

APPENDIX M

SAMPLING METHODS: A LIST OF SOURCES

M.1 Introduction

Planning activities associated with field survey work include developing new and compiling or adopting existing sampling methods. The following listing includes documents that represent examples for the types of information one encounters when searching for sampling methods. This listing initially presents references that appear with brief annotations that characterize the information found in each document.

Journal articles and books may list references that lead to still other types of useful information. Depending on survey needs, media being sampled, or site-specific requirements, one may follow these references to resources that describe other types of methods found in original papers or documents that appeared even as specific sampling techniques were first introduced.

The present listing is not exhaustive. Other titles or resources for sampling methods are available through online literature databases; Federal, State, and university libraries; the internet; and other sources.

M.2 List of Sources

Department of Energy (DOE). 1987. *The Environmental Survey Manual*. DOE/EH-0053, Vol. 1 of 4. DOE, Office of the Assistant Secretary for Environment, Safety, and Health, Office of Environmental Audit, Washington, D.C.

- *General Description of Document:* Size: Approximately 188 pages (single sided)—This is the first of a four volume set that amounts to over 4 ins. (total thickness) of documentation related to environmental surveys. The first volume represents the main document, with the remaining three volumes contain eleven appendices.
- *Key Features of This Document:* Unlike a number of other references listed here, this document *does* include information related to radionuclides and considers biota (animal, plant, and related sample types). Flow charts, checklists, planning diagrams, and figures help the reader to visualize a number of topics described in the text of all four volumes. Section 2 of this volume entertains topics related to a survey team's activities and survey reports. Section 3 considers the use of existing data, followed by technical checklists in Section 4 and health and safety issues described in Section 5.

Appendix M

A quick review of this first volume reveals a limited amount of depth to the information presented. There is little descriptive *How To Sample* information given here. However, as an overview, the document is quite comprehensive and this may encourage a survey team to consider obtaining additional information relevant to a particular project need.

Department of Energy (DOE). 1987. *The Environmental Survey Manual: Appendices A, B, and C*. DOE/EH-0053, Vol. 2 of 4. DOE, Office of the Assistant Secretary for Environment, Safety, and Health, Office of Environmental Audit, Washington, D.C.

- *General Description of Document:* Size: Approximately 188 pages (double sided)—This second volume contains three of eleven appendices.
- *Key Features of This Document:* The appendices include: A) Criteria for Data Evaluation, B) Checklists and Lines of Inquiry, and C) Health and Safety Plan for On-Site Survey Activities.

Department of Energy (DOE). 1987. *The Environmental Survey Manual: Appendix D*. DOE/EH-0053, Vol. 3 of 4. DOE, Office of the Assistant Secretary for Environment, Safety, and Health, Office of Environmental Audit, Washington, D.C.

- *General Description of Document:* Size: Approximately 438 pages (double sided)—This single volume is the largest part of the four part set and contains only one appendix: Appendix D - Analytical Methods.
- *Key Features of This Document:* The topics presented here have little to do with sample collection and are mostly concerned with the types of compounds or constituents within a sample. A radiological section covers a number of radionuclides that one may encounter in a number of sample matrices—including in water, air, soil, and sediments. Again, this is an appendix dedicated to sample analysis.

Department of Energy (DOE). 1987. *The Environmental Survey Manual: Appendices E, F, G, H, I, J, and K*. DOE/EH-0053, Vol. 4 of 4. DOE, Office of the Assistant Secretary for Environment, Safety, and Health, Office of Environmental Audit, Washington, D.C.

- *General Description of Document:* Size: Approximately 312 pages (double sided)—This fourth and final volume includes seven appendices.

- *Key Features of This Document:* Appendix E is entitled *Field Sampling Protocols and Guidance*—which offers a number of site scenarios to describe an approach to sampling under varied conditions. Each scenario is followed by a set of sampling procedures appropriate for a particular sample matrix. This appendix is 216 pages in length making this the largest part of Volume 4. Diagrams are included to illustrate scenarios and the appearance of sampling equipment.

