Chapter 3
DATA ASSESSMENT

3-1. Data Assessment. Any time chemical data are generated, their quality must be assessed prior to use. The type and degree of assessment required depends upon the project DQOs. Several different levels of data assessment exist, including data verification, data review, data evaluation, and data validation.

a. Data Verification. Data verification is the most basic assessment of data. Data verification is a process for evaluating the completeness, correctness, consistency, and compliance of a data package against a standard or contract. In this context, "completeness" means all required hard-copy and electronic deliverables are present. Data verification should be performed by the government or independent entity for QA laboratory deliverables, and by the laboratory contract holder for primary laboratory deliverables.

b. Data Review. Data review is the next step in the data assessment hierarchy. Data review is the process of data assessment performed to produce the CQAR. Data review includes an assessment of summary QC data provided by the laboratory. CQAR preparation is described in detail in Chapter 4. Data review may include examination of primary and QA laboratory data and the internal QC and QA sample results to ascertain the effects on the primary laboratory's data.

c. Data Evaluation. Data evaluation is the process of data assessment done by district project chemists to produce a CDQAR. Data evaluation is performed to determine whether the data meet project-specific DQOs and contract requirements. CDQAR preparation is described in Chapter 5. To prepare a CDQAR, the district project chemist relies upon the DQO summary from the SAP, the CQAR, field oversight findings, laboratory audits, PE sample results, and any other data quality indicators available.

d. Data Validation. Data validation may be required for certain projects. Validation is a process of data assessment in accordance with EPA regional or national functional guidelines, or project-specific guidelines. Data validation includes assessment of the whole raw data package from the laboratory.

e. Special Requirements. Often, the requirements for data assessment will depend upon the project phase. In particular, data for use in a risk assessment will have specific quality requirements. There are several excellent references on this topic, including Chapter 3 of EM 200-1-4, ["Risk Assessment Handbook: Human Health Evaluation"]; and "Guidance for Data Useability in Risk Assessments (Parts A and B) [Office of Emergency and Remedial Response, EPA Directive 9285.7-09A, 1992].

3-2. Required Level of Data Assessment. The degree of data assessment will be different for screening level data than for definitive data. Screening level data are typically characterized by less stringent QC/QA procedures. Assessment of screening level data consists of checking whatever QC/QA indicators are available, and confirming the results with definitive analyses, usually at a 10% frequency.

3-3. Assessment of Definitive Data. Definitive data are characterized by rigorous QA/QC procedures. The following set of general procedures should be applied to the extent possible for all definitive data sets.

a. Data Verification. Definitive data assessment begins at the primary and QA laboratories. General processes for data quality management at the laboratory are described in EM 200-1-1 as well as EM 200-1-2. Once the data have met the laboratory's standards, data verification is performed to determine if the data package is correct and complete.

b. Data Review. See the attached Table 3-1 for more details on the specifics of data review. Data review documents possible effects on the data that result from various QC failures. It does not determine data useability, nor does it include assignment of data qualifier flags.

(1) The initial inspection of the data screens for errors and inconsistencies. The chemist checks the chain of custody forms, sample handling procedures, analyses requested, sample description and ID, and cooler receipt forms. The chemist then verifies that the data were checked by the laboratory manager or QA officer. Sample holding times and preservation are checked and noted.

(2) The next phase of data quality review is an examination of the actual data. By examining data from laboratory matrix duplicates, blind duplicates, TBs, EBs, laboratory MBs, LCSs, LCSDs, MS samples, matrix spike duplicate (MSD) samples, surrogate recoveries, and field samples, the chemist can determine whether the data are of acceptable quality.

(a) Both laboratory control samples (LCSs) and matrix duplicates are examined during data review. The precision of the data is quantified by the RPD between two results obtained for the same sample. The samples may be either internal laboratory QC samples (*i.e.*, LCSs) or field samples. A high RPD in an LCS/LCSD pair is an indication of overall method failure, and may result in the rejection of an entire data set. Laboratory matrix duplicates and MSDs are also assessed by their RPD values. High RPD values for matrix duplicates indicate a lack of reproducibility, and such data may be qualified or rejected. Any such results should be noted in the assessment of data quality.

(b) Data from blank samples are examined to determine if sample contamination occurred either during or after the sample collection. Equipment or rinsate blanks consist of reagent water

passed through or over sampling equipment following sample collection and sample equipment decontamination. Contaminated EBs indicate inadequate decontamination between samples, and the strong likelihood of cross-contamination between samples. MBs are blank samples prepared in the laboratory and analyzed along with project samples. If analytes are detected in a MB, it is a strong indication of laboratory contamination. This would raise the possibility that project sample aliquots were contaminated in the laboratory as well. TBs are samples of pure water that accompany the project samples from the field to the laboratory. TBs accompany each shipment of water samples to be analyzed for volatile organic compounds. Analysis of the TBs indicate whether sample contamination occurred during shipment and/or storage.

