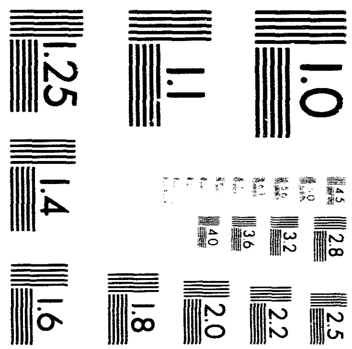

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DOE/OR-1152&D1
Y/ER-70&D1

Energy Systems Environmental Restoration Program
Y-12 Environmental Restoration Program

Remedial Investigation Work Plan for Chestnut Ridge Operable Unit 4 (Rogers Quarry/Lower McCoy Branch) at the Oak Ridge Y-12 Plant, Oak Ridge, Tennessee

Date Issued—September 1993

Prepared by
CDM Federal Programs Corporation
Oak Ridge, Tennessee
under contract 96C-99052C

Prepared for
U.S. Department of Energy
Office of Environmental Restoration and Waste Management
under budget and reporting code EW 20

OAK RIDGE Y-12 PLANT
Oak Ridge, Tennessee 37831-8169
managed by
MARTIN MARIETTA ENERGY SYSTEMS, INC.
for the
U.S. DEPARTMENT OF ENERGY
under contract DE-AC05-84OR21400

DRAFT

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ACRONYMS

ARARs	applicable or relevant and appropriate requirements
ASTM	American Society for Testing and Materials
BMAP	Biological Monitoring and Abatement Program
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CLP	Contract Laboratory Program
CSM	conceptual site model
DOE	Department of Energy
DOE-ORO	Department of Energy Oak Ridge Operations Office
DOT	Department of Transportation
DQO	data quality objective
EFPC	East Fork Poplar Creek
Energy Systems	Martin Marietta Energy Systems, Inc.
EPA	U.S. Environmental Protection Agency
ER	Environmental Restoration
ERA	Ecological Risk Assessment
ESP	Environmental Surveillance Procedure
FCRF	Field Change Request Form
FFA	Federal Facilities Agreement
FS	Feasibility Study
FSP	field sampling plan
HHRA	Human Health Risk Assessment
HR	heart rate
IDW	investigation-derived waste
MCB	McCoy Branch
MCL	Maximum Contaminant Limit
MDL	method detection limit
MS	matrix spike
MSD	matrix spike duplicate
MSL	mean sea level
NCP	National Contingency Plan
NEPA	National Environmental Policy Act
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NRDA	Natural Resource Damage Assessment
OREIS	Oak Ridge Environmental Information System
ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge Reservation
OU	operable unit
PA	preliminary assessment
PAH	polynuclear aromatic hydrocarbon
PARCC	precision, accuracy, representativeness, completeness, and comparability
PCB	polychlorinated biphenyl
PPE	personal protective equipment

PRG	preliminary remediation goal
QA	quality assurance
QAPjP	Quality Assurance Project Plan
QC	quality control
RA	remedial action
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act of 1976
RD	remedial design
RFI	RCRA Facility Investigation
RI	remedial investigation
ROD	record of decision
SI	site investigation
SOP	Standard Operating Procedure
SVOC	semivolatile organic compound
TAL	Target Analyte List
TDEC	Tennessee Department of Environment and Conservation
TRC	Technical Review Committee
VOC	volatile organic compound
WAG	waste area grouping

QAMS-005/80 LOCATOR PAGE

The criteria listed below are outlined in the EPA document *Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans* (QAMS-005/80, 1983). QAMS-005/80 is the standard used for specific quality assurance/quality control activities to meet data quality objectives. All of the QAMS-005/80 criteria apply to site monitoring and measurement activities.

QAMS-005/80 Criterion	CDM Federal Reference (Page or Section No.)
Title Page	Title Page
Table of Contents	Contents (p. iii)
Introduction	Quality Assurance Project Plan (QAPjP) (Sect. 8.1)
Project Description	Field Sampling Plan (FSP) (Sect. 7.3)
Project Organization and Responsibility	QAPjP (Sect. 8.2)
QA Objectives	QAPjP (Sect. 8.3.1)
Sampling Procedures	QAPjP (Sect. 8.4); FSP (Sect. 7.4.11)
Custody	QAPjP (Sect. 8.5); FSP (Sect. 7.5.4)
Equipment Calibration Procedures	QAPjP (Sect. 8.6)
Analytical Procedures	QAPjP (Sect. 8.8); FSP (Sect. 7.4.11.6)
Data Reduction, Validation, and Reporting	QAPjP (Sects. 8.9 and 8.11)
QC Checks	QAPjP (Sect. 8.10)
Performance and System Audits	QAPjP (Sect. 8.12)
Preventive Maintenance	QAPjP (Sect. 8.7)
Data Assessment Procedures	QAPjP (Sect. 8.3.5)
Corrective Action Procedures	QAPjP (Sect. 8.13)
Quality Assurance Reports	QAPjP (Sect. 8.14)

NQA-1 LOCATOR PAGE

The following 18 elements are outlined in the American Society of Mechanical Engineers Nuclear Quality Assurance (NQA)-1 document *Quality Assurance Program Requirements for Nuclear Facilities*, 1989 edition (ASME 1989). NQA-1 is the primary DOE quality assurance (QA) program standard. Some of the 18 NQA-1 elements are not applicable to this investigation.

NQA-1 Element	CDM Federal Reference (Page/ Section/Chapter No.)
QA Program	CDM Federal QA Manual (Part I)
Organization	QAPjP (Sect. 8.2)
Design Control	QAPjP (Chap. 8)
Procurement Document Control	CDM Federal QA Manual (QP 8.0 and 9.0)
Instructions, Procedures, Drawings	Standard Operating Procedures (SOPs) (ESH/Sub/87-21706/1)
Document Control	QAPjP (Sect. 8.5)
Control of Purchased Items and Services	CDM Federal QA Manual (QP 8.0 and 9.0)
Identification and Control of Items	Field Sampling Plan (Sect. 7.5)
Control of Processes	CDM Federal QA Manual (QP 18.0)
Inspection	QAPjP (Sect. 8.12.3)
Test Control	CDM Federal QA Manual (QP 15.0)
Control of Measuring and Test Equipment	SOPs (ESH/Sub/87-21706/1); Laboratory QA Plan/Analytical Procedures
Handling, Storage, and Shipping	SOPs (ESH/Sub/87-21706/1)
Inspection, Test, and Operating Status	SOPs (ESH/Sub/87-21706/1)
Control of Nonconforming Items	QAPjP (Sect. 8.13.1)
Corrective Action	QAPjP (Sect. 8.13)
Quality Assurance Records	QAPjP (Sect. 8.14)
Audits	QAPjP (Sect. 8.12.1)

EXECUTIVE SUMMARY

The Oak Ridge Y-12 Plant, located within the Oak Ridge Reservation (ORR), is owned by the U.S. Department of Energy and managed by Martin Marietta Energy Systems, Inc. (Energy Systems). The reservation contains both hazardous and mixed waste sites that are subject to regulations promulgated under the Resource Conservation and Recovery Act of 1976 (RCRA) and the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), amended in 1986 by the Superfund Amendments and Reauthorization Act.

Under RCRA guidelines and requirements from the Tennessee Department of Environment and Conservation, the Y-12 Plant initiated investigation and groundwater monitoring of various sites at the Y-12 Plant. The entire ORR was placed on the National Priorities List (NPL) of CERCLA sites in November 1989. Following CERCLA guidelines, sites under investigation require a remedial investigation (RI) to define the nature and extent of contamination and to determine the available alternatives for a feasibility study (FS) of potential remedial actions.

The Oak Ridge Y-12 Plant includes ~800 acres near the northeast corner of the reservation and adjacent to the city of Oak Ridge (Fig. 1-1). The plant is a manufacturing and developmental engineering facility that produced components for various nuclear weapons systems and provides engineering support to other Energy Systems facilities. More than 200 contaminated sites have been identified at the Y-12 Plant that resulted from past waste management practices. Many of the sites have operable units (OUs) based on priority and on investigative and remediation requirements.

This RI work plan specifically addresses Chestnut Ridge OU 4. Chestnut Ridge OU 4 consists of Rogers Quarry and Lower McCoy Branch (MCB). Rogers Quarry, which is also known as Old Rogers Quarry or Bethel Valley Quarry was used for quarrying from the late 1940s or early 1950s until about 1960. Since that time, the quarry has been used for disposal of coal ash and materials from Y-12 production operations, including classified materials. Disposal of coal ash ended in July 1993.

An RI is being conducted at this site in response to CERCLA regulations. The overall objectives of the RI are to collect data necessary to evaluate the nature and extent of contaminants of concern, support an Ecological Risk Assessment and a Human Health Risk Assessment, support the evaluation of remedial alternatives, and ultimately develop a Record of Decision for the site.

The purpose of this work plan is to outline RI activities necessary to define the nature and extent of suspected contaminants at Chestnut Ridge OU 4. Potential migration pathways also will be investigated. Data collected during the RI will be used to evaluate the risk posed to human health and the environment by OU 4.

In order to fill data gaps and supplement and confirm existing data, additional site characterization data are needed in the following areas: surface water hydrology, groundwater quality, surface water/sediment quality, and ecological characterization. The site investigation will specifically include the following activities:

- collecting groundwater samples from nine existing monitoring wells adjacent to and/or proximal to Rogers Quarry and one monitoring well from a background location in the same geologic group;
- collecting surface water and sediment samples from the quarry, from downstream of Lower MCB, from a drainage ditch south of the quarry, and from a control ditch;
- collecting various hydrologic data (e.g., quarry inflow, quarry outflow, precipitation, evaporation, etc.) to prepare a water balance for Rogers Quarry;
- conducting an underwater survey of Rogers Quarry, including magnetometer, radiation, and video surveys;
- conducting wetlands and endangered species and habitat surveys;
- collecting fish from Rogers Quarry for whole body contaminant analysis;
- performing a qualitative survey of the fish population in Rogers Quarry;
- performing fish pathology studies of abnormal fish that may be found in Rogers Quarry;
- performing a qualitative predator survey of avian and terrestrial species frequenting Rogers Quarry environs;
- performing in situ bioassays at the overflow from the quarry using clams known to accumulate polycyclic aromatic hydrocarbons.

The hydrological and geohydrological data will be used to assess the impact of water quality in Rogers Quarry on groundwater, to determine flow characteristics, and to prepare transport via groundwater and surface water pathways, and the biological/ecological data will specifically be used to evaluate aquatic and terrestrial risk pathways for biota and man. These data will also be used in preparation of the FS.

1. INTRODUCTION

1.1 REGULATORY INITIATIVE

The Oak Ridge Y-12 Plant, located within the Oak Ridge Reservation (ORR), is owned by the Department of Energy (DOE) and managed by Martin Marietta Energy Systems, Inc. (Energy Systems). The reservation contains both hazardous and mixed waste sites that are subject to regulations promulgated under the Resource Conservation and Recovery Act of 1976 (RCRA) and the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), amended in 1986 by the Superfund Amendments and Reauthorization Act.

Under RCRA guidelines and requirements from the Tennessee Department of Environment and Conservation (TDEC), the Y-12 Plant initiated investigation and groundwater monitoring of various sites at the Y-12 Plant. The entire ORR was placed on the National Priorities List (NPL) of CERCLA sites in November 1989. Following CERCLA guidelines, sites under investigation require a Remedial Investigation (RI) to define the nature and extent of contamination and to determine the available alternatives for a feasibility study (FS) of potential remedial actions.

DOE, the U.S. Environmental Protection Agency (EPA), and TDEC negotiated a Federal Facilities Agreement (FFA) in response to the NPL placement of the ORR. The FFA was developed for compliance pursuant to CERCLA, RCRA, the National Environmental Policy Act (NEPA), and the National Contingency Plan. A common goal of the parties that entered into the FFA is to ensure that past releases from operations and waste management at ORR are thoroughly investigated and that appropriate remedial action is taken for the protection of human health and the environment.

The general purposes of the FFA are to establish a framework and schedule for development, implementation, and monitoring of response actions at the ORR in accordance with applicable guidance and policy; to coordinate responses under CERCLA and RCRA to maximize flexibility and preclude redundant activity; to minimize duplication of analytical and investigative work and ensure quality of data management; and to expedite response actions.

1.2 ORR ENVIRONMENTAL RESTORATION PROGRAM

The Environmental Restoration (ER) Program has been established to plan and implement the investigation and remediation of the ORR in cooperation with the parties to the FFA. A fundamental goal in the implementation of the program is that remedial action be emphasized. The goal acknowledges that no investigatory process can resolve all uncertainties and that remedial actions must be able to accommodate deviation from original hypotheses after they are initiated. This approach to the process of investigation and remediation promotes early remedy selection, flexibility for the remedial action, and contingencies to account for new data obtained during investigation of the sites. Removal actions will be implemented, as necessary, to protect human health and the environment from an imminent short-term threat. Interim remedial actions may also be implemented if the site warrants quick stabilization or risk reduction.

The parties to the FFA divided the ORR into waste area groupings (WAGs)/operable units (OUs) that are prioritized to obtain effective and rapid investigation and cleanup. Characterization of WAGs and OUs will be planned on the basis of optimizing field sampling and maximizing the use of existing data. Using the framework of WAGs and OUs, the ER Program is following some guidelines that shape the overall approach for the remediation of the ORR. First, an emphasis is placed on the integration of ongoing activities and historical information concerning the sites. Second, activities of other major programs at the ORR are to be coordinated and integrated with the ER Program to ensure that adequate resources are available, that data are provided in a consistent format, and that technical issues and remediation technologies are communicated throughout the ER Program. Third, remedial action schedules for OUs can be revised by consent of the FFA parties. Fourth, OUs may be redefined or reprioritized, as the investigations proceed, by consent of the FFA parties. Finally, waste minimization and the prevention of recontamination will be emphasized in all investigations.

The lead agency for the investigations and remedial actions on the ORR is the DOE Oak Ridge Operations Office (DOE-ORO). The duties of the lead agency include overseeing and managing ORR remedial actions pursuant to the FFA, serving as primary contact and coordinator with the regulators for implementing the FFA, and ensuring the availability of resources required to implement the site management plan. The EPA and TDEC are working together within the terms of the FFA to provide regulatory oversight of remedial action work.

The ER Division of Energy Systems is the integrating contractor for the DOE ER Program. The primary function of the integrating contractor is to ensure technical and operational consistency among all participants involved in the Oak Ridge ER Program. The ER Division will conduct meetings; collect information; assemble total packages on ER Program activities; and prepare monthly status reports on budget, cost, schedule, and progress for use by DOE-ORO. Technical consistency in such areas as risk assessment, NEPA compliance, waste management, and others will be monitored and ensured by the ER Division.

In addition to these primary responsibilities, the ER Division has a variety of other responsibilities in its role as integrating contractor, including the following:

- Evaluating other DOE prime contractor, subcontractor, and prospective contractor ER programs, policies, and procedures
- Coordinating fieldwork with plant operations
- Evaluating design, strategies, and sequencing of work
- Preparing ER Program technical and administrative policy and procedures
- Coordinating technical reviews of all products and documents prepared by all ER Program participants
- Providing treatment, storage, and disposal services for management of ER-originated wastes

- Conducting a rigorous self-assessment program to evaluate regulatory compliance and procedure adherence during ER activities
- Developing and operating the Oak Ridge Environmental Information System (OREIS) to manage environmental data on the ORR
- Coordinating and evaluating priorities for ongoing and proposed activities for the DOE-ORO ER Program.

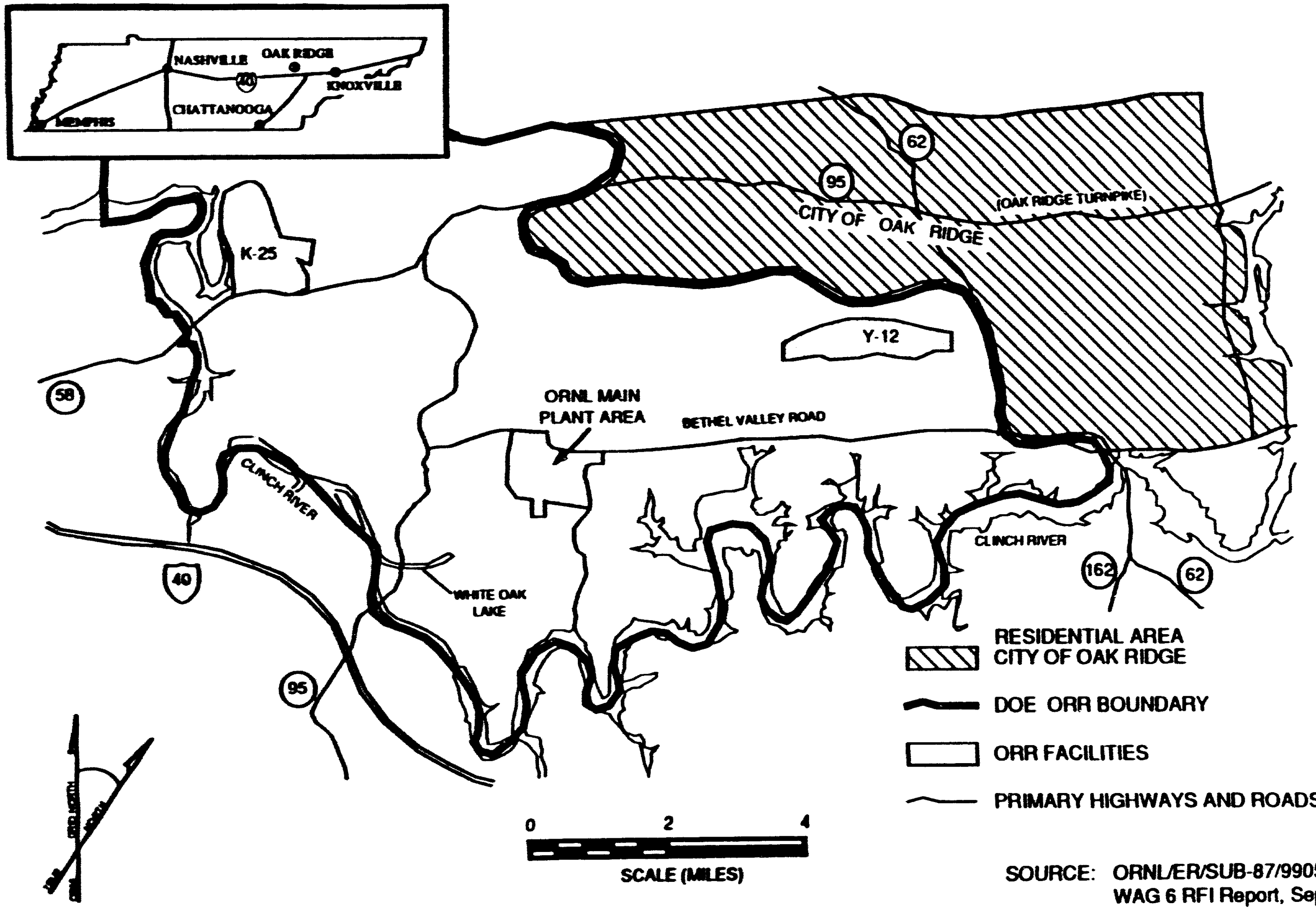
In addition to Energy Systems, DOE-ORO has delegated remediation activities at each WAG or OU to three primary contractors. Radian Corporation is responsible for the FSs, environmental assessments, proposed plans, interim records of decision, and records of decision (RODs). EBASCO Services is responsible for Remedial Designs. MK-Ferguson is responsible for the remedial actions. Additional information on the ER Program is in the *Oak Ridge Reservation Site Management Plan for the Environmental Restoration Program*, DOE/OR-1001/R2 (Energy Systems 1992b).

1.3 FACILITY-SPECIFIC ER PROGRAM

The Oak Ridge Y-12 Plant, one of three DOE facilities on the ORR, includes ~800 acres near the northeast corner of the reservation and adjacent to the City of Oak Ridge (Fig. 1-1). The plant is a manufacturing and developmental engineering facility that produced components for various nuclear weapons systems and provides engineering support to other Energy Systems facilities. More than 200 contaminated sites have been identified at the Y-12 Plant that resulted from past waste management practices. Many of the sites have been grouped into OUs, based on priority and on investigative and remediation requirements. Specific information on the OUs at the Y-12 Plant is provided in Sect. 1.4.

A major component of the investigative and remedial strategy to be applied to the Y-12 Plant, and indeed the entire ORR, is a structured approach. This approach is based on separate studies of groundwater, surface water, and contaminant sources. The hydrogeologic regime at the Y-12 Plant is complex and includes surface-water drainage, groundwater flow through a dominantly fractured system, and groundwater flow through a karst system. Numerous sources may have contributed to groundwater and surface water contamination. Given these circumstances, the parties to the FFA concluded that more timely and cost-efficient investigations would result if sources of contamination were studied separately from the groundwater and surface water.

OUs designated as both source control and integrator OUs are anticipated to reach a final ROD. OUs designated only as source control OUs will be addressed initially in interim action RODs. When all proposed source control OU interim actions are complete, there should be an adequate amount of monitoring data from integrator OUs to evaluate if the interim actions have been effective, and, if not, additional remediation will be undertaken in the integrator OU final ROD. Sites at the Y-12 Plant not included in an OU have been collectively grouped into the Y-12 Study Area. These lower priority sites will be investigated as preliminary assessments/site investigations (PA/SIs). Sites will be grouped into new OUs or added to existing OUs if the PA/SIs suggest that an RI/FS is necessary.



SOURCE: ORNL/ER/SUB-87/99053/5/VI
WAG 6 RFI Report, September 1991.

CDM FEDERAL PROGRAMS CORPORATION
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DOE FACILITIES ON THE OAK RIDGE RESERVATION

ROGERS QUARRY/LOWER McCOY BRANCH

CHESTNUT RIDGE OU4

FIGURE No. 1-1

1.4 FACILITY OPERABLE UNIT STRATEGY

The OUs established for the Y-12 Plant are distinguished as source control, groundwater, surface water, or combined units. The plant area includes two groundwater integrator units: Bear Creek and Upper East Fork Poplar Creek (EFPC). Chestnut Ridge is handled as a combined source control and groundwater OU. The ultimate integrator unit of all surface water and groundwater contamination from the ORR is the Clinch River/Melton Hill Lake/Watts Bar Lake.

There are 11 OUs at the Y-12 Plant, and they include 31 contaminated sites within the plant boundaries and surrounding areas. The sites generally were grouped on the basis of proximity and by common physical and hydrogeological characteristics. Bear Creek and Upper EFPC hydrologic regimes each are associated with an integrated surface water and groundwater OU. The Lower EFPC watershed constitutes both a source control and groundwater OU. The remaining eight OUs are source control OUs within the Bear Creek, Upper EFPC, and Chestnut Ridge hydrologic regimes. Groundwater contamination in the Chestnut Ridge hydrologic regime is associated with each source control OU.

Chestnut Ridge OU 4 includes Rogers Quarry and Lower McCoy Branch (MCB). All OUs in Chestnut Ridge are combined units that include source control and groundwater. Media to be addressed will be groundwater, surface water (both from the Rogers Quarry and Lower MCB), and sediments.

The ER Program has prioritized the OUs established for the ORR and surrounding areas. Evaluation of the OUs was based upon five weighted categories: human health risk, environmental impacts, regulatory obligations and other commitments, program impacts, and negative socioeconomic impacts. Chestnut Ridge OU 4 currently is ranked sixth in priority of the 11 OUs established at the Y-12 Plant. Additional information on the prioritization process is in the ORR Site Management Plan (Energy Systems 1992b).

1.5 INTENT AND SCOPE OF THE RI WORK PLAN

An RI is being conducted at the site in response to CERCLA regulations. The observational approach will be used in compiling and analyzing currently available data and new data planned for collection under this RI.

The purpose of this Work Plan is to outline RI activities necessary to define the nature and extent of suspected contaminants at Chestnut Ridge OU 4. Potential migration pathways also will be investigated. Data collected during the RI will be used to evaluate the risk posed to human health and the environment by OU 4.

Samples to be collected include surface water/sediment samples from Lower MCB, a drainage ditch south of Rogers Quarry, and a control drainage ditch; sediment and water samples from the quarry; and groundwater samples from ten monitoring wells, nine on-site and one off-site. The samples will be analyzed for metals and radionuclides; previous surface water/sediment and groundwater data indicate that these are the primary contaminants of concern. Samples will also be analyzed for semivolatile organic compounds (SVOCs) to determine the presence or absence of polynuclear aromatic hydrocarbons (PAHs), which are known to occur in coal ash. A percentage of the samples collected will also be analyzed for volatile organic compounds (VOCs) and pesticides/PCBs for comparison with data from other nearby waste sites. Finally, a variety of ecological sampling and testing procedures will be used at the site to evaluate ecological impacts.

After discussion with Energy Systems and DOE personnel, there was general consensus that installation of additional groundwater monitoring wells would not be necessary. A substantial number of wells exist around Rogers Quarry and a substantial amount of data from previous well sampling exists to characterize the groundwater in the unit and to evaluate the potential contaminant contribution from Rogers Quarry and MCB. Additional wells probably would not add any significant new information because previous studies (e.g., Haase et al. 1987) have included well installation and a discussion of hydrologic conditions at the site. Data from the ORR Groundwater Monitoring Program additionally define hydrologic characteristics of the site. Only existing monitoring wells will be used to evaluate the condition of groundwater.

1.6 SPECIAL PROBLEMS

Access to Rogers Quarry is restricted; therefore, all personnel performing the sampling must be badged and escorted by L- or Q-cleared escorts. Deep water sampling of the ash may present problems due to the unknown location of classified items disposed in the quarry that were subsequently buried by coal ash.

1.7 OVERALL PROJECT OBJECTIVES

The overall objectives of the RI are to collect data necessary to evaluate the nature and extent of contaminants of concern, support an Ecological Risk Assessment (ERA) and a Human Health Risk Assessment (HHRA), support the evaluation of remedial alternatives, and ultimately develop an ROD for the site. The ROD for OU 4 will be consistent with the strategy outlined in the ORR Site Management Plan (Energy Systems 1992b).

The Rogers Company leased the site from the Atomic Energy Commission for quarrying in the late 1940s or early 1950s. Around 1960 quarrying activities ceased and the quarry was used for coal ash disposal and materials from the Y-12 Plant production operations. The quarry initially received coal ash via Upper MCB when the Coal Ash Disposal Pond dam was breached around 1964. The quarry received coal ash on a regular basis beginning around 1968. Until November 1989, coal ash slurry was routed to the quarry via a pipeline and Upper MCB. During November 1989, additional pipeline was installed to bypass MCB and the Coal Ash Disposal Pond altogether.

The observational approach will be used to address the uncertainties inherent at hazardous waste sites such as this. The observational approach involves several steps to identify the most probable model of the site, and reasonable deviations from that model that must be accounted for during design and implementation. The observational approach recognizes that complete site characterization is not possible, and an attempt to define the nature and extent of contamination fully is generally not achievable.

Initially, existing information on general site conditions is gathered, and remedial objectives and general responses are set. Secondly, additional information is gathered to refine knowledge of general site conditions and the nature and extent of contamination, receptors, pathways, remedial objectives, etc. Thirdly, the most probable site conditions and reasonable deviations are identified. From this, a conceptual design incorporating both a base action and contingent action can be developed and a ROD signed. Development of an understanding of the processes involved in the fate and transport of hazardous contaminants and their exposure and effects on human health and the environment are necessary in addition to the observational approach so that a reasonable model of the site can be developed.

The remedial action is designed from the most probable conditions and reasonable deviations expected. Items to observe during remediation, which will detect deviations during construction and operation, should be chosen. Key indicators (chemical, physical, and others) are selected for observation during remediation. The purpose of this step is to identify where actual site conditions do not match assumed site conditions and to determine the level of deviation that will trigger a response. The observational approach is not appropriate if a model of the most probable conditions and reasonable deviations cannot be established or if key indicators cannot be defined. Lastly, the remedial alternative is implemented and selected parameters are measured during remediation to make necessary modifications.

Potential migration pathways for contaminants from the quarry include surface water and groundwater. Surface water is currently monitored at the National Pollutant Discharge Elimination System (NPDES) outfall from the quarry to Lower MCB. Groundwater pathways primarily include fractures in bedrock. To date, ten wells have been installed around the perimeter of the quarry and the wells monitor a range of depths in the bedrock.

A review of historical records and existing data from sampling of surface water, sediments, and groundwater around the quarry indicates that the primary contaminants of concern are metals and radionuclides. Samples to be collected during the investigation will include water and sediment samples from the quarry; groundwater samples from most of the monitoring wells surrounding the quarry and one background or control well; and surface water/sediment samples from Lower MCB and a drainage ditch south of the quarry. Sampling will occur twice; once during the winter months and once during the summer months. Chapter 7 provides additional information on sampling locations and rationale.

A pH, temperature, specific conductance, and dissolved oxygen survey of water in the quarry will provide data to determine if the water column is stratified with depth at the same time of sampling and if reducing conditions exist at the bottom. A water balance study will be conducted to evaluate the hydrology of the quarry and to determine whether the quarry is a recharge or discharge area.

The ecological survey and evaluation will include a threatened and endangered species survey, wetlands survey, in situ bioassays with clams, whole body fish tissue analyses, a qualitative fish survey, and a fish pathology study. Ongoing work at Rogers Quarry and Lower MCB associated with Biological Monitoring and Assessment Program (BMAP) and the ecological work to be performed under the *Phase II Sampling Plan for Chestnut Ridge Operable Unit 2 (Filled Coal Ash Pond/Upper McCoy Branch) at the Oak Ridge Y-12 Plant, Oak Ridge, Tennessee* (DOE 1992) will also be considered in this evaluation.

An underwater survey also will be performed to obtain information on the configuration of the quarry and potentially hazardous materials known or suspected to be present in the quarry. The survey will include a radiological survey, a magnetometer survey, a sonar survey, and a video survey.

1.8 DATA QUALITY OBJECTIVES

Data quality objectives (DQOs) are qualitative and quantitative statements that specify the quality needed for sample collection and analysis, based upon the intended uses of the data. The purpose of DQOs is to ensure that the data collected in a given study are of appropriate quality to support activities required in that study, such as site characterization, risk assessment, evaluation of remedial alternatives, or development of design criteria. DQOs are project-specific and applicable to all data collection activities. This section describes the DQO process as applied to Chestnut Ridge OU 4. A detailed presentation of the project DQOs is provided in Chap. 8, the Quality Assurance Project Plan (QAPjP).

1.8.1 Problem To Be Resolved

Chestnut Ridge OU 4 was formerly used to dispose of various wastes from the Y-12 Plant, including coal ash and classified objects. Previous studies of OU 4 indicated the presence of contaminants. Therefore, the overall problem to be resolved at OU 4 is to determine the nature and extent of contaminants and the degree to which OU 4 poses a threat to human health and the environment. To meet this end, an adequate amount of data will be collected to support contaminant characterization, to conduct both an Ecological Risk Assessment (ERA) and a Human Health Risk Assessment (HHRA), and to evaluate and select remedial alternatives.

The observational approach has been used in the development of RI activities described in this work plan. The volume of historical data from previous studies at the site provided the information necessary to narrow the scope of the investigation. Media to be sampled include groundwater, surface water, and sediments (including coal ash); soil is excluded because historical information from OU 4 does not suggest that soil is either a potential contaminant receptor or exposure pathway. Groundwater will be sampled from existing wells at OU 4 for contaminants of concern plus additional classes of contaminants for comparison with data from nearby sites. Surface water and sediments will be collected both from the quarry itself and Lower MCB. Analysis of these sediments will be for contaminants of concern with a small percentage analyzed for an extended list for confirmation/denial purposes.

The RI also will include sampling the quarry at multiple depths and a water balance study of the quarry. These activities have already been conducted at OU 4 (Bogle and Turner 1989; Turner, Bogle, and Lu 1993); however, ash disposal activities will cease in OU 4 in July 1993, and it will then be necessary to characterize the stratification and water balance of the quarry after the termination of waste disposal. Finally, various activities will be included in the RI to collect data necessary to support an ERA.

1.8.2 Decision To Be Made

Decisions to be made in RIs on the ORR are defined by the FFA. Sites on the ORR identified as requiring an RI are typically designated on the basis of existing data that indicate the presence of contamination. Decisions required after the RI include a determination of whether the site will require remediation, and, if so, what type will be necessary. The decision on whether to remediate will be based upon the nine criteria of CERCLA: overall protection of human health and the environment; compliance with applicable or relevant and appropriate requirements (ARARs); long-term effectiveness and permanence; reduction of toxicity, mobility, or volume through treatment; short-term effectiveness; implementability; cost; state acceptance; and community acceptance.

1.8.3 Identification of Inputs to the Decision

Input for decisions to be made based on RI activities at Chestnut Ridge OU 4 will consider both intended data users and intended data uses. Primary data users include personnel who collect the data, personnel who evaluate and manipulate the raw data, and personnel who make recommendations or draw conclusions from the data. Primary users include field personnel, the multidisciplinary project team that prepares the RI report, the feasibility subcontractor, or other subcontractors performing a specific task. Secondary data users include upper-level Energy Systems managers, DOE personnel, and regulatory personnel (EPA and TDEC) who approve recommendations and support conclusions prepared by the primary users.

Intended data uses for OU 4 include the definition of the nature and extent of contamination, the support of both an HHRA and ERA, the addressing of the requirements for evaluation of probable remedial alternatives, and the preparation of an ROD. The intended uses of data collected during health and safety monitoring and field screening include determination of appropriate personnel protection levels, measurement of indicator parameters, and screening of samples for radiation before shipment off site.

1.8.4 Definition of the Boundaries of the Study

The boundaries of an RI can be narrowed by application of a site conceptual model. The model should be based upon the history and current condition of the site and its environmental setting. Examples of factors that ultimately determine the boundaries of an RI include the existence of wetlands or floodplain, known or assumed groundwater flow direction, the relationship between the surface water drainage system and groundwater, potential migration and exposure pathways, and potential receptors.

A conceptual model for Chestnut Ridge OU 4 is presented in Chap. 3 that considers the environmental setting and illustrates potentially contaminated media and potential migration and exposure pathways. Chapter 3 also includes two models that consider the potential human health and ecological risks associated with the site.

1.8.5 Development of a Decision Rule

Decision rule requirement for RIs at the ORR are specified in the FFA for the ORR. The primary basis for the decision rule will be documents prepared from the RI fieldwork and subsequent activities (e.g., risk assessments, evaluation of alternatives, etc.). An RI report will be prepared that summarizes site history, investigatory activities, data collected, and conclusions based upon the study. The RI report will include the baseline risk assessment. The FS that follows the RI will include a report summarizing the evaluation of alternatives and will be followed by a proposed plan and then a ROD. After completion and approval of the ROD, the final stage of the process (remedial design/remedial action) will be implemented.

1.8.6 Development of Uncertainty Constraints

All data pertinent to the investigation, not just laboratory data, will be of defensible quality. Nonlaboratory data, such as field observations and field screening readings, will be recorded in a manner consistent with applicable Standard Operating Procedures (SOPs) and quality control (QC) procedures. Field personnel will be trained before initiation of fieldwork, and all fieldwork will be subject to audits by regulatory agencies, Energy Systems, and subcontractor personnel. Historical data or records included in the RI report will be used in a manner consistent with the level of scrutiny and review previously applied; known or potential uncertainties will be specified in the report. Additional detail concerning the collection and evaluation of these data is included in Sect. 7.5 and Chap. 8 of this document.

QC requirements of the laboratory will be specified in the quality assurance (QA) plan prepared by the contracted laboratory. The plan will identify internal quality control at the laboratory including calibration frequency, method blank frequency, corrective measures, etc. This quality assurance plan will be subject to review and approval by both Energy Systems and the subcontractor. Additionally, the laboratory must successfully complete an audit conducted by the Analytical Project Office, Energy Systems. The laboratory data will be of Level C quality and will include the entire Contract Laboratory Program (CLP) package of documentation. Additional detail concerning the quality of laboratory data is provided in Chap. 8.

1.8.7 Optimization of the Design for Obtaining Data

Data design optimization for Chestnut Ridge OU 4 is based upon a review of historical records, existing data, site visits, and discussion with Energy Systems personnel familiar with the site. The sampling locations identified in this work plan should provide representative samples of the potentially contaminated media at the site. A statistical analysis of the data may be necessary during the preparation of the RI report. The extent to which a statistical treatment is appropriate will be determined based upon the results of the fieldwork. A statistical analysis combining existing data and newly collected data may be attempted; however, the variable quality of existing data may preclude this type of treatment.

1.9 SCHEDULE

Table 1-1 is the detailed schedule for completion of the RI Work Plan, the RI itself, and subsequent remedial actions for Rogers Quarry. If all schedule deadlines are met by all parties involved, the final RI Work Plan should be submitted by March 1994. Field activities for this RI are anticipated to take ~10–12 months including the water balance study. The ROD is scheduled for September 1999, and final remedial actions are to be completed by July 2003.

1.10 QUALITY ASSURANCE

All QA and QC activities of this project will be governed by the Energy Systems *Environmental Restoration Quality Program Plan*, ES/ER/TM-4/R2 (1992a), which addresses the guidance in EPA's *Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans*, QAMS-005/80 (1983), and the specifications contained in Energy Systems quality-related procedures; the American Society of Mechanical Engineers document *Quality*

Table 1-1. Remedial investigation/remedial action schedule

Task name	Start date	End date
Receive Notice to Proceed	16 October 92	16 October 92
Submit draft work plan	12 February 93	12 February 93
Receive Energy Systems comments	29 March 93	29 March 93
Submit cost estimate	20 May 93	20 May 93
Submit final draft	07 May 93	07 May 93
Submit final draft to DOE (Energy Systems)	25 May 93	25 May 93
Receive comments from DOE	06 July 93	06 July 93
Submit final draft to regulators (Energy Systems)	23 September 93	23 September 93
Receive regulatory comments	29 December 93	29 December 93
Submit final RI work plan	02 March 94	02 March 94
Receive approval of RI work plan	30 March 94	30 March 94
Accomplish RI site preparation	31 March 94	01 July 94
Conduct field activities	31 March 94	18 January 95
Prepare RI report	13 October 94	12 June 96
Prepare FS/EA report	13 April 95	11 December 96
Prepare FS proposed plan	12 December 96	10 June 98
Prepare FS record of decision	11 June 98	22 September 99
Accomplish remedial design	05 February 98	02 February 00
Undertake RA integration	02 November 00	02 July 03
Undertake RA of Rogers Quarry	02 November 00	02 July 03

Assurance Program Requirements for Nuclear Facilities, ASME NQA-1 (1989); and applicable DOE orders. When appropriate, existing CDM Federal quality procedures will be used to implement ES/ER/TM-4/R2 requirements.

The QAPjP for this project is provided in Chap. 8. The QAPjP addresses QAMS-005/80 and applicable ES/ER/TM-4/R2 requirements. The QAPjP locator page that appears in the front matter of this document identifies the requirements and the location of the text that addresses each requirement.

2. HISTORY AND CURRENT CONDITIONS

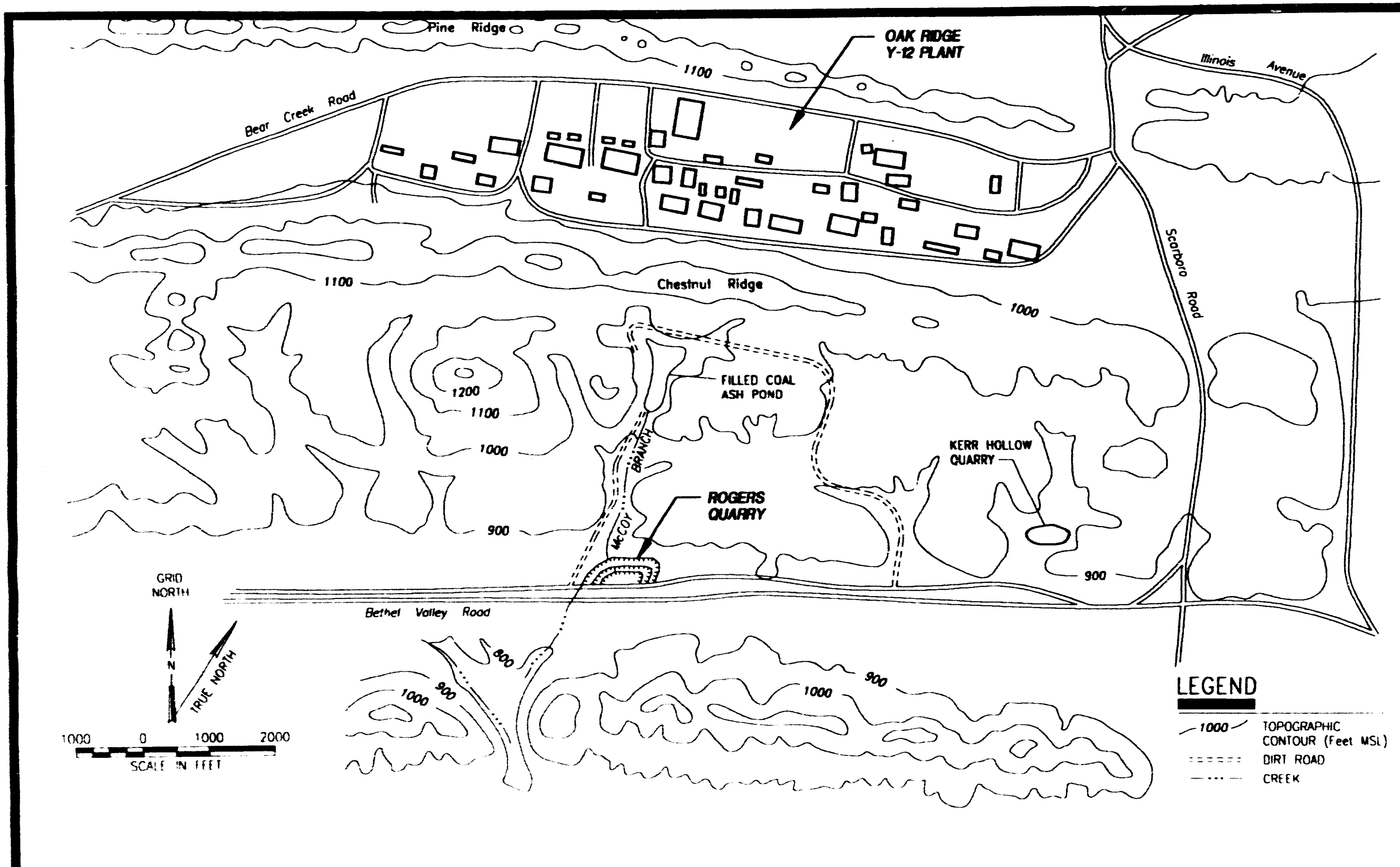
2.1 GEOGRAPHIC INFORMATION

Chestnut Ridge OU 4 consists of Rogers Quarry and Lower MCB and is located in Bethel Valley south of the crest of Chestnut Ridge and the Y-12 Plant (Fig. 2-1). Bethel Valley Road transects the unit, with Rogers Quarry to the north and Lower MCB to the south. A number of waste management sites are situated along Chestnut Ridge (HSW Environmental Consultants 1992) (Fig. 2-2); the closest sites to OU 4 are the Chestnut Ridge Security Pits (Chestnut Ridge OU 1), which is atop Chestnut Ridge proper, and the Filled Coal Ash Pond (Chestnut Ridge OU 2), which is north of and adjacent to OU 4. Given their proximity to OU 4, both of these sites are potential contaminant sources to OU 4.

An RI was conducted at the Filled Coal Ash Pond (CH2M HILL 1991), and it identified the presence of metals and radionuclides in various media at the site. This report, however, was determined to be inadequate in the current regulatory environment by EPA and TDEC. A Phase II RI will be conducted at the Filled Coal Ash Pond in 1993. This study should clarify interrelationships, if any, between OU 2 and OU 4.

Results from two dye tracer tests conducted from the Chestnut Ridge Security Pits did not suggest a hydrological connection with OU 4 (Geraghty & Miller 1990; SAIC 1992). An RI is currently being planned for OU 1 and is expected to be implemented in 1994. Other waste management sites along Chestnut Ridge near OU 4 include the United Nuclear Corporation site and Y-12 Landfills II and IV to the northwest; and Kerr Hollow Quarry, Y-12 Landfill III, the East Chestnut Ridge Waste Pits, and the Chestnut Ridge Sediment Disposal Basin to the east and northeast. These sites are not currently believed to be contaminant sources to OU 4.

Rogers Quarry, which has also been known as Old Rogers Quarry or Bethel Valley Quarry, is on the north side of Bethel Valley Road ~1 mile south of the Y-12 Plant. The quarry encompasses 9.81 acres, with maximum dimensions of ~1150 ft in length by 450 ft in width. Former quarry personnel have reported a maximum depth, before initiation of waste disposal, of 275 ft. Adams Craft Hertz and Walker Surveyors conducted a survey of that quarry in 1986 (Energy Systems 1986). The study included 13 cross sections showing the depth profile of the quarry. Data were obtained by dropping a cloth measuring tape with a lead weight to refusal and then recording the depth. Cross-sectional profiles were oriented north-south and show that the north wall of the quarry typically has a gentle to moderate slope and the south wall is steep and nearly vertical in places. Maximum depth is ~110 ft, with shallower depths (as low as 40 ft) more common in the west and southwest portions of the quarry. The shallow depths, in some cases, may coincide with an access road constructed within the quarry during mining operations and visible in an aerial photograph from the 1950s. The 1986 survey also estimated the volume of the quarry as 1.37 million yd^3, or 277 million gal. The lower portion of MCB runs from the discharge point on the south side of Rogers Quarry to MCB Embayment in Melton Hill Lake.



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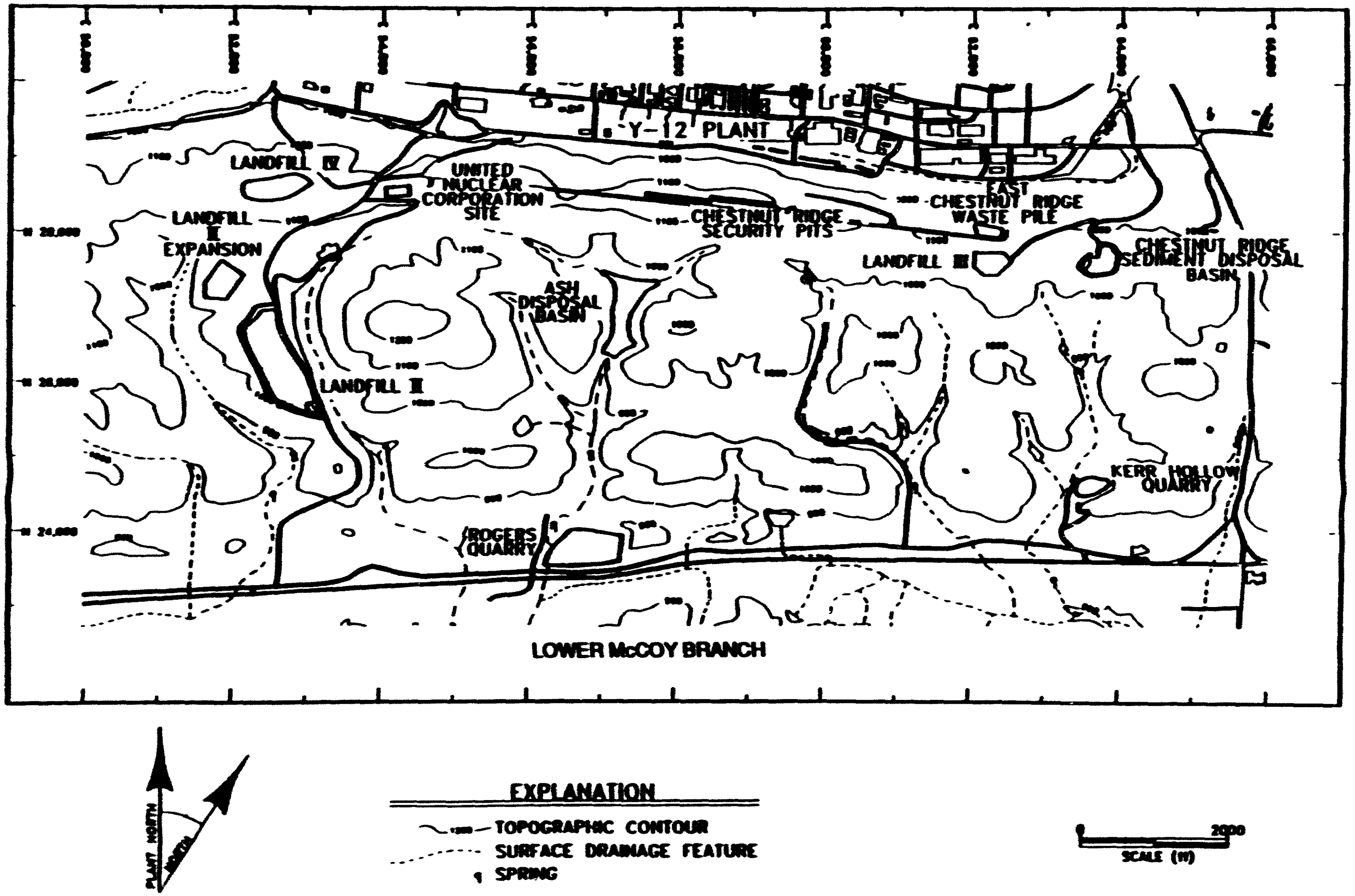
LOCATION OF CHESTNUT RIDGE OU4
ROGERS QUARRY/LOWER McCOY BRANCH
CHESTNUT RIDGE OU4

FIGURE No. 2-1



SOURCE: HSW, Inc., 1992.

WASTE MANAGEMENT UNITS IN THE CHESTNUT RIDGE HYDROGEOLOGIC REGIME

ROGERS QUARRY/LOWER McCOY BRANCH

CHESTNUT RIDGE OU4

FIGURE No. 2-2

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2.2 BACKGROUND INFORMATION

The Ralph Rogers Company leased the site from the Atomic Energy Commission for quarrying activities in the late 1940s or early 1950s. Photographs of the quarry from the 1950s indicate that the excavation resulted in one or several benches, commonly used as roads, to the bottom of the quarry, creating a terraced configuration. Quarrying intersected a water-bearing zone in the late 1950s, and continued operation necessitated the installation of two or more pumps to remove the water.

Quarrying operations continued until about 1960. Since that time the quarry has been used for the disposal of coal ash and materials from Y-12 Plant production operations. The quarry is currently filled with water; little, if any, construction or topographic modification has occurred at the site since the termination of quarrying activities.

2.3 OPERATIONAL INFORMATION

The site was used for quarrying by the Ralph Rogers Company from the late 1940s or early 1950s until about 1960. The quarry supplied limestone for road gravel and construction activities on the ORR. According to Mr. J. W. Sweeney, formerly of the Rogers Company, $\sim 5 \times 10^6$ yd^3 of rock were removed from the quarry during mining operations (Pokela 1967). As just stated, pumps were installed to remove water and maintain quarry operations. The quarry filled with water after the pumps failed, and it was abandoned with some equipment in place.

The disposal of coal ash (both fly ash and bottom ash) from the Y-12 Steam Plant became necessary as the coal ash pond north of the quarry (now Chestnut Ridge OU 2, the Filled Coal Ash Pond) approached capacity. The coal ash pond was constructed in 1955 by installing a 62-ft-high earthen dam across MCB to impound the ash. The earliest record of ash disposal in the quarry is from 1964, when a portion of the top of the dam eroded, releasing some ash (Pokela 1967), but this was not part of a planned disposal program. The coal ash pond received ash on a regular basis until 1967 or 1968; an examination of the coal ash pond in October 1968 indicated that it was entirely filled (Murphy 1988). Precise dates are not available, but it is reasonable to assume that disposal of coal ash in Rogers Quarry on a regular basis started sometime during 1968. MCB originally flowed directly into Melton Hill Lake from the coal ash pond, but it was diverted into Rogers Quarry approximately coincident with the abandonment of the pond for coal ash disposal.

The Y-12 Steam Plant, originally constructed in 1954 and upgraded several times, fired pulverized coal in a Wickes front wall configuration (Turner et al. 1986). Coal ash was removed using a wet collection system. Bottom ash and fly ash from the Steam Plant were then mixed with water to form a slurry and sluiced intermittently (generally three times a day) to the quarry using a pump rated at 2300 gal per minute to lift the ash slurry to the crest of Chestnut Ridge (Bogle and Turner 1989). Until November 1989, the slurry was routed to the quarry through a pipeline and then MCB; in November 1989, additional pipeline was installed that bypassed MCB and the coal ash pond altogether (Turner, Bogle, and Lu 1993). The pipeline installation in November 1989 shifted the location of ash sluice inflow into the quarry slightly west of the former location.

Modifications to the disposal process occurred in 1987 and 1988. In June 1987 a standard shallow draft aerator was installed and operated near the quarry outfall in an attempt to attenuate seasonal increases in effluent pH. The aerator was modified for deep mixing by installing a 20-ft pipe on the intake; this was activated on April 25, 1988. The aerator subsequently failed in September 1988. In addition, since May 1990, fly ash, which accounts for ~80% of the total ash volume, has been collected in hoppers for dry disposal in the Y-12 Sanitary Landfill II, thereby greatly decreasing the amount of ash deposited in the quarry. Turner, Bogle, and Lu (1993) discuss the details of these modifications.

In 1988 the Steam Plant initiated a conversion to partial natural gas firing to reduce the subsequent production of coal ash. Starting in November 1988, the plant was capable of an annual fuel mix of 80% natural gas and 20% coal. Coal is currently necessary only for peak periods and backup. By agreement with TDEC, ash disposal in Rogers Quarry will end by July 1993. Although historical records are not exact, Energy Systems personnel have estimated that annual average coal ash deposits made to the quarry were 24,000 tons when ash disposal occurred on a continuous basis.

Rogers Quarry also has been used for the disposal of a variety of plant process materials, including spent rounds of ammunition from plant security operations. Some of the objects placed in the quarry are classified; classification resulted not because of the composition of the objects but rather because of their configuration and the relationship of this configuration to production processes. Available information suggests that disposal of these types of materials started in 1965 and continued until 1982. Nonash disposals were generally accomplished by backing trucks down a ramp on the north side of the quarry and dumping the objects into the water. Despite the classified nature of some of the disposal inventory, potential contaminants of concern from the materials are known and include metals and radionuclides. These materials are believed to weigh more than 1×10^6 lb. A variety of metal debris (including used filing cabinets, etc.) is apparent in the woods upslope and north of the quarry. An exact inventory of these materials is not known.

2.4 RELEASES

Available information on OU 4 does not indicate that catastrophic releases or spills have occurred at the site. An NPDES outfall (S-19, previously designated 302) is located near the southwest corner of Rogers Quarry. The outfall is the point of origin of Lower MCB, which discharges to Melton Hill Lake. Samples are taken on a weekly schedule for a variety of parameters, including, for example, total suspended solids, sulfate, turbidity, temperature, pH, and metals. Data collected from the outfall show numerous exceedences of the NPDES permit. A particular problem has been pH exceedence, which has been frequently measured since the 1970s. The NPDES permit specifies pH limits ranging from 6.5 to 8.5 for water exiting the quarry via the outfall. A compilation of pH data from June 5, 1978, to December 31, 1991, shows frequent violations of the permit's upper limit, with very few violations of the permit's lower limit (Turner, Bogle, and Lu 1993). In addition to the pH violations, a number of exceedences of Ambient Water Quality Criteria have been reported. Data collected since 1986 have recorded exceedences of arsenic, cadmium, copper, iron, lead, mercury, selenium, zinc, and temperature.

3. CHARACTERIZATION OF ENVIRONMENTAL SETTING AND CONCEPTUAL SITE MODEL

3.1 GEOGRAPHY

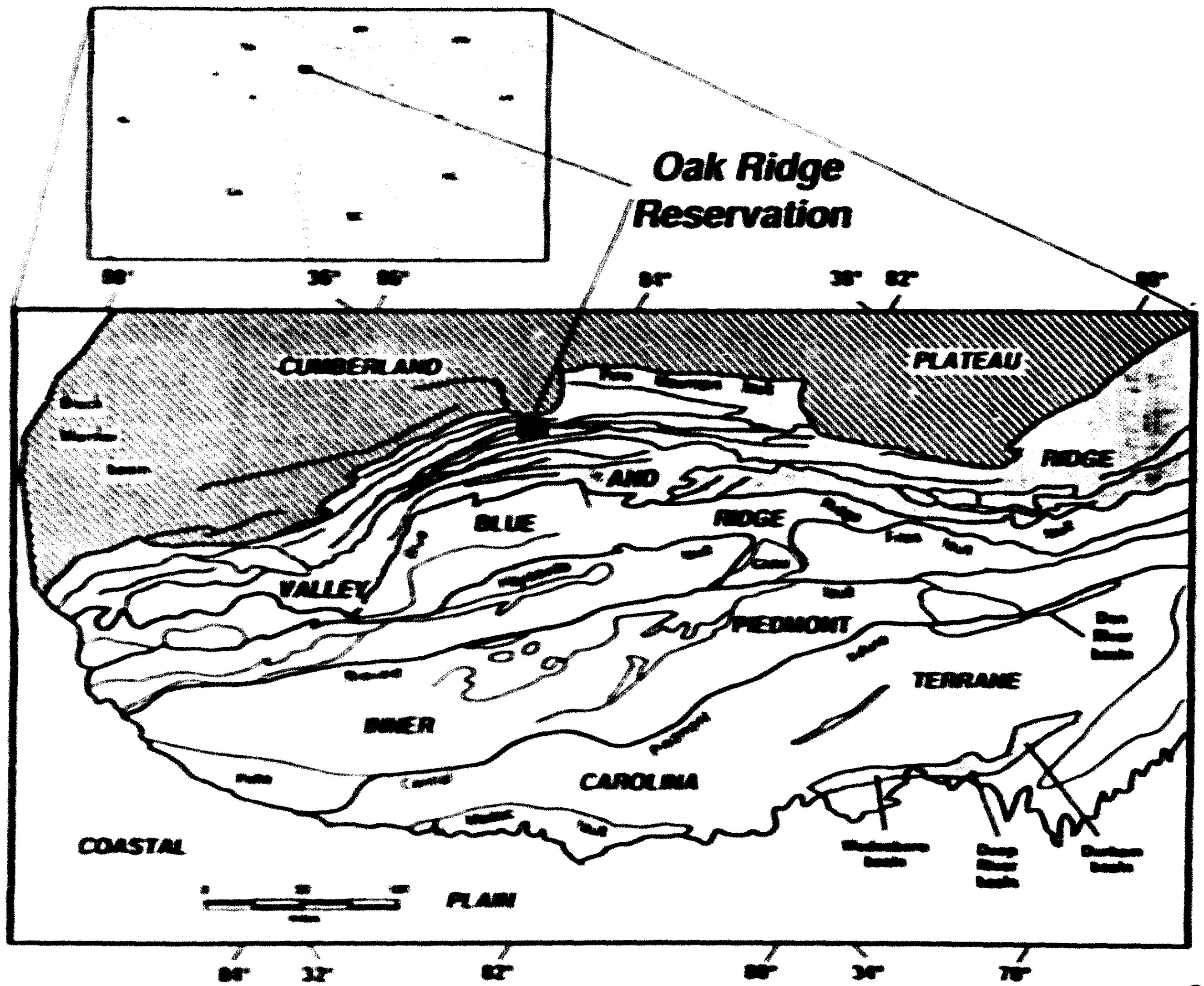
The ORR includes ~58,000 acres of federally owned land 20 miles west of Knoxville, Tennessee, bounded on the north and east by the city of Oak Ridge, Tennessee, and on the south and west by the Clinch River. The reservation is near the western margin of the Valley and Ridge physiographic province, a major subdivision of the Appalachians that stretches from Pennsylvania to Alabama. In the southern Appalachians the Valley and Ridge province is bounded by the Blue Ridge province to the southeast and the Cumberland Plateau province to the northwest (Fig. 3-1). Characteristic features of the province include parallel valleys and ridges, typically trending northeast-southwest; topography controlled by alternating weak and strong rock units that have been folded and faulted and are now exposed by erosion; a trellis drainage pattern; abundant water gaps through resistant ridges; and many ridges with accordant summit levels that suggest former erosion surfaces.

Chestnut Ridge OU 4 is located ~1-1.5 miles south of the Y-12 Plant, in Bethel Valley and on the southeast-facing slope of Chestnut Ridge (refer to Fig. 2-1). OU 4 is bounded to the north by Chestnut Ridge OU 2 (the Filled Coal Ash Pond) and to the south by Melton Hill Lake. The elevation of OU 4 ranges from just over 900 ft above mean sea level (MSL) adjacent to Rogers Quarry to just below 800 ft above MSL where Lower MCB enters Melton Hill Lake (Fig. 3-2). The surface elevation of Rogers Quarry, measured in 1986, was 816.72 ft above MSL (Energy Systems 1986). Haase et al. (1987) recorded surface elevations at Rogers Quarry weekly during 1986; the data showed a fluctuation between ~816.75 ft and 818.00 ft above MSL. Elevation, in general, decreases north to south across the unit.

3.2 CLIMATE

Climate in the vicinity of the ORR is strongly influenced by the presence of the Great Smoky Mountains to the southeast and the Cumberland Mountains to the northwest. The mountains exert a moderating influence on the climate, which results in warm, humid summers and cool winters. Noticeable extremes in precipitation, temperature, and winds occur rarely. The Cumberland Mountains retard and weaken the force of cold winter air that commonly reaches south to these latitudes. The mountains also modify the hot summer winds that are common in the plains to the west. The Great Smoky Mountains act as an inclined plane, which lifts warm, moist air flowing northward from the Gulf of Mexico, thereby increasing the frequency of afternoon thunderstorms during summer months.

The mean annual temperature in the Oak Ridge area is 58°F (Webster and Bradley 1988). January is generally the coldest month; temperatures average ~38°F but occasionally dip to 0°F or below. July is generally the warmest month, although average temperatures exhibit little variation between June and August. The average daily temperature in July is 77°F, with highs occasionally exceeding 100°F.



SOURCE: Hatcher, 1987.

