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ENVIRONMENTAL TECHNOLOGY SECTION (FORMERLY POLLUTANT ASSESSMENTS GROUP)

PROCEDURES MANUAL

VOLUME II: HEALTH AND SAFETY AND TECHNICAL PROCEDURES

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ORNL-6645/V2/R2

Health Sciences Research Division

ENVIRONMENTAL TECHNOLOGY SECTION (FORMERLY POLLUTANT ASSESSMENTS GROUP) PROCEDURES MANUAL VOLUME II: HEALTH AND SAFETY AND TECHNICAL PROCEDURES

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PREFACE

This manual describes procedures currently in use by the Environmental Technology Section, formerly the Pollutant Assessments Group. During the course of this revision of the manual, the group was changed into a section of the Health Sciences Research Division, formerly the Health and Safety Research Division. Newly revised procedures will reflect this change. Procedures that have not been revised since this manual was originally published will continue to carry the Pollutant Assessments Group designation.

The manual is divided into two volumes: Volume 1 includes administrative and support procedures, and Volume 2 includes health and safety and technical procedures. The health and safety procedures are being incorporated into this manual from *Health and Safety Procedures for Hazardous Waste Sites*, ORNL-6605.

All procedures are revised in an ongoing process to incorporate new developments in hazardous waste assessment technology and changes in administrative policy and support procedures. Format inconsistencies will be corrected in subsequent revisions of individual procedures.

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PREPARING A SITE-SPECIFIC HEALTH AND SAFETY PLAN

1.0 PURPOSE

The purpose of this procedure is to define the elements necessary to develop a site-specific health and safety plan to be used during the investigation of a site containing potentially hazardous waste.

2.0 APPLICABILITY

This procedure applies to the writing of health and safety plans that identify known or suspected site hazards, health effects, protective measures, and monitoring methods and procedures involving personnel at an investigation site.

3.0 OTHER DOCUMENTS

3.1 REFERENCES

3.1.1 29 CFR 1910.120
3.1.2 Procedure HS-080, Emergency Response Guidelines.
3.1.3 *Radiological Control Manual.* DOE/EH-0256T. U.S. Department of Energy.

3.2 APPENDICES

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4.0 EQUIPMENT AND MATERIALS

4.1 Site-Specific Information form
4.2 Health and Safety Checklist form

APPROVALS	
Author	Date
Supervisor J.E. Thate	Date 8/6/93
Group Leader	Date
Section Head Gail Little	Date 8/6/93

5.0 RESPONSIBILITY

5.1 The ORNL site safety and health officer (SSHO) is responsible for preparing the site health and safety plan from all appropriate information, including data from the site assessment.

5.2 The SSHO, chemical projects manager, site project manager (SPM), quality assurance coordinator, and all other personnel assigned to the site are responsible for determining the effectiveness of the plan.

5.3 The ORNL Hazardous Waste Operations and Emergency Response (HAZWOPER) program coordinator and, if necessary, the client's industrial hygiene and health physics personnel are responsible for reviewing all site health and safety plans prior to site activities.

6.0 DEFINITIONS

6.1 **Level of Protection:** the level of protective clothing that is required by the Occupational Safety and Health Administration (OSHA) when working at a hazardous waste site.

7.0 PROCEDURE

7.1 Prepare a plan for each hazardous waste site investigation as detailed in OSHA regulations 29 CFR 1910.120.

7.2 Prepare a facility description using the Site-Specific Information form, Appendix 1.

7.3 Describe known hazards by identifying the following:

7.3.1 physical hazards:

a. extreme temperatures,
b. industrial noise,
c. electrical supplies or equipment,
d. heavy equipment,
e. decontamination equipment;

7.3.2 potential chemical contaminants;

7.3.3 potential radiological contaminants.

7.4 List the key personnel and their alternates responsible for site safety, for protection of public health, and for emergency response.

7.4.1 Use the Emergency Information form, Appendix 3.

7.5 Delineate work areas, including the exclusion zone, the contamination reduction zone, and the support zone.

7.6 Develop designated levels of protection, with potential for upgrades.

7.6.1 Select the level of personal protective equipment (PPE) once the hazards of the site have been identified.

7.7 Establish procedures for access control of the investigation site, including the following:

7.7.1 document all site personnel and visitors in the SSHO's field logbook;

7.7.2 verify that all personnel, including subcontracted personnel and visitors, meet all ORNL and client safety training requirements;

7.7.3 conduct daily safety audits and record observations on the Health and Safety Checklist form (Appendix 2) and/or in the field logbook;

7.7.4 ensure that all visitors are aware of the safety precautions in effect and the PPE required during the visit;

a. Pre-arrange visits with the site point-of-contact or the (SPM) prior to entry.

b. Ensure that all site personnel including visitors undergo decontamination procedures before leaving the site.

7.7.5 conduct outdoor activities only during daylight and indoor work during normal plant operating hours.

7.8 Describe decontamination procedures for personnel and equipment.

7.9 Establish site emergency procedures.

7.9.1 Establish an emergency contact list. See Appendix 3.

7.9.2 Document an emergency route to the nearest hospital.

7.9.3 Establish emergency response guidelines in accordance with Procedure HS-080.

7.10 Determine the types of hazardous incidents that may occur and develop a plan for medical care of injuries and exposures.

7.11 Determine the requirements for an environmental surveillance program including:

7.11.1 air monitoring,

7.11.2 hearing protection,

7.11.3 respiratory protection,

7.11.4 a medical surveillance program.

a. Follow the guidelines in OSHA regulation 29 CFR 1910.120.

7.12 Identify the personnel training necessary to perform all tasks, including the following:

7.12.1 Ensure that all employees are adequately trained as detailed in OSHA regulation 29 CFR 1910.120 and the Department of Energy *Radiological Control Manual.*

7.12.2 Include in the plan the Documentation of Hazardous Site Training form (Appendix 4), which must be completed and signed by all site personnel and subcontractors stating that they have read and completely understand the site health and safety plan.

7.13 Establish procedures for protecting workers from weather-related problems at the site.

7.14 Describe procedures for entering confined spaces.

7.15 Include standard safe work practices for the investigation site. See Appendix 5.

Appendix 1. Site-Specific Information

SITE-SPECIFIC INFORMATION				
Site:				
Objectives:				
Proposed Date of Investigation:				
Background Review	Complete	Preliminary		
Documentation/Summary (Overall Hazard)				
Serious	Moderate	Low	Unknown:	
FACILITY DESCRIPTION				
Waste Types				
Liquid	Solid	Sludge	Gas	
Characteristics				
Corrosive	Ignitable	Radioactive	Volatile	
Toxic	Reactive	Unknown		
Sources:				
Minimum Level of Personal Protection	D	C	B	A
Personal Protective Equipment:				
Site Activities:				
Preliminary Site Evaluation:				
Physical Hazards:				
Personnel Requirements:				
General Site Information:				
Location and Size of Site:				
Duration of Activity:				
Site Topography:				
Site Accessibility:				
Pathways of dispersion:				

Appendix 2. Health and Safety Checklist

HEALTH AND SAFETY CHECKLIST

Date _____ Time _____ Project _____ Subcontractor(s) _____

Technicians Name _____ Site Location _____

ITEM	NA*	NC*	YES	NO	COMMENTS
Hard hats and safety glasses worn					
Leather/safety shoes worn					
All workers trained					
Dosimeters worn					
Safety equipment issued					
Work area restrictions followed					
First aid kit available					
Fire extinguisher available					
Rad survey frisking adequate					
Decon equipment available					
Proper decon operations					
Proper use of protective equipment					
Proper use of respirators					
Traffic restrictions observed					
Dust control appropriate					
Proper haulage techniques observed					
Vehicles in good operating condition					
Equipment storage adequate					
AC/heat in safe operating condition					
Noise below safe levels					
Vibration estimated to be safe					
Lighting adequate					
Housekeeping appropriate					
Safety precautions for public					
Walkways clear of obstructions					
Signs and safety posters adequate					
Hazardous material storage adequate					
Emergency exits adequate					
Fire hazards marked and guarded					
Break areas in safe locations					
Falling objects secured					
Stress factors recognized					
Electrical safeguards in place					
Machinery safeguards in place					
Burning permits secured					
Stop work order recommended					
**Work records submitted					
** Personnel monitors returned					
Unrestricted site access approved					
Confined space permit					
Other					

*NA = Not applicable
*NC = Not checked
YES = Proper safety compliance
NO = Corrective action required
**Required at end of job

Distribution: Project Manager
Health & Safety Officer

For Corrective Action: Project Manager
Subcontractor Supervisor

_____
Project Manager Date

_____
Subcontract Supervisor Date

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Appendix 3. Emergency Information

Contact	Person or Agency	Work Telephone Numbers
Police		
Fire		
Ambulance		
Hospital		
Poison Control		
ORNL Site Project Manager		
ORNL Chemical Program Manager		
ORNL Safety Coordinator		

LOCATION OF SITE RESOURCES

Water Supply: _____

Telephone: _____

Toilet Facilities: _____

EMERGENCY ROUTE TO HOSPITAL

Appendix 4. Documentation of Hazardous Site Training

DOCUMENTATION OF HAZARDOUS SITE TRAINING

NAME: _____ SSN: _____-_____-_____

COMPANY: _____ EMPLOYEE #: _____

JOB TITLE: _____ PROJECT: _____

☐ Identification of individuals responsible for site health and safety.

☐ I have read and understand the site health and safety plan and agree to perform work in accordance with this plan.

☐ I have reviewed the site emergency procedures including alarms, communication, evacuation routes, assembly areas, and know the site action levels and "stop work" policy.

☐ I know the site medical surveillance requirements, location of medical/first aid facilities, and policy for reporting injuries or emergencies. Site emergency response number _____.

☐ I understand the hazard communication for hazardous materials present at the site, including the type, form, and location of such materials and the locations of MSDS files.

☐ Site tour with identification of hazards, fire extinguishers, emergency and personal protective equipment, decontamination and monitoring stations, potable water and sanitation facilities.

☐ I have completed the OSHA 40 hour hazardous materials training course.

☐ I hold current certification in OSHA 8 hour annual refresher training.

☐ I hold current certification in OSHA 8 hour supervisory training.

☐ I hold current certification in cardiopulmonary resuscitation (CPR).

☐ I hold current certification in first aid.

_____	___/___/___	_____	___/___/___
Trainee Signature	Date	SSO Signature	Date

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Appendix 5. Standard Safe Work Practices

1. Wear designated personal protective equipment at all times while working in exclusion and decontamination areas.

2. Do not eat, drink, chew gum or tobacco, smoke, or apply cosmetics in contaminated or potentially contaminated areas or where the possibility of transferring contamination exists.

3. Avoid contact with potentially contaminated substances. Do not walk through puddles, pools, mud, etc. Avoid, whenever possible, kneeling, leaning, or sitting on equipment or on the ground. Do not place monitoring equipment on a potentially contaminated surface.

4. Prevent spills. If a spill occurs, contain the liquid, if possible, and notify the SPM.

5. Prevent splashing of hazardous materials.

6. Be prepared for potentially dangerous situations (e.g., strong, irritating, or nauseating odors), and immediately take measures to ensure everyone's safety if these situations arise.

7. Practice good housekeeping; keep all equipment and materials orderly and out of potentially harmful situations.

8. Be familiar with the physical characteristics of the investigation site, including;

   a. the nearest emergency assistance;

   b. wind direction in the area;

   c. access to associates, equipment, and vehicles;

   d. communication facilities at and near the site;

   e. hot zones (area of known or suspected contamination);

   f. site access and egress;

   g. the nearest water sources for additional emergency eye washes and showers.

9. Minimize the number of personnel and equipment in the contaminated area but only to the extent consistent with work-force safety requirements.

Appendix 5 (continued)

10. Dispose of all waste generated during ORNL and/or subcontractor activities at the site as directed by the client.

11. Report all injuries immediately, no matter how minor, to the ORNL Grand Junction office.

12. Do not wear loose clothing and jewelry while working with or near drilling and auguring equipment.

13. Tie long hair to keep it out of machinery or from catching on fire.

EMERGENCY PLANNING AND RESPONSE

1.0 PURPOSE

This procedure defines the activities necessary for contingency and emergency planning and for emergency response during field work.

2.0 APPLICABILITY

This procedure applies to pre-work contingency and emergency planning and emergency response while work is in progress at sites with potential hazards.

3.0 OTHER DOCUMENTS

3.1 APPENDICES

3.1.1 Appendix 1: Incident Response Form

4.0 EQUIPMENT AND MATERIALS

4.1 Health and safety logbook
4.2 Incident Response forms

5.0 RESPONSIBILITY

5.1 The site safety and health officer (SSHO) is responsible for following this procedure and for implementing emergency response activities at the work site with the full support of all other ORNL personnel present at the site.

6.0 DEFINITIONS

6.1 **Dose-Response relationships:** toxicity effects that are a function of: 1) a specific chemical agent, 2) synergistic effects with other chemical agents, 3) dose, 4) route of exposure, and 5) individual susceptibility.

APPROVALS	
Author	Date
Supervisor J.E. Thate	Date 8/6/93
Group Leader	Date
Section Head Cai Little	Date 8/6/93

7.0 PROCEDURE

7.1 Prepare a contingency plan that includes the following elements:

7.1.1 Notify all workers on site in the event of an emergency requiring evacuation of the site.

a. Evacuate by way of prescribed routes delineated in the site-specific health and safety plan.

7.1.2 Stop or delay work when non-routine occurrences cause hazardous working conditions.

a. Record any such halt or delay in the health and safety logbook.

Note: Any person on an investigation project may halt operations if hazardous conditions are apparent or suspected.

b. Initiate a modified work schedule if it is mutually agreeable to ORNL representatives and subcontractor personnel.

7.2 Plan for emergencies by specifying emergency medical services and preparing for on-site first aid.

7.2.1 Prior to on-site activities, contact nearby health facilities to determine their capabilities in relation to potential site-specific injuries and exposures.

a. Evaluate the following criteria:

1. emergency physician coverage,
2. decontamination capabilities,
3. available medical specialists.

b. Notify off-site emergency response facilities of potential site-specific, hazardous situations.

7.2.2 Provide an industrial first-aid kit at the work site.

a. Check the contents of the kit daily and restock as necessary.

7.2.3 Provide other first-aid equipment if the maximum off-site emergency medical response arrival time is 6 min or more:

a. surgical gloves,

b. CPR and medical masks,
c. backboard and straps,
d. ice packs,
e. thermometer,
f. activated charcoal,
g. syrup of Ipecac,
h. splints
i. cervical collar
j. bandaging materials.

7.2.4 Ensure that at least one person qualified to perform first aid is present on site or is immediately available to the site at all times during work activity.

a. Ensure that the SSHO and one field technician are trained in CPR and first aid if emergency medical facilities are not within a 6-min response time of the work site.

b. In the event of serious injury, provide aid to victims only in accordance with first aid/CPR training.

c. Call for emergency evacuation to the nearest hospital if needed.

7.2.5 Provide for a vehicle to be available at all times for use in transporting personnel to the hospital if injuries are determined to be minor.

a. Establish transportation routes to area hospitals prior to on-site activity.

7.3 Characterize potential hazardous material exposures at the site.

Note: Target levels correspond to Occupational Safety and Health Administration (OSHA) permissible exposure limits (PELs), which are concentrations or doses for an 8-h day, 40-h week below which no hazardous effect is observed.

7.3.1 Include in the site health and safety plan an evaluation of dose-response relationships.

a. Identify each contaminant.
b. Determine concentrations of each contaminant.
c. Evaluate potential routes of exposure.
d. Review the health status of each field worker.

7.3.2 Recommend conservative personnel protection if toxicological and contaminant migration information is unavailable.

7.4 Include the following elements in emergency response when on site:

7.4.1 Notify all personnel of known or suspected hazardous exposure levels (inhalation, skin, and ingestion).

Note: It is the responsibility of anyone on the site to also make this notification if experiencing and/or suspecting adverse health conditions.

7.4.2 Contact regional emergency response help if any unplanned situation requiring outside or support services occurs.

a. Include a prioritized list of contacts in the site safety plan.

7.4.3 Halt all work immediately if a field crew member is injured or experiences symptoms of exposure.

a. Follow the directions of the SSHO or SPM.

b. Only qualified personnel should perform emergency rescues.

7.4.4 Evacuate all personnel not wearing appropriate protective gear and move a minimum of 50 ft upwind if the following conditions occur:

a. if monitoring organic vapors using a photoionization detector (PID) and concentrations exceed prescribed health and safety action limits above background levels at the breathing zone,

b. if the combustible gas indicator (CGI) alarms,

c. if radiation limits are reached or exceeded.

7.4.5 Monitor the surrounding area first and then the borehole and breathing zone again following a reasonable period.

a. If levels have not subsided, evaluate the work plan and modify all pertinent health and safety protocols.

b. If levels have subsided, begin work activities again.

7.4.6 Evacuate the field team and notify and/or evacuate non-site personnel or members of the public if any condition is discovered that appears more hazardous than anticipated.

a. Notify the facility supervisor or local emergency response personnel.

b. Provide name, title, phone number, location, and nature of the situation to the emergency response provider.

c. Administer first aid and remove injured persons if necessary.

d. Extinguish flames and/or contain spills.

e. Remain at the scene, upwind and at a safe distance, to direct emergency personnel and provide information.

f. Follow appropriate ORNL reporting procedures and complete an Incident Response Form (Appendix 1).

g. Take follow-up actions to mitigate the situation causing the accident and report, within 24 h, any injuries involving five or more people and/or a death to the ORNL health and safety office and the OSHA representative in the immediate area.

h. Reevaluate the hazard and level of protection required.

7.4.7 Use site entrance and/or exit routes as emergency escape routes if these are located upwind or a safe distance beyond the contact of the contamination reduction zone and the exclusion zone from the hazardous source.

7.4.8 Maintain visual contact until everyone has safely evacuated the hazardous areas, with the field crew remaining to assist each other in case of emergencies.

Appendix 1. Incident Response Form

ACTION LEVEL INCIDENT RESPONSE FORM

_____
Employee

I. BEFORE RESPONSE

1. Incident: Site_____ City_____ State_____
   a. Response Dates _____
2. Type of Response: Spill_____Fire_____ Site_____Train_____ Other_____
3. Incident Safety Plan: Region _____ Not Developed _____
4. Suspected chemical(s) involved: (a) _____ (b) _____
   (c) _____ (d) _____
5. Protective Level(s) involved: A_____ B_____ C_____ D_____
   (a) If Level C - 1. Identify Canister _____
   2. Describe air monitoring source(s) _____
   (b) If Level D JUSTIFY (in comments section at bottom of page).
6. SCBA - Identify Buddy: Name/Organization _____
7. Last Response: (a) Level Used: A_____ B_____ C_____ D_____
   (b) Medical Attention/Exam Performed: Yes____ No_____

II. AFTER RESPONSE

1. Protective Level Used: A_____ B_____ C_____ D_____
   a. Level C - identify canister:_____b. Level D (Comment Below)
   c. Level B or C skin protection: Tyvek/Saran __ Acid/Rain____ Other_____
2. List analysis chemical exposure: Same as above: _____(a)_____
   (b) _____ (c)_____ Unconfirmed_____
3. Equipment Decontamination: (a) clothing (b) respirator (c) monitoring
   Disposed: _____ _____ _____
   Cleaned: _____ _____ _____
   No Action: _____ _____ _____
4. Approximate time in exclusion area: _____ hours per day for _____ days
5. Was medical attention/exam required for this response: Yes____ No_____

Part I: Date Prepared: _____ Prepared By_____

Part II: Post Analysis Date Preparation: _____ Reviewed By _____

COMMENTS: _____
_____
_____
_____

UCN-18975
(3 8/92)

MOBILE GAMMA SCANNING VAN

1.0 PURPOSE

This procedure explains in detail the operation of the mobile gamma scanning van and documentation of data generated by it.

2.0 APPLICABILITY

A mobile gamma scanning van is used to survey large outdoor areas for gamma radiation anomalies. A mobile scan can identify areas of potential radioactive contamination to be surveyed with inclusion survey procedures at a later date or can eliminate suspect areas from further investigation.

3.0 OTHER DOCUMENTS

3.1 APPENDICES

3.1.1 Appendix 1: System description for the PAG radiological scanning van

3.1.2 Appendix 2: System versatility

3.1.3 Appendix 3: Useful DOS program commands accessible from scan programs dated prior to 12/20/88 and SCAN30 program code

3.1.4 Appendix 4: Data handling and system startup

3.1.5 Appendix 5: Scan program modifications

3.1.6 Appendix 6: Gamma scanning program directory

3.1.7 Appendix 7: Instrument calibration

3.1.8 Appendix 8: Distance transducer calibration check data

Approved by:

Douglas K. Halford 9/26/90 (Date)

Clair A. Little 9/26/90 (Date)

C.A. Little

3.1.9 Appendix 9: Background scan CRT display

3.1.10 Appendix 10: Background mode CRT display

3.1.11 Appendix 11: Background mode operation

3.1.12 Appendix 12: Scan mode operation

3.1.13 Appendix 13: Identification mode CRT display

3.1.14 Appendix 14: Identification mode operation

3.1.15 Appendix 15: Data dump mode operation

3.1.16 Appendix 16: File list mode operation

3.2 EXHIBITS

3.2.1 Exhibit 1: Operator console area

3.2.2 Exhibit 2: CBM Model 8032 computer

3.2.3 Exhibit 3: CBM Model 8050 disk drive

3.2.4 Exhibit 4: Interface unit and NIM electronics

4.0 PREPARATION OF MOBILE GAMMA SCANNING SURVEY PLAN

This procedure provides guidelines for the preparation of mobile gamma scanning survey plans.

4.1 DEVELOPMENT OF MOBILE SCANNING SURVEY PLAN

Obtain, review, and assess information provided by previous aerial survey and mobile scan data, if available. Based on the available information, develop the survey plan following the steps below:

4.1.1 Define the scope or boundaries of the survey by outlining on a map of the general survey area, (a) the areas of known contamination as indicated by any previous aerial survey results, and (b) the extent of any previous mobile gamma scans.

4.1.2 Using the outline established in the previous step, develop a street-by-street scanning plan for the area. Note from the aerial survey or previous mobile scan information the specific areas of high radiation

levels that require special attention. This plan will normally identify the specific sections of town to be surveyed; or, if the entire city is to be scanned, define the outer limits of the survey.

4.1.3 Estimate the length of time required to complete the mobile gamma scan and develop a schedule for the survey. Provide a tentative date for start of the survey. This date is subject to the project manager's or funding agency approval.

4.1.4 Prepare the survey plan for submittal to the appropriate personnel for review. The plan should include the following:

a. An introduction summarizing the information on the site obtained from previous aerial surveys and mobile scans, as applicable,

b. The scope of the present planned survey, including (1) a ground level follow-up of the aerial survey, and (2) the plan for the street-by-street mobile scan; when available, include a map showing the areas and boundaries of the proposed survey plan, and

c. A schedule for the survey activities showing estimated survey start date, duration, end date, and date on which a report will be submitted.

4.2 PLAN SUBMITTAL, REVIEW, AND APPROVAL

The completed survey plan is submitted to the reviewers. Upon completion of the review, a final version of the plan is submitted for approval to appropriate administrative personnel and funding agency.

5.0 EQUIPMENT AND SUPPLIES

The mobile gamma scanning van and support systems consist of a modified Dodge Model 300 van that has a built-in, gasoline-powered electric generator and associated instrumentation, lead storage batteries, battery charger, inverter and associated instrumentation, field office supplies, distance transducer, support equipment, and supplies.

5.1 EQUIPMENT

The gamma scanning instrumentation consists of the following:

1. Three 4 x 4 x 16 in. NaI(Tl) Polyscin Log Crystals having integral 3.5-in. photomultiplier tubes mounted on a lead-shielded, hydraulically operated carriage;

2. ORNL designed interface unit;
3. Commodore CBM Model 8032 Computer;
4. Commodore CBM 8050 Dual Floppy Disk Drive;
5. Commodore Model 4022 Tractor Printer;
6. Tracor Northern Display Unit TN 1314;
7. Tracor Northern Pulse Height Analyzer, TN 1706;
8. ORTEC Model 113 Preamplifier;
9. ORTEC AMP & SCA, Model 490B;
10. ORTEC LOG/LIN Rate Meter, Model 449;
11. ORTEC High Voltage Power Supply, Model 456, 0-3kV;
12. TENNELEC TENNEBIN 3, Bin Power Supply;
13. Distance transducer;
14. Audio alarm system;
15. ^{208}Tl Source, no specifications;
16. ^{60}Co Source, 14182.5, 11.00 uCi (1-1-74) Isotope Products Laboratories;
17. ^{137}Cs Source, 7286-5, 12.0 uCi (11-1-79) Isotope Products Laboratories;
18. Lead pig for ^{60}Co and ^{137}Cs sources; and
19. Floppy Disk Scan Program, 4/8/83 and more recent modified scan programs (SCAN30 1/25/89).

5.2 SUPPLIES

The mobile scanning van support equipment and supplies consist of the following:

5.2.1 Office supplies:

a. Stapler and staples,

b. Three-hole paper punch,

c. Paper clips,

d. Tape, masking and transparent,

e. Pens, pencils, colored pencils, and

f. 3-ring binders with inserts.

5.2.2 Van accessories:

a. Tire wrench,

b. First aid emergency kit,

c. Quart of oil,

d. Two-ton hydraulic jack,

e. Tire pressure gauge, to 100 psi,

f. Waste basket,

g. Road map,

h. Slow-moving-vehicle sign, and

i. Fire extinguisher.

5.2.3 Electronic tools:

a. Voltmeter (VOM),

b. Tool kit (pliers, cutter, soldering iron, screw driver),

c. ORTEC Model 448 Research Pulser, and

d. Frequency counter.

5.2.4 Scanning supplies and backup equipment:

a. Tractor printer paper, and

b. Blank diskettes.

c. Backup electronics components:

1. ORTEC High voltage Power Supply Model 456, 0-3kV,
2. ORTEC AMP & SCA, Model 490B,
3. ORTEC LOG/LIN RATEMETER, Model 449,
4. ORTEC Model 113 Preamplifier, and
5. Tracor Northern Multichannel Analyzer 1706 and Model 1314 CRT.

5.3 EQUIPMENT SETUP

The detectors, computer and peripherals, pulse height analyzer components, and support systems are all interconnected and ready for operation. If, for some reason, component disconnect or reconnect is necessary, the mobile scan team leader may contact an instrument technologist from the Instrumentation and Controls Division at ORNL/OR or electronics technician at ORNL/GJ and obtain the necessary information to reconnect the system.

6.0 GENERAL PROCEDURE

Photographs of the mobile gamma scanning van system are provided as Exhibits 1 through 4.

For background information, a system description of the mobile scanning van is included as Appendix 1. Appendix 3 presents the useful DOS computer commands available for the on-board computer system.

6.1 Because the data analysis method employed on the van is based on computations involving background count rates in various energy regions, these background levels must first be established. To establish background, the city to be scanned is divided into small areas which the mobile scan team leader has determined to represent the areas for which an associated background level will be determined.

6.2 In each of these areas, a scan is made at normal driving speed traversing a representative area of the streets included in the section. At the end of this scan, the average count rates and associated standard deviation for each of the energy windows are computed, the average Ra/Th ratio and its standard deviation determined, and the data stored for later use.

6.3 After the background level for the survey area has been established, the street-by-street scans of each area can begin. For each street to be scanned, a storage file is opened on the floppy disk system and the file identified by the name of the street and any other descriptive title. Scanning is conducted at a maximum speed of 10 ft/sec, and an audio alarm system alerts the driver if this maximum is exceeded. Distance between the van and the property is also maintained at a minimum (i.e., next to the curb unless obstructions such as parked cars prevent it). During the scan, the detectors are secured in the full up position (approximately 6 ft above ground surface) to maximize the field-of-view and minimize the influence of street-side obstructions.

6.4 As the scan proceeds, permanent landmarks (house numbers, cross streets) are systematically input to the computer to be stored along with the rest of the scan data for cross reference. If during the scan, a property is passed that exhibits gamma radiation levels exceeding preset hit criteria, an alarm is sounded and special notation appears on the computer monitor. This alarm continues to sound until the anomaly has been passed. At the end of the scan, the data file is closed and computer analysis of the data begins. This analysis results in the printout of a list of all anomalies identified by the scan and provides exact location information in terms of net distance from the input comments (permanent landmarks). To further define the locations and to gain additional information, a second scan in the identification mode of each anomaly can be performed at an even slower speed to better define the area of concern and allow for detailed description of property (i.e., house address, or if unavailable, a description of the property location). If desired at this time, a detailed spectrum analysis can be undertaken utilizing the on-board multichannel analyzer system.

6.5 After one side of a street has been analyzed, the other side is scanned in the opposite direction. In addition, all accessible parking areas, alley-ways,and other public thoroughfares would be scanned within the survey section. When all the scanning has been completed, the complete set of raw data for the entire surveyed area can be printed out for future reference.

6.6 To maintain accurate and complete records of the scanning activities, the ORNL scanning system provides for data recording and storage. The primary data storage system is the floppy disk. This system maintains a continuous permanent record of all raw data obtained during the scan. Retrieval of this data occurs (1) at the end of each scan in the form of the computer-analyzed summary of the anomaly locations or (2) on command at a later time for a complete listing of the raw data or listing of the reduced data used in comparison with the hit criteria. A printed copy of all scan files is kept in a project logbook (3-ring notebook). Also, data disks once filled

are stored outside of the scan van to minimize the chance of losing the scan data.

6.7 An event marker is also used to identify the location of the permanent landmarks input by the operator into the computer for additional cross-correlation with the data printout.

6.8 To ensure that no loss of data occurs when the detector system experiences an unexpected power loss because of generator malfunction or other problem, the van has been provided with an uninterruptable battery power supply for the data handling and storage system. In the event of a detector system shutdown, the previously stored data is adequately protected and can be retrieved without concern of data deletion.

7.0 INSTRUMENT POWER SUPPLY STARTUP

7.1 After checking oil level and securely replacing oil fill/check cap, start the generator by turning on the generator start switch located on the right driver overhead panel. Starting the generator will also activate the clock counter, which will register the number of hours the generator has operated. This counter will be checked by the garage to determine when maintenance is needed.

7.2 To monitor the condition of the batteries, check the battery charge indicator on the overhead panel above the driver's position and dash ammeter.

7.3 After generator engine has stabilized (warmed-up for 2 to 3 minutes), turn on the inverter switch located on a panel below the computer. This is the top left switch on the panel.

7.4 Monitor the voltmeter and ensure that the power supply has stabilized at approximately 115 V before turning on the instrumentation.

7.5 Watch the voltmeter and frequency meter after generator startup. The voltmeter should indicate 115 V and the frequency meter should indicate 60 Hz (cycles per second). Notify the mobile scan team leader if the readings are abnormal when the generator is under load. The ammeter will indicate the load placed on the system.

7.6 To ventilate the inverter compartment, turn on the blower switch (toggle) located below small vent hole in panel.

7.7 When the scanning activities for the day are completed, turn off equipment power, inverter, and generator, in that order.

8.0 GAMMA SCANNING SYSTEM STARTUP

8.1 Start instrument power supply.

8.2 Turn on instrument bin power.

8.3 Turn on interface unit power and push "reset" on the interface unit.

8.4 Turn on high-voltage power supply and raise to 1000 V in 500-V increments. Pause for 5 to 20 s at 500 V before increasing to 1000 V.

8.5 Raise the detectors to the full "up" position by pressing the top button on the hydraulic controller. The hydraulic controller is located on the wall just below the right-rear window of the scanning van. When the full "up" position is reached, a limit switch will stop the pump.

8.6 Insert the two safety pins into the detector frame (this may require using one or both of the hydraulic control buttons to position the holes so the pins can be inserted).

8.7 When the safety pins are inserted, push the down button of the controller to release the pressure from the hydraulic system.

9.0 INSTRUMENT CALIBRATION

The scanning instrumentation is calibrated daily during scanning after system electronics and van working area have been warmed/cooled to room temperature and before any scanning is performed. If the system has been calibrated, proceed to any of the other program modes. The calibration procedure is detailed in Appendix 7.

10.0 DISTANCE TRANSDUCER CALIBRATION

10.1 Check tire pressures; each tire should have 75 psi. Record the tire pressure in the scanning van calibration log book.

10.2 Lay out a stretch of road or street a minimum of 500 ft long. Mark the beginning and the end of the stretch along the curb and each 50-ft increment in between.

10.3 Drive the van to the starting point.

10.4 Mount the slow-moving-vehicle sign and turn on emergency flashers.

10.5 Set the computer system on Identification mode.

10.6 When the operator signals ready, drive the van slowly toward the end point of the calibrated stretch.

10.7 Carefully stop the van at the end point of the stretch.

10.8 The operator reads the distance from the computer display.

10.9 Repeat this check procedure three to five times. If the computer display is $\pm$ 3% of the true value (500 ft), the distance transducer is ready to be used.

10.10 If the readings are outside the range, the mobile scan team leader will notify the instrument technician for further adjustments.

10.11 Document the results of the calibration check for the distance transducer in the Scanning Van Calibration Logbook. For each calibration check, enter the information indicated in Appendix 8.

10.12 An alternative check of the distance transducer can be made in either the Scan or Identification program mode when traveling along a public highway which has mile marker signs. This check will easily give results which indicate qualitatively if a detailed calibration of the distance transducer is required when distance is > $\pm$ 50 ft in one mile.

11.0 BACKGROUND MODE

The background mode of the scan program is accessed when determining the background radiation level to be used in establishing the "hit" criteria for an area to be scanned. Background radiation levels may be new (to be acquired) or old (previously determined). These two options are addressed in Appendices 10 and 11.

12.0 SCAN MODE

The scan mode of the scanning program is used to scan properties for anomalies. The procedure for scan mode operation is detailed in Appendix 12.

13.0 IDENTIFICATION MODE

The identification mode detailed in Appendix 14 is used to verify or obtain the exact location of hits. No data storage is provided for this mode of operation.

14.0 DATA DUMP MODE

This program mode (detailed in Appendix 15) allows for the printing of all recorded raw data obtained during scanning from the disk in drive 1. No computer analysis of the data is performed.

15.0 FILE LIST MODE

The file list program mode detailed in Appendix 16 will print out the computer analyzed data on a file basis for the disk in disk drive 1. This program mode has three options:

15.1 The scan data can be compared with the hit criteria that were used during the scan, resulting in a printout of the same summary that was provided from the scan mode. This option is accessed by typing U ("Use Stored Hit Criteria");

15.2 The scan data can be compared with new hit criteria input by the operator, resulting in a different analysis and summary of data. To access this option, type I ("Input New Hit Criteria") and input the appropriate new hit criteria when called for; and

15.3 All the scan data, including the data on properties where a hit did not occur, are printed. This option can be accessed by typing N and entering 0 and pressing the RETURN key for each of the needed criteria.

16.0 SYSTEM SHUTDOWN

16.1 Remove disks from disk drive 0 and 1.

16.2 Turn off floppy disk system.

16.3 Turn off computer.

16.4 Turn off the interface unit power.

16.5 Decrease high-voltage by 500 V increments to 0 V.

16.6 Turn off high-voltage power supply.

16.7 Turn off instrument bin power.

16.8 If travel over public roads is more than to a local office or temporary office (i.e. motel) or if project is complete, remove safety pins under detector

frame (may require use of hydraulic system controls to position detector). If project is incomplete go to 10.

16.9 Lower detectors to the lowest position, making sure that detector cables are free of obstructions (push in and hold the down button on the hydraulic controller).

16.10 Turn off the power inverter.

16.11 Turn off the generator.

17.0 DOCUMENTATION

Documentation of the gamma scanning operation is mainly provided by the computer system and floppy disk systems. Data analysis is also provided by the computer system with hard copy printout. The printout and any notes are filed as part of the gamma scanning operation records. Printouts are attached to the scanning van logbook.

Appendix 1. System description for the PAG radiological scanning van

BASIC SYSTEM DESCRIPTION

The gamma-ray detection system employed in the scanning van consists of three 4 x 4 x 16-in. NaI(Tl) Polyscin log crystals, each having an integral 3.5-in. photomultiplier tube. The crystals are housed in a partially lead-shielded steel frame to provide a 304 in^2 of unshielded surface area for acceptance of gamma rays through the right side and from beneath the survey van. Detector and shield height can be changed by use of a hydraulic lift mechanism to optimize the detector field-of-view.

Detector output is transferred to a computer-controlled interface designed and fabricated at ORNL. This unit provides for continuous analysis of data inputs for correlation of system location with count rate information. Six separate energy regions-of-interest (ROI) are analyzed and a ^{226}Ra-specific algorithm is employed to identify locations containing residual radium-bearing materials. Data on other naturally occurring radionuclides (such as ^{40}K and ^{232}Th) are obtained for comparison as part of the analysis. Multichannel analysis capabilities are included in the system for additional qualitative radionuclide identification.

The system is operator-controlled through keyboard instructions to an on-board computer. Data output is provided on the computer video screen and a printer. Data storage is provided by a dual floppy disk system.

DATA ANALYSIS TECHNIQUE

The algorithm employed for continuous analysis of the scan data was developed from techniques used for aerial scanning of radiologically contaminated areas. In this analysis, comparison is made between the observed count rates arising from naturally occurring radionuclides (^{232}Th daughters in our case) and residual radioactive materials (^{226}Ra daughters). Where the observed ratio of these count rates (Ra/Th) is determined to be significantly different from a normal background range, the location is identified as a radiation anomaly.

In the ORNL system, three ROI for ^{226}Ra are continuously analyzed (the 0.609 MeV, 1.120 MeV, and 1.764 MeV energy peaks of ^{214}Bi) and one for ^{232}Th (the 2.614 MeV energy peak of ^{208}Tl). Based on the observed count rates in these energy regions in a background area, an average background radium-to-thorium ratio (R) can be determined as follows:

$$R - Ra/Th = \frac{(0.609\ MeV + 1.120\ MeV + 1.764\ MeV)}{(2.614\ MeV)}$$

Appendix 1. (continued)

Associated with this average ratio is a standard deviation that is dependent upon the variation of the individual Ra and Th components.

$$\sigma R = R\left(\left[\frac{Th}{X_{Th}}\right]^2 + \left[\frac{Ra}{X_{Ra}}\right]^2\right)^{1/2}$$

where

σR = standard deviation of the Ra/Th ratio,

R = average Ra/Th ratio in background area,

σTh = standard deviation of the Th energy region (2.614 MeV),

X_{Th} = average Th count rate in background area,

X_{Ra} = average Ra count rate in background area,

σ_{Ra} = standard deviation of the Ra energy regions (0.609 MeV + 1.120 MeV + 1.764 MeV).

Thus, for any area to be scanned, some background Ra/Th ratio can be computed R $\pm$ $k\sigma_R$ (where k is the specified 2-sided confidence level) that can be used for comparison with the scan data obtained each second in the scan mode.

In identifying locations containing residual ^{226}Ra-bearing materials, the ORNL system uses three criteria (hit criteria), all based on the observed background Ra and Th count rates and the computed Ra/Th ratio. The first criterion that must be met involves the determination of a minimum count rate in the Ra energy regions that results in a detectable change in the observed Ra/Th ratio. The mathematical expression for this criterion is as follows:

$$C_m = 2K\left[X_{Ra}\,(R + 1)\right]^{1/2} + k^2,$$

where

C_m = minimum Ra count rate above background,

k = specified 2-sided confidence level,

X_{Ra} = average Ra count rate in background area,

Appendix 1. (continued)

R = average Ra/Th ratio in background area.

For a detected count rate to pass this first hit criterion, the total count rate in the three Ra energy windows must exceed $X_{Ra} + C_m$.

The second and third hit criteria, either of which must be met before a location is considered an anomaly, are based on comparison of the observed Ra/Th ratio with the computed background ratio. In the second criterion, the observed and background ratios are directly compared, and if the observed Ra/Th > $R \pm k\sigma_R$, the location is considered to have exceeded the criterion and the analysis moves to the third criterion. In the third criterion (called the difference techniques), a mathematical difference is computed.

$$\text{difference} = \text{observed Ra} - [\text{observed Th } (R + k\sigma_R)]$$

When this difference is positive, the observed count rate is considered above the criterion.

The second and third criteria, although based on the same background ratio, provide different degrees of sensitivity, depending on the magnitude of the observed count rates in the energy windows. Their combined use provides for a reduction in the incidence of false hits as follows:

1. The identification of properties containing radiation anomalies when actually no anomaly is present; and,

2. Identification of properties as having ^{226}Ra-bearing material (tailings) when only natural variations in background are present due to changes in counting geometry as is possible when passing close to a masonry wall or rock outcrop.

An index field is also calculated as a subjective indication of the anomaly strengths and is calculated as follows:

$$\text{Index} = \frac{\text{observed Ra (cps)/calculated Ra/Th ratio}}{\text{hit criteria Ra (cps)/hit criteria Ra/Th ratio}}$$

Appendix 2

SYSTEM VERSATILITY

The ORNL scanning van system has been optimized to look for locations containing ^{226}Ra-bearing materials. However if desired, system modifications could be made to allow for the analysis of other radionuclides. For instance, if the 0.662 MeV energy peak of ^{137}Cs was set as a region-of-interest (ROI) the scan van could be used as an emergency response vehicle in the event of a fission product leak at a nuclear power plant. The scan van might be utilized to quickly establish perimeter zones around the site.

In addition, the system is presently configured so that if the Ra/Th ratio is suppressed due to an increase in ^{232}Th (^{208}Tl), a low ratio hit criteria is displayed on the CRT and listed on the file printout. This is utilized to identify both ^{232}Th contamination and also to identify Th background variations due to causes such as some igneous rocks found in the natural environment or used in building materials.

Appendix 3. Useful DOS program commands accessible from scan programs dated prior to 12/20/88 and SCAN30 program code.

GENERAL

Command	Function
Place program disk in Drive 0 and press SHIFT and RUN/STOP keys.	This loads the DOS program. Once the DOS has been loaded, all communications with the disk can be obtained by the use of the following commands.
>$D	Will display the directory of the disk drive indicated by D. D must be either 0 or 1.
>iD	Will initialize the disk drive D (D is either 0 or 1).
↑Program Name	Will load and run the program (for scanning enter ↑scan).
↑Program Name	Will load but will not run the program.
.nD:name,XX	Will format a disk in drive D. The name can be no more than 24 characters and must be followed by a two-digit (XX) identification number.
>c1 = 0	Will copy the files on drive 0 to drive 1.
> press RETURN key	Will print the error message and clear the error channel.
Load "$D",8	Loads the directory from drive D.
Open 4,4:CMD4:LIST	Opens the communication channel to the printer and lists the directory.
Print #4:Close4	Closes the communication channel to the printer to print disk directory[b].

[a]The EXIT key is the CTRL-HOME key on the computer keyboard.
[b]This will erase all programs in the computer RAM except the DOS program.

Appendix 4. Data handling and system startup.

Technologist action	CRT display	Function or comment
1. Turn on computer (switch is located on rear lower left corner).	**COMMODORE BASIC 4.0** 31743 bytes free READY	
2. Turn on floppy disk system (switch is located on rear lower left corner).		Center green light will appear when system is ready.
3. Insert scan program disk into the floppy disk drive 0.		Disk title is "CBM Model 8050 Scan Program, 4/3/83".
4. Press SHIFT and RUN/STOP keys to load the computer/disk support programs (DOS Support using programs dated prior to 1/25/89).		Disk drive 0 green light will come on while information is being transferred.
	READY	DOS Support is loaded.
5. Insert blank disk into drive.		To format the blank disk for data storage.

Appendix 4. (continued)

6. Type >n1:disk name,XX		To format a new disk. Disk name is any appropriate identifying name of not more than 26 characters. XX is a sequential number from 00 to 99, you use when multiple disks are used on site. Disk Drive 1 green light will appear for 3 to 4 min. and disappear when formatting is complete.
7. Remove the disk from drive 1 and use a felt tip pen to write on the disk the name typed in Step 6 above.		Disk should be removed and reinserted to ensure that the disk is registered properly when formatted.
8. Type ↑scan and press RETURN key.	Input your name	Will load scan program from disk 0.
9. Enter your name. Press RETURN key.	Input date (e.g. 2/10/89)	After the log-on sequence, the program will automatically address the background program mode. If other modes are desired, go to step 11.
10. Enter date. Press RETURN key.		

Appendix 4. (concluded)

11. Press EXIT key.	CRT will display the six program modes that can be accessed (see Appendix 6)	Computer will return to the program mode directory. Any of the six program modes can now be accessed by typing the first letter of any program mode.

Appendix 5

SCAN PROGRAM MODIFICATIONS

Five software modifications have been initiated in the scan program in order to eliminate operational problems or to track scan project progress. All of the modifications were made between November 4, 1988 and January 25, 1989.

Scan program modifications include; (1) printing the total distance scanned on each scan file printout, (2) printing a directory of the current data disk files on scan file printouts, (3) locking out the Exit key and replace its function with the Esc key, (4) eliminating program crashes if to long a comment string is input during a scan and, (5) allowing the system to automatically escape from the scan program before the data disk currently in use runs out of storage capacity.

The modified scan program (SCAN30 dated 1/25/89) has to be loaded into the computer without the "UNIVERSAL WEDGE" (DOS) program as it was with earlier versions of the scan program. This is necessary in order for the SCAN30 program to print the directory of the data disk at the end of each scan file. If the DOS, "UNIVERSAL WEDGE", functions are needed such as in the case of formatting data disks the computer must be shut-off to remove the SCAN30 program from memory. The "UNIVERSAL WEDGE" program (included on all scan program disks dated prior to 12/20/88) can then be loaded when DOS functions are needed. Unless noted the following procedures describe the SCAN30 Program functions after it has been inserted into floppy disk drive 0 and loaded into the computer by pressing the SHIFT and RUN/STOP keys.

Appendix 6. Gamma scanning program directory.[a]

Program	Function
Scan	Records all street survey data (scan data)
Background	Defines background for areas to be scanned
Calibration	Used for system checkout
Data Dump	Prints all stored raw data
File List	Prints data above hit criteria
Identification	Pinpoints anomaly location

[a]Enter only the first letter of the desire program mode.

Appendix 7. Instrument calibration.

Technologist action	CRT display	Function or Comment
1. At main program directory, Press C key.	The CRT will display the calibration/instrument settings.	C is the first letter of the calibration program.
2. With the CRT display as a guide, check the discriminator window settings on the interface unit. Use the values under UPPER and LOWER columns of the display for the appropriate windows (A1 through A4 and B1 through B4).		
3. Remove the ^{137}Cs source from the lead pig and place it in the source holder on the power strip in front of the detector support frame.		
4. Push the acquire button on the MCA and observe the dead-time meter; it should be less than 10 percent.		
5. Move MCA cursor to Channel 111.		
6. Observe ^{137}Cs 0.662 MeV photopeak. If it falls in Channel 111 ± 1, do nothing. If not, adjust the fine gain on amplifier until the peak falls within the channel range.		When adjusting fine gain, always clear the acquired data to minimize confusion on the location of the photopeak.
7. Record the ^{137}Cs photopeak channel number in the scanning van calibration logbook, and amplifier gain setting. Include calibrator's name, date of calibration, and location of calibration.		

Appendix 7. (continued)

8. Replace the ^{137}Cs source with a ^{60}Co source. Clear data. Again observe the dead time (should be ≤ 10%).

9. Move the MCA cursor to the center of the 1.17 MeV photopeak (approximately at channel 195).

10. If photopeak is ± 3 channels of channel 195, go to step 11 below. If not, go back to step 3 above. If the problem cannot be resolved, go to step 21.

11. Record the ^{60}Co 1.17 MeV photopeak channel number in the scanning van calibration logbook.

12. Move the MCA cursor to the center of the 1.33 MeV ^{60}Co photopeak (approximately channel 221).

13. If photopeak is ± 3 channels of channel 221, go to step 15. If not, return to step 3.

14. If problem cannot be resolved, go to step 21.

15. Record the ^{60}Co 1.33 MeV photopeak in the scanning van calibration logbook.

16. Remove the ^{60}Co source and store in the lead pig. Place the ^{208}Tl source on the bracket directly in front of the detectors; observe dead time; should be less than 10%.

17. Move the MCA cursor to the center of the 2.61 MeV ^{208}Tl photopeak (approximately channel 425).

Appendix 7. (continued)

18. If the center of the photopeak is ± 5 channels of channel 425, go to step 19. If not, go back to step 3. If the problem cannot be resolved, go to step 21.

19. Record the photopeak channel number in the scanning van calibration logbook.

20. Return ^{208}Tl source to the source drawer.

21. If the MCA cannot be calibrated to the required tolerances, the scanning team leader may contact an instrument technologist at ORNL/OR or ORNL/GJ for further adjustments or repairs.

22. Type any character on the keyboard and observe on the display unit the count rates in the appropriate discriminator regions-of-interest (ROI).

23. Observe the "average count rate" in the Ra (0.609 MeV) region with no source present. (Allow time for average values to stabilize approximately 40 s). Record the average background count rate in the scanning van calibration logbook.

24. Remove the ^{137}Cs source from the lead pig and place it at the same location as when calibrating.

25. Observe the average count rate in the Ra (0.609 MeV) region associated with the ^{137}Cs source (allow approximately 40 s for count rate to stabilize). Record the average source count rate in the scanning van calibration logbook.

Appendix 7. (concluded)

26. Subtract the count rate in step (23) from that in step (25) and record the net count rate in the scanning van calibration logbook.

27. If the net count rate is within ± 5% of the previous calibration (see the logbook), the detector sensitivity is considered unchanged and property scanning can begin. If the net count rate is outside the tolerance range, inform the mobile scan team leader who will contact the appropriate instrument technologist for repairs.

28. Replace the ^{137}Cs source in the lead pig.

29. Press ESC key to return to the program mode directory.

Calibration is complete, and another program mode may be accessed.

Appendix 8. Distance transducer calibration check data.

Date: _____

Technologist: _____

Other members: _____

_____

Tire pressure: _____psi

Distance measurements:

1. _____ ft ____% error
2. _____ ft ____% error
3. _____ ft ____% error
4. _____ ft ____% error
5. _____ ft ____% error

Average_____ ft

$$\%\ error = \frac{500 - reading}{500} \times 100^{*}$$

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*If % error >3% notify Mobile Scan Team Leader.

Appendix 9. Background scan CRT display.

BACKGROUND SCAN

Scan of area should be obtained at normal driving speed

Max length of file name is 16 characters

Use the Esc key to close the background file and
return to program directory.

Appendix 10. Background mode CRT display.

APPROPRIATE BACKGROUND DATA MUST BE ENTERED

PRIOR TO ACCESSING ANY OTHER PROGRAM MODE

BACKGROUND DATA FOR AREA TO BE SCANNED CAN BE OBTAINED FROM

NEW FILE: BACKGROUND SCAN AREA

OLD FILE: DATA FROM PREVIOUS BACKGROUND FILE

ENTER ONLY THE FIRST LETTER OF THE DESIRED PROGRAM MODE

Appendix 11. Background mode operation.

Technologist action	CRT display	Function or comment
1. At scan program directory, press B key.	See Appendix 6	This will access the background mode of the scan program.
2. If a new file is to be established for background of the area, press N key. If data from a previous background file are to be used, go to step 6.	See Appendix 10 Input background filename	
3. Type in filename. Press RETURN key (only when ready to accumulate data).		Filename must be less than 16 characters.
4. Drive the vehicle at normal driving speed to cover a representative % of the accessible streets to establish the background; the mobile scan team leader has the responsibility of determining if variations in the local geology and/or land use warrant the acquisition of a new background throughout the project.	Accumulated background data and distance	Normal driving speed is the posted speed limit at the particular location being scanned.

Appendix 11. (continued)

5. When sufficient coverage has been obtained, press ESC key to close data acquisition.	CRT will display the program directory.	The computer will analyze the accumulated data and print out the results.
6. If a background has been established for the area to be scanned, press "O" (for old) key.	Input total Ra counts (mean)	
7. Enter total Ra counts (mean) from a previous background measurement. Push RETURN key.	Input Ra/Th Ratio (mean)	
8. Enter Ra/Th ratio (mean) from a previous background measurement. Push RETURN key.	Input Ra/Th ratio (std dev)	
9. Enter the Ra/Th ratio standard deviation from previous background measurement. Push RETURN key directory.	Computer will display the new hit criteria for a few seconds and return to the program.	

Appendix 12. Scan mode operation.

Technologist action	CRT display	Function or comment
1. Position the gamma scanning van at an identifiable permanent landmark in an area to be scanned.		Landmarks can be cross streets, house number and street, etc.
2. Type S.	Computer will give specifications for filename and an example. INPUT FILENAME	
3. Type filename.	Filename typed	Filename should be less than 16 characters.
4. When ready, press RETURN key.	Computer will display the accumulated data at 1-s intervals for the total distance, total Ra counts, Ra/Th ratio, and the sign of the positive difference analysis algorithm.	Green light on disk drive 1 will appear.
5. Type start landmark and press RETURN key.		Start landmark is usually a street or house number and street.
6. Drive the scanning van at 10 ft/sec or approx. 6 mph and as close as possible to the street curb.		Audio alarm will sound if 10 ft/sec speed is exceeded.

Appendix 12 (continued)

7. Type in landmarks and press RETURN key at regular intervals as the scan proceeds.	These landmarks will serve as check points when anomalies are detected. When entering house and/or business numbers, press return when detector crystals pass the main entrance of the building.
8. After all accessible roads within the area have been scanned, press ESC key to close the file and begin computer analysis of the data.	When the computer has completed analysis of the data, the printer will print out the locations where hits occurred. It will also provide location information (distance from last identifiable landmark), appropriate count rate data in the Ra channels, the Ra/Th ratio, and the magnitude of the computer positive difference. A remarks column is also provided for any comments the technologist wants to make.

Appendix 13. Identification mode CRT display.

IDENTIFICATION PROGRAM

THIS PROGRAM IS TO PINPOINT THE EXACT LOCATION OF THE ANOMALIES

The data is not stored in this program. If a permanent record is needed then return to the scan program

TO RESET DISTANCE, DEPRESS 0
TO EXIT PROGRAM, DEPRESS ESC KEY
DEPRESS ANY KEY TO START THE PROGRAM

Appendix 14. Identification mode operation.

Technologist action	CRT display	Function or comment
1. Type I to access the program mode; then follow instructions on CRT - press any key.	See Appendix 6	No data storage is provided in this mode of scanning. Also, the distance can be reset to zero at any time by typing 0.
2. Referring to the scan mode printout, find the location of the hit, and drive the van to the vicinity of the hit location.		
3. Reset the distance at the positions of the nearest landmark.		
4. Start scanning toward the location of the hit. Drive the van very slowly. Compare CRT displayed distance to that recorded on summary sheet obtained.	Similar information as in scan mode data	
5. Stop the vehicle at the hit location and identify the property where the hit occurred.		Identification may be by house number and street or other property descriptions.
6. Record the identification information under the remarks column of the summary data sheet.		

Appendix 14. (continued)

7. When all hit properties have been identified, press ESC key to end the identification mode and return to the program mode directory.	Program mode directory. (Appendix 6)

Appendix 15. Data dump mode operation.

Technologist action	CRT display	Function or comment
1. Type D.	Filenames of all files on the disk	Computer will read the file directory on the disk in drive 1. The filenames are numbered sequentially as they appear on the disk. To dump data from a single file, type the number of that file. To dump data from the entire disk, press RETURN key.
2. After obtaining the desired data, press ESC key to return to the program mode directory.		

Appendix 16. File list mode operation.

Technologist action	CRT display	Function or comment
1. Type F.	File names of all files on the disk	Computer will read the file directory of the disk. The files are numbered sequentially as they appear on the disk.
2. Choose the option desired as discussed at the beginning of this section.		
3. Select the number assigned to the desired file, enter it, and press RETURN.		
4. When the needed data are printed, press the ESC key to return to the program mode directory.		

Exhibit 1. Operator console area.

ORNL PHOTO-371-91

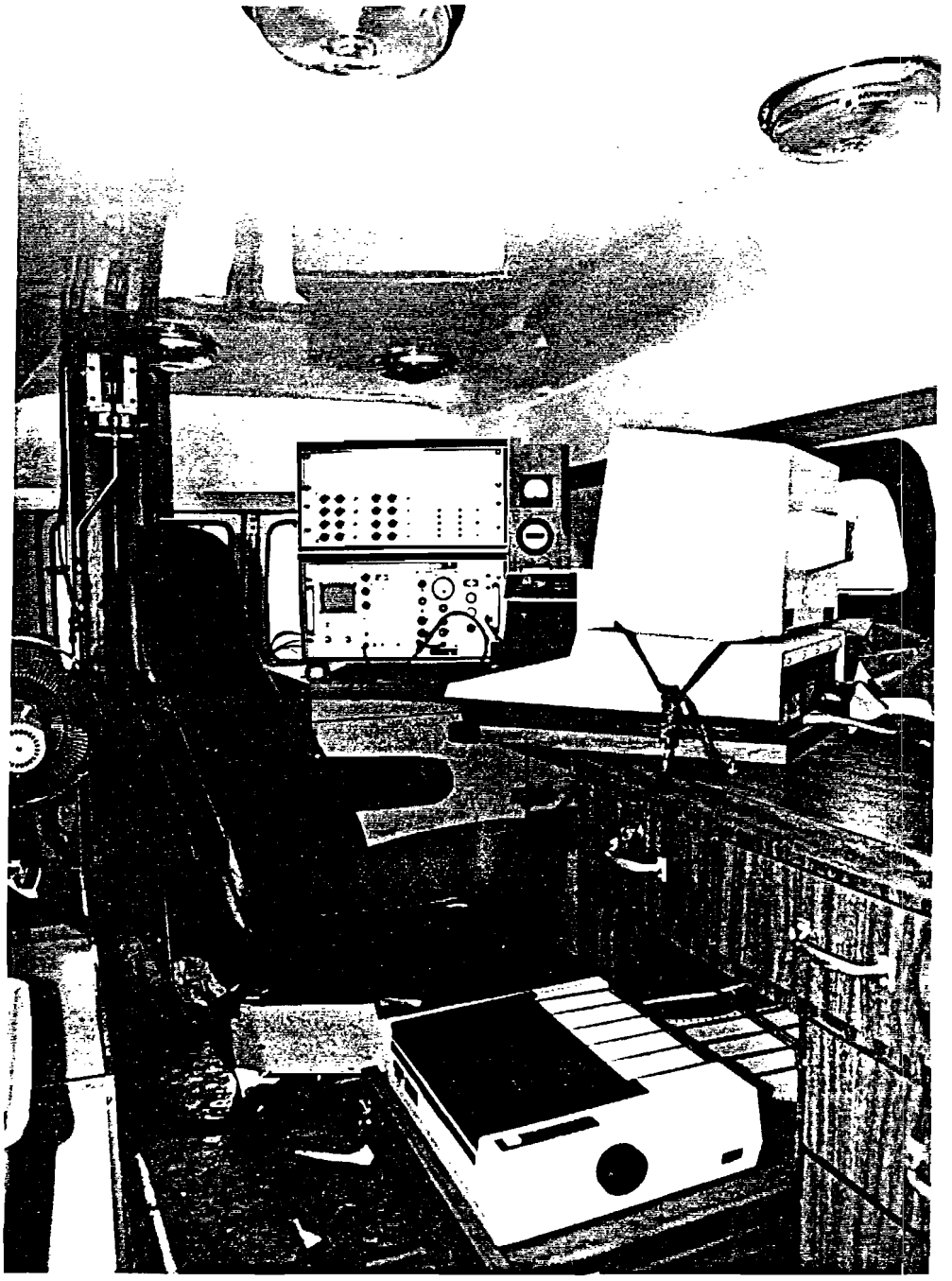


Exhibit 2. CBM Model 8032 computer.

ORNL PHOTO-372-91

Exhibit 3. CBM Model 8050 disk drive.

ORNL PHOTO-373-91

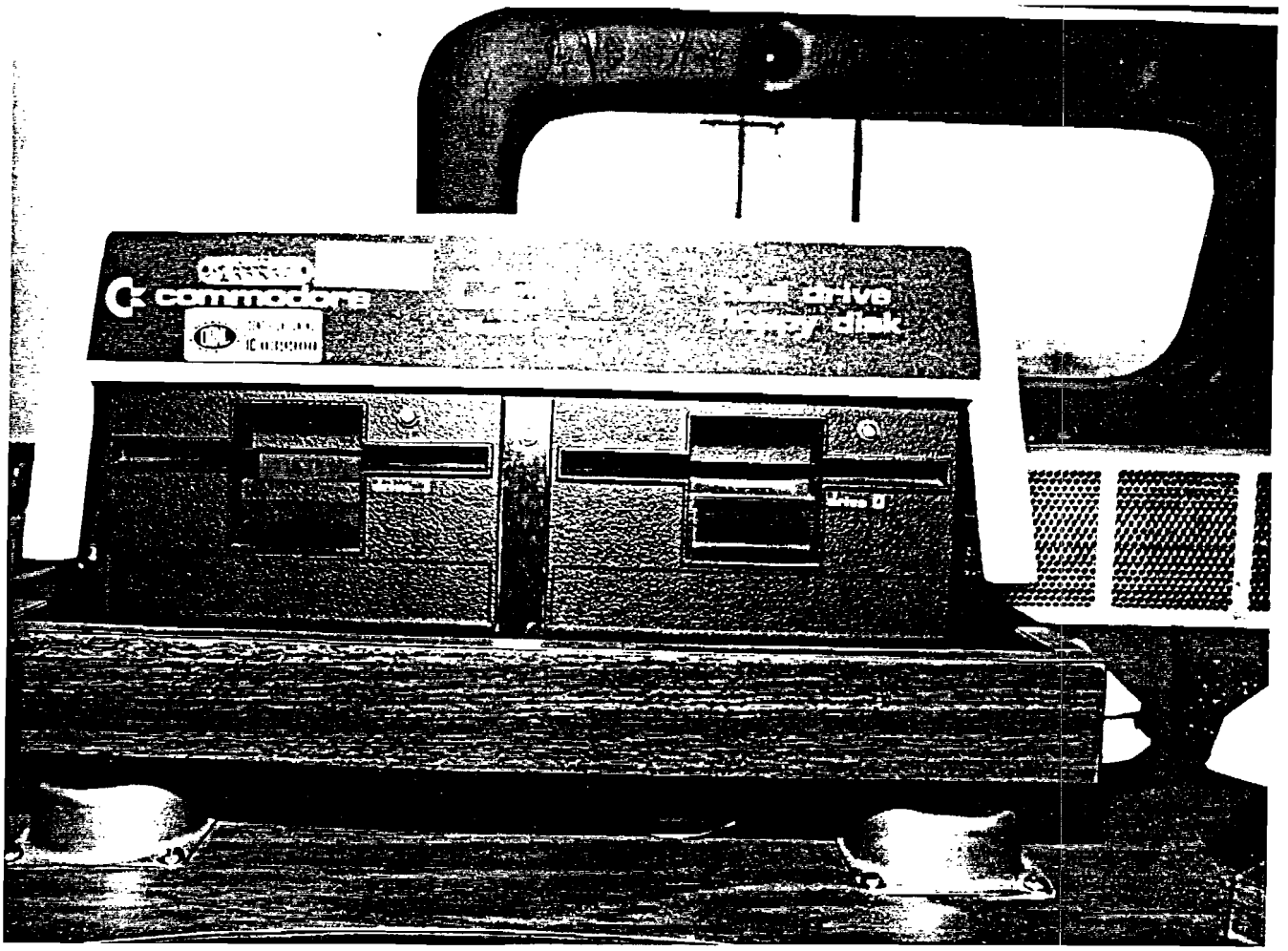
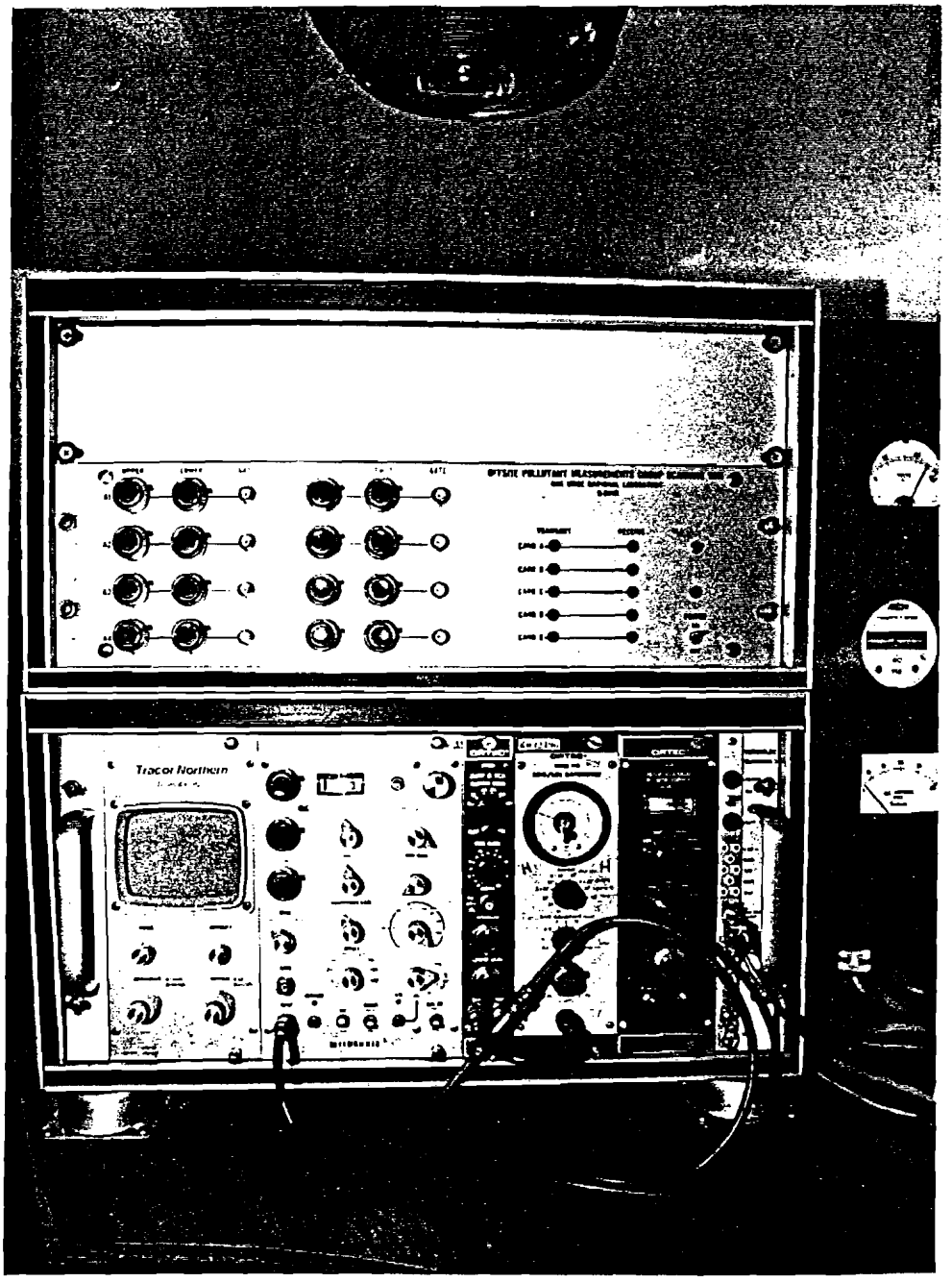


Exhibit 4. Interface unit and NIM electronics.

ORNL PHOTO-374-91



INCLUSION SURVEY ACTIVITIES

1.0 PURPOSE

This procedure describes inclusion survey field measurement activities and data recording.

2.0 APPLICABILITY

This procedure applies to all gamma inclusion surveys performed for the Uranium Mill Tailings Remedial Action (UMTRA) Project and the Monticello Vicinity Properties (MVP) Project.

3.0 OTHER DOCUMENTS

3.1 REFERENCES

3.1.1 *Vicinity Property Management and Implementation Manual* (VPMIM), UMTRA-DOE/AL-050601
3.1.2 Procedure TE-120, Physical Surveying
3.1.3 Procedure SU-061, Graphics for Inclusion Surveys of Vicinity Properties
3.1.4 Procedure TE-025, Alpha Radiation Measurement
3.1.5 Procedure TE-026, Beta-Gamma Radiation Measurement
3.1.6 Procedure TE-021, Gamma Scintillation Detector Operation
3.1.7 Procedure TE-032, Alpha-Track Radon Detector Placement and Retrieval
3.1.8 Procedure TE-023, GR-410 Portable Gamma Spectrometer Operation
3.1.9 Procedure TE-030, Inclusion Survey Report Completion
3.1.10 Procedure TE-022, Pressurized Ionization Chamber (PIC) Operation
3.1.11 Procedure TE-034, Chain of Sample Custody
3.1.12 *Radiation Protection for Occupational Workers*, DOE Order 5480.11, December 21, 1988.
3.1.13 Procedure TE-055, Opposed Crystal System (OCS) Van Activities

APPROVALS	
Author	Date
Supervisor	Date
Group Leader Dyan K. Halford	Date 8/6/93
Section Head Craig Little	Date 8/6/93

3.2 APPENDICES

3.2.1 Appendix 1: Survey Site Information
3.2.2 Appendix 2: Radiological Screening Summary
3.2.3 Appendix 3: Soil Sample Data Field Form
3.2.4 Appendix 4: Chain of Sample Custody/Soil Sample Analysis Form
3.2.5 Appendix 5: Guidelines to the Extent of Inclusion Surveys
3.2.6 Appendix 6: Conversion Formulas
3.2.7 Appendix 7: Point Source Handling Guidelines Calculations

3.3 EXHIBITS

3.3.1 Exhibit 1: Probe Measurement in Sample Holes
3.3.2 Exhibit 2: Methods of Locating Windblown Samples
3.3.3 Exhibit 3: Sampling Equipment
3.3.4 Exhibit 4: Decontamination of Sample Collection Equipment
3.3.5 Exhibit 5: Example of Field Map

4.0 EQUIPMENT AND MATERIALS

4.1 EQUIPMENT

4.1.1 Gamma scintillation detectors, one for each member of the survey team, plus one back-up
4.1.2 30-ft measuring tape
4.1.3 100-ft measuring tape
4.1.4 Survey flags, or other marking devices
4.1.5 Posthole digger
4.1.6 Trowel
4.1.7 Dandelion digger
4.1.8 Breaker bar
4.1.9 Weedsprayer with clean water
4.1.10 Wire brush
4.1.11 Hammer
4.1.12 Safety glasses
4.1.13 Shoe or boot coverings
4.1.14 Camera
4.1.15 Calculator
4.1.16 Surveying equipment
4.1.17 Brunton compass
4.1.18 Engineering scale
4.1.19 "Peg Leg" drawing platform
4.1.20 Portable gamma spectrometer
4.1.21 Eberline GJ140 alpha probe

4.2 SUPPLIES

4.2.1 Field data forms (Appendices 1, 2, and 3)
4.2.2 Chain of Sample Custody/Soil Sample Analysis form
4.2.3 3 ft x 3-ft-plastic sheets
4.2.4 Sample cans
4.2.5 Plastic sample can lids
4.2.6 Small plastic bags
4.2.7 Large plastic bags (turkey bags)
4.2.8 Black ball-point pens
4.2.9 Black felt-tip pens
4.2.10 Paper towels
4.2.11 Gridded drawing paper
4.2.12 Drawing pencils

5.0 RESPONSIBILITY

5.1 The team leader is responsible for delegating inclusion survey tasks, recording field data, assuring that all team members adhere to survey procedures, and making any field decisions relevant to the inclusion survey. The team leader is the point of contact with the property owner and usually surveys the interior areas. He or she may also assist the team members in the exterior scan or in mapping the property.

5.2 Team members are responsible for performing the exterior gamma scanning of the property, taking soil samples as directed by the team leader, and assisting the team leader in mapping and defining any regions of contamination. A team member may map the vicinity property prior to or during the survey and assist the team leader in the interior scan.

5.3 The technical assistant is responsible for documenting and ensuring implementation of changes in inclusion survey procedures.

6.0 DEFINITIONS

6.1 **Cpm:** counts per minute

6.2 **Extended measurements:** soil sampling and/or radon measurements performed during or after a radiological survey to determine if radiological contamination exceeds applicable standards.

6.3 **Gamma scan:** a measure of the gamma radiation level of surfaces using a portable gamma scintillation detector.

6.4 **GJRAP**: Grand Junction Remedial Action Project

6.5 **GM tube**: Geiger-Mueller counter; a radiation detection device that utilizes an ionization chamber to measure the pulses of energy released by radioactive material.

6.6 **Habitable structure**: a permanent building enclosed on all four sides and having a ceiling and floor and either currently inhabited or potentially inhabitable. A detached garage is generally considered uninhabitable unless it is used frequently or for long periods of time, as for a workshop. Mobile homes are not considered permanent structures.

6.7 **HIG**: high indoor gamma reading

6.8 **HOG**: high outdoor gamma reading

6.9 **Hot spot**: an area of radiological contamination 25 m^2 or less

6.10 **Inclusion survey**: a radiological survey conducted on a vicinity property to determine if radiological contamination is present and exceeds applicable standards and whether the property should be recommended for inclusion to or exclusion from the appropriate remedial action project.

6.11 **Kcpm**: thousand counts per minute

6.12 **μR/h**: micro Roentgen per hour or micro R per hour, a unit of radioactive exposure

6.13 **MVP Project**: Monticello Vicinity Properties Project

6.14 **NEAWA**: net estimated area-weighted average

6.15 **PIC**: pressurized ionization chamber

6.16 **Progeny**: in radioactivity, this refers to the product nuclei or atoms resulting from decay of the precursor or parent.

6.17 **Spillover**: a deposit that extends from one vicinity property (parent property) boundary to another vicinity property (daughter property)

6.18 **Subsurface soil sample**: soil sample taken from a depth greater than 15 cm below the soil surface.

6.19 **Surface soil sample**: soil sample taken from a depth of 0-15 cm below the surface.

6.20 **UMTRA Project**: Uranium Mill Tailings Remedial Action Project

6.21 **Vicinity property**: a public or private property in the vicinity of a millsite covered under the UMTRA Project or Monticello remedial action program.

6.22 **VPMIM**: Vicinity Properties Management Implementation Manual

6.23 **"Who-done-it" map**: a map indicating areas surveyed by individual team members.

6.24 **50-ft centers**: the lines technicians walk, 50 ft apart, during a gamma scan of large disturbed areas greater than 5 acres.

7.0 SAFETY

7.1 Always wear gloves when handling radioactive materials, for example, when sampling elevated regions and when handling point sources.

7.2 When handling a point source, adhere to the following guidelines:

7.2.1 Minimize handling time.

7.2.2 Do not carry the source next to the body.

7.2.3 Shield the source if left in the van for an extended period of time.

7.2.4 Alternate turns when handling point sources to lower the individual hand dose.

7.3 After handling radioactive materials, wash hands before eating or drinking.

7.4 If alpha contamination is suspected on body and/or clothes, use the Eberline GJ140 alpha probe in the soils laboratory for self monitoring.

7.4.1 Use the instrument carefully, since the mylar cover on the probe is very fragile.

7.4.2 If contamination in excess of 160 cpm is detected, remove the contaminated clothing, place it in a plastic bag, and take it to a designated laundry for cleaning.

7.4.3 If contamination is detected on skin, wash or shower immediately.

a. Repeat self monitoring and washing until no evidence of contamination remains.

8.0 PROCEDURE

Inclusion survey activities follow guidelines laid out in Reference 3.1.1.

8.1 PROPERTY SKETCH

8.1.1 Obtain a legal description of the property from the Mesa County tax assessor's files or from the plat maps maintained in the public relations department at ORNL/ETS.

a. For a property outside Mesa County, obtain the legal description by normal title search methods at the appropriate courthouse.

8.1.2 Sketch the property either prior to or at the time of the survey.

a. Using measuring tapes, a Brunton compass, or surveying equipment in the case of large properties, map boundary lines, buildings, concrete areas, fences, roads, and other major features of the property.

b. Sketch the property on gridded drawing paper using an engineering scale. Use as large a scale as appropriate, accurate to the nearest foot.

c. Procedures for using survey equipment are described in TE-120, Physical Surveying.

8.1.3 Following the visit, produce an accurate drawing of the property on AutoCAD.

a. See Procedure SU-061, Graphics for Inclusion Surveys of Vicinity Properties, for specific standards for base maps.

8.2 EXTENT OF INCLUSION SURVEY

The extent of an inclusion survey is guided by a decision matrix based on the EPA (Environmental Protection Agency) standards; it is designed to minimize the effort necessary to make a defensible inclusion/exclusion recommendation. In general, when an includable deposit is discovered on a property, further survey activities are not required (see Appendix 5, Guidelines to the Extent of Inclusion Surveys).

8.2.1 GJRAP Properties

a. Prior to scanning a Grand Junction UMTRA property, the team leader must determine whether or not the property has been remediated under GJRAP by examining the GJRAP folder which accompanies the file.

b. A property that was assessed under GJRAP but not remediated under the program must be given a complete gamma survey, including all indoor areas.

c. No indoor survey is conducted on GJRAP-remediated properties; however, an outdoor survey is performed.

8.2.2 Large Areas

a. Survey large undisturbed lands, greater than five acres, only in access areas (e.g. roads, driveways, frontage roads), structures, pavements, and any other items or regions believed to be man-made (e.g., drainage areas, rubble piles). Survey access roads by walking along both sides of the road, with stops to investigate elevated readings. Note scanned areas on the field map and on the "who-done-it" map.

b. Survey large disturbed lands, greater than 5 acres, by walking over the property on 50-foot centers. This is done in one direction (e.g., north-south) without crosswise surveying, unless areas likely to have contaminated deposits (i.e., obvious fill areas, dirt piles, debris, improvements, and landscaping) are not on the 50-foot scan pattern. Investigate any anomalous readings to ensure that a deposit is not present. Note scanned areas on the field map and on the "who-done-it" map.

c. Survey large areas with unusual radiologic conditions using smaller centers and more detailed investigation to provide sufficient documentation for exclusion.

8.2.3 Spillovers

a. After a signed consent form has been obtained, survey the daughter property of a non-includable spillover deposit according to standard inclusion survey procedures. The property is not includable if the spillover deposit in its entirety is not includable unless another deposit on the property exceeds EPA standards.

b. If the spillover deposit is known to exceed standards based on data from the parent property alone, a brief scan to verify that the deposit spills over onto the daughter property is adequate to make an inclusion recommendation.

c. Monticello spillover daughter properties must be sampled to ensure that elevated gamma readings are due to actual contamination and are not just emanation from the parent property.

d. Contaminated city sidewalks are never considered spillover deposits; the area of contamination is considered to end at the property line. Contaminated sidewalks of adjacent properties should be noted on the field map. However, do not include these sidewalks when calculating contaminated areas for the parent property.

8.2.4 Roads

a. For properties with adjacent paved roads, survey only to the edge of the curb or pavement.

b. For properties with adjacent unpaved roads and alleys, survey only to the midpoint of the road or alley.

c. For MVP unpaved roads and/or alleys, the inclusion boundary extends from the boundary of the block and/or the individual residence to the midpoint of the road.

8.2.5 Perimeters

To conclusively rule out any spillover contamination from adjoining properties, survey the perimeter of all properties, even if the survey has been terminated because it exceeds EPA inclusion criteria.

a. Large (>5 acres) undisturbed properties are excepted from this requirement.

8.2.6 Mobile Homes

Do not survey the interior of mobile homes, as they are not considered permanent structures.

8.2.7 Alpha and Beta Radiation Contamination

On occasion, the call for determining alpha and/or beta contamination may arise. Use Procedures TE-025 and TE-026 to measure these types of contamination and report results on field sheets.

8.3 GAMMA SCREENING

8.3.1 Conduct a gamma scan of the property using gamma scintillation detectors as described in Procedure TE-021, Gamma Scintillation Detector Operation.

a. The team leader or designated team member scans the lowest habitable level of the structures.

b. For UMTRA properties, a verbal refusal occurs when the owner denies access to any structure. No data is collected for the property. Obtain a signed refusal if possible in this case.

c. At the discretion of the team leader, team members either scan outdoors simultaneously with the interior scan or wait until the interior scan is completed.

8.3.2 The team leader makes a recommendation for exclusion with no further measurements under the following conditions:

a. the entire property has been scanned;

b. no area (see below) produces exposure rate averages greater than background rate plus 20%;

outdoors: 100 m^2
indoors: a room or 9.3 m^2.

8.4 DEPOSIT DEFINITION

Define the deposits of radioactive contamination in the following manner:

8.4.1 Note any region which exceeds the highest value of the representative background rate range by 1000 cpm on the base map and mark its boundary with flags or other appropriate markers.

8.4.2 Determine a gamma rate range and a field average for the deposit.

a. The field average gamma exposure rate is an estimate of the most frequently measured gamma exposure rate.

b. The gamma rate range should not exceed 50 kcpm. If the range for a particular deposit exceeds this maximum value, break the deposit into smaller regions to facilitate averaging of values found.

NOTE: It is possible to have a deposit with a determined gamma rate range that contains spots of contamination [<0.5 m^2] exceeding the highest range value. The spots must be discrete and few.

c. Record the ranges, averages, and any extraordinary notes on the field data sheets and on the field map.

8.4.3 Measure the area of the deposit.

a. For deposits <930 m^2 (100 ft x 100 ft), stretch a measuring tape across the surface of the deposit in varying directions as often as deemed necessary by the team leader to obtain accurate measurements of the deposit.

b. For deposits >930 m^2, measure the deposit as above or pace off.

c. Pace off the deposit in as many directions as necessary to obtain an accurate shape of the deposit.

d. Record the shape, location, and areal extent of the deposit to scale on the field map.

8.4.4 For indoor regions of elevated exposure rates, determine gamma rate ranges, average gamma rates, and deposit measurements by the same methods used for outdoor deposits. A "room" may be any room (regardless of size) or an interior area large enough to be partitioned from a larger area to make a room (9.3 m^2 or 10' X 10').

8.4.5 Doubling Gamma Exposure Rates Beneath Concrete and Asphalt

To determine whether contamination exists beneath a slab of concrete, asphalt, or other impenetrable material, or within the slab itself, dig a hole as specified by the team leader, adjacent to the slab and as close to the highest reading as possible.

a. If visible tailings are discovered beneath the slab, double the gamma exposure rate for the area beneath the slab, since the cover material (i.e., concrete, asphalt) will shield some of the gamma exposure. Calculate by doubling the counts per minute and then converting to μR/h. Base calculations for sampling decisions or inclusion/exclusion recommendations on the doubled gamma exposure rate.

b. If tailings are not visible beneath the slab or the area of contamination is inaccessible, the gamma exposure rate remains as measured. If the net estimated area weighted average gamma exposure rate exceeds background plus 20%, take a concrete sample and/or a sub-slab soil sample, if possible. If samples are inaccessible, the team leader refers the property to the extended measurements coordinator for coring.

8.4.6 Calculate the net estimated area-weighted average (NEAWA) gamma exposure rates for all regions of contamination:

a. Convert all gamma readings from kcpm to μR/h using the appropriate conversion formula ($y = mx + b$) or PIC measurements. Appendix 6 contains the known conversion formulas for UMTRA sites and Monticello.

b. Subtract the average background gamma exposure rate from the average gamma exposure rate of the contaminated region. The result is the net gamma exposure rate.

c. Calculate the area of contamination in m^2 by multiplying the area in ft^2 by 0.0929. If the area exceeds 100 m^2, round down to 100 m^2.

d. Multiply the net gamma exposure rate by the area in m^2 and divide by 100 m^2. The result is the NEAWA gamma exposure rate.

8.4.7 If any 100 m^2 outdoor area averages more than 25 μR/h above background, or if any room or 9.3 m^2 indoor area of a building averages more than 20 μR/h above background, the team leader makes a recommendation for inclusion and ends the survey.

a. Under these circumstances, it is not necessary to perform a gamma scan of the entire property. However, perform a perimeter scan to ensure there is no spillover contamination.

8.4.8 For UMTRA properties, extended measurements are required if gamma exposure rates exceed 20% above background averaged over 100 m^2 outdoors or 9.3 m^2 indoors or if the team leader is not satisfied with the adequacy of the data to make a recommendation.

a. Take soil samples from outdoor deposits.

b. The team leader refers the file for radon daughter concentration sampling if an indoor region has a NEAWA gamma exposure rate exceeding 20% of background. See Procedure TE-032.

8.4.9 Normally, floor plans of the structures are not included in property sketches. However, when an indoor region of contamination is detected, add floor plans of the affected structures to the field map at the time of the site survey.

8.4.10 If the outlying boundaries of the deposit are difficult to define, posthole and measure subsurface gamma rates to identify the extent of the contamination. The team leader determines the spacing and depth of the postholes. Reclaim postholes in the same manner as soil sample locations. Indicate the locations of the postholes on the field map.

8.4.11 Contaminated Mortar and Brick

a. Area Determination

To determine the area of contamination in a standard brick wall or fireplace, first determine which is elevated, the mortar or the brick. Slide the scintillometer probe slowly parallel to the surface of the area. The meter will show a slight increase when placed directly against the contaminated area. Calculate the total surface area of the wall or fireplace (length times height), and multiply the product by 0.33 if the mortar is contaminated, or by 0.77 if the brick is contaminated. As mortar volume varies from brick to brick, a conservative estimate is incorporated into the multiplication factor for standard brick walls. For material other than brick (e.g., cobble on cinder block walls), modify the multiplication factor if necessary.

b. Calculate the NEAWA gamma exposure rate as described above.

c. Gamma Spectrometer Data

Use the portable gamma spectrometer to determine if the elevated brick or mortar is contaminated with man-made or naturally occurring radioactive materials (see Procedure TE-023, GR-410 Portable Gamma Spectrometer Operation). A radium/thorium ratio greater than 2.5:1 (applies only to Mesa County, Colorado) indicates excess radium from uranium mill tailings. Conversely, a radium/thorium ratio less than 2.5:1 indicates that elevated gamma exposure rates are a result of the natural radiation within the building material. Therefore, extended measurements are not required.

d. Sampling

If the team leader requires further data, take a brick and/or mortar sample from a discrete location with the property owner's permission and analyze for a conclusive determination of brick or mortar contamination.

8.4.12 Trailer House Rule

When several small deposits can be included in a 14' x 70' rectangle (the size of a trailer house), the deposits may be combined as one region of contamination for calculation and sampling purposes. The rectangle cannot overlap a structure.

8.4.13 For Monticello properties, defining the deposit includes asking the owner for information regarding the source of contamination.

8.5 POINT SOURCES

8.5.1 For UMTRA, regions exhibiting elevated gamma rate ranges that are generally <1.0 m^2 in area and/or contain radioactive material that is not mill-related (i.e., ore, petrified wood and dinosaur bones) or is of undetermined type, are deemed point sources.

8.5.2 For MVP, point sources are defined the same as for UMTRA <u>except</u> that a point source is considered mill-related unless proven otherwise.

a. Contamination includes tailings, ore, radioactive mill equipment pieces, etc.

b. A property in Monticello can, therefore, be included on a point source using the hot spot limits described in Procedure TE-030.

c. Sample ore point sources but not petrified wood, bone, or other obvious collector's pieces.

8.5.3 A point source is represented on the field map with an asterisk (*) and its associated gamma rate.

8.5.4 A point source is never considered to be the site HOG and should not be recorded as such for UMTRA properties.

a. A MVP point source may be considered the HOG if it is mill-related or of an unknown type and cannot be removed by sampling.

8.5.5 Make a reasonable effort to uncover the point source to document its type and exposure rate.

8.5.6 For MVP, remove point sources after obtaining permission from the site owner. UMTRA point sources do not need to be removed.

8.5.7 The following limits for handling point sources apply to uranium ore, mill tailings, slag, etc., only; they do not apply to other radionuclide sources or radium salts. For other types of radioactive contamination, another dose limit must be calculated. Calculations and assumptions for the handling guidelines below are described in Appendix 7.

a. Point sources <800 kcpm or <1400 μR/h may be removed in the following way:

1. note the exposure rate on the appropriate field data sheet;

2. indicate on the field map the location of removal and the exposure rate;

3. double-bag the point source(s) and label as sample excess with site number, address, and date;

4. for point sources within Mesa County, take the point source to the soils laboratory;

5. for point sources outside Mesa County, contact appropriate waste disposal authorities if the point source is not needed for analysis;

6. for MVP, take the point source to the repository if not needed for analysis.

8.5.8 Remove point sources >800 kcpm or >1400 μR/h in the following way:

a. these point sources are outside gamma scintillation range and should be dealt with carefully;

   1. pregnant women and small children should not be allowed in the region of the point source;

b. note the general location of the point source and notify the team leader;

c. if the property owner requests that the point source be removed, the team leader uses a GM tube (from the electronics technician) to continue the investigation until the source is located;

d. note the location and exposure rate on the field map and appropriate field sheets;

e. if the source measures <50 mR/h, handle it double-bagged;

f. if the team is working in Mesa County and the surrounding area, take the source directly to the compound for evaluation and appropriate storage;

g. if the team is working outside the Mesa County area, contact appropriate waste disposal authorities regarding disposal;

h. for MVP, take the point source to the repository;

i. if the source measures >50 mR/h, it should not be handled; consult the project manager before taking further action.

8.6 SOIL SAMPLE COLLECTION

8.6.1 After the gamma scan is completed, the team leader specifies the sampling locations and notes these on the field map.

8.6.2 Soil sampling equipment consists of simple implements such as gardening trowels, post hole digger, or any implement that can be used for this purpose. See Exhibit 3, Sampling Equipment.

8.6.3 Take one sample and one subsurface sample (if necessary) at the HOG.

NOTE: For an MVP property with no elevated readings, take one sample at the highest background reading.

a. Take a gamma scintillometer measurement on the surface and record on the field data sheets prior to sampling.

b. Remove 15 cm (6 in.) of soil with a post-hole digger, place on a plastic sheet, and blend with a trowel or other tool.

c. Fill an aluminum sample can with sample representative of the entire interval, and cover with a plastic lid.

d. Take a gamma scintillometer measurement at each subsequent 15 cm (6 in.) depth.

e. If the gamma scintillometer measurement increases by more than 20%, continue sampling at subsequent 15 cm (6 in.) depths until measurement stabilizes or decreases.

f. Before the sample hole is reclaimed, insert the probe in the hole and note the thickness and depth of contaminated layer(s) on field data sheets. See Exhibit 1, Probe Measurement in Sample Holes.

8.6.4 Write the address, sample identification number, date, sampler's initials, and sample depth on the lid.

a. Assign each sample a unique alphanumeric identification:

ab01234-S1 (sample 1, surface only)
ab01234-S2 (sample 2, same property, surface only)

or

ab01234-S1A (0-15cm)
ab01234-S1B (15-30cm)
ab01234-S1C, etc. (30-45cm)
ab01234-S1Z (indicates concrete sample)

ab01234-S1U (indicates sample taken under a slab)

where:

ab - area location code
01234 - location number
S1 (or S2) - sample number
A - sample depth, 0-15 cm
B - sample depth, 15-30 cm
C - sample depth, etc.

8.6.5 Place each sample in a small sample bag.

a. Put all sample bags for one survey site in a larger plastic bag (turkey bag).

8.6.6 Record the appropriate data on the Soil Sample Data Field Form (Appendix 3).

8.6.7 Take a second sample at the next highest gamma exposure rate location (at least 1.5 meters away), again recording scintillometer measurements.

a. For MVP, sample a deposit that is <1.5 m^2 only once.

8.6.8 Take additional samples the team leader deems necessary for complete deposit definition.

8.6.9 If tailings are suspected to be within concrete, take a sample of the concrete as discreetly as possible.

a. Samples collected from under sidewalks, concrete slabs, and other impermeable surfaces should follow the same guidelines as for other samples, although sampling exactly at the HOG is often impossible.

b. Sample as close to the HOG as possible.

c. Note the thickness of the slab and the depth interval of the sample on the Soil Sample Data Field Form (Appendix 3).

d. If the team leader deems necessary, refer the property to the extended measurements team for concrete coring.

e. Site owner permission should precede concrete slab sampling.

8.6.10 In areas of suspected windblown contamination, the team leader specifies at least two samples to represent each 100 m^2 area.

a. See Exhibit 2, Methods of Locating Windblown Samples, for guidelines to locating windblown sample locations.

b. Always consider driplines and areas next to structures obstructing the wind direction for sampling.

c. Separate the surface sample into a 0-2.5 cm sample and a 2.5-15 cm sample to confirm the presence of windblown contamination.

8.6.11 Once samples have been collected, restore the area to as close to its original state as possible.

a. If a grass lawn is present, remove a top grass "plug" before taking samples and save for replacement.

b. Fill dirt may be required to replace soil collected as sample material.

8.7 MEASUREMENTS IN UNCONTAMINATED AREAS

8.7.1 Once the entire survey site has been gamma scanned, record the background exposure rates on the field data sheets and indicate the locations on the field map.

a. If the entire property exhibits elevated count rates, obtain a representative value from a previously surveyed and uncontaminated property in the area.

8.7.2 For those sites with no established conversion tables, obtain a direct conversion factor with a PIC (see Procedure TE-022, Pressurized Ionization Chamber Operation).

a. The team leader selects the PIC location as distant from any elevated gamma readings as is conveniently possible.

8.7.3 In areas known to have anomalously high background gamma exposure rates due to natural causes (e.g., Durango, Lowman, Rifle, and northern Grand Junction), take one or more soil samples from regions described as background to ensure that the source is not mill tailings.

8.8 DATA RECORDING

8.8.1 Record all data collected at an inclusion survey site on the three field data sheets and the field map.

a. Complete all appropriate entries before the team leaves the site.

b. Record the site location number and the survey date in the space provided at the top of all three field data sheets.

8.8.2 Field Map, see Exhibit 5.

a. Illustrate the locations of tailings deposits and point sources, indicate gamma radiation measurements at appropriate locations, and provide any other pertinent information on the field map.

b. Note background ranges indoors and outdoors and sample locations.

c. All regions must have an identifier, rate range, and average noted on the map.

d. Clearly indicate on the field map which portions of the property were surveyed.

8.8.3 Survey Site Information, see Appendix 1.

a. Owner data

Normally, the scheduler completes this section after making an appointment for the site survey. Complete the required information from the consent form and/or from the site owner contact.

1. Monticello zip code is 84535.

2. Monticello telephone area code and prefix are (801) 587-.

b. Land use

Complete this section during the inclusion survey. Describe each structure located on the survey site to aid in report writing. Entries in this section are self-explanatory.

c. Photographs

Complete this section after survey site photograph(s) have been taken. Do not complete the film roll and frame numbers for Polaroid camera pictures.

d. Spillover

If any deposit continues onto an adjacent property(ies), note it as "spillover" in this section. Record the address of the adjacent property in the space provided.

8.8.4 Radiological Screening Summary, see Appendix 2.

a. Enter survey team initials in the appropriate spaces.

b. The remaining entries on page two are self-explanatory.

8.8.5 Soil Sample Data Field Form, see Appendix 3.

a. Describe each sample location adequately. When possible, use measurements from easily relocatable points.

b. "Area Rep:" refers to total measured surface area that the collected sample represents. The remaining categories on this page are self-explanatory.

c. Normally, the "gamma, μR/h" blanks are filled in as part of the team leader pre-report activities. The "Ra^{226}, pCi/g" blanks are completed by the soils lab technician once the respective sample has been analyzed.

8.8.6 Chain of Sample Custody/Soil Sample Analysis Form, see Appendix 4.

a. This form should be completed at the time of sample collection. See Procedure TE-034.

8.8.7 A site photograph is taken before the team leaves the survey site.

a. Photograph general outdoor views of the property from a vantage point that provides a reasonable understanding of the property including relative size, structures, and terrain.

1. Take two photographs for UMTRA properties.

2. Take only one photograph for MVP.

b. A front view of the property is most commonly taken.

c. Subsequent photographs (i.e. indoor photographs) are not needed unless property is exceptionally large or is in some way peculiar.

d. After the photograph(s) is developed, label it with the location number and date surveyed and place in the vicinity property file.

8.8.8 Each team member indicates the portions of the property he or she surveyed on a copy of the property map called the "who-done-it" map.

a. Complete this map in black ink and indicate with initials or graphic symbols the portions of the property each individual scanned.

8.9 INSPECTION AND DECONTAMINATION OF EQUIPMENT AND PERSONNEL

8.9.1 Inspect sample collection equipment for visible contamination after collecting each sample.

a. Remove visible contamination using a brush, paper towels, and/or water before returning the equipment to the survey vehicle. See Exhibit 4.

8.9.2 Inspect gamma detection equipment for visible contamination after surveying each property. Decontaminate if necessary.

8.9.3 Following the completion of each inclusion survey, personnel will inspect themselves for visible contamination.

a. Remove visible contamination using a brush, paper towels, and/or water.

b. When field conditions are muddy, use shoe or boot coverings.

c. Following an inclusion survey during muddy conditions, wash shoes, boots, and/or coverings free of visible contamination using water, paper towels or a brush as appropriate.

d. Following sample handling or field work, wash hands before smoking, eating, or drinking.

8.9.4 After the team inspects and decontaminates all equipment and themselves at the end of each inclusion survey, the team leader marks the appropriate space on the Radiological Screening Summary form.

8.10 **OPPOSED CRYSTAL SYSTEM (OCS) ANALYSIS:**

8.10.1 For UMTRA properties, use the OCS van to analyze samples. See Procedure TE-055, Opposed Crystal System (OCS) Van Analysis.

a. Analyze samples from these properties in the laboratory to confirm OCS van analysis. See Procedure TE-036, Analysis of Radionuclides in Soils.

8.10.2 Do not use OCS analysis results between 4 pCi/g and 6.4 pCi/g for surface soil and between 13.5 pCi/g and 16.4 pCi/g for subsurface soil for inclusion or exclusion recommendations.

a. Notify the DOE immediately if confirmatory analysis results alter the inclusion or exclusion recommendation.

Appendix 1. Survey Site Information

OAK RIDGE NATIONAL LABORATORY SITE#_____

SURVEY SITE INFORMATION SURVEY DATE_____

OWNER DATA:

NAME:_____ LOCATION:_____
ADDRESS:_____ _____
_____ TENANT:_____
PHONE:_____ PHONE:_____

LAND USE

RESIDENTIAL___: SINGLE FAMILY___ COMMERCIAL___ RETAIL STORE___
MULTI-FAMILY ___ OFFICE ___
MANUFACTURE ___
MOTEL, HOTEL ___

PUBLIC BLDG.___: SCHOOL___
CHURCH___ VACANT LOT___
OPEN LAND ___

OTHER_____ DESCRIPTION_____
_____ _____

NUMBER OF STRUCTURES:_____

TYPE OF CONSTRUCTION: (# of levels, frame/masonry, basement /crawl/space/slab-on-grade, etc.)

Bldg. #1: _____
Bldg. #2: _____
Bldg. #3: _____
Bldg. #4: _____

PHOTOGRAPH(S): FILM ROLL #_____

	(compass direction)		(description)
FRAME #_____	LOOKING:_____	AT	_____
_____	LOOKING:_____	AT	_____
_____	LOOKING:_____	AT	_____
_____	LOOKING:_____	AT	_____

SPILLOVER:___ NO ___ YES

ADJACENT PROPERTIES:_____
_____

Appendix 2. Radiological Screening Summary

OAK RIDGE NATIONAL LABORATORY
RADIOLGICAL SCREENING SUMMARY

SITE #_____
SURVEY DATE_____

SURVEY TEAM:_____(LEADER) _____ _____
_____ _____ _____

SURVEY INSTRUMENTS USED FOR CORRELATION
gamm-rate meter #_____
PIC #_____

uR/h CONVERSION FORMULA USED
_____uR/h = 1.69 K + 3.45
_____other uR/h

_____DIRECT CONVERSION
cpm/uR/h (see below)

LOCATION	PIC(uR/h)	(cpm x 1000)
LOCATION	PIC(uR/h)	GAMMA-RATE METER - 6"
_____	_____	_____
_____	_____	_____
_____	_____	_____

CONVERSION(cpm/uR/h)
_____
_____
_____

BACKGROUND GAMMA-SCAN RANGE

Outdoor
_____to_____cpm x 1000
_____to_____uR/h

Indoor
_____to_____cpm x 1000
_____to_____uR/h

INDOOR SCAN RANGE:

INDOOR MAP_____YES_____NO

Region 1: _____kcpm _____uR/h Average:_____kcpm_____uR/h Area____m²
2: _____kcpm _____uR/h Average:_____kcpm_____uR/h Area____m²
3: _____kcpm _____uR/h Average:_____kcpm_____uR/h Area____m²

Non-Point Source HIG:____kcpm _____uR/h Location:_____
Point Source HIG: _____kcpm _____uR/h Location:_____

Comments:_____

OUTDOOR SCAN RANGE:

Region A:_____kcpm_____uR/h Average:_____kcpm_____uR/h Area____m²
B:_____kcpm_____uR/h Average:_____kcpm_____uR/h Area____m²
C:_____kcpm_____uR/h Average:_____kcpm_____uR/h Area____m²
D:_____kcpm_____uR/h Average:_____kcpm_____uR/h Area____m²
E:_____kcpm_____uR/h Average:_____kcpm_____uR/h Area____m²

Non-Point Source HOG: ____kcpm_____uR/h Location_____
Point source HOG: _____kcpm _____uR/h Location _____

Comments:_____

PROPERTY RECOMMENDED FOR: EXCLUSION___INCLUSION___(see addtl. data sheets)
SOIL ANALYSIS REQUIRED FOR DETERMINATON: _____YES _____NO
INDOOR EXTENDED MEASUREMENTS REQUIRED: _____YES _____NO
PERSONNEL & EQUIPMENT INSPECTED & DECONTAMINATED: _____YES

Appendix 3. Soil Sample Data Field Form

OAK RIDGE NATIONAL LABORATORY SITE #_____

SOIL SAMPLE DATA FIELD FORM SURVEY DATE _____

	Visible Tailing	Sample Number	Depth, m	Gamma, kcpm	Gamma, μR/h	^{226}Ra, pCi/g
Sample Location: _____						
Visible Ore: __yes__no		_____	Surface	_____	_____	_____
Background Sample: __yes__no	_____	_____	_____	_____	_____	_____
Area Rep: _____						
Other Description:	_____	_____	_____	_____	_____	_____
_____						
_____	_____	_____	_____	_____	_____	_____
_____						
_____	_____	_____	_____	_____	_____	_____
Sample Location: _____						
Visible Ore: __yes__no		_____	Surface	_____	_____	_____
Background Sample: __yes__no	_____	_____	_____	_____	_____	_____
Area Rep: _____						
Other Description:	_____	_____	_____	_____	_____	_____
_____						
_____	_____	_____	_____	_____	_____	_____
_____						
_____	_____	_____	_____	_____	_____	_____
Sample Location: _____						
Visible Ore: __yes__no		_____	Surface	_____	_____	_____
Background Sample: __yes__no	_____	_____	_____	_____	_____	_____
Area Rep: _____						
Other Description:	_____	_____	_____	_____	_____	_____
_____						
_____	_____	_____	_____	_____	_____	_____
_____						
_____	_____	_____	_____	_____	_____	_____
Sample Location: _____						
Visible Ore: __yes__no		_____	Surface	_____	_____	_____
Background Sample: __yes__no	_____	_____	_____	_____	_____	_____
Area Rep: _____						
Other Description:	_____	_____	_____	_____	_____	_____
_____						
_____	_____	_____	_____	_____	_____	_____

Appendix 4. Chain of Sample Custody/Soil Sample Analysis Form

ornl OAK RIDGE NATIONAL LABORATORY
Grand Junction Office

Mailing Address
P.O. Box 2567
Grand Junction, CO 81502

Street Address
2597 B¾ Road
Grand Junction, CO 81503

Phone (303) 248-6200

Chain of Sample Custody/ Soil Sample Analysis Form

Page _____ of _____

Date _____

TEAM LEADER _____

TEAM MEMBERS _____

1. Project No. _____ 2. Project Name _____

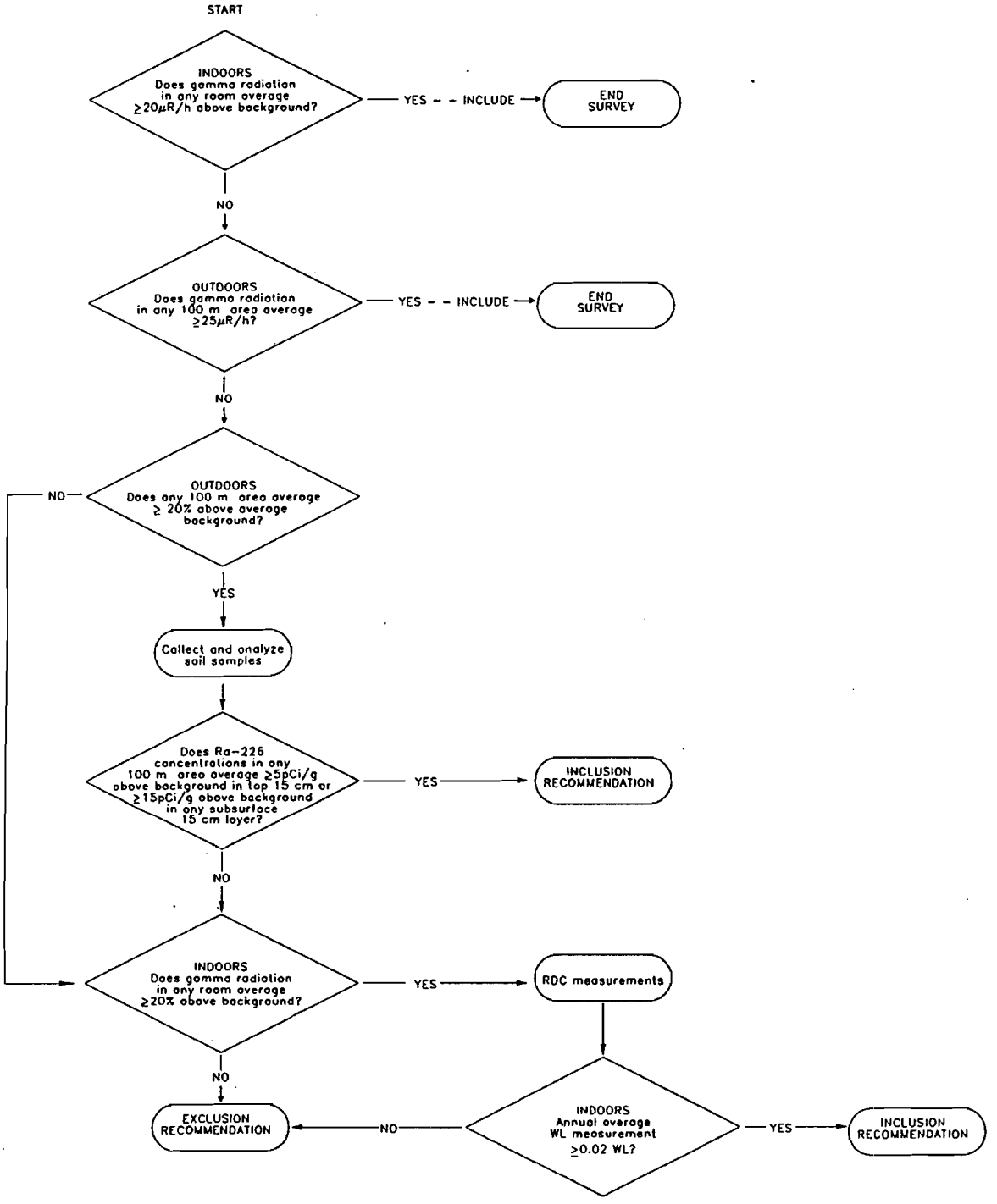
LOCATION ADDRESS	SAMPLE ID. NUMBER	PAN NO.	DATE TAKEN/ RECEIVED	DATE BOTTLED	DATE ANALYZED	DISK NO.	SAMPLE WT. (g)	226–Ra (pC1/g)	BBL NO.	COMMENT/ LAB ID

Relinquished By	Date	Dept.	Received By	Date	Dept.

