NEON USER GUIDE TO AQUATIC SEDIMENT CHEMICAL AND PHYSICAL PROPERTIES (NEON.DP1.200194.001 AND NEON.DP1.200197.001)

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CHANGE RECORD

REVISION	DATE	DESCRIPTION OF CHANGE
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TABLE OF CONTENTS

LIST OF TABLES AND FIGURES

1 DESCRIPTION

1.1 Purpose

This document provides an overview of the data included in this NEON Level 1 data product, the quality controlled product generated from raw Level 0 data, and associated metadata. In the NEON data products framework, the raw data collected in the field, for example the specific conductance of water are considered the lowest level (Level 0). Raw data that have been quality checked via the steps detailed herein, as well as simple metrics that emerge from the raw data are considered Level 1 data products.

The text herein provides a discussion of measurement theory and implementation, data product provenance, quality assurance and control methods used, and approximations and/or assumptions made during L1 data creation.

1.2 Scope

This document describes the steps needed to generate the L1 data product: Chemical and physical properties of aquatic sediments - the chemistry and physical properties based on external laboratory analyses as well as associated metadata from field collections. This document also provides details relevant to the publication of the data products via the NEON data portal, with additional detail available in the file, NEON Data Variables for Sediment Physical Properties (NEON.DP1.20197) (AD[05]), provided in the download package for this data product.

This document describes the process for ingesting and performing automated quality assurance and control procedures on the data collected in the field pertaining to AOS Protocol and Procedure: Sediment Chemistry Sampling in Wadeable Streams (AD[07]) and AOS Protocol and Procedure: Sediment Chemistry Sampling in Lakes and Non-Wadeable Streams (AD[08]) and . The raw data that are processed in this document are detailed in the file, NEON Raw Data Validation for Sediment Chemical and Physical Properties (NEON.DP0.20194 and NEON.DPO.20197) (AD[04]), provided in the download package for this data product. Please note that raw data products (denoted by 'DP0') may not always have the same numbers (e.g., '10033') as the corresponding L1 data product.

2 RELATED DOCUMENTS AND ACRONYMS

2.1 Associated Documents

AD[01]	NEON.DOC.000001	NEON Observatory Design (NOD) Requirements
AD[02]	NEON.DOC.000913	TOS Science Design for Spatial Sampling
AD[03]	NEON.DOC.002652	NEON Level 1, Level 2 and Level 3 Data Products Catalog
AD[04]	NEON.DP0.20194.001 and NEON.DPO.20197.001 _dataValidation.csv	NEON Raw Data Validation for Sediment Chemical and Physical Properties (NEON.DP0.20194 and NEON.DPO.20197)
AD[05]	NEON.DP1.20197.001 _variables.csv	NEON Data Variables for Sediment Physical Properties (NEON.DP1.20197)
AD[06]	NEON.DOC.001152	NEON Aquatic Sampling Strategy
AD[07]	NEON.DOC.001193	AOS Protocol and Procedure: Sediment Chemistry Sampling in Wadeable Streams
AD[08]	NEON.DOC.001191	AOS Protocol and Procedure: Sediment Chemistry Sampling in Lakes and Non-Wadeable Streams
AD[09]	NEON.DOC.000008	NEON Acronym List
AD[10]	NEON.DOC.000243	NEON Glossary of Terms
AD[11]	OS_Generic _Transitions.pdf	NEON Algorithm Theoretical Basis Document: OS Generic Transitions
AD[12]	Nicl Language.pdf	NEON's Ingest Conversion Language (NICL) specifications
AD[13]	NEON.DOC.004839	AOS Commissioning Test Report: Aquatic Sediment Chemistry Process Quality
AD[14]	NEON.DOC.004845	AOS Commissioning Test Report: Aquatic Sediment Chemistry Data Quality

2.2 Acronyms

Acronym	Definition
USGS	U.S. Geological Survey
cm	Centimeter

3 DATA PRODUCT DESCRIPTION

The chemical (NEON.DP1.20194) and physical properties (NEON.DP1.20197) of aquatic sediments data products provide chemical and physical data for aquatic sediment samples collected using AOS Protocol and Procedure: Sediment Chemistry Sampling in Wadeable Streams (AD[07]) and AOS Protocol and Procedure: Sediment Chemistry Sampling in Lakes and Non-Wadeable Streams (AD[08]). These procedures implement the guidelines and requirements described in the NEON Aquatic Sampling Strategy (AD[02]). All data are reported at the resolution of a single sediment sample, collected from a unique stationID within a sampled water body. The temporal resolution is that of a single collection date.

Field sampling strategies are specific to the type of waterbody as well as the predominant sediment size composition and are described further below. Sediments are collected by NEON technicians and analyzed by an external laboratory. Analytes are broadly grouped into suites which include the following chemical constituents, Inorganics (I), Organics (O), Total Organic Carbon/Total Carbon (C), and physical Sediment Size (SS).

Aquatic sediment chemical and physical data will allow researchers to assess aquatic biogeochemical cycles as sediments are hotspots for elemental cycling in aquatic systems. Measuring long-term trends in sediment chemical and physical properties is part of the overall NEON biogeochemistry goal to understand changes in major nutrient and carbon fluxes within and across air, land and water systems.