LOCATION OF ORR IN SOUTHERN APPALACHIAN VALLEY AND RIDGE PROVINCE

ROGERS QUARRY/LOWER McCOY BRANCH

CHESTNUT RIDGE OU4

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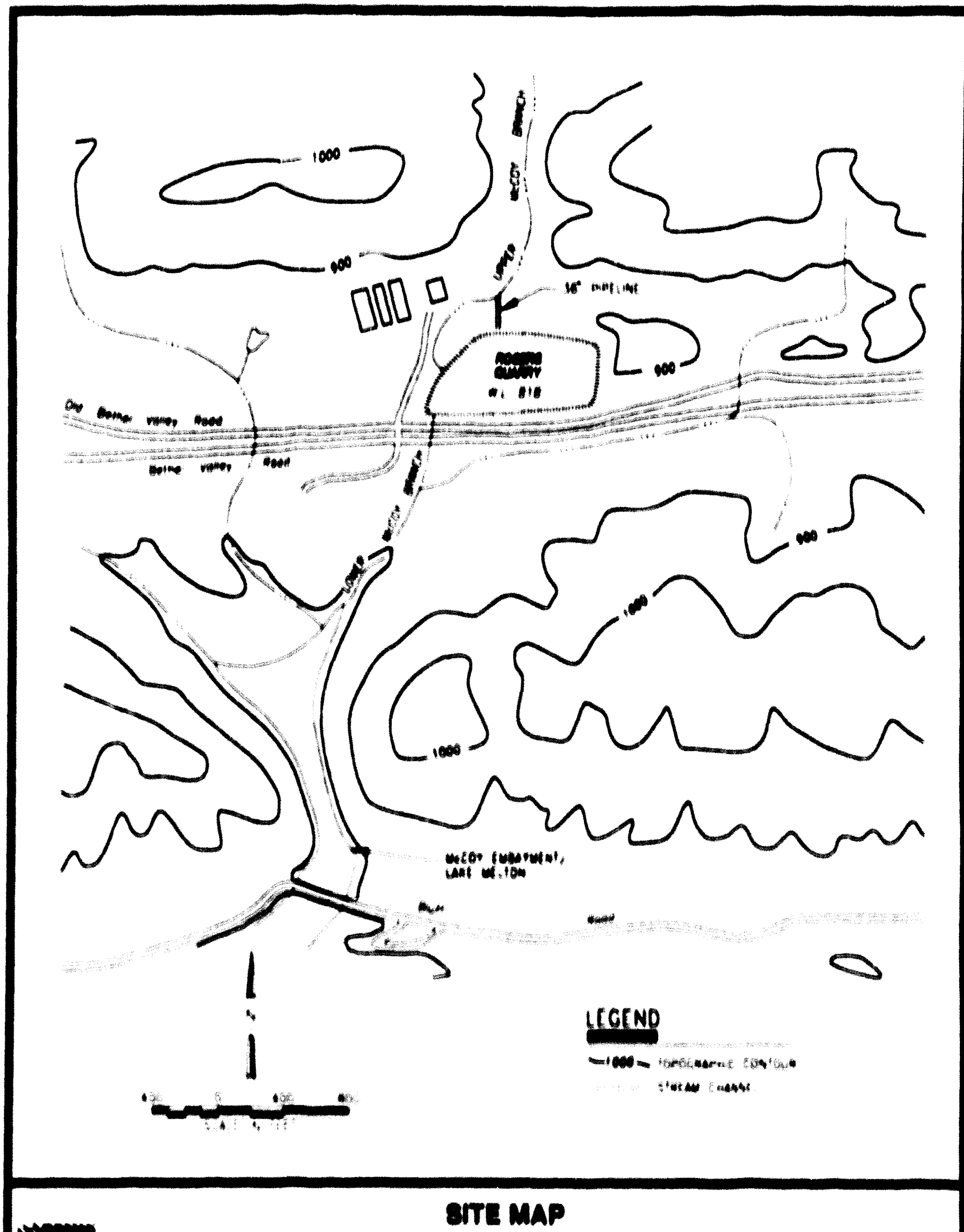
FIGURE No. 3-1



SITE MAP
ROGERS QUARRY/LOWER McCOY BRANCH
CHESTNUT RIDGE OU4

CDM FEDERAL PROGRAMS CORPORATION

FIGURE No. 3-2

Data from the National Oceanic and Atmospheric Administration indicate that the mean annual precipitation in the Oak Ridge area is 55 in. The climate in the area is typically humid with frequent rain, and periods of 5 days or more without precipitation occur on average only four to five times per year (Boegly et al. 1984). Maximum monthly precipitation generally occurs between December and March and is associated with winter storms that are commonly of low intensity but long duration. Approximately 40% of the yearly precipitation falls during this interval. Snows occur between November and March, for the most part, and are usually light and accumulate only a trace. The mean annual snowfall between 1951 and 1988 was 9.8 in. (Energy Systems 1989). A second precipitation maxima occurs in July, when short, heavy rainfalls associated with thunderstorms are common (Davis et al. 1984). The driest period of the year normally occurs in September and October when slow-moving high pressure cells suppress rain and provide clear and dry weather.

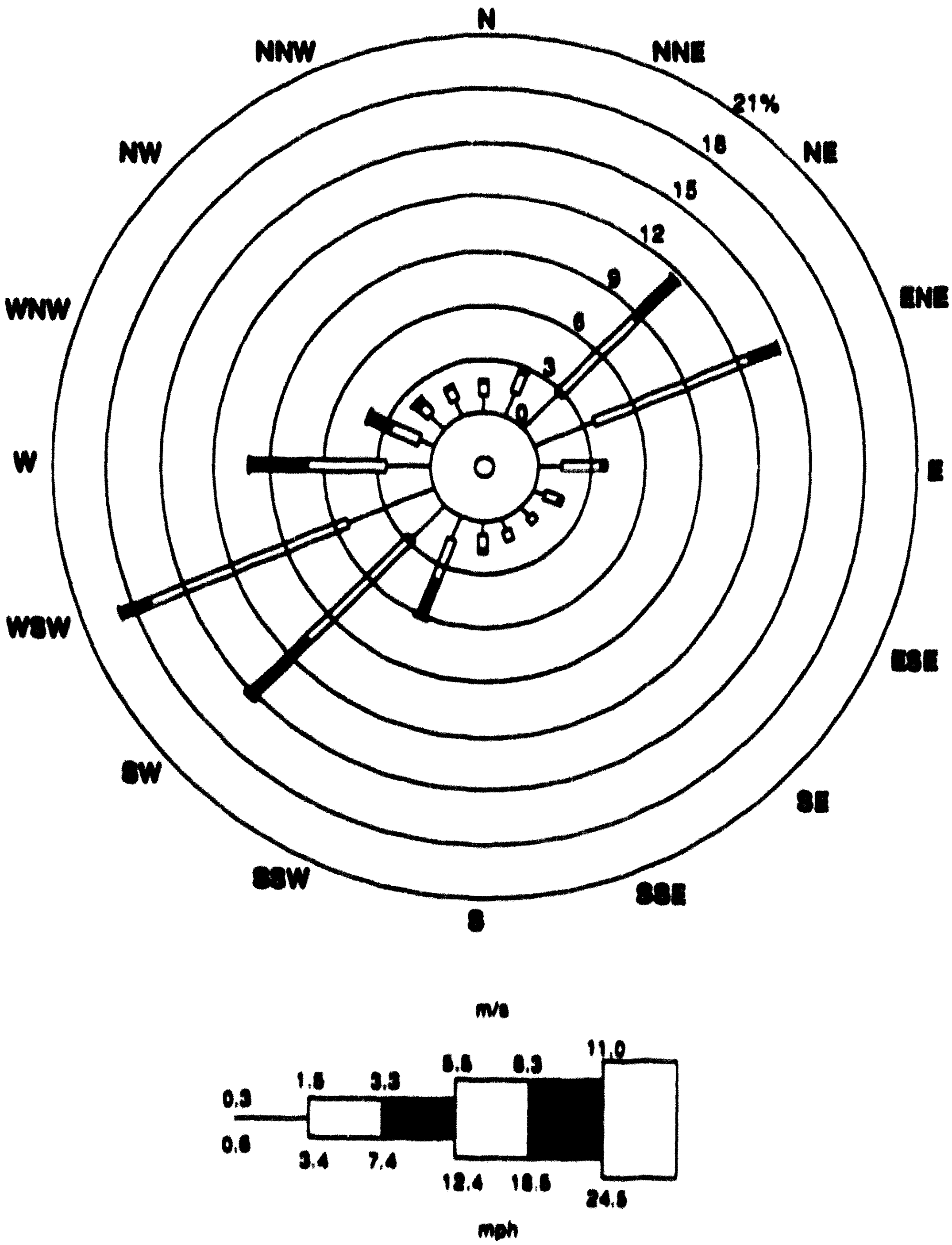
Winds in the Oak Ridge area are controlled to a large degree by the valley and ridge topography. The prevailing winds are either up valley (northeasterly) or down valley (southwesterly). Daytime winds generally blow up valley, while nighttime winds usually blow down valley (Davis et al. 1984). Figure 3.3 is a wind rose that shows the relative frequency (by percentage) of occurrence of winds by compass orientation and wind speed. High velocity winds and tornadoes are rare. Wind speeds are less than 7.4 mph 75% of the time, and wind speeds exceeding 18.5 mph are rare.

3.3 DEMOGRAPHY

Chestnut Ridge OU 4 is entirely within the ORR on federally owned land. Rogers Quarry still receives coal ash on an intermittent basis, but the site is largely inactive. Therefore, few Energy Systems employees use or visit the site regularly. Employees who do use or visit the site generally include maintenance and security personnel. Energy Systems employees regularly visit the Kerr Hollow Quarry site ~1.5 miles east of Rogers Quarry to work on an ongoing remediation project.

The Y-12 Plant employs ~6200 employees, as of April 1993. Within 0.5 mile of the OU 4 boundaries, all land is federally owned and there are no residents. Bethel Valley Road, a paved two-lane road, transects OU 4, passing just south of Rogers Quarry. Several businesses are located along Bethel Valley, just west of Lower MCB and 1.5–1.75 miles east at the Scarboro facility. The southern boundary of OU 4, MCB Embayment, empties into Melton Hill Lake. Clark Center Recreational Park is ~0.25–0.50 mile south-southeast of OU 4. Melton Hill Lake is open to recreational uses, including fishing, boating, and hunting, as sanctioned by the state of Tennessee.

There are no residents within a 1-mile boundary extension of OU 4. The closest residents are ~1.75 miles north of OU 4 in a residential neighborhood north of the ORR boundary. The closest major population center is Oak Ridge, ~1.75–2 miles north-northeast of OU 4. The 1990 population of Oak Ridge was reported as 27,310; the 1990 population of Anderson County was reported as 68,250. Knoxville is the largest local population center, with a population of 165,121 according to the 1990 census; the population of Knox County was reported as 335,749.



SOURCE: ORNL/ER/SUB-87/99053/5/VI
WAG 6 RFI Report, September 1991.

WIND ROSE FOR THE OAK RIDGE RESERVATION
ROGERS QUARRY/LOWER McCOY BRANCH
CHESTNUT RIDGE OU4

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FIGURE No. 3-3

3.4 GEOLOGY AND SOILS

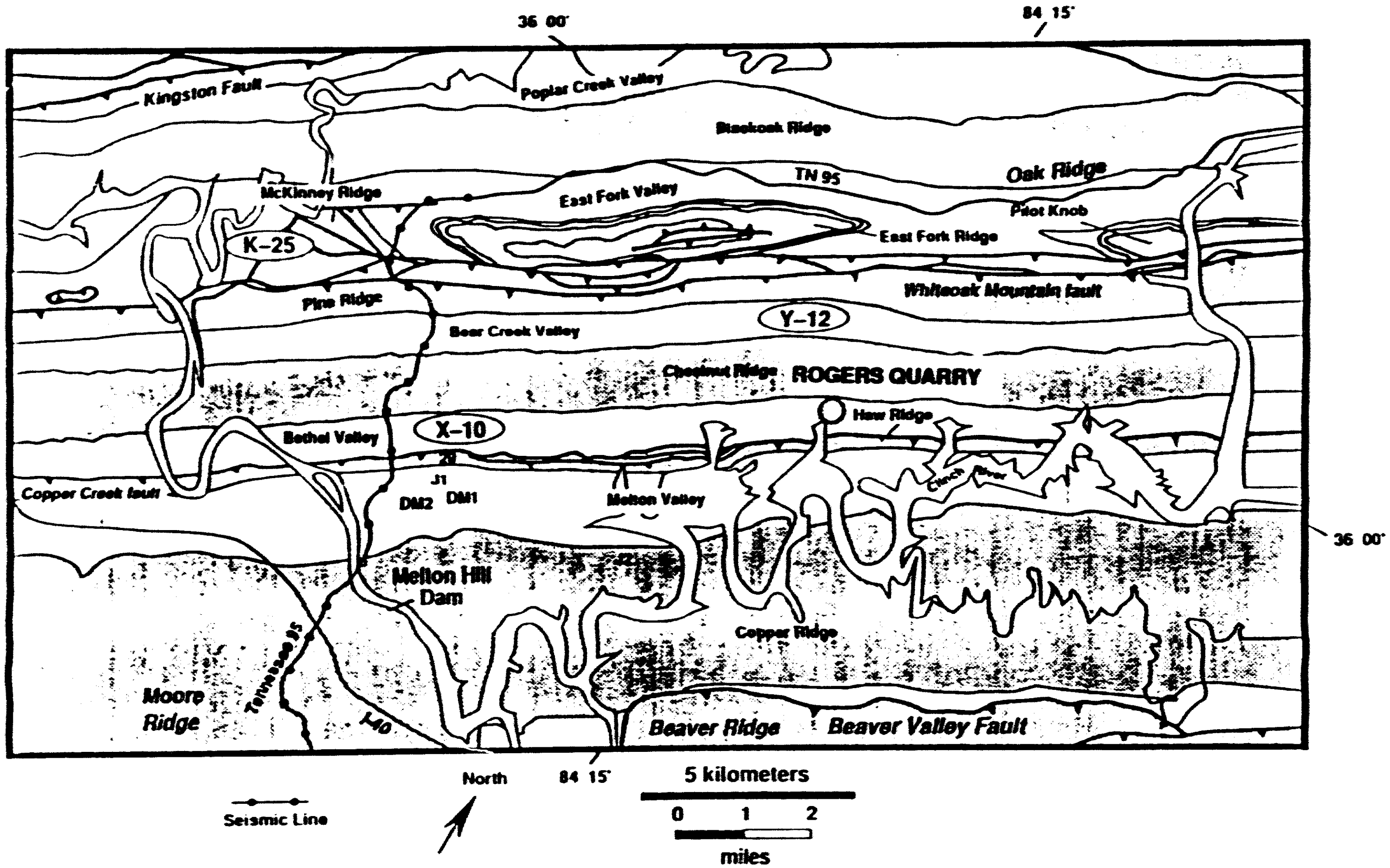
The Valley and Ridge of Tennessee, in which the ORR is located, is a belt of southeast-dipping thrust faults and accompanying folds. Two regionally extensive thrust faults, the Copper Creek and Whiteoak Mountain, are exposed across the ORR along with folds and small-scale subsidiary structures (Fig. 3-4). The stratigraphic section exposed on the ORR includes rocks that range in age from Early Cambrian to Early Mississippian. The stratigraphic section exposed in the vicinity of OU 4 has been abbreviated by faulting and includes beds ranging in age from Early Cambrian to Late Ordovician (Fig. 3-5). The units comprise a complex assemblage of lithologies, including shale, sandstone, siltstone, dolostone, and limestone; total thickness is ~2.0-2.5 km (Hatcher et al. 1992).

OU 4 is located within the Whiteoak Mountain thrust sheet, adjacent to and north of the Copper Creek thrust fault, which is located in Haw Ridge, just south of the unit. The unit is underlain entirely by the Middle Ordovician Chickamauga Group. The Chickamauga Group is a sequence of limestone, argillaceous limestone, shale, and siltstone found throughout the Valley and Ridge of East Tennessee and is traceable into southwest Virginia and northern Georgia. Walker, Shanmugan, and Ruppel (1983) provide an interpretation of the depositional environment and a summary of the Chickamauga Group in East Tennessee.

The Chickamauga Group ranges in thickness from ~400 to 700 m across the ORR and is exposed in Bethel and East Fork valleys. Stockdale (1951) subdivided the Chickamauga on the ORR [in the vicinity of Oak Ridge National Laboratory (ORNL)] into units designated A through H, on the basis of lithologic differences. Hatcher et al. (1992) conducted a comprehensive study of ORR geology and assigned formational names to Stockdale's units. The formational names were not new but had been used by previous workers in East Tennessee for some time. The stratigraphic characteristics of the Chickamauga Group differ between the two valleys, as described in Hatcher et al. (1992). The Bethel Valley section underlies OU 4, is divisible into seven formations, and ranges from 565 to 670 m in thickness.

Haase et al. (1987) summarized the geology at Rogers Quarry based upon core hole data and examination of rock outcrops at the site. The bottom of the quarry includes the uppermost portion of Stockdale's unit B (the Fleanor Member of the Lincolnshire Formation), and consists of interbedded red to reddish-gray calcareous siltstone; the uppermost 15-30 m of the formation is exposed in the quarry. The middle portion of the quarry (the "pay" zone when the quarry was active) spans Stockdale's unit C (lower portion of the Rockdell Formation) and includes medium to light gray, pure, evenly bedded limestone, ~46 m thick. The top of the quarry includes Stockdale's unit D and the lowermost portion of unit E (upper portion of the Rockdell Formation and lowermost portion of the Benbolt Formation) and is comprised of interbedded gray calcareous siltstones, wavy to evenly bedded limestones, and thinly bedded chert; the thickness is ~36-52 m. In general, beds exposed at OU 4 strike approximately N55°E; dip ranges from 12° to 52° southeast (Hatcher et al. 1992), although it is generally from 30° to 40°.

Fractures are well developed in all stratigraphic units on the ORR and are the most pervasive mesoscopic structure (Hatcher et al. 1992). Both systematic and nonsystematic fractures are present, and they formed at various times during the tectonic history of the southern Appalachians. The fractures form a network of discontinuities and intersections that provide pathways for groundwater flow. Although there is some scatter in the orientation of the fractures, most of them tend to develop systematic orientations over a particular area,



SOURCE: Hatcher, 1992.

SIMPLIFIED GEOLOGIC MAP OF THE OAK RIDGE RESERVATION

ROGERS QUARRY/LOWER McCOY BRANCH

CHESTNUT RIDGE OU4

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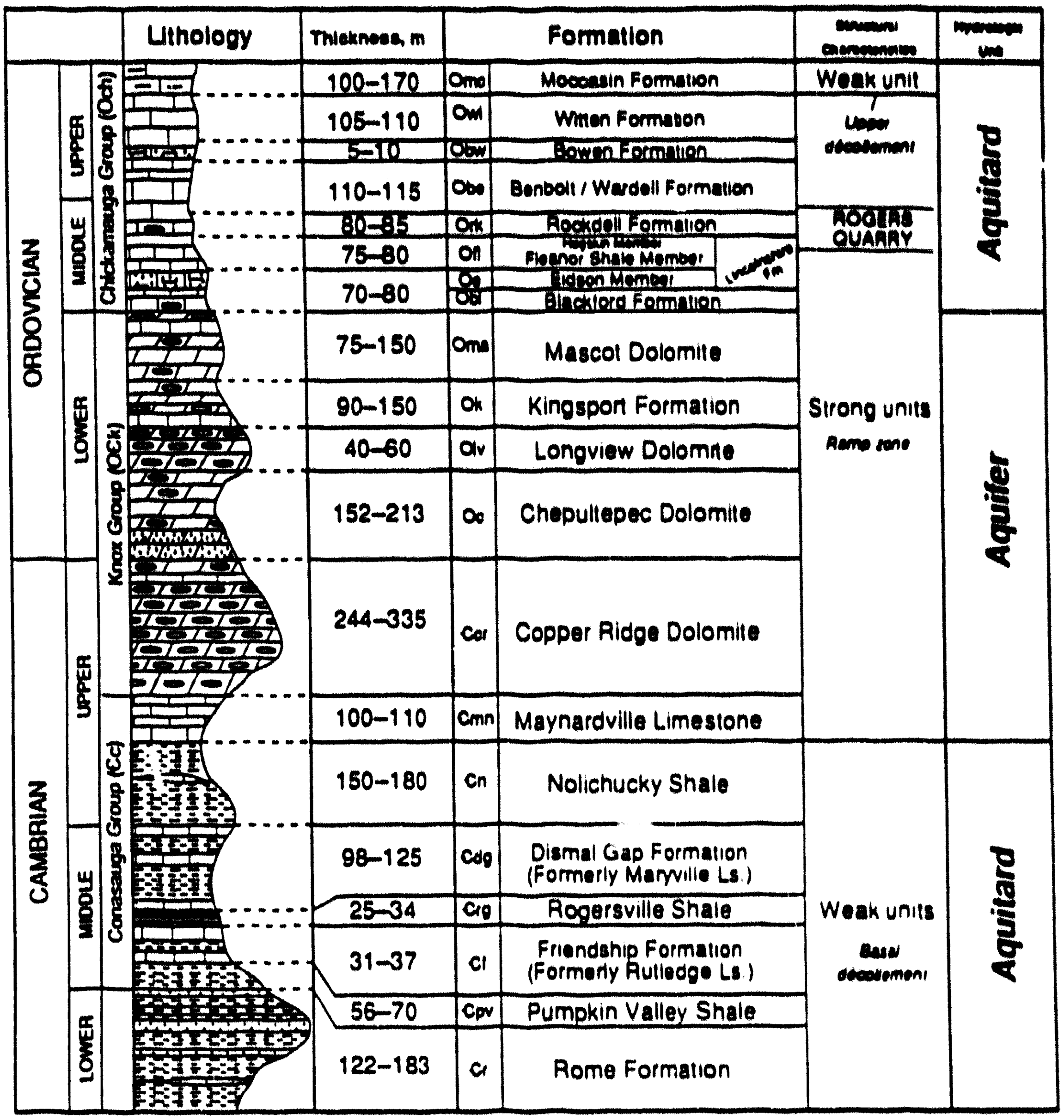
FIGURE No. 3-4



SOURCE: Hatcher, 1992.

STRATIGRAPHIC SECTION IN VICINITY OF CHESTNUT RIDGE OU4, ORR ROGERS QUARRY/LOWER McCOY BRANCH

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CHESTNUT RIDGE OU4

FIGURE No. 3-5

allowing patterns to be interpreted (Solomon et al. 1992). Fracture orientations observed in a previous study of the Chickamauga Group in Bethel Valley include bed-normal extension fractures parallel and perpendicular to bedding strike, bed-oblique shear fractures, and bed-parallel shear fractures (Hatcher et al. 1992).

Fracture density is highly variable and is noted to decrease with depth; reported values on the reservation range from 5 to 200 per m (Solomon et al. 1992). Fracture lengths generally range from several centimeters up to 1 m. Fracture spacing in limestones ranges from less than 5 cm in very thin beds to greater than 3 m in very thick or massive beds. Haase et al. (1987) note that the strata exposed in Rogers Quarry have well-developed fractures, some of which are in-filled with calcite. Some limestone-rich portions locally exhibit solutionally widened bedding surfaces and fracture zones (typically 0.3–1.5 m thick). Discrete solution cavities have not been reported. Haase et al. also examined logs derived from borehole geophysical testing at Rogers Quarry. Porosity and density logs suggest that most of the strata are "tight," with low porosity. Electric logs, however, showed some anomalies (especially in the upper portion of the quarry) that Haase et al. interpreted as thin, relatively permeable, water-bearing zones. The electric log anomalies generally correlated with fracture zones evident in cores.

The soil mantling the Chickamauga Group in OU 4 is of variable thickness and is especially thin adjacent to Rogers Quarry, where it is 15 ft thick or less. In general, the soil is dominantly clay, with small and variable amounts of sand and silt. Cherty horizons are also present. A variety of soil types are developed from Chickamauga Group lithologies, but the soils are dominantly Hapludalfs and Hapludults, which are groups within the Alfisol and Ultisol orders, respectively (Hatcher et al. 1992). Alfisols have a clay-enriched subsoil horizon and more than 35% base saturation at a depth of 1.8 to 2.0 m. Ultisols are similar to Alfisols but are mostly highly weathered and less than 35% base saturation at a depth of 1.8 to 2.0 m. The Hapludalfs and Hapludults typically have a light-colored surface layer, and the clay-enriched subsoil horizon is oxidized. Vegetation developed on Chickamauga Group soils is dominated by red cedar and Virginia pine (Hatcher et al. 1992).

3.5 SURFACE WATER AND SEDIMENTS

MCB is the primary natural body of surface water in Chestnut Ridge OU 4; however, Rogers Quarry is the largest body of water. The MCB watershed encompasses ~358 acres (Bogle and Turner 1989), and MCB itself runs from the top of Chestnut Ridge into Rogers Quarry and out of the quarry where it runs a short distance into Melton Hill Lake at McCoy Embayment. The portion of MCB north of Rogers Quarry is termed Upper MCB, and the portion south of the quarry, which is within OU 4, is Lower MCB.

The original course of MCB was altered by waste disposal activities on the ORR. The coal ash pond was built in 1955 to receive coal ash from the Y-12 Steam Plant and to serve as a settling basin. During the construction of the coal ash pond, a 62 ft-high earthen dam was built across Upper MCB to impound the ash. Additionally, Upper MCB was diverted into Rogers Quarry in 1967 as the pond filled and sediments and ash began to overflow the earthen dam. The NPDES outfall at the southwest corner of the quarry is the point of origin of Lower MCB.

Several small tributaries flow into MCB, two north of Rogers Quarry and one south of the quarry across Bethel Valley Road. In addition, several springs are present that feed Upper MCB; these occur both north and south of the earthen dam. Craig and Tschantz (1986) estimated that the combined baseflow of the springs below the dam to be in the range of 0.11 to 0.14 mgd. Sediments exposed in the Upper MCB streambed appear to consist of particles that are gravel-size and smaller. The sediments include Chestnut Ridge residuum and coal ash. Portions of the streambed south of Bethel Valley Road are covered with grasses and riparian vegetation.

Evidence of karst development also occurs along MCB. For example, MCB "disappears" and then reemerges downstream, much like sinking creeks described from many karst regions (Thornburg 1969). These features are related to the karst hydrologic system developed in the Knox Group, and such a system may transport to or remove contaminants from the watershed.

Pulliam (1985) collected water quality data from 34 sites near the Y-12 Plant, 3 of which were from the MCB watershed. Two of the samples from MCB are from areas draining the Chickamauga Group, while the third sample is from an area draining the Knox Group. Samples were analyzed for various parameters, including temperature (12.0-16.5°C), specific conductance (200-360 μS/cm), pH (7.2-8.7), alkalinity (one sample, 96 mg/L as $CaCO_3$), dissolved oxygen (two samples, 9.0 and 12.6 mg/L), and instantaneous discharge (<0.01-3.1 ft^3/s).

Samples were also submitted to a laboratory for analysis of major constituents and properties, trace constituents and compounds, and radionuclides. With respect to the major constituents, detectable concentrations were found for calcium (26-41 mg/L), magnesium (7.9-13 mg/L), sodium (1.6-3.3 mg/L), potassium (0.80-4.5 mg/L), alkalinity (96-143 mg/L as $CaCo_3$), chloride (2.7-3.8 mg/L), sulfate (6.5-48 mg/L), phosphorous (<0.010-0.080 mg/L), and solids residue (133-231 mg/L at 180°C). Most of the trace constituents had relatively low concentrations (i.e., <10 μg/L), with the exception of barium (100 μg/L), iron (250-1600 μg/L), lithium (10 and 90 μg/L), strontium (30-770 μg/L), and zinc ([illegible] μg/L). Radionuclide analyses detected both gross alpha and gross beta concentrations, all at relatively low (highest gross alpha hit reported as 2.6 μg/L; highest gross beta hit reported as 1.9 pCi/L) concentrations.

The NPDES outfall is a monitoring station (under the conditions of the current NPDES permit) and samples are taken weekly for a variety of water quality parameters. The flow rate is measured continuously and reported as a daily average; a water level monitor is also present that records quarry water level every 15 min. The new NPDES permit specifies that the outfall will be an ambient monitoring station only.

Monitoring at the NPDES outfall has been ongoing since the 1970s; Table 3-1 summarizes data collected during the period 1989 to March 1992. Many of the parameters appeared to have relatively stable concentrations during the interval, while the average concentrations of others apparently decreased. Parameters whose average concentrations appear to have decreased include sulfate, total suspended solids, turbidity, arsenic, selenium, iron, nickel, zinc, and temperature. Note, however, that the values are averages, and there have been numerous exceedences of the NDPES permit, especially for pH (Turner, Bogle, and Lu 1993), during this period. These pH exceedances were a direct result of algae productivity. Evaluation of water quality trends in MCB in recent years generally indicates an

Table 3-1. NPDES Outfall S-19 average water quality parameter concentrations from 1989 through March 1992

	1989	1990	1991	January-March 1992	Water quality criteria
Flow, mgd[a]	1.07	1.00	0.89	0.78	None
Total suspended solids, mg/L	6	5.3	<5	<5	None
Chemical oxygen demand, mg/L	6	6	5.6	7	None
Sulfate, mg/L	51	32	21.6	21	None
Turbidity, NTU[b]	3.48	2.25	1.6	1.20	None
Temperature, °C	17.5	17.9	19.4	8.9	None
Oil and grease, mg/L	<2	3	2.8	3	None
pH	8.3	8.2	8.4	8.2	None
Settleable solids, mg/L	<0.1	<0.1	<0.1	<0.1	None
Selenium,[c] mg/L	0.005	0.004	0.002	<0.002	0.02[d]
Mercury,[c] mg/L	<0.0002	<0.0002	<0.0002	<0.0002	0.0024[d]
Arsenic,[c] mg/L	0.08	0.05	0.04	<0.04	0.36[d,e]
Cadmium,[c] mg/L	<0.003	<0.003	<0.004	<0.004	0.004[d,f]
Chromium,[c] mg/L	<0.006	<0.006	<0.006	<0.006	0.1[d]
Copper,[c] mg/L	<0.002	<0.002	<0.006	<0.006	0.018[d]
Iron,[c] mg/L	0.14	0.11	0.08	<0.06	1.0[g]
Nickel,[c] mg/L	0.008	0.009	<0.008	<0.008	1.418[d,f]
Zinc,[c] mg/L	0.008	0.008	0.009	<0.01	0.117[d,f]
Lead,[c] mg/L	<0.02	<0.02	<0.02	<0.02	0.082[d]

[a]mgd = million gallons per day.
[b]NTU = Nephelometric Turbidity Unit.
[c]Total metals are presented.
[d]Tennessee Water Quality Criterion for Fish and Aquatic Life—Criterion Maximum Concentration (Rule 1200-4-3-.03).
[e]Trivalent arsenic.
[f]Based on a hardness of 100 mg/L of calcium carbonate.
[g]Federal Ambient Water Quality Criterion.

improvement, especially since the amount of coal ash sluicing has been reduced (Turner 1993). The RI report will consider long-term trends in MCB water quality; the purpose of the table presented here is to summarize relatively recent conditions.

The water balance of Rogers Quarry has been studied (Craig and Tschantz 1986; Bogle and Turner 1989) to gain an understanding of the dynamics of inflow and outflow to the quarry and the potential communication between water in the quarry and local groundwater. Craig and Tschantz (1986) conducted a study over a 2-month period that suggested net seepage was into the quarry, but the analysis had many accompanying uncertainties. Bogle and Turner (1989) conducted a thorough and systematic water balance study for the period January 1, 1987-June 30, 1988. The study measured inflow, outflow, precipitation, evaporation, and change in storage data; daily net seepage residual, a value equivalent to net loss or net gain from groundwater, was calculated from the other five components.

The data collected by Bogle and Turner indicated that net inputs and net outputs appeared to be relatively balanced, with a slight negative residual (-0.46×10^6 gal) over the period. The slight negative residual would appear to support the conclusion of Haase et al. (1987) who argued that the quarry recharges the shallow groundwater system, especially during times of low precipitation. On the other hand, the negative residual is less than 2% of the average measured cumulative inputs and outputs and could therefore be within error. Bogle and Turner concluded that, in general, the quarry is relatively tight with respect to exchanges with local groundwater but that the water balance relationships could be clarified with further reduction of uncertainties.

3.6 GROUNDWATER

The characteristics and movement of groundwater on the ORR are a function of the varying hydrologic properties of the underlying geologic units. Two broad groupings can be distinguished: the Knox aquifer, consisting of the Knox Group and the Maynardville Limestone of the Conasauga Group, and the ORR aquitards, consisting of the remaining geologic units on the ORR (Solomon et al. 1992). Groundwater flow in the Knox aquifer is dominated by conduit flow through solution features that resulted from karst processes. Flow in the ORR aquitards, on the other hand, is dominated by flow through fractures. Figure 3-6 shows the distribution of the Knox aquifer and the aquitards across the ORR.

The flow system in both the Knox aquifer and ORR aquitards can be divided into four zones (Solomon et al. 1992). The storm flow zone is a relatively thin interval at the surface. The zone includes precipitation-generated flow that constitutes nearly all of the water moving through the subsurface. It is a pathway for the transport of contaminants to the subsurface. The vadose zone is an unsaturated zone above the water table. The groundwater zone is continuously saturated and is the region in which the remainder of subsurface water (exclusive of the storm flow zone) occurs. The aquiclude is a zone in which any water movement occurs on a geologic time scale.

The Chickamauga Group (described in Sect. 3.4), which is an ORR aquitard, underlies Chestnut Ridge OU 4 and all of Bethel Valley. Flow in the aquitard is relatively shallow, generally at 100 ft or less; hydraulic conductivities measured from monitoring wells screened in the Chickamauga in Bethel Valley are $\sim 1.8 \times 10^{-5}$ cm/sec (Solomon et al. 1992). Flow volume and solute residence times increase with depth; transport rates may be as low as a few

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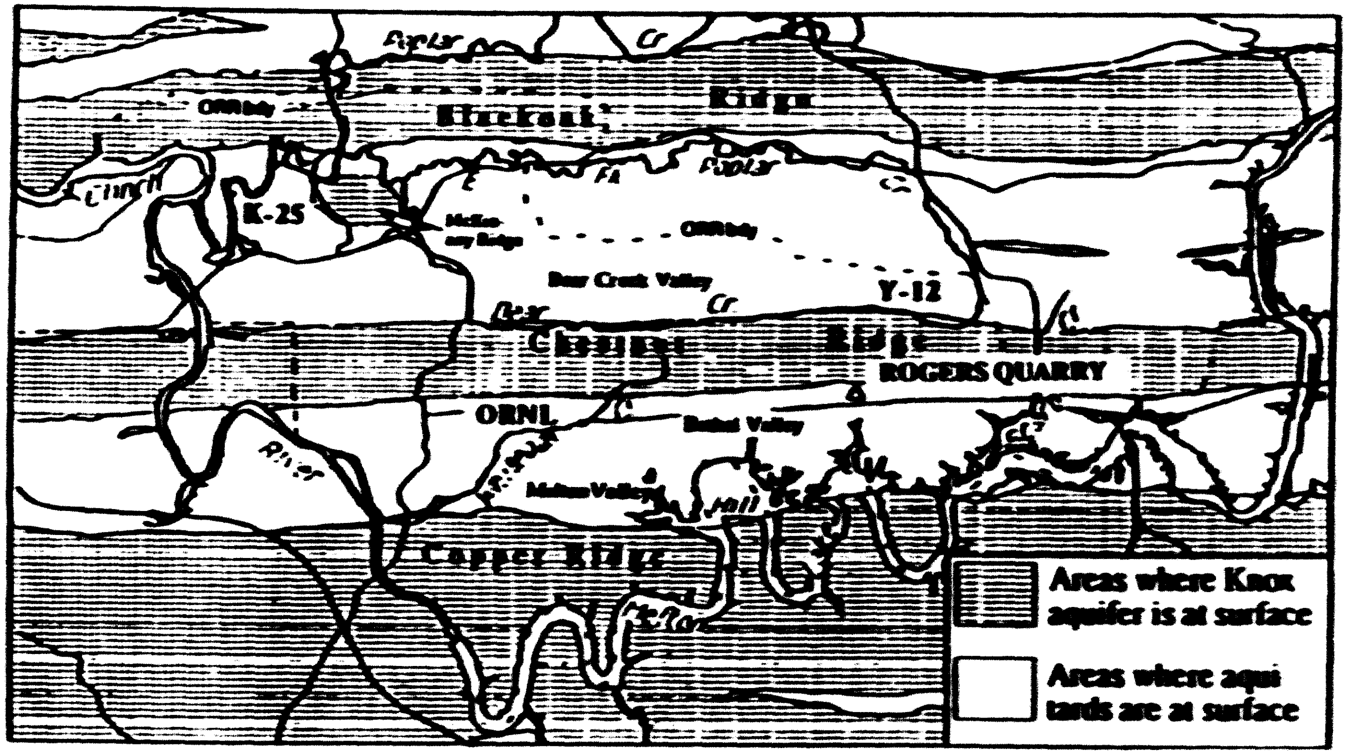

SOURCE: Solomon et. al., 1992

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DISTRIBUTION OF KNOX AQUIFER & AQUITARDS ACROSS THE OAK RIDGE RESERVATION

ROGERS QUARRY/LOWER McCOY BRANCH

CHESTNUT RIDGE OU4

FIGURE No. 3-6

centimeters per year. Solomon et al. (1992) point out that the water in the aquitards is a marginal resource, and, in many places, wells are incapable of producing domestic quantities of water.

Groundwater investigations conducted by Energy Systems in the 1980s included the installation of ten monitoring wells around the perimeter of Rogers Quarry. Monitoring well locations are shown in Sect. 6.0 (Fig. 6.1). These wells are screened at a variety of depths ranging from several tens to several hundreds of feet below surface. Table 3.2 summarizes some pertinent information about the monitoring wells, including elevations, total depths, screened intervals, construction materials, and stratigraphic intervals monitored. All of the available well logs for these wells are included in Appendix A.

A limited amount of flow information exists for these wells. During the installation of GW 185, a fracture zone was encountered at 73 ft below surface that produced 20–30 gpm. Since its completion, however, GW 185 has generally been dry. During the installation of GW 187, two fracture zones were encountered, one at 134–135 ft below surface and the other at 159–160 ft below surface. Both of these zones produced greater than 25 gpm.

Haase et al. (1987) installed seven of the ten monitoring wells (all but 1081, GW 318, and GW 319). Their study also included weekly water level measurements and quarterly collection of groundwater samples. Analysis of the quarterly groundwater samples included parameters to evaluate both water chemistry and water quality.

With respect to water level data, Haase et al. noted that the shallow groundwater system is complex, seasonably variable, and probably tied to the hydraulics of Rogers Quarry. Deeper groundwater exhibited trends that were quite independent of quarry water level fluctuations. In general, the water table in the vicinity of Rogers Quarry is relatively flat, only a very small hydrostatic head gradient was noticeable. Various wells become the "upgradient" well for the site throughout the year. For example, GW 184 had the greatest head during times of high precipitation. On the other hand, throughout most of the year, and especially during times of low precipitation, GW 188 or the quarry itself had the greatest head. Haase et al. concluded that Rogers Quarry appears to recharge shallow groundwater, especially during times of low precipitation.

With respect to the water chemistry data of Haase et al., the major cations were calcium, alkalis (sodium and potassium), and magnesium; major anions were carbonate-bicarbonate and sulfate. A small but consistent concentration of silicon was noted. Specific conductance values ranged from 330 to 1010 μmho/cm (with most in the range 300–500), and pH values were generally around 8.3, typical of water in contact with calcareous bedrock.

With respect to water quality data of Haase et al., organic compounds concentrations were near or below detection limits. Analysis for metals indicated that only arsenic, chromium, or lead approached or exceeded regulatory standards, and all the exceedences were in GW 188. Analysis for radioactivity (gross alpha, gross beta, and radium emitters) also indicated that levels were within regulatory limits, except for two gross alpha exceedences in GW 188. Haase et al. concluded that, with few exceptions, data from the wells did not indicate contaminant levels warranting additional concern or exceeding regulatory standards.

The areas around Rogers Quarry have been sampled as part of the ongoing ORR Groundwater Monitoring Program. Data from the years 1986 through 1992 are summarized

Table 3-2. Monitoring well summary for Chestnut Ridge OU 4

Well	TOC[a] (ft)	TD[b] (ft)	Screened interval[c] (ft)	Construction material	Stratigraphic interval[d]
1081	834.9	30	28–30	SS[e]	Unconsolidated residuum/Unit E
GW 184	927.6	130	107.5–127.5	PVC[f]	Lower Unit C
GW 185	831.1	471.5	Casing to 405; open to 471.5	Steel	Unit B
GW 186	831.3	171.0	150.0–170.0	PVC	Unit C
GW 187	834.3	162.0	147–162.0	PVC	Unit E
GW 188	837.1	68.0	52.5–67.5	PVC	Unit D
GW 189	831.53	210.0	190.0–210.0	PVC	Unit C
GW 224	832.5	126.0	106.0–126.0	PVC	Unit E
GW 318	823.9	80.0	69.1–79.6	SS	Unit E
GW 319	823.0	23.2	12.1–23.2	SS	Unconsolidated residuum/Unit E

[a]Top of casing (elevations of TOC are in feet above sea level)
[b]Total depth (given in feet below TOC)
[c]Screened interval is in feet below TOC
[d]Unit designations are subdivisions of the Chickamauga Group. Additional details on the Chickamauga Group stratigraphy are in Sect. 3.4
[e]Stainless steel
[f]Polyvinyl chloride

in Appendix A, only analytes present above detection limits are reported. Appendix A also includes executive summaries or abstracts from key references in Chap. 3. Table 1 in Appendix B lists the Safe Drinking Water Act maximum contaminant levels (MCLs). A comparison of these analytes with the Safe Drinking Water Act MCLs indicates that the majority of analytes are below the MCLs. The MCL for arsenic was exceeded in unfiltered samples from wells OW-184, OW-186, and OW-187 during January 1989 and in filtered samples from well OW-319 throughout 1988. Cadmium levels exceeded the MCL in an unfiltered sample from well OW-188 during February 1988. Concentrations of manganese were elevated above the Federal Secondary Maximum Contaminant Levels in wells OW-186 and OW-188 from 1986 through 1992. Nitrates exceeded the MCL in well OW-184 during October 1986, January 1989, and January and September 1990.

Two dye tracer studies have been performed in support of investigations at the Chestnut Ridge Security Pits (Chestnut Ridge OU 1), atop Chestnut Ridge and just north of OU 4. The first test was conducted during the driest part of 1990, and dye was injected into well OW-178 at OU 1. Forty monitoring points were established in both Bethel Valley and Bear Creek Valley, including streams, springs, and wells. The study indicated that flow is dominantly along the strike coincident with Chestnut Ridge itself, with some detection at points to the east and southeast (Geraghty & Miller 1990). No apparent connection was detected between the point of dye entry and springs or surface water in MCB, including the Filled Coal Ash Pond (OU 2) and OU 4.

These results suggest that any contaminants identified in the wells surrounding Rogers Quarry probably have originated from the quarry itself and not from upslope or upgradient sources. On the basis of results from the first study, Energy Systems recommended that a second test be conducted at OU 1. The second test was conducted during the wet season, beginning in February 1992 with a four-week baseline monitoring period. Dye injection commenced in March 1992 and monitoring was to continue for 12 weeks; however, the monitoring period was extended to 18 weeks because no definitive results were obtained. The test results were inconclusive. No results could be characterized on a quantitative or qualitative basis as positively indicating the detection of dyes at monitoring locations (SAIC 1992).

3.7 ECOLOGY

OU 4 consists of two ecologically distinct sections. Rogers Quarry is an artificial system, a flooded quarry that contains an aquatic system consisting of an unspecified mixture of naturally and artificially introduced species. Because of the structure of the outfall from the quarry, it is difficult for fish and invertebrates without an aerial stage or human assistance to colonize the quarry.

Lower MCB is a small second-order stream flowing ~0.2 km between the outfall of Rogers Quarry and the MCB Embayment of Melton Hill Reservoir. It contains a mixture of fish species typical of small streams and species more typical of a reservoir. The stream is lined by shrubbery and grassy wetland and upland riparian vegetation. Most of the land near the stream is in artificial grasslands with some woodlands. The ecological composition of these communities is discussed more extensively in Sect. 4.2.

3.8 RADIOLOGICAL SURVEY

In 1992 an aerial radiological survey, which included OU 4, was conducted for gamma radiation. The survey did not penetrate more than 2 in. of water and therefore did not detect any radiation in Rogers Quarry or in MCB stream sediments. Results indicated background levels of gamma radiation in areas around the quarry. A reservation-wide radiological survey was conducted during January 1993 from an elevation of 150 ft. This survey also included magnetics and electromagnetics. Results are expected late in May 1993. It is possible that the electromagnetics and magnetometer data will penetrate the water and provide data on Rogers Quarry and MCB.

Groundwater samples from existing wells around Rogers Quarry have been analyzed for radionuclides as part of the ongoing groundwater quality assessment program on the ORR. The 1991 groundwater assessment program for Chestnut Ridge included monitoring wells GW-184, GW-186, GW-187, and GW-190 adjacent to Rogers Quarry. Results were all below detection limits for both total and dissolved metals analysis for uranium and thorium. Gross alpha and gross beta values ranged from 0.00 pCi/L (GW-186) to 4.11 pCi/L (GW-190) and from -0.42 pCi/L (GW-184) to 18.49 pCi/L (GW-190), respectively.

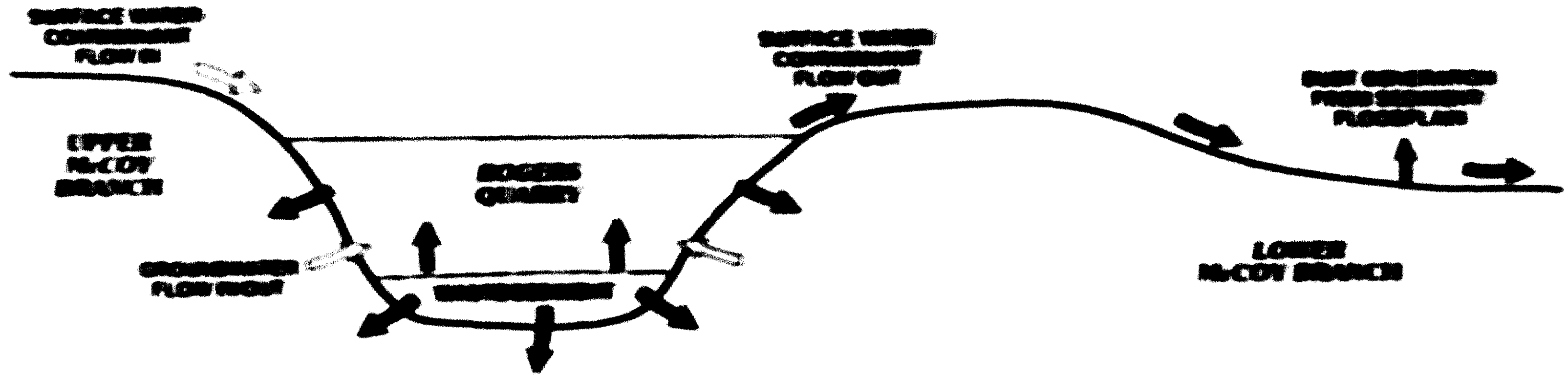
3.9 CONCEPTUAL SITE MODEL

A generalized conceptual site model (CSM) for Rogers Quarry/Lower McCoy Branch Chestnut Ridge OU 4 is presented in Fig. 3.7. This model depicts potential exposure pathways and sources of contaminants. Contaminants may enter Rogers Quarry via surface water flow from Upper McCoy Branch and storm water flow from the watershed and via groundwater from infiltration, depending on water table conditions. Wastes/sediments in the quarry may also act as a source of contaminants to the overlying surface water and/or to groundwater. Surface water discharge from the quarry through the outfall may act as a source of contaminants to Lower MCB.

Conceptual models for exposure of human and nonhuman receptors were developed to guide the RI sampling design and to identify all potential current and future pathways and receptors. Section 3.9.1 describes the conceptual model for exposure of human receptors. Sect. 3.9.2 describes the model for exposure of ecological (nonhuman) receptors. These models are the basis for the development of the RI sampling approach described in Chap. 7.

3.9.1 Conceptual Model for Exposure of Human Receptors

The human exposure model for Rogers Quarry and Lower MCB considers five potentially contaminated media: sediment/soil, surface water, groundwater, air, and biota. Figure 3.8 depicts the human conceptual exposure model. The primary sources of contaminants are surface water and sediments in Rogers Quarry. The primary release mechanisms are the outfall discharge from the quarry and infiltration/discharge to groundwater. The sources, pathways, and exposure media may lead to a variety of exposure to human and biological receptors although, under current conditions, there is minimal potential for human exposure. Future use scenarios will address residential and recreational use of the site.

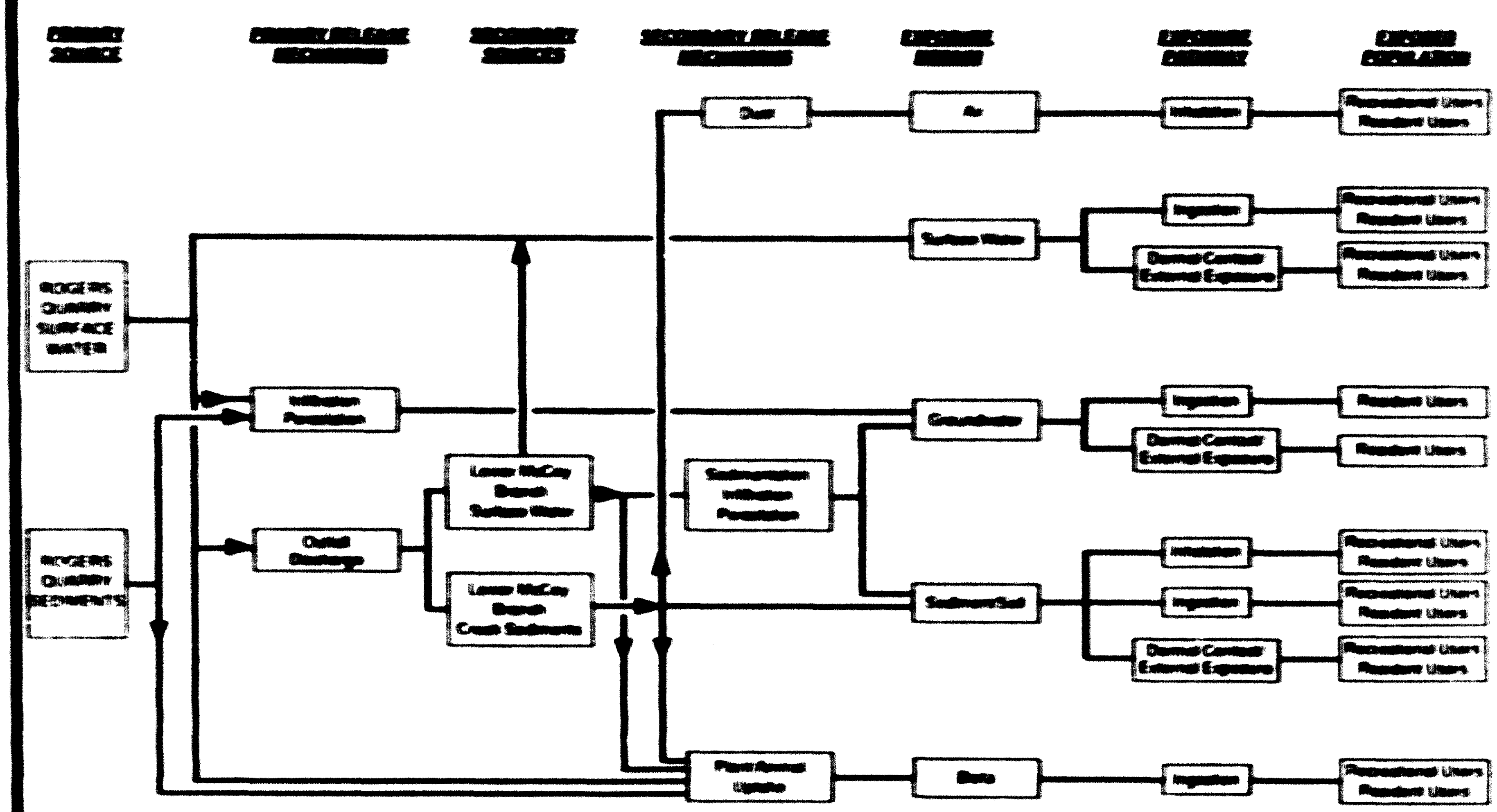


CONCEPTUAL SITE MODEL

ROGERS QUARRY/LOWER McCOY BRANCH

CHESTNUT RIDGE OU4

FIGURE No. 3-7



CONCEPTUAL MODEL OF EXPOSURE OF HUMANS TO CONTAMINANTS

ROGERS QUARRY/LOWER McCOY BRANCH

CHESTNUT RIDGE OU4

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FIGURE No. 3-8

The following is a brief discussion of each of the potential exposure media identified for OU 4 that focuses on human exposures and human health risks.

3.9.1.1 Sediment/soil

The sediment/soil is a potential pathway of migration for the contaminants at OU 4 via percolation into groundwater leaching and/or resuspension to surface water or resuspension of particulates into air. The contaminants could enter the groundwater from the Rogers Quarry sediment, as well as from the Lower MCB sediment. Leaching of contaminants to surface water from the coal ash or other materials in the quarry and resuspension of the coal ash into the water column are potential mechanisms of contaminant release. For the resuspension of particulates into the air, only the Lower MCB sediment would be considered a potential pathway of migration because Rogers Quarry sediment is not exposed to the atmosphere. In the shallow portions of the quarry, organisms that live or nest in the sediments and human receptors who invade the quarry could be exposed to contaminants. The potential exists for contaminants in the surface water from Rogers Quarry to be discharged to the Lower MCB, located outside the Y-12 Plant boundary. Therefore, the Lower MCB sediment/soil will be evaluated as a potential exposure pathway because these sediments are exposed to the atmosphere and potential human receptors.

3.9.1.2 Surface water

The most likely mechanism for contaminant transport at OU 4 is surface water. As stated earlier, the potential exists for contaminants in Rogers Quarry to be discharged into the Lower MCB. Lower MCB surface water will eventually erode the sediment/soil layer, thereby increasing the potential for surface water transport of contaminants at the site. Lower MCB discharges into the Melton Hill Lake. Percolation of the Rogers Quarry surface water into the surrounding groundwater is also a potential transport mechanism. Note that few, if any, volatile compounds have been reported for OU 4 or OU 2; their occurrence has been limited and largely attributed to laboratory contaminants. Therefore, volatilization is not considered a potential pathway.

3.9.1.3 Groundwater

The groundwater system within OU 4 is another potential mechanism for contaminant transport. Surface water can infiltrate shallow groundwater and water within Rogers Quarry can infiltrate deeper groundwater through fractures. Previous studies on the groundwater system (Haase et al. 1987) and the water balance (Bogle and Turner 1989) at the quarry concluded that the surface water and groundwater may be connected but the connection is not a strong one. Much of the strata exposed in the quarry appears to be relatively tight, with discrete zones of highly fractured beds that could act as recharge zones for groundwater. Water balance data suggest that the system is nearly balanced with a slight negative deficit. This would imply that the quarry acts as a recharge for groundwater, but the deficit is relatively small and may be within measurement error. Nevertheless, the groundwater system merits investigation because of the known disposal history of the quarry and the potential for recharge from the quarry. Previous groundwater monitoring data have shown VOCs at or below the detection limits (Sect. 3.6); therefore, volatilization is not considered a potential pathway of concern to human health.

3.9.1.4 Air

Atmospheric releases at OU 4 appear to be limited to dust generation from sediment in Lower MCB and its floodplain. Airborne contamination is believed to be minimal because Lower MCB is vegetated and generally flows year round.

3.9.1.5 Biota

Plants may accumulate contaminants that are present in sediment and surface water at Rogers Quarry. Aquatic and terrestrial animals may ingest surface water, plants, and other aquatic organisms that have absorbed or ingested contaminants from the surrounding media. The potential exists for contaminant uptake (primarily metals) by fish and other aquatic organisms feeding on fish and plant life in Rogers Quarry and Lower MCB. There is a potential for uptake of contaminants by biota. Species of game fish are found in Rogers Quarry (although fishing is prohibited in the quarry) and in Melton Hill Lake. Therefore, humans may be potential receptors and ingestion of fish and garden vegetables will be evaluated as potential routes of exposure.

3.9.2 Conceptual Model for Exposure of Ecological Receptors

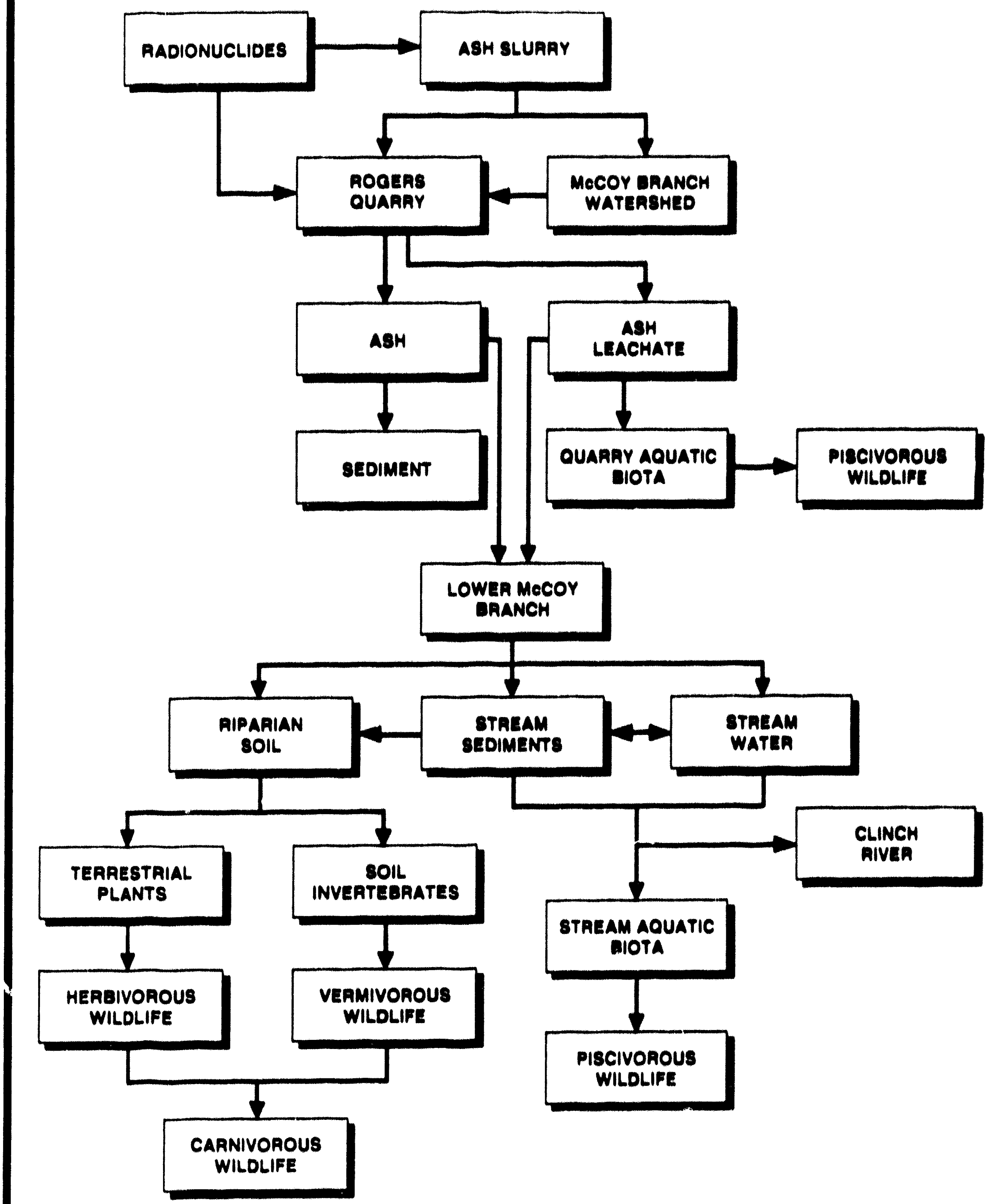
A conceptual exposure model for ecological (nonhuman) receptors is shown in Fig. 3-9. Development of this model was based on a screening level ERA (screening assessment) performed by Energy Systems personnel at ORNL.

3.9.2.1 Screening assessment

A screening assessment uses existing data to determine the issues and scope of the baseline assessment and to identify data needs for the baseline assessment. The recent report *Ecological Effects of Contaminants in McCoy Branch* (Ryon 1992) constitutes such an assessment for the aquatic biota of the OU. This assessment will not repeat that material but rather will summarize it in terms of a risk assessment paradigm and will discuss terrestrial ecological risks that are not discussed by Ryon (1992).

The standard paradigm for an ERA was followed in the screening assessment and will be followed in the baseline assessment (Suter 1992; EPA 1992a). It begins with a scoping phase termed hazard definition or problem definition that defines the sources of concern (ash disposal in the watershed and directly to the quarry); the media of concern (surface water, sediments, and soils); the spatial extent (Rogers Quarry and MCB below the quarry but above the embayment); and the assessment endpoints [20% or greater reductions in the abundance or production of any population of fish, wildlife, or vascular plant; greater than 10% occurrence of gross deformities in fish; and loss of or damage to floodplain or wetland communities] sufficient to cause loss of one of the following functions: (1) regulation of hydrology, (2) provision of habitat for wetland or floodplain dependent wildlife, or (3) processing of nutrient and contaminant chemicals. As explained in the *Approach and Strategy for Performing Ecological Risk Assessments for the DOE Oak Ridge Field Office Environmental Restoration Program* (Suter et al. 1992), these endpoints are based on an analysis of EPA guidance and regulatory practice and on the feasibility of detecting effects.

One product of this phase is a conceptual model of the site that shows how contaminants move from the source through the physical components of the site resulting in exposure of



CONCEPTUAL MODEL OF EXPOSURE OF NONHUMAN ORGANISMS TO CONTAMINANTS

ROGERS QUARRY/LOWER McCOY BRANCH

CHESTNUT RIDGE OU4

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FIGURE No. 3-9

various biotic components (Fig. 3-9). The movement of ash and ash leachate are emphasized because available contaminant data and ecological assessment by Ryon (1992) do not suggest the presence of any other hazardous contaminants. Radionuclides may be associated with the ash and other wastes disposed of in the quarry. If other sources are discovered in the course of the RI, the conceptual model will be expanded. Ash and ash leachate move into Rogers Quarry directly by pipe discharge and from Upper MCB by leaching and erosion. Most of the ash settles in the quarry but some ash and nearly all of the water (minus evaporation and plus direct precipitation) flow into Lower MCB and thence to the MCB Embayment of Melton Hill Lake that is part of the Clinch River OU. Contaminants are exchanged between the ash and the water column. Seeps and springs are not treated as a distinct contaminant source in this model because they would act simply as another route of transport for the leachate from upper to lower portions of McCoy Branch. Aquatic biota are exposed to contaminants in the surface water and in the pore water of the sediments that contain settled ash. Piscivorous wildlife consume the exposed fish. Ash also settles in the riparian wetlands along MCB where plants and soil invertebrates are directly exposed to ash-associated contaminants. Herbivorous, carnivorous, and vermivorous wildlife are potentially indirectly exposed by this route through food webs including incidental consumption of soil. In addition to these exposures to chemical contaminants, biota in the quarry are exposed to radiation from the objects dumped there.

