
CFA DIST.	--	0.2	--	--	--	--	--	--
CPP DIST.	--	0.2	--	--	--	--	--	--
CTF DIST.	--	1.1	--	--	--	--	--	--
GUN RANGE DIST.	--	0.5	--	--	--	--	--	--
PBF DIST.	--	0.3	--	--	--	--	--	--
TSF DIST.	--	0.5	--	--	--	--	--	--
TRA DIST.	--	0.2	--	--	--	--	--	--
			Tetrachloroethylene				(MCL = 5 µg/L)	
RWMC WELL	--	0.2	ND	--	ND	--	ND	--
TSF #1 WELL	--	--	0.8	--	--	--	1.2	--
TSF #2 WELL	--	--	0.5	--	--	--	1.1	--
TSF DIST.	--	0.2	ND	--	ND	--	ND	--

Table 5-20. Concentrations of volatile organic compounds in INEEL drinking water (2001) [Continued].[a]

Well	FEB	MAR	APR	JUN	AUG	SEP	OCT	DEC
				Dibromochloromethane				(NE)
CFA DIST.	--	1.5	2.0	0.8	--	1.6	--	2.2
CPP DIST.	--	0.5	ND	0.6	--	0.7	--	ND
CTF DIST.	--	1.3	1.3	0.8	--	1.0	--	0.9
GUN RANGE DIST.	--	0.5	ND	ND	--	ND	--	--
PBF DIST.	--	0.3	ND	ND	--	ND	--	ND
TRA DIST.	--	0.2	ND	1.0	--	ND	--	ND
TSF DIST.	--	0.5	ND	0.5	ND	0.5	--	--
				Total Trihalomethanes (TTHM)				(MCL = 100 µg/L)
CFA DIST.	--	8.8	--	4.1	--	8.6	--	7.5
CPP DIST.	--	1.5	--	1.2	--	1.3	--	ND
CTF DIST.	--	4.2	--	1.4	--	2.4	--	1.7
GUN RANGE DIST.	--	1.0	--	ND	--	ND	--	--
PBF DIST.	--	4.5	--	5.4	--	11.6	--	3.8
TRA DIST.	--	0.6	--	2.2	--	ND	--	ND
TSF DIST.	--	1.3	--	0.5	--	1.2	--	0.6
				Trichloroethylene				(MCL = 5 µg/L)
CFA DIST.	--	--	0.7	--	--	--	--	--
CFA WELL #2	--	--	1.2	--	--	--	--	--
RWMC DIST.	--	1.3	1.4	--	1.1	--	1.1	--
RWMC WELL	--	1.9	1.8	--	1.4	--	1.4	--
TSF #1 WELL	--	--	2.7	--	--	--	3.7	--
TSF #2 WELL	--	--	1.6	--	--	--	4.4	--
TSF DIST.	--	0.8	0.7	--	1.6	--	2.1	--
				Xylene (total)				(MCL = 10,000 µg/L)
CFA DIST.	--	0.6	--	--	--	--	--	--
TSF DIST.	--	0.7	0.6	--	0.9	--	0.5	--
				1,2-Xylene				(NE)
CTF DIST.	--	--	0.5	--	--	--	--	--
TSF DIST.	--	0.2	ND	--	ND	--	ND	--
				1,3-Xylene				(NE)
CFA DIST.	--	--	0.6	--	--	--	--	--
TSF DIST.	--	0.4	ND	--	0.9	--	0.5	--
				1,5-Xylene				(NE)
CFA DIST.	--	--	0.6	--	--	--	--	--
TSF DIST.	--	0.4	ND	--	0.9	--	0.5	--
				1,1-Dichloroethene				(NE)
RWMC WELL	--	0.2	ND	--	ND	--	ND	--
				Toluene				(MCL = 1 µg/L)
TSF DIST.	--	0.9	1.1	--	1.7	--	0.9	--

a. All values are in microgram per liter.
b. Only those months when samples were collected are shown.
c. A double dash (--) indicates no sample collected for that month.
d. ND = not detected.
e. NE = not established. The EPA has not yet established an MCL for this constituent.

Table 5-21. Concentrations of inorganic chemicals in INEEL distribution systems (2001).[a,b]

Well	Parameter	Concentration	MCL
CFA DIST.	Nitrate as nitrogen	3.1	10
CPP DIST.	Nitrate as nitrogen	0.9	10
CTF DIST.	Nitrate as nitrogen	0.8	10
EBR-I DIST.	Nitrate as nitrogen	0.5	10
GUN RANGE DIST.	Nitrate as nitrogen	0.9	10
MAIN GATE DIST.	Nitrate as nitrogen	0.8	10
PBF DIST.	Nitrate as nitrogen	0.9	10
RWMC DIST.	Nitrate as nitrogen	0.9	10
TRA DIST.	Nitrate as nitrogen	0.8	10
TSF DIST.	Nitrate as nitrogen	0.9	10

a. All values are in milligrams per liter.
b. All samples were collected on June 16, 2001.

No volatile organic compounds were detected above minimum detection levels. Concentrations of inorganic analytes and water quality parameters were all below regulatory limits. The USGS continued groundwater monitoring around NRF. Locations of the NRF groundwater monitoring wells are shown in Figure 5-4. Specifics regarding this monitoring are published in the *2001 Environmental Report for the Naval Reactors Facility* [Reference 5-6].

Offsite Drinking Water Sampling

This section presents results from radiological analyses performed on drinking water samples taken at offsite locations by the ESER contractor. In 2001, the ESER contractor collected 28 drinking water samples from 14 offsite locations.

Three drinking water samples contained detectable levels of gross alpha, ranging from 0.8 ± 0.7 pCi/L to 1.9 ± 1.4 pCi/L. The highest measured value is lower than the EPA MCL of 15 pCi/L for drinking water.

Gross beta activity above the minimum detectable concentration was present in 20 of the 28 offsite drinking water samples. Detectable concentrations ranged from 1.7 ± 1.7 pCi/L to 11.1 ± 2.5 pCi/L. The upper value of this range is below the EPA screening level for drinking water of 50 pCi/L. Concentrations in this range are normal and cannot be differentiated from the natural decay products of thorium and uranium that dissolve into water as the water passes through the basalt terrain of the Snake River Plain.

Tritium was detected in 11 drinking water samples during 2001. Drinking water values ranged from 65 ± 64 pCi/L to 230 ± 40 pCi/L, with the high result coming from Shoshone. The maximum level is still well below the DOE's DCG of 2.0×10^6 pCi/L and the EPA MCL of 20,000 pCi/L for tritium in water. Again, these levels can be explained by natural variability.

5.5. GROUNDWATER MONITORING

This section presents the analytical results of monitoring related to groundwater beneath and near the INEEL.

Aquifer Studies

The SRPA, which underlies the Eastern Snake River Plain and the INEEL, serves as the primary source for drinking water and crop irrigation in the Upper Snake River Basin. A brief description of the hydrogeology of the INEEL and the movement of water in the SRPA is given in Chapter 1. Further information may be found in numerous publications of the USGS. During 2001, the USGS published seven documents covering hydrogeologic

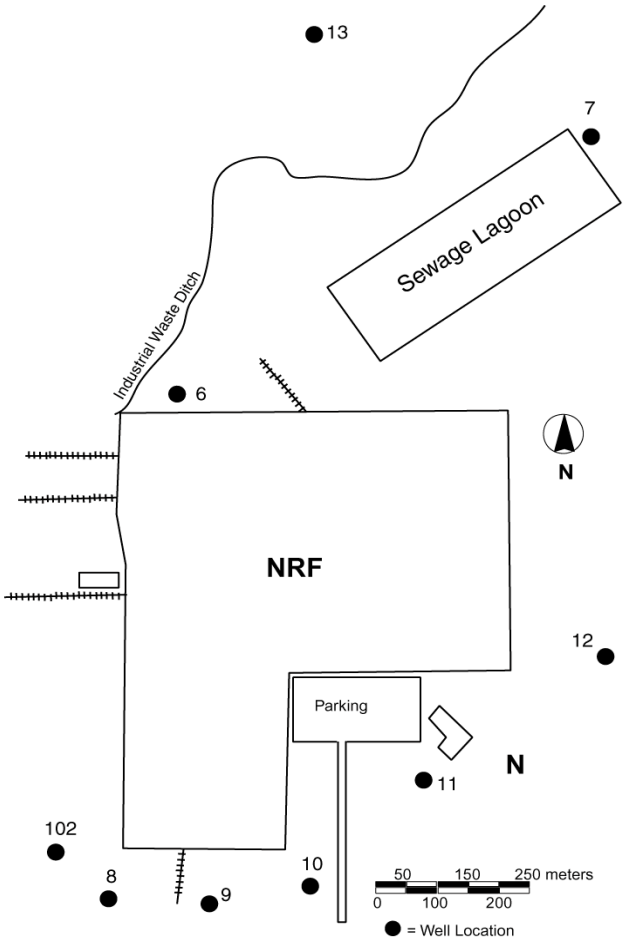


Figure 5-4. Monitoring wells around the Naval Reactors Facility.

conditions at the INEEL or on the Eastern Snake River Plain. The abstracts to each of these reports are presented in Appendix C.

Radiological Monitoring

Historic waste disposal practices have produced localized areas of radiochemical contamination in the SRPA beneath the INEEL. The INTEC facility used direct injection as a disposal method up to 1984. This wastewater contained high concentrations of both tritium and ^{90}Sr. Injection at the INTEC was discontinued in 1984 and the injection well sealed in 1990. When direct injection ceased, wastewater from INTEC was directed to a pair of shallow percolation ponds, where the water infiltrates into the subsurface. TRA also discharged contaminated wastewater, but to a shallow percolation pond. The TRA pond was replaced in 1993 by a flexible plastic-(hypalon) lined evaporative pond, which stopped the input of tritium to groundwater and the new INTEC percolation ponds are scheduled to go into operation in 2002.

The average combined rate of tritium wastewater disposal at the TRA and INTEC during 1952–1983 was 910 Ci/yr; during 1984–1991, 280 Ci/yr; and during 1992–1995, 107 Ci/yr. From 1952–1998, the INEEL disposed about 93 Ci of ^{90}Sr at TRA and about 57 Ci at INTEC. Up until 1984 there was no direct injection of ^{90}Sr at TRA, but at INTEC a portion of the ^{90}Sr was injected directly to the SRPA. From 1996 to 1998, the INEEL disposed about 0.03 Ci of

^{90}Sr to the INTEC infiltration ponds [Reference 5-1].

To date, both tritium and ^{90}Sr have been detected at levels above their respective MCL values.

U.S. Geological Survey

TRITIUM – Because tritium is equivalent in chemical behavior to hydrogen, tritium has formed the largest plume of any of the radiochemical pollutants. The configuration and extent of the tritium contamination area, based on the 1998 data, are shown in Figure 5-5 [Reference 5-1]. The area of contamination within the 0.5-pCi/mL contour line decreased from about 103 km^2 (40 mi^2) in 1991 to about 52 km^2 (~20 mi^2) in 1998.

Concentrations of tritium in the area of contamination have continued to decrease. The area of elevated concentrations near CFA likely represents water originating at INTEC some years earlier when larger amounts of tritium were disposed. This is further supported by the fact that there are no known sources of tritium contamination to groundwater at CFA.

Two monitoring wells downgradient of TRA (Well 65) and INTEC (Well 77) (see Figure 5-2) have continually shown the highest tritium concentrations in the aquifer over time. For this reason, these two wells are considered representative of maximum concentration trends in the rest of the aquifer. The average tritium concentration in Well 65 near TRA decreased from (2.12 ± 0.09) x 10^4 pCi/L in 1995 to (1.59 ± 0.07) x 10^4 pCi/L in 1998; the tritium concentration in Well 77 south of INTEC decreased from (2.51 ± 0.1) x 10^4 pCi/L in 1995 to (1.82 ± 0.07) x 10^4 pCi/L in 1998.

The EPA MCL for tritium in drinking water is 20,000 pCi/L. The values in both Well 65 and Well 77 have remained below this limit in recent years as a result of radioactive decay (tritium has a half-life of 12.3 years), a decrease in tritium disposal rates, and dilution within the SRPA.

STRONTIUM-90 – The configuration and extent of ^{90}Sr in groundwater, based on the latest data, are shown in Figure 5-6 [Reference 5-1]. The contamination originates from INTEC as a remnant of the earlier injection of wastewater. No ^{90}Sr in groundwater has been detected in the vicinity of TRA. All ^{90}Sr at TRA was disposed to infiltration ponds in contrast to the direct injection that occurred at the INTEC. At TRA, ^{90}Sr is retained in surficial sedimentary deposits, interbeds, and in the perched groundwater zones. The area of the ^{90}Sr contamination from INTEC is approximately the same as it was in 1991.

Concentrations of ^{90}Sr in wells have remained relatively constant since 1989. The concentrations in wells during 1996–1998 ranged from 2.1 ± 0.6 pCi/L to 41.1 ± 1.5 pCi/L. The MCL for ^{90}Sr in drinking water is 8 pCi/L.

Before 1989, ^{90}Sr concentrations had been decreasing because of changes in waste disposal practices, radioactive decay, diffusion, dispersion, and dilution from natural groundwater recharge. The relatively constant ^{90}Sr concentrations in the wells sampled from 1992 to 1998 are thought to be 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 INTEC infiltration ponds may have changed the affinity of ^{90}Sr on soil and rock surfaces, causing it to become more mobile [Reference 5-1].

Nonradiological Monitoring

U.S. Geological Survey

Sampling for purgeable (volatile) organic compounds in groundwater was conducted by the USGS at the INEEL during 2001. Water samples from an onsite production well and 11 groundwater monitoring wells were collected and submitted to the USGS National Water Quality Laboratory in Lakewood, Colorado, for analysis of

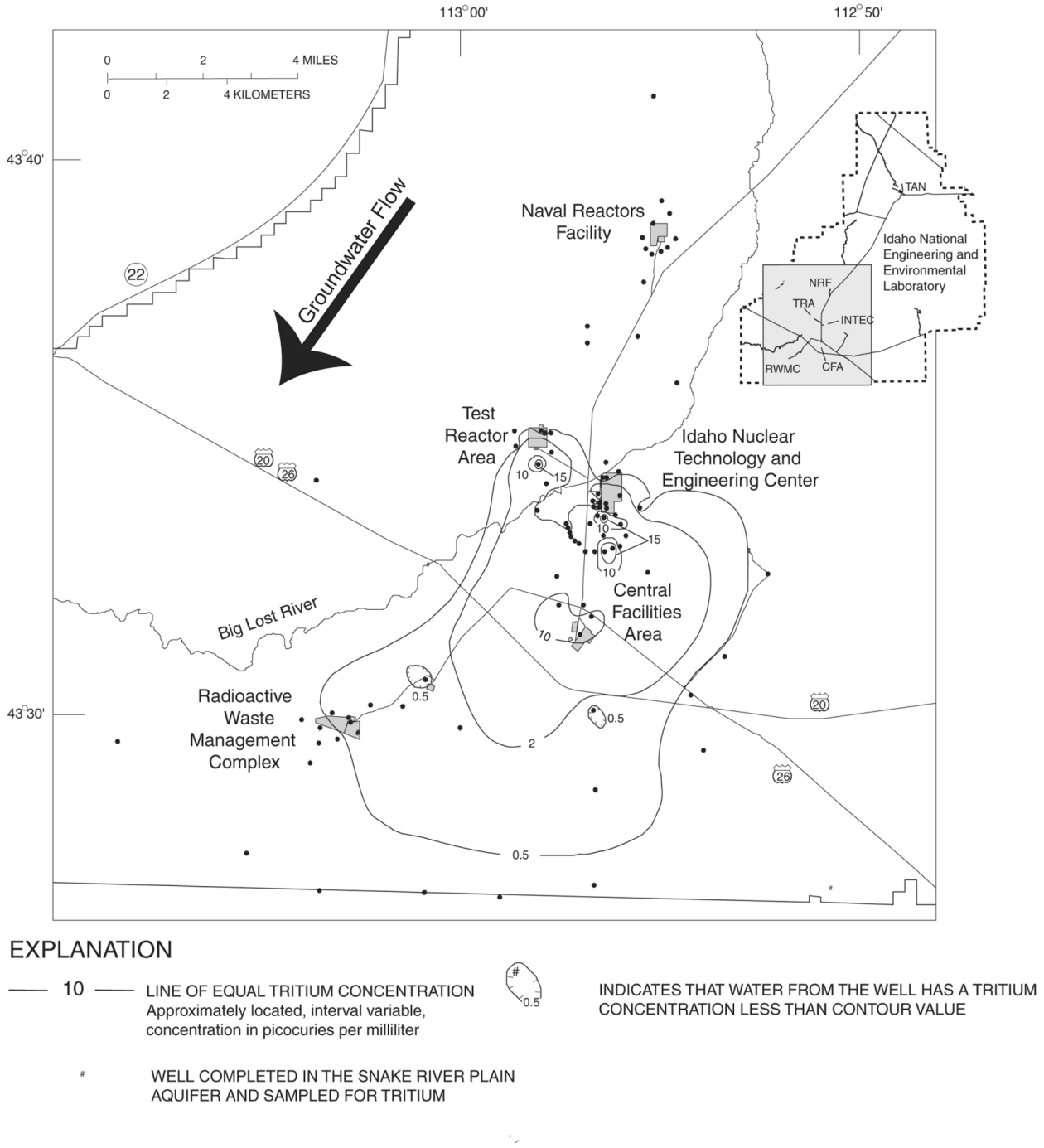


Figure 5-5. Distribution of tritium in the Snake River Plain Aquifer on the INEEL (1998) [Reference 5-1].

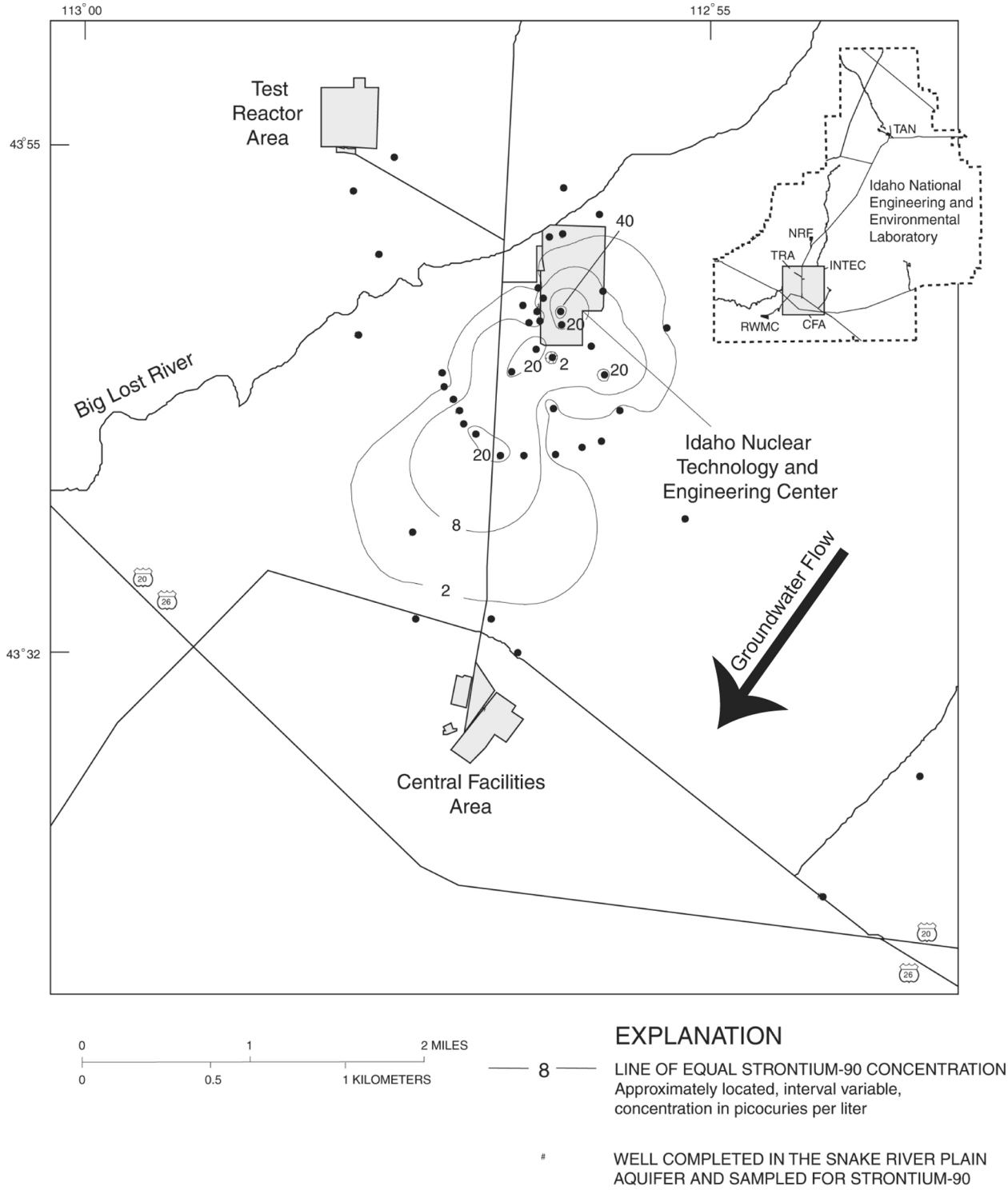


Figure 5-6. Distribution of strontium-90 in the Snake River Plain Aquifer on the INEEL (1998) [Reference 5-1].

61 purgeable organic compounds. A USGS report describes the methods used to collect the water samples and ensure sampling and analytical quality [Reference 5-7]. Nine purgeable organic compounds were detected at concentrations above the laboratory reporting level of 0.2 µg/L in at least one well on the INEEL (Table 5-22).

The RWMC production well contained detectable concentrations of five of these purgeable organic compounds. Annual average concentrations of these compounds in this well remained about the same as those observed in 2000. Carbon tetrachloride concentrations were above the MCL of 5 µg/L at the end of 2001 (Table 5-22).

Argonne National Laboratory–West

ANL-W samples five wells (four monitoring and one production) (Figure 5-7) twice a year for radionuclides, metals, total organic carbon, total organic halogens, and water quality parameters. Only the common metals calcium, magnesium, and sodium were detected. Other metals were not detected above laboratory reporting limits. Water quality parameters were within ranges of past values. No radionuclides were detected. Table 5-23 gives the range of values for the detected metals and water quality parameters.

5.6. SURFACE WATER AND STORM WATER MONITORING

Offsite Surface Water Sampling

This section presents results from radiological analyses performed on surface water samples taken at offsite locations by the ESER contractor. Locations outside of the INEEL boundary are sampled twice a year for gross alpha, gross beta, and tritium. In 2001, the ESER contractor collected 14 surface water samples from 5 offsite locations.

Three surface water samples contained detectable amounts of gross alpha activity. Results ranged from 0.91 ± 0.89 pCi/L at Bliss to 1.18 ± 0.93 pCi/L at Buhl. These levels of gross alpha activity are to be expected especially in springs, and they are related to the dissolution of naturally occurring radionuclides in the basalt terrain of the Snake River Plain. The highest value is lower than the EPA MCL of 15 pCi/L.

Gross beta activity was detected in all 14 offsite surface water samples. Measurable concentrations ranged from 2.2 ± 1.8 pCi/L to 8.3 ± 2.1 pCi/L at Twin Falls and Buhl, respectively. The upper value of this range is below the EPA screening level for gross beta in drinking water of 50 pCi/L. Concentrations in this range are normal and cannot be differentiated from natural decay products of thorium and uranium that dissolve into water as the water passes through the surrounding basalts of the Snake River Plain.

Tritium was detected in five offsite surface water samples during 2001. Surface water sample concentrations ranged from 73 ± 65 pCi/L to 240 ± 100 pCi/L, with the highest concentrations measured at Idaho Falls. The maximum levels are lower than the EPA MCL of 20,000 pCi/L and the DOE's DCG of 2.0 x 10^6 pCi/L for tritium in water. These levels can be attributed to natural variability.

Waste Management Surveillance – Onsite Surface Water Sampling

In compliance with DOE Order 435.1, surface water, as surface runoff, is collected at the Waste Experimental Reduction Facility (WERF) and Radioactive Waste Management Complex (RWMC) from the locations shown on Figures 5-8 and 5-9 to determine if radionuclide concentrations exceed alert levels or if concentrations have increased significantly compared to historical data.

Radionuclides could be transported outside the RWMC boundaries via surface water runoff. Surface water runs off at the Subsurface Disposal Area (SDA) only during periods of rapid snowmelt or heavy precipitation. At these times, water may be pumped out of the SDA into a drainage canal. Water also runs off the asphalt pads

Table 5-22. Concentrations of purgeable organic compounds in USGS well samples (2001).[a]

Well ID	Date	1,1-Dichloro-ethylene	Carbon Tetrachloride	1,1,1-Trichloro-ethylene	Dichloro-difluoromethane	Trichloro-ethylene	Xylene (total)	Ethylbenzene	Tetrachloro-ethylene	Chloroform
34	04/30	ND	ND[b]	0.1778	0.1912	ND	ND	ND	ND	ND
(SW of INTEC)	10/22	ND	ND	0.1419	0.1492	ND	0.15	ND	ND	ND
38	04/24	ND	ND	0.1518	0.1549	ND	ND	ND	ND	ND
(SW of INTEC)	10/11	ND	ND	0.1526	0.1761	ND	ND	ND	ND	ND
65	04/05	ND	ND	0.2597	0.2914	ND	ND	ND	ND	ND
(S of TRA)	10/23	0.13	ND	0.2307	0.6708	ND	ND	ND	ND	ND
84										
(S of TRA)	04/30	ND	ND	0.1469	0.1149	ND	ND	ND	ND	ND
87	01/11	ND	2.548	0.1903	0.1332	0.6103	ND	ND	0.1013	0.1442
(N of RWMC)	04/12	ND	2.719	0.2036	ND	0.5716	ND	ND	ND	0.1374
	07/12	ND	2.396	0.1784	ND	0.5853	0.1202	ND	ND	0.1267
	10/11	ND	2.512	0.202	0.1390	0.6049	ND	ND	ND	0.1387
88	01/23	ND	1.136	0.1238	ND	0.5021	ND	ND	ND	0.3852
(S of RWMC)	04/05	ND	1.526	0.1504	ND	0.5919	ND	ND	ND	0.4281
	07/12	ND	1.244	0.1076	ND	0.5173	ND	ND	ND	0.3732
	10/01	ND	1.582	0.1387	ND	0.625	ND	ND	ND	0.3597
92				ND						
(S of RWMC)	04/17	0.2246	376.8		22.41	125.4	8.466	602.5	0.2866	0.9809
119										
(S of RWMC)	01/02	ND	0.1620	ND	ND	ND	ND	ND	ND	ND

Table 5-22. Concentrations of purgeable organic compounds in USGS well samples (2001) [Continued].[a]

Well ID	Date	1,1-Dichloro-ethylene	Carbon Tetrachloride	1,1,1-Trichloro-ethylene	Dichloro-difluoromethane	Trichloro-ethylene	Xylene (total)	Ethylbenzene	Tetrachloro-ethylene	Chloroform
120	01/11	ND	5.914	0.5166	ND	1.78	ND	ND	0.1902	0.9611
(SW of RWMC)	04/12	ND	4.844	0.4405	ND	1.493	ND	ND	0.1516	0.8239
	07/12	ND	2.868	0.2637	ND	0.9167	ND	ND	ND	0.4895
	10/11	ND	4.367	0.4297	ND	1.514	ND	ND	0.1417	0.7952
RWMC PROD	01/11	ND	4.495	0.5097	ND	2.19	ND	ND	0.2346	0.7874
	02/08	ND	5.068	0.4916	ND	2.261	ND	ND	0.2535	0.8275
	03/08	ND	5.282	0.5362	ND	2.375	ND	ND	0.2633	0.8649
	04/12	ND	5.04	0.5273	ND	2.26	ND	ND	0.2256	0.9133
	05/10	ND	6.492	0.6033	ND	3.02	ND	ND	0.2746	1.144
	06/14	ND	6.894	0.6152	ND	3.017	ND	ND	0.2649	1.143
	07/12	ND	4.269	0.4411	ND	1.922	ND	ND	0.1812	0.7485
	08/9	ND	4.173	0.4152	ND	1.894	ND	ND	0.1856	0.6706
	10/11	ND	3.552	0.3875	ND	1.597	ND	ND	0.1698	0.5438
	11/15	ND	3.755	0.3794	ND	1.92	ND	ND	0.1965	0.6579
	12/20	ND	5.425	0.4803	ND	2.131	ND	ND	0.2333	0.7613
MCL		7.0	5.0	NE[c]	NE	5.0	10,000	700	5.0	NE

a. All values are in microgram per liter.

b. ND = not detected. The concentration is less than the reporting limit for the analysis.

c. NE = not established. EPA has not established an MCL for this constituent.

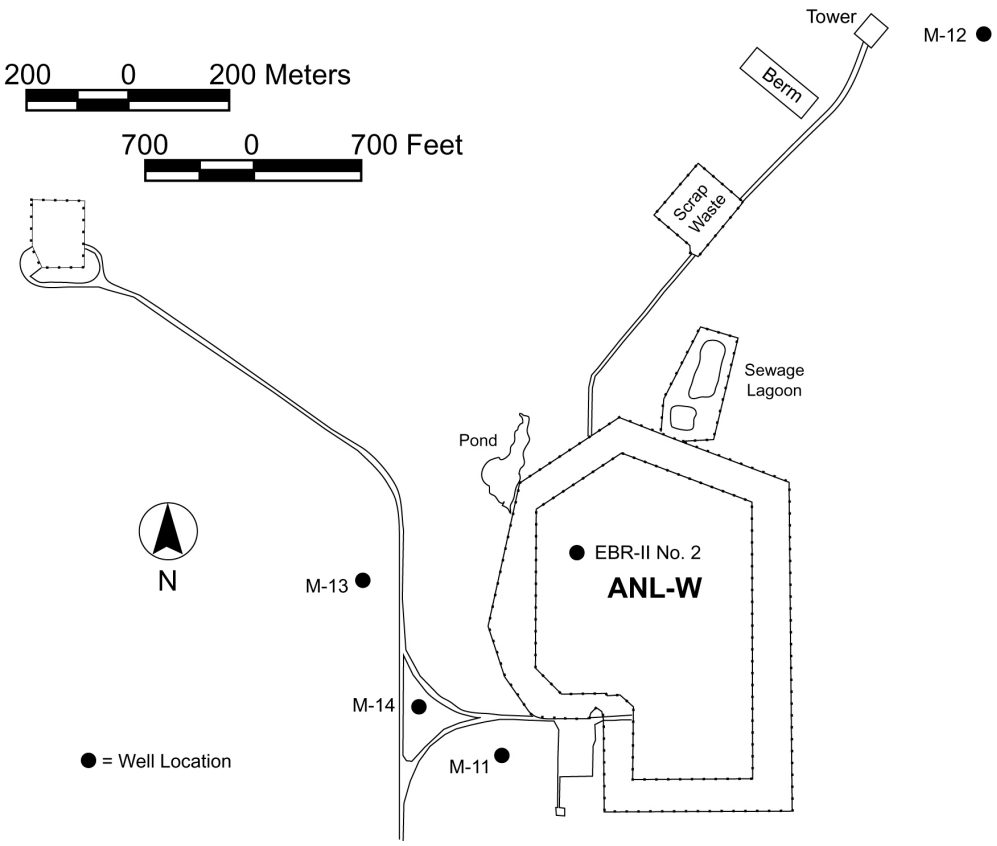


Figure 5-7. ANL-W monitoring well locations.

