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Idaho National Engineering Laboratory Groundwater Monitoring Plan

Volume 1

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EXECUTIVE SUMMARY

The INEL Groundwater Monitoring Plan (Plan) has been developed to establish the programmatic framework necessary to implement a comprehensive groundwater monitoring program for the Idaho National Engineering Laboratory (INEL). This Plan encompasses all facilities and areas operated by the U.S. Department of Energy, Idaho Field Office (DOE-ID) and the U.S. Department of Energy, Chicago Operations Office (DOE-CH). Groundwater monitoring at the Naval Reactors Facility (NRF), operated by the U.S. Department of Energy, Pittsburgh Naval Reactors, Idaho Branch Office (DOE-IBO) will be addressed under a separate plan.

The Groundwater Monitoring Plan is intended to be a dynamic document. It will be modified, as needed, to reflect evolving regulatory and budgetary requirements, to incorporate new information, and to accommodate the changing needs of a broad spectrum of DOE programs.

The Plan has been developed to fulfill, in part, the groundwater monitoring requirements of DOE Order 5400.1. It has been developed to meet the specific groundwater monitoring objectives in Chapter IV, part 9 of the order. Part 9 states:

> "Groundwater that is or could be affected by DOE activities shall be monitored to determine and document the effects of operations on groundwater quality and quantity and to demonstrate compliance with DOE requirements and applicable Federal, state, and local laws and regulations."

Part 9a establishes the basic requirements for groundwater monitoring **plans**. It states:

> "The plan **shall** identify all DOE requirements and regulations applicable to groundwater protection and include monitoring strategy. The elements of the groundwater monitoring program **shall** be specified (sampling plan, sampling, analysis, and data management), as **shall** the rationale or purpose for selecting these elements."

Part 9b establishes the basic requirements for groundwater monitoring **programs**. It states:

> "Groundwater monitoring programs **shall** be conducted on-site and in the vicinity of DOE facilities to:
>
> (1) Obtain data for the purpose of determining baseline conditions of groundwater quality and quantity;
>
> (2) Demonstrate compliance with and implementation of all applicable regulations and DOE Orders;
>
> (3) Provide data to permit the early detection of groundwater pollution or contamination;
>
> (4) Provide a reporting mechanism for detected groundwater pollution or contamination.
>
> (5) Identify existing and potential groundwater contamination sources and to maintain surveillance of these sources;

(6) Provide data upon which decisions can be made concerning land disposal practices and the management and protection of groundwater resources."

In addition to the requirements of DOE Order 5400.1, the Plan incorporates the applicable recommendations given in Section 5.10 of Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance (DOE, 1991).

The Plan was developed to meet three general needs: to provide a comprehensive overview of INEL operations and activities which have affected or could affect the groundwater resources beneath the INEL; to evaluate which operations and activities may affect the groundwater regime: and to establish the framework for a long-term, comprehensive groundwater monitoring program at and in the vicinity of the INEL. In addition, the Plan establishes Site-wide minimum requirements for coordinating the statistical analysis of groundwater monitoring data, data management and reporting, and the responses required if contaminants are detected in groundwater.

The overview information provides a comprehensive summary of historical and present INEL operations and activities which have affected or could affect the groundwater resources beneath the INEL. It also summarizes past and present contaminant releases to the environment which may affect the Snake River Plain Aquifer (SRPA), and historical and existing groundwater quality conditions at the INEL. The overview was developed by reviewing the large volume of groundwater- and contamination-related documents, reports, and data bases which have been written or developed at the INEL since 1949. In addition, cognizant personnel were interviewed to provide additional historical information and were asked to review the information for accuracy. The pertinent information was then summarized and documented to provide a benchmark of the effects of DOE operations at the INEL on the SRPA.

The INEL Groundwater Monitoring Program integrates all DOE and INEL Contractor compliance groundwater monitoring activities at the INEL with the exception of NRF. In addition, it provides an overview of the USGS INEL Project Office's observational groundwater monitoring program with primary emphasis on how it integrates with the INEL compliance monitoring program.

The Plan consists of 16 sections. Section 1 defines the purpose, policies, scope, objectives, strategies, goals and requirements for implementing the INEL Groundwater Monitoring Program. In addition, this section identifies the organizations responsible for conducting groundwater monitoring at the INEL and describes how these organizations will coordinate their activities. Section 2 provides an overview of the history of the INEL, regional demographics, and physical setting. This overview provides the framework necessary to understand the relationships between the regional groundwater monitoring plan presented in Section 12 and the nine area groundwater monitoring plans presented in Sections 3 through 11. Note that the word "area" as used in this Plan usually refers to one of the Site's major operational areas, such as ANL-W, ICPP, or TRA.

Sections 3 through 11 present area-specific overviews and groundwater monitoring plans for all areas which were determined to contain activities or operations which may negatively affect the SRPA. This determination was made by evaluating the present and historical operations and activities at each area and determining if the area contained operations or activities associated with significant quantities of radioactive or chemical materials. Those areas which have not been associated with significant quantities of radioactive or chemical materials were excluded from further consideration. The remaining areas were evaluated further to determine if they pose a significant risk to the SRPA and warrant groundwater monitoring. These areas were evaluated using a common set of criteria, and groundwater monitoring plans were developed for those areas which were determined to pose a potential risk.

Sections 3 through 10 consider the Site's major operational areas. Each section contains seven subsections.

- The first subsection describes the area and its operational practices. The intent of this discussion is to provide an overview of past and present operations and activities at the operational area which may affect groundwater.

- The second subsection describes each operational area's physiography, geology, and hydrology. The main purpose of this subsection is to summarize the hydrogeological factors which affect the fate and transport of contaminants in the subsurface environment.

- The third subsection provides an overview of past and present groundwater quality. It documents each area's baseline water quality conditions and reports documented effects of area-specific activities on the groundwater regime.

- The fourth subsection discusses the area-specific strategy for monitoring the SRPA based on the information provided in the preceding three subsections. The subsection begins by summarizing the contaminants or pollutants associated with each area, and provides information used in the selection of area-specific indicator parameters. It discusses the assumptions made in developing the area-specific monitoring program, defines the indicator parameters which will be monitored, describes the number, locations, and general construction requirements of wells in the monitoring network, and reports the calculated design efficiency of the area's monitoring network. In addition, this subsection discusses the general sampling and analysis requirements for each area, and ties these requirements to the implementing documentation contained in the appendices.

- The fifth subsection discusses the area-specific perched water monitoring program, where applicable. The structure of this subsection parallels that of subsection four.

- The sixth subsection summarizes the major activities necessary to implement the area-specific groundwater monitoring program.

- The seventh subsection identifies the organization responsible for sample collection at the area and provides an area-specific overview of the organization's general data management and reporting requirements.

Section 11 presents area-specific overviews and groundwater monitoring plans for miscellaneous areas located throughout the INEL. These areas, commonly referred to as "Site-wide" areas, include a wide variety of facilities (e.g., storage buildings, administrative support buildings, and various reactors which are presently nonoperational) that are not in close proximity to the major operational areas described in Sections 3 through 10.

The format of Section 11 is somewhat different from that of the preceding sections. Each area-specific subsection of Section 11 follows the general format of Sections 3 through 10. However, the discussions have been abbreviated for those areas where it is readily apparent that the area's operations and activities could not affect the SRPA, and for areas where the available information is insufficient to determine if a potential groundwater problem exists. The areas which lack sufficient information to determine if groundwater problems exist (i.e., the Fire Training Area, Liquid Chemical Corrosives Disposal Area, and Naval Ordinance Disposal Area) are scheduled to be characterized under the INEL Federal Facilities Agreement/Compliance Order (FFA/CO). The results of these characterizations will be evaluated by this program to determine if compliance monitoring is required.

Section 12 discusses the regional portion of the groundwater monitoring program. The regional groundwater monitoring program is a continuation of USGS's existing observational monitoring program. It is being conducted independently of DOE's and the INEL Contractors' compliance monitoring programs, with the exception that it will monitor for both the constituents of interest to the USGS's observational program and to the INEL compliance program. The regional program will both provide a backup for the INEL compliance monitoring program and will monitor contaminant plumes over a larger scale than the INEL compliance monitoring program.

Sections 13 through 15 define Site-wide minimum requirements for statistical analysis, data management and reporting, and contamination response. The purpose of these sections is to provide minimum Site-wide requirements and coordination of the analysis, management, and reporting of groundwater monitoring data at the INEL. Section 13 describes the general Site-wide procedures to be followed if contamination is detected. Section 14 presents general Site-wide requirements for statistical analysis of sampling data. Section 15 presents general Site-wide requirements for groundwater data management and reporting. Section 16 includes all references cited in this document.

The INEL groundwater monitoring strategy has been developed using a three-tiered approach. Monitoring will be conducted at the unit/facility-specific, area-specific, and regional levels. This version of the Plan develops the strategy for conducting area-specific and regional monitoring programs. The Plan will be revised in FY-1994 to incorporate monitoring at the unit/facility-specific level, which will include the monitoring of perched water bodies.

The regional monitoring program consists of the USGS observational monitoring program. The primary purpose of the regional monitoring program is to study the migration of contaminants through saturated fractured basalts. This program is primarily scientific in nature and has not been designed for the specific purpose of conducting compliance monitoring. However, much of the USGS data historically has been used by INEL contractors to satisfy their general compliance needs.

The existing regional network consists of on-Site aquifer and perched water monitoring wells, and boundary and off-Site aquifer monitoring wells and piezometers. On-Site monitoring wells are concentrated around areas where hazardous and radioactive constituents routinely have been disposed to the environment. However, monitoring wells and piezometers are located throughout the site. Most aquifer monitoring wells associated with specific areas of operation are located downgradient of the area of interest. Most areas that dispose large quantities of liquid waste have perched water bodies beneath them. These perched water bodies are also monitored. Boundary monitoring wells are primarily located near the southern (downgradient) boundary of the INEL to detect contaminants if they migrate from the site. Offsite wells are primarily located downgradient of the southern boundary and extend to the Thousand Springs/Hagerman, Idaho area. The design of the regional monitoring network has been based on site-specific knowledge gained during more than 40 years of groundwater monitoring by the USGS at the INEL.

RCRA TEGD standards did not exist when many of the wells in the USGS regional network were drilled, and thus most of these wells do not meet these standards. Most wells have been constructed by installing casing to the zone of interest, and completing the well with perforated casing or as an open borehole. The monitoring zone typically extends through a depth interval of 50 to 200 ft. Although this design may increase the probability of sample dilution, it also increases the probability of detecting contaminants over a large vertical interval through the aquifer. This design, therefore, complements that of the compliance monitoring wells, which are typically designed to sample the aquifer over a much shorter interval.

The area-specific monitoring networks have been designed to include wells both upgradient and downgradient from each operational area. Each area network will be monitored to determine whether the indicator parameters specific to that area exceed established action-level thresholds. If a parameter exceeds a prescribed threshold, a specific report and/or response is required. In addition, trend analysis will be conducted for each area to provide an early warning of potential groundwater monitoring problems. If trend analysis thresholds are exceeded, a specific report and/or response is also required. Area-specific action-level thresholds, as well as Site-wide reporting and response requirements, have been documented in this Plan.

The design of the area-specific groundwater monitoring networks was based on four key criteria. First, groundwater monitoring networks were designed for each area which contains contaminants in sufficient quantities to negatively affect the SRPA. Second, all networks were designed with wells located no closer that 500 ft from the furthest known or suspected extent of contamination. This criterion was established due to the complexity of the geology at the INEL, and the great depth from the ground surface to the water table. Contamination migrating through the vadose zone does not move directly downward; it is subject to some amount of lateral displacement. This necessitated offsetting downgradient monitoring wells from the neighboring contaminant source areas to ensure that any contamination reaching the aquifer would do so upgradient from the well network. The minimum offset distance of 500 feet was chosen based on professional judgement.

Third, the networks were designed to provide 95% or greater monitoring coverage at each area. This criterion is based on professional judgement in trying to balance costs of installing monitoring wells versus providing a level of coverage which is acceptable to the regulatory community and the public. Each network was designed and evaluated using best professional judgement and the Monitoring Efficiency Model (MEMO). MEMO was initially used by DOE on the Hanford Site in eastern Washington to provide analytical evaluations of shallow monitoring well networks. The model generates hypothetical plumes from the potential source area, and determines whether those plumes are detected by a given network of monitoring wells.

Fourth, most networks have been designed to monitor the upper portion of the aquifer. This criterion is based on the knowledge that most of the contaminants of concern at the INEL will migrate through the vadose zone and be released to the top of the aquifer. Few of the contaminants of concern are likely to act as dense non-aqueous phase liquids (DNAPLs), so they will remain detectable in the upper portion of the aquifer. The few instances where the contaminants may act as DNAPLs (e.g., the trichloroethylene plume at Test Area North) are being characterized by the INEL Environmental Restoration Program.

A total of 238 wells will be monitored as part of the INEL Groundwater Monitoring Program. Two hundred and seven (207) wells are or will be completed in the SRPA (76 area-specific, 76 regional onsite, and 55 regional offsite wells). Twenty-one (21) wells are completed in the perched water zones at three areas (ICPP, RWMC, and TRA). A summary of the number and types of wells is presented below.

Summary of INEL Monitoring Network Wells

	Area-Specific Monitoring Wells	Regional Monitoring Wells
Onsite Aquifer Wells		
Existing	25	52
Proposed	51	24*
Subtotal	76	76
Offsite Aquifer Wells		
Existing	0	55
Proposed	0	0
Subtotal	0	55
Perched Water Wells		
Existing	10	21
Proposed	0	0
Subtotal	10	21
TOTAL WELLS	86	152

* Includes six 3-piezometer clusters.

The INEL Groundwater Monitoring Program will be conducted throughout the remaining operational life of the INEL. For the most part, the existing regional program is already in place and operational, and will require only minor modifications to be made fully functional. Development of the compliance monitoring network will be initiated in FY-1993 and will continue until FY-2004.

The major activities associated with program development will consist of installing new monitoring wells, refurbishing existing wells where this is necessary and prudent, and conducting monitoring. All new area-specific monitoring wells will be sampled on a quarterly basis during the first two years of sampling to develop a statistical background. Where existing wells are employed, the historical data will be reviewed to determine whether the data are statistically sound. If the data are acceptable, an initial period of quarterly monitoring will not be required. During subsequent years, area-specific wells will be monitored on a semiannual basis, unless the types or levels of contaminants encountered dictate more frequent sampling. Regional observation wells will be sampled in accordance with USGS's programmatic requirements on a semiannual schedule in conjunction with the associated area-specific sampling regime. A summary schedule of these activities is presented below.

Summary Schedule for Implementing the INEL Groundwater Monitoring Program

FY-93

Construct 2 wells at STF
Conduct quarterly monitoring at STF
Initiate semiannual aquifer and perched water monitoring at ICPP

FY-94

Construct 4 monitoring wells at TRA
Construct 3 monitoring wells at ARA
Conduct quarterly aquifer and perched water monitoring at TRA
Conduct quarterly monitoring at ARA
Initiate semiannual monitoring at STF

FY-95

Construct 5 monitoring wells at PBF
Conduct quarterly monitoring at PBF
Initiate semiannual aquifer and perched water monitoring at TRA
Initiate semiannual monitoring at ARA

FY-96

Construct 4 monitoring wells at RWMC
Initiate semiannual monitoring at PBF

FY-97

Construct 3 monitoring wells at RWMC
Conduct quarterly aquifer and perched water monitoring at RWMC

FY-98

Construct 4 monitoring wells at TAN (TSF/IET)
Initiate semiannual aquifer and perched water monitoring at RWMC

FY-99

Construct 4 monitoring wells at TAN (2 at TSF/IET and 2 at CTF)
Conduct quarterly monitoring at TAN (TSF/IET)

FY-2000

Construct 4 monitoring wells at TAN (1 at CTF and 3 at WRRTF)
Conduct quarterly monitoring at TAN (CTF)
Conduct quarterly monitoring at TAN (WRRTF)
Initiate semiannual monitoring at TAN (TSF/IET)

FY-2001

Construct 4 monitoring wells, 3 at BORAX and 1 at CFA
Conduct quarterly monitoring at BORAX
Initiate semiannual monitoring at TAN (CTF)
Initiate semiannual monitoring at TAN (WRRTF)

FY-2002

Construct 4 monitoring wells at CFA
Initiate semiannual monitoring at BORAX

FY-2003

Construct 3 monitoring wells at CFA
Conduct quarterly monitoring at CFA

FY-2004

Initiate semiannual monitoring at CFA

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FIGURES

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ACRONYMS

AEA	Atomic Energy Act
AEC	Atomic Energy Commission
ANL-W	Argonne National Laboratory-West
ANP	Aircraft Nuclear Propulsion Program
ARA	Auxiliary Reactor Area
ARDC	Administrative Record Document Control
ARVFS	Army Reentry Vehicle Facility Site
ASWS	air support weather structure
ATF	automatic transmission fluid
ATR	Advanced Test Reactor
ATSDR	Agency For Toxic Substances and Disease Registry
BEHP	bis(2-ethylhexyl)phthalate
BGL	below ground level
BLS	below land surface
BOD	biological oxygen demand
BORAX	Boiling Water Reactor Experiment
BTU	british thermal units
CDDR	complete detection dilution ratio
CDR	critical dilution ratio
CERCLA	Comprehensive Environmental Response and Compensation Liability Act
CERT	Controlled Environmental Radioiodine Test
CFA	Central Facilities Area
CFR	Code of Federal Regulations
COCA	Compliance Order and Consent Agreement
CLP CRQL	Contract Laboratory Program Contract Required Quantitation Limit
CSI	contaminant source inventory
CTF	Containment Test Facility
CUSUM	Cumulative Sum Control Chart Technique
CWP	cold waste pond
DNAPL	dense non-aqueous phase liquid
DOE	Department of Energy
DOE-HQ	DOE Headquarters
DOE-IBO	DOE Pittsburgh Naval Reactors, Idaho Branch Office
DOE-ID	DOE Idaho Operations Office
DOP	dioctyl phthalate
DQO	data quality objective
EBOR	Experimental Beryllium Oxide Reactor
EBR-I	Experimental Breeder Reactor 1
EBR-II	Experimental Breeder Reactor 2
ECA	environmentally controlled area
EDF	engineering design file
EIP	environmental investigation procedures
EOC	DOE HQ Environmental Operations Center
EOCR	Experimental Organic Cooled Reactor
EPA	Environmental Protection Agency
ER/WM	DOE-ID Waste Management and Waste Management
ERD	Environmental Restoration Department
ERDA	Energy Research and Development Agency

ERIS	Environmental Restoration Information System
ERP	Environmental Restoration Program
ESD	DOE-ID Environmental Support Division
ESRP	Eastern Snake River Plain
ETR	Engineering Test Reactor
EWR	Early Waste Retrieval Program
FCF	Fuel Cycle Facility
FET	final engine test
FFA/CO	Federal Facilities Agreement and Consent Order
FMF	Fuel Manufacturing Facility
FPFRT	Fission Product Field Release Test
FRAN	Nuclear Effects Reactor
GCRE	Army Gas Cooled Reactor Experiment
GIN	Gas Injection North
GPD	gallons per day
HCWHNF	Hazardous Chemical Waste Handling and Neutralization Facility
HEPA	high efficiency particulate air
HFEF	Hot Fuel Examination Facility
HPTF	Howe Peak Transmitter Facility
HTRE	Heat Transfer Reactor Experiments
HWSF	Hazardous Waste Storage Facility
ICPP	Idaho Chemical Processing Plant
IDHW	Idaho Department of Health and Welfare
IDR	initial drum retrieval
IDWR	Idaho Department of Water Resources
IET	initial engine test
IFR	Integral Fast Reactor
ILTSF	Intermediate Level Transuranic Storage Facility
INEL	Idaho National Engineering Laboratory
IRIS	Integrated Risk Information System
IWMIS	Industrial Waste Management Information System
IWP	industrial waste pond
LCCDA	Liquid Corrosive Chemical Disposal Area
LDU	Land Disposal Unit
LLW	low level waste
LMFBR	Liquid-Metal Fast-Breeder Reactor
LNAPL	low-density non-aqueous phase liquid
LOCE	Loss of Coolant Experiment
LOFT	Loss of Fluid Test
LPT	Low Power Test
MAP	monitoring analysis package
MCL	maximum contaminant level
MEMO	Monitoring Efficiency Model
MFP	mixed fission product
MGF	Main Gate Facility
ML	mobile low power reactor
MSA	mine safety appliance
MTA	mobile test assembly
MTR	Materials Test Reactor
NOAA	National Oceanographic and Atmospheric Administration

NODA	Naval Ordnance Disposal Area
NPR	New Production Reactor
NRC	Nuclear Regulatory Commission
NRF	Naval Reactor Facility
NRTS	National Reactor Testing Site
NWCF	New Waste Calcining Facility
NWIS	National Water Information System
OMRE	Organic Moderated Reactor Experiment
ORNL	Oak Ridge National Laboratory
PBF	Power Burst Facility
PCE	tetrachloroethylene
PEW	process equipment waste
PMCL	primary maximum contaminant level
PREPP	Process Experimental Pilot Plant
QAPP	Quality Assurance Program Plan
RCRA	Resource Conservation and Recovery Act
RESL	Radiological & Environmental Sciences Laboratory
RFP	Rocky Flats Plant
RI/FS	Remedial Investigation and Feasibility Study
RLWTF	Radioactive Liquid Waste Treatment Facility
RMWS	Radioactive Mixed Waste Storage Program
RMWSF	Radioactive Mixed Waste Storage Facility
RPSSA	Radioactive Parts Security Storage Area
RSWF	Radioactive Storage and Waste Facility
RTR	real-time radiography
RWMC	Radioactive Waste Management Complex
RWMIS	Radioactive Waste Management Information System
SAIC	Science Applications International Corporation
SAP	Sampling and Analysis Plan
SARA	Superfund Amendments and Reauthorization Act
SCMS	Sodium Component Cleanup Shop
SCRAM	Sitewide Characterization, Remediation and Monitoring data base
SDA	Subsurface Disposal Area
SDP	Site Development Plan
SES	site engineering and support
SHADE	shielded hot-air drum evaporator
SMC	specific manufacturing capability
SMCL	secondary maximum contaminant level
SNAPTRAN	space nuclear auxiliary power transient
SOP	standard operating procedure
SPERT	special power excursion reactor test
SQL	sample quantitation limit
SRPA	Snake River Plain aquifer
STF	Security Training Facility
STORET	storage and retrieval system
STP	sanitary sewage treatment ponds
STPF	Shield Test Pool Facility
SWEPP	Stored Waste Examination Pilot Plant
SWMU	Solid Waste Management Unit
TAN	Test Area North

TBP	tributylphosphate
TCA	trichloroethane
TCE	trichloroethylene
TCL	CLP target compound list
TCLP	toxic compound leaching procedure
TCR	target cancer risk
TDA	Transuranic Disposal Area
TDS	total dissolved solids
THQ	target hazard quotient
TLV	threshold limit value
TMI	Three Mile Island
TOC	total organic carbon
TOX	total organic halogen
TOXNET	National Library of Medicine Toxicity Data Network
TRA	Test Reactor Area
TREAT	Transient Reactor Test Facility
TRU	transuranic
TSA	Transuranic Storage Area
TSCA	Toxic Substances Control Act
TSD	RCRA Treatment, Storage and Disposal facility
TSF	Technical Support Facility
UOR	Unusual Occurrence Report
USAEC	U.S. Atomic Energy Commission
USGS	U.S. Geological Survey
UST	underground storage tank
VOC	volatile organic compound
WAG	waste area group
WATSTOR	National WATer Data STOrage and Retrieval System
WCF	Waste Calcining Facility
WEDF	Waste Engineering Development Facility
WERF	Waste Experimental Reduction Facility
WINCO	Westinghouse Idaho Nuclear Company
WIPP	Waste Isolation Pilot Plant
WRC	Weapons Range Complex
WRD	USGS Water Resources Division
WRIR	Water-Resources Investigations Report
WRRTF	Water Reactor Research Test Facility
WWTF	Warm Waste Treatment Facility
ZPPR	Zero Power Physics Reactor

1. INTRODUCTION

1.1 Background

The Idaho National Engineering Laboratory (INEL) is a government-owned reservation (the Site), in the southeastern portion of Idaho, approximately 40 km (25 mi) west of Idaho Falls, Idaho (Figure 1-1). The Site covers approximately 2,300 km^2 (890 mi^2), extending a maximum 63 km (39 mi) from north to south and 58 km (36 mi) from east to west. There are nine major operational areas at the INEL, in addition to a number of miscellaneous facilities (Site-wide facilities) (Figure 1-2). Additional support and administrative facilities are located in Idaho Falls.

The INEL was established by the Federal Government in 1949 as the National Reactor Testing Station for the construction and testing of various kinds of nuclear reactors, primarily to demonstrate reactor safety (see summary in EG&G Idaho, 1990e). Nonreactor research activities include testing of irradiated fuels, the recovery of uranium from spent fuels, reactor training, and storage of low-level and transuranic (TRU) wastes. In 1975, the INEL was also designated as one of the nation's five National Environmental Research Parks for the scientific study of the environment and land management (Fritzen, 1991).

1.2 Purpose and Scope

1.2.1 Purpose

The purpose of the INEL Groundwater Monitoring Plan is to establish the programmatic framework for fulfilling the groundwater monitoring requirements of U.S. Department of Energy (DOE) Order 5400.1, "General Environmental Protection Program." DOE Order 5400.1 mandates the development of specific groundwater monitoring plans and programs for "each [DOE] site, facility, or process that uses, generates, releases, or manages significant pollutants or hazardous materials." The INEL Groundwater Monitoring Plan will be implemented through the INEL Groundwater Monitoring Program.

The primary purposes of the INEL Groundwater Monitoring Program are to do the following:

- Determine and document the effects of DOE operations at the INEL on the groundwater regime

- Help ensure that DOE's operations and activities at the INEL are conducted in a manner that is protective of human health and safety and of the environment

- Provide DOE and contractor management with high-quality data upon which operational and environmental decisions can be made

- Demonstrate DOE's compliance with all applicable Federal and state environmental regulations and DOE orders pertaining to groundwater monitoring.

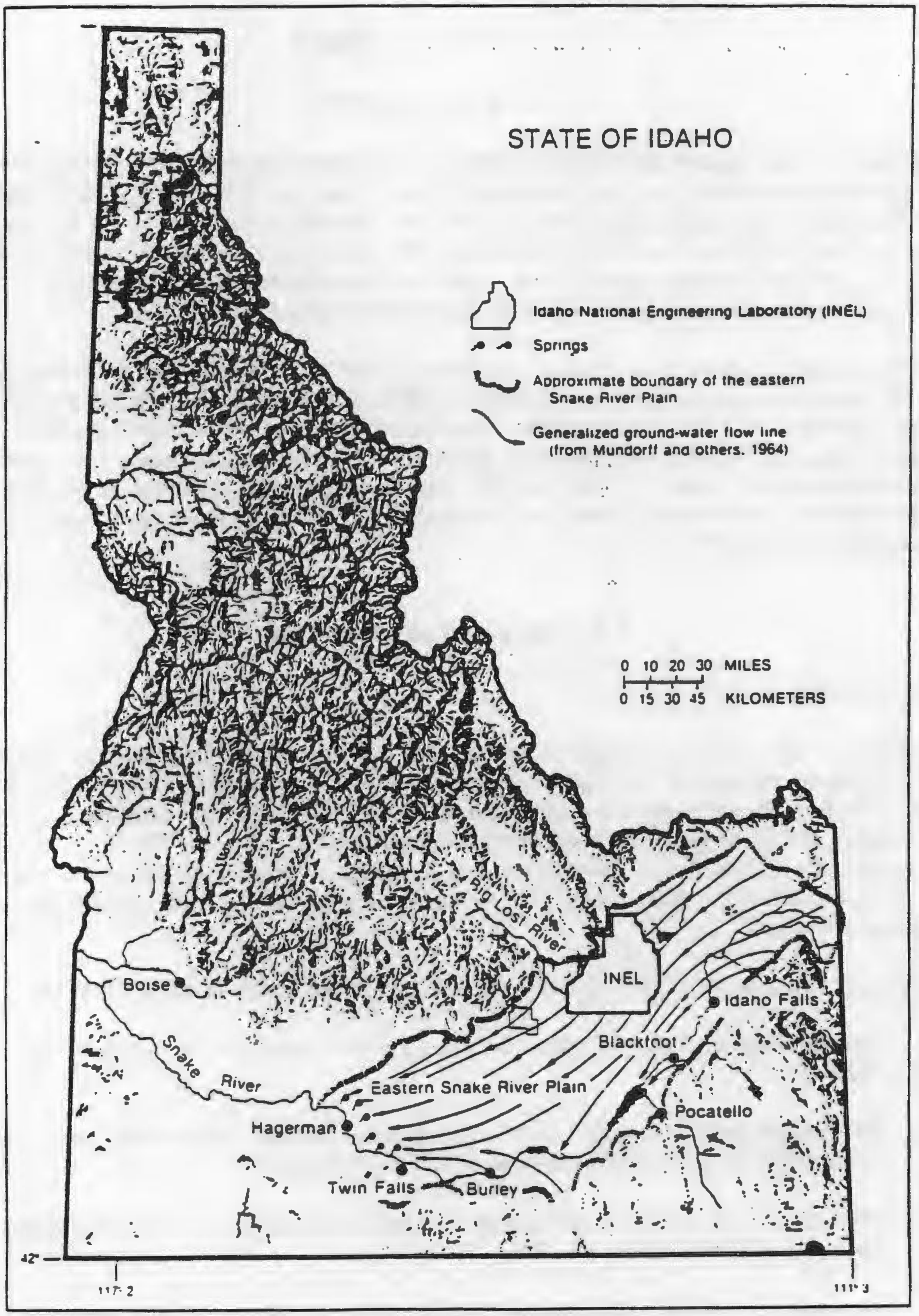


Figure 1-1. Location of the INEL, Snake River Plain, and generalized groundwater flow lines of the Snake River Plain aquifer (from Barraclough et al., 1981).

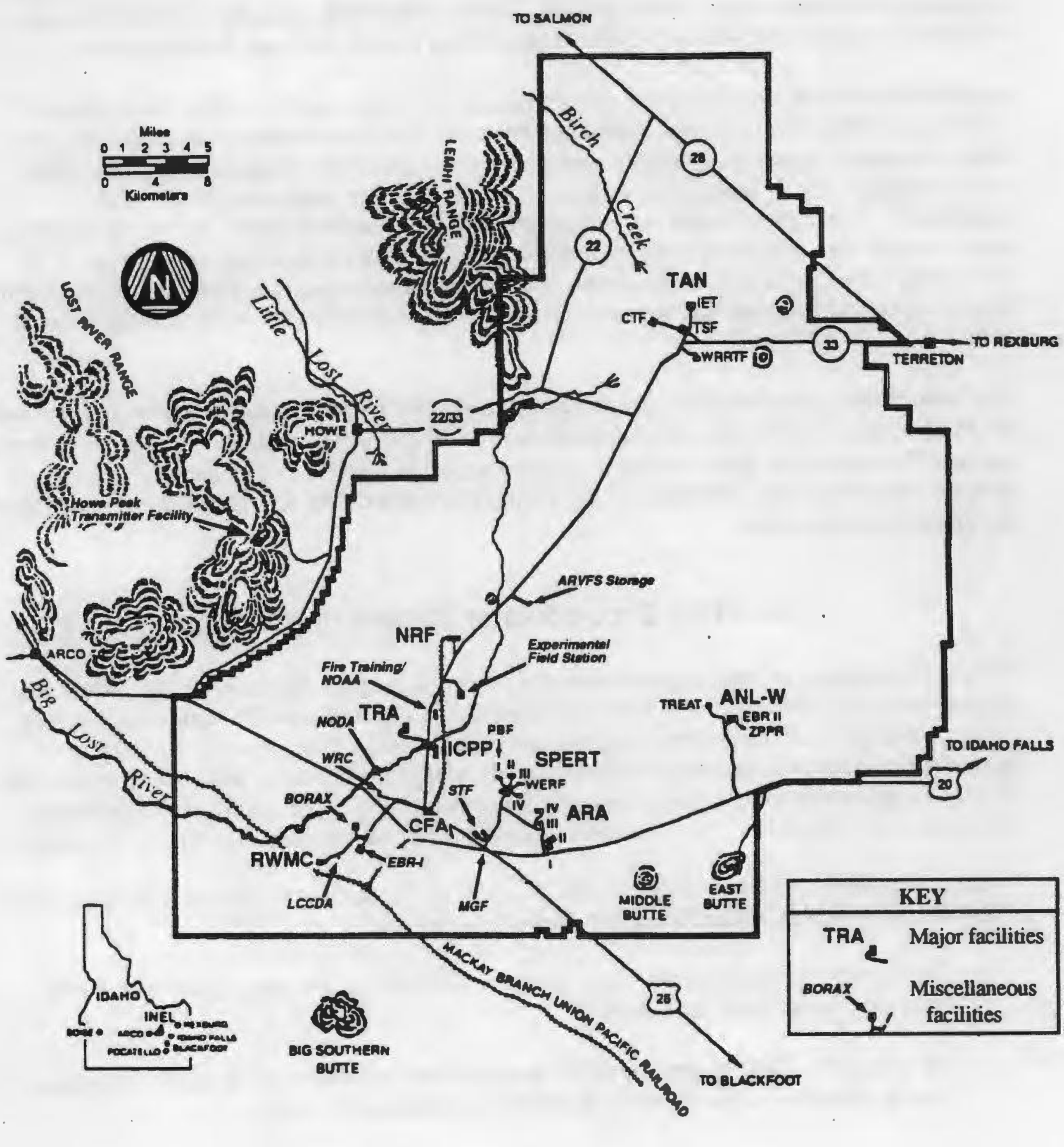


Figure 1-2. Location of INEL facilities.

1.2.2 Scope

DOE Order 5400.1 mandates that "environmental surveillance shall be conducted to monitor the effects, if any, of DOE activities on onsite and offsite environmental and natural resources." The INEL Groundwater Monitoring Plan establishes a comprehensive groundwater monitoring program that integrates all INEL contractor compliance groundwater monitoring programs, with the exception of the Naval Reactors Facility (NRF) program. NRF's groundwater monitoring program is being developed separately, but will be coordinated as much as possible with the INEL program.

Existing groundwater monitoring and characterization programs [e.g., U. S. Geological Survey (USGS) and INEL Environmental Restoration Program's (ERP's) characterization programs] have been evaluated to ensure compatibility among the various programs. These programs have been either integrated into or coordinated with the INEL Groundwater Monitoring Program, as appropriate. Where groundwater monitoring programs are deemed necessary but do not presently exist, the available monitoring infrastructure has been evaluated for adequacy, and interim monitoring strategies have been developed. The tasks required to upgrade each program are outlined in the implementation plans that have been developed for each operational area, or at the regional level.

ERP groundwater characterization and remediation activities are being conducted in accordance with the *INEL Federal Facilities Agreement/Compliance Order* (FFA/CO) (EPA, 1991). This program has not been included in this Plan since these activities are being negotiated in accordance with the FFA/CO. However, INEL Groundwater Monitoring Program and ERP activities will be coordinated to the greatest extent possible.

1.3 INEL Groundwater Monitoring Policy

DOE is committed to establishing environmental protection program requirements, authorities, and responsibilities for DOE operations that ensure compliance with applicable Federal, state, and local environmental laws and regulations, executive orders, and internal DOE policies. Concerning requirements, authorities, and responsibilities that are specifically related to groundwater monitoring, it is DOE's policy that groundwater monitoring plans shall be developed to provide a monitoring strategy that will help ensure the protection of groundwater resources associated with DOE facilities.

In addition to DOE's general policies, it is the policy of the Department of Energy Idaho Field Office (DOE-ID) that the INEL Groundwater Monitoring Program will:

- Be a comprehensive program which integrates all INEL on-Site and off-Site monitoring programs under DOE-ID authority

- Be managed to help ensure that DOE's operations and activities are conducted in a manner that is protective of human health and safety and of the environment

- Comply with the letter and spirit of all applicable Federal, state and DOE groundwater monitoring requirements

- Coordinate and cooperate with applicable state and Federal agencies, and with the public, to the greatest extent possible.

1.4 Groundwater Monitoring Objectives and Requirements

1.4.1 Definition of Groundwater Monitoring and Groundwater Characterization

In this Plan, INEL groundwater sampling and analysis activities are classified as belonging to one of two categories, groundwater monitoring or groundwater characterization. Groundwater monitoring is defined as repetitive groundwater sampling and analysis activities conducted over an extended period of time, generally more than one year. Groundwater characterization is defined as nonrepetitive or short-term groundwater sampling and analysis activities, which are conducted to establish a "snapshot" of the quality of groundwater at a given point in time. Generally, groundwater characterizations at the INEL will be conducted for the purpose of determining whether corrective actions are necessary (i.e., ERP, UST, and D&D programs), or for preconstruction site characterization.

Groundwater characterization activities for inactive waste sites are presently being implemented through the ERP. The extent of these activities and their specific requirements are negotiated among DOE, the U. S. Environmental Protection Agency (EPA), and the State of Idaho on a case-by-case basis under the FFA/CO. DOE Order 5400.1 requires preconstruction site characterization at all new facilities which have the potential to contaminate the environment. This characterization is the responsibility of the organization that is programmatically responsible for construction.

Groundwater monitoring at the INEL is subdivided into two categories, compliance monitoring and observational monitoring. Compliance monitoring includes all activities conducted specifically to meet Federal or State of Idaho regulations, as well as those activities required by DOE Order 5400.1. The programmatic and Quality Assurance/Quality Control (QA/QC) requirements for compliance monitoring programs are dictated by the applicable regulations, EPA guidance, and DOE orders. All groundwater compliance monitoring programs funded by DOE-ID and DOE-CH are being documented through the INEL Groundwater Monitoring Plan and implemented through the INEL Groundwater Monitoring Program.

Observational monitoring includes groundwater monitoring activities conducted for nonregulatory purposes where the data are collected exclusively for programmatic or scientific needs. The quality assurance requirements for these program are dictated by programmatic needs and will be documented and implemented through a formal QA plan. Presently, the USGS conducts observational monitoring (regional groundwater monitoring and hydrogeological regime analysis) on and in the vicinity of the INEL. Although data from these activities are used by the DOE-ID for DOE Order 5400.1 compliance, the USGS's programs are conducted independent of DOE and are not presently contractually bound to DOE's programmatic or QA/QC requirements. DOE-ID and the USGS will negotiate any additional requirements necessary to ensure compatibility between the agencies' monitoring programs during the renewal of the DOE-USGS interagency agreement in FY-93.

1.4.2 Design Basis

The INEL Groundwater Monitoring Plan is based primarily on the DOE Order 5400.1 performance objectives outlined in Section 1.4.3 and the applicable state and Federal groundwater monitoring regulations and guidances listed in Table 1-1. In addition, this Plan incorporates site-specific hydrogeological and process knowledge, and the knowledge acquired from over 40 years of groundwater monitoring at the INEL.

1.4.2.1 Basis for Long-Term Monitoring. DOE Order 5400.1 requires each DOE site to evaluate its need for a long-term monitoring program, but it is already known that INEL operations have discharged or released small quantities of radioactive and dilute chemical wastes to the Snake River Plain Aquifer (SRPA) since 1952 (Robertson et al., 1974). In addition, the INEL was placed on the Comprehensive Environmental Response. Compensation, and Liability Act (CERCLA) National Priorities List in December 1989, based on groundwater contamination at the Radioactive Waste Management Complex (RWMC), Test Area North (TAN), and Test Reactor Area (TRA) areas. These facts constitute sufficient justification for establishment of a long-term, comprehensive groundwater monitoring program.

1.4.2.2 Regulatory and DOE Groundwater Monitoring Requirements. The minimum Federal environmental regulations applicable to DOE facilities are outlined in DOE Order 5400.1, Attachment I-1 ("Mandatory Environmental Protection Standards"). These standards, State-of-Idaho environmental regulations, and DOE orders were evaluated to determine their applicability to the INEL Groundwater Monitoring Program. A list of the Federal and State-of-Idaho regulations and DOE orders that are potentially applicable to the INEL groundwater monitoring program is given in Table 1-1. The applicable regulations and orders given in Table 1-1 are discussed in detail in "Overview of Groundwater Monitoring Regulations Pertinent to the INEL" (EG&G Idaho, 1992).

The waiver of sovereign immunity under the Clean Water Act is not necessarily complete, which raises the issue as to the applicability of some of the State of Idaho's regulations for water discharge activities. As a matter of policy, however, DOE has determined that it will follow these requirements, and any issues in this regard should be coordinated with the DOE-ID Environmental Support Division.

1.4.3 Performance Objectives

This Plan has been developed to establish a groundwater monitoring program in accordance with the requirements of DOE Order 5400.1. The primary groundwater monitoring program objectives specified by DOE Order 5400.1 are the following:

- Obtain data for the purpose of determining baseline conditions of groundwater quality and quantity

Table 1-1. State, Federal, and DOE standards potentially applicable to the design and implementation of the INEL Groundwater Monitoring Program.

FEDERAL REGULATIONS	
40 CFR 258	Municipal Solid Waste Landfill Regulations
40 CFR 264	EPA Regulations for Owners and Operators of Permitted Hazardous Waste Facilities
40 CFR 265	EPA Interim Standards for Owners and Operators of Permitted Hazardous Waste Facilities
40 CFR 270	EPA Administered Permit Programs: The Hazardous Waste Permit Program
40 CFR 280	Underground Storage Tanks
40 CFR 300	National Oil and Hazardous Substances Pollution Contingency Plan
40 CFR 761	Polychlorinated Biphenyls (PCBs), Manufacturing, Processing, Distribution in Commerce and Use Prohibitions
STATE LAWS AND REGULATIONS	
Title 1, Chapter 2	Water Quality Standards and Wastewater Treatment Requirements
Title 1, Chapter 5	Rules Governing Hazardous Waste, Rules and Regulations of the Department of Health and Welfare
Title 1, Chapter 6	Idaho Solid Waste Management Regulations and Standards Manual
Title 1, Chapter 17	Wastewater-Land Application Permit Regulations
Section 42-238(4)	Well Construction Standards: Rules and Regulations
Section 42-3913	Construction and Use of Injection wells: Rules and Regulations
Section 42-238	Well Drillers Licenses: Rules and Regulations

Table 1-1. (continued).

DOE ORDERS AND GUIDANCE DOCUMENTS	
DOE Order 4320.1B	Real Property and Site Development Planning
DOE Order 5400.1	General Environmental Protection Program, November 9, 1988
DOE Order 5400.3	Hazardous and Radioactive Mixed Waste Program, February 2, 1989
DOE Order 5400.4	Comprehensive Environmental Response, Compensation, and Liability Act Requirements, October 6, 1989
DOE Order 5400.5	Radiation Protection of the Public and the Environment, May 3, 1989
DOE Order 5481.1B	Safety Analysis and Review System
DOE Order 5482.1B	Environmental Safety, and Health Appraisal Program
DOE Order 5484.1	Environmental Protection, Safety, and Health (ES&H) Protection Information Reporting Requirements, February 24, 1981
DOE Order 5820.2A	Radioactive Waste Management, September 26, 1988.
DOE Order 6430.1A	General Design Criteria, April 6, 1989
DOE Guidance (DOE/EH-0173T)	Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance, January 1991
STATE AND FEDERAL AGREEMENTS	
DOE/EPA/ State of Idaho	Federal Facilities Agreement/Consent Order for the INEL, December 9, 1991
DOE/State of Idaho	Environmental Oversight and Monitoring Agreement for the INEL, May 21, 1990

- Identify existing and potential groundwater contamination sources and maintain surveillance of these sources

- Demonstrate compliance with and implementation of all applicable regulations and DOE orders

- Provide data to permit the early detection of groundwater pollution or contamination

- Provide a reporting mechanism for detected groundwater pollution or contamination

- Provide data upon which decisions can be made concerning land disposal practices and the management and protection of groundwater resources.

In addition to the primary objectives of DOE Order 5400.1, the following INEL site-specific objectives have been established for the INEL Groundwater Monitoring Program:

- Develop a comprehensive monitoring program to determine the effects of INEL operations and accidental releases on groundwater quality

- Monitor and define trends for groundwater quality indicator parameters

It should be noted that DOE-ID's objective to "develop a comprehensive monitoring program to determine the effects..." includes the DOE Order 5400.1 objective to "provide data to permit the early detection of groundwater pollution or contamination." Therefore, these objectives will be treated as a single objective in this Plan using DOE-ID's broader scope.

1.5 Monitoring Strategy

The overall strategy used in developing this Plan was as follows. Existing groundwater conditions were benchmarked and potential sources of contamination were evaluated. Networks of monitoring wells were then planned to provide a balance between DOE's requirement of early contaminant detection and the general requirement that migrating contaminants not be permitted to escape detection altogether. The reasons that a trade-off was necessary to satisfy both requirements simultaneously are explained in Section 1.5.3.2.

A sampling and analysis program that is as much as possible Site-wide has been developed and will be implemented. The Site-wide nature of the program is important because this will help to ensure that analytical results generated by the various INEL groundwater organizations are comparable. Finally, a graded contaminant reporting and response system has been devised to ensure that detection of contamination at a given level of severity is matched by an appropriate level of response.

The strategies to be used in implementing each of the INEL Groundwater Monitoring Program Objectives listed in Section 1.4.3 are described below.

1.5.1 Determine and Document Groundwater Quality and Quantity Baseline Conditions

Determination and documentation of baseline conditions undertaken during development of the Plan has involved compilation of existing data for the description of past and current conditions, and will involve the conduct of a coordinated groundwater monitoring program for the generation of similar data in the future. Historical and current hydrogeological conditions were documented to establish snapshots of natural (prior to DOE operations at the INEL) and existing (as of 1992) water quality and quantity baselines. Data on the pre-INEL quality of groundwater were drawn from Robertson et al. (1974). Existing groundwater quality conditions were documented primarily based on a review of USGS publications and ERP documents. This baseline information is being used to determine the effects of past DOE operations at the INEL, and to establish benchmarks for future comparisons.

The ongoing monitoring program will be an effort coordinated among the USGS's observational monitoring program and the contractor compliance monitoring programs. The programs will use comparable sampling and analysis methods, and will analyze the same general indicator parameters on a Site-wide basis.

1.5.2 Identify and Document Existing and Potential Groundwater Contamination Sources

This objective requires that all contaminants which could potentially affect the aquifer be identified, documented, and evaluated, and that the list of such contaminants be updated as necessary. The purpose of this activity is to ensure that all known or potential sources of groundwater contamination are monitored.

To meet the objective, existing and potential contaminant sources were systematically identified and documented based on a review of USGS and contractor reports and data bases, and through interviews with cognizant personnel. The primary documents used in this evaluation were USGS Water-Resources Investigations Reports and Open File Reports, ERP Consent Order and Compliance Agreement (COCA) and FFA/CO documents and data bases, the DOE "Environmental Survey Preliminary Report," the "INEL Site Development Plan," INEL Resource Conservation and Recovery Act (RCRA) permit documentation, and the INEL Radioactive Waste Management Information System (RWMIS) and Industrial Waste Management Information System (IWMIS) data bases.

The resulting Contaminant Source Inventory (CSI) identified and documented approximately 1,000 known or potential sources of groundwater contamination at the INEL. This inventory, Appendix A, is a comprehensive summary of the contaminant sources broken down by operational area. As such, it contains entries which represent both serious water-quality threats as well as many entries whose associated risk is arguably trivial. The intent of this comprehensive approach is to ensure that no credible threat to the aquifer has been overlooked. Additional contaminant sources will be added to the inventory as they are discovered.

Among the units included in the CSI are sites being characterized by ERP under the FFA/CO. Some of these units have been recommended as "no action" sites, while characterization of others may not be scheduled to take place for several years. The decision to include these units in the CSI, and to describe some of them at greater length in the body of the INEL Groundwater Monitoring Plan, does not represent a contradiction of determinations made by ERP that a particular site does not constitute a threat to human health and the environment, or that characterization of a site can be safely deferred. The criteria used by ERP to determine whether a site requires characterization or remediation are different from those used by the INEL Groundwater Monitoring Plan to determine whether an area including the site should be monitored. Moreover, most of the contaminant source areas selected for monitoring under this program are aggregates of multiple individual potential sources. The presence of FFA/CO units within such aggregate source areas commonly is not the motivating reason for monitoring the area. It is thus natural that some areas containing units that have properly been dismissed by ERP would nonetheless be recommended for monitoring under this program.

The contaminant source information in the CSI was used to identify INEL areas that require groundwater monitoring, and to develop monitoring strategies at both regional and operational-area scales. If, based on professional judgement, it was concluded that contaminants from a given unit or facility could conceivably reach the SRPA, the unit or facility was plotted with others on operational-area or INEL maps. Areas containing such units were outlined on the maps after all the units were plotted. The resulting aggregate contaminant source areas were considered to be the maximum areas of potential contamination, the areas for which monitoring at the regional or operational-area scale is necessary.

Networks of groundwater monitoring wells were designed to provide monitoring coverage for the areas of potential contamination. As implied above, the design of the monitoring plan includes well networks at several different scales or levels: the regional level, the operational-area level, and the unit/facility level. For the purposes of this report, the terms "operational area" and "area-specific" refer to the major areas of concentrated development such as Argonne National Laboratory-West (ANL-W), the Idaho Chemical Processing Plant (ICPP), and TAN. "Unit/facility-specific" refers to individual facilities such as percolation ponds and waste-storage facilities, which are commonly found within the major operational areas and may have specific regulatory requirements for monitoring. The three-part division of well networks by scale of monitoring is described further in Section 1.5.3.

Groundwater contamination is known or suspected at a number of areas at the INEL. Areas where groundwater contamination is known to have resulted from DOE operations include ICPP, RWMC, TAN, and TRA. Areas where groundwater contamination may have resulted from DOE operations, and where further groundwater investigations or monitoring are warranted, include:

- Argonne National Laboratory-West (ANL-W)
- Army Reentry Vehicle Facility Site (ARVFS)
- Auxiliary Reactor Area (ARA)
- Central Facilities Area (CFA)
- Boiling Water Reactor Experiment (BORAX)
- Power Burst Facility (PBF)
- Liquid Corrosive Chemical Disposal Area (LCCDA)
- Naval Ordnance Disposal Area (NODA)
- Security Training Facility (STF).

Area-specific groundwater monitoring plans have been developed for each of the major operational areas above. Areas that do not contain operations or activities associated with large quantities of radioactive or chemical compounds were excluded from consideration in this Plan: the mobility and concentration of constituents were also considered. During annual groundwater monitoring activity reviews, each area will be reevaluated, and additional areas may be incorporated or deleted based on the acquisition of new information or monitoring results. The results of these reviews will be incorporated into future revisions of the Plan.

1.5.3 Develop a Comprehensive Groundwater Monitoring Program to Determine the Effects of DOE Operations and Accidental Releases on the INEL Groundwater Regime.

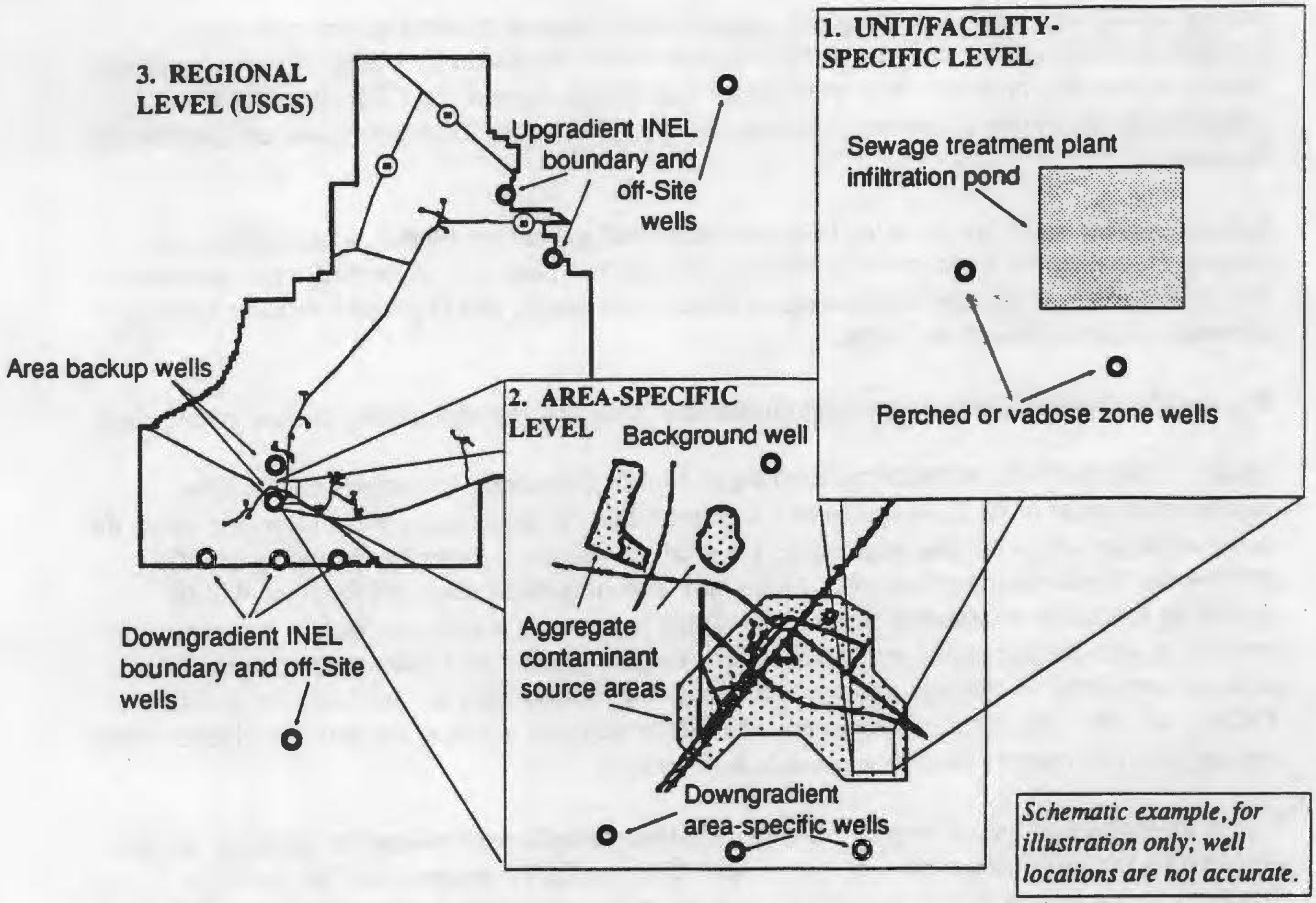
This objective calls for the establishment of an integrated groundwater monitoring program. The elements of the program are laid out in this Plan.

The Groundwater Monitoring Plan has been conservatively designed, based on best professional judgement and the best available information, to protect human health and safety and the environment. In situations where the extent of contamination or the potential threat associated with a given contaminant source cannot be definitively ascertained, the Plan generally defaults to the more conservative of the monitoring approaches available. The basis for using the more conservative approach is that it is considered preferable to err on the conservative side, at a higher initial cost, than to fail to detect a contaminant plume that could potentially cause harm to the public or the environment. However, the pertinent data collected during well construction, groundwater monitoring activities, and ERP groundwater characterization will be available for review by the INEL Groundwater Committee during the annual Groundwater Monitoring Activity Review. If the degree of conservatism of the monitoring program is judged to be inappropriate in light of new data, the Plan can be adjusted accordingly.

As stated above, a three-tiered monitoring network has been designed to determine the effects of INEL operations on the SRPA. Monitoring will be conducted at the level of individual units and facilities, at the level of operational areas, and at the regional level (Figure 1-3). Monitoring well networks associated with area-specific and regional monitoring have been designed, and are described in this Plan. Monitoring at the unit/facility-specific level is under development, and will be included in the next revision of the Plan.

Monitoring for the detection of accidental releases will be undertaken at the unit/facility-specific level where such monitoring is required by DOE Orders or other regulations. Monitoring will also be undertaken as a best management practice at units and facilities at which the consequences of a release could be high, or from which releases are considered to be especially likely. Area-specific monitoring networks have been designed to establish background (upgradient) and downgradient monitoring wells to document the affects on the SRPA of activities at operational areas.

A regional monitoring network has been designed to evaluate groundwater quality and quantity in regions between area-specific well networks, at Site boundaries, and at off-Site locations both upgradient and downgradient from the INEL. The regional well network is essentially a subset of the



Three-tier monitoring scheme example.

1) If unit/facility-specific monitoring details are not otherwise specified by regulation, monitoring specific to an individual facility (in this example, an infiltration pond) will be established in the perched water or vadose zone as close as possible to the facility perimeter.

2) Monitoring in the SRPA will be the province of the well network specific to the operational area that includes the facility (or a number of facilities). The area-specific network provides monitoring coverage for all of the units and facilities within the outlined aggregate contaminant source area.

3) At the regional level, USGS SRPA wells between the operational-area well networks serve as backup to those networks. The USGS wells typically have long open intervals, offering the possibility of sampling aquifer horizons that may not be sampled by the restricted-interval wells of the area-specific well networks. USGS wells at Site boundaries and off-Site provide a coarse-scale view of the quality of water entering and leaving the Site.

igure 1-3. Schematic illustration of three-tiered monitoring strategy.

existing USGS well network, although the recommended network includes several new wells. Regional-level monitoring undertaken for this Plan will be conducted by USGS. Regional and area-specific monitoring programs have been designed primarily to meet the DOE Order 5400.1 groundwater monitoring requirement for determining the effect of DOE operations on groundwater resources.

Because perched water bodies at the INEL are ephemeral and are not used as water supplies, the primary risk they pose is that of contaminating the aquifer. Therefore, if perched water is present it will be monitored as a means of maintaining source surveillance, and to provide an early warning of potential contamination of the SRPA.

The specific strategies for implementing unit/facility, area, and regional monitoring are given below.

1.5.3.1 Unit/Facility Monitoring Strategy. Unit/facility compliance monitoring will be conducted for units or facilities that have a high probability of impacting groundwater, for which the likely consequences of the potential impact are great, or which have specific regulatory or DOE groundwater monitoring requirements. Monitoring at nonregulated units and facilities will be tailored to individual unit/facility needs. Monitoring required by regulations will be conducted in accordance with the applicable regulations where specific groundwater monitoring requirements or guidance are given. If multiple groundwater monitoring requirements are applicable (e.g., RCRA, TSCA, and CERCLA), the monitoring networks will be designed to maximize cost-effectiveness while meeting the requirements of each applicable regulation.

If groundwater monitoring is required by regulation but specific requirements or guidance are not provided by the governing document, the groundwater monitoring program will generally be structured to resemble a RCRA monitoring program, with appropriate modifications (e.g., analyzing for the appropriate constituents). However, this does not imply that the INEL Groundwater Monitoring Program is a RCRA program per se. The basis for using RCRA is that it contains the most comprehensive Federal groundwater monitoring requirements. Therefore, it provides an excellent programmatic structure for establishing groundwater monitoring requirements. However, only those unit/facility-specific monitoring programs specifically designated as RCRA Groundwater Monitoring Programs in the text (i.e., the ICPP Percolation Ponds) must meet the specific requirements of RCRA.

One major exception to using the general RCRA monitoring program structure is in the location of unit/facility points of compliance. Where legally enforceable groundwater quality compliance points have been established (e.g., 40 CFR 264 and 40 CFR 191), the points of compliance will be located as specified in the regulations. However, if locations are not specified, vadose zone or perched water body monitoring will be implemented as close to the contaminant source as is reasonably achievable to establish early detection monitoring. The SRPA compliance points will consist of wells in the corresponding area-specific monitoring network. Unit/facility-level compliance monitoring plans are being developed in FY-93.

1.5.3.2 Area Monitoring Strategy. The primary purpose of operational area monitoring is to determine whether area-specific activities are contaminating the SRPA. Area-specific monitoring plans have been developed for all operational areas that were determined to have significant potential to affect the SRPA. These plans are described in detail in Sections 3 through 11.

Each INEL operational area was evaluated to determine whether it contains known or potential sources of contamination. Each area that contains such sources was further evaluated to determine whether it posed a threat to the SRPA. Area-specific groundwater monitoring plans were then developed for all areas that contain:

- Known sources of groundwater contamination which potentially could migrate to the SRPA
- CERCLA remedial action units
- Sources with a high potential for a release, or where the consequences of a release are potentially very significant (e.g., due to the large quantity or high toxicity of a contaminant)
- Activities or processes having specific regulatory groundwater monitoring requirements (e.g., low-level waste disposal areas).

Areas which consist solely of INEL FFA/CO units/facilities were evaluated, but as much as possible, institution of groundwater monitoring activities for them will be deferred until after FFA/CO characterization is completed. In addition, area-specific monitoring will be integrated with the unit/facility-level monitoring programs to either supplement or fulfill the requirements of the regulatorially driven programs.

Area-specific monitoring networks have been designed to monitor the SRPA and potentially contaminated spatially-continuous perched water zones. The monitoring networks were selected to ensure that the wells are far enough from each potential source area to encompass the lateral extent of significant soil or perched water contamination within the area, yet be sufficiently close to the source area to provide timely warning of aquifer contamination. Each area-specific SRPA monitoring network includes wells located upgradient and downgradient of the corresponding operational area. For the purposes of this Plan, unless there are other legally required compliance points, the downgradient SRPA wells will be considered the point of compliance, and these wells will be used to determine whether an area exceeds the action levels discussed in Section 13.

Unless area-specific needs dictate otherwise, downgradient monitoring wells in area-specific networks generally have been located approximately 150 m (500 ft) downgradient from the furthest downgradient extent of known or potential sources of contamination (e.g., surface spills or contaminated perched water bodies). The chosen width of this margin between contaminant sources and downgradient monitoring wells represents a trade-off between several competing needs. On one hand, wells should be located close to contaminant source areas in order to detect contamination from these sources as early as possible after it reaches the aquifer. Close proximity of wells to contaminant sources also minimizes the possibility that contaminants will be diluted to concentrations below detection levels before they reach a monitoring well.

On the other hand, for a given set of assumptions on dispersion values, reducing the margin between a well network and its monitored source area requires installation of a larger number of wells to obtain the same level of coverage. Wells that are too close to the source areas they are intended to monitor may fail to detect contaminants altogether. This can happen where downward-migrating contaminants encounter layers of reduced permeability within the thick [60-120 m (200-400 ft)] INEL vadose zone. In such circumstances, the contaminants may be displaced laterally, and may initially reach the aquifer downgradient from the monitoring wells. Based on professional judgement, the chosen margin width is considered a reasonable compromise between these competing needs.

1.5.3.3 Regional Monitoring Strategy. The USGS will have responsibility for monitoring to be conducted at the regional level as part of this Plan. Wells to be included in the Plan's regional monitoring network are drawn largely from the existing USGS observational monitoring network, although additional wells have been recommended to enhance the existing network. The existing USGS monitoring program is described in the INEL Groundwater Protection Management Program Plan, DOE-ID, 1992. The elements of the USGS program that are to form a part of the Site-wide monitoring program will be modified, as necessary, to ensure that they are well-integrated with other parts of this program. As part of its existing observational monitoring program, USGS monitors SRPA water quality on the Site between operational areas, at the upgradient and downgradient Site boundaries, downgradient of the INEL, and at selected perched water bodies. Regional monitoring and the USGS role in this program are described in detail in Section 12.

As part of this program, USGS will continue to monitor on-Site wells to determine general groundwater quality and quantity baseline conditions and to study contaminant migration. Each monitoring well in the regional-level network will be monitored for the contaminants of concern or for contaminant surrogates based on an evaluation of known or suspected contaminant sources at each area. In addition, since the existing USGS wells are open to the aquifer over long intervals or have open-ended casings, they will allow detection of contaminant plumes over a relatively large vertical distance within the aquifer. This will provide a degree of backup to compliance wells in the area-specific networks, which generally will be open only to the upper part of the aquifer over relatively short intervals [i.e., 6-9 m (20-30 ft)].

