STATE OF CONNECTICUT

DEPARTMENT OF ENERGY & ENVIRONMENTAL PROTECTION

LABORATORY QUALITY ASSURANCE & QUALITY CONTROL

DATA QUALITY ASSESSMENT & DATA USABILITY EVALUATION GUIDANCE DOCUMENT

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Laboratory Quality Assurance and Quality Control Guidance
Data Quality Assessment and Data Usability Evaluation
Guidance Document
(Effective May 1, 2009)

Preamble

The Connecticut Department of Energy and Environmental Protection (DEEP) has been working to improve the quality and consistency of analytical data used to support environmental investigation and remediation projects statewide. The DEEP Remediation Division, Laboratory Quality Assurance/Quality Control Work Group (Work Group) was established in 2004 to assist and advise the DEEP in these efforts. The Work Group is comprised of licensed environmental professionals (LEPs), data validators, representatives from private laboratories, and DEEP. DEEP gratefully acknowledges the contributions and assistance of those individuals who volunteered their time and effort to help develop and prepare this document.

The Release Based Cleanup Regulations, sections 22a-134tt-1 through 22a-134tt-13 and sections 22a-134tt-App-1 through 22a-134tt-App-12 of the Regulations of Connecticut State Agencies ("RBCRs"), include numeric criteria in Appendices 2 through 12 ("RBCR criteria") which are used to determine if a potential risk to human health or the environment may exist. The results of analyses performed on environmental media are used to determine if remediation is needed. Because of the nature of environmental media, limitations of analytical methods, characteristics of analytes, and human error, the results of environmental analysis may contain an element of uncertainty and in some cases may be significantly biased, and therefore may not be representative of the actual concentrations of the analytes in the environmental media. Thus, an evaluation of the quality of the analytical data in relation to the intended use is important for the Environmental Professional to make decisions which are supported by data of known and sufficient quality.

There are many ways to evaluate the quality of analytical data in terms of precision, accuracy, representativeness, comparability, completeness, and sensitivity in relation to the intended use of the data. Precision, accuracy, representativeness, comparability, completeness, and sensitivity are collectively referred to as the "PARCCS" parameters. This guidance document describes a DEEP-accepted, two-step process for data evaluation. The first step in the process consists of an assessment of data quality. The second step is an evaluation to determine whether the data can be used to support the decisions that will be made using that data. Use of this guidance provides consistency in evaluation and presentation of data quality information that will facilitate review. If an alternative process is used, such a process should be documented to explain the thought process and may involve a commitment of significant resources to demonstrate that the data is of known and sufficient quality and is usable relative to its intended purpose.

To assist the EP in obtaining analytical data of known quality, the Work Group developed the Reasonable Confidence Protocols (RCPs). The RCPs are analytical that include specific laboratory Quality Assurance and Quality Control (QA/QC) criteria that produce analytical data of known and documented quality. When Reasonable Confidence is achieved for a particular data set, the EP will have Reasonable Confidence that the

laboratory has followed the RCPs, has described non-conformances, if any, and has adequate information to make judgments regarding data quality.

The Reasonable Confidence Protocols were published in July and December 2006 and enhanced the ability of the EP to readily obtain from the laboratory the necessary information to identify and document the precision, accuracy and sensitivity of data. Therefore, DEEP will accept evaluations of the quality of data using available QC information to evaluate precision, accuracy and sensitivity for samples collected prior to September 1, 2007. If precision and accuracy QC data are not available, it is only necessary to evaluate sensitivity. For samples collected on or after September 1, 2007, DEEP expects the EP to evaluate the analytical data in relation to the PARCCS parameters either in accordance with this guidance or a similarly accurate alternative process.

This document excludes radiological issues including, but not limited to, those described in Title 22a Chapters 446 and 446A that are overseen by the DEEP Radiation Division of the Bureau of Air Management. This document does not apply to Polychlorinated Biphenyls pursuant to the Title 40 Code of Federal Regulations (CFR) Part 761.

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GLOSSARY

Acronym	Term	Definition
	Accuracy	Describes the closeness of agreement between an observed value and an accepted reference value (true value). Accuracy is typically evaluated by the use of laboratory control samples, check standards, matrix spike and matrix spike duplicate, or any other standard subjected to the entire analytical process. Accuracy is usually reported as a percentage of the observed value divided by the known value (percent recovery) using the following equation: $\%R = \left(\frac{observed\ value}{true\ value}\right) \times 100$ Where %R = percent recovery
A SVOCs	Acid Semi-volatile Organic Compound Surrogates	Acid semi-volatile organic compound surrogates are compounds that exhibit similar chemical behavior to acidic organic compounds such as phenols. Common acid surrogates include: 2-fluorophenol, phenol-d5 (a deuterated phenol), and 2,4,6-tribromophenol. (See also surrogate).
	Analyte	Analyte means the substance being measured by an analytical procedure.
	Analytical Batch	A group of samples that are processed and analyzed as a unit. For quality control purposes, the maximum number of field samples in a batch is 20 per matrix.
AOC	Area of Concern	Defined in the *State of Connecticut, Department of Energy and Environmental Protection, Release Characterization Guidance (RCG),* effective March 1, 2026, and as may be amended from time to time.
BN SVOCs	Base Neutral Semi-Volatile Organic Compound Surrogates	Base neutral semi-volatile organic compounds exhibit similar chemical behavior to the base-neutral semi-volatile organics. Common examples include nitrobenzene-d5, 2-fluorobiphenyl, and terphenyl-d14. (See also surrogate).
	Bias	Bias is the deviation of the measured value from the true value. This can be analytical bias within the analytical procedure, or it can be due to matrix effects. There is inherent bias within all analytical procedures. Quality control measurement tools that can be used to evaluate bias include laboratory control samples, check standards, matrix spikes, or any other standards used for analysis.

Acronym	Term	Definition
ICAL	Calibration Curve/Initial Calibration	A calibration curve/initial calibration curve is generated by analyzing a series of standards and plotting instrument response versus concentration. A calibration curve is used to calibrate an analytical system. Calibration criteria are specified in each analytical method.
°C	Celsius	The scale of temperature in which water freezes at 0° and boils at 100° under standard conditions.
	Check Standard	A check standard is a solution of one or more analytes that is used to document laboratory performance. This check standard can go by many different names including laboratory control samples (LCS), and laboratory fortified blank (LFB). Consult with the laboratory to understand the naming scheme used to identify such standards. This standard can also be used to check the validity of a purchased stock or calibration standard.
	Comparability	Comparability refers to the equivalency of two sets of data. This goal is achieved using standard or similar techniques to collect and analyze representative samples. Comparable data sets must contain the same variables of interest and must possess values that can be converted to a common unit of measurement. Comparability is normally a qualitative parameter that is dependent upon other data quality elements. For example, if the reporting limits for a target analyte were significantly different for two different methods, the two methods would not be comparable.
	Completeness	Completeness is a measure of the amount of valid data obtained from a measurement system compared to the amount that was expected to be obtained under correct, normal conditions.
CSM	Conceptual Site Model	Defined in the *State of Connecticut, Department of Energy and Environmental Protection, Release Characterization Guidance Document*, effective March 1, 2026, and as may be amended from time to time.
COC	Constituent of Concern	Defined in the *State of Connecticut, Department of Energy and Environmental Protection, Release Characterization Guidance Document*, effective March 1, 2026, and as may be amended from time to time.
	Control Sample	Control sample means a quality control sample introduced into a process to monitor the performance of a system.
DDT	Dichloro-diphenyl-trichloroethane	A polychlorinated biphenyl compound historically used as an insecticide.

Acronym	Term	Definition
DEEP	Connecticut Department of Energy & Environmental Protection	
DPH	Connecticut Department of Public Health	
DQA	Data Quality Assessment	The process of identifying and summarizing quality control problems that occurred during laboratory analysis (i.e., non-conformances). The DQA process should occur throughout the course of a project.
DQOs	Data Quality Objectives	Defined in the *State of Connecticut, Department of Energy and Environmental Protection, Release Characterization Guidance Document*, effective March 1, 2026, and as may be amended from time to time.
DUE	Data Usability Evaluation	The process of determining whether the quality of the analytical data is sufficient for the intended purpose.
EIS	Extracted Internal Standard	An isotopically labeled analog of a target analyte that is structurally identical to a native (unlabeled) analyte. The EIS compounds are added to the sample at the beginning of the sample preparation process and are used to quantify the native target analytes.
EP	Environmental Professional	An environmental professional is anyone, including a licensed environmental professional, who conducts environmental site assessments or collects soil, sediment, water, soil vapor, or air samples for environmental investigation and remediation projects. This term is also further defined in *State of Connecticut, Department of Energy and Environmental Protection, Release Characterization Guidance Document*, effective March 1, 2026, and as may be amended from time to time.
EPA	United States Environmental Protection Agency	
	Environmental Sample	An environmental sample is a sample of soil, groundwater, surface water, soil vapor, sediment, air, or any other environmental media collected for analysis.
ESA	Environmental Site Assessment	Described in the *State of Connecticut, Department of Energy and Environmental Protection, Release Characterization Guidance Document*, effective March 1, 2026, and as may be amended from time to time.

Acronym	Term	Definition
	Equipment-Rinsate Blank	An equipment-rinsate blank is a sample of analyte-free water that is used to rinse the sampling equipment. An equipment-rinsate blank is collected after decontamination to assess potential contamination from inadequate decontamination of field equipment. An equipment-rinsate blank can also be used to evaluate the potential for field sampling equipment to leach contaminants into a sample and cause cross contamination.
ETPH	Extractable Total Petroleum Hydrocarbons	An analytical method developed in 1999 by the Environmental Research Institute at the University of Connecticut as an alternative to the Total Petroleum Hydrocarbons (TPH) analytical method that historically relied on the Freon-111 as part of the laboratory methodology. This gas chromatography/flame ionization detection method quantifies the total concentration carbon-chain-based molecules in an environmental sample.
FB	Field Blank	A field blank is analyte-free media, usually water, prepared in the laboratory and transported to the sampling location along with the empty sample containers. At the sampling location the media is used to fill randomly selected sample containers and then returned to the laboratory for analysis. The field blank is treated as a sample in all respects, including exposure to sampling location conditions, storage, preservation, and all analytical procedures. Field blanks are used to assess any contamination contributed from sampling location conditions and the transport, handling, and storage of the samples.
FD	Field Duplicate	A field duplicate is a replicate or split sample collected in the field and submitted to the laboratory as a sample.
	Field Reagent Blank	See “Field Blank.”
GA PMC	Pollutant Mobility Criteria for Class GA Groundwater	Defined in RCSA Section 22a-134tt-1(a).
GB PMC	Pollutant Mobility Criteria for Class GB Groundwater	Defined in RCSA Section 22a-134tt-1(a).
GC/MS	Gas Chromatography/ Mass Spectrometry	Gas Chromatography/Mass Spectrometry is an analytical procedure in which a gas chromatograph is connected to a mass spectrometer. The technique allows for both accurate identification and quantitation of analytes.

Acronym	Term	Definition
GWPC	Ground Water Protection Criterion	Defined in RSCA Section 22a-134tt-1(a).
	Holding Time	The maximum amount of time a sample may be stored between collection and analysis is referred to as the holding time. Samples analyzed past the holding time are compromised and may be considered invalid, depending on the intended use of the data.
ICAL	Calibration Curve/Initial Calibration	A calibration curve/initial calibration curve is generated by analyzing a series of standards and plotting instrument response versus concentration. A calibration curve is used to calibrate an analytical system. Calibration criteria are specified in each analytical method.
I/C DEC	Industrial / Commercial Direct Exposure Criteria	Defined in RCSA Section 22a-134tt-1(a).
	Instrument Blank	An instrument blank is analyte free media that is introduced into the analytical instrumentation to verify the instrumentation is not contaminated. Typically gas chromatography methods (excluding volatile organic compounds) use pure solvent as an instrument blank while metals and wet chemistry techniques use water or acidified water. Gas chromatography methods for volatile organic compounds use either acidified water or methanol.
IPR	Initial Precision & Recovery Standard	Consists of four aliquots of a reference matrix spiked with the analytes of interest and labeled compounds and analyzed to establish the ability of the laboratory to generate acceptable precision and recovery. An IPR is performed prior to the first time this method is used and any time the method or instrumentation is modified.
IS	Internal Standards	Internal standards are compounds that are added, prior to analysis, at a known concentration to every standard, blank, sample, and quality control sample at a known concentration. Internal standards are used to calibrate the analytical system by plotting the response of the internal standards versus the compound(s) of interest. Internal standards should closely match the chemical behavior of the compound(s) of interest and be known not to be present in the sample.
LCF	Laboratory Certification Form	The DEEP prescribed certification form that certifies a laboratory followed the DEEP RCPs for the analyses conducted.

Acronym	Term	Definition
LCL	Lower Control Limit	The lowest value of a range is allowed to achieve without being considered out of the control limits.
LCS	Laboratory Control Sample	A laboratory control sample (LCS) is a reference standard carried through the analysis along with the samples. The LCS can either be a purchased reference sample or a reference spiking solution used to spike reagent water or clean soil. The LCS would contain known concentrations of target analytes and is used to document laboratory performance. LCSs are also known as laboratory fortified blanks (LFBs).
LCSD	Laboratory Control Sample Duplicate	A laboratory control sample duplicate (LCSD) is replicate sample of the LCS. The spiking occurs prior to sample preparation and analysis. The results are used to document the precision and bias of a method. See also “Laboratory Control Sample.”
LFB	Laboratory Fortified Blank	See “Laboratory Control Sample.”
LLOQ	Lower Limit of Quantitation	See “Reporting Limit”.
MD	Matrix Duplicate	A matrix duplicate refers to the replicate analysis of a sample prepared in the laboratory. Duplicates are used to evaluate precision, sample homogeneity, and field sample collection activities.
	Matrix Interference	Matrix effects are the overall effect of the sample matrix on the analytical results. Severe matrix effects are usually called matrix interference and can significantly affect the accuracy of an analytical measurement. For example, some matrices including silt, clay, coal, ash, and peat effectively bind analytes leading to low biased results for certain extraction procedures.
	Matrix	The matrix is the component or substrate (e.g., surface water, drinking water, soil) that may or may not contain an analyte of interest.
MS	Matrix Spike	A matrix spike (MS) is an aliquot of an environmental sample to which known quantities of target analytes are added in the laboratory. The matrix spike is analyzed in an identical manner as a sample. The purpose of a matrix spike sample is to determine whether the sample matrix contributes bias to the analytical results.

Acronym	Term	Definition
MSD	Matrix Spike Duplicate	A matrix spike duplicate (MSD) is a replicate aliquot of the matrix spike sample. The results are used to document the precision and bias of a method in a sample matrix. See also “Matrix Spike.”
	Media	See “Matrix.”
	Method Blank	A method blank is an analyte-free matrix to which all reagents are added in the same proportions as used in sample processing. The method blank should be carried through the entire sample preparation and analytical procedure. It is used to determine if method analytes or other analytes are present in the laboratory environment, the reagents, or the apparatus. A method blank may also be referred to as a laboratory reagent blank.
MIBK	4-methyl-2-pentanone	An organic solvent used for gums, resins, paint, varnishes, lacquers, and nitrocellulose.
µg/kg	Micrograms per Kilogram	Unit of measurement for mass. Used for reporting concentrations of target analyte(s) in solid samples. Commonly referred to as parts per billion.
µg/L	Micrograms per Liter	Unit of measure for mass by volume. Used for reporting concentrations of target analyte(s) in aqueous samples. Commonly referred to as parts per billion.
mg/kg	Milligrams per Kilogram	Unit of measurement for mass. Used for reporting concentrations of target analyte(s) in solid samples. Commonly referred to as parts per million.
mg/L	Milligrams per Liter	Unit of measure for mass by volume. Used for reporting concentrations of target analyte(s) in aqueous samples. Commonly referred to as parts per million.

Acronym	Term	Definition
	Non-conformance	A non-conformance is an occurrence during the processing or analysis of a sample that is not in conformance with the quality control performance criteria of the analytical method. Examples of nonconformances include, but are not limited to, missed holding times, temperature excursions, recoveries of surrogates or matrix spikes outside of performance criteria, initial or continuing calibration failures, et cetera.
ND	Non-detect	No detection of target analyte(s) above the Reporting Limit/Lower Limit of Quantitation.
	Non-target compounds	Non-target compounds are compounds that are not target analytes, see “Target Analytes” below.
OPR	On-going Precision & Recovery standard	Consists of a laboratory reagent-grade water spiked with known quantities of analytes. The OPR is analyzed exactly like a sample. Its purpose is to assure that the results produced by the laboratory remain within the limits specified in this method for precision and recovery.
PARCCS	PARCCS Parameters	The PARCCS parameters are precision, accuracy, representativeness, comparability, completeness, and sensitivity.
PCBs	Polychlorinated biphenyls	A class of organic compounds composed of two, or more, biphenyl rings and one, or more, chlorine atoms used for various industrial applications.
PCE	Tetrachloroethene (AKA perchloroethylene or tetrachloroethylene)	An organic compound widely used for dry-cleaning and metal degreasing operations.
	Performance Evaluation Sample	See “Proficiency Test Sample.”
	Petroleum	Petroleum is used in this document as the term is in Section 22a-449a of the Connecticut General Statutes.
PFAS	Per- and polyfluoroalkyl substances	Defined in RCSA Section 22a-134tt-1(a).
PMC	Pollutant Mobility Criteria	Defined in RCSA Section 22a-134tt-1(a).
	Polluted Soil	Defined in RCSA Section 22a-134tt-1(a).

Acronym	Term	Definition
RPD	Precision (Also known as the Relative Percent Difference)	Precision is the agreement among a set of replicate measurements without assumption of knowledge of the true value. Precision is estimated by means of duplicate/replicate analyses and illustrates the reproducibility of a laboratory's analysis. Field duplicates are used to assess precision for the entire measurement system including sampling, handling, shipping, storage, preparation, and analysis. Laboratory data precision analysis is evaluated using matrix spike/matrix spike duplicate and matrix duplicate sample results. $$RPD = \left[\frac{(A-B)}{((A+B)/2)}\right] \times 100$$ Where: A = Analytical results from first duplicate measurement B = Analytical results from the second duplicate measurement
PT Sample	Proficiency Test Sample	Proficiency test sample is a reference sample provided to a laboratory for the purpose of demonstrating that the laboratory and the individual analyst performing the test can successfully analyze the sample within acceptable limits. The true value of the sample is unknown by the analyst.
	Proficiency Testing	A proficiency testing is a program in which performance evaluation samples are used to evaluate the analytical performance of the laboratory.
QA Workgroup		Connecticut Department of Energy and Environmental Protection Remediation Division Laboratory Quality Assurance Quality Control Work Group.
QAPP	Quality Assurance Project Plan	A quality assurance project plan (QAPP) is an orderly assemblage of detailed procedures designed to produce data of sufficient quality to meet the data quality objectives for a specific data collection activity.
QA/QC	Quality Assurance/Quality Control	Quality Assurance (QA) involves planning, implementation, assessment, reporting, and quality improvement to establish the reliability of laboratory data. Quality Control (QC) procedures are the specific tools that are used to achieve this reliability. QC procedures measure the performance of an analytical method in relation to the QC criteria specified in the analytical method. QC information documents the quality of the analytical data.

Acronym	Term	Definition
	Reagent water	Reagent water is water that has been generated by any purification method that would achieve the performance specifications for American Society for Testing Materials Type II water. For organic analyses, reagent water is free from contamination of the analytes of interest.
	Reasonable Confidence	When "Reasonable Confidence" is achieved for a particular data set, the EP will have confidence that the laboratory has followed the Reasonable Confidence Protocols, has described non-conformances, if any, and has adequate information to make judgments regarding data quality.
RCPs	Reasonable Confidence Protocols	The Reasonable Confidence Protocols include specific laboratory quality assurance and quality control (QA/QC) criteria that produce analytical data of known and documented quality. The Reasonable Confidence Protocols are published on the DEEP webpage.
	Release	Defined in RCSA Section Section 22a-134tt-1(a) and Section 22a-134pp(6) of the Connecticut General Statutes. Further defined in the *State of Connecticut, State of Connecticut, Department of Energy and Environmental Protection, Release Characterization Guidance Document*, effective March 1, 2026, and as may be amended from time to time.
RCSA	Regulations of Connecticut State Agencies	
RA	Release Area	Defined in RCSA Section 22a-134tt-1(a) and in the *State of Connecticut, Department of Energy and Environmental Protection, Release Characterization Guidance,* effective March 1, 2026, and as may be amended from time to time.

Acronym	Term	Definition
RPD	Precision (Also known as the Relative Percent Difference)	Precision is the agreement among a set of replicate measurements without assumption of knowledge of the true value. Precision is estimated by means of duplicate/replicate analyses and illustrates the reproducibility of a laboratory's analysis. Field duplicates are used to assess precision for the entire measurement system including sampling, handling, shipping, storage, preparation, and analysis. Laboratory data precision analysis is evaluated using matrix spike/matrix spike duplicate and matrix duplicate sample results. $$RPD = \left[\frac{(A-B)}{((A+B)/2)}\right] \times 100$$ Where: A = Analytical results from first duplicate measurement B = Analytical results from the second duplicate measurement
RBCRs	Release Based Cleanup Regulations	The Release Based Cleanup Regulations, RCSA sections 22a-134tt-1 through 22a-134tt-13 and sections 22a-134tt-App-1 through 22a-134tt-App-12.
RBCR Criteria	Release Based Cleanup Regulations Criteria	Numeric criteria are presented in RCSA Sections 22a-134tt-App-2 through 22a-134tt-App-12.
RL	Reporting Limit	Reporting limit means the concentration of the lowest non-zero calibration standard of a calibration curve used for analysis of a given sample by a specific method, corrected for specific sample weight or volume, dilutions, and for soil and sediment samples moisture content. This term is further defined in the RCSA Section 22a-134tt-1(a) of the Regulations of Connecticut State Agencies.
	Representativeness	Representativeness is a qualitative measurement that describes how well the analytical data characterizes a release area or area of concern under investigation as part of an environmental site assessment. Many factors can influence how representative the analytical results are for a release area. These factors include, the selection of appropriate analytical procedures, the sampling plan, and the procedures and protocols used to collect, preserve, and transport samples.

Acronym	Term	Definition
ResDEC	Residential Direct Exposure Criteria	Defined in RCSA Section 22a-134tt-1(a).
	Sensitivity	Sensitivity refers to the ability of an analytical procedure to detect and quantify an analyte at a given concentration.
	Significant Data Gap	Defined in the *State of Connecticut, Department of Energy and Environmental Protection, Release Characterization Guidance,* effective March 1, 2026, and as may be amended from time to time.
RCG	Release Characterization Guidance	The RCG describes DEEP's recommendations for the investigation of properties and the suggested content of documentation that presents the facts and findings of site characterization by environmental professionals responsible for designing, conducting, and documenting site investigations and by any parties/persons required by law to conduct an investigation of a property in accordance with prevailing standards and guidelines.
SOP	Standard Operating procedure	A written procedure utilized for ensuring consistent approaches to collecting environmental samples and/or consistent analytical laboratory techniques.
	Spike	To spike a sample is to fortify a sample in the laboratory with known concentrations of target analytes.
SPLP	Synthetic Precipitation Leaching Procedure	An analytical procedure designed to determine the mobility of both organic and inorganic analytes present in liquids, soils, and wastes.
	Split Sample	A split sample is prepared when aliquots of sample taken from the same container and then analyzed independently. Split samples are usually taken after mixing or compositing and are used to document intra- or inter-laboratory precision.
	Standard of Care	Defined in the *State of Connecticut, Department of Energy and Environmental Protection, Release Characterization Guidance,* effective March 1, 2026, and as may be amended from time to time..
	Standards	Standards are solutions that contain known concentration of target analytes. Examples include stock standards, calibration standards, et cetera.
SRMs	Standard Reference Materials	A material or artifact that has had one or more of its property values certified by a technically valid procedure, and is accompanied by, or traceable to, a certificate or other documentation which is issued by NIST.
	Substance	Defined in RCSA Section 22a-134tt-1(a).

