Chapter 1
The Sampling Plan

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1.1 Introduction

There are a wide variety of reasons for collecting samples, and various sampling strategies will be needed for different situations. It is important that the purpose of the sampling and its associated data quality objectives be identified before fieldwork begins. For example, samples may be collected to determine: 1) the existence and/or extent of contamination at a site; 2) waste characterization and classification for disposal or recovery; and 3) compliance with existing regulations. Once the objective of the sampling is known, decisions about analytical parameter selection, NJ certified laboratory selection, quality control samples, sample location and frequency, etc. can be made more confidently. In sampling to assess permit compliance, some of these selections may have been mandated by the NJDEP. Here, the permit applicant has the responsibility of ensuring that any proposed requirements will be achievable. Defining sampling and data quality objectives is important to ensure that the sampling plan is complete. Environmental sampling is often conducted to gather data that will be the basis for remedial or regulatory decisions. Because of the potential threat to health and the environment, and high costs usually associated with site remediation, strict adherence to quality assurance measures are strongly recommended. The objective of the sampling helps to dictate what should be prescribed in the sampling plan.

An integral part of any sampling program is planning. Before a plan can be written, site-specific information must be gathered to ensure that the plan is logical, will meet the required objectives, and the course of action is achievable.

The purpose of developing a sampling plan is to detail a "plan of action." The person writing the plan should be very familiar with the site-specific conditions, and those implementing the plan should be very familiar with the plan's contents. A properly prepared sampling plan that is correctly implemented will allow the sampling objectives to be met, help avoid confusion in the field, preserve health and safety, and ultimately save time and money.

The NJDEP maintains a library of guidance documents on its website at https://www.nj.gov/dep/srp/guidance/. It is recommended the reader access the website and review the guidance documents pertinent to the respective task. Examples of some of the relevant guidance documents pertaining to this chapter are:

Soil Investigation Technical Guidance: https://www.nj.gov/dep/srp/guidance/#si_ri_ra_soils;

Ground Water Technical Guidance: https://www.nj.gov/dep/srp/guidance/#pa_si_ri_gw;

Ecological Evaluation Technical Guidance: https://www.nj.gov/dep/srp/guidance/#eco_eval; and

Vapor Intrusion Technical Guidance: https://www.nj.gov/dep/srp/guidance/#vi.

The following documents are available at: https://www.nj.gov/dep/srp/guidance/#analytic_methods.

- Quality Assurance Project Plan Technical Guidance
- Data Quality Assessment and Data Usability Evaluation Technical Guidance
- Data of Known Quality Protocols Technical Guidance

Additional guidance may also be found at websites of Occupational Safety and Health Administration (OSHA), United States Environmental Protection Agency (USEPA), and the American Society for Testing and Materials (ASTM).

OSHA: https://www.osha.gov

USEPA: https://www.epa.gov/hw-sw846/sampling-guidance-documents-sw-846-compendium

USEPA Guidance Documents: https://www.epa.gov/guidance

ASTM: https://www.astm.org/

1.2 The Triad Approach

The New Jersey Department of Environmental Protection is committed to streamlining the site investigation and remediation process at contaminated sites without compromising data quality and reliability. This goal can sometimes be better achieved by implementing the Triad approach, a process that integrates systematic planning, dynamic work plans, and real-time measurements to achieve more reliable, timely and cost-effective site characterization and cleanup. The Triad approach seeks to recognize and manage the uncertainties involved in generating representative data from heterogeneous environmental matrices. The NJDEP supports and encourages the use of the Triad approach for sites undergoing investigation and remediation within the Site Remediation and Waste Management Program. The NJDEP has evaluated the Technical Requirements for Site Remediation, N.J.A.C. 7:26E, in the context of Triad approach, and has determined that the concepts embodied in Triad approach can be implemented within the framework of the rules. More information and details on the Triad approach may be found at https://triadcentral.clu-in.org/ and https://itrcweb.org/GuidanceDocuments/SCM-3.pdf.