After the problem is defined, exposure and effects are assessed. The primary exposure data are analyses of contaminants in the waters of Rogers Quarry and MCB, sediments, riparian soils, and biota. These data are measures of external exposure. They are summarized in Sect. 3.5. A second source of exposure data is the analyses of contaminant concentrations in fish flesh. Concentrations in fish indicate the internal exposure levels of the fish and the dietary exposure levels of piscivorous wildlife. The existing data are concentrations in largemouth bass fillets that are appropriate for HHRAs, but not for ERAs.

Three types of effects data are used. As was mentioned earlier, the primary effects data are the biological survey data obtained by the BMAP (Ryon 1992). Effects data are also supplied by the ambient toxicity testing that has been performed in the BMAP (Ryon 1992). The tests used are the EPA's seven-day fathead minnow larval test and *Ceriodaphnia dubia* test. They are performed quarterly using water from the inlet to Rogers Quarry and the outfall from the quarry. In addition, *Ceriodaphnia dubia* life cycle tests and *Elimia clavaeformis* (a snail) tests are performed ad hoc. Finally, regulatory criteria and literature toxicity values will be used to characterize effects of individual aqueous contaminants found in MCB water in terms of standard toxicological benchmarks, literature toxicity information, and effects models (Suter 1992). All three of these types of effects data are available for aquatic biota. However, effects assessment of wildlife will rely on toxicological benchmarks for individual chemicals because wildlife survey data or toxicity testing are not available or feasible for this assessment.

The risk characterization phase combines the data from the exposure assessment and effects assessment to characterize the risks to the assessment endpoints, and it summarizes and explains the results and associated uncertainties. The aquatic biological survey data for this OU are more difficult to interpret than for most other sites. The fish community of the quarry is controlled by human introductions possibly supplemented by species that could get over the discharge structure from Lower MCB. Therefore, a reference community composition cannot be defined. The fish community of Lower MCB is a mixture of species that would be expected in a stream of its size and structure and of species typical of Melton Hill Lake. None of the currently surveyed streams is an appropriate reference for this reach.

Ryon (1992) concluded on the basis of species composition and fish condition that the fish community of Lower MCB is mildly stressed. The benthic invertebrate survey data from Lower MCB are also indicative of a mildly stressed community.

More direct evidence of toxic effects is supplied by the frequency of deformed fish. Severe deformities of the head, fins, operculum, and scales were found in largemouth bass from Rogers Quarry and in sunfish from MCB immediately below the quarry. Frequencies of these deformities are not well defined but they are qualitatively different from deformities previously observed on the reservation and are much more frequent than the 5% frequency that is considered to be the threshold for evidence of a stressed stream.

Toxicity tests of water flowing into and out of the quarry showed little to no toxicity. This is consistent with the finding of the standard biological survey data suggesting a mildly stressed ecosystem. The toxicity test results do not reflect on the issue of fish deformities because of the short fish exposures and absence of test endpoints for morphological development.

The final source of evidence concerning risks to aquatic biota is the measured concentrations of chemicals in water. Concentrations of metals in the outflow from Rogers Quarry, measured as part of the NPDES monitoring program, are summarized and related to water quality criteria and standards in Sect. 3.5. Other historic water quality data are presented by Ryon (1992) and their expected toxicity is discussed. Several metals have been detected at concentrations that exceed national criteria, state standards, and other aquatic toxicological benchmarks (Suter et al. 1992). However, because the measurements are of total recoverable metals rather than dissolved metals, some large fraction of the metals is likely to be unavailable to the biota, particularly at the alkaline pH values observed in this system (EPA 1992b). This fact explains why the fish and benthic communities of Lower MCB show relatively high abundance and diversity and tested toxicity is low despite the high reported levels of multiple metals.

No data have been collected in this system to specifically address terrestrial ecological risks. Two major modes of exposure are relevant to this OU: consumption of contaminated fish and uptake of contaminants from contaminated soils. The greatest hazard to piscivorous wildlife is selenium, which occurs at a mean of 3 mg/kg in largemouth bass fillets from Rogers Quarry (Ryon 1992). This concentration causes histological damage and reduced longevity in the diets of rats and is near the threshold for effects in birds (Eisler 1985). Arsenic (0.29 mg/kg) and thallium (0.03 mg/kg) are elevated in largemouth bass fillets (Ryon 1992), but concentrations are well below toxic effects levels reported for mammals or birds (Suter 1991). However, piscivorous wildlife do not consume the fillets of large fish, so the relevance of these measurements is doubtful.

The lush and diverse vegetation lining MCB and growing on the Filled Coal Ash Pond suggests that the ash and its soluble constituents have not been phytotoxic. It is possible that plants growing along Lower MCB could accumulate metals to concentrations that are toxic to herbivorous wildlife. However, based on a visual survey there appears to be relatively little soil contaminantion by ash in Lower MCB due to settling in Rogers Quarry, and the small extent of the riparian wetlands on Lower MCB ensure that this route of exposure would not have significant effects on wildlife populations. These issues are being assessed as part of the RI for Upper MCB where ash contamination is much more extensive and the ash constitutes 100% of the root zone in some areas (DOE 1992). Therefore, the ash to plants and animals route will not be assessed further in this OU unless results from Upper MCB indicate a significant risk.

The toxicity of ash to soil invertebrates will not be addressed here for the same reason; invertebrate toxicity testing is being conducted for Upper MCB and the results there will suffice to determine whether a hazard exists in Lower MCB. If those results suggest that the ash is highly toxic to soil invertebrates, this plan may need to be amended to include studies of that hazard.

3.9.2.2 Data needs for ecological risk assessment

Surveys should be conducted for wetlands and floodplains and for endangered, threatened, and in-need-of-management species and their habitats.

Currently, the fish community of Rogers Quarry is undefined. A survey should be conducted to determine the species composition of the quarry as well as the distribution of sizes. In conjunction with this survey, observed deformities should be described and enumerated by species and age for both the quarry and the branch. These data are needed to determine whether the frequency or severity of deformities is declining due to decreased ash input, to determine the extent and magnitude of effects, and to estimate the value of the fisheries resource.

The primary data needed for aquatic exposure assessment are dissolved concentrations of chemicals. Most data are for total recoverable concentrations, which are appropriate for HHRAs but not for ERAs (EPA 1992b).

Analyses of contaminant concentrations in small whole fish are needed for both Rogers Quarry and Lower MCB. These data are needed to estimate exposures of piscivorous wildlife and of the fish themselves. In addition, more extensive searching of the literature and consultation with fish toxicologists and biologists should be conducted to determine potential causes of the observed fish deformities.

If warranted by the fish survey results, fish tissue analyses, literature review, and consultation with experts, experimental studies should be performed to determine the cause of the observed deformities. Such studies would be justified if the deformities persist in the population and if no cause can be confidently assigned.

The current level of aquatic toxicity testing is adequate and appropriate for support of a baseline risk assessment. The sampling of fish and invertebrates is also appropriate. Both activities should be continued to support the RI.

4. POTENTIAL RECEPTORS AND EXPOSURE PATHWAYS

4.1 HUMAN POPULATIONS

The Y-12 Plant is a part of the DOE ORR, which covers ~58,000 acres. The Y-12 Plant is located along the northeastern boundary of the ORR adjacent to the city of Oak Ridge. Although adjacent to Oak Ridge, the Y-12 Plant is situated in a rural area, and no residences or drinking water sources are located on the plant site. In addition, because of security precautions, the presence of persons at the facility is controlled. Consequently, the potential for human exposure to contamination is minimized. Local demography is discussed in Sect. 3.3.

A conceptual model for human exposure was presented in Sect. 3.9, Fig. 3-8. Using available knowledge of site conditions, these pathways were selected as potential pathways of concern at OU 4. A potential exposure pathway is the means by which a chemical or physical agent moves from a source to a receptor. Hence, the pathway describes a unique mechanism by which an individual or population is exposed to contaminants at, or originating from, a site. Generally, a complete exposure pathway has five elements:

- A contaminant source
- A mechanism for contaminant release
- An environmental transport medium
- A point of potential human contact with the contaminated medium (exposure point)
- A feasible route of exposure.

Exposure could occur if contaminants migrated from OU 4 to an exposure point or if a receptor came into direct contact with contaminated media. Identification of exposure pathways for OU 4 includes descriptions of both primary sources (those that contribute contaminants to the unit) and secondary sources (those sources within the unit that contribute contaminants through their exposure media). Therefore, both primary release mechanisms and secondary release mechanisms are identified.

Sources of contamination may be considered to be primary or secondary in nature. Primary sources of contaminants consist of the waste-generating unit. Rogers Quarry was used as a disposal basin for coal ash and classified materials; however, disposals to Rogers Quarry have been substantially reduced and will terminate in July 1993. Secondary sources of contamination are media that have been contaminated through the transport of primary source contaminants. The secondary contaminant sources include the Lower MCB surface water and sediment.

The potential exists for ingestion of contaminants released as a result of activities at OU 4. Ingestion of contaminants could occur from surface water, groundwater, sediment (including coal ash), and biota that may function as transport media for contaminants released at OU 4. Exposure to contaminants through the ingestion of surface water could occur if the Rogers Quarry or Lower MCB surface water were used as a drinking water source by a future recreational user or hypothetical future on-site resident. Current access to Rogers Quarry is limited by a security fence and the steep banks surrounding most of the site.

The potential exists for contaminant infiltration into the groundwater at OU 4; however, the groundwater on the ORR is not used as a drinking water source. Exposure to contaminants through ingestion of groundwater could occur if the groundwater were used as a drinking water source by a hypothetical future on-site resident. The potential for exposure to populations via ingestion of groundwater that could result from OU 4 contamination is considered minimal.

Exposure to contaminants through ingestion of sediment could occur due to incidental contact by recreational users of the quarry or Lower MCB or by hypothetical future residents residing along Lower MCB or Rogers Quarry.

The ingestion of biota is another potential exposure pathway for the future OU 4 recreational user and the future on-site resident at OU 4. The ingestion of contaminated fish caught in Rogers Quarry or Lower MCB by the recreational user and future on-site resident will be evaluated as a potential exposure pathway.

Because there is no evidence that volatile contaminants are present at this site, potential exposure to these contaminants will not be discussed. Exposure to contaminants through the inhalation of resuspended sediment could occur to recreational users of Lower MCB and future residents along the branch. Inhalation of potentially contaminated particulates will likely occur only in situations where the Lower MCB sediment is disturbed. Therefore, the potential for inhalation of resuspended sediment is considered minimal.

Dermal contact is another potential exposure pathway at OU 4. Exposure to contaminants from dermal contact with surface water could occur if recreational users or future on-site residents were swimming in Rogers Quarry or Lower MCB. Dermal contact with contaminants in the groundwater while showering is another potential exposure pathway for the future on-site resident. Also, exposure to contaminants from dermal contact with sediment could occur to recreational users of Rogers Quarry and Lower MCB and future residents along Lower MCB.

The potential for external exposure to radionuclides also exists at OU 4. Exposure could occur from being directly exposed to possible gamma radiation from contaminated Lower MCB sediment, shallow sediments in the quarry, and radioactive materials placed in the quarry. Potential receptors for this scenario include recreational users of Lower MCB and future residents adjacent to the branch.

4.1.1 On-Site Potential Human Receptors

Employment at the Y-12 Plant, as of April 1993, consisted of ~6200 on-site personnel, the majority of whom work in the main Y-12 Plant complex in the northeast part of the ORR. OU 4 is situated to the south of the main Y-12 plant complex in a fenced area that the majority of employees do not frequent. Therefore, the exposure potential for the majority of facility employees is minimal and will not be evaluated.

The scope of this work plan entails bounding the potential risks due to exposure to OU 4 contaminants. This will be accomplished by evaluating two scenarios: a future recreational user of OU 4 for the lower bound (minimum) condition and a hypothetical resident residing at OU 4 for the upper bound (maximum) condition. Because the lower bound condition is represented by the recreational-user-of-OU-4 scenario, a Rogers-Quarry-trespasser scenario will not be evaluated. Even though exposure to OU 4 contaminants is a possibility for on-site workers, this scenario will not be evaluated because the risks for a worker scenario would fall between the lower and upper bound condition.

4.1.2 Off-Site Potential Human Receptors

The greatest potential for off-site human exposure is believed to be from Rogers Quarry surface water flow into Melton Hill Lake via Lower MCB. Because Rogers Quarry discharges into Lower MCB, it is anticipated that recreational users of Lower MCB and Melton Hill Lake could potentially be exposed to the contaminants in Rogers Quarry. However, the potential for exposure to off-site populations is considered to be minimal for the following reasons: (1) the area surrounding Lower MCB is rural and unpopulated and (2) the potential effects of exposure to contaminants will be lessened due to surface water dilution from the Melton Hill Lake. Because of the remote location of OU 4, no sensitive subpopulations are believed to be potentially at risk.

4.2 ECOLOGICAL POPULATIONS

This RI is concerned with the surface water of Rogers Quarry and the surface water and sediments of MCB downstream of the quarry and upstream of the embayment. Therefore, the ecological assessment is concerned with the aquatic biota that inhabit the surface waters, with the benthic community of the branch, and with the riparian terrestrial community. The sources for the following description of Rogers Quarry and MCB communities are the monitoring performed by the BMAP (Ryon 1992), the ORR Resource Management Plan (Parr 1984; Kroodsma 1987; Cunningham and Pounds 1991; Parr and Evans 1992), and the review of existing data in the RCRA Facility Investigation (RFI) Plan for MCB (Murphy and Loar 1988). An ecological CSM has been developed for OU 4 and is included in Sect. 6.4.2 with the ecological risk assessment.

4.2.1 Aquatic Biota

4.2.1.1 McCoy Branch aquatic biota

The abundance and productivity of fish populations comprise the primary assessment endpoint for aquatic ERAs on the ORR (Suter et al. 1992). Fourteen species of fish are found in MCB below the quarry (Table 4-1). The species composition and density of this fish community compared to two reference streams suggests that some disturbance has resulted in losses of some species that occur in similar streams. However, the species richness is relatively high because of the presence of species typical of larger water bodies that evidently immigrated from Melton Hill Lake. The sunfish in MCB exhibit high frequencies of fin deformities and some bluegill exhibit cranial deformities similar to the largemouth bass in the quarry.

Benthic invertebrates are not endpoint species, but they provide food to fish, and analysis of their community characteristics can aid in interpretation of the cause of effects on fish populations. The results of the benthic invertebrate community surveys in MCB

Table 4-1. Fish species found in Lower McCoy Branch Creek below Rogers Quarry (kilometer 1.56) in 1989 and 1990 (Ryon 1992)

Common name	Scientific name
Cyprinidae	
Blacknose dace	*Rhinichthys atratulus*
Bluntnose minnow	*Pimephales notatus*
Carp	*Cyprinus carpio*
Spotfin shiner	*Notropis spilopterus*
Stoneroller	*Campostoma anomalum*
Centrarchidae	
Bluegill sunfish	*Lepomis macrochirus*
Green sunfish	*Lepomis cyanellus*
Largemouth bass	*Micropterus salmoides*
Redbreast sunfish	*Lepomis auritus*
Redear sunfish	*Lepomis microlophus*
Warmouth sunfish	*Lepomis gulosus*
Percidae	
Greenside darter	*Etheostoma blennioides*
Tennessee snubnose darter	*Etheostoma simoterum*
Ictaluridae	
Yellow bullhead	*Ameiurus natalis*

(kilometer 1.40) with reference streams are indicative of a moderately degraded community, which may be attributable to toxic effects. However, Ryon (1992) concluded that more comparable reference sites are needed.

4.2.1.2 Rogers Quarry aquatic biota

There has been no survey of the aquatic biota of Rogers Quarry. However, largemouth bass have been collected by hook and line for chemical analyses. These fish have been found to have a high frequency of cranial and fin deformities. These deformities are not consistent with previously reported effects of any of the metals observed to be elevated in the fish and water, and their cause is unknown.

4.2.2 Terrestrial Biota

The shores of Rogers Quarry are, except for a small and highly disturbed area on the west side, extremely steep so that they do not support wetlands or other riparian communities that would be exposed to the ash or its constituents. For the same reason, wildlife are not expected to make significant use of the quarry and little wildlife use has been observed. Deer do not have access because of the fence. Waterfowl and piscivorous birds have been observed but rarely visit the quarry. Water snakes have been observed in the vicinity of the outfall but no turtles have been observed.

MCB below Rogers Quarry flows through an area of mixed woodlands and artificial grasslands maintained by mowing. Small areas of wetlands are apparent along low-gradient reaches of the stream. The area has no apparent unique or important habitat properties. Wildlife use of the stream is expected to be similar to that of other small streams on the ORR. This could include predation on fish and aquatic invertebrates (by kingfishers, mink, and raccoons), drinking of the water, and consumption of riparian vegetation.

4.2.3 Threatened and Endangered Species

No federally or state-listed threatened or endangered aquatic species or other specially designated species occur in MCB (Kroodsma 1987, Murphy and Loar 1988, Ryon 1992). No federally or state-listed threatened or endangered plant, reptile, amphibian, invertebrate, mammal, or bird has been observed on this OU. However, no survey specific to this OU has been conducted. Specially designated species that may occur are listed in Table 4-2.

4.2.4 Wetlands and Floodplains

The results of site reconnaissance suggest that small areas of wetlands are associated with Lower MCB but that there is no distinct floodplain. The area is designated as palustrine wetlands in the National Wetlands Inventory and in the Resource Management Plan for the ORR (Cunningham and Pounds 1991), but this designation is based on aerial reconnaissance. No wetland or floodplain surveys have been conducted for this OU.

Table 4-2. Federal- and state-listed threatened and/or endangered species and species designated in need of management by the state of Tennessee known or expected to occur on the Oak Ridge Reservation

Common name	Scientific name	Administrative status[a]
	Fish	
Tennessee dace	*Phoxinus oreas*	INM
	Birds	
Black-crowned night heron	*Nycticorax nycticorax*	INM
Black vulture	*Coragyps atratus*	INM
Common barn owl	*Tyto alba*	INM
Cooper's hawk	*Accipiter cooperii*	ST
Grasshopper sparrow	*Ammodramus savannarum*	ST
Osprey	*Pandion haliaetus*	SE
Red-shouldered hawk	*Buteo lineatus*	ST
Sharp-shinned hawk	*Accipiter striatus*	ST
	Mammals	
Indiana bat	*Myotis sodalis*	FE,SE
	Plants	
Spreading false-foxglove	*Aureolaria patula*	ST
Appalachian bugbane	*Cimicifuga rubifolia*	ST
Pink lady-slipper	*Cypripedium acaule*	SE
Tall larkspur	*Delphinium exaltatum*	SE
Northern bush-honeysuckle	*Diervilla lonicera*	ST
Nutall waterweed	*Elodea nuttallii*	SS
Mountain witch-alder	*Fothergilla major*	ST
Golden seal	*Hydrastis canadensis*	ST
Butternut	*Juglans cinerea*	ST
Canada lily	*Lilium canadense*	ST
Michigan lily	*Lilium michiganense*	ST
Fen orchid	*Liparis loeselii*	SE
Ginseng	*Panax quinquefolium*	ST
Tubercled rein-orchid	*Platanthera flava var herbiola*	ST
Purple fringeless orchid	*Platanthera peranoena*	ST
Carey saxifrage	*Saxifraga careyana*	SS
Lesser ladies-tresses	*Spiranthes ovalis*	SS

[a]FE = federally endangered, SE = state endangered, ST = state threatened, SS = state special concern; INM = in need of management according to the state of Tennessee

5. IDENTIFICATION OF INVESTIGATION REQUIREMENTS

5.1 IDENTIFICATION OF ARARs

CERCLA guidelines specify that remedial actions for cleanup of hazardous substances must comply with requirements or standards under federal or more stringent state environmental laws that are ARARs for a site. The potential ARARs for Chestnut Ridge OU 4 are summarized in Appendix B.

5.2 IDENTIFICATION OF PRELIMINARY REMEDIAL ACTION GOALS

The first step in the FS scoping process is to develop preliminary remedial action objectives (RAOs) for protecting human health and the environment. These objectives should specify contaminants and media of concern, potential exposure pathways, and preliminary remediation goals (PRGs). PRGs are chemical-specific concentrations in media that are based on readily available environmental or health-based ARARs or risk-based values calculated with default assumptions. As new information and data are collected and additional ARARs are identified during the RI, the PRGs may be modified. These goals are used throughout the RI/FS process for screening purposes after the first phase of sampling. They identify general response actions and help to identify, screen, and develop remedial action alternatives.

Chestnut Ridge OU 4 will be addressed in a ROD consistent with the strategy outlined in the ORR Site Management Plan (Energy Systems 1992b). The general goal for the Chestnut Ridge OU 4 remedial action is to protect human health and the environment from the contaminant sources within the OU. For each contaminant source, the PRGs will be set for each contaminant of concern and for each medium of concern at whichever of the following values is lowest and most technically feasible: (a) health-based criteria for carcinogenic effects or for systemic toxic effects, (b) the lowest chemical-specific ARARs, (c) ecologically based criteria, or (d) background concentrations.

5.3 IDENTIFICATION OF POTENTIAL CLASSES OF REMEDIAL TECHNOLOGIES

EPA-established requirements pertaining to the remediation of CERCLA sites are listed in Sect. 300.430(a)(1)(iii) of the National Contingency Plan (NCP). These requirements have been considered in developing the PRGs, which serve to focus the consideration of remedial action alternatives. The classes of remedial technologies are summarized below.

- **Institutional controls** such as fences and deed restrictions may be used alone or as a supplement for engineering controls, as appropriate, to prevent exposure to hazardous substances.
- **Containment technologies** such as capping, vertical barriers, horizontal barriers, and dust suppression may be used, as appropriate, to control contaminated areas that pose a

relatively low long-term threat and for sites where treatment is impractical (e.g., in a pyrophoric setting).

- **Removal technologies** such as excavation may be used, as appropriate, alone or in combination with treatment to remove contamination or to abate the further migration of contaminants.

- **Treatment technologies** such as solidification/stabilization, physicochemical, biological, thermal, or electrical may be used, as appropriate, alone or in combination with any of the above technologies to (1) abate principal threats such as highly mobile or toxic substances, (2) prevent further migration of contaminants, or (3) remove contamination. Where possible, treated material that no longer poses a threat to human health or the environment will be returned to the excavation site or treatment will occur in situ.

- **Innovative technologies** may be considered when they offer the potential for superior treatment performance or lower costs for performance similar to that of demonstrated technologies.

As the PROs are revised throughout the RI/FS process, the development and evaluation of the remedial action alternatives will reflect the scope and complexity of the site problems being addressed. During the FS, alternatives will be developed to protect human health and the environment by eliminating, reducing, and/or controlling risks posed through each exposure pathway.

Chestnut Ridge OU 4 consists of Rogers Quarry and Lower MCB/MCB Embayment. The media of concern are sediment/coal ash, surface water, and groundwater. Specific RAOs for Chestnut Ridge OU 4 are the following:

- **Sediment/coal ash**—The RAO is to protect human health and the environment by mitigating the effects of potential direct dermal, ingestion, and inhalation pathways, to minimize further contaminant migration, and to protect against future exposure to the contaminated sediment/coal ash.

- **Surface Water**—The RAO is to identify the potential for remediation of surface water transport of the contaminated sediment/coal ash.

- **Groundwater**—The RAO is to identify the potential for remediation of hazardous substances leaching into the groundwater from the contaminated sediment/coal ash and prevent further migration of groundwater that has already been contaminated.

Table 5-1 presents a preliminary range of remedial action alternatives and associated technologies for Chestnut Ridge OU 4. This table is not meant to present a detailed compilation of alternatives but to make an initial determination as to which general response actions might be applied to the sites. This will be used later during the FS process to screen process options and entire technology types as to their implementability for each site. Identifying potential technologies at this stage will help ensure that data needed to evaluate them can be collected as early as possible. Early identification of technologies will also determine whether treatability studies are needed.

The general response actions are (1) no action, (2) institutional actions, (3) source containment, and (4) removal/treatment technologies. The "no action" response required by CERCLA serves as a baseline comparison against which the other actions can be measured.

Based upon available information at the time of this screening, the potential principal contaminants of interest affecting the specified media are metals and radionuclides. As additional information becomes available, contaminants may be added or deleted, and the list will become more specific.

Table 5-1. Identification of preliminary remedial action goals, preliminary general response actions, and preliminary remedial technology types in specified media

Remedial action goals	General response actions	Remedial technology type
	Sediment/coal ash	
For protection of human health: Prevent ingestion and/or inhalation of and/or direct contact with contaminated sediment/coal **For protection of environment:** Prevent migration of contaminants that would result or has resulted in groundwater contamination	**No action:** 1. No action **Institutional actions:** 1. Access restrictions 2. Legal restrictions 3. Monitoring **Containment actions:** 1. Containment **Removal/treatment actions:** 1. Excavation/disposal 2. Excavation/treatment/ disposal 3. Excavation/treatment/ replacement 4. In situ treatment	**Institutional controls:** 1. Access barriers 2. Deed restrictions 3. Sampling and analysis **Containment technologies:** 1. Capping 2. Vertical barriers 3. Horizontal barriers **Removal technologies:** 1. Shallow excavation 2. Deep excavation **Treatment technologies:** 1. Physicochemical treatment 2. Biological treatment 3. Thermal treatment 4. Electrical treatment 5. In situ treatment
	Surface water	
For protection of human health: Prevent ingestion of and/or direct contact with contaminated surface water or vapor from contaminated surface water **For protection of environment:** Isolate the contaminated surface water and prevent further contamination of other media	**No action:** 1. No action **Institutional actions:** 1. Access restrictions 2. Legal restrictions 3. Monitoring **Containment actions:** 1. Containment **Collection/treatment actions:** 1. Collection/treatment/ discharge 2. In situ surface water treatment	**Institutional controls:** 1. Access barriers 2. Deed restrictions 3. Sampling and analysis **Containment technologies:** 1. Vertical barriers 2. Horizontal barriers **Collection technologies:** 1. Collection **Treatment technologies:** 1. Physicochemical treatment 2. Biological treatment 3. Thermal treatment 4. In situ treatment

Table 5-1 (continued)

Remedial action goals	General response actions	Remedial technology type
	Groundwater	
For protection of human health: Prevent ingestion and/or inhalation of and/or direct contact with vapor from contaminated groundwater **For protection of environment:** Isolate the contaminated groundwater and prevent further contamination of groundwater and other media	**No action:** 1. No action **Institutional actions:** 1. Access restrictions 2. Legal restrictions 3. Monitoring **Containment actions:** 1. Containment **Extraction/treatment actions:** 1. Collection/treatment discharge 2. In situ groundwater treatment	**Institutional controls:** 1. Fence/access barriers 2. Deed restrictions 3. Sampling and analysis **Containment technologies:** 1. Vertical barriers 2. Horizontal barriers 3. Capping 4. Subsurface collection drains 5. Groundwater diversion pumping **Extraction technologies:** 1. Groundwater collection and pumping 2. Dewater entire site 3. Selective alternate recovery **Treatment technologies:** 1. Physicochemical treatment 2. Biological treatment 3. Thermal treatment 4. Electrical treatment 5. In situ treatment 6. Existing Y-12 treatment facilities

6. SITE DATA NEEDS

As described in previous chapters, there have been a number of past investigations and monitoring activities conducted in and around Rogers Quarry. Despite these data and this body of knowledge, additional site characterization data are needed to perform the HHRA and ERA and to prepare the FS describing the most appropriate remedial action, if any.

6.1 PHYSICAL CHARACTERIZATION

Some of the physical characteristics of Rogers Quarry and Lower MCB have been well defined; surface and geological characteristics were presented and discussed in Sect. 3.4. Previous investigations by ORNL personnel have generated data that will be used in this RI. In order to fill data gaps and supplement and confirm existing data, additional site characterization data are needed in the following areas: surface water hydrology, groundwater quality, surface water/sediment quality, and ecological characterization. The site investigation will specifically include the following activities:

- Collecting groundwater samples from nine monitoring wells adjacent to and/or proximal to Rogers Quarry and one monitoring well from a background location in the same geologic group
- Collecting surface water and sediment samples from the quarry, from downstream of Lower MCB, from a drainage ditch south of the quarry, and from a control ditch
- Collecting various hydrologic data (e.g., quarry inflow, quarry outflow, precipitation, evaporation, etc.) to prepare a water balance for Rogers Quarry
- Conducting an underwater survey of Rogers Quarry, including magnetometer, radiation, and video surveys
- Conducting wetlands and endangered species and habitat surveys
- Collecting fish from Rogers Quarry for whole body contaminant analysis
- Performing a qualitative survey of the fish population in Rogers Quarry
- Performing fish pathology studies of abnormal fish that may be found in Rogers Quarry
- Performing a qualitative predator survey of avian and terrestrial species frequenting Rogers Quarry environs
- Performing in situ bioassays at the overflow from the quarry using clams known to accumulate PAHs.

In addition to the surface water samples to be collected from Rogers Quarry for chemical analyses, in situ physico-chemical measurements for temperature, dissolved oxygen, pH, and conductivity will be made at 25-ft depth intervals from the surface to the bottom to characterize limnological characteristics (at the time of sampling). These characteristics may affect the mobility and movement of contaminants in the water column and sediments.

The hydrological and geohydrological data will be used to assess the impact of water quality in Rogers Quarry on groundwater, to determine flow characteristics, and to prepare a water balance. The surface water and sediment data will be used to evaluate contaminant transport via groundwater and surface water pathways and the biological/ecological data will specifically be used to evaluate aquatic and terrestrial risk pathways for biota and man.

The data obtained to prepare the HHRA and ERA will also be used in preparation of the FS, in terms of identifying risk and remediation goals for the site. Existing data on the volume of coal ash in the quarry will be used; additional data will not be collected unless the results of the underwater survey indicate that additional information is needed or that current estimates are inaccurate.

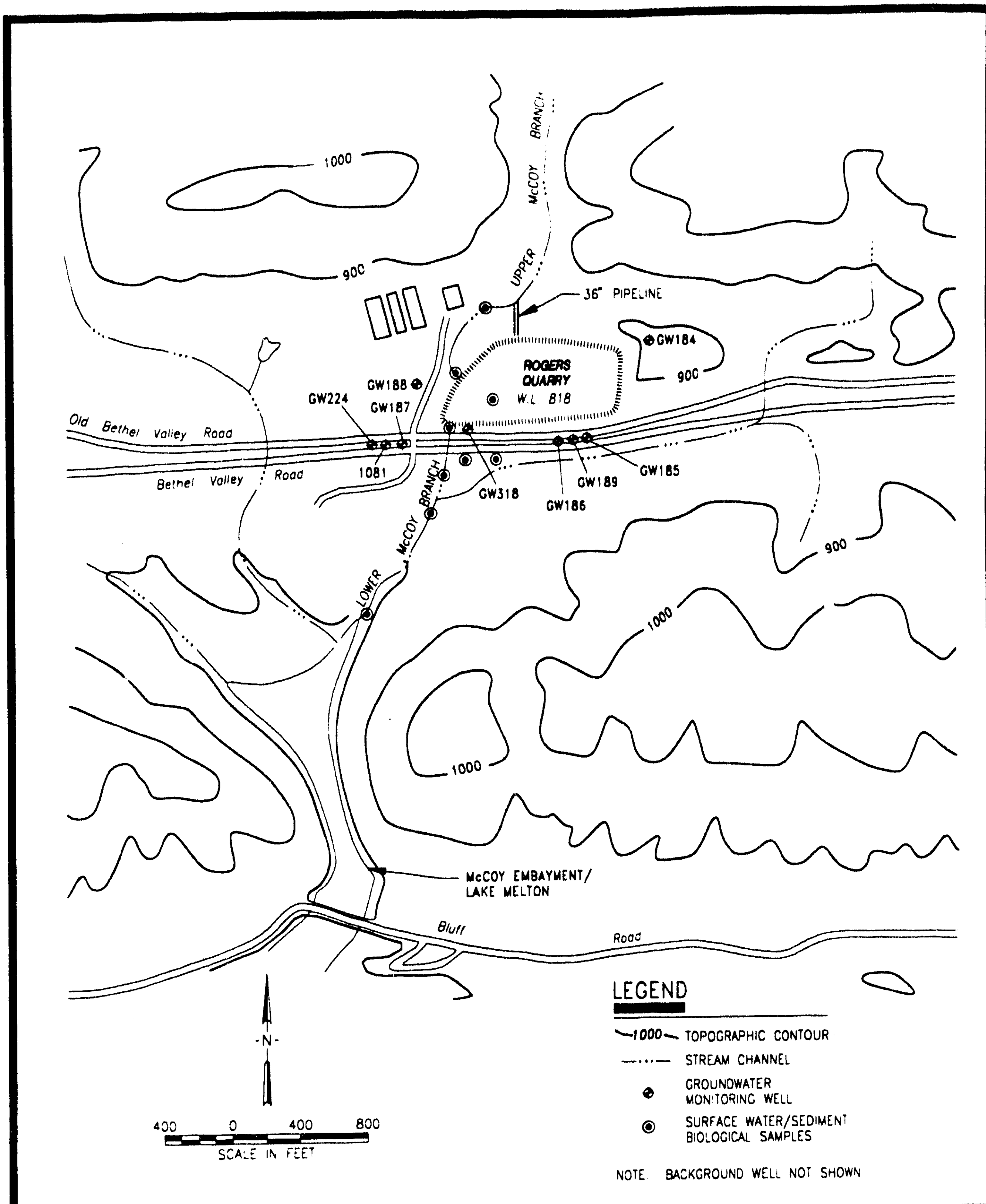
Background surface water and sediment samples will not be collected. EPA has agreed to the use of existing data from Walker Branch for comparison to site data. These data will be collected in conjunction with the Phase II RI at Chestnut Ridge OU 2, Filled Coal Ash Pond. Other data from this investigation will also be useful in evaluating and interpreting the data collected from Rogers Quarry including groundwater data, coal ash analyses, spring/ surface water quality data, and the results of ecological surveys. The Filled Coal Ash Pond and environs are adjacent to and immediately upstream of Rogers Quarry. (Refer to Fig. 2-1.)

6.2 SAMPLING AND ANALYTICAL REQUIREMENTS

Proposed sampling locations for the Chestnut Ridge OU 4 RI are shown in Fig. 6-1. The primary contaminants of concern for all matrices are metals and radionuclides. In addition, samples will be analyzed for SVOCs because of PAHs that are associated with coal ash. Groundwater samples also will be analyzed for volatile organic compounds (VOCs) for comparison with existing data from Chestnut Ridge OU 2 and the Chestnut Ridge Security Pits. Table 6-1 summarizes the sampling and analytical requirements, excluding QC samples. A detailed discussion of the number and type of QC samples is presented in the QAPjP (Table 8-6).

The following is a brief summary of the samples to be collected, analytical requirements, and other surveys and measurements to be performed.

- Two rounds of groundwater samples will be collected, one following the wet season and one following the dry season. During each round ten (total) groundwater samples will be collected from existing monitoring wells (nine site wells and one background well) and will be analyzed for total and dissolved Target Analyte List (TAL) metals, VOCs, SVOCs, isotopic uranium and isotopic thorium, and gross alpha and gross beta. Three samples will be analyzed for pesticides/polychlorinated biphenyls (PCBs); the locations of these samples will be determined in the field.
- Thirty surface water samples will be collected from Rogers Quarry, Lower MCB, and drainage ditches. The samples will be analyzed for total and dissolved TAL metals, SVOCs, gross alpha and gross beta, and isotopic uranium and isotopic thorium; three samples from Rogers Quarry and three samples from Lower MCB and the drainage ditch will also be analyzed for VOCs and pesticides/PCBs. Quarry water will be analyzed in situ for pH, temperature, dissolved oxygen and conductivity measurements in the field. Three surface water samples will be collected from Lower MCB. A minimum of 24 samples will



PROPOSED SAMPLING LOCATIONS
ROGERS QUARRY/LOWER McCOY BRANCH
CHESTNUT RIDGE OU4

CDM FEDERAL PROGRAMS CORPORATION
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FIGURE No. 6-1

Table 6-1. Summary of sample numbers, media, and parameters for chemical analysis

Parameters	Media			
	Groundwater[a]	Surface water	Sediment	Tissue
TAL[b] metals				
Total	20	30	14	48[c]
Dissolved	20	30		
Gross alpha-beta	20	30	14	
Isotopic uranium	20	30	14	
Isotopic thorium	20	30	14	
VOCs[d] (CLP[e])	20	3	3	
SVOCs[f] (CLP)	20	30	14	3
Pesticides, PCBs[g] (CLP)	3	3	3	
Dissolved oxygen, pH, temperature, conductivity		30		

[a]Numbers reflect two rounds of sampling; all other media are sampled only once.
[b]TAL = Target Analyte List.
[c]Metals to be quantified include only arsenic, cadmium, chromium, lead, mercury, selenium, and thallium.
[d]VOC = volatile organic compound.
[e]CLP = Contract Laboratory Program.
[f]SVOC = semivolatile organic compound.
[g]PCB = polychlorinated biphenyl.

be collected from 4 random locations within the quarry, and 2 samples will be collected from the drainage ditch south of and roughly parallel to Bethel Valley Road. One additional control drainage ditch sample will be collected from a similar drainage ditch away from the site and all other known waste sites. All parameters, including VOCs and PCBs/pesticides will be measured. Additional samples from the quarry may be taken on the basis of the underwater survey data.

- Fourteen sediment samples will be collected from Rogers Quarry, Lower MCB, and the same drainage ditches. The samples will be analyzed for TAL metals, SVOCs, gross alpha and gross beta, isotopic uranium, and isotopic thorium. Three samples from Rogers Quarry and four of the samples from Lower MCB and drainage ditch locations will also be analyzed for VOCs and pesticides/PCBs. Two samples will be taken from each of the four locations in Rogers Quarry; three samples from Lower MCB and three drainage ditch samples, including the control ditch. Additional samples from the quarry may be taken on the basis of underwater survey data.

- Forty-eight (total) fish tissue samples (whole body)—which will be collected from Rogers Quarry, Lower MCB, and a reference location—will be analyzed for arsenic, cadmium, chromium, lead, mercury, selenium, and thallium. Isotopic uranium and thorium do not bioaccumulate and therefore will not be analyzed. Data from OU 2 will be used for comparison.

- Two duplicate clam tissue samples, which will be collected from the in situ bioassay at the outfall from Rogers Quarry, will be analyzed for PAHs only; clams are known to accumulate PAHs. One sample will be collected from exposure at a reference location on Hinds Creek, and one control (QC) sample will be analyzed.

- A qualitative fish survey of Rogers Quarry to determine numbers and diversity will be conducted via electrofishing, preferably during the spring.

- A fish pathology study of deformed fish will be conducted by an independent expert to evaluate the source of fish pathology in Rogers Quarry.

- A qualitative terrestrial predator survey will be conducted around Rogers Quarry using scent-station transects; an avian survey also will be conducted by an experienced ornithologist with emphasis on identification of piscivorous bird species.

- A wetlands survey will be conducted according to conventional methods for identifying delineating wetlands; terrestrial vegetation will also be identified/described.

- A threatened and endangered species and habitat survey of the site also will be conducted.

In addition, biological data on Rogers Quarry and Lower MCB collected as part of the ongoing ORR-wide BMAP will be available for consideration and evaluation of site characteristics. These data include the results of benthic surveys and aquatic-toxicity tests that are conducted quarterly.

6.3 DATA EVALUATION AND INTERPRETATION

Data interpretation and evaluation will vary depending on the type of data. Groundwater data will be evaluated for presence of contaminants and possible flow direction. Results of the water balance study will help clarify the hydraulics of Rogers Quarry and its relationship to local groundwater flow direction. The results will build upon and be compared to the results of previous studies conducted when the quarry was an active disposal site. The impacts of ending disposals on quarry water balance will be assessed.

Results of in situ physico-chemical measurements in Rogers Quarry will demonstrate the presence or absence of stratification within the quarry. Analytical data from locations where historical data are available will be plotted to evaluate any trends that may exist.

In general, site data will be compared to previously collected data from the site and background data or data collected or available from other reference locations to evaluate the presence and potential impacts of site contaminants. Graphical tools and statistical analysis methods will be used, as appropriate, to facilitate presentation and interpretation of the results.

6.4 RISK ASSESSMENT METHODOLOGY

6.4.1 Baseline Human Health Risk Assessment

A baseline HHRA will be prepared for OU 4 using data collected during the RI. The methodology employed to conduct the risk assessment will follow the guidelines established in the *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part A)* (EPA 1989a). In addition, recommendations from the ER Risk Assessment Council and other supporting documentation will be followed.

6.4.2 Ecological Risk Assessment Methodology

A baseline ERA will be performed for this OU because of the manifest effects on fish in the OU and because it is an integrator OU for the ash deposited on Chestnut Ridge, in the Filled Coal Ash Pond, and directly in the quarry. In addition, this OU is a potential source of contaminants to the Clinch River Off-Site OU. Risk assessments for this OU will serve the needs for source characterization of the assessments of off-site risks.

An ERA for waste sites differs from an HHRA in that the consequences of the risks can be measured. Biological surveys provide a direct measure of the state of the biotic communities that constitute the ecological assessment endpoints. Hence, ecological epidemiology will be employed (Suter 1990; Suter 1992; Suter and Loar 1992). In ecological epidemiology, the primary data are the field survey data that indicate the actual state of the system relative to the expected uncontaminated state. Other data are used to support inferences concerning the causes of any deviations from the expected state. This approach is consistent with the *Risk Assessment Guidance for Superfund, Volume II: Environmental Evaluation Manual* (EPA 1989b).

The goals of the baseline risk assessment will be (1) to determine whether significant ecological effects are occurring in the OU, (2) to determine the cause of any such effects,

(3) to determine the source of that causal agent, and (4) to determine the consequences of leaving the system unremediated. This calls for an epidemiological approach based on weight of evidence. New and historical biological survey data will be compared to data from reference sites to determine the nature and magnitude of effects. Alternative causal factors such as habitat quality will be considered. The ambient water toxicity data will be used to determine whether apparent ambient toxic effects of particular sources are credible given the toxicity of the source water and diluted source water in the OU. Comparisons of the aquatic toxicological benchmarks to water concentrations will be used to determine which particular contaminants are responsible for the toxicity.

Because biological surveys would not reveal effects on piscivorous wildlife (densities are too low), and toxicity tests are not feasible for piscivorous wildlife, risk assessment will be based on contaminant concentrations in fish, dietary exposure models, and toxicological benchmarks for wildlife. The representative piscivorous species will be the belted kingfisher (*Ceryle alcyon*) and mink (*Mustela vison*).

6.5 FEASIBILITY STUDY

The following sections (Sects. 6.5.1 and 6.5.2) describe the tasks necessary to conduct and produce the FS report. The report will follow the format outlined in EPA's *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (EPA 1988) and the annotated outline developed by the DOE-ORO Document Content and Response Committee. The FS report will be prepared to integrate Natural Resource Damage Assessment (NRDA) and NEPA requirements. When EPA and TDEC approve the FS, a proposed plan will be submitted presenting the preferred alternative for a remedial action followed by a ROD.

6.5.1 FS Contractor Responsibilities

The FS contractor will prepare the FS within project quality, cost, and scheduling goals. The FS contractor will also provide engineering and technical resources to support QC efforts, provide project management, and coordinate project activities to ensure that established goals are achieved. Monthly progress reports on the FS process will be issued to DOE. FS contractor activities for Chestnut Ridge OU 4 include scoping activities and technical support of the RI and will be completed upon final approval of the ROD prepared for this OU.

6.5.2 Scope and Assumptions

As stated in Sect. 5.2, the general goal for Chestnut Ridge OU 4 remedial action is to protect human health and the environment from the contaminant sources within the OU. To meet this goal, the CERCLA process will be followed. The process will include characterization of this source control OU to the extent necessary to (1) identify, screen, and develop remedial action alternatives; (2) select a preferred remedial alternative or a set of alternatives; and (3) prepare the required decision documents.

The FS contractor will be responsible for completing the FS process for Chestnut Ridge OU 4. This process will require preparing the following milestone documents: (1) the FS Report, which documents the process used to examine the remedial technologies and select the preferred remedial alternative(s) and also incorporates the requirements under NRDA and NEPA; (2) the Proposed Plan, which is a summary plan for presenting the selected remedial alternative; and (3) the ROD, which is the legal document that confirms selected remediation methods meet statutory and regulatory requirements. The FS/proposed plan/ROD process may include the following principal Work Breakdown Structure elements:

- FS scoping activities
- Treatability studies
- FS development
- NEPA activities
- NRDA activities
- FS OU coordination/oversight
- Proposed plan development
- ROD development.

6.5.2.1 FS scoping activities

Preliminary remedial alternatives have been selected to address the response actions for Chestnut Ridge OU 4. The response actions are listed in Sect. 5.3 and in Table 5-1. These or similar alternatives will be screened as part of the FS process to eliminate those judged too difficult to implement based on unproved technologies, those judged insufficient to remediate the site within a reasonable time period, or those judged to have limited application for the specific contaminant or site conditions. Those technologies judged to have a reasonable chance of success for remediation will be carried forward for more detailed development and analysis.

The following issues must be addressed before the technologies can undergo detailed development and analysis. This list may change as additional information becomes available.

- Results of the HHRA
- Results of the ERA
- Groundwater characteristics
- Groundwater quality
- Surface water quality
- Presence of classified material
- Possible treatability studies.

6.5.2.2 Treatability studies

If necessary, treatability studies will be conducted (1) to provide data to allow treatment alternatives to be fully developed and evaluated during the detailed analysis and (2) to support the remedial design of a selected alternative.

6.5.2.3 FS development

The FS contractor will use the format presented in the CERCLA RI/FS guidance document and the DOE-ORO Document Content and Response Committee FS annotated outline to develop the FS. As required, exceptions and modifications to the format will be made for site-specific conditions at Chestnut Ridge OU 4. On the basis of the data obtained during the RI, selected alternatives will be analyzed and compared using the following 11 criteria:

- Overall protection of human health and the environment
- Compliance with ARARs
- Short-term effectiveness
- Long-term effectiveness
- Reduction of contaminant toxicity, mobility, and volume
- Implementability
- Cost
- State acceptance
- Community acceptance
- Compliance with NEPA requirements
- Compliance with NRDA requirements.

NEPA and NRDA requirements are discussed in more detail in the following subsections.

The FS will be developed in sufficient detail to allow the preferred alternatives to be selected in the proposed plan. Criteria will be developed to assess the ability of the alternatives to meet the cleanup goals and to comply with administrative and regulatory requirements. The draft FS report will be issued to EPA and TDEC for review. Submittal of the draft FS report to EPA is an FFA milestone.

6.5.2.4 NEPA activities

To comply with the federal facility requirements under NEPA, the remedial alternatives will be evaluated for their impact on the environment. NEPA establishes public policies and goals for protecting environmental quality and mandates procedural requirements to be considered when implementing decisions that may impact the environment. DOE Order 5400.4 requires that NEPA and CERCLA be integrated to the maximum extent possible to avoid duplication of efforts that might slow the process. NEPA issues to be addressed include rare and endangered species, archeological studies, wetlands, and floodplains. The environmental impacts of the alternatives will be considered integral to the evaluation and selection process. The appropriate level of NEPA documentation for this OU will probably be an Environmental Assessment.

6.5.2.5 NRDA activities

To comply with NRDA, the Natural Resource Trustees may assess damages for injuries to natural resources resulting from release of hazardous substances. The first step in the NRDA process is to perform a preassessment screening. If the screening indicates that NRDA is inappropriate, no further assessment actions will be taken. However, if the preassessment screening indicates that NRDA is appropriate, a type B assessment will begin, requiring an Injury Determination phase, a Quantification phase, and a Damage Determination phase (April 29, 1991, *Federal Register*).

6.5.2.6 FS OU coordination/oversight

The objective of FS oversight activities is to provide review and technical input during the FS. This ensures that the data and information obtained during the RI are incorporated properly into the FS report and that they are adequate to prepare a proposed plan and support the development of the ROD.

6.5.2.7 Proposed plan development

The proposed plan for Chestnut Ridge OU 4 will be prepared to present the preferred remediation alternative to the public. The proposed plan documents the investigation process, administrative and regulatory actions, and remedial alternatives. The proposed plan is a primary milestone document made available for public comment and subject to administrative and regulatory reviews.

6.5.2.8 ROD development

The final step in the decision process for any remedial action for Chestnut Ridge OU 4 will be the preparation of the ROD. This legal document formally describes the preferred remediation alternative and establishes the remediation schedule and monitoring plan for the site. The Chestnut Ridge OU 4 ROD will be written in accordance with the statutory requirements of CERCLA and applicable federal and state requirements. It will contain a decision summary outlining the nature and extent of the contamination and associated risks at Chestnut Ridge OU 4, the evaluation and analysis of the Remedial Action (RA) alternatives considered, and an explanation of how the selected alternative(s) will meet statutory requirements. The ROD will also contain a responsiveness summary addressing the public comments obtained during public review of the proposed plan and public examination of the administrative record. The ROD is a primary FFA milestone.

6.6 REMEDIAL DESIGN AND RA PLAN

6.6.1 Remedial Design (RD)

This section presents the scope of the RD effort which includes preparing the RD work plan; performing any required engineering studies; preparing the Title I 30% design package; and preparing the Title II 50%, 90%, and 100% final design reports that are required for Chestnut Ridge OU 4 remediation.

6.6.1.1 Scope and assumptions

The scope of the RD work plan for the remediation of Chestnut Ridge OU 4 is to provide necessary supporting documents to implement each RA activity. These documents require approval from DOE-ORO, DOE Headquarters, TDEC, and EPA. The following sections present details of the scope of work and assumptions associated with the remediation of Chestnut Ridge OU 4.

6.6.1.2 RD work plan

The RD work plan will provide the technical and management approach for the RD work. The RD contractor will prepare a draft RD work plan based upon the scope and design criteria specified in the proposed plan and the ROD. The RD work plan will include the detailed design process and schedule for the design effort and will be prepared in accordance with CERCLA/NEPA regulations. The RD contractor will incorporate comments from Energy Systems, DOE, EPA, and TDEC and submit the final RD work plan for approval.

6.6.1.3 RD work plan oversight activities

During the preparation of the RD work plan, the DOE prime contractors will provide review and technical input to ensure that the scope of work is adequately defined in accordance with the criteria specified in the ROD. Review of the draft RD work plan will also ensure that the selected technologies do not violate the intent of the ROD and that the work plan meets all regulatory and administrative requirements.

6.6.1.4 RD report Title I design

Based on the engineering studies and other information available from the RI/FS, the RD contractor will prepare Title I (30%) design/construction drawings for remedial activities showing the extent of remedial activities, site plan, details, and outline of specifications for the work involved.

6.6.1.5 RD report Title II design

Upon approval of Title I design document, the RD contractor will prepare Title II engineering designs, analyses, and calculations required for all civil, structural, mechanical, and electrical construction, construction drawings, technical specifications, and cost estimates.

All documents will be submitted to Energy Systems for comment at 50% completion. Upon resolution of comments, the 90% design package will be submitted to Energy Systems and DOE for review and comment. Upon resolution of 90% design comments, the final design report (100%) for remedial activities will be submitted to EPA and TDEC for review and approval. Agency comments will then be incorporated to prepare design documents certified for construction.

6.6.1.6 RD oversight activities

During the review of the Title I design documents at 30% and the Title II design documents at 50% and 90%, all participants will provide their review comments and technical input to help submit the final design document to TDEC and EPA in the given time frame.

6.6.2 Remedial Action (RA)

This section presents the scope of the RA activities required to prepare an RA work plan and implement the remediation of Chestnut Ridge OU 4. The risk, uncertainties, and communication issues for the remedial activities are also identified in this section.

6.6.2.1 Scope and assumptions

The scope of the RA includes the RA work plan, construction management, Title III construction services, construction of one remediation design package, construction support, independent certification, and verification.

6.6.2.2 RA work plan

The RA work plan will (1) define the scope and objectives of the RA based upon the ROD and final RD, (2) document the specific construction components of the RA, and (3) present the RA schedule, subcontracting strategy, QA plan, health and safety plan, and RA monitoring plan.

After comments from EPA and TDEC have been incorporated, the final RA work plan will be prepared for approval and implementation.

6.6.2.3 RA work plan oversight activities

The purpose of this activity is to provide technical input and review during the preparation of the RA work plan. During this time, all of the DOE prime contractors will review the work plan. This will ensure that the proposed construction efforts implement the selected remedial action consistent with the ROD and the final RD report. This oversight activity will also help ensure that the bid process and implementation plans comply with administrative and regulatory requirements.

6.6.2.4 RA integration

The objective of this element is to provide construction management, independent certification, Title III services, and construction support as required.

RA integration for Chestnut Ridge OU 4 remedial activities includes the following tasks:

- Ensuring that subcontracted work is performed on schedule, in accordance with all technical requirements, and in compliance with the Environmental Safety and Health Program, the QA Program, the Waste Management Program, and the Security Program
- Performing field inspections, providing as-built drawings, approving Design Change Notices and Field Change Requests as applicable, and ensuring that construction is accomplished according to final design requirements.

7. FIELD SAMPLING PLAN

7.1 INTRODUCTION

Chestnut Ridge OU 4 includes Rogers Quarry and Lower MCB. Rogers Quarry was excavated for construction material until approximately 1960 and subsequently has been used for disposal of coal ash and other materials from the Y-12 Plant. MCB originally flowed directly into Melton Hill Lake from the coal ash pond, but it was diverted into Rogers Quarry coincident with the abandonment of the pond for ash disposal. Rogers Quarry is on the north side of Bethel Valley Road ~ 1 mile south of the Y-12 Plant. The lower portion of MCB runs from the discharge point on the south side of Rogers Quarry to the MCB Embayment in Melton Hill Lake.

The purpose of the RI is to define the nature and extent of contamination in Chestnut Ridge OU 4; to gather information to assess the potential for off-site contaminant migration; to evaluate potential risk to human health and the environment from site contaminants; and to comply with the requirements of the FFA between DOE, EPA, and TDEC as described in more detail in Chap. 1 of the RI work plan.

This field sampling plan describes in detail the activities necessary to complete the RI at the site. Sampling procedures and the QAPjP are specific to the planned investigation and are consistent with current Energy Systems procedures and regulatory requirements.

This field sampling plan was developed to meet the following major data requirements:

- Ecological data on aquatic and terrestrial systems of Rogers Quarry and Lower MCB needed to perform an ERA and, secondarily, the HHRA
- Surface water/sediment and groundwater quality data needed to support both the ERA and HHRA
- Hydrologic measurements needed to better define transport mechanisms in support of the ERA and HHRA.

All of these data are needed to determine the risk associated with the no action alternative and to establish remediation goals for the FS. The results of the underwater survey will be used (1) to examine possible hazards buried in the coal ash, (2) to assess the accuracy of existing data on the volume of coal ash in Rogers Quarry and (3) to determine if additional direct measurements are needed. Coal ash/sediment in the quarry will be analyzed to a limited extent. The Phase II RI of Chestnut Ridge OU 2 (Filled Coal Ash Pond/Upper MCB) will include extensive analyses of coal ash and other media; these data will be available and will be used as appropriate in the evaluation of the data collected on OU 4.

Specific media to be sampled and biological measurements to be made include these:

- Groundwater
- Surface water/sediment
- Threatened and endangered species and habitat survey
- Wetlands survey
- In situ bioaccumulation testing of clams
- Surface water flow
- Groundwater and surface water elevation
- Fish pathology studies of deformed specimens
- Biochemical studies of fish tissue
- Qualitative fish survey in Rogers Quarry
- Qualitative predator survey
- Fish whole body contaminant analyses.

7.2 PROJECT ORGANIZATION AND RESPONSIBILITIES

The principal CDM Federal personnel assigned to prepare the work plan are Richard C. Johnson (Program Manager), Mary Leslie (Y-12 Program Coordinator), Charles T. Lutz (Project Manager, Hydrogeologist), David O. Johnson (QA Manager), and Charles Meyers (Health and Safety Manager). The Site Health and Safety Coordinator and the Field Task Manager will be designated at the beginning of mobilization for the fieldwork. Section 1.2 discusses the roles of DOE, Energy Systems, prime contractors, and other subcontractors in the ORR Environmental Restoration Program. Responsibilities of key individuals listed above and an organizational chart are included in the QAPjP, Chap. 8.

7.3 PROJECT DESCRIPTION

7.3.1 History and Current Conditions

The Ralph Rogers Company operated the quarry from the late 1940s or early 1950s until approximately 1960 and mined limestone for road gravel and construction purposes. Coal ash from the Y-12 Steam Plant has been disposed of in the quarry on a regular basis since 1968 when the coal ash pond (now Chestnut Ridge OU 2) just north of the quarry reached capacity and could no longer be used for coal ash disposal. Some documentation exists on sporadic disposal earlier than 1964 (Pokela 1967). The volume of coal ash disposal in the quarry has reduced substantially since November 1988, when the Y-12 Plant started to convert the Steam Plant to 80% firing by natural gas. In addition, fly ash collection started at the Steam Plant in May 1990. Fly ash, which accounts for ~80% of coal ash, is now collected in hoppers for dry disposal at the Y-12 Sanitary Landfill II. Coal ash disposal will end altogether in July 1993.

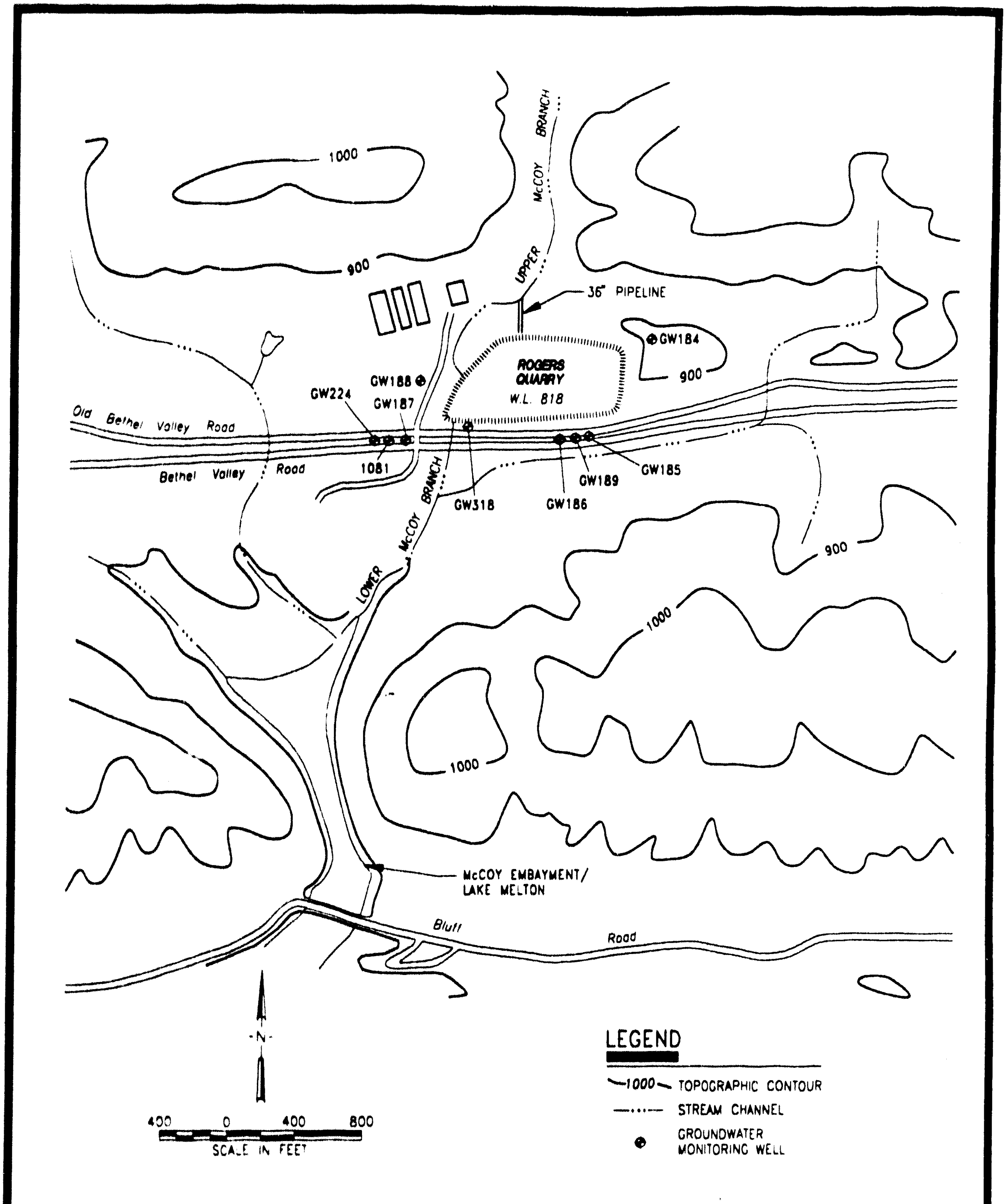
Rogers Quarry also has been used for the disposal of a variety of plant process materials, including spent rounds of ammunition from plant security operations. Some of the objects placed in the quarry are classified; classification resulted not from the composition of the objects but rather from their configuration and its relationship to production processes. Disposal of these types of materials started in 1965 and continued until 1982. Despite the classified nature of some of these objects, potential contaminants of concern are known and include metals and radionuclides. Chap:er 2 provides additional information on both coal ash and noncoal ash disposal in Rogers Quarry.

Several studies have been conducted at OU 4 to evaluate the impact of waste disposal practices on local groundwater (Haase et al. 1987), MCB (Turner et al. 1986), the quarry water balance (Bogle and Turner 1989), and discharge from the quarry to Lower MCB (Turner, Bogle, and Lu 1993). Ten monitoring wells have been installed around the quarry (Fig. 7-1) in support of these investigations; most of the wells have been sampled subsequently for the ongoing ORR groundwater monitoring program. The previous studies have generally concluded that the connection between water in the quarry and local groundwater is relatively limited. Contaminants of concern (i.e., metals and radionuclides) have been detected in samples from the monitoring wells, but concentrations are typically relatively low and do not generally exceed MCLs.