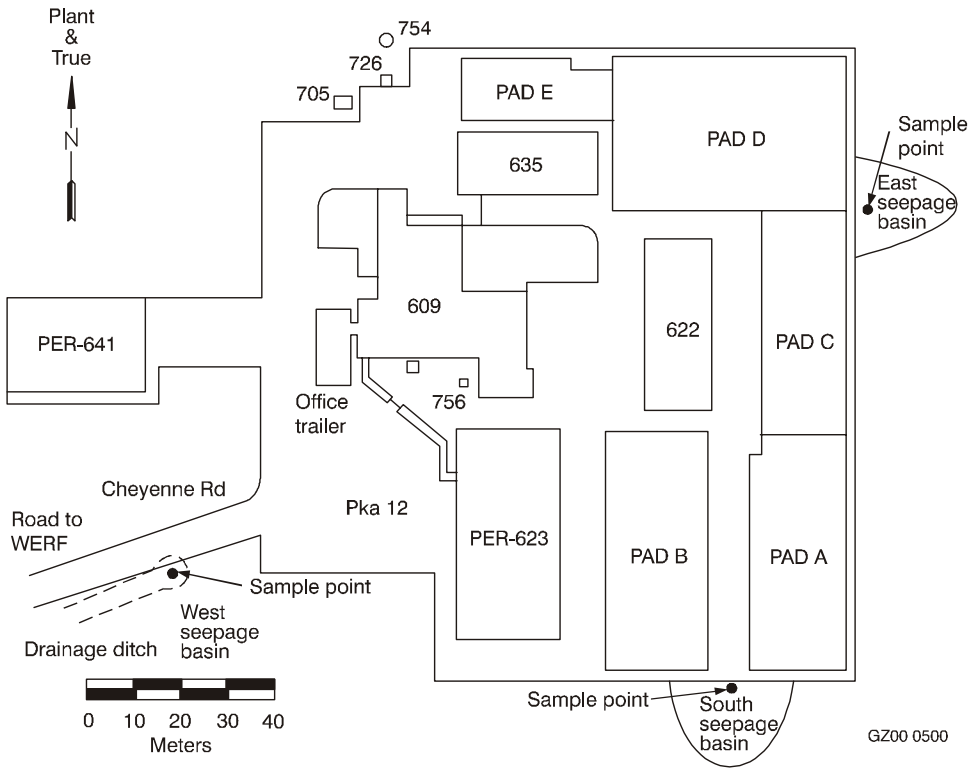


Figure 5-8. WERF surface water sampling locations.

Table 5-23. Summary of metals and water quality parameters in ANL-W monitoring wells (2001).[a]

Parameter	M-11		M-12		M-13		M-14		EBR-II No. 2		MCL
	04/23/01	08/07/01	04/23/01	08/07/01	04/23/01	08/07/01	04/23/01	08/07/01	04/23/01	08/07/01	
Bicarbonate Alkalinity	70	130	110	132	123	143	115	141	126	135	NE[b]
Calcium	40.2	42.4	41.8	42.3	39.2	39.7	41.4	42.7	41.2	41.1	NE
Chloride	22.4	19.7	18.5	18.2	20.1	18.7	21.9	21	28.6	21.9	250
Conductivity (µS)[c]	359	384	331	363	368	390	364	397	356	391	NE
Magnesium	12.9	12.4	11.8	11.3	12.9	12.4	13.1	12.6	12.9	12.4	NE
Sodium	18.0	17.6	17.7	17.7	20.4	18.5	18.2	18.3	18.9	18.6	NE
Sulfate	18.6	17.9	15.1	16.0	21.7	19.5	19.6	19.0	17.7	20.3	NE
Total Dissolved Solids	241	238	224	212	260	234	257	237	259	236	500
Total Organic Carbon	0.66[d]	0.37[d]	1.1	1.2	0.74[d]	0.94[d]	0.57[d]	0.94[d]	0.66[d]	1.4	NE
Total Organic Halogen	---[e]	---	---	---	6.2	---	---	---	13.4	---	NE

a. All values are in milligrams per liter (mg/L) unless otherwise noted.

b. NE = Not established. The EPA has not yet established an MCL for this constituent.

c. µS = microsiemens.

d. The analytical laboratory qualified the results as estimated.

e. --- signifies that the results were below the analytical detection limit of 3.6 mg/L for 04/23/01 samples and 5.0 mg/L for 08/07/01 samples.

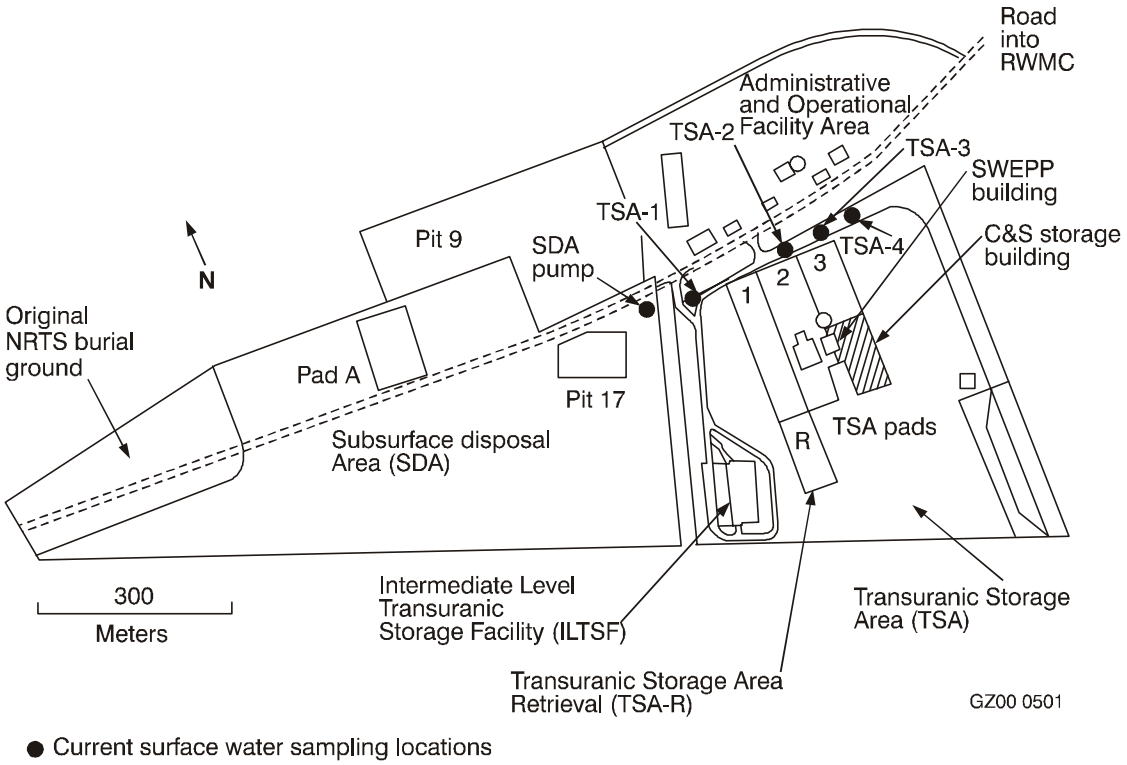


Figure 5-9. RWMC surface water sampling locations.

around the Transuranic Storage Area (TSA) and into drainage culverts and the drainage canal, which directs the flow outside the RWMC. The canal also carries outside runoff that has been diverted around the RWMC.

Since 1994, quarterly surface water runoff samples have been collected at the WERF seepage basins to determine if contamination has been released from stored waste.

Two control locations approximately 2 km (1.24 mi) north of the RWMC are sampled. The control location for the TSA and WERF is on the west side of the rest rooms at the Big Lost River Rest Area. The control location for the SDA is 1.5 km (0.93 mi) west from the Van Buren Boulevard intersection on U.S. Highway 20 and 10 m (33 ft) north on the T-12 road.

Surface water runoff samples were collected during the first and fourth quarters of 2001 at the RWMC and WERF. Table 5-24 presents the results.

Storm Water Monitoring

The EPA National Pollutant Discharge Elimination System (NPDES) rules for the point source discharges of storm water to waters of the U.S. require permits for discharges from industrial activities (63 CFR 189). For regulatory purposes, waters of the U.S. at the INEEL have been defined as the

- Big Lost River;
- Little Lost River;
- Birch Creek and Birch Creek Playa;
- Spreading areas;
- Big Lost River sinks; and
- Tributaries.

Together, the above locations compose the Big Lost River System (Figure 5-10).

A Storm Water Monitoring Program was implemented in 1993 when storm water permits initially applied to the INEEL. The

Table 5-24. Surface water runoff results (2001).

Location	Parameter	Maximum Concentration[a]	% DCG	Comment
RWMC				
TSA-1 1st Quarter	Cobalt-60	0.520 ± 0.240	0.01%	Comparable to historical concentrations
TSA-2 1st Quarter	Americium-241	0.067 ± 0.028	0.22%	Concentrations consistent with samples collected from waters with higher volumes of suspended particles
TSA-2 TSA-3 1st Quarter	Plutonium-239/240	0.020 ± 0.013	0.07%	
WERF				
East seepage basin 1st Quarter	Cesium-137	0.900 ± 0.400	0.03%	Comparable to historical concentrations

a. All values are in picocuries per liter.

program was modified as permit requirements changed, data were evaluated, and needs were identified. On September 30, 1998, the EPA issued the "Final Modification of the NPDES Storm Water Multi-Sector General Permit for Industrial Activities" (63 FR 189) (referred to as the General Permit). The INEEL implemented the analytical monitoring requirements of the 1998 General Permit starting January 1, 1999. Visual monitoring was implemented starting October 1, 1998, and continues to be performed quarterly.

The General Permit was reissued in October 2000. The INEEL gained coverage under this permit in January of 2001. The General Permit requires visual monitoring during the first, third, and fifth years of the permit's duration and both analytical and visual monitoring on the second and fourth years. The General Permit requires that samples be collected and visually examined from rain storms that accumulated at least 0.25 cm (0.1 in.) of precipitation preceded by at least 72 hours without measurable precipitation (< 0.25 cm [< 0.1 in.]) to allow pollutants to build up and then be flushed from the drainage basin. Because of unique meteorological conditions, not all sites may have storm water discharges every quarter resulting from storms that meet the General Permit requirements. Therefore, additional samples may be collected from snowmelt or from storms that do not meet General Permit requirements.

The storm duration, amount, and time between the storm event sampled and the end of the previous storm are recorded for all precipitation events. In addition, if a storm results in a discharge to the Big Lost River System and analytical samples are required at that location, total discharge volume is estimated as required by the General Permit.

The *INEEL Storm Water Pollution Prevention Plan for Industrial Activities* (DOE/ID-10431) was revised in 2001 to meet the requirements of the reissued General Permit [Reference 5-8]. This plan is written in two parts. The first part contains information pertaining to the scope of the storm water pollution prevention program, requirements, potential pollution from transportation activities, and responsibilities. It identifies the substantive requirements of the reissued General Permit that apply to each specific facility or activity in the second part of the plan. The second part contains addenda for regulated activities. The addenda were revised in 2001 following the comprehensive site evaluations and will be revised again during the 2002 comprehensive site evaluations

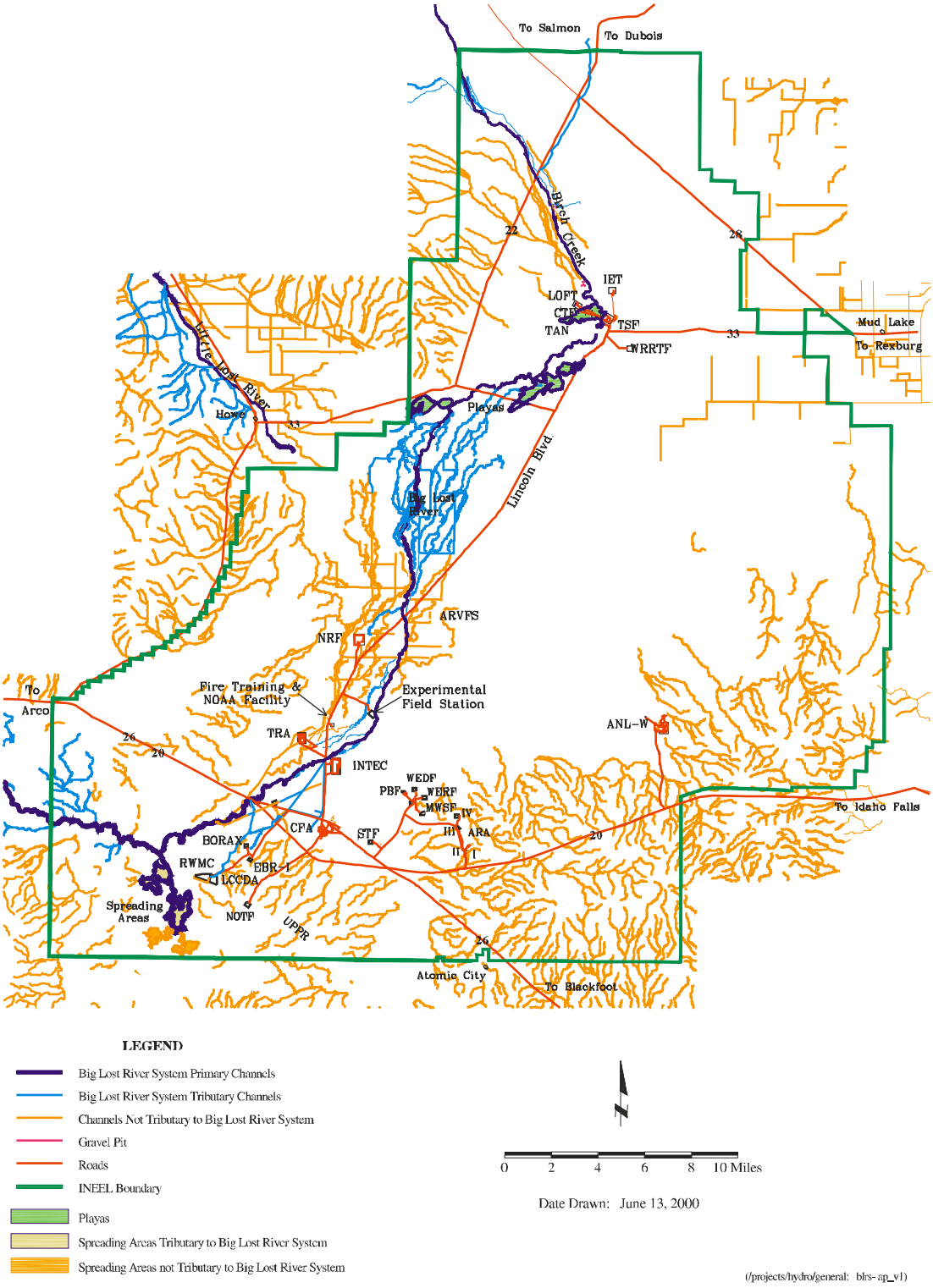


Figure 5-10. Big Lost River System.

unless an event necessitates earlier revision. The plan includes addenda for the following facilities or activities:

- Borrow Sources (nonmetallic mineral mining, Sector J);
- INTEC (hazardous waste treatment, storage, and disposal, Sector K);
- Landfills I, II, and III Extension at the CFA (Landfills, Sector L);
- RWMC (Sector K and Sector L); and
- Specific Manufacturing Capability (transportation equipment manufacturing, Sector AB).

Practices to minimize storm water pollution are evaluated annually, and the plan is revised accordingly.

The Storm Water Monitoring Program meets the General Permit requirements by conducting permit-required monitoring. In addition, the program monitors storm water to deep injection wells to comply with state of Idaho Injection Well Permits. Storm water data are reported as analytical data submitted to the EPA in a Discharge Monitoring Report; as General Permit visual data and analytical data included in the annual revisions of the plan; or data for storm water discharged to deep injection wells reported to the Idaho Department of Water Resources.

Thirty-four sites at five INEEL areas are designated as storm water monitoring locations based upon drainage patterns and proximity to potential sources of pollutants. Twenty-seven locations met the conditions for quarterly visual monitoring required by the General Permit when discharges occur to the Big Lost River System. The General Permit requires visual examinations of storm water for obvious indications of storm water pollution. In addition, visual examinations were conducted for surveillance purposes at some locations whether or not storm water discharged to the Big Lost River System.

The General Permit does not contain numeric limitations for analytical parameters, except for pH limitations from runoff from coal piles at INTEC. Other parameters are compared to benchmark concentrations to help evaluate the quality of storm water discharges.

In 1997, responsibility for monitoring of storm water entering deep injection wells was transferred from the USGS to the M&O contractor.

Storm Water Monitoring Results

During 2001, 102 visual storm water examinations were performed at 20 locations. No rainfall, snowmelt, or discharge down injection wells were observed at 15 monitoring points; therefore, no visual examinations were performed or analytical samples collected at those locations.

The visual examinations performed in 2001 showed satisfactory implementation of the INEEL Storm Water Pollution Prevention Plan for Industrial Activities (DOE/ID-10431), and no corrective actions were required or performed during the year.

Analytical samples were collected for qualifying rain events that potentially discharged to waters of the U.S. at applicable monitoring locations. Potential discharges to waters of the U.S. from a qualifying storm occurred at only two locations at the RWMC (RWMC-MP-1/2 and RWMC-MP-4/1). The 2001 results and Permit benchmark concentrations for these two locations are summarized in Table 5-25.

The results show that the measured concentrations for chemical oxygen demand, iron, and magnesium exceeded the benchmark concentration levels for the fourth quarter of 2001. These parameters have been above benchmark concentrations at this site in the past. There have been no deficiencies in pollution prevention practices identified in these areas that would lead to high concentrations for these parameters, and no definite cause has been identified. However, iron and

Table 5-25. Storm water sample results for RWMC-MP-1/2 and RWMC-MP-4/1 (2001).[a,b]

Parameter	RWMC-MP-1/2	RWMC-MP-4/1	Permit Benchmark
Rainfall (in.)	0.11	0.11	N/A
Flow (cfs)	N/A	N/A	N/A
Total volume (L)	43,016	42,340	N/A
Conductivity (µS)	170.2	283.2	N/A
pH	8.35	8.01	N/A
Cyanide	0.005 U[c]	0.005 U	0.0636
Chemical oxygen demand [d]	198	437	120
Nitrogen, as ammonia	1.0 U	2.7	19
Total suspended solids	84.0	50.0	100
Silver	0.002 U	0.002 U	0.0318
Arsenic	0.0044	0.0034	0.16854
Cadmium	0.001 U	0.001U	0.0159
Iron [d]	3.74	2.42	1.0
Mercury	0.00012	0.00013	0.0024
Magnesium [d]	5.91	5.30	0.0636
Lead	0.0051	0.0039	0.0816
Selenium	0.004 U	0.0051	0.2385

a. Values are in milligrams per liter unless otherwise noted.
b. Samples were collected on October 11, 2001.
c. U flag indicates that the result was below the detection limit.
d. Results exceeded permit benchmark concentrations.

magnesium are common soil-forming minerals and possibly may be attributed to suspended sediment in the storm water discharge deposited onsite from high winds. Storm drain filters for petroleum and sediment are in place and maintained regularly to provide additional pollution prevention.

5.7. SUMMARY

The M&O and ESER contractors, ANL-W, NRF, and USGS, sampled and analyzed water in 2001 to assess if operations at the INEEL are releasing contaminants to the environment in significant levels. Evaluation of the 2001 liquid effluent and water data indicate that although some contaminants were detected, they were not at levels posing a risk to human health or the environment. Furthermore, the maximum levels for the contaminants found were all well below regulatory health-based limits for protection of human health and the environment.

Chapter 6

Environmental Monitoring Programs - Agricultural, Wildlife, Soil, and Direct Radiation

6. ENVIRONMENTAL MONITORING PROGRAMS – AGRICULTURAL, WILDLIFE, SOIL, AND DIRECT RADIATION

6.1. ORGANIZATION OF MONITORING PROGRAMS

This chapter provides a summary of the various environmental monitoring activities that relate to agricultural products, wildlife, soil, and direct radiation currently being conducted on and around the Idaho National Engineering and Environmental Laboratory (INEEL) (Table 6-1). These media are potential pathways for transport of INEEL contaminants to nearby populations.

The Management and Operating (M&O) contractor monitored soil, biota, and direct radiation on the INEEL to comply with applicable DOE Orders and other requirements. The M&O contractor collected approximately 500 soil, vegetation, and direct radiation samples for analyses in 2001.

The ESER contractor conducted offsite environmental surveillance and collected samples from an area over approximately 23,309 km^2 (9,000 mi^2) of southeastern Idaho at locations on, around, and distant to the INEEL. Media including agricultural products, soil, and direct radiation were sampled. The ESER contractor collected approximately 339 agricultural and direct radiation samples for analyses in 2001. Soil samples are collected in even numbered years.

Section 6.2 presents the agricultural and wildlife surveillance results. Section 6.3 presents the results of soil sampling by the M&O contractor. The direct radiation surveillance results are presented in Section 6.4. Results of the waste management surveillance activities are discussed in Section 6.5. Finally Section 6.6 summarizes the data presented in this chapter.

The analytical results reported in the following surveillance sections are those that are greater than two times the analytical uncertainty (see Appendix B for information on statistical methods). Analytical uncertainties reported in text and tables are plus or minus two standard deviations (± 2s) uncertainty for the radiological analyses.

6.2. AGRICULTURAL AND WILDLIFE SAMPLING

Milk

During 2001, 316 milk samples were collected under the ESER Program. All of the samples were analyzed for gamma-emitting radionuclides and iodine-131 (^{131}I). During the first and third quarters, selected samples were analyzed for tritium. During the second and fourth quarters, selected samples were analyzed for strontium-90 (^{90}Sr).

Iodine-131 was detected in six milk samples. Values ranged from 1.9 ± 1.7 pCi/L to 8.1 ± 4.4 pCi/L. The maximum value is below the U.S. Department of Energy (DOE) derived concentration guide (DCG) for ^{131}I in water of 3,000 pCi/L. Tritium was detected in one milk sample from Roberts at a level of 102.7 ± 71.9 pCi/L. This value is well below the DCG for tritium in water of 2.0×10^6 pCi/L. Cesium-137 (^{137}Cs) was also detected in nine milk samples ranging from 1.7 ± 1.6 pCi/L to 6.2 ± 6.0 pCi/L. The highest value from a dairy, 6.2 ± 6.0 pCi/L, was measured in a sample collected from Idaho Falls. This value is below the DCG for ingested ^{137}Cs in water of 3,000 pCi/L.

Strontium-90 was detected in 9 of 10 samples ranging from 0.4 ± 0.3 pCi/L at Moreland to 1.2 ± 0.7 pCi/L in a sample from Roberts. All levels of ^{90}Sr in milk were consistent with those previously

Table 6-1. Other environmental surveillance activities at the INEEL.

Area/Facility	Media				
	Agricultural Products	Wildlife	Soil	Vegetation	Direct Radiation
Argonne National Laboratory-West					
ANL-W			●	●	
Management and Operating Contractor					
CFA			●		
RWMC			●	●	●
PBF/WROC				●	●
Sitewide[a]			●	●	●
Naval Reactors Facility					
NRF			●	●	
Environmental Surveillance, Education and Research Program					
INEEL/Regional	●	●	●	●	●
INEEL Oversight Program					
INEEL/Regional	●[b]		●	●	●

a. Sitewide includes TLDs located at major facilities (i.e., CFA, NRF, ANL-W, etc.)

b. The only agricultural product collected by the INEEL Oversight Program is milk.

reported by the EPA as resulting from worldwide fallout deposited on soil, then taken up by ingestion of grass by cows [Reference 6-1]. The maximum value is lower than the DOE DCG for ^{90}Sr in water of 1,000 pCi/L.

Lettuce

Nine lettuce samples, including one duplicate, were collected from regional private gardens. Strontium-90 above the 2s uncertainty was detected in three of the lettuce samples ranging from (114 ± 110) x 10^{-3} pCi/g at Idaho Falls to (186 ± 110) x 10^{-3} pCi/g in the duplicate from Carey (Table 6-2). Cesium-137 was detected in one sample at a level greater than its respective 2s value. The sample from Arco had a concentration of (624 ± 501) x 10^{-3} pCi/g. Both ^{137}Cs and ^{90}Sr are present in soil from aboveground nuclear weapons testing, which took place between 1945 and 1980.

Wheat

No measured concentrations of ^{90}Sr were above their 2s uncertainty in samples from any location (Table 6-3). One of the 14 wheat samples collected during 2001 contained measurable ^{137}Cs at a value of (3.3 ± 3.1) x 10^{-3} pCi/g. The concentrations of ^{137}Cs were similar to those detected in recent years, and they are attributed to historic aboveground nuclear weapons testing.

Table 6-2. Strontium-90 concentrations in garden lettuce (1996-2001).[a]

Location	1996	1997	1998	1999	2000	2001[b]
Distant Group						
Firth	270 ± 240	90 ± 70	100 ± 80	130 ± 60	80 ± 30	160 ± 110
Carey	NS[c]	70 ± 50	200 ± 50	120 ± 80	295 ± 140	144 ± 110 186 ± 110[d]
Idaho Falls	NS	50 ± 30	70 ± 40	60 ± 40	61 ± 50	114 ± 110
Pocatello	NS	NS	NS	NS	89 ± 60	6 ± 100
Grand Mean	**270 ± 240**	**60 ± 40**	**120 ± 60**	**103 ± 60**	**131 ± 70**	**122 ± 108**
Boundary Group						
Arco	200 ± 200	70 ± 70	200 ± 100	120 ± 40	81 ± 41	88 ± 110
Atomic City	120 ± 100	160 ± 60	100 ± 70	90 ± 40	NS	110 ± 110
Howe	100 ± 160	80 ± 80	100 ± 90	60 ± 70	88 ± 48	21 ± 110
Monteview	NS	90 ± 40	100 ± 50	225 ± 200	NS	74 ± 110
Mud Lake	160 ± 360	170 ± 80	100 ± 80	160 ± 80	51 ± 51	40 ± 110
Grand Mean	**145 ± 70**	**130 ± 60**	**120 ± 80**	**130 ± 90**	**73 ± 47**	**67 ± 110**

a. Analytical results are times 10^{-3} picocuries per gram (pCi/g) dry weight, plus or minus two standard deviations (± 2s).
b. Approximate minimum detectable concentration (MDC) of ^{90}Sr in lettuce is 80 x 10^{-3} pCi/g dry weight.
c. NS indicates no sample collected or sample was lost before analysis.
d. Duplicate sample result.

Table 6-3. Strontium-90 concentrations in wheat (1996-2001).[a]

Location	1996	1997	1998	1999	2000	2001[b]
Distant Group						
American Falls	7 ± 5	9 ± 5	6 ± 4	6 ± 5	5 ± 3	-20 ± 290
Blackfoot	6 ± 6	14 ± 6	8 ± 4	5 ± 5	6 ± 6	60 ± 99
Carey	5 ± 6	5 ± 4	NS[c]	8 ± 3	NS	49 ± 180
Dietrich	5 ± 5	4 ± 4	4 ± 3	5 ± 4	6 ± 4	NS
Idaho Falls	9 ± 18	4 ± 4	7 ± 3	8 ± 6	5 ± 3	-37 ± 88
Minidoka	8 ± 5	5 ± 4	6 ± 3	4 ± 3	6 ± 4	218 ± 290
Grand Mean	**7 ± 2**	**7 ± 4**	**6 ± 3**	**6 ± 4**	**6 ± 4**	**26 ± 160**
Boundary Group						
Arco	16 ± 40	4 ± 3	6 ± 3	5 ± 3	6 ± 4	95 ± 260 59 ± 87[d]
Monteview	3 ± 4	5 ± 5	9 ± 4	6 ± 5	2 ± 2	50 ± 97
Mud Lake	5 ± 5	4 ± 4	8 ± 4	3 ± 3	5 ± 4	19 ± 74
Groveland	10 ± 6	5 ± 5	6 ± 3	8 ± 6	6 ± 4	-93 ± 280
Roberts	NS	NS	NS	NS	NS	193 ± 230 29 ± 190[d]
Terreton	8 ± 6	6 ± 4	7 ± 3	5 ± 4	3 ± 3	63 ± 130
Grand Mean	**8 ± 6**	**5 ± 1**	**7 ± 3**	**5 ± 4**	**4 ± 3**	**54 ± 189**

a. Analytical results are times 10^{-3} picocuries per gram (pCi/g) dry weight, plus or minus two standard deviations (± 2s).
b. Approximate MDC of ^{90}Sr in wheat through 2000 was 4 x 10^{-3} pCi/g dry weight. For 2001 the MDC increased to 350 x 10^{-3} pCi/g dry weight.
c. NS indicates no sample collected.
d. Duplicate sample result.

Potatoes

Eleven potato samples, including one split, were collected during 2001: one sample each from five distant locations, three boundary locations, and three out-of-state locations (Figure 6-1). No ^{90}Sr or ^{137}Cs was detected in any of the samples. Idaho samples were collected from Arco, Blackfoot, Howe, Idaho Falls, Monteview, Moscow, Rupert, and Taber. Distant samples were received from Pasco, Washington; Platteville, Colorado; and Mantua, New Jersey.

Sheep

Certain areas of the INEEL are open to grazing under lease agreements managed by the Bureau of Land Management. Every year, during the second quarter, ESER personnel collect samples from sheep grazed in these areas, either just before or shortly after they leave the INEEL. For the calendar year 2001, six sheep were sampled. Four were from INEEL land, and two were from Dubois to serve as control samples. Cesium-137 was detected in the muscle tissue of two onsite samples (ranging from [5.3 ± 2.1] x 10^{-3} pCi/g to [11.1 ± 7.4] x 10^{-3} pCi/g) and in three liver tissue samples from two onsite and a control animal (ranging from [2.7 ± 2.2] x 10^{-3} pCi/g to [3.8 ± 2.1] x 10^{-3} pCi/g). All ^{137}Cs concentrations were similar to those found in both onsite and offsite sheep samples during recent years. Iodine-131 was not detected in any of the sheep.

Game Animals

Muscle, liver, and thyroid samples were collected from seven mule deer, one pronghorn, and one elk, which had been accidentally killed on INEEL roads. There was detectable ^{137}Cs radioactivity in four mule deer liver samples taken on or near the INEEL, ranging from (2.6 ± 2.0) x 10^{-3} pCi/g to (20.5 ± 6.8) x 10^{-3} pCi/g.