3.1 Spatial Sampling Design

The sampling strategy for sediment analysis focuses on fine-grained surficial sediments from natural depositional zones during low-flow conditions (USGS, 1994). Surface sediment is considered to range from 1 to 3 cm in depth (Golterman et al., 1983, Keith, 1991).

Each sediment sample (one each for inorganic, organic, TOC, and size) is collected and homogenized from several individual scoops (points) within several depositional zones per station. Each site contains 2 stations:

Wadeable and non-wadeable stream (river) sediment samples are collected from two sediment-sampling stations within the 500 m sediment sampling reach (Figure 1a and b). Each station covers up to ~250 m or half of the 500 m sediment reach. The location of the station divide is defined by the mid-way point between the top and bottom of the biology and morphology reach (Figure 1). The number of depositional zones sampled in streams will be dependent on stream morphology and the abundance of fine sediment, but typically will be around 5. However, if fine sediment is particularly scarce at a stream site, many more zones may have to be sampled (up to a dozen or so).

Lake sediment samples are collected from 2 sampling stations in the lake: the central and/or deepest part of the lake (representative of the maximum long-term accumulation), and from a nearshore (littoral)/inlet depositional zone (representing an area of shorter term sediment transport and deposition; Figure 1c). Depositional zones in lakes typically contain ample sediment, so fewer zones may be sampled (one or two). These stations were chosen from the site characterization lake bathymetric and morphologic maps. The sampling zones are between 5 and 10 m from aquatic sensors.

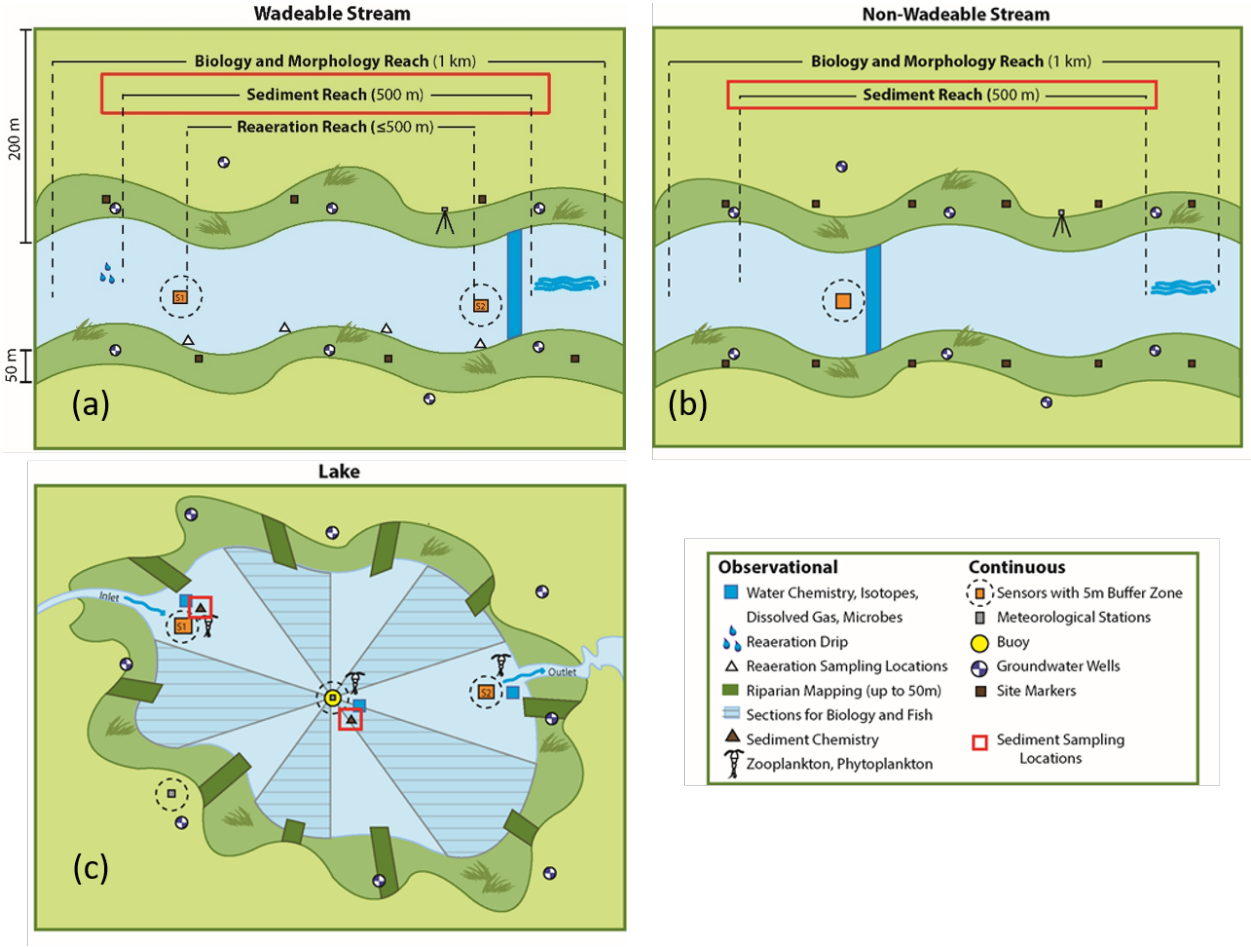

Figure 1: Generic wadeable stream (a), non-wadeable stream (b), and lake (c) site layouts with sediment sampling locations See AD[07] and AD[08] for further details.

