

Southeast Coast Network

National Park Service
Inventory and Monitoring Division



Standard Operating Procedure 2.2.09

Fixed-Station Continuous Water-Quality Data Entry, Processing, and QA/QC—Version 1.0

Please cite this as:

Starkey, E. N., and D. McCay. 2022. Fixed-station continuous water-quality data entry, processing, and QA/QC —Version 1.0. Southeast Coast Network Standard Operating Procedure NPS/SECN/SOP—2.2.09. Southeast Coast Network, Athens, Georgia.

Summary

This standard operating procedure (SOP) describes the step-by-step procedures for entering, processing, and quality assurance / quality control (QA/QC) of continuous water-quality monitoring data resulting from a sonde deployment event. Data from a deployment event include all data collected during sonde calibration, deployment, retrieval, and post-deployment. Deployment events are typically between one and two months in duration and reoccur throughout the year. Due to the complex nature of continuous estuarine water-quality data, successful completion of procedures outlined in this SOP require previous training and experience processing continuous data. This SOP is for users who already have access to Aquatic Informatics' Aquarius Time-Series on the Natural Resource Stewardship and Science (NRSS) server and the Southeast Coast Network (SECN) Estuarine Water-Quality Monitoring Database (EWQD).

Continuous data QA/QC techniques in this SOP are adapted from United States Geological Survey (USGS) guidance found in Wagner et al. (2006). These QA/QC methods have been implemented by the Southeast Coast Network since 2015, when management of continuous data began in Aquarius. Prior to 2015, the network managed continuous data in a local database and flagged questionable data with QC codes as per NEERS (2011), but did not actively correct data for sensor calibration drift or fouling drift, remove outliers, or apply data quality ratings. The network adopted the USGS approach to continuous data QA/QC so the final approved dataset is free of measurable bias and outliers that unduly influence trend analysis.

The Southeast Coast Network currently uses Aquarius Time-Series Springboard to meet its water-quality record processing needs but its use does not constitute an endorsement by the U.S. Government.

Revision Log

Revision Date	Author	Changes Made	Reason for Change	New Version #

Contents

	Page
Fixed-Station Activities and Workflow Summary.....	5
Before You Begin	6
Required Reading/Training	6
Recommended Training	6
Aquarius Tutorials and Resources.....	6
Required Software, Access, and Materials.....	6
Overview.....	7
Sonde Data Processing Workflow.....	10
SECN Estuarine Water-Quality Monitoring Database	11
Lookup Management.....	11
Add Personnel or Cooperators.....	11
Add a New Sonde.....	12
Other Lookup Table Additions.....	13
Data Entry.....	14
Fixed-station Selection	14
Continuous Event	15
Datasheet Quality Assurance (QA) and Processing	20
Data Processing Levels.....	20
Review of Data (QA).....	20
Correction Factors and Data Quality Ratings	23
Background	23
Deployment Summary Quality Control (QC) Report.....	23
Procedures	23
Suggested Correction Factors- How are they calculated?	25
Total Correction.....	25

Calibration Drift Correction	25
Fouling Drift Correction.....	26
Summary	26
Data Correction Criteria – Should the continuous data be corrected?	26
Suggested Data Quality Ratings – How are they determined?.....	27
Maximum Allowable Limits—How much can a dataset be corrected?	29
Continuous Data Processing and QA/QC	30
Summary and Objective	30
Continuous Data Pre-Processing	32
Trimming invalid data/times	32
Checking for Subdivided Files	32
AQUARIUS Time-Series Procedures	34
1. Continuous Data Upload	36
2. Data Correction	40
3. Data Quality Ratings (Grades)	59
4. Data Processing (Approval) Levels and Final Review (QA)	63
5. Parameter-Specific Processing Considerations	66
Literature Cited	69
Appendix A. Data sonde Deployment and Retrieval Datasheets.....	70
Appendix B. Example Deployment Summary QC Report	72
Appendix C. Setting up a new location and Time-Series in Aquarius.....	73
Appendix D. Station-Specific Processing Considerations	82

Fixed-Station Activities and Workflow Summary

An overview of fixed-station monitoring activities and workflow is presented in Figure 1. SOPs are presented left to right in the general order of operations for each activity. This SOP (2.2.09) pertains to the Data Processing and QA/QC activity.

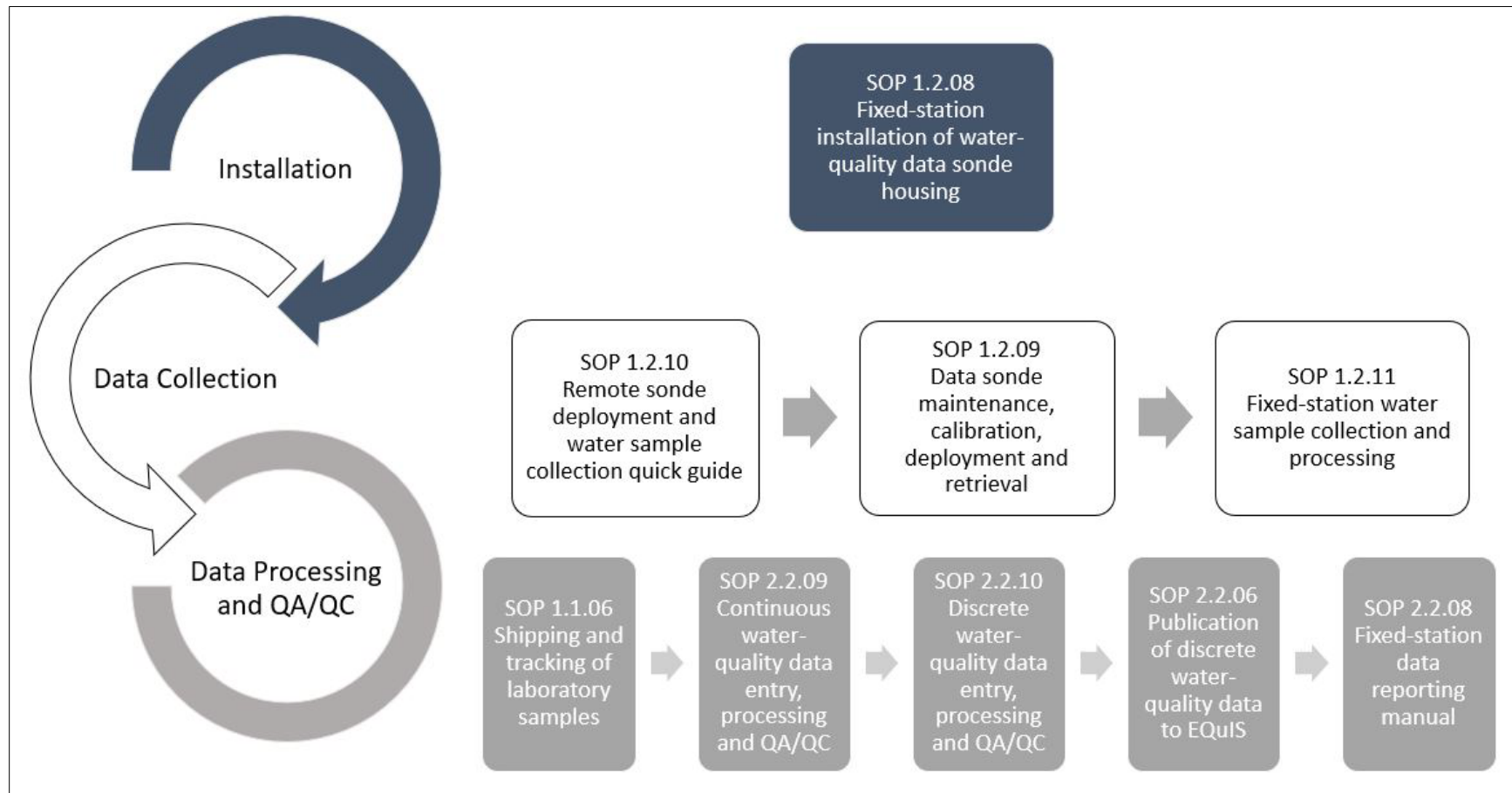


Figure 1. Fixed-station activities and workflow. SOPs are presented left to right in the general order of operations for each activity.

Before You Begin

Required Reading/Training

Wagner, R. J., R. W. Boulger Jr., C. J. Oblinger, B.A. Smith. 2006. Guidelines and Standard Procedures for Continuous Water-Quality Monitors: Station Operation, Record Computation, and data reporting: U.S. Geological Survey Techniques and Methods 1–D3, 51.
<https://pubs.usgs.gov/tm/2006/tm1D3/pdf/TM1D3.pdf>. (last accessed June 2022).

USGS training. QW2298 “Guidelines for the operation and computation of records of continuous water-quality monitors.” Enrollment is via DOI Talent USGS-OED-QW2298-OprCompRecQW (doi.gov). Last accessed May 2021.

Recommended Training

AQUARIUS Time-Series, Water-Quality Record Computation Training. Offered by Aquatic Informatics.

Aquarius Tutorials and Resources

Water Resources Data Management SharePoint: <https://doimspp.sharepoint.com/sites/nps-nrswrd/data/Pages/AquariusNG.aspx> (last accessed June 2022).

Required Software, Access, and Materials

- Access to NPS Network.
- Access to Aquatic Informatics’ Aquarius Time Series v2020.1 or newer on the NRSS server. For access contact the NPS Aquarius system administrator Dean Tucker (dean_tucker@nps.gov). See https://doimspp.sharepoint.com/sites/nps-nrswrd/data/Aquarius%20NG%20Documents/00_Getting_Started_Aquarius.docx for more information.
- Aquarius Time Series Client Software. See https://doimspp.sharepoint.com/sites/nps-nrswrd/data/Aquarius%20NG%20Documents/00_Getting_Started_Aquarius.docx for more information.
- Access to the SECN Estuarine Water-Quality Monitoring Database. Microsoft Access Front-end and SQL Backend. For access contact Wendy Wright (wendy_wright@nps.gov).
- Access to the NPS Microsoft Power Business Intelligence (BI) Report Server – [Estuarine Water-Quality Reports Estuarine Water-Quality - Power BI Report Server](#)
- Microsoft Excel
- Populated field forms: SECN Coastal Water-Quality Monitoring – Datasonde Datasheet (v1.43 or newer).

Overview

This SOP is intended to serve as a guide for processing continuous water-quality data collected at fixed monitoring stations. The overarching objective when processing continuous water-quality data is to take the data from raw data collected by a sonde to a dataset free of outliers and bias caused by sensor fouling and/or calibration drift. This is accomplished by using a combination of field and post-deployment readings to identify, and apply if necessary, corrections to the continuous data. A secondary objective is to assign data quality ratings, also referred to as ratings of accuracy, or grades. These ratings of accuracy are based on the combination of sensor fouling drift, calibration drift and professional judgement, and indicate the degree to which data represent field conditions (e.g., high degree of fouling/calibration drift = poor data quality rating). The final approved data for each parameter allow the Southeast Coast Network (SECN) to meet the objectives outlined in the protocol for monitoring estuarine water and sediment quality (Gregory et al. 2013). Data corrections and ratings of quality are discussed in more detail in the “Generation of Correction Factors and Data Quality Ratings” section below and in Wagner et al. (2006).

A prerequisite for processing continuous records is close adherence to the procedures outlined in SOP 1.2.08 *Fixed-Station Installation of Water-Quality Data Sonde Housing*—Version 3.0 (Starkey and McCay 2022), SOP 1.2.10 *Fixed-Station Remote Sonde Deployment and Water Sample Collection Quick Guide*—Version 2.0 (McCay and Starkey 2022), and SOP 1.2.09 *Fixed-Station, Water-Quality Data Sonde Maintenance, Calibration, Deployment, and Retrieval*—Version 3.0 (McCay et al. 2022; Figure 1). Continuous data processing and QA/QC involve using information recorded throughout the sonde deployment event. Data from a deployment event include all data collected during sonde calibration, deployment, retrieval, and post-deployment. Each component is thoroughly discussed in SOP 1.2.09. Deployment events are typically between one and two months in duration and reoccur throughout the year.

All deployment event data, other than the continuous logger file from the deployed sonde, are initially recorded on the paper data sheets found in Appendix A. Data on these datasheets are subsequently entered into the SECN Estuarine Water-Quality Monitoring Database (EWQD) and are used to inform continuous data processing in Aquarius Time Series. The general workflow associated with each data system is shown in Figure 2.

Sondes deployed by the Southeast Coast Network record data every half hour¹ for the following core parameters: dissolved oxygen, pH, specific conductance, water temperature, and turbidity. Additionally, chlorophyll *a* and blue green algae are measured at two locations deemed at risk for harmful algal blooms. For all 10 monitored stations this equates to approximately 3,000 data points per day and approximately 1.1 million data points per year. Both the SECN aquatic ecologist and SECN hydrological technician must screen all data prior to final approval and publication.

