Hello all,

We are looking forward to seeing you at our next Working Group meeting later today. At this meeting, DEEP plans to discuss:

- The under-construction release management system
- Statutory changes we believe are necessary to move forward in conjunction with the Release-based Cleanup Regulations
- DECD's effort to conduct a PFAS soil background study working with USGS, in coordination with DEEP

As a follow up, the Release Characterization Guidance is attached. It was important that this guidance be available to help inform your review of the regulations. This will be one of the items we will continue to coordinate on with the Working Group. DEEP will present the Release Characterization Guidance at the Remediation Roundtable on October 29th. That presentation will kick off an effort to seek public and Working Group comments on this guidance, with comments likely due in late 2024.

Further, at the last Working Group meeting, we made reference to two documents related to Permitted Environmental Professionals. Here are links to these documents: Role and Qualifications of Non-LEP Environmental Professionals (Subcommittee 10) and Draft Proposal for a Transformed Cleanup Program (see Early Exits). The older document uses the term QEPs (Qualified Environmental Professional) in discussing the group of professionals currently called PEPs. For reference, all previous Release-Based Clean-up Program Regulation Development documents are available at Stakeholder Engagement.

We look forward to seeing you soon.

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Connecticut
Department of Energy &
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Release Characterization Guidance

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1 Introduction

You've discovered a release. What do you do next?

The Connecticut Department of Energy and Environmental Protection (DEEP) has developed this Release Characterization Guidance (RCG) document to assist the environmental professional in constructing a conceptual site model (CSM) for an identified release and conducting investigations to support and refine the CSM as they develop an understanding of the release and the distribution of related contaminants in the environment.

In Connecticut, a site-wide approach to environmental characterization has traditionally been required, wherein the characterization begins with identifying potential sources of contaminants (Phase I) followed by development of a conceptual site model (CSM). Validating the CSM requires sampling of environmental media to determine if releases occurred (Phase II), and then characterizing the degree and extent of identified releases (Phase III). This phased approach may still be used, if not required, in some site characterization situations and is described in more detail in Section 4.

Under the Release-Based Cleanup Regulations (RBCRs), the obligation to characterize a release will typically begin once a release has been discovered. However, the investigation process will still use the same basic methodologies and tools common to the Phase I/II/III process to gather information and data about a release area and develop a release-specific CSM).

This RCG document explains what a CSM is and then describes the conceptual site modeling process (Section 2), which serves as the foundation for the characterization of both individual releases and entire sites. Section 3 describes the release characterization process and outlines the type of information needed to develop and validate a CSM. In Section 4, the release characterization concepts are expanded upon to implement Phase I/II/III investigations and develop a site-wide conceptual model, if necessary. Finally, Section 5 describes how to incorporate the CSM into a report.

Emergent Reportable Release: Guide Notes

Where appropriate, guide notes specifically relating to Emergent Reportable Releases (ERRs) will be called out to emphasize differences in the characterization process.

The certification or verification of ERRs by either a PEP or LEP may require less extensive characterization because remediation will often occur within hours of the release. As a result, the CSM can be streamlined.

1.1 What the RCG Is

The RCG is a roadmap to the conceptual site modeling process. In developing an understanding of the release conditions or site conditions (as applicable), and the distribution of contaminants in the environment, the environmental professional is expected to formulate a CSM and refine it throughout the characterization process as additional information about the release or site is gathered. The RCG is a guide to developing, implementing, and documenting that process.

The RCG describes an approach and standard of care for developing a CSM by designing, conducting, and documenting release characterization using the scientific method. When setting out to characterize any release in accordance with prevailing standards and guidelines, DEEP highly recommends the approach presented in the RCG, as such an approach will be acceptable to the Commissioner. DEEP acknowledges that there are other investigative approaches that may be acceptable; however, DEEP's review of alternative approaches would be necessary to evaluate the applicability of the alternative approach and whether such alternative approach meets characterization expectations necessary to properly apply the RBCRs.

The RCG also serves as a guide to implementing a site-wide, multi-phased approach to site characterization when such an approach may suit business needs better than implementing an individual release area investigation. Site-wide characterization takes a holistic approach to the characterization process and brings together all the potential release areas at a site under the Phase I/II/III umbrella. The site-wide CSM should build off the release-specific CSMs to create a unified environmental understanding of the site conditions.

1.2 What the RCG Is Not

The RCG is **not** intended to be a prescriptive manual that describes specific investigative procedures. Additional technical guidance pertaining to specific components of site characterization is available on DEEP's website.[1] These supplemental guidance documents will be updated as technologies and methodologies advance over time.

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

[1] Guidance Documents – https://portal.ct.gov/DEEP/Remediation--Site-Clean-Up/Guidance/Remediation-Guidance-Documents

2 Conceptual Site Modeling

The CSM and the environmental professional's documentation and presentation of the conceptual site modeling process are the basis for communication of an effective environmental characterization. Conceptual site modeling is based on the scientific method of inquiry and is DEEP's expectation for the standard of care used in identifying and/or characterizing releases. The CSM provides an understanding of the nature and distribution of contaminants necessary to evaluate compliance with the RBCRs, assess potential risks to human health and the environment, and design an effective remedial strategy. A CSM can be used to describe a single release, an area impacted by several comingled releases, or an entire site. The RCG focuses on development of a CSM for a single release area; however, the same principles apply when multiple release areas are present at a site and the individual release CSMs can be used to construct a larger site-wide CSM.

Emergent Reportable Release: Conceptual Site Model

The rapid nature of spill response may result in a less linear development of the CSM than the process described in this section; however, the pace at which details are gathered and decisions are made make the CSM process of gathering reliable data just as important for ERRs.

2.1 What is a Conceptual Site Model?

The RBCRs define a CSM as:

> "a representation in three dimensions of environmental conditions at a release area that is developed through a multi-phased investigative approach which validates such representation with information about, including, but not limited to, a substance's release, fate and transport, and pathway to human and environmental receptors." RCSA § 22a-134tt-1(a)(23).

At its most fundamental, a CSM is a story of "what happened" that is built around evidence gathered during the investigation and aims to identify receptors that could be impacted by an identified release. Other roles performed by the CSM include:

- Living model that will change over time as data is gathered.
- Representation of the environmental system under evaluation.
- Tool for understanding and explaining to others the basis and rationale for the investigation of a release area and the conclusions drawn about the environmental conditions at that release area in three dimensions and how those conditions change over time.
- Means of tying together information about a substance's release, fate, transport mechanisms and pathways, and any potential receptors.
- Critical tool for evaluating whether data gaps are significant. Every CSM will have data gaps because it is not possible to know everything about a release, but a well-developed CSM will help the environmental professional to determine if those data gaps hinder the formulation of a scientifically defensible interpretation of environmental conditions or potential risks.

At all times, the CSM is the most current understanding of the area being investigated/remediated. For this reason, effective communication of the CSM through proper documentation is essential.

2.2 The Conceptual Site Modeling Process

While the CSM itself represents the most current understanding of a release area, the process of developing the CSM is an iterative approach to site characterization that includes gathering information and collecting samples for analysis. 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. This includes what can be seen and measured in the field and data obtained by analyzing samples. Each piece of information is a line of evidence that can be used to test a hypothesis.
- **Hypothesis-based science** develops tentative answers to structured questions. These tentative answers are tested by making observations or by designing and carrying out investigations (descriptive science). While no scientific hypothesis can be absolutely proven, a hypothesis can be deemed credible or implausible through appropriate testing. The more lines of evidence there are to support a hypothesis, the stronger its credibility.

During the conceptual site modeling process, the environmental professional develops and validates a CSM. The CSM may start out as a hypothesis or even a question, such as, "What caused this release?" 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 vary and will be a function of the complexity of site conditions and the data quality objectives (DQOs – discussed below) established for the release characterization.

Components of the Conceptual Site Modeling Process

The conceptual site modeling approach consists of key components that should be applied throughout the entire release characterization process from the initial query through validation of the CSM.

Develop a preliminary CSM from available information – At the very beginning of the conceptual site modeling process, the investigator defines the boundaries of their knowledge to develop a plan of investigation. This compilation of what is known and what is not known is the CSM and will be modified as data is gathered.

