NEON USER GUIDE TO SEDIMENT CHEMICAL AND PHYSICAL PROPERTIES (DP1.20194.001)

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CHANGE RECORD

REVISION	DATE	DESCRIPTION OF CHANGE
A	11/21/2017	Initial Release
B	11/01/2020	Included general statement about usage of neonUtilities R package and statement about possible location changes, updated associated documents, updated generic site maps and sediment sampling locations, added section on sampling design changes, updated internal and external quality flagging information, updated language on seepage and flow-through lake sampling locations, updated data relationship information to include the sediment physical properties external lab data table.
C	03/02/2022	Removed information about the Sediment physical properties (DP1.20197.001) data product, updated subsample structure, updated sample processing, updated sampling design changes, added section on laboratory quality assurance and uncertainty, updated section 4.3 Data Revision with latest information regarding data release
D	02/18/2025	Updated the url for spatial data in section 3.7. Added information about the new neonUtilities Python package.
E	03/04/2026	Added information about samples shipped to the NEON Biorepository.

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 Sediment chemical and physical properties (DP1.20194.001) - the chemistry and physical properties of sediment 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 Chemical and Physical Properties (DP1.20194.001) (AD[06]), 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 Sampling for Physical and Chemical Properties (AD[04]). The raw data that are processed in this document are detailed in the file, NEON Raw Data Validation for Sediment Chemical and Physical Properties (DP0.20194.001) (AD[05]), 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.002652	NEON Data Products Catalog
AD[03]	NEON.DOC.001152	NEON Aquatic Sampling Strategy
AD[04]	NEON.DOC.TBD	AOS Protocol and Procedure: Sediment Sampling for Physical and Chemical Properties
AD[05]	Available with data download	NEON Raw Data Validation for Sediment Chemical and Physical Properties (DP0.20194.001)
AD[06]	Available with data download	NEON Data Variables for Sediment Chemical and Physical Properties (DP1.20194.001)
AD[07]	Available with data download	Categorical Codes csv
AD[08]	NEON.DOC.000008	NEON Acronym List
AD[09]	NEON.DOC.000243	NEON Glossary of Terms
AD[10]	NEON.DOC.004825	NEON Algorithm Theoretical Basis Document: OS Generic Transitions
AD[11]	NEON.DOC.004839	AOS Commissioning Test Report: Aquatic Sediment Chemistry Process Quality
AD[12]	NEON.DOC.004845	AOS Commissioning Test Report: Aquatic Sediment Chemistry Data Quality
AD[13]	Available on NEON data portal	NEON Ingest Conversion Language Function Library
AD[14]	Available on NEON data portal	NEON Ingest Conversion Language

2.2 Acronyms

Acronym	Definition
L0	Level 0 (raw) data
L1	Level 1 (processed) data
OS	Observational systems
DP	Data product
QA/QC	Quality assurance/quality control
USGS	U.S. Geological Survey
UI	User Interface
Nicl	NEON's Ingest Conversion Language
cm	Centimeter
m	Meter
mm	Milimeter
mg	Miligram
kg	Kilogram
L	Liter
sec	Second
°C	Degrees Celcius
PAH	Polycyclic aromatic hydrocarbons
PCB	Polychlorinated biphenyls
TC	Total carbon
TOC	Total organic carbon
I/IN	Inorganic sediment subsample
O	Organic sediment subsample
C	Carbon sediment subsample
SS	Sediment size subsample
SC	Sediment chemistry subsample
SA	Sediment archive subsample
DSF	Domain support facility
MDL	Method detection limit
PQL	Practical quantitation limit

3 DATA PRODUCT DESCRIPTION

The Sediment chemical and physical properties (DP1.20194.001) data product provides chemical and physical data for sediment samples collected using AOS Protocol and Procedure: Sediment Sampling for Physical and Chemical Properties (AD[04]). These procedures implement the guidelines and requirements described in the NEON Aquatic Sampling Strategy (AD[03]). All data are reported at the resolution of a single sediment sample, collected from a unique location 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 in more detail below. Sediment is collected by NEON technicians and analyzed by an external laboratory. Analytes are broadly grouped into suites subsampled into distinct sample containers (Table 1).

Table 1: Analyte suites in this data product

Analyte Suite	Analytes	Date Range Collected
organics (O)	PAH, PCB	2015-2019
carbon (C)	TC, TOC	2015-2021
inorganics (I/IN)	Metals, Nitrogen, Alkalinity, pH	2015-2021
sediment size (SS)	Particle size, Texture	2015-present
sediment chemistry (SC)	Combination of former C and I/IN suites	2021-present
sediment archive (SA)	Archived at NEON Biorepository	2021-present

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.

Frozen sediment samples are stored at the NEON Biorepository and are available by request for further study and analysis. Contact the Biorepository for detailed information about sample availability.