¹ Two monitored locations have more frequent (15 minute) data collection due to collaborator needs.

The data processing scheme outlined in this SOP is based on guidelines established in Wagner et al. (2006) and represents the most efficient method to process relatively high frequency continuous water-quality data. However, due to the volume of data produced by sondes, a substantial investment of SECN staff time is required to fully process continuous data. This is an important consideration, in addition to equipment cost, prior to the installation of additional monitoring stations.

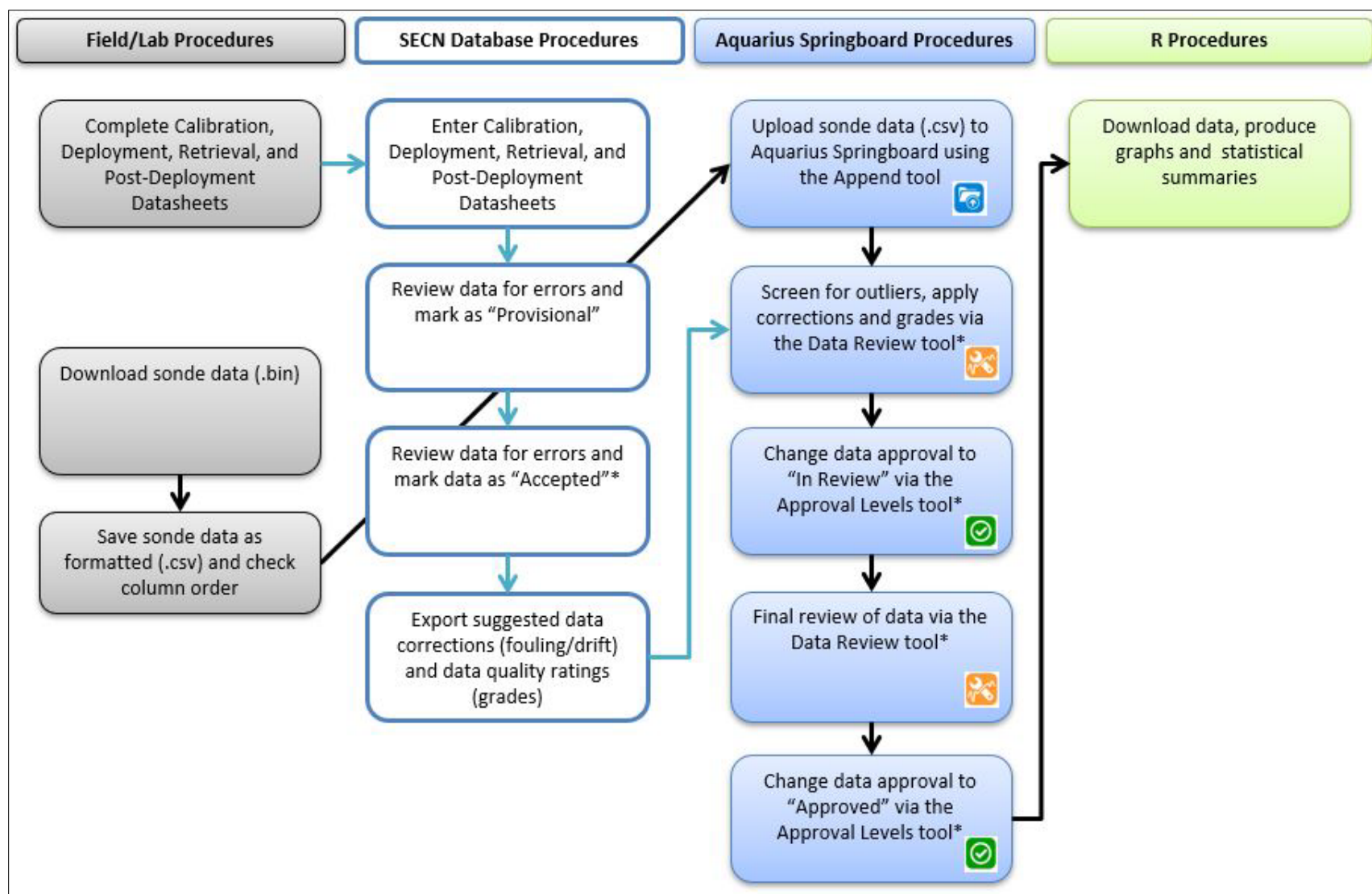


Figure 2. General sonde data processing workflow across multiple data systems. Arrows represent the flow of data and information. Blue arrows represent the flow of QC data that are used to process continuous sonde data. Boxes with an asterisk indicate an independent double check process between SECN aquatic ecologist and SECN hydrological technician.

Sonde Data Processing Workflow

1. Field and lab
 - a. Download sonde data files
 - b. Record deployment event data
 - i. Calibration
 - ii. Deployment
 - iii. Retrieval
 - iv. Post-Deployment
2. SECN estuarine water-quality monitoring database
 - a. Enter deployment event data
 - b. Review deployment event data
 - c. Accept deployment event data
3. NPS Power BI Report Server
 - a. Generate Deployment Summary QC Report
 - b. Review suggested correction factors and data quality ratings (grades)
4. Aquarius Time Series²
 - a. Upload continuous data, approval level is automatically set to “Working”
 - b. Apply correction factors (if needed)
 - c. Apply data quality ratings (grades)
 - d. Set approval level to “In Review”
 - e. Review data and set approval level to “Approved”

² Independent double check processes between SECN aquatic ecologist and SECN hydrological technician

SECN Estuarine Water-Quality Monitoring Database

The SECN Estuarine Water-Quality Monitoring Database (EWQD) consists of an SQL Server back-end database and a Microsoft Access front-end user interface. Both applications can be accessed by multiple users simultaneously. The data entry component is designed for the manual entry of associated data sheets (calibrations, deployments, retrieval, and post-deployment) and lab data (e.g., nutrient and chlorophyll *a* results and associated field QA/QC sample data). The application component includes all subsequent data analysis and data reporting required for both internal and external use.

The sections below describe the entry procedures for data recorded on the paper Deployment and Retrieval datasheets (Appendix A).

Lookup Management

Prior to entry of data for a deployment event, review the paper datasheets and determine if there is anything that should be added to the lookup tables in the database. The two most common additions are new personnel (e.g., protocol users) and new equipment (e.g., field or in situ sondes). The process for adding items to the lookup tables is described below. If no additions are necessary, skip directly to datasheet entry.

Add Personnel or Cooperators

1. Check for the most recent version of the EWQD front end on the SECN's Azure DevOps page. https://nrsssource.nps.gov/tfs/Networks/_git/SECN_WaterQuality (Accessed October 2021).
2. Open the EWQD front end.
3. From the Main Menu, select "Lookup Management" (Figure 3).

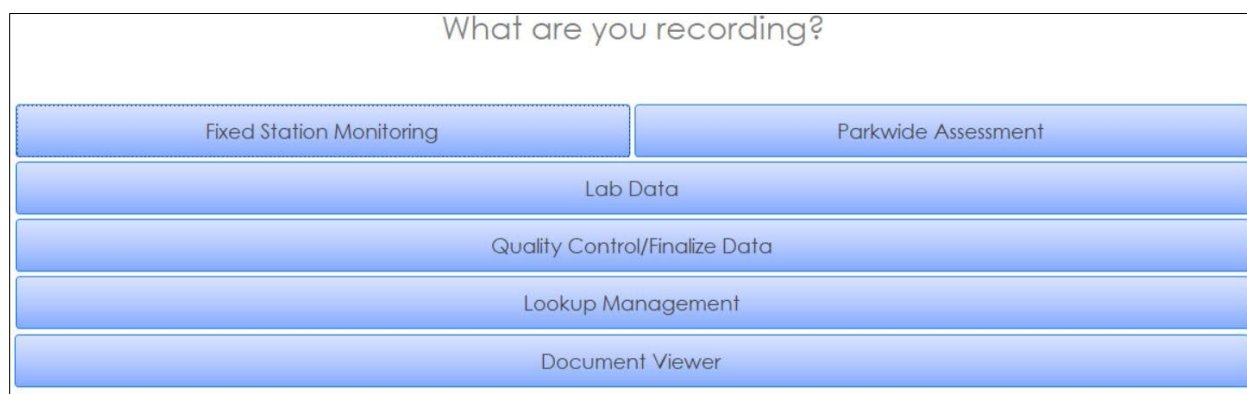


Figure 3. Estuarine Water-Quality Monitoring Database Main Menu.

4. From the "Select a table" drop-down, select "dbo_ProtocolUser" (Figure 4).

Select a table:

ProtocolUserID	FirstName	LastName	WindowsLogonN	IsAdmin	IsActive
1	Eric	Starkey	estarkey	True	True
2	Daniel	McCay	dmccay	True	True
3	Amy	Kalmbacher		False	True
4	Brice	Sweeney		False	True
5	Brandon	Puckett		False	True
6	Charlie	Denton		False	True
7	Bill	Karlavige		False	True
8	Paul	Bell		False	True
9	Ben	Flanders	bflanders	True	True
1000	False	None	Test	False	False

Figure 4. Estuarine Water-Quality Monitoring Database Lookup Management with the dbo_ProtocolUser table selected.

5. Click “Add a Lookup Value”
6. Fill in the required information in the “Add a Lookup Value” window. Required fields are:
 - a. First Name
 - b. Last Name
 - c. Windows Logon Name (if applicable)
 - d. Is Admin (True or False). Only the protocol lead, hydrological technician and data manager are set to True.
 - e. Is Active (True or False).
7. Click “Submit.”
8. Click “Refresh” (Figure 4) and ensure that the new protocol user is shown in the table.

Add a New Sonde

1. Open the EWQD front end.
2. From the Main Menu select “Lookup Management” (Figure 3).
3. From the “Select a table” drop down, select “dbo_Equipment” (Figure 5).

Select a table:

EquipmentID	Instrument	SerialNumber	Summary	IsActive
1	EXO 2	13K101824	YSI Multiparameter	True
2	EXO 2	13G101684	YSI Multiparameter	True
3	EXO 2	13G101685	YSI Multiparameter	True
4	EXO 2	13K101825	YSI Multiparameter	True
5	EXO 2	13K102222	YSI Multiparameter	True
6	EXO 2	16J102929	YSI Multiparameter	True
7	EXO 2	16H106904	YSI Multiparameter	True
8	EXO 2	17C102278	YSI Multiparameter	True
9	EXO 2	17H100655	YSI Multiparameter	True
10	EXO 2	17H100820	YSI Multiparameter	True

Figure 5. Estuarine Water-Quality Monitoring Database Lookup Management with the dbo_Equipment table selected.

4. Click “Add a Lookup Value”
5. Fill in the required information in the “Add a Lookup Value” window. Required fields are:
 - a. Instrument Model
 - b. Instrument Serial Number
 - c. Summary
 - d. IsActive (True or False)
6. Click “Submit.”
7. Click “Refresh” (Figure 5) and ensure that the new sonde is shown in the table.

Other Lookup Table Additions

Less common items may also be added via Lookup Management; however, any additions or changes must be cleared by the SECN aquatic ecologist and SECN data manager. Edits to values in these tables must be avoided since changes may have broad implications. Lookup tables related to continuous water-quality that may require additions include:

dbo_Equipment Components (e.g., probes, guards)

dbo_FoulingType (e.g., algae, sediment, eggs)

dbo_SiteObservation (e.g., fish kill, algal bloom, hurricane)

dbo_FoulingLevel (e.g., heavy, moderate, light)

Data Entry

Deployment event data are recorded on paper datasheets (Appendix A) and subsequently entered into the SECN EWQD within a week of recording post-deployment readings. To begin data entry, open the database and click “Fixed-station Monitoring” on the Main Menu (Figure 3).

Fixed-station Selection

Existing Station (most common)

From the “Fixed-station Selection” screen, select an existing station from the drop-down menu, and press the play button ► (Figure 6). After selection, the “Fixed-station Route Selection” screen will appear (Figure 7).