- What do you already know?
- What do you think might have happened (and what might happen in the future)?
- What do you not know that you need to know?

Define the purpose of the investigation – What are you trying to learn? How will you learn it? Some common questions that can help focus the purpose of the investigation include:

- Where and how did the release occur?
- What could be the source of a release and how did pollution get to where it is now?
- What substances are in the release, and the release area, and at what concentrations?
- Where might released substances go?

Emergent Reportable Release: Characterization

The investigation of ERRs will often be a condensed version of this process, possibly occurring within hours of the release. Increased certainty about the release may mean it requires fewer information sources and less data to understand what happened and demonstrate that remedial actions succeeded in removing all impacted material.

- Who/what could be impacted by a release?
- What are the background conditions in the release area? See Section 3.3 for more information regarding background.
- What is the three-dimensional extent of the release area?
- Do you need more data to determine if the release area meets cleanup standards or to satisfy other project objectives?

Establish DQOs – DQOs are goals specific to the release area being investigated to ensure that a sufficient quality and quantity of data are collected to achieve the investigation objectives and support conclusions and decisions made during characterization, development of the CSM, and evaluation of risks to human health and the environment. They are developed by the environmental professional so that a sampling and analysis plan can be designed to answer specific questions about a release area. Examples of some common DQO questions include:

Emergent Reportable Release: Data Quality Objectives

Although ERRs involve a rapid response, establishing DQOs are still important for collecting data of sufficient quality to close out the release.

- What are the constituents of concern (COCs)?
- What locations are most likely to be impacted by a release?
- What types of samples are needed (soil, groundwater, surface water, air, sediment, etc.)?
- How many samples are needed? From what depth? Will the data set be sufficiently representative if statistical analysis is conducted?
- Is background sampling needed?
- What sampling methods are appropriate to obtain the necessary data?
- What analyses and specific analytical methods are appropriate?
- What reporting limits are needed (consider factors such as compliance criteria, ecological risk evaluation, etc.)?

How far along the investigation is will often guide the answers to these and other DQO-related questions and frame how the results of the investigation are interpreted. As a result, DQOs may change through different stages of the investigation.

Additional information concerning the quality, usability, and evaluation of laboratory analytical data can be found online at DEEP's Laboratory Quality Assurance Quality Control - Reasonable Confidence Protocols (RCPs).[2]

Design and implement the investigation – Select sampling locations that will fulfill the purpose of the investigation and achieve the DQOs. Collect and analyze samples. Determine what the data tells you about the release and possible receptors. Does the information gathered support the CSM you used to design the investigation?

Identify and resolve significant data gaps – What critical information is missing after your investigation? How will you fill that gap in knowledge?

[2] RCPs – https://portal.ct.gov/DEEP/Remediation--Site-Clean-Up/Guidance/Quality-Assurance-and-Quality-Control

Refine the CSM based on new data

- Does the data solidify the current understanding?
- Does the data suggest something different happened than previously thought?
- Are there unresolved or new significant data gaps that need to be closed?
- Do receptors need to be reevaluated?

Continue the CSM process, working back through the steps above, until a final CSM can be validated to the point where all significant data gaps have been resolved and all DQOs have been achieved.

2.3 Documenting a Conceptual Site Model

At any given point in the conceptual site modeling process, the CSM should be presented as a description of what the environmental professional understands about a release area. It is **not** a chronological list of all the information collected or a list of substances detected in each sample. Rather, it is a synthesis of what has been learned throughout the investigation process. The level of detail necessary to document a CSM is dependent on the complexities of the release area, the findings of the investigations, and who is going to be reading the final document. Every CSM should leave the reader with an understanding of what the environmental professional understands about a release area and what information (if any) is missing.

Emergent Reportable Release: Conceptual Site Model Documentation

The complexity of a release and response will determine how much documentation is needed. For ERRs, CSM documentation should pull together the details critical for understanding the release, spill response, and data used to support closure.

2.3.1 General CSM Structure

Presentation of the CSM is as critical as the data collected. The information needs to be organized in an easily understood manner that provides the reader with a clear understanding of what happened, how extensive the release is, and what the risks are to human health and the environment. It should also make clear distinctions between findings, conclusions, inferences, and hypotheses. Naturally, the extent of investigation completed at a release area will determine how much information is available to describe the release area with more details and broader understanding being added as the investigation progresses. Key CSM structural elements include:

- **Narrative** – Description of the release area and associated impacts. What happened? What is the extent of contamination? Who has been impacted?
- **Visual Elements** – Photos, figures, tables, and graphs that highlight key points of the narrative and can be more effective than words.
- **Supporting Information** – Additional details that back up the narrative but don't necessarily need to be in the narrative, such as lab reports.

2.3.2 CSM Narrative

The CSM narrative is a clear, concise description of what happened, what you know about the release based on an interpretation of the available data, and who or what has been impacted. Below is an overview of the key types of information that comprise a fully developed CSM narrative. How much detail is needed will be determined by the nature of the release, but each of these elements has an important role in shaping the CSM:

- **General Release Information** – Describe the release area and key features that contribute to understanding the release mechanism and migration pathways. Use visual elements as appropriate to show current/former conditions at the release area.
- **Operational History** – Summarize the operational history and processes in and around the release area, including raw chemical and waste handling areas. Identify COCs that could be associated with the release area and any evidence that suggests how the release may have occurred.
- **Environmental Setting and Migration Pathways** – Describe the environmental setting in which the release occurred and potential migration pathways. Include the geology, hydrogeology, topography, and any other factors that could influence contaminant migration or affect interpretation of potential impacts (e.g., groundwater quality classification or well receptor survey results).
- **Release Identification** – Describe how the release was identified, what was released, and the source of the release. Show the release area and relevant sample locations on figures. Provide tabulated data that clearly and concisely indicates which classes of compounds were analyzed and what was detected.
- **Nature of the Contaminants** – Incorporate important properties of the contaminants into the CSM narrative, particularly as they relate to DQOs, characterization decisions, and risk evaluation, including solubility, volatility, degradability, and breakdown products.
- **Release Characterization** – Document the known lateral and vertical extent of the release area. Show the extent of the release area and relevant sample locations on figures. Provide tabulated data that clearly and concisely indicates which classes of compounds were analyzed and what was detected in each impacted medium.
- **Risk Evaluation and Receptors** – What are the risks to human health and the environment? Consider drinking water wells, indoor air (particularly the lowest level of a structure), surface water bodies, and sensitive ecological habitats. Also consider planned future uses of the property.
- **Remediation** – Summarize remediation conducted and results of confirmatory sampling, if applicable. Describe data gaps and explain why there are no remaining significant data gaps.
- **Rationale and Assumptions (DQOs)** – Throughout the characterization process, the information at hand will be used to determine the next steps and, in some cases, make assumptions and develop hypotheses, particularly when the available information is incomplete. It is critical to document how the data is representative of the release area and the rationale for various decisions along the way. Examples include why certain locations and depths were targeted for sampling and how the resultant data supports any conclusions. The context of why a sample was collected, where it was collected, and what it represents is just as important as the reported analytical value. This also relates to the DQOs, and part of the decision-making process is keeping track of how DQOs were met throughout the investigation to achieve reliable conclusions.
- **Conclusions** – The conclusions for release areas will vary based on the objective of the investigation and what is known at the completion. Conclusions should identify the lines of evidence and assumptions they rely on. Examples of some lines of evidence include:
    - Visual observations
    - Field measurements and screening results
    - Soil analytical data
    - Groundwater analytical data
- **Recommendations** – It may be appropriate in some instances to include recommendations to close significant data gaps. If so, clearly identify what the remaining questions are.

2.3.3 Visual Elements

Photos, figures, tables, and graphs are powerful tools to clearly show the extent, distribution, and magnitude of the release and present information important to the narrative that is otherwise difficult to convey with words:

- **Photos** – Provide a visual reference to situations and settings and minimize explanatory text.
- **Figures** – Useful for depicting a release area and the three-dimensional extent of impacts in the context of its surroundings, potential sources, migration pathways, and receptors. Show the known extent of impacts on a figure.
- **Tables and Graphs** – Can be used to concisely display numerical data and other information and to highlight patterns in numerical data. Consider what you are trying to convey in a table. Avoid making the tables a data dump (i.e., dumping all analytes into a table without considering organization based on key COC groups, detected parameters, or patterns in the data). The way the data is presented can highlight what is detected in specific samples or the distribution and magnitude of a specific parameter across multiple samples. Use tables and graphs to help make your point.