3.1 Spatial Sampling Design

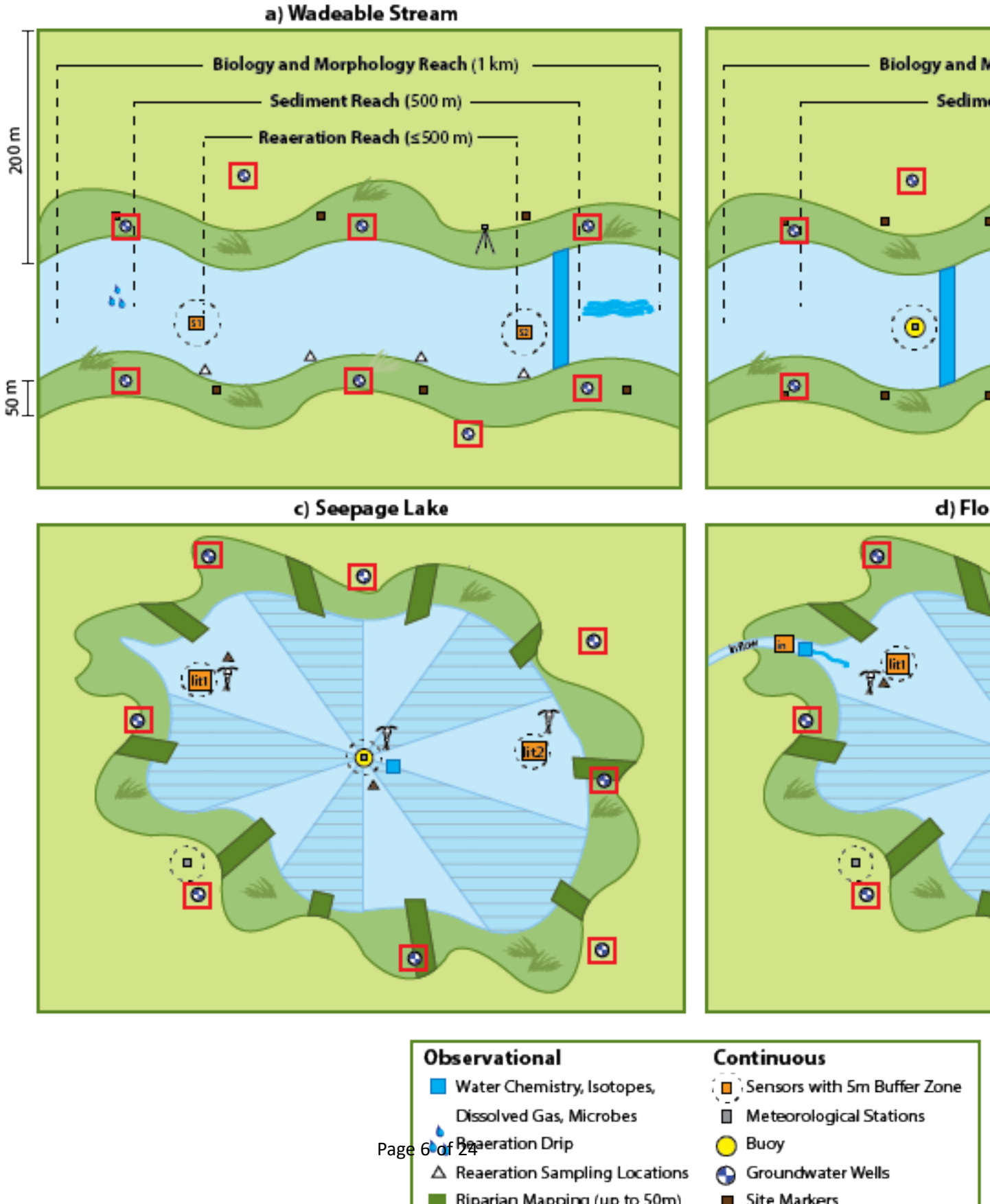
The sampling strategy for sediment analysis focuses on fine-grained surficial sediments from natural depositional zones during low-flow conditions (USGS, 1994). Surface sediment is considered to range from 1 to 3 cm in depth (Golterman et al., 1983, Keith, 1991).

Each sediment sample is a homogenized aggregate consisting of sediment collected from several individual points (single core, scoop, or Petite Ponar®sampling) from multiple depositional zones that span the length of the sampling reach. The aggregate sample is transported to the DSF where it is allowed to settle undisturbed at 4°C for 2-9 days. Once settled, the overlying water is decanted and the aggregate sample is subsampled based on the analytical suite collected during the bout (Table 1). Each site contains 2 stations.

Sediment samples collected from rivers and wadeable streams 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 1a and b). 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 (>10).