In 1998 and 1999, four pronghorn, five elk, and eight mule deer muscle samples were collected as background samples from hunters across the Western U.S.: three from central Idaho, three from Wyoming, three from Montana, four from Utah, and one each from New Mexico, Colorado, Nevada, and Oregon. Each background sample had small, but detectable, ^{137}Cs concentrations in their muscle ranging from (1.5 ± 0.2) x 10^{-3} pCi/g to (200 ± 200) x 10^{-3} pCi/g. Muscle results from animals sampled in 2001 are within this range, from (2.6 ± 2.0) x

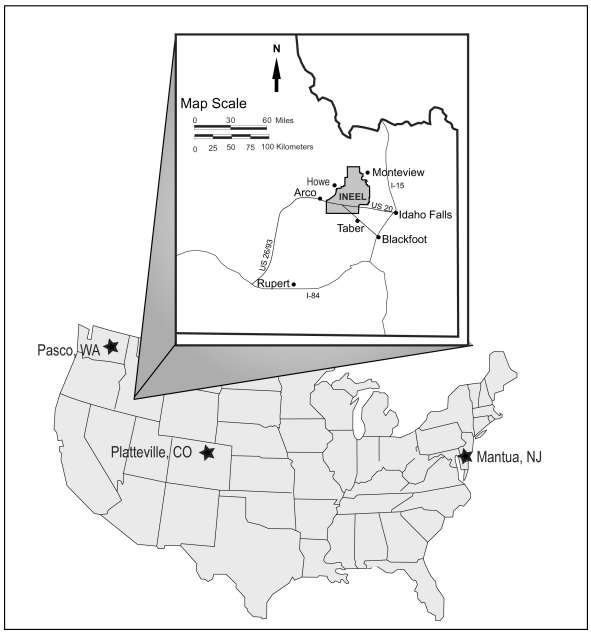


Figure 6-1. Locations of potato samples taken during 2001.

10^{-3} pCi/g to (15.8 ± 4.2) x 10^{-3} pCi/g. These values are also within the range of historical values. The highest value for ^{137}Cs was recorded in the liver of a mule deer at (20.5 ± 6.8) x 10^{-3} pCi/g. These values can be attributed to the ingestion of radionuclides in plants from worldwide fallout from aboveground nuclear weapons testing. No ^{131}I was detected in any of the thyroid glands.

No marmots or mourning doves were collected in 2001.

Fourteen ducks were collected during 2001: three each from the Idaho Nuclear Technology and Engineering Center (INTEC) percolation ponds and Market Lake, Idaho, and four each from the Argonne National Laboratory-West (ANL-W) and Test Reactor Area (TRA) ponds. All were analyzed for gamma-emitting radionuclides with a subset analyzed for ^{90}Sr, americium-241 (^{241}Am), plutonium-238 (^{238}Pu), and plutonium-239/240 ($^{239/240}$Pu). Seven samples had positive detections for one or more radionuclides. Total radionuclide concentrations for those samples are summarized in Table 6-4. Due to a miscommunication with the laboratory, the samples were not analyzed until the summer of 2002. As a result, there are no ^{131}I values, as this radionuclide has a half-life of 8 days and had effectively decayed by the time analysis was performed. Potential dose from consuming these ducks is discussed in Chapter 7.

6.3. SOIL SAMPLING

Soils are sampled to determine if long-term deposition of airborne materials released from the INEEL have resulted in a buildup of radionuclides in the environment. The ESER contractor collects offsite soil samples only during even numbered years. Therefore, no offsite soils were collected during 2001.

Radionuclide levels in soils at all 277 site surveillance locations near major INEEL facilities were measured by the M&O contractor in 2001 using in-situ gamma spectrometry with additional grab samples at 0-5 cm (0-2 in.) at selected locations. The surface soils were analyzed in-situ for gamma-emitting radionuclides and ^{90}Sr. No ^{90}Sr was detected during in-situ measurements. Table 6-5 presents the in-situ gamma results.

Results of selected samples collected by the M&O contractor and analyzed for alpha-emitting transuranics are presented in Table 6-6. The anthropogenic (human-made) radionuclides present are a result of worldwide fallout from atmospheric testing of nuclear weapons and INEEL facility operations.

Table 6-4. Radionuclides detected in seven ducks using INEEL wastewater disposal ponds (2001).[a]

Americium-241[b]	Cesium-137	Cobalt-60	Europium-152	Niobium-95	Strontium-90	Zinc-65
--[c]	0.03 ± 0.00	--	--	--	--	--
2.45 ± 1.90	--	--	--	--	--	--
1.31 ± 1.30	--	--	--	--	--	--
--	0.38 ± 0.04	2.55 ± 0.10	0.29 ± 0.04	--	--	--
4.04 ± 2.30	--	--	--	--	0.12 ± 0.04	--
--	0.17 ± 0.02	3.09 ± 0.10	0.07 ± 0.02	3.01 ± 1.95	--	--
--	0.70 ± 0.04	19.73 ± 0.57	0.19 ± 0.03	--	--	1.72 ± 0.17

a. All values are in picocuries per gram ± 2 standard deviations.

b. Americium-241 values are times 10^{-3} picocuries per gram.

c. A double dash (--) indicates the radionuclide was not detected in that sample.

Table 6-5. In-situ soil gamma results measured by the M&O contractor (2001).

Location	Radionuclide	Concentration [a]			Comment
		Minimum	Maximum	Mean	
ANL-W	Cesium-137	< mdc[b]	0.92 ± 0.20	0.62	Concentrations within the background range for the INEEL and surrounding areas and attributable to past fallout
ARA[c]	Cesium-137	< mdc	9.24 ± 0.34	2.36	Concentrations above background for the INEEL, but consistent with historical concentrations at ARA
	Europium-152	< mdc	0.37 ± 0.30	0.28	
INTEC large grid	Cesium-137	0.20 ± 0.02	0.74 ± 0.18	0.59	Concentrations within the background range for the INEEL and surrounding areas and attributable to past fallout
INTEC small grid	Cesium-137	1.37 ± 0.26	22.10 ± 0.54	5.2	Concentrations above background for the INEEL, but consistent with historical concentrations at INTEC
NRF[d]	Cesium-137	0.27 ± 0.10	1.10 ± 0.12	0.57	Concentrations within the background range for the INEEL and surrounding areas and attributable to past fallout
PBF[e]	Cesium-137	0.45 ± 0.20	0.65 ± 0.18	0.57	Concentrations within the background range for the INEEL and surrounding areas and attributable to past fallout
RWMC	Cesium-137	< mdc	1.20 ± 0.24	0.63	Concentrations within the background range for the INEEL and surrounding areas and attributable to past fallout
TAN	Cesium-137	< mdc	2.91 ± 0.22	0.64	Concentrations above background for the INEEL, but consistent with historical concentrations at INTEC
TRA	Cesium-137	< mdc	2.44 ± 0.38	1.13	Concentrations above background for the INEEL, but consistent with historical concentrations at TRA
	Cobalt-60	< mdc	1.01 ± 0.34	0.15	

a. All concentration values are in picocuries per gram with ± 2 standard deviations.
b. < mdc indicates less than minimum detectable concentration.
c. ARA = Auxiliary Reactor Area.
d. NRF = Naval Reactors Facility.
e. PBF = Power Burst Facility.

Table 6-6. Soil radiochemistry results reported by the M&O contractor (2001).

Location	Radionuclide	Concentrations[a]			Comment
		Minimum	Maximum	Mean	
ARA	Americium-241	< mdc[b]	$(5.62 \pm 5.18) \times 10^{-3}$	NA[c]	Concentrations within the background range for the INEEL and surrounding areas and attributable to past fallout
	Plutonium-239/240	< mdc	$(8.95 \pm 4.10) \times 10^{-3}$	NA	
	Strontium-90	< mdc	0.654 ± 0.098	NA	Concentrations above background for the INEEL, but consistent with historical concentrations at ARA
INTEC large grid	Americium-241	$(3.7 \pm 3.0) \times 10^{-3}$	$(6.1 \pm 3.4) \times 10^{-3}$	0.0052	Concentrations within the background range for the INEEL and surrounding areas and attributable to past fallout
	Plutonium-239/240	$(1.10 \pm 0.05) \times 10^{-2}$	$(1.91 \pm 7.6) \times 10^{-2}$	0.0144	
	Strontium-90	0.14 ± 0.07	0.33 ± 0.08	0.241	
INTEC small grid	Americium-241	$(7.21 \pm 4.68) \times 10^{-3}$	$(6.75 \pm 1.66) \times 10^{-2}$	0.0298	Concentrations within the background range for the INEEL and surrounding areas and attributable to past fallout
	Plutonium-239/240	0.0134 ± 0.0053	$(8.5 \pm 2.2) \times 10^{-2}$	0.0399	
	Strontium-90	4.94 ± 0.33	8.47 ± 0.52	6.94	Concentrations above background for the INEEL, but consistent with historical concentrations at INTEC.
NRF	Americium-241	$(4.35 \pm 3.20) \times 10^{-3}$	0.0112 ± 0.0051	0.0056	Concentrations within the background range for the INEEL and surrounding areas and attributable to past fallout
	Plutonium-239/240	$9.22 \pm 4.26 \times 10^{-3}$	0.0218 ± 0.0072	0.0155	
	Strontium-90	0.176 ± 0.096	0.281 ± 0.082	0.299	
PBF	Americium-241	NA	$(5.36 \pm 3.18) \times 10^{-3}$	NA	Concentrations within the background range for the INEEL and surrounding areas and attributable to past fallout
	Plutonium-239/240	NA	0.0149 ± 0.0059	NA	
	Strontium-90	NA	0.234 ± 0.072	NA	
TAN	Americium-241	NA	< mdc	NA	Concentrations within the background range for the INEEL and surrounding areas and attributable to past fallout
	Plutonium-239/240	NA	$(6.6 \pm 3.32) \times 10^{-3}$	NA	
	Strontium-90	NA	$(8.32 \pm 6.78) \times 10^{-2}$	NA	
TRA	Americium-241	0.0143 ± 0.0074	$(8.03 \pm 1.90) \times 10^{-2}$	0.0379	Concentrations within the background range for the INEEL and surrounding areas and attributable to past fallout
	Plutonium-239/240	0.0219 ± 0.0086	0.102 ± 0.027	0.0315	
	Strontium-90	0.273 ± 0.081	0.599 ± 0.097	0.395	Concentrations above background for the INEEL, but consistent with historical concentrations at TRA

a. All concentration values are in picocuries per gram with ± 2 standard deviations.

b. < mdc indicates less than minimum detectable concentration.

c. NA indicates not applicable.

Wastewater Land Application Permit Soil Sampling at CFA

The Wastewater Land Application Permit (WLAP) allows for nonradioactive wastewater to be pumped from lagoons at the Central Facilities Area (CFA) Sewage Treatment Plant to the ground surface. Soils at CFA are sampled from the land application area following each application season in accordance with the WLAP. Subsamples are taken from 0–30 cm (0–12 in.) and 30–61 cm (12–24 in.) at each location and composited, yielding two composite samples, one from each depth. These results are presented in Table 6-7. Baseline data collected by Cascade Earth Sciences, Ltd. in 1993 are presented for comparison purposes in Table 6-7.

Levels of pH have remained fairly constant during the application period (Table 6-7), even though the pH level at the 30–61 cm (12–24-in.) interval during 2001 represents the application period minimum. Percent organic matter has varied around baseline concentrations; however, it is expected to take several years for decomposed vegetation to be incorporated into the soil profile.

The soil salinity levels are within acceptable ranges based on electrical conductivity results. Soil salinity levels between 0–2 mmhos/cm are generally accepted to have negligible effects on plant growth. During 2001, the electrical conductivity in the 30–61-cm (12–24-in.) interval increased over historical levels, but it remained below the recommended 0–2 mmhos/cm maximum.

Soils with sodium adsorption ratios below 15 and electrical conductivity levels below 2 mmhos/cm are generally classified as not having sodium or salinity problems [Reference 6-2]. While 2001 sodium adsorption ratios were elevated at both depths relative to baseline levels and to past levels, they remain well below the ratio generally indicating a soil as having a sodium or salinity problem.

Nitrogen data suggest negligible nitrogen accumulation from wastewater application. The low soil-available nitrogen (ammonium-nitrogen [NH_4N] and nitrate-nitrogen [NO_3N]) concentrations suggest that the native sagebrush and grass vegetation utilize all of the plant-available nitrogen, and that the total nitrogen application is low. Increased nutrients and water from wastewater application may be stimulating plant growth, which in turn rapidly utilizes plant-available nitrogen. The ammonium and nitrate nitrogen concentrations are comparable to those of nonfertilized, background agricultural soils.

In 2001, available phosphorus concentrations remained below baseline concentrations and less than that considered adequate for range and pasture crop growth [Reference 6-3].

6.4. DIRECT RADIATION

Thermoluminescent dosimeters (TLDs) measure cumulative exposures to ambient ionizing radiation. The TLDs detect changes in ambient exposures attributed to handling, processing, transporting, or disposing radioactive waste. The TLDs are sensitive to beta energies greater than 200 kilo-electron-volts (KeV) and to gamma energies greater than 10 KeV. The TLD packets contain four lithium fluoride chips and are placed about 1-m (~3 ft) above the ground at specified locations. The four chips provide replicate measurements at each location. The TLD packets are replaced in May and November of each year. The sampling periods for 2001 were from November 2000 through May 2001 (spring) and from May through October 2001 (fall).

The measured cumulative environmental radiation exposure for offsite locations from November 2000 through October 2001 is shown in Table 6-8 for two adjacent sets of dosimeters maintained by the ESER contractor and the M&O contractor. For purposes of comparison,

Table 6-7. CFA Sewage Treatment Plant land application area soil monitoring results (2001).

	Baseline Data[b]		Application Period				
			1995 through 2000				
Parameter[a]	Depth (in.)	1993	Depth (in.)	Minimum	Maximum	Average	2001
pH [c] (standard units)	0–6	7.6	0–12	8.0	8.4	8.2	8.0
	6–16	8.0	12–24	8.1	8.6	8.3	7.9
	16–30	8.1					
Electrical Conductivity (mmhos/cm)	0–6	0.6	0–12	0.36	1.20	0.67	1.12
	6–16	0.7	12–24	0.20	1.10	0.53	1.64
	16–30	0.6					
Organic Matter (%) [c]	0–6	2.2	0–12	0.63	3.09	1.78	2.17
	6–16	1.6	12–24	0.56	2.29	1.16	1.18
	16–30	1.4					
Total Kjeldahl Nitrogen [d]	0–6	1,200	0–12	733	1,500	1,193	796
	6–16	900	12–24	362	1,300	722	492
	16–30	500					
Nitrate-Nitrogen	0–6	16	0–12	2.05[e]	6.00	3.54[f]	2.91
	6–16	6	12–24	0.43[e]	5.20	1.94[f]	2.25 U[g]
	16–30	3					
Ammonium-Nitrogen	0–6	7.9	0–12	1 U	6.10	3.21[f]	5.20
	6–16	7.6	12–24	1 U	6.00	2.70[f]	5.44
	16–30	7.4					
Phosphorus [h]	0–6	29	0–12	4.9	12.0	8.40	8.8
	6–16	18	12–24	2 U	10.2	4.28[f]	3.7
	16–30	12					
Sodium Adsorption Ratio	0–6	1.0	0–12	0.35	3.33	1.96	6.72
	6–16	1.4	12–24	0.31	2.51	1.14	4.03
	16–30	2.6					

a. All values are in milligrams per liter unless otherwise noted.

b. Baseline sample results were based on a composite of three representative samples taken at each depth. Baseline soil depths and locations differ from permit samples.

c. The minimum, maximum, and average shown do not reflect a result from 1995. While samples were collected in 1995, the analytical laboratory failed to analyze them.

d. Total Kjeldahl nitrogen was not a required parameter for the permit, but was analyzed for additional information.

e. Only includes values that were greater than the detection limit.

f. Where applicable, half the reported detection limit was used to calculate the average.

g. U flag indicates that the reported result is below the detection limit.

h. Available phosphorus was analyzed rather than the total phosphorus.

Table 6-8. Annual environmental radiation exposures (1998-2001).[a]

	1998		1999		2000		2001	
Distant Group	**ESER**	**M&O**	**ESER**	**M&O**	**ESER**	**M&O**	**ESER**	**M&O**
Aberdeen	128 ± 8	157 ± 18	130 ± 9	124 ± 7	152 ± 21	137 ± 19	144 ± 28	133 ± 18
Blackfoot	130 ± 6	134 ± 7	111 ± 4	111 ± 6	145 ± 20	136 ± 18	138 ± 27	126 ± 18
Blackfoot (CMS)[b]	113 ± 4		113 ±14		134 ±13		114 ± 22	
Craters of the Moon	122 ± 6	121 ± 8	115 ± 12	120 ± 13	137 ± 19	136 ± 18	126 ± 25	121 ± 17
Idaho Falls	124 ± 6	115 ± 6	124 ± 13	108 ± 10	147 ± 20	127 ± 17	129 ± 25	123 ± 17
Minidoka	116 ± 7	113 ± 6	112 ± 7	113 ± 12	131 ± 18	122 ± 17	118 ± 23	111 ± 16
Rexburg	144 ± 7	116 ± 4	129 ± 5	110 ± 11	155 ± 22	131 ± 18	148 ± 29	120 ± 16
Roberts	130 ± 6	137 ± 8	131 ± 9	129 ± 10	157 ± 22	144 ± 21	137 ± 27	139 ± 19
Mean	**126 ± 6**	**128 ± 11**	**121 ± 9**	**116 ± 10**	**146 ± 20**	**133 ± 18**	**132 ± 26**	**125 ± 17**
Boundary Group								
Arco	128 ± 7	117 ± 6	128 ± 12	124 ± 7	143 ± 20	134 ± 18	128 ± 25	121 ± 17
Atomic City	132 ± 6	124 ± 5	124 ± 8	133 ± 6	147 ± 20	137 ± 18	131 ± 26	128 ± 18
Howe	125 ± 5	116 ± 7	118 ± 6	116 ± 10	133 ± 18	130 ± 18	118 ± 23	114 ± 16
Monteview	124 ± 4	113 ± 8	114 ± 6	108 ± 14	134 ± 19	120 ± 16	122 ± 24	116 ± 16
Mud Lake	137 ± 7	130 ± 4	129 ± 9	128 ± 13	151 ± 21	140 ± 20	140 ± 27	126 ± 18
Birch Creek Hydro	117 ± 6	105 ± 6	113 ± 10	113 ± 18	114 ± 16	107 ± 15	118 ± 23	108 ± 16
Mean	**127 ± 5**	**118 ± 6**	**121 ± 9**	**120 ± 11**	**137 ± 19**	**128 ± 18**	**126 ± 25**	**119 ± 17**

a. All values are in milliroentgens with ± 2 standard deviations.
b. The M&O contractor does not sample at the Blackfoot Community Monitoring Station (CMS).

annual exposures from 1998–2000 are also included for each location.

The mean annual exposures from distant locations in 2001 were 132 ± 26 millroentgen (mR) as measured by ESER contractor dosimeters and 125 ± 17 mR, as measured by the M&O contractor's dosimeters. For boundary locations, the mean annual exposures were 126 ± 25 mR as measured by ESER contractor dosimeters and 119 ± 17 mR as measured by M&O contractor dosimeters. Using both ESER and M&O data, the average exposure of the distant group was equivalent to 132 millirem (mrem), when a dose equivalent conversion factor of 1.03 was used to convert from mR to mrem in tissue [Reference 6-4]. The average exposure for the boundary group was 126 mrem.

In addition to TLDs, the M&O contractor uses a global positioning radiometric scanner system to conduct gamma-radiation surveys. The global positioning radiometric scanner is mounted on a four-wheel drive vehicle. Two plastic scintillation detectors identify contaminated areas, and both global positioning system and radiometric data are recorded. The vehicle is driven at approximately 8 km/hr (5 mph) to collect survey data.

Onsite TLDs maintained by the M&O contractor representing the same exposure period as the offsite dosimeters are shown in Appendix D Figures D-1 through D-10. The results are expressed in mR ± 2 standard deviations (2s). Onsite dosimeters were placed on facility perimeters, concentrated in areas likely to show the highest gamma radiation readings.

Other onsite dosimeters are located in the vicinity of radioactive materials storage areas. At some facilities, elevated exposures result from areas of soil contamination around the perimeter of these facilities.

The ICPP 9 TLD is located in a controlled access area, which used to be a contaminated soil area, and ICPP 20 is near a radioactive material storage area. Exposures at ICPP 9, ICPP 20, and INTEC Tree Farm 1 for 2001 were all comparable to historical exposures.

TRA 2, 3, and 4 are adjacent to the former radioactive disposal pond, which has been drained, covered with clean soil, and large rocks. These locations are also close to a radioactive storage area, which is inside the facility fence line. TRA 3 had the maximum exposure at 692 $\pm$ 98 mR. This location is the closest to the radioactive storage area, where the amount of temporarily stored material increased in 2001.

Table 6-9 summarizes the calculated effective dose equivalent an individual receives on the Snake River Plain from various background radiation sources.

The terrestrial portion of natural background radiation exposure is based on concentrations of naturally occurring radionuclides found in soil samples collected in 1976. Data indicated the average concentrations of uranium-238 (^{238}U), thorium-232 (^{232}Th), and potassium-40 (^{40}K) were 1.5, 1.3, and 19 pCi/g, respectively. The calculated 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 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 2001, this resulted in a corrected dose of 67 mrem/yr due to snow cover, which ranged from 2.54 to 27.9 cm (1 to 11 in.) in depth with an average of 14.3 cm (5.5 in.) over 109 days with recorded snow cover.

Table 6-9. Calculated effective dose equivalent from background sources (2001).

Source of Radiation Dose Equivalent		Total Average Annual Dose[a]	
		Calculated	Measured
External			
	Terrestrial	67	NA[b]
	Cosmic	48	NA
	Subtotal	115	132
Internal			
	Cosmogenic	1	
	Inhaled Radionuclides	200	
	^{40}K and others	39	
	Subtotal	240	
Total		**355**	

a. All values are in millirem.

b. NA indicates terrestrial and cosmic radiation parameters were not measured individually.

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 1,500 m (4,900 ft) [Reference 6-5]. Cosmic radiation may vary slightly due to solar cycle fluctuations and other factors.

The estimated sum of the terrestrial and cosmic components of dose to a person residing on the Snake River Plain in 2001 was 115 mrem. This is below the value of 132 mrem measured at distant locations by TLDs, after conversion from mR to mrem in tissue.

The component of background dose that varies the most is inhaled radionuclides. According to the National Council on Radiation Protection and Measurements, the major contributor of external dose equivalent received by a member of the public from ^{238}U plus decay products are short-lived decay products of radon [Reference 6-5]. The amount of radon in buildings and groundwater depends, in part, upon the natural radionuclide content of the soil and rock of the area. This also varies 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 6-9 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 background dose of about 355 mrem shown in Table 6-9 and will vary from one location to another.

6.5. WASTE MANAGEMENT SURVEILLANCE SAMPLING

Vegetation, soil, and direct radiation sampling is performed at waste management facilities (RWMC, WERF, and TAN) in compliance with DOE Order 435.1, Radioactive Waste Management.

At the RWMC, vegetation is collected from the five major areas shown on Figure 6-2. Crested wheatgrass and perennials are collected in odd-numbered years. Vegetation has been collected every 3 years from WERF beginning in 1984. The next vegetation sampling event will be in 2002. A radiometric scanner system was used to conduct soil surface radiation surveys at the RWMC in addition to soil sampling.

The following subsections present the results from sampling of various environmental media conducted specifically for waste management purposes (compliance with DOE Order 435.1).

Crested Wheatgrass

Crested wheatgrass samples were collected in each of the five major areas from the RWMC in 2001. Control samples were collected near Frenchman's Cabin at the base of Big Southern Butte, approximately 11 km (6.8 mi) south of the RWMC (Figure 6-3). Cesium-137 was detected in one sample from Area-3 with a concentration of 0.1 ± 0.06 pCi/g. This was within the range reported in historical concentrations at the RWMC.

Six selected crested wheatgrass samples were submitted for radiochemistry analyses. Americium-241, $^{239/240}Pu$, and ^{90}Sr were detected in at least two samples (Table 6-10). All concentrations were within the background range for the INEEL and surrounding areas and are attributable to historic fallout from aboveground nuclear weapons testing.

Perennials

Samples of perennial plants were also collected in each of the five major areas from the RWMC in 2001. Control samples were again collected near Frenchman's Cabin.

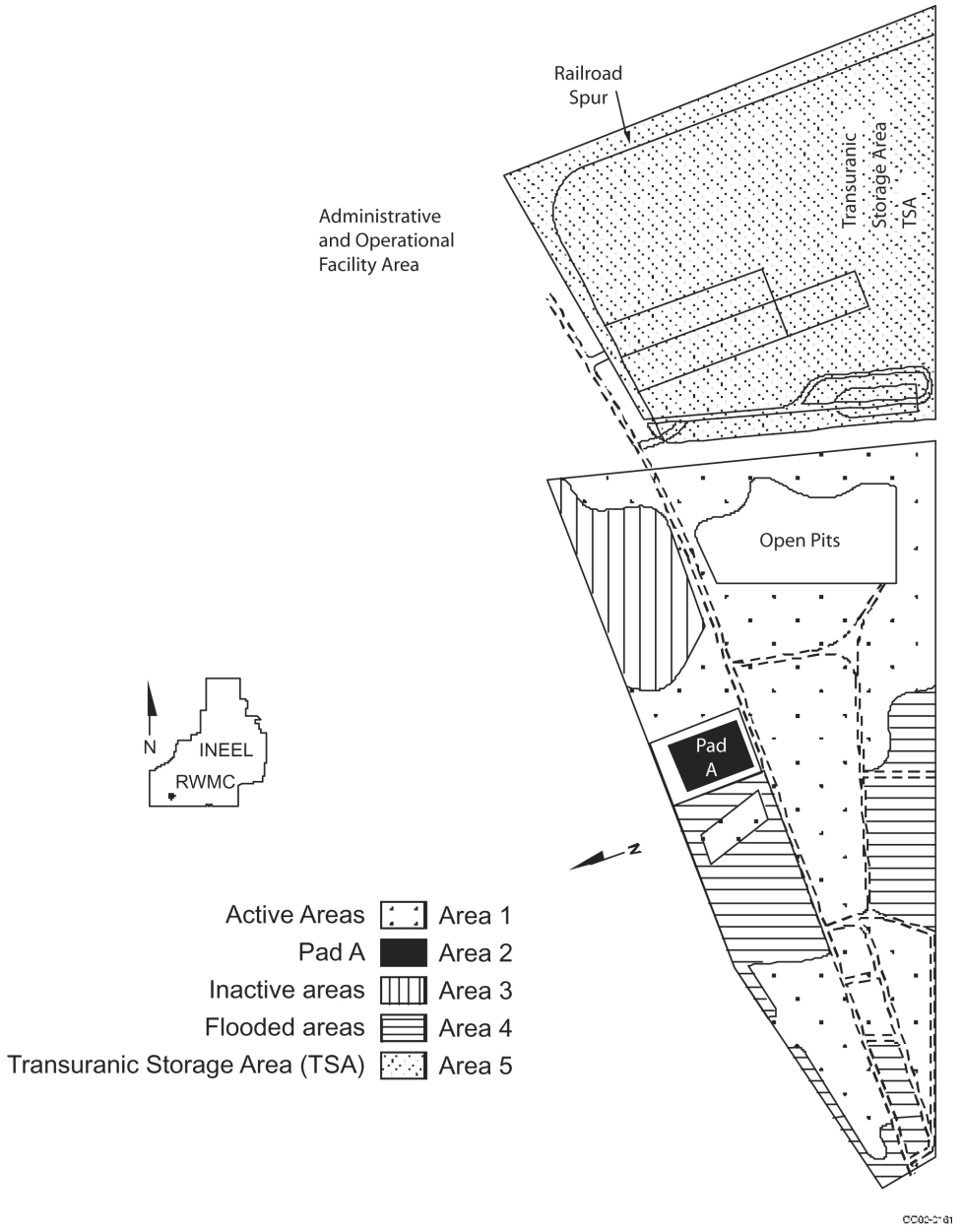


Figure 6-2. Five major areas of the RWMC used for M&O Waste Management vegetation collection.

Table 6-10. Crested wheatgrass sample results (2001).

Detection	Number of Samples	Maximum Concentration[a]
Americium-241	2	6.95 ± 1.80
Plutonium-239/240	5	24.20 ± 5.20
Strontium-90	6	1.49 ± 0.16

a. All values are times 10^{-3} picocuries per gram (pCi/g).

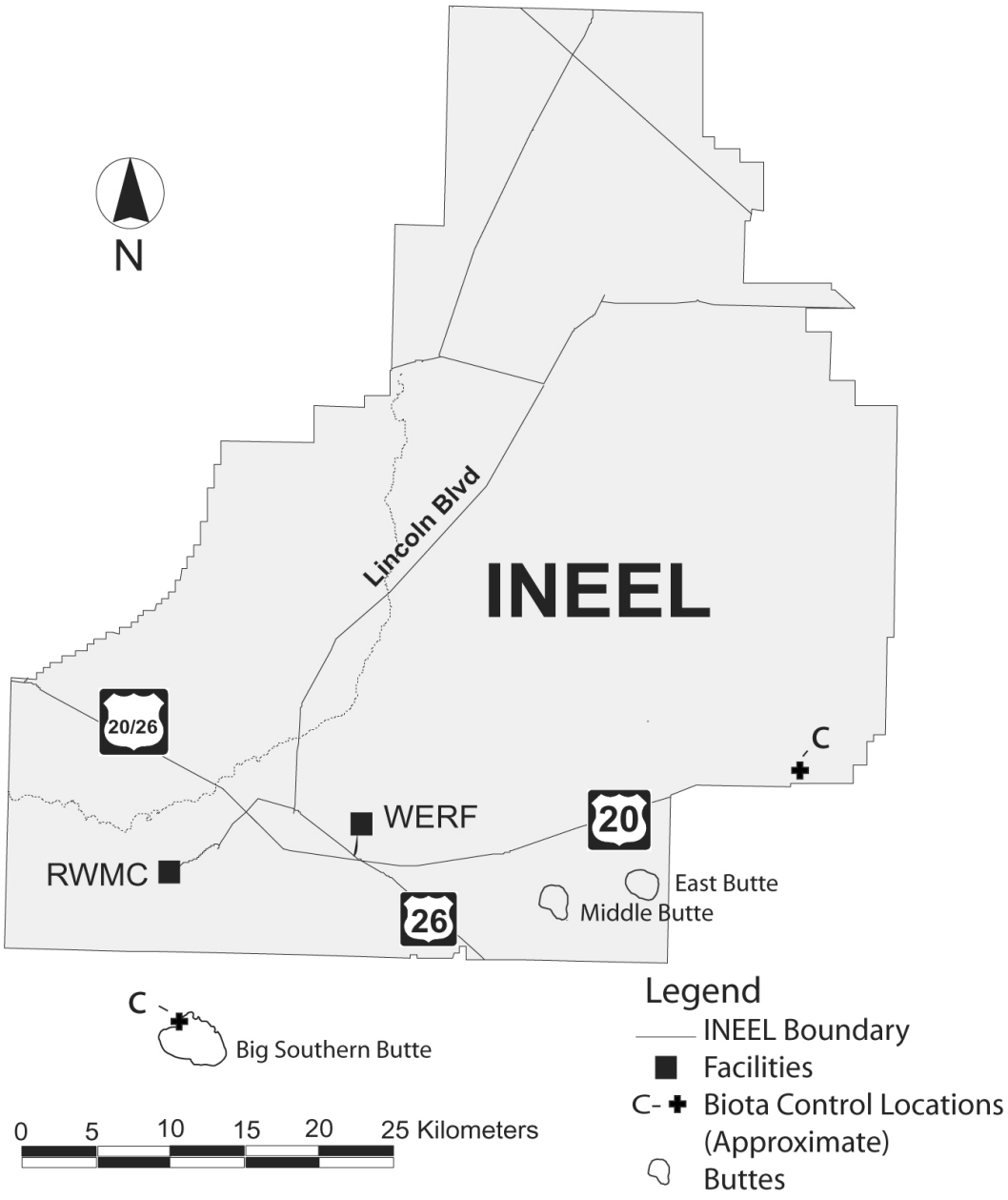


Figure 6-3. Vegetation control sample locations (RWMC–Frenchman's Cabin, WERF–Tractor Flats).