1.3 Site History – Evaluating Existing Data/File Information

The first step in a site investigation should be the gathering of background information. The NJDEP has provided guidance on the collection and evaluation of site historical information in the Preliminary Assessment (PA) Technical Guidance, https://www.nj.gov/dep/srp/guidance/#pa_guide. Per the PA Guidance, the purpose is to provide the investigator with a list of resources and framework on how to use the resources to conduct a preliminary assessment. This assessment must meet the diligent inquiry requirements of the Technical Requirements for Site Remediation (Technical Regulations) at N.J.A.C. 7:26E-3.1 and 3.2 to determine if there may be any potentially contaminated areas of concern that require further investigation. A Preliminary Assessment Data Gathering Checklist is included in Appendix B of the Guidance to provide the investigator with a list of potential areas of concern to consider in the historical evaluation.

Data from the DEP's Geographic Information System (GIS) are a valuable resource that can provide additional background information to investigators, enabling the ability to analyze mapped datasets on computer. GIS datasets relevant to the history of activity at a site include statewide land use, soils, geology, and digital aerial orthophotography. Visit the NJDEP GIS website for more information and data downloads at http://www.state.nj.us/dep/gis and the New Jersey Spatial Data Clearinghouse at https://gisdata-njdep.opendata.arcgis.com/. The data can also be viewed online at https://www.state.nj.us/dep/gis/.

By revealing what materials were/are handled on site, a file search may provide guidance in choosing which parameters to include for analysis. A good source for this information are the hazardous waste manifests for the site. The hazardous waste codes will give clues as to what materials were handled at the site. An example would be F001 waste, which is classified as chlorinated solvents. Additionally, while caution must still be used, judgments regarding health and safety requirements can be made. When no information is available, field personnel should consider that worst case conditions may exist and take proper precautions to ensure safety.

Below is a list of potential sources of historical information. This list is not required or meant to be exhaustive.

U.S. Government

U.S. Department of Justice
U.S. Geological Survey
U.S. DOA - Soil Conservation Service
U.S. DOA - Forest Service
U.S. DOI - Fish and Wildlife Agencies
U.S. Army Corps of Engineers
U.S. Nuclear Regulatory Commission
Federal Emergency Management Agency
National Oceanic and Atmospheric Administration
U.S. Environmental Protection Agency

State of New Jersey

NJ State Library
NJ State Attorney General Office
NJ Geological and Water Survey
NJ Department of Transportation
NJ Department of Agriculture
NJ Department of Health
NJ Department of Environmental Protection
- Site Remediation and Waste Management Program GeoWeb application
- Site Remediation and Waste Management Program file reviews via the Open Public Records Act (OPRA)
- Watershed Restoration
- Division of Water Quality
- Regional Enforcement (Northern, Central and Southern)
- Bureau of Freshwater and Biological Monitoring (see 305b report, STORET)
- Bureau of Case Management
- Bureau of Site Management
- Division of Air Quality
- Bureau of Emergency Response
- Bureau of Environmental Evaluation and Risk Assessment
- Bureau of Environmental Measurements and Site Assessment
- Environmental Research Library Bureau of Geographic Information and Analysis
- (Digital aerial orthophotography and other GIS data sets) at http://www.state.nj.us/dep/gis and https://gisdata-njdep.opendata.arcgis.com/
- Coastal Management Program (Hard copy historical aerial photography)
- Radiation Protection Element
- Bureau of Pesticide Compliance
- Office of Community Relations
- Office of Brownfield Reuse

County Government

County Health Department
County Planning Board
County Library

Local Government

Local Health Department
Tax Assessors Office
Economic Development Officer
Environmental Commission
Local Planning Board
Town Engineer
Local Chamber of Commerce
Local Airport
Local Library
Local Well Drillers
Local Historical Society

Other Sources

Facility Records
Employee Records
Citizens residing nearby
Local and regional waste haulers and generators
New Jersey Environmental Digital Library (http://njedl.rutgers.edu)
Sanborn Fire Insurance Maps available at Princeton University Library
(https://library.princeton.edu/libraries/firestone/rbsc/aids/sanborn/sanborn-web.htm
Non-profit environmental organizations (e.g., nature conservancies, watershed associations etc.)

