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State of Idaho

INEL Oversight Program

SUMMARY OF GROUND WATER AND SURFACE WATER FLOW AND CONTAMINANT TRANSPORT COMPUTER CODES USED AT THE IDAHO NATIONAL ENGINEERING LABORATORY (INEL)
VERSION 1.0, AUGUST 1992

by
Phillip J. Bandy and L. Flint Hall

State of Idaho
INEL Oversight Program Technical Report 92-XX

March 1993

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(Idaho state seal)

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SUMMARY OF GROUND WATER FLOW AND CONTAMINANT TRANSPORT COMPUTER CODES USED AT THE IDAHO NATIONAL ENGINEERING LABORATORY (INEL), VERSION 1.0, MARCH 1993

ABSTRACT

This report presents information on computer codes for numerical and analytical models that have been used at the Idaho National Engineering Laboratory (INEL) to model ground water and surface water flow and contaminant transport. Organizations conducting modeling at the INEL include: EG&G Idaho, Inc., U.S. Geological Survey, and Westinghouse Idaho Nuclear Company. Information concerning computer codes included in this report are: agency responsible for the modeling effort, name of the computer code, proprietor of the code (copyrite holder or original author), validation and verification studies, applications of the model at INEL, the prime user of the model, computer code description, computing environment requirements, and documentation and references for the computer code.

INTRODUCTION

Evaluation of the status and trend of environmental quality at the Idaho National Engineering Laboratory (INEL) is of concern to many of the subcontractors to the Department of Energy (DOE) and Federal and State agencies and organizations who conduct activities on the site. Analytical and numerical modeling techniques are tools used by organizations at INEL to determine how surface and ground water flows and how contaminants are transported across the surface of the site, through the vadose zone, and into the ground water in the Snake River Plain aquifer that underlies the site.

Agencies and organizations who conduct ground water and surface water modeling investigations include: EG&G, Idaho, Inc., U.S. Geological Survey (USGS), and Westinghouse Idaho Nuclear Company (WINCO). This report presents descriptions of computer modeling codes that have been employed by organizations at INEL. Details about ground water and surface water computer codes included in this report are: agency responsible for the modeling effort, name of the computer code, proprietor of the code (copyrite holder or original author), validation and verification studies that have been performed on the model, application of the model at INEL, prime user of the model, a description of the computer code, the computing environment requirements, and information on documentation and references for the computer code.

PURPOSE AND OBJECTIVE

The State of Idaho INEL Oversight Program is mandated to perform independent evaluation of environmental monitoring at and in the vicinity of the INEL. Reviewing numerical and analytical computer codes used to model ground water and surface water flow and contaminant transport is a means of assessing monitoring programs, and evaluating impacts of past, current, and proposed activities at the INEL. The purpose of this investigation was to compile information on computer codes that have been, or currently are being used to model ground water and surface water flow and contaminant transport. The objective of this investigation is to present computer code information in a single document in readily accessible form for ease of reference and use.

METHOD

Information on ground water and surface water flow and contaminant transport computer codes contained in this report was compiled from reviews of technical documents produced by DOE and its' subcontractors, interviews with program contacts, and interaction with agency and subcontractor personnel at technical meetings held in Idaho Falls in October 1991 and June 1992.

Ground Water and Surface Water Flow and Contaminant Transport Computer Codes used at INEL, Version 1.0, August 1992.

Agency	Code Name / Proprietor / Verification / Validation	Application / Prime User	Code Description / Computing Environment / Documentation & References
EG&G	**CHAINT** Proprietor: Westinghouse Hanford Operations, Richland, WA	2D GROUND WATER CONTAMINANT TRANSPORT R.C. Arnett, Subsurface and Environmental Modeling Unit, EG&G Idaho Inc.	Code Description: CHAINT is a counterpart to the MAGNUM-2D computer code designed to simulate multicomponent contaminant transport in a ground water system. The code considers advection, diffusion and dispersion, sorption, decay chains, and time varying mass release. CHAINT is limited to 2D systems. CHAINT uses the Galerkin finite element method to solve the transient form of the governing equation. The CHAINT code utilizes a dual permeability approach to represent fractured porous medium. The code can handle heterogeneous, anisotropic systems with networks of discrete fractures. The porous zones in the domain are modeled using standard two-dimensional isoparametric finite elements, i.e., triangles and quadrilaterals. Discrete fractures are modeled using line elements which are embedded along sides of the continuum elements. In addition, the code can accommodate a variety of initial and boundary conditions. Primary outputs of the CHAINT code are contaminant concentrations and fluxes at specified locations. The CHAINT computer code has been recently used at INEL to model major contaminant plumes in the Snake River Plain aquifer (Baca, et. al., 1984); the code has also been applied to other DOE sites. Computer Requirements: CHAINT is written in FORTRAN 90 standard language and is operational on the CRAY supercomputer. Practical applications of this code require availability of a large mainframe or a high-end workstation. Support software for this code requires DISSPLA and GKSS graphic kernals. A copy of the source code can be obtained directly from Westinghouse Hanford Operations in Richland, WA. The INEL version is significantly advanced and modified from the original base version. This new version will be released after preparation and issuance of updated documentation. References: Baca, R.G., R.C. Arnett, and D.W. Langford, 1984, Modeling Fluid Flow in Fractured Porous Rock Masses by Finite Element Techniques, International Journal of Numerical Methods in Fluids, Vol. 4, pp. 337-348. Kline, N.W., R.L. England, and R.G. Baca, 1986, CHAINT Computer Code: Users Guide, RHO-CR-144 P, Rockwell Hanford Operations, Richland, WA.

Ground Water and Surface Water Flow and Contaminant Transport Codes used at INEL, Version 1.0, August 1992.

Agency	Code Name / Proprietor / Verification / Validation	Application / Prime User	Code Description / Computing Environment / Documentation & References
EG&G	**Codell NRC Surface Water Codes** Proprietor: U.S. Nuclear Regulatory Commission	2D DISPERSION IN SURFACE WATER Art Rood, Subsurface and Environmental Modeling Unit, EG&G Idaho, Inc.	Code Description: The codes STTUBE and TUBE are useful for two-dimensional dispersion of a continuous source into a river after steady state has been attained. These codes require actual river cross sections and roughness coefficients. RIVLAK code is also used for dispersion in a river, but the source may be either steady or unsteady. The river channel must be of constant width and depth. Computer Requirements: Requires an IBM or compatable PC. Reference: Codell, R.B., K.T. Key, and G. Whelan, 1982, A Collection of Mathematical Models for Dispersion in Surface Water and Ground Water, NUREG-0868.

Agency	Code Name / Proprietor / Verification / Validation	Application / Prime User	Code Description / Computing Environment / Documentation & References
EG&G / WINCO	**DAMBRK** Proprietor: National Weather Service Verification and Validation: *The NWS version B of* DAMBRK was converted to Fortran 77 and compiled on the INEL CYBER 176 computer system. A DAMBRK Teton Dam failure-analysis data-set was included with the code and was used to verify the codes execution and results (Van Haaften, et. al., 1984)	HYDRAULIC ROUTING MODEL Van Haaften, D.H., Koslow, K.N., and Naretto, C.J., Thermal and Process Analysis *Branch Earth, and Life* Sciences Branch, EG&G Idaho, Inc. Thomas, T.R., Technical Department, WINCO.	Code Description: DAMBRK is a numerical routine using hydrodynamic theory to describe the dam-break wave and to propagate the wave downstream. Three functional elements are involved in the code: description of the dam failure mode and initial conditions; computation of the time-varying flow and water surface elevations at the breach; and routing of the flood through *the downstream valley. These functions are accomplished via a number of input elements,* including breach description, reservoir inflow and storage characteristics, downstream frictional resistance, flow losses, and downstream channel geometry. The DAMBRK code solves equations of continuity and momentum conservation in one dimension. It utilizes the partial differential equations for unsteady flow in open channels (Van Haaften, et. al., 1984). Analysis performed at the proposed New Production Reactor (NPR) Primary Site E on INEL. Analysis (Van Haaften, et. al., 1984) determined flood conditions resulting from an assumed inflow to Mackay Reservoir equal to the probable maximum flood for the watershed and consequent failure of Mackay Dam. Computer Requirements: Mainframe computer or high-end workstation. References: Fread, D.L., July 18, 1983, DAMBRK: The NWS Dam-Break Flood Forecasting Model, Office of Hydrology, National Weather Service, Silver Spring, Maryland. Thomas, T.R., Chipman, N.A., and Berreth, J.R., 1986, Impact of Rain, Flood, and River Water on Potential Near-Surface Disposal of High-Level Radioactive Waste at the Idaho Chemical Processing Plant; Westinghouse Idaho Nuclear Company, Inc., Idaho Falls, Idaho, WINCO-1042 Van Haaften, D.H., Koslow, K.N., and Naretto, C.J., May, 1984, Hydrologic Analysis of a Mackay Dam Failure During a Probable Maximum Flood on Big Lost River, Idaho, EG&G Internal Technical Report, SE-A-84-018.

Ground Water and Surface Water Flow and Contaminant Transport Codes used at INEL, Version 1.0, August 1992.

Agency	Code Name / Proprietor / Verification / Validation	Application / Prime User	Code Description / Computing Environment / Documentation & References
EG&G	FECTRA, v. 2.0 Proprietor: Westinghouse Hanford Operations, Richland, WA (the INEL version of this code is significantly modified from the base version). Verification and Validation: FECTRA has been verified and benchmarked to a limited degree. The FECTRA 3D code is still under development and will be available after completion of code verification, benchmarking, and documentation.	2 & 3D GROUND WATER CONTAMINANT TRANSPORT R.C. Arnett, Subsurface and - Environmental Modeling Unit, EG&G Idaho, Inc.	Code Description: FECTRA is designed to simulate contaminant migration through saturated, fractured, porous medium. It simulates advection, dispersion, diffusion, decay, and retardation. Using a 2 & 3D, finite element solution method, FECTRA is designed to be used with MAGNUM-3D. MAGNUM-3D provides the advective flow field for FECTRA. This code was selected because of its compatibility with MAGNUM-3D; it handles 2 & 3D, it has sheet elements to handle discrete zones, is specifically applicable to INEL, and is efficient. Computer Requirements: Requires a workstation or mainframe computer. Reference: User's manual and code testing report is in preparation, scheduled for completion in FY 1993.
EG&G	FLAME, v. 1.0 Proprietor: EG&G Idaho, Inc. Verification and Validation: The FLAME computer code has been verified and benchmarked to a limited degree.	CONTAMINANT TRANSPORT IN ARID SITE VADOSE ZONES R.C. Arnett, Subsurface and Environmental Modeling Unit, EG&G Idaho, Inc.	Code Description: The FLAME computer code is designed to predict contaminant migration through a variably saturated vadose zone. The code simulates advection, dispersion, diffusion, decay and sorption. The code uses a finite element technique to solve the governing equation. The FLAME contaminant transport code is used in conjunction with the FLASH fluid flow code. FLAME was chosen for use at INEL because a review of available codes indicated a lack of applicability of the codes in various areas. The FLAME code was developed for specific application to the hydrogeology of the INEL site. Computer Requirements: Requires a workstation or mainframe computer. Reference: The FLAME computer code was only recently developed. A technical report for the code is planned for completion in FY-92.

Ground Water and Surface Water Flow and Contaminant Transport Codes used at INEL, Version 1.0, August 1992.

Agency	Code Name / Proprietor / Verification / Validation	Application / Prime User	Code Description / Computing Environment / Documentation & References
EG&G	FLASH, v. 2.6 Proprietor: EG&G Idaho, Inc. Verification and Validation: The FLASH computer code has been verified and bench-marked.	FLUID FLOW IN ARID SITE VADOSE ZONES R.C. Arnett, Subsurface and Environmental Modeling Unit, EG&G Idaho Inc.	Code Description (from Baca, et al., 1992): FLASH was used in the verification and benchmark testing of the UNSAT-H computer code (Baca and Magnuson, 1990). FLASH was used also in the verification and benchmark testing of the PORFLO-3 computer code (Magnuson, et al., 1990). A technical report on the model theory, numerical technique, and code testing is in preparation and is expected to be issued in FY-92 (Baca, 1992). The FLASH computer code was designed to model the unique hydrologic characteristics of the RWMC vadose zone, which is composed of fractured-porous basalt strata and interbedded sediments. Development of the code was motivated by the fact many of the available codes were unable to: (1) describe flow in discrete fractures, (2) correctly solve the flow equation with the strongly nonlinear hydraulic properties of the site, and (3) provide convergent solutions for arid site conditions. The FLASH code is designed to simulate fluid flow and/or heat transport in a variably saturated, porous continuum with discreet fracture systems. The code solves the time-dependent, two dimensional forms of the governing equations in either Cartesian or radial coordinate systems. The major processes modeled are: liquid and vapor flow, fluid flow by capillary, gravity, and thermal forces, and heat transport by conduction. The code uses line elements for discrete conduits and isoparametric triangles and quadrilateral elements for porous zones. The code accommodates three types of boundary conditions: (1) fixed pressure head and/or temperature, (2) fluid and/or heat flux, and (3) free drainage flow boundary. The code is interfaced with a number of post processor routines that allow the user to calculate and plot: (1) velocity vectors, (2) streamlines or pathlines, and (3) pressure and/or temperature contours. The FLASH code is used in conjunction with the general contaminant transport code, FLAME. Computer Requirements: FLASH is written in FORTRAN 90 and is operational at INEL on a CRAY X-MP 2/16, SUN workstation, and IBM or compatable PC with extended memory. Practical applications of the FLASH code to realistic flow and transport problems in fracture-porous media will require an 80486-based PC, scientific workstation, or mainframe computer. References: Baca, R.G., 1992, A Finite Element Computer Code for Variably-Saturated Flow, EG&G, Idaho, Inc., EGG-GEO-10274 Baca, R.G., and S.O. Magnuson, 1990, Independent Verification and Benchmark Testing of the UNSAT-H Computer Code, Version 2.0, EGG-BEG-8811.

Ground Water and Surface Water Flow and Contaminant Transport Codes used at INEL, Version 1.0, August 1992.

Agency	Code Name / Proprietor / Verification / Validation	Application / Prime User	Code Description / Computing Environment / Documentation & References
EG&G	<u>**FLOWMC**</u> <u>Proprietor</u>: EG&G Idaho, Inc.	GROUND WATER TRANSPORT AND DISSOLVED PHASE TRANSPORT IN ONE DIMENSION S.O. Magnuson, Subsurface and Environmental Modeling Unit, EG&G Idaho, Inc.	<u>Code Description</u> (from Baca, et al., 1992): The FLOWMC computer code was developed at EG&G Idaho for specific application to the waste migration problems at INEL. It has also been applied to locations at the Nevada Test Site (Magnuson et al., 1991). The code is capable of solving vertical one-dimensional unsaturated flow through a multilayered system. The numerical solution of the flow equation uses a one-dimensional Galerkin finite element technique. The travel time through the vadose zone is calculated from the resulting pressure head and moisture content profiles. The stochastic FLOWMC code accounts for the statistical nature and spatial variability of hydraulic properties through the use of probability distribution functions. A set of correlated random fields are generated and used in a Monte Carlo simulation process. For each random field, the code solves the one-dimensional flow equation and the water travel-time equation. The Monte Carlo process is performed until the statistical properties (i.e., mean, median, and variance) of the travel-time distribution converge. FLOWMC computes the distribution of water travel-times as a function of the following input data: statistical distribution of the net surface water flux, statistical distribution of any or all hydrologic parameters, and spatial correlation of hydraulic conductivity. The code also has the capability to stochastically model dissolved phase transport in one-dimension. The transport component of the code is designed to solve the time-dependent advection-dispersion equation numerically or analytically. The analytical solution (Esliger and Sagar, 1988) is for a simplified form of the transport equation and uses weighted averages for the transport coefficients. <u>Computer Requirements</u>: FLOWMC is written in standard FORTRAN 77 and can be installed on mainframes, DEC and SUN workstations, and 80386 or 80486-based IBM or compatable PCs. Practical applications of the code require a high performance workstation or mainframe computer. <u>References</u>: Baca, R.G., S.O. Magnuson, H.D. Nguyen, and P. Martin, 1992, A Modeling Study of Water Flow in the Vadose Zone Beneath the Radioactive Waste Management Complex, EGG-GEO-10068. Esliger, P.W., and B. Sagar, 1988, EPASTAT: A Computer Mode for Estimating Releases at the Accessible Environmental Boundary of a High-Level Nuclear Waste Repository - Mathematical Model and Numerical Model, SD-BWI-TA-022, Hanford, WA.

Ground Water and Surface Water Flow and Contaminant Transport Codes used at INEL, Version 1.0, August 1992.

Agency	Code Name / Proprietor / Verification / Validation	Application / Prime User	Code Description / Computing Environment / Documentation & References
EG&G	**GRDFLX** Proprietor: U.S. Nuclear Regulatory Commission	GROUND WATER TRANSPORT AND RADIOACTIVE DECAY Art Rood, Subsurface and Environmental Modeling Unit, EG&G Idaho, Inc.	Code Description: GRDFLX consists of two models whose computational mechanics are quite similar though they perform different tasks. Program GRND calculates the vertically averaged concentration at points in a uniform aquifer of finite thickness with constant physical transport properties. Program FLUX calculates the flux of radioactive liquid effluent passing a plane perpendicular to the ground water flow direction. Both models require most of the same input data and are for horizontal area sources. The models are formulated as analytical solutions to the equations of mass transfer for conservative substances in porous media. Radioactive decay is treated separately from the transport computations. Computer Requirements: Requires an IBM or compatable PC. Reference: Codell, R.B., K.T. Key, and G. Whelan, 1982, A Collection of Mathematical Models for Dispersion in Surface Water and Ground Water, NUREG-0868.

Ground Water and Surface Water Flow and Contaminant Transport Codes used at INEL, Version 1.0, August 1992.

Agency	Code Name / Proprietor / Verification / Validation	Application / Prime User	Code Description / Computing Environment / Documentation & References
EG&G	**GWSCREEN** Version: 1.3 Proprietor: EG&G Idaho, Inc. Verification and Validation: GWSCREEN has shown comparable results when compared against other codes using similar algorithms and has also been shown to provide bounding estimates of ground water concentrations when compared to results from complex numerical codes.	GROUND WATER PATHWAY FROM LEACHING OF SUBSURFACE OR BURIED SOURCES Art Rood, Subsurface and Environmental Modeling Unit, EG&G Idaho, Inc.	Code Description: (from Rood, 1992) GWSCREEN is a semi-analytical mass balance-based model for risk assessment of the ground water pathway from the leaching of surficial and buried contamination. The code was designed for implementation in the Track I and Track II assessment of CERCLA sites identified as low probability hazard at the INEL. The code calculates the limiting soil concentration such that regulatory contaminant levels in ground water are not exceeded. The code uses a mass conservation approach to model three processes: contaminant release from a source volume, contaminant transport in the unsaturated zone, and contaminant transport in the saturated zone. The source model considers the sorptive properties and solubility of the contaminant. Transport in the unsaturated zone is described by a plug flow model. Transport in the saturated zone is calculated with a semi-analytical solution to the advection dispersion equation for transient mass flux input. One of the limitations of this code is that it does not deal with radioactive progeny. Radioactive progeny were ignored because very few of the sites identified for assessment contained radionuclides with long decay chains that would have significant ingrowth of decay progeny. GWSCREEN was designed for assessment and screening of the ground water pathway when field data are limited. It is not intended to be a predictive tool. Computing Environment: GWSCREEN is written in standard FORTRAN and is compiled for operation on an IBM or compatable PC. The FORTRAN source code is also compatible with most FORTRAN compilers on UNIX operating systems. References: Rood, A.S., 1992, GWSCREEN, A Semi-Analytical Model for Assessment of the Ground Water Pathway from Surface or Buried Contamination: Theory and User's Manual, 47 p.

Ground Water and Surface Water Flow and Contaminant Transport Codes used at INEL, Version 1.0, August 1992.

Agency	Code Name / Proprietor / Verification / Validation	Application / Prime User	Code Description / Computing Environment / Documentation & References
EG&G	<u>**MAGNUM-2D**</u>, <u>Proprietor</u>: Westinghouse Hanford Operations, Richland, WA (the INEL version of the code was significantly modified from the original base version.)	2D SATURATED GROUND WATER FLOW R.C. Arnett, Subsurface and Environmental Modeling Unit, EG&G Idaho, Inc.	<u>Code Description</u>: The MAGNUM-2D computer code was originally developed at the Hanford site for modelling ground water flow in the vicinity of a high-level waste repository. The MAGNUM-2D code is unique in that it can simulate ground water flow and/or heat transport in a two-dimensional domain, i.e., radial or Cartesian system. The MAGNUM-2D code uses a dual permeability approach to represent the hydraulic behavior of a fractured porous media. The porous zones in the domain are modeled using standard two- and three-dimensional isoparametric finite elements. Discrete fractures are modeled using line elements which are embedded along the sides of the continuum elements. The code can be used to produce transient and steady-state simulations of ground water flow. MAGNUM-2D is interfaced with support software that computes and plots: streamlines, pathlines, travel times, velocity vectors, contours, profiles, and time histories. MAGNUM-2D has been used in ground water modeling studies of plumes in the Snake River Plain aquifer. <u>Computer Requirements</u>: MAGNUM-2D is written in FORTRAN 90 standard language. Practical application of MAGNUM-2D requires availability of a large mainframe or a high-end workstation. <u>Reference</u>: England, R.L., N.W. Kline, K.J. Ekblad, R.G. Baca, 1986, MAGNUM-2D Computer Code: User's Guide, RHI-CR-143 P, Rockwell Hanford Operations, Richland, WA

Ground Water and Surface Water Flow and Contaminant Transport Codes used at INEL, Version 1.0, August 1992.

Agency	Code Name / Proprietor / Verification / Validation	Application / Prime User	Code Description / Computing Environment / Documentation & References
EG&G	**MAGNUM-3D**, v. 4.0 Proprietor: Westinghouse Hanford Operations, Richland, WA (the INEL version of the code was significantly modified from the original base version.) Verification and Validation: MAGNUM-3D has undergone extensive verification and benchmarking.	SATURATED GROUND WATER FLOW R.C. Arnett, Subsurface and - Environmental Modeling Unit, EG&G Idaho, Inc.	Code Description: MAGNUM-3D is a finite element code designed to model saturated flow in fractured porous media in 2D or 3D. 2D sheet elements are used for discrete zones or for strictly 2D problems and isoparametric hexahedrons or triangular prisms for three dimensional zones. MAGNUM-3D is used in conjunction with FECTRA for contaminant transport problems. Model features include: compatibility with unsaturated codes, sheet elements for use with discrete zones in basalt, 2D and 3D model domain, substantial set of pre- and post-processors, capable of modeling conditions where transmissivity anisotropy is not aligned with the coordinate system. Computer Requirements: Requires a workstation or mainframe computer. References: Arnett, R.C., S.A. Estey, and D.B. Aichele, 1986, Verification and Benchmarking of the MAGNUM-3D Ground Water Flow Code, Rockwell Hanford Operations, Richland, WA., RHO-BW-ST-69P. Estey, S.A., R.C. Arnett, and D.B. Aichele, 1985, User's Guide for MAGNUM-3D: A Three-Dimensional Ground Water Flow Numerical Model, Rockwell Hanford Operations, Richland, WA, RHO-BW-ST-67P.

Ground Water and Surface Water Flow and Contaminant Transport Codes used at INEL, Version 1.0, August 1992.

Agency	Code Name / Proprietor / Verification / Validation	Application / Prime User	Code Description / Computing Environment / Documentation & References
EG&G	**POREFLOW-3D**, v. 2.30 Proprietor: Analytical and Computational Research, Inc. Verification and Validation: POREFLO version 1.0 has been extensively verified and benchmark tested (Magnuson, et., al., 1990). POREFLOW version 2.36 is an updated, multifluid, multiphase version of the original POREFLO computer code, Version 1.0.	FLUID FLOW, HEAT AND CONTAMINANT TRANSPORT Swen Magnuson, Subsurface and Environmental Modeling Unit, EG&G Idaho Inc.	Code Description (from Baca, et al., 1992): POREFLOW is a computer code developed to evaluate hazardous and radioactive waste problems at the Hanford site by solution of multiphase, fluid flow, heat transfer, and mass transport in variably saturated porous or fractured media. The code is based on numerical solution of the general equation for: (1) time-dependent, nonisothermal porous flow, (2) transport of a reactive solute, and (3) coupled heat transport. The governing equations describing these processes are approximated by an integrated finite-difference technique. Both direct and iterative solution approaches are available and can be used to solve the finite difference equations (the code uses nodal point integration on a three-dimensional finite difference grid and employs several solution options such as ADI, conjugate gradient, etc.). Major assumptions of the model formulation are: (1) the fluid is incompressible, (2) fluid flow is independent of the air phase, (3) hydraulic properties are non-hysteretic, (4) the porous medium is rigid, and (5) solute concentrations do not affect the flow properties of the water. Versions of POREFLOW prior to Version 2.0 were denoted POREFLO. Computer Requirements: POREFLOW is written in FORTRAN 77, is hardware independent, uses FREEFORM command language input, and is easy to install on most mainframe computers. The code is relatively easy to convert to other computer systems. Practical applications of the POREFLOW code to realistic, flow and transport problems in multidimensions require the availability of a scientific workstation or mainframe computer. References: Baca, R.G., S.O. Magnuson, H.D. Nguyen, and P. Martin, 1992, A Modeling Study of Water Flow in the Vadose Zone Beneath the Radioactive Waste Management Complex, EGG-GEO-10068. Baca, R.G., 1992, A Finite Element Computer Code for Variably-Saturated Flow, EG&G Idaho Inc., EGG-GEO-10274 Magnuson, S.O., R.G. Baca, A.J. Sondrup, 1990, Independent Verification and Benchmark Testing of the POREFLOW-3 Computer Code, Version 1.0, EGG-BG-9175. Runchal, A.K., and B. Sagar, 1991, POREFLOW: A Model of Fluid Flow, Heat, and Mass Transport in Multifluid, Multiphase Fractured or Porous Media, User's Manual, Version 2.30, Analytic and Computational Research, Inc.

Ground Water and Surface Water Flow and Contaminant Transport Codes used at INEL, Version 1.0, August 1992.

Agency	Code Name / Proprietor / Verification / Validation	Application / Prime User	Code Description / Computing Environment / Documentation & References
EG&G	TARGET, ver. 4.0 Proprietor: Dames and Moore, Inc., Denver, CO Verification and Validation: TARGET has been verified against numerous analytical equations and laboratory experiments, and has been peer reviewed by Dr. Freeze.	Ground Water Flow and Density-Coupled Contaminant Transport User: Peter Sinton, Dames and Moore.	Code Description: TARGET is a collection of five finite difference computer codes: TARGET2DH - two dimensional, horizontal flow and transport. TARGET2DU - two-dimensional, density coupled, variably saturated, vertical flow and transport. TARGET2DM - three-dimensional flow and transport, structured similar to MODFLOW in that variable-thickness layers can be specified. TARGET3DS - three-dimensional, density-coupled, saturated flow and transport. Constant-thickness layers are specified. TARGET3DU - three-dimensional, density-coupled, variably saturated flow and transport. Constant-thickness layers are specified. All of the TARGET codes can handle transient flow and transport, steady-state flow, variable boundary conditions and variable material properties. The codes can provide detailed information on mass-balance (overall and cell-by-cell), saturation, Darcy velocities, etc. The codes are designed such that data sets are easily converted from one code to another. PLOTAR and POSTAR are acompaning post processors for the TARGET family of codes. PLOTAR permits graphical representation of TARGET results: contour maps of hydraulic head and concentration, vector plots of ground water flow, and plots showing the distrubution of material properties and boundary conditions. POSTAR calculates fluxes of water, heat, or contaminat through cell or model boundaries,plots heads or fluxes as a function of time or distance within the model domain. Computer Requirements: The TARGET codes can be used on IBM or compatable PCs using DOS or UNIX and on VAX computers. TARGET is written in standard FORTRAN 77 and is easily exported to most computer systems. Reference: Dames and Moore, Inc., October, 1985, User's Guide to TARGET. Lewis, S.M. (Dames and Moore), P.O. Scinton (Dames and Moore), M.J. Condran (Dames and Moore), J.W. Gordon (Dames and Moore), 1992, Remedial Ivestigation Report for The Test Reactor Area Percehed Water System (Operable Unit 2-12), EGG-WM-10002

Ground Water and Surface Water Flow and Contaminant Transport Codes used at INEL, Version 1.0, August 1992.