Distribution: Original accompanies samples, copies to relinquishers

UCN 17345 (1/91)

Appendix 5. Guidelines to the Extent of Inclusion Surveys



Appendix 6. Conversion Formulas

Grand Junction: $y = 1.69x + 3.45$

Durango: $y = 1.55x + 5.28$

Lowman: $y = 1.98x + 5.92$

Green River: $y = 1.60x + 7.34$

Gunnison: $y = 1.47x + 10.33$

Naturita, Nucla, Slickrock, and Vancorum: $y = 1.80x + 5.64$

Rifle: $y = 1.56x + 6.89$

Monticello: $y = 1.46x + 7.2$

y = gamma exposure rate in μR/h

x = gamma exposure rate detected by gamma scintillation detector in kcpm

Appendix 7. Point Source Handling Guideline Calculations

DOE Order 5480.11 (Reference 3.1.12) allows the following dose limits for radiation workers:

1. 5 rem (annual effective dose equivalent) for stochastic effects (equivalent to whole body irradiated uniformly);

2. 50 rem (annual dose equivalent) for non-stochastic effects to the extremities.

The dose limit which would be reached first (hand or whole body) and thus be limiting for the occupational worker was determined using the Microshield computer code.

Case 1: the ore was located in the workers hand.
The exposure rate in air at a point 0.1 cm from the source was determined to be 3.436×10^5 mR/hr.

Case 2: the dose was received from the ore located 30 cm away (whole body).
The exposure rate in air at a point 30 cm from the source was determined to be 6.811×10^5 mR/hr.

<u>Limiting Organ Calculation</u>:

DOE Order 5480.11 allows an effective dose equivalent (EDE) of 5 rem/yr and an extremity annual dose equivalent (ADE) of 50 rem. The ratio of the allowable 50 rem ADE extremity dose to the whole body EDE dose is a factor of 10. The ratio of Case 1 to Case 2 is:

$$\frac{\text{Case 1}}{\text{Case 2}} = \frac{3.436\text{E}05 \text{ mR/hr}}{6.811\text{E}03 \text{ mR/hr}} = 50$$

This ratio is 5 times (i.e., 50 divided by 10) that allowed by DOE Order 5480.11. This indicates that the extremity dose of 50 rem ADE will be achieved before the whole body reaches 5 rem EDE when handling uranium ore point sources. Therefore, the extremity dose of 50 rem ADE is limiting for hand held uranium ore.

Appendix 7. (continued)

Allowable Ore Exposure Rate:

The allowable exposure rate was determined by use of the extremity dose limit of 50 rem ADE since it was found to be the limiting dose.

The extremity dose was decreased by a factor of 10 to add conservatism to the calculation and to prevent the worker from reaching the maximum allowable exposure.

$$\frac{50 \text{ rem}}{10 \text{ hrs}} = 5 \text{ rem ADE}$$

The reduced extremity dose was then used to determine the allowable ore exposure rate:

$$\frac{5 \text{ rem}}{100 \text{ hrs}} = 50 \text{ mrem/hr} = 50 \text{ mR/hr}^{*} \text{ (i.e., measured on contact)}$$

* For gamma radiation - 1 R is approximately 1 rem in soft tissue

Assumptions in Calculation:

The following assumptions are inherent in the calculations:

1. Ore consists of ^{238}U and progeny in equilibrium.

2. Ore sample is assumed to have a radius of 6 cm and consist of SiO_2 with an effective density of 2.65 g/cm^3.

3. Only gamma radiation is considered.

4 Gamma contributions from branching decay progeny ^{234}Pa (0.13%), ^{218}At (0.02%), ^{210}Tl (0.02%) and ^{206}Tl (0.00013%) are ignored.

5. Contributions from ^{235}U and progeny are ignored due to the low natural percentage of U-235 in ore.

Appendix 7. (continued)

6. Emanation loss of Rn-222 is ignored.

7. The worker handles uranium ore an average of 100 hours per year.

8. A conservative extremity dose is used

The inclusion of beta radiation dose to the hand can create considerable difficulty in calculations due to the energy distribution of beta particles and the large energy ranges encountered for the U-238 chain. While computer codes are available which will compute the beta dose, the database of these codes generally requires considerable additions to simulate the whole ^{238}U decay chain. Therefore, a representative set of radionuclides (^{90}Sr and ^{90}Y) was chosen to show the effect of a thin protective layer such as a glove in reducing the beta dose. ^{90}Sr has a 0.544 MeV maximum beta, while ^{90}Y has a 2.245 MeV maximum beta. Computer runs were made for skin thickness of 0.007 cm and 0.1 cm, respectively. The data indicated that a glove of approximately 0.1 cm thickness would decrease the beta dose to the hand by 80 percent.

Exhibit 1. Probe Measurement in Sample Holes

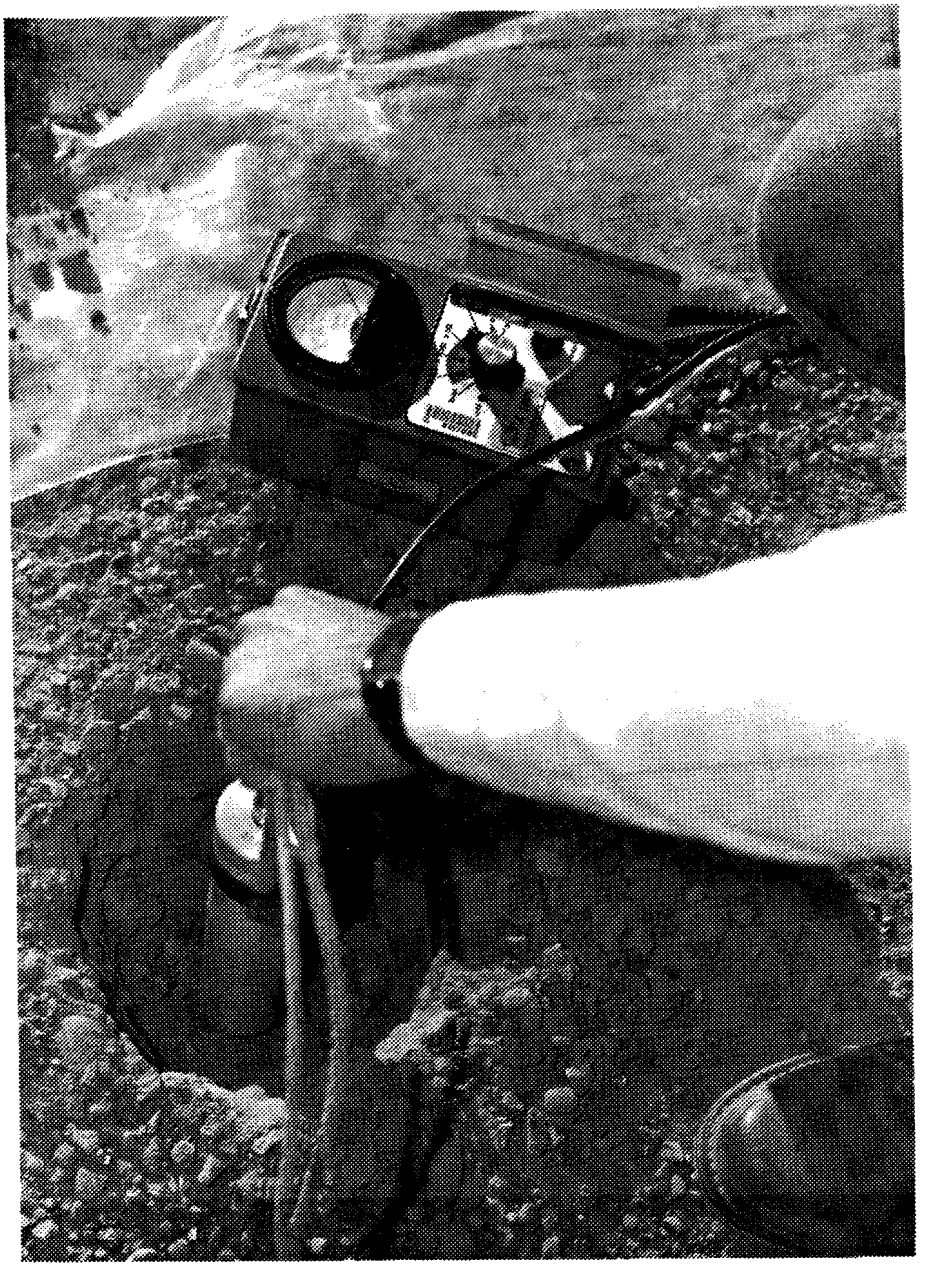
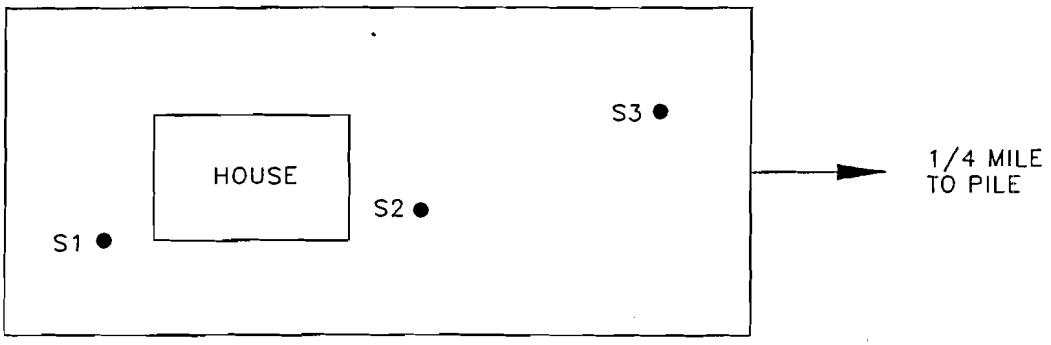
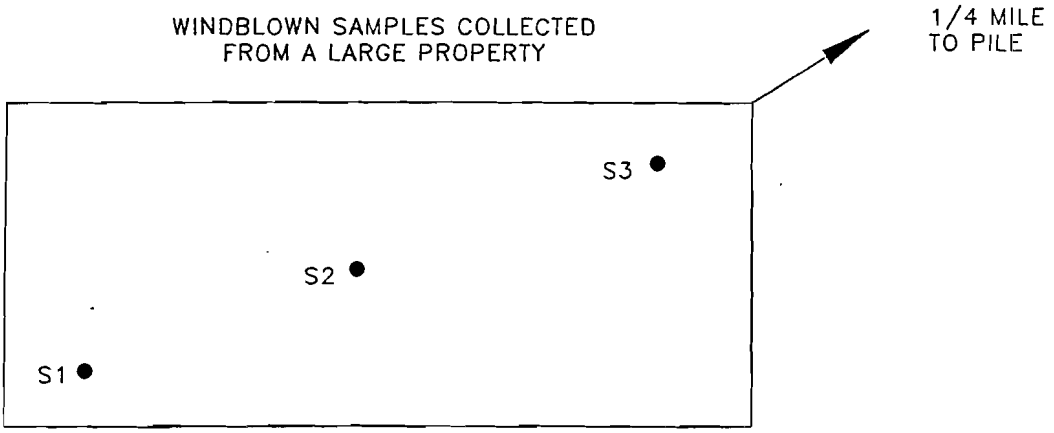


Exhibit 2. Methods of Locating Windblown Samples

WINDBLOWN SAMPLES COLLECTED FROM A SMALL PROPERTY



WINDBLOWN SAMPLES COLLECTED FROM A LARGE PROPERTY



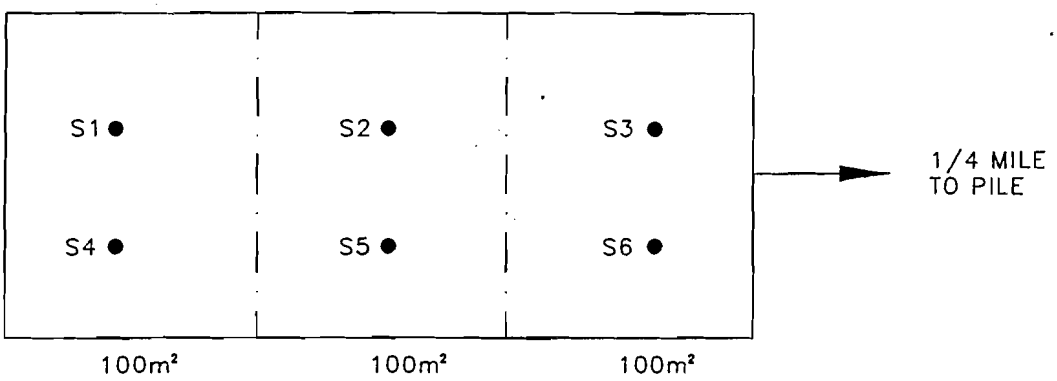


Exhibit 3. Sampling Equipment

Exhibit 4. Decontamination of Sample Collection Equipment

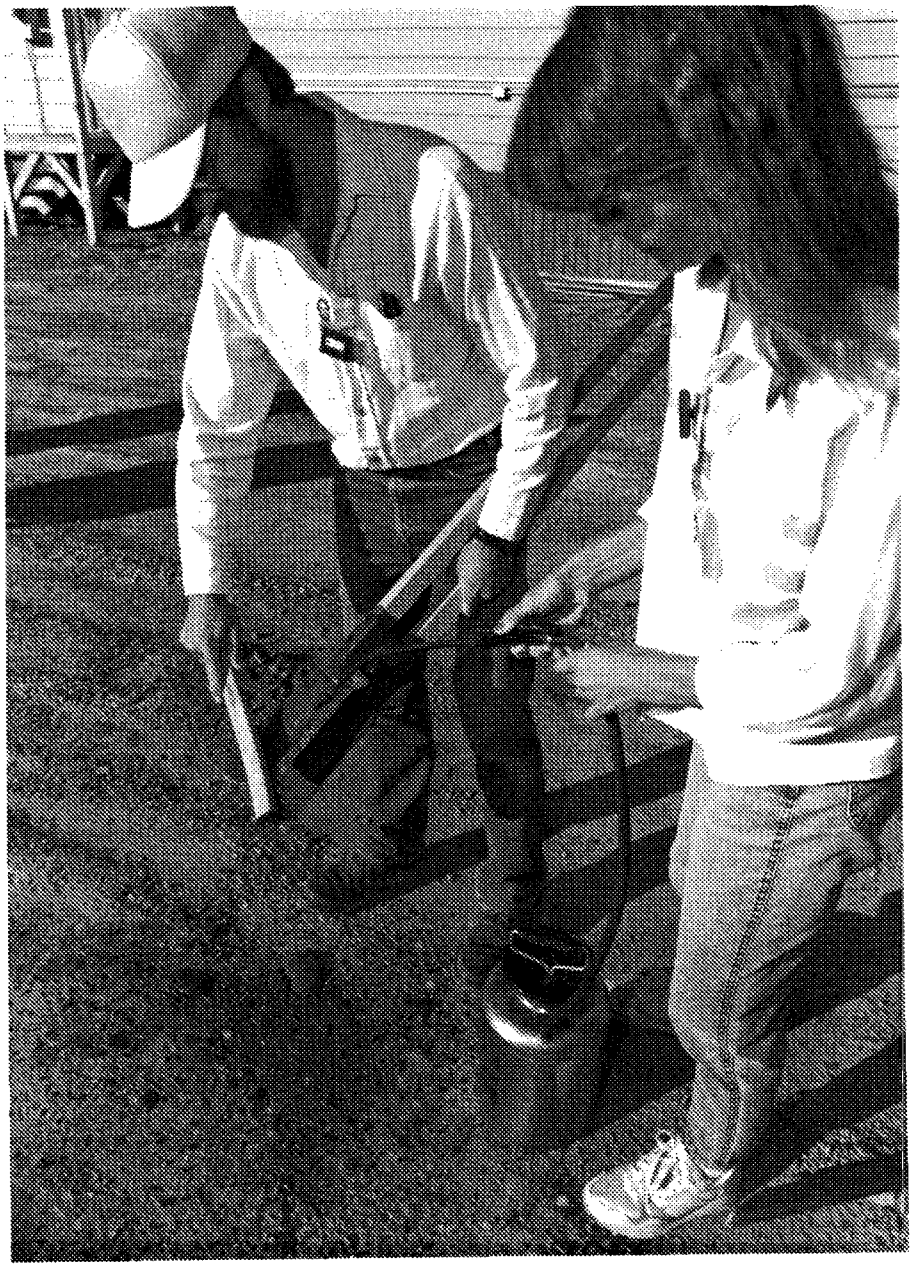


Exhibit 5. Example of Field Map

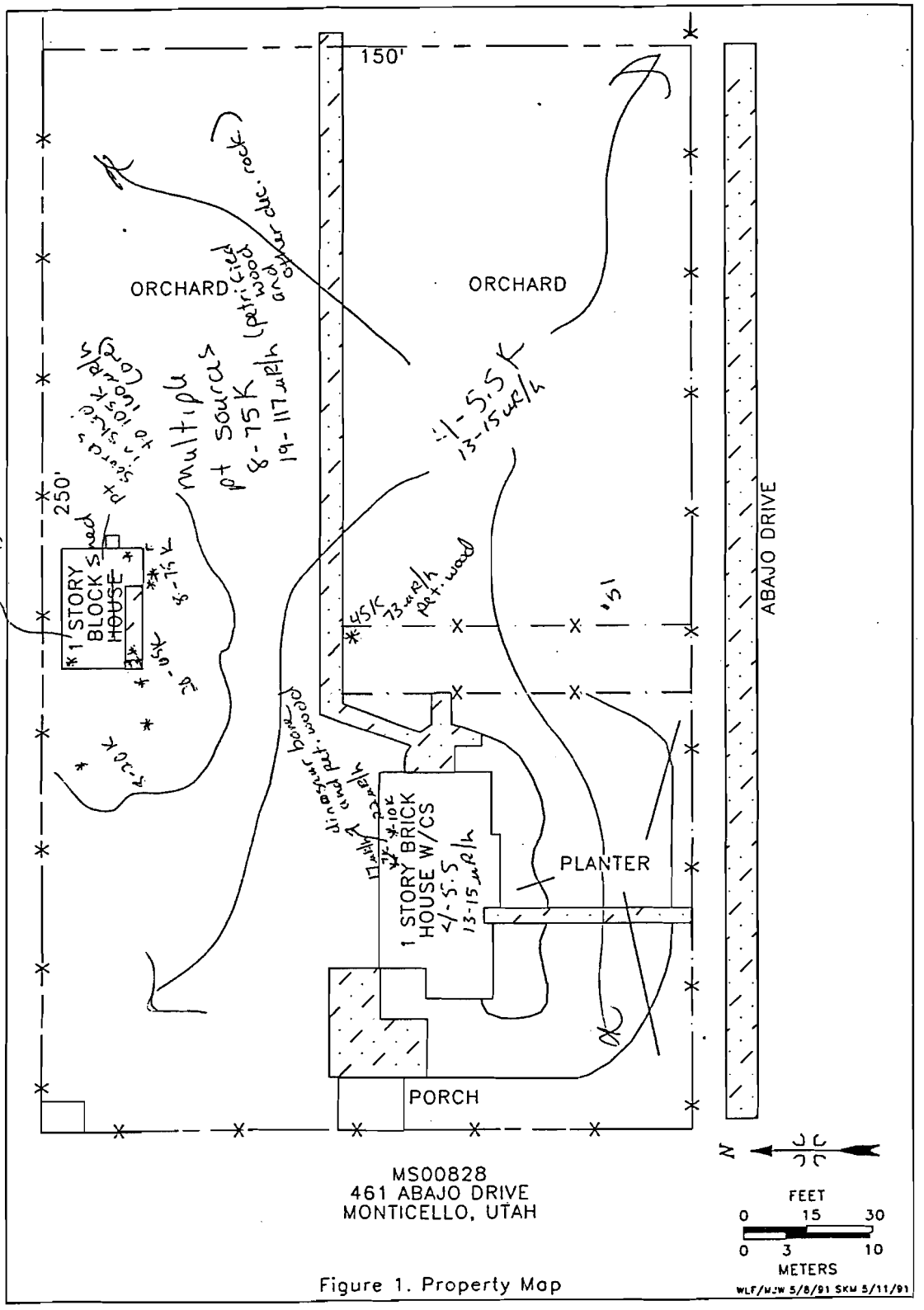


Figure 1. Property Map

GAMMA SCINTILLATION DETECTOR OPERATION

1.0 PURPOSE

This procedure briefly describes the operation of gamma scintillation detectors. For more detailed information about the instrument, refer to the manufacturer's instruction manual.

2.0 APPLICABILITY

This procedure applies to scintillation survey instruments used for detecting gamma radiation.

3.0 OTHER DOCUMENTS

3.1 REFERENCES

3.1.1 *Instrumentation Manual for Model 490, THYAC III*, Victoreen, Inc., Cleveland, OH.

3.2 APPENDICES

3.2.1 Appendix 1: Radiological Screening Summary

3.3 EXHIBITS

3.3.1 Exhibit 1: Survey Method

4.0 EQUIPMENT AND MATERIALS

4.1 EQUIPMENT

4.1.1 Victoreen portable ratemeter, Model 490, THYAC III, 0-800; 0-8,000; 0-80,000; 0-800,000 counts per minute (cpm); Victoreen Instrument Company
4.1.2 Battery: two (2) D-cell batteries, NEDA Type 13
4.1.3 Gamma scintillation probe, Model 489-55 [1.25 in. by 1.50 in.

Approved by:

Joyce K. Hilford 3/19/91 (Date)

Craig Little 3/20/91
C.A. Little (Date)

sodium iodide (thallium activated) scintillation crystal], Victoreen Instrument Company, to match corresponding ratemeter

4.1.4 Headphone set that attaches to ratemeter

4.1.5 A 6-ft nylon cord (or equivalent) attached to the top of the scintillation probe for use in handling the probe while surveying

5.0 RESPONSIBILITY

5.1 TEAM LEADER

The team leader assures that instruments are available and returned from the field each day and reports nonconformance items to the electronics technician.

5.2 TEAM MEMBERS

Team members prevent loss of or damage to instruments and clean and decontaminate instruments after field use.

5.3 ELECTRONICS TECHNICIAN

The electronics technician inventories field instruments and repairs inoperable instruments or transfers inoperable instruments to the Chem-Nuclear Geotech electronics laboratory for repair.

6.0 FREQUENCY

Perform the field check prior to the first field survey of each day.

7.0 PROCEDURE

7.1 EQUIPMENT SET UP

7.1.1 Remove the ratemeter and corresponding probe from storage in the survey vehicle and visually check for physical damage. If physically damaged, do not use; report damage to the instrument technician.

7.1.2 Attach the headphone set to the phone connector on the ratemeter. The headphone provides an audio indication of gamma radiation intensity.

7.1.3 Initially set the range at the highest level (x 1000). If the meter reading is less than 10% of full scale, switch to the next lower level (x 100). Repeat this procedure until the reading is over 10% of full scale.

7.1.4 The Model 490 Ratemeter has three response times designated slow, medium, or fast, which correspond to approximately 15 s, 5 s, and 1.5 s, respectively. The medium response is used for the majority of the readings.

7.2 FIELD CHECK

7.2.1 Check the battery condition by setting the Range switch to the "BAT" position and observing the THYAC III meter. The indicator should be in the "Battery Check" region or battery replacement is mandatory. (See the instruction manual for Model 490, THYAC III).

7.2.2 Enter in the field van logbook the instrument number, battery check, date, location at which the field check is made, and initials of person making the check.

7.2.3 Set the Response switch to the "MEDIUM" position and the Range switch to the appropriate position (the maximum upscale deflection without going off scale).

7.2.4 Determine the background level and record the background cpm in the field van logbook. This is usually done at a reference site for the area to be surveyed.

7.2.5 Place the probe in contact with the depleted uranium check source and read the gross cpm. Record the gross cpm in the field van logbook.

7.2.6 Calculate the net cpm by subtracting the background cpm from the gross cpm. Record the net cpm in the logbook. The net cpm reading must be within laboratory accepted limits (approximately ±20% of the reading taken during the previous field check).

7.2.7 If the net cpm is within the acceptable range, the instrument is now ready for use. If the net cpm is out of the acceptable range, change batteries and repeat steps 7.2.5 through 7.2.6. If the reading is still out of the acceptable range, return the instrument to the PAG electronics technician for repair and recalibration.

7.3 DISCRETE MEASUREMENTS (GAMMA SCINTILLOMETER)

7.3.1 Place the scintillometer probe against or at a specified distance from the surface to be surveyed.

7.3.2 Observe the count rate as displayed on the rate meter. Note the average value in cpm and record it on the radiological screening summary page of the field data sheets (Appendix 1).

7.3.3 When the survey is complete, turn the instrument off.

7.4 FIELD SCAN SURVEY PROCEDURES

7.4.1 Traverse the property to be surveyed by following parallel, adjacent but slightly overlapping, 3- to 4-ft wide paths. While traversing the property, the surveyor should move the detector from side to side (covering a 3- to 4-ft wide area) while holding it as close to the ground as possible (less than 6 in.); see Exhibit 1, Survey Method. The presence of rocks and other objects may not permit holding the detector at a constant height.

7.4.2 Use the detector's audio response to identify areas of anomalous radiation levels. Periodically observe the meter response to obtain an estimate of the average levels measured.

7.4.3 Note average background levels and their locations and readings at all locations with elevated radioactivity. Enter the observed detector response (cpm) on the radiological screening summary and on the field map for the appropriate surveyed site.

7.4.4 When the entire survey site has been scanned, turn the instrument off.

7.5 EQUIPMENT USE DURING INCLEMENT CONDITIONS

During inclement weather, cover each probe and ratemeter with a plastic sample bag and secure at the open end with tape; use the instrument as indicated in Sect. 7.4. Remove the bags prior to prolonged storage to prevent damage from condensation.

Appendix 1. Radiological Screening Summary

OAK RIDGE NATIONAL LABORATORY
RADIOLGICAL SCREENING SUMMARY

SITE # _____
SURVEY DATE _____

SURVEY TEAM: _____ (LEADER) _____ _____
_____ _____ _____

SURVEY INSTRUMENTS USED FOR CORRELATION
gamm-rate meter # _____
PIC # _____

uR/h CONVERSION FORMULA USED
_____ uR/h = 1.69 K + 3.45
_____ other uR/h

_____ DIRECT CONVERSION
cpm/uR/h (see below)

LOCATION	PIC(uR/h)	(cpm x 1000)
LOCATION	PIC(uR/h)	GAMMA-RATE METER - 6"

CONVERSION(cpm/uR/h)

BACKGROUND GAMMA-SCAN RANGE

Outdoor
_____ to _____ cpm x 1000
_____ to _____ uR/h

Indoor
_____ to _____ cpm x 1000
_____ to _____ uR/h

INDOOR SCAN RANGE:

INDOOR MAP _____ YES _____ NO

Region 1: _____ kcpm _____ uR/h Average: _____ kcpm _____ uR/h Area _____ m²
2: _____ kcpm _____ uR/h Average: _____ kcpm _____ uR/h Area _____ m²
3: _____ kcpm _____ uR/h Average: _____ kcpm _____ uR/h Area _____ m²

Non-Point Source HIG: _____ kcpm _____ uR/h Location: _____
Point Source HIG: _____ kcpm _____ uR/h Location: _____

Comments: _____

OUTDOOR SCAN RANGE:

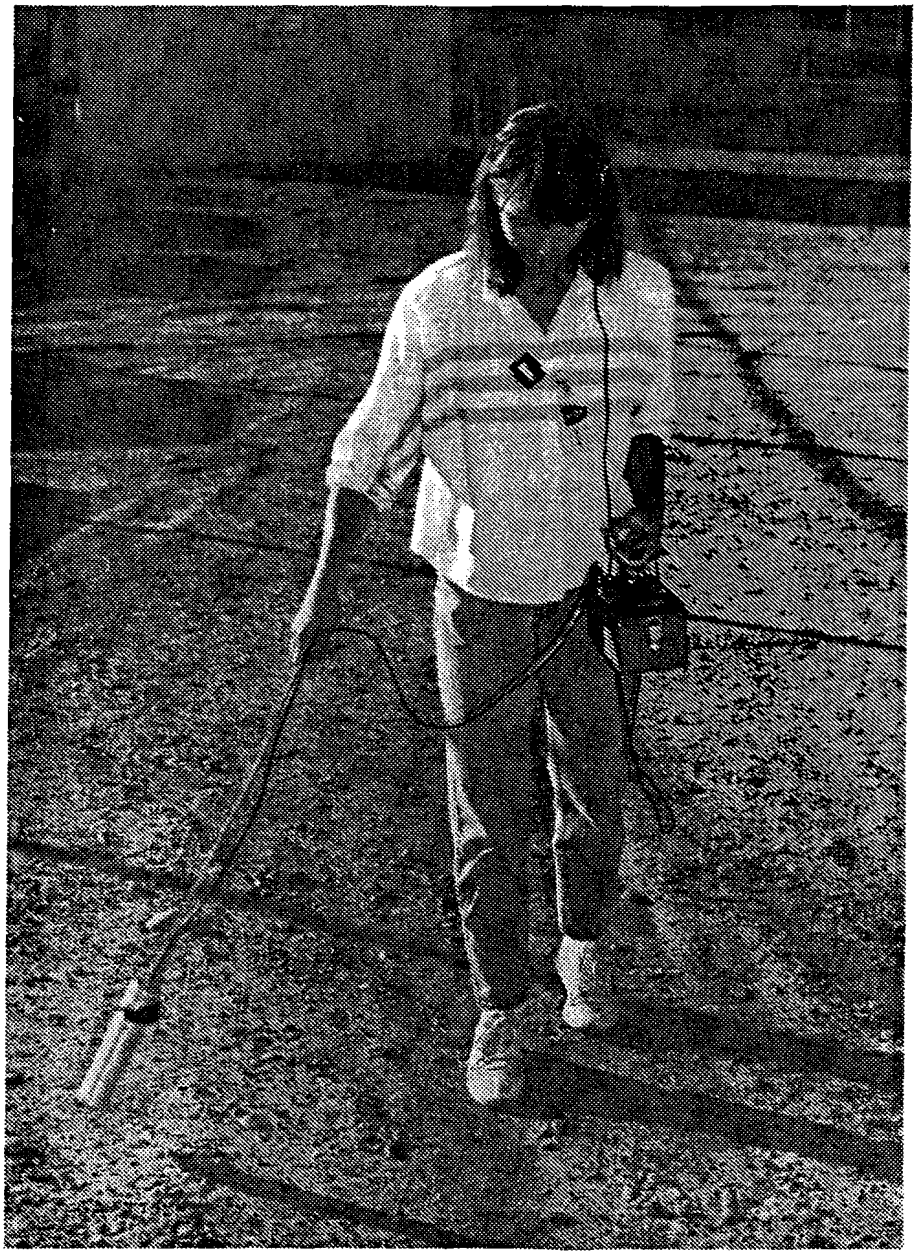
Region A: _____ kcpm _____ uR/h Average: _____ kcpm _____ uR/h Area _____ m²
B: _____ kcpm _____ uR/h Average: _____ kcpm _____ uR/h Area _____ m²
C: _____ kcpm _____ uR/h Average: _____ kcpm _____ uR/h Area _____ m²
D: _____ kcpm _____ uR/h Average: _____ kcpm _____ uR/h Area _____ m²
E: _____ kcpm _____ uR/h Average: _____ kcpm _____ uR/h Area _____ m²

Non-Point Source HOG: _____ kcpm _____ uR/h Location _____
Point source HOG: _____ kcpm _____ uR/h Location _____

Comments: _____

PROPERTY RECOMMENDED FOR: EXCLUSION ___ INCLUSION ___ (see addtl. data sheets)
SOIL ANALYSIS REQUIRED FOR DETERMINATON: _____ YES _____ NO
INDOOR EXTENDED MEASUREMENTS REQUIRED: _____ YES _____ NO
PERSONNEL & EQUIPMENT INSPECTED & DECONTAMINATED: _____ YES

Exhibit 1. Survey Method



PRESSURIZED IONIZATION CHAMBER (PIC) OPERATION

1.0 PURPOSE

This procedure briefly describes the operation of the pressurized ionization chamber (PIC). For more detailed information about the instrument, refer to the manufacturer's instruction manual.

2.0 APPLICABILITY

This procedure applies to the operation of the PIC, which is used to convert the gamma exposure rate reading measured by the gamma scintillation detector expressed in kcpm to gamma exposure rate expressed in μR/h.

3.0 OTHER DOCUMENTS

3.1 REFERENCES

3.1.1 *Operational Manual RS-111 Area Monitor System*, Second Printing, Reuter Stokes Inc., Cleveland, OH.
3.1.2 SU-021, Calibration of Pressurized Ionization Chamber.

3.2 APPENDICES

3.2.1 Appendix 1: Radiological Screening Summary
3.2.2 Appendix 2: Correlation between PIC Readings and Gamma Scintillation Detector Measurements

3.3 EXHIBITS

3.3.1 Exhibit 1: Pressurized Ionization Chamber (PIC)

4.0 EQUIPMENT AND MATERIALS

4.1 EQUIPMENT

Reuter Stokes Portable Environmental Radiation Monitor Model RSS-111. This system includes the following:

Approved by:

Joe K. Halford 3/19/91 (Date)

C.A. Little 3/20/91 (Date)

4.1.1 Monitor
4.1.2 Digital display
4.1.3 Auto-disconnect battery pack with batteries
4.1.4 Integrating digital readout apparatus with timer (see Exhibit 1)

4.2 MATERIALS

4.2.1 Radiological screening summary (Appendix 1)

5.0 RESPONSIBILITY

5.1 TEAM LEADER

The team leader ensures that instruments are available and returned from the field each day and reports nonconformance items to the electronics technician. The team leader is responsible for selection of PIC data collection locations and recording the data correctly.

5.2 TEAM MEMBERS

Team members prevent loss of or damage to instruments and clean and decontaminate instruments after field use. Team members are responsible for taking PIC readings and assisting the team leader in documentation of field data.

5.3 ELECTRONICS TECHNICIAN

The electronics technician inventories field instruments and repairs inoperable instruments or transfers inoperable instruments to the Chem-Nuclear Geotech electronics laboratory for repair.

6.0 DEFINITIONS

6.1 PIC: pressurized ionization chamber.

7.0 PROCEDURE

7.1 CHECKOUT PROCEDURE

7.1.1 Place the sensor head directly on the surface to be measured with handle facing upward.

7.1.2 Make sure all switches are OFF.

7.1.3 Connect all cables... 12VDC, V/F, ints. to the head.

7.1.4 Turn the ELECTROMETER switch to ZERO.

7.1.5 Turn the MODE switch to BATT.

7.1.6 Turn the DISPLAY/RECORDER switch to ON.

7.1.7 Simultaneously depress the μR/h switch and the 300 V switch.

a. Display will give the % of full charge for the 300 V battery.

b. This battery should be replaced when the charge degrades to 85% or less.

c. -14V, +14V, and +12 V checks must be in white or recharge.

7.2 OPERATING PROCEDURE

7.2.1 The DISPLAY/RECORDER switch may be turned off unless the LED readout on the instrument is needed.

7.2.2 Turn the ELECTROMETER switch to READ when it has been on ZERO for about 60 s to allow the transients to die.

7.2.3 Take several 9-s readings until stabilized.

7.2.4 Use the 180-s setting for readings.

7.2.5 When through, turn OFF all switches before disconnecting the cables.

7.2.6 Field check: See SU-021, Calibration of Pressurized Ionization Chambers.

7.3 FIELD PROCEDURE

7.3.1 After the entire survey site has been scanned with the gamma scintillometer, place the PIC sensor head on an average background region as assigned by the survey site team leader. The head faces are numbered 1-4. Always place face #1 in the general direction of north.

7.3.2 Read and record the PIC measurement.

7.3.3 Remove the sensor head and place the scintillometer probe 15 cm above the surface of the assigned sensor head location; read and record the scintillometer measurement.

7.3.4 Repeat as indicated by the team leader on the HOG, HIG, and any other desired anomalies and/or background activity locations.

7.3.5 When all desired measurements have been taken, turn off the instrument.

7.4 EQUIPMENT USE DURING INCLEMENT CONDITIONS

7.4.1 Cover each sensor head and the monitor with large plastic storage bags.

7.4.2 Secure the bag at the open end with tape.

7.4.3 Use the instrument as indicated in Sect. 7.2

7.4.4 Remove the bags prior to prolonged storage.

7.5 DATA CONVERSION

Convert gamma scintillator data to μR/h using a conversion factor as determined in Appendix 2, Correlation between PIC Readings and Gamma Scintillation Detector Measurements.

Appendix 1. Radiological Screening Summary

OAK RIDGE NATIONAL LABORATORY
RADIOLGICAL SCREENING SUMMARY

SITE #_____
SURVEY DATE_____

SURVEY TEAM:_____(LEADER) _____ _____
_____ _____ _____

SURVEY INSTRUMENTS USED FOR CORRELATION
gamm-rate meter #_____
PIC #_____

uR/h CONVERSION FORMULA USED
_____uR/h = 1.69 K + 3.45
_____other uR/h
_____DIRECT CONVERSION
cpm/uR/h (see below)

LOCATION	PIC(uR/h)	(cpm x 1000)
LOCATION	PIC(uR/h)	GAMMA-RATE METER - 6"

			CONVERSION(cpm/uR/h)
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

BACKGROUND GAMMA-SCAN RANGE

Outdoor
_____to_____cpm x 1000
_____to_____uR/h

Indoor
_____to_____cpm x 1000
_____to_____uR/h

INDOOR SCAN RANGE:

INDOOR MAP_____YES_____NO

Region 1: _____kcpm _____uR/h Average:_____kcpm_____uR/h Area____m^2
2: _____kcpm _____uR/h Average:_____kcpm_____uR/h Area____m^2
3: _____kcpm _____uR/h Average:_____kcpm_____uR/h Area____m^2

Non-Point Source HIG:____kcpm _____uR/h Location:_____
Point Source HIG: _____kcpm _____uR/h Location:_____

Comments:_____

OUTDOOR SCAN RANGE:

Region A:_____kcpm_____uR/h Average:_____kcpm_____uR/h Area____m^2
B:_____kcpm_____uR/h Average:_____kcpm_____uR/h Area____m^2
C:_____kcpm_____uR/h Average:_____kcpm_____uR/h Area____m^2
D:_____kcpm_____uR/h Average:_____kcpm_____uR/h Area____m^2
E:_____kcpm_____uR/h Average:_____kcpm_____uR/h Area____m^2

Non-Point Source HOG: ____kcpm_____uR/h Location_____
Point source HOG: _____kcpm _____uR/h Location_____

Comments:_____

PROPERTY RECOMMENDED FOR: EXCLUSION___INCLUSION___(see addtl. data sheets)
SOIL ANALYSIS REQUIRED FOR DETERMINATON: _____YES _____NO
INDOOR EXTENDED MEASUREMENTS REQUIRED: _____YES _____NO
PERSONNEL & EQUIPMENT INSPECTED & DECONTAMINATED: _____YES

Appendix 2. Correlation between PIC Readings and Gamma Scintillation Detector Measurements

Readings are taken with both the gamma scintillation detector and the PIC to determine a conversion factor for each study area, until a conversion equation has been determined by linear regression.

Calculate a conversion factor (CF) as follows:

$$CF = G_1/P_1$$

where:

G_1 = gamma scintillation detector reading in kcpm at Location 1

P_1 = PIC reading in μR/h at Location 1

Calculate a separate conversion factor for representative and contaminated areas, and where there are grossly different gamma range readings for individual contaminated regions.

Correlation between the PIC and the scintillometer is assumed to be linear according to the equation:

$$Y = X/CF$$

where:

Y = μR/h
X = scintillometer data in kcpm
CF = conversion factor

Exhibit 1. Pressurized Ionization Chamber (PIC)

GR-410 PORTABLE GAMMA SPECTROMETER OPERATION

1.0 PURPOSE

This procedure describes the operation of the GR-410 portable gamma spectrometer. For more detailed information, refer to the manufacturer's instruction manual.

2.0 APPLICABILITY

This procedure applies to the operation of the GR-410 portable gamma spectrometer used for differentiating the source of gamma radiation.

3.0 OTHER DOCUMENTS

3.1 REFERENCES

3.1.1 *Technical Manual for Portable Gamma Ray Spectrometer*, V3342, V. 1 and 2, Geometrics/Exploranium Corporation Canada, Ltd., 1977.

3.1.2 Procedure TE-020, Inclusion Survey Activities.

3.2 APPENDICES

3.2.1 Appendix 1: Extended Measurements Data Form

3.3 EXHIBITS

3.3.1 Exhibit 1: GR-410 Portable Gamma Spectrometer

4.0 EQUIPMENT AND MATERIALS

4.1 EQUIPMENT

4.1.1 Model GR-410 Portable Gamma Ray Spectrometer, GeoMetrics, Inc.
4.1.2 Portable Detector GPX-21, GeoMetrics, Inc.
4.1.3 Interface cable
4.1.4 Field pack for carrying instrument

Approved by:

Douglas K. Holland 2/3/92 (Date)

Craig A. Little 2/4/92
C.A. Little (Date)

4.2 MATERIALS

4.2.1 Twelve D-cell batteries

5.0 RESPONSIBILITY

5.1 The team leader is responsible for the following:

5.1.1 Ensures that instruments are available and are returned from the field each day;

5.1.2 Reports instrument nonconformance to the electronics technician;

5.1.3 Selects data collection locations;

5.1.4 Ensures that the data is recorded correctly.

5.2 Team members are responsible for the following:

5.2.1 Preventing loss of or damage to instruments;

5.2.2 Cleaning and decontaminating instruments after field use;

5.2.3 Taking gamma spectrometer readings;

5.2.4 Assisting the team leader in field data documentation.

5.3 The electronics technician is responsible for the following:

5.3.1 Keeping inventories of field instruments;

5.3.2 Repairing inoperable instruments or transferring them to the Chem-Nuclear Geotech electronics laboratory for repair.

6.0 PROCEDURE

6.1 Set up the instrument for operation.

6.1.1 Remove the outer casing of the instrument package.

6.1.2 Check that the three dials on the right side are at the following settings, left to right:

a. Th = 8.68
b. U = 5.82
c. K = 4.42

6.1.3 Reset any incorrect dials by rotating the cylinder through the hole on the top above the dial.

6.1.4 Check battery charge.

a. Turn the FUNCTION selector to BT where the meter needle should be within the green triangle designated BATT.

b. If the needle is to the left of the triangle, the batteries need to be replaced.

6.1.5 The messages in the message indicator window have the following meanings:

Message	Meaning
1*	Total counts are being displayed (all energies between 0.5 and 3.0 MeV).
2*	K counts are being displayed (window peak is 1.46 MeV).
3*	U (Ra) counts are being displayed.
4*	Th counts are being displayed.
A	Instrument is counting (accumulating).
C (flashing)	Unit requires gain calibration.
L (flashing)	Battery charge too low; replace batteries

* Flashing indicates an overflow in channel; a shorter counting period is required.

NOTE: K window peak is 1.46 MeV.
U (Ra) window peak (^{214}Bi) is 1.76 MeV.
Th window peak (^{208}Tl) is 2.61 MeV.

6.2 Measure gamma radiation.

6.2.1 Turn the FUNCTION selector to GM.

a. Check that the meter needle is centered between the two green triangles marked -E and +E.

b. If not, unlock the GAIN selector by moving the black peg (next to the dial) up.

c. Rotate the dial until the needle is centered between the two triangles.

d. Lock the GAIN selector by moving the black peg back down.

6.2.2 Turn the FUNCTION selector to MIN (minutes).

6.2.3 Turn the SAMPLE PERIOD selector to the desired period.

a. Select a time period to give a minimum Th count of about 100, approximately 10 min in background areas.

b. Three 1-min interval readings give a good range of results to average when measuring a region of elevated gamma.

6.2.4 Press the READ button momentarily to turn the power on.

a. A flashing "C" appears in the message indicator for about 5 s as the system gain stabilizes.

b. If the "C" continues to flash, recalibrate the gain as described above.

6.2.5 Place the detector head against the material to be measured.

a. This should preferably be a flat surface.

6.2.6 After the flashing "C" has disappeared, press the READ button once more.

a. The message indicator displays an "A"; this indicates that the system is counting.

b. At the end of the counting period, the "A" disappears and an alarm sounds.

6.2.7 Press the READ button a third time.

a. The unit displays the accumulated counts for each of the four channels for 4 s in the following order: total counts, K, Ra, and Th.

b. A flashing number in the message indicator window during the display of the accumulated counts indicates that an overflow has occurred in that channel and a shorter counting period is required.

c. During the display of total counts, a red light flashes next to the message indicator, indicating that the displayed results should be multiplied by 10.

6.3 Record data.

6.3.1 Record gamma spectrometer data on the Extended Measurements Data Form. See Appendix 1.

6.3.2 Calculate and record the Ra:Th ratio using the average of the Ra and Th counts.

a. This ratio is used during inclusion survey activities to determine if the source of gamma radiation is mill tailings related. See Procedure TE-020.

6.3.3 A gamma spectral readout may accompany concrete and asphalt coring and radon monitoring.

Appendix 1. Extended Measurements Data Form

EXTENDED MEASUREMENTS DATA FORM

Date:

Location Number:	Exposure Rates Kcpm:						
Address:	uR/h:						
	Gamma Spec Data Time Intervals:						Ave
Source Code:	Total Cts:						
Source Def. & Sample Location:	K Cts:						
	Ra Cts:						
Sample Number:	Th Cts:						
Sample Depth Interval:	Ra/Th Ratio						

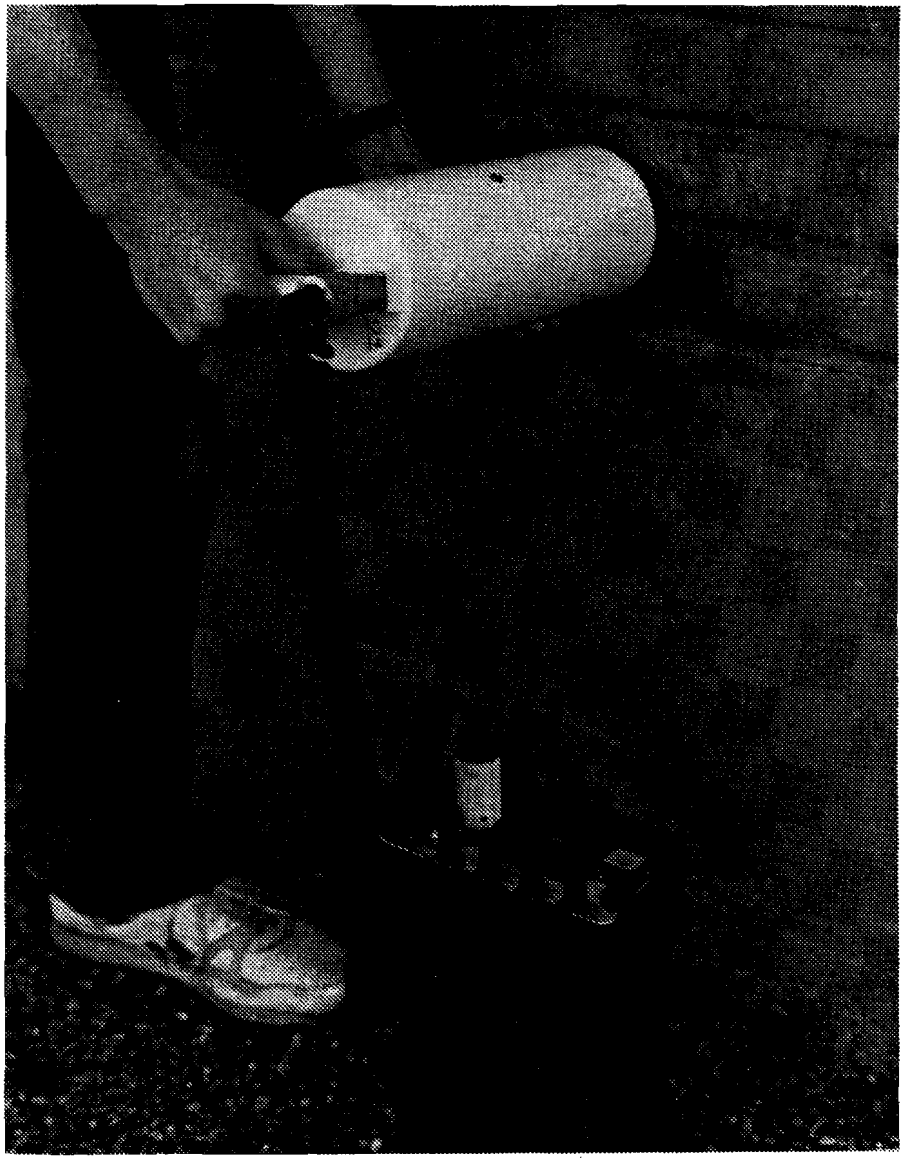
Remarks:

Date:

Location Number:	Exposure Rates Kcpm:						
Address:	uR/h:						
	Gamma Spec Data Time Intervals:						Ave
Source Code:	Total Cts:						
Source Def. & Sample Location:	K Cts:						
	Ra Cts:						
Sample Number:	Th Cts:						
Sample Depth Interval:	Ra/Th Ratio						

Remarks:

Exhibit 1. GR-410 Portable Gamma Spectrometer



DELTA COUNTER OPERATION

1.0 PURPOSE

This procedure briefly describes the operation of the delta counter.

2.0 APPLICABILITY

This procedure applies to the operation of the delta counter used to determine the difference (or delta) between the amount of gamma radiation emanating from adjacent sources of radiation and the amount of gamma radiation emanating from directly beneath the delta counter.

3.0 OTHER DOCUMENTS

3.1 APPENDICES

3.1.1 Appendix 1: Delta Gamma Field Data

4.0 EQUIPMENT AND MATERIALS

4.1 EQUIPMENT

4.1.1 Bendix-designed delta counter EL-0018 or EL-0018a
4.1.2 Field check jig BFEC-EL0012 or equivalent

4.2 MATERIALS

4.2.1 Radium source BFEC 10027-2 or equivalent for the Bendix EL-0018 with front mounted detector or BFEC RA-32b2 or equivalent for the Bendix EL-0018a
4.2.2 Metal shield
4.2.3 Delta gamma field data sheet (Appendix 1)
4.2.4 Delta calibration logbook

Approved by:

Joyce K. Hilford 3/19/91 (Date)

Craig Little 3/20/91
C.A. Little (Date)

5.0 RESPONSIBILITY

5.1 TEAM LEADER

The team leader ensures that instruments are available and returned from the field each day and reports nonconformance items to the electronics technician. The team leader is responsible for selecting the appropriate measurement locations and for recording data accurately.

5.2 TEAM MEMBERS

Team members prevent loss of or damage to instruments and clean and decontaminate instruments after field use. Team members are responsible for taking delta counter readings and assisting the team leader in field data documentation.

5.3 ELECTRONICS TECHNICIAN

The electronics technician inventories field instruments and repairs inoperable instruments or transfers inoperable instruments to the Chem-Nuclear Geotech electronics laboratory for repair.

6.0 FREQUENCY

The field check for the delta counter is performed prior to the field survey by the team members.

7.0 PROCEDURE

7.1 DELTA COUNTER FIELD CHECK

7.1.1 Turn the power switch ON.

7.1.2 If the batteries are low, an arrow and colons will appear in the display; batteries should be replaced if these indicators appear.

7.1.3 Select the proper counting interval of 5 min.

7.1.4 Remove the metal shield from the base of the instrument.

7.1.5 Match the plastic source jig GJ# to the GJ# on the delta counter. Place the Ra-226 source with the matching GJ# in the source jig.

7.1.6 Press the START button to begin the UP (total) count (the UP and DOWN counts are both initiated by pressing the START button).

7.1.7 Verify that the count is increasing. The RESTART switch can be used to initiate counting at any point.

7.1.8 After 5 min, the delta counter emits an audible signal. Record the total count in the verification field calibration logbook.

7.1.9 Insert the metal shield into the base of the counter.

7.1.10 Push the START button and verify that the count is decreasing. Count DOWN for 5 min.

7.1.11 Record the difference, or delta count, in the delta calibration logbook.

7.1.12 If the delta count is not within the range stipulated, the measurement must be repeated. If the second delta count is also outside the range, the instrument cannot be used. Report the instrument's failure to the electronics technician and obtain a replacement delta counter.

7.2 FIELD MEASUREMENTS WITH DELTA COUNTER

7.2.1 Position the instrument on the surface to be measured. A plastic bag may be placed between the detector and the soil to protect it from contamination or dampness as needed.

NOTE: If possible, the instrument should not be moved during the sequence of unfiltered and filtered measurements.

7.2.2 Turn the instrument on and set the counting interval at 2 min.

7.2.3 With the metal shield removed, depress the START button to initiate the total count. Make sure the count is increasing; if not, RESET the instrument and start again.

7.2.4 At the end of the counting interval, record the total count on the delta gamma field data sheet.

7.2.5 Place the metal shield into the slot beneath the detector without moving the detector, if possible.

7.2.6 Depress the START button and verify that the count is decreasing. If not, RESET and start again.

7.2.7 At the end of the counting interval record the difference, or delta count, on the delta gamma field data sheet.

7.3 DATA REDUCTION OF DELTA COUNTS

Reduction of the delta counts per second to equivalent-radium (^{226}Ra) concentrations is accomplished by a program in Quick Basic Clipper. The program is called DELTA10.EXE and is started with a batch file called DELTA.BAT. The team leader and electronics technician can assist team members in locating and running the program.

Appendix 1. Delta Gamma Field Data

VICINITY PROPERTY INDEPENDENT VERIFICATION

DELTA GAMMA FIELD DATA SHEET

PROPERTY ADDRESS: _____ LOCATION NUMBER _____

_____ INSTRUMENT GJAO # _____

_____ CALIBRATION EXPIRES _____

TECHNICIAN NAME : _____ DATE _____

RESULTS CALCULATED BY: _____

****

ALL COUNT TIMES ARE 120 SECONDS UNLESS NOTED OTHERWISE

SAMPLE LOCATION	TOTAL COUNT	DELTA COUNT	%UNCERTAINTY (<15%)	Ra-226 pCi/g	DEPTH cm	COMMENTS (OPTIONAL)

UCN17173(8/90)

DETERMINATION OF REMOVABLE CONTAMINATION

1.0 PURPOSE

This procedure describes the method for measuring removable alpha and beta-gamma radioactivity on equipment and building surfaces.

2.0 APPLICABILITY

When contamination is suspected, levels of contamination on equipment and building surfaces must be determined according to criteria set forth for specific sites. This procedure applies to measuring removable contamination. See Appendix 1 for removable surface contamination limits for radiation protection of the public.

3.0 OTHER DOCUMENTS

3.1 APPENDICES

3.1.1 Appendix 1: Summary of Contamination Limits
3.1.2 Appendix 2: Lab Smear Data
3.1.3 Appendix 3: Contamination Survey Summary
3.1.4 Appendix 4: Surface Contamination Survey

3.2 EXHIBITS

3.2.1 Exhibit 1: Acquiring a Smear Sample

4.0 EQUIPMENT AND MATERIALS

4.1 EQUIPMENT

4.1.2 Proportional counter

APPROVALS		
Author		Date
Supervisor		Date
Group Leader	Jay K. Halford	Date 8/6/93
Section Head	Clair Little	Date 8/6/93

4.2 MATERIALS

4.2.1 Filter papers
4.2.2 Glassine or paper envelopes

5.0 RESPONSIBILITY

It is the responsibility of field personnel and their supervisors to follow this procedure when surveying for removable radioactive contamination.

6.0 PROCEDURE

6.1 Collect sample.

6.1.1 Applying moderate pressure with two or three fingers, wipe smear (filter) paper over approximately 100 cm^2 of the surface. See Exhibit 1.

a. This area is about the size of a dollar bill.

6.1.2 Place the filter in an envelope.

6.1.3 Complete the Lab Smear Data form (see Appendix 2) by entering the following information:

a. Surveyor's initials

b. Date taken

c. Smear number.

6.1.4 If determining radon or thoron daughters or other short half-life radionuclides, smears should be counted within 1 - 2 hours. Otherwise delay counting for at least 4 hours to permit decay of short-lived radionuclides.

a. For longer half-life radionuclides, send to lab for counting along with the Lab Smear Data form.

6.2 Perform an operational check on the alpha and beta-gamma detectors.

Note: The following instructions are for the Ludlam 2929 Dual Channel Scaler Smear Counter. For instructions on using other smear counters, see the electronics technician.

6.2.1 Obtain alpha and beta-gamma check sources from the electronics technician.

a. The specific source to be used is listed on the top of the instrument.

6.2.2 Turn on the instrument.

a. Check calibration sticker to ensure that calibration date is current.

6.2.3 Collect ten background readings by inserting an empty chamber into the proportional counter and counting for one minute per background count.

a. The dual scaler will give readings simultaneously for alpha and for beta-gamma.

6.2.4 Average the ten background readings each for alpha and for beta-gamma.

6.2.5 Check instrument response by counting the alpha check source for one minute and then the beta-gamma check source for one minute.

a. Place check source in the proportional counter facing up, insert, and lock into place.

6.2.6 Compare net count (gross counts minus background counts) to the 3-sigma range indicated on the side of the instrument.

a. If the net count rate falls within this range, the instrument is usable.

b. If it does not, repeat the check source one minute count.

c. If still out of range, report the instrument to the electronics technician.

6.2 Count smears.

6.2.1 Remove filter paper from envelope and place in the planchet in the counter, smeared side up.

6.2.2 Count for one minute.

a. If contamination levels are high or it is not practical to return the samples to the laboratory for analysis, portable alpha and beta-gamma meters may be used for counting.

6.2.3 Subtract background count (determined by counting blank or un-used smear) and convert net count to dpm/100 cm^2 using proper time and detector efficiency values.

$$dpm/100\ cm^2 = \frac{N}{T \times E}$$

Where

N = net counts
T = count time, min.
E = detector efficiency, counts per disintegration

6.2.4 If the area smeared is other than 100 cm^2, calculate an adjusted counts value and substitute it for net counts in the equation above:

$$C_a = \frac{100\ cm^2}{A} \times N$$

Where

C_a = adjusted counts
N = net counts
A = area smeared, cm^2

6.2.5 Record results on Lab Smear Data form and Contamination Survey Summary (Appendix 3).

a. For samples from individual grid blocks, record results on a separate Surface Contamination Survey form for each Block. See Appendix 4.

Appendix 1. Summary of Contamination Limits

Nuclide (see note 1)	Removable, dpm/100 cm^2 (see notes 2 & 3)	Total (Fixed and Removable), dpm/100 cm^2
U-natural, ^{235}U, ^{238}U and associated decay products	1,000 alpha	5,000 alpha
Transuranics, ^{226}Ra, ^{228}Ra, ^{230}Th, ^{228}Th, ^{231}Pa, ^{227}Ac, ^{125}I, ^{129}I	20	500
Th-natural, ^{232}Th, ^{90}Sr, ^{223}Ra, ^{224}Ra, ^{232}U, ^{126}I, ^{131}I, ^{133}I	200	1,000
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except ^{90}Sr and others noted above. Includes mixed fission products containing ^{90}Sr.	1,000 beta-gamma	5,000 beta-gamma
Tritium organic compounds, surfaces contaminated by tritium gas, tritiated water, and metal tritide aerosols	10,000	10,000

Notes:

1. The values in this table apply to radioactive contamination deposited on but not incorporated into the interior of the contaminated item. Where contamination by both alpha- and beta-gamma-emitting nuclides exists, the limits established for the alpha- and beta-gamma-emitting nuclides apply independently.

2. The amount of removable radioactive material per 100 cm^2 of surface area should be determined by wiping the area with dry filter or soft absorbent paper while applying moderate pressure and then assessing the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. For objects with a surface area less than 100 cm^2, the entire surface should be wiped, and the activity per unit area should be based on the actual surface area. Except for transuranics, ^{226}Ra, ^{227}Ac, ^{228}Th, ^{230}Th, ^{231}Pa and alpha emitters, it is not necessary to use wiping techniques to measure removable contamination levels if direct-scan surveys indicate that the total residual contamination levels are below the values for removable contamination.

3. The levels may be averaged over 1 m^2 provided the maximum activity in any area of 100 cm^2 is less than three times the values in this table.

Source: *Radiation Control Manual.* DOE/EH-0256T. U. S. Department of Energy, 1992.

Appendix 2. Lab Smear Data

LAB SMEAR DATA

TECHNICIAN:________

SMEAR #	DATE / TIME TAKEN	COUNTS	EFFICIENCY	DPM/ 100CM²	DATE / TIME ANALYZED

COMMENTS:________________________________

Appendix 3. Contamination Survey Summary

DATE: _____

AREA IDENTIFIER: _____

SURVEYOR: _____

BLDG: _____

ROOM: _____

CONTAMINATION SURVEY SUMMARY

	INSTRUMENT	BACKGROUND	EFFICIENCY	GEOMETRY	LLD dpm/100cm2	ACTION LEVEL
ALPHA		cpm				
BETA–GAMMA		cpm				
GAMMA		kcpm				

		DIRECT PROBE MEASUREMENTS									REMOVABLE CONTAMINATION (Smears)				
Item/ Grid Block	Point	Alpha		Beta–Gamma					Gamma		Smear #	Alpha		Beta–Gamma	
		cpm	dpm/ 100cm^2	cpm Down	dpm/ 100cm^2	cpm Up	dpm/ 100cm^2	Absorbed Dose Rate	kcpm	μR/h @ 1 meter		cpm	dpm/ 2 100cm	cpm	dpm/ 2 100cm

Comments: _____

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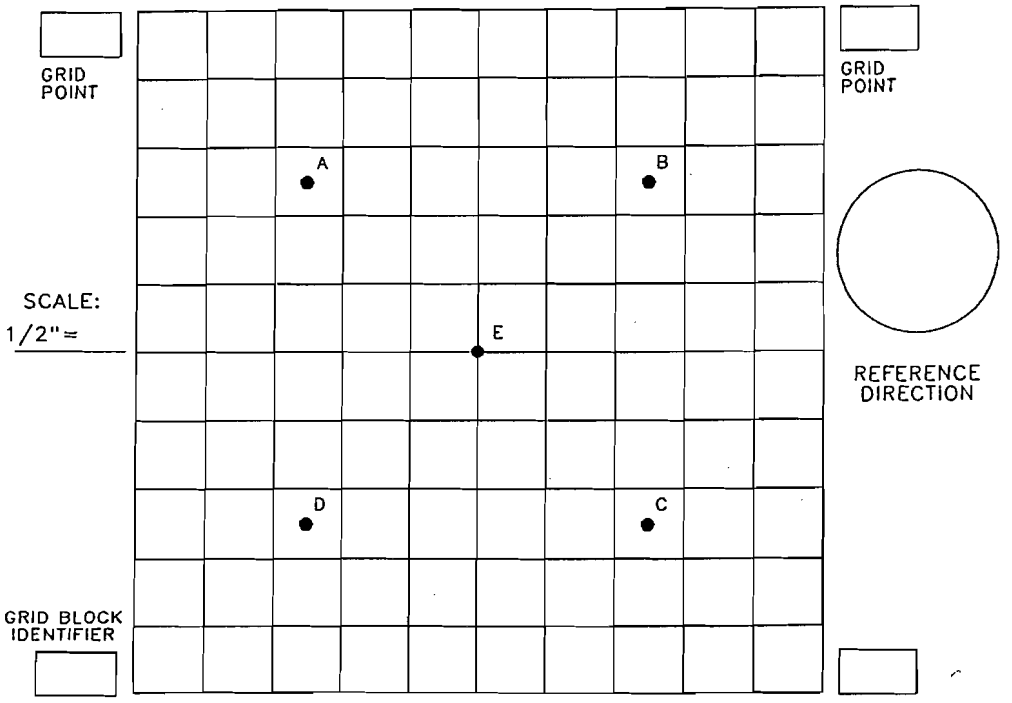
Appendix 4. Surface Contamination Survey

DATE: _____
PHASE: _____
ROOM: _____
BUILDING: _____
TECHNICIANS: _____

SURFACE CONTAMINATION SURVEY

	INST.	BKGD	EFF.	GEOM	LLD DPM/100CM2	ACTION LEVELS
γ		μR/h				
$\beta\gamma$		kcpm				
α		kcpm				



Average or range of levels: α _____ β _____ γ _____

LOCATION	DIRECT PROBE MEASUREMENTS ALPHA cpm	ALPHA dpm/100cm2	$\beta\gamma$ DOWN cpm	$\beta\gamma$ DOWN dpm/100cm2	$\beta\gamma$ UP cpm	$\beta\gamma$ UP dpm/100cm2	DOSE RATE	SMEAR #
A								
B								
C								
D								
E								
AVE								

Comments: _____

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Exhibit 1. Acquiring a Smear Sample

ALPHA RADIATION MEASUREMENT

1.0 PURPOSE

This procedure describes the method for measuring total alpha radiation levels on surfaces that are potentially contaminated with alpha-emitting radionuclides.

2.0 APPLICABILITY

When contamination is suspected, levels of alpha contamination must be determined according to criteria set forth for specific sites. This procedure applies to measuring total contamination, before removable contamination has been sampled. See Appendix 1 for surface contamination limits for radiation protection of the public.

3.0 OTHER DOCUMENTS

3.1 REFERENCES

3.1.1 Field Instrument Logbook
3.1.2 Procedure TE-027, Determination of Removable Contamination
3.1.3 Procedure TE-073, Equipment Decontamination

3.2 APPENDICES

3.2.1 Appendix 1: Summary of Contamination Limits
3.2.2 Appendix 2: Surface Contamination Survey
3.2.3 Appendix 3: Contamination Survey Summary

3.3 EXHIBITS

3.3.1 Exhibit 1: Counting for Alpha Activity

4.0 EQUIPMENT AND MATERIALS

APPROVALS		
Author		Date
Supervisor		Date
Group Leader	Dylan K. Halford	Date 8/6/93
Section Head	Clair Smith	Date 8/6/93

4.1 EQUIPMENT

4.1.1 Alpha scintillation probe:

a. Bicron Analyst A50 Alpha Probe
b. Bicron Analyst A100 Alpha Probe

c. Ludlum 43-65 Alpha Probe

4.1.2 Scaler/ratemeter:

a. Ludlum 2221
b. Bicron Analyst
c. Eberline ESP-2

4.1.3 Cable

4.2 MATERIALS

4.2.1 Alpha check sources
4.2.2 Paint or grease pencil

5.0 RESPONSIBILITY

It is the responsibility of field personnel and their supervisors to follow this procedure when surveying for alpha contamination.

6.0 PROCEDURE

6.1 Perform an operational check on the alpha probe.

NOTE: The following scaler/ratemeter instructions are for the Ludlum 2221 specifically. For instructions when using other scaler/rate-meters, see the electronics technician.

6.1.1 Obtain alpha check sources from the electronics technician.

a. The specific source to be used is listed on the side of the instrument.

6.1.2 Attach alpha probe to scaler/ratemeter.

6.1.3 Turn on scaler/ratemeter.

6.1.4 Check battery which should be > 4.5 volts.

a. Turn instrument switch to OFF when changing batteries or cables.

6.1.5 Set "IN WIN OUT" switch to "OUT".

6.1.6 Check calibration sticker to ensure that calibration date is current.

6.1.7 Collect background count by placing the probe face up on a clean surface and counting for one minute.

6.1.8 Check instrument response by counting for one minute using a check source.

6.1.9 Compare net count (gross count minus background count) to the 3 sigma range indicated on the side of the instrument.

a. If the net count rate falls within this range, the instrument is usable.

b. If it does not, repeat the above steps, acquiring a new background count and gross count.

c. If the net count rate still does not fall within the 3 sigma range, check with the electronics technician.

6.1.10 Enter the following data in the field instrument logbook:

a. Surveyor's initials
b. Date
c. Instrument number
d. Background counts
e. Gross counts
f. Net counts
g. Battery check
h. 3-sigma rate range
i. Instrument efficiency (listed on side of instrument)
j. Comments

6.2 Determine field background.

6.2.1 Set ratemeter in scaler mode.

6.2.2 Set count time to one minute.

6.2.3 Press "Count" to initiate counting.

6.2.4 After counting is completed, repeat for a total of two background readings.

6.2.5 Record the following information on both the Surface Contamination Survey form (Appendix 2) and the Contamination Survey Summary (Appendix 3):

a. the average of the two background readings;

b. the instrument number;

c. instrument efficiency (the reciprocal of the conversion factor);

d. probe geometry (active probe area, cm^2, divided by 100).

6.3 Determine the Lower Limit of Detection (LLD) for the area to be surveyed:

$$LLD = \frac{2.71 + 4.66\sqrt{\frac{B}{T}}}{E \times G}$$

Where

LLD = lower limit of detection, dpm/100 cm^2
B = background, counts
T = count time, min.
E = detector efficiency, counts per disintegration
G = probe area, cm^2 divided by 100

6.3.1 In order for the instrument to be adequately sensitive, the LLD must be < 50% of the applicable guideline.

6.3.2 Enter the LLD value on the appropriate field sheet.

6.4 Determine action level.

$$AL = (SC \times E \times G) + B$$

Where

AL = action level, cpm
SC = site criteria, dpm/100 cm^2
B = background, cpm
E = detector efficiency, counts per disintegration

G = probe area, cm^2, divided by 100

6.4.1 A field count at or above this value indicates that further investigation is needed at this location.

6.5 Scan for alpha activity.

6.5.1 Switch scaler/ratemeter into "DIG. RATE", ratemeter mode.

6.5.2 Set "RESP", response time switch, to "S" for slow response.

6.5.3 Set range selection switch to "X 1" for 500 cpm (counts per minute) full scale or to "X 10" for 5,000 cpm full scale.2

6.5.4 Pass the detector slowly, approximately one quarter (1/4) inch, over the surface of interest.

a. Do <u>not</u> touch the surface with the probe in order to avoid contamination of the probe itself.

b. The speed of probe movement will vary depending upon the experience of the surveyor but is typically 10-20 cm per second.

c. Because the probe face is very fragile, take care to avoid damage by rough surfaces or sharp objects.

6.5.5 Note increases in count rates as indicated by the audible meter output.

a. Typically, count rates 5-10 times the background rate are indicative of contamination or radionuclide concentrations exceeding allowable levels.

b. Circle areas of increased count rate using paint or grease pencil.

6.5.6 Continue traversing the area at close intervals.

a. Due to the relatively short range of the particles and the directional dependence of the scanning, intervals usually overlap.

6.5.7 For individual grid blocks, record range results on a separate Surface Contamination Survey form for each block. See Appendix 2.

6.5.8 For other scans, record results on the Contamination Survey Summary form. See Appendix 3.

6.5.9 Take systematic point measurements for all areas of increased activity as described below.

6.6 Make systematic point measurements.

6.6.1 Place scaler/ratemeter in "SCALER" mode.

6.6.2 Using "MINUTES" switch, set count time to 1 minute.

6.6.3 Place probe above point to be read. See Exhibit 1.

a. Grid blocks selected for systemic measurements require a predetermined number of readings, usually 5 per grid block.

b. For the first reading, place probe on point A, as shown on the Surface Contamination Survey form (Appendix 2).

6.6.4 Press "COUNT" button to count for 1 minute.

6.6.5 Record the number of counts on the Surface Contamination Survey form.

6.6.6 For grid blocks, repeat this counting and recording procedure at each of the four other points (B, C, D, and E) as shown on the form.

a. When required, take a duplicate reading every 10th reading and indicate this on the form.

b. Average the cpm for the five readings and record.

c. Calculate the alpha activity average from the cpm average.

6.7 If removable contamination is suspected, collect smear samples according to Procedure TE-027, Determination of Removable Contamination.

6.8 After the area has been scanned and/or counted, calculate alpha dpm/100 cm^2 by subtracting background and applying appropriate time, detector efficiency, and effective area factors to the net counting rate.

$$\alpha\ dpm/100\ cm^2 = \frac{N}{T \times E \times G}$$

Where

N = net counts
T = count time, min
E = detector efficiency, counts per disintegration
G = probe area, cm^2 divided by 100

6.9 After the systematic survey has been completed, transfer the data from the Surface Contamination Survey sheet to the Contamination Survey Summary form (Appendix 3) by entering the following information:

6.9.1 Area identifier (where or what is being surveyed)
6.9.2 Building number
6.9.3 Room number
6.9.4 Date
6.9.5 Surveyor's initials
6.9.6 Direct radiation measurement average results.

Appendix 1. Summary of Contamination Limits

Nuclide (see note 1)	Removable, dpm/100 cm^2 (see notes 2 & 3)	Total (Fixed and Removable), dpm/100 cm^2
U-natural, ^{235}U, ^{238}U and associated decay products	1,000 alpha	5,000 alpha
Transuranics, ^{226}Ra, ^{228}Ra, ^{230}Th, ^{228}Th, ^{231}Pa, ^{227}Ac, ^{125}I, ^{129}I	20	500
Th-natural, ^{232}Th, ^{90}Sr, ^{223}Ra, ^{224}Ra, ^{232}U, ^{126}I, ^{131}I, ^{133}I	200	1,000
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except ^{90}Sr and others noted above. Includes mixed fission products containing ^{90}Sr.	1,000 beta-gamma	5,000 beta-gamma
Tritium organic compounds, surfaces contaminated by tritium gas, tritiated water, and metal tritide aerosols	10,000	10,000

Notes:

1. The values in this table apply to radioactive contamination deposited on but not incorporated into the interior of the contaminated item. Where contamination by both alpha- and beta-gamma-emitting nuclides exists, the limits established for the alpha- and beta-gamma-emitting nuclides apply independently.

2. The amount of removable radioactive material per 100 cm^2 of surface area should be determined by wiping the area with dry filter or soft absorbent paper while applying moderate pressure and then assessing the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. For objects with a surface area less than 100 cm^2, the entire surface should be wiped, and the activity per unit area should be based on the actual surface area. Except for transuranics, ^{228}Ra, ^{227}Ac, ^{228}Th, ^{230}Th, ^{231}Pa and alpha emitters, it is not necessary to use wiping techniques to measure removable contamination levels if direct-scan surveys indicate that the total residual contamination levels are below the values for removable contamination.

3. The levels may be averaged over 1 m^2 provided the maximum activity in any area of 100 cm^2 is less than three times the values in this table.

Source: *Radiation Control Manual.* DOE/EH-0256T. U. S. Department of Energy, 1992.

Appendix 2. Surface Contamination Survey

DATE: _____

PHASE: _____

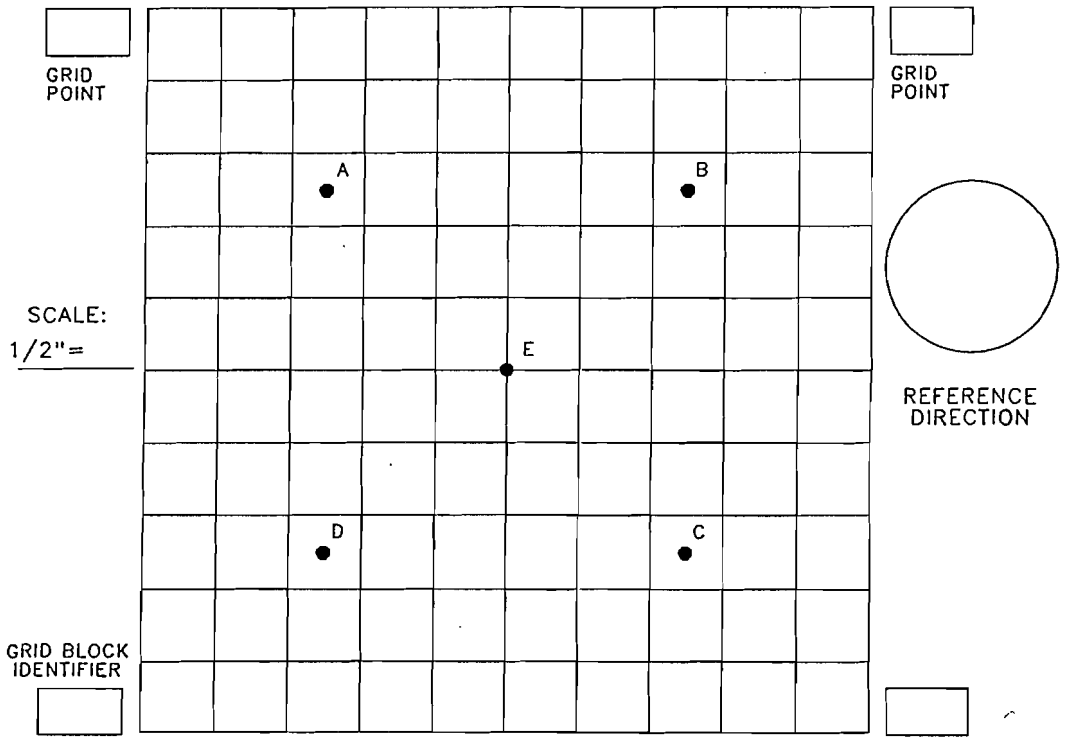
ROOM: _____

BUILDING: _____

TECHNICIANS: _____

SURFACE CONTAMINATION SURVEY

	INST.	BKGD	EFF.	GEOM	LLD DPM/100CM2	ACTION LEVELS
γ		μR/h				
$\beta\gamma$		kcpm				
α		kcpm				



Average or range of levels: α _____ β _____ γ _____

LOCATION	DIRECT PROBE MEASUREMENTS						DOSE RATE	SMEAR #
	ALPHA		$\beta\gamma$ DOWN		$\beta\gamma$ UP			
	cpm	dpm/100cm2	cpm	dpm/100cm2	cpm	dpm/100cm2		
A								
B								
C								
D								
E								
AVE								

Comments: _____

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Appendix 3. Contamination Survey Summary

DATE: _____

AREA IDENTIFIER: _____

SURVEYOR: _____

BLDG: _____

ROOM: _____

CONTAMINATION SURVEY SUMMARY

	INSTRUMENT	BACKGROUND	EFFICIENCY	GEOMETRY	LLD dpm/100cm2	ACTION LEVEL
ALPHA		cpm				
BETA-GAMMA		cpm				
GAMMA		kcpm				

		DIRECT PROBE MEASUREMENTS									REMOVABLE CONTAMINATION (Smears)				
Item/ Grid Block	Point	Alpha		Beta-Gamma					Gamma		Smear #	Alpha		Beta-Gamma	
		cpm	dpm/ 100cm^2	cpm Down	dpm/ 100cm^2	cpm Up	dpm/ 100cm^2	Absorbed Dose Rate	kcpm	μR/h @ 1 meter		cpm	dpm/ 100cm 2	cpm	dpm/ 100cm 2

Comments: _____

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Exhibit 1. Counting for Alpha Activity

BETA-GAMMA RADIATION MEASUREMENT

1.0 PURPOSE

This procedure describes the method for measuring beta-gamma radiation on surfaces that are potentially contaminated with beta-emitting radionuclides.

2.0 APPLICABILITY

When contamination is suspected, levels of beta-gamma contamination must be determined according to criteria set forth for specific sites. This procedure applies to measuring total contamination, before removable contamination has been sampled. See Appendix 1 for surface contamination limits as applied to radiation protection of the public.

3.0 OTHER DOCUMENTS

3.1 REFERENCES

3.1.1 Field Instrument Logbook
3.1.2 Procedure TE-027, Determination of Removable Contamination

3.2 APPENDICES

3.2.1 Appendix 1: Summary of Contamination Limits
3.2.2 Appendix 2: Surface Contamination Survey
3.2.3 Appendix 3: Contamination Survey Summary
3.2.4 Appendix 4: Area Scan & Radiation Level Survey

3.3 EXHIBITS

3.3.1 Exhibit 1: Counting for Beta-gamma Activity

APPROVALS	
Author	Date
Supervisor	Date
Group Leader	Date 8/6/93
Section Head	Date 8/6/93

4.0 EQUIPMENT AND MATERIALS

4.1 Beta-gamma probe:

4.1.1 Ludlum 44-9 Beta-gamma Probe
4.1.2 Bicron Analyst PGM Beta-gamma Probe
4.1.3 Eberline HP-260 Beta-gamma Probe

4.2 Scaler/ratemeter:

4.2.1 Ludlum 2221
4.2.2 Bicron Analyst
4.2.3 Eberline ESP-2

4.3 Cable
4.4 Beta check sources

5.0 RESPONSIBILITY

It is the responsibility of field personnel and their supervisors to follow this procedure when surveying for beta-gamma activity.

6.0 PROCEDURE

6.1 Perform an operational check on the beta-gamma probe.

NOTE: The following scaler/ratemeter instructions are for the Ludlum 2221 specifically. For instructions on using other scaler/ratemeters, see the electronics technician.

6.1.1 Obtain beta-check sources from the electronics technician.

a. The specific source to be used is listed on the side of the side of the instrument.

6.1.2 Attach beta-gamma probe to scaler/ratemeter.

6.1.3 Turn on scaler/ratemeter.

6.1.4 Check battery which should be > 4.5 volts.

a. Turn instrument switch to OFF when changing batteries or cables.

6.1.5 Set "IN WIN OUT" switch to "OUT".

6.1.6 Check calibration sticker to ensure that calibration date is current.

6.1.7 Collect background count by placing the probe face up on a clean surface and counting for one minute.

6.1.8 Check instrument response by counting for one minute using a check source.

6.1.9 Compare net count (gross counts minus background counts) to the 3-sigma range indicated on the side of the instrument.

a. If the net count rate falls within this range, the instrument is usable.

b. If it does not, repeat the above steps, acquiring a new background count and gross count.

c. If the net count rate still does not fall within the 3-sigma range, check with the electronics technician.

6.1.10 Enter the following data in the field instrument logbook:

a. Instrument number
b. Battery check
c. Background counts
d. Gross counts
e. Net counts
f. 3-sigma rate range
g. Instrument efficiency (listed on side of instrument)
h. Surveyor's initials
i. Date
j. Comments

6.1.11 GM counters have several limitations that can lead to erroneous results unless the user is aware of them.

a. Slow recovery of the counter at high radiation levels causes a decreased response to radiation events; at extremely high levels, the response may no longer increase with increased radiation. In certain cases, the response may decrease or go to zero at very high levels.

b. At extreme temperatures, the instrument may respond erratically or not at all. Under these conditions, a check source is needed to ensure reliable behavior.

c. The GM tube is delicate and sensitive to damage if dropped or exposed to significant changes in air pressure. If a rattling sound is heard when the user blows air across the probe face, it is likely that the tube has broken. To avoid a common means of tube breakage, do not ship the probe in an unpressurized airplane.

d. Beta-gamma probes respond to gamma radiation which makes direct contamination monitoring difficult in areas of high gamma background or where gamma emitting contamination is present.

6.2 Determine field background.

6.2.1 Set ratemeter in scaler mode.

6.2.2 Set count time to one minute.

6.2.3 Press "Count" to initiate counting.

6.2.4 After counting is completed, repeat for a total of two background readings.

6.2.5 For indoor scanning, record the following information on both the Surface Contamination Survey form (Appendix 2) and the Contamination Survey Summary (Appendix 3):

a. the average of the two background readings;

b. the instrument number;

c. instrument efficiency (the reciprocal of the conversion factor);

d. probe geometry (active probe area, cm^2, divided by 100).

6.2.6 For outdoor scanning, record the above information on the Area Scan and Radiation Level Survey form (Appendix 4).

6.3 Determine the Lower Limit of Detection (LLD) for the area to be surveyed:

$$LLD = \frac{2.71 + 4.66\sqrt{\frac{B}{T}}}{E \times G}$$

Where

LLD = lower limit of detection, dpm/100 cm^2
B = background, CPM
T = count time, min
E = detector efficiency, counts per disintegration
G = probe area, cm^2 divided by 100

6.3.1 In order for the instrument to be adequately sensitive, the LLD must be < 50% of the applicable guideline.

6.3.2 Enter the LLD value on the appropriate field sheet.

6.4 Determine action level.

$$AL = (SC \times E \times G) + B$$

Where

AL = action level, cpm
SC = site criteria, dpm/100 cm^2
B = background, cpm
E = detector efficiency, counts per disintegration
G = probe area, cm^2 divided by 100

6.4.1 A field count at or above this value indicates that further investigation is needed at this location.

6.5 Scan for beta-gamma activity.

6.5.1 Switch scaler/ratemeter into "DIG. RATE", ratemeter mode.

6.5.2 Set "RESP", response time switch, to "S" for slow response.

6.5.3 Set range selection switch to "X 1" for 500 cpm (counts per minute) full scale or to "X 10" for 5,000 cpm full scale.

6.5.4 If alpha activity is suspected, shield the probe with a piece of paper or similar material.

6.5.5 Pass the detector slowly over the surface of interest.

a. Maintain the smallest air gap possible between the probe and the surface to be scanned. Do not touch the surface with the probe in order to avoid contamination of the probe itself.

b. Scan at a rate of 1 second per width of probe.

c. Due to the short range of beta particles, scanning intervals should overlap.

d. CAUTION: Avoid placing the probe on surfaces with sharp projections which may puncture the thin detector face.

6.5.6 After the area has been scanned, calculate beta-gamma activity by subtracting background and applying appropriate time, detector efficiency, and detector area factors to the net counting rate.

$$ß \ dpm/100 \ cm^2 = \frac{N}{T \times E \times G}$$

Where

N = net counts
T = count time, min
E = detector efficiency, counts per disintegrations
G = probe area, cm^2 divided by 100

NOTE: A SrY-90 source calibration efficiency will be about 50% greater than a Tc-99 source efficiency due to differing beta energy values.

6.5.7 For individual grid blocks, record range results on a separate Surface Contamination Survey form for each block. See Appendix 2.

6.5.8 For outdoor areas, record range results on the Area Scan & Radiation Level Survey form. See Appendix 4.

6.5.9 For other scans, record results on the Contamination Survey Summary form. See Appendix 3.

6.6 When necessary, make systematic point measurements. See Exhibit 1.

6.6.1 Place scaler/ratemeter in "SCALER" mode.

6.6.2 Using "MINUTES" switch, set count time to 1 minute.

6.6.3 Place probe above point to be read.

a. Grid blocks that have been selected for systemic measurements require a predetermined number of readings, usually 5 per grid block.

b. For the first reading, place probe on point A, as shown on the Surface Contamination Survey form (Appendix 2).

6.6.4 Press "COUNT" button to count for 1 minute.

6.6.5 Record the number of counts on the Surface Contamination Survey form.

6.6.6 For grid blocks, repeat this counting and recording procedure at each of the four other points (B,C,D,and E) as shown on the form.

a. When required, take a duplicate reading every 10th reading and indicate this on the form.

b. Average the cpm for the five readings and record on the form.

c. Calculate the beta-gamma activity average from the cpm average.

6.6.7 Convert cpm to beta-gamma dpm/100 cm^2.

6.6.8 If removable contamination is suspected, collect smear samples according to Procedure TE-027, Determination of Removable Contamination.

6.6.9 If it is necessary to determine beta-gamma dose rate, repeat the measurement at the same location with the probe face up.

6.6.10 Calculate the beta-gamma dose rate using the calibration factor for the instrument used:

$$DR = \frac{C_1 - C_2}{T \times CF} + (\gamma \times 0.87)$$

Where

DR = dose rate, μrad/h
C_1 = counts probe down

T = count time, min
CF = conversion factor, cpm/μrad/h
γ = gamma exposure rate, μR/h
0.87 = conversion factor for exposure rate to dose rate, μrad/μR

6.6.11 After a systematic survey has been completed, transfer the data from the Surface Contamination Survey form to the Contamination Survey Summary form (Appendix 3) by entering the following information:

a. Area identifier (where or what is being surveyed)
b. Building number
c. Room number
d. Date
e. Surveyor's initials
f. Instrument identification number
g. Instrument efficiency factor
h. Direct radiation measurement average results.

Appendix 1. Summary of Contamination Limits

Nuclide (see note 1)	Removable, dpm/100 cm^2 (see notes 2 & 3)	Total (Fixed and Removable), dpm/100 cm^2
U-natural, ^{235}U, ^{238}U and associated decay products	1,000 alpha	5,000 alpha
Transuranics, ^{226}Ra, ^{226}Ra, ^{230}Th, ^{228}Th, ^{231}Pa, ^{227}Ac, ^{125}I, ^{129}I	20	500
Th-natural, ^{232}Th, ^{90}Sr, ^{223}Ra, ^{224}Ra, ^{232}U, ^{126}I, ^{131}I, ^{133}I	200	1,000
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except ^{90}Sr and others noted above. Includes mixed fission products containing ^{90}Sr.	1,000 beta-gamma	5,000 beta-gamma
Tritium organic compounds, surfaces contaminated by tritium gas, tritiated water, and metal tritide aerosols	10,000	10,000

Notes:

1. The values in this table apply to radioactive contamination deposited on but not incorporated into the interior of the contaminated item. Where contamination by both alpha- and beta-gamma-emitting nuclides exists, the limits established for the alpha- and beta-gamma-emitting nuclides apply independently.

2. The amount of removable radioactive material per 100 cm^2 of surface area should be determined by wiping the area with dry filter or soft absorbent paper while applying moderate pressure and then assessing the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. For objects with a surface area less than 100 cm^2, the entire surface should be wiped, and the activity per unit area should be based on the actual surface area. Except for transuranics, ^{228}Ra, ^{227}Ac, ^{228}Th, ^{230}Th, ^{231}Pa and alpha emitters, it is not necessary to use wiping techniques to measure removable contamination levels if direct-scan surveys indicate that the total residual contamination levels are below the values for removable contamination.

3. The levels may be averaged over 1 m^2 provided the maximum activity in any area of 100 cm^2 is less than three times the values in this table.

Source: *Radiation Control Manual.* DOE/EH-0256T. U. S. Department of Energy, 1992.

Appendix 2. Surface Contamination Survey

DATE: _____

PHASE: _____

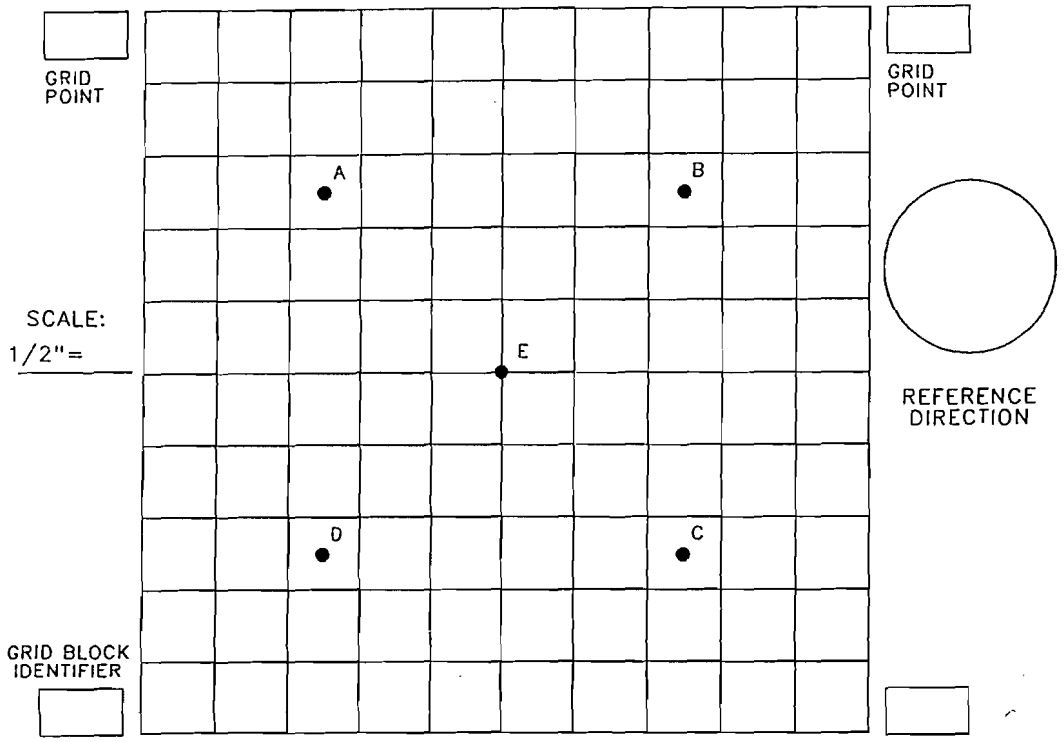
ROOM: _____

BUILDING: _____

TECHNICIANS: _____

SURFACE CONTAMINATION SURVEY

	INST.	BKGD	EFF.	GEOM	LLD DPM/100CM2	ACTION LEVELS
γ		μR/h				
$\beta\gamma$		kcpm				
α		kcpm				



Average or range of levels: α _____ β _____ γ _____

LOCATION	DIRECT PROBE MEASUREMENTS						DOSE RATE	SMEAR #
	ALPHA		$\beta\gamma$ DOWN		$\beta\gamma$ UP			
	cpm	dpm/100cm2	cpm	dpm/100cm2	cpm	dpm/100cm2		
A								
B								
C								
D								
E								
AVE								

Comments: _____

UCN-17231
(3 Rev. 5/91)

Appendix 3. Contamination Survey Summary

DATE: _____

AREA IDENTIFIER: _____

SURVEYOR: _____

BLDG: _____

ROOM: _____

CONTAMINATION SURVEY SUMMARY

	INSTRUMENT	BACKGROUND	EFFICIENCY	GEOMETRY	LLD dpm/100cm2	ACTION LEVEL
ALPHA		cpm				
BETA-GAMMA		cpm				
GAMMA		kcpm				

		DIRECT PROBE MEASUREMENTS									REMOVABLE CONTAMINATION (Smears)				
Item/ Grid Block	Point	Alpha		Beta-Gamma					Gamma		Smear #	Alpha		Beta-Gamma	
		cpm	dpm/ 100cm^2	cpm Down	dpm/ 100cm^2	cpm Up	dpm/ 100cm^2	Absorbed Dose Rate	kcpm	µR/h @ 1 meter		cpm	dpm/ 100cm^2	cpm	dpm/ 100cm^2

Comments: _____

UCN - 17230
(3 Rev. 5/91)

Appendix 4. Area Scan and Radiation Level Survey

PHASE: _____

DATE: _____

TECHNICIANS: _____

AREA SCAN & RADIATION LEVEL SURVEY

	INST.	BKGD	EFF.	GEOM	LLD DPM/100CM2	ACTION LEVELS
γ		μR/h				
γ		μR/h				
$\beta\gamma$		CPM				

GAMMA SCAN

AREA IDENTIFIER	GAMMA RANGE		GAMMA AVERAGE	
	kcpm	μR/h	kcpm	μR/h

DELTA COUNT MEASUREMENTS

LOCATION	GROSS CNT.	DELTA CNT.	%UNCERT.	Ra-226 pCi/G

FIXED POINT MEASUREMENTS

	GAMMA				BETA-GAMMA				DOSE RATE
	SURFACE		1M		DOWN		UP		
LOCATION	kcpm	μR/h	kcpm	μR/h	cpm net	dpm 100 cm2	cpm net	dpm 100 cm2	

COMMENTS: _____

Exhibit 1. Counting for Beta-gamma Activity

SITE PREPARATION FOR RADIOLOGICAL SURVEYING

1.0 PURPOSE

This procedure describes the methods for clearing a site and establishing a grid system for referencing radiological survey activities.

2.0 APPLICABILITY

This procedure applies to all site surveying activities for which grid referencing is necessary.

3.0 OTHER DOCUMENTS

None

4.0 EQUIPMENT AND MATERIALS

4.1 Chalk

4.2 Tape

4.3 Grease pencil

4.4 Grid point markers (stakes, hubs, spikes, flags, etc.)

4.5 Moving and clearing equipment as necessary

5.0 RESPONSIBILITY

5.1 The site team leader is responsible for the following:

5.1.1 Determining the degree of clearing needed;

5.1.2 Determining the gridding requirements;

Approved by:

(Date) C.A. Little (Date)

5.1.3 Supervising onsite clearing and gridding activities to assure compliance with condition of survey plans and subcontract agreements.

5.2 Survey personnel are responsible for establishing indoor grids not already in place and outdoor grids of small land areas.

5.3 Gridding of open land areas will usually be performed by a professional land survey organization under subcontract arrangements.

5.4 Removal or relocation of equipment and materials which may entail special precautions to prevent damage or maintain inventory accountability should be performed by the property owner whenever possible.

6.0 PROCEDURE

6.1 Clear indoor area.

6.1.1 Remove or relocate equipment and material which impede the radiological survey.

a. In the case of private property surveys, this should be done by the property owner when possible to avoid potential damage by the subcontractor.

b. When radiological history indicates, check all equipment and material removed for potential contamination.

6.1.2 Provide access to potentially contaminated interior surfaces such as drains, ductwork, tanks, pits, and equipment by removing covers or disassembling equipment.

6.2 Clear outdoor area if necessary.

6.2.1 The extent of site clearing required in specific areas will be primarily dependent upon the potential for radioactive contamination existing in those areas.

a. Where the radiological history and/or results of previous surveys do not indicate potential contamination of an area, it may be sufficient to perform only minimum clearing to establish a reference grid system.

b. Areas where contamination is known to exist or which have a high potential for contamination must be completely cleared to provide access to all surfaces.

c. Findings as the survey progresses may require that additional clearing be performed.

6.2.2 Clearing includes providing access to potentially contaminated interior surfaces such as drains, tanks, pits, etc.

6.2.3 When clearing open land areas, caution must be exercised to prevent relocations of surface contamination or damage to site features such as drainage ditches, utilities, fences, and buildings.

6.3 Define indoor grid.

6.3.1 Select grid baseline, usually the longest dimension of the structure.

6.3.2 If the property has already been gridded as part of the owner's decontamination and survey activities, use this grid to provide consistency and easy comparison of measurements.

6.3.3 Determine grid dimensions based on the following:

a. Potential for contamination;

b. Providing adequate systematic measurement;

c. Providing adequate sampling points for statistical significance.

6.3.4 A minimum of 30 grid blocks is required with 60 to 100 blocks preferable.

6.3.5 Metric units are preferred for the grid, but English units may be followed if an acceptable grid system has been pre-established.

6.3.6 Use a basic grid system of 1 or 2 meters per block.

6.3.7 Mark grid blocks on the floor and lower wall (up to 2 m) using a chalk line or other appropriate marking system.

a. Use one of the inside corners of the building as the starting point for referencing the grid.

6.3.8 Mark grid points (grid line intersections) with paint, tape, or grease pencil.

a. Ask owner's permission before using paint or other markers which may deface the surface.

6.3.9 Identify grid points using an alpha-numeric system.

a. Lines perpendicular to the baseline are identified alphabetically.

b. Lines parallel to the baseline are identified by a number indicating the distance from the baseline.

6.3.10 Any location within a grid system may be designated by measuring the distance from the point of intersect to a grid marker.

6.3.11 If more convenient, grid each room individually in buildings containing multiple rooms.

a. This is at the discretion of the team leader.

b. Small rooms (< 10 m^2) do not require gridding.

6.3.12 Upper walls and ceiling areas are not usually gridded.

a. Reference measurements on these surfaces to prominent building features or to locations corresponding to the gridded floor and lower walls.

6.8 Prepare open land grid system.

6.8.1 Use a basic grid interval of 10 m.

a. This interval may be decreased or increased depending on the total property area and the radiological history.

6.8.2 Grid points (also called grid line intersections) include points where the grid lines intersect with buildings and property boundaries.

a. These points are marked using stakes, hubs, spikes, point, flags, or survey tape, depending on the characteristics and routine uses of the surface.

6.8.3 Reference the grid using a specific grid point identified on the grid marker as point 0,0.

a. This point is generally near the center or at a corner of the property.

6.8.4 Reference the coordinates of other grid points to the 0,0 point using alpha-numeric identifiers.

a. The numeric identifier indicates the distance in meters or feet from the reference point.

b. The alphabetic identifier indicates the direction from the reference point, i.e., N(north), S(south), E(east), W(west), or L(left of baseline) and R(right of baseline).

6.8.5 Label the grid point markers with the coordinates of the grid point.

6.8.6 Any location within a grid system may be designated by measuring the distance and direction from the point of interest to a grid point marker.

6.8.7 The field map may be used for noting grid coordinates.

INCLUSION SURVEY REPORT COMPLETION

1.0 PURPOSE

The purpose of this procedure is to describe the tasks performed to complete and transmit inclusion survey reports.

2.0 APPLICABILITY

This procedure applies to the UMTRA (Uranium Mill Tailings Remedial Action) and Monticello Vicinity Properties (MVP) projects.

3.0 OTHER DOCUMENTS

3.1 REFERENCES

3.1.1 *Vicinity Properties Management and Implementation Manual* (VPMIM), UMTRA-DOE/AL-050601.

3.1.2 *State Background Radiation Levels: Results of Measurements Taken During 1975-1979*, T. E. Myrick, B. A. Berven, and F. F. Haywood, ORNL/TM-7343.

3.1.3 EPA Standards for Remedial Action at Inactive Uranium Mill Processing Sites, Code of Federal Regulations, Sect. 40, Part 192.

3.1.4 U.S. Department of Energy Guidelines for Residual Radioactive Material at Formerly Utilized Sites Remedial Action Program and Remote Surplus Facilities Management Program Sites, Rev. 2, March 1987.

3.1.5 Procedure TE-020, Inclusion Survey Activities

3.1.6 Procedure SU-061, Graphics for Inclusion Surveys of Vicinity Properties

3.1.7 Procedure SU-070, Document Control

APPROVALS	
Author	Date
Supervisor	Date
Group Leader Douglas K. Halford	Date 7/30/93
Section Head Craig Little	Date 7/30/93

3.2 APPENDICES

3.2.1 Appendix 1: Inclusion Survey Report Flow Chart
3.2.2 Appendix 2: Radiological Screening Summary sheet
3.2.3 Appendix 3: Conversion Formulas
3.2.4 Appendix 4: Soil Sample Data Field Form
3.2.5 Appendix 5: Property File Tracking Form
3.2.6 Appendix 6: Gamma Analysis Worksheet
3.2.7 Appendix 7: Soil Analysis Worksheet
3.2.8 Appendix 8: Background Concentrations of ^{226}Ra in Surface Soil
3.2.9 Appendix 9: Hot Spot Limits
3.2.10 Appendix 10: UMTRA Report Skeleton
3.2.11 Appendix 11: MVP Report Skeleton
3.2.12 Appendix 12: PUOR Report Skeleton
3.2.13 Appendix 13: PU5 Report Skeleton
3.2.14 Appendix 14: UMTRA Condensed Report Skeleton
3.2.15 Appendix 15: MVP Condensed Report Skeleton
3.2.16 Appendix 16: PUOR Condensed Report Skeleton
3.2.17 Appendix 17: PU5 Condensed Report Skeleton
3.2.18 Appendix 18: UMTRA Letter of Recommendation
3.2.19 Appendix 19: MVP Letter of Recommendation
3.2.20 Appendix 20: PUOR Letter of Recommendation
3.2.21 Appendix 21: PU5 Letter of Recommendation
3.2.22 Appendix 22: UMTRA Vicinity Property Summary Evaluation and Recommendation
3.2.23 Appendix 23: MVP Vicinity Property Summary Evaluation and Findings
3.2.24 Appendix 24: VPDMS Form
3.2.25 Appendix 25: ISC Report Review Checklist
3.2.26 Appendix 26: Laboratory Soil Analysis Results Addendum
3.2.27 Appendix 27: Cover Letter for Addendum

4.0 EQUIPMENT AND MATERIALS

4.1 MATERIALS

4.1.1 Team Leader logbook
4.1.2 Gamma Analysis Worksheet
4.1.3 Soil Analysis Worksheet
4.1.4 Report skeleton
4.1.5 Letter of recommendation (not needed for condensed reports)
4.1.6 Vicinity Property Summary Evaluation Form
4.1.7 VPDMS form (UMTRA properties only)
4.1.8 ISC Report Review Checklist
4.1.9 Vicinity property file

5.0 RESPONSIBILITY

5.1 The team leader is responsible for the following:

5.1.1 Preparing the survey report for writing,
5.1.2 Assigning the survey report for writing and review,
5.1.3 Reviewing the survey report for clarity, accuracy, and completeness,
5.1.4 Tracking the report until ready for transmittal to the appropriate agency.