2.3.4 Supporting Information

All the details and data from which the narrative, rationale, and compliance evaluation are derived, while important, do not always warrant an exhaustive description within the CSM narrative itself. Such information is important for backing up conclusions and assumptions, however, care should be taken not to simply list analytical data for the reader to interpret and overwhelm the core narrative with too many details about data collection and interpretation methods. Examples of supporting information that should be referenced in, and possibly appended to, the narrative include:

- Data quality assessments (DQA) and data usability evaluation (DUE) – see DEEP's Quality Assurance and Quality Control webpage[3]
- Investigation and analytical methods
- Field data, logs, and screening results
- Standard operating procedures
- Laboratory reports

[3] DQA/DUE Resources – https://portal.ct.gov/DEEP/Remediation--Site-Clean-Up/Guidance/Quality-Assurance-and-Quality-Control

3 Release Characterization

Release characterization is a process whereby sufficient data is collected to define the nature, magnitude, and three-dimensional extent of a release. The CSM approach is critical in the planning, implementation, and interpretation of investigations as they progress from an earlier emphasis on release origins and mechanisms to development and testing of hypotheses regarding contaminant fate and transport of the identified release and who or what might be impacted by the release. The characterization process should identify and address data gaps until the environmental professional has generated a valid CSM, in which no significant data gaps remain and all DQOs have been met. Such characterization achieves the following:

> **Emergent Reportable Release: Characterization**
>
> Release characterization is about defining the extent of a release, often to assist with cleanup decisions. For ERRs, the extent will typically be determined concurrent with cleanup and may incorporate, or consist solely of, confirmatory sampling.

- An understanding of the site conditions that control the migration of substances at the 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
- The three-dimensional extent and distribution of substances associated with the release
- How the distribution and concentration of COCs may change with time
- Identification of receptors and a description of how the current or future extent and concentration of such COCs may affect human health or the environment
- Identification of potential ecological exposure pathways where contaminants could affect aquatic and terrestrial life and potential ecological risks through the completion of a screening-level ERA

At this point, the environmental professional should have a sufficient understanding of the environmental system (including geology, hydrogeology, chemistry, and fate of COCs, and ecology) to evaluate potential risks to human health and the environment, determine the need for remediation, and design a remedial approach.

If significant data gaps remain at the anticipated completion of characterization 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 and validate the CSM. Refer to Section 2.3 for additional details on documenting a CSM.

3.1 Release Area Research

Once a release has been identified, an important next step is to gather sufficient information about the possible nature of the release to design and implement an investigation to characterize the release. Such information may include current and historical operations in and around the release area that could be a source, possible migration pathways, and who or what might ultimately be at risk from the release. These details help to build a solid foundation for a CSM before additional samples are collected and will serve to inform future steps in the investigatory process.

> **Emergent Reportable Release: Release Area Research**
>
> This process may be limited to gathering key information about the nature of the release and associated operations to properly respond. The collection of this information should not impede the timely removal of ERRs.

Appendix A includes a list of possible resources that can be used to acquire historical details about a release area and its immediate surroundings. The types of information that may be obtained through a review of historical documentation, site personnel interviews, and site inspections include the following:

- **Site History and Operations**
  - Current and historical operations and processes in the vicinity of the release area
  - Current and historical material storage, handling, and disposal practices at the release area
  - Site development history and building additions and/or modifications near the release area
  - Substances and COCs that could be components of the release
  - Potential release mechanisms
  - Abutting property use and potential release sources that could also impact the release area
- **Environmental Setting**
  - Surface cover (e.g., paved/unpaved areas), wooded areas, and landscaped areas
  - Topography and its significance to inferred direction of shallow groundwater flow, surface water drainage, inferred depth to the water table, and potential contaminant migration
  - 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
  - Hydrology and hydrogeology, including surface water, groundwater, and wetland boundaries
  - Modifications to the natural environment, such as construction, cutting and filling, watercourse modification, and underground utilities
- **Potential Receptors**
  - Land uses specific to the site and the surrounding areas with specific attention to land uses that may involve sensitive receptors, such as schools, childcare centers, recreational areas, and healthcare facilities.
  - Water use, including but not limited to, public or private drinking water wells, reservoirs, wastewater, surface water intakes, and industrial/commercial or agricultural purposes (consider state groundwater and surface water quality classifications)
  - Ecological receptors – A Scoping-Level Ecological Risk Assessment (ERA) may be necessary to evaluate whether there are potential stressors and ecological communities associated with a release. If the potential for ecological risk is found to exist, the ERA continues throughout the CSM process.

The level of research should be sufficient to support the conclusions drawn by the environmental professional regarding the release and to allow others to understand how those conclusions were reached.

3.2 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. 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. To understand the spatial distribution and temporal variations of contamination in the environment, it will be necessary to understand the characteristics of each COC and obtain data regarding the physical, chemical, and biological nature of the soil and groundwater:

- **Spatial Distribution** – Factors that affect the spatial distribution include the rate and direction of migration and preferential pathways.
- **Temporal Variations** – 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.
- **Degradation** – 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.

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

- **Surface Spills** – 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.
- **Subsurface Liquid Migration** – Non-aqueous phase liquids (NAPL) 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, the bedrock surface, 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.
- **Volatilization** – 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.

- **pH** – 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.

3.3 Appropriate Degree of Characterization

Determining compliance of a release area with cleanup standards is often a key concern during characterization and is closely linked with protecting human health and environmental receptors. It is important to understand, however, that while data may be compared to various cleanup criteria throughout the investigation phases as part of a continuous assessment of risk to receptors, final compliance with the RBCRs cannot be demonstrated until the magnitude and extent of the release area are characterized. Most compliance provisions in the RBCRs are designed to be implemented for an entire release area, not individual samples.

Emergent Reportable Release: Appropriate Characterization

ERRs are expected to be removed to the maximum extent practicable, and characterization will typically occur concurrent with cleanup, often in a shorter timeframe than existing releases.

The degree of characterization necessary to consider a release characterized will depend on the knowledge available about the release. Without sufficient knowledge about a release source, timing, and the fate and transport mechanisms of the release constituents, a release is characterized when the point at which it can no longer be detected is identified. When there is sufficient knowledge about a release source, timing, and the fate and transport mechanisms of the release constituents, it may be possible to consider a release characterized based on other factors.

It should also be noted that completion of characterization is not necessary to initiate immediate actions required under RCSA § 22a-134tt-5. While some action taken to abate IAs may result in compliance with the RBCRs, the need for additional characterization beyond that point should be evaluated.

3.3.1 Multiple Lines of Evidence

If the limits of impacts associated with a release have not been identified, multiple lines of evidence will be necessary to demonstrate that the CSM is sufficient to achieve project goals and regulatory objectives. Such lines of evidence should include an evaluation of the following:

- The source is known and/or the source area is clearly defined with concentrations decreasing away from the point of release (e.g., stained soil beneath a soldering vent).
- The release mechanism is known.
- Migration pathway(s) are well understood.
- Environmental setting into which the release occurred (including composition of the soil, exposure to precipitation, hydrogeologic conditions, etc.) is well understood.
- Potential receptors are known and protected.
- Data gaps are insignificant.

- There is a technical reason for limiting characterization:
    - Impacts extend to bedrock.
    - Impacts are contained entirely below a building.
    - The presence of roadways, utilities, steep terrain, etc. prevent safe access.
    - A planned remedial strategy will be sufficiently protective of human health and the environment such that additional characterization would not alter the remedial action plan.
    - The investigation is for a brownfield assessment that limits the degree of off-site characterization required (Abandoned Brownfield Cleanup and Brownfield Remediation & Revitalization Program).