Agency	Code Name / Proprietor / Verification / Validation	Application / Prime User	Code Description / Computing Environment / Documentation & References
EG&G	UNSAT-H, v. 2.0 Proprietor: M.J. Fayer, Pacific Northwest Laboratories, Richland, Washington Verification and Validation: The UNSAT-H code has been verified using analytical solutions and benchmark tested against other independent codes. Some limited comparisons have been made against field data.	WATER BALANCE IN ARID SITE VADOSE ZONE R.C. Arnett or Swen Magnuson, Subsurface and Environmental Modeling Unit, EG&G Idaho, Inc.	Code Description (from Baca et al., 1992): The UNSAT-H code is designed to model dynamic soil-moisture movement through the vadose zone in an arid site. The code solves the one-dimensional Richard's equation. One dimensional movement of water in the vertical direction is modeled as a function of the site-specific meteorological conditions, soil-hydraulic properties and hydrologic boundary conditions. The code accounts for water flow by gravity, capillarity, evapotranspiration, and uptake by plants. The code is useful for estimating the net infiltration rate into the soil. The net infiltration rate for a site can be estimated with the UNSAT-H code by simulating a historical period and monitoring the computed moisture flux at selected depths. The estimated net infiltration rate provides a necessary boundary condition for multidimensional simulations of fluid flow and contaminant transport. One limitation of the code is that it applies strictly to unsaturated flow, i.e., does not handle fully saturated conditions leading to positive pressure heads. A review of water balance codes indicates that UNSAT-H is the only code available that models soil-water flow as a function of meteorological conditions, evapotranspiration, etc. The code is being used at other DOE sites. The code is written in FORTRAN 77 and consists of three modules: (1) DATAINH - a general input file processor, (2) UNSAT-H - the flow simulator, and (3) DATAOUT - a general output processor. Computer Requirements: UNSAT-H will run on an 80386-based IBM or compatable PC. However, more complex simulations require a 80486-based PC or scientific workstation. References: Fayer, M.J., G.W. Gee, and T.L. Jones, 1986, UNSAT-H Version 1.0: Unsaturated Flow Code Documentation and Applications for the Hanford Site, Pacific Northwest Laboratory, Richland, WA., PNL-5899. Baca, R.G. and S.O. Magnuson, 1990, Independent Verification and Benchmark Testing of the UNSAT-H Computer Code, Version 2.0, EGG-BEG-8811. Baca, R.G., S.O. Magnuson, H.D. Nguyen, and P. Martin, 1992, A Modeling Study of Water Flow in the Vadose Zone Beneath the Radioactive Waste Management Complex, EGG-GEO-10068.

Ground Water and Surface Water Flow and Contaminant Transport Codes used at INEL, Version 1.0, August 1992.

Agency	Code Name / Proprietor / Verification / Validation	Application / Prime User	Code Description / Computing Environment / Documentation & References
WINCO	**TRACR3D** Proprietor: Los Alamos National Laboratory	GROUND WATER FLOW AND CONTAMINANT TRANSPORT (3D, finite difference, iso-thermal code) Tom Thomas, Technical Department, WINCO	Code Description: Used to model ground water flow and contaminant transport in the vadose zone and the Snake River Pain aquifer (Thomas, Chipman, and Berreth, 1986). Flooding was modeled to represent a transient water flow and rainfall over several thousand years, a steady-state water flow. Radionuclides which completely leach out in the first few years of rainfall to represent a transient contaminant flow whereas the highly insoluble radionuclides represent a steady-state contaminant flow. Radionuclides modeled were Se-79, Sr-90, Tc-99, Cs-135, and Am-241. It was assumed that the behavior of Cs-137 would be similar to Sr-90 and the behavior of Am-243, Pu-239, and Pu-240 would be similar to Am-241 based on solubilities, sorption coefficients, and half-lives. Computer Requirements: Requires a mainframe computer. References: Robertson, J.B., May, 1974, Digital Modeling of Radioactive and Chemical Waste Transport in the Snake River Plain Aquifer at the National Reactor Testing Station, Idaho, U.S. Geological Survey National Reactor Testing Station Open-File Report, IDO-22054. Robertson, J.B., January, 1977, Numerical Modeling of Subsurface Radioactive Solute Transport from Waste - Seepage Ponds at the Idaho National Engineering Laboratory, IDO-22057. Thomas, T.R., 1988, Modeling Hypothetical Ground Water Transport of NO_3Cr and Cd at the ICPP, WINCO-1060. Thomas, T.R., 1991, Solute Transport Benchmark Studies for TRACR3D Code Verification, WINCO-1083. Thomas, T.R., Chipman, N.A., and Berreth, J.R., 1986, Impact of Rain, Flood, and River Water on Potential Near-Surface Disposal of High-Level Radioactive Waste at the Idaho Chemical Processing Plant; Westinghouse Idaho Nuclear Company, Inc., Idaho Falls, Idaho; WINCO-1042 Thomas, T.R., J.A. Del Debbio, 1988, Fitting the Corrective Dispersive Solute Transport Equation to Soil Column Effluent Data, WINCO-1053. Thomas, T.R., J.A. Del Debbio, 1989, Transport Properties of Radionuclides and Hazardous Chemical Species in the Soils at ICPP, WINCO-1068.

Ground Water and Surface Water Flow and Contaminant Transport Codes used at INEL, Version 1.0, August 1992.

Agency	Code Name / Proprietor / Verification / Validation	Application / Prime User	Code Description / Computing Environment / Documentation & References
USGS	**MODFLOW** Version: None Proprietor: Author is the U.S. Geological Survey. MODFLOW is Public Domain Verification: This model has been tested and used extensively by the regulatory and research communities.	GROUND WATER FLOW Dan Ackerman and Brennon Orr, U.S. Gelogical Survey, INEL Project Office.	Code Description: MODFLOW is a modular quasi-three-dimensional finite-difference model for solving the saturated ground water flow equation. Ground water flow is simulated using a block-centered finite difference approach. The equations can be solved using one of two methods of solving systems of simultaneous linear equations; the strongly implicit procedure or the slice successive overrelaxation method. The modular structure of the code consists of a number of independent packages that deal with the hydrologic system to be simulated such as wells, areal recharge, evapotranspiration, drains, and streams. Layers within the aquifer can be simulated as confined, unconfined, or a combination of the two. MODFLOW includes a variety of options for source terms, input/output, boundary conditions, and time dependent data. The code is also interfaced with pre- and post-processors to aid in the input and output. Computer Requirements: MODFLOW is written in FORTRAN 77 and requires an IBM or compatable PC. Reference: McDonald, M.G., A.W. Harbaugh, 1988, A Modular Three-Dimensional Finite Difference Ground Water Flow Model, in Techniques of Water Resources Investigations of the United State Geological Survey, Book 6, Modeling Techniques, Chapter A1.

Ground Water and Surface Water Flow and Contaminant Transport Codes used at INEL, Version 1.0, August 1992.

Agency	Code Name / Proprietor / Verification / Validation	Application / Prime User	Code Description / Computing Environment / Documentation & References
USGS	**NETPATH** Version: 1.2 Proprietor: Author is the U.S. Geological Survey. NETPATH is Public Domain Verification and Validation: Comparison of results to a series of test cases.	MODELS NET GEOCHEMICAL REACTIONS ALONG A FLOW PATH LeRoy L. Knobel and Roy C. Bartholomay, U.S. Gelogical Survey, INEL Project Office.	Code Description: NETPATH is a computer code for modeling geochemical mass-balance reactions between initial and final waters along a flow path. The processes of dissolution, precipitation, ion exchange, oxidation/reduction, degradation of organic compounds, incongruent reaction, gas exchange, mixing, evaporation, dilution, isotope fractionation, and isotope exchange can be considered. This code is used by the USGS, other governmental agencies, academia, and the general public. Complete chemical analyses of waters, knowledge of likely chemical reactions, and knowledge of primary and secondary mineralogy are required to use the computer code. Computer Requirements: IBM or compatible PC. References: Plummer, L.N., Prestemon, E.C., and Parkhurst, D.L., 1991, An Interactive Code (NETPATH) for Modeling Net Geochemical Reactions Along a Flow Path; US Geological Survey Water-Resources Investigations Report 91-4078, 227 p., 1 diskette.

Ground Water and Surface Water Flow and Contaminant Transport Codes used at INEL, Version 1.0, August 1992.

Agency	Code Name / Proprietor / Verification / Validation	Application / Prime User	Code Description / Computing Environment / Documentation & References
USGS	**VS2D** Version: April 1, 1990 Proprietor: Author is the U.S. Geological Survey. VS2D is Public Domain Verification and Validation: Results of verification are documented in USGS WRIR 83-4099 and USGS WRIR 90-4025	2-DIMENSIONAL VARIABLY SATURATED SINGLE PHASE GROUND WATER FLOW IN POROUS MEDIA John R. Pittman, U.S. Geological Survey, INEL Project Office.	Code Description: VS2D is a computer code for solving problems of variably saturated, single-phase flow in porous media. The mathematical model of this physical process is developed by combining the law of conservation of fluid mass with a nonlinear form of Darcy's law. The resultant mathematical model, or flow equation, is written with total hydraulic potential as the dependent variable. This allows straightforward treatment of both saturated and unsaturated conditions. The spatial derivatives in the flow equation are approximated by central differences written about grid block boundaries. Time derivatives are approximated by a fully implicit backward scheme. Nonlinear storage terms are linearized by an implicit Newton-Raphson method. Nonlinear conductance terms, boundary conditions, and sink terms are linearized implicitly. Relative hydraulic conductivity is evaluated at cell boundaries by using full upstream weighting, the arithmetic mean, or the geometric mean of values from adjacent cells. Saturated hydraulic conductivities are evaluated at cell boundaries by using distance-weighted harmonic means. The linearized matrix equations are solved using the strongly implicit procedure. Nonlinear conductance and storage coefficients are assumed to be represented by one of three closed- form algebraic equations. Alternatively, these values may be interpolated from tabulated data. Nonlinear boundary conditions treated by the code include infiltration, evaporation, and seepage faces. Extraction by plant roots is included as a nonlinear sink term. The code is written in standard ANSI Fortran. Computer Requirements: For most applications, the VS2D code will run effectively on 80386 or 80486 based IBM or campatable PC, however, a scientific workstation or mainframe may be required for more complex model runs. References: Lappola, E.G., Healy, R.W., and Weeks, E.P., 1987, Documentation of computer program VS2D to solve the equations of fluid flow in variably saturated porous media: USGS Water-Resources Investigations Report 83-4099, 184 p. Healy, R.E., 1990, Simulation of solute transport in variably saturated porous media with supplemental information on modifications to the USGS's computer program VS2D: USGS Water Resources Investigations Report 90-4025, 125 p.

Ground Water and Surface Water Flow and Contaminant Transport Codes used at INEL, Version 1.0, August 1992.

Agency	Code Name / Proprietor / Verification / Validation	Application / Prime User	Code Description / Computing Environment / Documentation & References
USGS	**VS2DT** Version: April 1, 1990 Proprietor: US Geological Survey. VS2DT is Public Domain. Verification and Validation: Results of verification are documented in USGS WRIR 83-4099 and USGS WRIR 90-4025	2-DIMENSIONAL SOLUTE TRANSPORT IN VARIABLY SATURATED POROUS MEDIA John R. Pittman, U.S. geolocial Survey, INEL Project Office.	Code Description: VS2DT is a computer code for solving problems of solute transport in variably saturated media. The program uses a finite-difference approximation to the advection-dispersion equation. The program is an extension to the computer program VS2D developed by the USGS, which simulates water movement through variably saturated porous media. Simulated regions can be one-dimensional columns, two-dimensional vertical cross-sections, or axially symmetric, three-dimensional cylinders. Program Options include: Backward or centered approximations for both space and time derivatives, first-order decay, equilibrium adsorption as described by Freundlich or Langmuir isotherms, and ion exchange. The code is written in standard ANSI Fortran. Computer Requirements: For most applications, the VS2DT code will run effectively on an 80386 or 80486-based IBM or compatable PC, however, a scientific workstation or mainframe may be required for more complex model runs. References: Lappola, E.G., Healy, R.W., and Weeks, E.P., 1987, Documentation of computer program VS2D to solve the equations of fluid flow in variably saturated porous media: USGS Water-Resources Investigations Report 83-4099, 184 p. Healy, R.E., 1990, Simulation of solute transport in variably saturated porous media with supplemental information on modifications to the USGS's computer program VS2D: USGS Water-Resources Investigations Report 90-4025, 125 p.

Ground Water and Surface Water Flow and Contaminant Transport Codes used at INEL, Version 1.0, August 1992.

Agency	Code Name / Proprietor / Verification / Validation	Application / Prime User	Code Description / Computing Environment / Documentation & References
USGS	**WATEQ4F** Version: 2.0; Fortran-77 version of PL-1 code of WATEQ Proprietor: U.S. Geological Survey. WATEQ4F is Public Domain. Verification and Validation: Comparison of results to series of test cases, (see Ball and Nordstrom, 1991).	CHEMICAL SPECIATION IN NATURAL WATERS LeRoy L. Knobel and Roy C. Bartholomay, U.S. Geolocial Survey, INEL Project Office.	Code Description: WATEQ4F is a computer code for calculating speciation of major, trace, and elements sensitive to redox conditions in natural water using a revised thermodynamic data base. The code is used by the USGS, other government agencies, academia, and the general public. It is most effective on waters with ionic strengths ranging up to the ionic strength of sea water. Efficiency decreases at larger ionic strengths. Computer Requirements: IBM or compatible PC. References: Ball, J.W., and Nordstrom, D.K., 1991, User's Manual for WATEQ4F, with Revised Thermodynamic Data Base and Test Cases for Calculating Speciation of Major, Trace, and Redox Elements in Natural Water; US Geological Survey Open-File Report 91-183, 189 p., 1 diskette.

Ground Water and Surface Water Flow and Contaminant Transport Codes used at INEL, Version 1.0, August 1992.

Agency	Code Name / Proprietor / Verification / Validation	Application / Prime User	Code Description / Computing Environment / Documentation & References
EG&G	**MINTEQ**, v. A1 Proprietor: EPA-Athens Research Center. Verification and Validation: MINTEQ was verified during development by comparison calculations with WATEQ4. Validation has only been conducted for aqueous systems containing Cu(II), Pu, and U.	EQUILIBRIUM OF ROCK/WATER SYSTEMS C.A. Dicke, Subsurface and Environmental Modeling Unit, EG&G Idaho, Inc.	Code Description: MINTEQ is a geochemical computer code for predicting and evaluating the equilibrium of inorganic pollutants in a variety of geochemical environments. The code can model the complex equilibrium relationships among aqueous species, solids, gases, and adsorbed species. The code can also be used to calculate the consequences of equilibrium mass transfer between aqueous and solid phases. The code is used at many DOE sites, is familiar to INEL users, and is capable of handling a wide variety of geochemical problems. Computer Requirements: Requires IBM or compatable PC, workstations, or mainframes. References: Brown, D.S., and J.D. Allison, 1987, MINTEQ A1, An Equilibrium Metal Speciation Model: User's Manual, U.S. EPA, Athens GA EPA-600/3-87/012. Felmay, A.R., D.C. Garvin, and E.A. Jenne, 1984, MINTEQ: A Computer Program for Calculating Aqueous Geochemical Equilibria, National Technical Information Service, Springfield, VA, (NTIS PB84-157148) EPA-600/3-84-032. Peterson, S.R., C.J. Hostetler, W.J. Deutsch, and C.E. Cowan, 1987, MINTEQ Users Manual, U.S. Nuclear Regulatory Commission, Washington, D.C., NUREG/CR-4804, PNL-6106.

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State of Idaho

INEL Oversight Program

SUMMARY OF ENVIRONMENTAL MONITORING PROGRAMS AT THE IDAHO NATIONAL ENGINEERING LABORATORY (INEL) VERSION 1.0, AUGUST 1992

by
Phillip J. Bandy

State of Idaho
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(Idaho state seal)

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SUMMARY OF ENVIRONMENTAL MONITORING PROGRAMS AT THE IDAHO NATIONAL ENGINEERING LABORATORY (INEL) VERSION 1.0, August 1992

ABSTRACT

This report presents status information on environmental monitoring programs being conducted at, and in the vicinity of, the Idaho National Engineering Laboratory (INEL). Information on monitoring programs is presented in both an abbreviated list, segregated by agency and media, and more extensive tables where programs are grouped by media and listed by agency.

Information contained in this report includes: the agency responsible for environmental monitoring, the purpose of the monitoring program, the agency responsible for collecting samples, sampling methodology and frequency, what samples are analyzed for, the contact person for the monitoring program, and data retention locations for environmental data.

INTRODUCTION

Environmental monitoring at the Idaho National Engineering Laboratory (INEL) covers a broad range of media including air, water, soil, and biota. To evaluate the scope of environmental monitoring conducted at INEL, the State of Idaho INEL Oversight Program (INEL-OP) has researched the range of monitoring programs at, and in the vicinity of, the INEL site. This report presents status information on monitoring programs as of the date of this publication.

Components of environmental monitoring programs defined in this report are: the agency responsible for conducting the monitoring program, the purpose for monitoring program implementation, identification of the agency responsible for collecting samples, the locations of monitoring programs, sampling methods and frequency, sample analyses, the contact person for the monitoring program, and data retention locations. Information compiled is presented in two formats, an abbreviated list of monitoring programs and a more extensive description of monitoring programs in tabular form.

The abbreviated version of environmental monitoring programs presents programs segregated by the organization responsible for monitoring and listed by media under the organization heading. This short version lists the agency conducting the monitoring, the media being monitored, the location of the monitoring program, and data retention locations.

The more robust version of monitoring programs is categorized by media with organizations responsible for monitoring listed within each media group. This version contains information pertaining to; the sampling organization, method and frequency of sampling, identification of sample analyses, and contact persons for the monitoring programs.

PURPOSE AND OBJECTIVES

Environmental monitoring programs are carried out by subcontractors to the Department of Energy (DOE) as well as by several federal and state agencies. Organizations conducting environmental monitoring at INEL include: Argonne National Laboratory - West (ANL-W), EG&G, Idaho Department of Water Resources (IDWR) [in cooperation with the USGS], Idaho State University (ISU), the National Oceanographic and Atmospheric Administration (NOAA), the Navy, the United States Geological Survey (USGS), and Westinghouse Idaho Nuclear Company (WINCO). Each of these groups monitors numerous components of the environment either specifically, at specific facilities located at INEL, or generally, conducting monitoring both on- and off-site. The purpose of this project was to consolidate status information about monitoring programs conducted by each subcontractor, organization, and agency into a single document.

The State of Idaho INEL Oversight Program is mandated to perform independent evaluations of environmental monitoring at INEL; information included in this document will serve as part of the baseline of information that is required for future studies and evaluations. The objective of this project was to compile information on environmental monitoring programs being conducted by federal and state agencies and subcontractors to (DOE) into a readable format from which information about monitoring programs may be easily accessed and extracted.

METHODS

Environmental monitoring program information contained in this report was compiled from reviews of technical documents produced by DOE and its' subcontractors, interviews with program contacts, and interaction with agency and subcontractor personnel at technical meetings held in Idaho Falls in October 1991 and June 1992.

STATE OF IDAHO INEL OVERSIGHT PROGRAM SUMMARY OF ENVIRONMENTAL MONITORING PROGRAMS, LOCATIONS, AND DATA REPOSITORIES AT INEL

I. **ANL-W**

A. Airborne Effluent Monitoring - Radioactive Waste Management Information System (RWMIS)

1. Zero Power Physics Reactor (ZPPR) stack
2. Fuel Manufacturing Facility (FMF) stack
3. Main stack (including Experimental Breeder Reactor No.2 [EBR-II] and Hot Fuels Examination Facilities [HFEF/S])
4. Integral Fast Reactor (IFR)
5. Laboratory and Office Building
   a. Non-destructive Assay (NDA) area stack
   b. Lab area stack
   c. Fuel assembly and storage building
   d. Radioactive Liquid Waste Treatment Facility
   e. Hot Fuels Examination Facilities (HFEF/N)
   f. Sodium Components Maintenance Shop
   g. Transient Reactor Test Facility (TREAT)

6. Main parking lot - Atmospheric Sampling

B. Biotic - ANL-W files

1. Industrial Waste pond perimeter (vegetation)
2. Each corner of the Site Security Perimeter (vegetation)

C. Drinking Water - Drinking Water Monitoring Data Management System (DWMDMS)

1. Production Wells
2. Distribution Systems

D. Liquid Effluent - Industrial Waste Management Information System (IWMIS)

1. Industrial Waste Flow to the Industrial Waste Pond (IWP)
2. Industrial Waste Pond (IWP)
3. Waste flow to Sanitary Lagoon
4. Primary and secondary lagoons

E. Radiation - ANL-W files

1. Surface of major industrial and surface drainage ditches.
2. Perimeter fence of Radioactive Scrap and Waste Facility (RSWF).
3. Within RSWF.
4. ANL-W Site Boundary.

F. Soil and Sediment - ANL-W files

1. Within Perimeter Fence - soil
2. Radioactive Scrap and Waste Facility (RSWF) - soil
3. Industrial Waste ditch and intercepter canal - surface sediment
4. Off-site
5. Industrial Waste Pond (IWP)

II. EG&G

A. Air

1. Facility Stack Monitoring - Radioactive Waste Management Information System (RWMIS).
    a. Central Laundry and Respirator Facility
    b. Advanced Test Reactor (ATR)
    c. Test Area North Hot Shop (TAN)
    d. Process Experimental Pilot Plant (PREPP)
    e. Waste Experimental Reduction Facility (WERF)

2. Environmental Monitoring for Airborne Particulate Radioactivity - Environmental Surveillance Program Data Management System (ESPDMS)
    a. Radioactive Waste Management Complex (RWMC)
    b. Stored Waste Examination Pilot Project (SWEPP)
    c. Waste Experimental Reduction Facility (WERF)
    d. Mixed Waste Storage Facility (MWSF)

B. Biotic - Environmental Surveillance Program Data Management System (ESPDMS)

1. Radioactive Waste Management Complex (RWMC)
    a. Small Mammals
    b. Vegetation
    c. Excavated Soil

2. Waste Experimental Reduction Facility (WERF)
    a. Vegetation

3. Stationary Low Power Reactor No. 1 (SL-1)
    a. Burrowing activity
    b. Deep rooted plants

4. Organic Moderated Reactor Experiment (OMRE)
    a. Burrowing activity
    b. Deep rooted plants

C. Drinking Water - Drinking Water Monitoring Data Management System (DWMDMS)

    a. Production Wells
    b. Distribution Systems

D. Liquid Effluent

1. Sewage treatment plants for all EG&G operated facilities - Industrial Waste Management Information System (IWMIS)
2. Non-rad effluent - Effluent Monitoring Data Management System (EMDMS)

E. Radiation Monitoring - Environmental Surveillance Program Data Management System (ESPDMS)

1. Thermoluminescent Dosimeters
    a. Radioactive Waste Management Complex (RWMC), Waste Experimental Reduction Facility (WERF)

2. Surface Radiation Surveys
    a. RWMC, Stationary Low Power Reactor No. 1 (SL-1), Organic Moderated Reactor Experiment (OMRE)

F. Seismic Network
1. Seismographs
2. Strong-motion Accelerographs

G. Soil and Sediment - Environmental Surveillance Program Data Management System (ESPDMS)
1. Radioactive Waste Management Complex (RWMC), Stored Waste Examination Pilot Project (SWEPP), Mixed Waste Storage Facility (MWSF), Process Experimental Pilot Plant (PREPP), previous preoperational sampling at MWSF and PREPP, and Waste Experimental Reduction Facility (WERF).

H. Surface Water - Environmental Surveillance Program Data Management System (ESPDMS)
1. Radioactive Waste Management Complex (RWMC) and Stored Waste Examination Pilot Project (SWEPP).

I. Visual Inspections
1. RWMC-SDA/TSA
2. Stationary Low Power Reactor No. 1 (SL-1)
3. Organic Moderated Reactor Experiment (OMRE)

III. **IDWR-USGS**

A. Ground Water

1. Sampling of wells and springs downgradient of INEL facility.

IV. **Idaho State University**

A. Air Monitoring

1. Atomic City, Craters of the Moon, Experimental Field Station, and Van Buren Ave. (these samplers are collocated with existing DOE samplers).

B. Biotic

1. Milk

C. Ground Water

1. Springs and Wells.

V. **NOAA**

A. Meteorological Monitoring

VI. **NRF**

A. Air - Environmental Controls Data Base
   1. Radiological
      a. Radiological Effluent Particulate Monitoring
         (1) S5G, A1W, ECF, S1W, Background
      b. Tritium Monitors
         (1) S5G, A1W, ECF, S1W, Background

   2. Nonradiological
      a. Sulfate content of fuel oil
      b. Emissions from Boiler House
      c. Emissions from Generators
      d. Emissions from Incinerator
      e. Opacity from Boiler House
      f. Opacity from Incinerator

B. Biotic - Environmental Controls Data Base
   1. Vegetation
      a. Industrial Waste Ditch, S1W Leaching Bed, A1W Leaching Bed, selected grid locations

C. Drinking Water - Environmental Controls Data Base
   1. Production Wells
   2. Distribution System(?)

D. Environmental Survey - Environmental Controls Data Base
   1. Barrel Survey
   2. Ecology Survey
   3. Oil Usage Survey
   4. Waste Dumpster Survey
   5. Waste Box Survey

E. Ground Water - Environmental Controls Data Base
   1. Production Wells
   2. Upgradient Wells
   3. Downgradient Wells
   4. Sewage Lagoon
   5. Piezometers

F. Hazardous or Toxic Substances - Environmental Controls Data Base
   1. System Oil/Water Separations
   2. Waste Stream Analysis

G. Liquid Effluent
   1. Radiological Waste Water - Environmental Controls Data Base
      a. S1W spray pond, A1W cooling tower, S5G cooling tower, Industrial

Waste Ditch, Sewage Lagoon, Piezometers

2. Waste Water (nonradiological) - Environmental Controls Data Base
   a. Industrial Waste Ditch
   b. Waste Water Processes (Interior)
   c. Industrial Waste Ditch effluent limit
   d. Industrial Waste Ditch Bacteria
   e. Sewage Lagoon
   f. Waste Water Processes (Exterior)
   g. Lagoon Piezometers
   h. Waste Stream Analysis

H. Preliminary Facility Area Surveillance

I. Radiation - Environmental Controls Data Base
   1. Thermoluminescent Dosimeters
      a. Perimeter
      b. 5 miles out
   2. Radiation Survey - Environmental Controls Data Base
      a. S1W Leaching Bed, A1W Leaching Bed, selected grid locations, underground piping system locations (4), known areas of contamination (10), waste dumpsters (12)

J. Soil and Sediment - Environmental Controls Data Base
   1. S1W spray pond, A1W cooling tower, S5G cooling tower, Industrial Waste Ditch, Sewage Lagoons, S1W Leaching Bed, A1W Leaching Bed, Selected Grid Locations

VII. **RESL-DOE**

A. Air Surveillance - RESL Environmental Sciences Data Base

1. Low Volume
   a. On-site locations
   b. Off-site locations

2. High Volume
   a. On-site locations
   b. Off-site locations

3. Kr-85 sampling

4. Tritium

5. Constant Air Monitors

6. Nitrogen Oxides
7. Sulfur Dioxide

8. Precipitation Monitoring

B. Biotic - RESL Environmental Sciences Data Base

1. Animal tissues
2. Foodstuffs Monitoring - RESL Environmental Sciences Data Base

C. Drinking Water - RESL Environmental Sciences Data Base

1. On-site
2. Off-site

D. Liquid Effluent

1. TRA
2. ICPP

E. Radiation Exposure Monitoring - RESL Environmental Sciences Data Base

1. Thermoluminescent dosimeters
   a. On-site
   b. Off-site
2. Gamma radiation surveys
   a. On-site

F. Soil Monitoring - RESL Environmental Sciences Data Base

1. On-site
2. Off-site

VIII. **USGS**

A. Ground Water

1. Ground Water Levels - GWSI
    a. SRP aquifer
    b. Perched water
2. Ground Water Quality - QWDATA
    a. SRP aquifer
    b. Perched Water
    c. Springs

3. Closed Basin Monitoring

4. Unsaturated Zone Monitoring

B. Surface Water

a. Water volume at surface gauging stations

IX. **WINCO**

A. Air

1. ICPP stack - Radioactive Waste Management Information System (RWMIS) and Industrial Waste Management Information System (IWMIS)

2. Flourinel Dissolution Process and Fuel Storage Facility (FAST) stack - RWMIS and IWMIS

3. New Waste Calcining Facility (NWCF) stack - RWMIS and IWMIS(?)

4. Remote Analytical Laboratory (RAL) stack - RWMIS and IWMIS(?)

5. Coal Fired Steam-Generating Facility (CFSGF) stack - IWMIS(?)

6. Ambient Air Monitoring
   a. Construction phase work projects which have the potential for generating local ambient levels of contamination (gamma) - data base maintained by ICPP

B. Drinking Water

1. Drinking Water - Drinking Water Monitoring Data Management System (DWMDMS)
   a. Production Wells
   b. Distribution Systems

C. Ground Water

1. Ground water monitoring at ICPP and High Level Rad Waste Storage Area - maintained by WINCO in files/logbooks concerning the tank farm.