The water balance study concluded that the quarry may act as a recharge for groundwater because of a slight negative deficit, but the deficit was quite low with respect to measured inputs and outputs and may be within measurement error. The quality of quarry discharge at the NPDES outfall (5-19) has been an ongoing problem, particularly with respect to pH exceedances (Turner, Bogle, and Lu 1993). Other parameters and compounds have also exceeded the NPDES permit limits, but a trend showing general improvement in water quality has been developing likely resulting from the reductions in disposal volume since 1990.

Chestnut Ridge OU 2, the Filled Coal Ash Pond, has also been investigated previously. Turner (1981) and Turner et al. (1982) investigated, respectively, the oxidation state of arsenic in coal ash leachate and the leachability and aqueous speciation of some trace constituents in the fly ash. These studies included sampling and analysis of coal ash and pore water and the installation of two piezometers (i.e., wells of polyvinylchloride construction) in the coal ash pond. Geotek Engineering Company (1986) conducted a geotechnical and hydrologic evaluation of the coal ash pond dam across MCB. The purpose of this study was to evaluate the overall stability of the earthen dam structure and to provide recommendations for any necessary remedial action or monitoring.

CH2M HILL conducted an RI at the coal ash pond in 1990 and 1991 (CH2M HILL 1991) to define the nature and extent of contamination at the site and to assess the potential for off-site migration of contaminants. Analyses of coal ash samples collected during the study indicated elevated concentrations of metals relative to background samples. Several metals, including arsenic, copper, nickel, magnesium and zinc, exhibited elevated concentrations in soil samples taken from below the coal ash. Surface water contained arsenic, aluminum, manganese, and iron at levels exceeding one or more regulatory standards for surface waters. Concentrations were greatest at the foot of the earthen dam. Groundwater samples from monitoring wells screened in overburden also exhibited elevated metals concentrations; samples from monitoring wells screened in bedrock typically had lower metals concentrations.



MONITORING WELL LOCATION MAP
ROGERS QUARRY/LOWER McCOY BRANCH
CHESTNUT RIDGE OU4

CDM FEDERAL PROGRAMS CORPORATION
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FIGURE No. 7-1

A Phase II RI will be conducted during the late spring and early summer of 1993, following a work plan (DOE 1992) that addresses concerns and deficiencies raised by the regulators in their review of the previous RI report. The Phase II RI will include sampling of coal ash, soil, sediments, surface water, groundwater, and biota. The purpose of collecting these data will be to define fully the nature and extent of contaminants from the coal ash pond and the extent of coal ash deposition along Upper MCB and to support both an ERA and HHRA. Results from both RIs at the coal ash pond will be used as much as possible during the investigation and evaluation of OU 4.

7.3.2 Conceptual Site Model

The generalized CSM is shown in Fig. 3-7. The conceptual exposure models for human and nonhuman receptors for the quarry (see Figs. 3-8 and 3-9) consider five media potentially contaminated by the coal ash: groundwater, sediment/soil, air, surface water, and biota. A number of release mechanisms could introduce ash or contaminants from the quarry into these media, particularly to the groundwater and surface water. Volatilization is not considered to be a significant mechanism because VOCs have not been identified in samples taken during previous investigations. Sediment/contaminant transport from the quarry is not considered to be a primary mechanism because contaminants, coal ash, and other disposed materials are at the bottom of the quarry and are not in contact with turbulent water. Contaminants could be carried by surface water, either in solution or as suspended sediments. Groundwater could potentially transport contaminants off-site. Exposure pathways include ingestion/bioaccumulation, dermal absorption, and potential inhalation of contaminated dust/particulates.

Flora and fauna both on-site and off-site may be influenced by site contaminants via these exposure pathways. Aquatic and terrestrial species may be exposed via uptake of contaminated surface water, soil/sediment, and/or vegetation, which may result in toxicity or bioaccumulation of contaminants up the food chain. These exposure pathways are currently complete and will be evaluated in the ERA based on the data to be collected.

Under current conditions, human receptors of contaminants from the various exposure pathways are few and, therefore, exposure pathways are essentially incomplete. There are no residences or drinking water supplies on the ORR, and security precautions at the Oak Ridge Y-12 Plant restrict access to the site. Although security procedures minimize exposure potential, the model includes future residential use, and the HHRA will address potential future use of the site under a homesteader scenario.

7.3.3 Identification of Investigation Requirements

7.3.3.1 Applicable or relevant and appropriate requirements (ARARs)

CERCLA specifies that remedial actions for cleanup of hazardous substances must comply with requirements or standards under federal or more stringent state environmental laws that are applicable or relevant and appropriate. The following is a preliminary list of federal and state chemical- and location-specific ARARs for Chestnut Ridge OU 4:

- National Contingency Plan
- National Environmental Policy Act

- CERCLA
- RCRA
- Safe Drinking Water Act
- Clean Water Act
- Clean Air Act
- TDEC, Chapter 1200-4-6-.05(2)
- TDEC, Chapter 1200-5-1.12
- TDEC, Chapter 1200-1-13-.08(4) (proposed)
- TDEC, Chapters 1200-4-3 and 1200-4-4
- TDEC, Chapter 1200-1-13 (proposed)
- TDEC, Chapters 4-7 et seq.
- Toxic Substances Control Act.

The relevance of each of these federal or state laws or regulations is presented and discussed in Appendix B.

7.3.3.2 Treatment alternatives

The contaminants within Rogers Quarry may be carried to potential receptors by surface water either in solution or as suspended sediments, by groundwater migration, or by dermal contact. The implementation of any of several classes of remedial technologies could minimize these hazards: (1) institutional controls, such as fences and deed restrictions; (2) containment technologies, such as capping, vertical barriers, and horizontal barriers; (3) removal technologies, such as excavation; and (4) treatment technologies, such as solidification/stabilization and biological, thermal, and electrical methods. Chapter 5 provides a complete discussion and additional detail on the selection of remedial alternatives.

7.4 SITE ACTION PLAN

The activities included in the RI are based on a review of existing data and discussions with Energy Systems personnel. The ultimate goal of the RI is to gather data for full site characterization and to complete an ERA and an HHRA.

The primary contaminants of concern for all matrices are metals and radionuclides. Therefore, all samples will be analyzed for TAL metals, gross alpha and gross beta, and isotopic uranium and isotopic thorium. A review of compositional data on coal ash indicated that uranium and thorium are common constituents. PAHs, a group of SVOCs, have not been identified in any of the previous samples; however, PAHs will be considered because they may form during high temperature coal combustion and adsorb to fly ash. Therefore, most samples will be analyzed for SVOCs. Groundwater samples will be analyzed for VOCs to determine their presence or absence and for comparison with data from Chestnut Ridge OU 1 and OU 2; one groundwater sample will be analyzed for pesticides/PCBs. In addition, VOCs and pesticides/PCBs will be analyzed on at least one sample from each of the other matrices collected (surface water and sediment). Biological samples will be analyzed for parameters relevant to toxicity and bioaccumulation: metals and PAHs.

A minimum of eight core samples (two samples each at four locations) of the sediment will be collected at randomly selected locations within the quarry. Water samples will be collected at 25-ft intervals from the surface to a depth of 100 ft and then at ~110 ft, just above the sediments/coal ash at these locations. Additional water and sediment samples may be taken on the basis of the results from the wastewater survey. Water quality parameters will be measured in situ (pH, dissolved oxygen, temperature, and conductivity) at each interval. Groundwater samples will be taken from nine of the existing wells adjacent to the quarry and from one background location. Three surface water/sediment samples will be collected along Lower MCB. These locations will coincide with the current BMAP biological monitoring locations. Two surface water/sediment samples will be collected from the drainage ditch south of the quarry and roughly parallel to Bethel Valley Road. A variety of biological tests and surveys will be performed including whole body fish tissue analyses, in situ bioaccumulation testing with clams, fish pathology studies, biochemical studies, qualitative fish and predator surveys, threatened and endangered species survey, a wetlands survey, and the ongoing BMAP work (benthic survey and aquatic toxicity testing). Finally, various hydrologic measurements will be conducted for a water balance study of Rogers Quarry.

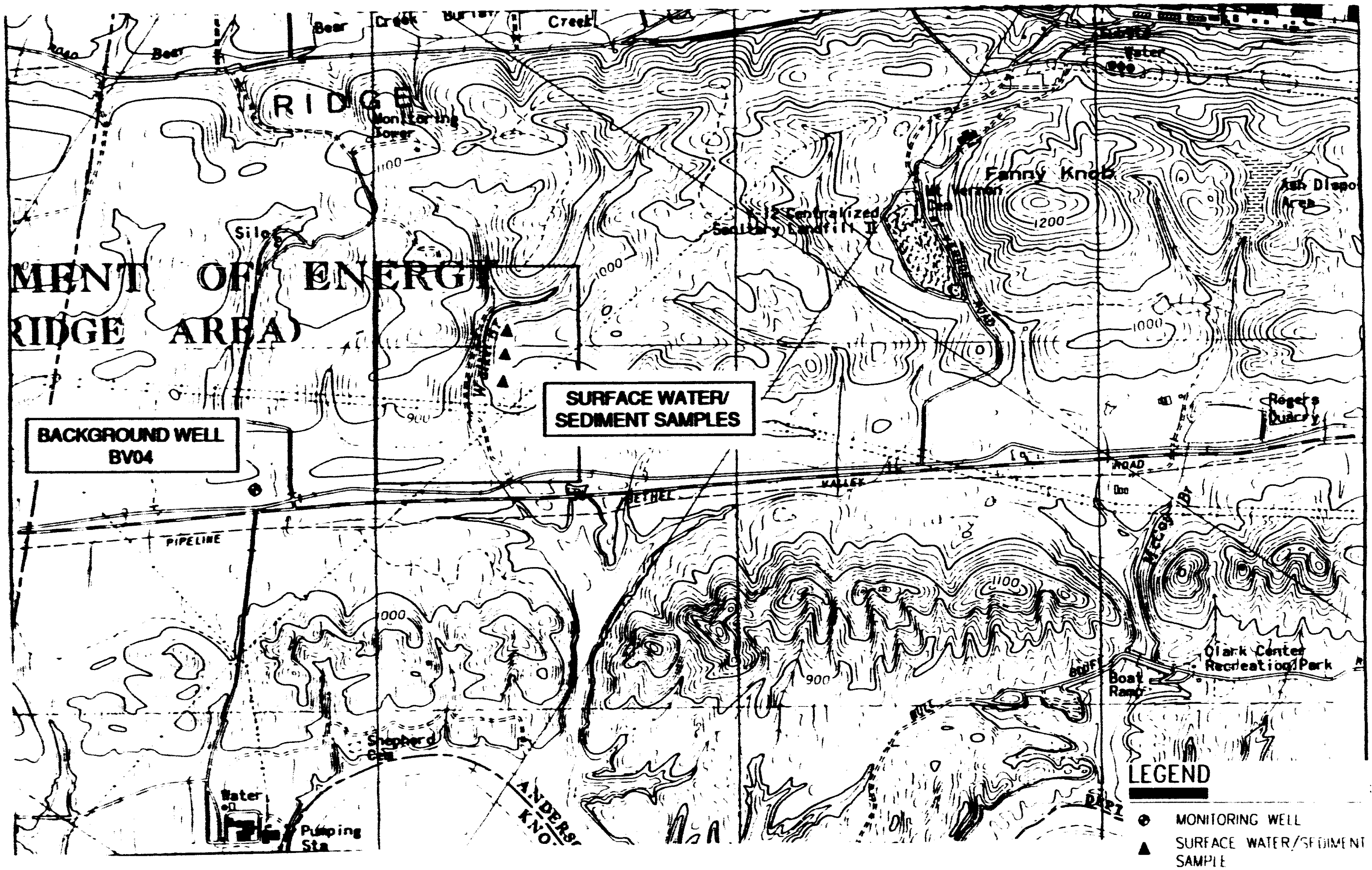
Details of each of the sampling activities follow. (Figure 6-1 shows the proposed sampling locations and Table 6-1 provides a summary of samples by media.) Figure 7-2 shows the locations of the background samples, including locations where background surface water/sediment samples were collected in conjunction with the Chestnut Ridge OU 2 RI. These results will be used in lieu of collecting additional background samples. QC samples and frequencies are discussed in the QAPjP (Chap. 8).

7.4.1 Groundwater Sampling

Two rounds of groundwater sampling will be conducted, one following the dry season and one following the wet season. The purpose of two sampling rounds is to determine if there is seasonal variation in groundwater quality. Haase et al. (1987) concluded that Rogers Quarry may act as a recharge to local groundwater, especially during periods of low precipitation. The two sampling rounds will provide data that may confirm or deny this conclusion and help to clarify the hydrology in the vicinity of the quarry. Section 3.6 provides additional information on the monitoring wells; Appendix A summarizes the results of analyses from previous sampling rounds.

Ten monitoring wells will be sampled; nine wells are on-site (1081, GW 184, GW 185, GW 186, GW 187, GW 188, GW 189, GW 224, and GW 318) and one well (BV 04) is off-site and will be used for background data. The off-site well is screened in the Chickamauga Group (as are all the wells at OU 4) and is located in Bethel Valley several miles west of OU 4. This well was selected as a background or control well because it will sample groundwater from the same stratigraphic interval as the wells at OU 4, and it is distant from the quarry.

One well at OU 4, GW 319, will not be sampled because Energy Systems personnel familiar with the site believe that the well is actually sampling quarry water since it was installed within 15 ft of the blasted vertical wall of the quarry (Turner 1993). In addition, it may not be possible to sample GW 185 because this well has a record of consistently being



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BACKGROUND SAMPLING LOCATIONS
ROGERS QUARRY/LOWER McCOY BRANCH
CHESTNUT RIDGE OU4

FIGURE No. 7-2

dry (Haase et al. 1987) or nearly so. Field personnel will take a water level measurement to determine if any standing water is in the well and, if so, whether there is a sufficient volume for purging and sampling. The integrity of GW 184 is considered to be suspect based on sudden and unusually high concentrations of nitrate in samples from it (Haase et al. 1987); however, this well will be sampled because it is the only well near the northern and eastern walls of the quarry. Given the uncertainties associated with some of the previous results from GW 184, the data from this well may be flagged accordingly.

Groundwater samples will be analyzed for total and dissolved metals, gross alpha and gross beta, isotopic uranium, isotopic thorium, VOCs, and SVOCs. Samples for dissolved metals will be filtered at the time of collection, using a 0.45 μm in-line filter or its equivalent. Three samples will be analyzed for pesticides/PCBs; the location of this sample will be randomly selected in the field. All wells will be purged and sampled using a bladder pump operated at a low flow rate to minimize groundwater turbidity and maximize analytical accuracy. Puls and Powell (1992) discuss the advantages of this approach to monitoring well sampling.

7.4.2 Surface Water/Sediment Sampling

The extent and transport of contaminants from Rogers Quarry through surface water discharge will be investigated by taking three surface water/sediment samples along Lower MCB at the BMAP monitoring stations. Two surface water/sediment samples will be collected from the drainage ditch immediately south of and roughly parallel to Bethel Valley Road. This ditch generally has standing water in it, and the purpose of the samples will be to determine if any contaminants are being contributed from the quarry through seepage via bedrock fractures. In addition, a control ditch surface water/sediment sample will be collected for comparison. The control ditch will be of similar configuration and distant from all known waste sites.

Each sediment sample will be composited from three aliquots. These samples will provide information concerning the extent and transport of contaminants from the quarry through the surface water discharge from Rogers Quarry. These samples will be analyzed for total and dissolved TAL metals, SVOCs, gross alpha and gross beta, and isotopic uranium and isotopic thorium. Four surface water and four sediment samples will be analyzed for VOCs and pesticides/PCBs.

7.4.3 Remote Surveillance System Surveys

A survey of Rogers Quarry will be conducted to provide more accurate documentation on the spatial distribution, amount, and types of materials present. The information obtained from the survey may be used to select additional sampling locations in the quarry (see Sect. 7.4.4) and will be useful during the evaluation of remedial alternatives. Video surveys have been successfully conducted at nearby Kerr Hollow Quarry. The Robotics and Process Systems Division of Energy Systems could provide appropriate support for such a survey.

On the basis of discussions with Energy Systems and subcontractor personnel on March 30, 1993, Perry Technologies of Riviera Beach, Florida, is currently preparing a plan for a survey of Rogers Quarry. Perry Technologies has over 30 years of experience in underwater investigations. The proposed plan will likely include a video survey, a radiological survey, a magnetometer survey, and a sonar survey.

7.4.4 Quarry Sampling

Both water and sediment samples will be taken from Rogers Quarry to evaluate the quality of these media and the presence or absence of contaminants. Given the disposal history of Rogers Quarry, it is likely that the sediment samples will consist largely of coal ash. Initially, the quarry will be divided into four roughly equal quadrants. One location will be randomly selected from each of the quadrants. Additional sample locations may be added based on the results of the underwater survey in the quarry. For example, if the radiological and/or magnetometer surveys identify "hot spots," samples will be taken from these locations.

The depths for collection of water samples from the quarry will vary depending on limnological conditions at the time of sampling. If the water column is isothermal, as is expected during the winter months, samples will be collected at regular intervals, approximately every 25 in. to depth (1 ft, 25 ft, 50 ft, 75 ft, and 100 ft). Assuming an average depth to sediments of ~110 ft, based on the 1986 survey of the quarry (drawings CZE 135109 and CZE 135110), an additional sample will be taken at each location from a depth of 110 ft, for a total of six samples from each location. Every effort will be made to maintain this sampling interval, but variations may be necessary due to local depth variations. If sampling occurs during the summer months and the quarry is stratified, the depth of the thermocline will be determined based on temperature, dissolved oxygen, and conductivity measurements. Sample collection locations will be distributed above and below the thermocline to best characterize the water column. The preference is to collect samples when the quarry is stratified to characterize the worst case scenario. All water samples from the quarry will be analyzed for total and dissolved TAL metals, SVOCs, gross alpha and gross beta, and isotopic uranium and isotopic thorium. Three samples will be analyzed for VOCs and pesticides/PCBs. Field measurements of conductivity, dissolved oxygen, pH, and temperature also will be taken at each interval. Appendix C outlines the EPA SOPs for the dissolved oxygen method. These samples will provide information on the water quality across a depth profile of the quarry.

Quarry sediment samples will be taken at the same locations as the water samples using a coring device. Two samples will be taken from each core, one from at or near the sediment/water interface and the other from 2 to 3 ft below the interface. Both bulk sediment and pore water will be analyzed from each sample. Turner (1981) demonstrated that coal ash pore water has relatively high concentrations of arsenic (III), which is considerably more toxic than other forms of arsenic and may be a concern with regard to human health and the environment; the pore water samples will provide data to evaluate this possibility.

Samples will be analyzed for total and dissolved TAL metals, SVOCs, gross alpha and gross beta, isotopic uranium and isotopic thorium. Three samples will be analyzed for VOCs and pesticides/PCBs. These data will provide information on the nature of the contaminants within the sediments of the quarry.

7.4.5 Quarry Water Balance Study

A water balance study will be conducted to estimate the water loss to groundwater from Rogers Quarry and to evaluate the extent of contaminant migration from the quarry. Two previous water balance studies (Craig and Tschantz 1986; Bogle and Turner 1989) have been conducted at Rogers Quarry, but both studies were conducted when the quarry was an active disposal site. This RI will be conducted after the termination of coal ash sluicing and disposal;

therefore, it is possible that the water balance may differ considerably from the earlier studies. To characterize the site accurately and to evaluate remedial alternatives effectively, another study will be necessary.

The water balance study will use an approach similar to the study of Bogle and Turner (1989); one of the investigators (Turner) has offered assistance in the initial setup of the study. Measurement devices installed in the 1980s at the quarry will be used to measure inflow and outflow. These devices include a 36-in. Palmer-Bowlus invert flume and a Cipolletti weir with a 36-in. crest. A rain gauge will be installed at the quarry to measure precipitation; other rain gauges in the nearby Walker Branch watershed also may be available for use in the study. Evaporation will be estimated using available meteorological data and possibly the Class A evaporation pan that is maintained by The University of Tennessee, Department of Plant and Soil Science, and that was used in the Bogle and Turner study. Groundwater level measurements will also be obtained from the wells in OU 4. The exact duration of the study has not been established; one year is a likely minimum.

7.4.6 Background Surface Water/Sediment Sampling

Background surface water and sediment samples for comparison to Upper MCB and Lower MCB samples will not be collected during this RI. These data will be collected from Walker Branch during the Phase II RI of Chestnut Ridge OU 2 to be conducted during the spring and summer of 1993.

7.4.7 Ecological Surveys

A number of ecological surveys will be conducted during the RI including a qualitative fish population survey in Rogers Quarry, a qualitative terrestrial predator survey around Rogers Quarry, a threatened and endangered species survey, and a wetlands survey. The fish population survey will be conducted by electroshocking and/or by hook and line and will be used to determine the number and diversity of fish present, preferably during the spring months. The qualitative predator survey will be conducted using scent-station transects and direct observation of avian species present; the presence of piscivorous bird species is of particular interest. Other terrestrial species, such as mink and raccoon, who may be year-round residents, are also of interest.

The threatened and endangered species and wetlands surveys will be conducted throughout all aquatic and terrestrial zones at OU 4. Concurrent with these surveys, a qualitative description of the terrestrial and aquatic communities will be prepared.

7.4.8 Bioaccumulation Testing

Two types of bioaccumulation studies will be performed: whole body tissue analyses of fish from Rogers Quarry and in situ bioassay testing with clams. The whole body tissue analyses will include a species of sunfish and a minnow species. Eight samples (one fish/sample) of each species will be collected from Rogers Quarry from Lower MCB (assuming they are present) and a reference location on Hinds Creek; a total of 48 fish tissue samples will be collected and analyzed for As, Cd, Cr, Pb, Hg, Se, and Tl. Hinds Creek serves as a reference location for the BMAP. A total of four clam tissue samples will be collected during the in situ bioaccumulation study for PAH analyses only. Two duplicate samples will be analyzed from the exposure site; one sample will come from exposure at a reference location, and one sample will be a control prepared from unexposed specimens.

7.4.9 Fish Pathology Studies

Fish deformities have been noted in specimens of bass, in particular, collected during previous BMAP events. Deformities are predominantly found in bony structures in the head region and as eroded fins. In order to better understand the cause of these deformities, an expert fish pathologist will be engaged to perform fish pathology studies of deformed specimens from Rogers Quarry.

7.4.10 BMAP Studies

The results of the ongoing BMAP work around Rogers Quarry will be available for inclusion in the site characterization database of OU 4. These data will include the results of quarterly aquatic toxicity testing with *Ceriodaphnia dubia* in MCB above and below the quarry and benthic macroinvertebrate community assessments, at a minimum. Additional, ad hoc investigations may be performed including reintroduction of fish into Upper MCB, fish population surveys, and snail release studies. These studies and surveys are not considered to be within the scope of the RI but rather will augment the ecological data that will specifically be collected during the RI.

7.4.11 Sampling and Procedures Analysis

7.4.11.1 Sampling procedures

All surface water, sediment, and groundwater sampling will be conducted using the media-specific SOPs provided in *Environmental Surveillance Procedures* (ESPs), *Quality Control Program*, ESH/Sub/87-21706/1 (Energy Systems 1990a). Several additional procedures found in an ER procedures manual are also relevant to this project. Applicable SOPs from both documents are the following:

- Surface Water and Sediment Sampling: ESP-301-1, ESP-301-4, and ESP-304-1
- Stream Flow Measurement: ESP-301-5
- Water Level Measurement: ESP-302-1
- Well Purging: ESP-302-2, Temperature: ESP-307-1, pH: ESP-307-2, and Oxidation/ Reduction Potential: ESP-307-5
- Groundwater Sampling with Pumps: ESP-302-4 and ESP-302-5
- Groundwater Sampling with Bailers: ESP-302-3
- Groundwater Sampling: Energy Systems SOP No. 8102.R2
- Field Equipment Decontamination: ESP-900 and ESP-901
- Waste Removal and Disposition through the Y-12 ER Program: ER/Y-P2102
- Handling Investigation-Derived Waste: ESP-1000
- Field Sampling and Analytical Processes within Environmental Restoration: ER/C-S2301.

In addition, the following Energy Systems procedure is applicable: "Sample Classifying, Packaging, Marking, Labeling, and Shipping for Analysis through the K-25 and Y-12 Environmental Restoration Programs": ER/C-P2302(IAD), Rev. 0. Any deviations from the SOPs will be documented on a field change request form and approved by Energy Systems. Field changes are discussed in greater detail in Sect. 8.16.

For a majority of the biological/ecological samples to be collected, there are no environmental surveillance SOPs. In cases for which they will be available, they have been referenced accordingly in the preceding list. For those cases for which SOPs are not now available, applicable methods are described in Appendix D.

7.4.11.2 Threatened and endangered species and wetlands surveys

There are no SOPs for conducting these surveys but rather conventions by which biologists/ecologists approach the work. Complia· e with federal legislation concerning threatened and endangered species has been formally addressed on the ORR, and the program has been reviewed with both the U.S. Fish and Wildlife Service and the appropriate state of Tennessee agencies. Although several federally listed threatened and endangered species occur in the region (Kroodsma 1987), none are known to occur at Rogers Quarry and Lower MCB. Several state-listed species do occur on the ORR and may be present in the study area. The site will be surveyed to determine whether the federally listed and/or state-listed species are present or likely to be present. The surveys will be conducted by biologists familiar with the species that may be expected to live in habitats similar to the site and will be conducted when species that are expected to occur on the ORR are likely to be most readily observed. For plants, the surveys will be scheduled to coincide with the flowering season. Because there are no federally listed threatened or endangered wildlife species known to occur on the ORR, the animal surveys are generally limited to identifying suitable habitat. The surveys may provide only evidence of the presence or absence of the species; quantitative information on population status will not be obtained. In addition, wetlands areas will be delineated and wetlands plant species will be identified based on nationally accepted standards (Federal Interagency Committee for Wetland Delineation 1989; Reed 1988; and U.S. Fish and Wildlife Service 1979).

7.4.11.3 Bioaccumulation testing

Whole body fish tissue analyses will be performed on sunfish and minnows to be collected by electrofishing in Rogers Quarry, in Lower MCB, and at the reference location, Hinds Creek. There will be 8 specimens of each type of fish collected, if possible, for a total of 48 fish tissue samples. Fish will be placed on ice and returned to the laboratory where they will be weighed, measured, and prepared for chemical analyses. The in situ bioassay with clams will be set up just below the outfall from Rogers Quarry. The bioassay will be conducted according to an ORNL Environmental Sciences Division SOP. A copy of the procedure is included in Appendix D. Approximately 40 clams (2 sample sets of 20 each) will be encaged at the bioassay location for testing. There will be 20 clams exposed under similar conditions at the reference location, and tissue from 20 clams will be collected on receipt of the specimens for a pretest control. A total of four tissue samples will be subject to chemical analyses for PAHs (reference, control, and duplicate site samples).

7.4.11.4 Qualitative ecological surveys

A qualitative fish population survey will be conducted in Rogers Quarry by electrofishing and hook and line techniques. Species numbers, diversity, age, and size will be recorded; however, the survey will be semi-quantitative at best. The fish survey will be conducted coincidentally with the fish tissue collection effort such that appropriate specimens for the tissue analyses will be collected and the specimens that are not of interest will be released.

The qualitative terrestrial predator survey will be performed in two components: scent-station transects for small mammals and other terrestrial species and an avian survey to identify birds frequenting the area. Piscivorous birds are of particular interest. Scent-stations, consisting of a 1-m-diam tracking surface (agricultural lime) and attractant (appropriate for piscivorous species), will be established at 0.3-km intervals along Old Bethel Valley Road and the road up from the Filled Coal Ash Pond. Transects will consist of 6-10 scent-stations. Transects will be monitored for a 3-month period, over the breeding season (February-May), and censused to produce a total of 100 station-nights.

Any number of tracks made by one species at a station will be recorded as one visit. An index of relative abundance will be calculated for each species by dividing the number of responses from a species by the number of station-nights and multiplying by 100. The transects will be located in accessible areas around Rogers Quarry. The avian survey will be conducted by an experienced ornithologist who will visit the site three or four times to record observations.

7.4.11.5 Fish pathology studies

Deformed fish specimens will be collected from Rogers Quarry by electrofishing or the hook and line method in conjunction with sampling for the tissue analyses and qualitative fish population survey. These specimens will be frozen and transported to a fish pathology expert for examination at the tissue/histological level.

7.4.11.6 Sample analysis

The analytes selected for the various media are dependent on the amount of information available on site history and previous sampling. CLP methods will be used, except for those analytes for which other methods are necessary, and Level C QC will be required. Detailed information on method numbers, detection limits, precision, accuracy, etc., are provided in the QAPjP (Chap. 8).

Analytical methods, method detection limits, sample container requirements, and sample preservation requirements for all environmental, ERA, HHRA, and waste characterization sampling required during this investigation are summarized in the QAPjP (Chap. 8).

7.5 SAMPLE TRACKING AND RECORDS MANAGEMENT

Field documentation will be maintained throughout this project in various formats, including field logbooks, sample tags, chain-of-custody forms, field data sheets, and field calibration and maintenance data. Documentation will follow requirements outlined in procedure ESP-500 in the Energy Systems document ESH/Sub/87-21706/1 (1990a). The following general guidelines for maintaining field documentation will be followed.

- Documentation will be completed in permanent black ink.
- All entries will be legible.
- Errors will be crossed out with a single line, dated, and initialed.
- None of the documents will be altered, destroyed, or discarded, even if they are illegible or contain inaccuracies that require correction. They will be maintained on-site and referenced in the site logbook.

7.5.1 Field Logbooks

Field team personnel will use bound field logbooks with sequentially numbered pages for the maintenance of field records and for documenting any information pertinent to field activities. Information identified in the field logbook will be obtained from site exploration, observation, and sampling activities and will be recorded by the Field Task Manager or his/her designee.

The front cover of the logbook will list the contract name and number, the task order number, the site name, the names of subcontractors, the name of the client, the name of the Field Task Manager, the start date, and, when complete, the finish date. The logbooks will be sequentially numbered, and if a logbook is dedicated to a particular task or site, that information will be noted on the cover.

The field logbook will be included as an appendix to the appropriate site investigation report. Specific information to be recorded in field logbooks is provided in procedure ESP-500 of ESH/Sub/87-21706/1 (Energy Systems 1990a).

7.5.2 Field Data Sheets

Field data sheets will be maintained as appropriate and will include the following logs and forms:

- Water level measurement log
- Environmental survey forms
- Surface water/sediment sampling log
- Sample request form
- Well purging log
- Groundwater sampling log
- Chain-of-custody form
- Instrument calibration log.

Data to be recorded will include such information as the sample location (e.g., depth, sampling station, elevation, and field coordinates) and applicable sample analysis to be conducted. If necessary, field-generated data forms will be prepared based on the appropriate requirements. The same information may be included in the field logbook.

7.5.3 Sample Identification, Numbering, and Labeling

In addition to field logbooks and field data sheets, the sampling team will use labels to track sample holding times, to ensure sample traceability, and to initiate the chain-of-custody record on the environmental samples. Custody seals will also be used to ensure traceability and to prevent tampering. Figure 7-3 is an example of a sample label and chain-of-custody seal. A completed label will be secured to each sample container, including duplicates and trip or field blanks, at or before the completion of collection of that sample. Sample labels will be waterproof or will be sealed to the sample container with clear acetate tape after all information has been written on the label. Labels will include the project code number, the station number and location for the sampling site, the type of sample and the analyses required, the date and time of sampling, and the signature of the sampler. The person who physically collects each sample is the sampler and will sign the sample label. Information to be included on sample labels and seals is provided in ESP-500 (Energy Systems 1990a).

The sample numbers will be recorded in the field logbook along with the time of collection and descriptive information on the sampling conditions.

Samples will be identified and numbered according to the following system:

Y12RQ-BB-XX-ZZ

where

Y12RQ identifies the site as the Y-12 Plant, Rogers Quarry.
BB identifies the media, with the following codes used:

GW	Groundwater	SD	Sediments (includes coal ash)
TB	Trip blank	BF	Bioaccumulation—fish tissue
FB	Field blank	BS	Bioaccumulation—clams
EB	Equipment blank	SW	Surface water

XX identifies the location of the sample, which will be consistent with the Y-12 Plant identification system.

ZZ is the sample number at that location.

Therefore, the sample number "Y12RQ-GW-01-01" designates the groundwater sample from monitoring well 1. The "01" at the end of the sample number indicates that it is the first sample taken at this location. The actual location where this sample was collected is specified in the field logbook along with a complete description of the sample.

QC samples are numbered in the same manner as that for the other samples using the system just described. Duplicate samples, however, will be assigned a unique sample number by the sampling team, and this number will be recorded in the field logbook along with sample information such as the time of collection, matrix type, analysis requested, and corresponding sample. This procedure ensures that subsequent tracking of the QC sample

CDM FEDERAL PROGRAMS CORPORATION		Sample Container
		LOT NO.:
DATE:	TIME:	COLLECTED BY:
SAMPLING SITE:		
SAMPLE TYPE: ☐ Grab ☐ Composite ☐ Other ______		
TESTS REQUIRED:		PRESERVATIVE

CDM FEDERAL PROGRAMS CORPORATION	SIGNATURE	DATE
	SEAL BROKEN BY	DATE

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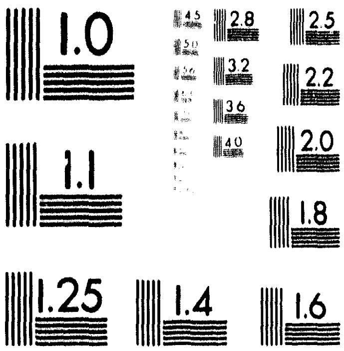
EXAMPLES OF A SAMPLE LABEL AND CHAIN-OF-CUSTODY SEAL

ROGERS QUARRY/LOWER McCOY BRANCH

CHESTNUT RIDGE OU4

FIGURE No. 7-3


1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0

results is facilitated. The data validators and users will be told which of the samples were duplicates, spikes, or blanks. A list of analyzed samples, including QC samples, and their locations will also be included in the draft RI report.

7.5.4 Sample Chain of Custody

Chain-of-custody procedures will document sample possession from the time of collection through all transfers of custody to receipt at the laboratory and subsequent analysis. Chain-of-custody records will accompany each packaged lot of samples; the laboratory will not accept samples for analysis without a correctly prepared chain-of-custody record form. Internal laboratory records will document the custody of the sample through its final disposition.

Custody records following the National Enforcement Investigations Center format will be used for this project. The multipart carbonless copy forms will be correlated with the sample collection tags; requested information will have the same heading on both. Figure 7-4 presents an example of a chain-of-custody record form. One similar to this will be used by CDM Federal throughout this field effort. Environmental Sciences Division personnel will use their existing chain-of-custody records, which may vary from the one shown in Fig. 7-4. The sampler or sample custodian will complete a chain-of-custody record form to accompany each sample shipment from the field to the laboratory.

The custody records will be used for a packaged lot of samples; more than one sample will usually be recorded on one form. More than one custody record sheet may be used for one package, if necessary. Their purpose is to document the transfer of a group of samples traveling together; when the group of samples changes, a new custody record is initiated. The original custody record travels with the samples; the initiator of the record keeps a copy. When custody of the same group of samples changes hands, several people will not have a copy of the custody record. This is acceptable as long as the original custody record shows that each person who had received custody has properly relinquished custody.

The sampling event will have a designated sample custodian with overall responsibility for sample custody and for field document control. The custodian will ensure that the sampling teams have used the appropriate identification and custody records, resolved custody problems in the field, and handled the shipment of samples to the analytical laboratories. The analytical laboratory will have an identified sample custodian and document control officer.

The following procedure is used to complete the chain-of-custody form.

1. The originator (e.g., sample custodian) fills in all requested information from the sample label. The bill-of-lading number obtained from the overnight carrier is recorded in the comments section of the form, and it also is recorded in the field logbook.
2. The originator signs in the top left "Relinquished by" box and keeps a copy.
3. The original record sheet and remaining copies travel with the samples.
4. The laboratory sample custodian receiving the samples checks the sample label information against the custody record. He/she also checks the sample condition and notes anything unusual under "Comments" on the custody form. The laboratory custodian receiving custody signs in the adjacent "Received by" box and keeps a copy. The original and the additional copy are returned to the originator.

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CHAIN OF CUSTODY RECORD

PROJECT No.	PROJECT LEADER	REMARKS
PROJECT NAME/LOCATION		
	SAMPLERS *(sign)*	

CIRCLE/ADD parameters desired. List no. of containers submitted — ANALYSES

STATION No.	SAMPLE TYPE	19__ DATE	TIME	COMP	GRAB	STATION LOCATION/DESCRIPTION	TOTAL CONTAINERS	COD, TOC, NUTRIENTS	BOD, SOLIDS	METALS	EXT ORG/PEST/PCBs	VOA	CYANIDE					TAG No./REMARKS	LAB USE ONLY

Relinquished by: (print)	Date/Time	Received by: (print)	Date/Time	Relinquished by: (print)	Date/Time	Received by: (print)	Date/Time
(sign)		(sign)		(sign)		(sign)	
Relinquished by: (print)	Date/Time	Received by: (print)	Date/Time	Relinquished by: (print)	Date/Time	Received by: (print)	Date/Time
(sign)		(sign)		(sign)		(sign)	

DISTRIBUTION: White and Pink copies to accompany sample shipment to laboratory. Pink copy retained by laboratory.
White copy is returned to samplers. Yellow copy retained by samplers.

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EXAMPLE OF A CHAIN OF CUSTODY RECORD FORM
ROGERS QUARRY/LOWER McCOY BRANCH
CHESTNUT RIDGE OU4

FIGURE No. 7-4

5. The date/time will be the same for both signatures because custody must be transferred to another person. When samples are shipped via common carrier (e.g., Federal Express), the date/time will not be the same for both signatures. Common carriers are not required to sign the form. The original travels with the samples, and the shipper (e.g., field sample custodian) keeps the copy. The shipper also keeps all shipping papers, bills of lading, etc.

In all cases, it must be apparent that the same person who received custody has relinquished it to the next custodian. If samples are left unattended or if a person refuses to sign, this occurrence must be documented and explained on the custody record.

To enable tracking of the shipment of samples from the field to the laboratory, the field sample custodian will promptly telephone the laboratory following shipment and will provide the following information:

- The exact number and types of samples collected and the sample identification numbers
- The air carrier and airbill number(s)
- The estimated date and time of arrival at each designated laboratory
- Other pertinent information including special handling instructions, changes in scheduled sampling activity, or deviations from established sampling procedures.

Internal laboratory custody procedures will be specified in the laboratory QA plan.

Custody seals are narrow strips of adhesive paper that are used to demonstrate that no tampering has occurred (see Fig. 7-3). Custody seals will be placed on coolers used for sample shipment. Seals will not be placed on individual sample containers. The sampler must sign and date each custody seal.

7.5.5 Sample Shipment

Each sample shipped will be packed in accordance with ER/C-P2302(IAD), Rev. 0, "Sample Classifying, Packaging, Marking, Labeling, and Shipping for Analysis Through the K-25 and Y-12 Environmental Restoration Programs." All shipping procedures will comply with Department of Transportation (DOT) regulations. In addition, each sample will be identified with a sample identification label and will be listed on the chain-of-custody record completed for each sample shipping container. The field sample custodian will notify the laboratory sample custodian of sample shipment.

7.6 DATA ASSESSMENT AND INTERPRETATION

Data collected during this RI will be used to evaluate the nature and extent of contamination at OU 4, to support an HHRA and ERA, and to evaluate remedial alternatives for the FS. An RI report will be prepared that discusses the OU (i.e., site history, geology, hydrology, etc.); the work conducted during the investigation; an interpretation of the data; conclusions; and, as appropriate, recommendations. The report will follow the format specified by Energy Systems and will be subject to review by Energy Systems, DOE, and regulatory agencies (i.e., EPA and TDEC).

In order to accomplish the objectives of the RI, the data will be assessed and interpreted in a variety of ways. Before any interpretation or assessment, all analytical data from the contract laboratory will be verified and validated. Data will meet appropriate precision, accuracy, representativeness, comparability, and completeness parameters. The QAPjP (Chap. 8) discusses data assessment and validation parameters applicable to this RI.

All sampling locations will be surveyed and clearly shown on a base map of OU 4. Water level data will be presented in tabular form and also plotted on a map to evaluate any patterns in hydrostatic head for both shallow and deep groundwater. Cross sections may be prepared to depict the water table and/or potentiometric surface. Similarly, validated laboratory data from the monitoring wells will be tabulated. Contaminant concentrations and contours also may be prepared on maps, as appropriate, to depict relevant trends. If the data suggest vertical variation in contaminant levels, cross sections also may be prepared. Validated surface water and sediment data will be presented in a tabular format and, if appropriate, plotted on a map.

Water and sediment data obtained from the quarry will be tabulated for analysis and inclusion in the RI report. Parameters measured in the field to evaluate water stratification in the quarry will be plotted graphically with depth on the vertical axis to distinguish any trends. These data could also be superimposed on a cross section of the quarry if this appears to be appropriate. Validated water and sediment data from the quarry will be presented in a similar manner. Preparation of cross sections will involve the use of existing data from the 1986 survey of the quarry.

Analytical data obtained from the RI will also be compared to existing data from OU 4 and, as necessary, the adjacent OU 2. Every attempt will be made to determine the statistical significance and associated confidence represented by the entire body of data. However, given the likely variability in data quality, it is not possible to specify exact methods of statistical treatment at this time.

The data collected during the water balance study will be tabulated and will likely be manipulated and interpreted using a spreadsheet or similar software package, as in Bogle and Turner's (1989) study. Monitoring locations will be clearly shown on a map and may be supplemented with photographs showing the apparatus (e.g., flume, weir, etc.) used for monitoring. Hydrographs will be prepared to show variations in flow, precipitation, and water level. Data may be plotted on a map if determined to be especially appropriate.

The HHRA and ERA will use the data just described (excluding the water balance data) as well as data from the ecological/biological studies. The baseline ERA will follow the standard paradigm for an ERA, as described in Chap. 3. Because OU 4 is a potential source of contaminants to the Clinch River off-site OU, the ERA will serve the needs for source characterization of the assessments of off-site risks. The baseline HHRA will be conducted following established EPA guidelines. In addition, recommendations from the ER Risk Assessment Council and other supporting documentation will be followed.

ENVIRONMENTAL RESTORATION PROGRAM
FIELD AND LABORATORY QUALITY ASSURANCE
PROJECT PLAN

Project Title: REMEDIAL INVESTIGATION WORK PLAN FOR CHESTNUT RIDGE OPERABLE UNIT 4 (ROGERS QUARRY/LOWER McCOY BRANCH) AT THE OAK RIDGE Y-12 PLANT, OAK RIDGE, TENNESSEE

Prepared By: CDM Federal Programs Corporation

______________________________ Date:________
Technical Support Contractor
Program Manager

Approved By: ______________________________ Date:________
Technical Support Contractor
Quality Assurance/Quality Control
Officer Concurrence

Approved By: ______________________________ Date:________
DOE-ER Division Program Manager

Approved By: ______________________________ Date:________
DOE-ER Division QA Program Manager

Approved By: ______________________________ Date:________
Energy Systems ER Site Program Manager

Approved By: ______________________________ Date:________
Energy Systems ER Site Project Manager

Approved By: ______________________________ Date:________
Energy Systems ER Site
Quality Assurance Specialist

8. FIELD AND LABORATORY QUALITY ASSURANCE PROJECT PLAN

8.1 INTRODUCTION

Work on this assignment will be performed in accordance with the Energy Systems document *Environmental Restoration Quality Program Plan* (Energy Systems 1992a) and the CDM Federal *Quality Assurance Manual* (1993). This QAPjP has been prepared in accordance with EPA *Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans* (QAMS-005/80), revised 1983, and EPA Region IV *Standard Operating Procedures and Quality Assurance Manual*, revised February 1991; the Energy Systems *Environmental Restoration Quality Program Plan* (ES/ER/TM-4/R2); and the Energy Systems *Environmental Surveillance Procedures, Quality Control Program* (ESH/Sub/87-21706/1). This QAPjP has been reviewed for QA/QC requirements by the CDM Federal QA staff, who will maintain QA oversight for the duration of this project. Energy Systems will also maintain oversight during this project to ensure compliance with all applicable QA requirements. In addition, all deliverables will be subject to technical review by CDM Federal technical specialists, and all deliverables presenting measurement data will be reviewed by the CDM Federal QA staff. A description of the project can be found in Chaps. 1-3 of this RI work plan.

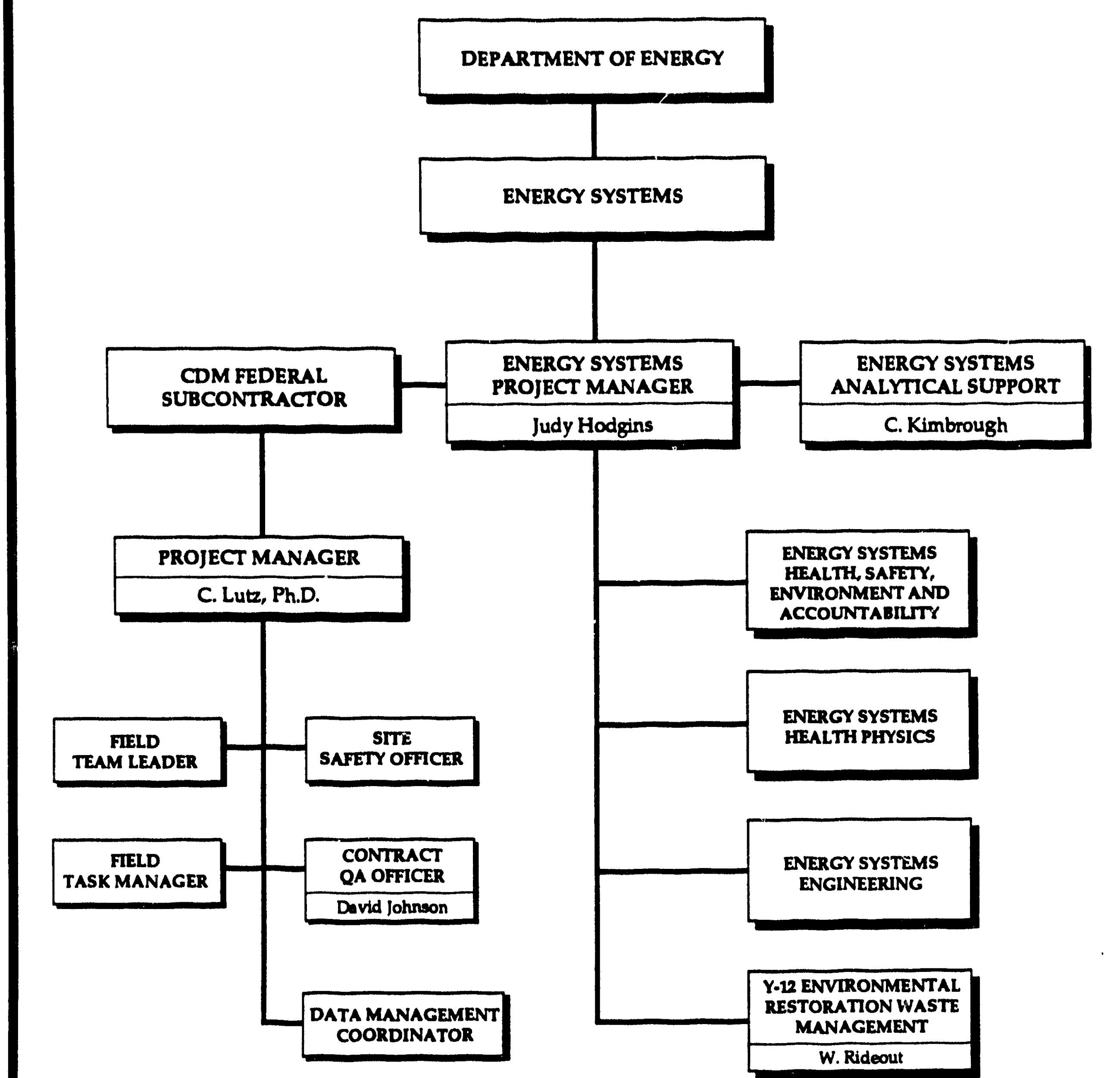
8.2 QUALITY ASSURANCE/PROJECT ORGANIZATION

The principal CDM Federal personnel assigned to prepare and review the work plan are Richard C. Johnson, P.E., P.G. (Program Manager); Mary Leslie (Y-12 Program Coordinator); Charles T. Lutz, Ph.D. (Project Manager); RoseMary Ellersick (Corporate QA Manager); David O. Johnson (Contract QA Manager); Charles Meyers (Health and Safety Manager); the Site Health and Safety Coordinator; and the Field Task Manager. Figure 8-1 shows the project organization, reporting relationships, and lines of authority for this project. General responsibilities of key individuals are discussed in this section. Other personnel will be assigned as necessary.

8.2.1 Project Manager

The Project Manager, Charles T. Lutz, will be the main point of contact with Energy Systems and will have primary responsibility for technical, financial, and scheduling matters. His duties will include the following:

- Implementing the CDM Federal QA program
- Preparing, reviewing, and approving all project documents
- Assigning duties to the project staff and orienting the staff to the needs and requirements of the project



QUALITY ASSURANCE/PROJECT ORGANIZATION CHART
ROGERS QUARRY/LOWER McCOY BRANCH
CHESTNUT RIDGE OU4

CDM FEDERAL PROGRAMS CORPORATION
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FIGURE No. 8-1

- Obtaining the approval or guidance from Energy Systems for proposed major changes to the QAPjP and field sampling plan
- Supervising the performance of project team members
- Evaluating training needs for the project staff
- Providing budget and schedule control
- Reviewing subcontractor work and approving subcontractor invoices
- Establishing a project record system
- Ensuring that major project deliverables are reviewed for technical accuracy and completeness before their release
- Ensuring that the requirements of the RI work plan are satisfied
- Regularly communicating project status, progress, and any problems to the Energy Systems Project Manager.

8.2.2 Field Task Manager

The Field Task Manager will be responsible for execution of all field activities by CDM Federal personnel and will have authority to direct activities of subcontractors including stopping work and/or taking appropriate emergency actions. The Field Task Manager's duties and responsibilities are as follows:

- Reviewing and implementing the field sampling plan and QAPjP
- Notifying the Project Manager and QA staff of problems encountered in the field and implementing corrective action
- Providing orientation and any necessary training to field personnel (including subcontractors) on the requirements of the field sampling plan and the QAPjP before the start of work
- Providing direction and supervision to CDM Federal and subcontractor personnel to ensure that all on-site sampling and activities adhere to the QAPjP and the field sampling plan
- Ensuring the use of calibrated measurement and test equipment
- Establishing and maintaining a field records management system
- Coordinating activities with the Project Manager
- Overseeing field data documentation
- Reviewing reports for compliance with applicable requirements
- Assigning the duties of the Site Health and Safety Coordinator to a qualified on-site individual, if necessary.

8.2.3 Quality Assurance Managers

The Corporate QA Manager, RoseMary Ellersick, is responsible for ensuring and assessing the implementation of the CDM Federal QA program. The CDM Federal Corporate QA Manager is independent of the technical staff and reports to the CDM Federal Office of the President. The Corporate QA Manager thus has the authority to review and identify problems and the authority to bring corporate resources to bear in solving problems, if necessary. The Corporate QA Manager is assisted by the Contract QA Manager and other QA staff, who report directly to the Corporate QA Manager on quality matters.

The CDM Federal Corporate QA Manager is responsible for these activities:

- Actively identifying and responding to QA/QC needs, resolving problems, and answering requests for guidance or assistance
- Preparing and submitting QA/QC reports to CDM Federal senior managers
- Conducting an annual trend analysis to identify potential problem areas
- Verifying that appropriate corrective actions are taken for all nonconformances
- Scheduling, on a quarterly basis, appropriate QA audits or surveillances for significant activities to ensure compliance with requirements and procedures.

The CDM Federal Contract QA Manager is responsible for the following activities:

- Reviewing and approving the field sampling plan and QAPjP and all subsequent changes to the field sampling plan and the QAPjP
- Actively tracking the progress of QA requirements in this plan and consulting periodically with the Project Manager
- Arranging or conducting training of project personnel
- Preparing a monthly QA status report for submittal to the Corporate QA Manager
- Arranging or performing audits or surveillances
- Participating in field planning sessions for field activities.
- Issuing a stop work order in the event that out-of-control events occur or nonconformances fail to be resolved appropriately.

8.2.4 Technical Review Committee

The Technical Review Committee (TRC) is a forum for peer review that is comprised of individuals with fields of expertise appropriate to the project. The TRC for this project includes Mary Leslie, Robert Kasper, and Fletcher Armstrong. The TRC has reviewed the field sampling plan and QAPjP and will review future major deliverables. Compliance with internal TRC requirements is checked in audits or surveillances.

8.3 QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT DATA

8.3.1 Data Quality Objectives

DQOs are qualitative and quantitative statements developed by data users to specify the quality of data from field and laboratory data collection activities to support specific decisions or regulatory actions. The DQOs describe what data are needed, why the data are needed, and how the data will be used to address the problem being investigated. DQOs also establish numeric limits for the data to allow the data user (or reviewers) to determine whether data collected are of sufficient quality for use in their intended application. Some of the tests to be performed in support of the ERA and ecological characterization of the site do not have applicable QC levels for measurement data (i.e., toxicity testing and the various surveys to be performed). Although QC levels do not apply, DQOs do apply. For toxicity testing, DQOs are frequently defined by the method in terms of percent survival in the control samples and percent error among replicates. For field surveys, DQOs are tangible in terms of the time of year of the survey, minimum number of species encountered, the expertise level of the surveyor, and so on. Although more subjective, these DQOs are real and in many cases, such as toxicity testing, are formalized in the SOPs.

8.3.2 Intended Uses of Acquired Data

The intended uses of the acquired data are as follows:

- To characterize the nature and extent of contamination in sediment, surface water, and groundwater in Rogers Quarry and Lower MCB
- To characterize the nature of contaminated media at the site to drive the alternatives assessment and FS
- To characterize surface water and sediment contaminant concentrations to determine if human and environmental receptors are at risk from exposure to contaminants
- To characterize the quality of groundwater at the site and evaluate if contaminants are entering the site from an off-site source of groundwater contamination
- To characterize the aquatic and terrestrial communities at the site and to perform tests and collect data on the levels of contaminants in flora and fauna (to support an ERA)

Data objectives for accomplishing these actions are as follows:

- Scientific data generated will be of sufficient quality to withstand scientific and legal scrutiny.
- Data will be gathered or developed in accordance with procedures appropriate for intended use.
- Data will be of known precision, accuracy, representativeness, completeness, and comparability within the limits of the project.

8.3.3 Intended Users of Data

The primary users of data during this investigation will be the following:

- The Field Task Manager will use field data for well purging and health and safety monitoring.
- The project team will use the data to determine the nature, extent, transport, and fate of contaminants and present these results in an RI report.
- The risk assessor(s) will use the data to complete the risk assessment data base and to conduct an HHRA and an ERA.
- The engineers/scientists who are involved will use the data to develop alternatives and conduct the FS.

8.3.4 Levels of Quality Control

Five general levels of analytical options to support data collection are specified by the EPA as QC levels (Levels I, II, III, IV, and V). Energy Systems has defined QC levels in Chap. 3 of *Requirements for Quality Control of Analytical Data* (Energy Systems 1990b) as Levels A, B, C, D, and E; these are generally analogous to the EPA levels. These levels are based on the type of site to be investigated, the level of accuracy and precision required, and the intended use of the data.

Level A QC is designated for field screening. The objective of Level A analysis is to generate data that are generally used to refine sampling plans and monitor health and safety. Level A also is used for screening samples that will be subject to further analysis. No data quality criteria are specified for Level A because this level is characterized by the use of hand-held instrumentation that is not conducive to the generation of quantitative data. An organic vapor meter or photoionization detector is an example of such instrumentation. However, a calibration or performance check of the instrument is required.

Level B QC is designed to provide real-time data for ongoing field activities or to provide initial data that will be the basis for seeking laboratory analytical support. Level B QC data typically are confirmed by submitting some duplicate samples to a fixed-base laboratory. Level B analysis is used for on-site, real-time screening; baseline data development; extent of contamination determination; and on-site remedial activities. Field analysis involves the use of portable or transportable instruments that are based at or near a sampling site and that can provide data from the analysis of air, soil, and water samples for organic and inorganic compounds. Examples of those instruments include portable gas chromatographs, pH meters, and conductivity meters. Since Level B analyses are performed in the field, the amount and type of documentation available will vary with the type of analysis and SOPs used. Field and analysis logbooks also would be a source of additional documentation.

Level C QC applies to data produced by a laboratory meeting Energy Systems QA/QC requirements. Level C QC includes review and approval of the laboratory QA plan, field sampling plan, and the field QA plan. Level C allows the use of non-CLP methods but requires that the methods be EPA-approved or EPA-equivalent methods. The laboratory is required to provide the summary CLP package with the analytical results (not the full CLP package). Level C QC results in technically defensible data, which can be used for risk assessment purposes.

Level D QC field and laboratory requirements are similar to Level C for the basic laboratory QA/QC, field sampling plan, and QAPjP development and approvals. However, for Level D QC, the laboratory is required to submit the full CLP data package (or its equivalent) with analytical results. This QC level typically applies to sites on the NPL and results in very defensible data.

Level E QC requires the use of EPA or EPA-equivalent analytical methods. It generally is method specific and applies to unique materials such as pure waste, biota, explosives, etc.

QC Levels A, B, and C will apply to data collected during this investigation. Table 8-1 identifies the intended use, intended users, and QC level for various field activities and types of data.

8.3.5 Precision, Accuracy, Representativeness, Completeness, and Comparability

The precision, accuracy, representativeness, completeness, and comparability (PARCC) parameters are tools by which data sets can be evaluated. PARCC parameters can help ensure that DQOs are met. Definitions of the parameters and procedures for assessing them are provided in the remainder of Sect. 8.3.5.

Precision—refers to the level of agreement among repeated measurements of the same characteristic, usually under a given set of conditions.

To determine the *precision* of the laboratory analysis, a routine program of replicate analyses in accordance with the analytical method requirements is performed by the laboratory. The results of replicate analyses are used to calculate the relative percent difference, which is used to assess laboratory precision.

For replicate results C_1 and C_2,

$$\text{relative percent difference} = \frac{|C_1 - C_2|}{\frac{C_1 + C_2}{2}} \times 100 .$$

Precision of the total sampling and analytical measurement process will be assessed from field duplicates. Although a quantitative goal cannot be set due to field variability, CDM Federal will review field duplicate relative percent difference values to estimate precision.

Accuracy—refers to the nearness of a measurement to an accepted reference or true value.

Table 8-1. Data uses and quality control levels

Field activity/media	Intended uses	Intended users[a]	QC level[b]
Health and safety monitoring	• Determination of appropriate protection levels for field personnel	• Field personnel	A
Field screening	• Measurement of indicator parameters • Screening of samples for radiation before shipment off site	• Field personnel	B
Groundwater-monitoring wells	• Site/source characterization • Determination of the presence/ absence of contaminants • Risk assessment support • Establishment of background values	• Project team • Risk assessors • FS team	C[c]
Surface water/sediment	• Site characterization • Determination of the presence/ absence of contaminants • Risk assessment support • Establishment of background values	• Project team • Risk assessors • FS team	C
Biota	• Site characterization • Establishment of background values • Risk assessment support	• Project team • Risk assessors • Biological monitoring program personnel • FS team	E[b]

[a]Primary data users are listed. Secondary data users include Energy Systems, DOE, EPA, and TDEC personnel.
[b]QC level applies to those data where chemical analyses are performed on tissue samples only. QC levels generally do not apply to toxicity testing and the other biological measurement techniques to be used.
[c]Twenty percent of the analytical data will be validated under level C requirements.

To determine the accuracy of an analytical method and/or the laboratory analysis, a periodic program of sample spiking is conducted (minimum 1 spike and 1 spike duplicate per 20 samples). The results of sample spiking are used to calculate the QC parameter for accuracy evaluation, the percent recovery (*% R*).

For surrogate spikes and QC samples:

$$\%R = \frac{C_s}{C_t} \times 100 ,$$

where C_s equals measured spiked sample concentration (or amount), and C_t equals true spiked concentration (or amount).

For matrix spikes:

$$\%R = \frac{|C_s - C_o|}{C_t} \times 100 ,$$

where C_s equals measured spiked sample concentration, C_o equals sample concentration (not spiked), and C_t equals true concentration of the spike.

Objectives for accuracy and precision for this project are shown in Tables 8-2 and 8-3. Accuracy of the total sampling and analytical measurement process will not be determined. This would require the addition of chemical spiking compounds to the samples in the field.

Representativeness is the degree to which discrete samples accurately and precisely reflect a characteristic of a population, variations at a sampling location, or an environmental condition. Representativeness is a qualitative parameter and will be achieved through careful, informed selection of sampling sites and analytical parameters and through the proper collection and handling of samples to avoid interferences and to minimize contamination and sample loss.

Completeness is a measure of the percentage of valid, viable data obtained from a measurement system compared to the amount expected under normal conditions. The goal of completeness is to generate a sufficient amount of valid data to satisfy project needs. For this project, the completeness objective, 90%, is shown in Tables 8-2 and 8-3.

Comparability is the extent to which comparisons among different measurements of the same quantity or quality will yield valid conclusions. Comparability will be achieved through the use of SOPs, analytical methods, QC, and data reporting. In addition, data validation evaluates processes employed by the laboratory that affect data comparability.

Table 8-2. Quality assurance objectives for laboratory measurements

Parameter	Method	Matrix	Precision[a,b]	Accuracy[c]	Completeness (%)
Target contaminant list (TCL) volatiles	CLP method[d]	Sediment	CLP	CLP	90
		Water	CLP	CLP	90
TCL semi-volatiles	CLP method	Sediment	CLP	CLP	90
		Water	CLP	CLP	90
TAL metals	CLP method	Sediment	CLP	CLP	90
		Water	CLP	CLP	90
Chromium-hexavalent	SW-846[e] 7196	Water	20%	80–20%	90
Gross alpha	SW-846 9310	Sediment	30%	80–130%	90
		Water	20%	80–130%	90
Gross beta	SW-846 9310	Sediment	30%	80–120%	90
		Water	20%	80–120%	90
Isotopic thorium	EPA 907.0[f]	Sediment	30%	75–125%	90
		Water	20%	75–125%	90
Isotopic uranium	EPA 908.0[f]	Sediment	30%	75–125%	90
		Water	20%	75–125%	90
Pesticides/PCBs	CLP	Sediment	CLP	CLP	90
		Water	CLP	CLP	90

[a]Precision and Accuracy values shown for radionuclides represent levels of 5 pCi/L and 5 pCi/g and above. Lower levels will have substantially greater precision and accuracy limits.