3.2 Temporal Sampling Design

Wadeable stream, non-wadeable stream, and lake sediment samples are collected 2 times per year during aquatic biology bout 1 and bout 3 (spring and fall). Additional sampling events may be warranted following a major storm event that alters the morphology of the system. The timing of the sampling is flow dependent. Sampling bouts occur during base flow and/or stable flow conditions to provide maximum direct access to the stream bed and to minimize seasonal streamflow variability. Sediment samples can only be taken when velocity in the wadeable streams is below 0.93 $m^2 sec^{-1}$ (USGS, 2006). The specific times are determined using multivariate statistics and site specific historical information provided in the NEON Aquatic Sample Strategy Document (AD[06]).

Samples are processed within 12 hours of returning to the Domain lab. It is recommended that the samples are shipped to the external Laboratory within 72 hours following processing. If it is expected to take longer to ship the sediment samples, they are refrigerated between 0-6°C until the samples can be shipped. Samples must be shipped to the external lab on ice between 0-6°C but not frozen and arrive within 7 days of sample collection.

3.3 Theory of Measurements

Sediment chemical and physical properties are measured by an external laboratory using a suite of analytical methods common to the aquatic biogeochemistry community. More details about the specific methods employed can be found on the NEON Data Portal (http://data.neonscience.org/home), in the Resources > Data Documentation > External Lab Protocols section.

3.4 Variables Reported

All variables reported from the field technician or laboratory (L0 data) are listed in the files, NEON Raw Data Validation for Sediment Chemical and Physical Properties (NEON.DP0.20194 and NEON.DPO.20197) (AD[04]). All variables reported in the published data (L1 data) are also provided separately in the file, NEON Data Variables for Sediment Physical Properties (NEON.DP1.20197) (AD[08]) and NEON Data Variables for Sediment Physical Properties (NEON.DP1.20197) (AD[08]).

Field names have been standardized with Darwin Core terms (http://rs.tdwg.org/dwc/; accessed 16 February 2014), the Global Biodiversity Information Facility vocabularies (http://rs.gbif.org/vocabulary/gbif/; accessed 16 February 2014), the VegCore data dictionary (https://projects.nceas.ucsb.edu/nceas/projects/bien/wiki/VegCore; accessed 16 February 2014), where applicable. NEON AOS spatial data employs the World Geodetic System 1984 (WGS84) for its fundamental reference datum and Earth Gravitational Model 96 (EGM96) for its reference gravitational ellipsoid. Latitudes and longitudes are denoted in decimal notation to six decimal places, with longitudes indicated as negative west of the Greenwich meridian.

Some variables described in this document may be for NEON internal use only and will not appear in downloaded data.

3.5 Spatial Resolution and Extent

The finest resolution at which sediment spatial data are reported is at a single depositional zone collected from a unique stationID. Sediments are collected and composited from a minimum of 5 depositional zones from two stations at wadeable and non-wadeable stream sites. Sediments collected at lake sites are composited from up to five locations within the two stations. Overall, this results in a spatial hierarchy of:

sampleID (unique ID given to the individual sediment sample) → **siteID** (ID of the NEON site) → **stationID** (ID of station location).

StationID in wadeable and non-wadeable (i.e. rivers) streams appears in the **namedLocation** field, and is indicated as 'SITE.AOS.sediment.01' for station 1 (upstream) or 'SITE.AOS.sediment.02' for station 2 (downstream). StationIDs for lakes are designated as 'SITE.AOS.inlet' for inlet/littoral and 'SITE.AOS.buoy.c0' for center.

The basic spatial data included in the data downloaded include the latitude and longitude of the depositional zone (plus associated uncertainty due to GPS error) within each station. Samples composited among several depositional zones within a station have a single stationID. Shapefiles of all NEON Aquatic Observation System sampling locations can be found in the Document Library: http://data.neonscience.org/documents.

3.6 Temporal Resolution and Extent

The finest temporal resolution at which sediment data are reported is the **startDate**, a single date on which sediment samples were collected. The total number of sampling events per year is expected to be 2 for all site types.

The NEON Data Portal currently provides data in monthly files for query and download efficiency. Queries including any part of a month will return data from the entire month. All queries, regardless of the date range specified, will include a copy of asc_externalLabSummaryData which provides summary information from the external sediment chemistry lab about the method detection limits, the equipment used, and precision and accuracy. Code to stack files across months is available here: https://github.com/NEONScience/NEON-utilities

3.7 Associated Data Streams

This data product is dependent on the field data collected in Sediment Chemical Properties (NEON.DP1.20194) and Sediment Physical Properties (NEON.DP1.20197). Data can be linked to the parent sample through the **namedLocation** and **sampleID** fields.

3.8 Product Instances

The NEON Observatory contains 34 aquatic sites, consisting of 24 wadeable streams, 3 non-wadeable streams (rivers), and 7 lakes.