Acronym	Term	Definition
SURR	Surrogate Analyte	A surrogate analyte is an organic compound, which is similar to the target analyte(s) in chemical composition and behavior in the analytical process but is not normally found in environmental samples. The surrogate concentration is measured using the same procedures used to measure other analytes in the sample. Surrogate recoveries are used to evaluate the performance of the analysis.
SVOCs	Semi-Volatile Organic Compounds	A class of organic compounds that are more likely to be liquids or solids at ambient, or lower, temperatures.
	Target Analytes	Target analytes are the compounds included on the list of analytes for an analytical method.
TICs	Tentatively Identified Compounds	Tentatively identified compounds (TICs) are unknown compounds for which a possible identification was made by comparing the mass spectra of the unknown to a library of known mass spectra. Concentrations may also be estimated by assuming a response factor. TICs are not part of the standard target analyte list of the method.
	Trip Blank	Trip blanks originate within the laboratory. Trip blanks are sample containers that have been filled with analyte-free reagent water carried with other sample containers out to the field and back to the lab without being exposed to sampling procedures. Trip blanks are used to ascertain if sample containers may have been contaminated during transportation and storage.
TAT	Turn-Around Time	The turn-around time is the amount of time it takes for the laboratory to report the analytical results to the customer following the submittal of the samples to the laboratory.
TCE	Tricholorethene	An organic solvent primarily used to make refrigerants and used for metal degreasing.
TCLP	Toxicity Characteristic Leaching Procedure	An analytical procedure designed to determine the mobility of both organic and inorganic analytes present in liquid, solid, and multiphasic wastes.
UCL	Upper Control Limit	The highest value of a range is allowed to achieve without being considered out of the control limits.
VOCs	Volatile Organic Compounds	A class of organic compounds that have a high vapor pressure at room temperature, i.e., are commonly in the gaseous state at room temperature.

1. INTRODUCTION

Laboratory Quality Assurance and Quality Control (QA/QC) is a comprehensive program used to enhance and document the quality of analytical data. QA involves planning, implementation, assessment, reporting, and quality improvement to establish the reliability of laboratory data. QC procedures are the specific tools that are used to achieve this reliability.

Evaluating the quality of analytical data to determine whether the data are of sufficient quality for the intended purpose is a two-step process. The first step of the process is a data quality assessment (DQA) to identify and summarize any quality control problems that occurred during laboratory analysis (i.e., QC nonconformances). The results of the DQA are used to perform the second step, which is a data usability evaluation (DUE) to determine whether the quality of the analytical data is sufficient for the intended purpose.

To assist the environmental professional (EP) in obtaining analytical data of known quality, the DEEP Remediation Division Laboratory Quality Assurance/Quality Control Work Group developed the Reasonable Confidence Protocols (RCPs). The RCPs are a collection of analytical methodologies that contain specific performance criteria and are based on analytical methods published by the EPA and others. RCPs have been developed for the most commonly used analytical methods, and RCPs may be developed for other methods in the future.

When the RCPs are followed, the EP can have confidence that the data are of known and documented quality. This will enable the EP to evaluate whether the quality of the data is sufficient for its intended purpose. Information regarding the RCPs and laboratory QA/QC protocols is presented in the DEEP guidance document titled *Laboratory Quality Assurance and Quality Control Guidance Reasonable Confidence Protocols, Guidance Document*, effective November 17, 2007 (RCP Guidance). The RCP Guidance and RCPs are published on the DEEP website.

The RCP Guidance includes an RCP Laboratory Analysis QA/QC Certification Form that the laboratory uses to certify whether the data meet the guidelines for “Reasonable Confidence.” The guidance also describes the narrative that must be included as a laboratory deliverable to describe QA/QC non-conformances. When “Reasonable Confidence” is achieved for a particular data set, the EP will have confidence that the laboratory has followed the RCPs, has described non-conformances, if any, and has adequate information to make judgments regarding data quality.

A basic premise of the RCPs is that good communication and the exchange of information between the EP and the laboratory will increase the likelihood that the quality of the analytical data will meet project-specific Data Quality Objectives (DQOs), and therefore, will be suitable for the intended purpose. To this end, an example laboratory communication form included within the RCP Guidance provides an outline of the specific information that the laboratory should have prior to analyzing the associated samples.

When using this guidance, after September 1, 2007, when a laboratory uses a non-RCP for an analysis for which there is an existing RCP, the RCP Equivalency Demonstration Form must be submitted to the DEEP by the EP with the analytical data submittal. The

RCP Equivalency Demonstration Request Form is not required for analytical methods for which no RCP has been published. The RCP Equivalency Demonstration Request Form is included within the RCP Guidance.

The process of obtaining analytical data that are of sufficient quality for the intended purpose and evaluating the quality of analytical data in relation to project-specific DQOs occurs throughout the course of a project. Because there may, on occasion, be complex information associated with laboratory QC data, the EP is advised to seek assistance from laboratory personnel and others knowledgeable in performing DQAs and DUEs when needed. Information on the RCP Program and additional information on QA/QC issues is published on the DEEP website at Quality Assurance and Quality Control (ct.gov).

It is not unusual for laboratory reports to contain QC non-conformances, especially for those analyses that have extensive analyte lists such as SW-846 Methods 8260 (Volatile Organics and 8270 (Semivolatile Organics) and EPA Method 1633A (PFAS). The chances of every analyte passing all the QC criteria are remote and not expected. In many cases, the DQA and DUE will reveal QC nonconformances that do not affect the usability of the analytical data for the intended purpose. In these cases, the EP and others that will be relying on the data can have confidence that the quality of the data is appropriate for the intended purpose.

In other cases, the DQA and DUE will reveal QC nonconformances that will affect the usability of the analytical data for the intended purpose. In these cases, the EP has developed an understanding of the limitations of the analytical data and can avoid making decisions that are not technically supported and may not be fully protective of human health and the environment.

It is important to note that bias introduced through the collection of non-representative samples, or an inadequate number of samples will, in many cases, exceed the bias caused by laboratory analysis of the samples. It is imperative that the EP ensure that the number and location of samples collected and analyzed are sufficient to provide adequate characterization of site conditions. A comprehensive discussion of site characterization sampling is provided in the Release Characterization Guidance Document (RCG).

Neither the RCPs nor this guidance require formal data validation, such as that outlined in the *Region 1, EPA-New England, Environmental Data Review Supplement for Region 1 Data Review Elements and Superfund Specific Guidance/Procedures, September 2020,* the *Data Validation Functional Guidelines for Evaluating Environmental Analyses, July 1996, Revised December 1996,* and other analogous documents. Specifically, such documents describe formal, systematic processes for reviewing analytical data. These processes involve verifying derived results, inspection of raw data, review of chromatograms, mass spectra, inter-element correction factors, etc., to ascertain that the data set meets the data validation criteria and the DQOs specified in the quality assurance project plan (QAPP). In most cases, use of the RCPs will allow the EP to perform a DQA without conducting formal data validation. In cases where formal data validation will be necessary, the EP will have to contact the laboratory to obtain a full data package and evaluate the data in accordance with the EPA Guidance mentioned above.

2. OVERVIEW OF THE DATA QUALITY ASSESSMENT AND DATA USABILITY EVALUATION PROCESS

The DQA and DUE constitutes a two-step process that is designed to evaluate the quality of analytical data to determine if the data are of sufficient quality for the intended purpose. The DQA is an assessment of the laboratory quality control data, the laboratory report, and laboratory narrative conducted by the EP to identify and summarize QC nonconformances. The DUE is an evaluation conducted by the EP to determine if the analytical data are of sufficient quality for the intended purpose. The DUE uses the results of the DQA and evaluates the quality of the analytical data in relation to the project-specific DQOs and the intended use of the data. The DQA should be performed when the data are received throughout the course of a project. The DUE is performed whenever the data are used to make decisions.

The process of obtaining analytical data of sufficient quality for the intended purpose and evaluating the quality of analytical data in relation to project-specific DQOs and the conceptual site model (CSM) occurs throughout the course of a project. This process includes:

- Development of project-specific DQOs in accordance with professional judgment taking cognizance of published EPA guidance, and a CSM in accordance with the RCG;
- Communication with the laboratory regarding project-specific DQOs and the selection of appropriate analytical methods in accordance with DEEP's RCG;
- Performance of quality assurance and quality control activities during the analysis of the samples and reporting of QC results by the laboratory;
- Performance of a DQA by the EP when analytical results are received from the laboratory to identify QC nonconformances; and,
- Performance of a DUE by the EP to determine if the analytical data are of sufficient quality for the intended purpose. The DUE uses the results of the DQA and evaluates the quality of the analytical data in relation to the project-specific DQOs and the CSM.

The types of data that must be considered during an evaluation to determine if data from an environmental site assessment are representative of site conditions are presented in the RCG.

This process is presented in Figure 1.

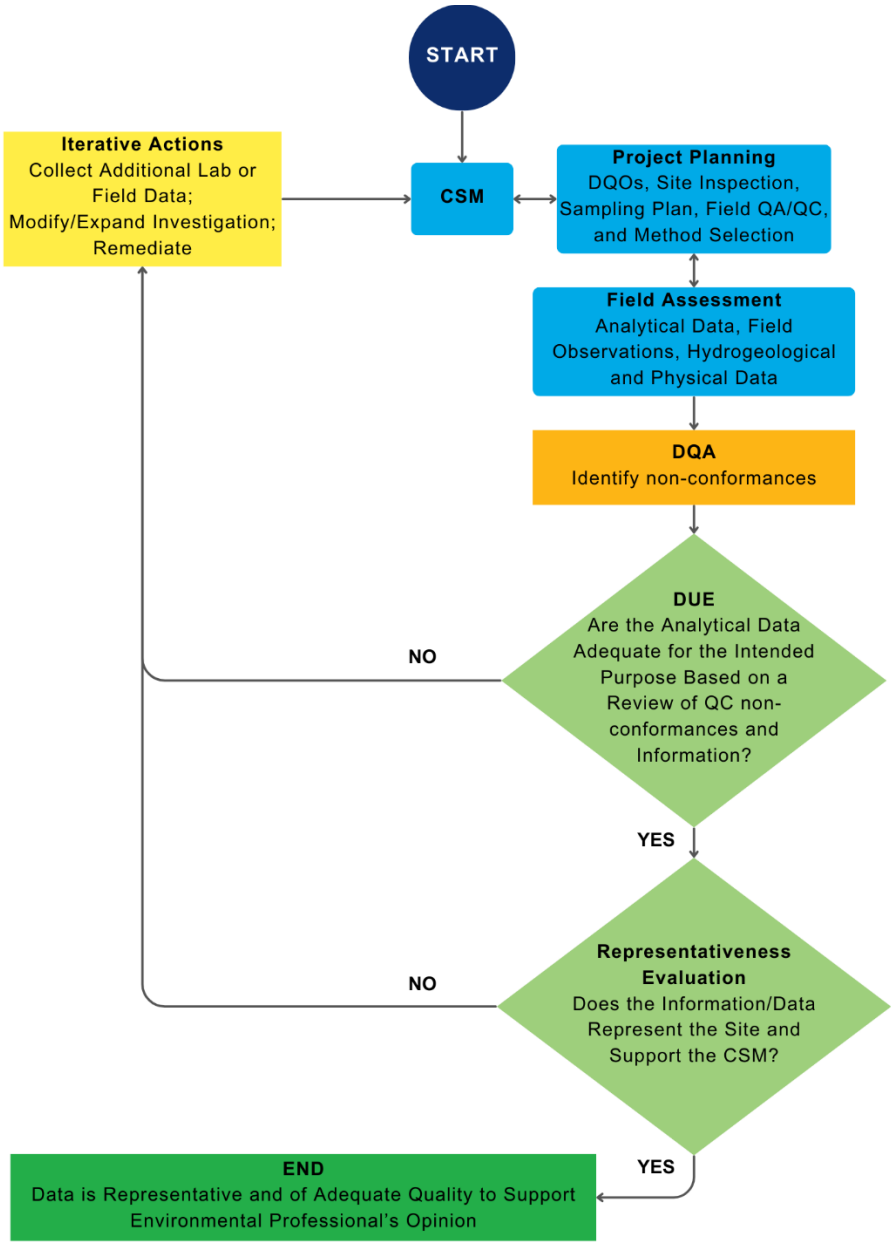

Figure 1: DQA/DUE Flow Chart

2.1 Data Quality Objectives

DQOs are developed by the EP to ensure that a sufficient quantity and quality of analytical data are generated to meet the goals of the project and support defensible conclusions that protect human health and the environment. DQOs should be developed at the beginning of a project and revisited and modified as needed as the project progresses. Similarly, the quality of the analytical data is evaluated in relation to the DQOs throughout the course of a project.

It is important to document the DQOs for a project in the context of the CSM so there is a roadmap to follow during the project and so there is documentation that the DQOs were

met after the project is finished. The DQOs for a project can be documented in a project work plan, a QAPP, an environmental investigation report, or in another document. Sources of detailed information regarding the development of DQOs and QAPPs are listed in Appendix A of this document.

Typical analytical DQOs include, but are not limited to:

- the QA/QC criteria specified in the RCPs or in other analytical methods with an equivalent degree of QA/QC as the RCPs;
- the applicable regulatory criteria, identified in the Release Based Cleanup Regulations (RBCRs) Sections 22a-134tt-1 through 22a-134tt-13 of the Regulations of Connecticut State Agencies (RCSA); and
- the Reporting Limit (RL) / Lower Limit of Quantitation (LLOQ) for a specific substance when determining the extent and degree of polluted soil, groundwater, or sediment from a release.

The DQOs, which are based on the intended use of the analytical data, determine how reliable the analytical data must be to make sound, rational decisions regarding data usability. For example, analytical data can be used by an EP to determine if a release took place, evaluate the nature and extent of a release, confirm that remediation is complete, or determine compliance with the applicable numeric criteria presented in the RBCRs (RBCR criteria).

2.2 Uncertainty in Analytical Data

All measurements have a degree of uncertainty. It is important to understand this uncertainty because analytical data with an unknown amount of uncertainty may be difficult to use with any degree of confidence. However, it is still possible to have an appropriate degree of confidence in the analytical data if the EP understands the degree of uncertainty, which is assessed using the DQA/DUE process. The intended use of the analytical data determines how much uncertainty is acceptable and how dependable the analytical data must be.

For example, when analytical data will be used for determining compliance with RBCR criteria, the EP must have a high degree of confidence in that data and must understand whether the degree of uncertainty will affect the usability of the data for that purpose. In cases where contaminants are known to be present at concentrations greater than the RBCR criteria and that remediation will be conducted, the amount of uncertainty associated with the analytical data can be much greater than when compliance with the RBCR criteria is to be demonstrated.

2.3 Types of Analytical Data

The three types of analytical data that the EP is likely to encounter are described in Table 2-1 along with the associated DQA tasks. The type of data determines the level of effort that is required for the DQA and DUEs.

Because many environmental investigation and remediation projects have been on-going since before the RCPs were developed and because RCPs are not published for all analytical methods, it is possible that many EPs will need to integrate the data generated by non-RCP methods with data generated in accordance with the RCPs. This evaluation must be performed on a site-specific and release area-specific basis, but the basic principles should be similar for each situation. Sections 6 and 7 of the RCP Guidance present information on the types of laboratory QC information that are needed to demonstrate equivalency with the RCPs.

Table 2-1
Types of Analytical Data

Type of Data	Description	Data Quality Assessment
RCP Data	Analytical data generated using the RCPs	Evaluate precision, accuracy, and sensitivity.
Non-RCP Data	Analytical data generated from samples collected after September 1, 2007 using a non-RCP method where there is an existing RCP; OR,	Demonstrate equivalency to RCPs (use RCP Equivalency Demonstration Form). Evaluate precision, accuracy, and sensitivity.
	Analytical data generated from samples collected after September 1, 2007 when no RCP is published.	Demonstrate equivalency to similar RCP. Evaluate precision, accuracy, and sensitivity.
Pre-RCP Data	Analytical data generated prior to September 1, 2007[1] that were not generated using an RCP.	Use existing QC data to evaluate precision, accuracy, and sensitivity. If precision and accuracy QC data are not available, evaluate sensitivity.

2.3.1 RCP Data

The term "RCP data" refers to analytical data generated in accordance with the RCPs for which there is a properly completed and signed RCP Laboratory Analysis Quality Assurance/Quality Control Certification Form and a required narrative of nonconformances. The use of a draft RCP that is published for public comment constitutes use of a RCP until such time as the RCP is published as a final method.

2.3.2 Non-RCP Data

"Non-RCP data" refers to analytical data generated after September 1, 2007, using a non-RCP method for an analysis for which a published RCP exists. In addition, the term "Non-RCP data" also indicates analytical data generated by an analytical method for which there is no published RCP at the time of sample collection or analysis. Information regarding demonstrating equivalency with the RCPs is presented in Sections 6 and 7 of the RCP guidance.

After September 1, 2007, when a laboratory uses a non-RCP method for an analysis for which there is an existing RCP, the RCP Equivalency Determination Request Form must be submitted to the DEEP by the EP with the analytical data submittal. The RCP Equivalency Demonstration Form is not required for analytical methods for which no RCP has been published. The RCP Guidance presents information regarding the RCP Equivalency Demonstration Form in Section 5.3 of that document, and a copy of the form is included in Appendix A of that document.

2.3.3 Pre-RCP Data

"Pre-RCP data" refers to analytical data generated before September 1, 2007, using a non-RCP method. To conduct a DQA of Pre-RCP data, the EP will review existing laboratory QC data to evaluate precision, accuracy, and sensitivity. In cases where QC information to evaluate precision and accuracy are not available, the EP will QC information related to sensitivity.

3. DATA QUALITY ASSESSMENT

A DQA is the process of identifying and summarizing QC nonconformances. The DQA process should occur throughout the course of a project. The RCP Laboratory Analysis QA/QC Certification Form, laboratory narrative, and analytical data package should be reviewed by the EP soon after it is received, so the laboratory can be contacted regarding any questions, and issues may be resolved in a timely manner. The DQA must be performed prior to the DUE. The level of effort necessary to complete this task depends on the type of analytical data, as described in Table 2-1. The types of quality control information that are to be reviewed as part of the DQA are described in Appendix C of this document. Results from the DQA are used during the DUE to evaluate whether the analytical data for the samples associated with the specific QA/QC information are usable for the intended purpose.

The quality control checks and information required to be reported under the RCPs are provided in Table 1A of each of the RCPs. Appendix B of this document also includes a table that summarizes RCP performance standards and the recommended frequencies for the various types of QC information.

The DQA is usually most efficiently completed by summarizing QC nonconformances on a DQA worksheet or another manner that documents the thought process and findings of the DQA. Sample DQA worksheets are included in Appendix D of this document. These worksheets may be modified by the user. For larger projects, these worksheets in conjunction with electronic data deliverables should help the EP efficiently evaluate and summarize large quantities of QC information. The use of computer programs such as spreadsheets and databases and electronic laboratory deliverables will help the EP efficiently manage laboratory information. Appendix D also presents a summary of selected RCP acceptance criteria which may be useful during the completion of DQA worksheets.

3.1 Batch Quality Control Versus Site Specific Quality Control

A group or "batch" of up to 20 field samples processed at the laboratory require specific QC elements to document and monitor accuracy, precision, and bias. These QC elements typically include two different types of spike samples and/or duplicates. "Batch" QC elements include samples such as Laboratory Control Samples (LCS/LCSD) and method blanks. "Site specific" QC elements include Matrix Spike (MS/MSD) samples and Matrix Duplicate (MD) duplicates. Further information regarding all QC samples are presented in detail throughout this document.

Since a laboratory batch may include samples from several different sites, the accuracy and precision assessment will not be germane to any site in the batch except for the site from which the QC samples originated. QC samples from a specific site are referred to as site specific QC. Because batch QC may include samples from different sites, it may be of limited value when evaluating precision and accuracy for a site.

3.2 Evaluating Significant Quality Control Variances

Some QC nonconformances that are so excessive that they must be considered as significant or gross violations of QC criteria. Appendix E of this document presents a summary of significant QC variances or gross QC failures. If the DQA is performed when the laboratory deliverable is received it may be possible for the EP to request that the laboratory perform reanalysis of the sample or sample extract within the holding time. During the DUE, data with gross QC failures in most cases will be deemed unusable, unless the EP provides adequate justification for its use. However, samples with significant QC variances can be used to determine that remediation is needed. The DEEP expects that any data that is deemed unusable will not be used to support environmental decisions. For example, complex matrices often confound analytical measurements by binding contaminants to the matrix (matrix interference), causing a significant QC variance.

3.3 Poorly Performing Compounds

Not all compounds of interest perform equally well for a given analytical method or instrument. Typically, this is due to the chemical properties of these compounds and/or the limitations of the methods and instrumentation, as opposed to laboratory error. These compounds are commonly referred to as "poor performers”. Appendix F of this document presents a summary of compounds that are typically poorly performing compounds. A laboratory’s specific list of poorly performing compounds should not be substantially greater than this list. The EP should contact the laboratory to confirm which compounds are poor performers, and this information should be evaluated during the DUE. EPs may refer to the Department of Defense (DoD) Quality Systems Manual (QSM), EPA National Functional Guidelines, and other analogous documents for additional information on poorly performing compounds.

3.4 PARCCs Parameters

The PARCCs parameters are used to describe the quality of analytical data in quantitative and qualitative terms using the information provided by the laboratory quality control information. The PARCCS parameters – precision, accuracy, representativeness, comparability, completeness, and sensitivity – are described below. The types of QC information that can be used to evaluate the quality of analytical data using the PARCCS parameters are provided in Appendix B of this document. Also found in Appendix B is a table that summarizes RCP performance standards and the recommended frequency for the various types of QC information.

3.4.1 Precision

Precision expresses the closeness of agreement, or degree of dispersion, between a series of measurements. Precision is a measure of the reproducibility of sample results. The goal is to maintain a level of analytical precision consistent with the DQOs. As a conservative approach, it is appropriate to compare the greatest numeric results from a series of measurements to the applicable regulatory criteria.

Precision is measured through the calculation of the relative percent difference (RPD) between two quantities across two measurements or two. The RPD is calculated using the following equations:

$$RPD = \left[\frac{(A - B)}{((A + B)/2)}\right] \times 100$$

Where: A = Analytical results from the first measurement

B = Analytical results from the second measurement

For example, the analytical results for two field duplicates were 50 milligrams per kilogram (mg/kg) and 350 mg/kg for a specific analyte. The RPD for the analytical results for these samples was calculated to be 150%, which indicates a high degree of heterogeneity in the sample matrix and a low degree of precision in the analytical results. When using the results from duplicates, the higher result from the duplicate samples should be used as a conservative approach.

3.4.2 Accuracy

Accuracy is used to describe the agreement between an observed value and an accepted reference, or true value. The goal is to maintain a level of accuracy consistent with the DQOs. Accuracy is usually reported as a percentage of the observed value divided by the reference value using the following equation:

$$\%R = \frac{observed\ value}{reference\ value} \times 100$$

Where: %R = the percent recovery.

For example, the analytical result for a LCS was 5 mg/kg. The LCS was known to contain 50 mg/kg of the analyte. The % recovery for the analytical results for this analyte was calculated to be 10%, which indicates an extremely low degree of accuracy of the analytical results for the analyte and would indicate a significant low bias to any associated field sample in that analytical batch. Therefore, the actual concentration of the analyte in this sample is significantly higher than reported.

3.4.3 Representativeness

Representativeness is a qualitative measurement that describes how well the analytical data characterizes a release area. Many factors can influence how representative the analytical results are for a release area. These factors include the selection of appropriate analytical procedures, the sampling plan, matrix heterogeneity and the procedures and

protocols used to collect, preserve, and transport samples. Information to be considered when evaluating how well the analytical data characterizes a release area is presented in various sections of the RCG.

For example, as part of a sampling plan, an EP collected soil samples at locations of stained soil near the base of several above-ground petroleum storage tanks known to be more than seventy years old and observed to be in deteriorated condition. The samples were analyzed for extractable total petroleum hydrocarbons (ETPH). The concentrations of all ETPH results were below the RL/LLOQ or not detected (ND). The EP evaluated these results in relation to visual field observations that indicated that petroleum-stained soil was present. The EP questioned how well the analytical results characterized the locations where stained soil was observed and collected several additional samples for ETPH analysis to confirm the results. The results of the second set of samples collected from locations of stained soil indicated the presence of ETPH at concentrations of approximately 5,000 mg/kg. Therefore, the EP concluded that the original samples for which the analytical results were reported as ND for ETPH were not representative of the stained soil and that the second set of samples were representative of the stained soil.