1.4 Defining the Physical Environment

Equal in importance to finding out what may have occurred on-site historically, and what may be taking place on-site currently, is determining where possible releases are most likely to be found (i.e., where did things actually take place). A pre-sampling site visit should be conducted to gather additional background information. The PA Guidance provides additional information on the site inspection. Labels and DOT numbers on drums and tanks may be useful. Files found on-site may include information about materials that were manufactured, stored, or disposed of on-site. Product names may be determined from shipping labels or manifests. Any and all information will be useful in sampling plan preparation, and in formulating a site-specific Health and Safety Plan (see Chapter 4, *Site Entry Activities*).

The fate of environmental contaminants is dictated by the source, the characteristics of the contaminant itself, (i.e., persistency and toxicity) and perhaps most importantly, by the physical environmental system into which it is released. Contaminants move at varying rates and to varying degrees when released into different kinds of matrices. It is extremely important to the success of achieving the sampling objectives to determine what kind of environmental system the site encompasses. An investigation into the local geology, hydrology (including flow rates of nearby surface waters, average depth to ground water and ground water flow direction, identification of areas of recharge, etc.), and climatology is necessary. The biological system should also be assessed. The flora and fauna of the area (including identification of sensitive environments and/or species, stressed vegetation, potential for bioaccumulation and biotransformation in the plant and animal life, especially agricultural) are definite factors to be taken into account. Stressed vegetation may serve as an indicator for contaminant migration to a particular area. A GIS system and GIS data can assist investigators in defining both the environmental and biological systems. Specific NJ based GIS data is available for download at http://www.state.nj.us/dep/gis and https://gisdata-njdep.opendata.arcgis.com/. These data elements include Coastal Area Facility Review Act (CAFRA) boundary, Pinelands boundary, soil

type, hydrography, land use, wetland delineation, surface contours and more. The data can also be viewed online at https://www.state.nj.us/dep/gis/. Defining the physical environment of the site will help in determining the fate of the contaminants. Migration pathways should also be identified, assuring that samples will be collected in the most appropriate area.

The factors addressed above offer an overview of considerations that should be evaluated for a sampling plan to be complete. The more information that is obtained, the more that will be known about the source, movement, and concentrations of contaminants in the media to be sampled. With this knowledge, it will be easier to develop a complete site-specific, sampling plan.

Along with the historical and physical information needed prior to sampling plan development, the following topical areas of basic information are necessary components for an inclusive sampling plan.

1.5 Sample Locations and Numbers

When choosing the location of sampling points, the objective of the sampling event is important. A field sampling approach should be based on information gathered about the site and/or areas of concern. Information may be gathered as part of the Preliminary Assessment and/or due diligence phase. The investigator should conduct data gathering in accordance with the Preliminary Assessment Technical Guidance; especially when applicable for a site (i.e., Industrial Site Recovery Act (ISRA)). Based on the information gathered about a site and/or area of concern, samples are then collected. Sample locations should be biased to characterize suspected or known areas of contamination. However, for sites where limited background information is available, and/or obvious contaminated areas do not exist, a random sampling scheme may be useful. Random sampling depends on the theory of random chance probabilities to choose the most representative sample. This process is utilized when there are numerous available sampling locations and there are no satisfactory reasons for choosing one location over another (i.e., bias). The investigator should develop a field sampling approach as noted in the Technical Guidance for Site Investigation of Soil, Remedial Investigation of Soil, and Remedial Action Verification Sampling for Soil. Subsequent investigations and sampling of groundwater should be biased based on any previous soil sampling results (i.e., biased toward areas of soil contamination), and follow the Ground Water Technical Guidance: Site Investigation, Remedial Investigation, Remedial Action Performance Monitoring. For guidance on sample locations and numbers for Ecological Evaluations refer to the NJDEP Ecological Evaluation Technical Guidance document available at https://www.nj.gov/dep/srp/guidance/#eco_eval.

