NEON USER GUIDE TO SECCHI DEPTH AND DEPTH PROFILE (NEON.DP1.20252 AND NEON.DP1.20254)

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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 dry weights of litter functional groups from a single collection event 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 products Secchi Depth (measurement of water clarity) and Depth Profile at specific depths (the depth profile of water temperature, conductivity and dissolved oxygen) at lakes and rivers - and associated metadata from input data. This document also provides details relevant to the publication of the data products via the NEON data portal, with additional detail available in the files, NEON Data Variables for Secchi Depth (NEON.DP1.20252) (AD[06]) and NEON Data Variables for Depth Profile (NEON.DP1.20254) (AD[07]), 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: Secchi Disk and Depth Profile Sampling in Lakes and Non-wadeable Streams (AD[07]). The raw data that are processed in this document are detailed in the files, NEON Raw Data Validation for Secchi Depth (NEON.DP0.20252) (AD[04]) and NEON Raw Data Validation for Depth Profile (NEON.DP0.20254) (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., '20252') 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.DP0.20252.001 _dataValidation.csv	NEON Raw Data Validation for Secchi Depth (NEON.DP0.20252)
AD[05]	NEON.DP0.20254.001 _dataValidation.csv	NEON Raw Data Validation for Depth Profile (NEON.DP0.20254)
AD[06]	NEON.DP1.20252.001 _variables.csv	NEON Data Variables for Secchi Depth (NEON.DP1.20252)
AD[07]	NEON.DP1.20254.001 _variables.csv	NEON Data Variables for Depth Profile (NEON.DP1.20254)
AD[06]	NEON.DOC.001152	Aquatic Sampling Strategy
AD[07]	NEON.DOC.002792	AOS Protocol and Procedure: Secchi Disk and Depth Profile Sampling in Lakes and Non-wadeable Streams
AD[08]	NEON.DOC.000008	NEON Acronym List
AD[09]	NEON.DOC.000243	NEON Glossary of Terms
AD[10]	OS_Generic_Transitions .pdf	NEON Algorithm Theoretical Basis Document: OS Generic Transitions
AD[11]		NEON's Ingest Conversion Language (NICL) specifications

2.2   Acronyms

Acronym	Definition
DO	Dissolved oxygen
USEPA	U.S. Environmental Protection Agency

3   DATA PRODUCT DESCRIPTION

Aquatic communities and water quality are highly dependent on water clarity and temperature. Secchi depth is often used as a quick measurement of productivity as it measures the depth to which light penetrates and can indicate a lake is either oligotrophic (low-nutrient) or eutrophic (high-nutrient). In lakes, light penetration is typically limited by phytoplankton growth (although turbidity also limits light penetration in some lakes).

Depth or vertical temperature profiles indicate whether or not the lake or river is thermally stratified, where the body of water is separated into two or more layers based on temperature. Typically, in a thermally stratified system, the top layer of water is warmer (epilimnion) while the lower layer is colder (hypolimnion). The area separating the two layers is known as the thermocline. The thermocline occurs when the rate of decreasing temperature with increasing depth is greatest, where there is a change of>1oC per 1.0 m change in depth (USEPA 2012). Thermal stratification can dramatically change the water chemistry and biology of each layer. If the lake or river is thermally stratified, samples may be taken at multiple depths to capture the conditions of each layer in the associated protocols.