5.2 Assigned team members have the following responsibilities:

5.2.1 Performing necessary calculations,
5.2.2 Writing and reviewing the survey report.

5.3 Clerical staff are responsible for:

5.3.1 Transmitting MVP field data to the RAC,
5.3.2 Typing the draft report and letter of recommendation,
5.3.3 Typing corrections after report editing,
5.3.4 Transmitting the report and associated documentation to the appropriate project management office.

5.4 Public relations staff are responsible for:

5.4.1 Entering property and recommendation information into the data base,
5.4.2 Submitting the property folder to Document Control for filing.

6.0 DEFINITIONS

6.1 **ACAD**: AutoCAD™, computer-aided drafting program

6.2 **Authorized limit**: a level of residual radioactive material that must not be exceeded if the remedial action is to be considered completed and the site is to be released for unrestricted use.

6.3 **Defense D & D**: Defense Decontamination and Decommissioning

6.4 **Extended measurements**: measurements or samples in addition to gamma radiation field surveying; soil samples and radon measurements.

6.5 **HIG**: high indoor gamma radiation measurement

6.6 **HOG**: high outdoor gamma radiation measurement

6.7 **ISC**: inclusion survey contractor

6.8 **Kcpm**: thousand (kilo) counts per minute

6.9 **MVP Project**: Monticello Vicinity Properties Project

6.10 **NEAWA**: net estimated area-weighted average

6.11 **PUOR**: post-UMTRA owner request; vicinity property requested to be surveyed by the owner after the cut-off date for accepting requests of July 31, 1990.

6.12 **PU5**: supplemental UMTRA inclusion survey performed on disturbed portions including fields of large vicinity properties usually greater than 5 acres. The original exclusion recommendation was based on a partial survey of the outlying areas as directed by the DOE.

6.13 **RAC**: remedial action contractor

6.14 **RDC**: radon daughter concentration, usually expressed in working levels (WL)

6.15 **TAC**: technical assistance contractor

6.16 **UMTRA Project**: Uranium Mill Tailings Remedial Action Project

6.17 **VPDMS form**: vicinity property data management system form used for data entry at the UMTRA project office.

6.18 **WL**: working level; any combination of radon daughters in one liter of air that will result in the ultimate emission of 1.3×10^5MeV of alpha particle energy.

7.0 PROCEDURE

See Appendix 1, Inclusion Survey Report Flow Chart, for the flow-of-work pattern followed in preparing inclusion survey reports.

7.1 TEAM LEADER PRE-REPORT ACTIVITIES

7.1.1 Convert scintillometer count rates (kcpm) to exposure rates (μR/h).

a. Calculate exposure rates for sites with no derived conversion factor.

1. This direct conversion requires a conversion factor (CF) obtained by dividing the scintillometer count rate by the corresponding exposure rate in μR/h measured by a PIC (pressurized ionization chamber).

$$CF = \frac{y(kcpm)}{x(\mu R/h)}$$

where:

x = PIC value (μR/h)
y = gamma scintillometer value, kcpm

2. Divide the resulting conversion factor into the remaining scintillometer rates.

3. Record the calculated exposure rates on the Radiological Screening Summary sheet (Appendix 2) and the field map.

b. Calculate exposure rates for sites with a predetermined conversion factor.

1. Refer to Appendix 3, Conversion Formulas, for the appropriate conversion equation, $y = mx + b$

where:
y = gamma exposure rate, μR/h
x = scintillometer count rates, kcpm
b = y intercept

2. Record the calculated exposure rates on the Radiological Screening Summary sheet (Appendix 2) and the field map.

7.1.2 Write the following data on the field map:

a. all scintillometer rate ranges in kcpm,
b. all exposure rate ranges in μR/h,
c. HOG and HIG locations and values,
d. soil sample locations,
e. point source locations and exposure rates,
f. adjacent property address and location number if a spillover deposit is present (for UMTRA properties only),
g. posthole locations, and

h. any additional pertinent comments.

7.1.3 Enter soil sample analysis data on the Soil Sample Data Field Form (Appendix 4).

a. Obtain soil sample analysis results from the soils data base on the computer network or from the photocopy of the soil sample analysis sheet provided by extended measurements personnel.

b. For UMTRA properties, use OCS (opposed crystal system) analysis results.

7.1.4 Transmit copies of MVP field data to the TAC.

a. Complete soil and gamma worksheets as in 7.2.

b. Submit copies of the following to the clerical staff for transmittal to the RAC:

1. Soil Analysis Worksheet,
2. Gamma Analysis Worksheet,
3. Consent form,
4. Field map,
5. Survey Site Information sheet,
6. Radiological Screening Summary, and
7. Soil Sample Data Field Form.

7.1.5 Photographs

a. Label all site photographs with the location number.

b. Write the date surveyed on all UMTRA photographs.

c. Attach one site photograph securely to the property file.

d. For UMTRA photographs, archive one site photograph in an archive album retained by the team leader.

7.1.6 Initial and date the Property File Tracking Form in the appropriate spaces (Appendix 5).

7.1.7 Assign the property file to a team member for report writing.

7.2 CALCULATIONS

7.2.1 Calculate the net estimated area-weighted average (NEAWA) gamma exposure rate values for outdoor regions of contamination.

a. Use the Gamma Analysis Worksheet to record calculations. See Appendix 6 for a sample worksheet.

b. Field average elevated exposure rates for indoors and outdoors should be noted on the field data sheets by team leader. In the absence of this average, a mean average is calculated by the following equation:

$$G_{AV} = \frac{(G_l + G_h)}{2}$$

where:

G_{AV} = average scintillometer measurement, kcpm

G_l = low value of scintillometer measurement range, kcpm

G_h = high value of scintillometer measurement range, kcpm

c. Subtract the average background gamma exposure rate from the average gamma exposure rate of the contaminated region. The result is the net gamma exposure rate.

d. Multiply the net gamma exposure rate by the area in m^2 and divide by 100 m^2. The result is the NEAWA gamma exposure rate.

7.2.2 Calculate the NEAWA gamma exposure rate for indoor contaminated regions the same as for outdoor regions above.

a. Average over 9.3 m^2 or the area of the room, whichever is smaller, instead of 100 m^2.

b. Record calculations on the Gamma Analysis Worksheet.

7.2.3 Round the NEAWA gamma exposure rate to two significant digits for reporting purposes.

7.2.4 Compare the calculated NEAWA gamma exposure rate to the inclusion guideline of 25 μR/h above background averaged over 100 m^2 for outdoor regions and 20 μR/h averaged over 9.3 m^2 or the area of the room for indoor regions (see Reference 3.1.1, VPMIM).

a. If any NEAWA gamma exposure rate exceeds either criterion, a recommendation for inclusion may be written.

7.2.5 If there are no areas of contamination, calculate a background NEAWA gamma exposure rate of 0 for both indoor and outdoor areas on the Gamma Analysis Worksheet.

7.2.6 Calculate the NEAWA ^{226}Ra concentrations, recording calculations on the Soil Analysis Worksheet. See Appendix 7 for a sample worksheet.

a. Average the ^{226}Ra concentrations for all samples within each region at each depth (i.e., 0-15 cm, 15-30 cm).

b. Record the regional background ^{226}Ra concentration in pCi/g found in Appendix 8, from Reference 3.1.2, where average background ^{226}Ra concentrations were calculated on a state-by-state basis.

c. Record the area of the contaminated region.

d. Record the soil sample thickness as a range (e.g., 0-15 cm, 15-30 cm).

e. Use the following formula to calculate the NEAWA ^{226}Ra concentration:

$$C_{AW} = \frac{(C_{AV} - C_{BGD})(A_i)(D_i)}{(100\ m^2)(0.15\ m)}$$

where:

C_{AW} = net estimated area-weighted average ^{226}Ra concentration, pCi/g

C_{AV} = average ^{226}Ra concentration of samples, pCi/g

C_{BGD} = regional background ^{226}Ra concentration, pCi/g

A_i = area of contamination that samples represent, m^2

D_i = thickness of sample, m

7.2.7 Compare the calculated net estimated area-weighted average ^{226}Ra concentration to the inclusion criterion of ≥5 pCi/g (surface) or ≥15 pCi/g (subsurface) above background, averaged over 100 m^2 (see Reference 3.1.3).

a. If any NEAWA ^{226}Ra concentration exceeds either criterion, a recommendation for inclusion may be written.

7.2.8 For MVP, determine whether any point sources exceed the hot spot guideline (see Reference 3.1.4).

a. Record calculations on the Soil Analysis Worksheet.

b. Average areas less than 1 m^2 over 1 m^2.

c. Apply hot spot limits to areas 25 m^2 and smaller.

d. Find the appropriate calculated hot spot limits for areas from 1 to 25 m^2 in Appendix 9.

e. Subtract the background ^{226}Ra concentration from the gross average concentration to obtain the net ^{226}Ra concentration.

1. The background ^{226}Ra concentration for Monticello is 2.0 pCi/g. This value is consistent with the measurements made by the RAC (Remedial Action Contractor).

f. Compare the net ^{226}Ra concentration with the hot spot limit derived from the equation in Appendix 9 (S_{hg}) to determine if the hot spot exceeds the limits.

1. If any NEAWA ^{226}Ra concentration from an unknown or mill-related point source exceeds the hot spot guideline, a recommendation for inclusion may be written.

7.2.9 Round the resulting NEAWA ^{226}Ra concentrations to two significant digits for reporting purposes.

7.2.10 If no soil samples were taken, record "No samples taken" on the Soil Analysis Worksheet.

7.3 REPORT SKELETON

7.3.1 Choose the appropriate report skeleton:

a. UMTRA report (Appendix 10),
b. MVP report (Appendix 11),
c. PUOR report (Appendix 12),
d. PU5 report (Appendix 13),
e. UMTRA condensed report (Appendix 14),
f. MVP condensed report (Appendix 15),
g. PUOR condensed report (Appendix 16), or
h. PU5 condensed report (Appendix 17).

7.3.2 A condensed report may be written if the property meets all the following criteria:

a. The UMTRA property is not on the designated property list, or a daughter property of a spillover investigation. See Procedure TE-020.

b. The UMTRA property has no contamination other than point sources.

c. The MVP has no elevated gamma exposure rates except for natural radioactivity from dinosaur bone, petrified wood, brick, or other non-mill-related sources.

7.3.3 Write the site location number in the upper right-hand corner of each page of the report.

7.3.4 From the consent form or Survey Site Information sheet, enter the following on the cover page:

a. Address,
b. Team leader (for UMTRA reports), and
c. Report author, and report date (month and year).

7.3.5 Complete the introduction with the following information:

a. Date of radiological survey after "survdate",
b. Correct number of figures and tables,
c. For UMTRA reports, the type of conversion of gamma scintillometer measurements (kcpm) to exposure rates (μR/h) method used as appropriate, and

d. For UMTRA reports, the correct conversion factors from the Radiological Screening Summary sheet.

7.3.6 Significance of Findings:

The significance of findings describes idiosyncracies not found in the tables and briefly summarizes the survey findings. The exact wording is left to the discretion of the individual writer.

a. Provide a brief discussion of radiological results found on the site, both indoors and outdoors.

b. State the indoor and outdoor background gamma exposure rate ranges.

c. State the calculated net estimated area-weighted average gamma exposure rate and/or ^{226}Ra concentrations to support the recommendation for inclusion or exclusion.

d. It is not necessary to discuss every region of contamination if the specific exposure rate or extended measurements data are not pertinent to the recommendation.

e. For UMTRA reports, conclude by stating the site location number and recommendation for inclusion or exclusion by UMTRA.

7.3.7 Recommendation (UMTRA) or Findings (MVP):

a. For UMTRA reports, circle either "RECOMMENDED FOR: inclusion" or "RECOMMENDED FOR: exclusion".

b. For MVP reports, check the appropriate box for "EXCEED" or "DO NOT EXCEED" the DOE guidelines.

c. Circle the applicable criteria to support the recommendation or findings. An exclusion recommendation or finding not exceeding the DOE guidelines requires that two standards be satisfied, one for indoors and one for outdoors. Only one standard need be satisfied for an inclusion recommendation or finding exceeding the DOE guideline.

7.3.8 Supplemental Standards

a. In certain situations, the radiological results may dictate that an inclusion recommendation which would be inappropriate; examples of such circumstances follow:

   1. Remediation may result in higher health risk to workers or the public.

   2. Harm to environment outweighs potential health benefit to persons living near the site.

   3. Cost of remediation outweighs the long-term benefits due to current and anticipated future use of site; e.g., tailings under roads, sidewalks, or railroad crossing.

   4. No known remedial action.

   5. Radionuclides other than ^{226}Ra and its decay products are present. See 40 CFR, Part 192.21, "Criteria for Applying Supplemental Standards", Reference 3.1.3.

b. If any of the above situations exists, make a recommendation for "Supplemental Standards"; the underlying reason does not have to be given.

c. State in the "Significance of Findings" and "Recommendation" sections of the report skeleton, in the letter of recommendation, and in the Vicinity Property Summary Evaluation form that supplemental standards are suggested.

7.3.9 Table 1. Location Information:

a. Enter owner and tenant information from the Survey Site Information sheet and the consent form. Include all applicable area codes and zip codes.

b. Enter the applicable two-letter property classification code from 7.6.2.

c. Enter the total area of the property in m^2, rounded to two significant digits.

   1. Convert area units using the following equation:

$$y = (X)(0.0929)$$

where:

y = area of deposit, m^2
X = area of deposit, ft^2
0.0929 = conversion factor, m^2/ft^2

d. Briefly describe all structures present on the property.

7.3.10 Table 2. Radiological Screening Survey Results:

a. Complete a separate Table 2 for indoor and outdoor screening data from the Radiation Screening Summary sheet and the Gamma Analysis Worksheet.

b. Complete a separate Table 2 for each habitable structure surveyed, unless the structures have identical gamma exposure rates. In this case the structures may be summarized on one table.

c. Enter a high outdoor gamma (HOG) and high indoor gamma (HIG) in every report.

d. Write "General" for Location of HOG if there are no elevated readings other than point sources. A point source cannot be a HOG or a HIG.

e. The wording may be adapted (within reason) to fit the specific site. For example, if exposure rates other than measured background are present on a site but are known not to be associated with mill tailings, the phrase "exposure rate range in elevated regions" may be substituted for "exposure rate range in contaminated regions".

f. Round off all gamma exposure rates and area measurements to two significant digits except for gamma exposure rates less than 10 μR/h, which should be rounded to one significant digit.

7.3.11 Table 3. Extended Survey Results:

a. Complete the Soil Sample Summary using the Soil Analysis Worksheet.

b. Complete the Radon Monitoring Summary from radon information provided by the extended measurements coordinator.

c. Round off all ^{226}Ra concentrations, area measurements, and annual average RDC to two significant digits.

d. Record individual alpha track radon measurements to three significant digits.

e. If any page of Table 3 is not used, draw an "X" through the page and include with the draft to inform the typist. Do not throw the page away.

7.3.12 Complete the caption for Figure 2, the property photograph, with the site location number and direction of the view shown. This information is taken from the Survey Site Information sheet.

7.3.13 Complete the property map as described in Procedure SU-061, Graphics for Inclusion Surveys of Vicinity Properties.

7.4 LETTER OF RECOMMENDATION

7.4.1 Choose the appropriate letter of recommendation:

a. UMTRA letter of recommendation (Appendix 18),
b. MVP letter of recommendation (Appendix 19),
c. PUOR letter of recommendation (Appendix 20), or
d. PU5 letter of recommendation (Appendix 21).

7.4.2 Check appropriate responses in the text of the letter.

a. The <u>evaluation</u> basis shall reflect the measurements taken in the field.

b. The <u>recommendation</u> basis shall reflect the laws set out in the Federal Register (Reference 3.1.3).

7.4.3 Complete the site information at the bottom of the page.

7.4.4 Address the letter to the appropriate program manager.

a. For Grand Junction, CO, and Edgemont, SD reports, address it to the current or acting DOE/GJPO (Grand Junction Projects Office) Project Manager.

b. For all other UMTRA site reports, address it to the current or acting DOE/UMTRA Project Manager.

c. For MVP reports, address to the Defense D & D Program Manager.

7.5 VICINITY PROPERTY SUMMARY EVALUATION

7.5.1 Choose the appropriate summary evaluation:

a. UMTRA Vicinity Property Summary Evaluation and Recommendation for all UMTRA reports, or

b. MVP Vicinity Property Summary Evaluation and Findings for all MVP reports.

7.5.2 Complete all five sheets in black ink as neatly as possible. If an error is made, redo the page. Correction fluid may not be used.

7.5.3 Enter the location number at the top right-hand corner of each page.

7.5.4 Check the appropriate responses to each question on pages one and two under the column headed "Inclusion Survey Contractor (ISC)".

7.5.5 Check the correct box on page three for a recommendation for inclusion or exclusion (UMTRA reports) or whether radiation levels exceed or do not exceed the DOE guidelines (MVP reports).

7.5.6 Enter only the location number on pages four or five.

7.6 VPDMS FORM (Appendix 24)

This form is used only for UMTRA properties. Complete the following information:

7.6.1 Location ID: Site location number

7.6.2 Class: Location class code as shown below:

VL VACANT LAND: A parcel of land on which no habitable structure exists.

RS RESIDENTIAL SIMPLE: A single family residence on a parcel of land where there is no contamination involved with the habitable structure. An attached garage is part of the habitable structure. A detached garage is not, unless it contains living quarters.

MR MAJOR RESIDENTIAL: A single family residence on a parcel of land where contamination is associated with the habitable structure. See RS for definition of habitable structure.

SC SCHOOL: A habitable structure which serves primarily as an education facility. It may be a public or private institution.

HO HOSPITAL: A habitable structure which serves primarily as an in-patient medical care facility.

AP APARTMENT: A habitable structure containing more than one separate unit which serves as a primary dwelling.

MO MOTEL/HOTEL: A habitable structure which serves primarily as an establishment to provide lodging.

CS COMMERCIAL SIMPLE: A habitable structure which serves primarily as a place of business and is not any of the four types listed immediately above.

CC COMPLEX COMMERCIAL: A property specifically designated as such.

BU OTHER: A property which does not fit any of the above classifications.

NOTE: COMPLEX (usually) and MAJOR (always) indicate structural tailings involvement.

7.6.3 Consent Form Data

a. Enter the date the consent form was signed.

b. Enter the appropriate code from the Consent Form Status Codes table at the bottom of the VPDMS form.

7.6.4 Survey Data

a. Enter the date of the inclusion survey.

b. Enter the HIG in μR/h and the source code from the table at the bottom of the VPDMS form (I for ISC surveys).

c. Enter the HOG in μR/h and source code from the table at the bottom of the VPDMS form.

d. Enter the RDC in working levels (WL), Source and Type codes from the tables at the bottom of the VPDMS form.

e. Enter the tailing location code from the table at the bottom of the VPDMS form. This indicates the tailings location that the recommendation is based upon.

f. Enter the property and owner information from the consent form.

7.7 CONDENSED EXCLUSION REPORTS

7.7.1 Complete all report information as indicated.

7.7.2 All condensed exclusion reports must include the following:

a. Gamma Analysis Worksheet,
b. Soil Analysis Worksheet,
c. ACAD map,
d. photograph, and
e. Vicinity Property Summary Evaluation.

7.7.3 UMTRA reports must include a VPDMS form.

7.7.4 Do not complete recommendation letters for any condensed exclusion reports.

7.8 REPORT COMPLETION

7.8.1 Place the report, letter, worksheets, Vicinity Property Summary Evaluation, and VPDMS form in the location folder.

7.8.2 Initial and date the "draft preparation" space of the Property File Tracking Form (Appendix 5).

7.8.3 Submit the folder to the clerical staff for typing.

7.9 REPORT REVIEW

7.9.1 After the draft is typed, the team leader or assigned team member other than the report writer completes the initial review.

a. Place an ISC Report Review Checklist (Appendix 25) in the location file.

b. Examine the report and forms for correctness, consistency, and completeness.

c. Make all necessary corrections and check the appropriate boxes on the checklist.

d. Initial and date the Property File Tracking Form (Appendix 5) in the space "Team Leader Review".

e. Submit the file to typing for corrections.

7.9.2 After the report is corrected, an assigned team member other than the report writer completes the final review.

a. Review the report and all forms as above.

b. Make all necessary corrections and check the appropriate boxes on the checklist.

c. Initial and date the Property File Tracking Form (Appendix 5) in the space "Alternate Team Review".

d. Submit the file to typing for corrections.

7.9.3 After the clerical staff corrects edits, the team leader or project manager verifies the final corrections and returns the folder to the clerical staff for transmittal.

7.10 CONFIRMATORY LABORATORY ANALYSIS RESULTS

7.10.1 Upon receipt of analysis result for soil samples from the soils laboratory, complete the Laboratory Soil Analysis Results Addendum and cover letter and send to the DOE (Appendices 26 and 27).

7.11 FILE TRANSMITTAL

7.11.1 Have the appropriate project manager or designee sign the recommendation letter or condensed report and Vicinity Property Summary Evaluation form.

7.11.2 Place the following items in a manila folder stamped "Official Location Folder," and transmit to the appropriate project office:

a. Letter of recommendation,
b. VP Summary Evaluation form,
c. Two copies of the finished inclusion survey report, including one color photograph of the property.
d. Original signed access consent form,
e. Complete historical data file (if one exists),
f. Field map with raw and converted data,
g. Gamma Analysis Worksheet,
h. Soils Analysis Worksheet,
i. Copy of Soil Sample Data Field Form, and a
j. Copy of property drawing which has been shaded to show surveyed portions of the property.

7.11.3 Retain a copy of all transmitted materials in the original property file.

7.11.4 Pull the VPDMS form from the folder. Transmit all VPDMS forms completed during the month to the TAC on a monthly basis.

7.11.5 Submit the original file to the public relations department.

7.12 DATA BASE ENTRY

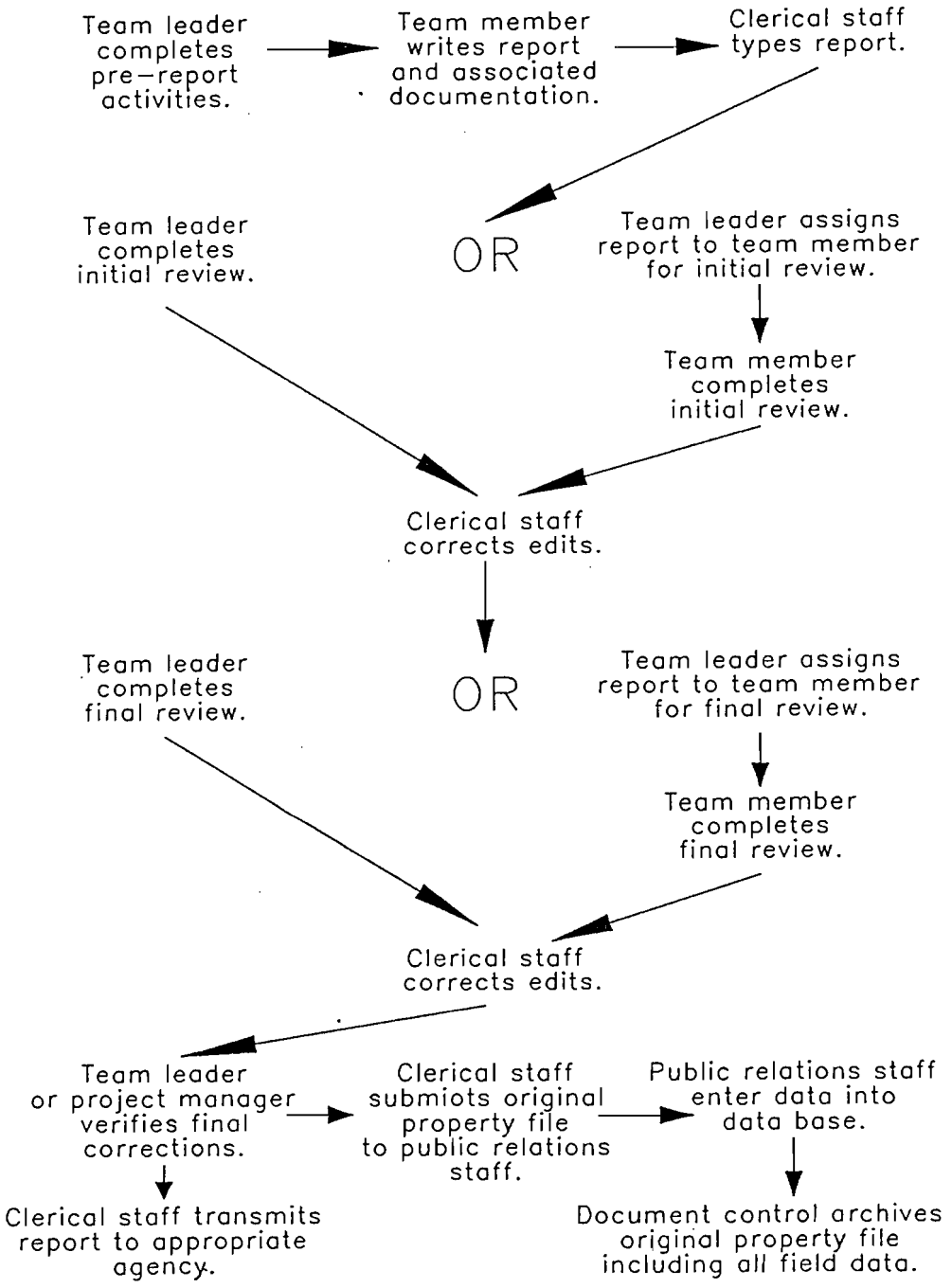
7.12.1 Enter the recommendation information into the data base.

a. Use the following codes to describe the recommendation basis:

WOS Walk-on survey
01 indoor gamma
02 radon
03 outdoor gamma
04 soil samples
05 spillover

7.12.2 Submit the folder to Document Control for filing. See Procedure SU-070, Document Control.

Appendix 1. Inclusion Survey Report Flow Chart



Appendix 2. Radiological Screening Summary sheet

OAK RIDGE NATIONAL LABORATORY
RADIOLGICAL SCREENING SUMMARY

SITE # _____
SURVEY DATE _____

SURVEY TEAM: _____ (LEADER) _____ _____
_____ _____ _____

SURVEY INSTRUMENTS USED FOR CORRELATION
gamm-rate meter # _____
PIC # _____

uR/h CONVERSION FORMULA USED
_____ uR/h = 1.69 K + 3.45
_____ other uR/h
_____ DIRECT CONVERSION cpm/uR/h (see below)

LOCATION	PIC(uR/h)	(cpm x 1000) GAMMA-RATE METER - 6"	CONVERSION(cpm/uR/h)
LOCATION	PIC(uR/h)		

BACKGROUND GAMMA-SCAN RANGE

Outdoor
_____ to _____ cpm x 1000
_____ to _____ uR/h

Indoor
_____ to _____ cpm x 1000
_____ to _____ uR/h

INDOOR SCAN RANGE:

INDOOR MAP _____ YES _____ NO

Region 1: _____ kcpm _____ uR/h Average: _____ kcpm _____ uR/h Area ____ m^2
2: _____ kcpm _____ uR/h Average: _____ kcpm _____ uR/h Area ____ m^2
3: _____ kcpm _____ uR/h Average: _____ kcpm _____ uR/h Area ____ m^2

Non-Point Source HIG: ____ kcpm _____ uR/h Location: _____
Point Source HIG: _____ kcpm _____ uR/h Location: _____

Comments: _____

OUTDOOR SCAN RANGE:

Region A: _____ kcpm _____ uR/h Average: _____ kcpm _____ uR/h Area ____ m^2
B: _____ kcpm _____ uR/h Average: _____ kcpm _____ uR/h Area ____ m^2
C: _____ kcpm _____ uR/h Average: _____ kcpm _____ uR/h Area ____ m^2
D: _____ kcpm _____ uR/h Average: _____ kcpm _____ uR/h Area ____ m^2
E: _____ kcpm _____ uR/h Average: _____ kcpm _____ uR/h Area ____ m^2

Non-Point Source HOG: ____ kcpm _____ uR/h Location _____
Point source HOG: _____ kcpm _____ uR/h Location _____

Comments: _____

PROPERTY RECOMMENDED FOR: EXCLUSION ___ INCLUSION ___ (see addtl. data sheets)
SOIL ANALYSIS REQUIRED FOR DETERMINATON: _____ YES _____ NO
INDOOR EXTENDED MEASUREMENTS REQUIRED: _____ YES _____ NO
PERSONNEL & EQUIPMENT INSPECTED & DECONTAMINATED: _____ YES

Appendix 3. Conversion Formulas

Grand Junction:	$y = 1.69x + 3.45$
Durango:	$y = 1.55x + 5.28$
Lowman:	$y = 1.98x + 5.92$
Green River:	$y = 1.60x + 7.34$
Gunnison:	$y = 1.47x + 10.33$
Naturita, Nucla, Slickrock and Vancorum:	$y = 1.80x + 5.64$
Rifle:	$y = 1.56x + 6.89$
Monticello:	$y = 1.46x + 7.20$

where:

y = gamma exposure rate, μR/h
x = gamma exposure rate, kcpm

Appendix 4. Soil Sample Data Field Form

OAK RIDGE NATIONAL LABORATORY SITE #_____

SOIL SAMPLE DATA FIELD FORM SURVEY DATE _____

	Visible Tailing	Sample Number	Depth, m	Gamma, kcpm	Gamma, μR/h	^{226}Ra, pCi/g
Sample Location: _____						
Visible Ore: __yes__no		_____	Surface	_____	_____	_____
Background Sample: __yes__no	_____	_____	_____	_____	_____	_____
Area Rep: _____						
Other Description:	_____	_____	_____	_____	_____	_____
_____						
_____	_____	_____	_____	_____	_____	_____
_____						
_____	_____	_____	_____	_____	_____	_____
Sample Location: _____						
Visible Ore: __yes__no		_____	Surface	_____	_____	_____
Background Sample: __yes__no	_____	_____	_____	_____	_____	_____
Area Rep: _____						
Other Description:	_____	_____	_____	_____	_____	_____
_____						
_____	_____	_____	_____	_____	_____	_____
_____						
_____	_____	_____	_____	_____	_____	_____
Sample Location: _____						
Visible Ore: __yes__no		_____	Surface	_____	_____	_____
Background Sample: __yes__no	_____	_____	_____	_____	_____	_____
Area Rep: _____						
Other Description:	_____	_____	_____	_____	_____	_____
_____						
_____	_____	_____	_____	_____	_____	_____
_____						
_____	_____	_____	_____	_____	_____	_____
Sample Location: _____						
Visible Ore: __yes__no		_____	Surface	_____	_____	_____
Background Sample: __yes__no	_____	_____	_____	_____	_____	_____
Area Rep: _____						
Other Description:	_____	_____	_____	_____	_____	_____
_____						
_____	_____	_____	_____	_____	_____	_____

Appendix 5. Property File Tracking Form

**********PROPERTY FILE TRACKING FORM**********

SITE NUMBER PARCEL NUMBER PROPERTY CLASS
ADDRESS

	Date Sent	Date Received	Status
Consent Form Follow-up	/ /	/ /	

	Date Tel.	Personal Visit	Status
Other Contact			

	Assigned	Completed	Drawing By
Graphics	/ /	/ /	

********** RADIATION SURVEY AND REPORT TRACKING **********

	DATE ASSIGNED PRC.CORD. INITIALS	DATE PERFORMED TEAM LEADER INITIALS
SURVEY DATE	_____	_____

DATE & INITIALS

Soils Results _____ Data Conversion _____
Data Archiving _____ Photos _____

****

	Date compl/initials			Date compl/initials
Draft Preparation	_____	>TYPING	Requires Radon Sampling	_____
Team Leader Review	_____		Radon Sampling Complete	_____
Alternate Team Review	_____		Requires Drilling/Auger	_____
Process Coordinator	_____	> TYPING	Drilling/Auger Complete	_____
Transmittal Letter	_____			

****

SPILLOVER DATA

Loc.No.	Parcel No.	Address
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

DOE Action	INCL/EXCL	DATE	RETURNED DATE
	_____	_____	_____

Comments _____

	Date complete & initials		Date complete & initials
Changes	_____	Transmittal letter	_____
Typing	_____	Resubmittal	_____

DOE Action	INCL/EXCL	DATE	RETURNED DATE
	_____	_____	_____

Comments _____

UCN17179 (9/90)

Appendix 6: Gamma Analysis Worksheet

5/87

GAMMA ANALYSIS WORKSHEET

LOCATION # GJ50001

REG.	RANGE µR/h	FIELD AVG. µR/h	GAMMA SHIELD CPMx2	GAMMA SHIELD µR/h	SLAB THICK (cm)	REP. AREA (m²)	BKG. AVG. µR/h	FORMULA	NET AVG. µR/h	NET CRITERIA µR/h	20% of BKG. AVG.	exceeds inclusion criteria yes	exceeds inclusion criteria no	< 20% BKG. AVG. yes	< 20% BKG. AVG. no	RMKS.
GEN	10-14	12				>100	12	$\frac{(12-12)\ 100}{100}$	Ø	>25	2.4		✓	✓		Bkgd
A	15-40	25				30	12	$\frac{(25-12)\ 30}{100}$	3.9	>25	2.4		✓		✓	Soils
INDOOR																
GEN	10-15	12				>9.3	12	$\frac{(12-12)\ 9.3}{9.3}$	Ø	>20	2.4		✓	✓		Bkgd
1	15-35	30				9.3	12	$\frac{(30-12)\ 9.3}{9.3}$	18	>20	2.4		✓		✓	Ext. Meas.

Appendix 7. Soil Analysis Worksheet

SOIL ANALYSIS WORKSHEET LOCATION # GJ 50001

SAMPLE NBR(S)	REGION SMPLD	(LAB) RA-226 CONC. pCi/g		AVG. RA-226 CONC. pCi/g	(BKG) RA-226 CONC. pCi/g	REP. AREA SQUARE METERS	SOIL SAMPLE THICKNESS IN (m)	FORMULA	NET RA-226 CONC. pCi/g	NET CRITERIA pCi/g	RMKS.
		SMPL 1	SMPL 2								
S1A/S2A	A.	10.3	19.8	15.1	1.4	30	.15	$\frac{(15.1-1.4)(15)(30)}{(.15)(100)}$	4.11	75	Excl
S1B/S2B	A.	17.6	15.2	16.4	1.4	30	.15	$\frac{(16.4-1.4)(15)(30)}{(.15)(100)}$	4.5	715	Excl

Appendix 8. Background Concentrations of ^{226}Ra in Surface Soil

State	pCi/g
Alabama	0.82
Alaska	0.65
Arizona	0.95
California	0.77
Colorado	1.4
Delaware	1.2
Florida	0.84
Georgia	0.88
Idaho	1.1
Illinois	0.97
Indiana	1.1
Kansas	0.97
Kentucky	1.5
Louisiana	0.71
Maryland	0.72
Michigan	1.1
Mississippi	1.2
Missouri	1.1
Nevada	1.5
New Jersey	0.87
New Mexico	1.5
New York	0.85
North Carolina	0.78
Ohio	1.5
Oregon	0.82
Pennsylvania	1.2
Tennessee	1.1
Texas	0.89
Utah*	1.3
Virginia	0.85
West Virginia	1.3
Wyoming	1.0

*Note: the background ^{226}Ra concentration for Monticello, Utah, is 2.0 based on measurements by the RAC.

Appendix 9. Hot Spot Limits

To calculate the hot spot limit:

$$S_{hg} = S_g \times (100\ m^2/A)^{1/2}$$

where:

S_{hg} = the hot spot limit, pCi/g

S_g = the authorized limit (5 pCi/g for surface soil or 15 pCi/g for subsurface soil)

A = the area of the hot spot in m^2

Appendix 9. (continued)

SURFACE SOILS		SUB-SURFACE SOILS	
Area (m^2)	Limit (pCi/g)	Area (m^2)	Limit (pCi/g)
1.0	50.0	1.0	150.0
1.5	41.0	1.5	122.0
2.0	35.0	2.0	106.0
2.5	32.0	2.5	95.0
3.0	29.0	3.0	87.0
3.5	27.0	3.5	80.0
4.0	25.0	4.0	75.0
4.5	24.0	4.5	71.0
5.0	22.0	5.0	67.0
5.5	21.0	5.5	64.0
6.0	20.0	6.0	61.0
6.5	20.0	6.5	59.0
7.0	19.0	7.0	57.0
7.5	18.0	7.5	55.0
8.0	18.0	8.0	53.0
8.5	17.0	8.5	51.0
9.0	17.0	9.0	50.0
9.5	16.0	9.5	49.0
10.0	16.0	10.0	47.0
11.0	15.0	11.0	45.0
12.0	14.0	12.0	43.0
13.0	14.0	13.0	42.0
14.0	13.0	14.0	40.0
15.0	13.0	15.0	39.0
16.0	13.0	16.0	38.0
17.0	12.0	17.0	36.0
18.0	12.0	18.0	35.0
19.0	11.0	19.0	34.0
20.0	11.0	20.0	34.0
21.0	11.0	21.0	33.0
22.0	11.0	22.0	32.0
23.0	10.0	23.0	31.0
24.0	10.0	24.0	31.0
25.0	10.0	25.0	30.0

Appendix 10. UMTRA Report Skeleton

page 1

Location Number (GJ5001)

HEALTH AND SAFETY RESEARCH DIVISION

REPORT OF INCLUSION SURVEY AT LOCATION GJ 50001
address 777 Home Court
Grand Junction, CO

Investigation Team

C. A. Little - Pollutant Assessment Group Leader
M. L. Espegren - PAG/UMTRA Project Coordinator
A.Z. Fames - Survey Team Leader

Author's Name Sam Berkoff

Date January 92

Prepared by the
OAK RIDGE NATIONAL LABORATORY
Grand Junction Office
Grand Junction, Colorado 81502
operated by
MARTIN MARIETTA ENERGY SYSTEMS, INC.
for the
U.S. DEPARTMENT OF ENERGY
under Contract No. DE-AC-5-84OR21400

Appendix 10. (continued)

page 2

Location Number: GJ 50001

REPORT OF INCLUSION SURVEY AT LOCATION GJ 50001
address 777 Home Ct
Gr. Jct. CO

INTRODUCTION

An inclusion radiological survey of location GJ50001 was conducted on (survdate) July 19, 1990 ~~1988~~ by Oak Ridge National Laboratory. This property consists of a Single family residence. This survey was conducted using methods as defined in the Vicinity Properties Management and Implementation Manual, UMTRA-DOE/AL-050601 (March 1988) and the PAG UMTRA Project Procedures Manual (April 1987). General location information is provided in Table 1, radiological survey results are given in Table 2 and 3, and supporting graphics are provided in Figure 1 (a and b). A view of the property is provided in Figure 2. All measurements are gross readings; background has not been subtracted. If presented, radon daughter concentrations result from radon measurements which were converted to working levels, assuming a 50% equilibrium factor.

(Insert for Direct Conversion)
The conversion formula used is y = x/CF, where "y" equals the exposure rate in μR/h, "x" equals the scintillometer measurements in kcpm, and "CF" equals the conversions factor determined in the field through a direct correlation between PIC and scintillometer measurements in kcpm/μR/h. For this property, CF equals ._____ for uncontaminated regions, ._____ for contaminated regions, and ._____ for indoor/other regions.

(or Insert for Conversion Equation):
The conversion formula used is y = mx + b, where "y" equals the exposure rate in μR/h, "x" equals scintillometer measurement in kcpm, and "m" and "b" are predetermined constants. On this property, "m" equals 3.69 and "b" equals 3.45.

SIGNIFICANCE OF FINDINGS

A complete gamma radiation screening of this property revealed a background gamma exposure rate ranges of 10-14 μR/h outdoors and 10-15 μR/h indoors.

Outdoors, one region of elevated gamma exposure rates was found (15-40 μR/h) (Region A, Figure 1a). Region A had a NEAWA gamma

Appendix 10. (continued)

page 3

Location Number: GJ50001

exposure rate of 3.9 μR/h. Radionuclide analysis of samples taken (Table 3) revealed NEAWA ^{226}Ra concentrations of 4.1 pCi/g for surface soils and 4.5 pCi/g for subsurface soils. These concentrations do not exceed the EPA inclusion criteria of 5 pCi/g for surface soils and 15 pCi/g for subsurface soils. One point source, identified as ore, was found in the shed and had a gamma exposure rate of 600 μR/h. It was removed at the owners request.

Indoors, one region of elevated gamma exposure rates was found in the southeast bedroom with a gamma exposure rate range of 15-35 μR/h. The NEAWA gamma exposure rate was 18 μR/h which exceeds 20% of the background average. Three valid measurements for ^{222}Rn concentrations were taken. When converted to Radon daughter concentrations (RDC), they result in an annual average RDC of .031 WL which is greater than the EPA criterion of 0.02 WL (Table 3)

Based on these findings, it is recommended that location GJ50001 be included for further concideration by the UMTRA Project.

Appendix 10. (continued)

page 4

Location Number: GJ 50001

RECOMMENDATION

RECOMMENDED FOR: Inclusion
RECOMMENDED FOR: Exclusion

RECOMMENDATION BASIS: Outdoor gamma is >25 μR/h above background averaged over 100 m^2

RECOMMENDATION BASIS: Outdoor gamma is <background plus the acceptable difference or 20% averaged over 100 m^2

RECOMMENDATION BASIS: ^{226}Ra is >5 pCi/g above background in surface 15 cm soil layer averaged over 100 m^2

RECOMMENDATION BASIS: ^{226}Ra is <5 pCi/g above background in surface 15 cm soil layer averaged over 100 m^2

RECOMMENDATION BASIS: ^{226}Ra is >15 pCi/g above background in subsurface 15 cm soil layer averaged over 100 m^2

RECOMMENDATION BASIS: ^{226}Ra is <15 pCi/g above background in subsurface 15 cm soil layer averaged over 100 m^2

RECOMMENDATION BASIS: Spillover from includable deposit on an adjoining property

RECOMMENDATION BASIS: Indoor gamma is >20 μR/h above background averaged in any room

RECOMMENDATION BASIS: Indoor gamma is < the acceptable difference or 20% above background in all rooms

RECOMMENDATION BASIS: Grab sample radon daughter concentration is >0.04 WL

RECOMMENDATION BASIS: Grab sample radon daughter concentration is >0.01 WL

RECOMMENDATION BASIS: Annual average radon daughter concentration is >0.02 WL

RECOMMENDATION BASIS: Annual average radon daughter concentration is <0.02 WL

Appendix 10. (continued)

page 5

Location Number: GJ 50001

Table 1. Location Information

Property Information

LOCATION:	777 Home Court Grand Junction, CO
OCCUPANT/TENANT:	James T. Brothers
TELEPHONE:	247-8000 (H) 247-0001 (B)
PROPERTY CLASSIFICATION:	Residential Major
TOTAL AREA OF PROPERTY:	1,100 m^2
STRUCTURES ON PROPERTY:	1- Single story brick house w/ c.s. 1- Garage - S.G 1- Shed - w/ dirt floor

Owner Information

OWNER:	Alice B. Toklass
ADDRESS:	52960 127th St. West #672 San Francisco, CA 91277
TELEPHONE:	902-677-8210 (H) 902-821-7211 (B)

Appendix 10. (continued)

page 6

Location Number: GJ 50001

Table 2. Radiological Screening Survey Results

Outdoor Screening Data

BACKGROUND EXPOSURE RATE:	12 μR/h
BACKGROUND + 20%:	14 μR/h
BACKGROUND EXPOSURE RATE RANGE:	10-14 μR/h
EXPOSURE RATE RANGE IN CONTAMINATED REGIONS:	A: 15-.0 μR/h ~~B: μR/h~~ ~~C: μR/h~~
HIGHEST OUTDOOR GAMMA (HOG) IN CONTAMINATED REGION:	40 μR/h
LOCATION OF HOG:	Region A
POINT SOURCE *:	600 μR/h
ESTIMATED AREA OF OUTDOOR CONTAMINATION BY REGION:	A: 30 m^2 ~~B: m^2~~ ~~C: m^2~~
NET ESTIMATED AREA-WEIGHTED AVERAGE BY REGION**:	A: 3.9 μR/h ~~B: μR/h~~ ~~C: μR/h~~

*Point source measurements are discussed in "Significance of Findings" section.

**Formula used: $$G_{AW} = \frac{\sum_{i=1}^{n} G_i A_i}{100}$$

where:
G_{AW} = the area-weighted exposure rate in [μR/h]
G_i = net average exposure rate in [μR/h]
($G_i = G_{Gross} - G_{Background}$)
A_i = area of region involved in [m^2] and,
100 = threshold area in [m^2]

Appendix 10. (continued)

page 7

Location Number: GJ 50001

Table 2. Radiological Screening Survey Results (Continued)

Indoor Screening Data

STRUCTURE DESCRIPTION OR NUMBER: House

BACKGROUND EXPOSURE RATE: 12 μR/h

BACKGROUND + 20%: 14 μR/h

BACKGROUND EXPOSURE RATE RANGE: 10-15 μR/h

EXPOSURE RATE RANGE IN CONTAMINATED REGIONS:
1: 15-35 μR/h
2: ~~μR/h~~
3: ~~μR/h~~

HIGHEST INDOOR GAMMA (HIG) IN CONTAMINATED REGION: 35 μR/h

LOCATION OF HIG: Region 1

POINT SOURCE*: none μR/h

ESTIMATED AREA OF INDOOR CONTAMINATION BY REGION:
1: > 9.3 m^2
2: ____ m^2
3: ____ m^2

NET ESTIMATED AREA-WEIGHTED AVERAGE BY REGION/ROOM**:
1: 18 μR/h
2: ____ μR/h
3: ____ μR/h

*Point source measurements are discussed in "Significance of Findings" section.

**Formula used: $x = \frac{\sum_{i=1}^{n} G_i A_i}{9.3}$

where:

x = area-weighted gamma exposure rate [μR/h]

G_i = net gamma exposure rate in [μR/h]

A_i = area of deposit in [m^2]

9.3 = threshold area in [m^2]

Appendix 10. (continued)

page 8

Location Number: GJ 50001

Table 3. Extended Survey Results

Outdoor Extended Data

Soil Sample Summary

Soil Sample Number	Region Sampled	Sample Depth (cm)	^{226}Ra Concentration (pCi/g) (Canalysis)	Representative (biased) Sampling Area m^2	Net Estimated Area-Weighted Average* (pCi/g, CAW)
S1A S2A	A	0-15	10 20	30	4.1
S1B S2B	A	15-30	18 15	30	4.5

$$*\text{Formula used } CAW = \frac{\sum_{i=1}^{n} CiAiDi}{(100)\ (.15)}$$

where= C_{AW} = area-weighted ^{226}Ra concentration in [pCi/g]
C_i = net ^{226}Ra concentration in [pCi/g] and

($Ci = C_{analysis} - C_{background}$)
A_i = area of region that sample represents in [m^2]
D_i = thickness of sample in [m]
100 = threshold area in [m^2], and
.15 = threshold thickness in [m]

Appendix 10. (continued)

page 9

Location Number: GJ 50001

Table 3. Extended Survey Results (continued)

Indoor Extended Data

Radon Monitoring Summary

Region	Room	Date	RDC (WL)	Annual Average RDC (WL)**
1	S.E. Bedroom	Aug 17, 1990	0.0361	0.031
		Dec 1, 1990	0.0303	
			0.0272	

** Formula used: $WL = \frac{(WLR)\ (Rn)}{100}$

where: WL = Working Level
WLR = .5 (WL ratio as per VPMIM assuming 50% equilibrium)
Rn = Average ^{222}Rn concentration in pCi/l as reported by vendor.

**Annual average (WL) determined by: Oak Ridge National Laboratory - Terradex Track Etch[R] Type SF Air Monitors

Appendix 10. (continued)

page 10

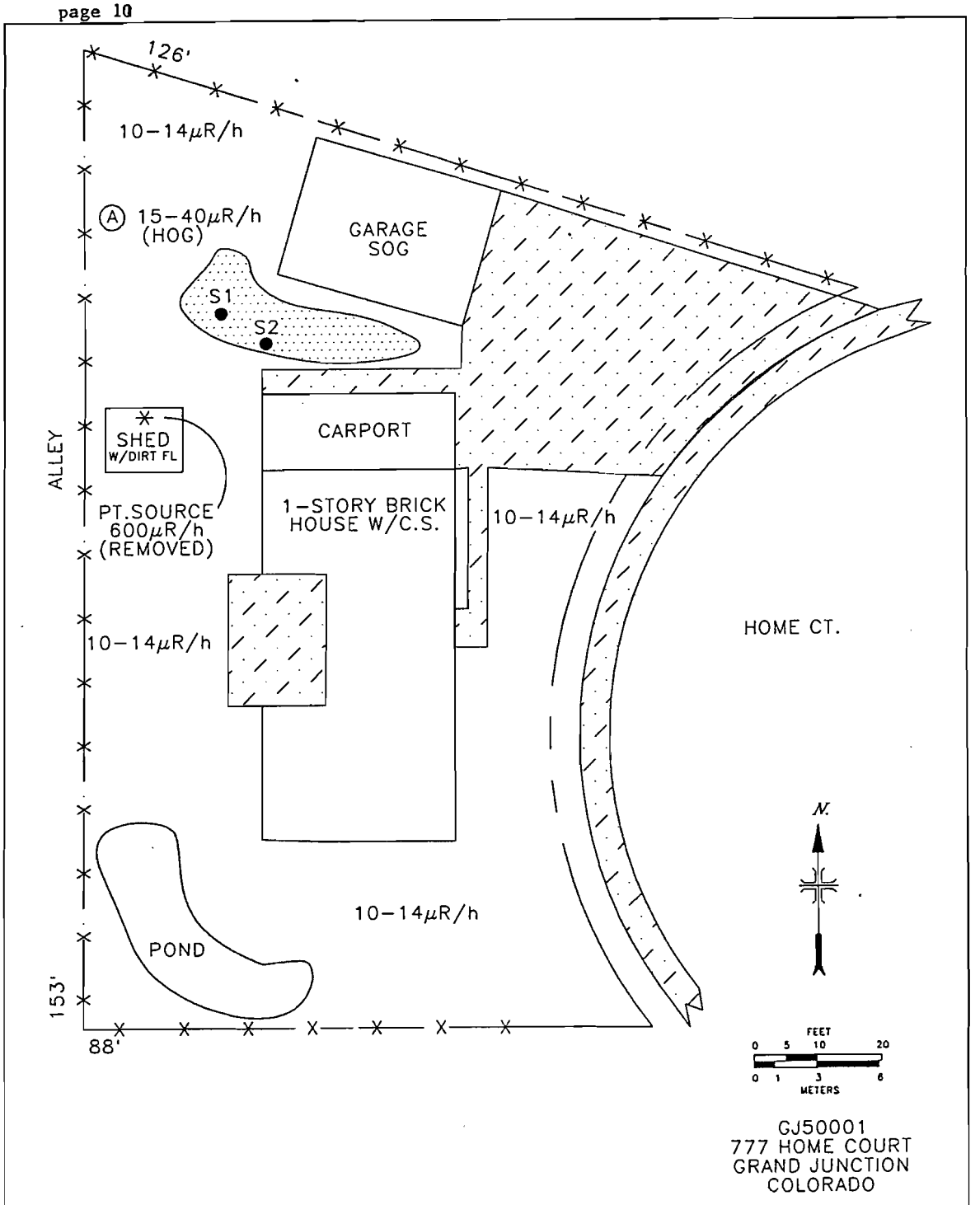


Figure 1a. Property Map

Appendix 10. (continued)

page 11

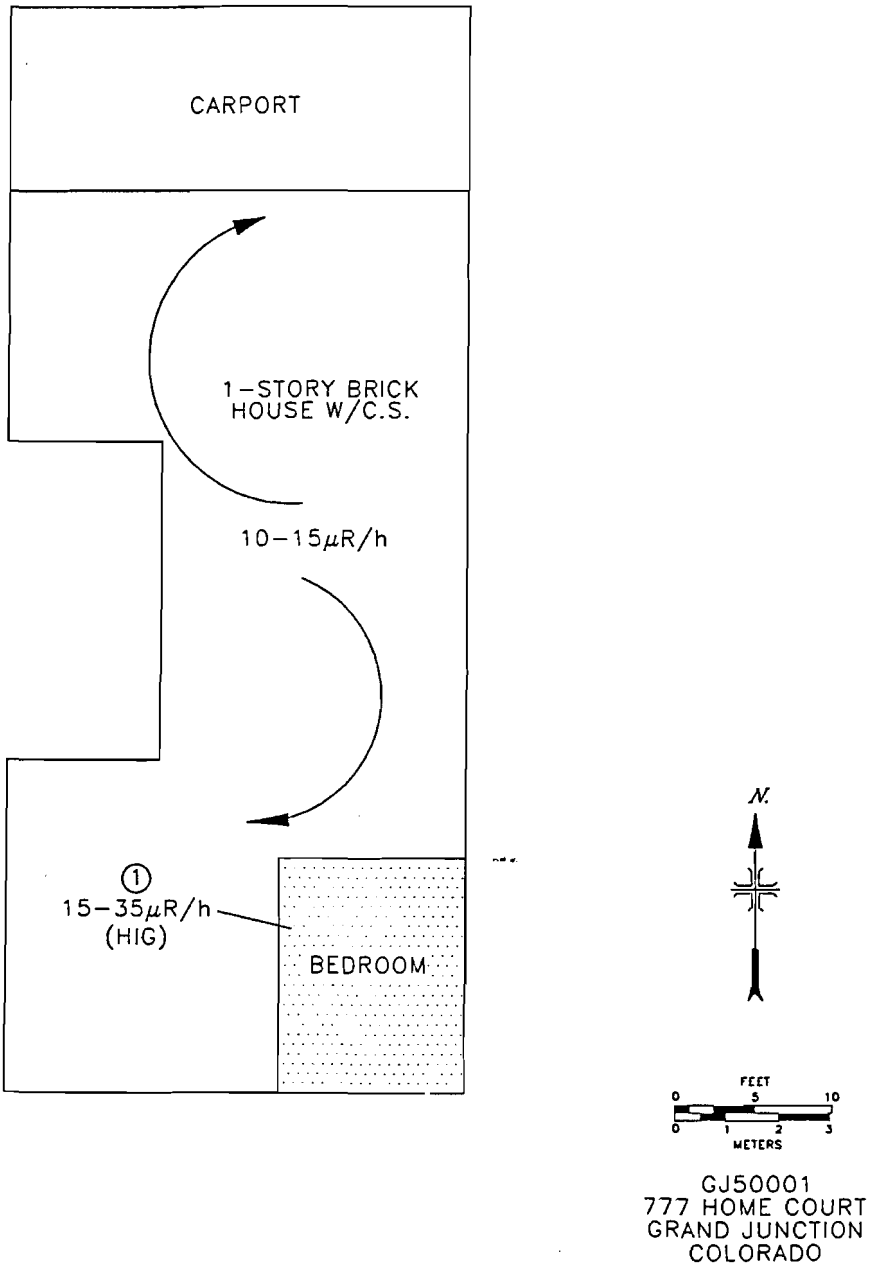


Figure 1b. Property Map

AZL 7/2/91
SMB 7/18/91

Appendix 10. (continued)

page 12

Figure 1. Location GJ50001, 777 Home Ct., Grand Junction, Colorado

Figure 2. Location GJ50001, looking W at the front of the property.

Appendix 11. MVP Report Skeleton

page 1

Location Number MSXXXXX

HEALTH AND SAFETY RESEARCH DIVISION

REPORT OF RADIOLOGICAL SURVEY AT LOCATION MSXXXXX
19 South 1st West Street
MONTICELLO, UT 84535

Investigation Team

B. A. Berven - Environmental Measurements and Applications Section
C. A. Little - Pollutant Assessment Group Leader
M. J. Wilson - MVP-IVC Project Manager

S. K. Mather

July 1991

Prepared by the
OAK RIDGE NATIONAL LABORATORY
Grand Junction Office
Grand Junction, Colorado 81502
operated by
MARTIN MARIETTA ENERGY SYSTEMS, INC.
for the
U.S. DEPARTMENT OF ENERGY
under Contract No. DE-AC-5-84OR21400

Appendix 11. (continued)

Location Number: MSXXXXX

REPORT OF RADIOLOGICAL SURVEY AT LOCATION MSXXXXX
19 South 1st West Street
MONTICELLO, UT 84535

INTRODUCTION

The Surplus Facilities Management Program (SFMP) was established by the Department of Energy (DOE) in 1978. SFMP is responsible for managing the maintenance and surveillance of numerous DOE-owned radioactively contaminated facilities that have been declared surplus, and conducting a program leading to the ultimate disposition of those facilities. The SFMP's fundamental responsibility is to protect the public health and the environment from potentially harmful radioactive contamination contained within or derived from DOE-owned facilities. The Monticello mill site was declared surplus in 1981 and is currently awaiting remedial action to bring its condition up to present decontamination and reclamation standards. Prior to performing remedial action on the mill site, the properties surrounding the site and designated privately owned properties in Monticello are being assessed. Oak Ridge National Laboratory (ORNL) was directed by the DOE in July 1988 to assess the radiological condition of privately owned properties in Monticello which have been identified as possibly containing mill-related materials. If radiation levels on these properties exceed EPA and DOE standards, the property is eligible for clean-up under the Surplus Facilities Management Program. These assessments are referred to as screening and scoping surveys. A detailed investigation is referred to as a "screening" survey and an abbreviated form as a "scoping" survey.

A radiological screening survey of location MSXXXXX was conducted on (survdate) 06/01/91 ~~1989~~ by Oak Ridge National Laboratory. This property consists of a single family residence
This survey was conducted using methods as defined in the Vicinity Properties Management and Implementation Manual, UMTRA-DOE/AL-050601 (March 1988) and the PAG UMTRA Project Procedures Manual (April 1987), the Procedures Manual for the ORNL Radiological Survey Activities (RASA) Program (April 1987) and the U.S. Department of Energy Guidelines for Residual Radioactive Material at Formerly Utilized Sites Remedial Action Program (FUSRAP) (Revision 2, March 1987). The radiological survey of this property included: (1) a gamma scan of the entire ground surface outdoors and indoors; (2) samples of outdoor soil; and (3) evaluation of historical data when present. The gamma scan was conducted using a Victoreen Portable Ratemeter, Model 490 which is a gamma scintillometer.

General location information is provided in Table 1, radiological survey results are given in Tables 2 and 3, and supporting graphics are provided in Figure 1. A view of the property is provided in Figure 2. All measurements are gross readings; background has not been subtracted.

Appendix 11. (continued)

page 3

Location Number: MSXXXXX

SIGNIFICANCE OF FINDINGS

A complete gamma radiation scan was conducted on this property yielding background gamma exposure rate ranges of 12-15 uR/h outdoors and 12-14 uR/h indoors.

One area of elevated gamma exposure rates was detected and labeled Region A (Figure 1). Radionuclide analysis of soil sample S1 taken from Region A yielded a ^{226}Ra concentration of 47 pCi/g. This value exceeds the DOE Hot Spot guidelines for surface soils of areas 5 m^2 (Table 3).

A point source with a gamma exposure rate of 110 uR/h was located in a rock garden in the front yard. It was a piece of petrified wood and the property owner requested that it be left in place.

Appendix 11. (continued)

page 4

Location Number: MSXXXXX

FINDINGS

SITE CONTAINS RADIATION LEVELS WHICH [X] EXCEED [] DO NOT EXCEED THE DOE GUIDELINES BELOW:

Outdoor gamma is >25 μR/h above background averaged over 100 m^2

Outdoor gamma is <background plus the acceptable difference or 20% averaged over 100 m^2

^{226}Ra is > the Hot Spot Guideline

^{226}Ra is >5 pCi/g above background in surface 15 cm soil layer averaged over 100 m^2

^{226}Ra is <5 pCi/g above background in surface 15 cm soil layer averaged over 100 m^2

^{226}Ra is >15 pCi/g above background in subsurface 15 cm soil layer averaged over 100 m^2

^{226}Ra is <15 pCi/g above background in subsurface 15 cm soil layer averaged over 100 m^2

Spillover from includable deposit on an adjoining property

Indoor gamma is >20 μR/h above background averaged in any room

Indoor gamma is < the acceptable difference or 20% above background in all rooms

Appendix 11. (continued)

page 5

Location Number: MSXXXXX

Table 1. Location Information

Property Information

LOCATION: 19 South 1st West Street
Monticello, UT 84535

OCCUPANT/TENANT: Holden Caulfield

TELEPHONE: 801-555-1234

PROPERTY CLASSIFICATION: Residential, Simple

TOTAL AREA OF PROPERTY: 3200 m^2

STRUCTURES ON PROPERTY: 1 single story brick house with basement
2 sheds, 1-slab-on-grade, 1 dirt floor

Owner Information

OWNER: Holden Caulfield

ADDRESS: PO Box 999
Monticello, UT 84535

TELEPHONE: same as above

Appendix 11. (continued)

page 6

Location Number: MSXXXXX

Table 2. Radiological Screening Survey Results

Outdoor Screening Data

BACKGROUND EXPOSURE RATE:	14 μR/h
BACKGROUND + 20%:	17 μR/h
BACKGROUND EXPOSURE RATE RANGE:	12-15 μR/h
EXPOSURE RATE RANGE IN CONTAMINATED REGIONS:	A: 16-26 μR/h B: ~~μR/h~~ C: ~~μR/h~~
HIGHEST OUTDOOR GAMMA (HOG) IN CONTAMINATED REGION:	26 μR/h
LOCATION OF HOG:	Region A
POINT SOURCE *:	110 μR/h
ESTIMATED AREA OF OUTDOOR CONTAMINATION BY REGION:	A: 5 m² B: ~~m²~~ C: ~~m²~~
NET ESTIMATED AREA-WEIGHTED AVERAGE BY REGION**:	A: <1.0 μR/h B: ~~μR/h~~ C: ~~μR/h~~

*Point source measurements are discussed in "Significance of Findings" section.

**Formula used: $G_{AW} = \frac{\sum_{i=1}^{n} G_i A_i}{100}$

where:
G_{AW} - the area-weighted exposure rate in [μR/h]
G_i - net average exposure rate in [μR/h]
$(G_i - G_{Gross} - G_{Background})$
A_i - area of region involved in [m²] and,
100 - threshold area in [m²]

Appendix 11. (continued)

page 7 Location Number: MSXXXXX

Table 2. Radiological Screening Survey Results (Continued)

Indoor Screening Data

STRUCTURE DESCRIPTION OR NUMBER:	All structures
BACKGROUND EXPOSURE RATE:	13 μR/h
BACKGROUND + 20%:	16 μR/h
BACKGROUND EXPOSURE RATE RANGE:	12-14 μR/h
~~EXPOSURE RATE RANGE IN CONTAMINATED REGIONS:~~	~~1: ___ μR/h~~ ~~2: ___ μR/h~~ ~~3: ___ μR/h~~
HIGHEST INDOOR GAMMA (HIG) ~~IN CONTAMINATED REGION:~~	14 μR/h
LOCATION OF HIG:	~~Region~~ General
POINT SOURCE*:	None μR/h
~~ESTIMATED AREA OF INDOOR CONTAMINATION BY REGION:~~	~~1: ___ m²~~ ~~2: ___ m²~~ ~~3: ___ m²~~
NET ESTIMATED AREA-WEIGHTED AVERAGE BY REGION/ROOM**:	0 μR/h 1: ___ μR/h 2: ___ μR/h 3: ___ μR/h

*Point source measurements are discussed in "Significance of Findings" section.

**Formula used: $x = \frac{\sum_{i=1}^{n} G_i A_i}{9.3}$

where:

x = area-weighted gamma exposure rate [μR/h]

G_i = net gamma exposure rate in [μR/h]

A_i = area of deposit in [m²]

9.3 = threshold area in [m²]

Appendix 11. (continued)

page 8

Location Number: M5XXXXX

Table 3. Extended Survey Results

Outdoor Extended Data

Soil Sample Summary

Soil Sample Number	Region Sampled	Sample Depth (cm)	^{226}Ra Concentration (pCi/g) (Canalysis)	Representative (biased) Sampling Area m^2	Net Estimated Area-Weighted Average* (pCi/g, CAW)	Hot Spot Guideline** (pCi/g)
51	A	0-15	47	5	2.3	>22

$$*\text{Formula used CAW} = \frac{\sum_{i=1}^{n} CiAiDi}{(100)\ (.15)}$$

where- C_{AW} - area-weighted ^{226}Ra concentration in [pCi/g]
C_i - net ^{226}Ra concentration in [pCi/g] and

(C_i - $C_{analysis}$ - $C_{background}$)
A_i - area of region that sample represents in [m^2]
D_i - thickness of sample in [m]
100 - threshold area in [m^2], and
.15 - threshold thickness in [m]

$$**Shg = Sg * (100\ m^2/A)^{1/2}$$

where, Shg - the Hot Spot Limit (pCi/gram)
Sg - the Authorized Limit for a specific site (pCi/g)
A - the area of the Hot Spot in square meters

$(100/A)^{1/2}$ is the Hot Spot multiplication factor

Appendix 11. (continued)

page 9

Location Number: MSXXX

Table 3. Extended Survey Results (continued)

Indoor Extended Data

Radon Monitoring Summary

Region	Room	Date	RDC (WL)	Annual Average RDC (WL)**

** Formula used: $WL = \frac{(WLR)\ (Rn)}{100}$

where: WL - Working Level
WLR - .5 (WL ratio as per VPMIM assuming 50% equilibrium)
Rn - Average ^{222}Rn concentration in pCi/l as reported by vendor.

**Annual average (WL) determined by: Oak Ridge National Laboratory - Terradex Track Etch^{R} Type SF Air Monitors

page 10

Appendix 11. (continued)

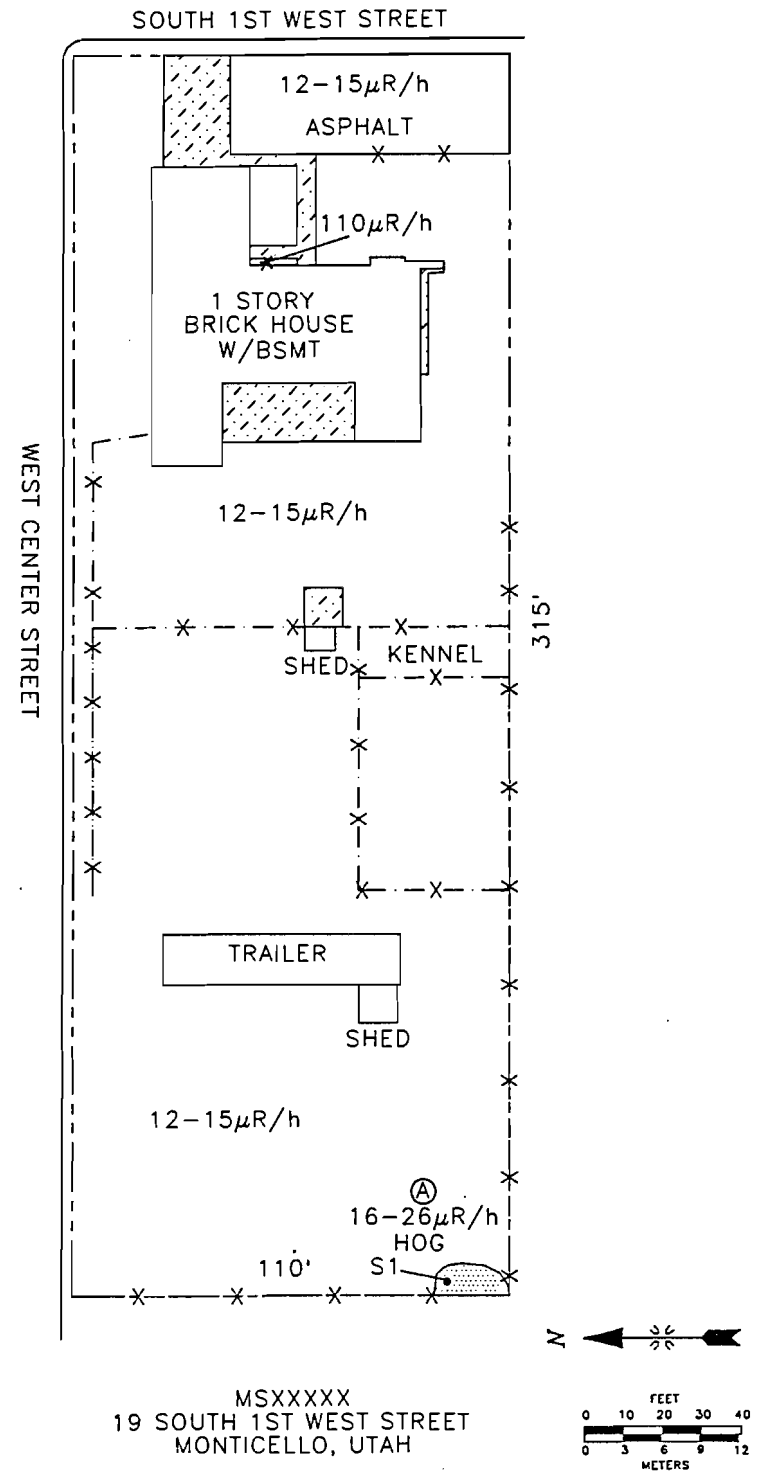


Figure 1. Property Map

SKM 3/21/91 3/27/91

Appendix 11. (continued)

page 11

Figure 2. Location MSXXXX, looking west at the front of the property.

Appendix 12. PUOR Report Skeleton

The PUOR Skeleton includes pages 1 and 2 following, and pages 3-12 of the UMTRA report skeleton.

page 1
PUOR SKELETON

Location Number (_____)

HEALTH AND SAFETY RESEARCH DIVISION

REPORT OF INCLUSION SURVEY AT LOCATION _____
address_____
_____

Investigation Team

C. A. Little - Pollutant Assessments Group Leader
J. A. Rice - PAG/UMTRA Project Coordinator
- Survey Team Leader

Author's Name_____

Date_____

WORK PERFORMED AS PART OF THE
RADIOLOGICAL SURVEY ACTIVITIES PROGRAM

Prepared by the
OAK RIDGE NATIONAL LABORATORY
Grand Junction Office
Grand Junction, Colorado 81502
operated by
MARTIN MARIETTA ENERGY SYSTEMS, INC.
for the
U.S. DEPARTMENT OF ENERGY
under Contract No. DE-AC-5-840R21400

Appendix 12. (continued)

page 2

Location Number:_____

REPORT OF INCLUSION SURVEY AT LOCATION _____
address_____
_____

INTRODUCTION

The Department of Energy announced a cut-off date of July 31, 1990 for accepting requests for radiological surveys from property owners. The request to survey location_____ was accepted after the cut-off date.

An inclusion radiological survey of this location was conducted on (survdate) _____, 1991 by Oak Ridge National Laboratory. This property consists of_____. This survey was conducted using methods as defined in the Vicinity Properties Management and Implementation Manual, UMTRA-DOE/AL-050601 (March 1988), and the ORNL PAG Procedures Manual (February 1991). General location information is provided in Table 1, radiological survey results are given in Table 2 and 3, and supporting graphics are provided in Figure 1. A view of the property is provided in Figure 2. All measurements are gross readings; background has not been subtracted.

The conversion formula used is $y = mx + b$, where "y" equals the exposure rate in $\mu R/h$, "x" equals scintillometer measurement in kcpm, and "m" and "b" are predetermined constants. On this property, "m" equals 1.69 and "b" equals 3.45.

SIGNIFICANCE OF FINDINGS

_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

Appendix 13. PU5 Report Skeleton

The PU5 skeleton includes pages 1, 2, 4, and 5 following, and pages 3, 6-12 of the UMTRA report skeleton.

page 1
PU5 SKELETON (8/91)

Location Number (_____)

HEALTH AND SAFETY RESEARCH DIVISION

REPORT OF SUPPLEMENTAL INCLUSION SURVEY AT LOCATION _____
address_____
_____

Investigation Team

C. A. Little - Pollutant Assessments Group Leader
J. A. Rice - PAG/UMTRA Project Coordinator
- Survey Team Leader

Author's Name_____

Date_____

WORK PERFORMED AS PART OF THE
RADIOLOGICAL SURVEY ACTIVITIES PROGRAM

Prepared by the
OAK RIDGE NATIONAL LABORATORY
Grand Junction Office
Grand Junction, Colorado 81502
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U.S. DEPARTMENT OF ENERGY
under Contract No. DE-AC-5-840R21400

Appendix 13. (continued)

page 2

Location Number: _____

REPORT OF SUPPLEMENTAL INCLUSION SURVEY AT LOCATION _____
address_____
_____

INTRODUCTION

A supplemental inclusion radiological survey of location _____ was conducted on (survdate)_____, 1991 by Oak Ridge National Laboratory. This property consists of_____. This survey was conducted using methods as defined in the Vicinity Properties Management and Implementation Manual, UMTRA-DOE/AL-050601 (March 1988), VPMIM Directive #E8 (December 1990), and the ORNL PAG Procedures Manual (February 1991). General location information is provided in Table 1, radiological survey results are given in Table 2 and 3, and supporting graphics are provided in Figure 1. A view of the property is provided in Figure 2. All measurements are gross readings; background has not been subtracted.

The conversion formula used is $y = mx + b$, where "y" equals the exposure rate in $\mu R/h$, "x" equals scintillometer measurement in kcpm, and "m" and "b" are predetermined constants. On this property, "m" equals 1.69 and "b" equals 3.45.

SIGNIFICANCE OF FINDINGS

_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

Appendix 13. (continued)

page 4

Location Number: _____

RECOMMENDATION

RECOMMENDED FOR:	Inclusion
RECOMMENDED FOR:	Exclusion
RECOMMENDATION BASIS:	Outdoor gamma is >25 mR/h above background averaged over 100 m^2
RECOMMENDATION BASIS:	Outdoor gamma is <background plus the acceptable difference or 20% averaged over 100 m^2
RECOMMENDATION BASIS:	^{226}Ra is >5 pCi/g above background in surface 15 cm soil layer averaged over 100 m^2
RECOMMENDATION BASIS:	^{226}Ra is <5 pCi/g above background in surface 15 cm soil layer averaged over 100 m^2
RECOMMENDATION BASIS:	^{226}Ra is >15 pCi/g above background in subsurface 15 cm soil layer averaged over 100 m^2
RECOMMENDATION BASIS:	^{226}Ra is <15 pCi/g above background in subsurface 15 cm soil layer averaged over 100 m^2
RECOMMENDATION BASIS:	Spillover from includable deposit on an adjoining property
RECOMMENDATION BASIS:	Indoor gamma is >20 mR/h above background averaged in any room
RECOMMENDATION BASIS:	Indoor gamma is < the acceptable difference or 20% above background in all rooms

Appendix 13. (continued)

page 5

Location Number: _____

Table 1. Location Information

Property Information

LOCATION: _____

OCCUPANT/TENANT: _____

TELEPHONE: _____ (H)
_____ (B)

PROPERTY CLASSIFICATION: _____

TOTAL AREA OF PROPERTY: _____ m^2

Owner Information

OWNER: _____

ADDRESS: _____
_____

TELEPHONE: _____ (H)
_____ (B)

Appendix 14. UMTRA Condensed Report Skeleton

page 1

Location Number:_____
Location Address:_____
_____
Date of Issue:___ (month/year)_____
Survey Date:_____

ISC CONDENSED EXCLUSION REPORT
ORNL Health and Safety Research Division
Work performed as part of the Radiological Activities Program

This radiological survey was conducted using methods as defined in the Vicinity Properties Management and Implementation Manual, UMTRA-DOE/AL-050601 (March 1988) and the PAG/UMTRA Project Procedures Manual (April 1987). This property is recommended for exclusion from further consideration by the SFMP project based on: 1) Outdoor gamma is less than background plus the acceptable difference or 20% averaged over 100 m^2, and 2) Indoor gamma is less than the acceptable difference or 20% above background in all rooms.

Supporting graphics, views and data are as follows:

-Owner Information-
Owner Name(s):_____
Owner Address:_____
_____

-Outdoor Screening Data-
Exposure Rate Range(s) _____ μR/h
Background Exposure Rate + 20%: _____ μR/h
High Outdoor Gamma (HOG): _____ μR/h
Point Source(*): _____ μR/h

-Indoor Screening Data-
Exposure Rate Range(s): _____ μR/h
Background Exposure Rate + 20%: _____ μR/h
High Indoor Gamma (HIG): _____ μR/h
Point Source(*): _____ μR/h

Soil Sample Number	Sample Depth (cm)	^{226}Ra Concentration (pCi/g)	Sample Area m^2	Net Estimated Area-weighted (pCi/g)

Comments:_____
_____

_____ _____
Inclusion Survey Contractor DOE Evaluator

Appendix 14. (continued)

page 2

Figure 2. Location _____.

Appendix 15. MVP Condensed Report Skeleton

The MVP condensed report skeleton includes page 1 following, and page 2 of the UMTRA condensed report skeleton.

Location Number: xx???
Location Address: _____
Monticello, Utah 84535
Date of Issue: January 1991
Survey Date: _____

MVP-ISC CONDENSED EXCLUSION REPORT
ORNL Health and Safety Research Division
Work performed as part of the Radiological Activities Program

This radiological survey was conducted using methods as defined in the Vicinity Properties Management and Implementation Manual, UMTRA-DOE/AL-050601 (March 1988) and the PAG Procedures Manual (April 1987). This property is recommended for exclusion from further consideration by the SFMP-MVP project based on: 1) Outdoor gamma is less than background plus the acceptable difference or 20% averaged over 100 m^2, and 2) Indoor gamma is less than the acceptable difference or 20% above background in all rooms.

Supporting graphics, views and data are as follows:

-Owner Information-
Owner Name(s): _____
Owner Address: _____
Monticello, Utah 84535

-Outdoor Screening Data-
Exposure Rate Range(s) μR/h
Background Exposure Rate + 20%: μR/h
High Outdoor Gamma (HOG): μR/h
Non Mill-related Point Source(*): μR/h

-Indoor Screening Data-
Exposure Rate Range(s): μR/h
Background Exposure Rate + 20%: μR/h
High Indoor Gamma (HIG): μR/h
Non Mill-related Point Source(*): μR/h

Soil Sample Number	Sample Depth (cm)	^{226}Ra Concentration (pCi/g)	Sample Area m^2	Net Estimated Area-weighted (pCi/g)

Comments: _____

_____ Inclusion Survey Contractor

_____ DOE Evaluator

Appendix 16. PUOR Condensed Report Skeleton

The PUOR condensed report skeleton includes page 1 following, and page 2 of the UMTRA condensed report skeleton.

page 1 of 2

PUOR SHORT FORM

OAK RIDGE NATIONAL LABORATORY

OPERATED BY MARTIN MARIETTA ENERGY SYSTEMS, INC.

GRAND JUNCTION OFFICE
P. O. BOX 2567
GRAND JUNCTION, COLORADO 81502

Location Number:_____
Location Address: _____
_____

Date of Issue:_____
Survey Date:_____

ISC CONDENSED EXCLUSION REPORT
ORNL Health and Safety Research Division
Work performed as part of the Radiological Activities Program

The Department of Energy announced a cut-off date of July 31, 1990 for accepting requests for radiological surveys from property owners. The request to survey this location was accepted after the cut-off date.

This radiological survey was conducted using methods as defined in the Vicinity Properties Management and Implementation Manual, UMTRA-DOE/AL-050601 (March 1988) and the ORNL PAG Procedures Manual (February 1991). This property is recommended for exclusion from further consideration by the UMTRA Project based on: 1) Outdoor gamma is less than background plus the acceptable difference or 20% averaged over 100 m^2, and 2) Indoor gamma is less than the acceptable difference or 20% above background in all rooms.

Supporting graphics, views and data are as follows:

-Owner Information-
Owner Name(s):_____
Owner Address:_____
_____

-Outdoor Screening Data-
Exposure Rate Range(s): _____ μR/h
Background Exposure Rate + 20%: _____ μR/h
High Outdoor Gamma (HOG): _____ μR/h
Point Source(*): _____ μR/h

-Indoor Screening Data-
Exposure Rate Range(s): _____ μR/h
Background Exposure Rate + 20%: _____ μR/h
High Indoor Gamma (HIG): _____ μR/h
Point Source(*): _____ μR/h

Soil Sample Number	Sample Depth (cm)	^{226}Ra Concentration (pCi/g)	Sample Area m^2	Net Estimated Area-weighted (pCi/g)
No soils taken				

Comments:_____
_____

_____ _____
Inclusion Survey Contractor DOE Evaluator

Appendix 17. PU5 Condensed Report Skeleton

The PU5 condensed report skeleton includes page 1 following, and page 2 of the UMTRA condensed report skeleton.

page 1 of 2

5 SHORT FORM

OAK RIDGE NATIONAL LABORATORY

OPERATED BY MARTIN MARIETTA ENERGY SYSTEMS, INC.

GRAND JUNCTION OFFICE
P. O. BOX 2567
GRAND JUNCTION, COLORADO 81502

Location Number:_____
Location Address:_____
_____
Date of Issue:_____
Survey Date:_____

Michael K. Tucker, Manager
U. S. Department of Energy
Grand Junction Projects Office
P.O. Box 2567
Grand Junction, CO 81502

Dear Mr. Tucker:

By letter from Mark L. Matthews to Douglas K. Halford, dated April 22, 1991, the UMTRA Project Office of the Department of Energy requested that Oak Ridge National Laboratory (ORNL) return to certain vicinity properties to perform outdoor surveys on lands associated with properties that were previously excluded.

Based on data taken during the supplemental survey of the location noted above, there is no change in the original recommendation that the property be excluded from further consideration by the UMTRA Project. Results of the survey follow:

-Owner Information-
Owner Name(s):_____
Owner Address:_____
_____

Area surveyed: see attached map

-Screening Data-

Exposure Rate Range(s)	μR/h
Background Exposure Rate + 20%:	μR/h
High Outdoor Gamma (HOG):	μR/h
Point Source(*):	μR/h

Comments:_____
_____

_____ _____
Inclusion Survey Contractor DOE Evaluator

(8/91)

Appendix 18. UMTRA Letter of Recommendation

Mr. Michael K. Tucker, Manager
U. S. Department of Energy
Grand Junction Area Office
P. O. Box 2567
Grand Junction, Colorado 81502

Dear Mr. Tucker,

Radiation levels at the property identified below appear [] to [] not to exceed the U. S. Environmental Protection Agency (EPA) standards as specified in 40 CFR 192.

This evaluation is based on [] indoor [] outdoor screening measurement criteria, [] indoor [] outdoor extended measurement criteria of the U. S. Department of Energy Vicinity Properties Management and Implementation Manual (UMTRA-DOE/A1-050601), Appendix A, and/or [] other criteria stated below.

Other:

_____

_____

This recommendation is based upon the Inclusion Survey Contractor's assessment of the [] ^{226}Ra concentration in the soil [] indoor radon daughter concentration [] indoor gamma exposure rate at this property.

Therefore, this property is recommended for [] inclusion in [] exclusion from the Uranium Mill Tailings Remedial Action Project.

Sincerely,

C. A. Little, Ph. D.
Inclusion Survey Contractor

Location Number:_____
Location Address:_____
_____
Property Owner:_____
Owner Address:_____
_____
Tenant:_____

Appendix 19. MVP Letter of Recommendation

A. F. Kluk
Defense D & D Program Manager
Environmental Restoration and Waste Management
Northwestern Programs Branch
U.S. Department of Energy (MS-EM-423)
Washington, DC 20545

Dear Dr. Kluk:

Radiation levels at the property identified below appear [] to [] not to exceed the guidelines specified by the U.S. Department of Energy for Residual Radioactive Material at Formerly Utilized Sites Remedial Action Program (FUSRAP) and Remote Surplus Facilities Management Program Sites (SFMP) [Revision 2, March 1987].

This evaluation is based on [] indoor [] outdoor screening measurement criteria, [] indoor [] outdoor extended measurement criteria of the U. S. Department of Energy Vicinity Properties Management and Implementation Manual (UMTRA-DOE/A1-050601), Appendix A, and/or [] Hot Spot Guideline.

Other: _____

_____

This finding is based upon the Inclusion Survey Contractor's assessment of the [] ^{226}Ra concentration in the soil [] indoor radon daughter concentration [] indoor gamma exposure rate at this property.

Sincerely,

C. A. Little, Ph. D.
Inclusion Survey Contractor

Location Number: _____
Location Address: _____
Monticello, Utah 84535
Property Owner: _____
Owner Address: _____
Monticello, Utah 84535
Tenant Name: _____

Appendix 20. PUOR Letter of Recommendation

LETTER

OAK RIDGE NATIONAL LABORATORY
OPERATED BY MARTIN MARIETTA ENERGY SYSTEMS, INC.

GRAND JUNCTION OFFICE
P. O. BOX 2567
GRAND JUNCTION, COLORADO 81502

Mr. Michael K. Tucker, Manager
U. S. Department of Energy
Grand Junction Projects Office
P. O. Box 2567
Grand Junction, Colorado 81502

Dear Mr. Tucker,

Radiation levels at the property identified below appear [] to [] not to exceed the U. S. Environmental Protection Agency (EPA) standards as specified in 40 CFR 192.

This evaluation is based on [] indoor [] outdoor screening measurement criteria, [] indoor [] outdoor extended measurement criteria of the U. S. Department of Energy Vicinity Properties Management and Implementation Manual (UMTRA-DOE/A1-050601), Appendix A, and/or [] other criteria stated below.

Other:

_____

_____

This recommendation is based upon the Inclusion Survey Contractor's assessment of the [] ^{226}Ra concentration in the soil [] indoor radon daughter concentration [] indoor gamma exposure rate at this property.

Therefore, this property is recommended for [] inclusion in [] exclusion from the Uranium Mill Tailings Remedial Action Project.

Sincerely,

C. A. Little, Ph. D.
Inclusion Survey Contractor

Location Number:_____
Location Address:_____
Property Owner:_____
Owner Address:_____
Tenant:_____

Appendix 21. PU5 Letter of Recommendation

PU5 LETTER (8/91)

OAK RIDGE NATIONAL LABORATORY
OPERATED BY MARTIN MARIETTA ENERGY SYSTEMS, INC.

GRAND JUNCTION OFFICE
P. O. BOX 2567
GRAND JUNCTION, COLORADO 81502

Mr. Michael K. Tucker, Manager
U. S. Department of Energy
Grand Junction Projects Office
P. O. Box 2567
Grand Junction, Colorado 81502

Dear Mr. Tucker,

Radiation levels at the property identified below appear [] to [] not to exceed the U. S. Environmental Protection Agency (EPA) standards as specified in 40 CFR 192.

This evaluation is based on [] indoor [] outdoor screening measurement criteria, [] indoor [] outdoor extended measurement criteria of the U. S. Department of Energy Vicinity Properties Management and Implementation Manual (UMTRA-DOE/A1-050601), Appendix A, and/or [x] other criteria stated below.

Other:
VPMIM Directive #E8, dated December 7, 1990, which addresses the method to be used in surveying large area vicinity properties.

This recommendation is based upon the Inclusion Survey Contractor's assessment of the [] ^{226}Ra concentration in the soil [] indoor radon daughter concentration [] indoor gamma exposure rate at this property.

Therefore, this property is recommended for [] inclusion in [] exclusion from the Uranium Mill Tailings Remedial Action Project.

Sincerely,

C. A. Little, Ph. D.
Inclusion Survey Contractor

Location Number:_____
Location Address:_____
Property Owner:_____
Owner Address:_____
Tenant:_____

Appendix 22. UMTRA Vicinity Property Summary Evaluation and Recommendation

Location Number _____

VICINITY PROPERTY SUMMARY EVALUATION AND RECOMMENDATION

1. SUMMARY EVALUATION

1.1 OUTDOOR MEASUREMENTS

	Inclusion Survey Contractor (ISC)			U. S. Department of Energy (DOE)		
	Yes	No	Not Taken*	Yes	No	Not Taken*
Gamma is >25 μR/h above background averaged over 100 m^2	[]	[]	[]	[]	[]	[]
Gamma is < the acceptable difference or 20% above background averaged over 100 m^2	[]	[]	[]	[]	[]	[]
^{226}Ra is >5 pCi/g above background in top 15 cm layer averaged over 100 m^2	[]	[]	[]	[]	[]	[]
^{226}Ra is >15 pCi/g above background in any subsurface 15 cm layer averaged over 100 m^2	[]	[]	[]	[]	[]	[]
Total activity of deposit(s) exceeds the total activity of criterion	[]	[]	[]	[]	[]	[]

Appendix 22. (continued)

Location Number _____

1.2 INDOOR MEASUREMENTS

	Inclusion Survey Contractor (ISC)			U. S. Department of Energy (DOE)		
	Yes	No	Not Taken*	Yes	No	Not Taken*
Gamma is >20 μR/h above background averaged in any room	[]	[]	[]	[]	[]	[]
Gamma is < the acceptable difference or 20% above background in all rooms	[]	[]	[]	[]	[]	[]
Grab sample radon daughter concentration is >0.04 WL	[]	[]	[]	[]	[]	[]
Grab sample radon daughter concentration is <0.01 WL	[]	[]	[]	[]	[]	[]
Annual average radon daughter concentration is >0.02 WL	[]	[]	[]	[]	[]	[]
Annual average radon daughter concentration is <0.02 WL	[]	[]	[]	[]	[]	[]

Other: _____

*Data were not taken because:

[ ] Data were not required to derive inclusion/exclusion recommendation.
[ ] This is a dovetail property.
[ ] Property owner did not authorize access for interior sampling.

Appendix 22. (continued)

Location Number _____

2. INCLUSION SURVEY CONTRACTOR RECOMMENDATION

Based on the ISC's evaluation, I recommend this property for [] inclusion in [] exclusion from the Uranium Mill Tailings Remedial Action Project.

_____ _____

C. A. Little, Ph.D. Date
Inclusion Survey Contractor

Appendix 22. (continued)

Location Number _____

3. DOE EVALUATION

Based on the DOE's evaluation, [] this property should be included, [] this property should be excluded, or [] additional data are required to support a determination.

_____ _____
DOE Evaluator Date

3.1 ADDITIONAL DATA REQUIRED:

_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

(Revised 6/88)
UCN17202

Appendix 22. (continued)

Location Number _____

3.2 ISC'S RESPONSE TO DOE'S REQUEST TO ADDITIONAL DATA:

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

3.3 DOE APPROVAL OF RESPONSE:

Based on the DOE's review of this evaluation, including the further information provided by the ISC in Sect. 3.2 above, this property should be an [] inclusion [] exclusion.

_____ _____

DOE Evaluator Date

UCN17202
(Revised 6/88)

Appendix 23. MVP Vicinity Property Summary Evaluation and Findings

Location Number

VICINITY PROPERTY SUMMARY EVALUATION AND FINDINGS

1. SUMMARY EVALUATION

1.1 OUTDOOR MEASUREMENTS

	Inclusion Survey Contractor (ISC)			U.S. Department of Energy (DOE)		
	Yes	No	Not Taken*	Yes	No	Not Taken*
Gamma is >25 μR/h above background averaged over 100 m^2	[]	[ ]	[]	[]	[]	[]
Gamma is < the acceptable difference or 20% above background averaged over 100 m^2	[ ]	[]	[]	[]	[]	[]
^{226}Ra is >5 pCi/g above background in top 15 cm layer averaged over 100 m^2	[]	[ ]	[]	[]	[]	[]
^{226}Ra is >15 pCi/g above background in any subsurface 15 cm layer averaged over 100 m^2	[]	[]	[ ]	[]	[]	[]
^{226}Ra is > Hot Spot Guideline	[]	[ ]	[]	[]	[]	[]

Appendix 23. (continued)

Location Number

1.2 INDOOR MEASUREMENTS

	Inclusion Survey Contractor (ISC)			U.S. Department of Energy (DOE)		
	Yes	No	Not Taken*	Yes	No	Not Taken*
Gamma is >20 μR/h above background averaged in any room	[]	[ ]	[]	[]	[]	[]
Gamma is < the acceptable difference or 20% above background in all rooms	[ ]	[]	[]	[]	[]	[]
Grab sample radon daughter concentration is >0.04 WL	[]	[]	[ ]	[]	[]	[]
Grab sample radon daughter concentration is <0.01 WL	[]	[]	[ ]	[]	[]	[]
Annual average radon daughter concentration is >0.02 WL	[]	[]	[ ]	[]	[]	[]
Annual average radon daughter concentration is <0.02 WL	[]	[]	[ ]	[]	[]	[]

Other:_____

*Data were not taken because:

[ ] Data were not required to derive the findings.
[ ] Property owner did not authorize access for interior sampling.

Appendix 23. (continued)

Location Number

2. INCLUSION SURVEY CONTRACTOR FINDINGS

Based on the ISC's evaluation, this property contains radiation levels which [] exceed [] do not exceed the DOE guidelines for the Surplus Facilities Management Program.

_____ _____

C. A. Little, Ph.D. Date
Inclusion Survey Contractor

Appendix 23. (continued)

Location Number

3. DOE EVALUATION

Based on the DOE's evaluation, [] this property should be included, [] this property should be excluded, or [] additional data are required to support a determination.

DOE Evaluator _____ Date _____

3.1 ADDITIONAL DATA REQUIRED:

Appendix 23. (continued)

Location Number

3.2 ISC'S RESPONSE TO DOE'S REQUEST FOR ADDITIONAL DATA:

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

3.3 DOE APPROVAL OF RESPONSE:

Based on the DOE's review of this evaluation, including the further information provided by the ISC in Sect. 3.2 above, this property should be an [] inclusion [] exclusion.

_____ _____

DOE Evaluator Date

Appendix 24. VPDMS Form

VPDMS INPUT SHEET - ORNL

LOCATION ID CLASS

CONSENT FORM DATA:
Sign Date:. . . __/__/__
Status: . . . . __

SURVEY DATA: Survey Date . __/__/__
HIG-Src: . . . _____-__
HOG-Src: . . . _____-__
RDC-Src-Typ: . _.____-__-__

Tailings location code: . . ____

PROPERTY INFORMATION [ ] Check if owner address same as property address

Tenant/Desc: _____

Address : _____

City, St, Zip : _____ _____ _____

OWNER INFORMATION

Name : _____

Address : _____

City, St, Zip : _____ _____ _____

CONSENT FORM STATUS CODES:
A = Access approved
L = Limited access approved
D = Access denied

TAILINGS LOCATION CODES:
0 = None
1 = Structural
2 = Exterior
3 = Structural & exterior
4 = Windblown
5 = Spillover
6 = Unknown

RDC TYPE CODES:
A = Full-time (1yr.) integrated sample
B = Part-time (<1yr.) integrated sample
C = Multiple grab sample
D = Single grab sample

HIG/HOG/RDC SOURCE CODES:
P = Preliminary survey
I = Inclusion survey
R = REA survey
D = Access denied
X = Reading not reported or taken
N = Code not applicable

Appendix 25. ISC Report Review Checklist

ISC REPORT REVIEW CHECKLIST

LOCATION NUMBER | SURVEY TEAM LEADER | T.L. REVIEW/DATE

RECOMMENDATION/BASIS | SURVEY DATE | FINAL REVIEW/DATE

	Team Leader Review				Final Review				Comments
	ok	no	na	typo	ok	no	na	typo	
Are FIELD DATA SHEETS complete?									
Do gamma ranges, areas (regions), pt. sources agree? (FIELD SHEETS vs. FIELD MAP)									
Gamma and Soils CALCULATION SHEETS correct? In black ink and legible?									
TABLE 2: Agree with calculation sheets, two significant digits, pt. sources? Indoors - is there a TABLE 2 for each structure? (may be combined for identical gamma ranges)									
TABLE 3: Soil sample data agrees with field sheet, calculation sheet? Two significant digits?									
Rn data - correct detector type and location? highlighted values from ext. measurement sheet? two significant figures for annual average?									
RECOMMENDATION BASIS: Agrees with Tables 2 and 3? Two reasons for exclusion (unless vacant), at least one for inclusion?									
Location number(s) correct on each page of report? (multiple numbers in ascending order, addresses match?)									
INTRODUCTION: Survey date, compare field sheets and tracking sheet? Property classification correct? Correct # of figures, Tables? Conversion formula correct?									

UCN17178 (9/90)

INCLUSION SURVEY REPORT COMPLETION

Number: TE-030
Page: 80 of 82

Appendix 25. (continued)

	Team Leader Review				Final Review				Comments
	ok	no	na	typo	ok	no	na	typo	
S.O.F.									
Information correct? Recommendation supported?									
Point sources mentioned (see Table 2 and field sheet/map)?									
Unusual circumstances described?									
Spillover data (location number and address)?									
Grammar, spelling, punctuation correct?									
OWNER/PROPERTY INFORMATION:									
Table I: Location address/tenant data agrees with consent?									
Owner address/phone agrees with consent?									
Property classification and structure description agrees with field sheets and map?									
Area of property?									
MAP (Figure 1):									
North arrow correct?									
Gamma ranges agree with field map?									
HOG, HIG where required?									
Location Number/Address correct?									
Is there a completed " WHODUNNIT" Map in the folder?									
Does it agree with field map and sheets as to areas surveyed?									
PHOTO (Figure 2):									
Check direction taken (field sheet and map)?									
RECOMMENDATION TO DOE LETTER:									
Property and owner information correct?									
Correct evaluation and basis for recommendation boxes?									
SUMMARY EVALUATION SHEETS:									
In black ink, no staples, no corrections?									
Agree with Calculation sheets, Table 2, recommendation?									
Location number(s) on each page?									
Inclusion/Exclusion checked on page three?									
VPDMS:									
Location number and property classification correct?									
Survey and consent acquisition dates correct?									
HIG, HOG, Rn values recorded?									
Property/owner addresses correct?									
Location of contamination code?									

Appendix 26. Laboratory Soil Analysis Results Addendum

Location Number: _____

(address)_____

_____

Extended Survey Results

Outdoor Data

Soil Sample Summary of Laboratory Analysis

Soil Sample Number	Region Sampled	Sample Depth (cm)	226Ra Concentration (pCi/g) (Canalysis)	Representative (biased) Sampling Area m^2	Net Estimated Area-Weighted Average* pCi/g, (C_{AW})

$$* \textit{ The formula used is } C_{AW} = \sum_{i=1}^{n} \frac{C_i A_i D_i}{(100)(.15)} \textit{ where:}$$

C_{AW} = area-weighted ^{226}Ra concentration in [pCi/g],
C_i = net ^{226}Ra concentration in [pCi/g] (net being the analyses results minus background),
A_i = area of region that sample represents in [m^2],
D_i = thickness of sample in [m],
100 = threshold area in [m^2], and
.15 = threshold thickness in [m].

Appendix 27. Cover Letter for Addendum

OAK RIDGE NATIONAL LABORATORY
OPERATED BY MARTIN MARIETTA ENERGY SYSTEMS, INC.

GRAND JUNCTION OFFICE
P. O. BOX 2567
GRAND JUNCTION, COLORADO 81502

Date_____

Eldon Bray
U.S. Department of Energy
P.O. Box 2567
Grand Junction, CO 81503

Dear Mr. Bray:

Laboratory Soil Analysis Results for GJ_____

Please find attached laboratory analysis results for soils taken at (address) _____, GJ_____. This confirms the analysis results of the Opposed Crystal System as presented in the "Report of Inclusion Survey at Location GJ_____".

Sincerely,

Craig A. Little, Ph.D.
Pollutant Assessments Group

Attachments

JAR/tlh

CORING DRILL OPERATION

1.0 PURPOSE

This procedure describes the operation of the portable coring drill used to core concrete and asphalt for slab sampling and subslab soil sampling.

2.0 APPLICABILITY

This procedure applies to concrete and asphalt coring to a maximum depth of 41 cm (16 in.) during radiological survey sampling.

3.0 OTHER DOCUMENTS

3.1 EXHIBITS

3.1.1 Exhibit 1: Electric Coring Drill

4.0 EQUIPMENT AND MATERIALS

4.1 EQUIPMENT

4.1.1 2-speed electric coring drill, KOR-IT Model 102, or equivalent
4.1.2 6-in.-diameter diamond coring bit
4.1.3 Expander set to fit the bit to the drill
4.1.4 Portable electric generator
4.1.5 Strap wrench
4.1.6 Extension cords
4.1.7 Tool box
4.1.8 Indoor/outdoor vacuum
4.1.9 Portable pressurized water can
4.1.10 Wedge
4.1.11 Bucket
4.1.12 Cement trowel
4.1.13 Tamping stick
4.1.14 Rubber mallet

Approved by:

2/3/92 (Date) C.A. Little 2/4/92 (Date)

4.2 MATERIALS

4.2.1 Water
4.2.2 Gasoline
4.2.3 Cement or asphalt sufficient to reclaim sample holes
4.2.4 Orange surveyor's tape
4.2.5 Sand
4.2.6 Spray lubricant

5.0 RESPONSIBILITY

5.1 The drill operator is responsible for the following:

5.1.1 Setting up the drilling and sampling equipment;

5.1.2 Operating the equipment during coring;

5.1.3 Directing the assistant in sampling and equipment decontamination and lubrication;

5.1.4 Ensuring that all personnel are informed of all safety requirements pertaining to the operation of the equipment prior to drilling.

5.2 The drilling assistant is responsible for the following:

5.2.1 Assisting the drill operator in setting up the drill, generator, and sampling equipment and in running the coring equipment;

5.2.2 Collecting all samples and decontaminating and lubricating the equipment after coring is completed;

5.2.3 Assisting the drill operator in reclaiming the core hole.

6.0 SAFETY

6.1 All personnel involved in the coring operation must wear safety glasses or goggles, steel-toed boots, and hearing protection.

6.2 Consult the property owner and available maps, and visually check the area for buried gas, water, electrical or other utility lines.

6.3 Check the power box on top of the coring rig and all extension cords for frayed and exposed wires before starting the drill. Repair all defective wires before operating the coring rig.

6.4 Be familiar with coring procedures and follow all safety practices described in Section 7.0.

7.0 PROCEDURE

7.1 Attach bit to drill (Exhibit 1).

7.1.1 Diamond bits of 6 in. diameter are not threaded and require the use of an expander set to attach them to the main shaft of the drill.

a. The expander set consists of two bevelled plates and one split expanding ring.

7.1.2 Lubricate the bevelled plates and shaft to allow easy removal of bit after drilling.

7.1.3 Place the unthreaded expander plate on the shaft first with the bevelled portion down.

7.1.4 Install the expanding ring and then the threaded expander plate with the bevelled portion up.

a. The bevelled edges must face each other to expand the split ring outward against the inside of the bit barrel.

7.1.5 Slip the bit barrel over the expander set and tighten until a firm fit is obtained.

CAUTION: Make certain that the top of the bit is flush against the shoulder of the upper expander plate and then hand tighten as securely as possible. The bit must be flush against this shoulder to ensure the bit alignment. Do not drill until the bit runs true. A true-running bit ensures maximum bit life and lowest drilling cost.

7.1.6 Tighten the bit with a strap wrench.

7.2 Set up equipment.

7.2.1 Place the core drill with the attached bit over the sample location.

a. The core drill should be level and the bit perpendicular to the surface of the sample location.

b. Position the drill by adjusting the 3 leveling screws on the base of the drill. Wooden slats may be placed under the back end of the base if necessary.

c. When drilling on a surface at an angle such as a driveway, position the drill base on the downhill side of the incline.

7.2.2 Lay an extension cord from the drill to the generator or to an available electrical outlet.

7.2.3 Position an indoor/outdoor vacuum to remove excess water during and after the drilling process.

a. Lay a separate extension cord to connect the vacuum to the generator or electrical outlet.

7.2.4 Connect the line attached to the portable pressurized water can to the water swivel on the drill.

7.2.5 Start up the generator used to power the coring drill if no electrical outlet is available.

a. Open the fuel valve (on/off switch).

b. Close the choke if the engine is cold.

c. Set the speed control lever about midway between IDLE SPEED and OPERATING.

d. With one hand on the generator to steady it during cranking, grip the recoil starter handle and pull out smoothly and quickly. Repeat as necessary until the generator starts.

7.2.6 After the generator has warmed up for a couple of minutes, connect the extension cords from the drill and vacuum to the generator.

7.3 Drill the hole.

7.3.1 Turn on the water supply.

a. It is important to NEVER DRILL DRY.

b. The water must be flowing at all times when drilling to flush the cuttings and cool the bit.

c. Control the flow of water by the valve located on the water swivel. Adjust it so that enough water is flowing back out of the hole to flush the cuttings from the face of the bit.

d. Supply sufficient water to remove the cuttings and maintain a circle of clear water around the outside of the bit on the surface of the material being drilled.

e. Periodically pressurize the water can during the drilling to maintain the supply of water.

f. When in doubt, use too much water rather than too little.

7.3.2 Hold the drill firmly in place when drilling to permit application of proper feed pressure and to prevent possible shifting of the base, which would result in excessive wear on the bit and possible jamming in the hole being drilled.

a. Use body weight to stabilize the machine by standing on the base of the drill.

7.3.3 With the water flow adjusted, turn on the drill and lower the carriage carefully until the bit is in contact with the material to be drilled.

7.3.4 While drilling, maintain a firm steady pressure on the bit so that it is cutting at all times. This will prevent "polishing" of the diamonds which would impair their cutting ability.

7.3.5 If unsmooth drilling occurs, either:

a. increase the pressure on the bit until chattering ceases (especially when starting the hole) or

b. back out of the hole while the machine is still running and check to ensure that the bit is properly aligned on the main shaft and is running true.

7.3.6 If the core breaks while drilling, it will cause a bumping action and the bit should be backed up out of the hole immediately. After the bit is clear of the hole, shut off the power and remove the broken core.

CAUTION: To continue drilling with a broken core inside the barrel may seriously damage the bit.

7.3.7 If for any reason the bit jams in the hole, shut off the power at once.

WARNING: Do not step off the drill base if the bit jams or at any time when the power is on. This will cause the drill base to rotate out of control. Personnel could potentially be knocked down and seriously injured by the moving equipment.