The remaining appendices cover: F) guidelines for preparation of quality assurance plans, G) decontamination guidance, H) data management and analysis, I) sample and document management guidance, J) health and safety guidance for sampling and analysis teams, and K) documents for sampling and analysis program.

Department of Energy (DOE). 1991. *Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance*. DOE/EH-0173T, DOE, Assistant Secretary for Environment, Safety, and Health, Washington, D.C. (DE91-013607)

- *General Description of Document:* Size: approximately 90 pages— This guide covers a number of topics related to radiation and environmental surveillance.
- *Key Features of This Document:* To accomplish environmental surveillance, various sample types—from biotic (animal and plant) to abiotic (air, water, soil, *etc.*)—are considered in Chapter 5 (title: Environmental Surveillance). The basis for taking certain samples appears along with information on sample location and frequency. A brief statement on sampling methods completes each section but procedures or techniques are not given in detail. References to other guidance documents on sampling are cited. The reader is directed to other sources to obtain additional regulatory information or descriptions of specific procedures.

Chapter 6 provides information on laboratory procedures. Other chapters cover: liquid effluent monitoring, airborne effluent monitoring, meteorological monitoring, data analysis and statistical treatment, dose calculations, records and reports, quality assurance (QA), and reports.

Department of Energy (DOE). 1994. *Decommissioning Handbook*. DOE/EM-0142P. DOE, Office of Environmental Restoration, Germantown, MD

- *General Description of Document:* Size: Approximately 312 pages—The manual is essentially written for those involved in decommissioning a nuclear power facility. While not specifically focused on radiation sampling methods, this document may play a role in

identifying activities or sampling needs related to survey work before or during remediation at some Federal facilities.

- *Key Features of This Document:* Chapter 6 presents information on final project configuration based on planning and as such speaks of site boundaries. Chapter 7 presents topics related to characterization including on-site measurements.

This document includes discussion and illustrations of robotic devices used in sampling operations. Perhaps only appropriate in extreme situations, the use of a robot for obtaining a sample may apply where radiation levels are high, dust or air quality pose problems, or where technical staff cannot physically reach a sample location due to structural limitations.

Environmental Protection Agency (EPA). 1980. *Samplers and Sampling Procedures for Hazardous Waste Streams*. EPA-600/2-80-018, EPA, Municipal Environmental Research Laboratory, Cincinnati, OH.

- *General Description of Document:* Size: 67 pages—the procedures listed here cover different types of media and include helpful diagrams of sampling devices.
- *Key Features of This Document:* While not specifically geared to radioactive samples, this short manual outlines and presents information in a logical sequence—starting with descriptions of sampling devices, followed by discussion of selecting an appropriate device for various media (including samples taken from various sources; *e.g.*, drum, barrel, waste pile), container types, labels, seals, use of a log book, chain of custody, sample receipt and logging, preservation and storage of samples, and references. The document includes five appendices, covering development of the composite liquid waste sampler, parts for constructing the sampler, checklist of items required in the field for sampling hazardous waste, random sampling, and systematic errors in using the composite liquid waste sampler.

Environmental Protection Agency (EPA). 1982. *Test Methods For Evaluating Solid Waste, Physical / Chemical Methods, 2nd Edition*. EPA, Office of Solid Waste, Washington, D.C. (PB87-120291)

- *General Description of Document:* Size: Approximately 375 pages—composed of chapters and methods that update the first edition of this volume.

- *Key Features of This Document:* Chapter 1 of this manual pulls together information from the first three chapters of the first edition. This includes a Sampling Methodology section that addresses statistics, sampling strategies and examples, implementing a sampling plan, plus tables and figures of sampling devices, *etc.* The main focus is on solid waste including metals and organics. Methods are described with the same format as indicated above in reference 1. As above, the methods include some information relevant to the field component of sampling work, but the remainder of each method essentially is most useful to laboratory personnel.