3.1   Spatial Sampling Design

Secchi depth and Depth Profile and Specific Sites are measured at all lake and river sites at the buoy location. In lakes, the buoy is located at the deepest part of the main basin, while in rivers the buoy is located in a deep area outside of the navigable channel.
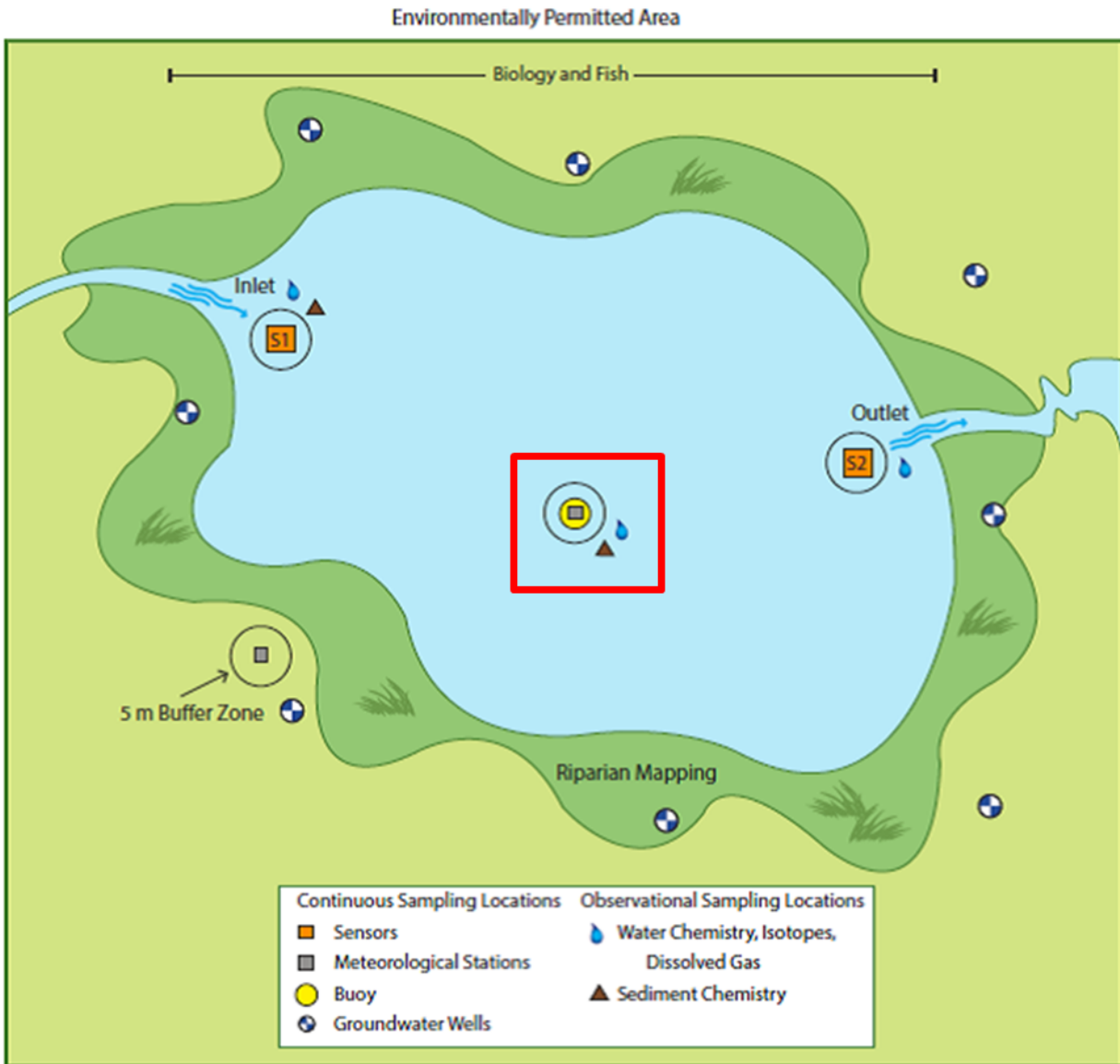
Figure 1: A generic site layout for lakes with Secchi depth and vertical profile sampling locations (red box).
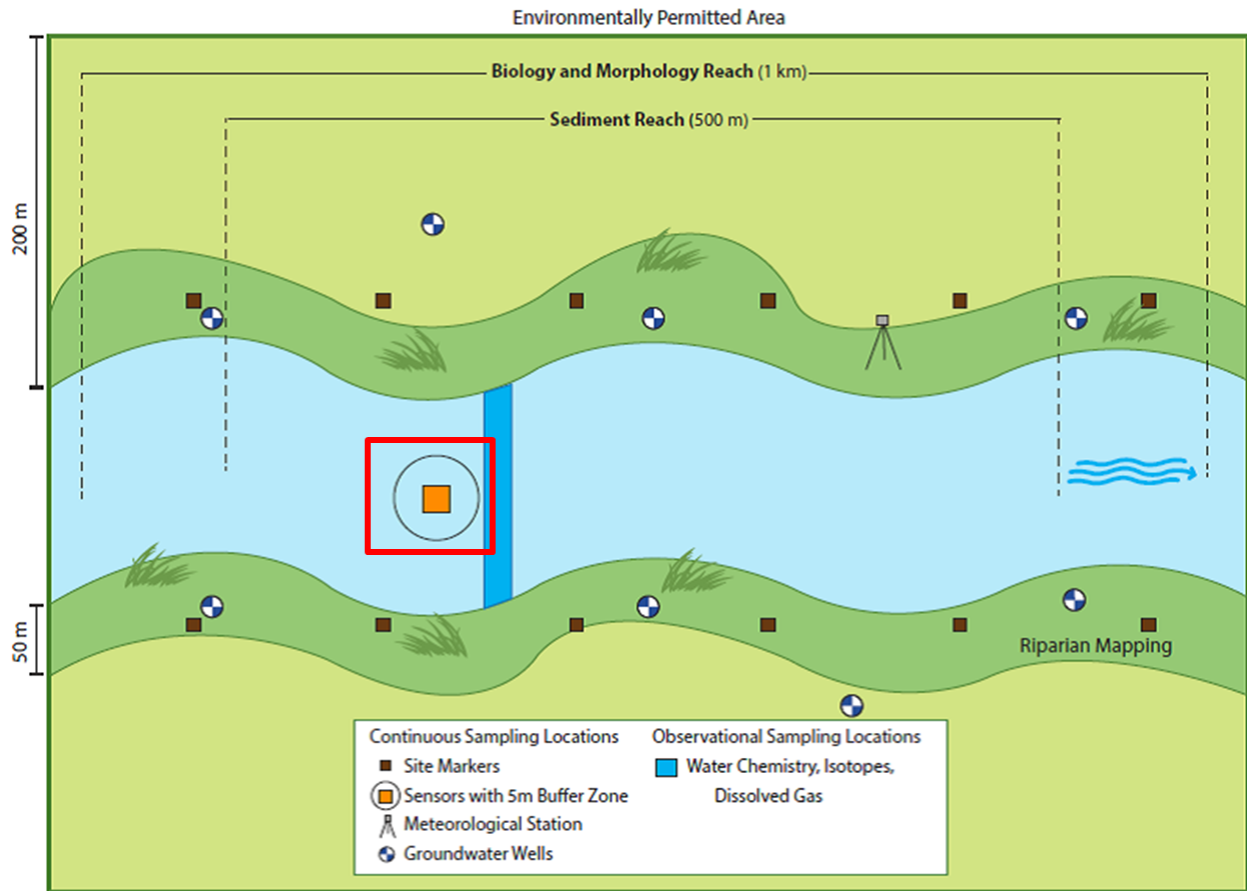
Figure 2: A generic site layout for rivers with Secchi depth and vertical profile sampling locations (red box).