7.3.8 Upon completing the hole, withdraw the bit while the machine is still running.

7.3.9 When the bit is clear of the hole, shut off the power.

7.3.10 Tighten the locking thumb screw to secure the diamond bit from dropping, and then turn off the water.

7.3.11 Use a strap wrench to remove the bit from the drill.

a. Place the strap wrench on the bit barrel near the expander in order not to damage the lower section of the barrel (Exhibit 2).

b. Do not use a pipe wrench since it will damage the bit barrel.

CAUTION: Take care not to drop the bit or hit it against anything hard. An accidental blow can damage either the diamond or the end of the bit.

7.4 Remove core from bit.

7.4.1 If the core does not drop out of the bit, remove the bit from the drill spindle and push the core out through the rear of the bit.

a. <u>Do not pry</u> cores out of the front of the bit.

7.4.2 A rubber mallet may be used to dislodge cores caught in the bit.

a. Tap lightly while flushing with water.

7.5 Remove core from the hole.

7.5.1 If the core remains in the hole, drive a wedge in one side to snap the core loose at its base.

7.5.2 Use screwdrivers placed on opposite sides of the core to pry the core up and out (Exhibit 3).

7.5.3 Use an extra bit, wedging the end without the diamonds around the core.

a. Twist the bit around a few times to secure the core within the bit.

b. Remove both the bit and the core from the hole.

7.6 Remove excess water from the hole with the vacuum.

7.7 Measure and record the depth of the core.

7.8 Reclaim the sample hole.

7.8.1 For concrete cores:

a. Replace any unused portion of the sample into the core hole.

b. Add sand to the hole to approximately 1 in. above the lower depth of concrete.

c. With a tamping stick, level out the sand.

d. To prepare concrete, mix enough water with pre-mix cement in a bucket to obtain a plastic consistency.

e. Use a cement trowel to fill the hole and smooth the surface, allowing the wet concrete to blend around the edge of the hole for adhesion.

f. Wet the concrete around the diameter of the hole to improve bonding.

g. Place orange surveyor's tape over the hole to prevent pedestrians from stepping in the wet concrete.

7.8.2 For asphalt cores:

a. Replace any unused portion of the sample into the core hole.

b. Replace asphalt cores with pre-mix cold patch asphalt.

c. Use a 2- to 3-lb hammer to compact the asphalt.

7.9 Decontaminate and lubricate equipment.

7.9.1 Thoroughly clean the drill bit and the square column.

7.9.2 Spray the bevelled plates and shaft with lubricant to prevent rust.

7.9.3 Oil and grease moving parts of the machine as required.

7.9.4 Empty the dirty water from the vacuum in an appropriate location either on-site or upon returning to the DOE compound.

Exhibit 1. Electric Coring Drill

ALPHA-TRACK RADON DETECTOR PLACEMENT AND RETRIEVAL

1.0 PURPOSE

This procedure describes the activities for placement, retrieval, and associated documentation of alpha-track radon monitoring devices.

2.0 APPLICABILITY

This procedure applies to alpha-track radon monitoring detectors placed by PAG personnel.

3.0 OTHER DOCUMENTS

3.1 REFERENCES

3.1.1 J. L. George and G. H. Langner Jr., *Validation of the Prompt Alpha-Track Method*, UNC/GJ-33 (TMC), United Nuclear Corporation, Grand Junction, Colorado, 1987.

3.2 APPENDICES

3.2.1 Appendix 1: Radon Verification Check Sheet - Track-Etch Method
3.2.2 Appendix 2: Data Conversion
3.2.3 Appendix 3: Radon Database Operations

3.3 EXHIBITS

3.3.1 Exhibit 1: Alpha-track Radon Monitoring Detectors on Spindle

4.0 EQUIPMENT AND MATERIALS

4.1 EQUIPMENT

4.1.1 Alpha-track radon monitoring detectors (three for each monitored location)
4.1.2 Detector badge clips (one for each detector)
4.1.3 Spindles (one for each monitored location)

Approved by:

Joyce K. Holford 2/3/92 (Date)

Cai Little 2/4/92 C.A. Little (Date)

4.1.4 Gamma scintillation detector
4.1.5 Property folder

4.2 MATERIALS

4.2.1 Radon Verification Check Sheet - Track-Etch Method (one for each monitored location)

5.0 RESPONSIBILITY

5.1 It is the responsibility of the extended measurements coordinator to perform the following:

5.1.1 Determine the radon detector placement and retrieval dates.

5.1.2 Assign folders for radon detector placement and retrieval to the field technician.

5.1.3 Calculate the radon working levels from the manufacturer's results.

5.1.4 Direct exposure and documentation of the control detectors.

5.1.5 Ship the detectors back to the manufacturer for analysis.

5.1.6 Maintain the radon database.

5.2 It is the responsibility of the field technician to place and retrieve detectors and complete associated documentation. The technician may perform any of the extended measurements coordinator's responsibilities if assigned.

6.0 DEFINITIONS

6.1 **Alpha-track radon detector**: a passive monitor containing plastic detector material that registers damage tracks when exposed to alpha particles from the decay of radon and its daughter products.

6.2 **Radon**: the heaviest element of the noble gas group; produced as a gaseous emanation from the radioactive decay of radium.

6.3 **Radon daughter**: nuclide formed by the radioactive decay of radon.

6.4 **RDC**: radon daughter concentration, usually expressed in working levels (WL).

6.5 **Spindle**: an upright spike on a base usually used to stick papers for filing.

6.6 **WL**: working level; any combination of radon daughters in 1 L of air that will result in the ultimate emission of 1.3×10^5 MeV of alpha particle energy.

7.0 PROCEDURE

7.1 Prior to placement, store alpha-track radon monitoring detectors in a radon-free barrel until the scheduled installation date.

7.2 Place detectors in monitoring locations.

7.2.1 Use a minimum of three detectors together per monitored location.

a. Record the number of each detector.

b. Save the protective pouches in the property folder for returning the detectors to the manufacturer.

7.2.2 Label each detector with the date of installation.

7.2.3 Place a business card with the name and phone number of the extended measurements coordinator on a standing spindle.

7.2.4 Clip the detectors to the standing spindle. See Exhibit 1.

7.2.5 Using a gamma scintillation detector, place the spindle with the detectors in the structure according to the following priority:

a. room with the lowest elevation,

b. room with the highest gamma exposure rate, and

c. room with the least ventilation.

7.2.6 Document any deviation from the above priority on the Radon Verification Check Sheet (Appendix 1).

a. Structures with more than one region of indoor contamination may require monitoring of additional locations.

b. A separate Radon Verification Check Sheet should be completed for each location.

7.2.7 Place the detectors within the selected room, satisfying as completely as possible the following conditions:

a. at least 18 in. off floor, preferably at breathing height;

b. located to be least disturbed by the occupant and out of children's reach;

c. within the most natural air flow possible;

d. away from vents, doorways, windows, or other possible drafts;

e. away from concrete or masonry walls;

f. away from direct sunlight or heat sources;

g. not within a corner; and

h. not in a high humidity area such as a bathroom or laundry room.

7.2.8 Note the location of the detectors on the field map in the property folder.

7.2.9 Complete and initial the Radon Verification Check Sheet for placement and location requirements.

7.2.10 Enter the owner information, detector numbers, gamma information including the region monitored, placement date, and pertinent comments into the radon database.

a. See Appendix 3 for Radon Database Operations procedures.

7.3 Retrieve exposed detectors from the property after approximately 1 year exposure time.

7.3.1 Within Mesa County, detectors may be placed for periods of 2 to 6 months.

a. For details on the prompt track-etch method, see Reference 3.1.1.

7.3.2 At the time of retrieval, determine if measurements are valid by checking the filters for damage and whether or not the meters have been moved.

7.3.3 Complete the retrieval requirements on the Radon Verification Check Sheet.

7.3.4 To stop the monitoring period, place seals provided by the manufacturer over all the holes on the top of the detector.

7.3.5 Record the ending date on the detector labels.

7.3.6 Return the detectors to their respective pouches, fold the open end several times, and tape closed to prevent further exposure.

7.3.7 Store retrieved detectors in a radon-free barrel until returning them to the manufacturer for analysis.

7.3.8 Enter the retrieval date and any pertinent comments into the radon database.

7.4 Return the detectors and sheet to the manufacturer for analysis in batches of approximately 20.

7.4.1 Log the detector numbers on the sheet provided by the manufacturer, with corresponding dates of installation and removal.

7.5 Separate at least 4 to 6 detectors from each shipment of 20 to 40 detectors to be used as controls.

7.5.1 Locally Exposed Detectors

Keeping them in their foil pouches, send the detectors to Chem-Nuclear Geotech for exposure to known values in the radon chamber.

7.5.2 Standard Blanks

Keeping them in their foil pouches, place the detectors in the radon-free barrel for approximately 1 year.

7.5.3 Replicate Measurements

Place extra detectors on the spindle with the three standard detectors and place as in Sect. 7.2 to collect replicate measurements.

7.5.4 Documentation

a. Note detector numbers, exposure dates, type of exposure (locally exposed, standard blank, or replicate measurement), and exposure information in the appropriate shipment file located in the extended measurements coordinator's office.

b. Record dummy dates approximately 1 year apart for control detectors on the manufacturer's data sheet to be included with the shipment back to the manufacturer.

7.5.5 Evaluate results from control detectors.

a. Perform a linear regression between the known radon exposure level in pCi/L-days and the manufacturer's results to provide a means of comparison to manufacturer results.

b. If the results reported by the manufacturer are dubious, verify control results with Chem-Nuclear Geotech, have the detectors reanalyzed, or repeat the measurements, as necessary.

7.6 Enter the results received from the manufacturer into the radon database.

7.6.1 The database will convert the results to WL units using the formula described in Appendix 2.

7.6.2 Database procedures are located in Appendix 3.

Appendix 1. Radon Verification Check Sheet - Track-Etch Method

Alpha Track Detector Placement and Retrieval

Sheet ____ of ____

Location # _____
Address _____
_____

Choose one: _____ Inclusion Survey _____ Verification Survey

Detector ID # _____ _____ _____

Type of detector: Tech/Ops Landauer Radtrak™ Alpha-Track (Radon Gas) Monitors

PLACEMENT

Start date _____ Projected retrieval date _____
ORNL technician _____ RAC technician _____
Building _____ Room _____
Exact location in room _____
Region _____, Gamma range _____ μR/h, average _____ μR/h, area _____ m^2

	YES	NO
1. Placement Location		
a. Habitable room on the lowest level?	____	____
b. Indoor area of removal (verification only)?	____	____
c. Room with the highest gamma exposure rate?	____	____
d. Room with the least ventilation?	____	____
2. Placement Requirements		
a. Sealed bags intact before opening?	____	____
b. Number on bag same as number on detector?	____	____
c. Is the detector filter undamaged?	____	____
d. Detector placed away from direct sunlight, heat sources, doors, windows, or vents?	____	____
e. Placed at least 18 inches off the floor?	____	____
f. Out of reach of children?	____	____
g. Not in humid room (laundry or bathroom)?	____	____
3. Noted location on map?	____	____
4. Consent current for 1 year (inclusion survey only)?	____	____
5. Meets all requirements listed above? If "no", explain below.	____	____

RETRIEVAL

End date _____
ORNL technician _____
RAC technician _____

1. Are the filters undamaged?	____	____
2. Have the detectors been moved?	____	____
3. Was the detector properly sealed after retrieval?	____	____
4. Meets all requirements listed above? If "no", explain below.	____	____

COMMENTS

_____

_____

_____

Appendix 2. Conversion of Analysis Results to Working Levels

The analysis results sent from the detector manufacturer are converted to RDC WL values using a 50% equilibrium factor according to the following calculation:

$$WL = \frac{(WLR) * (Rn)}{100}$$

where:

WL = working level average value
WLR = WL ratio, 0.5
Rn = $\frac{^{222}Rn \text{ concentration in pCi/L-days reported by manufacturer}}{\text{number of days exposure}}$

Appendix 3. Radon Database Operations

1. **Data input when detectors are placed.**
   a. Turn on computer and monitor.
   b. Enter the following:
      1. system password
      2. network
      3. M:
      4. KMAN -G
   c. The KMAN screen will appear.
      1. Follow the login procedure.
      2. The KMAN prompt will appear.
      3. Type, USE RADON.
      4. Type, E.LMOD=FALSE.
      5. Type CREATE.
   d. A blank record file will appear.
      1. In the chronologic order as appearing in the table, enter the following data:
         LOCNO:
         ADDR:
         OWNER:
         PLACED: (date placed)
         PICKUP: (this is the projected pickup date)
         GRANGE: (gamma scan range)
         GAVG: (gamma average)
         SQMETER: (area of contaminated region)
         LCUP1: (detector monitor number)
         LCUP2: (detector monitor number)
         LCUP3: (detector monitor number)
         FILMLO: (detector location)
         GSTC: (if applicable, gamma spectrometer total counts)
         GSK: (if applicable, potassium counts)
         GSRA: (if applicable, radium counts)
         GSTH: (if applicable, thorium counts)
         GSRA/TH: (if applicable, radium/thorium ratio)
         CONC1: (if applicable, concrete ^{226}Ra concentration)
         CONC2: (if applicable, concrete ^{226}Ra concentration, 2nd sample)
         SOIL1: (if applicable, soil sample ^{226}Ra concentration)
         SOIL2: (if applicable, soil sample ^{226}Ra concentration, 2nd sample)
         REM1: (pertinent comments)
         REM2: (pertinent comments)
         REM3: (pertinent comments)
      2. Press the escape key to exit the data record.
      3. At the KMAN prompt, type BYE.

Appendix 3. (continued)

e. Log out of the network.
   1. Park the hard drive.
   2. Turn computer and monitor off.

2. Data input when detectors are retrieved.

a. Turn on computer and monitor.
b. Enter the following:.
   1. system password
   2. network
   3. M:
   4. KMAN -G
c. The KMAN screen will appear.
   1. Follow the login procedure.
   2. The KMAN prompt will appear.
   3. Type USE RADON.
   4. Type BROWSE FOR LOCNO="GJ-----".
d. The requested data file will come on screen.
   1. Check detector numbers on field sheet and on screen for accuracy.
   2. In the chronologic order as appears in the table, enter the following data:
      DATE: (actual pickup date)
      SHIP: (radon shipment to Tech/OPS, enter shipment number)
      REM1: (pertinent comments).
   3. Press the escape key to exit the data record.
   4. At the KMAN prompt, type BYE.
e. Log out of the network.
   1. Park the hard drive.
   2. Turn computer and monitor off.

3. Data input when results are received from Tech/OPS.

a. Turn on computer and monitor.
b. Enter the following:
   1. system password
   2. network
   3. M:
   4. endspool
   5. KMAN -G
c. The KMAN screen will appear.
   1. Follow the login procedure.
   2. The KMAN prompt will appear.
   3 Type USE RADON.
   4. Type BROWSE FOR LOCNO="GJ-----".

Appendix 3. (continued)

d. The requested data file will come on screen.
   1. In the chronologic order as appears in the table, enter the following data:
      LRN1: (enter the RN concentration-pCi/l provided on the Tech/OPS report)
      LRN2: (enter the RN concentration-pCi/l provided on the Tech/OPS report)
      LRN3: (enter the RN concentration-pCi/l provided on the Tech/OPS report).
   2. Press the escape key to exit the data record.

e. To print the radon results for a property, input the following at the KMAN prompt:
   1. USE RADON
   2. E.OPRN=TRUE
   3. E.STAT=FALSE
   4. E.PAUS=FALSE
   5. EJECT
   6. #PREFIX="C:"
   7. REPORT RADON2 FOR LOCNO="GJ-----"

f. Press the escape key to exit the data record.

g. At the KMAN prompt, type BYE.

h. Log out of the network.
   1. Park the hard drive.
   2. Turn computer and monitor off.

4. Data input to obtain a printout of all properties in the radon database by pickup date.

a. Follow procedure to enter KMAN as described in section 3a and 3b of this appendix.

b. Follow procedure to set up printer as described in section 3e.1-6 of this appendix.

c. Type SELECT LOCNO,ADDR,PICKUP FOR TOJUL(Pickup)>=TOJUL("1/1/9-1") ORDER BY TOJUL(Pickup).

d. Press the escape key to exit the data record.

e. At the KMAN prompt, type BYE.

f. Log out of the network.
   1. Park the hard drive.
   2. Turn computer and monitor off.

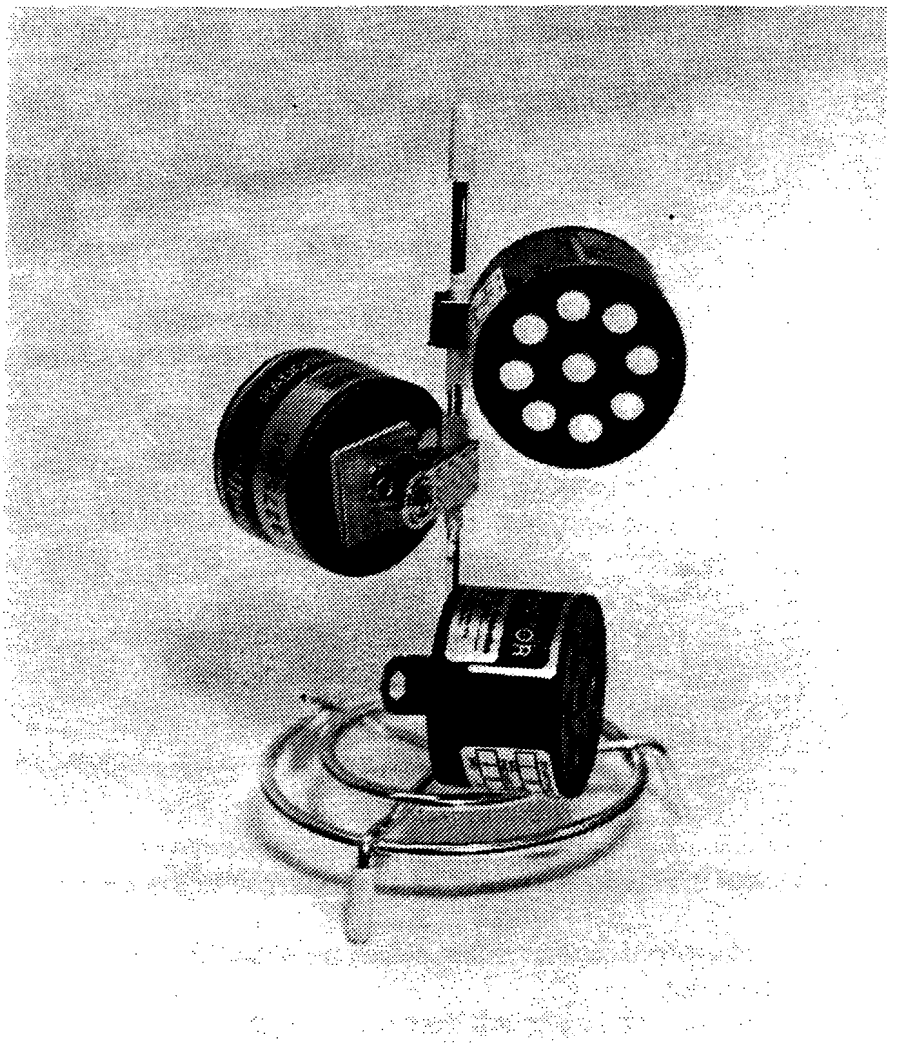
5. To backup radon database onto a floppy after input of new data.

a. Enter network.

b. Insert radon backup floppy.

c. Type Copy M:\RADON.ITB A:

Exhibit 1. Alpha-track Radon Monitoring Detectors on Spindle



OAK RIDGE NATIONAL LABORATORY Health & Safety Research Division	PROCEDURE Pollutant Assessments Group	Number: TE-034 Page: 1 of 7 Revision: 0 Date: 07/01/91

CHAIN OF SAMPLE CUSTODY

1.0 PURPOSE

This procedure establishes chain of sample custody procedures for samples collected and/or analyzed by ORNL/PAG personnel.

2.0 APPLICABILITY

This procedure applies to all samples taken by PAG personnel and/or analyzed at ORNL/PAG facilities by ORNL/PAG personnel or other authorized personnel.

3.0 OTHER DOCUMENTS

3.1 APPENDICES

3.1.1 Appendix 1: Chain of Sample Custody
3.1.2 Appendix 2: Chain of Sample Custody/Soil Sample Analysis Form
3.1.3 Appendix 3: Chain of Custody Seal

4.0 EQUIPMENT AND MATERIALS

4.1 MATERIALS

4.1.1 Chain of Sample Custody or Chain of Sample Custody/Soil Sample Analysis Form, whichever is applicable
4.1.2 Chain of Custody Seals

5.0 RESPONSIBILITY

5.1 TEAM LEADER/SITE PROJECT MANAGER

The team leader or site project manager assures all personnel follow chain of custody procedures, thereby maintaining sample accountability.

Approved by:

Jack K. Hoffman 6/26/91 (Date)

Craig Little 6/26/91
C.A. Little (Date)

5.2 SAMPLER

The sampler maintains surveillance of the sample until custody is transferred to another individual or the sample is locked in a secure area or placed in sealed container. The sampler completes documentation on the applicable chain of custody form and packages the samples in sealed containers when appropriate.

5.3 LABORATORY PERSONNEL

Laboratory personnel receive samples from field personnel and maintain sample validity throughout the analysis process. Laboratory personnel are responsible for the care and custody of samples from the time they are received until they are relinquished to the originator, transferred to another individual, or transferred for ultimate disposal.

6.0 DEFINITIONS

6.1 **Chain of custody**: procedures which create an accurate written record that can be used to trace the handling and possession of a sample from the time of its collection through analysis and, if necessary, its introduction as evidence.

6.2 **Chain of custody seals**: strips of partially perforated adhesive-backed paper used to indicate tampering of a container.

6.3 **Secure area**: a locked cupboard, room, or building accessible only to authorized personnel. Hotel rooms and vehicles are not considered secure areas, even when locked.

7.0 PROCEDURE

7.1 An acceptable chain of custody is maintained when a sample is:

7.1.1 under direct surveillance by the assigned individual,

7.1.2 maintained in a tamper-free container, or

7.1.3 placed within a secure area.

7.2 FIELD CUSTODY

7.2.1 Complete the appropriate Chain of Sample Custody Form (Appendix 1 or 2) at the time of sample collection.

a. A photostat of the Chain of Sample Custody Form may be used if the sample will be analyzed in-house.

b. All samples should be handled by a minimum number of persons.

c. Information entered on the chain of sample custody form must match exactly information on the sample labels.

7.2.2 When the samples are not under direct surveillance or in a secure area, keep them in containers sealed with chain of custody seals (Appendix 3).

a. Sign and date the seal just before applying it to the container.

7.2 TRANSFER OF CUSTODY

7.2.1 Sign and date the chain of sample custody form when relinquishing custody of samples to the ORNL/PAG laboratory.

7.2.2 If no laboratory personnel are available to take custody of the samples, leave the samples with the signed chain of sample custody form inside the ORNL/PAG laboratory in a sealed container or in a secure area.

a. Notify laboratory personnel at the earliest opportunity that the samples are awaiting analysis.

7.2.3 When shipping samples, retain a copy of the completed Chain of Sample Custody Form and place the original Chain of Sample Custody Form inside the shipping container.

7.3 LABORATORY CUSTODY PROCEDURES

7.3.1 When receiving samples in the laboratory, verify that:

a. the samples have not been tampered with,

b. all samples are present, and and

c. information on the Chain of Sample Custody Form and the sample labels match.

7.3.2 Sign and date the Chain of Sample Custody Form and take possession of the samples.

7.3.3 Return a copy of the Chain of Sample Custody Form to the team leader or project manager if duplicate copies of the Chain of Sample Custody Form are required by the project.

7.3.4 Store all samples in a secure area until after analysis.

Appendix 1. Chain of Sample Custody

ornl OAK RIDGE NATIONAL LABORATORY
Grand Junction Office

Mailing Address:
P.O. Box 2567
Grand Junction, CO 81502

Street Address:
2597 B-3/4 Road
Grand Junction, CO 81503

Phone (303) 248-6200

Chain of Sample Custody

Page _____ of _____

Date _____

Project No. _____ Project Name _____

Sample No.	Sample Type	Container	Filtered	Preservative	Analysis	Collection date/time	Remarks

Relinquished By	Date	Department	Received By	Date	Dept.
			Company Name _____		
			Received By _____		
			Date _____		

Distribution: Original accompanies samples, copies to relinquishers.

UCN-17189 (Rev. 3/91)

Appendix 2. Chain of Sample Custody/
Soil Sample Analysis Form

ornl OAK RIDGE NATIONAL LABORATORY
Grand Junction Office

Mailing Address
P.O. Box 2567
Grand Junction, CO 81502

Street Address
2597 B¾ Road
Grand Junction, CO 81503

Phone (303) 242-8621

Chain of Sample Custody/ Soil Sample Analysis Form

Page _____ of _____

Date _____

TEAM LEADER _____

TEAM MEMBERS _____

1. Project No. _____ 2. Project Name _____

LOCATION ADDRESS	SAMPLE ID. NUMBER	PAN NO.	DATE TAKEN/ RECEIVED	DATE BOTTLED	DATE ANALYZED	DISK NO.	SAMPLE WT. (g)	226-Ra (pC1/g)	BBL NO.	COMMENT/ LAB ID

Relinquished By	Date	Dept.	Received By	Date	Dept.

Distribution: Original accompanies samples, copies to relinquishers

UCN 17345 (1/91)

Appendix 3. Chain of Custody Seal

CUSTODY SEAL

DATE _____

SIGNATURE _____

CHEM
Hayward, CA 94545
New Castle, DE 19720
(800) 443-1689
(800) 553-3696
Specialty Cleaned Containers

SOIL SAMPLE PREPARATION FOR RADIONUCLIDE ANALYSIS

1.0 PURPOSE

This procedure describes the preparation of soil samples for radionuclide analysis.

2.0 APPLICABILITY

This procedure applies to all soil samples analyzed at the PAG soils laboratory for radionuclide concentration.

3.0 OTHER DOCUMENTS

3.1 REFERENCES

3.1.1 Procedure TE-034, Chain of Sample Custody.

3.2 APPENDICES

3.2.1 Appendix 1: Chain of Sample Custody/Soil Sample Analysis Form

3.3 EXHIBITS

3.3.1 Exhibit 1: Jaw Crusher
3.3.2 Exhibit 2: Cross Flow Solids-Solids Blender
3.3.3 Exhibit 3: Automatic Can Sealer

4.0 EQUIPMENT AND MATERIALS

4.1 EQUIPMENT

4.1.1 Electronic scale
4.1.2 Ovens
4.1.3 Canner
4.1.4 Compressor
4.1.5 Crusher

Approved by:

12/3/91 (Date)

C.A. Little 12/3/91 (Date)

4.1.6 Blender
4.1.7 Safety glasses
4.1.8 Laboratory coats
4.1.9 Vacuum cleaner
4.1.10 Standard weights
4.1.11 Sample-excess container
4.1.12 Sample-excess barrel

4.2 MATERIALS

4.2.1 1/2 size medium deep aluminum pans (12 by 10 in.)
4.2.2 Sample labels
4.2.3 Rubber sealed aluminum lids
4.2.4 Rad-Con™ or similar surface decontaminant spray
4.2.5 Plastic bags
4.2.6 Transparent tape
4.2.7 Paper towels
4.2.8 Scale calibration logbook
4.2.9 Sample analysis form binder
4.2.10 Soils preparation logbook for each project
4.2.11 16-oz aluminum cans
4.2.12 Radionuclide dust mask
4.2.13 Rubber gloves
4.2.14 Ear plugs

5.0 RESPONSIBILITY

5.1 The extended measurements coordinator is responsible for supervising all lab personnel and ensuring that all procedures are followed.

5.2 The soils laboratory technician is responsible for preparing all soil samples, decontaminating the soils preparation laboratory, and recording all sample preparation data.

6.0 DEFINITIONS

6.1 Barrel: 55-gal drum used for soil sample storage after analysis.

6.2 ISC: inclusion survey contractor.

6.3 IVC: independent verification contractor.

6.4 RAC: remedial action contractor.

6.5 Sample excess: soil sample left over after canning; dust and sweepings from the soils preparation laboratory.

7.0 SAFETY

7.1 Do not eat, drink, or smoke in the soils preparation laboratory.

7.2 Unauthorized personnel are not allowed in the soils preparation laboratory when sample preparation is in progress.

7.3 Wear safety glasses, a lab coat, a radionuclide dust mask, and rubber gloves during soil sample preparation.

7.4 Turn on the appropriate fan when operating the crusher or blender or when working under the hood.

7.5 Check for visible contamination and clean up as necessary after handling soil samples.

7.6 Laboratory personnel are required to wear a thermoluminescent dosimeter (TLD) when working in the soils preparation laboratory.

8.0 PROCEDURE

8.1 Follow chain of sample custody procedures as defined in Procedure TE-034.

8.2 Prepare ISC samples for drying.

8.2.1 Prepare all ISC samples for one project at a time.

a. Each project has its own soil sample analysis form binder.

8.2.2 Line up the ISC samples in the aluminum sample cans or pans on the counter top.

8.2.3 Obtain the Chain of Sample Custody/Soil Sample Analysis Forms (Appendix 1) for the samples from the front section of the soil sample analysis form binder. This form will hereafter be known as the soil sample analysis form.

8.2.4 Align the cans and pans in the order listed on the soil sample analysis forms, starting with the form showing the earliest sample date.

8.2.5 Refer to the previous ISC soil sample analysis form for the last pan number assigned and record the next consecutive pan number on the current soil sample analysis form.

8.2.6 Write the corresponding pan numbers on the sample cans and pans.

8.2.7 Remove the can lids and place them in the box below the ovens.

8.2.8 Record the sample location identification, pan number, and date in the soils preparation logbook.

8.2.9 Fill out a sample can label for each sample.

8.2.10 Return the soil sample analysis forms to the ISC section of the back of the sample analysis form binder.

8.3 Prepare IVC field composite samples for drying.

8.3.1 Line up the verification field samples in the 8- by 8-in. ziplock bags on the counter.

8.3.2 Obtain the soil sample analysis forms from the appropriate soil sample analysis form binder.

8.3.3 Organize the samples in the order listed on the field sample analysis forms, starting with the earliest form.

8.3.4 Refer to the previous soil sample analysis form, and write the next consecutive pan numbers on the current soil sample analysis forms.

8.3.5 Number large aluminum sample pans accordingly.

8.3.6 Transfer the samples to the numbered pans.

8.3.7 Record the sample location identification, pan number, and date in the verification preparation logbook.

8.3.8 Fill out a sample can label for each sample.

8.4 Prepare RAC split samples for canning.

8.4.1 Line up the samples in the order listed on the soil sample analysis form.

8.4.2 Refer to the previous verification soil sample analysis form, and write the next consecutive pan number on the current soil sample analysis form.

8.4.3 Fill in the verification preparation logbook.

8.4.4 Fill out a sample can label for each sample.

8.4.5 Record the RAC's soil ticket number in the comments section of the preparation logbook and on the sample label.

8.4.6 Return the soil sample analysis forms to the back of the verification section of the soil field data logbook.

8.4.7 Write the sample number range (e.g., V162-V187) on the box the samples arrived in.

8.4.8 For RAC split samples, remove the can lid and proceed to 8.8.

8.5 Place the pans in the oven.

8.5.1 Load samples in the oven from the top rack down to prevent cross-contamination.

8.5.2 Turn on the oven to approximately 120° F (setting "6") and dry samples for 12 h.

8.5.3 Inspect the area for contamination and clean up and dispose of any visible contamination in the radioactive waste trash container.

a. Place any excess sample material in plastic bags.

b. Mark the bags with the date and the appropriate site code (e.g., GJ for Grand Junction, RF for Rifle).

c. Place the bags in the assigned sample excess barrel outside the soils analysis laboratory.

8.5.4 If samples still contain moisture after 12 h, leave them to dry another 12 h.

8.5.5 Turn off the ovens to allow the samples to cool.

8.5.6 Remove the pans from the oven and place them on the counter opposite the ovens.

a. Remove pans from the bottom rack upward to prevent cross-contamination.

8.6 Crush samples.

8.6.1 Check the grease and oil levels in the jaw crusher (Exhibit 1) and automatic canner (Exhibit 3).

8.6.2 Grease and oil the crusher and canner if necessary.

8.6.3 Crush each sample in the jaw crusher.

a. The jaws of the crusher are set to produce material fine enough to pass through a 1/4-in. sieve.

8.6.4 Replace each sample in its numbered pan or can.

8.6.5 Place the samples in sequence under the hood.

8.6.6 Clean the jaw crusher and the tray that catches the crushed sample with compressed air between each sample.

8.7 The IVC field composite samples in the large aluminum pans must be further blended to obtain a homogeneous sample.

8.7.1 Place the sample in the cross flow blender (Exhibit 2) approximately 5 min for thorough mixing.

8.7.2 Replace each sample in its numbered pan.

8.8 Can samples.

8.8.1 Turn on the electronic scale and allow it to warm up for 30 min.

8.8.2 When the scale is warmed up, check its calibration by using the 200 g and 500 g standard weights.

a. Weigh the standards.

b. Record the weights, scale, date, and initials in the scale calibration logbook.

8.8.3 Check each can for damage. If the lip is damaged, discard and replace.

8.8.4 Tare a sample can on the scale.

a. Place a can on the scale.

b. Depress the tare key; the scale should zero.

8.8.5 For samples in pans, pour a sample into the can and fill the can up to, but not over, the top ridge on the side of the can while working in the hood.

a. Tap the can on the counter to settle the sample.

b. Continue filling until the contents have reached the top ridge on the side of the can.

c. Dump any excess from the cans into the sample-excess container under the crusher.

d. If there is not enough sample to fill the can up to the marked line, measure the height of the sample and record that value in the soil preparation logbook.

e. Wipe off the lips of the cans with tissues to remove dirt from the seals.

8.8.6 For samples in cans, dump any excess from the can into the sample-excess container under the crusher so that the sample reaches to, but not over, the top ridge on the side of the can.

8.8.7 Wipe off the lips of the cans with tissues to remove dirt from the seals.

8.8.8 Place the can on the scale.

8.8.9 Record the weight on the soil sample analysis form, in the preparation logbook, and on the label corresponding to the sample.

8.8.10 Place an aluminum lid on the can.

8.8.11 Turn the base plate handle to the left as far as possible.

8.8.12 Set the can on the base plate of the automatic can sealer, and turn the base plate handle to the right as far as possible.

8.8.13 Push the power foot switch located on the floor underneath the automatic canner.

8.8.14 Push the starting lever on the right side of the canner frame; the machine will make one complete cycle and stop.

8.8.15 When the machine has stopped, push the base plate handle to the left and remove the can.

a. If the can sticks to the sealing chuck, it can be removed by pushing the can towards the sealer.

8.8.16 Spray the can with Rad-Con, and wipe it off with a paper towel.

8.8.17 Attach the completed label to the can.

a. Cover the label on the side of the can with transparent tape.

8.8.18 Repeat until all samples have been canned and labeled.

8.9 Clean the working area.

8.9.1 Place all sample excess in large plastic bags.

8.9.2 Place the sample cans in an empty cabinet in the soils analysis laboratory.

8.9.3 Write the number of samples, date canned, and the date due for analysis (18 days from the date canned) on the sheet on the side of the cabinets near the entrance to the soils analysis lab.

8.9.4 Wipe off the canner with a dry paint brush if necessary.

8.9.5 Vacuum the area under the hood, crusher, blender, and all countertops, and clean with Rad-Con and paper towels at the end of each day.

a. Throw the used paper towels in the radioactive waste trash container.

8.9.6 Store the radioactive waste trash and plastic bags containing sample excess in the sample-excess barrel.

Appendix 1. Chain of Sample Custody/Soil Sample Analysis Form

ornl OAK RIDGE NATIONAL LABORATORY
Grand Junction Office

Mailing Address
P.O. Box 2567
Grand Junction, CO 81502

Street Address
2597 B¾ Road
Grand Junction, CO 81503

Phone (303) 248-6200

Chain of Sample Custody/ Soil Sample Analysis Form

Page _____ of _____

Date _____

TEAM LEADER _____

TEAM MEMBERS _____

1. Project No. _____ 2. Project Name _____

LOCATION ADDRESS	SAMPLE ID. NUMBER	PAN NO.	DATE TAKEN/ RECEIVED	DATE BOTTLED	DATE ANALYZED	DISK NO.	SAMPLE WT. (g)	226–Ra (pC1/g)	BBL NO.	COMMENT/ LAB ID

Relinquished By	Date	Dept.	Received By	Date	Dept.

Distribution: Original accompanies samples, copies to relinquishers

UCN 17345 (1/91)

Exhibit 1. Jaw Crusher

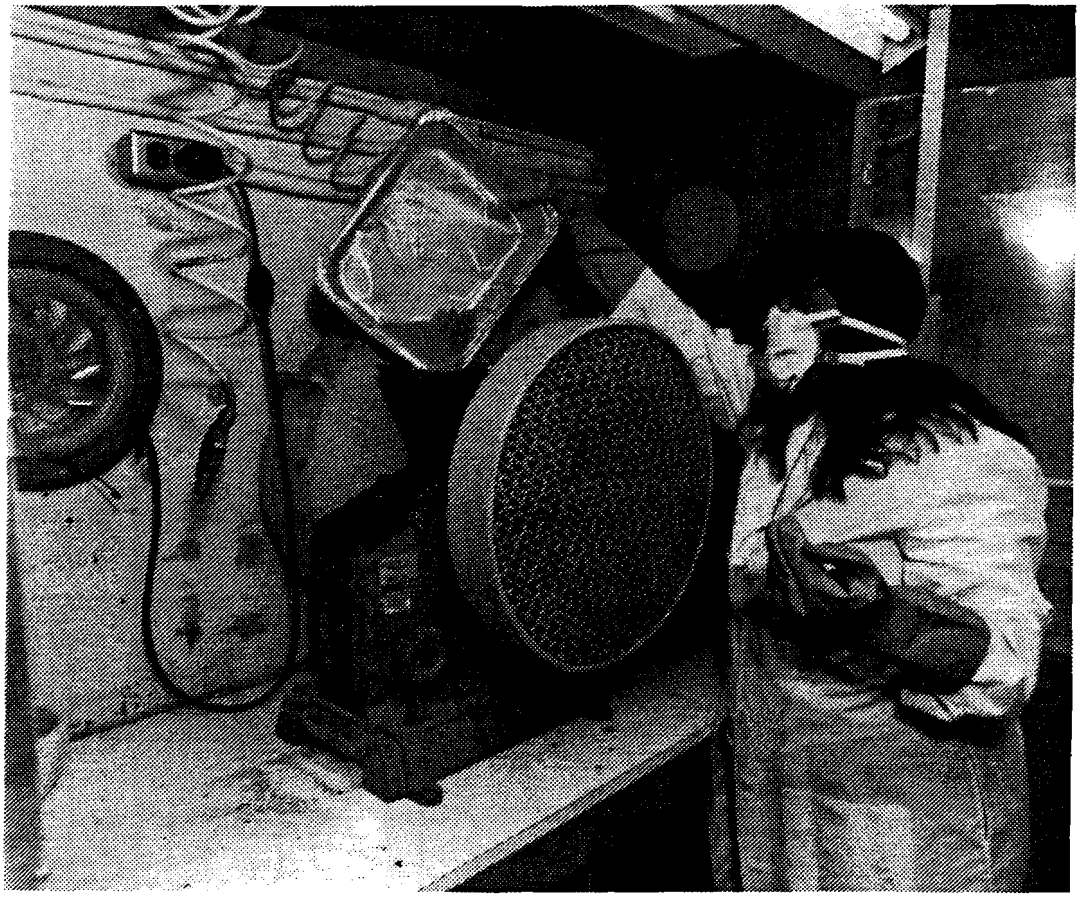
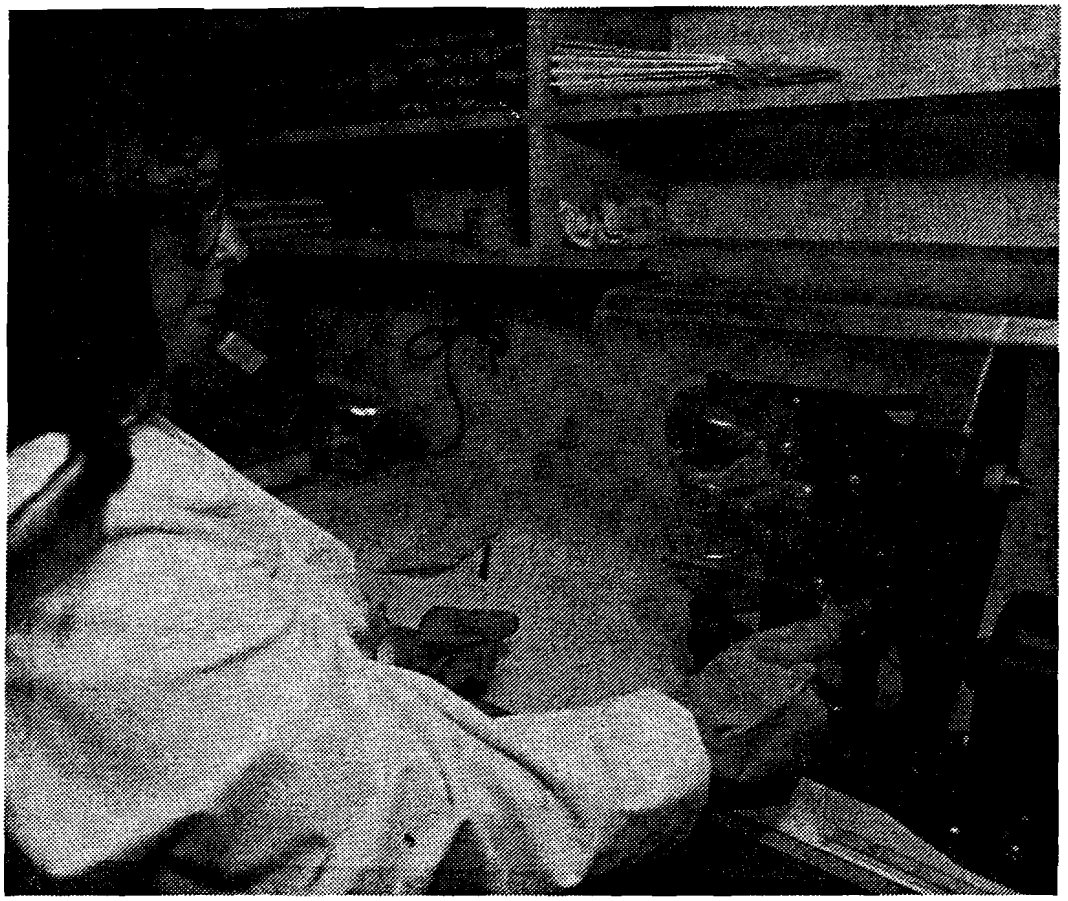


Exhibit 2. Cross Flow Solids-Solids Blender

Exhibit 3. Automatic Can Sealer



ANALYSIS OF RADIONUCLIDES IN SOILS

1.0 PURPOSE

This procedure describes the analysis of radionuclides in soils using the ND-66 gamma spectroscopy system.

2.0 APPLICABILITY

This procedure applies to all soil samples analyzed for radionuclides by the ND-66 system at the PAG soils laboratory.

3.0 OTHER DOCUMENTS

3.1 REFERENCES

3.1.1 Procedure SU-022, Calibration of Soil Laboratory Gamma Spectrometry System.
3.1.2 Procedure TE-034, Chain of Sample Custody.

3.2 APPENDICES

3.2.1 Appendix 1: Chain of Sample Custody/Soil Sample Analysis Form
3.2.2 Appendix 2: Soil Data Base Menu Procedures

3.3 EXHIBITS

3.3.1 Exhibit 1: Lead Pig
3.3.2 Exhibit 2: ND-66 gamma spectroscopy system

4.0 EQUIPMENT AND MATERIALS

4.1 EQUIPMENT

4.1.1 ND-66 NaI(Tl) well detector system
4.1.2 IBM computer
4.1.3 Computer printer

Approved by:

12/6/91 (Date) — C.A. Little 12/6/91 (Date)

4.2 MATERIALS

4.2.1 Rad-Con™ or similar surface decontaminant spray
4.2.2 Utility wipes
4.2.3 Soil analysis logbook
4.2.4 Soil analysis form binder
4.2.5 Spectral data storage disk

5.0 RESPONSIBILITY

5.1 The extended measurements coordinator is responsible for supervising all laboratory personnel and ensuring that all procedures are followed.

5.2 The soils laboratory technician is responsible for the following analyzing the soil samples and recording the analysis data.

6.0 DEFINITIONS

6.1 **ADC**: analog to digital converter; electronic equipment which sorts the pulses received from the amplifier.

6.2 **Barrel**: 55-gal drum used for soil sample storage after analysis.

6.3 **Detector**: sodium iodide (NaI) crystal used to detect photon emissions from unstable radioactive samples.

6.4 **KMAN**: Knowledge Man data base management software.

6.5 **KRTCOM**: command program for acquisition of analytical data.

6.6 **ND number**: unique, alpha-numeric number assigned by the KRTCOM program to each acquired spectrum.

7.0 SAFETY

7.1 Do not eat, drink, or smoke in the soils analysis laboratory.

7.2 Wear a thermoluminescent dosimeter (TLD) at all times when working in the soils analysis laboratory.

8.0 PROCEDURE

8.1 Follow chain of sample custody procedures as described in Procedure TE-034.

8.2 Wait at least 18 days after canning to analyze samples.

8.3 Calibrate the soils analysis system according to Procedure SU-022.

8.4 Obtain the appropriate Chain of Sample Custody/Soil Sample Analysis Forms (Appendix 1) from the soil analysis form binder.

8.5 Analyze samples.

8.5.1 Enter the analysis mode by selecting option 3 on the KRTCOM program main menu. The printer will print a sample header.

8.5.2 Place a sample in the lead pig for analysis (see Exhibit 1).

8.5.3 Begin data acquisition by pressing the acquire and initialize keys on the ND-66 keyboard (Exhibit 2).

8.5.4 When data acquisition is finished, input the number of the detector for transfer of data to the computer. The spectral data will be printed on the screen and the data automatically stored on disk.

8.5.5 Input all sample information requested.

a. Verify that the information has been entered correctly. Type "Y" to continue execution of the program. Any other response will return the user to the first requested data input.

b. Hit any key except zero (0) to return to the analysis mode.

8.5.6 Repeat the above steps until all samples have been analyzed.

8.5.7 After analyzing all samples, input a zero (0) to return to the main menu.

8.6 Add sample results to the KMAN data base by executing the following steps. See Appendix 2 for more detailed information about the soil data base menu.

8.6.1 Select option 4 of the main menu and log into the network.

8.6.2 Select option 15 to copy the sample set TEMPDB.DAT to the network.

8.6.3 Select option 12 to enter the KMAN data base.

8.6.4 Select option 4 of the KMAN data base menu to add records to the soil data base.

a. Assign a barrel number to each sample for storage until disposal.

b. Input the barrel number and edit any records at this time.

8.6.5 Select option 6 to obtain a printout.

8.6.6 Select option 5 to update the soil data base to the network data base for all users to view.

a. The data base does not have to be updated every time soil samples are analyzed but should be updated at least once a week.

8.6.7 Select option 0 to exit KMAN. This automatically exits the network.

8.7 Select option 8 of the main menu to park the hard disk.

8.8 Turn off the monitor and printer.

8.9 Complete the Chain of Sample Custody/Soil Sample Analysis Forms with the date analyzed, barrel number, spectral data storage disk, and sample pCi/g concentration.

8.10 Put photocopies of these forms into the appropriate team leader's or project manager's mailbox.

8.11 Place the hard-copy printout and the original Chain of Sample Custody/Soil Sample Analysis Forms in the back of the appropriate soil sample analysis form binder.

8.12 Place the analyzed samples in the designated barrel for storage and archival.

Appendix 1. Chain of Sample Custody/Soil Sample Analysis Form

ornl OAK RIDGE NATIONAL LABORATORY
Grand Junction Office

Mailing Address
PO Box 2567
Grand Junction, CO 81502

Street Address
2597 B¾ Road
Grand Junction, CO 81503

Phone (303) 242-8621

Chain of Sample Custody/ Soil Sample Analysis Form

Page ____ of ____

Date ____

TEAM LEADER ____

TEAM MEMBERS ____

1. Project No. ____ 2. Project Name ____

LOCATION ADDRESS	SAMPLE ID. NUMBER	PAN NO.	DATE TAKEN/ RECEIVED	DATE BOTTLED	DATE ANALYZED	DISK NO.	SAMPLE WT. (g)	226-Ra (pC1/g)	BBL NO.	COMMENT/ LAB ID

Relinquished By	Date	Dept.	Received By	Date	Dept.

Distribution: Original accompanies samples, copies to relinquishers

UCN 17345 (1/91)

Appendix 2. Soil Data Base Menu Procedures

Soil analysis data acquisition is accomplished by the KRTCOM program which stores the data in an ASCII text file named TEMPDB.DAT. The data is then transferred to the KMAN data base where it may be accessed.

To add records to the soil data base and to access the KMAN data base:

1. Select option 4 on the main menu.

2. Log into the network.

3. Select option 15 to copy TEMPDB.DAT to the network.

4. Select option 12, Data Base Menu.

5. Log into KMAN; the soil data base main menu will appear.

KMAN Data Base Options:

1.0 Reindex Soil Table

a. This option reindexes IDS.IND and SDB01.IND used for soil program operation.
b. Do <u>not</u> use this option unless so instructed by computer support personnel.

2.0 View Records by Date Analyzed

a. This option allows the user to browse/edit the soil data base by retrieving records on the date analyzed.

b. Enter the date for which soils analysis results are desired.

c. If no records satisfy the given input date, the message "NO RECORDS SATISFY THIS REQUEST" is displayed at the bottom of the screen. Press any key to return to the main menu.

d. If the input date matches records in the data base, the first record for the given date is displayed on the screen. Notice the cursor at the upper right corner of the screen.

1. To edit, press the return key. The cursor will move to the first field allowable for editing. The user may edit the sample I.D., weight, and barrel number fields.

Appendix 2. (Continued)

2. If no change is desired, press the return key and that field will remain unchanged. The cursor will move to the next field allowable for editing.

e. At the bottom of the display, notice three choices:

1. Select the next record
2. Select the previous record
3. Return to menu.

f. Input the first letter of the desired option to execute that option.

1. The next record option will display the next record for the given day analyzed. If the next record's date does not match the date requested, the program returns to the main menu.

2. The previous record option will display the previous record for the given day analyzed. If the previous record's date does not match the date requested, the program returns to the main menu.

3.0 View Records by Sample Number

a. This option allows the user to browse/edit the soil data base by retrieving records by sample number or ND number. The records are organized in alpha-numeric order.

b. Enter the sample number for which analysis results are desired.

c. If no records match the given request, the user is notified and is asked whether to continue with the closest match.

1. A "Y" response to this request will display the record which most closely matches the given sample I.D. number.

2. Any other response will return the user to the data base main menu.

d. The routine will continue viewing records in alpha-numeric order regardless of the analysis date when requesting "next" or "previous" records.

e. At the bottom of the display, notice three choices:

Appendix 2. (Continued)

1. Select the next record
2. Select the previous record
3. Return to menu.

f. Input the first letter of the desired option to execute that option.

1. The next record option will display the next record for the given day analyzed. If the next record's sample number does not match the date requested, the program returns to the main menu.

2. The previous record option will display the previous record for the given day analyzed. If the previous record's sample number does not match the date requested, the program returns to the main menu.

4.0 Add Records to Data Base

a. This option transfers records for samples just analyzed to the soil data base, inputs the barrel number, and shows how many records were added.

b. After logging into the network, select option 4, "Add Records to Data Base."

c. Input the correct barrel number.

5.0 Update Network Soil Data Bases

a. This option transfers the updated data in the network to the users' data base for all users to view.

6.0 Hard-Copy Printout

a. This gives a printout either by daily, weekly, or monthly analysis.

7.0 Delete Individual Records

a. This feature allows the user to delete a specific record.

b. Identify the record by the sample number or ND number. The program will bring key fields onto the screen for viewing.

Appendix 2. (Continued)

c. At this point the user can back out, view the next record to delete or go ahead and delete.

d. When a record is deleted, a printout is produced showing the deleted record with its fields.

8.0 Barrel Routine

a. This option accesses the barrel routine menu.

9.0 Exit to K-MAN

10.0 Exit to DOS

a. This exits out of KMAN and returns the user to DOS programs.

Exhibit 1. Lead Pig

Exhibit 2. ND-66 Computer Analysis System

TYPE A (TYPE I) VICINITY PROPERTY VERIFICATION ACTIVITIES

1.0 PURPOSE

The purpose of this procedure is to describe the activities of the Type A (also known as Type I) verification.

2.0 APPLICABILITY

This procedure applies to the verification of remedial action of vicinity properties in support of the Uranium Mill Tailings Remedial Action (UMTRA) and Monticello Vicinity Property (MVP) projects and peripheral properties remediated under the Monticello Remedial Action Project (MRAP). This procedure applies to those properties requested for verification after remedial action and restoration are complete.

3.0 OTHER DOCUMENTS

3.1 REFERENCES

3.1.1 Procedure TE-034, Chain of Sample Custody
3.1.2 Procedure TE-035, Soil Sample Preparation for Radionuclide Analysis
3.1.3 Procedure TE-036, Analysis of Radionuclides in Soils
3.1.4 Procedure TE-032, Alpha-Track Radon Detector Placement and Retrieval

3.2 APPENDICES

3.2.1 Appendix 1: UMTRA Type 1 Verification Tracking Sheet
3.2.2 Appendix 2: MVP and MRAP Tracking Sheet
3.2.3 Appendix 3: Chain of Sample Custody/ Soil Sample Analysis Form
3.2.4 Appendix 4: Vicinity Property Independent Verification Completion Report Review

APPROVALS		
Author		Date
Supervisor		Date
Group Leader	Leo K. Halford	Date 8/6/93
Section Head	Gail Little	Date 8/6/93

3.2.5 Appendix 5: Vicinity Property Certification Summary and Decision Form and Report Skeleton, UMTRA vicinity properties
3.2.6 Appendix 6: Letter of Recommendation, UMTRA Vicinity Properties

4.0 EQUIPMENT AND MATERIALS

4.1 EQUIPMENT

4.1.1 Project logbook
4.1.2 RAC property folio

4.2 MATERIALS

4.2.1 Chain of Sample Custody/Soil Sample Analysis Form (MVP and MRAP properties)
4.2.2 Vicinity Property Independent Verification Completion Report Review
4.2.3 Vicinity Property Certification Summary and Decision and report skeleton (UMTRA properties)
4.2.4 Type A report skeleton (MVP and MRAP properties)
4.2.5 Letter of recommendation

5.0 RESPONSIBILITY

5.1 The project manager is responsible for overseeing the activities of team leaders and team members, overseeing tracking property folders throughout the verification process, conducting final review of reports, and signing completed reports.

5.2 The team leader is responsible for ordering soil samples and requesting any other pertinent information from the remedial action contractor (RAC) (e.g., copies of original radon measurement results). The team leader may track property folders throughout the verification process and conduct the final review if so designated by the project manager.

5.3 Team members are responsible for writing and reviewing reports.

5.4 The public relations staff is responsible for creating a tracking sheet and file folder for each Type A verification and maintaining the current verification data base and tracking information.

5.5 The clerical staff is responsible for typing draft and corrected report documents and transmitting completed documents to the Department of Energy (DOE).

6.0 DEFINITIONS

6.1 **Peripheral property**: a property, either publicly or privately owned, adjacent to the Monticello mill site. A peripheral property may have substantial amounts of windblown contamination or may be dissected by Montezuma Creek. Remediation is funded through MRAP.

6.2 **Split sample**: a portion of another agency's sample.

6.3 **Vicinity property**: a public or private property in the vicinity of a mill site covered under the UMTRA or MVP projects.

7.0 PROCEDURE

7.1 The DOE notifies the project manager of properties to be verified and forwards the completion reports for the selected properties. At this time, a public relations staff member generates a property file folder and a tracking sheet (Appendices 1 and 2).

7.2 CONFIRMATORY SOIL ANALYSIS

Confirmatory soil analysis is performed on splits of soil samples tabulated in the RAC's completion report for MVP and MRAP project samples only.

7.2.1 For UMTRA properties, in order to accommodate DOE sample disposal guidelines, no analysis of splits of RAC verification samples are performed beginning June 23, 1992 until the close of the Grand Junction vicinity properties activities.

7.2.2 Request at least 10% of the total samples reported in the RAC's completion report.

7.2.3 Obtain the RAC's ticket numbers from the property completion report.

7.2.4 Fill out a Chain of Sample Custody/Soil Sample Analysis Form (Appendix 3) showing the property address, location number, split sample identification number, (e.g., X1, X2, etc.), and RAC ticket number.

7.2.5 File a carbon copy of the Chain Sample Custody Form in the project file.

7.2.6 Give the original Chain of Sample Custody Form to appropriate RAC personnel.

7.2.7 Note the date of request in the project logbook and on the tracking sheets for each vicinity property for which split samples are requested.

7.2.8 Sign the Chain of Sample Custody Form when the samples are picked up.

7.2.9 Deliver the samples to the ETS soils preparation laboratory for analysis.

a. Follow chain-of-sample-custody procedures as described in Procedure TE-034.

7.2.10 File the original Chain of Sample Custody Form in the soils analysis laboratory in the appropriate project logbook.

7.2.11 Refer to Procedures TE-035 and TE-036 for sample preparation and analysis procedure details. File the analysis results in the project file.

7.3 RADON MEASUREMENT DATA

7.3.1 Check the completion report to confirm that radon measurements were taken correctly. Refer to Procedure TE-032 for placement and retrieval requirements.

7.3.2 If copies of the original radon report data are not in the property folio, continue with steps 7.3.3 through 7.3.5 below.

7.3.3 The file of radon report data may provide radon measurement results for some properties, and is filed chronologically by retrieval date. Check the file for the specific detector results for the vicinity property.

7.3.4 If the file does not contain radon data for the specific vicinity property, send a letter to the RAC requesting copies of the original radon report.

7.3.5 Upon receipt of the report, place a copy in the appropriate property folder and a copy in the radon data file.

7.4 COMPLETION REPORT REVIEW AND REPORT DRAFT PROCESS

7.4.1 After soils analysis results and radon data are entered into the file, the project manager or team leader assigns the folder to a team member for completion report review and report writing.

a. Obtain the property folio from the RAC.

b. Review the completion report using the Vicinity Property Independent Verification Completion Report Review sheets (Appendix 4). Sign and date the last page.

c. For UMTRA properties, complete the following forms and letter:

1. Vicinity Property Certification Summary and Decision form and report skeleton (Appendix 5), and
2. Letter of recommendation to the DOE project manager (Appendix 6).

d. For MVP and MRAP properties, complete the following forms and letter, which vary slightly from the UMTRA documentation because of differing project requirements:

1. Type A verification report skeleton, and
2. Letter of recommendation to the DOE project manager.

e. Adapt the report skeleton to note discrepancies between the RAC's and ORNL's data, and whether the RAC's documentation is adequate. Carefully document any discrepancies causing the report to be recommended for any action other than certification.

f. Initial and date the tracking sheet.

g. Submit the above documents, along with the vicinity property folder and RAC folio, to the clerical staff for typing.

7.4.2 After all report documents are typed, the project manager or team leader assigns the folder and RAC folio to another team member for a second review of the completion report and first review of the draft documents.

a. Review the completion report using the Completion Report Review sheets. Sign and date the last page.

b. Review the other report documents.

c. Sign and date the tracking sheet.

d. Turn in the report documents with corrections along with the folder and folio to the clerical staff for corrections.

7.4.3 After all report documents are corrected and returned to the project manager, the project manager or team leader reviews the report documents.

a. If corrections are necessary, return the report to typing.

b. If the documents are acceptable, send the cover letter and the recommendation to the ETS leader or his designee for signing.

c. Submit the property file to the clerical staff for transmittal to the DOE.

7.5 Create a new folder for transmittal. Copy the following documents for the vicinity property file and transmit the originals to the appropriate DOE office:

7.5.1 Letter of recommendation
7.5.2 Vicinity Property Certification Summary and Decision form and report skeleton (UMTRA properties), or
7.5.3 Vicinity Property Summary Evaluation and Findings and Type A Verification report skeleton (MVP and MRAP properties),
7.5.4 RAC completion report
7.5.5 RAC Vicinity Property Certification Summary and Recommendation (UMTRA properties), or
7.5.6 RAC Summary of Remedial Action.

7.6 Submit the vicinity property file containing copies of original IVC documents to the public relations staff for data base input.

7.7 Input all relevant report information into the project data base.

7.8 Submit the vicinity property file to the ETS Document Control department for archival.

Appendix 1. UMTRA Type 1 Tracking Sheet

SITE NUMBER:
PARCEL NO:

SITE ADDRESS:

PROPERTY CLASS:

OWNER INFO:

DATE ASSIGNED TO ORNL: / / VERIFICATION TYPE I

SITE SURVEY INFORMATION

SITE VISIT	SURVEY DATE	TECH. INITIALS	SITE VISIT	SURVEY DATE	TECH. INITIALS

GJRAP? YES_____ NO_____

RADON INFORMATION

MONITOR TYPE	TIME NUMBER WLM OR RPISU	IN DATE	INITIALS	OUT DATE	INITIAL

REPORT INFORMATION

SPLITS ORDERED: _____
RADON REPORT ORDERED: _____

TYPING
DRAFT: _____
SECOND: _____
FINAL: _____

COMPLETION REPORT

REVIEW 1: _____
REVIEW 2: _____

FINAL REVIEW _____

DATABASE VERIFIED: _____

DOE CERTIFICATION: _____

COMMENTS: _____

UCN 17219 (9/90)

Appendix 2. MVP and MRAP Tracking Sheet

SITE NUMBER: PROPERTY CLASS:

SITE ADDRESS: OWNER INFO:

TYPE VERIFICATION (A, B or C):

SITE SURVEY INFORMATION

SITE VISIT	SURVEY DATE	TECH. INITIALS	SITE VISIT	SURVEY DATE	TECH. INITIALS

RADON INFORMATION

IN DATE	INITIALS	OUT DATE	INITIALS

REPORT INFORMATION

ISC REPT REVIEW: _____
REA REVIEW: _____

COMPLETION REPORT
REVIEW 1: _____
REVIEW 2: _____

VERIFICATION REPORT (TYPE B & C)
DRAFT: _____
REVIEW 1: _____
REVIEW 2: _____

TYPING
DRAFT: _____
FINAL: _____

FINAL REVIEW _____

COVER LETTER: _____

DATABASE VERIFIED: _____

DOE CERTIFICATION: _____

COMMENTS: _____

UCN17299 (11/90)

Appendix 3. Chain of Sample Custody/ Soil Sample Analysis Form

ornl OAK RIDGE NATIONAL LABORATORY
Grand Junction Office

Mailing Address
P.O. Box 2567
Grand Junction, CO 81502

Street Address
2597 B¾ Road
Grand Junction, CO 81503

Phone (303) 242-0621

Chain of Sample Custody/ Soil Sample Analysis Form

Page _____ of _____

Date _____

TEAM LEADER _____

TEAM MEMBERS _____

1. Project No. 6R0004-180 2. Project Name Monticello Vicinity Properties ISC & IVC

LOCATION ADDRESS	SAMPLE ID. NUMBER	PAN NO.	DATE TAKEN/ RECEIVED	DATE BOTTLED	DATE ANALYZED	DISK NO.	SAMPLE WT. (g)	226-Ra (pCi/g)	BBL NO.	COMMENT/ LAB ID

Relinquished By	Date	Dept.	Received By	Date	Dept.

Distribution: Original accompanies samples, copies to relinquishers

UCN 17345A (1/91)

Appendix 4. Vicinity Property Independent Verification Completion Report Review

VICINITY PROPERTY INDEPENDENT VERIFICATION
COMPLETION REPORT REVIEW

LOCATION NO._____ REVIEWER_____
PROPERTY ADDRESS_____ DATE_____
_____

COMPLETION REPORT REQUIREMENT	COMPLIANCE YES	NO	N/A	COMMENTS (Pg. in Completion Report) (Attach added pgs, if needed)
I. COMPLETION REPORT GENERAL STRUCTURE & SUMMARY (Section I)				
1) Project manager signature?				
2) Is vicinity property location number present and correct on all pages and figures?				
except table of contents)				
3) Is the report documentation concise (e.g., no extraneous pages, figures, or tables)?				
4) Summary section reasonable and correct? (Section I)				
5) Do addresses, parcel #'s, dates, and statistics agree throughout the report?				
6) Is the owner's name correct?				
II. OPERATIONS SUMMARY (Section 2.0)				
1) Sec. 2.1, Abstract of Remedial Action Plan				
a) Reasonable and correct				
b) Description of where remedial action took place, backfill material, and restoration?				
2) Sec 2.2, Previously Unidentified Contamination				
Description and explanation?				

Appendix 4. (continued)

VICINITY PROPERTY INDEPENDENT VERIFICATION
COMPLETION REPORT REVIEW

LOCATION NO._____DATE_____REVIEWER_____

COMPLETION REPORT REQUIREMENT	COMPLIANCE YES	NO	N/A	COMMENTS (Pg. in Completion Report) (Attach added pgs, if needed)
3) Sec 2.3, Unanticipated Items				
Description and explanation?				
4) Sec 2.4, Application of Supplemental Standards (if applicable)				
a) Description of areas where supplemental standards were applied?				
b) Volume of remaining material stated?				
c) Location of remaining material stated?				
d) Radiological activity of remaining material stated?				
e) If numerical standards were not met, is this due to presence of natural radioactivity? (Sec 2.4)				
f) If all residual radioactivity at the property was not cleaned up, were supplemental standards (40 CFR 192 Subpart C) applied? (Sec. 2.4)				
g) Did appropriate state and federal agencies concur in this application of supplemental standards?				

Appendix 4. (continued)

VICINITY PROPERTY INDEPENDENT VERIFICATION
COMPLETION REPORT REVIEW

LOCATION NO._____DATE_____REVIEWER_____

COMPLETION REPORT REQUIREMENT	COMPLIANCE YES	NO	N/A	COMMENTS (Pg. in Completion Report) (Attach added pgs, if needed)
III. VERIFICATION SUMMARY (Sec 3.0)				
1) Sec 3.1.2 and Figure 2.1, Soil Excavation				
a) Was an outdoor gamma survey conducted in excavated areas? (Sec. 3.1.2, Fig. 2.1)				
b) Were soil samples or composites collected from contaminated regions after excavation? (Sec. 3.1.2, Fig. 2.1)				
2) Sec 3.1.2,Post-Excavation Survey				
a) Is contamination to remain on the property adequately described?				
b) Post-excavation exposure rate range?				
c) Exterior post-excavation soil sample results correct?				
d) Interior contamination to remain adequately described?				
e) Interior post-excavation exposure rate range?				
3) Sec. 3.1.3, Post-Remedial Action RDC measurements				
If RDC measurements were performed before remedial action and results were above standards, were they repeated after remedial action was completed? (Sec. 3.1.1 & Sec. 3.1.3)				

Appendix 4. (continued)

VICINITY PROPERTY INDEPENDENT VERIFICATION
COMPLETION REPORT REVIEW

LOCATION NO._____DATE_____REVIEWER_____

COMPLETION REPORT REQUIREMENT	COMPLIANCE YES	NO	N/A	COMMENTS (Pg. in Completion Report) (Attach added pgs, if needed)
4) Sec. 3.2, Recommendation for Certification				
Present and accurate?				
5) Certification Data Summary Table:				
a) Are survey results below the associated standards for:				
Interior gamma?				
RDCs?				
Exterior surface soils?				
Exterior subsurface soils?				
IV. 4.0 APPENDIX				
Table 3.1, Post-Excavation Sample Measurement Results:				
1) Area identifier and exposure ranges match with Figure 2.1?				
2) Sample results quoted?				
Table 3.2, Post-Remedial Action RDC measurement results?				
1) Are working level measurements correct (if original data sheets are available)?				
2) Instrument type(s) listed?				
3) Start and end dates and times correct?				
4) Do total hours agree with start/end times (RPISU or WLMI)				

Appendix 4. (continued)

VICINITY PROPERTY INDEPENDENT VERIFICATION
COMPLETION REPORT REVIEW

LOCATION NO._____DATE_____REVIEWER_____

COMPLETION REPORT REQUIREMENT	COMPLIANCE YES	NO	N/A	COMMENTS (Pg. in Completion Report) (Attach added pgs, if needed)
5) Are measurement locations stated?				
V. FIG. 2.1, (MAP) (RADIOLOGICAL-AS-BUILT)				
Does Figure 2.1 clearly show:				
1) Post-remedial action exposure rate ranges?				
2) Soil sample or composite sample locations and numbers?				
3) Areas of contamination removal clearly shown?				
4) Remaining contamination?				
5) Is legend clear and legible?				
6) Structure outlines?				
7) RDC sampler locations?				
VI. GENERAL INDOOR RADIOLOGICAL				
If interior excavation was performed, does Figure 2.1 or additional figure(s) show:				
1) Post-remedial action exposure rate ranges?				
2) Soil sample or composite sample locations and numbers?				
3) Basement and second story information (if applicable)?				
4) Remaining contamination?				

Appendix 4. (continued)

VICINITY PROPERTY INDEPENDENT VERIFICATION
COMPLETION REPORT REVIEW

LOCATION NO._____DATE_____REVIEWER_____

COMPLETION REPORT REQUIREMENT	COMPLIANCE YES	NO	N/A	COMMENTS (Pg. in Completion Report) (Attach added pgs, if needed)
5) Were assessment measurements taken in the lowest habitable level of every habitable building? (Sec. 3.1.2)				
6) After remedial action, was the average value for each room or 9.3 m^2 area less than 20 $\mu R/hr$ above background? (Sec. 3.1.2)				
7) If any measurment exceeded 20 $\mu R/hr$ above background, was it investigated to ensure no tailings involvement? (Sec. 3.1.2)				
VII. CERTIFICATION Is this property recommended for certification as meeting the EPA standards for residual radioactive material?				
_____ Signature of Reviewer & Date				
_____ Second Reviewer Signature & Date				

UCN17168(8/90)

Appendix 5. Vicinity Property Certification Summary and Decision form and Report Skeleton, UMTRA Vicinity Properties

DOE ID Number:_____

VICINITY PROPERTY CERTIFICATION SUMMARY AND DECISION

1.0 SUMMARY EVALUATION

The data presented in the property portfolio indicate:

		IVC (ORNL)			U.S. Dept. of Energy		
		Yes	No	N/A	Yes	No	N/A
1.	The Ra-226 concentration in the top 15cm of soil averages < 5 pCi/g above background over 100 m2.	[]	[]	[]	[]	[]	[]
2.	The Ra-226 concentration in any 15 cm layer of soil below the top 15cm surface layer averages <15 pCi/g above background over 100 m2.	[]	[]	[]	[]	[]	[]
3.	The indoor gamma readings are <20 mR/hr above background in every habitable room.	[]	[]	[]	[]	[]	[]
4.	The radon daughter concentration in any habitable room is < 0.02 working levels, or at most 0.03 WL's.	[]	[]	[]	[]	[]	[]
5.	Supplemental standards were applied in accordance with EPA standards 192.21.*	[]	[]	[]	[]	[]	[]

COMMENTS:_____

_____

_____

_____

Appendix 5. (continued)

DOE ID Number: _____

2.0 ORNL's RECOMMENDATION

Based on ORNL's evaluation of the [] Completion Report [] Completion Report and field survey data, I recommend this property for:

[] Certification

[] Additional measurements and/or additional information in the Completion Report as described below

[] Certification pending resolution of the deficiencies described below

[] Additional remedial action

_____ Date:_____

C. A. Little, Ph.D.
Independent Verification Contractor

2.1 ORNL's DESCRIPTION OF FINDINGS AND EVALUATION

This summary describes the findings of the IVC after review of the Completion Report, information in the property portfolio, and analysis of other available data.

Confirmatory analysis of sample splits from the RAC was performed. The splits were taken from the samples tabulated in the completion report. They are as follows:

UNC Ticket #	RAC Ra226 Content	IVC Ra226 Content
	pCi/g	pCi/g
	pCi/g	pCi/g
	pCi/g	pCi/g
	pCi/g	pCi/g
	pCi/g	pCi/g
	pCi/g	pCi/g
	pCi/g	pCi/g

A review of the completion report and folio for location _____ found the property to be in compliance with EPA regulations for ^{226}Ra concentrations in surface/subsurface soil layers. Analysis of the ^{226}Ra concentrations of split samples from the Remedial Action Contractor (RAC) were found to be in close agreement with those of ORNL IVC.

_____

_____

_____

Appendix 5. (continued)

The indoor gamma exposure rate range and annual radon daughter concentration are both in compliance with EPA standards.

Based on these findings, it is recommended that location _____ be certified by the DOE.

Appendix 5. (continued)

DOE ID Number: _____

3.0 DOE/UMTRA EVALUATION

DOE Decision: [] Certify

[] Requires additional measurements prior to certification

[] Requires additional remedial action

Comments:_____

_____

_____

_____

_____

_____ Date:_____

U.S. Department of Energy
Certification Official

*Certification concurred on by NRC on_____
(date)

Appendix 6. Letter of Recommendation, UMTRA Vicinity Properties

Mr. Michael K. Tucker, Manager
U.S. Department of Energy
Grand Junction Area Office
P.O. Box 2567
Grand Junction, Colorado 81502

Dear Mr. Tucker,

Radiation levels at the property identified below do not exceed the U.S. Environmental Protection Agency (EPA) standards as specified in 40 CFR 192.

This recommendation is based upon the Independent Verification Contractor's assessment of the ^{226}Ra concentration in the soil, indoor radon daughter concentration, and indoor gamma exposure rate at this property.

Therefore, this property is recommended for

(choose one)

certification by the U.S. Department of Energy.

certification upon resolution of the deficiencies described in the ORNL/IVC Certification Summary and Decision.

further study by the Uranium Mill Tailings Remedial Action Project.

further remedial action by the Uranium Mill Tailings Remedial Action Project.

Sincerely,

C.A. Little, Ph.D.
Independent Verification Contractor

Location Number: _____
Location Address: _____
_____

Property Owner: _____
Owner Address: _____

TYPE B (TYPE II) VICINITY PROPERTY VERIFICATION SURVEY ACTIVITIES

1.0 PURPOSE

The purpose of this procedure is to describe the tasks related to the collecting of field data during a Type B (also known as Type II) verification site survey.

2.0 APPLICABILITY

This procedure applies to Type B or Type II verification surveys performed in support of the Uranium Mill Tailings Remedial Action (UMTRA) and Monticello Vicinity Property (MVP) projects and peripheral properties remediated under the Monticello Remedial Action Project (MRAP). The procedure applies to those properties where remedial action is in progress.

3.0 OTHER DOCUMENTS

3.1 REFERENCES

3.1.1 Procedure TE-055, Opposed Crystal System (OCS) Van Analysis
3.1.2 Procedure TE-021, Gamma Scintillation Detector Operation
3.1.3 Procedure TE-024, Delta Counter Operation
3.1.4 Procedure TE-020, Inclusion Survey Activities

3.2 APPENDICES

3.2.1 Appendix 1: Gamma Screening Summary Form
3.2.2 Appendix 2: Delta Gamma Field Data Sheet
3.2.3 Appendix 3: Vicinity Property Independent Verification Soil Data Sheet
3.2.4 Appendix 4: Chain of Sample Custody/Soil Sample Analysis Form
3.2.5 Appendix 5: Hot Spot Limits
3.2.6 Appendix 6: Verification Survey Notes
3.2.7 Appendix 7: Tracking sheet (MVP and MRAP properties)

APPROVALS		
Author		Date
Supervisor		Date
Group Leader	Douglas K. Halford	Date 8/6/93
Section Head	Dai Little	Date 8/6/93

3.2.8 Appendix 8: Type II Tracking Sheet (UMTRA properties)

3.3 EXHIBITS

3.3.1 Exhibit 1: Gridded Field Map

4.0 EQUIPMENT AND MATERIALS

4.1 EQUIPMENT

4.1.1 Gamma scintillation detector
4.1.2 Delta counter
4.1.3 Van-mounted opposed crystal system
4.1.4 JMC auger
4.1.5 JMC "mud sampler" auger
4.1.6 Pager
4.1.7 Field radio
4.1.8 Clipboard
4.1.9 Engineering scale
4.1.10 Measuring tapes
4.1.11 Shovel
4.1.12 Water sprayer and brush
4.1.13 Rain gear
4.1.14 Hard hats for all personnel
4.1.15 Steel-toed boots for all personnel
4.1.16 Lead shielding
4.1.17 Shoe coverings
4.1.18 Project logbook

4.2 MATERIALS

4.2.1 Gamma Screening Summary form
4.2.2 Delta Gamma Field Data Sheet
4.2.3 Soil Data Sheet
4.2.4 Chain of Sample Custody/Soil Sample Analysis Form
4.2.5 Verification Survey Notes sheet
4.2.6 Black or blue pens
4.2.7 Red pens
4.2.8 Large ziplock bags or other sample containers
4.2.9 Sharpie pens
4.2.10 Drinking water
4.2.11 Paper towels
4.2.12 Tracking sheet (project specific)

5.0 RESPONSIBILITIES

5.1 The project manager oversees the activities of the team leaders and team members.

5.2 The team leader has the following responsibilities:

5.2.1 selecting properties for verification,
5.2.2 reviewing the inclusion survey and assessment information,
5.2.3 directing field technicians,
5.2.4 mapping excavation areas on site,
5.2.5 recording all field data,
5.2.6 determining background gamma radiation exposure rate ranges,
5.2.7 determining soil sample locations,
5.2.8 archiving field data, and
5.2.9 tracking the property folder throughout the final verification survey.

5.3 The field technician(s) has the following responsibilities:

5.3.1 preparing equipment and vehicle for a survey,
5.3.2 completing gamma scans of excavated areas,
5.3.3 collecting soil samples, and
5.3.4 decontaminating survey equipment.

5.4 The OCS van operator has the following responsibilities:

5.4.1 preparing the OCS van for analysis,
5.4.2 analyzing soil samples on site, and
5.4.3 documenting analysis results.

5.5 The office assistant has the following responsibilities:

5.5.1 preparing the property and archival folders,
5.5.2 generating a tracking sheet, and
5.5.3 entering property information into the data base.

6.0 DEFINITIONS

6.1 **Anomaly**: a gamma radiation exposure rate reading that is above background.

6.2 **Composite sample**: a sample made up of two or more individual samples, to make up a representative sample of a large area.

6.3 **Hot spot limits**: EPA guidelines for allowable ^{226}Ra concentrations for small areas; applicable to MRAP and MVP projects.

6.4 **OCS**: opposed crystal system; a mobile field laboratory used for analysis of ^{226}Ra in soil samples.

6.5 **Peripheral property**: a property, either publicly or privately owned, adjacent to the Monticello mill site.

6.6 **Split sample**: a portion of another organization's sample.

6.7 **Vicinity property**: a public or private property in the vicinity of a mill site covered under the UMTRA or MVP projects.

7.0 SAFETY

7.1 Do not eat, drink, or smoke at a verification site.

7.2 Wear appropriate protective clothing, including steel-toed boots and a hard hat, while at a verification site. Hearing protection is suggested in areas of heavy construction activity.

7.3 Wash hands after handling potentially radioactive materials and before eating or drinking.

7.4 Check for visible contamination on personnel and clean as necessary after handling soil samples.

7.5 Wear a personal dosimeter when working at verification sites.

7.6 Exercise caution when working in excavated areas and around heavy equipment. Report unsafe working conditions to remedial action contractor (RAC) construction personnel.

8.0 PROCEDURE

8.1 The RAC notifies the project manager, team leader, or team member on call of pending verifications before the verification is scheduled to start. At this time, verification team personnel select properties at random for independent verification, depending upon milestone requirements. The ensuing visit will either be the first and final visit or the first visit for a partial verification. The RAC will notify the independent verificaiton contractor (IVC) by phone or radio of all subsequent verifications for a selected property.

8.2 Perform a field check of the gamma scintillation detector (refer to Procedure TE-021).

8.3 Obtain a copy of the remedial engineering assessment (REA), the inclusion survey contractor (ISC) report, the RAC's gridded field map (see Exhibit 1), and any other appropriate maps from the RAC's record management department.

8.4 Review the ISC report and the REA report and compare their maps for inconsistencies.

8.5 Map the excavation using the RAC's gridded property map.

8.5.1 Title the map as the IVC field map.

8.5.2 Duplicate the RAC's excavation areas. Follow excavation borders and spray-painted area designations and consult with RAC verification personnel.

8.5.3 Duplicate the RAC's area identifiers, e.g., V1, V2.

8.5.4 Mark the location of the RAC's aliquot samples.

8.5.5 Note all extraordinary circumstances (e.g., contamination left in place, biased sample locations).

8.6 The OCS operator prepares the OCS van for soil sample analysis (refer to Procedure TE-055).

8.7 OUTDOOR GAMMA SCAN

8.7.1 Complete a gamma radiation scan of all excavated areas being verified and border areas approximately 10 ft in width surrounding the excavated areas.

8.7.2 Report the gamma radiation exposure rate range for each excavated area and any anomalous (above background) readings to the team leader.

8.7.3 The team leader records all gamma exposure rates on the map and Gamma Screening Summary form (Appendix 1).

8.7.4 At the team leader's discretion, investigate any anomalous readings by any of the following methods:

a. Kick the top dirt away from the area and re-scan.

b. Remove a shovel of dirt and re-scan, being careful to scan the sides of the hole.

c. Auger around the area and take readings in the auger holes to establish the extent of the anomaly.

d. Sample the soil of the area and analyze in the OCS van.

e. Use a delta counter to estimate pCi/g in soil (refer to Procedure TE-024). Record delta-counter measurements on the Delta Gamma Field Data Sheet (Appendix 2).

8.7.5 Ensure that all areas identified in the inclusion survey were addressed during remedial assessment and subsequent remedial action.

8.7.6 Continue investigation until the gamma exposure rate decreases to background after remediation or until it can be determined that the net estimated area-weighted average gamma exposure rate is less than background plus 20% averaged over 100 m^2.

8.7.7 The team leader or designated team member informs the RAC verification personnel of anomalous gamma exposure rates.

8.8 Determine the background exposure rate for the property using one of three sources: the inclusion survey, the REA, or a post-excavation measurement.

8.9 COMPOSITE SOIL SAMPLES

8.9.1 Collect at least one composite soil sample from each property where there is an outdoor excavation. The number of composite samples will vary according to the extent of the remedial action as follows:

Total Excavation Area, m^2	Number of Composite Samples
<100	1
100-500	2
>500	4

a. For UMTRA Grand Junction vicinity properties (GJVP), sample approximately every 100 ft^2 (9.3 m^2) of the gridded area of excavations beginning June 23, 1992, and continuing until the close of GJVP verification activities.

8.9.2 Choose excavation area(s) to collect samples from either by random selection of the RAC's sampling areas or by selection of a 100 m^2 area containing the high outdoor gamma (HOG) radiation measurement.

8.9.3 Soil sample locations will usually parallel the RAC's sample locations. Generally, a composite sample will be taken from each selected area of excavation, composed of one individual sample from each 10 ft^2 grid block within this area.

a. Take individual samples from the center of each grid block or from grid intersections.

8.9.4 Take composite samples using a JMC auger or similar tool.

8.9.5 Place all individual samples for one composite sample in a large ziplock bag or other appropriate sample container.

8.9.6 Label composite samples as in Procedure TE-020, using a "V" for the verification sample code (e.g., GJ88888-V1).

8.10 BIASED SOIL SAMPLES

8.10.1 At the team leader's discretion, take biased soil samples from areas of suspected contamination.

a. Label biased samples as in Procedure TE-020, using a "B" for the verification sample code (e.g., GJ-88888-B1).

8.11 Record soil sample information on the Soil Data Sheet (Appendix 3).

8.12 Complete a Chain of Sample Custody/Soil Sample Analysis Form (Appendix 4).

8.13 The OCS operator analyzes the soil samples at the site to verify compliance with Department of Energy (DOE) requirements for radium in soil. See Procedure TE-055 for analysis details.

8.14 If gamma exposure rates or soil sample results indicate that radium-in-soil is >5 pCi/g for surface soil and >15 pCi/g for subsurface soil averaged over 100 m^2, request the RAC personnel on site to further investigate and/or remediate.

8.15 For MVP and MRAP properties, if soil sample results indicate that the hot spot limits (Appendix 5) have been exceeded, request the RAC personnel on site to further investigate and/or remediate.

8.16 INDOOR VERIFICATION ACTIVITIES

8.16.1 Map interior excavation areas as described above for exterior excavations.

8.16.2 Scan excavations inside structures with a scintillometer as described in Procedure TE-020.

8.16.3 Record a range for the entire indoor excavation on the field map and the Gamma Screening Summary form (Appendix 2).

a. Indoor gamma exposure rates should not exceed 20 μR/h. In some cases, a contaminated footer may remain in place, which will affect the indoor gamma exposure rate range. When measuring gamma radiation, take care to eliminate any emanation from contaminated areas engineered to remain in place. This may be done with a delta counter or by using lead shielding with the gamma scintillometer.

b. If the remedial action has resulted in an interior gamma exposure rate range that is as low as reasonably achievable (ALARA) but exceeds 20 μR/h, the verification depends solely on the result of the radon daughter concentration (RDC) measurement. The RAC may take measures to vent the structure, ultimately lowering the RDC. Note venting on a separate indoor map or on the outdoor field map if space is available.

8.17 TAILINGS LEFT IN PLACE

8.17.1 In some instances, the RAC may have justification for leaving exterior and interior contamination in place. These unique occurrences may be due to one of the following:

a. The engineering design cannot provide reasonable assurance that significant structure damage would not occur. This often refers to foundations where tailings were used as part of the concrete matrix.

b. The safety of workmen cannot be assured. This often refers to high voltage lines, high pressure water lines, or other utilities.

c. Mature trees or shrubbery will be permanently damaged.

8.17.2 Obtain independent measurements of contamination to be left in place.

a. Take gamma exposure rate and radium-in-soil measurements (using OCS van analyses) to determine if U.S. Environmental Protection Agency (EPA) standards have been exceeded.

b. Average these values over 100 m^2 for outdoor areas and 9.3 m^2 for indoor areas.

8.17.3 In most cases, the outdoor and indoor areas designated to be left in place must have net estimated area-weighted radium concentrations and gamma exposure rates that fall below EPA standards (<5 pCi/g for surface soil and <15 pCi/g for subsurface soil). If they do not, the RAC must apply for supplemental standards.

8.18 Record all noteworthy events and details of the site visit on the Verification Survey Notes (Appendix 6).

8.19 If field measurements cannot establish that the property is below EPA standards after remediation, notify the DOE immediately, with a written explanation following within one day.

8.20 DECONTAMINATION OF EQUIPMENT AND PERSONNEL

8.20.1 Decontaminate equipment and personnel before leaving the site.

8.20.2 If OCS results are above the EPA standards, clean all equipment at a location to be remediated.

8.20.3 Inspect for and remove visible contamination from sample collection equipment using a brush, paper towels, and/or water.

8.20.4 Inspect for and remove visible contamination from gamma detection equipment using a brush and/or paper towels.

8.20.5 Inspect for and remove visible contamination from personnel using a brush, paper towels, and/or water.

a. During muddy conditions, clean shoes, boots, and/or coverings until free of visible contamination using water, paper towels, or a brush as appropriate.

b. Wash hands before smoking, eating, or drinking.

8.21 FOLDER GENERATION AND DATA BASE INPUT

8.21.1 Keep copies of all field information to be put in the archive folder.

8.21.2 If the site visit was the first for the property, give the original field information to the office assistant to generate the following:

a. data base file,
b. property folder,
c. archival folder, and
d. tracking sheet.

8.21.3 Upon receiving the property folder, enter all site visit information for the following:

a. tracking sheet (Appendix 7 or 8),
b. data base file, and
c. project logbook.

8.22 Place copies of the field information in the archive folder and file in the project archive files.

8.23 If the site verification was a final survey, that is, all remediation is complete, enter the final survey date in the project logbook.

8.24 If obvious problems with respect to possible certification are encountered, notify DOE by letter within 24 hours.

Appendix 1. Gamma Screening Summary form

VICINITY PROPERTY INDEPENDENT VERIFICATION
GAMMA SCREENING SUMMARY

LOCATION: G588888 SHEET 1 OF 1
ADDRESS: 555 Venus Drive
Grand Junction, CO
81501
POST RDC's REQUIRED: YES X NO ____
BACKGROUND GAMMA EXPOSURE RATE FOR PROPERTY-Range 10-14 μR/h Ave 12 μR/h
BACKGROUND DETERMINED BY REA: YES X NO ___ OTHER ____

Area Identifier	Kcpm	uR/h	Area (m²)	uR/h from REA	Exterior/Interior
VISIT 1	TECH/INITS SAR	ORNLINST # 53		DATE 2/2/92	
V1	5-15		100		Exterior
VISIT	TECH/INITS	ORNLINST #		DATE	
VISIT	TECH/INITS	ORNLINST #		DATE	
VISIT	TECH/INITS	ORNLINST #		DATE	
VISIT	TECH/INITS	ORNLINST #		DATE	
VISIT	TECH/INITS	ORNLINST #		DATE	

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Appendix 2: Delta Gamma Field Data Sheet

VICINITY PROPERTY INDEPENDENT VERIFICATION

DELTA GAMMA FIELD DATA SHEET

PROPERTY ADDRESS: 2701

LOCATION NUMBER GTC0194

INSTRUMENT GJAO #

CALIBRATION EXPIRES 3-1-90

TECHNICIAN NAME : DLS

DATE 4-9-90

RESULTS CALCULATED BY: DLS

****

ALL COUNT TIMES ARE 120 SECONDS UNLESS NOTED OTHERWISE

SAMPLE LOCATION	TOTAL COUNT	DELTA COUNT	%UNCERTAINTY (<15%)	Ra-226 pCi/g	DEPTH cm	COMMENTS (OPTIONAL)
1	12273	3956	4.3	7.96	Wall Surface	
2	11841	3255	4.4	7.64	Wall	
3	7505	1610	7.35	2.31	Cistern	
4	11035	2911	4.75	~~6.45~~		
5	10791	2876	4.76	6.34		
6	12189	3922	3.65	9.66		

Appendix 3: Vicinity Property Independent Verification Soil Data Sheet

VICINITY PROPERTY INDEPENDENT VERIFICATION
SOIL DATA SHEET

PROPERTY ADDRESS:_____ LOCATION _____

_____

_____

Check One____ Type A (I) Remedial Action Complete (Paper Review)
____ Type B (II) Remedial Property in Progress (IVC Site Survey)
____ Type C (III) Special Property

Intls	Date			SOILS Ra-226 Concentration (pCi/g)				
IVC	RAC			IVC				RAC
Sample #	Sample #	Ticket #	Depth	S/S #	1S/S	2IVC	3OCS	4C/RAC

Intls	Date			SOILS Ra-226 Concentration (pCi/g)				
IVC	RAC			IVC				RAC
Sample #	Sample #	Ticket #	Depth	S/S #	1S/S	2IVC	3OCS	4C/RAC

Intls	Date			SOILS Ra-226 Concentration (pCi/g)				
IVC	RAC			IVC				RAC
Sample #	Sample #	Ticket #	Depth	S/S #	1S/S	2IVC	3OCS	4C/RAC

Intls	Date			SOILS Ra-226 Concentration (pCi/g)				
IVC	RAC			IVC				RAC
Sample #	Sample #	Ticket #	Depth	S/S #	1S/S	2IVC	3OCS	4C/RAC

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Note. 1. S/S are split sample results of RAC soil samples analyzed by ORNL lab.
2. IVC are results of IVC sample analyzed by ORNL lab.
3. OCS are results of IVC samples analyzed by OCS van on site.
4. C/RAC are results of RAC samples analyzed by RAC lab.

Appendix 4. Chain of Sample Custody/Soil Sample Analysis Form

ornl OAK RIDGE NATIONAL LABORATORY
Grand Junction Office

Mailing Address
P.O. Box 2567
Grand Junction, CO 81502

Street Address
2597 B¾ Road
Grand Junction, CO 81503

Phone (303) 242-8621

Chain of Sample Custody/ Soil Sample Analysis Form

Page 1 of 1
Date 2/2/92
TEAM LEADER JAR
TEAM MEMBERS DLS
DBE

1. Project No. _____ 2. Project Name UMTRA-IVC

LOCATION ADDRESS	SAMPLE ID. NUMBER	PAN NO.	DATE TAKEN/ RECEIVED	DATE BOTTLED	DATE ANALYZED	DISK NO.	SAMPLE WT. (g)	226-Ra (pC1/g)	BBL NO.	COMMENT/ LAB ID
555 Vomas Dr.	G388888-V1		2/2/92							

Relinquished By	Date	Dept.	Received By	Date	Dept.

Distribution: Original accompanies samples, copies to relinquishers

UCN 17345 (1/91)

Appendix 5. Hot Spot Limits

To calculate the hot spot limit:

$$S_{hg} = S_g \times (100\ m^2/A)^{1/2}$$

where:

S_{hg} = hot spot limit, pCi/g

S_g = authorized limit (5 pCi/g for surface soil or 15 pCi/g for subsurface soil)

A = area of the hot spot, m^2

Appendix 5. (continued)

SURFACE SOILS		SUB-SURFACE SOILS	
Area (m^2)	Limit (pCi/g)	Area (m^2)	Limit (pCi/g)
1.0	50.0	1.0	150.0
1.5	41.0	1.5	122.0
2.0	35.0	2.0	106.0
2.5	32.0	2.5	95.0
3.0	29.0	3.0	87.0
3.5	27.0	3.5	80.0
4.0	25.0	4.0	75.0
4.5	24.0	4.5	71.0
5.0	22.0	5.0	67.0
5.5	21.0	5.5	64.0
6.0	20.0	6.0	61.0
6.5	20.0	6.5	59.0
7.0	19.0	7.0	57.0
7.5	18.0	7.5	55.0
8.0	18.0	8.0	53.0
8.5	17.0	8.5	51.0
9.0	17.0	9.0	50.0
9.5	16.0	9.5	49.0
10.0	16.0	10.0	47.0
11.0	15.0	11.0	45.0
12.0	14.0	12.0	43.0
13.0	14.0	13.0	42.0
14.0	13.0	14.0	40.0
15.0	13.0	15.0	39.0
16.0	13.0	16.0	38.0
17.0	12.0	17.0	36.0
18.0	12.0	18.0	35.0
19.0	11.0	19.0	34.0
20.0	11.0	20.0	34.0
21.0	11.0	21.0	33.0
22.0	11.0	22.0	32.0
23.0	10.0	23.0	31.0
24.0	10.0	24.0	31.0
25.0	10.0	25.0	30.0

Appendix 6. Verification Survey Notes

VERIFICATION SURVEY NOTES

LOCATION NUMBER GJ00199-CS SHEET 1 OF 3

ADDRESS 2701 Hwy 50
GT Co

	SITE VISIT 1	SITE VISIT 2	SITE VISIT 3
RAC VERIFICATION PERSONNEL:	Kevin Mitchell	K. Mitchell	Dave Mill/s
IVC PERSONNEL:	RLS/DAL	RLS/DAL	RLS/DAL
STATE PERSONNEL:	Donna Foster	Chuck Thornburg	Donna Foster
OTHERS:			

ARE POST EXCAVATION RDG'S REQUIRED? YES ✓ NO ___ WHY? ___

SURVEY NOTES: (Record Site Visit #, Date and Initial after each entry)

1st Partial, 4-9-90, RLS. No interior only for 1st partial. The Excavation is identified as IVA and had a gamma exposure rate range of 7K - 14K. 15-27uR/h w/ an Ave of 17uR/h. The excavation consisted of Foundation, floor and concrete slab.

The Foundation (as marked on map) that remains on the East side of excavation is elevated to 14K. This will remain. Pressure of this Vertical foundation does not exceed 20uR/h above background Bkg = 14uR/h. Deltas 1,2,4,5,6. were also taken.

The excavation will continue (as shown on map) to the west which shows contamination of 20K - 37uR/h.

The High gamma rate range is due to elevated Vertical wall and contamination that temporarily remains.

2nd Partial Interior: No problems mentioned on map?

3rd Partial Exterior V3 See Field map. Area was along Sewer Line. No problems RLS - 5-1-90

Appendix 7. Tracking Sheet (MVP and MRAP Properties)

SITE NUMBER: PROPERTY CLASS:

SITE ADDRESS: OWNER INFO:

TYPE VERIFICATION (A, B or C):

SITE SURVEY INFORMATION

SITE VISIT	SURVEY DATE	TECH. INITIALS	SITE VISIT	SURVEY DATE	TECH. INITIALS
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____

RADON INFORMATION

IN DATE	INITIALS	OUT DATE	INITIALS
_____	_____	_____	_____

REPORT INFORMATION

ISC REPT REVIEW: _____
REA REVIEW: _____

COMPLETION REPORT
REVIEW 1: _____
REVIEW 2: _____

VERIFICATION REPORT (TYPE B & C)
DRAFT: _____
REVIEW 1: _____
REVIEW 2: _____

TYPING
DRAFT: _____
FINAL: _____

FINAL REVIEW _____

COVER LETTER: _____

DATABASE VERIFIED: _____

DOE CERTIFICATION: _____

COMMENTS: _____

UCN17299 (11/90)

Appendix 8. Type II Tracking Sheet (UMTRA Properties)

SITE NUMBER:
PARCEL NO:

SITE ADDRESS:

PROPERTY CLASS:

OWNER INFO:

DATE ASSIGNED TO ORNL: / / VERIFICATION TYPE II

SITE SURVEY INFORMATION

SITE VISIT	SURVEY DATE	TECH. INITIALS	DATABASE INPUT	SITE VISIT	SURVEY DATE	TECH. INITIA

GJRAP? YES_____ NO_____

RADON INFORMATION

MONITOR TYPE	TIME NUMBER WLM OR RPISU	IN DATE	INITIALS	OUT DATE	INITIAL

REPORT INFORMATION

SPLITS ORDERED: _____
RADON REPORT ORDERED: _____
REA/ISC REPT REVIEW: _____

COMPLETION REPORT
REVIEW 1: _____
REVIEW 2: _____

VERIFICATION REPORT
DRAFT: _____
REVIEW 1: _____
REVIEW 2: _____

TYPING
DRAFT: _____
SECOND: _____
FINAL: _____

FINAL REVIEW _____

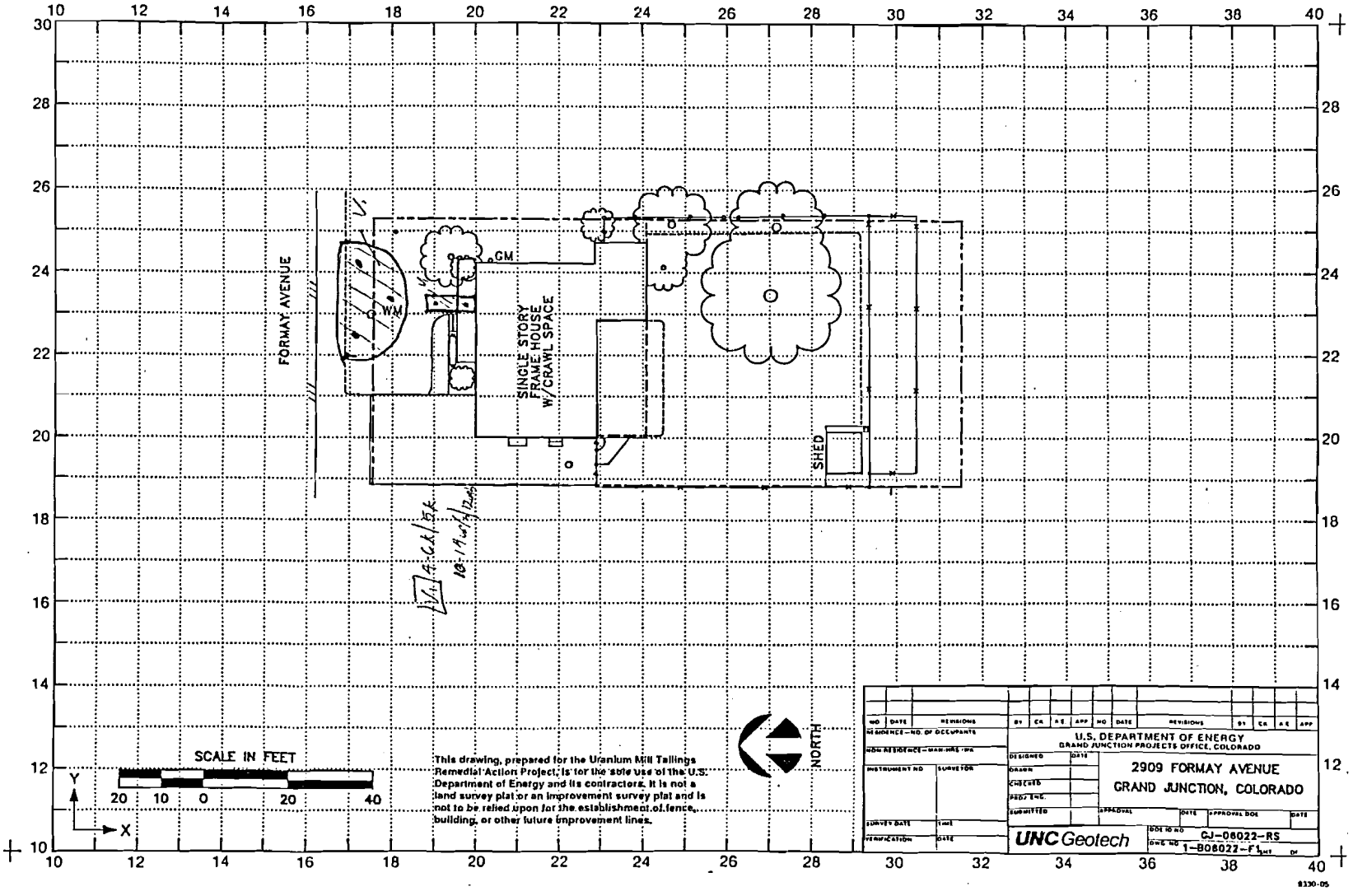
DATABASE VERIFIED: _____

DOE CERTIFICATION: _____

COMMENTS: _____

UCN 17220 (9/90)

Exhibit 1. Gridded Field Map



TYPE B (TYPE II) VICINITY PROPERTY POST-SURVEY VERIFICATION ACTIVITIES

1.0 PURPOSE

The purpose of this procedure is to describe the activities following final Type B (also known as Type II) verification surveys that include radon measurement observation and report completion and review.

2.0 APPLICABILITY

This procedure applies to the verification of remedial action of vicinity properties in support of the Uranium Mill Tailings Remedial Action (UMTRA) and Monticello Vicinity Property (MVP) projects and peripheral properties remediated under the Monticello Remedial Action Project (MRAP). The procedure applies to those properties selected for verification while remedial action was in progress.

3.0 OTHER DOCUMENTS

3.1 REFERENCES

3.1.1 Procedure TE-034, Chain of Sample Custody
3.1.2 Procedure TE-035, Soil Sample Preparation for Radionuclide Analysis
3.1.3 Procedure TE-036, Analysis of Radionuclides in Soils
3.1.4 Procedure TE-030, Inclusion Survey Report Completion
3.1.5 Procedure SU-062, Graphics for Verification of Vicinity Properties

3.2 APPENDICES

3.2.1 Appendix 1: Alpha Track Detector Placement and Retrieval Form
3.2.2 Appendix 2: Chain of Sample Custody/Soil Sample Analysis Form
3.2.3 Appendix 3: IVC Gamma Analysis Worksheet
3.2.4 Appendix 4: Soil Analysis Worksheet
3.2.5 Appendix 5: Radon Calculations Worksheet

APPROVALS		
Author		Date
Supervisor		Date
Group Leader	Nyles K. Halford	Date 8/6/93
Section Head	Craig Little	Date 8/6/93

3.2.6 Appendix 6: Vicinity Property Independent Verification Completion Report Review
3.2.7 Appendix 7: Vicinity Property Certification Summary and Decision Form
3.2.8 Appendix 8: Report Skeleton, UMTRA Vicinity Properties
3.2.9 Appendix 9: Letter of Recommendation, UMTRA Vicinity Properties

4.0 EQUIPMENT AND MATERIALS

4.1 EQUIPMENT

4.1.1 Project logbook
4.1.2 RAC property folio
4.1.3 IVC property folder

4.2 MATERIALS

4.2.1 Alpha Track Detector Placement and Retrieval form
4.2.2 Chain of Sample Custody/Soil Sample Analysis Form
4.2.3 Vicinity Property Independent Verification Soil Data Sheet
4.2.4 Vicinity Property Independent Verification Completion Report Review
4.2.5 Vicinity Property Certification Summary and Decision form (UMTRA properties)
4.2.6 Report skeleton
4.2.7 Letter of recommendation

5.0 RESPONSIBILITY

5.1 The project manager is responsible for overseeing the activities of the team leaders and team members, overseeing tracking of property folders throughout the report writing and review process, and conducting final review of reports.

5.2 The team leader is responsible for ordering soil samples and requesting any other pertinent information from the remedial action contractor (RAC) (e.g., copies of original radon measurement results). The team leader may track property folders throughout the verification process and conduct the final review in lieu of the project manager.

5.3 Team members are responsible for writing and reviewing reports.

5.4 The clerical staff is responsible for typing draft and corrected report documents and transmitting completed documents to the Department of Energy (DOE).

5.5 The office assistant is responsible for entering report information into the project data base and transmitting the property folder to the Document Control department.