Environmental Protection Agency (EPA). 1982. *Handbook for Sampling and Sample Preservation of Water and Wastewater*. EPA-600/4-82-029, EPA, Environmental Monitoring and Support Laboratory, Cincinnati, OH. (PB83-124503)

- *General Description of Document:* Size: Approximately 500 pages—composed of information specifically focused on sample collection and preservation. While the document concerns only water sampling, this volume is comprehensive and even includes a chapter on *Sampling Radioactive Materials*.
- *Key Features of This Document:* The handbook is geared to address sampling issues. The scope of the document covers all types or sources of water, including: municipal, industrial, surface, agricultural, ground, and drinking waters. Types of samples are defined and discussed, including grab and composite samples. Diagrams, tables, and forms are provided to illustrate key points raised in the text. Statistical methods and related tables are provided. Each topic is accompanied by references. The chapter on radioactive samples is brief but touches on: background, radioactive decay, detection capability, frequency of sampling, sampling location, sample volume, containers, filtration, preservation, general procedures, radiation safety, and references.

Environmental Protection Agency (EPA). 1984. *Soil Sampling Quality Assurance User's Guide*. EPA 600/4-84-043, EPA, Environmental Monitoring Systems Laboratory, Office of Research and Development, Las Vegas, NV.

- *General Description of Document:* Size: 102 pages—The introduction to this document starts with: “An adequate quality assurance/quality control (QA/QC) program requires the identification and quantification of all sources of error associated with each step of a monitoring program so that the resulting data will be of known quality. the components of error, or variance, include those associated with sampling, sample preparation, extraction, analysis, and residual error.”

- *Key Features of This Document:* Because of potential inhomogeneity in soil samples, the authors state this QA/QC document is specifically concerned with soil sampling. The general outline of the document includes: objectives of QA/QC, statistics, exploratory studies, sample number and sample sites, sample collection, sample handling and documentation, analysis and interpretation of QA/QC data, and systems audits and training. References are provided followed by two appendices covering sample number precision and confidence plus tables for use in calculating confidence tolerance limits and judging validity of measurements.

The sample collection chapter is very brief and does not specifically outline methods or types of equipment. This and the following chapter on sample handling and documentation mention relevant topics in light of QA/QC.

Environmental Protection Agency (EPA). 1986. *Engineering Support Branch Standard Operating Procedures and Quality Assurance Manual*. EPA, Region IV, Environmental Services Division, Athens, GA. (Sections 3 to 5 reviewed)

- *General Description of Document:* Size: approximately 90 pages (single sided)—The introduction states: “The objectives of this section are to present the Branch standard operating procedures for sample identification, sample control and chain of custody, maintenance of field records, and document control.
- *Key Features of This Document:* The basic format of the document is that of a compendium of standard operating procedures bound in one volume. Each Standard Operating Procedure (SOP) is several pages and is dedicated to a specific topic. A five page outline pertaining to sampling procedures presents a brief overview that is a relatively typical treatment of this topic. Sample preservation, for example, is summarized with five bullet points. The next section offers a three page listing of definitions covering grab, composite, split, duplicate, reference or control, and background samples, plus a very brief definition for sample aliquot.

The document lacks figures but does include descriptive notes for equipment and methods related to taking samples of waste water, surface water (fresh and salt water), ground water, potable water supply, soil, samples from landfills and hazardous waste sites, followed by references. The last part of the guide include information on making flow measurements.

The document does not appear to focus on radioactive materials, but as with other documents the information can in part be used in conjunction with obtaining radioactive samples.

Environmental Protection Agency (EPA). 1987. *A Compendium of Superfund Field Operations Methods*. EPA/540/P-87/001, EPA, Office of Emergency and Remedial Response, Washington, D.C.