Site boundary monitoring will be conducted to detect groundwater contaminants entering or leaving the INEL. This monitoring includes wells located near the northern (upgradient) Site boundary in areas of high expected recharge (e.g., Little Lost River, Birch Creek and Mud Lake areas). Boundary monitoring also includes monitoring wells located near the southern (downgradient) Site boundary at points where contaminants originating at upgradient INEL operations and activities can be expected to arrive. Water quality downgradient from the Site is monitored using an extensive network of wells, which extends downgradient from the Site's southern boundary to the Thousand Springs area, near Hagerman, Idaho. The primary purpose of the downgradient monitoring program is to document the quality of water and determine the effect of Site operations and activities on off-Site groundwater resources.

Perched water monitoring is conducted by the USGS at the ICPP, RWMC, and TRA. The purpose of perched water monitoring is to study the migration of contaminants through the vadose zone to the SRPA.

1.5.3.4 Analytical Evaluation of Monitoring Network Design. The optimum number and locations of wells in the monitoring networks were based on best professional judgment and the results of modeling using the Monitoring Efficiency Model (MEMO). MEMO was developed by Golder Associates for the DOE, and was initially used on the Hanford Site in eastern Washington. The model generates hypothetical plumes from a potential source area, and determines whether those plumes are detected by a given network of monitoring wells. The model output consists of a map showing the areas at the modeled site where a release would and would not be detected by the site's monitoring wells along with a calculation of monitoring efficiency, which is reported as the size of the area from within which a release would be detected as a percentage of the total potential source area.

It should be noted that the groundwater flow directions displayed on the MEMO maps are not reported in terms of normal compass conventions. The flow directions are reported in degrees, but they increase in a counterclockwise direction, with zero degrees corresponding to due east. Using this system, a value of 90° indicates north, 180° indicates west, and 270° indicates south. MEMO has proven useful in providing a quantitative evaluation of the adequacy of monitoring networks, through the maps showing release detection areas and the computed monitoring efficiency value. A technical description of MEMO and a discussion of its assumptions and limitations are presented in Appendix B.

The monitoring networks have been designed to provide acceptable detection capabilities over the range of groundwater flow directions that may reasonably be expected beneath each area. The density and spacing of wells and the depth ranges of open well intervals were chosen using a three-part process:

- Evaluate existing documents to determine the area-specific hydrogeological and contaminant characteristics. The area-specific characteristics used for designing each network are listed in Sections X.5 (where "X" stands for a number between 3 and 10, corresponding to the area-specific Sections).

- Evaluate each area using a consistent methodology (including both MEMO analysis and professional judgement) and area-specific parameters. The general parameters and the methodology for deriving area-specific parameters used for MEMO are given in Appendix B. The area-specific assumptions and parameters are given in Sections X.5.

- Evaluate the MEMO results to determine whether the results are reasonable given what is known about area-specific conditions.

Shallow aquifer wells are defined as wells that monitor the uppermost portion of the aquifer, normally the top 6 to 15 m (20 to 50 ft). MEMO provided analytical evaluations of the shallow aquifer monitoring well networks during the design process for all INEL operational areas. A value of 95%

was chosen as the minimum acceptable monitoring efficiency for the monitoring networks. In theory, this means that a release occurring at any point within 95% of the outlined potential contaminant source area would be detected. Releases at points amounting to 5% of the source area could pass the buffer zone beyond the monitoring network without being detected. Monitoring efficiency values for each area are provided in Appendix B.

The hydrogeology of the INEL is complex. Our knowledge of the migration of contaminants through the vadose zone and their subsequent movement within the SRPA is limited. The complexity of the hydrogeologic regime and the limits of our knowledge defy definitive modeling of contaminant transport in the SRPA. Some of the assumptions used in the MEMO model may be overly simplistic, but that simplicity may be consistent with the state of our knowledge. Moreover, the results of MEMO modeling were not used in the absence of professional judgement.

Prior to installing wells, all pertinent data will be reevaluated to ensure that the most recent and best available data are used as the basis for locating wells. In addition, if more than four or five new wells are planned for a given well network, they will be constructed using a phased approach. This will consist of installing a small number of wells, evaluating the body of the accumulated data including that generated by the new wells, and modifying the design of the next planned phase as necessary. The reevaluation may result in the drilling of more or fewer wells than had been planned, or it may require that proposed locations of planned wells be modified. Therefore, the monitoring networks as actually constructed can be expected to differ from the specific designs shown in this document.

1.5.3.5 Groundwater Monitoring Well Construction. All available INEL well construction information has been compiled in the "Comprehensive Well Survey for the Idaho National Engineering Laboratory," and all existing INEL monitoring wells are being evaluated to determine their fitness for use. Each well is being evaluated against applicable DOE and other regulatory well construction requirements, resurveyed to confirm its location and elevation, and evaluated to determine its adequacy for detecting contaminant plumes. Wells found to be inadequate will be upgraded or replaced, and new wells will be constructed where necessary to ensu: adequate monitoring capability. Wells controlled by USGS that are recommended for upgrading will be upgraded with USGS concurrence. All new area-specific and unit/facility-specific monitoring wells will, at a minimum, be constructed to meet the general requirements of RCRA and State-of-Idaho regulations for the construction of wells.

The construction of regional monitoring wells varies, depending on site-specific monitoring needs. Most regional wells at the INEL have been constructed with much longer monitoring intervals than the 3- to 9-m (10- to 30-ft) interval that is standard for RCRA monitoring wells. Although this design may permit some sample dilution, it also provides a greater chance of detecting contaminants over a larger vertical distance through the aquifer (assuming low detection limits are used). At a minimum, regional wells will meet DOE-ID's wellhead completion requirements and the applicable requirements of the State-of-Idaho "Rules and Regulations for the Construction of Wells" (IDWR, 1988).

New Well Construction Standards - New wells will be constructed according to the following guidelines, unless otherwise noted in the area-specific sections. New wells will be constructed in general conformance with current RCRA guidelines (EPA, 1986). The wells are expected to use schedule-five type 304 stainless-steel screen, and either stainless steel or carbon steel casing. All casing and screen segments will be factory cleaned and wrapped, and will be inspected for integrity and cleanliness prior to installation. Screens are expected to be wire-wrapped, with a slot size of 0.5 mm (0.020 in., 20 slot) and a length of 9 m (30 ft). Drilling will be performed until the first productive zone beneath the water table is penetrated. Wells will be screened across this first productive zone of the aquifer.

Wells are expected to be drilled by direct rotary methods, with conductor casing used in the overburden materials to support the borehole walls. Selected wells will be cored where detailed geological information is determined to be needed for other INEL programs. Drilling diameters will be stepped down with depth, as dictated by subsurface conditions, to a minimum of 10 cm (4 in). In wells which are to be screened, the top of the screen will be placed approximately 1.5 m (5 ft) above the uppermost productive zone.

Drill cuttings will be monitored with hand-held instruments for organics and radionuclides as cuttings are produced from the borehole, in accordance with the Health and Safety Plan for drilling. Downhole drilling equipment will be decontaminated in accordance with the Environmental Investigation Procedures (EIPs) specified in the Sampling and Analysis Plan provided in Appendix D. Decontamination will be conducted at a minimum: (a) after passing through any contaminated horizons encountered in the vadose zone, (b) prior to use of drilling equipment at a new borehole, and (c) as required for the protection of on-site personnel. Appropriate decontamination equipment and materials will be available at the drilling site or at a location designated for decontamination activities.

1.5.3.6 General Indicator Parameters. The general indicator parameters shown in Table 1-2 will be measured during each sampling event conducted for this Plan. General indicator parameters will be analyzed Site-wide to determine baseline levels of parameters that are useful as indicators of contamination, to allow for checking of results, and to facilitate calculation of ion balance. The rationale for selection of each of the general parameters is provided in the table.

Although most of the areas monitored at the INEL do not have RCRA facilities that require groundwater monitoring, a number of the general indicator parameters chosen are required in 40 CFR 265.92(b) for interim status RCRA monitoring. Two RCRA-required parameters are not included as general indicators because they are not prevalent at the INEL and because their presence can be indicated by surrogates. They are radium, which will rely on gross alpha as a surrogate, and gross phenols, which will rely on total organic carbon (TOC) as a surrogate.

1.5.3.7 Area-Specific Indicator Parameters. A list of contaminants of potential concern was developed for each operational area. These lists were intended to include all chemical and radioactive contaminants suspected to be in an area's waste streams, or known or suspected to have been released to the environment, based on process knowledge and historical documentation. The constituents included on the lists have toxic or carcinogenic effects at certain concentrations, and may have an impact on human health.

Table 1-2. General indicator parameters.

Parameter	Rationale for Selection
General Groundwater Contamination Parameters	
pH (field and laboratory) Specific Conductance (field and laboratory) Total Organic Carbon (TOC) Total Organic halogen (TOX)	General indicators of groundwater contamination parameters required for all RCRA interim status monitoring programs
Gross Alpha	Provides general indication of a wide variety of radionuclides
Gross Beta	Provides general indication of a wide variety of radionuclides
Other General Indicators	
Sodium	Major cation needed for ion balance calculations and checking analyses
Calcium	Major cation needed for ion balance calculations and checking analyses
Magnesium	Major cation needed for ion balance calculations and checking analyses
Potassium	Major cation needed for ion balance calculations and checking analyses
Iron	Major cation needed for ion balance calculations and checking analyses
Chloride	Major anion needed for ion balance calculations and checking analyses
Sulfate	Major anion needed for ion balance calculations and checking analyses
Carbonate	Major anion needed for ion balance calculations and checking analyses
Bicarbonate	Major anion needed for ion balance calculations and checking analyses

Table 1-2. (continued).

Parameter	Rationale for Selection
Other General Indicators (cont'd)	
Nitrate	Major anion needed for ion balance calculations and checking analyses
Tritium	Widespread distribution across INEL, cannot be detected well by general radiological parameters (alpha and beta)
Arsenic	May occur naturally at relatively elevated concentrations at the INEL and was also present in some INEL waste streams.
Total Alkalinity	Needed for evaluating correctness of analysis and checking analyses
Total Dissolved Solids	Needed for evaluating correctness of analyses and for comparison to specific conductance values
Turbidity (field)	Provides qualitative measurement of the amount of suspended solids
Water Temperature (field)	Needed to measure pH and specific conductance in the field and may be helpful in evaluating groundwater origin
Water Level (field)	Needed to help determine groundwater flow rates and directions

For each operational area, a set of specific indicator parameters was selected from among that area's contaminants of potential concern. Groundwater samples collected from monitoring wells in the area-specific networks will be analyzed for these area-specific indicator parameters in addition to the general indicator parameters described previously. Selection of a contaminant to serve as an area-specific indicator parameter was done using one of two methods. The first method involved comparison of groundwater concentrations detected in area-specific monitoring wells against certain threshold concentrations. The second method involved a subjective evaluation of contamination potential.

For the first method of indicator parameter selection, the maximum concentrations of constituents that had been detected in groundwater at each area were compared with one or more threshold concentration levels. Above these threshold levels, human health effects may occur under a given exposure scenario. If the maximum detected concentration of a constituent exceeded one of these threshold levels, the constituent was considered a strong candidate for inclusion on the list of indicator parameters.

The threshold concentrations against which the maximum detected concentrations were compared are of two types, 1) water quality standards, and 2) human health risk-based screening concentrations. Water quality standards include Federal maximum contaminant levels (MCLs) developed to support implementation of the Safe Drinking Water Act (SDWA) and Idaho State MCLs. Risk-based concentrations are based upon the toxicity factors associated with each contaminant. For most contaminants, the risk-based screening concentrations have been calculated by EPA as an appendix to the Region 10 Supplemental Risk Assessment Guidance for Superfund. These are informally known as the EPA "cheat sheets" and are presented in Appendix C. Risk-based concentrations were not available for radioactive contaminants and some of the nonradioactive contaminants. For these contaminants, risk-based concentrations were calculated using standard EPA methods. More information is available on these calculations and their underlying assumptions in Appendix C.

The second method of choosing candidates for inclusion on the list of indicator parameters was applied to all constituents suspected of having the potential to contaminate groundwater, and involved a subjective evaluation of the factors controlling such contamination. Consideration was given to such variables as quantities disposed, mode of disposal (e.g., injection well versus infiltration pond), constituent transport characteristics, and toxicity of the contaminant. Based on this evaluation, constituents that were judged to have a realistic possibility of causing groundwater contamination were considered strong candidates for inclusion on the list of area-specific indicator parameters.

Best professional judgement was used to compile the final list of area-specific indicator parameters at each operational area. This list does not include all possible contaminants at the area, but is a representative set of contaminants that are good indicators of groundwater quality.

Initially, groundwater samples collected from the monitoring networks will be analyzed for the area-specific indicator parameters. If these contaminants are not detected over a prescribed period of time (which is still to be determined), the monitoring frequency may be reduced, or groundwater monitoring may be discontinued altogether. Adjustments to the groundwater monitoring program wil be based on the outcome of the annual Groundwater Monitoring Activity Review. This review will be conducted by the 5400.1 program on an annual basis in conjunction with the INEL Groundwater Committee.

1.5.3.8 Sampling and Analytical Methods. The INEL Groundwater Monitoring Program requires the acquisition of analytical data with known quality in order to ensure the detection of groundwater contaminants and to ensure comparability of data derived from the various INEL monitoring locations. Therefore, all compliance groundwater monitoring activities at the INEL will be conducted in accordance with a common sampling and analysis plan (SAP) (Appendix D), established quality plans, and common standard operating procedures (SOPs). In addition, all USGS observation monitoring will be conducted in accordance with an established quality plan and SAP. The quality plans and SOPs will be included in the Draft Quality Assurance Manual for INEL Groundwater Monitoring.

The compliance SAP establishes sitewide groundwater monitoring data quality objectives (DQOs) and analytical parameters. The selection of compliance monitoring parameters was primarily based on the requirements of DOE Order 5400.1 and RCRA (40 CFR 264 and 265). In addition, the parameters include selected radionuclides necessary to meet DOE's monitoring needs for the Atomic Energy Act (AEA), and the hazardous substances and radionuclides necessary for CERCLA.

USGS's SAP establishes DQOs and analytical parameters in accordance with internal USGS requirements and the general requirements of DOE Order 5400.1. USGS's monitoring parameters are primarily based on Site-specific knowledge gained through more than 40 years of monitoring at the INEL.

Each sampling organization participating in this Plan has developed a groundwater monitoring quality assurance plan. Although a single quality plan would be desirable for the entire groundwater monitoring program, the approach used here accounts for the reality that each organization's groundwater quality plan is required to integrate with its organization-specific upper-tier quality plans or manuals. Each groundwater monitoring quality plan will be reviewed by DOE-ID to ensure compatibility among the plans.

The groundwater monitoring SOPs have been based on standard EPA and industry practices modified to meet INEL-specific needs.

1.5.4 Define Trends for Groundwater Quality Parameters

This objective calls for conducting trend analysis on groundwater sample results to determine whether groundwater quality is changing. Trend analysis used for this program is designed to provide an early warning of increasing contaminant concentrations that could lead to unacceptably high levels of contamination, and to permit corrective actions to be taken prior to the occurrence of major problems. During the first year of sampling carried out under this program, trend analysis will be applied to establish a baseline for the parameters of interest that will help identify any seasonal variations. Thereafter, the primary objective of the trend analysis will be to project chemical and radionuclide concentrations into the future for each monitored well, and to identify significant changes in the sampling results.

Trend analysis is expected to permit optimal use of the existing data base by providing a means of attenuating extreme values. It will permit decisions to be based upon consideration of data from a sequence of sampling rounds over an extended period of time, rather than upon isolated results from a single round.

1.5.5 Demonstrate Compliance with and Implementation of all Applicable Regulations and DOE Orders

This objective would demonstrate that the INEL is in compliance with the applicable groundwater monitoring regulations and requirements. A three-phase approach will be used: (1) identify the applicable regulations and monitoring requirements; (2) determine the specific technical requirements for each regulation or requirement; (3) evaluate each facility or operation against the applicable technical requirements.

The minimum Federal regulatory standards that are applicable to DOE facilities are outlined in DOE's "Mandatory Environmental Protection Standards" (see DOE Order 5400.1). These standards, along with State-of-Idaho environmental regulations and DOE orders, were evaluated in the "Overview of Groundwater Regulations Pertinent to the INEL" to determine which regulations contain groundwater monitoring requirements that are or could be applicable to the INEL. In addition, the applicable technical groundwater monitoring requirements of each regulation were documented. A summary of the standards reviewed and their groundwater-related requirements is given in Table 1-1, and a detailed discussion of each applicable regulation is presented in "Overview of Groundwater Regulations Pertinent to the INEL" (EG&G Idaho, 1992).

Presently, there are no regulatory requirements to conduct regional hydrogeological regime analysis or groundwater monitoring. Therefore, for the purposes of this Plan, all USGS monitoring is considered to be observational monitoring, which is conducted to meet DOE programmatic and USGS programmatic and research needs. However, the USGS data are being used by DOE and site contractors to meet baseline groundwater quality monitoring requirements of DOE Order 5400.1, the FFA/CO, and other applicable regulations. The USGS is presently evaluating and updating its QA/QC procedures. DOE-ID and the USGS will renegotiate the minimum QA/QC requirements (e.g., DOE Order 5400.1 QA requirements) applicable to USGS groundwater activities during the renewal of the DOE/USGS Interagency Agreement in FY-93.

There are no specific regulatory requirements to conduct area-specific groundwater monitoring. However, area-specific groundwater characterization is an integral part of the RI/FS work plans at some areas under the FFA/CO. In addition, groundwater monitoring will probably play a key role in demonstrating the performance of various remedial actions implemented under the FFA/CO.

An evaluation will be conducted at each operational area to determine the specific regulatory requirements for groundwater monitoring at each unit/facility. Each area will then be evaluated and the technical monitoring requirements applicable to each unit/facility will be documented. The appropriate technical monitoring requirements will be incorporated into the appropriate area-specific monitoring chapters in this Plan. The evaluations will be conducted and unit/facility-specific groundwater monitoring plans will be developed and incorporated into this Plan in FY-93.

When the groundwater monitoring program has been implemented, all monitoring data from SRPA wells used in this program will be evaluated as outlined in Section 14, and compared against the applicable DOE or regulatory action levels during the data evaluation phase of each sampling round. Wells that produce samples that exceed specific action levels will be resampled. If a resample confirms the initial sample results, DOE-ID will be notified in accordance with specific reporting requirements as outlined in Section 15, and response actions will be implemented as outlined in Section 13.

1.5.6 Provide a Reporting Mechanism for Detected Groundwater Pollution or Contamination

1.5.6.1 Sitewide Coordination. This objective covers the establishment of programs for Site-wide integrated data management (Section 15), reporting (Section 13), and response (Section 13) for all INEL compliance groundwater monitoring programs. This will include a single data management system and data repository to provide a Site-wide clearing house for all INEL groundwater monitoring data. It will also provide a central point of contact for initiating contaminant responses.

1.5.6.2 Action Levels. "Action level" refers to a specified contaminant concentration or other specific condition that, when observed, results in initiation of a specified response scenario. The action level thresholds implemented by this program have been developed based on DOE Orders, EPA regulations and guidance, and best management practices. The action levels established for this Plan apply only when the detected contaminant has <u>not</u> previously been detected at the observed level. A hierarchy has been established for the action levels and their associated responses.

Three general hierarchical action levels will be employed for this program, ranked in order of increasing seriousness: Routine (no action); Unusual Occurrence; and Environmental Occurrence. Each action level is associated with an increased level of contamination as compared to the level beneath it. The allowable response time and intensity of the response activity vary with the action level.

Routine Action Level - The Routine action level applies to all analytical results in which a pollutant or hazardous substance is:

- Not detected above background concentrations
- Measured at a contaminant level which is $\leq$ 50% of that parameter's Maximum Contaminant Level (MCL)
- Through trend analysis, is not projected to exceed 80% of that parameter's MCL within 2 years.

UOR Action Level - The UOR action level is triggered when analytical results for contaminants significantly exceed pre-established background levels. The UOR action level response scenario meets all requirements for Site monitoring activities originating from DOE Order 5000.3B, "Occurrence Reporting and Processing of Operations Information."

The UOR action level includes additional INEL-specific followup responses and reporting when specific conditions are met. For this Plan, two additional sub-categories have been established within the UOR action level. These sub-categories are "Moderate Concern Response" and "Significant Concern Response." Significant Concern is the most severe sub-category. The criteria for these response categories are as follows:

- Moderate Concern Response: Analytical results, for pollutants or hazardous substances, are greater than 50% of the MCL or, using trend analysis, the projected concentration will exceed 80% of the MCL within two years.

- Significant Finding Response: Analytical results, for pollutants or hazardous substances are greater than 80% of the MCL or, based on trend analysis, the projected concentration will exceed 80% of the MCL within six months.

Environmental Concern Action Level - The Environmental Occurrence action level is activated when contaminants are observed at levels in excess of a DOE or other regulatory threshold.

The subset of compliance monitoring activities which are conducted specifically to meet regulatory requirements (e.g., RCRA or CERCLA) will meet both the regulatory and the DOE action levels and associated responses.

RCRA Action Levels - RCRA action levels are activated when an observed analytical result is significantly greater than the given parameter's statistical background, or pH is significantly less than background. Under RCRA the response scenarios differ for detections made at upgradient and downgradient wells. All RCRA responses at the INEL, unless superseded by the INEL FFA/CO, will be conducted in accordance with 40 CFR 265.93.

All characterization and remediation of inactive waste sites is conducted in accordance with CERCLA under the jurisdiction of the INEL FFA/CO. Section 1.3.2 of the FFA/CO Action Plan (Integration with Other Programs) states that "Releases or threatened releases of hazardous substances under regulatory programs that require investigation and study for cleanup are addressed under this Action." CERCLA action levels are addressed in the INEL FFA/CO and other ERD documents, and are not presented here.

1.5.6.3 Site-wide Reporting. All reporting activities will be coordinated through the DOE-ID Environmental Support Division (ESD) groundwater monitoring contact person. The USGS and all contractor sampling organizations under DOE-ID's cognizance will report directly to DOE-ID ESD. Copies of all excursion reports transmitted to DOE-ID ESD will also be transmitted to the sampling organization's programmatic counterpart and to the facility landlord. ANL-W will transmit all necessary reports through its appropriate organizations to DOE-ID ESD through DOE-CH, in accordance with its established procedures.

1.5.7 Provide Data Upon Which Decisions Can Be Made Concerning Land Disposal Practices and the Management and Protection of Groundwater Resources

This objective will be carried out through monitoring of all active land disposal facilities, and comparing the monitoring data against the wastes being disposed to determine if the disposal practices are causing unacceptable environmental degradation. Based on the results of these ongoing evaluations, recommendations for adjusting or discontinuing waste disposal practices, if necessary, will be transmitted to the appropriate DOE and contractor managers.

Groundwater monitoring will be conducted at all land disposal facilities which discharge or contain significant quantities of chemical or radioactive constituents (e.g., percolation ponds and landfills). This monitoring will be conducted as part of the "unit/facility" monitoring programs (Section 1.5.3.1). All water quality data will be evaluated, maintained on a common data base, and summarized in the Annual Site Environmental Report. Any data that indicate that existing land disposal practices are causing or may cause a statistically significant groundwater problem will be documented in a report to the facility landlord and DOE-ID as soon as practical (Section 14). If additional data confirm that a significant environmental problem is developing or exists, a formal report will be submitted to the facility landlord and DOE-ID for corrective action.

1.6 Groundwater Monitoring Program Organization

1.6.1 Associated Monitoring Programs

Operations at the INEL are known to have affected the quality of groundwater in the underlying SRPA. Known and potential sources of groundwater contaminants include discharges to injection wells and shallow percolation ponds, inactive and active buried waste sites, and underground storage tanks. Due to these impacts, various environmental regulations, and DOE's programmatic needs, numerous groundwater monitoring and characterization programs have been initiated at the INEL. The primary INEL groundwater-related programs are outlined below.

- The USGS's regional hydrogeological regime analysis and groundwater monitoring program are observational monitoring programs and are not required by specific regulations. However, data from these programs have been used to delineate subsurface waste areas and to support most INEL groundwater-related programs.

  As was discussed above, portions of the existing USGS program have been selected for inclusion in the integrated Site-wide monitoring program. Within the integrated program, the selected USGS wells will back up and tie together the area-specific monitoring networks, as well as provide water quality information at and beyond Site boundaries both upgradient and downgradient from the INEL. Monitoring conducted under this Plan at the regional level, which is the responsibility of USGS, is described in Section 12.

- Contractor SDWA programs monitor potable water at the facilities under their jurisdiction. Drinking water monitoring is conducted in accordance with 40 CFR 141 through 143, and Title 1, Chapter 8, Idaho Code.

  Due to the specific nature and requirements of the SDWA program, the SDWA program is documented in separate program plans. However, the INEL Groundwater Monitoring and SDWA programs will coordinate by ensuring that data and information collected by each program are available to the other program. The specifics concerning how programmatic coordination will be ensured will be contained in the unit/facility-specific portions of this Plan.

- Underground injection control programs are being developed by each contractor for the injection wells under its jurisdiction. Any necessary underground injection well monitoring is conducted in accordance with Federal (40 CFR 149 and 40 CFR 265) and State of Idaho (Title 42, Chapter 39) underground injection requirements.

  No active underground injection now occurs at the INEL. UIC permit applications have been submitted for eight INEL surface water injection wells (gravity-flow). Since active waste streams are not discharged to these wells, neither effluent nor groundwater monitoring directed at them is being conducted at this time. If groundwater monitoring becomes required in the future, this monitoring will be integrated into the unit/facility-specific monitoring sections of this Plan.

- The Environmental Restoration Program is responsible for the characterization and cleanup of past hazardous waste activities and sites (operational before March 1, 1987). ERP activities are conducted in accordance with the INEL FFA/CO.

  Sites being characterized and remediated by ERP have been consolidated into Waste Area Groups (WAGs). Since ERP's groundwater characterization activities are negotiated on a WAG-by-WAG basis, ERP's groundwater characterization will be documented in their respective RI/FS documents, as required by the INEL FFA/CO. However, the INEL groundwater monitoring program has coordinated with these ERP programs by using existing ERP data and information to the greatest extent possible, and by directly involving the contractor WAG Managers in the monitoring plan scoping and review processes. The area-specific monitoring programs developed in this Plan are essentially the same as ERP's at ANL-W, ICPP, ARA, and PBF. The area-specific monitoring programs developed in this Plan are similar to those plans proposed by ERP at TRA and RWMC. Due to program-specific needs, the area-specific monitoring programs developed in this Plan are quite different from ERP plans for TAN, CFA, and EBR-I, though they are compatible with them.

  The INEL Groundwater Monitoring Program will continue to coordinate with ERP by sharing groundwater characterization and monitoring data with ERP WAG Managers, by exchanging information and ideas through direct contact with them, and by participating in the INEL Groundwater Committee. The INEL Groundwater Monitoring Program will continue to involve the ERP WAG Managers directly in the development and implementation of the

Monitoring Plan to the extent that both programs determine that this involvement is mutually beneficial.

- The INEL Decontamination and Decommissioning (D&D) program is managed by each contractor for the facilities under its jurisdiction. The purpose of the D&D program is to implement the Surplus Facilities Management Program and the Defense Facilities Decommissioning Program for excess facilities and areas at the INEL.

  Presently, no INEL facilities scheduled to be D&D'd have been identified as needing groundwater monitoring. However, the INEL Groundwater Monitoring Program will meet with the facility-specific D&D managers during development of the unit/facility-specific plans to determine if unit/facility-specific groundwater monitoring may be needed in the future. If unit/facility-specific groundwater monitoring is needed, the 5400.1 program will offer assistance to the D&D managers. If groundwater monitoring becomes necessary in the future, D&D groundwater monitoring activities will be incorporated into the appropriate unit/facility-specific section, as requested by the applicable contractor D&D manager.

- The INEL Tank Management Program includes: underground storage tanks (USTs) regulated by 40 CFR Part 280; nonregulated USTs; radioactive waste tanks; hazardous material storage tanks; and hazardous waste storage tanks.

  This program is managed jointly by DOE-ID ERP (for inactive USTs contained on the FFA/CO list), and by DOE-ID ESD in conjunction with the tank "owner" or facility landlord (for active tanks). Tanks under ERP's jurisdiction will be remediated as required by the FFA/CO. Tanks under the jurisdiction of ESD and the facility landlord will be monitored in accordance with applicable regulations (e.g., 40 CFR Part 280). However, based on site-specific conditions (primarily the depth to groundwater), using groundwater monitoring to monitor for UST releases at the INEL is not a viable option. Therefore, inventory control and monitoring of the vadose zone at selected locations may be used to monitor for releases to the environment.

  The INEL Groundwater Monitoring Program will meet with facility landlords and UST program managers during development of unit/facility-specific plans to offer assistance in developing facility-specific vadose monitoring programs, as requested.

- Nonradiological effluent monitoring is conducted by each INEL contractor at its facilities. Nonradiological liquid effluents are monitored to determine compliance with DOE Orders 5480.1, 5481.1, 5480.4, 5484.1, and 5400.1; with Title 1, Chapter 2, Idaho Code; and with 40 CFR 122. Effluent monitoring is also used to evaluate the effectiveness of effluent treatment and control systems.

  The INEL Groundwater Monitoring Program has evaluated information for all known nonradiological liquid effluent discharge points and designed each area-specific network to encompass the appropriate facilities. During the unit/facility groundwater monitoring evaluation, the INEL Groundwater Monitoring Program will work with the appropriate area-specific managers to assist them in determining their groundwater monitoring needs (e.g., for State of Idaho Waste Water Land Application permits). In addition, the program will work with area-specific managers to ensure that effluent and groundwater monitoring are coordinated to maximize the usefulness of the data produced and to minimize costs.

- Radioactive liquid effluent monitoring at the INEL is conducted at all discharge points that release radioactive effluents to soil columns, including percolation ponds or drain fields. Radioactive liquid effluent monitoring is conducted in accordance with DOE Orders 5400.1 and 5400.5.

  The INEL Groundwater Monitoring Program has evaluated information for all known radiological liquid effluent discharge points and designed each area-specific network to encompass the appropriate facilities. During the unit/facility groundwater monitoring evaluation, the INEL Groundwater Monitoring Program will work with the appropriate area-specific managers to assist them in determining their groundwater monitoring needs (e.g., for State of Idaho Waste Water Land Application permits). In addition, the program will work with the area-specific managers to ensure that effluent and groundwater monitoring are coordinated to maximize the usefulness of the data produced and to minimize costs.

- RCRA establishes unit/facility-specific groundwater monitoring regulations and permit application requirements for RCRA hazardous waste facilities. The State of Idaho has adopted these regulations by reference, and was granted primacy by EPA to regulate hazardous waste (including mixed waste) effective on April 9, 1990 (55 FR 11015-11018). State of Idaho groundwater monitoring regulations are contained in: IDAPA 16.01.5000, "Rules, Regulations and Standards for Hazardous Waste:" Section 01.5008, State of Idaho (40 CFR 264); Section 01.5009, State of Idaho (40 CFR 265); and Section 01.5012, State of Idaho (40 CFR 270).

  The INEL RCRA Technical Support (IRTS) program is responsible for obtaining RCRA permits for EG&G RCRA Treatment, Storage and Disposal facilities and for coordinating Site-wide permitting efforts. ANL-W, B&W, Idaho, and WINCO maintain analogous RCRA permitting programs, which they coordinate with the IRTS program. One function of the permitting program is to identify INEL land-based RCRA units (e.g., surface impoundments, waste piles, land treatment units, some tank systems, and some miscellaneous units such as open burn/open detonation areas), and to establish RCRA-compliant groundwater monitoring programs/systems, as necessary. A preliminary evaluation of the INEL RCRA TSD facilities indicates that six units may require groundwater monitoring:

  - Transuranic Storage Area and Intermediate-Level Transuranic Storage Facility (TSA/ILTSF)
  - Naval Ordnance Disposal Area (NODA)
  - Reactives Storage and Treatment Area (RSTA)
  - Radioactive Scrap and Waste Facility (RSWF)
  - ICPP Percolation Ponds 1 and 2
  - ICPP Tank Farm.

A RCRA groundwater monitoring program has been developed for the ICPP percolation ponds. Although groundwater monitoring at the ICPP tank farm is not directly required by RCRA, DOE Order 5820.2A requires that such monitoring be undertaken and that RCRA standards be used (see following bullet). The remaining four units do not require RCRA groundwater monitoring under interim status. However, the groundwater monitoring needs of all INEL RCRA TSD facilities will be reevaluated during development of monitoring plans at the unit/facility level. A RCRA groundwater monitoring plan will be written for any facility at which it is found to be necessary.

- Radioactive wastes generated, treated, stored or disposed at the INEL include high-level, TRU, low-level, and mixed wastes. Groundwater monitoring at DOE radioactive waste management facilities is governed by DOE Orders 5400.1, 5400.3, 5400.5, 5484.1, 5820.2A, and 6430.1A. A minimum requirement of DOE Order 5820.2A is that groundwater or vadose-zone monitoring wells meeting 40 CFR 264 requirements be installed around clusters of high-level liquid waste storage tanks. High-level wastes are generated at the ICPP and stored in the ICPP Tank Farm for processing (calcination) and storage in ICPP bin sets.

  New TRU interim waste storage facilities are required to be "sited, designed, constructed and operated consistent with the requirements of the applicable RCRA regulations." At a minimum, consideration must be given to the proximity of the facilities to groundwater, a monitoring system must be developed to detect releases, and monitoring must be conducted to establish background concentrations for the primary radioactive and hazardous waste constituents. Areas where TRU wastes are generated, treated, stored, or disposed at the INEL include ANL-W, RWMC and TRA.

  Low-level waste must be managed to protect groundwater resources, but detailed requirements for implementation of this objective are not explicitly defined. Areas where low-level wastes are generated, treated, stored, or disposed at the INEL include ANL-W, CFA, ICPP, RWMC, SMC, TAN, TRA, and WERF.

  A groundwater monitoring program has been established at the ICPP to monitor the high-level wastes stored in the ICPP Tank Farm (Section 6). This program has been established in accordance with the requirements of RCRA and DOE Order 5820.2A. During the development of the unit/facility-specific plans, the other INEL areas which contain radioactive waste management facilities will be evaluated in accordance with the requirements of the above DOE Orders and the recommendations of the *DOE Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance* DOE/EH 0173T (DOE 1991a) to determine if groundwater monitoring is required. These evaluations and the development of unit/facility-specific monitoring plans will be developed with the applicable facility landlord or program.

- Contractor groundwater consumption programs monitor potable and production water wells that produce more than 10 gpm at the facilities under their jurisdiction. The primary purposes of this program are to ensure that the withdrawals do not negatively affect the aquifer and to verify compliance with the Federal Reserves water rights agreement between

DOE and the State of Idaho. The INEL is required by the DOE/State of Idaho Environmental Monitoring and Oversight Agreement (EMOA) to report the quantity of water pumped from production wells or injected through injection wells at the INEL. The EMOA also requires the INEL to report the quality of water being discharged through injection wells. In addition, the INEL Groundwater Protection Management Program Plan establishes requirements for Management and Operating (M&O) contractors to submit a Water Resources Management Plan to DOE-ID on an annual basis.

The INEL Groundwater Monitoring Program has been working with EG&G's Environmental Technical Support (ETS) Unit to coordinate the collection, evaluation, and reporting of water quality/quantity data with the ETS RWMIS/INWMIS reporting programs. During the unit/facility groundwater monitoring evaluation, the INEL Groundwater Monitoring Program will coordinate with the RWMIS/INWMIS reporting programs and the area-specific managers to establish a single reporting program which will meet the requirements of both programs to maximize the usefulness of the data produced and minimize the cost.

- The INEL Comprehensive Well Survey program is an ongoing program which identifies, documents, and maps all INEL-related wells and boreholes. The fitness-for-use of each well is being evaluated and documented through the Well Fitness Evaluation for the Idaho National Engineering Laboratory (EG&G, 1993). These evaluations are intended to determine whether each well meets all applicable regulatory and DOE requirements based on the well's intended use.

  This program is being implemented cooperatively by DOE-ID, USGS, and each INEL M&O contractor through the IRTS program. The results of these evaluations are being documented through the Well Fitness Evaluation for the INEL, and an INEL-wide implementation plan will be developed to remediate or abandon deficient wells if necessary. Data from this evaluation are being incorporated directly into this Plan as necessary, for example for the development of the monitoring well networks.

1.6.2 Organizational Responsibilities

Organizational responsibilities for groundwater monitoring at the INEL are divided among USGS, DOE, and the various INEL contractor organizations based on facility ownership or programmatic requirements. These responsibilities are outlined in Table 1-3.

1.6.2.1 DOE. Groundwater monitoring at the INEL is under the overall management responsibility of three DOE Offices: DOE Idaho Operations Office (DOE-ID); DOE Pittsburgh Naval Reactors, Idaho Branch Office (DOE-IBO); and DOE Chicago Operations Office (DOE-CH). DOE-ID is directly responsible for groundwater monitoring at 12 areas and has overall responsibility for coordination of groundwater monitoring at the INEL. DOE-IBO is responsible for groundwater monitoring at NRF, and DOE-CH is responsible for groundwater monitoring at ANL-W. The NRF groundwater monitoring program is being developed and documented independently from, but consistent with, the INEL Groundwater Monitoring Program.

Table 1-3. Primary INEL organizations responsible for groundwater monitoring.

DOE	Responsibility
DOE-ID Energy Programs:	
Radiological & Environmental Sciences Laboratory	• Conducts surveillance of selected offsite drinking water systems • Performs radiological analyses for USGS and contractors
DOE-ID Site Engineering and Support: Environmental Support Division	• Oversees site-wide compliance monitoring • Coordinates INEL Groundwater Protection Management Program and Groundwater Monitoring Program • Oversees INEL Groundwater Protection Management Program • Oversees INEL Comprehensive Well Survey
DOE-ID Environmental Restoration & Waste Management	• Oversees implementation of INEL Federal Facilities Agreement/Compliance Order • Oversees implementation of INEL Decontamination and Decommissioning Program • Oversees implementation of INEL Underground Storage Tank Program • Facility Manager of SPERT II, SPERT III, SPERT IV, and RWMC
DOE-ID Administration: Site Management Division	• Facility Manager of non-nuclear facilities
DOE-ID Nuclear Programs	• Facility manager of TRA, ICPP, and SMC; Reactor facilities at PBF
DOE-CH	• Facility Manager of Argonne National Laboratory - West
DOE-IBO	• Facility Manager of Naval Reactors Facility
INEL Agencies	Responsibility
USGS	• Provides independent large-scale and long-term hydrogeological regime analysis and modeling • Provides independent site-wide groundwater monitoring • Disseminates information through routine publications and as requested
NOAA	• Climatology/meteorology data collection

Table 1-3. Continued.

Contractor	Responsibility
EG&G Environmental Programs:	• Conducts drinking water sampling for EG&G and B&W production wells • Reports sitewide groundwater consumption data • Conducts injection well monitoring for EG&G operated facilities • Coordinates development and implementation of site-wide groundwater monitoring program • Coordinates the development and implementation of the groundwater-related requirements of the EOMA • Implements EG&G 5400.1 groundwater monitoring • Implements EG&G RCRA TSD facility groundwater monitoring requirements
EG&G Science and Technology Department: Geosciences Unit	• Provides hydrogeological support services including characterization,drilling, monitoring, sampling, modeling, and research
EG&G ERD	• Project Management for groundwater characterization specific to WAGs 1, 2, 5, 6, 7 and 10 • Management and development of Environmental Restoration Information System (ERIS) • Responsibility for D&D, USTs (in part)
WINCO ERP	• Project management for groundwater characterization specific to WAG 3
WINCO ES&H Department	• Implements WINCO 5400.1 groundwater monitoring • Implements WINCO RCRA TSD facility groundwater monitoring requirements
WEC ERP	• Project management for groundwater characterization specific to WAG 8
ANL-W ERP	• Project management for groundwater characterization specific to WAG 9
B&W ERP	• Addresses groundwater characterization specific to SMC facilities at WAG 1

The primary DOE-ID organizations with general (not necessarily facility-specific) programmatic responsibilities associated with groundwater monitoring at the INEL include Site Engineering and Support (SES), Energy Programs (EP), and Environmental Restoration and Waste Management (ER/WM).

SES has overall management responsibility to implement the groundwater monitoring requirements associated with DOE orders, the EOMA, RCRA, and general regulatory compliance. The AM/SES is responsible for overall Site coordination of groundwater protection and monitoring activities and ensuring implementation of the INEL Environmental Monitoring Plan, the INEL Groundwater Monitoring Plan, and the DOE-ID Environmental Protection Implementation Plan. These tasks are implemented by the Environmental Support Division, which reports to the Assistant Manager of SES (AM-SES). Also, ESD is the technical liaison between DOE-ID and the USGS for coordinating regional groundwater monitoring and regional hydrogeological regime analysis.

ER/WM has overall management responsibility for implementing all groundwater monitoring at waste management-operated facilities, and characterization and remediation activities associated with CERCLA operable units under the INEL FFA/CO. ER has overall management responsibility for implementing all groundwater characterization and remediation activities associated with the characterization and cleanup of inactive waste facilities and CERCLA operable units. In addition, ER is the responsible line management organization for implementing the INEL D&D and UST programs. WM has line management responsibility for implementing any groundwater monitoring necessary at all RCRA TSD and solid waste management facilities, and at all radioactive waste management facilities operated by EG&G Idaho. DOE-ID facility managers have overall management responsibility to ensure that the appropriate compliance monitoring is conducted at their respective facilities. They are directly responsible for ensuring that all necessary groundwater monitoring and corrective actions are implemented.

The facility managers include DOE-ID Nuclear Programs Division, DOE-ID Site Management Division, ER/WM, DOE-CH, and DOE-IBO. DOE-ID Nuclear Programs Division has landlord responsibilities for the reactor facilities at the Power Burst Facility (PBF), and for TRA, ICPP, and Special Manufacturing Capability (SMC) facilities. ER/WM has facility management responsibility for the nonreactor facilities at PBF and RWMC. DOE-IBO has facility management responsibilities for NRF, and DOE-CH has facility management responsibilities for ANL-W. DOE-ID Site Management Division has facility management responsibilities for CFA, TAN, and "Site-wide" facilities, which are facilities and lands located outside of the nine primary functional areas but inside the Site borders.

1.6.2.2 USGS. The USGS INEL Project Office is part of the USGS Water Resources Division. Since 1949, the USGS has been the lead organization for conducting independent regional hydrogeological regime analysis and groundwater monitoring at the INEL. The USGS is funded as an independent monitoring and research organization through an Interagency Agreement with DOE-ID ER/WM. The three primary tasks of the hydrogeological regime analysis are (a) analysis of the natural groundwater system, (b) analysis of the effects of groundwater pumping and recharge, and (c) monitoring the migration and attenuation of contaminant solutes. In addition to conducting hydrogeological research, the USGS acts as a technical consultant to DOE, Site contractors, the State of Idaho, and EPA Region X on INEL-related groundwater issues.

The USGS has been the primary organization collecting hydrogeologic, hydraulic, geochemical, and radiochemical data for determining natural background conditions and examining the effects of INEL operations on the natural hydrogeological regime. The USGS has collected the vast majority of the groundwater data in existence at the INEL, and has conducted most of the Site's hydrogeological studies. In addition, USGS and DOE-ID's Radiological and Environmental Sciences Laboratory (RESL) have conducted groundwater monitoring at the INEL boundaries and around communities located hydrologically downgradient from the INEL.

1.6.2.3 INEL Contractors. Each contractor will be required to maintain a groundwater compliance monitoring program for areas under its control. EG&G Idaho is the prime M&O contractor for the INEL and has the lead for implementing the INEL Groundwater Monitoring Program. EG&G Idaho has groundwater monitoring responsibilities for six functional areas at the site. Westinghouse Idaho Nuclear Company (WINCO) has groundwater monitoring responsibilities for ICPP. The University of Chicago is responsible for monitoring at ANL-W. Westinghouse Electric Company (WEC) is responsible for monitoring at NRF.

Although B&W is responsible for operating the SMC program, located at the Contained Test Facility (CTF) and Technical Support Facility (TSF) at TAN, EG&G Idaho will be the technical lead for developing and implementing the TAN groundwater compliance monitoring programs for both EG&G Idaho and B&W operations. EG&G Idaho will elicit B&W's assistance in developing the programs and will keep B&W cognizant of all pertinent results.

1.6.3 Site-wide Coordination of Groundwater Protection and Monitoring

To ensure a cohesive groundwater program, the various INEL groundwater-related programs must be coordinated to reduce redundancy, ensure that all necessary tasks are completed, maximize cost-effectiveness, and maximize the usefulness of the data collected by ensuring that all Site data are as comparable as possible. These programs must be coordinated and integrated to the greatest extent possible, taking into consideration the diversity of programmatic needs at the INEL. Coordination and integration will be realized through DOE-ID management oversight, formal and informal communication, meetings, documentation, data and information sharing, and as much as possible, through the development of minimum Data Quality Objectives (DQOs) for groundwater monitoring.

1.6.3.1 DOE Management Oversight. The DOE-ID AM/SES has overall responsibility for coordinating and integrating groundwater-related programs at the INEL. The AM/SES will promote the greatest possible degree of coordination and integration among programs, while taking into consideration that each groundwater program has specific programmatic or regulatory drivers that may take precedence over the goals and objectives of the INEL Groundwater Program.

1.6.3.2 Sharing of Data and Information. Data-sharing will be facilitated among the various groundwater programs by developing and maintaining an INEL distributed data management network. Each groundwater program will either maintain its data on the INEL data base, or periodically upload its data into the INEL-wide distributed data base. All data uploaded into the system must be of a known quality, and the quality level must be explicitly designated in the database. Funding for developing this distributed data base has been requested. Copies of all final reports and validated data associated with groundwater monitoring at the INEL will be maintained in a central data repository.

1.6.3.3 INEL Groundwater Committee. The DOE offices, the USGS, and all Site contractors associated with groundwater monitoring at the INEL exchange information on a regular basis through the INEL Groundwater Committee. Information-sharing is also facilitated by publishing and distributing minutes from the committee's monthly meetings. In addition, the committee will review the groundwater portion of the annual INEL Site Environmental Report. This review will include:

- A general review of the quality and accuracy of the report
- An evaluation of the data and conclusions
- An evaluation of the adequacy of existing INEL groundwater programs, to include making recommendations for initiating new monitoring or decreasing the intensity of existing monitoring (i.e, the number of wells sampled or the sampling frequency).

All appropriate comments and recommendations will be incorporated into the groundwater portion of the annual report and forwarded to DOE-ID ESD and the USGS INEL Project Office for concurrence prior to being published.

1.6.3.4 Planning and Budget Coordination. Coordination of short-term (annual) and long-term planning for groundwater monitoring and groundwater-related activities will be conducted through the INEL Groundwater Committee.

A planning and coordination workshop will be facilitated by the INEL Groundwater Committee prior to the beginning of each new fiscal year budget cycle. At this workshop, representatives from each groundwater or groundwater-related program will outline their program strategies, goals, and proposed activities for the upcoming fiscal year. The INEL Groundwater Committee will then:

- Evaluate existing INEL program strategies, goals, and policies against Federal, state, and DOE environmental standards, and DOE's policies and goals
- evaluate the groundwater-related programs for programmatic overlap
- recommend strategies and activities necessary to ensure that all applicable groundwater-related requirements are being met.

This evaluation serves two main purposes: (a) to ensure the most efficient and effective use of INEL resources, and (b) to make all groundwater programs cognizant of activities proposed by other INEL groundwater programs. However, these reviews must take into account that each groundwater program has specific programmatic or regulatory drivers which may take precedence over the goals and objectives of the overall INEL Groundwater Program.

In addition to the programmatic review, the committee will review proposals for scientific research projects that can benefit the overall groundwater program. Recommendations for funding high-value scientific research projects will be made to DOE-ID management.

1.6.3.5 Lessons-Learned Meetings and Workshops. Informational and "lessons-learned" meetings and/or workshops will be held on a regular basis. To the extent possible, these meetings and workshops should include the entire INEL groundwater community and other interested personnel, to disseminate program strategies, goals, ongoing activities, lessons learned, new developments and techniques, and new philosophies and requirements. Members of the INEL groundwater community at large will be encouraged to participate actively by giving presentations on their specific programs or areas of specialty.

1.6.3.6 Documentation. To the extent possible, the program requirements, strategies, policies, goals, and activities will be developed and documented by each program through integrated INEL-wide (inter-contractor) documents. Presently, each INEL groundwater-related program is documented in the INEL Environmental Monitoring Plan (which contains an overview of existing programs and requirements), the INEL Groundwater Protection Management Program Plan (which contains requirements, strategies, policies, and goals), and program-specific implementing documents (e.g., program management plans, monitoring plans, or work plans).

Results from groundwater monitoring activities must be reported in the INEL Annual Site Environmental Report. This report will be made available to the regulatory community and the public.

1.6.3.7 Minimum Data Quality Objectives (DQOs). Data collected separately by the various programs should be as comparable possible. To achieve this goal, DOE-ID AM/SES, in cooperation with USGS and the appropriate AMs for the groundwater-related programs, should establish minimum DQOs for groundwater activities. At a minimum, the DQOs for each program will be documented in each program's implementing documentation, and the quality level of all data uploaded into the INEL-wide distributed data base will be explicitly designated. Development of the DQOs will take into account that each groundwater program has specific programmatic or regulatory drivers which may take precedence over the goals and objectives of the INEL Groundwater Program.

1.6.3.8 Coordination with Federal and State Agencies and Public Participation. Cooperation and coordination with federal and state agencies and the public are essential to maximize the efficiency and effectiveness of the INEL Groundwater Monitoring Program. Input will be solicited from the State of Idaho Environmental Oversight and Monitoring Program on all upper-tier INEL groundwater plans. Continued coordination will be promoted through regular information exchanges and meetings with the oversight program and EPA as needed. Copies of the INEL Groundwater Monitoring Plan will be supplied to the oversight program and maintained for public review in public reading rooms. A summary of groundwater monitoring program activities and monitoring results will be made available to the oversight program and the public on a regular basis.

1.7 Groundwater Monitoring Plan Format and Organization

1.7.1 Format

The design of the INEL Sitewide Groundwater Monitoring Plan differs from that of traditional groundwater monitoring plans. Rather than consisting of a cookbook-style document restricted to lists of wells, parameters, and sampling schedules, the Plan was meant to provide an overview of the INEL. It was intended to document:

- Local and regional groundwater regimes
- Known and potential groundwater contaminants
- Criteria used to design the monitoring plan
- Wells which will be sampled as part of this program
- Groundwater sampling and analysis program (e.g., sampling frequencies, parameters to be analyzed)
- Standard procedures and quality assurance.

The purpose of making the Plan so comprehensive was to document all of the pertinent information used in the design of the monitoring program, and to maintain that information in one place. This Plan is also intended to be the base planning document for INEL groundwater monitoring activities. The comprehensive nature of the Plan allows all of the relevant criteria, information and proposed monitoring activities to be evaluated simultaneously. The existence of a single comprehensive plan should also reduce the need for separate future development of a multiplicity of similar monitoring documents, which could contain conflicting information. It is intended that new INEL groundwater monitoring programs (e.g., for new units/facilities, areas, or programs) be added to this integrated Plan rather than having independent monitoring plans developed for them separately.

The main disadvantage of developing a comprehensive groundwater monitoring plan is that the resulting document is large. The Plan also contains redundancies, particularly between the area-specific Sections. Although these redundancies may become tiresome to a reader reading the Plan from beginning to end, most users are expected to focus on a single operational area. For these readers, the redundancies serve the useful purpose of making each area-specific Section relatively free-standing. In sum, it is believed that the advantages of comprehensiveness are greater than the disadvantages.

Quantities in the text of this document are reported in metric units, followed parenthetically by their English-unit equivalents. However, where tables and figures have been drawn directly from other reports, this information is reported in the original units.

1.7.2 Organization

This document consists of 16 sections. Section 1 defines the purpose, policies, scope, objectives, strategies, goals and requirements for implementing the INEL Groundwater Monitoring Program. This section also identifies the organizations responsible for conducting groundwater monitoring at the INEL and describes how these organizations will coordinate their activities.

Section 2 provides an overview of the history of the INEL, regional demographics, and the Site's physical setting. This overview provides the framework necessary to understand the relationship between the nine area groundwater monitoring plans presented in Sections 3 through 11 and the regional groundwater monitoring plan presented in Section 12.

Sections 3 through 11 present area-specific overviews and groundwater monitoring plans for all operational areas that were determined to contain activities or operations which may negatively affect the SRPA. This determination was made by evaluating the present and historical operations and activities at each area and determining whether the area contained operations or activities associated with significant quantities of radioactive or hazardous-chemical materials. Areas which have not been associated with significant quantities of such materials were excluded from further consideration. The remaining areas were evaluated further to determine if they pose a significant risk to the SRPA and warrant groundwater monitoring. These areas were evaluated using a common set of criteria, and groundwater monitoring plans were developed for those areas which were determined to pose a significant risk. Sections 3 through 10 contain the area-specific overviews and groundwater monitoring plans for the following primary operational areas:

- Section 3 - Argonne National Laboratory - West (ANL-W)
- Section 4 - Auxiliary Reactor Area (ARA)
- Section 5 - Central Facilities Area (CFA)
- Section 6 - Idaho Chemical Processing Plant (ICPP)
- Section 7 - Power Burst Facility (PBF)
- Section 8 - Radioactive Waste Management Complex (RWMC)
- Section 9 - Test Area North (TAN)
- Section 10 - Test Reactor Area (TRA).

Sections 3 through 10 are each divided into seven subsections. These subsections are listed below, where, for each listed subsection, the character "X" is a generic placeholder for the primary section numbers 3 through 10.

- Subsection X.1 provides an overview of the operational area and operational practices. The intent of this discussion is to provide an overview of past and present operations and activities which may affect groundwater.

- Subsection X.2 describes area-specific physiography, geology, and hydrology. The main purpose of this subsection is to summarize the pertinent hydrogeological factors which affect the fate and transport of contaminants in the subsurface environment.

- Subsection X.3 provides an overview of past and present groundwater quality. This subsection documents the baseline water quality conditions at the area and reports documented effects of area-specific activities on the groundwater regime.

- Subsection X.4 discusses the area-specific strategy for monitoring the SRPA based on the information provided in the preceding three subsections. The subsection begins by summarizing the contaminants or pollutants associated with each area, and provides information used in the selection of area-specific indicator parameters. It discusses the assumptions made in developing the area-specific monitoring program, defines the indicator parameters which will be monitored, describes the number, locations, and general construction requirements of wells in the monitoring network, and reports the calculated design efficiency of the area's monitoring network. In addition, this subsection discusses the general sampling and analysis requirements for each area, and ties these requirements to the implementing documentation contained in the appendices.

- Subsection X.5 discusses the area-specific perched water monitoring program, where applicable. The structure of this subsection parallels that of subsection four.

- Subsection X.6 provides a summary of the major activities necessary to implement the area-specific groundwater monitoring program.

- Subsection X.7 identifies the organization responsible for sample collection at the area and provides an area-specific overview of the organization's general data management and reporting requirements.

Section 11 presents area-specific overviews and groundwater monitoring plans for "miscellaneous" areas located throughout the INEL. These areas, commonly referred to as Site-wide areas, include a wide variety of areas and facilities (e.g., storage buildings, administrative support buildings, and various reactors which are presently nonoperational). Site-wide areas that were evaluated include:

- Army Reentry Vehicle Facility (ARVFS)
- Boiling Water Reactor Experiment (BORAX)
- Experimental Breeder Reactor-I (EBR-I)
- Experimental Field Station
- Fire Station #2
- Fire Training and National Oceanic and Atmospheric Administration (NOAA) area
- Liquid Corrosive Chemical Disposal Area (LCCDA)
- Naval Ordinance Disposal Area (NODA)
- Security Training Facility (STF)
- Weapons Range Complex (WRC).

Section 11 varies somewhat from the format common to Sections 3 through 10. Each area-specific subsection of Section 11 follows the general format of Sections 3 through 10. However, the discussions have been abbreviated for those areas where it is readily apparent that the area's operations and activities could not affect the SRPA, and for areas where the available information is insufficient to determine whether a potential groundwater problem exists. The areas that lack sufficient information to determine whether groundwater problems exist (i.e., the Fire Training Area, LCCDA, and NODA) are scheduled to be characterized under the FFA/CO. The results of these characterizations will be evaluated by this program to determine if compliance monitoring is required.

Section 12 describes the regional component of the groundwater monitoring program. The regional monitoring program includes a large part of the USGS's existing observational program, modified as necessary to agree with other elements of the Site-wide program. Section 12 describes the pertinent portions of the USGS program to study the fate and transport of radionuclide and chemical contaminants. It also describes how the regional program ties together the area-specific monitoring networks.

Sections 13 through 15 define Site-wide minimum requirements for statistical analysis, data management and reporting, and contamination response. The purpose of these sections is to provide minimum Site-wide requirements and coordination of the analysis, management, and reporting of groundwater monitoring data at the INEL. Section 13 describes the general Site-wide procedures to be followed if contamination is detected. Section 14 presents Site-wide requirements for statistical analysis of sampling data. Section 15 presents general Site-wide requirements for groundwater data management and reporting. Section 16 includes all references cited in this document.

2. INEL OVERVIEW

2.1 General Area Descriptions

The INEL was established in 1949 as the National Reactor Testing Station to provide an isolated location for the testing of nuclear reactors. As of 1990, 52 reactors had been built at the INEL, of which 13 are still active. Nonreactor research activities include testing of irradiated fuels, recovery of uranium from spent fuels, reactor training, and storage of low-level and transuranic (TRU) wastes. Reactor and nonreactor operations are presently located within nine major operational areas (Figure 2-1), which include:

- Argonne National Laboratory-West (ANL-W)
- Auxiliary Reactor Area (ARA)
- Central Facilities Area (CFA)
- Idaho Chemical Processing Plant (ICPP)
- Naval Reactors Facility (NRF)
- Power Burst Facility (PBF)
- Radioactive Waste Management Complex (RWMC)
- Test Area North (TAN)
- Test Reactor Area (TRA).

In addition, numerous smaller "miscellaneous" facilities or areas are located throughout the INEL. These areas are commonly referred to as "Site-wide" areas. This category includes a wide variety of areas and facilities (e.g., small guard shacks, storage buildings, administrative support buildings, transformer areas, and reactors of various sizes), most of which are no longer in operation. For the purposes of this plan, facilities or areas that have not contained operations or activities associated with sizable quantities of radioactive or chemical compounds were excluded from further consideration.

Site-wide areas that were evaluated to determine if groundwater monitoring is warranted include:

- Army Reentry Vehicle Facility (ARVFS)
- Boiling Water Reactor Experiment (BORAX)
- Experimental Breeder Reactor-I (EBR-I)
- Experimental Field Station
- Fire Station #2
- Fire Training and National Oceanic Atmospheric Administration (NOAA) area
- Liquid Corrosive Chemical Disposal Area (LCCDA)
- Naval Ordinance Disposal Area (NODA)
- Security Training Facility (STF) (formerly EOCR/OMRE areas)
- Weapons Range Complex (WRC).

2.1.1 Argonne National Laboratory-West

ANL-W is located in the southeastern portion of the INEL. ANL-W is operated by the University of Chicago under the guidance of the U.S. Department of Energy Chicago Operations Office, and is supported by a local area office (DOE-CH-AAO) for interfacing with DOE-ID.

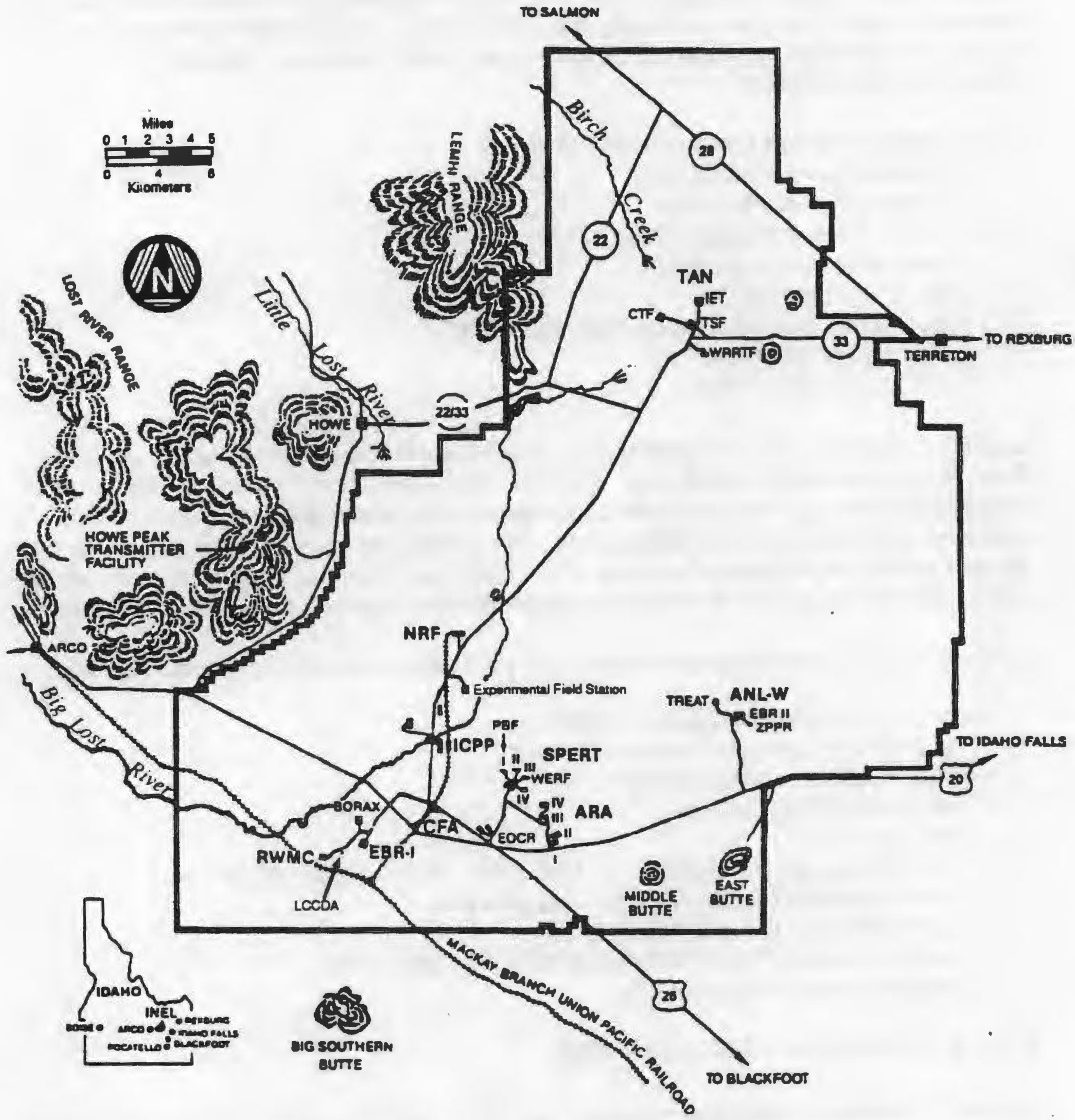


Figure 2-1. Location of INEL operational areas.

ANL-W has administrative control over an area of approximately 360 ha (890 acres) in the southeastern corner of the INEL, while the facilities themselves cover less than 24 ha (60 acres). Construction began at the present ANL-W site in the mid-1950s, with the plant becoming operational in stages from 1959 through the mid-1960s. The ANL-W facility was constructed for the purpose of researching and developing liquid metal fast breeder reactor technology. The present facility consists of seven major research complexes:

- Experimental Breeder Reactor No. 2 (EBR-II)
- Transient Reactor Test Facility (TREAT)
- Zero Power Physics Reactor (ZPPR)
- Fuel Manufacturing Facility (FMF)
- Hot Fuel Examination Facility (HFEF)
- Fuel Cycle Facility (FCF)
- Laboratory and Office building (L&O).