3.3.2 Minimum DQOs

The appropriate degree of characterization will vary by release area and the knowledge available, but the DQOs for all release areas should, at a minimum, include the following:

- Be protective of potential receptors.
- Collect sufficient data to demonstrate that the concentrations of all COCs for the release are decreasing away from the point of release in three dimensions.
- Collect sufficient data to demonstrate that there are no exceedances associated with the release beyond the extent of samples collected.

3.4 Designing and Implementing an Appropriate Investigation

When designing the investigation work plan, the environmental professional is expected to consider the following:

- Substances at the release area and related COCs, including breakdown products and constituents that may result from reactions in the environment
- Environmental media that could potentially be impacted based on the release mechanisms
- Fate and transport and migration pathways
- How to document the rationale for the selection of sampling locations, depths, quantities, screening methods, and analytical parameters, all of which should be based on the CSM, DQOs, and professional judgment

Establish DQOs

A critical component of designing an investigation is establishing DQOs that will guide the collection of data suitable for the project needs. Examples of key items to consider in establishing DQOs are:

- What are the constituents of concern?
- What locations are most likely to be impacted by a release?

- What are the potential receptors?
- What types of samples are needed (soil, groundwater, surface water, air, sediment, etc.)?
- How many samples are needed? From what depth? Will the data set be sufficiently representative if statistical analysis is conducted?
- Is background sampling needed?
- What sampling methods are appropriate to obtain the necessary data?
- How do monitoring wells need to be constructed to obtain the necessary groundwater data?
- How should the monitoring well network be distributed to evaluate the plume and assess risks to receptors?
- What analyses and specific analytical methods are appropriate? The selected analyses should be sufficient to detect impacts from a release. Detailed information on quality assurance/quality control (QA/QC) and soil sampling and preservation is provided in supplemental guidance[4] 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.
- What reporting limits are needed (consider factors such as compliance criteria, ecological risk evaluation, etc.)?

All applicable procedural guidance[5] should be consulted to ensure appropriate procedures are followed. The environmental professional should continually evaluate the significance of the data/data gaps, revise the CSM, and develop subsequent investigation activities accordingly to build a scientifically defensible interpretation of environmental conditions and potential risks.

3.5 Background

In the context of release determination and characterization, background can mean different things:

- The RBCRs define background as naturally occurring conditions or conditions minimally affected by human influences at concentrations less than criteria specified in the RBCRs (RCSA § 22a-134tt-1(a)(13)).
- In practice, background can also mean any pre-existing condition that is not related to the release being evaluated.

In both instances, it is necessary to understand existing conditions to determine if a release has occurred and, ultimately, characterize its extent. Each of these is discussed in more detail below.

3.5.1 Naturally Occurring Background

In Connecticut, metals are generally the only substances accepted as naturally occurring. The RBCRs specify procedures to be used to quantify naturally occurring metals at a site. While such quantification can be conducted at any time during the characterization process, knowing the naturally occurring concentrations

[4] QA/QC Guidance – https://portal.ct.gov/DEEP/Remediation--Site-Clean-Up/Guidance/Quality-Assurance-and-Quality-Control; Preservation Guidance – https://portal.ct.gov/DEEP/Remediation--Site-Clean-Up/Guidance/Soil-Preservation-Guidance-for-VOCs

[5] https://portal.ct.gov/DEEP/Remediation--Site-Clean-Up/Guidance/Remediation-Guidance-Documents

of metals in the vicinity of a release area where metals are a COC can provide valuable context for low concentrations of detected metals and help establish DQOs for designing investigations. Some key factors to consider when evaluating naturally occurring metals include:

- What metals do you need to evaluate? There is no benefit to analyzing background samples for metals that are not COCs associated with any site activity or release source.
- Samples should be collected from locations outside the release area.
- Samples should be collected from areas not expected to be impacted by site activities or historical fill.
- Samples should be collected from locations that are geologically similar to the release area.

3.5.2 Pre-Existing Conditions as "Background"

Sometimes, a release occurs into soil or groundwater that has already been impacted by another source of pollution. Examples include:

- **Release of fuel oil into fill containing coal ash** – Coal ash will have elevated concentrations of PAHs, metals, and possibly ETPH. Characterization of a release of fuel oil in such fill would consist of delineating the fuel oil impacts to the point where the only remaining impacts are related to the fill. This could be based on where concentrations of shared COCs diminish to that of the background range of those compounds in the fill. Note that background here does not refer to a natural condition but rather to a pre-existing level of contamination relative to the release being investigated. As an alternative, it may be possible to delineate the fuel oil release based on a COC that is present in the fuel oil but not in the fill.

- **Upgradient release comingling with an on-site release** – In this instance, characterization of the target release requires having a sufficient understanding of the upgradient release to know what those preexisting concentrations are and how widespread that upgradient release is relative to the target release being investigated. Again, background in this instance refers to the baseline concentration of contaminants that are from some other source.

When conducting a release determination investigation, the initial determination may simply be that a release of something has been identified. If, at some point, it becomes necessary to further assess the source, extent, and fate and transport mechanism for a specific release, then the background condition needs to be well understood to evaluate data related to a release into it.

3.6 Release Mechanisms and Source Area Sampling Considerations

When an investigation is initiated based on physical observations or an unexpected detection in a sample, early sampling should consider the possible sources and release mechanisms. If the initial identification of the release did not specifically target the source, early sampling should include locations and depths at the suspected source to gain an understanding of the magnitude of impacts. In such instances, the environmental professional will benefit from an understanding of the history of the release area, potential release mechanisms, chemical constituents of the substances associated with each release area, and migration pathways. The table below presents some common release sources, possible release mechanisms, and locations that should be considered when confirming a release source and designing an investigation.

Common Release Areas and Source Area Sampling Locations to Consider

Common Release Sources	Possible Release Mechanisms	Sampling Locations to Consider
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, or depth of groundwater table if encountered within tank grave.
	Piping/valve/dispenser leaks	In the vicinity of buried pipe fittings and swing joints, beneath product lines along the piping run at no more than 20 ft intervals, and beneath the dispensers.
	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
Waste Containers	Leaks, overfills, spillage	Beneath and/or near equipment, at nearest downslope, low lying, cracks/joints, pervious area

Common Release Sources	Possible Release Mechanisms	Sampling Locations to Consider
Septic Tanks, Leaching Fields, and Drywells that received waste 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
Waste Handling/Shipping 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

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
- Bedrock fractures

3.7 Soil Characterization

A primary objective of release characterization is to define the three-dimensional degree and extent of contaminated soil resulting from a release 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.

3.7.1 Soil Sampling Plan Considerations

The sampling and analysis plan should specify 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 and existing information about the release determines the types and number of soil samples to be collected and the overall sampling strategy:

- **Grab Samples** – Collection of a grab sample of surficial soil below a discharge pipe may be appropriate to identify the most significant impacts.
- **Continuous Sampling** – Continuous sampling of a defined interval may be necessary to evaluate subsurface releases or the vertical extent of surficial releases. 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 beneficial to adequately understand the variations in the geology and the three-dimensional extent of contamination in the subsurface.
- **Saturated Samples** – Saturated soil samples are integrated samples because they are affected by the environmental quality 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.
- **Grid Sampling** – Grid sampling may be appropriate when the specifics about a potential release location are unknown or the release mechanism covers a broad area with varying or unpredictable concentrations.

- **Composite Sampling** – In general, composite sampling is only useful for waste characterization. While a release may be detected using composite sampling, composite soil samples are not suitable for determining that a release has not occurred because the evidence of a release may be diluted.
- **Historically Impacted Material** – Characterization of historically impacted material in an industrial/commercial setting may warrant a different approach based on the level of knowledge of the historical filling and fill characteristics.

3.7.2 Field Screening

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. Field screening should not be used as a substitute for laboratory analysis or for demonstrating compliance with regulatory cleanup standards but as a tool to determine the best location to collect samples for laboratory analysis. 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 that measures relative concentrations of total VOCs and portable gas chromatographs that quantify the concentrations of specific compounds in real time
- Soil vapor sampling to identify the best locations to target soil sampling.
- Conducting on-site analyses with field test kits that can detect the presence and/or magnitude of chemical compounds
- Conducting water-soil shake tests, dye tests, and screening samples under ultra-violet light

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, as should the results of such methods.

