STATE OF CONNECTICUT

DEPARTMENT OF ENVIRONMENTAL PROTECTION

SITE CHARACTERIZATION GUIDANCE DOCUMENT

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(Effective September 1, 2007)

PREAMBLE

The Connecticut Department of Environmental Protection (CTDEP) has developed this guidance document, with critical support provided by select licensed environmental professionals associated with the Environmental Professionals' Organization of Connecticut (EPOC).

The Site Characterization Guidance Document (SCGD) describes an approach and standard of care for designing, conducting, and documenting site characterization in accordance with prevailing standards and guidelines. When site characterization is required by law, CTDEP highly recommends the approach presented in the SCGD, which if utilized, will be acceptable to the Commissioner. CTDEP acknowledges that there are other investigative approaches that may be acceptable; however, CTDEP's review of alternative approaches may be more intensive to evaluate the applicability of the alternative approach and whether such alternative approach meets prevailing standards and guidelines. Therefore, the environmental professional should fully document his/her rationale for any alternative approach.

The SCGD incorporates the multi-phased approach to site characterization presented in CTDEP's published Transfer Act Site Assessment (TASA) Guidance Document[1] (June 1989, Revised November 1991) and continues to promote the conceptual site modeling approach introduced in CTDEP's June 2000 Draft Site Characterization Guidance Document. This SCGD supersedes the June 2000 Draft Site Characterization Guidance Document.

The SCGD is not intended to be a prescriptive manual that describes specific investigative processes. Additional CTDEP technical guidance pertaining to specific components of site characterization is available as supplemental guidance. The supplemental guidance documents are subject to modification as the appropriate technologies and methodologies change over time and will be made available as they are completed. In some cases, the SCGD references specific supplemental guidance that may not yet be

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[1] The TASA guidance document is superseded by this SCGD, except for limited use of TASA pursuant to Conn. Gen. Statute Section 22a-133w (voluntary site remediation in GB or GC areas). At such sites, TASA may be used in conjunction with this SCGD.

available. The references to such should be considered as placeholders until the supplemental guidance is completed.

The SCGD is not intended to provide guidance on how to demonstrate compliance with the RSRs. The RSRs provide specific provisions and prerequisites to demonstrate compliance with applicable criteria. It is incumbent upon the environmental professional to have current knowledge of the RSRs and remedial technologies to properly select and implement a feasible and appropriate remedial alternative to be protective of human health and the environment.

The SCGD should be identified as a Requirement To Be Considered for Remedial and Removal sites under CERCLA.

The SCGD, including supplemental guidance documents, are available on the Remediation Division webpage (http://www.ct.gov/dep/remediation). When new or updated supplemental guidance is available, it will be announced and posted on the CTDEP Remediation Division webpage.

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LIST OF ACRONYMS

AOC	Area of Concern
COC	Contaminant of Concern
CSM	Conceptual Site Model
CTDEP	Connecticut Department of Environmental Protection
DQO	Data Quality Objective
ERA	Ecological Risk Assessment
ESA	Environmental Site Assessment
ExSA	Expedited Site Assessment
NAPL	Non-aqueous Phase Liquid
PCBs	Polychlorinated Biphenyls
QA/QC	Quality Assurance / Quality Control
RCPs	Reasonable Confidence Protocols
RCSA	Regulations of Connecticut State Agencies
RRSA	Rapid Response Site Assessment
RSRs	Remediation Standard Regulations
SCGD	Site Characterization Guidance Document
TASA	Transfer Act Site Assessment
USGS	United States Geological Survey
UST	Underground Storage Tank
VOCs	Volatile Organic Compounds

DEFINITION OF TERMS

Term	Definition
Area of Concern	Locations or areas at a site where hazardous waste and or hazardous substances (including petroleum products) have been or may have been used, stored, treated, handled, disposed, spilled, and/or released to the environment
Background Concentration for Soil	See Remediation Standard Regulations, Section 22a-133k-1(a) of the Regulations of Connecticut State Agencies. Essentially, a COC may be considered a background condition in soil if the COC is present in soil in areas outside of any release area. This must be demonstrated with representative sampling from the same stratigraphic unit and in the general geographic vicinity. If the compound is a COC for the site, the environmental professional must demonstrate, through an appropriate sampling and analysis plan, that the COC is not a result of a release or due to the presence of fill.
Background Concentration for Groundwater	See Remediation Standard Regulations, Section 22a-133k-1(a) of the Regulations of Connecticut State Agencies. Certain substances may be present in groundwater as a result of naturally occurring conditions in soil or background concentrations of a substance in soil; however, this must be demonstrated with representative groundwater sampling at the nearest location upgradient of and unaffected by the release area. A plume migrating onto the site from an off-site source may also be considered a background condition; however, groundwater sampling locations must be representative and the environmental professional must have an appropriate understanding of the hydrogeology of the site and of all releases and plumes on the site.
Composite Sampling	The combination of two or more discrete samples of the same media for laboratory analysis. Composite sampling to determine that a release has not occurred, to delineate the extent and degree of contamination, or to establish compliance with the RSRs is not acceptable. Compositing samples may dilute the concentrations and will not provide a true representation of remaining contamination. Furthermore, if contaminants are detected in a composite sample, the specific location of the contamination remains unknown.
Constituent of Concern	A component, breakdown product, or derivative of a substance that may be found in the environment as a result of a release or a reaction caused by such a release.
Data Quality Objectives	Site-specific, AOC-specific, and/or release area-specific goals developed to ensure that sufficient quality and quantity of data are collected to support the decisions made during site characterization and to further develop and refine the conceptual site model. Data quality objectives are necessary to identify when enough information has been obtained to answer the hypothetical questions with the level of certainty that a given situation might require. It is through this evaluation of the data, using the data quality objectives, that the significance of a data gap is determined.

Term	Definition
Environmental Professional	An individual who has specific education, training, and experience necessary to exercise sound professional judgment to develop conclusions regarding conditions indicative of releases or potential releases at a site.
Naturally Occurring	Certain chemical compounds may be considered naturally occurring in soil, if such compound is not a COC for the site, and representative sampling demonstrates the presence of the subject chemical compound is not due to fill. If the compound is a COC for the site, the environmental professional must demonstrate, through an appropriate sampling and analysis plan, that the COC is not a result of a release or due to the presence of fill.
Permanent Monitoring Well	A well constructed for the purpose of multiple monitoring events to establish trends in groundwater quality. This type of well requires a protective casing, surface seal, and annular seal to prevent downward migration of precipitation and contamination through annular space along well casing and is designed to provide a representative groundwater sample. To achieve representative groundwater quality in overburden wells, appropriately sized filter sand and corresponding screen size should be used to reduce the presence of excessive silt/ turbidity.
Release	See Remediation Standard Regulations, Section 22a-133k-1(a) of the Regulations of Connecticut State Agencies. A release has occurred if COCs are detected, unless appropriate sampling and analysis can show that the COCs are present solely to naturally occurring or background conditions.
Release Area	The area at and beneath which polluted soil is located as a result of a release.
Representative Sampling	A collection of samples that accurately reflects the environmental quality of media at specific locations.
Significant Data Gap	For a Phase II investigation, a significant data gap exists when it is not possible to conclude with an appropriate level of confidence whether or not a release has occurred. For a Phase III investigation, a significant data gap exists when evaluation of all data, in proper context, does not/cannot support the CSM, or if more than one CSM can be supported by the existing data set.
Standard of Care	The degree of competence and diligence that an environmental professional is expected to exercise to hold paramount human health and the environment.
Substance	An element, compound, or material that has the potential to be released to the environment.
Temporary Monitoring Well	A well installed for the purpose of groundwater quality screening. Temporary monitoring wells may allow for multiple sampling rounds or the collection of single groundwater sample before being removed. Because of the method of construction (see “Permanent Monitoring Well”), such wells are inappropriate for establishing compliance or for long-term monitoring.

1. INTRODUCTION

The Site Characterization Guidance Document (SCGD) promotes and recommends the scientific method of inquiry using the conceptual site modeling process to characterize the environmental condition of a site using a multi-phased approach. In developing an understanding of the site conditions and the distribution of contaminants in the environment, the environmental professional is expected to formulate and refine a conceptual site model (CSM) throughout the site characterization process. The environmental professional uses the conceptual site modeling process to evaluate existing information, to guide investigations, and to evaluate new data.

This SCGD describes the phases of site characterization and the conceptual site modeling process. The following is a general description of each phase of site characterization:

- A Phase I Environmental Site Assessment (ESA) is an evaluation of the current and historical uses of a site and the activities that have been conducted at a site, for the purpose of identifying all areas of concern (AOCs) at which a release to the environment has the potential to have occurred.

- A Phase II investigation involves the collection of sufficient data from each identified AOC, based on the Phase I ESA and the environmental professional's preliminary CSM, to determine whether or not a release to the environment has occurred.

- A Phase III investigation includes the characterizations of the nature, degree, and three-dimensional extent of contamination resulting from each release that has occurred. A complete Phase III investigation results in an understanding of the hydrogeologic conditions on and in the vicinity of the site, the distribution of contaminants associated with releases at a site, and the fate and transport of the contamination. While interim or emergency remedial actions to abate pollution may be conducted at any time in the course of characterizing a site, a final remedial action plan can be developed only after a Phase III investigation that addresses all on-site release areas has been completed.