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

As much as possible, sampling occurs in the same locations over the lifetime of the Observatory. However, over time some sampling locations may become impossible to sample, due to disturbance or other local changes. When this occurs, the location and its location ID are retired. A location may also shift to slightly different coordinates. Refer to the locations endpoint of the NEON API for details about locations that have been moved or retired: https://data.neonscience.org/data-api/endpoints/locations/


a) Wadeable Stream
Biology and Morphology Reach (1 km)
Sediment Reach (500 m)
Reaeration Reach (≤500 m)
200 m
50 m
S1
S2
c) Seepage Lake
lit1
lit2
d) Flo
in
lit1
Observational
Water Chemistry, Isotopes, Dissolved Gas, Microbes
Reaeration Drip
Reaeration Sampling Locations
Riparian Mapping (up to 50m)
Continuous
Sensors with 5m Buffer Zone
Meteorological Stations
Buoy
Groundwater Wells
Site Markers

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). 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^2sec^{-1} (USGS, 2006). The specific times are determined using multivariate statistics and site specific historical information provided in the NEON Aquatic Sampling Strategy (AD[03]).

Samples are processed within 9 days of returning to the DSF. It is recommended that the SC and SS subsamples are shipped to the external laboratory within 1 day of subsampling and a max of 10 days following collection. The SC and SS subsamples must be shipped to the external lab on ice between 0-6°C but not frozen and arrive within 12 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. The specific analytical method for each record in **asc_externalLabData** is recorded in the **method** field. More details about the specific methods employed can be found on the NEON Data Portal (http://data.neonscience.org/home), in the Resources > Document Library > External Lab Protocols > Aquatic Chemistry section.

3.4 Sampling Design Changes

2014-2017: During the first three years of sampling, each sediment sampling station was sampled for all analyte suites (I/IN, O, C, SS) up to 3 times per year. Beginning in 2018, I/IN and SS subsamples were collected 2 times per year per station and O and C subsamples were collected 1 time per year per station.

Fall 2020: Organic (O; PAH/PCB) subsampling was discontinued.

Fall 2021: Multiple updates to sample structure and sample processing. The former Carbon (C) and Inorganic (I) subsamples were combined into the Sediment Chemistry (SC) subsample and sampled in the spring and fall bouts. Four sediment archive (SA.1-4) subsamples were added to the sample structure to be sampled during fall bouts. Sample processing changed from subsampling in the field to transporting the aggregate sample back to the DSF, allowing the suspended sediment to settle for 2-9 days, decanting overlying water, and subsampling in the DSF. The *SS* and *SC* subsamples are not sieved, but the *SA* subsamples are sieved to < 2-mm for archiving.

2022: The Sediment physical properties (DP1.20197.001) data product was bundled into DP1.20194.001. The DP1.20194.001 data product was renamed “Sediment chemical and physical properties” and now contains all chemical and physical parameters.

3.5 Laboratory Quality Assurance and Uncertainty

External laboratory facilities have been chosen for their use of analytical methods widely adopted by the scientific community. The current external lab for this data product uploads a summary file

(asc_externalLabSummary) once per year or whenever analytical parameters change (e.g., new method implemented, new instrument is acquired, a change is detected in analytical precision). For each **analyte** x **method** x **labSpecificStartDate** combination, the **methodDetectionLimit** (MDL) and **quantitationLimit** (PQL) are reported. This allows users to interpret and model sediment chemical and physical properties in the context of standard MDL and PQL values. Specific MDL and PQL values for a given **analyte** in asc_externalLabSummary may contain different units than the same **analyte** reported in asc_externalLabData, resulting in vastly different values. If an **analyte** is reported with units of mg/L in asc_externalLabSummary and mg/kg in asc_externalLabData, this means the standard reported in the summary file was in the form of a water sample and should be adjusted by a dilution factor of 5 to represent MDL and PQL values for solid matrix samples like sediment.

In the asc_externalLabData table, batch-level MDL and PQL values are also reported in the fields **methodDetectionLimit** and **practicalQuantitationLimit**, respectively. The batch-level MDL and PQL values reported in asc_externalLabData represent the adjusted MDL and PQL values specific to the quality metrics of the analytical run unique to the **sampleID** x **analyte** combination, and are in the same units as the analyte.

3.6 Variables Reported

All variables reported from the field technician or laboratory (L0 data) are listed in the file, NEON Raw Data Validation for Sediment Chemical and Physical Properties (DP0.20194.001) (AD[05]). All variables reported in the published data (L1 data) are also provided separately in the file, NEON Data Variables for Sediment Chemical and Physical Properties (DP1.20194.001) (AD[06]).

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 Geoid12A geoid model for its vertical reference surface. 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.