- *General Description of Document:* Size: Approximately 375 pages—the size and title of this document is a clue to the comprehensive nature of this volume. In brief, the text of this document provides a potentially valuable resource to field workers involved with Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) surveys. While relatively complete—in that the document covers a broad range of topics—some readers may desire additional depth to the information provided here. Conversely, planners and field personnel might gain added insight by considering the broad range of topics included here before approaching the survey process.
- *Key Features of This Document:* Perhaps the best summary of this compendium is provided by a listing of sections, as follows: 1) Use of the Compendium, 2) Preparation of Project Description and Statement of Objectives, 3) Implementing Field Objectives, 4) Sample Control, Including Chain of Custody, 5) Laboratory Interface, 6) Sample Containers, Preservation, and Shipping, 7) Field Methods for Screening Hazardous Material, 8) Earth Sciences (*i.e.*, drilling, excavations, reconnaissance, geophysics, and ground water), 9) Earth Sciences Laboratory Procedures, 10) Surface Hydrology, 11) Meteorology and Air Quality, 12) Specialized Sampling Techniques (*e.g.*, wipes, human habitation sampling, TCDD, and container sampling), 14) Land Surveying, Aerial Photography, and Mapping, 15) Field Instrumentation (a comprehensive treatment including radiation monitors), 16) data handling, 17) Document Control, 18) Corrective Action, 19) QA Audit Procedures, and 20) QA Reporting.

That this document serves objectives set forth by Superfund—and is not specifically focused on radionuclide sampling—in no way diminishes the importance of the compendium's complete overview of field sampling equipment and activities.

Environmental Protection Agency (EPA). 1989. *Test Methods For Evaluating Solid Waste Physical / Chemical Methods - Third Edition Proposed Update Package*. EPA, Office of Solid Waste, Washington, D.C. (PB89-148076)

- *General Description of Document:* Size Approximately 500 pages—composed of several updated chapters and 46 methods that are described by text and graphics. Only methods that are updated from 2nd Edition appear in this volume.

- *Key Features of This Document:* Chapters 1, 2, 4, and 7 describe QC, Choosing the Correct Procedure, Organic Analytes, and Regulatory Definitions, respectively. Of primary interest are the 46 methods that are described in what constitutes the bulk of this document. However, as is evident from some of the first methods listed for organics, sample collection techniques are only briefly touched on by a section of Chapter Four. This essentially makes the methods laboratory oriented protocols and the only reference to field methods appears in the text of a short chapter as opposed to part of each method. Some methods do list *Sample Collection, Preservation, and Handling* information with emphasis on use of containers, acidification or refrigeration, or a brief set of points to consider when preparing to go out to the field.

Each method includes a method number and a title, plus the following information:

1) Scope and Application, 2) Summary of Method, 3) Interferences, 4) Apparatus and Materials, 5) Reagents, 6) Sample Collection, Preservation, and Handling, 7) Procedure, 8) QC, 9) Method Performance, and 10) References. Diagrams, flow charts, and tables follow the initial sequence of sections.

The listing of methods include Method 9320 for Radium-228, Method 9310 for Gross Alpha & Gross Beta, and Method 9315 for Alpha-Emitting Radium Isotopes. These methods do not appear in the bound volume used for this review and thus no further comment is offered here.

Environmental Protection Agency (EPA). 1991. *Compendium of ERT Surface Water and Sediment Sampling Procedures*. OSWER Directive 9360.4-03, EPA, Office of Emergency and Remedial Response, Washington, D.C. (PB91-921274)

- *General Description of Document:* Size: 31 pages—this document includes three standard operating procedures (SOPs), the first of which is the same as the first SOP listed in the document described below.
- *Key Features of This Document:* The three SOPs included in this document include: 1) Sampling Equipment Decontamination, 2) Surface Water Sampling, and 3) Sediment Sampling. Each SOP is similar in content with sections that cover: scope, method summary, preservation, containers, equipment, apparatus, *etc.*

Environmental Protection Agency (EPA). 1991. *Compendium of ERT Ground water Sampling Procedures*. OSWER Directive 9360.4-06, EPA, Office of Emergency and Remedial Response, Washington, D.C. (PB91-921275)

- *General Description of Document:* Size: 71 pages—this document embodies eight standard operating procedures (SOPs) with a similar format as that described above.
- *Key Features of This Document:* The SOPs covered in this document include sampling equipment decontamination, ground water well sampling, soil gas samples, installing monitor wells, water level measurements, and other topics related to ground water and wells.