While comprehensive site assessments are typically completed in three major phases, it is recognized that in many situations, it may be prudent to combine different phases of investigation. For instance, the environmental professional may conduct a Phase III investigation at one or more release areas while conducting activities consistent with a Phase I ESA or a Phase II investigation for other AOCs at a site. For the purposes of this document, the phases of site characterization are presented sequentially.

However, as long as the goals of each phase are met for all AOCs and the report clearly identifies which phase of the site characterization process has been completed at each AOC, the environmental professional may conduct the characterization of the AOCs in any combination appropriate for a particular site.

Expedited Site Assessments (ExSA) may be an alternative approach at certain sites. ExSAs rely on dynamic strategies and on-site decision making by experienced, senior-level environmental professionals. Rapid Response Site Assessments (RRSA) may be prudent at sites in which have the potential to cause immediate or severe consequences by posing an imminent threat to human health, safety and/or the environment. RRSAs are normally performed as an interim and/or emergency response assessment. It is incumbent upon the environmental professional to document their rationale and justification for any alternative approach, and evaluate the findings of such in proper context and in conjunction with this SCGD. Detailed information on Expedited and Rapid Response Site Assessments is available as supplemental guidance.

2. CONCEPTUAL SITE MODELING

The conceptual site modeling approach and the environmental professional's documentation and presentation of the conceptual site modeling process are the basis for effective environmental site characterizations. Conceptual site modeling is based on the scientific method of inquiry and is CTDEP's expectation for the standard of care used in characterizing contaminated and potentially contaminated sites. A CSM describes, explains, and provides an understanding of the nature and distribution of contaminants necessary to evaluate potential risks to human health and the environment.

2.1 The Conceptual Site Model

A CSM is a representation of an environmental system that is used as a tool for understanding and for explaining to others the basis and rationale for the site investigation and the conclusions drawn about the environmental conditions at a site. A CSM incorporates information about a chemical's release, fate, transport mechanisms and pathways and any potential receptors. Effective communication of the CSM through proper documentation is essential.

CSMs have many specific uses, including identifying AOCs; determining whether or not a release to the environment has occurred; describing the nature, extent, and degree of a release to the environment; and serving as the basis for determining whether data gaps are significant. A significant data gap is defined as one that limits the formulation of a scientifically defensible interpretation of environmental conditions or potential risks.

2.2 The Conceptual Site Modeling Process

Conceptual site modeling is an iterative approach to site characterization and begins prior to development of the initial scope of work for a site. Conceptual site modeling is based on the scientific method of inquiry, which combines elements of both descriptive and hypothesis-based science. Descriptive science uses observations and data analyses to describe a system. Hypothesis-based science develops tentative answers to structured questions. These tentative answers are tested by making observations or by designing and carrying out investigations. While no scientific hypothesis can be absolutely proven, a hypothesis can be deemed credible or implausible through appropriate testing.

During the conceptual site modeling process, the environmental professional develops and validates a CSM. As additional information becomes available, the initial CSM should be refined, revised, and ultimately, validated. The number of iterations and the quantity and quality of information that is necessary will be a function of the complexity of site conditions and the data quality objectives (DQOs) established for the site characterization.

DQOs are site-specific, AOC-specific, and/or release area-specific goals developed to ensure that a sufficient quality and quantity of data are collected to support the decisions made during site characterization and to further develop and refine the CSM. DQOs are developed by the environmental professional to design a sampling and analysis plan that minimizes the risk of having insufficient quality or quantity of data to meet the goals of the investigation and draw defensible conclusions that protect human health and the environment. For example, the ultimate objective of a Phase II investigation is to determine if a release has occurred at an AOC. Based on the environmental setting, release mechanisms, and known, expected, or suspected factors influencing the migration of a substance, DQOs will require a certain number of soil samples collected from specific depths and locations and analyzed for specific constituents of concern (COCs) in order to obtain a sufficient quantity and quality of data for the environmental professional to render a conclusion. To determine that DQOs have been met, it is necessary to know the quality of the analytical data used for decision-making and to conclude whether or not the data is sufficient for the intended purpose. Additional information concerning the quality, usability, and evaluation of laboratory analytical data is presented in CTDEP's Laboratory Quality Assurance Quality Control - Reasonable Confidence Protocols (RCPs), which is provided as supplemental guidance.

The CSM approach consists of key elements that should be followed throughout the entire site characterization process and should result in a final, validated CSM. These elements include:

- defining the purpose of the investigation;
- developing a preliminary CSM from available information;
- identifying and resolving significant data gaps;
- refining the CSM based on the newly acquired data;
- identifying unresolved or new significant data gaps and resolving such data gaps; and
- continuing the CSM process until a final CSM can be validated where all significant data gaps have been resolved, all DQOs have been achieved, and the final CSM is consistent with the findings.

2.3 Documenting a Conceptual Site Model

A CSM should be documented for each phase of site characterization and should be presented as a narrative description of what the environmental professional knows and understands about a site. This presentation should include a discussion of the assumptions used in developing a CSM and the rationale used in refining a CSM. The narrative description of a CSM should be supported by tables and figures, as appropriate. The level of detail necessary to document a CSM is dependent on the complexities of the site and the findings of the site characterization. Documentation of a CSM is further described in relation to specific phases of site characterization in Sections 3, 4, and 5 of this guidance document.

3. PHASE I ENVIRONMENTAL SITE ASSESSMENTS

A Phase I Environmental Site Assessment (ESA) is an evaluation of the current and historical uses of a site and the activities that have been conducted at a site, for the purpose of identifying all areas at which a release to the environment has the potential to have occurred. A completed Phase I ESA includes the findings of factual information and the conclusions of the environmental professional regarding identification of AOCs. A complete Phase I ESA describes current and historical site operations and processes; current and historical storage, handling, and disposal practices; site development history, including historical fill placement; the location and nature of AOCs; substances and constituents of concern; potential for release; potential release mechanisms; environmental setting; potential migration pathways; and potential receptors. A complete Phase I ESA includes the environmental professional's preliminary CSM.

While other published guidance documents, such as the American Society for Testing and Materials (ASTM) *Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment,* E-1527-05 and the USEPA's "All Appropriate Inquiries" rule under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) provide some useful protocols to complete a Phase I ESA, they are not inclusive of the key components to complete a Phase I ESA in accordance with this SCGD.

The Phase I ESA provides the foundation for subsequent phases of investigation and for demonstrating that sufficient site-wide investigations have been completed to the extent necessary to characterize the environmental condition of a site. Therefore, the research, collection, evaluation, and presentation of data in the appropriate context are essential. The purpose, objectives, and guidance for conducting a Phase I ESA that is acceptable to the Commissioner are presented in the following subsections.

3.1 Purpose of a Phase I Environmental Site Assessment

The primary purpose of a Phase I ESA is to identify AOCs that have resulted from current or historical uses of a site. AOCs are defined as locations or areas at a site where hazardous waste and/or hazardous substances (including, but not limited to, petroleum products) have been or may have been used, stored, treated, handled, disposed, spilled, and/or released to the environment. When determining how to describe an AOC, the environmental professional should take into account the physical and cultural setting of the site. An AOC may refer to a single known or potential release point, or it may be useful to group individual release points or areas into a single AOC. However, if individual release points are combined into a single AOC, the release mechanisms at the individual release points should still be considered in the CSM.

The level of detail provided in a Phase I ESA should be sufficient to support the conclusions drawn by the environmental professional regarding AOCs at the site and to allow others to understand how those conclusions were reached. An appropriate level of detail is necessary in a Phase I ESA to develop a work plan for the Phase II investigation.

3.2 Components of a Phase I Environmental Site Assessment

A complete Phase I ESA should include a site description; site history; file and record reviews of federal, state, and local agencies; review of previous assessments/documentation; the environmental setting; a site reconnaissance survey; and documentation of findings and a preliminary CSM. A variety of information sources may be available to develop the Phase I ESA. A description of the information that is expected to be included in the Phase I ESA is provided in the following subsections.

3.2.1 Site Description

An appropriate description of the site provides a visual overview of the site configuration, physical location, size, improvements, and physical setting. The site description includes, but is not necessarily limited to, an evaluation of the following characteristics:

- property location, including a property boundary map and possibly a legal description and latitude and longitude/State plane coordinates;
- land use for the site and surrounding area;
- improvements, including the type, number, and locations of buildings, building descriptions (including basements, footings, drains, etc.) and any modifications, construction dates, and other structures;
- utilities, including water, electrical, gas, storage tank facilities, and waste-stream;
- historical and current areas of site operations;
- areas of historical fill;
- surface cover (e.g., paved/unpaved areas), wooded areas, and landscaped areas;

- abutting properties; and
- access and egress locations, including such features as current or former roads and railway spurs.

The description of the site should reference appropriate maps and detailed site plans that provide a visual presentation of information included in the site description. Documentation on how the site has changed over time with respect to the above characteristics is necessary to identify and evaluate AOCs.