3.7 Spatial Resolution and Extent

Sediment depth, water temperature, and water quality parameters are reported at the resolution of a single sampling point (**namedLocation** x **zoneNumber** x **pointNumber**). Spatial data are reported at the resolution of a single depositional zone (**namedLocation** x **zoneNumber**). Because sediment samples are station-wide aggregates, the finest resolution at which sediment chemical and physical properties are reported is a **stationID**. Overall, this results in a spatial hierarchy of:

sedimentSampleID (unique ID given to the aggregate sediment sample) → **stationID** (ID of the sampling location) → **siteID** (ID of NEON site) → **domainID** (ID of a NEON domain).

The **namedLocation** field represents the stationID in wadeable and non-wadeable streams, and is indicated as 'SITE.AOS.sediment.01' for station 1 (upstream) or 'SITE.AOS.sediment.02' for station 2 (downstream). StationIDs (**namedLocation**) for seepage and flow-through lakes are designated as 'SITE.AOS.littoral1' for near-shore littoral stations and 'SITE.AOS.buoy.c0' for center stations.

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. Shapefiles related to the NEON Aquatic Observation System sampling locations can be found on the NEON science webpage at https://www.neonscience.org/data-samples/data/spatial-data-maps.

3.8 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. One sediment subsample each for *SC* and *SS* are collected 2 times per year per station (spring, fall). Up to 4 *SA* subsamples are collected 1 time per year per station (fall)

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

3.9 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 parent sample (**sedimentSampleID**) per **siteID** x **namedLocation** x **startDate**. A single parent sample can contain up to 6 child samples, 1 per sample type (**chemistrySedimentSampleID**, **physicalSedimentSampleID**, **archiveSedimentSample1ID**, **archiveSedimentSample2ID**, **archiveSedimentSample3ID**, **archiveSedimentSample4ID** fields in asc_fieldDataStation). There are 2 sampling events (bout 1 and bout 3). Child samples *SC* and *SS* are collected during both bout 1 and 3. Child samples *SA* are collected only during bout 3. Thus, there will be up to 4 unique sample records per site per year for *SC* and *SS* child samples, and 8 unique sample records per site per year for *SA* child samples, for a total of up to 544 samples per year. External lab data for this product are reported in long format, resulting in up to 40 (up to 36 per *SC* child sample, 4 per *SS* child sample) unique records per parent sample (**sedimentSampleID**), or approximately 10,880 external lab data records per year.

3.10 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 6 child samples within the same record, depending on whether a sediment sample was collected for all sample types (SC, SS, SA.1-4) 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 (1 record 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 record 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 (1 record for each analyte). Each record in the point, zone, and station tables can be linked by **sedimentSampleID**. Each **sampleID** in a record from asc_externalLabData can be linked to one of the following child sample IDs in asc_fieldDataStation: **chemistrySedimentSampleID** or **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 - > 1 record expected per **sedimentSampleID**. A single **sedimentSampleID** generates up to 6 child sampleIDs (**chemistrySedimentSampleID**, **physicalSedimentSampleID**, **archiveSedimentSample1ID**, **archiveSedimentSample2ID**, **archiveSedimentSample3ID**, **archiveSedimentSample4ID**) to be used for external laboratory analyses and sediment archiving.

asc_fieldDataZone - > Several records (varies based on local conditions) expected per **sedimentSampleID**. Field data associated with the zone level record.

asc_fieldDataPoint - > Several records (varies based on local conditions) expected per **sedimentSampleID**. Field data associated with the point level record.

asc_externalLabData - > Several records (up to 40) expected per **namedLocation** x **startDate** (one record per **namedLocation** x **startDate** x **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.

Sediment sample IDs and barcodes will be generated for each child sample at every sampling event. After shipment to external labs are complete, any physical sample that remains will be discarded.

Data downloaded from the NEON Data Portal are provided in separate data files for each site and month requested. The neonUtilities package in R and the neonutilities package in Python contain functions to merge these files across sites and months into a single file for each table. The neonUtilities R package is available from the Comprehensive R Archive Network (CRAN; https://cran.r-project.org/web/packages/neonUtilities/index.html) and can be installed using the install.packages() function in R. The neonutilities package in Python is available on the Python Package Index (PyPi; https://pypi.org/project/neonutilities/) and can be installed using pip. For instructions on using the package in either language to merge NEON data files, see the Download and Explore NEON Data tutorial on the NEON website: https://www.neonscience.org/download-explore-neon-data.

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 (DP0.20194.001) (AD[06]), 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[16]) and function library (AD[15]).

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 UI, 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[12]).

4.3 Data Revision

All data are provisional until a numbered version is released. Annually, NEON releases a static version of all or almost all data products, annotated with digital object identifiers (DOIs). The first data Release was made in 2021. 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 Issue Log section of the data product landing page 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. Please see the table below for an explanation of **dataQF** code specific to this data product.