Environmental Protection Agency (EPA). 1991. *Compendium of ERT Soil Sampling and Surface Geophysics Procedures*. OSWER Directive 9360.4-02, EPA, Office of Emergency and Remedial Response, Washington, D.C. (PB91-921273)

- *General Description of Document:* Size: 39 pages—this document lists four standard operating procedures (SOPs) for soil sampling—with a similar format as that described above.
- *Key Features of This Document:* The SOPs covered in this document include sampling equipment decontamination, soil sampling, soil gas sampling, and soil sampling and surface geophysics. The SOP for soil sampling is five pages in length. This treatment essentially covers samples collected from the soil surface, to use of augers and tube samplers, a trier, split-spoon (barrel) sampler, and excavation techniques.

Environmental Protection Agency (EPA). 1991. *Environmental Compliance Branch Standard Operating Procedures and Quality Assurance Manual*. EPA, Region IV, Environmental Services Division, Athens, GA.

- *General Description of Document:* Size: Approximately 500 pages (single sided)—This document is presented with seven sections and eleven appendices. The main sections cover standard operating polices and procedures which relates to the Region IV laboratory's administrative functions to SOPs that are specifically focused on sampling activities.
- *Key Features of This Document:* Sections 3 and 4 are of primary importance when thinking of sample control, field record keeping, document control and sampling procedures. Section 4 on sampling procedures is descriptive—without diagrams or figures—and quite comprehensive in that this section touches on a multitude of topics not mentioned in a number of other guides, including: selection of parameters to be measured, holding time, cross contamination, and Data Quality Objectives (DQOs) (described as Level I to V). The sampling of soil, water, and air are covered in this

section with many of the subsections covering topics that are common to other documents reviewed here. A number of example forms are presented, including several that relate to State programs. Section 6 covers field analytical methods and Section 7 describes field physical measurements.

The appendices include helpful information relevant to sampling, including: A) sample containers, preservation, holding times, and permissible sample type, B) standard cleaning procedures, C) shipping procedures, D) standard field analytical methods, E) monitoring wells, F) pump operation procedures, G) air monitoring, H) wastewater field methods, I) saturation monitoring, and K) safety protocols.

Environmental Protection Agency (EPA). 1992. *Characterizing Heterogeneous Waste: Methods and Recommendations*. EPA/600/R92/033, EPA, Environmental Monitoring Systems Laboratory, Office of Research and Development, Las Vegas, NV. (PB92-216894)

- *General Description of Document:* Size: 144 pages—the focus of this document is on all types of waste materials that one might encounter. The base scenario appears to be one where a drum is encountered and the objective is to work to a point when the drum contents are understood. Because a drum may include more than one type of waste, this document provides a review of a wide variety of materials one might expect when surveying a site.
- *Key Features of This Document:* The table of contents reveals that the text attempts to provide a complete picture, from definitions of terms, to planning studies, QA/QC and data assessment, to sample acquisition, and steps that follow to the lab and what makes the characterization process a success. Radioactive waste materials, along with organics, solids, liquids, *etc.*, are covered, but in a relatively brief fashion. The model scenario of dealing with wastes in a drum is incorporated into a hypothetical example in an appendix.

Environmental Protection Agency (EPA). 1992. *Preparation of Soil Sampling Protocols: Sampling Techniques and Strategies*. EPA/600/R92/128, EPA, Office of Research and Development, Washington, DC. (PB92-220532)

- *General Description of Document:* Size: 174 pages—this document summarizes various statistical and geostatistical concepts and procedures pertaining to the design, implementation, and data interpretation of appropriate sampling designs.
- *Key Features of This Document:* This document focuses on applying the concept of the Data Life Cycle to soil sampling. The document describes statistical concepts that apply to soil sampling, including particulate sampling theory. Types of samples, numbers of samples, and size of samples as well as methods for sampling soils from conveyor belts and stockpiles are also discussed. A bibliography is provided.