3.2.2 Site History

Site history information should be used to develop a historical record of site ownership and operations and, as appropriate, the surrounding area. A review of site history traces the industrial, commercial, residential, agricultural, and other uses of the site as far back as possible. The following information is expected to be included in the site history review:

- ownership, past and present;
- dates of occupancy;
- current and historical site uses;
- operational history/detailed nature and location of processes at the site (i.e., nature of manufacturing and other operations, types of machinery);
- substances used or produced throughout the history of the site, and related constituents of concern;
- known and likely materials management history (detailed information on use, storage, handling, and disposal of all materials, including hazardous substances, hazardous waste, industrial waste, petroleum products, and virgin products);
- historical utilities (i.e., industrial/sanitary waste discharge systems; previous process or water supply wells; use of coal, oil, gas, electricity, and on-site generation of power) and the dates and locations of operation or use;
- environmental permit and compliance history (not necessarily to determine whether past activities were in compliance, but rather to review that information in terms of identifying AOCs);

- pertinent information from building records, such as Sanborn® Fire Insurance maps, municipal building and zoning documentation, and other similar record sources, that provide historical layouts of buildings and that may identify the types and locations of prior operations that occurred at the site and surrounding area; and

- other site-specific information that may pertain to identifying AOCs.

Such information is necessary to evaluate the likelihood that historical uses have or could have resulted in a release to the environment. A well-documented site history is necessary for development of a CSM. If there is uncertainty regarding the past site uses, this should be identified as a data gap in the documentation of findings and in the CSM.

3.2.3 File Reviews

The regulatory file review component of a Phase I ESA includes a review of federal, state, and local files. Review of regulatory files provides information and aids in understanding the regulatory history of the site and surrounding area and the substances that may have been used and potentially released at a site or that may be affecting the environmental quality of soil, groundwater, or other media at a site due to migration of contaminants from off-site locations. A file review should also gather information relating to regulatory identification (United States [U.S.] Environmental Protection Agency [EPA] Resource Conservation and Recovery Act [RCRA] ID number, RCRA notification status, identified regulated units, and Comprehensive Environmental Response, Compensation and Liability Information System [CERCLIS] number); permits and registrations (RCRA, National Pollutant Discharge Elimination System [NPDES], underground storage tank [UST] notification, and general permits); documented releases; and enforcement history.

3.2.3.1 *Federal*

File reviews of federal records chiefly include, but are not limited to, those associated with the following programs managed by EPA: CERCLA, RCRA, RCRA Corrective Action, Toxic Substances Control Act (TSCA), Superfund, Superfund Amendments Reauthorization Act (SARA), and Emergency Response Notification System (ERNS). Other federal agencies that maintain information that may be relevant to a Phase I ESA include, but are not limited to, Federal Emergency Management Agency (FEMA) for flood frequency information; U.S. Fish and Wildlife Service for locations of shellfish beds, other aquaculture areas, and locations of threatened or endangered species; U.S. Army Corps of Engineers for information regarding relocated or otherwise manipulated surface water channels; and U.S. Geological Survey for well completion logs/reports and geologic and topographic mapping and reports.

3.2.3.2 *State*

The primary sources of state regulatory records that pertain to a Phase I ESA are found at the offices of CTDEP. Records available at CTDEP include, but are not limited to, the following topics and categories: property transfer act filings; investigation and remediation reports; waste management practices; manifests; hazardous waste; solid waste; underground storage tanks (USTs); polychlorinated biphenyls (PCBs); oil and chemical spills; storm water management; general regulatory correspondence and compliance; discharge permits; discharge monitoring reports; P-5 inspection reports; Preliminary Inspection Questionnaires (PIQs) for air emissions; water quality standards and leachate wastewater maps; natural resources; published and unpublished geologic maps; and water resource bulletins. Other state agencies/offices that may contain information pertinent to a Phase I ESA include, but are not limited to, the State Library for city directories, aerial photographs, Sanborn® Fire Insurance maps, historical topographic maps, and archived CTDEP files; the Connecticut Department of Public Health for locations of public water supply sources and community water systems in Connecticut, illness cluster studies, and health advisories; and the Connecticut Department of Transportation for historical maps showing access routes, soil boring information, and detailed topographic information.

3.2.3.3 *Local/Municipal*

A significant amount of information about a site may be obtained at the municipal offices for the city/town where the site is located. The municipal offices where information may be found include, but are not limited to, Tax Assessor for property record cards and assessor mapping; Town Clerk for land records, deeds, flood information, and property maps; Building Department for permits, site plans, and inspections; Health Department for drinking water quality information, domestic well locations, and septic system information; Engineering and Public Works for permits, site plans, utility connections, inspections and historical landfills and dumps; Fire Marshal for historical fire documentation, facility inspection records, spill reports, and UST information; Historical Society, museums, and Town Library for historical town directories and photographs; Planning and Zoning for land use; Economic Development for previous environmental assessments; local Water Authority for water distribution records; and Inland Wetland and Conservation Commission for wetland delineation and conservation easement maps.

3.2.4 Review of Previous Assessments and Investigations

It is necessary to review the information and data presented in the documentation related to the site. However, it is important for the environmental professional to understand the purpose, scope, and limitations of such work if he/she uses historical documentation to develop Phase I findings and a preliminary CSM.

3.2.5 Environmental Setting

The environmental setting for a site and surrounding area is described in terms of the physical and cultural setting. The physical setting encompasses topography, geology, hydrology, hydrogeology, soils, and, as appropriate, ecology. The cultural setting encompasses land use, water use, and modifications to the natural environment. Information regarding a site's environmental setting will be necessary in order to assess the fate and transport of substances that may have been released on and/or off site and related COCs and in identifying and evaluating potential receptors. The environmental professional should document his/her rationale for the geographic extent of the surrounding area evaluated in a Phase I ESA.

3.2.5.1 *Physical Setting*

Phase I ESA information pertaining to physical settings should include, to the extent available, the following:

- topography and its significance to inferred direction of shallow groundwater flow, surface water drainage, and inferred depth to the water table;
- surficial geology, including soil type, structure, permeability, stratigraphy, and the significance of potential preferential pathways for, and barriers to, groundwater flow;
- bedrock geology, including depth to bedrock, bedrock type, and structure; and
- hydrology and hydrogeology, including surface water, groundwater, and wetland boundaries.

3.2.5.2 *Cultural Setting*

Phase I ESA information pertaining to cultural settings should include, to the extent available, the following:

- current and historical land uses specific to the site and more generally for the surrounding areas (e.g., industrial, commercial, and/or residential) – additional detail may be warranted for nearby land used for schools, childcare centers, recreational areas, healthcare facilities, and other land uses that may involve sensitive receptors;

- State groundwater and surface water quality classifications;

- water use, including but not limited to, public or private drinking water wells, reservoirs, wastewater, surface water intakes, and industrial/commercial or agricultural purposes; and

- modifications to the natural environment, such as construction, cutting and filling, watercourse modification, and underground utilities.

3.2.6 Site Reconnaissance Survey

A site reconnaissance survey is an extremely important component of a Phase I ESA and is used to form the basis for the visual image of the site that is presented in a Phase I ESA report. The survey is conducted to verify or modify the reported information for the site and, to the extent possible, identify AOCs and evidence of releases of substances on and adjacent to the site. Consequently, the site reconnaissance survey should be conducted or supervised by the environmental professional.

A description of the physical layout of current and historical operations at the site is fundamental for development of a preliminary CSM that will be presented in a Phase I ESA report. The site reconnaissance survey includes an evaluation and documentation of the following items:

- date and time of site visit;

- names of environmental professionals conducting the site reconnaissance survey;

- information from interviews with individuals knowledgeable about current or historical site operations and environmental history, including the names and positions of such individuals,;

- facility documents;

- any limitations to observations or access (e.g., weather conditions, snow cover, locked rooms);

- overall condition and apparent housekeeping practices of the site (e.g., well-maintained, dirty, occupied, abandoned, derelict);

- staining, dust or industrial residuals, discolorations, stressed vegetation, and odors;

- waste/chemical storage areas;
- drums and/or evidence of former drum storage areas;
- pits, ponds, and lagoons;
- fill/vent pipes and/or former evidence of such;
- exterior drainage structures, such as catch basins and dry wells;
- seeps and/or leachate;
- oily sheens;
- anomalous topographic features (e.g. depressions, fill areas, subsidence);
- pavement cuts/new or old asphalt;
- evidence of active/historical above and below-ground utilities;
- water supply;
- detailed descriptions and locations of current operations and vestiges of historical operations;
- floor drains, sumps, trenches, and other drains;
- loading docks and the nature of materials handled at each;
- facility maintenance areas;
- potential off-site sources of contamination that could result in pollution on the site;
- wastewater disposal;
- raw material handling and storage;
- detailed information on waste storage, handling, and disposal practices;
- areas of access and egress that may be or have been associated with use, handling, storage, and disposal of hazardous substances;

- dumpsters and other disposal containers or locations;
- storage tanks and containers;
- equipment containing, or possibly containing, PCBs;
- indications of solid waste disposal;
- visible geologic features (such as outcrops and gravel pit operations); and
- any other possible sources of environmental concern or unexplained site features.