6.0 DEFINITIONS

6.1 **Peripheral property**: a property, either publicly or privately owned, adjacent to the Monticello mill site; remediation is funded through MRAP

6.2 **Split samples**: a portion of another agency's sample

6.3 **Vicinity property**: a public or private property in the vicinity of a mill site covered under the UMTRA Project or MVP project

7.0 PROCEDURE

7.1 RADON MONITORING

7.1.1 Upon completion of the final verification survey, determine whether the property needs radon daughter concentration (RDC) measurement. All properties with habitable structures, including mobile homes, need RDC monitoring.

a. If there are no habitable structures on the property, continue to 7.2.

7.1.2 If the property requires RDC measurement, notify the RAC RDC department of the need for ORNL personnel to observe RDC monitor placement and retrieval.

7.1.3 File the property folder in the project files.

7.1.4 The RAC will notify the team member on call of pending placement of RDC measuring devices. Observe the placement of the RDC monitoring devices and complete the Alpha Track Detector Placement and Retrieval form (Appendix 1).

7.1.5 Note the date of placement and the technician's initials in the project logbook and on the tracking sheet located in the property folder.

7.1.6 Transfer the file to the project manager or team leader to order split samples.

7.1.7 The RAC will notify the team member on call of pending retrieval of RDC measuring devices. Obtain the property folder from the project files, observe the retrieval of the RDC monitoring devices, and complete the Alpha Track Detector Placement and Retrieval form (Appendix 1).

7.1.8 Note the date of retrieval and the technician's initials in the project logbook and on the tracking sheet.

7.2 CONFIRMATORY SOIL ANALYSIS

7.2.1 For UMTRA properties, in order to accommodate DOE sample disposal guidelines, no analysis of splits of RAC verificaiton samples are performed beginning June 23, 1992 until the close of the Grand Junction vicinity properties verification activities.

7.2.2 For MVP and MRAP, request at least 10% of the samples presented in the RAC's completion report.

7.2.3 Fill out a Chain of Sample Custody/Soil Sample Analysis Form (Appendix 2) showing the property address, location number, split sample identification number, e.g., X1, X2, etc., and RAC ticket number from the Soil Data Sheet in the property folder.

7.2.4 File a carbon copy of the Chain of Sample Custody Form in the project file.

7.2.5 Give the original form to appropriate RAC personnel.

7.2.6 Note the date of request in the project logbook and on the tracking sheets for each vicinity property for which split samples are requested.

7.2.7 Sign the Chain of Sample Custody form when the samples are picked up.

7.2.8 Deliver the samples to the ETS soils preparation laboratory for analysis, following chain-of-sample-custody procedures as described in Procedure TE-034.

7.2.9 File the original Chain of Sample Custody Form in the soils analysis lab in the appropriate project logbook.

7.2.10 Refer to Procedures TE-035 and TE-036 for sample preparation and analysis procedure details.

7.2.11 File the analysis results in the property folder.

7.3 File the property folder in the project file until the completion report is received from the RAC.

7.4 Upon receipt of the completion report, enter the date received in the project logbook and on the file tracking sheet.

7.4.1 Place the completion report in the property folder.

7.5 If RDC measurement results are not in the RAC folio, enter them in the property folder.

7.5.1 The file of radon report data may provide radon measurement results for some properties and is filed chronologically by retrieval date. Check the file for the specific detector results for the vicinity property.

7.5.2 If the file does not contain radon data for the specific vicinity property, send a letter to the RAC requesting copies of the original radon report.

7.5.3 Upon receipt of the radon report, place a copy in the appropriate property folder and a copy in the radon data file.

7.6 REPORT WRITING

7.6.1 After soils analysis results, radon data, and the completion report are entered into the file, the project manager assigns the folder to a team member for completion report review and report writing.

7.6.2 Obtain the property folio from the RAC.

7.6.3 Explanations of the following calculations are found in Procedure TE-030, Inclusion Survey Report Completion.

a. Convert kcpm to μR/h.

b. Complete gamma analysis calculations using the IVC Gamma Analysis Worksheet (Appendix 3) for anomalous areas.

c. Complete radium-in-soil calculations using the Soil Analysis Worksheet (Appendix 4) for biased samples.

d. Calculate RDC using the original radon report data and the Radon Calculations Worksheet (Appendix 5).

7.6.4 Review the completion report using the Vicinity Property Independent Verification Completion Report Review sheets (Appendix 6). Sign and date the last page.

a. The Completion Report Review sheets vary slighty for the MVP Project and MRAP to incorporate compliance with the Hot Spot Guidelines.

7.6.5 For UMTRA properties, complete the following forms and letter:

a. Vicinity Property Certification Summary and Decision form (Appendix 7),

b. Report skeleton, UMTRA properties (Appendix 8), and

c. Letter of recommendation to the DOE project manager (Appendix 9).

7.6.6 For MVP and MRAP properties, complete the following forms and letter, which vary slightly from the UMTRA documentation because of differing project requirements:

a. Type B Verification report skeleton, and

b. Letter of recommendation to the DOE project manager.

7.6.7 If a Grand Junction UMTRA property has been previously remediated under the Grand Junction Remedial Action Program (GJRAP), delete all references to indoor measurements and remediation throughout the report skeleton and letter of recommendation.

a. If the RAC uses GJRAP RDC info, it may be repeated in the report and identified as such.

7.6.8 Complete the report skeleton.

a. Write the site location number in the upper right-hand corner of each page of the report.

b. Complete the cover page using information from the RAC property folio.

c. Enter in the introduction the location number and the type of conversion used.

d. Complete the significance of findings, noting discrepancies between the RAC's and ORNL's data, and whether the RAC's documentation is adequate. Carefully document any discrepancies causing the report to be recommended for any action other than certification.

e. Circle the appropriate recommendation and recommendation basis.

f. Complete Table 1, Location Information from the property portfolio. Describe all structures on the site. Call the assessor's office for current owner and property information.

g. Enter the applicable radiological information from the appropriate source.

7.6.9 Complete the recommendation letter.

a. Delete references to indoor radon daughter concentration and indoor gamma exposure rate if there are no habitable structures on the property.

b. Circle the appropriate recommendation basis.

c. Complete the property information at the bottom of the letter.

7.6.10 Complete the Vicinity Property Certification Summary and Decision form (UMTRA properties only) in permanent black ink as neatly as possible. If an error is made, the form must be redone (do not use correction fluid or cross out).

7.6.11 Complete the final site location map according to Procedure SU-062, Graphics for Verification of Vicinity Properties.

7.6.12 Initial and date the tracking sheet.

7.6.13 Submit the above documents, along with the property folder and RAC folio, to the clerical staff for typing.

7.7 REPORT REVIEW

7.7.1 After all report documents are typed, the project manager or designee assigns the folder and RAC folio to another team member for a second review of the RAC completion report and first review of the draft documents.

7.7.2 Review the completion report using the Completion Report Review sheets. Sign and date the last page.

7.7.3 Review the IVC report documents for the following:

a. Site location number on all pages;

b. Site address on all appropriate pages;

c. Report author and date on cover page;

d. Verification survey dates on all appropriate pages;

e. Owner information on all appropriate pages;

f. No spelling or grammatical errors;

g. Two significant digits on all data;

h. Correct conversion formula in the Introduction;

i. Significance of Findings: wording is correct and complete. Assumptions, inferences, recommendations, and interpretations are consistent;

j. Consistent recommendation;

k. Consistent indoor and outdoor gamma exposure rates and areas throughout the report;

l. Consistent extended measurements and corresponding regions throughout the report;

m. Correct figure captions and number of figures;

n. Correct greater than (>) and less than (<) signs;

o. Site location map(s): soil sample numbers and locations, gamma exposure rates, and any other pertinent information are accurate and in agreement with the report and field maps; and

p. Consistent recommendations on the verification report, recommendation letter, and summary sheets.

7.7.4 Sign and date the tracking sheet.

7.7.5 Submit the report documents with corrections along with the folder and RAC's folio to the clerical staff for corrections.

7.8 The project manager or team leader reviews the report documents after all are corrected.

7.8.1 If corrections are necessary, return the report to typing.

7.8.2 If the documents are acceptable, send the cover letter and the recommendation to the ETS Section Head or his designee for signing.

7.9 Return the RAC's folio to the RAC records management department.

7.10 Submit the property folder to the clerical staff for transmittal to the DOE.

7.10.1 Create a new folder for transmittal. Copy the following documents for the IVC vicinity property folder and transmit the originals to the appropriate DOE office(s):

a. Letter of recommendation
b. Vicinity Property Certification Summary and Decision form (UMTRA properties only)
c. Report skeleton,
d. RAC Vicinity Property Certification Summary and Recommendation,
e. RAC completion report
f. RAC Summary of Remedial Action.

7.11 Submit the vicinity property folder to the public relations staff for data base entry.

7.11.1 Input all relevant report information into the project data base.

7.12 Submit the vicinity property folder to the ETS Document Control department for archival.

Appendix 1. Alpha Track Detector Placement and Retrieval form

Alpha Track Detector Placement and Retrieval

Sheet 1 of 2

Location # GJO 1268
Address 1051 Reed Ave Apt #2
RJ.

Choose one: _____ Inclusion Survey _____ Verification Survey

Detector ID # 3315604 3315634 3315845

Type of detector: Tech/Ops Landauer Radtrak™ Alpha-Track (Radon Gas) Monitors

PLACEMENT

Start date 8/8/91 Projected retrieval date 10/31/91 – 12/26/91
ORNL technician GA Perry RAC technician C Decrow
Building House Basement Room _____
Exact location in room NE living room on dresser
Region _____, Gamma range _____ μR/h, average _____ μR/h, area _____ m^2

	YES	NO
1. Placement Location		
a. Habitable room on the lowest level?	✓	
b. Indoor area of removal (verification only)?		✓ n/a
c. Room with the highest gamma exposure rate?	✓	
d. Room with the least ventilation?	✓	
2. Placement Requirements		
a. Sealed bags intact before opening?	✓	
b. Number on bag same as number on detector?	✓	
c. Is the detector filter undamaged?	✓	
d. Detector placed away from direct sunlight, heat sources, doors, windows, or vents?	✓	
e. Placed at least 18 inches off the floor?	✓	
f. Out of reach of children?	✓	
g. Not in humid room (laundry or bathroom)?	✓	
3. Noted location on map?	✓	
4. Consent current for 1 year (inclusion survey only)?		✓
5. Meets all requirements listed above? If "no", explain below.	✓	

RETRIEVAL

End date _____
ORNL technician _____
RAC technician _____

1. Are the filters undamaged?		
2. Have the detectors been moved?		
3. Was the detector properly sealed after retrieval?		
4. Meets all requirements listed above? If "no", explain below.		

COMMENTS

12/19/91 Replaced cups #3471152, #3463010, #3471214
SAP – ORNL
Sorted – Joe Mayers Placed in NE living area on nail
on NE wall. Projected out 6/17/92 to 8/12/92

Appendix 2. Chain of Sample Custody/ Soil Sample Analysis Form

ornl OAK RIDGE NATIONAL LABORATORY
Grand Junction Office

Mailing Address
P.O. Box 2567
Grand Junction, CO 81502

Street Address
2597 B¾ Road
Grand Junction, CO 81503

Phone (303) 242-8621

Chain of Sample Custody/ Soil Sample Analysis Form

Page _____ of _____

Date _____

TEAM LEADER _____

TEAM MEMBERS _____

1. Project No. **6R0004-180** 2. Project Name **Monticello Vicinity Properties ISC & IVC**

LOCATION ADDRESS	SAMPLE ID. NUMBER	PAN NO.	DATE TAKEN/ RECEIVED	DATE BOTTLED	DATE ANALYZED	DISK NO.	SAMPLE WT. (g)	226–Ra (pC1/g)	BBL NO.	COMMENT/ LAB ID

Relinquished By	Date	Dept.	Received By	Date	Dept.

Distribution: Original accompanies samples, copies to relinquishers

UCN 17345A (1/91)

Appendix 3. IVC Gamma Analysis Worksheet

6/88

IVC GAMMA ANALYSIS WORKSHEET

LOCATION # _____

REG.	RANGE μR/h	FIELD AVG. μR/h	GAMMA SHIELD CPMx2	GAMMA SHIELD μR/h	SLAB THICK (cm)	REP. AREA (m²)	BKG. AVG. μR/h	FORMULA	NET AVG. μR/h	NET CRITERIA μR/h	30% of BKG AVG.	exceeds inclusion criteria yes	exceeds inclusion criteria no	< 30% BKG. AVG. yes	< 30% BKG. AVG. no	RMKS.
INDOOR																

Appendix 4. Soil Analysis Worksheet

5/88

IVC SOIL ANALYSIS WORKSHEET

LOCATION # _____

SAMPLE NBR(S)	REGION SMPLD	(LAB) RA-226 CONC. pCi/g		(BKG) RA-226 CONC. pCi/g	REP. AREA SQUARE METERS	SOIL SAMPLE THICKNESS IN (m)	FORMULA	ORNL NET RA-226 CONC. pCi/g	SPLIT NET RA-226 CONC. pCi/g	NET CRITERIA pCi/g	RMKS.
		ORNL	RAC SPLIT								

UCN17170(8/90)

Appendix 5. Radon Calculations Worksheet

LOCATION NUMBER GJ00199

RADON CALCULATIONS WORKSHEET

DETECTOR NO.	EXPOSURE pCi/l – days	NUMBER DAYS	Rn CONC. EXPOS./DAYS	WL Rn CONC./200	AVERAGE WL
3132493	125.2	102	1.2275	.0061	
3130378	78.8	102	.7725	.0039	
3130410	142.3	102	1.3951	.0070	
				.0170 ÷ 3 =	.0057

UCN17172(8/90)

Appendix 6. Vicinity Property Independent Verification Completion Report Review

VICINITY PROPERTY INDEPENDENT VERIFICATION
COMPLETION REPORT REVIEW

LOCATION NO._____ REVIEWER_____
PROPERTY ADDRESS_____ DATE_____
_____

COMPLETION REPORT REQUIREMENT	COMPLIANCE YES	NO	N/A	COMMENTS (Pg. in Completion Report) (Attach added pgs, if needed)
I. COMPLETION REPORT GENERAL STRUCTURE & SUMMARY (Section I)				
1) Project manager signature?				
2) Is vicinity property location number present and correct on all pages and figures?				
except table of contents)				
3) Is the report documentation concise (e.g., no extraneous pages, figures, or tables)?				
4) Summary section reasonable and correct? (Section I)				
5) Do addresses, parcel #'s, dates, and statistics agree throughout the report?				
6) Is the owner's name correct?				
II. OPERATIONS SUMMARY (Section 2.0)				
1) Sec. 2.1, Abstract of Remedial Action Plan				
a) Reasonable and correct				
b) Description of where remedial action took place, backfill material, and restoration?				
2) Sec 2.2, Previously Unidentified Contamination				
Description and explanation?				

Appendix 6. (continued)

VICINITY PROPERTY INDEPENDENT VERIFICATION
COMPLETION REPORT REVIEW

LOCATION NO._____DATE_____REVIEWER_____

COMPLETION REPORT REQUIREMENT	COMPLIANCE YES	NO	N/A	COMMENTS (Pg. in Completion Report) (Attach added pgs, if needed)
3) Sec 2.3, Unanticipated Items				
Description and explanation?				
4) Sec 2.4, Application of Supplemental Standards (if applicable)				
a) Description of areas where supplemental standards were applied?				
b) Volume of remaining material stated?				
c) Location of remaining material stated?				
d) Radiological activity of remaining material stated?				
e) If numerical standards were not met, is this due to presence of natural radioactivity? (Sec 2.4)				
f) If all residual radioactivity at the property was not cleaned up, were supplemental standards (40 CFR 192 Subpart C) applied? (Sec. 2.4)				
g) Did appropriate state and federal agencies concur in this application of supplemental standards?				

Appendix 6. (continued)

VICINITY PROPERTY INDEPENDENT VERIFICATION
COMPLETION REPORT REVIEW

LOCATION NO._____DATE_____REVIEWER_____

COMPLETION REPORT REQUIREMENT	COMPLIANCE YES	COMPLIANCE NO	COMPLIANCE N/A	COMMENTS (Pg. in Completion Report) (Attach added pgs, if needed)
III. VERIFICATION SUMMARY (Sec 3.0)				
1) Sec 3.1.2 and Figure 2.1, Soil Excavation				
a) Was an outdoor gamma survey conducted in excavated areas? (Sec. 3.1.2, Fig. 2.1)				
b) Were soil samples or composites collected from contaminated regions after excavation? (Sec. 3.1.2, Fig. 2.1)				
2) Sec 3.1.2,Post-Excavation Survey				
a) Is contamination to remain on the property adequately described?				
b) Post-excavation exposure rate range?				
c) Exterior post-excavation soil sample results correct?				
d) Interior contamination to remain adequately described?				
e) Interior post-excavation exposure rate range?				
3) Sec. 3.1.3, Post-Remedial Action RDC measurements				
If RDC measurements were performed before remedial action and results were above standards, were they repeated after remedial action was completed? (Sec. 3.1.1 & Sec. 3.1.3)				

Appendix 6. (continued)

VICINITY PROPERTY INDEPENDENT VERIFICATION
COMPLETION REPORT REVIEW

LOCATION NO._____DATE_____REVIEWER_____

COMPLETION REPORT REQUIREMENT	COMPLIANCE			COMMENTS (Pg. in Completion Report) (Attach added pgs, if needed)
	YES	NO	N/A	
4) Sec. 3.2, Recommendation for Certification				
Present and accurate?				
5) Certification Data Summary Table:				
a) Are survey results below the associated standards for:				
Interior gamma?				
RDCs?				
Exterior surface soils?				
Exterior subsurface soils?				
IV. 4.0 APPENDIX				
Table 3.1, Post-Excavation Sample Measurement Results:				
1) Area identifier and exposure ranges match with Figure 2.1?				
2) Sample results quoted?				
Table 3.2, Post-Remedial Action RDC measurement results?				
1) Are working level measurements correct (if original data sheets are available)?				
2) Instrument type(s) listed?				
3) Start and end dates and times correct?				
4) Do total hours agree with start/end times (RPISU or WLMI)				

Appendix 6. (continued)

VICINITY PROPERTY INDEPENDENT VERIFICATION
COMPLETION REPORT REVIEW

LOCATION NO._____DATE_____REVIEWER_____

COMPLETION REPORT REQUIREMENT	COMPLIANCE YES	NO	N/A	COMMENTS (Pg. in Completion Report) (Attach added pgs, if needed)
5) Are measurement locations stated?				
V. FIG. 2.1, (MAP) (RADIOLOGICAL-AS-BUILT)				
Does Figure 2.1 clearly show:				
1) Post-remedial action exposure rate ranges?				
2) Soil sample or composite sample locations and numbers?				
3) Areas of contamination removal clearly shown?				
4) Remaining contamination?				
5) Is legend clear and legible?				
6) Structure outlines?				
7) RDC sampler locations?				
VI. GENERAL INDOOR RADIOLOGICAL				
If interior excavation was performed, does Figure 2.1 or additional figure(s) show:				
1) Post-remedial action exposure rate ranges?				
2) Soil sample or composite sample locations and numbers?				
3) Basement and second story information (if applicable)?				
4) Remaining contamination?				

Appendix 6. (continued)

VICINITY PROPERTY INDEPENDENT VERIFICATION
COMPLETION REPORT REVIEW

LOCATION NO._____DATE_____REVIEWER_____

COMPLETION REPORT REQUIREMENT	COMPLIANCE YES	NO	N/A	COMMENTS (Pg. in Completion Report) (Attach added pgs, if needed)
5) Were assessment measurements taken in the lowest habitable level of every habitable building? (Sec. 3.1.2)				
6) After remedial action, was the average value for each room or 9.3 m^2 area less than 20 $\mu R/hr$ above background? (Sec. 3.1.2)				
7) If any measurment exceeded 20 $\mu R/hr$ above background, was it investigated to ensure no tailings involvement? (Sec. 3.1.2)				
VII. CERTIFICATION				
Is this property recommended for certification as meeting the EPA standards for residual radioactive material?				
_____ Signature of Reviewer & Date				
_____ Second Reviewer Signature & Date				

Appendix 7. Vicinity Property Certification Summary and Decision form

Location Number GJ88888

Vicinity Property Certification Summary and Decision

1.0 SUMMARY EVALUATION

The data presented in the property portfolio indicate:

	IVC ORNL			U.S. Depart. of Energy (DOE)		
	Yes	No	N/A	Yes	No	N/A
1. The ^{226}Ra concentration in the top 15 cm of soil averages <5 pCi/g above background over 100 m^2.	[X]	[]	[]	[]	[]	[]
2. The ^{226}Ra concentration in any 15 cm layer of soil below the top 15 cm surface layer averages <15 pCi/g above background over 100 m^2.	[X]	[]	[]	[]	[]	[]
3. The indoor gamma readings are <20 μR/h above background in every habitable room	[X]	[]	[]	[]	[]	[]
4. The radon daughter concentration in any habitable room is <0.02 working levels, or at most 0.03 WLs.	[X]	[]	[]	[]	[]	[]
5. Supplemental standards were applied in accordance with EPA standards 192.21.*	[]	[]	[X]	[]	[]	[]

COMMENTS: _____

* See Section 3.0 for NRC concurrence date.

Appendix 7. (continued)

Location Number G388888

2.0 ORNL's RECOMMENDATION

Based on ORNL's evaluation of the [] completion report [] completion report and field survey data, I recommend this property for:

[] Certification

[X] Certification pending resolution of the deficiencies described below

[] Additional measurements and/or additional information in the completion report below

[] Additional remedial action

C. A. Little, Ph.D.
Independent Verificaiton Contractor

Date

2.1 ORNL's EVALUATION

See ORNL/IVC "Report of Verification Survey"

Appendix 7. (continued)

Location Number GJ88888

3.0 DOE/UMTRA EVALUATION

DOE Decision: [] Certify

[] Requires additional measurements prior to certification

[] Requires additional remedial action

Comments: _____

_____

_____

_____

_____

_____

_____ _____

U.S. Department of Energy Date

Certification Official

Certification concurred on by NRC on _____

(date)

Appendix 8. Report Skeleton, UMTRA Vicinity Properties

Location Number: _____

HEALTH AND SAFETY RESEARCH DIVISION

REPORT OF VERIFICATION SURVEY AT LOCATION _____
_____
_____

Investigation Team

C.A. Little - PAG Program Manager
D.K. Halford - Radiologic Projects Manager
J.A. Rice - PAG/UMTRA Verification Project Coordinator

_____(author)

_____DATE

WORK PERFORMED AS PART OF THE
RADIOLOGICAL SURVEY ACTIVITIES PROGRAM

Prepared by the
OAK RIDGE NATIONAL LABORATORY
Grand Junction Office
Grand Junction, Colorado 81502
operated by
MARTIN MARIETTA ENERGY SYSTEMS, INC.
for the
U.S. DEPARTMENT OF ENERGY

Appendix 8. (continued)

Location Number:

INTRODUCTION

Property location _____ was selected for verification by Oak Ridge National Laboratory, the Independent Verification Contractor (IVC). A review of the initial radiologic and engineering assessment was performed, and surveys were conducted at the time of the remedial action. The Completion Report was reviewed upon receipt. The review and survey were conducted using methods as defined in the Vicinity Properties Management and Implementation Manual, UMTRA-DOE/AL-050601 (March 1988) and the applicable portions of the PAG Procedures Manual (February 1992). General location information is provided in Table 1, a comparison of pre-remedial and post-remedial gamma screening results is provided in Table 2, Table 3 provides a soil sample summary, Table 4 is a RDC data summary, and Table 5 is a net estimated area-weighted average data summary. Supporting graphics are provided in Figure 1 (a and b). All measurements are gross readings; background has not been subtracted.

(Insert for Direct Conversion)
The conversion formula used is $y = x/CF$, where 'y' equals the exposure rate in μR/h, 'x' equals the scintillometer measurements in kcpm, and 'CF' equals the conversions factor determined in the field through a direct correlation between PIC and scintillometer measurements in kcpm/μR/h. For this property, CF equals x.xx for uncontaminated regions, x.xx for contaminated regions, and x.xx for indoor/other regions.

(or Insert for Conversion Equation):
The conversion formula used is $y = mx + b$, where 'y' equals the exposure rate in μR/h, 'x' equals scintillometer measurement in kcpm, and 'm' and 'b' are predetermined constants. On this property, 'm' equals 1.69 and 'b' equals 3.45.

SIGNIFICANCE OF FINDINGS

A field verification was conducted on the *outdoor and indoor* remediation of location _____ on _____ prior to backfilling the excavation (Figure 1).

The outdoor excavation had a gamma scan exposure rate range of _____μR/h for the designated area(s) identified as _____ (Figure 1). The Remedial Action Contractor (RAC) and the IVC gamma exposure rates are shown in Table 2. Composite sample(s) _____ were collected to document radium-in-soil concentrations over the approximate 100 m^2 excavation(s). The IVC, RAC, and split (X) composite sample analysis results are below EPA standards and are recorded in Table 3.

Appendix 8. (continued)

_____

_____

_____

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_____

_____

_____

_____

Interior excavation(s), designated _____ had a gamma exposure rate range(s) of _____μR/h, respectively (Figure 1). RAC and IVC gamma exposure rates are shown in Table 2.

Terradex Radtrak[R] detectors were placed _____ _____ to monitor for radon (Figure 1). Analysis *verified/did not verify* that the annual average radon daughter concentration is less than the EPA standard of 0.02 WL (see Table 4). An ORNL IVC representative *was/was not* present at the placement *and/or* retrieval of the detectors.

The data presented in the RAC's property completion report was reviewed and *found/not found* to comply with EPA standards. (If not, explain)_____

_____

_____

_____

Based on these findings, it is recommended that location _____ be <u>certified</u> by the DOE.

Based on these findings, it is recommended that location _____ be <u>certified pending</u> resolution of the deficiencies described above.

Based on these findings, it is recommended that location _____ have <u>additional measurements taken and/or additional information</u> supplied in the Completion Report as described above.

Based on these findings, it is recommended that location _____ undergo <u>additional remedial action</u>.

Appendix 8. (continued)

Location Number: _____

RECOMMENDATION

RECOMMENDED FOR:	Certification
RECOMMENDED FOR:	Certification pending resolution of the deficiencies described in the report
RECOMMENDED FOR:	Further study requiring additional measurement or information as described in the report
RECOMMENDED FOR:	Further remediation
RECOMMENDATION BASIS:	Ra-226 is >5 pCi/g above background in surface 15 cm soil layer averaged over 100 m^2
RECOMMENDATION BASIS:	Ra-226 is <5 pCi/g above background in surface 15 cm soil layer averaged over 100 m^2
RECOMMENDATION BASIS:	Ra-226 is >15 pCi/g above background in subsurface 15 cm soil layer averaged over 100 m^2
RECOMMENDATION BASIS:	Ra-226 is <15 pCi/g above background in subsurface 15 cm soil layer averaged over 100 m^2
RECOMMENDATION BASIS:	Indoor gamma is >20 μR/h above background averaged in any room
RECOMMENDATION BASIS:	Indoor gamma is <1 standard deviation or 20% above background in all rooms
RECOMMENDATION BASIS:	Annual average radon daughter concentration is >0.02 WL
RECOMMENDATION BASIS:	Annual average radon daughter concentration is <0.02 WL

Appendix 8. (continued)

Location Number: _____

Table 1. Location Information

Property Information

LOCATION: _____

_____

PROPERTY CLASSIFICATION _____

STRUCTURES ON PROPERTY _____

_____

_____

OWNER INFORMATION

OWNER: _____

ADDRESS: _____

_____

TELEPHONE: _____(H)

_____(B)

Appendix 8. (continued)

Location Number: _____

Table 2. Comparison of Pre- and Post-remedial Action Gamma Screening Results

Outdoor Data

Excavation Identifier IVC/RAC	Gamma Exposure Rate Range In Excavation(s), μR/hr.		
	RAC (Pre-remedial)	RAC (Post-remedial)	IVC (ORNL) (Post-remedial)

Indoor Data

Excavation Identifier IVC/RAC	Gamma Exposure Rate Range In Excavation(s), μR/hr.		
	RAC (Pre-remedial)	RAC (Post-remedial)	IVC (ORNL) (Post-remedial)

Appendix 8. (continued)

Location Number: _____

Table 3. Composite Soil Samples
Comparative Results

Outdoor Data

Excaction Identifier IVC/RAC	Composite Sample Number IVC	RAC Ticket Number	Sample Depth, cm	IVC 226-Ra Conc., pCi/g	RAC 226-Ra Conc., (pCi/g)	IVC Split Sample Number	Split Sample Conc., pCi/g

* composite sample not taken by ORNL IVC.
X split of the sample taken by the RAC verification group and analyzed by ORNL.
V sample aliquots removed by ORNL IVC in the proximity of the RAC sample.
B bias sample collected by ORNL IVC.

Appendix 8. (continued)

Location Number: _____

Table 4. Radon Daughter Concentration (RDC) Summary

The RAC personnel are required to place a Radon or Radon progeny measuring device in all habitable structures on the remediated property. This table is a restatement of the RAC's data.

Bldg. ID	Room ID	Date	RDC (WL)*	Average of RDC (WL)**

* Formula used:

$$WL = \frac{(1WL)\ (Rn)\ (50\%)}{100\ (100\%)}$$

where

- WL - working level
- 50% - 50% equilibrium is assumed per the VPMIM
- Rn - average daily ^{222}Rn concentration in pCi/L as reported by vendor (Terradex Radtrak® detector)
- 100 - concentration of ^{222}Rn in pCi/L at 100% equilibrium for 1 WL

** Reported in two significant digits.

Appendix 8. (continued)

Location Number: _____

Table 5. Net Estimated Area Weighted Average Calculation

Outdoor Extended Data

Soil Sample Summary

Soil Sample Number	Region Sampled	Sample Depth (cm)	^{226}Ra Concentration (pCi/g) (Canalysis)	Representative (biased) Sampling Area m^2	Net Estimated Area-Weighted Average* (pCi/g, C_{AW})

* Formula used

$$C_{AW} = \sum_{i=1}^{n} \frac{C_i A_i D_i}{(100)(0.15)}$$

where

C_{AW} - area-weighted ^{226}Ra concentration, pCi/g
C_i - net ^{226}Ra concentration, pCi/g (gross minus background)
A_i - area of region that sample represent, m^2
D_i - thickness of sample, m
100 - threshold area, m^2
0.15 - threshold thickness, m

Appendix 9. Letter of Recommendation, UMTRA Vicinity Properties

OAK RIDGE NATIONAL LABORATORY

OPERATED BY MARTIN MARIETTA ENERGY SYSTEMS, INC.

GRAND JUNCTION OFFICE
P. O. BOX 2567
GRAND JUNCTION, COLORADO 81502

Mr. Michael K. Tucker, Deputy Manager
U.S. Department of Energy
Grand Junction Area Office
P.O. Box 2567
Grand Junction, Colorado 81502

Dear Mr. Tucker,

Radiation levels at the property identified below do not exceed the U.S. Environmental Protection Agency (EPA) standards as specified in 40 CFR 192.

This evaluation is based on a review of the Remedial Action Contractor's completion report, pre-restoration site visits, and for indoor and outdoor criteria of the U.S. Department of Energy Vicinity Properties Management and Implementation Manual (UMTRA-DOE/AL-050601), Appendix E, and/or other criteria stated below.

Other: _____

_____

This recommendation is based upon the Independent Verification Contractor's assessment of the ^{226}Ra concentration in the soil, indoor radon daughter concentration, and indoor gamma exposure rate at this property.

Therefore, this property is recommended for

(choose one)

certification by the United States Department of Energy.

certification upon resolution of the deficiencies described in the ORNL IVC Certification Summary and Decision.

further study by the Uranium Mill Tailings Remedial Action Project.

further remedial action by the Uranium Mill Tailings Remedial Action Project.

Sincerely,

C.A. Little, Ph.D.
Independent Verification Contractor

Location Number: _____
Location Address: _____
_____

Property Owner: _____
Owner Address: _____

TYPE C (TYPE III) VICINITY PROPERTY VERIFICATION ACTIVITIES

1.0 PURPOSE

The purpose of this procedure is to describe the activities of the Type C (also known as Type III) verification.

2.0 APPLICABILITY

This procedure applies to the verification of remedial action of vicinity properties in support of the Uranium Mill Tailings Remedial Action (UMTRA) Project and, if requested by the Department of Energy (DOE), the Monticello Vicinity Property (MVP) project. This procedure applies to those properties specifically requested by the DOE as Type C verifications after remedial action and restoration are complete or a decision for no remedial action was determined by the remedial action contractor (RAC).

3.0 OTHER DOCUMENTS

3.1 REFERENCES

3.1.1 Procedure TE-020, Inclusion Survey Activities
3.1.2 Procedure TE-055, Opposed Crystal System (OCS) Van Analysis
3.1.3 Procedure TE-036, Analysis of Radionuclides in Soils
3.1.4 Procedure TE-043, Type B (II) Vicinity Property Post-Survey Verification Activities

3.2 APPENDICES

3.2.1 Appendix 1: Type III Verification Tracking Sheet, UMTRA Vicinity Properties
3.2.2 Appendix 2: Vicinity Property Independent Verification Completion Report Review Sheets

APPROVALS	
Author	Date
Supervisor	Date
Group Leader Douglas K. Halford	Date 7/30/93
Section Head Craig Little	Date 7/30/93

3.2.3 Appendix 3: Vicinity Property Certification Summary and Decision Form
3.2.4 Appendix 4: Type III Verification Report Skeleton, UMTRA Properties
3.2.5 Appendix 5: Letter of Recommendation, UMTRA Vicinity Properties

4.0 EQUIPMENT AND MATERIALS

4.1 EQUIPMENT

4.1.1 Project logbook
4.1.2 RAC property folio

4.2 MATERIALS

4.2.1 Vicinity Property Independent Verification Completion Report Review sheets (UMTRA properties)
4.2.2 Vicinity Property Certification Summary and Decision form (UMTRA properties)
4.2.3 Report skeleton
4.2.4 Letter of recommendation
4.2.5 Property map

5.0 RESPONSIBILITY

5.1 The project manager is responsible for overseeing the activities of team leaders and team members, tracking property folders throughout the verification process, and conducting a final review of reports.

5.2 The team leader is responsible for ordering soil samples and requesting any other pertinent information from the RAC (e.g., copies of original radon measurement results) and leading the verification survey. The team leader may track property folders throughout the verification process and conduct the final review in lieu of the project manager.

5.3 Team members are responsible for assisting in the verification survey, analyzing samples using the OCS van, and writing and reviewing reports.

5.4 The office assistant is responsible for creating the tracking sheet and file folder for each Type C verification and maintaining current verification data base information.

5.5 The clerical staff is responsible for typing draft and corrected report documents and transmitting completed documents to the DOE.

6.0 DEFINITIONS

6.1 **Split sample**: a portion of another agency's sample

6.2 **Vicinity property**: a public or private property in the vicinity of a mill site covered under the UMTRA Project or MVP project

7.0 PROCEDURE

7.1 The DOE notifies the project manager of properties to be verified and forwards completion reports for the selected properties.

7.1.1 At this time, the office assistant generates a property file folder and tracking sheet (Appendix 1).

7.2 Collect field measurements, including extended measurements and associated documentation, according to Procedure TE-020, Inclusion Survey Activities. OCS analysis may be used to expedite the soils results but is not required (see Procedure TE-055).

7.3 Complete confirmatory soil analysis of splits of soil samples tabulated in the RAC's completion report for MVP project samples only. Follow the confirmatory soil analysis procedures described in Procedure TE-036, Analysis of Radionuclides in Soils.

7.4 Obtain radon measurement results as described in Procedure TE-043, Type B (Type II) Vicinity Property Post-Survey Verification Activities.

7.5 After soils analysis results and radon data are entered into the file, the project coordinator assigns the folder to a team member for completion report review and report writing.

7.5.1 Obtain the property folio from the RAC.

7.5.2 Review the RAC's completion report using the Vicinity Property Independent Verification Completion Report Review sheets (Appendix 2). Sign and date the last page.

7.5.3 Complete the following forms and letter:

a. Vicinity Property Certification Summary and Decision form (Appendix 3),

b. Type III verification report skeleton, UMTRA properties (Appendix 4), and

c. Letter of recommendation to the DOE project manager, UMTRA properties (Appendix 5).

7.5.4 Initial and date the tracking sheet.

7.5.5 Submit the above documents, along with the vicinity property folder and RAC folio, to the clerical staff for typing.

7.6 Continue the report review process as described in Procedure TE-043, Type B (Type II) Vicinity Property Post-Survey Verification Activities.

7.7 Create a new folder for transmittal.

7.7.1 Transmit the following original documents to the appropriate DOE office:

a. Letter of recommendation,
b. Vicinity Property Certification Summary and Decision form,
c. Verification report,
d. RAC completion report,
e. RAC Vicinity Property Certification Summary and Recommendation,
f. RAC Summary of Remedial Action.

7.8 Submit the vicinity property file to the public relations staff for data base entry.

7.8.1 Enter all relevant report information into the project data base.

7.9 Submit the vicinity property file to the ETS Document Control department for archival.

Appendix 1. Type III Tracking Sheet, UMTRA Vicinity Properties

SITE NUMBER:
PARCEL NO:

SITE ADDRESS:

PROPERTY CLASS:

OWNER INFO:

DATE ASSIGNED TO ORNL: / / VERIFICATION TYPE III

SITE SURVEY INFORMATION

SITE VISIT	SURVEY DATE	TECH. INITIALS	DATABASE INPUT	SITE VISIT	SURVEY DATE	TECH. INITIA

GJRAP? YES_____ NO_____

RADON INFORMATION

MONITOR TYPE	TIME NUMBER WLM OR RPISU	IN DATE	INITIALS	OUT DATE	INITIAL

REPORT INFORMATION

SPLITS ORDERED: _____
RADON REPORT ORDERED: _____

TYPING
DRAFT: _____
SECOND: _____
FINAL: _____

VERIFICATION REPORT

DRAFT: _____
REVIEW 1: _____
REVIEW 2: _____

FINAL REVIEW _____

DATABASE VERIFIED: _____

DOE CERTIFICATION: _____

COMMENTS: _____

UCN 17221 (9/90)

Appendix 2. Vicinity Property Independent Verification Completion Report Review

VICINITY PROPERTY INDEPENDENT VERIFICATION
COMPLETION REPORT REVIEW

LOCATION NO._____ REVIEWER_____
PROPERTY ADDRESS_____ DATE_____
_____

COMPLETION REPORT REQUIREMENT	COMPLIANCE YES	NO	N/A	COMMENTS (Pg. in Completion Report) (Attach added pgs, if needed)
I. COMPLETION REPORT GENERAL STRUCTURE & SUMMARY (Section I)				
1) Project manager signature?				
2) Is vicinity property location number present and correct on all pages and figures?				
except table of contents)				
3) Is the report documentation concise (e.g., no extraneous pages, figures, or tables)?				
4) Summary section reasonable and correct? (Section I)				
5) Do addresses, parcel #'s, dates, and statistics agree throughout the report?				
6) Is the owner's name correct?				
II. OPERATIONS SUMMARY (Section 2.0)				
1) Sec. 2.1, Abstract of Remedial Action Plan				
a) Reasonable and correct				
b) Description of where remedial action took place, backfill material, and restoration?				
2) Sec 2.2, Previously Unidentified Contamination				
Description and explanation?				

Appendix 2. (continued)

VICINITY PROPERTY INDEPENDENT VERIFICATION
COMPLETION REPORT REVIEW

LOCATION NO._____DATE_____REVIEWER_____

COMPLETION REPORT REQUIREMENT	COMPLIANCE YES	NO	N/A	COMMENTS (Pg. in Completion Report) (Attach added pgs, if needed)
3) Sec 2.3, Unanticipated Items				
Description and explanation?				
4) Sec 2.4, Application of Supplemental Standards (if applicable)				
a) Description of areas where supplemental standards were applied?				
b) Volume of remaining material stated?				
c) Location of remaining material stated?				
d) Radiological activity of remaining material stated?				
e) If numerical standards were not met, is this due to presence of natural radioactivity? (Sec 2.4)				
f) If all residual radioactivity at the property was not cleaned up, were supplemental standards (40 CFR 192 Subpart C) applied? (Sec. 2.4)				
g) Did appropriate state and federal agencies concur in this application of supplemental standards?				

Appendix 2. (continued)

VICINITY PROPERTY INDEPENDENT VERIFICATION
COMPLETION REPORT REVIEW

LOCATION NO._____DATE_____REVIEWER_____

COMPLETION REPORT REQUIREMENT	COMPLIANCE YES	NO	N/A	COMMENTS (Pg. in Completion Report) (Attach added pgs, if needed)
III. VERIFICATION SUMMARY (Sec 3.0)				
1) Sec 3.1.2 and Figure 2.1, Soil Excavation				
a) Was an outdoor gamma survey conducted in excavated areas? (Sec. 3.1.2, Fig. 2.1)				
b) Were soil samples or composites collected from contaminated regions after excavation? (Sec. 3.1.2, Fig. 2.1)				
2) Sec 3.1.2,Post-Excavation Survey				
a) Is contamination to remain on the property adequately described?				
b) Post-excavation exposure rate range?				
c) Exterior post-excavation soil sample results correct?				
d) Interior contamination to remain adequately described?				
e) Interior post-excavation exposure rate range?				
3) Sec. 3.1.3, Post-Remedial Action RDC measurements				
If RDC measurements were performed before remedial action and results were above standards, were they repeated after remedial action was completed? (Sec. 3.1.1 & Sec. 3.1.3)				

Appendix 2. (continued)

VICINITY PROPERTY INDEPENDENT VERIFICATION
COMPLETION REPORT REVIEW

LOCATION NO._____DATE_____REVIEWER_____

COMPLETION REPORT REQUIREMENT	COMPLIANCE YES	NO	N/A	COMMENTS (Pg. in Completion Report) (Attach added pgs, if needed)
4) Sec. 3.2, Recommendation for Certification				
Present and accurate?				
5) Certification Data Summary Table:				
a) Are survey results below the associated standards for:				
Interior gamma?				
RDCs?				
Exterior surface soils?				
Exterior subsurface soils?				
IV. 4.0 APPENDIX				
Table 3.1, Post-Excavation Sample Measurement Results:				
1) Area identifier and exposure ranges match with Figure 2.1?				
2) Sample results quoted?				
Table 3.2, Post-Remedial Action RDC measurement results?				
1) Are working level measurements correct (if original data sheets are available)?				
2) Instrument type(s) listed?				
3) Start and end dates and times correct?				
4) Do total hours agree with start/end times (RPISU or WLMI)				

Appendix 2. (continued)

VICINITY PROPERTY INDEPENDENT VERIFICATION
COMPLETION REPORT REVIEW

LOCATION NO._____DATE_____REVIEWER_____

COMPLETION REPORT REQUIREMENT	COMPLIANCE YES	COMPLIANCE NO	COMPLIANCE N/A	COMMENTS (Pg. in Completion Report) (Attach added pgs, if needed)
5) Are measurement locations stated?				
V. FIG. 2.1, (MAP) (RADIOLOGICAL-AS-BUILT)				
Does Figure 2.1 clearly show:				
1) Post-remedial action exposure rate ranges?				
2) Soil sample or composite sample locations and numbers?				
3) Areas of contamination removal clearly shown?				
4) Remaining contamination?				
5) Is legend clear and legible?				
6) Structure outlines?				
7) RDC sampler locations?				
VI. GENERAL INDOOR RADIOLOGICAL				
If interior excavation was performed, does Figure 2.1 or additional figure(s) show:				
1) Post-remedial action exposure rate ranges?				
2) Soil sample or composite sample locations and numbers?				
3) Basement and second story information (if applicable)?				
4) Remaining contamination?				

Appendix 2. (continued)

VICINITY PROPERTY INDEPENDENT VERIFICATION
COMPLETION REPORT REVIEW

LOCATION NO._____DATE_____REVIEWER_____

COMPLETION REPORT REQUIREMENT	COMPLIANCE YES	COMPLIANCE NO	COMPLIANCE N/A	COMMENTS (Pg. in Completion Report) (Attach added pgs, if needed)
5) Were assessment measurements taken in the lowest habitable level of every habitable building? (Sec. 3.1.2)				
6) After remedial action, was the average value for each room or 9.3 m^2 area less than 20 $\mu R/hr$ above background? (Sec. 3.1.2)				
7) If any measurment exceeded 20 $\mu R/hr$ above background, was it investigated to ensure no tailings involvement? (Sec. 3.1.2)				
VII. CERTIFICATION Is this property recommended for certification as meeting the EPA standards for residual radioactive material?				
_____ Signature of Reviewer & Date				
_____ Second Reviewer Signature & Date				

Appendix 3. Vicinity Property Certification Summary and Decision Form

DOE ID Number _____

VICINITY PROPERTY CERTIFICATION SUMMARY AND DECISION

1.0 SUMMARY EVALUATION

The data presented in the property portfolio indicate:

		IVC (ORNL)			U.S. Dept. of Energy		
		Yes	No	N/A	Yes	No	N/A
1.	The ^{226}Ra concentration in the top 15cm of soil averages <5 pCi/g above background over $100m^2$.	[]	[]	[]	[]	[]	[]
2.	The ^{226}Ra concentration in any 15 cm layer of soil below the top 15cm surface layer averages <15 pCi/g above background over $100m^2$.	[]	[]	[]	[]	[]	[]
3.	The indoor gamma readings are <20 uR/hr above background in every habitable room.	[]	[]	[]	[]	[]	[]
4.	The radon daughter concentration in any habitable room is <0.02 working levels, or at most 0.03 WL's.	[]	[]	[]	[]	[]	[]
5.	Supplemental standards were applied in accordance with EPA standards 192.21.*	[]	[]	[]	[]	[]	[]

COMMENTS: _____

_____

_____

_____

_____

Appendix 3. (continued)

DOE ID Number: _____

2.0 ORNL's RECOMMENDATION

Based on ORNL's evaluation of the [] completion report [] completion report and field survey data, I recommend this property for:

[] Certification

[] Certification pending resolution of the deficiencies described below

[] Additional measurements and/or additional information in the completion report as described below

[] Additional remedial action

_____ Date: _____

G. A. Little, Ph.D.
Independent Verification Contractor

2.1 ORNL's EVALUATION

_____

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_____

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_____

Appendix 3. (continued)

DOE ID Number: _____

3.0 DOE/UMTRA EVALUATION

DOE Decision: [] Certify

[] Requires additional measurements prior to certification

[] Requires additional remedial action

Comments: _____

_____

_____

_____

_____ Date: _____

U.S. Department of Energy
Certification Official

*Certification concurred on by NRC on _____
(date)

Appendix 4. Type III Verification Report Skeleton, UMTRA Properties

Location Number: _____

HEALTH AND SAFETY RESEARCH DIVISION

REPORT OF TYPE III VERIFICATION SURVEY AT LOCATION _____
_____
_____

Investigation Team

C.A. Little - PAG Program Manager
D.K. Halford - Radiologic Projects Manager
J.A. Rice - PAG/UMTRA Verification Project Coordinator

_____(author)

_____DATE

WORK PERFORMED AS PART OF THE
RADIOLOGICAL SURVEY ACTIVITIES PROGRAM

Prepared by the
OAK RIDGE NATIONAL LABORATORY
Grand Junction Office
Grand Junction, Colorado 81502
operated by
MARTIN MARIETTA ENERGY SYSTEMS, INC.
for the
U.S. DEPARTMENT OF ENERGY
Under Contract No. DE-AC-5-840R21400

Appendix 4. (continued)

Location Number: _____

REPORT OF TYPE III VERIFICATION SURVEY AT LOCATION _____
address_____
_____

INTRODUCTION

A Type III verification survey of location _____ was conducted on (survdate) by Oak Ridge National Laboratory. This property consists of a ____ _____. This survey was conducted using methods as defined in the Vicinity Properties Management and Implementation Manual, UMTRA-DOE/AL-050601 (March 1988) and the PAG Procedures Manual (March 1992). General location information is provided in Table 1, radiological survey results are given in Tables 2 and 3, and supporting graphics are provided in Figure 1. All measurements are gross readings; background has not been subtracted.

(Insert for Direct Conversion)
The conversion formula used is $y = x/CF$, where 'y' equals the exposure rate in $\mu R/h$, 'x' equals the scintillometer measurements in kcpm, and 'CF' equals the conversions factor determined in the field through a direct correlation between PIC and scintillometer measurements in kcpm/$\mu R/h$. For this property, CF equals x.xx for uncontaminated regions, x.xx for contaminated regions, and x.xx for indoor/other regions.

(or Insert for Conversion Equation):
The conversion formula used is $y = mx + b$, where 'y' equals the exposure rate in $\mu R/h$, 'x' equals scintillometer measurement in kcpm, and 'm' and 'b' are predetermined constants. On this property, 'm' equals 1.69 and 'b' equals 3.45.

SIGNIFICANCE OF FINDINGS

_____
_____
_____
_____
_____
_____
_____
_____
_____

Appendix 4. (continued)

_____

_____

Based on these findings, it is recommended that location _____ be certified by the DOE.

Based on these findings, it is recommended that location _____ be certified pending resolution of the deficiencies described above.

Based on these findings, it is recommended that location _____ have additional measurements taken and/or additional information supplied in the Completion Report as described above.

Based on these findings, it is recommended that location _____ undergo additional remedial action.

Appendix 4. (continued)

Location Number: _____

RECOMMENDATION

RECOMMENDED FOR:	Certification
RECOMMENDED FOR:	Certification pending resolution of the deficiencies described in the report
RECOMMENDED FOR:	Further study requiring additional measurement or information as described in the report
RECOMMENDED FOR:	Further remediation
RECOMMENDATION BASIS:	Ra-226 is >5 pCi/g above background in surface 15 cm soil layer averaged over 100 m^2
RECOMMENDATION BASIS:	Ra-226 is <5 pCi/g above background in surface 15 cm soil layer averaged over 100 m^2
RECOMMENDATION BASIS:	Ra-226 is >15 pCi/g above background in subsurface 15 cm soil layer averaged over 100 m^2
RECOMMENDATION BASIS:	Ra-226 is <15 pCi/g above background in subsurface 15 cm soil layer averaged over 100 m^2
RECOMMENDATION BASIS:	Indoor gamma is >20 μR/h above background averaged in any room
RECOMMENDATION BASIS:	Indoor gamma is <1 standard deviation or 20% above background in all rooms
RECOMMENDATION BASIS:	Annual average radon daughter concentration is >0.02 WL
RECOMMENDATION BASIS:	Annual average radon daughter concentration is <0.02 WL

Appendix 4. (continued)

Location Number: _____

Table 1. Location Information

Property Information

LOCATION: _____
_____

PROPERTY CLASSIFICATION _____

STRUCTURES ON PROPERTY _____
_____
_____

OWNER INFORMATION

OWNER: _____

ADDRESS: _____
_____

TELEPHONE: _____(H)
_____(B)

Appendix 4. (continued)

Location Number: _____

Table 2. Comparison of Pre- and Post Remedial Action Gamma Screening Results

Outdoor Data

	Area Identifier IVC/RAC	RAC (Pre-Remedial)	RAC (Post-Remedial)	IVC (ORNL) (Post-Remedial)
Gamma Exposure Rate Range In Area Identifier(s) (μR/h)				

Indoor Data

	IVC Area Identifier	RAC (Pre-Remedial)	RAC (Post-Remedial)	IVC (ORNL) (Post-Remedial)
Gamma Exposure Rate Range In Area Identifier(s) (μR/h)				

Appendix 4. (continued)

Location Number: _____

Table 3. Composite Soil Samples
Comparative Results

Outdoor Data

Area Identifier IVC/RAC	Composite Sample Number IVC/RAC	Sample Depth (cm)	IVC 226-Ra Conc. (pCi/g)	RAC 226-Ra Conc. (pCi/g)	IVC Split Sample Number	Split Sample Conc. (pCi/g)	RAC Ticket Number

* designates that the composite sample was not taken by ORNL/IVC.
X designates a split of the sample taken by the RAC Verification Group, reanalyzed in the ORNL Soils Lab.
V designates the sample aliquots removed by ORNL/IVC in the proximity of the RAC sample and verification area identifier.
B designates a bias sample collected by ORNL/IVC.

Appendix 4. (continued)

Location Number: _____

Table 4. Radon Daughter Concentration (RDC) Summary

The RAC personnel are required to place a Radon or Radon progeny measuring device in all habitable structures on the remediated property. This table is a restatement of the RAC's data.

Bldg. ID	Room ID	Date	RDC (WL)*	Average of RDC (WL)**

* Formula used:

$$WL = \frac{(1WL)\ (Rn)\ (50\%)}{100\ (100\%)}$$

where

- WL - Working Level
- 50% - 50% equilibrium is assumed per the VPMIM
- Rn - Average daily ^{222}Rn concentration in pCi/l as reported by vendor (Terradex Radtrak® Detector)
- 100 - Concentration of ^{222}Rn in pCi/l at 100% equilibrium for 1 WL

** Reported in two significant digits.

Appendix 4. (continued)

Location Number: _____

Table 5. Net Estimated Area Weighted Average Calculation

Outdoor Extended Data

Soil Sample Summary

Soil Sample Number	Region Sampled	Sample Depth (cm)	^{226}Ra Concentration (pCi/g) (Canalysis)	Representative (biased) Sampling Area m^2	Net Estimated Area-Weighted Average* (pCi/g, C_{AW})

* Formula used

$$C_{AW} = \sum_{i=1}^{n} \frac{C_i A_i D_i}{(100)(0.15)}$$

where

- C_{AW} - area-weighted ^{226}Ra concentration, pCi/g
- C_i - net ^{226}Ra concentration, pCi/g (gross minus background)
- A_i - area of region that sample represent, m^2
- D_i - thickness of sample, m
- 100 - threshold area, m^2
- 0.15 - threshold thickness, m

Appendix 5. Letter of Recommendation, UMTRA Vicinity Properties

OAK RIDGE NATIONAL LABORATORY

OPERATED BY MARTIN MARIETTA ENERGY SYSTEMS, INC.

GRAND JUNCTION OFFICE
P.O. BOX 2567
GRAND JUNCTION, COLORADO 81502

Mr. Michael K. Tucker, Deputy Manager
U.S. Department of Energy
Grand Junction Area Office
P.O. Box 2567
Grand Junction, Colorado 81502

Dear Mr. Tucker,

Radiation levels at the property identified below do not exceed the U.S. Environmental Protection Agency (EPA) standards as specified in 40 CFR 192.

This recommendation is based upon the Independent Verification Contractor's assessment of the ^{226}Ra concentration in the soil, indoor radon daughter concentration, and indoor gamma exposure rate at this property.

Therefore, this property is recommended for

(choose one)

certification by the United States Department of Energy.

certification upon resolution of the deficiencies described in the ORNL IVC Certification Summary and Decision.

further study by the Uranium Mill Tailings Remedial Action Project.

further remedial action by the Uranium Mill Tailings Remedial Action Project.

Sincerely,

C.A. Little, Ph.D.
Independent Verification Contractor

Location Number: _____
Location Address: _____
_____

Property Owner: _____
Owner Address: _____

OAK RIDGE NATIONAL LABORATORY Health & Safety Research Division	PROCEDURE Pollutant Assessments Group	Number: TE-046 Page: 1 of 5 Revision: 0 Date: 08/19/91

TYPE B FIELD VERIFICATION ACTIVITIES FOR LARGE AREAS

1.0 PURPOSE

This procedure describes the protocol for conducting Type B independent field verifications of large remediated areas.

2.0 APPLICABILITY

Type B independent field verification of large remediated areas are performed on excavations that are greater than 2,000 m^2 (21,530 ft^2).

3.0 OTHER DOCUMENTS

3.1 References

3.1.1 Procedure TE-028, Site Preparation for Radiological Surveying.
3.1.2 Procedure TE-021, Gamma Scintillation Detector Operation.
3.1.3 Procedure TE-024, Delta Counter Operation.
3.1.4 Procedure TE-025, Alpha Radiation Measurement.
3.1.5 Procedure TE-026, Beta-Gamma Radiation Measurement.
3.1.6 Procedure TE-034, Chain of Sample Custody.
3.1.7 Procedure TE-055, Opposed Crystal System (OCS) Van Analysis.

4.0 EQUIPMENT AND MATERIALS

4.1 EQUIPMENT

4.1.1 Measuring tape
4.1.2 Gamma scintillometer
4.1.3 Sampling tools
4.1.4 Camera
4.1.5 Calculator
4.1.6 Survey flags or other marking devices
4.1.7 Weedsprayer with clean water
4.1.8 Wire brush
4.1.9 Hard hat
4.1.10 Steel toe safety shoes

Approved by:

Jon Jack K. Hodford 7/30/91 (Date) Craig A. Little 8/14/91 (Date)
C.A. Little

4.1.11 Safety glasses
4.1.12 Engineering scale

4.2 MATERIALS

4.2.1 Field data forms
4.2.2 Chain of custody forms
4.2.3 Pens/pencils
4.2.4 Felt tip markers
4.2.5 Ziplock bags
4.2.6 Field map
4.2.7 Paper towels

5.0 RESPONSIBILITY

5.1 The site project manager is responsible for determining if this procedure is applicable to the site.

5.2 The team leader is point of contact on the verification with the other agencies involved and is responsible for implementation of the procedure. The team leader performs necessary calculations and is responsible for mapping of the areas.

5.3 Team members are responsible for carrying out the procedure and may assist the team leader in the mapping of the areas.

6.0 DEFINITIONS:

6.1 **Aliquots:** equal parts of a composite sample taken from representative areas to be verified.

6.2 **Composite sample:** soil sample composed of several aliquots blended together and analyzed as one sample.

6.3 **HOG:** High outdoor gamma reading.

6.4 **RAC:** Remedial Action Contractor

7.0 SAFETY:

7.1 Wear steel-toed shoes and hard hats during verification.

7.2 Wear safety glasses and gloves when necessary.

7.3 Wear orange vests when working near heavy equipment or roads.

7.4 Wear personal dosimeter badge at all times.

8.0 PROCEDURE:

8.1 Perform a gamma scan of the area to be verified.

8.1.1 The Remedial Action Contractor's (RAC) grid may be followed if appropriate.

a. If necessary, use the gridding method outlined in Procedure TE-028.

8.1.2 Mark the grid sections on the field map.

8.1.3 Scan each grid section using a gamma scintillometer.

a. See Procedure TE-021 for details.

b. Note the HOG for each area and place a pin flag or other marker at the HOG.

8.1.4 Record the range and average gamma exposure rate for each section on the field map.

8.1.5 Further investigate any area with anomalous gamma exposure rate readings by post-holing, taking delta counter measurements, or by taking one or more biased samples.

8.1.6 Perform delta counter measurements in areas of emanation according to Procedure TE-024.

a. Note delta counter measurement locations on the field map.

8.1.7 Record data on appropriate field sheets for the project.

8.1.8 Photograph the area of remediation and verification using a polaroid camera.

a. Label the back of any photographs with the date, direction, area identifier, and initials.

8.2 When covered under the specific project, perform alpha radiation and\or beta radiation scans according to Procedures TE-025 and TE-026 if surface contamination is suspected.

8.3 Sample the soil of the verification area.

8.3.1 Take composite samples each consisting of 8-12 aliquots from the HOG of each grid block.

a. These samples should be taken in the same areas sampled by the RAC in order to obtain comparable data.

b. Place the samples in plastic bags and seal.

8.3.2 Label the sample according to the requirements of the specific project.

8.3.3 Fill out a sample chain-of-custody form and appropriate field data sheets. See Procedure TE-034.

8.3.4 Analyze the sample using the Opposed Crystal Spectroscopy (OCS) van if available. See Procedure TE-055.

8.3.5 Submit samples to the ORNL/PAG soils laboratory for analysis and/or archival.

8.4 Inspect and decontaminate equipment and personnel.

8.4.1 Inspect sample collection equipment for visible contamination after collecting each sample.

a. Remove contamination using a brush, paper towels, and/or water before returning the equipment tot the survey vehicle.

8.4.2 Inspect all instrumentation for visible contamination and decontaminate if necessary.

8.4.3 Inspect all personnel involved in the survey for visible contamination.

a. Remove visible contamination using a brush, paper towels, and/or water.

b. Following a verification performed during muddy conditions, wash shoes, boots, and/or coverings to remove visible contamination using water, paper towels, or a brush as appropriate.

8.4.4 Following any field work or sample handling, wash hands before smoking, eating, or drinking.

OAK RIDGE NATIONAL LABORATORY Health & Safety Research Division	PROCEDURE Pollutant Assessments Group	Number: TE-051 Page: 1 of 8 Revision: 0 Date: 02/03/92

ULTRASONIC RANGING AND DATA SYSTEM (USRADS) OPERATION

1.0 PURPOSE

This procedure describes the method for measuring gross gamma radiation and collecting geophysical data using the Ultrasonic Ranging and Data System (USRADS). For detailed information, refer to the manufacturer's operating manual, Reference 3.1.1.

2.0 APPLICABILITY

This procedure applies to the use of USRADS for collecting gamma radiation and geophysical data.

3.0 OTHER DOCUMENTATION

3.1 REFERENCES

3.1.1 *USRADS™ User's Manual*, Chemrad Tennessee Corp., Oak Ridge, TN, 1991.
3.1.2 Procedure TE-021, Gamma Scintillation Detector Operation.

3.2 EXHIBITS

3.2.1 Exhibit 1. Stationary Receiver Placement
3.2.2 Exhibit 2. Using USRADS in the Field

4.0 EQUIPMENT AND MATERIALS

4.1 EQUIPMENT

4.1.1 Battery charger
4.1.2 Data pack
4.1.3 EM31 Geophysical instrument
4.1.4 FM radios
4.1.5 Gamma check source
4.1.6 Hand-held terminal
4.1.7 Host computer

Approved by:

Joe K. Halford 2/3/92 (Date)

Craig A. Little 2/4/92
C.A. Little (Date)

4.1.8 Master receiver
4.1.9 Portable gamma scintillometer
4.1.10 Stationary receivers (SRs)
4.1.11 Top hat
4.1.12 USRADS software

4.2 MATERIALS

4.2.1 Field instrument logbook

5.0 RESPONSIBILITY

5.1 It is the responsibility of the computer operator to:

5.1.1 boot the software and

5.1.2 operate the host computer in performing the equipment check, set-up, and survey routines.

5.2 It is the responsibility of the surveyor to:

5.2.1 set up the SRs,

5.2.2 perform the set-up routine,

5.2.3 operate the handheld terminal, and

5.2.4 perform the survey by walking the grid block and swinging the gamma scintillation detector probe.

6.0 DEFINITIONS

6.1 **Battery charger**: an instrument used to charge the batteries for the data pack and SRs.

6.2 **Data pack**: a pack attached to a pack frame and carried by the surveyor during set up and survey operations. The function of the pack is to locate the surveyor by sending ultrasonic pulses to the SRs and also to transmit location and gamma data to the host computer.

6.3 **EM31 Geophysical instrument**: an auxiliary instrument that can be attached to the data pack used to record the conductivity of the surface soils.

6.4 **FM radios**: voice-activated radios used for verbal communication between the surveyor and the computer operator.

6.5 **Gamma check source**: a registered gamma source used for scintillometer calibration checks.

6.6 **Handheld terminal**: a calculator-size terminal attached to the data pack used to communicate with the host computer.

6.7 **Host computer**: an IBM-compatible PC that performs the location calculations and stores the survey data for subsequent analysis.

6.8 **Master receiver**: receiver located within the survey vehicle that receives transmissions from both the data pack and the SRs.

6.9 **Stationary receivers (SRs)**: receivers placed within the survey grid block used to locate the data pack by transmitting time-of-flight for ultrasonic transmissions to the host computer.

6.10 **Time-of-flight**: the amount of time for an ultrasonic signal to travel from the transmitter to any given receiver within the array.

6.11 **Top hat**: an accessory ultrasonic crystal used during the set up routine to locate the relative positions of SRs within the grid to the baseline SRs.

6.12 **USRADS software**: computer code written for the instrument set up, data collection, and data analysis.

7.0 PROCEDURE

7.1 Perform an equipment check of the system.

7.1.1 Attach each SR with a microphone and antenna to a tripod and turn the switch to the "On" position.

7.1.2 Place the data pack near the group of SRs and switch on.

7.1.3 Boot up the USRADS software.

7.1.4 Select the "Check Equipment" operation from the main menu.

7.1.5 Monitor responses from each SR and the data pack on the master receiver and the host computer to determine if a carrier signal and time-of-flight pulse data are present.

7.2 Set up equipment for surveying.

7.2.1 Place SRs within the area to be surveyed as shown in Exhibit 1.

7.2.2 Place two SRs along an arbitrary survey baseline and measure the distance between the two microphones.

a. This measurement will be used to determine the speed of sound calibration under the conditions that the survey will be conducted.

7.2.3 Select the "Set Up" operation from the main menu.

7.2.4 Attach the top hat to the data pack.

7.2.5 Place the top hat on top of an SR.

a. Do not stand between the SR and the host computer.

7.2.6 Key in the appropriate SR number on the hand-held terminal and follow the instructions given on the hand-held terminal.

7.2.7 Repeat the above steps for each SR used within the survey array.

7.2.8 Enter a zero (0) into the hand-held terminal.

a. This invokes the host computer to calculate the matrix of time-of-flight data and calibrate the speed of sound.

7.2.9 Once the matrix calculation is complete, the host computer will display the grid block scale and relative SRs locations. Study this setup file carefully to determine if the setup is valid.

7.2.10 Select the "Perform Site Survey" option from the main menu.

7.2.11 Turn the power switch on the data pack to the "Off" position.

7.2.12 Remove the top hat from the data pack.

7.2.13 Connect the ultrasonic crystal located on the pack frame.

7.3 Collect radiation data.

7.3.1 Perform an operation check of the scintillometer as outlined in Procedure TE-021.

7.3.2 Connect the gamma scintillation detector to the data pack.

7.3.3 Turn on the gamma scintillation detector and remove the probe from handle.

7.3.4 Invoke the host computer, selecting an average gamma threshold relative to the location of the survey.

7.3.5 Turn the power switch on the data pack to the "On" position.

7.3.6 Begin traversing the survey grid block in either a north to south or an east to west direction in parallel paths.

7.3.7 Survey the grid block according to Procedure TE-021.

a. Walk at a slower than average pace to allow the gamma instrument an adequate response to potential contamination.

7.4 Collect geophysical data.

7.4.1 Connect the EM31 geophysical instrument to the data pack and suspend it from the pack with two auxiliary straps.

7.4.2 Change a switch within the software to collect geophysical data.

a. Type "USRADCFG".

b. Select menu option "Survey Parameters".

c. Change the toggle switches to read:

1. Counter Disabled
2. Analog 1 Enabled
3. Analog 2 Enabled

d. After setting these options press the escape key to go back to the main menu.

7.4.3 Begin traversing the survey grid block in either a north to south or an east to west direction in parallel paths.

a. Walk at a slower than average pace to allow the instrument an adequate response to potential conductivity variations in shallow surface soils.

7.5 Upon completion of the survey, use the ALT F1 keys on the host computer to terminate the survey mode and data collection to the host computer.

7.5.1 The computer closes the data file and is ready to analyze data or continue with the next survey grid block.

7.6 Move the SRs to the next grid block and repeat the above steps for each subsequent block within the area of concern.

7.7 For data analysis procedures, refer to the manufacturer's operating manual, Reference 3.1.1.

7.8 Charge the batteries for the data pack and SRs at the end of every survey day according to procedures in the manufacturer's operating manual.

Exhibit 1. Stationary Receiver Placement

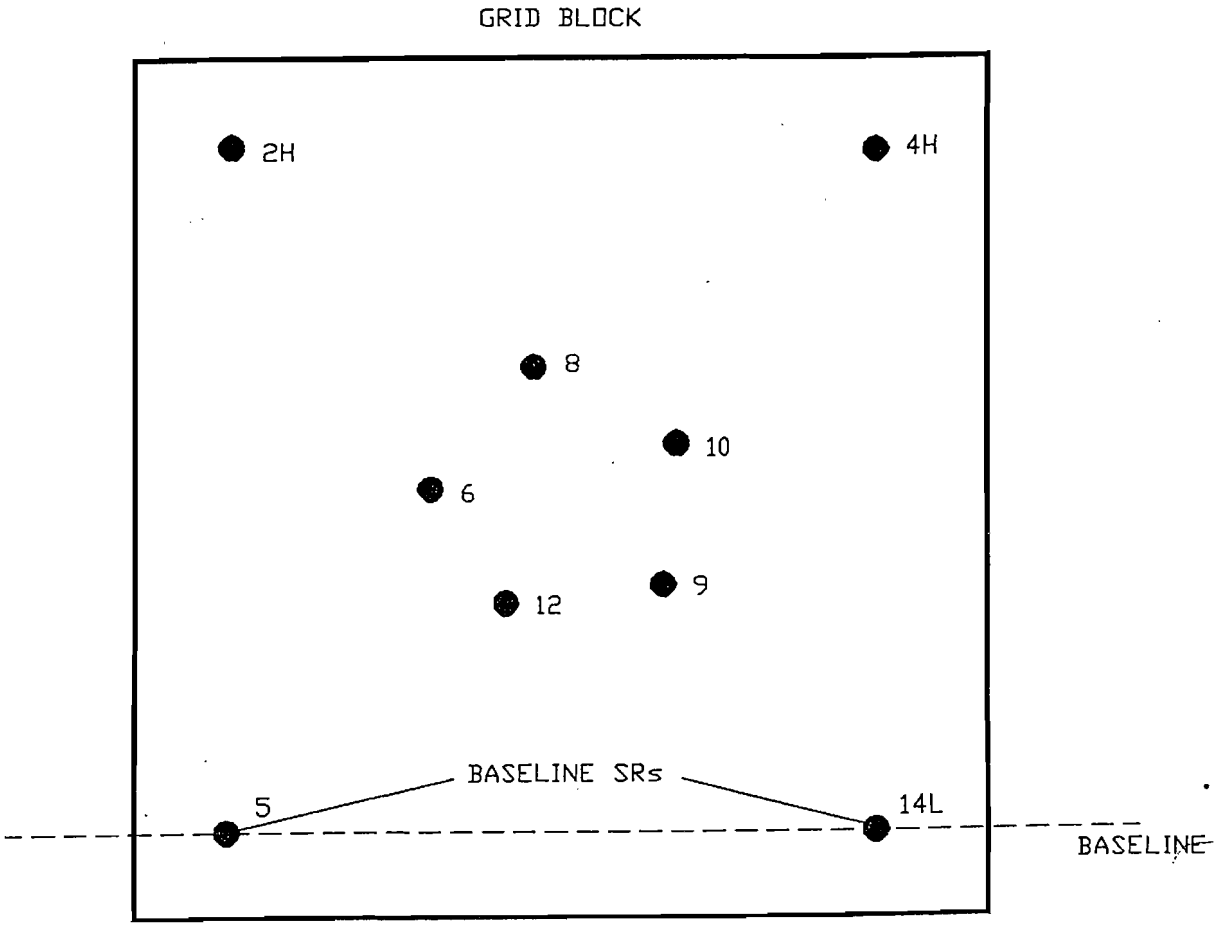
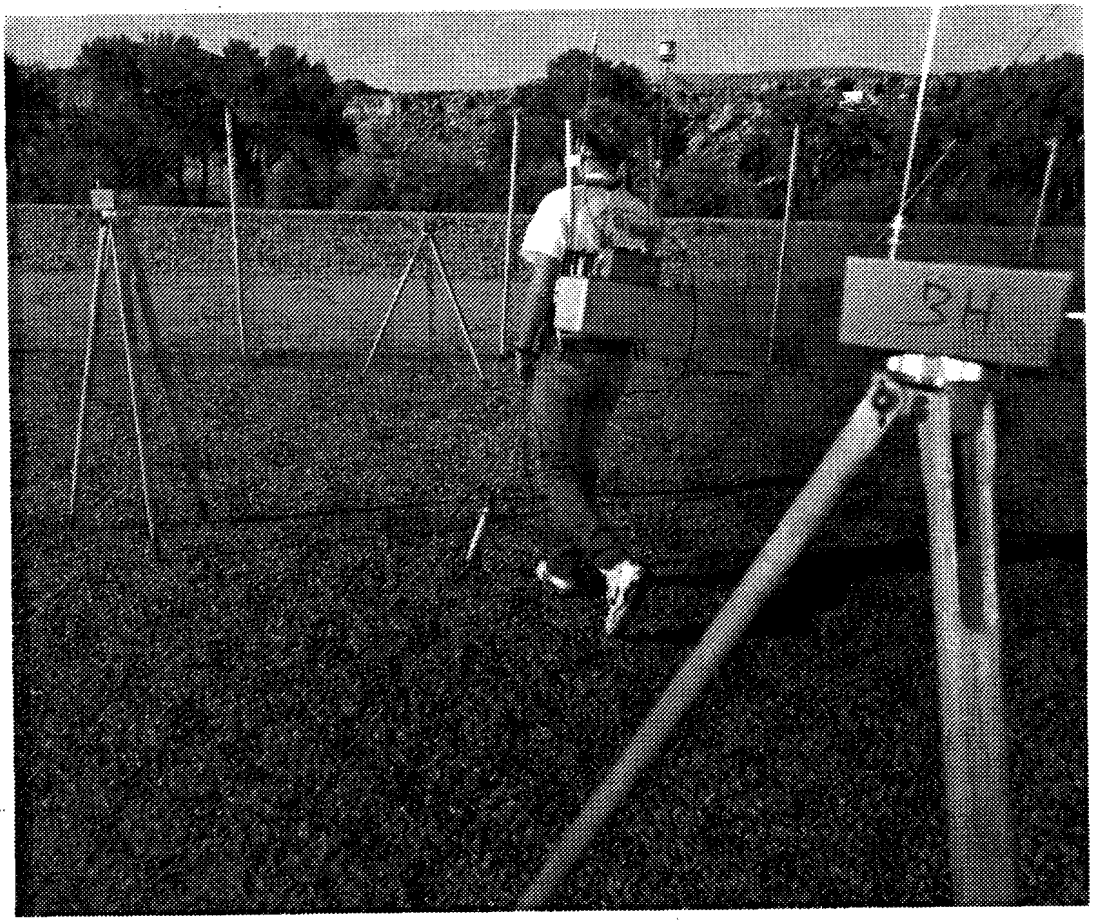


Exhibit 2. Using USRADS in the Field



OPPOSED CRYSTAL SYSTEM (OCS) VAN ANALYSIS

1.0 PURPOSE

This procedure describes the operation of the mobile gamma spectroscopy lab called the opposed crystal system (OCS) van.

2.0 APPLICABILITY

This procedure applies to the analysis of soil samples in the field for ^{226}Ra activity using the OCS van.

3.0 OTHER DOCUMENTS

3.1 REFERENCES

3.1.1 ONAN generator owner's manual
3.1.2 *DMR-II™ Digital Multiplexer Router Operation and Instruction Manual*, The Nucleus®, Inc., 1989.
3.1.3 Procedure SU-023, Calibration of the Opposed Crystal System (OCS).

3.2 APPENDICES

3.2.1 Appendix 1: OCS Operational Check Form
3.2.2 Appendix 2: Using the OCS Data Base
3.2.3 Appendix 3: ^{137}Cs Interference Correction
3.2.4 Appendix 4: OCS Data Sheet

3.3 EXHIBITS

3.3.1 Exhibit 1: Interior of the OCS Van
3.3.2 Exhibit 2: Block Diagram of the OCS System
3.3.3 Exhibit 3: Typical Spectrum of a 50-pCi/g ^{226}Ra Standard

APPROVALS		
Author		Date
Supervisor		Date
Group Leader	Lisa K. Holford	Date 8/6/93
Section Head	Gail Little	Date 8/6/93

4.0 EQUIPMENT AND MATERIALS

4.1 EQUIPMENT

4.1.1 PCA-II™ NaI(Tl) detector systems
4.1.2 Compaq™ SLT/286 PC
4.1.3 Microspeed™ PC-TRAC mouse
4.1.4 NIM bin
4.1.5 High-voltage power supply
4.1.6 ^{226}Ra standards, 50 Pci/g
4.1.7 ^{137}Cs check sources
4.1.8 Sample mixing pails
4.1.9 Sample mixing tools
4.1.10 Speedy™ moisture tester
4.1.11 Pressurized water sprayer for decontamination
4.1.12 Scale
4.1.13 Brush

4.2 MATERIALS

4.2.1 Calcium carbide reagent
4.2.2 Sample cans and lids
4.2.3 Marking pen
4.2.4 Generator oil
4.2.5 Plastic sample bags
4.2.6 OCS Data Sheet
4.2.7 OCS Operational Check Form

5.0 RESPONSIBILITY

5.1 The OCS operator is responsible for:

5.1.1 preparing the van prior to a field survey,
5.1.2 analyzing samples,
5.1.3 performing moisture tests, and
5.1.4 decontaminating sample equipment.

6.0 DEFINITIONS

6.1 **Batch files:** text files of commands used to control the MCA

6.2 **Channel:** a place of storage and display of the energy of converted pulses from the detectors; higher energies are sorted into higher channels.

6.3 **GJVERF:** Grand Junction verification-survey sample data base

6.4 **GJISC:** Grand Junction inclusion-survey sample data base

6.5 **Input:** a pair of detectors housed in a lead shield; Pig 1 is synonymous with Input 1.

6.6 **KeV:** kiloelectron volts; the unit of energy used to quantify gamma radiation.

6.7 **MCA:** multichannel analyzer; an MCA counts the pulses of light produced in the detector by gamma radiation and converts them into digital signals. A gamma ray of higher energy produces a larger digital signal that is displayed in a higher channel. In the OCS system, the MCA quantifies the net counts observed in the 609-keV peak. The 609-keV peak is emitted by ^{214}Bi, one of the radon daughters.

6.8 **MONTIVC:** Monticello inclusion- and verification-survey sample data base

6.9 **MSDS:** material safety data sheet

6.10 **NaI(Tl) detector systems:** two detector systems, each consisting of two 3 x 3-in. thallium-drifted sodium iodide [NaI(Tl)] crystals and photomultiplier tube assemblies housed in a round, elongated lead shield. The detectors are mounted in each end of the lead shield and oppose each other with a sample chamber between the detectors.

6.11 **NIM bin:** Nuclear Instrumentation Modules housing that stores and provides power to NIM units such as amplifiers

6.12 **OCS:** opposed crystal system; a mobile field laboratory used for analysis of ^{226}Ra in soil samples.

6.13 **PCA-II™ MCA:** a multichannel analyzer (MCA) based on a personal computer consisting of a full-size computer card with a ¾ length piggyback board

6.14 **PCA-II™ DMR-II™:** a hardware and software package designed for multiple detectors that send data to a single MCA (the PCA-II)

6.15 **Photopeak or peak:** the visual representation of the specific gamma radiation energy emitted by a radionuclide

6.16 **ROI:** region of interest; typically incorporates a peak produced by the decay of a specific radionuclide. In the OCS system, an ROI is set at the 609-keV peak.

6.17 **Source pig:** a lead container for storing radioactive materials

6.18 **Spectrum:** the visual display produced by the MCA of the peak or peaks produced by radionuclides in materials placed in the detector systems. In typical soil samples analyzed in the OCS, thorium, potassium, and radium peaks are displayed in the sample's spectrum.

7.0 SAFETY

7.1 **DANGER:** calcium carbide, the reagent used in the Speedy moisture tester, reacts with soil moisture to form a flammable gas, acetylene.

7.2 Always keep calcium carbide away from moisture and sealed except when in use.

7.3 Read the MSDS for calcium carbide prior to handling and storage.

7.4 Wear safety glasses when using the Speedy.

7.5 Discard the used reagent and soil from the Speedy in a plastic bag and seal. Double bag and dispose of the used reagent in the soils lab sample-excess container.

8.0 PROCEDURE

8.1 Prepare van and check equipment prior to travel.

8.1.1 Place the computer and keyboard in drawer and lock.

8.1.2 Ensure that an adequate supply of cans and lids are in the van.

8.1.3 Lock all drawers and secure all equipment.

8.1.4 Check the supply of calcium carbide.

8.1.5 Fill the decon sprayer for auger decontamination.

8.1.6 Check the oil in the generator; if acceptable, the generator is ready for operation.

a. If it is necessary to add oil, refer to the ONAN generator owner's manual.

8.1.7 Check the gasoline supply of the generator; refill if necessary.

8.2 After arriving on site, set up the system for operation. See Exhibits 1 and 2.

8.2.1 Plug in the power cord and start the generator to allow it to warm up.

8.2.2 Place the portable computer next to the expansion base.

8.2.3 Plug the mouse into the rear of the computer.

8.2.4 Slide the computer into the socket in the expansion base.

8.2.5 Plug the expanded keyboard into the expansion base.

8.2.6 Power up the expansion base and then the computer.

8.2.7 Turn on the NIM bin and the high-voltage power supply. Voltage should read between 800 and 900 V.

8.3 Prepare samples.

8.3.1 Empty sample into a pail and mix thoroughly.

8.3.2 Tare the scale for the weight of an empty can and lid.

8.3.3 Fill can with a representative sample of soil and put on a lid.

8.3.4 Use an indelible marking pen to write the sample number on the plastic lid.

8.4 Determine sample moisture when necessary.

8.4.1 This test can be performed during the 500-s sample analysis time.

NOTE: Be extremely careful when using the Speedy moisture tester due to flammable gas produced during the test. Refer to section 7.0 for further safety information.

8.4.2 For clayey soil, weigh 6 g of the sample.

8.4.3 Load the moisture tester.

a. Pour two scoops of calcium carbide reagent into the Speedy body and add the two steel balls.

b. Put the sample material into the Speedy cap.

c. Carefully hold the Speedy body horizontally as the cap is positioned into the body to prevent mixing of the sample material and the reagent before the Speedy is sealed.

d. Move the stirrup into position on the cap and tighten.

8.4.4 Turn the Speedy vertically so the sample material falls into the body.

8.4.5 Holding the Speedy horizontally, rotate it briskly for 10 s to put the steel balls into motion around the body.

8.4.6 Rest the Speedy in a vertical position with the gauge facing up for 20 s.

8.4.7 Repeat the rotate-rest cycle until the reading on the gauge has stopped increasing or is increasing very slowly.

8.4.8 Set the Speedy aside in a vertical position with the gauge facing up and allow to stabilize.

a. The reading after the Speedy has stabilized is used as the sample moisture content.

8.4.9 Empty the material into a plastic bag, double bag, and seal.

8.4.10 Clean out the Speedy body and cap with a brush.

a. Dispose of this used reagent and soil by placing in the soils lab sample-excess container.

8.4.11 For sandy soil, weigh 6 g of the sample.

8.4.12 Load the moisture tester.

a. Place the sample into the Speedy body.

b. Pour two level scoops of reagent into the cap.

c. Carefully hold the Speedy body horizontally as the cap is positioned onto the body to prevent mixing the sample material and reagent before the Speedy is sealed.

8.4.13 With the gauge facing down, shake the Speedy vigorously for 5 s and then quickly rotate so the gauge is facing up. Tap the body to ensure that the contents fall into the cap.

8.4.14 Hold the Speedy in a vertical position for about 1 min. Repeat this cycle 3 times.

8.4.15 Again shake the Speedy, and then hold the Speedy horizontally at eye level.

a. Enter the value on the gauge as the sample moisture content, %.

8.4.16 Clean moisture tester as outlined above.

8.5 Adjust the fine gain for each amplifier to ensure that the 609-keV peak is in the proper position in the spectrum.

8.5.1 Set the number of channels per DMR-II™ input and the conversion gain if necessary.

a. At the OCS main menu, type "N" to access the Nucleus® DMR-II™ program.

b. Type "S" to choose the DMR-II setup menu.

c. Select "DMR Setup" to set the number of channels.

d. Select "Number of Channels per DMR Input".

e. Select "512".

f. Use the ESC key to exit the setup menu.

g. Set the conversion gain by choosing "Conversion Gain" from the DMR-II setup menu.

h. Select "1024".

i. Use the ESC key to exit the setup menu.

8.5.2 Switch off both S2 toggle switches on the switchboard.

8.5.3 Remove the ^{137}Cs sources from the source pig, place each one in a source holder, and place one source holder in each lead pig.

8.5.4 With the cursor on channel 110 of Input 1, press the F1 key to begin acquiring a spectrum. After 2 to 3 s, press the F1 key again to halt acquisition.

8.5.5 An imaginary line below the cursor should split the peak into two equal halves. If the peak is offset to either side, the amplifier fine gain must be adjusted.

8.5.6 Use the various horizontal and vertical scales to view the peak when adjusting the fine gain.

a. The ↑ and ↓ arrow keys allow selection of various vertical scales.

b. The F4 key selects the horizontal display.

c. Refer to the command key summary, Section 4.11 in the DMR-II™ manual, for more information (Reference 3.1.2).

8.5.7 Adjust the fine gain knob a small amount in the direction the spectrum needs to move to center the peak. Continue adjusting until the cursor is centered above the peak.

8.5.8 Switch S1 off and S2 on, and press the CTRL and F2 keys together to erase the existing spectrum. Repeat the above steps for spectrum acquisition and adjustment of S2.

8.5.9 Turn S1 on and, with both switches on, acquire a spectrum again. If the peak has shifted slightly, turn both fine gain knobs together and in the same direction to center the peak.

8.5.10 Lock the fine gain knobs into position after the gain is adjusted.

8.5.11 When the detectors in Input 1 are adjusted, zoom into Input 2.

8.5.12 Repeat the steps above to adjust the fine gain on the amplifier in Input 2.

8.5.13 When fine gain adjustment is complete, return the ^{137}Cs check sources to the source pig.

8.6 Perform an operational check of each detector system.

8.6.1 Press the Z key to zoom out the DMR-II display.

a. All eight input windows are now displayed.

8.6.2 Erase any existing spectral data by pressing the CTRL and F2 keys at the same time.

8.6.3 Press F3 to enter the preset counting time of 100 s for both inputs.

a. Enter 100 for both inputs and press the ESC key.

8.6.4 Place a 50-pCi/g ^{226}Ra standard into each lead pig.

8.6.5 With the display zoomed out, press the F1 key to begin acquiring spectra in both inputs.

8.6.6 When counting is complete, zoom into Input 1 and set an ROI at the 609-keV peak.

a. The left side of the 609-keV peak is typically identified by a shallow valley adjacent to the left side of the peak. Place the cursor on the channel at the low point of the valley and press the F9 key.

b. The right side of the ROI may be a shallow valley adjacent to the peak. If there is no valley, place the cursor into the channel just to the right of where the peak ends and press the F10 key.

c. Exhibit 3 shows a spectrum for the standard, including the channels where the ROI is typically set.

8.6.7 Set an ROI for Input 2 also, following the steps above.

8.6.8 Compare the net counts in each ROI to the 3-sigma range for each standard (found on the OCS Operational Check Form, Appendix 1.)

a. If the net counts do not fall into the 3-sigma range, do not use that particular detector system for sample analysis.

b. Recalibrate the detector system and establish a new 3-sigma range. See Procedure SU-023.

c. If problems persist, see the Geotech electronics lab for trouble shooting.

8.6.9 Remove the radium standards and return them to the storage drawer.

8.6.10 Fill out the OCS Operational Check Form. See Appendix 1.

a. Record the date and operator's initials.

b. Record the net counts from both inputs.

c. Enter Y if the net counts are within the 3-sigma range.

d. Enter N if the net counts are out of range.

8.7 Input sample data and begin analysis.

Sample data input and analysis use two separate batch files. The first batch file to run, "OCS.NBE", initiates sample data input and begins analysis in both detector systems (Inputs 1 and 2). The data input screen is split between Inputs 1 and 2. Sample data can be entered and saved in the first, the second, or both screens.

8.7.1 Run the batch file "OCS.NBE".

a. This batch file can be accessed by either the main menu or the options menu in the DMR-II software.

b. When in the DMR-II software, press "O" to select to Options menu.

c. Select "Run a Batch File."

d. At the filename prompt, type in "OCS.NBE" and press Enter.

e. When at the main menu, type "O" to call the DMR-II software with the OCS batch file.

8.7.2 On the data input screen, note which data base is being used and change if necessary. See Appendix 2 for data base use.

a. The sample date (current date) is automatically displayed.

8.7.3 Enter the following:

a. location ID
b. sample number
c. wet weight, g
d. percent moisture (if this is not known, press Enter)
e. operator's initials
f. appropriate comments.

8.7.4 If necessary, edit the preset excavation depth and count time.

8.7.5 Save the Input 1 data by pressing the CTRL and W keys simultaneously.

8.7.6 Enter data for the next sample in the Input 2 part of the screen.

a. The first seven characters of the location ID from Input 1 are carried over.

b. If only one sample is being analyzed, press the ESC key at this point to escape the data input screen.

8.7.7 Once the sample data is saved, the batch file returns to the MCA display and prompts the operator to check the MCA settings. Gain is 1024, and the analysis time is 500 s. Press Enter.

8.7.8 The batch file prompts the user to place a sample in Pig 1 and press any key to continue. Note that analysis begins in Pig 1 once a key is pressed.

8.7.9 The batch file then prompts the user to place a sample in Pig 2 and press any key to continue. Once again, analysis begins as soon as any key is pressed.

8.7.10 The screen displays both inputs acquiring spectrums.

a. If only one sample is being analyzed, use the F1 key to halt analysis in the empty pig.

8.7.11 The sample or samples are counted for 500 s, after which the batch file sets an ROI around the 609-keV peak in both spectra.

a. At this point, the batch file is finished, and control is returned to the operator.

8.8 Complete sample analysis.

8.8.1 When the 500-s counting time is complete for both samples, the spectrum in Input 1 is displayed.

a. The "OCS.NBE" batch file sets the ROI's in both inputs after counting is complete.

b. The 609-keV peaks are highlighted and the net counts displayed on the screen.

c. The operator has the option of accepting or rejecting the preset ROI.

d. Reset the ROI if the highlighted ROI does not adequately cover the peak (as in the case of a high activity sample) or covers an area larger than the peak.

e. Press the ALT and R keys at the same time to toggle the highlighted portion of the peak on and off.

8.8.2 Zoom in on the 609-keV peak in Input 1. See Exhibit 3.

a. Use the various horizontal and vertical scales to view the peak.

b. Carefully check the highlighted area of the peak: a peak that does not completely fill the ROI or highlighted areas beyond the peak requires resetting the ROI.

c. The left side of the 609-keV peak is typically identified by a shallow valley adjacent to the left side of the peak. Place the cursor on the channel at the low point of the valley and press the F9 key.

d. The right side of the ROI may be a shallow valley adjacent to the peak. If there is no valley, place the cursor into the channel just to the right of where the peak ends and press the F10 key.

e. If necessary, correct for ^{137}Cs interference. See Appendix 3.

8.8.3 Zoom in on the 609-keV peak in Input 2 and check the ROI. Reset if necessary using the above instructions.

8.8.4 Select the options menu by pressing the O key; select "Run a Batch File."

a. The default batch file "OCS.NBE" is displayed. Move the cursor underneath the "." and type "2". Press Enter.

1. This changes the batch file to the second batch file named "OCS2.NBE". Press Enter.

b. A column of samples is displayed by the batch file along with the last two samples run in each input.

c. Use the ↑ and ↓ arrow keys to choose the desired sample(s) to complete analysis and press Enter to make a selection.

8.8.5 Enter the moisture content (%) determined using the Speedy at the next prompt.

8.8.6 Press Enter at the calibration-factor prompt. For more information on the calibration factor, refer to Procedure SU-023.

8.8.7 The ROI net counts from each sample are displayed. Press Enter.

8.8.8 A data screen for each sample is displayed, showing the sample's uncorrected and corrected ^{226}Ra activity. Carefully check the data screen for any errors and edit if necessary.

8.8.9 Save data by pressing the PgDn (page down) key and then Ctrl W. If using the portable keyboard, press the Fn key together with the PgDn key.

8.8.10 Repeat the steps above for each sample.

8.9 Save the sample spectra to disk.

8.9.1 Place a floppy disk into Drive A:.

8.9.2 Press the Z key to zoom into Input 1.

8.9.3 Press the F key to select the File menu.

8.9.4 Choose "Save Binary File" by pressing Enter.

8.9.5 At the file name prompt, type "A: location and sample number."

a. Press Enter.

8.9.6 Zoom into Input 2 and repeat the above steps.

8.9.7 Exit the program after all samples have been analyzed by pressing Alt Q and selecting "Exit to DOS."

8.10 Fill out the OCS Data Sheet. See Appendix 4.

8.10.1 Record the property ID, operator, date, and Pig 1 and 2 calibration factors.

8.10.2 Record each unique sample identifier.

8.10.3 Record the sample's wet weight, g.

8.10.4 Once sample analysis is complete and the ROI's are set, record the net counts.

8.10.5 Record the estimated moisture content (%) if the sample was tested for moisture.

8.10.6 Record the uncorrected and corrected ^{226}Ra concentration.

8.10.7 If on site, record the results of the RAC (Remedial Action Contractor) OCS.

8.10.8 Add any appropriate comments.

8.10.9 Fill out this sheet in addition to entering the sample information at the data input screen.

Appendix 1. OCS Operational Check Form

OCS OPERATIONAL CHECK FORM

3-Sigma Range for 50 pCi/g: 1050 to 1620

Count Time = 100 Seconds

Date	Initials	ROI Net Pig #1 50 pCi/g	3-Sigma Range, Y/N	ROI Net Pig #2 50 pCi/g	3-Sigma Range, Y/N

Appendix 2. Using the OCS Data Base.

1. The OCS data base consists of several specific project data bases where sample data for particular projects are stored.

2. Each project data base consists of 2 parts: a .DBF file containing all sample data and an .NTX (index) file that allows data sorting.

3. Use the OCS data base to select the desired data base and to print, edit, delete, or move data.

   a. Use the GJVERF data base for Grand Junction verification samples.

   b. Use the GJISC data base for Grand Junction inclusion samples.

   c. Use the MONTIVC data base for Monticello inclusion and verification samples.

4. All project data bases are stored in the C:\CLIPPER\DMR209 subdirectory.

   a. If the path to this directory is lost, a warning appears when the OCS batch file "OCS.NBE" is run. The batch file will not continue until the path is re-established.

   b. To re-establish the path, access the OCS data base by typing "D" at the main menu.

   c. The warning will again appear. Press any key to continue.

   d. Choose the "HELP" menu.

   e. Select "Display\Edit MEM Vars".

   f. The default data base file is mvDBF. Type in "C:\CLIPPER\DMR209\GJVERF.DBF".

   g. The default data base file is mvNTX. Type in "C:\CLIPPER\DMR209\GJVERF.NTX".

   h. The default date sort index is mvDateNtx. Type in "C:\CLIPPER\DMR209\-DATESORT.NTX".

   i. The default path is mvDefltPth. Type in "C:\CLIPPER\DMR209".

Appendix 2. (continued)

j. Use the Enter key to move through the other default settings. At the bottom of the screen, press Enter to save the default path.

k. The other project data bases are now accessible by following the steps below.

5. Select a data base prior to analysis.

   a. Access the OCS data base by typing "D" at the main menu.

   b. Choose the "File" menu. Note that menu choices are displayed near the top of the screen.

      1. Choose "Pick default dbf, ntx."

      2. Use the F3 key to display the project data bases.

      3. Select a data base and press Enter.

      4. Press Enter once more to change the .NTX (index) file.

      5. Sample data is saved into this data base.

6. The .DBF and .NTX project data bases in use are displayed at the top of the OCS data base screen.

7. To print data, access the OCS data base by typing "D" at the main menu.

   a. Select the "Soil Samples" menu.

   b. Select "Edit a Record".

   c. Select the sample to be printed using the F3 or F4 keys or by typing the sample I.D.

   d. With the sample displayed, press the PgDn key.

   e. Select "Print Current Data" in the Edit and Print menu which is displayed after pressing PgDn.

   f. Choose "Local Printer" to print.

Appendix 2. (continued)

8. To edit a record, select the "Soil Samples" menu and "Edit a Record".

   a. Use the F3 or F4 key to choose a sample or type in the sample I.D.

   b. Make the necessary edits; note that the sample I.D. cannot be changed.

   c. Press PgDn to recalculate the sample's ^{226}Ra activity based on the changes.

   d. Changes can be saved or aborted in the Edit and Print menu.

9. To move a record, select the "Soil Samples" menu and "Move a Record".

   a. Use the F3 or F4 keys to choose a sample or type in the sample I.D.

   b. Type "Yes" at the prompt to move the record.

   c. The screen now prompts for the target data base; this is the data base the sample will be moved to.

   d. Press the F3 key to display the multiple data bases.

   e. Select the desired data base and press Enter.

   f. Press Enter to change the .NTX extension.

   g. Sample data is moved to the chosen data base.

10. To delete a record, select the "Soil Sample" menu and "Delete a Record".

    a. Use the F3 or F4 key to choose a sample or type in the sample I.D.

    b. Respond to the prompt by typing "Yes" to continue.

    c. Press Enter, and the record is deleted.

Appendix 3. ^{137}Cs Interference Correction

^{137}Cs has a single gamma decay of 661.6-keV that can interfere with and add net counts to the 609-keV ROI. Cesium, if present, is manifested as a double peak or shoulder on the right side of the 609-keV peak.

1. If cesium interference is suspected, first complete the sample analysis and set the ROI to incorporate the entire peak.

2. Run the second batch file and save the data.

3. Adjust the fine gain.

4. Rerun the sample.

5. When the 500-s analysis is complete, cut off the double peak or shoulder by resetting the ROI.

6. Finish the sample analysis and note the ^{226}Ra activity.

    a. If the difference between analysis runs is greater than 0.5 pCi/g, inform the team leader of suspected Cs contamination.

7. Due to the limited resolution of NaI(Tl) detectors, it is not possible to completely resolve the 609-keV peak from the 661.6-keV cesium peak. A long count of 2000 s or more will aid in separating the two peaks.

8. To confirm the presence of cesium, the sample should be submitted to the ORNL soils lab with a request to determine if cesium is present.

Appendix 4. OCS Data Sheet

OCS DATA SHEET

DOE ID NUMBER _____

OPERATOR _____

DATE _____

CALIBRATION FACTORS:

PIG 1: _____

PIG 2: _____

Composite or biased sample #	Sample weight	Estimated moisture	Net Counts	226-Radium concentration (uncorrected)	226-Radium concentration (corrected)	RAC OCS	Comments

UCN-18618
(3 Rev. 8/93)

Exhibit 1. Interior of the OCS Van

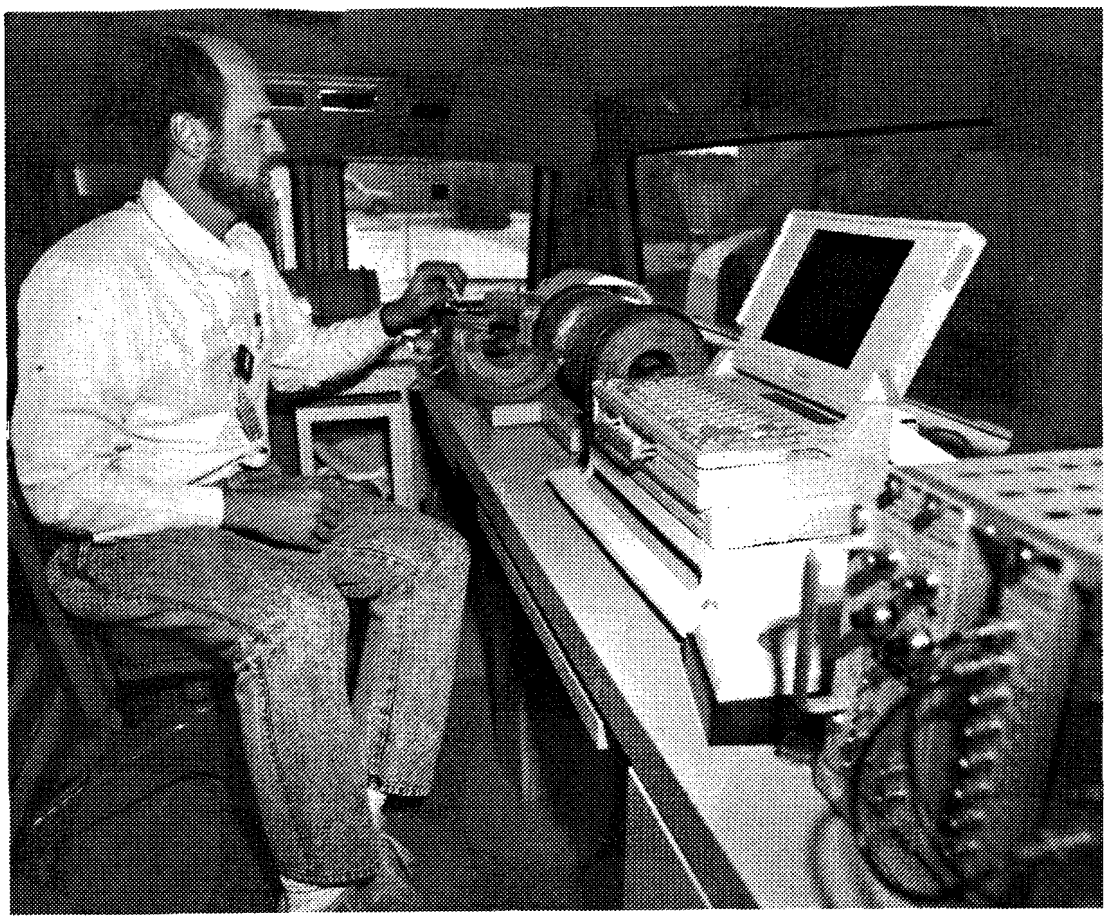


Exhibit 2. Block Diagram of the OCS System

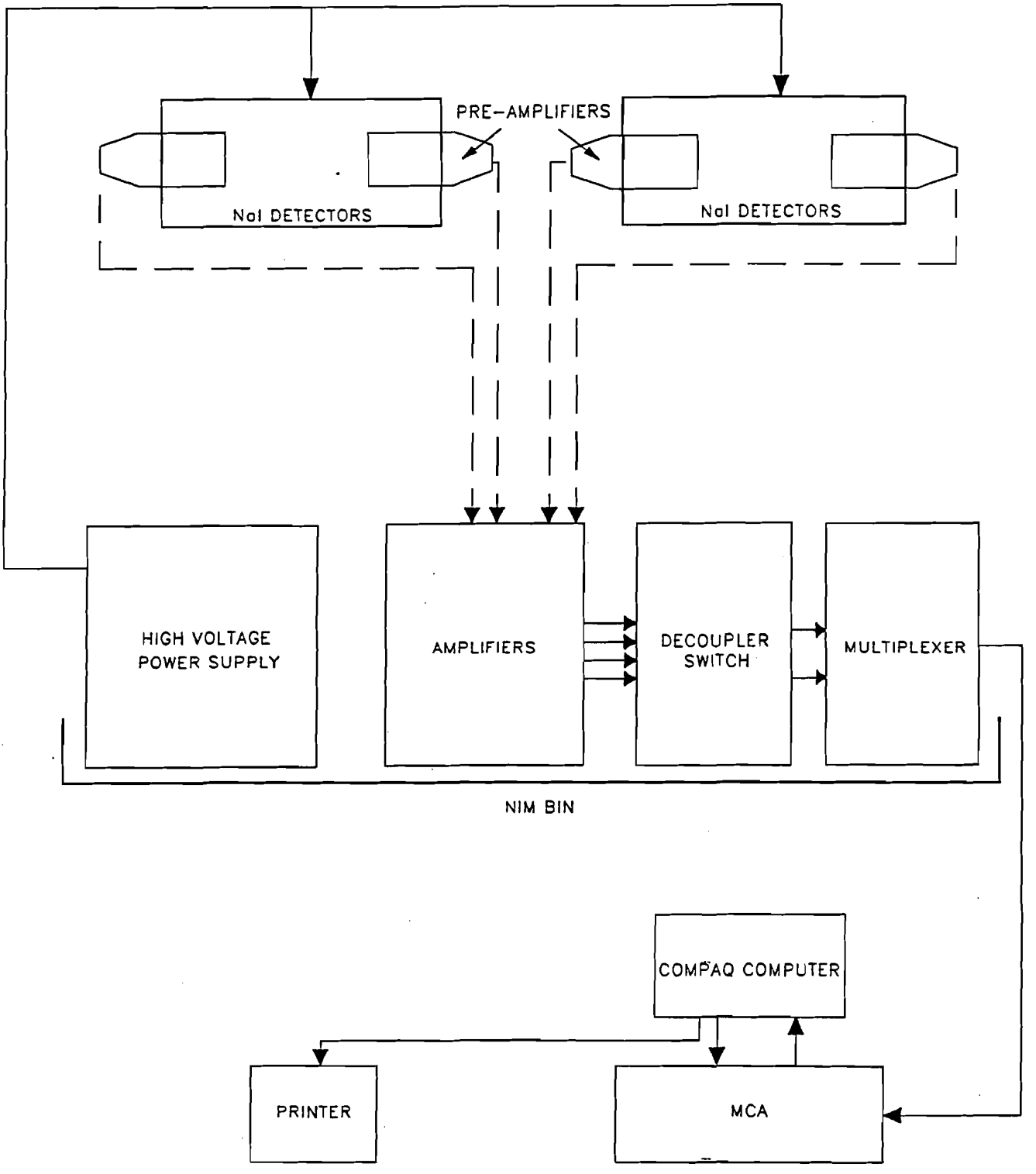
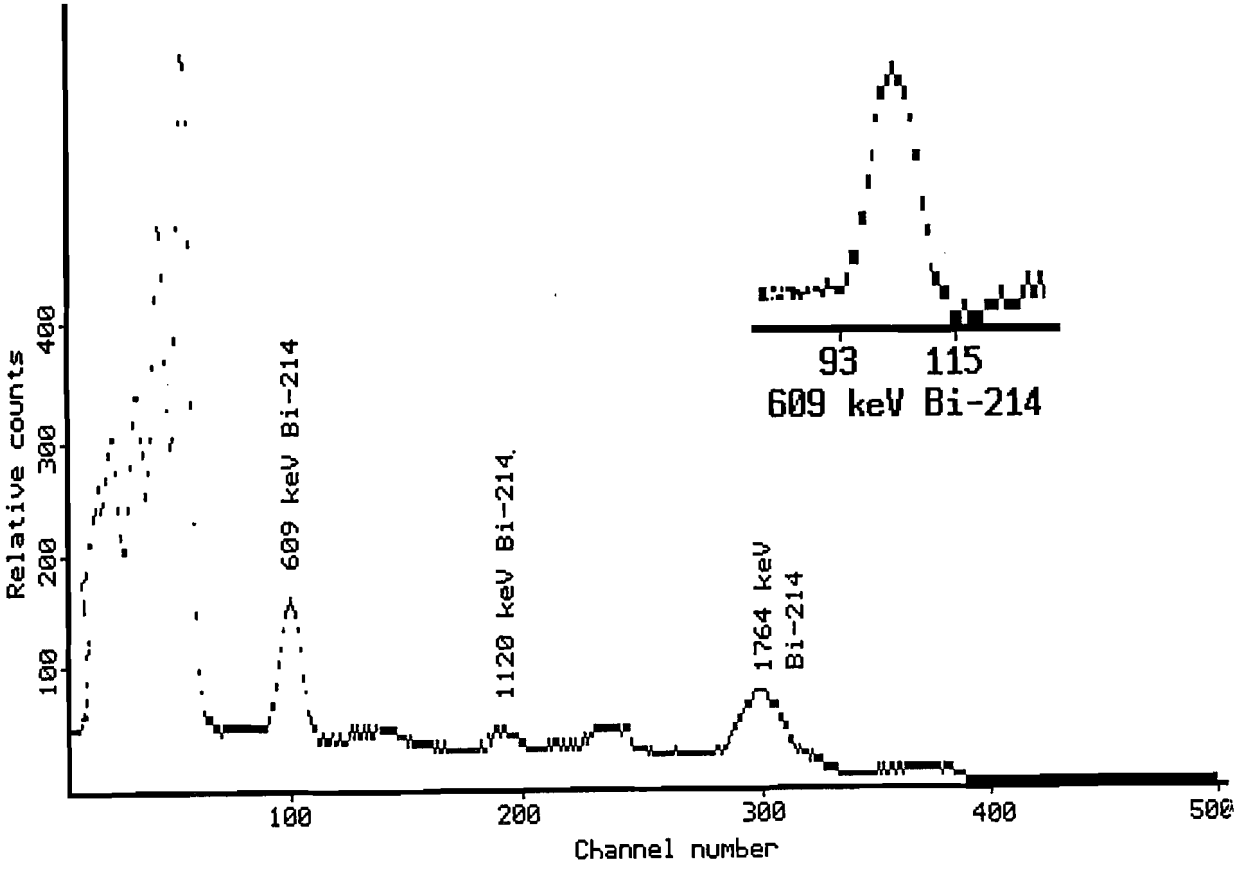


Exhibit 3. Typical Spectrum of a 50-pCi/g ^{226}Ra Standard



Typical 50 pCi/g standard spectrum with expanded 609 keV ROI displayed.