Cesium-137 was detected in one sample from Area-5 (Table 6-11). The concentration was within the range reported in historical concentrations at the RWMC. Three selected perennial samples were submitted for radiochemistry analyses. Americium-241, $^{239/240}$Pu, and ^{90}Sr were detected as shown in Table 6-11. The concentrations were all within the background range for the INEEL and surrounding areas and are attributable to past fallout.

Soil Sampling

Triennial soil sampling was conducted during 2001. Soil samples were collected at

the RWMC Stored Waste Examination Pilot Plant (SWEPP) locations shown in Figure 6-4, at 0-5 cm (0-2 in.). The soils were analyzed for gamma-emitting radionuclides and ^{90}Sr. Selected samples were analyzed for alpha-emitting transuranics.

Cesium-137, $^{239/240}Pu$, and ^{90}Sr were detected in all samples (Table 6-12). The concentrations are within the background range for the INEEL and surrounding areas and are attributable to past fallout. Americium-241 was also detected in all samples (Table 6-12). Americium-241 concentrations are above background for the INEEL but are consistent with historical concentrations at the RWMC and are attributable to past operational activities and fallout.

Table 6-11. Perennial sample results (2001).

Parameter	Number of Samples	Maximum Concentration[a]
Cesium-137	1	37.00 ± 36.00
Americium-241	2	1.25 ± 0.64
Plutonium-239/240	3	2.74 ± 1.14
Strontium-90	3	54.50 ± 9.40

a. All values are times 10^{-3} picocuries per gram (pCi/g).

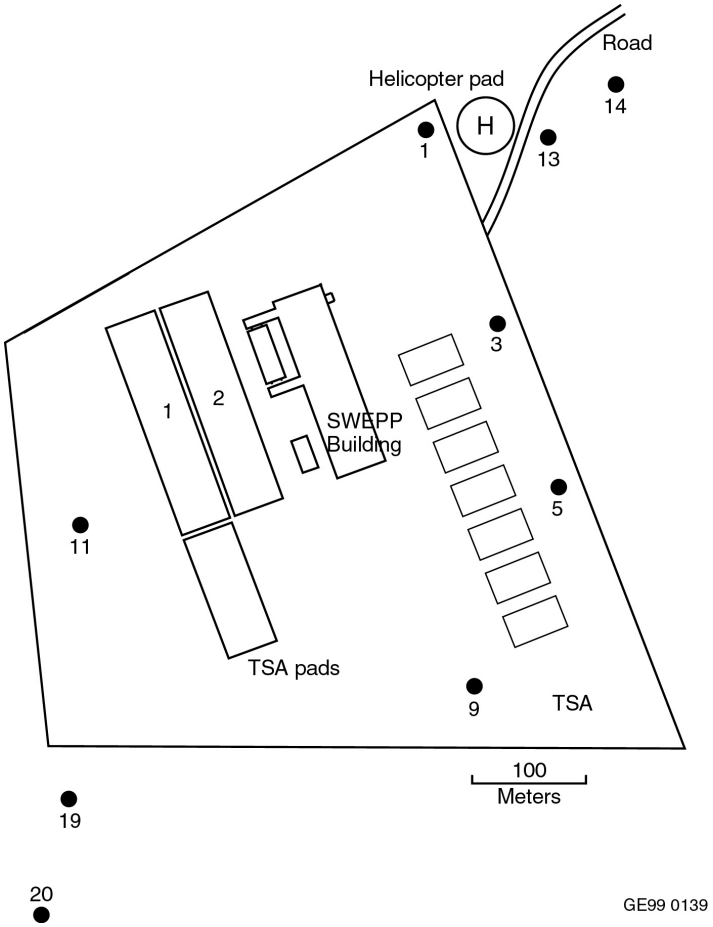


Figure 6-4. SWEPP soil sampling locations.

Table 6-12. SWEPP soil sampling results (2001).

Parameter	No. of Samples	Maximum Concentration (pCi/g)	ECG (pCi/g)[a]
Cesium-137	4	$6.4 \pm 0.8 \times 10^{-1}$	6.0
Americium-241	4	$3.42 \pm 1.02 \times 10^{-2}$	0.4
Plutonium-239/240	4	$1.91 \pm 0.78 \times 10^{-2}$	0.8
Strontium-90	4	$2.55 \pm 0.68 \times 10^{-1}$	6.0

a. ECG = Environmental Concentration Guide [Reference 6-6].

Direct Radiation

The M&O contractor uses a global positioning radiometric scanner system to conduct gamma-radiation surveys of soil surfaces. The global positioning radiometric scanner is mounted on a four-wheel drive vehicle; two plastic scintillation detectors identify contaminated areas, and both global positioning system and radiometric data are recorded. The vehicle is driven at approximately 8 km/hr (5 mph) to collect survey data.

Figures 6-5 and 6-6 show the radiation readings from the 2001 RWMC spring and fall surveys, respectively. The spring and fall surveys around the active low-level waste pit were comparable to or lower than historical measurements for that area. No new elevated readings were identified during either survey. Table 6-13 compares the maximum results of the spring and fall surveys. The results are comparable to 2000 measurements taken at the same location.

Pad A cannot be surveyed via the global positioning radiometric scanner because of driving restrictions. Therefore, it was traversed with a hand-held detector. No elevated readings were identified on Pad A during either the spring or fall survey.

6.6. SUMMARY

The M&O and ESER contractors, along with the INEEL Oversight program, sampled a variety of media in 2001, including agricultural products, wildlife, soil, and direct radiation to assess if operations at the INEEL are releasing contaminants to the environment in significant levels. Assessment of the 2001 data indicates that although some contaminants were detected, they could not be directly linked to operations at the INEEL. Concentrations of radionuclides detected were consistent with levels attributed to fallout from atmospheric weapons testing. Furthermore, the maximum levels for the contaminants found were all well below regulatory health-based limits for protection of human health and the environment.

Table 6-13. Comparison of spring and fall global positioning radiometric survey.

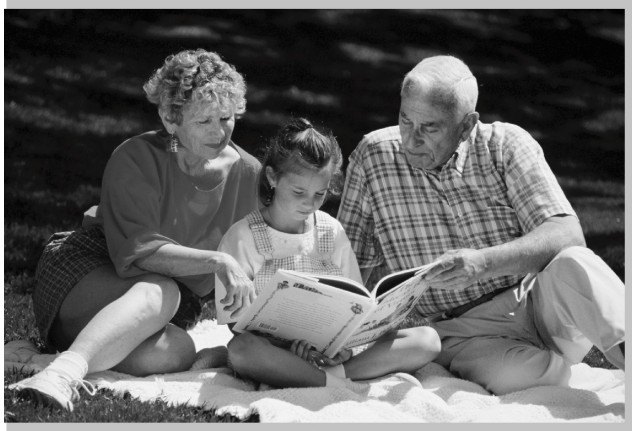
	Spring		Fall	
	2000	2001	2000	2001
Maximum[a]	582	353	607	502
Location of Maximum Value[b]	Soil Vault Row #18		Soil Vault Row #18	

a. All values are in microroentgens per hour.

b. Excludes operating low-level waste pit.

Figure 6-5. RWMC surface radiation Spring 2001.

Figure 6-6. RWMC surface radiation Fall 2001.



Chapter 7

Dose to the Public

7. DOSE TO THE PUBLIC

It is the policy of the U.S. Department of Energy (DOE) "to conduct its operations in an environmentally safe and sound manner. Protection of the environment and the public are responsibilities of paramount importance and concern to DOE" [Reference 7-1]. DOE Order 5400.5 further states, "It is also a DOE objective that potential exposures to members of the public be as far below the limits as is reasonably achievable..." [Reference 7-2]. This chapter describes the dose to members of the public and to the environment based on the 2001 radionuclide concentrations from operations at the Idaho National Engineering and Environmental Laboratory (INEEL).

7.1. GENERAL INFORMATION

Because individual radiological impacts to the public surrounding the INEEL remain too small to be measured by available monitoring techniques and to show compliance with federal regulations set to ensure the safety of the public, the dose from INEEL operations has been calculated using the reported amounts of radionuclides released during the year from INEEL facilities (see Chapter 4) and appropriate air dispersion models. During 2001, this was accomplished for the radionuclides summarized in Table 4-2.

The following estimates were calculated:

- The effective dose equivalent to the hypothetical maximally exposed individual (MEI), as defined by the National Emission Standards for Hazardous Air Pollutants (NESHAP) regulations, using the CAP-88 model as required by the regulation [Reference 7-3];
- The effective dose equivalent to the MEI residing offsite using dispersion values from the MDIFF (mesoscale diffusion) model to comply with DOE Order 5400.1 [Reference 7-4]; and
- The collective effective dose equivalent (population dose) within 80 km (50 mi) of an INEEL facility to comply with DOE Order 5400.1. The estimated population dose was based on the effective dose equivalent calculated with the MDIFF air dispersion model for the MEI.

In this chapter, the term "dose" refers to effective dose equivalent unless another term is specifically stated. Dose was calculated by summing the effective dose equivalents from each exposure pathway. 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. DOE dose conversion factors and a 50-year integration period were used in calculations with the MDIFF air dispersion model for internally deposited radionuclides [Reference 7-5] and for radionuclides deposited on the ground surface [Reference 7-6]. The CAP-88 model uses dose and risk tables developed by the U.S. Environmental Protection Agency (EPA). No allowance is made in the MDIFF model for shielding by housing materials, which is estimated to reduce the dose by about 30 percent, or less than year-round occupancy time in the community. The CAP-88 model does not include shielding by housing materials, but it does include a factor to allow for shielding by surface soil contours from radioactivity on the ground surface.

Of the potential exposure pathways by which radioactive materials from INEEL operations could be transported offsite (see Figure 3-1), atmospheric transport is the principal potential pathway for exposure to the surrounding population. This is because winds can carry airborne radioactive material rapidly and some distance from its source. The water pathways are not

considered major contributors to dose since no surface water flows off the INEEL and no radionuclides from the INEEL have been found in drinking water wells offsite. Because of these factors, the MEI dose is determined through the use of models of atmospheric dispersion of airborne materials.

7.2. MAXIMUM INDIVIDUAL DOSE - AIRBORNE EMISSIONS PATHWAY

Summary of Models

The NESHAP as outlined in the Code of Federal Regulations, Title 40, Part 61 (40 CFR Part 61), Subpart H requires the demonstration that radionuclides other than radon released to air from any DOE nuclear facility do not result in a dose to the public of greater than 10 mrem/yr [Reference 7-7]. This includes releases from stacks and diffuse sources. The EPA requires the use of an approved computer model to demonstrate compliance with 40 CFR Part 61. The INEEL uses the code CAP-88.

The National Oceanic and Atmospheric Administration Air Resources Laboratory–Field Research Division (NOAA ARL-FRD) developed a mesoscale air dispersion model called MDIFF (formerly known as MESODIF) [Reference 7-4]. The MDIFF diffusion curves, developed by the NOAA ARL-FRD from tests in desert environments (e.g., the INEEL and the Hanford Site in eastern Washington), are more appropriate for the INEEL than the dispersion model used in CAP-88.

The MDIFF model has been in use for almost 40 years to calculate doses to members of the public residing near the INEEL. 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 7-8]. The offsite concentrations calculated using both models were compared to actual monitoring results at offsite locations in 1986, 1987, and 1988 [References 7-8, 7-9, and 7-10]. 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.

The primary difference is the atmospheric dispersion portion of the codes. CAP-88 makes its calculations based on the joint frequency of wind conditions from a single wind station located near the source in a straight line from that source. MDIFF calculates the trajectories of a puff using wind information from 34 towers in the Upper Snake River Plain. This allows for more accurate modeling of the movement of a release using prevailing wind conditions between time of the release and the time that the plume leaves the INEEL region. For this reason, the two models may not agree on the location of the MEI or the magnitude of the maximum dose.

CAP – 88 Model

The dose from INEEL airborne releases of radionuclides calculated to demonstrate compliance with NESHAPs are published in the *National Emissions Standards for Hazardous Air Pollutants-Calendar Year 2001 INEEL Report for Radionuclides* [Reference 7-11]. For these calculations, 63 potential maximum locations were evaluated. The CAP-88 model predicted the highest dose to be at Frenchman's Cabin, located at the southern boundary of the INEEL. This location is only inhabited during portions of the year, but it must be considered as a potential MEI location according to the NESHAP. At Frenchman's Cabin, an effective dose equivalent of 0.035 mrem (3.5×10^{-4} mSv) was calculated. The facilities making the largest contributions to this dose were the Idaho Nuclear Technology and Engineering Center (INTEC) at 65 percent, Test Reactor Area (TRA) at 18 percent, the Radioactive Waste Management Complex (RWMC) at 5 percent, and Test Area North (TAN) at

2 percent. The dose of 0.035 mrem is well below the whole body dose limit of 10 mrem for airborne releases of radionuclides, established by 40 CFR, Part 61.

MDIFF Model

Using data gathered continuously at meteorological stations on and around the INEEL and the MDIFF model, the NOAA ARL-FRD prepares a mesoscale map (Figure 7-1) showing the calculated 2001 concentrations. These concentrations are based on a unit release rate distributed among the various INEEL facilities and on their relative contributions to the total. The unit released was partitioned as follows: TRA (38.1%), INTEC (29.3%), TAN (21.3%), Argonne National Laboratory-West (ANL-W) (8.5%), RWMC (2.7%), and Central Facilities Area (CFA) (0.1%). Summing the contributions from these release points created the isopleths shown in Figure 7-1. To obtain the average air concentration (curies per cubic meter) for a radionuclide released from a facility at any point along any dispersion coefficient isopleth (line of equal air concentration) in Figure 7-1, the value of the dispersion coefficient is multiplied by the number of curies of the radionuclide released during the year and divided by the number of hours in a year squared ([8,660 hours]^2 or 7.50 x 10^7).

In 2000, a revision to the methods and values used for the calculation of the MEI

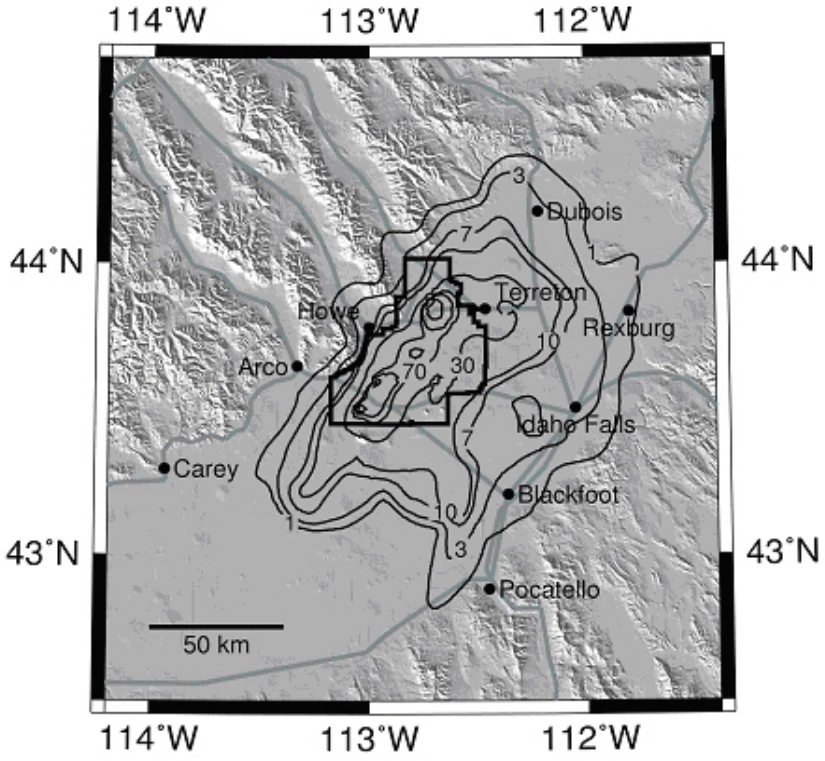


Figure 7-1. Average mesoscale dispersion isopleths of air concentrations[a] at ground level normalized to unit release rate from all INEEL facilities.

a. Concentrations are times 10^{-9} hours squared per meter cubed (x 10^{-9} hr^2/m^3).

from the MDIFF dispersion values was undertaken. Values for the deposition and plant uptake rates of radionuclides, most noticeably radioiodines, were modified to reflect the present operations and current values in use. The most notable change, mathematically, is the increase of the iodine-129 (^{129}I) deposition velocity from 0.01 m/sec to 0.035 m/sec. These changes resulted in a mathematical increase in the amount of radionuclides deposited on the ground and available for plant uptake. This resulted in a net increase in the ingestion dose.

The MDIFF model predicted that the highest concentration of radionuclides in air at a location with a year-round resident during 2001 would have occurred approximately 8.7 km (5.4 mi) west-northwest of Mud Lake, Idaho. The maximum hypothetical dose was calculated for an adult resident at that location from inhalation of air, submersion in air, ingestion of radioactivity on leafy vegetables, and exposure due to deposition of radioactive particles on the ground. The calculation was based on data presented in Table 4-2 and in Figure 7-1.

Using the largest calculated dispersion coefficient of 6.92 x 10^{-8} hr^2/m^3 at a location inhabited by a full-time resident and allowing for radioactive decay during the 42-km (26-mi) transit of the radionuclides from the TRA/INTEC midpoint to the location of the MEI, northwest of Mud Lake, the potential annual effective dose equivalent from all radionuclides released was calculated to be 0.074 mrem (7.4 x 10^{-4} mSv) (Table 7-1). This dose is well below the whole body dose limit of 10 mrem set in the 40 CFR, Part 61 for airborne releases of radionuclides.

As a result of the above-mentioned changes, the ingestion pathway is now the primary route of exposure and accounted for 94 percent of the total dose, followed by immersion at 4 percent, and inhalation at 2 percent. For 2001, the particulate ^{129}I contributed approximately 83 percent of the total dose, followed by ^{90}Sr with 7 percent, argon-41 (^{41}Ar) at 4 percent, ^{131}I contributing 3 percent, and all others at 3 percent (Figure 7-2).

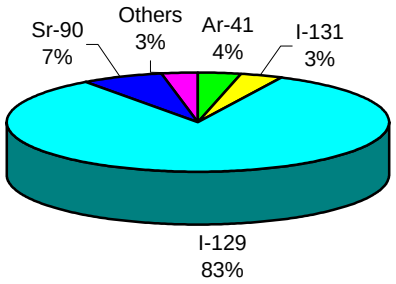


Figure 7-2. Radionuclides contributing to maximum individual dose (as calculated using the MDIFF air dispersion model) (2001).

The calculated maximum dose resulting from INEEL operations is still a small fraction of the average dose received by individuals in southeastern Idaho from cosmic and terrestrial sources of naturally occurring radiation found in the environment. The total annual dose from all natural sources is estimated at approximately 355 mrem (Table 6-9).

7.3. 80-KILOMETER (50-MILE) POPULATION DOSE

As with the calculation of the maximum individual dose, the determination of the population dose, also underwent changes in 2000. Utilizing the power of a Geographic Information System (ArcView), annual population no longer needs to be distributed using growth estimations and a specialized computer code. In addition to this simplification, the population dose is now calculated for the population within an 80-km (50-mi) radius of any INEEL facility. This takes into account the changes in facility operations, in that the INTEC is no longer the single largest contributor of radionuclides released.

Table 7-1. Maximum individual effective dose equivalent as calculated from MDIFF model results (2001).

Radionuclide[a]	Radionuclide Concentration in Air At Maximum Offsite Location[b] (Ci/m^3)	Maximum Effective Dose Equivalent	
		mrem	mSv
^{129}I[c]	1.36×10^{-17}	6.09×10^{-2}	6.09×10^{-4}
$^{90}Sr + D$[d]	3.09×10^{-17}	5.14×10^{-3}	5.14×10^{-5}
^{131}I	2.58×10^{-17}	2.50×10^{-3}	2.50×10^{-5}
^{241}Am	3.46×10^{-20}	2.31×10^{-3}	2.31×10^{-5}
^{3}H	1.74×10^{-12}	9.34×10^{-4}	9.34×10^{-6}
^{60}Co	2.32×10^{-17}	5.65×10^{-4}	5.65×10^{-6}
^{41}Ar	4.11×10^{-13}	2.73×10^{-4}	2.73×10^{-6}
^{239}Pu	3.38×10^{-20}	2.19×10^{-4}	2.19×10^{-6}
^{85}Kr	1.24×10^{-11}	1.39×10^{-4}	1.39×10^{-6}
$^{137}Cs + D$[d]	2.54×10^{-17}	1.07×10^{-4}	1.07×10^{-6}
^{238}Pu	6.26×10^{-21}	3.68×10^{-5}	3.68×10^{-7}
^{135}Xe	1.69×10^{-14}	2.12×10^{-5}	2.12×10^{-7}
^{14}C	1.03×10^{-15}	1.81×10^{-5}	1.81×10^{-7}
Total		**0.074**	**7.4×10^{-4}**

a. Table includes only radionuclides that contribute a dose of 1.0×10^{-5} mrem or more.

b. Estimate of radioactive decay is based on a 0.1 day transport time using the distance to Mud Lake (26.4 miles) and the average wind speed (12.6 mi/hr).

c. Concentration adjusted for plume depletion.

d. When indicated (+D), the contribution of progeny decay products was also included in the dose calculations.

An estimate was made of the collective effective dose equivalent (CEDE), or population dose, from inhalation, submersion, ingestion, and deposition resulting from airborne releases of radionuclides from the INEEL. This collective dose included all members of the public within 80 km (50 mi) of an INEEL facility. The population dose was calculated in a spreadsheet program that multiplies the average dispersion coefficient for the county census division (in hours squared per cubic meter [hr^2/m^3]) by the population in each census division within that county division and the normalized dose received at the location of the MEI (in rem per year per hour squared per meter squared [$rem/yr/hr^2/m^2$]). 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 CEDE by the population in that particular 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 the 42-km (26-mi) distance from the TRA/INTEC midpoint to the residence of the MEI located near Mud Lake. Idaho Falls, for example, is about 66 km (41 mi) from the TRA/INTEC midpoint. Neither residence time nor shielding by housing was considered when

calculating the MDIFF dose on which the CEDE 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 MEI. This individual is potentially exposed through ingestion of contaminated leafy garden vegetables grown at that location.

The 2001 MDIFF population dose within each census division was obtained by averaging the results from appropriate areas contained within those divisions (Table 7-2). The total population dose is the sum of the population doses for the various census divisions. The estimated potential population dose was 0.59 person-rem (0.00059 person-Sv) to a population of approximately 229,920. When compared with an approximate population dose of 43,600 person-rem (436 person-Sv) from natural background radiation, this represents an increase of only about 0.001 percent. The dose of 0.59 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 its greater population; Hamer is relatively high because it includes population centers such as Mud Lake and Terreton, which are in the predominant downwind direction from the INEEL.

7.4. 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 (a) waterfowl that reside briefly at waste disposal ponds at TRA, INTEC, and ANL-W used for the disposal of low-level radioactive wastes and (b) game birds and game animals that may reside on or migrate across the INEEL.

Waterfowl

A study was initiated in 1994 to obtain data on the potential doses from waterfowl using INEEL waste disposal ponds. This study focused on the two hypalon-lined evaporation ponds at TRA that replaced the percolation ponds formerly used for disposal of wastes at that facility [Reference 7-12].

In the fall of 2001, 14 ducks were collected from waste ponds on the INEEL and 3 were collected from an offsite location (Market Lake, Idaho) as a control group. Of the waterfowl collected from the INEEL, four were collected from radioactive waste ponds at the TRA, four from the industrial waste pond and sanitary lagoon at the ANL-W facility, and three from percolation ponds at the INTEC. The maximum potential dose from eating 225 g (8 oz) of meat from ducks collected in 2001 is presented in Table 7-3. Radionuclide concentrations driving these doses are reported in Table 6-4. Doses from consuming waterfowl are based on the assumption that ducks are killed and eaten immediately after leaving the ponds.

The maximum potential dose of 0.08 mrem for these waterfowl samples is substantially below the 0.89 mrem committed effective dose equivalent estimated from the most contaminated duck taken from the evaporation ponds between 1993 and 1998 [Reference 7-12].

Mourning Doves

No mourning doves were collected in 2001.

Big Game Animals

A conservative 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 2.7 mrem in a

Table 7-2. Dose to population within 80 kilometers (50 miles) of INEEL facilities (2001).

Census Division	Population[a]	Population Dose	
		Person-rem	Person-Sv
Aberdeen	3,264	2.26×10^{-3}	2.26×10^{-5}
Alridge	561	1.25×10^{-4}	1.25×10^{-6}
American Falls	2,820	5.63×10^{-4}	5.63×10^{-6}
Arbon (part)	28	1.86×10^{-5}	1.86×10^{-7}
Arco	2,377	2.73×10^{-2}	2.73×10^{-4}
Atomic City (city)	25	2.26×10^{-5}	2.26×10^{-7}
Atomic City (division)	2,663	2.80×10^{-2}	2.80×10^{-4}
Blackfoot	13,152	2.13×10^{-2}	2.13×10^{-4}
Carey (part)	889	1.53×10^{-3}	1.53×10^{-5}
East Clark	72	8.46×10^{-5}	8.46×10^{-7}
Firth	3,230	4.90×10^{-3}	4.90×10^{-5}
Fort Hall (part)	2,026	1.71×10^{-3}	1.71×10^{-5}
Hailey-Bellevue (part)	4	3.84×10^{-13}	3.84×10^{-15}
Hamer	2,309	8.07×10^{-2}	8.07×10^{-4}
Howe	319	8.24×10^{-3}	8.24×10^{-5}
Idaho Falls	75,431	1.82×10^{-1}	1.82×10^{-3}
Idaho Falls, west	1,802	1.00×10^{-2}	1.00×10^{-4}
Inkom (part)	560	1.98×10^{-4}	1.98×10^{-6}
Island Park (part)	80	9.33×10^{-5}	9.33×10^{-7}
Leadore (part)	6	9.16×10^{-8}	9.16×10^{-10}
Lewisville-Menan	3,754	2.06×10^{-2}	2.06×10^{-4}
Mackay (part)	1,125	1.50×10^{-6}	1.50×10^{-8}
Moody (part)	4,333	2.33×10^{-3}	2.33×10^{-5}
Moreland	9,298	4.30×10^{-2}	4.30×10^{-4}
Pocatello (part)	46,817	2.85×10^{-2}	2.851×10^{-4}
Rigby	10,322	2.80×10^{-2}	2.80×10^{-4}
Ririe	1,427	8.04×10^{-4}	8.04×10^{-6}
Roberts	1,646	1.40×10^{-2}	1.40×10^{-4}
Shelley	7,129	2.12×10^{-2}	2.12×10^{-4}
South Bannock (part)	285	1.44×10^{-4}	1.44×10^{-6}
St Anthony (part)	2,204	2.48×10^{-3}	2.48×10^{-5}
Sugar City	4,903	1.11×10^{-2}	1.11×10^{-4}
Swan Valley (part)	460	3.56×10^{-5}	3.56×10^{-7}
Thornton	18,336	2.86×10^{-2}	2.86×10^{-4}
Ucon	5,282	1.80×10^{-2}	1.80×10^{-4}
West Clark	981	2.15×10^{-3}	2.15×10^{-5}
Totals	**229,920**	**0.59**	**5.9×10^{-3}**

a. Population based on 2000 Census Report for Idaho and updated to 2001 based on county population growth from 1990 to 2000.

b. (Part) means only a part of the county census division lies within the 80-km (50-mi) radius of a major INEEL facility.

Table 7-3. Maximum potential dose from ingestion of edible tissue of waterfowl using INEEL waste disposal ponds in 2001.[a]

Radionuclide	Dose[b]
Cesium-137	0.0194
Europium-152	4.23×10^{-4}
Americium-241	3.31×10^{-3}
Strontium-90	4.48×10^{-3}
Niobium-95	1.74×10^{-3}
Cobalt-60	0.0452
Zinc-65	1.47×10^{-3}
Total Dose	**0.08**

a. Committed (50-yr) effective dose equivalent from consuming 225 g (8 oz) based on DOE dose conversion factors.

b. All values are in millirem. These are the maximum doses from the highest radionuclides concentrations in seven different ducks.

study on the INEEL from 1976-1986 [Reference 7-13]. Game animals collected at the INEEL during the past few years have shown much lower concentrations of radionuclides. Based on the highest concentration of radionuclides found in a game animal during 2001, the potential dose was approximately 0.05 mrem.

Yellow-bellied Marmots

Marmots were not sampled in 2001. A special study of marmots at the RWMC is planned for 2002.

7.5. SUMMARY

Table 7-4 summarizes the calculated annual effective dose equivalents for 2001 from INEEL operations using both the CAP-88 and MDIFF air dispersion models. A comparison is shown between these doses and the EPA airborne pathway standard and the estimated dose from natural background. The reasons for such a disparity in the MDIFF and CAP-88 dose is a result of the changes made to the calculations in 2000.

The contribution of game animal consumption to the population dose has not been calculated because only a limited 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 [Reference 7-14]. The total population dose contribution from these pathways would, realistically, be less than the sum of the population doses from inhalation of air, submersion in air, ingestion of vegetables, and deposition on soil.

Table 7-4. Summary of annual effective dose equivalents due to INEEL operations (2001).