The rationale for excluding such items from the evaluation and documentation process is expected to be provided in a Phase I ESA report.

3.3 Documentation of Findings and Preliminary Conceptual Site Model

The findings and conclusions of a Phase I ESA are documented in a Phase I ESA report. The findings are a summary of factual information that includes the site description, site history, summary of file review and documentation, environmental setting, and results of the site reconnaissance survey. The environmental professional should use the findings (facts) to develop conclusions (interpretations) that create a representation, or preliminary CSM, of the site. A Phase I preliminary CSM identifies the AOCs within the context of the environmental setting and discusses the rationale for such identification. A Phase I ESA report should make clear distinctions among findings, conclusions, inferences, and hypotheses. Any uncertainties and limitations of the environmental professional's confidence in the conclusions should also be presented in a Phase I ESA report. A Phase I ESA report includes, at a minimum, appropriate discussion and documentation of the following items:

- the purpose and goals of the Phase I ESA, including identification of the general scope of the assessment; a statement regarding for whom the assessment was completed; and a description of the site with necessary information such as site name, address, regulatory identification numbers (if any), and other relevant location information;
- a description of the actions taken during the assessment, the rationale for those actions, and the findings of the assessment - findings may be presented as a summary of key information or data, which may or may not indicate that a release to the environment occurred;
- the identification of AOCs, substances and related COCs, and potential for releases; and

- a presentation of a preliminary CSM and the conclusions of the Phase I assessment, which involves an interpretation of the findings and an evaluation of the implications of any item that may pose an environmental concern - In developing conclusions, the assumptions and rationale for the environmental professional's interpretations is expected to be provided. Some situations may require conclusions regarding the significance of documented site features and conditions, in context of further characterization of AOCs. The preliminary CSM will be refined and further developed as the conceptual site modeling process continues throughout the course of subsequent site investigations.

It is expected that the text of a Phase I ESA report will be supplemented with relevant figures and site plans. A topographic map representing the appropriate portion of the U.S. Geological Survey topographic quadrangle map for the site and surrounding area (with the site location clearly indicated) and a site plan, drawn to scale, showing the locations of AOCs and other pertinent site features described in the text, should be included in a Phase I ESA report. Additional graphics, such as Sanborn® Fire Insurance maps, historical topographic maps, historical site maps, previous sample location maps, regional geologic and/or hydrogeologic maps, and current and historical ground and aerial photographs of the site may be included, as appropriate. Tables may also be used to supplement the report text, including those that summarize the history of site use, results of file reviews, previous investigation results, or results of the site reconnaissance survey.

A Phase I ESA alone is generally not sufficient to determine whether or not a release to the environment has occurred. It is unlikely that information gathered during this phase of site characterization could support a determination that a release did not occur. The evaluation as to whether a release has or has not occurred is the primary objective of a Phase II investigation, which is described in Section 4 of this SCGD.

4. PHASE II INVESTIGATIONS

The purpose of a Phase II investigation is to collect sufficient information to determine whether or not a release has occurred at each AOC identified during a Phase I ESA. A release is considered to have occurred if concentrations of COCs are detected above the reporting limits identified in the RCPs, unless such detections can be shown to be attributable solely to naturally occurring or background conditions. A Phase II investigation is to be conducted using the conceptual site modeling approach and may pertain to an entire property, a portion thereof, or an individual AOC. If appropriate for the circumstances, a Phase II investigation could be conducted as an Expedited Site Assessment, as described in supplemental guidance. Regardless, the scope of the investigation should be clearly stated. The environmental professional is expected to consider the environmental setting, potential receptors, and potential risks posed by failing to detect a release when designing a scope of work for a Phase II investigation. The rationale and basis for concluding whether or not a release has occurred must be clearly documented.

4.1 Conceptual Site Modeling Approach to Phase II Investigations

Application of the conceptual site modeling approach is critical to achieve the degree of certainty necessary for the intended use of site characterization and environmental data in a scientifically defensible manner. For a Phase II investigation, a sampling and analysis program should be consistent with the DQOs and sufficient to evaluate whether or not a release to the environment has occurred. Generally, the more information that is available regarding the potential release and the AOC, including factors that influence contaminant migration, the more focused the sampling program can be. The conceptual site modeling process for Phase II investigations includes understanding and describing the following information, to the extent such information is available:

- timing, amounts, durations, locations, and mechanisms for potential releases to determine the appropriate locations and depths for soil, soil vapor, sediment, surface water, or groundwater sample collection;

- substances that may have been released to determine the appropriate COCs and the requisite analyses to perform; and

- contaminant fate and transport characteristics and migration pathways to determine where contaminants are most likely to be detected and how chemical or physical changes may have altered contaminants or their distribution over time.

4.2 Designing and Implementing an Appropriate Phase II Investigation

The conceptual site modeling process is used to refine the investigation effort and to design a sampling and analysis plan to collect sufficient information to make a definitive statement regarding whether or not a release has occurred at a particular AOC with the degree of certainty necessary to meet DQOs. Generally, it is not possible to draw a conclusion that a release to the environment did not occur without some sampling of environmental media. The documentation necessary to support a decision not to sample, either at an individual AOC or at the site as a whole, will require significantly more justification and documentation than would be expected for a decision based on quantitative analyses.

Sampling locations and depths should be biased to where the potential releases are most likely to be detected. Therefore, to design an appropriate Phase II investigation, it is necessary for the environmental professional to have an understanding of the history of each AOC; potential release mechanisms and locations; chemical constituents of the substances associated with each AOC; and the fate and transport and migration pathways.

The number and locations of samples collected and analyzed to determine if a release has occurred at each AOC will be related to how much is known about the AOC and the amount of detail provided in the CSM. Multiple lines of evidence may be necessary to demonstrate that a release has not occurred. These may include direct sampling and analysis of environmental media, visual observations, and screening results. In cases where it is not feasible to sample at the desired location, only indirect lines of evidence may be available. Under these circumstances, multiple lines of evidence to support a conclusion that a release did not occur are needed. A comprehensive understanding of the site in the context of the CSM is necessary to be able to establish the rationale for indirect sampling locations.

Field screening methods can be an effective tool for guiding soil, groundwater, and other media sampling programs and for designing analytical strategies. Field screening methods and resulting data often provide preliminary information regarding the presence of a potential release. However, field screening data are usable only as long as the limitations associated with reproducibility and sampling interval are understood and factored into the process of making a Phase II conclusion. It is inappropriate to use field screening data to determine that a release has not occurred. Analytical data are necessary to confirm that a release to the environment has not occurred.

4.2.1 Potential Release Mechanisms and Locations

When designing a sampling and analysis plan, the environmental professional is expected to consider all potential release mechanisms for each substance at each AOC. Table 4.1 presents some common AOCs and associated possible release mechanisms and locations that should be considered in determining where releases are most likely to have occurred and be detected.

Table 4.1 Common AOCs and Likely Release Locations

Common AOCs	**Possible Release Mechanisms**	**Examples of Likely Release Locations Appropriate for Phase II Investigation Sampling and Analysis**
Aboveground Storage Tanks	Tank leak	Beneath and/or near tank at nearest downslope, low lying, pervious area
	Piping/valve/dispenser leaks	At/beneath fittings and pipe segments subject to leakage
	Overfills	Beneath and/or adjacent to the fill pipe/dispenser, at nearest downslope, low lying, pervious area
Underground Storage Tank Systems	Tank leak	Underlying native soil at each end of tank, sidewall samples at depth of tank bottom
	Piping/valve/dispenser leaks	In the vicinity of buried pipe fittings and swing joints, beneath product lines along the piping run, beneath the dispenser island, <u>particularly when no dispenser pans are present</u>
	Overfills	Beneath and/or adjacent to the fill pipe/vent pipe/dispenser, at nearest downslope, low-lying, pervious area
Interior Chemical Storage Areas	Leaks, spills from overfill containers, leaks from spigots, accidental container punctures	Beneath stains on the floor, and/or in the immediate area of the stored materials Beneath joints or cracks in the floor through which released substances may have preferentially migrated (e.g., joint between the building wall and floor)
Exterior Chemical Storage Areas	Leaks, spills from overfull containers, leaks from spigots, accidental container punctures	Beneath and/or near storage area at nearest downslope, low lying, pervious area, near entrances Beneath joints or cracks through which released substances may have preferentially migrated
Transformers, Capacitors and other Equipment with Polychlorinated Biphenyls	Leaks, explosions, spillage	Beneath and/or near equipment, at nearest downslope, low lying, cracks/joints, pervious area