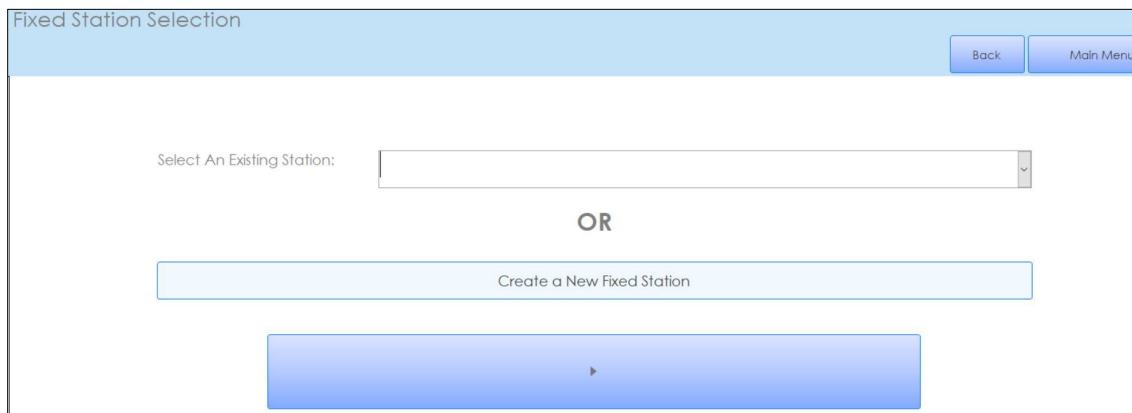


Figure 6. Estuarine Water-Quality Monitoring Database Fixed-station Selection screen.



Figure 7. Estuarine Water-Quality Monitoring Database Fixed-station Route Selection screen.

Create New Station (less common)

If the monitoring station does not exist in the drop-down list:

1. Check the datasheet to make sure that the station name has been recorded correctly. Do not enter new station names for existing monitoring locations already entered in the EWQD.
2. From the “Fixed-station Selection” menu, select “Create a New Fixed-station” (Figure 6).
3. On the “SECN Fixed-station Creation Form” populate all fields and click “Submit” (Figure 8).

SECN Fixed Station Creation Form
STATION FORM v1.1 (04/2017)

Station Name:

Water Body Name: **Staging Area:**

GPS X: Y:
UTM Zone: (17 or 18) Datum (NAD83):

Recorded By: **Notes**

Figure 8. Estuarine Water-Quality Monitoring Database Fixed-station Creation Form.

4. From the “Fixed-station Selection” menu, select the new station from the drop-down menu, and press the play button ► (Figure 6). After selection, the “Fixed-station Route Selection” screen will appear (Figure 7).

Continuous Event

From the Fixed-station Route Selection screen select “New” continuous event (Figure 7). Note that a record can also be resumed if an entry is incomplete and is set to the “Raw” data processing level.

Calibration and Pre-Deployment Data

Populate the calibration QC and pre-deployment fields (Figure 9) with data from the paper datasheet. Note that not all instruments are outfitted with a chlorophyll / blue green algae sensor so those fields can be null (i.e., blank). In addition, if the sensors were within tolerance they may not have been calibrated and the “Calibrated” fields will be null (i.e., blank). Pay attention to any warnings that appear during data entry. When finished, click “Submit” to advance to the deployment form.

Datasonde Calibration QC — PRE-DEPLOYMENT

DATASHEET v1.41 (09/2019)

Instrument # (SN) 19G104609

Calibration Date 2020-08-26
Calibrated By Daniel McCay

Battery Voltage Pre Calibration 5.5
Battery Voltage Post-Calibration 6.2

Check The Following: (not recorded)
Battery Voltage > 5.3
Central Wiper Replaced
Central parking 180°

Barometric Pressure (mmHg) 745.0
Conductivity Cell Constant 5.16
ODO Gain 1.09

pH7 (mv) -19.50
pH10 (mv) -198.90
pH4 (mv) (check)
pH Slope 179.40

Parameter	Temp (C)	Sp. Cond (mS/cm)	Depth (m)	ODO (%Sat.)	ODO (mg/l)	pH7	pH10
Standard	23.40	50.00	-0.204	97.70	7.96	7.01	10.02
Measured	23.53	51.20	-0.203	96.50	7.83	7.21	10.22
Calibrated		50.00		97.70	7.96	7.01	10.02

Parameter	pH4 (check)	Turbidity Low (FNU)	Turbidity High (FNU)	Chl Low (ug/l)	Chl High (ug/l)	BGA-PC Low (ug/l)	BGA-PC High (ug/l)
Standard		0.0	124.0				
Measured		0.1	125.2				
Calibrated							

Figure 9. Estuarine Water-Quality Monitoring Database Datasonde Calibration QC- Pre-Deployment data entry screen.

Deployment Data

Populate the deployment fields (Figure 10) with data from the paper datasheet. Be sure that all times are in Eastern Standard Time (EST). When finished click “Submit” to advance to the retrieval form.

Datasonde Datasheet —DEPLOYMENT

DATASHEET v1.41 (09/2019)

Display Pre-Deployment Summary

Deployment Information

Deployed By	Elizabeth Rico	File Name	CUISeac03_20200911
(Station Name_YYYYMMDD)			
Sonde Start Date	2020-09-07	Sonde Start Time (EST)	08:00:00
Actual Deployment Date	2020-09-11	Actual Time Placed in Water (EST)	09:15:00
Notes			
Swapped sonde bodies due to wiped probe failure. New copper tape. Added non-wiped CT probe.			
Site Observations			
☐ Fish Kill ☐ Algal Bloom ☐ Debris ☐ Hurricane/Tropical Storm ☐ Other			
Observation Description			

Figure 10. Estuarine Water-Quality Monitoring Database Datasonde Deployment data entry screen.

Retrieval Data

Populate the retrieval fields (Figure 11) with data from the paper datasheet. Note that if no field meter was used, select “No Field Meter Used” from the Field Meter # (SN) drop-down (Figure 12). Make sure the retrieval time is in Eastern Standard Time (EST). Note that these entries are especially important for the calculation of sensor fouling and calibration drift; as a result, be sure to document any issues or irregularities in the “Comments” field.

When finished, click “Submit” to advance to the post-deployment form.

Datasonde Datasheet — RETRIEVAL
 DATASHEET v1.4 (07/2019)

In situ Sonde # (SN)
 Retrieved By

Retrieval Date
 Retrieval Time (EST)

Field Meter # (SN)
 Field Meter Calibration Date

On Site Reading

Parameter	Temp (C)	Baro. Pres. (mmHg)	ODO (% Sat.)	ODO (mg/l)	Sp. Cond. (mS/cm)	Salinity (psu)	pH	Turbidity (FNU)	Depth (m)	Chla (µg/l)	BGA (µg/l)
Field Meter	30.17	764.8	80.00	5.26	39.13	24.80	7.44	15.3	.168		
In situ sonde	30.19	764.8	80.10	5.28	39.70	25.19	7.84	11.1	.168		

Fouling Presence: Please record type of fouling AND amount (eg A, B, E, / H)
 Types A= Algae, B= Barnacles, C= Crabs, E= Eggs, F= Fish, O= Other, N= none / Amount H=Heavy, M= Moderate, L= Light, N= None.

Equipment Type	Fouling Type	Fouling Amount
ODO probe	Other	Light
Turbidity probe	Other	Light

Fouling Type Comments: (If fouling type is other)

Comments:

Figure 11. Estuarine Water-Quality Monitoring Database Datasonde Retrieval data entry screen.

Datasonde Datasheet — RETRIEVAL
 DATASHEET v1.4 (07/2019)

In situ Sonde # (SN)
 Retrieved By

Retrieval Date
 Retrieval Time (EST)

Field Meter # (SN)
 Field Meter Calibration Date

On Site Reading

Parameter	Temp (C)	Baro. Pres. (mmHg)	Sp. Cond. (mS/cm)	Salinity (psu)	pH	Turbidity (FNU)	Depth (m)	Chla (µg/l)	BGA (µg/l)
Field Meter									
In situ sonde									

Fouling Presence: Please record type of fouling AND amount (eg A, B, E, / H)
 Types A= Algae, B= Barnacles, C= Crabs, E= Eggs, F= Fish, O= Other, N= none / Amount H=Heavy, M= Moderate, L= Light, N= None.

Equipment Type	Fouling Type	Fouling Amount

Figure 12. Estuarine Water-Quality Monitoring Database Datasonde Retrieval data entry screen showing “No Field Meter Used” in the Field Meter # (SN) drop-down.

Post-Deployment Data

Populate the post deployment fields (Figure 13) with data from the paper datasheet. Note that these entries are especially important for the calculation of sensor fouling and calibration drift; as a result, be sure to document any issues or irregularities in the “Comments” field. When finished click “Submit” and review the entry summary screen.

When the post-deployment form has been submitted, data entry for this deployment event has been completed. Enter data for another event or continue with datasheet quality assurance and processing.

Datasonde Datasheet — POST DEPLOYMENT
DATASHEET v1.4 (07/2019)

Display Retrieval Summary

Post Deployment Reading Date

Battery Voltage Central Wiper Parking 180

Barometric Pressure (mmHg) Conductivity Cell Constant

pH7 (mv) pH10 (mv) pH4 (mv)

pH Slope

Parameter	Temp (C)	Sp. Cond. (mS/cm)	Depth (m)	ODO (%SAT)	ODO (mg/l)	pH7	pH10
Standard	21.15	50.00	-0.102	99.00	8.39	7.02	10.05
Measured	21.16	50.10	-0.105	98.70	8.37	7.19	10.22

Parameter	pH4 (check)	Turbidity Low (FNU)	Turbidity High (FNU)	Chl Low (ug/l)	Chl High (ug/l)	BGA-PE Low (ug/l)	BGA-PE High (ug/l)
Standard		0.00	124.0				
Measured		0.20	126.5				

Any Probe Malfunctions If Y, please describe below

Checked By

Comments:

Figure 13. Estuarine Water-Quality Monitoring Database Datasonde Post-deployment data entry.

Datasheet Quality Assurance (QA) and Processing

Deployment event data (calibration, pre-deployment, deployment, retrieval, and post-deployment) are used to inform quality control measures applied to the continuous dataset and must be carefully reviewed for accuracy. This section outlines the procedures for the review of records related to the deployment event.

Data Processing Levels

As indicated in Figure 2 (SECN Estuarine Water-Quality Monitoring Database Procedures), data from the paper datasheets are entered in the database and reviewed several times for quality assurance. Data processing levels indicate the level of review that has been applied to a given dataset within the database.

Raw:	Data that have been entered but received no further review or data that have been reviewed and found to contain errors that need to be fixed.
Provisional:	The person that performed the data entry has checked all values against the original paper forms and found them to be free of errors. Considered the initial review.
Accepted:	An independent observer has checked all values against the original paper forms and found them to be free of errors. Considered the final review.

Review of Data (QA)

This process is the same for the initial and final review of data.

1. Obtain the original paper datasheets filed in the SECN Athens office.
2. Open the SECN Estuarine Water-Quality Monitoring Database (EWQD).
3. From the Main Menu, select “Quality Control/Finalize Data” (Figure 3).
4. From the “Quality Control Manager” screen, select the Form Type “FixedContinuousEvent” of interest (Figure 14).

Quality Control Manager

Back Main Menu

Please Select a Single Processable Data Record:

FormType	Station Name	Date Deployed/Collected (If applicable)	Entered By	Date Entered	Current Data Processing Level	Data Processed By
DiscreteFixedEvent	CONGbann01	2021-04-11	Daniel McCay	2021-05-05	Raw	Daniel McCay
DiscreteFixedEvent	CONGbann01	2021-04-11	Daniel McCay	2021-05-05	Raw	Daniel McCay
DiscreteFixedEvent	CONGbann01	2021-04-11	Daniel McCay	2021-05-05	Raw	Daniel McCay
DiscreteFixedEvent	CONGccbr01	2021-04-11	Daniel McCay	2021-05-05	Raw	Daniel McCay
FixedContinuousEvent	TIMUking01	2020-10-14	Daniel McCay	2021-05-04	Provisional	Eric Starkey
FixedContinuousEvent	FOMAvctr01	2020-11-10	Daniel McCay	2021-05-04	Provisional	Daniel McCay
FixedContinuousEvent	FOMAvctr01	2021-02-01	Daniel McCay	2021-05-04	Provisional	Daniel McCay
FixedContinuousEvent	TIMUking01	2021-02-25	Daniel McCay	2021-05-04	Provisional	Daniel McCay
FixedContinuousEvent	CUISeac03	2020-09-11	Daniel McCay	2021-05-05	Provisional	Eric Starkey
FixedSamplingLocation	FAKEfake99		Ben Flanders	2021-04-29	Raw	Ben Flanders
FixedStationNutrientLabData					NA	

New Processing Level:

RAW
ACCEPTED

Figure 14. Estuarine Water-Quality Monitoring Database Quality Control Manager screen with a Fixed Continuous Event selected.

5. After selecting the event of interest, use the drop-down menu to select the new processing level that will be applied to the data (i.e., Raw, Provisional, or Accepted; Figure 14).
 - a. Raw data can move up to Provisional
 - b. Provisional data can move up to Accepted or back to Raw
 - c. Accepted data are considered final and can no longer be moved back to Provisional or Raw. As a result, Accepted records do not appear in the list of forms that can be processed.
6. Click “Continue” and then “Open Continuous Event.”
7. Review all entries against the paper datasheet.
 - a. If an error is found, it can be corrected but the database will automatically move the record back to the Raw processing level.
 - b. If all data match the paper datasheet, click “Confirm and Apply New Processing Level” (Figure 15).