(c) Surrogate recoveries are scrutinized to ensure they fall within an acceptable range. Adequate surrogate recoveries in QC samples (blanks and LCSs) indicate that sample extraction procedures were effective, and that overall instrument procedures were acceptable. Surrogate recoveries in field samples are a measure of possible matrix effects and can indicate complete digestion or extraction of a sample. Surrogate recoveries outside control limits may result in qualified or rejected data.

(d) A LCS is an aliquot of a clean matrix (*i.e.*, clean water or sand) which contains a known quantity of an analyte. Good recoveries from an LCS indicate that the analytical method is in control and that the laboratory is capable of generating acceptable data. The evaluation of possible matrix effects and accuracy of the data are monitored by analysis of MS/MSD samples. A MS sample is prepared by adding a known quantity of an analyte to a field sample. The MSD is prepared in an identical manner. MS/MSD should be analyzed at least once per every twenty samples, or once per preparation batch, whichever is greater. Recovery of the MS indicates the absence of a matrix effect and is another measure of data accuracy. Comparison of the MS/MSD results provides an indication of data precision. All MS/MSD data should be examined. Low or high spike recoveries are evidence of matrix effects and poor accuracy; a high RPD for duplicates is evidence of low precision; all such results should be reported in the data review.

(e) A blind duplicate QC sample is submitted to the primary laboratory, which analyzes the majority of the samples. Analysis of the QC duplicate sample provides a measure of sample homogeneity and intra-laboratory variations. An additional replicate sample is provided to an independent QA laboratory, to provide a further test of sample homogeneity and a test of inter-laboratory accuracy. QC and QA samples effectively provide triplicate analysis of a subset of the total project samples. The three results for each set are carefully compared and tabulated. Data comparison criteria for evaluation of data comparability are described in Chapter 4. If two of three data sets agree, each laboratory's internal QC/QA data should be reassessed to determine which set of data is the most accurate. Data from related analyses may be inspected to determine which set of data is more accurate.

c. Data Evaluation. Data evaluation follows data review. During data evaluation, the district

project chemist uses the results of the data review as summarized in the CQAR to determine the useability of the data. The CQAR documents the potential effects of QC/QA failures on the data, and the district project chemist assesses their impact on attainment of DQOs and contract compliance.

d. Data Qualifiers. Data assessment will result in documentation of the quality and useability of the data. Data qualifiers, called flags, will be applied as appropriate to alert the data user of deficiencies in the data. Data qualifiers are applied by the district project chemist, taking into account the project-specific DQOs. The qualifiers may be different depending on the type of data evaluation performed. Data validation by EPA functional guidelines procedures may employ different flags than project-specific validation data qualifiers. Despite the data assessment flags used, the qualifiers serve the same purpose. The flags are used to delimit the useability of the data, generally because of QC failures.

Table 3-1
Data Evaluation
(Note 1)

QC Element (Sample Type, Analysis Condition, or Characteristic)	Type of Failure	Possible Causes (Note 2)	Major PARCCS Parameters Affected (Note 3)	Possible Effect on Data (Documented in CQAR)	Worst Case Data Evaluation (Documented in CDQAR) (Note 4)
Chain of custody	Chain broken or not kept	***Missing signatures***; missing seals; missing dates/times.	Completeness	Incomplete data	Data not legally defensible.
Sample labeling	Sample labels unreadable, missing or not attached to containers	***Failure to protect from moisture***; failure to use appropriate marker or labels; improper SOP	Representativeness Completeness	Incomplete data False positives False negatives	Invalidates all sample results.
Sample labeling	Samples mislabeled	***Sampler error***; improper SOP.	Representativeness	Incomplete data False positives False negatives	Invalidates all sample results.
Sample containers	Plastic container for organic analytes	***Samplers unaware of requirement***; improper SOP; failure to read SAP; SAP incorrect; insufficient containers.	Representativeness Accuracy Completeness	False positives False negatives High or low bias Phthalate interference	Invalidates all sample results.
Sample containers	Glass containers for boron, silica, & fluoride	***Samplers unaware of requirement***; improper SOP; failure to read SAP; SAP incorrect; insufficient containers.	Representativeness Accuracy Completeness	False positives High bias	Invalidates all sample results.
Headspace	Bubbles in water VOC vial > 6 mm; visible headspace in soil VOC container.	***Poor sampling technique***; caps not sealed tight; septum caps not used; dirt between cap and rim; soil not packed tight; improper SOP	Representativeness Accuracy Completeness	False negatives Low bias	Invalidates all sample results. Sample results > DL considered as minimum values only.