D. Liquid Effluent

1. Liquid effluent monitoring at the ICPP facility, service waste system - Radioactive Waste Management Information System (RWMIS) and Industrial Waste Management Information System (IWMIS)
2. Sewage Treatment Plant (domestic waste water), sampled by EG&G - IWMIS
3. Percolation Ponds - maintained in files associated with the request. Data from grab samples are maintained in the RESL Environmental Sciences Data Base.

E. Radiation Monitoring

1. Perimeter of ICPP - data maintained by WINCO is a computer data base

F. Solid Waste Monitoring

1. Various locations - data maintained in files concerning particular request

Program / Purpose	Sampling Organization	Location	Method/Frequency	Analysis	Contact Person
ANL-W / Surveillance	ANL-W	Zero Power Physics Reactor (ZPPR) stack	Exhaust stack air monitors. All monitors are source checked weekly, calibrated semiannually.	Gross α and gross β-γ particulates.	Amy Powell, EWM
	ANL-W	Fuel Manufacturing Facility (FMF) stack	Exhaust stack air monitors. All monitors are source checked weekly, calibrated semiannually.	Gross α and gross β-γ particulates.	Amy Powell, EWM
	ANL-W	Main Stack including EBR-II and HFEF/S	Exhaust stack air monitors. All monitors are source checked weekly, calibrated semiannually.	Gross α and β particulates, gross γ (gaseous), Cs-137, I-131, and Xe-133.	Amy Powell, EWM
	ANL-W	Integral Fast Reactor (IFR) program will install detectors for Pu and Kr-85.	Exhaust stack air monitors. All monitors are source checked weekly, calibrated semiannually.	Gross α and β particulates, gross γ (gaseous), Cs-137, I-131, and Xe-133.	Amy Powell, EWM
	ANL-W	Non-destructive Assay (NDA) area stack	Exhaust stack air monitors. All monitors are source checked weekly, calibrated semiannually.	Gross α, β and γ particulates.	Amy Powell, EWM
	ANL-W	Lab Area stack	Exhaust stack air monitors. All monitors are source checked weekly, calibrated semiannually.	Gross α, β, and particulates, gross β gases, and I-131.	Amy Powell, EWM
	ANL-W	Fuel Assembly and Storage Building	Exhaust stack air monitors. All monitors are source checked weekly, calibrated monthly.	Gross α and β - γ particulates.	Amy Powell, EWM
	ANL-W	Radioactive Liquid Waste Treatment Facility	Exhaust stack air monitors. All monitors are source checked weekly, calibrated semiannually.	Gross α, β and γ particulates, I-131, and gross β gases.	Amy Powell, EWM
	ANL-W	Hot Fuels Examination Facilities (HFEF/N)	Exhaust stack air monitors. All monitors are source checked weekly, calibrated semiannually.	Gross α, β and γ particulates, Cs-137, I-131, gross β gases, Xe-133, and Kr-85.	Amy Powell, EWM
	ANL-W	Sodium Components Maintenance Shop	Exhaust stack air monitors. All monitors are source checked weekly, calibrated semiannually.	Gross α and β-γ particulates.	Amy Powell, EWM
	ANL-W	Transient Reactor Test Facility (TREAT)	Exhaust stack air monitors. All monitors are source checked weekly, calibrated semiannually.	Gross γ.	Amy Powell, EWM

Program / Purpose	Sampling Organization	Location	Method/Frequency		Analysis	Contact Person
ANL-W Atmospheric Sampling	ANL-W	Main Parking Lot, southwest of the security perimeter.	Continuous particulate air sampler.	Weekly	Gross β	Amy Powell, EWM
				Quarterly (composites of continuous air samples)	Pu-238, Pu-239/240, and Am-241	
EG&G Facility Stack Monitoring	EG&G	Central Laundry and Respirator Facility	Continuous particulate monitoring system (filters for radiochemistry changed weekly) Monthly		Gross α/β, Sr-90, γ spec. (Ce-141, Ce-144, Co-60, Cs-134, Cs-137, Mn-54, Ru-103, Ru-106, Sb-125, Sr-90, Zr-95, Am-241, Pu-238, Pu-239/240)	Charles Hicks, EG&G WM
	EG&G	Advanced Test Reactor (ATR)	SPING monitoring system - Particulate. Continuous		α, β	Bob Beatty, EG&G PRP
			SPING monitoring system - AgX. Continuous		Iodine, γ	
			SPING monitoring system - Nobel Gas. Continuous		β	
			GeLi on-line remote detector. Continuous (2-hr update)		γ	
			Radiochemistry particulate filter. Weekly		γ spec. (Ce-141, Ce-144, Co-60, Cs-134, Cs-137, Mn-54, Ru-103, Ru-106, Sb-125)	
			Radiochemistry particulate filter (4-week composite). Monthly		α, β, Sr-90	
			AgX. Monthly		γ spec., halogens, Hg.	
			Noble Gas. Daily		γ spec.	
	EG&G	Test Area North Hot Shop (TAN)	SPING radiation alarm (filters for radiochemistry changed weekly).	Continuous	β/γ, α, halogens, noble gasses	Kevin Streeper, EG&G WM
				Weekly	Gross α/β, γ spec. (Ce-141, Ce-144, Co-60, Cs-134, Cs-137, Mn-54, Ru-103, Ru-106, Sb-125, Sr-90, Zr-95, Am-241, Pu-238, Pu-239/240)	
	EG&G	Process Experimental Pilot Plant (PREPP)	Continuous nonradioactive gaseous monitoring system. Continuous		O_2, CO	Jane Welch, EG&G EM

Program / Purpose	Sampling Organization	Location		Method/Frequency		Analysis	Contact Person
EG&G Facility Stack Monitoring (cont.)	EG&G	Power Burst Facility (PBF). Reactor main stack.		Continuous Eberline SPING system, weekly particulate analysis, charcoal filter as needed.		gross α/β, γ spec., Sr-90.	Jane Welch, EG&G EM
	EG&G	Radioactive Waste Management Complex (RWMC). Drum venting facility.		CAM, specifics to be determined.		gross α/β, γ spec., Sr-90	Jane Welch, EG&G EM
	EG&G	Test Reactor Area (TRA).	MTR Stack	Continuous Eberline SPING, particulates and charcoal filter analyzed weekly.		gross α/β, γ spec., Sr-90, I-131.	Jane Welch, EG&G EM
			Alpha Wing Hoods	Pump with filter, particulates analyzed weekly.		gross α/β, γ spec., Sr-90, I-131.	
			New Alpha Wing Hoods	Alpha Continuous Air Monitoring System, particulates and charcoal filter analyzed weekly.		gross α/β, γ spec., Sr-90, I-131.	
			TRA Hot Cells	Continuous Eberline SPING, particulates and charcoal filter analyzed weekly.		gross α/β, γ spec., Sr-90, I-131.	
			ATR Stack	Continuous Eberline SPING.	particulate analysis weekly.	gross α/β, γ spec., Sr-90, I-131.	
					iodine radionuclides monthly		
					nobel gases for gamma rad. real time.		
	EG&G	Waste Experimental Reduction Facility (WERF) <u>North Stack</u> - incineration, furnace sizing, solidification <u>South Stack</u> - compaction		Continuous environmental monitoring system (filters for radiochemistry changed weekly)	Continuous	O_2, Co, HCL	Steve Poling, EG&G WM
					Monthly	Gross α/β, γ spec. (Ce-141, Ce-144, Co-60, Cs-134, Cs-137, Mn-54, Ru-103, Ru-106, Sb-125, Zr-95)	
					Quarterly	Sr-90	

Program / Purpose	Sampling Organization	Location	Method/Frequency		Analysis	Contact Person
EG&G Environmental Monitoring for Airborne Particulate Radioactivity	EG&G EM/RESP	Radioactive Waste Management Complex (RWMC), Subsurface Disposal Area (SDA)	Low volume air sampler: 4 in. dia. membrane filter, operated at 5 cfm, oil-less, carbon vane pump (est. June 30, 1992, new Wedding PM-10 air samplers to be on-line. 4 in. dia. membrane filter, operated at 4 cfm, oil-less, carbon vane pump.)	Biweekly	Gross α/β	Jane Welch, EG&G EM
				Monthly	γ spectroscopy for 27 γ-emitting radionuclides (e.g. Cr-51, Mn-54, Co-58, Fe-59, Co-60, Nb-95, Zr-95, Ru--103, Ru-106, Sb-125, Cs-134, Cs-137, Ce-141, Ce-144, Eu-152, Am-241)	
				Quarterly	Radiochemistry analysis for specific α and β emitters (e.g., Sr-90, U-232, U-233, U-234, U-235, U-238, Am-241, Pu-238, Pu-239/240	
	EG&G EM/RESP	Stored Waste Examination Pilot Project (SWEPP) Transuranic Storage Area (TSA)	Low volume air sampler: 4 in. dia. membrane filter, operated at 5 cfm, oil-less, carbon vane pump (est. June 30, 1992, new Wedding PM-10 air samplers to be on-line. 4 in. dia. membrane filter, operated at 4 cfm, oil-less, carbon vane pump.)	Biweekly	Gross α/β	Jane Welch, EG&G EM
				Monthly	γ spectroscopy for 27 γ-emitting radionuclides (e.g. Cr-51, Mn-54, Co-58, Fe-59, Co-60, Nb-95, Zr-95, Ru--103, Ru-106, Sb-125, Cs-134, Cs-137, Ce-141, Ce-144, Eu-152, Am-241)	
				Quarterly	Radiochemistry analysis for specific α and β emitters (e.g., Sr-90, U-232, U-233, U-234, U-235, U-238, Am-241, Pu-238, Pu-239/240	

Program / Purpose	Sampling Organization	Location	Method/Frequency		Analysis	Contact Person
EG&G Environmental Monitoring for Airborne Particulate Radioactivity (cont.)	EG&G EM/RESP	Waste Experimental Reduction Facility (WERF)	Low volume air sampler: 4 in. dia. membrane filter, operated at 5 cfm, oil-less, carbon vane pump (est. June 30, 1992, new Wedding PM-10 air samplers to be on-line. 4 in. dia. membrane filter, operated at 4 cfm, oil-less, carbon vane pump.)	Biweekly	Gross α/β	Jane Welch, EG&G EM
				Monthly	γ spectroscopy (Ce-141, Ce-144, Co-60, Cs-134, Cs-137, Mn-54, Ru-103, Ru-106, Sb-125, Sr-90, Zr-95, Am-241, Pu-238, Pu-239/240)	
	EG&G EM/RESP	Mixed Waste Storage Facility (MWSF)	Low volume air sampler: 4 in. dia. membrane filter, operated at 5 cfm, oil-less, carbon vane pump (est. June 30, 1992, new Wedding PM-10 air samplers to be on-line. 4 in. dia. membrane filter, operated at 4 cfm, oil-less, carbon vane pump.)	Biweekly	Gross α/β	Jane Welch, EG&G EM
				Monthly	γ spectroscopy (Ce-141, Ce-144, Co-60, Cs-134, Cs-137, Mn-54, Ru-103, Ru-106, Sb-125, Sr-90, Zr-95, Am-241, Pu-238, Pu-239/240)	
ISU-INEL Air Monitoring Program	ISU	Atomic City, Craters of the Moon, Experimental Field Station, Van Buren Avenue (colocation with existing DOE samplers)	Continuous low volume sampling and collection of particulate on a filter paper and collection of halogen gases on a charcoal cartridge.	Weekly	Analysis of charcoal for iodine.	Bernie Graham, Idaho State University, College of Pharmacy
				Weekly	Analysis of filter paper for gross α and β activity.	
				Quarterly	Analysis of composite filter papers for γ. Cs-137	

Summary of Air Monitoring Programs at INEL, Version 1.0, August 1992

Program / Purpose	Sampling Organization	Location	Method/Frequency	Analysis	Contact Person
NOAA National Oceanographic and Atmospheric Administration	NOAA	Key INEL Facilities (?)	Weather towers at key INEL facilities.	Temperature (on 6 min. means), Wind Speed and Vector, Precipitation, Dew Point, and Solar Radiation. NOAA performs meteorological and air dispersion modeling for the RESL surveillance program.	Gene Start, NOAA Air Resources Lab Field Research Division.
NRF Radiological Air Monitoring	WEC	S5G	Air Monitor (1) with Fixed Filter. Weekly	Isotopic fixed filter Co-60 of primary concern.	R.D.E. Newbry, DOE-IBO
			Tritium monitor (1) with canister. Weekly	H-3	
	WEC	A1W	Air Monitors (9) with Fixed Filters. Weekly	Isotopic fixed filter Co-60 of primary concern.	R.D.E. Newbry, DOE-IBO
			Tritium monitor (1) with canister. Weekly	H-3	
	WEC	ECF	Air Monitors (5) with Fixed Filters. Weekly	Isotopic fixed filter Co-60 of primary concern.	R.D.E. Newbry, DOE-IBO
			Tritium monitor (1) with canister. Weekly	H-3	
	WEC	S1W	Air Monitors (10) with Fixed Filters. Weekly	Isotopic fixed filter Co-60 of primary concern.	R.D.E. Newbry, DOE-IBO
			Tritium monitor (1) with canister. Weekly	H-3	
	WEC	Background	Air Monitors (3) with Fixed Filters. Weekly	Isotopic fixed filter Co-60 of primary concern.	R.D.E. Newbry, DOE-IBO

Program / Purpose	Sampling Organization	Location	Method/Frequency		Analysis	Contact Person
DOE-RESL Air Surveillance	DOE-RESL	On-site locations, 53 total	Low volume samplers, continuous, 40 L/m	Weekly	Gross α, gross β	Eddie Chew, DOE-ID RESL
				Quarterly	Specific γ, Pu, Am, Sr-90, particulate matter (dust burden on sample filter)	
		Off-site locations, 48 total	Low volume samplers, continuous, 40 L/m	Weekly	Gross α, gross β	Eddie Chew, DOE-ID RESL
				Quarterly	Specific γ, Pu, Am, Sr-90, particulate matter (dust burden on sample filter)	
	DOE-RESL	On-site Locations - one at CFA and one at EFS.	High volume samplers (2), continuous, 1270 L/m (45 cfm)	Daily	Gross γ - provide quantitative records of daily variations in radon daughter activity.	Eddie Chew, DOE-ID RESL
				Monthly	Specific γ	
		Off-site Location - one at the NOAA building on Foote Drive in Idaho Falls.	High volume sampler use to provide filters for analysis by EPA laboratory in Montgomery Alabama. Filters are changed twice a week.		Gross γ counted by ESB, then filters sent to EPA lab. If unusually high count rate is found the filter may be submitted to ACB (Analytical Chemistry Branch) for γ spectrometric analysis.	Eddie Chew, DOE-ID RESL
	DOE-RESL	Location: CF-690	Kr-85 sampler (1), continuous		Kr-85	Eddie Chew, DOE-ID RESL
	DOE-RESL	Downwind of ICPP stack at EFS and VANB. Also a sampler for background located in Idaho Falls.	Tritium samplers (2), continuous, silica gel column, 3 - 7 weeks		H-3 as HTO	Eddie Chew, DOE-ID RESL
	DOE-RESL	On-site Location - roof of CF-690	Constant Air Monitor (850 L/min [30 cfm]). Daily observation of the recorder chart.		Qualitative record of significant RESL radioactivity releases or of passage of radioactivity from other sources. Comparison with high-volume samplers provides additional information on radon contributions.	Eddie Chew, DOE-ID RESL
	DOE-RESL	Off-site Locations	Tritium sampler (1), continuous, silica gel column, 3 - 7 weeks		H-3 as HTO	Eddie Chew, DOE-ID RESL

Program / Purpose	Sampling Organization	Location	Method/Frequency	Analysis	Contact Person
DOE-RESL Air Surveillance (cont.)	DOE-RESL	On-site Locations	TSP sampler (1), sampler operates for 24 h every six days, weekly	Total suspended particulates	Eddie Chew, DOE-ID RESL
		VANB, EFS	Nitrogen oxides samplers (2), EPA method, continuous	Nitrogen dioxide	Eddie Chew, DOE-ID RESL
		VANB	Sulfur dioxide sampler, continuous	Sulfur dioxide	Eddie Chew, DOE-ID RESL
DOE-RESL Precipitation Monitoring	DOE-RESL	EPA collector in Idaho Falls, NOAA collector at CFA.	Containers are emptied monthly, and a small amount is submitted to the ASB for analysis.	H-3, pH	Eddie Chew, DOE-ID RESL
		Collector at EFS	Samples collected weekly.	pH and specific conductance	Eddie Chew, DOE-ID RESL
			Dry deposition samples are collected every six weeks from the "dry bucket" which is open to the air.	Particles are resuspended in water then filtered through a preweighed filter; the difference in mass is calculated and reported.	
WINCO Air Monitoring	WINCO	ICPP stack	Continuous particulate monitoring system: Daily	γ	Phil Peistrup, WINCO EC/SIS
			Continuous particulate monitoring system: Weekly	Sr-90 (composite of daily samples)	
			Continuous particulate monitoring system: Monthly	Total plutonium (composite of all daily samples)	
			Continuous radioactive gaseous monitoring system. Bi-monthly (composite of two samples per month)	H-3, C-14, I-129, and Sb-125	
			Krypton surface barrier detector. Continuous	Kr-85	
			Continuous Beckman Model 951A NO/NO_x analyzer.	Nitrogen oxide and nitrogen dioxide.	

Program / Purpose	Sampling Organization	Location	Method/Frequency		Analysis	Contact Person
WINCO Air Monitoring (cont.)	WINCO	Flourinel Dissolution Process and Fuel Storage Facility (FAST) stack	Continuous particulate monitoring system	Daily	γ	Phil Peistrup, WINCO EC/SIS
				Weekly	Sr-90 (composite of daily samples)	
				Monthly	Total plutonium (composite of all daily samples)	
			Continuous radioactive gaseous monitoring system. Bi-monthly (composite of two samples per month)		H-3, C-14, I-129, and Sb-125	
			Krypton surface barrier detector. Continuous		Kr-85	
			Continuous Beckman Model 951A NO/NO_x analyzer.		Nitrogen oxide and nitrogen dioxide.	
	WINCO	New Waste Calcining Facility (NWCF) stack	Continuous particulate monitoring system	Weekly	γ, Sr-90	Phil Peistrup, WINCO EC/SIS
				Monthly	Total Pu (monthly composite of all weekly samples)	
	WINCO	Remote Analytical Laboratory (RAL) stack	Continuous particulate monitoring system	Weekly	γ, Sr-90	Phil Peistrup, WINCO EC/SIS
				Monthly	Total Pu (monthly composite of all weekly samples)	
	WINCO	Coal Fired Steam-Generating Facility (CFSGF) stack	Continuous particulate monitoring system (Thermo-electron Analyzer)		Opacity	Phil Peistrup, WINCO EC/SIS
			Continuous environmental monitoring system (Thermo-electron Analyzer)		Sulfur dioxide, and NO_x	
			Continuous monitoring (Dynatron Model 1200)		O_2	
WINCO Ambient Air Monitoring	WINCO	Construction phase work projects which have the potential for generating local ambient levels of contamination (γ)	Methods? Frequency dependent upon projects. Non-routine		γ	Phil Peistrup, WINCO EC/SIS

Program / Purpose	Sampling Organization	Location	Method/Frequency		Analysis	Contact Person
ANL-W Solids Sampling	ANL-W	Industrial Waste Pond	Four vegetation samples taken annually. Each sample collected within a surface area of one m^2.		Pu-239/240 and Cs-137.	Chris Martin, Environment and Waste Management
		Each corner (4) of the site security perimeter.	Four vegetation samples taken annually. Each sample collected within a surface area of one m^2.		Pu-239/240 and Cs-137.	
EG&G Biotic Sampling	EG&G/EM/RESP	Radioactive Waste Management Complex (RWMC), 5 major areas: Active Areas, Pad A, Inactive Areas, Areas Previously Flooded, TSA and a control sample.	Small mammals:	Even Years: Ground Squirrels (live traps) collected April 1.	γ spec. for 27 γ-emitting radionuclides (Cr-51, Co-60, Ru-106, Ce-141, Mn-54, Nb-95, Sb-125, Ce-144, Co-58, Zr-95, Cs-134, Eu-152, Fe-59, Ru-103, Cs-137, Am-241)	Jane Welch, EG&G EM
					Radiochemistry for specific α and β emitting radionuclides (Pu-238, Pu-239/240, Am-241, Sr-90, Cs-137).	
				Odd Years: Deer Mice (snap traps) collected August 15	γ spec. for 27 γ-emitting radionuclides (Cr-51, Co-60, Ru-106, Ce-141, Mn-54, Nb-95, Sb-125, Ce-144, Co-58, Zr-95, Cs-134, Eu-152, Fe-59, Ru-103, Cs-137, Am-241)	
					Radiochemistry for specific α and β emitting radionuclides (Pu-238, Pu-239/240, Am-241, Sr-90, Cs-137).	
			Vegetation:	Even Years: Russian Thistle	γ spec. for 27 γ-emitting radionuclides (Cr-51, Co-60, Ru-106, Ce-141, Mn-54, Nb-95, Sb-125, Ce-144, Co-58, Zr-95, Cs-134, Eu-152, Fe-59, Ru-103, Cs-137, Am-241)	
					Radiochemistry for specific α and β emitting radionuclides (Pu-238, Pu-239/240, Am-241, Sr-90, Cs-137).	
				Odd Years: Crested Wheatgrass	γ spec. for 27 γ-emitting radionuclides (Cr-51, Co-60, Ru-106, Ce-141, Mn-54, Nb-95, Sb-125, Ce-144, Co-58, Zr-95, Cs-134, Eu-152, Fe-59, Ru-103, Cs-137, Am-241)	
					Radiochemistry for specific α and β emitting radionuclides (Pu-238, Pu-239/240, Am-241, Sr-90, Cs-137).	

Program / Purpose	Sampling Organization	Location	Method/Frequency	Analysis	Contact Person
EG&G Biotic Sampling (cont.)	EG&G/EM/RESP	Radioactive Waste Management Complex (RWMC), 5 major areas: Active Areas, Pad A, Inactive Areas, Areas Previously Flooded, TSA and a control sample.	Excavated Soil - even years	γ spec. for 27 γ-emitting radionuclides (Cr-51, Co-60, Ru-106, Ce-141, Mn-54, Nb-95, Sb-125, Ce-144, Co-58, Zr-95, Cs-134, Eu-152, Fe-59, Ru-103, Cs-137, Am-241)	Jane Welch, EG&G EM
				Radiochemistry for specific α and β emitting radionuclides (Pu-238, Pu-239/240, Am-241, Sr-90, Cs-137).	
	EGG EM/RESP	Waste Experimental Reduction Facility (WERF)	Vegetation: Perennials. Triennially	γ spec. for 27 γ-emitting radionuclides (Cr-51, Co-60, Ru-106, Ce-141, Mn-54, Nb-95, Sb-125, Ce-144, Co-58, Zr-95, Cs-134, Eu-152, Fe-59, Ru-103, Cs-137, Am-241)	
		SL-1	Locations of burrowing activity and deep rooted plants (e.g., Russian thistle) are recorded biannually in April and August.	Soil from burrowing activity is surveyed with a mR/hr meter.	
		OMRE	Burrowing animal activity and deep rooted plants are recorded annually in July.	Locations are noted and soil from burrowing animals is surveyed with at cps meter. If above background, a soil sample is collected.	
ISU Environmental Monitoring Program (EMP)	ISU	Monteview, Blackfoot, and Rupert-Minidoka areas	Milk Samples. Monthly	H-3 and γ emitting radionuclides including I-131.	Bernie Grahm, ISU, College of Pharmacy
NRF Vegetation Monitoring	Environmental Controls (WEC)	Industrial Waste Ditch, S1W Leaching Bed, A1W Leaching Bed, 15 selected grid locations	Vegetation samples by cutting tops off vegetation in selected areas. Annually	Co-60, Cs-137, Isotopic (varies)	R.D.E. Newbry, DOE-IBO

Program / Purpose	Sampling Organization	Location	Method/Frequency	Analysis	Contact Person
DOE-RESL Animal tissue surveillance	DOE-RESL Environmental Sciences Branch	On-site: - two cattle from one location, two (2) total - two sheep from two locations, four (4) total - number of game animals is variable as is the location.	Beef muscle, liver, lung and thyroid samples ("on-site" animals grazed on-site for at least four weeks before being sampled). Biennially in even numbered years.	Specific γ, Pu-239/240, Am-241, Pu-238, I-131	Eddie Chew, Dianna Hoff, Russ Mitchell, DOE-ID RESL ESB
			Sheep muscle and liver samples ("on-site" animals grazed on-site for at least four weeks before being sampled). Annually	γ spec.	
			Game Animals - muscle, liver and thyroid tissues are collected from elk, deer, and antelope. Muscle tissues only are collected from smaller game species. Road-killed game animals are sampled on-site. Fish may be collected when the Big Lost River is flowing. No controls are generally collected except for specific ecological studies. Annually	Specific γ, I-131	
		Off-site: - two cattle from one location, two (2) total - two sheep from one location, two (2) total	Beef muscle, liver, lung and thyroid samples ("off-site" animals have never grazed on-site and serve as controls). Annually	Specific γ, Pu-239/240, Am-241, Pu-238, I-131.	
			Sheep muscle, liver, and thyroid samples ("off-site" animals have never grazed on-site and serve as controls). Annually	γ spec. The thyroid is specifically analyzed for I-131.	
DOE-RESL Foodstuffs Sampling	DOE-RESL Environmental Sciences Branch	Off-site	Milk Samples: Weekly, 1 gal.	I-131	Eddie Chew, Dianna Hoff, Russ Mitchell, DOE-ID RESL ESB
			Milk Samples: Monthly, 1 gal.	I-131, Sr-90, and H-3 as HTO	
			Milk Samples: Annually	I-129 (samples collected in Sept. or Oct.), H-3 and Sr-90 (about half the samples are analyzed in May and the other half in November)	
			Wheat Samples (spring and winter). Annually	γ spec. and Sr-90	
			Lettuce Samples. Annually	γ spec., and Sr-90	

Program / Purpose	Sampling Organization	Location	Sampling Method/Frequency	Analysis	Contact Person
Drinking Water Supply Monitoring at ANL-W Facility. Annual samples collected to satisfy state and federal drinking water monitoring requirements. DOE Order 5400.1 SDWA 40 CFR 141-143 IDAPA 16.01.8000-8900	Environment, Safety, and Waste Management (ESWM) Department (ANL-W)	Production Wells, sampled at point where water enters distribution system. Samples are collected from one of two wells at ANL-W. Alternate wells are sampled each month.	Grab sample. Monthly	α, β, H-3. Analysis by RESL.	Chris Martin ANL-W
			Grab Sample. Annually	Primary Pollutants (As, Ba, Cd, Cr, CN^-, F^-, Pb, Hg, NO_3^- (as N), Se, Ag, Na^+, Endrin, Lindane, Methoxychlor, Toxaphene, 2,4-D, 2,4,5-TP Silvex, Trihalomethanes), regulated VOCs, unregulated VOCs, and radionuclides.	
	Environment, Safety, and Waste Management (ESWM) Department (ANL-W)	Distribution Locations, e.g., drinking fountain or tap. Sampling points vary each month so that the entire ANL-W distribution system is evaluated during the course of each calendar year.	Grab Samples (4). Monthly	Coliform. Analysis by EG&G	
			Grab Samples. Annually	Coliform. Analysis by state approved laboratory.	