Plant activities require the use of numerous chemicals and radioactive materials, resulting in generation of a variety of hazardous, radioactive, and mixed wastes. Although contaminants have been released to the environment at ANL-W, groundwater contamination has not been detected in the limited number of wells being sampled.

2.1.2 Auxiliary Reactor Area

ARA, formerly referred to as the Army Reactor Area, is located in the south-central portion of the INEL. ARA was built to develop a compact power reactor for use as a power source at remote military bases. The area is operated by EG&G Idaho through DOE-ID.

ARA is made up of four facility areas: ARA I, ARA II, ARA III, and ARA IV. In addition, the SL-1 burial ground is located east of ARA II. The burial ground contains debris produced by a nuclear excursion and explosion, which took place at the SL-1 reactor during maintenance operations on January 3, 1961. The ARA facilities occupy a total area of less than 16 ha (40 acres).

Activities associated with the ARA program occurred from 1957 through 1965. The level of use of ARA facilities has been low since the Army reactor program was phased out in 1965, and essentially no activities have been undertaken there since 1988. Noteworthy potential sources of contamination at ARA include several wastewater discharge points and the SL-1 burial ground. The quality of groundwater in the ARA area is generally good, although there are some indications that contaminants have reached the aquifer.

2.1.3 Central Facilities Area

CFA is located in the south-central part of the Site and is operated by EG&G Idaho through the DOE Idaho Field Office (DOE-ID). The original facilities were built in the 1940s and 1950s to house Naval Gunnery Range personnel and were later used for office space for National Reactor Testing Station (NRTS) personnel. The facilities have been modified over the years and now provide four major types of functional space: craft, office, services, and laboratory for approximately 1,800 employees located at CFA.

CFA covers a large area. It includes approximately 81 buildings and 58 other structures, and is divided into eight functional zones:

- Remote Services Facilities zone
- Administrative Offices and Support zone
- Handling and Open Storage zone
- Service Shops zone
- Engineering and Light Laboratory zone
- Landfill and Open Pit zone
- Warehousing and Storage zone
- Security Complex zone.

Although there are no reactors, processing activities, or major manufacturing activities at CFA that would produce large quantities of wastes, numerous, mostly small potential sources of contamination are dispersed over a large portion of the CFA area. These potential sources include landfills, a central sanitary sewage treatment plant, laboratory effluents, underground storage tanks, and past releases of radioactive and chemical constituents to the environment. Although contaminants have been released to the environment at CFA, none of the CFA contaminant sources is known to have caused groundwater contamination. The groundwater beneath CFA is contaminated due to underground injection and land disposal practices that have occurred at TRA and the ICPP. The predominant groundwater contaminant detected beneath CFA is tritium.

2.1.4 Idaho Chemical Processing Plant

ICPP is located on approximately 81 ha (200 acres) in the south-central part of the Site and is operated by Westinghouse Idaho Nuclear Company (WINCO) through DOE-ID. ICPP was constructed in the late 1940s to reprocess spent nuclear fuel from naval and research reactors. The plant includes a variety of laboratory and processing facilities, process chemical storage facilities, process chemical and waste transfer pipelines, process waste storage and disposal facilities, office and maintenance facilities, and nonprocess waste disposal facilities. The principal facilities are listed below:

- Fuel storage facilities
- Fuel reprocessing facilities
- Process equipment waste (PEW) facility
- Tank farm
- Waste calciner facilities
- Injection well (abandoned)
- Percolation ponds.

Plant activities require the use of numerous chemicals and radioactive materials, resulting in generation of a variety of hazardous, radioactive, and mixed wastes. The facilities of primary interest with regard to hydrogeologic impact include the wastewater percolation ponds, the tank farm, and a deep well formerly used to discharge process waste to the Snake River Plain aquifer (SRPA).

2.1.5 Naval Reactors Facility

NRF is located in the central part of the Site and is operated by Westinghouse Electric Company (WEC) through the DOE Naval Reactors, Idaho Branch Office (DOE-IBO). Its primary function is training naval reactor operators. NRF contaminant sources and groundwater monitoring will be addressed under a separate groundwater monitoring plan.

2.1.6 Power Burst Facility

PBF is located in the south-central portion of the INEL, and is operated by EG&G through DOE-ID. It was initially constructed for testing of reactor transient behavior and for safety studies on light-water-moderated enriched fuel systems. The tests, called Special Power Excursion Reactor Tests (SPERT), began in the late 1950s. Following conclusion of the SPERT studies, PBF and its support facilities were constructed in 1970 and placed on standby in 1975. All four reactors were removed, and in 1984 and 1985, the facilities were radiologically decommissioned and decontaminated (D&D'd). The PBF operational area consists of five subareas:

- PBF Control Area
- PBF/SPERT I Area
- Waste Engineering Development Facility (WEDF/SPERT II)
- Waste Experimental Reduction Facility (WERF/SPERT III)
- Mixed Waste Storage Facility (MWSF/SPERT IV).

The PBF Control Area will not be addressed because no hazardous or radioactive wastes were generated or disposed at that facility. The primary contaminants of concern for the other areas include demineralizer regenerant, which contained sulfuric acid and sodium hydroxide, and chromium and low levels of radiological contamination, which have been disposed to the area's injection wells and ponds.

2.1.7 Radioactive Waste Management Complex

RWMC is situated on 58 ha (144 acres) located 11 km (7 mi) southwest of CFA. It is operated by EG&G Idaho through DOE-ID. Construction began at RWMC in 1952 for the storage and disposal of solid TRU-contaminated and low-level radioactive wastes from the INEL and other DOE facilities. It also supports research and development projects dedicated to shallow land burial technology, and alternate ways of removing, reprocessing, and repackaging TRU wastes. The RWMC is subdivided into three primary zones:

- Administrative Area
- Subsurface Disposal Area (SDA)
- Transuranic Storage Area (TSA).

The Administrative Area occupies approximately 4 ha (10 acres). No environmental hazards are known to exist at the administrative area.

The SDA is a fenced 36-ha (88-acre) facility dedicated to the permanent disposal of low-level beta/gamma and nonretrievable TRU waste (buried prior to 1970) contaminated with mixed fission product. Major features at the SDA include the pits, trenches, and soil vaults in which waste was buried, and Pad A, which received low-level waste, primarily nitrate salts, from off-Site generators.

TSA is a 23-ha (56-acre) fenced facility dedicated to storage of contact- and remote-handled solid TRU wastes. The wastes stored at TSA include TRU (e.g., plutonium), and intermediate-level waste. Major facilities at the TSA include the Stored Waste Examination Pilot Plant (SWEPP) (Building 610), Certified and Segregated (C&S) Building, ASWS-2 (Air Support Weather Structure; WMF-711), and various support buildings.

Contaminant plumes of radionuclide and chemical constituents in the groundwater below the RWMC are attributed to waste-disposal practices at the RWMC and other operations on the INEL. At least two radionuclides, tritium and strontium-90, are currently present above background levels in the groundwater near the RWMC. The tritium in wells at the RWMC probably originated from wastewater disposal practices at ICPP and TRA. However, local waste disposal may also be contributing to the tritium in the vicinity of RWMC. Strontium in wells at the RWMC probably originated from disposal sites at the RWMC. Chromium has been detected above established maximum contaminant levels. Elevated concentrations of sodium, chloride, and nitrate also exist in the groundwater as a result of RWMC activities. At least five volatile organic compounds are above background levels in water in the aquifer. The organics include carbon tetrachloride, trichloroethylene, 1,1,1-trichloroethane, tetrachloroethylene, and chloroform.

2.1.8 Test Area North

TAN is located approximately 43 km (27 mi) northeast of CFA. The TAN complex consists of several facilities for conducting research and development activities on reactor performance. The major facilities at TAN include the following:

2.1.8.1 Technical Support Facility (TSF). TSF is located in the central part of TAN and serves as the main administration, assembly, and maintenance section for TAN. Major programs at TSF include the Three-Mile Island Unit 2 Core Off-Site Examination, Process Experimental Pilot Plant (PREPP), Spent Fuel Program, and the Specific Manufacturing Capability (SMC).

2.1.8.2 Contained Test Facility (CTF). CTF is located on the west end of TAN. The mission of CTF was to perform reactor loss-of-coolant studies. After these studies were completed, the facility was decontaminated and used for D&D of reactors used in the Aircraft Nuclear Propulsion (ANP) Program.

2.1.8.3 Initial Engine Test (IET) Facility. The IET area is located approximately 2.4 km (1.5 mi) north of TSF. The IET was constructed for the ANP Program. It was later used for the Space Nuclear Auxiliary Power Transient Program (SNAPTRAN), and then for the Hallam D&D project. The facility has been inactive since 1987.

2.1.8.4 Water Research Test Facility (WRRTF). WRRTF is located 2.6 km (1.6 mi) southeast of TSF. The facility was originally constructed for conducting pool and table reactor experiments. Various reactor programs were conducted at WRRTF including the Semiscale (TAN-646) thermal hydraulic loss-of-coolant project, and the Blowdown Facility (TAN 640) and Two-Phase Flow Loop (TAN-640) loss-of-coolant projects.

CTF and part of the TSF area are dedicated to the SMC project and are operated by Babcock and Wilcox (B&W) through DOE-ID. The remainder of TAN is operated by EG&G Idaho through DOE-ID.

Noteworthy potential sources of groundwater contamination at TAN include wastewater infiltration ponds, injection wells, spills, and underground tanks. Monitoring of groundwater in the TAN area has revealed a plume of contamination extending to the southeast from TSF. Contaminants include both organic and radioactive chemical species. An injection well at TSF has been identified as the source of this contamination. The TAN-area groundwater contamination is the subject of a CERCLA Remedial Investigation/Feasibility Study currently being undertaken by EG&G Idaho Environmental Restoration.

2.1.9 The Test Reactor Area

TRA is located in the southwestern area of the INEL, approximately 8 km (5 mi) northwest of CFA. It is operated by EG&G Idaho through DOE-ID. The area was originally established in the early 1950s to conduct experiments associated with the development, testing, and analysis of materials utilized in nuclear and reactor applications. Approximately half of TRA personnel provide direct support to the Advanced Test Reactor (ATR) program. Other major facilities include the Materials Test Reactor (MTR) and the Engineering Test Reactor (ETR).

The most noteworthy sources of potential groundwater contamination at TRA have been several disposal ponds and an injection well, which collectively have been used for the disposal of several distinct waste streams of hazardous and low-level radioactive wastewater. Use of the infiltration ponds has caused the formation of perched water zones at two depth intervals beneath the area. Significantly elevated levels of both radioactive and chemical constituents have been detected in water samples from the perched zones. Elevated levels of chromium, trichloroethylene, and tritium have been detected in the SRPA in TRA-area wells. TRA and ICPP wastewater disposal practices have together contributed to a plume of tritium contamination in the aquifer that extends approximately to the southern boundary of the INEL.

2.1.10 Site-wide Areas

Site-wide areas include facilities and lands located within the Site boundaries, but outside of the nine primary functional areas. All Site-wide areas are operated by EG&G through DOE-ID. These include the following miscellaneous areas.

2.1.10.1 Army Reentry Vehicle Facility Site (ARVFS). ARVFS is located in the central part of the Site approximately 15 km (9 mi) north of CFA. It consists of less than 0.4 ha (1 acre), which was used in the late 1960s by the Department of Defense for nuclear fuel experiments. The facility consisted of a test pit, underground bunker, and a system of pulleys and cables. When the program was completed, the pit was decontaminated. In 1980, a protective shed and crane were built above the pit, and in 1980 and 1981, a series of explosive tests was conducted.

2.1.10.2 Boiling Water Reactor Experiment (BORAX). The BORAX program was conducted at two locations (BORAX-I and V), located approximately 8 km (5 mi) southwest of CFA. BORAX included eight reactor experiments conducted from the mid-1950s to the mid-1960s. BORAX-I was an open-top boiling water reactor experiment in which the reactor was intentionally destroyed to determine its safety characteristics. Most of the equipment from the test was decontaminated and salvaged. However, the reactor was buried in place and abandoned. BORAX-II, -III, -IV, and -V were conducted at the present site of BORAX-IV. The fuels and a portion of the reactor have been removed. In 1960, the old reactor building was removed and replaced with a new building (AEF-603) and reactor. The reactor vessel still remains in the building, but the fuel and portions of the reactor internals were removed, and the facility was D&D'd.

2.1.10.3 Experimental Breeder Reactor-I (EBR-I). EBR-I consists of the Reactor Building and Annex (EBR-601), situated on approximately 4 ha (10 acres) of land located approximately 10 km (6 mi) southwest of CFA. EBR was constructed in 1949 and the early 1950s. Criticality was first achieved there in 1951, and several reactor cores were tested. EBR-I was D&D'd in 1963 and has been designated as a National Historic Site. The Waste Management Office, located next to EBR-I, was constructed in 1949. It is out of service and scheduled for demolition.

2.1.10.4 Liquid Corrosive Chemical Disposal Area (LCCDA). The LCCDA is an inactive facility located approximately 0.8 km (0.5 mi) northeast of the RWMC. The facility occupied approximately 0.4 ha (1 acre), and consisted of two surface percolation units used for the disposal of nonradioactive liquid chemicals.

2.1.10.5 Naval Ordnance Disposal Area (NODA). NODA is located in the southwest part of the Site. In the past, parts of the INEL were used by the U.S. Navy and U.S. Army Air Corps for gunnery and bombing ranges. NODA was used by the U.S. Navy for disposal of unexploded ordnance. The Naval Ordnance Disposal Area has been used for the thermal treatment and open burning or detonation of ordnance and reactive hazardous waste at the INEL since the early 1950s. NODA activity is presently limited to the intermittent burning of reactive/explosive materials in an open pit.

2.1.10.6 Security Training Facility (STF). The STF consists of two adjacent areas located approximately 4 km (2.5 mi) east of CFA. The STF was formerly known as the Experimental Organic Cooled Reactor (EOCR) and Organic Moderated Reactor Experiment (OMRE) areas. The OMRE was designed to develop power from an organic coolant reactor. It consisted of a reactor control building, reactor, heat exchangers, septic system, leach pond, and water tank. The EOCR was constructed directly northwest of the OMRE in 1962. The project was canceled prior to completion and has since been used for materials storage, security force practice, and explosives testing.

2.2 Regional Demographics

The INEL is located in southeastern Idaho, roughly equidistant from Salt Lake City, Utah (351 km; 211 mi), Butte, Montana (357 km; 214 mi), and Boise, Idaho (428 km; 257 mi) (Table 2-1). A total of 14 Idaho counties are located in part or entirely within 80 km (50 mi) of the INEL (see Figure 2-2 and Table 2-1). The INEL includes portions of five counties (Bingham, Bonneville, Butte, Clark, and Jefferson).

The largest population centers near the INEL are to the southeast and east along the Snake River and Interstate Highway 15. The largest communities in closest proximity to the boundaries of the INEL include Idaho Falls (43,929 persons in 1990), which is about 35 km (22 mi) east of the nearest Site boundary; Blackfoot (9,646 persons in 1990), about 37 km (23 mi) southeast of the nearest Site

Table 2-1. Population of counties and places within 80 km (50 mi) of the INEL boundary.[a]

County	Place[b]	Population (1990)
Bannock		66,026
	Chubbuck	7,791
	Inkom	769
	Pocatello	46,080
Bingham		37,583
	Aberdeen	1,406
	Atomic City	25
	Basalt	407
	Blackfoot	9,646
	Firth	429
	Shelley	3,536
Blaine		13,552
Bonneville		72,207
	Ammon	5,002
	Idaho Falls	43,929
	Iona	1,049
	Ucon	895
Butte		2,918
	Arco	1,016
	Butte City	59
	Moore	190
Clark		762
	Dubois	420
	Spencer	11
Custer		4,133
	Mackay	574
	Lost River	29
Fremont		10,937
	Newdale	377
	Parker	288
	St Anthony	3,010
	Teton	570

Table 2-1. (continued).

County	Place[b]	Population (1990)
Jefferson		16,543
	Hamer	79
	Lewisville	471
	Menan	601
	Mud Lake	179
	Rigby	2,681
	Ririe	596
	Roberts	557
Lemhi		6,899
Lincoln		3,308
Madison		23,674
	Rexburg	14,302
	Sugar City	1,275
Minidoka		19,361
	Minidoka	67
Power		7,086
	American Falls	3,757

a. 1990 census data.

b. The word "place" is defined by the Census Bureau as a census-designated place (CDP) or an incorporated place. CDPs comprise densely settled concentrations of population that are identifiable by name, but are not legally incorporated places. State and local census statistical committees have identified and delineated boundaries for CDPs. There may be other small population concentrations with names identified on maps located within the 80 km (50 mi) distance from the INEL boundary, but they are not recognized as a place by the Census Bureau. The population of those areas would be included only in the total county population. Total county population has been noted, but only portions of some counties fall within the 80 km (50 mi) distance (Figure 2-2).

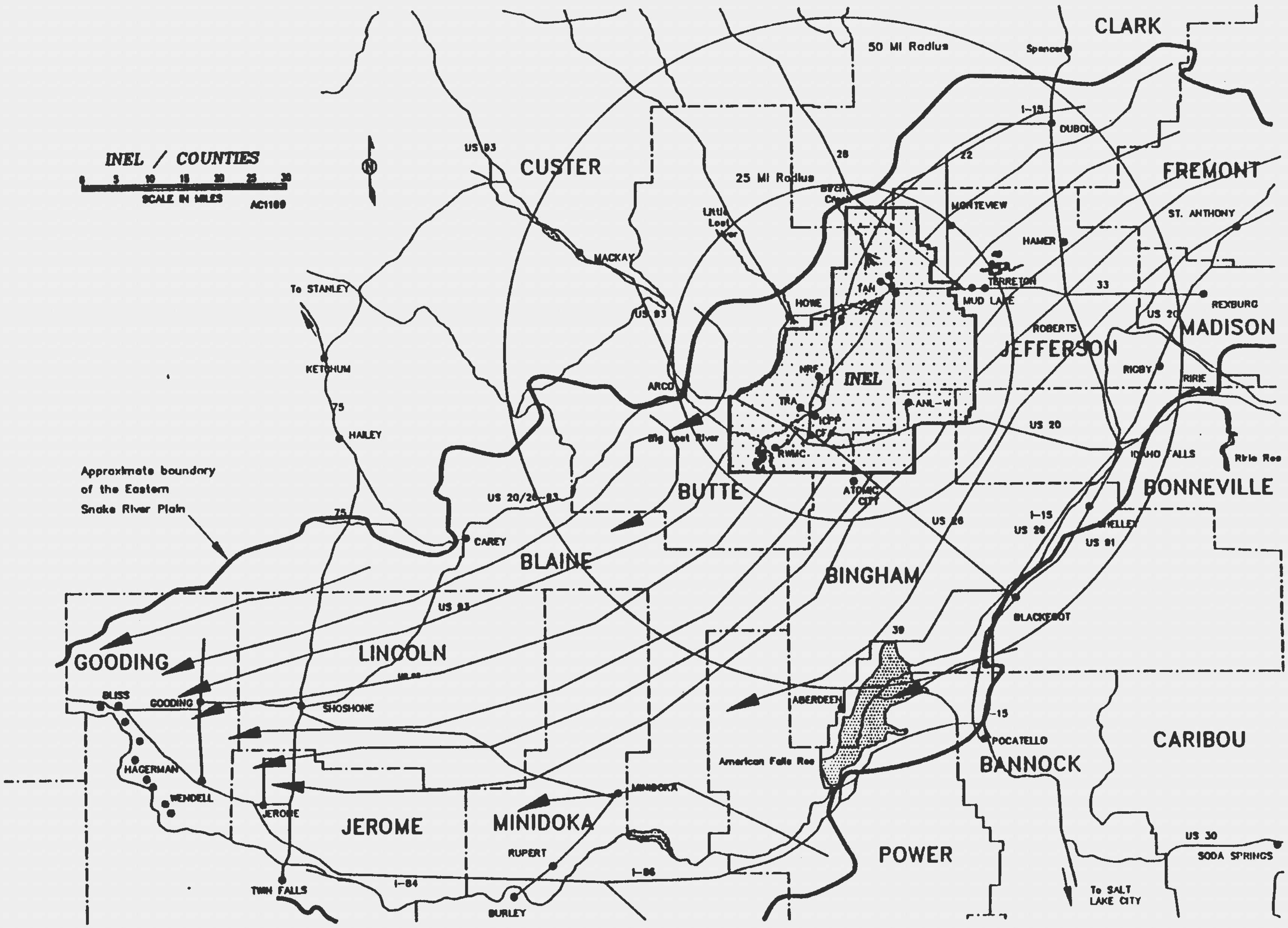


Figure 2-2. Snake River Plain aquifer and communities downgradient from the INEL.

boundary; Pocatello (46,080 persons in 1990), about 60 km (37 mi) south-southeast of the nearest Site boundary; and Arco (1,016 persons in 1990), about 11 km (7 mi) west of the nearest Site boundary. Atomic City (25 persons in 1990), which is within about 0.8 km (0.5 mi) of the southern boundary of the INEL, is the closest town (EG&G Idaho, 1984).

A total of 12,185 persons were employed at the INEL in June 1992. Of these, 8,116 work on a regular basis at the INEL Site, and 4,069 regularly work at facilities located in Idaho Falls, Idaho. A summary of the number of employees working at the INEL Site is given in Table 2-2.

The primary off-Site concern, for the purposes of this report, is the use or consumption of water from the SRPA on-Site or downgradient of the INEL. This is because groundwater is the primary source of water for both on-Site facilities and downgradient neighbors of the INEL. All water used at the INEL is pumped from the SRPA. Water is used at the INEL for production, cooling, and domestic purposes.

The SRPA is the primary source of water downgradient of the INEL. The primary uses of water downgradient of the INEL include domestic consumption, irrigation, and stock watering. Eight counties are located, at least in part, hydrologically downgradient of the INEL (see Table 2-3). Twenty-four centers of population are located downgradient of the INEL. Each of the larger communities is supplied with drinking water through public water supply systems that obtain their water from the SRPA. With the exception of Lincoln and Twin Falls counties, the majority of the downgradient population is located in rural areas. It is assumed that all drinking water consumed in the rural areas is derived from the SRPA also.

Table 2-2. INEL Site population by area.[a]

Argonne National Laboratory - West	939
Auxiliary Reactor Area	0
Central Facilities Area	1,299
Idaho Chemical Processing Plant	2,095
Naval Reactors Facility	2,129
Power Burst Facility	142
Radioactive Waste Management Complex	107
Test Area North	707
Test Reactor Area	698
Total Employees at the INEL	8,116

a. All numbers are based on the *INEL Employment Report, Idaho Falls & Idaho National Engineering Laboratory, Report by Area, Report for FY-1992*, as of June 1992.

Table 2-3. Population of counties and places hydrologically downgradient of the INEL.[a]

County	Place[b]		Population	% of county population[c]	Distance from INEL boundary
Bingham			37,583		
	Atomic City		25		1 km (<1 mi)
		Subtotal	25	.1%	
Butte			2,918		
Blaine			13,552		
Gooding			11,633		
	Bliss		185		155 km (96 mi)
	Gooding		2820		135 km (84 mi)
	Hagerman		600		155 km (96 mi)
	Wendell		1,963		145 km (90 mi)
		Subtotal	5,568	48%	
Jerome			15,137		
	Eden		314		126 km (78 mi)
	Hazelton		394		122 km (76 mi)
	Jerome		6,529		135 km (84 mi)
		Subtotal	7,237	48%	

Table 2-3. (continued).

County	Place[a]		Population	% of county population[c]	Distance from INEL boundary
Lincoln			3,308		
	Dietrich		127		106 km (66 mi)
	Richfield		383		90 km (56 mi)
	Shoshone		1,249		114 km (71 mi)
		Subtotal	1,759	53%	
Mindoka			19,361		
Twin Falls			53,580		
	Twin Falls		25,591		143 km (89 mi)
		Subtotal	25,591	48%	
TOTAL (population of places)			40,180		

a. 1990 census data.

b. The word "place" is defined by the Census Bureau as a census-designated place (CDP) or an incorporated place. CDPs comprise densely settled concentrations of population that are identifiable by name, but are not legally incorporated places. State and local census statistical committees have identified and delineated boundaries for CDPs. There may be other small population concentrations with names identified on maps located within the 80 km (50 mi) distance from the INEL boundary, but they are not recognized as a place by the Census Bureau. The population of those areas would be included only in the total county population. Total county population has been noted, but only portions of some counties fall within the 80 km (50 mi) distance (Figure 2-2).

c. The number represents the percent of county population that resides only within the places listed on table.

Distances were scaled from the Delorme Idaho Atlas using an engineer's scale.

2.3 Regional Physical Setting

2.3.1 Physiography

The INEL is located in the north-central part of the eastern Snake River Plain (ESRP). The ESRP is the eastern segment of the Snake River Plain and extends from the Hagerman-Twin Falls area northeast toward the Yellowstone Plateau (Figure 2-3). The ESRP is bounded on the northwest and southeast by the north- to northwest-trending fault-block mountains of the Basin and Range physiographic province (Figure 2-4). The southern extremities of the Lost River and Lemhi Ranges and the Beaverhead Mountains extend to the western and northwestern borders of the INEL. At the base of the mountain ranges, the average elevation of the INEL is about 5,000 ft above mean sea level. Individual mountains immediately adjacent to the plain rise to elevations of 10,830 ft above mean sea level.

The surface of the ESRP is rolling to broken and is underlain by basalt with a thin, discontinuous covering of surficial sediment. Hundreds of extinct volcanic craters and cones are scattered across the surface of the plain. Craters of the Moon National Monument, Big Southern Butte, Twin Buttes, and many small volcanic cones are aligned generally along a broad volcanic ridge trending northeastward from Craters of the Moon toward the Mud Lake basin (Nace et al., 1972). Between this ridge and the northern edge of the plain is a somewhat lower area from which there is no exterior drainage. The INEL occupies a substantial part of this closed topographic basin.

The INEL covers an area of approximately 2,307 km^2 (890 mi^2). It is approximately 63 km (39 mi) long in a north-south direction and 58 km (36 mi) wide at its widest point. The topography of the INEL, like that of the entire Snake River Plain, is rolling to broken. The lowest area on the INEL is the Birch Creek Sinks at an elevation of 1,455 m (4,774 ft) above mean sea level. The highest elevations occur at East Butte, 2,003 m (6,572 ft) above mean sea level, and Middle Butte, 1,948 m (6,391 ft) above mean sea level.

2.3.2 Climatology

Physiography is very important to the climatology of the INEL (Clawson et al., 1989). The mountains to the west and north of the INEL deflect moisture-laden air masses upward creating an arid to semiarid climate on the downwind side of the mountains. The climate is characteristically warm and dry in the summer and cold in the winter. The relatively dry air and infrequent low clouds permit intense solar heating of the surface during the day and rapid radiational cooling at night. The northeast-southwest orientation of the ESRP and the bordering mountain ranges tends to channel the west winds that prevail regionally so that a southwest wind predominates over much of the INEL (Figure 2-4). The second most frequent wind direction is from the northeast.

Meteorological data have been collected at over 45 locations on and near the INEL since 1949. The weather station at CFA has over 35 years of records for air temperature and precipitation. A weather station at TAN was operated from 1950 to 1964. Other smaller stations have been used periodically across the Site. The following climatological data came from a National Oceanic and Atmospheric Administration report by Clawson et al. (1989).

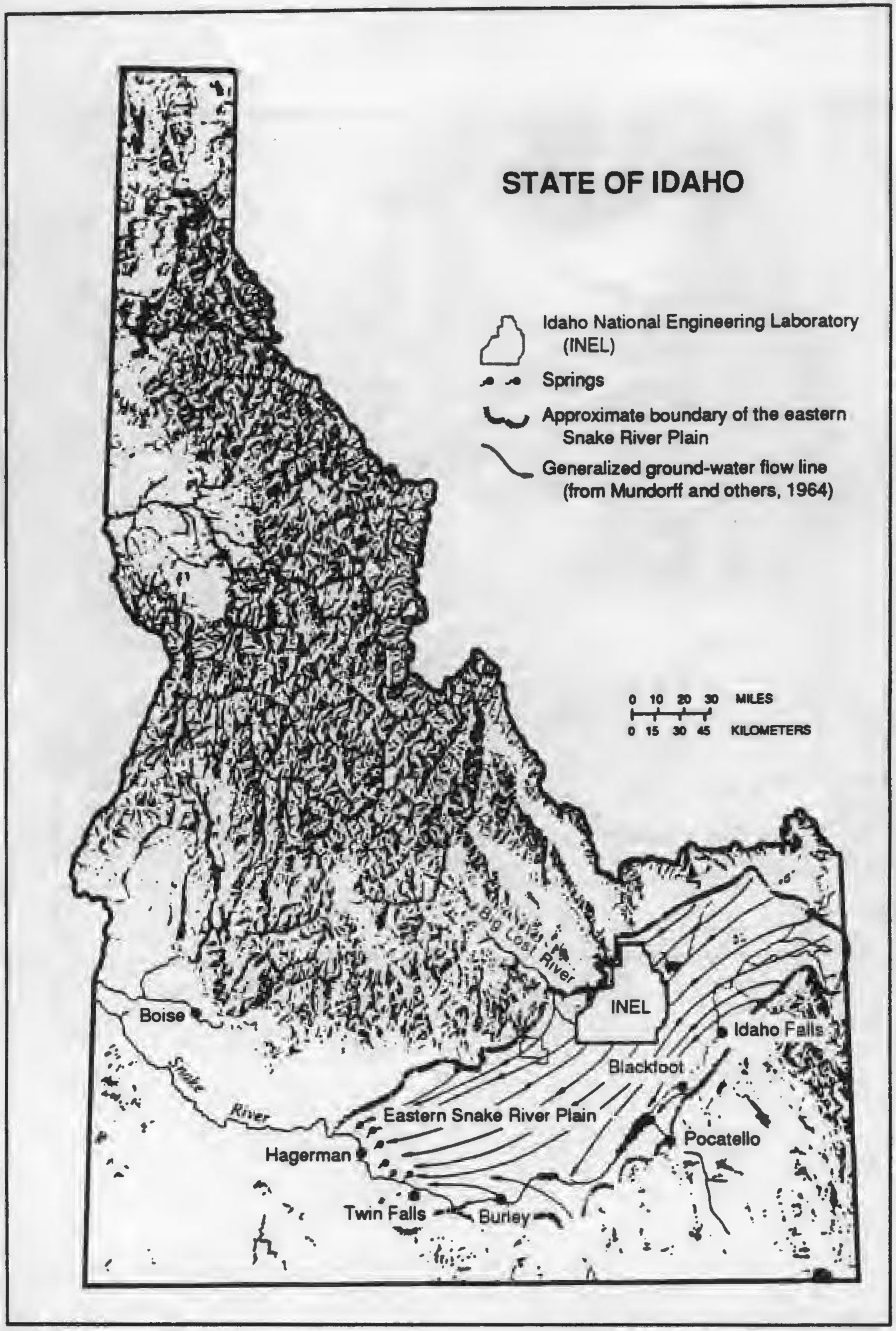


Figure 2-3. Location of INEL and Eastern Snake River Plain aquifer (after Barraclough et al., 1981)

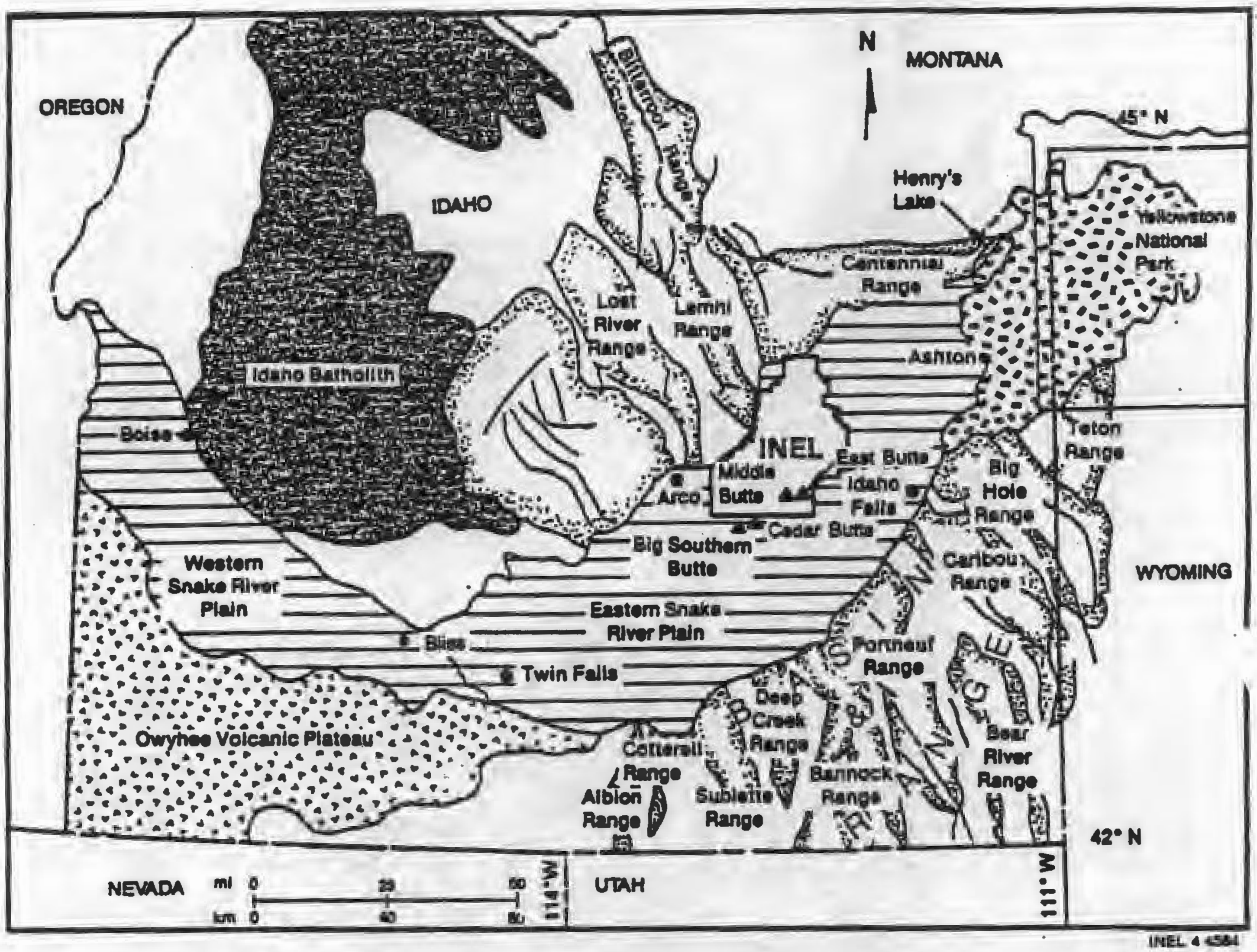


Figure 2-4. General Geology of Southern Idaho.

Average annual precipitation amounts at CFA and TAN are 22.12 cm (8.71 in.) and 19.94 cm (7.85 in.), respectively. The maximum daily precipitation was 4.17 cm (1.64 in.) at CFA and 4.52 cm (1.78 in.) at TAN for the period of record. Thunderstorms cause a pronounced precipitation peak in May and June at both CFA and TAN, with an average of 3.1 cm (1.2 in.) at CFA and 3.3 cm (1.3 in.) at TAN for each of these months. The maximum 1-hr precipitation, over the period of record, was 1.37 cm (0.54 in.) at CFA and 2.92 cm (1.15 in.) at TAN, again due to thunderstorms.

Snowfall is a substantial contributor to total annual precipitation. Snowfall and snow depth records are available only for CFA. The annual average snowfall is 70.1 cm (27.6 in.), with a maximum yearly snowfall of 151.6 cm (59.7 in.) in 1971. The maximum average monthly snowfall is 16.3 cm (6.4 in.), occurring in December. The maximum monthly snowfall during the period of record was 56.6 cm (22.3 in.), occurring in December 1971. The maximum 24-hr snowfall was 21.8 cm (8.6 in.), and it occurred in March 1973. The water content of melted snow probably contributes between one-quarter and one-third of average annual precipitation.

Surface air temperatures at the INEL are measured at CFA and TAN. A third station located at the ANL-W area has been in operation since 1964. A 30-year average of air temperatures at TAN cannot be calculated directly because the period of record is only 15 years. To overcome this deficiency, the existing TAN temperature data were supplemented with data normalized using temperatures recorded at nearby off-Site stations to show a full 30-year period of record. This was done according to standard National Climatic Data Center procedures.

The average daily air temperature for CFA ranges from a low of -12°C (10°F) on January 2 to a high of 21°C (70°F) on several days in late July. The 30-year normalized average daily air temperature at TAN ranges from -11°C (13°F) during mid-January to 21°C (70°F) during the latter half of July. The maximum air temperature recorded at CFA was 38°C (101°F). The minimum was -44°C (-47°F). The maximum and minimum air temperatures recorded for TAN were 39°C (103°F) and -45°C (-49°F), respectively.

The average annual temperature at the Site exhibits a gradual seven-month increase beginning with the first week in January and continuing through the third week in July. The temperature then decreases over the course of five months until the minimum average temperature is again reached in January. A winter thaw has occurred on a number of years in late January. This thaw often has been followed by more cold weather until the spring thaw.

Wind speed and direction (always recorded as the direction from which the wind is blowing) have been continuously monitored at many stations on and surrounding the INEL since 1950 (Clawson et al., 1989). The orientation of the bordering mountain ranges and the general northeast trend of the ESRP exert a strong influence on wind direction. Eastern Idaho lies in a region of prevailing westerly winds. Channeling of these winds within the ESRP usually produces a west-southwest or southwest wind at most locations on the INEL. The highest and lowest average wind speeds at CFA occur in April [15.0 km/hr (9.3 mph)] and December [8.2 km/hr (5.1 mph)], respectively. The highest hourly average wind speed measured at CFA was 108 km/hr (67 mph), from the west-southwest or southwest.

Local topographic features at TAN result in a greater diversity of wind directions there than elsewhere on the INEL. At the mouth of Birch Creek, the northwest to southeast orientation of the Birch Creek valley occasionally channels strong north-northwest winds into the TAN area. At TAN, average wind speeds are highest in April [15.3 km/hr (9.5 mph)] and lowest in December [7.4 km/hr (4.6 mph)].

The highest hourly average wind speed recorded at TAN was 100 km/hr (62 mph). Several wind directions are associated with the highest hourly wind speeds. Like the rest of the INEL, TAN usually experiences the highest hourly wind speeds in association with west-southwest or southwesterly winds. However, TAN is an unusual area because strong winds also blow from the northwest and north-northwest.

2.3.3 Geology

The ESRP is a broad structural depression that has been filled with silicic and mafic volcanic rocks. It extends in a swath 80 to 112 km (50 to 70 mi) wide across southeastern Idaho from the Twin Falls area to Yellowstone National Park in northwest Wyoming. Its northeast trend cuts across the northwest-trending structures that otherwise prevail in the northern Basin and Range physiographic province.

2.3.3.1 Regional Geologic History. Evidence of the geologic history of southeastern Idaho can be found in sedimentary rocks that were deposited as long ago as the late Precambrian, more than 600 million years ago. Beginning in the late Precambrian, and continuing in the Paleozoic and Mesozoic eras, thousands of feet of marine sediment was deposited intermittently in a north-trending linear submarine trough. This trough, the Cordilleran Geosyncline, marked the western edge of the North American continent. It was gradually filled with sediment produced by the erosion of neighboring highlands.

The sediment of the geosyncline was folded and faulted during the late Cretaceous Laramide Orogeny. This event was followed in the Miocene period by Basin and Range faulting, when crustal extension caused a pervasive pattern of block faulting in a wide belt running through what is currently the western U. S. and Mexico. Areas falling within the Basin and Range province are characterized by subparallel sets of linear mountain ranges separated by valleys representing down-dropped fault blocks. The Basin and Range province apparently terminates a short distance north of the ESRP, at about the latitude of Salmon (Robertson et al., 1974). The block-faulted mountains north and south of the ESRP have a northwesterly trend.

The development of the ESRP began in the middle Pliocene period with eruption of silicic volcanics near the southwest end of the plain. During development of the ESRP, silicic volcanic activity may have been confined to a relatively restricted portion of the plain at any given time, but the area of active volcanism gradually migrated northeastward. The migration of the center of active volcanism is marked by a series of collapse calderas, which are progressively younger to the northeast (Figure 2-5). Rocks of the Blue Creek Caldera, whose projected outline roughly coincides with the INEL, are approximately 5.6 million years old. The Kilgore Caldera of the Rexburg area is 4.3 million years old. The youngest and northeasternmost of the calderas is the Yellowstone Caldera, which is approximately 800,000 years old (Hackett et al., 1986).

Although the preceding discussion was framed in terms of the northeastward movement of a center of volcanism, current thinking is that the northeast-younging series of collapse calderas beneath the ESRP traces the southwestward movement of the North American crustal plate over a persistent, localized, deep-seated source of molten rock (Leeman, 1982). Since volcanic activity began at the southwest end of the ESRP, the rate of movement of the plate over the deep-seated "hotspot" has averaged 1.4 cm/yr (0.55 in./yr) (Embree et al., 1982).

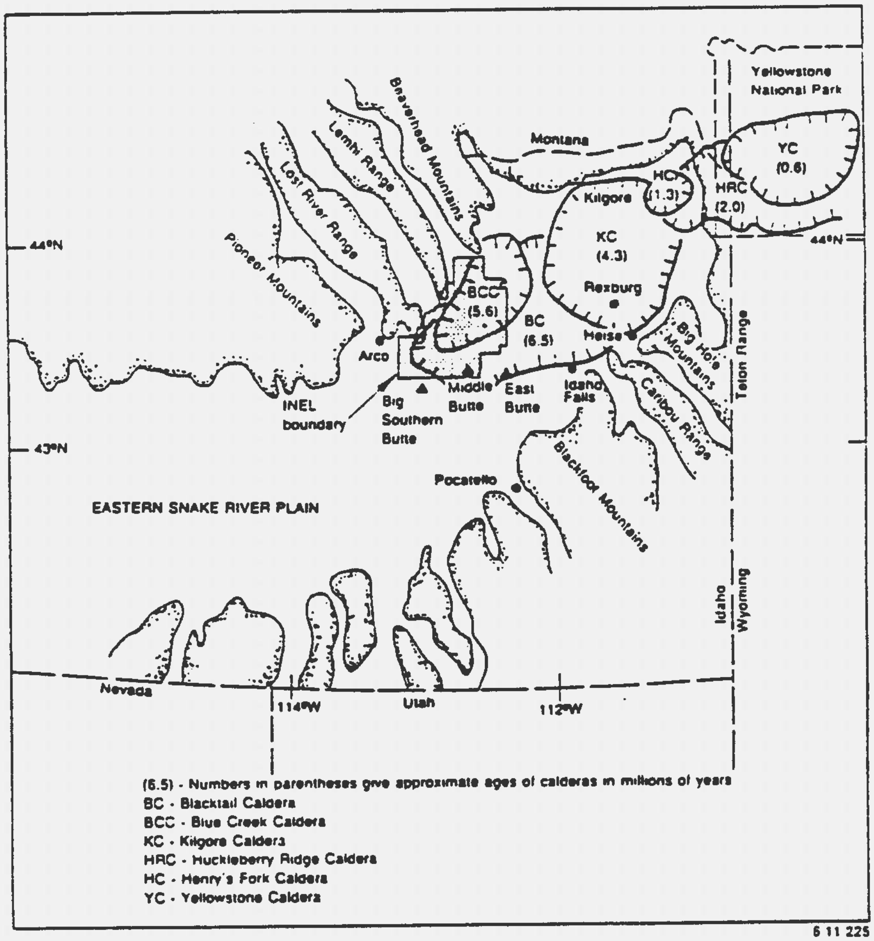


Figure 2-5. Rhyolite calderas of Yellowstone National Park and the eastern Snake River Plain (Hackett et al., 1986).

As the hotspot advanced to the northeast along the length of the ESRP, silicic volcanic activity at any given location subsided and was followed by mafic volcanism. Highly fluid molten basalt poured from rift zones and isolated vents, and flowed across the ESRP. Through the gradual accumulation of individual flows, a considerable thickness of basalt built up, which eventually engulfed and buried the landforms associated with the preceding period of silicic volcanism. The outpouring of basalt has continued until the recent past. Basalt flows encountered in the upper 200 m (700 ft) of wells drilled at the RWMC near the southern edge of the INEL yield ages ranging from approximately 100,000 to 600,000 years (Anderson and Lewis, 1989). The youngest flows in the ESRP occur at Craters of the Moon National Monument, with an age of approximately 2,100 years (Kuntz et al., 1986).

Three volcanic buttes lining the southern boundary of the INEL represent a late resurgence of silicic volcanic activity. Silicic volcanic rocks from Big Southern Butte and East Butte yielded potassium-argon (K-Ar) dates of approximately 300,000 to 500,000 years. Although silicic rocks do not outcrop on middle Butte, the elevation and orientation of the basalt cap on the butte suggests that the cap was lifted and tilted by a hidden intrusion, presumably related to the silicic volcanics exposed in the neighboring buttes (Robertson et al., 1974).

Broad crustal downwarping accompanied expulsion from the subsurface of the huge volumes of silicic and mafic volcanics that fill the ESRP. Evidence for this downwarping is provided by the orientation of volcanic rocks along the margins of the plain (Robertson et al., 1974). These volcanic units dip toward the axis of the plain, and the oldest units show the steepest dips. Evidently, the floor of the ESRP continued to subside after these units were emplaced, and the oldest units have witnessed the largest amount of subsidence. Other evidence for subsidence of the floor of the ESRP comes from drill holes and geophysics, which show that rocks equivalent to the Paleozoic and Mesozoic sedimentary rocks exposed at the surface in the block-faulted mountains north and south of the ESRP have been depressed thousands of feet beneath the plain (Robertson et al., 1974).

Some uncertainty exists concerning the nature of the boundaries between the ESRP and the enclosing areas of block-faulted mountains. Some workers consider the ESRP to be a broad downwarp that is not bounded by well-defined boundary faults. However, Robertson et al. (1974) conclude that the ESRP is a graben bounded by normal faults, and that these faults have been hidden by recent volcanism. Regardless of the precise nature of the boundary, northwest-trending Basin and Range structures are known to extend into the ESRP (Robertson et al., 1974).

2.3.3.2 Geology of the INEL. With the exception of several silicic volcanic buttes, the INEL is underlain by basaltic lava flows, the youngest of which may be less than 100,000 years old. In many places the basalt is covered by a thin veneer of eolian, alluvial and lacustrine sediments. Figure 2-6 is a generalized map of the surficial geology of the INEL.

The thickness of basalt lava flows and interflow sediments beneath the INEL may vary from as little as 120 m (400 ft) [based on geophysics in a well near the southern edge of the Site as reported by Robertson et al. (1974)] to 760 m (2,500 ft) or more. The larger number is based on the thickness of basalt, 744 m (2440 ft), encountered in well INEL-1. The average thickness of the underlying silicic volcanics is unknown, but the same well penetrated 2,406 m (7,893 ft) of rhyolite ash flow tuffs, air fall ash, and volcaniclastic sediments (Figure 2-7) (Doherty et al., 1979).

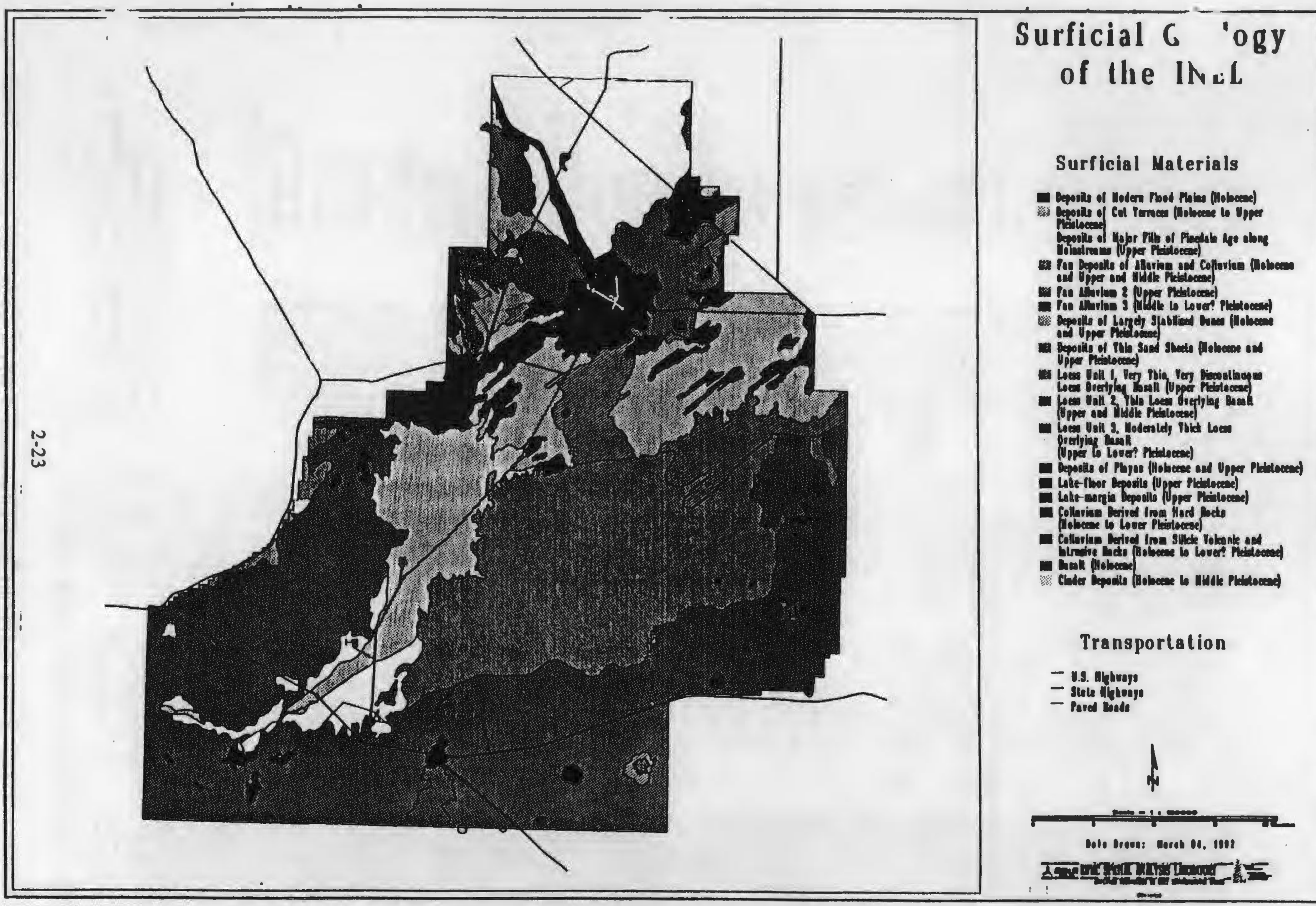
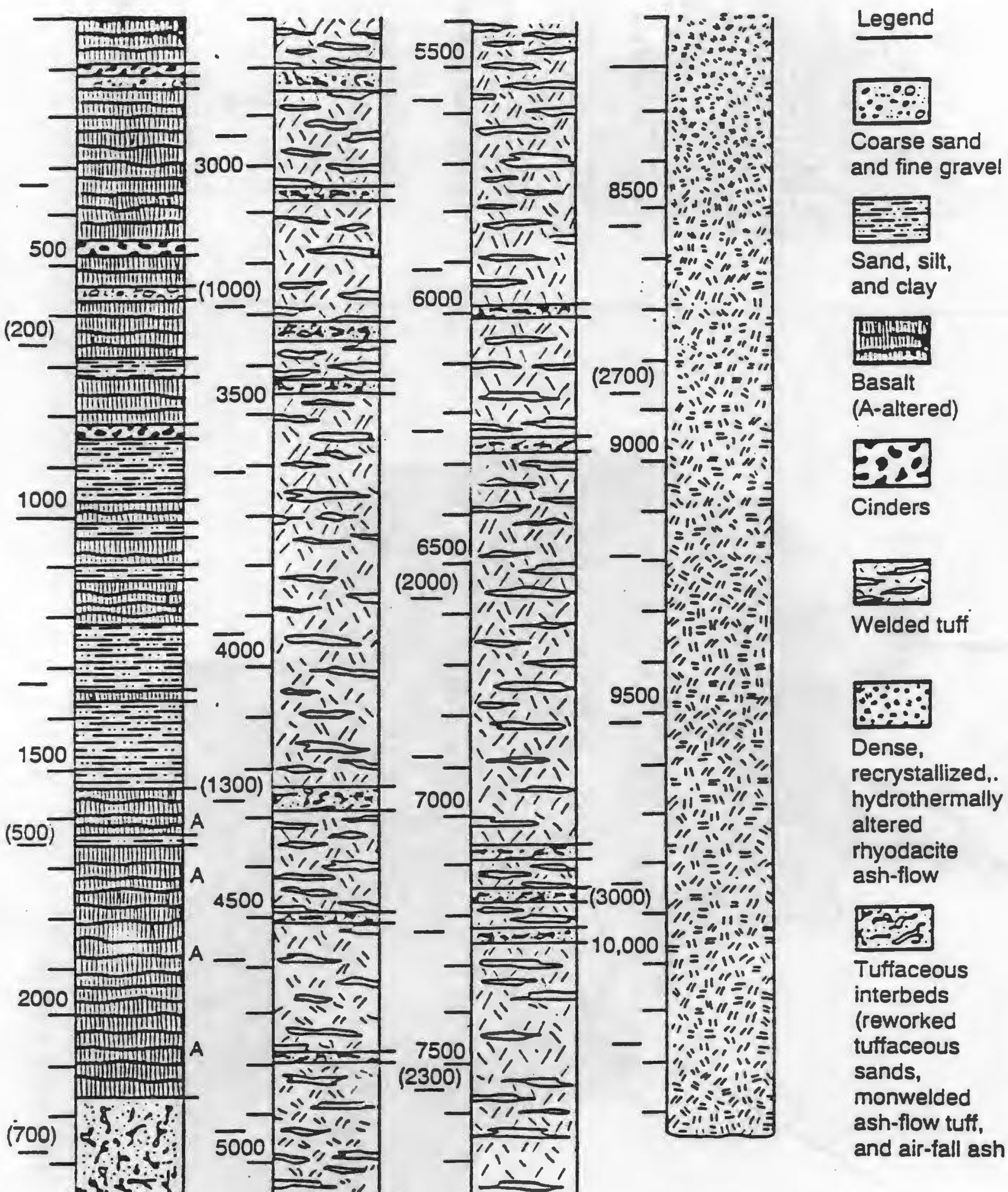


Figure 2-6. Surficial geology of the INEL.



Depth shown in feet (metres)
Total depth: 10,365 ft (3159 m)
Depths measured from ground level.
Elevation: 4873 ft (1485 m) GL

Figure 2-7. Log of drill hole INEL-1 (from Mann, 1986).

1-0277

The basalts of the ESRP can be classified as olivine tholeites having relatively low concentrations of silica and alkalis, and relatively high concentrations of iron (Nace et al., 1956). Multiple flow units of the smooth, ropy variety of basalt (pahoehoe) are typical, but rough-textured aa flows also occur. Individual flows typically vary in thickness from about 3 to 75 m (10 to 250 ft). The basalt flows are interlayered with sediments, cinders, and breccia.

Considerable variation in texture occurs within individual basalt flows (Nace et al., 1956). In general, the bases of the flows are glassy to fine-grained and minutely vesicular. The middle portions are typically coarser grained, and contain fewer vesicles than flow tops or bottoms. The upper portions are fine-grained, highly fractured, and contain many vesicles. This distribution of textures within the flow results from rapid cooling of the upper and lower surfaces, and slower cooling of the interior. Another typical artifact of the slow cooling of the main mass of flow interiors is vertical hexagonal jointing, which results from the contraction of the rock that accompanies its cooling.

Basalt vents of the ESRP form linear arrays of fissure flows, small shields, cones, pit craters, and open cracks. These features define volcanic rift zones where eruptive activity has been concentrated. Several postulated northwest-trending volcanic rift zones cross the INEL (Nace et al., 1956). The youngest volcanism in this set of rift zones occurred at Hell's Half acre, south of the INEL, about 4,100 years ago.

Sedimentary interbeds represent quiescent periods between volcanic episodes, when the uppermost lava flow was covered by accumulations of eolian, alluvial, and lacustrine sediments (Nace et al., 1956). The sedimentary deposits display a wide range of grain size distributions depending on their mode of deposition, the source rock, and transport distance. The sediments seen in the interbeds accumulated in isolated depressions on the irregular surface of the basalt flows.

2.3.4 Hydrology

2.3.4.1 Surface Water Hydrology. Three surface drainages terminate within the INEL. Big Lost River, Little Lost River, and Birch Creek drain mountain watersheds located to the north and west of the Site (Figures 2-4 and 2-8). For more than 100 years, flows from the Little Lost River and Birch Creek have been diverted for irrigation, or have been lost to the subsurface because of high infiltration rates along the channel bed leading to the INEL. More recently, Birch Creek has been diverted for hydropower purposes. Birch Creek terminates at a playa near the north end of the Site. The Little Lost River terminates at a playa just north of the central northwestern boundary of the INEL. Surface water from the Birch Creek and Little Lost River watersheds has negligible impact on the INEL except during infrequent high-runoff events caused by rapid snowmelt and heavy precipitation.

The Big Lost River, the major surface-water feature on the INEL, drains more than 3,600 km^2 (1,400 mi^2) of mountainous area that includes parts of the Lost River Range and the Pioneer Range west of the INEL (Figure 2-8). The river flows onto the INEL near the Site's southwestern corner, bends to the northeast, and flows northeastward to the Big Lost River playas.

Diversion systems on the Big Lost River include Mackay Dam, several irrigation diversions between Mackay and Arco, and the INEL diversion dam. Mackay Dam is an earthfill structure 435 m (1,430 ft) long and 24 m (79 ft) high . Located approximately 65 km (40 mi) upstream from the INEL, Mackay Reservoir has a storage capacity of 54.9×10^6 m^3 (44,500 acre-ft) of water.

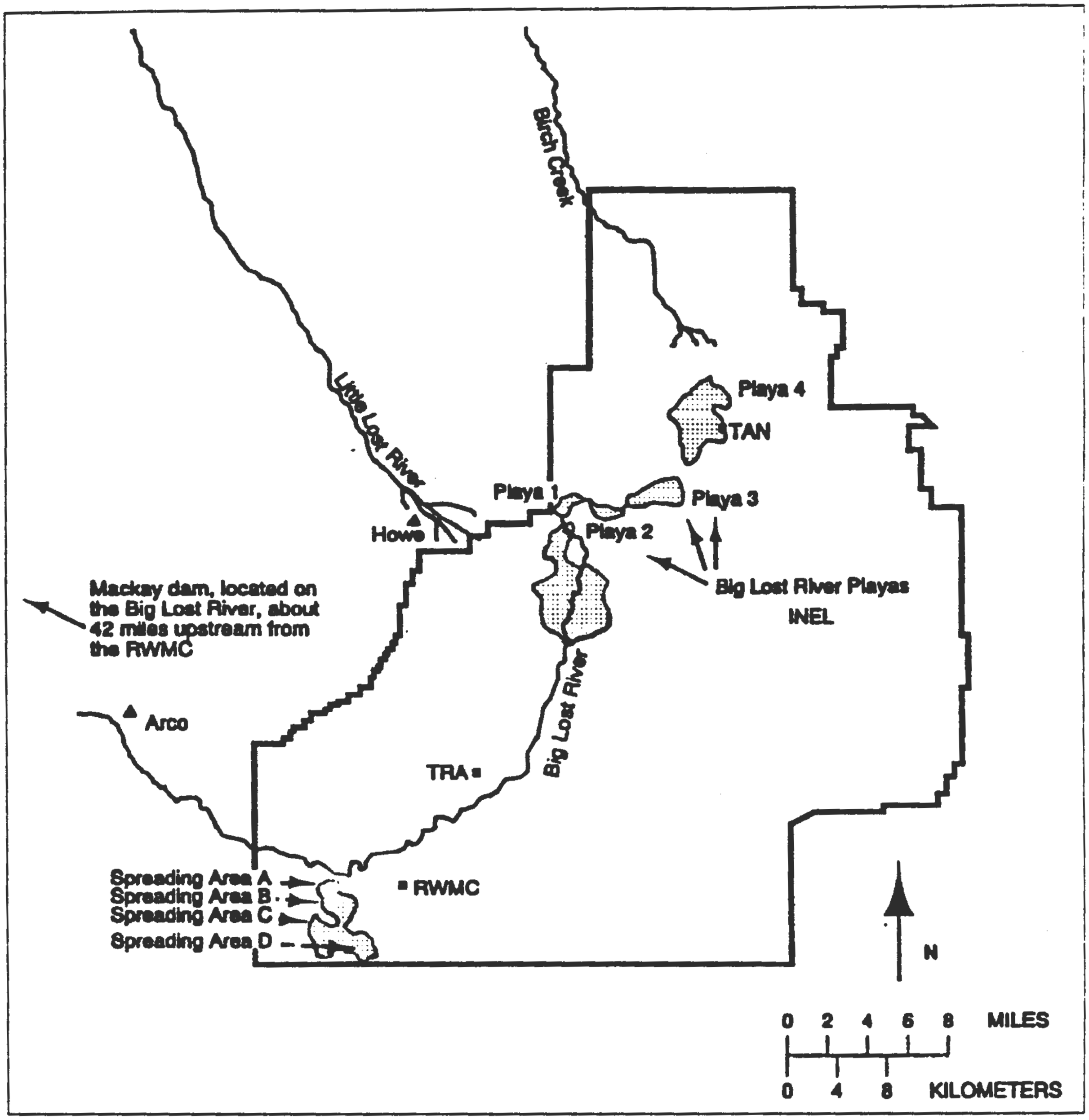


Figure 2-8. Surface water drainage features.

Flow in the Big Lost River at the INEL boundary is usually diminished by evaporation from Mackay Dam, irrigation diversions, and infiltration losses along the river channel. However, when runoff from the Big Lost River valley is heavy, flow may reach the INEL at its southwest boundary. From this point, flow moves northeastward in the natural channel of the Big Lost River, terminating at the playas near TAN. When flow exceeds 10,700 L/sec (377 cfs), some of the flow automatically is diverted from the channel to the INEL spreading areas, located 3 km (2 mi) northwest of RWMC. The diversion area consists of spreading areas A through D (Figure 2-8). When flow in the Big Lost River reaches the INEL, it constitutes an important source of localized recharge to the SRPA.

The INEL diversion system and spreading areas were constructed in 1958 to divert high-runoff flows from the Big Lost River to protect downstream INEL facilities. The diversion system consists of a diversion dam, diversion channel, two gated culverts 1.8 m (6 ft) in diameter, three dikes, four spreading areas, and two interconnecting channels (Figure 2-9). The dam and dikes were upgraded in the early 1980s to handle larger flow volumes. The diversion channel is capable of carrying 204 m^3/s (7,200 ft^3/s) from the river into the spreading areas (Bennett, 1986). Two low swales located southwest of the main channel can carry an additional 59 m^3/s (2,100 ft^3/s), producing a combined diversion capacity of 263 m^3/s (9,300 ft^3/s) (Bennett, 1986). Water diverted from the river enters the spreading areas, where it either evaporates or infiltrates the ground surface. Most of the water entering the spreading areas infiltrates the surface and eventually percolates to the aquifer (Wood, 1989a).

Discharge to the spreading areas is variable depending on the volume of flow in the Big Lost River and the setting of the diversion gate. As shown in Figure 2-10, discharge to the spreading areas was highest during the mid- to late-1960s and the mid-1980s (Orr and Cecil, 1991). Flow volume measured below Mackay Reservoir during 1965 was higher than that measured in any of the preceding 49 years (Barraclough et al., 1967). In 1965, the monthly discharge to the spreading areas peaked at about 43×10^6 m^3 (35,000 acre-ft) (Bennett, 1990). The volume of flow diverted to the spreading areas in 1967 and 1969 approached that diverted in 1965. For several years following 1969, discharge to the spreading areas was much less. Then, starting in 1982, discharge to the spreading areas increased for several years, peaking in June, 1984, with a discharge of nearly 62×10^6 m^3 (50,000 acre-ft) (Bennett, 1990). Diversions to the spreading areas have been moderate to nonexistent since 1984. Flow in the Big Lost River has not reached the INEL since 1987.