[b]Precision is given as a relative percent difference based on laboratory replicates. Precision for CLP methods is based on matrix spike/matrix spike duplicate (MS/MSD) (organics) or laboratory duplicate (inorganics); objectives are as given in the CLP Statement of Work.

[c]Accuracy is given as Percent Recovery based on laboratory spikes. For CLP methods, accuracy is based on matrix spikes; objectives are as given in the CLP Statement of Work.

[d]EPA CLP, *Statement of Work for Inorganics Analysis*, March 1990a; *Statement of Work for Organics Analysis*, March 1990b.

[e]EPA *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*, Third Edition, SW-846, November 1986.

[f]EPA *Radiochemistry Procedures Manual*, 520/5-84-006, 1984.

Table 8-3. Quality assurance objectives for field measurements

Parameter	Matrix	Accuracy	Precision	Completeness (%)
pH	Aqueous	ND[a]	±0.05 unit	90
Conductivity	Aqueous	ND	±50 units	90
Temperature	Aqueous	ND	±1°C	90
Dissolved oxygen	Aqueous	ND	±0.1 ppm	90
Total organic vapors	Gas	ND	*b*	90
Water level	Aqueous	ND	±0.01 ft	90
Water flow rate	Aqueous	±5%	ND	90

[a]Not determined in the field. Accuracy variable with the type of instrument. Instruments will be calibrated daily or more frequently as specified in manufacturer's guidelines.

[b]Direct reading instrument, not capable of reproducing a value without an air standard due to atmospheric concentration variability. Users will rely on calibration results to verify proper function of instrument.

8.4 SAMPLE COLLECTION PROCEDURES

Sampling rationale, locations, methods, and SOPs from the Energy Systems document *Environmental Surveillance Procedures, Quality Control Program*, ESH/Sub/87-21706/1 (1990a), are discussed in the field sampling plan. Several procedures from an ER Division procedures manual are also relevant to this project. Procedures from both documents that are applicable to this investigation include the following:

- Surface Water and Sediment Sampling: ESP-301-1, ESP-301-4, and ESP-304-1
- Stream Flow Measurement: ESP: 301-5
- Water Level Measurement: ESP-302-1
- Well Purging: ESP-302-2, Temperature: ESP-307-1, pH: ESP-307-2, and Oxidation/Reduction Potential: ESP-307-5
- Groundwater Sampling: Energy Systems SOP No. 8102.R2
- Groundwater Sampling with Bailers: ESP-302-3
- Groundwater Sampling with Pumps: ESP-302-4 and ESP-302-5
- Field Sampling and Analytical Processes within Environmental Restoration: ER/C-S2301
- Sample Classifying, Packaging, Marking, Labeling, and Shipping for Analysis through the K-25 and Y-12 Environmental Restoration Programs: ER/C-P2302(IAD), Rev. 0
- Field Equipment Decontamination: ESP-900 and ESP-901
- Handling Investigation-Derived Waste: ESP-1000
- Waste Removal and Disposition Through the Y-12 ER Program: ER/Y-P2102.

Any modification of or deviation from these procedures will be documented and approved by the Energy Systems Project Manager. Some of the sampling necessary for the ERA will require procedures not included in the document cited above. These methods are described in the field sampling plan.

Table 6-1 in the Site Data Needs Section lists sample totals for all media. Analytical methods, sample preservation requirements, and sample container requirements are summarized in Table 8-4.

8.5 SAMPLE AND DOCUMENT CUSTODY PROCEDURES

Procedures for project documentation and for sample and document custody are described in the Energy Systems document ESH/Sub/87-21706/1 (1990a) under ESP-500, "Manual Chain of Custody Procedures," and in the field sampling plan, Sect. 7.5.4. Records of all field activities, including sampling locations, site conditions, types of samples taken, and analyses requested, will be documented in appropriate field logbooks and on field data sheets. The laboratory will be responsible for maintaining chain of custody of samples received for analysis. Laboratory custody procedures will be discussed in detail in the laboratory QA plan.

Table 8-4. Analytical methods and sample requirements for environmental samples

Parameter	Method	Matrix	Holding time (from time of collection)	Sample container[a]	Preservation
Volatile organic compounds	CLP[b]	Aqueous, sediment	14 days	Two 40-mL amber glass vials with Teflon-lined septum	HCl to pH <2[c] Cool to 4°C
Semivolatile organic compounds	CLP	Aqueous	7 days to extraction; 40 days to analysis	1-L amber glass with Teflon-lined closure	Cool to 4°C
		Sediment/tissue	14 days to extraction; 40 days to analysis	8-oz. widemouth glass jar with Teflon-lined closure	Cool to 4°C
Metals[d] (other than mercury), total and dissolved	CLP	Aqueous	180 days	1-L polyethylene with polyethylene-lined closure	HNO_3 to pH <2
	CLP	Sediment/tissue	180 days	8-oz. widemouth glass with Teflon-lined closure	Cool to 4°C
Mercury, total and dissolved	CLP	Aqueous	28 days	1-L polyethylene with polyethylene-lined closure	HNO_3 to pH <2
	CLP	Sediment/tissue	28 days	8-oz. widemouth glass with Teflon-lined closure	Cool to 4°C
Pesticides/PCBs	CLP	Aqueous	7 days to extraction; 40 days to analysis	1-L amber glass with Teflon-lined closure	Cool to 4°C
		Sediment	14 days to extraction; 40 days to analysis	8-oz. widemouth glass with Teflon-lined closure	Cool to 4°C
Gross alpha and gross beta	SW-846, 9310[e]	Aqueous	6 months	Two 1-gal polyethylene with polyethylene-lined closure	HNO_3 to pH <2
		Sediment	6 months	8-oz. widemouth amber glass jar with Teflon-lined closure	Cool to 4°C

Table 8-4 (continued)

Parameter	Method	Matrix	Holding time (from time of collection)	Sample container[a]	Preservation
Isotopic uranium Isotopic thorium	EPA 908.0[f] EPA 907.0[f]	Aqueous	6 months	Two 1-gal polyethylene with polyethylene-lined closure	HNO_3 to pH <2
		Sediment	6 months	8-oz. widemouth glass jar with Teflon-lined closure	None

[a]Additional volume is needed for aqueous matrix spike/matrix spike duplicate samples (triple volume for organics; double volume for metals).

[b]EPA Contract Laboratory Program (CLP), *Statement of Work for Organics Analysis*, March 1990b.

[c]The first sample for volatile analysis will be tested for pH by first adding 4 drops of HCl to a spare 40-mL vial, adding the water sample, and testing with pH paper. If pH >2, more acid will be added until pH <2 is achieved. Once this determination has been made, remaining volatile organic analysis vials will be pre-preserved before sample collection.

[d]Samples for these parameters can occupy the same sample containers.

[e]U.S. Environmental Protection Agency, November 1986, *Test Methods for Evaluating Solid Wastes, Physical/Chemical Methods*, SW-846, 3rd Edition.

[f]U.S. Environmental Protection Agency, 1984, Eastern Environmental Radiation Facility, *Radiochemistry Procedures Manual*, 520/5-84-006.

Document control is the act of ensuring that documents, including revisions, are reviewed for adequacy, approved for release by authorized personnel, and distributed to and used at the locations where the prescribed activities are performed. CDM Federal's document control procedure (QP 3) is given in the CDM Federal *Quality Assurance Manual* (1993). The Project Manager will develop distribution lists for the various types of documents to be issued during this project.

Procedures have been established for the inventory, control, filing, storage, and retrieval of data collected and of reports/documents generated under this program. CDM Federal's record control procedures are given in the CDM Federal *Quality Assurance Manual.* The Field Task Manager will forward field documentation to the CDM Federal document control center for processing as QA records. The project files will be maintained in the Oak Ridge office.

8.6 EQUIPMENT CALIBRATION AND FREQUENCIES

8.6.1 Equipment Calibration Procedures and Frequencies

All field equipment, including pH, conductivity, dissolved oxygen, radiation, and organic vapor (or equivalent) meters will be calibrated daily (or more frequently as necessary) by the user according to the manufacturer's specifications. The off-site laboratory(ies) will use written, standard procedures for equipment calibration and frequency. These procedures are based on EPA guidance or manufacturer's recommendations and are given in the laboratory QA plan or in the EPA-approved analytical methods. The laboratory QA plan then will be reviewed and accepted by CDM Federal and Energy Systems as part of the laboratory review process. The appropriate references for all analyses are included in the reference section of this document. All standards used for calibration will be National Institute of Standards and Technology traceable. Procedures for correcting improperly functioning equipment will be addressed in the laboratory QA plan and in factory manuals for equipment.

8.6.2 Calibration Records

Calibration records (kept on a calibration form, a sample of which appears in Fig. 8-2) will be maintained for each piece of field measuring and test equipment and each piece of reference equipment. The records will indicate that established calibration procedures have been followed. The frequency of calibration against a traceable standard will be specified on the calibration record form. The lot number of all calibration gases will be recorded in the field logbook. Records of equipment use will be kept in the project files. The off-site laboratory(ies) will use written, standard procedures for calibration records. These procedures are based on EPA guidance and are given in the laboratory QA plan. The laboratory QA plan will be reviewed and accepted by CDM Federal and Energy Systems as part of the laboratory review process.

8.7 PREVENTIVE MAINTENANCE

Periodic preventive maintenance is required for all equipment. CDM Federal will keep a maintenance log for each piece of field equipment. Appendix E contains forms that will be used to log the maintenance record of each field instrument. Specific preventive maintenance

CALIBRATION LOG *for* ______________________________ Required calibration frequency: ______________

equipment used

Project Name ______________________ Project # ____________________ Page____ of ____

DATE	TIME	SERIAL #	STANDARD(S) USED	STANDARD LOT NO.	READING	COMMENTS	INITIALS

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EXAMPLE OF AN EQUIPMENT CALIBRATION FORM

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FIGURE No. 8-2

practices, frequencies, and spare parts are described in the factory manual for each instrument. The troubleshooting section of factory manuals will be used in assisting personnel in performing maintenance tasks. CDM Federal maintains critical spare parts on hand to minimize equipment downtime.

Preventive maintenance procedures for laboratory equipment and instruments are provided in laboratory QA plans. All maintenance activities will be recorded in maintenance logs. Laboratories will be required to maintain an adequate inventory of spare parts and consumables to prevent downtime as a result of minor problems.

8.8 ANALYTICAL PROCEDURES

Table 8-4, presented earlier, summarizes the analytical methods, sample container requirements, and sample preservation requirements for sampling required during this investigation. A discussion of method detection limits (MDLs) follows.

MDLs describe the extent to which the equipment or analytical process can provide accurate, minimum data measurements of a reliable quality for specific constituents in replicate field samples. An MDL is defined as the minimum concentration of a substance that can be measured and reported with 99% confidence that the value is above zero. The actual quantitation limit for a given analysis will vary depending on instrument sensitivity and matrix effects. MDLs for this project are shown in Table 8-5. The MDLs for aqueous media are equal to or lower than the established MCLs used to evaluate potential risks to human health and the environment. Detection limits will not be established for analyses performed using field instruments. The detection limits established by the manufacturer will be used as guidelines.

8.9 DATA REDUCTION AND REPORTING

To ensure that data management activities provide an accurate and controlled flow of data generated by the laboratory, it is important that the following data reduction and reporting steps be defined and implemented. Data management procedures applicable to field-generated data are discussed in the field sampling plan.

8.9.1 Data Reduction

Field program data will be produced through visual observation, direct-reading instrumentation, measuring devices, and laboratory chemical analyses. All field activities, direct-reading instruments, and measuring devices will occur or be used in accordance with the procedures in the Energy Systems document ESH/Sub/87-21706/1 and the specifications in the manufacturers' operations and maintenance manuals, as appropriate.

For the presentation of field data in a report, the data recorded in data books and forms will need to be summarized and transferred to tables, figures, maps, or logs. For the analysis of data, some data will need to be entered into computer data bases or onto spreadsheets. The Field Task Manager and other team members are responsible for data transfer activities pertinent to their roles on the project. The data manager will be responsible for ensuring that data transfers are performed accurately and will perform spot checks of the transfer activities.

Table 8-5. Method detection limits for laboratory analyses

Water (µg/L)	Sediment (µg/kg)	Volatile organic compounds CLP method[a]		
10	NA[b]	Acetone	1,1-Dichloroethane	1,1,2,2-Tetrachloroethane
		Benzene	1,2-Dichloroethane	Tetrachloroethene
		Bromodichloromethane	1,1-Dichloroethene	Toluene
		Bromoform	1,2-Dichloroethene (Total)	1,1,1-Trichloroethane
		Bromomethane	1,2-Dichloropropane	1,1,2-Trichloroethane
		2-Butanone	Cis-1,3-dichloropropene	Trichloroethene
		Carbon disulfide	Trans-1,2-dichloropropene	Vinyl acetate
		Carbon tetrachloride	Ethyl benzene	Vinyl chloride
		Chlorobenzene	2-Hexanone	Xylenes (Total)
		Chloroethane	Methylene chloride	
		2-Chloroethyl vinyl ether	4-Methyl-2-pentanone	
		Chloroform	Styrene	
		Chloromethane		
		Dibromochloromethane		

Water (µg/L)	Sediment (µg/kg)	Semivolatile organic compounds[c] [including polynuclear aromatic hydrocarbons (PAHs)] CLP method
10	330	Acenaphthene
10	330	Acenaphthylene
10	330	Anthracene
10	330	Benzo(a)anthracene
10	330	Benzo(a)pyrene
10	330	Benzo(b)fluoranthene
10	330	Benzo(g,h,i)perylene
10	330	Benzo(k)fluoranthene
10	330	Carbazole
10	330	2-Chloronaphthalene
10	330	Chrysene
10	330	Dibenzo(a,h)anthracene
10	330	Dibenzofuran
10	330	Fluoranthene
10	330	Fluorene
10	330	Indeno(1,2,3-cd)pyrene
10	330	2-Methylnaphthalene
10	330	Naphthalene
10	330	Phenanthrene
10	330	Pyrene
CLP	CLP	Other Target Compound List semivolatiles

Table 8-5 (continued)

Water (µg/L)	Sediment (mg/kg)	Metals[a] CLP method
200	40	Aluminum
60	4	Antimony
10	1	Arsenic
200	10	Barium
5	1	Beryllium
5	1	Cadmium
5000	50	Calcium
10	2	Chromium
50	2	Cobalt
25	2	Copper
100	20	Iron
3	1	Lead
5000	10	Magnesium
15	3	Manganese
0.2	0.1	Mercury
40	3	Nickel
5000	12	Potassium
5	1	Selenium
10	2	Silver
5000	50	Sodium
10	1	Thallium
50	1	Vanadium
20	4	Zinc

Table 8-5 (continued)

Water (µg/L)	Soil (µg/kg)	Pesticides and PCBs CLP method		
0.10	3.3	Dieldrin		
0.05	1.7	Alpha-BHC	Beta-BHC	Delta-BHC Gamma-BHC
0.05	1.7	Aldrin		
0.10	3.3	4,4'-DDD	4,4'-DDE	4,4'-DDT
0.05	1.7	Alpha-chlordane	Gamma-chlordane	
0.10	3.3	Endrin	Endrin Ketone	Endrin Aldehyde
0.05	1.7	Endosulfan I		
NA	44.2	Endosulfan sulfate	Endosulfan II	
0.05	1.7	Heptachlor	Heptachlor epoxide	
0.5	17.0	Methoxychlor		
5.0	170.0	Toxaphene		
2.0	67.0	Aroclor 1221		
NA	ND[d]	Aroclor 1016 Aroclor 1232	Aroclor 1242 Aroclor 1248 Aroclor 1254	Aroclor 1260

Water (pCi/L)	Sediment (pCi/g)	Radionuclides	
		Analytes	Method
3	10	Gross alpha and beta	SW-846, Method 9310[f]
1.0	0.5	Isotopic thorium	EPA 907.0[e]
2.0	0.5	Isotopic uranium	EPA 908.0[e]

[a]EPA Contract Laboratory Program (CLP), *Statement of Work for Organics Analysis*, March 1990, and *Statement of Work for Inorganics Analysis*, March 1990.
[b]NA denotes that the medium will not be analyzed for these compounds.
[c]All Target Compound List semivolatiles will be analyzed and reported. Only PAHs are listed here, detection limits for other semivolatiles will be the CLP contract-required detection limits.
[d]U.S. Environmental Protection Agency, *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*, SW-846, 3rd Edition, November 1986.
[e]U.S. Environmental Protection Agency, *Radiochemistry Procedures Manual*, 520/5-84.006, 1984

Data generated by laboratories will be reduced using the format specified by the EPA or other standard analytical methods. The analytical data packages will be checked by CDM Federal for completeness (i.e., all deliverables required for data validation must be in the package) and reasonableness. CDM Federal will contact the laboratory if deliverables are absent from the data packages or if discrepancies are noted. Laboratory data will be reconciled with field records before data validation.

It will be the responsibility of the data manager to ensure that all data transferred to tables, spreadsheets, logs, maps, figures, or into computerized data bases are transferred correctly. All data transferred, both hard copy and electronic copy, will be checked at least once for completeness and accuracy of transfer. Checking will be performed by comparing the raw data with the transferred data. All computer programs used for calculation or analysis will be checked at least once with a data set of known results before the program is used to process data for any site.

8.9.2 Data Reporting

The laboratory is required to report data in accordance with ES/ER/TM-16 level C QC requirements. The appropriate CLP forms are presented in the latest revision of the EPA CLP *Statement of Work for Inorganics Analysis* (1990a) and the *Statement of Work for Organics Analysis* (1990b). The other Level C parameters will be reported in CLP-type format. The laboratory also is required to submit control charts for the blank spike analyses for each method and matrix and, if requested, calculations used to obtain results. Two copies of each data package will be required. Equivalent information, in accordance with ES/ER/TM-16, will be reported for radionuclides and other parameters.

8.10 FIELD QUALITY CONTROL SAMPLES

QC sampling will be conducted to check sampling and analytical accuracy and precision for both laboratory and field analyses of the original samples. If contaminants are found in the blanks, attempts will be made to identify the source of contamination, and corrective action will be initiated in accordance with Sect. 8.13. The laboratory analyzing the samples will also include QC samples. These samples will be discussed in the laboratory QA plan. The QC samples and frequency specified in ES/ER/TM-11 (Energy Systems 1991b) will be used for this task. All QC samples will be shipped according to the chain-of-custody procedures specified in the field sampling plan and in ESP-500 (ESH/Sub/87-21706/1).

QC samples will have sample numbers as described in the field sampling plan. Duplicates will be submitted as "blind" to the laboratories. These samples will be analyzed for the parameters of interest. Results of these samples will be included in the analytical report. Table 8-6 summarizes QC samples necessary for this investigation.

- A **trip blank** consists of a sealed container of American Society for Testing and Materials (ASTM) Type II water that travels from the field to the laboratory with the samples to be analyzed for VOCs. The trip blank identifies contamination that may have been contributed to the field samples during transport (receives same treatment as sample containers). One trip blank will be placed in each cooler containing samples to be analyzed for VOCs.

Table 8-6. Summary of quality control sample requirements

	Trip blanks	Duplicates	Matrix spike/ matrix spike duplicate	Equipment rinseates	Total[a]
Groundwater[b]					
• organics, rad, total metals	20	2	2	2	26
• dissolved metals	-	2	2	2	6
Surface water					
• organics, rad, total metals	2	3	2	3	10
• dissolved metals	-	3	2	3	8
Sediment	2	2	1	2	7
Tissue	-	6	3	-	9
Totals	24	18	12	12	66

[a]Field blanks will also be taken, two each from two anticipated samples.
[b]Samples to be collected under two separate field mobilizations.

- An **equipment rinseate** is collected in the field from a final ASTM Type II water rinse of decontaminated field sampling equipment. The field rinseate determines if the decontamination procedure is adequate to avoid carryover of contamination from one sampling location to another. One field rinseate will be collected for every ten samples (per matrix) for each equipment type during each sampling event (sampling period without a 48-h interruption).

- A **field blank** consists of water used for rinse during field decontamination. One field blank will be collected from each source of rinse water (ASTM Type II and tap water) at the beginning of the sampling program and at the end.

- The **field duplicate** samples are collected from the composited sample matrix in a separate set of containers and labeled with a different sample number. They indicate whether the field sampling and measurement technique is reproducible and are collected at a frequency of one for every ten samples.

- **Matrix spike/matrix spike duplicate** (MS/MSD) samples may require the collection of additional sample volume and are often collected at the same location as duplicates. Samples are split into duplicates. The laboratory adds predetermined quantities of spiking solutions to the samples before preparation and analysis. The relative percent difference between samples is used to evaluate analytical precision. Percent recoveries are used to evaluate accuracy. MS/MSD samples will be collected at a minimum frequency of 1 for every 20 samples. For inorganics, a laboratory duplicate will be analyzed instead of the MSD.

8.11 DATA VALIDATION

Data validation is the process of screening data and accepting, rejecting, or qualifying them on the basis of sound criteria. Data validation will be performed in accordance with EPA procedures and ES/ER/TM-16, *Requirements for Quality Control of Analytical Data*. Data will be validated, as appropriate, based on holding times, initial calibration, continuing calibration, blank results, and other QC sample results. Level C data packages will be requested for 20% of the results for validation.

The Field Task Manager will review all field documentation, and the CDM Federal data validation staff will review all laboratory documentation for completeness, legibility, consistency, and for reasonable agreement with expected or typical results. Field measurements and observations will be checked against the field log and records and discussed with the individuals who collected the data to determine the possibility of error. However, checking of field instrument data is largely performed in the field at the time of analysis, based on equipment calibration and professional judgment.

All data packages received from the analytical laboratory will be reviewed and verified by CDM Federal project personnel to determine whether they are in compliance with all contractual requirements. Specific activities include checking for the following things:

- Invalid or missing key fields (Sample ID, Sample Delivery Group No.)
- Missing forms
- Invalid reporting and analysis times
- Correct reporting units
- Cross-reference to field sample and location records
- Valid method and analysis codes.

Twenty percent of the data packages then will be validated by CDM Federal or subcontractor personnel using ES/ER/TM-16 guidelines to determine whether the data can be used for their intended purpose as specified in the DQOs. The results will be reviewed by a project chemist and reported to the Project Manager. Examples of QC information reviewed during data validation include the following:

- Holding times
- Calibrations
- Blanks
- Surrogates
- Internal standards
- Matrix spikes
- Duplicate analyses
- Control charts.

The procedures used to assess the data from field measurements for PARCC are given in procedures specific to field measurements (ESP-307 series) in Energy Systems ESH/Sub/87-21706/1 and, more generally, in ESP-1100, "Statistical Sampling Design."

The output from both the data verification and validation processes will be used by the data validators to assign data usability flags (e.g., U = not detected, J = estimated value, R = rejected) to each result as needed. A summary for each data package will be prepared, documenting the results that are not within the QC acceptance criteria and any other laboratory or field occurrences that affect the data quality. This report will explain the resulting data qualifiers applied to the data.

Deliverables to be supplied to the Energy Systems Project Manager on completion of the project include the following:

- Completed and signed data compliance checklists
- Completed and signed data validation summary reports
- Completed and signed validation definitions and narrative
- Copy of the Form I CLP report or equivalent with accompanying data flags.

Analytical data outliers, as defined in the laboratory QA plan, will be discussed with the data validators, and possibly the analytical laboratory, to determine if the outlier is a result of laboratory error. If necessary and possible, additional samples or measurements may be performed to confirm or disprove the outlier. If the outlier cannot be confirmed, it will be flagged as such and not used for decision purposes until subsequent analyses/measurements allow confirmation.

8.12 FIELD AUDITS, SURVEILLANCES, AND INSPECTIONS

Audits, surveillances, and inspections are conducted regularly by the CDM Federal QA staff to accomplish these objectives:

- Check on adherence to the QA/QC requirements specified in the project documents
- Evaluate the procedures used for data collection, data handling, and project management
- Verify that the QA program developed for this project is being implemented according to the specified requirements
- Assess the effectiveness of the QA program
- Verify that identified deficiencies are corrected.

CDM Federal's policies and procedures are given in the CDM Federal *Quality Assurance Manual.* Specific procedures for scheduling and performing audits are given in QP 6 (Audits) of the CDM Federal *Quality Assurance Manual.* Specific procedures for scheduling and performing surveillances (QP 19) and inspections (QP 17) also are presented in the *Quality Assurance Manual.*

The Corporate QA Manager is responsible for scheduling audits, surveillances, and inspections and will prepare a quarterly schedule planned to coincide with appropriate activities on the project schedule and sampling plans. The Contract QA Manager is responsible for conducting or arranging audits, surveillances, and inspections. Scheduled audits, surveillances, and inspections may be supplemented by additional audits, surveillances, and inspections for one or more of the following reasons:

- Significant changes are made in the QAPjP.
- Significant personnel changes occur.
- It is necessary to verify that corrective action has been taken on a deficiency reported in a previous audit.
- The Corporate QA Manager has requested the additional audit/surveillance/inspection.

8.12.1 Audits

Audits are qualitative reviews of project activity to check that the overall CDM Federal QA program is functioning. Audits are conducted for projects that involve significant effort and have a long duration (several quarters). Audits should be conducted early in the project so that problems can be quickly corrected. An audit involves the review of all available and relevant project and contract documents and includes an evaluation of QC measures for field, laboratory, and office work.

Office audits evaluate the following:

- Record keeping, including appropriate available field documentation, training, problem prevention, corrective action, change control, monthly reports, and other documentation of project work and QA measures
- Preparation of deliverables specified in the work plan
- Proper technical and QA review of documents
- Filing, storage, and completeness of documents in the central files.

For this project, one office audit will be conducted when ~30-50% of the work has been completed.

Field audits examine these things:

- Cleaning/decontamination and storage of sampling equipment and containers
- Sample collection, preservation, custody, and shipping procedures
- Preparation and frequency of collection of QC samples
- Calibration, operation, and maintenance procedures
- Documentation of field activities in the field logbook or appropriate data forms.

A field audit will not be performed since the field effort is of a relatively short duration. However, a field surveillance will be conducted as discussed herein.

Laboratory audits are conducted to verify that QA/QC measures specified in the QAPjP, laboratory QA plan, or other project documents are followed in the laboratory. The following is reviewed during the laboratory audit:

- Documentation of training, nonconformance reporting, and corrective action
- Frequency of QC checks, such as blanks and spikes
- Calibration and preventive maintenance records
- Chain of custody
- Data review and filing procedures.

All laboratories used for this project will have been audited by Energy Systems and/or CDM Federal before initiation of fieldwork.

8.12.2 Surveillances

Surveillances follow the same general format as an audit, but they are less detailed and require a less formal report. A surveillance is designed to provide rapid feedback to the project staff concerning QA compliance and to facilitate corrective action. Further discussion of surveillances is found in QP 19 of the CDM Federal *Quality Assurance Manual*.

For this project, two field surveillances are planned; one will take place shortly after mobilization, and the other will be conducted during the second field mobilization. The following activities and documentation will be subject to surveillance:

- Surface water and sediment sampling
- Groundwater sampling
- Equipment and supplies related to sampling, measurements, and calibration
- Chain of custody
- Field documentation
- Field training records
- Field QC procedures.

8.12.3 Inspections

An inspection is defined as an examination or measurement to verify whether an item or activity conforms to specified requirements. Inspections focus on field procedures, equipment, and supplies and are conducted early in the field effort to identify and resolve problems quickly. No stand-alone inspections are planned for this project since the field surveillance discussed in Sect. 8.12.2 will include a review of procedures, equipment, and supplies. However, field inspections may be conducted if deemed necessary by the QA Manager.

8.13 CORRECTIVE ACTION PROCEDURES

8.13.1 Nonconformances

Nonconforming equipment, items, activities, and conditions and unusual incidents that could affect compliance with project requirements will be identified, controlled, and reported in a timely manner. The Field Task Manager or Project Manager initiates the nonconformance reporting and corrective action process by completing a Nonconformance Report. An example of a Nonconformance Report is shown in Fig. 8-3. Nonconforming equipment will be immediately labeled or tagged and segregated, if possible. Specific procedures for controlling nonconforming items are described in the CDM Federal *Quality Assurance Manual* (QP 4, Control of Nonconforming Items). All work performed by the ORNL Environmental Sciences Division will conform with requirements described in the their QA procedures.

8.13.2 Corrective Action

CDM Federal's corrective action system is described in the CDM Federal *Quality Assurance Manual* (QP 13, Corrective Action). This procedure requires that conditions adverse to quality be identified, documented, and corrective action taken and verified. Specific procedures for controlling nonconforming items and the corrective action systems of the subcontractor laboratories are contained in the respective laboratory QA plans. Other team

NONCONFORMANCE REPORT

Job/Task Order No./Site location: ____________________

Name/ID No. of nonconforming item: ____________________

Nature of nonconformance: ____________________

____

____

____

____

Requirement/Specification not met: ____________________

____

Identified by: ____________________ Date: __________

(Forward to property manager; copy to QA manager)

(Below for use by property manager)

Method of identification of nonconforming item (label, tag, etc.): ____________________

____

Storage or hold location: ____________________

Disposition: *(circle)* Use-as-is Repair Rework Reject

Justification: ____________________

____

Approved by: ____________________ *(Tech Spec.)* Date: __________

Approved by: ____________________ *(Property Mgr.)* Date: __________

If item was repaired or reworked:
Reinspected and accepted by: ____________________ Date: __________

Information copies to: ____________________

EXAMPLE OF A NONCONFORMANCE REPORT FORM
ROGERS QUARRY/LOWER McCOY BRANCH
CHESTNUT RIDGE OU4

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FIGURE No. 8-3

subcontractors (drilling and surveying) are required to follow equivalent corrective action procedures.

Each staff member on the CDM Federal Team is responsible for notifying the Field Task Manager, the Project Manager, the QA staff, or other responsible persons when they discover a condition that may affect the quality of the work being performed. The following staff have specific corrective action responsibility:

- CDM Federal Program Manager—Implementing corrective actions
- CDM Federal Corporate QA Manager—Tracking and accepting corrective actions
- CDM Federal Project Manager—Implementing task-specific corrective actions
- CDM Federal Field Task Manager—Identifying and implementing corrective actions during field activities. Notifying the Project Manager and QA Manager of conditions not immediately corrected
- Subcontractor Laboratory Supervisor—Identifying and implementing corrective action during analysis. Notifying the CDM Federal Project Manager and QA Manager when applicable acceptance criteria or DQOs are not satisfied.

Immediate corrective actions will be noted in task notebooks. Deficiencies or nonconformances not immediately corrected will require formal corrective action as described in QP 13 (Corrective Action) in the CDM Federal *Quality Assurance Manual*. Deficiencies or nonconformances will be submitted to the Environmental Restoration Division for review.

8.14 QUALITY ASSURANCE REPORTS

As described in the CDM Federal *Quality Assurance Manual*, all levels of the CDM Federal Team QA staff are responsible for preparing QA reports. The types and persons responsible for preparing the reports are as follows:

- **Weekly Quality Status Reports**—The Project Manager is responsible for reporting quality problems to the Program Manager and QA Manager on a weekly basis.
- **Monthly QA Staff Reports**—The Contract QA Manager (David O. Johnson) will submit a monthly activity report to the CDM Federal Corporate QA Manager.
- **Laboratory Monthly Progress Reports**—The subcontractor laboratory will submit a report in accordance with ES/ER/TM-16 to the CDM Federal Project Manager by the 15th of the month following each month in which work is performed. This report will be forwarded to the Energy Systems Project Manager.
- **Audit, Surveillance, and Inspection Reports**—The QA staff member(s) performing an audit, surveillance, or inspection will submit a report on the results of each audit/surveillance/inspection within 30 working days of the date the activity was accomplished.
- **QA Sections in Project Reports**—All reports that present measurement data generated during the work assignment require a QA section addressing the quality of the data and its limitations. Each QA section will be prepared by the QA staff member(s) associated with the work and will address, at a minimum, these things:

- Precision, accuracy, and completeness achieved for reported measurement data in relation to goals for these indicators
- Results of performance and system audits of the measurement work
- Quality problems found and corrective actions taken
- Deviations from the field sampling plan and QAPjP.

All reviews and document checks will be documented. All deliverables produced for this project will be subject to at least the following three QC reviews:

- **The technical review** will be performed by senior professionals who have not been involved in project management or data collection activities. This technical review will focus on technical statements, conclusions, and recommendations to ensure that they are justifiable and defensible.
- **The QA review** will be conducted by the QA staff to ensure that QA/QC requirements have been addressed.
- **The final review** will be performed by the Project Manager. This review will be conducted to ensure that the document addresses all contractual requirements.

8.15 QUALIFICATIONS AND TRAINING OF PERSONNEL

Personnel assigned to the project, including field personnel and subcontractors, will be qualified to perform the tasks to which they are assigned. In addition to education and experience, specific training may be required to qualify individuals to perform certain activities. Training will be documented on appropriate forms and placed in the project file as a record. Project personnel will receive an orientation to the field sampling plan, QAPjP, relevant ESPs, health and safety plan, and their responsibilities before participation in project activities. The field planning meeting will be the forum for the orientation. All field personnel will be required to read and familiarize themselves with the Field Sampling Plan, QAPjP, relevant ESPs, and Health and Safety Plan before completing any work at the site. A copy of the following documents will be available to all field personnel while in the field:

- CDM Federal *Quality Assurance Manual*
- CDM Federal *Health and Safety Assurance Manual—Hazardous Waste Projects*
- CDM Federal *Field Equipment Operation, Calibration, and Maintenance Manual*
- This RI work plan, which includes these elements:
  - Field Sampling Plan (Chap. 7)
  - QAPjP (Chap. 8)
  - Health and Safety Plan (Chap. 9)
  - Waste Management Plan (Chap. 10)
- Relevant Energy Systems ESPs.

At a minimum, the following records will be maintained:

- Required reading reports
- Attendance lists

- Certificates of qualification.

8.16 FIELD CHANGES

The CDM Federal *Quality Assurance Manual* requires that field changes be governed by control measures commensurate with those applied to the documentation of the original design. The procedure for control of field changes is as follows:

- Major changes from approved field operating procedures, project scope, cost, or schedule will be documented on a Field Change Request Form (FCRF). An example FCRF is shown in Fig. 8-4. The Field Task Manager will initiate and maintain the FCRFs.
- Each FCRF requires the approval of the Energy Systems Project Manager before work proceeds. Approval by the Energy Systems Project Manager can be initiated on a verbal basis via telephone with follow-up sign-off. In no case will a subcontractor initiate a field change. If a field change is proposed by the client, it will be so recorded. Copies of the FCRFs will be kept on-site until the fieldwork is complete and then will be sent to the project files. Weekly reports prepared by the CDM Federal Project Manager serve as the mechanism for notifying the QA staff of field changes.
- Variances or minor changes to field operating procedures will be documented in the field logbook and reported on a weekly basis.
- If deemed necessary, the field sampling plan, QAPjP, Health and Safety Plan, or other relevant documents will be revised, reviewed, approved, and reissued in accordance with CDM Federal's document control procedures. The Energy Systems Project Manager must approve each FCRF before work proceeds.
- For the tasks to be conducted by the ORNL Environmental Sciences Division, field changes will be recorded directly in the registered field notebooks. These are controlled documents.

FIELD CHANGE REQUEST FORM

Project No. ______________________ Field Change No. ______ Page___of___

Project: ____

Applicable Document: ____

Description: ____

____

____

____

Reason for change: ____

____

____

____

Recommended disposition: ____

____

____

____

Impact on present and completed work: ____

____

____

____

Requested by: ______________________________ *(Field/Project Manager)*

Approval: ______________________________ *(Energy Systems Project Manager)*

NOTE: the Energy Systems Project manager is notified of the need for change in project cost, schedule direction, or scope. This form does NOT satisfy Section 3, "Changes", of contract Terms and Conditions.

EXAMPLE OF FIELD CHANGE REQUEST FORM
ROGERS QUARRY/LOWER McCOY BRANCH
CHESTNUT RIDGE OU4

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FIGURE No. 8-4

ENVIRONMENTAL RESTORATION PROGRAM
HEALTH AND SAFETY PLAN

Revision No. 1

Project Title: REMEDIAL INVESTIGATION WORK PLAN FOR CHESTNUT RIDGE OPERABLE UNIT 4 (ROGERS QUARRY/LOWER McCOY BRANCH) AT THE OAK RIDGE Y-12 PLANT, OAK RIDGE, TENNESSEE

Prepared By: CDM Federal Programs Corporation

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Technical Support Contractor
Program Manager

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Technical Support Contractor
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Quality Control Officer

Approved By: ________________________ Date:________
DOE-ER Division
Program Manager

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DOE-ER Division
QA Program Manager

Approved By: ________________________ Date:________
Energy Systems
ER Site Program Manager

Approved By: ________________________ Date:________
Energy Systems
ER Site Project Manager

Approved By: ________________________ Date:________
Energy Systems
ER Site Quality Assurance Specialist

9. HEALTH AND SAFETY PLAN

This chapter includes the documented health and safety plan for the RI work to be accomplished at Chestnut Ridge OU 4 (Rogers Quarry/Lower McCoy Branch). The plan is documented on the required Health and Safety Plan Form and consists of the 12 pages that follow.

HEALTH AND SAFETY PLAN FORM

CDM FPC Health and Safety Program

CDM FEDERAL PROGRAMS CORPORATION

PROJECT DOCUMENT #:__________

PROJECT NAME Rogers Quarry/Lower McCoy Branch

WORK ASSIGNMENT # NA

REGION SED

JOBSITE ADDRESS Oak Ridge Y-12 Plant off Bethel Valley Road

CLIENT Martin Marietta Energy Systems, Inc.

PROJECT # 7907-004-001-01WP/02 DOC

SITE CONTACT Charles T. Lutz

PHONE # 482-1065

CLIENT CONTACT Judy Hodgins

PHONE # 576-2368

( ) AMENDMENT #_____ TO EXISTING APPROVED HSP - DATE EXISTING APPROVED HSP__________

OBJECTIVES OF FIELDWORK:

To obtain samples of surface waters/sediments, groundwater, and a variety of biological samples for chemical analysis and toxicity testing.

TYPE: Check as many as applicable

( ) Active	( ) Landfill	( ) Unknown
(X) Inactive	( ) Uncontrolled	( ) Military
(x) Secure	( ) Industrial	( ) Other specify:
( ) Unsecure	( ) Recovery	
( ) Enclosed space	( ) Well Field	

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DESCRIPTION AND FEATURES: Summarize below. Include principal operations and unusual features (containers, buildings, dykes, power lines, hills, slopes, stream)

Rogers Quarry is situated 0.5 mile south of the Y-12 Plant along the southeastern slope of Chestnut Ridge. The ridge is 1100 ft in elevation and rises approximately 240 ft above Bethel Valley. The terrain is generally not level and is vegetated. McCoy Branch flows into the quarry, exits the southern side, and continues to Melton Lake. The dimensions of the quarry are 1150 ft by 450 ft with a maximum depth of approximately 110-120 ft. The volume is estimated to be 1.37 x 10(6) cubic yards or 277 million gallons.

SURROUNDING POPULATION: ( ) Residential (X) Industrial (X) Rural ( ) Urban (X) OTHER: Commercial/Office

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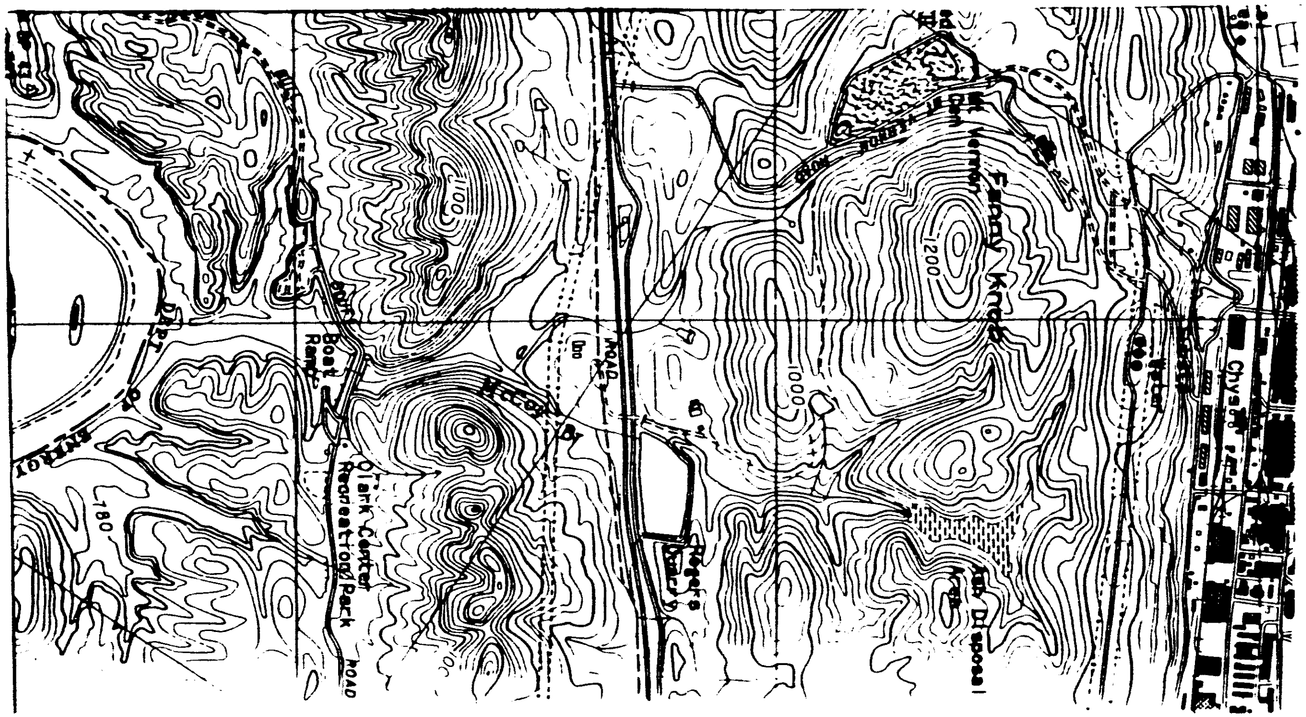

HISTORY: Summarize below. In addition to history, include complaints from public, previous agency actions, known exposures or injuries, etc.

The quarry was operated from the late 1940s or early 1950s until 1960. Until 1967 or 1968, McCoy Branch flowed into Melton Hill Lake. At that time, McCoy Branch, carrying coal ash, was diverted into Rogers Quarry. Since 1989, coal ash was sluiced directly into the quarry via a pipeline bypassing McCoy Branch altogether. Coal ash was disposed in the quarry from 1968 to 1993. The Quarry also has been used for the disposal of a variety of plant process materials, some of which are classified. Disposal of these types of materials started in 1965 and continued until 1982. These materials are believed to be in excess of 1 x 10(6) lb.

WASTE TYPES: ( ) Liquid (X) Solid ( ) Sludge ( ) Gas ( ) Unknown ( ) Other specify:

WASTE CHARACTERISTICS: Check as many as applicable.

( ) Corrosive	( ) Flammable	(X) Radioactive
(X) Toxic *	( ) Volatile	( ) Reactive
( ) Inert Gas	( ) Unknown	( ) Other specify:

* low concentrations of heavy metals

WORK ZONES: Describe the Exclusion, Contamination Reduction, and Support Zones in terms on-site personnel will recognize

The contamination reduction zones or support zone will be established at the agricultural maintenance facility approximately 200 ft to the north of the intersection of the dirt road and Old Bethel Valley Road. The exclusion zone will be considered to be approximately 50 ft around the perimeter of the Quarry and a 15-ft radious at any sampling location along lower McCoy Branch.

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HAZARDS OF CONCERN:

(X) Heat Stress attach guidelines	(X) Noise
(X) Cold Stress attach guidelines	(X) Inorganic Chemicals
( ) Explosive/Flammable	( ) Organic Chemicals
( ) Oxygen Deficient	( ) Motorized traffic
(X) Radiological	(X) Heavy Machinery
(X) Biological - deer ticks	(X) Slips, Trips & Falls
(X) Other specify: snakes, poison ivy	

PRINCIPAL DISPOSAL METHODS AND PRACTICES: Summarize below:

Area was used as a settling basin for coal ash residuals and various plant process materials.

HEALTH AND SAFETY PLAN FORM — **CDM FEDERAL PROGRAMS CORPORATION**

CDM FPC Health and Safety Program

HAZARDOUS MATERIAL SUMMARY : Circle waste type and estimate amounts by category

CHEMICALS: Amount/Units:	SOLIDS: Amounts/Units:	SLUDGES: Amounts/Units:	SOLVENTS: Amounts/Units:	OILS: Amounts/Units:	OTHER: Amounts/Units:
Acids	Flyash	Paint	Halogenated (chloro, bromo) Solvents	Oily Wastes	Laboratory
Pickling Liquors	Asbestos	Pigments	Hydrocarbons	Gasoline	Pharmaceutical
Caustics	Milling/Mine Tailings	Metal Sludges	Alcohols	Diesel Oil	Hospital
Pesticides	Ferrous Smelter	POTW Sludge	Ketones	Lubricants	Radiological
Dyes/Inks	Non-ferrous Smelter	Aluminum	Esters	PCBs	Municipal
Cyanides	**Metals**	Distillation Bottoms	Ethers	Polynuclear Aromatics	Construction
Phenols		Other Specify:	Other Specify:	Other Specify:	Munitions
Halogens					Other Specify:
Dioxins					
Other Specify:					

OVERALL HAZARD EVALUATION: ( ) High ( ) Medium (X) Low ( ) Unknown (Where tasks have different hazards, evaluate each. Attach additional sheets if necessary)

JUSTIFICATION: Slightly elevated concentrations of heavy metals. Low potential for inhalation hazard in that materials may be wet and surface of pond is heavily vegetated.

FIRE/EXPLOSION POTENTIAL: ( ) High ( ) Medium (X) Low ( ) Unknown

BACKGROUND REVIEW: (X) COMPLETE ( ) INCOMPLETE

KNOWN CONTAMINANTS	HIGHEST OBSERVED CONCENTRATION (specify units and media)	PEL/TLV ppm or mg/m3 (specify)	IDLH ppm or mg/m3 (specify)	WARNING CONCENTRATION ppm	SYMPTOMS/EFFECTS OF ACUTE EXPOSURE	PHOTOIONIZATION POTENTIAL
Barium	0.21 mg/L GW	0.5 mg/m3	1100 mg/m3		Respiratory irritation, eye irritation, skin burns	N/A
Beryllium	0.00047 mg/L GW	0.002 mg/m3	CA		Respiratory irritation and fatigue	N/A
Copper	0.02 mg/L GW	1.0 mg/m3	NE		Irritation to nasal and mucous membranes, eye irritation, metallic taste	N/A
Iron	0.88 mg/L GW	5 mg/m3	NE		Pneumoconiosis	N/A
Mercury	0.00031 mg/L GW	0.05 mg/m3	10 mg/m3		Cough, chest pain, fatigue	N/A
Uranium (Total)		0.2 mg/m3	30 mg/m3			N/A
Thorium 228			4 X 10(-12) µCi/mL			
Thorium 234			8 X 10(-8) µCi/mL		Carcinogen - No warning properties	N/A
Zinc	0.015 mg/L GW	5 mg/m3	NE		Skin and mucous membrane irritant	N/A

NA = Not Available NE = None Established U = Unknown

S = Soil SW = Surface Water T = Tailings W = Waste TK = Tanks SD = Sediment CA = Potential Carcinogen
A = Air GW = Groundwater SL = Sludge D = Drums L = Lagoon OFF = Off-site

FIELD ACTIVITIES COVERED UNDER THIS PLAN

TASK DESCRIPTION/SPECIFIC TECHNIQUE-STANDARD OPERATING PROCEDURES/SITE LOCATION (attach additional sheets as necessary)	TYPE	Primary	Contingency	HAZARD SCHEDULE
1 Surface water/subsurface water/sediment sampling	Intrusive	D Modified	C	Low
2 Groundwater sampling	Non-intrusive	D Modified	C	Low
3 Biological Sampling	Non-intrusive	D	D Modified	Low
5	Non-intrusive	Modified	A B C D	Hi Med Low
6	Intrusive Non-intrusive	A B C D Modified	A B C D Exit Area	Hi Med Low

PERSONNEL* AND RESPONSIBILITIES (Include subcontractors)

NAME	FIRM/REGION	CDM FPC HEALTH CLEARANCE	RESPONSIBILITIES	On site?
Charles Lutz	CDM FPC/SED	BT	WORK ASSIGNMENT MANAGER	1 - 2 - 3
Del R. Baird	CDM FPC/SED	BT-CS	SITE HEALTH AND SAFETY COORDINATOR	1 - 2 - 3
Keith Owens	CDM FPC/SED	BT	ALTERNATE SITE H&S COORDINATOR	1 - 2 - 3
Angela Luckie	CDM FPC/SED	BT-BS	STAFF	1 - 2 - 3
Driller				1 - 2 - 3
Surveyor				1 - 2 - 3

All personnel must be 40 hr OSHA 1910.120 trained with current refresher and be involved in a medical surveillance program.

HEALTH AND SAFETY PLAN FORM

CDM FEDERAL PROGRAMS CORPORATION

CDM FPC Health and Safety Program

PROTECTIVE EQUIPMENT: Specify by task. Indicate type and/or material as necessary. Uses copies of this sheet if needed.

BLOCK A TASKS: 1 & 2 LEVEL: D - Modified

(X) Primary
( ) Contingency

Respiratory: (X) Not Needed
( ) SCBA, Airline: ______
( ) APR: ______
( ) Cartridge: ______
( ) Escape Mask: ______
( ) Other: ______

Prot. Clothing ( ) Not Needed
( ) Encapsulated Suit: ______
( ) Splash Suit: ______
( ) Apron: ______
(X) Tyvek Coverall: ______
( ) Saranex Coverall: ______
( ) Cloth Coverall: ______
( ) Other: ______

Head and Eye: ( ) Not Needed
(X) Safety Glasses: ______
( ) Face Shield: ______
( ) Goggles: ______
( ) Hard Hat: Drilling only
( ) Other: ______

Gloves: ( ) Not Needed
(X) Undergloves: ______
(X) Gloves: Nitril
( ) Overgloves: ______

Boots: ( ) Not Needed
(X) Boots: Leather steel-toed work boots
(x) Overboots: Nitrile
( ) Rubber:

( ) Other - specify below:

BLOCK B TASKS: 1 & 2 LEVEL: C

( ) Primary
(X) Contingency

Respiratory: ( ) Not Needed
( ) SCBA, Airline: ______
(X) APR: ______
(X) Cartridge: Dust Filter/OVC-H
( ) Escape Mask: ______
( ) Other: ______

Prot. Clothing: ( ) Not Needed
( ) Encapsulated Suit: ______
( ) Splash Suit: ______
( ) Apron: ______
(X) Tyvek Coverall: ______
( ) Saranex Coverall: ______
( ) Cloth Coverall: ______
( ) Other: ______

Head and Eye: ( ) Not Needed
(X) Safety Glasses: ______
( ) Face Shield: ______
( ) Goggles: ______
(X) Hard Hat: ______
( ) Other: ______

Gloves: ( ) Not Needed
(X) Undergloves: ______
(X) Gloves: Nitrile
( ) Overgloves: ______

Boots: ( ) Not Needed
(X) Boots: Leather steel-toed work boots
(x) Overboots: ______
( ) Rubber:

( ) Other - specify below:

BLOCK C TASKS: 3 LEVEL: D

(X) Primary
( ) Contingency

Respiratory: (X) Not Needed
( ) SCBA, Airline: ______
( ) APR: ______
( ) Cartridge: ______
( ) Escape Mask: ______
( ) Other: ______

Prot. Clothing (X) Not Needed
( ) Encapsulated Suit: ______
( ) Splash Suit: ______
( ) Apron: ______
( ) Tyvek Coverall: ______
( ) Saranex Coverall: ______
( ) Cloth Coverall: ______
( ) Other: ______

Head and Eye: ( ) Not Needed
(x) Safety Glasses: ______
( ) Face Shield: ______
( ) Goggles: ______
( ) Hard Hat: ______
( ) Other: ______

Gloves: ( ) Not Needed
(X) Undergloves: ______
( ) Gloves: ______
( ) Overgloves: ______

Boots: ( ) Not Needed
(X) Boots: Leather steel-toed work boots
(x) Overboots: Nitrile
( ) Rubber:

( ) Other - specify below:

BLOCK D TASKS: 3 LEVEL: D - Modified

( ) Primary
(X) Contingency

Respiratory: (X) Not Needed
( ) SCBA, Airline: ______
( ) APR: ______
( ) Cartridge: ______
( ) Escape Mask: ______
( ) Other: ______

Prot. Clothing: ( ) Not Needed
( ) Encapsulated Suit: ______
( ) Splash Suit: ______
( ) Apron: ______
(X) Tyvek Coverall: ______
( ) Saranex Coverall: ______
( ) Cloth Coverall: ______
( ) Other: ______

Head and Eye: ( ) Not Needed
(X) Safety Glasses: ______
( ) Face Shield: ______
( ) Goggles: ______
( ) Hard Hat: ______
( ) Other: ______

Gloves: ( ) Not Needed
(X) Undergloves: ______
(X) Gloves: Nitrile
( ) Overgloves: ______

Boots: ( ) Not Needed
(X) Boots: Leather steel-toed work boots
(x) Overboots: Nitrile
( ) Rubber:

( ) Other - specify below:

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MONITORING EQUIPMENT: Specify by task. Indicate type as necessary. Attach additional sheets as necessary.

INSTRUMENT	TASK	ACTION GUIDELINES	COMMENTS (Includes schedules of use)
Combustible Gas Indicator	1-2	0-10% LEL No explosion hazard. 10-25% LEL Potential explosion hazard; notify SHSC. >25% LEL Explosion hazard; interrupt task/evacuate 21.0% O_2 Oxygen normal <21.0% O_2 Oxygen deficient; notify SHSC <19.5% O_2 Interrupt task/evacuate	(X) Not Needed
Radiation Survey Meter	1-2-3	3X Background: Notify SHSC >2mR/hr: Interrupt task/evacuate >150 counts/min above background: Interrupt Task	Alpha, beta, and gamma detectors will be used. ( ) Not Needed
Photoionization Detector Type HNu meter	1-2 ( ) 11.7 ev (X) 10.2 ev ( ) 9.8 ev ( ) ____ ev	Level D: Less than 5 ppm above background Level C: From 5 to 25 ppm above background	HNu will be used for screening during monitoring well opening and sampling activities. ( ) Not Needed
Flame Ionization Detector Type ________		Specify:	(X) Not Needed
Detector Tubes/ Monitox Type ________ Type ________		Specify:	(X) Not Needed
Respirable Dust Monitor Type ________ Type ________		Specify:	(X) Not Needed
Other Specify		Specify:	

DECONTAMINATION PROCEDURES

ATTACH SITE MAP INDICATING EXCLUSION, DECONTAMINATION, AND SUPPORT ZONES AS PAGE TWO

<u>Personnel/Level Decontamination</u>
Summarize below and/or attach diagram; discuss use of work zones.

Discard disposable booties and gloves at CRZ as appropriate.

Hands and face washed on leaving site.

Shower stations will be identified at the initial safety meeting with the facility employees.

( ) Not needed

<u>Sampling Equipment Decontamination</u>
Summarize below and/or attach diagram; discuss use of work zones.

Air monitoring equipment will require sponge wash and rinse if in contact with surfaces on-site.

Mixing bowls, bailers, and spoons will be washed with non-ionic detergent, rinsed with tap water, rinsed with organic-free water, then rinsed with pesticide-grade isopropanol and allowed to air dry before wrapping in aluminum foil.

Personnel will wear neoprene or nitrile gloves, apron, and safety glasses during equipment decontamination.

( ) Not needed

<u>Heavy Equipment Decontamination</u>
Summarize below and/or attach diagram; discuss use of work zones.

Drill rig will have no new paint surfaces, will be free of friable oxidation, will not have any oil or hydraulic leaks, and will be inspected before initial use on-site.

Decontamination of all down-the-hole equipment will include the following steps:

1. Steam cleaning
2. Organic-free water rinse
3. Isopropanol rinse
4. Air dry
5. Transportation in visqueen

(X) Not needed

<u>Containment and Disposal Method</u>

Contaminated personal protective equipment will be collected into contractor garbage bags and drummed into DOT-approved 17H 55-gal drums. Drums will be properly labeled and marked for storage on-site and subsequent disposal.

<u>Containment and Disposal Method</u>

Excess soil cuttings will be returned to borehole or drummed and stored on-site for later disposal. Drums will be properly labeled and marked for storage on-site and subsequent disposal.

<u>Containment and Disposal Method</u>

Decontamination liquids and solids will be contained in a bermed or sump area for pumping into 55-gal 17H or 17E DOT approved drums. Drums will be properly labeled and marked for storage on-site and subsequent disposal.

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HEALTH AND SAFETY PLAN FORM — **CDM FEDERAL PROGRAMS CORPORATION**

CDM FPC Health and Safety Program

EMERGENCY CONTACTS

Water Supply	On-site Storage Tanks
Site Telephone	Currently unknown
EPA Release Report # :	1-800-424-8802
CDM 24-Hour Emergency:	1-800-455-PAGE [illegible]
Facility Management:	(615) 576-7172 Plant Shift Superintendent
Other (specify)	
CHEMTREC Emergency:	1-800-424-9300

CONTINGENCY PLANS Summarize Below:

Contingency will be based on field instrument readings and evaluation of hazard by the site safety officer. Upgrades in PPE are outlined on Page 6 of 11.

HEALTH AND SAFETY PLAN APPROVALS

Prepared by ______________________ Date ________

SHSC Signature ______________________ Date ________

HSM Signature ______________________ Date ________

EMERGENCY CONTACTS	NAME	PHONE:
Health and Safety Manager	Chuck Myers	(703) [illegible]
Project Manager	Charles Lutz	(615) 482-1065
Site Safety Coordinator		
Client Contact	Judy Hodgins	(615) 576-2368
Other (specify)		
Environmental Agency	TDEC	(615) 481-0995
State Spill Number		
Fire Department	Plant Fire Department	911
Police Department	Plant Security	(615) 576-7272
State Police	THP	(615) 685-7311
Health Department	Tenn. Health Department (Regional Office)	(615) 546-9221
Poison Control Center		911
Occupational Physician	David Barnes	(800) 229-3674

MEDICAL EMERGENCY

Hospital Name: Methodist Medical Center Phone: (615) 481-1000

Hospital Address: 990 Oak Ridge Turnpike, Oak Ridge, TN

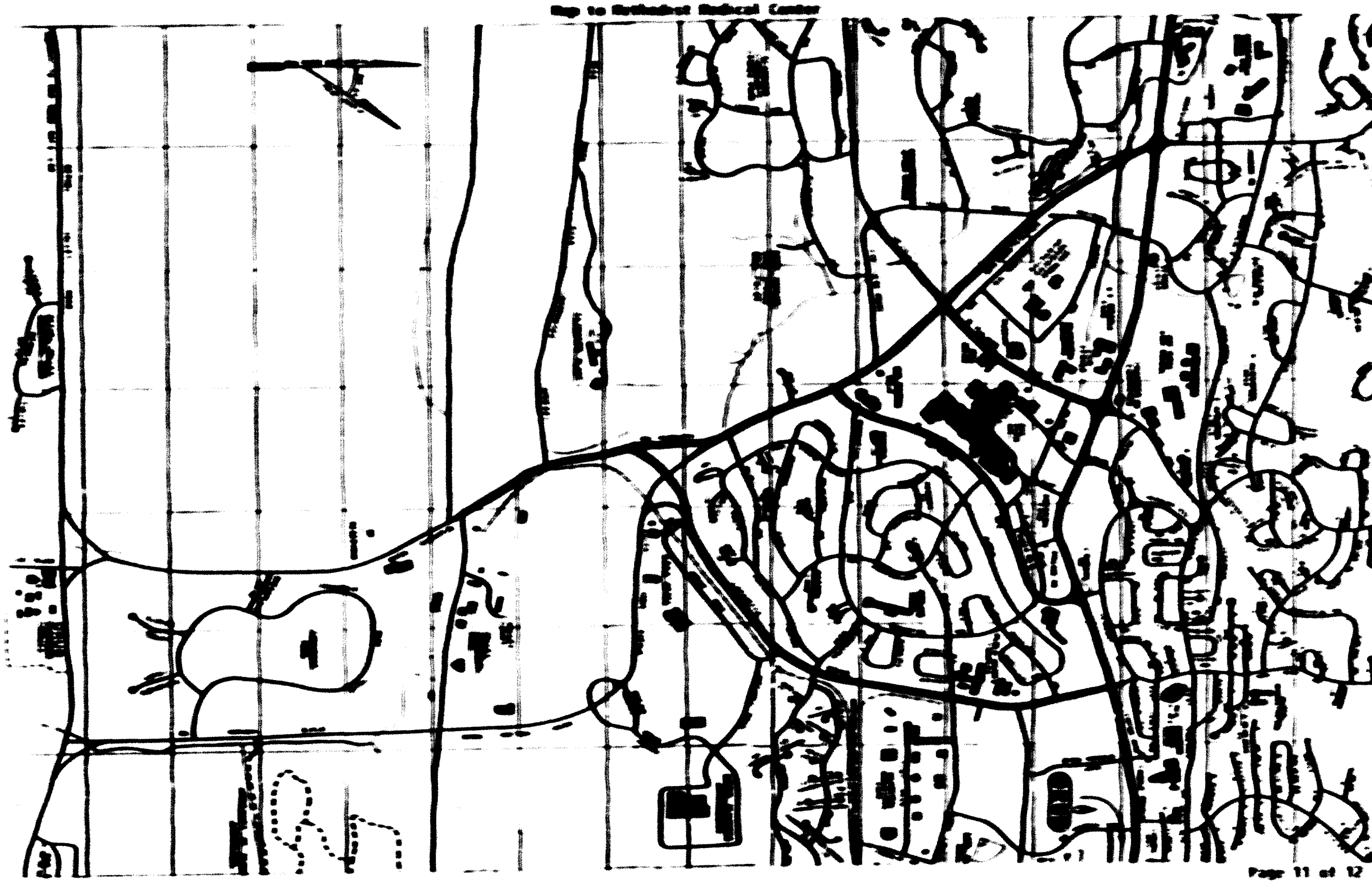
Name of Contact at Hospital:

Name of 24-Hour Ambulance: Oak Ridge/Anderson County Phone: (615) 457-2520

Route to Hospital:
Exit site, turn left onto Bethel Valley Road. Proceed to Scarboro Road and turn left onto it. Scarboro merges with Lafayette Drive just north of Bear Creek Road. Bear right onto Lafayette Drive. Follow Lafayette to Oak Ridge Turnpike. Turn right onto Turnpike, left at the first light into hospital.