Program / Purpose	Sampling Organization	Location	Sampling Method/Frequency	Analysis	Contact Person
Drinking Water Supply Monitoring of Production Wells at EG&G Facilities. SDWA 40 CFR 141-143 IDAPA 16.01.8000-8900 DOE Order 5400.1 and 5400.5 DOE-ID Environmental Compliance Planning Manual	EG&G Environmental Monitoring (EM) Unit	EG&G Idaho Facilities Production Wells: ARA-2 (Inactive), CFA-1, CFA-2, EBR-1, Fire St. #2, LOFT(CTF)-1, LOFT(CTF)-2, Main Gate, OMRE (STF) (Inactive), PBF-1, PBF-2, Gun Range, RWMC, TRA-1, TRA-3, TRA-4, TSF (TAN)-1, TSF (TAN)-2, WRRTF (TAN) (Inactive)	500 ml poly bottles - acidified w/ HNO_3. Monthly	α, β. Analysis by RESL	Jane Welch, Brad Anderson, EG&G EM
			250 ml bottles - no preservative. Monthly	H-3. Analysis by RESL	
			3-40 ml amber glass bottles; <4°C; HCL preservative; no head space. At least quarterly	VOCs Analysis by laboratory certified by the state of Idaho or has reciprocity.	
			500 ml poly bottles; acidified. Annually (started biannually in 1991)	γ Analysis by laboratory certified by the state of Idaho or has reciprocity.	
			500 ml glass/poly bottles; <4°C. Annually (started biannually in 1991)	Metals (As, Ba, Cd, Cr, Pb, Se, Ag, Cu, Fe, Mn, Zn, Hg) Analysis by laboratory certified by the state of Idaho or has reciprocity.	
			125 ml glass/poly bottles; <4°C; Annually (started biannually in 1991)	Anions (NO_3^-, Cl^-, SO_4^{2-},)	
			4L amber glass with teflon lined cap; <4°C. Annually (started biannually in 1991)	Pesticides and Herbicides Analysis by laboratory certified by the state of Idaho or has reciprocity.	
			Field measurements on grab samples. Monthly	pH, conductivity, and temperature	
			500 ml poly bottles; acidified.Every Four Years (began in CY 1990)	α, β, total Sr, Ra-226, -228, H-3, and total Ce. Analysis by Accu-Labs in Denver, Colorado (has reciprocity with Idaho)	

Program / Purpose	Sampling Organization	Location	Sampling Method/Frequency	Analysis	Contact Person
Drinking Water Supply Monitoring of Distribution Systems at EG&G Facilities. SDWA 40 CFR 141 IDAPA 16.01.8300, 01-04 DOE Order 5400.1 and 5400.5 DOE-ID Environmental Compliance Planning Manual	EG&G Environmental Monitoring (EM) Unit	EG&G Idaho Facilities Distribution Systems Sampling Locations Building Number: EBR-1, EBR 601 RWMC, RWMC 613 CFA, CFA 641 Main Gate, B-27-603 STF, STF 611 (Inactive) TAN/TSF, TAN/TSF 610 TAN/CTF, TAN/CTF 614 TRA 608, TRA 667 PBF, PBF 602 TAN WRRTF, TAN WRRTF 645 (Inactive) Fire Station #2, B-16-601 (Inactive) Gun Range, B-21-607	100 ml Colilert bottle; <4°C; sodium thiosulfate added. Monthly	Coliform	Jane Welch, Brad Anderson EG&G EM
			1 gallon polyethylene or glass, acidified to a pH of <2 with HNO_3 All systems sampled on quarterly sampling schedule once every four years.	α, β, Ra-226, Ra-228, Sr-90, Cs-134	
			75 ml amber glass bottle All systems sampled on a quarterly sampling schedule once every four years.	H-3	
Drinking Water Supply Monitoring at NRF. SDWA 40 CFR 141-143 IDAPA 16.01.8000-8900	Environmental Controls (EC) Unit of Westinghouse Electric Corporation (WEC)	System Coliform Bacteria	Plate count - Monthly	Total Coliform	R.D.E. Newbry, DOE-IBO
		System Nitrate	Environmental Controls Procedure - Quarterly	NO_3^- as N	
		Production Well	Environmental Controls Procedure - Quarterly	Comprehensive RCRA Surveillance List - VOCs	
		Production Well	Grab Samples - Monthly	α, β, H-3	
		Production Well	Grab samples - Tri-annually	Comprehensive state list - drinking water	

Program / Purpose	Sampling Organization	Location	Sampling Method/Frequency	Analysis	Contact Person
Drinking Water Supply Monitoring at ICPP (WINCO) SDWA 40 CFR 141-143 IDAPA 16.01.8000-8900	Westinghouse Idaho Nuclear Company (WINCO) (analyzed by RESL)	Production (CPP1, CPP2) & potable (CPP4) water wells.	Grab samples. Monthly	α, β, H-3, Sr-90	Leon Pruett, WINCO
			Grab samples. Monthly	γ	
			Grab samples. Monthly	As, Ba, Cd, Cl^-, Cr, F^-, Pb, Hg, NO_3^-, Se, Ag, SO_4^{2-}, PO_4^{3-}, and Na^+	
			Grab samples taken at various buildings and after any maintenance or construction on the water lines. Monthly	Bacteriological contamination analyses	
			Grab samples taken at the entry into the distribution system. Annually	TOC, endrin, lindane, methoxychlor, toxaphene, 2,4-D, 2,4,5-TP silvex, hexone, and TBP	
			Grab samples. Quarterly	Trihalomethanes	
			Grab samples. 3-yr intervals	VOCs	
			Grab samples. 4-yr intervals	α, H-3, Ra-226, Ra-228, Sr-89, Sr-90, I-131, and Cs-134	
			Grab samples. 5-yr intervals	Various organics	

Program / Purpose	Sampling Organization	Location	Method/Frequency	Analysis	Contact Person
ANL-W / Characterization of waste areas for the FFA-CO.	ANL-W Environmental and Waste Management (EWM) section	EBR-II Leach Pit	Ground Water samples collected from ANL-W monitoring well. Samples will be taken quarterly (if after one year monitoring constituents are less than the prescribed level, the monitoring schedule will be modified to reflect a longer interval between sampling events).	? ______ (Sampling plan is still in the development stage. Initial soil samples have been collected. Parameters will be based on constituents found in soils, ground water, and parameters sampled in routine potable water samples).	Nancy Stewart, ANL-W
Ground Water Quality in vicinity of ANL-W (Program to begin 1992)	ANL-W	EBRII 1 and 2, MW-11, USGS 100, and TBD	Quarterly for one year then annually.	Modified Appendix VIII constituents for the first four quarters, then detected constituents for annual samples	Chris Martin, ANL-W
Ground Water Quality (characterization, surveillance)	U.S. Geological Survey (USGS) and Idaho Department of Water Resources (IDWR)	Snake River Plain Aquifer Downgradient of INEL - 50 wells and 5 springs.	Approx. 1/3 of 55 wells and springs off-site, between the southern boundary and Thousand Springs, are split sampled between IDWR and USGS annually. All sites were sampled in 1989; one third of the sites are sampled annually on a rotating basis. Wells are pumped and springs are dipped.	Primary and secondary drinking water VOCs, major inorganic elements, α, β, γ, H-3, Sr-90. Coliform bacteria, total U, Ra-226, Ra-228, Ru-222, nutrients, pesticides, trace elements. Duplicate samples for some constituents are sent to ISU or IDHW.	Larry Mann, USGS Lin Campbell, IDWR
Water Sampling (characterization, surveillance)	Idaho State University (ISU)	Minidoka, Shoshone, Alpheus Spring, Clear Springs, Bill Jones Fish Farm.	Grab samples of ground water and surface water collected in cooperation with DOE and USGS. Monthly	α, β, γ, H-3	B.W. Graham, Idaho State University College of Pharmacy
		Birch Creek, Well #104, Rest Stop Highway No. 3, Well #112, CFA #1, Well #65, RWMC Well #115, Well #8, Well #103, Well #11, Well #87.	Grab samples of ground water and surface water collected in cooperation with DOE and USGS. Quarterly or semiannually.	α, β, γ, H-3	
Ground Water Monitoring at NRF. (compliance, surveillance)	Environmental Controls (Westinghouse Electric Corporation)	Production Wells, Upgradient Wells, Downgradient Wells in the vicinity of the Sewage Lagoon, Piezometers	USGS Procedure - Bimonthly (piezometers are bailed - quarterly)	α, β, γ, H-3, Sr-90, Am, Pu, I-129, specific conductance, Na^+, Cl^-, NO_3^- as (NO_3), total Cr, VOCs.	R.D.E. Newbry, DOE-IBO

Program / Purpose	Sampling Organization	Location	Method/Frequency	Analysis	Contact Person
Water Surveillance (RESL Environmental Surveillance Program)	Contractor for most locations. Samples are collected concurrently with other contractors' monitoring programs	On-site locations	Water sampled in 23 on-site locations. Monthly	α, β, H-3 as HTO	Eddie Chew, Dianna Hoff, Russ Mitchell, DOE-ID RES
			Water sampled in 2 on-site locations (CPP-4, and CPP-2 or CPP-2 on rotation). Monthly	Sr-90	
	DOE-RESL (Samples collected by USGS and DOE-RESL)	Off-site locations	Water sampled from 13 locations. Semiannually	α, β, H-3 as HTO	
			Water sampled from 2 locations. Monthly	γ, Sr-90, H-3 as HTO, pH, Na^+, and Cl^-.	
		On-site locations	Water sampled from 1 location. Quarterly	I-129, U, Am, Pu, Chromium (total)	
Ground Water Levels	USGS	Snake River Plain Aquifer 161 wells: 48 in ICPP-TRA area, 18 in TAN area, 8 in RWMC area, and 87 Site-wide.	Ground water level measurement in 17 wells; 8 wells equipped with recorders. Monthly	Water level	Larry Mann, USGS
			Ground water level measurement in 65 wells Quarterly	Water level	
			Ground water level measurement in 38 wells Semiannually	Water level	
			Ground water measurement in 25 wells. Annually	Water level	

Program / Purpose	Sampling Organization	Location	Method/Frequency	Analysis	Contact Person
Ground Water Levels (cont.)	USGS	Perched-water zones: 29 wells (6 at ICPP, 23 at TRA, and 1 at RWMC) and 135 auger holes (36 at ICPP, 79 at TRA, and 20 at LOFT Pond)	Perched-water level measurement in 3 wells and 2 auger holes (1 well is equipped with a recorder). Monthly	Water level	
			Perched-water level measurement in 24 wells and auger holes. Quarterly	Water level	
			Perched-water levels in 9 wells. Semiannually	Water level	
			Perched-water level measurement in 130 auger holes. Annually	Water level	
Ground Water Quality (characterization)	USGS	Snake River Plain Aquifer	Ground water sampled from 36 wells. Quarterly	Major and trace ions - Na, Cl, NO_3, and Cr	Larry Mann, USGS
			Ground water sampled from 73 wells. Semiannually	Am-241, Pu-238, Pu-239, Pu-240, U-234, U-235, U-238, S-90, H-3	
			Ground water sampled from 1 well. Annually	H-3, α, β, γ, Am-241, Pu-238, Pu-239, Pu-240, U-235, U-238, S-90	
	USGS (for EG&G at RWMC)		Ground water sampled from four wells located at the north, south, east and west corners of RWMC. Quarterly	γ, Am-241, Pu-238, Pu-239, Pu-240, U-235, U-238, S-90, specific conductance, and inorganic chemistry.	
	USGS	Perched water zones - 39 wells	Perched water sampled from 12 wells. Quarterly	H-3, α, β, γ, Am-241, Pu-238, Pu-239, Pu-240, U-235, U-238, S-90	
			Perched water sampled from 13 wells. Semiannually	H-3, α, β, γ, Am-241, Pu-238, Pu-239, Pu-240, U-235, U-238, S-90, VOCs, specific conductance, pH, temp.	
		Upgradient - 14 wells	Water sampled from 14 wells. Sampled in 1989	Pesticides, man-made and naturally occurring radionuclides, nutrients, trace metals, VOCs, and surfactants	
Ground Water Quality Monitoring in the Vicinity of ANL-W	USGS	Arbor Test Well	Semi-annually	H-3, Cl^-, dissolved Cr, Cr^{VI}	
		USGS 100 Well	Quarterly	H-3, Cl^-, dissolved Cr, Cr^{VI}	
			Annually	Na^+	

Program / Purpose	Sampling Organization	Location	Method/Frequency	Analysis	Contact Person
Unsaturated Zone beneath Big Lost River Diversion Area (characterization)	USGS	Three neutron-access holes beneath the Big Lost River diversion areas. Also 14 neutron access auger holes at RWMC.	Neutron data are recorded in counts per second. Logs will be collected depending on frequency and magnitude of flow in the river and diversion channel. When a flow event occurs, logging will be conducted on a daily or weekly basis.	Monitor "wetting" and "drying" of the uppermost ± 200 feet of the unsaturated zone in recharge areas.	Larry Mann, USGS
Ground Water Monitoring at ICPP (WINCO)	WINCO Environmental Restoration	Tank farm in high-level radioactive waste storage area.	9 screened wells which provide ground water sampling capability (wet wells).Monthly	Direct radiation survey.	Ken Taylor, WINCO
			9 screened wells which provide ground water sampling capability (wet wells). Quarterly	pH, and γ if water is detected.	
			29 solid monitoring pipes and the 9 screened wells allow direct instrument survey (dry wells). Monthly	Direct radiation survey of the sub-soils	

Program / Purpose	Sampling Organization	Location	Method/Frequency	Analysis	Contact Person
Ground Water Monitoring at ICPP (WINCO)* *This is a new plan to be implemented, to conform to RCRA regs.	WINCO	Tank Farm	3 of 4 perched water wells downgradient (33-2, 33-3, 33-4, 5504) and one upgradient to be sampled quarterly the first year.	RCRA constituents. As, Ba, Cd, Cr, F, Pb, Hg, NO_3, as N, Se, Ag, Endrin, Lindane, Methoxychlor, Toxaphene, 2,4-D, 2,4,5-TP Silvex, Gross α, Gross β, Coliform, Cl, Fe, Mn, Na, Sulfate, pH, Specific Conductance, Total Organic Carbon (TOC), Total Organic Halogen (TOX) Additional radiological constituents on one well. Analysis subcontracted to outside laboratory.	Ken Taylor, WINCO
		Percolation Ponds (State may define more constituents and more frequent sampling as a result of the Land Application of Waste Permit)	Wells in the vicinity of the percolation ponds (PW 1, 2, 4, and 5) to sampled quarterly the first year. 6 downgradient aquifer wells and 1 upgradient aquifer well.	RCRA constituents. As, Ba, Cd, Cr, F, Pb, Hg, NO_3 as N, Se, Ag, Endrin, Lindane, Methoxychlor, Toxaphene, 2,4-D, 2,4,5-TP Silvex, Gross α, Gross β, Coliform, Cl, Fe, Mn, Na, Sulfate, pH, Specific Conductance, Total Organic Carbon (TOC), Total Organic Halogen (TOX) Semivolatile and volatile organics? Analysis subcontracted to outside laboratory.	Ken Taylor, WINCO
		Sewage Lagoons (Land Application of Waste Permit Submitted to State of Idaho)	One upgradient well. Downgradient well not drilled yet, one new well anticipated. Perched water wells not drilled yet, 2 new wells anticipated. Monitoring frequency and reporting requirements to be defined by the state.	Constituents to be sampled for to be defined by the state.	Ken Taylor, WINCO

Program / Purpose	Sampling Organization	Location	Method/Frequency	Analysis	Contact Person
Liquid Effluent Industrial Waste Monitoring at ANL-W Facility (characterization, operations, surveillance)	Health Physics (ANL-W)	Industrial waste flow to industrial waste pond	In-line monitor. Source checked weekly, calibrated semiannually.	γ	Gary Marshall, ANL-W
	Plant Services under the direction of Environment, Waste Management (ANL-W)	Industrial Waste Pond (IWP)	Grab sample, (1) 1-liter. Monthly, April through October	BOD, DO, α, β, H-3, γ, pH, H-3, total Cr, Cr^{6+}, conductivity, SO_4^{2-}, PO_4^{3-}, Cl^-, Na^+, Zn, Cd, and Ag. Analysis by ANL-East.	Chris Martin, ANL-W
			Grab sample, 3 gallons. Semiannually (April and October).	Pu and γ. Analysis by ANL-East	
	EWM under the direction of DOE-CH	Industrial Waste Pond (IWP)	Grab Samples. Annually (May)	Totals Analysis for TCLP constituents. Analysis by Contract Laboratory.	
Liquid Effluent Sanitary Sewage Monitoring at ANL-W Facility (Sanitary Sewege) (characterization, operations, surveillance)	Health Physics (ANL-W)	Sanitary Waste Flow to Sanitary lagoon	In-line monitor. Source checked weekly, calibrated semiannually	γ	Gary Marshall, ANL-W
	EWM (ANL-W)		Grab sample, (2) 500 ml. Monthly, April through October	BOD, DO, TSS, pH. Analysis performed by EG&G.	Chris Martin, ANL-W
	Plant Services under the direction of EWM (ANL-W)	Sanitary lagoon, primary	Grab sample, (1) 1-liter. Monthly, April through October	α, β, H-3, γ, Cd, pH. Analysis by ANL-W	
	Plant Services under the direction of EWM (ANL-W)	Sanitary lagoon, secondary	Grab sample, (2) 500 ml. Monthly, April through October	BOD, DO, TSS, pH. Analysis performed by EG&G Environmental Laboratory at CFA Health and Industrial Hygiene.	
			Grab sample, 3 gallons. Semiannually (April and October).	Pu and γ. Analysis by ANL-East	
Routine Sampling (operations, surveillance)	EG&G individual facility operations	EG&G Sewage Treatment Plants (CFA, TRA, PBF, RWMC, SMC, TSF, TAN, WRF)	Daily Grab Samples	pH, settleable solids, chlorine.	Ron Dickson EG&G F&M
			Weekly Grab Samples	BOD, DO, γ.	
			Monthly Grab Samples	α, β, Sr-90, H-3.	Jane Welch EG&G EM

Program / Purpose	Sampling Organization	Location	Method/Frequency	Analysis	Contact Person
Routine Sampling (operations, surveillance)	TRA operations	TRA Warm Waste system effluent, retention basin	500 ml sample collected daily from Retention Basin inlet compositor	α, β, γ	Lori Petersen, EG&G, TRA Operations
		TRA Warm Waste Treatment system	(2) 500 ml samples collected when transfer to retention basin is necessary	γ	
			(2) 500 ml samples collected when transfer to retention basin is necessary	pH, conductivity	
			90 ml samples collected when transfer to retention basin is necessary	α, β	
		TRA effluent Cold Waste system effluent	500 ml sample collected daily from CWP sump compositor	α, β, γ	
			500 ml sample collected weekly from CWP compositor	Chemical analysis	

Program / Purpose	Sampling Organization	Location	Method/Frequency	Analysis	Contact Person
Nonradiological Liquid Effluent Monitoring (characterization, compliance)	EG&G EM	EG&G Idaho Facilities: TRA influent to sewage treatment plant, TRA effluent to Cold Waste Pond, TRA Effluent to Chemical Leaching Pond, TRA Effluent to Retention Basin, TRA Effluent to STP Trickling Filter Pond, PBF Effluent to Waste Disposal Evaporation, TAN influent to sewage treatment plant, TAN TSF Effluent from Sewage Treatment Plant, TAN TSF Effluent to Drainage Pond, CTF Effluent to Liquid-Disposal Pond, CFA influent to sewage treatment plant, CFA effluent to drainfield, CFA 608 effluent to oil water separator, CFA 612 light laboratory effluent, CFA 603 medical services effluent, CFA 690 RESL effluent, CFA 688 printshop effluent, CFA Effluent from CLRF, CFA Effluent to Sewage Treatment Plant, CFA Oil /Water Separator Effluent, IRC waste Effluent, WCB waste Effluent, LOFT effluent to drainage pond, IETC waste effluent, WERRTF effluent to sewage lagoon, WERRTF effluent to evaporation pond.	All effluent discharges are monitored at a minimum of semi-annually or in the case of PBF effluent to the evaporation pond, when discharge occurs.	Monitored parameters vary with each discharge source. Parameters include: Anions: F^-, Cl^-, NO_3^-, ammonia nitrate, PO_4^{3-}, SO_4^{2-} Metals: As, Be, Ba, Cd, Cr, Cu, Pb, Hg, Se, Zn, Ag, Ni, Tl, Co, Mg, Na, K Total organic carbon (TOC) Total Oil and Grease Total Suspended Solids (TSS) Total Residual Chlorine Total Sulfide Total Phenolics Volatile organic compounds (VOCs) pH and conductivity Cyanide Specific parameters monitored at each discharge source are discussed in the Effluent Monitoring Handbook for Operational Facilities.	Jane Welch, EG&G EM

Program / Purpose	Sampling Organization	Location	Method/Frequency	Analysis	Contact Person
Waste Water Monitoring at NRF. (characterization, operations, surveillance)	Environmental Controls (WEC)	Industrial Waste Ditch	Grab sample - Weekly	pH, cond., TDS, PO_4^{3-}, SO_4^{2-}, Cl^-, Na^+	R.D.E. Newbry, DOE-IBO
		Waste Water Processes	Grab sample - Weekly	TBD	
		Industrial Waste Ditch effluent limit	Grab Sample - Monthly	Comprehensive	
		Industrial Waste Ditch bacteria	Plate Count - Annually	Fecal Coliform	
		Sewage Lagoon	Grab sample - Monthly	DO, pH, BOD	
		Waste Water grab samples (outside)	Grab sample - Weekly	TBP	
		Lagoon Piezometers	Bailer - Quarterly	Total N, NO_3^-, NO_2^-, NO, NH_3	
		Waste Stream Analysis	Various - Annually	TBD	
Waste Water Monitoring at NRF. (operations, characterization, surveillance)	Environmental Controls (WEC)	S1W spray pond, S1W Cooling Tower, S5G Cooling Tower, Sewage Lagoon, Industrial Waste Ditch, Piezometers.	Grab samples - weekly, monthly, quarterly, annually	β, α, H-3, Co-60, Cs-137	

Program / Purpose	Sampling Organization	Location	Method/Frequency		Analysis	Contact Person
DOE-RESL	RESL	ICPP Percolation Pond	Three (3) 1-liter samples are collected each month. Samples are labeled A, B, and C.	Sample type A, acidified with HCL and contains 200 mg of metabisulfate and one crumbled ashless paper pulp tablet.	γ spec., particularly Nb-95, Zr-95, Cs-134, Cs-137, and Ce-144. The sample is saved and composited with two other monthly samples for the quarter to be analyzed for Pu-238, Pu-239/240, Am-241, uranium isotopes, and Sr-90.	Eddie Chew, Dianna Hoff, Russ Mitchell, DOE-ID RESL
				Sample type B, acidified with HCL and contains 200 mg of metabisulfate.	Ru-106, I-131, and Sb-125.	
				Sample type C, unpreserved	pH, specific conductance, H-3, Na^+, and Cl^-	
			Two (2) 4-liter samples are collected each quarter. Labeled Sample type E.		I-129 by γ scan. The second sample is used as a blank	
			One (1) 1-liter sample is collected quarterly. Sample type D.		Sample is given to USGS to be sent to the USGS National Water Quality Laboratory in Colorado for any analysis USGS deems necessary.	
		TRA Percolation Pond	Two (2) one-liter unfiltered water samples are collected in polyethylene cubitainers from the pond each month.	Acidified	Na-24, Cr-51, Co-58, Co-60, Sr-90, Nb-95, Zr-95, Ru-103, Sb-124, I-131, Cs-137, Ce-141, Ce-144, Hf-181.	
				Unpreserved	Na-24, Cr-51, Co-58, Co-60, Sr-90, Nb-95, Zr-95, Ru-103, Sb-124, I-131, Cs-137, Ce-141, Ce-144, Hf-181, H-3, Na^+, pH. First sample from each quarter is analyzed for Cl^-, and total chrome.	

Program / Purpose	Sampling Organization	Location	Method/Frequency	Analysis	Contact Person
Liquid Monitoring at ICPP Facility (characterization, surveillance, operations)	WINCO	Service Waste System (CPP-797)	Continuous proportional sampler - Daily	γ	Robert Olsen, Production Dee Williamson WINCO
			Composite of all daily samples Monthly	Sr-89, Sr-90, H-3, C-14, I-129, total U, total Pu, As, Ba, Cd, Cl^-, Cr, CN^-, F^-Pb, Hg, NO_3^-, SO_4^{2-}, Se, Ag, spec. cond., TDS, α, β, and pH.	
			Grab samples Every 3 years	TOC, endrin, lindane, methoxychlor, toxaphene, 2,4-D and 2, 4, 5-TP silvex	
	EG&G contracted by WINCO	Sewage Treatment Plant	Grab samples of both the influent and effluent. Daily	pH and settleable solids	John Gill, WINCO
			Flow meters Daily	Flow volume	
			Grab samples of both inlet and outlet Weekly.	pH, BOD, DO	
			Composite analysis of daily effluent samples. Weekly	γ	
			Composite analysis of 4 weekly samples. Monthly	Sr-89, Sr-90, total Pu	
			Composite analysis of 3 monthly samples. Quarterly	Total Pu	
	WINCO	Percolation Ponds	Stevens type F water gauge and visual inspection. Continuous and bi-weekly	Water level	Paul Owens, Production
			Water grab samples collected at random. Semiannually	α, β, γ, H-3, Sr-89, Sr-90, As, Ba, Cd, Cr, Hg, Pb, Se, Ag, pH, total Pu, total U, TDS, conductivity, I-129, C-14, Cl^-, F^-, NO_3^-, PO_4^{3-} and SO_4^{2-}	
	RESL		Grab samples of pond water. Monthly	γ, Sr-89, Sr-90, H-3, I-129	Eddie Chew, DOE-ID RESL, Dianna Hoff, Russ Mitchell, DOE-RESL

Program / Purpose	Sampling Organization	Location	Method/Frequency	Analysis	Contact Person
ANL-W	ANL-W Radiation Safety Group - (Radiation, Fire, and Safety Group)	Surface of major industrial waste and surface drainage ditches.	β-γ radiation surveys taken close to ground- or water-level. Annually in October	β-γ radiation survey	Chris Martin, ANL-W EWM
		Perimeter fence of RSWF.	β-γ surveys taken at one meter above ground level. Biannually in April and October	β-γ radiation survey	
		Within RSWF	β-γ surveys taken at one meter directly above 10 randomly selected storage liners. The top surfaces of the liners are also surveyed for possible loose contamination. Biannually in April and October.	β-γ radiation survey	
			Top surfaces of 10 randomly selected liners are surveyed for possible loose contamination. Biannually April and October.	α	
ANL-W Thermoluminescent Dosimeters	ANL-W Radiation Safety Group.	ANL-W Site Boundary. Nine TLDs located in the vicinity of EBR-II and three in the vicinity of TREAT	Dosimeters mounted one meter above ground level. Six-month exposure levels. Compared to background readings from seven distant communities.	Six Month Exposure levels in mR.	Amy Powell, ANL-W
EG&G	EG&G and RESL	RWMC - SDA and TSA	Thermoluminescent Dosimeters (TLDs) around facility perimeters. Semiannually	External radiation levels of β particles (>200 KeV) and γ photons (>10 KeV).	Amy Powell, ANL-W
			Surface Radiation Surveys - Truck mounted VRM-1 detector system - Plastic scintillation detection system	External radiation levels of β particles (>200 KeV) and γ photons (>10 KeV).	
		WERF	Thermoluminescent Dosimeters (TLD)	External radiation levels. Alert level = 1111 mR in 6 months	
		Stationary Low Power Reactor No. 1 (SL-1)	Surface Radiation Surveys using a hand held cps and mR/hr-γ survey instrument. Biannual surveys in April and August.	External radiation levels. Sl-1 is a non-operational surplus facility and has maintenance monitoring only.	
		Organic Moderated Reactor Experiment (OMRE)	Surface Radiation Surveys using a truck mounted plastic scintillation detector system, or equivalent instrument. Annually in July.	External radiation levels. OMRE is a non-operational surplus facility and has maintenance monitoring only.	