Common AOCs	Possible Release Mechanisms	Examples of Likely Release Locations Appropriate for Phase II Investigation Sampling and Analysis
Dumpsters/ Waste Containers	Leaks, overfills, spillage	Beneath and/or near equipment, at nearest downslope, low lying, cracks/joints, pervious area
Septic Tanks, Leaching Fields, Drywells, Wastewater Treatment Facilities	Leaks from septic tanks, piping and distribution boxes	Beneath and/or directly adjacent to the tanks, solid piping and distribution boxes, and at pipe fittings and bends
	Designed discharges to leaching beds, galleries, drywells	Beneath and/or directly adjacent to leaching components and drywells
Buried and Above Ground Piping (e.g., sewer, process)	Pipe leaks	Beneath and/or adjacent to the piping, at fittings, bends, and segments subject to corrosion
	Pipe discharge points to ground surface or surface water	At the discharge point
Floor Drains, Trenches and Sumps	Leaks through cracks, joints, or pervious sections of drains, and through pipe fittings and bends	Beneath and/or adjacent to the drain, trench, or sump at cracks, joints, and pervious sections, and beneath and/or adjacent to pipe fittings and bends
Door/Window Disposal Areas	Spills and waste “dumping”	At nearest downslope, low lying, cracks/joints, pervious area, likely disposal areas
Loading Docks and Delivery Areas	Spills	Areas of stained soil and/or stressed vegetation
Interior Material Handling/Use Areas (e.g., metal machining, degreasing, plating)	Chronic drips, spills and leaks to floor	Beneath and/or adjacent to handling/use areas at stained floors, cracks, or joints
	Leaks through associated floor drains, trenches, piping, and sumps	Beneath and/or adjacent to the drain, trench or sump at cracks, joints and pervious sections, and beneath and/or adjacent to pipe fittings and bends
Roof drains, air vents	Fallout of airborne COCs and/or condensation from process exhaust vents directly to ground or to roof tops and with subsequent entrainment into roof runoff	Beneath and/or downslope of nearest vents and/or roof drain outlets, taking into consideration air flow and runoff patterns
Landfills, waste piles, pits, trenches lagoons, and fill areas	Intentional placement, often in accordance with acceptable practice during a prior time period	Within the placed materials

4.2.2 Contaminant Fate and Transport and Migration Pathways

When designing a sampling and analysis plan, the environmental professional is also expected to understand and consider the COCs, contaminant migration pathways and potential preferential pathways, potential chemical and physical changes to the COCs, and how COCs from a potential release could be affected by or interact with the environment. Knowledge of contaminant fate and transport characteristics of each COC is necessary to identify the most likely contaminated areas for sampling and analysis. Therefore, temporal considerations of potential releases should be considered in the CSM.

Some examples of fate and transport and migration pathways are as follows:

- Liquid spills to exterior paved surfaces may flow downslope to a nearby low-lying area, where the liquid may accumulate and preferentially permeate into the underlying soil. Hence, analyzing samples from immediately below the release point alone may not be sufficient, and analyzing samples from the low-lying area is often warranted.

- Light non-aqueous phase liquids (LNAPL), dense non-aqueous phase liquids (DNAPL), and other liquid substances released above the water table will generally migrate vertically through a relatively small and difficult-to-detect permeable portion of the unsaturated zone and may spread laterally at stratigraphic changes, the groundwater capillary fringe, or the water table where contaminants are often more readily detected. Therefore, sample collection should occur where the NAPL or other liquid is most likely to have migrated. Special care should be taken to ensure that cross-contamination does not occur when evaluating the presence of NAPLs.

- Volatile organic compounds (VOCs) from a release to the ground surface may have volatized from the upper-most soil horizon and may only be detectable in a lower interval. The fate and transport and rate of biodegradation of VOCs are highly dependent upon the media, available oxygen, and the toxicity of the chemical to microorganisms. Continuous vertical sampling and field screening for related COCs may be used to help select the appropriate sampling interval for analytical testing. Further information on sampling VOCs in soil is presented in supplemental guidance.

- Releases of high or low pH solutions may result in changes in the natural pH in the subsurface and/or the mobilization of historical COCs. Analysis for pH would be appropriate to evaluate if a release has occurred.

Some examples of preferential contaminant migration pathways that should be considered when designing the sampling and analysis plan are:

- cracks in building floors and pavement;
- building floor joints and intersections with walls and footings;
- utility bedding materials;
- low points in and near known or possible spill areas;
- permeable horizons atop or within relatively less permeable zones; and
- bedrock fractures.

4.2.3 Selecting Appropriate Analyses

When designing the analytical plan for a Phase II investigation, the environmental professional is expected to consider the substances at each AOC and related COCs, including breakdown products and constituents that result from reactions in the environment. The selected analyses should be sufficient to detect a release. Detailed information on quality assurance/quality control (QA/QC) and soil sampling and preservation is provided in supplemental guidance and should be consulted to ensure that the analytical data are of sufficient quality for the intended purpose and that preservation techniques are appropriate for the respective analyses. The environmental professional is also expected to consider the media being tested, screening data, and the DQOs of a Phase II investigation.

4.2.4 Phase II Sampling and Analysis Plan

The sampling and analysis plan provides the rationale for the selection of sampling locations, depths, quantities, and analytical parameters prior to conducting field work. It will also be necessary to provide this rationale in a Phase II investigation report. The level of detail in each Phase II sampling and analysis plan may vary significantly, given the variability in the type of AOCs at each site.

4.2.4.1 *Soil Sampling and Analysis*

A Phase II soil sampling and analysis plan specifies the type of soil samples to be collected, the sampling strategy, the depths at which the samples are to be collected, analytical parameters, and field screening methods.

The nature of the potential release being investigated determines the types of soil samples to be collected. For example, collection of a grab sample of surficial soil below a discharge pipe may be appropriate, whereas continuous sampling of a defined interval may be necessary to evaluate if a release has occurred from an underground tank system. Similarly, saturated soil samples are integrated samples because they are affected by the environmental quality of a relatively large zone of unsaturated soil, capillary fringe soil, and aquifer material, through which water migrates. As such, saturated soil samples represent much larger spatial zones than individual soil samples collected from the unsaturated zone, and therefore, can often provide more information about the potential for a release to have occurred than soil samples collected from the unsaturated zone. Accordingly, collection of saturated soil samples should be considered in designing soil sampling and analysis plans. Although a release may be detected using composite sampling techniques, the collection of composite soil samples is not acceptable to determine that a release has not occurred because the evidence of a release may be diluted.

The appropriate number and location of samples for an AOC should be based on the soil sampling strategy selected. The soil sampling strategy (grid versus focused/ biased) should be based on the level of detail known about the AOC and the potential release mechanisms. In general, focused sampling is appropriate where observations and existing data indicate where a release is most likely to be detected, whereas grid sampling is appropriate when the specifics about a potential release location are unknown.

The depths at which soil samples will be collected should be based on the depth at which a release is most likely to be detected. Release mechanisms and fate and transport of contaminants must be considered.

4.2.4.2 *Groundwater Sampling and Analysis*

A Phase II groundwater sampling and analysis plan specifies the number, location, depth interval and construction details of the monitoring well/device, the analytical parameters and number of samples to collect, and the sampling and analytical methodologies. A groundwater sample is an integrated sample because it is affected by the environmental quality of a relatively large zone of unsaturated soil, capillary fringe soil, and aquifer material, through which water migrates before reaching the well screen. As such, groundwater samples represent much larger spatial zones than individual soil samples collected from the unsaturated zone, and therefore, can often provide more information about the potential for a release to have occurred than soil samples collected from the unsaturated zone. As a result, groundwater data may be considered an indirect line of evidence and can indicate that a release has occurred, but do not necessarily indicate where a release occurred. Accordingly, further investigation would be necessary to determine the source of the release.

Major factors that are expected to be considered in developing a groundwater sampling and analytical strategy include the following:

- the quantity and quality of existing information in the context of the CSM (including the geologic and hydrogeologic characteristics) that are pertinent to each AOC;
- the likelihood that a release might not be detected by the sampling strategy for soil or other media;
- the solubility and mobility of the COCs in groundwater;
- the locations of other nearby AOCs or background conditions that may affect the groundwater quality at the sampling point; and
- the desired level of confidence in context of the DQOs, considering the environmental and cultural setting of the site and surrounding areas (e.g., current and future land use of the site, information regarding existing or potential uses of groundwater, and potential risks to sensitive receptors).

The number and location of groundwater sampling points for a Phase II investigation should be based on the size of each AOC and the quantity and quality of the other information pertaining to each AOC. Groundwater sampling points should be located at the AOC and/or immediately downgradient of the AOC. Groundwater sampling points should be close enough to each AOC to detect a release, considering the age of the suspected release, information concerning the known or inferred groundwater velocity and flow path, and fate and transport characteristics of the COCs. Generally, monitoring wells with screened intervals intercepting the upper portion of the saturated zone are appropriate for evaluating whether or not a release has occurred to groundwater. However, in some cases, other depths for screened intervals are necessary. The depths at which groundwater samples are collected should be based on the depths at which a release is most likely to be detected. Wells should be constructed to yield representative samples, based on the nature of the geologic unit. Generally, screen lengths of up to approximately 10 feet are appropriate for a Phase II investigation, and the rationale for screen length and placement should be documented.

A single groundwater sampling event may not be sufficient to determine that a release has not occurred. For example, seasonal or tidal variations may influence the detection of contaminants. The need for multiple sampling events should be based on evaluation of the data using the conceptual site modeling process and DQOs.

The selection of the type of sampling point, permanent versus temporary, should be based on the intended use of the data from that sampling point. Permanent wells afford the opportunity for sampling during more than one event and, if properly installed, developed, and maintained, will reliably represent the same aquifer location and depth over time. Wells of this type are necessary to evaluate groundwater flow direction and, when applicable, to establish future compliance with the RSRs.