Tables of random numbers are readily available from many sources and should be used to eliminate any possible bias generated by those collecting the sample, assuming a random approach is used.

Also, important when choosing sample locations is consideration of the site's physical environmental setting and how these factors can influence the concentration and movement of the material of concern. Sampling at hazardous waste sites is usually conducted in an attempt to discover contamination and to define its extent and variability. With such an objective, it is most logical to choose sample locations that will yield the most information about site conditions. Here, judgment (or biased) sampling should be employed. Biased samples are those collected at locations that were chosen based on historical information, knowledge about the location and behavior of the contaminant(s), and/or knowledge about the effects of the physical system on the contaminants' fate.

Both biased and random sampling techniques can be used together to thoroughly address an entire site or area of concern. Some samples may be biased to potentially contaminated areas (e.g., stained soil, former process or disposal areas) or potentially impacted areas (e.g., areas of stressed vegetation, sediment downstream from discharge pipe). In areas less likely to be contaminated or areas with little available background information, random samples may be used to allow adequate assessment of the entire site.

There are several factors that help determine the number of samples needed for site characterization:

- Exposure pathways
- Statistical performance objectives
- Data quality objectives
- Quality assurance objectives
- Background samples
- Sampling objectives
- Site specific conditions

Data quality and quality assurance objectives should be incorporated in a site-specific quality assurance project plan (QAPP) in accordance with 7:26E-2.2, Quality Assurance Project Plan Technical Guidance, and other applicable guidance. Additionally, data quality and sampling objectives should comply with the Data of Known Quality Protocol Technical Guidance.

Background sampling should be conducted in accordance with the appropriate guidance applicable per media. Sampling to evaluate naturally occurring background or upgradient/offsite source background should be implemented in accordance with the soil, groundwater, and/or ecological technical guidance documents, as applicable. Additional considerations for evaluation of background conditions may also include implementing investigations in accordance with Historic Fill and/or Historically Applied Pesticide Technical Guidance. Specific programs may have different requirements, please refer to the program guidance for details.

Considerations of the biased or random sampling should be evaluated on a site-by-site basis. If the objective of the event is to determine whether the site is contaminated, a limited number of samples, from properly chosen locations, will yield useful information. A greater number of samples may be needed however, if the site is known to be contaminated and delineation of the contamination is the objective. In many cases, statistical considerations can be helpful in determining sampling strategy. For sites suspected of being impacted by radioactive material, refer to Chapter 12, *Radiological Assessments*, for specific sampling considerations.

An additional consideration should be made if the sampling locations and results are to be analyzed or modeled in GIS with other spatial data. Accurate sampling locations (NJ State Plane Coordinates) must (per 7:26E-1.6(a)5) be determined in order to reference the data spatially. Depending on the accuracy requirements of the analysis, these locations could be determined through high accuracy surveys (including elevation), the use of Global Positioning System (GPS) receivers or from digital aerial orthophotography data on the GIS. General NJDEP GPS Standards, and GIS Mapping and Digital Data Standards, can be reviewed at http://www.state.nj.us/dep/gis. SRWMPs *Guidance for the Submission and Use of Data in GIS Compatible Formats Pursuant to Technical Requirements for Site Remediation* (TECHGIS2) can be reviewed at https://www.nj.gov/dep/srp/regs/techgis/techgis2.pdf. Sampling points inside a structure should be identified by physical and logical connections and relative locations with respect to other fixed structures and equipment.

1.6 Sample Methodology and Matrix

Once the appropriate number of samples and locations have been chosen, consideration should be given to what sample collection method will be used. An assessment of the proposed sampling method is needed to assure that representative samples of site conditions are obtained. To prevent the possible cross-contamination of samples, the sampling investigation should begin at the least contaminated or background areas of the site and proceed to the areas suspected of being the most highly contaminated. The selected sampling

methodology will be matrix dependent. In some instances, there may be several acceptable options available for collecting a sample. In other instances, site-specific conditions may dictate that only one approach will work, even though that method may not be the preferred method. In all cases, the construction material of the sampling device, its design, its decontamination, and proper use are critical factors and should be included in the proposed sampling plan.