Table 2: Descriptions of the dataQF codes for quality flagging

fieldName	value	definition
dataQF	legacyData	Data recorded using a paper-based workflow that did not implement the full suite of quality control features associated with the interactive digital workflow

Records of land management activities, disturbances, and other incidents of ecological note that may have a potential impact are found in the Site Management and Event Reporting data product (DP1.10111.001)

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 and asp_externalLabData. These quality flags are defined below:

Table 3: Descriptions of the analytical facility codes for quality flagging

fieldName	value	definition
externalQualifier	B	Inorganic analyte concentration detected at a value between MDL and PQL. The associated value is an estimated quantity.
externalQualifier	H	Analysis exceeded method hold time. pH is a field test with an immediate hold time.
externalQualifier	J	Organic analyte concentration detected at a value between MDL and PQL. The associated value is an estimated quantity.
externalQualifier	L	Target analyte response was below the laboratory defined negative threshold.
externalQualifier	O	Analyte concentration is estimated due to result exceeding calibration range.
externalQualifier	U	The material was analyzed for, but was not detected at the indicated method detection limit.
externalQualifier	X	Indicates there was an extended qualifier

externalQualifier	BH	Analyte concentration detected at a value between MDL and PQL. The associated value is an estimated quantity. Analysis exceeded method hold time.
externalQualifier	UH	The material was analyzed for, but was not detected at the indicated method detection limit. Analysis exceeded method hold time.
extendedQualifier(1-5)	A1	Too numerous to count.
extendedQualifier(1-5)	A2	Sample incubation period exceeded method requirement.
extendedQualifier(1-5)	A3	Sample incubation period was shorter than method requirement.
extendedQualifier(1-5)	A4	Target organism detected in associated method blank.
extendedQualifier(1-5)	A5	Incubator/water bath temperature was outside method requirements.
extendedQualifier(1-5)	A6	Target organism not detected in associated positive control.
extendedQualifier(1-5)	A7	Micro sample received without adequate headspace.
extendedQualifier(1-5)	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
extendedQualifier(1-5)	B1	Target analyte detected in prep / method blank at or above the method reporting limit. See Case Narrative.
extendedQualifier(1-5)	B2	Non-target analyte detected in prep / method blank and sample, producing interference.
extendedQualifier(1-5)	B3	Target analyte detected in calibration blank [ICB or CCB] at or above acceptance limit.
extendedQualifier(1-5)	B4	Target analyte detected in blank at or above the acceptance criteria.
extendedQualifier(1-5)	B5	Target analyte detected in prep / method blank at or above the method reporting limit, but below trigger level or MCL.
extendedQualifier(1-5)	B6	Target analyte detected in calibration blank at or above the method reporting limit, but below trigger level or MCL.
extendedQualifier(1-5)	B7	Target analyte detected in prep / method blank at or above acceptance limit. Sample value is > 10X the concentration in the method blank.
extendedQualifier(1-5)	BA	Target analyte detected in prep / method blank at or above acceptance limit. Sample value is > 20X the concentration in the method blank.

extendedQualifier(1-5)	BB	Target analyte detected in calibration blank at or above acceptance limit. Sample value was > 10X the concentration in the calibration blank.
extendedQualifier(1-5)	BE	Target analyte in continuing calibration blank (CCB) at or above the acceptance criteria. Target analyte was not detected in the sample [< MDL].
extendedQualifier(1-5)	BF	Target analyte in prep / method blank at or above the acceptance criteria. Target analyte was not detected in the sample [< MDL].
extendedQualifier(1-5)	C1	Confirmatory analysis not performed as required by the method.
extendedQualifier(1-5)	C3	Qualitative confirmation performed.
extendedQualifier(1-5)	C4	Confirmatory analysis was past holding time.
extendedQualifier(1-5)	C5	Confirmatory analysis was past holding time. Original result not confirmed.
extendedQualifier(1-5)	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.
extendedQualifier(1-5)	CA	Initial analysis within method holding time; however, reanalysis to confirm sample chemistry was past holding time.
extendedQualifier(1-5)	CB	Analyte concentration verified by repeat analysis.
extendedQualifier(1-5)	D1	Sample required dilution due to matrix.
extendedQualifier(1-5)	D2	Sample required dilution. Target analyte exceeded calibration range.
extendedQualifier(1-5)	D4	Minimum Reporting Limit (MRL) adjusted to reflect sample amount received and analyzed.
extendedQualifier(1-5)	D5	Sample required dilution. Sample matrix causing internal standards to recover outside method limits.
extendedQualifier(1-5)	DA	Sample required dilution due to reactivity.
extendedQualifier(1-5)	DB	Sample required dilution due to low bias result.
extendedQualifier(1-5)	DC	Sample required dilution. Non-target analyte exceeded calibration range.
extendedQualifier(1-5)	DD	Sample required dilution due to matrix color or odor.
extendedQualifier(1-5)	DE	Sample required dilution. See Case Narrative.
extendedQualifier(1-5)	DF	Sample required dilution due to high sediment.
extendedQualifier(1-5)	DG	Sample required dilution due to poor resolution of Sulfate and Bromide caused by high Sulfate concentration.
extendedQualifier(1-5)	DH	Sample required dilution due to high TDS and/or EC value.