OAK RIDGE NATIONAL LABORATORY Health Sciences Research Division	PROCEDURE Environmental Technology Section	Number: TE-060 Page: 1 of 1 Revision: Date:

WATER QUALITY DETERMINATION

TE-060, Water Quality Determination, has been replaced with the following:

TE-061, Measurement of pH of Water Samples
TE-062, Measurement of Electrical Conductivity of Water Samples
TE-063, Measurement of Dissolved Oxygen in Water Samples
TE-064, Measurement of Alkalinity of Water Samples.

OAK RIDGE NATIONAL LABORATORY Health Sciences Research Division	PROCEDURE Environmental Technology Section	Number: TE-061 Page: 1 of 6 Revision: 0 Date: 04/15/93

MEASUREMENT OF pH OF WATER SAMPLES

1.0 PURPOSE

This procedure describes the activities necessary for measuring the pH of water samples.

2.0 APPLICABILITY

This procedure applies to pH measurement of all water samples.

3.0 OTHER DOCUMENTS

3.1 REFERENCES

3.1.1 pH meter user's manual

3.2 APPENDICES

3.2.1 Appendix 1: Water Sample Data Record

4.0 EQUIPMENT AND MATERIALS

4.1 EQUIPMENT

4.1.1 pH meter
4.1.2 Combination pH electrode
4.1.3 Thermometer or temperature probe
4.1.4 Deionized water wash bottle
4.1.5 Spare electrode
4.1.6 Flow-through cell
4.1.7 Sample logbook

APPROVALS		
Author		Date
Supervisor		Date
Group Leader	[illegible]	Date 8/4/93
Section Head	Gail Little	Date 8/6/93

4.2 MATERIALS

4.2.1 Glass or disposable beakers
4.2.2 Deionized water
4.2.3 Standard buffer solutions, pH 4.00, 7.00, and 10.00
4.2.4 Litmus paper
4.2.5 Water Sample Data Record sheets
4.2.6 Electrode filling solution
4.2.7 Electrode storage solution
4.2.8 Electrode cleaning solution

5.0 RESPONSIBILITY

5.1 Field technicians are responsible for following this procedure when measuring the pH of water samples.

6.0 DEFINITIONS

6.1 **pH**: hydrogen ion (H^+) concentration of a solution; the greater the hydrogen ion concentration, the more acidic the solution.

6.2 **Buffer solutions**: solutions of essentially stable pH. These solutions contain both a weak acid and its conjugate weak base; the pH changes only slightly on addition of acid or base.

6.3 **Flow-through cell**: a closed container made of inert material with connections and outlets for hoses and measuring probes.

7.0 PROCEDURE

7.1 Check the pH meter before taking it into the field.

7.1.1 Visually inspect the instrument, examining all wires and probes for damage.

7.1.2 Check the glass bulb at the end of the pH electrode to ensure that it is not broken.

7.2 In the field, prepare the electrode for use.

7.2.1 Fill the electrode with the correct filling solution according to the manufacturer's operating instructions.

7.2.2 Close or cover the filling hole to keep the solution from spilling.

7.2.3 If using a liquid junction electrode, ensure that the level of the filling solution is always above the reference junction.

a. The filling hole should always be open when the electrode is in use.

7.2.4 To use, remove the electrode from storage solution and rinse well with deionized water.

a. Avoid rubbing the electrode, which may cause a static charge that will disrupt measurements.

b. Do not touch the delicate glass bulb on the bottom of the pH electrode.

7.2.5 Connect the pH electrode to the meter.

7.3 Calibrate the meter.

7.3.1 If necessary, use litmus paper to determine which buffers will bracket the pH of the sample.

a. Pour a little sample into a separate container.

b. Dip the litmus paper into the sample.

c. Compare the color of the pH paper to the color chart on the paper container.

7.3.2 If sample pH is known to be less than 7.00, use pH 4.00 and 7.00 buffer solutions to calibrate.

7.3.3 If sample pH is known to be greater than 7.00, use pH 7.00 and 10.00 buffer solutions to calibrate.

7.3.4 Refer to the manufacturer's operating instructions for calibration procedures.

a. Use at least a two-point calibration.

7.3.5 Rinse the electrode with deionized water.

7.3.6 Recalibrate the instrument each time it is turned on or at each sampling station.

7.3.7 Record the buffers used and date and time of calibration on the Water Sample Data Record (Appendix 1) and, if requested, in the sample logbook.

7.4 Measure the pH and temperature of surface water or groundwater using a flow-through cell.

7.4.1 Connect the flow-through cell to the pump discharge tubing.

a. Minimize the length of tubing from the top of the well/ground level to the flow-through cell.

b. Keep the tubing out of direct sunlight to avoid heating the sample.

c. Attempt to keep water at the same temperature during sampling and pH measurement.

7.4.2 Place the probes in the flow-through cell and allow pH and temperature readings to stabilize.

7.4.3 When readings have stabilized, record the pH and temperature on the Water Sample Data Record.

7.4.4 If the pH of the sample does not fall between the calibration buffer pH values, recalibrate using buffers that bracket the sample pH and remeasure the pH and temperature using fresh sample.

7.5 Measure the pH of a water sample without the use of a flow-through cell.

7.5.1 Thoroughly rinse a beaker with sample water.

7.5.2 Place the pH and temperature probes into the beaker.

7.5.3 Pour in fresh or new sample.

7.5.4 After allowing the readings to stabilize, read the temperature and pH of the sample.

7.5.5 Record the pH, temperature, and time of sampling on the Water Sample Data Record.

7.5.6 Rinse the probes thoroughly with deionized water.

7.5.7 Recalibrate the instrument every time it is turned on or at each sampling station.

7.6 Record the following information on the Water Sample Data Record:

7.6.1 buffer solutions used (4.00 and 7.00 or 7.00 and 10.00);

7.6.2 temperature of buffers at calibration;

7.6.3 temperature of sample;

7.6.4 pH reading of sample;

7.6.5 time of sampling;

7.6.6 weather conditions (cloudy, windy, rainy, etc.);

7.6.7 time and date of the last pH calibration;

7.6.8 pH readings during calibration.

7.7 Rinse the electrodes thoroughly with deionized water and store according to manufacturer's recommendation.

Appendix 1. Water Sample Data Record

Water Sample Data Record

Project:	Location:	Date:	Field#:
Samplers:	Time Start:	Time Completed:	
No. of Completions:	Depth to Water:	Total Well Depth:	Well Volume:
Well Diameter:	Screened Interval:	Volume Purged:	Weather Conditions:
Sampling Equipment Used:		PID:	

No. of Bottles	Bottle Size/Description	Filtered	Preservative	Analyses Requested

Instrument Calibrations

Conductivity				
Standard Values				Calib. time:
Measured Value				
Temp. of Std.				
pH				
Standard				Calib. time:
Temp. of Std.				

Sample Parameters

Time	Temp.	Conductivity	pH	Time	Temp.	Conductivity	pH

MEASUREMENT OF ELECTRICAL CONDUCTIVITY OF WATER SAMPLES

1.0 PURPOSE

This procedure describes the activities necessary for measuring the electrical conductivity of water samples.

2.0 APPLICABILITY

This procedure applies to electrical conductivity measurement of all water samples.

3.0 OTHER DOCUMENTS

3.1 REFERENCES

3.1.1 Conductivity meter user's manual

3.2 APPENDICES

3.2.1 Appendix 1: Water Sample Data Record

4.0 EQUIPMENT AND MATERIALS

4.1 EQUIPMENT

4.1.1 Conductivity meter
4.1.2 Thermometer or temperature probe
4.1.3 Flow-through cell

4.2 MATERIALS

4.2.1 Glass or disposable beakers
4.2.2 Deionized water
4.2.3 Wash bottle

APPROVALS		
Author		Date
Supervisor		Date
Group Leader	[illegible]	Date 8/4/93
Section Head	Gail Little	Date 8/6/93

4.2.4 Conductivity standards
4.2.5 Water Sample Data Record sheets

5.0 RESPONSIBILITY

5.1 Field technicians measuring the electrical conductivity of water samples are responsible for following this procedure.

6.0 DEFINITIONS

6.1 **Electrical conductivity**: the property of a substance that describes its ability to transfer electricity; the reverse of resistivity.

6.2 **Flow-through cell**: a closed sample container made of inert material with connections and outlets for hoses and measuring probes.

7.0 PROCEDURE

7.1 Inspect the conductivity meter before taking it into the field.

7.1.1 Several different instruments are available for measuring conductivity, each with different features. Read the user's manual to acquaint yourself with the instrument.

7.1.2 Examine all wires, cables, and probes for damage and replace if necessary.

7.2 In the field, check the instrument response against known conductivity standards.

7.2.1 Rinse the electrical conductivity and temperature probes with deionized water.

7.2.2 If possible, select two standards that will bracket the expected conductivity of the sample.

7.2.3 Measure and record the temperature and conductivity of the standards.

7.2.4 Correct the readings to 25°C, if necessary, with the following equation:

$$\text{conductivity at } 25°\text{C} = \frac{\text{conductivity at T} \times \text{cell constant}}{1 + 0.0191\,(T - 25°)}$$

where T = measured temperature, °C.

a. If the instrument has an automatic temperature compensating mode (ATC), the above calculation is not necessary.

7.2.5 When measured, conductivity standards should fall within ±10% of the given values. If not, consult the instrument user's manual for troubleshooting assistance.

7.2.6 Rinse the probes with deionized water.

7.3 Measure the conductivity of a sample using a flow-through cell.

7.3.1 Obtain groundwater samples with a non-gas-contact pump.

a. Do not filter samples before analysis.

7.3.2 Connect the flow-through cell to the pump discharge tubing.

a. Minimize the length of tubing from the top of the well/ground level to the flow-through cell.

b. Keep the tubing out of direct sunlight to avoid heating the sample.

7.3.3 Place probes in the flow-through cell and allow conductivity and temperature readings to stabilize.

7.3.4 Record the time, electrical conductivity, and temperature of the sample on the Water Sample Data Record (Appendix 1).

7.4 Measure the conductivity of a sample without the use of a flow-through cell.

7.4.1 Thoroughly rinse a beaker with sample water.

7.4.2 Pour in fresh sample.

7.4.3 Immerse the probes in the sample and allow the readings to stabilize.

7.4.4 Record the time, electrical conductivity, and temperature of the sample on the Water Sample Data Record.

7.4.5 When measuring surface water directly, keep the probes several inches from large rocks since they can bias the reading.

7.5 Record the following information on the Water Sample Data Record:

7.5.1 standard values,

7.5.2 measured values of standards,

7.5.3 temperature of standards,

7.5.4 temperature of sample,

7.5.5 conductivity of sample,

7.5.6 time of sampling,

7.5.7 weather conditions (cloudy, windy, rainy, etc.) and,

7.5.8 time of last calibration check.

7.6 Rinse the probes with deionized water and store.

Appendix 1. Water Sample Data Record

Water Sample Data Record

Project:	Location:	Date:	Field#:
Samplers:	Time Start:	Time Completed:	
No. of Completions:	Depth to Water:	Total Well Depth:	Well Volume:
Well Diameter:	Screened Interval:	Volume Purged:	Weather Conditions:
Sampling Equipment Used:		PID:	

No. of Bottles	Bottle Size/Description	Filtered	Preservative	Analyses Requested

Instrument Calibrations

Conductivity				
Standard Values				Calib. time:
Measured Value				
Temp. of Std.				
pH				
Standard				Calib. time:
Temp. of Std.				

Sample Parameters

Time	Temp.	Conductivity	pH	Time	Temp.	Conductivity	pH

MEASUREMENT OF DISSOLVED OXYGEN IN WATER SAMPLES

1.0 PURPOSE

This procedure describes the activities necessary for measuring the dissolved oxygen (DO) content of water samples.

2.0 APPLICABILITY

This procedure applies to measurement of dissolved oxygen in surface-water and groundwater samples.

3.0 OTHER DOCUMENTS

3.1 REFERENCES

3.1.1 DO meter user's manual

3.2 APPENDICES

3.2.1 Appendix 1: Water Sample Data Record
3.2.2 Appendix 2: Correction Factors for Dissolved Oxygen Saturation Values Determined by Pressure or Altitude
3.2.3 Appendix 3: Dissolved Oxygen Saturation Values at Various Temperatures

4.0 EQUIPMENT AND MATERIALS

4.1 EQUIPMENT

4.1.1 DO meter and probe
4.1.2 Sampling chamber
4.1.3 Portable barometer
4.1.4 Field logbook

APPROVALS		
Author		Date
Supervisor		Date
Group Leader	[illegible]	Date 8/4/93
Section Head	[illegible]	Date 8/6/93

4.2 MATERIALS

4.2.1 Deionized water
4.2.2 Wash bottle
4.2.3 Standard solution
4.2.4 Spare membranes
4.2.5 Water Sample Data Record sheets

5.0 RESPONSIBILITY

5.1 Field technicians measuring the dissolved oxygen content of water samples are responsible for following this procedure.

6.0 PROCEDURE

6.1 Inspect the DO meter before taking it into the field.

6.1.1 Examine all wires, cables, and probes for damage and replace if necessary.

6.2 Calibrate the instrument in the field according to the manufacturer's instructions.

6.3 Measure the DO content of groundwater.

6.3.1 Rinse the sample chamber and probe with deionized water before and after each sample to remove any contamination.

6.3.2 Obtain groundwater samples using a submersible pump, bladder pump, or other method that minimizes degassing of the samples.

6.3.3 Do not filter samples before analysis.

6.3.4 Measure the DO content of the sample according to the instrument manufacturer's directions.

6.3.5 Record the DO content and sampling time in the project or field logbook or on the Water Sample Data Record (Appendix 1) in the Comments section.

a. Record DO values to the nearest 0.1 ppm.

6.4 Calculate the DO saturation value by multiplying the DO value by the correction factor from Appendix 2.

6.4.1 Determine the barometric pressure at the site using a portable barometer or by contacting a local weather information service.

a. If neither of these methods is available, determine the approximate elevation of the sampling site.

6.4.2 Use the measured barometric pressure, if available, or the altitude to determine the correction factor.

6.5 Record the following information in the field or project logbook:

6.5.1 date and time zero check was last performed,

6.5.2 atmospheric pressure or elevation of the sampling site,

6.5.3 temperature of the sample,

6.5.4 DO saturation value from Appendix 3,

6.5.5 DO saturation value corrected for pressure from Appendix 2,

6.5.6 calibration values, and

6.5.7 measured DO.

6.6 Note any drifting measurements on the Water Sample Data Record or field logbook. Instrument drift often occurs in cold weather for samples containing less than 1 ppm DO.

6.7 Rinse the sampling chamber and probe with deionized water and store in the storage case.

Appendix 1. Water Sample Data Record

Water Sample Data Record

Project:		Location:	Date:	Field#:
Samplers:		Time Start:	Time Completed:	
No. of Completions:		Depth to Water:	Total Well Depth:	Well Volume:
Well Diameter:	Screened Interval:	Volume Purged:	Weather Conditions:	
Sampling Equipment Used:			PID:	

No. of Bottles	Bottle Size/Description	Filtered	Preservative	Analyses Requested

Instrument Calibrations

Conductivity				
Standard Values				Calib. time:
Measured Value				
Temp. of Std.				
pH				
Standard				Calib. time:
Temp. of Std.				

Sample Parameters

Time	Temp.	Conductivity	pH	Time	Temp.	Conductivity	pH

Appendix 2. Correction Factors for Dissolved Oxygen Saturation Values as Determined by Pressure or Altitude

Pressure, mm	Altitude, ft	Correction Factor
775	-540	1.02
760	0	1.00
745	542	0.98
730	1094	0.96
714	1688	0.94
699	2274	0.92
684	2864	0.90
669	3466	0.88
654	4082	0.86
638	4756	0.84
623	5403	0.82
608	6065	0.80
593	6744	0.78
578	7440	0.76
562	8204	0.74
547	8939	0.72
532	9694	0.60
517	10472	0.68
502	11272	0.66

Appendix 3. Dissolved Oxygen Saturation Values at Various Temperatures

Temp., °C	Sat. Value, ppm	Temp., °C	Sat. Value, ppm
0	14.6	23	8.7
1	14.2	24	8.5
2	13.9	25	8.4
3	13.5	26	8.2
4	13.2	27	8.1
5	12.8	28	7.9
6	12.5	29	7.8
7	12.2	30	7.7
8	11.9	31	7.5
9	11.6	32	7.4
10	11.3	33	7.3
11	11.1	34	7.2
12	10.8	35	7.1
13	10.6	36	7.0
14	10.4	37	6.8
15	10.2	38	6.7
16	9.9	39	6.6
17	9.7	40	6.5
18	9.5	41	6.4
19	9.3	42	6.3
20	9.2	43	6.2
21	9.0	44	6.1
22	8.8	45	6.0

OAK RIDGE NATIONAL LABORATORY Health Sciences Research Division	PROCEDURE Environmental Technology Section	Number: TE-064 Page: 1 of 5 Revision: 0 Date: 4/15/93

MEASUREMENT OF ALKALINITY OF WATER SAMPLES

1.0 PURPOSE

This procedure describes the activities necessary for measuring the alkalinity of water samples.

2.0 APPLICABILITY

This procedure applies to measurement of alkalinity of surface-water and ground-water samples.

3.0 OTHER DOCUMENTS

3.1 REFERENCES

3.1.1 Hach Digital Titrator Methods Manual

3.2 APPENDICES

3.2.1 Appendix 1: Water Sample Data Record

4.0 EQUIPMENT AND MATERIALS

4.1 EQUIPMENT

4.1.1 Hach alkalinity test kit, Model AL-DT
4.1.2 Field logbook

4.2 MATERIALS

4.2.1 Water Sample Data Record sheets

APPROVALS		
Author		Date
Supervisor		Date
Group Leader	[illegible]	Date 8/4/93
Section Head	Craig Little	Date 8/6/93

5.0 RESPONSIBILITY

5.1 Field technicians measuring the alkalinity of water samples are responsible for following this procedure.

6.0 DEFINITIONS

6.1 **Alkalinity:** the capability of water to neutralize acids; the state of being alkaline. Carbonates, bicarbonates, and hydroxides most often cause alkalinity in natural waters.

6.2 **Titration:** a method for determining the concentration of a substance in solution by adding a standard solution until a reaction is completed, usually as indicated by a change in color due to an indicator.

6.3 **Titrant:** the substance (standard solution) that is added in a titration.

7.0 PROCEDURE

7.1 Inspect the Hach alkalinity kit before taking it into the field.

7.1.1 Ensure that all reagents are present and glassware is clean. Replace and/or clean if necessary.

7.2 Obtain groundwater samples using a non-gas-contact pump or bailer to minimize degassing of the samples.

7.2.1 Do not filter samples before analysis.

7.3 Measure the alkalinity of groundwater or surface water.

7.3.1 Select the sample volume and H_2SO_4 titration cartridge from the Hach kit according to the expected alkalinity concentration. Use the following table:

Range, mg/L as $CaCO_3$	Sample Volume,	Titration Cartridge, mL	Correction Factor *N* H_2SO_4
10 - 40	100	0.1600	0.1
40 - 160	25	0.1600	0.4
100 - 400	100	1.600	1.0
200 - 800	50	1.600	2.0
500 - 2000	20	1.600	5.0
1000 - 4000	10	1.600	10.0

NOTE: The final concentration arrived at by titration must be multiplied by the appropriate correction factor.

7.3.2 Attach a clean delivery tube to the sulfuric acid titration cartridge.

7.3.3 Twist the cartridge onto the titrator body.

7.3.4 Flush out the delivery tube by turning the small knob until a few drops of titrant are ejected.

7.3.5 Wipe the tip and reset the counter to zero.

7.3.6 Using a clean 100-mL graduated cylinder, take the appropriate volume of water sample and dilute to 100 mL if necessary with deionized water.

7.3.7 Pour the sample into a clean 250-mL Erlenmeyer flask.

7.3.8 Add the contents of one phenolphthalein indicator powder pillow and swirl to mix.

7.3.9 If the color turns pink, titrate with the sulfuric acid standard solution to a colorless end point (pH 8.3).

a. Titrate by swirling the water in the Erlenmeyer flask and adding titration solution by twisting the small knob on the dispenser.

7.3.10 If the pink color does not develop, proceed with Step 7.3.12.

7.3.11 Read and record the concentration of phenolphthalein alkalinity as mg/L $CaCO_3$.

a. If the 0.1600 *N* H_2SO_4 titration cartridge is used, determine the alkalinity by dividing the reading on the digital counter window by 10. Multiply by the appropriate correction factor.

b. If the 1.600 *N* H_2SO_4 titration cartridge is used, determine the alkalinity by reading directly from the digital counter window. Multiply by the appropriate correction factor.

7.3.12 Add the contents of one bromcresol green/methyl red indicator powder pillow to the same sample and swirl to mix.

7.3.13 Continue to titrate with the sulfuric acid standard solution to one of the following:

a. light greenish blue-gray (pH 5.1) if alkalinity is approximately 30 mg/L,

b. light bluish pink-gray (pH 4.8) if alkalinity is approximately 150 mg/L,

c. light pink (pH 4.5) if alkalinity is approximately 500 mg/L.

7.3.14 Read and record the concentration of total alkalinity as mg/L $CaCO_3$.

a. If the 0.1600 *N* H_2SO_4 titration cartridge is used, determine the alkalinity by dividing the reading on the digital counter window by 10.

b. If the 1.600 *N* H_2SO_4 titration cartridge is used, determine the alkalinity by reading directly from the digital counter window.

7.4 Record the following information in the field logbook or in the Comments section of the Water Sample Data Record (Appendix 1):

7.4.1 normality of titration cartridge,

7.4.2 temperature of sample,

7.4.3 phenolphthalein alkalinity, to the nearest 10 mg/L, and

7.4.4 total alkalinity, to the nearest 10 mg/L.

7.5 If concentrations of hydroxide or bicarbonate alkalinity are needed, see the Hach methods manual for more information.

Appendix 1. Water Sample Data Record

Water Sample Data Record

Project:		Location:			Date:		Field#:
Samplers:			Time Start:			Time Completed:	
No. of Completions:		Depth to Water:			Total Well Depth:		Well Volume:
Well Diameter:	Screened Interval:		Volume Purged:		Weather Conditions:		
Sampling Equipment Used:						PID:	

No. of Bottles	Bottle Size/Description	Filtered	Preservative	Analyses Requested

Instrument Calibrations

Conductivity				
Standard Values				Calib. time:
Measured Value				
Temp. of Std.				
pH				
Standard				Calib. time:
Temp. of Std.				

Sample Parameters

Time	Temp.	Conductivity	pH	Time	Temp.	Conductivity	pH

SOIL SAMPLING WITH A BARREL AUGER

1.0 PURPOSE

This procedure describes the method used for collecting surface and shallow subsurface soil samples with manually operated barrel augers with and without a thin-walled tube sampler. The method is best suited to nongravelly soil.

2.0 APPLICABILITY

2.1 BARREL AUGER

A barrel auger is used to obtain a sample at a desired soil depth. It consists of a section of tube or pipe (the barrel portion) attached to an orchard bit. The bit cuts the soil and forces cuttings into the barrel, which holds the soil cuttings and presents contact with the borehole sidewalls, thus minimizing sample contamination by soil from other parts of the borehole. If the barrel auger is used to collect samples, cuttings from the top of the barrel and soil lodged in the bit must be discarded in order to guarantee that no cross-contamination occurs.

2.2 BARREL AUGER USED WITH A THIN-WALLED TUBE SAMPLER

The thin-walled tube sampler consists of a metal tube with an inside diameter of typically 1 in. or less, which is manually pressed into the soil to obtain a relatively undisturbed core. It is used to sample soil below the bottom of the borehole. It may also be used in conjunction with an auger after the auger bores to the desired depth. The chief advantage of using a barrel auger with the sampler over use of the auger alone is that cross-contamination is virtually eliminated. The chief disadvantage is the small volume of the sample (Reference 3.1.1).

Approved by:

Nic Rento 9/25/90 (Date)

Craig Little 9/26/90 C.A. Little (Date)

3.0 OTHER DOCUMENTS

3.1 REFERENCES

3.1.1 P.E. Ford, P.J. Turina, and D.E. Seely, "Subsurface Solid Sampling with Auger and Thin-Walled Tube Sampler," pp. 5-7 in Characterization of Hazardous Waste Sites -- A Methods Manual, Vol. 2, Meth. II-2, EPA-600/4-83-040, U.S. EPA, Office of Research and Development, Las Vegas, Nevada, 1983.

3.1.2 Procedure TE-073, "Equipment Decontamination"

3.1.3 Procedure TE-072, "Soil Sample Packaging and Preservation"

3.1.4 Procedure TE-071, "Sample Documentation"

3.2 APPENDICES

3.2.1 Appendix 1: "Soil/Sediment Sample Data Record"

4.0 EQUIPMENT

4.1 barrel auger;

4.2 thin-walled tube sampler;

4.3 stainless steel spoon;

4.4 stainless steel knife;

4.5 dowel (up to 5 ft long, 0.5 to 1 in. diam);

4.6 disposable surgical gloves;

4.7 leather gloves;

4.8 metal trays;

4.9 metal tape measure (12 ft);

4.10 JMC Backsaver Handle or similar tool;

4.11 Dyalon mallet;

4.12 sample containers; and

4.13 sample labels.

5.0 PROCEDURE

5.1 Clear the sampling area of any surface debris or litter.

5.2 Begin augering, periodically removing any accumulated material from the auger barrel. If the soil is loose and runs through the bottom of the auger, use the dowel to lightly compact the soil in the barrel before lifting it out of the hole.

5.3 For inorganic analysis samples only.

When the desired depth is reached, remove the auger and clean it according to Reference 3.1.2. Measure and record the depth with a metal tape measure. Lower the auger into the hole, being careful not to loosen the soil on the sidewalls, and drill one full barrel length, usually 6 to 9 in. Use a dowel to compact the soil in the barrel if the soil is loose and runs out the bottom of the auger. Carefully remove the auger from the hole. Use the spoon to remove and discard the upper 1 or 2 in. of soil from the top of the barrel and remove exposed soil in the bit below the barrel to minimize cross-contamination. Measure the depth of the sample with a tape measure and record on the soil/sediment sample data record (Appendix 1).

5.4 For organic analysis samples only.

When the desired depth is reached with the barrel auger, measure the depth of the hole with a tape measure. Carefully lower the thin-walled tube sampler into the hole. Gradually press the sampler into the soil, being careful to avoid any contact with the walls of the hole by the sampler extension rods. If the soil resists penetration, use the JMC Backsaver handle or drive with the Dyalon mallet. When the coring is complete, twist the sampler gently to break the core at the base. Remove the sampler and discard the upper 2 in. of the core.

5.5 Transfer sample from the auger or tube sampler to the sample container over a metal tray. Use a knife to remove the packed soil from the barrel auger if necessary. Transfer any soil falling on the metal tray to the sample container; package and store the sample according to Reference 3.1.3.

5.6 Document the sarnple according to Reference 3.1.4.

5.7 Decontaminate trays, spoon, knife, and any other equipment in contact with the soil according to Reference 3.1.2. When used for auger sampling, the

auger needs to be cleaned only immediately prior to taking a sample. It is not necessary to clean the auger when it is only used for drilling the hole.

5.8 Specialized augers may be obtained for loose, sandy soil and heavy, clayey soil. A barrel auger for clay soil is typically open-sided to facilitate removal of the clay cuttings. Such an auger should be used only for penetration and not for sampling.

Appendix 1. Soil/Sediment Sample Data Record

Oak Ridge National Lab
Grand Junction Office
P.O. Box 2567
Grand Junction, CO 81502
(303) 248-6209
(FTS) 326-6209

SOIL / SEDIMENT SAMPLE DATA RECORD

Field No. _____

Location _____

Time Sampled _____ ☐ AM ☐ PM Date _____

Field Information _____

_____

_____

No. of Containers	Container Size/Description	Preservative	Analyses Requested

Sampler _____

UCN 17191 (9/90)

SAMPLE DOCUMENTATION

1.0 DISCUSSION

This procedure applies to all samples collected for outside laboratory analysis. Sample documentation begins with a 17-character description written in black, permanent ink in the project logbook. This sample numbering system is for Oak Ridge National Laboratory/Pollutant Assessment Group (ORNL/PAG) tracking and identification only. A four-digit number is used to interface with the analytical lab. The four-digit number appears in the project logbook, sample label (Appendix 1), soil/sediment sample data record (Appendix 2), chain of sample custody form (Appendix 3), and the ORNL/CAT data base.

2.0 OTHER DOCUMENTS

2.1 Appendix 1: Sample Label

2.2 Appendix 2: Soil/Sediment Sample Data Record

2.3 Appendix 3: Chain of Sample Custody

3.0 PROCEDURE

3.1 SAMPLE IDENTIFICATION SYSTEM

3.1.1 Each sample is identified according to the following description:

AA	AA	NNN	AA	NN NN NN	NNN
Site ID	Sample source	Well, Borehole #	Matrix	(MM DD YY) Date	Sample # or depth

A = Alpha

N = Numeric

Approved by:

Nic Kate 9/25/90 (Date)

Craig Little 9/26/90 (Date)
C.A. Little

3.1.2 Site ID:

Two letters signify the installation or project.

Sample Source:

BH = Borehole	SD = Sediment
MW = Monitoring well	VG = Vegetation
SF = Surface soil	OT = Other
FB = Field blank	ER = Equipment rinse
TB = Trip blank	SW = Surface water

3.1.3 Well or borehole number:

Each sampling location is given a unique sequential number beginning with 01. Multiple completion wells are designated according to the completion that was sampled, where U = upper, M = middle, and L = lower. This designation is placed immediately after the monitoring well number (see examples).

3.1.4 Matrix:

GW = Groundwater	SR = Soil replicate
SO = Soil	WR = Water replicate
RI = Rinsate	WT = Water
SL = Sludge	DI = Deionized water
GR = Grab	MB = Matrix Blank

3.1.5 Event date:

The date of the sampling event is recorded as part of the sample number by using two-digit numeric designations for the month and day and year (e.g., March 14, 1990, is shown as 031490).

3.1.6 Sample number from borehole or monitoring well:

Sequential numbers signifying the depth at which the sample was taken are assigned to each soil sample as it is collected from a particular borehole. Groundwater samples are noted according to the number of samples taken from a particular well on the same day. For example, if the well was sampled once during the day, the final digits are 01. If it was sampled twice, the second sampling event would have the digits 02, etc.

3.1.7 Examples:

1. ABBH003SO-031490-19

   AB: Site abbreviation is AB.
   BH: Sample is from a borehole.
   03: Borehole is labeled 003.
   SO: The sample collected is soil.
   031490: The sample was collected on March 14, 1990.
   19: The sample was taken at a depth of 19 ft.

2. ABTB-000DI-031290-01: Signifies a trip blank taken for site abbreviated AB, it is deionized water bottled on September 23, 1987, and it is the first trip blank of the sampling trip.

3. ABER001RI-031490-01: Site AB, equipment rinse, taken at location 001 (borehole or monitoring well, etc.) on 3/14/90, the first rinsate collected at site 01 on that day.

4. ABMW001WR-031490-02: Site AB, monitoring well 01, replicate, taken on March 14, 1990. The original sample would be labeled ABMW001GW-031490-01.

5. ABMW-27LGW-031490-01: Site AB, monitoring well MW027, collected from the lower completion (L), groundwater, March 14, 1990, the first sample from MW027 (L) on that day.

3.1.8 A numeric segment which does not apply to a particular sample is designated 000.

3.1.9 Circumstances may arise in which portions of the labeling system need to be modified to accommodate a sample. Changes must be documented in the appropriate field logbooks and brought to the attention of the site project manager (SPM).

3.2 SOIL/SEDIMENT SAMPLE DATA RECORD

The purpose of the Soil/Sediment Sample Data Record (Appendix 2) is to document the collection of soil samples taken at locations other than a borehole. Borehole soil samples are documented on the well summary information sheet.

3.3 CHAIN OF SAMPLE CUSTODY FORM

3.3.1 The chain of custody procedure creates an accurate written record that can be used to trace the handling and possession of the sample from its collection through analysis and, if necessary, its introduction as evidence.

3.3.2 A sample is in "custody" if:

1. it is in one's actual possession; or
2. it is in one's view, after being in one's possession; or
3. it is in one's physical possession and then locked up so that no one can tamper with it; or
4. it is restricted and kept in a secured area.

3.4 TRANSFER OF CUSTODY AND SHIPMENT

3.4.1 When transferring the samples, the transferee must sign and date the chain of custody record (Appendix 3). Every person taking custody must fill in the appropriate section of the form. Although couriers are not considered custodians, a copy of the airbill must be obtained by everyone who relinquishes custody.

3.4.2 The completed form is placed in a plastic bag, sealed and taped to the underside of the cooler lid placed on top of the samples. The original accompanies the samples to the laboratory; the carbon copy is retained by the sampling team.

Appendix 1. Sample Label

UCN 17186 8/90

Oak Ridge National Lab/Pollutant Assessment Center

Sample No. _____

Date/Time Sampled _____

Filtered ☐No ☐.45 μ ☐Glass fiber ☐Other

Preserved ☐No ☐HCl ☐HNO_3 ☐H_2SO_4

☐Other _____

Analysis _____

Field Information _____

_____

Collector _____

Appendix 2. Soil/Sediment Sample Data Record

Oak Ridge National Lab
Grand Junction Office
P.O. Box 2567
Grand Junction, CO 81502
(303) 248-6209
(FTS) 326-6209

SOIL / SEDIMENT SAMPLE DATA RECORD

Field No. _____

Location _____

Time Sampled _____ ☐ AM ☐ PM Date _____

Field Information _____

_____

_____

No. of Containers	Container Size/Description	Preservative	Analyses Requested

Sampler _____

Appendix 3. Chain of Sample Custody

ornl OAK RIDGE NATIONAL LABORATORY
Grand Junction Office

Mailing Address
P.O. Box 2567
Grand Junction, CO 81502

Street Address
2597 B¼ Road
Grand Junction, CO 81503

Phone (303) 248-6200

Chain of Sample Custody

Page _____ of _____

Date _____

1. Project No. _____ 2. Project Name _____

3. Sample No.	4. Sample Type	5. Remarks

6. Relinquished By	Date	Dept.	Received By	Date	Dept.

7. Company Name _____

Received By _____

Date _____

Distribution: Original accompanies samples, copies to relinquishers.

UCN 17189 8/90

SAMPLE PACKAGING, PRESERVATION, AND SHIPPING

1.0 PURPOSE

This procedure provides guidance for sample volume requirements, container types, container cleaning, sample preservation, holding times, and sample packing and shipping.

2.0 APPLICABILITY

This procedure applies to the following types of samples: water, wastes, sediment, sludge, and soil. The following types of analyses are included: physical parameters of water samples, metals, nonmetallic parameters, organic compounds, and radionuclides.

3.0 OTHER DOCUMENTS

3.1 REFERENCES

3.1.1 Procedure TE-071, Sample Documentation

3.1.2 49 CFR Parts 171, 172, 173, Code of Federal Regulations.

3.1.3 *USEPA Contract Laboratory Program Statement of Work for Inorganics Analysis*. Doc. No. ILM02.0. U.S. Environmental Protection Agency, 1990.

3.1.4 *Test Methods for Evaluating Solid Waste, Volume II: Field Manual*. 3rd edition, SW-846. Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, revised through 1992.

3.1.5 40 CFR Part 136, Code of Federal Regulations.

APPROVALS		
Author		Date
Supervisor		Date
Group Leader	[illegible]	Date 8/4/93
Section Head	[illegible]	Date 8/6/93

3.1.6 *USEPA Contract Laboratory Program Statement of Work for Organics Analysis*. Doc. No. OLM01.8. U.S. Environmental Protection Agency, 1991.

3.1.7 *Leaking Underground Fuel Tank Field Manual*, State of California Leaking Underground Fuel Tank (LUFT) task force, December, 1987.

3.1.8 *General Radiochemical Analytical Services Protocol, Statement of Work.* Draft. U.S. Environmental Protection Agency, 1992.

3.2 APPENDICES

3.2.1 Appendix 1: Requirements for Measurement of Physical Parameters of Water Samples
3.2.2 Appendix 2: Requirements for Analysis of Metals in Water and Soil Samples
3.2.3 Appendix 3: Requirements for Analysis of Nonmetallic Parameters
3.2.4 Appendix 4: Requirements for Analysis of Organic Compounds in Water and Soil Samples
3.2.5 Appendix 5: Requirements for Analysis of Radionuclides in Water and Soil Samples

4.0 EQUIPMENT AND MATERIALS

4.1 EQUIPMENT

4.1.1 Sample containers
4.1.2 Transfer pipette and tips
4.1.3 Blue Ice™ or equivalent
4.1.4 Insulated coolers
4.1.5 Ballpoint pen, permanent black ink
4.1.6 Felt-tip marker pen, permanent black ink
4.1.7 Teflon™ wash bottles
4.1.8 Drying oven, if necessary
4.1.9 Autoclave, if necessary

4.2 MATERIALS

4.2.1 Packing material; styrofoam " packing peanuts", bubble wrap, or equivalent padding
4.2.2 Zippered plastic bags
4.2.3 Strapping tape
4.2.4 Disposable gloves: latex, Sol-vex®, other suitable plastic, or rubber
4.2.5 Paper towels

4.2.6 Hexane, if required
4.2.7 Methanol, if required
4.2.8 ASTM Type 1 deionized water, if required
4.2.9 Concentrated or 1:1 HNO_3, H_2SO_4, and HCl, if required
4.2.10 Pesticide-grade methylene chloride, if required
4.2.11 Laboratory-grade detergent

5.0 RESPONSIBILITY

5.1 It is the site sampling coordinator's responsibility to:

5.1.1 Contact the analytical laboratory before sampling begins and establish sample volume, container requirements, preservatives, and holding times for each type of analysis to be performed;

5.1.2 Ship samples via overnight courier within 24 hours of collection;

5.1.3 Inform the lab of sample shipments; and

5.1.4 Verify that the lab received the samples intact and that preservation requirements were met.

5.2 It is the project manager's responsibility to determine Department of Transportation (DOT) classification of site-specific samples.

6.0 DEFINITIONS

6.1 **1:1 nitric acid:** a diluted acid made up of one part concentrated nitric acid to one part deionized water. To prepare 500 mL of 1:1 nitric acid, mix 250 mL of concentrated nitric acid with 250 mL deionized water.

7.0 SAFETY

7.1 Acids, methylene chloride, hexane, and methanol are all potentially dangerous chemicals. Read the individual MSDS (Material Safety Data Sheet) for each chemical before using.

7.2 Wear latex or rubber gloves and safety glasses when washing containers and adding preservatives.

8.0 PROCEDURE

8.1 Volume requirements, container types, preservative methods, and holding times are shown in the appendices for the following types of samples:

8.1.1 physical parameters of water samples: Appendix 1;

8.1.2 metals: Appendix 2;

8.1.3 nonmetallic parameters: Appendix 3;

8.1.4 organic compounds: Appendix 4;

8.1.5 radionuclides: Appendix 5.

SAMPLE CONTAINERS

8.2 Use sample containers that are nonreactive with the sample and the analytes of interest.

8.2.1 Always use glass or Teflon containers with samples to be analyzed for organic compounds.

8.2.2 Use wide-mouth containers for soil and sediment and narrow-mouth containers for liquids.

8.2.3 Ensure that the rigid plastic screw caps for bottles are Teflon-lined.

8.2.4 Verify the choice of containers with the laboratory performing the analyses and with the project sampling and analysis plan.

8.2.5 Calculate the number of each type of container required, including those for duplicate samples, blanks, and spikes. Add <u>at least</u> an extra 10% to compensate for broken bottles or re-sampling.

a. Ensure that the volume of sample is sufficient to perform all the required analyses plus an additional amount to provide for any quality control needs.

b. The volumes listed in the appendices are general guidelines. Consult the laboratory receiving the sample for specific volume requirements.

<u>NOTE:</u> A sufficient number of containers must be available to ship the proper sample volume. For example, Department of Transportation (DOT) and International Air Transport Association (IATA) regulations limit the size of a sample container to 16 oz if the contents may include hazardous materials. In this case, two 500-mL or four 250-mL containers would be required to ship a 1-L liquid sample.

SAMPLE CONTAINER CLEANING

8.3 Containers precleaned to EPA specifications may be obtained from suppliers at additional cost. If cleaning is needed, follow the steps below:

8.3.1 Wear latex or rubber gloves while washing containers.

8.3.2 Inorganic compound and general-parameter analyses:

a. Wash containers, septa or liners, and closures in hot tap water with laboratory-grade detergent. Use non-phosphate detergent if phosphate is an analyte.

b. Rinse three times with tap water.

c. Rinse three times with ASTM Type 1 deionized water.

d. Dry containers, septa or liners, and closures in an oven at no higher than 70°C.

8.3.3 Trace metals analysis:

a. Wash containers, closures, and Teflon liners in hot tap water with laboratory-grade detergent.

b. Rinse three times with tap water.

c. Rinse once with 1:1 nitric acid.

d. Rinse three times with ASTM Type 1 deionized water.

e. Air dry in a contaminant-free environment.

8.3.4 Organic compounds analysis:

a. Wash containers, closures, and Teflon liners in hot tap water with laboratory-grade detergent.

b. Rinse three times with tap water.

c. Rinse once with 1:1 nitric acid.

d. Rinse three times with ASTM Type 1 deionized water.

e. Rinse once with pesticide-grade methylene chloride.

f. Oven dry at no higher than 70°C.

8.3.5 Microbiological analyses:

a. Sterilize the container and its stopper/cap by autoclaving at 121°C for 15 min or by dry heat at 180°C for 2 hrs.

b. Heat-sensitive plastic bottles may be sterilized with ethylene oxide at low temperatures.

c. The sample bottles can be wrapped with aluminum foil before sterilization.

d. An acceptable alternative sterilization method for emergency or field use is to boil the containers in water for 15 min.

8.3.6 Place Teflon liners in closures and place closures on containers.

8.3.7 Do not remove containers from preparation area until sealed.

SAMPLE PRESERVATION

8.4 Preserve samples before analysis according to the following considerations:

8.4.1 Sample containers may be ordered with the proper type and amount of preservatives in them from suppliers at additional cost. Otherwise, add preservative to a container just before sample collection.

8.4.2 Store precleaned containers, preservatives, and shipping coolers in a facility that can be locked or guarded.

8.4.3 Do not store sample containers with fuel containers or other potential sources of contamination.

8.4.4 When required, place samples in a cooler.

a. Maintain the samples at 4 ± 2°C with Blue Ice (or equivalent) or ice cubes sealed in plastic bags.

b. Avoid freezing the sample.

8.4.5 Avoid exposing the sample to temperature extremes and intense sunlight.

8.4.6 Establish before sample collection which holding times to use. Refer to the site-specific sampling plan.

SAMPLE SHIPPING

8.5 Pack and ship sample containers in insulated coolers with frozen coolant packs or ice cubes sealed in plastic bags.

8.5.1 Use packing material to keep sample bottles from direct contact with coolant packs.

a. Sample containers, frozen coolant packs, and padding material should fit tightly in the cooler.

8.5.2 Do not allow vials containing samples for analysis of volatile organics to freeze.

8.5.3 Put the completed chain of custody form in a plastic bag, seal the bag, and place in the packed cooler. See Procedure TE-071.

8.5.4 Attach two custody seals across the cooler and lid, signing and dating each one.

8.5.5 Attach the shipping label to the top of the cooler.

8.5.6 Deliver the samples or ship them to the analytical laboratory as soon as possible by overnight courier.

a. If samples are not delivered to the laboratory on a daily basis, check coolers every 24 h and replace thawed coolant as needed.

Note: Any sample shipped by common carrier or U.S. Postal Service must comply with DOT Hazardous Materials Regulations, 49 CFR Parts 171, 172, 173. The person offering such material for transport is responsible for ensuring such compliance. Consult the project manager for classification of site-specific samples.

Appendix 1. Requirements for Measurement of Physical Parameters of Water Samples

Parameters	Volume Requirement, mL	Container[a]	Preservative[b]	Holding Time[c]
Color	50	P,G	4°C	48 h
Conductance	100	P,G	4°C	28 d
Hardness	100	P,G	HNO_3 to pH<2	6 months
Odor	200	G only	4°C	24 h
pH	25	P,G	none required	Analyze immediately
Temperature	1000	P,G	none required	Analyze immediately
Turbidity	100	P,G	4°C	48 h

[a] Plastic (P) or Glass (G)

[b] Sample preservation should be performed immediately upon sample collection. For composite samples, each aliquot should be preserved at the time of collection.

[c] Samples should be analyzed as soon as possible after collection. The times listed are the maximum times that samples may be held before analysis and still considered valid.

Appendix 2. Requirements for Analysis of Metals in Water and Soil Samples

Analysis	Container: Water	Container: Soil	Preservation[a]	Holding Time[b]
TAL metals[c] except Hg and Cr^{+6}	Not specified	Not specified	HNO_3 to pH<2	180 d
SW-846 metals[d] except Hg and Cr^{+6}	600-mL PE or glass	200 g	HNO_3 to pH<2	6 months
Hg	400-mL PE or glass	200 g	HNO_3 to pH<2	26 d[c] 28 d[d]
Cr^{+6}	400-mL PE or glass	200 g	4°C	24 h

[a] Addition of chemical preservatives applies only to water samples; soils and sediments are held at 4 ± 2°C.

[b] Samples should be analyzed as soon as possible after collection. The times listed are the maximum times that samples may be held before analysis and still considered valid.

[c] These requirements are from the *USEPA Contract Laboratory Program Statement of Work for Inorganics Analysis*, U.S. Environmental Protection Agency, 1990.

[d] These requirements are from the U.S. EPA *Test Methods for Evaluating Solid Waste, Volume II: Field Manual*, 3rd edition, SW-846. Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, revised through 1992.

TAL = target analyte list
PE = polyethylene

Appendix 3. Requirements for Analysis of Nonmetallic Parameters

Analysis	Container: Water	Container: Soil	Preservation[a]	Holding Time[b]
CN^-	1-L PE	100 g	Cool to 4°C NaOH to pH>12[c]	12 d[d] 14 d[e,f]
Total Dissolved Solids (TDS)	PE or glass		4°C	7 d[e]
Total Suspended Solids (TSS)	PE or glass		4°C	7 d[e]
Alkalinity	PE or glass		4°C	14 d[d]
Nitrate	PE or glass		4°C	48 h[e]
Nitrate-nitrite	PE or glass		4°C, H_2SO_4 to pH<2	28 d[e]
Nitrite	PE or glass		4°C	48 h[e]
Orthophosphate	PE or glass		4°C, filter immediately	48 h[e]
Phosphorus, elemental	Glass		4°C	48 h[e]
Phosphorus, total	PE or glass		4°C, H_2SO_4 to pH<2	28 d[e]

[a] Addition of chemical preservatives applies only to water samples; soils and sediments are held at 4 ± 2°C.
[b] Samples should be analyzed as soon as possible after collection. The times listed are the maximum times that samples may be held before analysis and still considered valid.
[c] Add 0.6 g ascorbic acid if residual chlorine is present.
[d] These requirements are from the *USEPA Contract Laboratory Program Statement of Work for Inorganics Analysis*, U.S. Environmental Protection Agency, 1990.
[e] These requirements are from 40 CFR Part 136.
[f] These requirement are from the U.S. EPA *Test Methods for Evaluating Solid Waste, Volume II: Field Manual*, 3rd edition, SW-846. Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, revised through 1992.

PE = polyethylene

Appendix 4. Requirements for Analysis of Organic Compounds in Water and Soil Samples

Analysis	Container: Water	Container: Soil	Preservation[a]	Holding Time[b]
TCL volatile organic compounds[c]	Not specified	Not specified	Not specified	10 d
SW-846 volatile organic compounds[d]	2 40-mL septum vials with Teflon-lined caps	4-oz glass	4°C, pH<2 with H_2SO_4, HCl, or solid $NaHSO_4$	14 d
40 CFR 136 Purgeable halocarbon compounds	Glass, Teflon-lined septum	Not specified	4°C, 0.008% $Na_2S_2O_3$ [e]	14 d
40 CFR 136 Purgeable aromatic compounds	Glass, Teflon-line septum	Not specified	4°C, HCl to pH<2, 0.008% $Na_2S_2O_3$ [e]	14 d
TCL semivolatile organic compounds[c]	Not specified	Not specified	Not specified	water: 5 d/40 d[f] soil: 10 d/40 d
SW-846 semivolatile organic compounds[d]	1-gal amber glass, Teflon-lined lid	Not specified	4°C	water: 7 d/40 d[f] soil: 14 d/40 d
40 CFR 136 semivolatile organic compounds[g]	Glass, Teflon-lined septum	Glass, Teflon-lined lid	4°C	7 d/40 d, water and soil[f]
Purgeable petroleum hydrocarbon compounds as gasoline[h]	2 40-mL septum vials	500-mL wide-mouth glass, Teflon-lined lid, or brass sleeve	4°C, HCl to pH<2	14 d, water and soil
Extractable petroleum hydrocarbons as gasoline[h]	1-L glass	500-mL wide-mouth glass, Teflon-lined lid or, brass sleeve	4°C, HCl to pH<2	14 d/40 d, water and soil[f]

Appendix 4. (continued)

Analysis	Container: Water	Container: Soil	Preservation[a]	Holding Time[b]
Petroleum hydrocarbons as diesel[h]	1-L glass	500-mL wide-mouth glass, Teflon-lined lid or brass	4° C	14 d/40 d, water and soil[f]

[a] Addition of chemical preservatives applies only to water samples; soils and sediments are held at 4 ± 2° C.

[b] Samples should be analyzed as soon as possible after collection. The times listed are the maximum times that samples may be held before analysis and still considered valid.

[c] These requirements are from the *USEPA Contract Laboratory Program Statement of Work for Organics Analysis*, U.S. Environmental Protection Agency, 1991.

[d] These requirements are from the U.S. EPA *Test Methods for Evaluating Solid Waste, Volume II: Field Manual*, 3rd edition, SW-846. Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, revised through 1993.

[e] Sodium thiosulfate should be added to water samples only if residual chlorine is present.

[f] Holding times for compounds requiring extraction prior to analysis are given as the maximum time from collection (or receipt by the laboratory) to extraction, followed by the maximum allowable time from extraction to analysis.

[g] These requirements are from 40 CFR Part 136, Code of Federal Regulations.

[h] These requirements are from the *Leaking Underground Fuel Tank Field Manual,* State of California Leaking Underground Fuel Tank (LUFT) task force, December 1987.

TCL = target compound list

Appendix 5. Requirements for Analysis of Radionuclides in Water and Soil Samples[a]

Analysis	Container[b]	Preservation[c,d]	Holding Time[e]
Alpha, beta, and radium	P,G	HCl or HNO_3 to pH<2	180 d
Tritium	G	none	180 d
Isotopic uranium	P	HCl or HNO_3 to pH<2	180 d
^{90}Sr	P	HCl or HNO_3 to pH<2	180 d
^{238}Pu	P,G	HCl or HNO_3 to pH<2	180 d
^{239}Pu	P,G	HCl or HNO_3 to pH<2	180 d
^{137}Cs	P,G	HCl to pH<2 pH<2	180 d
^{241}Am	P,G	HCl or HNO_3 to pH<2	180 d

[a] Requirements for radionuclide analysis are from *General Radiochemical Analytical Services Protocol, Statement of Work.* Draft. U.S. Environmental Protection Agency, 1992.

[b] Plastic (P) or Glass (G); sample volume to be specified by analytical laboratory.

[c] Sample preservation should be performed immediately upon sample collection. Maintain the sample at 4 ± 2°C until analysis.

[d] Addition of chemical preservatives applies only to water samples; soils and sediments are held at 4 ± 2°C.

[e] Samples should be analyzed as soon as possible. The times listed are the maximum that samples may be held before analysis and still be considered valid.

EQUIPMENT DECONTAMINATION

1.0 PURPOSE

This procedure provides steps for the decontamination of all equipment used during the sampling of soil, soil gas, sludge, surface water, and groundwater.

2.0 APPLICABILITY

This procedure applies to all sampling equipment used at sites where chemical wastes (organic and inorganic) and low-level radioactive wastes are a concern.

3.0 OTHER DOCUMENTS

None

4.0 EQUIPMENT AND MATERIALS

4.1 EQUIPMENT

4.1.1 Teflon™ wash bottles
4.1.2 Plastic tubs or buckets
4.1.3 Scrub brushes, plastic or fiber bristles
4.1.4 Steam cleaner or high-pressure hot water washer

4.2 MATERIALS

4.2.1 Disposable wipes
4.2.2 Laboratory detergent, phosphate-free if phosphate is an analyte
4.2.3 Plastic trash-can liners
4.2.4 Analyte-free tap water
4.2.5 Distilled or deionized water, analyte-free
4.2.6 Pesticide-grade hexane, methanol or ethanol, if needed
4.2.7 Aluminum foil

APPROVALS		
Author		Date
Supervisor		Date
Group Leader	[illegible]	Date 8/4/93
Section Head	Craig Little	Date 8/6/93

5.0 RESPONSIBILITY

All field personnel required to decontaminate equipment are responsible for following this procedure.

6.0 SAFETY

6.1 Follow specific requirements of the site health and safety plan for appropriate personal protective equipment.

6.2 Ensure that an NFPA-type ABC fire extinguisher is nearby and fully charged if a steam cleaner or high-pressure hot water washer is being used.

6.3 Ensure that all electrical lines are protected by Ground Fault Circuit Interrupters (GFCIs) if a steam cleaner or high-pressure washer is being used.

6.4 Wear safety glasses or goggles and latex or nitrile gloves when cleaning equipment with a steam cleaner, high-pressure washer, or solvents.

6.5 Check the steam cleaner or high-pressure washer for damaged or frayed hoses or electrical lines and connections.

7.0 PROCEDURE

7.1 When choosing a site for decontamination, avoid fugitive dust, oils, gasoline, fuel oils, organic solvents, or any potential source of contamination.

7.1.1 If decontamination is performed at a site other than the location where the equipment was used, carefully transport the equipment to the decontamination area in a manner that minimizes the spread of contaminants.

7.2 Steam clean or pressure wash all well screens and casings, backhoes, dredges, augers, and other heavy equipment before use.

7.3 Clean sampling equipment after use.

7.3.1 Use the following sequence for equipment used with inorganic target analytes:

a. Remove gross contamination (e.g., mud) with tap water, if needed.

b. Wash with tap water.

c. Wash with soapy water.

d. Rinse with tap water.

e. Rinse with analyte-free deionized water.

f. Dry with disposable wipes or allow to air dry.

7.3.2 Use a different scrub brush with each wash.

7.3.3 Contain all decontamination rinse fluids in an appropriate vessel for disposal.

7.4 If samples are to be analyzed for organic compounds, decontaminate sampling equipment with organic solvents.

7.4.1 Wash equipment with analyte-free soapy water and rinse with analyte-free tap water.

7.4.2 Rinse with methanol or ethanol, followed by hexane. Solvents must be specified as pesticide-grade or better.

7.4.3 Rinse with deionized or distilled, analyte-free water.

7.4.4 Allow to air dry prior to next use.

Note: Because of the health risks involved in using solvents, particularly hexane, steam cleaning and/or copious rinsing with deionized water following a detergent wash are adequate for most situations.

7.5 If samples are to be analyzed for radionuclides, the following steps apply.

7.5.1 Scan sampling equipment for the appropriate activity, i.e., α, β, or γ.

7.5.2 If samples will be analyzed for radionuclides only, wipe the sampling equipment with a disposable wipe and remove any loose material.

7.5.3 If samples will be analyzed for radionuclides and metals but not organic compounds, use the steps in 7.3.

7.5.4 If samples will be analyzed for radionuclides, metals, and organic compounds, use the steps in 7.3 and 7.4.

7.5.5 If elevated activity was detected before decontamination, perform another scan after cleaning to confirm that equipment is back to background levels. If elevated activity is still present, do not re-use equipment.

7.6 Wrap sampling equipment for transport with aluminum foil.

7.6.1 Polyethylene sheeting or plastic bags may be used temporarily.

7.7 Document any deviations from this procedure in the sampling plan before beginning the field work.

7.8 Document equipment decontamination in the project or sample logbook or in some location specified in the sampling plan.

STREAM-SEDIMENT AND SURFACE-SOIL SAMPLING USING A PISTON-TYPE CORE SAMPLER

1.0 PURPOSE

This procedure describes the activities necessary for sampling stream bed material or soil with a hand-operated, piston-type core sampler.

2.0 APPLICABILITY

This procedure applies to sampling fine-grained stream bed material and sediment and to collecting samples in unconsolidated surface soil up to 24 in. deep.

3.0 OTHER DOCUMENTS

3.1 REFERENCES

3.1.1 Procedure TE-072, Sample Packaging, Preservation, and Shipping.
3.1.2 Procedure TE-073, Equipment Decontamination.
3.1.3 Procedure TE-071, Sample Documentation.

4.0 EQUIPMENT AND MATERIALS

4.1 EQUIPMENT

4.1.1 Stainless steel drive barrels, 6 in. and 24 in.
4.1.2 Sampler with extension rod
4.1.3 Screwdriver
4.1.4 Pipe wrench
4.1.5 Vise grips
4.1.6 Stainless steel knife or putty knife
4.1.7 Stainless steel spoon
4.1.8 Tape measure
4.1.9 Rubber hip waders, if needed

APPROVALS		
Author		Date
Supervisor		Date
Group Leader	[illegible]	Date 8/4/93
Section Head	[illegible]	Date 8/6/93

4.1.10 Camera
4.1.11 Stainless steel sample trays or bowls
4.1.12 Bucket
4.1.13 Sampling logbook

4.2 MATERIALS

4.2.1 Rubber gloves
4.2.2 Scrub brush for 2-in. i.d. cylinder
4.2.3 Sample labels
4.2.4 Sample containers
4.2.5 Film
4.2.6 Zip-lock bags
4.2.7 Paper towels and trash bags

5.0 RESPONSIBILITY

All field personnel required to sample material with a hand-operated, piston-type soil sampler are responsible for following this procedure.

6.0 DEFINITIONS

6.1 **Bed material:** the sediment mixture composing the stream bed. In alluvial streams, bed-material particles are likely to move at any moment or during some future flow condition.

6.2 **Composite sample:** a sample created by combining two or more samples or representative portions thereof.

6.3 **Sediment:** either: 1) particles derived from rocks or biological materials transported by water or 2) solid material (sludges) suspended in or settled from water.

7.0 PROCEDURE

7.1 Wear rubber gloves while sampling, while handling potentially contaminated samples or equipment, and while decontaminating.

7.2 Collect samples.

7.2.1 If sampling a stream bed, wade to the sampling point in the stream channel.

7.2.2 Using the frame handle, push the cylinder into the bed material to the desired depth with piston handle extended.

a. If necessary, pull up on the piston operating handle to activate the piston while forcing the cylinder handle into the stream bed.

7.2.3 To retract the sampler, rotate the cylinder clockwise with the frame handle and break the sediment core at the base.

a. While holding the piston handle steady to prevent losing the core, pull slowly upward using the frame handle.

7.2.4 To extract the core, push the piston handle downward.

a. Extract and slice off any unwanted core with a knife.

b. Extract the remaining core and save in a sample bottle or tray.

Example: If only the upper 3 in. of core is desired, extract the lower 5 in., slice it off, and save the remainder.

7.3 To clean the cylinder wall, submerge the cylinder in the stream water (or a bucket of water if collecting soil samples) and move the piston a full stroke several times.

7.4 If a composite sample is needed, collect and mix individual samples.

7.4.1 Store the composite sample in the appropriate container as described in Procedure TE-072.

7.5 Before decontaminating the cylinder, repeat step 7.3.

7.5.1 Use a scrub brush to wash mud off the cylinder in the stream or in a bucket of water if collecting soil samples.

7.5.2 After washing the mud off the cylinder, remove mud from the scrub brush in the stream or bucket.

a. Do not use this brush for any other step in the decontamination operation.

b. Dispose of the scrub brush at an appropriate location on site. Do NOT ship back to Grand Junction.

7.6 Package the sample as described in Procedure TE-072.

7.7 Disassemble the sampler in the following way:

7.7.1 Remove the stainless steel cylinder by turning it counterclockwise.

7.7.2. Remove brass plates from the base of the piston by turning counter-clockwise.

7.7.3 Remove the screws and brass plate at base of the piston.

7.7.4 Remove the rubber O-ring.

7.7.5 Remove the extension rod.

7.7.6 Invert the sampler and brace the T-handle.

7.8 Decontaminate the sampler as described in Procedure TE-073.

7.8.1 Pour clean water into the frame tube and piston rod of the inverted sampler to flush out any sediment or steam clean the inside of the sampler.

7.9 Reassemble the sampler.

7.9.1 The brass plate on the base of the piston presses against and partly flattens the O-ring, which, in turn, contacts the cylinder wall.

7.9.2 The piston's ease of movement can be controlled to some extent by adjusting the screws in the brass plate.

7.10 Label and document all samples according to Procedure TE-071.

7.11 Measure the distance of the sample location from permanent structures and sketch the sampling site.

7.12 Maintain a sampling logbook.

7.12.1 Describe the location of each new sample site and any prominent landmarks.

7.12.2 Photograph the upstream and downstream views, record these photographs in the logbook, and label them with site number or designations, flow conditions, difficulties in sampling, etc.

7.12.3 Record in the logbook sample numbers and analyses requested, along with any other pertinent information required for the project.

7.12.4 If required in the site-specific work plan, describe the sample with unified soil classification symbol, soil type (fill, alluvial, etc.), grain size, plasticity, consistency, moisture content, color, and other terms.

STREAM-SEDIMENT SAMPLING USING A SCOOPING DEVICE

1.0 PURPOSE

This procedure describes the activities necessary for sampling bed material in streams using a scoop, trowel, or similar device.

2.0 APPLICABILITY

This procedure is used to sample surface stream sediments when a depth profile is not required.

3.0 OTHER DOCUMENTS

3.1 REFERENCES

3.1.1 Procedure TE-073, Equipment Decontamination
3.1.2 Procedure TE-072, Sample Packaging, Preservation, and Shipping
3.1.3 Procedure TE-071, Sample Documentation

4.0 EQUIPMENT AND MATERIALS

4.1 EQUIPMENT

4.1.1 Camera
4.1.2 Polyethylene or stainless steel scoop, trowel, or similar device
4.1.3 Stainless steel sample trays
4.1.4 Sampling logbook
4.1.5 Tape measure

4.2 MATERIALS

4.2.1 Paper towels or absorbent wipes
4.2.2 Sample labels

APPROVALS		
Author		Date
Supervisor		Date
Group Leader	[illegible]	Date 8/4/93
Section Head	Craig Little	Date 8/6/93

4.2.3 Sample containers
4.2.4 Film
4.2.5 Rubber gloves

5.0 RESPONSIBILITY

All field personnel required to sample stream sediments with scooping devices are responsible for following this procedure.

6.0 DEFINITIONS

6.1 **Bed material:** the sediment mixture composing the stream bed. In alluvial streams, bed material particles are likely to move at any moment or during some future flow condition.

6.2 **Composite sample:** a sample created by combining two or more samples or representative portions thereof.

6.3 **Sediment:** either: 1) particles derived from rocks or biological materials transported by water or 2) solid material (sludges) suspended in or settled from water.

6.4 **Eolian material:** that which is deposited by wind.

7.0 PROCEDURE

7.1 Wear rubber gloves while sampling, while handling potentially contaminated samples or equipment, and while decontaminating.

7.2 Decontaminate all equipment that contacts samples according to Procedure TE-073 before and after sampling.

7.3 Take samples of sediment in a flowing stream.

7.3.1 Ensure that sampling equipment is compatible with sampling requirements. For example, when sampling for certain organic compounds, use only Teflon™, PTFE, or stainless steel.

7.3.2 Rinse the scoop in stream water.

7.3.3 Collect a scoop of sediment from the bed material below the water surface.

7.3.4 Remove the larger gravel by hand.

7.3.5 When sampling for volatile organic compounds (VOCs), cap or enclose the sample immediately upon packaging.

a. Package and store the sample according to Procedure TE-072.

7.3.6 If a composite sample is desired, repeat steps 7.3.2 through 7.3.4.

a. Collect samples for the composite, mix together in the sample tray, and package immediately.

b. When sampling for VOCs, do **NOT** collect composite samples.

c. Package and store the sample according to Procedure TE-072.

7.4 Take samples of sediment in a dry stream.

7.4.1 Where eolian contribution might be significant, scrape away the upper 2 to 3 cm of bed material to avoid eolian material in the sample.

7.4.2 Measure the sampling interval, the difference between depth before sampling and depth after sampling.

7.4.3 Collect a scoop of the sediment.

7.4.4 Remove the larger gravel by hand.

7.4.5 When sampling for VOCs, cap or enclose the sample immediately upon packaging.

a. Package and store the sample according to Procedure TE-072.

7.4.6 If a composite sample is desired, repeat steps 7.4.3 and 7.4.4.

a. Collect samples for the composite, mix in the sample tray, and package immediately.

b. When sampling for VOCs, do **NOT** collect composite samples.

c. Package and store the sample according to Procedure TE-072.

7.5 Label and document all samples according to Procedure TE-071.

7.6 Maintain a sampling logbook.

7.6.1 Describe the location of each sample site and any prominent landmarks.

7.6.2 Measure and record the distance and direction of the sampling site from a permanent structure.

7.6.3 Photograph the upstream and downstream views, record these photographs in the logbook, and label them with site number or designations, flow conditions, difficulties in sampling, etc.

7.6.4 Describe the sample material.

7.6.5 Record in the logbook sample numbers and analyses requested, along with any other pertinent information required for the project.

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SOIL-GAS AND WATER FIELD SCREENING SYSTEM

1.0 PURPOSE

The environmental field screening equipment is designed to allow the measurement of subsurface soil-gas and liquid volatile contaminants without the need for actual drilling of the location.

2.0 PROCEDURE

2.1 PROCEDURE FOR DRIVING THE PROBE

2.1.1 Attach 1/8 in. Teflon tubing to the filter well point securely and slide the tubing through 2-1/2 ft probe from the non-threaded end.

2.1.2 Attach "T" handle to down-hole hammer with bolt. Attach 6 in. union adapter to hammer head and slide tubing through side port of hammer head.

2.1.3 Place the hammer and the probe with a point into the soil and hammer the probe until the joint of the probe and union is 6 in. above ground level.

Caution: Use a "T" handle when slide hammering.

2.1.4 Unscrew the hammer and union from 2-1/2 ft probe, pull the tubing out of the hammer head, and add 3-ft probe extension(s) to the required depth.

2.1.5 When the required depth is reached, slide the SST tube union into the tubing coming out of the hammer-head side port and attach the union to the side port. Tighten the tube compression nut to form a gas-tight seal at the side port and hook up the tubing to the pump. Hammer up 3 in. to expose the gas vents in the filtered well point.

Approved by:

9/17/90 (Date)

C.A. Little 9/19/90 (Date)

2.2 SUBSURFACE PROBE POWER ADAPTERS

2.2.1 To drive a subsurface probe into soil with a jack hammer, attach a 6 in. jack-hammer adapter to a 2-1/2 ft probe.

2.2.2 To remove the probe, replace 6 in. union adapter or jack-hammer adapter with a Hi-Lift jack adapter. Attach a truck jack to the Hi-Lift adapter and jack the probe from the soil.

2.3 SURFACE PROBE ASSEMBLY AND USE

2.3.1 Attach "T" handle and 3-ft SST surface probe to the down-hole hammer.

2.3.2 Place the well point into the probe and hammer the probe to the desired depth. Then hammer up 2 in. to remove the well point.

2.3.3 Attach the tube fitting to the hammer-head side port, and attach 1/8 in. Teflon tubing to the tube fitting.

2.4 SOIL-GAS AND SOIL-LIQUID SAMPLING

2.4.1 Follow steps 1 through 4 in Sect. 2.1 for driving the probe.

2.4.2 After reaching the required depth, slide the SST tube union into the tubing coming out of the hammer-head side port and attach the union to the side port. Tighten the tube compression nut to form a gas-tight seal at the side port. Hook up the tubing to the pump, and pump the liquid into a pre-cleaned headspace sample bottle, leaving sufficient headspace for syringe injection.

a. It is critically important that no liquid is injected into the GC; it is designed for analysis of gas only.

b. The concentration of analyte found in the headspace of a water sample is a relative value used for screening purposes only (degassing of the volatile analyte occurs during suction lift pumping).

2.4.3 For soil-gas sampling, the same procedure applies except that a syringe is inserted through a septum in the tubing. Rather than pumping soil-gas into a headspace sample bottle, take an aliquote by syringe after sufficient air has been evacuated from the sample tubing.

SOIL AUGERING USING A LITTLE BEAVER MECHANICAL EARTH DRILL

1.0 PURPOSE

This procedure describes the operation of a mechanical earth drill system used to auger a hole for soil sampling.

2.0 APPLICABILITY

These operation instructions apply to the Little Beaver mechanical earth drill system.

3.0 OTHER DOCUMENTS

3.1 REFERENCES

3.1.1 Procedure TE-078, Subsoil Sampling Probe.

3.2 EXHIBITS

3.2.1 Little Beaver mechanical earth drill

4.0 EQUIPMENT AND MATERIALS

4.1 EQUIPMENT

4.1.1 Little Beaver, including:

a. Briggs and Stratton engine assembly
b. Torque tube assembly (3 pieces)
c. Operator handle and flexible drive shaft assembly

4.1.2 Carbide and pengo cutting points, 1 each
4.1.3 Auger flights
4.1.4 Leather gloves
4.1.5 Flathead shovel

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2/5/92 (Date)

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4.1.6 Slip shoe
4.1.7 Metal tape measure
4.1.8 Pipe wrenches and general tools
4.1.9 Steam cleaning machine
4.1.10 Decontamination trough
4.1.11 Auger flight A-frame
4.1.12 Bucket auger

4.2 MATERIALS

4.2.1 Disposable surgical gloves

5.0 DEFINITIONS

5.1 **Clutch:** located at the juncture of the flexible drive shaft and the engine. The clutch prevents damage to the engine should the drive shaft stop while the engine is running at full throttle. The clutch assembly may overheat if this situation is continued for more than a short time.

5.2 **Cutting bit:** attachment to the auger that actually cuts the soil. Two cutting bits are available for different augering conditions. The broad carbide cutting bit is suggested for use with clayey and/or compact soils.

5.3 **Flexible drive shaft:** a rubber-coated shaft leading from the clutch assembly on the engine to the transmission in the operator handle.

5.4 **Torque bar assembly:** connects the engine to the operator handle so that the torque occurring from the auger flight will be counteracted by the torque bar and the weight of the engine.

5.5 **Transmission:** located on the underside of the operator handle; transfers power from the flexible drive shaft to the auger flights. The transmission should be serviced daily according to maintenance instructions.

6.0 PROCEDURE

6.1 Be sure the area is clear of any underground utilities. Also be sure to check for any overhead obstructions which may be encountered when pulling the auger flights out of the hole.

6.2 Attach the torque tube assembly (larger end) to the engine bracket and thread the tube pieces together.

6.3 Attach the other end of the torque tube to the operator handle. Check that all snap pins are locked in the corresponding holes.

6.4 Check to make sure the stop switch is in the ON position and that all engine fluids are full before starting the engine. Allow 2 to 3 minutes for the engine to warm up before augering.

6.5 Slide the auger top into the adaptor at the bottom of the transmission. Important: Be sure the spring-loaded button snaps into the mating hole to hold it in place.

6.6 Hold the operator handle with left index finger on the throttle lever and right hand on the handle bar. The leg pad should be placed against left leg when starting the auger.

6.7 Pull the throttle in completely and allow the auger to turn at full speed. Allow the auger to cut into the soil with little or no pressure applied to the operator handle. Increase or decrease the pressure on the operator handle once the auger has started a hole and as soil conditions dictate.

Note: If the auger strikes an immovable object or cuts too fast to clean the hole, the centrifugal clutch will slip to protect the mechanical components and the operator from kickback. If the auger flight will not turn it may be necessary to use a pipe wrench to "unscrew" the auger from the hole.

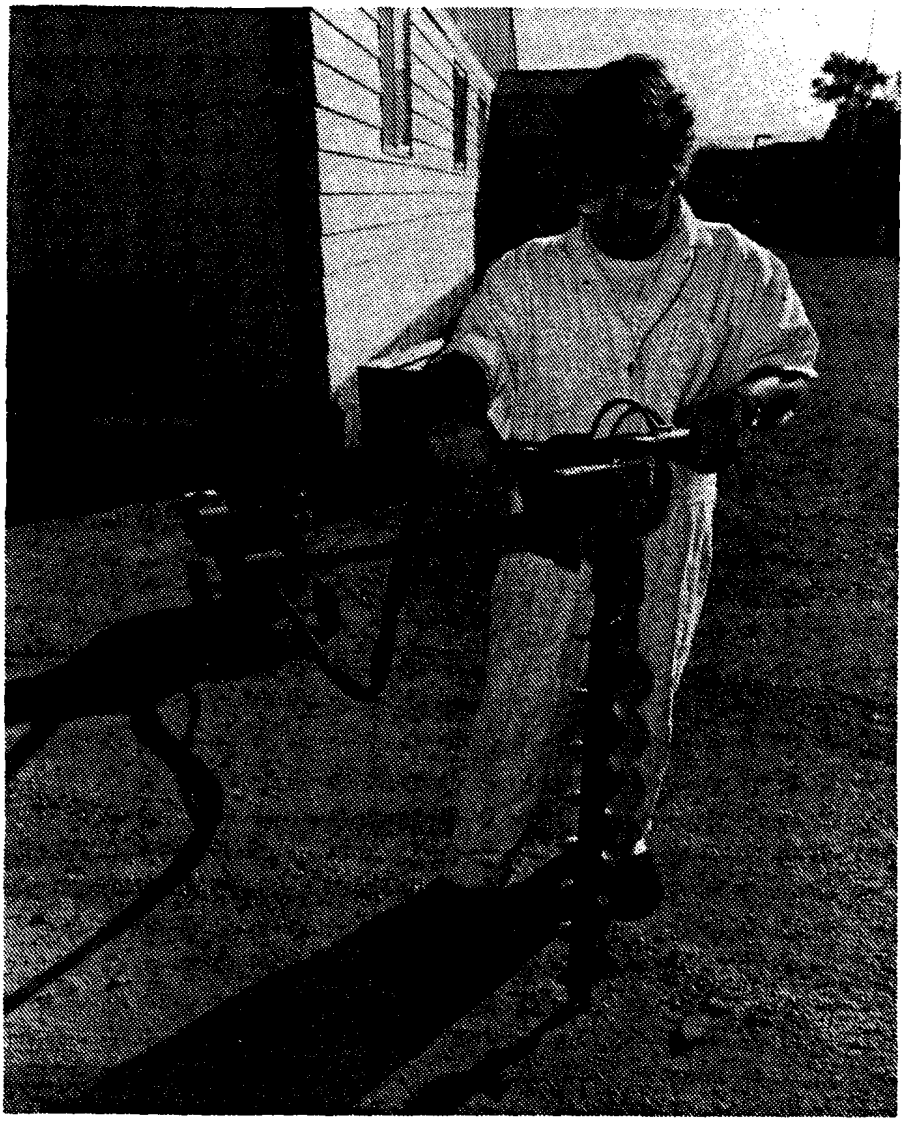
6.8 To add additional auger flights do not remove the auger from the hole, but disconnect the handle by pushing the spring-loaded snap button. Snap the additional flight onto the top of the auger flight and the handle onto the extension. Resume drilling.

6.9 When the hole has reached the desired depth and the auger has stopped turning, disconnect the handle and remove the auger from the hole. If more than one auger flight has been used, it may be necessary to use the "slip shoe" so that the auger flights can be disassembled as they are taken out of the hole.

6.10 All soil should have been removed from the hole; however, if loose soil remains at the bottom, use a bucket auger to remove the rest.

6.11 Sample soil according to Procedure TE-078.

Exhibit 1. Little Beaver Mechanical Earth Drill



SUBSOIL SAMPLING PROBE

1.0 PURPOSE

This procedure describes the method used for taking subsoil samples with the JMC Environmentalist Subsoil Probe to obtain undisturbed samples for field and laboratory measurements. The JMC Environmentalist system is hand-operated and is composed of three basic parts: the subsoil probe, the drop hammer, and the foot-operated jack for probe retrieval. This system is best suited for use in non-gravely soils.

2.0 EQUIPMENT AND MATERIALS

2.1 Environmentalist Subsoil Sampling Probe;

2.2 12 in. or 36 in. sampling tube;

2.3 drop hammer assembly;

2.4 foot-operated jack;

2.5 wooden dowel;

2.6 copolyester liners;

2.7 stainless steel liners;

2.8 red vinyl caps;

2.9 black vinyl caps;

2.10 Teflon tape;

2.11 metal tape measure;

2.12 leather gloves;

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9/17/90 (Date)

C.A. Little 9/19/90 (Date)

2.13 disposable surgical gloves;

2.14 assorted wrenches and tools; and

2.15 Zero Contamination Tube penetration pin.

3.0 DEFINITIONS

3.1 DROP HAMMER: The drop hammer weighs 12.5 pounds and drives the sample probe into the soil.

3.2 FOOT JACK: The foot-operated jack is retrieves the sample probe once the desired sample depth is reached. The foot jack is left in place even while the drop hammer is being used to drive the sample probe.

3.3 ZERO CONTAMINATION TUBE: The Zero Contamination Tube is composed of two parts: the sampling tube and the liners. The sampling tube has a removable top with a retaining pin and is directly attached to the drive rod. The liner is either stainless steel or copolyester and is slipped inside the sampling tube for sample collection. Important: do not use the sampling tube without the liners.

3.4 MASTER EXTENSION: The master extension attaches to the sampling tube.

3.5 REGULAR EXTENSION: Regular extensions cannot be attached to the sampling tube, and are only used to reach a deeper sampling depth.

3.6 STRAIGHT PIN: The straight pins connect the various components of the system and allow re-entry into the previous sampling hole.

3.7 ZERO CONTAMINATION TUBE PENETRATION PIN: The penetration pin is used to link the subsoil sample to the gas chromatograph or photoionization detector probe for field measurements and screening purposes.

4.0 PROCEDURE

4.1 Insert a liner (stainless or copolyester) into the top of the sampling tube.

4.2 Sheathe the guide rod (the long rod with a larger diameter section on one end) inside the drop hammer (the long heavy piece with the welded collar).

4.3 Insert the aluminum end of the guide rod into the top of the sampling tube.

4.4 Push the probe into the soil as far as comfortably possible. If sampling on a hillside, place the foot pedal on the downhill side.

4.5 When the probe can be pushed no farther into the ground, depress the foot pedal slightly and lock the foot pedal into position by flipping down the holding screw. Important: To avoid equipment damage, be sure the foot pedal is in position two while using the drop hammer.

4.6 Grip the drop hammer and raise it 12 to 18 in. above its resting position and drive it sharply against the top of the sampling tube or extension. The tube should move with each blow. If this does not occur, discontinue hammering, as a rock may be obstructing the tube.

Continue driving the tube until the drop hammer collar meets the top ofthe probe body.

4.7 Depress the foot pedal so the holding screw can be swung out of the way. The jack will not work with the holding screw in place. Release the jack lever by lifting the black plastic handle and pushing the jack lever away from the probe. The jack should then move into a position roughly similar to that of the foot pedal.

4.8 To extract the sample, put one foot on the jack lever and the other on the ground. Now, step down on the jack lever; this will raise the sampling tube and probe approximately 1 in. Next, shift weight from the jack lever to the foot on the ground. While resting one foot lightly on the jack lever, press down on the hand grips. Notice that the jack lever returns to its former position. Repeat this procedure until the sampling tube has been pulled from the soil.

4.9 When the bottom of the drop hammer can be seen, stop using the jack and remove the drop hammer. Pick up the probe and lay it horizontally on the ground. Insert the wood dowel into the cutting end of the sampling tube. Push the sample and liner out where you can grasp them. Remove by hand and put Teflon tape and caps over both ends of the liner.

4.10 Label the tube by listing hole number, sample interval, sample number, uphole direction (top), etc.

4.11 Once the sampling operations are completed, clean the sample tube and any portions of the sampler coming in contact with the soil with a wire brush, inspect for contamination and damage, and decontaminate if necessary.

4.12 After the first 3 ft have been sampled, the extensions may be used to reach a deeper sample depth. Put a new liner into the sampling tube. Insert the sampling tube back into the sampler or auger hole. Attach the aluminum adapter to the sampling tube. Remove the pin from the longer end of the

adapter and insert it into the sampling tube. Align the crossholes in both the sampling tube and the adapter, then reinsert the pin through the holes.

If this is the extension which will be closest to the drop hammer during the sampling procedure, make sure that it does not have a solid protrusion at the top. This extension needs to be hollow at both ends so that the end of the drop hammer will fit. For example, if a sample was taken at 6 ft and the next sample will be taken at 9 ft, the equipment is assembled in this order: sampling tube, adaptor, a regular extension (which has a solid piece of steel protruding from one end), master extension (a hollow tube with two crossholes), and drop hammer.

4.13 To obtain GC or PID readings from the liners, cap one end as described in step 4.9, cover the other end of the liner with aluminum foil, and insert a decontaminated penetration pin. The gas chromatograph (GC) or photoionization detector (PID) probe may now be inserted for a field measurement of volatile organic compounds.

OAK RIDGE NATIONAL LABORATORY Health & Safety Research Division	PROCEDURE Pollutant Assessments Group	Number: TE-079 Page: 1 of 3 Revision: 0 Date: 10/01/90

COLLECTING SOIL SAMPLES USING BRASS SLEEVES

1.0 PURPOSE

One of the major problems associated with sampling soil for volatile organic compounds (VOCs) is the loss of analytes through volatilization between collection and analysis. The use of brass sleeves in a split spoon sampler reduces volatilization during sample collection by minimizing the amount of time a sample is exposed to the atmosphere. The following procedures apply to collecting samples both for laboratory analysis and for on-site screening with a hand-held PID and portable GC.

2.0 PROCEDURE

2.1 Place brass sleeves, decontaminated according to Procedure TE-073, into clean split-spoon sampler.

2.2 Before a sample is collected, fill out the sample label and, if field GC analysis is required, prepare a pre-cleaned headspace sample bottle (1- L wide-mouth jar with Teflon-lined lid and septum top) by wrapping the jar threads with 2 turns of Teflon tape. Place lid loosely on jar.

2.3 When the split spoon is retrieved from the hole, number the brass sleeves from deepest to shallowest (i.e., the sleeve closest to the drive shoe is No. 1, the sleeve closest to sampler head is No. 4). Quickly place numbers on the sleeves with felt-tipped marker. If one of the sleeves is to be analyzed with a field GC, do <u>not</u> mark that sleeve (volatiles from the ink can be detected by the G.C.). It is important to work quickly at this point, to avoid loss of volatile analytes.

2.4 Discard the No. 4. sleeve (closest to the sampler head); the contents may be mostly cavings from the borehole.

2.5 If one sleeve is to be sent to the laboratory for VOC analysis, place plastic caps with Teflon liners over the ends of the sleeve and seal with silicone tape. Place the sample label on the sleeve, put the sleeve in a plastic bag, and immediately place the sample into an iced cooler.

Approved by:

[illegible] 9/19/90 (Date)

Clair Little 9/19/90
C.A. Little (Date)

2.6 If field screening for VOCs is to be performed, the following steps apply:

a. Place plastic caps over the ends of the sleeve but omit the Teflon liners.

b. Drive a clean steel spike or 40-penny nail through the plastic cap at least halfway down the length of the sleeve. Remove the spike and quickly insert the probe of the PID meter into the opening, taking care not to pack dirt into the end of the probe.

   Allow 5 seconds for the reading to stabilize. Record the value in the sample log book and on the Air Quality Monitoring Record.

c. If sample allocation is such that the same sleeve which was monitored in (b) above is to be analyzed by a field GC, remove the plastic end caps and quickly place the sleeve into a headspace sample bottle. Replace the lid tightly. Place the prepared label on the bottle, indicating borehole number, depth, 4-digit sample number, date and time of collection, and HNU reading.

d. If GC analysis is not performed on the sample as described above, the sample may be returned for geologic logging.

2.7 The disposition of the brass sleeve samples will depend on what parameters are to be determined for individual site investigations. These parameters may consist of chemical analysis (multiple sleeves may be needed for chemical analysis if a large volume is required), field gas chromatography, geologic logging, and various soils engineering parameters, e.g., gravimetric moisture content.

2.8 There are several considerations to keep in mind when deciding which sleeve to use for what purpose:

2.8.1 The deepest sample (No. 1) will have the least exposure to air and sampling tools.

2.8.2 Assuming the sampler is full, sample No. 1 should be used for the most delicate analyses.

2.8.3 Sample No. 2 should have good integrity and provide valid field screening data.

2.8.4 The geologist needs at least one sleeve for the lithologic logging used in well completion planning.

2.8.5 Lithologic logging of field-screened samples (No. 2 sleeve) is an efficient use of the sample.

2.8.6 The top sleeve (No. 4) is the most likely to be contaminated by drilling fluids and/or borehole cavings. It may be used for lithologic logging at geologist's discretion but should not be used for screening or analytical data.

2.8.7 When sample recovery is less than 50%, samples should be used only for lithologic logging.

HEADSPACE SAMPLING WITH A GAS CHROMATOGRAPH

1.0 PURPOSE

This procedure describes the operation of the Photovac 10S50 portable gas chromatograph (GC).

2.0 APPLICABILITY

This procedure applies to the direct analysis of air and soil gas and to the headspace analysis of soil and water. Analyte detection is limited to volatile organic compounds that undergo photoionization at 10.6 eV or less.

3.0 OTHER DOCUMENTS

3.1 REFERENCES

3.1.1 Photovac 10S50 operator's manual.

3.2 APPENDICES

3.2.1 Appendix 1: Detectable Compounds
3.2.2 Appendix 2: Retention Times Relative to Benzene

4.0 EQUIPMENT AND MATERIALS

4.1 EQUIPMENT

4.1.1 Photovac 10S50 GC
4.1.2 Analytical column, usually a CAPSil5CB, 0.52-mm-I.D. X 10-m-long capillary column
4.1.3 Column oven designed for the 10S50
4.1.4 120-V power supply or external battery pack
4.1.5 Assortment of fittings, connections, and Teflon™ tubing

APPROVALS		
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Supervisor		Date
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4.1.6 Syringe oven
4.1.7 Regulator, 2-stage stainless steel
4.1.8 Tool kit for GC

4.2 MATERIALS

4.2.1 Gas-tight syringes: 10, 25, 50, 100, and 250 μL
4.2.2 Replacement needles and plungers for gas-tight syringes
4.2.3 Spare recorder pens and paper
4.2.4 Carrier gas: ultra-pure air, total hydrocarbon content <0.1 ppm as methane or nitrogen, at least 99.995% pure.
4.2.5 Calibration standards
4.2.6 Pre-cleaned 40-mL septum vials

5.0 RESPONSIBILITY

The GC operator is responsible for following this procedure and ensuring the safe operation of the equipment.

6.0 DEFINITIONS

6.1 **Syringe blank**: an injection of contaminant-free air into the GC to demonstrate that a decontaminated syringe contains no residual contamination.

6.2 **Gas chromatograph (GC)**: a device that separates, by means of a column, individual compounds by time according to each compound's vapor pressure and vapor density. The GC employs one or more detectors to determine when each compound is eluted from the column.

6.3 **Isothermal oven**: an oven that holds the GC column at a pre-defined temperature through changes in ambient air temperature.

6.4 **Standard**: a solution of known concentrations of contaminants of interest. An injection of a standard is used to determine the relative concentration and retention times of individual contaminants.

7.0 PROCEDURE

7.1 Prepare equipment prior to sampling.

7.1.1 NEVER inject liquid samples, however small, into the GC.

7.1.2 When transferring the GC from very cold conditions into a warm, humid environment, be alert to the possibility of condensation on the detector lamp.

7.1.3 Always keep approximately 2-cc/min air flow through the column when the GC is not in use.

a. This keeps contaminants from entering the system and saves time in establishing a clean baseline.

7.1.4 Decontaminate syringes by baking in a clean oven at 50°C.

Note: The time required to decontaminate a syringe depends on the contaminant level. Syringe blanks injected before each sample will demonstrate whether or not the syringe is clean.

7.1.5 Purchase pre-diluted liquid standards to reduce the chance of cross-contamination and to eliminate the need for large volume containers and sub-µL injections to achieve the final dilution of the working standards.

7.2 Start up and calibrate the GC.

7.2.1 Adjust the flow rate to 5 to 15 mL/min.

a. When necessary, reduce the flow rate to achieve satisfactory separation of peaks.

7.2.2 Turn on the isothermal oven and set to 30°C, 40°C, or 50°C.

a. Allow the oven at least 20 min to warm up.

Note: The ambient temperature must be within 25°C of the oven temperature in order for the oven to hold the column at its pre-selected temperature.

7.2.3 Enter the current date and time into GC.

7.2.4 Adjust the precolumn backflush flow to equal the column flow.

7.2.5 Set the gain to the desired sensitivity and establish an acceptable baseline by making a blank run with no injection.

7.2.6 Calibrate the GC with the appropriate standards.

a. Update retention times and compound libraries.

b. Frequency of calibration varies with operating conditions.

7.2.7 Inject a syringe blank into the GC with the syringe to be used for the first sample.

7.3 Analyze samples.

7.3.1 Collect the sample in a clean syringe.

a. Adjust the sample volume according to the anticipated level of contamination in the sample.

b. The maximum sample size that can be injected into the GC is 1 mL.

7.3.2 Place the syringe needle in the injection port but do not pierce the septum.

7.3.3 Press the start button; the buzzer should sound for ~8 s.

7.3.4 As soon as the buzzer stops, press the syringe needle through the septum, quickly inject the sample, and remove the needle.

a. Draw the plunger back and place the syringe in the oven for decontamination.

7.3.5 Run standards at least every 10 samples.

7.4 Shut down the GC.

7.4.1 Turn off the isothermal oven at the temperature selector switch.

7.4.2 Reduce the carrier-gas flow to approximately 2 mL/min if the internal reservoir is supplying the carrier gas.

a. Ensure that the reservoir has an adequate supply of carrier gas to last until the instrument is connected to a larger bottle.

7.4.3 Turn the instrument off.

Appendix 1. Detectable Compounds

	eV		eV
Acetone	9.69	Cyclopentanone	9.26
Ammonia	10.15	Cyclopentene	9.01
Aniline	7.70	Cyclopropane	10.06
Benzaldehyde	9.53	2-Decanone	9.40
Benzene	9.25	1,2-Dichlorobenzene	9.07
1-Bromo-2-chloroethane	10.63	1,3-Dichlorobenzene	9.12
Bromochloromethane	10.77	1,4-Dichlorobenzene	8.94
n-Butane	10.63	Freon 12 (CF_2Cl_2)	12.31
2-Butanone	9.53	1,1-Dichloroethane	11.06
1-Butene	9.58	1,2-Dichloroethane	11.04
cis-2-Butene	9.13	*cis*-1,2-Dichloroethene	9.65
trans-2-Butene	9.13	*trans*-1,2-Dichloroethene	9.66
Butyl cellosolve	8.68	Ethane	11.65
Carbon disulfide	10.13	Ethanol	10.62
Carbon tetrachloride	11.28	Ethene (ethylene)	10.52
Chlorobenzene	9.07	Ethyl acetate	10.11
Cyclohexane	9.98	Ethyl benzene	8.76
Cyclohexanone	9.14	Ethyl chloride (chloroethane)	10.98
Cyclohexene	8.95	Freon 11 ($CFCl_3$)	11.77
Cyclopentane	10.52	Freon 12 (CF_2Cl_2)	12.91

Appendix 1. (continued)

	eV		eV
Freon 13 (CF_3Cl)	12.08	n-Pentane	10.35
Freon 13 B-1	12.08	1-Pentene	9.50
Freon 14 (neat)	16.25	Phenol	8.69
Freon 22 ($CHClF_2$)	12.45	Phosphine	9.96
Freon 113 (CF_3CCl_3)	11.78	Propane	11.07
n-Hexane	10.18	n-Propanol	10.51
n-Heptane	10.07	Styrene	8.47
1-Hexene	9.46	Tetrachloroethene	9.32
Isobutane	10.57	Toluene	8.82
Isopentane	10.32	1,1,1-Trichloroethane	11.25
Isoprene	8.85	Trichloroethene	9.45
Isopropyl alcohol	10.16	1,2,3-Trimethylbenzene	8.48
Methanol	10.85	1,2,4-Trimethylbenzene	8.27
Methyl butyl ketone	9.34	1,3,5-Trimethylbenzene	8.39
Methylcyclohexane	9.85	Vinyl benzene (styrene)	8.47
4-Methylcyclohexene	8.91	Vinyl chloride	10.00
Methylcyclopropane	9.52	*o*-Xylene	8.56
Methyl ethyl ketone	9.53	*m*-Xylene	8.56
Methyl isobutyl ketone	9.30	*p*-Xylene	8.45
Naphthalene	8.10		

Appendix 2. Retention Times Relative to Benzene

Compound	Temperature 20°C	30°C	40°C	50°C
Vinyl chloride	0.288	0.306	0.361	0.413
Freon 11	0.365	0.379	0.428	0.448
Methylene chloride	0.475	0.489	0.539	0.585
trans-1,2-Dichloroethylene	0.517	0.529	0.563	0.580
1,1-Dichloroethane	0.550	0.557	0.611	0.669
Chloroform	0.715	0.720	0.742	0.752
1,2-Dichloroethane	0.840	0.851	0.868	0.872
1,1,1-Trichloroethane	0.948	0.950	0.959	1.000
Benzene	1.000	1.000	1.000	1.000
Carbon tetrachloride	1.095	1.050	1.048	1.086
1,2-Dichloropropane	1.266	1.254	1.214	1.192
Trichloroethylene	1.413	1.396	1.342	1.361
2-Chloroethyl vinyl ether	1.667	1.644	1.551	1.539
1,1,2-Trichloroethane	2.293	2.211	1.976	1.860
Toluene	2.693	2.621	2.358	2.339
Tetrachloroethylene	3.985	3.853	3.314	3.272
Chlorobenzene	5.153	4.962	4.148	4.076
Ethylbenzene	6.223	5.985	4.882	4.743
Bromoform	6.282	5.261	4.713	4.351
m- and *p*-Xylene	6.767	6.490	5.247	5.071
o-Xylene	8.145	7.826	6.234	5.979
1,1,2,2-Tetrachloroethane	8.311	7.190	5.943	5.345

These values apply at a flow rate of 5 mL/min using a CPSil5CB capillary column.

WATER SAMPLING FOR ANALYSIS OF INORGANIC COMPOUNDS AND RADIONUCLIDES

1.0 PURPOSE

This procedure describes methods for collecting water samples for analysis of inorganic compounds and radionuclides and measurement of physical parameters.

2.0 APPLICABILITY

This procedure applies to sampling both surface water and groundwater locations.

3.0 OTHER DOCUMENTS

3.1 REFERENCES

3.1.1 Procedure TE-071, Sample Documentation
3.1.2 Procedure TE-072, Sample Packaging, Preservation, and Shipping
3.1.3 Procedure TE-130, Peristaltic Pump Operation
3.1.4 Procedure TE-094, Water-Level Measurement
3.1.5 Procedure TE-132, Well Development Pump Operation
3.1.6 Procedure TE-061, Measurement of pH of Water Samples
3.1.7 Procedure TE-062, Measurement of Electrical Conductivity of Water Samples
3.1.8 Procedure TE-034, Chain of Sample Custody
3.1.9 Procedure TE-073, Equipment Decontamination
3.1.10 Procedure TE-133, Submersible Pump Operation
3.1.11 Procedure TE-131, Bladder Pump Operation

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3.2 APPENDICES

3.2.1 Appendix 1: Water Sample Data Record
3.2.2 Appendix 2: Sample Label

4.0 EQUIPMENT AND MATERIALS

4.1 EQUIPMENT

4.1.1 Water-level indicator
4.1.2 Bailer, stainless steel or Teflon™
4.1.3 Peristaltic variable-speed sampling pump, if needed
4.1.4 Marschalk bladder pump, if needed
4.1.5 Grundfos Readi-Flo2 pump, if needed
4.1.6 Well Wizard Model HR4105D well development pump
4.1.7 Flow meter, if needed

4.2 MATERIALS

4.2.1 Silicon tubing
4.2.2 Teflon tubing
4.2.3 Filter holders
4.2.4 High-capacity glass fiber filters
4.2.5 High-capacity 0.45 µm filters
4.2.6 Deionized or distilled analyte-free water
4.2.7 HCl, HNO_3, NaOH, H_2SO_4, as needed
4.2.8 Pre-cleaned polyethylene bottles with caps
4.2.9 Pre-cleaned glass bottles with caps
4.2.10 Sample labels
4.2.11 Marking pens
4.2.12 Water Sample Data Record sheets
4.2.13 Chain of Sample Custody sheets
4.2.14 Litmus paper or ColorpHast
4.2.15 Sample logbook

5.0 RESPONSIBILITY

5.1 It is the responsibility of the project manager or a designated sampler to supervise sample collection and ensure that all samples are collected according to the project sampling plan.

5.2 It is the responsibility of the sample technician to collect samples, record all field data, and decontaminate equipment.

6.0 DEFINITIONS

6.1 **Annulus:** the space between the well casing and the borehole wall.

6.2 **Aquifer:** a permeable stratum or zone below the surface of the earth through which groundwater moves.

6.3 **Casing:** pipe placed in a well to prevent the wall of the hole from caving in and to provide a means of extracting groundwater.

6.4 **Potentiometric surface:** level to which water in an aquifer will rise by hydrostatic pressure.

6.5 **Well screen:** perforated or slotted casing that allows water to flow into the well.

7.0 SAFETY

7.1 Wear personal protective clothing as required in the site health and safety plan.

7.2 Wear latex or nitrile gloves when contact with sample water or sample preservatives is possible.

8.0 PROCEDURE

8.1 Sample surface waters and groundwater wells in order of increasing contamination.

8.1.1 Begin with sources of least contamination, when possible, to reduce the risk of cross-contamination between sites.

8.2 Before sampling, assign sample numbers to the site. See Procedure TE-071.

8.3 For groundwater samples, initiate the Water Sample Data Record for the sample location. See Appendix 1.

8.3.1 Refer to section 8.11 for information on completing this form.

8.3.2 Do not use the Water Sample Data Record for surface water samples.

8.4 Record on the sample label (Appendix 2) the following information and permanently affix the label to the bottle:

8.4.1 time,
8.4.2 location,
8.4.3 sample number,
8.4.4 initials of collector,
8.4.5 type of analysis,
8.4.6 preservative, and
8.4.7 filter.

8.5 Add preservatives to the sample bottle before collecting the sample.

8.5.1 Check for adequate pH adjustment when necessary by pouring a little sample in a separate container and using litmus paper to determine pH.

8.5.2 See Procedure TE-072 for sample containers, preservation methods, and holding times.

8.6 Collect surface water samples either by using a pump or by dipping with a clean bottle or container.

8.6.1 If the sample is to be filtered, hook up the pump in-line with the filter if possible so that the sample is collected directly from the surface water.

a. Collect non-filtered samples by pumping directly from the surface water.

8.6.2 If a pump cannot be used, collect the sample by simply dipping the container into the water

a. Do not disturb the bottom sediments.

b. If the sample is to be filtered, filter the sample from the dipping container into the collection bottle.

c. Collect non-filtered samples directly into the sample bottle.

8.7 Collect groundwater samples.

8.7.1 Measure the water level in the well. See Procedure TE-094 for additional information.

a. Lower the clean water-level indicator into the well until the indicator sounds.

b. Measure the depth to water at the mark on the well casing to the nearest 0.01 ft.

1. If the casing is not marked, measure to the north side of the well casing.

2. Record this measurement (h_2 in the formula below) on the Water Sample Data Record sheet and in the sample logbook.

8.7.2 Using information from the well log, determine the height of the water column from the total depth of the well, the length of screened interval, and the water level.

8.7.3 Calculate the well volume using one of the methods given below:

a. For 2-in. schedule-40 pipe, multiply the height of the water column by 0.174 to obtain the volume in gallons. For 2-in. schedule-80 pipe, multiply the height of the water column by 0.153 to obtain the volume in gallons.

b. For measurements in feet, use this equation:

$$WV = \left(\frac{d}{2}\right)^2 \pi \, (h_1 - h_2) \times 7.48$$

where

WV	= well volume, gal
d	= diameter of casing, ft
h_1	= depth of well from top of casing, ft
h_2	= depth to water, ft
7.48	= constant, gal/ft^3

c. For measurements in inches, use this equation:

$$WV = \left(\frac{d}{2}\right)^2 \pi \, (h_1 - h_2) \left(\frac{1}{231}\right)$$

where

WV	= well volume, gal
d	= diameter of casing, in.
h_1	= depth of well from top of casing, in.
h_2	= depth to water, in.
1/231	= constant, gal/in.^{3}

d. If the sampling plan defines the well volume as the amount of water in the casing plus saturated annulus, use the following formula:

$$WV = \left((0.30)\ (\pi)\ (h) \left[\left(\frac{d_1}{2}\right)^2 - \left(\frac{d_2}{2}\right)^2\right] + \pi \left(\frac{d_2}{2}\right)^2 h\right) x\ 7.48$$

Where
- WV = well volume, gal
- h = height of water column, ft
- d_1 = diameter of borehole, ft
- d_2 = diameter of casing, ft
- 0.30 = approximate porosity of sand pack
- 7.48 = constant, gal/ft^3

e. In cases where the potentiometric surface of the aquifer is above the screened interval of the well, calculate two volumes: (1) the volume of water in the casing above the screened interval and (2) the volume of the casing plus the saturated annulus around the screen.

Note: It is convenient to calculate a volume per linear foot of (1) and (2) so that a total volume can be found simply by multiplying the height of each water column by its appropriate factor (gal/ft) and then adding the volumes together.

f. Record the amount of water in the well on the Water Sample Data Record.

8.7.4 Purge the well before sampling.

a. Refer to the site-specific work plan to determine the purge procedure to use.

b. Use the peristaltic pump or Grundfos Redi-Flo2 pump for shallow wells < 20 ft below ground level. See Procedures TE-130 and TE-133.

c. For deeper wells, use the Well Wizard Model HR4105D well development pump, the Marschalk bladder pump, or the Grundfos Redi-Flo2 pump. See Procedures TE-131, TE-132, and TE-133.

d. Lower the pump into the well until the intake is just at the top of the water column.

e. Initiate pumping.

f. Check pH, temperature, and conductivity during purging and use them as guidelines for determining well-water stabilization.

Note: Generally, the sample chemistry is sufficiently stable when these parameters agree ±10% over two successive well volumes. See Procedures TE-061 and TE-062.

g. Use large collection vessels to measure the volume of water purged.

1. Alternatively, use a flow meter to monitor the volume of purged water.

8.7.5 Note the starting time, finish time, and the volume of water pumped on the Water Sample Data Record.

8.8 Collect filtered samples by connecting the pump-outlet tubing directly to the filter unit.

8.8.1 Decrease the pump pressure so that pressure build-up on the filter does not force particles through the filter.

8.9 Collect non-filtered samples directly from the outlet tubing into the sample bottle.

8.10 Use a bailer to collect the sample in wells that are too muddy, too shallow, or unable to be pumped for any other reason.