Distance to hospital ___4.5 - 5.0 miles___

Map to Methodist Medical Center



The following personnel have read and fully understand the contents of this Health and Safety Plan and further agree to all requirements contained herein.

Name	Affiliation	Date	Signature

9.1 STRESS

Stress can contribute significantly to accidents or harm workers in other ways. The term **stress** denotes the physical (gravity, mechanical force, heat, cold, pathogen, injury) and psychological (fear, anxiety, crises, joy) forces that are experienced by individuals. The body's response to stress occurs in three stages:

- **Alarm reaction.** The body recognizes the stressor and the pituitary-adreno-cortical system responds by increasing the heart rate and blood sugar level, decreasing digestive activity, and dilating pupils.
- **Adaptive stage.** The body repairs the effect of stimulation, and the stress symptoms disappear.
- **Exhaustion stage.** The body can no longer adapt to stress, and the individual may develop emotional disturbances and cardiovascular and renal diseases.

The most common types of stress that affect field personnel are heat and cold stress. Currently, it is believed that heat and cold stress may be the most serious hazard to workers at waste sites.

9.2 HEAT STRESS

For field workers, heat stress usually is a result of protective clothing decreasing the natural body ventilation; however, it may occur any time work is being performed at elevated temperatures.

If the body's physiological processes fail to maintain a normal body temperature because of excessive heat, a number of physical reactions can occur, ranging from mild (such as fatigue, irritability, anxiety, and decreased concentration, dexterity, or movement) to fatal. Because heat stress is one of the most common and potentially serious illnesses at hazardous waste sites, regular monitoring and other preventive measures are vital. Site workers must learn to recognize and treat the various forms of heat stress. The following is the best approach to preventive heat stress management:

- Require workers to drink 16 oz. of water before beginning work, such as in the morning or after lunch. Provide disposable, 4-oz. cups, and water that is maintained at 50 to 60°F. Urge workers to drink 1-2 cups of water every 20 min, for a total of 1-2 gal per day. Provide a cool, shaded area for rest breaks. Discourage the use of alcohol during nonworking hours, and discourage the intake of coffee during working hours. Monitor workers for signs of heat stress.
- Acclimate workers to site work conditions by slowly increasing workloads (i.e., do not begin site work activities with extremely demanding tasks).
- Provide cooling devices to aid natural body ventilation. These devices, however, add weight, and their use should be balanced against worker efficiency. An example of a cooling aid is long cotton underwear, which acts as a wick to help absorb moisture and protect the skin from direct contact with heat-absorbing protective clothing.

- Install mobile showers and/or hose-down facilities to reduce body temperature and cool protective clothing.
- Conduct field activities in the early morning or evening in hot weather.
- Ensure that adequate shelter is available to protect personnel against heat, as well as cold, rain, snow, etc., which can decrease physical efficiency and increase the probability of both heat and cold stress. If possible, set up the command post in the shade.
- Rotate shifts of workers wearing impervious clothing in hot weather.
- Require workers to maintain good hygienic standards by urging frequent changes of clothing and showering. Clothing should be permitted to dry during rest periods. Persons who notice skin problems should immediately consult medical personnel.

9.2.1 Heat Stroke

Heat stroke is an acute and dangerous reaction to heat stress caused by a failure of heat regulating mechanisms of the body, which means that the individual's temperature control system that causes sweating stops working correctly. Body temperature rises so high that brain damage and death will result if the person is not cooled quickly.

- Symptoms—Red, hot, dry skin, although person may have been sweating earlier; nausea; dizziness; confusion, extremely high body temperature, rapid respiratory, and pulse rate; unconsciousness or comatose.
- Treatment—Cool victim quickly. If body temperature is not brought down fast, permanent brain damage or death will result. Soak victim in cool but not cold water. Sponge body with cool water, or pour water on body to reduce temperature to a safe level (102°F). Observe victim, and obtain medical help. Do not give victim coffee, tea, or alcoholic beverages.

9.2.2 Heat Exhaustion

Heat exhaustion is a state of very definite weakness or exhaustion caused by the loss of fluids from the body. This condition is much less dangerous than heat stroke, but it nonetheless must be treated.

- Symptoms—Pale, clammy, moist skin, profuse perspiration, and extreme weakness. Body temperature is normal, pulse is weak and rapid, breathing is shallow. Victim may have a headache, may vomit, and may be dizzy.
- Treatment—Take victim to cool, air-conditioned place, loosen clothing, place in head-low position, and provide bed rest. Consult physician, especially in severe cases. The normal thirst mechanism is not sensitive enough to ensure body fluid replacement. Have victim drink 1-2 cups of water immediately and every 20 min thereafter until symptoms subside. Total water consumption should be about 1-2 gal per day.

9.2.3. Heat Cramps

Heat cramps are caused by perspiration that is not balanced by adequate fluid intake. Heat cramps are often the first sign of a condition that can lead to heat stroke.

- Symptoms—Acute painful spasms of voluntary muscles (e.g., abdomen and extremities).
- Treatment—Take victim to cool area, and loosen clothing. Have victim drink 1-2 cups of water immediately and every 20 min thereafter until symptoms subside. Total water consumption should be 1-2 gal per day. Consult physician.

9.2.4. Heat Rash

Heat rash is caused by continuous exposure to heat and humid air and aggravated by chafing clothes. The condition decreases ability to tolerate heat.

- Symptoms—Mild red rash, especially in areas of the body in contact with protective gear.
- Treatment—Decrease amount of time in protective gear, and provide powder to help absorb moisture and decrease chafing.

9.3 HEAT STRESS MONITORING AND WORK CYCLE MANAGEMENT

For strenuous field activities that are part of on-going site work activities in hot weather, the following procedures will be used to monitor the body's physiological response to heat and to manage the work cycle, even if workers are not wearing impervious clothing.

The following procedures are to be instituted when the temperature exceeds 70°F:

- **Measure heart rate (HR).** HR should be measured by the radial pulse for 30 s as early as possible in the resting period. The HR at the beginning of the rest period should not exceed 110 beats/min. If the HR is higher, the next work period should be shortened by 33%, while the length of the rest period stays the same. If the pulse rate still exceeds 110 beats/min at the beginning of the next rest period, the following work cycle should be further shortened by 33%. The procedure is continued until the rate is maintained below 110 beats/min.
- **Measure body temperature.** Body temperature should be measured orally with a clinical thermometer as early as possible in the resting period. Oral temperature at the beginning of the rest period should not exceed 99.6°F. If it does, the next work period should be shortened by 33%, while the length of the rest period stays the same. If the temperature exceeds 99.6°F at the beginning of the next period, the following work cycle should be further shortened by 33%. The procedure is continued until the body temperature is maintained below 99.6°F.

- **Manage work/rest schedule.** The following work/rest schedule should be used as a guide:

Adjusted temperature (°F)	Active work time (min/hr) using level B/C protective gear
75 or less	50
80	40
85	30
90	20
95	10
100	0

- **Calculate the adjusted temperature.**

$$T\ (\text{adjusted}) = T\ (\text{actual}) + (13 \times \text{fraction sunshine})$$

- **Measure the air temperature with standard thermometer.** Estimate fraction of sunshine by judging what percent the sun is out:

100% sunshine = no cloud cover = 1.0
50% sunshine = 50% cloud cover = 0.5
0% sunshine = full cloud cover = 0.0

- **Reduce or increase work cycle.** Alter work cycle according to the guidelines under heart rate and body temperature.

9.4 COLD STRESS

Persons working outdoors in low temperatures, especially at or below freezing, are subject to cold stress. Exposure to extreme cold for a short time causes severe injury to the surface of the body, or results in profound generalized cooling, causing death. Areas of the body that have high surface area to volume ratio such as fingers, toes, and ears are the most susceptible. Protective clothing generally does not afford protection against cold stress. In many instances, it *increases* susceptibility.

Two factors influence the development of a cold injury: (1) ambient temperature and (2) velocity of the wind. Wind chill is used to describe the chilling effect of moving air in combination with low temperature.

As a general rule, the greatest incremental increase in wind chill occurs when a wind of 5 mph increases to 10 mph. Additionally, water conducts heat 240 times faster than air. Thus, the body cools suddenly when chemical-protective equipment is removed if the clothing underneath is soaked with perspiration.

9.4.1 Frostbite

Local injury resulting from cold is included in the generic term frostbite. Frostbite of the extremities can be categorized into the following:

- Frost nip or incipient frostbite is characterized by sudden blanching or whitening of skin.
- Superficial frostbite is characterized by skin with a waxy or white appearance that is firm to the touch, but tissue beneath is resilient.
- Deep frostbite is characterized by tissues that are cold, pale, and solid.

To administer first aid for frostbite—Take victim indoors, and rewarm frozen areas quickly in water that is between 39°C and 41°C (102°F-105°F). Give victim a warm drink—**not coffee, tea, or alcohol.** The victim must not smoke. Keep the frozen parts in warm water or covered with warm clothes for 30 min, even though the tissue will be very painful as it thaws. Then elevate the injured area, and protect it from injury. Do not allow blisters to be broken. Use sterile, soft material to cover injured areas. Keep victim warm and get immediate medical care.

After thawing, the victim should try to move the injured areas a little, but no more than can be done alone, without help. The following rules should always be followed when caring for a frostbite victim:

- Do *not* rub the frostbitten part (this may cause gangrene).
- Do *not* use ice, snow, gasoline, or anything cold on the frostbitten area.
- Do *not* use heat lamps or hot water bottles to rewarm the part.
- Do *not* place the part near a hot stove.

9.4.2 Hypothermia

Systemic hypothermia is caused by exposure to freezing or rapidly dropping temperature. Its symptoms are usually exhibited in the following five stages:

- shivering,
- apathy, listlessness, sleepiness, and (sometimes) rapid cooling of the body to less than 95°F,
- unconsciousness, glassy stare, slow pulse, and slow respiratory rate,
- freezing of the extremities,
- death.

As a general rule, field activities should be curtailed if equivalent chill temperature (°F) as defined by the U.S. Army Research Institute of Environmental Medicine is below 0°F unless the activity is of an emergency nature.

9.5 BOAT SAFETY

Collecting samples in the aquatic environment is a potentially hazardous task. Sampling teams should always consist of two or more qualified personnel per boat. Sampling team personnel should carry a radio for field communications. Gear should always be loaded into the boats prior to launch, as the water and shoreline surrounding most launch ramps is uneven and steep. General hazards to be avoided when sampling water, biota, or sediment from boats include the following:

- Make as few movements as possible. If in the normal process of taking samples, it is necessary to change position within the boat. Make those movements with caution.
- Personnel should always keep the center of their mass low to help avoid loss of balance.
- Personnel should be aware of the speed at which conditions will change.
- Boat decks should be maintained as free from obstructions as possible.

9.5.1 Safety Equipment Requirements

The basic safety equipment must include the following:

- one Coast Guard approved personal flotation device (PFD) per passenger,
- one PFD that can be thrown from the boat per boat,
- one anchor with adequate line,
- first-aid kit,
- radio,
- bailing device or pump,
- oar(s),
- visual distress signals,
- audio device (whistle, bell, horn, etc.),
- safety checklist for pretrip briefing (to be completed, dated, and signed by the operator).

PFD must be used by all boat occupants.

9.5.2 Responsibilities

The operator of a boat performs the following duties:

- operates the boat and its associated equipment in a safe and responsible manner,
- provides a boat safety orientation to passengers prior to boarding,
- conducts field safety inspections and performs minor field repairs as necessary to ensure safe operations,
- assumes responsibility for all aspects of boat operation including trailering and launching,
- uses proper safety equipment as necessary,
- ensures that the boat is equipped with a first-aid kit before being deployed in the field.

The crew members perform the following duties:

- operates the equipment in a safe and responsible manner,
- assists the operator as directed.

10. WASTE MANAGEMENT PLAN

10.1 SCOPE

This waste management plan outlines the procedures to be followed for the handling and management of investigation-derived waste (IDW) generated during the implementation of the RI sampling plan at Chestnut Ridge OU 4. Waste minimization will be practiced during both the generation and disposal of waste. Every attempt will be made to minimize the amount of waste generated during field sampling activities. Plastic sheeting will be reused as long as sample integrity is not compromised. Use of Tyvek coveralls will be limited to those activities presenting a threat of external contamination to the participant. While coveralls are not to be worn longer than a single work shift, every attempt will be made to minimize changes during the shift. Sediments and surface water not used for samples will be returned to the original collection location. Liquid wastes will be minimized by a combination of evaporation and sparing usage. Other waste minimization and reduction techniques will include segregation, decontamination, compaction, selection of personal protective equipment (PPE), material recycle, and selection of equipment. Every attempt will be made to keep waste types (low level wastes, hazardous, etc.) segregated so that no mixed wastes are generated.

Waste minimization techniques will be documented in project logs and records. All waste streams will be assessed to implement minimization/prevention activities. Audits of the project waste minimization will be conducted to ensure adequacy and effective implementation. A waste generator evaluation scoresheet for numerical evaluation of this project's waste minimization program will be completed and submitted to Environmental Restoration Central Waste Management.

Practices included in waste management will comply with procedures for the Environmental Restoration Program at the Oak Ridge Y-12 Plant, "Waste Removal and Disposition Through the Y-12 ER Program," ER/Y-P2102 (IAD), Rev. 0, and with procedures outlined in the Energy Systems document *Environmental Surveillance Procedures, Quality Control Program*, ESH/Sub/87-21706/1, Rev. 1 (1990a), Method ESP-1000, "Waste Management." In addition, a waste management planning checklist will be prepared in coordination with ER Waste Management.

Previous work at the site indicated that the primary contaminants of concern are metals and radionuclides. These contaminants exceeded background levels at some sampling locations, and MCLs were exceeded for several metals in a few samples; concentrations generally were not excessively high. Neither VOCs nor SVOCs have been detected at the site (except for presumed laboratory contaminants). PAHs may be present in the coal ash disposed of in the quarry. The generation of listed waste during this investigation is not anticipated.

10.2 PROJECT CONTACTS

The project contacts for this site are as follows:

Judy Hodgins, Energy Systems Project Manager, 576-2368
Chris Smith, Y-12 ER Waste Management, 576-6526
Charles Lutz, CDM Federal Project Manager, 482-1065

10.3 WASTE TYPES

A variety of IDW will be generated during the investigation. All IDW will be handled in accordance with Energy Systems Procedure ER/C-2101. An identification of each type of waste and activities responsible for their generation follows.

Purge Water—Each monitoring well will be purged of three to five well volumes before sampling to ensure that samples taken for analysis are representative of formation water. Water generated during purging will be discharged to the ground surface in accordance with Y-12 Plant policy. Field personnel will maintain continuous monitoring for VOCs and radionuclides during purging using an organic vapor analyzer; HNu; and an alpha, beta, gamma detector.

Decontamination Water—Decontamination water will be generated each time the sampling equipment is cleaned. This water will contain any solvents used for decontamination and may contain contaminants present at the site. Decontamination water will be placed in drums on-site in accordance with procedures outlined in Energy Systems Y-12 Procedure 70-903, "Transfer, Storage, and Disposal of Waste." Steel, 55-gal, 17E DOT-approved drums will be used to store the decontamination water on-site. Filled drums will be taken to the West End Treatment Facility, where the contents will be emptied and treated.

Personal Protective Equipment—Although the suspected hazards at Chestnut Ridge OU 4 are low, on-site personnel will be required to wear PPE. Types of disposable PPE include Tyvek coveralls, gloves, plastic sheeting, and tape. These items will be bagged on-site and will be subsequently taken to a trash dumpster designated by Environmental Restoration personnel. The contents of the dumpster will ultimately be taken to the sanitary landfill at the Y-12 Plant.

During the field activities, additional Energy Systems and DOE requirements may be identified. Necessary revisions to the waste management plan will ensure the inclusion of these additional requirements in the daily activities performed by each of the waste management personnel.

Analytical Waste—Analysis of samples taken during the RI will generate two types of waste: (1) laboratory extracts and digestates and (2) excess sample material. The contract laboratory will dispose of extracts, digestates, and excess sample material. Energy Systems has ultimate determination of the disposal of analytical wastes.

10.4 WASTE ESTIMATES

The wastes that will be generated are decontamination and purge water, which are estimated to be ~275 gal, and PPE. This waste will be properly containerized and labeled in accordance with ER/Y-P2102 and DOT requirements.

10.5 WASTE STAGING AND STORAGE REQUIREMENTS

No wastes will be permanently stored at the site. All wastes will be transported to a storage area within the ORR. Bethel Valley Road and Scarboro Road will be used to transport wastes, as necessary.

11. REFERENCES

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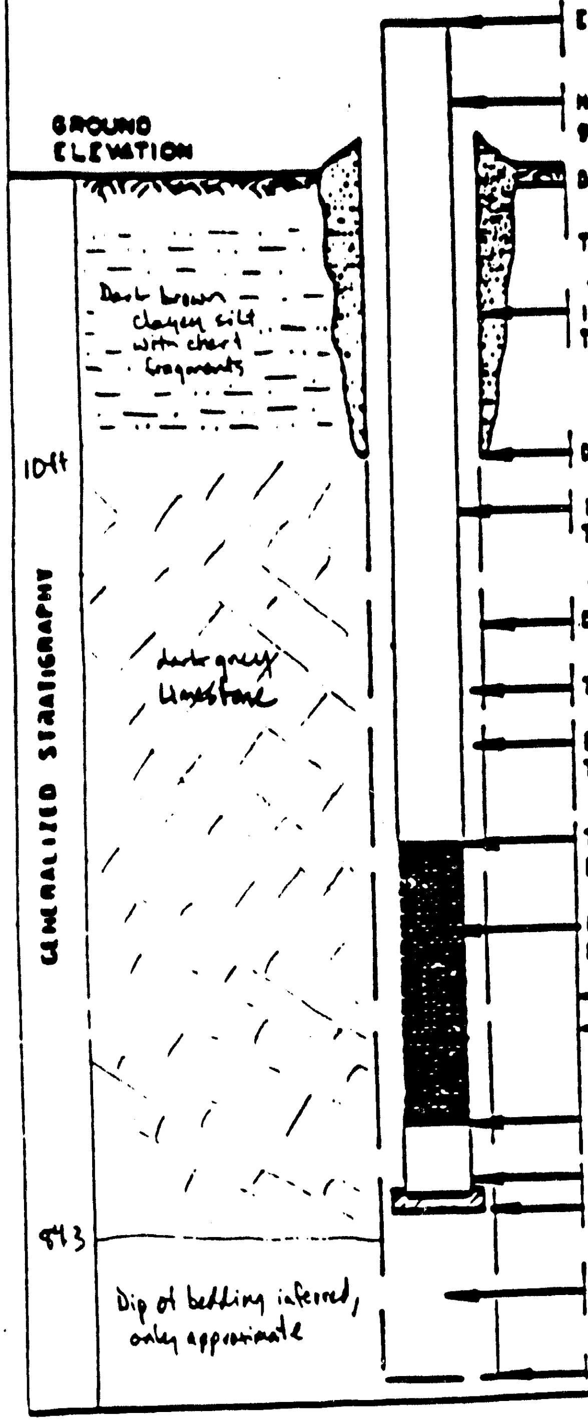
Appendix A

GROUNDWATER DATA FOR ROGERS QUARRY, 1986–1992

~~GW 218~~ 318

PROJECT: Argonne National Lab Water Quality Study	WELL NO. GW-318
SITE: Y-12 at old Rogers Quarry	
COORDINATES: 23 ft east of utility pole at SW corner of Rogers Quarry	AQUIFER:
DATE COMPLETED: Aug. 7, 1987 (except for concrete pad and protective casing)	
SUPERVISED BY: Joseph Matlock Geologist, Geotek Engineering Co.	



Elevation of reference point	
Height of reference point above ground surface	
Depth of surface seal	10.0 ft
Type of surface seal: Cement grout	
I.D. of surface casing	10¼"
Type of surface casing: Carbon Steel	
Depth of surface casing	10.0 ft
I.D. of riser pipe	4"
Type of riser pipe: 304 Stainless Steel	
Diameter of borehole	8"
Type of filler: Cement grout	
Elevation / depth of top of seal	63.8 ft
Type of seal: bentonite	
Type of gravel pack: coarse sand	
Elev./depth of top of gravel pack	67.6 ft
Elevation / depth of top of screen	69.1 ft
Description of screen: 304 Stainless steel	
I.D. of screen section	4"
Elevation / depth of bottom of screen	79.6 ft
Elev./depth of bottom of gravel pack	79.6 ft
Elev./depth of bottom of plugged blank section	
Type of filler below plugged section	
Elevation of bottom of borehole	

Well Construction Summary.

GW-274 319

PROJECT Argonne National Lab Water Quality Study

SITE Y-12 at old Rogers Quarry

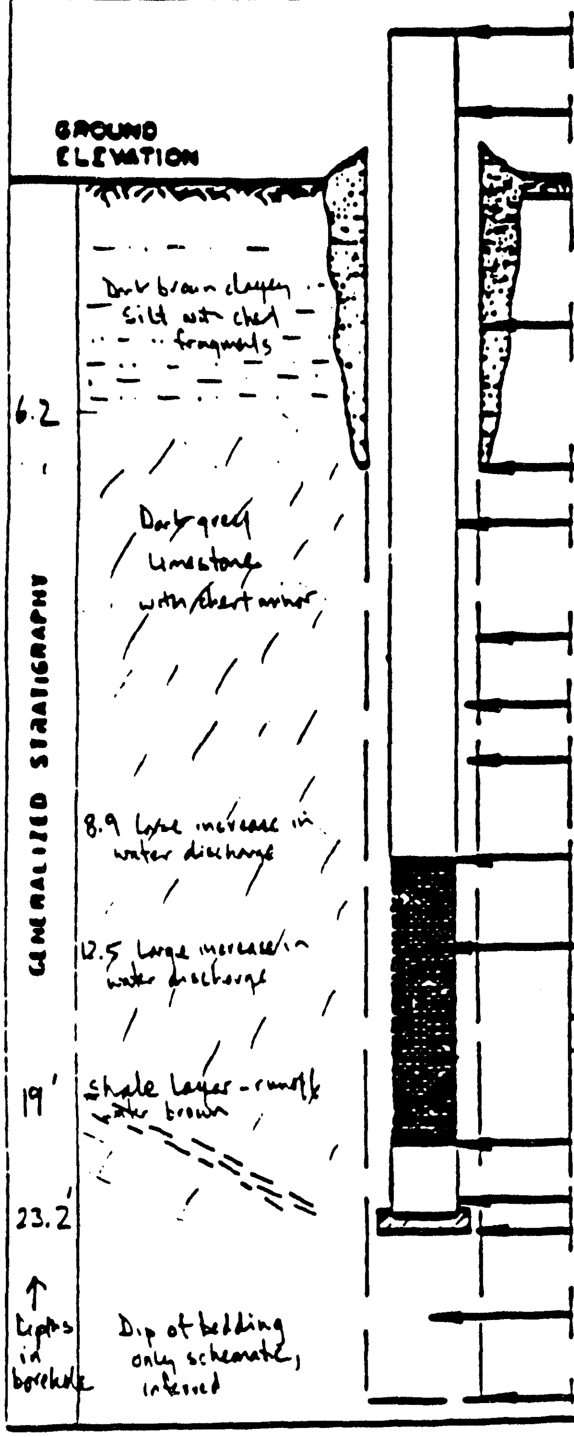
COORDINATES 53 ft east of utility pole at SW corner of Rogers Quarry

DATE COMPLETED Aug 24, 1987 except for concrete pad and protective casing

SUPERVISED BY Joseph Mattock, Geologist, Geotek Engineering Co.

WELL NO. GW-319

AQUIFER



Elevation of reference point	
Height of reference point above ground surface	
Depth of surface seal	7.5'
Type of surface seal: Cement grout	
I.D. of surface casing	10¼"
Type of surface casing: Carbon steel	
Depth of surface casing	7.5'
I.D. of riser pipe	4"
Type of riser pipe: 304 stainless steel	
Diameter of borehole	8"
Type of filler: Cement grout	
Elevation / depth of top of seal	8.2'
Type of seal: bentonite	
Type of gravel pack: coarse sand	
Elev./depth of top of gravel pack	10.2'
Elevation / depth of top of screen	12.2'
Description of screen: 304 Stainless steel	
I.D. of screen section	4"
Elevation / depth of bottom of screen	23.2'
Elev./depth of bottom of gravel pack	23.2'
Elev./depth of bottom of plugged blank section	
Type of filler below plugged section	Gravel pack and bottom of screen are at bottom of borehole.
Elevation of bottom of borehole	

Well Construction Summary.

6W 220

DATE Completed

PROJECT Argonne National Lab Water Quality Study

SITE Y-12 Ash Pond Earth Dam

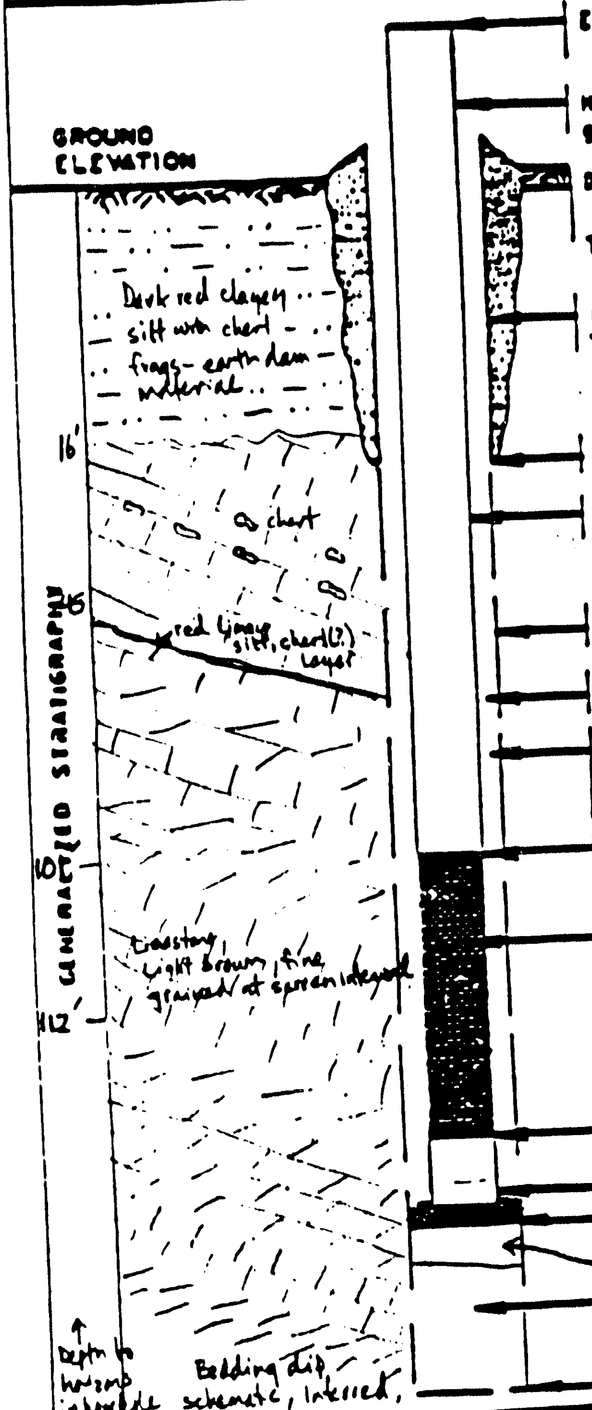
COORDINATES 33 ft east of well cluster 5 at ash pond dam

DATE COMPLETED Aug 20, 1987 except for concrete pad and protective casing

SUPERVISED BY Joseph Matlock, geologist, Geotek Engineering Co

WELL NO. 6W 320

AQUIFER



Elevation of reference point	
Height of reference point above ground surface	
Depth of surface seal	16.9 ft
Type of surface seal: cement grout	
I.D. of surface casing	10¼"
Type of surface casing: Carbon steel	
Depth of surface casing	16.9 ft.
I.D. of riser pipe	4"
Type of riser pipe: Johnson 304 Stainless Steel	
Diameter of borehole	8"
Type of filler: cement grout	
Elevation / depth of top of seal	90.7 ft
Type of seal: bentonite	
Type of gravel pack: coarse sand	
Elev./depth of top of gravel pack	97.8 ft
Elevation / depth of top of screen	100.0 ft
Description of screen: 304 Stainless Steel	
I.D. of screen section	4"
Elevation / depth of bottom of screen	110.0 ft
Elev./depth of bottom of gravel pack	115.0 ft
Elev./depth of bottom of ~~plugged~~ grout	118 ft
~~blank section~~ Depth ~~.....~~ of seal (bentonite)	118 - 124 ft
Type of filler below plugged section: Cement grout with 5% bentonite	124 - 200' ft. 200
Elevation of bottom of borehole	

Well Construction Summary.

Note: Well used by Argonne as observation well only because of contamination

Project: Argonne National Lab Water Quality Study

DOE ENVIRONMENTAL SURVEY — **WELL COMPLETION RECORD**

DOE SITE NAME: Y-12

WELL ID NUMBER: GW-321

WELL COORDINATES or WELL LOCATION: 29 ft west of well 5B at ash pond dam

DRILLING COMPANY: Geotek Engineering

TYPE OF RIG: T4

DATE INSTALLATION COMPLETED (dd/mmm/yy): 09/SEP/87 except for concrete pad and protective casing.

TOTAL DEPTH: 98.6 ft.

DEVELOPMENT

METHOD: Submersible Pump

START DATE: __/___/__
TIME: ____

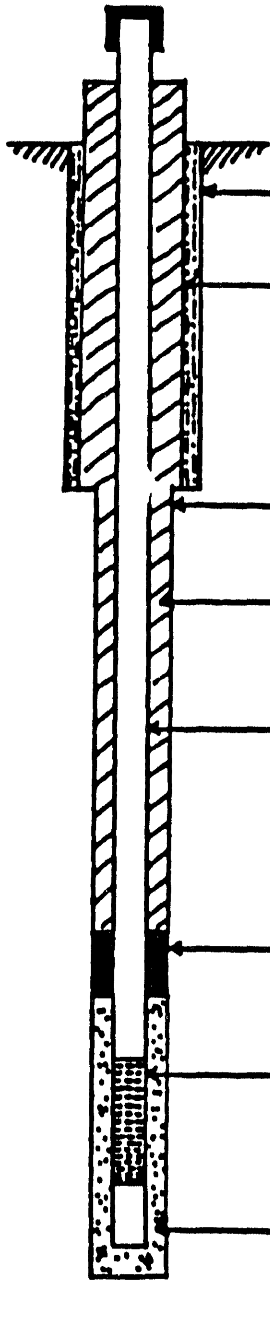
END DATE: __/___/__
TIME: ____

TOTAL WATER REMOVED DURING DEVELOPMENT: ______ gal.

DESCRIPTION OF TURBIDITY AT END OF DEVELOPMENT:
[ ] Clear [ ] Slightly cloudy
[ ] Mod. turbid [ ] Very cloudy

ADDITIONAL COMMENTS: Well will be developed again in mid October prior to water sampling.

WELL CONSTRUCTION SUMMARY



WELL CAP ELEVATION: ______ ft.*

GROUND SURFACE ELEVATION: ______ ft. *

* will be determined by surveying crew in October.

CONDUCTOR HOLE DIA.: 12 in.
0.0 to 22.3 ft.

SURFACE CONDUCTOR
TYPE: Carbon steel
ID: 10 3/4 in. OD: 10 3/4 in.
0.0 to 22.0 ft.
with 6' stick-up

BOREHOLE DIA.: 8 in.
22.3 to 99.6 ft.

FILLER
TYPE: Cement Grout
0.0 to 80 ft.

CASING (with screen)
TYPE: Johnson 304 Stainless steel
ID: 4 in. OD: 4 7/8 in.
0.0 to 98.0 ft.
with 3' stick up

SEAL
TYPE: Bentonite
80 to 84.0 ft.

SCREEN
TYPE: Johnson 304 Stainless Steel
ID: 4 in. OD: 4 3/8 in.
87.3 to ~~84.0~~ 98.0 ft. JM 09 Sep 87

PACK
TYPE: Coarse Sand
84.0 to 98.6 ft.

RECORDED BY: Joseph Matlock (Signature) QA CHECK BY: Ronald P. R. (Signature)

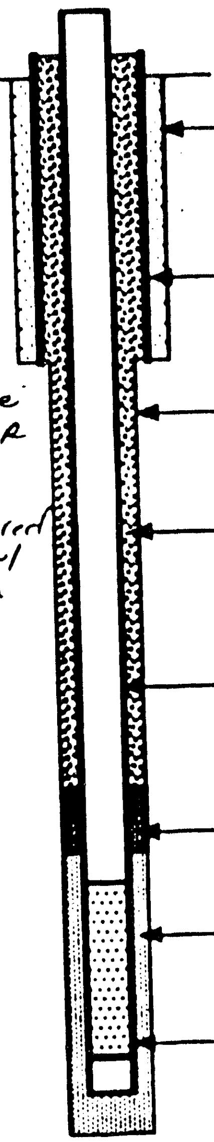
WELL CONSTRUCTION SUMMARY

Well Name: OW 184 **Total Depth:** 130'
Location: Roger's Quarry
Drilled By: Geotek (R.M. Collins) **Date Completed:** 15 Nov 85
Notes:

Geologic Summary

115' fracture w/ water

[illegible] fractured zone w/ water



Downhole Depths

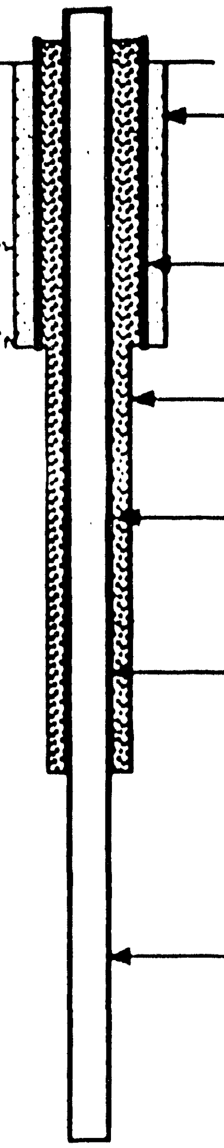
		Top	Bottom
Conductor Hole Dia: 16"		0	8'
Surface Conductor	Type: PVC, sch 40; I.D. 9 7/8"; O.D. 10 5/8"	0	8'
Borehole Dia: 10"		8'	130'
Filler: Cement, Portland Type I			
Casing (with Screen)	Type: PVC, sch 40; I.D. 4"; O.D. 4½"		127.5'
Seal: Bentonite		98'	101.5'
Pack: Sand		101.5'	130.0'
Screen	Type: PVC, sch 40; I.D. 4"; O.D. 4½"	107.5	127.5'

WELL CONSTRUCTION SUMMARY

Well Name: GW 125 **Total Depth:** 471.5
Location: Rogers Quarry
Drilled By: Geotek (K.A. Collins) **Date Completed:** 10 Dec 85
Notes:

Geologic Summary

TOWR 5.0
TOFR 17.0
Frac Q
73' 20-30 gpm
170' water
366 foamy water
oil smell



Downhole Depths

		Top	Bottom
Conductor Hole Dia: 16"		0	17
Surface Conductor	Type: PVC; I.D. 10"; O.D. 10 5/8	0	17
Borehole Dia: 10"		0	405
Grout: Halliburton, Pozmix A			
Casing	Type: Steel; I.D. 6"; O.D. 6 5/8"	+1.0	405
Open Hole Dia: 6.0"		405	471.5

WELL CONSTRUCTION SUMMARY

Well Name: SW 186 **Total Depth:** 171'

Location: Rogers Quarry

Drilled By: Geotek (R.W. Collins) **Date Completed:** 20 Dec 85

Notes:

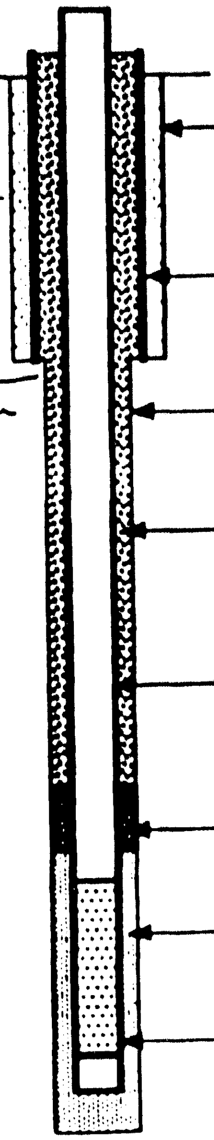
Geologic Summary

TOUR 12.0
TOFR 14.5

Frac @
25 W
164-169 W

Limestone & Shale
12 - 25

Limestone
25 - 171



Downhole Depths

		Top	Bottom
Conductor Hole Dia: 15"		0	14.5
Surface Conductor Type: PVC, sch #40	I.D. 10" O.D. 10 5/8	0	14.5
Borehole Dia: 10"		14.5	171.0
Filler: Cement, Type I			
Casing (with Screen) Type: PVC, sch #40	I.D. 4.0 O.D. 4 1/2	+1.0	170.0
Seal: bentonite		139.0	142.0
Pack: Sand		142.0	171.0
Screen Type: PVC, slotted	I.D. 4 O.D. 4 1/2	150.0	170.0

WELL CONSTRUCTION SUMMARY

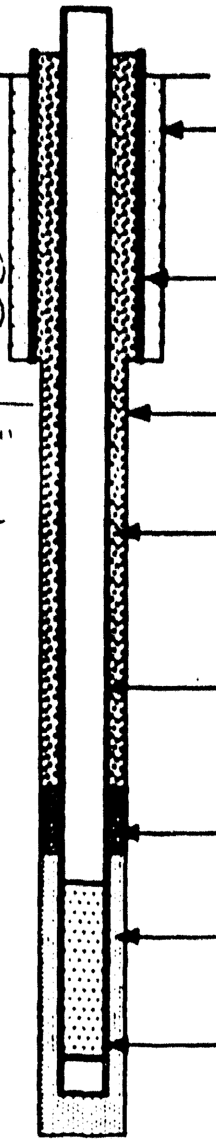
Well Name: GW 127 **Total Depth:** 162'
Location: ROGERS QUARRY
Drilled By: GEOTEK (K.M COLLINS) **Date Completed:** 04 Dec 85
Notes:

Geologic Summary

TOWR 7'
TOFR 15'
Frac @ 92(w)
15-121(w)
134-135(w)
159-160(w)
each > 25 gpm

Shale & Limestone
15-92

Gray Limestone
92-160



Downhole Depths

		Top	Bottom
Conductor Hole Dia: 15'		0	7'
Surface Conductor	Type: PVC sch; I.D. 10"; O.D. 10½"	0	7'
Borehole Dia: 10"		7'	162.0'
Filler: CEMENT			
Casing (with Screen)	Type: PVC, sch 40; I.D. 4"; O.D. 4½"	3' stickup	162.0'
Seal: BENTONITE		136.5'	139.0'
Pack: SAND		139.0'	162.0'
Screen	Type: PVC sch 40; I.D. 4"; O.D. 4½"	147.0'	162.0'

WELL CONSTRUCTION SUMMARY

Well Name: GW 100 **Total Depth:** 68'

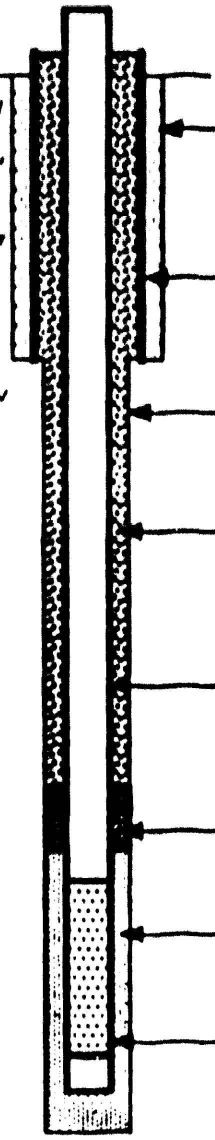
Location: Rogers Quarry

Drilled By: Geotek (Randy Collins) **Date Completed:** 03 Oct 85

Notes:

Geologic Summary

Weathered rock at 13'
Solid rock at [illegible]'
Cavity 37'-39' w/ muddy water
fractured zones
47-48'
[illegible]-58.5'
[illegible]-68'
lost circulation at [illegible]' and [illegible]'



Downhole Depths

		Top	Bottom
Conductor Hole Dia:	11'	0	68'
Surface Conductor	Type: PVC #40; I.D. 9 7/8"; O.D. 10 5/8"	0	15'
Borehole Dia:		0	15'
Filler:	Grout, Portland Type I		
Casing (with Screen)	Type: PVC #40; I.D. 4"; O.D. 4 1/2"	Above Surface 3'	
Seal:	Bentonite	47.5'	49'
Pack:	Sand	49'	68'
Screen	Type: PVC #40; I.D. 4"; O.D. 4 1/2"	52.5'	67.5'

WELL CONSTRUCTION SUMMARY

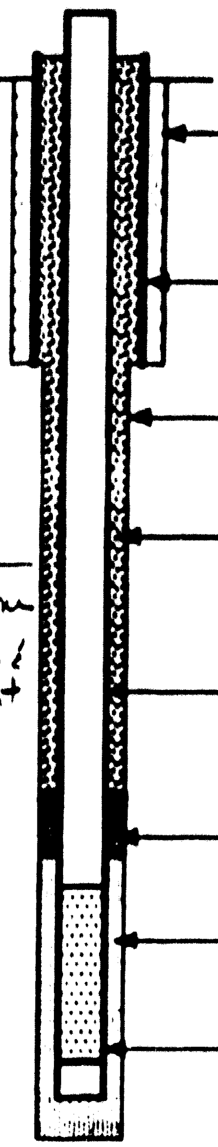
Well Name: [illegible] 19C **Total Depth:** 21[illegible]
Location: Roggers Quarry
Drilled By: Geotek (R. Al Collins) **Date Completed:** 18 Dec 85
Notes:

Geologic Summary

TOVR 17.0
TOFR 17.0

Frac @
44 (W)
143-145 W
164-165
172 (W)
200 W

19-170 Limestone
170-210 Limestone & chert



Downhole Depths

		Top	Bottom
Conductor Hole Dia: 15"		0	19.0
Surface Conductor	Type: PVC, sch #40; I.D. 10"; O.D. 10 5/8"	0	19.0
Borehole Dia: 10"		19.0	210.0
Filler: Cement, type I			
Casing (with Screen)	Type: PVC, sch #40; I.D. 4"; O.D. 4 1/2"	+1.0	210.0
Seal: bentonite		176.0	180.0
Pack: sand		180.0	210.0
Screen	Type: PVC, slotted; I.D. 4; O.D. 4 1/2	190.0	210.0

WELL CONSTRUCTION SUMMARY

Well Name: 6(1) 224 **Total Depth:** 136'

Location: Rogers Quarry

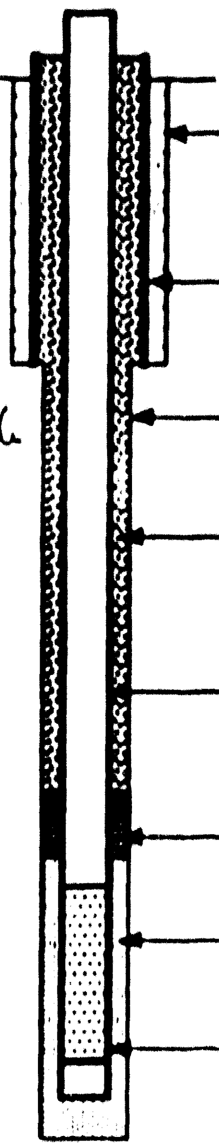
Drilled By: GeoTek (R.M. Collins) **Date Completed:** 21 Nov 85

Notes:

Geologic Summary

TOWR 7'
TOFR 18'
Frac @ 115-126 (W, [illegible])
>25 gpm

18-126
Blu-gr[illegible] shale
and
Limestone



Downhole Depths

		Top	Bottom
Conductor Hole Dia:	16"	0	7'
Surface Conductor	Type: PVC, sch 40; I.D. 12"; O.D. 12 3/4	0	7'
Borehole Dia:	10"	7.0'	126.0'
Filler:	CEMENT		
Casing (with Screen)	Type: PVC, sch 40; I.D. 4"; O.D. 4 1/2'	3' stickup	126.0'
Seal:	BENTONITE	101.5'	103.0'
Pack:	SAND	103.0'	126.0'
Screen	Type: PVC, sch; I.D. 4"; O.D. 4 1/2"	106.0'	126.0'

EXPLANATION OF ABBREVIATIONS IN APPENDIX A

UF = unfiltered sample

F = filtered sample

NA = not analyzed for this parameter

ND = parameter was not detected

GROUNDWATER RESULTS FOR GW-184

Units MG/L unless spec'd		02-86	04-86	07-86	10-86
PH (STD UNITS)	UF	7.4	7.4	7.4	7.8
ALUMINUM	UF	<0.02	<0.02	<0.02	0.12
ARSENIC	UF	0.007	<0.005	<0.005	<0.005
BARIUM	UF	0.0082	0.0087	0.011	0.018
BETA ACTIV (PCI/L)	UF	<1	2.79	<1	<1
BORON	UF	0.013	0.017	0.039	0.037
CALCIUM	UF	63	68	80	96
CHLORIDE	UF	1.2	1.5	1.6	4.9
CHROMIUM	UF	<0.01	<0.01	<0.01	0.01
COPPER	UF	0.0059	<0.004	<0.004	0.0046
FLUORIDE	UF	0.08	<0.10	0.20	0.10
IRON	UF	0.04	<0.004	0.019	0.054
LEAD	UF	0.004	<0.004	0.013	<0.004
MAGNESIUM	UF	5.3	7.2	9.7	9.6
MANGANESE	UF	0.001	0.0045	0.0074	0.006
MOLYBDENUM	UF	<0.01	<0.01	<0.01	0.016
NIOBIUM	UF	<0.007	<0.007	<0.007	0.11
NITRATE NITROGEN	UF	0.38	0.3	<0.11	15.6
PHENOLS	UF	0.002	0.009	0.003	0.006
POTASSIUM	UF	<0.6	<0.6	1.5	2.1
SILICON	UF	2.9	3	3.1	3.4
SODIUM	UF	1.3	1.5	2.2	2.1
STRONTIUM	UF	0.077	0.12	0.14	0.21
SULFATE	UF	13	24	28.1	31
TITANIUM	UF	<0.003	<0.003	0.013	<0.003
URANIUM	UF	0.003	0.001	0.001	<0.001
ZINC	UF	0.024	0.027	0.0063	<0.001
ZIRCONIUM	UF	<0.005	<0.005	0.0071	<0.005
ALPHA ACTIV (PCI/L)	F	1	<1	<1	<1
ALUMINUM	F	<0.02	<0.02	<0.02	0.095
ARSENIC	F	0.006	<0.005	<0.005	<0.005
BARIUM	F	0.0093	0.0087	0.011	0.017
BORON	F	0.041	0.015	0.058	0.041
CALCIUM	F	66	71	81	95
COPPER	F	0.0055	<0.004	<0.004	0.0095
IRON	F	0.019	<0.004	0.0056	0.0073
LEAD	F	0.004	<0.004	0.008	<0.004
LITHIUM	F	<0.004	<0.004	0.026	<0.004
MAGNESIUM	F	5.5	7.5	9.7	9.6
MANGANESE	F	0.0053	0.0019	0.0071	0.006
NIOBIUM	F	<0.007	<0.007	<0.007	0.11
POTASSIUM	F	0.87	0.66	<0.6	1.8
SILICON	F	3.1	2.9	3.1	3.3
SODIUM	F	1.5	1.6	2.2	2.1
STRONTIUM	F	0.08	0.12	0.14	0.22
TITANIUM	F	<0.003	<0.003	0.011	<0.003
URANIUM	F	0.002	0.001	0.003	<0.001
ZINC	F	0.033	0.0068	0.01	<0.001
ZIRCONIUM	F	<0.005	<0.005	0.009	<0.005

GROUNDWATER RESULTS FOR GW- FOR GW-184

Units MG/L unless spe	UF	2-87	08-87	02-88	1-89	1-90	9-90
PH (STD UNITS)	UF	7.4	7.2	7.4	6.5	7.0	6.9
ALUMINUM	UF	NA	NA	0.11	ND	.023	.093
ALKALINITY (HCO3)	UF	NA	205	176	148	156	203
ARSENIC	UF	NA	NA	NA	0.071	0.013	NA
BARIUM	UF	NA	NA	.031	0.02	0.033	.028
BERYLLIUM	UF	NA	NA	NA	ND	ND	ND
BETA ACTIV (PCI/L)	UF	NA	NA	NA	NA	NA	NA
BORON	UF	NA	NA	.044	0.006	0.044	0.031
CADMIUM	UF	NA	NA	ND	0.0039	ND	ND
CALCIUM	UF	NA	NA	100	110.0	81.0	86
CHLORIDE	UF	NA	NA	3.8	4.0	3.0	2.0
CHROMIUM	UF	NA	NA	ND	ND	ND	ND
COPPER	UF	NA	NA	.015	0.011	ND	ND
FLUORIDE	UF	NA	NA	NA	0.10	0.10	ND
IRON	UF	NA	NA	.10	0.058	0.27	ND
LEAD	UF	NA	NA	NA	.0042	ND	ND
MAGNESIUM	UF	NA	NA	NA	11.0	10.0	9.5
MANGANESE	UF	NA	NA	.009	0.005	ND	0.03
MOLYBDENUM	UF	NA	NA	0.024	ND	ND	ND
NIOBIUM	UF	NA	NA	ND		NA	NA
NITRATE NITROGEN	UF	NA	NA		37.0	21.0	10.9
PHENOLS	UF	NA	NA	ND	ND	ND	NA
POTASSIUM	UF	NA	NA	0.89	5.20	1.90	1.9
SILICON	UF	NA	NA	3.1	3.30	3.50	3.7
SODIUM	UF	NA	NA	2.3	3.00	2.3	2.3
STRONTIUM	UF	NA	NA	0.16	0.16	0.250	.240
SULFATE	UF	NA	NA	36	37.0	25.0	29.0
TITANIUM	UF	NA	NA	ND		NA	NA
URANIUM	UF	NA	NA	0.004		ND	ND
ZINC	UF	NA	NA	0.0140	0.024	ND	0.009
ZIRCONIUM	UF	NA	NA	ND	NA	NA	NA
ALPHA ACTIV (PCI/L)	F	NA	NA	NA	NA	NA	NA
ALUMINUM	F	NA	NA	<0.02	ND	0.029	.056
ARSENIC	F	NA	NA	NA	0.0720	ND	ND
BARIUM	F	NA	NA	.03	0.210	0.040	.031
BERYLLIUM	F	NA	NA	0.0003	ND	ND	ND
BORON	F	NA	NA	0.025	0.016	0.016	.027
CADMIUM	F	NA	NA	110	ND	0.0034	ND
CALCIUM	F	NA	NA	110	110.0	86.0	85
COPPER	F	NA	NA	0.0057	0.0043	ND	ND
IRON	F	NA	NA	ND	0.04	0.021	NA
LEAD	F	NA	NA	NA	0.0060	ND	ND
MAGNESIUM	F	NA	NA	10	11.0	11.0	9.3
MANGANESE	F	NA	NA	0.011	0.00560	0.0074	.028
MOLYBDENUM	F	NA	NA	<0.01	ND	ND	ND
POTASSIUM	F	NA	NA	0.79	4.40	1.80	1.9
SILICON	F	NA	NA	3.4	3.30	1.50	3.6
SODIUM	F	NA	NA	2.3	2.9	2.3	2.3
STRONTIUM	F	NA	NA	0.16	0.170	0.25	.23
TITANIUM	F	NA	NA	ND	NA	NA	NA
URANIUM	F	NA	NA	0.004	ND	ND	ND
ZINC	F	NA	NA	0.0089	0.015	ND	.0094
ZIRCONIUM	F	NA	NA	<0.005	NA	NA	NA

GROUNDWATER RESULTS FOR GW-184

Units MG/L unless spec'd		9-91	11-91	2-92	6-92
PH (STD UNITS)	UF	7.2	7.2	7.7	7.4
ALUMINUM	UF	<0.02	0.028	.058	.058
ALKALINITY (HCO3)	UF	202	198	162	192
ALPHA ACTIVITY (PC	UF	0.88	0.32		
BARIUM	UF	0.028	0.025		.024
BERYLLIUM	UF				.00031
BETA ACTIV (PCI/L)	UF	2.13	-0.42		
BORON	UF	0.069	0.041	.029	.036
CALCIUM	UF	88	88		76
CHLORIDE	UF	1	1.5	2	1.3
COPPER	UF	<0.004	0.02	.0084	.0089
FLUORIDE	UF			.2	.2
IRON	UF	0.039	0.026	0.023	.021
MAGNESIUM	UF	9	9.8	7.9	7.7
MANGANESE	UF	0.0064	0.018	0.0018	<.001
NITRATE NITROGEN	UF	7.2	5.1	9.31	3
POTASSIUM	UF	1.3	1.9	1.5	1.6
SODIUM	UF	1.7	2.1	1.6	1.6
STRONTIUM	UF	0.19	0.20	.25	.16
SULFATE	UF	27	28.8	23	22.9
URANIUM	UF				
ZINC	UF	0.0091	0.013		
ALUMINUM	F	0.029	<0.02	.11	.11
BARIUM	F	0.032	0.026		.024
BERYLLIUM	F	0.00035			.0039
BORON	F	0.048	0.03	.03	.0038
CALCIUM	F	83	92		79
COPPER	F	0.0079	0.0078	0057	0.017
IRON	F	0.068	<0.005		.022
MAGNESIUM	F	9.5	10	7.8	7.8
MANGANESE	F	0.015	0.016		.0017
POTASSIUM	F	1.4	1.8	1.6	1.6
SODIUM	F	1.7	2.1	1.7	1.7
STRONTIUM	F	0.22	0.20	.25	.16
URANIUM	F				
ZINC	F	0.015	0.013	.0048	0.027
TOLUENE	UF	0.4			
bis(2-ethylhexyl)phtha	UF	1.0			
di-n-Octylphthalate	UF	1.0			

GROUNDWATER RESULTS FOR GW-186

MG/L unless spec'd		03-86	04-86	07-86	10-86
PH (STD UNITS)	UF				
ALPHA ACTIV (PCI/L)					2
BETA ACTIV (PCI/L)	UF	9		4	10
CHLORIDE	UF	14	15.6	19.1	17
CHROMIUM	UF				
FLUORIDE	UF	0.289	0.3	0.2	0.1
SULFATE	UF	68	66	64	63
ALPHA ACTIV (PCI/L)	F				
ALUMINUM	F				0.053
ARSENIC	F				
BARIUM	F	0.079	0.077	0.086	0.1
BERYLLIUM	F			0.0004	
BORON	F	0.14	0.12	0.12	0.16
CALCIUM	F	120	110	120	110
CHROMIUM	F				0.013
COPPER	F	0.0076			
IRON	F	0.91	0.52	0.81	0.54
LEAD	F			0.008	
LITHIUM	F	0.03	0.029	0.027	0.033
MAGNESIUM	F	29	27	30	29
MANGANESE	F	0.4	0.3	0.33	0.3
MOLYBDENUM	F				0.012
NIOBIUM	F				
PHOSPHORUS	F		0.3	0.3	
POTASSIUM	F	9.1	6.8	5.4	5.6
SILICON	F	5.6	6	5.2	5.4
SODIUM	F	31	32	31	36
STRONTIUM	F	1.3	1.4	1.4	1.5
TITANIUM	F		0.019	0.022	
URANIUM	F	0.002	0.001		0.005
ZINC	F	0.0016	0.0064	0.016	0.0043
ZIRCONIUM	F				0.0079

GROUNDWATER RESULTS FOR GW-186

Units MG/L unless spec'd		02-87	08-87	02-88	1-89	1-90	9-90
PH (STD UNITS)	UF	7.4	7.1	7.5	NA	NA	
ALUMINUM	UF	NA	NA	ND	NA	NA	0.047
ALKALINITY (HCO3)	UF	NA	418	372	NA	NA	409
ARSENIC	UF	NA	NA	NA	NA	NA	NA
BARIUM	UF	NA	NA	0.11	NA	NA	0.12
BETA ACTIV (PCI/L)	UF	NA	NA		NA	NA	NA
BORON	UF	NA	NA	0.16	NA	NA	0.13
CADMIUM	UF	NA	NA	ND	NA	NA	ND
CALCIUM	UF	NA	NA	110	NA	NA	110
CHLORIDE	UF	NA	NA	12.7	16.0	15.0	19
CHROMIUM	UF	NA	NA	ND	NA	NA	ND
COPPER	UF	NA	NA	ND	NA	NA	0.0065
FLUORIDE	UF	NA	NA	NA	0.150	0.20	ND
IRON	UF	NA	NA	1.0	NA	NA	0.860
LEAD	UF	NA	NA	1.0	NA	0.0087	0.0087
LITHIUM	UF	NA	NA	0.029	NA	NA	NA
MAGNESIUM	UF	NA	NA	30	NA	NA	33
MANGANESE	UF	NA	NA	0.16	NA	NA	0.15
MOLYBDENUM	UF	NA	NA	ND	NA	NA	ND
NIOBIUM	UF	NA	NA	ND	NA	NA	NA
NITRATE NITROGEN	UF	NA	NA		NA	NA	ND
PHENOLS	UF	NA	NA		NA	NA	NA
POTASSIUM	UF	NA	NA	2.8	NA	NA	3.2
SILICON	UF	NA	NA	5.9	NA	NA	6.1
SODIUM	UF	NA	NA	34	NA	NA	39
STRONTIUM	UF	NA	NA	1.6	NA	NA	1.7
SULFATE	UF	NA	NA	61	71	71	65
TITANIUM	UF	NA	NA	ND	NA	NA	NA
URANIUM	UF	NA	NA	<0.001	NA	NA	ND
ZINC	UF	NA	NA	ND	NA	NA	0.011
ZIRCONIUM	UF	NA	NA	ND	NA	NA	NA
ALPHA ACTIV (PCI/L)	F	NA	NA	NA	NA	NA	NA
ALUMINUM	F	NA	NA	ND	ND	0.23	0.096
ARSENIC	F	NA	NA	NA	0.120	ND	ND
BARIUM	F	NA	NA	0.11	0.100	.12	.12
BORON	F	NA	NA	0.17	0.130	.12	.12
CADMIUM	F	NA	NA	ND	ND	ND	0.0024
CALCIUM	F	NA	NA	110	110	110	110
COPPER	F	NA	NA	ND	ND	ND	.0087
IRON	F	NA	NA	0.089	.02	.51	0.81
LEAD	F	NA	NA	NA	0.0060	ND	0.0042
LITHIUM	F	NA	NA	0.030	NA	NA	NA
MAGNESIUM	F	NA	NA	30	32	32	32
MANGANESE	F	NA	NA	0.16	0.14	0.16	0.15
MOLYBDENUM	F	NA	NA	ND		ND	ND
NIOBIUM	F	NA	NA	ND	NA		NA
POTASSIUM	F	NA	NA	3.3	5.8	2.9	3.2
SILICON	F	NA	NA	5.7	5.7	6.4	5.9
SODIUM	F	NA	NA	34	33	35	38
STRONTIUM	F	NA	NA	1.6	1.5	1.6	1.7
TITANIUM	F	NA	NA	ND	NA	NA	NA
URANIUM	F	NA	NA	<0.001	ND	ND	ND
ZINC	F	NA	NA	0.004	ND	ND	.013
ZIRCONIUM	F	NA	NA	ND	NA	NA	NA

GROUNDWATER RESULTS FOR GW-186

Units MG/L unless spec'd		9-91	11-91	2-92	6-92
PH (STD UNITS)	UF	7	7.1	7.1	7.1
ALUMINUM	UF	0.021	<0.02	<.02	0.058
ALKALINITY	UF	388	388	403	412
ALPHA ACTIV (PC/L)	UF	0.63	0.00		
BARIUM	UF	0.12	0.13		.14
BERYLLIUM	UF				0.0004
BETA ACTIV (PCI/L)	UF	2.47	1.28		
BORON	UF	0.13	0.15	.14	.16
CALCIUM	UF	110	120		120
CHLORIDE	UF	13	13.6	14	12
CHROMIUM	UF				
COPPER	UF			.0059	
FLUORIDE	UF	0.10	0.10	.2	.2
IRON	UF	0.88	0.82	.86	1.1
LEAD	UF				
MAGNESIUM	UF	34	34	36	33
MANGANESE	UF	0.16	0.15	.16	.16
MERCURY	UF	0.00031	<0.0002		
POTASSIUM	UF	2.6	3.3	2.8	3.4
SILICON	UF				
SODIUM	UF	26	35	32	33
STRONTIUM	UF	1.7	1.8	2.5	1.8
SULFATE	UF	67	70.2	66	66
TITANIUM	UF				
URANIUM	UF				
ZINC	UF	0.004	0.0044	.0027	.0031
ALUMINUM	F	<0.02	0.02	.046	.037
ARSENIC	F				
BARIUM	F	0.12	0.13		.13
BERYLLIUM	F				.00048
BORON	F	0.13	0.16	.14	.16
CALCIUM	F	110	110		120
COPPER	F			.01	
IRON	F	0.88	0.79	.85	1.1
LEAD	F				
LITHIUM	F				
MAGNESIUM	F	34	34	35	33
MANGANESE	F	0.16	0.15	.16	.16
MERCURY	F	<0.0002	<0.0002		
POTASSIUM	F	2.8	3.1	3.2	3.4
SILICON	F				
SILVER	F			.093	
SODIUM	F	25	35	31	32
STRONTIUM	F	1.7	1.8	2.4	1.8
TITANIUM	F				
URANIUM	F				
ZINC	F	0.0071	<0.002	.002	.0055
ZIRCONIUM	F				
TOLUENE	UF	0.90			
1,2,4-trichlorobenzene	UF	4.9			