In addition to runoff from the Big Lost River, local precipitation and surface runoff occasionally affect the INEL. INEL facilities, such as the RWMC, experienced flooding in 1962, 1969, and 1982 caused by local basin runoff (Karlsson, 1977; DeVries, 1983). These events were caused by rapid snowmelt combined with heavy rains, and often compounded by frozen-soil conditions. Details of the flooding events at the RWMC are described in Section 8.

2.3.4.2 Groundwater Hydrology.

Snake River Plain aquifer - The SRPA, part of which underlies the INEL, is approximately 320 km (200 mi) long and 48 to 97 km (30 to 60 mi) wide. It covers an area of about 24,600 km^2 (9,600 mi^2). The aquifer extends from near Ashton, Idaho, to Thousand Springs, near Twin Falls, Idaho, and is bounded by less-permeable rocks along the mountains bordering the ESRP

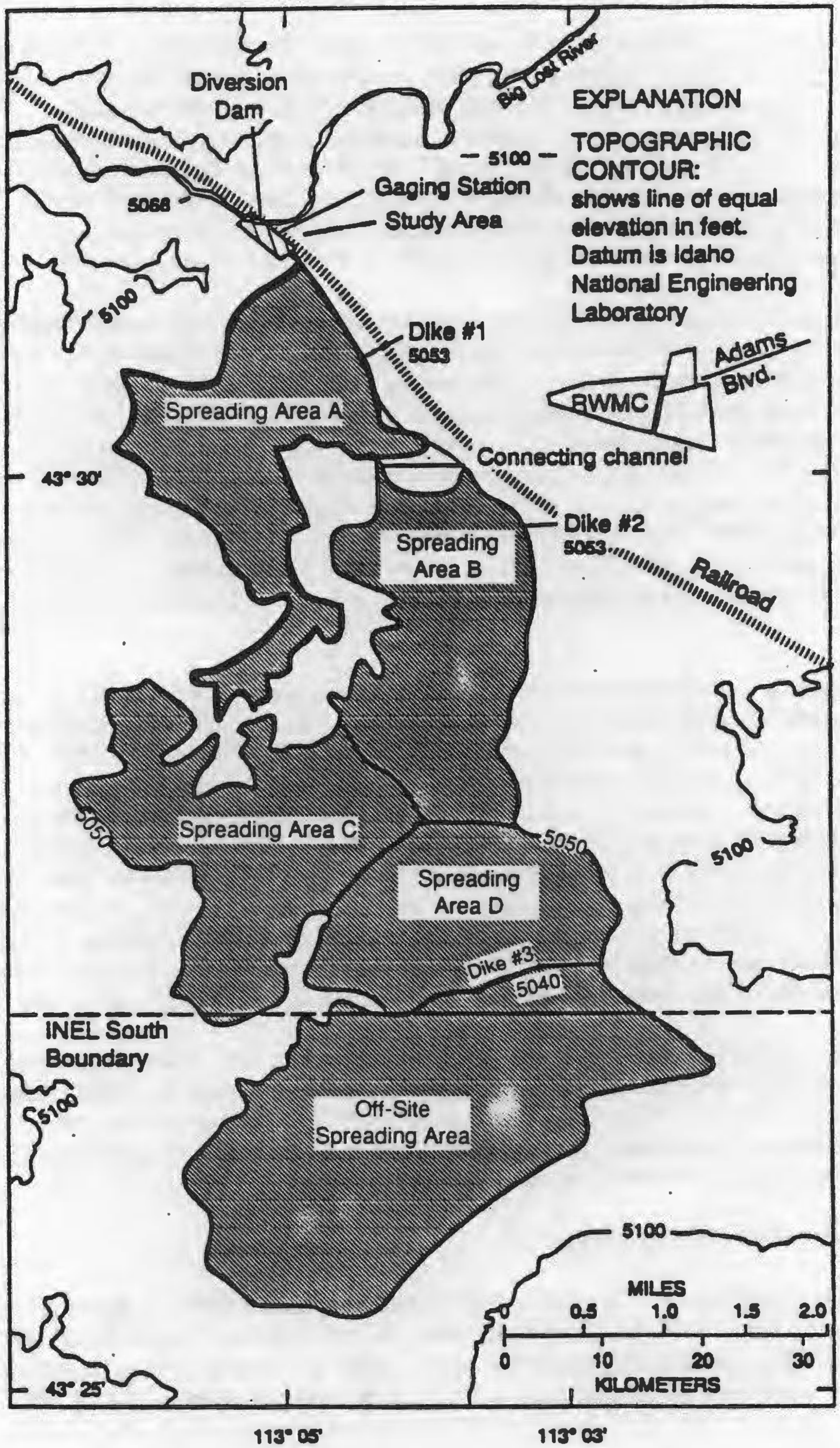


Figure 2-9. Big Lost River diversion and spreading areas (adapted from Bennett, 1986).

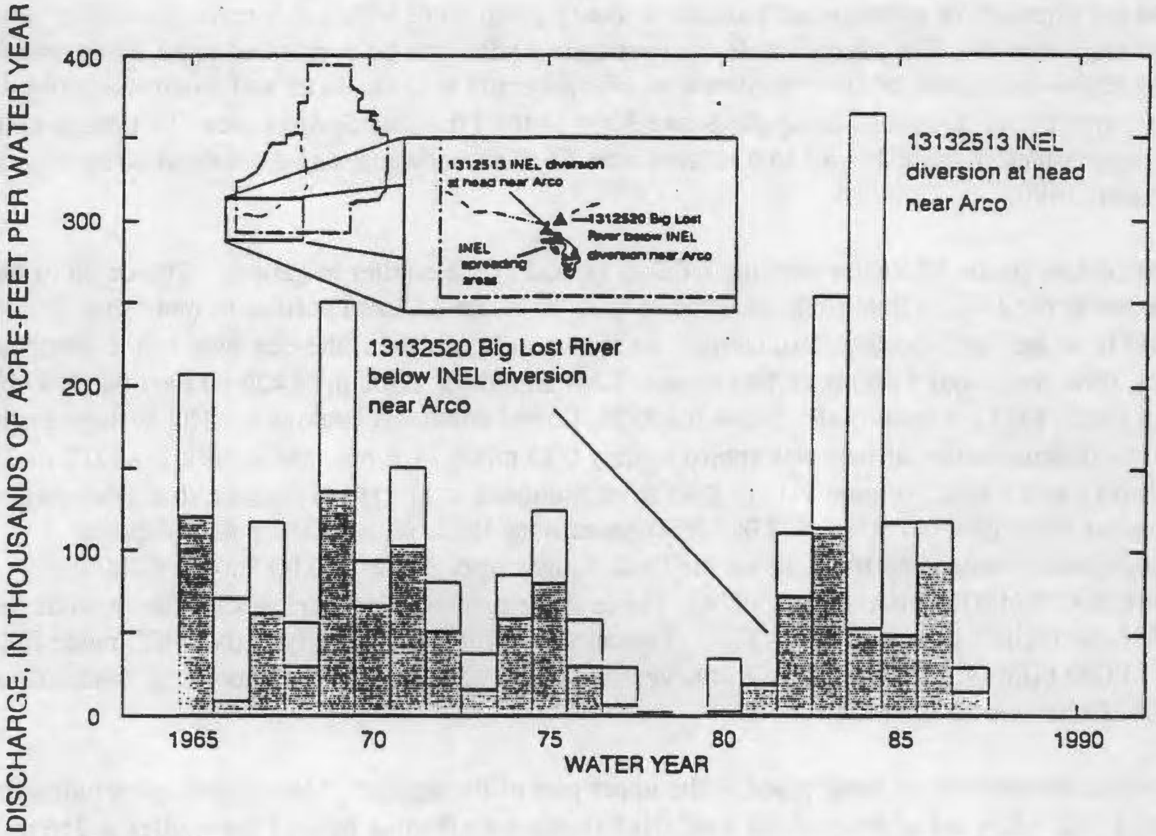


Figure 2-10. Discharge of the Big Lost River below the INEL diversion, and the INEL diversion at head near Arco (water years 1965-88) (Orr and Cecil, 1991).

(Figure 2-4). The SRPA is one of the most productive aquifers in the United States (USGS, 1985). The aquifer may contain more than 1×10^{12} m^3 (1×10^9 acre-ft) of water (Barraclough, Lewis, and Jensen, 1981), and consists of a thick sequence of saturated basalts and sedimentary interbeds filling a large, arcuate, structural basin in southeastern Idaho.

The aquifer is composed of a series of basalt flows interbedded with sediment of eolian, fluvial, and lacustrine origin. Basalt permeability is controlled by pore spaces and fractures. On a small scale (feet to hundreds of feet), the hydraulic properties of the basalt are nonuniform and highly variable, and the direction of groundwater movement at any given point within it is correspondingly variable and unpredictable. On a larger scale, however, the aquifer can be considered more homogeneous. The regional direction of flow within the aquifer generally is to the south and southwest, toward discharge points at springs along the Snake River in the Thousand Springs area. In 1988, a volume of approximately 5.3×10^9 m^3 (4.3 million acre-ft) of groundwater was discharged at these springs (Mann, 1986).

The portion of the SRPA beneath the INEL is typical of the aquifer in general. The depth to the aquifer at the INEL varies from about 60 m (200 ft) in the northern portion to more than 280 m (900 ft) at the Site's southeastern corner. As shown in Figure 2-11, the elevation of the water table in July 1988 was about 1,400 m (4,590 ft) near TAN and about 1,300 m (4,420 ft) near the RWMC (Orr and Cecil, 1991). Groundwater below the INEL flowed south and southwest. The average gradient of the potentiometric surface was approximately 0.75 m/km (4 ft/mi), and ranged from 0.2 to 2.8 m/km (1 to 15 ft/mi) (Figure 2-11). Data from Mundorff et al. (1964) indicate that groundwater flows at a rate of about 60 m^3/s (2,000 ft^3/s) beneath the INEL at its widest point. Aquifer transmissivity calculated for wells on the INEL ranges from 372 to 223,000 m^2/d (4,000 to 2,400,000 ft^2/d) (Robertson et al., 1974). The lower transmissivities were reported from wells near TAN, the highest from wells near TRA. Typical values for transmissivity at the INEL range from 0.1 to 71,000 m^2/d (1.1 to 760,000 ft^2/d) (Ackerman, 1991). Storage coefficients range from 0.01 to 0.06 (Robertson et al., 1974).

Most groundwater flow takes place in the upper part of the aquifer. Mann (1986) concluded from data produced by the drilling of test well INEL-1 that the effective base of the aquifer is 256 to 366 m (840 to 1,220 ft) below land surface. Since the depth to water near INEL-1 is approximately 120 m (400 ft), Mann's interpretation suggests that the thickness of the effective portion of the aquifer is between 134 and 250 m (440 and 820 ft). The hydraulic conductivity of basalts in the upper 244 m (800 ft) of the aquifer ranges from approximately 0.3 to 31 m/d (1 to 100 ft/d), generally diminishing with depth (Mann, 1986). The hydraulic conductivity of the underlying material is much lower.

Inflow to the SRPA beneath the INEL is primarily by underflow from the northeastern part of the ESRP and by infiltration from the Big Lost River (Bennett, 1990). Groundwater levels near the river are influenced by recharge from the Big Lost River when it flows onto the INEL. Infiltration from the Little Lost River and Birch Creek to the north and west also adds lesser amounts of recharge to the aquifer. Infiltration of direct precipitation on the INEL probably contributes a minor amount of recharge. Withdrawals by pumping at the INEL are small in comparison to the total volume of water stored in the aquifer and do not affect water levels significantly.

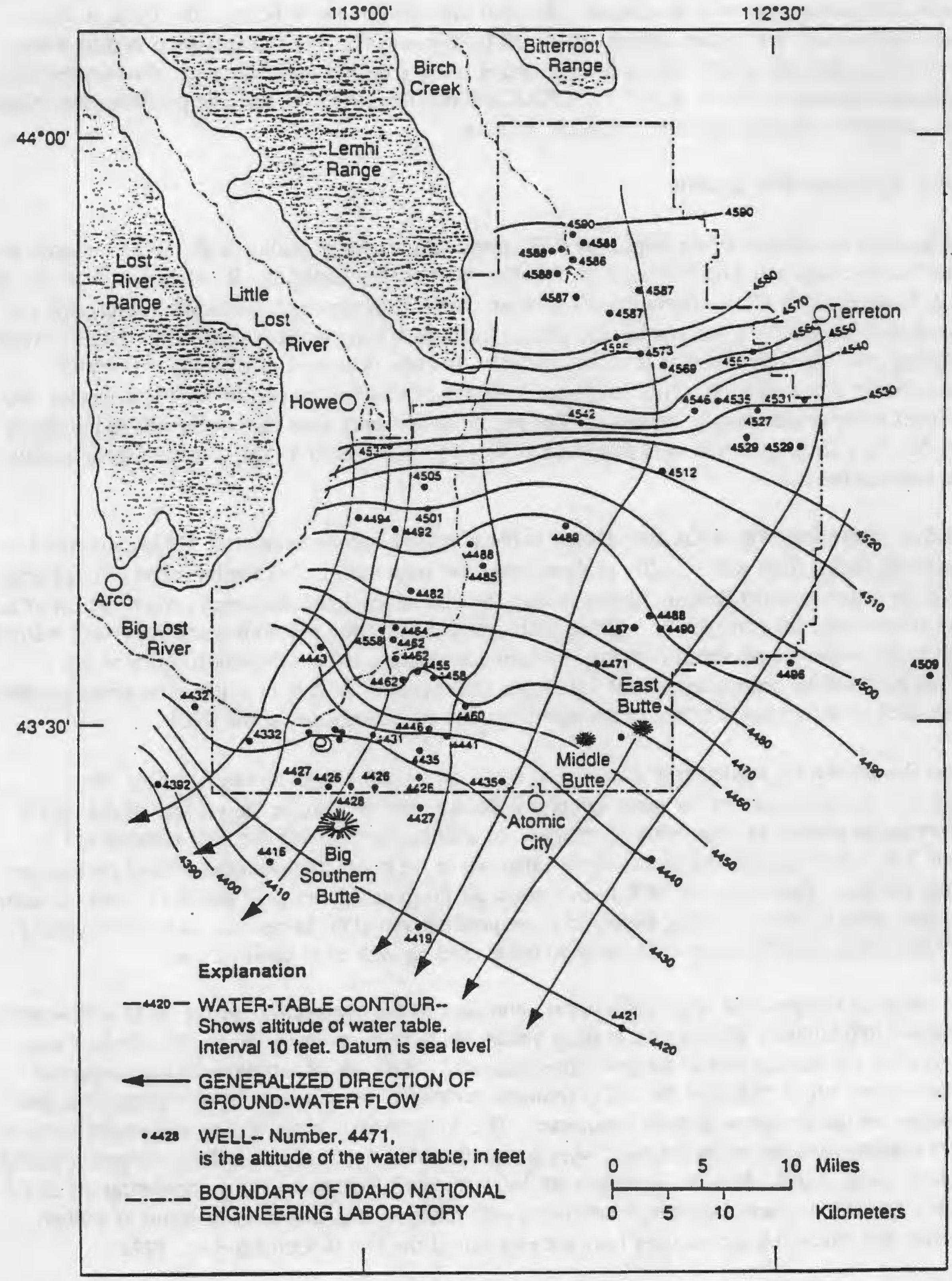


Figure 2-11. Altitude of the water table, Snake River Plain aquifer, and general direction of groundwater movement. July 1988 (Orr and Cecil, 1991).

Perched Water - Perched water is groundwater separated from the underlying regional aquifer by an interval of unsaturated rock or sediment. Perched groundwater exists beneath the INEL in areas where downward flow to the aquifer is impeded by layers of fine-grained sediments and by basalt flows with low permeability. Perched water occurs below the Big Lost River, and below wastewater discharge operations at TRA, ICPP, TAN, NRF, and possibly ANL-W. Specific perched water bodies are discussed in subsequent facility-specific sections.

2.3.5 Groundwater Quality

An accurate assessment of the impact of INEL operations on water quality in the SRPA depends on both baseline data and data produced by ongoing water quality sampling. Baseline water quality data must be gathered to allow discrimination between chemical parameter concentration levels that can be considered "normal" for the aquifer and higher levels indicating contamination from DOE activities. Ongoing water quality sampling must be conducted in areas of known, suspected, or potential groundwater contamination. The USGS has for many years taken responsibility for gathering both kinds of water quality data at the INEL. The results of this work have been presented in numerous reports, the earliest of which were published as long ago as the early 1950s. Some of these reports are summarized below.

2.3.5.1 Baseline Water Quality Data. Schoen, writing in Robertson et al. (1974), compiled analytical results from water quality analyses that were conducted before the initiation of large-scale activities at the National Reactor Testing Station (NRTS), as the INEL was once known. Much of the data comes from the early 1950s. Although the sample collection procedures and analytical methods then in use were less advanced than their modern counterparts, the internal consistency of this information and its general agreement with more recent results indicate that it is sufficiently reliable to be used to define broad trends in the natural quality of groundwater at the INEL.

Table 2-4 shows, for a number of parameters, mean values and ranges of values for the "best available chemical analyses" of water samples collected from 69 wells in the vicinity of the NRTS before the beginning of large-scale operations. In addition to reporting the data summarized in Table 2-4, Schoen plotted the data to show variations in the concentrations of dissolved constituents across the Site. Two examples of Schoen's maps are given as Figures 2-12 and 2-13. Schoen related the observed variations in water quality to corresponding variations in bedrock in the surrounding drainage basins which contribute recharge to the aquifer, as well as to other factors.

The chemical composition of groundwater is controlled by the composition of the rocks with which it has come into contact. Higher-than-average values for calcium, magnesium, and bicarbonate were observed in the western half of the Site. These elevated values can be attributed to the passage of surface water, which recharges the SRPA from the northwest, through areas in which limestone and dolomite are the dominant bedrock lithologies. This hypothesis is supported by analysis of surface water samples from the major drainages west and northwest of the Site, which show elevated levels of the same constituents. Rhyolite volcanics are the dominant lithology in regions bordering the SRPA to the north and northeast, and this is consistent with relatively elevated concentrations of sodium, fluorine, and silica in water samples from the east half of the Site (Robertson et al., 1974).

Other processes also have an influence on water quality in the SRPA. Intensive irrigation in the Mud Lake/Terreton area results in higher levels of total dissolved solids and other constituents in a restricted area on the east side of the Site (Figure 2-12). Irrigation is accompanied by a high level of

Table 2-4. Mean values and ranges for selected water quality parameters for samples from 69 wells (summarized from Robertson et al., 1974).[a]

Parameter	Range	Average
Temperature (°F)	49-65.5	55.0 (65)
pH	7.2-8.4	7.9 (68)
Specific conductance (micromhos @ 25°C)	225-963	358
Calcium	22-93	40.0
Magnesium	5.9-33	14.8
Sodium	2.7-42	11.4
Potassium	1.2-6.8	2.7
Bicarbonate	81-226	167.5
Sulfate	9.1-57	23.8
Chloride	6.0-160	15.7
Nitrate	0.5-29	2.6
Fluoride	0-0.9	0.3
Silica	11-39	25.1
Iron (dissolved)	0-0.52	0.08 (67)
Total hardness	94-368	161

a. Values in milligrams/liter unless otherwise indicated. Numbers in parentheses are number of samples in average if fewer than 69.

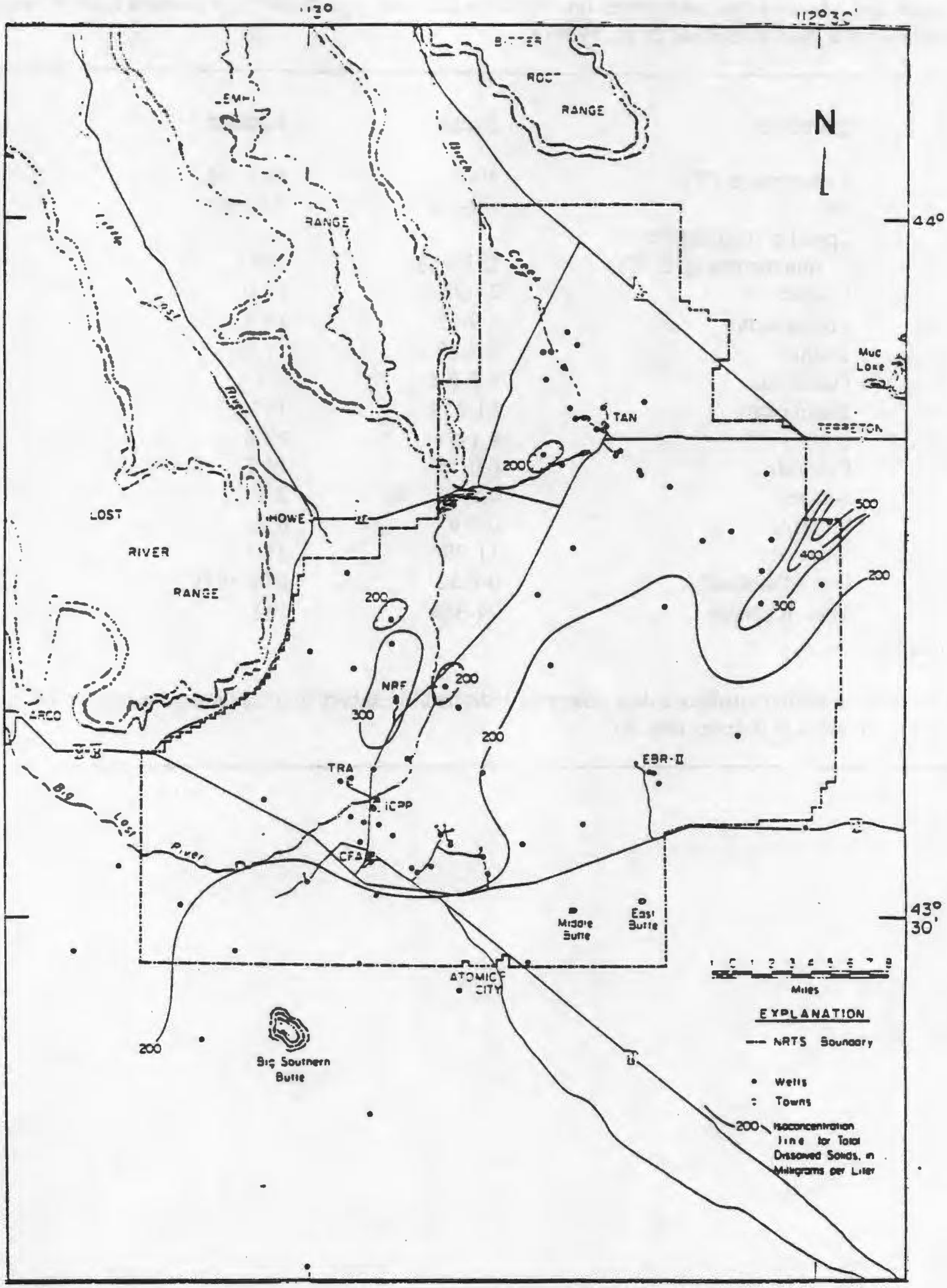


Figure 2-12. Natural distribution of total dissolved solids (residue on evaporation) in water from the Snake River Plain aquifer (Robertson et al., 1974).

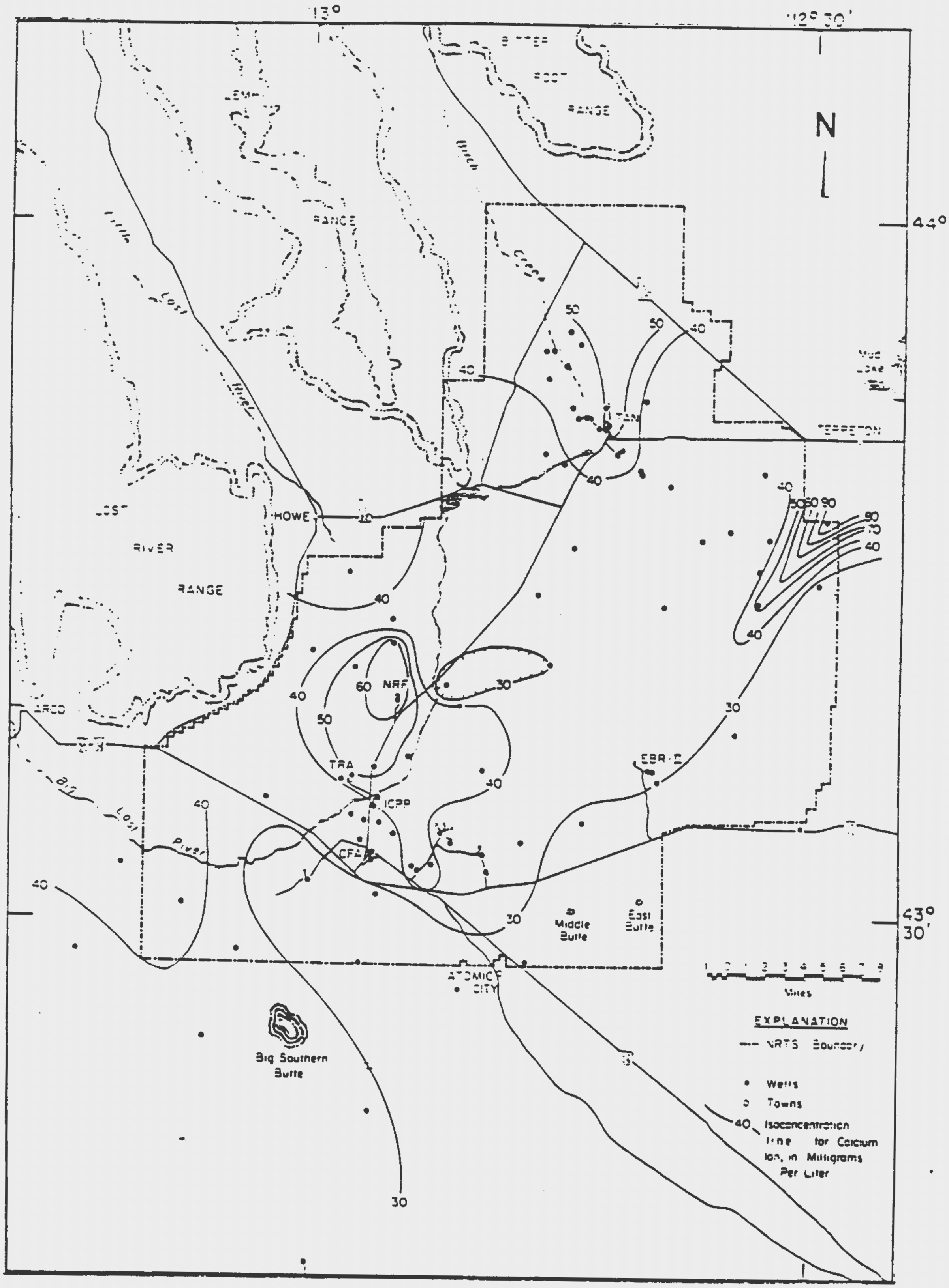


Figure 2-13. Natural distribution of total dissolved calcium in water from the Snake River Plain aquifer (Robertson et al., 1974).

evaporation, resulting in infiltration to the aquifer of water enriched in any dissolved constituents it already carried. Infiltrating irrigation water may also carry elevated levels of constituents such as sodium, which are especially easily leached from the soil. Relatively high levels of nitrate downgradient from the Mud Lake area can be linked to the use of fertilizer.

The relatively low level of total dissolved solids observed in the aquifer is partly a function of proximity to recharge areas in the surrounding mountains, short geochemical reaction times, and the low solubility of the silicate minerals that predominate in the basalts of the aquifer.

Recent USGS studies have characterized background concentrations of selected constituents in groundwater at the INEL and in downgradient areas. Orr et al. (1991) studied background concentrations of selected radionuclides, organic compounds, and chemical constituents on and around the INEL. In essence, the constituents selected for study were those that might be expected to appear as groundwater contaminants related to activities at the INEL, and for which establishment of a baseline is critical. Tables 2-5 and 2-6 summarize some of the results of this report.

Table 2-5 lists background concentrations of selected radionuclides in the SRPA. Most of the tabulated values represent the mean of analyses conducted on water samples collected from 12 wells and three irrigation wastewater drains in an area approximately 105 km (65 mi) southwest of the INEL. These samples can be assumed not to have been influenced by contaminants originating at the INEL because flow rates in the SRPA are insufficient to have transported contaminants such a long distance from the Site in the time the INEL has been in operation. Natural background concentrations for some constituents are shown as zero because these constituents are not naturally occurring substances, and are found only in association with nuclear operations.

Table 2-6 provides background concentrations of ten inorganic constituents in the SRPA. These constituents were selected because maximum contaminant levels have been established for them (EPA, 1989).

Organic compounds that could be associated with industrial processes undertaken at the INEL include the following: benzene, bromoform, carbon tetrachloride, chloroform, dibromochloromethane, dichlorobromomethane, 1,4-dichlorobenzene, 1,2-dichloroethane, 1,1-dichloroethylene, 1,1,1-trichloroethane, trichloroethylene, and vinyl chloride. These compounds may be detected in groundwater at the INEL. They do not occur naturally.

A report by Wegner and Campbell (1991) provides analytical results for groundwater samples collected from 55 wells and springs downgradient from the INEL, between the Site's southern boundary and the major discharge zone at the Hagerman-Thousand Springs area. The samples were tested for a broad range of constituents, including selected radionuclides, trace metals, nutrients, surfactants, purgeable organic compounds, insecticides and polychlorinated compounds, and herbicides. The data revealed no detectable groundwater contamination in the SRPA downgradient from the Site that could be attributed to activities at the INEL. However, since the Wegner and Campbell report was published, tritium, I-129, and Cl-35 have been detected off-Site in extremely small quantities.

2.3.5.2 Groundwater Contamination. Operations at the INEL have resulted in measurable groundwater contamination at several locations within the Site. The contamination in these areas has been described in a series of USGS studies that examined the influence of INEL operations on water

Table 2-5. Background concentrations of selected radionuclides in the Snake River Plain aquifer (Orr et al., 1991).

Constituent	Concentration (pCi/l)
Tritium	35 ± 13[a]
Potassium-40	300[c]
Cobalt-60	0[b]
Strontium-90	0[a]
Iodine-129	0 ± 0.05[a]
Cesium-137	0[b]
Radon-222	0 to 250[a]
Radium-226	0 to 0.1[a]
Radium-228	0 to 0.3[a]
Total uranium	3.0 ± 0.3[a]
Gross beta	0 to 8[a]
Gross alpha	0 to 5[a]

a. Median concentration in 12 wells and three irrigation wastewater drains 105 mi (65 mi) downgradient from the INEL.

b. Not a naturally occurring constituent of groundwater.

c. Estimate based on analysis for potassium and known relative abundance of K-40 isotope.

Table 2-6. SRPA background concentrations for selected inorganic constituents in the vicinity of the INEL (Orr et al., 1991).

Constituent	Natural background concentration for SRPA (µg/l)
Arsenic	2 - 3
Barium	50 - 70
Cadmium	< 1
Chromium	2 - 3
Lead	< 5
Mercury	< 0.1
Selenium	< 1
Silver	< 1
Fluoride	400 - 500
Nitrate (expressed as nitrate)	< 6,200

quality since the 1950s. Examples of general reports include Robertson et al. (1974), Barraclough et al. (1976), Barraclough and Jensen (1976), Barraclough et al. (1981), Lewis and Jensen (1984), Pittman et al. (1988), and Orr and Cecil (1991). In addition to this series of reports on general groundwater conditions, USGS also produced a number of reports devoted to individual contaminants or groups of contaminants of special interest:

- Mann and Knobel, 1987 (purgeable organic compounds)
- Mann and Knobel, 1988 (nine trace metals)
- Knobel and Mann, 1988 (radionuclides)
- Mann et al., 1988 (iodine-129)
- Mann and Cecil, 1990 (tritium)

INEL activities have resulted in elevated concentrations of a number of radiochemical and chemical constituents in water from the SRPA. These constituents include tritium, strontium-90, cobalt-60, cesium-137, plutonium, americium-241, chromium, sodium, chloride, sulfate, nitrate, and various volatile organic compounds. The horizontal distribution of these constituents in the aquifer has been estimated based on their concentration in wells. Vertical concentration variations are poorly known.

Water samples collected from zones of perched groundwater also have been collected and analyzed. Contamination of perched water has been documented at several locations, and each zone of contaminated perched water is described in the section devoted to the corresponding facility.

Tritium released from INEL facilities has been present as a contaminant in the SRPA since the 1950s. The principal causes of tritium contamination have been subsurface injection of radioactively contaminated wastewater through the disposal well at ICPP and discharge of wastewater to infiltration ponds at both ICPP and TRA. Mann and Cecil (1990) produced a series of maps showing the development of the ICPP/TRA tritium plume with time (Figures 2-14 through 2-18). Changes in the shape and extent of the plume from one period to the next can be attributed to the direction of regional groundwater flow, changes in waste disposal practices, dilution of the wastes in the aquifer, and radioactive decay (Mann and Cecil, 1990).

Plumes of strontium-90, sodium, chloride, and nitrate have also appeared in the SRPA as a result of operations at ICPP and TRA. These plumes are less widespread than the tritium plume. Figures 2-19 through 2-22 show the extent of these four contaminants in 1988 (Orr and Cecil, 1991).

Several radionuclides other than tritium and strontium-90 have been detected in wells completed in the SRPA at the INEL. Reportable concentrations of plutonium, cobalt-60, cesium-137, and americium-241 were measured in water samples collected from several wells in 1986 and 1988. Cobalt-60, cesium-137, and americium-241 were measured only in the TAN disposal well. Plutonium isotopes were measured in groundwater near both the TAN and ICPP disposal wells, and plutonium-238 was measured in water drawn from well CFA-1. Areas affected by these radionuclides are discussed in greater detail in later sections describing individual facilities.

Groundwater samples from 81 INEL wells were analyzed for total chromium in 1987 as part of a trace metals sampling program (Mann and Knobel, 1988). Chromium was detected at or above the maximum contaminant level of 50 μg/L at some wells at RWMC and TRA. This contamination is discussed in more detail in the facility-specific sections.

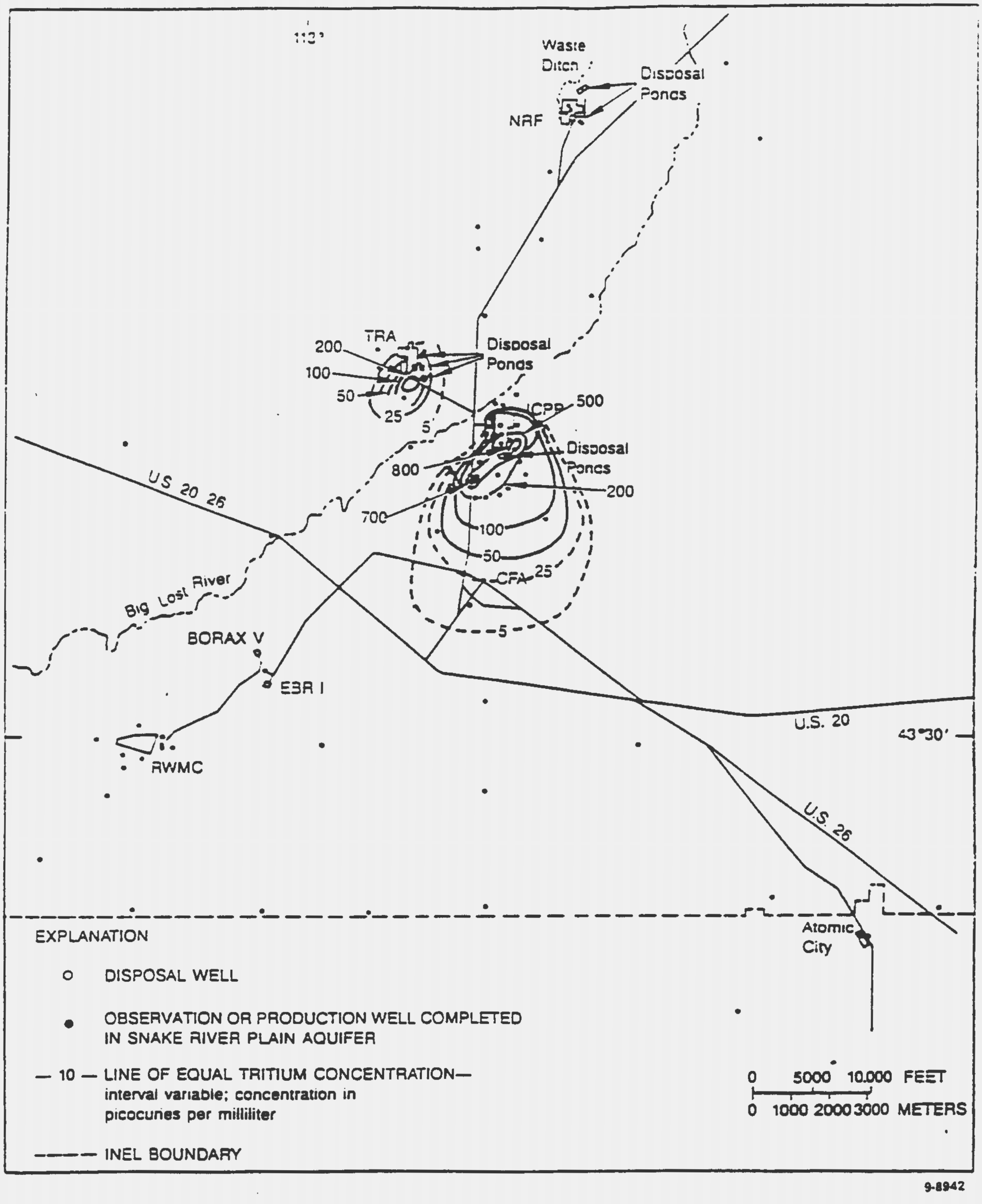


Figure 2-14. Distribution of tritium in water from the Snake River Plain aquifer in the south-central part of the INEL, 1961 (Mann and Cecil, 1990).

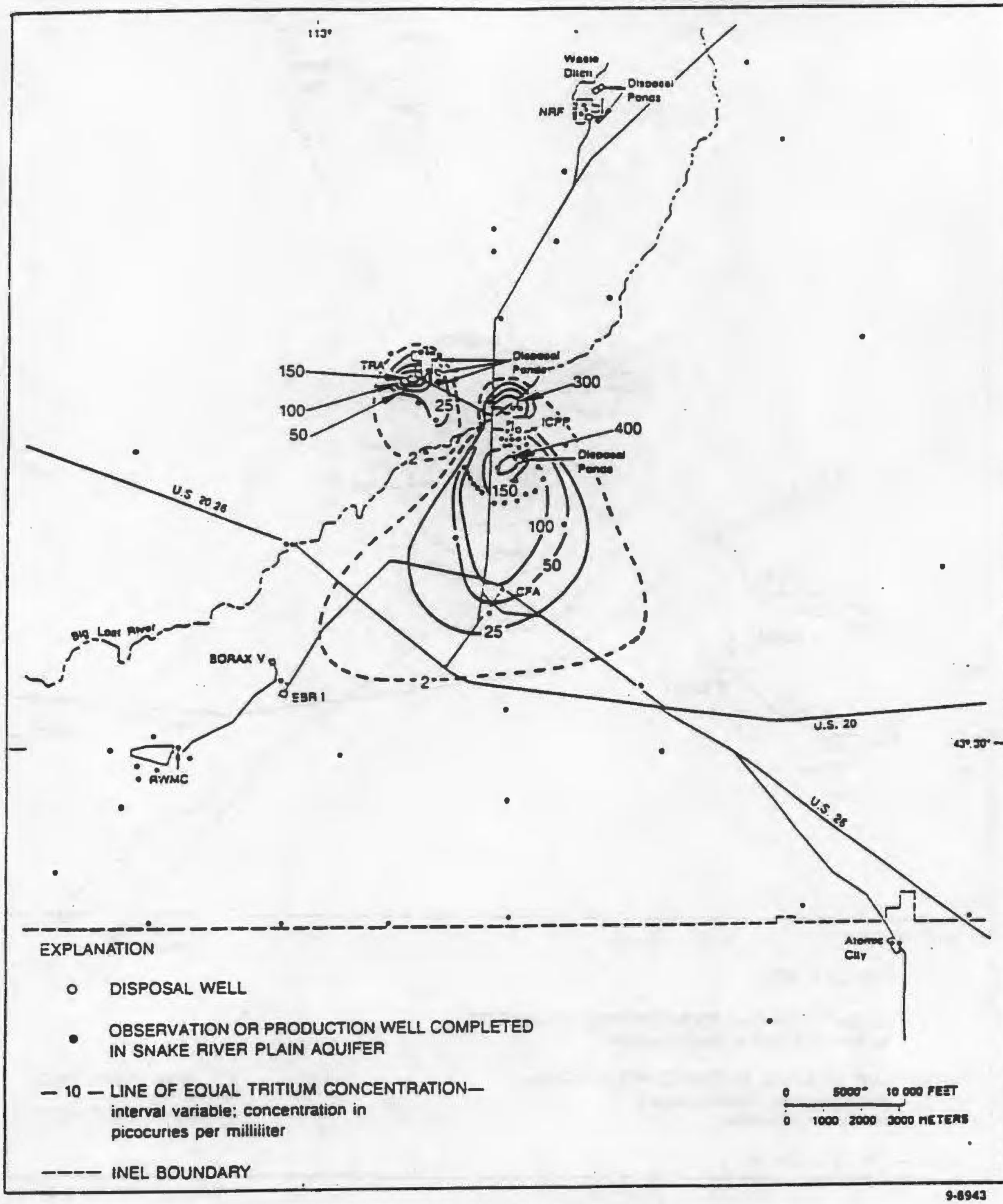


Figure 2-15. Distribution of tritium in water from the Snake River Plain aquifer in the south-central part of the INEL, 1970 (Mann and Cecil, 1990).

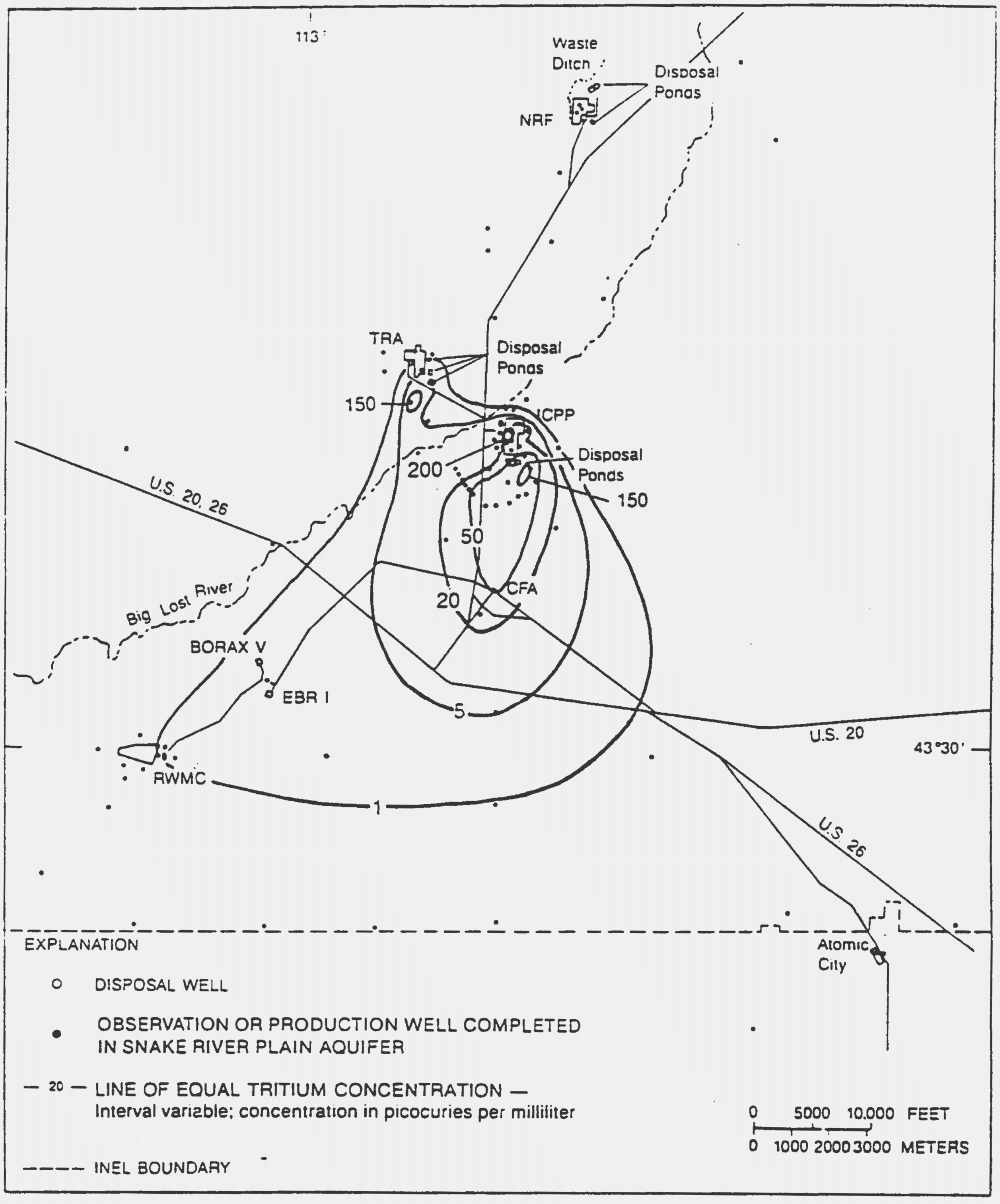


Figure 2-16. Distribution of tritium in water from the Snake River Plain aquifer in the south-central part of the INEL, 1977 (Mann and Cecil, 1990).

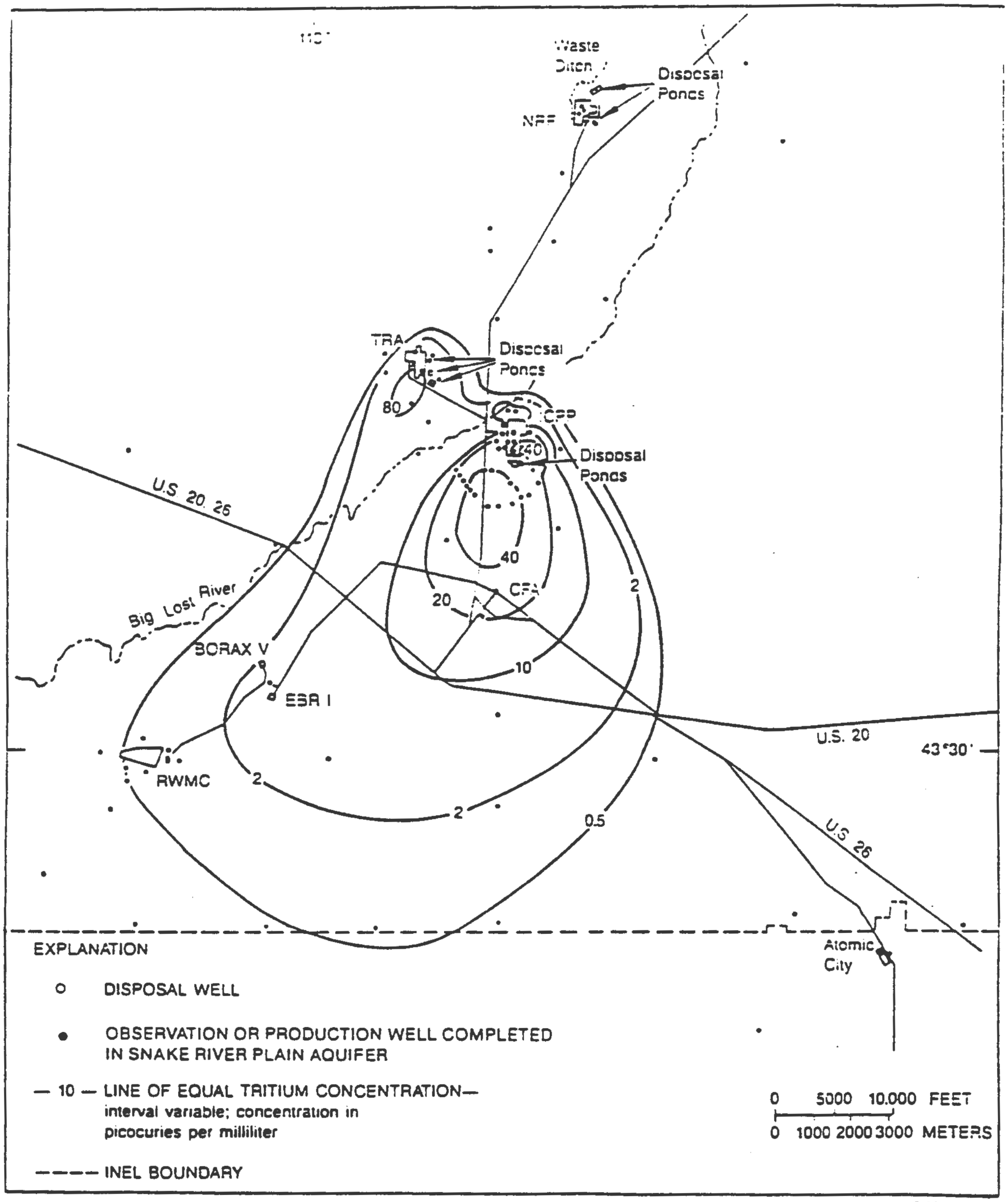


Figure 2-17. Distribution of tritium in water from the Snake River Plain aquifer in the south-central part of the INEL, 1985 (Mann and Cecil, 1990).

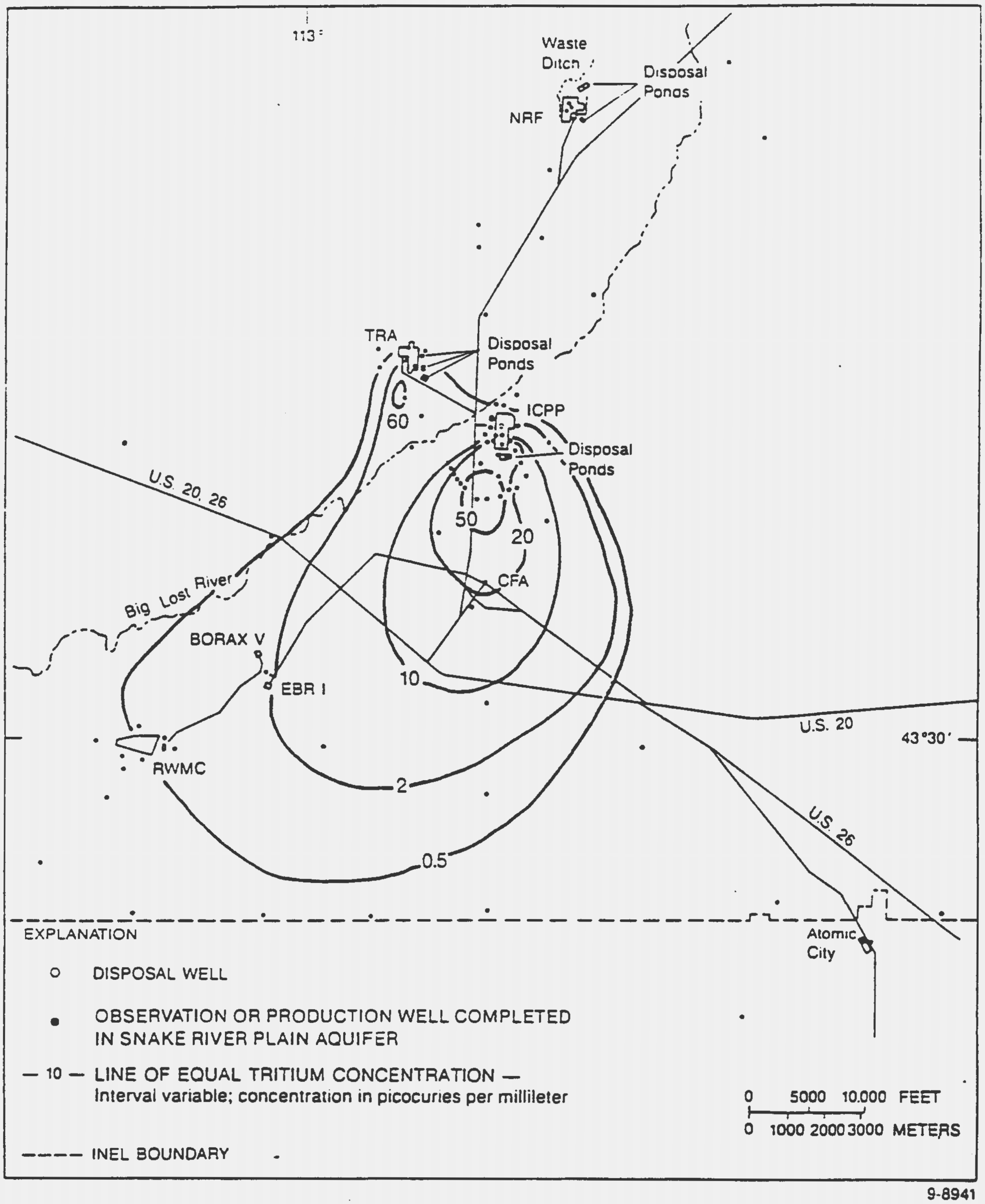


Figure 2-18. Distribution of tritium in water from the Snake River Plain aquifer in the south-central part of the INEL, 1988 (Mann and Cecil, 1990).

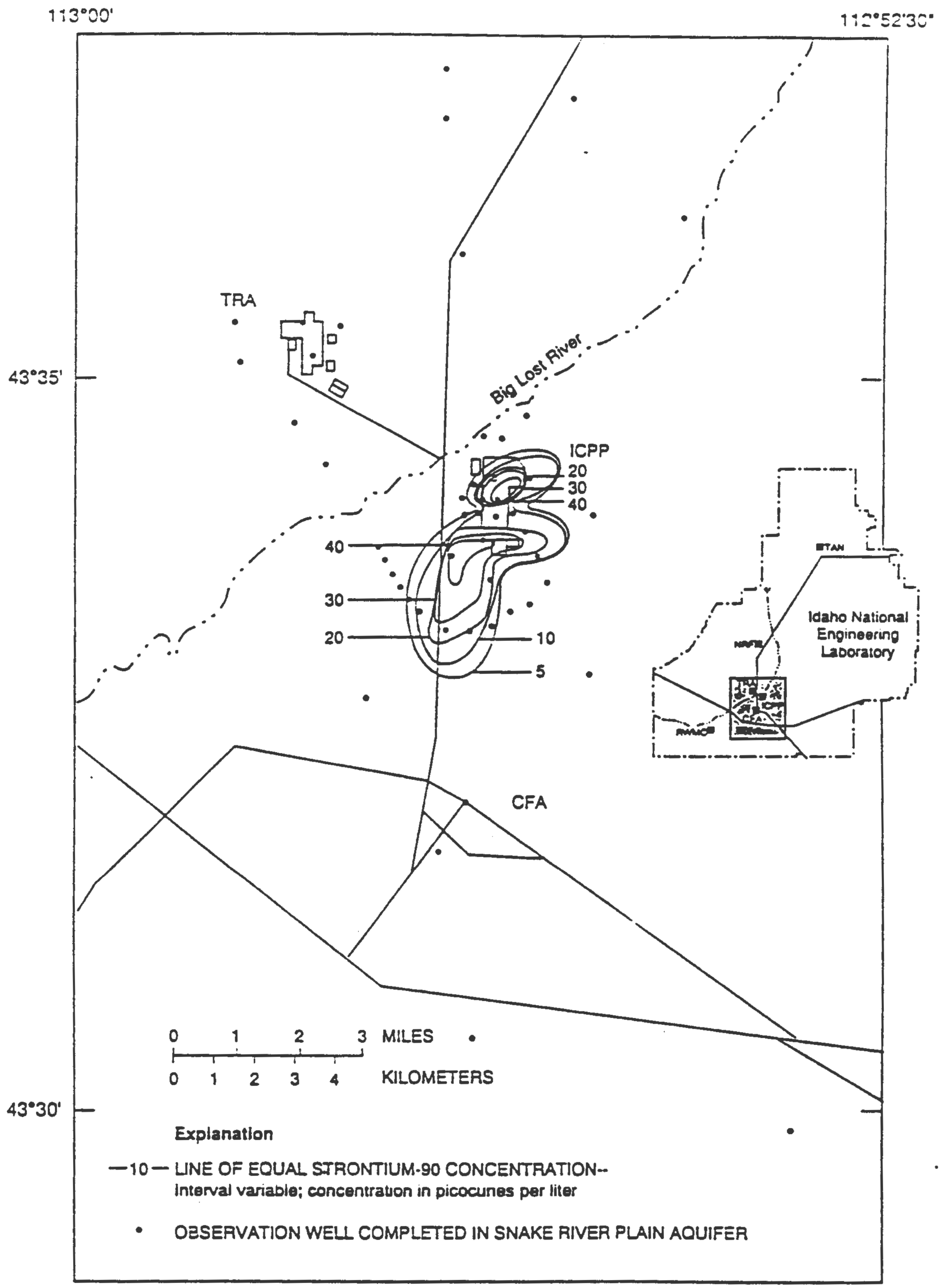


Figure 2-19. Distribution of strontium-90 in water from the Snake River Plain aquifer in the south-central part of the INEL, 1988 (Orr and Cecil, 1991).

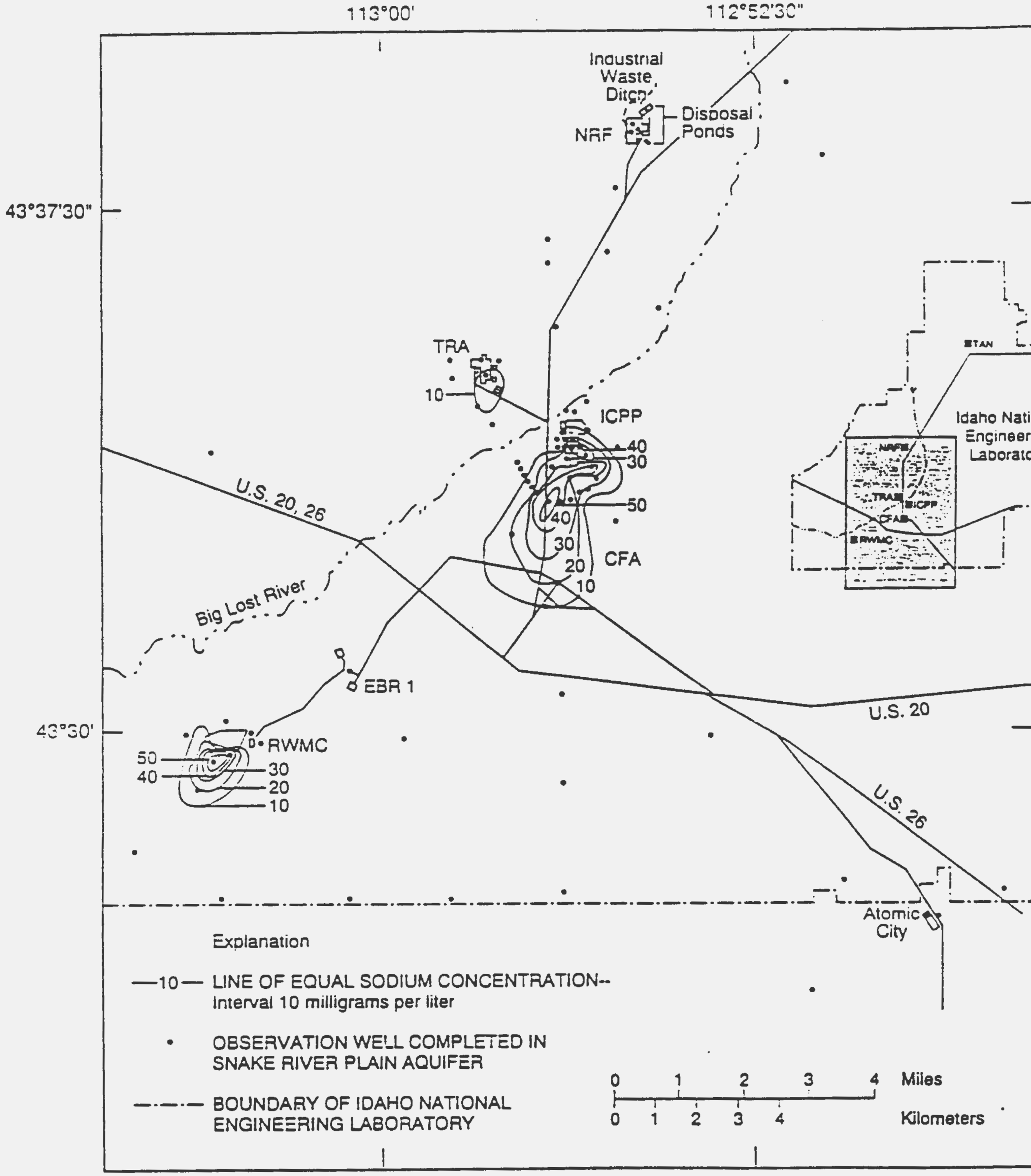


Figure 2-20. Distribution of sodium in water from the Snake River Plain aquifer in the south-central part of the INEL, 1988 (Orr and Cecil, 1991).

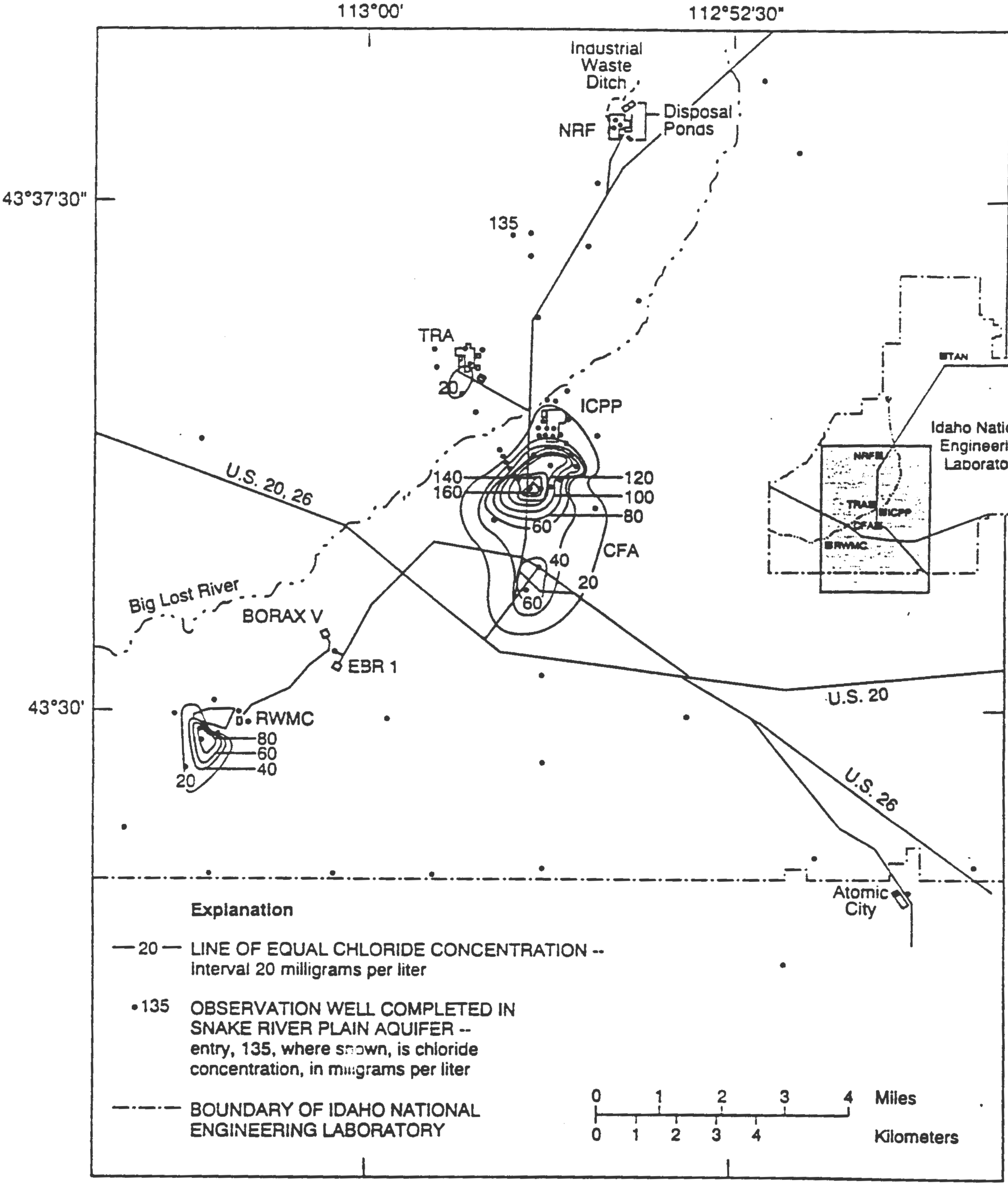


Figure 2-21. Distribution of chloride in water from the Snake River Plain aquifer in the south-central part of the INEL, 1988 (Orr and Cecil, 1991).