Sediment sampling yields one unique sample per siteID, per namedLocation, per startDate, per sample type (inorganics, organics, Total Organic Carbon/Total Carbon, and sediment size). There are 2 sampling events (bout 1 and bout 3) to collect sediments at 2 stations for up to 4 suites of analytes. Inorganics and sediment size samples are collected during both bout 1 and 3. Organics and TOC/TC samples well only be collected during bout 3. Thus, there will be up to 4 unique sample records per site per year for inorganic and sediment size samples and 2 unique sample records per site per year for organic and TOC/TC samples, for a total of up to 204 samples per year. External lab data for this product are reported in long format, resulting in approximately 50 records per parent sample (sedimentSampleID), or 10,000 total records per year.

3.9 Data Relationships

The protocol dictates that each **siteID** x **namedLocation** combination is sampled at least once per sediment bout (one record expected per **sedimentSampleID** in asc_fieldDataStation). Each **sedimentSampleID** may have up to four child samples within the same record, depending on whether a sediment sample was collected for all sample types (inorganic, organic, TOC/TC, sediment size) or none. In the event that a sediment sample cannot be taken, a record will still be created in asc_fieldDataStation and **samplingImpractical** will be something other than NULL, but there will be no corresponding record in any other table. Each record from asc_fieldDataStation is expected to have up to several child records in asc_fieldDataZone (one each for each zone , the number of zones sampled depends on the amount of fine sediment deposition at that site–more zones sampled if less deposition). Each record from asc_fieldDataZone is expected to have several child records in asc_fieldDataPoint (one each for each point, the number of points depends on the amount of fine sediment deposition at that site–more

points sampled if less deposition). Each record in asc_fieldDataStation is expected to have several child records in asc_externalLabData (one each for each analyte). Each record in the point, zone, and station tables can be linked by **sedimentSampleID**. Each **sampleID** in a record from the external lab table can be linked to one of the following child sample IDs in the station table: **inorganicSedimentSampleID**, **organicSedimentSampleID**, **carbonSedimentSampleID**, and **physicalSedimentSampleID**. However, duplicates and/or missing data may exist where protocol and/or data entry abberations have occurred; *users should check data carefully for anomalies before joining tables*.

asc_fieldDataStation - > One record expected per **sedimentSampleID**, i.e. one per site, per station, per collectDate (day of year, local time). A single parent sample ID (**sedimentSampleID**) generates up to 4 child sampleIDs (**inorganicSedimentSampleID**, **organicSedimentSampleID**, **carbonSedimentSampleID**, and **physicalSedimentSampleID**) to be used for external laboratory analyses.

asc_fieldDataZone - > Several records (typically 5) expected per **sedimentSampleID**. Field data associated with the zone level record.

asc_fieldDataPoint - > Several records (typically 7) expected per **sedimentSampleID**. Field data associated with the point level record.

asc_externalLabData - > Several records (typically a few dozen) expected per **sampleID**, one per analyte, associated with external laboratory sediment chemical and physical analyses.

asc_externalLabSummaryData - > One record expected per **laboratoryName** x **analyte** x **method** x **labSpecificStartDate** combination. Can use corresponding variables in asc_externalLabData to associate sample data with relevant uncertainty values and method detection limits.

sedimentSampleIDs and **sedimentSampleBarcodes** will be generated for each sampling event. After shipment to external labs are complete, any physical sample that remains will be discarded.

4 DATA QUALITY

4.1 Data Entry Constraint and Validation

Many quality control measures are implemented at the point of data entry within a mobile data entry application or web user interface (UI). For example, data formats are constrained and data values controlled through the provision of dropdown options, which reduces the number of processing steps necessary to prepare the raw data for publication. An additional set of constraints are implemented during the process of ingest into the NEON database. The product-specific data constraint and validation requirements built into data entry applications and database ingest are described in the document NEON Raw Data Validation for Sediment Chemical and Physical Properties (NEON.DP0.20194 and NEON.DPO.20197), provided with every download of this data product. Contained within this file is a field named 'entryValidationRulesForm', which describes syntactically the validation rules for each field built into the data entry application. Data entry constraints are described in Nicl syntax in the validation file provided with every data download, and the Nicl language is described in NEON's Ingest Conversion Language (NICL) specifications ([AD[12]).

Data collected prior to 2017 were processed using a paper-based workflow that did not implement the full suite of quality control features associated with the interactive digital workflow.

4.2 Automated Data Processing Steps

Following data entry into a mobile application or web user interface, the steps used to process the data through to publication on the NEON Data Portal are detailed in the NEON Algorithm Theoretical Basis Document: OS Generic Transitions (AD[11]).

4.3 Data Revision

All data are provisional until a numbered version is released; the first release of a static version of NEON data, annotated with a globally unique identifier, is planned to take place in 2020. During the provisional period, QA/QC is an active process, as opposed to a discrete activity performed once, and records are updated on a rolling basis as a result of scheduled tests or feedback from data users. The Change Log section of the data product readme, provided with every data download, contains a history of major known errors and revisions.

4.4 Quality Flagging

The **dataQF** field in each record is a quality flag for known issues applying to the record, added by NEON Science upon data review. At this time, there are no known issues applying to the records in this data product.