Program / Purpose	Sampling Organization	Location	Method/Frequency	Analysis	Contact Person
NRF Environmental Thermoluminescent Dosimeter Monitoring		Perimeter	27 Thermoluminescent Dosimeters. Quarterly	External radiation levels.	R.D.E. Newbry, DOE-IDO
		5 miles out	15 Thermoluminescent Dosimeters. Quarterly	External radiation levels.	
NRF Radiation Survey		S1W Leaching Bed, A1W Leaching Bed, 15 selected grid locations, 4 underground piping system locations, 10 known areas of contamination	PRM-5n, E140-N (?) annually	External radiation.	R.D.E. Newbry, DOE-IDO
		12 waste dumpsters	PRM-5n, E140-N (?) quarterly	External radiation.	
DOE-RESL		On-site: 16 in vicinity of ANL-W 4 in vicinity of CFA 17 in the vicinity of ICPP 11 in vicinity of NRF 24 in vicinity of RWMC 13 in vicinity of SPERT/ PBF/WERF 23 along lincoln Blvd. and Highways 20 and 26	Thermoluminescent Dosimeters exposed for six months for routine measurements. Changed out in November and May of each year.	mR of exposure/6 months, β >200 keV, γ >10 keV.	Eddie Chew, DOE-ID RESL, Dianna Hoff, Russ Mitchell, ESB
			γ Radiation Surveys with μR meters and followed up with other handheld β-γ or α-sensitive instruments as needed. Surveys conducted every third year at ICPP, TRA, RWMC, CFA, NRF, TAN, ARA, PBF/SPERT/WERF, and ANL-W.	γ radiation intensities around operating INEL facilities. Radiation area: >5 mrem/hr but <100 mrem/hr at 30 cm High Radiation area: ≥100 mrem/hr but <5 rem/hr at 30 cm Very High Radiation area: ≥5 rem/hr at 30 cm.	
		Off-site: 13 in communities near the INEL boundary and some distant locations.	Thermoluminescent Dosimeters	mR of exposure/6 months, β>200 keV, γ >10 keV.	
		Road monitoring	Roads are scanned with a bumper mounted array of G-M tubes. Small hand held alpha-sensitive instruments may be used for small, isolated areas where actinides are suspected to be present.	β-γ contamination, α	

Program / Purpose	Sampling Organization	Location	Method/Frequency	Analysis	Contact Person
INEL Seismograph Stations. The INEL Seismic Network operates six seismograph stations and monitors two Ricks College stations, and a University of Utah station. INEL collects earthquake data to develop a historical seismic data base. Data collected is utilized in development of seismic design criteria for constructing facilities at the INEL.	EG&G Biotechnology, Environmental, and Geosciences Group	INEL: Cedar Butte, ID (CBTI) Circular Butte, ID (CRBI) Big Grassy Butte, ID (GBI) Howe Peak, ID (HPI) Juniper Gulch, ID (JGI) Taylor Mountain, ID (TMI) Ricks College: Red Ridge, ID (RRI) Indian Meadows, WY (IMW) University of Utah: Pocatello, ID (PTI)	Each location has a Mark Products vertical seismometer, a Teledyne Geotech amplifier, a Teledyne Geotech voltage controlled oscillator, and a Monitron or Ritron frequency modulated (FM) radio transmitter. Information is sent to the Idaho Research Center in Idaho Falls. Seismograms are analyzed daily.	Seismic data (earthquake activity) along with WWVB time trace (Universal Coordinated Time). The time trace is accurate to ± 0.001 seconds. The arrival times for primary (P) and secondary (S) waves are measured to 0.1 seconds. The accuracy of selecting P-wave arrival time is about 0.15 seconds and for the S-wave arrival time, approximately 0.20 seconds. The epicenter is located if near or within the ISSA (Idaho Special Study Area), and the magnitude is determined.	S.M. Jackson and D.M. Anderson
INEL Strong-motion Accelerographs. INEL began the SMA network for the purpose of recording strong ground motion from local moderate or major earthquakes. Data collected is utilized in development of seismic design criteria for constructing facilities at the INEL.	EG&G Biotechnology, Environmental, and Geosciences Group	20 SMAs total: 5 at ICPP, 2 at ANL, 3 at PBF, 2 at TRA, 1 at OFS (old fire station), 4 at TAN in the LOFT, 1 at IRC, and 2 at NRF	INEL uses Teledyne Geotech RFT-250, Kinemetrics SMA-1, and SMA-1A accelerographs.	Ground motion data. When instruments are triggered by ground motion exceeding 0.008 g, they record an acceleration time-history on 70-mm film. The film is digitized then processed to produce acceleration, velocity, and displacement time histories along with Fourier and response spectra.	

Program / Purpose	Sampling Organization	Location	Method/Frequency	Analysis	Contact Person
Soil Monitoring at ANL-W Facility. (surveillance) DOE Orders 5400.1, 5400.5, and DOE E 0173T	EWM (ANL-W)	Experimental Breeder Reactor - II (EBR-II)	Six (6) samples - one in the NW corner of the site security area, one in the SE corner of the site security area, two in the SW corner, and two in the NE corner. Annually (June or July)	Cs-137, Th-232 decay chain, Ra-226 decay chain, Pu-238, and Pu-239/240. Analysis performed by ANL-E Analytical Laboratory.	Chris Martin, ANL-W
		Radioactive Scrap and Waste Facility (RSWF)	Four (4) samples - collected at random from a numbered grid, selected by a random number generator. Annually (June or July).	Cs-137, Th-232 decay chain, Ra-226 decay chain, Pu-238, and Pu-239/240. Analysis performed by ANL-E Analytical Laboratory.	
		ANL-W Perimeter.	Four (4) samples - collected: S. of drain ditch S. of Bldg. 758; NW of Bldg. 799; NE corner, S & W of boundary roads; and SE corner, SE of boundary roads.	Cs-137, Th-232 decay chain, Ra-226 decay chain, Pu-238, and Pu-239/240. Analysis performed by ANL-E Analytical Laboratory.	Dianna Hoff, RESL
Erosion Control	EM/Plant Services	ANL-W site	Annually and after severe weather disturbances.	Erosion - corrective actions taken by ANL-W	Chris Martin, ANL-W
Concentration of Off-site Surface Soils	EWM (ANL-W)	Off-site of ANL-W facility.	Soil samples results given in geometric mean with 95% confidence interval. Locations of samples not given in report.	Cs-137, Pu-238, Pu-239/240.	Chris Martin, ANL-W
Surface Sediment Monitoring at ANL-W (surveillance) DOE Orders 5400.1, 5400.5, and 5400.6	EWM (ANL-W)	Surface-Inlet to Industrial Waste Pond (IWP).	One sample collected at a depth of 5 - 6 cm. Annually	Cs-137, Th-232 decay chain, Ra-226 decay chain, Pu-238, and Pu-239/240. Analysis by ANL-E Analytical Laboratories.	Chris Martin, ANL-W
			One sample collected at a depth of 5 - 6 cm. Annually	39 RCRA TCLP constituents. Analysis by Contract Laboratory.	
ANL-W / Characterization of waste areas for the FFA-CO.	ANL-W Environmental and Waste Management (EWM) section	EBR-II Leach Pit	Soil	? ______ (Sampling plan is still in the development stage.)	Nancy Stewart, ANL-W

Program / Purpose	Sampling Organization	Location	Method/Frequency	Analysis	Contact Person
Soil Monitoring (characterization, surveillance		Off-site locations: St. Anthony, Crystal Ice Caves, Blackfoot, Atomic City, Butte City, Howe, Reno Ranch, Monteview, Mud Lake #1, Mud Lake #2, FAA Tower, Carey	Soil samples (0-5 cm, 5-10 cm, 5 samples from a 10 m x 10 m grid composited) Biennially	γ, Pu-238, Pu-239/240, Am-241, Sr-90	Eddie Chew, DOE-RESL
		On-site locations: ANL-W (EBR-II, TREAT), NRF, ICPP, TAN (TSF, IET, CTF), WERF, TRA, ARA/SL-1, SPERT/PBF/WERF, RWMC	Soil sampling is performed at different on-site facilities on a rotating 7-year schedule.	γ, Pu-238, Pu-239/240, Am-241, Sr-90	
Soil Monitoring (surveillance)	EG&G EM/RESP	RWMC (Active Areas, Pad A, Inactive Areas, Flooded Area, Transuranic Storage Area (TSA)), SWEPP, MWSF, PREPP	Sampling rings: 5" diam. x 2" deep; 5 sub-samples from each composite plot. Triennially at RWMC and SWEPP.	γ, Radiochemistry analysis for specific α and β emitters (e.g., Sr-90, U-232, U-233, U-234, U-235, U-238, Am-241, Pu-238, Pu-239/240	Jane Welch, EG&G EM
		WERF	Sampling rings: 5" diam. x 2" deep; 5 sub-samples from each composite plot. Triennially	Non radioactive trace elements: Sb, As, Be, B, Cd, Cr, Cu, Pb, Hg, Ni, Se, Ag, Tl, Zn, Cl, NO_3^- + NO_2^-, and SO_4^{2-} γ spectroscopy for 27 γ-emitting radionuclides (e.g. Cr-51, Mn-54, Co-58, Fe-59, Co-60, Nb-95, Zr-95, Ru--103, Ru-106, Sb-125, Cs-134, Cs-137, Ce-141, Ce-144, Eu-152, Am-241)	
Sediment/Soil Monitoring at NRF. (surveillance)	Environmental Controls (WEC)	S1W Spray Pond, A1W Cooling Tower, S5G Cooling Tower, Industrial Waste Ditch, Sewage Lagoon, S1W Leaching Bed, A1W Leaching Bed, 15 Selected Grid Locations.	Soil Samples 4" x 4" wide by 1" deep for surface samples. Core with drilling tools, depth drilling and sampling. Annually	Co-60, Cs-137, Isotopic (varies)	R.D.E. Newbry, DOE-IBO
		Industrial Waste Ditch	Grab Sample - Annually	Metals - Cr, Pb, Hg, Ni	

Program / Purpose	Sampling Organization	Location	Method/Frequency		Analysis	Contact Person
Surface-Water Monitoring (surveillance)	EG&G Environmental Monitoring (EM)	RWMC-SDA (discharge pipes from the SDA gate ditch) and control location (1.5 km west of the Highway 20 and Van Buren Ave. intersection and 20 m south on T-12 access road).	4-L Fisher cubitainer; acidified in the field.	Quarterly, depending on precipitation	Gross α, gross β, γ, Am-241, Pu-238, Pu-239, Pu-240, U-235, U-238, and Sr-90.	Jane Welch, EG&G EM
				Annually in spring.	A sample from each location is analyzed for specific α and β radionuclides.	
		SWEPP: TSA-1, 2, 3, 4 (Culvert pipes on the north end of TSA) and control location (1/4 mi. west of T-12 on west side of the rest rooms at the rest area).	4-L Fisher cubitainer; acidified in the field.	Quarterly, depending on precipitation	Gross α, gross β, γ, Am-241, Pu-238, Pu-239, Pu-240, U-235, U-238, and Sr-90.	
				Annually in spring.	A sample from each location is analyzed for specific α and β radionuclides.	
Surface "Run-off" Water	EG&G EM/RESP	Sump Pump for the SDA ditch and the 4 culverts leaving the TSA pads that discharge into the main channel.	4-L container preserved with acid and ashless filter tablet.	Quarterly when available.	γ spectroscopy on both the liquid and solid fraction.	Jane Welch, EG&G EM
				Second quarter if available	radiochemistry for specific α and β emitting radionuclides	
Surface Water Levels and Flows	USGS-WR, Idaho Falls Field Office	USGS gauging stations on Big Lost River and Little Lost River Drainages.	Stream Gauging		Water Level and Flow Rate	Jake Jacobson, USGS-WR, Idaho Falls Field Office
Small Basin Gauging Stations	USGS-WR, Idaho Falls Field Office	Argonne - just north of waste pond. Big Lost Tributary #2 - 3 miles southeast of ANL on U.S. 20 about 28 miles west of Idaho Falls. Howe - 3.5 miles south of Howe, near eightmile canyon on U.S. 22. RWMC - 0.5 miles east of RWMC.	Sites are equipped with: - Crest stage gauges. - CR-10 data loggers with pressure transducers. - RWMC site also instrumented with ISCO automatic sampler.		Gauging and pressure transducers are used to estimate recharge to Snake River Plain Aquifer.	Larry Mann, USGS-WR Idaho Falls Field Office
Surface Water Levels and Flows	Sorenson and Associates Eng. (USGS-WR retains data)	USGS gauging stations on Birch Creek Drainage	Stream Gauging		Water Level and Flow Rate	Ted Sorenson, Sorenson Engineering and Associates Consulting Engineers.

Program / Purpose	Sampling Organization	Location	Method/Frequency	Analysis	Contact Person
EG&G Visual Inspection Monitoring	EM/RESP	RWMC - SDA/TSA	Walk through visual inspection. monthly	Surface depressions, exposed buried waste, missing or damaged trench and pit monuments, broken fence lines, illegible or missing warning signs, debris, and other irregularities. In addition, the drainage system and well locations are inspected several times yearly.	Jane Welch, EG&G EM
		SL-1	Walk through visual inspection. Biannually April and August.	Surface depressions, exposed buried waste, missing or damaged trench and pit monuments, broken fence lines, illegible or missing warning signs, debris, burrowing, deep rooted plants, and other irregularities. Burrowing activity is surveyed with a mR/hr meter.	
		OMRE	Walk through visual inspection annually in July.	Surface depressions or disturbances, locations of burrowing activity and deep rooted plants. Soil from burrowing activity is surveyed with a cps meter (if above background a sample is collected).	

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State of Idaho

INEL Oversight Program

SUMMARY OF LOCATIONS FOR ENVIRONMENTAL DATA BASES AT THE IDAHO NATIONAL ENGINEERING LABORATORY (INEL)
DRAFT VERSION

by
Phillip J. Bandy and L. Flint Hall

State of Idaho
INEL Oversight Program Technical Report 93-XX

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SUMMARY OF LOCATIONS FOR ENVIRONMENTAL DATA BASES AT THE IDAHO NATIONAL ENGINEERING LABORATORY (INEL) DRAFT VERSION

INTRODUCTION

This report presents status information on data retention locations for data generated from environmental monitoring programs being conducted at, and in the vicinity of, the Idaho National Engineering Laboratory (INEL). To evaluate the status and trend of environmental quality upon, beneath, and in the vicinity of the Idaho National Engineering Laboratory (INEL), subcontractors to the Department of Energy (DOE), and several federal and state agencies and organizations conduct environmental monitoring of a broad range of media including air, water, soil, and biota. These monitoring activities generate a great deal of data that are retained in a number of locations and forms, e.g., computer data bases and hard copy files.

Components of environmental data locations defined in this report are: the media being monitored, locations of monitoring programs, the retention location of environmental data produced from specific environmental monitoring programs, the data custodian or program contact for specific monitoring programs, and where data are ultimately reported. Environmental data retention location information is presented in a tabular format.

Data retention information is grouped by agency or organization and segregated within the group by media, i.e, air, biotic, drinking water, etc. Because of space limitations in the tables, expanded descriptions of data retention locations are included as endnotes[1].

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[1] Data retention locations in the tables have a superscript number, e.g., RWMIS[2], which correlates to the corresponding number in the endnote descriptions.

PURPOSE AND OBJECTIVE

Environmental data retained at INEL are generated from environmental monitoring programs carried out by subcontractors to the Department of Energy (DOE) as well as by several federal and state agencies. Organizations conducting environmental monitoring at INEL include: Argonne National Laboratory - West (ANL-W), EG&G, Idaho Department of Water Resources (IDWR) [in cooperation with the USGS], Idaho State University (ISU), the National Oceanographic and Atmospheric Administration (NOAA), the Navy, the United States Geological Survey (USGS), and Westinghouse Idaho Nuclear Company (WINCO). Each of these groups monitor numerous components of the environment either specifically, at specific facilities located at INEL, or generally, conducting monitoring both on- and off-site. The purpose of this project was to consolidate information about the location of data generated from monitoring programs conducted by each subcontractor, organization, and agency into a single document.

The State of Idaho INEL Oversight Program is mandated to perform independent evaluations of environmental monitoring at INEL; information included in this document will serve as part of the baseline of information that is required for future studies and evaluations. The objective of this project was to compile information on locations of data bases generated from environmental monitoring programs being conducted by federal and state agencies and subcontractors to (DOE) into a readable format from which information about data bases may be easily accessed and extracted.

METHODS

Information on environmental data base locations contained in this report was compiled from reviews of technical documents produced by DOE and it's subcontractors, interviews with program contacts, and interaction with agency and subcontractor personnel at technical meetings held in Idaho Falls in October, 1991 and June, 1992.

ANL-W Environmental Monitoring Programs and Data Retention Locations

Media	Monitoring Program Location	Data Location	Contact Person	Data Reporting
Air	Zero Power Physics Reactor (ZPPR) stack Fuel Manufacturing Facility (FMF) stack Main stack (including Experimental Breeder Reactor No.2 [EBR-II] and Hot Fuels Examination Facilities [HFEF]) Laboratory and Office Building: Non-destructive Assay (NDA) area stack Lab area stack Fuel assembly and storage building (FASB) Radioactive Liquid Waste Treatment Facility (RLWTF) Hot Fuels Examination Facilities (HFEF) Sodium Components Maintenance Shop (SCMS) Transient Reactor Test Facility (TREAT)	Environment, Safety, and Waste Management Dept. files[1].	**Amy Powell**, 533-7259, Environment and Waste Management.	RWMIS[2]
	Main parking lot - Atmospheric Sampling	RESL		
Biotic	Industrial Waste pond perimeter (vegetation)	Environment, Safety, and Waste Management Dept. files[1].	**Chris Martin**, 533-7379, Environment and Waste Management.	ANL-W annual Environmental Monitoring Report
	Each corner of the Site Security Perimeter (vegetation)	Environment, Safety, and Waste Management Dept. files[1].	**Chris Martin**, 533-7379, Environment and Waste Management.	ANL-W annual Environmental Monitoring Report
Drinking Water	Production Wells	Environment, Safety, and Waste Management Dept. files[1].	**Paul Mikolaycik**, 533-7163, Environment, Safety and Waste Management (ESWM) Department	DWMDMS[3] (EG&G)
	Distribution Systems	Environment, Safety, and Waste Management Dept. files[1].	**Paul Mikolaycik**, 533-7163, Environment, Safety and Waste Management (ESWM) Department	DWMDMS[3] (EG&G)
Ground Water	Characterization of waste areas for the FFA-CO; EBR-II Leach Pit	Environment and Waste Management files[1].	**Amy Powell**, 533-7259, Environment and Waste Management (EWM) section	?

ANL-W Environmental Monitoring Programs and Data Retention Locations

Media	Monitoring Program Location	Data Location	Contact Person	Data Reporting
Liquid Effluent	Industrial Waste Flow to the Industrial Waste Pond (IWP)	Environment, Safety, and Waste Management Dept. files[1].	**Gary Marshall**, 533-7666, Health Physics	IWMIS[4], ANL-W Environmental Monitoring Report.
	Industrial Waste Pond (IWP)	Environment, Safety, and Waste Management Dept. files[1].	**Skip Wallace**, 533-7902, Environment and Waste Management (EWM)	IWMIS[4], ANL-W Environmental Monitoring Report.
	Waste flow to Sanitary Lagoon	Environment, Safety, and Waste Management Dept. files[1].	**Gary Marshall**, 533-7666, Health Physics, and **Skip Wallace**, 533-7902, Environment and Waste Management (EWM)	IWMIS[4], Annual Report to DOE-CH and DOE-ID.
	Primary and secondary lagoons	Environment, Safety, and Waste Management Dept. files[1].	**Skip Wallace**, 533-7902, Environment and Waste Management (EWM)	IWMIS[4], Annual Report to DOE-CH and DOE-ID.
Radiation	Surface of major industrial and surface drainage ditches.	Environment, Safety, and Waste Management Dept. files[1].	**Chris Martin**, 533-7379 Environment and Waste Management.	ANL-W Annual Environmental Monitoring Report
	Perimeter fence of Radioactive Scrap and Waste Facility (RSWF).	Environment, Safety, and Waste Management Dept. files[1].	**Chris Martin**, 533-7379 Environment and Waste Management.	ANL-W Annual Environmental Monitoring Report
	Within RSWF.	Environment, Safety, and Waste Management Dept. files[1].	**Chris Martin**, 533-7379 Environment and Waste Management.	ANL-W Annual Environmental Monitoring Report

ANL-W Environmental Monitoring Programs and Data Retention Locations

Media	Monitoring Program Location	Data Location	Contact Person	Data Reporting
Radiation	ANL-W Site Boundary. TLD program conducted by RESL.	RESL	**Dianna Hoff**, RESL	Quarterly reports to ANL-W, Annual INEL Environmental Monitoring Report.
Soil and Sediment	Within Perimeter Fence - soil	Environment, Safety, and Waste Management Dept. files[1].	**Chris Martin**, 533-7621, Environment and Waste Management.	ANL-W Annual Environmental Monitoring Report.
	Radioactive Scrap and Waste Facility (RSWF) - soil	Environment, Safety, and Waste Management Dept. files[1].	**Chris Martin**, 533-7621, Environment and Waste Management.	ANL-W Annual Environmental Monitoring Report.
	Industrial Waste ditch and intercepter canal - surface sediment	Environment, Safety, and Waste Management Dept. files[1].	**Chris Martin**, 533-7621, Environment and Waste Management.	ANL-W Annual Environmental Monitoring Report.
	Off-site	Environment, Safety, and Waste Management Dept. files[1].	**Chris Martin**, 533-7621, Environment and Waste Management.	ANL-W Annual Environmental Monitoring Report.
	Industrial Waste Pond (IWP)	Environment, Safety, and Waste Management Dept. files[1].	**Chris Martin**, 533-7621, Environment and Waste Management.	ANL-W Annual Environmental Monitoring Report.

EG&G Environmental Monitoring Programs and Data Retention Locations

Media	Monitoring Program	Data Location	Contact Person	Data Reporting
Air	Facility Stack Monitoring Central Laundry and Respirator Facility Drum Vent Facility Advanced Test Reactor (ATR) Test Area North Hot Shop (TAN) Test Reactor Area (TRA) Process Experimental Pilot Plant (PREPP) Waste Experimental Reduction Facility (WERF)		EG&G Operations	RWMIS[2]
	Environmental Monitoring for Airborne Particulate Radioactivity Radioactive Waste Management Complex (RWMC) Stored Waste Examination Pilot Project (SWEPP) Waste Experimental Reduction Facility (WERF) Mixed Waste Storage Facility (MWSF)	ESPDMS[5]	**Jane Welch**, EG&G Environmental Surveillance Program.	ESPDMS[5] EM/RESP Annual Report
Biotic	Radioactive Waste Management Complex (RWMC) Small Mammals Vegetation Excavated Soil	ESPDMS[5]	**Jane Welch**, 526-9535, EG&G Environmental Surveillance Program.	ESPDMS[5] EM/RESP Annual Report
	Waste Experimental Reduction Facility (WERF) Vegetation	ESPDMS[5]	**Jane Welch**, 526-9535, EG&G Environmental Surveillance Program.	ESPDMS[5] EM/RESP Annual Report
	Stationary Low Power Reactor No. 1 (SL-1) Burrowing activity Deep rooted plants	ESPDMS[5]	**Jane Welch**, 526-9535, EG&G Environmental Surveillance Program.	ESPDMS[5] EM/RESP Annual Report
	Organic Moderated Reactor Experiment (OMRE) Burrowing activity Deep rooted plants	ESPDMS[5]	**Jane Welch**, 526-9535, EG&G Environmental Surveillance Program.	ESPDMS[5] EM/RESP Annual Report
Drinking Water	Production Wells	DWMDMS[3]	**Jane Welch**, 526-9535, EG&G EM	DWMDMS[3]
	Distribution Systems	DWMDMS[3]	**Jane Welch**, 526-9535, EG&G EM	DWMDMS[3]

EG&G Environmental Monitoring Programs and Data Retention Locations

Media	Monitoring Program	Data Location	Contact Person	Data Reporting
Liquid Effluent	Sewage treatment plants for all EG&G operated facilities		EG&G-ESQ, EG&G-WM	IWMIS[4]
	Non-rad effluent	EMDMS	**Jane Welch**, 526-9535, EG&G EM	EMDMS[6]
	TRA Operations		**R.N. Beatty**, 526-4569, EG&G TRA Operations	
Radiation Monitor-ing	Thermoluminescent Dosimeters Radioactive Waste Management Complex (RWMC), Waste Experimental Reduction Facility (WERF)	ESPDMS[5]	EG&G and DOE-RESL	ESPDMS[5]
	Surface Radiation Surveys RWMC, Stationary Low Power Reactor No. 1 (SL-1), Organic Moderated Reactor Experiment (OMRE)	ESPDMS[5]	EG&G and DOE-RESL	ESPDMS[5]
Seismic Network	Seismographs Strong-motion Accelerographs		**S.M. Jackson**, 526-4293, **D.M. Anderson**, 526-4220, EG&G Biotechnology, Environmental, and Geosciences Group	
Soil and Sediment	Radioactive Waste Management Complex (RWMC), Stored Waste Examination Pilot Project (SWEPP), Mixed Waste Storage Facility (MWSF), Process Experimental Pilot Plant (PREPP), previous preoperational sampling at MWSF and PREPP, and Waste Experimental Reduction Facility (WERF).	ESPDMS[5]	**Jane Welch**, 526-9535, EG&G EM	ESPDMS[5] EM/RESP Annual Report
Surface Water	Radioactive Waste Management Complex (RWMC) and Stored Waste Examination Pilot Project (SWEPP).	ESPDMS[5]	**Jane Welch**, 526-9535, EG&G EM	ESPDMS[5] EM/RESP Annual Report
Visual Inspections	RWMC-SDA/TSA Stationary Low Power Reactor No. 1 (SL-1) Organic Moderated Reactor Experiment (OMRE)		**Jane Welch**, 526-9535, EG&G EM	EM/RESP Annual Report