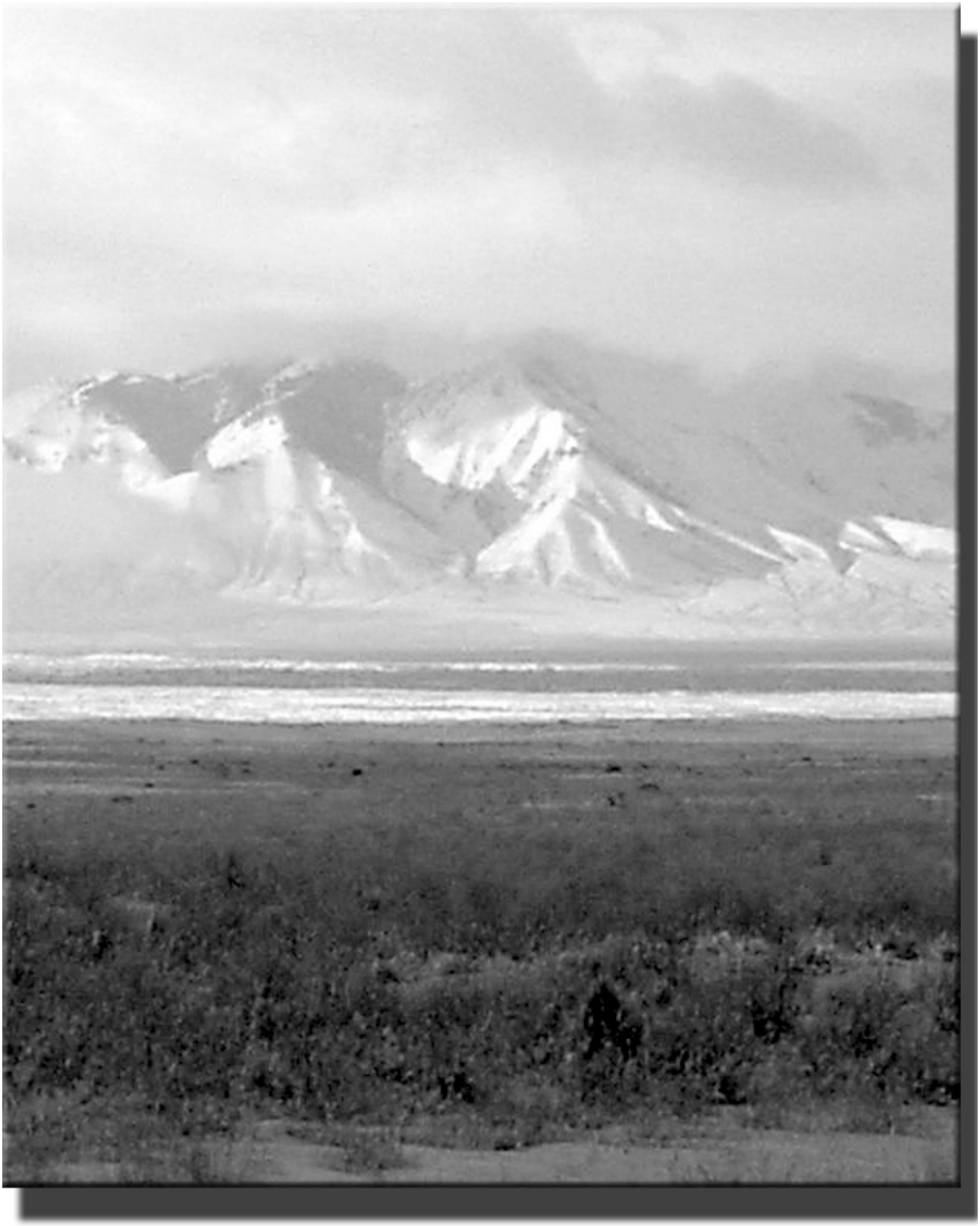
	Maximum Dose to an Individual[a]		Population Dose
	CAP-88[b]	MDIFF[c]	MDIFF
Dose	0.035 mrem 3.5×10^{-4} mSv	0.074 mrem 7.4×10^{-4} mSv	0.59 person-rem 5.9×10^{-3} person-Sv
Location	Frenchman's Cabin	~ 8.7 km (5.4 mi.) W-NW of Mud Lake	Area within 80 km (50 mi) of any INEEL facility
Applicable radiation protection standard[d]	10 mrem (0.1 mSv)	10 mrem (0.1 mSv)	No standard
Percentage of standard	0.35 %	0.74 %	No standard
Natural background	355 mrem (3.6 mSv)	355 mrem (3.6 mSv)	43,600 person-rem (436 person Sv)
Percentage of background	0.01 %	0.02 %	0.001 %

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

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

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

d. Although the DOE standard for all exposure models is 100 mrem/yr 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/yr.



Chapter 8

Quality Assurance

8. QUALITY ASSURANCE

Quality assurance and quality control programs are maintained by contractors conducting environmental monitoring and by laboratories performing environmental analyses.

8.1. QUALITY ASSURANCE PROGRAMS

The purpose of a quality assurance and quality control program is to ensure precise, accurate, representative, and reliable results and maximize data completeness. Elements of typical quality assurance 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 National Institute of Standards and Technology;
- 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 measure possible contamination occurring during analysis;
- Analysis of blind spike samples (samples containing an amount of a constituent known to the sampling organization, but not the analytical laboratory) to verify the accuracy of a measurement;
- Internal and external surveillance to verify quality elements; and
- Data verification and validation programs.

8.2. LABORATORY INTERCOMPARISON PROGRAMS

Data reported in this document were obtained from several commercial, university, government, and government contractor laboratories. In 2001, the Management and Operating (M&O) contractor used their Idaho National Engineering and Environmental Laboratory (INEEL) Radiological Measurements Laboratory (RML) and General Engineering Laboratories for radiological analyses and Southwest Research Institute of Oklahoma, for inorganic analyses. The M&O Drinking Water Program used the INEEL Environmental Hygiene Laboratory for bacteriological analyses; Paragon for radiological analysis; and Environmental Health Labs for inorganic and organic analyses.

The Environmental Surveillance, Education and Research (ESER) contractor used the Environmental Assessments Laboratory (EAL) located at Idaho State University (ISU) for gross radionuclide analyses (gross alpha, gross beta, and gamma spectrometry) and Severn-Trent of Richland, Washington, for specific radionuclide analyses (e.g., strontium-90 [^{90}Sr], americium-241 [^{241}Am], plutonium-238 [^{238}Pu], and plutonium-239/240 [$^{239/240}$Pu]). The U.S. Department of Energy's (DOE's) Radiological and Environmental Sciences Laboratory (RESL) performed radiological analyses for the U.S. Geological Survey (USGS). The USGS National Water Quality Laboratory conducted nonradiological analyses. All these laboratories participated in a variety of

programs to ensure the quality of their analytical data. Some of these programs are described below.

Quality Assessment Program

The Quality Assessment Program, administered by the DOE Environmental Measurements Laboratory (EML) in Brookhaven, New York, is a performance evaluation program that tests the quality of DOE contractor and subcontractor laboratories in performing environmental radiological analyses. EML prepares samples containing known amounts of up to 15 radionuclides in four media: simulated air filters, soil, vegetation, and water. These are distributed to participating laboratories in March and September. Participants can use any method for the analysis, and they are required to report their results within 90 days. EML issues quality assessment reports twice per year in which the identities of participating laboratories, their results, and comparison to EML results are presented. These reports are now available, along with a searchable database of results, on the Internet at http://www.eml.doe.gov/qap/reports/.

2001 Quality Assurance Program Results

Comparisons of the air and water results for the labs used by environmental monitoring organizations in 2001 are presented in Figures 8-1 and 8-2. For the June air only the cobalt-60 (^{60}Co) and cesium-137 (^{137}Cs) results from the INEEL RML were qualified as acceptable with warning. For December, the ISU EAL and General Engineering Labs received acceptable with warning on their gross beta analysis, and Severn-Trent received an acceptable with warning on their ^{137}Cs result.

Water results were qualified with the ISU EAL receiving an acceptable with warning for gross alpha in both June and December. The INEEL RML received an acceptable with warning in June and a not acceptable in December for their gross alpha analysis. General Engineering Labs received an acceptable with warning for gross alpha in December. All lab analysis was acceptable for ^{60}Co and ^{137}Cs except for Severn-Trent, who received a not acceptable for both analyses, and Southwest Labs who received an acceptable with warning on both analyses.

National Institute of Standards and Technology

RESL participates in a traceability program administered through the National Institute of Standards and Technology (NIST). NIST prepares several alpha-, beta-, and gamma-emitting standards, generally in liquid media, for analysis by RESL.

Dosimetry

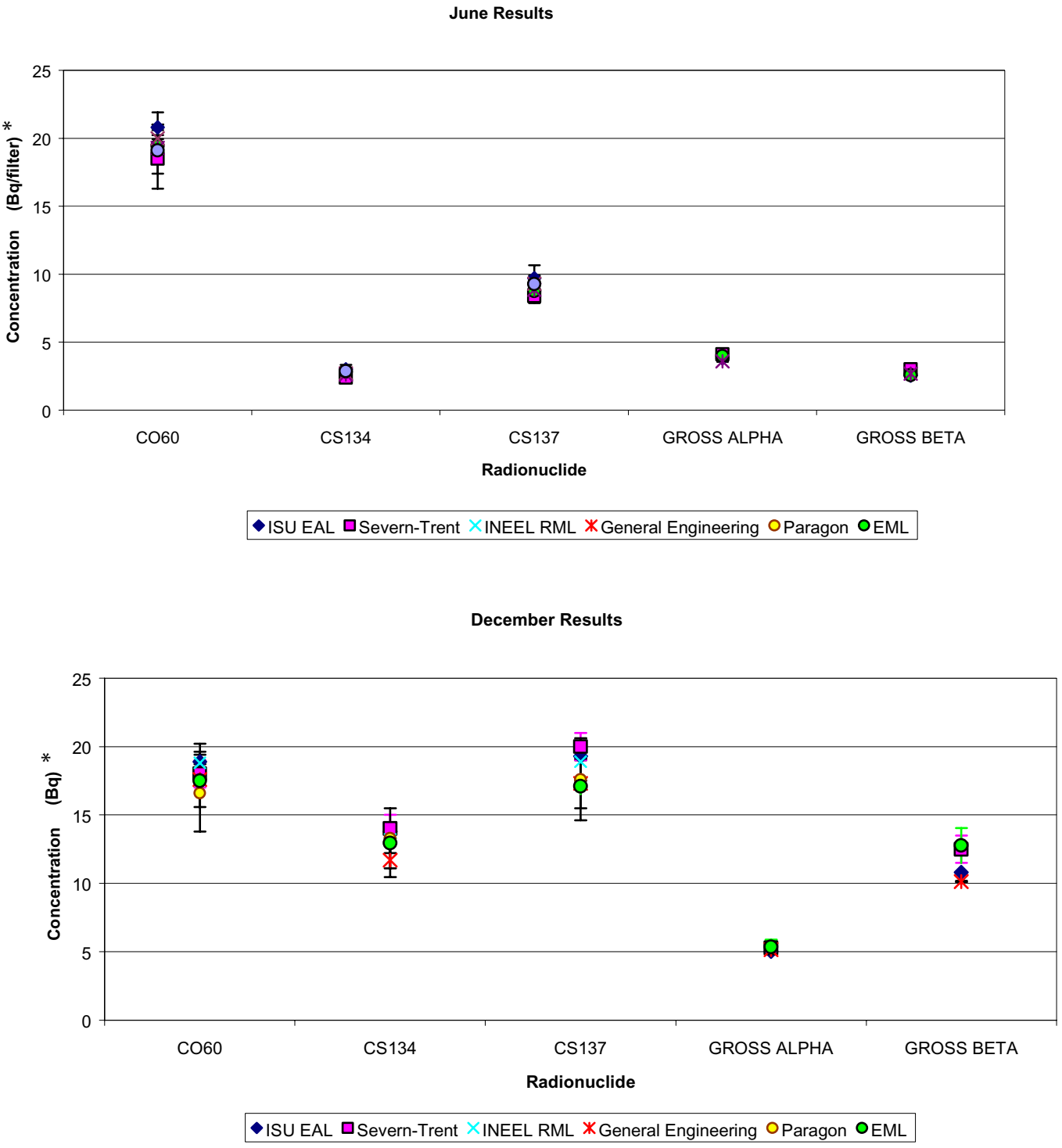
To verify the quality of the environmental dosimetry program conducted by the M&O contractor, the Operational Dosimetry Unit participates in International Environmental Dosimeter Intercomparison Studies. The Operational Dosimetry Unit's results have been within ± 30 percent of the test exposure values on all intercomparisons. Quality control of the environmental dosimetry program is maintained through internal check measurements every month.

Other Programs

INEEL contractors participate in additional performance evaluation programs, including those administered by the International Atomic Energy Agency, the Environmental Protection Agency (EPA), 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.

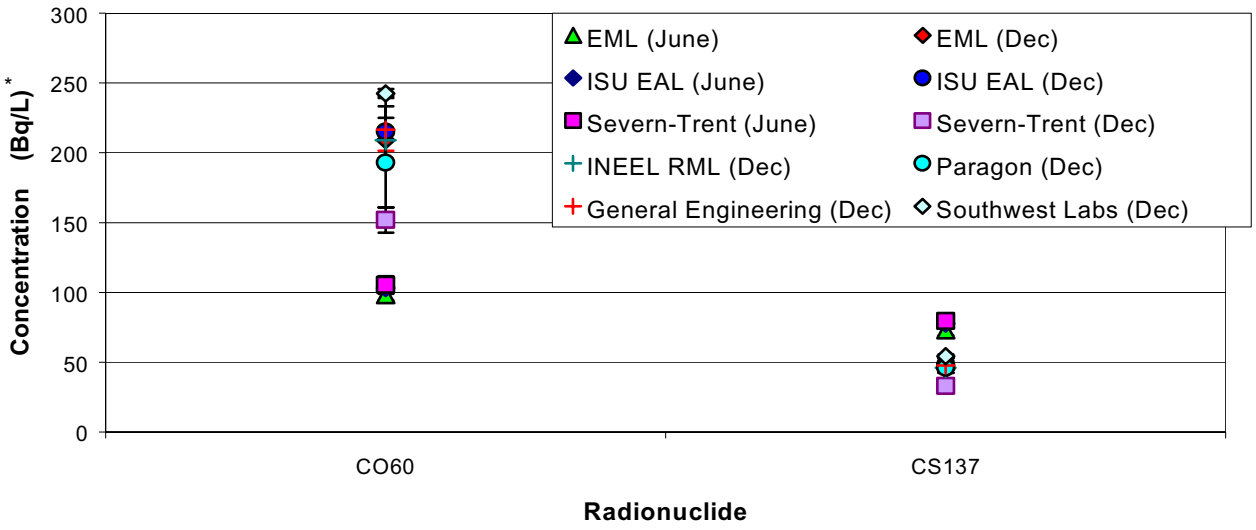
8.3. DATA PRECISION AND VERIFICATION

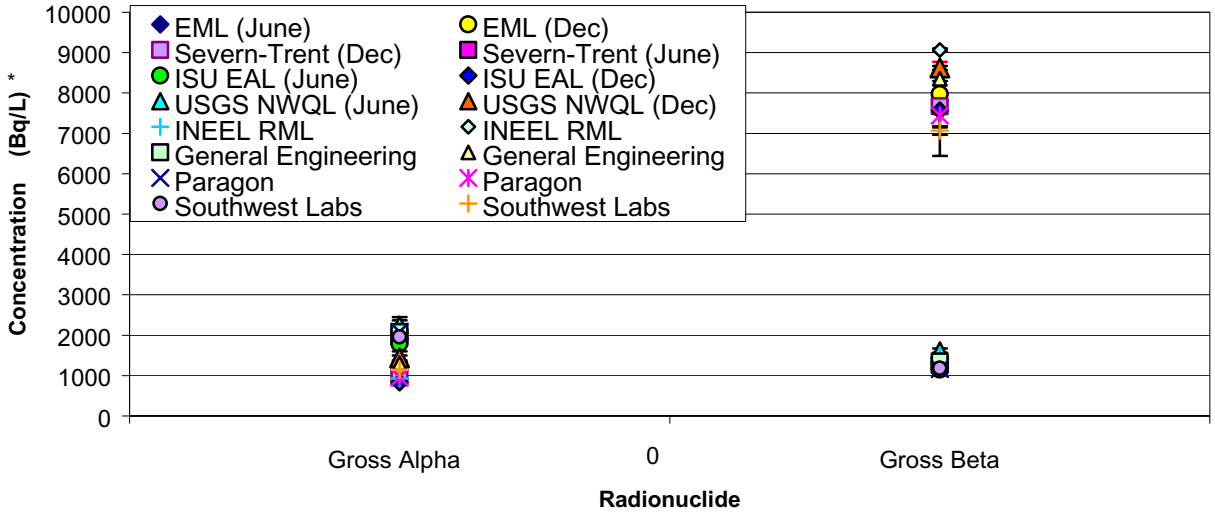
As a measure of the quality of data collected, the ESER contractor, the M&O contractor, the USGS, and other contractors



* EML reports data in SI units (Bq). To convert to pCi, multiply Bq by 27.

Figure 8-1. Surveillance contractor labs air sampling results from the EML intercomparison (2001).





* EML reports data in SI units (Bq). To convert to pCi, multiply Bq by 27.

Figure 8-2. Surveillance contractor labs water sampling results from the EML intercomparison (2001).

performing monitoring use a variety of quality control samples of different media. Quality control samples include blind spike samples, duplicate samples, and split samples.

Blind Spikes

Groups performing environmental sampling use blind spikes to assess the accuracy of the laboratories used for analysis. Contractors purchase samples spiked with known amounts of radionuclides or nonradioactive substances from suppliers who are traceable to the NIST. These samples are then submitted to the laboratories with regular field samples, with the same labeling and sample numbering system. The analytical results are expected to compare to the known value within a set of performance limits.

Duplicate Sampling within Organizations

Monitoring organizations also collect a variety of quality control samples as a measure of the precision of sampling and analysis activities. One type is a duplicate sample, where two samples are taken from a single location at the same time. A second type is a split sample, where a single sample is taken and later divided into two portions that are analyzed separately. Contractors specify in quality assurance plans relative differences expected to be achieved in reported results for both types of quality assurance samples.

Both the ESER contractor and the M&O contractor maintained duplicate air samplers at two locations during 2001. The ESER contractor operated duplicate samplers at the locations in Arco and Howe. The M&O contractor duplicate samplers were located at the Test Area North (TAN) and the Central Facilities Area (CFA). Filters from these samplers were collected and analyzed in the same manner as filters from regular air samplers. Graphs of gross beta activity for the duplicate samplers are shown in Figures 8-3 and 8-4.

Duplicate Sampling between Organizations

Another measure of data quality can be made by comparing data collected simultaneously by different organizations. The ESER contractor, the M&O contractor, and the state of Idaho's INEEL Oversight Program collected air monitoring data throughout 2001 in conjunction with the INEEL at four sampling locations: the distant locations of Craters of the Moon National Monument and Idaho Falls; and on the INEEL at the Experimental Field Station and Van Buren Boulevard. Data from these sampling locations for gross beta are shown in Figure 8-5.

The ESER contractor also collects semiannual samples of drinking and surface water jointly with the INEEL Oversight Program at five locations in the Magic Valley area. Table 8-1 contains results of the gross alpha, gross beta, and tritium analyses for the 2001 samples taken from these locations.

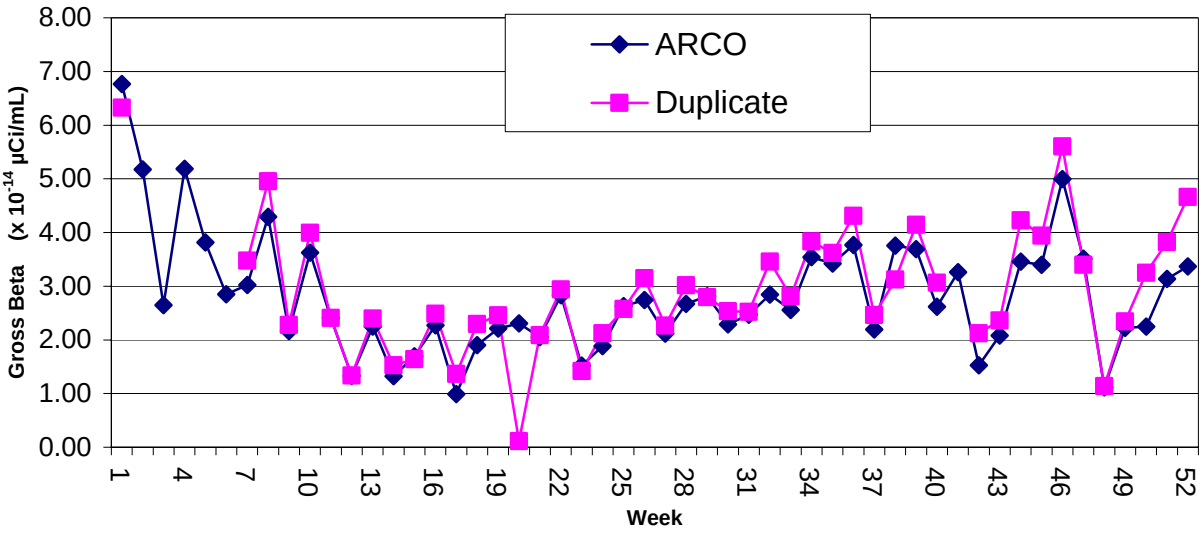
The USGS also collects groundwater samples simultaneously with the INEEL Oversight Program on a routine basis. Results from this sampling are regularly documented in reports prepared by the two organizations.

8.4. PROGRAM QUALITY ASSURANCE

Liquid Effluent Program Quality Assurance/Quality Control

The M&O contractor's Liquid Effluent Monitoring Program has specific quality assurance/quality control objectives for monitoring data. Goals are established for accuracy, precision, and completeness, and all analytical results are validated following standard EPA protocols. This section applies to all groundwater and effluent monitoring.

Performance evaluation (PE) samples (submitted as field blind spikes) are required to assess analytical data accuracy. At a minimum, PE samples are required



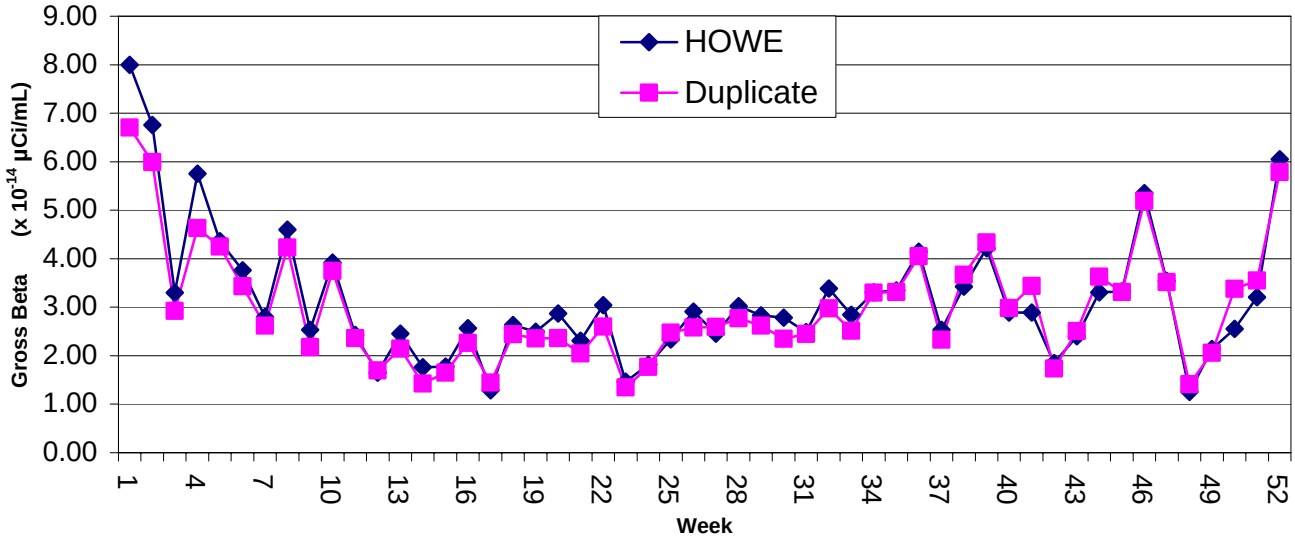


Figure 8-3. ESER contractor duplicate air sampling gross beta results (2001).

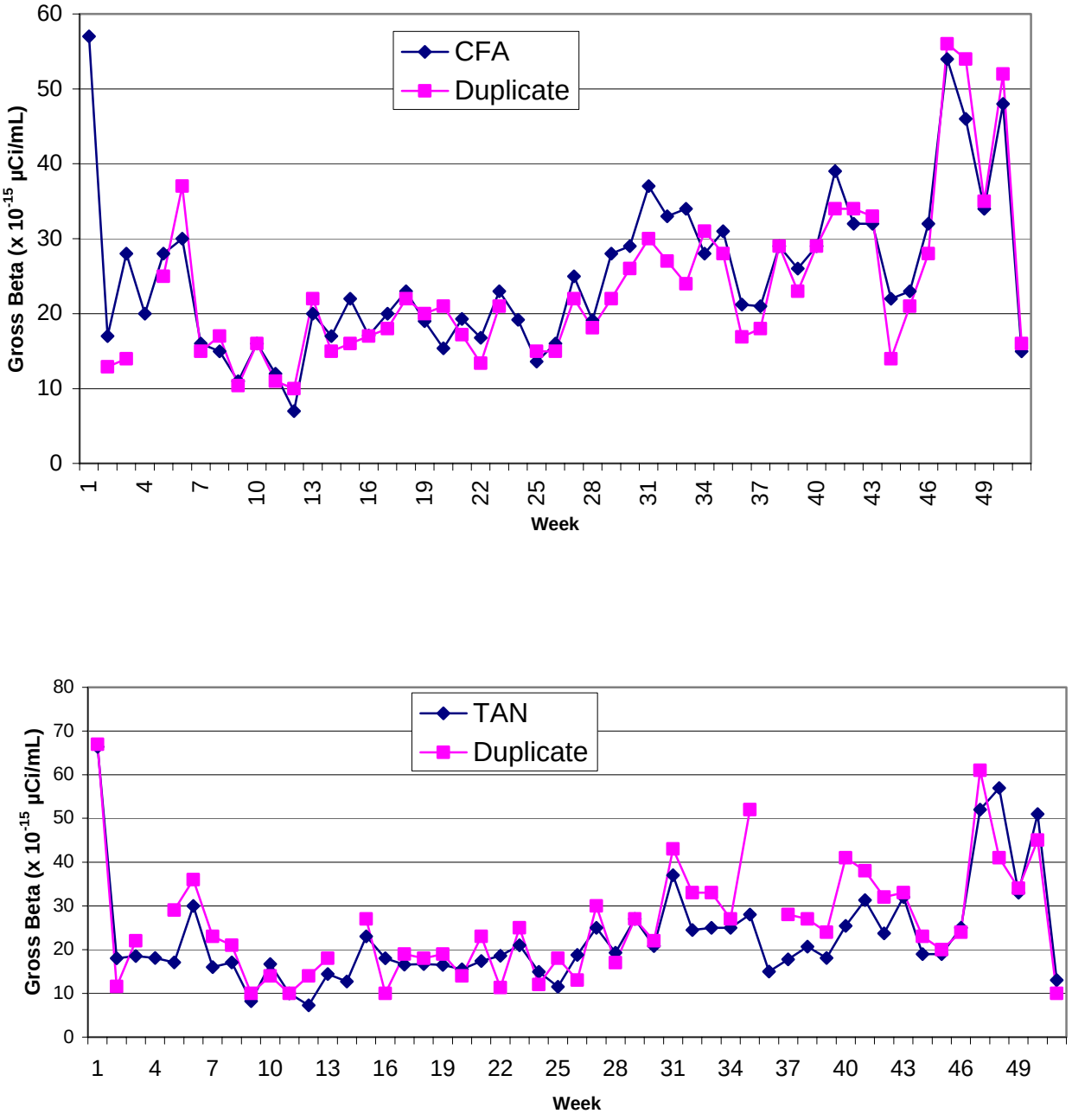


Figure 8-4. M&O contractor duplicate air sampling gross beta results (2001).

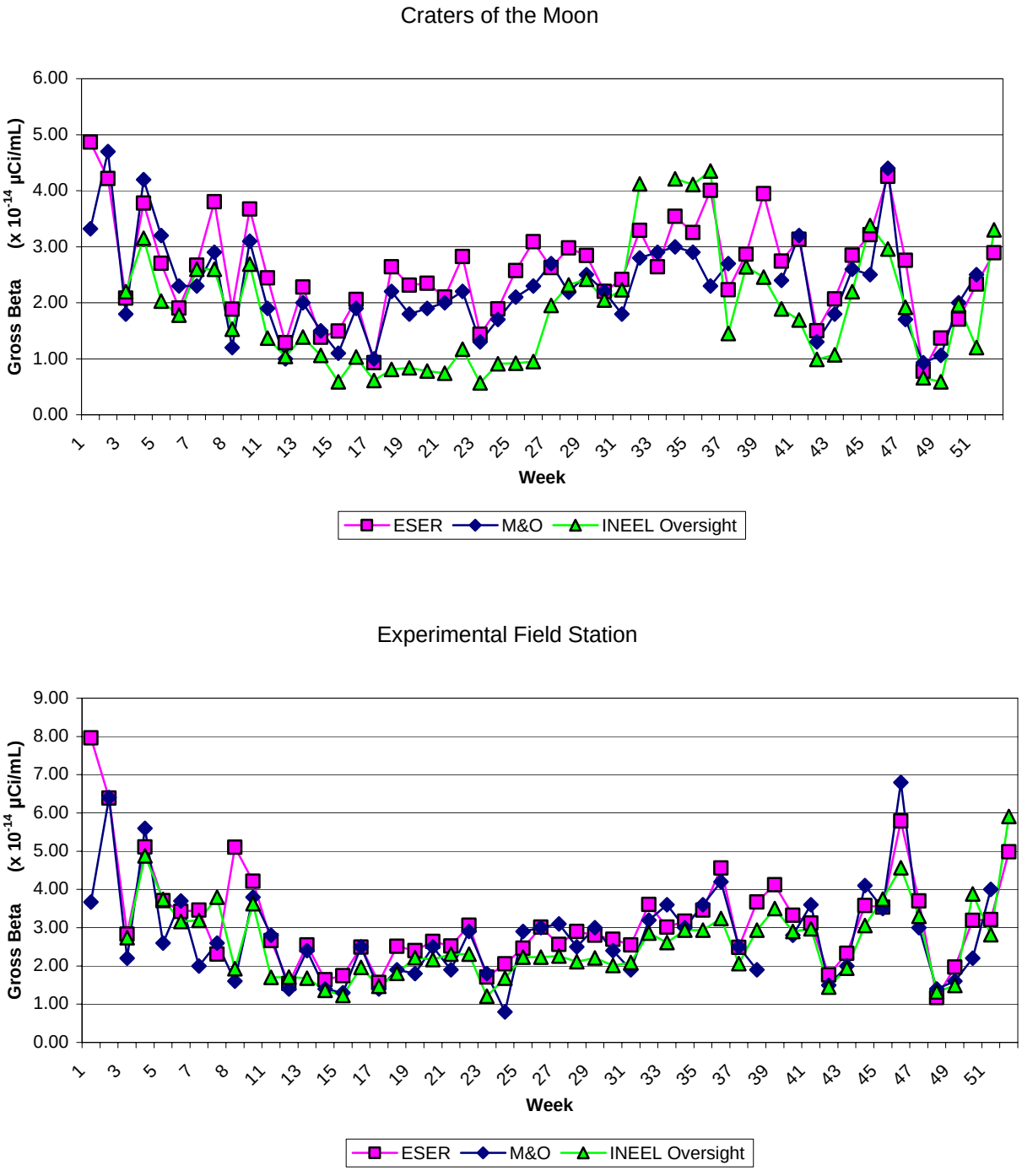


Figure 8-5. Comparison of gross beta concentrations measured by ESER contractor, M&O contractor, and state of Idaho (2001).