GROUNDWATER RESULTS FOR GW-187

MG/L unless spec'd		03-86	04-86	07-86	10-86
ALPHA ACTIV (PCI/L)	UF	11.5	1.34		
BETA ACTIV (PCI/L)	UF	13.3	<2	<2	<2
CHLORIDE	UF	7.1	6.6	6.4	25.0
FLUORIDE	UF	0.4	0.5	0.5	0.2
SULFATE	UF	57	65	67	66
ALPHA ACTIV (PCI/L)	F				
ALUMINUM	F	<0.02	0.02	<0.02	0.04
ARSENIC	F				
BARIUM	F	0.13	0.12	0.12	0.15
BORON	F	0.34	0.35	0.40	0.47
CALCIUM	F	55	49	62	55
COPPER	F				
IRON	F	0.043	0.007	0.047	0.087
LEAD	F	<0.004	<0.004	0.006	<0.004
LITHIUM	F	0.088	0.100	0.120	0.140
MAGNESIUM	F	21	17	18	18
MANGANESE	F	0.0051	0.0019	<0.0010	0.0037
MOLYBDENUM	F	<0.01	0.011	0.016	0.013
PHOSPHOROUS	F	<0.2	<0.2	0.28	<.0.2
POTASSIUM	F	0.7	<0.6	1.3	1.6
SILICON	F	3.5	3.3	3.2	3.3
SODIUM	F	21	17	15	37
STRONTIUM	F	0.68	0.63	0.58	0.65
TITANIUM	F	<0.003	<0.003	0.016	<0.003
URANIUM	F	0.002	0.003	<0.001	0.004
ZINC	F	0.0036	0.001	0.0075	<0.001

GROUNDWATER RESULTS FOR GW-187

Units MG/L unless spec'd		02-87	08-87	02-88	01-89	01-90	09-90
PH (STD UNITS)	UF	7.9	7.7	7.8	6.7	NA	7.1
GROSS ALPHA (PCI/L)	UF				0.2		
ALUMINUM	UF	NA	NA	ND	ND	NA	0.045
ALKALINITY (HC03)	UF	NA	221	215	238	277	277
ARSENIC	UF	NA	NA	NA	0.062	NA	
BARIUM	UF	NA	NA	0.17	0.26	NA	0.23
BERYLLIUM	UF	NA	NA	0.0004	ND	NA	ND
BETA ACTIV (PCI/L)	UF	NA	NA		0.75	NA	
BORON	UF	NA	NA	0.59	0.53	NA	0.59
CADMIUM	UF	NA	NA	ND	ND	NA	0.0036
CALCIUM	UF	NA	NA	53	56.0	NA	50
CHLORIDE	UF	NA	NA	28	150.0	78.0	93
CHROMIUM	UF	NA	NA	ND	ND	NA	
COPPER	UF	NA	NA	ND	ND	NA	0.0063
FLUORIDE	UF	NA	NA	NA	0.950	0.70	.60
IRON	UF	NA	NA	0.11	0.100	NA	.160
LEAD	UF	NA	NA	NA	ND	NA	ND
LITHIUM	UF	NA	NA	.14		NA	NA
MAGNESIUM	UF	NA	NA	19	23.0	NA	20.0
MANGANESE	UF	NA	NA	0.004	0.0013	NA	0.0045
MOLYBDENUM	UF	NA	NA	ND	ND	NA	ND
NIOBIUM	UF	NA	NA	ND	NA	NA	NA
NITRATE NITROGEN	UF	NA	NA		ND	NA	
PHENOLS	UF	NA	NA		ND	NA	NA
POTASSIUM	UF	NA	NA	0.8	2.9	NA	1.9
SILICON	UF	NA	NA	4.1	4.40	NA	4.5
SODIUM	UF	NA	NA	43	130.0	NA	100
STRONTIUM	UF	NA	NA	0.71	0.870	NA	.87
SULFATE	UF	NA	NA	48	68.0	40	37
TITANIUM	UF	NA	NA	ND	NA	NA	
URANIUM	UF	NA	NA	0.001	ND	NA	
ZINC	UF	NA	NA	0.0075	ND	NA	0.0057
ZIRCONIUM	UF	NA	NA	ND	NA	NA	
ALPHA ACTIV (PCI/L)	F	NA	NA		.20	NA	NA
GROSS BETA	F	NA	NA		0.75	NA	NA
ALUMINUM	F	NA	NA	ND	ND	0.02	0.066
ARSENIC	F	NA	NA	ND	ND	ND	ND
BARIUM	F	NA	NA	0.17	.26	0.220	.23
BORON	F	NA	NA	0.57	.55	0.61	.59
CALCIUM	F	NA	NA	56	56.0	54	50
COPPER	F	NA	NA	ND	ND	ND	0.0069
IRON	F	NA	NA	0.19	0.0077	0.07	0.10
LEAD	F	NA	NA	NA	0.0044	ND	ND
LITHIUM	F	NA	NA	0.14	NA	NA	NA
MAGNESIUM	F	NA	NA	20	23	22	20
MANGANESE	F	NA	NA	0.0099	0.00130	.0043	.0038
MOLYBDENUM	F	NA	NA	ND		ND	
NIOBIUM	F	NA	NA	ND	NA	NA	NA
POTASSIUM	F	NA	NA	1.2	2.9	1.50	2.0
SILICON	F	NA	NA	4.3	4.3	4.6	4.6
SODIUM	F	NA	NA	46	130	87	100
STRONTIUM	F	NA	NA	0.74	0.88	0.86	.88
TITANIUM	F	NA	NA	ND	NA	NA	NA
URANIUM	F	NA	NA	<0.001	ND	ND	
ZINC	F	NA	NA	<0.001	ND	ND	.0060
ZIRCONIUM	F	NA	NA	ND	NA	NA	NA

GROUNDWATER RESULTS FOR GW-187

Units MG/L unless spec'd		9-91	11-91	2-92	6-92
PH (STD UNITS)	UF	7.6	7.1	7.5	7.5
ALUMINUM	UF	0.039	<0.02		.061
ALKALINITY	UF	258	261	260	279
BARIUM	UF	0.2	0.21		.00031
BERYLLIUM	UF	<0.0003	<0.0003		.23
BETA ACTIV (PCI/L)	UF	3.72	3.72		
BORON	UF	0.61	0.64	.56	.58
CALCIUM	UF	51	52		51.0
CHLORIDE	UF	43	51	63	54.3
FLUORIDE	UF	0.60	0.60	.7	.8
IRON	UF	0.15	0.18	.14	.2
MAGNESIUM	UF	21	21	20	20
MANGANESE	UF	0.0028	0.0045	.0027	0.0041
POTASSIUM	UF	3.2	2.6	1.4	1.7
SODIUM	UF	65	68	77	72
STRONTIUM	UF	0.87	0.85	.81	.88
SULFATE	UF	26	23	33	21.4
URANIUM	UF				
ZINC	UF	0.0083	0.0024	.0049	.0063
ALUMINUM	F	0.065	<0.02	.025	0.061
BARIUM	F	0.2	0.21		22
BERYLLIUM	F	0.0003	0.00047		.00031
BORON	F	0.60	0.62	.57	.58
CALCIUM	F	50	49		51
COPPER	F				.0085
IRON	F	0.14	0.13	.13	.19
LEAD	F				
MAGNESIUM	F	20	A-23 20	21	20
MANGANESE	F	0.0028	0.0045	.003	.005
POTASSIUM	F	2.6	3.0	1.9	1.5
SODIUM	F	67	68	77	70
STRONTIUM	F	0.85	0.85	0.81	0.87
URANIUM	F				
ZINC	F	0.011	0.005	<.002	.0043

GROUNDWATER RESULTS FOR GW-188

MG/L unless spec'd		02-86	04-86	07-86	10-86	10-86
PH (STD UNITS)	UF	NA	NA	NA	NA	NA
ALPHA ACTIV (PCI/L)	UF	20	< 1	21	< 2	< 2
BETA ACTIV (PCI/L)	UF	36	4.59	27	4	4
CHLORIDE	UF	3.8	7.6	8.2	7.4	7.1
FLUORIDE	UF	0.52	0.60	0.70	0.50	0.40
SULFATE	UF	26	33	33	33	27
ALPHA ACTIV (PCI/L)	F					
ALUMINUM	F	0.031	<0.02	1.6	0.06	0.04
ARSENIC	F	0.008	<0.005	0.006	<0.005	<0.005
BARIUM	F	0.037	0.015	0.120	0.027	0.022
BERYLLIUM	F	<0.0003	<0.0003	0.00080	<0.0003	<0.003
BORON	F	0.26	0.13	0.13	0.15	0.14
CADMIUM	F	<0.003	<0.003	0.0041	<0.003	<0.003
CALCIUM	F	27	21	41	33	35
COBALT	F	<0.005	<0.005	0.010	<0.005	<0.005
COPPER	F	0.0064	<0.004	0.098	<0.004	<0.004
IRON	F	0.0210	<0.004	1.6000	0.0053	0.014
LEAD	F	0.008	0.004	0.020	<0.004	0.005
LITHIUM	F	0.022	0.023	0.020	0.018	0.018
MAGNESIUM	F	22	15	22	23	22
MANGANESE	F	0.34	0.13	2.00	0.061	0.15
MOLYBDENUM	F	<0.01	0.11	0.012	<0.01	<0.01
NICKEL	F	<0.01	<0.01	0.016	<0.01	<0.01
NIOBIUM	F	<0.007	<0.007	<0.007	0.11	0.11
PHOSPHOROUS	F	<0.2	<0.2	0.34	<0.2	<0.2
POTASSIUM	F	22	14	5.8	4.3	3.9
SILICON	F	4.9	4	5.1	5.1	4.8
SODIUM	F	22	46	24	22	23
STRONTIUM	F	1.5	0.93	1.4	1.8	1.4
TITANIUM	F	<0.003	<0.003	0.017	<0.003	<0.003
URANIUM	F	0.001	0.002	0.002	0.001	0.003
ZINC	F	0.0011	<0.001	0.074	<0.001	0.0051
ZIRCONIUM	F					

GROUNDWATER RESULTS FOR GW-188

Units MG/L unless spec'd		02-87	08-87	02-88	01-89	01-90
PH (STD UNITS)	UF	8.5	8.0	7.8	NA	
ALUMINUM	UF	NA	NA	1.4	NA	
ALKALINITY (HCO3)	UF	NA	228.0	196	NA	199
ARSENIC	UF	NA	NA	NA	NA	
BARIUM	UF	NA	NA	0.047	NA	
BERYLLIUM	UF	NA	NA	0.0003	NA	
BETA ACTIV (PCI/L)	UF	NA	NA		NA	
BORON	UF	NA	NA	0.14	NA	
CADMIUM	UF	NA	NA	0.0061	NA	ND
CALCIUM	UF	NA	NA	33	NA	
CHLORIDE	UF	NA	NA	5.8	6.0	4
CHROMIUM	UF	NA	NA	ND	NA	ND
COPPER	UF	NA	NA	0.0052	NA	
FLUORIDE	UF	NA	NA	NA	0.67	.60
IRON	UF	NA	NA	1.6	NA	
LEAD	UF	NA	NA	NA	NA	.0048
LITHIUM	UF	NA	NA	0.021	NA	
MAGNESIUM	UF	NA	NA	26	NA	
MANGANESE	UF	NA	NA	0.21	NA	
MOLYBDENUM	UF	NA	NA	ND	NA	
NIOBIUM	UF	NA	NA	ND	NA	
NITRATE NITROGEN	UF	NA	NA		NA	
PHENOLS	UF	NA	NA		NA	
POTASSIUM	UF	NA	NA	1.4	NA	
SILICON	UF	NA	NA	6.1	NA	
SODIUM	UF	NA	NA	18	NA	
STRONTIUM	UF	NA	NA	2	NA	
SULFATE	UF	NA	NA	35	33	34
TITANIUM	UF	NA	NA	0.0095	NA	
URANIUM	UF	NA	NA	0.001	NA	
ZINC	UF	NA	NA	0.015	NA	
ZIRCONIUM	UF	NA	NA	ND	NA	
ALPHA ACTIV (PCI/L)	F	NA	NA			
ALUMINUM	F	NA	NA	<0.02	.028	ND
ARSENIC	F	NA	NA		ND	ND
BARIUM	F	NA	NA	0.04	0.03	.030
BERYLLIUM	F	NA	NA	0.0003	ND	ND
BORON	F	NA	NA	0.13	0.20	.12
CALCIUM	F	NA	NA	33	31	28
COPPER	F	NA	NA	<0.004	ND	ND
IRON	F	NA	NA	0.0055	0.031	ND
LEAD	F	NA	NA	NA	ND	ND
LITHIUM	F	NA	NA	0.019	NA	NA
MAGNESIUM	F	NA	NA	26	23	23
MANGANESE	F	NA	NA	0.14	0.11	.077
MOLYBDENUM	F	NA	NA	ND		ND
NIOBIUM	F	NA	NA	ND	NA	NA
POTASSIUM	F	NA	NA	1.7	4.6	11.0
SILICON	F	NA	NA	5.8	5.3	4.8
SODIUM	F	NA	NA	17	25	24
STRONTIUM	F	NA	NA	2.1	1.7	1.5
TITANIUM	F	NA	NA	<0.003	NA	NA
URANIUM	F	NA	NA	0.001	ND	ND
ZINC	F	NA	NA	<0.001	0.022	ND
ZIRCONIUM	F	NA	NA	ND	NA	NA

GROUNDWATER RESULTS FOR GW-188

Units MG/L unless spec'd		09-90	09-91	11-91	02-92	06-92
PH (STD UNITS)	UF	7.0	8.2	8.0	8.2	7.9
ALUMINUM	UF	0.490	0.18	1.1		1.6
ALKALINITY (HCO3)	UF	199	184	187	199	220
ALPHA ACTIV (PC/L)	UF	NA	4.11	2.62		
BARIUM	UF	.044	0.038	0.052		.034
BETA ACTIV (PCI/L)	UF	NA	18.49	5.85		
BORON	UF	.12	0.11	0.13	.01	.16
CALCIUM	UF	27	30	31		17.0
CHLORIDE	UF	4.0	4	3	7	5.4
CHROMIUM	UF	ND				
COPPER	UF	ND				
FLUORIDE	UF	.60	0.6	0.6	.7	.9
IRON	UF	0.50	0.19	1.3	.23	1.8
LEAD	UF	.0048				
MAGNESIUM	UF	20	25	25	20	15
MANGANESE	UF	.096	0.025	0.073	.71	0.16
MOLYBDENUM	UF	ND				
NIOBIUM	UF	NA				
NITRATE NITROGEN	UF	ND				
PHENOLS	UF	NA				
POTASSIUM	UF	10.0	13	8.6		16
SILICON	UF	5.4				
SODIUM	UF	37	17	29	7.20	67
STRONTIUM	UF	1.5	1.8	1.8	.064	0.09
SULFATE	UF	34	22	26	28	33.4
TITANIUM	UF	NA				
URANIUM	UF	ND				
ZINC	UF	ND	0.0092	0.013	.006	0.18
ZIRCONIUM	UF	NA				
ALPHA ACTIV (PCI/L)	F	NA				
ALUMINUM	F	ND	<0.02		.89	0.04
ARSENIC	F	ND				
BARIUM	F	0.037	0.032	0.044		.022
BERYLLIUM	F	ND				<.0003
BORON	F	0.13	0.14	0.12	.12	.16
CALCIUM	F	24	16	30		16.0
COPPER	F	0.0086				
IRON	F	.012	<0.005		.97	.023
LEAD	F	ND				
LITHIUM	F	NA				
MAGNESIUM	F	18	18	24	24	15
MANGANESE	F	.0033		0.02	0.058	.0015
NIOBIUM	F	NA				
POTASSIUM	F	14	42	6.9	4.1	15
SILICON	F	4.2				
SODIUM	F	55	34	24	21	64
STRONTIUM	F	1.3	1.0	1.8	1.8	0.93
TITANIUM	F	NA				
URANIUM FLOURIMETRI	F	ND				0.001
ZINC	F	ND	0.0047	0.0024	.0078	.0036
ZIRCONIUM	F	NA				

GROUNDWATER RESULTS FOR GW-189

Units MG/L unless spec'd		03-86	05-86	07-86	10-86
PH (STD UNITS)	UF	NA	NA	NA	NA
ALPHA ACTIV (PCI/L)	UF	3	1.16	2	3
BETA ACTIV (PCI/L)	UF	16	20.41	19	5
CHLORIDE	UF	39	46	25	83
FLUORIDE	UF	0.719	0.8	0.5	1.2
SULFATE	UF	63	59	58	40
ALPHA ACTIV (PCI/L)	F				
ALUMINUM	F				0.12
ARSENIC	F				
BARIUM	F	0.059	0.056	0.047	0.110
BORON	F	0.34	0.32	0.24	0.50
CALCIUM	F	42	30	41	43
CHROMIUM	F	<0.01	<0.01	<0.01	0.048
COPPER	F	0.0076	<0.004	<0.004	0.029
IRON	F	0.0190	0.0098	0.1	0.1200
LEAD	F	<0.004	<0.004	0.011	0.006
LITHIUM	F	0.14	0.14	0.14	0.16
MAGNESIUM	F	15	14	16	16
MANGANESE	F	0.088	0.052	0.071	0.100
MOLYBDENUM	F	<0.01	<0.01	<0.01	0.019
NICKEL	F	<0.01	<0.01	<0.01	0.011
NIOBIUM	F	<0.007	<0.007	<0.007	0.01
POTASSIUM	F	24	19	25	6.2
SILICON	F	4.7	5.5	5.1	5.6
SILVER	F	<0.006	<0.006	0.0064	0.016
SODIUM	F	170	170	120	200
STRONTIUM	F	0.89	0.87	0.78	1.10
TITANIUM	F	<0.003	<0.003	0.020	<0.003
URANIUM	F	0.004	0.002	<0.001	0.004
ZINC	F	0.0011	0.0019	0.0037	<0.001
ZIRCONIUM	F	<0.005	<0.005	<0.005	0.019

GROUNDWATER RESULTS FOR GW-189

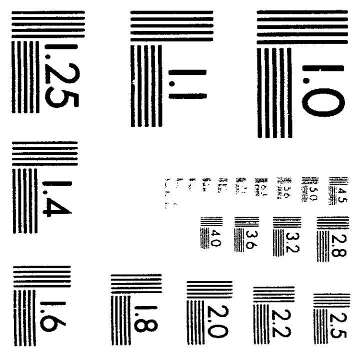
Units MG/L unless spec'd		02-87	08-87	02-88
PH (STD UNITS)	UF	7.6	7.8	8.1
ALUMINUM	UF	NA	NA	3.5
ALKALINITY (HCO3)	UF	NA	540.0	747
ARSENIC	UF	NA	NA	NA
BARIUM	UF	NA	NA	0.33
BERYLLIUM	UF	NA	NA	0.0006
BETA ACTIV (PCI/L)	UF	NA	NA	
BORON	UF	NA	NA	1.3
CALCIUM	UF	NA	NA	220
CHLORIDE	UF	NA	NA	510
CHROMIUM	UF	NA	NA	0.032
COPPER	UF	NA	NA	0.021
FLUORIDE	UF	NA	NA	NA
IRON	UF	NA	NA	9
LEAD	UF	NA	NA	NA
LITHIUM	UF	NA	NA	0.47
MAGNESIUM	UF	NA	NA	18
MANGANESE	UF	NA	NA	0.24
MOLYBDENUM	UF	NA	NA	ND
NIOBIUM	UF	NA	NA	ND
PHENOLS	UF	NA	NA	0.001
PHOSPHOROUS	UF	NA	NA	<0.2
POTASSIUM	UF	NA	NA	9.2
SILICON	UF	NA	NA	6
SODIUM	UF	NA	NA	490
STRONTIUM	UF	NA	NA	5.8
SULFATE	UF	NA	NA	8.1
TITANIUM	UF	NA	NA	0.00890
URANIUM	UF	NA	NA	0.002
ZINC	UF	NA	NA	0.075
ZIRCONIUM	UF	NA	NA	<0.0050
ALPHA ACTIV (PCI/L)	F	NA	NA	
ALUMINUM	F	NA	NA	<0.02
ARSENIC	F	NA	NA	NA
BARIUM	F	NA	NA	0.033
BERYLLIUM	F	NA	NA	0.00040
BORON	F	NA	NA	1.3
CALCIUM	F	NA	NA	14
CHROMIUM	F	NA	NA	0.01
COPPER	F	NA	NA	<0.004
IRON	F	NA	NA	0.074
LEAD	F	NA	NA	NA
LITHIUM	F	NA	NA	0.44
MAGNESIUM	F	NA	NA	12
MANGANESE	F	NA	NA	0.036
MOLYBDENUM	F	NA	NA	ND
PHOSPHOROUS	F	NA	NA	0.8
POTASSIUM	F	NA	NA	7.9
SILICON	F	NA	NA	4.4
SODIUM	F	NA	NA	500
STRONTIUM	F	NA	NA	1.4
TITANIUM	F	NA	NA	<0.003
URANIUM	F	NA	NA	<0.001
ZINC	F	NA	NA	<0.001
ZIRCONIUM	F	NA	NA	0.0061

GROUNDWATER RESULTS OR GW-224

MG/L unless spec'd		03-86	04-86	07-86	10-86
PH (STD UNITS)	UF	NA	NA	NA	7.8
ALPHA ACTIV (PCI/L)		1	< 1	< 1	< 2
ALUMINUM	UF	NA	NA	NA	0.022
ARSENIC	UF	NA	NA	NA	
BARIUM	UF	NA	NA	NA	0.15
BETA ACTIV (PCI/L)	UF	5	2.39	5	< 2
BORON	UF	NA	NA	NA	0.27
CALCIUM	UF	NA	NA	NA	42
CHLORIDE	UF	10.7	21.8	20	21
CHROMIUM	UF	NA	NA	NA	
COPPER	UF	NA	NA	NA	
FLUORIDE	UF	0.273	0.5	0.4	0.2
IRON	UF	NA	NA	NA	0.047
LEAD	UF	NA	NA	NA	0.006
LITHIUM	UF	NA	NA	NA	0.076
MAGNESIUM	UF	NA	NA	NA	19
MANGANESE	UF	NA	NA	NA	0.0035
MOLYBDENUM	UF	NA	NA	NA	0.01
NIOBIUM	UF	NA	NA	NA	
NITRATE NITROGEN	UF	NA	NA	NA	
PHENOLS	UF	NA	NA	NA	0.003
POTASSIUM	UF	NA	NA	NA	2.5
SILICON	UF	NA	NA	NA	4.5
SODIUM	UF	NA	NA	NA	92
STRONTIUM	UF	NA	NA	NA	0.99
SULFATE	UF	58	49	48	43
TITANIUM	UF	NA	NA	NA	
URANIUM	UF	NA	NA	NA	0.003
ZINC	UF	NA	NA	NA	0.014
ZIRCONIUM	UF	NA	NA	NA	0.011
ALUMINUM	F	<0.02	<0.02	<0.02	0.029
ARSENIC	F				
BARIUM	F	0.12	0.12	0.10	0.14
BORON	F	0.15	0.20	0.22	0.26
CALCIUM	F	63	45	15	42
COPPER	F				
IRON	F	0.015	0.018	<0.004	0.27
LEAD	F	<0.004	<0.004	0.005	0.005
LITHIUM	F	0.028	0.061	0.070	0.074
MAGNESIUM	F	23	18	19	19
MANGANESE	F	0.0068	<0.001	<0.001	0.0048
NICKEL	F	<0.01	<0.01	<0.01	0.01
NIOBIUM	F				
POTASSIUM	F	2.1	2.1	3.9	2.7
SILICON	F	4.4	4.3	4.5	4.4
SODIUM	F	43	73	81	90
STRONTIUM	F	1.10	0.99	0.80	0.97
TITANIUM	F	<0.003	<0.003	0.014	<0.003
URANIUM	F	<0.001	<0.001	0.001	0.003
ZINC	F	0.0012	0.0063	0.0024	<0.001
ZIRCONIUM	F				

GROUNDWATER RESULTS FOR GW-224

Units MG/L unless spec'd		02-87	08-87	02-88	05-88	07-88	9-88
PH (STD UNITS)	UF	8.2	7.5	7.4			7.3
ALUMINUM	UF	NA	NA	ND			
ALKALINITY (HCO3)	UF	NA	373	317	NA	NA	299
ANTIMONY	UF	NA	NA	<0.05			
ARSENIC	UF	NA	NA	NA	NA	NA	NA
BARIUM	UF	NA	NA	0.17	NA	NA	NA
BERYLLIUM	UF	NA	NA	<0.0003	NA	NA	NA
BETA ACTIV (PCI/L)	UF	NA	NA				
BORON	UF	NA	NA	0.17			
CALCIUM	UF	NA	NA	53	NA	NA	NA
CHLORIDE	UF	NA	NA	13			
CHROMIUM	UF	NA	NA	ND	NA	NA	NA
COPPER	UF	NA	NA	ND	NA	NA	NA
FLUORIDE	UF	NA	NA	NA	NA	NA	NA
IRON	UF	NA	NA	0.13	NA	NA	NA
LEAD	UF	NA	NA	NA	NA	NA	NA
LITHIUM	UF	NA	NA	0.091	NA	NA	NA
MAGNESIUM	UF	NA	NA	22	NA	NA	NA
MANGANESE	UF	NA	NA	0.005	NA	NA	NA
MOLYBDENUM	UF	NA	NA	<0.01	ND	NA	NA
NIOBIUM	UF	NA	NA	0.007	ND	NA	NA
NITRATE NITROGEN	UF	NA	NA				
PHENOLS	UF	NA	NA				
POTASSIUM	UF	NA	NA	4.9	NA	NA	NA
SILICON	UF	NA	NA	0.69	NA	NA	NA
SODIUM	UF	NA	NA	82	NA	NA	NA
STRONTIUM	UF	NA	NA	1.2	NA	NA	NA
SULFATE	UF	NA	NA	46	NA	NA	NA
TITANIUM	UF	NA	NA	ND	NA	NA	NA
URANIUM	UF	NA	NA	0.01			
ZINC	UF	NA	NA	0.00620	NA	NA	NA
ZIRCONIUM	UF	NA	NA	<0.005	NA	NA	NA
ALPHA ACTIV (PCI/L)	F	NA	NA				
ALUMINUM	F	NA	NA	ND			
ANTIMONY	F	NA	NA	0.11			
ARSENIC	F	NA	NA				
BARIUM	F	NA	NA	0.16	NA	NA	NA
BERYLLIUM	F	NA	NA	0.0004			
BORON	F	NA	NA	0.28			
CALCIUM	F	NA	NA	45			
COPPER	F	NA	NA	ND	NA	NA	NA
IRON	F	NA	NA	0.14	NA	NA	NA
LEAD	F	NA	NA	NA	NA	NA	NA
LITHIUM	F	NA	NA	0.081	NA	NA	NA
MAGNESIUM	F	NA	NA	21	NA	NA	NA
MANGANESE	F	NA	NA	0.0089			
MOLYBDENUM	F	NA	NA	0.022			
NIOBIUM	F	NA	NA	0.016	NA	NA	NA
POTASSIUM	F	NA	NA	3.7	NA	NA	NA
SILICON	F	NA	NA	4.9	NA	NA	NA
SODIUM	F	NA	NA	78			
STRONTIUM	F	NA	NA	1.1	NA	NA	NA
TITANIUM	F	NA	NA	ND	NA	NA	NA
URANIUM	F	NA	NA	0.027			
ZINC	F	NA	NA	ND	NA	NA	NA
ZIRCONIUM	F	NA	NA	0.015			


1.0
1.1
1.25
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2.0
2.2
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3.6
4.0
4.5
5.0

GROUNDWATER RESULTS FOR GW-318

Units MG/L unless spec'd		02-88	05-88	07-88	10-88
PH (STD UNITS)	UF	NA	NA	NA	8.0
ALUMINUM	UF				0.410
ALKALINITY (HC03)	UF	NA	NA	NA	281
ARSENIC	UF	NA	NA	NA	0.0068
BARIUM	UF	NA	NA	NA	0.64
BETA ACTIV (PCI/L)	UF				
BORON	UF				1
CALCIUM	UF	NA	NA	NA	59
CHLORIDE	UF	8.4	6	7	10
CHROMIUM	UF	NA	NA	NA	0.016
COPPER	UF	NA	NA	NA	0.047
FLUORIDE	UF	4.5	3.38	3.80	3.73
IRON	UF	NA	NA	NA	3.4
LEAD	UF	NA	NA	NA	0.023
LITHIUM	UF	NA	NA	NA	0.17
MAGNESIUM	UF	NA	NA	NA	9.5
MANGANESE	UF	NA	NA	NA	0.04
MERCURY	UF	NA	NA	NA	NA
MOLYBDENUM	UF	NA	NA	NA	ND
NICKEL	UF	NA	NA	NA	0.054
NIOBIUM	UF	NA	NA	NA	ND
NITRATE NITROGEN	UF	NA	NA	NA	ND
POTASSIUM	UF	NA	NA	NA	5.7
RADIUM (PCI/L)	UF	NA	NA	NA	0.14
SILICON	UF	NA	NA	NA	2.3
SODIUM	UF	NA	NA	NA	140
STRONTIUM	UF	NA	NA	NA	2.5
SULFATE	UF	36	40	32	26
TITANIUM	UF	NA	NA	NA	.0055
URANIUM	UF	NA	NA	NA	ND
ZINC	UF	NA	NA	NA	0.055
ZIRCONIUM	UF	NA	NA	NA	ND
ALPHA ACTIV (PCI/L)	F				
ALUMINUM	F	0.063	0.026	<0.02	0.037
ARSENIC	F	0.008	0.019	<0.005	<0.005
BARIUM	F	0.30	0.28	0.37	0.18
BORON	F	1.6	1.6	1.5	1.7
CALCIUM	F	9.8	14	14	16
COPPER	F	ND	ND	ND	ND
IRON	F	0.045	0.017	0.011	0.010
LEAD	F	<0.004	<0.004	0.027	<0.004
LITHIUM	F	0.18	0.16	0.15	0.16
MAGNESIUM	F	8.1	8.1	8.6	7.4
MANGANESE	F	0.015	0.011	0.0016	0.007
MERCURY	F	0.002	<0.002	<0.002	<0.002
MOLYBDENUM	F	<0.01	0.013	<0.01	0.015
NIOBIUM	F	<0.007	0.015	<0.007	<0.007
POTASSIUM	F	11.0	7.9	5.1	8.0
SILICON	F	3.0	3.0	3.1	2.7
SODIUM	F	140	130	130	140
STRONTIUM	F	0.81	0.83	0.91	0.78
TITANIUM	F	ND	ND	ND	NA
URANIUM	F	0.001	0.007	0.002	0.004
ZINC	F	0.0015	0.0040	<0.020	<0.020
ZIRCONIUM	F	ND	ND	ND	ND

GROUNDWATER RESULTS FOR GW-319

Units MG/L unless spec'd		01-88	05-88	07-88	10-88
PH (STD UNITS)	UF	NA	8.0	7.8	8.0
ALKALINK\ITY (HCO3)	UF		96	103	93
ALUMINUM	UF		0.063	0.061	0.048
ARSENIC	UF	NA	0.22	0.14	0.17
BARIUM	UF	NA	0.057	0.078	0.063
BETA ACTIV (PCI/L)	UF				
BORON	UF	.40	0.44	0.39	0.57
CALCIUM	UF	NA	54	54	52
CHLORIDE	UF	4.6	4.0	5.0	5.0
CHROMIUM	UF	NA	ND	ND	ND
COPPER	UF		ND	ND	ND
FLUORIDE	UF	0.50	0.33	0.40	0.30
IRON	UF		0.028	<0.004	0.062
LEAD	UF		<0.004	0.0078	<0.004
LITHIUM	UF	NA	0.16	0.14	0.12
MAGNESIUM	UF	NA	13	13	13
MANGANESE	UF	NA	0.0041	0.001	0.0046
MOLYBDENUM	UF	NA	0.079	0.053	0.081
NIOBIUM	UF	NA	0.014	<0.007	<0.007
NITRATE NITROGEN	UF	NA	0.16	<0.11	0.13
PHENOLS	UF				
POTASSIUM	UF	NA	6.1	4.7	6.5
SELENIUM	UF	NA	0.016	0.010	0.013
SILICON	UF	NA	2.5	2.6	2.1
SODIUM	UF	NA	6.5	6.2	6.2
STRONTIUM	UF	NA	0.45	0.48	0.46
SULFATE	UF	74	77	93	86
TITANIUM	UF	NA	ND	ND	ND
URANIUM	UF	NA	0.010	0.010	0.002
VANADIUM	UF	NA	0.034	0.028	0.026
ZINC	UF	NA	0.0032	ND	ND
ZIRCONIUM	UF	NA	ND	ND	ND
ALPHA ACTIV (PCI/L)	F				
ALUMINUM	F	0.088	0.063	0.082	0.064
ARSENIC	F	0.20	0.22	0.14	0.18
BARIUM	F	0.070	0.057	0.079	0.063
BORON	F	0.40	0.44	0.39	0.57
CALCIUM	F	55	54	54	50
COPPER	F	ND	ND	ND	ND
IRON	F	0.02	0.01	<0.004	0.026
LEAD	F	0.005	<0.004	0.015	<0.004
LITHIUM	F	0.17	0.16	0.14	0.12
MAGNESIUM	F	13	13	13	12
MANGANESE	F	0.0041	0.0031	<0.0010	0.0032
MOLYBDENUM	F	.073	0.090	0.072	0.075
NIOBIUM	F	<0.007	<0.007	<0.007	<0.007
POTASSIUM	F	4.5	6.1	5.0	7.6
SELENIUM	F	0.0200	0.0160	0.0098	0.0120
SILICON	F	2.6	2.4	2.6	2.1
SODIUM	F	6.1	6.5	6.0	7.0
STRONTIUM	F	0.47	0.45	0.48	0.44
TITANIUM	F	ND	ND	ND	ND
URANIUM	F	<0.001	0.011	0.002	0.009
VANADIUM	F	0.036	0.033	0.026	0.027
ZINC	F	0.0100	0.0065	<0.02	<0.02
ZIRCONIUM	F	ND	ND	ND	ND

Y/TS-269

PRELIMINARY ANALYSIS OF GROUNDWATER DATA FOR THE ROGERS QUARRY SITE AT THE Y-12 PLANT OAK RIDGE, TENNESSEE

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April 6, 1987

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U.S. DEPARTMENT OF ENERGY
under Contract No. DE-AC05-840R21400

ABSTRACT

Preliminary groundwater investigations have been conducted for a formerly used waste disposal site, Rogers Quarry, on the U. S. Department of Energy Y-12 Plant.

Data on hydrostatic heads and water quality for the shallow flow regime in soils and the upper weathered bedrock zone and deep flow regimes within the bedrock below the zone of significant weathering have been obtained. During CY 1986 wells at this site were monitored for inorganic and organic indicator parameters. There is, with minor exceptions, no evidence of contamination entering the groundwater system from this site. This document provides an initial summary and interpretation of hydrostatic head, water chemistry, and water quality data obtained during CY 1986.

Y/TS-506

ENVIRONMENTAL SCIENCES DIVISION

ROGERS QUARRY WATER BALANCE
JANUARY 1, 1987, THROUGH JUNE 30, 1988

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Environmental Sciences Division
Publication No. 3254

Date Published - January 1989

Prepared for the
Oak Ridge Y-12 Plant Assessment and Remediation Program
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for the
U.S. DEPARTMENT OF ENERGY
under contract DE-AC05-840R21400

EXECUTIVE SUMMARY

Water balance, calculated from measurements or estimates of surface water inflow, surface water outflow, precipitation, evaporation, and change in storage volume, is used to estimate losses to groundwater from ponds, lakes, and reservoirs. The water balance of Rogers Quarry, which has been used as a waste disposal facility for the Oak Ridge Y-12 Plant from about 1962 to the present, is pertinent to future remediation and closure of the quarry. The data obtained can be used, in conjunction with groundwater-level and -quality data, to determine whether waste contaminants disposed of in the quarry are migrating or have the potential to migrate into the groundwater. If water-balance and groundwater-level data indicate that the quarry functions like a sealed basin with respect to groundwater, then contaminant migration, except via surface water outflow, is unlikely.

To determine a water budget for Rogers Quarry for the period January 1, 1987, through June 30, 1988, we have collected and analyzed data for five of the six components of the water-balance equation (i.e., inflow, outflow, precipitation, evaporation, and change-in-storage data). Daily data for these five parameters were entered into a Lotus 1-2-3 (TM) spreadsheet. With five of the six elements of the water-balance equation measured or estimated, the sixth and unmeasured element, daily net seepage residual (equivalent to net loss to or net gain from groundwater), was automatically calculated by the spreadsheet with the water-balance equation

seepage residual = outflow + evaporation + change in storage - inflow - precipitation.

The spreadsheet was also used to calculate monthly totals for the six elements of the water-balance equation.

Analysis of the Rogers Quarry water-balance data and groundwater-level data for seven monitoring wells near Rogers Quarry for the period January 1987 through June 1988 suggests that the quarry is relatively

tight with respect to exchanges with local groundwater. For the 7-month period with the most reliable hydrologic data (December 1987-June 1988), the quarry-measured net inputs and net outputs appear to be nearly balanced (i.e., the unmeasured parameter of net seepage residual fluctuates closely around zero). There is a slight negative residual over these 7 months (average cumulative residual = -0.46×10^6 gal/month), suggesting that the quarry is only a minor recharge source into the shallow groundwater system. From these results in conjunction with previously published water-quality data, it appears that contaminant migration from Rogers Quarry into local groundwater may not be a major concern during future remediations.

ORNL/TM-12074

Environmental Sciences Division

STATUS REPORT ON THE GEOLOGY OF THE OAK RIDGE RESERVATION

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Date Published—October 1992

Prepared for the
Office of Environmental Restoration and Waste Management
(Budget Activity EW 20 10 30 1)

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U.S. DEPARTMENT OF ENERGY
under contract DE-AC05-84OR21400

EXECUTIVE SUMMARY

This report provides an introduction to the present state of knowledge of the geology of the Oak Ridge Reservation (ORR) and a cursory introduction to the hydrogeology. An important element of this work is the construction of a modern detailed geologic map of the ORR (Plate 1), which remains in progress. An understanding of the geologic framework of the ORR is essential to many current and proposed activities related to land-use planning, waste management, environmental restoration, and waste remediation. Therefore, this report is also intended to convey the present state of knowledge of the geologic and geohydrologic framework of the ORR and vicinity and to present some of the available data that provide the basic framework for additional geologic mapping, subsurface geologic, and geohydrologic studies. In addition, some recently completed, detailed work on soils and other surficial materials is included because of the close relationships to bedrock geology and the need to recognize the weathered products of bedrock units. Weathering processes also have some influence on hydrologic systems and processes at depth.

Major long-term goals of geologic investigations in the ORR are to determine what interrelationships exist between fracture systems in individual rock or tectonic units and the fluid flow regimes that are present, to understand how regional geology can be used to help predict groundwater movement, and to formulate a structural-hydrologic model that for the first time would enable prediction of the movement of groundwater and other subsurface fluids in the ORR. Development of a state-of-the-art geologic and geophysical framework for the ORR is therefore essential for formulating an integrated structural-hydrologic model. The groundwater systems of this area are similar to those of large areas of the humid eastern United States that are underlain by consolidated sedimentary rocks of low hydraulic conductivity. Partly because of their low water-yielding capabilities, but more because of their intractability to established mathematical representation, such systems have not been as extensively studied as have those that are more productive and more tractable. Now, with the emphasis on environmental protection and restoration, and in light of the enormous costs attached to corrective actions, it is essential that these systems be better understood and quantified so that conceptual models can be verified and suitable numerical models can be developed and applied. The Oak Ridge Hydrologic and Geologic Study (ORRHAGS) Project was begun in 1987 with the intent of coordinating these efforts and involves geoscientists from both the Environmental Sciences and Energy divisions at Oak Ridge National Laboratory (ORNL).

The bedrock geology exposed in the ORR is composed entirely of sedimentary rocks that range in age from Early Cambrian to early Mississippian. This stratigraphy formed as part of the early Paleozoic drift (ocean-opening) succession. The carbonate bank was developed, uplift and erosion of the carbonate bank occurred in early Middle Ordovician time forming the regional post-Knox unconformity, and the carbonate bank was reestablished during the Middle Ordovician only to be destroyed later in the Ordovician by development of a clastic wedge in the Late Ordovician and Silurian. This was followed by erosion and formation of another unconfromity, then by the deposition of the Upper Devonian–Early Carboniferous clastic wedge.

Nine major stratigraphic units have been recognized previously in the ORR: Rome

Formation, Conasauga Group, Knox Group, Chickamauga Group, Reedsville Shale, Sequatchie Formation, Rockwood Formation, Chattanooga Shale, and Fort Payne Formation. Detailed studies of surface geology and core over the past decade have permitted, for the first time, subdivision of the Conasauga, Knox, and Chickamauga Groups. The Conasauga, and to a much lesser extent the Knox and Chickamauga Groups, have served as the principal units for disposal of radionuclides and other waste materials in the ORR, so this more detailed knowledge is very important in environmental restoration and related activities.

The ORR is located in the western part of the Valley and Ridge—at the narrowest part of the Appalachian foreland fold–thrust belt. Here the Valley and Ridge is dominated by several west-directed thrust faults that formed when the huge Blue Ridge sheet to the east pushed the Valley and Ridge sedimentary succession in front of it. The ORR contains a variety of geologic structures. The map-scale structure of the ORR is dominated by a uniform southeast dip of sedimentary layering interrupted only by the two large thrust faults, the Copper Creek and Whiteoak Mountain faults, and the East Fork Ridge (and Pilot Knob) syncline in the footwall of the Whiteoak Mountain thrust (Plate 1). The Whiteoak Mountain fault also has a very large displacement, compared with the Copper Creek fault, indicated by the character of facies changes occurring in the Middle Ordovician rocks northwest and southeast of it. Additional evidence for the greater displacement on the Whiteoak Mountain fault is derived from the preservation of rocks as young as Mississippian in footwall synclines, but nowhere in the vicinity of the ORR are rocks younger than the Middle Ordovician preserved in the footwall of the Copper Creek fault.

Outcrop-scale structures consist of inclined, faulted, and folded bedding, and joints. Joints (systematic fractures) are the most common structures present here, and several sets of joints with different orientations have been recognized. The dominant joint sets are oriented northeast and northwest, with lesser north–south and east–west sets. These structures are probably the most important in the ORR because they, along with bedding and local karst, form the conduit system that controls groundwater movement. Documenting joint attitude, timing, and evolution is one means of inferring the stress orientation history of a thrust sheet, but joint studies from the Appalachian Cumberland Plateau, Valley and Ridge, Blue Ridge, and Piedmont indicate that some joints developed in response to erosional unloading and the recent stress field, while others formed during Triassic–Jurassic extension related to the opening of the present Atlantic. Therefore, it is unwise to assume that all joints observed are a result of Paleozoic folding and thrust-sheet emplacement.

A number of criteria are being considered to aid in deciphering the history of joint formation within the ORR. Besides a more accurate portrayal of the stress history related to thrust-sheet emplacement by using only tectonic joints, further application of such an analysis involves an understanding of the control that joints have on groundwater flow paths in sedimentary rock and of how regional permeability is controlled by different joint sets.

The stable isotopic composition of minerals in sedimentary rocks can provide important insights into depositional and diagenetic processes affecting these rocks. Of interest to researchers studying the geology and hydrogeology of the ORR is the opportunity for stable isotopic studies of sedimentary rocks to provide basic information for identifying groundwater flow pathways, recording water–rock interaction, and understanding controls on groundwater chemistry. In deeper aquifers in particular, the chemistry of groundwater is strongly controlled by the composition of surrounding rocks as a result of longer groundwater residence times and increased opportunity for groundwater and rock to reach chemical and isotopic equilibrium. Characterizing the isotopic compositions of rocks and fracture-filling minerals (where significant ground-water flow may occur) and understanding controls on their compositions are crucial for future studies of groundwater flow and chemistry.

The relationship between the oxygen composition of interbedded limestones and vein calcites in the Nolichucky Shale reflects varying contributions of oxygen from two major sources: (1) formation water in near-isotopic equilibrium with interbedded silicate units and (2) formation water close to equilibrium with interbedded limestone. Similarities in the carbon isotopic composition of the veins and limestone are expected if the dominant carbon reservoir is the interbedded limestone. In the case of the Nolichucky, an intraformational source of oxygen and carbon could provide the neces-sary fluids to form calcite veins. From the isotopic data alone, large-scale migration of fluids into the Nolichucky Shale from other sources is not required to explain the occur-rence and compositions of Nolichucky calcite veins, although large-scale fluid migration cannot be ruled out from the isotopic data alone.

In recent years, as a result of expanding environmental restoration activities, inter-est in hydrology of the ORR has escalated rapidly because groundwater is the primary medium for contaminant transport. Groundwater quality, and to a lesser extent the water-bearing properties of the geologic units in the vicinity of waste areas on the ORR, is now being studied intensively. Several recent contributions have been made for ORNL to develop conceptual models of groundwater occurrence and flow in systems of the Oak Ridge area through extensive acquisition, compilation, analysis, and interpreta-tion of aquifer data, such as hydraulic conductivity, obtained mostly from the Chickamauga and the Conasauga Groups in the ORR. Intensive studies of shallow groundwater flow and modeling through aquifer tests and quantitative dye-tracing methods have documented geologic controls of flow.

The mantle of unconsolidated residual materials, or regolith, derived by in situ weathering of bedrock, is composed mostly of silt and clay. Water occurs in and moves through the regolith in pore spaces between particles or in voids created by the structure of the materials. The stormflow zone occurs at the top of the regolith; the water table is present in most places near the base. Wastes are buried in regolith in the ORR.

The carbonate rocks, deposited mostly by chemical precipitation, were formed without large interconnected pore spaces. Thus water in bedrock is present in second-ary fractures or, in the carbonate rocks, in cavities formed along fractures. In the shales and sandstones, the abundance, the degree of openness, and the interconnectedness of fractures are spatially variable.

Near-surface water in the saturated zone is under unconfined or water table condi-tions. A transition to confined conditions occurs at deeper levels, particularly in the Chickamauga and Conasauga groups.

The water table typically is near the interface between regolith and bedrock. Depth to the water table is less in topographically lower locations—near or at ground surface along perennial stream channels or swampy areas—and greater in higher locations. Range in annual variation of water levels is topographically and geologically related—less in lower elevations, greater in higher. In a normal year, the water table is lowest during September–October and highest during February–March. Perched water tables are common, especially in the Conasauga Group.

Groundwater systems here are local, as opposed to regional, with flow path lengths from recharge point to discharge point. All groundwater discharges in the Oak Ridge area are to the Clinch River or its tributaries.

Three general zones of groundwater flow exist in the ORR: the stormflow zone (or root zone), from ground surface to a depth of 1 to 2 m; the shallow zone, which includes the vadose, or unsaturated, zone, and the shallow saturated zone, extending generally to a depth of 20 to 60 m; and the deeper zone, to the base of fresh water at depths of about 150 m (may be deeper in Bear Creek Valley). Flow in the stormflow zone is transient, generated by rainfall events that lead to saturation. Only about 3 to 7 cm of water annually percolates through the vadose zone to enter the saturated flow system, and, of that, only about 5 percent enters and flows through the deeper zone, except in the Knox and Maynardville. Below the water table, water in the shallow zone moves through regions of interconnected fractures, or, in the case of carbonate beds, cavities, which are more or less enlarged by the circulating water, and water is present only in the matrix.

The Knox Group and the underlying Maynardville Limestone function as one hydrologic unit, the Knox aquifer. Most of the perennial springs and all of the larger springs in the area flow from the Knox aquifer and sustain almost all the natural base flow of perennial streams in the area. A significant difference between the Knox aquifer and other geologic units of the area is that areally extensive, locally large cavity systems occur to depths of nearly 100 m. While water-table divides correspond fairly closely to surface topography in other geologic units, those in the Knox aquifer may not.

Appendix B

APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

1. INTRODUCTION

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980 was passed by Congress and signed into law on December 11, 1980 (Public Law 96-510). This act was intended to provide for "liability, compensation, cleanup, and emergency response for hazardous substances released into the environment and the cleanup of inactive waste disposal sites." The Superfund Amendments and Reauthorization Act (SARA), adopted on October 17, 1986 (Public Law 99-499), did not substantially alter the original structure of CERCLA but provided extensive amendments to it.

In particular, §121 of CERCLA specifies that remedial actions for cleanup of hazardous substances must comply with requirements or standards under federal or more stringent state environmental laws that are applicable or relevant and appropriate to the hazardous substances or particular circumstances at a site. Inherent in the interpretation of applicable or relevant and appropriate requirements (ARARs) is the assumption that protection of human health and the environment is ensured.

The purpose of this section is to supply a preliminary list of available federal and state chemical- and location-specific ARARs that might be considered for the cleanup of Rogers Quarry, i.e., Chestnut Ridge Operable Unit 4 (CR OU4), for surface water, groundwater and sediments. The process of ARAR identification is an iterative one that is continually changing as the Remedial Investigation/Feasibility Study (RI/FS) progresses. Therefore, this list of ARARs represents a compilation of potential ARARs, of which subsets will be used or additional ARARs added as further site characterization is done.

It is understood that the Department of Energy (DOE) will comply with the requirements of the National Environmental Policy Act (NEPA) as specified in DOE Order 5440.1D (*National Environmental Policy Act Compliance Program*). Further, DOE Order 5400.4 (*Comprehensive Environmental Response, Compensation, and Liability Act Requirements*) calls for integration of NEPA and CERCLA requirements for DOE remedial actions at CERCLA sites. This issue has been reaffirmed in the FFA §I(A)(3) and §III(A)(2) and Secretary of Energy Notice (SEN) of February 5, 1990 (SEN-15-90), which was issued to ensure that DOE's NEPA activities are carried out in a centralized and uniform manner. Therefore, the regulations found in NEPA will not be addressed in this report as ARARs.

Similarly, DOE addresses occupational safety in DOE Orders 5480.11 (*Radiation Protection for Occupational Workers*), 5480.4 (*Environmental Protection, Safety, and Health Protection Standards*), 5483.1A (*Occupational Safety and Health Program for Contractors at GOCO Facilities*), 5480.9 (*Construction Safety and Health Program*), and 5480.10 (*Contractor Industrial Hygiene Program*). However, ARARs apply to those federal and state regulations that are designed to protect the environment, and do not generally apply to occupational safety regulations. Therefore, the DOE Orders related to occupational safety, as well as the regulations promulgated by the Occupational Safety and Health Administration (OSHA) are not addressed as ARARs; these regulations appear in the site-specific Health and Safety Plan for CR OU4.

The following is a listing of the definitions of terms used throughout this report:

Applicable requirements are "those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site" (40 CFR 300.5).

Relevant and appropriate requirements are "those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting law that, while not applicable to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site" (40 CFR 300.5).

Requirements under federal or state law may be *either* applicable *or* relevant and appropriate to CERCLA cleanup actions, but not both. However, requirements must be *both* relevant *and* appropriate for compliance to be necessary. In the case where a federal and a state ARAR are available, or where there are two potential ARARs addressing the same issue, the more stringent regulation must be selected. However, CERCLA §121(d)(4) provides several ARAR waiver options that may be invoked, providing that the basic premise of protection of human health and the environment is not ignored. A waiver is available for state standards that have not been applied uniformly in similar circumstances across the state. In addition, CERCLA §121(d)(2)(C) forbids state standards that effectively prohibit land disposal of hazardous substances.

CERCLA on-site remedial response actions must only comply with the substantive requirements of a regulation and not the administrative requirements to obtain federal, state, or local permits [CERCLA §121(e) and FFA §XXII]. In order to ensure that CERCLA response actions proceed as rapidly as possible, EPA has reaffirmed this position in the final National Contingency Plan (NCP) (55 *FR* 8756). **Substantive requirements** pertain directly to the actions or conditions at a site, while **administrative requirements** facilitate their implementation. EPA recognizes that certain of the administrative requirements, such as consultation with state agencies, reporting, etc., are accomplished through the state involvement and public participation requirements of the NCP. These administrative requirements should be observed if they are useful in determining cleanup standards at the site (55 *FR* 8757).

In the absence of federal- or state-promulgated regulations, there are many criteria, advisories, guidance values, and proposed standards that are not legally binding but may serve as useful guidance for setting protective cleanup levels. These are not potential ARARs but are **"to-be-considered" (TBC)** guidance.

2. CHEMICAL-SPECIFIC ARARs

Chemical-specific requirements set health or risk-based concentration limits or discharge limitations in various environmental media for specific hazardous substances, pollutants, or contaminants (53 *FR* 51437). These requirements generally set protective cleanup levels for the chemicals of concern in the designated media or else indicate a safe level of discharge that may be incorporated when considering a specific remedial activity.

Rogers Quarry was used for quarrying of limestone from the late 1940s or early 1950s until about 1960. Quarrying intersected a water-bearing zone in the late 1950s, and pumps were installed to remove water and maintain quarry operations. The quarry filled with water after the pumps failed, and was abandoned with all equipment left in place. Since that time, the quarry has been used for disposal of various types of materials. Prior to 1990, DOE disposed of coal ash from its Y-12 steam plant operations as a slurry which was pumped over Chestnut Ridge, released, and allowed to flow southward by gravity into the Filled Coal Ash Pond (FCAP) just north of Rogers Quarry. The ash pond was constructed in 1955 by building an earthern dam across the northern tributary of the McCoy Branch of the Clinch River. By 1967 the pond was full and the slurry spilled over into McCoy Branch. In 1968 McCoy Branch was diverted into Rogers Quarry, which became the main settling basin for the ash. In 1990, the slurry pipeline was extended to convey the ash slurry directly to the quarry, bypassing the ash pond completely. Since November 1988, the steam plant has been burning natural gas as its primary fuel and coal as it secondary fuel, thus greatly reducing the amount of ash disposal in the quarry. By agreement with TDEC, ash disposal in the quarry will end altogether by July 1993. The quarry has also been used for disposal of various plant process materials over the years, including classified objects. Despite the classified nature of some of the disposal inventory, potential contaminants of concern (COCs) from the materials are known and include metals, inorganics, and radionuclides. Although limited in number, chemical-specific standards have been established under several statutes, including RCRA, the Safe Drinking Water Act (SDWA) and the Clean Water Act (CWA) for these COCs.

Rogers Quarry was originally included as part of the Filled Coal Ash Pond operable unit which was identified as a RCRA Sect. 3004(u) Solid Waste Management Unit (SWMU) in the Y-12 Plant General RFI Document. If Rogers Quarry is still considered a RCRA SWMU, or if toxicity testing of media reveals the presence of RCRA-characteristic or -listed hazardous waste as defined in 40 CFR 261, it is subject to RCRA corrective action regulations.

2.1 GROUNDWATER AND SURFACE WATER

Available chemical-specific ARARs that have been promulgated under federal law are listed in Table 1 for COCs that have been detected in surface water and groundwater at CR OU4.

In the NCP, EPA states the preference for SDWA maximum contaminant levels (MCLs) and non-zero maximum contaminant level goals (MCLGs) or other health-based standards, criteria, or guidance for cleanup of Class I and II groundwater at CERCLA sites (55 *FR* 8732). Alternate concentration limits (ACLs) may also be used when active restoration of the groundwater to MCLs or non-zero MCLGs is not practicable (55 *FR* 8754). For Class III groundwaters, EPA establishes remediation levels based on specific site conditions, the beneficial use of the groundwater, and environmental receptors (55 *FR* 8732). Final determination of ARARs for site-specific cleanup of groundwater at CR OU4 will depend on the chosen groundwater classification.

The Tennessee Department of Environment and Conservation (TDEC) Office of Superfund has released a preliminary draft groundwater classification rule which classified groundwater as: Class A - current or future sources of drinking water; Class B - not a current or future source of drinking water but protected for other beneficial uses; Class C - not protected for drinking water or other beneficial uses; and Surface Water Recharge - groundwater that recharges surface waters. Class A groundwaters are listed by aquifer; two are identified for east Tennessee - the Cambrian-Ordovician Carbonate Aquifer, and the Crystalline Rock Aquifer. This early draft has been revised many times in response to comments and TDEC hopes to reissue it as a draft for formal comments by March 1993 (Moss 1993). Numerical standards for cleanup of groundwater that is classified for drinking water have been proposed [Rules of the TDEC, Chapter 1200-1-13-.08(4)]. These include specific criteria for groundwater found in Rules of the TDEC, Chapter 1200-4-6-.05(2), federal SDWA MCLs and secondary maximum contaminant levels (SMCLs), and naturally occurring background levels. However, the proposed rule provides three approaches to establish cleanup levels: use of the numerical standards discussed above; use of the human health and environmental risk assessment approach; or use of background levels as further defined in 1200-1-13-.08(6) [Rules of the TDEC, Chapter 1200-1-13-.08(3)(a)]. This proposed rule is expected to be final sometime in mid-1993 (Binford 1993).

2.1.1 Resource Conservation and Recovery Act

Subtitle C of RCRA lists maximum concentration levels for 14 chemicals; the concentration of these chemicals in groundwater at the plant boundary of a RCRA-permitted treatment, storage, or disposal (TSD) facility may not exceed the stated maximum concentration level [Title 40, Code of Federal Regulations, Part 264, §94 (40 CFR 264.94)]. In addition, background concentrations or ACLs are established in 40 CFR 264.94 as groundwater protection standards. Table 1 lists RCRA MCLs; however, as mentioned above, EPA has specified SDWA MCLs and non-zero MCLGs for cleanup of Class I and II groundwater and site-specific remediation levels for Class III groundwaters. This approach is consistent with the substantive requirements of RCRA MCLs, ACLs, or background limits (53 *FR* 51433).

2.1.2 Safe Drinking Water Act

EPA has promulgated primary and secondary drinking water regulations applicable to public water systems that have at least 15 service connections or serve an average of at least 25 people daily at least 60 days of the year. National Primary Drinking Water Standards (NPDWS) are established in 40 CFR 141 and include MCLs and MCLGs. New drinking water standards promulgated for eight synthetic organic chemicals (52 *FR* 25690, July 8, 1987) added a new category of suppliers referred to as noncommunity, nontransient systems that regularly serve at least 25 people for 6 months of the year. Table 1 lists SDWA MCLs and MCLGs.

MCLs are enforceable standards that take into consideration human health effects, available treatment technologies, and costs of treatment. MCLGs are strictly health-based standards that disregard cost or treatment feasibility and are not legally enforceable. MCLs are legally applicable to water "at the tap" but are not applicable to cleanup of groundwater or surface water. However, they may be considered as relevant and appropriate in situations where groundwater or surface water is classified or may be used for drinking water. CERCLA §121(d)(2)(A) specifically mentions that remedial actions must require a level or standard of control that at least attains MCLGs and federal ambient water quality criteria (WQC) where such goals or criteria are relevant and appropriate under the circumstances of the release. Although MCLGs and WQC are nonenforceable guidelines, Congress elevated them to a higher status by specifically mentioning them in CERCLA. Therefore, promulgated MCLGs are listed in Table 1. At present, EPA is planning to use the SDWA MCLs for remedial action compliance for carcinogens which have an MCLG of zero and any nonzero MCLG for remedial action compliance for systemic toxicants (55 *FR* 8752).

The SDWA amendments of 1986 mandated that EPA propose MCLs and MCLGs for contaminants in drinking water that may cause any adverse effect on human health. Proposed MCLs/MCLGs appeared in 55 *FR* 30370 (July 25, 1990). These proposed MCLs/MCLGs became final July 17, 1992 (57 *FR* 31776) for all but sulfate. EPA has deferred setting the MCL/MCLG for sulfate pending further study.

EPA has revised its drinking water standards for lead and copper, eliminating the MCL and replacing it with a treatment technique which is triggered by an "action level" of 15 μg/L and 1300 μg/L, respectively (56 *FR* 26460, June 7, 1991), applicable to community and non-transient, non-community water systems. If the action level for lead or copper is exceeded at the tap, a state is required to analyze source water samples and to decide what treatment technique is necessary to minimize lead or copper levels delivered to users from the affected distribution system. In the instance of lead-contaminated groundwater at CR OU4, the action level for lead is neither legally applicable nor relevant and appropriate. The RCRA MCL for lead (50 μg/L) may be relevant and appropriate. However,the EPA Office of Solid Waste and Emergency Response (OSWER) has recommended that a final cleanup level of 15 μg/L for lead in groundwater usable for drinking water is protective of sensitive populations (OSWER memorandum dated June 21, 1990). This might be considered TBC guidance for remediation of lead-contaminated groundwater. The action levels for lead and copper have also been listed in the proposed TDEC Rule (discussed above) as cleanup standards for groundwater to be used as a domestic water supply and, when promulgated, will be legally applicable to groundwater classified for drinking water.

Chapter 1200-5-1 of the Rules of the TDEC lists MCLs for public water systems that are identical to the federal MCLs, including the recent revisions to the Phase II (55 *FR* 30266, July 1, 1991) and lead and copper (56 *FR* 26460, June 7, 1991) MCLs. These regulations will be revised to incorporate the recent Phase V (57 *FR* 31776, July 17, 1992) revisions in federal MCLs, with promulgation expected by the fall of 1993 (Foster 1993). Therefore, they are not repeated here.

National Secondary Drinking Water Standards (NSDWS) regulate contaminants that affect the aesthetic qualities related to public acceptance of drinking water and are implemented in 40 CFR 143.3 as secondary maximum contaminant levels (SMCLs).

Tennessee has promulgated SMCLs in Chap. 1200-5-1.12 of the Rules of the TDEC. These regulations are designed to provide water to the consumer which is aesthetically pleasing, and they apply to all community water systems and to those noncommunity water systems "as may be deemed necessary" by TDEC. In that context, they would not be legally applicable to cleanup of groundwater or surface water, but may be considered as relevant and appropriate in the absence of an MCL. Tennessee SMCLs, as well as federal SMCLs for COCs at CR OU4 that do not have a federal or state MCL are listed in Table 1.

2.1.3 Clean Water Act

The McCoy Branch watershed drains the south side of Chestnut Ridge southward to Rogers Quarry and ultimately discharges into Melton Hill Reservoir on the Clinch River. There is a NPDES monitoring station at the southwest corner of Rogers Quarry. The NDPES permit covering this outfall sets monitoring requirements for specific chemicals and parameters, but sets specific limits only for oil and grease, pH, total suspended solids, settleable solids, and temperature.

CERCLA §121(d)(2)(A) specifically states that remedial actions shall at least attain federal ambient WQC established under the CWA if they are relevant and appropriate. In determining whether any WQC are relevant and appropriate, one must consider the "designated or potential use of the surface or groundwater, the environmental media affected, the purposes for which the criteria were developed, and the latest information available" [CERCLA §121(d)(2)(B)]. Federal WQC are derived for the protection of freshwater aquatic organisms and for the protection of human health from the consumption of contaminated drinking water and/or aquatic organisms. The EPA Region IV Water Quality Standards Unit has adjusted the federal WQC for human health based on recent human toxicity information [reference doses (RfDs) and carcinogen slope factors (CSFs)] obtained from the EPA *Integrated Risk Information System (IRIS)*. Federal WQC are not promulgated standards.