QC Element (Sample Type, Analysis Condition, or Characteristic)	Type of Failure	Possible Causes (Note 2)	Major PARCCS Parameters Affected (Note 3)	Possible Effect on Data (Documented in CQAR)	Worst Case Data Evaluation (Documented in CDQAR) (Note 4)
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. Affects legal defensibility of data. Sample results > DL considered as minimum values only.
Preservation	Wrong preservative	***Improper SOP***; failure to read SAP; SAP incorrect; correct preservative unavailable.	Representativeness Accuracy Completeness	Incomplete data False positives False negatives	Invalidates or qualifies some or all sample results. Affects legal defensibility of data.
Preservation	Too warm (> 6 °C; Note (5))	***Insufficient ice***; shipping container inadequately insulated; samples not pre-chilled prior to shipping; transit time too long.	Representativeness Accuracy Completeness	False negatives Low bias	Invalidates sample results. Affects legal defensibility of data. Sample results > DL considered as minimum values only.
Preservation	Too cold (< 2 °C; Note (6))	***Shipping container inadequately insulated***; use of dry ice.	Representativeness Accuracy Completeness	False negatives Low bias	Invalidates sample results. Affects legal defensibility of data. Sample results > DL considered as minimum values only.

QC Element (Sample Type, Analysis Condition, or Characteristic)	Type of Failure	Possible Causes (Note 2)	Major PARCCS Parameters Affected (Note 3)	Possible Effect on Data (Documented in CQAR)	Worst Case Data Evaluation (Documented in CDQAR) (Note 4)
Sample filtration	Samples not filtered and preserved in field for dissolved metals.	***Samplers avoided time consuming step***; samplers unaware of requirement; improper SOP; failure to read SAP; SAP incorrect; filtration apparatus not available.	Representativeness Accuracy Completeness	False positives False negatives High bias Low bias	Invalidates sample results for dissolved metals.
Laboratory status	Laboratory not validated by HTRW-CX	Validation request not made by A/E, PM, or TM; laboratory not validated for one or more parameters; laboratory validation lapsed.	All may be affected	Various	Invalidates all or part of data set.
Holding times	Holding times exceeded	***Excessive analysis time; tardy ship date***; inappropriate shipping method.	Representativeness Accuracy Completeness	False negatives Low bias (Note 7)	Invalidates all sample results. Sample results > DL considered as minimum values only.
Analysis method	Wrong method	***Incorrect COC***; laboratory/analyst unaware of requirement; failure to read SAP; SAP incorrect.	Representativeness Comparability Completeness Accuracy Sensitivity	False negatives Low or high bias Low or high sensitivity	Invalidates or qualifies some or all sample results.
Detection limit (DL)	DL 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 < DL

QC Element (Sample Type, Analysis Condition, or Characteristic)	Type of Failure	Possible Causes (Note 2)	Major PARCCS Parameters Affected (Note 3)	Possible Effect on Data (Documented in CQAR)	Worst Case Data Evaluation (Documented in CDQAR) (Note 4)
Method blank (MB)	Method blank absent (Note 8)	Improper SOP; lost during analysis.	Representativeness Accuracy Completeness	False positives	Invalidates all sample results > DL; sample results < DL are valid.
Method blank (MB)	Contamination > DL	***Contaminated reagents, gases, glassware; ambient contamination***; poor laboratory technique.	Representativeness Accuracy Completeness	False positives High bias	Invalidates all sample results where MB contamination is > 5% of sample concentration.
Equipment blank (EB) (rinsate blank)	Contamination > DL	***Improper decontamination of field sampling equipment***; contaminated rinsate water, containers, or preservatives.	Representativeness Accuracy Completeness	False positives High bias	Invalidates all sample results where EB contamination is > 5% of sample concentration.
Trip blank (TB) (travel blank) Applies to volatile-type analyses only (VOCs, BTEX, & GRO)	Trip blank absent	***Improper SOP***; broken during shipment; lost during analysis.	Representativeness Accuracy Completeness	False positives	Invalidates all sample results > DL; sample results < DL are valid.
Trip blank (TB) (travel blank) Applies to volatile-type analyses only (VOCs, BTEX, & GRO)	Contamination > DL	***Cross-contamination during shipment or storage***; contaminated reagent water, glassware, or preservatives.	Representativeness Accuracy Completeness	False positives High Bias	Invalidates all sample results where TB contamination is > 5% of sample concentration.