4.2.4.3 *Other Media Sampling and Analysis*

When appropriate, a Phase II sampling and analysis plan may include the collection of surface water, sediment, and/or soil vapor samples to evaluate whether or not a release to the environment has occurred. In addition, Phase II sampling and analysis plans may include the evaluation of the presence of NAPL. The proposed media type, locations, and depths at which the samples are to be collected, analytical parameters, and field screening methods should be based on the CSM and the understanding of the potential release mechanisms, transport mechanisms, and properties of COCs.

The type of media to be sampled should be based on the potential release being investigated. Collection of samples in other media is necessary in cases where soil or groundwater sampling alone is insufficient or impractical in determining if a release has occurred. For example, soil vapor samples may be valuable because they are integrated samples, and as such, are affected by the environmental quality of a relatively large zone of unsaturated soil, capillary fringe soil, and shallow groundwater.

4.3 Evaluation of Phase II Investigation Results

The environmental professional is expected to evaluate the data to determine if the DQOs for the Phase II investigation have been met. The data should be of sufficient quality and quantity to support a Phase II conclusion for each AOC as to whether a release has occurred. The environmental professional should use Phase II results to further develop the CSM and to determine where data gaps may exist. A Phase II investigation is not complete until all significant data gaps are filled. For a Phase II investigation, a significant data gap exists when it is not possible to conclude with the appropriate level of confidence whether or not a release has occurred. When the risk to human health and/or the environment would be serious if a release has occurred, the environmental professional must have a high level of confidence to support a conclusion that a release has not occurred.

For each AOC evaluated by a Phase II investigation, one of the following two conclusions will be drawn:

- A release to the environment has occurred (COCs have been detected); or
- A release to the environment has not occurred (sufficient investigations have been completed, and COCs have not been detected).

A Phase II data evaluation requires knowledge of natural and/or background soil and groundwater quality based upon the weight of available evidence from multiple sources. Information to consider in evaluating whether concentrations of inorganic constituents are from a release or represent natural background concentrations includes:

- site-specific background data (representative data collected outside of any release area from soil with a similar texture and composition);
- occurrence with other contaminants (e.g., elevated concentrations [above background] of inorganic constituents and/or presence of man-made substances);
- leachability, particularly using the synthetic precipitation leaching procedure (SPLP) methodology for soil; and
- turbidity of groundwater samples.

It is not appropriate to compare Phase II laboratory data to RSR criterion to determine whether or not a release has occurred or to demonstrate compliance with the RSRs. However, Phase II data should be compared to the Significant Environmental Hazard Threshold concentrations for soil, groundwater, and soil vapor to determine potential obligations pursuant to Conn. Gen. Stat. Section 22a-6u.

4.4 Phase II Investigation Report

A Phase II investigation report is expected to be a clear, concise, and logical presentation of the information collected during a Phase II investigation and a refined CSM. In cases where Phase I and II objectives are addressed together, a combined report may be appropriate. A Phase II investigation report should include, but not be limited to, the following elements:

- an introduction stating the purpose, objective, and scope of the Phase II investigation and for whom the investigation was completed;
- a presentation of the preliminary CSM (typically compiled during a Phase I ESA) including, but not limited to, a summary of the current and historical environmental conditions at the site and

the current and former manufacturing or chemical handling processes conducted at the site; the identification of AOCs at the site, potential release mechanisms and locations, media of concern, substances and related COCs, potential migration pathways, and potential receptors;

- a discussion of the AOC-specific or site-wide DQOs for the Phase II investigation;

- a summary of the work completed during a Phase II investigation, including a description of the investigative strategy, sampling methodologies and analytical parameters; rationale for sampling location and depths, and a discussion of any deviations from the proposed Phase II scope of work and any relevant QA/QC issues that may affect data quality and data usability, based on the data quality assessment and data usability evaluation performed in accordance with procedures described in the QA/QC guidance document;

- findings of the Phase II investigation including, but not limited to, a description of site geology and hydrogeology and a summary of analytical sampling results of soil, groundwater, and other media of concern, and an assessment of whether the DQOs were met; and

- a presentation of the environmental professional's revised CSM, with conclusions drawn from the Phase II investigation that indicate whether or not a release has occurred at each individual AOC, including the rationale and assumptions used to arrive at the conclusions – if significant data gaps exist, indicating that the investigation is insufficient to determine whether a release has occurred, the conclusions should clearly state that the Phase II investigation is incomplete and that such data gaps should be filled before the Phase II investigation will be considered complete.

It may be appropriate to provide recommendations for further investigation to address data gaps associated with evaluating whether a release has occurred (a supplemental Phase II investigation) or delineating the nature and extent of a release (a Phase III investigation).

Information pertaining to the above topics should be presented in text, tables (e.g., analytical summary tables, summary of boring completion and well construction details, sampling rationale tables, summary of field measurements, summary of groundwater elevation measurements, details of field screening and instrument calibration), and figures (e.g., site location map presented on a USGS topographic map, map of locations of areas of concern, sample location map, groundwater contour map, geologic cross-section). Complete laboratory reports (including reported QA/QC data and narratives, as applicable), boring logs, and well completion reports should also be included as an appendix to a Phase II investigation report.

5. PHASE III INVESTIGATIONS

The purpose of a Phase III investigation is to define the nature, degree, and extent of the releases identified during the Phase II or other site investigations. The environmental professional uses Phase III information to further refine the CSM and, if necessary, to determine if remedial actions are required to achieve compliance with the RSRs and to provide sufficient data to develop a Remedial Action Plan (RAP). A complete Phase III investigation achieves the following:

- provides an understanding of the site conditions which control the migration of substances at each release area by assessing the transport properties of the environmental media (soil, sediment, groundwater, surface water, soil vapor, and indoor air) and subsurface structures through which contaminants may travel;
- defines the three-dimensional extent and distribution of substances associated with each release;
- evaluates how the distribution and concentration of COCs may change with time; and
- identifies receptors and describes how the current or future extent and concentration of such COCs may affect human health or the environment.

At the conclusion of a Phase III investigation, the environmental professional should have a sufficient understanding of the environmental system, which requires knowledge of site geology, hydrogeology, chemistry and fate of COCs and, where appropriate, ecology to evaluate potential risks to human health and the environment and to evaluate the need for remediation and to design a remedial approach.

5.1 Conceptual Site Modeling Approach to Phase III Investigations

The conceptual site modeling approach is critical in the planning, implementation, and interpretation of a Phase III investigation. The focus of a Phase III CSM progresses from an earlier emphasis on release origins and mechanisms to development and testing of hypotheses regarding contaminant fate and transport of the identified releases.

The conceptual site modeling process for a Phase III investigation should identify and address data gaps until the environmental professional has generated a valid CSM, in which no significant data gaps remain. A valid CSM should include an understanding and description of the following:

- DQOs;
- nature of the release, such as substances, timing, duration, volume, and location;
- nature of the contaminants, including solubility, volatility, degradability, and breakdown products;
- transport mechanisms, such as advection, diffusion, dispersion, colloidal and suspended transport, adsorption, desorption, gravity-driven flow of NAPL or highly concentrated solutions, and cross-media transfer;
- migration pathways, taking into consideration surface topography, surface water, geologic units, and man-made structures; and
- receptors, including humans, supply wells, sensitive flora and fauna, groundwater, surface water, sediment, and existing structures.

A complete Phase III investigation provides data of sufficient quantity and quality to develop and support a CSM that explains the distribution of contaminants in the context of the geologic and hydrologic framework, as well as the cultural setting, and how this distribution changes over time.

5.2 Designing and Implementing an Appropriate Phase III Investigation

A Phase III investigation should be designed and implemented to provide information about the geologic and hydrogeologic setting, to address data gaps from previous investigations, and to evaluate the nature, degree, and three-dimensional extent of a release to soil, groundwater, or other media. The rationale for the selection of sampling locations, depths, quantities, and methods, as well as analytical parameters and methodologies are based on the CSM, DQOs, and sound professional judgment. All applicable supplemental guidance should be consulted to ensure appropriate procedures are followed.

A Phase III investigation may be conducted in stages, with each subsequent stage building upon the preceding one. If appropriate for the circumstances, a Phase III investigation could be conducted as an Expedited Site Assessment, as described in supplemental guidance. Regardless, the scope of the investigation should be clearly stated.

The environmental professional should continually evaluate the significance of the data/data gaps, revise the CSM, and develop subsequent investigation activities accordingly. Key elements in designing and implementing a Phase III investigation are presented in the following subsections.

5.2.1 Geologic and Hydrogeologic Setting and Contaminant Fate and Transport

The geology and hydrogeology of a site and surrounding area affects the distribution, fate, and transport of contaminants. A Phase III investigation is based on knowledge of the geologic setting at a site, such as characteristics of the unconsolidated materials, identification and orientation of stratigraphic units, and bedrock (depth, structure, and type). Knowledge of site hydrogeology, including groundwater flow through geologic materials, horizontal and vertical hydraulic gradients, groundwater and surface water interaction, and preferential pathways, provides the framework for the environmental professional to evaluate the distribution, fate, and transport of contaminants within the context of the groundwater flow regime.