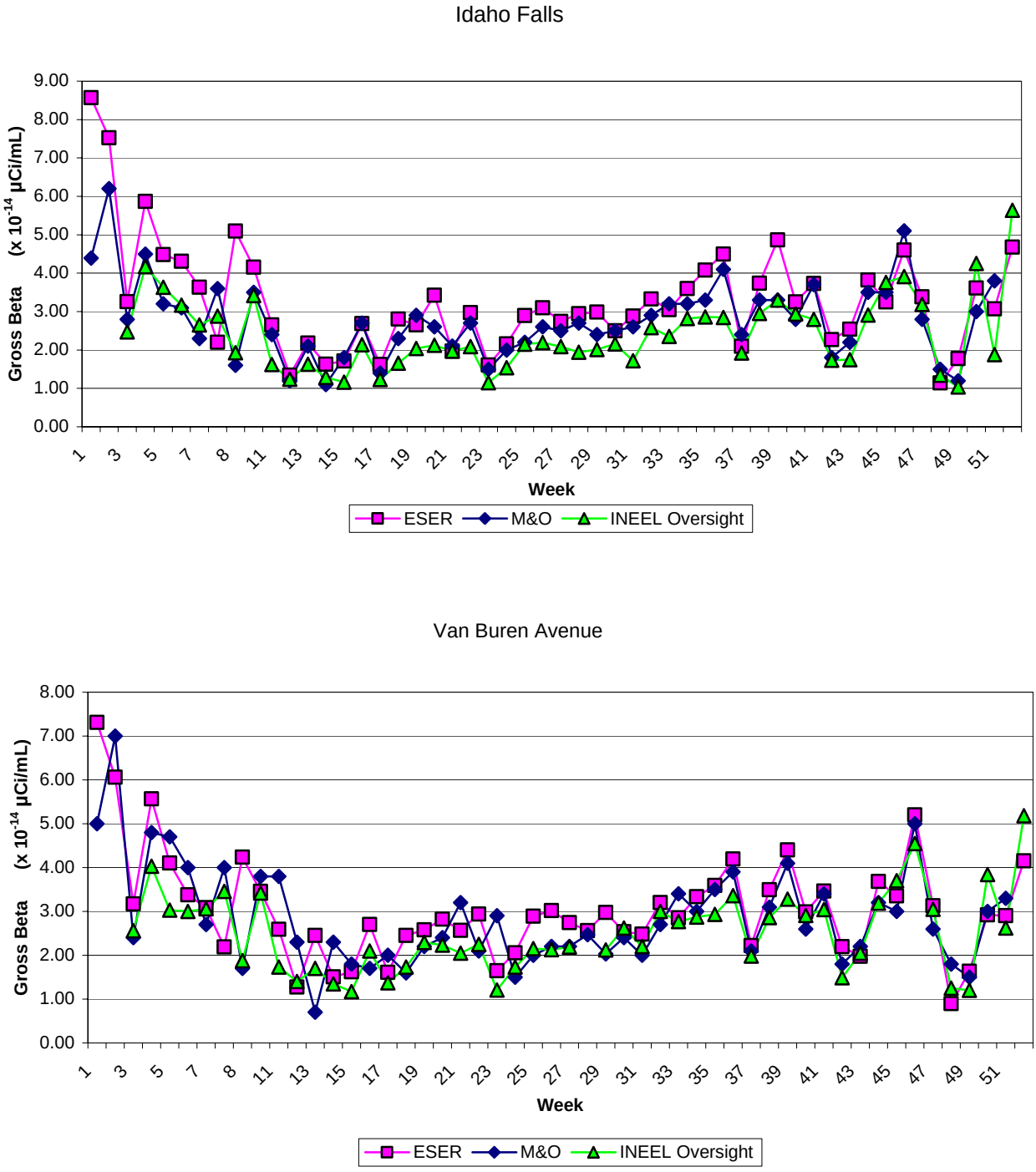


Figure 8-5. Comparison of gross beta concentrations measured by ESER contractor, M&O contractor, and state of Idaho (2001) [Continued].

Table 8-1. Comparison of ESER and INEEL Oversight Program water monitoring results (2001).[a]

Location	Date	Gross Alpha (pCi/mL)		Gross Beta (pCi/mL)		Tritium (pCi/mL)	
		ESER	State	ESER	State	ESER	State
Drinking Water							
Atomic City	05/01	0.75 ± 0.74	2.2 ± 1.6	3.75 ± 1.70	2.6 ± 0.6	-16.76 ± 72.02	40 ± 80
	11/01	0.91 ± 0.87	-0.2 ± 1.8	2.23 ± 1.68	3 ± 0.9	136.97 ± 64.50	120 ± 90
Minidoka	05/01	-0.10 ± 0.59	-0.1 ± 1.7	2.72 ± 1.75	3.5 ± 0.7	86.40 ± 70.08	-10 ± 80
	11/01	0.37 ± 0.81	0.5 ± 0.8	2.98 ± 1.74	1.3 ± 0.7	72.84 ± 64.50	0 ± 90
Mud Lake	05/01	0.01 ± 0.29	0.5 ± 1.3	4.65 ± 1.59	5.5 ± 0.8	12.44 ± 70.55	-30 ± 80
	11/01	0.12 ± 0.55	1.3 ± 1.3	3.70 ± 1.67	5.3 ± 0.9	-144.69 ± 60.21	30 ± 90
Shoshone	05/01	0.69 ± 0.77	0.8 ± 2.4	3.62 ± 1.80	2.8 ± 0.9	233.50 ± 71.39	40 ± 57
	11/01	0.67 ± 0.86	3.0 ± 1.0	3.59 ± 1.77	0.5 ± 0.7	77.39 ± 59.63	40 ± 90
Bill Jones Hatchery	05/01	0.08 ± 0.59	3.5 ± 2.1	3.63 ± 1.76	4.4 ± 0.9	51.81 ± 69.55	-10 ± 80
	11/01	0.43 ± 0.79	1.7 ± 1.8	2.78 ± 1.71	3.3 ± 0.9	73.43 ± 64.51	80 ± 64
Clear Springs	05/01	1.10 ± 0.90	2.6 ± 2.5	5.49 ± 1.86	7 ± 1.1	-23.86 ± 69.35	-10 ± 80
	11/01	-0.23 ± 0.95	1.7 ± 1.7	2.42 ± 1.76	2.8 ± 1	25.88 ± 64.55	50 ± 90
Alpheus Spring	05/01	0.42 ± 0.83	-1.9 ± 3.1	6.98 ± 2.09	3.4 ± 1	33.67 ± 72.06	-10 ± 80
	11/01	0.49 ± 0.97	1.7 ±2.7	2.98 ± 1.73	4.1 ± 1.1	43.04 ± 64.71	50 ± 90

a. Values are shown as the result ± 2 standard deviations, where the standard deviation is the total uncertainty.

quarterly. During 2001, 13 sets of PE samples were submitted to the laboratory along with routine monitoring samples. During the first quarter, all PE samples submitted for total Kjeldahl nitrogen fell below the performance acceptance limits. However, the remainder of PE samples submitted for total Kjeldahl nitrogen during the year were acceptable. No other blind spike parameters submitted during the year routinely missed the performance acceptance limits. For blind spike results that fall below the performance acceptance limit, the concern is that all the associated reported concentrations could be biased in the same direction as the blind spike results and could result in an exceedance of a Permit limit. A review of the reported concentrations for all blind spike parameters that fell below the performance acceptance limit showed that there were no impacts to regulatory limits.

Relative percent difference between duplicate samples is used to assess data precision. Ninety-three percent of the relative percent differences calculated for inorganic and metals parameters and all relative percent differences for radiological parameters between duplicate sample results fell within the program goal of less than or equal to 35 percent relative percent difference between any pair of duplicate samples. For those inorganic and metal relative percent differences that exceeded the 35 percent, half of the reported analytical results were at concentrations

less than five times the method detection limit, where quantification of the analyte becomes less certain and can impact the relative percent difference.

The goal for completeness is to collect 100 percent of all required compliance samples. During the 2001 year, this goal was not met due to construction activities and inadvertently missing one total dissolved solids and chloride sample at the Idaho Nuclear Technology and Engineering Center (INTEC) Sewage Treatment Plant. Steps were taken to ensure that all required samples are collected and analyzed at all locations. No environmental consequences occurred due to the failure to collect these samples.

Validation performed on analytical results from the 2001 sampling efforts resulted in three biological oxygen demand results being rejected as unusable due to the analytical laboratory missing required hold times by an excessive amount.

No other sampling or validation issues were identified during the year.

Wastewater Land Application Permit Groundwater Monitoring Quality Assurance/ Quality Control.

The groundwater sampling activities associated with Wastewater Land Application Permit compliance sampling follow established procedures and analytical methodologies.

During 2001, 246 groundwater samples, which yielded 424 parameter results, were collected from the INTEC and TAN Wastewater Land Application Permit monitoring wells for compliance sampling. In addition, 58 quality control samples were collected. One hundred percent of the samples required for permit compliance were collected (meeting project data completeness goals), and only five parameter results (less than 2 percent of the total) were rejected as unusable during data validation due to laboratory errors.

Field quality control samples were collected or prepared during the sampling activity in addition to regular groundwater samples. Laboratories qualified by the INEEL Sample Management Office performed all M&O wastewater and groundwater analyses during 2001. Because TAN and INTEC are regarded as separate sites, quality control samples (duplicate samples, field blanks, and equipment blanks) were prepared for each site. One duplicate groundwater sample was collected for every 20 samples collected or, at a minimum, 5 percent of the total number of samples collected. Duplicates were collected using the same sampling techniques and preservation requirements as regular groundwater samples. Field blanks were collected at the same frequency as the duplicate samples, and they were prepared by pouring deionized water into the prepared bottles at the sampling site. Equipment blanks (rinsates) were collected from the sample port manifold after decontamination and before subsequent use, also using deionized water.

Duplicate samples are collected to assess the potential for any bias introduced by analytical laboratories. Duplicates have precision goals within 35 percent, as determined by the relative percent difference measured between the paired samples. For all duplicate analyses, 68 out of 71 total pairs (96 percent) had relative percent differences less than 35 percent. This high percentage of acceptable duplicate results indicates little problem with laboratory contamination and good overall precision.

Field blanks and equipment blanks are collected to assess the potential introduction of contaminants during sampling and decontamination activities. For most chemical constituents, results above two times the method detection limit are identified as suspected contamination. Results from the field blanks and rinsates did not indicate field contamination or improper decontamination procedures.

Results from the duplicate, field blank, and rinsate samples indicate that field sampling procedures, decontamination procedures, and laboratory procedures have been used effectively to produce high quality data.

Storm Water Monitoring Quality Assurance/ Quality Control

The two samples at the RWMC were collected as unfiltered grab samples. No trip blanks or duplicate samples were collected. Sample containers and preservation methods were used according to internal procedures. The data were reviewed according to internal procedures.

Visual examination reports were checked for accuracy against logbook entries prior to submittal to the industrial storm water coordinator.

Drinking Water Program Quality Assurance/ Quality Control

The Drinking Water Program's completeness goal is to collect, analyze, and verify 100 percent of all compliance samples. This goal was met during 2001.

The Drinking Water Program requires that 10 percent of the samples collected for each analysis type be quality assurance/quality control samples to include duplicates, field blanks, trip blanks, blind spikes, and splits. This goal was met in 2001 for all parameters.

The Drinking Water Program's precision goal states that the relative percent difference determined from duplicates must be 35 percent or less for 90 percent of all duplicates. All relative percent differences calculated from a sample and its duplicate were less than the required 35 percent (for those with both results detected). Relative percent differences were not calculated if either the sample or its duplicate were reported as nondetects.

Waste Management Surveillance Program Quality Assurance/Quality Control

The M&O contractor analytical laboratories analyzed all Waste Management Surveillance Program (WMSP) samples as specified in the statements of work. These laboratories participate in a variety of intercomparison quality assurance programs, which verify all the methods used to analyze environmental samples. The programs include the DOE EML QAP and the EPA Environmental Measurements Systems Laboratory Quality Assurance Program. The laboratories met the performance objectives specified by the EML and Environmental Measurements Systems Laboratory.

The WMSP met its completeness goals. Samples were collected and analyzed as planned from all available media. The WMSP submitted duplicate, blank, and control samples with routine samples for analyses. Quality assurance/quality control samples were also routinely submitted with program samples and demonstrated an acceptable agreement ratio with spiked values for all radionuclides.

8.5. SUMMARY

Laboratories used by the ESER Program met their quality assurance goals in 2001. An issue was raised with the ISU EAL concerning elevated tritium levels detected in samples and blanks. A meeting was held with the ISU lab director and lab personnel to discuss the issue. As of the end of 2001 ISU was investigating the possible cause for these elevated readings.

As reported in the previous section M&O contractor quality issues were addressed with the laboratory and resolved.

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APPENDIX A

ENVIRONMENTAL STATUTES AND REGULATIONS

The following environmental statutes and regulations are applicable, in whole or in part, on the Idaho National Engineering and Environmental Laboratory (INEEL) or at the INEEL boundary.

U.S. Environmental Protection Agency (EPA), "National Primary and Secondary Ambient Air Quality Standards," 40 CFR 50, 2001.

U.S. Environmental Protection Agency, "National Emission Standards for Hazardous Air Pollutants," 40 CFR 61, 2001.

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U.S. Environmental Protection Agency, "National Interim Primary Drinking Water Regulations," 40 CFR 141, 2001.

U.S. Environmental Protection Agency, "Hazardous Waste Management System: General," 40 CFR 260, 2001.

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Executive Order 11990, "Protection of Wetlands," May 1977.

Executive Order 12580, "Superfund Implementation," January 1987.

Executive Order 12856, "Federal Compliance With Right-to-Know Laws and Pollution Prevention Requirements," August 1993.

Executive Order 12873, "Federal Acquisition, Recycling, and Waste Prevention," October 1993.

Executive Order 13101, " Greening the Government Through Waste Prevention, Recycling, and Federal Acquisition," September 1998.

The Derived Concentration Guides (DCGs) are based on the U.S. Department of Energy (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, and submersion in air. The principal standards and guides for release of radionuclides at the INEEL are those of DOE Order 5400.5, "Radiation Protection of the Public and the Environment." The DOE standard is shown in Table A-2 along with the EPA statute for protection of the public, airborne pathway only.

Table A-1. Derived concentration guides for radiation protection.

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

a. Derived concentration guides (DCGs) are from DOE Order 5400.5 and are based on an effective dose equivalent of 100 mrem/yr.
b. All values are in microcuries per milliliter (µCi/mL).
c. Based on the most restrictive alpha emitter (^{241}Am).
d. Based on the most restrictive beta emitter (^{228}Ra).
e. Submersion in a cloud of gas is more restrictive than the inhalation pathway.
f. An "m" after the number refers to a metastable form of the radionuclide.

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 (all pathways)	100[a]	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 refer to normal, planned operations and do not include accidental or unplanned releases.

Ambient air quality statutes are shown in Table A-3. Water quality statutes 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 drinking water systems in 40 CFR 141.

Table A-3. EPA ambient air quality standards.

Pollutant	**Type of Standard[a]**	**Sampling Period**	**EPA[b,c]**
Sulfur Dioxide	Secondary	3-hour average	1300
	Primary	24-hour average	365
	Primary	Annual average	80
Nitrogen Dioxide	Primary and Secondary	Annual average	100
	Secondary	24-hour average	150
Total Particulates[d]	Primary and Secondary	Annual average	50

a. National primary ambient air quality standards define levels of air quality to protect the public health. Secondary 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. All values are in micrograms per cubic meter ($\mu g/m^3$).

d. 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 public drinking water systems.

Constituent	Maximum Contaminant Levels[a]
Gross alpha	15 pCi/L
Gross beta[b]	50 pCi/L
Beta/gamma emitters	Concentrations resulting in 4 mrem total body or organ dose equivalent
Nitrate (as N)	10
Fluoride	4
Trihalomethanes (Chloroform)	0.1
Carbon Tetrachloride	0.005
Tetrachloroethylene	0.005
Toluene	1.0
1,1,1-trichloroethane	0.2
Trichloroethylene	0.005
Arsenic	0.05
Barium	2
Cadmium	0.005
Chromium	0.1
Lead	0.05
Mercury	0.002
Selenium	0.05
Silver	0.05

a. All values are in milligrams per liter (mg/L) unless otherwise noted.

b. The maximum contaminant level is established for gross beta as an exposure (4 mrem). The value shown is the screening level concentration.

APPENDIX B

STATISTICAL METHODS USED IN THE IDAHO NATIONAL ENGINEERING AND ENVIRONMENTAL LABORATORY ANNUAL SITE ENVIRONMENTAL REPORT

Relatively simple statistical procedures are used to analyze the data collected by the Idaho National Engineering and Environmental Laboratory (INEEL) Environmental Surveillance, Education and Research (ESER) program. ESER program personnel initially review field collection information and analytical results to determine whether there are clearly 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 affect on the regional environment.

Reporting Results

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, "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 (MDC). The MDC is an analytical/instrument value, determined by the laboratory before each analysis, above which there is a greater than 99.99 percent confidence that an analyte in a sample can be accurately measured. For example, in gamma spectrometric analyses, a given radionuclide is not considered detected unless the net count in the peak is greater than three times its estimated analytical uncertainty (3s). If the result lies in the range of two to three times its estimated analytical uncertainty (2s to 3s), and assuming that the result belongs to a Gaussian distribution (a bell-shaped curve), 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 higher confidence that the material was detected (or, that the radionuclide was indeed present in the sample).

A deliberate search for specific radionuclides 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. These factors are considered and included in the methods used to determine the estimated uncertainty of the measurement. Counting statistics primarily cause uncertainties in measurements near the MDC. For low concentrations near the MDC, the uncertainty in the measurement is nearly equal to the measurement itself, and the lower limit of the range of the measurement approaches "zero." As a result, such values 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 (termed a false positive). Therefore, when analytical results show a measurement very near the MDC, statistical tools, meteorological data, and INEEL release information are all considered when interpreting and evaluating the results

Statistical Tests

An example set of data are presented here to illustrate the statistical tests used to assess data collected by the ESER contractor. The dataset used are the gross beta environmental surveillance data collected from January 8, 1997 through December 26, 2001. The data were collected weekly from several air monitoring stations located around the perimeter of the INEEL and air monitoring stations throughout the Snake River Plain. The perimeter locations are termed "boundary" and the Plain locations are termed "distant." There are seven boundary locations: Arco, Atomic City, Birch Creek, FAA Tower, Howe, Monteview, and Mud Lake, and five distant locations: Blackfoot, Blackfoot Community Monitoring Station (CMS), Craters of the Moon, Idaho Falls, and Rexburg CMS. The gross beta data are of the magnitude $1E^{-15}$. To simplify the calculations and interpretation, these have been coded by multiplying each measurement by $1E^{15}$.

Only portions of the complete gross beta data set will be used. The purpose of this task is to evaluate and illustrate the various statistical procedures, and not a complete analysis of the data.

Test of Normality

The first step in any analysis of data is a test for normality. Many standard statistical tests of significance require that the data be normally distributed. The most widely used test of normality is the Shapiro-Wilk W test [Reference B-1]. The Shapiro-Wilk W test is the preferred test of normality because of its good power properties as compared to a wide range of alternative tests [Reference B-2]. If the W statistic is significant ($p<0.00001$), then the hypothesis that the respective distribution is normal should be rejected.

Graphical depictions of the data should be a part of any evaluation of normality. The following histogram (Figure B-1) presents such a graphical look along with the results of the Shapiro-Wilk W test. The data used for the illustration are the five years of weekly gross beta measurements for the Arco boundary location. The W statistic is highly significant ($p<0.0001$) indicating that the data are not normally distributed. The histogram shows that the data are asymmetrical with right skewness. This suggests that the data may be lognormally distributed. The Shapiro-Wilk W test can be used to test this distribution by taking the natural logarithms of each measurement and calculating the W statistic. Figure B-2 presents this test of lognormality. The W statistic is not significant ($p=0.8024$) indicating that the data are lognormal.

To perform parametric tests of significance such as Student's t test or One-Way Analysis of Variance (ANOVA), it is required that all data be normally (or lognormally) distributed. Therefore, if one desires to compare gross beta results of each boundary location, tests of normality must be performed before such comparisons are made. Table B-1 presents the results of the Shapiro-Wilk W test for each of the seven boundary locations.

From Table B-1, none of the locations consist of data that are normally distributed and only some of the data sets are lognormally distributed. This is a typical result and a common problem when one desires to use a parametric test of significance. When many comparisons are to be made, attractive alternatives are nonparametric tests of significance.

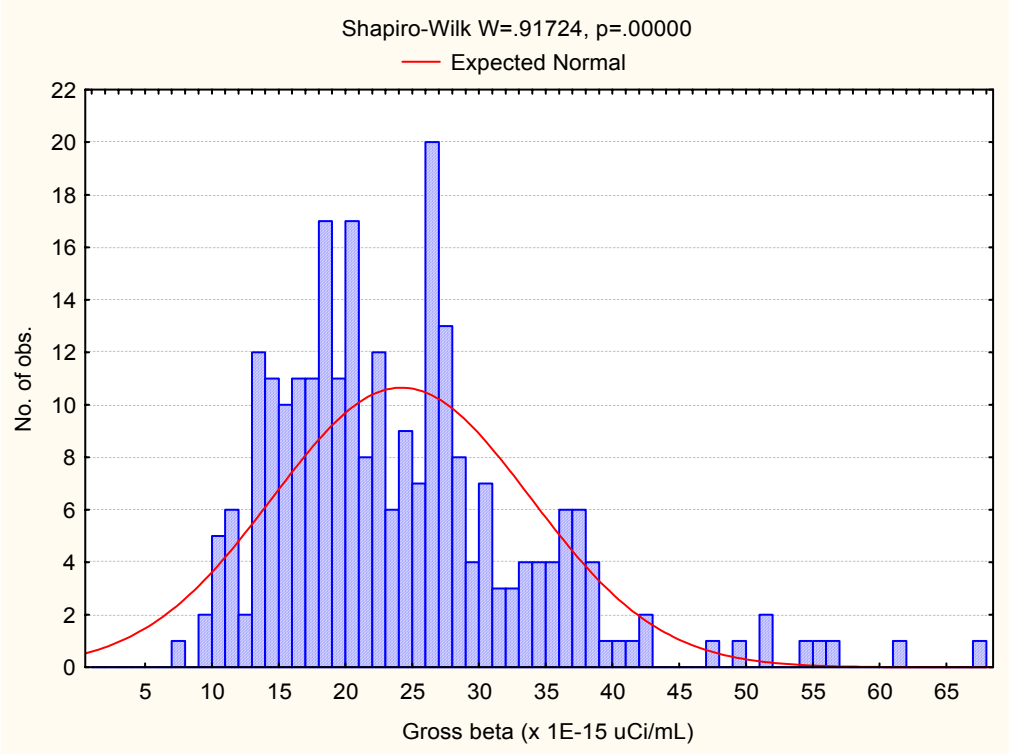

Figure B-1. Test of normality for Arco gross beta data.

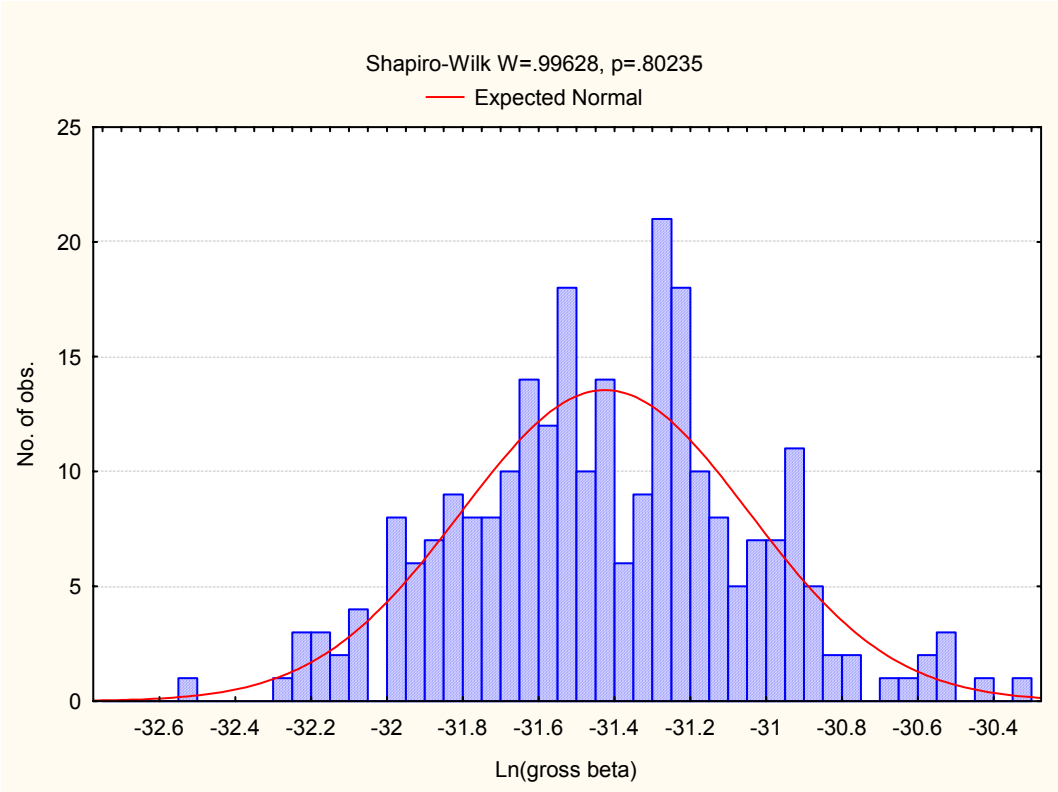

Figure B-2. Test of log normality for Arco gross beta.

Table B-1. Tests of normality for boundary locations.

Location	Normal		Lognormal	
	W statistic	p-value	W statistic	p-value
Arco	0.9172	<0.0001	0.9963	0.8024
Atomic City	0.9174	<0.0001	0.9411	<0.0001
Birch Creek	0.8086	<0.0001	0.9882	0.0530
FAA Tower	0.9119	<0.0001	0.9915	0.1397
Howe	0.8702	<0.0001	0.9842	0.0056
Monteview	0.9118	<0.0001	0.9142	<0.0001
Mud Lake	0.6130	<0.0001	0.9704	<0.0001

Comparison of Two Groups

For comparison of two groups, the Mann-Whitney U test [Reference B-3) is a powerful nonparametric alternative to the Student's t test. In fact, the U test is the most powerful (or sensitive) nonparametric alternative to the t test for independent samples; in some instances it may offer even greater power to reject the null hypothesis than the t test. The interpretation of the Mann-Whitney U test is essentially identical to the interpretation of the Student's t test for independent samples, except that the U test is computed based on rank sums rather than means. Because of this fact, outliers do not present the serious problem that they do when using parametric tests.

Suppose we wish to compare all boundary locations to all distant locations. Figure B-3 presents the box plots for the two groups. The median is the measure of central tendency most commonly used when there is no assumed distribution. It is the middle value when the data are ranked from smallest to largest. The 25th and 75th percentiles are the values such that 75 percent of the measurements in the data set are greater than the 25th percentile and 75 percent of the measurements are less than the 75th percentile. The large distance between the medians and the maximums seen in Figure B-3 indicate the presence of outliers. It is apparent that the medians are of the same magnitude indicating graphically that there is probably not a significant difference between the two groups.

Outliers and extreme values are atypical, infrequent observations; data points which are far from the middle of the distribution of data. Outliers are defined mathematically as values that are equal to 1.5 times the height of the box in a box plot, above or below the box. Extreme values are equal to 2 times the height of the box, above or below the box. Outliers and extreme values may reflect inherent variability, or may be due to errors associated with transcription, measurement or other anomalies.

The Mann-Whitney U test compares the rank sums between the two groups. In other words, for both groups combined, it ranks the observations from smallest to largest. Then it calculates the sum of the ranks for each group and compares these rank sums. A significant p-value ($p<0.05$) indicates a significant difference between the two groups. The p-value for the

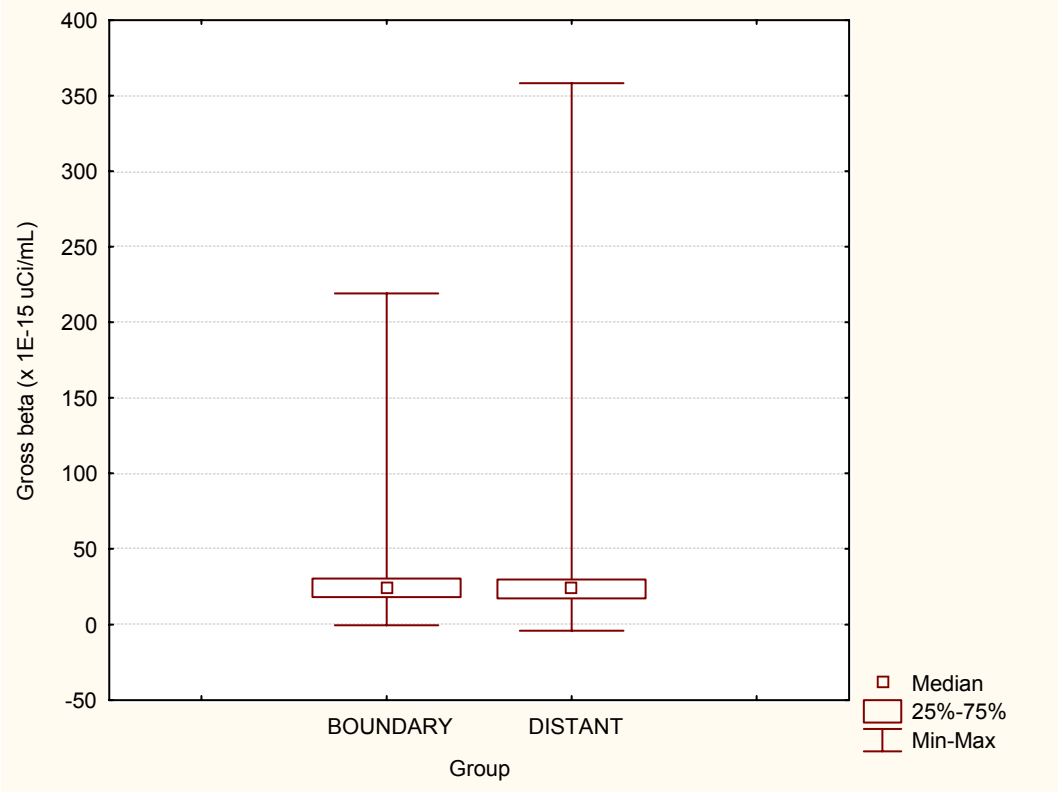

Figure B-3. Box plot of gross beta data from boundary and distant locations.

comparison of boundary and distant locations is not significant (p=0.0599). Therefore, the conclusion is that there is not strong enough evidence to say that a significant difference exists between boundary and distant locations.

Comparison of Many Groups

Now suppose we wish to compare the boundary locations amongst themselves. In the parametric realm, this is done with a One-Way ANOVA. A nonparametric alternative to the One-Way ANOVA is the Kruskal-Wallis ANOVA [Reference B-3]. The test assesses the hypothesis that the different samples in the comparison were drawn from the same distribution or from distributions with the same median. Thus, the interpretation of the Kruskal-Wallis ANOVA is basically identical to that of the parametric One-Way ANOVA, except that it is based on ranks rather than means.

Figure B-4 presents the box plot for the boundary locations. The Kruskal-Wallis ANOVA test statistic is highly significant ($p<0.0001$) indicating a significant difference amongst the seven boundary locations. Table B-2 gives the number of samples, medians, minimums, and maximums for each boundary location. The Kruskal-Wallis ANOVA only indicates that significant differences exist between the seven locations and not the individual occurrences of differences. If desired, the next step is to identify pairs of locations of interest and test those for significant differences using the Mann-Whitney U test. It is cautioned that all possible pairs should not be tested, only those of interest. As the number of pairs increases, the probability of a false conclusion also increases.