IDWR-USGS Environmental Monitoring Programs and Data Retention Locations

Media	Monitoring Program	Data Location	Contact Person	Data Reporting
Ground Water	Sampling of wells and springs downgradient of INEL facility.	IDWR - EDMS USGS - INEL Program Office Files	**Lin Campbell**, 327-7965, IDWR **Larry Mann**, 526-2439, USGS	USGS Open-File Reports

Idaho State University Environmental Monitoring Programs and Data Retention Locations

Media	Monitoring Program	Data Location	Contact Person	Data Reporting
Air	Atomic City, Craters of the Moon, Experimental Field Station, and Van Buren Ave. (these samplers are collocated with existing DOE samplers).		**Dr. Bernie Graham**, 236-3475, College of Pharmacy	
Biotic	Milk		**Dr. Bernie Graham**, 236-3475, College of Pharmacy	
Ground Water	Springs and Wells.		**Dr. Bernie Graham**, 236-3475, College of Pharmacy	

NOAA Environmental Monitoring Programs and Data Retention Locations

Media	Monitoring Program	Data Location	Contact Person	Data Reporting
Climatological Monitoring	Weather towers at key INEL facilities.	Some data are retained on tapes in the Idaho Falls Office IRC.	**Gene Start**, 526-2743, NOAA Air Resources Lab Field Research Division	National Climatological Data Center (NCDC)

NRF Environmental Monitoring Programs and Data Retention Location

Media	Monitoring Program	Data Location	Contact Person	Data Reporting
Air	Radiological Radiological Effluent Particulate Monitoring S5G, A1W, ECF, S1W, Background Tritium Monitors S5G, A1W, ECF, S1W, Background	Environmental Controls Data Base[7]	**R.D.E. Newbry**, 533-5057, Westinghouse Environmental Controls (WEC), DOE-IDO	RWMIS[2]
	Nonradiological Sulfate content of fuel oil Emissions from Boiler House Emissions from Generators Emissions from Incinerator Opacity from Boiler House Opacity from Incinerator	Environmental Controls Data Base[7]	**R.D.E. Newbry**, 533-5057, Westinghouse Environmental Controls (WEC), DOE-IDO	IWMIS[4]
Biotic	Vegetation Industrial Waste Ditch, S1W Leaching Bed, A1W Leaching Bed, selected grid locations	Environmental Controls Data Base[7]	**R.D.E. Newbry**, 533-5057, Westinghouse Environmental Controls (WEC), DOE-IDO	RWMIS[2], IWMIS[4]
Drinking Water	Production Wells Distribution System(?)	Environmental Controls Data Base[7]	**R.D.E. Newbry**, 533-5057, Westinghouse Environmental Controls (WEC), DOE-IDO	IWMIS[4]
Environmental Survey	Barrel Survey Ecology Survey Oil Usage Survey Waste Dumpster Survey Waste Box Survey	Environmental Controls Data Base[7]	**R.D.E. Newbry**, 533-5057, Westinghouse Environmental Controls (WEC), DOE-IDO	IWMIS[4]
Ground Water	Production Wells Upgradient Wells Downgradient Wells Sewage Lagoon Piezometers	Environmental Controls Data Base[7]	**R.D.E. Newbry**, 533-5057, Westinghouse Environmental Controls (WEC), DOE-IDO	IWMIS[4]
Hazardous or Toxic Substances	System Oil/Water Separations Waste Stream Analysis	Environmental Controls Data Base[7]	**R.D.E. Newbry**, 533-5057, Westinghouse Environmental Controls (WEC), DOE-IDO	IWMIS[4]

NRF Environmental Monitoring Programs and Data Retention Locations

Media	Monitoring Program	Data Location	Contact Person	Data Reporting
Liquid Effluent	Radiological Waste Water S1W spray pond, A1W cooling tower, S5G cooling tower, Industrial Waste Ditch, Sewage Lagoon, Piezometers	Environmental Controls Data Base[7]	**R.D.E. Newbry**, 533-5057, Westinghouse Environmental Controls (WEC), DOE-IDO	RWMIS[2]
	Waste Water (nonradiological) Industrial Waste Ditch Waste Water Processes (Interior) Industrial Waste Ditch effluent limit Industrial Waste Ditch Bacteria Sewage Lagoon Waste Water Processes (Exterior) Lagoon Piezometers Waste Stream Analysis	Environmental Controls Data Base[7]	**R.D.E. Newbry**, 533-5057, Westinghouse Environmental Controls (WEC), DOE-IDO	IWMIS[4]
Prelimi-nary Facility Area Surveil-lance			**R.D.E. Newbry**, 533-5057, Westinghouse Environmental Controls (WEC), DOE-IDO	
Radiation	Thermoluminescent Dosimeters Perimeter 5 miles out Radiation Survey - Environmental Controls Data Base S1W Leaching Bed, A1W Leaching Bed, selected grid locations, underground piping system locations (4), known areas of contamination (10), waste dumpsters (12)	Environmental Controls Data Base[7]	**R.D.E. Newbry**, 533-5057, Westinghouse Environmental Controls (WEC), DOE-IDO	RESL Annual Report
Soil and Sediment	S1W spray pond, A1W cooling tower, S5G cooling tower, Industrial Waste Ditch, Sewage Lagoons, S1W Leaching Bed, A1W Leaching Bed, Selected Grid Locations	Environmental Controls Data Base[7]	**R.D.E. Newbry**, 533-5057, Westinghouse Environmental Controls (WEC), DOE-IDO	RWMIS[2], IWMIS[4]

RESL Environmental Monitoring Programs and Data Retention Locations

Media	Monitoring Program	Data Location	Contact Person	Data Reporting
Air	Low Volume On-site locations Off-site locations	RESL Environmental Sciences Data Base[8]	**Eddie Chew**, 526-2335 **Dianna Hoff**, 526-2160 Environmental Sciences Branch	RESL Annual Report.
	High Volume On-site locations Off-site locations	RESL Environmental Sciences Data Base[8]	**Eddie Chew**, 526-2335 **Dianna Hoff**, 526-2160 Environmental Sciences Branch	RESL Annual Report.
	Kr-85 sampling	RESL Environmental Sciences Data Base[8]	**Eddie Chew**, 526-2335 **Dianna Hoff**, 526-2160 Environmental Sciences Branch	RESL Annual Report.
	Tritium	RESL Environmental Sciences Data Base[8]	**Eddie Chew**, 526-2335 **Dianna Hoff**, 526-2160 Environmental Sciences Branch	RESL Annual Report.
	Constant Air Monitors	RESL Environmental Sciences Data Base[8]	**Eddie Chew**, 526-2335 **Dianna Hoff**, 526-2160 Environmental Sciences Branch	RESL Annual Report.
	Nitrogen Oxides	RESL Environmental Sciences Data Base[8]	**Eddie Chew**, 526-2335 **Dianna Hoff**, 526-2160 Environmental Sciences Branch	RESL Annual Report.
	Sulfur Dioxide	RESL Environmental Sciences Data Base[8]	**Eddie Chew**, 526-2335 **Dianna Hoff**, 526-2160 Environmental Sciences Branch	RESL Annual Report.
	Precipitation Monitoring	RESL Environmental Sciences Data Base[8]	**Eddie Chew**, 526-2335 **Dianna Hoff**, 526-2160 Environmental Sciences Branch	RESL Annual Report.
Biotic	Animal tissues Foodstuffs Monitoring	RESL Environmental Sciences Data Base[8]	**Eddie Chew**, 526-2335 **Dianna Hoff**, 526-2160 Environmental Sciences Branch	RESL Annual Report.

RESL Environmental Monitoring Programs and Data Retention Locations

Media	Monitoring Program	Data Location	Contact Person	Data Reporting
Drinking Water	On-site Off-site	RESL Environmental Sciences Data Base[8]	**Eddie Chew**, 526-2335 **Dianna Hoff**, 526-2160 Environmental Sciences Branch	RESL Annual Report.
Liquid Effluent	TRA	IWMIS[4] or RWMIS[2]	**Eddie Chew**, 526-2335 **Dianna Hoff**, 526-2160 Environmental Sciences Branch	RESL Annual Report.
	ICPP	IWMIS[4] or RWMIS[2]	**Eddie Chew**, 526-2335 **Dianna Hoff**, 526-2160 Environmental Sciences Branch	RESL Annual Report.
Radiation Exposure Monitoring	Thermoluminescent dosimeters On-site Off-site Gamma radiation surveys On-site	RESL Environmental Sciences Data Base[8]	**Eddie Chew**, 526-2335 **Dianna Hoff**, 526-2160 Environmental Sciences Branch	RESL Annual Report.
Soil Monitoring	On-site Off-site	RESL Environmental Sciences Data Base[8]	**Eddie Chew**, 526-2335 **Dianna Hoff**, 526-2160 Environmental Sciences Branch	RESL Annual Report.

USGS Environmental Monitoring Programs and Data Retention Locations

Media	Monitoring Program	Data Location	Contact Person	Data Reporting
Ground Water	Ground Water Levels SRP aquifer Perched water	INEL Program Office Files.	**Larry Mann**, 526-2439, USGS	GWSI[9]
	Ground Water Quality SRP aquifer Perched Water Springs	INEL Program Office Files.	**Larry Mann**, 526-2439, USGS	QWDATA[10]
	Closed Basin Monitoring	INEL Program Office Files	**Larry Mann**, 526-2439, USGS	Internal Reports
	Unsaturated Zone Monitoring	INEL Program Office Files	**Larry Mann**, 526-2439, USGS	Internal Reports
Surface Water	Water volume at surface gauging stations on the Big Lost River and Little Lost River Drainages		**Jake Jacobson**, 522-4287, USGS-WR, Idaho Falls Field Office	NWIS
	Water volume at surface gauging stations on Birch Creek Drainage.		**Ted Sorenson**, 522-8069, Sorenson and Associates Consulting Engineers. Historic data reside with USGS-WR Idaho Falls Field Office.	NWIS

WINCO Environmental Monitoring Programs and Data Retention Locations

Media	Monitoring Program	Data Location	Contact Person	Data Reporting
Air	ICPP stack Flourinel Dissolution Process and Fuel Storage Facility (FAST) stack New Waste Calcining Facility (NWCF) stack Remote Analytical Laboratory (RAL) stack Coal Fired Steam-Generating Facility (CFSGF) stack		**Jim Linhart**	RWMIS[2] and IWMIS[4]
	Ambient Air Monitoring Construction phase work projects which have the potential for generating local ambient levels of contamination (gamma)	Data base maintained by ICPP[11]		
Drinking Water	Drinking Water Production Wells Distribution Systems	DWMDMS[3]	**Dee Williamson**, 526-5916, WINCO	DWMDMS[3]
Ground Water	Ground water monitoring at ICPP and High Level Rad Waste Storage Area	Data maintained by WINCO in files/logbooks concerning the tank farm[12].	**Dee Williamson**, 526-5916, WINCO	
Liquid Effluent	Liquid effluent monitoring at the ICPP facility, service waste system		**Bud Olsen**, 526-4487, Production	RWMIS[2] and IWMIS[4]
	Sewage Treatment Plant (domestic waste water), sampled by EG&G		**Dee Williamson**, 526-5916, WINCO	
	Percolation Ponds - maintained in files associated with the request.	Percolation Ponds - maintained in files associated with the request.	**Paul Owens**, 526-3451, Production	Perc Ponds: Data maintained in RESL Environmental Sciences Data base.
Radiation Monitoring	Perimeter of ICPP	Data maintained by WINCO in a computer data base.		
Solid Waste Monitoring	Various locations	Data maintained in files concerning particular request	**Kirkland Jones**, 526-5282, Frank Ward, 526-3010	

ENDNOTES

1. **ANL-W Files:**

"In regards to data bases, ANL-W does not at this time store its environmental monitoring data in any type of formalized computer data base. Sampling data is however, stored in hardcopy form in the Environment, Safety, and Waste Management Department files (correspondence from Amy Powell 10/24/91)." ESWM personnel are responsible for evaluating the data results and providing an annual report of the results to DOE-CH and DOE-ID, as well as supply a monthly BOD, DO, suspended solids, oil/grease, and Ph data to the Waste Management Engineer for inclusion in the IWMIS report.

Data generated from the following activities are stored in hardcopy files:

Air Monitoring: Monitoring Locations - ZPPR stack, FMF stack, Main stack including EBR-II and HFEF/S, IFR stack, NDA area stack, Lab Area stack, Fuel Assembly and Storage Building stack, Radioactive Liquid Waste Treatment Facility stack, HFEF/N stack, Sodium Components Maintenance Shop stack, Treat stack.

Data retained: Varies depending on the stack-radionuclide information. Data may include: α, β, γ, Cs-137, I-131, Xe-133, Kr-85, and particulates.

Location of files: Environment, Safety, and Waste Management Department.

Atmospheric Sampling: Monitoring Location - Main parking lot, southwest of the security perimeter.

Data retained: β, Pu-238, Pu-239/240, and Am-241.

Location of files: RESL.

Biotic Monitoring: Industrial Waste Pond Perimeter and Site Security Perimeter.

Data Retained: Pu-239/240, and Cs-137.

Location of files: Environment, Safety, and Waste Management Department.

Liquid Sampling:

Secondary Sanitary Lagoon: BOD, DO, TSS, Ph, Pu, and γ.
Primary Sanitary Lagoon: α, β, H-3, γ, and Cd.
Industrial Waste Pond: α, β, γ, H-3, total Cr, Hexavalent chromium, Ph, chloride, phosphate, sodium, sulfate, silver, zinc, cadmium, plutonium, and TCLP constituents.
Drinking Water: Coliform bacteria. Samples results are maintained in the Environmental and Waste Engineering files for at least 5 years.
Production Wells: α, β, H-3, primary pollutants (As, Ba, Cd, Cr, CN, Pb, Hg, F, NO_3, Se, Ag, Na, Endrin, Lindane, Methoxychlor, Toxaphene, 2,4-D, 2,4,5-TP Silvex, Trihalomethanes), regulated Volatile Organic Chemicals (VOCs), unregulated VOCs.

Sediment, Soil, and Vegetation Sampling:

Sediment: 39 RCRA TCLP constituents (sediment from the industrial waste pond).
Sediment, Soil, and Vegetation: Samples from various specified areas for Pu and γ.

Penetrating Radiation Exposure Data: Location of data files: Environment, Safety, and Waste Management Department.

TLDs are set up in the vicinity of EBR-II (9 TLDs) and TREAT (3 TLDs) to measure six month exposure in Mr.

Environmental monitoring at ANL-W is designed to supplement, not duplicate, the RESL monitoring effort, by providing additional surveillance within the ANL-W area of responsibility.

2. **Radioactive Waste Management Information System** - RWMIS

   RWMIS is a NOMAD2 (a fourth generation data base language) data base that contains a detailed record of all radioactively contaminated airborne and liquid effluents and solid waste streams on the INEL. Data stored is provided by all INEL facilities generating radioactive wastes. RWMIS has been used at INEL since January, 1971.

   Types of information include: volume, radioactivity, isotopic identity, origin, and decay status. This system serves as the official repository for this data and provides reports for all types of radioactive effluents and solid waste disposed, sent for reduction, or stored at the INEL.

   ANL-W input for RWMIS reports is provided to the INEL Service Contractor (EG&G) each month by the Waste Management Engineer of the Safety, Environment, and Safeguards Department.

3. **Drinking Water Monitoring Data Management System** - DWMDMS

   DWMDMS was established in FY-1988 and is used to maintain records of EG&G drinking water system analyses.

4. **Industrial Waste Management Information System** - IWMIS

   IWMIS is a NOMAD2 (a fourth generation data base language) data base that contains detailed records of all industrial, non-radioactive waste streams on the INEL as reported by the INEL areas. The data base has been in use at the INEL since 1971. The system serves as the official record of all types of industrial waste stored or disposed at the INEL. It is also the source for reports on industrial waste storage and disposal, fuel oil usage, and water usage and disposal at the INEL. The quantities of industrial waste are reported for the following categories: airborne and liquid effluent disposal, fuel oil consumption, and water usage

   ANL-W input for IWMIS reports is provided to the INEL Service Contractor (EG&G) each month by the Waste Management Engineer of the Safety, Environment, and Safeguards Department.

5. **Environmental Surveillance Program Data Management System** - ESPDMS

   ESPDMS was developed for environmental radiation monitoring activities at waste management facilities. Purposes are to data bases (air, water, soil, TLD, vegetation, nitrate and subsurface), to store and sort data after analysis, to provide a method of tracking trends of monitoring activities, and to help generate various monitoring reports.

6. **Effluent Monitoring Data Management System** - EMDMS

   EMDMS is used for interpretation and reporting of effluent sampling results. Sampling analysis assists in determining the regulatory significance of the results and in discriminating normal releases from releases of concern.

7. **Environmental Controls Data Base**

NRF utilizes this data base for the retention of data generated from the following environmental monitoring programs:

A. Air Emissions
Radiologic - Effluent particulate and tritium
Nonradiologic - Sulfate content of fuel oil; Boiler House, Generators, and Incinerator emissions; Boiler House and Incinerator opacity.

B. Biotic Vegetation

C. Direct Radiation
Thermoluminescent Dosimeters

D. Environmental Survey
Barrels, Ecology, Oil Usage, Waste Dumpster, Waste Box

E. Hazardous and Toxic Substances
System Oil/Water Separations, Waste Stream Analysis

F. Preliminary Facility Area Surveillance

G. Radiation Survey

H. Soil and Sediment Sampling

I. Water
- Drinking Water
- Distribution System
- Ground Water
  - Production Wells
  - Upgradient Wells
  - Downgradient Wells
  - Sewage Lagoons
  - Piezometers
- Liquid Effluent
  - Radiological Waste Water
- Waste Water (non-rad)
  - Industrial Waste Ditch
    - Effluent limit
    - Bacteria
  - Waste Water Processes
    - Interior
    - Exterior
  - Sewage Lagoon
  - Waste Stream Analysis

8. **RESL Environmental Sciences Data Base**

RESL retains data from the following RESL Environmental Monitoring Programs:

Air:

Constant Air Monitors: radon

Low Volume Samplers: α, β, specific γ, Pu, Am, Sr-90, particulate matter.

High Volume Samplers: gross γ, specific γ.

Kr-85 Sampler: Kr-85.

H-3 Samplers: H-3 as HTO.

TSP Sampler: Total Suspended Particulates (Sampler operates for 24 hours every six days).

Water:

Drinking Water: α, β, H-3 as HTO, Sr-90.

Surface Water Ponds (TRA and ICPP infiltration ponds): specific γ, Sr-90, H-3 as HTO, I-129, U, Am, Pu, pH, Na^+, Cl^-, total chromium.

Animal Tissues: "On-site" animals grazed on-site for at least four weeks before being sampled. "Off-site" animals have never grazed on-site and serve as controls.

Beef--Muscle, Liver: specific γ, Pu-238, Pu-239/240, Am-241.

Sheep--Muscle, Liver: specific γ.

Game Animals--Muscle: specific γ. Only road-killed game animals are sampled on-site. No controls are generally collected except for specific ecological studies.

Foodstuffs: Grown only off-site.

Milk: I-129, I-131, Sr-90, H-3 as HTO.

Wheat: specific γ, Sr-90.

Lettuce: specific γ, Sr-90.

Soil: On-site soil sampling is performed each year at different on-site facilities on a rotating 7-year schedule. Specific γ, Pu, Am, Sr-90.

Direct Radiation: Thermoluminescent Dosimeters, γ Radiation Surveys

9. **Ground Water Site Inventory Original Data** - GWSI

   Well construction, water level, and water quality data retained on Prime computer. Accessed by modem.

10. **Water Quality Data Original Data**

    USGS water quality data retained on Prime computer. Accessed by modem.

11. WINCO maintains data for the following monitoring programs in a data base:

A. Ambient Air Monitoring
Local ambient levels of γ contamination generated at construction phase work projects.

B. Perimeter Radiation Monitoring

12. WINCO maintains data for the following programs in files:

A. Air
ICPP stack
Flourinel Dissolution Process and Fuel Storage Facility (FAST) stack
Remote Analytical Laboratory (RAL) stack
Coal Fired Steam-Generating Facility (CFSGF) stack

B. Solid Waste Monitoring

C. Water
Drinking Water
- Production Wells
- Distribution Systems

Ground Water
Liquid Waste
- Service Waste
- Sewage Treatment
- Percolation Ponds

OPTR 93-XX

State of Idaho

INEL Oversight Program

SUMMARY OF HYDROGEOLOGIC/ENVIRONMENTAL INVESTIGATIONS AT THE IDAHO NATIONAL ENGINEERING LABORATORY (INEL) DRAFT VERSION, APRIL 1993

by
Phillip J. Bandy and L. Flint Hall

State of Idaho
INEL Oversight Program Technical Report 93-XX

April 1993

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SUMMARY OF HYDROGEOLOGIC/ENVIRONMENTAL INVESTIGATIONS AT THE IDAHO NATIONAL ENGINEERING LABORATORY (INEL), DRAFT VERSION, APRIL 1993

INTRODUCTION

In addition to long term environmental monitoring programs conducted by subcontractors to the Department of Energy, Idaho Operations (DOE/ID) at the Idaho National Engineering Laboratory (INEL), specific studies are conducted for the purposes of characterizing environmental parameters that are considered in evaluations of changes in environmental quality over time. This report presents status information on hydrogeologic investigations and short term environmental monitoring programs that have been conducted at INEL. The focus of this document is summarization of studies of surface water, soil, vadose zone, and saturated zone investigations and monitoring.

Summaries of investigations included in this report are grouped by the location at which they were conducted. Facilities covered in this document are: Argonne National Laboratory West (ANL-W), the Central Facilities Area (CFA), the Idaho Chemical Processing Plant (ICPP), the Naval Reactors Facility (NRF), the Radioactive Waste Management Complex (RWMC), Test Area North (TAN), and the Test Reactor Area (TRA).

Information in this report is presented in tabular form. Information included is: the area where the study took place, the program that was responsible for conducting the study, and the purpose of the study; the sampling organization; the location and media studied as well as references; the method of investigation and frequency of sampling; and analyses that were conducted.

It should be noted that this is a status document containing information on only those documents that have been reviewed and abstracted by the INEL Oversight Program (INEL-OP) and its cooperators at the time of publication, and should not be considered a complete compendium of information from all investigations that have taken place at INEL.

PURPOSE AND OBJECTIVE

The State of Idaho INEL Oversight Program is mandated to conduct independent evaluations of environmental monitoring programs conducted at INEL. Review of hydrological investigations that have been performed at the INEL provides information on physical makeup and character of the environment, on background environmental quality, and on changes in environmental quality over time. The purpose of this document is to compile information derived from reviews and abstracts of documents produced from investigations and short term monitoring studies into a single document. The objective of this report is to present information about investigations in a concise, organized, and readable format.

METHODS

Summaries contained in this report were compiled from ongoing reviews and abstractions of technical documents conducted by staff of the Oversight Program and the University of Idaho. This project was conducted as part of the Oversight Program's Research and Development Projects 2 and 3 which focus on unsaturated zone contamination and transport processes (R&D 2) and surface water-ground water interactions (R&D 3).

Program / Purpose	Sampling Organization	Location / Media / Reference	Method / Frequency Inclusive Dates of Investigation		Analysis
ANL-W / Vadose / Surface Water Investigations. Geologic and hydrogeologic characterization of the area adjacent to the industrial waste water pond, and water quality of the uppermost aquifer.	Chen-Northern, Inc.	Industrial Waste Pond Chen-Northern, Inc., 1988. "Final Report on the Geohydrologic Investigation of the Industrial Waste Pond at Argonne National Laboratory - West, Idaho Falls, Idaho". Report for Argonne National Laboratory - West, NE497.HG.	<u>Borehole Investigations</u> Six boreholes (ANL-M1, M2, M3, M4, M5, and M6) were drilled around the periphery of the waste pond. USGS logged the boreholes with geophysical instruments. August, 1987 through July, 1988.		Detailed borehole logs describing lithologies encountered by drilling. Caliper, natural gamma, neutron (neutron-gamma-neutron), and gamma-gamma logs. Well completion information. Depth to static water.
			<u>Subsurface Characterization</u> August, 1987 through July, 1988.		Geology, hydrogeology, ground water flow, recharge and discharge. Fence diagrams developed from boreholes. Isopach map of sedimentary interbed.
			<u>Ground Water Quality</u> 8/87 - 7/88	ANL-M4	Static water level, temp., spec. cond., pH, Eh, DO.
				ANL-M5	Static water level, temp., spec. cond., pH, Eh, DO, BNA, herbicides, organo-pesticides, AC, ACN, carbofuran, VOC, chlorinated pesticides, TCDD, TCDF, metals, CN, sulfide, TOC, TOX.
			<u>Surface Water Quality</u> 8/87 - 7/88	IWP	temp., spec. cond., pH, Eh, DO, BNA, herbicides, organo-pesticides, AC, ACN, carbofuran, VOC, chlorinated pesticides, TCDD, TCDF, metals, CN, sulfide, TOC, TOX.
			<u>Sediments</u> 8/87 - 7/88	Top and bottom of IWP sediment. Sample composited from three locations.	BNA, herbicides, organo-pesticides, AC, ACN, carbofuran, VOC (sample from top of IWP sed. was lost), chlorinated pesticides, TCDD, TCDF, metals, CN, sulfide, TOC, TOX.
				Estuary	BNA, herbicides, organo-pesticides, AC, ACN, carbofuran, VOC, chlorinated pesticides, TCDD, TCDF, metals, CN, sulfide, TOC, TOX.

Program / Purpose	Sampling Organization	Location / Media / Reference	Method / Frequency Inclusive Dates of Investigation	Analysis
ANL-W / Characterization of the geology and hydrogeology adjacent to and underlying the industrial waste pond and ditch as well as provide evidence of background soils and ground water chemical characteristics. (Continuation of 1988 study)	Chen-Northern, Inc.	Soil and Water Quality Sampling Chen-Northern, Inc., 1989. "Background Soil and Water Quality Sampling, Argonne National Laboratory - West", CNI3408.HG.	Ground Water Samples collected from EBR-I, EBR-II, and the Arbor Test Well (ATW). Samples collected 8/88 and 2/89.	pH, spec. cond., Eh, temp., VOCs, Sb, As, Ba, Be, Cd, Cr, Co, Cu, Pb, Hg, Ni, Se, Ag, Tl, V, Sn, Phenol.
			Soils Four boreholes (STF-1, STF-2, NWC-1, NWC-2) were drilled using a hollow stem auger and a stainless steel split-spoon sampler with mylar liners at the Sodium Test Facility (STF) and the northwest corner of the administration area (NWC). Composite samples were collected from 0 to 1.5 ft., 1.5 to 3.0 ft., 3.0 to 4.5 ft., and from 4.5 to 7.0 ft. Samples from each of these intervals from each of the four boreholes were composited and analyzed.	Drillers logs. VOCs, Al, Sb, As, Ba, Be, Cd, Ce, Cr, Co, Cu, Fe, Pb, Hg, Ni, K, Se, Ag, Na, Tl, V, Zn, CN, Sr, phenols, sulfide.
			Soils At each of the two locations (STF and NWC), soil samples from the top five vertical intervals in both boreholes were composited, yielding ten separate soil samples (5 from STF and 5 from NWC).	Grain size, cation exchange capacity (CEC), pH, specific electrical conductivity (SC), acid base potential

Program / Purpose	Sampling Organization	Location / Media / Reference	Method / Frequency Inclusive Dates of Investigation	Analysis
ANL-W / Site characterization.	Chen-Northern, Inc.	Chen-Northern, Inc., 1989, "Investigation / Characterization of Site Hydrology for Main Cooling Tower Blowdown Ditch, Appendix A". Report for Argonne National Laboratory - West, W001-0917-ES-00. Appendix attached to Chen-Northern, 1991, report.	Collection, analysis, and assimilation of data necessary to develop a reliable understanding of hydrogeologic, chemical, and physical parameters which could affect the performance of a ground water monitoring system.	Regional: tectonic history and depositional environment, surface geology, subsurface geology, Snake River Plain aquifer, surface water hydrology. Local (ANL-W): surface geology, sub-surface geology, ground water hydrology.
ANL-W / Hydrogeologic characterization of the Main Cooling Tower Blowdown Ditch. Identification of soils from shallow sedimentary interbeds and evaluating perched water that may be associated with them.	Chen-Northern, Inc.	Main Cooling Tower Blowdown Ditch. Located inside the inner security fence and between the two security fences within the ANL-W administrative grounds. The unlined ditch is approx. 800 ft. long and 3 to 4 ft. wide.	Borings September, 1989 - drilled 4 borings (M7, M8, M9, and M10) along the Main Cooling Tower Blowdown Ditch, classified cuttings and recovered samples from borings.	Boring log, lithology, depth to perched water, gamma log, gamma-gamma log, neutron log and caliper log.
		Chen-Northern, Inc., 1991. "Hydrogeological Characterization of Main Cooling Tower Blowdown Ditch, Argonne National Laboratory - West, Idaho National Engineering Laboratory". Report for Argonne National Laboratory - West, CNI7498.HG.	Soils September, 1989 - collected soil samples. Two soil samples, one duplicate, and six quality control samples. Soil samples from boreholes were collected using a thin-walled shelby tube and lexan core barrel.	Appendix VIII parameters, VOC, dioxins/furans, Al, Sb, As, Ba, Be, Cd, Ca, Cr, Cu, Fe, Pb, Hg, Ni, Se, Ag, Tl, V, Zn, CN, Sn, K, Na, sulfides, fluorides, phenols.