4.5 Analytical Facility Data Quality

All analytical labs generating sediment chemical and physical data include standards run as unknowns alongside NEON samples in order to gauge run acceptability. Long-term analytical precision and accuracy of these standard analyses are reported for each lab to allow users to interpret and analyze sediment data in the context of its uncertainty range. The data table asc_externalLabSummary, which is available in the sediment chemical and physical properties data product expanded packages, contains the long-term precision and accuracy of lab analyses. The external lab also reports quality flags in the following fields: **externalQualifier**, **extendedQualifier1**, **extendedQualifier2**, **extendedQualifier3**, **extendedQualifier4** and **extendedQualifier5** in asc_externalLabData, as well as in **qaQF** in asc_externalLabBatchQA. These quality flags are defined below:

Quality Flag	Definition
B	Inorganic analyte concentration detected at a value between MDL and PQL. The associated value is an estimated quantity.
H	Analysis exceeded method hold time. pH is a field test with an immediate hold time.
J	Organic analyte concentration detected at a value between MDL and PQL. The associated value is an estimated quantity.
L	Target analyte response was below the laboratory defined negative threshold.

O	Analyte concentration is estimated due to result exceeding calibration range.
U	The material was analyzed for, but was not detected at the indicated method detection limit.
X	Indicates there was an extended qualifier
BH	Analyte concentration detected at a value between MDL and PQL. The associated value is an estimated quantity. Analysis exceeded method hold time.
A1	Too numerous to count.
A2	Sample incubation period exceeded method requirement.
A3	Sample incubation period was shorter than method requirement.
A4	Target organism detected in associated method blank.
A5	Incubator/water bath temperature was outside method requirements.
A6	Target organism not detected in associated positive control.
A7	Micro sample received without adequate headspace.
A8	ACZ observes a 3 week holding time for BARTs if samples are thermally preserved at less than 6 degrees celsius and above freezing. The holding time for unpreserved samples is 4 hours. Hold time exceedances are indicated on laboratory reports where appli
B1	Target analyte detected in prep / method blank at or above the method reporting limit. See Case Narrative.
B2	Non-target analyte detected in prep / method blank and sample, producing interference.
B3	Target analyte detected in calibration blank [ICB or CCB] at or above acceptance limit.
B4	Target analyte detected in blank at or above the acceptance criteria.
B5	Target analyte detected in prep / method blank at or above the method reporting limit, but below trigger level or MCL.
B6	Target analyte detected in calibration blank at or above the method reporting limit, but below trigger level or MCL.
B7	Target analyte detected in prep / method blank at or above acceptance limit. Sample value is > 10X the concentration in the method blank.
BA	Target analyte detected in prep / method blank at or above acceptance limit. Sample value is > 20X the concentration in the method blank.
BB	Target analyte detected in calibration blank at or above acceptance limit. Sample value was > 10X the concentration in the calibration blank.
BD	Target analyte detected in prep blank above the ICPMS acceptance limit. For a solid prep blank (PBS) quality control sample, reagents are added to Type 1 water. During the prep stage, solid matrices more efficiently consume the Hydrochloric Acid (HCl) t

BE	Target analyte in continuing calibration blank (CCB) at or above the acceptance criteria. Target analyte was not detected in the sample [< MDL].
BF	Target analyte in prep / method blank at or above the acceptance criteria. Target analyte was not detected in the sample [< MDL].
C1	Confirmatory analysis not performed as required by the method.
C3	Qualitative confirmation performed.
C4	Confirmatory analysis was past holding time.
C5	Confirmatory analysis was past holding time. Original result not confirmed.
C8	Sample RPD between the primary and confirmatory analysis exceeded 40%. Per EPA Method 8000C, the lower value was reported as there was no evidence of chromatographic problems.
CA	Initial analysis within method holding time; however, reanalysis to confirm sample chemistry was past holding time.
CB	Analyte concentration verified by repeat analysis.
D1	Sample required dilution due to matrix.
D2	Sample required dilution. Target analyte exceeded calibration range.
D4	Minimum Reporting Limit (MRL) adjusted to reflect sample amount received and analyzed.
DA	Sample required dilution due to reactivity.
DB	Sample required dilution due to low bias result.
DC	Sample required dilution. Non-target analyte exceeded calibration range.
DD	Sample required dilution due to matrix color or odor.
DE	Sample required dilution. See Case Narrative.
DF	Sample required dilution due to high sediment.
DG	Sample required dilution due to poor resolution of Sulfate and Bromide caused by high Sulfate concentration.
DH	Sample required dilution due to high TDS and/or EC value.
DJ	Sample dilution required due to insufficient sample.
E1	Concentration estimated. Analyte exceeded calibration range. See Case Narrative.
E2	Concentration estimated. Analyte exceeded calibration range. Reanalysis not performed due to sample matrix.
E3	Concentration estimated. Analyte exceeded calibration range. Reanalysis not performed due to holding time requirements.
E5	Concentration estimated. Analyte was detected below laboratory minimum reporting limit (MRL), but not confirmed by alternate analysis.