3.7.3 Soil Sampling

Generally, 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.

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 increased 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. Additional data needs to consider when planning soil sampling include:

- **Sample Distribution** – 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 release area.
- **Vertical Delineation** – When conducting vertical delineation, choose the sample intervals carefully. A four- or five-foot long sampler may be quicker, but it will be important to keep the potential for low recovery in mind. One-foot of recovery in a four-foot sampler cannot necessarily be ascribed to a particular one-foot depth interval without additional, strong lines of evidence. If evaluation of a particular depth interval is critical, consider using a shorter sampler.
- **Supporting Statistics** – If the use of statistical methods is anticipated to evaluate the data, the environmental professional should ensure that a sufficient number of samples representative of the release are collected to create a statistically representative data set. Supplemental guidance provides further information on certain statistical methods.
- **Off-Site Evaluation** – If an on-site release extends off-site, the environmental professional is expected to employ best efforts to delineate the extent of the off-site impacts.

3.8 Groundwater Characterization

The objectives of a groundwater investigation are to characterize the hydrogeology of the site, to delineate the spatial distribution of COCs associated with the release, and to evaluate the temporal variations and trends of a groundwater plume. Characterizing a groundwater plume requires an understanding of the geologic setting, the hydrogeology of the site and surrounding areas, and the nature of the release. Detailed knowledge of the composition and sequencing of geologic units is necessary for the proper placement and construction of monitoring wells 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 to understand bedrock structure and groundwater flow and to characterize contaminant distribution in the bedrock aquifer that are beyond the scope of this document.

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 a broader area than unsaturated soil samples. As a result, groundwater data may lead to discovery of an additional release; however, additional investigation will be needed to identify the source of that release and characterize the magnitude and three-dimensional extent of impacts.

3.8.1 Groundwater Sampling Plan Considerations

The sampling and analysis plan should specify 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. Major factors that are expected to be considered in developing a groundwater sampling and analytical strategy include the following:

- Quantity and quality of existing information in the context of the CSM (including the geologic and hydrogeologic characteristics) that are pertinent to the release area
- Solubility and mobility of the COCs in groundwater
- Locations of other nearby releases or background conditions that may affect the groundwater quality at the sampling location and depth interval
- 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)
- If an on-site release extends off-site, the environmental professional is expected to employ best efforts to delineate the extent of the off-site plume.

Number and Type of Groundwater Sampling Points

The number and location of groundwater sampling points should be based on the size of each release area and the quantity and quality of the other information pertaining to each release area. At a minimum groundwater sampling points should be located at the release area and/or immediately downgradient. The sampling points should be close enough 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. Additional monitoring wells may be necessary to define the extent of the groundwater plume and evaluate the risk to potential receptors. Specific monitoring well considerations are presented in Section 3.8.2.

Number of Groundwater Sampling Events

A single groundwater sampling event may not be sufficient to determine that groundwater has not been impacted. For example, seasonal or tidal variations may influence the detection of contaminants. If a release to groundwater has been identified, multiple rounds of groundwater sampling will be needed to characterize temporal variations in groundwater quality, assess risks to potential receptors, and demonstrate compliance with the RBCRs. The need for multiple sampling events should be based on evaluation of the data using the conceptual site modeling process and DQOs.

3.8.2 Monitoring Wells

There is no such thing as a standard monitoring well. While there are common screen lengths, slot sizes, and filter pack grain sizes, each groundwater monitoring situation requires careful consideration to select the proper monitoring well construction components best suited to the substance(s) being monitored and surrounding geology. For those reasons, monitoring wells should be properly located and designed under the direction of an environmental professional who has familiarity with the site hydrogeology. Some key considerations to keep in mind include the following:

- **Representativeness** – Monitoring wells should provide representative data pertaining to the three-dimensional extent of the groundwater plume and fill data gaps identified in the CSM.
- **Location & Depth** – 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.
- **Plume Boundaries** – 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. If a monitoring well is placed sufficiently far downgradient from a release area, groundwater impacts will not be evident. Such a well may be useful for delineating the limits of a plume only if sufficient lines of evidence are provided to show that the plume would have reached that well between the release occurrence and the time the groundwater samples were collected.

- **Screened Intervals and Screen Construction** – 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. Screen construction, including length and placement should be selected based on the groundwater sampling/monitoring objective.
    - *Sampling Depth* – 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 screens should be constructed to yield representative samples, based on the nature of the geologic unit.
    - *Screen Depth* – Monitoring wells with screened intervals intercepting the upper portion of the saturated zone are generally appropriate for evaluating whether a release has occurred to groundwater. However, in some cases, other depths for screened intervals are necessary (e.g., if substances with a specific gravity greater than water were released).
    - *Screen Length* – Screen lengths of up to approximately 10 feet are generally appropriate. Shorter screen lengths may be better suited to evaluate a specific hydrostratigraphic zone. The rationale for screen length and placement should be documented.
    - *Slot Size* – Screen slot size and filter pack grain size should be selected based on the surrounding geology to filter out natural fine material.
    - *Hydrostratigraphic Units* – If a screened interval crosses more than one hydrostratigraphic unit, data obtained from this well is weighted toward the units with higher transmissivity.
- **Temporary Wells** – 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. Temporary monitoring wells may not have the proper screen/filter pack construction for long-term monitoring.
- **Alternative Drilling Techniques** – If a critical position is inaccessible to standard drilling techniques, other methods, such as angle drilling from a remote location, should be considered.
- **Supporting Lines of Evidence** – If direct data collection is not practicable, reliance on other lines of evidence will be necessary to fill data gaps.
- **Cross-Contamination** – Care should be taken when designing and installing monitoring wells to avoid cross-contamination between aquifers.

3.8.3 Groundwater Elevations and Gradients

Maps of hydraulic head distribution should be constructed using groundwater elevation data collected only from wells screened in the same hydrostratigraphic unit, and water table elevation contours should be constructed using only wells screened across the water table. Well screens that are entirely below the water table are not suitable for evaluating water table fluctuations and may not detect LNAPL. Groundwater elevation contour 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.

3.8.4 Other Groundwater Influences to Consider

The environmental professional should consider how groundwater plumes frequently change size, position, and concentration over time.

- **Temporal Changes** – 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.
- **Seasonal Changes** – 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** – Concentration changes also may be attributable to tidal fluctuations and should be considered where appropriate.
- **Historical Trends** – If a round of groundwater data does not match historical trends, additional evaluation is needed to assess the cause. Once a change in conditions is observed, whether it is truly a trend change or an anomaly, past data is generally not sufficient to draw conclusions about the significance of the change. Future data is needed to validate any assumptions or hypotheses.

3.9 Non-Aqueous Phase Liquids (NAPLs)

If the CSM indicates a potential for NAPLs, the 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 or other subsurface materials. Some factors to consider when evaluating NAPLs include:

- If NAPL is present, characterization should include identification of the source and evaluation of the spatial distribution.
- If dense NAPL (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.
- Special care should be taken to ensure that cross-contamination does not occur when evaluating the presence of NAPLs.

3.10 Characterization of Other Types of Media

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

3.10.1 Surface Water

If the CSM indicates that surface water may be impacted because of a release or discharge of pollutants from the release area, surface water quality should be evaluated. The investigation should be sufficient to characterize the degree and extent of contamination and to evaluate the potential impacts to sensitive receptors. The investigation approach should consider:

- Upstream (background) water quality data
- Surface water characteristics
- Groundwater and sediment quality
- The need for an ecological risk assessment based on a scoping level ERA

3.10.2 Sediment

If the CSM indicates that sediment may have been impacted by a release or may be composed of eroded polluted soil from a release, sediment samples should be collected to characterize the degree and three-dimensional extent of contamination and to evaluate the potential impacts to sensitive receptors. The investigation approach should consider:

- Depositional and transport mechanisms
- Background sediment quality
- Groundwater and surface water quality
- The need for an ecological risk assessment based on a scoping level ERA

3.10.3 Soil Vapor

If there is a risk of vapor intrusion, soil vapor data should be of sufficient quality to assess such risk. Be sure to 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
- Presence of temporary and permanent barriers

3.10.4 Indoor Air

When conducting indoor air sampling and analysis, consider the following:

- Potential sources of off-gassing
- Preferential vapor intrusion pathways
- Presence of temporary and permanent barriers
- Building construction
- Building use/occupancy
- Ventilation/air conditioning systems
- Indoor sources of VOCs and other background conditions
- Seasonal conditions

3.10.5 Other Media

When other media are present and require evaluation, the type of media to be sampled should be based on the release being investigated. The locations and depths at which the samples are to be collected, analytical parameters, and field screening methods should be based on the CSM and an understanding of the following:

- Potential release mechanisms
- Transport mechanisms
- Properties of COCs
- Properties of the media being sampled
- Potential risks associated with the media in question being contaminated

3.11 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 used 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
- Every model has its limitations, and these limitations should be viewed objectively and carefully considered based on the stated purpose of the model

While valuable insights can be gained from modeling, a model is ultimately a prediction. Reliance on any model should be supported by a plan to collect actual data in the future to demonstrate the accuracy of the model or identify areas where modifications need to be made to the model and associated investigation or remediation strategy.