8.10.1 Use an all-Teflon or stainless steel bailer connected to a clean, unused rope or a clean stainless steel cable.

8.10.2 For purging, remove bore volumes from the well by successive bailings taken from the top of the water column.

8.10.3 For sampling, lower the bailer to a depth so that the top of the bailer is at the top of the well screen if the well is screened below the top of the water column.

a. Lower the bailer to the top of the water column if the well is muddy or has a slow recharge.

8.10.4 Empty the bailer into the sample bottle by either pouring it from the top or using a Teflon bottom-emptying device.

8.11 Fill out the Water Sample Data Record (Appendix 1) in the following format:

8.11.1 Project: name of installation, facility, or locale;

8.11.2 Sample no.: see Procedure TE-071;

8.11.3 Station no./location: monitoring well number or name of stream, pond, or other location where water sample was collected. If sampling surface water, describe the location using grid coordinates or reference point;

8.11.4 Sampling data: the time sampling started and finished at the station no./location, outside temperature (°C), and a brief description of weather conditions;

8.11.5 Groundwater:

a. number of completions of a particular monitoring well;

b. depth to water from top of casing, measured to nearest 0.01 ft;

c. well depth measured from ground level to bottom of well screen to the nearest 0.01 ft;

d. well diameter: inside diameter;

e. screened intervals measured to the nearest 0.1 ft from ground level;

f. dual completion wells: U = upper interval, L = lower interval;

g. three completion wells: U = upper interval, M = middle interval, L = lower interval;

h. volume purged: calculate the volume of water purged from the well;

i. sampling equipment used: stainless steel or Teflon bailer, pump, etc.

8.11.6 Sample information:

Example:

Number of bottles	Bottle size/ description	Filtered	Pres/vol	Analyses requested
1	250-mL PE	0.45 μm	2 mL 1:1 HNO_3	metals

8.11.7 After labeling each bottle, compare the sample bottles with those recorded on the Water Sample Data Record sheet before leaving the sampling site.

8.12 Decontaminate reusable sampling equipment (downhole pumps, Teflon tubing) according to Procedure TE-073 or the site sampling plan.

8.12.1 Discard non-reusable materials (rope, polyethylene tubing) in an appropriate container.

Appendix 1. Water Sample Data Record

Water Sample Data Record

Project:	Location:	Date:	Field#:
Samplers:	Time Start:	Time Completed:	
No. of Completions:	Depth to Water:	Total Well Depth:	Well Volume:
Well Diameter:	Screened Interval:	Volume Purged:	Weather Conditions:
Sampling Equipment Used:		PID:	

No. of Bottles	Bottle Size/Description	Filtered	Preservative	Analyses Requested

Instrument Calibrations

Conductivity				
Standard Values				Calib. time:
Measured Value				
Temp. of Std.				
pH				
Standard				Calib. time:
Temp. of Std.				

Sample Parameters

Time	Temp.	Conductivity	pH	Time	Temp.	Conductivity	pH

Appendix 2. Sample Label

Oak Ridge National Lab/Pollutant Assessment Center

Sample No. _____

Date/Time Sampled _____

Filtered ☐No ☐.45 µ ☐Glass fiber ☐Other

Preserved ☐No ☐HCl ☐HNO_3 ☐H_2SO_4

☐Other _____

Analysis _____

Field Information _____

_____

Collector _____

Label filled out by hand

```
Oak Ridge National Laboratory

Sample Number: 1041  Type: ER
Date: 10/05/92  Time: 1050
Filtered: NO   Preserved: NO
Analyses: PHC   CLP
Comments: EQUIP. RINSATE (LOW BOILER)
          DON'T ANALYZE
Collector: EMP
```

Computer-generated label

WATER SAMPLING FOR ANALYSIS OF ORGANIC COMPOUNDS

1.0 PURPOSE

This procedure describes the methods and equipment used to collect a valid water sample for analysis of organic compounds.

2.0 APPLICABILITY

This procedure applies to sampling both surface water and groundwater.

3.0 OTHER DOCUMENTS

3.1 REFERENCES

3.1.1 Procedure TE-071, Sample Documentation
3.1.2 Procedure TE-094, Water-Level Measurement
3.1.3 Procedure TE-081, Water Sampling for Analysis of Inorganic Compounds and Radionuclides
3.1.4 Procedure TE-072, Sample Packaging, Preservation, and Shipping
3.1.5 Procedure TE-061, Measurement of pH of Water Samples
3.1.6 Procedure TE-062, Measurement of Electrical Conductivity of Water Samples
3.1.7 Procedure TE-131, Bladder Pump Operation
3.1.8 Procedure TE-034, Chain of Sample Custody
3.1.9 Procedure TE-073, Equipment Decontamination

3.2 APPENDICES

3.2.1 Appendix 1: Typical Sample Volumes for Organic Analysis
3.2.2 Appendix 2: Sample Label
3.2.3 Appendix 3: Water Sample Data Record

4.0 EQUIPMENT AND MATERIALS

APPROVALS		
Author		Date
Supervisor		Date
Group Leader	Alice Kats	Date 8/4/93
Section Head	Craig Little	Date 8/6/93

4.1 EQUIPMENT

4.1.1 Non-gas-contact bladder pump (with Teflon™ tubing)
4.1.2 Oiless compressor or compressed gas
4.1.3 Teflon bailer
4.1.4 Transfer pipet
4.1.5 Insulated coolers
4.1.6 Frozen Blue Ice™ or equivalent
4.1.7 Field logbook

4.2 MATERIALS

4.2.1 Glass bottles with Teflon-lined caps
4.2.2 Glass vials with Teflon-lined septa (40 mL)
4.2.3 Deionized water
4.2.4 Concentrated or 1:1 H_2SO_4 (if required)
4.2.5 Concentrated or 1:1 HCl (if required)
4.2.6 40% NaOH (if required)
4.2.7 Padding for packaging of samples
4.2.8 Sample labels
4.2.9 Disposable pipet tips
4.2.10 Marking pens
4.2.11 Water Sample Data Record sheets
4.2.12 Chain of Sample Custody forms

5.0 RESPONSIBILITY

5.1 It is the responsibility of the project manager or a designated sampler to supervise sample collection and ensure that all samples are collected according to the project sampling plan.

5.2 It is the responsibility of the sample technician to collect samples, record all field data, and decontaminate equipment.

6.0 DEFINITIONS

6.1 **Annulus:** the space between the well casing and the borehole wall.

6.2 **Aquifer:** a permeable stratum or zone below ground surface through which groundwater moves.

6.3 **Casing:** pipe placed in a well to prevent the wall of the hole from caving in and to provide a means of extracting groundwater.

6.4 **Potentiometric surface:** level to which water in an aquifer will rise by hydrostatic pressure.

6.5 **Well screen:** perforated or slotted casing that allows water to flow into the well.

7.0 SAFETY

7.1 Wear personal protective clothing as required in the site health and safety plan.

7.2 Wear latex or nitrile gloves when contact with sample water or sample preservatives is possible.

8.0 PROCEDURE

8.1 Sample surface waters and groundwater wells in order of increasing contamination.

8.1.1 Begin with sources of least contamination, when possible, to reduce the risk of cross-contamination between sites.

8.2 Prepare sample containers, labels, and Water Sample Data Record.

8.2.1 Before sampling a site, assign sample numbers to the site. See Procedure TE-071.

8.2.2 Prepare sample label with the following information and permanently affix the label to the bottle:

a. sample number (field number),
b. date and time of sample collection,
c. filter,
d. preservative,
e. type of analysis,
f. field information, if any,
g. initials of collector.

8.2.3 Record all pertinent field information in the field logbook.

8.2.4 For groundwater samples, fill out the Water Sample Data Record (Appendix 2) in the following format:

a. Project: name of installation, facility, or locale;

b. Location: monitoring well or borehole number;

c. Date

d. Sample no. (field no.): see Procedure TE-071;

e. Sampling data: time sampling started and finished, outside temperature (°C), and a brief description of weather conditions (e.g., cloudy, breezy, light rain);

f. Number of completions for a particular monitoring well;

g. Depth to water from top of well casing (not the protective casing) to the nearest 0.01 ft; see Procedure TE-094;

h. Total well depth: measured from ground level to bottom of well screen to the nearest 0.01 ft;

i. Well volume: calculate the volume of water in the well (see Procedure TE-081);

j. Well diameter: inside diameter;

k. Screened intervals: to nearest 0.1 ft from ground level:

   dual completion wells: U = upper interval, L = lower interval;

   triple completion wells: U = upper interval, M = middle interval, L = lower interval;

l. Volume purged: calculate the volume of water purged from the well;

m. Sampling equipment used: stainless steel or Teflon bailer, bladder pump, etc.;

n. Sample information:

Example:

Number of bottles	Bottle size/ description	Filtered	Pres/vol	Analyses requested
2	40-mL glass vial	No	0.2 mL 1:1 HCl	VOCs
1	100-mL glass	No	0.5 mL 1:1 HCl	Petroleum hydrocarbons
1	250-mL PE	0.45 μm	2 mL 1:1 HNO_3	Metals

8.2.5 If preservation is required, use a clean transfer pipet to add preservative to the sample container prior to collecting the sample.

a. Use a new pipet tip for each type of preservative.

b. See Appendix 4 of Procedure TE-072 for sample containers, preservation methods, and holding times.

8.3 Collect samples manually using either a bailer or non-gas-contact gas-operated pump.

8.3.1 Collect surface water samples using the grab sampling method or with a bailer.

a. Avoid disturbing bottom sediments and/or agitating the sample.

8.3.2 Sample groundwater after well purging using either a bailer or a non-gas-contact pump. See Procedure TE-131.

8.4 Purge wells before sampling.

8.4.1 Consult the project work plan to determine if a well volume is defined as water in the casing plus saturated annulus or water in the casing only.

Note: Normally, 3 to 5 volumes of water (casing plus saturated annulus) are considered sufficient to remove stagnant water from the well and to ensure that the samples represent formation water. However, this is a general guideline and may need modification according to site-specific conditions:

1. If the well is extremely slow to recharge, only one evacuation to dryness may be practical.

2. If the well is situated in permeable geological material with good recharge from the aquifer, it may be continually purged by natural groundwater flow.

8.4.2 Check field parameters (pH, temperature, and conductivity) in-line during purging and use them as a guideline for determining well water stabilization. See Procedures TE-061 and TE-062.

Note: Generally, the sample chemistry is sufficiently stable when the field parameters agree $\pm$10% over two successive well volumes.

8.5 Bail samples with an all-Teflon or stainless steel bailer equipped with a stainless steel cable or a clean, unused rope.

8.5.1 Lower the bailer to the depth of the well screen if the water is clean and the well has good recharge, or to the top of the water column if the well is muddy or has slow recharge.

8.5.2 Empty the bailer into the sample bottle by either pouring it from the top or using a Teflon bottom-emptying device.

8.6 When using a bladder pump, leave dedicated sample-line Teflon tubing in each well.

8.6.1 See Procedure TE-131 for operation and setup of the pump.

8.6.2 Attach the tubing to the pump.

8.6.3 Lower the pump down the hole with the stainless steel cable, Teflon air line, and sample line so that the intake (the bottom of the pump) is at the middle of the well screen.

8.6.4 Purge several pump and tubing volumes from the line before collecting the sample.

8.7 Collect samples directly in glass containers pre-cleaned to EPA standards. See Procedure TE-072.

Note: The required number and type of bottles and volume of sample will be determined by the analyses to be done. Appendix 1 lists typical sample volumes for a number of organic analyses.

8.7.1 The collected sample must remain hermetically sealed until it is analyzed.

8.7.2 Do not filter the samples.

8.7.3 The procedure for filling and sealing sample containers consists of the following steps:

a. Slowly fill the container to overflowing.

b. Place the cap on the convex water meniscus, and seal the cap tightly.

c. Test the seal by inverting the sample container and lightly tapping the lid on a solid surface.

Note: The absence of entrapped air bubbles indicates a proper seal. If air bubbles are present, open the bottle, add additional sample water, and reseal. The sample must not contain any headspace.

8.8 Fill out the chain of sample custody form (see Procedure TE-034) and send the original with the samples to the laboratory.

8.8.1 Keep a copy for the project archives.

8.8.2 Pack the sample according to the guidelines in Procedure TE-071.

8.8.3 Deliver the samples or ship to the laboratory as soon as possible by overnight courier.

8.9 After all samples are collected and preserved, decontaminate the sampling equipment according to Procedure TE-073 or the site sampling plan.

Appendix 1. Typical Sample Volumes for Organic Analysis

Analytical parameter	Volume, mL
Purgable petroleum hydrocarbons as gasoline	2 or 3 40-mL septum vials
Extractable petroleum hydrocarbons as gasoline or diesel	1000
Pesticides/herbicides	1000
Coliform	250 (sterile bottle)
Volatile organic compounds (VOCs)	2 40-mL septum vial
Base/neutral and acid extractable semivolatile compounds (BNAs)	1000
PCBs	1000 (may be combined with pesticide/herbicide sample)

Note: these volumes may be modified at the request of the analytical laboratory.

Appendix 2. Sample Label

Oak Ridge National Lab/Pollutant Assessment Center

Sample No. _____

Date/Time Sampled _____

Filtered ☐No ☐.45 μ ☐Glass fiber ☐Other

Preserved ☐No ☐HCl ☐HNO_3 ☐H_2SO_4

☐Other _____

Analysis _____

Field Information _____

_____

Collector _____

Label filled out by hand

```
Oak Ridge National Laboratory

Sample Number: 1041  Type: ER
Date: 10/05/92  Time: 1050
Filtered: NO   Preserved: NO
Analyses: PHC   CLP
Comments: EQUIP. RINSATE (LOW BOILER)
          DON'T ANALYZE
Collector: EMP
```

Computer-generated label

Appendix 3. Water Sample Data Record

Water Sample Data Record

Project:	Location:	Date:	Field#:
Samplers:	Time Start:	Time Completed:	
No. of Completions:	Depth to Water:	Total Well Depth:	Well Volume:
Well Diameter:	Screened Interval:	Volume Purged:	Weather Conditions:
Sampling Equipment Used:		PID:	

No. of Bottles	Bottle Size/Description	Filtered	Preservative	Analyses Requested

Instrument Calibrations

Conductivity				
Standard Values				Calib. time:
Measured Value				
Temp. of Std.				
pH				
Standard				Calib. time:
Temp. of Std.				

Sample Parameters

Time	Temp.	Conductivity	pH	Time	Temp.	Conductivity	pH

GROUNDWATER SAMPLING *IN SITU* WITH THE HYDROPUNCH II®

1.0 PURPOSE

This procedure describes the use of the Hydropunch II®, a field screening tool for collecting groundwater samples.

2.0 APPLICABILITY

This procedure applies to sampling groundwater using the Hydropunch II without the need for installing a monitoring well.

3.0 OTHER DOCUMENTATION

3.1 REFERENCES

3.1.1 *Health and Safety Procedures for Hazardous Waste Sites.* Oak Ridge National Laboratory, Health and Safety Research Division, Grand Junction, Colo. 1992.
3.1.2 *Hydropunch® User's Guide*, Edition number 010191, QED Groundwater Specialists, Ann Arbor, Mich.
3.1.3 Procedure TE-071, Sample Documentation
3.1.4 Procedure TE-072, Sample Packaging, Preservation, and Shipping
3.1.5 Procedure TE-073, Equipment Decontamination
3.1.6 *Hydropunch II® Field User's Guide 1, Quick Reference for Assembly and Use.* QED Groundwater Specialists, Ann Arbor, Mich.
3.1.7 *Hydropunch II® Field User's Guide 2, How the Hydropunch II Works.* QED Groundwater Specialists, Ann Arbor, Mich.
3.1.8 *How to Use the Hydropunch II®.* Video cassette, QED Groundwater Specialists, Ann Arbor, Mich.

3.2 EXHIBITS

3.2.1 Exhibit 1: Hydropunch II Assembly, Hydrocarbon Mode

APPROVALS		
Author		Date
Supervisor		Date
Group Leader	Mid Keats	Date 8/4/93
Section Head	Craig Little	Date 8/6/93

3.2.2 Exhibit 2: Hydropunch II Assembly, Groundwater Mode
3.2.3 Exhibit 3: Hydropunch II, How it Works

4.0 EQUIPMENT AND MATERIALS

4.1 EQUIPMENT

4.1.1 Hydropunch II
4.1.2 Drive shoe
4.1.3 EW casing adapter
4.1.4 Sleeve cartridge
4.1.5 Inlet
4.1.6 AW casing adapter
4.1.7 Two reed check valves
4.1.8 Modified barb
4.1.9 Bailer
4.1.10 Teflon™ stopcock
4.1.11 Water-level indicator

4.2 MATERIALS

4.2.1 Drive cone
4.2.2 5-ft polypropylene screen
4.2.3 Stainless steel screen
4.2.4 O-rings
4.2.5 Teflon tape

5.0 RESPONSIBILITY

5.1 It is the responsibility of field personnel to:

5.1.1 ensure that the Hydropunch II, associated parts, and drive casing are clean prior to assembly;

5.1.2 determine the specific mode for use of the Hydropunch II: hydrocarbon mode or groundwater mode; and to assemble the Hydropunch II in the desired mode;

5.1.3 oversee the drilling subcontractor in driving the Hydropunch II to the desired depth and then pulling it up the correct amount in order to obtain the sample;

5.1.4 take the sample;

5.1.5 retrieve, disassemble, and decontaminate the Hydropunch II;

5.1.6 ensure that the drive casing is also decontaminated after use.

5.2 The drilling subcontractor is responsible for supplying AW and EW casing.

6.0 DEFINITIONS

6.1 **Hydropunch II**: a specialized field screening tool designed to obtain a groundwater sample *in situ*. The tool can be pushed or driven to the desired sample depth, either from the ground surface (in soft soils) or from the bottom of an augered borehole.

6.2 **Hydrocarbon mode**: in this mode of operation, the Hydropunch II is used to sample free product. It can also be used to obtain a sample of groundwater from the uppermost portion of the aquifer, if the aquifer is very thin, or to obtain a large volume of sample.

6.3 **Groundwater mode**: the Hydropunch II is used in this mode when the sample can be collected from 5 ft (1.5 m) or more below the top of the water table or when no more than 1.2 L of sample is needed.

6.4 **EW casing**: required casing for the hydrocarbon mode. This casing is hollow, allowing the passage of a bailer.

6.5 **AW casing**: required casing for the groundwater mode.

6.6 **Galling**: abrasion of metal.

7.0 SAFETY

7.1 Be familiar with and follow all procedures outlined in Sect. 13, Reference 3.1.1, Sampling and Drilling Safety Procedures.

7.2 Wear a hard hat, steel-toed shoes, safety glasses, and gloves.

7.3 Wear hearing protection if needed.

8.0 PROCEDURE

8.1 Ensure that all equipment and casing are clean before using.

8.2 See References 3.1.2 and 3.1.7 for how the Hydropunch II works and basic operating sequence.

8.3 Assemble the Hydropunch II in the hydrocarbon mode.

8.3.1 Place O-rings on each end of the Hydropunch II. Refer to Reference 3.1.6 and Exhibit 3.

8.3.2 Thread the drive shoe onto one end of the Hydropunch II body and the EW casing adapter onto the other end. Tighten both fittings by hand as much as possible.

8.3.3 Place an O-ring on the drive cone.

8.3.4 Push either end of the 5-ft (1.5-m) polypropylene screen onto the barbed end of the drive cone.

8.3.5 Insert the screen and drive cone into the drive shoe end of the Hydropunch II and seat the O-ring and cone in the drive shoe.

8.3.6 Stretch the rubber sleeve over the drive cone and place it about half-way between the drive cone and drive shoe. This holds the cone in place as the Hydropunch II is lowered into the hole.

8.4 Collect sample in the hydrocarbon mode.

8.4.1 Refer to Exhibit 1 for a diagram of how the Hydropunch II works in this mode.

8.4.2 If site conditions permit, use the Hydropunch II to sample without first drilling a hole.

a. Attach the Hydropunch II to a section of casing.

b. Drive or push the Hydropunch II from the surface to the desired sample depth.

c. While driving or pushing, carefully count and mark the casing to know exactly where the end of the Hydropunch II is. Proceed to 8.4.4.

8.4.3 If using an auger rig, drill to a point just above the desired sampling depth.

a. If sampling free product, stop drilling above the top of the aquifer.

b. Attach the Hydropunch II to a section of EW casing.

c. Lower the Hydropunch II to the bottom of the borehole, attaching additional casing as needed.

CAUTION: Once on the bottom of the borehole, do not lift up the casing/Hydropunch II. This will open the tool, ruin the sample integrity, and may damage the Hydropunch II.

d. Drive or push the Hydropunch II a minimum of 1 ft (0.3 m) (preferably 3 to 5 ft [1.0 to 1.5 m]) past the bottom of the borehole to the final sampling depth.

8.4.4 At the final sampling depth, pull up on the casing to pull the cone and screen out of the Hydropunch II body, permitting groundwater or free product to enter the screen.

CAUTION: a. Do not pull the tool up further than it has been driven. For example, if the tool is driven 3 ft (1 m), do not pull it up more than 2.5 ft (0.8 m).

b. To effectively isolate the sample from outside contamination, the body of the Hydropunch II must remain in the hole made during driving or pushing.

c. A minimum of 6 in. of the body of the tool needs to be above the screen in the drive hole to provide an annular seal.

d. The tool cannot be pulled up more than 5 ft without separating from the screen. This may make it difficult to sample and should be avoided.

8.4.5 Clamp or otherwise hold the casing in position.

8.4.6 Disconnect the casing at the surface and lower a water-level indicator down the casing to check for water.

8.4.7 When an adequate volume of water has filled the tool, lower the bailer through the casing and collect the sample.

a. In fine-grained silts and clays or in very thin water-bearing units, the compression of soil particles may lower permeability and inhibit sample collection. A wait of an hour or more may be necessary to obtain a sample. In some cases, it may not be possible to obtain a sample.

b. Document the sample according to Procedure TE-071.

c. See Procedure TE-072 for sample packaging, preservation, and shipping.

8.4.8 When sample collection is complete, pull the casing and tool to the surface.

a. Normally the drive cone and screen remain downhole.

b. Augering and continuous sampling can continue at the bottom of the borehole. Typically the cone and screen will be recovered by the continuous sampler. Do not reuse the screen if recovered.

8.4.9 Disassemble the Hydropunch II while it is still wet.

a. Water lubricates the parts which reduces the potential for galling.

8.4.10 Decontaminate the Hydropunch II and casing according to Procedure TE-073 or the site sampling plan.

8.5 Assemble the Hydropunch II in the groundwater mode.

8.5.1 Place O-ring in the groove on sleeve cartridge assembly. Refer to Reference 3.1.6 and Exhibit 2.

8.5.2 Place O-ring on the groove on the inlet.

8.5.3 Thread the open end of the stainless steel screen onto the threaded portion of the inlet.

8.5.4 Push the reed check valve over the barb on the inlet.

8.5.5 Thread the inlet/screen assembly into the sleeve cartridge assembly. Use teflon tape on the inlet threads for easier assembly.

8.5.6 Place O-rings onto each end of Hydropunch II body.

8.5.7 Insert the sleeve cartridge assembly into the body of the Hydropunch II.

8.5.8 Thread the drive shoe into the same end of Hydropunch II as the sleeve assembly.

8.5.9 Attach an O-ring to the groove on the drive cone and push the cone into the end of the drive shoe.

8.5.10 Assemble the check disk.

a. Place the O-ring on the check disk.

b. Thread the modified barb into the check disk.

c. Push the reed check valve over the modified barb.

8.5.11 Insert the check disk assembly into the Hydropunch II body.

8.5.12 Thread the AW casing adapter onto the Hydropunch II.

8.5.13 Stretch the rubber retainer sleeve over the drive cone and place it about half-way between the drive cone and drive shoe. This holds the cone in place as the Hydropunch II is lowered down the hole.

8.6 Collect sample in groundwater mode.

8.6.1 Refer to Exhibit 2 for a diagram of how the Hydropunch II works in this mode.

8.6.2 If site conditions permit, use the Hydropunch II to sample without first drilling a hole.

a. Attach the Hydropunch II to a section of AW casing.

b. Drive or push the Hydropunch II from the surface to the desired sample depth.

c. While driving or pushing, carefully count and mark the casing to know exactly where the end of the Hydropunch II is.

d. In order to collect a full sample, the bottom of the Hydropunch II must be at least 5 ft (1.5 m) below the water table.

8.6.3 If using an auger rig, drill to a point just above the desired sampling depth.

a. Attach the Hydropunch II to a section of AW casing.

b. Lower the Hydropunch II to the bottom of the borehole, attaching additional casing as needed.

CAUTION: Once on the bottom of the borehole, do not lift up on the casing/Hydropunch II. This will open the tool, ruin the sample integrity, and may damage the Hydropunch II.

c. Drive or push the Hydropunch II a minimum of 1 ft past the bottom of the borehole to the final sampling depth.

1. To collect a full sample, the bottom of the Hydropunch II must be at least 5 ft (1.5 m) below the water table.

8.6.4 At the final sampling depth, pull up on the casing to pull the cone out of the Hydropunch II, permitting groundwater to enter the screen.

CAUTION: a. Do not pull the tool up further than it has been driven. For example, if the Hydropunch II has been driven 3 ft (1 m), do not pull it up more than 2.5 ft (0.8 m).

b. To effectively isolate the sample from outside contamination, the body of the Hydropunch II must remain in the hole it made during driving or pushing.

c. A minimum of 6 in. (15 cm) of the body of the tool needs to be above the screen in the drive hole to provide an annular seal.

8.6.5 Clamp or otherwise hold the casing in position.

8.6.6 Disconnect the casing at the surface.

8.6.7 If the AW casing is hollow, lower a water-level indicator inside the casing to determine when the sample has been collected.

a. If the AW casing is not hollow, wait about 20 minutes for the first sample.

b. In fine-grained silts and clays or in very thin water-bearing units, the compression of soil particles may lower permeability and inhibit sample collection. A wait of an hour or more may be necessary to obtain a sample. In some cases, it may not be possible to obtain a sample.

8.6.8 When sample collection is complete, pull the Hydropunch II to the surface.

a. As the tool is pulled upward, the hydrostatic head closes the upper and lower check valves, which retains the sample within the Hydropunch II body.

8.6.9 Remove the AW casing adapter from the Hydropunch II and thread on the retainer cap.

8.6.10 Unthread the modified barb from the check disk and thread in the Teflon stopcock.

a. Attach the discharge tube to the stopcock.

b. Invert the Hydropunch II and open the stopcock to decant sample.

c. Document the sample according to Procedure TE-071.

d. See Procedure TE-072 for sample packaging, preservation, and shipping.

8.6.11 Disassemble the Hydropunch II while it is still wet.

a. Water lubricates the parts which reduces the potential for galling.

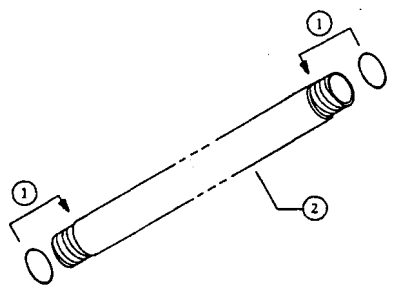
8.6.12 Decontaminate the Hydropunch II and casing according to Procedure TE-073 or the site sampling plan.

8.7 A video cassette, Reference 3.1.8, is available for instruction in using the Hydropunch II.

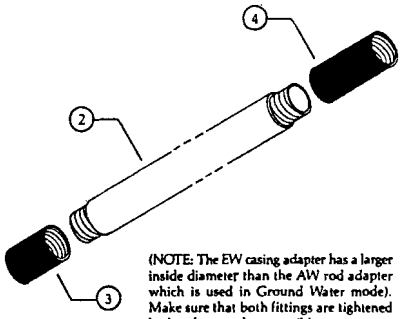
Exhibit 1. Hydropunch II Assembly, Hydrocarbon Mode

ASSEMBLY: HYDROCARBON MODE

1. Place O-rings (1) on each end of HydroPunch II (HP-II) body (2).

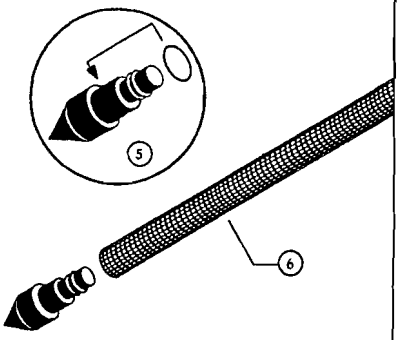


2. Thread drive shoe (3) onto one end of body (2) and EW casing adapter (4) onto other end. Tighten both fittings by hand as much as possible.

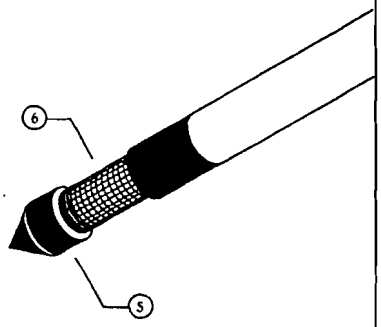


(NOTE: The EW casing adapter has a larger inside diameter than the AW rod adapter which is used in Ground Water mode). Make sure that both fittings are tightened by hand as much as possible.

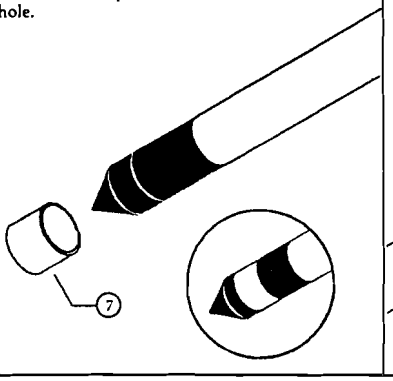
3. Make sure preattached O-ring is on drive cone (5). Push the barbed end of the drive cone (5) into the 5-foot polypropylene screen (6).



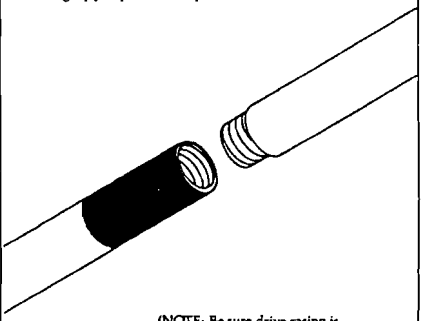
4. Insert the screen (6) and drive cone (5) assembly into the drive shoe end of the HP-II and seat the O-ring and cone in the drive shoe.



5. Stretch rubber retainer sleeve (7) over cone and body to hold cone in place as the tool is lowered down hole.



6. Attach HP-II to EW casing (or other drive casing) using appropriate adapter.



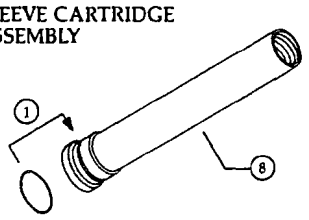
(NOTE: Be sure drive casing is thoroughly cleaned before attaching to the HydroPunch.

Exhibit 2. Hydropunch II Assembly, Groundwater Mode

ASSEMBLY: GROUND WATER MODE

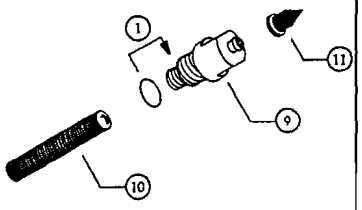
1. Place O-ring (1) in groove on sleeve cartridge assembly (8).

SLEEVE CARTRIDGE ASSEMBLY

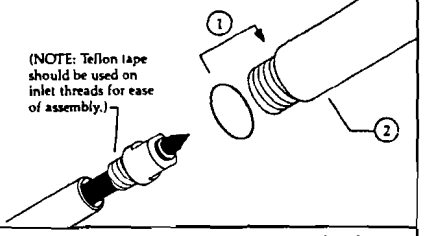


2. Place O-ring (1) in groove on inlet (9). Thread open end of SS screen (10) onto threaded portion of inlet. Push reed valve (11) over barb on inlet.

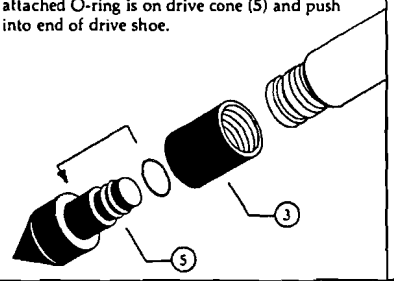
SCREEN ASSEMBLY



3. Thread inlet and screen assembly into sleeve cartridge assembly. Place large O-rings (1) on each end of HydroPunch body (2). Insert complete assembly into body of tool.

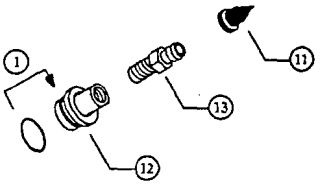


4. Thread drive shoe (3) onto body. Make sure pre-attached O-ring is on drive cone (5) and push into end of drive shoe.

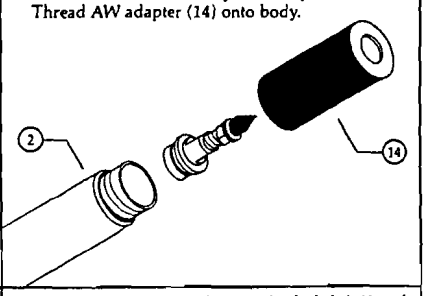


5. Place O-ring in groove on check disk (12). Thread modified barb (13) into check disk (12). Push reed check valve (11) over modified barb (13).

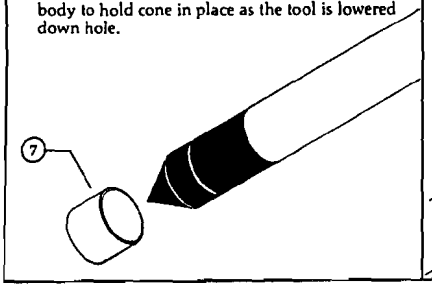
CHECK DISK ASSEMBLY



6. Insert check disk assembly into body of tool (2). Thread AW adapter (14) onto body.

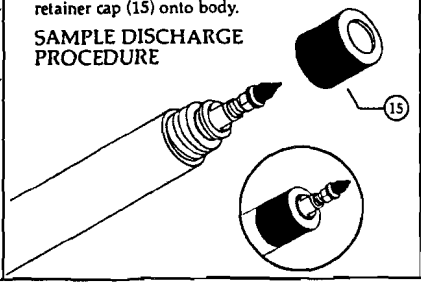


7. Stretch rubber retainer sleeve (7) over cone and body to hold cone in place as the tool is lowered down hole.



8. Remove AW adapter from top of body and thread retainer cap (15) onto body.

SAMPLE DISCHARGE PROCEDURE



9. Unthread modified barb from check disk (12) and thread in Teflon stopcock (16). Attach discharge tube (17) to stopcock. Invert the tool and open stopcock to discharge sample.

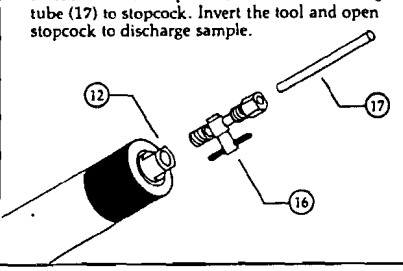
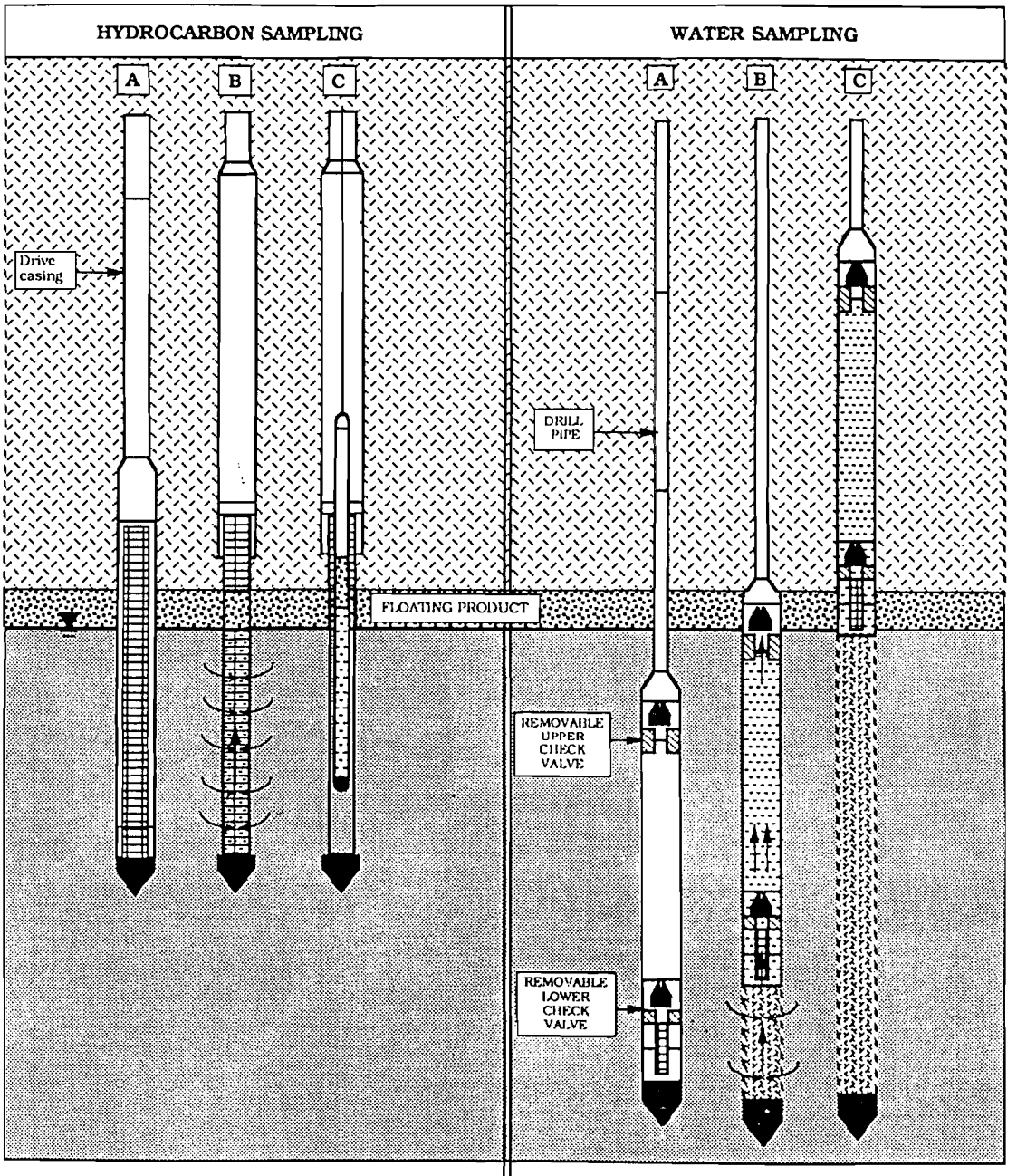


Exhibit 3: Hydropunch II, How it Works



LEGEND: HYDROCARBON SAMPLING

- A HydroPunch II closed while being driven into position.
- B Tool opened and 5 foot screen telescopes into position for collection of hydrocarbon or water sample at the very top of the aquifer.
- C Hydrocarbon sample being collected using bailer lowered through drive casing.

LEGEND: WATER SAMPLING

- A HydroPunch II closed while being driven into position.
- B Cone separated and tool open to collect sample.
- C Check valves closed as sample is retrieved within body of the tool.

FIELD OPERATION OF THE HEWLETT PACKARD 5890 SERIES II GAS CHROMATOGRAPH

1.0 PURPOSE

This procedure describes the use of the Hewlett Packard (HP) 5890 Series II gas chromatograph (GC) for analysis of environmental pollutants.

2.0 APPLICABILITY

This procedure applies to the HP 5890 Series II gas chromatograph, which is equipped with two injector ports and two detectors configured for parallel operation: the electron capture detector (ECD) and the photoionization detector (PID). The injector and detector ports are configured for wide-bore capillary columns (0.53 mm I.D.). Variable temperature programs and various column types may be used.

3.0 OTHER DOCUMENTS

3.1 REFERENCES

3.1.1 Hewlett Packard 5890 Series II Gas Chromatograph Operating Manual.
3.1.2 HP 3396 Series II Integrator Operating Manual.
3.1.3 Procedure TE-088, Using the Chrom Perfect Gas Chromatograph Software.

3.2 EXHIBITS

3.2.1 Exhibit 1: Example of Chromatogram and Report

4.0 EQUIPMENT AND MATERIALS

APPROVALS		
Author		Date
Supervisor		Date
Group Leader	[illegible]	Date 8/4/93
Section Head	Gail Little	Date 8/6/93

4.1 EQUIPMENT

4.1.1 HP 5890 Series II Gas Chromatograph
4.1.2 HP 3396 Series II Integrator
4.1.3 Carrier gas bottles
4.1.4 In-line oxygen trap
4.1.5 Moisture trap
4.1.6 Forceps
4.1.7 Set of box and open-end wrenches
4.1.8 Personal computer (PC) when using Chrom Perfect software

4.2 MATERIALS

4.2.1 Liquid leak detector
4.2.2 Non-liquid leak detector
4.2.3 Gas-tight syringes
4.2.4 Calibration standards
4.2.5 Septums

5.0 RESPONSIBILITY

It is the responsibility of the operator of the HP 5890 Series II gas chromatograph to follow this procedure.

6.0 DEFINITIONS

6.1 **Carrier gas:** gas that serves to transport the standard or sample through the column.

6.2 **Chromatogram:** a graphic display in the form of peaks of the detector's response to a given standard or sample.

6.3 **Retention time:** the elapsed time from the injection of standard or sample (when START was activated) until detection.

6.4 **Photoionization detector (PID):** a GC detector in which the GC column effluent gas stream is subjected to ultraviolet radiation energetic enough to ionize many organic compounds in the gas stream. Since each organic molecule has a characteristic ionization potential (the energy required to remove an electron from a molecule), the PID can be tuned to detect certain classes of organic compounds.

6.5 **Electron capture detector (ECD):** a GC detector that measures a decrease in electrical signal rather than an increase in electrical current. The loss of current is proportional to the amount of compound present. The ECD is virtually insensitive to hydrocarbons. It is especially valuable for the analysis of pesticides and PCBs.

7.0 PROCEDURE

7.1 Start up the GC, following the steps below:

7.1.1 Connect the GC to the carrier gas supply.

a. Nitrogen, if used, must be at least 99.9995% hydrocarbon free.

7.1.2 Install the moisture trap and in-line oxygen trap as close to the injector as possible to ensure carrier gas purity.

7.1.3 Test all connections for leaks.

a. Use a liquid leak detector such as Snoop™ on the connections to the oxygen trap.

b. Use a non-liquid leak detector on all gas-line and column connections past the oxygen trap.

7.1.4 Set the desired column flow rate and the total flow output, referring to the operating manual, Reference 3.1.1.

a. Recommended column flow rates are between 5 and 15 mL/min but may be outside this range depending on the type of analysis performed.

b. When using the ECD detector, total flow must be greater than 50 mL/min.

7.1.5 Enter the oven ramping program, injector, and detector temperatures, referring to the operating manual.

EXAMPLE: for the VOCOL column with the ECD detector enter:

ECD temperature:	250° C
Injector temperature:	175° C
Program:	35° C for 4.00 min
	Ramp at 4.0° C/min to 100° C
	Hold at 100° C for 1.00 min

Ramp at 20°C/min to 170°C
Hold at 170°C for 12.00 min

Note: The final temperature and hold time ensure that the column is free of residual contamination.

7.1.6 Turn on the detector injector and oven and allow the GC to stabilize at operating temperatures.

a. Stabilization time will depend on how long the GC has been turned off.

b. A recommended baseline signal is less than 20 mV.

c. Referring to the operating manual, Reference 3.1.1, troubleshoot the instrument if the baseline is unstable.

7.1.7 Set up the HP 3396 Integrator.

a. Connect the two "INET" cables from the back of the integrator to the instrument block on top of the GC.

b. Set the current date and time.

c. If using the Chrom Perfect software with the integrator and PC, see Procedure TE-088.

7.2 Calibrate the GC using known standards.

7.2.1 Withdraw a specific volume of headspace from prepared calibration standards using a gas-tight syringe.

a. 10 to 25 μL is recommended for a 500-ppb standard.

b. Do NOT inject liquid into the instrument.

7.2.2 Inject the calibration standard into the GC using a quick consistent motion.

7.2.3 Withdraw the syringe and press START on the GC or START on the integrator.

a. A peak appears on the chromatogram plot at ~0.85 min. This is the air from the syringe injection detected by the ECD. Use this peak (which always appears) as:

1. a timing guide for syringe injection consistency, and

2. an indicator that the sample has been placed on the column.

b. The result of the injection is a chromatogram plot and table of the individual components of the standard. The following are shown:

1. retention times
2. areas of the peaks (concentrations).

7.2.4 At the integrator, create a single or multi-level calibration file following the procedures outlined in the operating manual.

a. Store the resulting calibration file, using a name unique to the project, e.g., TUCSON.CAL.

b. If using the Chrom Perfect software with the integrator and PC, see Procedure TE-088.

7.2.5 Create a method file, setting the appropriate parameters outlined in the operating manual.

a. Replace the existing calibration file within the method file with the calibration file created above.

b. Store the resulting method file using a name unique to the project, e.g., TUCSON.MET.

7.2.6 Load the newly created method file prior to analyzing samples or after power is interrupted to the integrator.

CAUTION: The integrator has a limited amount of memory. Protect all method and calibration files as well as critical chromatograms.

7.3 Analyze a sample.

7.3.1 If using the Chrom Perfect software with integrator and PC, see Procedure TE-088.

7.3.2 Using a gas-tight syringe, withdraw a specific volume of headspace from the sample.

a. Use the same volume as that used for the calibration standard unless the sample possibly contains high concentrations of contaminants. Under these circumstances, use a smaller sample volume.

7.3.3 Inject the sample and press START on the GC or on the integrator.

7.3.4 Using the integrator, calculate the contaminant concentrations in the sample. See the operating manual, Reference 3.1.2.

7.3.5 Store the chromatogram.

a. Exhibit 1 shows an example of a chromatogram and report that result when using the Chrom Perfect software.

7.4 When contamination of the column or detector(s) is indicated by an upward drift in the signal level output, bake out either or both of these with the following steps:

7.4.1 Increase the column temperature to 190°C to drive off residual contamination within the column.

7.4.2 Increase the temperature of the ECD to 275°C and the PID temperature to 225°C to purge contaminants from the detectors.

7.5 Replace the septum at the end of the day in order for the GC to stabilize overnight.

7.5.1 Turn off the detectors.

7.5.2 Lower the injector and detector temperatures to 35°C.

7.5.3 Unscrew the septum retaining nut and remove the septum using forceps or a clean syringe.

7.5.4 Quickly install a new septum and replace the retaining nut. DO NOT OVERTIGHTEN THE RETAINING NUT.

7.6 Turn off the instrument:

7.6.1 Lower the oven, injector, and detector temperatures to 35°C.

7.6.2 Turn off the detectors.

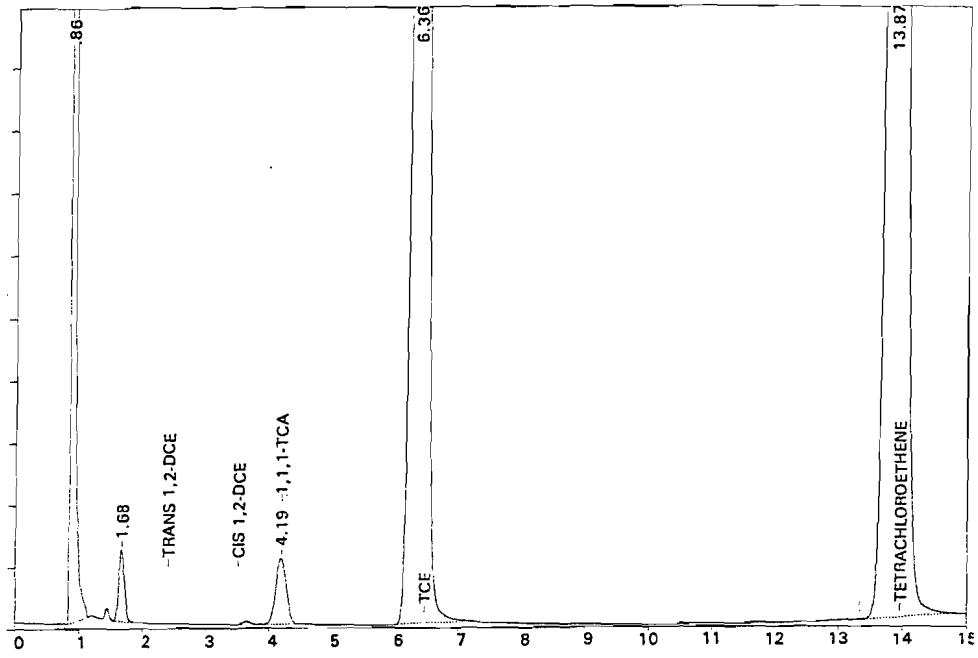
7.6.3 Turn off the oven.

7.6.4 Turn off the GC.

Exhibit 1. Example of Chromatogram and Report

File=C:\CP\DATA1\TUCS.65R Sample name=SV042-10' Date printed= 06-01-1993 Time= 11:05:56

0.00 to 15.00 min. Low Y = 0.26992 mv High Y = 0.76992 mv Span = 0.50000 mv



C:\CP\DATA1\Q67B0652.BNC
Data file = C:\CP\DATA1\TUCS.65R
Date stamp = 05/19/93 Time = 09:52:42
Sample name = SV042-10'
Collected on MAY 19, 1993 09:37:21 from port # 1
Operator = J.L. ZUTMAN
Reference file name = Q67B0652b#66
Instrument = HP 5890 II
Method name = C:\CP\DATA1\TUCAIR.MET version # 5
Date method last modified = 06/01/93 Time = 10:54:12
Calibration file = C:\CP\DATA1\TUCAIR.CAL version # 16
Date cal file last modified = 06/01/93 Time = 10:53:52
Run time = 15.00 minutes Area reject = 100
Amount injected = 1 Dilution Factor = 1
Sample Weight = 1 Internal Standard Amount = 0
Sampling rate = 10 per second
Peak detect threshold = 0 Starting peak width = .04 minutes
Chrom-Perfect Software Serial # 12948 Version = 5.05 For Martin Marietta
Today's date = 06-01-1993 Time = 11:06:30

PK	Ret Time	Name	Amount	Amount %	Area	Area %	Type	Width	Height	Height %
1	0.863		408,929.0625	98.1405%	29,331.3	26.121%	BB	0.028	17,527.78	74.2850%
2	1.680		4,138.1436	0.9931%	355.5	0.317%	BB	0.102	57.84	0.2451%
3	4.188	1,1,1-TCA	10.6134	0.0025%	606.2	0.540%	BB	0.190	53.10	0.2250%
4	6.357	TCE	2,523.0984	0.6055%	28,674.3	25.536%	BB	0.206	2,316.57	9.8179%
5	13.870	TETRACHLOROETHENE	1,076.3005	0.2583%	53,323.9	47.487%	BB	0.244	3,640.01	15.4269%

Total area = 112291.3 Total amount = 416677.3 Sample units = ug/l Total height = 23595.29

WATER SAMPLING FOR FIELD SCREENING USING THE GEOPROBE AND U2CRT

1.0 PURPOSE

This procedure describes the use of the Geoprobe in conjunction with the U2CRT truck-mounted auger rig for collecting water samples for field screening of contaminants.

2.0 APPLICABILITY

This procedure applies to the Geoprobe, a system for hydraulically driving well points that may then be used with a miniature bailer, inertial pump, or other method to collect water samples from groundwater.

3.0 OTHER DOCUMENTS

3.1 REFERENCES

3.1.1 Procedure TE-105, U2CRT Operation.
3.1.2 Procedure TE-094, Water-Level Measurement
3.1.3 Procedure TE-071, Sample Documentation
3.1.4 Procedure TE-072, Sample Packaging, Preservation, and Shipping
3.1.5 Procedure TE-082, Surface and Groundwater Sampling for Organic Parameters
3.1.6 Procedure TE-034, Chain of Sample Custody
3.1.7 Procedure TE-073, Equipment Decontamination
3.1.8 Procedure TE-081, Water Sampling or Analysis of Inorganc Compounds and Radionuclides

3.2 APPENDICES

3.2.1 Appendix 1: Water Sample Data Record

APPROVALS		
Author		Date
Supervisor		Date
Group Leader	[illegible]	Date 8/4/93
Section Head	Craig Little	Date 8/6/93

4.0 EQUIPMENT AND MATERIALS

4.1 EQUIPMENT

4.1.1 U2CRT
4.1.2 Water-level recorder, if needed
4.1.3 Push rods
4.1.4 Expendable drive point, retractable drive point, or slotted rod
4.1.5 Inertial pump sampler
4.1.6 Sample logbook

4.2 MATERIALS

4.2.1 Expendable well points
4.2.2 Tubing for sampling
4.2.3 String or stainless steel cable
4.2.4 Wooden blocks

5.0 RESPONSIBILITY

5.1 It is the responsibility of the Geoprobe operator to follow this procedure and to ensure that the equipment is operated safely.

5.2 It is the responsibility of the Geoprobe technician to provide support for the Geoprobe operator and to follow this procedure and all instructions of the operator.

5.3 It is the responsibility of the site project manager to direct the operator and technician to required sample locations and intervals.

6.0 DEFINITIONS

6.1 **Geoprobe:** a system for hydraulically driving rods and various sampling devices into the subsurface.

6.2 **Geoprobe adapter assembly (sub):** a device that adapts the U2CRT drive rod to the Geoprobe system.

6.3 **Latch:** a device that attaches to the adapter assembly to pull the Geoprobe rods out of the ground.

6.4 **Hammer anvil:** a device that fits into the Geoprobe adapter assembly and is used for pushing and hammering the rods into the ground.

6.5 **Inertial Pump:** a water sampler that operates like a miniature bailer.

7.0 SAFETY

7.1 Strictly adhere to the safety instructions given in Procedure TE-105, U2CRT Operation.

7.2 All personnel within a minimum radius of the height of the drill mast must wear hard hats, steel toed boots or shoes, and safety glasses or goggles.

7.3 Wear ear plugs or muffs with a minimum noise reduction rating of 15 dBA during operation of the hydraulic hammer.

7.4 Use gloves during operation of U2CRT. Gloves are required when contact with sample material is anticipated.

7.5 KNOW THE LOCATION OF THE KILL SWITCH.

8.0 PROCEDURE

8.1 Following Procedure TE-105, prepare the U2CRT for Geoprobe sampling.

8.2 Assemble push rods by following the steps below:

8.2.1 Install the expendable-point adapter to the female end of the first probe push rod.

8.2.2 Install the expendable well point on the end of the well-point adapter.

NOTE: Other methods that allow for collection of groundwater samples are the retractable point and slotted drive rod.

8.2.3 Thread the drive cap on the male end of the first push rod.

8.3 Push and/or drive multiple sections of probe rods:

8.3.1 Lift the latch and insert the hammer anvil into the Geoprobe adapter assembly (sub).

8.3.2 Push the latch back in order to hold in the hammer anvil.

8.3.3 Position the first push rod below the hammer anvil.

8.3.4 Lower the drive rod and sub until the hammer anvil makes contact with the drive cap.

8.3.5 Push the rod into the ground, increasing the hydraulic pressure and/or using the hydraulic hammer as needed.

8.3.6 Raise the sub and connect additional Geoprobe rods until near the desired depth.

8.3.7 Push the probe rods 4 in. (10 cm) past the desired sampling depth.

8.4 Prepare the probe rods for *in situ* sampling:

8.4.1 Remove drive cap and install puller cap on the top probe rod.

8.4.2 Unlatch and remove hammer anvil.

8.4.3 Lower the sub until it is in contact with the puller cap and lower the latch under the puller cap.

8.4.4 Raise the probe rod combinations approximately 1 ft (30 cm).

8.4.5 Release pressure from the sub and unlatch from the probe rods.

8.4.6 Slide the U2CRT mast forward to allow working room, if possible.

8.4.7 Remove the puller cap.

8.5 Measure the water level in the rods, if requested by site project manager.

8.5.1 Lower the water-level indicator inside the rods and measure the water level as directed in Procedure TE-094.

NOTE: Water-level measurements may not be feasible if soil or silt has entered the rods or if the water level is deep. The water-level indicators are only slightly smaller than the ID of the probe rods.

8.6 Take water samples using the inertial pump sampler.

8.6.1 Attach to the inertial pump one end of a section of clean Teflon™ tubing (or approved equivalent) that is long enough to reach the bottom of the well point and extend ~ 3 ft (1 m) above the top of the uppermost probe rod.

a. Ensure that the tube is connected tightly to the sampler.

8.6.2 Lower the sampler end of the tubing to the bottom of the well point.

a. Resistance along the side of the tubing will diminish when the sampler has passed the bottom section of the rod.

8.6.3 Raise the tubing above the very bottom of the well point and begin an oscillating up and down motion.

8.6.4 Once water begins flowing from the end of the tube, fill the required number of sampling containers.

a. See Procedures TE-071 and TE-072 for sample container, preservatives, and labeling requirements or follow special instructions from the site project manager.

b. See Procedures TE-081, TE-082 and TE-034 for guidance on filling out the Water Sample Data Record (Appendix 1) and Chain of Sample Custody forms or follow special instructions from the site project manager.

8.6.5 Drain excess water from the tubing back into the well point; remove the inertial pump sampler and dispose of the tubing according to site-specific waste management requirements.

8.7 Take water samples using a mini-bailer:

8.7.1 Attach the mini-bailer to a string or stainless steel cable.

8.7.2 Lower the bailer inside the Geoprobe rods to water.

8.7.3 Allow the bailer to fill and retrieve the bailer.

8.7.4 Fill the required sample containers from the bailer.

8.8 Remove probe rods from the ground:

8.8.1 Reattach the puller cap to the drive rods. Slide the U2CRT mast back until the sub is aligned over the drive rods.

8.8.2 Remove the hammer anvil from the sub.

8.8.3 Lower the sub onto the puller cap.

8.8.4 Stack wooden blocks under the derrick feet attached to the rig or lower the "outriggers" on the U2CRT, if needed.

8.8.5 Slowly raise the drive rod and pull the probe rods from the ground.

8.8.6 Unthread each probe rod and lay to the side to avoid a tripping hazard. Repeat this procedure until all rods are retrieved.

CAUTION: KEEP HANDS AWAY FROM THE GEOPROBE ASSEMBLY DURING THIS PROCEDURE.

8.9 Decontaminate the inertial pump, probe rods, point holders, and other soiled downhole equipment according to Procedure TE-073 or specific instructions from the site project manager.

Appendix 1. Water Sample Data Record

Water Sample Data Record

Project:	Location:	Date:	Field#:
Samplers:	Time Start:	Time Completed:	
No. of Completions:	Depth to Water:	Total Well Depth:	Well Volume:
Well Diameter:	Screened Interval:	Volume Purged:	Weather Conditions:
Sampling Equipment Used:		PID:	

No. of Bottles	Bottle Size/Description	Filtered	Preservative	Analyses Requested

Instrument Calibrations

Conductivity				
Standard Values				Calib. time:
Measured Value				
Temp. of Std.				
pH				
Standard				Calib. time:
Temp. of Std.				

Sample Parameters

Time	Temp.	Conductivity	pH	Time	Temp.	Conductivity	pH

SOIL SAMPLING FOR FIELD SCREENING USING THE GEOPROBE AND U2CRT

1.0 PURPOSE

This procedure describes the use of the Geoprobe in conjunction with the U2CRT truck-mounted auger rig for collecting soil samples for field screening of contaminants.

2.0 APPLICABILITY

This procedure applies to the Geoprobe, a hydraulically driven probe that enables the operator to collect undisturbed soil samples to bedrock or refusal. The Geoprobe may be used to collect samples that provide a maximum of 450 g of soil from a 2-ft (0.6 m) sampler.

3.0 OTHER DOCUMENTS

3.1 REFERENCES

3.1.1 Procedure TE-105, U2CRT Operation
3.1.2 Procedure TE-072, Sample Packaging, Preservation, and Shipping
3.1.3 Procedure TE-071, Sample Documentation
3.1.4 Procedure TE-034, Chain of Sample Custody
3.1.5 Procedure TE-073, Equipment Decontamination

4.0 EQUIPMENT AND MATERIALS

4.1 EQUIPMENT

4.1.1 U2CRT
4.1.2 Push rods
4.1.3 Soil sample tube assembly
4.1.4 Sample logbook

APPROVALS		
Author		Date
Supervisor		Date
Group Leader	[illegible]	Date 8/4/93
Section Head	Craig Little	Date 8/6/93

4.1.5 Extension rods
4.1.6 Extruder rack

4.2 MATERIALS

4.2.1 Two 24-in. (0.6-m) bars
4.2.2 ¾-in.-diameter (1.9-cm) steel rod or wooden dowel
4.2.3 Square sample tubes
4.2.4 Wooden blocks

5.0 RESPONSIBILITY

5.1 It is the responsibility of the U2CRT operator to follow this procedure and to ensure that the equipment is operated safely.

5.2 It is the responsibility of the U2CRT technician to provide support for the U2CRT operator and to follow this procedure and all instructions of the operator.

5.3 It is the responsibility of the site project manager to direct the operator and technician to required sample locations and intervals.

6.0 DEFINITIONS

6.1 **Geoprobe:** a system for hydraulically driving rods and various sampling devices into the subsurface.

6.2 **Geoprobe adapter assembly (sub):** a device that adapts the U2CRT drive rod to the Geoprobe system.

6.3 **Latch:** a device that attaches to the adapter assembly to pull the Geoprobe rods out of the ground.

6.4 **Hammer anvil:** a device that fits into the Geoprobe adapter assembly and is used for pushing and hammering rods into the ground.

6.5 **Soil sample tube:** a thin-walled, shelby-type tube with a sharpened end; used for collecting soil samples.

6.6 **Piston rod and point:** a point and attached rod that slides into the soil sample tube. When held in place by the piston stop pin, no soil sample is collected; after removing the piston stop pin, the point and rod slide up into the sample tube allowing soil to enter the tube.

6.7 **Piston stop pin:** a pin that threads (reverse) into the sample tube adapter and holds the piston rod and point in place.

6.8 **Sample tube adapter:** an adapter from soil sample tube to probe rods.

6.9 **Extension rods:** rods that fit inside the probe rods, the ends of which thread into piston stop pins, allowing the pin to be removed at the proper sample depth.

7.0 SAFETY

7.1 Strictly adhere to the safety instructions given in Procedure TE-105, U2CRT Operation.

7.2 All personnel within a minimum radius of the height of the drill mast must wear hard hats, steel-toed boots or shoes, and safety glasses or goggles.

7.3 Wear ear plugs or muffs with a minimum noise reduction rating of 15 dBA, during operation of the hydraulic hammer.

7.4 Use gloves during operation of U2CRT. Gloves are required when contact with sample material is anticipated.

7.5 KNOW THE LOCATION OF THE KILL SWITCH.

8.0 PROCEDURE

8.1 Following Procedure TE-105, prepare the U2CRT for Geoprobe sampling.

8.1.1 Lift the latch and insert the hammer anvil into the Geoprobe.

8.1.2 Push the latch back in order to hold in the hammer anvil.

8.2 Assemble the soil sample tube in the following way:

8.2.1 Thread the piston rod onto the point.

8.2.2 Slide the piston rod and point into the sample tube.

8.2.3 Thread the sample tube adapter into the soil sample tube and thread (reverse thread) the piston stop pin into the sample tube adapter.

8.3 Prepare the probe rods for sampling:

8.3.1 Thread a section of probe rod onto the sample tube and install the drive cap.

8.3.2 Position the sampling rod assembly below the hammer anvil.

8.3.3 Lower the drive rod and sub until the hammer anvil makes contact with the drive cap.

8.3.4 Push the sampling rod assembly into the ground, increasing the hydraulic pressure and/or the hydraulic hammer as needed.

8.3.5 Raise the drive rod and sub and connect a second Geoprobe rod.

8.3.6 Continue with this procedure until the desired depth is reached.

8.4 Extract the piston stop pin:

8.4.1 Slide the drill rig mast forward to allow more working room, if possible.

8.4.2 Remove drive cap.

8.4.3 Using the necessary sections of threaded extension rods, remove the sampler piston stop pin by rotating the extension rods until the pin is free.

8.5 Collect the soil sample and remove from ground.

8.5.1 Slide the drill rig mast back over the probe rods.

8.5.2 Replace the drive cap and advance the Geoprobe rods the length of the sampler less 3 in. (7.6 cm) to compensate for the length of the sampler adapter and the piston point.

8.5.3 Raise the drive rod and remove the hammer anvil.

8.5.4 Thread the probe rod puller cap onto the probe rod.

8.5.5 Lower the drive rod so that it is sitting directly on top of the rod puller cap.

8.5.6 Latch the drive rod to the puller cap.

8.5.7 Stack wooden blocks under the derrick feet or lower the "outriggers" on the U2CRT, if needed.

8.5.8 Slowly raise the drive rod and pull the probe rods from the ground.

8.5.9 Unthread each probe rod and lay to the side to avoid tripping hazards.

8.5.10 Install the probe rod puller cap and repeat the steps above until the sample tube has been retrieved to the surface.

8.6 Extract the soil sample:

8.6.1 Place two 24-in. (0.6-m) bars across the derrick feet.

8.6.2 Place the extruder rack on the bars and align it directly below the drive rod.

8.6.3 Remove the sample tube from the probe rods; remove the piston rod, point, and sample tube adapter from the sample tube.

8.6.4 Place the sampler in the extruder rack.

8.6.5 Push the sample from the sample tube using a ¾-in.-diameter (1.9-cm) steel rod or wooden dowel and the drive rod from the U2CRT.

CAUTION: Perform this maneuver very carefully.

8.7 Package and preserve the sample according to Procedure TE-072 or according to special instructions from the site project manager.

8.8 Label and document samples according to Procedure TE-071 and Procedure TE-034, or as instructed by the site project manager.

8.9 Decontaminate the sample tubes according to Procedure TE-073 or site-specific procedures before re-use.

8.10 Decontaminate the probe rods and other downhole equipment according to Procedure TE-073 or site-specific procedures prior to use at another location.

SOIL SAMPLING WITH THE MICROCORER

1.0 PURPOSE

This procedure describes the use of the microcorer, a small, hand-held, soil-extraction device.

2.0 APPLICABILITY

This procedure applies to sampling soils to be analyzed for volatile organic compounds (VOCs). The microcorer is often used to obtain gram-sized samples from larger samples, such as those extracted during soil boring or groundwater-monitoring-well drilling.

3.0 OTHER DOCUMENTS

3.1 REFERENCES

3.1.1 Procedure TE-072, Sample Packaging, Preservation, and Shipping.
3.1.2 Procedure TE-073, Equipment Decontamination.

3.2 EXHIBITS

3.2.1 Exhibit 1: Diagram of Microcorer

4.0 EQUIPMENT AND MATERIALS

4.1 EQUIPMENT

4.1.1 Microcorer sampler
4.1.2 Electronic balance
4.1.3 Automatic pipette

APPROVALS	
Author	Date
Supervisor	Date
Group Leader	Date 8/4/93
Section Head	Date 8/6/93

4.2 MATERIALS

4.2.1 Sample logbook
4.2.2 40-mL glass vials and caps
4.2.3 Methanol, pesticide grade
4.2.4 Deionized (DI) water
4.2.5 Disposable pipette tips

5.0 RESPONSIBILITY

5.1 It is the responsibility of the field personnel collecting soil samples to follow this procedure if so directed by the site-specific sampling plan or the site project manager (SPM).

6.0 DEFINITIONS

6.1 **Microcorer:** a small, hand-held sampler used to collect a soil sample that will fit inside a 40-mL glass vial.

7.0 PROCEDURE

7.1 Clean and decontaminate all equipment and materials that will be used during sampling according to Procedures TE-072 and TE-073.

7.2 Determine an appropriate sampling point for VOCs as directed by the site-specific sampling plan or the SPM.

7.3 Using a pipette, introduce 10 mL of methanol or DI water into a pre-cleaned 40-mL glass vial, depending on what is called for in the site-specific sampling plan.

7.4 Cap and weigh the vial.

7.4.1 Record weight on the vial or label.

7.5 Set microcorer for the desired sample size.

7.5.1 Each line inscribed on the barrel indicates approximately 1 g, depending on the soil type to be sampled.

7.5.2 Loosen the set screw, slide the stop to the desired line, and tighten the set screw.

7.6 Insert the microcorer into the soil to be sampled, ensuring that soil fills the barrel to the stop.

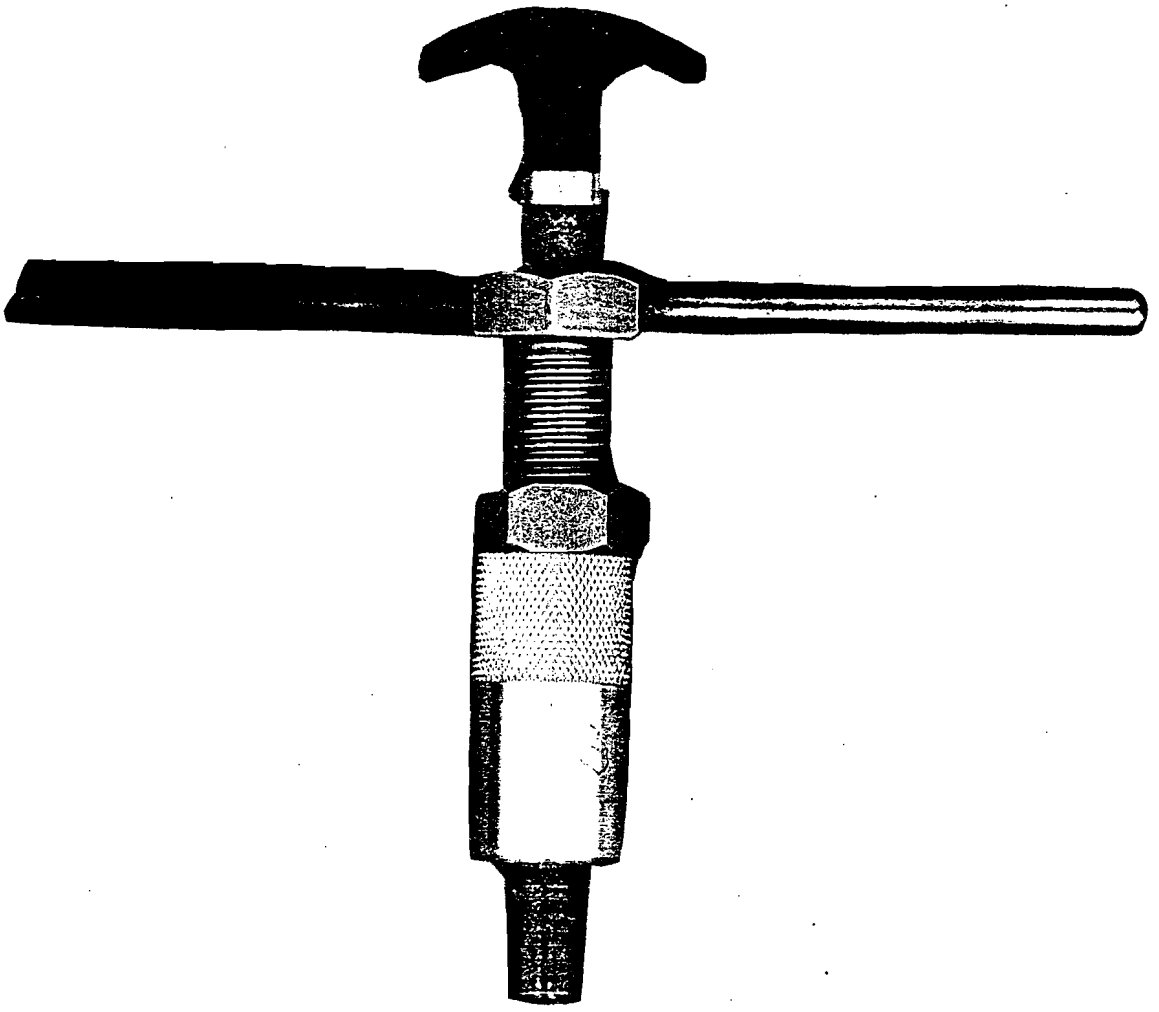
7.7 Extrude the soil from the microcorer into the pre-weighed 40-mL vial.

7.8 Weigh the vial, including methanol (or DI water) and soil.

7.8.1 Record weight in sample logbook and/or on the vial label as directed by the sampling plan or site project manager.

7.9 Decontaminate the microcorer according to Procedure TE-073.

Exhibit 1. Diagram of Microcorer



USING THE CHROM PERFECT GAS CHROMATOGRAPH SOFTWARE

1.0 PURPOSE

This procedure describes the use of the Chrom Perfect software in conjunction with the Hewlett Packard (HP) 5890 Series II gas chromatograph (GC) and the HP 3396 Series II integrator for analysis of environmental pollutants.

2.0 APPLICABILITY

This procedure applies to Chrom Perfect Version 6.0, the HP 3396 II integrator, and the HP 5890 Series II gas chromatograph. Accessory components include a personal computer (PC) capable of running the software and a HP LaserJet printer configured with ample memory to plot the chromatograms.

3.0 OTHER DOCUMENTS

3.1 REFERENCES

3.1.1 Chrom Perfect User's Manual.
3.1.2 HP 3396 Series II Integrator Operating Manual.
3.1.3 Procedure TE-084, Field Operation of the Hewlett Packard 5890 Series II Gas Chromatograph.

3.2 EXHIBITS

3.2.1 Example of Chromatogram and Report

4.0 EQUIPMENT AND MATERIALS

4.1 EQUIPMENT

4.1.1 HP 5890 Series II gas chromatograph
4.1.2 HP 3396 Series II integrator

APPROVALS			
Author		Date	
Supervisor		Date	
Group Leader	[illegible]	Date	8/4/93
Section Head	Craig Little	Date	8/6/93

4.1.3 HP LaserJet III or IV
4.1.4 Personal computer with monitor
4.1.5 Chrom Perfect Version 6 software

5.0 RESPONSIBILITY

It is the responsibility of the operator of the HP 5890 II GC to follow this procedure.

6.0 PROCEDURE

6.1 Connect the integrator to the PC:

6.1.1 Connect the RS-232 cable from the COM1 port on the computer to the computer output port on the integrator.

6.1.2 Set the integrator baud rate to 2400.

a. Toggle all configuration switches to the on (up) position except switches 1 and 2, which are off (down).

6.1.3 Connect the activator device to the LPT1 parallel port on the computer.

6.1.4 Connect the printer cable from the activator device on the LPT1 parallel port on the computer to the parallel port on the printer.

6.1.5 Turn on the PC and integrator.

6.2 Load the Chrom Perfect software into the PC.

6.3 Configure the software.

6.3.1 At the c:\cp> prompt, type MENU.

6.3.2 Tab to the Configuration option in the Chrom Perfect main menu.

6.3.3 Follow the software prompts and enter the appropriate responses, referring to the Chrom Perfect User's Manual for details.

6.3.4 Return to the main menu.

6.4 Create a method file.

6.4.1 Edit an existing file, e.g., STARTING.MET.

6.4.2 Set the necessary parameters in the Acquire, Integration, and Events options located within the main method menu, referring to the Chrom Perfect User's Manual for details.

6.4.3 Save the resulting method using a unique file name for the project, e.g., TUCSON.MET.

6.4.4 Return to the main menu.

6.5 Prepare the integrator for data acquisition.

6.5.1 From the Chrom Perfect main menu, select Show Status of Integrators.

a. This starts the Acquire program and brings up the Acquire menu.

6.5.2 Type D from the Acquire menu to download integrator for data acquisition.

6.5.3 Follow the software prompts and enter the appropriate responses, referring to the Chrom Perfect User's Manual for details.

a. The integrator will print a list of settings including run time, sampling rate, and synchronized time with the PC.

6.6 Create a calibration file when the screen shows READY FOR RUN TO BEGIN.

6.6.1 Withdraw a specific volume of headspace from a prepared calibration standard. See Procedure TE-084.

6.6.2 Inject the calibration standard into the GC using a quick consistent motion.

6.6.3 Withdraw the syringe and press START on the GC or on the integrator.

6.6.4 Record the resulting retention times and area counts for each peak of the calibration standard.

6.6.5 Exit to the main menu.

6.6.6 Enter the Calibration File Editor from the main menu.

6.6.7 Edit an existing calibration file, e.g., STARTING.CAL.

6.6.8 Following the software prompts at the bottom of the screen, enter the appropriate responses, referring to the Chrom Perfect User's Manual.

6.6.9 Save the resulting calibration file using a file name unique to the project, e.g, TUCSON.CAL.

6.6.10 Exit the Calibration File Editor and return to the main menu.

6.6.11 Enter the Method File Editor.

6.6.12 Edit the newly created method file, e.g., TUCSON.MET.

6.6.13 Enter the Cal option from the horizontal menu at the top of the screen.

6.6.14 Specify the newly created calibration file to be used, e.g., TUCSON.CAL.

6.6.15 Exit the Method File Editor.

6.7 Analyze a sample. See Procedure TE-084.

6.7.1 At the Chrom Perfect main menu, tab to Show Status of HP Integrators and return.

6.7.2 If the screen <u>does not</u> show READY FOR RUN TO BEGIN, download the integrator as outlined in 6.5 above.

6.7.3 Tab to Change Sample Data and return.

6.7.4 Change the necessary information in the table.

a. This table will be printed on the report at the end of the run.

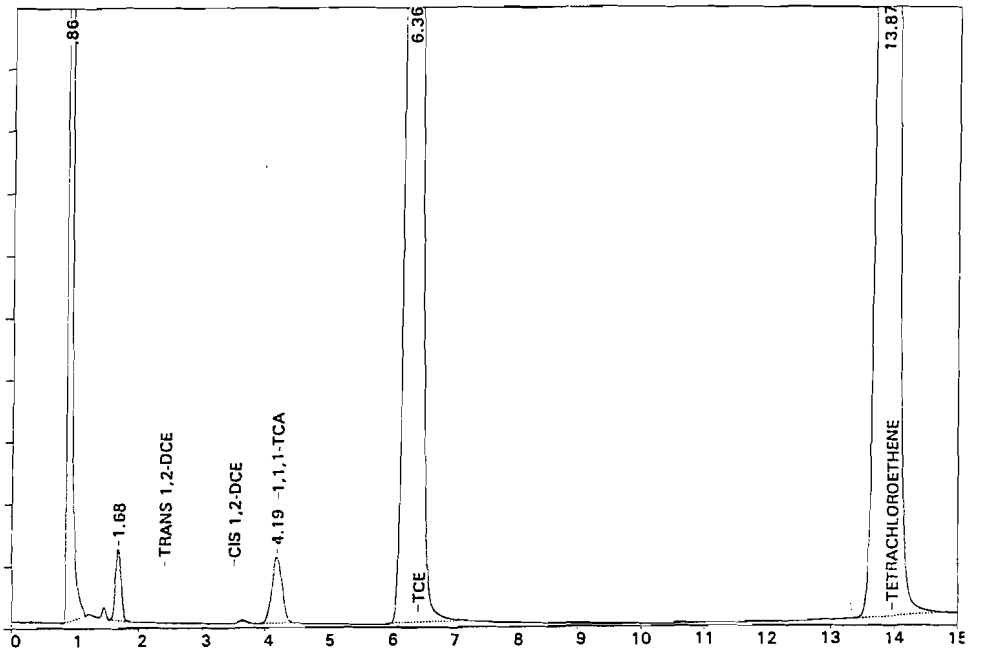
6.7.5 Inject the sample and press START on the GC or on the integrator.

a. During the run, the elapsed time from when the run began will be shown on the PC screen.

6.7.6 At the end of the run or at any time STOP is pressed on the GC or on the integrator, the data file will be transferred to the PC and the chromatogram and report will be printed on the HP LaserJet printer.

Exhibit 1. Example of Chromatogram and Report

File=C:\CP\DATA1\TUCS.65R Sample name=SV042-10' Date printed= 06-01-1993 Time= 11:05:56
0.00 to 15.00 min. Low Y = 0.26992 mv High Y = 0.76992 mv Span = 0.50000 mv



C:\CP\DATA1\Q67B0652.BNC
Data file = C:\CP\DATA1\TUCS.65R
Date stamp = 05/19/93 Time = 09:52:42
Sample name = SV042-10'
Collected on MAY 19, 1993 09:37:21 from port # 1
Operator = J.L. ZUTMAN
Reference file name = Q67B0652b#66
Instrument = HP 5890 II
Method name = C:\CP\DATA1\TUCAIR.MET version # 5
Date method last modified = 06/01/93 Time = 10:54:12
Calibration file = C:\CP\DATA1\TUCAIR.CAL version # 16
Date cal file last modified = 06/01/93 Time = 10:53:52
Run time = 15.00 minutes Area reject = 100
Amount injected = 1 Dilution Factor = 1
Sample Weight = 1 Internal Standard Amount = 0
Sampling rate = 10 per second
Peak detect threshold = 0 Starting peak width = .04 minutes
Chrom-Perfect Software Serial # 12948 Version = 5.05 For Martin Marietta
Today's date = 06-01-1993 Time = 11:06:30

PK	Ret Time	Name	Amount	Amount %	Area	Area %	Type	Width	Height	Height %
1	0.863		408,929.0625	98.1405%	29,331.3	26.121%	BB	0.028	17,527.78	74.2850%
2	1.680		4,138.1436	0.9931%	355.5	0.317%	BB	0.102	57.84	0.2451%
3	4.188	1,1,1-TCA	10.6134	0.0025%	606.2	0.540%	BB	0.190	53.10	0.2250%
4	6.357	TCE	2,523.0984	0.6055%	28,674.3	25.536%	BB	0.206	2,316.57	9.8179%
5	13.870	TETRACHLOROETHENE	1,076.3005	0.2583%	53,323.9	47.487%	BB	0.244	3,640.01	15.4269%

Total area = 112291.3 Total amount = 416677.3 Sample units = ug/l Total height = 23595.29

MEASUREMENT OF HYDRAULIC CONDUCTIVITY USING A BAIL TEST

1.0 PURPOSE

This procedure describes the equipment, operation, and data interpretation involved in performing a bail test on a groundwater monitoring well. A bail test is a single-well hydraulic test to measure the hydraulic conductivity of an aquifer.

2.0 APPLICABILITY

The procedure applies to all employees involved with hydrologic investigations. The staff hydrologist trains and field checks any technician assigned to performing bail tests; the project technical supervisor reviews the calculations and results of the bail tests.

3.0 OTHER DOCUMENTS

3.1 REFERENCES

3.1.1 R. A. Freeze and J. A. Cherry, Groundwater, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, pp. 339-341.

3.1.2 M. J. Hvorslev, Time Lag and Soil Permeability in Groundwater Observations, Bul. 36, U.S. Army Corps of Engineers, 1951.

4.0 DEFINITIONS

4.1 HYDRAULIC CONDUCTIVITY: A constant of proportionality which relates the groundwater velocity (Darcian velocity) to the hydraulic gradient.

4.2 BCL: Below casing level.

5.0 EQUIPMENT AND MATERIALS

5.1 Nitrogen bottle;

5.2 Water level indicator;

Approved by:

Mi Kuta 9/19/90 (Date)

Clair Little 9/19/90 C.A. Little (Date)

5.3 Air hose with nozzle, bottle attachment fitting, and air line;

5.4 Crescent wrench;

5.5 Stopwatch.

6.0 PROCEDURE

Two individuals are required to obtain the measurements H (initial water level), H_o (water level at time t = 0), h (actual head readings during the test), e (base of natural logarithms ~ 2.718), and T_o (basic time lag). These measurements are used in the formula presented below for determination of the normalized recovery rate:

$$\frac{H-h}{H-H_o} = e^{-t/T} \qquad (1)$$

Once T_o is determined from Equation (1), hydraulic conductivity (K) is calculated using the following formula, assuming that the ratio of L (piezometer intake length) to r (borehole radius) is greater than 8 to 1.

$$K = \frac{r^2 \ln (L/r)}{2LT_o} \qquad (2)$$

6.1 Measure the standing water level in the well before beginning the test. The water level should be measured from the top of the well casing and recorded as feet below casing level (e.g., 9.5 ft BCL).

6.2 Attach the air hose with nozzle to the nitrogen bottle (Only nitrogen should be used in the procedure because compressed air or oxygen will affect the chemistry of the well water). Insert both the air hose (calibrated in feet to indicate approximate depth) and the air line into the well.

6.3 Turn the nitrogen on to the air hose and air-lift the water out of the well bore. Turn the nitrogen off and quickly remove the air hose from the well. As soon as possible, measure the depth to water using the water-level indicator. Record this value as H_o in the field book and at the same time start the stopwatch. As quickly as possible, continue measuring the water level and the time at which the measurement is made until the well recovers to the initial water level. If recovery is slow, readings can be spaced at the appropriate time interval where significant pressure changes occur. During the testing, one person should be reading and orally relaying the data to another person who records it in a field notebook.

6.4 The data from the bail test are now entered into individual data files on the computer. The first line of the data file contains H and H_o, respectively. The following lines contain time versus the head value recorded during the bail test. The program used to calculate the bail-test data accepts free format data input.

6.5 The computer program BAIL is an interactive program which calculates the hydraulic conductivity of an unconfined aquifer from bail test data. The program will plot the log of the normalized drawdown versus time. Bad data points can easily be eliminated to obtain an accurate straight-line fit. Well completion information, along with the proper units, are then entered and the hydraulic conductivity calculated. All of the above information should be recorded in a project notebook.

OAK RIDGE NATIONAL LABORATORY Health & Safety Research Division	PROCEDURE Pollutant Assessments Group	Number: TE-091 Page: 1 of 2 Revision: 0 Date: 10/01/90

FIELD DETERMINATION OF GRAVIMETRIC MOISTURE

1.0 PURPOSE

This procedure briefly describes the method of determining the amount of moisture in soil, sediment, and rock samples.

2.0 APPLICABILITY

This procedure applies to field determination of the gravimetric moisture content of dry or wet soil, sediments, or rock samples.

3.0 DISCUSISON

Gravimetric determination of the moisture content of soil or rock is based on field-weighing the sample, drying it in an oven, and then reweighing the sample to determine the percentage of water. To ensure accuracy, weigh the sample in the field as soon after collection as possible to prevent moisture loss. Place the sample in a preweighed, prelabeled sample container with an airtight lid immediately upon collection and weigh it as soon as possible using a top-loading balance. For samples with low moisture content, the accuracy of the balance can make considerable difference; therefore, use a balance with a range of 0 to 4000 g and a readability of 0.01 g.

4.0 EQUIPMENT AND MATERIALS

4.1 Top-loading electronic balance (preferably with a weighing range of 0 to 4000 g, readability of 0.01 g);

4.2 wide-mouth sample bottles with airtight lids;

4.3 drying oven with thermostatic control;

4.4 sample labels.

Approved by:

Mi Peta 9/19/90 (Date)

Craig A Little 9/19/90 C.A. Little (Date)

5.0 PROCEDURE

5.1 Prepare, label, and weigh sample containers (including the air tight lid).

5.2 Collect the sample and immediately place it in a prepared container.

5.3 Weigh the sample-filled container as soon as possible with a top-loading balance.

5.4 Deliver the sample-filled containers to the laboratory for oven drying. The temperature of the oven should be set at 105°C. Oven temperatures should not exceed 110°C, since higher temperatures can drive off water in the mineral structure of the sediment or rock and distort the accuracy of the test.

5.5 After drying for a minimum of 24 hours, reweigh the samples. Take care to weigh not only the bottle and sample, but also the lid. Samples should be weighed as soon as possible after cooling to room temperature.

6.0 DOCUMENTATION

Prelabel bottles and lids with the appropriate sample number. A description of the sample should be included in the sample log book and retained as a permanent record (TE-071).

All data obtained from the gravimetric moisture determination procedure should be recorded in a field notebook and retained as a permanent record.

DETERMINING PERMEABILITY USING A PACKER TEST

1.0 DISCUSSION

A packer test determines the approximate values of permeability of individual strata penetrated by drill borings. The purpose of this procedure is to describe the equipment and the operation of the equipment involved in conducting a packer test.

2.0 APPLICABILITY

This procedure applies to all PAG employees involved with hydrologic investigations.

3.0 RESPONSIBILITY

The staff hydrologist trains and field checks any technician assigned the duty of performing the packer test. The project technical supervisor reviews the calculations and results of the packer test.

4.0 OTHER DOCUMENTS

4.1 REFERENCES

4.1.1 Seminar for Drillers and Exploration Managers, conducted by the University of Missouri at Rolla in Orlando Fla., February 25, 1981.

4.1.2 Earth Manual: A Water Resource Technical Publication, 2d ed. U.S. Dept. of the Interior, 1974.

4.2 APPENDICES

4.2.1 Pump-in Borehole Test Form

5.0 EQUIPMENT AND MATERIALS

5.1 pump;

Approved by:

Nic Kito 9/25/90 (Date)

Craig Little 9/26/90 C.A. Little (Date)

5.2 water meter;

5.3 pressure gauges;

5.4 conductor pipe;

5.5 dual packer system;

5.6 common valves and fittings;

5.7 short pressure hoses;

5.8 water level indicator.

6.0 CONDUCTER PIPE CALIBRATION

Calibrate the conductor pipe by assembling about 100 ft of pipe horizontally on the ground. Regulate flows by opening and/or closing valves at each end of the conductor pipe. Check at least three flow rates in the range of 0 gallons per minute (gpm) to the flow capacity of the conductor pipe and pump and develop a calibration curve of flow pressure loss versus flow rate.

7.0 WATER CHARACTERISTICS

The packer test described below is a pumping-in type of test; that is, it measures the amount of water accepted by the ground through the open bottom of a pipe or through an uncased section of the hole. Unless clear water is used, the test is invalid and test data may be grossly misleading. The presence of even small amounts of silt or clay in the added water will result in a plugging of the test section and give permeability results that are too low. Using a settling tank or a filter, make an effort to assure that only clear water is used. The temperature of the added water should be higher than the groundwater temperature to prevent creating air bubbles in the ground which may greatly reduce its acceptance of water.

8.0 PROCEDURE

8.1 Determine the test depth (and packer spacing if a dual packer is used).

8.2 Select the number of conductor pipe sections to give the correct depth of the setting.

8.3 Lower the packers into the open borehole and expand them against the side of the borehole. (NOTE: Usually an effective packer pressure of about 30

pounds per square inch (psi) above the maximum test water pressure is adequate to seal pneumatic packers).

8.4 Record header information on the data sheet.

8.5 Make a water level measurement in the conductor pipe to determine the formation pressure. Check the water level several times until a stable value is obtained. Record the initial water level on the data sheet.

8.6 With the valve to the borehole closed, start pumping water.

8.7 Record the initial gauge pressure on the data sheet.

8.8 Carefully and slowly open the valve that regulates water flow to the borehole.

8.9 Regulate the flow until the gauge pressure can be held relatively constant. The pressure may fluctuate as a result of the pump (especially common in piston-type pumps). Record the minimum and maximum pressure readings in the gauge pressure column on the data information sheet.

8.10 Check clock time and start recording the water meter readings at 1 min intervals (or as specified).

8.11 Compare the fluid flow rate at a specified time interval with the previous time interval. If the difference is less than 5%, then the test at that pressure level can be terminated. If the difference is greater than 5%, continue to pump at constant pressure until the difference becomes less than 5% (or as specified) or until 15 min of pumping time elapses (or the specified test duration is reached).

8.12 Perform the test two more times, once at a higher and once at a lower pumping pressure.

(From References 4.1.1 and 4.1.2).

9.0 DOCUMENTATION

Record all data from the packer test on a data information sheet (Appendix 1). This form should be filled out during the test and retained as a permanent record.

Appendix 1. Pump-in Borehole Test Data Sheet

PUMP-IN BOREHOLE TEST

PROJECT NAME _____ PROJECT NO. _____

BOREHOLE NO. _____ INCREMENT DRILLED _____

READING MADE BY _____ DATE _____

SWIVEL ELEVATION _____

TOP PACKER SET _____ BOTTOM PACKER SET _____

TYPE OF PACKER _____ TEST INCREMENT _____

GROUNDWATER LEVEL MEASUREMENTS _____

APPROVAL (TECHNICAL SUPERVISOR) _____

READING NO.	CLOCK	ELAPSED TIME	FLUID METER	FLOW RATE	GAUGE PRESSURE

PUMPING TEST IN AN UNCONFINED AQUIFER

1.0 PURPOSE

The principle for an aquifer test is: water is pumped from a well for a certain time period at a certain rate. The effect of this pumping on the water table is measured at the pumping well and selected observation wells in the vicinity. Although pumping tests measure several pertinent hydraulic parameters from a variety of different aquifers, the following discussion will be limited to determining the transmissivity and storativity in an unconfined aquifer.

2.0 OTHER DOCUMENTS

2.1 REFERENCES

2.1.1 F.G. Driscoll, Groundwater and Wells, Johnson Division, St. Paul, 1986.

2.1.2 N. Korte and P. Kearl, Procedure for the Collection and Preservation of Groundwater and Surface Water Samples and for the Installation of Monitoring Wells, 2d ed., GJ/TMC-08 (85), U.S. DOE Technical Measurements Center, Grand Junction, Colo., 1985, pp. 15, 16-18, 29-30.

2.1.3 G.P. Kruseman and N.A. DeRitter, Analysis and Evaluation of Pumping Test Data, International Institute for Land Reclamation and Improvement, The Netherlands, 1979.

2.1.4 R.W. Stallman, "Aquifer Test Design, Observation and Data Analysis, Techniques of Water Resources Investigations of the U.S. Geological Survey, Chap. B1, Government Printing Office, Washingtin, D.C., 1971.

2.1.5 J.A. Cherry, "Migration of Contaminants in Groundwater at a Landfill: A Case Study," Journal of Hydrology, Vol. 63. No. 1/2 (special issue), 1983.

2.1.6 J.A. Cherry and P.E. Johnson, "A Multilevel Device for Monitoring in Fractured Rock," Groundwater Monitoring Review, Summer, 1982, pp. 41-44.

Approved by:

9/19/90 (Date)

C.A. Little 9/19/90 (Date)

3.0 PROCEDURE

The most common procedure for determining the hydraulic properties of an aquifer is to:

1. calculate the expected response in the aquifer by letting the hydraulic properties be variable and taking into account the hydraulic and physical boundaries;

2. compare the observed response with the computed response;

3. adapt those hydraulic properties that were assumed in the computed response and match the observed response.

3.1 RESPONSE PREDICTION

Identifying hydraulic and physical boundaries is part of the response prediction necessary to check the assumptions upon which the aquifer analysis is based. In addition to the boundary identification process (which is part of the aquifer characterization), the second component for response prediction includes estimating aquifer hydraulic parameters (i.e., transmissivity and storativity).

Since the type of aquifer for this study is unconfined, the first step of identifying the type of aquifer as confined or semi-confined can be disregarded. Specific information necessary for the correct analysis of the aquifer includes:

- depth to the water table;

- thickness;

- areal extent;

- stratification; and

- nearby aquifer discontinuities caused by changes in lithology, geologic structure, or by incised streams and lakes.

Estimating the aquifer's hydraulic properties is not only important to anticipating the response of an aquifer due to pumping, but is also useful when determining the appropriate pumping rate and observation well placement. Methods for estimating the transmissivity and storage include the following:

- review the literature for previous tests performed in the area;

- use published values based on the lithology of the aquifer; and
- perform single-well tests on existing wells to measure the hydraulic conductivity and estimate the specific yield.

3.2 TEST DESIGN

A successful pumping test includes properly designed pumping and observation wells, sufficient duration of pumping, and compensation for barometric fluctuations and other changes which could affect the water levels during the tests. A description of the well design and construction (i.e., gravel pack, screen slot size, grouting, etc.), is in TE-110 and TE-111, which were adapted from methods described in Reference 2.1.1 and Reference 2.1.2. Major items in this procedure include:

1. The pumping well must be equipped with reliable power, pump, and discharge-control equipment.
2. The well diameter should accommodate the pump with proper clearance for installation and efficient operation.
3. The water discharge must be carried away from the test area so it cannot return to the aquifer during the test.
4. The well head and discharge lines should be accessible for installing discharge, regulating, and monitoring equipment.
5. It should be possible to measure depth to water in the pumping well before, during, and after pumping.

One of the most important aspects of the pumping well design is the penetration depth and length of well screen. This criterion is not only critical to the pumping well design but has a direct influence on the spacing of the observation wells. Ideally, the pumping well should be fully penetrating and screen the entire length of the aquifer. This type of well design results in horizontal flow in the aquifer during pumping, which greatly simplifies the aquifer analysis.

Another important advantage to a fully penetrating pumping well is that drawdowns measured even at short distances can be used for the analysis. Close spacing of observation wells is especially important in lower permeable aquifers where steep cones of drawdown surrounding the pumping well will only propagate a short distance. Achieving a sufficient amount of drawdown in the observation well is an important consideration. Experience has shown that at least 2 ft of drawdown in the observation well obtains a drawdown

curve of sufficient accuracy for analytical purposes. Therefore, based on the expected response of the aquifer, an observation well should be located near enough to the pumping well to allow a sufficient amount of drawdown.

In many cases, conditions may not allow installing a well screen over the entire thickness of the aquifer. If the length of the well screen is considerably less than the saturated thickness of the aquifer, it induces a distorted drawdown pattern near the well due to vertical flow components. Drawdown readings from wells close to such a partially-penetrating well may lead to incorrect results, and rather complicated correction methods have to be applied before these readings can be used in the test data analysis. These difficulties can be avoided by placing the observation wells away from the pumping well where these abnormal effects do not appear. As a general rule, the nearest observation wells should be placed at a distance at least equal to the thickness of the aquifer (Reference 2.1.3), so that one can assume that flow is essentially horizontal.

Other design considerations for observation wells include:

1. Response of all observation wells to changing water levels should be tested by injecting a known volume of water and measuring the subsequent decline in water level. The initial rise of water should dissipate within a few minutes if the observation well is to satisfactorily reflect change of head in the aquifer during the test.

2. Total depth, diameter, and screened interval should be recorded.

3. A minimum of two observation wells are required for the test. Preferably, two of the observation wells should be placed along the same radial line from the pumping well. This arrangement allows for possible steady-state determinations of the aquifer's transmissivity (assuming an isotropic aquifer) if the duration of the pumping test is sufficient.

3.3 DURATION OF PUMPING

The length of a pumping test is controlled by the type of aquifer and the degree of accuracy required. In unconfined aquifers, the propagation of hydraulic head loss is rather slow because the release from storage water is mainly due to dewatering of the zone through which the water is moving and only partly due to the compressibility of water and aquifer material in the saturated zone. If steady-state conditions are required for the analysis, a common pumping duration of three days may be required.

For transient state analysis, a lesser pumping duration is required. The amount of time is dependent upon the hydraulic properties of the system, the

spacing of the observation wells, and the amount of drawdown necessary to obtain an accurate analysis. For this type of test, it is recommended that the on-site hydrologist continually plot the data on log-log graph paper and match the data to the appropriate type curve until enough data has been collected. Commonly, the plotted data will uniquely match a type curve and additional days of pumping will only yield data making up a minor portion of the drawdown versus time curve.

3.4 DATA COLLECTION

Discharge and water-level measurements are the key parameters to be collected during a pumping test. Discharge from a well may be constant or variable during the test. The most simple approach, in terms of data analysis, is to maintain a constant discharge rate. To do so, install a valve on the discharge line and partially close it before starting pumping.

As the water level in the pumped well declines, discharge tends to decrease. Discharge is maintained constant by progressively opening the valve, a procedure which keeps the total head against the pump constant.

Several methods are available to measure discharge from a pumping well. The most important factor controlling the measurement is the quantity: a simple bucket will suffice for small discharge volumes (less than 100 Lpm) while large volumes may require use of a weir similar to those used for surface-water flow measurement. The easiest and most direct method of measuring discharge is an in-line water meter. Various types of meters are available depending on the amount of discharge and the degree of accuracy required. Other methods for measuring the discharge of a pumping well include:

- container or calibrated bucket (i.e., an oil drum);
- orifice;
- orifice bucket (Reference 2.1.3);
- jet-stream method;
- flumes.

The frequency of measuring water levels decreases as the duration of the test increases. During the initial stage of the test, the water level in the pumping well changes rapidly. This fluctuation requires constant monitoring of the discharge until the rate of water level decline decreases. The interval between readings can gradually increase as the pumping continues. By plotting the

data on log-log paper, one can easily determine the required frequency of measurement.

Several methods are also available for water level measurements including:

- steel tape and chalk;
- water level indicator;
- Stephen Type F recorder; and
- pressure transducers.

Pressure transducers are by far the easiest and most accurate method to obtain water level measurements. Used in conjunction with a scanner/ recorder, transducers can take large numbers of measurements. This is especially important in the earlier stages of testing when water levels change rapidly. Unfortunately, pressure transducers are the most expensive of the water level measuring options.

Reference 2.1.4 outlines important information requiring documentation during a pumping test. The accuracy and tolerance of measurements generally considered acceptable for a pumping test are:

- pumping well discharge (± 10%);
- water level measurement (± 0.01 ft);
- distance from pumping well to each observation well (± 0.5%);
- synchronous time (± 1% of time since pumping initiated);
- description of measuring points;
- elevation of measuring points (± 0.01 ft);
- vertical distance between measuring point and land surface (± 0.1 ft);
- total depth of all wells (± 1%);
- depth and length of screened intervals of all wells (± 1%);
- diameter, casing type, screen type, and method of construction of all wells; and

- location of all wells in plan view relative to land survey.

Much of this information can be recorded in a field notebook, especially if a scanner-recorder is storing time and water level data during the test. Discharge records should also be documented in the field notebook.

WATER-LEVEL MEASUREMENT

1.0 PURPOSE

This procedure describes the steps for taking water-level measurements of groundwater.

2.0 APPLICABILITY

This procedure applies to measuring water levels in boreholes, piezometers, or monitoring wells.

3.0 OTHER DOCUMENTS

3.1 REFERENCES

3.1.1 Procedure TE-073, Equipment Decontamination

4.0 EQUIPMENT AND MATERIALS

4.1 Steel tape
4.2 Electric sounder
4.3 Reflection sounder
4.4 Transducer
4.5 Air line
4.6 Field logbook

5.0 RESPONSIBILITY

5.1 All personnel measuring water levels in a well, borehole, or piezometer are responsible for following this procedure.

APPROVALS			
Author		Date	
Supervisor		Date	
Group Leader	[illegible]	Date	8/4/93
Section Head	[illegible]	Date	8/6/93

6.0 DEFINITIONS

6.1 **Air line:** a tube inserted into a well so that the end is submerged below the present water level. The surface end can be connected to a pressure monitoring system that will record changes in air pressure in the line. As the water level fluctuates, so does air pressure in the line, allowing the fluctuations to be recorded.

6.2 **Electric sounder:** a probe attached to the end of a measuring tape that is attached to an electronic device at the surface. The probe, using several possible methods, completes a circuit as it touches water; the device at the surface indicates this contact with an audio or visual signal; and depth is obtained from the tape.

6.3 **Reference measuring point:** marked measuring point on PVC riser pipe, protective steel casing, or concrete pad surrounding well casing from which all water-level measurements for individual wells are measured, thus providing consistency in future water-level measurements.

6.4 **Reflection sounder:** a device that transmits a signal (e.g., sound or radio) down a borehole and measures the time of arrival of the reflected signal. This time is proportional to the depth to the water.

6.5 **Transducer:** a pressure-measuring device that senses and measures the height of a water column above the device. The device is installed at a known depth below the water level, and the height of the water column above the device allows for determination of the water level. These systems can be connected to a data storage device for recording water-level fluctuations.

7.0 SAFETY

7.1 Wear personal protective equipment appropriate for the location of the well, borehole, or piezometer; the site health and safety plan specifies requirements.

8.0 PROCEDURE

8.1 Prior to measurement, allow water levels in piezometers and monitoring wells to stabilize for a minimum of 24 h after well construction, development, or purging.

8.1.1 In low-yield situations, recovery may take longer.

8.2 Collect water-level measurements at a given site within a 24-h period.

Note: This practice is adequate if the change is small over that period of time.

8.2.1 Under the following conditions, take all measurements within a shorter time interval:

a. atmospheric pressure change;

b. tidally influenced aquifers;

c. aquifers affected by river stage, impoundments, and/or unlined ditches;

d. aquifers stressed by intermittent pumping of production wells;

e. aquifers being actively recharged due to precipitation.

8.3 Establish a reference measuring point if one does not already exist.

8.3.1 Place a survey mark on the north side of the well-casing riser pipe.

8.3.2 Locate another measuring reference on the grout apron.

8.3.3 Document the measuring point in the field logbook.

8.4 Measure water level.

8.4.1 Remove locking well cap and note the location, time of day, and date in the field logbook or on the appropriate field form.

8.4.2 Remove the well casing cap.

8.4.3 If required by site-specific conditions, sniff the headspace of the well with a photoionization or flame ionization detector to determine the presence of volatile organic compounds and record the results in the field logbook.

8.4.4 Lower the water-level measuring device into the well until the water surface is reached.

8.4.5 Measure the distance from the water surface to the reference measuring point on the well casing and record the measurement in the field logbook.

8.4.6 Measure the depth to the water surface at least twice for confirmation and record the measurement in the field logbook.