Suppose a comparison between Arco and Atomic City is of special interest due to their close proximity to each other. A test of significance using the Mann-Whitney U test

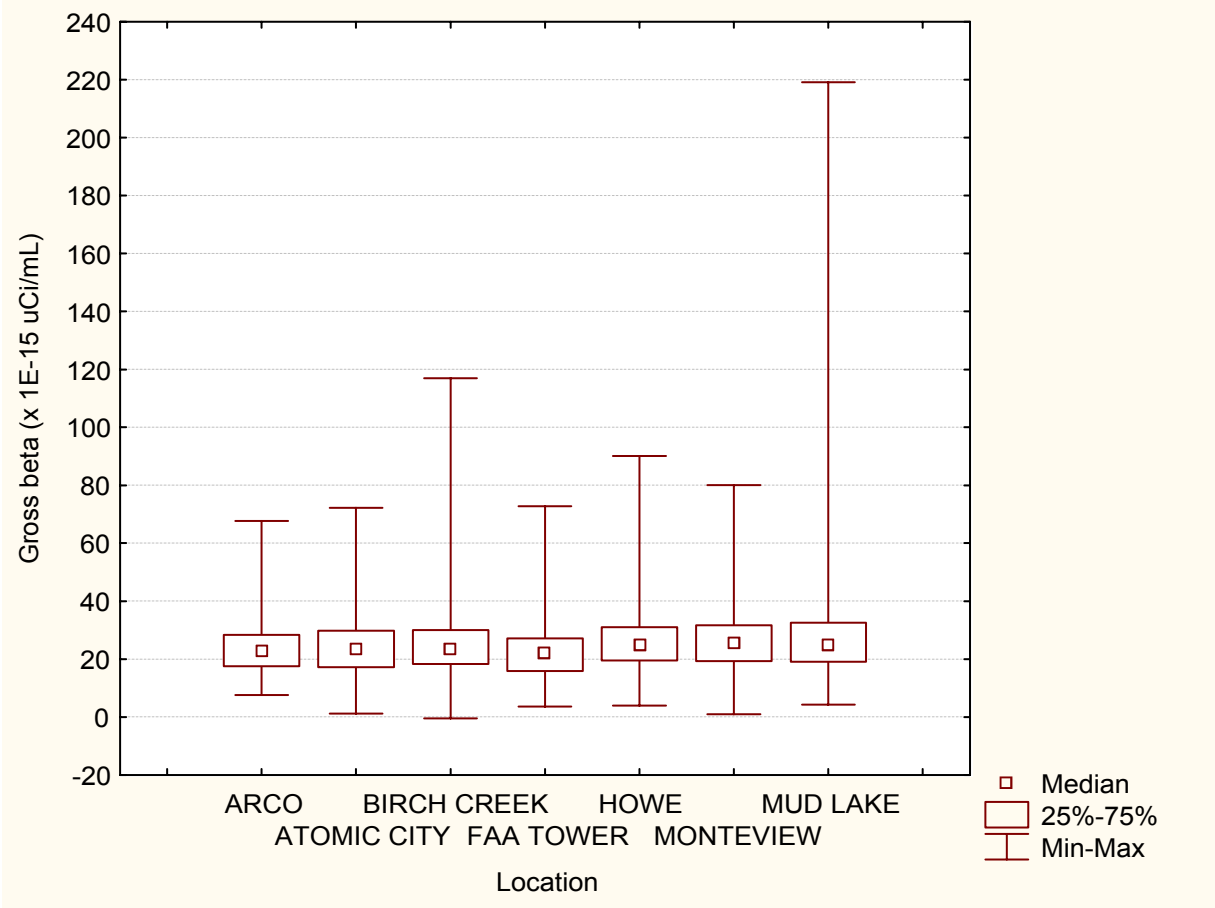

Figure B-4. Box plot of gross beta data for each boundary location.

Table B-2. Summary statistics for boundary locations.

Location	Number of Samples	Median	Minimum	Maximum
Arco	258	22.49	7.53	67.66
Atomic City	260	23.61	1.13	72.20
Birch Creek	234	23.15	-0.52	117.00
FAA Tower	260	21.90	3.59	72.78
Howe	260	24.55	3.95	90.10
Monteview	260	25.30	1.03	80.10
Mud Lake	260	24.85	4.30	219.19

a. All values are × 10^{-15} microcuries per milliliter (µCi/mL).

results in a p-value of 0.7288 indicating that a significant difference does not exist between gross beta results at Arco and Atomic City. Other pairs can similarly be tested, but with the caution given above.

Tests for Trends over Time

Regression analysis is used to test whether or not there is a significant positive or negative trend in gross beta concentrations over time. To illustrate the technique, the regression analysis is performed for the boundary locations as one group and the distant locations as another group. The tests of normality performed earlier indicated that the data were closer to lognormal than normal. For that reason, the natural logarithms of the original data are used in the regression analysis. Regression analysis assumes that the probability distributions of the dependent variable (gross beta) have the same variance regardless of the level of the independent variable (collection date). The natural logarithmic transformation helps in satisfying this assumption.

Figure B-5 presents a scatterplot of the boundary data with the fitted regression line superimposed. Figure B-6 presents the same for the distant data. Table B-3 gives the regression equation and associated statistics. There appears to be slightly increasing trends in gross beta over time for both the boundary and distant locations. A look at the regression equations and correlation coefficients in Table B-3 confirm this. Notice that the slope parameter of the regression equation and the correlation coefficient are equal. This is true for any linear regression fit. So, a test of significant correlation is also a test of significant trend. The p-value associated with testing whether or not the correlation coefficient is different from zero is the same as for testing if the slope of the regression line is different from zero. For both the boundary and distant locations, the slope is significantly different from zero and positive indicating an increasing trend in gross beta over time.

Another important point of note in Figures B-5 and B-6 is the obvious existence of a cyclical trend in gross beta. It appears as if the gross beta measurements are highest in the summer months and lowest in the winter months. Since the regression analysis performed above is over several years, we are still able to detect a positive trend over time even though it is confounded somewhat by the existence of a cyclical trend. This is important because a linear regression analysis performed over a shorter time period may erroneously conclude a significant trend, when in fact, it is just a portion of the cyclical trend.

Comparison of Slopes

A comparison of slopes between the regression lines for the boundary locations and distant locations will indicate if the rate of change in gross beta over time differs with location. The comparison of slopes can be performed by constructing 95 percent confidence intervals about the slope parameter [Reference B-4]. If these intervals overlap, we can conclude that there is no evidence to suggest a difference in slopes for the two groups of locations.

A confidence interval for the slope is constructed as

$$b - t_{0.025,n-2} s_b \le \beta \le b + t_{0.025,n-2} s_b$$

where

b = point estimate of the slope

$t_{0.025,n-2}$ = the Student's t-value associated with two-sided 95 percent confidence and n-2 degrees of freedom

s_b = the standard deviation of the slope estimate, b

β = the true slope, which is unknown.

Table B-4 gives the values used in constructing of the confidence intervals and the resulting confidence intervals. As seen in the fifth column of Table B-4, the confidence intervals for the slope overlap

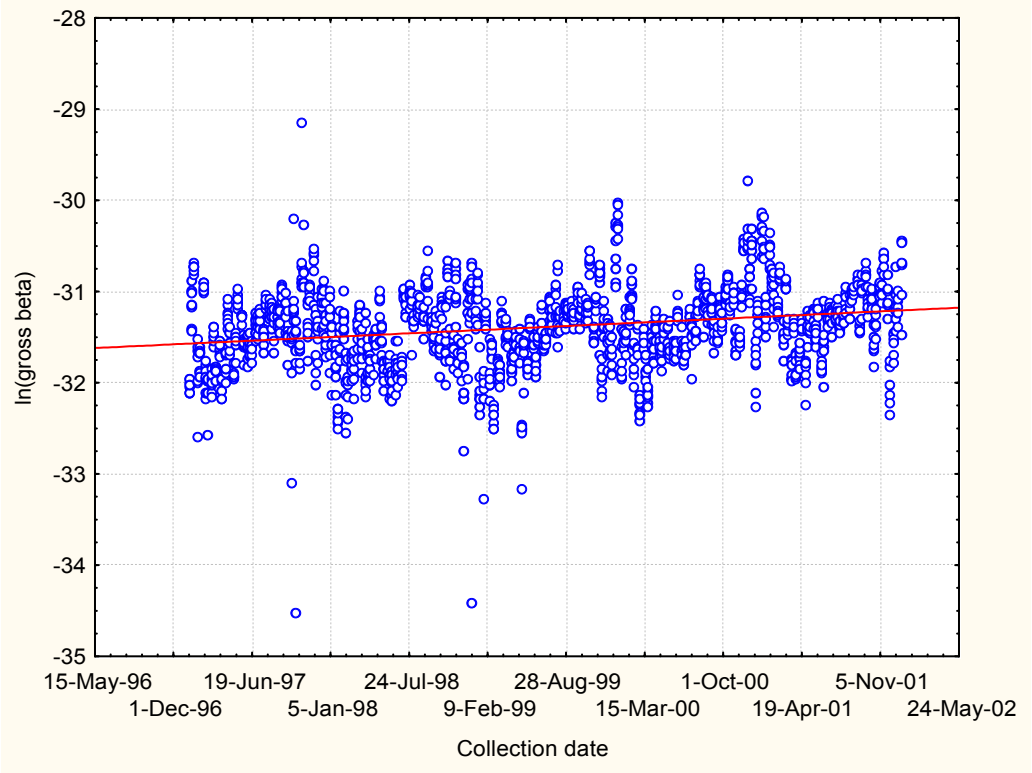

Figure B-5. Scatter plot and regression line for ln(gross beta) from boundary locations.

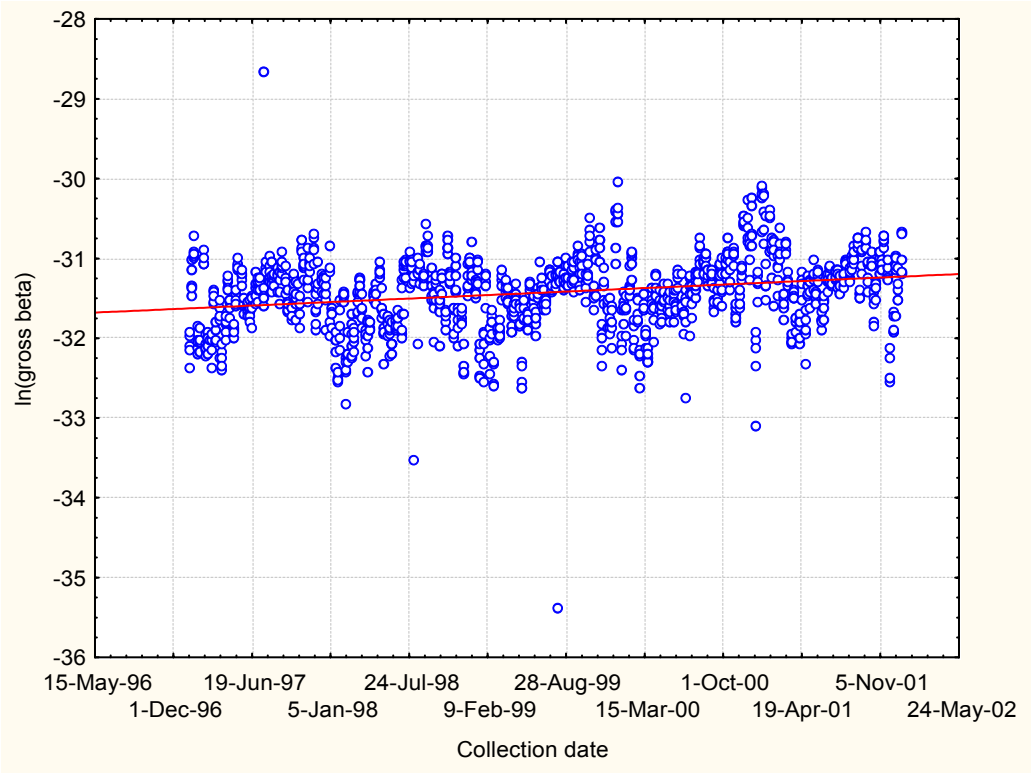

Figure B-6. Scatter plot and regression line for ln(gross beta) from distant locations.

Table B-3. Regression equations and associated statistics for boundary and distant locations.

Sample Group	Regression Equation	Correlation Coefficient	p-value
Boundary	ln(gross beta) = -38.7 + 0.245×(date)	0.245	<0.0001
Distant	ln(gross beta) = -39.4 + 0.253×(date)	0.253	<0.0001

Table B-4. Ninety-five percent confidence intervals on the true slope.

Sample group	b	z[a]	s_b	95% C.I.[b]
Boundary	0.245	1.96	0.0229	[0.200, 0.290]
Distant	0.253	1.96	0.0269	[0.200, 0.306]

a. For large sample sizes, the standard normal z-value is used instead of the Student's t-value.

b. C.I. = confidence interval.

and we can conclude that there is no difference in the rate of change in gross beta measurements for the two location groupings, boundary and distant.

APPENDIX C

U.S. GEOLOGICAL SURVEY 2001 INEEL PUBLICATION ABSTRACTS

Chemical And Radiochemical Constituents In Water From Wells In The Vicinity Of The Naval Reactors Facility, Idaho National Engineering and Environmental Laboratory, Idaho, 1999 **[Reference C-1]**

The U.S. Geological Survey, in response to a request from the U .S. Department of Energy's Pittsburgh Naval Reactors Office, Idaho Branch Office, sampled water from 13 wells during 1999 as part of a long-term project to monitor water quality of the Snake River Plain aquifer in the vicinity of the Naval Reactors Facility, Idaho National Engineering and Environmental Laboratory, Idaho. Water samples were analyzed for naturally occurring constituents and anthropogenic contaminants. A total of 52 samples were collected from the 13 monitoring wells. The routine samples contained detectable concentrations of total cations and dissolved anions, and nitrite plus nitrate as nitrogen. Most of the samples also contained detectable concentrations of gross alpha- and gross beta-particle radioactivity and tritium. Eight quality-assurance samples also were collected and analyzed; four were field-blank samples, and four were replicate samples. Most of the field blank samples contained less-than-detectable concentrations of target constituents.

Chemical Composition of Selected Solid Phase Samples from the Snake River Plain Aquifer System and Contributing Drainages, Eastern Idaho and Western Wyoming **[Reference C-2]**

This report presents chemical compositions determined from 25 solid-phase samples from the eastern Snake River Plain aquifer system and contributing drainages. Seven samples were collected at selected depths from 6 coreholes located on or near the Idaho National Engineering and Environmental Laboratory, Idaho, and from 18 outcrops in the recharge areas of the Snake River Plain aquifer. The U.S. Geological Survey, in cooperation with the U.S. Department of Energy – Idaho Operations Office, prepared this report.

Ten major elements, as many as 28 trace elements, and the amount of volatile material were determined for each sample by inductively coupled plasma-atomic emission spectroscopy, instrumental neutron activation analysis, loss on ignition, or ion-selective electrode potentiometry.

Geochemistry Of The Big Lost River Drainage System, Idaho **[Reference C-3]**

The U.S. Geological Survey and Idaho State University, in cooperation with the U.S. Department of Energy, are conducting studies to describe the chemical character of ground water that moves as underflow from drainage basins into the Snake River Plain aquifer (SRPA) system at and near the Idaho National Engineering and Environmental Laboratory (INEEL) and the effects of these recharge waters on the geochemistry of the SRPA system. Each of these recharge waters has a hydrochemical character related to geochemical processes, especially water-rock interactions that occur during migration to the SRPA. Results of these studies will benefit ongoing and planned geochemical modeling of the SRPA at the INEEL by providing model input on the hydrochemical character of water from each drainage basin.

For this study, water samples were collected from 10 wells in the Big Lost River drainage basin during 1999 and analyzed for selected inorganic constituents, dissolved organic carbon, stable isotopes, tritium, and selected gross measurements of radioactivity. One additional sample was

collected as a quality-assurance replicate. Results show that water from the Big Lost River drainage basin has a calcium-magnesium bicarbonate character. The computer code NETPATH was used to evaluate geochemical mass-balance reactions in the Big Lost River basin. Chemical reactions of water with calcite, dolomite, and carbon dioxide gas were considered the dominant reactions. The Arco City well is the farthest downgradient well sampled in the basin, and water from this well can be geochemically modeled from water in upgradient wells. However, the Arco City well is 250 feet deep, and water from it could represent only the deep underflow into the SRPA. Water from the Owen well (114 feet deep) could better represent the shallow underflow into the SRPA; therefore, a combination of water from these two wells could represent the total underflow from the Big Lost River drainage basin into the SRPA. If a 50-percent contribution of water from both wells is assumed, Big Lost River basin recharge to the SRPA would contain 61 milligrams per liter (mg/L) calcium, 14.5 mg/L magnesium, 6.6 mg/L sodium, 1.2 mg/L potassium, 15.5 mg/L silica, 0.2 mg/L fluoride, 6.4 mg/L chloride, 232 mg/L bicarbonate, and 21.5 mg/L sulfate.

Radiochemical and Chemical Constituents in Water from Selected Wells South of the Idaho National Engineering and Environmental Laboratory, Idaho **[Reference C-4]**

The U.S. Geological Survey and the Bureau of Land Management, in cooperation with the U .S. Department of Energy, sampled water from five stock wells to monitor water quality of the Snake River Plain aquifer south of the Idaho National Engineering and Environmental Laboratory. The samples were analyzed for selected radiochemical and chemical constituents.

The concentrations of strontium-90, transuranic elements, and cesium-137 in all samples were less than the reporting level. Concentrations of tritium in four samples and concentrations of gross alpha- and beta-particle radioactivity in all samples were greater than the reporting level. Most of the inorganic-constituent concentrations were greater than the minimum reporting level so concentrations of all 63 purgeable organic compounds analyzed for were less than the respective minimum reporting levels.

Radiochemical and Chemical Constituents in Water from Selected Wells and Springs from the Southern Boundary of the Idaho National Engineering and Environmental Laboratory to the Hagerman Area, Idaho, 2000 **[Reference C-5]**

The U.S. Geological Survey and the Idaho Department of Water Resources, in cooperation with the U .S. Department of Energy, sampled water from 18 sites as part of the fifth round of a long-term project to monitor water quality of the Snake River Plain aquifer from the southern boundary of the Idaho National Engineering and Environmental Laboratory to the Hagerman area. The samples were analyzed for selected radiochemical and chemical constituents. The samples were collected from five domestic wells, eight irrigation wells, two springs, one dairy well, one stock well, and one observation well. Two quality assurance replicate samples also were collected and analyzed. Tritium analyses from 18 spring samples collected along the Snake River in the Twin Falls-Hagerman area also are presented.

None of the reported radiochemical or chemical constituent concentrations exceeded the established maximum contaminant levels for drinking water. Many of the radionuclide- and inorganic-constituent concentrations were greater than the respective minimum reporting levels. Most of the organic-constituent concentrations were less than the minimum reporting levels.

Chemical And Radiochemical Constituents In Water From Wells In The Vicinity Of The Naval Reactors Facility, Idaho National Engineering and Environmental Laboratory, Idaho, 2000 **[Reference C-6]**

The U.S. Geological Survey, in response to a request from the U .S. Department of Energy's Pittsburgh Naval Reactors Office, Idaho Branch Office, sampled water from 13 wells during 2000 as part of a long-term project to monitor water quality of the Snake River Plain aquifer in the vicinity of the Naval Reactors Facility, Idaho National Engineering and Environmental Laboratory, Idaho. Water samples were analyzed for naturally occurring constituents and anthropogenic contaminants. A total of 52 samples were collected from the 13 monitoring wells. The routine samples contained detectable concentrations of total cations and dissolved anions, and nitrite plus nitrate as nitrogen. Most of the samples also contained detectable concentrations of gross alpha- and gross beta-particle radioactivity and tritium. Eight quality-assurance samples also were collected and analyzed; four were field-blank samples, and four were replicate samples. Most of the field-blank samples contained less-than-detectable concentrations of target constituents.

Estimated Age And Source Of The Young Fraction Of Ground Water At The Idaho National Engineering and Environmental Laboratory **[Reference C-7]**

The U.S. Geological Survey, in cooperation with the U.S. Department of Energy, used concentrations of chlorofluorocarbons (CFCs), sulfur hexafluoride, helium (He), and tritium (^3H) to determine the estimated age of the young fraction of ground water at and near the Idaho National Engineering and Environmental Laboratory (INEEL). These environmental tracers were introduced into the Snake River Plain aquifer by natural recharge, return flow of irrigation water, and wastewater disposal at facilities at the INEEL. The source of the water and the fraction of young water in the samples also were used to date the ground water. The data indicate that most ground-water samples are mixtures containing young fractions of water recharged after 1950 and older regional ground water.

Data indicate that water in samples from wells in the southeastern part of the INEEL are a binary mixture of local recharge and very old regional ground water, and samples from most of the wells are about 20 to 50 percent young water that is about 14 to 21 years old. Two main mechanisms of recharge of the young fraction of ground water were recognized in samples from the northern part of the INEEL: (1) water recharged by rapid focused recharge through the thick unsaturated zone and (2) water recharged by slow infiltration through the thick unsaturated zone. Some of the wells in the northern part of the INEEL contained all old regional water. Three wells in the northeastern part of the INEEL contained water that was strongly affected by agricultural practices and likely was recharged in the Terreton-Mud Lake area. This water was present in wells 4, 27, and 29 and had estimated ages of 5, 10-13, and 24-28 years, respectively.

Water samples from wells that contained a young fraction of water that recharged in the central, western, and southwestern parts of the INEEL are complex mixtures of regional ground water, agricultural return flow, natural recharge, and artificial recharge from infiltration ponds and injection wells at the various facilities at the INEEL. The chemistry and age of the young fraction of the samples varied greatly and could be correlated with distance from the source of recharge, depth of the open interval below the water table, length of the interval sampled, and location of the well with respect to the different sources of recharge. Age increased with distance from the source of recharge and increased with depth below the water table. The young recharge water composes a very small

fraction of the total volume of water in the Snake River Plain aquifer, and this young water was sampled because most of the wells at and near the INEEL are completed in the upper 15 m of the aquifer.

Concentrations of fluoride (F), boron, lithium (Li), strontium, oxygen isotope ratios ($\delta^{18}O$), dissolved atmospheric gases, He, and ^{3}H, were used to determine the sources of water in the Snake River Plain aquifer at and near the INEEL. Three natural ground-water types were identified from their He, Li, and F concentrations: (1) northeastern regional water with very high He, Li, and F concentrations; (2) recharge from the southeast with moderate He and high Li and F concentrations; (3) recharge from mountain valleys in the western part of the INEEL with low concentrations of He and Li and high concentrations of Ca, Mg, and alkalinity. The water was modified locally by mixing with agricultural runoff and wastewater from INEEL facilities. $\delta^{18}O$ ratios were used to calculate the fraction of young water in the samples from the western part of the INEEL. Terrigenic He and ^{3}H concentrations were used to calculate the fraction of infiltration recharge at the INEEL.

A preferential ground-water flowpath that extends from the Little Lost River and Big Lost River Sinks southward through central INEEL past Big Southern Butte was identified. Flow velocities were estimated from tritium/helium ages and were about 3 m per day through the preferential flowpath. Flow velocities decreased to 1 m or less per day outside this preferential flowpath.

In areas where fractured basalts are exposed at the surface, both tritium and CFCs were present in the ground water. The presence of these constituents indicates that focused recharge of post-1950s infiltration water occurred along preferential flowpaths through the unsaturated zone. This type of recharge was recognized in many areas at and near the INEEL.

Recharge temperatures were calculated from nitrogen and argon concentrations for many of the ground-water samples and are useful indicators of the source of water in the Snake River Plain aquifer at the INEEL. Recharge temperatures of about 6 degrees Celsius (^{o}C) characterize underflow from Birch and Camas Creeks and Little Lost and Big Lost Rivers. Recharge temperatures of 9 to 13 ^{o}C were calculated for the regional ground water of the Snake River Plain aquifer at the INEEL.

Ground water near the Radioactive Waste Management Complex, the Test Reactor Area, and the Idaho Nuclear Technology and Engineering Center (INTEC) contains concentrations of CFCs that are indicative of contamination. A large CFC-12 waste plume originating near the INTEC extends beyond the southern boundary of the INEEL.

Water in wells that are cased a few tens of meters below the water table contained no halocarbons, except for water in wells downgradient from injection wells. Greater-than-atmospheric concentrations of CFCs and other halocarbons were found in soil gases obtained from a depth of 1 m as far as 20 km south of the southwest corner of the INEEL. High concentrations of halocarbons also were found in unsaturated-zone air blowing from the annulus of some wells in the southwestern part of the INEEL. The advective transport of CFCs and other halocarbons throughout the unsaturated zone probably occurs preferentially both vertically and horizontally along fractures associated with volcanic vent corridors. Barometric pumping appears to be the primary mechanism controlling the distribution of gases in the unsaturated zone in the southwestern part of the INEEL. Diffusion is the primary mechanism of gas transport in the northern and northeastern part of the INEEL in the areas that are covered by thick lacustrine and sedimentary playa deposits.

APPENDIX D

ONSITE DOSIMETER MEASUREMENTS AND LOCATIONS

Table D-1. Environmental dosimeter measurements at Argonne National Laboratory-West (ANL-W) (2001).

Location	Exposure[a]
ANL 7	143 ± 20
ANL 8	130 ± 18
ANL 9	154 ± 21
ANL 10	137 ± 19
ANL 11	137 ± 19
ANL 12	132 ± 18
ANL 13	130 ± 18
ANL 14	131 ± 18
ANL 15	166 ± 23
ANL 16	166 ± 23
ANL 17	128 ± 18
ANL 18	136 ± 19

a. All values are in milliroentgen (mR) plus or minus 2 standard deviations (± 2s).

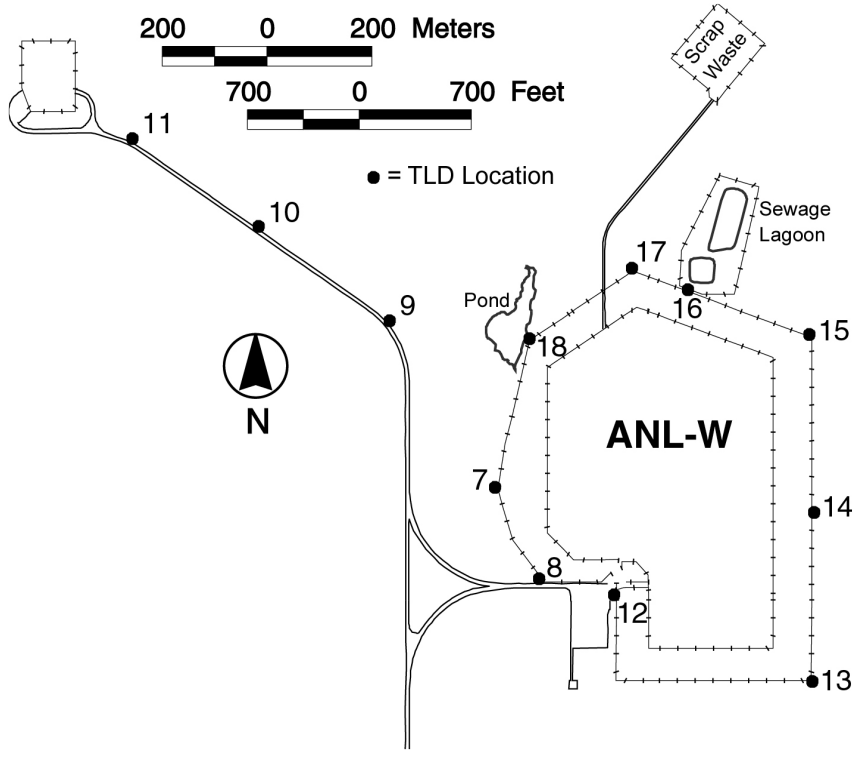

Figure D-1. Environmental dosimeter locations at ANL-W (2001).

Table D-2. Environmental dosimeter measurements at the Auxiliary Reactor Area (ARA) (2001).

Location	Exposure[a]
ARA 1	158 ± 22
ARA 2	184 ± 26
ARA 3	675 ± 121
ARA 4	[b]

a. All values are in milliroentgen (mR) plus or minus 2 standard deviations (± 2s).
b. This TLD location was eliminated due to D&D activities.

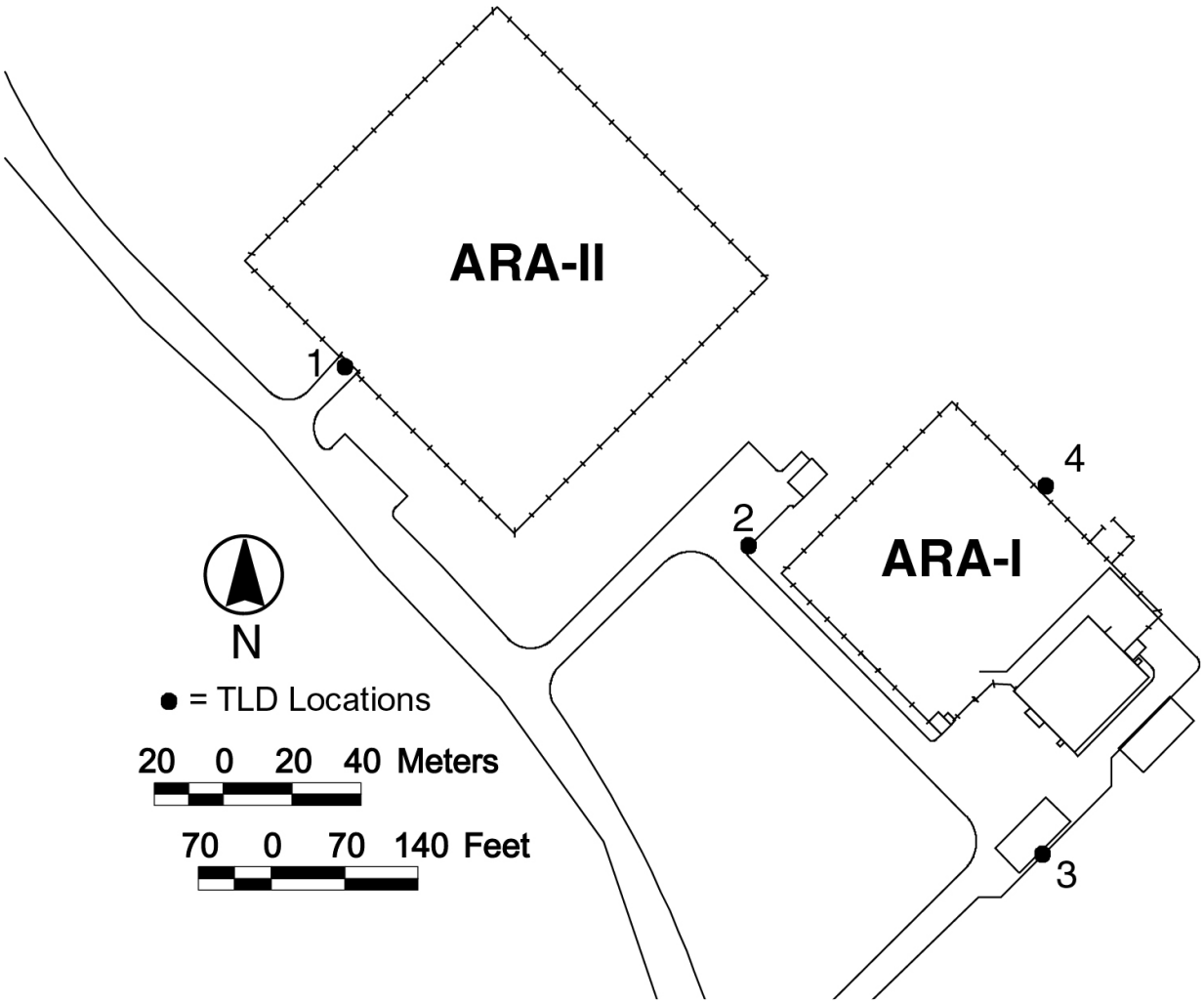

Figure D-2. Environmental dosimeter locations at ARA (2001).