3.2   Temporal Sampling Design

Secchi depths and depth profiles will be measured every time techs sample for water chemistry, surface microbes, phytoplankton, zooplankton and sediment chemistry.

3.3   Variables Reported

All variables reported from the field or laboratory technician (L0 data) are listed in the files, NEON Raw Data Validation for Secchi Depth (NEON.DP0.20252) (AD[04]) and NEON Raw Data Validation for Depth Profile (NEON.DP0.20254) (AD[05]). All variables reported in the published data (L1 data) are also provided separately in the files, NEON Data Variables for Secchi Depth (NEON.DP1.20252) (AD[06]) and NEON Data Variables for Depth Profile (NEON.DP1.20254) (AD[07]).

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.

3.4   Spatial Resolution and Extent

The finest spatial resolution at which Secchi and depth profile data will be tracked is per station (1 stationID per site). Each surface Secchi and/or depth profile sample will be representative of the site level (i.e., siteID).

Overall, this results in a spatial hierarchy of:

stationID (ID of sampling location within the site) -> **siteID** (ID of NEON site) -> **domainID** (ID of a NEON domain)

3.5   Temporal Resolution and Extent

The finest temporal resolution that Secchi and/or depth profile data will be tracked is at the level of an individual sample in a sampling bout (i.e., date-YYYYMMDD).

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. Code to stack files across months is available here: (LINK TBD)

3.6   Associated Data Streams

eventID is a linking variable that can tie measurements of Secchi Depth and Depth Profile to each other. Depth Profile data can also be linked to continuous temperature measurements from the temperature chain attached to the buoy (NEON.DP1.20264).

3.7   Product Instances

The total number of bouts per year is expected to be 18 per lake site (12 associated with surface water chemistry and surface microbes, 3 associated with phytoplankton and zooplankton, and 3 associated with sediment chemistry) and 32 per river site (26 associated with surface water chemistry-12 of which will also include surface microbes, 3 associated with phytoplankton and zooplankton, and 3 associated with sediment chemistry).

3.8 Data Relationships

The protocol dictates that profile measurements are recorded from the surface of the water down, starting at 0.5 m and recording every 0.5 m. The header information (location, date, recordedBy etc) is recorded once in dep_profileHeader. Each record in dep_profileHeader can therefore have one or more child records (profile measurements in dep_profileData) associated with it, depending on the depth of the lake. These two tables (dep_profileHeader and dep_profileData) can be joined using the **eventID** field. 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.

dep_profileHeader.csv - > one record expected per namedLocation per collectDate (day of year, UTC) combination

dep_profileData.csv - > one record expected per depth per namedLocation per collectDate (day of year, UTC) combination

4 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 documents NEON Raw Data Validation for Secchi Depth (NEON.DP0.20252) (AD[04]) and NEON Raw Data Validation for Depth Profile (NEON.DP0.20254) (AD[05]), 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[11]).