The environmental professional's understanding of physical, chemical, and biological processes provides insight into the migration pathway of contaminants, rate of degradation of COCs, and rate of transport. This insight is important to understand the spatial and temporal distribution of contamination and to predict the potential impact of contamination on receptors. In order to understand the spatial distribution and temporal variations of contamination in the environment, it will be necessary to obtain data regarding the physical, chemical, and biological nature of the soil and groundwater.

Factors that affect the spatial distribution include the rate and direction of migration and preferential pathways. Factors that affect the temporal variations of contaminant concentration and distribution include physical or chemical processes, such as advection, adsorption, absorption, dilution, phase transfer, oxidation/reduction, organic complexation, biodegradation, dispersion, and diffusion. Compounds produced by the degradation of contaminants or interaction of contaminants with the environment or other contaminants should also be considered in determining the degree and extent of contamination at a site.

5.2.2 Soil Characterization

A primary objective of a Phase III soil investigation is to characterize the three-dimensional degree and extent of contaminated soil resulting from releases and to evaluate this information within the context of the geologic and hydrogeologic setting. Only after the degree and extent of contaminated soil has been delineated and the geologic conditions have been identified can the environmental professional evaluate the potential risk and the necessity for remedial measures.

Generally, Phase III subsurface soil investigations are conducted using methods that allow the collection of soil samples from discrete depth intervals, such as split-spoon sampling or direct-push sampling methodologies. Other methods for evaluating the geologic setting at a site include trenching/test pitting, geophysical surveys, and review of existing engineering or environmental data collected during previous investigations. In some situations, the environmental professional may have sufficient information relating to a specific release to develop a sampling plan for a pre-determined depth. However, because of the inherent heterogeneity of soils and the need for chemical and geological information, continuous sample collection is usually necessary to adequately understand the variations in the geology and the three-dimensional extent of contamination in the subsurface.

Field screening methods often provide preliminary information regarding the distribution of contamination, the selection of soil samples for analysis, and the selection of additional soil sampling locations. Common field screening methods for soil may include, but are not limited to, the following:

- observations of staining or evidence of NAPL;
- using devices, such as a photoionization detector (PID) or a flame ionization detector (FID) that measures relative concentrations of total VOCs and portable gas chromatographs (GCs) that quantify the concentrations of specific compounds in real time;
- conducting on-site analyses with field test kits that can detect the presence and/or magnitude of chemical compounds; and
- conducting water-soil shake tests, dye tests, and screening samples under ultra-violet blacklight.

Field screening data often suggest a pattern to the distribution of pollution. Using the results of field screening as a guide, sampling locations may be selected that will ensure that the areas where COCs are found in the highest concentrations are identified and that the boundaries of the release are located both horizontally and vertically. If field screening methods are used, calibration procedures and protocols for use of field instruments should be documented.

Soil samples should be collected to identify and describe relevant stratigraphic units and soil characteristics. Delineation of polluted soil does not necessarily stop at the depth of the water table. Impacted soil may be present within the saturated portion of the unconsolidated material. Impact to saturated soil is particularly likely if the constituents are denser than water, the seasonal variation of the water table is significant, the release occurred below the water table, and/or a significant downward vertical gradient is present. Impacted soil below the water table represents a potential continuing source of groundwater pollution and a potential risk of direct human exposure. Therefore, such impacted soil should be delineated. Although the remedial strategy for polluted soils may be dependent on the depth of the contamination and the water table, the environmental professional is expected to have an appropriate understanding of the distribution of the contaminants in the saturated as well as the unsaturated zones.

The number and location of samples needed to delineate the degree and extent of contamination may be affected by the uncertainty of the location of the pollutant source/release area and the area of soil likely to be impacted by the individual source, or point source, relative to the size of the AOC. If the use of statistical methods is anticipated to evaluate the data, the environmental professional should ensure that a sufficient number of samples are collected to create a statistically representative data set. Supplemental guidance provides further information on certain statistical methods. If an on-site release extends offsite, the environmental professional is expected to employ best efforts to delineate the extent of the off-site release.

5.2.3 Groundwater Characterization

The objectives of a Phase III groundwater investigation are to characterize the hydrogeology of the site, to delineate the spatial distribution of COCs, and to evaluate the temporal variations and trends of all groundwater plumes originating from on-site releases. Characterizing groundwater plumes requires an understanding of the geologic setting, the hydrogeology of the site and surrounding areas, and the nature of the releases. Detailed knowledge of the composition and sequencing of geologic units is necessary for the proper placement and construction of monitoring wells in order to fully delineate groundwater plumes.

Factors affecting the distribution of contaminant plumes in bedrock aquifers generally differ from those in unconsolidated aquifers. Because of the heterogeneity and anisotropy of bedrock in Connecticut, characterization of these aquifers requires specific planning and specialized methods of data collection and interpretation. Advanced techniques may be required in order to understand bedrock structure and groundwater flow and to characterize contaminant distribution in the bedrock aquifer.

Monitoring wells should be properly located and designed under the direction of an environmental professional who has familiarity with the site hydrogeology. Such monitoring wells should provide representative data pertaining to the three-dimensional extent of the groundwater plume and fill data gaps identified in the CSM. Monitoring well locations and depths should be based upon source and receptor locations, known groundwater concentrations, hydrostratigraphic units, groundwater flow velocity, groundwater flow direction, and site-specific logistical considerations. Wells should be placed to find the groundwater plume boundaries, in three dimensions: laterally to find the horizontal limits at various depths to determine the vertical limit, and downgradient to establish the leading edge. Care should be taken when designing and installing monitoring wells to avoid cross-contamination between aquifers. If an on-site release extends offsite, the environmental professional is expected to employ best efforts to delineate the extent of the off-site release. If a critical position is inaccessible to standard drilling techniques, other methods, such as angle drilling from a remote location, should be considered. If direct data collection is not practicable, reliance on other lines of evidence will be necessary to fill data gaps.

Temporary monitoring wells can be effective tools for guiding the delineation of groundwater plumes in three dimensions and for determining the locations of permanent monitoring wells, which are necessary to evaluate temporal variations in groundwater quality. Sampling of permanent monitoring wells may be necessary to confirm results obtained from the temporary sampling points, if warranted by the DQOs.

Groundwater chemical and physical data obtained from a well are only representative of the area in proximity to the screened interval. Therefore, it is critical that screened intervals are selected with foreknowledge of the subsurface geology, the contaminant distribution, and with a specific purpose. If a screened interval crosses more than one hydrostratigraphic unit, data obtained from this well is weighted toward the units with higher transmissivity.

Maps of hydraulic head distribution should only be constructed using groundwater elevation data collected from wells screened in the same hydrostratigraphic unit. Such maps should be developed with, and evaluated in context of, the environmental professional's understanding of the site and regional hydrogeology.

It is often necessary to evaluate both horizontal and vertical hydraulic gradients. Determining the horizontal gradient is necessary to evaluate the rate and direction of groundwater flow. Determining the vertical gradient will assist in evaluating the rate and direction of groundwater flow between hydrostratigraphic units, the vertical profile of a groundwater plume, and the local or regional discharge and recharge areas. The environmental professional is expected to document their rationale and basis for not evaluating both the horizontal and vertical hydraulic gradients.

The environmental professional should consider how groundwater plumes frequently change size, position, and concentration over time. The temporal changes can be consistent, such as with an advancing or a shrinking plume, or they can be variable, such as with seasonal concentration changes related to fluctuating groundwater levels. Sometimes, seasonal changes are superimposed on a larger-scale consistent trend of an advancing or receding plume, making a correct interpretation difficult if sufficient data are not collected. Concentration changes also may be attributable to tidal fluctuations and should be considered where appropriate.

5.2.4 Non-Aqueous Phase Liquids

If the CSM indicates a potential for NAPLs, the Phase III sampling and analysis plan should be designed to evaluate if NAPLs are present. NAPL may be present at the site either as mobile, separate-phase product, relatively immobile interstitial separate-phase product, or sorbed onto soil grains. Special care should be taken to ensure that cross-contamination does not occur when evaluating the presence of NAPLs. If NAPL is present, the Phase III investigation should identify the source and evaluate the spatial distribution. If DNAPL is present, permeability contrasts in unconsolidated materials, saturated and unsaturated flow characteristics, and/or the topography of the bedrock surface may play a crucial role in the migration of contaminants. The environmental professional must take into consideration cross-media contaminant transfer and potential impacts to receptors when conducting investigations that may encounter NAPLs.

5.2.5 Characterization of Other Media

If the characterization of other media is necessary to investigate the extent and degree of a release, a Phase III investigation of such media should be conducted using the conceptual site modeling approach.

5.2.5.1 *Surface Water*

If the CSM indicates that surface water may be impacted at levels that pose a risk to human health, the environment, or the designated uses of such surface water as a result of a release or discharge of pollutants from the site, a Phase III investigation should include an investigation of surface water quality. Such an investigation should be sufficient to characterize the degree and extent of contamination and to evaluate the potential impacts to sensitive receptors. The environmental professional’s evaluation of the impact to surface water quality may require upstream (background) water quality data, knowledge of surface water characteristics, and an understanding of groundwater and sediment quality.