3.4.4 Comparability

Comparability refers to the equivalency of two sets of data. This goal is achieved using standard or similar techniques to collect and analyze representative samples. Comparable data sets must contain the same variables of interest and must possess values that can be converted to a common unit of measurement. Comparability is primarily a qualitative parameter that is dependent upon the other data quality elements. For example, if the RL/LLOQs for a target analyte were significantly different for two different methods, the two methods would not be comparable.

3.4.5 Completeness

Completeness is a quantitative measure that is used to evaluate how much valid analytical data was obtained in comparison to the amount that was planned. Completeness is usually expressed as a percentage of usable analytical data. Completeness goals must be specified for the various types of samples that will be collected during an investigation. Completeness goals are used to estimate the minimum amount of analytical data required to support the conclusions of the EP. If the completeness goal is 100% for samples that will be used to determine compliance with the applicable regulations, all the samples must be collected, analyzed and yield analytical data that are usable for the intended purpose. Critical samples include those samples that are relied upon to determine the presence, nature, and extent of a release, or determine compliance with applicable regulations. The completeness goal for critical samples is usually 100%.

3.4.6 Sensitivity

Sensitivity is related to the RL/LLOQ. In this context, sensitivity refers to the capability of a method or instrument to detect a given analyte at a given concentration and reliably

quantitate the analyte at that concentration. Typically, EPs should verify that the instrument or method can detect and provide an accurate analyte concentration that is not greater than the RBCR criteria; it is the responsibility of the data user, in concert with the laboratory, to establish the range and required RL/LLOQ for the target analytes to meet the Release Based Cleanup Criteria (RBCR) criteria requirements for their project with the laboratory. In most cases, RL/LLOQs are significantly less than the RBCR criteria. Analytical results for samples with RL/LLOQs greater than the RBCR criteria cannot be used to demonstrate compliance with the RBCRs. It is never appropriate for an EP to request that the laboratory raise an RL/LLOQ to a concentration that is equal to the applicable regulatory criteria to eliminate reported values less than the RBCR criteria.

3.5 Common Laboratory Contaminants

During the preparation and analysis of samples and extracts, chemicals and some common laboratory hardware may be a source of contamination. These contaminants may be introduced from contaminated reagents, gases, and/or glassware; ambient contamination; poor laboratory technique; et cetera. A list of common laboratory contaminants can be found in Appendix G of this document. However, not all detections of the contaminants on that list in environmental samples can be attributed to laboratory contamination. During the DUE, the EP must take the CSM and site-specific information into account to support a hypothesis that the detection of common laboratory contaminants in environmental samples is actually as result of laboratory contamination and not due to releases at the site.

3.6 Bias

When QC data for analytical results indicates that low or high bias is present, this means that the true values of the target analytes are lower or higher than the reported concentration. Bias can also be non-directional, which means that the analytical results have poor analytical precision. Bias is evaluated by the EP as part of the DUE.

Bias can be caused by many factors, including improper sample collection and preservation, exceedances of the holding times, and the nature of sample matrix. The sample matrix can cause matrix effects and matrix interferences. Typically, matrices such as peat, coal, coal ash, clay, and silt can exhibit significant matrix effects by binding contaminants or reacting with analytes of concern. The EP should contact the laboratory to determine the appropriate laboratory methods to address these difficult matrices. The evaluation of bias is further discussed in section 4.1 of this document.

3.6.1 High and Low Bias

High or low bias can be caused by many factors. EPs should be cautioned that it is not acceptable to “adjust laboratory reported” compound concentrations or RL/LLOQs based on percent recovery. Accuracy is associated with high and low (i.e., directional) bias.

3.6.2 Non-Directional Bias

Non-directional bias means that the analytical results exhibit a poor degree of precision. Duplicate sample results are used to evaluate the degree of precision between the measurements. Non-directional bias occurs when heterogeneous media, such as contaminated soil or soil containing wastes such as slag, are sampled. The heterogeneity of the matrix causes the analytical results to vary and may cause a large RPD between the sample results. The degree to which the analytical results represent the environmental conditions is related to the number of samples taken to characterize the heterogeneous media and how those samples are selected and collected. For example, as a greater number of samples are analyzed, the analytical results will better represent the concentrations of the analytes present in the environment.

4. DATA USABILITY EVALUATION

The DUE is an evaluation by the EP to determine if the analytical data are of sufficient quality for the intended purpose and can be relied upon by the EP with the appropriate degree of confidence to support the conclusions that will be made using the data. The EP uses the results of the DQA to evaluate the usability of the analytical data during the DUE in the context of project-specific DQOs and the CSM.

One of the primary purposes of the DUE is to determine if any bias that might be present in the analytical results, as identified during the DQA, affects the usability of the data for the intended purpose. The DUE can use multiple lines of evidence from different types of laboratory QC information or from site-specific conditions described in the CSM to evaluate the usability of the analytical data.

The primary PARCCS parameters that are used to evaluate the quality of the analytical data during the DQA are precision, accuracy, and sensitivity. The results of the DQA, in conjunction with an evaluation of the data with respect to the other PARCCS parameters of representativeness, completeness, and comparability, must be evaluated as part of a DUE and must be considered when incorporating analytical data into the CSM.

DEEP expects that more scrutiny regarding the quality of analytical data will be necessary when the EP intends to use the data to demonstrate compliance with the RBCRs than when the data are used to design additional data collection activities or when remediation will be conducted. Data that may not be deemed to be of sufficient quality to demonstrate compliance with the RBCRs may be useful for determining that a release has occurred in cases when remediation will be conducted or to guide further data collection activities.

Typically, the most challenging DUE decisions are for situations when the analytical results are close to, or at, the RBCR criteria and there are QC nonconformances that might affect the usability of the data. In situations such as this, the DEEP expects that the EP will use a conservative approach that is fully protective of human health and the environment. Coordination with the laboratory to understand QC information, additional investigation, and re-analysis of samples may be necessary in some cases. If the DQA is performed when the laboratory deliverable is received, it may be possible to perform re-analysis of the sample extract within the holding time.

To help expedite the DUE, it may be useful to determine if the QC nonconformances identified in the DQA are significant for a particular project. The types of questions listed below are not inclusive and are intended to help the EP evaluate QC nonconformance for a particular project. Additional questions for the EP to consider are also listed of Page 2 of the DUE Worksheet provided in Appendix I of this document.

- Will remediation be conducted at the release area? If remediation will be conducted, the EP should use the QC information to work with the laboratory to minimize QC issues for the samples to be collected to evaluate the effectiveness of remediation. Alternately, if remediation will not be conducted, the analytical data must be of sufficient quality to demonstrate compliance with the RBCRs.
- Were significant QC Variances were reported? Analytical data with gross QC failures are usually deemed unusable unless the EP provides adequate

justification for its use. Generally, samples with significant QC variances can be used to determine that remediation is needed. Significant QC Variances are discussed in Section 3.2 and Appendix E of this document.

- Were QC nonconformances noted for substances that are not constituents of concern at the site? Such a finding must be supported by a comprehensive site investigation conducted in accordance with the RCG. The EP is cautioned that documented chemical usage at a site is often incomplete or inaccurate, that many chemicals contain impurities, that many chemical formulas are proprietary, and that the breakdown products of many compounds may not be known. Therefore, limiting the list of constituents of concern without appropriate investigation and analytical testing can inadvertently overlook substances that should be identified as constituents of concern.
- Were QC nonconformances reported for compounds that are poorly performing compounds? If the nonconformances are noted for poorly performing compounds that are not constituents of concern for the release area, such nonconformances have little or no impact on the usability of the data. However, if the nonconformances are noted for poorly performing compounds that are constituents of concern for the release area, the EP will need to work with the laboratory to resolve this issue. Supplemental sampling and analysis may be required to address this. Poorly performing compounds are discussed in Section 3.3 and Appendix F of this document.

The DUE process is discussed in detail using examples in the sections that follow. The examples presented below are for illustrative purposes only and are not meant to be a strict or comprehensive evaluation of all types of laboratory quality control information or all the possible outcomes of data quality evaluations. The discussion begins with examples of less complex QC information and concludes with the use of multiple lines of evidence to evaluate more complicated DUE issues using more than one type of laboratory QC information and information from the CSM for a hypothetical site. The numeric RBCR criteria identified in the examples are for illustrative purposes and may not be consistent with current RBCR criteria.

Appendix H of this document illustrates many common QC issues and a range of potential DUE outcomes for each issue and is provided as a general guidance tool for data users. The DUE is usually most efficiently completed by using a worksheet or another manner that documents the thought process and findings of the DUE. Appendix I of this document presents a DUE Worksheet that can be used and modified as needed to summarize the types of issues that should be discussed in the EP's written opinion regarding data usability.

4.1 Evaluation of Bias

The types of bias are discussed in Section 3.5 of this document. When evaluating sample results that exhibit bias, it is useful to compare the concentrations detected and the RL/LLOQs to the RBCR criteria as described below:

- If the detected concentrations of analytes or RL/LLOQs for analytes for which the result is reported as ND are significantly below the RBCR criteria, the bias has limited impact on the usability of the data.
- If the detected concentrations of analytes or RL/LLOQs for analytes for which the result is reported as ND are significantly above the RBCR criteria, the bias has limited impact on the usability of the data only if remediation will be conducted.
- If the detected concentrations of analytes or RL/LLOQs for analytes for which the result is reported as ND are close to the RBCR criteria, this bias has limited impact on the usability of the data only if remediation will be conducted. If remediation will not be conducted, additional analytical information, including possibly the collection of additional samples for analysis may be necessary to evaluate how the bias affects the analytical data. For situations such at this, the EP may contact the laboratory for further assistance.

4.2 General Quality Control Information

The following subsections discuss issues associated with quality control information related to sample management, preservation, holding times, and field QC samples.

4.2.1 Chain of Custody Forms

Chain of Custody Forms are used to document the history of sample possession from the time of collection to the time the samples are received by the laboratory. Samplers sometimes enter incorrect information on the Chain of Custody form, such as incorrect dates, sample identification numbers, and analysis requested. Usually, these errors are found through the course of the project. However, simply correcting this information without documentation of the problem and the resolution may amount to falsification of the chain of custody or simply cause confusion. The error may be corrected with a single-line, cross-out of the error, initialing/signing, dating of the correction, and an explanation for the correction.

4.2.2 Sample Preservation and Holding Times

Once a sample is collected, changes in the concentrations of analytes in the sample can occur. To minimize these changes, the sample must be collected, stored, and preserved as specified in the analytical method and/or for volatile organic compounds (VOCs) the DEEP's *Guidance for Collecting and Preserving Soil and Sediment Samples for Laboratory Determination of Volatile Organic Compounds*, effective March 1, 2006 (Soil Preservation Guidance Document). The sample must also be analyzed within the specified holding time. The holding time for a sample has two components. The first component is the time from when a sample is collected to when it is prepared for analysis or, if no preparation step is required, the time from when the sample is collected to when it is analyzed. If a test requires a preparation step, such as solvent extraction for determination of polychlorinated biphenyls (PCBs) or acid digestion for determination of metals, there is a second holding-time component referred to as the extract holding time.

This is the time between when the sample is prepared and when the resultant extract or digestate is analyzed. Failure to analyze a sample within the prescribed holding time could render the data unusable.

Sample preservation can be either physical or chemical. Physical preservation might be cooling, freezing, or storage in a hermetically sealed container. Chemical preservation refers to addition of a chemical, usually a solvent, acid, or base, to prevent loss of any analyte in the sample. An example of physical storage is the freezing of soil samples for determination of VOCs. This procedure and other procedures for preserving soil samples for determination of VOCs, can be found in the Soil Preservation Guidance Document. DEEP expects that all soil samples collected in or for use in Connecticut for the purpose of laboratory analysis for VOCs on or after March 1, 2006, be collected and preserved in accordance with the procedures described in the Soil Preservation Guidance Document. Soil or sediment samples that are collected on or after March 1, 2006 in a manner that is not in compliance with the Soil Preservation Guidance Document are deemed to have a significant QC variances or gross QC failure, as described in Section 3.2 and Appendix E of this document. DEEP anticipates that the vast majority of data generated before the effective date of this guidance will be acceptable without the need for resampling and analysis for VOCs. However, EPs should evaluate the data in the context of their site-specific CSM to determine whether potentially low-biased results for VOCs that may be present in soil or sediment at the site would create a significant data gap or whether the possible low bias might result in a potential significant risk to human health. Based on this evaluation, additional investigation and/or remediation may be warranted. Improperly preserved samples cannot be used to determine the maximum concentrations of the contaminants in the soil or sediment nor that there were no releases of VOCs.

4.2.3 Equipment, Trip, Field, and Method Blanks

Equipment-rinsate, trip, field, method blank samples can be used to evaluate contamination in a sample resulting from improperly decontaminated field equipment, contamination introduced during transportation or collection of the sample, or contamination during laboratory procedures.

Compounds typically detected include, but are not limited to, the common laboratory contaminants identified in Appendix G as well as site-specific contaminants.

The presence of any analytes in any blanks should be noted in the DQA review of the data. The concentrations of the analytes in the blanks are compared to any detected analyte concentrations in the associated samples, accounting for any dilution factors for the samples. Analytes that are detected in the blanks, but ND in the sample can be ignored. Analytes detected in the laboratory method blank and detected in any associated sample should be flagged by the laboratory with a "B" suffix to draw attention to the data user. Data users should use professional judgement to evaluate if detections in the sample are true positives or false positive possibly attributed to cross contamination.

<u>Example 1: Trip Blanks – Blank concentration greater than sample concentration</u>

Acetone was found in groundwater samples at concentrations up to 10 µg/l. Acetone is also present at a concentration of 15 µg/l in a water trip blank. In this example, the blank

concentration is greater than the sample concentration indicating the blank has been contaminated during collection, storage, or transportation. However, the EP should review these results in relation to the CSM for the site, including results for other samples in the vicinity, to determine if this evaluation is reasonable before concluding that Acetone is not actually present in the sample.

Example 2: Method Blanks – Sample concentration greater than blank concentration

Acetone was found in groundwater samples at concentrations up to 40 µg/l. Acetone is also present at a concentration of 15 µg/l in the laboratory method blank. In this example, the sample concentration is greater than 2x the method blank concentration, therefore, it is likely the detection in the sample is not a false positive. However, the EP should review these results in relation to the CSM for the site, including results for other samples in the vicinity, to determine if this evaluation is reasonable before concluding that Acetone is actually present in the sample.

4.2.4 Field Duplicates

Field duplicates are replicate or split samples collected in the field and submitted to the laboratory as two different samples. Field duplicates are used to assess precision for the entire measurement system including sampling, handling, shipping, storage, preparation and analysis. Blind duplicates are field duplicate samples submitted to the laboratory without being identified as duplicates. Duplicate samples are used to evaluate the sampling technique and homogeneity/heterogeneity of the sample matrix. The results of field duplicates are reported as the RPD between the sample and duplicate results. As a conservative approach, it is appropriate to compare the higher of the two results for field duplicate samples to the applicable regulatory criteria.

In general, solid matrices have a greater amount of heterogeneity than water matrices because solid matrices are not mixed as well as liquids. When the RPD for detected constituents (concentrations greater than the RL/LLOQ) is greater than or equal to 50% for nonaqueous matrices or greater than or equal to 30% for aqueous matrices, the EP is advised to consider the representativeness of the sample results in relation to the CSM.

Field duplicate results should be evaluated along with any laboratory duplicate results that are available to identify whether the issue is related to the sample matrix, collection techniques, or the laboratory analysis of the sample. If the laboratory duplicates are acceptable, but the field duplicates are not, the likely source of this lack of reproducibility is heterogeneity of the matrix or the sampling or compositing technique. Conversely, if the laboratory duplicates are not acceptable, but the field duplicates are acceptable, the likely source of this lack of reproducibility is related to the analysis of the sample by the laboratory. The RL/LLOQ for the analyte in question must be considered in this evaluation because, typically, analytical precision decreases as the results get closer to the RL/LLOQ. Usually, analytical results need to be four to five times the RL/LLOQ to evaluate matrix issues or sampling issues.

Example 4: Duplicate Sample Results – Heterogeneity

Duplicate sample analytical results for lead in two soil samples were 500 mg/kg and 1,050 mg/kg. The RL/LLOQ was 1 mg/kg. The RPD for these samples is approximately 71%,

which is greater than the guideline of 50%. The boring logs indicated that small pieces of metal slag were present in the samples. The lack of precision for these sample results and the boring logs for these samples indicate that the samples are heterogeneous and lack reproducibility because of the presence of slag. The EP is advised to consider the representativeness of the sample results in relation to the CSM. Additional investigation and analysis are needed to evaluate the accurate concentrations and distribution of lead at the site.

4.3 Laboratory Quality Control Information

The RCPs and commonly used analytical methods for environmental samples have been verified to produce reliable data for most matrices encountered. The reliability of the results to represent environmental conditions is predicated on many factors including:

- the sample must be representative of field conditions;
- the sample must be properly preserved and analyzed within holding times;
- the preparation steps used to isolate the analytes from the sample matrix must be such that no significant amounts of the analytes are lost;
- the analytical system must be free from contamination;
- the analytical system must be calibrated and the calibration verified prior to sample analysis; and
- no significant sample matrix interferences are present which would affect the analysis.

Except for the first bullet, the laboratory can provide the data user with laboratory quality control information that provides insight into these key indicators. The determination that a sample is representative of the field conditions is based on reviewing the sampling plan, the field team's standard operating procedures and field logs, and the results for other samples including field and laboratory duplicates.

The primary laboratory QC data quality information that the EP considers during the DQA are the RCP Laboratory Analysis QA/QC Certification Form, the chain of custody form, sample preservation, holding times, RL/LLOQs, laboratory and field duplicates, surrogates, matrix spikes and matrix spike duplicates (when requested by the EP) and laboratory control samples. However, there are other non-standard types of QC information that are required to be reported by the RCPs that are described in Table 1A of the various RCPs.

4.3.1 Reasonable Confidence Protocol Laboratory Analysis QA/QC Certification Form

The Reasonable Confidence Protocol Laboratory Analysis QA/QC Certification Form (RCP Certification Form) is used by the laboratory to certify whether the data meet the requirements for "Reasonable Confidence." The RCP certification form is available at the DEEP website at Quality Assurance and Quality Control (ct.gov) presented in Appendix

A of the RCP Guidance. All the questions on the Certification Form must be answered, the form must be signed, and a narrative of nonconformances included with the analytical data package. If all the questions are not answered, the Certification Form is not signed, or if a narrative of nonconformances is not included with the data package, the EP should contact the laboratory to obtain a properly completed Certification Form and/or the missing narrative. If the laboratory cannot supply the requested information, the EP will have to demonstrate equivalency with the RCPs for the dataset by following the guidance presented in Sections 6 or 7 of the RCP Guidance.

4.3.2 Reporting Limits / Lower Limits of Quantitation

The RL/LLOQ is the lowest concentration that a method can achieve for a target analyte with the necessary degree of accuracy. The RL/LLOQ must be set as the concentration of the lowest non-zero calibration standard of a calibration curve used for analysis of a given sample by a specific method, corrected for specific sample weight or volume and dilutions. For soil and sediment samples, moisture content of the samples must also be used to determine the RL/LLOQ for each sample. Also, the RL/LLOQ is the minimum concentration of an analyte that can be identified and quantified within specified limits of precision and accuracy.

To demonstrate compliance with the RBCR criteria, the RL/LLOQ must be less than or equal to the applicable, numeric regulatory criterion. If the RL/LLOQ is less than an applicable RBCR criterion, it is not appropriate for the laboratory to artificially elevate the RL/LLOQ, nor is it appropriate for the EP to request that the laboratory report an artificially elevated RL/LLOQ. For example, the RBCR industrial/commercial direct exposure criterion (I/C DEC) and pollutant mobility criterion (PMC) for a class GB groundwater area (GB PMC) for ETPH is 2,500 mg/kg. It is not appropriate for an EP to request the laboratory raise the RL/LLOQ for ETPH to 2,500 mg/kg when the laboratory normally calibrates its instrumentation at some lower concentration.

Not all methods can achieve RL/LLOQs that are at or below RBCR criteria for some constituents. For example, it will be necessary to use EPA Method 504.1 to achieve RBCR criteria for aqueous samples for the following compounds: Ethylene Dibromide (EDB), 1,2-dibromo-3-chloropropane, and 1,2,3-trichloropropane.

Example 5: Reporting Limits – Dilution Factors

Results for a soil sample analyzed for tetrachloroethylene (PCE) indicate ND, with a RL/LLOQ of 1,000 micrograms per kilogram (µg/kg) and a dilution factor of 10 times. Dilution of highly contaminated samples is performed when the analysis of the undiluted sample may cause contamination of the instrument that is difficult and time consuming to remove, or because the analyte concentration is above the calibration curve. In these cases, the laboratory will possibly analyze the sample a number of times with decreasing dilutions until either a RL/LLOQ less than the RBCR criteria is achieved or the analyte is detected in the sample. In this case, it would be incorrect to state based on the ND reported for the sample, that this sample concentration is below the GA PMC for PCE of 100 µg/kg, but it would be possible to demonstrate compliance with the IDEC, which is 110,000 µg /kg for PCE.

Example 6: Reporting Limits

Reported analytical results for PCE in a groundwater sample indicated a RL/LLOQ of 12 µg/l. Because the elevated RL/LLOQ was >GWPC, these results cannot be used to demonstrate if compliance with criteria has been achieved.

4.3.3 Method Blanks

Most analytical methods require method blanks. The purpose of the method blank is to determine the presence and concentration of any contamination associated with the processing or analysis of the samples. Ideally, method blanks should not contain any detected analytes, but for certain tests, low levels of common contaminants are not unusual because of the nature of the typical commercial analytical laboratory. Common laboratory contaminants or artifacts include methylene chloride, acetone, methyl ethyl ketone (MEK), for Volatile Organic Compounds (VOCs) and or any phthalate for Semi-Volatile Organic Compounds (SVOCs). A summary of common laboratory contaminants is presented in Appendix G of this document.

The presence of any analytes in any method blanks should be noted during the review of the data. The concentrations of contaminants in blanks are compared to any detected analyte concentrations in the associated samples, considering any dilution factors. Analytes present in the blanks, but ND in the sample can be ignored. Analytes detected in the laboratory method blank and detected in any associated sample should be flagged by the laboratory with a "B" suffix to draw attention to the data user.

4.3.4 Laboratory Duplicates

Laboratory duplicates measure laboratory precision. The analytical results for laboratory duplicates are reported as the RPD between the sample and duplicate results. Laboratory duplicates are replicate samples and are prepared by taking two aliquots from one sample container. As a conservative approach, it is appropriate to compare the greatest numeric duplicate result to the applicable regulatory criteria.

Laboratory duplicate results should be evaluated along with any field duplicate results to identify whether any precision issues are related to the sample matrix and collection techniques or to the laboratory analysis of the sample. Information regarding the interpretation of duplicate sample results can be found in Section 4.2.4 of this document.

4.3.5 Surrogates

A surrogate is an organic compound that is similar to the target analyte(s) in chemical composition and behavior in the analytical process but is not normally found in environmental samples. Spiking the samples with surrogate compounds and determining the percent recovery of the spiked surrogate compound evaluates sample matrix effects, accuracy, and laboratory performance on individual samples. The surrogate concentration is measured using the same procedures used to measure other analytes in the sample. Certain analyses that have extensive target compound lists require several surrogates. If the reported recovery for a surrogate is outside acceptance criteria for

VOCs, then all VOC results are biased high or low depending on whether the surrogate was higher or lower than the acceptance criteria. For SVOCs, if two or more surrogates in the same fraction (acid SVOC surrogates or base neutral SVOC surrogates) are outside acceptance criteria, all results in that fraction are biased high or low depending on whether the surrogate was higher or lower than the acceptance criteria. For SVOCs, by understanding which surrogates are related to which target compounds, the percent recovery of a surrogate can be related to the specific constituents of concern, which may be useful in evaluating whether the data are useable. Information regarding surrogates and internal standards for SVOCs is presented in Appendix J of this document.