1. **samplingImpractical** captures scenarios where attempts at measurements and/or sample collection were made. If **samplingImpractical** is set to "other" additional **remarks** are required.
2. When ice is present at a lake or river secchi readings are not collected and an abbreviated depth profile are collected. The App accommodates this with a **Ice Present?** field that changes the requirements for an entry depending on the selection.
3. If a lake is clear to the bottom the **Euphotic Depth** is set to the **Maximum Depth** and the **Secchi Mean Depth** is set to NULL.
4. Following entry of the depth profile measurements, the app calculated the stratification status of the water body. A water body is stratified if there is a change of 1 or more $^\circ$C per meter.
5. In a non-stratied water body, the upper segment depth is the surface (i.e. 0 m) and the lower segment depth is the maximum depth.
6. In a stratified water body, the first segment is the epilimnion and upper segment 1 depth is the surface (i.e. 0 m) and the lower segment 1 depth is the top of the metalimnion. The metalimnion is the region where the temperaturee change is at least 1 $^\circ$C per meter. The second segment is the hypolimnion and upper segment 2 depth is the bottom of the metalimnion and the lower segment 2 depth is the max depth.
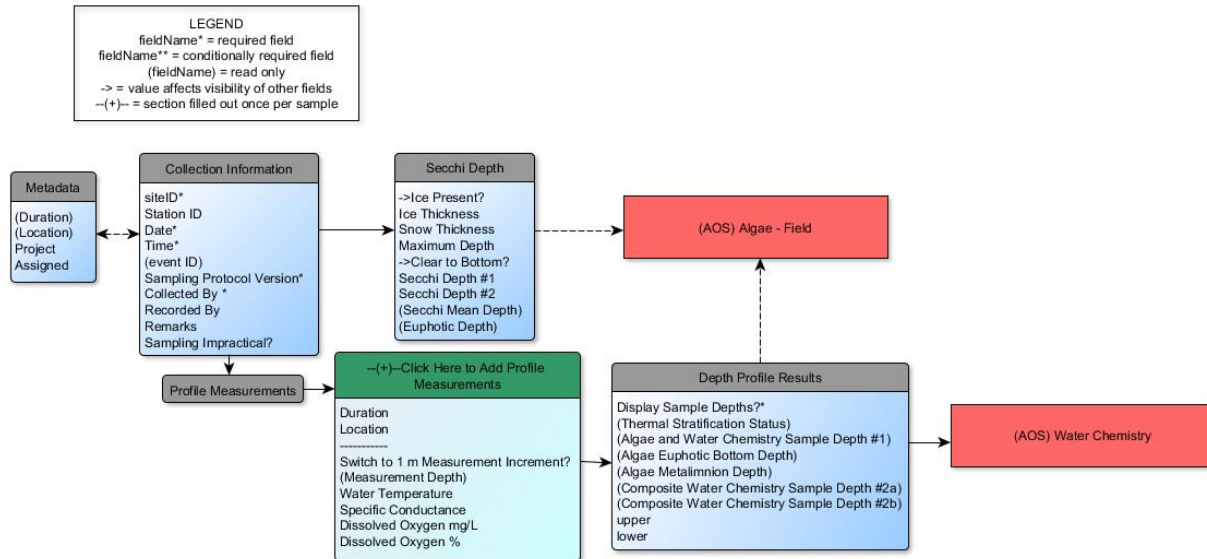
Figure 3: Schematic of the applications used by field technicians to enter secchi depth and depth profile field data

These values are passed to the Water Chemistry app where the data is stored with additional measurements and samples.

7. The app calculates sample depths for water chemistry and algae samples. In non-stratified water bodies, algae samples are collected at 0.5 m and 0.5 m above the **Euphotic Depth**, water chemsitry samples are collected at 0.5 m. In a stratified water body, algae samples are collected at 0.5 m and at the mid-point of the metalimnion, water chemistry samples are collected at 0.5 m and at the midpoint of the hypolimnion. If the hypolimnion is at least 2 m in depth a composite sample from two points in the hypolimnion is collected. These sample depths are linked to the Algae and Water Chemistry apps.

5   DATA PROCESSING STEPS

Following data entry into a mobile application of 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[10]).

6   REFERENCES