Datasonde Calibration QC — PRE-DEPLOYMENT

DATASHEET v1.41 (09/2019)

Instrument # (SN)

Calibration Date Calibrated By

Battery Voltage Pre Calibration Battery Voltage Post-Calibration

Check The Following: (not recorded)

Barometric Pressure (mmHg) Conductivity Cell Constant ODO Gain

pH7 (mv) pH10 (mv) pH4 (mv) (check) pH Slope

Parameter	Temp (C)	Sp. Cond (mS/cm)	Depth (m)	ODO (%Sat.)	ODO (mg/l)	pH7	pH10
Standard	19.44	50.00	-0.247	97.60	8.62	7.02	10.06
Measured	19.54	49.90	-0.245	97.20	8.58	7.14	10.27
Calibrated						7.02	10.06

Parameter	pH4 (check)	Turbidity Low (FNU)	Turbidity High (FNU)	Chl Low (ug/l)	Chl High (ug/l)	BGA-PC Low (ug/l)	BGA-PC High (ug/l)
Standard		0.0	124.0	0.0	44.0	0.0	124.0

Current Processing Level Previously Processed By:

New Processing Level

Figure 15. Estuarine Water-Quality Monitoring Database options to review a datasheet and apply a new processing level.

- c. Each of the forms must be reviewed separately and all must pass the review to pass to the next processing level.
8. After confirming and applying the processing levels to each datasheet, double check that the new data processing level is shown in the “Quality Control Manager” (Figure 14).
9. If this was the initial review of the data, alert the secondary reviewer that the data are available for final review.
10. When the review has been completed, file the paper datasheets in the station-specific notebook located in the SECN Athens office.

Correction Factors and Data Quality Ratings

Sonde retrieval and post-deployment data are stored in the SECN Estuarine Water-Quality Monitoring Database (EWQD) and can be used to correct continuous data stored in Aquarius Time-Series. This section outlines how to generate a deployment summary report from the EWQD and describes how corrections and ratings are derived. The summary report shows total drift, fouling drift, calibration drift, and a rating of accuracy for the selected deployment period.

Background

Continuous data collected with sondes may become measurably less accurate over the course of a deployment due to environmental and electronic factors (i.e., bias). In other words, data collected by sensors during a deployment may drift away from the “true” value over time. The Southeast Coast Network uses data collected during sonde retrieval and post-deployment evaluation to determine total drift, fouling drift, and calibration drift. If the total drift exceeds pre-defined data correction criteria, it may be used to correct continuous data in Aquarius.

In addition, determination of total drift allows the Southeast Coast Network to assign ratings of accuracy to the continuous data. These ratings of accuracy are also referred to as data quality ratings or data grades.

Methods used to correct data and assign ratings of accuracy are based on methods used by the United States Geological Survey (USGS; Wagner et al. 2006).

Deployment Summary Quality Control (QC) Report

After all data have been reviewed and “accepted” in the SECN Estuarine Water-Quality Monitoring Database, a report is generated that shows total drift, fouling drift, calibration drift, and a rating of accuracy for each parameter during the selected deployment period (Appendix B). The Deployment Summary Report (DSR) is a quality control (QC) tool and provides suggested correction factors and ratings of accuracy; however, these suggestions may or may not be applied to the final continuous record in Aquarius. Final “approved” corrections and data quality ratings are maintained alongside the continuous record in the Aquarius data system.

Procedures

1. Connect to the NPS Network directly or via VPN.
2. Use an internet browser (Microsoft Edge or Internet Explorer) to access Estuarine Water-Quality Reports on the NPS Power BI Report Server (Figure 16). The server path available from the SECN data manager upon request.

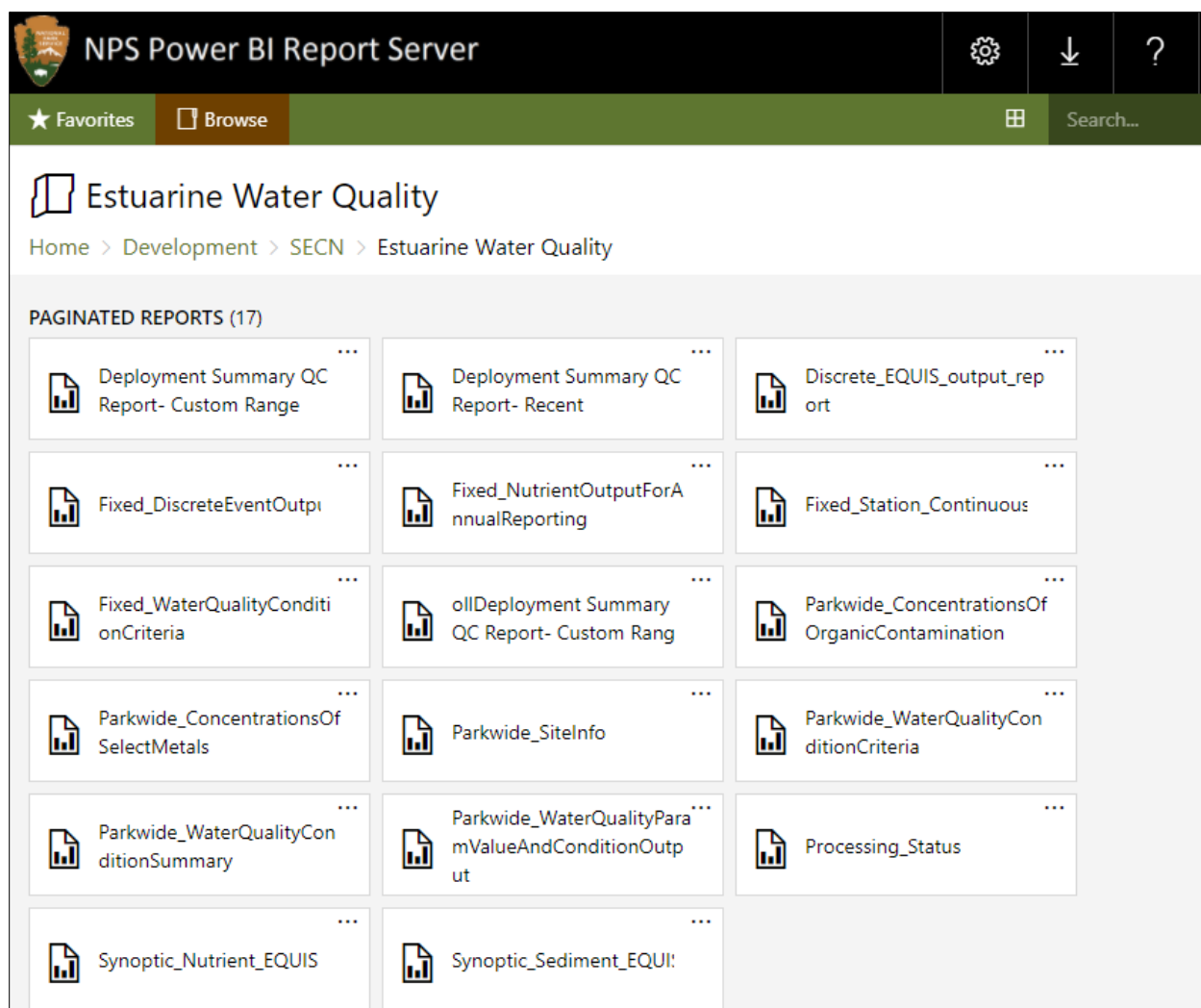


Figure 16. Estuarine Water-Quality Reports on the NPS Power BI Report Server.

3. Select Deployment Summary QC Report-Recent.
4. Select the Fixed-Station Name from the drop down (Figure 17).

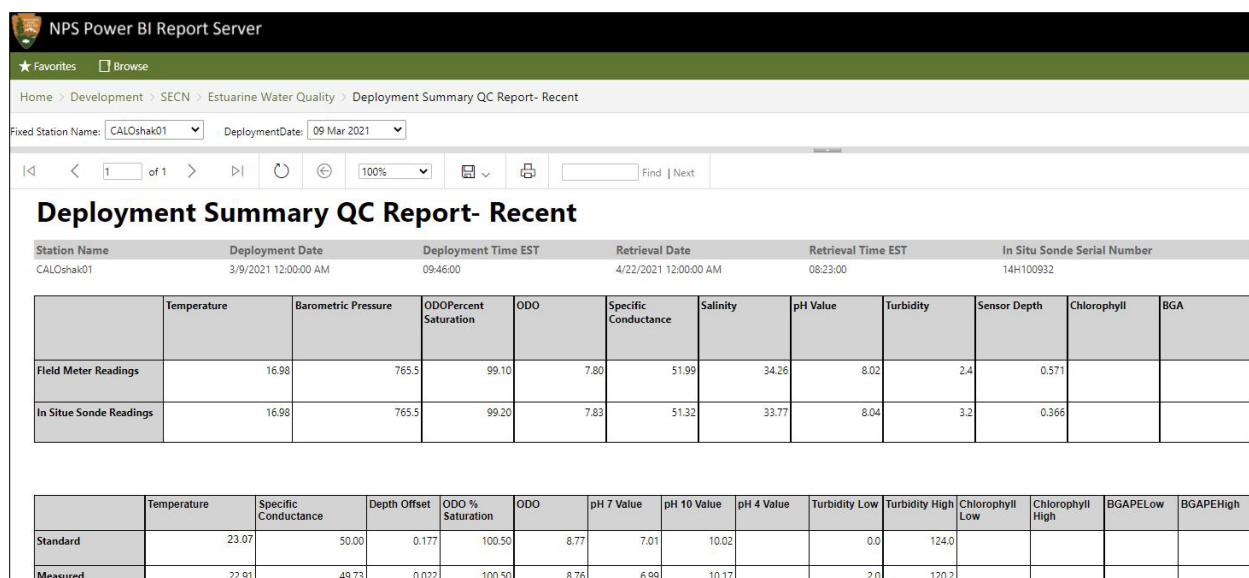


Figure 17. Fixed-station Deployment Summary QC report screen.

5. Select the Deployment Date for the period of interest.
6. Click “View Report”
7. The report can be viewed and used directly within the web browser. Because these reports can be generated on demand they do not need to be saved locally.

Suggested Correction Factors- How are they calculated?

Prior to discussion about correction factor calculation, it is important to note that the procedure to determine total, calibration and fouling drift has been modified slightly from Wagner et al. (2006) because on-site cleaning of the sensors and sonde is not possible due to hard fouling (barnacle growth). Retrieval procedures are outlined in SOP 1.2.09 *Fixed-station, Water-Quality Data Sonde Maintenance, Calibration, Deployment, and Retrieval*—Version 3.0 (McCay et al. 2022).

Total Correction

Upon *in situ* sonde retrieval, field sonde readings and *in situ* sonde readings are recorded for each parameter (SOP 1.2.09 [McCay et al. 2022]). The difference between these two readings is referred to as the total drift or total correction, both terms are synonymous (i.e., Total Correction = Field Meter Readings - *In Situ* Sonde Readings). Note that because the total correction is determined in the field with a clean field sonde and the *in situ* sonde, it includes the effect of fouling and calibration drift.

Calibration Drift Correction

During the post-deployment evaluation, each *in situ* sonde’s sensor readings are compared to standard solutions (SOP 1.2.09 [McCay et al. 2022]). The difference between the clean sensor reading and the standard is equal to the calibration drift (i.e., Calibration Drift Correction = Value of Standard Solution – Clean Sensor Readings).

Fouling Drift Correction

Since both the total correction and calibration drift correction are known, the fouling drift correction is simply the difference between the total correction and calibration drift correction (i.e. Fouling Drift Correction = Total Correction – Calibration Drift Correction).

Summary

Total Correction = Field Meter Readings - *In Situ* Sonde Readings

Calibration Drift Correction = Value of Standard Solution – Clean Sensor Readings

Fouling Drift Correction = Total Correction – Calibration Drift Correction

This method assumes that the rate of fouling and calibration drift is linear from the start of the deployment until the sonde is retrieved (i.e., pro-rated). Due to variability caused by site and sensor conditions, the correction factors shown in the DSR should be considered suggested corrections that may or may not need to be applied in Aquarius. This will be discussed more in the Aquarius section of this SOP (below).

Data Correction Criteria – Should the continuous data be corrected?

In addition to corrections, the DSR indicates if a correction should be applied to the continuous data stored in Aquarius. For a given parameter, if the sum of the absolute values for fouling and calibration drift error exceeds the values listed in Table 1, the DSR will indicate “Yes,” a correction is needed. Otherwise, the DSR will indicate “No,” a correction is unnecessary. Ultimately the application of the correction in Aquarius is left to the discretion of the user processing the record, but data correction criteria serve as a guide. This will be discussed more in the Aquarius section of this SOP (below).