8.4.7 Remove all downhole equipment, replace the well casing cap, and lock the steel caps.

8.5 To measure water levels manually, use an electric or reflection sounder accurate to 0.01 ft.

8.5.1 If using an electric sounder, check the accuracy of the tape.

NOTE: The accuracy should be checked periodically or if the tape has undergone stress from pulling, kinking, etc.

a. Unroll 20 ft of the electric sounder tape next to a steel tape.

b. Secure both tapes at the 20-ft mark; pull tight on the other ends of both tapes.

c. If the measuring point of the electric sounder tape does not fall within 0.01 ft of the 0.0 mark on the steel tape, replace the electric sounder tape.

8.5.2 Follow instructions for the specific instrument being used to measure water levels.

8.6 To measure water levels automatically, install a transducer or air line .

8.6.1 Measure depth to water using the methods described in step 8.4.

8.6.2 Insert the air line or transducer at a depth below the measured water level that will allow the device to stay submerged throughout any expected fluctuations.

a. Record the depth of the instrument to within 0.01 ft.

8.6.3 Remain within the specifications of the instruments being utilized (e.g., a transducer may not be rotated for more than 10 ft of submergence).

8.6.4 According to manufacturers' deviations, connect the transducers and/or air lines to an electronic readout, data-logger, or other recording device.

8.6.5 Follow manufacturer's instructions for measurement of water levels.

8.7 Clean up and restore the site if necessary.

8.7.1 Note any physical changes, such as erosion or cracks, in the protective concrete pad in the field logbook.

8.8 Decontaminate equipment according to Procedure TE-073.

8.9 Ensure that the field logbook contains:

8.9.1 log date: the day water levels are being measured;

8.9.2 comments: any information that field personnel deem applicable;

8.9.3 time of measurement;

8.9.4 depth to water; and

8.9.5 reference measuring point.

DRILLING LOG PREPARATION AND WELL CONSTRUCTION DOCUMENTATION

1.0 PURPOSE

This procedure outlines the information included on a standard form when logging core holes or boreholes used for completing groundwater monitoring wells. The intent of the procedure is to ensure uniform information on forms.

2.0 OTHER DOCUMENTS

2.1 APPENDICES

2.1.1 Appendix 1: Well summary information sheet

2.1.2 Appendix 2: Rock structural classification

2.1.3 Appendix 3: Fracture intensity

2.1.4 Appendix 4: Rock strength classification

2.2 EXHIBITS

2.2.1 Exhibit 1: Unified soil classification system

3.0 EQUIPMENT

- Munsell color chart (for soils);
- G.S.A. rock color chart;
- magnifying lens;
- ball-point pen (permanent ink);
- total depth indicator;
- water level indicator;

Approved by:

Mi Kate 1/8/91 (Date)

Craig Little 1/8/91 C.A. Little (Date)

- engineer scale or ruler;
- appropriate soil classification chart; and
- well summary information form (Appendix 1).

4.0 PROCEDURE

4.1 Record preliminary information on the well summary information form (Appendix 1): name, date, project, hole number, location, rig type, auger/bit-size, and sample type (split spoon, Shelby tube, core, etc.).

4.2 Depict textures and textural changes (including fractures, fracture zones, fossil zones, lithologies, etc.) either as sharp discontinuities or as gradational changes. Where uncertainty exists, draw the boundary line with dashed, wavy, or slanted lines.

4.3 Record sample interval or core runs, depth, and number of blows per sample interval (or, if applicable, per unit of length) or core-box number in the appropriate columns.

4.4 The description and comments column should contain textural, lithologic, and color descriptions of the core/auger cuttings and sample intervals. Descriptions of unconsolidated material should include the unified soil classification names and group symbols (Exhibit 1), plus any other significant geologic terminology, and comments on the water characteristics (i.e., where water first appears in the section, which soils are saturated, etc.). The water level indicator may be used as an aid in determining water levels.

4.5 Record both the grain size and the specific scale used to estimate grain size (either the Wentworth scale or the unified soil classification scale). Record the consistency or strength of clays (Appendix 2) and the relative densities of sands (Appendix 3) based on blows per ft. Record any soil or rock core color and color changes using the Munsell color chart or the G.S.A. rock-color chart.

4.6 Rock core logs shall have a record of all pertinent geologic characteristics (i.e., rock name, color, grain size, etc.). In addition, the rock structural classification (Appendix 4), the fracture intensity (Appendix 5), and the rock strength classification (Appendix 6) must be documented on the well summary information form.

4.7 Note any modifications in groundwater monitoring well construction while completing the graphic log column. Planned depths do not always correspond with the actual depths obtained when using the depth indicator. When

that situation occurs, the well summary information form must be neatly redone as soon as possible after the hole is completed and both the original version and the new version submitted for data verification. After the field version has been redone (if applicable), both versions should be presented to the project manager or qualified staff geologist, who verifies that the data presented on the form are sufficient and correct and so signifies by signing and dating the appropriate space on the form.

Appendix 1. Well summary information sheet

ornl OAK RIDGE NATIONAL LABORATORY

Well Summary Information

Prepared By _____ Date _____ Page ___ of ___

Hole No. _____ Casing Elev. _____ Ground Elev. _____ Location _____

Total Depth _____ Number of Completions _____ Rig Type _____

Auger Size _____ Sample Type _____

Project _____ Date Verified By _____ Date _____

DEPTH (FEET)	DEPTH (")	SAMPLE INTERVAL	WELL CONSTRUCTION	LITHOLOGY	DESCRIPTION

UCN17192 (9/90)

Appendix 2. Rock Structural Classification

Structural classification	Typical geologic classification	Common identification characteristics	Coring characteristics (%) NX[a] or larger		BX[b] or smaller	
			Recovery	Rock quality designation	Recovery	Rock quality designation
Class 1- hard sound rock slightly jointed Unweathered	Crystalline igneous or metamorphic rocks	Rings when struck with bar. Does not disintegrate upon exposure nor slake in water.	95 or More	85 or More	85 or More	75 or More
	highly siliceous sedimentary rocks	Joints or fractures generally unweathered, less than 1/8 in. wide, and no closer than 3 ft apart in exposure. Sharp, hard fracture surface when broken.				
Class 2- medium-hard rock Moderately sound Moderately jointed Slightly weathered	Same as class 1 Moderately siliceous sedimentary rocks Certain calcareous rocks	Characteristics same as class 1 except joints or fractures may be 1/4 in. wide and slightly weathered. Generally no closer than 2 ft apart in exposure. Piece can be broken off with hammer and the fracture surface iron-stained.	70	50 - 85	50	40

Appendix 2. (continued)

Class 3- intermediate rock Moderately to highly jointed Moderately weathered	Same as class 2 Most sedimentary rock other than compaction shales Most calcareous rocks are not porous	Gives dull sound when struck with bar. Does not disintegrate upon exposure. Unweathered pieces do not slake in water. Joints or fractures may be up to 1 in. wide. Contains weathered material. Spaced as close as 8 ft in exposure. Piece can be broken off with hammer on weathered surface.	50	35 - 50	35	25
Class 4- soft rock Highly jointed Extensively weathered Porous	Weathered rocks of class 3 Compaction sedimentaries Calcareous rocks with soil filled cavities	May soften upon exposure. May slake in water. May include thoroughly weathered zones up to 3 in. wide with stiff soil weathered zones or soil-filled cavities exhibit standard penetration resistance exceeding 50 blows per foot.	Less than 50	Less than 35	Less than 35	Less than 25

[a] NX = Outside diameter 3 1/2 in., inside diameter 3 1/16 in.

[b] BX = Outside diameter 2 7/8 in., inside diameter 2 9/16 in.

Appendix 3. Fracture Intensity

Fracture frequency (measured parallel to core length)	Classification
-5 micron to 0.05 ft (contains clay)	Crushed
0.05 to 0.1 ft (contains no clay)	Intensely fractured
0.1 to 0.5 ft	Closely fractured
0.5 to 1 ft	Moderately fractured
1 to 30 ft	Little fractured
4 ft and larger	Massive

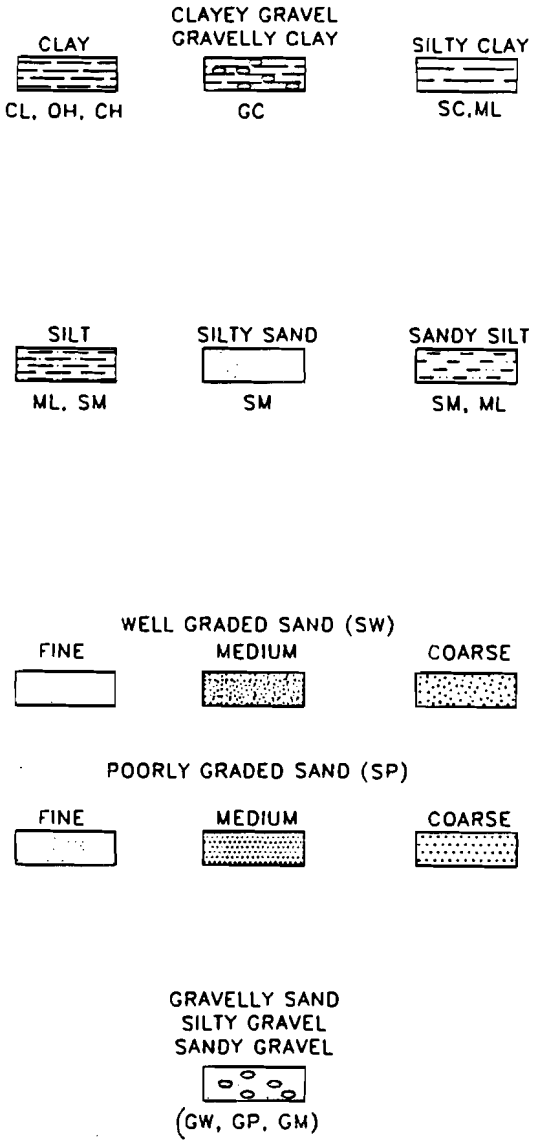
Appendix 4. Rock Strength Classification

Strength test	Classification
Easily deformed with finger pressure.	Plastic
Crumbles under finger pressure.	Friable
Unfractured rock; crumbles under light hammer blows.	Weak
Withstands a few firm hammer blows before breaking.	Moderately strong
Yields large fragments with difficulty and withstands several heavy, ringing hammer blows.	Strong
Yields only dust and small fragments; resists ringing hammer.	Very strong

Exhibit 1. Unified soil classification system

UNIFIED SOIL CLASSIFICATION SYSTEM

HATCHING PATTERNS



CH INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS.
OH ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS.
CL INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS.

MH INORGANIC SILT, MICACEOUS OR DIATOMACEOUS FINE SANDY OR SILTY SOIL, ELASTIC SILT.
OL ORGANIC SILT, SILT-CLAY OF LOW PLASTICITY.
ML INORGANIC SILT AND VERY FINE SAND, ROCK FLOUR, SILTY OR CLAYEY FINE SAND, CLAYEY SILT WITH SLIGHT PLASTICITY.

SC CLAYEY SAND, SAND-CLAY MIX.
SM SILTY SAND, SAND-SILT MIX.

SP POORLY GRADED SAND, GRAVELLY SAND.
SW WELL GRADED SAND, GRAVELLY SAND.

GC CLAYEY GRAVEL, GRAVEL-SAND-CLAY MIXTURE.
GM SILTY GRAVEL, GRAVEL-SAND-SILT MIXTURE.
GP POORLY GRADED GRAVEL, GRAVEL-SAND MIXTURE.
GW WELL GRADED GRAVEL, GRAVEL-SAND MIXTURE.

P:USCS

SUBSURFACE SAMPLING USING A 5-FT CONTINUOUS SAMPLER AND A SPLIT-BARREL SAMPLER

1.0 PURPOSE

A standard method is used in continuous and split-barrel sampling to ensure a representative sample for quantitative analysis by the laboratory. This procedure provides instructions for using a continuous and split-barrel sampler for collection of subsurface soil samples.

2.0 APPLICABILITY

The continuous sampler is designed for continuous sampling from ground surface to the total depth or to bedrock. The sampler is connected to the drive rods in such a manner that it does not rotate with the auger. As the lead auger penetrates, the continuous sampler collects the undisturbed column of soil inside the hollow stem of the auger. Penetration with a continuous sampler will be hindered by the presence of large cobbles in the subsurface. In this case the sampler is removed and the borehole is augered past the obstruction. The sampler is then replaced and sampling can continue.

3.0 OTHER DOCUMENTS

3.1 ASSOCIATED PROCEDURES

3.1.1 TE-071 Sample Documentation;

3.1.2 TE-072 Soil sample Packaging and Preservation;

3.1.3 TE-073 Equipment Decontamination; and

3.1.4 TE-100 Drilling Log Preparation and Well Construction Documentation.

4.0 EQUIPMENT

- safety glasses;

- split-barrel sampler;
- 5-ft continuous sampler;
- disposable latex gloves;
- felt-tip marker (permanent);
- stainless steel scoop or spoon;
- sample log book; and
- truck-mounted hollow stem auger rig (with hollow stem augers, center bit(s) and drive rod(s), and 140-lb hammer or equivalent hydraulic driver).

5.0 PROCEDURE

5.1 The sampler should be decontaminated before use according to TE-073.

5.2 (Applies only to the split-barrel sampler.) Auger the hole to the sampling depth, then lower the split barrel sampler to the top of the interval to be sampled. Drive the sampler using a 140-lb hammer with a 30-in. drop, or the equivalent, for the length of the sampler or until no further penetration can be accomplished after 50 hammer blows for each 6 in. of penetration. Record the number of blows for each 6 in. penetration on the well summary information form (TE-100, Appendix 1).

5.3 Once the full sample is acquired or no further penetration is possible, remove the sampler from the borehole, taking care not to lose any of the sample. Separate the sampler from the drive-rod assembly, lay the sampler on a flat, uncontaminated surface, and remove the sampler head and drive shoe. Carefully remove one-half of the split barrel, making certain that the other half is positioned to hold the sample. Discard the uppermost part of the sample (material sloughed into the hole).

5.4 Log the sample on the well summary information form.

5.5 Complete necessary documentation on the sample label (TE-071).

5.6 Remove and package the sample (TE-072).

NOTE: All soil sample replicates are collected, homogenized, and then split, except volatile organics. Volatiles are <u>NOT</u> mixed, but selected segments of soil are taken from the core length and placed in the appropriate glass jars.

Generally, replicates are taken at a 10% frequency and analyzed by the same lab.

SUBSURFACE SAMPLING USING A SHELBY THIN-WALL TUBE SAMPLER

1.0 PURPOSE

This procedure provides a standard method for Shelby thin-wall tube sampling which ensures acquiring an undisturbed subsurface sample.

2.0 OTHER DOCUMENTS

2.1 ASSOCIATED PROCEDURES

2.1.1 TE-071 Sample Documentation;

2.1.2 TE-072 Soil Sample Packaging and Preservation;

2.1.3 TE-073 Equipment Decontamination;

2.1.4 TE-100 Drilling Log Preparation and Well Construction Documentation.

3.0 EQUIPMENT

- wire or stiff-bristled brush;
- disposable wipes;
- felt-tip marker (permanent ink);
- ball-point pen (permanent ink);
- sample log book;
- Shelby thin-wall tube sampler (with head and thin-wall tubes 36 in. long by 3 in. outside diameter, equipped with end caps);
- paraffin or beeswax (if required);
- friction or plastic tape; and

Approved by:

9/19/90 (Date)

C.A. Little 9/19/90 (Date)

- cases or core boxes.

4.0 PROCEDURE

4.1 Before using, inspect all downhole equipment, including the Shelby tube sampler and drive rods, for possible contamination and damage. Any tool found visibly contaminated must be thoroughly decontaminated and reinspected before being used downhole (TE-072).

4.2 Drill the hole to the specified sampling depth, then run the Shelby tube sampler to the bottom of the hollow stem auger.

4.3 Press the sampler into the undisturbed soil with a hydraulic feed core drill or its equivalent with one fast, smooth stroke.

4.4 Once a full 36-in. sample is acquired or no further penetration is possible, rotate the sampler to shear off the sample and retrieve the entire drill string from the borehole.

4.5 Separate the Shelby thin-wall tube from the head assembly. Remove 1 to 2 in. of material from the top and bottom ends of the sampler. If required, seal both ends of the sampler by pouring in hot, melted paraffin or beeswax to prevent moisture loss. Cover both ends of the tube with close-fitting caps; secure the caps with friction or plastic tape.

4.6 Label the tube by listing the hole number, sample interval, sample number, uphole direction (top), etc.

4.7 Place tube in a case or core box for protection.

4.8 Log the sample on the well summary information form (TE-100, Appendix 1) and complete sample label as described in TE-070.

4.9 Once sampling operations are completed, clean the Shelby sampler head with the wire brush, inspect for contamination and damage, decontaminate if necessary (TE-072), and reassemble with a new thin-wall tube. Store the sampler in an uncontaminated area.

DEMOLITION HAMMER OPERATION

1.0 PURPOSE

The purpose of this procedure is to describe the operation of the demolition hammer.

2.0 APPLICABILITY

This procedure applies to the operation of the demolition hammer used to break up frozen soil, asphalt, or road base, or to compact soil or asphalt.

3.0 OTHER DOCUMENTS

3.1 Portable electric generator user's manual.

4.0 EQUIPMENT AND MATERIALS

4.1 EQUIPMENT

4.1.1 Demolition hammer
4.1.2 Electrical extension cord (three prongs)
4.1.3 Ground fault circuit interrupter (GFCI) box
4.1.4 Portable electric generator
4.1.5 Hammer bits

4.2 MATERIALS

4.2.1 Water
4.2.2 Gasoline

5.0 RESPONSIBILITY

5.1 The hammer operator is responsible for the following:

APPROVALS		
Author		Date
Supervisor		Date
Group Leader	[illegible]	Date 8/4/93
Section Head	Gail Little	Date 8/6/93

5.1.1 ensuring that all personnel are informed of all safety requirements pertaining to the operation of the equipment prior to operation;

5.1.2 following all safety practices outlined below;

5.1.3 setting up, operating, and dismantling the demolition hammer.

5.2 The assistant is responsible for:

5.2.1 following all safety practices outlined below;

5.2.2 assisting the hammer operator in setting up, operating, and dismantling the equipment;

5.2.3 decontaminating the equipment after use.

6.0 SAFETY

6.1 Wear gloves, safety glasses or goggles, steel-toed boots, and hearing protection when operating the hammer.

6.2 Consult the property owner and available maps and visually check the area for buried gas, water, electrical or other utility lines.

6.3 Check for any electrical cord damage before operating the hammer.

6.4 Do not operate the hammer near electrical lines, gasoline, propane, or any other flammable liquids or gases.

6.5 Ensure that persons who are not involved in operating the hammer stay as far away as possible to reduce exposure to noise, dust, and eye hazards.

7.0 PROCEDURE

7.1 Start up the generator used to power the hammer if no electrical outlet is available.

7.1.1 Refer to the generator user's manual for operating instructions.

7.2 Insert and lock the correct bit into the hammer.

7.2.1 Use the bull point bit for general demolition work.

7.2.2 Use the clay spade for digging and trenching in clay and dirt.

7.2.3 Use the tamping bit to compact asphalt and soil.

7.3 Plug the extension cord into the generator or an electrical receptacle that has a visible reset button.

7.3.1 If there is no reset button visible, use a GFCI box between the receptacle and the extension cord.

7.4 Place the hammer bit on the surface to be broken.

7.5 Press the switch to turn on the hammer.

7.6 Move the hammer from side to side while breaking ground in order to prevent the hammer bit from wedging into the ground.

7.7 When hammering or breaking concrete on a level surface, apply approximately 6 to 10 lb of force to the hammer.

NOTE: Allow the hammer to do the work. Excessive force will inhibit the operation. However, if too little or no force is applied, the tool will not operate effectively.

7.8 If the GFCI should trip, a short may be present. Inspect the cord and plug for frays or water puddles around a connection point prior to using the reset button.

7.9 When hammering is complete, release the switch to shut off the hammer.

7.10 Disconnect the electrical cords.

7.11 Decontaminate the equipment, thoroughly cleaning the drill bit and removing any visible contamination.

7.11.1 Empty the dirty water in an appropriate location either on site or upon returning to the DOE compound.

U2CRT OPERATION

1.0 PURPOSE

This procedure describes the set up and general operation of the ORNL-developed truck-mounted auger rig, the U2CRT.

2.0 APPLICABILITY

This procedure applies to drilling and sampling methods using the U2CRT.

3.0 OTHER DOCUMENTS

3.1 REFERENCES

3.1.1 Procedure TE-073, Equipment Decontamination
3.1.2 Procedure TE-106, Solid-Stem Augering Using the U2CRT
3.1.3 Procedure TE-107, Split-Spoon Sampling Using the U2CRT
3.1.4 Procedure TE-085, Water Sampling for Field Screening Using the Geoprobe and U2CRT
3.1.5 Procedure TE-086, Soil Sampling for Field Screening Using the Geoprobe and U2CRT

3.2 EXHIBITS

3.2.1 Exhibit 1: U2CRT with Mast Raised
3.2.2 Exhibit 2: U2CRT Operating Control Panel

4.0 EQUIPMENT AND MATERIALS

4.1 EQUIPMENT

4.1.1 U2CRT drill rig
4.1.2 Flexible exhaust pipe

APPROVALS		
Author		Date
Supervisor		Date
Group Leader	[illegible]	Date 8/4/93
Section Head	Clair Little	Date 8/6/93

4.1.3 Hydraulic jacks
4.1.4 Screw jacks
4.1.5 Tool box

5.0 RESPONSIBILITY

5.1 It is the U2CRT operator's responsibility to operate all equipment in a safe and efficient manner. The operator should not leave the control panel when any part of the rig is moving or engaged.

5.2 It is the U2CRT technician's responsibility to perform tasks such as making connections, moving equipment, and assisting the operator in all aspects of rig operations while drilling, soil sampling, and installing piezometers so that the operator can concentrate on the operation of the rig.

6.0 DEFINITIONS

6.1 **"A" rod:** 2-in. hollow coupled rods that are driven into the borehole, forming the connection rod between the split-spoon and the drive hammer.

6.2 **Control panel:** the panel on the left rear of the drill rig containing controls for operating the drill rig.

6.3 **Drill stem:** all parts in the assembly used for drilling from the swivel to the bit, including the kelly, drill pipe/rods, augers, and bit.

6.4 **Drive shoe:** an adapter for driving split spoons that is threaded onto the hydraulic hammer on one end and to the "A" rod on the other.

6.5 **Geoprobe adapter assembly (sub):** an adapter that threads onto the drive rod that attaches the Geoprobe sampling system.

6.6 **Hammer attachment:** tooling to attach the hydraulic hammer to the "A" rod and to the drive shoe.

6.7 **Hydraulic hammer:** a hydraulically-powered piston hammer located on the middle of the mast used to drive split-spoon samplers and Geoprobe rods into the ground.

6.8 **Hydraulic splitter:** a device, operated with a push/pull button, that diverts the flow of hydraulic oil from one system to another; only one system is active at a time.

6.9 **Kelly:** a hollow steel bar that is the top section of the drill stem and transmits power directly from the rotary motor to the auger flights.

6.10 **Kill switch:** a safety switch used to turn off the drill rig in an emergency.

6.11 **Mast:** the portable derrick, capable of being erected as a unit, that is upright during drilling or sampling.

6.12 **NFPA:** National Fire Protection Association.

6.13 **P.T.O. (Power Take Off):** a mechanism that converts power from the truck engine to the hydraulic system that powers all functions on the rig.

6.14 **RPM:** revolutions per minute.

6.15 **Table:** the flat, movable surface at the back of the drilling rig.

7.0 SAFETY

7.1 Inspect the first aid kit for proper bandages, eye wash, and burn dressings.

7.2 Check the fire extinguisher for NFPA-type ABC extinguishing agents and determine that it is fully charged.

7.3 Look for overhead and underground utilities within the site and review utility maps to determine safe locations for soil borings.

7.4 Ensure a safe distance between the mast and overhead electric power lines.

7.4.1 Do not operate drilling equipment closer than 10 ft to electrical transmission lines.

7.5 Confirm that no unnecessary personnel or support vehicles are within the zone having a minimum radius of the height of the drill mast.

7.6 Check the drill rig for contamination, damaged cables, loose bolts, frayed wires, and leaks.

7.6.1 Wrap hydraulic lines if necessary.

7.6.2 Check drill stems for contamination and decontaminate as necessary. See Procedure TE-073.

7.7 Watch for pinch points, cables and hoses hanging up, loose equipment lying on the mast, and other hazards as the drill mast is being raised.

7.8 Wear hard hats, steel-toed boots, and safety glasses or goggles within a minimum radius of the height of the drill mast.

7.9 When performing any activities within the area having a minimum radius of the height of the drill mast, approach the drill rig only after confirming that the operator is aware of approach and that drill stems, augers, or split-spoons have been secured on the ground, on racks, or safely supported next to the drill mast.

7.10 Avoid touching the drill rig when auguring in areas of potential electrical hazard.

7.10.1 The operator should contact only the control knobs in these situations.

7.11 When drilling operations are performed in areas of suspected underground pipelines, vaults, or other buried objects, use extreme caution when noting unusual auger sounds, change in speed, change in depth rate, or directional deviations.

7.11.1 A change in auger soil cuttings from normal lithology to back-fill material (especially sand) will be cause to suspend auguring operations until the cause of the lithology change can be determined and safe working conditions can be assured.

7.12 KNOW THE LOCATION OF THE KILL SWITCH.

8.0 PROCEDURE

8.1 Set up the drill rig. See Exhibit 1.

8.1.1 Locate the rig <u>across</u> the fall line of the terrain, rather than nose up or nose down.

8.1.2 Place the transmission of the truck in neutral.

8.1.3 Set the emergency brake on the truck.

8.1.4 Using screw jacks mounted on each side of the rear of the truck, level the rig from side to side.

8.1.5 Attach flexible exhaust pipe to tailpipe of truck.

a. Position the end of this hose downwind from the rig and away from personnel and sampling equipment.

8.1.6 Engage the P.T.O.

a. The P.T.O. is located in the cab of the truck and provides power to the hydraulics of the drill rig.

b. Leave the engine at idle speed.

8.1.7 To engage the hydraulics for the mast, press down the button located in the upper left corner of the control panel marked ACCY HYD - MAST.

a. See Exhibit 2 for control panel description.

8.1.8 Using the lever located in the lower left corner of the control panel marked MAST-RAISE/LOWER, slowly engage the hydraulics by moving the lever to raise the mast.

CAUTION: WATCH ALL HYDRAULIC LINES SO THAT THEY DO NOT BECOME ENTANGLED IN TOOLS OR OBSTRUCTIONS IN THE TRUCK BED.

8.1.9 After the mast is in the full upright position, lock the mast in place by installing the pin through holes on the drill table and through the turn buckle attached to the mast.

8.1.10 Set the engine RPMs to 1900 using the throttle control inside of the truck on the P.T.O.

a. Watch the tachometer located on the left side above the dashboard to find the RPM setting.

8.2 To auger with U2CRT, see Procedure TE-106, Solid-Stem Auguring Using the U2CRT.

8.3 To soil sample with U2CRT, see Procedure TE-107, Split-Spoon Sampling Using the U2CRT.

8.4 See Procedures TE-085 and TE-086 for operation of the U2CRT during Geoprobe sampling.

Exhibit 1. U2CRT with Mast Raised

Exhibit 2. U2CRT Operating Control Panel

A. ACCY/HYD - MAST: hydraulic splitter control; when in the up position, the rotary hydraulic motor or the hydraulic hammer is activated; when in the down position, the hydraulics are diverted to the mast hydraulic ram.

B. Power switch: emergency kill switch for the drill rig; when the switch is pushed away from the operator, power is on; when it is pulled toward the operator, power is off.

C. HYDRAULIC SYSTEM PRESSURE: pressure dial for the hydraulic system; the operator should not exceed 2000 psi when operating the system.

D. HAMMER FLOW CONTROL-ROTARY SPEED: controls hydraulic pressure to either the hydraulic hammer or the rotary motor, depending on which is selected by the hydraulic splitter on the mast. It also acts as a splitter between the hydraulic hammer or the rotary motor and the hydraulic rams that move the kelly up and down. The closer the operator moves the lever towards him, the less hydraulic pressure provided to the kelly.

E. HAMMER/ROTARY: hydraulic splitter button that turns on the hydraulic hammer or the rotary motor, depending on which has been selected using the hydraulic splitter button on the mast. When in the OFF position, the hydraulics are diverted to the Table Slide.

F. MAST: toggle lever that raises and lowers the mast when the hydraulic splitter button ACCY/HYD - MAST is engaged to MAST.

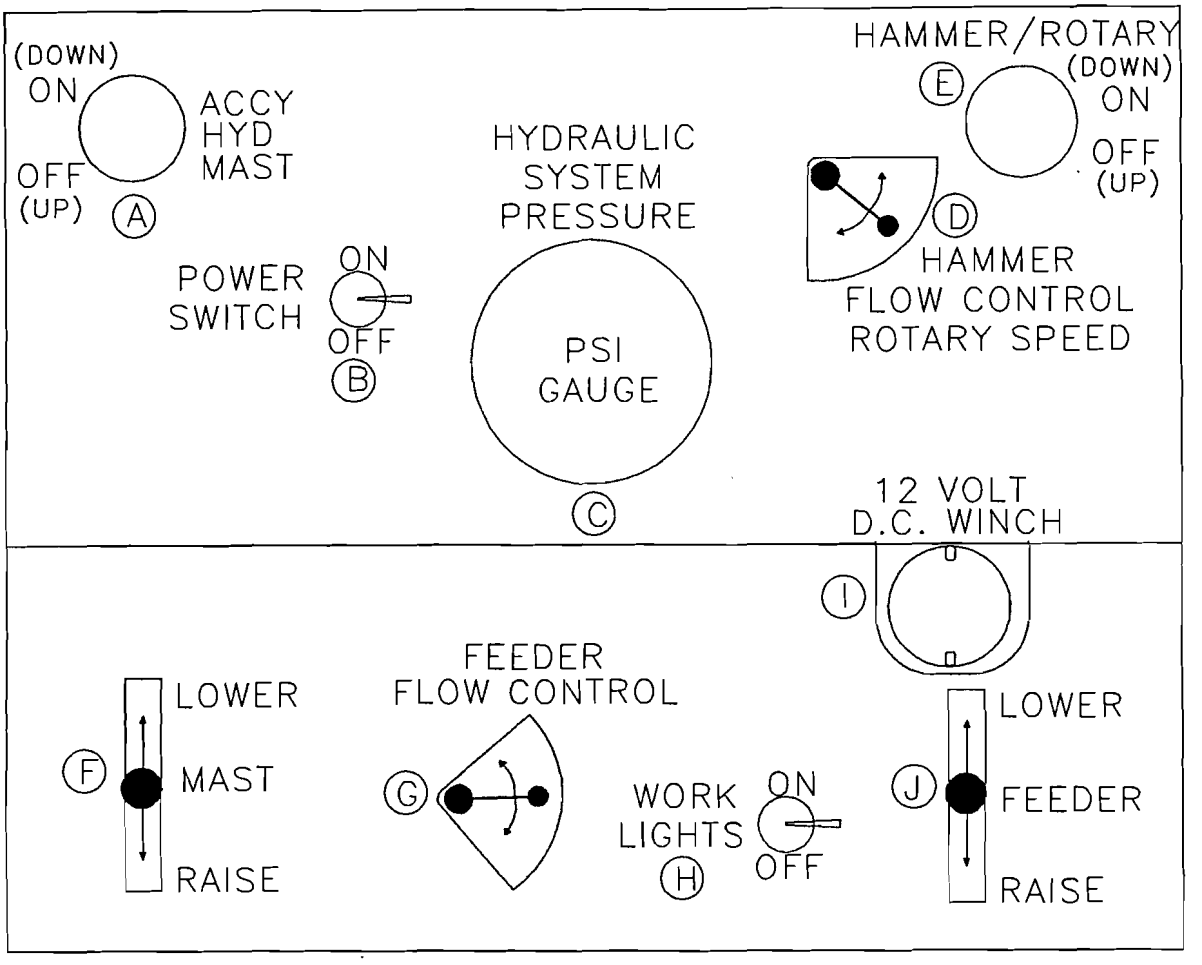
G. FEEDER FLOW CONTROL: a throttle that controls the downward movement of the auger during drilling operations.

H. WORK LIGHTS: toggle switch that operates the rig's overhead work lights; when the switch is pushed away from the operator, the lights will be activated; when switch is towards the operator, the lights they will be off.

I. WINCH: switch that operates the electric winch line located on top of the mast; twisting the switch clockwise reels the winch line in; counter-clockwise lets the line out.

J. FEEDER: toggle lever that raises and lowers the hydraulic cylinders for both the hydraulic hammer and the rotary motor.

Exhibit 2 (continued)



OAK RIDGE NATIONAL LABORATORY Health Sciences Research Division	PROCEDURE Environmental Technology Section	Number: TE-106 Page: 1 of 5 Revision: 0 Date: 08/05/93

SOLID-STEM AUGERING USING THE U2CRT

1.0 PURPOSE

This procedure describes the use of the truck-mounted auger rig, the U2CRT, for solid-stem augering.

2.0 APPLICABILITY

This procedure applies to using the U2CRT to drill in unconsolidated soils to a depth of 50 ft.

3.0 OTHER DOCUMENTS

3.1 REFERENCES

3.1.1 Procedure TE-105, U2CRT Operation
3.1.2 Procedure TE-073, Equipment Decontamination

4.0 EQUIPMENT AND MATERIALS

4.1 EQUIPMENT

4.1.1 Augers, 3-in. solid stem or 4 or 6-in. hollow stem
4.1.2 Auger dog
4.1.3 Auger fork
4.1.4 Auger bits, soft sediment or hard rock
4.1.5 Auger bolts
4.1.6 Hand tools

APPROVALS		
Author		Date
Supervisor		Date
Group Leader	[illegible]	Date 8/4/93
Section Head	Craig Little	Date 8/6/93

5.0 RESPONSIBILITY

5.1 The U2CRT operator is responsible for adhering to operational procedures according to Procedure TE-105 and ensuring the equipment is operated safely.

5.2 The U2CRT technician is responsible for providing support for the operator and following the operators' instructions in all activities.

6.0 DEFINITIONS

6.1 **Auger:** a drilling device that continuously removes cuttings from the bottom of the hole during drilling without the use of fluids.

6.2 **Auger dog:** a device that attaches the winch hook to the auger; used when augers are pulled from a hole.

6.3 **Auger flights:** the winding metal cutting edges of the auger that carry cuttings to the surface during drilling; alternatively, a section of the auger itself.

6.4 **Auger fork:** a U-shaped, flat metal piece with a welded handle that is placed between auger flights at ground level to prevent the auger from falling into the borehole.

6.5 **Control panel:** the panel on the left rear of U2CRT containing controls for operating the drill rig.

6.6 **Drill stem:** all parts in the assembly used for drilling from the swivel to the bit, including the kelly, drill pipe/rods, augers, and bit.

6.7 **Kelly:** a hollow steel bar that is the top section of the drill stem and transmits power directly from the rotary motor to the auger flights.

6.8 **Kelly extension:** a 3-ft-extension pipe that connects the kelly to the auger.

6.9 **Kill switch:** a safety switch used to turn off the drill rig in an emergency.

6.10 **Table:** the flat, movable surface at the back of the drilling rig.

7.0 SAFETY

7.1 Follow all safety requirements listed in Procedure TE-105, U2CRT Operation.

7.2 Keep hands, feet, and tools away from the augers while they are in motion.

7.3 Do not wear loose fitting clothing or bind loose clothing to the body (e.g., Tyvek™ overalls).

7.4 Tie long hair back so it is not in danger of becoming caught in rotating equipment.

8.0 PROCEDURE

8.1 Prepare the U2CRT for auguring following Procedure TE-105.

8.1.1 Prior to beginning any rotary work, be certain that both feeder controls located on the upper and lower console of the control panel are in the full forward position (away from the operator).

8.1.2 Push the HAMMER/ROTARY button, located in the upper right-hand corner of the control panel, to the OFF position.

8.1.3 Pull the ROTARY SPEED lever, located at the top center on the control panel, down slightly to lower the RPM's.

8.1.4 Pull the TABLE SLIDE lever, inside the box next to the control panel, towards the rear of the truck to move the table away from the truck; release the lever when the table is fully extended.

8.1.5 Engage the HAMMER/ROTARY button located in the upper right-hand corner of the control panel to the ON position.

8.1.6 Push in the flow control button located on the mast.

8.1.7 Pull out the flow control button located in the upper left-hand corner of the control panel to ACCY HYD.

8.1.8 Connect an auger to the kelly by depressing the button on the side of the auger and sliding the auger up into the kelly until the snap button pops out.

8.1.9 Push the FEEDER lever located in the lower right-hand corner of the control panel forward, moving the auger toward the ground.

a. Stop the movement when the auger has touched the ground by moving the lever to the neutral position.

8.1.10 Slowly pull the ROTARY SPEED lever out to begin rotating the auger.

8.1.11 Push the FEEDER lever forward to lower the auger while slowly pulling the ROTARY SPEED lever out.

a. These two controls are used together to regulate the amount of rotation and vertical movement of the auger.

8.1.12 Continue drilling until the hydraulic cylinders bottom out.

8.1.13 Push the FEEDER control to the neutral position and push the ROTARY SPEED lever to the OFF position, stopping all downward and rotating movements.

8.1.14 Slide the auger fork in between the auger flights to hold the augers stationary.

8.1.15 Disconnect the auger near ground level from the kelly extension.

8.1.16 Pull the FEEDER lever to the "Raise" position and raise the kelly to the fully upright position or high enough so that an additional auger can be attached to the first auger.

8.1.17 Connect the second auger to the lead auger protruding from the ground using the snap button.

8.1.18 Rotate the kelly by hand counterclockwise to line up the kelly with the new auger.

8.1.19 Using the FEEDER lever, slowly lower the kelly onto the auger connection while the technician guides the kelly extension into place on the auger.

8.1.20 Repeat the above drilling steps until the desired depth has been reached.

8.2 Remove the augers from the hole after drilling.

8.2.1 Push the HAMMER/ROTARY button to the OFF position.

8.2.2 Pull the ROTARY SPEED lever down slightly.

8.2.3 Push the TABLE SLIDE lever forward to move the table towards the front of the truck. Release the lever when the table is in the full forward position.

8.2.4 Attach the auger dog to the top of the last auger.

8.2.5 Using the winch line switch located at the center right of the control panel, lower the winch line and attach the hook to the top of the auger dog.

8.2.6 Remove the auger fork.

8.2.7 Reel in the winch line, pulling three augers from the hole at one time, and place the auger fork onto the fourth auger to prevent the remaining auger string from falling downhole.

8.2.8 Disconnect the third auger flight from the fourth auger flight.

a. Remove all loose mud and debris from the auger flights.

8.2.9 While the operator lets out the winch line, the technician pulls the augers out and away from the drill rig and lays them on the ground.

8.2.10 Repeat the above steps until all augers are removed from hole.

8.2.11 After pulling the last auger, disconnect the winch line, reel it in and connect it to the end of a bungie cord on the mast.

8.3 Decontaminate the augers, bit, and other sampling equipment according to Procedure TE-073 or as specified in the site-specific sampling plan.

SPLIT-SPOON SAMPLING USING THE U2CRT

1.0 PURPOSE

This procedure describes split-spoon sampling using the U2CRT.

2.0 APPLICABILITY

This procedure applies to soil sampling in unconsolidated soils.

3.0 OTHER DOCUMENTS

3.1 REFERENCES

3.1.1 Procedure TE-105, U2CRT Operation
3.1.2 Procedure TE-106, Solid-Stem Augering Using the U2CRT
3.1.3 Procedure TE-073, Equipment Decontamination
3.1.4 Procedure TE-101, Subsurface Sampling Using a 5-ft Continuous Sampler and a Split-Barrel Sampler

4.0 EQUIPMENT AND MATERIALS

4.1 EQUIPMENT

4.1.1 "A" Rods
4.1.2 Drive shoe
4.1.3 Pulling shoe
4.1.4 Split-spoon sampler
4.1.5 Hydraulic jacks

4.2 MATERIALS

4.2.1 Brass or stainless steel sleeves, if required

APPROVALS		
Author		Date
Supervisor		Date
Group Leader	[illegible]	Date 8/4/93
Section Head	Craig Little	Date 6/6/93

5.0 RESPONSIBILITY

5.1 The U2CRT operator is responsible for adhering to operational procedures according to Procedure TE-105 and ensuring the equipment is operated safely.

5.2 The U2CRT technician is responsible for providing support for the operator and following the operator's instructions in all activities.

6.0 DEFINITIONS

6.1 **"A" rods:** 2-in. hollow coupled rods that are driven into the borehole, forming the connection rod between the split-spoon and the drive hammer.

6.2 **Control panel:** the panel on the left rear of the U2CRT containing controls for operating the drill rig.

6.3 **Drive shoe:** an adapter for driving split spoons that is threaded onto the hydraulic hammer on one end and to the "A" rod on the other.

6.4 **Hammer attachment:** tooling to attach the hydraulic hammer to the "A" rod and to the drive shoe.

6.5 **Hydraulic hammer:** a hydraulically-powered piston located on the middle of the mast used to drive split-spoon samplers and Geoprobe rods into the ground.

6.6 **Split-spoon sampler:** a sampler that may be attached to the bottom of the "A" rods in order to obtain and hold subsurface soil samples; after removing both ends, the sampler can be split in half to remove soils samples.

7.0 SAFETY

7.1 Follow all safety requirements listed in Procedure TE-105, U2CRT Operation.

8.0 PROCEDURE

8.1 Prepare the U2CRT for split-spoon sampling following Procedure TE-105.

8.2 Auger to the appropriate sample depth according to the project sampling plan and following Procedure TE-106.

8.3 Collect a split-spoon sample.

8.3.1 See Procedure TE-101 for details on split-spoon sampling.

8.3.2 Prior to beginning any split-spoon sampling work, be certain that the feeder controls located on both the upper and lower console of the control panel are in the full forward position.

8.3.3 Push the HAMMER/ROTARY button, located in the upper right-hand corner of the control panel, to the OFF position.

8.3.4 Pull the ROTARY SPEED lever, located at the top center on the control panel, down slightly to lower the RPM's.

8.3.5 Use the TABLE SLIDE level to move the table halfway between the fully out and fully retracted positions.

8.3.6 Engage the HAMMER/ROTARY button located in the upper right-hand corner of the control panel.

8.3.7 Pull out the flow control button located on the mast.

8.3.8 Remove the kelly extension from the kelly.

8.3.9 Connect the hammer attachment to the drive shoe coming from the hydraulic hammer.

8.3.10 Place the hydraulic jacks with base plates under each side of the mast and lower the hammering jacks located on both sides of the mast onto the hydraulic jacks.

a. Adjust the jacks to provide support for the drilling mast.

8.3.11 Remove the pulling shoe at the base of the hydraulic hammer by removing the bolt and sliding the shoe out.

8.3.12 Lower the drive hammer by using the FEEDER lever.

8.3.13 Slowly pull the HAMMER FLOW CONTROL feeder forward.

8.3.14 After driving the split-spoon to the desired depth, move the HAMMER FLOW CONTROL to the forward position and the FEEDER switch to the neutral position.

8.3.15 Replace the pulling shoe at the base of the hydraulic hammer.

CAUTION: FAILURE TO REPLACE THIS SHOE WILL RESULT IN SERIOUS DAMAGE TO THE HYDRAULIC HAMMER.

8.3.16 Using the FEEDER switch, remove the split spoon by lifting slowly.

a. Use the hydraulic hammer in conjunction with lifting to more easily remove the split spoon.

8.3.17 Disconnect the split spoon and "A" rod from the drive shoe.

8.4 After removing the sample, decontaminate the split spoon, "A" rods, another equipment according to Procedure TE-073 or as specified in the site-specific sampling plan.

MONITORING WELL DESIGN

1.0 PURPOSE

This procedure gives guidelines for the design of groundwater monitoring wells, including multiple completion wells.

2.0 OTHER DOCUMENTS

2.1 REFERENCES

2.1.1 N. Korte and P. Kearl, Procedure for the Collection and Preservation of Groundwater and Surface Water Samples and for the Installation of Monitoring Wells, 2d ed., GJ/TMC-08 (85), U.S. DOE Technical Measurements Center, Grand Junction, Colo., 1985, pp. 15, 16-18, 29-30

2.1.2 F. G. Driscoll, Groundwater and Wells, Johnson Division, St. Paul, 1986.

2.1.3 J. A. Cherry, "Migration of Contaminants in Groundwater at a Landfill: A Case Study," Journal of Hydrology, Vol. 63. No. 1/2 (special issue), 1983.

2.1.4 J. A. Cherry and P. E. Johnson, "A Multilevel Device for Monitoring in Fractured Rock," Groundwater Monitoring Review, Summer, 1982,pp. 41-44.

2.1.5 J. F. Pickens et al., "A Multilevel Device for Groundwater Sampling," Groundwater Monitoring Review, Spring, 1981, pp. 48-51.

2.1.6 G. P. Kruseman and N. A. DeRidder, Analysis and Evaluation of Pumping Test Data, International Institute for Land Reclamation and Improvement, The Netherlands, 1979.

2.2 APPENDICES

2.2.1 Appendix 1: Well construction: material and procedures checklist

Approved by:

9/25/90 (Date) C.A. Little 9/26/90 (Date)

2.3 EXHIBITS

2.3.1 Exhibit 1: Typical construction of a monitoring well in an unconsolidated unit

2.3.2 Exhibit 2: Typical multiple completion monitoring well

3.0 SCREEN DEPTH AND INTERVAL

Different densities and aqueous solubilities can cause contaminants to stratify into "floaters", "mixers", and "sinkers". Consequently, large screened intervals covering several geologic units can cause a more contaminated unit to be diluted with water from less contaminated units. Therefore, obtaining water samples from specific zones of interest within the aquifer is often desirable (multiple completion wells are discussed in Sect. 9.0). In general, Korte and Kearl (1985) have recommended the following guidelines:

- Individually screen permeable units within a stratified sedimentary sequence.
- In fractured media, screen individual fractures with short screen lengths.
- If the aquifer is contaminated with compounds denser than water, locate the screened interval at the top of the first impermeable unit underlying the permeable unit. For most applications, a 5-ft screened interval is recommended.

For monitoring wells that also serve as pumping wells for hydrologic testing, the screened interval should fully penetrate the aquifer. The general rule is to screen 70 to 80% of the aquifer's thickness (Kruseman and DeRidder 1979), thereby increasing the maximum yield of the aquifer to 90% or more.

Another advantage of this screen length is that the data obtained through pumping may be assumed to represent horizontal groundwater flow, an assumption that underlies most hydrologic tests. It should be noted, however, that this size of screened interval is impractical for large saturated zones because of the prohibitive well completion cost.

4.0 WELL SCREEN SLOT OPENINGS

4.1 DISCUSSION

Screen slot openings for the same formation can differ depending on whether the well is naturally developed or filter packed. Either design is satisfactory and the choice for a particular well depends primarily on the grain size of the aquifer materials. Coarse-grained heterogeneous materials can be developed

naturally, whereas fine-grained homogeneous materials are best developed using a filter pack. Well screen slot openings for either method are selected depending on the grain size of the water-bearing formation.

In rotary drilling, clay added to the drilling fluid can contaminate samples and lead to recommended slot sizes that are smaller than necessary. The well log should show the presence of natural clays which should be considered in the screen design. In some cases, fine material from formations overlying the aquifer may be kept in suspension in the drilling fluid while the aquifer is being drilled. These fine materials may then be included in the cuttings from the aquifer, although they originate in the overburden. The drilling method may also affect the the sample's accuracy. In air drilling, samples collected at the surface tend to be finer in texture than the materials in the formation. As the bit advances, formation water entering the borehole may pull in finer material differentially, resulting in a higher proportion of fine particles in samples taken at the surface.

Conversely, highly viscous drilling fluids made with clay additives may entrain fine aquifer materials and prevent them from settling out in the mud pit, making the sample coarser than the actual formation materials. Using a polymeric drilling fluid with little or no gel strength will minimize these sampling problems. Other problems associated with drilling fluids are discussed in Appendix A.

4.2 SCREEN SLOT SELECTION FOR NATURALLY DEVELOPED WELLS

In a naturally developed well, select the screen slot size so that most of the finer formation materials near the borehole are brought into the screen and pumped from the well during development. This practice creates a zone of graded formation materials extending 1 to 2 ft outward from the screen. The screen slot size should retain 60 to 70% of the formation materials opposite the screen before development.

Use a conservative slot opening in calcareous formations (shell fragments) which dissolve readily if the well is acid treated. Removing calcareous materials reduces the amount of bridging material and allows fine clastic material to enter the well.

A more conservative slot selection may be advisable when (1) there is some doubt about the reliability of the samples, (2) the aquifer is thin and overlain by fine-grained loose material, (3) development time is at a premium, and (4) the formation is well sorted. Under these conditions, slot sizes retaining 40 to 50% of the aquifer material are preferred.

On the other hand, when using Teflon screen in very deep formations, it may be necessary to select a slightly larger screen-slot size, since Teflon tends to compress and reduce the effective slot size.

When the formation consists of coarse sand and gravel, there is greater latitude in selecting the slot openings. An increase of a few thousandths of an inch in the slot size allows only a small amount of additional material to pass through the well screen during development. The slot size selected, therefore, may retain from 30 to 50% of the aquifer material. If the openings retain only 30%, more material is brought through the screen during development, which increases the time required to develop the well.

When designing screens for heterogeneous formations, choose slot openings for different sections of the well screen according to the gradation of materials in the different layers if the layers are at least 4 ft thick and their depths have been accurately determined. Two additional recommendations should be followed, however, when selecting slot openings for a multiple-slot screen. If fine material overlies coarse material:

1. Extend at least 3 ft of the screen designed for fine material into the coarse layer below;

2. The slot size for the screen section installed in the coarse layer 3 ft beneath the formation contact should not be more than double the slot size for the overlying finer material. Double the slot size over screen increments of 2 ft or more.

The guide for slot-size selection indicates that about 60% of the formation material near the screen will come through the screen during the development process. Removing this fraction results in some material settlement around the screen. Thus, the overlying finer layer moves downward slightly as settling occurs.

5.0 FILTER PACK DESIGN

Filter packing is the second primary method for completing wells. In filter packed wells, the zone immediately around the well screen is made more permeable by removing some formation material and replacing it with specially graded material. This relatively thin zone separates the screen from the formation material and increases the effective hydraulic diameter of the well. A filter pack retains most of the formation material; a well screen opening is then selected to retain about 90% of the filter pack after development. Filter pack materials should be well sorted to assure good porosity and hydraulic conductivity of the materials near the screen.

Filter packing is especially advantageous when the sediments are highly uniform and fine grained, when the sediments are highly laminated, or when all the materials to be used in the well construction must be on-site before drilling begins.

The grain size of the filter pack should be three to five times the average grain size of the formation materials. A filter pack selected in this manner ordinarily does not restrict the flow from the layers of coarsest material. The hydraulic conductivity of the pack is generally several times greater than that of the coarsest layers because the pack is cleaner and more uniform.

Filter pack material should consist of clean, well-rounded grains of a uniform size to increase its permeability and porosity. The chemical nature of the filter pack is as important as its physical characteristics; filter pack material must consist only of siliceous particles. If calcareous particles are present and the groundwater is slightly acidic, the pack may partially dissolve over time. Particles of shale, anhydrite, and gypsum in the filter-pack material also are undesirable.

5.1 THICKNESS OF FILTER PACK

The design theory of filter-pack gradation is based on the mechanical retention of formation particles; therefore, a pack thickness of only two or three grain diameters is actually needed to retain and control a formation. Laboratory tests made by the Johnson Division show that a properly sized pack with a thickness of less than 0.5 in. successfully retains the formation particles regardless of the velocity of water passing through the filter pack. It is impossible, however, to place a filter pack only 0.5 in. thick and expect the material to completely surround the well screen. To ensure a continuous layer of filter material surrounding the entire screen, the design should specify that the annulus around the screen be at least 3 in.

Filter-pack thickness does little to reduce the possibility of sediment pumping because the controlling factor is the grain size ratio of the pack material to the formation material. Also, a filter pack that is too thick can make final development of the well more difficult. Under most conditions, filter packs should not be more than 8 in. thick because the energy created by the development procedure must be able to penetrate the pack to repair damage done by drilling, break down any residual drilling fluid on the borehole wall, and remove fine particles near the borehole.

When calculating the required volume of filter pack, remember that the filter pack should extend at least 1 ft above the well screen to compensate for settlement during development and to ensure that no annular sealant can enter the well screen. It is good practice to have extra filter pack on the site.

6.0 ANNULAR SEALANT

The annular sealant must prevent contaminants from migrating to the sampling zone from surface or intermediate zones and so prevent cross contamination between strata. The permeability of the sealants should be one to two orders of magnitude less than the surrounding formation. An appropriate use of annular sealant material is using a minimum of 2 ft of certified sodium bentonite pellets immediately over the filter pack when in a saturated zone. The pellets are most appropriate in a saturated zone because they will penetrate the column of water to create an effective seal. Coarse grit sodium bentonite is likely to hydrate and bridge before reaching the filter pack. Use a cement and bentonite mixture, bentonite chips, or anti-shrink cement mixtures as the annular sealant in the unsaturated zone above the certified-bentonite pellet seal and below the frost line. Again, select a clay on the basis of the environment in which it is to be used. In most cases, sodium bentonite is appropriate.

6.1 GROUT

Place grout composed by weight of 6 parts cement to 1 part bentonite, with just enough water for a pumpable mix, in the monitoring well as follows:

6.1.1 Fill the annulus between the well casing and borehole wall with grout.

6.1.2 Place a grout pipe just over the top of a bentonite seal, which separates the wet sand or gravel pack from the grout.

6.1.3 Pump the grout through the grout pipe to the bottom of the open annulus until undiluted grout flows from the annulus at ground surface.

6.1.4 Install the protective casing.

7.0 PROTECTIVE CASING

Protective casing should be installed around all monitoring wells. At a minimum its design should incorporate the following elements.

7.1 Extend a 5-ft (minimum) length of steel casing approximately 3 ft above the ground surface and set in cement grout. Use a 6-in. diameter pipe for 4-in. wells, and 4-in. diameter pipe for 2-in. wells. For wells located on access roads, the casing can be flush with the ground surface. Otherwise, the top of the steel casing should not be more than 3 in. above the riser pipe to ensure that water level measurements can be taken accurately.

7.2 Secure a well covering, usually a hinged cover or a loose telescoping cap (Exhibit 1), with a padlock to the top of the protective casing to prevent

precipitation from entering (a single key should open all padlocks at a given site).

7.3 Pour a concrete apron with a minimum radius of 3 ft around the protective casing and slope it so water runs away from the steel casing (Exhibit 1).

7.4 Install three posts, 4 x 4 in. wood or 3-in. diameter steel, around the well. Set each post 4 ft from the well, extending 2 ft below and at least 4 ft above ground surface, and flag in areas of high vegetation. In grazing areas, install four posts with three-strand barbed wire strung around them to act as a livestock guard.

7.5 Drill a small hole at the base of the protective casing to allow trapped water to escape.

8.0 DOCUMENTATION

Completed monitoring wells should be documented on the well summary information sheet according to the procedure in TE-100. A typical completed monitoring well appears on Exhibit 2. In addition, the well construction material and procedural checklist form is filled out (Appendix 3).

A base map showing the approximate locations of all monitoring wells and abandoned drill holes should also be prepared. Following installation, survey the actual well locations and elevations according to the procedures TE-120, and update the map accordingly.

The log and checklist are prepared and maintained for each monitoring well installation, and should include the following information:

- the exact location of the well, including a brief description of the surrounding area;
- the start and completion dates for each boring;
- sequential soil and/or lithologic boundaries (when depths are estimated, note the degree of accuracy);
- the results of all water-table measurements (note also the method of determination);
- for drive (split-spoon), pushed (thin-wall or Shelby), and cored samples, the length and depth of the sampled interval and the length of sample recovered for that interval;

- for split-spoon samples obtained using a drive sampler, the number of blow counts, hammer weight, and length of fall (for thin-wall samples, indicate whether the sampler was hydraulically or manually pushed);

- when drilling fluid is used, the amount of fluid loss (quantitatively estimated) and the depth interval over which the loss occurred (the fluid loss should also be generally described using the following terminology: "no loss" means that no fluid was apparently lost other than through spillage while filling the hole; "partial fluid loss" means that the amount of return was significantly less than the amount used; and "complete water loss" means that no fluid returned to the surface during pumping);

- the type and amount of any drilling additive used for each boring, including lubricants, together with the reason for and start depth of additive use;

- a general description of drilling equipment, including bit type, rig manufacturer, and model; and

- all special problems or conditions, such as hole squeezing, recurring problems at a particular depth, grout in the well, excessive ground takes, drilling fluid losses, tools in the hole, and lost casings and screens.

9.0 MULTIPLE COMPLETION WELLS

When conducting a groundwater investigation in a stratified sedimentary regime or a fracture-flow system, obtaining representative samples from a number of specific depth intervals in order to accurately characterize the system is important. In such systems, certain flow paths may contain high contaminant concentrations while the remainder of the system may be relatively contaminant-free. Slotted wells completed over the length of the flow system tend to yield only an integrated sample, which may or may not be representative of the entire system. Instead, use a multilevel well completion in those cases where sampling at specific depth intervals is essential. Work at the University of Waterloo in Ontario, Canada, resulted in some excellent guidance relative to equipment and installation of multilevel sampling devices (Cherry 1983). A typical multiple completion monitoring well is illustrated in Exhibit 2. Piezometer nests are the easiest to install and provide the highest degree of integrity with respect to sampling of the desired intervals and preventing interlevel contamination. High cost is a major drawback of this method, however. Installation of a piezometer nest costs up to ten times that of a multilevel device with an equivalent number of sampling intakes.

Single borehole nests provide several sampling points within an individual borehole. This type of well completion is well-suited for most applications, especially where three completions per borehole are enough to characterize the system. The disadvantages of single borehole nests are the limited number of

piezometers that can be installed in each borehole, the difficulty of installing sand packs and seals at desired levels, and the large borehole that is required.

Multilevel sampling devices are becoming more popular as a result of improved efficiency, reliability, and lower cost. A device developed by Pickens and others (1981) and Cherry and Johnson (1982), consists of a bundle of tubes housed within a PVC pipe capped on the bottom. Each of the tubes is connected to a 90 elbow which protrudes through the casing. Each tube extends to a different depth in the casing so that water can be drawn from different intervals in the borehole. The depth interval sampled by each tube is isolated from above and below by expandable packers so that the annulus between the casing and the borehole wall is sealed over the specified intervals.

The packers are made from a solid but flexible sealant that expands with water. The sealant, which resembles a soft, light rubber, is formed into a cylindrical sleeve in a mold. The sleeve is placed around precut lengths of PVC pipe, the same type as that used for the casing. Packers can be conveniently joined into the casing using standard threadless couplings with a small amount of solvent joiner (solvent can be eliminated if threaded pipe and couplings are used for jointing the packers and for joining the PVC casing at other points in the assembly).

One disadvantage associated with the multilevel sampling device is its propensity for clogging at the sampling ports. In addition, the device makes it difficult to conduct hydrologic testing in an aquifer, to position the samplers at the desired depth intervals, and to efficiently isolate the sampling ports with properly placed packers.

Appendix 1. Well construction: material and procedures checklist

OAK RIDGE NATIONAL LABORATORY
CHEMICAL ASSESMENTS TEAM
GRAND JUNCTION OFFICE
P.O. BOX 2567
GRAND JUNCTION, CO. 81502
(303) 248-8208
(FTS) 328-6208

WELL CONSTRUCTION MATERIAL
AND PROCEDURAL CHECKLIST

Project _____ Site _____

Well # _____ Date _____

Location Sketch

WELL CONSTRUCTION

DRILLING	WELL COMPLETION
Method:	Borehole diameter:
Contractor:	Casing depth:
Rig type:	Total depth:
Driller:	Screened interval:
QA/QC:	Water level(Pre-level):
Equip. decon. prior to drlg?	Water level(post-level):
COMMENTS:	QA/QC:
	Casing decon. prior to setting?
MATERIALS	Grout mixed to specs?
	COMMENTS:

	Size	Amount
Sand		
Portland Cement		
Powdered Bentonite		
Bentonite Pellets		
Casing		
Type		
Well cap		
Well points		
Screen: Length		
Size		
Type		

CAT/REP.

COMMENTS:

WELL DEVELOPMENT

Developed by: Date:

Method:

Volume of water purged:

Water quality | Temp: Cond: pH:

WELL TESTS

Bail test by: Date:

Pump test by: Date:

Other:

COMMENTS:

WELL SAMPLING

Temp.	pH	Cond.	WL	Date	By

COMMENTS:

Exhibit 1. Typical construction of a monitoring well in an unconsolidated unit

ORNL DWG-91-6012

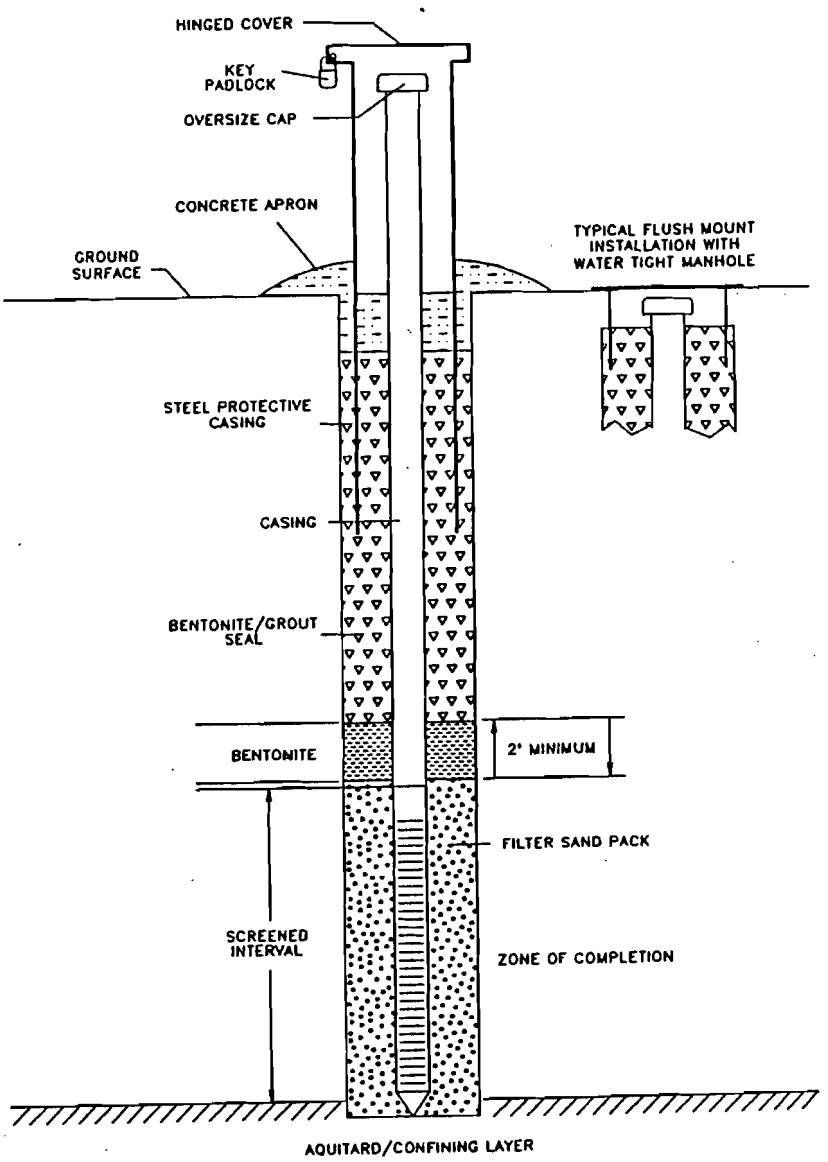
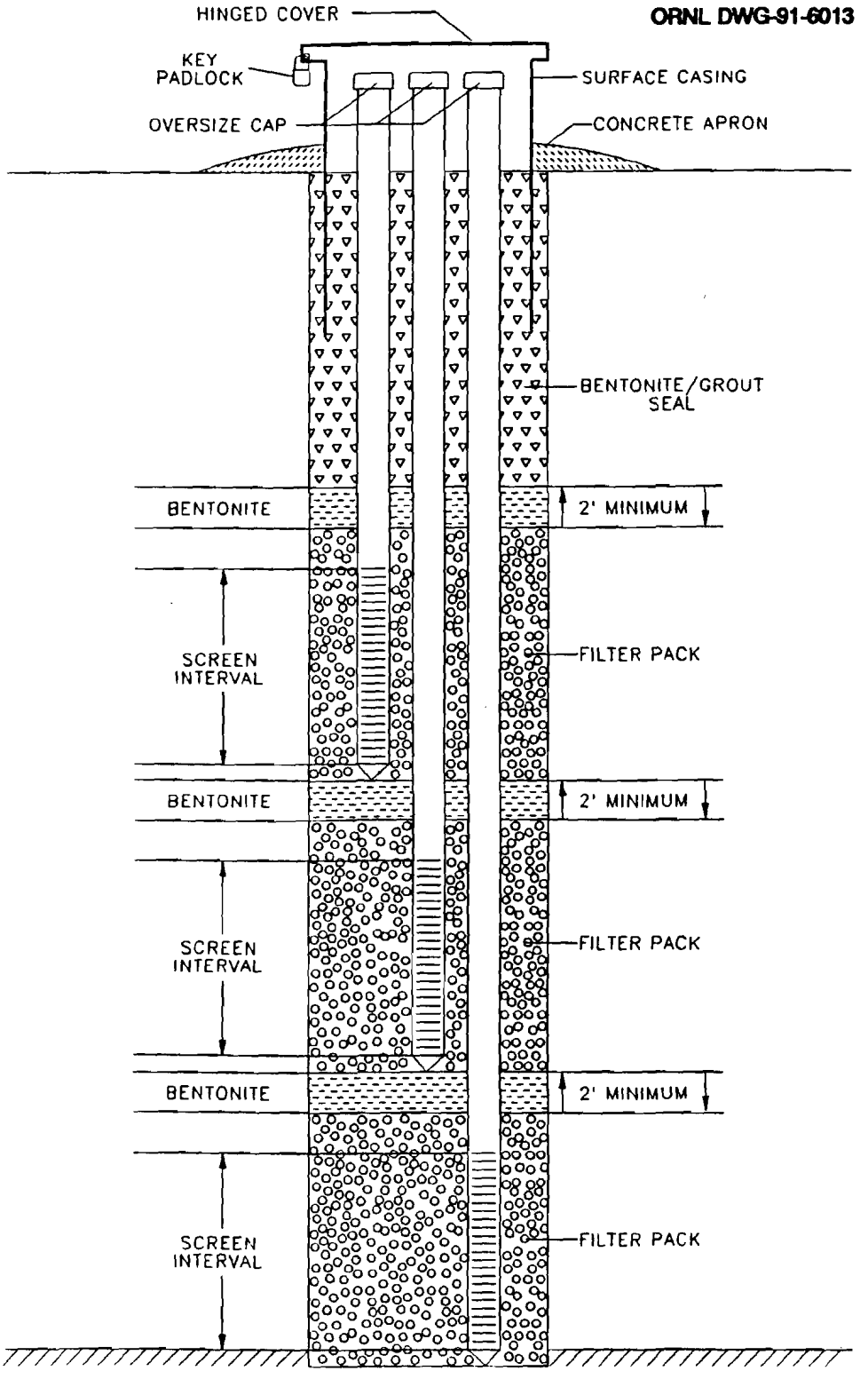


Exhibit 2. Typical multiple completion monitoring well



WELL DEVELOPMENT

1.0 DISCUSSION

During the drilling, fine-grained materials smear on the sides of the borehole and form a mud "cake" that reduces the hydraulic efficiency of the well. To facilitate water entry into the monitoring well (a particularly important factor for low-yielding geologic materials), this mud cake must be broken down and the fine-grained materials removed from the well or well bore by well development. Development also removes fluids, primarily water, which are introduced to the water-bearing formations during the drilling process.

Additionally, develop monitoring wells to provide water samples free of suspended solids. When sampling for metal ions and other inorganic constituents, filter water samples and preserve at the well site at the time of collection. Improperly developed monitoring wells will produce samples containing suspended sediments that will bias the chemical analysis of the collected samples and frequently cause clogging of the field-filtering mechanisms.

The time and money spent for this important procedure will expedite sample filtration and result in samples more representative of water in the monitored formation.

Successful development methods include bailing, surging, and flushing with air or water. The basic principle behind each method is to create flow reversals in and out of the well (and/or borehole) to break down the mud cake and draw the finer materials into the hole for removal. This process also helps remove the finer materials close to the borehole, leaving behind a "natural" pack of coarser-grained materials.

2.0 OTHER DOCUMENTS

2.1 REFERENCES

2.1.1 M. J. Barcelona et al., Practical Guide for Groundwater Sampling, Illinois State Water Survey, November 1985. pp. 40-41.

Approved by:

Mic Kerte 9/19/90 (Date)

Gail Little 9/19/90 C.A. Little (Date)

2.1.2 National Water Well Association, Manual of Water Well Construction Practices, U.S. Environmental Protection Agency, 1975.

3.0 EQUIPMENT

- development pump, an appropriate amount of hose, controller;
- oil-less compressor and generator, or compressed nitrogen ("A" size cylinder), regulator and fittings;
- tripod and reel;
- 5-gal bucket;
- purge record form;
- containers for purge water (if required);
- Solvex or surgical gloves;
- jetting tool, air hose, compressed nitrogen ("A" size cylinder);
- large peristaltic pump (if needed), Tygon tubing, and extra silicone pump head tubing;
- water level indicator;
- stopwatch or wristwatch;
- distilled water;
- tap water;
- laboratory grade detergent;
- paper towels;
- keys to well casing padlocks;
- knife or file to mark north side of stick-up;
- crescent wrenches (2);
- Teflon tape for threads; and

- 50-ft extension cord gauge appropriate to amperage of generator.

4.0 PROCEDURE FOR ROUTINE WELL DEVELOPMENT

4.1 Develop the well as soon as practical after installation, but no sooner than 48 hr after completing the grouting. The objective is to remove as much sediment from the well as practical.

4.2 Use a combination of jetting with nitrogen gas and pumping to maintain a flow of fines from the mudcake and gravel pack to the inside of the well. The nitrogen can be used to remove the water from the well only if containerization of development water is not required. Adjust the flow of nitrogen so that an adequate turbulence is maintained but the water column is not ejected from the well. Raise and lower the jetting tool along the screened interval, then remove it from the well and begin pumping. The Well Wizard model HR4105D well development pump can be equipped with a wiper which enhances the surging action. Raise and lower the pump a few times to stir the sediment in the well, then start the pump.

4.3 The following guidelines have been developed as minimal requirements for well development:

4.3.1 For wells where the borehole was drilled without using fluid (mud or water), remove five times the volume of standing water in the well (well screen and casing plus saturated annulus).

4.3.2 For those where the borehole was drilled or enlarged using fluid (mud or water), remove five times the measured or estimated amount of total fluids lost drilling plus five times the volume of standing water in the well. This procedure also applies in cases of slow recharge, or discolored or particulate-laden water.

4.3.3 Remove the standing water from points near the bottom of the well screen, as well as from points near the top of the water column.

4.3.4 If possible, add no water to the well during development. In addition, use no dispersing agents, acids, or disinfectants.

5.0 WELL DEVELOPMENT IN A LOW HYDRAULIC CONDUCTIVITY FORMATION

The following discussion and well-development technique is taken from Barcelona et al., "Practical Guide For Groundwater Sampling," 1985.

Development procedures for monitoring wells in relatively unproductive geologic materials are somewhat limited. The low hydraulic conductivity of the materials

makes surging water in and out of the well casing difficult. When the well is pumped the entrance velocity of water may be too low to effectively remove fines from the well bore and the gravel pack material outside the well screen.

Clean water can be circulated down the well casing, out through the screen and gravel pack, and up the open borehole prior to placement of the grout or seal in the annulus. Maintain relatively high water velocities so that the mud cake from the borehole wall will be broken down effectively and removed. Control flow rates to prevent floating the gravel pack out of the borehole. Because of the relatively low hydraulic conductivity, a small amount of water will penetrate the formation being monitored. Immediately following this procedure, instal the well sealant and pump the well to remove as much of the water used in the development process as possible.

6.0 ADDITIONAL PROCEDURES

Additional well-development procedures are described in the Manual of Water Well Construction Practices, prepared by the National Water Well Association (U.S. Environmental Protection Agency, 1975).

WELL INSPECTION AND MAINTENANCE

1.0 PURPOSE

This procedure is designed to provide guidelines for inspection and maintenance of small diameter, shallow monitoring wells.

2.0 APPLICABILITY

Site-specific conditions determine the frequency of well development. However, the wells should be inspected at least annually, depending on the frequency of sampling.

3.0 OTHER DOCUMENTS

3.1 ASSOCIATED PROCEDURES

3.1.1 TE-073 Equipment Decontamination;

3.1.2 TE-094 Water Level Measurement;

3.1.3 TE-111 Well Development.

4.0 EQUIPMENT

4.1 water level indicator;

4.2 oil-free compressed nitrogen;

4.3 surge block;

4.4 fluorescent spray paint;

4.5 pumps (choice dependent on depth and volume requirements);

4.6 tank for containing purge water (if necessary);

Approved by:

9/19/90 (Date) — C.A. Little 9/19/90 (Date)

4.7 steel stamp for numbering wells.

5.0 PROCEDURE

5.1 INSPECTION

Check the surface exterior of the well for damage, including the following conditions. Note any damage and actions taken to correct it in the personal logbook.

5.1.1 Lock working;

5.1.2 Cap on surface easing intact;

5.1.3 Surface casing intact;

5.1.4 Surface grouting intact;

5.1.5 Riser cap present;

5.1.6 Perimeter guard posts present;

5.1.7 Guard posts adequately painted for high visibility; and

5.1.8 Well clearly and correctly numbered.

5.2 SUBSURFACE DAMAGE IDENTIFICATION

5.2.1 Measure the static water level and record. A dramatic change in water level since the last measurement could indicate damage to the casing.

5.2.2 Inspect the interior of the casing for dirt or microbial growth. Bail a sample from the surface of the water table and inspect it for microbial films. Redevelop if microbial growth is evident.

5.2.3 Measure the total depth of the well and record the results. If sediment has reached the bottom of the screen or higher, redevelop.

5.3 WELL REDEVELOPMENT PROCEDURE

Inspect wells annually to determine whether redevelopment is necessary. Any excessive sedimentation would require that the well be redeveloped. Use compressed nitrogen as a surge block jetting the casing and the screen. Frequently, this should be followed by slow overpumping until the well is

clear. Jetting and surging should be done cautiously to prevent damage to the screen, casing, or bentonite seal.

Local regulations should be checked to determine the proper disposition for purge water.

5.4 AIR DEVELOPMENT

5.4.1 Before each use, clean all equipment to be placed in the well according to TE-073.

5.4.2 Place the jetting tool (connected to a compressed nitrogen gas source) at the bottom of the screened interval. Release the nitrogen at a low flow rate to begin "air lift" pumping of bore water and to reduce the head in the well before surging.

5.4.3 Jet the bottom of the screen to surge water out of the screen and filter pack.

5.4.4 Airlift repeatedly until the sediment removal is complete. For many wells, this technique will not sufficiently remove sediment; They require a surge block and slow overpumping with a peristaltic or other suitable pump.

5.4.5 Raise the jetting tool and repeat the above two steps. Continue until the entire length of screen and filter pack have been developed.

5.4.6 Lower the jetting tool or a pump to the bottom of the well and pump until the water is sediment free.

5.5 SURGE BLOCKING

5.5.1 Before each use, clean all equipment to be placed in the well with tap water containing laboratory-grade detergent (1% solution), followed by a tap water rinse, then a deionized water rinse.

5.5.2 Lower the surge block into the well below the water level but several feet above the screen (if possible). Using a gentle action at first to prevent damaging the well installation, begin surging action to move fine-grained sediments through the screen.

5.5.3 When flow through the well screen begins to improve, lower the surge block several feet and operate over successively deeper intervals of the screen (be careful that the surge block is the proper size and does not

damage the screen--particularly in wells completed with Johnson continuous slot screen, which has vertical ribs on the inside).

5.5.4 Remove the surge block periodically to pump or jet loosened sediment from the bottom.

5.5.5 After surging the entire screened interval, pump the well from the bottom until the water is sediment-free.

WELL ABANDONMENT

1.0 PURPOSE

This procedure describes the steps necessary to abandon a small-diameter, shallow monitoring well.

2.0 APPLICABILITY

This procedure applies to the abandonment of shallow (<100 ft) monitoring wells. The procedure may not satisfy all states regulations or client requirements and may be adjusted accordingly.

3.0 OTHER DOCUMENTS

None

4.0 EQUIPMENT AND MATERIALS

4.1 EQUIPMENT

4.1.1 Project logbook
4.1.2 Saw
4.1.3 Cement pump
4.1.4 Tremie line
4.1.5 Shovel

4.2 MATERIALS

4.2.1 Water
4.2.2 Bentonite
4.2.3 Cement

APPROVALS		
Author		Date
Supervisor		Date
Group Leader	[illegible]	Date 8/4/93
Section Head	Craig Little	Date 8/6/93

5.0 RESPONSIBILITY

5.1 The acting field supervisor is responsible for directing and documenting the well abandonment.

5.2 The subcontractor is responsible for performing the well abandonment procedures.

6.0 DEFINITIONS

6.1 **Flush mount**: set at or below the ground surface with a manhole-type cover for protection

6.2 **Tremie line**: a small-diameter pipe used to carry fill material (sand, gravel, cement) to the desired depth in a borehole or well.

7.0 SAFETY

7.1 All field personnel must wear hard hats, gloves, safety glasses or goggles, and steel-toed boots.

8.0 PROCEDURE

8.1 Record the following information in the field logbook:

8.1.1 well number,
8.1.2 date,
8.1.3 ETS personnel present,
8.1.4 subcontractor's name,
8.1.5 subcontractor personnel present,
8.1.6 number of completions abandoned,
8.1.7 depths of completions, and
8.1.8 diameter of completions.

8.2 Make a location sketch or indicate the well location on the site map.

8.3 Calculate the inside volume of the well casing and gravel pack to determine the volume of grout required to fill the well:

$$\text{Volume} = \pi\ [r_w^2 L_w + n(r_g^2 - r_w^2)L_g]$$

where

π = 3.14
r_w = ½ well diameter, m or ft

L_w = length of the well, m or ft
n = porosity (assume 0.2 to 0.3)
r_g = ½ gravel pack diameter, m or ft
L_g = length of gravel pack, m or ft

8.4 Mix a grout consisting of six parts cement to one part bentonite.

8.5 Pump the appropriate amount of grout into the well using a tremie line.

8.6 When the grout is at the top of the well casing, pull out the tremie line and fill the rest of the well casing with grout to the surface.

8.7 Remove the protective casing and cement pad, if applicable, by breaking or pulling.

8.8 If the well is flush mount, pull the flush mount.

8.9 Cut the well casing off at or below the land surface.

8.10 After the grout has hardened, fill any excavated area remaining around the well casing with material similar to the surrounding material (i.e., dirt, asphalt, etc.)

8.11 Send documentation of the abandonment to the state agency regulating monitoring and/or water wells if necessary.

8.11.1 This documentation is the responsibility of the subcontractor in most states.

PHYSICAL SURVEYING

1.0 PURPOSE

This procedure describes the equipment and methods used to perform a physical survey of a site.

2.0 APPLICABILITY

This procedure applies to physically surveying any ETS work site where documenting and mapping the property boundaries, visible utilities, physical parameters, structural features, monitoring and sampling locations, etc. are required.

3.0 OTHER DOCUMENTS

3.1 REFERENCES

3.1.1 Lietz Set 3 Total Station operating instructions.
3.1.2 Procedure SU-061, Graphics for Inclusion Surveys of Vicinity Properties
3.1.3 Procedure SU-062, Graphics for Verification of Vicinity Properties
3.1.4 Procedure SU-063, Graphics for Chemical Assessments Projects

3.2 APPENDICES

3.2.1 Appendix 1: Proper Adjustment of Instruments

4.0 EQUIPMENT AND MATERIALS

4.1 EQUIPMENT

4.1.1 Tripods
4.1.2 Brunton compass
4.1.3 Optical reading compass

APPROVALS			
Author		Date	
Supervisor		Date	
Group Leader	[illegible]	Date	8/4/93
Section Head	[illegible]	Date	8/6/93

4.1.4 Philadelphia level rod
4.1.5 Stadia rod
4.1.6 Range pole
4.1.7 Fargo level rod
4.1.8 Automatic level
4.1.9 Chaining pins
4.1.10 Locke or abney hand level
4.1.11 Steel tapes (calibrated)
4.1.12 Fiberglass measuring tape
4.1.13 Theodolite (total station)
4.1.14 Plane table with alidade
4.1.15 Survey stakes
4.1.16 Other survey markers
4.1.17 Survey logbook

5.0 RESPONSIBILITY

5.1 It is the responsibility of the surveyor to operate the instrument or oversee its operation and ensure that: the instrument is calibrated and leveled, all points are surveyed, and proper quality assurance and closure are conducted.

5.1.1 The surveyor determines the acceptable margin of error based on professional judgement and the accuracy required for the work to be performed.

5.2 It is the responsibility of the rod person to ensure that the rod or other station is properly positioned and plumb, as needed.

5.3 It is the responsibility of the note taker to document all work: angles measured, distances, and special conditions.

6.0 SAFETY

Safety requirements for surveyors will vary greatly depending on the terrain and site conditions. Personnel must be familiar with special requirements that may be necessary.

7.0 PROCEDURE

7.1 Maintain surveying instruments in a good operating condition and handle in the following manner:

7.1.1 Transport equipment to the field in the proper instrument cases.

7.1.2 Set up the tripod, tighten the wing nuts, and remove any dust or sand from the tripod head.

7.1.3 Carefully remove the instrument from its case and securely attach it to the tripod.

7.1.4 Level and lock the pivoting-scope instrument into position so that the line of sight is horizontal.

a. Remove the lens cap and attach the sunshield.

7.1.5 Inspect and clean instruments and return them to their respective cases when field work is complete.

7.1.6 Wipe steel tapes dry with a clean cloth; oil lightly.

7.1.7 Store all survey equipment in a dry location to avoid damage or warping.

7.2 Inspect and adjust the instruments as necessary before each use to maintain an acceptable level of accuracy.

NOTE: Only factory-trained personnel are to perform the adjustments if calibration is required.

7.2.1 See Appendix 1, Proper Adjustment of Instruments, for further information.

7.3 Acquire all land information pertaining to the selected site.

7.3.1 Determine and identify apparent property corners for the survey starting point based on the legal description of the site or property.

7.4 Measure horizontal distances using one or more of the following methods.

7.4.1 Chain or tape distances using a calibrated steel or fiberglass tape, maintaining uniform tension for each measurement.

a. Use a series of short measurements to keep the tape horizontal on sloping terrain.

7.4.2 Use the Leitz Set 3 Total Station electronic distance-measuring instrument for very accurate, quick measurements up to a maximum of 9600 ft (2925 m). See Reference 3.1.1 for operating instructions.

7.4.3 Use a stadia rod, read with a transit or automatic level, for quick measurements that do not require the accuracy of chaining.

7.5 Determine elevation differences between two or more points by using differential leveling.

7.5.1 Start and end the circuit at a benchmark or other point of known elevation.

7.5.2 Set the level at a convenient point between the starting benchmark and the next benchmark or turning point.

7.5.3 Enter the following preliminary information into the survey logbook:

a. survey location,
b. project name,
c. weather conditions,
d. temperature,
e. names of surveyors,
f. date,
g. description of starting and/or ending benchmark, and
h. column headings.

7.5.4 Observe and record the level rod readings (using the triple wire method) at the backsight benchmark.

a. Record the total as the height of the instrument.

7.5.5 Sight any number of foresights from the control station.

7.5.6 If the survey requires a series of stations in a traverse, close by sighting a known, established control station as the last foresight and computing the error of closure of the traverse.

7.5.7 If it is necessary to locate the present position, triangulate by sighting several other known stations.

a. Calculate the present position using the various trigonometric functions that relate the leg distances and the interior angles of a triangle.

7.6 Conduct topographic surveys to obtain ground-relief data and relative ground elevations and to determine the location of physical features.

7.6.1 When possible, correct elevations to the nearest U.S. Geological Survey (USGS) bench mark.

7.6.2 Use the Leitz Set 3 Total Station as the primary instrument, mounted and accurately leveled on a tripod positioned over a benchmark, section corner, or other control station.

7.6.3 With the instrument, locate and sight a backsight point whose bearing and measured distance from the control station are known through qualified research (recorded survey plats and previously located survey points).

a. Set the horizontal vernier to zero while sighting the backsight point.

7.6.4 Rotate the instrument (or the object whose location is desired) to sight and foresight and read the horizontal angle with the vertical crosshair set on the target.

a. Obtain the vertical angle with the horizontal crosshair centered on the target.

7.6.5 Determine the slope or horizontal distance between the two stations using the electronic distance measurement (EDM) while sighting the reflecting prism (with attached target) located on the foresight.

7.6.6 Sight any number of foresights from the control station.

7.6.7 If the survey requires a series of stations in a traverse, close by sighting a known, established control station as the last foresight and computing the error of closure of the traverse.

7.6.8 If it is necessary to locate the present position, triangulate by sighting several other known stations.

a. Calculate the present position using the various trigonometric functions that relate the leg distances and the interior angles of a triangle.

7.7 For field mapping, use an alidade, plane table, and stadia rod to plot topographic, natural, and man-made features directly as the physical survey proceeds.

7.7.1 Set up the alidade and plane table, determine the declination of magnetic north to grid north, and draw a line representing magnetic north on the paper.

a. Rotate the table and lock in place at the point where the magnetic compass lines coincide.

7.7.2 Determine the instrument position by sighting a known point, reading the stadia distance, and scaling the distance on the map using the alidade straightedge, which parallels the line of sight.

7.7.3 Plot any other point by placing the straightedge through the mapped instrument position, reading the stadia distance, and scaling the distance on the map using the alidade straightedge.

7.7.4 If the plane table must be moved, use a previously located point as the backsight to determine the instrument's new position.

7.8 Assign each drawing a number using an established drawing identification numbering system.

7.9 Complete the surveyor's final drawing with the addition of dimensions, north arrow, box scale, and any other relevant information.

7.9.1 Complete AutoCAD™ drawings according to Procedures SU-061, SU-062, and SU-063.

7.9.2 Check the surveyor's final drawing for accuracy when it is completed by the following:

a. the team leader, chief surveyor, or designated alternate;

b. the rod person or draftsman.

Appendix 1. Proper Adjustment of Instruments

The following describes the conditions required for each instrument to be in proper adjustment.

1. The automatic level is considered to be in adjustment when the instrument is leveled, the horizontal crosshair is truly horizontal, the bubble is centered, and the line of sight is parallel to the axis of the telescope tube.

2. The theodolite does not generally need to be calibrated. It is in adjustment if the tubular plate level will center on the midpoint, regardless of the direction in which the instrument is rotated.

    a. The circular-level bubble should be centered through two right-angle turns of the theodolite.

    b. The line of site is in adjustment if readings of a bearing on both faces differ by exactly 180°.

3. The electronic distance measurement (EDM) portion of the theodolite is in adjustment when no deviation in measurement exists between a known standard distance and the distance measured by the instrument.

    a. A deviation of several tenths of a foot or less does not require adjustment, but a correction factor should be noted and applied in those cases where extreme accuracy is required.

    b. Service the instrument when readings become very erratic.

PERISTALTIC PUMP OPERATION

1.0 PURPOSE

This procedure describes the general use of a peristaltic pump. For more detailed information, refer to the specific manufacturer's manual for the pump used.

2.0 APPLICABILITY

This procedure applies to the operation and use of peristaltic pumps.

3.0 OTHER DOCUMENTS

3.1 REFERENCES

3.1.1 Procedure TE-073, Equipment Decontamination

4.0 EQUIPMENT AND MATERIALS

4.1 EQUIPMENT

4.1.1 Peristaltic Pump

4.2 MATERIALS

4.2.1 Tygon™ tubing
4.2.2 Silicone tubing
4.2.3 Stainless steel tubing weights
4.2.4 Tap water
4.2.5 Deionized water

APPROVALS		
Author		Date
Supervisor		Date
Group Leader	[illegible]	Date 8/4/93
Section Head	Craig Little	Date 8/6/93

5.0 RESPONSIBILITY

5.1 It is the responsibility of the peristaltic pump operator to follow this procedure and to ensure that the equipment is operated safely.

6.0 DEFINITIONS

6.1 **BGL:** below ground level

6.2 **Peristaltic pump**: a pump that creates suction by means of rollers turning about a central shaft on the pump head. The rollers squeeze a length of silicone tubing flat, creating suction behind them. The silicone tubing is connected to the sample tubing, which is lowered into the well. A peristaltic pump never needs to be primed and can pump shallow, slow-recharge wells to dryness. However, suction lift is limited to ~20 ft BGL, and the pumping rate is relatively slow. Also, suction degasses the water as it is pulled through the tubing, making this type of pump unsuitable for collecting volatile organic compound samples.

7.0 PROCEDURE

7.1 Connect Tygon tubing to silicone tubing at the pumphead.

7.1.1 Use larger diameter, thicker-walled tubing for purging.

7.1.2 Use smaller diameter tubing and slower flow rates for sampling.

7.2 Lower the intake end of the tubing to the appropriate depth in the well.

7.2.1 Attach a stainless steel tubing weight to the end of the tube to eliminate the tube curling.

7.3 Connect the outlet end of the tubing to the in-line filter, flow-through cell, or other discharge.

7.3.1 If the pump is connected to a filter system, decrease the flow rate at this point to avoid leaks .

7.4 Decontaminate the tubing and filter holders after use.

7.4.1 Wash with detergent tap water.

7.4.2 Rinse with tap water and deionized water.

7.4.3 Dedicate sample tubing to each well.

7.5 Decontaminate the exterior surface of non-dedicated tubing according to procedure TE-073.

7.6 Replace silicone tubing when necessary.

7.6.1 If tubing begins to leak due to sand or sediment forced into the tubing, replace with a new piece according to manufacturer's instructions.

7.6.2 Replace tubing if highly contaminated water is pumped through it.

BLADDER PUMP OPERATION

1.0 PURPOSE

This procedure describes the use of the ISCO Series 3600 bladder pump. For more information, refer to the manufacturer's manual.

2.0 DEFINITIONS

2.1 psig: pounds per square inch gauge

3.0 DISCUSSION

The bladder pump operates by alternately inflating and deflating a Teflon covered elastomeric silicone bladder, which pushes against the pump body and, displaces water upward through a ball check valve and into the sample line. Since the sample water contacts only Teflon and stainless steel, and is pushed through the tubing rather than pulled, this type of pump is suitable for collecting volatile organics (provided Teflon tubing is used for the sample line). The bladder pump operates at a maximum depth of ~150 ft; maximum flow rate varies from 1.7 to 3.7 L/min, depending on depth.

Disadvantages to this type of pump are that the well water must be free of sediment, especially of angular particulates which tear the Teflon outer bladder, and the pump must be fully submerged in order for the bladder to effectively push water upward. Also, the ISCO 3600 pump cannot be used for well purging or development, as extended bladder cycling tears the Teflon.

4.0 PROCEDURES (ISCO SERIES 3600 WELL SAMPLING SYSTEM)

4.1 Connect the Teflon air line and the Teflon sample line to the controller and pump. Connect the stainless steel cable to the pump. The operator's manual should be consulted for tubing requirements. While lowering the pump into the well, make certain that the Teflon lines are lowered at the same rate as the cable to prevent the lines from becoming kinked at the top of the pump.

Approved by:

9/19/90 (Date)

C.A. Little 9/19/90 (Date)

4.2 Air can be supplied by either a portable compressor or a tank of compressed air or nitrogen. However, take care to regulate all gas supplies to a pressure no greater than 115 pounds per square inch gauge (psig). For limited sampling, scuba tanks of compressed air provide a lightweight gas supply.

4.3 Control the flow rate by adjusting both the air inlet pressure and the sample volume switch on the controller. Longer, smoother pulses can be obtained by rotating the Off/On/Sample Volume switch clockwise (to increase). Achieve short, rapid surges and maximum pumping rate by turning the switch counterclockwise (to decrease). The Isco operator's manual states that the pump will operate from ~20 to 115 psig. However, to prolong the life of the Teflon outer bladder, keep the gas supply pressure at a minimum. Isco offers the following guidelines for determining gas supply pressure:

4.3.1 for pumping from depths <50 ft, use 50 psig; and

4.3.2 for pumping from depths >50 ft, use the formula $P = 0.6H + 20$, where: P = the gas supply pressure, in psig; and H = the lift head, from the pump inlet to the ground surface, in feet. For example, the minimum required gas pressure for a pump lift head of 80 ft is $0.6 \times 80 + 20 = 68$ psig.

4.4 To minimize turbulence and aeration of the pumped water, decrease the gas pressure until a satisfactory flow rate is obtained. It may be necessary to increase the Off/On/Sample Volume switch to maintain sample volume. Extremely low turbulence can be achieved by rotating the Off/On/Sample Volume switch to off, then pressing the Manual Sample button while slowly increasing the gas pressure as a trickle of water comes out of the sample tube. When the sample is obtained, release the Manual Sample button. If more sample is needed, repeat the above procedure by first returning the pressure to zero.

4.5 When retrieving the pump from the well, again make certain that the Teflon tubes are withdrawn at the same rate as the cable.

4.6 Disassemble the pump and decontaminate according to TE-073.

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WELL DEVELOPMENT PUMP OPERATION

1.0 PURPOSE

This procedure describes the use of the Well Wizard Model HR4105D well development pump with Model 350 controller. For more information, refer to the manufacturer's manual.

2.0 OTHER DOCUMENTS

2.1 ASSOCIATED PROCEDURES

2.1.1 TE-073 Equipment Decontamination;

2.1.2 TE-111 Well Development.

3.0 DISCUSSION

The well development pump is similar in principle to the bladder pump, except that gas is used to displace the water in the pump body. The pump controller alternately pressurizes, then vents the air supply line into the pump. Because the pump and tubing are not made from inert materials and turbulence is created by the air surges, this pump is unsuitable for sampling. Maximum pumping depth is 150 ft at a maximum rate of ~0.6 gal/min. At shallower depths it is possible to pump up to ~5 gal/min.

4.0 PROCEDURE

4.1 WELL PURGING AND DEVELOPING

4.1.1 Using the female end of the coupling supplied, attach the red compressed gas source hose to the long quick-connect nipple labeled "Pump Pressure Inlet" on the face of the controller, located in the upper right hand corner of the controller panel. Install the other end of this hose (a male 1/4 in. pipe thread fitting) in the air-cylinder regulator or air compressor.

Approved by:

9/19/90 (Date)

Craig Little 9/19/90
C.A. Little (Date)

4.1.2 Connect either end of the red controller air hose to the short brass quick-connect nipple labeled "Pump Supply," located on the lower right hand side of the controller panel. Connect the other end of the controller air hose to the same type of quick-connect nipple located on the hose reel or the pump air hose.

4.1.3 To begin operating the pump, turn on the supply of compressed gas connected to the controller. Set pressure to 80 to 100 psig. If, after 10 to 15 s, the controller has not begun cycling, briefly push down the battery test button located in the middle of the controller panel. After 5 to 15 pumping cycles, full water flow from the sample supply tube should begin.

4.1.4 The refill and discharge control knobs, which control cycle times, are located on the controller panel just to the left of the pump supply quick-connect. They should be set in a 12 o'clock position for average well depths and average pump submergence (depths of 50 to 75 ft, submergence of 20 to 30 ft). To optimize pumping efficiency for a specific well depth, use the following three-step procedure:

a. Adjust the refill and discharge cycles to 10 to 15 s each. Measure the water volume discharged in a single discharge cycle.

b. Shorten the discharge cycle period (by adjusting the knob counterclockwise) until the end of the discharge cycle just begins to coincide with the end of water flow from the pump outlet.

c. Shorten the refill cycle period until the water volume per discharge cycle decreases 10 to 25% from the maximum value measured in step a.

4.1.5 To reduce water flow rate, decrease the pump supply pressure by turning the yellow knob labeled "Flow Throttle" counterclockwise. This knob is located at the lower left of the controller panel. When the pump supply pressure is decreased, increase the discharge cycle time to allow the full pump volume to exit the discharge tube.

4.2 OPERATING GUIDELINES

4.2.1 Deeper wells require both the refill and discharge cycles to be lengthened by turning the control knobs clockwise.

4.2.2 During the <u>discharge cycle</u>, apply the compressed gas source to the sample pump to discharge water. During the <u>refill cycle</u> vent the pump to atmosphere at the controller and allow the pump to refill.

4.2.3 When the water discharge flow rate decreases with the flow throttle, it is often necessary to increase the discharge cycle time to deliver a full pump volume.

4.2.4 The volume of water pumped per cycle should be approximately 250 to 350 mL. If the volume is below this level, recheck the cycle lengths according to the 3-step procedure outlined in step 5 above. If the volume is still unsatisfactory, check all air and water fittings for leaks.

4.2.5 When pumping deeper wells (>100 ft), the weight of the water line with water can cause the hose to separate at its connections. Reinforce the connections in order to avoid losing the pump in the hole.

4.3 FLOW THROTTLE GUIDELINES

4.3.1 Turning the yellow throttle-control knob clockwise increases both the pressure supplied to the pump and the flow rate.

4.3.2 Turning the yellow throttle-control knob counter-clockwise decreases both the pressure supplied to the pump and the flow rate.

4.3.3 The yellow throttle-control knob locks into place when pushed down; in this position it cannot be rotated. To rotate the knob, pull it up.

4.3.4 The pressure gauge on the controller shows the pressure applied to the sample pump. During the discharge cycle the gauge will indicate that pressure is being applied to the pump; during the refill cycle the gauge will fall to zero as the pressure is vented through the controller.

4.4 BATTERY GUIDELINES

4.4.1 Alkaline batteries are recommended.

4.4.2 As controller operating temperatures drop below 40 to 50°F, battery life decreases.

4.4.3 A continuous green battery life indicator light signal while the battery test button is depressed indicates fresh batteries.

4.4.4 A split-second flash of green on the battery life indicator light or a dead light while the battery test button is depressed indicates batteries need replacement.

4.4.5 The battery test button is also used to "start the controller" when a sampling session is just beginning. See controller operation section.

COMBUSTIBLE GAS INDICATOR (CGI) OPERATION

1.0 PURPOSE

This procedure describes the operation of the combustible gas indicator (CGI), GasTech Model GX-86, used in the field to monitor for combustible gases, oxygen level, hydrogen sulfide, and carbon monoxide. For more detailed information, refer to the manufacturer's instruction manual.

2.0 APPLICABILITY

This procedure applies to the operation of the GasTech Model GX-86 CGI.

3.0 OTHER DOCUMENTS

3.1 REFERENCES

3.1.1 *Instruction Manual: GasTech Personal Four-Way Alarm, Model GX-86, for Simultaneous Detection of Combustibles, Oxygen, Hydrogen Sulfide, and Carbon Monoxide*, GasTech Inc., Newark, Calif.

3.2 APPENDICES

3.2.1 Appendix 1: Air Quality Monitoring Record

4.0 EQUIPMENT AND MATERIALS

4.1 EQUIPMENT

4.1.1 GasTech Model GX-86 combustible gas indicator
4.1.2 Field pack for carrying instrument

APPROVALS		
Author		Date
Supervisor		Date
Group Leader	[illegible]	Date 8/4/93
Section Head	Craig Little	Date 8/6/93

4.2 MATERIALS

4.2.1 C-cell batteries
4.2.2 Air Quality Monitoring Record sheet

5.0 RESPONSIBILITY

5.1 Equipment personnel are responsible for checking the CGI instrument before shipping to the field site.

5.2 Field personnel are responsible for following this procedure when operating the CGI.

6.0 DEFINITIONS

6.1 CO: carbon monoxide; a poisonous gas detected by the CGI, which alarms at concentrations of 35 ppm or more

6.2 H_2S: hydrogen sulfide; a poisonous gas detected by the CGI, which alarms at concentrations of 10 ppm or more

7.0 PROCEDURE

7.1 Keep and use the CGI in its carrying case.

7.2 Press the ON switch and observe the following automatic preparatory sequence:

7.2.1 BATT. CK (MIN 2.3 V)

a. This is the minimum battery voltage that will operate the instrument.

7.2.2 BATT. (X.X V)

a. This is the actual battery voltage, for example 2.7 V.

b. If this reading is below 2.3 V, replace batteries.

c. New batteries should be good for approximately 8 hours.

7.2.3 SELF DIAGNOSIS

a. This indicates that an internal analysis of the readiness of the instrument is in process.

7.2.4 STAND BY

a. This indicates a pause during which circuits are reset.

7.2.5 00, 20.9, 00, 000

a. These are the ideal readings for the instrument and, along with a double tone, indicate that the start-up sequence is complete.

b. 00 = % combustible gas
20.9 = % oxygen
00 = hydrogen sulfide, ppm
000 = carbon monoxide, ppm

7.3 If the start-up readings deviate substantially from ideal, adjust the instrument.

7.3.1 Take the instrument to a fresh-air location where there is no exhaust from vehicles or machines, preferably out of doors.

7.3.2 Press the BATT/AIR switch for 3 seconds and then press the PEAK/AIR switch.

a. The instrument self-adjusts to the ideal readings shown above and retains these settings even after the instrument has been turned on and off repeatedly.

7.4 Check that operation is normal.

7.4.1 Breathe over the detector end of the instrument.

a. Oxygen reading should drop to about 18%; the buzzer sounds, and the red OXY alarm light flashes until the oxygen level returns to normal.

7.4.2 Combustibles response may be checked using a controlled source of vapor, such as a bottle of isopropyl alcohol.

a. Do not use machinery exhaust since this may saturate the CO detector.

7.5 The following are standard settings and alarms for the instrument:

7.5.1 Combustibles: 10% and 50%

a. above 20%, buzzer and COMB alarm light pulse.

b. above 50%, buzzer and COMB light become steady.

c. 10% is considered the lower explosive limit, LEL.

7.5.2 Oxygen: 19.5% and 25%

a. below 19.5%, buzzer sounds and OXY alarm light pulses.

b. above 25%, buzzer sounds continuously.

1. This indicates a potential fire hazard.

7.5.3 H_2S: 10 and 30 ppm

a. above 10 ppm, buzzer sounds long pulses and H_2S light flashes.

b. above 30 ppm, both buzzer and light are steady.

7.5.4 CO: 35 and 100 ppm

a. above 35 ppm, buzzer sounds long pulses and CO light flashes.

b. above 100 ppm, both buzzer and light are steady.

7.6 Battery voltage may be checked at any time during operation of instrument.

7.6.1 Press BATT/AIR momentarily and release.

a. A single tone is sounded.

b. The display shows battery voltage for 5 seconds and then reverts to standard operating reading.

7.6.2 2.2 V is the minimum operating voltage.

a. When voltage drops to 2.2 V, B flashes at the left end of the display.

b. At 2.1 V, the instrument goes to low battery condition.

1. The display shows LOW BATT.
2. The buzzer sounds continuously.

7.6.3 If battery voltage is below 2.2 V prior to turn on, the instrument will buzz erratically or will not start.

7.6.4 A new set of batteries reads approximately 3.0 V.

7.7 The instrument controls and indicators have the following meanings:

7.7.1 ON

a. Press to apply power to the instrument.

b. The instrument sounds a single tone.

c. This starts the automatic preparatory sequence.

7.7.2 OFF

a. This switch incorporates a time delay.

b. Apply pressure to the OFF pad for about 5 seconds continuously.

7.7.3 BATT/AIR

a. Press to display battery voltage.

b. The instrument sounds a single tone.

c. After 5 seconds, the normal display returns.

7.7.4 BATT/AIR and PEAK/AIR

a. Initiates automatic zero and span adjustment.

b. Press the BATT/AIR switch for 3 seconds.

c. Then, while pressing the BATT/AIR switch, press the PEAK/AIR switch.

7.7.5 DOSE

a. Press to display <u>accumulated</u> detections of H_2S and CO divided by the elapsed time.

1. Each exposure is added to all previous exposures.

b. The instrument sounds a single tone.

c. Accumulations and time are since the last time the instrument was turned on.

7.7.6 PEAK/AIR

a. Press to display the highest gas reading (lowest for oxygen) since the instrument was turned on.

b. The instrument sounds a single tone.

c. The letter P shows at the left indicating that the instrument is in HOLD mode.

d. The display is retained for 5 seconds.

7.8 Keep instrument away from the exhaust of the drill rig.

7.8.1 Vehicle exhaust adds erroneously to the DOSE readings.

7.8.2 Zero the instrument as described above when readings from vehicle exhaust are suspected.

7.9 Do not ship spare batteries with the instrument unless specifically packaged according to HAZMAT regulations and shipped at least 1 week before needed.

7.10 Record daily CGI readings and operational check information in the comments section of the Air Quality Monitoring Record (Appendix 1).

Appendix 1. Air Quality Monitoring Record

PAGE_____ OF _____

AIR QUALITY MONITORING RECORD

PROJECT_____ DATE _____ SAMPLE STATION_____
ON-SITE TIME-START _____ END _____ INSTRUMENT _____

AMBIENT WEATHER DATA
LAST CALIBRATION_____ BAROMETRIC PRESSURE_____ HUMIDITY_____
CONDITIONS (i.e., FOG, RAIN)_____ TEMPERATURE _____ °F
WIND SPEED/DIRECTION_____

PID MEASUREMENTS

TIME	TYPE & VALUE (ppm)				BORE HOLE DEPTH (FT)	TIME	TYPE & VALUE (ppm)				BORE HOLE DEPTH (FT)
	AA	BZ	BS	SS			AA	BZ	BS	SS	

AA = AMBIENT AIR
BZ = BREATHING ZONE
BS = BOREHOLE SPACE
SS = SOIL SAMPLE

COMMENTS_____

_____

SIGNATURE _____

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