E6	Concentration estimated. Internal standard recoveries did not meet method acceptance criteria.
E7	Concentration estimated. Internal standard recoveries did not meet laboratory acceptance criteria.
E8	Analyte reported to MDL per project specification. Target analyte was not detected in the sample.
EA	Concentration estimated. Analytical result was less than the negative MDL due to matrix interferences.
EB	A pH value outside the range of the probe standardization is estimated.
EC	For Method 1010 there was insufficient sample volume to confirm the flash point. The result is considered approximate.
ED	Unable to obtain a temperature difference of 18-28 C between initial application of flame source and sample flashpoint. The result is considered approximate.
EE	CN value may be biased low because the sample tested positive for sulfide more than 24 hours after collection.
EF	Sample contains sulfur/organic compounds that may cause false high bias for Selenium results by ICPMS. The sulfur/organic compounds were detected due to matrix odor. Se concentration is estimated.
EG	The sample tested positive for chlorine and was subsequently treated with a reducing agent by the laboratory.
H1	Sample prep or analysis performed past holding time. See case narrative.
H2	Initial analysis within holding time. Reanalysis for the required dilution was past holding time.
H3	Sample was received and analyzed past holding time.
H4	Sample was extracted past required extraction holding time, but analyzed within analysis holding time.
HC	Initial analysis within holding time. Reanalysis was past holding time, which was required due to a QC failure during the initial analysis.
HD	Analysis is outside the intended scope of the method, which does not provide hold time information for soil extracts. No hold time is observed for collection to extraction. The referenced method hold time is observed for extraction-to-analysis.
HE	Analysis performed past holding time. Method holding time is less than or equal to 7 days and sample was received with less than half of the holding time remaining (refer to item C5 of ACZ's Terms and Conditions).
HF	BOD analysis performed outside of 24-hour hold time stated in the method but within 48-hour hold time stated in 40 CFR.
HG	Sample received unpreserved. Method 1631 requires samples to be either preserved or analyzed within 48 hours of collection.

IA	Internal standard recovery exceeded the acceptance limits. Concentration of associated target analyte(s) in the sample is < MDL.
IB	Internal standard recovery exceeded the acceptance limits. Sample retest was not performed.
K1	The sample dilutions set-up for the BOD/CBOD analysis did not meet the oxygen depletion criteria of at least 2 mg/L. Any reported result is an estimated value.
K2	The sample dilutions set up for the BOD/CBOD analysis did not meet the criteria of a residual dissolved oxygen of at least 1 mg/L. The reported result was derived from the most diluted sample aliquot and is an estimated value.
K5	The dilution water D.O. depletion was > 0.2 mg/L.
K6	Glucose/glutamic acid BOD/CBOD was below method acceptance criteria.
K7	A discrepancy between the BOD and COD results has been verified by reanalysis of the sample for COD.
K8	Glucose/glutamic acid BOD/CBOD was above method acceptance levels.
KA	The seed depletion was outside the method acceptance limits, the DO-axis intercept is > 0.2 mg/L. The reported result is an estimated value.
LA	Recovery for target analyte in the control sample (LCS or LFB) exceeded the acceptance criteria. Target analyte was not detected in the sample [< MDL].
M1	Matrix spike recovery was high, the recovery of the associated control sample (LCS or LFB) was acceptable.
M2	Matrix spike recovery was low, the recovery of the associated control sample (LCS or LFB) was acceptable.
M3	The spike recovery value is unusable since the analyte concentration in the sample is disproportionate to the spike level. The recovery of the associated control sample (LCS or LFB) was acceptable.
M4	The spiked sample required a dilution such that the spike recovery calculation does not provide useful information. The recovery of the associated control sample (LCS or LFB) was acceptable.
M5	Analyte concentration was determined by the method of standard addition (MSA).
M6	Matrix spike recovery was high. Data reported per ADEQ policy 0154.000.
M7	Matrix spike recovery was low. Data reported per ADEQ policy 0154.000.
MA	Recovery for either the spike or spike duplicate was outside of the acceptance limits; the RPD was within the acceptance limits.
MB	For method 7196A the recovery of the post-digestion spike was outside of the acceptance limits.
MC	Recovery for matrix spike and matrix spike duplicate are outside of acceptance limits; recovery for the method control sample was acceptable.

MD	The spike recovery (and spike duplicate RPD, if applicable) was not used for data validation because the concentration of the sample and/or the spike was less than the reporting limit.
MR	Hexavalent Chromium matrix spike recovery was low. Recovery of the associated LCS was acceptable. ORP & pH measurements of the sample selected for spiking indicate the low recovery may be attributed to a reducing sample matrix.
N1	See Case Narrative.
N1A	See Case Narrative.
N1B	See Case Narrative.
N1C	See Case Narrative.
N6	Data suspect due to quality control failure, reported per data user's request.
NA	Unable to perform analysis. See Case Narrative.
NB	Unable to perform analysis due to insufficient sample. See Case Narrative.
Q1	Sample integrity was not maintained. See Case Narrative.
Q10	Sample received in inappropriate sample container.
Q11	Sample is heterogeneous. Sample homogeneity could not be readily achieved using routine laboratory practices.
Q12	A filtered sample was used for analysis because an unfiltered sample was not available.
Q2	Sample received with head space.
Q3	Sample received with improper or inadequate chemical preservation.
Q4	Sample received and analyzed without chemical preservation.
Q5	Sample received with inadequate chemical preservation. Additional preservation performed by the laboratory.
Q6	Sample was received above recommended temperature.
Q7	Sample inadequately dechlorinated.
Q8	Insufficient sample received to meet method QC requirements. Batch QC requirements satisfy ADEQ policies 0154.000 and 0155.000.
Q9	Insufficient sample received to meet method QC requirements.
QA	Sample container with preservation type specified by the method was not available for analysis. Alternate sample container was used.
QB	Method-specified preservation criteria cannot be met due to sample matrix.
QD	Reported value is the background-corrected concentration, as described by the method.
QF	The aliquot for total dissolved solids was taken from a field-filtered sample.