Table 1. Criteria for water-quality data corrections, modified from Wagner et al. (2006).

Parameter	Data Correction Criteria ¹
Temperature	± 0.2 °C
Specific conductance	± 5 µS/cm or ± 3% of the measured value, whichever is greater
Dissolved oxygen	± 0.3 mg/L
pH	0.2 pH units
Turbidity	± 0.5 turbidity units or ± 5% of the measured value, whichever is greater
Depth ²	± 0.2 m
Chlorophyll <i>a</i> ³	± 5% of the measured value
Blue Green Algae ³	± 5% of the measured value

¹ Apply correction when the sum of the absolute values for fouling and calibration drift error exceeds the value listed.

² There are no data correction criteria outlined in Wagner et al. 2006 for depth. The correction criteria outlined here are set based on YSI EXO depth sensor accuracy of 0.04m and SECN data.

³ There are no published data correction criteria for Chl *a* and BGA. As a result, the criteria presented here are based on the performance of the sensor at monitoring stations managed by the Southeast Coast Network.

Suggested Data Quality Ratings – How are they determined?

The DSR provides suggested data quality ratings for each parameter based on the combined fouling and calibration drift corrections (i.e., total correction). The range of correction corresponding to each parameter and rating are shown in Table 2.

Ratings for depth, chlorophyll *a*, and blue green algae are considered “Estimated” due to the lack of previously published guidelines for processing these parameters. However, the range of corrections for these parameter ratings are based on published sensor accuracy and performance at monitoring stations managed by the Southeast Coast Network.

Table 2. Accuracy ratings of continuous water-quality records or “data grades” (modified from Wagner et al. 2006).

Measured field parameter	Excellent ¹	Good ^{1,2}	Fair ^{1,2}	Poor ^{1,2}
Water temperature	$\leq \pm 0.2$ °C	$> \pm 0.2\text{-}0.5$ °C	$> \pm 0.5\text{-}0.8$ °C	$> \pm 0.8$ °C
Specific conductance	$\leq \pm 3\%$	$> \pm 3\text{-}10\%$	$> \pm 10\text{-}15\%$	$> \pm 15\%$
Dissolved oxygen	$\leq \pm 0.3$ mg/L or $\leq \pm 5\%$, whichever is greater	$> \pm 0.3\text{-}0.5$ mg/L or $> \pm 5\text{-}10\%$, whichever is greater	$> \pm 0.5\text{-}0.8$ mg/L or $> \pm 10\text{-}15\%$, whichever is greater	$> \pm 0.8$ mg/L or $> \pm 15\%$, whichever is greater
pH	$\leq \pm 0.2$ units	$> \pm 0.2\text{-}0.5$ units	$> \pm 0.5\text{-}0.8$ units	$> \pm 0.8$ units
Turbidity	$\leq \pm 0.5$ FNU or $\leq \pm 5\%$, whichever is greater	$> \pm 0.5\text{-}1.0$ FNU or $> \pm 5\text{-}10\%$, whichever is greater	$> \pm 1.0\text{-}1.5$ FNU or $> \pm 10\text{-}15\%$, whichever is greater	$> \pm 1.5$ FNU or $> \pm 15\%$, whichever is greater
Depth ³	$\leq \pm 0.08$ m	$> \pm 0.08\text{-}0.12$ m	$\geq \pm 0.12\text{-}0.16$ m	$\geq \pm 0.16\text{-}0.2$ m
Chlorophyll <i>a</i> ⁴	$\leq \pm 5\%$	$> \pm 5\text{-}10\%$	$> \pm 10\text{-}15\%$	$> \pm 15\text{-}30\%$
Blue green algae ⁴	$\leq \pm 5\%$	$> \pm 5\text{-}10\%$	$> \pm 10\text{-}15\%$	$> \pm 15\text{-}30\%$

¹ Ratings of accuracy are based on combined fouling and calibration drift corrections applied to the record.

² Considered “Estimated” data quality ratings for chlorophyll *a* and blue green algae. Note the Southeast Coast Network does not rate any data as Estimated Excellent. In other words, all estimated data will be considered < Excellent

³ No ratings of accuracy are outlined in Wagner et al. (2006) for depth. The accuracy ratings outlined here are guidelines based on YSI EXO depth sensor accuracy of 0.04 m and SECN data.

⁴ There are no published accuracy ratings for chlorophyll *a* and blue green algae. As a result, the ratings presented here are based on the performance of the sensor at monitoring stations managed by the Southeast Coast Network.

Maximum Allowable Limits—How much can a dataset be corrected?

The DSR indicates data for a parameter need to be rated as “unusable” when the total correction value exceeds the limits shown in Table 3. Methods for dealing with unusable data are outlined in the Aquarius section below.

Table 3. Maximum allowable limits for continuous water-quality monitor sensors (modified from Wagner et al. 2006); m=meters.

Measured field parameter	Maximum allowable limits for water-quality sensor values ¹
Water temperature	± 2.0 °C
Specific conductance	± 30%
Dissolved oxygen	± 2.0 mg/L or 20%, whichever is greater
pH	± 2 pH units
Turbidity	± 3.0 FNU or ± 30%, whichever is greater
Depth ²	± 0.2 m
Chlorophyll a ³	± 30%
Blue green algae ³	± 30%

¹ Based on combined fouling and calibration drift corrections.

² No maximum allowable limits are outlined in Wagner et al. 2006 for depth. The maximum allowable limit set here is based on YSI EXO depth sensor accuracy of 0.04 m and SECN data.

³ There are no published maximum allowable limits for chlorophyll a and blue green algae. As a result, the limit set here is based on the performance of the sensor at monitoring stations managed by the Southeast Coast Network.

Continuous Data Processing and QA/QC

Summary and Objective

This section documents the procedures and techniques necessary to “process” continuous water-quality records within Aquatic Informatics’ Aquarius Time Series data system. “Processing” data refers to completion of the following:

1. Removal of outliers as needed
2. Application of correction factors as needed
3. Application of data grades
4. Review and approval of the dataset

The objectives of this process are to ensure:

1. Data are free of errors and correctable bias
2. Data grades clearly convey data accuracy and quality
3. Data are publishable

Often, the decision to apply a suggested correction and data grade depends on professional judgement based on the body of evidence for a given deployment at a fixed station. Evidence considered while processing continuous data include, but are not limited to field readings, post-deployment readings, time-series alignment with adjacent deployments, and site conditions (Figure 18). Throughout the QA/QC process it is important to keep the overarching objectives in mind. All corrections and data grades are annotated with comments that explain what was done to the data and a justification.

Typically, data are loaded into Aquarius and processed by deployment period (approximately monthly intervals) with corrections and grades not spanning multiple deployments.

All corrections, grades and justifications are verified using an independent double check process between the SECN aquatic ecologist and SECN hydrologic technician. This means that any record processed by one position is checked and approved by the other.

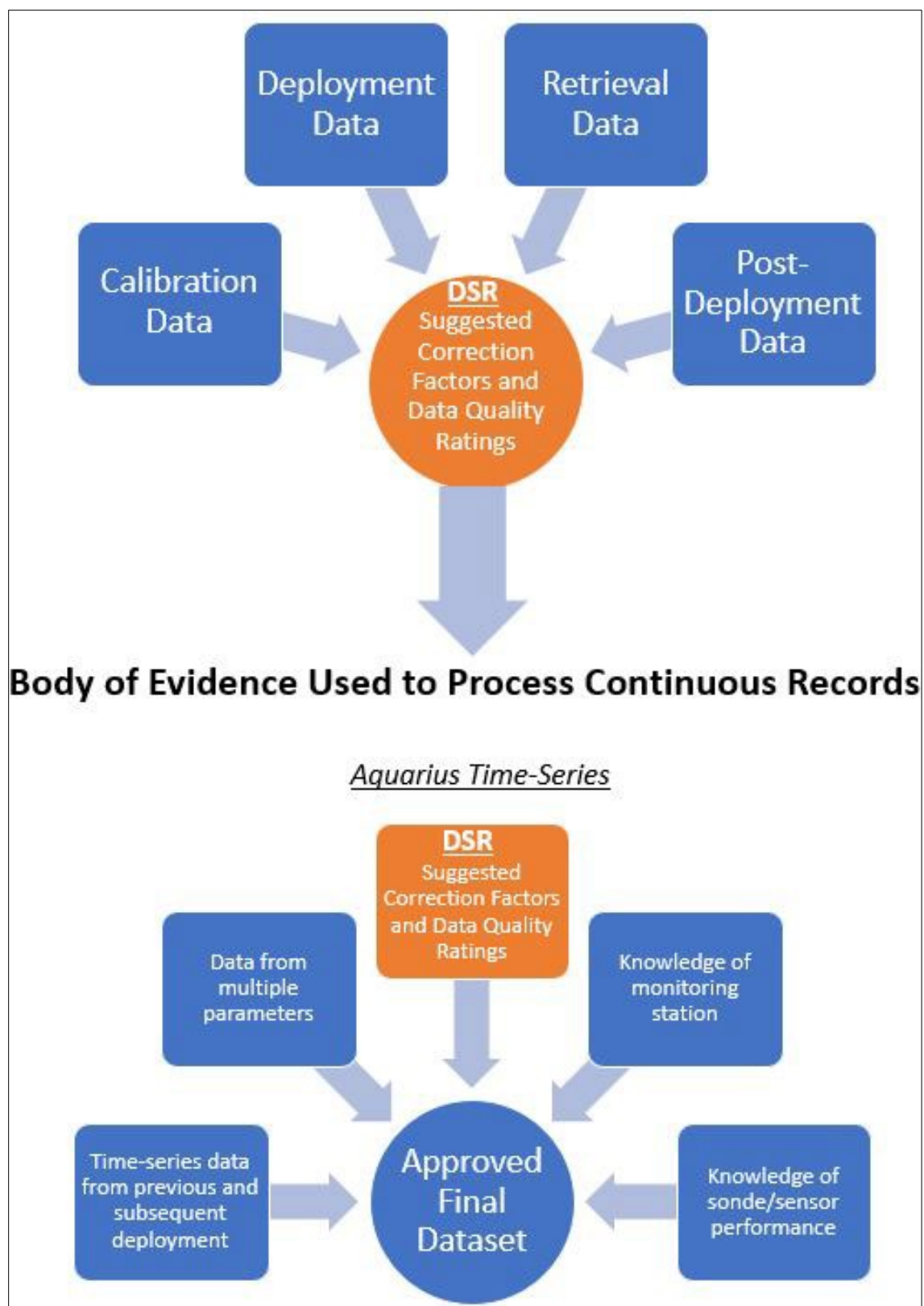


Figure 18. Body of evidence used to process continuous records. DSR is the Data Summary Report generated from the Estuarine Water-Quality Monitoring Database.

Continuous Data Pre-Processing

Before data are loaded into Aquarius, the formatted data file needs to be checked again for any known bad values at the beginning or end of a deployment. The data must be in uniform order with no breaks or extra headers to assure that they load properly. The most common issues and screening are described below. Follow SOP 1.2.09 *Fixed-station, Water-Quality Data Sonde Maintenance, Calibration, Deployment, and Retrieval*—Version 3.0 (McCay et al. 2022) for specific instructions on producing a formatted CSV file through the YSI datasonde KorEXO program and file paths for archiving on the SECN drive.

Trimming invalid data/times

While it is best to avoid collecting invalid data, it often happens that a data point is collected prior to the sonde being deployed in the water or after the sonde has been retrieved. This is sometimes unavoidable due to field constraints and it is an easy fix to screen the data prior to uploading into Aquarius. **It is important to fix these issues outside Aquarius because the program has a first loaded precedent.** This means that a bad value loaded first will restrict an overlapping good value from being loaded with the forthcoming deployment. To prevent this, the beginning and the end of the CSV file must be checked against the deployment/retrieval times listed on the datasheet as well as scanned for any large drops in depth and specific conductivity. Rows that are determined to be invalid are deleted entirely and the file saved (Figure 19). The original BIN file is always kept separately for backup.