4 Site Characterization

Site owners may choose to perform site-wide characterization to meet business needs. Site-wide characterization would also be required if a site is subject to the requirements of the Property Transfer Law or other site-wide cleanup program. Site characterization is typically a multi-phased approach that includes Phase I, Phase II, and Phase III investigations; however, even this site-wide approach relies on the characterization of individual (and sometimes overlapping) release areas. Consequently, at the core of the site characterization process is a site-wide CSM that is supported by release-specific CSMs developed using the processes outlined in Section 2 and Section 3.

Below is a general description of three main phases of site characterization:

- **Phase I: Is a release possible?** – A Phase I assessment 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 may have occurred. The key questions to be considered during a Phase I include:

    - Where and how might a release have occurred?
    - What could be the source of a release?
    - What substances could be in a release?
    - Where might released substances have gone?
    - Who/what could be impacted by a release?

  Note that many of these questions are the same ones asked on the release-based path after a release has been discovered. As a result, the process of answering these questions through research and site reconnaissance is much the same.

- **Phase II: Did a Release Occur?** – During a Phase II investigation, each AOC identified in the Phase I is investigated to determine whether a release to the environment has occurred. For context with respect to the release-based path for an individual release, the discovery of a historical release following a Phase II type investigation would be the entry point to the release-based program.

  Phase III: Elimination of Significant Data Gaps – A Phase III investigation characterizes the nature, degree, and extent of contamination resulting from all releases at the site. While some elements of the Phase III characterization process may be conducted on a site-wide basis (e.g., groundwater monitoring, characterization of overlapping release areas), many others will be conducted on a release-by-release basis, with a CSM being constructed and validated for each AOC and incorporated into a broader site-wide CSM. A Phase III investigation results in an understanding of:

    - Hydrogeologic conditions surrounding each release area and the site
    - Three-dimensional distribution of all contaminants associated with each release
    - Fate and transport of the contamination
    - Impacts to each receptor
    - Whether the site complies with cleanup standards (Regulations of Connecticut State Agencies (RCSA) §§ 22a-134tt-7 to 22a-134tt-10, inclusive)

As the site CSM is developed, these phases may be visited once or multiple times as the environmental professional refines their understanding of each release and its potential impacts on the site as a whole. It is also likely that elements of the different phases are conducted concurrently. For example, details about historical processes (Phase I) may be researched while an identified release is being delineated (Phase III). The phases (I, II, and III) are structuring tools to break down the site-wide conceptual site modeling process into more discrete pieces, each with its own informative goal. Throughout the process, the key question to be asked is, "Is more data needed to determine if all release areas meet cleanup standards or other project objectives?" That question should be asked repeatedly, and the appropriate investigation should be conducted, regardless of which phase it falls within, until the answer is "no."

4.1 Phase I Assessment

A Phase I assessment is an evaluation of the current and/or historical uses of a site and the activities that have been conducted at a site for the purpose of identifying all areas where releases to the environment may have occurred and for gaining an understanding of potential transport mechanisms associated with site conditions. As a result, the Phase I is the foundation for the site-wide CSM and provides the context for demonstrating that sufficient investigations have been completed to the extent necessary to characterize the environmental conditions at a site. Because of this, the research and collection, evaluation, and presentation of data in the appropriate context are critical.

4.1.1 AOC Identification

The primary purpose of a Phase I is to identify AOCs. AOCs are defined as locations or areas at a site where hazardous waste and/or hazardous substances have been or may have been used, stored, treated, handled, disposed, spilled, and/or released to the environment. An AOC may refer to a single known or potential point of release, or it may be useful to group potential release areas into a single AOC based on proximity. However, if individual releases are combined into a single AOC, the release mechanisms at each potential point of release should still be considered in the CSM.

While other published guidance documents, such as the American Society for Testing and Materials *Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment*, E-1527-21 and the EPA's "All Appropriate Inquiries" rule provide some useful protocols to conduct a Phase I site assessment, they are not inclusive of all key Phase I components that should be considered in building the CSM. Refer to the Reconnaissance Survey section of *Appendix A* for examples of additional items that should be considered AOCs.

4.1.2 Phase I Components

A Phase I assessment should cover the information outlined in Section 3.1 (Release Area Research) expanded to a site-wide context and should include (at a minimum) the following components, which can, in turn, be incorporated into the CSMs for both the site and individual AOCs:

- **Site description**
    - Property location and boundaries
    - Number and location of buildings
    - Building descriptions (consider basements, drains, footings, etc.)
    - Utilities

    - Other site improvements
- **Site history** – Site history provides insight into the likelihood that historical uses could have resulted in a release to the environment and the probable sources of contaminants associated with historical releases.
    - Past and present ownership
    - Dates of occupancy
    - Current and historical site uses
    - Changes in site operations or locations of operations (including details regarding processes and raw material and waste handling practices)
    - Building modifications/additions
    - Building or addition construction dates
    - Historical utilities (e.g., industrial or sanitary waste discharge, water supply, use of fuels such as coal, oil, gas, etc.)
- **File reviews of federal, state, and local agencies** – Review of regulatory files aides in understanding the regulatory history of a site and surrounding area and provides information on substances that may have been used and potentially released at a site. See *Appendix A* for a list of resources that can be used to acquire regulatory file information.
- **Review of previous assessments/documentation** – Such documents may include much of the information outlined in this section as well as the results of historical environmental sampling and can serve as a starting point for the initial CSM. However, the environmental professional should understand the purpose, scope, and limitations of such works when incorporating information from them into the CSM.
- **Environmental Setting** – Include the geology, hydrogeology, topography, and any other factors that could influence contaminant migration or affect interpretation of potential impacts. Also consider water use, groundwater and surface water quality classifications, modifications to the natural environment (cutting/filling), and nearby land use.
- **Site reconnaissance survey** – The site reconnaissance survey is conducted to verify the information gathered about the site through research 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 an environmental professional. See *Appendix A* for items to consider with respect to the release area and possible sources, migration pathways, and receptors.
- **Findings** – Identification of AOCs where releases could have occurred as well as any data gaps that may have prevented the identification of an AOC (e.g., locked rooms, inaccessible portions of the site, snow cover, etc.).

Note that a Phase I alone is generally not sufficient to determine whether a release to the environment has occurred. A Phase II investigation is typically required.

4.2 Phase II Assessment

The purpose of a Phase II investigation is to collect sufficient data to determine if a release has occurred to the environment. A Phase II investigation is typically undertaken when there is existing information that suggests a release could have occurred, and data confirming the presence or absence of environmental impacts is needed to achieve regulatory or project-specific objectives.

4.2.1 Phase II Design

When designing a Phase II scope of work, the environmental professional is expected to consider the following key components:

- All potential release mechanisms for each substance at each AOC
- Environmental setting (see Section 3.2)
- Potential receptors, including ecological
- Potential risks posed by failing to detect a release

In addition, refer to the following sections of this document for additional guidance relevant to designing a Phase II investigation for each AOC:

- Section 3.4 – Investigation design
- Section 3.5 – Background conditions
- Section 3.6 – Release mechanisms and source area sampling
- Sections 3.7 to 3.10 – Characterization considerations for various media

4.2.2 Release Determination

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.

  or

- A release to the environment has not occurred. Sufficient investigations have been completed, and the rationale for concluding that no release has occurred must be clearly documented. Analytical data are usually necessary to confirm that a release to the environment has not occurred.