Use of sampling equipment constructed of inappropriate or undesirable material may compromise sample quality by several processes: 1) Compounds related to the sampling equipment material may leach into the sample; 2) The sampling equipment used during sample collection may adsorb compounds from the sample itself; and 3) After repeated use and decontamination, compounds previously adsorbed onto the sampling device may now desorb from the sampling equipment into a cleaner sample. Sampling equipment design is also important. For example, a ground water sampling device that aerates the sample during collection may yield a sample that is not representative of actual aquifer conditions.

Even the most well designed, constructed, and cleaned sampling device may yield a non- representative sample if used improperly. All personnel involved in collection of the sample should receive training on the use, care, and limitations of the sampling equipment used.

Further, decontamination of the chosen device must be considered. The sampling device should be resistant to the decontamination solutions and should be constructed to allow ease of cleaning and assure thorough decontamination (see Chapter 5 *Sampling Equipment*, for decontamination procedures).

1.7 Laboratory Selection

Prior to selecting a laboratory, the certification status of the laboratory must be determined. Laboratories submitting analytical data to the State of New Jersey must hold current certification where applicable under the *Regulations Governing the Certification of Laboratories and Environmental Measurements* N.J.A.C. 7:18. Details on laboratory accreditation are provided in Chapter 2.

The Office of Quality Assurance offers certification in the following regulatory programs:

- Drinking Water Program
- Solid and Hazardous Waste
- Air
- Wastewater -Non Potable Water
- Radon
- The Contract Laboratory Program

The State of New Jersey Certification Program requires certification of the samplers collecting “Analyze Immediately” parameters for NJDEP programs. Certification for those parameters can be obtained from the Office of Quality Assurance. Additionally, immunoassay methods that are considered laboratory or field methods require certification under the Solid and Hazardous Waste Program. Regardless of whether a company or organization is or is not a laboratory, matrix, parameter, and method specific certification must be obtained. This includes but is not limited to responsible parties, contractors, and facilities.

More information on the two options available for laboratory certification offered by the Office of Quality Assurance (OQA) can be found at: https://www.nj.gov/dep/enforcement/oqa/labcert.html.

1.8 Electronic Submission of Data for Site Remediation and Waste Management

1.8.1 General Requirements

According to the Technical Requirements for Site Remediation (N.J.A.C. 7:26E) herein called the Tech Regs, the results of environmental sample analysis must be submitted to NJDEP Site Remediation and Waste Management Program (SRWMP) in an electronic format (per 7:26E-1.6(a)5). This requirement is applicable to the Site Investigation Report and applies to all subsequent phases of the remedial process. Furthermore, every sample point must be geographically referenced using approved accuracy standards (per 7:26E-1.6(a)5). NJDEPs GIS compatibility requirements can be reviewed at http://www.state.nj.us/dep/gis and the *Digital Data Standards* and *Guidance for the Submission and Use of Data in GIS Compatible Formats Pursuant to Technical Requirements for Site Remediation* (TECHGIS2) at https://www.nj.gov/dep/srp/regs/techgis/techgis2.pdf.

Prior to conducting sampling, it is important to consider the type and format of data that will be required when the results are submitted to SRWMP, as well as other information that must be gathered while in the field, such as geographic location of sampling points.

The current requirements call for the submission of three files. HZSAMPLE contains field sampling information; HZRESULT contains analytical results; DTST identifies the data submission. The complete requirements are outlined in detail at http://www.state.nj.us/dep/srp/hazsite. This site contains numerous guidance documents and related software to assist in the preparation of an electronic data submission. Both the *Getting Started Guide* and the *SRP Electronic Data Interchange Manual (SRP-EDI)* will assist in this effort. The SRP-EDI, in particular, specifies the three data tables that must be submitted, the fields in each of those tables, and the data requirements, such as field length and valid values, etc. Note that the SRP-EDI is updated periodically. The website should be accessed prior to preparing data to ensure that the latest requirements are met. Another important tool available at the website is the "Environmental Data Submittal Application Checking" (EDSA) program. Once samples have been collected and data prepared, the data should be run through EDSA to determine compliance with data requirements.