Date (MM/DD/YY)	Time (HH:MM)	FracSite Name	Depth m	ODO % sa	ODO mg/L	Sal psu	SpCond m	Turbidity f	Wiper Pos	pH	pH mV	Temp °C	Battery V
8/24/2021	10:30:00	0 SHACK_CA	1.085	96.7	6.08	35.89	54.422	6.57	1.165	8.03	-70.7	29.15	4.55
8/24/2021	10:45:00	0 SHACK_CA	1.071	100.9	6.32	35.88	54.417	7.02	1.167	8.04	-71.4	29.444	4.55
8/24/2021	11:00:00	0 SHACK_CA	1.046	103.6	6.46	35.87	54.415	8.91	1.169	8.05	-71.8	29.698	4.54
8/24/2021	11:15:00	0 SHACK_CA	0.994	105.7	6.57	35.84	54.39	6.02	1.174	8.05	-72.2	29.967	4.54
8/24/2021	11:30:00	0 SHACK_CA	0.953	108.4	6.72	35.82	54.379	6.27	1.166	8.06	-72.6	30.121	4.56
8/24/2021	11:45:00	0 SHACK_CA	0.884	109.9	6.79	35.82	54.381	6.1	1.167	8.06	-72.8	30.335	4.55
8/24/2021	12:00:00	0 SHACK_CA	0.847	111.3	6.85	35.76	54.318	5.9	1.169	8.06	-72.9	30.638	4.55
8/24/2021	12:15:00	0 SHACK_CA	0.047	98.8	7.76	0.04	0.082	1.26	1.166	7.69	-50.9	27.777	4.55

Figure 19. Screen shot of a CSV file showing the drop in depth and specific conductivity during a retrieval. The bottom row was deleted based on the significant drops across multiple parameters indicating the sonde was out of the water.

Checking for Subdivided Files

A common problem with EXO sondes is that they will sometimes produce multiple subdivisions within one BIN file. It is important to catch this early because it could prevent all the collected data from being loaded into Aquarius. As shown in Figure 20, all the subdivisions can be selected and exported into a CSV. Check against the deployment/retrieval times to make sure all the subdivisions were selected. The data can be sorted within the exported CSV file in Microsoft Excel.

To sort:

1. Select the “Date (MM/DD/YYYY)” cell at the beginning of the file.
2. On the keyboard, press Ctrl, Shift, End in sequence. The whole dataset should now be selected.

3. Select “Sort & Filter” from the top toolbox.
4. Within the drop-down menu, select “Custom Sort.” Under “Column,” “Sort By,” select “Time (HH:mm:ss),” click “OK.”
5. Repeat step 4 to sort again by “Date (MM/DD/YYYY).”
6. Visually scan the file to make sure the file is sorted chronologically.
7. The final step is to delete all the extra headers and metadata now sorted to the bottom of the file. Save this file and archive it accordingly. The file should look identical to any exported CSV file from a non-subdivided deployment.

Select Data to View

RECENT DOWNLOADS

☒ Recently Downloaded

START DATE

END DATE

DEVICE SERIAL NUMBER(S)

SITE NAME

INSTRUMENT ID

FILE NAME

USER ID

PARAMETERS

Results

☒	START DATE	END DATE	INSTRUMENT	FILE NAME	DATA S
☒	7/14/2021 1:32:29 PM	7/23/2021 9:02:29 PM	CAHAocbr01 #2	CAHAocbr01_19G104608_071421_13	448
☒	7/23/2021 9:32:29 PM	7/25/2021 6:02:29 PM	CAHAocbr01 #2	CAHAocbr01_19G104608_071421_13	90
☒	7/25/2021 6:32:29 PM	7/30/2021 3:32:29 PM	CAHAocbr01 #2	CAHAocbr01_19G104608_071421_13	235
☒	7/30/2021 4:02:29 PM	8/4/2021 12:02:29 AM	CAHAocbr01 #2	CAHAocbr01_19G104608_071421_13	209
☒	8/4/2021 12:32:29 AM	8/4/2021 12:02:29 PM	CAHAocbr01 #2	CAHAocbr01_19G104608_071421_13	24
☒	8/4/2021 12:32:29 PM	8/5/2021 5:02:29 AM	CAHAocbr01 #2	CAHAocbr01_19G104608_071421_13	34
☒	8/5/2021 5:32:29 AM	8/11/2021 8:02:29 PM	CAHAocbr01 #2	CAHAocbr01_19G104608_071421_13	318
☒	8/11/2021 8:32:29 PM	8/15/2021 12:32:29 PM	CAHAocbr01 #2	CAHAocbr01_19G104608_071421_13	177
☒	8/15/2021 1:02:29 PM	8/16/2021 1:32:29 AM	CAHAocbr01 #2	CAHAocbr01_19G104608_071421_13	26
☒	8/16/2021 2:02:29 AM	8/19/2021 1:32:29 AM	CAHAocbr01 #2	CAHAocbr01_19G104608_071421_13	144
☒	8/19/2021 2:02:29 AM	8/19/2021 12:32:29 PM	CAHAocbr01 #2	CAHAocbr01_19G104608_071421_13	22
☒	8/19/2021 1:02:29 PM	8/23/2021 8:02:29 PM	CAHAocbr01 #2	CAHAocbr01_19G104608_071421_13	207
☒	8/23/2021 8:32:29 PM	8/24/2021 12:02:29 PM	CAHAocbr01 #2	CAHAocbr01_19G104608_071421_13	32

Figure 20. KorEXO program showing a subdivided BIN file because of a sonde malfunction.

AQUARIUS Time-Series Procedures

The procedures outlined in the section require a NPS network connection and access to Aquatic Informatics' Aquarius Time Series v2020.1 or newer on the NRSS server. For access contact the NPS Aquarius system administrator Dean Tucker (dean_tucker@nps.gov). See https://doimspp.sharepoint.com/sites/nps-nrss-wrd/data/Aquarius%20NG%20Documents/00_Getting_Started_Aquarius.docx for more information. Once the installation has been completed, the user can access Aquarius via the Springboard interface.

The workflow for processing data in Aquarius starts with data upload and then proceeds with screening of the data for outliers, application of corrections, and data grades. Subsequently, the data approval level is changed depending upon the level of review completed for the data (Figure 21).

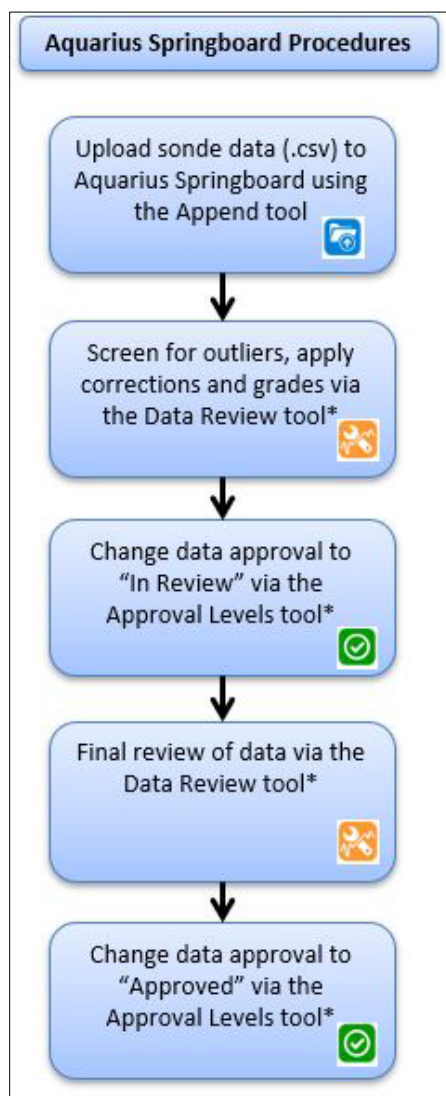


Figure 21. Aquarius data processing workflow. Arrows represent the flow of data and information. Boxes with an asterisk indicate an independent double check process between Aquatic Ecologist and Hydrological Technician.

The procedures to be completed in Aquarius are:

1. Continuous Data Upload
2. Data Correction
 - a. Location and Deployment Period Selection
 - b. Outlier Removal³
 - i. Adjustable Trim
 - ii. Delete Region or Single Point
 - iii. Outlier Trim
 - c. Drift Correction³
 - i. Fouling, Sensor and Total Drift
 - d. Offset³
 - e. Multipoint³
 - i. Offset Correction
 - ii. Pro-rated Correction for Drift or Fouling
 - iii. Advanced Calibration Correction
3. Data Quality Ratings (Grades)
 - a. Sectioning
 - b. Grades and Estimated Grades
 - c. Downgrading³
 - d. Grade Comments
 - e. Apply the Grade
4. Data Processing (Approval) Levels and Final Review (QA)

³ Not all procedures are applicable to data collected during a given deployment. Subsequent sections in this SOP will describe when each procedure is necessary.

- a. Apply the Approval Level
- b. Final Review of Data (QA)

5. Parameter Specific Processing Considerations

1. Continuous Data Upload

Before data can be processed, the CSV file for a deployment must be loaded into Aquarius. Within Aquarius there is the option to set up parsers to allow for ‘drag-and-drop’ loading of routine data files. While manual loading is always available for non-standard files, the Southeast Coast Network has set up parsers for all sites for routine data files. Not only is this more efficient, but it also helps minimize potential issues from loading data incorrectly.

Configuration File Creation and Parser Setup

To set up a parser for a site, a configuration file must first be created. A configuration file tells Aquarius *what* is in the data file, while the parser tells it *where* the data need to be loaded. Only one configuration file is needed for each sonde setup. For instance, all standard sonde setups can use the same configuration file, e.g., Standard_EXO2_2019_EST.cfg. If a sonde has a different sensor setup or records in an incorrect time zone then it will need a separate adjusted configuration file, e.g., ChlBGA_EXO2_2019_EST.cfg for sondes with algae sensors. While only a few configuration files will be needed, each site will have a separate parser. Follow the steps below to create configuration files and assign a parser to a site. The basic steps outlined may also be used to manually load data files that do not fit the usual configuration.

1. Select a site, then select the “Append” tool at the top of the main Aquarius screen, .
2. A blank version of Figure 22 will pop up. In “Step 1,” click  to select a data file, known as a logger file in Aquarius.
3. Now select “Config Settings”.
 - a. In the pop-up window select “Text File (CSV, etc)”. Click “Next.”
 - b. Now in the “Start import at row:” box enter 10. In the “Number of headers:” box enter 1. Make sure the “Delimiters” section is selected for “Comma” Click “Next.” These settings are for the current KorEXO – EXO2 sonde data export and can potentially change with updates.
 - c. Proceed through the next screens using Table 4 as a reference, click on each column to assign the correct date/time format and time zone, parameter, units, and label to each column of the data file. Double check that each column is correct before clicking “Next >>”

- d. “Browse” to the network location to save the configuration file, S:\Monitoring\EstuarineWaterQuality\FixedStation\Data\Aquarius\Parsers. Select “Finish.”
4. Now select the “Load File” button. An overview of the data file should be displayed as shown below in “Step 2” with the assigned parameters and units. Be sure to confirm that the ‘# Points’ Aquarius finds for each parameter matches the number of points you expect.
5. If everything is correct, proceed through each line changing the “Action” to “Append to selected dataset” and in the “Append to” column search for the time-series to which the data will be loaded to (Figure 22).
6. Once all the rows have been assigned to a time-series dataset, select the “Create Parser from Data Sets” button. Select “Ok,” in the pop-up window.
7. The parser is now set up for the selected site. Close the “Append Logger File” window and select “Append Data” from the site hamburger menu on the main Aquarius screen. This will open a new tab where data files for that site can be loaded by ‘drag and drop.’

Append Logger File - Cape Hatteras NS - Ocracoke Boat Ramp and Dock | CAHAocbr01

Append data from a logger file and set up a parser to allow easy logger data updates for the location.

Step 1: Select a logger file and load it:

Logger File:
S:\Monitoring\EstuarineWaterQuality\FixedStation\Data\Sonde Data\CAHAocbr01\2021\Formatte

...

Config File:
S:\Monitoring\EstuarineWaterQuality\FixedStation\Data\Aquarius\Parsers\Standard_EXO2_20

(Optional)

...

View Logger File

Load File

Config Settings...

Step 2: Choose the target data sets and append:

Append the data from the logger file selected above to an existing data set or create a new data set.
When creating a new data set, attributes from Step 1 above will be used to describe the data parameter, label and unit

Label	Pararr	Units	# Poir	From	To	Action	Append to	Status
Depth n	DepthFi	m	1965	2021-07-14 14:0;	2021-08-24 12:0;	Append to s	DepthFromWater CAHAocbr01 De	
ODO %	Dis Oxy	%	1965	2021-07-14 14:0;	2021-08-24 12:0;	Append to s	Dis Oxygen Sat.Ir CAHAocbr01 Di	
ODO m	O2 (Dis)	mg/l	1965	2021-07-14 14:0;	2021-08-24 12:0;	Append to s	O2 (Dis).Instanta CAHAocbr01 O;	
Sal psu	Water S	PSU	1965	2021-07-14 14:0;	2021-08-24 12:0;	Append to s	sa	
SpCond	Sp Conc	mS/cm	1965	2021-07-14 14:0;	2021-08-24 12:0;	Do not appe	Water Salinity.Instantaneous CAHAocbr01 Water Salinity Instantaneous	
Turbidit	Turbidit	_FNU	1965	2021-07-14 14:0;	2021-08-24 12:0;	Do not appe		
pH	pH	pH Unit	1965	2021-07-14 14:0;	2021-08-24 12:0;	Do not appe	Do not append	
pH mV	pH Volt	mV	1965	2021-07-14 14:0;	2021-08-24 12:0;	Do not appe	Do not append	
Temp °C	Water T	°C	1965	2021-07-14 14:0;	2021-08-24 12:0;	Do not appe	Do not append	
Battery	Battery	V	1965	2021-07-14 14:0;	2021-08-24 12:0;	Do not appe	Do not append	

Create Parser From Data Sets

Manage Existing Parsers

Append

History:

Figure 22. Append data toolbox.