Program / Purpose	Sampling Organization	Location / Media / Reference		Method / Frequency Inclusive Dates of Investigation		Analysis
ANL-W / Characterization of waste areas for the FFA-CO.	ANL-W Environmental and Waste Management (EWM) section	Industrial Waste Pond		Water samples.	Monthly	α, β, γ, H-3, Cd, Ag, Zn, Na, PO_4^{3-}, SO_4^{2-}, Cl^-, Cr total, Cr^{6+}, and pH.
					Biannually	γ, Pu
					Annually	TCLP Constituents
		Sanitary Lagoons	Primary	Liquid Effluent samples. Monthly, during the ice free months April through October.		α, β, γ, H-3, Cd, and pH.
			Secondary	Liquid Effluent samples.	Monthly. April - October	BOD, DO, total suspended solids, and pH.
					Biannually.	γ and Pu.
		EBR-II Leach Pit		Soil		- CLP Volatile Organics, - Appendix VIII and IX Alcohols, Volatile Organics, Semivolatile Organics, Pesticides/PCBs, Phosphate Pesticides, Chlorinated Herbicides, Dioxins and Furans (tetra through octa isomers), and metals (Al, Sb, As, Ba, Be, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mn, Hg, Ni, K, Se, Ag, Na, Tl, V, Zn, and Sn)
				Ground Water samples collected from ANL-W monitoring well.		- Cyanide/Sulfide/Ph - TCLP Metals (As, Ba, Cd, Cr, Pb, Hg, Se, and Ag) - Am-241, Sb-125, Cs-134, Cs-147, Ce-144, Co-58, Co-60, I-129, Np-237, Pu-238, Pu-239, Ru-103, Ru-106, Sr-90, H-3, U-234, U-235, U-238, Y-90.

Area/Program/Purpose	Sampling Organization	Location / Media / Reference	Method/Frequency Inclusive Dates of Investigation	Analysis
CFA / Soil profile, hydraulic conductivity, and moisture content.	Allied Chemical Corporation	Soils Paige, B. E., F. A. Siedenstrang and M. R. Niccum, 1974, Allied Chemical Corporation, Idaho Chemical Programs - Operations Office, National Reactor Testing Station, Idaho Falls, Idaho, ICP-1013	NRTS soils were reviewed for soil profile, hydraulic conductivity, and moisture content. Three distinct soil types are located at different NRTS areas: CPP-TRA, TAN, and ARA-SPERT-CFA.	Soil resistivity, moisture equivalent, pH, CO_3^{2-}, HCO_3^-, Cl^-, SO_4^{2-}, hardness, generalized soil profile, grain size distribution, hydraulic conductivity, infiltration rate.
CFA / Ground water and geology	US Geological Survey	Geology and Ground Water Nace, R. L., J. H. Jones, P. T. Voegeli and Morris Deutsch, 1951, Geology and Ground Water in the Central Construction Area, Reactor Testing Station, Idaho, IDO-22044-USGS	Principal results of a detailed study of the ground water and geology of the central construction and facilities area (CFA) on the NRTS.	Grain size distribution, near surface stratigraphy, subsurface basalt contour, fence diagram, discharge-drawdown. Ground water quality: pH, specific conductance, temperature, SiO_2, Fe, Ca, Mg, Na, K, CO_3^{2-}, HCO_3^-, Cl^-, SO_4^{2-}, F^-, NO_3^-, B, Mn, turbidity, total dissolved solids, hardness. condensed drillers logs.
CFA / Shallow drilling program at CFA Landfills II and III to define geologic and hydrologic characteristics of the shallow surficial sediments, to quantify the amounts and rates of water movement into and through the sediments, and to sample the sediments and the soil gas for contaminants.	EG&G	Landfill II Ansley, S.L., L.C. Hull, and S.M. Burns, 1988, Shallow Drilling Report for CFA Landfills II and III -- FY-1988, Characterization of Surficial Sediments, EGG-ER-8291.	Four shallow boreholes were drilled adjacent the backfilled pit and trenches in December, 1988. Boreholes were instrumented with moisture and contaminant sensing probes and access ports. A total of 24 heat dissipation sensors and 6 salinity sensors were installed. Three neutron access tubes were emplaced. Sediment collected during the augering was analyzed for contamination, and soil gas samples were collected and analyzed in May 1988.	Water content measurements, soil moisture, soil salinity, soil gas, and total dissolved solids in the sediment water. Soil samples were analyzed for semivolatile base/neutral and acid extractable compounds, VOCs, and metals (Al, Sb, As, Ba, Be, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mn, Hg, Ni, K, Se, Ag, Na, Tl, V, Zn).

Area/Program/Purpose	Sampling Organization	Location / Media / Reference	Method/Frequency Inclusive Dates of Investigation		Analysis
CFA / Shallow drilling program at CFA Landfills II an III to define geologic and hydrologic characteristics of the shallow surficial sediments, to quantify the amounts and rates of water movement into and through the sediments, and to sample the sediments and the soil gas for contaminants.	EG&G Idaho, Inc.	<u>Landfill III</u> Ansley, S.L., L.C. Hull, and S.M. Burns, 1988, Shallow Drilling Report for CFA Landfills II and III - - FY-1988, Characterization of Surficial Sediments, EGG-ER-8291.	Five shallow boreholes were drilled adjacent the backfilled pit and trenches in December, 1988. Boreholes were instrumented with moisture and contaminant sensing probes and access ports. Landfill III had 18 heat dissipation sensors and 10 salinity sensors. Two neutron access tubes were driven alongside two of the augered holes. Sediment collected during the augering was analyzed for contamination, and soil gas samples were collected and analyzed in May 1988.		Water content measurements, soil moisture, soil salinity, soil gas, and total dissolved solids in the sediment water. Soil samples were analyzed for semivolatile base/neutral and acid extractable compounds, VOCs, and metals (Al, Sb, As, Ba, Be, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mn, Hg, Ni, K, Se, Ag, Na, Tl, V, Zn).
CFA / Shallow drilling program at CFA Landfills II an III to define geologic and hydrologic characteristics of the shallow surficial sediments, to quantify the amounts and rates of water movement into and through the sediments, and to sample the sediments and the soil gas for contaminants.	EG&G Idaho, Inc.	<u>Landfills II and III</u> Ansley, S.L., L.C. Hull, and S.M. Burns, 1988, Shallow Drilling Report for CFA Landfills II and III - - FY-1988, Characterization of Surficial Sediments EGG-ER-8291.	Materials Testing: 101 soil samples were collected using 2.04 in. diameter stain-less steel liners inside a split spoon sampler. Three samples were taken at every 5 foot interval. Ninety-six of the samples were 3" long and the remaining 5 were 10" long.	Approximately two-thirds of the 3" samples.	Moisture content, sieve analysis, bulk density, porosity, and specific gravity.
				15 of the remaining 3" samples.	Soil moisture characteristic curve.
				Excess 3" samples.	Archive storage.
				5 - 10" samples.	Permeability.

Area/Program/Purpose	Sampling Organization	Location / Media / Reference	Method/Frequency Inclusive Dates of Investigation		Analysis
CFA	EG&G Idaho, Inc.	Landfill II Wood, T.R., L.C. Hull, and M.H. Doornbos, 1989, Ground Water Monitoring Plan and Interim Status Report for Central Facilities Area Landfill II. EGG-ER-8496.	3 neutron access tubes were installed at Landfill II by driving to approximately the basalt interface, 18-24 ft depth. Data collection monthly from neutron access tubes, heat dissipation blocks, and salinity blocks beginning January 1988 and continued until January 1991. Data reside in Lotus 123 version 3.0 format.		Soil Moisture Content from measurement of moisture content and suction vs. time, instantaneous values of potential gradient and flux can be obtained, allowing calculations of hydraulic conductivity and flow velocity.
			Four holes 11-31 ft depth.	Heat dissipation blocks at 5 ft intervals, 24 total.	Soil moisture content.
				Salinity blocks installed at the base and 5 ft above the base of the augerings, 6 total.	Electrical resistivity via soil salinity. Can also be used to measure in situ moisture content. Salinity sensors must be calibrated to provide a curve of soil salinity versus electrical conductance (electrical conductance is highly temperature dependent, so accurate measurement of soil solution temperature is a necessary companion to this device).
				Gas sampling ports were installed at the base of the holes	Soil gas surveys - VOCs.

Area/Program/Purpose	Sampling Organization	Location / Media / Reference	Method/Frequency Inclusive Dates of Investigation		Analysis
CFA	EG&G Idaho, Inc.	Landfill III Wood, T.R., L.C. Hull, and M.H Doornbos, 1989, Ground Water Monitoring Plan and Interim Status Report for Central Facilities Area Landfill III. EGG-ER-8521	2 neutron access tubes were installed at Landfill III by driving to approximately the basalt interface, 18-24 ft depth. Data collection monthly from neutron access tubes, heat dissipation blocks, and salinity blocks beginning January 1988 and continued until January 1991. Data reside in dBase III format.		Soil moisture content from measurement of moisture content and suction vs. time, instantaneous values of potential gradient and flux can be obtained, allowing calculations of hydraulic conductivity and flow velocity.
			Five holes 11-31 ft depth.	Heat dissipation blocks at 5 ft intervals, 18 total.	Soil moisture content.
				Salinity blocks installed at the base and 5 ft above the base of the augerings, 10 total.	Electrical resistivity via soil salinity. Can also be used to measure in situ moisture content. Salinity sensors must be calibrated to provide a curve of soil salinity versus electrical conductance (electrical conductance is highly temperature dependent, so accurate measurement of soil solution temperature is a necessary companion to this device).
				Gas sampling ports were installed at the base of the holes	Soil gas surveys - VOCs.

Area/Program/Purpose	Sampling Organization	Location / Media / Reference	Method/Frequency Inclusive Dates of Investigation	Analysis
ICPP - Lithologic Characterization of Sediments and Basalts	US Geological Survey	Unsaturated Zone Anderson, S.R., 1991, Stratigraphy of the Unsaturated Zone and Uppermost Part of the Snake River Plain Aquifer at the Idaho Chemical Processing Plant and Test Reactors Area, Idaho National Engineering Laboratory, Idaho, IDO-22095	Stratigraphic analysis of wells drilled to a depth of 700 feet that penetrate a sequence of 23 basalt-flow groups and 15 to 20 sedimentary interbeds that range in age from about 200,000 to 640,000 years.	Stratigraphy. Basalt: flow group, thickness, altitude. Surficial sediment: thickness, altitude. Saturated thicknesses of basalt and sedimentary interbeds.
ICPP / Monitoring perched water bodies which have formed as the result of previous disposal activities, leaks, and failure of the waste injection well, in addition to perched water formed as a result of redirecting service waste to infiltration ponds.	US Geological Survey, Golder Associates	Lower Perched Zone	1986: 6 Air-rotary holes (PW-1, 2, 3, 4, 5, 6) were completed in the lower perched zone, about 140-200 feet.	USGS: Water levels, water quality indicator parameters. Golder Ass.: RCRA characterization
ICPP	Golder Associates	Tank Farm See references attached to the end of this table[1].	1990: Boreholes 1-5 were completed immediately surrounding the Tank Farm. At least 4 were to be completed with vacuum lysimeters, 2 at the surficial sediment-basalt interface about 40 ft depth, and at least 2 completed in the basalt above the 110 ft. sedimentary interbed.	Pressure-vacuum (suction) lysimeters allow collection of in situ soil water samples.

Area/Program/Purpose	Sampling Organization	Location / Media / Reference	Method/Frequency Inclusive Dates of Investigation	Analysis
ICPP	US Geological Survey	Hydrology and Waste Disposal Jones, P. H., 1961, Hydrology of Waste Disposal National Reactor Testing Station Idaho, U.S. Geological Survey, IDO-22042-USGS	The purpose of the research is to provide detailed and accurate information on the occurrence, movement, quality, and geologic environment of water beneath the land surface. Primary to these investigations is research on the principles of basalt hydrology which is necessary to trace the movement and observe and interpret attenuation of radioactive waste discharged to the ground. The report discusses the adoption of gamma-ray logging and other new tools and methods to identify aquifers and their ability to transmit water, hydraulic head and quality of water.	Liquid waste: volume, radioactivity, source, Sr-90, I-131, Ce-144, Zr- 95, Nb-95, Cs-137, Ru-106, Rh-106. stratigraphy, lithologic logs, gamma-ray logs, caliper logs, subsurface basalt contour, uppermost extensive sedimentary interbed contour, lowermost extensive sedimentary interbed contour, basalt chemical analysis, regional water table. Perched water: TRA, ICPP, altitude, thickness, extent, temperature, specific conductance, tritium. Aquifer: depth, altitude, thickness, structure, straddle packer test, injection test. Water quality: Cl^-, temp., resistivity, spec. cond., Na^+, H-3.
ICPP	ENICO - Exxon Nuclear Idaho Company, Inc.	Off-gases, precipitation and soils. Burr, J. R., G. J. McManus, F. A. Hohorst, F. A. Duce, G. L. Peterson and S. J. Fernandez, 1983, Determination of Baseline Levels of Toxic Non-Radioactive Substances at the ICPP, Exxon Nuclear Idaho Company, Inc., ENICO-1136	This report documents the concentrations of nonradioactive hazardous materials in off-gas, precipitation, and soil at the ICPP. Also, methods of collection and analysis were evaluated for boron, cadmium, fluoride, and mercury in ICPP off-gas and for mercury and cadmium in ICPP soil.	Airborne waste: concentration, release rate, Hg, B, Cd, F^-. Precipitation: concentration, Hg, Cd. Surface soil: concentration, Hg, Cd.
ICPP	WINCO	Air Quality, precipitation, and soils Adamic, M. L., J. R. Burr and G. J. McManus, 1984, Baseline Levels of Controlled Pollutants in the Vicinity of ICPP Processes, Westinghouse Idaho Nuclear Company, Inc., WINCO-1018	In this study, baseline levels of controlled pollutants at the ICPP were determined. Pollutants included in this study were: hydrogen sulfide, sulfur dioxide, non-methane hydrocarbons, particulates, mercury and cadmium.	Air quality: concentration, hydrogen sulfide, sulfur dioxide, non-methane hydrocarbons, total suspended particulate, suspended Hg, suspended Cd. Precipitation: concentration, sulfide, Hg, Cd, pH. Surface soil: concentration, Hg, Cd.

Area/Program/Purpose	Sampling Organization	Location / Media / Reference	Method/Frequency Inclusive Dates of Investigation	Analysis
ICPP	EG&G Idaho, Inc.	Geology and Hydrology of LDU CPP-37 Hull, L. C., 1987, Hydrogeologic Assessment of Land Disposal Unit, CPP-37 ICPP Gravel Pit #2, EG&G Idaho Inc.	This report describes the geology and hydrology of the Land Disposal Unit CPP-37, which consists of Gravel Pit #2 in the northeast corner of the ICPP compound at the INEL.	Generalized stratigraphy, cation exchange capacity, distribution coefficient, grain size distribution, transmissivity, hydraulic conductivity, dispersivity, porosity, velocity, storage coefficient, specific yield, bulk density, moisture content, generalized lithology, caliper log, gamma-ray log, gamma-gamma log, borehole log, mineralogy, calcite, quartz, plagioclase, augite, olivine, chlorite, kaolinite, illite, montmorillonite, carbonate content, pyroxene. Water quality: specific conductance.
ICPP	Atomic Energy Commission	Disposal Well Peckham, A. E., 1959, Investigation of Underground Waste Disposal, Chemical Processing Plant Area, National Reactor Testing Station, Idaho, U. S. Atomic Energy Commission, IDO-22039-USGS	This interim report describes the progress made in observations of the rate and direction of movement of liquid waste discharged through the disposal well at the ICPP. The report contains tabulated data and tentative conclusions based on explorations through March 1958.	Transmissivity, storage coefficient, velocity.

Area/Program/Purpose	Sampling Organization	Location / Media / Reference	Method/Frequency Inclusive Dates of Investigation	Analysis
ICPP Analysis of water-level and water-quality data collected from discontinuous perched ground-water zones during 1986-88 as part of the ongoing geohydrologic investigations at the INEL.	US Geological Survey	Perched Water Zones Cecil, L.D., Orr, B.R., Norton T., and Anderson, S.R., 1991, Formation of Perched Ground-Water Zones and Concentrations of Selected Chemical Constituents in Water, Idaho National Engineering Laboratory, Idaho 1986-1988, U.S. Geological Survey Water Resources Investigations Report 91-4166, DOE/ID-22100, 53 p.	The USGS routinely samples water from 38 wells competed in discontinuous perched ground water zones at INEL. These samples are analyzed for selected radiochemical and chemical constituents, and physical and chemical characteristics. Water level data are also collected routinely from 30 wells and numerous shallow auger holes. Water quality and water level data are used to determine the effects of wastewater disposal on the formation of discontinuous perched ground water zones and to characterize the geochemical and hydrologic processes in these zones.	The INEL water level network for perched ground water zones was designed to determine **hydraulic gradient** changes that influence the **rate and direction of ground water movement** and **transport of radio-chemical and chemical constituents**, and to measure the **areal extent of the effects of recharge**. **Water levels** were monitored during 1986-88 in approximately 30 observation wells. Continuous recorders also monitored **water level fluctuations** in three of these wells. Additionally water levels are monitored annually in numerous, shallow auger holes. The **radiochemical and chemical character** of water in perched zones is determined from analyses of samples collected as part of a comprehensive sampling program to identify **contaminant concentrations** and to define the **pattern of waste migration in the Snake River Plain aquifer**. Nearby surface water sites are sampled to document the chemical quality of water that recharges the ground water system. Constituents: H-3, Sr-90, Co-60, Ce-137, Cr-51, total dissolved chromium, Na^+, and Cl^-.

Endnotes:

1. References for Special Investigations at <u>ICPP</u>:

Golder Associates, Inc. October 1990. Well Completion Report for Wells 121, 122 and 123 at the Idaho Chemical Processing Plant. C86-131159, Task 6.

——— January 1991. Report for the Chemical Processing Plant Drilling and Sampling Program at Solid Waste Management Unit CPP-51. Ref: C86-131159, Task 6, Mod 4.

——— January 1991. Report For The Idaho Chemical Processing Plant Drilling And Sampling Program At Land Disposal Unit CPP-39. 893-1195.310.

——— January 1991. Report for the Idaho Chemical Processing Plant Drilling and Sampling Program at Land Disposal Unit CPP-59. Ref: C86-131159, Task 6, Mod 4.

——— January 1991. Report for the Chemical Processing Plant Drilling and Sampling Program at Solid Waste Management Unit CPP-54. Ref: C86-131159, Task 6, Mod 4.

——— January 1991. Report for the Chemical Processing Plant Drilling and Sampling Program at Land Disposal Unit CPP-64. Ref: C86-131159, Task 6, Mod 4.

——— January 1991. Geohydraulic and Petrographic Analyses of Samples from Well #121 and Well #123. Ref: C86-131159 Task Order 6.

Program / Purpose	Sampling Organization	Location / Media / Reference	Method/Frequency Inclusive Dates of Investigation	Analysis
NRF	US Geological Survey	Geology and Ground Water Jones, J. R., Morris Deutsch. and P. T. Voegeli, 1951, Geology and Ground Water at Site 3, Reactor Testing Station, Idaho, IDO-22002-USGS	Summary of the principal results of a detailed study of the ground water and geology of Site 3 (NRF) on the NRTS. Emphasis is on the rocks, soils and sediments present at the land surface, their types, surficial distribution, and probable subsurface extensions.	Grain size distribution, near surface stratigraphy, fence diagram, discharge-drawdown, drillers log.
NRF	Atomic Energy Commission-US Geological Survey	Hydrology Morris, D. A., W. E. Teasdale and Others, 1964, Hydrology of Subsurface Waste Disposal National Reactor Testing Station Idaho Annual Progress Report 1963, U.S. Atomic Energy Commission, IDO-22046-USGS	Results from studies of the geohydrology of waste disposal at the NRF are presented.	Water quality: specific conductance, sodium, gross gamma radioactivity, temperature, color, pH, total dissolved solids, calcium, magnesium, sodium, potassium, bicarbonate, carbonate, sulfate, chloride, fluoride, silica, iron, hardness, chromium. Liquid waste: radioactivity, volume, Sr-90, Co-60, Co-58, Cs-134, Cs-137, I-129, I-131, tritium, gross gamma radioactivity. Basalt: altitude. Alluvial sediment: generalized stratigraphy, gamma-ray log, gross gamma radioactivity, moisture profile. perched water: areal extent, altitude
NRF	Atomic Energy Commission	Perched Water Robertson, J. B., Robert Schoen and J. T. Barraclough, 1974, The Influence of Liquid Waste Disposal on the Geochemistry of Water at the National Reactor Testing Station, Idaho: 1952-1970, U. S. Atomic Energy Commission, IDO-22053	This report presents a summarized evaluation of the geology, hydrology, and water geochemistry of the NRTS and the associated influences of subsurface liquid waste products discharged from the NRTS facilities.	Perched water: areal extent, altitude, tritium, Sr-90, Cs-137, Co-60, chloride, specific conductance, well hydrograph.
NRF	US Geological Survey	Sewage lagoons Barraclough, J.T., W.E., Teasdale, and R.G. Jensen, 1965, Hydrology of the National Reactor Testing Station, IDO-22048	4 holes were augered at the NRF sewage lagoons, wells 65-1 - 4	Holes drilled to obtain water samples for bacterial analyses. Holes were dry upon completion of drilling and again when rechecked in January 1966. Dry holes indicate that little leakage occurred from the impervious bottom of the sewage lagoon.

Program / Purpose	Sampling Organization	Location / Media / Reference	Method/Frequency Inclusive Dates of Investigation	Analysis
NRF Test designed to investigate the feasibility of small-scale disposals of gaseous waste in the regolith.	US Geological Survey	Unsaturated Zone Mudra, P.J. and B.L. Schmalz, 1965, An Appraisal of Gaseous Waste Disposal Into the Lithosphere at the National Reactor Testing Station, IDO-12024, pp. 59-65.	Gas Injection tests. Three tests conducted in the summer cf 1964 to test the hypothesis of disposal of radioactive waste gases in the lithosphere. Test #1 was conducted at TRA, Test #2 was conducted in the vicinity of the Experimental Beryllium Oxide Reactor (EBOR) at TAN, and Test #3 was conducted northeast of the Naval Reactors Facility (NRF).	Drilling information, well logs, core, and well construction data. Lithology and stratigraphy of surface soils. Particle-size distribution and permeability of soils. Storage capacity of the lithosphere. Direction and velocity of migration of injected gas. Dilution and dispersion effects on initial concentrations of injected gas. Pressures required for injection of gas

Program / Purpose	Sampling Organization	Location / Media / Reference	Method/Frequency Inclusive Dates of Investigation	Analysis
RWMC	DOE/ID	Burgus, W.H., and Maestas, S.E., 1976, The 1975 RWMC Core Drilling Program, A Further Investigation of Subsurface Radioactivity at RWMC, INEL.	1975: Wells 93A, 96A, and 96B were drilled to approximately 230 ft, being cored from about 30 ft. to 230 ft. depth. Bores were then cemented.	Core description. Selected samples taken from cores for radiochemical analyses. Ge-Li gamma-ray spectrometer for Cs-137, Ce-144, and Co-60. Alpha-ray spectroscopy for Pu-238, Pu-239,240, and Am-241. Beta counting for Sr-90 Geophysical logging: gamma-gamma, gamma, and neutron.
RWMC Characterization of paths and rates of movement of radionuclides transported by infiltrating water.	US Geological Survey	Rightmire, C.T., 1984, Description and Hydrogeologic Implications of Cored Sedimentary Material from the 1975 Drilling Program and the RWMC.	This investigation is a follow-on investigation to the 1975 Drilling Program of Burgus and Maestas (1976).	Description of sedimentary interbeds and fracture filling on the basis of sedimentologic and stratigraphic character, mineralogy, and geochemistry. Particle-size distribution, statistical grain size analysis, bulk mineralogy, clay mineralogy, cation exchange capacity, and carbonate content. Thin section optical petrography.
RWMC	EG&G Idaho, Inc.	Humphrey, T.G., and F.H. Tingey, 1978, The Subsurface Migration of Radionuclides at the RWMC 1976-1977, TREE-1171.	1976-77: Wells 76-1 - 6 were drilled to about 250 ft depth and then backfilled with cement to the surface. Cores and water encountered were sampled. Well 77-1 was cored to 600 ft depth, and then cemented back to 400 ft depth and completed with gas samplers. 77-2 was completed at perched water, 87.7 ft.	Construction diagrams, generalized stratigraphy and core description, geophysical logs (gamma-gamma, gamma, neutron). Core material sampled at 30-ft, 110-ft, and 240-ft interbeds. Radiochemical analyses were made for Pu-238, Pu-239,240, Am-241, Sr-90, Ce-144, and Cs-137. Perched water samples were analyzed for H-3 in addition to the above radionuclides.