QH	The sample vial used for the batch duplicate QC contained headspace with a diameter greater than 6mm. No vial without headspace was available as a substitute.
QM	The sample vial used for the batch spike QC contained headspace with a diameter greater than 6mm. No vial without headspace was available as a substitute.
QN	The sample vial used for the batch duplicate QC was received and analyzed with inadequate chemical preservation.
QO	The sample vial used for the batch spike QC was received and analyzed with inadequate chemical preservation.
QP	The sample was filtered at the laboratory more than 15 minutes after sample collection. For Orthophosphate, 40 CFR Part 136.3 requires filtration within 15 minutes of collection.
QR	Sample matrix is solid rock and a homogenous sample aliquot could not be created for Hg analysis prior to preparation and air drying. Hg analysis was performed on crushed, homogenized, and air dried (40C) sub sample. Some loss of Hg may have occurred.
QS	Acidification of the Drinking Water sample was not performed within 14 days after sample collection as required by the lead and copper rule (40 CFR Part 141.86).
R1	RPD exceeded the method or laboratory acceptance limit. See Case Narrative.
R11	The RPD calculation for MS/MSD does not provide useful information due to the varying sample weights when Encore samplers / methanol field preserved samples are used.
R4	RPD for a spike and spike duplicate exceeded the method or laboratory acceptance limit. At a minimum, one spike recovery met acceptance criteria.
R5	RPD for a spike and spike duplicate exceeded the method or laboratory acceptance limit. See Case Narrative.
RA	Relative Percent Difference (RPD) was not used for data validation because the concentration of the duplicated sample is too low for accurate evaluation (< 10x MDL).
RB	Precision assessment measurement (RER or RPD) exceeded the control limit, indicating the precision of the sample preparation batch is questionable. See Case Narrative.
RC	For a solid matrix, the matrix duplicate precision assessment (RPD or RER) exceeded the control limit, which is attributable to the non-homogeneity of the sample.
RD	For a solid matrix, the duplicate RPD (spike or matrix) exceeded the control limit, which is attributable to the non-homogeneity of the sample.
RF	Relative Percent Difference (RPD) for Ag in spiked samples exceeded limit. In the absence of HCl, precipitation of Ag may occur at different rates.
RG	Sample concentration is less than 5x LLD; RPD was not used for data validation. Replicate Error Ratio (RER) is less than 2. Precision judged to be in control.
RH	For Radiochemistry non-drinking water samples, Replicate Error Ratio (RER) is used as the sole evaluator of precision.

RJ	LCS/LCSD RPD or RSD exceeded the method or laboratory control limit. Sample(s) could not be re-prepped. See Case Narrative.
RK	LCSS/LCSSD recovery within acceptance criteria but RPD exceeded the laboratory control limit. Acceptable MS/MSD RPD demonstrates precision.
RL	Recovery for either the LCS or LCS duplicate was outside of the acceptance limits; the RPD was within the acceptance limits.
RM	For a water matrix, the duplicate precision assessment (RPD or RER) exceeded the control limit. High sediment, turbidity, or presence of an immiscible liquid attributed to non-homogeneity of the sample.
RN	Sample concentration is greater than 5x LLD; RPD was used for data validation. Replicate Error Ratio (RER) is greater than 2. Precision judged to be in control.
RO	The duplicate originally assigned to this sample was not used for precision assessment because residue density exceeded the method limits. Another duplicate in the batch was used to assess precision. Method required duplicate frequency was not met.
RP	The duplicate originally assigned to this sample could not be used for precision assessment because the titrant normality was too weak or too strong for the sample alkalinity. Another duplicate in the batch was used to assess precision. Method required
RS	RPD of matrix spikes for total or total recoverable silica is outside acceptance limits. Acceptable precision for other metals indicates silica RPD failure may be attributed to digestion-triggered silica polymerization and precipitation.
S10	Surrogate recovery was above laboratory and method acceptance limits. See Case Narrative.
S13	Surrogate recovery was below laboratory and method acceptance limits. See Case Narrative.
S14	Surrogate was above acceptance limits in QC sample, no target analytes were detected in associated samples.
S15	Surrogate was outside acceptance limits in QC sample but within acceptance limits in associated samples.
S4	Surrogate recovery was above laboratory and method acceptance limits. No target analytes were detected in the sample.
S5	Surrogate recovery was below laboratory acceptance limits, but within method acceptance limits.
S6	Surrogate recovery was below laboratory and method acceptance limits. Reextraction and/or reanalysis confirms low recovery caused by matrix effect.
S7	Surrogate recovery was below laboratory and method acceptance limits. Unable to confirm matrix effect.