The evaluation of interfering matrix effects or high concentrations of target compounds that may mask the detection of surrogate recoveries is a complex issue and not straightforward in some cases. Common problems include the presence of non-target compounds. The review and evaluation of surrogate compound results involves the evaluation of multiple lines of evidence and is described in Section 4.4 of this document. Data from surrogate results should be used in conjunction with other QC data, such as laboratory control samples and matrix spikes. The performance standards for surrogates are presented in Table 1A of various RCPs and in Appendix D of this document.

Example 7: Surrogates – High Recovery

A soil sample analyzed by SW-846 Method 8270 was collected to determine if remediation was needed.

- The percent recovery for the surrogate chrysene-d12 was reported to be 159%. Chrysene-d12 is a surrogate for pyrene and other compounds, as described Appendix J of this document. The method specifies that the recovery limits for SVOC surrogates must be within 30 to 130%.
- Pyrene was reported at a concentration of 10 mg/kg, which is greater than the GA PMC applicable to the release area of 4 mg/kg.

The DEP guidance for evaluating surrogate recoveries for Method 8270 requires at least two surrogates in a given fraction (e.g., base/neutrals or acids) be out of criteria before any bias is assigned to the fraction. As only one surrogate is out for the base/neutral fraction, no bias is assigned to the results. In addition, because the reported concentration of pyrene is well above the pollutant mobility criteria, the reported QC information has no bearing on the usability of the results to determine that the concentration of pyrene is greater than the GA PMC and that remediation is needed.

Example 8: Surrogates – Low Recovery

A soil sample was analyzed by SW-846 Method 8260. The intended use of the analytical data was to determine if contaminants were present at concentrations that exceed the GA PMC.

- The percent recovery for the surrogate toluene-d8 was reported to be 20%. The method specifies that the recovery limits for surrogates must be within 70 to 130%. Because the reported recovery for this surrogate is outside acceptance criteria for VOCs, then all VOC results are biased low.

- 1,1,1-trichloroethane was reported at a concentration of 2.5 mg/kg, which is < GA PMC applicable to the release area of 4 mg/kg.

The reported percent recovery for the surrogate toluene-d8 indicates a potential low bias for 1,1,1-trichloroethane. Because the reported concentration of 1,1,1-trichloroethane is below the pollutant mobility criteria, the reported potential low bias means the results should not be used to demonstrate that 1,1,1-trichloroethane is present at a concentration less than the GA PMC. Before drawing any conclusions regarding the effect of the low bias reported by the surrogate, the EP should consider using multiple lines of evidence, as described in Section 4.4 of this document. This example is evaluated further in Appendix K of this document, with Example K-1 using multiple lines of evidence.

4.3.6 Laboratory Control Samples and Laboratory Control Sample Duplicates

Laboratory control samples (LCS) and laboratory control sample duplicates (LCSD) are used to monitor the accuracy of the analyst(s) performing the laboratory method. Both LCS and LCSD should contain all target analytes. The recovery of target analytes in the LCS can be used to evaluate method accuracy while, the LCS/LCSD pair can be used to evaluate both precision and accuracy. %The evaluation of results of LCS/LCSD involves the evaluation of multiple lines of evidence, as described in Section 4.4 of this document. Data from the LCS/LCSD should be used in conjunction with other QC data, such as surrogates and matrix spikes. The performance standards for LCSs are presented in Table 1A of various RCPs.

Note, LCS/LCSD may also be referred to ask Blank Spike (BS) and Blank Spike Duplicate (BSD).

Example 9: Laboratory Control Samples – Low Recovery

Groundwater samples were analyzed by SW-846 Method 8260. The purpose of sampling was to determine compliance with RBCRs. The GWPC for benzene is 1 µg/l.

- The results for the LCS indicate a 54% recovery for benzene. The method specifies that the recovery limits for the LCS must be within 70 to 130%.
- The analytical results were ND for benzene at a RL/LLOQ of 0.5 µg/l.

The results of the laboratory control sample indicate a low bias in the accuracy of the method. Therefore, the results reported could have been affected by the low bias of the method, and the results cannot be used to demonstrate if benzene is present at a concentration greater than the GWPC. Before drawing any conclusions regarding the effect of the low bias reported associated with the LCS, the EP should consider using multiple lines of evidence, as described in Section 4.4 of this document. This example is further evaluated in Appendix K of this document, with Example K-2 using multiple lines of evidence.

Example 10: Laboratory Control Samples – High Recovery

Groundwater samples were analyzed using SW-846 Method 8260. The purpose of sampling was to evaluate groundwater contamination prior to the start of remediation. The GWPC for trichloroethene (TCE) is 5 µg/l.

- TCE was detected in the LCS at a concentration of 135 µg/l, indicating a 190% recovery. The method specifies that the recovery limits for the LCS must be within 70 to 130%.

The results for the LCS sample indicate a potential high bias. However, the reported concentration of TCE is >> RBCR criteria. Therefore, this high bias does not affect the usability of the data for the intended purpose.

4.3.7 Matrix Spike and Matrix Spike Duplicates

The purpose of a matrix spike sample is to determine whether the sample matrix contributes bias to the analytical results. The results of matrix spike and matrix spike duplicate (MS/MSD) analysis only apply to the sample that was analyzed. A matrix spike is an environmental sample to which known quantities of target analytes are added or spiked by the laboratory prior to sample analysis. A MS/MSD pair is prepared by spiking two aliquots of an environmental sample. The two aliquots are analyzed separately, and the results are compared. A matrix spike can be used to evaluate method accuracy, while a MS/MSD pair can be used to evaluate both precision and accuracy. Matrix spikes should not be performed on trip, equipment, or field blanks. For analysis of samples for organic analytes, a MS/MSD pair is typically performed. For inorganic analysis, a sample duplicate and matrix spike are typically performed, although a MS/MSD pair is acceptable.

To evaluate accuracy one must compare the results of the unspiked sample against the spiked sample. To evaluate precision, the results of the matrix spike are compared to those for the matrix spike duplicate. One could also evaluate precision by comparing a sample result to a sample duplicate result (no spiking is performed), although representativeness of the samples could be a factor when evaluating the results of duplicate analyses. Furthermore, if the results for a specific analyte are ND in both samples, the evaluation of precision is not very meaningful.

To evaluate accuracy, the % recoveries of the matrix spike compounds in both the matrix spike and the matrix spike duplicate are compared to the unspiked sample. Poor recoveries are usually the results of matrix interference and indicate that the sample results have a significant bias. The RPD between a set of duplicate results (either a sample and duplicate pair or a MS/MSD pair) is used to evaluate precision. High RPDs indicate a lack of sample homogeneity. Poor recoveries or high RPDs can also be caused by laboratory error, which would affect the interpretation of results.

Ideally, the sample selected for MS/MSD evaluation should not contain significant concentrations of the contaminants compared to the spiked concentrations, as this may prevent accurate measurement of the spiked compounds. The sample submitted for MS/MSD evaluation should be representative of the potentially contaminated matrix. The laboratory will need additional sample quantity when MS/MSDs are requested.

The evaluation of precision and accuracy using matrix spike/matrix spike duplicates or sample/duplicate results is a complex issue and not straightforward in some cases. Common problems include interfering matrix effects or high concentrations of target compounds or non-target compounds that mask the detection or quantitation of spiked compounds. This review and evaluation involves evaluating multiple lines of evidence, as

described in Section 4.4 of this document. Data from matrix spike results should be used in conjunction with other QC data, such as LCS, duplicate samples, and surrogates.

The performance standards for MS/MSDs are presented in Table 1A of various RCP's.

Example 11: Matrix Spike/Matrix Spike Duplicates – Low Recovery

A soil sample was analyzed by the Synthetic Precipitation Leaching Procedure (SPLP) for metals by SW-846 Method 1312 and SW-846 Method 6010. The intended purpose of the analysis was to confirm that remediation was needed.

- Lead was detected at 4.5 mg/l.
- The MS/MSD percent recoveries for lead were 28% and 32%. The method specifies that MS/MSD spike recovery limits must be from 75 to 125%.
- The RPD for the MS/MSD pair is 13.3%. The method specifies that RPD must be less than 30% for the MS/MSD pair.
- A sample duplicate was also analyzed. Lead was detected at 4.7 mg/l (RPD of 4%).
- All other QC criteria were within the RCP acceptance criteria.

The RPD for the sample/duplicate pair was well within the acceptance criteria specified in RCP. The MS/MSD percent recovery indicated a potential low bias for lead. The report narrative stated that the MS was re-prepared and re-analyzed with similar results. It was also noted that the spiking concentration (20 µg/L) was small in comparison to the native sample concentration. Therefore, the low recoveries were probably not due to sample matrix interference, but most likely a result of a high concentration of lead in the sample compared to the spiking concentration. The concentration of lead detected was well above the GA PMC, and any potential low bias would not prevent the EP from concluding that concentration of lead was greater than that criterion.

Example 12: Matrix Spike/Matrix Spike Duplicates – Low Recovery

A soil sample was analyzed by SW-846 Method 8260 for VOCs. The intended purpose of the analysis was to evaluate the concentrations of VOCs that were present at a release area.

- PCE was detected at a concentration of 0.9 mg/kg, which is just below the GB PMC of 1 mg/kg.
- The percent recoveries for PCE generated by a MS/MSD pair are 13 and 15% respectively. According to the method, the recovery limits for the MS/MSD must be within 70 to 130%
- The RPD for the MS/MSD was 14%. According to the method, the RPD must be less than 30%.

The spike recoveries for PCE indicated a potential low bias for PCE. Because of the reported low bias and the fact that the sample result was just below the GB PMC, the actual concentration of PCE in the sample may be higher and may actually exceed the GB PMC. The RPD for the MS/MSD pair was within the acceptance criteria specified in

RCP; therefore, MS/MSD results show an acceptable degree of the precision. Further evaluation of the data in conjunction with multiple lines of evidence, as described in Section 4.4 of this document, is needed to assess this potential low bias.

Example 13: Matrix Spike/Matrix Spike Duplicates – High Recovery

A soil sample was analyzed by SW-846 Method 8260 for VOCs. The intended use of the data is to determine compare the concentrations of VOCs to the GA pollutant mobility criteria.

- TCE was reported at a concentration of 0.11 mg/kg, which is just above the GA PMC of 0.1 mg/kg.
- The percent recoveries for TCE generated by a MS/MSD pair are 180 and 185% respectively. According to the method, the recovery limits for the MS/MSD must be within 70 to 130%.
- The RPD for the MS/MSD pair is 2.7%. The RPD must be less than 30% for the MS/MSD pair.

The spike recoveries indicate a potential high bias for trichloroethene. Because of the reported high bias and the sample result just above the GA PMC, the actual concentration of TCE in the sample may be lower and may be less than the GA PMC. However, the EP cannot adjust the concentrations of the reported values lower. The RPD for the MS/MSD pair was within the acceptance criteria specified in RCP; therefore, MS/MSD results show an acceptable degree of the precision. Further evaluation of these results in conjunction with multiple lines of evidence, as described in Section 4.4 of this document, is needed to assess this potential high bias. This example is evaluated further in Appendix K of this document, with Example K-3 using multiple lines of evidence.

4.4 Using Multiple Lines of Evidence to Evaluate Laboratory QC Information

The use of several different types of laboratory QC information as multiple lines of evidence to understand complex QC issues is an important component of DUEs. The following examples illustrate the evaluation of commonly reported QC information using a “multiple lines of evidence” approach. The EP should seek experienced assistance, as needed, when evaluating QC data involving multiple lines of evidence. These examples are intended to build on the information presented in earlier in this document. Additional examples using multiple lines of evidence are also presented in Appendix K of this document.

Example 14: Multiple Lines of Evidence – Low Recovery for LCS and MS/MSD

A soil sample was analyzed by SW-846 Method 8260 for VOCs. The intended purpose of the analysis was to evaluate the concentrations of VOCs that were present at a release area.

- The reported concentrations of the constituents of concern are just below the applicable regulatory criteria.

- The percent recoveries for TCE generated by a MS/MSD pair are low and are less than 45%. According to the method, the recovery limits for the MS/MSD must be within 70 to 130%.
- LCS % recoveries are low and are less than 35%. The method specifies that the recovery limits for the LCS must be within 70 to 130%. About 25% of the 8260 target compounds are outside of the acceptance criteria specified in the RCP.
- Analytical results for several VOCs are just below the GA PMC.

The QC data for the LCS and the MS/MSD indicate a low bias but do not indicate whether the low recoveries are caused by the sample matrix or by the analysis of the sample in the laboratory. MS/MSDs evaluate method precision and accuracy in relation to the sample matrix in the sample which was analyzed. LCSs evaluate the laboratory's performance. The QC sample results indicate consistent low bias associated with both the sample analysis and the laboratory's performance. Therefore, the actual concentrations of the constituents of concern may be higher than reported and actually above the GA PMC.

The LCS is a measure of how well the laboratory can perform a given method in a clean sample matrix. Failure to get adequate LCS recoveries can indicate a problem with the results for the samples associated with the LCS. However, for some methods with extensive target compound lists, such as VOCs by SW-846 Method 8260 or SVOCs by SW-846 Method 8270, it is extremely unlikely that all target compounds in the LCS will meet the acceptance criteria specified in the methods. LCS results for these methods should be evaluated based on 1) whether the compounds for which results did not meet acceptance criteria are “poor performers”, as described in Section 3.3 of this document, and 2) how many compounds failed to meet the LCS criteria. If QC results for more than 10% of the compounds fail to meet acceptance criteria detailed in the RCP for SW-846 Method 8260 or more than 20% fail to meet criteria detailed in the RCP for SW-846 Method 8270, the data may not be usable to demonstrate that concentrations are less than RBCR criteria, without additional lines of evidence to support such a decision.

The EP may need to contact the laboratory for guidance on how to best resolve issues associated with the failure of an LCS to meet acceptance criteria. Reanalysis of the samples (if within holding time), use of alternative analytical methods, or collection of additional samples may be necessary to obtain data that could be used to demonstrate that the reported concentrations are less than the applicable regulatory criteria.

If remediation were to be performed in the area where the samples had been collected, the identified QA/QC issues might be less likely to affect the usability of the data. On the other hand, prior to the collection of samples for the purpose of compliance with RBCR criteria, the EP should contact the laboratory to evaluate alternatives that might be employed to resolve the types of QA/QC issues described in this example that make this data not usable.

Example 15: Multiple Lines of Evidence – Low MS/MSD Recovery

A soil sample was analyzed by SW-846 METHOD 8260 for VOCs. The intended purpose of the analysis was to evaluate the concentrations of VOCs that were present at a release area.

- The reported concentrations of the constituents of concern are ND, and the RL/LLOQs are well below the applicable regulatory criteria.
- The MS/MSD recoveries were outside acceptance limits. Recoveries were in the 40-50% range. According to the method, the recovery limits for the MS/MSD must be within 70 to 130%.
- The results for the surrogates and the LCS were within acceptance limits.

The results for the surrogates and the laboratory control sample indicate laboratory and method performance are acceptable. The results for the MS/MSD indicate a potential low bias, but as no compounds were detected and the RL/LLOQs were far below the regulatory criteria, there is no significant impact on the usability of the data.

4.5 Data Usability Evaluations for Non-RCP and Pre-RCP Analytical Data

To evaluate if Non-RCP or Pre-RCP data can be used to support environmental decision-making, an EP should go through a multi-step evaluation process. One objective of that evaluation would be to make a decision as to whether additional data collection is necessary to corroborate the Non-RCP or pre-RCP data or whether the quality of the Non-RCP or Pre-RCP data is such that it could be used for its intended purpose without the collection of additional data. Table 2-1 of this document describes the types of analytical data. Such an evaluation process includes the following steps:

- Perform a DQA and DUE to evaluate precision, accuracy and sensitivity. For Pre-RCP data only, if no other QC information is available other than the RL/LLOQ or detection limits, the EP must evaluate the RL/LLOQ, detection limit or practical quantification limit, holding times, and sample preservation. For Non-RCP data generated from samples collected after September 1, 2007, equivalency with the RCPs must be demonstrated as described in Section 6 or Section 7 of the RCP guidance.
- Consider such factors as the age of previously generated data, limitations and benefits of analytical method(s), laboratory QA/QC results, and how any of those factors might affect the quality of the data or the usability of the data with respect to its intended purpose.
- Determine whether any newer data corroborate the older results and whether both sets of data are consistent with the CSM.
- Review available field collection information, preservation techniques, filtering, etc. for the older samples to evaluate how those techniques compare to current knowledge and how any differences from more recent scientific perspectives might affect the quality of the pre-RCP data.
- Consider decisions that have already been made based on the old data.
- Consider future decisions that will be made based on the old data.
- Consider any other site-specific factors.

DEEP expects more scrutiny regarding the quality of previously generated data will be necessary when the EP intends to use that data to demonstrate compliance with applicable regulations than when that data are used to design additional data collection activities.

4.6 Data Usability Evaluations Using Multiple Lines of Evidence from DQOs and the CSM

Using multiple lines of evidence during a DUE is not limited to the use of analytical QC data. Multiple lines of evidence using DQOs and CSM should also be used to determine if the quality of the analytical data is adequate for the intended purpose. The DQOs are used to determine if a sufficient quantity and quality of analytical data was generated to meet the goals of the project and support defensible conclusions that are protective of human health and the environment. Information regarding the DQOs is presented in Section 2.1. The EP will also evaluate the analytical data in relation to the CSM to determine if any significant data gaps result from the quality of the data. For these evaluations, DEEP expects that the EP will use a conservative approach that is fully protective of human health and the environment. This evaluation includes, but is not limited to, the following:

- Evaluation of the analytical data to determine if the DQOs for precision, accuracy, representativeness, comparability, completeness, and sensitivity are met.
- Evaluate the entire body of information (type, amount, and quality data) available for the specific area/release for which the data are presumed to be representative.
- Determine whether the data are consistent with the CSM and if any significant data gaps are present.
- Consider the risk of being wrong based on risk to potential receptors and the risk to human health and the environment.
- Consider the source of data (e.g., whether the data were generated by the EP's own firm or some other firm, the EP's own involvement with the project, method of collection for the samples, and reporting methods by other firms/laboratories generating the data). Perform a critical review of these data to evaluate its reliability.
- Consider any other site-specific factors.

In addition to the items listed above, the reader should also refer to the Data Usability Evaluation Worksheet presented in Appendix I-2 of this document for further information to consider during this evaluation.

4.7 Factors to be Considered During Data Usability Evaluations

Factors that must be considered during DUEs are presented below:

- Adjusting analytical results reported by the laboratory based on laboratory QC information is not appropriate. If the results for a matrix spike indicate a percent

recovery of 150%, it is not scientifically valid to adjust the results. If a contaminant is reported in a blank, it is never appropriate to subtract the concentration of the concentration found in the blank from the sample results.

- False positives can occur because of interference in laboratory methods or due to sample preservation procedures. For example, acetone can be formed when sodium bisulfate is used to preserve a soil sample for VOCs analysis. **The EP should contact the laboratory for assistance when the results do not make sense in relation to the CSM.**
- In addition to evaluating high or low bias, it is also necessary to consider non-directional bias caused by high RPDs. High RPDs indicate a lack of sample homogeneity and raise questions regarding the representativeness of the sample.
- It is important that the meaning of laboratory acceptance criteria be understood when evaluating QC results. The purpose of acceptance criteria is to define a range where data are acceptable as reported. A recovery of 99% is not considered to be “better” than an 85% recovery. When QC results and information are within acceptance criteria, the reported value is “accepted” as the concentration that should be used for decision-making purposes.
- Results from surrogate analytes do not automatically indicate that a QC issue exists for a specific compound, rather matrix spikes are used to evaluate the performance of specific compounds in a specific sample.
- Results should not be reported on a wet-weight. Wet-weight measurements dilute analytical results because of the additional water in the sample. Dry weight must be used to report analytical results. Wet-weight measurements can be converted to dry-weight measurements. If this is an issue, the EP should contact the laboratory for assistance.
- Sample heterogeneity issues when evaluating total results and results following Synthetic Precipitation Leaching Procedure (SPLP) or Toxicity Characteristic Leaching Procedure (TCLP) extraction. For example, the total sample results of analysis for total VOCs are “ND,” while the results for the SPLP or TCLP leachate indicate the presence of VOCs at substantial concentrations.
- Documentation of the thought process used during the performance of the DQA and DUE is as important as the other elements of the DQA and DUE process.
- It is inappropriate to conclude that because the matrix spike and matrix spike duplicate results are biased low, the contaminants are bound up in the sample matrix, and therefore the low bias is irrelevant. The EP should contact the laboratory to determine how to overcome such matrix interference issues. An evaluation to determine if a compound is bound up in the sample matrix is outside of the scope of this document and may involve a significant study.
- It is important to work with the laboratory to resolve analytical difficulties or bias. There are several options for sample clean-up and analysis. Typically, sediment sampling for pesticides or PCBs needs extensive sample clean-up because naturally occurring interferences can cause analytical problems.

4.8 Documentation of Data Quality Assessments and Data Usability Evaluations

Documentation of the thought process used, as well as the outcomes of the DQA and DUE is an essential task that is necessary to support the EP's decisions regarding the usability of the analytical data for the intended purpose. This documentation is a thoughtful and succinct evaluation and presentation of the findings and conclusions of the DQA and DUE process. DEEP expects that this documentation will be presented in the report where the analytical data are used to support the EP's opinion that the quality of analytical data is appropriate, or not appropriate, for the intended purpose(s).

As stated previously, there are various ways to document this information, including using the DQA Checklists in Appendix D and DUE Worksheet in Appendix I of this document and the text of the document that uses the analytical data. The DQA checklists and DUE worksheets may be modified by the user as deemed appropriate, provided the final product meets the objectives expressed in this guidance document.

Typical documentation of a DQA and DUE includes a written summary regarding data usability. The DQA/DUE summary that presents the analytical data should also include:

- The laboratory reports, laboratory narratives, and Reasonable Confidence Protocol Laboratory Analysis QA/QC Certification Form, and chain of custody form.
- Reasonable Confidence Protocol Equivalency Demonstration Form (if needed).
- Any other pertinent information.

The EP should work with the laboratory to receive the analytical data in a convenient format, particularly if the laboratory report is provided in electronic format. The use of electronic deliverables from the laboratory can make the transfer of data into computer spreadsheets and databases more efficient, which in turn will improve efficiency when performing the DQA and DUE.

An example DQA and DUE case study is provided in Appendix L of this document.

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APPENDIX A
SUPPLEMENTAL INFORMATION ON DQOS AND QUALITY ASSURANCE PROJECT PLANS

APPENDIX A
SUPPLEMENTAL INFORMATION ON DATA QUALITY OBJECTIVES AND QUALITY ASSURANCE PROJECT PLANS

Data Quality Objectives (DQOs) are project-specific goals for an environmental investigation that address the generation, assessment, and intended use of the data associated with that investigation. DQOs express the qualitative and quantitative measures that will be used to determine whether the amount and quality of data associated with the investigation are sufficient and sufficiently accurate to draw the conclusions that will be necessary. Information on developing Data Quality Objectives can be found in the United States Environmental Protection Agency (EPA) Quality Assurance guidance document: *Guidance on Systematic Planning Using the Data Quality Objective Process* (QA/G-4), February 2006, EPA/240/B-06/001 and in the US EPA *Environmental Data Review Supplement for Region 1 Data Review Elements and Superfund Specific Guidances/Procedures*, September 2020.