As part of the federal requirement for a triennial review of state water quality standards, the TDEC Division of Water Pollution Control has promulgated amendments to Chaps. 1200-4-3 and 1200-4-4 of the Rules of the TDEC. The TDEC Rules include WQC for protection of recreational uses; these criteria are human health criteria derived to protect the consumer from consumption of contaminated fish. These criteria are the WQC for the protection of human health from consumption of fish alone. For carcinogens, the TDEC WQC are based on a risk of 10^{-5} rather than the 10^{-6} risk on which the federal WQC are based. State WQC are promulgated standards and so would be legally applicable for cleanup of surface water bodies. If no state WQC is available for a specific chemical, any available federal WQC would then become relevant and appropriate.

Chapter 1200-4-3 of the Rules of the TDEC lists seven use designation categories for Tennessee's surface waters and groundwaters. Specific water quality standards are promulgated for each use category. Chapter 1200-4-4 of the Rules of the TDEC identifies by name individual water bodies in the state and list specific use classifications for each. Rogers Quarry is not included on the lists. However, the standards also state that "all other surface water bodies, named and unnamed, which have not been specifically noted shall be classified for fish and aquatic life, recreation, irrigation, and livestock watering and wildlife uses." Since McCoy Branch flows into Rogers Quarry and the outfall flows into the Clinch River, Rogers Quarry, by state regulatory definition, would be considered a surface water body and would fit into the above classification.

Table 2 lists state WQC available for COCs at CR OU4 for recreation and for the protection of freshwater aquatic life. These criteria would be ARAR for cleanup of the surface waters in Rogers Quarry. Where no state criterion is available for a specific chemical, a federal criterion is listed if available.

2.2 SOIL/SEDIMENT

Very little legislation or guidance is available governing cleanup criteria for contaminated soils or sediments at CERCLA sites. RCRA has addressed land disposal of treated hazardous wastes in its land disposal restrictions (LDRs) (40 CFR 268). If disposal of any RCRA-characteristic or -listed wastes is considered as an alternative, the LDRs will be applicable. This will be addressed during selection of alternatives during the RI/FS phase.

The TDEC has proposed a new Chapter 1200-1-13 (*Hazardous Substance Site Remedial Action*) to the Rules of the TDEC; the proposed rule is projected to go final by mid-1993 (Binford 1993). In this proposed rule are three approaches for the establishment of cleanup levels: 1) use of listed soil cleanup levels for residential and industrial sites; 2) use of a site-specific human health and environmental risk assessment; and 3) use of background levels [1200-1-13-.08(3)(a)]. In cases where site-specific risk-based cleanup levels are proposed, the TDEC must review and approve those levels [1200-1-13-.08(3)(b)].

EPA has suggested cleanup values for lead in soils based on studies of blood lead levels in exposed children. The EPA OSWER Directive 9355.4-02 (dated September 7, 1989) recommends a cleanup level for soils of 500-1000 ppm lead. These would be TBC guidance, not ARARs.

EPA Region IV has made available a summary of chemical-specific concentrations that may be used to flag contaminant levels of concern in sediments. The values which may be applicable for COCs at CR OU4 are given in Table 3. These values have been calculated by the National Oceanic and Atmospheric Administration (NOAA) and are **not intended as cleanup standards.** Biological effects-based testing using highly sensitive organisms is recommended for contaminants which have exceeded the NOAA "action levels."

2.3 OTHER "TO-BE-CONSIDERED" (TBC) GUIDANCE

In the absence of federally or state-promulgated ARARs, or in the case where ARARs are not adequately protective, EPA states a preference for RfDs or reference concentrations (RfCs) for systemic toxicants, and CSFs for carcinogens. The RfDs, RfCs, and CSFs are available through *IRIS* (USEPA 1991) and the EPA *Health Effects Assessment Summary Tables* (USEPA 1992).

The EPA ODW has developed nonregulatory HAs for concentrations of noncarcinogenic contaminants in drinking water at which no adverse health effects would be expected to occur. Lifetime HAs of 0.6 mg/L for boron and 0.02 mg/L for vanadium are listed. These are the only two contaminants of concern at CR OU4 which do not have promulgated MCLs/SMCLs but do have HAs available.

3. RADIATION PROTECTION STANDARDS

Very few applicable standards are available for the cleanup of radioactively contaminated CERCLA sites. The Atomic Energy Act (AEA) of 1954 and its amendments delegated authority for control of nuclear energy to DOE, the U.S. Nuclear Regulatory Commission (NRC), and EPA. In addition, certain states have regulatory authority and programs for radioactive waste. EPA's regulations are derived from several other statutes as well and cover many types of activities and all types of radioactive materials. The NRC licenses the possession and use of various types of radioactive materials at certain types of facilities. Tennessee is an NRC-Agreement state and, as such, has its own authority and licensing regulations.

DOE is authorized to control all types of nuclear materials at sites under its jurisdiction and is exempt from the NRC licensing and regulatory requirements. Therefore, NRC regulations are not considered to be legally applicable to CERCLA cleanup at DOE facilities; however, all or parts of individual NRC regulations may be considered relevant and appropriate depending on the particular conditions at each operable unit. The decision as to whether a particular section or part of an NRC requirement is relevant and appropriate or TBC guidance depends on site-specific technical evaluation of suitability and need. This evaluation will be performed during selection of remedial alternatives for CR OU4.

DOE regulations for handling and cleanup of radioactive materials are outlined in a series of internal DOE Orders that are contractually binding to DOE contractors but are not considered by EPA to be ARARs. However, DOE Orders are generally consistent with, and typically incorporate NRC technical requirements that are appropriate for DOE operations and waste management. Therefore, for the purposes of development of ARARs, DOE Orders will be treated as TBC guidance.

In addition to hazardous waste, Rogers Quarry shows evidence of possible radiological contamination of groundwater, surface water, and soils with uranium, thorium-228 and -234, and cesium-137, as well as gross alpha and beta activity. The proper definition of "mixed low-level radioactive and hazardous waste" has caused considerable debate with regard to dual jurisdiction by EPA and NRC. However, EPA has published a clarification of the problem (53 *FR* 37045, September 23, 1988), as did DOE previously [52 *FR* 15937, May 1, 1987 and DOE Order 5400.3 (*Hazardous and Radioactive Mixed Waste Program*, dated February 22, 1989)]. In effect, mixed wastes are those containing a RCRA hazardous waste as defined in 40 CFR 261 and a radioactive waste subject to the AEA. RCRA regulations apply to the hazardous component of the waste, and AEA regulations apply to the radioactive component. When the application of both standards is conflicting or inconsistent, RCRA yields to the AEA. Tennessee received final authorization to regulate radioactive mixed waste on July 3, 1986 (53 *FR* 37045, September 23, 1988); however, the state has not implemented any regulations or guidance related to the handling of mixed waste (West 1991). In June 1992, EPA and DOE signed a Federal Facilities Compliance Agreement (FFCA) to bring mixed waste generating and storage facilities on the Reservation into compliance with environmental law. Effective immediately, the FFCA allows DOE ORR facilities to continue to generate and store mixed wastes, including solid mixed wastes, while addressing LDR mixed waste compliance issues.

3.1 EPA REGULATIONS

EPA has promulgated MCLs for radionuclides in community water systems (see Table 4). These MCLs appear in two forms — concentration limits for certain alpha-emitting radionuclides (40 CFR 141.15) and an annual dose limit for the ingestion of certain beta- and gamma-emitting radionuclides (40 CFR 141.16). MCLs and MCLGs were proposed for radon and uranium and reproposed for ^{226}Ra and ^{228}Ra, beta, and photon emitters on July 18, 1991, and are included in Table 4. Final promulgation of the concentration limits is not expected until the end of 1993. As with the chemical-specific MCLs, these may be relevant and appropriate for cleanup of contaminated groundwater at CR OU4.

Table 5 lists EPA and DOE radiation protection standards that are described below. These regulations and standards generally address specific types of activities , and will be analyzed in detail for action-specific ARARs during the remedial alternatives selection phase. General requirements are discussed below.

Subpart H of 40 CFR 61 addresses atmospheric radionuclide emissions from DOE facilities and may be applicable to airborne emissions during cleanup of ORR. EPA has issued a final NESHAP rule (54 *FR* 51654, December 15, 1989) that limits emissions of radionuclides to the ambient air from DOE facilities to amounts that would not cause any member of the public to receive an effective dose equivalent of 10 mrem/year (40 CFR 61.92).

3.2 DOE ORDERS

DOE Orders are not promulgated regulations and thus are not considered to be ARARs by EPA. They are, however, contractually binding between DOE and Martin Marietta Energy Systems, Inc. (MMES) because of contractual agreements and would be considered TBC guidance. The radiation exposure limits defined in DOE Order 5400.5 (*Radiation Protection of the Public and the Environment*, February 8, 1990) are: an effective dose equivalent (EDE) of 100 mrem/year from all exposure pathways and all DOE sources of radiation and a dose of less than 500 rem/year as a temporary maximum exemption under specially-permitted and DOE-approved circumstances. In addition, effluent releases to surface water must not result in exposures to aquatic organisms exceeding an absorbed dose of 1 rad/day. The overriding principle of the DOE Order is that all releases of radioactive material shall be ALARA.

DOE Order 5820.2A (*Radioactive Waste Management*, September 9, 1988) states that the management of low-level radioactive waste must assure that external exposure to the waste and concentrations of radioactive material that may be released into surface water and soil does not exceed 25 mrem/year to any member of the public. Releases to the atmosphere shall not exceed 10 mrem/year. Reasonable effort should be made to maintain releases to the environment to ALARA levels. The Order pertains to the management of radioactive waste that is not mixed with RCRA hazardous waste.

DOE Order 5480.11 (*Radiation Protection for Occupational Workers*, December 21, 1988) contains guidelines for worker protection that are similar to those of 10 CFR 20; i.e., 5 rem/year and 50 rem/year annual effective dose equivalent for stochastic (cancer) and nonstochastic (systemic) effects, respectively, from both internal and external sources for continuous exposures. Also included in the Order are standards for the general public when entering a controlled area. Exposures to the public are limited to an effective dose equivalent of 100 mrem/year. As with the other DOE Orders, the ALARA principle prevails. Remediation of radionuclide-contaminated soils must ensure that exposures to on-site workers or public intruders will not exceed these standards. DOE has proposed for codification in 10 CFR 835 the primary standards for radiation protection of occupational workers from normal operation of DOE facilities (56 *FR* 64334, December 9, 1991). A final rule is expected in March 1993. When promulgated, these standards will then be legally applicable for CERCLA cleanup at DOE sites.

3.3 OTHER TBC GUIDANCE FOR RADIOLOGICAL RISK ASSESSMENT

The EPA Office of Radiation Programs has derived slope and unit risk factors for radionuclides of concern at remedial sites for each of three major exposure pathways (inhalation, ingestion, and external exposure to contaminated soil). These are available in the EPA *Health Effects Assessment Summary Tables* (USEPA 1991b), and would be considered TBC guidance for COCs at CR OU4, given known characteristics of the site. ARARs based on conjecture are listed in the text but not on Table 6.

4. LOCATION-SPECIFIC ARARs

Location-specific requirements "set restrictions upon the concentration of hazardous substances or the conduct of activities solely because they are in special locations" (53 *FR* 51394). Table 6 lists the major federal and state location-specific ARARs that might be pertinent to remedial actions at CR OU4.

4.1 GEOLOGIC CHARACTERISTICS

There are no indications of salt-dome formations, salt-bed formations, or underground mines on or near Rogers Quarry. However, if any caves are located in areas where remedial activities may occur, the regulations found in RCRA [40 CFR 264.18(c)] which prohibit the placement of noncontainerized or bulk liquid hazardous waste in caves might be ARAR (Table 6).

The faults on ORR are ancient (pre-Holocene) and are stable (Ketelle 1991). The possibility of fault movement is considered extremely unlikely (Chance 1986).

4.2 AQUATIC RESOURCES

There are no known designated wilderness areas, wildlife refuges, or scenic rivers on ORR, or within range of the reservation such that remedial action would likely impact these resources. However, if any remedial action is taken which affects wildlife or alters McCoy

Branch or Rogers Quarry, which are designated by the state of Tennessee for fish and aquatic life, recreation, irrigation, and wildlife and livestock watering, then the Fish and Wildlife Coordination Act (16 USC 661 *et seq.*), the Tennessee Water Quality Control Act of 1977 (TCA 69-3-101 *et seq.*), the Clean Water Act §404, 40 CFR 230 and 6.302(g), and 33 CFR 320-330 may be applicable (see Table 6). In addition, if streambed modifications occur during remediation, then substantive requirements fo the TDEC Aquatic Resources Alteration Permitting (ARAP) process (TDEC Rules, Chapter 1200-4-7 *et seq.*) may be applicable to this response action. This will be addressed during selection of remedial alternatives.

Certain portions of ORR have been designated as a DOE National Environmental Research Park (NERP), which also includes Research Areas (RSAs) located both within and without the NERP itself (Parr and Pounds 1987). Neither the NERP nor any RSAs occurr at or in close proximity to Rogers Quarry (Parr and Pounds 1987).

In addition to the NERP and its associated RSAs, DOE has also designated areas on ORR as DOE-NERP Reference Areas (RAs) and DOE-NERP Natural Areas (NAs). The RAs are located in various sites on ORR, with several in close proximity to the reservation facilities. Specifically, RA14 - Fanny Knob white oak area is located about 0.5 miles west of the FCAP (Parr and Pounds 1987). NAs have been established to protect rare plant and animal species (Parr and Pounds 1987). Like RAs, these are located in various places within the reservation. One natural area, NA-8, McCoy Branch embayment "barren," is located just south of the FCAP site, on the south side of Bethel Valley Road. The latter is also registered by Tennessee as State Natural Areas (SNAs), SN-8, and contains the largest known population of tall larkspur (*Delphinium exaltatum*) which is state-listed as endangered (Parr and Pounds 1987). Because of the unique purposes and goals in establishing the NERP, the uses and restrictions which apply to these resources should be considered TBC guidance if remedial actions appear likely to impact the designated areas. In addition, if the McCoy Branch embayment barren is affected, the provisions of the Tennessee Natural Areas Preservation Act of 1971 (TCA 11-14-101 *et seq.*) would be applicable.

4.3 WETLANDS AND FLOODPLAINS

Rogers Quarry appears to be located outside the 100- and 500-year floodplains (Welch 1989). A preliminary survey of the wetlands on the ORR identified wetlands hydrology and dominant hydrophytic species in the McCoy Branch/FCAP area (Cunningham and Pounds 1991). In the event a NEPA survey indicates the presence of wetlands, Executive Order 11990, 40 CFR 6.302(a), 40 CFR 6 (Appendix A), 10 CFR 1022, the Clean Water Act §404, 40 CFR 230, and 33 CFR 320-330 may supply ARARs for remedial actions.

4.4 HISTORIC SITES AND ARCHAEOLOGICAL FINDINGS

The region surrounding ORR is rich in both archaeological and historic resources and a number of studies have indicated the presence of abundant resources on the reservation. These surveys are summarized in Volume 3, Appendix B of the *Resource Management Plan for the U.S. Department of Energy Oak Ridge Reservation* (Sanders 1984) which also includes a list and description of most of the documented sites. Although the surveys are not exhaustive of the entire reservation, no known historic or archaeological sites appear to be located at or near Rogers Quarry (Sanders 1984). In the event a NEPA survey indicates the presence of archeological resources, the National Historic Preservation Act (16 USC 470a-w), the Archaeological Resources Recovery Act (16 USC 470aa-ll), the Archaeological and Historic Preservation Act (16 USC 469a-c), 43 CFR 7, and 40 CFR 6.301 may provide ARARs.

4.5 RARE, THREATENED, OR ENDANGERED SPECIES

Although there are a number of state- and federal-listed species on ORR, there appear to be no known threatened or endangered species at Rogers Quarry (Kroodsma 1987).

As noted earlier, there is a very important tall larkspur (*Delphinium exaltatum*) population just south of FCAP at the McCoy Branch NA-8. This species is state-listed and therefore any actions which impact the population should consider the Tennessee Rare Plant Protection and Conservation Act of 1985 (TCA 11-26-209 *et seq.*). The prohibitions of the Tennessee Rare Plant Protection and Conservation Act do not apply to a landowner, lessee, or other person entitled to possession of the land on which the species is located (TCA 11-26-209). This also includes managers in the case of publicly-owned land and those with written permission of the landowner or manager (TCA 11-26-209). These exclusions would apparently apply to ORR. However, the purpose of the statute to protect and preserve rare plants should be considered TBC guidance for any remedial actions on the reservation. Since this plant is also a candidate for inclusion on the federal list, upon listing, the provisions of the Endangered Species Act of 1973 (16 USC 1531 *et seq.*) should also be considered.

5. ACTION-SPECIFIC ARARs

Performance, design, or other action-specific requirements set controls or restrictions on particular kinds of activities related to the management of hazardous waste (52 *FR* 32496). Selection of a particular remedial action at a site will invoke the appropriate action-specific ARARs that may specify particular performance standards or technologies, as well as specific environmental levels for discharged or residual chemicals. Action-specific ARARs are established under RCRA, CAA, CWA, SDWA, and TSCA. Action-specific ARARs for Rogers Quarry will be developed during selection of remedial alternatives.

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Table 1. Available chemical-specific federal and state ARARs for protection of human health for contaminants of concern at Rogers Quarry[a,b]

Chemical	RCRA[c] MCLs[d] (μg/L)	Tennessee Public Water Supply MCLs (μg/L)	Safe Drinking Water Act MCLs (μg/L)	Safe Drinking Water Act MCLGs[e] (μg/L)
Aluminum	—	—	50-200[f,g]	—
Arsenic[h]	50	50	50	—
Barium	1,000	2,000	2,000[i]	2,000[i]
Beryllium	—	—	4[j]	4[j]
Cadmium[k]	10	5	5	5
Chloride	—	250,000[f]	250,000[f]	—
Chromium (total)[k]	50	100	100	100
Copper	—	TT[l]	TT[l]	1,300
Fluoride	—	4,000	4,000[m]	4,000[m]
Iron	—	300[f]	300[f]	—
Lead	50	TT[l]	TT[l]	0
Manganese	—	50[f]	50[f]	—
Mercury[k]	2	2	2	2
Nickel	—	—	100[j]	100[j]
Nitrate (as N)	—	10,000[k]	10,000[k]	10,000[k]
Nitrate + nitrite (as N)	—	10,000[k]	10,000[k]	10,000[k]
Selenium[k]	10	50	50	50
Sulfate	—	—	400,000/500,000[n]	400,000/500,000[n]
Zinc	—	5000[f]	5000[f]	—

[a]ARAR = applicable or relevant and appropriate requirements.
[b]Federally promulgated regulations under RCRA and the Safe Drinking Water Act, as well as TDEC Public Water Supplies MCLs (Chapter 1200-5-1.06) are included in this table.
[c]RCRA = Resource Conservation and Recovery Act (40 CFR 264.94).
[d]MCL = maximum contaminant level; RCRA MCLs are properly termed "maximum concentration limits."
[e]MCLG = maximum contaminant level goal.
[f]Seconday maximum contaminant level (SMCL); 56 *FR* 3526 (January 30, 1991). Tennessee has adopted the federal SMCLs, except for aluminum.
[g]Level recommended to prevent posttreatment precipitation in the distribution system.
[h]40 *FR* 59570 (December 24, 1975).
[i]56 *FR* 30266 (July 1, 1991). Effective January 1, 1993.
[j]57 *FR* 31776 (July 17, 1992); effective January 17, 1994. Tennessee is in the process of revising their MCLs to match these federal MCLs; projected to be final in fall of 1993 (Foster 1993).
[k]The final MCL/MCLG was set for this chemical (56 *FR* 3526, January 30, 1991), and supercedes the original interim SDWA MCL; effective July 30, 1992. Tennessee has revised their MCL to match this federal MCL, effective October 8, 1992.
[l]56 *FR* 26460 (June 7, 1991); effective December 7, 1992. TT=treatment technique; "action levels" of 1300 and 15 μg/L for copper and lead respectively, when measured in the 90th percentile at the consumer's tap, trigger initiation of corrosion control studies and treatment technique requirements. OSWER has recommended that a final cleanup level of 15 μg/L for lead in groundwater usable for drinking water is protective of sensitive populations (OSWER memorandum dated June 21, 1990).

[m]MCL - 51 *FR* 11396 (April 1, 1986); applies to community water systems only. MCLG - 50 *FR* 47141 (November 14, 1985).
[n]This is a proposed MCL/MCLG only (55 *FR* 30370, July 25, 1990) and thus is not ARAR. Two proposal options are presented for public comment. EPA has deferred setting a final MCL/MCLG for sulfate pending further study (57 *FR* 31776, July 17, 1992).

Table 2. Tennessee water quality criteria applicable to the cleanup of McCoy Branch and Rogers Quarry (μg/L)[a]

Chemical	Freshwater Fish and Aquatic Life: Criterion Maximum Concentration(CMC)	Freshwater Fish and Aquatic Life: Criterion Continous Concentration(CCC)	Recreation (10^{-5} risk factor for carcinogens) Organisms Only
Arsenic (III)	360	190	--
Beryllium	--	--	1.3
Cadmium[b]	6.48[c]	1.61[c]	--
Chromium, total	--	100	--
Chromium (III)	2499.76[d]	297.96[d]	670,000
Chromium (VI)	16	11	--
Copper[b]	26.95[c]	17.29[c]	--
Lead[b]	143.83[c]	5.60[c]	--
Mercury	2.4	0.012	0.15
Nickel[b]	2066.27	229.71	4600
Selenium	20	5	--
Zinc[b]	170.59[c]	1254.51[c]	--

[a]Chapter 1200-4-3 of the Rules of the TDEC, as amended effective August 30, 1991.
[b]Water hardness dependent criteria; based on an average water hardness of 156 mg/L as $CaCO_3$ for McCoy Branch.
[c]Values presented are for the dissolved form of this metal.
[d]Federal WQC; Tennessee does not have a fish and aquatic life criterion for trivalent chromium. Source: EPA Region IV Criteria Chart (October, 1991).

Table 3. Summary of Available NOAA[a] Action Levels for Contaminants in Sediment (ppb)[b]

Chemical	Low Effects Range	Median Effects Range	Overall Apparent Effects Threshold	Degree of Confidence
Arsenic	33 (ppm)	85 (ppm)	50 (ppm)	Low/moderate
Beryllium	NA[c]	NA	NA	
Cadmium	5 (ppm)	9 (ppm)	5 (ppm)	High/high
Chromium (total)	80 (ppm)	145 (ppm)	None	Moderate/ moderate
Copper	70 (ppm)	390 (ppm)	300 (ppm)	High/high
Lead	35 (ppm)	110 (ppm)	300 (ppm)	Moderate/high
Manganese	NA	NA	NA	
Mercury	0.15 (ppm)	1.3 (ppm)	1 (ppm)	Moderate/high
Nickel	30 (ppm)	50 (ppm)	NSD[d]	Moderate/- moderate
Selenium	NA	NA	NA	
Vanadium	NA	NA	NA	
Zinc	120 (ppm)	270 (ppm)	200 (ppm)	High/high

[a]NOAA = National Oceanic and Atmospheric Administration.
[b]USEPA Region IV Memorandum from Catherine Fox, Coastal Programs Unit, dated April 15, 1991, *Suggested Guidance for Evaluating Sediment Concentration Data.*
[c]NA = Not available.
[d]NSD = Not sufficient data.

Table 4. Radionuclide-specific applicable or relevant and appropriate requirements (ARARs) for groundwater and surface water contamination at Rogers Quarry

Radionuclide	Proposed SDWA MCLs[a,b]	Present SDWA MCLs
Radium[c]	20 pCi/L	5 pCi/L
Gross alpha[d]	15 pCi/L	15 pCi/L
Gross beta	4 mrem/year	4 mrem/year
Strontium-90	8 PCi/L	8 pCi/L
Tritium	20,000pCi/L	20,000 pCi/L
All other man-made radionuclides	4 mrem/year[e]	4 mrem/year[e]
Natural uranium	30 pCi/L	-----
Radon-222	300 pCi/L	-----

[a]MCL = maximum contaminant level.
[b]Proposed rule, July 18, 1991 (56 *FR* 33050); final rule expected December 1993.
[c]Present MCL applies to combined radium-226 and radium-228; proposed MCL applies to each separately.
[d]Present MCL excludes radon and uranium but includes radium-226; proposed MCL excludes all three compounds.
[e]If two or more radionuclides are present, the sum of their annual dose equivalent to the total body or to any organ shall not exceed 4 mrem/year.

Table 5. Radiation protection standards that may be "relevant and appropriate" or "to-be-considered" guidance for Rogers Quarry

Regulation	Applicability	Exposure conditions	Standard
40 CFR 61	National Emmission Standards for Hazardous Air Pollutants for DOE facilities	Public exposure, airborn emissions	10 mrem/year
40 CFR 141	Drinking water maximum contaminant levels	Community water systems, gross beta	4 mrem/year
DOE Order 5400.5	Radiation Protection of the Public and the Environment	Public exposure, all sources	100 mrem/year
		Temporary maximum exemption	500 mrem/year
		Aquatic organism exposure, absorbed dose	1 rad/d
DOE Order 5820.2A	Radioactive Waste Management	Public exposure, all sources, excluding air	25 mrem/year
		Public exposure, atmospheric releases	10 mrem/year
DOE Order 5480.11[b]	Radiation Protection for Occupational Workers	Worker exposure limits, continuous exposure	5 rem/year, cancer effects
			50 rem/year, noncancer effects, any organ or tissue
		Public exposures, controlled areas, effective dose equivalent	100 mrem/year

[a]Final rule of May 22, 1991 (56 *FR*23360), effective June 21, 1991. Implementation of this regulation by NRC-licensees may be deferred until January 1, 1993. This rule deleted the quarterly limits for occupational exposures and lowered the limit for public exposure from 500 to 100 mrem/year.
[b]Proposed as 10 CFR 835 (56 *FR* 64334, December 9, 1991). Final rule expected March 1993.

Table 6. Tentative location-specific applicable or relevant and appropriate requirements for Rogers Quarry

Location characteristic(s)	Operating condition(s)	Requirement(s)	Citation(s)
Wetlands			
Presence of wetlands as defined in Executive Order 11990 §7(c) and 40 CFR 6, Appendix A §4(j)	Agency action which involves: – acquiring, managing, and disposing of lands and facilities – providing federally undertaken, financed, or assisted construction and improvements – conducting federal activities and programs affecting land use	Whenever possible, actions must avoid or minimize adverse impacts on wetlands and act to preserve and enhance their natural and beneficial values. New construction in wetlands areas should be particularly avoided unless there are no practicable alternatives Wetlands protection considerations shall be incorporated into planning, regulating, and decision-making processes	Executive Order 11990 40 CFR 6.302(a) 40 CFR 6, Appendix A 10 CFR 1022
Presence of wetlands as defined in 40 CFR 230.3(t) and 33 CFR 328.3(b)	Action involving discharge of dredge or fill material into wetlands	Action to avoid degradation or destruction of wetlands must be taken to the extent possible. Discharges for which there is a practicable alternative with less adverse impacts or those which would cause or contribute to significant degradation are prohibited If adverse impacts are unavoidable, action must be taken to enhance, restore, or create alternative wetlands	Clean Water Act §404 40 CFR 230 33 CFR 320-330
Aquatic Resources			
Within area encompassing or affecting waters of the state of Tennessee as defined in TCA[a]69-3-103(32) and the presence of wildlife or aquatic life	Action involving the discharge of any pollutants into the waters of the state [see TCA 69-3-103(18) and (21) for noninclusive list]	Discharge of "substances" which "will result or will likely result in harm, potential harm or detriment to the health of animals, birds, fish, or aquatic life" is prohibited	Tennessee Water Quality Control Act of 1977 (TCA 69-3-101 *et seq.*) Stream Use Classifications (TDEC[b] Rules - Chap. 1200-4-4)

Table 6 (continued)

Location characteristic(s)	Operating condition(s)	Requirement(s)	Citation(s)
Aquatic Resources (continued)			
Within area affecting stream or river *-and-* presence of fish or wildlife resources	Action which results in the control or structural modification of a natural stream or body of water	The effects of water-related projects on fish and wildlife resources must be considered Action must be taken to prevent, mitigate, or compensate for project-related damages or losses to fish and wildlife resources Consultation with the FWS[c] and/or appropriate state agency is recommended for on-site actions that alter a resource	Fish and Wildlife Coordination Act (16 USC 661 *et seq.*) 40 CFR 6.302(g)
Location encompassing aquatic ecosystem with dependent fish, wildlife, other aquatic life, or habitat	Action involving the discharge of dredge or fill material into aquatic ecosystem	Degradation or destruction of aquatic ecosystems must be avoided to the extent possible. Discharges which cause or contribute to significant degradation of the water of such ecosystem are prohibited	Clean Water Act §404 40 CFR 230 33 CFR 320-330
Location encompassing a state-designated natural area		The scientific, scenic, recreational, and educational values of these areas must be preserved and steps taken to prevent impairment thereof	TCA 11-14-101 *et seq*

[a]TCA = Tennessee Code Annotated.
[b]TDEC = Tennessee Department of Environment and Conservation.
[c]FWS = Fish and Wildlife Service.

Appendix C

EXCERPTS FROM ENVIRONMENTAL COMPLIANCE BRANCH
STANDARD OPERATING PROCEDURES
AND QUALITY ASSURANCE MANUAL,
FEBRUARY 1, 1991

EXCERPTS FROM:

ENVIRONMENTAL COMPLIANCE BRANCH

STANDARD OPERATING PROCEDURES

AND

QUALITY ASSURANCE MANUAL

FEBRUARY 1, 1991

Section 6.0 Field Analytical Procedures

Section D.4 Method D.4 Dissolved Oxygen
(Membrane Electrode)

Section D.5 Method D.5 Specific Conductance

U. S. Environmental Protection Agency
Region IV
Environmental Services Division
College Station Road
Athens, Georgia 30613

6.0 FIELD ANALYTICAL PROCEDURES

6.1 GENERAL

Field analytical equipment used by Branch personnel should be suitable for the analysis to be accomplished and properly calibrated. In addition to being accurate, field analyses must be conducted on a sample which is representative of the source from which it was collected. Therefore, the type of sample and location of the sampling site are critical. A detailed discussion of sample type and sample site selection is given in Section 4 for the various media investigated by Branch personnel.

The objectives of this section are to:

- list the specific field analytical techniques that shall be used by Branch personnel;
- list the specific quality control procedures and calibration techniques for each piece of field analytical equipment used by Branch personnel;
- list the source of all reagents and standards used to perform field analyses and/or calibrate field analytical equipment; and
- specify the training required of Branch personnel to perform the listed field analyses.

Specific field analytical methodology for each parameter is given in Appendix D.

6.2 SPECIFIC ANALYTICAL TECHNIQUES

The specific field analytical techniques used by Branch personnel are listed below and the specific procedures for each analytical technique and field test are presented in Appendix D.

Analytical Parameter	Method	Reference	Equipment
Temperature	Calibrated glass (mercury), dial (mechanical), or electrometric thermometer	1	Mercury filled glass, mechanical dial type thermometer, or thermistor with electronic readout
pH	Electrometrically using a glass electrode in combination with a reference potential or a combination electrode	1	Portable field pH meter
Dissolved Oxygen (DO)	Modified Winkler or membrane electrode	1	Standard DO kit with fresh sodium thiosulfate, or membrane electrode and electronic readout
Specific Conductance	Wheatstone bridge type or equivalent meter corrected to 25$_0$C	1	Self-contained - conductivity meter, Wheatstone bridge type, or equivalent with automatic temperature compensation to 25$_0$C or "dial in" temperature compensation
Total Chlorine Residual	Back titration, iodometric with starch or amperometric end-point or DPD colorimetric	1	Iodometric backtitration kit with fresh reagents, or amperometric titrator with fresh reagents, or DPD kit with color standards
Tracer-Fluorescence	Analysis of fluorescent dyes using a fluorometer	2	Rhodamine WT dye and Turner fluorometer
Salinity	Electrodeless Inductive Conductivity Cell Salinometer	3	Beckman RS5-3 Portable Salinometer and Hydrolab Surveyor II Meter

6.3 SPECIFIC QUALITY CONTROL PROCEDURES

Quality assurance procedures for field analysis, and field analytical and test instrumentation calibration are an essential part of these standard operating procedures. All field analytical procedures shall be conducted in duplicate at least 10 percent of the time. A record of these duplicate analyses shall be kept in field logbooks. A significant difference in the replicate analyses (greater than specified in the following sections) shall result in recalibration of the instruments used, re-examination of the analytical methodology being used, or re-examination of the sampling location.

All field analyses must be traceable to the specific individual performing the analyses. Time records shall be kept in local time using the military 2400 hour format and shall be recorded to the minute. This information shall be entered into the field logbooks for all field analyses performed by Branch personnel.

A specific calibration and/or standardization plan for all field analytical equipment is presented in this subsection. Included in this plan are: calibration and maintenance intervals; listing of required calibration standards and conditions requiring recalibration.

6.3.1 Temperature

6.3.1.1 Initial Calibration -- All thermometers shall be initially calibrated against a National Bureau of Standards (NBS) certified thermometer or one traceable to NBS certification.

6.3.1.2 Inspection and Calibration -- Each glass mercury filled thermometer shall be inspected before each field trip to see that it is not cracked and has no air space in the mercury column. If a mechanical dial-type thermometer is used, it should not have a broken face cover or otherwise show damage. A cross-check with a calibrated NBS certified thermometer shall be made at least semi-annually. Thermistors and electronic readout units should be calibrated in the same manner. Recording thermometers shall be checked for recording accuracy before each use. The recorder time scale accuracy shall be checked semi-annually. Before using a thermometer in the field, a visual observation shall be made to assure that it has not been damaged. If a thermistor is used, the instrument shall be checked against a thermometer before field use. Cross-checks and duplicate field analyses should agree within $\pm 0.5^{o}C$.

6.3.1.3 Calibration Records -- A logbook shall be maintained with each thermometer number and/or equipment property number recorded. All calibration information including individuals making the calibrations and dates of calibration shall be recorded.

6.3.1.4 Reporting Units -- Report all temperature data to the nearest $0.5^{o}C$.

6.3.2 pH

6.3.2.1 Equipment -- Only electronic (portable) pH meters with automatic temperature compensation (ATC) should be used. Temperature resistant, combination electrodes should be employed in conjunction with the meters. pH test paper will be used only for determining pH ranges, for determining approximate pH values, or for concentrated hazardous waste samples which would damage the instrument.

6.3.2.2 Equipment Inspection and Calibration -- The pH meter shall be checked before each field trip for any mechanical or electrical failures, weak batteries, and cracked or fouled electrodes. The slope of the meter shall also be checked initially with three fresh standard buffer solutions (e.g., 4, 7, and 10). All pH recorders shall be checked for recording accuracy and time scale accuracy. While in the field, the meter shall be calibrated daily before use with two buffers bracketing the expected sample pH. Thereafter, the meter shall be checked against two buffers when moving to a new sample location. Fresh buffer solutions shall be used for each field trip. In case of an apparent pH violation, the electrode shall be checked with pH 7.0 buffer and recalibrated to the closest reference buffer. Then the sample shall be retested. Duplicate tests should agree within 0.1 standard unit.

6.3.2.3 Reporting Units -- Report pH to the nearest 0.1 standard unit.

6.3.3 Dissolved Oxygen (DO)

6.3.3.1 Equipment -- Modified Winkler kits and membrane electrode DO meters should be used.

6.3.3.2 Equipment Inspection and Calibration -- DO meters shall be checked before each field trip by inspecting the membrane for air bubbles and holes. If the membrane is dry, it shall be replaced and soaked in water before calibrating. Calibration should be made against the modified Winkler test.

DO kits shall be refilled with new standardized sodium thiosulfate before each field trip. Each solution shall be checked for clarity and volume.

Before using the DO meter each day, duplicate deionized or known clean water samples shall be collected by siphoning water from a bucket into two DO bottles. These duplicate samples shall be analyzed by the modified Winkler test for DO content. The DO meter shall be calibrated against the DO content measured by the Winkler test by placing the DO probe in the bucket containing the water used for the Winkler test.

While using the DO meter, the instrument shall be recalibrated at least twice per day or if a change in water quality is noted. If the sample temperature is 5°C greater than the calibration temperature, the meter shall also be recalibrated.

Duplicate analyses should agree with ± 0.1 mg/l.

6.3.3.3 Reporting Units -- Results for the DO test should be reported to the nearest 0.1 mg/l.

6.3.4 Specific Conductance

6.3.4.1 Equipment -- A portable specific conductance meter, Wheatstone bridge type or equivalent should be used.

6.3.4.2 Inspection and Calibration -- Each conductivity meter shall be checked before each field trip. Batteries shall be checked, and conductivity cells shall be cleaned and checked against known conductivity standards (KCl).

6.3.4.3 Field Calibration -- Before using in the field, check instrument daily with known standards. Refer to the instrument instructions for temperature conductance calculations. Duplicate field analyses should agree within ± 10 percent.

6.3.4.4 Reporting Units -- Results should be expressed in micromhos/centimeter (umhos/cm) corrected to 25°C. Results should be reported to the nearest ten units for readings under 1,000 umhos/cm and the nearest 100 units for readings over 1,000 umhos/cm.

6.3.5 Total Chlorine Residual

6.3.5.1 Equipment -- The iodimetric back titration method with a starch-iodide end point or amperometric end point or a Hach DR 100 colorimetric (DPD) kit may be used.

6.3.5.2 Inspection and Calibration -- Each titration kit or meter shall be checked before each field trip by inspecting the meter for battery strength and fresh reagents. The normality of the iodate should be checked with a distilled water blank to establish a correction factor for the titrant. This will also serve to check the response of the amperometric titrator. Duplicate chlorine residual analyses should agree within ± 0.01 mg/l.

If the Hach DR 100 colorimeter (DPD) kit is used, the method must agree with the requirements of Method 408E, "Standard Methods," 16th Edition, or Method 330.5 "Methods for Chemical Analysis of Water and Wastes," and calibration scales must be calibrated on site at a minimum of three points (blank and two standards) that bracket the expected sample concentration.

6.3.5.3 Reporting Units -- Results should be reported to the nearest 0.01 mg/l residual chlorine.

6.3.6 Fluorescent Tracing

6.3.6.1 Tracer -- Rhodamine WT dye is the standard tracer used by Branch personnel.

6.3.6.2 Fluorometer -- A filter fluorometer (fluorometer) is the instrument used to determine intensity of emitted light or concentration of dye in the sample.

6.3.6.3 Fluorometer Calibration and Calibration Standards -- Before a fluorometer is used in the field, it shall be checked against a set of standard dye solutions. All standard concentrations shall be made relative to the stated concentration of the manufacturer's solution.

All standard solutions shall be made with distilled water. Sufficient solution volumes shall be made to permit calibration checks. Calibration checks shall be conducted whenever the fluorometer has been turned off for an extended period of time.

The fluorometer and all associated equipment shall be thoroughly cleaned between uses.

6.3.6.4 Reporting Units -- Turner Design fluorometer results shall be reported as $\pm$ 1 percent of full scale concentration.

6.3.7 Salinity

6.3.7.1 Equipment -- A portable salinometer, electrical conductivity type shall be used.

6.3.7.2 Inspection and Calibration -- Each salinometer shall be checked before every field trip. Batteries shall be checked and the cell inspected to determine if it is free of marine growth and salt. The meter shall be checked against the resistor loop supplied with the meter.

6.3.7.3 Reporting Units -- Results should be reported to the nearest 0.1 part per thousand of salinity.

6.4 SEMI-ANNUAL MAINTENANCE

All analytical and test instruments and kits shall be inspected on a semi-annual basis, whether used during the intervening period or not. The purpose of the semi-annual inspection is to maintain the equipment in a ready-to-use condition. This inspection shall consist of a general examination of the electrical system (including batteries) and a calibration against standards. Any expired reagents, broken glassware, or parts shall be replaced.

6.5 SOURCES OF CHEMICALS AND STANDARDS

All chemicals used in test kits and with field analytical instruments as reagents and standards shall be supplied and standardized by the Analytical Support Branch (ASB). Certified pH buffer solutions shall be purchased from chemical supply houses. All reagents and solutions shall have expiration dates attached to the containers. All out-of-date reagents, buffers, and chemical solutions shall be properly disposed of at their expiration date. All field reagent containers shall be identified with the chemical name, concentration, and date prepared.

Tracer-fluorescence standards will be prepared for each study using the actual tracer as outlined in Appendix D.9.

6.6 TRAINING

Each member of the Branch involved in field studies shall undergo an initial review of field analytical and test procedures and equipment. After the initial review, subsequent reviews shall take place annually. The Branch Quality Assurance Officer, in conjunction with personnel from the ASB, shall conduct the instruction. Any new instrumentation adopted by the Branch will be introduced to Branch personnel in a training session before it will be authorized for routine use.

6.7 REFERENCES

1. "Guidelines for Establishing Test Procedures for the Analysis of Pollutants," Federal Register, Volume 49, No. 209, 40 CFR 136, October 26, 1984, and any subsequent revisions.

2. Wilson, J. F., Fluorometric Procedures for Dye Tracing: USGS Techniques of Water-Resources Investigations, Book 3, Chapter A12, United States Department of Interior, Geological Survey, 1968.

3. Standard Methods for the Examination of Water and Wastewater, 1985, 16th Edition.

4. Methods for Chemical Analysis of Water and Wastes, EPA, 600/4-79-020, and all current revisions.

METHOD D.4 DISSOLVED OXYGEN (MEMBRANE ELECTRODE)

D.4.1 Scope and Application

The membrane electrode (ME) probe method for DO measurements is recommended for those samples containing materials which interfere with the modified Winkler procedure as listed in Section D.3.1 of Method D.3.

The ME probe method may be used as a substitute for the modified Winkler procedure provided that the meter itself is standardized against the Winkler method on samples free of interferences.

D.4.2 Summary of Method

The most common ME instruments for determination of DO in water are dependent upon electrochemical reactions. Under steady-state conditions, the current or potential can be correlated with DO concentration. Interfacial dynamics at the ME-sample interface are a factor in probe response and a significant degree of interfacial turbulence is necessary. For precision performance, turbulence should be constant.

Refer to the manufacturer's instructions for calibrating and operating each specific DO meter.

D.4.3 Interferences

- Dissolved organic materials are not known to interfere in the output from DO probes.
- Dissolved inorganic salts are a factor in the performance of DO probes
- Reactive gases which pass through the ME probes may interfere. For example, chlorine will depolarize the cathode and cause a high probe output. Long-term exposures to chlorine will coat the anode with the chloride of the anode metal and eventually desensitize the probe. Hydrogen sulfide will interfere with ME probes if the applied potential is greater than the half-wave potential of the sulfide ion.
- Dissolved oxygen ME probes are temperature sensitive, and temperature compensation is normally provided by the manufacturer.

D.4.4 Apparatus

- YSI Model 57 DO Meter
- YSI 5700 Series DO Probe
- Hydrolab Surveyor II

D.4.5 Sample Handling

Refer to Appendix D.3.4 (Method D.3).

D.4.6 Calibration

1. Fill a clean bucket with uncontaminated or deionized water and place the ME probe into the bucket. Using the siphon method described in Section D.3.4.4 of Method D.3, fill duplicate BOD bottles and determine the DO by the Winkler method.

2. Adjust the meter according to manufacturer's instructions. Be sure to adjust the meter to the temperature of the water in the bucket, then calibrate the DO indicator dial to read the average DO concentration of the two samples determined by the Winkler test.

D.4.7 Test Procedure

1. When making measurements be sure that the ME stirring apparatus is working, adjust the temperature compensator, and read the DO dial to the nearest 0.1 mg/l.

2. Keep the probe in water when not in use to prevent the membrane from drying out.

3. If the sample temperature is 5°C greater than the calibration temperature, the meter should be recalibrated to the temperature of the sample.

4. Recalibrate against the Winkler test when the DO readings show a distinct change in DO levels, or when the probe has been in waters high in sulfide.

D.4.8 Precision and Accuracy

Manufacturer's specification claims 0.1 mg/l repeatability with ± 1 percent accuracy.

D.4.9 References

Standard Methods for the Examination of Water and Wastewater, 16th Edition p. 395, Method 421 F (1985).

Methods for Chemical Analysis of Water and Wastes, US-EPA, 360.1 (1983).

Instruction Manual YSI Model 57, Dissolved Oxygen Meter, Science Division, Yellow Springs Instrument Company.

Surveyor II Operating Manual, Hydrolab Corporation.

METHOD D.5 SPECIFIC CONDUCTANCE

D.5.1 Scope and Application

This method is applicable to ground, surface, and saline waters, as well as domestic and industrial wastes.

D.5.2 Summary of Method

- The specific conductance of a sample is measured by use of a self-contained conductivity meter, Whetstone bridge-type, or equivalent.
- Samples are preferably analyzed at 25°C. If not, temperature corrections are made and results reported at 25°C.

D.5.3 Test Procedure

1. Follow instructions manual for specific field conductivity meter used.
2. Check the meter with two standard solutions of approximate specific conductances of 100 and 1,000 umhos/cm, or standards that bracket the expected sample conductance. If the meter does not read within one percent of the standards, determine what the problem is and correct it before proceeding. Most field instruments read conductivity directly; with those instruments, follow the manufacturer's instructions. Report the results to the nearest ten units for readings under 1,000 umhos/cm and the nearest 100 units for readings over 1,000 umhos/cm.
3. Record the actual sample temperature when the measurement is made. The meter reading should be converted to specific conductance at 25°C using the information in the manufacturer's instruction manual.

5.4 Apparatus Section

- Beckman SoluBridge® Model RB-5/RB-6
- YSI Model 3530 Flow Through Cell
- Hydrolab Corporation Surveyor II

D.5.5 Precision and Accuracy

The conductivity meters listed above have an accuracy of ± 2 percent of reading. With satisfactory equipment, results within 1 percent of the true value should be obtained.

D.5.6 References

Standard Methods for the Examination of Water and Wastewater, 16th Edition, p. 76, Method 205 (1985).

Annual Book of ASTM Standards, Part 31, "Water," Standard D1125-64, P. 120.

Methods for Chemical Analysis of Water and Wastes, US-EPA, 120.1 (1983).

Instruction Manual, SoluBridge® RB-5/RB-6, Beckman Instruments, Inc., Rev. January 1982.

Surveyor II Operating Manual, Hydrolab Corporation, Rev. A February 1985.

YSI Model 3560 Water Quality Monitoring System Instructions, July, 1988.

Appendix D

BIOACCUMULATION MONITORING PROJECT STANDARD OPERATING PROCEDURES

Project Title:

Bioaccumulation Monitoring

QAP Number:

QAP-X-90-ES-065

Date Approved:

Section Head

10/23/92
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Program Manager

10-22-92
J. M. Loar

Principal Investigator

10/12/92
G. R. Southworth

ESD QA Specialist

10/14/92
L. E. Roberson

BMAP QA Coordinator

10-12-92
M. L. Frank

SUBJECT: USING CAGED ASIATIC CLAMS AS A BIOACCUMULATION MONITOR

Purpose

To use caged Asiatic clams (*Corbicula fluminea*) in streams to (1) gain insight as to the degree of organic contaminant exposure to resident biota, and (2) identify possible sources of these contaminants.

Scope

This procedure applies to all uses of caged clams as monitors of contamination in (1) BMAPs and other biological monitoring programs at the three DOE facilities in Oak Ridge and (2) biological monitoring programs at DOE facilities in Oak Ridge; Paducah, Kentucky; Portsmouth, Ohio; and Kansas City, Missouri.

References

BMAP Bioaccumulation Monitoring Project (SOP-5)

Equipment

Fish dip nets (maximum 1/4 in. mesh)
5-gallon buckets
Hip boots or chest waders
Polypropylene cages (1 per site monitored)
Methylene chloride
Liquinox (laboratory detergent)
Indelible marker
Plastic bags
Ice
Gloves
Brush
Identification tags
Aluminum wire
Scissors
Regulated area tape
Radioactive material tape
Cooler with lock
Heavy-duty aluminum foil
Freezer
Data collection forms
Chain-of-custody forms
Registered bioaccumulation logbook
String (nylon or other strong material)

SUBJECT: USING CAGED ASIATIC CLAMS AS A BIOACCUMULATION MONITOR

Procedures

1. Collect clams to be used from a stream known to be uncontaminated (clams must contain low to undetectable levels of organic contaminants). Use the buddy system and bring a two-way radio when performing field sampling. Collect clams as follows.

    a. Put on hip boots or chest waders to collect clams from the stream.

    b. Fill two buckets about 1/4-full of stream water.

    c. Set fish dip net on the stream bottom and kick the bottom substrate immediately upstream of the net. Lift net from the water, pick clams from the sediment, and deposit clams into buckets.

    d. Where clams are abundant in clear and shallow water, pick clams from the stream bottom by hand and deposit into buckets.

    e. Repeat sampling until desired number of clams is collected (approximately 50 clams /site to be monitored).

    f. Keep only clams of a size containing at least 0.5 grams of soft tissue (approximately 1.6 cm in length).

    g. Measure temperature of stream, and record in logbook according to step 4.

    h. After collection, transport clams in the buckets with water to the laboratory. Place the clams in a tank with flowing dechlorinated process water for 24 h at a temperature that is ±5°C of the temperature at the collection site.

2. Deposition of clams into selected monitoring sites involves the following steps.

    a. Wash polypropylene cages with Liquinox and rinse thoroughly in lab. Allow to air dry.

    b. Attach by wire a unique 4-digit tag to each polypropylene cage.

    c. Divide clams among the polypropylene cages so that each cage holds approximately 50 clams.

    d. To assure that the clams will be contained within the cages, seal the cage closed with plastic closures.

    e. Set each cage into a bucket that is 1/4 full of water from the holding tank.

f. Transport promptly to field sites.

g. Put on hip boots or chest waders, and gloves.

h. At each site, use string to tie the cage containing clams to a secure object in the stream in such a way that will allow the clams to remain submerged, yet suspended above the bottom sediment, despite normal fluctuations in streamflow.

i. Leave clams for 28 days.

3. Retrieval of clams from stream monitoring sites involves the following steps.

a. Put on hip boots or chest waders, and gloves.

b. Remove cage from stream, cut the string with scissors, and gently brush and rinse clams in stream water.

c. Wrap clams in aluminum foil and label the foil package as to the site, date, sample type, and cage tag number with an indelible marker.

d. Place foil packages in a cooler with ice while other sites are visited. After all cages have been collected, lock the cooler and transport samples to the laboratory.

e. At the laboratory, lock clam packages in a freezer until processing.

f. Additional steps are required for handling samples from Radiological Areas.

1. Wear C-Area (yellow) coveralls in addition to waders and gloves.

2. Place packaged clams from Radiological Areas in a separate ice chest that is clearly marked with Radioactive Material Tape.

3. Place waders, gloves, and polypropylene cages in a plastic bag at the point of departure from Radiological Area. Place coveralls in a separate plastic bag.

4. Survey the cooler and equipment (waders, etc.) for contamination before returning to laboratory. Also have the coveralls checked and tagged prior to delivery to laundry (See QA-BMAP-19-200).

5. At the laboratory, lock clam packages in a freezer storage compartment designated for radioactive samples.

SUBJECT: USING CAGED ASIATIC CLAMS AS A BIOACCUMULATION MONITOR

4. Record field data as specified in section SOP-5. A stepwise summation of necessary record keeping for clam monitoring follows.

   a. Immediately after conducting the initial collection of clams, record the site, date, beginning and ending collection time, species collected, and the names of the collectors and field custodian on the data collection forms (Attachment 2). Tape the data collection forms onto the 5-gallon buckets containing clams.

   b. Also at the site, record all field data on the chain-of-custody form (Attachment 3) and in the registered bioaccumulation logbook.

   c. At the time of cage placement into the stream to be monitored, record pertinent field data such as site, date, time, and cage tag number in the registered bioaccumulation logbook.

   d. At the time of cage removal from monitoring site, record the site, date, time, names of collectors, and cage tag number in the registered bioaccumulation logbook, on the chain-of-custody form, and on a data collection form. Tape the data collection form onto the cooler when transporting samples.

Results

Results are groups of clams that, after processing (Procedure SOP-2) and chemical analysis at ORNL Analytical Chemistry Division, will yield data on contaminant levels in clams accumulated at specific sites and times. Data will eventually be tabulated, analyzed, and reported in BMAP Annual Reports.

Approvals

PRINCIPAL INVESTIGATOR [signature] DATE 10/12/92

SUBJECT: **PROCESSING OF ASIATIC CLAMS**

Purpose

To prepare Asiatic Clams tissue samples for organic contaminant analyses.

Scope

This procedure applies to all uses of caged clams as monitors of contamination in (1) BMAPs and other biological monitoring programs at the three DOE facilities in Oak Ridge and (2) biological monitoring programs at DOE facilities in Oak Ridge; Paducah, Kentucky; Portsmouth, Ohio; and Kansas City, Missouri.

References

BMAP Bioaccumulation Monitoring Project (SOP-5)
Martin Marietta Energy Systems, Inc., ORNL Health Physics Manual, Procedures RP 5.1, RP 2.5

Equipment

20 ml pre-washed (I Chem, AVID No. 226-0020) glass vials with teflon lined caps
Knife
Liquinox
Forceps
Disposable gloves
Photo tray
Lab coat
Safety glasses
Indelible marker
Plastic bags
Blotter paper
Regulated area tape
Analytical balance
Freezer
Chain-of-custody form
Registered bioaccumulation logbook
Beta gamma radiation survey meter
Radioactive material labels
Radiological survey registered logbook

SUBJECT: PROCESSING OF ASIATIC CLAMS

Procedures

1. Processing clams involves the following steps.

   a. Use pre-washed 20 ml glass vials and caps (available through AVID stores, select I-Chem or equivalent from another supplier.)

   b. Label a vial with sample number (corresponding to cage tag number) and analysis to be performed with an indelible marker. Place vial on balance and push the tare key.

   c. Remove a clam package (representing one site) from freezer and allow clams to thaw slightly.

   d. Pry open clams with knife and remove frozen soft tissue with forceps. Carry out work on heavy-duty aluminum foil.

   e. Place clam tissue in 20 ml glass vial on balance. Process enough clams to obtain a 5-10 gram composite sample (5 grams for PCB analysis, 10 grams for organics).

   f. Prepare additional sample vials such that 2 samples are made for each analysis to be performed. Label vials accordingly to distinguish between duplicate samples. Example: Sample 1111A vs Sample 1111B (duplicate samples from Cage 1111).

   g. Place sample vials in freezer pending delivery to ORNL Analytical Chemistry Division.

   h. Wipe knife and forceps with a paper towel, then wash with Liquinox and rinse in tap water. Remove another clam package and repeat above steps until all sites are processed.

2. The following additional steps are required for processing clams from Contamination Areas.

   a. Before proceeding, survey the clams to determine if they must be treated as radioactive materials. (ORNL Health Physics Manual, Procedure RP 5.1). If clams are non-contaminated according to criteria provided by Health Physics, proceed as above. If clams are determined to be radioactive material, proceed with steps b through h. Record results of survey in radiological survey registered logbook.

   b. Carry out work on a large sheet of aluminum foil placed over blotter paper covering a table within a temporary Regulated Area. Follow procedures for setting up, working in, exiting, and decommissioning the temporary Regulated Area; as described in ORNL Health Physics Manual Procedure RP 2.5.

c. Wear a lab coat, safety glasses, and disposable plastic gloves. Tools and implements (knife, forceps, etc.) should be designated for use only on contaminated samples and stored in a separate, labeled container.

d. After soft tissue is removed from the clams, place the shells in a plastic bag labelled "Biological Radioactive Waste". Label vials containing clams as "Radioactive Material".

e. Place vials containing samples in a bag, box, or foil envelope labeled as radioactive material and store in a Radiological Area portion of freezer.

f. Place paper towels, blotter paper, foil, and gloves in a plastic bag labeled "Compactible Radioactive Waste". Survey the contents of the bag upon completion using a β- survey meter to determine if they are contaminated, as described in ORNL Health Physics Manual Procedure RP 5.1. If the contents are not contaminated, dispose of as normal waste. Otherwise, leave the plastic bag open and allow contents to dry before closing. Label the bag with the name of the waste generator and the isotopes present, and place in can labeled "Compactible Radioactive Waste".

g. Contact Health Physics to survey samples to be sent to Analytical Chemistry Division, to tag Biological Radioactive Waste bag, and to survey temporary contamination zone prior to removing warning labels.

h. Contact Waste Management to pick up Biological Radioactive Waste bag for disposal.

3. Record processing data as specified in Procedure SOP-5. Following is a brief summation of necessary record keeping for clam processing.

   a. Record processing data immediately into the registered bioaccumulation logbook. Include beginning and ending times, sites, sample numbers, species, and analyses to be done. Sign and date entry.

   b. Record the species, sample numbers, and analyses to be done onto the chain-of-custody form.

SUBJECT: **PROCESSING OF ASIATIC CLAMS**

Results

Results are groups of clams that, after chemical analysis at ORNL Analytical Chemistry Division, will yield data on levels of contaminants accumulated in clams at specific sites and times. Data will eventually be tabulated, analyzed, and reported in various ORNL/TM and other reports.

Approvals

PRINCIPAL INVESTIGATOR ________________ DATE 10/12/92

Appendix E

FIELD INSTRUMENT MAINTENANCE RECORD FORM

Photoionization Detector

Make: ______________

Serial #: ______________

Property #: ______________

Preventative Maintenance

The PID's performance is affected by a number of factors. These include the decay of the UV lamp output and the accumulation of dust and other material on the lamp and in the ion chamber. Because of these factors, PID's should not be left in the field for a period of more than a month before being serviced or replaced with a fresh instrument. All monitoring instruments are to be returned to the FPC Equipment Service Center (Fairfax, VA) or the Regional Field Equipment Manager when monthly calibration orother servicing is required.

The following procedures are to be performed for routine preventative maintenance. Procedure details can be found in the "CDM Field Equipment Operation, Maintenance and Calibration" report, or in equipment manuals.

Procedure	*Frequency*
Operational Check	Prior to use and at instrument return
Calibration Check	Prior to use and at instrument return
Calibration	Monthly or following lamp and ion chamber cleaning, or lamp replacement
Clean UV Lamp and Ion Chamber	Monthly, or as needed
Replace UV Lamp	As needed
Factory Maintenance	Yearly

Date	*Name*	*Procedure Performed and Comments*

Radiation Meter

Make: ______________________
Serial #: ______________________
Property #: ______________________

Preventative Maintenance

The meter's performance is generally stable over time. However, the instrument's probes contain delicate components which can be easily broken and are expensive to replace. Typical maintenance includes keeping the instrument clean, checking the batteries, and semiannual calibration. The radiation meters are not to be left on a site unattended or left on a site in use for more than a month at a time. If the instrument is to be stored for more than a month without being used, the batteries are to be removed. All monitoring instruments are to be returned to the FPC Equipment Service Center (Fairfax, VA) or Regional Field Equipment Manager when monthly calibration or other servicing is required.

The following procedures are to be performed for routine preventative maintenance. Procedure details can be found in the "CDM Field Equipment Operation, Maintenance and Calibration" report, or in equipment manuals.

Procedure	*Frequency*
Calibration	Semiannually
Battery Replacement	Quarterly

Date	*Name*	*Procedure Performed and Comments*

Conductivity Meter

Make: ____________________
Serial #: ____________________
Property #: ____________________

Preventative Maintenance

The meter's most vulnerable piece is the glass probe. Care should be employed that it is not broken, scratched, or allowed to dry out. When the electrode is not in use, it should either be soaking in a buffer solution or distilled water, or covered with its rubber cap. Should the instrument become erratic in its performance, it is to be returned for service. All monitoring instruments are to be returned to the FPC Equipment Service Center (Fairfax, VA) or Regional Field Equipment Manager when monthly calibrationor other servicing is required.

The following procedures are to be performed for routine preventative maintenance. Procedure details can be found in the "CDM Field Equipment Operation, Maintenance and Calibration" report, or in equipment manuals.

Procedure	*Frequency*
Inspect electrode for integrity	Before each use
Electrode cleaning	Weekly
Battery replacement	As needed
Calibration	Monthly

Date	*Name*	*Procedure Performed and Comments*

pH Meter

Make: ______________________
Serial #: ______________________
Property #: ______________________

Preventative Maintenance

The ph meter's most vulnerable piece is the glass probe. Care should be employed that it is not broken, scratched, or allowed to dry out. When the electrode is not in use, it should either be soaking in a buffer solution or distilled water, or covered with its rubber cap. Should the instrument become erratic in its performance, it is to be returned for service. All monitoring instruments are to be returned to the FPC Equipment Service Center (Fairfax, VA) or Regional Field Equipment Manager when monthly calibration or other servicing is required.

The following procedures are to be performed for routine preventative maintenance. Procedure details can be found in the "CDM Field Equipment Operation, Maintenance and Calibration" report, or in equipment manuals.

Procedure	*Frequency*
Inspect electrode for integrity	Before each use
Electrode cleaning	Weekly
New electrode chamber solution	Weekly
Battery replacement	As needed

Date	*Name*	*Procedure Performed and Comments*

DISTRIBUTION

1. D. T. Bell
2. V. J. Brumback
3. R. L. Carlson, Radian
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48–57. S. L. Lankford, DOE Oak Ridge Operations Office, P.O. Box 2001, Oak Ridge, TN 37831-8541

58. Duncan Moss, Science Applications International Corporation, 800 Oak Ridge Turnpike, Oak Ridge, TN 37831

59–60. R. L. Nace, Branch Chief, Nonenrichment Facilities, Oak Ridge Program Division, Office of Eastern Area Programs, Office of Environmental Restoration, EM-423, Trevion 2, U.S. Department of Energy, Washington, DC 20585

61. R. C. Sleeman, DOE Oak Ridge Operations Office, P.O. Box 2001, Oak Ridge, TN 37831-8541
62. D. W. Swindle, Radian Corporation, 120 South Jefferson Circle, Oak Ridge, TN 37830

63–64. H. M. Thron, Chief, Enrichment Facilities, Oak Ridge Program Division, Office of Eastern Area Programs, Office of Environmental Restoration, EM-423, Trevion 2, U.S. Department of Energy, Washington, DC 20585

65. R. L. Carlson, Radian Corporation, 120 South Jefferson Circle, Oak Ridge, TN 37830

DATE

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12/27/93

END