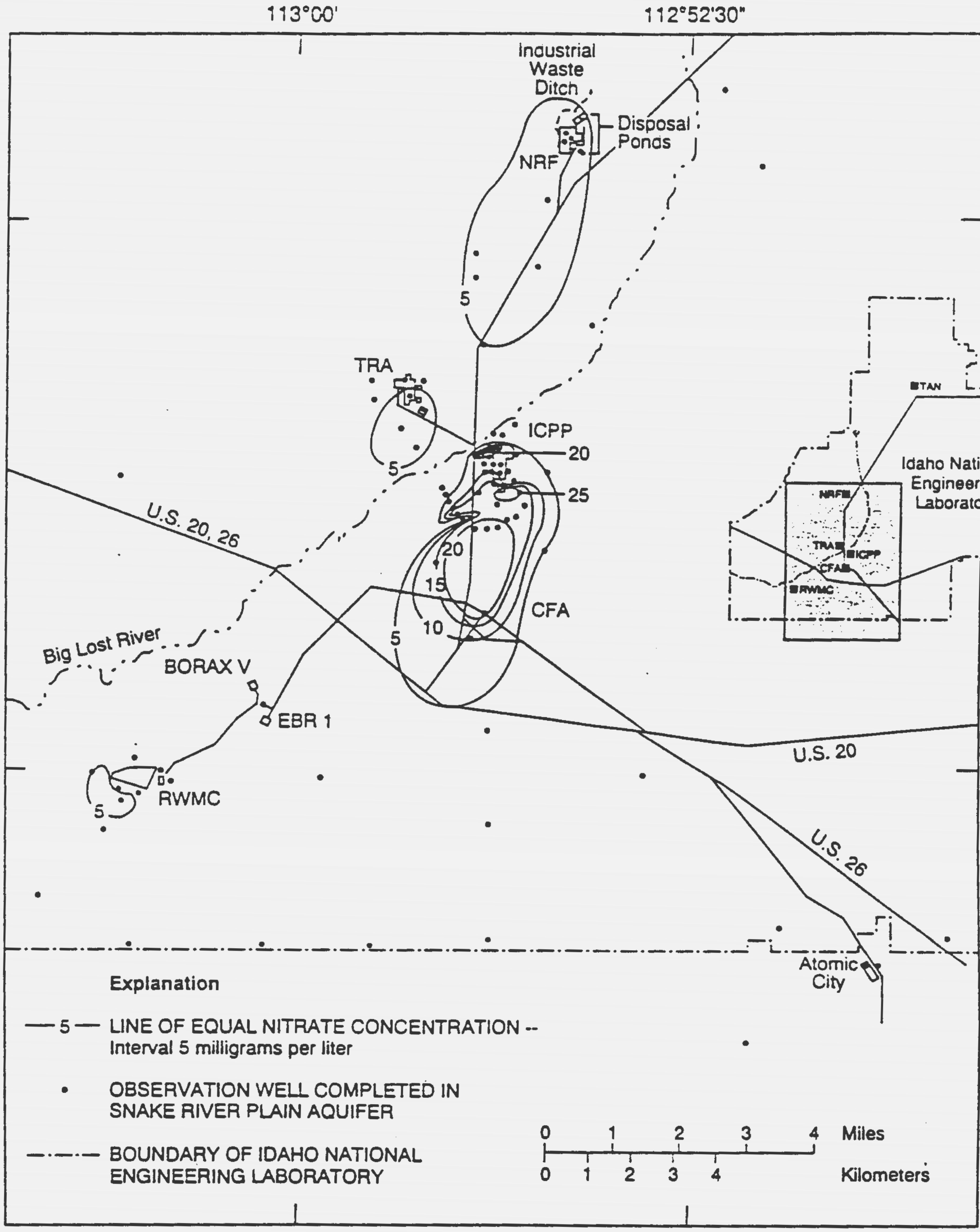


Figure 2-22. Distribution of nitrate in water from the Snake River Plain aquifer in the south-central part of the INEL, 1988 (Orr and Cecil, 1991).

Water samples from 81 wells were collected and analyzed for 36 volatile organic compounds in 1987. The results indicated that water in the SRPA locally contained detectable concentrations of 12 volatile organic compounds. The prevalent compounds were carbon tetrachloride, 1,1,1-trichloroethane, trichloroethylene, tetrachloroethylene, chloroform, toluene, 1,1-dichloroethylene, and dichlorodifluoromethane. Wells yielding water containing one of more of the twelve detected compounds are located at or near the ICPP, RWMC, TAN, CFA, and TRA. Additional information on the extent of organic contamination at these facilities is provided in the sections dealing with each facility.

3. ARGONNE NATIONAL LABORATORY-WEST

3.1 Areas and Operational Practices

3.1.1 Area Description

Argonne National Laboratory-West (ANL-W) is the most eastern of the INEL facilities. It is located approximately 26 km (16 miles) northeast of CFA (Figure 3-1). ANL-W is operated by the University of Chicago under the guidance of the U.S. Department of Energy Chicago Operations Office, and supported by a local area office (DOE-CH-AAO) for interfacing with DOE-ID. ANL-W has administrative control over an area of approximately 360 ha (890 acres) in the southeastern corner of the INEL, while the facilities themselves cover less than 24 ha (60 acres).

ANL-W has been at the Idaho site since the Site's inception as the NRTS, where it originally built and operated the Experimental Breeder Reactor (EBR-I) facility (now under EG&G Idaho control). Construction began at the present ANL-W site in the mid-1950s, with the plant becoming operational in stages from 1959 through the mid-1960s. The ANL-W facility was constructed for the purpose of researching and developing liquid metal fast breeder reactor technology. In general, these activities consist of irradiating reactor fuels and structural materials, and conducting high-temperature nuclear experiments, reactor physics experiments, diagnostic inspections, and laboratory analyses.

The present facility consists of nine major research and support complexes: the Experimental Breeder Reactor No. 2 (EBR-II), the Transient Reactor Test Facility (TREAT), the Zero Power Physics Reactor (ZPPR), the Fuel Manufacturing Facility (FMF), the Hot Fuel Examination Facility (HFEF), the Fuel Cycle Facility (FCF), the Sodium Component Maintenance Shop (SCMS), the Radioactive Liquid Waste Treatment Facility (RLWTF), and the Laboratory and Office building (L&O), as well as a variety of chemical storage facilities, waste storage and disposal facilities, and office and maintenance facilities. Plant activities require the use of numerous chemicals and radioactive materials, resulting in generation of a variety of hazardous wastes and radioactive mixed wastes. The principal facilities and a brief description of each are listed below. Their locations are shown in Figure 3-2.

3.1.1.1 Experimental Breeder Reactor-II. EBR-II is a sodium-cooled reactor operated as a fuel and material irradiation facility. EBR-II demonstrates normal-power operation of a liquid metal reactor plant as well as generating electrical power, supplying ANL-W and the INEL with a portion of the electrical power used at the various facilities.

3.1.1.2 Transient Reactor Test Facility. TREAT contains an air-cooled UO_2-graphite-fueled reactor operated to produce high power transients of very short duration for reactor safety tests. Because the reactor is air-cooled and produces high power transients, its control room is located in a separate building approximately 0.8 km (0.5 mile) from the reactor building.

3.1.1.3 Zero Power Physics Reactor. ZPPR is a large air-cooled fast-reactor critical assembly (a reactor core model) used to study the physics of liquid metal reactor cores. ZPPR also provides basic experimental physics data for the design of fast reactors. ZPPR has an operating power of no

Figure 3-1. Location of Argonne National Labs - West.

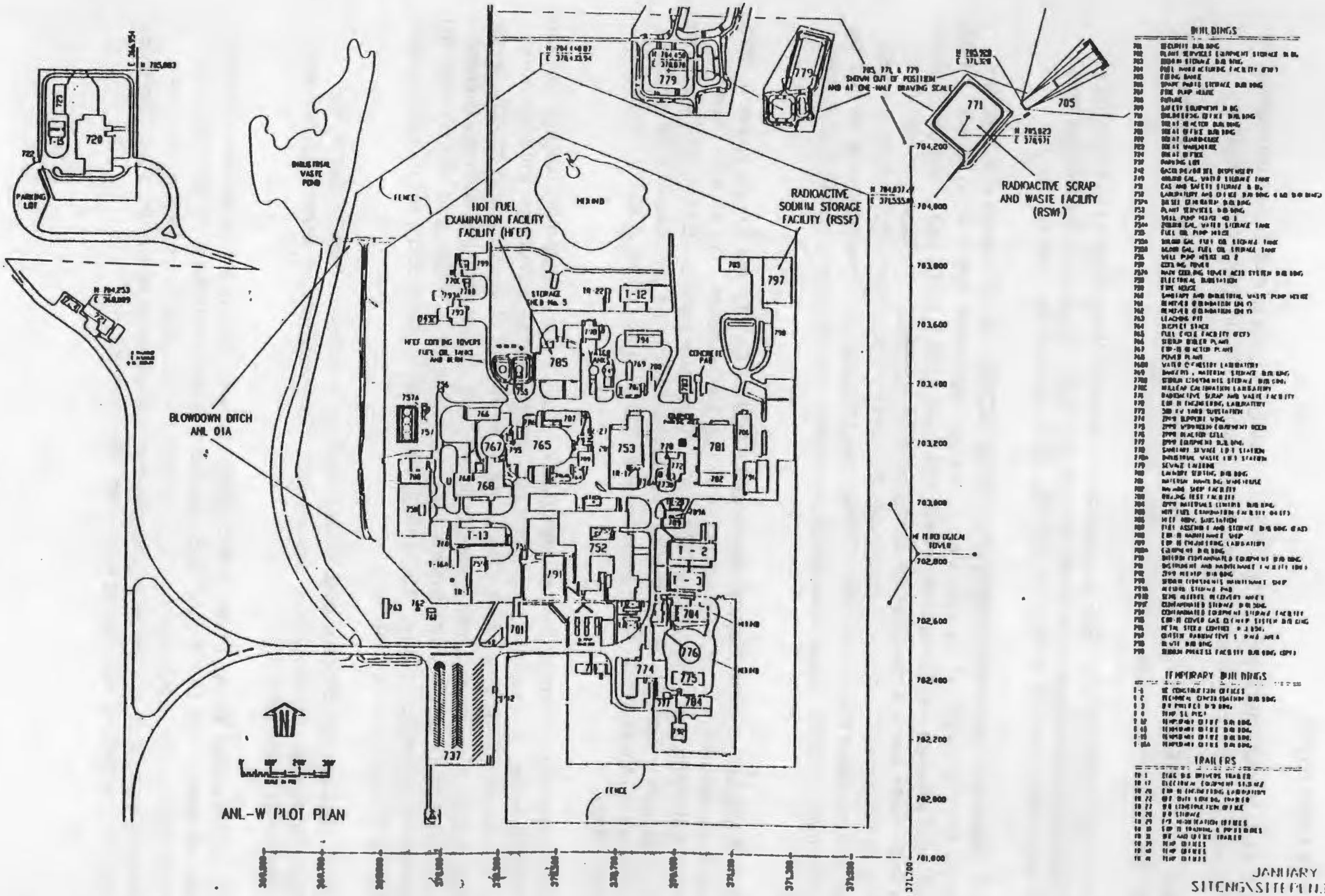


Figure 3-2. ANL-W facility locations.

more than a few kilowatts.

3.1.1.4 Fuel Manufacturing Facility. FMF is a facility designed to manufacture unirradiated or "cold" uranium fuel for EBR-II and the Integral Fast Reactor (IFR) in a secure environment.

3.1.1.5 Hot Fuel Examination Facility. HFEF is a large hot-cell laboratory used for destructive and nondestructive examination of irradiated fuels and materials.

3.1.1.6 Fuel Cycle Facility. FCF is a large hot cell currently being modified to demonstrate reprocessing of metal fuels using an electrochemical technique. This hot cell is connected via a tunnel to the EBR-II reactor, from which fuel rods can be removed for reprocessing.

3.1.1.7 Sodium Component Maintenance Shop (SCMS). SCMS consists of a "high bay," where the cleaning operations are conducted, a "low bay" equipment annex, which houses a 15,000-L (4,000-gal) polyester-vinyl-lined suspect waste tank [with 7,500 L (2,000 gal) of useable volume], and a small annex that accommodates the alcohol recovery equipment. The facility is used for the removal of sodium which adheres to components that have been in contact with the EBR-II reactor sodium systems, when they are removed. Cleaning takes place in one of two systems in the high bay. One system allows for the sodium to be reacted with water, while the other system uses an alcohol wash.

3.1.1.8 Radioactive Liquid Waste Treatment Facility. RLWTF was brought on line in 1982 to replace the radioactive liquid evaporator located in the L&O complex. The RLWTF treats low-level radioactive waste from all ANL-W facilities utilizing the patented SHADE (shielded hot air drum evaporator) evaporation treatment system. Using six evaporation units, the RLWTF processes up to 227,000 L (60,000 gal) of liquid waste per year. The SHADE process at RLWTF consists of five subsystems.

3.1.1.9 Laboratory and Office Complex (L&O). The L&O is a single-story building consisting of two main wings. The southern wing houses administrative and support offices, while the north wing contains an analytical laboratory. The analytical lab consists of seven shielded hot cells, seven general-purpose chemistry labs, one glovebox lab, two mass spectrometry labs, and three counting rooms. The primary mission of the analytical lab is to provide ANL-W programs with chemical and radiochemical analysis capabilities. The hot cells are utilized for the handling and chemical analysis of EBR-II irradiated fuels and materials.

3.1.1.10 Radioactive Storage and Waste Facility. RSWF is a secured facility for the underground storage of radioactive surplus materials. These materials are stored in carbon-steel-lined boreholes with welded lids.

3.1.1.11 Industrial Waste Pond. IWP has been used since 1964 to receive wastewater from a number of sources. The IWP is an unlined evaporative seepage pond that is fed by a system of drainage ditches. The largest sources of liquid industrial waste going to the IWP are blowdown effluents from the main and auxiliary cooling towers, auxiliary boiler blowdown, water from once-through air conditioning, and cooling water from other sources.

3.1.1.12 Sanitary Sewage Treatment Ponds. The sanitary STPs are located north of the main facility and cover an area of approximately 0.8 ha (2 acres). There are three ponds of various sizes, with one maintained as an emergency overflow pond. The primary pond, constructed in 1965, receives sanitary waste directly from Building 778, the sanitary lift station, and starts the process of biological degradation of the wastewater. The primary pond is a square pond with a bentonite-lined bottom and rip-rap sides. From this pond, water is directed to the secondary pond for final biological treatment. The secondary pond, constructed in 1974, is an evaporation pond with a bentonite-lined base and geotextile-lined sides. The sides also have a rip-rap cover. The emergency overflow pond is a smaller version of the primary pond and was constructed at the same time. Prior to 1965, sanitary waste was discharged to individual septic systems.

Facilities at ANL-W to be permitted under the Resource Conservation and Recovery Act (RCRA) are currently operating under an interim status RCRA permit. Currently, ANL-W is not required to have an established RCRA groundwater monitoring plan since it does not operate any land-based TSD facilities. If RCRA groundwater monitoring is deemed necessary at a later date, the required elements will be incorporated into this Plan as a future revision.

3.1.2 Operational Practices

Those ANL-W operational practices that have the potential to be associated with groundwater contamination or had such potential in the past are discussed in this section. This section considers only those processes that produced wastes in quantities sufficient to adversely impact groundwater quality should they be released.

3.1.2.1 Experimental Breeder Reactor-II. EBR-II is an experimental liquid-metal cooled fast-breeder reactor which became operable in 1961. EBR-II is an unmoderated heterogeneous, sodium-cooled reactor with a thermal power output of 62.5 MW, an intermediate closed-loop secondary sodium heat transfer system, and a steam/electric plant that is designed to produce 20 MW of electrical power through a conventional steam turbine generator. The reactor plant, originally designed to demonstrate its engineering concept, was the prime DOE facility for irradiating samples of reactor fuels and structural materials for the Liquid-Metal Fast-Breeder Reactor (LMFBR) development program. This program has now become the Integral Fast Reactor (IFR) Demonstration Project.

The current program emphasis at ANL-W in general and at EBR-II in particular involves the development of the Integral Fast Reactor (IFR) concept. The IFR includes development of a full-scale demonstration of the complete reactor fuel cycle, from fuel sub-assembly manufacture through reprocessing. The IFR incorporates four basic elements:

(1) Use of liquid metal (sodium) coolant
(2) Use of ternary metal alloy fuel
(3) Use of a pool configuration to contain the reactor-coolant system
(4) Incorporation of an integral fuel recycling facility.

The entire reactor is submerged in a large container (primary tank) filled with approximately

340,000 L (90,000 gal) of molten sodium. The molten sodium is pumped through the core of the reactor, then through a heat exchanger to transfer the heat from the primary sodium system to a secondary sodium system. The primary sodium, which is radioactive, is confined to the primary tank and is isolated from the secondary sodium.

The primary system is located exclusively within the confines of the reactor building, a cylindrical gas-tight steel containment shell. The primary system includes the reactor system, which generates heat by nuclear fission; the primary cooling system, which absorbs heat from the reactor and transfers the heat in the intermediate heat exchanger to the secondary system; and a fuel-handling system for removal and insertion of subassemblies in the reactor.

Also associated with EBR-II operation, but outside the containment building, is a cooling tower to dissipate the 42.5 MW of thermal energy rejected by the condenser. A component cleanup facility (removed in 1979), the Sodium Component Maintenance Shop (which replaced the cleanup pad), the power generating plant, sodium boiler building, EBR-II maintenance shop, and a fuel assembly and storage building are also related to EBR-II operations.

3.1.2.1.1 Systems for Disposal of Radioactive Liquid Waste at EBR-II - No radioactive liquid waste is produced by the EBR-II operations or within the containment building except for controlled gallon-batch quantities of water/alcohol used for component decontamination. This liquid is under administrative control (i.e., weighed and logged in, weighed and logged out). This liquid is evaporated in the RLWTF and the remaining solids are disposed of as solid radioactive waste. Therefore, no liquid waste systems have been installed in the containment building.

Prior to 1979, the outdoor component cleanup facility was utilized for the removal of sodium from reactor components. The cleanup facility consisted of a 7.6- x 10.7-m (25- x 35-ft) concrete slab covered with carbon steel, a 9,500-L (2,500-gal) carbon steel retention tank, and the necessary equipment and hardware for retention and disposal of liquids. Radioactive liquid waste was produced by the reaction of water/alcohol with radioactive sodium. This sodium adheres to components that have been in contact with the sodium systems when the components are removed. Figure 3-3 is a schematic diagram showing the liquid collection and retention system that existed at the Component Cleanup Facility.

Designed features of the system included an impervious steel pad surface to prevent the buildup of radioactive materials by absorption, a 7- to 10-cm (3- to 4-in.) lip on three sides of the pad to prevent flow of the liquids to the surrounding soil, and a sloping surface feeding into a 9,500-L (2,500-gal) underground tank for the retention of any liquid. The lip around the pad would contain about 5,700 L (1,500 gal) if the tank were to overflow and back up onto the pad. All liquids produced in this area, including natural runoff, were collected in a tank and treated as radioactive. The internal surface of the tank was coated with a primer to prevent corrosion and the associated drain piping was hydrostatically tested at 50 psig. The level of the tank was measured periodically using a dipstick. When the tank level reached 7,600 L (2,000 gal), it was emptied by pumping into a portable 8,700-L (2,300-gal) transfer tank for later transfer to the liquid waste processing system. The contents of the tank were monitored for radioactivity levels prior to pumping to the portable tank for transfer. The radioactive waste stream consisted primarily of mixed activation products and mixed fission products.

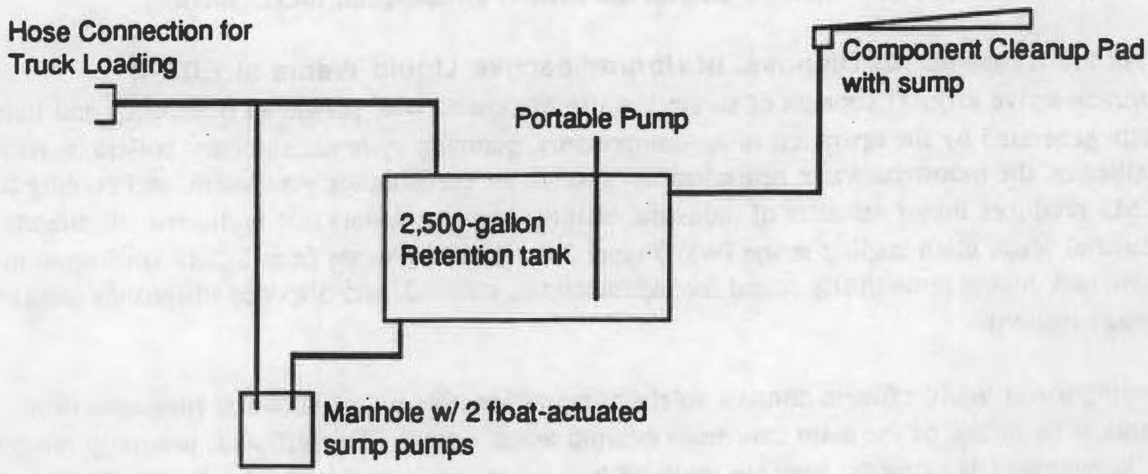


Figure 3-3. Component Cleanup Facility radioactive waste system.

In 1979, the outdoor cleanup facility was removed and the Sodium Component Maintenance Shop (SCMS) was brought on line. This facility consists of a "high bay", where the cleaning operations are conducted, a "low bay" equipment annex, which houses a 15,000-L (4,000-gal) polyester vinyl-lined suspect waste tank [with 7,500 L (2,000 gal) of useable volume], and a small annex that accommodates the alcohol recovery equipment. The suspect waste tank receives waste liquids produced from the reaction of sodium-contaminated components with water. A separate alcohol wash system recycles the contaminated alcohol. All floor drains also empty into the suspect waste tank. When the tank is full, it is sampled for pH, heavy metals, and radionuclides. The contents of the tank are then neutralized to a pH between 5 and 10, if necessary, pumped into a tank truck, and transferred to the RLWTF.

The only other source of radioactive liquids from EBR-II is a personnel decontamination system. Liquid wastes from the personnel decontamination lavatory, shower, and locker room floor drain are gravity-fed to a receiver at the foot of a pipe trench. A float-controlled pump transfers these wastes to a 19,000-L (5,000-gal) retention tank in the EBR-II ground floor locker room.

3.1.2.1.2 Systems for Disposal of Nonradioactive Liquid Waste at EBR-II - Nonradioactive effluent consists of sanitary waste associated with personnel occupancy and industrial waste generated by the operation of air compressors, pumping systems, auxiliary boilers, reactor plant auxiliaries, the industrial waste neutralization system, air conditioning equipment, and cooling towers. SCMS produces minor amounts of industrial effluent (cooling water) that is discharged directly to the industrial waste ditch leading to the IWP (Figure 3-4). Sanitary waste from SCMS is directed to a septic tank that is periodically tested for radionuclides, emptied, and disposed of into the sanitary sewage lagoons.

Cooling tower liquid effluent consists solely of nonradioactive industrial waste produced from chemical treatment of the main condenser cooling water system. This effluent, generally referred to as "blowdown," is extracted from the main cooling water supply line to the condenser. In the past, blowdown was directed to a sulfur dioxide treatment tank where the hexavalent chromium ion was chemically reduced to trivalent chromium prior to discharge. Chromium treatment of blowdown water was discontinued in July 1980 to eliminate a potential source of environmental contamination. Various chemicals are now used for corrosion and microbiological control (Section 3.1.2.9.1). Auxilary boiler blowdown and ion exchange regeneration effluent are also discharged to the industrial waste system. Ion exchange effluent is not discharged until neutralized, as discussed in Section 3.1.2.9.4. Auxilary blowdown effluent is discussed in Section 3.1.2.9.5.

Sanitary waste is routed internally in the EBR-II complex through a 15-cm (6-in.) cast iron pipe to the sanitary sewer lift station, which discharges to the sanitary lagoon. The industrial waste effluent is combined with the blowdown effluent from the cooling tower and is routed first to an interceptor canal, and then to the industrial waste pond (Figure 3-4). Sanitary and industrial wastes are not measured until after mixing with effluent from other facilities, with the exception of auxiliary boiler blowdown.

3.1.2.1.3 Systems for Disposal of Radioactive Solid Wastes at EBR-II - A major source (by volume but not by activity) of solid radioactive waste is the accumulation of wipe rags, plastic

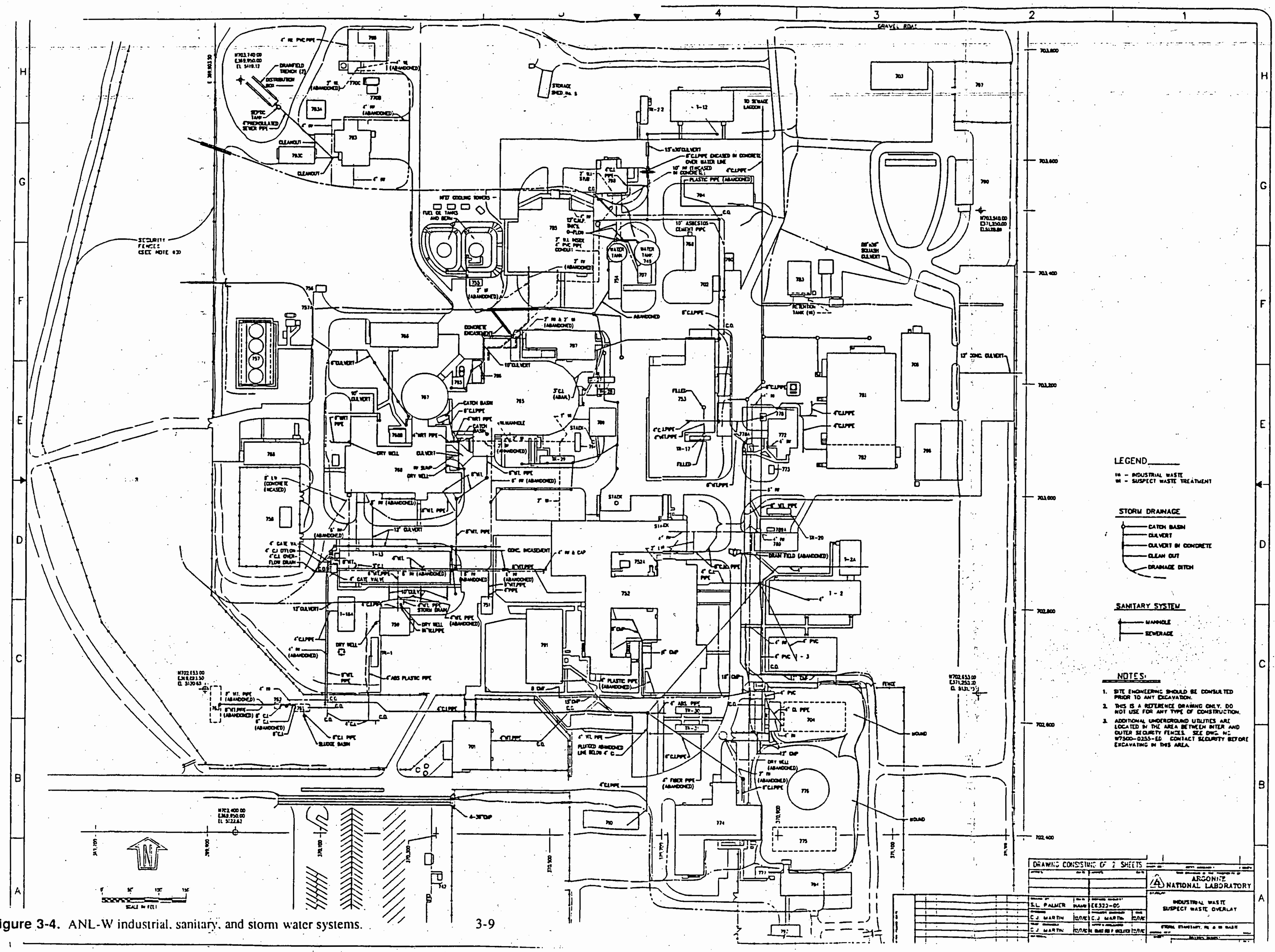


Figure 3-4. ANL-W industrial, sanitary, and storm water systems.

containers, shoe covers, and other industrial solids associated with maintenance activities at a nuclear reactor facility. Reactor components such as thermocouples, nuts and bolts, and other hardware are disposed of as solid radioactive wastes. Radiation from these components is generally low-level (less than 10 mR/hr). The components are collected, separated into "compactable," "combustible," or "non-compactable, non-combustible" categories, and are packaged. Compactable and combustible waste are packed in polyethylene bags or polyethylene-lined cardboard boxes and sent to WERF for volume reduction (incineration or compaction). Non-compactable, non-combustible waste is packed in 1 x 1 x 2.5-m (4 x 4 x 8-ft) plywood boxes and sent to RWMC for disposal by burial. Radiation levels and smears of the bags and boxes are taken to ensure that there is no loose contamination and that radiation levels are not excessive. The containers are then transported in special dumpsters to an appropriate disposal area on the INEL (i.e. the RWMC, WERF). Dumpsters and transport vehicles are surveyed by taking smears and by measuring the radiation levels to ensure that no loose contamination exists and that radiation levels are within INEL limits.

3.1.2.2 Transient Reactor Test Facility. TREAT is a reactor designed to produce short extreme pulses of nuclear energy with resultant temperatures high enough to permit meltdown studies of selected prototype and experimental fuel elements. The reactor became operational in February 1959. The immediate objective of TREAT tests is to provide quantitative data and indirect visual information on the mechanism of melting fast reactor fuel elements by nuclear heating analogous to a power excursion in a fast reactor core. The TREAT complex is comprised of a reactor building and a control building located northwest of the EBR-II reactor building.

3.1.2.2.1 Systems for Disposal of Radioactive Liquid Waste at TREAT - Radioactive liquid waste from TREAT facility activities may be produced from personnel decontamination and equipment decontamination. The radioactive liquid waste disposal system consists of washbasins, floor drains, a janitor's sink, and the necessary piping and plumbing connecting to a sump. The washbasins, floor drains, and janitor's sink are isolated from the sanitary waste disposal system, thus eliminating any possibility of contamination of the sanitary waste system. Effluent entering this isolated liquid system is piped to a common line leading to a sump, from which the waste effluent is then pumped to a retention tank. The system is shown schematically in Figure 3-5. The sump is equipped with a HEPA-filtered air vent and a pump with automatic float actuation. The sump discharge piping runs above ground in the reactor building to a 3,800-L (1,000-gal) carbon steel retention tank. The tank is equipped with a level indicator which activates visual and audible alarms when a predetermined level is reached.

The retention tank also is provided with an air vent to a HEPA filter. It has a valved discharge line to a pump, a flanged inspection port 15 cm (6 in.) in diameter, a level indicator, and a sampling valve. The retention tank discharge line is connected to a 3,800-L (1,000-gal) septic tank to which liquid discharge from the retention tank may be authorized after the liquids are determined to be nonradioactive [less than DOE Derived Concentration Guide (DCG) values]. The septic tank discharge line is connected to a seepage field located inside the security fence of the facility. The retention tank effluent also may be discharged to a portable truck-mounted tank for transportation of radioactive liquid wastes to the RLWTF evaporator.

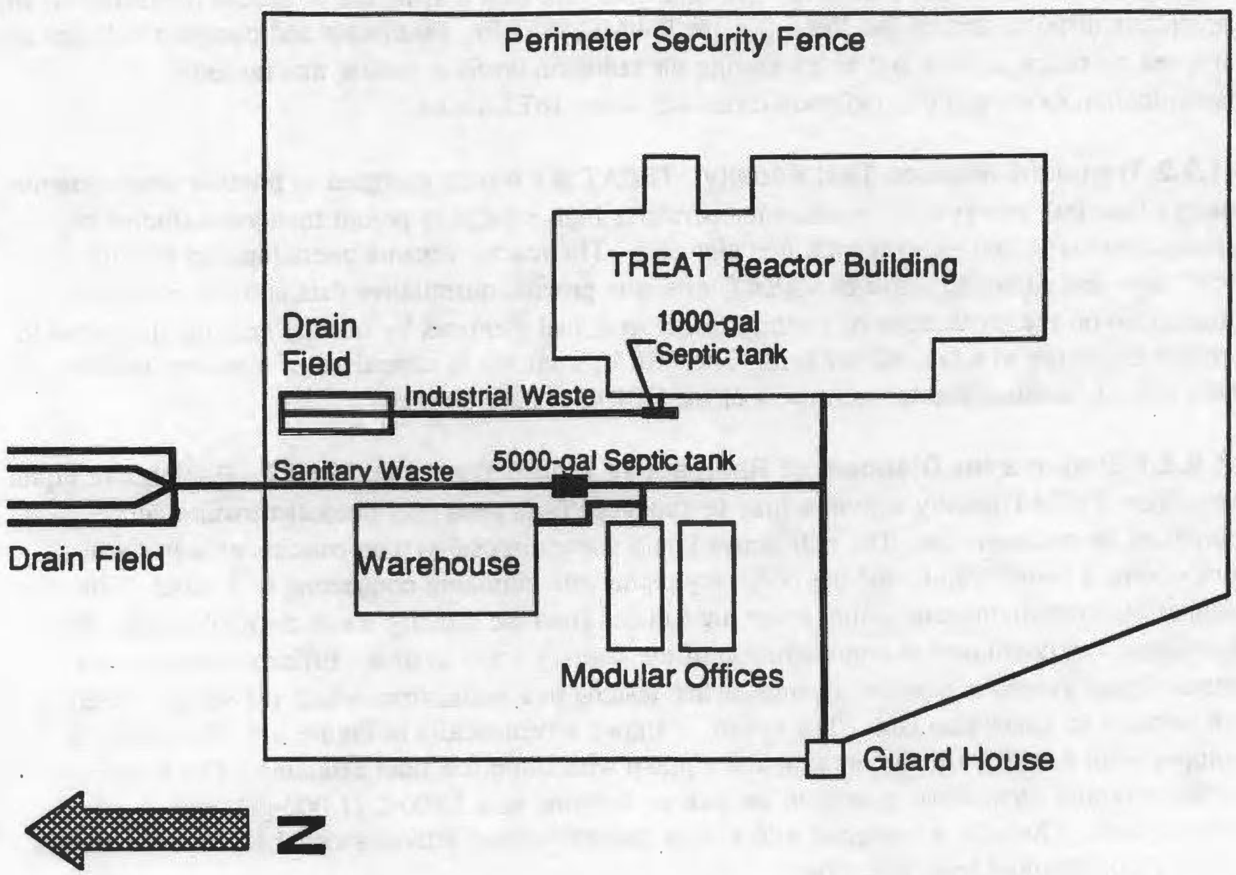


Figure 3-5. TREAT radioactive waste system.

3.1.2.2.2 Systems for Disposal of Nonradioactive Liquid Waste at TREAT - Approximately 605,000 L (160,000 gal) of raw water are supplied annually to the TREAT facility, which produces approximately 322,000 L (85,000 gal) of industrial waste and 284,000 L (75,000 gal) of sanitary waste annually. The TREAT sanitary waste effluent system is shown in Figure 3-5.

Prior to 1983 industrial waste effluents were discharged into a dry well with an underlay of coarse gravel. In 1983 the dry well, located east of the reactor building, was capped and the present discharge system was put into operation. The current system directs all liquid industrial waste to a floor catch basin that in turn drains into an open ditch on the east side of the facility outside the security fence. Of the total pre-1983 annual industrial effluent, approximately 2,300 L (600 gal) per year were produced as boiler blowdown, which contained small amounts of Nalco-35 and phosphate. Current industrial waste comes from once-through cooling waters for heat exchangers and air compressors.

Separate sanitary waste disposal systems are provided for the reactor building and for the control and office building. The system for the reactor building consists of a 19,000-L (5,000-gal) septic tank, which discharges into a drain field outside the security fence of the facility. The contents of this septic tank are periodically sampled for radionuclides, pumped out, and transferred to the sanitary lagoons for treatment. The sanitary system for the control building consists of a 3,800-L (1,000-gal) septic tank, which also drains to a drain field. Both of these systems are pumped out approximately annually, tested for radionuclides, and discharged to the primary sanitary lagoon.

3.1.2.2.3 Systems for Disposal of Radioactive Solid Wastes at TREAT - The sources and disposal practices for solid radioactive waste at the TREAT facility are similar to those at EBR-II.

3.1.2.3 Zero Power Physics Reactor. ZPPR is situated about 300 m (1,000 ft) southeast of the EBR-II reactor. Experiments using ZPPR provide reactor physics information needed for designing and developing large plutonium-fueled fast-breeder reactors for future commercial nuclear powerplants, which will generate up to 1,000 MW of thermal power.

ZPPR consists of two assemblies of honeycombed lattices mounted on separate steel tables. The tables are kept separated while the lattices are loaded with drawers of mockup fuels and other materials, and then are brought together for operation. Because the materials can be loaded in a variety of patterns, ZPPR can be used to simulate many reactor core designs. The ZPPR reactor has been on standby since May, 1992.

The ZPPR cell is housed in a 15-m (50-ft) diameter concrete building approximately 10 m (32 ft) high. The building has concrete access tunnels to the vault building and the outside. The entire cell, the tunnels, and the vault building are enclosed in an earth mound approximately 15 m (50 ft) high. The roof of the cell [approximately 186 m^2 (2,000 ft^2)] is filled with a sand-gravel mix to a minimum depth of 5 m (16 ft). The cell roof was designed so that it would release the sand-gravel mix and bury the reactor in the event of a major accident.

3.1.2.3.1 Systems for Disposal of Radioactive Liquid Waste at ZPPR - The radioactive liquid waste system is shown in Figure 3-6. A change room is provided for personnel

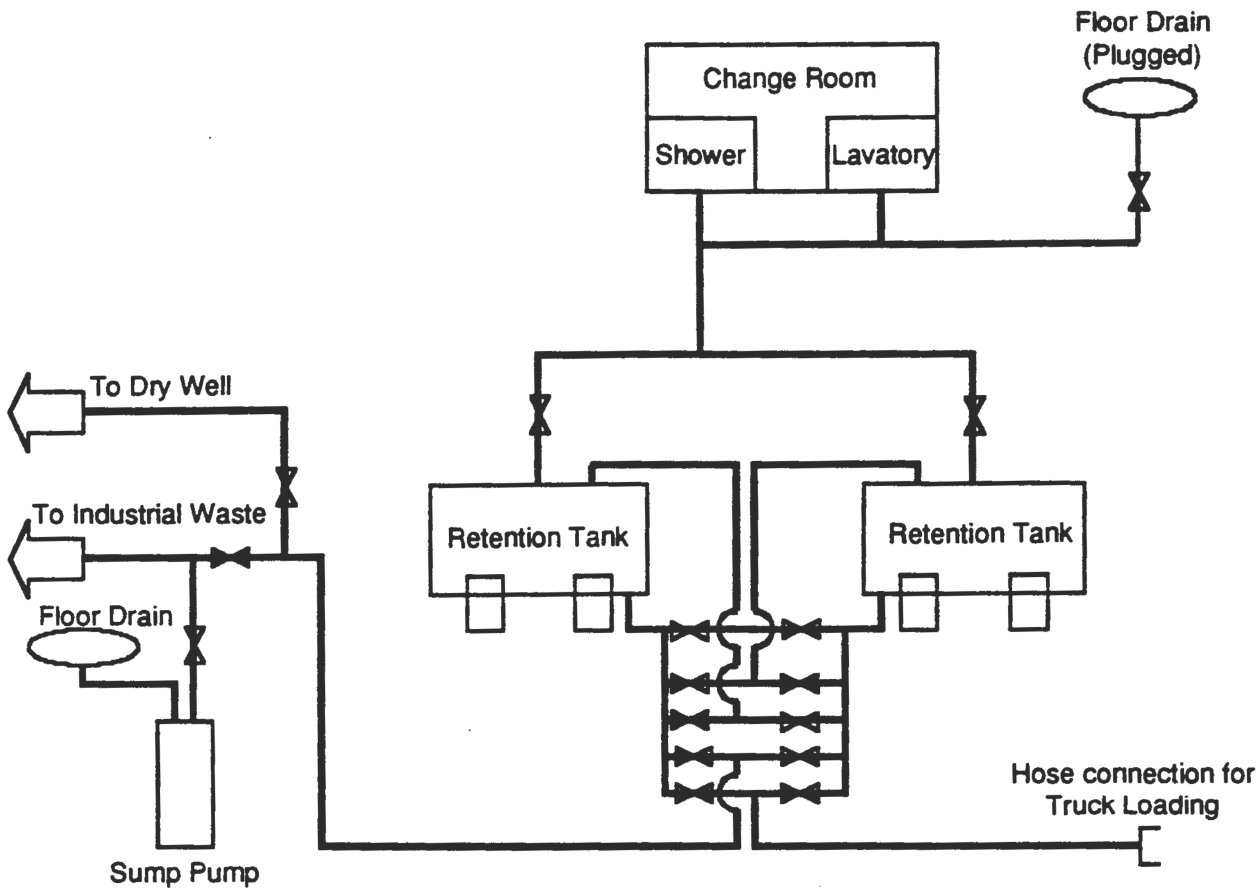


Figure 3-6. ZPPR radioactive waste system.

decontamination. This room contains a shower and lavatory draining by gravity into two epoxy-lined carbon steel retention tanks, each having a 1,900-L (500-gal) capacity, located in the basement of the support wing. The tanks are equipped with two transfer pumps and the necessary interconnecting piping and valves to provide, if the effluent is not radioactive, a discharge point to either a truck fill station or directly to the industrial waste system. If the effluent is radioactive, a tank truck is used to transport the effluent to the evaporator station at the RLWTF building. There is a watertight concrete curb around the retention tanks to ensure retention of up to 125% of the total capacity of the retention tanks in the event the liquid is inadvertently released from the tanks. The contents of these tanks are monitored for radioactive concentrations to determine the mode of disposal. Each tank is equipped with redundant level indicators that alarm locally and remotely when the tank contents reach approximately 1,820 L (480 gal). This alarm alerts personnel to determine disposition of the radioactive waste, and to execute the required disposal process.

3.1.2.3.2 Systems for Disposal of Nonradioactive Liquid Waste at ZPPR - Nonradioactive liquid wastes consist of sanitary waste and the industrial waste produced by the cooling/process water for the air compressors, and other rotating machinery. All industrial waste effluents are discharged to the industrial waste system.

3.1.2.3.3 Systems for Disposal of Radioactive Solid Wastes at ZPPR - The sources and disposal practices for solid radioactive waste at the ZPPR facility are similar to those at EBR-II.

3.1.2.4 Hot Fuel Examination Facility. The HFEF building is used for interim and final examination of fast reactor fuel and structural specimens irradiated in facilities supporting the LMFBR program. The main cell is constructed of high-density concrete with a gas-tight steel-lined enclosure. An argon atmosphere in the cell provides an inert atmosphere needed for remote examinations. An adjacent air atmosphere cell is used for the decontamination of equipment and associated parts.

3.1.2.4.1 Systems for Disposal of Radioactive Liquid Waste at HFEF - Radioactive liquid waste is produced in several areas and transferred, along with other miscellaneous streams, to a 5,700-L (1,500-gal) stainless steel decontamination drain retention tank. The decontamination cell, transfer tunnel floor drains, personnel decontamination showers and sinks, hot repair area, and other controlled areas that have a high probability of contamination also go to the decon drain retention tank. Currently the decontamination cell spray chamber sump is pumped directly to a HFEF dedicated holdup tank in the RLWTF for disposal. If this tank is full or out of service the sump can be pumped to the decon drain retention tank. Liquid from laboratory sinks, janitors' sinks in controlled areas, and floor drains are diverted into a 5,700-L (1,500-gal) suspect waste/laboratory drain retention tank. The retention tanks are equipped with remote liquid level indicators and alarms, and are located in a recessed floor area designed to contain the liquid in the event of a tank failure. The suspect waste/laboratory drain retention tank vents to the building exhaust system, while the decon drain retention tank is vented through the cell exhaust system. Any overflow from the suspect waste/laboratory drain retention tank goes to the decon drain retention tank. Any overflow from the decon drain retention tank is directed to a recessed sump, where a pump will return the flow back to that tank.

When full, the suspect waste/laboratory drain retention tank contents are circulated and sampled for total alpha, beta, gamma, pH, and heavy metals prior to pumping to either the industrial waste ditch north of the facility or to the RLWTF. A schematic diagram of the disposal system for this waste is shown in Figure 3-7.

3.1.2.4.2 Systems for Disposal of Nonradioactive Liquid Waste at HFEF - Nonradioactive liquid effluent at HFEF consists of both sanitary waste and industrial wastes. The suspect waste/laboratory drain retention tank, discussed in Section 3.1.2.4.1, is also considered part of this system. The sanitary waste effluent is discharged through a single 15-cm (6-in.) cast iron pipe to the sanitary lift station, where it is pumped to the sanitary lagoon. Industrial waste is collected in three sumps. These sumps are equipped with automatic level switches to discharge the wastewaters to a small ditch just north of the facility, which drains to the industrial waste pond (Figure 3-4). HFEF also maintains a small cooling tower that is treated similar to the main tower discussed in Section 3.1.2.1.2.

3.1.2.4.3 Systems for Disposal of Radioactive Solid Wastes at HFEF - The HFEF facility produces and disposes of radioactive solid wastes with low gamma radiation levels in a manner similar to that at EBR-II. In addition, waste material greater than 100 mR/hr is produced from the disassembly and inspection of subassemblies, fuel cladding scrap and discarded equipment items, and high gamma level waste and plutonium contained in reactor blanket subassemblies. The high gamma level waste and plutonium-bearing materials were stored in the ANL-W Radioactive Scrap and Waste Facility. These types of wastes are now handled on site, at RSWF, or sent offsite to the RWMC.

3.1.2.5 Fuel Cycle Facility. The FCF is comprised of an argon atmosphere cell and an adjacent air atmosphere cell. Prior to 1977, irradiated reactor subassemblies were disassembled, inspected, and reassembled in these cells. The argon cell provides a radiation shield area where fuel can be exposed in an inert atmosphere during processing operations. The facility was devoted entirely to examination of materials and fuels irradiated in EBR-II and TREAT for the LMFBR program. The FCF cells were designed to handle core subassemblies with activities up to about 500,000 Ci. The cells are shielded for gamma radiation levels of up to 10^6 R/hr. The FCF building has access to the EBR-II reactor building, through an airlock, for transferring fueled subassemblies in suitable shielded casks.

Starting in 1989 the FCF began undergoing a major remodeling effort to allow for disassembly, reprocessing and remanufacture/reassembly of fuel rods. This is being done as part of the Integral Fast Reactor (IFR) demonstration project.

3.1.2.5.1 Systems for Disposal of Radioactive Liquid Waste at FCF - The final radioactive liquid waste system for FCF is shown in Figures 3-8 and 3-9. Before upgrade of FCF began, potentially radioactive liquids from the laboratories, repair area, janitor sink, and emergency sink and shower drained into a 5,700-L (1,500-gal) carbon steel epoxy-lined retention tank. This system was sampled for pH, heavy metals, fissile material, and radionuclides to insure compliance with RLWTF acceptability criteria. Effluent was discharged to either the L&O evaporator or the RLWTF, when it came on line. As part of the FCF upgrade work, the 5,700-L (1,500-gal) retention tank was removed. A 1,900-L (500-gal) carbon steel tank now receives the radiologically contaminated wash water from

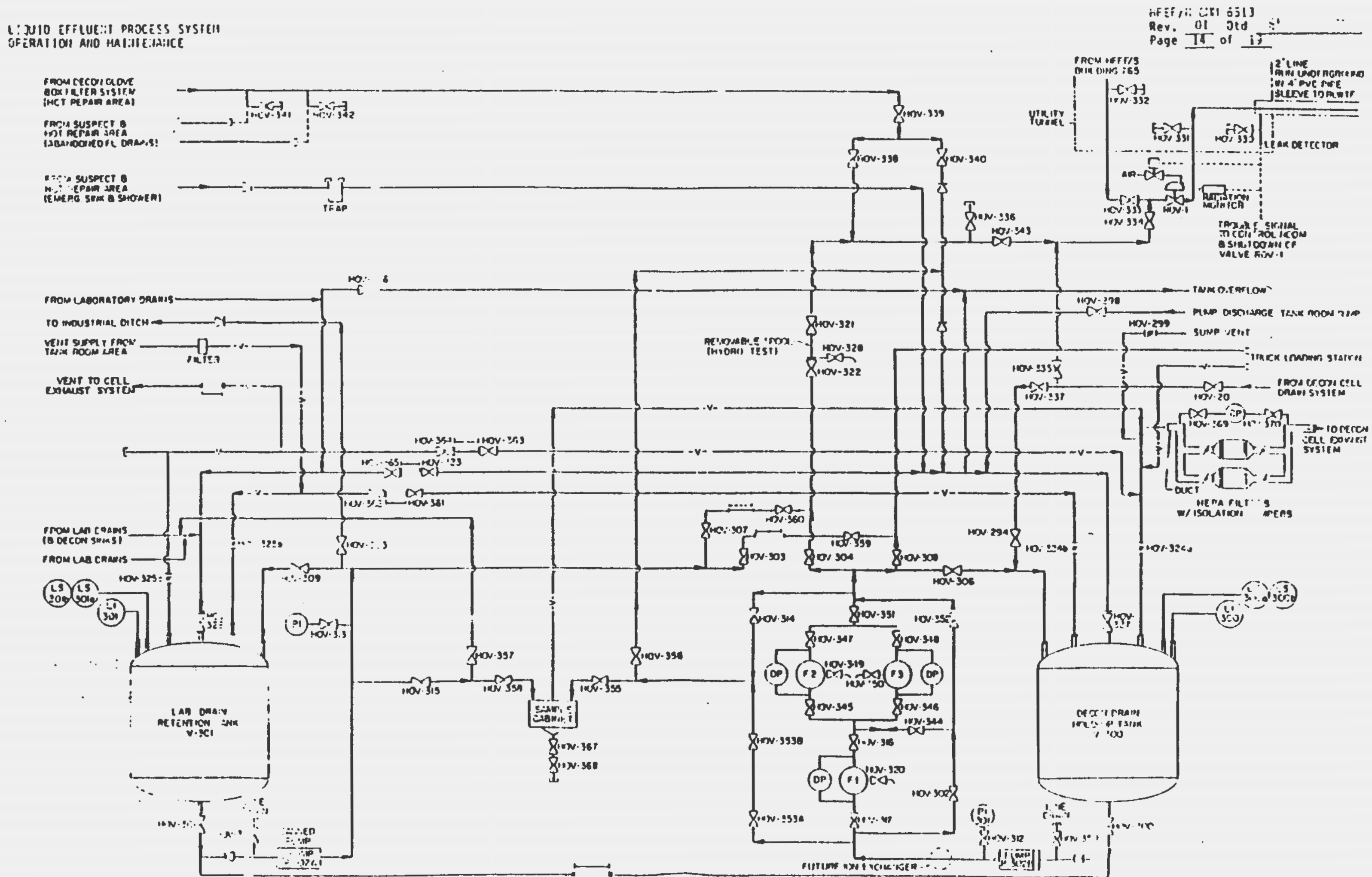


FIG 1
LIQUID EFFLUENT PROCESS SYSTEM
SCHEMATIC - HFEF/N

Figure 3-7. HFEF radioactive waste system.

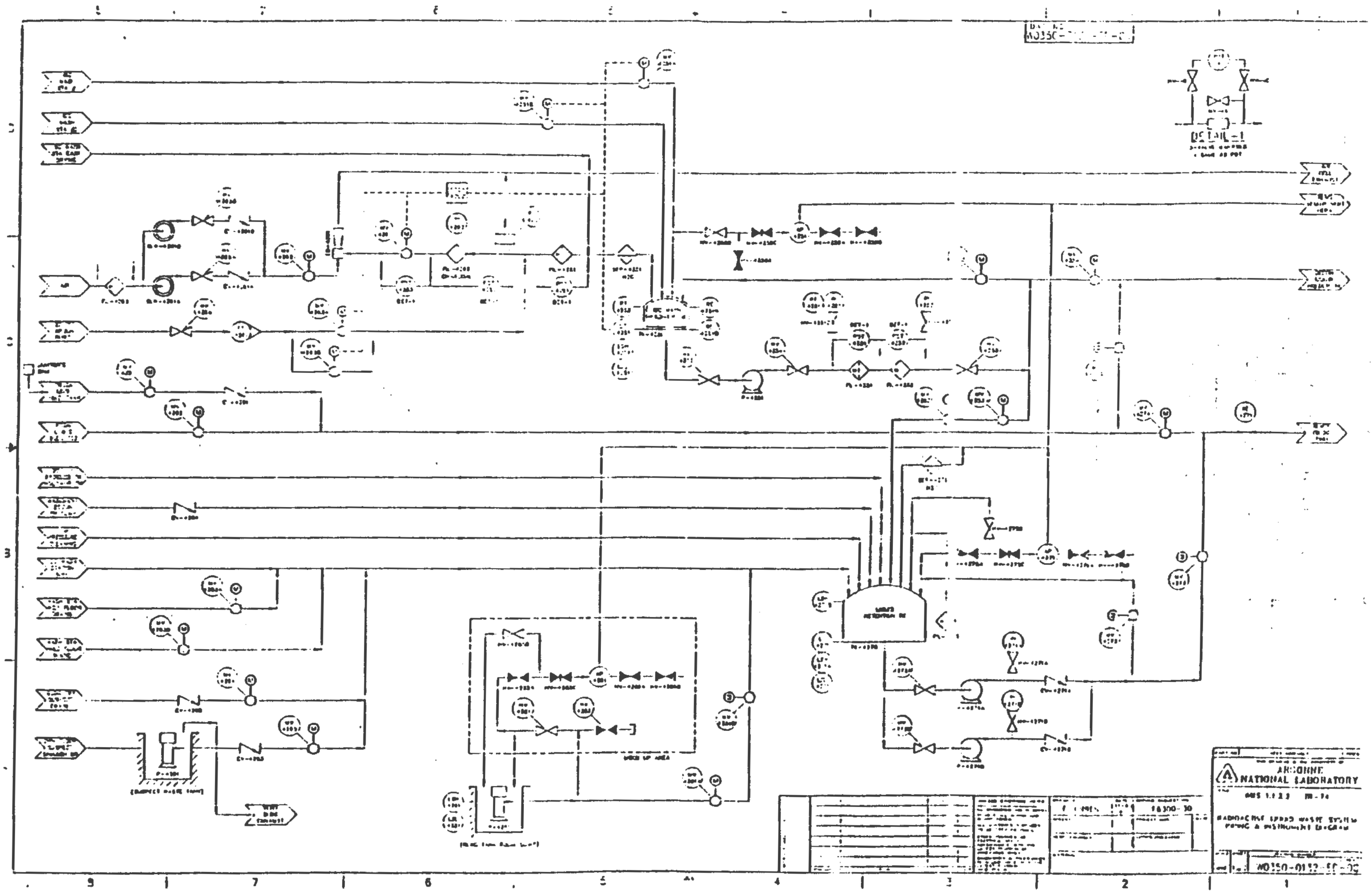


Figure 3-8. FCF radioactive liquid waste system (part 1).

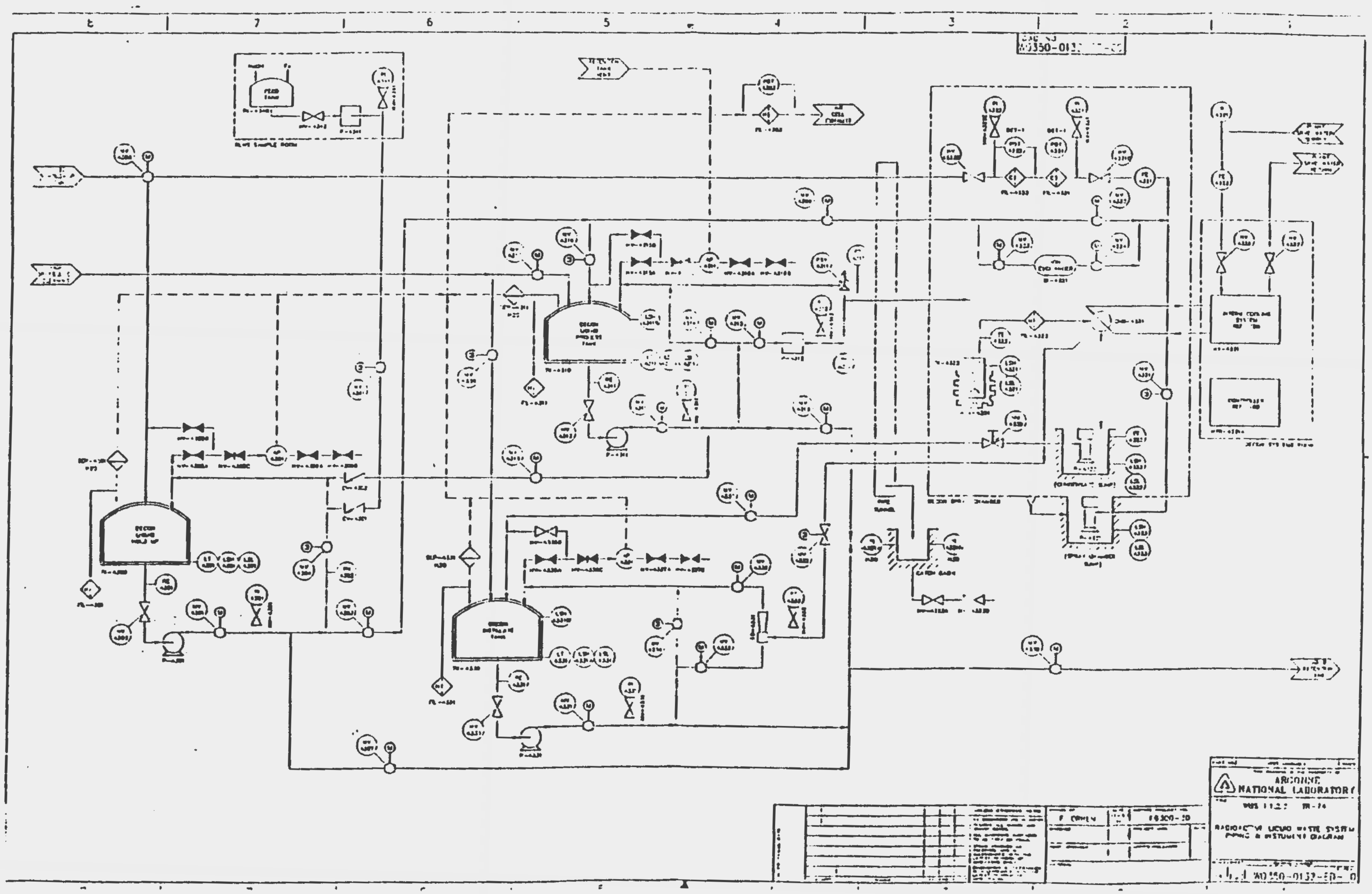


Figure 3-9. FCF radioactive liquid waste system (part 2).

the inter-building cask (IBC) wash stations, located in the FCF passageway. This tank also receives water from the emergency decontamination sink and shower, when used. This tank is sampled for gross radioactivity, pH, heavy metals and fissile material prior to pumping to the RLWTF.

Suspect liquid from the truck lock area is collected in an underground 11,400-L (3,000-gal) carbon steel tank equipped with a high-level indicator and alarm. This tank can be either transferred to the RLWTF building via a portable tank trailer or discharged to the industrial waste system, based on the results of sampling the tank. This tank is sampled for gross radioactivity, pH, heavy metals and fissile material prior to discharge. To date the contents of this tank have not required treatment at RLWTF.

Welded stainless steel piping and stainless steel or lined tanks provides the high integrity required for this system. Materials selected for the liquid effluent systems were based on longevity criteria. The radioactive liquid lines that could not be inspected visually were periodically tested to pressure levels consistent with operational conditions. These lines were later placed in a utility tunnel running from FCF to HFEF, and they are now visually inspected. The retention tanks are equipped with local liquid level indicators and remote high-level alarms, which sound out and alert the operations office staff. The tanks are vented to the facility exhaust system.

The radioactive liquid waste disposal system is isolated from the liquid industrial waste disposal system. These systems also are physically isolated from the sanitary liquid waste disposal system. No connections exist between the sanitary waste system and the other two systems.

3.1.2.5.2 Systems for Disposal of Nonradioactive Liquid Waste at FCF - Nonradioactive liquid effluent at FCF consists of sanitary waste and industrial wastes. The sanitary waste effluent is discharged through a single 15-cm (6-in.) vitreous clay tile pipe to the west side sanitary lift station. From there it is pumped to the main sanitary lift station and then to the sanitary lagoons. Several floor drains in the facility clean area empty directly into the industrial waste system.

3.1.2.5.3 Systems for Disposal of Radioactive Solid Wastes at FCF - FCF produces and disposes of radioactive solid wastes with low gamma radiation levels in a manner similar to that at EBR-II. In addition, waste material greater than 100 R/hr is produced from the disassembly and inspection of subassemblies, fuel cladding scrap and discarded equipment items, and high level gamma waste and plutonium contained in reactor blanket subassemblies. These wastes are packaged and disposed off site, at the RWMC.

3.1.2.6 Laboratory and Office Complex. The Laboratory and Office Complex (L&O) is a single-story building housing offices in the southern portion and an analytical laboratory in the north. The analytical lab is the only portion that generates contaminants of concern to this Plan. The analytical lab consists of seven shielded hot cells, seven general purpose chemistry labs, one glovebox lab, two mass spectrometry labs, and three counting rooms. The primary mission of the analytical lab is to provide ANL-W programs with chemical and radiochemical analysis capabilities. The hot cells are utilized for the handling and chemical analysis of EBR-II irradiated fuels and materials.

3.1.2.6.1 Systems for Disposal of Radioactive Liquid Waste at the L&O - The L&O building radioactive liquid waste system consists of a series of separate transfer lines. These lines collect radioactive liquids or liquids suspected of being radioactive and transfer them to a central station for processing. All lines are constructed of stainless steel, carbon steel, or polyvinyl chloride plastic.