A Quality Assurance Project Plan (QAPP) documents the planning, implementation, and assessment procedures for a particular project, as well as any specific quality assurance and quality control activities. It integrates all the technical and quality aspects of the project in order to provide a "blueprint" for obtaining the type and quality of environmental data and information needed for a specific decision or use. All work performed or funded by the EPA that involves the acquisition of environmental data must have an approved QAPP. DEEP and the EPA must review all QAPPs prior to the commencement of any monitoring component of the project. All QAPPs shall be written in conformance with EPA guidance. Referenced below are selected EPA requirements and/or guidance for QAPPs:

- EPA New England **Quality Assurance Project Plan Program Guidance,** April 2005. Compendium provides the framework for all project-specific and generic program QAPPs prepared for environmental data operations conducted in EPA-New England. Revised 2010.
- **Guidance for QAPPs (G-5)**, December 2002, EPA/240/R-02/009. Guidance on developing QAPPs that meet EPA specifications.
- **Guidance for QAPP for Modeling (G-5M)**, December 2002, EPA/240/R-02/007. Guidance on developing QAPPs for modeling projects.
- **EPA Requirements for QAPPs (QA/R-5)**, March 2001 (Reissued May 2006), EPA/240/B-01/003. Defines specifications for QAPPs prepared for activities conducted by or funded by EPA.
- Guidance on **QAPPs for secondary Research Data**. July 1999. Example guidance by the QA managers in EPA's National Risk Management Research Laboratory.

These and other quality assurance documents can be accessed through the following website: www.epa.gov/quality1. The documents are located under Quality System Documents. EPA New England documents can be accessed through the EPA website.

APPENDIX B
QC INFORMATION SUMMARY AND MEASUREMENT PERFORMANCE CRITERIA

Appendix B-1
Types of Information Used to Evaluate Precision, Accuracy, Representativeness, Comparability, Completeness, and Sensitivity

QC Element	Laboratory Measures	Field Measures
Precision	Laboratory Control Samples	Field Duplicates
	Laboratory Control Sample Duplicates	Matrix Spike Duplicates (collect samples for)
	Matrix Spike Duplicates	Matrix Duplicates (collect samples for)
	Historical Data Trends	Appropriate Sampling Procedure
Accuracy	Laboratory Control Samples	Matrix Spikes/Matrix Spike Duplicates (collect samples for)
	Matrix Spikes/Matrix Spike Duplicates	Inclusion of “Blind” Samples
	Internal Standards	Appropriate Sampling Procedures
	Surrogate Recovery	Appropriate Sample Containers
	Initial Calibration	Appropriate Sample Preservation
	Continuing Calibration	Holding Times
	Standard Reference Material	Equipment Blank/Field Blank
	Initial & Ongoing Precision & Recovery (PFAS)	
Representativeness	Laboratory Homogenization	Appropriate Sampling Procedures Appropriate Sample Containers
	Appropriate Sub-sampling	Appropriate Sample Preservation
	Appropriate Dilutions	Incorporation of Field Screening Data
	“As Received” Sample Preservation Meeting Hold Times	Appropriate Number of Samples
Comparability	Gas Chromatography/Mass Spectrometry Tuning	Comparison to Previous Data Points
	Calibration	Comparison to Similar Data Points
	Analytical Method Followed	
Completeness	Percent Sample Per Batch Analyzed and Reported	Percent Planned Samples Collected
	All Critical Samples Reported and Unqualified	All Critical Samples Collected
Sensitivity	Method Blanks	Equipment Blank/Field Blanks
	Instrument Blanks	Appropriate Sample Volume or Weight
	Reporting Limit (Lowest Calibration Standard)	
	Appropriate Analytical Method	

Adapted from Massachusetts Department of Environmental Protection, Bureau of Waste Site Cleanup, *MCP Representativeness Evaluations and Data Usability Assessments, Policy #WSC-07-350*, September 19, 2007.

Appendix B-2
Information Derived from Quality Control Checks and Samples

Data Quality Indicator (Type of Information Provided)	QC Checks and Samples	Sources of Measurement Error										
		Sample Collection				Sample Transport	Laboratory					
		Sampling Equipment	Sample Container	Preservation Technique	Sample Matrix	Shipment Process	Sample Storage at Laboratory	Sample Preparation Reagents	Sample Preparation Equipment	Analytical Method Reagents	Analytical Equipment	Purpose
Accuracy/Bias (Contamination)	Equipment Blank (Rinsate Blank)	X	X	X		X	X	X	X	X	X	To evaluate carryover contamination resulting from successive use of sampling equipment.
	Bottle Blank (per Lot #)		X					X	X	X	X	To evaluate contamination introduced from the sample container.
	VOA Trip Blank		X	X		X	X	X	X	X	X	To evaluate contamination introduced during shipment.
	Storage Blank						X	X	X	X	X	To evaluate cross contamination introduced during sample storage.
	Method Blank							X	X	X	X	To evaluate contamination introduced during sample preparation and/or analysis by laboratory, including reagents, equipment, sample handling and ambient laboratory conditions.
	Reagent Blank (per Lot #)							X	X	X	X	To evaluate contamination introduced by specific method reagents.
	Instrument (System) Blank									X	X	To evaluate contamination originating from the analytical reagents instrumentation.

Data Quality Indicator (Type of Information Provided)	QC Checks and Samples	Sources of Measurement Error										
		Sample Collection				Sample Transport	Laboratory					
		Sampling Equipment	Sample Container	Preservation Technique	Sample Matrix	Shipment Process	Sample Storage at Laboratory	Sample Preparation Reagents	Sample Preparation Equipment	Analytical Method Reagents	Analytical Equipment	Purpose
Accuracy/Bias	**Matrix Spike**				X			X	X	X	X	To determine laboratory preparatory and analytical bias for specific compounds in specific sample matrices.
	Surrogate Spike				X			X	X	X	X	To evaluate laboratory preparatory and analytical bias for specific sample matrices.
Accuracy/Bias	**Laboratory Control Sample (LCS) / IPR / OPR**							X	X	X	X	To evaluate the laboratory's ability to accurately identify and quantitate target compounds in a reference matrix at a known concentration, usually mid range of the calibration curve.
	Performance Evaluation Sample-Ampulated Single Blind							X	X	X	X	To evaluate sample handling procedures from field to laboratory. To evaluate the laboratory's ability to accurately identify and quantitate target compounds in a reference matrix. Frequently used for data quality assessments and for laboratory self-assessments and external assessments.
	Performance Evaluation Sample-Full Volume Single Blind		X	X		X	X	X	X	X	X	

Data Quality Indicator (Type of Information Provided)	QC Checks and Samples	Sources of Measurement Error										
		Sample Collection				Sample Transport	Laboratory					
		Sampling Equipment	Sample Container	Preservation Technique	Sample Matrix	Shipment Process	Sample Storage at Laboratory	Sample Preparation Reagents	Sample Preparation Equipment	Analytical Method Reagents	Analytical Equipment	Purpose
	Performance Evaluation Sample Double Blind		X	X		X	X	X	X	X	X	To evaluate sample handling procedures from field to laboratory. To evaluate the laboratory's ability to accurately identify and quantitate target compounds in a reference matrix.
	Laboratory Fortified Blank (LFB) or Laboratory Control Sample (LCS)							X	X	X	X	A type of LCS used to evaluate laboratory (preparatory and analytical) sensitivity and bias for specific compounds in a reference matrix at the quantitation limit concentrations.
Accuracy/Bias	**Initial Calibration**									X	X	To ensure that the instrument is capable of producing acceptable qualitative and quantitative data.
	Continuing Calibration/ Continuing Calibration Verification									X	X	To ensure the accuracy and stability of the instrument response.
	Instrument Performance Check Sample									X	X	To verify that an instrument can accurately identify and quantitate target analytes at specific concentration levels.

Data Quality Indicator (Type of Information Provided)	QC Checks and Samples	Sources of Measurement Error										
		Sample Collection				Sample Transport	Laboratory					
		Sampling Equipment	Sample Container	Preservation Technique	Sample Matrix	Shipment Process	Sample Storage at Laboratory	Sample Preparation Reagents	Sample Preparation Equipment	Analytical Method Reagents	Analytical Equipment	Purpose
Accuracy/Bias (Preservation)	**Cooler Temp. Blank (VOC only)**			X								To evaluate whether or not samples were adequately cooled during shipment.
Sensitivity	**Low-level calibration standard**							X	X	X	X	A standard used to evaluate accuracy and sensitivity at a specific concentration. Used to evaluate laboratory sensitivity and bias for specific compounds in a reference matrix at the quantitation limit concentrations.
	Method Detection Limit Studies				X (if performed using same reference matrix)			X	X	X	X	A statistical determination that defines the minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero.
Sensitivity	**Low Point of Initial Calibration Curve (Reporting Limit)**									X	X	To ensure that the instrument is capable of producing acceptable qualitative and quantitative data at the lowest concentration that sample results will be reported; the Reporting Limit.
Precision	**Field Duplicates**	X	X	X	X	X	X	X	X	X	X	To measure overall precision by evaluating cumulative effects of both field and laboratory precision.

Data Quality Indicator (Type of Information Provided)	QC Checks and Samples	Sources of Measurement Error										
		Sample Collection				Sample Transport	Laboratory					
		Sampling Equipment	Sample Container	Preservation Technique	Sample Matrix	Shipment Process	Sample Storage at Laboratory	Sample Preparation Reagents	Sample Preparation Equipment	Analytical Method Reagents	Analytical Equipment	Purpose
	Laboratory Duplicates				X			X	X	X	X	To evaluate laboratory preparatory and analytical precision.
	Matrix Spike Duplicates							X	X	X	X	To determine laboratory preparatory and analytical bias and precision for specific compounds in specific sample matrices. The results of MS and MSD analysis only apply to the sample that was analyzed.
	Analytical Replicates (e.g., duplicate injections)										X	To evaluate analytical precision for determinative instrumentation.
	Internal Standards										X	To evaluate instrument precision and stability.
Inter-laboratory Comparability	**Field Splits**					X	X	X	X	X	X	To evaluate sample handling procedures from field to laboratory and to evaluate inter-laboratory comparability and precision.

Notes:

Not all of the types of QC checks and samples listed in this table are standard deliverables that are reported or required by the RCPs.

Table adapted from Region I, EPA New England *Compendium of Quality Assurance Project Plan Requirements and Guidance, Final October 1999, Attachment A*: Region I, EPA-NE Quality Assurance Project Plan Manual, Draft, September 1998, Table 4, pages 83-87.

Appendix B-3
Summary of Quality Control Checks and Samples

QC Sample or Activity used to Assess Measurement Performance	Frequency
Field Duplicate	One in ≤20 field samples per matrix for each parameter
Site Specific Matrix Spike, Matrix Spike Duplicate (MS/MSD) Pair	One in ≤20 field samples, one MS/MSD per matrix for each parameter
Field Blank	Project specific
Equipment Blank	One in 20 samples with non-dedicated equipment. PFAS only: one per equipment per sampling day.
Trip Blank	One per cooler (VOCs only) per event for VOCs
Performance Evaluation Sample	Project specific
Inter-Lab Split Samples	Project specific
Methanol Trip Blank	Project specific

Appendix B-4
Field Quality Control Samples

FIELD QUALITY CONTROL SAMPLE RECOMMENDATIONS FOR PUBLISHED RCPs						
ANALYTICAL METHOD[2]	**ANALYTICAL GROUP**	**FIELD DUPLICATE/ MATRIX DUPLICATE[1]**	**Site-Specific MS/MSD**	**EQUIPMENT BLANK**	**FIELD BLANK**	**TRIP BLANK**
		Field quality control samples may be limited to site constituents of concern rather than all analytical groups.				
		Recommended Frequency Requirement is 1 per 20 per matrix for all field quality control samples (✓), unless otherwise specified		**One per 20 field samples per type of non-dedicated equipment**	**Method-specific**	**One per cooler containing VOC/VPH samples**
1633	PFAS	✓	Note[3]	✓	Note[4]	
6010, 6020, 7000/7010, 7196, 7470/7471	Metals	✓	✓ - required for soil, recommended for other matrices	✓		
9010/9012/9014	Cyanide	✓	✓	✓		
8260	Volatile Organics (VOCs)	✓	✓	✓		✓
8270	Semivolatile Organics (SVOCs)	✓	✓	✓		
8081	Pesticides	✓	✓	✓		
8082	PCBs	✓	✓	✓		
8151	Chlorinated Herbicides	✓	✓	✓		
EPH	Extractable Petroleum Hydrocarbons	✓	✓	✓		
VPH	Volatile Petroleum Hydrocarbons	✓	✓	✓		✓
CT ETPH	Extract petroleum Hydrocarbons	✓	✓	✓		
APH	Air-Phase Petroleum Hydrocarbons	✓[1]				
TO-13	PAHs in Air	✓[1]				
TO-15	VOCs in Air (Summa Canisters)	✓[1]				
TO-17	VOCs in Air (sorbent tube)	✓[1]			✓[5]	

Notes:

[1] Collocated duplicate for air samples

[2]All method references are to the latest promulgated version of the method found in "Test Methods for Evaluating Solid Waste, SW-846" or in the CFR (e.g., PFAS).

[3] Site-specific matrix spike/matrix spike duplicate (MS/MSD) analyses are generally not necessary for isotope dilution methods because each sample is fortified with extracted internal standards prior to extraction, effectively providing a sample-specific assessment of recovery and matrix effects.

[4] Field blanks are recommended for aqueous samples where contamination from sampling, handling, preservatives, or containers during handling is a concern.

[5] Cleaned certified cartridges and blank filter/sorbent cartridges shipped with samples are highly recommended for evaluating contamination from media, handling, shipment, and storage.

APPENDIX C
QC INFORMATION TO REVIEW DURING DATA QUALITY ASSESSMENTS

Appendix C

Quality Control Information to be Evaluated During DQA and DUEs

DEEP expects that the EP will evaluate all laboratory reported QC information and nonconformances in accordance with this guidance. Nonconformances that are found may be noted on the DQQ Worksheets found in Appendix D of this document.

The information below summarizes standard, required deliverables required by the RCPs. In addition, the RCPs require additional QC information to be reported. The standard and non-standard RCP deliverables are presented in Table 1A of each of the RCPs. This summary does not supersede the QC deliverables required by the respective RCPs. The QC information that must be reviewed during the DQA by the EP includes, but is not limited to the following:

STANDARD RCP DELIVERABLES

Laboratory Report Inspection

Goal: Determine if all laboratory deliverables are provided and complete:

Tasks:

- Review the laboratory report to determine that the following items are present for all sample batches:
    - Reasonable Confidence Protocol Laboratory Certification Form (LCF);
    - Narrative identifying QC nonconformances;
    - Analytical results;
    - Chain of Custody Form; and,
    - Quality control results, including but not limited to:
        - Method Blanks;
        - Laboratory Control Samples (LCS);
        - MS/MSD (when requested);
        - Surrogates (as appropriate for method); and,
        - Other QC results and information provided in the laboratory report.

- Review information on the LCF to determine that:
    - All the questions in the LCF are answered;
    - The LCF is dated and signed; and,
    - The narrative includes an explanation for the questions which were answered “NO.”

- Review the laboratory narrative to identify QC nonconformances:
    - Review the narrative for significant findings (i.e., QC nonconformances that could affect usability of the reported results) and request additional information from the laboratory, if applicable.

- Review the Chain of Custody Form for completeness and correctness:
    - Review Chain of Custody Form to ensure form is complete and correct;
    - Verify sample identification numbers and collection information;

- Verify that there is an acceptance signature for each relinquished signature documenting the delivery of the samples to the laboratory facility. Check for errors in noted dates and times;
- Correct any errors with a single line, initial and note reason for correction; and,
- Contact the laboratory for help or clarification if needed.

Reasonable Confidence Evaluation

Goal: Determine if Reasonable Confidence was achieved.

Tasks: Review the LCF to determine if Reasonable Confidence was achieved.

Chain of Custody (COC) Evaluation

Goal: Evaluate the information presented on the Chain of Custody Form to determine if any QC issues or nonconformances are present.

Tasks:

- Determine if samples appropriately preserved/refrigerated/iced; and,
- Determine if samples were received by the laboratory an appropriate temperature.

Sample Result Evaluation

Goal: Determine if sample results have been properly reported.

Tasks: Evaluate the sample results:

- Determine that reporting limits/Lower Limits of Quantitation (RL/LLOQs) were noted;
- Verify that only concentrations greater than the /LLOQ were reported;
- Verify that the results for soils and sediments were reported on a dry weight basis;
- Check dilution factor to see if a dilution was performed;
- Determine that RL/LLOQs are less than, or equal to the regulatory criteria; and,
- Determine if sample results are provided for the each requested analysis

Sample Preservation and Holding Times Evaluation

Goal: Determine if samples were preserved properly and analyzed within holding times.

Tasks:

- Review the chain of custody and or narrative to determine if the samples were preserved in accordance with the requirement of the RCP reported.

- Review the narrative to determine if the holding time specified in the RCP was met.

- Determine if samples analyzed for volatile organic chemicals were collected and preserved in accordance with DEP's *Guidance for Collecting and Preserving Soil and Sediment Samples for Laboratory Determination of Volatile Organic Compounds*, February 2006.

Method, Field or Trip Blank Evaluation

Goal: Determine the existence and magnitude of contamination resulting from laboratory or field activities.

Task: Review all blank data and narratives for possible contamination.

Field Duplicates and Laboratory Duplicates

Goal: Evaluate Precision

Task: Review all duplicate sample information.

Laboratory Control Samples Evaluation

Goal: Evaluate accuracy of laboratory method.

Task: Review the narrative to determine if nonconformances were noted in the laboratory narrative.

Surrogate Results Evaluation

Goal: Evaluate accuracy in the sample matrix.

Task: Review the narrative to determine if nonconformances were noted in the laboratory narrative.

Matrix Spike/Matrix Spike Duplicate Results Evaluation

Goal: Evaluate accuracy (Matrix Spike) and precision (Matrix Spike Duplicate) in the sample matrix. The results of MS Spikes and MSD analysis only apply to the sample that was analyzed.

Task: Review the narrative to determine if nonconformances were noted in the laboratory narrative.

Method 7196 - Hexavalent Chromium Evaluation

Goal:

- Site specific soluble $Cr6^{+}$ matrix spike (solid samples only). For cases with poor matrix spike recovery. The purpose of this is to evaluate if the soil has reducing conditions ($Cr6^{+}$ will be reduced to $Cr3^{+)}$.

- Site specific matrix spike (aqueous samples only). The results of MS and MSD analysis only apply to the sample that was analyzed.

Task: Review the narrative to determine if nonconformances were noted in the laboratory narrative.

Method 8081 - Endrin and Dichloro-Diphenyl-Trichloroethane (DDT) Breakdown Standard Evaluation

Goal: Evaluate laboratory accuracy. Endrin and DDT will break down if the instrument is not properly maintained. Endrin and DDT also break down in the environment naturally form these same daughter products. This standard is used to confirm that the instrument is properly maintained.

Task: Review the narrative to determine if nonconformances were noted.

Other Information and QC Information:

VPH Method - Fractionation Check Standard

Goal: Evaluate the separation of the aromatic and the aliphatic hydrocarbons in the fractionation column.

Task: Review the narrative to determine if nonconformances were noted in the laboratory narrative.

CTDPH ETPH - Discrimination Check

Goal: To ensure the analytical system is performing correctly and results are therefore accurate.

Task: Review the narrative to determine if nonconformances were noted in the laboratory narrative.

Other Laboratory Information:

Goal: Evaluate precision, accuracy, representativeness, comparability, completeness, and sensitivity as appropriate.

Task: Review information provided.

APPENDIX D
DATA QUALITY ASSESSMENT CHECKLISTS

Appendix D-1
Instructions for the Use of the Data Quality Assessment Checklists

The checklists presented in Appendices D-2 and D-3 are two examples of Data Quality Assessment Checklists (DQA Checklists) that may be used to summarize the QC nonconformances that are reported for a laboratory deliverable for each sample in one place. These checklists are intended to be a starting point, can be modified by the user, and are available at the DEEP website at Quality Assurance and Quality Control (ct.gov). A summary of the QC information to be reviewed as part of a Data Quality Assessment is presented in Appendix C of this document.

If needed, the acceptance criteria for each of the RCPs can also be found in Table 1A of each of the RCPs or in the RCP Summary Comparison Table that is available on the DEEP website Quality Assurance and Quality Control (ct.gov).

Appendix D-2, DQA Checklist 1

RCP protocols are listed on the left-hand side of the checklist and QC samples are listed in the top row. QC nonconformances, if any, are checked for each method so that data reviewers know which methods and QC to review and/or narrate when completing the Data Quality Assessment.

Appendix D-3, DQA Checklist 2

This one-page checklist can be used to list all of the nonconformances for a sample in one place. To help streamline data entry this form can be filled out electronically by using a spreadsheet program. For smaller projects, it may be useful to add a column to list applicable regulatory criteria and preliminary DUE findings.

Appendix D-2
Data Review Checklist 1

PAGE __ OF __

PROJECT:				**FILE NUMBER:**				
LABORATORY WORK ORDER:				**REVIEWER:**			**DATE:**	
	Mark Non-Conformances							
Method	**Method Blank**	**LCS / LCSD**	**MS/MSD**	**Surrogates**	**ISTD**	**Field Duplicates (RPD)**	**Lab Duplicates (RPD)**	**SRM**
VOCs (8260)								
SVOCs (8270)								
Pest (8081)								
PCBs (8082)								
Herb (8151)								
ETPH								
VPH								
EPH								
Metals (6010/6020)								
Metals (7000)								
Mercury (7470/7471)								
Cr(VI) (7196)								
Total Cyanide								
TO-13								
TO-15								
TO-17								
APH								
Reasonable Confidence Achieved? Y/N Significant QC Variances Noted? Y/N Requested Reporting Limits Achieved? Y/N								
Preservation Requirements Met? Y/N Holding Time Requirements Met? Y/N								

Abbreviations: Laboratory Control Sample; RPD = Relative Percent Difference; VOCs = Volatile Organic Compounds; SVOCs = Semivolatile Organic Compounds; VPH = Volatile Petroleum Hydrocarbons; EPH = Extractable Petroleum Hydrocarbons; PCBs = Polychlorinated Biphenyls; Pest = Pesticides; ETPH Extractable Total Petroleum Hydrocarbons ; Cr = Chromium

Appendix D-3
Data Review Checklist 2

Project:
File Number:
Reviewer:
Date:
Notes:

Sample Number(s)	Compound(s)	Quality Control Nonconformance	Percent Recovery	Relative Percent Difference (RPD)	High/Low Bias	Comments
Note other QC nonconformances below (data package inspection, reasonable confidence. chain of custody, sample result, sample preservation and holding time evaluations.						

Notes:
Bias High: Reported result may be lower. RL/LLOQ is acceptable as reported.
Bias Low: Reported results may be higher. RL/LLOQ may be higher than reported.

APPENDIX E
EVALUATING SIGNIFICANT QA/QC VARIANCES

Appendix E

Evaluating Significant QA/QC Variances

On occasion, the EP may encounter Quality Control (QC) nonconformances that are so excessive that they must be considered as significant or gross violations of QC criteria. Causes may range from problems associated with the sampled medium, such as severe matrix interference, or may be the result of improper sample handling and management. Whatever the cause, the EP must determine whether the data associated with such significant QC violations can be used in making the environmental decisions for which the associated samples were collected.

In general, data associated with significant QC violations will be of limited use in decision-making, and it is the responsibility of the EP to demonstrate that such data are, in fact, usable for a particular purpose. It should be understood that the same data set with the same QC issues may be usable for one purpose but not for another. It is certainly possible that data associated with significant violations of QC might be used for qualitative or screening purposes, but it is highly unlikely that such data would be suitable for demonstrating compliance with applicable regulations. However, samples with significant QC variances can be used to determine that remediation is needed. The extent to which such data may be relied upon clearly depends on the intended use of that data.

It is possible to review a data set with significant QC violations and, depending on the intended purpose, the EP may choose to use or qualify the data in one case and reject it in another. For example, if significant QC failures occur, but an analyte is detected and the purpose of the sample analysis is to characterize environmental media to determine if a release has occurred, the EP can reasonably justify using that data to determine that there was, in fact, a release of the specific compounds that were detected. The data may not be usable to determine all the constituents that may have been released (i.e., determine the full nature of the release), and it should be clearly understood that additional measures should be taken to ensure that QC results for sampling during follow-up portions of the investigation are within acceptable limits.

If significant QC failures occur and the purpose of the sampling was to conclusively demonstrate compliance with regulations, then it is unlikely that the data will be usable for that purpose.