Table 4. Append data settings to load data and set up parsers. Column numbers can change depending on sensor setups and malfunctions. It is important to match Column Headers with the correct assignment, parameter, and units shown below.

Column #	Column Header	Assignment	Date/Time Format	Time Zone	Parameter	Units
Column 1	Date (MM/DD/YYYY)	Date/Time:	mm/dd/yyyy	UTC-05:00 (EST)	–	–
Column 2	Time (HH:mm:SS)	Date/Time:	HH:MM:SS	UTC-05:00 (EST)	–	–
Column 3	Time (Fract.Sec)	Skip	–	–	–	–
Column 4	Site Name	Skip	–	–	–	–
Column 5	Depth m	Data	–	–	DepthFromWaterPressure	m
Column 6	ODO % sat	Data	–	–	Dis Oxygen Sat	%
Column 7	ODO mg/L	Data	–	–	O2 (Dis)	mg/L
Column 8	Sal PSU	Data	–	–	Water Salinity	PSU
Column 9	SpCond mS/cm	Data	–	–	Sp Cond	mS/cm
Column 10	Turbidity FNU	Data	–	–	Turbidity, Form Nept	FNU
Column 11	Wiper Position volt	Skip	–	–	–	–
Column 12	pH	Data	–	–	pH	pH
Column 13	pH mV	Data	–	–	pH Voltage	mV
Column 14	Temp C	Data	–	–	Water Temp	Deg C
Column 15	Battery V	Data	–	–	Battery Voltage Under Load	V
			–	–		
*Column 5	Chlorophyll	Data	–	–	Chlorophyll	ug/L
*Column 11	BGA	Data	–	–	BGA	ug/L

* For sondes with chlorophyll/blue green algae sensors, the columns will be shifted due to the addition of the two additional parameters. For example, “ODO% sat” would become “Column 7” and “Battery V” would then be “Column 17”.

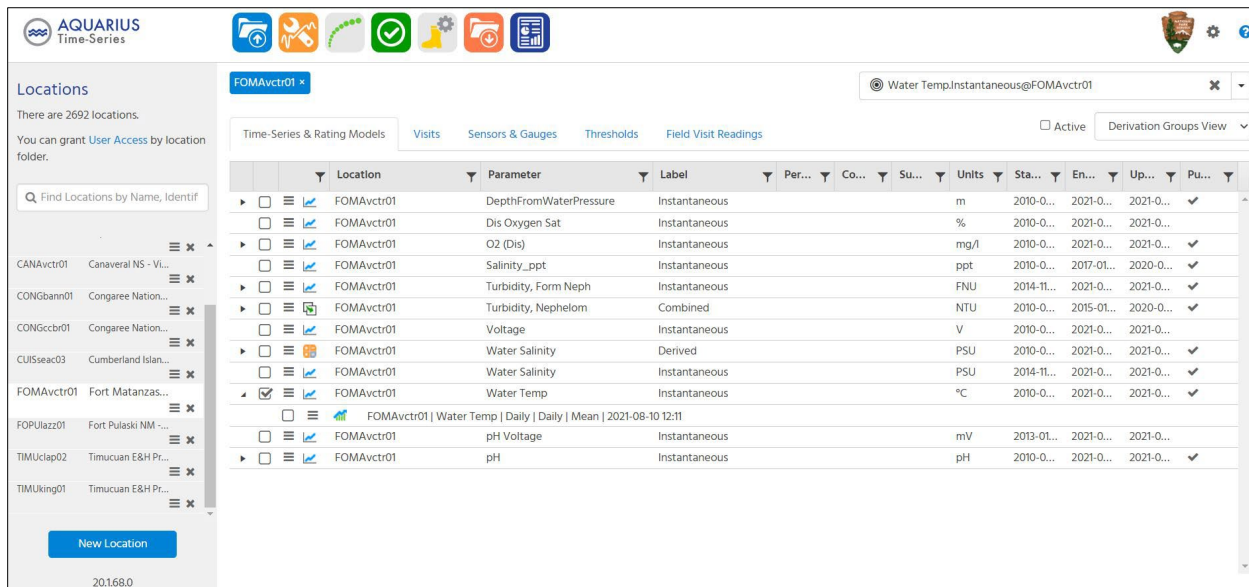
2. Data Correction

Location and Deployment Period Selection

1. Open Aquarius Springboard.
2. Within the Locations menu on the left, search for a location or select a location shown below the search box (Figure 23). Locations will only appear below the search box when they have been previously viewed, because they are stored in the browser's cache.
3. With a location selected, all available parameters for that location will be visible in the Time-Series & Rating Models tab (Figure 23). Select the check box to the left of a “Basic Time-Series” for a given parameter () (labeled as “Instantaneous”), and then click the icon for Data Review .

Corrections are applied to the basic time-series () and are not applied to statistically derived () (e.g., daily mean water temperature) or calculated derived () (e.g., salinity) time series.

4. From the Power BI Report Server, open the Deployment Summary QC Report for the deployment period of interest (see procedures earlier in this SOP). This report will serve as reference for the correction factors and data grades.
5. With the Aquarius Data Review Toolbox open, navigate to the deployment period of interest and use the Selection Tool to highlight the corresponding data. The Edit pane is useful for refining the selected dates and times (Figure 24).



The screenshot shows the Aquarius Time-Series application interface. On the left, the 'Locations' menu is open, displaying a list of locations including CANAvctr01, CONGBann01, CONGccbr01, CUISseac03, FOMAvctr01, FOPulazz01, TIMUclap02, and TIMUking01. The main panel shows the 'Time-Series & Rating Models' tab for the selected location 'FOMAvctr01'. A table lists various parameters and their corresponding data series. The 'Water Temp' row is selected, showing an 'Instantaneous' data series with units in °C. The table columns include Location, Parameter, Label, Units, Sta..., En..., Up..., and Pu....

Location	Parameter	Label	Units	Sta...	En...	Up...	Pu...
FOMAvctr01	DepthFromWaterPressure	Instantaneous	m	2010-0...	2021-0...	2021-0...	✓
FOMAvctr01	Dis Oxygen Sat	Instantaneous	%	2010-0...	2021-0...	2021-0...	✓
FOMAvctr01	O2 (Dis)	Instantaneous	mg/l	2010-0...	2021-0...	2021-0...	✓
FOMAvctr01	Salinity_ppt	Instantaneous	ppt	2010-0...	2017-01...	2020-0...	✓
FOMAvctr01	Turbidity, Form Neph	Instantaneous	FNU	2014-11...	2021-0...	2021-0...	✓
FOMAvctr01	Turbidity, Nephelom	Combined	NTU	2010-0...	2015-01...	2020-0...	✓
FOMAvctr01	Voltage	Instantaneous	V	2010-0...	2021-0...	2021-0...	✓
FOMAvctr01	Water Salinity	Derived	PSU	2010-0...	2021-0...	2021-0...	✓
FOMAvctr01	Water Salinity	Instantaneous	PSU	2014-11...	2021-0...	2021-0...	✓
FOMAvctr01	Water Temp	Instantaneous	°C	2010-0...	2021-0...	2021-0...	✓
FOMAvctr01	Water Temp Daily Mean 2021-08-10 12:11						
FOMAvctr01	pH Voltage	Instantaneous	mV	2013-01...	2021-0...	2021-0...	✓
FOMAvctr01	pH	Instantaneous	pH	2010-0...	2021-0...	2021-0...	✓

Figure 23. Aquarius Time-Series location and time-series selection screen.

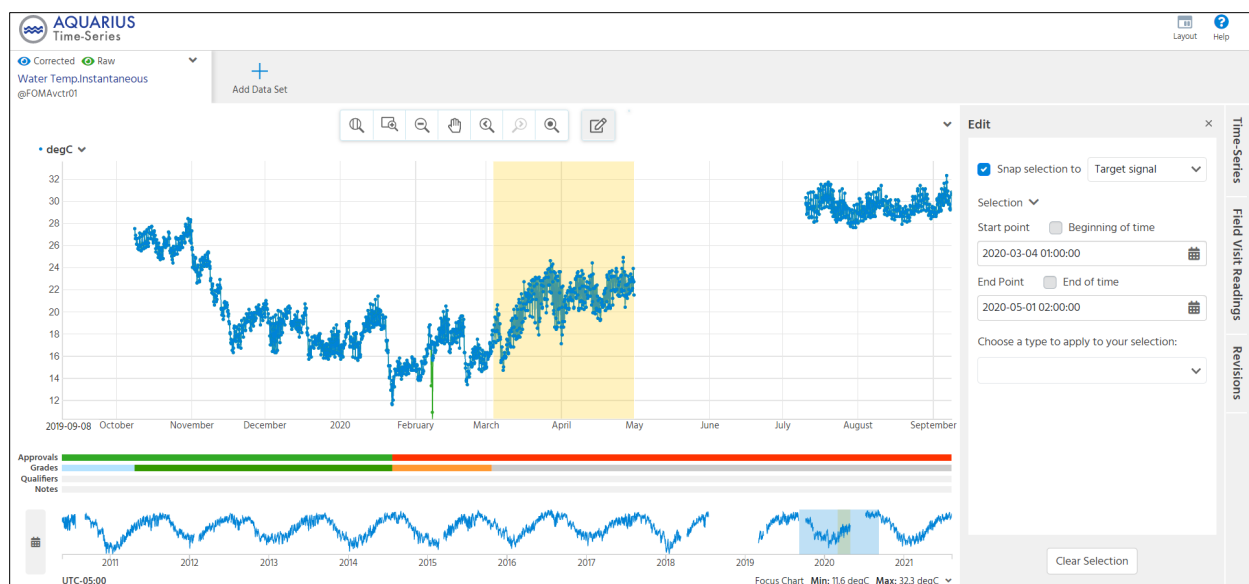


Figure 24. Aquarius Time-Series Data Review Toolbox – Water temperature data selection.

Outlier Removal

Outliers are extreme values that do not represent actual conditions at a monitoring station. Common causes of outliers are sensor error and the erratic effects of fouling. These values generally fall well outside the range of average daily maximums and minimums experienced at a site and are identifiable with a visual scan of the data. If a value is visually identifiable as being well above or below the moving approximate 1.5-hour average, it may be an outlier. Due to the 30-minute frequency of data collection, storm and flood events generally cause multiple readings leading up to, and down from, the most extreme value. In other words, natural extreme events have a signature that differs from outliers caused by fouling or sensor error. It is often helpful to compare suspect extreme values to periods with data collected during known extreme events (e.g., hurricanes, floods). When in doubt, err on the side of leaving data intact rather than removing an outlier from the data set. The data grade can always be downgraded if there is less confidence in the quality of data (see Data Quality Ratings section).

The original raw time-series is maintained alongside the corrected time-series and “deleted” data are only removed from the “corrected” time-series. In other words, incorrect removal of an outlier can be undone during the review process.

Note that extreme values at one monitoring station may not represent extreme values at another. This is particularly the case for turbidity. For example, 50 FNU at CAHAocbr01 would be an extreme value, whereas 50 FNU occurs with frequency at CUISseac03. An extreme reading at CUIseac03 would be over 150 FNU. For this reason, it is important to keep in mind the typical range of each parameter at each monitoring station.

With the deployment period selected there are several correction types available in Aquarius for removing outliers, including Adjustable Trim, Delete Region, and Outlier Trim. It is possible to use

all, or a combination of these, to remove outliers and erroneous readings. **Regardless of the method used to remove outliers, the processing priority is set to “Pre” for all suppression of data (Table 5 and Figure 25).** If no outliers are present, proceed to the next section (Drift Correction).

Adjustable Trim

This correction type is useful when there are multiple outliers throughout the deployment period. Any values outside the sensor limits identified in Table 6 are removed using this or the Outlier Trim type.

1. With a region of data selected, open the Edit pane on the right side of the screen and select “Adjustable Trim” from the drop-down menu (Figure 25).
2. Change the processing priority to “Pre” (Figure 25).
3. Select the upper or lower limit icon  and then add cut points to the time-series graph (Figure 25). Anything above or below these limits will be trimmed. The exact limits can also be changed within the Edit pane (Figure 25).
4. Add a comment describing why the points were trimmed.
5. When finished click “Apply.”

Table 5. Correction processing priority settings in Aquarius.