Program / Purpose	Sampling Organization	Location / Media / Reference	Method/Frequency Inclusive Dates of Investigation	Analysis
RWMC / Test scale vapor vacuum extraction tests to evaluate soil gas extraction.	EG&G Idaho, Inc.	Vapor Vacuum Extraction Sisson, J.B., and G.C. Ellis, 1990, Summary Report of Results of the Vapor Vacuum Extraction Test at the RWMC, EG&G Idaho, Inc., EGG-WM-9301.	1988-89: 5 wells (8801D, 8902D, D02, 78-4, and WWW-1) were drilled to about 250 ft and completed with multiple gas-sampling ports. Each monitoring well was equipped with 5 to 9 sampling ports at depths ranging from 30-240 ft. Well 8901D, drilled to a depth of 234 ft., was completed as the vapor vacuum extraction well. Monitoring Wells: Absolute pressure transducers to measure pressure fluctuations downhole and at the surface. Extraction Well: flow meter to measure stream flow, differential pressure transducer for measuring the vacuum generated, thermocouples for monitoring temperature, stream temperature, and DAS enclosed temperature.	Pressure fluctuations downhole and at the surface, stream flow, vacuum generated, temperature, stream temperature, DAS enclosed temperature.
			Portable GC was used to measure the concentrations of the contaminants. Gas analyses were performed on three types of samples: Tedlar bag samples from 8901D, Tedlar bag samples from 8801D, 8902D, D02, WWW-1, and 78-4, and continuous samples of the stack effluent. 8801D, 8902D, and D02 - weekly WWW-1 and 78-4 - biweekly	CCL_4, TCE, and CCL_4 + TCE

Program / Purpose	Sampling Organization	Location / Media / Reference	Method/Frequency Inclusive Dates of Investigation	Analysis
RWMC	US Geological Survey	Trenches Pittman J. R., 1989, Hydrological and Meteorological Data for an Unsaturated Zone Study near the Radioactive Waste Management Complex, Idaho National Engineering Laboratory, Idaho - 1985-86, U. S. Geological Survey, IDO-22079	1985-86: 2 test trenches were installed. Trenches were instrumented with thermocouple psychrometers, temperature sensors, and tensiometers. Neutron probe access tubes were installed adjacent the trenches. A weather station was also installed. During 1985 and 1986, soil temperature and soil water potential measurements were taken every 12 hours from 30 sensors placed at selected depths from 0.5 to 6.1 m. Weekly soil moisture content measurements were collected in 9 neutron probe access holes using a neutron moisture depth gage. Wind speed, wind direction, relative humidity, and air temperature data were averaged every 6 hours. Solar radiation and precipitation were totaled over the 6-hour intervals. This study was designed to obtain a reliable estimate of the amount of water that infiltrates the surficial sediment and eventually recharges the aquifer by quantifying ET rates, soil moisture content and variability, soil-moisture flux, hydraulic conductivities, soil moisture velocities, and soil temperatures. The data are to be used to calibrate a numerical model of the unsaturated zone to predict the migration of radionuclides in the subsurface.	Tensiometers measure soil matrix potential (pressure head). Thermocouple psychrometers measure in situ soil-water pressure under very dry conditions and also provide measurements of total water potential. Neutron access tubes provide information on soil moisture content. From measurement of moisture content and suction vs. time, instantaneous values of potential gradient and flux can be obtained, allowing calculations of hydraulic conductivity and flow velocity. Test trench instrumentation, soil temperature, capillary pressure, moisture content, soil moisture profile, bulk density, moisture retention, total solar radiation, reflected solar radiation, wind speed, wind direction, relative humidity, air temperature, precipitation.

Program / Purpose	Sampling Organization	Location / Media / Reference	Method/Frequency Inclusive Dates of Investigation	Analysis
RWMC	US Geological Survey	Radionuclide Migration Barraclough, J. T., J. B. Robertson, V. J. Janzer and L. G. Saindon, 1976, Hydrology of the Solid Waste Burial Ground, as Related to the Potential Migration of Radionuclides, Idaho National Engineering Laboratory, U. S. Geological Survey, IDO-22056	Summarizes a study conducted at the RWMC to (1) evaluate the hydrologic, radiologic and geochemical variables that control the potential for subsurface migration of waste radionuclides from the burial trenches to the Snake River Plain aquifer: (2) to determine the extent of radionuclide migration, if any: and, (3) to construct monitoring wells into the aquifer. Four observation wells were drilled around the outside of the burial ground into the Snake River Plain aquifer to define subsurface geologic and hydrologic conditions, to monitor water level changes, and to collect water samples subsequently. Six additional observation wells were drilled within the burial ground to determine the subsurface geologic and hydrologic conditions and to detect radionuclides that may have migrated downward from the wastes in the burial ground. The thickness and extent of sedimentary layers interbedded with the basalt were determined by coring, sampling and logging wells drilled. The basalt and interflow sedimentary layers were cored at selected depths and analyzed for waste radioactive constituents to obtain information on their hydraulic conductivity, mineralogy, and ion-exchange capacities. Particular attention was given to the sampling of the sedimentary layers between the basalts because of their potential capacity to adsorb or filter dissolved and entrained wastes.	Well completion, generalized lithology, gamma-ray log, gamma-gamma log, caliper log, neutron log, stratigraphy, grain size distribution, clay content, surficial sediment thickness, recharge, percolation, hydraulic conductivity, permeability, perched water, saturation. Sedimentary interbed: thickness, altitude, K-40, Mn-54, Fe-59, Co-60, Zn-65, Sr-90, Cs-127, Zr-95, Nb-95, Ru-106, Ba-140, La-140, Ce-144, Bi-214, Pb-214, Ac-228, Th-232, Pu-232, Pu-238, Pu-239, Pu-240, Am-241, specific gravity, porosity, bulk density, moisture content, hydraulic conductivity, calcite, quartz, plagioclase, augite, olivine, chlorite, kaolinite, illite, montmorillonite, cation exchange capacity, gross gamma radioactivity. basalt: thickness, altitude. Regional ground water: altitude, gradient, flow direction. Water quality: tritium, K-40, Mn-54, Fe-59, Co-60, Zn-65, Sr-90, Cs-127, Zr-95, Nb-95, Ru-106, Ba-140, La-140, Ce-144, Bi-214, Pb-214, Ac-228, Th-232, Pu-232, Pu-238, Pu-239, Pu-240, Am-241, SiO_2, Al, Fe, Mn, Ca, Mg, Na, K, HCO_3^-, CO_3^{2-}, OH^-, alkalinity, SO_4^{2-}, Cl^-, F, NO_3^-, ammonia-nitrogen, organic-nitrogen, NH_3, PO_4^-, ortho phosphorus, dissolved solids, hardness, percent sodium, sodium adsorption ratio, specific conductance, temperature, pH, CO_2, Cr, Cu, Pb. Surficial sediment: Co-60, Sr-90, Cs-137, Pu-238, Pu-239, Pu-240, Am-241.

Program / Purpose	Sampling Organization	Location / Media / Reference	Method/Frequency Inclusive Dates of Investigation	Analysis
RWMC	US Geological Survey	Sediments Rightmire, C. T., 1984, Description and Hydrogeologic Implications of Cored Sedimentary Material from the 1975 Drilling Program at the Radioactive Waste Management Complex, Idaho, U. S. Geological Survey, IDO-22067	Samples of sedimentary material from interbeds between basalt flows and from fractures in the flows, from beneath the RWMC were analyzed for 1) particle size distribution, 2) bulk mineralogy, 3) clay mineralogy, 4) cation exchange capacity, and 5) carbonate content. Thin sections of selected sedimentary interbed material were made for petrographic examination. The results of these analyses are interpreted as a first step in characterizing the paths and rates of movement of radionuclides transported by infiltrating water.	Grain size distribution, specific gravity, bulk mineralogy, quartz, potassium feldspar, plagioclase, calcite, pyroxene, clay content, chlorite illite, montmorillonite, kaolinite, cation exchange capacity, carbonate content, lithologic log, gamma-gamma log, gamma-ray log, neutron log.
RWMC	US Geological Survey	Geology and Vadose Zone Rightmire, C. T. and B. D. Lewis, 1987, Geologic Data Collected and Analytical Procedures Used During a Geochemical Investigation of the Unsaturated Zone, Radioactive Waste Management Complex Idaho National Engineering Laboratory, Idaho, U. S. Geological Survey, DOE/ID-22072	Describes the cored material and subpit sedimentary samples, and documents the sample preparation and analytical techniques used to characterize the hydrologic and geochemical environment of the unsaturated zone at the RWMC. This characterization is needed to develop a conceptual model of the hydrogeochemical environment of the shallow unsaturated zone, and to determine how changes in that environment may influence the mobility and migration of waste radionuclides buried in pits and trenches at the RWMC between the early 1950's and early 1970's.	Core descriptions, thin-section analyses, x-ray diffraction. Visual and optical inspections of cored material collected from 8 well drilled during a 1976-1977 drilling program, along with subpit sedimentary samples, provided the needed hydrogeologic data.

Program / Purpose	Sampling Organization	Location / Media / Reference	Method/Frequency Inclusive Dates of Investigation	Analysis
RWMC	EG&G Idaho, Inc.	Vadose Zone McElroy, D. L. and J. M. Hubbell, 1989, Vadose Zone Monitoring at the Radioactive Waste Management Complex, Idaho National Engineering Laboratory, EG&G Idaho, Inc., EGG-M-8906 McElroy, D.L., 1990, Vadose Zone Monitoring At The Radioactive Waste Management Complex At The Idaho National Engineering Laboratory 1985-1989. EGG-WM-9299.	A network of vadose zone instruments was installed in sediments at the RWMC of the INEL to measure capillary pressure and monitor water movement. The vadose zone monitoring system is part of a continuing effort to develop an understanding of the hydrogeologic and contaminant transport process at the RWMC. Instruments were installed at depths up to 70 m below land surface in a heterogeneous geologic system comprised of sediments which overlie and are intercalated with basalt flows. An array of instruments, which included psychrometers, gypsum blocks, heat-dissipation sensors, and tensiometers, porous-cup lysimeters, and neutron access tubes, were installed.	Generalized stratigraphy. Surficial sediment: capillary pressure, hydraulic gradient. Sedimentary interbed: capillary pressure, hydraulic gradient.
RWMC	US Geological Survey	Stratigraphy Anderson, S. R. and B. D. Lewis, 1989, Stratigraphy of the Unsaturated Zone at the Radioactive Waste Management Complex, Idaho National Engineering Laboratory, Idaho, U. S. Geological Survey, IDO-22080	Wells drilled to 700 feet penetrate a sequence of 10 basalt-flow groups and 7 major sedimentary interbeds that range in age from about 100,000 to 600,000 years old. The 10 flow groups consist of 22 separate lava flows and flow-units. Each flow group is make up of from one to five petrographically similar flows that erupted from common source areas during periods of volcanic inactivity ranging from thousands to hundreds of thousands of years. Flows and sediment are unsaturated to a depth of about 600 feet. Flows and sediment below a depth of 600 feet are saturated and make up the uppermost part of the Snake River Plain aquifer. The areal extent of flow groups and interbeds was determined from well cuttings, cores, geophysical logs, potassium-argon ages, and geomagnetic properties. Stratigraphic control was provided by four sequential basal flows near the base of the unsaturated zone that have reversed geomagnetic polarity and high emission of natural gamma radiation compared to other flows. Natural gamma logs were used as a primary correlation tool.	Liquid waste: volumes, source, types, radioactivity. Stratigraphy. Basalt: flow group, thickness, altitude. Sedimentary interbed: thickness, altitude.

Program / Purpose	Sampling Organization	Location / Media / Reference	Method/Frequency Inclusive Dates of Investigation	Analysis
RWMC Analysis of water-level and water-quality data collected from discontinuous perched ground-water zones during 1986-88 as part of the ongoing geohydrologic investigations at the INEL.	US Geological Survey	Perched Water Zones Cecil, L.D., Orr, B.R., Norton T., and Anderson, S.R., 1991, Formation of Perched Ground-Water Zones and Concentrations of Selected Chemical Constituents in Water, Idaho National Engineering Laboratory, Idaho 1986-1988, U.S. Geological Survey Water Resources Investigations Report 91-4166, DOE/ID-22100, 53 p.	The USGS routinely samples water from 38 wells competed in discontinuous perched ground water zones at INEL. These samples are analyzed for selected radiochemical and chemical constituents, and physical and chemical characteristics. Water level data are also collected routinely from 30 wells and numerous shallow auger holes. Water quality and water level data are used to determine the effects of wastewater disposal on the formation of discontinuous perched ground water zones and to characterize the geochemical and hydrologic processes in these zones.	The INEL water level network for perched ground water zones was designed to determine **hydraulic gradient** changes that influence the **rate and direction of ground water movement** and **transport of radiochemical and chemical constituents**, and to measure the **areal extent of the effects of recharge.** **Water levels** were monitored during 1986-88 in approximately 30 observation wells. Continuous recorders also monitored **water level fluctuations** in three of these wells. Additionally water levels are monitored annually in numerous, shallow auger holes. The **radiochemical and chemical character** of water in perched zones is determined from analyses of samples collected as part of a comprehensive sampling program to identify **contaminant concentrations** and to define the **pattern of waste migration in the Snake River Plain aquifer.** Nearby surface water sites are sampled to document the chemical quality of water that recharges the ground water system. Constituents: H-3, Sr-90, Co-60, Ce-137, Cr-51, total dissolved chromium, Na^+, and Cl^-.

Program / Purpose	Sampling Organization	Location / Media / Reference	Method/Frequency Inclusive Dates of Investigation	Analysis
TAN	Allied Chemical Corporation	Soils: Paige, B. E., F. A. Siedenstrang and M. R. Niccum, 1972, Evaluation of Hazards and Corrosion of Buried Waste Lines in NRTS Soils, Allied Chemical Corporation, Idaho Chemical Programs - Operations Office, National Reactor Testing Station, Idaho Falls, Idaho, ICP-1013.	NRTS soils were reviewed for soil profile, hydraulic conductivity, and moisture content. Three distinct soil types are located at different NRTS areas: CPP-TRA, TAN, and ARA-SPERT-CFA. By relating the chemical and physical properties determined on soil samples from these sites to other soils examined by the National Bureau of Standards, the corrosivity of soils at the NRTS were evaluated.	Soil resistivity, moisture equivalent, pH, CO_3^{2-}, HCO_3^-, Cl^-, SO_4^{2-}, hardness, generalized soil profile, grain size distribution, hydraulic conductivity, infiltration rate.
TAN	US Geological Survey	Unsaturated Zone: Mudra, P.J. and B.L. Schmalz, 1965, An Appraisal of Gaseous Waste Disposal Into the Lithosphere at the National Reactor Testing Station, IDO-12024, pp. 59-65.	Gas Injection tests. Three tests conducted in the summer of 1964 to test the hypothesis of disposal of radioactive waste gases in the lithosphere. Test #1 was conducted at TRA, Test #2 was conducted in the vicinity of the Experimental Beryllium Oxide Reactor (EBOR) at TAN, and Test #3 was conducted northeast of the Naval Reactors Facility (NRF). Five wells were drilled for this test.	Drilling information, well logs, core, and well construction data. Lithology and stratigraphy of surface soils, basalts, and sedimentary interbeds. Particle-size distribution and permeability of soils. Depth to regional ground water. Storage capacity of the lithosphere. Direction and velocity of migration of injected gas. Dilution and dispersion effects on initial concentrations of injected gas. Pressures required for injection of gas.
		Unsaturated Zone: Robertson, J.B., July, 1969, Behavior Of Xenon 133 Gas After Injection Underground Molecular Diffusion Materials Balance Barometric Pressure Effects. IDO-22051-USGS.	Nine hundred and eighty-seven curies of radioactive Xe-133 gas were injected rapidly under pressure to 1.5 to 1.65 psig with one million cubic feet of air into permeable basalt strata. A capping layer of fine-grained playa sediments confined the gas underground. Under-ground distribution patterns after injection pressures had dissipated were evaluated by materials-balance analysis.	Concentration contours of Xe-133, porosity, effective porosity, diffusion coefficient, moisture content, diffusion rate, permeability, barometric flux rate

Program / Purpose	Sampling Organization	Location / Media / Reference	Method/Frequency Inclusive Dates of Investigation	Analysis
TAN	US Geological Survey	Purgeable Organic Compounds: Mann, L.J., and Knoble, L.L., 1987, Purgeable Organic Compounds in Ground Water at the Idaho National Engineering Laboratory, Idaho, USGS Open-File Report 87-766, DOE/ID-22074. Mann, L.J., 1990, Purgeable Organic Compounds in Groundwater at the Idaho National Engineering Laboratory, Idaho 1988 and 1989, U. S. Geological Survey Open-File Report 90-367, DOE/ID-22089.	Ground water samples from 38 wells at the INEL were analyzed for 36 purgeable organic compounds in 1988-89 (Mann, 1990). The samples were collected and analyzed as a continuation of a water quality program initiated in 1987 (Mann and Knoble, 1987).	Water quality: VOCs
TAN	EG&G Idaho, Inc.	TSF disposal ponds Closure Plan for the Test Area North Technical Support Facility Disposal Pond (COCA Unit TSF-07), EGG-ER-8405	1988 - Grab samples of surface soil/sediment were collected near the outfall of the TSF sump pump as part of the preliminary assessment of the TSF disposal pond.	3 samples and 1 duplicate were collected analyzed for Appendix IX compounds; Analyses included metals, volatile organic compounds.
			1988 - Surface soil samples were collected from around infiltration ponds within TSF disposal ponds as part of a DOE environmental survey and by EG&G as part of the RI. Additional borings B - 1-4 were planned for 1989.	DOE: 6 sediment, 6 pond water, and 6 subsurface soil samples collected. EG&G: 4 borings split-spoon sampled with depth. Constituents: VOCs, metals, gross alpha, gross beta, gamma spectroscopy, H-3, Sr-90, Am-241

Program / Purpose	Sampling Organization	Location / Media / Reference	Method/Frequency Inclusive Dates of Investigation	Analysis
TRA	EG&G Idaho, Inc.	Warm Waste Pond Hull, L. C., 1989, Conceptual Model and Description of the Affected Environment for the TRA Warm Waste Pond (Waste Management Unit TRA-03), EG&G Idaho, Inc., EGG-ER-8644	This report discusses the development of a conceptual model of the movement of water and contaminants associated with the TRA warm waste pond based on an analysis of existing data. The conceptual model is a verbal description of the processes which are important for contaminant migration. As such, it serves as a summary of what is known about the warm waste pond and the hydrogeologic system at TRA. Areas of uncertainty are highlighted in the development of the conceptual model, which lead to the identification of tasks needed to complete site characterization.	History, generalized stratigraphy, generalized lithology, gamma-ray log, caliper log, annual wind rose, Big Lost River discharge, regional water table, transmissivity, storage coefficient, velocity, ecology, solubility. Unsaturated zone: hydraulic conductivity, thickness, dispersivity, porosity, velocity. Liquid waste: volume, radioactivity, chromium, Co-60, Cr-51, Cs-134, Cs-137, H-3, Sr-90, Perched water: altitude, areal extent, recharge source, specific conductance, H-3, chromium, Surficial sediment: thickness, grain size distribution, bulk density, porosity, hydraulic conductivity. Water quality: spec. cond., Na^+, Cl^-, NO_3^-, SO_4^{2-}, Mg, Ca, K, pH, Cr, Distribution coefficient: Cr-51, Co-60, Cs-134, Cs-137, H-3, Sr-90, Am-241, Cm-244, U-232, U-234, U-238, Pu-238, Pu-239. Retardation factor: Cr-51, Co-60, Cs-134, Cs-137, H-3, Sr-90, Am-241, Cm-244, U-232, U-234, U-238, Pu-238, Pu-239. Surficial sediment (pond bottom): concentration profile, Ar, Be, Cd, Cr, Pb, Hg, Cr-51, Co-60, Cs-134, Cs-137, Sr-90, Am-241, U-232, U-234, U-238, Pu-238, Pu-239, Cm-244.

Program / Purpose	Sampling Organization	Location / Media / Reference	Method/Frequency Inclusive Dates of Investigation	Analysis
TRA	US Geological Survey	Liquid Waste Barraclough, J. T. and R. G. Jensen, 1976, Hydrologic Data for the Idaho National Engineering Laboratory Site, Idaho 1971 to 1973, U. S. Energy Research and Development Administration, IDO-22055	The TRA utilizes ponds and a deep well to dispose of about 400 million gallons of dilute wastes per year. About half of the liquid waste is discharged to a radioactive waste pond. Infiltration from the pond has formed a large perched water body in the basalt. The perched ground water body contains H-3, Cr-51, Co-60, and Sr-90. The extent and concentrations of these radionuclides are shown on maps in this report.	Transmissivity, velocity, regional water table, pumpage, Big Lost River hydrograph, well hydrograph. Perched water: TRA areal extent, altitude, well hydrograph, H-3, Cr-51, Co-60, Sr-90, spec. cond. Liquid waste: radioactivity, H-3, Sr-90, Cs-137, Co-60, NaCl, SO_4^{2-}, sulfite, $PO_4^{3-}NO_3^-$. Water quality: distribution, concentration, H-3, Sr-90, Cs-137, Co-60, spec. cond., Na^+.
TRA	US Geological Survey	H-3 and Chromium Barraclough, J. T., W. E. Teasdale, J. B. Robertson and R. G. Jensen, 1967, Hydrology of the National Reactor Testing Station Idaho 1966, U. S. Geological Survey, IDO-22047	Describes on-going studies to determine the hydrologic effects of disposal of radioactive waste to the ground at the NRTS. This has involved the collection and analyses of ground and surface water samples for radiometric and chemical changes. The results are evaluated and mapped. Ground water levels are also mapped of the NRTS. Several aspects of H-3 disposal have been studied in detail at the TRA. Dissolved chromium has been used to trace TRA pond waste water in perched water bodies and downgradient 2-1/2 miles in the Snake Plain aquifer.	Regional water table, water table fluctuations, well hydrographs, travel time contour, ground water velocity, Birch Creek Playa thickness, air injection test. Perched water: altitude in alluvium, altitude in basalt, H-3 in basalt, spec. cond. Water quality: H-3, spec. cond., Na^+, Cr, Sr-90, γ, fluoride. caliper logs, gamma-ray logs, gamma-gamma logs, generalized lithology, borehole flow. Well pumpage, Big Lost River discharge, diversion area storage capacity, infiltration rate. Liquid waste: volume, H-3. Aquifer air: discharge, temp., relative humidity, barometric pressure.

Program / Purpose	Sampling Organization	Location / Media / Reference	Method/Frequency Inclusive Dates of Investigation	Analysis
TRA	US Geological Survey-DOE/ID	Perched Zone Barraclough, J. T., B. D. Lewis and R. G. Jensen, 1981, Hydrologic Conditions at the Idaho National Engineering Laboratory, Idaho Emphasis: 1974-1978, U. S. Department of Energy, IDO-22060 Lewis, B. D. and R. G. Jensen, 1984, Hydrologic Conditions at the Idaho National Engineering Laboratory, Idaho: 1979-1981 Update, U. S. Department of Energy, IDO-22066	A large body of perched ground water has formed in the basalt underlying the waste disposal ponds in the TRA. This perched zone contains H-3, Cr-51, Co-60, Sr-90, and several nonradioactive ions. H-3 is the only mappable waste constituent in that portion of the Snake River Plain aquifer directly underlying this perched zone.	Regional water table, velocity, transmissivity, pumpage, Big Lost River hydrograph, well hydrograph. Perched water: TRA areal extent, altitude, well hydrograph, Cr-51, Co-60, Sr-90, H-3, spec. cond., Na^+, Cr, Cl^-, SO_4^{3-}. Water quality: distribution, concentration, H-3, Sr-90, I-129, spec. cond., Na^+, Cl^-, NO_3^-. Liquid waste: radioactivity, H-3, Sr-90, Cr-51, Cs-137, Co-60, Pu-238, Pu-239, Pu-240, I-129, SO_4^{3-}, Na^+, sulfite, PO_4^{3-}.
TRA	US Geological Survey	Basalt Hydrology Jones, P. H., 1961, Hydrology of Waste Disposal National Reactor Testing Station Idaho, U. S. Geological Survey, IDO-22042-USGS	The purpose of the research is to provide detailed and accurate information on the occurrence, movement, quality, and geologic environment of water beneath the land surface. Primary to these investigations is research on the principles of basalt hydrology which is necessary to trace the movement and observe and interpret attenuation of radioactive waste discharged to the ground. Special emphasis is given to study of conditions in the vicinity of the ICPP and MTR-ETR (TRA) facilities.	Liquid waste: volume, radioactivity, source, Sr-90, I-131, Ce-144, Zr- 95, Nb-95, Cs-137, Ru-106, Rh-106. stratigraphy, lithologic logs, gamma-ray logs, caliper logs, subsurface basalt contour, uppermost extensive sedimentary interbed contour, lowermost extensive sedimentary interbed contour, basalt chemical analysis, regional water table. Perched water: TRA, ICPP, altitude, thickness, extent, temp., spec. cond., H-3. aquifer: depth, altitude, thickness, structure. straddle packer test, injection test. Water quality: Cl^-, temp., resistivity, spec. cond., Na^+, H-3.

Program / Purpose	Sampling Organization	Location / Media / Reference	Method/Frequency Inclusive Dates of Investigation	Analysis
TRA	Allied Chemical Corporation	Soils Paige, B. E., F. A. Siedenstrang and M. R. Niccum, 1972, Evaluation of Hazards and Corrosion of Buried Waste Lines in NRTS Soils, Allied Chemical Corporation, Idaho Chemical Programs - Operations Office, National Reactor Testing Station, Idaho Falls, Idaho, ICP-1013	Three distinct soil types are located at different NRTS areas: CPP-TRA, TAN, and ARA-SPERT-CFA. By relating the chemical and physical properties determined on soil samples from these sites to other soils examined by the National Bureau of Standards, the corrosivity of soils at the NRTS were evaluated.	Soil resistivity, moisture equivalent, pH, CO_3^{2-}, HCO_3^-, CL^-, SO_4^{3-}, hardness, generalized soil profile, grain size distribution, hydraulic conductivity, infiltration rate.
TRA	US Geological Survey	Stratigraphy Anderson, S. R, 1991, Stratigraphy of the Unsaturated Zone and Uppermost Part of the Snake River Plain Aquifer at the Idaho Chemical Processing Plant and Test Reactors Area, Idaho National Engineering Laboratory, Idaho, U. S. Geological Survey, IDO-22095	Study of a complex sequence of basalt flows and sedimentary interbeds that underlie the ICPP and TRA at INEL.	Stratigraphy. Basalt: flow group, thickness, altitude. Surficial sediment: thickness, altitude.

Program / Purpose	Sampling Organization	Location / Media / Reference	Method/Frequency Inclusive Dates of Investigation	Analysis
TRA Analysis of water-level and water-quality data collected from discontinuous perched ground-water zones during 1986-88 as part of the ongoing geohydrologic investigations at the INEL.	US Geological Survey	Perched Water Zones Cecil, L.D., Orr, B.R., Norton T., and Anderson, S.R., 1991, Formation of Perched Ground-Water Zones and Concentrations of Selected Chemical Constituents in Water, Idaho National Engineering Laboratory, Idaho 1986-1988, U.S. Geological Survey Water Resources Investigations Report 91-4166, DOE/ID-22100, 53 p.	The USGS routinely samples water from 38 wells competed in discontinuous perched ground water zones at INEL. These samples are analyzed for selected radiochemical and chemical constituents, and physical and chemical characteristics. Water level data are also collected routinely from 30 wells and numerous shallow auger holes. Water quality and water level data are used to determine the effects of wastewater disposal on the formation of discontinuous perched ground water zones and to characterize the geochemical and hydrologic processes in these zones.	The INEL water level network for perched ground water zones was designed to determine hydraulic gradient changes that influence the rate and direction of ground water movement and transport of radio-chemical and chemical constituents, and to measure the areal extent of the effects of recharge. Water levels were monitored during 1986-88 in approximately 30 observation wells. Continuous recorders also monitored water level fluctuations in three of these wells. Additionally water levels are monitored annually in numerous, shallow auger holes. The radiochemical and chemical character of water in perched zones is determined from analyses of samples collected as part of a comprehensive sampling program to identify contaminant concentrations and to define the pattern of waste migration in the Snake River Plain aquifer. Nearby surface water sites are sampled to document the chemical quality of water that recharges the ground water system. Constituents: H-3, Sr-90, Co-60, Ce-137, Cr-51, total dissolved chromium, Na^+, and Cl^-.
TRA Test to investigate the feasibility of disposing gaseous waste to the lithosphere. This test was designed to investigate the effects of perched water on gas migration.	US Geological Survey	Unsaturated Zone: Mudra, P.J. and B.L. Schmalz, 1965, An Appraisal of Gaseous Waste Disposal Into the Lithosphere at the National Reactor Testing Station, IDO-12024, pp. 59-65.	Gas Injection tests. Three tests conducted in the summer of 1964 to test the hypothesis of disposal of radioactive waste gases in the lithosphere. Test #1 was conducted at TRA, Test #2 was conducted in the vicinity of the Experimental Beryllium Oxide Reactor (EBOR) at TAN, and Test #3 was conducted northeast of the Naval Reactors Facility (NRF).	Drilling information, well logs, core, and well construction data. Lithology and stratigraphy of surface soils, basalts, and sedimentary interbeds. Particle-size distribution and permeability of soils. Depth to regional ground water. Storage capacity of the lithosphere. Direction and velocity of migration of injected gas. Dilution and dispersion effects on initial concentrations of injected gas. Pressures required for injection of gas.

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