QC Element (Sample Type, Analysis Condition, or Characteristic)	Type of Failure	Possible Causes (Note 2)	Major PARCCS Parameters Affected (Note 3)	Possible Effect on Data (Documented in CQAR)	Worst Case Data Evaluation (Documented in CDQAR) (Note 4)
LCS	LCS absent (Note 9)	***Improper SOP***	Accuracy Completeness Comparability	False positives False negatives Poor precision (high or low bias)	Invalidates all sample results.
LCS and/or LCSD (also blank spike (BS) and/or blank spike duplicate (BSD))	Low recoveries	***Method failure***; improper spiking; degraded spiking solution; failed spiking device.	Accuracy Completeness Comparability	False negatives Low bias	Invalidates all sample results.
LCS and/or LCSD (also BS and/or BSD)	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	Invalidate all sample results.
LCS/LCSDs	High RPDs	***Method failure***; improper spiking; failed spiking device; contaminated reagents, gases, glassware, etc.	Representativeness Precision Completeness Comparability	Poor precision (high variability)	Invalidate all sample results.
Surrogates in MB, LCS, and LCSD (or BS and/or BSD)	Low recoveries	***Method failure***; improper spiking; degraded spiking solution; failed spiking device.	Accuracy Completeness	False negatives Low bias	Invalidates all sample results.
Surrogates in MB, LCS, and LCSD (or BS and BSD)	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.

QC Element (Sample Type, Analysis Condition, or Characteristic)	Type of Failure	Possible Causes (Note 2)	Major PARCCS Parameters Affected (Note 3)	Possible Effect on Data (Documented in CQAR)	Worst Case Data Evaluation (Documented in CDQAR) (Note 4)
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
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 and/or MSD	MS and/or MSD missing	***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)
MS and/or MSD	Low recoveries (Note 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)

QC Element (Sample Type, Analysis Condition, or Characteristic)	Type of Failure	Possible Causes (Note 2)	Major PARCCS Parameters Affected (Note 3)	Possible Effect on Data (Documented in CQAR)	Worst Case Data Evaluation (Documented in CDQAR) (Note 4)
MS and/or MSD	High recoveries (Note 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 > DL (i.e., possible matrix effects).
MS/MSD	High RPDs	***Sample inhomogeneity***; inadequate sample mixing in laboratory; samples misidentified; method failure; improper spiking; failed spiking device; contaminated reagents, gases, glassware, etc.	Representativeness Precision	Non-Representative Sample Poor precision (high variability)	Qualifies all sample results > DL (i.e., possibly highly variable results).
Dilution factors	Extremely high dilution factors.	***High concentrations of interferences or analytes***; inappropriate method.	Accuracy Comparability Completeness	Low sensitivity False negatives Poor accuracy.	Invalidates samples with high DLs. May qualify sample results as "estimated".
Field QC sample	Field and QC sample concentrations do not compare within acceptable limits.	***Sample inhomogeneity***; insufficient mixing in field; samples not split but collocated (Note 11); insufficient mixing in laboratory.	Representativeness Precision	Non-representative sample Poor precision (high and /or low bias)	Qualifies all sample results > DL (i.e., possible highly variable results). Sample results < DL are valid.

QC Element (Sample Type, Analysis Condition, or Characteristic)	Type of Failure	Possible Causes (Note 2)	Major PARCCS Parameters Affected (Note 3)	Possible Effect on Data (Documented in CQAR)	Worst Case Data Evaluation (Documented in CDQAR) (Note 4)
Field QA sample (Note 12)	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 may be affected	Various	Invalidates all or part of data set.

Notes:

(1) This table can be applied to both QA laboratory and primary laboratory sample results. 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 evaluation more complex. Data evaluation involving multiple failure types is beyond the scope of this table.

(2) Most common cause in bold, *italic* and underline type.

(3) PARCCS parameters most affected are listed; one could almost argue that Representativeness, Completeness, and Comparability are affected by all of these failures, but only the most obvious are listed. Any failure that results in invalid data affects Completeness.

(4) All data evaluations are subject to discretion of district project chemist taking into account project DQOs and other factors.

(5) Refrigeration not required for trace metals (excluding mercury), bromide, chloride, fluoride, hexavalent chromium, gross alpha, gross beta, and total radium.

(6) Applies to silica in water. Also may apply to fresh and marine water sediments.

(7) 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 and 4,4'-DDD can occur.

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

(9) Laboratory Control Samples (LCSs) are not appropriate for all analyses, i.e., pH, % solids, total suspended solids (TSS), etc.

(10) Note that when native sample concentrations are significantly greater than the effective spike concentration that the conclusion of a 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 for the matrix effect to be considered probably present.

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

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