extendedQualifier(1-5)	DJ	Sample dilution required due to insufficient sample.
extendedQualifier(1-5)	DK	Sample mass used for extraction decreased due to high moisture content.
extendedQualifier(1-5)	E1	Concentration estimated. Analyte exceeded calibration range. See Case Narrative.
extendedQualifier(1-5)	E2	Concentration estimated. Analyte exceeded calibration range. Reanalysis not performed due to sample matrix.
extendedQualifier(1-5)	E3	Concentration estimated. Analyte exceeded calibration range. Reanalysis not performed due to holding time requirements.
extendedQualifier(1-5)	E5	Concentration estimated. Analyte was detected below laboratory minimum reporting limit (MRL), but not confirmed by alternate analysis.
extendedQualifier(1-5)	E6	Concentration estimated. Internal standard recoveries did not meet method acceptance criteria.
extendedQualifier(1-5)	E7	Concentration estimated. Internal standard recoveries did not meet laboratory acceptance criteria.
extendedQualifier(1-5)	E8	Analyte reported to MDL per project specification. Target analyte was not detected in the sample.
extendedQualifier(1-5)	EA	Concentration estimated. Analytical result was less than the negative MDL due to matrix interferences.
extendedQualifier(1-5)	EB	A pH value outside the range of the probe standardization is estimated.
extendedQualifier(1-5)	EC	For Method 1010 there was insufficient sample volume to confirm the flash point. The result is considered approximate.
extendedQualifier(1-5)	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.
extendedQualifier(1-5)	EE	CN value may be biased low because the sample tested positive for sulfide more than 24 hours after collection.
extendedQualifier(1-5)	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.
extendedQualifier(1-5)	EG	The sample tested positive for chlorine and was subsequently treated with a reducing agent by the laboratory.
extendedQualifier(1-5)	H1	Sample prep or analysis performed past holding time. See case narrative.
extendedQualifier(1-5)	H2	Initial analysis within holding time. Reanalysis for the required dilution was past holding time.

extendedQualifier(1-5)	H3	Sample was received and analyzed past holding time.
extendedQualifier(1-5)	H4	Sample was extracted past required extraction holding time, but analyzed within analysis holding time.
extendedQualifier(1-5)	HC	Initial analysis within holding time. Reanalysis was past holding time, which was required due to a QC failure during the initial analysis.
extendedQualifier(1-5)	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.
extendedQualifier(1-5)	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).
extendedQualifier(1-5)	HF	BOD analysis performed outside of 24-hour hold time stated in the method but within 48-hour hold time stated in 40 CFR.
extendedQualifier(1-5)	HG	Sample received unpreserved. Method 1631 requires samples to be either preserved or analyzed within 48 hours of collection.
extendedQualifier(1-5)	IA	Internal standard recovery exceeded the acceptance limits. Concentration of associated target analyte(s) in the sample is < MDL.
extendedQualifier(1-5)	IB	Internal standard recovery exceeded the acceptance limits. Sample retest was not performed.
extendedQualifier(1-5)	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.
extendedQualifier(1-5)	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.
extendedQualifier(1-5)	K5	The dilution water D.O. depletion was > 0.2 mg/L.
extendedQualifier(1-5)	K6	Glucose/glutamic acid BOD/CBOD was below method acceptance criteria.
extendedQualifier(1-5)	K7	A discrepancy between the BOD and COD results has been verified by reanalysis of the sample for COD.
extendedQualifier(1-5)	K8	Glucose/glutamic acid BOD/CBOD was above method acceptance levels.

extendedQualifier(1-5)	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.
extendedQualifier(1-5)	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].
extendedQualifier(1-5)	M1	Matrix spike recovery was high, the recovery of the associated control sample (LCS or LFB) was acceptable.
extendedQualifier(1-5)	M2	Matrix spike recovery was low, the recovery of the associated control sample (LCS or LFB) was acceptable.
extendedQualifier(1-5)	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.
extendedQualifier(1-5)	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.
extendedQualifier(1-5)	M5	Analyte concentration was determined by the method of standard addition (MSA).
extendedQualifier(1-5)	M6	Matrix spike recovery was high. Data reported per ADEQ policy 0154.000.
extendedQualifier(1-5)	M7	Matrix spike recovery was low. Data reported per ADEQ policy 0154.000.
extendedQualifier(1-5)	MA	Recovery for either the spike or spike duplicate was outside of the acceptance limits; the RPD was within the acceptance limits.
extendedQualifier(1-5)	MB	For method 7196A the recovery of the post-digestion spike was outside of the acceptance limits.
extendedQualifier(1-5)	MC	Recovery for matrix spike and matrix spike duplicate are outside of acceptance limits; recovery for the method control sample was acceptable.
extendedQualifier(1-5)	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.
extendedQualifier(1-5)	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.