The environmental professional is expected to evaluate the data to determine if the DQOs for the Phase II investigation have been met and if any significant data gaps exist. For a Phase II investigation, a significant data gap exists when it is not possible to conclude with the appropriate level of confidence whether 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.

It is not appropriate to compare Phase II laboratory data to RBCR criteria to determine if a release has occurred or to demonstrate compliance with the RBCRs. However, Phase II data should be evaluated to determine if any immediate actions are necessary to protect human health or the environment pursuant to Section 22a-134tt-5 of the RCBRs.

4.3 Phase III Assessment

The purpose of a Phase III investigation is to define the nature, degree, and extent of each release identified during the Phase II or other site investigations. The environmental professional uses Phase III information to further refine the CSM and eliminate data gaps. Considerations for designing and implementing an investigation to characterize a single release area are described in Section 3. When conducting a site-wide Phase III assessment, the same process is used to refine the CSM for each AOC where a release was identified. Just as the Phase I serves as the foundation for a site CSM, these AOC-specific CSMs serve as building blocks of the final site CSM and subsequent remedial actions.

A Phase III investigation achieves the following objectives:

- Provides an understanding of the site conditions that 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.
- Delineates of the three-dimensional extent and distribution of substances associated with each release area at the site.
- Describes how the distribution and concentration of COCs may change with time.
- Identifies receptors and how the current or future extent and concentration of such COCs may affect human health or the environment. This includes identification of potential ecological exposure pathways and the completion of ecological risk assessments, as necessary.

A Phase III investigation should be designed with the following objectives in mind:

- Provide information about the geologic and hydrogeologic setting
- Address data gaps from previous investigations
- Characterize the nature, magnitude, and three-dimensional extent of a release to soil, groundwater, or other media

A Phase III investigation may be conducted in stages, with each subsequent stage building upon the preceding one. The rationale for the selection of sampling locations, depths, quantities, and methods, as well as analytical parameters and methodologies are based on the AOC-specific CSMs, DQOs, and sound professional judgment. While the work may be conducted within a site-wide framework, the process for characterizing a release area and validating each release-specific CSM are the same as those outlined in Section 2 and Section 3.

At the conclusion of a Phase III investigation, the environmental professional should have a sufficient understanding of the environmental system(s) across the site to evaluate potential risks to human health and the environment and determine if remediation is necessary to achieve compliance with the RBCRs.

5 Reporting

Reporting is an important step in the release characterization process to communicate the CSM and what the environmental professional knows about the release, where the release may have migrated to, and who may be exposed to the released substances. Section 2.3 provides key components on how to document a CSM.

> **Emergent Reportable Release: Reporting**
>
> The closure report for an ERR may be brief; however, the CSM still needs to document what happened, cleanup procedures, compliance with cleanup goals, and rationales and assumptions.

A report can be a stand-alone CSM or incorporate a CSM into a broader picture (e.g., a site-wide CSM report). Reports may be prepared at any stage of CSM process, from release identification to completion of characterization, to release closure. How the information is presented will vary based on how much characterization has been completed and how well the CMS is developed. Regardless of the stage of investigation, the report structure is important to successfully relay critical information and justify the decision-making process regarding characterization, remediation, and receptor protection. Early in the CSM process, the report may focus more on what additional information is needed to complete characterization and make remedial decisions. By the end of the CSM process, the report structure should lead the reader across a well-constructed bridge from identification of a release to a clear understanding of exactly what was released, where it went, who and what are impacted, and what will be or has been done to address the release.

It is the environmental professional's role to reframe the patchwork of information gathered into a clear, easily understood, presentation of what happened, the extent of the release, and the risks to human health and the environment supported by relevant facts and decisions. Although the characterization processes itself is often not very neat or linear, describing information in the order in which it was obtained, or recreating the exact path the environmental professional followed through various hypotheses and dead ends to a conclusion, will not be particularly useful to the reader.

Elements to consider including in the report structure include the following:

Introduction

Set up what the reader can expect to learn from this report and why it matters.

- Provide some context for whom the work was completed and why.
- Make the objective of the report clear. Is this a closure report? Is the report documenting final characterization or perhaps focusing on closing a specific data gap? Be sure that the report, and specifically the conclusions, speak to that objective.

Regulatory Framework

Describe any relevant regulatory parameters guiding the investigations and within which data will ultimately be evaluated. This provides additional context for many of the decisions made throughout the characterization process.

> **MAKE YOUR ELECTRONIC REPORTS EASIER TO USE**
>
> - Use *Heading Styles* in your word processing software to create your *Table of Contents* and link the table of contents to the report headings.
> - Use a *PDF Creator* add-in or the *Print to PDF* feature built into your word processing software to enhance report functionality. Headers will become PDF bookmarks.
> - Avoid saving reports as an image. It will remove all functionality and make the report file size very large.

CSM Narrative

See Section 2.3.2 for details on constructing a CSM narrative. What gets presented and in what order will depend on several factors. Keep in mind that the purpose of the report is to describe what you know about the release, not recreate every twist and turn of the investigatory process. You are reframing and illuminating the compiled information in a way that helps the reader quickly grasp the key facts and the rationale for decisions.

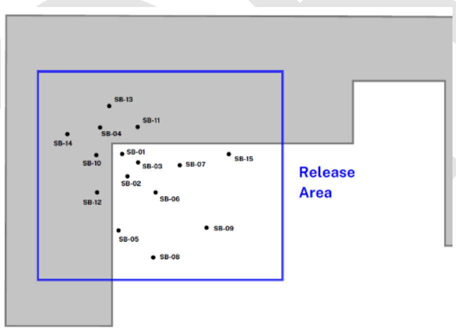
When constructing a site-wide CSM report, there will typically be multiple AOC-specific CSMs in addition to the site-wide CSM. In preparing such a report, the greatest challenge will be organizing the information so that each AOC has a clear CSM that is distinct from, yet supports, the overall site-wide CSM. Each AOC-specific CSM should clearly and concisely document the characterization of the AOC. The site-wide CSM should incorporate all the AOC-specific CSMs and clearly identify where on the site releases are present and which ones represent a risk to human health and the environment.

Visual Elements

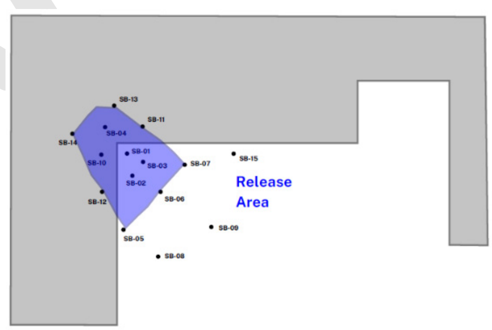
Wherever possible, show, don't tell. Use photos, figures, tables, and graphs to *show* critical information.

- **Photos** – Photos can convey much more information about a setting and the orientation of key reference points in much less space than explanatory text.
- **Figures** – A figure delineating the limits of contamination is much more effective than a paragraph that lists the sample locations that define those limits with the expectation that the reader will mentally locate the relevant points and correctly connect the dots. Draw that picture.

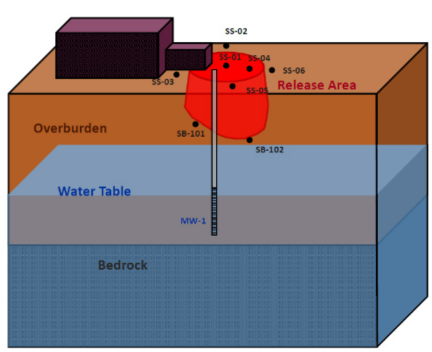
Example Figure 1
Extent of pollution is unclear



Example Figure 2
Clear presentation of lateral extent of pollution



Example Figure 3
Clear presentation of 3D extent of pollution



- **Tables and Graphs** – A table of data is more digestible than a laboratory report or text listing detections. Use tables to concisely display pertinent data. Use graphs to show trends in data. Use words to explain patterns in data.