Table D-3 Environmental dosimeter measurements at the Central Facilities Area (CFA) (2001).

Location	Exposure[a]
CFA 1	142 ± 20
CFA 2	124 ± 18
CFA 3	148 ± 21
CFA 4	144 ± 21

a. All values are in milliroentgen (mR) plus or minus 2 standard deviations (± 2s).

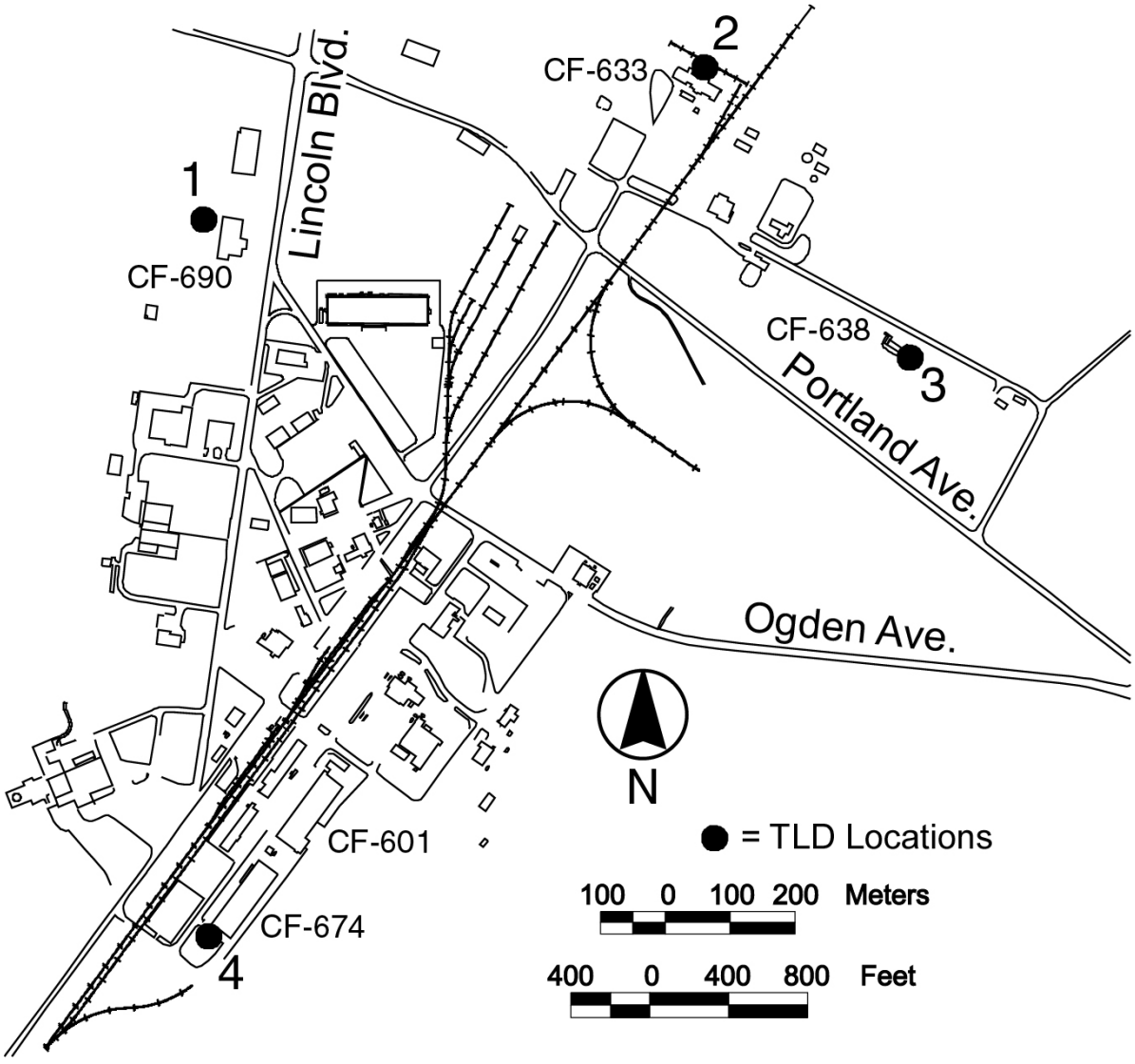

Figure D-3 Environmental dosimeter locations at CFA (2001).

Table D-4. Environmental dosimeter measurements at the Idaho Nuclear Technology and Engineering Center (INTEC) (2001).

Location	Exposure[a]
INTEC 1	164 ± 23
INTEC 9	184 ± 25
INTEC 14	152 ± 21
INTEC 15	153 ± 21
INTEC 16	141 ± 20
INTEC 17	141 ± 20
INTEC 18	139 ± 19
INTEC 19	147 ± 21
INTEC 20	259 ± 36
INTEC 21	172 ± 24
INTEC 22	209 ± 29
INTEC 23	152 ± 21
INTEC 24	142 ± 20
INTEC 25	135 ± 19
INTEC 26	147 ± 21
TREE FARM 1	196 ± 27
TREE FARM 2	178 ± 25
TREE FARM 3	178 ± 25
TREE FARM 4	215 ± 30

a. All values are in milliroentgen (mR) plus or minus 2 standard deviations (± 2s).

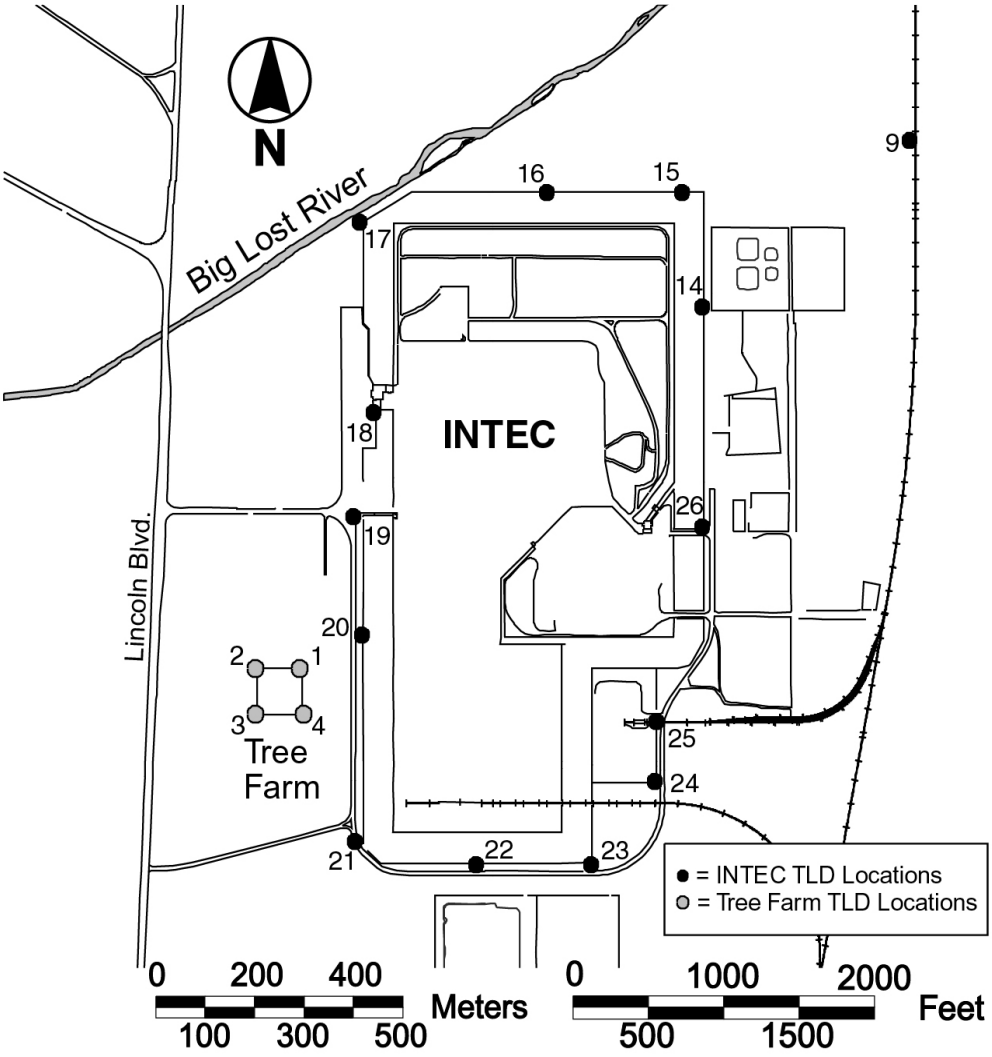

Figure D-4. Environmental dosimeter locations at INTEC (2001).

Table D-5. Environmental dosimeter measurements at the Naval Reactors Facility (NRF) (2001).

Location	Exposure[a]
NRF 4	148 ± 21
NRF 5	152 ± 21
NRF 11	141 ± 19
NRF 12	69 ± 14[b]
NRF 13	140 ± 19
NRF 16	145 ± 20
NRF 17	147 ± 21
NRF 18	146 ± 21
NRF 19	145 ± 21
NRF 20	149 ± 21
NRF 21	140 ± 20

a. All values are in milliroentgen (mR) plus or minus 2 standard deviations (± 2s).
b. This is only a six-month reading (11/2000 to 05/2001) due to a missing TLD for the second six-month period.

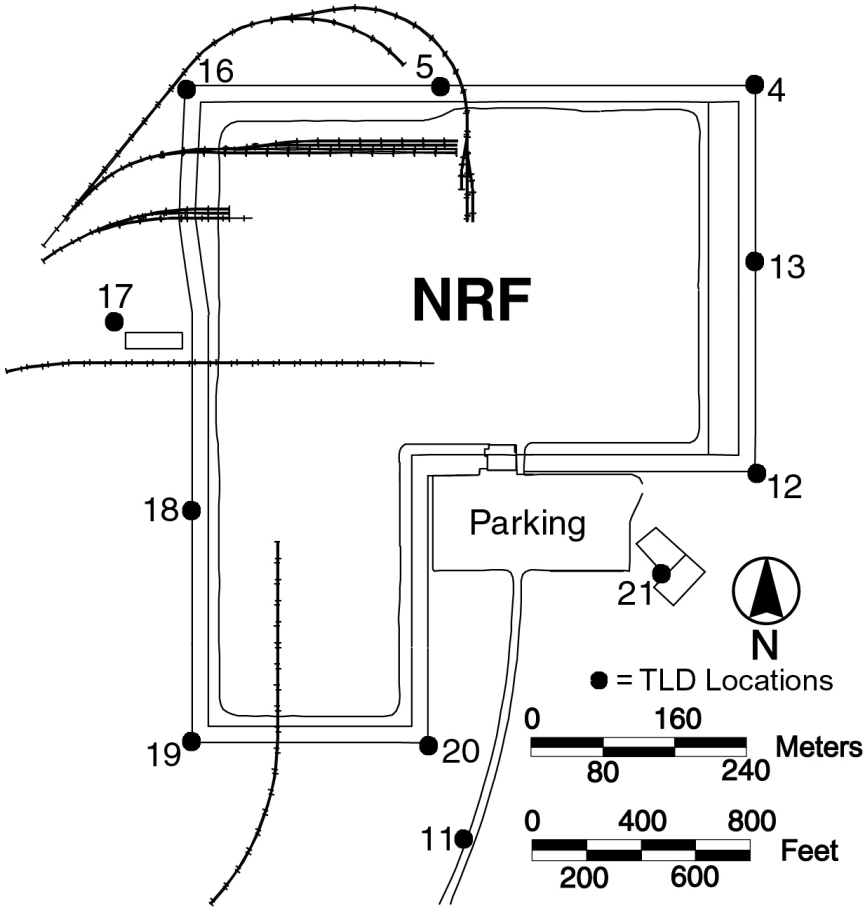

Figure D-5. Environmental dosimeters locations at NRF (2001).

Table D-6. Environmental dosimeter measurements at the Power Burst Facility (2001).

Location	Exposure[a]
PBF/SPERT 1	140 ± 19
PBF/SPERT 2	70 ± 14[b]
PBF/SPERT 3	149 ± 21
PBF/SPERT 4	152 ± 21
PBF/SPERT 5	141 ± 20
PBF/SPERT 6	146 ± 20
PBF/WERF1	144 ± 20
PBF/WERF2	123 ± 17
PBF/WERF3	139 ± 19
PBF/WERF4	147 ± 20
PBF/WERF5	143 ± 20
PBF/WERF6	141 ± 19
PBF/WERF7	146 ± 20

a. All values are in milliroentgen (mR) plus or minus 2 standard deviations (± 2s).
b. This is only a six-month reading (11/2000 to 05/2001) due to a missing TLD for the second six-month period.

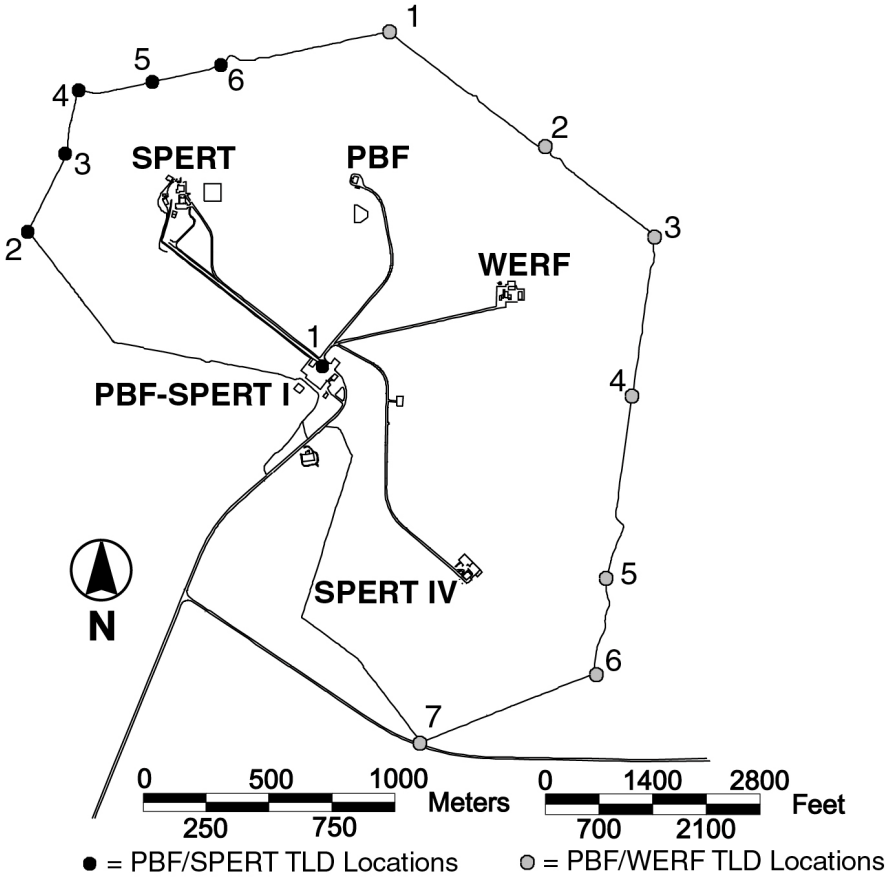

Figure D-6. Environmental dosimeter locations at PBF (2001).

Table D-7. Environmental dosimeter measurements at the Radioactive Waste Management Complex (2001).

Location	Exposure[a]
RWMC 3a	149 ± 21
RWMC 5a	137 ± 19
RWMC 7a	145 ± 21
RWMC 9a	139 ± 19
RWMC 11a	155 ± 21
RWMC 13a	138 ± 19
RWMC15a	133 ± 19
RWMC 17a	144 ± 20
RWMC 19a	132 ± 18
RWMC 21a	148 ± 20
RWMC 23a	142 ± 20
RWMC 25a	144 ± 21
RWMC 27a	168 ± 23
RWMC 29a	177 ± 25
RWMC 31a	158 ± 22
RWMC 37a	137 ± 19
RWMC 39	145 ± 20
RWMC 40	158 ± 22
RWMC 41	410 ± 57
RWMC 42	144 ± 20
RWMC 43	139 ± 20
RWMC 45	134 ± 19
RWMC 46	141 ± 20
RWMC 47	130 ± 18

a. All values are in milliroentgen (mR) plus or minus 2 standard deviations (± 2s).

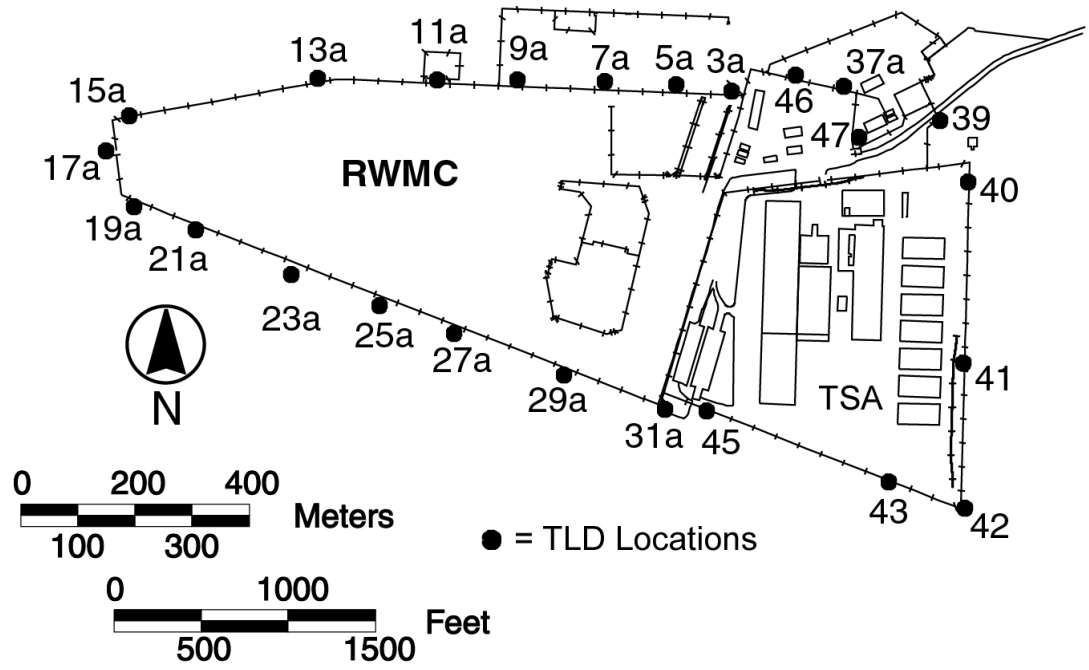

Figure D-7. Environmental dosimeter locations at RWMC (2001).

Table D-8. Environmental dosimeter measurements at the Test Area North (2001).

Location	Exposure[a]
TAN/TSF 1	114 ± 16
TAN/TSF 2	137 ± 19
TAN/TSF 3	114 ± 16
TAN/TSF 4	128 ± 18
TAN/LOFT 1	137 ± 19
TAN/LOFT 2	147 ± 21
TAN/LOFT 3	118 ± 16
TAN/LOFT 4	122 ± 17
TAN/LOFT 5	124 ± 17
TAN/LOFT 6	144 ± 20
TAN/LOFT 7	141 ± 20
TAN/WRRTF1	128 ± 18
TAN/WRRTF2	121 ± 17
TAN/WRRTF3	121 ± 17
TAN/WRRTF4	122 ± 17

a. All values are in milliroentgen (mR) plus or minus 2 standard deviations (± 2s).

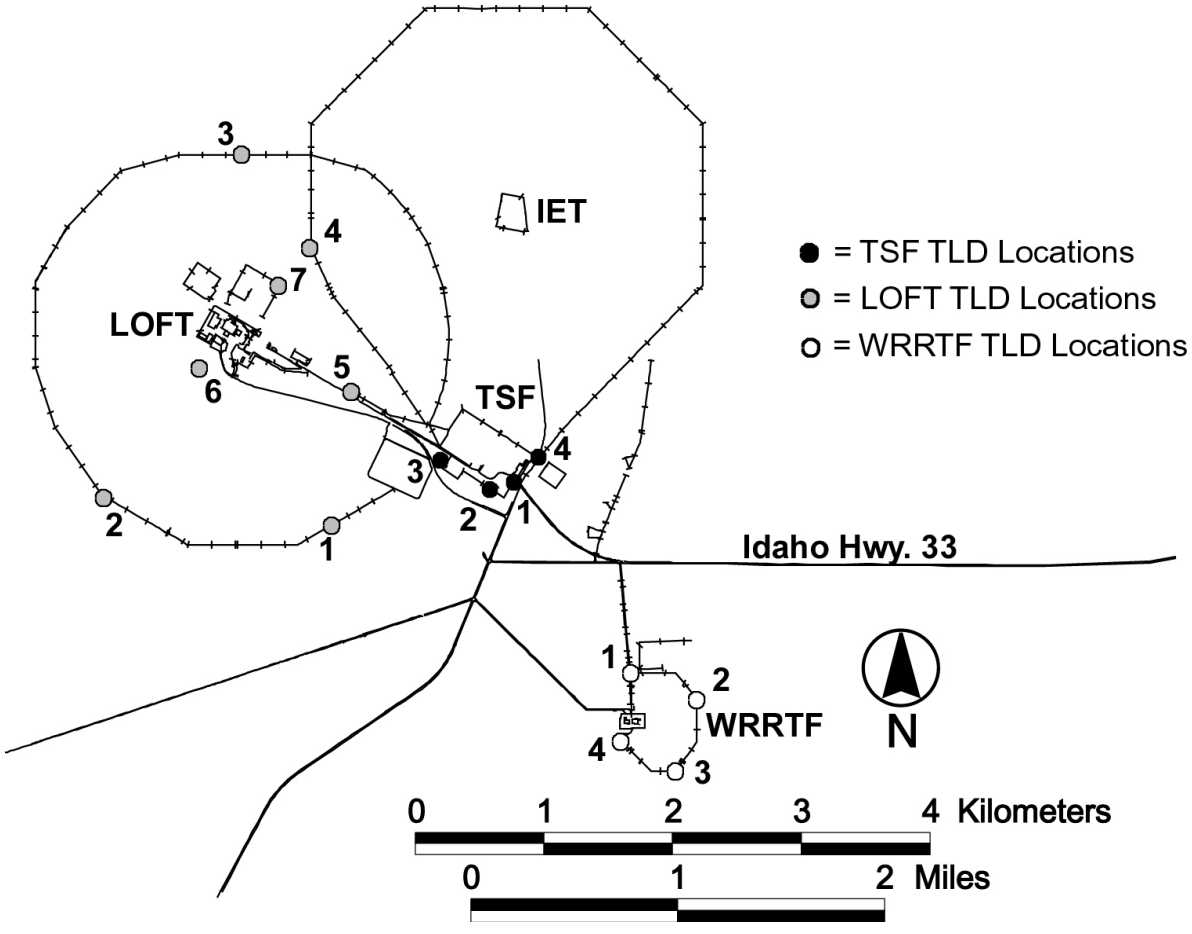

Figure D-8. Environmental dosimeter locations at TAN (2001).

Table D-9. Environmental dosimeter measurements at the Test Reactor Area (2001).

Location	Exposure[a]
TRA 1	226 ± 31
TRA 2	850 ± 119
TRA 3	1026 ± 143
TRA 4	296 ± 41
TRA 5	190 ± 26
TRA 6	154 ± 21
TRA 7	149 ± 21
TRA 8	164 ± 23
TRA 9	152 ± 21
TRA10	151 ± 21
TRA11	160 ± 22
TRA12	151 ± 21
TRA13	150 ± 21

a. All values are in milliroentgen (mR) plus or minus 2 standard deviations (± 2s).

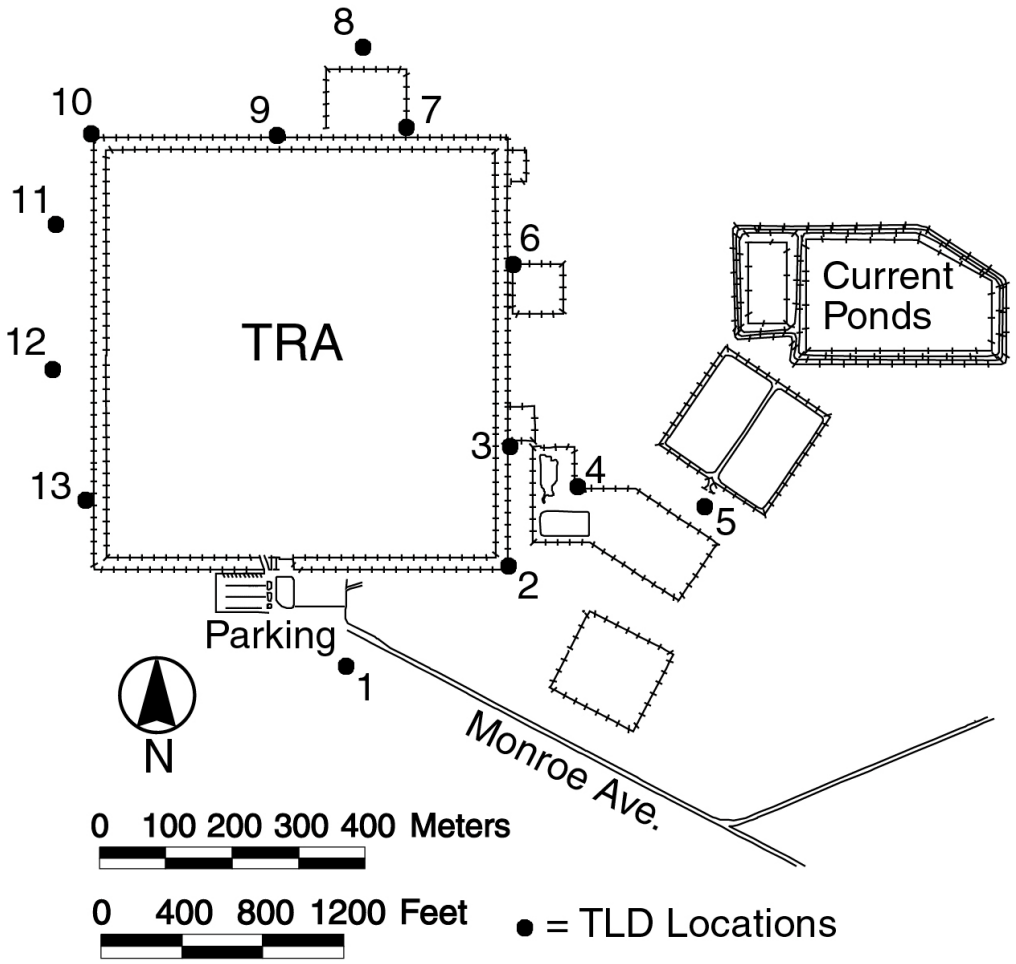

Figure D-9. Environmental dosimeter locations at TRA (2001).

Table D-10. Environmental dosimeter measurements along Lincoln Blvd. and US Highway 20 (2001).

Location	Exposure[a]
LINCOLN BLVD 1	137 ± 19
LINCOLN BLVD 3	152 ± 21
LINCOLN BLVD 5	146 ± 21
LINCOLN BLVD 7	143 ± 20
LINCOLN BLVD 9	149 ± 21
LINCOLN BLVD 11	144 ± 21
LINCOLN BLVD 13	142 ± 20
LINCOLN BLVD 15	145 ± 20
LINCOLN BLVD 17	156 ± 21
LINCOLN BLVD 19	134 ± 18
LINCOLN BLVD 21	132 ± 18
LINCOLN BLVD 23	131 ± 18
LINCOLN BLVD 25	130 ± 19
HWY 26-266	143 ± 20
HWY 26-268	136 ± 18
HWY 26-270	142 ± 20
HWY 20-264	135 ± 19
HWY 20-266	126 ± 18
HWY 20-268	67 ± 13[b]
HWY 20-270	127 ± 18
HWY 20-272	129 ± 18
HWY 20-274	111 ± 16
HWY 20-276	130 ± 18
EBR 1	131 ± 18

a. All values are in milliroentgen (mR) plus or minus 2 standard deviations (± 2s).
b. This is only a six-month reading (11/2000 to 05/2001) due to a missing TLD for the second six-month period.

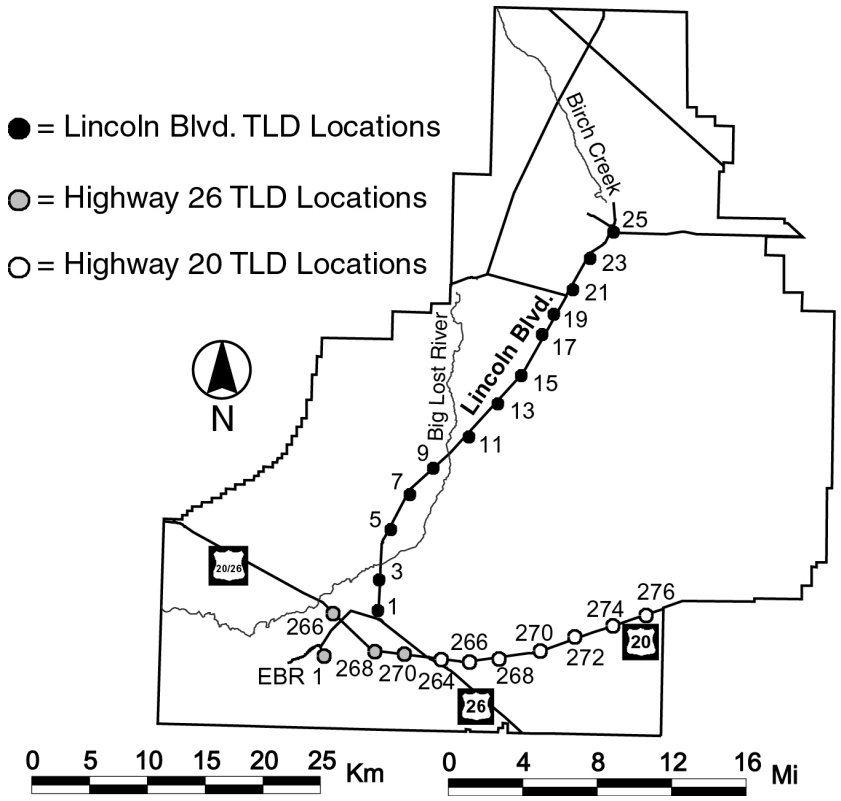

Figure D-10. Environmental dosimeter locations along Lincoln Blvd. and US Highway 20 (2001).