extendedQualifier(1-5)	N1	See Case Narrative.
extendedQualifier(1-5)	N1A	See Case Narrative.
extendedQualifier(1-5)	N1B	See Case Narrative.
extendedQualifier(1-5)	N1C	See Case Narrative.
extendedQualifier(1-5)	N6	Data suspect due to quality control failure, reported per data user's request.
extendedQualifier(1-5)	NA	Unable to perform analysis. See Case Narrative.
extendedQualifier(1-5)	NB	Unable to perform analysis due to insufficient sample. See Case Narrative.
extendedQualifier(1-5)	Q1	Sample integrity was not maintained. See Case Narrative.
extendedQualifier(1-5)	Q2	Sample received with head space.
extendedQualifier(1-5)	Q3	Sample received with improper or inadequate chemical preservation.
extendedQualifier(1-5)	Q4	Sample received and analyzed without chemical preservation.
extendedQualifier(1-5)	Q5	Sample received with inadequate chemical preservation. Additional preservation performed by the laboratory.
extendedQualifier(1-5)	Q6	Sample was received above recommended temperature.
extendedQualifier(1-5)	Q7	Sample inadequately dechlorinated.
extendedQualifier(1-5)	Q8	Insufficient sample received to meet method QC requirements. Batch QC requirements satisfy ADEQ policies 0154.000 and 0155.000.
extendedQualifier(1-5)	Q9	Insufficient sample received to meet method QC requirements.
extendedQualifier(1-5)	Q10	Sample received in inappropriate sample container.
extendedQualifier(1-5)	Q11	Sample is heterogeneous. Sample homogeneity could not be readily achieved using routine laboratory practices.
extendedQualifier(1-5)	Q12	A filtered sample was used for analysis because an unfiltered sample was not available.
extendedQualifier(1-5)	QA	Sample container with preservation type specified by the method was not available for analysis. Alternate sample container was used.
extendedQualifier(1-5)	QB	Method-specified preservation criteria cannot be met due to sample matrix.
extendedQualifier(1-5)	QD	Reported value is the background-corrected concentration, as described by the method.
extendedQualifier(1-5)	QF	The aliquot for total dissolved solids was taken from a field-filtered sample.

extendedQualifier(1-5)	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.
extendedQualifier(1-5)	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.
extendedQualifier(1-5)	QN	The sample vial used for the batch duplicate QC was received and analyzed with inadequate chemical preservation.
extendedQualifier(1-5)	QO	The sample vial used for the batch spike QC was received and analyzed with inadequate chemical preservation.
extendedQualifier(1-5)	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.
extendedQualifier(1-5)	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.
extendedQualifier(1-5)	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).
extendedQualifier(1-5)	R1	RPD exceeded the method or laboratory acceptance limit. See Case Narrative.
extendedQualifier(1-5)	R4	RPD for a spike and spike duplicate exceeded the method or laboratory acceptance limit. At a minimum, one spike recovery met acceptance criteria.
extendedQualifier(1-5)	R5	RPD for a spike and spike duplicate exceeded the method or laboratory acceptance limit. See Case Narrative.
extendedQualifier(1-5)	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.
extendedQualifier(1-5)	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).
extendedQualifier(1-5)	RB	Precision assessment measurement (RER or RPD) exceeded the control limit, indicating the precision of the sample preparation batch is questionable. See Case Narrative.
extendedQualifier(1-5)	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.

extendedQualifier(1-5)	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.
extendedQualifier(1-5)	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.
extendedQualifier(1-5)	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.
extendedQualifier(1-5)	RH	For Radiochemistry non-drinking water samples, Replicate Error Ratio (RER) is used as the sole evaluator of precision.
extendedQualifier(1-5)	RJ	LCS/LCSD RPD or RSD exceeded the method or laboratory control limit. Sample(s) could not be re-prepped. See Case Narrative.
extendedQualifier(1-5)	RK	LCSS/LCSSD recovery within acceptance criteria but RPD exceeded the laboratory control limit. Acceptable MS/MSD RPD demonstrates precision.
extendedQualifier(1-5)	RL	Recovery for either the LCS or LCS duplicate was outside of the acceptance limits; the RPD was within the acceptance limits.
extendedQualifier(1-5)	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.
extendedQualifier(1-5)	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.
extendedQualifier(1-5)	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.
extendedQualifier(1-5)	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
extendedQualifier(1-5)	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.