Because of processing requirements, the effluents are segregated into acid and non-acid systems. Late in 1973 a modification was made so that the acid system effluent was collected in a fiberglass retention mixing tank with a 910-L (240-gal) capacity and a level indicator. The collected acids were neutralized with caustic and then evaporated in a disposable container, with the residue disposed of as solid waste. The nonacid streams were evaporated in the same manner. Fumes produced from the radioactive liquids collected by the system were prevented from venting to the laboratory air by liquid traps at all sinks. The traps were flushed daily with clean water to prevent concentrated acids from standing in the traps. The retention mixing tank downstream from the traps was vented to the HEPA filter system. The tanks and equipment were surrounded by a curbed retention area so that any spilled liquid would be fully contained in the curbed area. Any leakage was removed by absorption materials and disposed of as solid waste. The retention area was made impervious with a suitable coating to avoid absorption of radioactive liquids into the concrete. If precipitates accumulated in the bottom of the retention mixing tank, compressed air was used to disperse such materials so that they could be handled as liquids. This system was taken out of service in 1982 when RLWTF came on line.

Prior to 1982, radioactive liquid waste from all facilities at ANL-W was transported either through underground pipes or by means of portable tanks to retention tanks at the evaporator located at the L&O building. The liquid was received in one of two 11,000-L (2,900-gal) carbon steel settling tanks. When this tank was full, the waste was pumped through a welded stainless steel piping and filter system to one of two 5,700-L (1,500-gal) glass-lined evaporator feed tanks. Both feed tanks were equipped with high-level indicators which activate local and remote visual and audible alarms. The effluent was then pumped from this feed tank to the evaporator through stainless steel welded pipe.

The evaporator was a commercially available natural circulation-type system composed of two main parts: the heat exchanger and the flash chamber. The evaporator had a design capacity of 985 L/hr (260 gal/hr) with a measured decontamination factor of between 10^2 and 10^4.

Vapor from the evaporator was carried through first a condenser and then a cooler to transform it into a condensate. The condensate then flowed to a 5,700-L (1,500-gal) glass-lined carbon steel evaporator condensate tank. The condensate was then processed through ion-exchange columns and collected in a plastic-lined, 6,060-L (1,600-gal) carbon steel retention tank for sampling. Processed condensate was sampled and analyzed for residual radioactivity. Nonradioactive condensate was discharged to the industrial waste system, and radioactive condensate was discharged to a leach pit located in the southwest portion of the site (Figure 3-4). This leach pit served as the final receiver for low-level radioactive liquid condensate until October 1973, when use of the pit was discontinued. The radioactive liquid waste stream from the evaporator contained trace amounts of fission and activation products. Radioactivity concentrations were below DCG radiation protection standards for release to uncontrolled areas. The pit has not been used since 1975, and all lines leading to it have been abandoned by removal.

The evaporator discussed above was replaced in 1982 with the Radioactive Liquid Waste Treatment Facility, a dedicated facility for the evaporation of radioactive liquid wastes. Liquid waste generated at the L&O is currently segregated into one of four categories: (a) characteristic corrosive, (b) TCLP metals and characteristic corrosive, (c) radioactive characteristic corrosive, and (d) radioactive TCLP metals and characteristic corrosive. Treatment of the nonradioactive waste is discussed below.

The radioactive characteristic corrosive waste is further divided into two types, those compatible with the 5,700-L (1,500-gal) stainless steel suspect waste tank and those incompatible with it (hydrochloric acid). Compatible waste is accumulated in the suspect waste tank, neutralized to a pH between 5 and 10, and transferred through underground lines to the RLWTF via FCF. These lines are either double-encased or contained within a service tunnel where they may be visually inspected. Incompatible waste is accumulated in corrosion-resistant containers in a satellite accumulation area (SAA), and then either added to the suspect waste tank immediately before transfer to be neutralized or neutralized and then added to the suspect tank.

Radioactive TCLP metals and characteristic corrosive waste is accumulated in 19-L (5-gal) corrosion-resistant containers in the area of generation. When these containers are half full, the contents are neutralized to a pH between 6 and 9, and emptied into a 114-L (30-gal) corrosion-resistant container in the SAA. When this container is almost full, it is sampled for TCLP metals and radionuclide makeup before transfer to EG&G Idaho's Mixed Waste Storage Facility.

3.1.2.6.2 Systems for Disposal of Nonradioactive Liquid Waste at the L&O - Industrial waste generated at the L&O comes from floor drains and janitor sinks in the clean portion of the building. This waste is discharged to the industrial lift station, from which it is transferred to the waste pond via the HFEF ditch (Figure 3-4). The analytical laboratory produces both (a) characteristic corrosive and (b) TCLP metals and characteristic corrosive liquid wastes. Characteristic corrosive liquid waste is accumulated in corrosion-resistant containers at the area of generation. When a container is approximately half full, it is neutralized to a pH between 6 and 9 and discharged to the industrial waste system. TCLP metals and characteristic corrosive waste are accumulated in the same way as characteristic corrosive waste. After neutralization to a pH between 5 and 10, the contents are sampled for TCLP metal concentration and then transferred to EG&G Idaho's Hazardous Waste Storage Facility.

Sanitary waste produced from facility restrooms, sinks, drinking fountains, and the cafeteria is transferred to the main lift station, from which it is pumped to the sanitary lagoons.

3.1.2.6.3 Systems for Disposal of Radioactive Solid Wastes at the L&O - Low-level radioactive solid wastes are produced and disposed of at the L&O complex in a manner similar to that at EBR-II. High-intensity gamma-emitting waste produced in this complex is a result of chemistry sample preparation and of liquid waste evaporation and concentration, which have been described previously in Section 3.1.2.6.1. This waste was packaged in specially designed containers for disposal. In 1982 the RLWTF was brought on line and replaced the evaporator located in the L&O complex, thus ending generation of this type of solid waste.

3.1.2.7 Systems for Disposal of Nonradioactive Solid Wastes at ANL-W. Nonradioactive solids are similar for all facilities at the ANL-W complex. These are comprised of wastepaper, rags, wood, and metal associated with administrative office work and plant maintenance operations. These wastes are collected, surveyed, and transported in dumpsters to the CFA sanitary landfill.

3.1.2.8 Radioactive Liquid Waste Treatment Facility. The RLWTF treats low-level radioactive waste from all ANL-W facilities utilizing the patented SHADE (shielded hot air drum evaporator) evaporation treatment system. Using six evaporation units, the RLWTF can process up to 227,000 L (60,000 gal) of liquid waste per year. To date annual processing has been about 114,000 L (30,000 gal). The SHADE process at RLWTF consists of six subsystems. They are: 1) the radioactive liquid waste fill, 2) the radioactive liquid waste supply system, 3) the radioactive liquid waste return, 4) the radioactive liquid waste overflow, 5) the process air system, and 6) the actual SHADE unit. The radioactive liquid waste fill provides a means for transfer of radioactive liquid waste from the truck unloading station or the underground feed line to one of four holding tanks. The radioactive liquid waste supply system provides for temporary storage, sampling, recirculation, and transfer of liquids to the evaporators. The radioactive liquid waste return carries fluids not drawn for use by the evaporators and returns it to the holding tanks. The radioactive liquid waste overflow collects excess liquid from the evaporators. A liquid sensor closes the supply valve to the overfilled evaporator and alerts the operator. Overflowed liquid drains by gravity to an overflow tank and is automatically pumped back to the holding tanks. The process air system consists of the air-handling units that provide the hot dry air for the evaporators and the exhaust duct work and fans that filter and release exhaust air to the atmosphere. The SHADE is a patented, self-contained evaporator/shipping/disposal container. It consists of a series of evaporation trays set inside a standard 114-L (30-gal) drum. Hot air is passed over the evaporation trays, evaporating the water and leaving behind a solid residue containing the radionuclides. Once the drum has reached capacity it is removed and sent to the RWMC for disposal.

3.1.2.8.1 Systems for Disposal of Radioactive Liquid Waste at RLWTF - There are no radioactive liquid waste effluents associated with this facility.

3.1.2.8.2 Systems for Disposal of Nonradioactive Liquid Waste at RLWTF - Sanitary waste is transferred to the main lift station, from which it is pumped to the sanitary lagoons. Industrial waste disposal varies depending on the system. Steam condensates are returned to the boiler room, while cooling water is discharged to the sanitary system.

3.1.2.8.3 Systems for Disposal of Radioactive Solid Wastes at RLWTF - The low-level radioactive solidified wastes produced by the evaporation process are packaged and disposed at RWMC.

3.1.2.9 Industrial Waste Pond (IWP). Before waste is allowed to be discharged to the IWP, its disposal must meet the requirements found in Chapter 4, Section IX of the ANL-W Environment, Safety, and Health Manual (ANL-W ES&H Manual). In some cases, routine sampling is conducted at facilities before liquid waste is discharged to the ditch system. A total of 1.75×10^8 L (46.117×10^6 gal) of wastewater was discharged to the IWP during 1992. Table 3-1 lists the contaminants and volumes of various constituents found in the industrial effluent discharged to the IWP.

Table 3-1. 1992 discharges to the Industrial Waste Pond.

Substance (Kgs)	January	February	March	April	May	June	July	August	September	October	November	December	Annual Total
1-Bromo-3-Chloro-5,5-Dimethylhydant	50	25	38	4	8	38	105	306	105	117	42	115	953
Aminemethylpropanol	1		1		3	2	1	1	1	2	1	2	15
Aromatic Solvents	6	17	17	3	2	22	13	18	11	22	13	24	168
B-Bromo-B-Nitorstyrene		2	2	1		5	3	3	2	5	3	5	31
BETZ 20K	430		105	11	99	215	622	1,272	292	661	628	556	4891
Bis(trichloromethyl)sulfone	7	7	7		1			6					28
Dimethylisopropanolamine										1	1		2
Ethylamine						1							1
Heavy Aromatic Naptha	5	5	5			1			4				20
Methylene Bis(thiocyanate)	1	2	2			2	1	2	1	2	1	2	16
N-Methylpyrrolidone	7	11	11	1	2	7	4	10	4	7	4	8	76
Nonylphenoxypoly(ethyleneoxy)ethanol	2	3	3			2	1	3	1	2	1	2	20
Photo Lab Chemicals					81		181			70		460	792
Polyacrylate	25	11		1	6	8	23	76	13	35	48	34	280
Sodium Hydrate Solution								1	1	3	1		6
Sodium Ion	374	415	415	83	332	166	456	291	332	415	416	390	4085
Sodium Sulfite										1	2		3
Sodium Tripolyphosphate										1			1
Stoddard Solvent		6	6	2	1	13	7	7	6	13	7	14	82
Sulfate Ion	4,361	1,108	1,800	208	1,038	2,077	4,431	7,961	2,215	4,912	1,411	4,912	36434
Sulfite Ion										1	1		2
Tritium (Liters)							1.31E+05	1.87E+05	7.87E+04	1.69E+05	9.84E+04	2.59E+05	923100

All effluents passing through the industrial waste lift station are monitored continuously for radioactivity by an in-line gamma scintillation monitor that alarms both locally and remotely at the reception building, which is occupied at all times. Alarm results in notification of waste management personnel, who institute prescribed procedures to correct the situation. Industrial waste from the EBR-II facility is also monitored for pH.

3.1.2.9.1 Potential Contaminants from the Main and Auxiliary Cooling Towers - The following discussion is on chemicals used in the main and auxiliary cooling towers. The composition of cooling water passing through the towers is regulated to remain within the following limits:

1. pH = 7.4 to 7.8
2. Phosphate = 15 to 20 ppm
3. Dispersant (Betz 2020) = 30 ppm (min.)
4. Conductivity (max) = 1900 micromhos

Dianodic-II Treatment - The cooling water is kept continuously saturated with dissolved oxygen while passing over the cooling tower. To prevent oxygen corrosion of the cooling-water system and to control deposition, a water treatment called "Dianodic-II" is added to the system. The corrosion inhibitors in this treatment are orthophosphate (monomolecular PO_4^{-3}) and polyphosphate (a polymer containing many phosphate groups). The treatment does not use chromates for corrosion control.

Betz 20K, the solution containing ortho- and polyphosphate, is continuously injected into the system to maintain phosphate levels between 15 and 20 ppm. At such high concentrations, precipitation of calcium phosphate can become a problem. Prevention of $Ca_3(PO_4)_2$ precipitation is accomplished by injection of another chemical, Betz 2020. This solution contains a modified poly-acrylic acid that disperses calcium salts as well as other salts (e.g., iron and magnesium salts). In addition to phosphates, the Betz 20K contains two other chemicals: HEDP, which inhibits precipitation of scale ($CaCO_3$) and prevents formation of tubercles, and (2) tolytriazole, which inhibits corrosion of copper alloys such as admiralty metal.

Sulfuric Acid - The purpose of sulfuric acid addition is to decrease the bicarbonate alkalinity of the main cooling tower water, thereby reducing the potential of the water to deposit calcium carbonate scale on heat transfer surfaces. The sulfuric acid reacts with the bicarbonates in the raw water, yielding the corresponding sulfates. The cooling water pH (7.4-7.8) must be controlled to prevent scale buildup.

Concentrated (93%) sulfuric acid is received in bulk and transferred to the acid storage tank located northeast of the main cooling towers. It is transferred from the storage tank to the acid measuring tank by a raw water eductor system. The measuring tank drains to the acid day tank which provides a suction for the acid injection pumps. Sulfuric acid is added to the main cooling tower basin as necessary to maintain the pH in a control band of 7.4 to 7.8.

Microbiological Treatment - Oxidizing and non-oxidizing biocides are added to the condenser cooling water to kill or retard the growth of microorganisms. Microorganisms can cause biological fouling of piping systems and heat exchanger equipment.

The oxidizing biocide is supplied in "Aquabrome" pellets which are added through a brominator (tank). The total halogen level is maintained at a level of approximately 0.5 ppm. Pellets are added approximately once a month, while the non-oxidizing biocide (slimicide) is added about twice a month.

3.1.2.9.2 Potential Contaminants from the HFEF Cooling Towers - Cooling tower water is sampled during a weekly preventative maintenance walk-through. Two samples are taken. One is analyzed for gross beta, and the other is taken to the auxiliary boiler room for water treatment analysis. Based upon the results of the water treatment analyses, water treatment chemicals are added to the cooling tower water which undergoes continuous blowdown of roughly 190 L/m (50 gpm). The HFEF cooling tower operates under the following monitoring and analysis parameters:

- Total Dissolved Solids = 800-1000 ppm
- Hardness = 300-400 ppm
- pH = 8.0 ± 0.5.

3.1.2.9.3 Potential Contaminants from EBR-II Turbine Condensate - The EBR-II turbine condensate is monitored every four hours for pH. pH is maintained between 8.8 and 9.2 by the addition of either caustic or acid to raise or lower the pH, respectively. Residual hydrazine, a carry-over from the turbine steam and condensate, is analyzed. Hydrazine is no longer used in this system due to health and safety concerns. Currently a carbohydrazide is added that decomposes to hydrazine at the temperatures encountered in the steam system. Normal operations maintain a hydrazine level in the feedwater of 10 - 20 ppb. This results in a carry-over of approximately 2 - 3 ppb.

3.1.2.9.4 Potential Contaminants from Ion Exchanger Regeneration Effluent - The ion exchanger regeneration effluent from the EBR-II Power Plant is piped into the industrial waste neutralization tank. Once inside the tank, the pH of the effluent is measured. The pH is adjusted, by the addition of either caustic (NaOH) or acid (H_2SO_4), so as to fall within a range between 4 and 11, and the effluent is discharged. Both the effluent and the salts from the effluent have been analyzed for lead and chromium. Monitoring is conducted in accordance with Operating Instructions for EBR-II, Chapter 13H.

3.1.2.9.5 Potential Contaminants from Auxiliary Boilers - The auxiliary boilers operate under the following monitoring and analysis parameters:

- Sulfite = 20-40 ppm
- Alkalinity = 200-400 ppm
- Phosphate = 30-60 ppm
- Conductivity (max) = 800 micromhos
- pH = 8.0-9.0.

Boiler water is tested at least once every 24 hours when the boilers are operating. The boilers are blown down only when test results indicate that it is necessary. Frequency and discharge depend on the level of solids in the boiler water. Blowdown can be as frequent as daily, but is at least once a month. Monthly volumes normally average about 1,900 L (500 gal).

3.1.2.9.6 Potential Contaminants from Other Systems - In addition to the potential contaminants outlined in Sections 3.1.2.9.1 through 3.1.2.9.5, all suspect wastewater (in which a possibility for radiologic contamination exists) is analyzed for the suspected constituents. If the possibility exists for the wastewater to be radioactively contaminated, the suspect wastewater is monitored for gross alpha, gross beta, tritium, gamma-emitting isotopes, and pH. If wastewater is suspected to contain other hazardous substances (e.g. heavy metals), the wastewater is sampled for the suspected hazardous substance (for example see 3.1.2.9.3 and 3.1.2.9.4 above).

In addition to sampling conducted by the facilities, the ANL-W Environment and Waste Management (EWM) section collects monthly samples of IWP water during the ice-free months of April through October. The samples are analyzed for alpha, beta, and gamma contamination, tritium, cadmium, silver, zinc, sodium, phosphate, sulfate, chloride, total and hexavalent chromium, and pH. These samples are not required for compliance purposes. They serve merely as indicators of IWP status. EWM also collects biannual samples from the IWP, which are analyzed for low-level gamma-emitters and plutonium content. By direction from DOE-CH, EWM collects an annual IWP water sample which is analyzed for the TCLP constituents. Procedures for the sampling and handling of these EWM IWP samples can be found in Chapter 24, Section IX of the ANL-W ES&H Manual.

3.1.2.10 Main Cooling Tower Blowdown Ditch. When routine water analyses of the main cooling tower indicate that the conductivity of the cooling water is 4.5 times the conductivity of the makeup water (4.5 cycles of concentration), system blowdown is started. The cycles of concentration are normally maintained between 4.5 and 5.0, which reduces the blowdown rate and the required amount of chemical additions to the system. Various chemicals are used in the cooling tower systems to prevent buildup of unwanted microorganisms. Types and amount of chemicals used are described in Section 3.1.2.9.1. The blowdown from the system is drained to the industrial waste pond through a series of unlined ditches (Figure 3-4). These ditches continually contain water associated with normal plant operations.

3.1.2.11 EBR-II Leach Pit. The leach pit, located southwest of EBR-II (Figure 3-2), is an unlined, underground basin 11 m (37 ft) long, 5.5 m (18 ft) wide, and 3 m (10 ft) deep, covered with a concrete slab 20 cm (8 in.) thick, which protected it from weather and ingress of wildlife when it was in use. An inlet pipe, located below ground level, discharged radioactive and mixed hazardous waste into the pit. The leach pit was used between 1959 and 1973, and once in 1975. After the last usage in 1975, the inlet pipe was removed and the system was abandoned in place.

3.1.2.12 TREAT Industrial Ditch. The TREAT industrial ditch is a natural swale, approximately 60 m (190 ft) long, running east from the facility outside the security fence. Water discharged to this ditch comes from various heat exchanger cooling coils and water system drains. Although discharges to this ditch are not large, they are continuous.

3.1.2.13 Sanitary Lagoons. The sanitary sewage treatment plant (STP) lagoons are located about

300 m (1,000 ft) north of the ANL-W building facilities, and receive all sanitary wastes from the ANL-W building facilities, with the exception of the TREAT facilities and SCMS. The STP consists of three open ponds having a combined area of 0.9 ha (2.3 acres). Sanitary waste effluent is piped into the first pond for initial biologic digestion, then overflows to the secondary pond for final cleanup and evaporation. One lagoon is kept in reserve as an overflow pond. The bottom of each lagoon is sealed with bentonite to minimize seepage into the underlying strata. This lagoon serves as a final receiver for sanitary wastes. The sanitary lagoons in operation at ANL-W are sampled on a monthly basis, during the ice-free months April through October. The samples collected are analyzed for the following:

- Primary Sanitary Lagoon - alpha, beta, and gamma contamination; tritium and cadmium content; and pH.
- Secondary Sanitary Lagoon - BOD, DO, total suspended solids, and pH. The results from these samples are compared with the results obtained from identical samples taken in the sewage lift station to evaluate the efficiency of the sewage lagoon's operation.

All sanitary effluent is monitored continuously for radioactivity by an in-line gamma scintillation monitor. If radioactivity levels exceed the predetermined set point (2.0×10^{-5} µCi/mL), an alarm sounds locally and remotely at the reception building. Biannual samples are also collected in the secondary lagoon and are analyzed for low-level gamma-emitters and plutonium content. Procedures for sanitary lagoon sample collection and handling can be found in Chapter 25, Section IX of the ANL-W ES&H Manual.

The data listed in Table 3-2 were recorded during the nonfreezing months of 1991. A total of 12.18 $\times 10^{6}$ L (3.218×10^{6} gal) of effluent was discharged to the sanitary lagoon during 1991.

3.1.3 Potential Sources of Contamination

Potential sources of contamination at ANL-W are mainly those identified in the FFA/CO as areas requiring characterization and cleanup, and petroleum or chemical storage tanks. Appendix A contains EG&G Idaho's Contaminant Source Inventory list. This list includes all known potential contaminant sources at ANL-W. Due to the great depth to groundwater, releases from most USTs are not considered to be a likely source of contamination. Furthermore, many of the tanks listed are contained within buildings and cells that serve as secondary containment. The facilities of primary interest with regard to hydrogeological impact are those that handle, or have handled in the past, large volumes of potentially hazardous or radioactive solutions or wastewaters, and that are not equipped with adequate secondary containment. These include the industrial wastewater pond, sanitary sewage lagoons, the EBR-II leach pit, and cooling tower blowdown ditches (Figures 3-2 and 3-4).

Industrial Waste Pond - As discussed in Section 3.1.2.8, the industrial waste pond has been used since 1964 to receive wastewater from a number of sources. In the late 1980s, investigations were conducted to determine the presence of contaminants in sediments and water from the waste pond and blowdown ditch. Constituents of greatest concern were chromium and zinc because of their presence in cooling tower blowdown water discharged to the industrial waste pond. In addition, lead and silver were discharged in other industrial waste (i.e., photographic processing).

Table 3-2. 1991 discharges to sanitary lagoons.

	Average, mg/L	Range, mg/L
Biochemical Oxygen Demand		
Raw Effluent	245	190-330
Final Effluent	17	6-34
(Average percent Removed = 93%)		
Dissolved Oxygen		
Raw Effluent	2.12	0.2-4.6
Final Effluent	4.2	1.5-8.2
pH (no units)		
Raw Effluent	8.2	7.1-8.6
Final Effluent	8.4	7.8-9.2
Suspended Solids		
Raw Effluent	5.8 E-1	(1.0 E-1)-(2.8)
Final Effluent	9.8 E-2	(5 E-3)-(1.9 E-1)

NOTE: Raw effluent is sampled at the Building 778 lift station; final effluent is the mixed contents of the secondary lagoon. Both are sampled monthly, April through October.

In 1988, two water samples were collected from the IWP for Appendix IX (40 CFR 261) chemical analyses (Northern, 1988). One water sample was collected from the middle of the industrial waste pond; the other sample was collected from perched water, 12 m to 18 m (40 to 60 ft) below land surface, in borehole ANL-M5. Arsenic, barium, and zinc were detected in the industrial waste pond water, but below maximum contaminant levels. Arsenic, barium, iron, and manganese were detected in the perched water sample. Concentrations of arsenic and barium in the water samples obtained from the industrial waste pond and perched water did not exceed the primary drinking water standards. Zinc and iron did not exceed the secondary drinking water standards. However, the secondary drinking water standard for manganese was exceeded nearly fourfold. Trace metal concentrations of chromium, lead, and silver were not detected in the waste pond water or in perched water derived from the waste pond. Apparently, the chromium, lead, and silver, detected in IWP sediments, are not being leached or remobilized (Chen-Northern, Inc., 1988).

Sediment samples were also collected from the industrial waste pond for Appendix VIII chemical analyses. Results of the chemical analyses indicated that high concentrations of chromium and total organic carbon were present only in the upper sediment layer beneath the industrial waste pond. In the presence of organic matter, hexavalent chromium is easily reduced and bound to organic matter as trivalent chromium. In the trivalent state, chromium is relatively inert, and leaching of the chromium from the upper layer would not be expected.

Main Cooling Tower Blowdown Ditch - An investigation characterizing sediments associated with the main cooling tower blowdown ditch (Chen-Northern, Inc., 1991) collected two samples, one duplicate sample, and six QC samples from the shallowest sedimentary interbed for chemical analysis of Appendix VIII parameters. The organic and Dioxin/Furan compounds reported above detection limits were determined to be the result of laboratory contamination, rather than contamination from past discharges to the blowdown ditch. However, inorganic analyses of samples from the sedimentary interbed yielded concentrations of chromium and silver greater than the EP toxicity characteristic levels. As a result of this initial testing, this area was designated as a RCRA land disposal unit (LDU). This implies that migration of metals may have occurred or may be occurring from the main cooling tower blowdown ditch to the first interbed (Chen-Northern, Inc., 1991).

EBR-II Leach Pit - An inlet pipe, located below ground surface, discharged radioactive and mixed hazardous waste into the pit. Radioactive activation and fission products were the primary radioactive contaminants in liquid waste discharged to the leach pit. In addition, some industrial waste containing chromates from cooling tower blowdown may also have been discharged to the pit. A characterization study of the leach pit was conducted in 1991. Various radionuclides and metals were detected from the sludge within the pit (Table 3-3).

TREAT Industrial Ditch - Discharges to this ditch are from various cooling systems in contact with hot hydraulic oil. For this reason, TREAT personnel perform monthly visual inspections for oil at the industrial ditch. TREAT personnel also conduct an annual hydrocarbon screening of soil in the ditch area.

Table 3-3. EBR-II leach pit analytical results.

Location/Sample Depth (ft)	G1 Grab (sludge)	G2 Grab (sludge)	G3 Grab (sludge)	C3 36 (soil)	C1 2 (soil)	C2 1 (soil)	Units
Volatile Organic Compounds							
Methylene Chloride	ND	74 B	ND	ND	ND	ND	µg/Kg
Acetone	280 E	1100 E	ND	ND	ND	ND	µg/Kg
Unknown	4 J	16 J	20 J	4 J	3 J	8 J	µg/Kg
Semivolatile Compounds							
Phenanthrene	ND	ND	340 J	380 UJ	ND	ND	µg/Kg
Anthracene	ND	ND	110 J	380 UJ	ND	ND	µg/Kg
Di-n-butyl phthalate	ND	ND	170 J	2000 J	ND	ND	µg/Kg
Fluoranthene	ND	ND	170 J	380 UJ	ND	ND	µg/Kg
Pyrene	410 UJ	ND	670 J	380 UJ	ND	ND	µg/Kg
Butylbenzyl phthalate	410 UJ	ND	51 J	10 UJ	ND	ND	µg/Kg
Benzo(a)anthracene	410 UJ	ND	480 J	380 UJ	ND	ND	µg/Kg
Chrysene	410 UJ	ND	630 J	380 UJ	ND	ND	µg/Kg
Benzo(k)fluoranthene	410 UJ	ND	450 J	380 UJ	ND	350 UJ	µg/Kg
Unknown	1400 J	342 J	6090 J	420 J	126 J	1363J	µg/Kg
PESTICIDE/ PCB ORGANIC COMPOUNDS							
PCB 1260	800	1800	1300	ND	ND	ND	µg/Kg
PCB 1254	3900	6100	2000	ND	ND	ND	µg/Kg
TOTAL DIOXINS/ FURANS							
Total TCDD	0.17 UJ	0.72 UJ	0.22	ND	ND	ND	ng/Kg
Total PeCDD	3.2 UJ	4.2 UJ	5.6 J	ND	ND	ND	ng/Kg
Total HxCDD	15.4 J	76.4 J	5.5	ND	ND	ND	ng/Kg
Total HpCDD	29.2 J	104 J	45.4	ND	ND	ND	ng/Kg
OCDD	139 J	419 J	289 J	0.24	0.052 J	ND	ng/Kg
Total TCDF	0.42 UJ	0.65 J	0.35	ND	ND	ND	ng/Kg
Total PeCDF	0.95 J	2.6 J	1.2	ND	ND	ND	ng/Kg
Total HxCDF	4.4 J	15.0 J	7.9	ND	ND	ND	ng/Kg
Total HpCDF	4.5 J	15.2 J	10.0	ND	ND	ND	ng/Kg
OCDF	2.4 J	7.2 J	6.2 J	ND	ND	ND	ng/Kg

Table 3-3. EBR-II leach pit analytical results (continued).

Location/Sample Depth (ft)	G1 Grab	G2 Grab	G3 Grab	C3 36	C1 2	C2 1	Units
TCLP METALS							
Arsenic	0.01	0.04	ND	0.01	0.02	0.01	mg/Kg
Barium	1.55	0.18	0.40	0.67	2.62	0.93	μg/Kg
Cadmium	0.08	1.09	0.06	ND	ND	ND	μg/Kg
Chromium	0.99	3.48	ND	0.06	0.07	0.06	
Lead	0.09	0.10	ND	0.05	ND	0.07	μg/Kg
Mercury	ND	0.0004	ND	ND	ND	ND	μg/Kg
Selenium	ND	ND	ND	ND	ND	ND	μg/Kg
Silver	ND	ND	ND	ND	ND	ND	μg/Kg
RADIOCHEMICAL ANALYTES							
Americium-241	ND	0.25 ±0.07	0.65 ±0.18	ND	0.32 ±0.23	0.17 ±0.09	pCi/g
Cerium-144	ND	ND	ND	ND	ND	ND	pCi/g
Cesium-134	0.62 ±0.2	1.8 ±0.3	ND	ND	ND	ND	pCi/g
Cesium-137	6619 ±40	29110 ±10	18460 ±10	93.6 ±0.8	0.44 ±0.09	ND	pCi
Cobalt-58	ND	ND	ND	ND	ND	ND	pCi/g
Cobalt-60	61.3 ±0.6	64.1 ±2.3	196 ±2	1.93 ±0.21	ND	ND	pCi/g
Iodine-129	ND	ND	124 ±27	ND	ND	ND	pCi/g
Neptunium-237	46.5 ±2.5	329 ±9	221 ±11	1.53 ±0.65	ND	ND	pCi/g
Plutonium-238	ND	ND	0.21 ±0.04	ND	ND	ND	pCi/g
Plutonium-239	ND	ND	2.86 ±0.15	ND	ND	ND	pCi/g
Ruthenium-103	ND	ND	ND	ND	ND	ND	pCi/g
Ruthenium-106	ND	ND	ND	ND	ND	ND	pCi/g
Strontium-90	12.1 ±0.3	488.4 ±1.8	2247 ±5	0.17 ±0.07	5.92 ±0.21	0.21 ±0.07	pCi/g
Uranium-234	35.64 ±3.54	27.61 ±1.09	14.52 ±0.22	0.29 ±0.03	0.17 ±0.03	0.15 ±0.02	pCi/g
Uranium-235	2.18 ±0.87	1.38 ±0.24	0.50 ±0.04	ND	ND	ND	pCi/g
Uranium-238	3.54 ±1.11	1.96 ±0.29	1.61 ±0.07	0.16 ±0.03	0.14 ±0.02	0.14 ±0.01	pCi/g
Yttrium-90	12 ±1	490 ±2	2247 ±5	0.2 ±0.1	6 ±1	0.2 ±0.07	pCi/g

ND - Compound was analyzed for but not detected, number in parenthesis is the sample quantitation limit.
J - Indicates reported value is an estimate.
UJ - Indicates that compound was analyzed for but not detected, the reported value is an estimate of the sample quantitation limit.

Table 3-3. EBR-II leach pit analytical results (continued).

Location	G1 Grab	G2 Grab	G3 Grab	C3	C1	C2	Units
TOTAL METALS / CYANIDE / SULFIDE / pH							
Aluminum	6927.52	9722.04	15036.72	5148.59	6122.25	4137.78	mg/Kg
Antimony	11.14	37.09 E	27.08	14.91	12.15	8.48	mg/Kg
Arsenic	7.00 J	52.80 J	19.8 J	3.52 J	11.93 J	4.27 J	mg/Kg
Barium	169.59	255.20	250.30	146.89	105.26	136.99	mg/Kg
Beryllium	0.58	0.95	759.09	0.52UJ	0.56	0.41	mg/Kg
Cadmium	9.60	49.78	18.30	8.02	4.82	4.78	mg/Kg
Calcium	24214.69	42465.62	1295.10	28.69 J	15.47 J	14.2 J	mg/Kg
Chromium	596.25 J	4305.33 J	1295.10	28.69 J	15.47 J	14.2 J	mg/Kg
Cobalt	6.29	12.55	10.80	11.54	7.29	5.61	mg/Kg
Copper	3283.56 J	18839.40 J	6308.54	22.33 J	18.73 J	6.73 J	mg/Kg
Iron	23055.37	29961.40	25233.74	13028.07	11365.54	8296.46	mg/Kg
Lead	93.71	287.98	123.20	14.70J	13.54	13.17	mg/Kg
Magnesium	7010.00	11981.71	10123.17	15124.14	8323.17	5584.39	mg/Kg
Manganese	225.10	352.61	309.09	147.31	254.77	134.55	mg/Kg
Mercury	ND	496.60	132.90	0.52	0.41	0.12	mg/Kg
Nickel	31.51 J	75.24 J	39.46	11.03 J	20.97 J	5.00 J	mg/Kg
Potassium	1933.08	2298.52	2269.00	796.29	1661.12	1048.21	mg/Kg
Selenium	ND	ND	0.15 J	ND	ND	ND	mg/Kg
Silver	22.63	5.26	11.40	3.14	ND	ND	mg/Kg
Sodium	192.69	1047.99	491.33	744.69	312.08	133.65	mg/Kg
Tin	24.68	223.65	64.20	27.47	16.24	11.02	mg/Kg
Thallium	5.00	15.76	22.40	9.09	6.91	5.00	mg/Kg
Vanadium	18.38	50.47	50.90	19.87	17.13	18.32	mg/Kg
Zinc	459.75	3016.80	567.21	28.86	44.76	32.10	mg/Kg
Cyanide	1.00 J	34.32 J	9.61	0.88 J	0.96 J	0.73 J	mg/Kg
Sulfide	11.3	82.2	ND	31.3	15.8	14.9	mg/Kg
pH	8.9	7.4	7.96	9.3	9.4	9.5	SU

B - Indicates that compound was detected above the instrument detection limit but below the contract required detection limit.
E - Indicates that compound exceeds the calibration range of the instrument.

Sanitary Lagoons - The two sanitary lagoons in operation at ANL-W are sampled on a monthly basis, during the ice-free months April through October. The samples collected are analyzed for the following:

- Primary Sanitary Lagoon - alpha, beta, and gamma contamination, tritium and cadmium content and pH.

- Secondary Sanitary Lagoon - BOD, DO, total suspended solids, and pH. The results from these samples are compared with the results obtained from identical samples taken in the sewage lift station to evaluate the efficiency of the sewage lagoon's operation.

Biannual samples are also collected in the secondary lagoon and are analyzed for low-level gamma emitters and plutonium content. Procedures for sanitary lagoon sample collection and handling can be found in Chapter 25, Section IX of the ANL-W ESH Manual.

3.2 Physical Setting

Characteristics of the uppermost water-bearing units beneath ANL-W, as well as regional and local physiographic, geologic, and hydrologic settings of the ANL-W facilities are summarized in the following sections. This information has been assembled from several documents including Robertson et al. (1974) and Pittman et al. (1988).

3.2.1 Physiographic and Geomorphic Setting

The ANL-W facility is located in the southeastern portion of the INEL (Figure 3-1), in Sections 11, 12, 13, and 14 of T3N R32E. The ANL-W administrative area is a rectangular area, encompassing approximately 890 acres. ANL-W facilities are located within a topographically closed basin (Figure 3-10). The surface of the facility slopes gradually from south to north, at approximately 9 m (30 ft) per mile. Maximum topographic relief within the ANL-W administrative boundary is about 15 m (50 ft), ranging from 1,558 m (5,110 ft) above mean sea level on the north boundary to 1,573 m (5,160 ft) on a basalt ridge to the southeast.

3.2.2 Geology

This subsection provides a description of the local geological characteristics at ANL-W. Where applicable, pertinent geological information including geomorphology, stratigraphy, lithology and bedrock structures are described.

3.2.2.1 Surface Geology. The ANL-W facilities are located within a topographically closed basin. Low ridges of basalt located east of the area rise as high as 30 m (100 ft) above the level of the plain. Surficial sediments cover most of the underlying basalt, except where pressure ridges form basalt outcrops. The thickness of these surficial sediments ranges from zero to 6 m (20 ft) (Chen-Northern, Inc., 1989a).

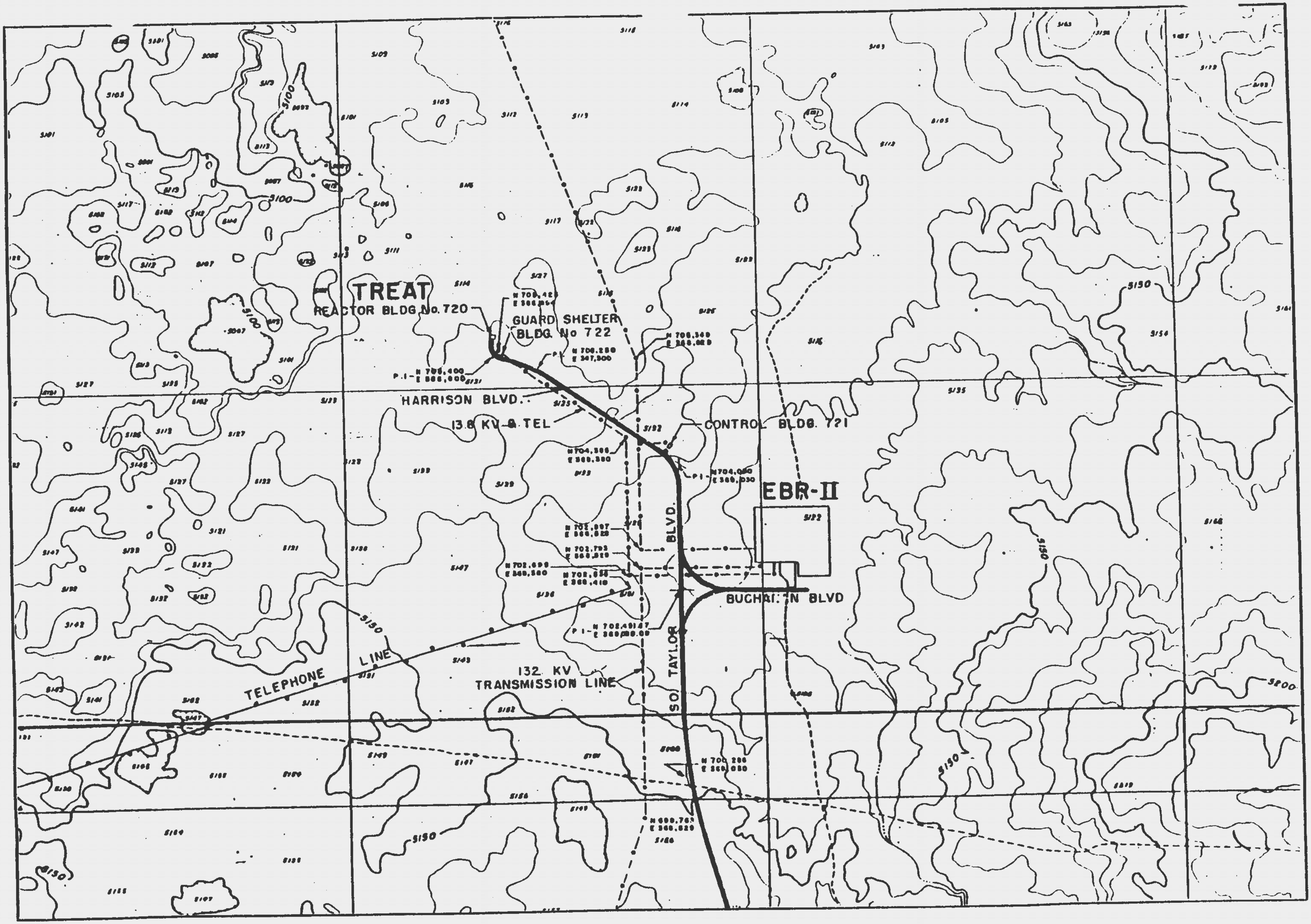


Figure 3-10. ANL-W area topographic map.

Test borings at ANL-W have revealed two distinct horizons in the surface sediments. The uppermost portion, from zero to several feet below land surface (BLS), consists of a light brown silty loam. The upper 0.3 to 0.6 m (1 to 2 ft) of this silty loam horizon contains plant roots. This horizon is underlain by a sandy silt, which extends to the underlying basalt. The silts and fine sands (loess) were probably transported by wind from other parts of the plain. The windblown loess is calcareous and light buff to brown in color. Small bodies of well-sorted sand that occur within the loess are probably the result of reworking by surface runoff in local depressions. The lower portion of this loess horizon generally contains basalt fragments from cobble to boulder size. The upper surface of the underlying basalt is highly irregular.

3.2.2.2 Subsurface Geology. The subsurface lithology is dominated by basaltic lava flows. Sedimentary interbeds occur at various depths, overlying the tops of basalt flows.

The geology at ANL-W is similar to the rest of the INEL. Most of the sedimentary interbeds appear to be discontinuous stringers, deposited in low areas on basalt surfaces. The ANL-W area generally has fewer and thinner sedimentary interbeds than most of the INEL. These sedimentary interbeds are generally composed of calcareous silt, sand, or cinders. There are also cinder layers within the basalts that are composed of sand and gravel sized material. The interbeds range in thickness from less than 2.5 cm (1 in.) to 3 m (10 ft). Drilling near areas of contaminant concern (industrial waste pond and cooling tower blowdown ditch) targeted a discontinuous but locally extensive interbed located at approximately 12 to 15 m (40 to 50 ft) BLS, near the waste pond area. This interbed is not continuous across the ANL-W area and does not appear west of the industrial waste pond. More areally extensive interbeds have been identified above the regional water table, at approximately 122 m (400 ft), 168 m (550 ft), and 183 m (600 ft) BLS (Holzemer and Krenz, 1988). The fine-grained nature of these sedimentary interbeds may cause perching or retention of water, as noted in neutron logs.

The thickness and texture of individual basalt (lava) flows is quite variable. Individual basalt flows range in thickness from 3 to 30 m (10 to 100 ft). The upper surfaces of the basalt flows are often irregular and contain numerous fractures and joints that may be filled with sediment. The existence of rubble zones of variable depth and extent is indicated by caliper logs, which reveal zones of blocky or loose basalt. Exposed fractures commonly have silt and clay infilling material. The middle portions of the flows typically have few vesicles and are dominated by vertical fractures formed during cooling. The bases of many flows are glassy in texture and are slightly vesicular.

The sequence of interbedded basalt and sediments, discussed above, continues to a depth well below the water table. The water table is typically encountered at depths of about 194 m (635 ft) BLS in the vicinity of the ANL-W facility.

3.2.3 Surface Water

Recharge to the SRPA in the ANL-W area is limited to precipitation in the form of snow or rain, and seepage from the Industrial Waste Pond and ditches constructed to dispose of wastewater from facility operations. During the spring snowmelt season, moderate recharge to the aquifer can occur. High evapotranspiration rates during the summer and early fall reduce significant infiltration from rainfall during this period.

Seepage from the industrial waste pond and associated cooling tower blowdown ditch (Figure 3-2) may also yield some recharge to the SRPA. The pond has been used since 1964 to receive main and auxiliary cooling tower blowdown water. The discharge rate to the pond varies from 5.4 to 16 million L/mo (1.42 to 4.22 million gal/mo) (CH_2M Hill, 1978). The average discharge rate is 120 million L/yr (31.7 million gal/yr), measured over the July 1977 to June 1978 period. Over the 1961 to 1970 time period, approximately 91 million L/yr (24 million gal/yr) were discharged to the industrial waste pond.

Discharge rates to the industrial waste pond are much lower than discharge rates at other facilities on the INEL (ie. ICPP and TRA). ICPP discharges on the order of approximately 1.4 billion L/yr (370 million gal/yr) to its percolation ponds, while TRA discharged an average of approximately 680 million L/yr (180 million gal/yr) from 1986 to 1991.

There are no permanent natural surface waters near ANL-W. The existing surface water features (e.g., drainage ditches and discharge ponds/pits) were constructed for the collection of intermittent surface runoff.

3.2.4 Groundwater Hydrology

Estimates show that nearly 1.2×10^{12} m^3 (1×10^9 acre-ft) of water exist in the SRPA, with water usage within the boundaries of the INEL being approximately 6.9×10^6 m^3 (5.6×10^3 acre-ft) per year. From 1984 to 1986, the ANL-W withdrew an average of 5,700 m^3 (4.6 acre-ft) of water per year from the SRPA. Principal uses of the water are for plant cooling and potable water.

Figure 3-11, which presents the water table elevation for the ANL-W region, indicates groundwater in the SRPA generally flows from northeast to southwest with some local variations in this area. This map is based on July, 1981 water level data for the six wells shown on the figure, as well as five others located somewhat further from the ANL-W. These data reveal that the average local gradient of the water table ranges from 1.7 to 2.3 m/km (9.0 to 12 ft/mi). This is significantly steeper than the average regional gradient, which is on the order of 0.6 to 1.1 m/km (3.0 to 6.0 ft/mi). Because the wells were completed in approximately the same interval, and the contour pattern was repeated for different time periods, the data were retained despite the disparity. Depth to the SRPA in the vicinity of the ANL-W facility is approximately 192 m (630 ft) BLS, based on 1992 water level measurements. Transmissivity in the SRPA near ANL-W ranges from 1,000 to 52,000 m^2/d (11,000 to 560,000 ft^2/d) based on aquifer test data from four area wells (Ackerman, 1991). Assuming an average regional gradient of 0.8 m/km (4.0 ft/mi), a porosity of 10%, and the above-mentioned transmissivity range, the horizontal groundwater flow velocity in the ANL-W region may range from 0.2 to 13 m/d (0.8 to 42 ft/d).

3.2.5 Perched Water Hydrology

Only three of the six boreholes drilled adjacent to the industrial waste pond encountered perched water, and only one of these boreholes yielded enough water for chemical sampling. The three

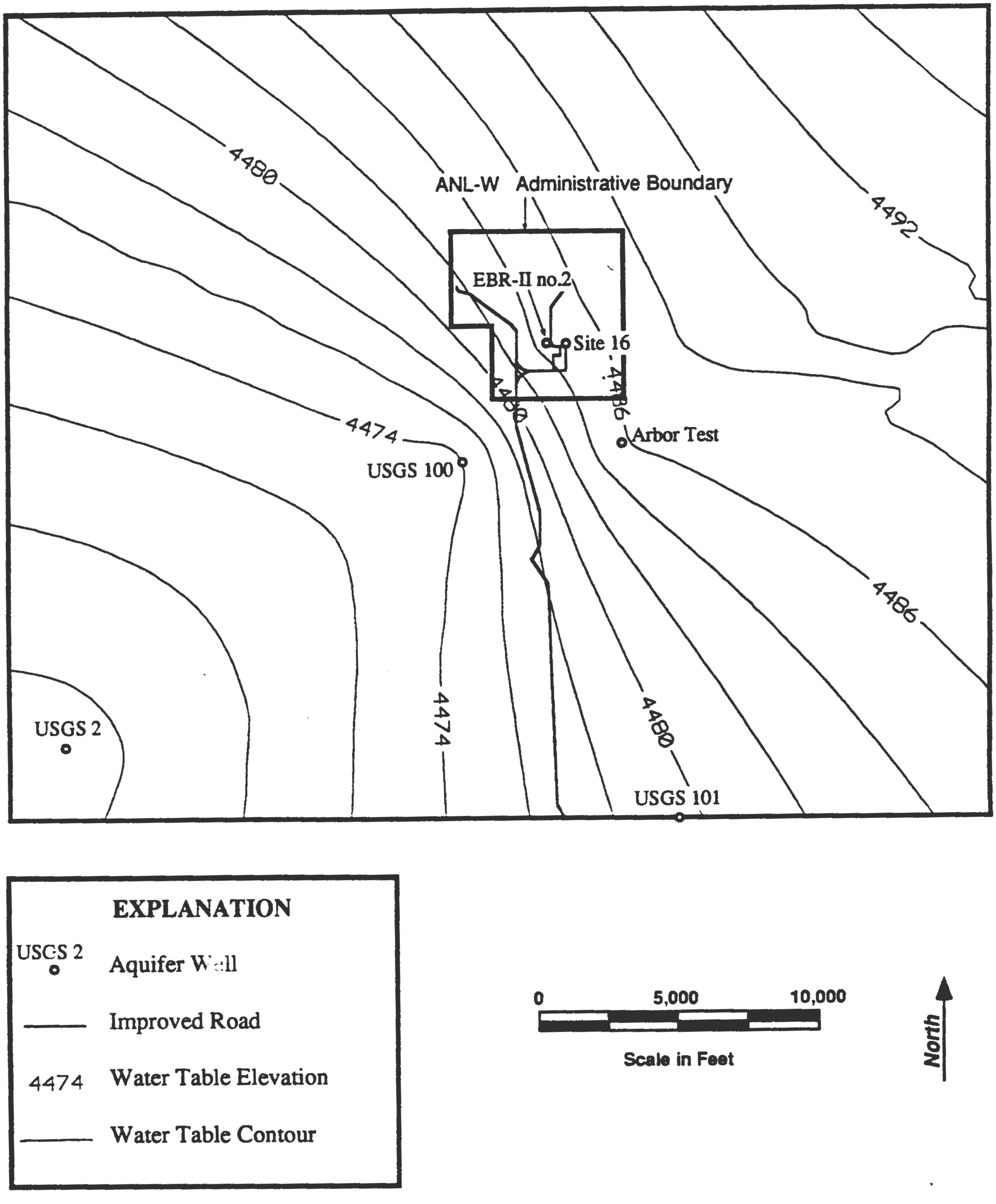


Figure 3-11. Equipotential Map for the ANL-W Region, July, 1981.

boreholes that encountered perched water are located adjacent to the west side of the industrial waste pond (boreholes ANL-M4, -M5, and -M6). Three out of four boreholes drilled adjacent to the Cooling Tower Blowdown Ditch encountered perched water, but these did not yield enough water for collection of samples for analysis. The shallow perched water is derived from seepage from the industrial waste pond and associated Cooling Tower Blowdown Ditch, based on analytical results of water quality samples from the industrial waste pond and perched water from borehole ANL-M5 (Northern, 1988).

The localized, nonextensive nature of the shallow perched water zone is related to two factors. First, discharge volumes to the ditch and waste pond are small compared to those at other facilities where extensive perched water zones have formed (e.g., TRA and ICPP). Second, the shallow interbeds are not as extensive as those in other areas where perched water zones exist.

Other perched water zones may exist, deeper in the subsurface. A fine-grained sedimentary interbed exists at an approximate depth of 120 m (400 ft). Neutron logs indicate that this 3-m (10-ft) thick, areally extensive unit may be saturated with water. A somewhat coarser-grained sedimentary unit occurs at a depth of about 170 m (550 ft) BLS. Neutron logs indicate that this 3-m (10-ft) thick areally extensive unit also may perch or retain water (Holzemer and Krenz, 1988). Neutron logs indicate that an areally extensive, 2-m (8-ft) thick, very fine-grained sedimentary unit, located at a depth of about 180 m (600 ft) BLS, may also be saturated with water. Neutron logs also indicate that the entire 12-m (40-ft) basalt sequence between the 170- and 180-m (550- and 600-ft) sedimentary interbeds in well 100 may also be saturated or partially saturated with water. Gamma logs show that the basalt flows underlying the 180-m (600-ft) sedimentary interbed have a high degree of sedimentary infilling and may contribute to the formation of perched water (Holzemer and Krenz, 1988).

3.3 Water Quality

3.3.1 Groundwater Quality

This section outlines the present quality of groundwater beneath the ANL-W facility. This information is based on monthly and annual water sample analysis currently conducted at ANL-W. Characterization activities at ANL-W are just getting under way. For this reason, no conclusions can be drawn as to the effect of ANL-W operations on the groundwater in relation to past releases. As remediation characterization activities are completed, this section will be revised to reflect new information and understandings gained from these activities.

Water from the industrial waste pond and shallow perched zone can be differentiated from water derived from the SRPA in the ANL-W area. Pond water and shallow perched water are a mixed cationic (calcium-sodium sulphate) type, whereas groundwater from the SRPA is characterized as a single cationic, calcium bicarbonate type (Northern, 1988). The similarity in cation percentages between the pond water and the perched water samples is consistent with derivation of the shallow perched water from downward seepage of pond water.

Historical background water quality data from the SRPA are presented in Table 3-4. The groundwater sample that was analyzed to produce these data was collected from well EBR-II no.1 in October 1958. The 1958 sampling event was conducted prior to large-scale operations in this area. In their presentation of the data, Robertson et al. (1974) pointed out that the pH, alkalinity, and dissolved iron data are suspect. However, these data provide reasonable background information for evaluating the effects of later INEL or ANL-W operations.

Background groundwater samples for the ANL-W area were analyzed for organic and inorganic parameters from 40 CFR 264, Appendix IX, in 1988 and 1989 (Chen-Northern, Inc., 1989). The groundwater samples were collected from three wells at or near ANL-W (EBR-II no.1, EBR-II no. 2, and Arbor Test Well).

Organic compounds were detected in the groundwater background samples; however, these organics were considered to be contaminants introduced during field collection or laboratory analysis. Inorganic parameter analysis of groundwater yielded trace concentrations of As, Ba, Cu, Se, Tl, V, and Zn. The concentrations were within expected values for natural groundwater (Table 3-5).

The two ANL-W production wells (EBR-II no.1 and EBR-II no.2) are analyzed annually for primary pollutants, regulated volatile organic compounds (VOCs), unregulated VOCs, and radionuclides. These annual samples are collected in order to satisfy state and Federal drinking water monitoring requirements. The policy and procedures for this sampling are found in Section IX, Chapter 23 of the ANL-W ESH Manual. On at least one occasion, MCLs for some organic contaminants were exceeded in a sample from EBR-II no. 2.

Water samples from the production wells are collected for radiochemical analysis on a rotating monthly basis such that water from each well is sampled and analyzed six times annually. Samples are sent to the DOE-ID Radiological and Environmental Sciences Laboratory (RESL) for analysis. The policy and procedures for this sampling are found in Section IX, Chapter 21 of the ANL-W ESH Manual. Occasional gross beta values slightly above detection limits have been observed. Gross alpha and tritium activities have been consistently below detection limits (Holzemer, 1986).

A monitoring well has recently been completed to the SRPA downgradient of the EBR-II leach pit. Analytical results from groundwater samples collected from this well are listed in Table 3-6.

3.3.2 Perched Water Quality

Currently, there is only limited information on perched water quality. Sampling was initially done during characterization work on the IWP in 1986. These results are listed in Table 3-7. Since that time, no sampling of perched water has been conducted.

Table 3-4. Chemical analysis of a background groundwater sample from the ANL-W site collected on 10/3/58 (Robertson et al., 1974).

Characteristic	Concentration in mg/L, unless noted
Temperature	54 (°F)
Specific conductance	293 (μmhos at 25° C)
pH	7.7
Total dissolved solids	192
Calcium	32
Magnesium	9.7
Sodium	14
Potassium	3.0
Bicarbonate	149
Carbonate	0
Sulfate	13
Chloride	12
Nitrate	1.9
Fluoride	0.7
Silica	33
Dissolved iron	0.25
Total hardness (as CaCO3)	0

Table 3-5. Chemical analysis of background water quality at ANL-W (Chen Northern. 1989b).

	PW-1[a,h]	PW-2[b,h]	PW-4[c,h]	PW-2D[d,i]	PW-5[e,i]	ATW[f,h]	ATW-E
Methylene Chloride	11 B[j]	6 B	34 B	7 J[k]B	21 B	ND[l]	ND
Acetone	ND	ND	110 B	3 JB	4 JB	ND	ND
Di-n-butylphthalate	3 JB	ND	ND	ND	ND	ND	ND
bis(2-ethylhexyl)phthalate	ND	ND	ND	3 J	ND	ND	8 JB
Chloroform	ND	ND	8	ND	ND	ND	ND
Trichlorofluoromethane	ND	ND	5	ND	ND	ND	ND
2,6-bis(1,1 dimethyl)Phenol	ND	ND	ND	8	ND	ND	ND
N-Nitorsodiphylamine	ND	ND	ND	8 JB	ND		ND
Di-n-octylphthalate	ND	ND	ND	ND	ND		1 J
Antimony	< 5.0	< 5.0		<30.0		<30.0	
Arsenic	< 3.5	< 3.5		< 2.0		2.4	
Barium	37.0	37.0		33.0		34.0	
Beryllium	< 5.0	< 5.0		< 1.0		< 3.0	
Cadmium	< 5.0	< 5.0		< 5.0		< 5.0	
Chromium	< 10.0	< 10.0		< 10.0		< 10.0	
Cobalt	< 50.0	< 50.0		< 20.0		< 23.0	
Copper	< 20.0	< 20.0		< 10.0		20.0	
Lead	< 2.1	< 2.1		< 3.0		< 5.0	
Mercury	< 0.2	< 0.2		< 0.2		< 0.2	
Nickel	< 24.0	< 24.0		< 20.0		< 19.0	
Selenium	< 2.5	< 2.5		< 3.0		2.4	
Silver	< 2.5	< 2.5		< 5.0		< 2.0	
Thallium	< 3. 0	< 3.0		< 3.0		2.5	
Vanadium	< 20.0	< 20.0		< 10.0		13.0	
Zinc	< 20.0	< 20.0		14.0		437	
Tin	< 114	< 114		< 20.0		< 114	
Phenol	3	< 5		< 5		< 5	

[a] Production Well EBR-II no. 1.
[b] Production Well EBR-II no. 2.
[c] Trip Blank.
[d] Duplicate from well EBR-II no. 2 .
[e] Trip Blank.
[f] Arbor Test Well.
[g] Trip blank.
[h] Analyzed by Envirodyne Engineers, Inc.
[i] Analyzed by International Technology Corporation (IT).
[j] B - value is above instrument detection limit but below contract required detection limit (CRDL).
[k] J - value is an estimated concentration.
[l] ND - Constituent was not detected (less than CRDL and insrument detection limits)

Table 3-6. Water analysis from EBR-II leach pit monitoring well (MW-11).

LOCATION	CONCENTRATION	UNITS
VOLATILE ORGANIC COMPOUNDS		
Unknown	3 J	μg/L
SEMIVOLATILE ORGANIC COMPOUNDS		
Unknown	11 J	μg/L
Di-n-Butylphthalate	1 J	μg/L
TOTAL DIOXIN/FURAN		
OCDD	1.9	μg/L
TOTAL METALS		
Aluminum	26.00	μg/L
Antimony	ND (50.00)	μg/L
Arsenic	ND (10.00)	μg/L
Barium	43.00	μg/L
Beryllium	ND (1.00)	μg/L
Calcium	35,734.00	μg/L
Cadmium	ND (10.00)	μg/L
Chromium	ND (10.00)	μg/L
Cobalt	ND (10.00)	μg/L
Copper	25.00 B	μg/L
Cyanide	10.00 UJ	μg/L
Iron	156.00	μg/L
Lead	10.00 UJ	μg/L
Magnesium	11,787.00	μg/L
Manganese	ND (30.00)	μg/L
Mercury	0.2	μg/L
Nickel	30.00 UJ	μg/L
Potassium	1,945.00	μg/L
pH	8.09	S.U.

Table 3-6. Water analysis from EBR-II leach pit monitoring well (MW-11), continued.

LOCATION	CONCENTRATION	UNITS
Selenium	ND (5.00)	μg/L
Silver	ND (10.00)	μg/L
Sodium	9,395.00	μg/L
Sulfate	ND (1.00)	mg/L
Tin	ND (50.00)	μg/L
Thallium	16.00 UJ	μg/L
Vanadium	ND (10.00)	μg/L
Zinc	26.00 B	μg/L
RADIOCHEMISTRY		
Americium-241	ND (0.1)	pCi/L
Antimony-125	ND (10)	pCi/L
Cerium-144	ND (18)	pCi/L
Cesium-134	ND (8)	pCi/L
Cesium-137	ND (10)	pCi/L
Cobalt-58	ND (15)	pCi/L
Cobalt-60	ND (9)	pCi/L
Iodine-129	ND (5)	pCi/L
Neptunium-237	0.4 ± 0.2	pCi/L
Plutonium-238	2.1 ± 1.4	pCi/L
Plutonium-239	ND (0.6)	pCi/L
Ruthenium-103	ND (15)	pCi/L
Ruthenium-106	ND (21)	pCi/L
Strontium-90	ND (0.5)	pCi/L
Tritium	578 ± 770 J	pCi/L
Uranium-234	11.3 ± 8.3	pCi/L
Uranium-235	ND (0.6)	pCi/L
Uranium-238	11.3 ± 8.3	pCi/L
Yttrium-90	ND (0.5)	pCi/L

ND - Compound was analyzed for but not detected, number in parenthesis is the sample quantitation limit.
J - Indicates reported value is an estimate.
UJ - Indicates that compound was analyzed for but not detected, the reported value is an estimate of the sample quantitation limit.
B - Indicates that compound was detected above the instrument detection limit but below the contract required detection limit.

Table 3-7. Perched water quality results in 1986.

PARAMETER	CONCENTRATION ($\mu g/L$)	MAXIMUM WATER QUALITY LEVEL
Aluminum	ND (125)	---
Antimony	ND (28)	146
Arsenic	10.1	50
Barium	83	1000
Beryllium	ND (5)	---
Cadmium	ND (5)	10
Calcium	98,600	---
Chromium	ND (10)	50
Cobalt	ND (20)	---
Copper	ND (20)	1000
Iron	75	300
LEad	ND (2.1)	50
Magnesium	30,400	---
Manganese	210	50
Mercury	ND (20)	2
Nickel	ND (24)	13
Potassium	15,000	---
Selenium	ND (2)	10
Silver	ND (2)	50
Sodium	74,300	---
Thallium	ND (2.2)	13
Tin	----	---
Vanadium	ND (20)	---
Zinc	ND (20)	5000
Cyanide	ND (5)	200
Sulfide	ND (1000)	---
Sulfate	----	250,000
Total Organic Carbon	5,100	---
Total Organic Halogens	17	---

ND - Compound was analyzed for but not detected, number in parenthesis is the sample quantitation limit.

3.4 Groundwater Monitoring Program

The groundwater monitoring program for ANL-W is presented in this section. This program addresses the groundwater monitoring requirements of DOE Order 5400.1, General Environmental Protection Program, and other pertinent DOE orders (see Section 1.5.5). This Plan was also written such that the monitoring data obtained may be used to support the INEL FFA/CO program. No facilities at ANL-W requiring RCRA groundwater monitoring have been identified. Because of the depth to groundwater and the uncertain influences of fracture-controlled vertical flow in the vadose zone basalts, ANL-W will be monitored as an aggregate area.

The groundwater monitoring program will include routine measurement of radiological and chemical characteristics, water temperatures, and water levels. The water quality measurements are designed to detect the presence of hazardous and radioactive contaminants in the SRPA at an established line of detection downgradient from ANL-W. Measurements will be made at both downgradient and background (upgradient) locations. The monitoring program contains the following elements:

- The chemical and radiological parameters that will be used to indicate the presence of groundwater contamination

- The monitoring well network design (number and locations of wells, and general well construction requirements) for downgradient and background wells

- The frequency of groundwater monitoring

- The sampling and analysis procedures to be used.

The statistical procedures that will be used to analyze the monitoring data are common to all operational areas and are presented in Section 14. The groundwater contamination response procedures that will be followed if contamination is detected are summarized in Section 13.

3.4.1 Groundwater Indicator Parameters

General indicator parameters that will be monitored at all INEL areas were presented in Section 1.5.3.6. Area-specific indicator parameters were selected from the ANL-W contaminants of potential concern using the methodology described in Section 1.5.3.7.