If historical site data or concurrent samples from a particular release area are consistent with the results of the data associated with significant QC failures and site conditions have not changed as demonstrated through subsequent data, then it is possible that the data with poor QC could be used with qualification. If the data with poor QC appear anomalous relative to previous results, then it is unlikely that they can be relied on to draw final conclusions. The EP must be able to demonstrate that the use of data associated with significant QC violations will not result in missing an increasing trend in groundwater concentrations or a hotspot in soil if the nature of the QC violation was indicative of a likely low bias in the reported analytical results.

QC results for laboratory data associated with investigation and remediation projects should always be evaluated with respect to the intended use of that data and the project-specific or task-specific data quality objectives that were established for types of decisions

that will be made using that data. DEEP expects that data with significant QC failures will be deemed unusable, unless the EP provides adequate justification for the use of such data and qualifies the data accordingly, such as indicating that such data is used as qualitative, rather than quantitative, information. Once the EP concludes that data are unusable, DEEP expects that any data deemed unusable will not be used to demonstrate compliance with regulatory criteria.

The following paragraphs identify typical types and causes of significant QC violations and provide a discussion of the factors that an EP should consider when evaluating data usability.

General QC Violations

Sample Receipt Issues

The following examples are all related to sample temperature at the time of receipt at the laboratory or at the time the sample is relinquished to the laboratory's representative at the laboratory and courier in the field:

- Samples to be analyzed for VOCs received above a maximum temperature of 12º Celsius (°C) more than 12 hours after collection;
- Samples to be analyzed for VOCs received above a maximum temperature of 6 ºC more than 24 hours after collection;
- Samples for other parameters, except polychlorinated biphenyls (PCBs) and metals (excluding mercury and hexavalent chromium) received above a maximum temperature of 12 ºC more than 24 hours from collection; and
- Lack of evidence of cooling with ice or use of artificial ice substitutes, such as "blue ice," which are not acceptable as evidence of cooling if the sample temperature is outside the acceptance limits specified in the RCP and the three prior bullets above.

Sample Containers

Any improper sample container, as described in the applicable RCP, or a sample container that is not properly sealed or has been otherwise compromised, should be considered to be a significant QC violation.

Sample Preservation

VOC soil or sediments samples that are collected on or after March 1, 2006 in a manner that is not in compliant with CTDEP's *Guidance for Collecting and Preserving Soil and Sediment Samples for Laboratory Determination of Volatile Organic Compounds*, effective March 1, 2006 (Soil Preservation Guidance Document).

Analytical results from samples that are not preserved in accordance with the requirements of the analytical method should be considered to be a significant QC violation.

Analysis Holding-time Excursions (total holding time from collection)

Analytical results that are greater than the applicable regulatory criteria can be considered usable, regardless of the holding time, as long as the intended use of the data is to identify locations where concentrations of constituents exceed those criteria. However, analytical results less than regulatory criteria that were analyzed and/or extracted after more than two times the holding time has passed should not be considered usable unless the EP can provide the rationale for the use of the data. Similarly, if samples for which analytical results are greater than regulatory criteria were subject to holding-time issues and such results are intended for use in demonstrating compliance in any way, such as using an alternative criterion, those results must be considered in a manner similar to results that are less than regulatory criteria.

Calibration Issues

If calibration issues are reported, the EP should contact the laboratory, as needed, for guidance. Although reporting of calibration issues is not required under the RCPs on a routine basis, the RCPs require that the laboratory narrate nonconformance of calibration issues, as described on Table 1A of the various RCPs. The following calibration issues would be considered significant QC violations:

- Initial calibration did not meet method specifications. Less than 5 points were used in the calibration curve;
- Initial calibration did not meet method specifications. Compound was calibrated using a response factor where %RSD is outside of method specified criteria;
- Initial calibration did not meet method specifications. Compound was calibrated using linear regression with correlation coefficient <0.99;
- No continuing calibration standard analyzed within 24 hrs of ICAL;
- Gas Chromatography/Mass Spectrometry tune criteria significantly out of criteria (greater than 20% for any one atomic mass unit); and
- Response Factor (RRF) is outside of method specific criteria (refer to appropriate method-appropriate RCP). Significant uncertainty is associated with the results.

Reporting Issues

Sample analysis reported as being conducted before the laboratory received the sample or before the analysis was performed by the laboratory (“time traveling”) must be considered as a serious QC violation. In many cases, this may be caused by typographical errors, such as incorrect dates being manually entered into the Laboratory Information Management System. If the laboratory and EP cannot legitimately correct typographical errors, the data must be rejected. The laboratory narrative must present information that explains the basis of the correction to the EP for evaluation.

Improper Data Manipulation

Issues associated with improper manual integration of any data (such as calibration standards, LCS, initial calibration curves, MS/MSD, etc.) are considered significant QC violations. If either of these issues is reported, the EP is encouraged to contact the laboratory for guidance.

Professional Judgment

In some cases, it is appropriate to reject data based on professional judgment. These cases include, but are not limited to the following:

- Severely poor overall instrument performance;
- Low percent solids(less than 10%); and
- Multiple QC nonconformances and gross failures.

Significant QC Violations for Specific Analytes

The following situations are considered to be significant QC violations. If any of the following issues are reported, the EP is encouraged to contact the laboratory for guidance.

Inorganic Compounds

- *LCS recovery is less than 50% of the control limit –*
    - An LCS less than 50% of control limit may be off-set by matrix spike data from the sample which was analyzed that is within acceptance criteria to reasonably determine that the problem is only associated with the LCS.
- *MS recovery is less than 30% for all affected analytes in a batch, with the exception of hexavalent chromium if supported by Oxidation Reduction Potential (ORP) and pH data which indicates reducing conditions*
    - Hexavalent chromium readily reduces to trivalent chromium in a reducing environment.

Organic Compounds

- *LCS recovery is less than 10%*
    - Usability of results reported as below the reporting limit for analytes with LCS recovery less than 10% is severely limited and would require substantial justification by the EP.
- *Surrogate recoveries less than 10%*
    - Usability of results reported as below the reporting limit for analytes associated with surrogates with LCS recovery less than 10% is severely limited and would require substantial justification by the EP.
- *MS/MSD recoveries less than 10%*
    - Usability of results reported as below the reporting limit for affected compound in the unspiked sample (i.e., field sample used for MS/MSD only) is severely limited and would require substantial justification by the EP. The EP should also evaluate how these results may affect the usability of other sample results in the batch.
- *Internal standard area counts of internal standards in continuing calibration must be between 50 – 200% of the area counts in the associated mid-level initial calibration standard.*
    - Contact laboratory for further guidance.
- *Fractionation Check Standard recovery for EPH is less than 10%*

    - Affects non-detect results for affected analyte in all samples fractionated using the associated lot of silica gel cartridges.
- *Endrin/DDT Breakdown Check Standard, breakdown > 20%*
    - Reject non-detected results for endrin or DDT, whichever compound is affected. This indicates the equipment was in need of maintenance at the time of analysis. Results >RL/LLOQ may be biased low.
- *Dual column relative percent difference is greater than 100% for single response pesticides and herbicides*
    - Reject all positive results for affected pesticides and herbicides. Dual columns are used to confirm the presence of analytes.
- *Dual column relative percent difference is greater than 500% for multi-response pesticides and polychlorinated biphenyls*
    - Reject all positive results for affected pesticides and herbicides.

APPENDIX F
POORLY PERFORMING COMPOUNDS

Appendix F
Poorly Performing Compounds[1]

Method 8260

The following list contains potentially poorly performing compounds, this list may not be all inclusive, EPs may refer to the DoD QSM (2013) and other analogous documents for additional information on poorly performing compounds: acetone, bromoform, bromomethane, 2-butanone (MEK), chloroethane, chloromethane, 1,2-dibromo-3-chloropropane, dibromochloromethane, dichlorodifluoromethane, cis-1,3-dichloropropene, 1,4-dioxane, 2-hexanone, hexachlorobutadiene, 4-methyl-2-petanone (MIBK), naphthalene, styrene, and 1,1,2,2-tetrachloroethane, and trichlorofluoromethane. (See EPA Methods 8000 and 8260 for more detail.) The following lists may not be all inclusive, EPs may refer to the DoD QSM, EPA National Functional Guidelines, and other analogous documents for detailed lists: acetone, 2-hexanone, MEK, MIBK, and 1,4-dioxane are water soluble and are therefore poor purgers; they are not easily purged from the water sample onto the trap. Naphthalene is a relatively high boiling compound for volatiles and is also poorly purged from the sample. The remaining compounds, bromoform, bromomethane, chloroethane, chloromethane,1,2-dibromo-3-chloropropane, dibromochloromethane, dichlorodifluoromethane, cis-1,3-dichloropropene, hexachlorobutadiene, styrene, 1,1,2,2-tetrachloroethane and trichlorofluoromethane, are easily degraded by heat as found in the injection port of the gas chromatograph or can react in certain sample matrices resulting in poor recovery. Additionally, bromomethane and dichlorodifluoromethane are gases and are sometimes lost from the trap during analysis.

Method 8270

Potentially difficult classes of compounds include anilines, phenols, phthalates, plus potentially difficult compounds including hexachlorocyclopentadiene, pyridine, and others. (See EPA Methods 8000 and 8270 for more detail.) Most of these compounds are thermally reactive and are potentially lost in the injection port of the gas chromatograph. All the phenolics are reactive with base and relatively water soluble. They are sometimes poorly extracted from aqueous samples and if a soil sample has a basic pH, may not be extracted at all.

APPENDIX G
COMMON LABORATORY CONTAMINANTS

Appendix G
Common Laboratory Contaminants

Methylene Chloride

Acetone

2-Butanone (methyl ethyl ketone (MEK))

Phthalates:

- Dimethyl phthalate
- Diethyl phthalate
- Di-n-butyl phthalate
- Butylbenzyl phthalate
- Bis(2-ethylhexyl) phthalate
- Di-n-octyl phthalate

Solvent preservative artifacts:

- Cyclohexanone
- Cyclohexenone
- Cyclohexanol
- Cyclohexenol
- Chlorocyclohexene
- Chlorocyclohexanol)

Tentatively Identified Compounds (TICs):

- Diethyl ether
- Hexanes

Aldol reaction products of acetone:

- 4-hydroxy-4-methyl-2-pentanone
- 4-methyl-2-pentanone
- 5,5-dimethyl-2(5H)- foranone

Metals

- Aluminum
- Iron
- Zinc

EPs may refer to the DoD QSM (2013) and other analogous documents for additional information on common laboratory contaminants.

APPENDIX H
RANGE OF DATA USABILITY EVALUATION OUTCOMES

Appendix H
Range of Data Usability Outcomes[1]

This table was adapted from US Army Corps of Engineers, Environmental Quality Assurance for HTRW Projects, Engineer Manual. October 10, 1997, EM 200 1-6, table 3-1.

Quality Control Element (Sample Type, Analysis, Condition or Characteristic)	Type of Non-Conformance	Possible Causes	Major PARCCS Parameters Affected[2]	Range of Outcomes for Data Usability Assessment[3]	
				Least Effect	Most Effect
Chain of Custody	Chain broken, incomplete, or not kept	Missing signatures, missing seals, missing dates or times, type of analysis requested not listed	Completeness	Incomplete data	Invalidates all sample results
Sample labeling	Sample labels unreadable, missing, or not attached containers	Failure to protect label from moisture, failure to use appropriate marker or labels, improper standard operating procedure (SOP)	Representativeness Completeness	Incomplete data False positives False negatives	Invalidates all sample results
	Samples mislabeled	Sampler error Improper SOP	Representativeness	Incomplete data False positives False negatives	Invalidates all sample results
Sample containers	Plastic containers for organic analytes	Samplers unaware of container requirements, improper SOP, failure to read SOP, SOP incorrect, insufficient quantity of correct containers samplers used containers on-hand	Representativeness Accuracy Completeness	False positives False negatives High or low bias Phthalate interference	Invalidates all sample results

APPENDIX H
RANGE OF DATA USABILITY OUTCOMES[1]

Quality Control Element (Sample Type, Analysis, Condition or Characteristic)	Type of Non-Conformance	Possible Causes	Major PARCCS Parameters Affected[2]	Range of Outcomes for Data Usability Assessment[3]	
				Least Effect	Most Effect
Sample containers	Glass containers for boron, silica, and fluoride	Samplers unaware of container requirements, improper SOP, failure to read SOP, SOP incorrect, insufficient containers	Representativeness Accuracy Completeness	False positives High bias	Invalidates all sample results
Headspace	Bubbles in water inside volatile organic chemical (VOC) vial	Poor sampling technique, caps not sealed tightly, septum caps not used, water vials not completely filled, improper SOP	Representativeness Accuracy Completeness	False negatives Low Bias	Invalidates all sample results; results are considered as minimum values only.
Preservation – soil and sediment samples	VOC soil or sediment samples collected on or after March 1, 2006 in a manner not compliant with DEEP's Soil Preservation Document[4]	Varies	Accuracy Representativeness Completeness Comparability	False negatives Low bias	Invalidates sample results; results considered as minimum values only.
Preservation	No preservative or wrong pH	No preservative added or improper amount of preservative added	Representativeness Accuracy Completeness	False negatives Low bias	Invalidates sample results; results considered as minimum values only.
	Wrong preservative	Improper SOP, failure to read SOP, SOP incorrect, correct preservative unavailable	Representativeness Accuracy Completeness	Incomplete data False positives False negatives	Invalidates sample results; results considered as minimum values only.
Preservation	Too warm (temperature >6 °C)[5]	Insufficient ice, shipping container inadequately insulated, samples adequately cooled at time of sampling and during shipping, transit time too long	Representativeness Accuracy Completeness	False negatives Low bias	Invalidates sample results; results considered as minimum values only.

APPENDIX H
RANGE OF DATA USABILITY OUTCOMES[1]

Quality Control Element (Sample Type, Analysis, Condition or Characteristic)	Type of Non-Conformance	Possible Causes	Major PARCCS Parameters Affected[2]	Range of Outcomes for Data Usability Assessment[3]	
				Least Effect	Most Effect
Preservation	Too cold VOC soil or sediment samples. Sample containers and En Core®-type samplers should not be frozen below -20º C.	Shipping container inadequately insulated, use of dry ice which is not appropriate	Accuracy Representativeness Completeness Comparability	False negatives Low bias	Invalidates sample results; results considered as minimum values only.
CTDPH certification status not current or laboratory is not approved by CTDPH for the specific analysis	Laboratory not certified or approved for specific analytes by CTDPH.	Varies	All may be affected	Violation of Connecticut General Statutes	Invalidates all or part of data set.
Holding times	Holding times exceeded	Excessive analysis time; tardy ship date; inappropriate shipping method; slow laboratory turn-around time.	Representativeness Accuracy Completeness	False negatives Low bias[6]	Invalidates all sample results. Sample results considered as minimum values only.
Analysis method	Wrong method used to analyze samples	Incorrect laboratory method specified on chain of custody form; laboratory/analyst unaware of requirement; failure to read SOP; SOP incorrect.	Representativeness Comparability Completeness Accuracy Sensitivity	False negatives, Low or high bias Low or high sensitivity	Invalidates or qualifies some or all sample results.
Reporting Limit / Lower Limit of Quantitation (RL/LLOQ)	RL/LLOQ too high	Insufficient measures to combat interferences (i.e., cleanup, background correction); insufficient sample; high dilution factor; wrong or inappropriate method.	Comparability Completeness Sensitivity	False negatives Low sensitivity	Invalidates sample results
Method blank (MB)	Method blank absent[7]	Improper SOP	Representativeness Accuracy Completeness	False positives	Invalidates all sample results

APPENDIX H
RANGE OF DATA USABILITY OUTCOMES[1]

Quality Control Element (Sample Type, Analysis, Condition or Characteristic)	Type of Non-Conformance	Possible Causes	Major PARCCS Parameters Affected[2]	Range of Outcomes for Data Usability Assessment[3]	
				Least Effect	Most Effect
Method blank (MB)	Contamination	Contaminated reagents, gases, glassware; ambient contamination; poor laboratory technique.	Representativeness Accuracy Completeness	False positives High bias	Invalidates all sample results
Equipment blank (EB) or Rinsate blank	Contamination	Improper decontamination of field sampling equipment; contaminated rinsate water, containers, or preservatives.	Representativeness Accuracy Completeness	False positives High bias	Invalidates all sample results
Trip blank (TB) for analysis of VOCs	Trip blank absent	TB not included; Improper SOP; TB broken during shipment; TB lost during shipment.	Representativeness Accuracy Completeness	False positives	Invalidates all sample results
Trip blank (TB) for analysis of VOCs	Contamination	Cross-contamination during shipment or storage; contaminated reagent water, glassware, or preservatives	Representativeness Accuracy Completeness	False positives High bias	Invalidates all sample results
Laboratory Control Sample (LCS)	LCS absent[8]	Improper laboratory SOP	Accuracy Completeness Comparability	False positives False negatives Poor precision (high or low bias)	Invalidates all sample results.
LCS, Laboratory Control Sample Duplicate (LCSD)	Low recoveries	Method failure; improper spiking; degraded spiking solution; failed spiking device.	Accuracy Completeness Comparability	False negatives Low bias	Invalidates all sample results.

APPENDIX H
RANGE OF DATA USABILITY OUTCOMES[1]

Quality Control Element (Sample Type, Analysis, Condition or Characteristic)	Type of Non-Conformance	Possible Causes	Major PARCCS Parameters Affected[2]	Range of Outcomes for Data Usability Assessment[3]	
				Least Effect	Most Effect
LCS, Laboratory Control Sample Duplicate (LCSD)	High recoveries	Method failure; improper spiking; degraded spiking solution; failed spiking device; contaminated reagents, gases, glassware, etc.	Accuracy Completeness Comparability	High bias Possible false positives	Invalidates all sample results.
LCS, LCSD	High RPDs	Method failure; improper spiking; failed spiking device; contaminated reagents, gases, glassware, etc.	Representativeness Precision Completeness. Comparability	Poor precision (high variability)	Invalidates all sample results.
Surrogates in MB, LCS, LCSD	Low recoveries	Method failure; improper spiking; degraded spiking solution; failed spiking device.	Accuracy Completeness	False negatives Low bias	Invalidates all sample results.
	High recoveries	Method failure; improper spiking; degraded spiking solution; failed spiking device; contaminated reagents, gases, glassware. etc.	Accuracy Completeness	High bias Possible false positives	Invalidate all sample results.
Surrogates in samples	Low recoveries	Matrix effects; inappropriate method; method failure; improper spiking; degraded spiking solution; failed spiking device.	Accuracy Completeness	False negatives Low bias	Qualifies all sample results (i.e., possible matrix effects); rejection of individual sample results

APPENDIX H
RANGE OF DATA USABILITY OUTCOMES[1]

Quality Control Element (Sample Type, Analysis, Condition or Characteristic)	Type of Non-Conformance	Possible Causes	Major PARCCS Parameters Affected[2]	Range of Outcomes for Data Usability Assessment[3]	
				Least Effect	Most Effect
Surrogates in samples	High recoveries	Matrix effects; inappropriate method; method failure; improper spiking; degraded spiking solution; failed spiking device; contaminated reagents, gases, glassware, etc.	Accuracy Completeness	High bias False positives	Qualifies all sample results (i.e., possible matrix effects); rejection of individual sample results
MS, MSD When requested by Data User	MS and/or MSD missing[9]	Insufficient sample; improper SOP; lost during analysis.	Representativeness Accuracy Precision	False negatives Low bias High bias	Qualifies all sample results (i.e., no measure of matrix effects). The results of MS Spikes and MSD analysis only apply to the sample that was analyzed.
	Low recoveries[10]	Matrix effects; inappropriate method; method failure; inadequate cleanup; inadequate background correction; failure to use method of standard additions; improper spiking; degraded spiking solution; failed spiking device.	Accuracy	False negatives Low bias	Qualifies all sample results (i.e., possible matrix effects). The results of MS Spikes and MSD analysis only apply to the sample that was analyzed.

APPENDIX H
RANGE OF DATA USABILITY OUTCOMES[1]

Quality Control Element (Sample Type, Analysis, Condition or Characteristic)	Type of Non-Conformance	Possible Causes	Major PARCCS Parameters Affected[2]	Range of Outcomes for Data Usability Assessment[3]	
				Least Effect	Most Effect
MS, MSD When requested by Data User	High recoveries[10]	Matrix effects; inappropriate method; method failure; inadequate cleanup; inadequate background correction; failure to use method of standard additions; improper spiking; degraded spiking solution; failed spiking device; contaminated reagents, gases, glassware, etc.	Accuracy	High bias False positives	Qualifies all sample results greater than the RL/LLOQ (i.e., possible matrix effects). The results of MS Spikes and MSD analysis only apply to the sample that was analyzed.
MS, MSD When requested by Data User	High Relative Percent Difference	Sample heterogeneity; inadequate sample mixing for non-voc samples in the laboratory or the field; samples misidentified; method failure; improper spiking; failed spiking device, duplicate spiking of a sample, contaminated reagents, gases, glassware, etc.	Representativeness Precision	Non-representative sample results Poor precision (high variability)	Qualifies all sample results greater than RL/LLOQ (i.e., possibly highly variable results). The results of MS Spikes and MSD analysis only apply to the sample that was analyzed.
Dilution factors	Extremely high dilution factors	High concentrations of interferences or analytes; inappropriate analytical method used or selected	Accuracy Comparability Completeness	Low sensitivity False negatives Poor accuracy	Invalidates samples with high RL/LLOQs. May qualify sample results as “estimated.” RL/LLOQs may be greater than regulatory criteria.

APPENDIX H
RANGE OF DATA USABILITY OUTCOMES[1]

Quality Control Element (Sample Type, Analysis, Condition or Characteristic)	Type of Non-Conformance	Possible Causes	Major PARCCS Parameters Affected[2]	Range of Outcomes for Data Usability Assessment[3]	
				Least Effect	Most Effect
Field QC sample (monitors quality of sampling operations; split samples, duplicates, and various types of blank samples)	Field and QC sample concentrations do not compare within acceptable limits	Sample heterogeneity; insufficient mixing in field; samples not split but collocated[11]; insufficient mixing in laboratory.	Representativeness Precision	Non-representative sample Poor precision (high and /or low bias)	Invalidates all or part of data set.
Field QA sample[12] (monitors quality of sampling operations; split samples, duplicates, and various types of blank samples)	QA sample results do not agree with project and/or QC sample results.	Improper SOP (QA and primary laboratories used different analytical methods), inadequate cleanup; inadequate background correction; laboratory contamination; preservative problem; sample misidentification; method failure; etc.; sample inhomogeneity (no agreement with both project and QC sample results).	All maybe affected	Various	Invalidates all or part of data set.

APPENDIX H
RANGE OF DATA USABILITY OUTCOMES[1]

Notes:

(1) Entries in the Possible Causes, PARCCS Parameters Affected, Effect on Data, and Possible Data Evaluation columns assume only one type of failure occurring at any one time. The cumulative or synergistic effects of more than one failure type occurring simultaneously make data usability evaluation more complex. Data usability evaluations involving multiple failure types are beyond the scope of this table. Not all possible QC failures and outcomes are illustrated on this table.

(2) The PARCCS parameters most affected are listed. All of the PARCCS parameters may affected in some cases. Any failure that results in invalid data affects Completeness.

(3) All data usability evaluations are subject to discretion of the EP taking into account project DQOs, and the intended use of the analytical data. The DQA and DUE thought process must be documented in the report using the data.

(4) Soil or sediments samples that are collected on or after March 1, 2006 in a manner that is not in compliant with the DEP's Guidance for Collecting and Preserving Soil and Sediment Samples for Laboratory Determination of Volatile Organic Compounds, effective March 2006 (Soil Preservation Guidance Document) are deemed to have a significant QC variances or gross QC failure as described in Section 3.2 of this document.

(5) Refrigeration not required for trace metals (excluding mercury).

(6) Exceeding holding times on some analyses can produce false positives (i.e., carbonates, dissolved oxygen, etc.) and high bias (i.e., pH, carbonates, dissolved oxygen, etc.). High bias and false positives can also occur when degradation products of contaminants are also themselves analytes, i.e., when 4,4'-DDT is present and holding times are exceeded, high bias and false positives for the degradation products 4,4 DDD, 4,4 DDE, 4,4 DDT, 2,4 DDD, 2,4 DDE, 4,4’-DDT can occur.