extendedQualifier(1-5)	S4	Surrogate recovery was above laboratory and method acceptance limits. No target analytes were detected in the sample.
extendedQualifier(1-5)	S5	Surrogate recovery was below laboratory acceptance limits, but within method acceptance limits.
extendedQualifier(1-5)	S6	Surrogate recovery was below laboratory and method acceptance limits. Reextraction and/or reanalysis confirms low recovery caused by matrix effect.
extendedQualifier(1-5)	S7	Surrogate recovery was below laboratory and method acceptance limits. Unable to confirm matrix effect.
extendedQualifier(1-5)	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.
extendedQualifier(1-5)	S10	Surrogate recovery was above laboratory and method acceptance limits. See Case Narrative.
extendedQualifier(1-5)	S13	Surrogate recovery was below laboratory and method acceptance limits. See Case Narrative.
extendedQualifier(1-5)	S14	Surrogate was above acceptance limits in QC sample, no target analytes were detected in associated samples.
extendedQualifier(1-5)	S15	Surrogate was outside acceptance limits in QC sample but within acceptance limits in associated samples.
extendedQualifier(1-5)	SA	Surrogate recovery was outside acceptance limits due to matrix interference.
extendedQualifier(1-5)	T1	Method approved by EPA, but not yet licensed by ADHS at this time.
extendedQualifier(1-5)	T2	Cited ADHS licensed method does not contain this analyte as part of method compound list.
extendedQualifier(1-5)	T3	Method not promulgated either by EPA or ADHS.
extendedQualifier(1-5)	T4	Tentatively identified compound. Concentration is estimated and based on the closest internal standard.
extendedQualifier(1-5)	T5	Alternate method used.
extendedQualifier(1-5)	TA	Analyte is not covered by Arizona licensure program #AZ0102, or ACZ does not maintain ADHS certification for this analyte.
extendedQualifier(1-5)	TB	Analyte is not covered by NELAC certificate #ACZ, or ACZ does not maintain NELAC certification for this analyte.
extendedQualifier(1-5)	TC	VOA Landfill compounds only.
extendedQualifier(1-5)	TD	VOA Appendix 2 compounds only.
extendedQualifier(1-5)	TE	BNA Appendix 2 compounds only.

extendedQualifier(1-5)	TG	Recovery is outside of laboratory acceptance criteria; method 624 acceptance criteria observed
extendedQualifier(1-5)	TO	Target analyte is not included in the scope and application of the referenced method.
extendedQualifier(1-5)	V1	CCV recovery was above method acceptance limits. Target analyte was not detected in the sample.
extendedQualifier(1-5)	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.
extendedQualifier(1-5)	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.
extendedQualifier(1-5)	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.
extendedQualifier(1-5)	V6	Data reported from one-point calibration criteria per ADEQ policy 0155.000.
extendedQualifier(1-5)	VA	Sample matrix caused CCV to fail; sample was analyzed on dilution for confirmation.
extendedQualifier(1-5)	VB	CCV recovery was outside of acceptance limits. See Case Narrative.
extendedQualifier(1-5)	VC	CCV recovery was above the acceptance limits. Target analyte was not detected in the sample [< MDL].
extendedQualifier(1-5)	VD	CCV recovery was outside of the acceptance limits. CCC and SPCC compounds met the method acceptance criteria.
extendedQualifier(1-5)	Z1	The NPDWR required detection limit was not satisfied.
extendedQualifier(1-5)	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.
extendedQualifier(1-5)	ZC	Low boiling point hydrocarbons present.
extendedQualifier(1-5)	ZD	Diesel range hydrocarbons present.
extendedQualifier(1-5)	ZE	High boiling point hydrocarbons present.
extendedQualifier(1-5)	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.
extendedQualifier(1-5)	ZH	Serial Dilution exceeded the acceptance criteria. Matrix interference [physical or chemical] is suspected.

extendedQualifier(1-5)	ZJ	Matrix Spike recovery was outside of laboratory acceptance limits, but within method acceptance limits.
extendedQualifier(1-5)	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.
extendedQualifier(1-5)	ZL	Sample exhibited non-coliform growth.
extendedQualifier(1-5)	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.
extendedQualifier(1-5)	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.
extendedQualifier(1-5)	ZO	Concentration is based on a final residue greater than 200 mg.
extendedQualifier(1-5)	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.
extendedQualifier(1-5)	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.
extendedQualifier(1-5)	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.
extendedQualifier(1-5)	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
extendedQualifier(1-5)	ZT	Carbonate peak tail extends into Bromide retention time; however, no Bromide peak was observed in the carbonate tail.
extendedQualifier(1-5)	ZU	Analysis date/time preceeds filter date/time. A portion of sample was filtered and analyzed prior to the creation of a Filter workgroup.
extendedQualifier(1-5)	ZV	Sulfate and Bromide peaks not resolved in chromatogram due to high Sulfate concentration.
extendedQualifier(1-5)	ZW	Method deviation. The sample was centrifuged prior to analysis due to high solid content.
extendedQualifier(1-5)	ZX	Bis(2-Chloroisoproply)ether results are estimated due to a co-eluting impurity in the reference standard material.

extendedQualifier(1-5)	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).