3.4.1.1 Contaminants of Potential Concern. Analytical results are available from soil samples and sampling of monitoring wells completed in the SRPA near ANL-W. These data were used in the identification of contaminants of potential concern. The nonradioactive and radioactive contaminants of potential concern are identified and discussed below. The list of contaminants of potential concern (Table 3-8) is based on disposal records, soil samples, and groundwater samples, and may be modified based on the results of sampling performed under this Plan. If a contaminant was detected more than once during monitoring well sampling, the maximum

Table 3-8. Summary of contaminants of potential concern for ANL-W.

Parameters	Maximum concentration detected	Water quality standard[a]	Risk-based concentrations THQ=1	Risk-based concentrations TCR=1E-05
INORGANIC	mg/L	mg/L	mg/L	mg/L
Barium	0.043	2		—
Chromium	0.003	0.1	0.2[c]	—
Copper	0.025	1[d]	1	—
Fluoride	0.67	4.0	6	—
Lead	—	0.015	—	—
Mercury	0.0002	0.002	0.01	—
Nitrate as N	1.5	10	160	—
Selenium	0.0024	0.05	0.2	—
Silver	—	0.100	0.2	—
Thallium	0.0025	0.002[b]	0.003	—
Vanadium	0.013	—	0.3	—
Zinc	0.437	5[d]	10	—
ORGANIC	µg/L	µg/L	µg/L	µg/L
Chlorobenzene	10.8	100	50	—
Chloroform	9.5	100	400	4
1,1-Dichloroethane	9.7	—	1,000	—
1,2-Dichloroethane	11.0	5	—	3
1,1-Dichloroethylene	9.4	7	300	0.8
1,2-trans-Dichloroethylene	9.6	100	700	—
Methylene Chloride	9.7	5[b]	2,000	70
Phenol	3	7[f]	20,000	—

Table 3-8. (continued).

Parameters	Maximum concentration detected	Water quality standard[a]	Risk-based concentrations THQ=1	TCR=1E-05
	µg/L	µg/L	µg/L	µg/L
Tetrachloroethylene	11.6	5	400	20
1,1,1-Trichloroethane	10.2	200	2,000	—
1,1,2-Trichloroethane	9.4	5[b]	100	4
Trichloroethylene	11.7	5	200	30
RADIOACTIVE	pCi/L	pCi/L	pCi/L	pCi/L
Hydrogen-3	—[e]	61,000[b]	—	30,000
Cobalt-60	—	220[b]	—	110
Strontium-90	—	42[b]	—	44
Cesium-137	—	120[b]	—	57
Uranium-238	—[e]	30[b]	—	57
Neptunium-237	—[e]	7.2[b]	—	7.3
Americium-241	—	6.4[b]	—	6.7

a. Primary Maximum Contaminant Level (MCL) unless otherwise noted. Sources are 40 CFR 141 and 143.
b. Proposed MCL.
c. Assumes all chromium to be Cr VI.
d. Secondary MCL.
e. Uncertainty in measurement was approximately equal to or greater than the measured value; these parameters are considcred undetected.
f. Secondary MCL, State of Idaho.

THQ = Target Hazard Quotient
TCR = Target Cancer Risk

NOTE: Highlighted cells indicate groundwater concentrations that exceed a risk-based concentration or primary MCL. Source of risk-based concentrations EPA "cheat sheets" or standard EPA calculations (Appendix C).

concentration detected is presented and compared to the corresponding risk-based concentration and water quality standard.

Nonradioactive Contaminants. Although silver has not been detected in the groundwater, it is a major waste constituent associated with photographic processes at ANL-W, and is considered a contaminant of potential concern. Lead is also suspected to have been used at ANL-W, and although it has not been detected in the groundwater, it is considered a contaminant of potential concern.

Radioactive Contaminants. The presence of radionuclides beneath ANL-W has not been conclusively determined. Currently, there are not enough data to estimate the quantity of radionuclides that may be in the SRPA near ANL-W due to contamination from ANL-W. However, soil samples and disposal records indicate that several types of radionuclides have been disposed of in the EBR-II leach pit. Of these, only radionuclides with half-lives greater than two years are considered to be persistent enough to potentially represent a groundwater hazard. These radioactive contaminants of potential concern are tritium, Co-60, Sr-90, Cs-137, U-238, Np-237, and Am-241.

3.4.1.2 Area-Specific Indicator Parameters. The suite of indicator parameters specific to ANL-W and the rationale for their selection are presented in Table 3-9. Although no facilities requiring RCRA groundwater monitoring have been identified at ANL-W, a number of the parameters required in 40 CFR 265.92(b) for interim status RCRA monitoring will be monitored because of their general usefulness as indicators. The area-specific parameters were selected from the list of contaminants of potential concern presented in Table 3-8 and reflect the requirements of DOE Order 5400.1 and potential CERCLA needs. This list of indicators may be modified based on the results of the chemical analyses performed under this Plan. In addition, the adequacy of the indicators will be reviewed for relevancy to any new process wastewater streams that may be initiated in the future.

All parameters that have been considered potential health risks are included as indicators. Silver and lead were not included. Although they are contaminants of concern, they were not detected in groundwater and are relatively immobile. Chromium and zinc were included because they were process waste constituents that were detected in the soil and have a higher mobility. Organic indicator parameters include chlorinated hydrocarbons such as tetrachloroethylene and trichloroethylene, and their degradation products.

Several radionuclides that are present in the ANL-W process waste stream but have not been detected in groundwater were not included as indicators because of their low mobility or because of the availability of a surrogate parameter. The more significant among these are the radioactive isotopes of cobalt, strontium, cesium, uranium, neptunium, and americium. Gross alpha and gross beta analyses will be used as surrogates to screen for the presence of radioactive contamination. If such a screening indicates significant levels of radioactive contamination, additional analyses will be performed to determine which radionuclide species are present.

Table 3-9. Area-specific indicator parameters for ANL-W.

Parameter	Rationale for Selection
Inorganic Indicators	
Thallium	Detected in groundwater at elevated concentrations and is above proposed MCL
Chromium	Process waste constituent, detected soil contaminant
Zinc	Process waste constituent, detected soil contaminant
Organic Indicators	
1,2-Dichloroethane	Detected in aquifer above MCL; is a probable human carcinogen
1,1-Dichloroethylene	Detected in aquifer above MCL and above risk-based concentrations; is a possible human carcinogen
Methylene Chloride	Detected in aquifer above proposed MCL; is a possible human carcinogen and is a systemic toxin
Tetrachloroethylene	Detected in aquifer above MCL; is a probable human carcinogen and is a systemic toxin
1,1,2-Trichloroethane	Detected in aquifer above proposed MCL; is a probable human carcinogen and is a systemic toxin
Trichloroethylene	Detected in aquifer above MCL; is a probable human carcinogen
Radiogenic Indicators	
^3H	Present in elevated concentrations in process waste; is highly mobile
Gross Beta	Beta-emitters detected in soils and are known to have been disposed of in leach pit
Gross Alpha	Alpha-emitters detected in soils and are known to have been disposed of in leach pit

Field sampling procedures, laboratory analytical procedures, and data quality objectives are presented in the Sampling and Analysis Plan (SAP). That plan is incorporated as Appendix D to this groundwater monitoring plan, and is further discussed in Section 3.4.3.

3.4.2 Groundwater Monitoring System

This section describes the elements of the groundwater monitoring system and the rationale used to develop that system. It includes a discussion of the groundwater monitoring strategy, the network of monitoring wells, and general well construction details.

3.4.2.1 Groundwater Monitoring Strategy. Because of similarities in hydrogeologic conditions and operational practices, the groundwater monitoring strategy for ANL-W is similar to those developed for other INEL operating areas. The conditions and practices at the INEL are different from those commonly encountered at facilities in less arid areas and will require special consideration in design.

The equipotential map presented in Figure 3-11 was used to derive a range of groundwater flow directions to be used in the modeling. The water table will be reevaluated after installation of each well. If the flow direction is not within the predicted range, well locations will be modified accordingly.

In preparing a monitoring design for ANL-W, the following hydrogeologic conditions must be addressed:

- Currently, groundwater flow direction is poorly defined

- The top of the SRPA near ANL-W is beneath an approximately 190-m (630-ft) thick vadose zone consisting of basalts, sedimentary interbeds, and alluvium

- Groundwater movement through the vadose zone basalts may be fracture-controlled and difficult to predict in direction and rate

- Perched water zones may develop beneath larger natural and artificial surface discharge points and can cause infiltrating contaminants to spread laterally beneath their points of origin over distances and in directions that are difficult to predict

- Perched water zones are ephemeral, may last only a few years longer than their sources, and may consist primarily of water released from plant operations

- Groundwater in the SRPA near ANL-W moves laterally in the basalts at an average rate of about 3 m/d (10 ft/d), near the center of the range of flow rates reported in Section 3.2.4.

- Groundwater movement in the SRPA near ANL-W is largely fracture-controlled, and contaminant migration may occur in directions and at rates that would not be anticipated under normal porous-medium flow

- Local groundwater flow directions are not expected to change appreciably with time because ANL-W is far from the principal areas of groundwater recharge.

In addition, the following source conditions must be addressed in the monitoring design:

- Contaminants would enter the SRPA from ANL-W by migrating from the ground surface in a liquid and possibly in vapor phase, through the unsaturated zone and any intermediate perched zones that might exist, providing an initial contaminant distribution at the upper surface of the aquifer

- Perched water zones are expected to be ephemeral, are not used for any purpose, and any contaminants that may enter such zones pose no risk to human health or to the environment except to the extent that such contaminants may ultimately enter the SRPA

- The facilities of primary interest that handle or have handled large volumes of potentially hazardous or radioactive solutions or wastewaters are not equipped with secondary containment

- No liquid wastes were directly injected into the SRPA at ANL-W

- No large quantities of pure product organics that could act as dense nonaqueous-phase liquids (DNAPLs) are reported to have been disposed of at ANL-W, and based on the low concentrations of organics observed in existing wells, it does not appear that DNAPLs are present in the aquifer

- Potential sources of contamination have been identified at many locations within and in the vicinity of ANL-W

- Additional potential sources may be identified in the future.

In view of the hydrogeologic and source conditions described above, the following strategy has been adopted in designing a groundwater monitoring network for ANL-W:

- Primary reliance will be placed on shallow aquifer monitoring wells because no mechanism (such as a deep injection well) has existed at ANL-W that could have directly introduced contaminants into the deeper parts of the aquifer, and no large sources of pure product organics that could act as potential DNAPLs are reported to have been disposed of at ANL-W

- Groundwater monitoring wells will be placed at sufficient horizontal distances from the nearest potential sources of contamination to minimize the risk that contaminants may move laterally within a perched zone or within basalt fractures and enter the aquifer at a point downgradient of the well, thereby escaping detection

- Existing groundwater monitoring wells will be incorporated into the network to the extent possible

- The groundwater monitoring network will be designed to provide effective monitoring under a range of anticipated flow directions

- Data from the initial monitoring wells installed under this program will be used to help confirm groundwater flow directions and design a final monitoring well network for ANL-W.

3.4.2.2 Groundwater Monitoring Network. A groundwater monitoring network that implements the aforementioned strategy is developed in this section. A network comprised of shallow wells open at the top of the aquifer has been designed to monitor for contaminants migrating from the ground surface through the vadose zone. The wells in this network will be sampled for potential low-density nonaqueous phase liquids (LNAPLs) floating on the surface of the water, as well as for contaminants dissolved in the groundwater.

Wells designed to monitor the bottom of the aquifer have not been included because the concentrations of organics in the available groundwater sampling results are too low to suggest the presence of DNAPLs. As discussed in Section 3.3.1, organic contaminant levels are consistently low in ANL-W production wells. No organic chemicals were detected in a water sample collected on January 3, 1991 from production well EBR-II no. 1. Although some of the organic contaminant concentrations detected in a sample from well EBR-II no. 2 exceeded their MCLs (see Section 3.4.1), the concentrations were several orders of magnitude below their solubility limits and therefore do not suggest the presence of DNAPLs. The production wells draw water from the upper approximately 34 m (110 ft) of the aquifer, and therefore penetrate the upper and middle parts of the aquifer. A RCRA-compliant monitoring well, the EBR-II leach pit well, has recently been installed in ANL-W area. It is screened over a 11-m (35-ft) interval, and samples the upper part of the aquifer. Results of chemical analysis performed on a water sample collected from this well on October 9, 1991 indicate only one unqualified (probable source not verified) detection of an organic contaminant at a concentration that was again very low. In general, organic contaminants were found to be sporadically detected in both shallow and deep wells, but their concentrations were uniformly low, and unqualified detects were so few that no pattern for organic contamination could be determined.

Despite the lack of evidence for DNAPLs, several organic parameters have been retained and can serve as indicators for the presence of pure products that could act as DNAPLs. If organic contaminants are found in sufficient concentrations to indicate the possible presence of DNAPLs, additional sampling will be conducted for confirmation, and the monitoring network will be modified appropriately.

The shallow well monitoring network planned for ANL-W is presented in the following paragraphs, accompanied by a quantitative analysis of its expected performance. Implementation of the network and monitoring activities will be staged as described in Section 3.6.

3.4.2.2.1 Shallow Aquifer Monitoring Well Network—Shallow aquifer monitoring wells are designed to monitor the top of the aquifer for contaminants that may migrate through the vadose zone from surface sources. Because of the uncertainties introduced by the thick vadose zone and the fractured basalts, the network is designed to monitor ANL-W as an aggregate area, rather than as separate individual sources. In view of these uncertainties, the monitoring wells are generally located from about 300 to 600 m (1,000 to 2,000 ft) from the surface locations of the sources to minimize the risk that contaminants may move laterally within interflow zones and enter the aquifer at a point downgradient of the line of detection, thereby escaping detection. Wells located closer to the sources could provide earlier detection, but may completely miss a release. In balancing these conflicting needs, and in view of the geographical isolation of the site from the public, early detection was considered less important than the possibility of not detecting a release. Although this design is not in strict conformance with draft DOE 5400.AA guidance that monitoring wells should be within 100 m (approximately 330 ft) of the downgradient limit of a source (DOE, 1989a), it is believed to best serve the overall objectives of a detection monitoring network.

Three shallow downgradient monitoring wells, temporarily designated as ANL-MW-1, ANL-MW-2, and ANL-MW-3, have been identified for the network. These wells are located along a line of detection that forms an arc about the western and southwestern sides of the operational area, as shown in Figure 3-12. The selected monitoring locations will provide detection under a southwesterly groundwater flow direction. None of the planned shallow monitoring wells is an existing well. The approximate coordinates and depths of these wells are shown in Table 3-10.

The planned schedule for installing these wells is presented in Section 3.6. The first monitoring wells to be installed should be selected on the basis of their potential to provide additional data to assist in understanding the configuration of the water table in the ANL-W area. A staged installation would give first priority to installing well ANL-MW-3, followed by ANL-MW-1 and ANL-MW-2. Well ANL-MW-4 would be installed last.

3.4.2.2.2 Analytical Evaluation of Shallow Network Design—The Monitoring Efficiency Model (MEMO) was used to provide analytical evaluations of the shallow monitoring well network during the design process. General descriptions of this model and of those aspects of its application that are similar for all INEL operational areas area presented in Section 1.5.3.4. A technical description of MEMO and a general discussion of input parameters for the INEL are presented in Appendix B. Summaries of the basis for selecting those parameters specific to ANL-W are provided in the following paragraphs.

Geometry of ANL-W—MEMO was used to evaluate the efficiency of the monitoring network for all potential source areas at ANL-W. For the purposes of this analysis, the boundary for ANL-W aggregate area was considered to be the outer security fence of ANL-W. The ANL-W facility also includes two outlying areas, the first area consisting of three open burn pits, and the second area being the Radioactive Scrap and Waste Facility. Although there are no designated RCRA facilities at ANL-W requiring groundwater monitoring, all potential source areas must be monitored under DOE Order 5400.1. In addition to being responsive to DOE Order 5400.1, the facility boundary is expected to include all potential CERCLA sites at ANL-W.

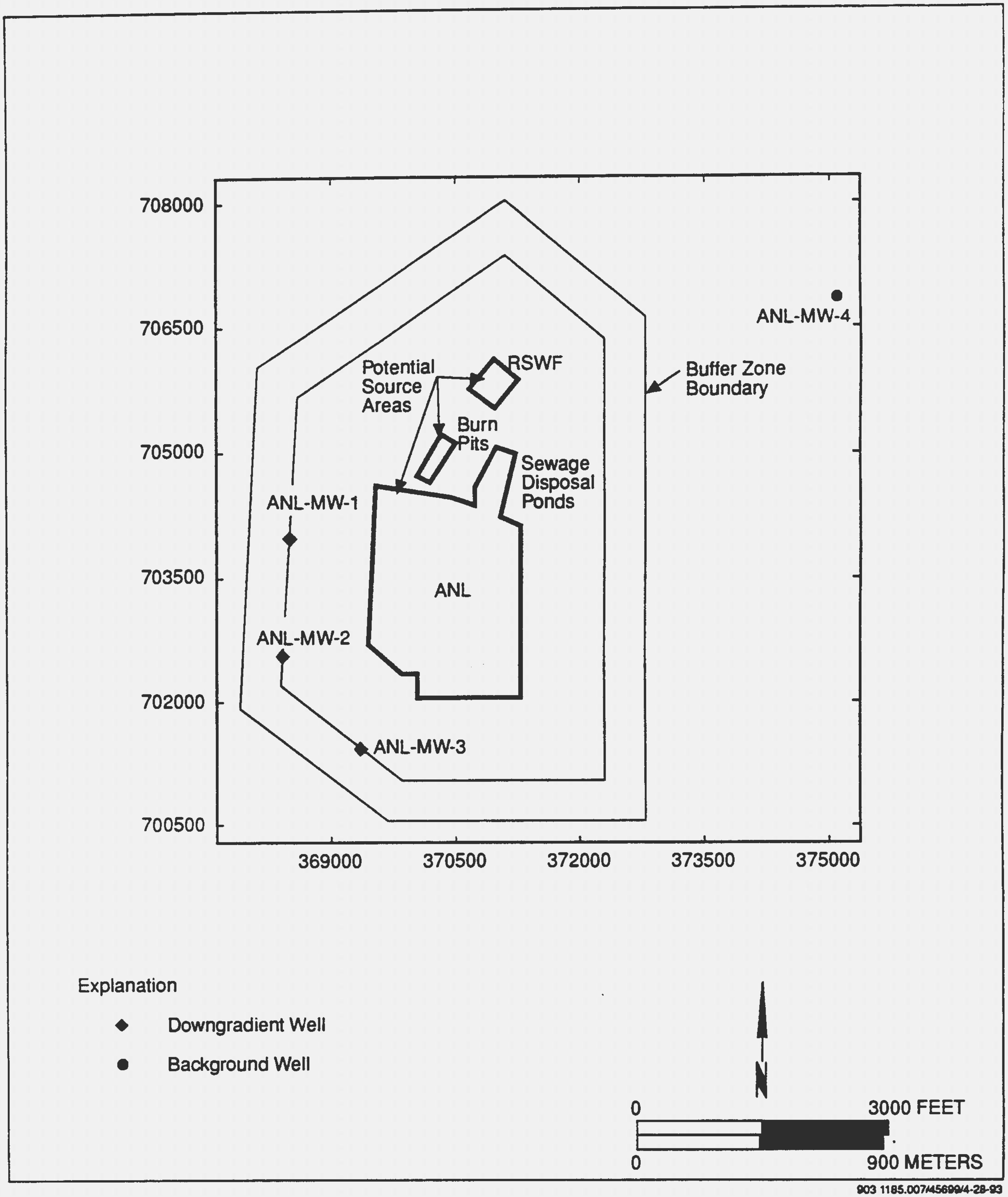


Figure 3-12. Groundwater monitoring network for ANL-W.

Table 3-10. Groundwater monitoring well locations and depths for ANL-W.

Well number	Network	North coordinate	East coordinate	Total depth m (ft)
ANL-MW-1	Downgradient	703972	368502	200 (655)
ANL-MW-2	Downgradient	702560	368420	200 (655)
ANL-MW-3	Downgradient	701455	369351	200 (655)
ANL-MW-4	Background	706850	375100	200 (655)

Note: These wells are planned and have not been installed; all related values are estimated.

Groundwater Flow Velocity—The average linear groundwater flow velocity in the vicinity of ANL-W has been estimated to be about 3 m/d (10 ft/d) as discussed in Section 3.2.4. Sensitivity studies (see Appendix B) have shown the monitoring efficiency to be relatively insensitive to groundwater flow velocity.

Groundwater Flow Direction—The groundwater flow directions taken from the equipotential map presented in Section 3.2.4 are measured in a counterclockwise direction with zero degrees oriented due east. The network was evaluated for flow directions of 205 and 225 degrees to the southwest. These are consistent with the regional flow. Groundwater flow directions will be redetermined annually (see Section 3.4.4), and the continuing adequacy of the network will be evaluated. These evaluations will include addressing the effects of any errors found in wellhead elevations based on the results of more recent land survey data.

Source Concentration and Contaminant Detection Limit—Upon reviewing the process information and groundwater quality data, nitrate (a general indicator parameter) and tritium were selected for evaluation as key indicators. Nitrate is mobile and present in readily detectable concentrations in ANL-W wells (see Section 3.3.1). Although tritium was not detected in the groundwater, it is highly mobile and a known constituent of the process waste stream. Both parameters are also recognized to be potentially hazardous and have assigned drinking water quality standards (e.g., MCLs). Organic compounds were detected too sporadically and their concentrations were too close to their detection limits to be considered as key indicators.

Using a detection limit for tritium of 500 pCi/L and for nitrate of 0.10 mg/L, the ratio C_D/C_o for these parameters is 0.025 and 0.01, respectively. A value of C_D/C_o equal to 0.02 was selected for the analysis.

Size of Contaminant Source—The size of the source was estimated from the 190 m (630 ft) depth to groundwater and from the sizes of the facilities that have handled or presently handle large volumes of potentially hazardous or radioactive wastewaters that are not equipped with adequate secondary containment (e.g., the industrial waste pond, the sanitary sewage lagoons, the EBR-II leach pit, and the cooling tower blowdown ditches). With the exception of a leach pit, which has a width of about 12 m (40 ft), the maximum dimensions of these facilities range from about 120 m (400 ft) to over 300 m (1,000 ft) for the length of the industrial waste pond ditches. A length of 90 m (300 ft) was used for these sources.

The lateral spreading that occurs with depth as contaminants migrate through the vadose zone was estimated to equal 60 m (200 ft) given the depth of approximately 190 m (630 ft) to the water table at ANL-W. The lateral spreading assumed at ANL-W is equivalent to an average spreading angle of about 10 degrees from the vertical. Taking into account both the dimensions of the source at the ground surface and the lateral spreading during vertical migration in the vadose zone, a total source width of 150 m (500 ft) was conservatively assumed for MEMO analyses.

MEMO Data Base Summary—The standard data base used in performing the MEMO monitoring network design studies is summarized in the following tabulation:

Parameter	Value
Source length	152 m (500 ft)
Longitudinal dispersivity	18 m (60 ft)
Transverse dispersivity	9 m (30 ft)
Source term C_D/C_o	0.02
Groundwater velocity	3 m/d (10 ft/d)
Flow direction (Alternative 1)	220 degrees
Flow direction (Alternative 2)	170 to 210 degrees
Diffusion coefficient	Zero
Decay coefficient	Zero
Contaminant retardation	Zero

Modeling Results—The MEMO model included in Version 1.1 of Golder Associates' Monitoring Analysis Package (MAP) was used in these studies. Results are presented for two sets of flow directions. A target monitoring efficiency of 95% or better was adopted for this analysis for both flow angles. The results of these analyses are presented in Figures 3-13 and 3-14. Figure 3-13 shows MEMO results for flow to the southwest (205 degrees). Figure 3-14 shows results for flow to the southwest (225 degrees). The computed monitoring efficiency for both directions was above 95%.

These results indicate the planned monitoring networks would be expected to perform well under the range of groundwater flow conditions expected at ANL-W. As discussed previously, the network will be evaluated based upon water level data collected from the first wells installed. Other alternative networks may be proposed if the additional water level data indicate unforeseen

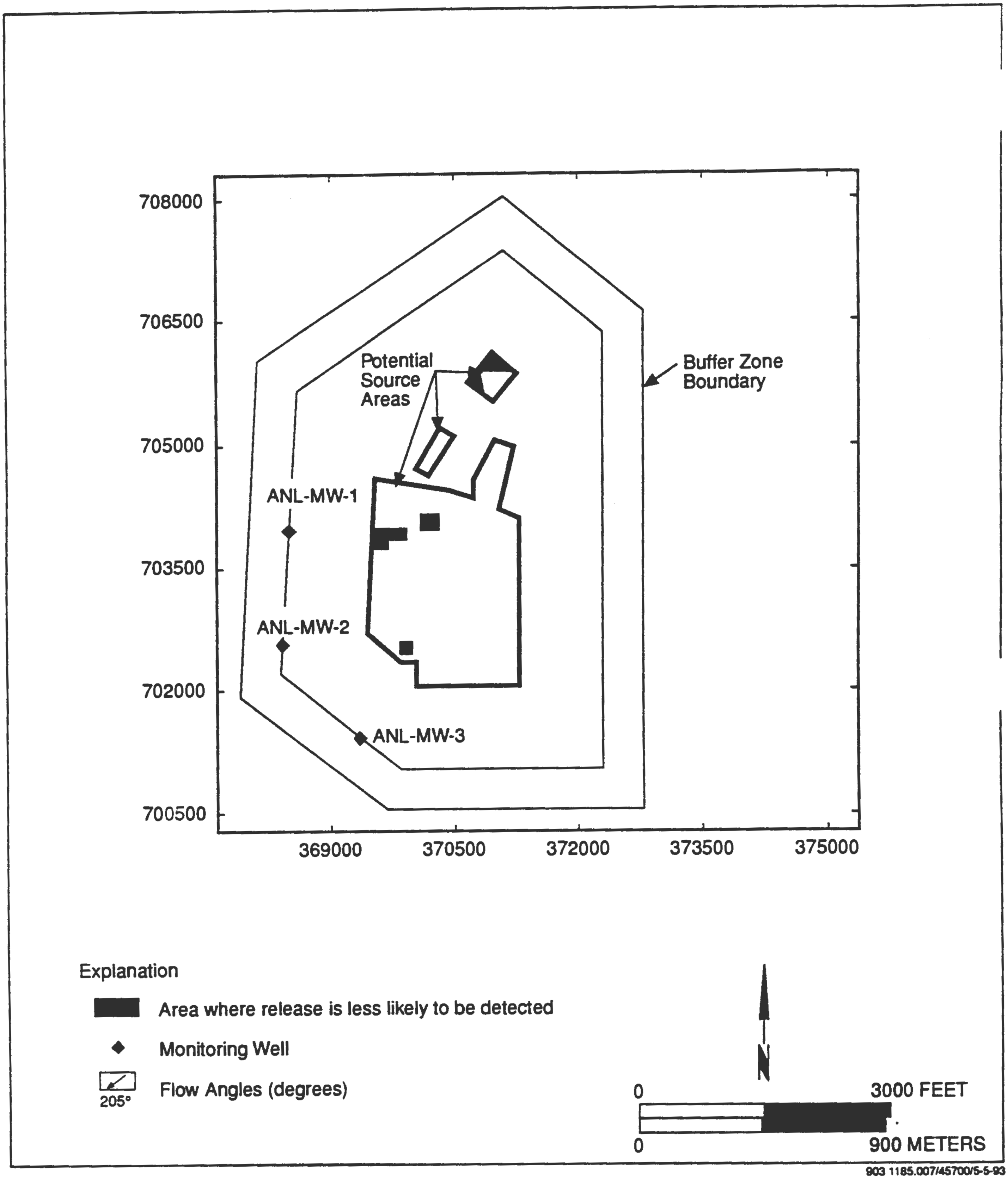


Figure 3-13. Monitoring efficiency for flow to the southeast (205°) at ANL-W.

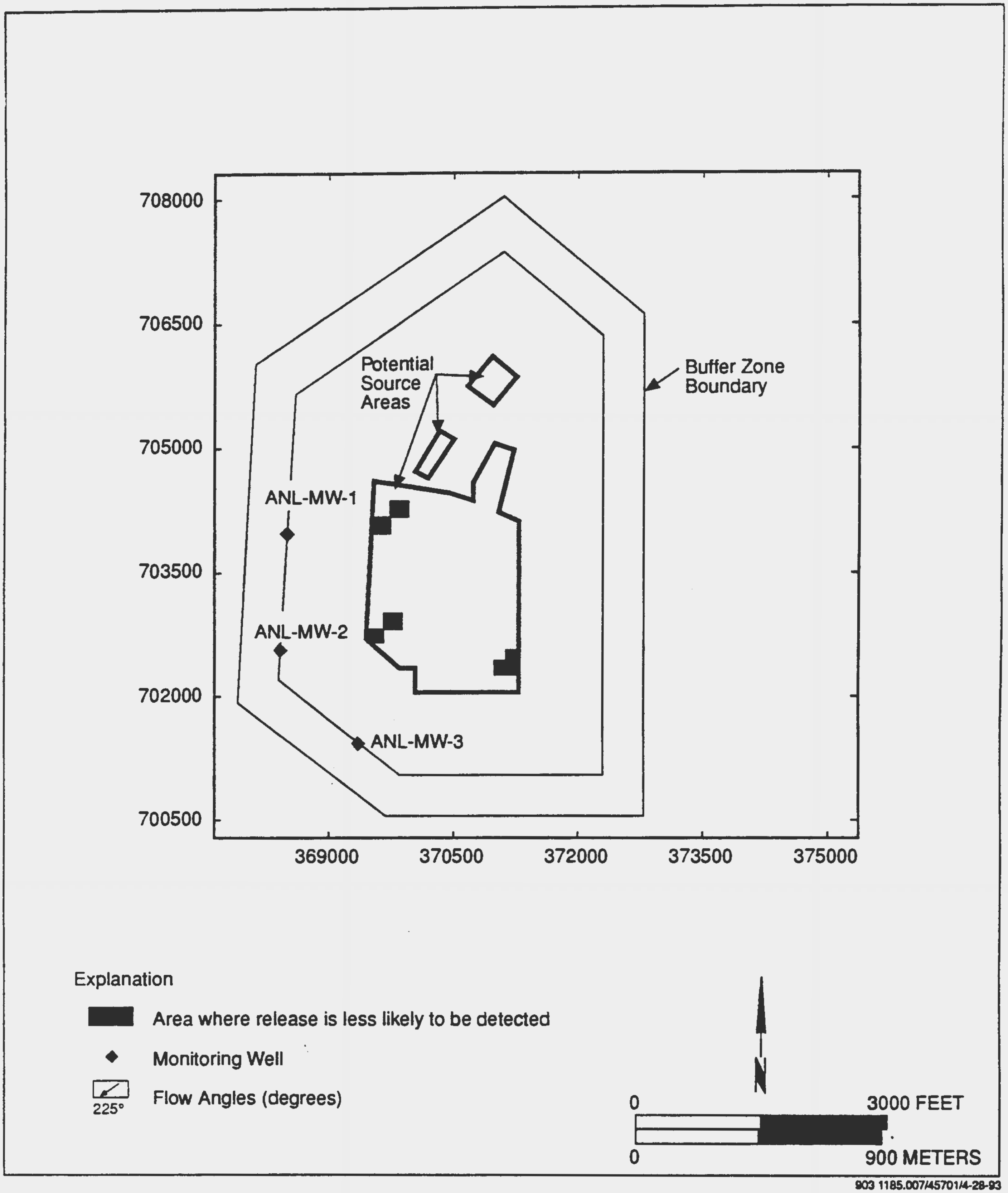


Figure 3-14. Monitoring efficiency for flow to the southwest (225°) at ANL-W.

groundwater flow conditions. The design may also be modified if needed to accommodate any new facilities located at ANL-W that require groundwater monitoring.

3.4.2.3 Background Monitoring. Background (upgradient) groundwater monitoring is planned at well ANL-MW-4, located approximately 1220 m (4,000 ft) upgradient of ANL-W (see Figure 3-12). This new well will be constructed according to RCRA guidelines and completed to monitor the upper 7 m (25 ft) of the aquifer. No existing wells were found to be appropriately located to serve for collection of background data.

3.4.2.4 Monitoring Well Specifications. Specifications for the new shallow monitoring wells and background well (temporarily designated ANL-MW-1 through ANL-MW-4) are summarized on Table 3-11.

3.4.3 Groundwater Sampling and Analysis

This section provides information on the groundwater sampling and analysis procedures planned for ANL-W. As is noted below, much of the information for this section is incorporated by reference to the SAP (see Appendix D) and the EIPs referenced therein. This SAP presents both the field instructions and quality assurance requirements for the sampling and analysis activities.

3.4.3.1 Sample Collection, Preservation and Shipment. Groundwater samples will be collected, preserved, and shipped in accordance with the procedures specified in the SAP. Samples will be collected for the general indicator parameters discussed in Section 1.5.3.6. Samples will be collected for the specific indicator parameters at ANL-W listed in Table 3-9.

Static water level measurements, temperature measurements, and well purging will be performed in all monitoring network wells prior to collecting samples. In addition, static water level measurements will be taken during one sampling round per year in all remaining, available wells penetrating the SRPA within at least a 8-km (5-mi) radius of ANL-W. These data will be used to help obtain a more comprehensive understanding of groundwater flow rates and directions (see Section 3.4.4). Procedures for these activities are identified in the SAP.

During the first sampling round in each well, the samples will be analyzed for the full suite of organic, inorganic, and radionuclide parameters identified in the SAP. These data will be used to evaluate the completeness of the initial set of indicator parameters identified in Table 3-9. During subsequent sampling rounds, the samples will be analyzed for the indicator parameters identified for ANL-W. The background wells will be sampled for all indicator parameters associated with ANL-W downgradient areas.

3.4.3.2 Laboratory Analytical Procedures. Samples collected under this program will be analyzed for the identified ANL-W indicator parameters. Analytical procedures and data quality objectives for laboratory analysis of the groundwater samples are specified in the QAPjP. The laboratory performing sample analysis will use the analytical methods specified in the QAPjP and will follow internal, ANL-W-approved quality assurance/quality control procedures.

Table 3-11. Monitoring well specifications for ANL-W.

	Casing			Existing Screen			Proposed Screen		
Well Number	Interval m (ft)	Diameter cm (in.)	Material	Interval m (ft)	Length m (ft)	Material	Interval m (ft)	Length m (ft)	Material
ANL-MW-1	191 (625)	TBD	TBD	N/A	N/A	N/A	190-200 (625-655)	10 (30)	stainless steel
ANL-MW-2	191 (625)	TBD	TBD	N/A	N/A	N/A	190-200 (625-655)	10 (30)	stainless steel
ANL-MW-3	191 (625)	TBD	TBD	N/A	N/A	N/A	190-200 (625-655)	10 (30)	stainless steel
ANL-MW-4	191 (625)	TBD	TBD	N/A	N/A	N/A	190-200 (625-655)	10 (30)	stainless steel

N/A - Not applicable
TBD - To be determined

3.4.3.3 Chain-of-Custody Procedures. Chain-of-custody procedures will be followed to ensure the integrity of the samples and to trace their possession and handling from the time of collection through laboratory analysis and data reporting. Chain-of-custody procedures are addressed in the QAPjP.

3.4.3.4 Sampling Frequency. Schedules for network installation and start of sampling at ANL-W are presented in Section 3.6. All wells included in the first year of sampling will be sampled quarterly for all required parameters to obtain a statistical baseline. After the first year, all wells will be sampled semiannually for the duration of the active and postclosure care period of ANL-W, unless a problem is identified requiring more intensive sampling. In addition, sampling may be suspended if it is determined that no further risk to human health or the environment is present, or that continued sampling serves no further practical purpose. The quarterly data from the first year of sampling will be reviewed for evidence of seasonal fluctuations, and if such fluctuations are found, the semiannual sampling will be timed to approximately coincide with the annual high and low water levels. Periodic changes in the water level may be partially caused by ANL-W reactors, which are run in "campaigns" (on and off periodically). The effect of the reactor campaigns on ANL-W water levels will be evaluated as data are accumulated. During each sampling event, one sample will be taken from each monitoring well and will be analyzed as specified in Section 3.5.3.2. Statistical analysis of sampling results is discussed in Section 14. If a constituent concentration exceeds the statistical background concentration, the sampling frequency will be modified in accordance with the guidelines for contaminant detection/response provided in Section 13.

3.4.4 Determination of Groundwater Flow Rate and Direction

Groundwater flow rates and directions will be determined annually throughout the period of active groundwater monitoring at ANL-W. Average horizontal flow rates and directions will be determined from groundwater elevation contour maps constructed after each sampling event. If significant changes in the direction of groundwater flow are identified by this evaluation, the continued adequacy of the groundwater monitoring network will be reviewed. If the network is found to be no longer adequate to meet the objectives of this Plan, it will be modified to bring it into compliance.

The velocity of flow will be determined using Darcy's law, as described in Appendix C. Nominal values of the horizontal hydraulic conductivity (K) and effective porosity (n) are proposed in the following tabulation are based upon information provided in Section 3.2. The hydraulic gradient (i) is obtained from the groundwater elevation contour maps. Modifications of these values may be proposed as additional knowledge is gained about the groundwater flow system.

Parameter	Value
K	365 m/d (1,200 ft/d)
n	0.1

3.4.5 Compliance with Regulatory Requirements

As described more fully in Section 1.5.5, this groundwater monitoring program has been designed to comply with all applicable regulations and guidance consistent with the overall objective of achieving a high level of confidence in detecting contaminant releases downgradient of ANL-W. To meet this objective, hydrogeologic conditions at ANL-W required locating the monitoring wells at greater distances from the site than the preferred maximum of 100 m (about 330 ft) expressed in draft DOE guidance (DOE, 1989a). As explained in the discussions in Section 3.4.2, the requirement for greater distances arose because of the significant depths to groundwater, the potential influence of perched water zones, and the uncertain influence of fracture flow conduits in the basalt bedrock. These factors were addressed by locating the monitoring wells at distances of 300 to 600 m (1,000 to 2,000 ft) from the source areas. As previously stated, this design enhances confidence in the ability of the network to detect a release, but could also delay that detection. Based upon an average groundwater linear flow velocity of 3 m/d (10 ft/d), the increased distance from the source could result in a delay in detection of about three to six months. Considering the remoteness of the source areas from locations not controlled by the DOE, this delay in detection is not significant, and the approach taken to effect a workable design under the prevailing site conditions is considered appropriate.

An area-specific evaluation will be conducted in fiscal year (FY) 1993 to determine if any facilities require specific groundwater monitoring to meet specific regulatory requirements. If additional groundwater monitoring is required, this Plan will be amended accordingly.

3.5 Perched Zone Surveillance Monitoring Program

A thin perched water zone has occasionally been encountered beneath ANL-W to the west of the industrial waste pond during past exploratory drilling. Several of these boreholes have been completed as monitoring wells, but they are often found to be dry during periodic checks. The size of the perched zone appears to be dependent upon the volume and flow rate of wastewater sent to the pond. The perched zone, when present, does not appear to have a significant lateral extent and would not be expected to consistently provide sampleable quantities of water. Therefore, no perched water monitoring is planned.

3.6 Implementation Plan for ANL-W

A plan for implementing the Groundwater Monitoring Plan at ANL-W is presented in this section. The plan is proposed to be implemented in stages as outlined below. Although this plan was prepared based upon conservative assumptions, modifications may be required to address unexpected circumstances. This may include the addition of new monitoring wells or modifications to existing wells.

3.6.1 First Stage

The first stage of the Plan will be implemented in FY 1993. The following activities are planned for that year:

- Commence monitoring for all required baseline parameters in four downgradient and one upgradient groundwater monitoring wells

- Perform a fitness-for-use survey of all proposed groundwater monitoring wells

- Perform additional hydrogeological characterization.

3.6.2 Second Stage

The second stage of the plan will be implemented in FY 1994 and subsequent years. The following activities are planned:

- Continue monitoring for all required indicator parameters in four downgradient and one upgradient groundwater monitoring wells

- Perform necessary modifications to the existing wells to make them fit for use in the groundwater monitoring network if required

- Install new RCRA-compliant groundwater monitoring wells as required to complete the groundwater monitoring network (this activity is tentatively scheduled for FY 1996)

3.6.3 Discussion

During the first year of monitoring, all downgradient groundwater sampling will be conducted in existing wells. Because these wells (MW-11, EBR-II no. 1., and EBR-II no. 2) are not included in the final well network, no distinction will be made in this first year between the existing and planned well networks. These wells were selected such that monitoring coverage of ANL-W operations may begin as soon as possible, until funding for the new network wells is available.

During the subsequent years of monitoring, the final groundwater monitoring network will be decided upon and installed, and routine monitoring of the full suite of indicator parameters will commence.

The proposed implementation plan provides for the earliest startup of detection-level monitoring, as well as the earliest reasonable completion of the final groundwater monitoring network.

3.6.4 Fiscal Year Funding

FY 1993 funding for Stage 1 of this implementation plan is as follows:

Activity	Cost (in thousands of $)
Commence monitoring for all required baseline parameters in four downgradient and one upgradient groundwater monitoring wells.	232
Perform a fitness-for-use survey of all proposed groundwater monitoring wells.	Funded by EG&G Idaho
Perform additional hydrogeological characterization.	375 (C/O)
Determine final proposed groundwater monitoring network and Groundwater Monitoring Plan updates.	operating cost

Funding requirements for FY 1994 and beyond are dependent upon definition of the final well monitoring network, outcome of the fitness-for-use survey, and acceptability of this Plan by the regulators. Therefore, it is unreasonable to estimate cost requirements for the outyears at this time.

3.7 Area Data Collection and Reporting

Compliance groundwater monitoring at ANL-W will be managed by the ANL-W Environment and Waste Management (EWM) section. Groundwater sampling activities may be conducted by ANL-W EWM or delegated to either another INEL organization or a subcontractor organization. Regardless of which organization conducts the sampling, all sampling activities will be conducted in accordance with the applicable requirements of the "INEL Groundwater Monitoring Program Sampling and Analysis Plan" (SAP) (Appendix D) and the "Quality Assurance Project Plan for Groundwater Monitoring Activities at ANL-W". If sampling activities are delegated, overall program management responsibility will be retained by ANL-W EWM.

Samples may be analyzed by ANL-W, DOE RESL, or a subcontracted analytical laboratory. Regardless of which laboratory is selected, at a minimum all analytical laboratory service agreements shall meet the applicable analytical requirements contained in Sections 7 and 8.1 of the SAP. In addition to these requirements, all raw and summarized analytical data will be transmitted to ANL-W in electronic and hard-copy form in accordance with the general format and content requirements of Section 6.10, "Procedures for Evaluating Assessment Monitoring Data," contained in the RCRA Groundwater Monitoring Technical Enforcement Guidance Document (EPA, 1986). The TEGD format and content requirements will be maintained throughout the data management and reporting process.

At a minimum, all raw analytical data will be validated, summarized, and maintained in accordance with the data management requirements of Section 8 of the INEL SAP. The validated data shall be assessed as described in Section 12 of the SAP. The validated data shall be uploaded and maintained in a Site-wide groundwater monitoring data base.

A summary report will be written by ANL-W and transmitted through the DOE-AAO to DOE-ID ESD within 90 days of completing a sampling round. This report will include hard and electronic copies of all sampling data. The electronic copies will be transmitted to DOE-ID using data base management software that is compatible with the Site-wide groundwater monitoring data base. At a minimum, all summary reports will be transmitted in accordance with the document control requirements of the ANL-W QPP.

13. CONTAMINATION DETECTION AND RESPONSE

13.1 Introduction

Operations at the INEL are known to have affected the quality of the groundwater in the underlying Snake River Plain aquifer (SRPA). In order to reduce the potential impact of releases to the environment, meet the requirements of the applicable environmental regulations, and meet DOE's programmatic needs, it is imperative that the INEL Groundwater Monitoring Program adopt a consistent and integrated approach toward responding to the detection of groundwater contamination. The purpose of this section is to establish DOE-ID's requirements for responding to the detection of any new contamination discovered during groundwater monitoring at the INEL. The monitoring and response activities conducted under this Plan will be coordinated with those of ERP WAG 10 performed under the INEL FFA/CO.

This section establishes INEL action levels (i.e., a pre-specified set of levels of contamination that, when observed, initiate a pre-specified set of responses). The purpose of developing these action levels is to establish consistent response scenarios throughout the INEL when certain prescribed levels of contamination are observed. The required responses apply to all groundwater monitoring activities at the INEL (i.e., both observational and compliance monitoring). Any exceptions to adherence to these standards should be documented, with the reasons specified, and forwarded to DOE-ID ESD.

Three general hierarchical action levels have been established for the INEL: Routine (no action), Unusual Occurrence, and Environmental Occurrence. Each succeeding action level is associated with a correspondingly higher level of contamination. Depending on the specific action level triggered, both the level and immediacy of response may vary. It should be noted that these action levels (and associated responses) only apply when the detected contaminant has <u>not</u> been previously detected at the observed action level. Therefore, the additional reporting and corrective action responses are not required for known contaminant plumes, unless the level of contamination in those plumes increases to the extent that it exceeds a higher action level.

The thresholds and reporting associated with each action level have three sources: DOE Orders, EPA Regulations and Programs, and INEL-specific best management practices. Two regulatorially driven subsets of compliance monitoring activities are RCRA and CERCLA. These regulatory programs have their own response requirements which must be satisfied in addition to the INEL-specific requirements. Additional action levels originating from RCRA and CERCLA requirements are discussed.

The general data flow and reporting requirements common to all INEL groundwater monitoring activities are presented in Figure 13-1. General responsibility for INEL groundwater monitoring activities resides with DOE-ID ESD. When specified action levels are exceeded, responsibility may be elevated within the DOE management chain.

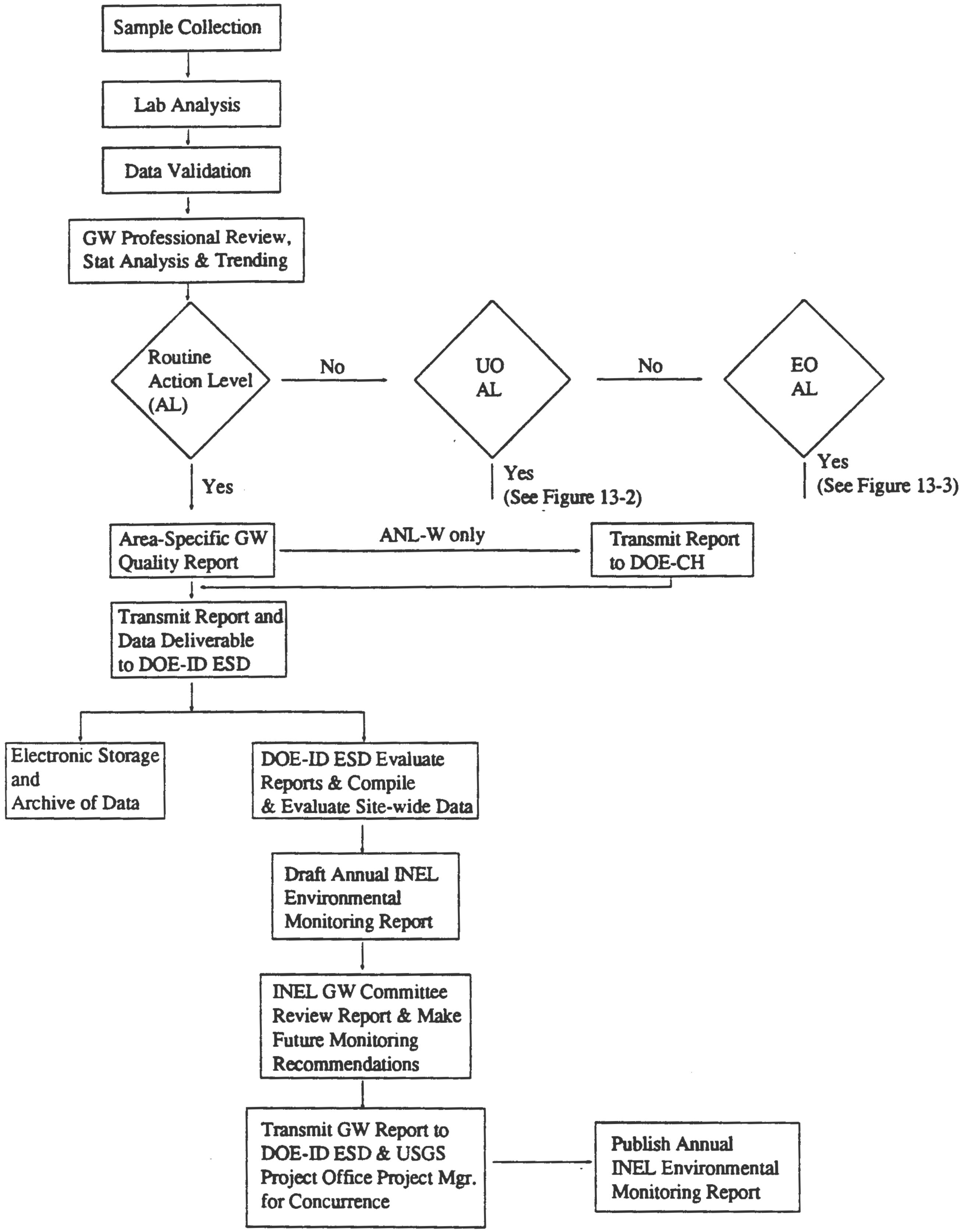


Figure 13-1. INEL Groundwater Monitoring Program Generic Data/Report Process for Routine Samples.

DOE-ID ESD is responsible for:

- Compiling and evaluating all sampling organization reports to determine if any new Site-wide groundwater problems exist (based on a comparison between groundwater data and the action levels discussed in Section 13.3)

- Establishing a common repository for all groundwater monitoring data

- Integrating all INEL groundwater sampling data and evaluating it, on a Site-wide basis, for significant levels of groundwater contaminants or increasing contaminant trends

- Initiating proper responses and corrective actions, when necessary.

13.2 Sample Analysis and Validation

All contractor laboratory analysis of samples will be performed in accordance with statements of work (SOWs) issued by the INEL Sample Management Office (SMO) to INEL Groundwater Monitoring Program approved laboratories. The procedures for obtaining laboratory services from the SMO are contained in EG&G ERP Policy Directives (PDs) 5.5 and 5.6.

All groundwater monitoring data will be validated. Data validation is defined as a systematic process for reviewing a body of data against a set of criteria to provide assurance that the data are adequate for their intended use. Method validation is a subset of the Data Validation box shown in Figure 13-1. Method validation is defined as the process of evaluating the accuracy and completeness of analytical data, to a specified level of detail, using a pre-specified set of information or data. All contractor groundwater monitoring data, unless specified otherwise, will be method-validated in accordance with SMO standard practices. Applicable procedures include SOP No. SMO-SOP-12.1.1, "Levels of Method Validation", SMO-SOP-12.1.2, "Radiological Data Validation", and SMO-SOP-12.1.5, "Inorganic Data Validation."

There are some features unique to the USGS data flow process that are not shown in Figure 13-1. All USGS samples will be analyzed and validated by the USGS National Water Quality Laboratory (NWQL) in Lakewood, Colorado and maintained on the DOE-ID RESL database. All USGS water-quality data will then be evaluated by a qualified USGS groundwater professional prior to being transmitted to DOE-ID ESD.

13.3 INEL Action Levels and Responses

This section of the Plan focuses on INEL "Action Levels" (see Figure 13-1). An **action level** is defined as follows:

> A pre-specified set of criteria that, when met, trigger initiation of a pre-specified set of actions (i.e., a response scenario) by designated parties.

For INEL Site monitoring activities, the following three action levels have been established:

- Routine (no action)
- Unusual Occurrence
- Environmental Occurrence.

The three levels are hierarchical, with environmental occurrence representing the most severe level of contamination. These three levels are discussed below. *In the ensuing discussions, all criteria that involve an MCL apply only when the MCL is greater than the INEL background level for the particular contaminant.*

13.3.1 Routine Action Level and Response

The Routine action level represents the "normal" response and reporting done as a part of routine Site monitoring activities. The Routine action level includes all analytical results in which a groundwater contaminant is:

- Not detected above background concentrations
- Measured at a contaminant level which is $\leq$ 50% of that parameter's MCL
- Through trend analysis, is not projected to exceed 80% of that parameter's MCL within 2 years.

The response requirements for samples which are classified as "Routine" are summarized in Figure 13-1 and discussed below.

Once validated by the SMO, all contractor groundwater monitoring data will be transmitted in hard copy and electronic form to the sampling organization for evaluation by a qualified groundwater professional as defined in attachment A, Section A.6.8 of the INEL Groundwater Protection Management Plan (DOE/ID-10274; DOE, 1993). The sampling organization will evaluate and summarize the data and write an area-specific Groundwater Quality Report. The sampling organization will transmit the area-specific Groundwater Quality Report, in hard copy and electronic form, to DOE-ID ESD through normal channels (e.g., ANL-W's data will be transmitted to DOE-ID ESD, through DOE-CH). This transmittal will include electronic copies of all summary and raw data.

USGS groundwater data will be validated by the NWQL and transmitted in hard copy and electronic form to the USGS INEL Project Office for evaluation by a USGS groundwater professional. The USGS will summarize the groundwater monitoring results and transmit the summary and a progress report of ongoing groundwater activities to DOE-ID ESD on a quarterly basis. These transmittals will be in hard copy and electronic form. In addition, an electronic copy of all pertinent groundwater data received from the NWQL will be transmitted to DOE-ID ESD for inclusion in a Site-wide groundwater data base in conjunction with submitting its January and July quarterly summaries.

DOE-ID ESD will review the contractor and USGS reports, integrate all INEL groundwater sampling data, and evaluate the data on a Site-wide basis, for significant levels of groundwater contaminants or significant contamination trends. The results will be summarized and included in the Annual INEL Environmental Monitoring report. Hard copies of all contractor and USGS reports and data will be archived in the INEL Groundwater Repository. Electronic copies of all pertinent contractor and USGS groundwater data will be archived in a Site-wide groundwater data base.

The INEL Groundwater Committee will evaluate the groundwater monitoring portion of the Annual INEL Environmental Monitoring report and make recommendations (e.g., increase or decrease the level of then-current monitoring efforts, or recommend corrective actions), based on the data collected. CERCLA-related recommendations will be communicated to ER. The groundwater monitoring portion of the report will then be transmitted to the Director of DOE-ID ESD and the Project Manager of the USGS INEL Project Office for concurrence prior to the report being published.

13.3.2 Unusual Occurrence Action Levels and Responses

The INEL Unusual Occurrence (UO) action level and response scenario were developed to meet the reporting and response requirements of DOE Order 5000.3B, "Occurrence Reporting and Processing of Operations Information," for Site monitoring activities. In addition to the requirements of DOE Order 5000.3B, the INEL has developed two INEL-specific responses and reporting subcategories (i.e., action levels) as best management practices (BMPs). The UO action levels and their required responses are summarized in Figure 13.2 and discussed below. More specific details for reporting an UOR event are presented in Section 15.3.

13.3.2.1 Unusual Occurrence Action Level and Response. The general requirements for reporting and responding to "unusual occurrences" are established in DOE Order 5000.3B. In accordance with DOE Order 5000.3B (Attachment I, Group 3 C), a discovery of new groundwater contamination above background levels is classified as an "Unusual Occurrence" and requires specific reporting and response actions to be conducted. Therefore, groundwater contamination at the INEL will be classified as a UO when the following criteria are met:

- Analytical results for groundwater contaminants significantly exceed the established INEL background levels for the specific constituent; **and**

- Groundwater contaminants have <u>not</u> been previously reported in either an annual report at the UO or environmental occurrence action level or in any CERCLA/RCRA

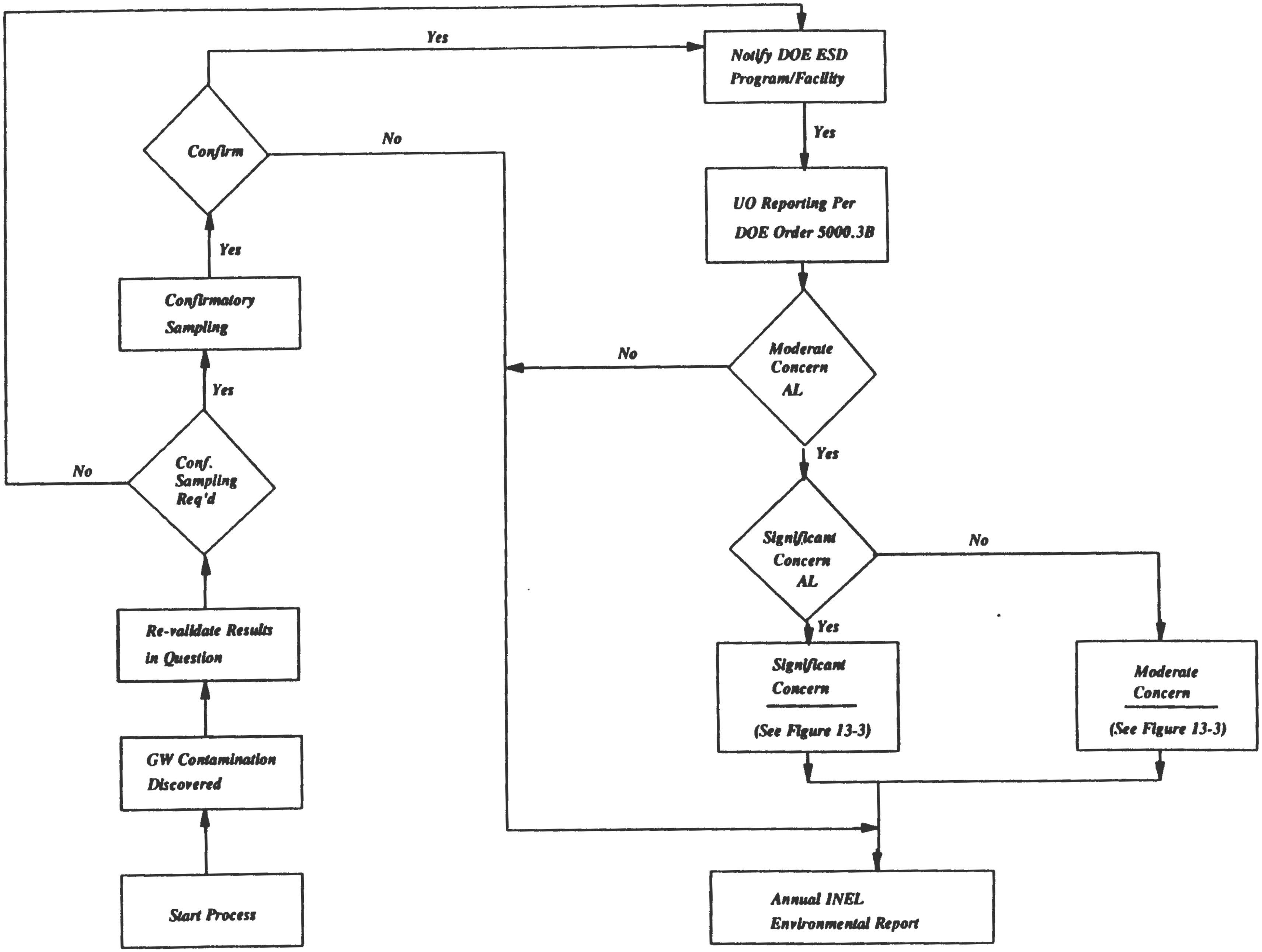


Figure 13-2. UO Action Level Response.

activity report at the particular sampling location (i.e., well).

In addition to meeting the Routine response requirements outlined in Section 13.3.1, the following "special" response requirements must be met. Upon discovery of groundwater samples at the UOR action level, the sample results will be revalidated. If the results are questionable, the well in question will be resampled and the samples will be analyzed as soon as practical. No response actions are required until confirmatory samples have been analyzed and the results are validated and evaluated. If the results of the confirmatory sample indicate that the initial sample results were in error (i.e, cannot be replicated and are below the Unusual Occurrence action level), the results of both the initial and followup sampling will be noted in the Annual INEL Environmental Monitoring report and no further response actions will be required.

If the results of the revalidation/resample confirm that the contaminants exceed the action level for a UO, the event will be classified as an unusual occurrence in accordance with DOE Order 5000.3B. The sampling organization will verbally notify the DOE-ID ESD contact for groundwater issues. DOE-ID ESD will contact the appropriate DOE Facility Manager and/or Program Manager. The sampling organization, DOE-ID ESD, and the DOE Facility Manager/Program Manager will then initiate the UO reporting process, as required in DOE Order 5000.3B. Refer to DOE Order 5000.3B for the specific details of the UO reporting process.

13.3.2.2 INEL-Specific Action Level and Response. Two INEL-specific sub-categories have been established within the UO action level. These subcategories are the "Moderate Concern" action level and "Significant Concern" action level. These response categories are hierarchical, with Significant Concern being the most severe. The purpose of these sub-categories is to establish graded criteria for conducting additional INEL-specific response actions, and for developing UO followup reports in accordance with DOE Order 5000.3B. These INEL-specific action levels and their required responses are summarized in Figure 13.3 and discussed below.

13.3.2.2.1 Moderate Concern Action Level–Groundwater contamination at the INEL will be classified as a Moderate Concern when the following criteria are met:

- Analytical results, for groundwater contaminants, are greater than 50% of the Maximum Contaminant Level (MCL); and/or

- Based on trend analysis, the projected concentration will exceed 80% of the MCL within two years.

Upon discovery of groundwater samples at the Moderate Concern action level, the sample results will be revalidated. If the results are questionable, the well in question will be resampled and the samples will be analyzed as soon as practical. No response actions are required until the revalidation is complete or the confirmatory samples have been analyzed and the results are evaluated. If the results of the confirmatory sample indicate that the initial sample results were in error (i.e, cannot be replicated and are below the Moderate Concern action level), the results will be reclassified. That is, the results will be classified as either routine or UO, and action will be taken accordingly.

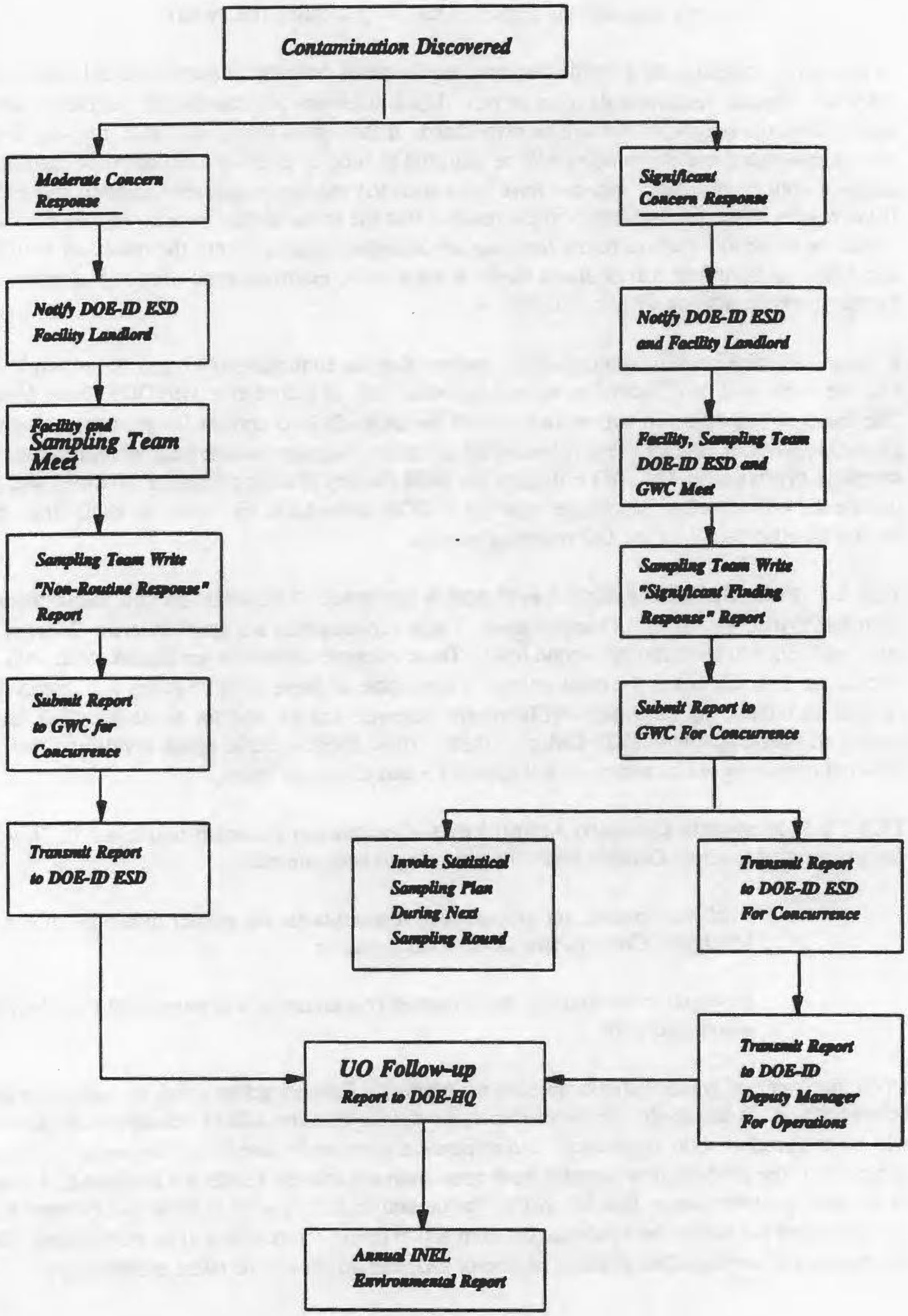


Figure 13-3. UO Followup Level Responses.