1.8.2 Consistency in Data Fields Among Data Tables

In DEP's system, three fields are used to link together the three data tables that comprise a complete submission. The fields are SRP ID, Sample Date, and Sample Number. Therefore, it is imperative that these fields are created per the SRP-EDI definitions, and are reproduced EXACTLY the same in each of the tables. Consistency among these fields is particularly important when one party, such as a consultant, is preparing the part of the submission related to sample collection, and a second party, such as a laboratory, is providing the analytical results information. Please review the definitions of the three fields SRP ID, Sample Number, and Sample Date that are in the most current version of the SRP-EDI prior to collecting samples, supplying samples to the laboratory for reference in the result table, and preparing a submission.

1.8.3 Securing Laboratory Services

Prior to securing the services of a laboratory, it is important to know what services they provide for meeting these electronic data requirements and are certified by the NJDEP OQA for the matrix and parameters being investigated. Several laboratories already have exports from their Information Management Systems that meet the required results format. Ensure that the laboratory has submitted results successfully in the past and that they will run the SRWMP data checker program, called EDSA, on the result file to ensure that it meets the required data format.

1.8.4 Geographically Referenced Points

All sample results must be submitted with a geographically referenced location associated with them (per 7:26E-1.6(a)5). Locations should be provided in State Plane Feet, using North American Datum 1983. Digital mapping shall conform to the "New Jersey Department of Environmental Protection Mapping the Present to Protect New Jersey's Future: Mapping and Digital Data Standards," in N.J.A.C. 7:1D, Appendix A. Additional accuracy standards are defined in the NJDEP, Mapping and Digital Data Standards at http://www.state.nj.us/dep/gis.

Detailed instructions outlining the specific map elements, support data and metadata requirements for GIS compatible digital map submissions for SRWMP are included in *Guidance for the Submission and Use of Data in GIS Compatible Formats* at https://www.nj.gov/dep/srp/gis/.

1.8.5 Permit Application and Compliance

Several permitting programs have provided for permit application data and/or sampling data required by permits to be submitted electronically. Since software development is an ongoing process, interested persons should contact the appropriate permitting bureaus for current capabilities and procedures.

1.9 Quality Assurance Considerations

Quality assurance measures must be associated with each sampling and analysis event as an additional measure of control to assure that the sample delivered to the lab for analysis is representative of site conditions. The field sampling plan should outline how the representative quality of the samples will be assured. This will include, but not be limited to: data quality objectives, laboratory SOPs, field SOPs, sample bottle preparation, equipment decontamination, trip blanks, field blanks, duplicates, split samples, sample preservation and handling, chain of custody, analysis request, analytical methods, parameters, and deliverables. See Chapter 2 for further quality assurance information.

1.10 Health and Safety Concerns

Prior to any work being performed at a hazardous waste site, as defined by 29 CFR 1910.120, the organization, or company, engaged for the work must develop a written Health and Safety Program for its employees. As part of the overall Health and Safety Program, a site-specific safety and health plan, which addresses the safety and health hazards at a particular site, must be developed and kept available at the site during the duration of all site work. Typically, a Health and Safety Program will address the following areas: organizational responsibilities, risk analysis, underground utility markouts, employee training, personnel personal protective equipment (PPE), respiratory protection, medical surveillance, air monitoring, site control, decontamination, site standard operating procedures, contingency planning, permit required confined space operations, hot work, spill containment, emergency response, emergency contacts, and hospital route. Depending on the types of contaminants, other hazards present, and the type of work that is anticipated, some of these concern areas may not be applicable to all aspects of a particular sampling episode. See Chapter 4 for more information on Site Entry Activities and training requirements.