TABLE DO'S & DON'TS	
Do	**Don't**
Do – Provide a table summarizing pertinent results. Include relevant non-detects (e.g., a line showing that VOCs were analyzed but not detected). **Do** – Consider what you are trying to show in a table. A table can be more than just a data summary. The way the data is presented can focus the reader's attention on what is detected in specific samples or how a specific substance is distributed across multiple sample locations or depths. **Do** – When incorporating multiple AOCs into a report, separate data by AOC to support the AOC-specific CSMs.	**Don't** – List every analyte not detected within an analyte class. For example, it may be important to document every metal not detected, but it is not helpful to list every analyte on the VOC list when only two are detected. **Don't** – List every soil sample collected and every analyte detected in the body of the narrative with no interpretation.

Conclusions

Keep in mind the report objective, as reflected in the introduction, and present conclusions that resolve the issues that were established at the beginning. Emphasize decision points and key pieces of information relevant to those decisions. If the issues aren't resolved yet, the conclusions should refine them and identify the remaining uncertainties (note that the reader will also expect this in the introduction).

Supporting Information (Appendices)

Reference materials that serve as backup to the narrative. These are sources on which all the decisions and conclusions are based. The report body is an interpretation of observations and measurements. The appendices can serve as a repository for the direct observations and measurements that the reader can refer to understand your rationale. Examples of relevant appendices include:

- Limitations of work product
- Soil boring logs
- Monitoring well construction
- Field data sheets
- Field screening logs
- Calculations
- Reference documentation
- Laboratory reports

Glossary

Definition of Acronyms and Terms

Definition of Acronyms and Terms

Term	Definition
Area of Concern (AOC)	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	The concentration of a substance in soil or groundwater that, based on a validated conceptual site model, is:
	• in the general geographic vicinity of a release; and
	• either:
	    o Naturally occurring; or
	    o Minimally affected by human influences at concentrations equal to or less than criteria specified in the RBCRs.

Composite Sampling	The combination of two or more discrete samples of the same media for laboratory analysis. Composite sampling **cannot** be used to determine that a release has not occurred, to delineate the extent and degree of contamination, or to establish compliance with the RBCRs.
Conceptual Site Model (CSM)	A representation in three dimensions of environmental conditions at a release area that is developed through a multi-phased investigative approach which validates such representation with information about, including, but not limited to, a substance's release, fate and transport, and pathway to human and environmental receptors.
Constituent of Concern (COC)	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 Assessment (DQA)	An assessment of the laboratory quality control data, the laboratory report, and laboratory narrative by the environmental professional to identify and summarize QC nonconformances.
Data Quality Objectives (DQO)	Goals developed to ensure that sufficient quality and quantity of data are collected to support the decisions made during release 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.
Data Usability Evaluation (DUE)	An evaluation by the environmental professional to determine if the analytical data are of sufficient quality for the intended purpose.

Term	Definition
Ecological Risk Assessment (ERA)	A process to evaluate the likelihood that adverse ecological effects may occur or are occurring due to exposure to one or more environmental stressors (https://www.epa.gov/risk/ecological-risk-assessment).
Emergent Reportable Releases (ERR)	A release to the land and waters of the state discovered by an observed change in conditions that is required to be reported by regulations adopted pursuant to section 22a-450 of the Connecticut General Statutes.
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.
ETPH	Extractable Total Petroleum Hydrocarbons
Naturally Occurring	Substance present in the environment in forms that have not been influenced by human activity.
NAPL	Non-aqueous Phase Liquid, can be light or dense (LNAPL or DNAPL)
PAHs	Polycyclic Aromatic Hydrocarbons
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.
PCBs	Polychlorinated Biphenyls
Quality Assurance / Quality Control (QA/QC)	For additional information, see https://portal.ct.gov/DEEP/Remediation--Site-Clean-Up/Guidance/Quality-Assurance-and-Quality-Control.
RBCRs	Release-Based Cleanup Regulations
RCPs	Reasonable Confidence Protocols
RCSA	Regulations of Connecticut State Agencies

Term	Definition
Release	Any spilling, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping, or disposing into or onto the land and waters of the state, not authorized by permit, of oil or petroleum or chemical liquids or solids, liquid or gaseous products or hazardous waste. “Release” does **not** include automotive exhaust or the application of fertilizer or pesticides consistent with their labeling;
Release Area	The land 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	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.
Significant Existing Release (SER)	A discovered historical release creating one or more of the significant impacts to human health or the environment identified in section 22a-134tt-5(f) of the RBCRs.
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 which, when added to air, water, soil, or sediment, may alter the physical, chemical, biological, or other characteristic of such air, water, soil, or sediment.
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, such wells may be inappropriate for long-term monitoring.
Underground Storage Tank (UST) System	An underground storage tank and any associated ancillary equipment and containment system.
VOCs	Volatile Organic Compounds
Volatile Organic Substances (VOSs)	An organic substance that has a high vapor pressure and low boiling point at room temperature.
Volatile Petroleum Substances (VPSs)	A volatile organic substance found in gasoline, diesel fuel, fuel oil, heating oil, kerosene, jet fuel, or similar fuels, along with volatile organic substances that may have been used as fuel additives.

Appendix A

Research Tools

Research Tools

Review of regulatory records 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 have migrated onto the site from off-site locations. These tools are also used to conduct research as part of a site-wide Phase I investigation.

Federal Resources

File reviews of federal records chiefly include many programs managed by US EPA, which may be obtained for specific sites using EnviroMapper.[6]

Other federal agencies that maintain relevant information include Federal Emergency Management Agency[7] and U.S. Geological Survey[8] for geologic and topographic mapping and more.

State Resources

Information from many State of Connecticut Environment and Natural Resources databases is available at Connecticut Open Data,[9] including DEEP databases, natural resources, and various maps.

DEEP records can be found at DEEP Document Online Search Portal.[10] DEEP records include:

- Property transfer act filings
- Site investigation and remediation reports
- Waste management practices; manifests
- Hazardous waste; solid waste
- USTs
- PCBs
- Oil and chemical spill reports
- Storm water management
- Discharge permits
- P-5 inspection reports
- Preliminary Inspection Questionnaires (PIQs) for air emissions
- water quality standards and leachate wastewater maps
- Well completion logs/reports
- Water resource bulletins

[6] https://enviro.epa.gov/envirofacts/enviromapper/search
[7] https://www.fema.gov/flood-maps/national-flood-hazard-layer
[8] https://www.usgs.gov/
[9] https://data.ct.gov/
[10] https://filings.deep.ct.gov/DEEPDocumentSearchPortal/

Connecticut Environmental Conditions Online[11] contains aerial photographs, and maps based on data from DEEP, the University of Connecticut, USGS, USACE, NOAA, and other state and federal agencies. Other state agencies/offices that may contain relevant information include, but are not limited to:

- State Library for city directories, Sanborn® Fire Insurance maps, and historical topographic maps
- Connecticut Department of Public Health for locations of public water supply sources and community water systems in Connecticut.

Local Resources

A significant amount of information about a site may be obtained at the local offices for the municipality where the site is located including:

- 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, photographs, and descriptions of historical factories
- Planning and Zoning for land use
- Economic Development for previous environmental assessments
- Local Water Authority for water distribution records
- Inland Wetland and Conservation Commission for wetland delineation and conservation easement maps.

Reconnaissance Survey

The reconnaissance survey is conducted to verify or modify the information gathered about the release area. Consequently, the reconnaissance survey should be conducted or supervised by the environmental professional. By the time a release is identified, at least some degree of reconnaissance has likely been conducted. Items to consider with respect to the release area and possible sources, migration pathways, and receptors related to a release (particularly if the source has not yet been identified) include the following:

- Interviews with individuals knowledgeable about current or historical site operations and environmental history

[11] https://maps.cteco.uconn.edu/

- Facility documents
- Limitations to observations or access (e.g., weather conditions, snow cover, locked rooms)
- Overall condition and apparent housekeeping practices (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
- 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)
- Any other possible sources of environmental concern or unexplained site features

When conducting a site-wide Phase I, the rationale for excluding such items from consideration as an AOC is expected to be documented.