If the results of the revalidation/resample confirm that the contaminants exceed the Moderate Concern action level, the sampling organization will verbally notify the DOE-ID ESD contact for groundwater issues. DOE-ID ESD will contact the appropriate DOE Facility Manager and/or Program Manager. The sampling organization, DOE-ID ESD, and DOE Facility Manager/Program Manager will meet to assess the available data and information. At a minimum, they will reevaluate the potential sources of contamination and recommend corrective actions. An informal Moderate Concern Response report will then be generated by the sampling organization and submitted to DOE-ID ESD. The informal report will be transmitted to the INEL Groundwater Committee for concurrence. If deemed necessary by the Chairman of the INEL Groundwater Committee, the INEL Groundwater Committee will convene a special meeting to review and discuss the report. The Director of DOE-ID ESD will then transmit the report to DOE-HQ as an UO followup report. The results will also be summarized in the Annual INEL Environmental Monitoring report.

13.3.2.2.2 Significant Concern Action Level–Groundwater contamination at the INEL will be classified as a Significant Concern when the following criteria are met:

- Analytical results for groundwater contaminants are greater than 80% of the Maximum Contaminant Level (MCL); and/or

- Based on trend analysis, the projected concentration will exceed 80% of the MCL within six months.

The Significant Concern action level and its required responses are summarized in Figure 13-3 and discussed below.

Upon discovery of groundwater samples at the Significant Concern action level, the sample results will be revalidated. If the results are questionable, the well in question will be resampled and the samples will be analyzed as soon as practical. No response actions are required until the revalidation or the confirmatory samples have been analyzed and the results are evaluated. If the results of the confirmatory resample indicate that the initial sample results were in error (i.e., cannot be replicated and are below the significant finding response level), the results will be reclassified. That is, the results will be classified as either routine, a UO, or Moderate Concern, and action will be taken accordingly.

If the results of the revalidation/resample confirm that the contaminants exceed the Significant Concern action level, the sampling organization will verbally notify the DOE-ID ESD contact for groundwater issues. DOE-ID ESD will contact the appropriate DOE Facility Manager and/or Program Manager, and Director of the appropriate DOE ER program (i.e., DOE-ID, or DOE-CH). The sampling organization, DOE-ID ESD, and DOE Facility Manager/Program Manager will meet within one week of confirming the sample results. At a minimum, they will reevaluate the potential sources of contamination, develop a corrective action plan, and if possible/practical, initiate corrective actions.

A formal Significant Concern Response report will then be generated by the sampling organization and submitted to DOE-ID ESD. The report will be transmitted to the INEL Groundwater Committee, which will convene a special meeting to review and discuss the report, and ultimately will provide concurrence. The Director of DOE-ID ESD will transmit the report to the DOE-ID Deputy Manager for Operations for concurrence. The DOE-ID Deputy Manager for Operations will then transmit the report to DOE-HQ as a UO followup report. DOE-ID ESD will summarize the findings, including all followup actions taken, in the annual INEL Site Environmental Report. Once a Significant Concern has been detected, a statistical sampling plan will be developed, and it will be implemented during the next sampling round. Statistical sampling will continue until DOE-ID has determined that the level of the contaminant has decreased to an acceptable level or that sufficient data have been collected.

When USGS sampling produces results that trigger a Significant Concern response, reporting in addition to USGS's routine reporting is required. Written notification is provided upon receipt of the initial analysis to the Director DOE-ID ESD. The Director DOE-ID ESD will contact the appropriate Facility Manager/Program Manager. USGS policy for reporting data that suggest a health or environmental problem is described in WRD Memorandum No. 90.38. After receiving the USGS report, DOE-ID ESD will write the formal Significant Concern response report and transmit the report to the INEL Groundwater Committee for concurrence. The INEL Groundwater Committee will convene a special meeting to review and discuss the report. The Director of DOE-ID ESD will transmit the report to the DOE-ID Deputy Manager for Operations for concurrence. The DOE-ID Deputy Manager for Operations will then transmit the report to DOE-HQ as a UO followup report. DOE-ID ESD will summarize the findings, including all applicable followups, in the annual INEL Site Environmental Report.

13.3.3 Environmental Occurrence Action Level and Response

The Environmental Occurrence action level is reached when contaminants are detected in groundwater at levels in excess of a DOE or regulatory threshold. The response scenario for environmental occurrences is shown in Figure 13-4. Consistent with the hierarchical structure of the action levels, this scenario includes reporting in accordance with DOE Order 5000.3B.

Upon initial discovery of groundwater samples at the Environmental Occurrence action level, the sample results will be revalidated, and two groundwater samples will be collected from the well in question. The samples will be analyzed as soon as possible. If the results of the revalidation indicate that the Environmental Occurrence action level has been exceeded, the Director of DOE-ID ESD will verbally inform the State of Idaho's designated contact.

In conjunction with the confirmatory (resampling) effort, the DOE-ID Deputy Manager for Operations (DMO) will be notified by DOE-ID ESD. The DMO will convene an Environmental Occurrence Investigation Board to investigate the potential sources of contamination and consider possible corrective actions. At a minimum, the board will include the DOE-ID Deputy Manager for Operations, the DOE-ID ESD Director and the contact person for groundwater issues, the Director of DOE-ID ERP, a representative of the sampling organization, the affected facility landlord, and selected members of the INEL Groundwater Committee (at the DMO's or ESD Director's request).

The sampling organization will immediately notify the DOE-ID ESD contact for groundwater issues and the Environmental Occurrence Investigation Board regarding the results of the resampling. If

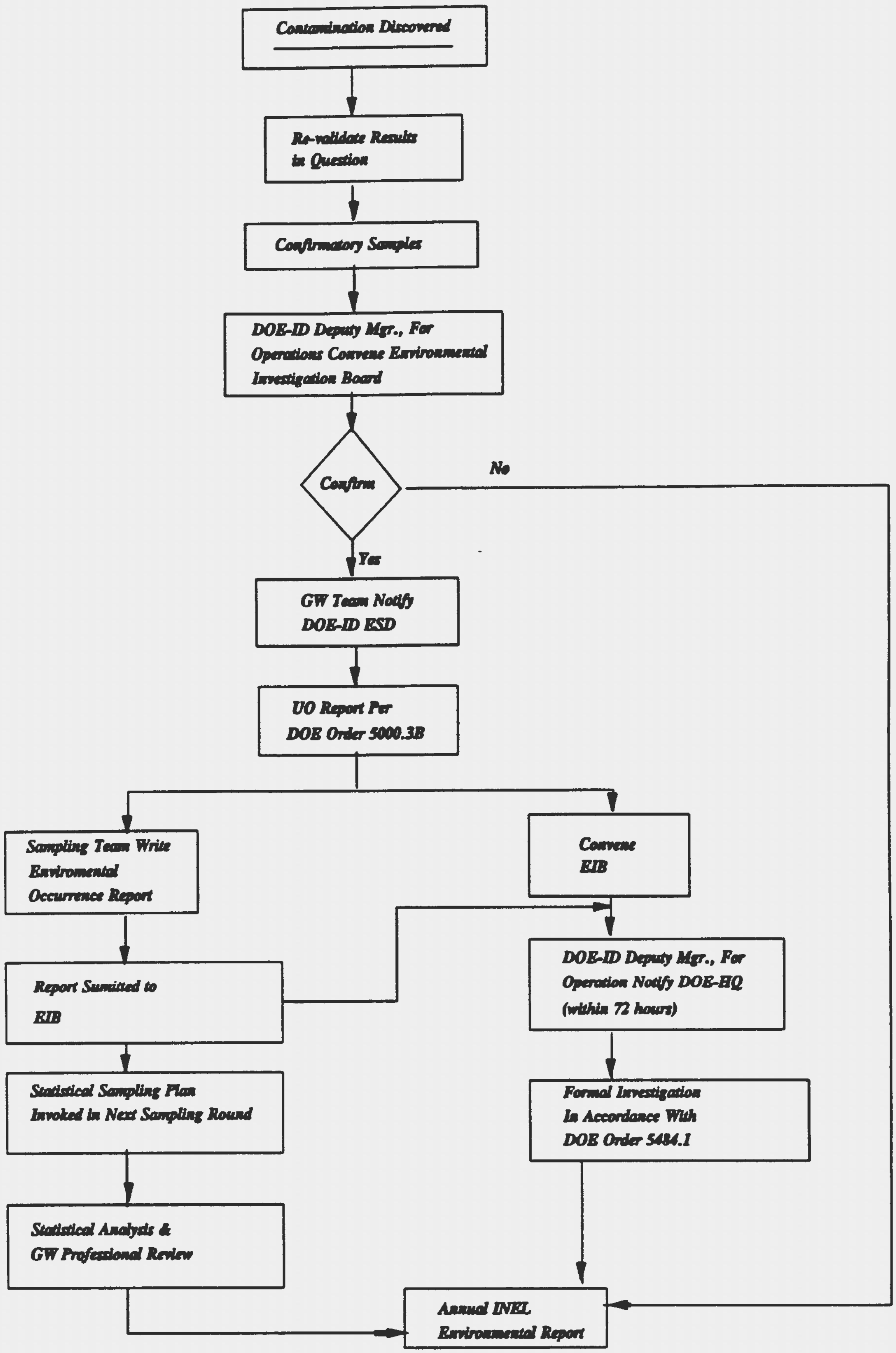


Figure 13-4. Environmental Occurrence Action Level Response.

the results of the revalidation and confirmatory resample indicate that the initial sample results were in error (i.e., cannot replicate the initial sample results and are below the Environmental Occurrence response level), the results will be reclassified (e.g., as Routine or UO) as necessary, and the Investigation Board will be disbanded. Action will be taken accordingly.

If the results confirm the initial sampling results, the groundwater team will immediately notify the DOE-ID ESD contact for groundwater issues and will follow up the notification(s) with an Environmental Occurrence report (see Section 15.3) and other notifications, if necessary (e.g., RCRA or CERCLA reporting). If the occurrence is due solely to exceeding a DOE threshold, the DOE-ID Deputy Manger for Operations will inform DOE-HQ within 72 hours and a formal investigation will be convened in accordance with the requirements of DOE Order 5484.1. If the occurrence is due to exceeding a regulatory threshold, the notification will be made in accordance with the specific regulatory requirements (e.g., see Section 13.4) in addition to meeting the requirements of DOE Order 5484.1. Copies of the Environmental Occurrence report and any additional regulatory notifications will be transmitted to the INEL Groundwater Committee. Copies of all Environmental Occurrence reports will be forwarded to the Idaho Department of Environmental Quality.

Once contamination has been detected at an environmental occurrence action level, a statistical sampling plan will be developed and implemented during the next sampling round. Statistical sampling will be continued until DOE-ID has determined that the level of contamination has decreased to an acceptable level or that sufficient data have been collected.

When USGS sampling produces results that trigger a Environmental Occurrence response, reporting in addition to USGS's routine reporting is required. Upon receipt of the initial analysis, oral and written notification is provided to the Director DOE-ID ESD. The Director DOE-ID ESD will contact the appropriate Facility Manager/Program Manager. USGS policy for reporting data that suggest a health or environmental problem is described in WRD Memorandum No. 90.38. DOE-ID ESD will write a formal Environmental Occurrence report and transmit the report to the Environmental Occurrence Investigation Board for concurrence. The DOE-ID Deputy Manager for Operations will then transmit the report to DOE-HQ and to the appropriate regulatory agency, if necessary. DOE-ID ESD will summarize the findings, including all applicable followups, in the annual INEL Site Environmental Report. Copies of all Environmental Occurrence reports will be forwarded to the Idaho Department of Environmental Quality.

13.4 Regulatory Action Levels

A subset of compliance monitoring activities at the INEL includes groundwater monitoring in accordance with either RCRA or CERCLA regulations. In these instances, adherence to both the appropriate DOE and INEL-specific regulatory action levels and associated responses is required. The INEL-specific responses are discussed in Section 13.3.3. The RCRA/CERCLA action levels and responses are discussed below.

13.4.1 RCRA Action Levels

RCRA action levels are defined as being reached when an observed analytical result is significantly greater than the parameter's statistical background, or pH is significantly less than background.

Under RCRA, response scenarios differ for detections made at upgradient and downgradient wells. All RCRA responses at the INEL, unless superseded by the INEL FFA/CO, will be conducted in accordance with 40 CFR 265.93. The response scenario for RCRA action levels is shown in Figure 13-5.

For upgradient wells, in accordance with the requirements of 265.93(b), a determination is made of whether the observed analytical result is significantly greater than the parameter's statistical background mean or the observed pH is significantly less than background. If either condition is met, the sampling organization will immediately inform DOE-ID ESD and follow up with a written report as soon as practical. DOE-ID ESD will notify the State, submitting information in accordance with 265.94(a)(2). DOE-ID ESD will include a summary of the details, including followup responses, in the annual INEL Environmental Report.

For downgradient, wells in accordance with the requirements of 265.93(b), a determination is made of whether the observed analytical result is significantly greater than the parameter's statistical background mean or the observed pH is significantly less than background. If either condition is met, the sampling organization will immediately collect confirmatory samples from those downgradient wells in which a significant difference was detected. The samples will be split into two, and confirmatory analyses will be performed. If the analytical results confirm the inital sampling results, the sampling organization will inform DOE-ID ESD in writing, and DOE-ID ESD must send written notice to the EPA Region 10 Administrator and the State in accordance with 265.93(d)(1). In accordance with DOE Order 5400.1 (Chapter II, 2), the sampling organization and DOE-ID ESD will notify the DOE-HQ Emergency Operations Center (EOC) concurrent with notification of EPA and the State.

The sampling organization will then develop a Water Quality Assessment Plan (WQAP) in accordance with 265.93(d)(2), and submit the plan to DOE-ID ESD. DOE-ID ESD will submit the WQAP to the EPA and the State in accordance with 265.93(d)(3).

The sampling organization is responsible for implementation of the WQAP. In accordance with 265.93(d)(4), the sampling organization will, at a minimum, make a first determination of the rate and extent of migration of the hazardous waste or hazardous waste constituents in the groundwater,

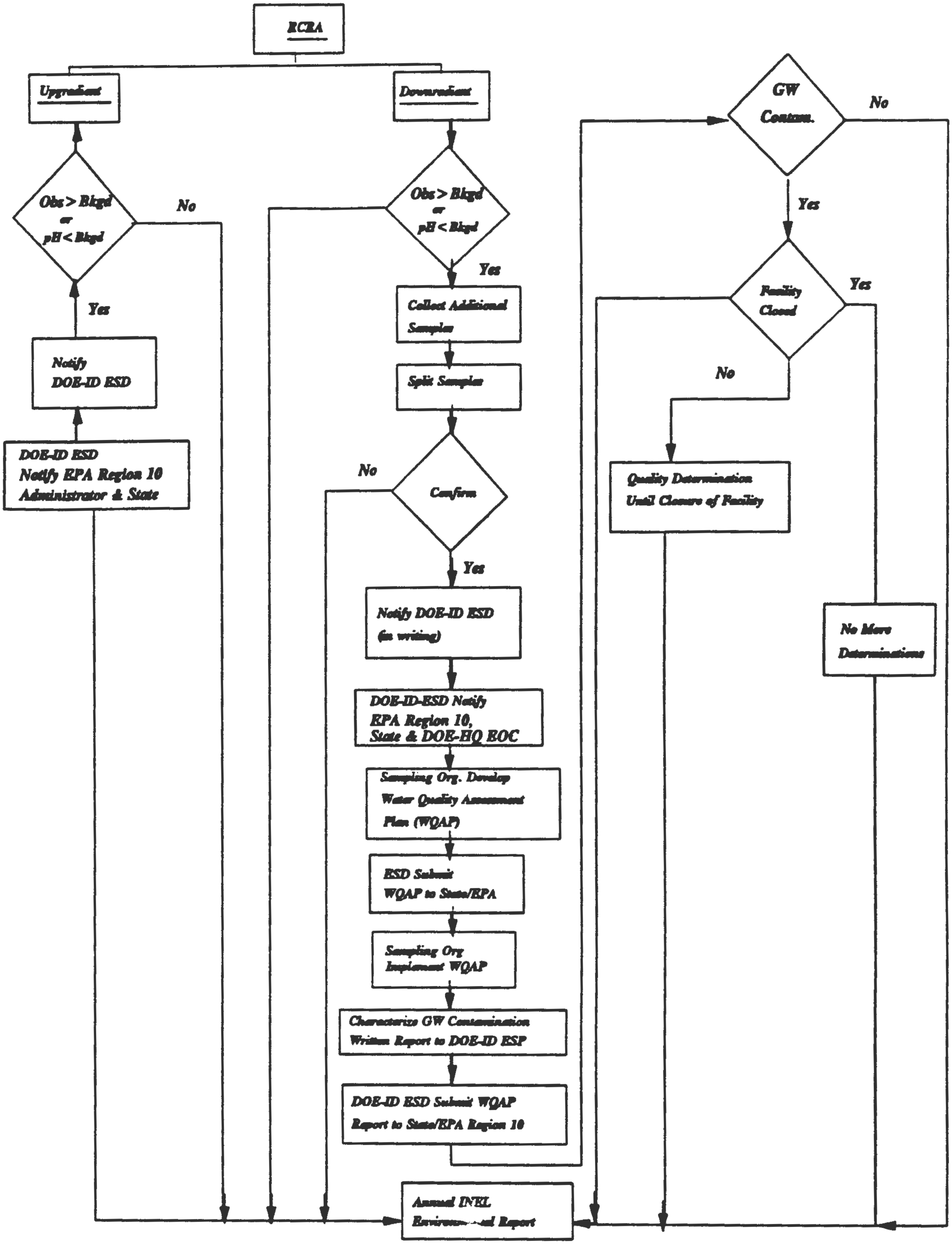


Figure 13-5. RCRA Action Level Response Scenario.

and will determine the concentrations of the hazardous waste or hazardous waste constituents in the groundwater. This determination will be made as soon as technically feasible. The sampling organization will generate a WQAP report, and submit the report to DOE-ID ESD. DOE-ID ESD will submit the report to the State and EPA Region 10 Administrator in accordance with 265.93(d)(5).

When the extent of groundwater contamination has been determined, one of two monitoring responses must be initiated, based on the facility status. These responses are as follows:

- Continue to make the determinations required under 265.93(d)(4) on a quarterly basis until final closure of the facility, if the groundwater quality assessment plan was implemented prior to final closure of the facility

- Cease to make the determinations required under 265(d)(4), if the groundwater quality assessment plan was implemented during the post-closure care period.

All groundwater quality assessments conducted to satisfy the requirements of 265.93(d)(4), which are initiated prior to final closure of the facility, must be completed and reported in accordance with 265.93(d)(5).

13.4.2 CERCLA Action Levels

All CERCLA characterization and cleanup response actions at the INEL are under the jurisdiction of the INEL FFA/CO. Section 1.3.2 (Integration with Other Programs) of the FFA/CO Action Plan states that "releases or threatened releases of hazardous substances under regulatory programs that require investigation and study for cleanup are addressed under this Action." Therefore, it is important that the INEL Groundwater Monitoring Program and the ERP work closely and communicate on INEL groundwater issues.

CERCLA action levels are addressed in the INEL FFA/CO and other ERP documents and will not be presented. However, the bilateral notification process between the INEL Groundwater Monitoring Program and ERP is described below.

In the event of the detection of a new pollutant or hazardous substance at or above the significant contamination level (i.e., a significant contamination or an environmental occurrence) by the INEL Groundwater Monitoring Program, the initial notifications will be made by the sampling organization. DOE-ID ESD will notify DOE-ID ERP and the appropriate contractor ERP organization(s). Followup notification will by made by the Director, DOE-ID ESD through the transmittal of a copy of the appropriate action level report to the Director, DOE-ID ERP. Conversely, the Director, DOE-ID ERP will inform the Director, DOE-ID ESD of any significant groundwater contamination detected during unit characterization or evaluation which may pose an unacceptable threat to groundwater quality.

If groundwater monitoring or characterization results indicate that CERCLA or SARA reportable quantities (RQs) have been exceeded, the directors of the appropriate DOE organizations will ensure that proper reporting is carried out in accordance with applicable regulatory and DOE requirements.

14. STATISTICAL METHODS

The application of statistical methods in the assessment of groundwater compliance allows an objective methodology for controlling Type I and II errors. For the purposes of this document a Type I error is said to occur when it is concluded that a well is out of compliance when, in fact, it is in compliance. A Type II error is said to occur when it is concluded that a well is in compliance when, in fact, it is out of compliance.

The methods discussed in this section are generally based on RCRA guidance documents published by the EPA. Of most interest are the two EPA documents titled "Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities" published in 1989 and 1992, the 1992 document being an Addendum to the 1989 document. Throughout this section the 1989 EPA document will be referred to as the Interim Final Guidance and the 1992 document will be referred to as the Addendum.

The recommendations covered in this section are for compliance monitoring under this INEL Groundwater Monitoring Plan. However, sampling conducted under other programs, such as USGS observational monitoring and CERCLA groundwater characterization, may be required to have sampling programs that deviate from those discussed in this section.

14.1 Introduction

In this section, the methods to be used to determine whether action levels are exceeded (see Section 13) are introduced. In the latter half of the section, a discussion of assumptions and requirements for the application of the statistical methods is given.

14.1.1 General Methods

Assessment of whether action levels defined in Section 13 are exceeded falls into three categories:

- Observed sample concentration exceeds background concentration
- Observed sample concentration exceeds a stated limit
- Projected (trended) concentration exceeds a stated limit.

Three methods are recommended for assessing each of these categories. The first method will be assessed using "prediction intervals;" an upper prediction limit is computed for the background concentrations to determine whether the observed concentration exceeds this limit. The second method employs "tolerance intervals;" an upper tolerance limit is computed on the observed concentrations to determine whether this value exceeds the stated limit (e.g. one-half the MCL). The third method employs control charts and regression.

The background concentrations are established through the initial year of sampling at the well, and will be updated periodically. In this sense, "background" is essentially the baseline concentrations at a particular well. Background and establishment of background are discussed in Section 14.1.2.1.

14.1.1.1 Prediction Intervals. A prediction interval is constructed to contain the next sample value(s) from a population or distribution with a specified probability. For instance, the routine action level requires comparison of the current concentration to background concentrations. To do this an upper limit of the prediction interval is computed for the background data. The current mean concentration is then compared to this upper limit. If the current mean concentration exceeds the limit, then one may conclude that the current concentration exceeds background.

14.1.1.2 Tolerance Intervals. Tolerance intervals are designed to contain a designated proportion of the population (e.g., 95% of all possible sample measurements). There are two coefficients associated with any tolerance interval. The first is the proportion of the population that the interval is supposed to contain, called the **coverage**. The second is the degree of confidence with which the interval reaches the specified coverage, called the **tolerance**. A tolerance interval with a coverage of 95% and a tolerance coefficient of 95% is constructed to contain, on average, 95% of the distribution with a probability of 95%.

The tolerance intervals will be used to compare current monitoring well data to predefined limits; namely, 50%, 80%, and 100% of the MCL. An upper one-sided tolerance interval is calculated based on the current monitoring data for the well. If this calculated upper limit exceeds the action limit, then it is concluded that the action level has been exceeded.

14.1.1.3 Control Charts and Regression. Control charts are a common tool for characterizing the concentrations in a well over time. Trends and changes in the concentration levels can be seen easily, because all sample data is consecutively plotted on the chart as it is collected, giving the data analyst an historical overview of the pattern of contamination. For this reason, control charts will be kept for each well to help detect whether trends in contaminant concentrations are occurring over time.

The combined Shewhart-CUSUM control chart discussed in the Interim Final Guidance will be constructed for each constituent at each well to provide a tool for detecting both trends (a steady increase in concentration) and abrupt changes in concentration levels. Standardized values of the observed mean concentrations from each sampling round are plotted in sequence. If the value exceeds the Shewhart Control Limit (SCL), then an unexpected change in concentration has occurred. The chart will also plot the cumulative sums (CUSUMs) which are sums of deviations from the background mean. When the CUSUM line exceeds the CUSUM Control Limit (h), a trend or abrupt change in concentration has occurred.

If h is exceeded, then regression methods will be implemented to first determine if there is a trend or if the groundwater concentration has shifted (i.e. a change point). If it is determined that a trend is occurring, the regression line will be used to project the concentration over 6 months and 2 years. The projected concentrations will then be compared to the action limit. If the projected concentration exceeds the action limit, then it is concluded that the action level has been exceeded.

14.1.2 Considerations When Applying Statistical Methods

When applying statistical methods to groundwater data, there are a number of special considerations and assumptions that must be taken into account. Considerations include definition of background and handling "less-than-detectable" (LTD) data. Assumptions used when applying statistical methods include the form of the data distribution, independence of samples, and homogeneity of variance. The special considerations and assumptions used for this Plan are discussed below.

14.1.2.1 Definition of Background. The monitoring scenarios discussed in this document differentiate between comparison to background and comparison to upgradient wells, much as is done under the groundwater monitoring requirements in RCRA. Background is established for a well through an initial sampling effort during the first year after installation of the well. That is, the first year of data collected from a well forms the background concentrations for that well.

It is also necessary to monitor changes in the groundwater from upgradient wells to ascertain whether any increase in concentration is due to an area upgradient from the monitoring well. The locations of the upgradient wells are given in Sections X.4.

In order to determine the status of a well with respect to the action levels, background concentrations must be established. Sampling to establish background concentrations is critical to the success of the monitoring. As such, the first year of sampling from a well must be given special consideration, and is discussed further in Section 14.3.

14.1.2.2 Handling of LTD Data. The analysis of groundwater data is commonly made more difficult by the presence of LTD data. These are data that represent concentrations below the detection limit of the analytical method. The Interim Final Guidance and Addendum provide a number of methods for handling LTD data. A summary of their recommendations with respect to the methods advocated in this document follows.

- If less than 15 percent of all samples are nondetect, replace each nondetect by half its detection limit and proceed with the analysis

- If the percent of nondetects is between 15 and 50, either use Cohen's adjustment to the sample mean and variance in order to proceed with an analysis, or employ a nonparametric procedure by using the ranks of the observations and by treating all nondetects as tied values

- If the percent of nondetects is between 50 and 90 percent, use the Test of Proportions, discussed in EPA (1989).

When less than 15 percent of the data are nondetect, the use of simple replacement techniques such as one-half the detection limit is acceptable since using more advanced methods of handling the nondetects will not significantly improve the quality of the data analysis and will have little or no impact on the results. The detection limit to be used when replacing nondetect values with half the detection limit should be the method detection limit (MDL) for those samples that are not detected.

This is discussed in more detail in the Interim Final Guidance and Addendum. However, caution should be used when assigning a value of one half the detection limit, particularly if detection limits change significantly due to sample dilutions. In this situation, the detection limit may be so large as to overwhelm the remainder of the data. Dilution is most commonly a problem when dealing with odd matrices, and hence should not present a problem for the vast majority of the groundwater sample results. The Interim Final Guidance and Addendum should be consulted for more detailed information.

When the percent of nondetects is between 15 and 50, the EPA recommends the use of Cohen's method. The method involves calculating the mean and variance of the detected data and then adjusting these parameters based on the number of nondetects and the value of the detection limit. The adjusted parameters may then be used in the calculation of the tolerance interval. The adjustment is straightforward to calculate, but requires the use of a table, given as Table 7 in Appendix B of the Interim Final Guidance. The method is good only when less than 50 percent of the data is LTD. The method does not handle multiple detection limits. Cohen's method does assume the data are either normally or lognormally distributed.

When the majority of the values are nondetect (between 50 and 90 percent), the EPA recommends the use of the Test of Proportions for comparing monitoring well results to background wells. If all the background well results were LTD and all the monitoring well results are detects, one would suspect that contamination has occurred. The Test of Proportions is a more exact method for assessing the same comparison. The method essentially tests whether the proportion of nondetects is significantly smaller in the monitoring well than in the background wells.

14.1.2.3 Distributional Assumptions. The use of statistical intervals such as the prediction and tolerance intervals discussed in this document require that the data follow a particular distribution. It is common to assume either a normal or lognormal distribution. An incorrect assumption about the distribution can seriously impact the Type I and II error rates.

All INEL groundwater data covered under this document will initially be assumed to be lognormally distributed. This assumption will be verified through the use of either a probability plot or the Shapiro-Wilks test. These methods are discussed in the Addendum.

If it is concluded that the lognormal assumption is appropriate, tolerance limits will be calculated with the natural log (base e) transformed data. If the assumption is not appropriate, the data will next be checked to determine if it is normally distributed. Failing this assumption, a statistician will be consulted for further guidance in selecting a distribution or nonparametric methods may be applied to the data.

14.1.2.4 Homogeneity of Variance. When comparing upgradient concentrations to downgradient concentrations, an initial assessment of the variances from the two groups must be made. The Addendum recommends use of either a boxplot or Levene's test. For the purposes of the monitoring described in this document either of these procedures may be used for assessing the homogeneity of variance, though the Levene's test is preferred.

The boxplot is a fairly simple graphical procedure that requires a subjective assessment about the homogeneity of variance between groups. The Levene's test provides a more sophisticated and objective assessment at the cost of increased complexity.

14.2 Methods for Action Level Assessment

In this section, more details are given for how the methods discussed in Section 14.1.1 are applied to the INEL Groundwater Monitoring Plan. Brief examples are given to illustrate the procedures. Note that the examples are given in untransformed units. In fact, many of the data analyses will be done on the log-transformed data as discussed in Section 14.1.2.3. The technical details of calculations which will be employed by the INEL Groundwater Monitoring Program will be contained in an SOP. General guidance is provided in the Interim Final Guidance and Addendum.

14.2.1 Routine Action Level

The routine action level is invoked when concentrations are at background levels or do not pose a threat to human health or the environment (see Section 13). To establish whether the concentrations are at the routine action level, the following must be assessed:

- If the contaminant is not detected above background concentrations, then it is at the routine action level
- If the measured contaminant concentration is less than or equal to 50% of that parameter's MCL then it is at the routine action level
- If, through trend analysis, the contaminant concentration is not projected to exceed 80% of that parameter's MCL within 2 years, then it is at the routine action level.

The assessment of whether a well falls under the Routine action level generally requires three analyses. The first analysis will verify that the analyte does not exceed background for the well and will use a prediction interval procedure. The second analysis will verify that the analyte concentration does not exceed 50% of the MCL and will use a tolerance interval procedure. The third analysis will assess whether a trend is present through a CUSUM procedure, and if so, a verification that the projected trend does not exceed 80% of the MCL within 2 years.

14.2.1.1 Verification That Background Is Not Exceeded. To verify that background is not exceeded, the data analyst will determine the one-sided upper 95% prediction limit on the background concentrations. If this upper limit is greater than the current mean concentration for that analyte, then the action level is Routine. Otherwise, proceed to the verification for the Unusual Occurrence (UO) action level.

As an example, consider chloride concentrations in well XYZ. The average background concentration for chloride in well XYZ is 1500 mg/L, with a standard deviation of 300 mg/L. The upper 95% prediction limit (for a mean calculated with 4 current observations and 16 background concentrations) is then 1800 mg/L. The four samples taken during the current sampling period have a mean concentration of 1700 mg/L. Since the upper limit is greater than the current mean chlorine concentration, the well "passes" the first test of the Routine action level.

14.2.1.2 Verification That 50% of the MCL Is Not Exceeded. To verify that 50% of the MCL is not exceeded, the data analyst will determine the one-sided 95/95% upper tolerance limit on the current observed concentrations. If this upper limit is less than 50% of the MCL for the contaminant, then the action level is Routine. Otherwise, proceed to the verification for the UO action level.

As an example, consider barium concentrations in well XYZ. The MCL for this contaminant is 1.0 mg/L; so 50% of the MCL is 0.5 mg/L. The four samples collected during the current sampling period have a mean barium concentration of 0.2 mg/L and a standard deviation of 0.015 mg/L. Then the upper 95/95% tolerance limit on the current barium concentration is 0.277 mg/L. Since the upper tolerance limit is less than 50% of the MCL, the well "passes" the second test of the Routine action level.

14.2.1.3 Verification That Projected Concentration Does Not Exceed 80% of the MCL. To verify that the projected trend (over 2 years) does not exceed 80% of that parameter's MCL, the analyst must first determine if a trend exists through a Shewhart CUSUM control chart. If a trend does not exist and the analyte has passed the first two tests, then the concentrations are Routine. If a trend does exist, the analyst must implement a regression analysis to predict the concentration two years from the current time. If the predicted concentration does not exceed 80% of the parameter's MCL and the previous two tests were passed, then the concentrations are Routine. Otherwise, proceed to verification for the UO action level.

As an example, consider barium concentrations in well XYZ. The control chart for this contaminant is shown in Figure 14-1. Since the CUSUM does not exceed the limit h, there is no need to project the concentrations out 2 years and the well "passes" this test. If the other two tests were passed, the well is at the Routine action level.

14.2.2 Unusual Occurrence Action Level

The UO action level includes all analytical results in which a contaminant exceeds background levels. The UO action level is divided into two hierarchical responses: Moderate Concern, and Significant Concern responses. Whether the contaminant exceeds background is established through the upper prediction limit discussed in Section 14.2.1.1. To establish the level of OU response the following must be assessed:

- If the contaminant concentration is greater than 80% of the MCL or the projected 6-month trend is greater than 80% of the MCL then it is a Significant Concern response

- If the contaminant is greater than 50% of the MCL or the projected concentration will exceed 80% of the MCL within two years, then it is a Moderate Concern

- If neither the first nor second criteria are met, then the contaminant response level is UO.

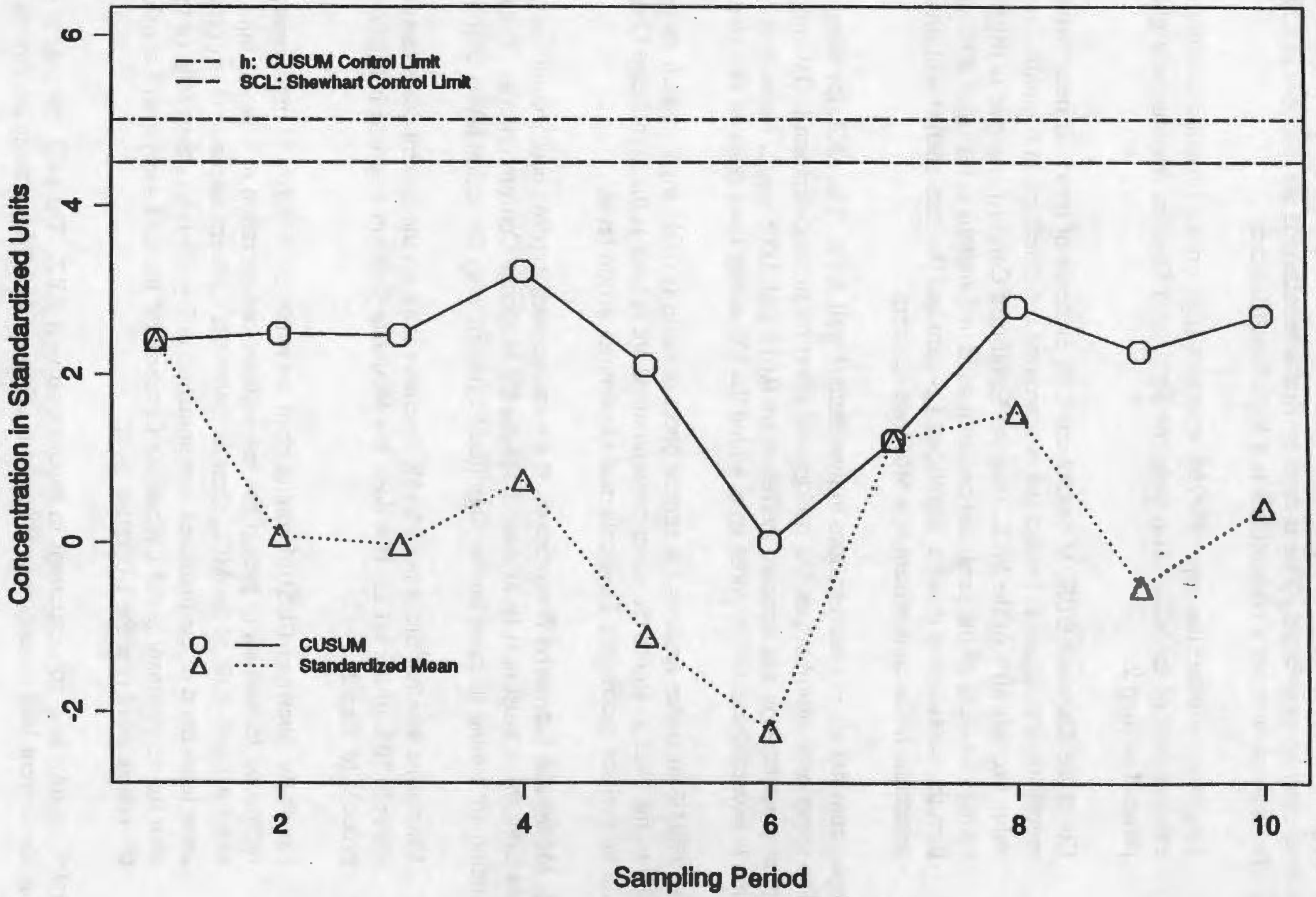


Figure 14–1. Example of a combined Shewhart–CUSUM control chart with h = 5 and SCL = 4.5.

The assessment of whether a well falls under the UO action level initially requires verification that the contaminant concentration is greater than background. This is discussed in Section 14.2.1.1. If background is exceeded, then determine the response level.

14.2.2.1 Significant Concern Response. If the contaminant does exceed background, then the response level must be established. This is done by first determining if the response is a Significant Concern. To establish whether a contaminant is a Significant Concern:

- Determine whether the upper 95/95% tolerance limit on the current concentrations exceeds 80% of the MCL. If it does, the Significant Concern response is triggered. If not proceed to Step 2.

- Check the Shewhart-CUSUM control chart for evidence of trend. If trend exists, use regression techniques to predict the contaminant concentration in 6 months' time. If this value exceeds 80% of the MCL, then the Significant Concern response is triggered. If there is no trend or the predicted contamination in 6 months is less than 80% of the MCL, then the contaminant is not a Significant Concern and the data analyst will proceed to determine if the contaminant is a Moderate Concern.

For example, consider silver concentrations in hypothetical well XYZ. The MCL for silver is 0.05 mg/L. The upper prediction limit on the background silver mean concentration is 0.01 mg/L, and the current mean concentration and standard deviation are 0.015 and 0.005 mg/L, respectively. Hence, background is exceeded and the response level within the UO action level must be assessed.

The upper 95/95% tolerance limit on the current concentrations is 0.041 mg/L, which exceeds 0.04 mg/L (80% of the MCL). Hence the silver concentrations are at least at the Significant Concern level, and should be verified against the Environmental Occurrence action level.

14.2.2.2 Moderate Concern Response. If the contaminant exceeds background but is not a Significant Concern, it must next be evaluated against the Moderate Concern criteria. The steps in this evaluation are similar to those for the Significant Concern, only the action levels change:

- Determine whether the upper 95/95% tolerance limit on the current concentrations exceeds 50% of the MCL. If it does, the Moderate Concern response is triggered. If not proceed to Step 2.

- Check the Shewhart-CUSUM control chart for evidence of trend. If trend exists, use regression techniques to predict the contaminant concentration in 2 years' time. If this value exceeds 80% of the MCL, then the Moderate Concern response is triggered. If there is no trend or the predicted contamination in 2 years is less than 80% of the MCL, then the contaminant is not a Moderate Concern and the data analyst will conclude that the contaminant is at the UO action level.

For example, consider lead concentrations in hypothetical well XYZ. The MCL for lead is 0.05 mg/L. Say the current lead concentrations exceed background but did not meet the criteria for a

Significant Concern. The current mean concentration and standard deviation are 0.01 and 0.002 mg/L, respectively.

The upper 95/95% tolerance limit on the current concentrations is 0.02 mg/L, which is less than 0.025 mg/L (50% of the MCL). So lead passes the first test for the Moderate Concern response.

Next the data analyst plots the current values on the Shewhart-CUSUM chart as shown in Figure 14-2. Since the CUSUM control limit (h) is exceeded, trend is present. The analyst next computes a regression equation to predict the concentration at two years from the current date. The predicted value is 0.035 mg/L, which is less than 0.04 mg/L (80% of the MCL). Hence the analyst concludes that the response level is a UO.

14.2.3 Environmental Occurrence Action Level

The Environmental Occurrence action level is triggered when a contaminant exceeds a DOE or Regulatory threshold. This is assessed by calculating the upper 95/95% tolerance limits on current concentrations and comparing this upper limit to the threshold. If the upper limit exceeds the DOE or regulatory threshold, then the contaminant is an Environmental Occurrence. Otherwise, it falls into one of the prior action levels discussed above.

As an example of testing whether the Environmental Occurrence action level is exceeded, consider chromium concentrations in hypothetical well XYZ. The MCL for chromium is 0.05 mg/L. The current mean concentration and standard deviation are 0.035 and 0.002 mg/L, respectively. The upper 95/95% tolerance limit is then 0.045 mg/L, which is less than the MCL. So this contaminant has not triggered the Environmental Occurrence action level. In fact, the analyst would conclude that this contaminant is at the Significant Concern action level as the upper tolerance limit exceeds 80% of the MCL.

As discussed in Section 13, wells that have background concentrations greater than the MCL can only fall under either the Routine or Environmental Occurrence action levels. So long as the concentrations at the well remains within background (as discussed in Section 14.2.1), the well is in a Routine status. If the well does exceed background, it becomes an Environmental Occurrence.

14.3 Sample Size Assessment

In order to properly assess the quality of the groundwater beneath the INEL, a sufficient number of samples must be collected. Without prior data it is difficult to establish a statistically appropriate number of samples (sample size). By appealing to RCRA regulations, one finds that the minimum sampling requirements are for four independent samples to be taken semiannually for a total of 8 samples per well per year. However, during the initial year of sampling from a well, four independent samples must be collected quarterly for a total of 16 samples per well per year. In the absence of other information, these minimum sample sizes are recommended for the INEL Groundwater Monitoring Program for wells which do not have an established sampling history.

For wells in which this sampling strategy is adopted, a sampling round is a 6-month interval. All analyses discussed in Section 14.2 are then done semiannually after the first year of sampling. During the first year of sampling, the data should be compared to MCLs and other regulatory thresholds as discussed in Section 14.2. During this time, background concentrations are being established so there is no ability to compare concentrations to background.

If a well has a history of sampling results, then these results will be analyzed to determine the background levels and whether any trends are occurring. These established wells should also be checked to determine the status of the well with respect to the action levels (if not already done). If this evaluation shows that a well does exceed an action level, there may be enough data to confirm the status so that confirmation sampling is not necessary. The current sampling frequencies at established wells will be continued if they provide sufficient data to meet the data needs for the analyses discussed in Section 14.2 on a semiannual basis.

Once a sufficient amount of data has been collected to establish the contaminant characteristics of the groundwater at a specific well, the sampling frequency will be reassessed for that well. For a new well, this will take at least two years of data under the minimum sampling requirements. The reassessment of the sampling frequency will be based on statistical, hydrological, and fiscal concerns.

14.3.1 Independent Samples

The analysis methods discussed in Section 14.2 assume that the individual sample results are independent. The EPA defines independence with respect to hydrogeologic parameters of the groundwater. The intent is to set a sampling frequency that allows sufficient time to pass between sampling events to ensure, to the greatest extent technically feasible, that an independent groundwater sample is taken. The selection of the time between sample collections is discussed in the Interim Final Guidance. The time interval is determined after evaluating the uppermost aquifer's effective porosity, hydraulic conductivity, and hydraulic gradient, and the fate and transport characteristics of potential contaminants.

There is some concern that, in order to assure independence of samples, the samples must be collected with long periods of time between them, for example, a year between sample intervals. This is due well-specific hydrogeological characteristics. Under this situation, special considerations will have to be made to meet the needs of the groundwater monitoring program. This will be done on a case-by-case basis. In general, though, the samples should be evenly spaced over the sampling period. For example, if four samples are to be collected semiannually, then samples should be collected approximately every six weeks.

14.3.2 Routine Sampling

The minimum sampling frequency for routine sampling will generally be four samples semiannually per well. However, after the groundwater parameters for a well are established (a minimum of two years of routine sampling), the sampling frequency will be reevaluated. This evaluation will take into account hydrologic and fiscal considerations, as well as statistical requirements.

The statistical reevaluation of sampling frequency should be based on a components of variance analysis, such that the recommended sampling plan will target the largest sources of variation. The recommended sampling plan must be able to provide sufficient data to meet the requirements of the analyses discussed in Section 14.2 on a semiannual basis.

14.3.3 Confirmation Sampling

When a well initially exceeds one of the action levels, a confirmation sample may need to be collected. A single sample should be collected as soon as possible after it has been determined that an action level may have been exceeded. In most cases a single confirmation sample should be sufficient. Under certain circumstances, such as a well with large short term sampling variability, it may be desirable to collect more than a single confirmation sample.

The results of this sample will be compared to a one-sided 95% lower prediction limit. This limit is to be calculated from the current data that triggered the action level. If the confirmation sample results are less than the lower limit, the action level is considered unconfirmed and sampling and reporting proceeds as before. If the confirmation result is greater than the lower limit, exceedance of the action level is confirmed and the appropriate response is taken. The construction of a prediction limit for a single value (as opposed to a mean value, as discussed in Section 14.2) will be included in an SOP.

The analyst should also compare the results from any well that triggers an action level to those from upgradient wells to see if the source may be isolated. This comparison is best done through Analysis of Variance (ANOVA) techniques. The determination of what wells are upgradient to the well in question will need to be established through consultation with cognizant groundwater professionals.

14.3.4 Nonroutine Sampling

Once an action level is exceeded, the sampling frequency should generally be increased to rebaseline the groundwater parameters in the well. Since triggering of an action level indicates a change over the previous characteristics of the groundwater at the well, the new well characteristics may be established much the same as if the well were new. Hence, upon exceeding an action level, sampling will be increased to four samples taken quarterly for one year. Alternatively, a statistical sampling design may be implemented based on the historical data from the well and the severity of the problem at the well.

15. SITE-WIDE DATA MANAGEMENT AND REPORTING

Groundwater information at the INEL is collected by DOE, the USGS and numerous contractor organizations. The purpose of this section is to outline the minimum data management and reporting requirements for data and information collected under the INEL Groundwater Monitoring Program. The primary data management and reporting objectives for the INEL Groundwater Monitoring Program are:

- Establish a well-defined and consistent process
- Integrate all pertinent groundwater monitoring data and information from the various INEL groundwater sampling organizations
- Ensure the maximum availability and usefulness of the data and information collected
- Maximize the use of existing information system resources.

Data management and reporting practices for observational monitoring and compliance monitoring can vary. Where appropriate, distinctions are made regarding these practices.

15.1 Records Management

A record is broadly defined as "...papers or other documentary materials, regardless of their physical form, that are made or received in the course of public business and are worth preserving temporarily or permanently." (DOE Order 1324.5, "Records Management Program").

All original records generated under the INEL Groundwater Monitoring Plan, or under any of its implementing appendices or procedures, will be retained by the sampling organization as permanent project records. These records shall be maintained in a records management system by the appropriate contractor or agency. Each INEL contractor's records management system will meet the requirements in DOE Order 1324.2A,"Records Disposition" and the QA records requirements as stated in its contractor-specific quality plans (see draft "Quality Assurance Manual for INEL Groundwater Monitoring"; DOE, 1993). The USGS will maintain its system in accordance with the USGS QA records requirements stated in its agency-specific quality plan. The applicable QA plans include:

- Quality Assurance Project Plan for Groundwater Monitoring Activities at Argonne National Laboratory - West (ANL-W)
- Quality Program Plan for the EG&G Idaho Environmental Monitoring Unit Groundwater Monitoring Program (EG&G Idaho)

- Quality Assurance Project Plan for Groundwater Monitoring, Westinghouse Idaho Nuclear Company (WINCO)

- Quality Assurance and Sampling and Analysis Program, USGS.

Hard and electronic copies of all appropriate records will be maintained in a central groundwater data repository. The records developed from the data/information submitted by the sampling organizations shall be maintained in a management system that:

- Meets the requirements of DOE Order 1324.2A

- Ensures that INEL Environmental Monitoring Program records are generated, identified, authenticated, and indexed, and that they are retrievable

- Ensures that records are maintained, until disposition, in Records Storage.

At a minimum, INEL Groundwater Monitoring Program records will include the following:

- Laboratory analytical data (raw and summarized) for all specified analytes

- Water quality data collected in the field, including temperature, pH, and specific conductance

- Measurements of depth to groundwater at the time of sample acquisition, for all samples acquired

- Statistical calculations performed on the results of groundwater sample analyses, including documented comparisons of such results with background values

- Sample management and tracking records

- Field logs

- Document control records

- Sample validation and evaluation records

- Evaluations of sampling results

- Deliverable reports

- QA records and documentation.

Copies of all groundwater data collected by this program represent official records. These records will be retained throughout the duration of the active and closure/D&D phases of the applicable facility or facilities or for a minimum of 10 years, whichever is longer. After this period, DOE will notify EPA and/or IDHW, as appropriate, at least 45 days prior to destruction or disposal of any such records.

All groundwater records specifically related to RCRA-required groundwater sampling activities will comply with the recordkeeping and reporting requirements of 40 CFR 265.94.

Copies of data that are used in selection of response actions for the FFA/CO will be maintained by ER in compliance with Section 20.1 of the FFA/CO. An Administrative Record and Index have been established by ER for all INEL CERCLA response actions, in accordance with the FFA/CO.

15.2 Data Management

A data management plan is necessary to ensure effective management of data generated or used for INEL Groundwater Monitoring Program activities. Data management practices will be established that ensure data are technically valid and meet all regulatory and programmatic requirements.

DOE-ID ESD is responsible for maintaining a copy of all INEL groundwater monitoring data in a central data management system. Hard and electronic copies of all groundwater data submitted to DOE-ID ESD in support of the INEL Groundwater Monitoring Program will be maintained in this system. The system will be accessible by all INEL groundwater monitoring and groundwater-related programs. The specification and selection process for the central data base system will include a detailed review and evaluation of existing information system resources.

15.2.1 Compliance Monitoring Data Management

All raw analytical data will be validated, summarized, and maintained by the sampling organization in accordance with its organization-specific data management requirements. At a minimum, each sampling organization has the following responsibilities for data management:

- Ensure that data are readily accessible and retrievable
- Maintain hard and electronic copies of all analytical results for both regular and QA samples
- Ensure that data are maintained in a controlled environment, with respect to both access and changes to the data
- Ensure that data base structures are compatible with the data structures for the central repository for INEL Groundwater Monitoring Program data.

As shown in Figure 13-1, the INEL Groundwater Monitoring Program Generic Data/Report Flow Process for Routine samples, electronic copies of all analytical results data are transmitted to DOE-ID ESD. This deliverable shall be an ASCII file with a standard data structure. The deliverable will meet the requirements for data listings and summary statistics tables requirements of Section 6.10 ("Procedures for Evaluating Assessment Monitoring Data"), contained in the *RCRA Groundwater Monitoring Technical Enforcement Guidance Document* (EPA, 1986). Responsibility for validation of all data, prior to submittal to DOE-ID ESD, resides with the data submitter.

All groundwater monitoring information and data collected under the INEL Groundwater Monitoring Program will be made available to the INEL ERP through the INEL CERCLA administrative records repository and the Environmental Restoration Information System (ERIS) data base.

15.2.2 Observational Monitoring Data Management

15.2.2.1 USGS Monitoring Data Management. There are two final repositories for the groundwater monitoring data collected by USGS. The data will be uploaded into the DOE-ID ESD central data base and are also maintained in STORET (STOrage and RETrieval), an EPA data base system for environmental data accessible by most states and EPA regional offices.

Groundwater monitoring analytical results from USGS sampling activities are produced by either RESL or the USGS National Water Quality Laboratory in Lakewood, Colorado. RESL analytical results reside in the RESL data base. RESL periodically provides the data in electronic format to the USGS District Office for inclusion in the water-quality data base of the NWIS (National Water Information System). The NWIS data are periodically uploaded to WATSTOR (National WATer Data STORage and Retrieval System), a nationally accessible data base supported by the USGS. Data from WATSTOR will be downloaded semiannually to the DOE-ID ESD central data base and periodically to STORET.

15.2.2.2 Other Observational Monitoring Data Management. All groundwater monitoring data and information collected by "other" (i.e., non-USGS) observational monitoring programs or by preconstruction characterization (as required in DOE Order 5400.1) programs will be collected, maintained and stored in accordance with the specific programmatic and QA requirements outlined in the program-specific Program Management and QA plans. However, all data, to the greatest extent possible, should be compatible with the general format and contract requirements for compliance monitoring data (Section 15.2.1). Copies of all pertinent groundwater data will be submitted to DOE-ID ESD for inclusion in the central data management system (Section 15.2).

15.3 Data Reporting

Routine and special reporting will be done in conjunction with INEL monitoring activities. Routine reports will be written and transmitted to DOE in accordance with the general flow diagram in Figure 13-1. Special reports will be written and transmitted to DOE in response to detecting groundwater contamination which exceeds the action levels described in Section 13. All deliverable reports, and data included in these reports, will be reviewed for compliance with applicable quality plan requirements, prior to submittal. Review documentation and all deliverable reports will be retained as permanent project quality records in compliance with the applicable requirements for "Quality Assurance Records" or "Quality Records" for each sampling organization, and the requirements of Section 15.1.

15.3.1 Routine Reporting

Routine reporting for INEL Groundwater Monitoring activities is comprised of:

- Area-specific Groundwater Quality Reports
- USGS Reports
- RCRA Reports
- CERCLA Reports
- Annual INEL Environmental Monitoring report.

An area-specific Groundwater Quality report will be written by the sampling organization after each sampling round, and after subsequent data review and analysis processes are completed. This report is due to DOE-ID ESD within 90 days of completion of the sampling round. This report will include hard and electronic copies of all sampling data. Sampling organizations under DOE-ID's cognizance will transmit their reports directly to DOE-ID ESD in accordance with their standard company reporting procedures. ANL-W will transmit its report through DOE-CH to DOE-ID ESD in accordance with its standard company reporting procedures. At a minimum, this report shall include the following:

- Laboratory analytical data (raw and summarized) for all specified analytes
- Water quality data collected in the field, including temperature, pH, and specific conductance
- Measurements of depth to groundwater at the time of sample acquisition, for all samples
- Statistical calculations performed on the results of groundwater sample analyses, including documented comparisons of such results with background values

- Evaluation of sampling results.

To the greatest extent possible, these reports will adhere to the format for the appropriate sections of the annual INEL Environmental Monitoring report, outlined in DOE Order 5400.1, Attachment II-1.

The USGS will provide a progress report to DOE-ID ESD on a quarterly basis. In addition, USGS-gathered hydrologic data and results of USGS interpretive studies are released as Open-File data reports, Water-Resources Investigations reports, and as journal articles and scientific abstracts.

A routine RCRA Interim Status Groundwater Monitoring report will be compiled and periodically submitted to the Director of the Idaho Department of Health and Welfare (IDHW) through DOE-ID. Reporting will be conducted in accordance with the requirements of 40 CFR 265.94(a) and State of Idaho Hazardous Waste Regulations IDAPA 01.5009.065. Reporting frequencies are as follows:

- Within 15 days after the validation of quarterly analytical results, during the first year of operation, all validated analytical results for the monitored analytes for each monitoring well will be submitted. For each well, any parameter whose concentration exceeded the maximum concentration limits (MCLs) listed in Appendix III of 40 CFR 265 will be identified.

- By the following March of each calendar year during the active life of the facility, all analytical results for all monitored analytes for each monitoring well will be reported, along with the required statistical evaluations for those parameters; all significant differences from initial background values will be identified; and an evaluation of water table elevation measurements will be included. If specific actions have been taken as a result of fluctuations in water table elevations, such actions will be described in all necessary detail.

The annual INEL Environmental Monitoring report is a compendium of all groundwater data, including results of data analysis, determinations made, and recommendations made in the course of the year under the INEL Groundwater Monitoring Program or related programs (e.g., ERP CERCLA activities). Per DOE Order 5400.1, "The purpose of the report is to present summary environmental data so as to characterize site environmental management performance, confirm compliance with environmental standards and requirements, and highlight significant programs and efforts.

In accordance with DOE Order 5400.1, Chapter II-1, 4, all applicable groundwater monitoring data collected during the previous year will be summarized and submitted to DOE-ID for inclusion in the annual INEL Environmental Report. All sampling organizations will submit their reports annually to DOE-ID ESD by February 1. DOE-ID ESD will integrate the information on all pertinent groundwater monitoring activities at the INEL, which will include summarizing all significant routine activities and/or incidents by April 1. The general format for the report is provided in DOE Order 5400.1, Attachment II-1.

15.3.2 Action Level Reporting

INEL-specific action level criteria and their required response scenarios were presented in Section 13. These response scenarios include routine and additional (special) reporting requirements. The reporting and reports done as a part of action level response scenarios are discussed below. All reports referenced are generated only after the original sampling results have been validated, confirmatory samples have been collected, and the results confirm the initial sampling results.

15.3.2.1 Routine Action Level Reporting

No additional reports are produced in conjunction with this action level.

15.3.2.2 Unusual Occurrence (UO) Action Level Reporting

If a contaminant(s) is detected which meets the UO action level criteria outlined in Section 13.2.2, the minimum response will be to meet all Occurrence Reporting requirements specified in DOE Order 5000.3B, Attachment II. In addition, if a Moderate Concern or a Significant Concern action level is exceeded, then an informal Moderate Concern report or a Significant Concern report will be produced. These reports will be written by the sampling organization and will be based on the available sampling and operations information. In addition, the contents of the Significant Concern report will incorporate the recommendations of the INEL Groundwater Committee. Each report will describe the situation (e.g., quantity, type, and location of the contamination), the probable sources of contamination, additional monitoring requirements, and corrective actions which have been taken or should be taken to mitigate the release or spread of contamination.

Each report will be transmitted by the sampling organization, as soon as practical, to the INEL Groundwater Committee and subsequently to the Director, DOE-ID ESD for concurrence. The Significant Concern report is then transmitted to the DOE-ID Deputy Manager for Operations for management review and further disposition.

15.3.3.3 Environmental Occurrence Reporting

If a groundwater contaminant is detected which meets the Environmental Occurrence action level criteria outlined in Section 13.3.3, an Environmental Occurrence report will be prepared in accordance with the requirements of DOE Orders 5484.1 and 5000.3B.

If a release of a groundwater contaminant that exceeds either a DOE standard or a regulatory threshold (e.g., SDWA MCLs) is discovered during monitoring, the sampling organization will immediately notify DOE-ID ESD. The DOE-ID ESD contact for groundwater issues will immediately notify the DOE-ID Deputy Manager for Operations, who will convene the Environmental Occurrence Investigation Board.

The notification will be followed up by a written summary report. Sampling organizations under the cognizance of DOE-ID will report directly to DOE-ID ESD. ANL-W will report to DOE-ID ESD through DOE-CH.

In the event of an environmental occurrence caused solely by exceeding a DOE action level, the DOE-ID Deputy Manager for Operations will inform DOE-HQ within 72 hours and a formal investigation will be convened in accordance with the requirements of DOE Order 5484.1. The Environmental

Occurrence report will be written by the sampling organization and forwarded to the Environmental Occurrence Investigation Board as soon as possible. At a minimum the report will describe the situation (e.g., quantity, type, and location of the contamination), the probable sources of contamination, additional monitoring requirements, and corrective actions which have been taken or should be taken to mitigate the source of contamination.

If resampling confirms that a regulatory threshold has been exceeded, DOE-ID ESD, DOE-CH if applicable, and the sampling organization will jointly notify the DOE Headquarters Emergency Operations Center (EOC) as required by any applicable regulations, as well as the facility landlord and the WCC. DOE/contractor notification to any regulatory agency of any significant release shall be concurrent with notification of the DOE-HQ EOC. The discovery of a release of any CERCLA hazardous substance in excess of a reportable quantity (40 CFR 302.4 and 302.5) will be reported to the National Response Center in accordance with 40 CFR 302.6. The discovery of an EPA Interim Primary Drinking Water Standards (40 CFR 265, Appendix III) being exceeded at a RCRA Interim Status facility, unless superseded by the FFA/CO, will be reported through DOE-ID to the Director of the Idaho Department of Health and Welfare (IDHW) in accordance with 40 CFR 265.94. Nonperiodic notification requirements are addressed in 40 CFR 265.94, and will take precedence over the requirements above for RCRA facilities. Where applicable, existing reporting formats will be used.

In accordance with the DOE/State of Idaho Environmental Oversight and Monitoring Agreement (DOE, 1990), DOE-ID will notify the State's designated INEL coordinator of any release of a hazardous substance, pollutant, contaminant or radioactive material at the INEL that exceeds applicable regulations, standards or permit conditions. DOE-ID ESD will notify the State's designated INEL coordinator by telephone within 48 hours of detecting such a release. If the presence of the release is confirmed through followup sampling and analysis, a formal report will be made through DOE-ID to the State as soon as practical.

DOE-ID ESD shall maintain documentation of responses to environmental occurrences and have it available for regulatory agency inspectors, DOE auditors, and the general public.

15.3.3 USGS Reporting

If the USGS detects a contaminant which exceeds a historical trend, or if the contaminant exceeds the concentration occurring in water from nearby wells, it will provide oral notification to the DOE-ID ESD groundwater contact followed by a written report. USGS data which indicate any new potential health or environmental problems at the environmental occurrence level will first be verified, and if confirmed, a written report will then be distributed to DOE, the State of Idaho, and EPA Region 10. This report will be made available to the public upon request.

15.4 Coordination with Agencies and the Public

Cooperation and coordination with Federal and State agencies and the public are essential to maximize the efficiency and effectiveness of this program. Although this Plan has been developed primarily to meet the requirements of DOE, input has been solicited from the State of Idaho Environmental Oversight and Monitoring Program. Final copies of this Plan will be made available to the applicable federal and state agencies upon request and maintained for public review in the Idaho Falls Public Reading Room. In addition, a summary of groundwater monitoring results will be made available to the applicable federal and state agencies and the public on an annual basis.

Information concerning the discovery of significant groundwater quality issues will be made available to the public, through DOE-ID, as soon as practical. Significant groundwater quality issues will be reported upon confirmation that a significant problem exists and after the issue has been reviewed by DOE-ID and DOE-HQ.

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