(7) Method blanks are not appropriate for all analysis, i.e. pH, conductivity, % solids, etc.

(8) Laboratory control samples are not appropriate for all analyses, i.e. pH, conductivity, % solids, etc.

(9) Matrix spike and matrix spike duplicates are performed at the request of the EP and may not be present.

(10) Note that when the native sample concentrations are significantly greater than the effective spike concentration that the conclusion of the matrix effect is only tentative. As a general rule of thumb, the native sample concentration should be no more than four times higher than the effective matrix spike concentration of for the matrix effect to be considered probably present.

(11) Conventional sampling protocols for some analyte classes (i.e., VOCs) prohibit sample mixing and splitting because it results in the loss of analytes. Field and QC samples for these analytes are more appropriately collected as sample pairs.

(12) The use of field QA data to evaluate project sample data assumes that the field QA sample data is supported by a complete set of in-control laboratory quality control data.

APPENDIX I
DATA USABILITY EVALUATION WORKSHEET

Appendix I-1
Instructions for use of the
Data Usability Evaluation Worksheet

The Data Usability Evaluation Worksheet (DUE Worksheet) can be used to document the EP's thought process during a DUE of the QC nonconformances that were cataloged as part of the DQA. A description of the "Nonconformance DQA Review Elements" listed in the left-hand column can be found in Appendix C of this document. This worksheet can be modified by the user and is available on the DEEP website.

APPENDIX I-2

DATA USABILITY EVALUATION WORKSHEET

Project Name: _____
Laboratory: _____
Sample Delivery Group: _____
Sample Delivery Group Number: _____
Date Samples Collected: _____
Reviewer: _____

Describe the intended use of the data:

Nonconformance DQA Review Elements	**Briefly Summarize DQA Nonconformances**
Laboratory Report Inspection	
Reasonable Confidence Evaluation	
Chain of Custody Evaluation	
Sample Result Evaluation	
Sample Preservation and Holding Time Evaluation	
Blank Evaluation	
Laboratory Control Samples and Laboratory Control Sample Duplicates	
Surrogates	
Site Specific Matrix Spikes and Matrix Spike Duplicates	
Tentatively Identified Compounds	
Other QC data	

APPENDIX I-2 (CONTINUED)
DATA USABILITY EVALUATION WORKSHEET

Provide a summary statement describing how the analytical data set relied upon is of adequate quality and of sufficient accuracy, precision, and sensitivity for the intended purpose. Questions for the EP to consider during the DUE include, but are not limited to, the following, please see the text of this guidance for additional information:

How will the analytical data be used:

- Will the analytical results be used to determine compliance with RBCR criteria?
- Will be analytical results be used to determine a release has occurred?
- Will remediation be conducted?
- Has remediation been conducted?
- Are the results going to be used to guide further investigation?
- Are the results going to be used to guide further remediation (including monitored natural attention of groundwater)?
- Evaluate seasonal variability, or homogeneity in an environmental sample?

Laboratory QC Information

- Are significant QC variances reported?
- Are the identified QC nonconformances related to results for substances that are reported as "ND," and the reporting limits are significantly less than RBCR criteria?
- Are the nonconformances related to poorly performing compounds that are not constituents of concern?
- Are the nonconformances related substances that are not constituents of concern?
- Is the reported bias high or low? For cases with low bias, are the results well below applicable RBCR criteria or are they close to applicable RBCR criteria?
- How do the nonconformances effect "NDs" and reported concentrations?

DQOs

- Were the DQOs precision, accuracy, representativeness, comparability, completeness and sensitivity met?
- Are all critical samples usable for the intended purpose(s)?
- Does sample homogeneity or heterogeneity effect the representativeness of the samples?

CSM

- Do any analytical QC nonconformances create significant data gaps in the Conceptual Site Model?
- Evaluate the entire body of information (type, amount, and quality data) available for the specific area/release for which the data are presumed to be representative. Determine whether any newer data corroborate the older results and whether both sets of data are consistent with the CSM.
- Consider the risk of being wrong based on risk to potential receptors and the risk to human health and the environment.
- Consider the source of data (e.g., whether the data were generated by the EP's own firm or some other firm, the EP's own involvement with the project, method of collection for the samples, and reporting methods by other firms/laboratories generating the data). Perform a critical review of these data to evaluate its reliability.
- Consider any other site-specific factors.

PRE RCP DATA - See section 4.5 of this guidance document for information to consider.

APPENDIX J
SURROGATES AND INTERNAL STANDARDS

Appendix J
Internal Standards and surrogates

The table provided below is meant to serve as a reference, when needed, to evaluate potential biases in compounds associated with specific internal standards. This table lists the commonly used internal standards (ISTDs) and their associated target compounds and surrogates for semivolatiles. If the laboratory data indicates a problem with the internal standard(s), this table can be used to evaluate which target compounds are affected. For instance, if the surrogate 1,4-Dichlorobenzene-d4 had a low recovery, the compounds listed in the same column would potentially be affected as well, and bias should be suspected unless otherwise indicated by additional QC data. If there is concern regarding bias based on internal standard recovery, EPs should discuss with their laboratory.

1,4-dichlorobenzene-d4 (ISTD)	**naphthalene-d8 (ISTD)**	**acenaphthene-d10 (ISTD)**	**phenanthrene-d10 (ISTD)**	**chrysene-d12 (ISTD)**	**perylene-d12 (ISTD)**
2-Fluorophenol (surrogate)*	nitrobenzene-d5 (surr)*	2-fluorobiphenyl (surr)*		p-terphenyl-d14 (surr)*	di-n-octyl phthalate
phenol-d6 (surr)*	nitrobenzene	hexachlorocyclopentadiene	4,6-dinitro-2-methylphenol	pyrene	benzo(b) fluoranthene
2-chlorophenol-d4 (surr)*	isophorone	2,4,6-trichlorophenol	4-bromophenyl-phenylether	butylbenzylphthalate	benzo(k) fluoranthene
1,2-dichlorobenzene-d4 (surr)*	2-nitrophenol	2,4,5-trichlorophenol	n-nitroso-diphenylamine	3,3'-dichlorobenzidine	benzo(a)pyrene
aniline	2,4-dimethylphenol	2-chloronaphthalene	hexachlorobenzene	benzo(a)anthracene	indeno(1,2,3-cd)-pyrene
phenol	bis-(2-chloroethoxy)methane	2-nitroaniline	pentachlorophenol	chrysene	dibenzo(a,h)-anthracene
bis-(2-chloroisopropyl ether)	2,4-dichlorophenol	dimethylphthalate	phenanthrene	bis-(2-ethylhexyl)phthalate	benzo(g,h,i)perylene
2-chlorophenol	naphthalene	2,6-dinitrotoluene	anthracene	benzidine	benzo(e)pyrene
2-methylphenol	4-chloroaniline	acenaphthylene	carbazole	dimethyl aminoazobenzene	dibenz(a,j)acridine
pyridine	hexachlorobutadiene	3-nitroaniline	di-n-butylphthalate	di-n-octyl phthalate	7,12-dimethylbenz(a)anthracene
	4-chloro-3-methylphenol	acenaphthene	fluoranthene		3-methylchloanthrene
3,4-methylphenol	2-methylnaphthalene	2,4-dinitrophenol	pentachloronitro-benzene		perylene

n-nitroso-di-n-propylamine	1,2,4-trichlorobenzene	4-nitrophenol	1,2-diphenylhydrazine		
hexachloroethane	2,6-Dichlorophenol	dibenzofuran	4-aminobiphenyl		
benzaldehyde	caprolactam	2,4-dinitrotoluene	atrazine		
benzyl Alcohol	benzoic Acid	diethylphthalate	diphenylamine		
n-nitrosodimethylamine	1-methylnaphthalene	fluorene	4-nitroquinoline-1-oxide		
bis(2-chloroethyl)ether	acetophenone	4-chlorophenylphenylether	phenacetin		
1,3-dichlorobenzene	α,α-dimethylphenethylamine	4,4-nitroaniline	pronamide		
1,4-dichlorobenzene	n-nitrosi-n-butylamine	1,2,4,5-tetrachlorobenzene			
1,2-dichlorobenzene	n-nitrosopiperidine	biphenyl			
acetophenone		2,3,4,6-tetrachlorophenol			
1,4-dioxane		atrazine			
ethyl methanesulfonate		2,4,6-tribromophenol (surr)			
methyl methanesulfonate		1-chloronaphthalene			
2-picolne		1-naphthylamine			
		2-Naphthylamine			
		Pentachlorobenzene			
*Indicates compounds that may be used as surrogates					

APPENDIX K
SUPPLEMENTAL EXAMPLES USING MULTIPLE LINES OF EVIDENCE

Appendix K

Supplemental Examples Using Multiple Lines of Evidence

These examples illustrate how multiple lines of evidence may be used to QC nonconformances.

Example K-1: Surrogates – Low Recovery, Expanded Version of Example 8

A soil sample was analyzed by SW-846 Method 8260. The intended use of the analytical data was to determine if contaminants were present at concentrations that exceed GA Pollutant Mobility Criteria (GA PMC).

The percent recovery for the surrogate Toluene-d8 was reported to be 20%. The method specifies that the recovery limits for surrogates must be within 70 to 130%. Because the reported recovery for this surrogate is outside acceptance criteria for VOCs, then all VOC results are biased low.

- 1,1,1-Trichloroethane was reported at a concentration of 2.5 mg/kg, which is just below the GA PMC applicable to the release area of 4 mg/kg.
- MS/MSD percent recoveries from the soil sample analyzed , were within the RCP acceptance criteria for all compounds reported by SW-846 Method 8260. 1,1,1-trichloroethane was not detected (ND) as a target compound in the MS/MSD sample.
- The RPD for the MS/MSD for pair for 1,1,1-trichloroethane is 13.3%. The method specifies that relative percent difference must be less than 30% for the MS/MSD pair.
- All other quality control criteria were within the RCP acceptance criteria.

The reported percent recovery for the surrogate Toluene-d8 indicates a potential low bias for all VOCss. Because the reported concentration of 1,1,1-trichloroethane is just below the GA PMC, the reported potential low bias associated with the surrogate recovery means the results should not be used to solely determine that 1,1,1-trichloroethane is present at a concentration less than the GA PMC. Multiple lines of evidence such as matrix spikes and matrix spike duplicates were used to evaluate this data set further. However, the MS/MSD percent recoveries from the soil sample analyzed were reported within RCP acceptance criteria. The evaluation of these results using multiple lines of evidence would not prevent the EP from concluding that 1,1,1-Trichloroethane is not present at a concentration greater than the GA PMC.

Example K-2: Laboratory Control Samples – Low Recovery, Expanded Version of Example 9

Groundwater samples were analyzed by SW-846 Method 8260. The purpose of sampling was to determine compliance with RBCRs. The Groundwater Protection Criteria (GWPC) for benzene is 1 µg/l.

- The results for the LCS indicate a 54% recovery for benzene. The method specifies that the recovery limits for the LCS must be within 70 to 130%.
- The analytical results were ND for benzene at a reporting limit of 0.5 µg/l.

- The surrogate recoveries are within RCP acceptance criteria.
- The MS/MSD percent recoveries from the water sample which was analyzed were within the RCP acceptance criteria for all compounds reported by SW-846 Method 8260. Benzene was ND as a target compound in the MS/MSD sample.
- The RPD for the MS/MSD for pair for Benzene is 23.3%. The method specifies that the RPD must be less than 30% for the MS/MSD pair.
- All other QC criteria are within the RCP acceptance criteria.

The results of the laboratory control sample indicate a potential low bias in the accuracy of the method. Therefore, the results reported could have been affected by the low bias of the associated with the method, and the results should not solely be used to determine if benzene is present at a concentration greater than the GWPC. Multiple lines of evidence such as surrogates, and matrix spikes and matrix spike duplicates were used to evaluate this data set further. However, the surrogate recoveries were within RCP acceptance indicating an acceptable degree of accuracy with the analytical method. In addition, the MS/MSD percent recoveries from the sample analyzed were reported within RCP acceptance criteria. The evaluation of these results using multiple lines of evidence would not prevent the EP from concluding that benzene is not present at a concentration greater than the GWPC in the sample.

Example K-3: Matrix Spike/Matrix Spike Duplicates High Recoveries, Expanded Version of Example 13

A soil sample was analyzed by SW-846 Method 8260 for VOCs. The intended use of the data is to determine if contaminants were present at concentrations that exceed the GA PMC.

- Trichloroethene (TCE) was reported at a concentration of 0.25 mg/kg, which is just above the GA PMC of 0.1 mg/kg.
- The percent recoveries for TCE generated by a MS/MSD pair are 180 and 185 percent respectively. According to the method, the recovery limits for the MS/MSD must be within 70 to 130%.
- The RPD for the MS/MSD pair is 2.7%. The relative percent difference must be less than 30% for the MS/MSD pair.
- The surrogates are within RCP acceptance criteria.
- In a duplicate sample, TCE was reported at a concentration of 0.3 mg/kg, which is just above the GA PMC of 0.1 mg/kg. The relative percent difference between the original and duplicate sample is 18.2%, which indicates an acceptable degree of precision between the two samples.
- All other QC criteria were within the RCP acceptance criteria.
- The results of groundwater investigation at this release area indicate the presence of TCE in groundwater samples.

The spike recoveries indicate a potential high bias for TCE. Because of the reported high bias and the sample result just above the GA PMC, the actual concentration of TCE in the sample may be lower and may be less than the GA PMC. However, the EP cannot adjust the concentrations of the reported values lower. The RPD for the MS/MSD pair was within the acceptance criteria specified in RCP, and therefore, MS/MSD results show an acceptable degree of the precision. Because of the reported high bias associated the MS/MSD pair the results should not be used solely to determine if TCE is present at a concentration greater than the GWPC.

Multiple lines of evidence including surrogate recoveries, duplicate samples and groundwater investigation results were used to evaluate this data set further. The surrogate recoveries are within the range specified in the RCP. The duplicate sample results indicate that the concentration of TCE is above the GA PMC. Groundwater investigation results indicate that TCE is present in groundwater at this release area. The evaluation of these results using multiple lines of evidence would not prevent the EP from concluding that TCE is present at a concentration greater than the GA PMC in these samples.

APPENDIX L
DATA QUALITY ASSESSMENT AND DATA USABILITY EVALUATION CASE STUDY

Appendix L

Data Quality Assessment and Data Usability Evaluation Case Study

The following case study is intended to provide an example Data Quality Assessment (DQA) and Data Usability Evaluation (DUE). This example uses both of the DQA worksheets to illustrate the use of these worksheets with analytical data. Only one worksheet should be used when performing an actual DQA.

Part one of this example presents the laboratory information and the chain of custody.

Part two of this example presents the DQA worksheets, the DUE Worksheet, and a written summary of the findings of the DQA and DUE.

Note: This example is fictitious, any similarities to persons or commercial entities is coincidental.

DATA QUALITY ASSESSMENT AND DATA USABILITY EVALUATION
CASE STUDY
PART ONE

REASONABLE CONFIDENCE PROTOCOL
LABORATORY ANALYSIS QA/QC CERTIFICATION FORM

Laboratory Name: Analysis 'R Us

Client: Earth Firm

Project Location: Cleaners

Project Number:

Laboratory Sample ID(s): AD82658

Sampling Date(s): 8/7/2008

List RCP Methods Used (e.g., 8260, 8270, et cetera): 8260

Lab#: 0866200

1	For each analytical method referenced in this laboratory report package, were all specified QA/QC performance criteria followed including the requirement to explain any criteria falling outside of acceptable guidelines, as specified in the CT DEP method-specific Reasonable Confidence Protocol documents?	☒Yes ☐No
1A	Were the method specified preservation and holding time requirements met?	☐Yes ☒No
1B	**VPH and EPH Methods only:** Was the VPH or EPH method conducted without significant modifications (see section 11.3 of respective RCP methods)	☐Yes ☐ No ☒ N/A
2	Were all samples received by the laboratory in a condition consistent with that described on the associated chain-of-custody document(s)?	☒Yes ☐No
3	Were samples received at an appropriate temperature (<6°C)?	☒Yes ☐ No ☐N/A
4	Were all QA/QC performance criteria specified in the CT DEP Reasonable Confidence Protocol documents achieved?	☐Yes ☒No
5	a) Were reporting limits specified or referenced on the chain-of custody? b) Were these reporting limits met?	☒Yes ☐No ☒Yes ☐No
6	For each analytical method referenced in this laboratory report package, were results reported for all constituents identified in the method-specific analyte lists presented in the Reasonable Confidence Protocol documents?	☒Yes ☐No
7	Are project-specific matrix spikes and laboratory duplicates included in this data set?	☒Yes ☐No

Notes: For all questions to which the response was "No" (with the exception of question #7), additional information must be provided in an attached narrative. If the answer to question #1, #1A, or #1B is "No", the data package does not meet the requirements for "Reasonable Confidence". This form may not be altered and all questions must be answered.

I, the undersigned, attest under the pains and penalties of perjury that, to the best of my knowledge and belief and based upon my personal inquiry of those responsible for providing the information contained in this analytical report, such information is accurate and complete.

Authorized Signature: Bill Jones **Position:** Laboratory Director

Printed Name: Bill Jones **Date:** 8/12/2008

Name of Laboratory: Analysis 'R Us

This certification form is to be used for RCP methods only.

CTDEP RCP Laboratory Analysis QA/QC Certification Form-November 2007
Laboratory Quality Assurance and Quality Control Guidance Reasonable Confidence Protocols

Analysis 'R Us

966 Potter Field
Nowhere, CT

August 12, 2008

Mr. Caesar Ramiro
Earth Firm
200 Main Street
Bethlehem, CT

Project: Cleaners
CET #: 0866200
Soil: Soil 1
Collection Date(s): 8/7/2008

PREP ANALYSIS:

Closed System P&T Extraction [EPA 5035]

Client ID	Soil 1
CET ID	AD82658
Date Analyzed	8/11/2008

ANALYSIS:

Total Solids [EPA 160.3 mo] Units: percent

Client ID	Soil 1
ARU ID	AD82658
Date Analyzed	8/11/2008
Total Solids	93

Volatile Organics [EPA 8260C] Units: micrograms/kilogram (ug/kg) - dry Wt)

Client ID	Soil 1
ARU ID	AD82658
Date Analyzed	8/11/2008
Dilution	2.1
Dichlorodifluoromethane	ND < 17
Chloromethane	ND < 12
Vinyl Chloride	ND < 6.0
Bromomethane	ND < 12
Chloroethane	ND < 12
Acetone	ND < 170
Acrylonitrile	ND < 9.0
Trichlorofluoromethane	ND < 17
Trichlorotrifluoroethane	ND < 34
1,1-Dichloroethene	ND < 6.0
Methylene Chloride	28 B
Carbon Disulfide	ND < 12
Methyl-t-Butyl Ether (MTBE)	ND < 6.0
trans-1,2-Dichloroethene	ND < 6.0
1,1-Dichloroethane	ND < 6.0
2-Butanone (MEK)	ND < 28
2,2-Dichloropropane	ND < 6.0
cis-1,2-Dichloroethene	ND < 6.0
Chloroform	ND < 6.0
Tetrahydrofuran	ND < 28
1,1,1-Trichloroethane	ND < 6.0
Carbon Tetrachloride	ND < 6.0
1,1-Dichloropropene	ND < 6.0
Benzene	ND < 6.0
1,2-Dichloroethane	ND < 6.0
Methyl Isobutyl Ketone	ND < 28
Trichloroethene	ND < 6.0
1,2-Dichloropropane	ND < 6.0
Dibromomethane	ND < 6.0
Bromodichloromethane	ND < 6.0
2-Hexanone	ND < 28
cis-1,3-Dichloropropene	ND < 6.0
Toluene	ND < 6.0
trans-1,3-Dichloropropene	ND < 6.0
1,1,2-Trichloroethane	ND < 6.0
Tetrachloroethene	400
1,3-Dichloropropane	ND < 6.0
Dibromochloromethane	ND < 6.0

Client ID	Soil 1
1,2-Dibromoethane	ND < 6.0
trans-1,4-Dichloro-2-Butene	ND < 28
Chlorobenzene	ND < 6.0
1,1,1,2-Tetrachloroethane	ND < 6.0
Ethylbenzene	ND < 6.0
m+p Xylenes	ND < 6.0
o-Xylene	ND < 6.0
Styrene	ND < 6.0
Bromoform	ND < 6.0

Volatile Organics [EPA 8260C] Units: ug/kg (Dry Wt)

Client ID	Soil 1
Isopropylbenzene	ND < 6.0
1,1,2,2-Tetrachloroethane	ND < 6.0
Bromobenzene	ND < 6.0
1,2,3-Trichloropropane	ND < 6.0
n-Propylbenzene	ND < 6.0
2-Chlorotoluene	ND < 6.0
4-Chlorotoluene	ND < 6.0
1,3,5-Trimethylbenzene	ND < 6.0
tert-Butylbenzene	ND < 6.0
1,2,4-Trimethylbenzene	ND < 6.0
sec-Butylbenzene	ND < 6.0
1,3-Dichlorobenzene	ND < 6.0
4-Isopropyltoluene	ND < 6.0
1,4-Dichlorobenzene	ND < 6.0
1,2-Dichlorobenzene	ND < 6.0
n-Butylbenzene	ND < 6.0
1,2-Dibromo-3-Chloropropane	ND < 6.0
1,2,4-Trichlorobenzene	ND < 6.0
Hexachlorobutadiene	ND < 6.0
Naphthalene	ND < 6.0
1,2,3-Trichlorobenzene	ND < 6.0
1,2 Dichloroethane-d4 (SURR) 70-130	115
toluene-d8 (SURR) 70-130	126
4-bromofluorobenzene (SURR) 70-130	93.5

Sincerely,

Bill Jones
Laboratory Director

Analysis 'R Us

966 Potter Field
Nowhere, CT

QC Report

Project: Cleaners
CET#: 0866200

Blank/LCS Report

Units: micrograms/liter (ug/l)

QA Type: Volatile Organics Date Analyzed: 8/11/2008 Batch ID: 57034

Analyte	Blank	LCS%Rec	LCS CL
Dichlorodifluoromethane	ND<25	74	70-130
Chloromethane	ND<5.0	98	70-130
Vinyl Chloride	ND<5.0	77	70-130
Bromomethane	ND<5.0	98	70-130
Chloroethane	ND<5.0	99	70-130
Acetone	ND<100	60 L	70-130
Acrylonitrile	ND<100	73	70-130
Trichlorofluoromethane	ND<5.0	99	70-130
Trichlorotrifluoroethane	ND<25	96	70-130
1,1-Dichloroethene	ND<5.0	87	70-130
Methylene Chloride	27	73	70-130
Carbon Disulfide	ND<5.0	84	70-130
Methyl-t-Butyl Ether (MTBE)	ND<5.0	90	70-130
trans-1,2-Dichloroethene	ND<5.0	90	70-130
1,1-Dichloroethane	ND<5.0	90	70-130
2-Butanone (MEK)	ND<25	63 L	70-130
2,2-Dichloropropane	ND<5.0	104	70-130
cis-1,2-Dichloroethene	ND<5.0	91	70-130
Chloroform	ND<5.0	90	70-130
Tetrahydrofuran	ND<25	65 L	70-130
1,1,1-Trichloroethane	ND<5.0	96	70-130
Carbon Tetrachloride	ND<5.0	92	70-130
1,1-Dichloropropene	ND<5.0	87	70-130
Benzene	ND<5.0	88	70-130
1,2-Dichloroethane	ND<5.0	88	70-130

Analyte	Blank	LCS%Rec	LCS CL
Methyl Isobutyl Ketone	ND<25	66 L	70-130
Trichloroethene	ND<5.0	76	70-130
1,2-Dichloropropane	ND<5.0	87	70-130
Dibromomethane	ND<5.0	75	70-130
Bromodichloromethane	ND<5.0	92	70-130
2-Hexanone	ND<25	62 L	70-130
cis-1,3-Dichloropropene	ND<5.0	89	70-130