S8	The sample required a dilution such that the surrogate recovery calculation does not provide useful information. The recovery for the associated control sample was acceptable.
SA	Surrogate recovery was outside acceptance limits due to matrix interference.
T1	Method approved by EPA, but not yet licensed by ADHS at this time.
T2	Cited ADHS licensed method does not contain this analyte as part of method compound list.
T3	Method not promulgated either by EPA or ADHS.
T4	Tentatively identified compound. Concentration is estimated and based on the closest internal standard.
T5	Alternate method used.
TA	Analyte is not covered by Arizona licensure program #AZ0102, or ACZ does not maintain ADHS certification for this analyte.
TB	Analyte is not covered by NELAC certificate #ACZ, or ACZ does not maintain NELAC certification for this analyte.
TC	VOA Landfill compounds only.
TD	VOA Appendix 2 compounds only.
TE	BNA Appendix 2 compounds only.
TG	Recovery is outside of laboratory acceptance criteria; method 624 acceptance criteria observed
TO	Target analyte is not included in the scope and application of the referenced method.
V1	CCV recovery was above method acceptance limits. Target analyte was not detected in the sample.
V2	CCV recovery was above method acceptance limits. This target analyte was detected in the sample. The sample could not be reanalyzed due to insufficient sample.
V3	CCV recovery was above method acceptance limits. This target analyte was detected in the sample, but the sample was not reanalyzed. See case narrative.
V5	For Organic SW-846 methods: CCV recovery after a group of samples was above acceptance limits. This target analyte was not detected in the sample; acceptable per EPA Method 8000C.
V6	Data reported from one-point calibration criteria per ADEQ policy 0155.000.
VA	Sample matrix caused CCV to fail; sample was analyzed on dilution for confirmation.
VB	CCV recovery was outside of acceptance limits. See Case Narrative.
VC	CCV recovery was above the acceptance limits. Target analyte was not detected in the sample [< MDL].

VD	CCV recovery was outside of the acceptance limits. CCC and SPCC compounds met the method acceptance criteria.
Z1	The NPDWR required detection limit was not satisfied.
ZA	Poor recovery for Silver quality control is accepted due to low Silver solubility in samples, digestates, or extracts that do not contain sufficient Hydrochloric acid.
ZC	Low boiling point hydrocarbons present.
ZD	Diesel range hydrocarbons present.
ZE	High boiling point hydrocarbons present.
ZG	The ICP or ICP-MS Serial Dilution was not used for data validation because the sample concentration was less than 50 times the MDL.
ZH	Serial Dilution exceeded the acceptance criteria. Matrix interference [physical or chemical] is suspected.
ZJ	Matrix Spike recovery was outside of laboratory acceptance limits, but within method acceptance limits.
ZK	Analyte concentration in the blank was less than the lower acceptance limit. Sample concentration is at least ten times greater than the absolute value of the blank concentration.
ZL	Sample exhibited non-coliform growth.
ZM	Data is estimated because result is below 200 ug/Kg; ACZ does not have a closed-system purge and trap as described in method 5035.
ZN	Lowest calibration standard dropped from the calibration curve. The concentration of the lowest calibration standard used is the reporting limit for the analysis. See Case Narrative.
ZO	Concentration is based on a final residue greater than 200 mg.
ZP	For Hg-1631, target analyte detected in trip blank at or above method reporting limit of 0.5 ng/L. Associated sample value was > 5X the concentration in the trip blank.
ZQ	Analyte was not evaluated in the laboratory control standard. Either the analyte is not included in the scope of the analytical method or a commercial standard containing the analyte is not available.
ZR	Fe 2+ data is estimated because samples should be analyzed within 1 hour from sampling. After 1 hour the ferrous-ferric ratio changes in acidic solutions or with exposure to air.
ZS	Digestion procedures have the potential to trigger silica polymerization and precipitation, leading to low biased results. Silica chemistry is complex and polymerization kinetics are unpredictable. Dissolved and/or acid soluble silica analyses may provi
ZT	Carbonate peak tail extends into Bromide retention time; however, no Bromide peak was observed in the carbonate tail.

ZU	Analysis date/time preceeds filter date/time. A portion of sample was filtered and analyzed prior to the creation of a Filter workgroup.
ZV	Sulfate and Bromide peaks not resolved in chromatogram due to high Sulfate concentration.
ZW	Method deviation. The sample was centrifuged prior to analysis due to high solid content.
ZX	Bis(2-Chloroisoproply)ether results are estimated due to a co-eluting impurity in the reference standard material.
ZZ	Laboratory measured pH and temperature were used in this calculation. Sampler did not report either field pH, field temperature, or both.

5 REFERENCES

Golterman, H.L., P.G. Sly, R.L. Thomas. 1983. Study of the relationship between water quality and sediment transport. 231pp., Techn. Papers in Hydrology, UNESCO, Paris.

International Atomic Energy Agency (IAEA). 2003. Annual Report, Collection and preparation of bottom sediment samples for analysis of radionuclides and trace elements.

Keith, L.H.. 1991. Environmental sampling and analysis: A practical guide: 143 pp. Lewis Publ., CRC Press, Boca Raton, Florida

United States Geological Survey. 1994. Guidelines for Collecting and Processing Samples of Stream bed Sediment for Analysis of Trace Elements and Organic Contaminants for the National Water-Quality Assessment Program., Larry R. Shelton and Paul D. Capel, U.S. GEOLOGICAL SURVEY Open-File Report 94-458, Sacramento, California

United States Geological Survey (USGS). 2006. National Field Manual for the Collection of Water-Quality Data (U.S. Geological Survey TWRI Book 9, Chapter A4, Version 2.0, 9/2006).