5.2.5.2 *Sediment*

If the CSM indicates that sediment may have been impacted by a release or may be comprised of eroded polluted soil from a release, the collection of sediment data should be sufficient to characterize the degree and three-dimensional extent of contamination and to evaluate the potential impacts to sensitive receptors. The environmental professional's evaluation of potential impacts to sediment requires an understanding of the depositional and transport mechanisms, background sediment quality, and groundwater and surface water quality.

5.2.5.3 *Soil Vapor*

If the environmental professional determines that soil vapor sampling and analysis is appropriate, he/she should consider potential sources of off-gassing and preferential vapor migration pathways in the design of the soil vapor sampling plan. Factors that may affect vapor migration include phase changes, partitioning, diffusion and advection; weather; and the presence of temporary and permanent barriers. If the environmental professional determines that there is a risk of vapor intrusion, soil vapor data should be of sufficient quality to assess such potential risk. Supplemental guidance provides more detail on soil vapor sampling.

5.2.5.4 *Indoor Air*

When an environmental professional conducts indoor air sampling and analysis, he/she should consider potential sources of off-gassing, preferential vapor intrusion pathways, the presence of temporary and permanent barriers, building usage/occupancy, ventilation/air conditioning systems, indoor sources of VOCs, seasonal conditions, building construction, and background conditions. Additional information on indoor air sampling can be found in supplemental guidance.

5.2.6 Analytical and Numerical Modeling

Analytical and numerical models are tools that can be used to represent an environmental system and the fate and transport of contaminants within that system. For example, models can be effectively used to help select well locations and to assist in the subsequent remedial decision and design process. It is necessary that any model analysis utilized as a basis for a remedial action plan be fully supported by quantitative data, including three-dimensional data, as needed in the context of the specific situation.

The purpose of any model should be clearly stated. Properly constructed, calibrated, and validated models are useful in predicting the behavior of the modeled system. Sensitivity analysis should be performed to demonstrate that the input parameters are known to an adequate degree of certainty for the modeling objective.

While valuable insights can be gained from any modeling exercise, every model has its limitations. These limitations should be viewed objectively and carefully considered based on the stated purpose of the model.

5.3 Evaluation of Phase III Investigation Results

5.3.1 Relationship to the CSM

Before a Phase III investigation can be considered complete, the environmental professional is expected to evaluate all of the data collected in the context of the CSM and the DQOs. That evaluation should determine whether the data collected throughout the investigation process supports the existing CSM, whether the CSM requires additional refinement, or whether the CSM has been validated by the Phase III data collection effort.

The CSM is considered to be validated when all significant data gaps have been filled and only one CSM can be supported by the existing data. The significance of remaining data gaps is determined in the context of the DQOs. If significant data gaps remain at the anticipated completion of a Phase III investigation or if more than one CSM can be supported by the existing data set, then it can only be concluded that additional data collection is necessary to resolve outstanding issues.

5.3.2 Sufficiency of the Investigation

The data collected during the investigation of the site should be of sufficient quantity and quality for the environmental professional to understand the nature of the release, the nature of the contaminants, the three-dimensional distribution of contaminants in the context of the geologic and hydrologic framework, as well as the cultural setting, and the spatial distribution and temporal variations of the pollution. Based on this understanding, the environmental professional should have sufficient data to evaluate the potential risk of impact to human or environmental receptors and the need for remediation. In order for the environmental professional to determine that the investigation is sufficient, he/she should be able to conclude that the data and level of confidence in the data are appropriate. The level of confidence in an investigation is a function of the quality and quantity of the data, consistency of the CSM with the collected data, and the potential risk to human health and the environment. To determine that data quality objectives have been met, it is necessary to know the quality of the data used for decision-making and to conclude whether or not the data is sufficient for the intended purpose. When evaluating if the site investigation is sufficient, the environmental professional should ask, "With an appropriate level of confidence:"

- Did the investigation achieve the data quality objectives?
- Have all potentially impacted environmental media been adequately characterized?
- Are the fate and transport dynamics of each COC at each release area understood in the context of the physical setting?
- Are the data of sufficient quantity and quality to explain the three-dimensional and temporal distribution of contaminants in the context of the geologic, hydrogeologic, and hydrologic framework?

- Is the refined CSM consistent with the data (e.g., Do the data make sense?)?

- Based on the data, does the CSM need to be refined in terms of the environmental setting and understanding of the pollution (e.g., Do the data indicate the presence of previously unknown stratigraphic units/lenses which may influence the migration of pollution?)?

- Are there significant data gaps identified through the CSM?

- Is the QA/QC appropriate and defensible? Does it achieve the standard of care?

- Are the data sufficient to evaluate the potential risk to human health and the environment and the necessity for remedial measures?

5.3.3 Ecological Considerations

For the purposes of site characterization, further investigation may be needed to determine if a release has contaminated an ecological receptor. Such investigation may include additional assessment of soil, sediment, and/or surface water. Pursuant to Section 22a-133k-2(i) of the RSRs, the Commissioner has the authority to require that an Ecological Risk Assessment (ERA) be conducted in accordance with USEPA "Framework for Ecological Risk Assessment" (February1992) and that any additional remediation be conducted to mitigate any risks identified in such an assessment. Therefore, CTDEP strongly recommends that potential ecological exposure pathways, where contaminants could affect aquatic and terrestrial life, as identified in the CSM, are evaluated. CTDEP also recommends that the environmental professional consult with DEP in a timely manner if the site characterization data indicates that an ERA would be necessary, so that CTDEP can then work with all stakeholders throughout the ERA process.

5.4 Phase III Investigation Report

A Phase III investigation report is expected to clearly and logically present the environmental data collected during a Phase III investigation and explain how these data validate the hypotheses of the CSM regarding the fate and transport of COCs from each release. A Phase III investigation report may also present an evaluation of site data with respect to compliance with the RSRs and of remedial technologies or strategies for achieving compliance with RSRs.

It is important that findings of facts be clearly differentiated in the report from conclusions/professional opinions drawn from the facts. It is expected that the environmental professional will present the rationale for sampling strategies, DQOs, and conclusions. A reader of the report who is unfamiliar with the site should be able to follow the environmental professional's line of reasoning and reach the same conclusion based on data presented in the report.

For some site investigations, separate reports for each phase may not be necessary. In cases where a Phase III is combined with a Phase I and/or Phase II and the objectives are addressed in one investigation, a combined report is appropriate. However, if a combined report is prepared, that fact should be clearly documented, and the key components of each individual phase should be defined.

A Phase III investigation report includes, but is not limited to, the following elements:

- an introduction stating the purpose, objective, and scope of the Phase III investigation and for whom the investigation was completed;

- a summary of the environmental setting and current and historical environmental conditions at the site and the current and former operations, including chemical and/or waste storage and handling processes conducted at the site, the AOCs identified at the site, and the substances and related COCs associated with each AOC;

- a presentation of the revised CSM based on the Phase II investigation, including, but not limited to the identification of release areas, release mechanisms and locations, media of concern, substances and related COCs, and migration pathways;

- a discussion of the DQOs for the Phase III investigation of each release area;

- a summary of the work completed during the Phase III investigation in context of the Phase II CSM, including the rationale for and a summary of the sampling objectives; the density, frequency, locations, and depths of sampling; field procedures and any deviations from the proposed sampling plan; analytical methods; details of field screening and instrument calibration; and any relevant QA/QC issues that may affect data quality and data usability, based on the data quality assessment and data usability evaluation performed in accordance with procedures described in the QA/QC guidance document;

- findings of the Phase III investigation which include, at a minimum, a more fully developed description of site geology and hydrogeology, the spatial distribution and temporal variations in concentrations of COCs for each media of concern for the site, and an assessment of whether the DQOs for each release area were met;

- a fully developed CSM which addresses potential source mechanisms, potential pathways for contaminant migration in each medium, sensitive receptors, and the fate of substances and related COCs in the environment, as well as any issues that were not addressed or tasks that were not completed during the site characterization – additionally, any data gaps remaining after the completion of the Phase III investigation should be clearly documented;

- conclusions of the Phase III investigation, including an interpretation of the findings that document the degree, three-dimensional extent, temporal variation and migration of released COCs; an assessment of the environmental implications of the release; and the rationale used to arrive at the conclusions; and

- recommendations for additional investigations if significant data gaps remain.

The results of a Phase III investigation are expected to be presented in a clear, concise, and logical format. Tabular, graphical, and other methods of data presentation should be considered in organizing and presenting data, evaluating the results, and making decisions for further actions. Examples of appropriate tables include analytical summary tables, a summary of boring completion and well construction details, sampling rationale tables, a summary of field measurements, a summary of groundwater elevation measurements, and a summary of samples collected, sampling rationale, and analytical results organized by AOC. Examples of appropriate figures include site location maps presented on a USGS topographic map, AOC and sample location maps, groundwater contour maps, geologic cross-sections, contaminant distribution maps, and bar and/or line graphs illustrating concentration with respect to time or distance to predict contaminant trends at the site. Complete laboratory reports, including reported QA/QC data and narratives, as applicable, should also be included as an appendix to a Phase III investigation report.