QA Type: Volatile Organics Date Analyzed: 8/11/2008 Batch ID: 57034

Analyte	Blank	LCS%Rec	LCS CL
Toluene	ND<5.0	88	70-130
trans-1,3-Dichloropropene	ND<5.0	87	70-130
1,1,2-Trichloroethane	ND<5.0	83	70-130
Tetrachloroethene	ND<5.0	88	70-130
1,3-Dichloropropane	ND<5.0	82	70-130
Dibromochloromethane	ND<5.0	79	70-130
1,2-Dibromoethane	ND<5.0	71	70-130
Chlorobenzene	ND<5.0	83	70-130
1,1,1,2-Tetrachloroethane	ND<5.0	84	70-130
Ethylbenzene	ND<5.0	84	70-130
m+p Xylenes	ND<5.0	87	70-130
o-Xylene	ND<5.0	85	70-130
Styrene	ND<5.0	86	70-130
Bromoform	ND<5.0	72	70-130
Isopropylbenzene	ND<5.0	86	70-130
1,1,2,2-Tetrachloroethane	ND<5.0	83	70-130
Bromobenzene	ND<5.0	94	70-130
1,2,3-Trichloropropane	ND<5.0	91	70-130
n-Propylbenzene	ND<5..0	95	70-130
2-Chlorotoluene	ND<5.0	85	70-130
4-Chlorotoluene	ND<5.0	110	70-130
1,3,5-Trimethylbenzene	ND<5.0	94	70-130
tert-Butylbenzene	ND<5.0	96	70-130
1,2,4-Trimethylbenzene	ND<5.0	93	70-130
sec-Butylbenzene	ND<5.0	94	70-130
1,3-Dichlorobenzene	ND<5.0	90	70-130
4-Isopropyltoluene	ND<5.0	96	70-130

Analyte	Blank	LCS%Rec	LCS CL
1,4-Dichlorobenzene	ND<5.0	89	70-130
1,2-Dichlorobenzene	ND<5.0	88	70-130
n-Butylbenzene	ND<5.0	94	70-130
1,2-Dibromo-3-Chloropropane	ND<5.0	65 L	70-130
1,2,4-Trichlorobenzene	ND<5.0	83	70-130
Hexachlorobutadiene	ND<5.0	85	70-130
Naphthalene	ND<5.0	75	70-130
1,2,3-Trichlorobenzene	ND<5.0	81	70-130

All associated samples: AD82658

Matrix Spike Report

Units: micrograms/kilogram (ug/kg)

QA Type: Volatile Organics Date Analyzed: 8/11/2008 QA Sample ID: AD82658

Analyte	SampRes	Amt	MS% R	MSD% R	MS CL	RPD	RPD CL
Dichlorodifluoromethane	ND<16	194	83	85	70-130	2.4	30
Chloromethane	ND<11	194	85	74	70-130	20.00	30
Vinyl Chloride	ND<6.0	194	82	84	70-130	2.4	30
Bromomethane	ND<11	194	72	81	70-130	12.20	30
Chloroethane	ND<11	194	71	88	70-130	21.40	30
Acetone	ND<150	388	82	96	70-130	15.7	30
Acrylonitrile	ND<9.0	194	95	76	70-130	22.2	30
Trichlorofluoromethane	ND<16	194	74	88	70-130	17.20	30
Trichlorotrifluoroethane	ND<31	194	74	90	70-130	19.50	30
1,1-Dichloroethene	ND<6.0	194	71	88	70-130	21.40	30
Methylene Chloride	28	194	75	70	70-130	6.90	30

QA Type: Volatile Organics Date Analyzed: 8/11/2008 QA Sample ID: AD82658

Analyte	SampRes	Amt	MS% R	MSD% R	MS CL	RPD	RPD CL
Carbon Disulfide	ND<11	194	82	79	70-130	3.72	30
Methyl-t-Butyl Ether (MTBE)	ND<6.0	194	74	91	70-130	20.00	30
trans-1,2-Dichloroethene	ND<6.0	194	76	93	70-130	20.00	30
1,1-Dichloroethane	ND<6.0	194	77	95	70-130	20.30	30
2-Butanone (MEK)	ND<26	388	52 L	58 L	70-130	10.40	30
2,2-Dichloropropane	ND<6.0	194	78	97	70-130	21.90	30

Analyte	SampRes	Amt	MS%R	MSD%R	MS CL	RPD	RPD CL
cis-1,2-Dichloroethene	ND<6.0	194	78	96	70-130	20.60	30
Chloroform	ND<6.0	194	78	96	70-130	20.60	30
Tetrahydrofuran	ND<26	194	60 L	66 L	70-130	9.80	30
1,1,1-Trichloroethane	ND<6.0	194	82	99	70-130	18.20	30
Carbon Tetrachloride	ND<6.0	194	82	99	70-130	18.80	30
1,1-Dichloropropene	ND<6.0	194	79	97	70-130	20.40	30
Benzene	ND<6.0	194	83	101	70-130	19.60	30
1,2-Dichloroethane	ND<6.0	194	79	95	70-130	17.70	30
Methyl Isobutyl Ketone	ND<26	388	68 L	78	70-130	12.70	30
Trichloroethene	ND<6.0	194	72	87	70-130	19.00	30
1,2-Dichloropropane	ND<6.0	194	82	100	70-130	19.20	30
Dibromomethane	ND<6.0	194	81	95	70-130	15.80	30
Bromodichloromethane	ND<6.0	194	84	103	70-130	19.70	30
2-Hexanone	ND<26	388	63 L	71	70-130	12.00	30
cis-1,3-Dichloropropene	ND<6.0	194	83	102	70-130	20.50	30
Toluene	ND<6.0	194	80	99	70-130	20.70	30
trans-1,3-Dichloropropene	ND<6.0	194	82	98	70-130	18.30	30
1,1,2-Trichloroethane	ND<6.0	194	79	94	70-130	17.20	30
Tetrachloroethene	400	194	95	110	70-130	14.60	30
1,3-Dichloropropane	ND<6.0	194	78	94	70-130	17.90	30
Dibromochloromethane	ND<6.0	194	80	95	70-130	17.70	30
1,2-Dibromoethane	ND<6.0	194	75	87	70-130	15.30	30

Analyte	SampRes	Amt	MS%R	MSD%R	MS CL	RPD	RPD CL
Chlorobenzene	ND<6.0	194	76	94	70-130	20.60	30
1,1,1,2-Tetrachloroethane	ND<6.0	194	79	96	70-130	18.80	30
Ethylbenzene	ND<6.0	194	76	93	70-130	20.70	30
m+p Xylenes	ND<6.0	388	77	95	70-130	21.20	30
o-Xylene	ND<6.0	194	78	96	70-130	21.40	30
Styrene	ND<6.0	194	77	95	70-130	20.30	30
Bromoform	ND<6.0	194	77	90	70-130	15.50	30
Isopropylbenzene	ND<6.0	194	78	96	70-130	21.40	30
1,1,2,2-Tetrachloroethane	ND<6.0	194	85	98	70-130	14.00	30
Bromobenzene	ND<6.0	194	84	106	70-130	23.20	30
1,2,3-Trichloropropane	ND<6.0	194	88	108	70-130	20.90	30
n-Propylbenzene	ND<6.0	194	87	111	70-130	24.10	30
2-Chlorotoluene	ND<6.0	194	76	93	70-130	20.20	30
4-Chlorotoluene	ND<6.0	194	102	135 H	70-130	27.80	30
1,3,5-Trimethylbenzene	ND<6.0	194	84	106	70-130	23.70	30
tert-Butylbenzene	ND<6.0	194	86	108	70-130	23.10	30
1,2,4-Trimethylbenzene	ND<6.0	194	84	106	70-130	23.20	30
sec-Butylbenzene	ND<6.0	194	84	107	70-130	23.50	30
1,3-Dichlorobenzene	ND<6.0	194	87	108	70-130	22.00	30
4-Isopropyltoluene	ND<6.0	194	86	109	70-130	24.00	30
1,4-Dichlorobenzene	ND<6.0	194	86	107	70-130	22.20	30

QA Type: Volatile Organics Date Analyzed: 8/11/2008 QA Sample ID: AD82658

Analyte	SampRes	Amt	MS%R	MSD%R	MS CL	RPD	RPD CL
1,2-Dichlorobenzene	ND<6.0	194	87	106	70-130	20.10	30
n-Butylbenzene	ND<6.0	194	86	109	70-130	23.50	30
1,2-Dibromo-3-Chloropropane	ND<6.0	194	72	84	70-130	16.50	30
1,2,4-Trichlorobenzene	ND<6.0	194	84	110	70-130	26.20	30
Hexachlorobutadiene	ND<6.0	194	83	108	70-130	26.20	30
Naphthalene	ND<6.0	194	72	90	70-130	22.40	30
1,2,3-Trichlorobenzene	ND<6.0	194	80	104	70-130	25.60	30

ND is not detected

VOCs Continuing Calibration

Compound	Batch	Result	LCL	UCL	Analysis Date
Methyl Isobutyl Ketone	57034	64 L	70	130	8/11/2008
2-Butanone (MEK)	57034	69 L	70	130	8/11/2008
2-Hexanone	57034	69 L	70	130	8/11/2008
Acetone	57034	61 L	70	130	8/11/2008
1,2-Dibromo-3-Chloropropane	57034	65 L	70	130	8/11/2008

Narrative

Sample was not frozen within the 48 hour hold time window.

Question 4 of the RCP Laboratory Analysis Laboratory Analysis Certification Form:

Acetone LCS recovery low (60%) for batch 57034.
Methylene Chloride found in the Blank for batch 57034.
2-Butanone (MEK) LCS recovery low (63%) for batch 57034.
Tetrahydrofuran LCS recovery low (65%) for batch 57034.
Methyl Isobutyl Ketone LCS recovery low (66%) for batch 57034.
2-Hexanone LCS recovery low (62%) for batch 57034.
1,2-Dibromo-3-Chloropropane LCS recovery low (65%) for batch 57034.
2-Butanone (MEK) matrix spike recovery low (52%) and matrix spike dup recovery low (58%) for sample AD82658.
Tetrahydrofuran matrix spike recovery low (60%) and matrix spike dup recovery low (66%) for sample AD82658.
Methyl Isobutyl Ketone matrix spike recovery low (68%) for sample AD82658.
2-Hexanone matrix spike recovery low (63%) for sample AD82658.
4-Chlorotoluene matrix spike dup recovery high (135%) for sample AD82658.
Methyl Isobutyl Ketone CC low for batch 57034.
2-Butanone (MEK) CC low for batch 57034.
2-Hexanone CC low for batch 57034.
Acetone CC low for batch 57034.
1,2-Dibromo-3-Chloropropane CC low for batch 57034.

Analysis 'R US

CHAIN OF CUSTODY RECORD

Volatile Soils Only:

Date and Time in Freezer
Client:
CET: 8/10/08 10:00 AM

966 Potter Field
Nowhere, CT

Sample ID	Date/Time	Matrix (A=Air, S=Soil, W=Water, DW=Drinking W., C=Cassette, Solid, Wipe, Other (Specify))	Turnaround Time ** (check one): Same Day	24 Hours	2-3 Days	Standard	Organics: 8260 CT List	8260 Aromatics	8260 Halogens	SPLP 8260	TCLP 8260	TPH (418.1)	CT ETPH	8270 CT List	8270 PNAs	PCBs	Pesticides	Metals (check all that apply): 13 Priority Poll	8 RCRA	TOTAL	TCLP	SPLP	Field Filtered	Lab To Filter	Additional Analysis: Total Solids	TOTAL # OF CONT.	NOTE #
Soil 1	8/7/08 - 10:00	S			X		X																	X	4	

PRESERVATIVE (Cl–HCl, N–HNO_3, S–H_2SO_4, Na–NaOH, C=Cool, O–Other): C

CONTAINER TYPE (P–Plastic, G–Glass, V–Vial, O–Other): G

Soil VOCs Only (M=MeOH, B= Sodium Bisulfate, W=Water, F= Empty Vial, E=Encore): H = M*

RELINQUISHED BY:	DATE/TIME	RECEIVED BY:
John Smith	8/10/07 9:30 AM	Bill Jones
RELINQUISHED BY:	DATE/TIME	RECEIVED BY:
RELINQUISHED BY:	DATE/TIME	RECEIVED BY:

NOTES:
* 8/11/08, 9:58 A.M, JOHN JONES, ASSIST. LAB. CHEM., SWP not needed for soil sample per telephone call with Caesar Ramiro.

Client / Reporting Information

Company Name: Earth Firm
Address: 200 Main St.
City: Bethlehem State: CT Zip:
Report To: Caesar Ramiro E-mail:
Phone # Fax #

Project Information

Project Contact: PO #:
Project: Cleaners Project #:
Location: Collector(s):

QA/QC: ☐ Std ☐ Site Specific (MS/MSD) * ☑ RCP Pkg *
Data Report: ☐ Email ☐ PDF ☐ Excel ☐ Other
RSR Reporting Limits (check one): ☑ GA ☐ GB ☑ SWP * ☐ Other (Specify)

Lab Use:
Evidence of Cooling: Temp Upon Receipt 3.2 °C (Y) or N

SHEET 1 OF 1

* Additional charge may apply. ** TAT begins when the samples are received at the Lab. TAT for samples received after 3 p.m. will start on the next business day.

REV. 5/9/05

DATA QUALITY ASSESSMENT AND DATA USABILITY EVALUATION
CASE STUDY
PART TWO

APPENDIX D-2
DATA QUALITY ASSESSMENT WORKSHEET 1

PAGE 1 OF 1

PROJECT: CLEANERS				FILE NUMBER: 086620		
LABORATORY WORK ORDER				REVIEWER: C. RAMIRO		DATE: 8/17/08
BLANKS		**Compound**	**Compound**	**Compound**	**Compound**	**Notes**
Method Blank, VOCs	(>RL?)	METHLYNE	CHLORIDE			27 B
Method Blank, SVOCs	>RL?					
Method Blank, VPH	>RL?					
Method Blank, EPH	>RL?					CC LOW
Method Blank, PCBS	>RL?					FOR VOCS
Method Blank, Pest	>RL?					
Method Blank, Metals	>RL?					
Method Blank, Total Cyanide	>RL?					
Method Blank, ETPH	>RL?					
Field Blank	>RL?					
Trip Blank	>RL?					
VPH Blank (methanol)	>RL?					
Blank Soil VOCs (methanol)	>RL?					
Blank Soil VOCs (water/bisulfate) circle	>RL?					
LCS	**SV**	**Low Bias**	**High Bias**	**Compound**	**Compound**	**Notes**
VOCs	<10%	(> 10% & < LCL)	>UCL			
SVOCs	<10%	> 10% & < LCL	>UCL			
VPH	<10%	> 10% & < LCL	>UCL			
EPH	<10%	> 10% & < LCL	>UCL			
PCB	<10%	> 10% & < LCL	>UCL			
PEST	<10%	> 10% & < LCL	>UCL			
Metals	<10%	> 10% & < LCL	>UCL			
Total Cyanide	<10%	> 10% & < LCL	>UCL			
ETPH	<10%	> 10% & < LCL	>UCL			
SURROGATES	**SV**	**Low Bias**	**High Bias**	**Compound**	**Compound**	**Notes**
VOCs	<10%	> 10% & < LCL	>UCL			
SVOCs	<10%	> 10% & < LCL	>UCL			
VPH	<10%	> 10% & < LCL	>UCL			
EPH	<10%	> 10% & < LCL	>UCL			
PCB	<10%	> 10% & < LCL	>UCL			
PEST	<10%	> 10% & < LCL	>UCL			
ETPH	<10%	> 10% & < LCL	>UCL			
MS/MSDS	**SV**	**Low Bias**	**High Bias**	**QC Source**	**RPDS**	**Notes**
VOCs	<10%	(> 10% & < LCL)	>UCL	Batch? Site?		
SVOCs	<10%	> 10% & < LCL	>UCL	Batch? Site?		
VPH	<10%	> 10% & < LCL	>UCL	Batch? Site?		
EPH	<10%	> 10% & < LCL	>UCL	Batch? Site?		
PCB	<10%	> 10% & < LCL	>UCL	Batch? Site?		
PEST	<10%	> 10% & < LCL	>UCL	Batch? Site?		
Metals	<10%	> 10% & < LCL	>UCL	Batch? Site?		
Total Cyanide	<10%	> 10% & < LCL	>UCL	Batch? Site?		
ETPH	<10%	> 10% & < LCL	>UCL	Batch? Site?		
FIELD DUPLICATES RPDS		**Soil**	**Water**	**Compound**	**Compound**	**Notes**
VOCs		RPD > 50%	RPD > 20%			
SVOCs		RPD > 50%	RPD > 20%			
VPH		RPD > 50%	RPD > 20%			
EPH		RPD > 50%	RPD > 20%			
PCB		RPD > 50%	RPD > 20%			
PEST		RPD > 50%	RPD > 20%			
Metals		RPD > 50%	RPD > 20%			
Total Cyanide		RPD > 50%	RPD > 20%			
ETPH		RPD > 50%	RPD > 20%			
LAB DUPLICATES RPDS		**Soil**	**Water**	**Compound**	**Compound**	**Notes**
		RPD > 50%	RPD > 20%	Batch? Site?		

General QC Indicators:

Reasonable Confidence Achieved? Y/N Significant QC Variances Noted? Y/N Requested Reporting Limits Achieved? Y/N

Preservation Requirements Met? (Y/N) Holding Time Requirements Met? Y/N

Notes: NOT FROZEN IN 48 HRS, STORED ON ICE, FROZEN AT LAB 8/10/08 10 A.M

Abbreviations: RL = Reporting Limit; LCS = Laboratory Control Sample; SV = Significant QC Variance, LCL= RCP Lower Control Limit; UCL= RCP Upper Control Limit; RPD = Relative Percent Difference; VOCs = Volatile Organic Compounds; SVOCs = Semivolatile Organic Compounds; VPH = Volatile Petroleum Hydrocarbons; EPH = Extractable Petroleum Hydrocarbons; PCBs = Polychlorinated Biphenyls; Pest = Pesticides; ETPH Extractable Total Petroleum Hydrocarbons

ACETONE LCS/CC
MEK LCS/MS/CC
TETRAHYDROFURAN LCS/MS
MIBK LCS/MS/CC

2-HEXANONE LCS/MS/CC
1,2 DIBROMO-3-CHLOROPROPANE LCS
4-CHLOROTOLUENE MS/CC

APPENDIX D-3

DATA QUALITY ASSESSMENT WORKSHEET 2

Project: CLEANERS
File Number: 0866200
Reviewer: CAESAR RAMIRO
Date: 8/17/08
Notes:

Sample Number(s)	Compound(s)	Quality Control Nonconformance	Percent Recovery	Relative Percent Difference	High/Low Bias	Comments
SOIL 1						
	ACETONE	LCS / CC	60L / 61L		L	PP
	MEK	LCS / MS / CC	63L / 52+58L / 69L		L	PP
	TETRAHYDROFURAN	LCS / MS	65L / 60L + 66L		L	PP
	MIBK	LCS / MS / CC	66L / 68L / 64L		L	PP
	2-HEXANONE	LCS / MS / CC	62L / 63L / 69L		L	PP
	1,2-DB-3CP	LCS	65L / 65L		L	PP
	4-CHLOROTOLUENE	MS / CC	135 H		H	PP
	METHYLENE CHLORIDE	FOUND IN BLANK AT 27 PPB			H	28 ppb in SAMPLE

Note other QC nonconformances below (data package inspection, reasonable confidence. chain of custody, sample result, sample preservation and holding time evaluations. SAMPLE NOT FROZEN WITHIN 48 HOURS, LOW BIAS. SAMPLE STORED ON ICE PRIOR TO DELIVERY TO LAB. SAMPLE PUT IN FREEZER AT LAB ON 8/10/08 AT 10:00 A.M.

Notes:
Bias High: Reported result may be lower. Reporting Limit (RL) is acceptable as reported.
Bias Low: Reported results may be higher. Reporting Limit (RL) may be higher than reported

1,2-DB-3CP = 1,2 DIBROMO-3-CHLOROPROPANE
PP= POOR PERFORMING COMPOUNDS

DATA USABILITY EVALUATION WORKSHEET

Project Name: Cleaners _____
Laboratory: Analysis 'R Us _____
Sample Delivery Group: _____
Sample Delivery Group Number: Soil 1 _____
Date Samples Collected: 8/7/08_____

Describe the intended use of the data:
Confirm PCE release at area of stained soil at location of dry cleaning filter storage.

Nonconformances DQA Review Elements	**Briefly Summarize DQA Nonconformances**
STANDARD RCP DELIVERABLES	
Data Package Inspection	
Reasonable Confidence Evaluation	
Chain of Custody Evaluation	
Sample Result Evaluation	
Sample Preservation and Holding Time Evaluation	Samples not frozen within 48 hours – low bias
Blank Evaluation	
Laboratory Control Samples	Low Bias for poorly performing compounds acetone, MEK, tetrahydrofuran, MIBK, 2-Hexanone, 1,2-Dibromo-3-chloropropane. Low Bias for tetrahydofuran and 4-Chlorotoluene
Surrogates	
Site Specific Matrix Spikes and Matrix Spike Duplicates	Low Bias for poorly performing compounds MEK, tetrahydrofuran, MIBK, 2-Hexanone, low Bias for tetrahydofuran and 4-Chlorotoluene.
Tentatively Identified Compounds	

Other QC data	
Continuing Calibration Blank or Initial Calibration Blank Evaluation	Low Bias for poorly performing compounds acetone, MEK, MIBK, 2-Hexanone, Low Bias for tetrahydofuran and 4-Chlorotoluene. Methylene chloride in blank 27 ppb in sample at 28 ppb
Notes	Tetrachloroethene detected in sample at 400 µg/kg. GAPMC is 0.1 mg/kg
	Site is a historic drycleaners site.

DATA USABILITY EVALUATION WORKSHEET (CONTINUED)

Provide a summary statement describing how the analytical data set relied upon is of adequate quality and of sufficient accuracy, precision, and sensitivity for the intended purpose.

Because the sample was not frozen/preserved within 48 hours of collection, the sample exhibits low bias. However, tetrachloroethene detected in sample at 400 µg/kg well above GA PMC of 100 µg/kg.

Nonconformances related to MS/MCDs, LCS and CC are not related to substances that are constituents of concern at the release area and in most cases are poorly performing compounds.

Methlylene chloride was found in the sample and a blank. Application of the 10x rule indicates that the methlylene chloride found in the sample is related to laboratory contamination.

Groundwater investigation of this release area indicates the presence of tetrachloroethene.

The analytical data are of adequate quality and of sufficient accuracy, precision, and sensitivity to confirm that remediation of this release area is required. Further investigation will be conducted to characterize the extent this release area.

EXCERPT FROM DQA AND DUE PORTION OF THE REPORT USING THE DATA

One soil was collected at the Cleaners property at 967 Breadbaker Lane, Nowhere CT and submitted to a state-certified analytical laboratory for VOCs using SW-846 Method 8260. This sample was collected to confirm the results of a previous investigation that concluded that a PCE release area is located near a location used for dry cleaning filter storage. The site was used a dry cleaner for at least 40 years from 1950 to 1990.

A data quality assessment and data usability evaluation was performed for data generated in accordance with DEEP guidance and noted the following quality control nonconformances.

Methylene chloride was found in a laboratory blank and in a sample at a concentration less than the class GA Groundwater Protection Criteria (GA PMC) as a result of laboratory contamination.

Continuing Calibration, Laboratory Control Samples, and Matrix Spike/Matrix Spike Duplicates exhibited bias for poor performing compounds and several other compounds that are not constituents of concern at the release area.

The sample was not frozen within 48 hours of collection and exhibits low bias for VOCs. Tetrachloroethene detected in sample at 400 µg/kg well above GA PMC of 100 ug/kg.

Groundwater data indicates that a PCE release has occurred at the site.

Based on the above findings from the DQA and DUE, the analytical data is adequate quality and of sufficient accuracy, precision, and sensitivity to confirm that remediation of this release area is required. Further investigation will be conducted to characterize the extent this release area. DQA and DUE worksheets are included in the appendix to this document.