Processing Priority in Aquarius	When to use?
Pre, Set 1	Fouling correction, delete region, adjustable trim, outlier trim
Normal, Set 2	Instrument drift correction, total correction (drift + fouling)
Post, Set 3	Offsets (calibration issues)

Table 6. YSI EXO2 data sonde sensor upper and lower limits (YSI 2014). [mg/L—milligrams per liter; mS/cm—milli-Siemens per centimeter; m—meter; ft—foot; FNU—formazin nephelometric unit].

Parameter	Range
Dissolved oxygen (mg/L)	0 to 50 mg/L
Specific Conductivity	0 to 200 mS/cm
Temperature	-5 to +50 °C
pH	0 to 14
Depth	Shallow: 0 to 33 feet (10 meters)
Turbidity	0 to 4000 FNU
Chlorophyll	0-400 µg/L
Blue Green Algae (BGA)	0-2800 µg/L

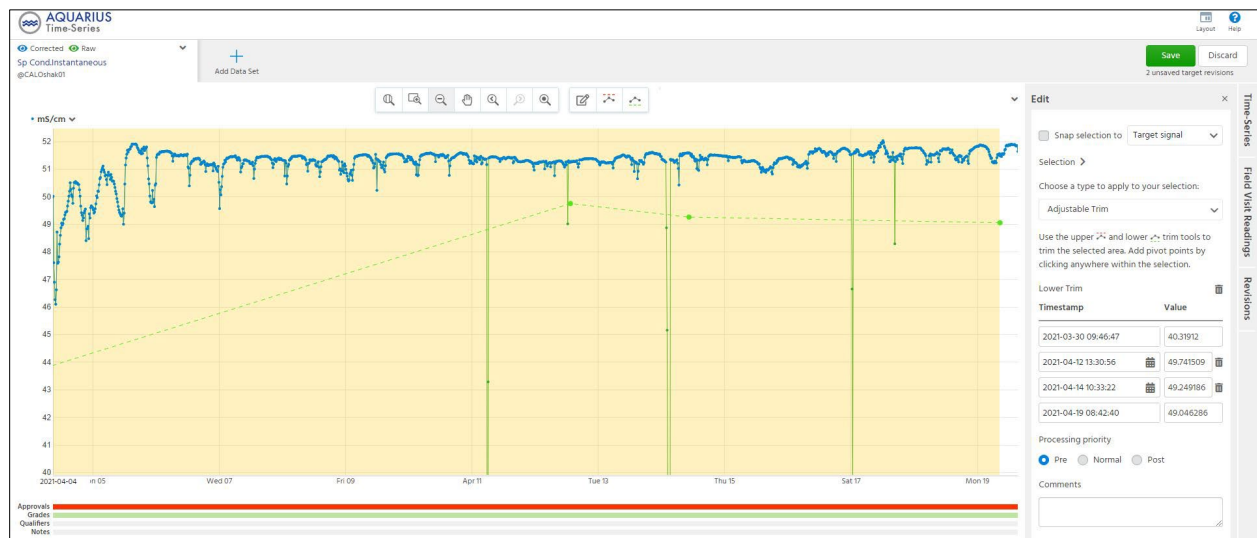


Figure 25. Adjustable Trim, lower limit outlier removal. The green dashed line indicates the lower limit, and the green dots are outliers that have been removed.

Delete Region or Single Point

This correction type is useful when an entire segment of data or a single datum needs to be suppressed due to sensor or sonde failure (i.e., data is erroneous and un-correctable). In addition, if the Data Summary QC Report indicates that the sensor was outside of the maximum allowable limits (Table 3) and is rated as “Unusable,” the data are deleted. Note that data are only “deleted” from the corrected time-series.

1. With a region of data, or single point selected, open the Edit pane on the right side of the screen and select “Delete Region” from the drop-down menu (Figure 26).
2. Change the processing priority to “Pre” (Figure 26).
3. Add a comment describing why the points were deleted.
4. When finished click “Apply.”

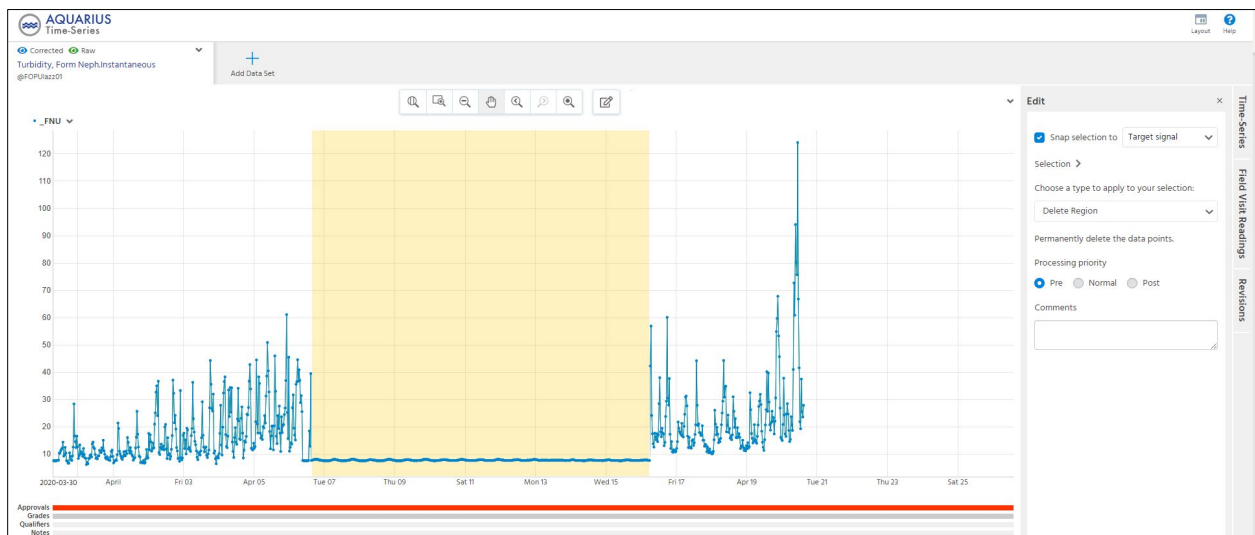


Figure 26. Data selected for Delete Region correction type.

Outlier Trim

The outlier trim correction is useful for the automated removal of values outside of a specified tolerance. This tool is convenient, but it requires working knowledge of the parameter at a given monitoring station during a given season. Blanket application of an outlier trim correction may result in the removal of data that are representative of field conditions. Table 7 shows general thresholds that may be useful starting points for processing SECN estuarine water-quality data. Again, this tool must be used with caution as the thresholds in Table 7 are starting points that need to be refined situationally.

1. With a region of data, or single point selected, open the Edit pane on the right side of the screen and select “Outlier Trim” from the drop-down menu (Figure 27).
2. Define the specific tolerance outside of which data should be removed (Table 7 and Figure 27):
 - a. Pick the appropriate deviation from Min, Max or Average
 - b. Define the window size in minutes. This is the rolling window.
 - c. Enter the deviation value.
3. Change the processing priority to “Pre” (Table 5 and Figure 27).
4. Add a comment describing why the points were deleted.
5. When finished click “Apply.”

Table 7. Suggested tolerance settings for the outlier trim tool.

Parameter	Units	Deviation From	Window Size	Deviation Value
Blue Green Algae	µg/l	Average	180	5.0
Chlorophyll	µg/l	Average	180	1.0
Depth	M	Average	60	0.1
Dissolved Oxygen Concentration	mg/l	Average	60–180	0.2–1.0
pH	pH	Average	60	0.1
Specific Conductance	mS/cm	Average	180	0.5–1.0
Temperature	°C	Average	180	0.5
Turbidity	FNU	Average	60–180	10

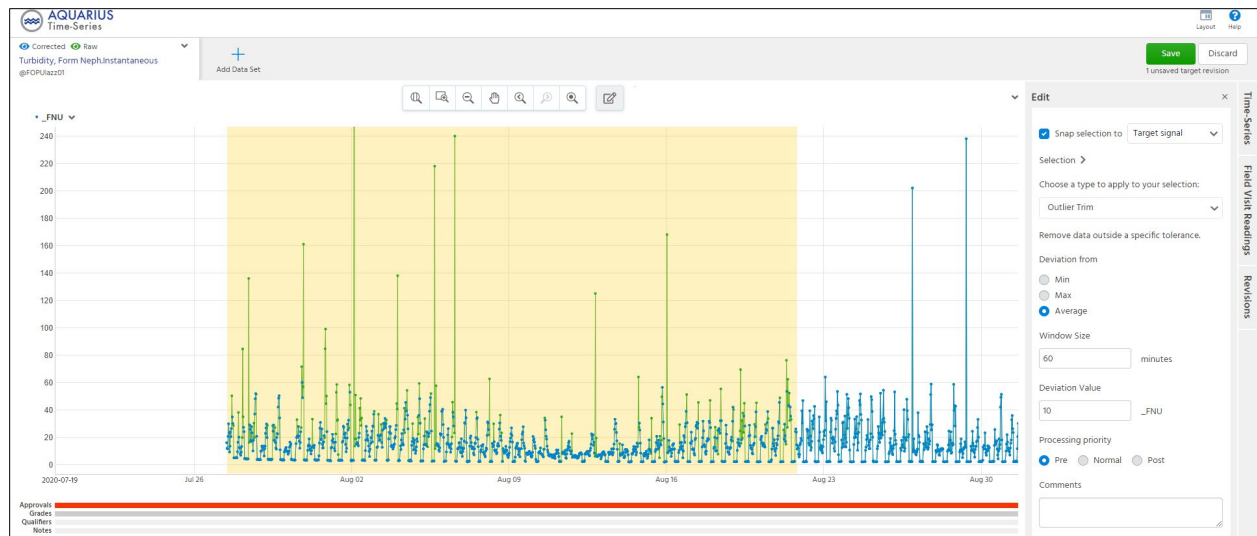


Figure 27. Application of Outlier Trim to a turbidity (FNU) time series.

Outlier Removal Example

A useful tactic for determining if an outlier represents actual field conditions is to view multiple parameters in the same graph. For example, turbidity data are often processed while viewing water depth and/or specific conductance. When turbidity data in Figure 28 are viewed for CUISseac03 it initially appears that there are potential outliers present throughout the period. However, when water depth is added it is more apparent that this site experiences extra variability and spikes before and after high tide (Figure 29). After viewing both datasets we can reasonably conclude that the spikes in turbidity are real and not a product of fouling or sensor error. This observation has also been confirmed in the field. For this site, turbidity values over 150 FNU are rare even during a hurricane.

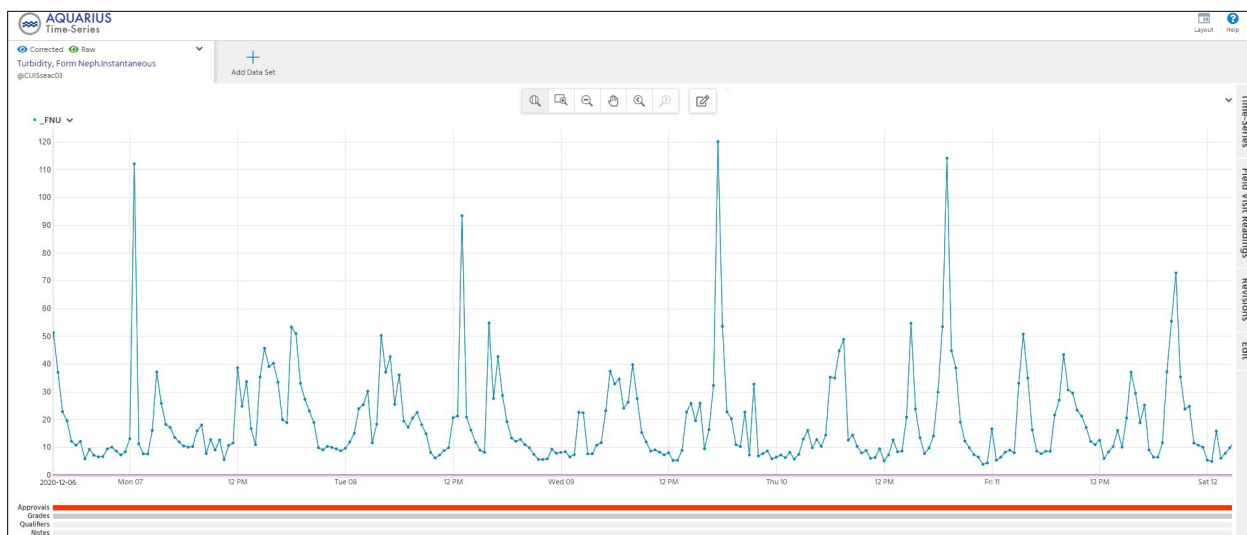


Figure 28. Turbidity data from the Cumberland Island Sea Camp monitoring station (CUISseac03).

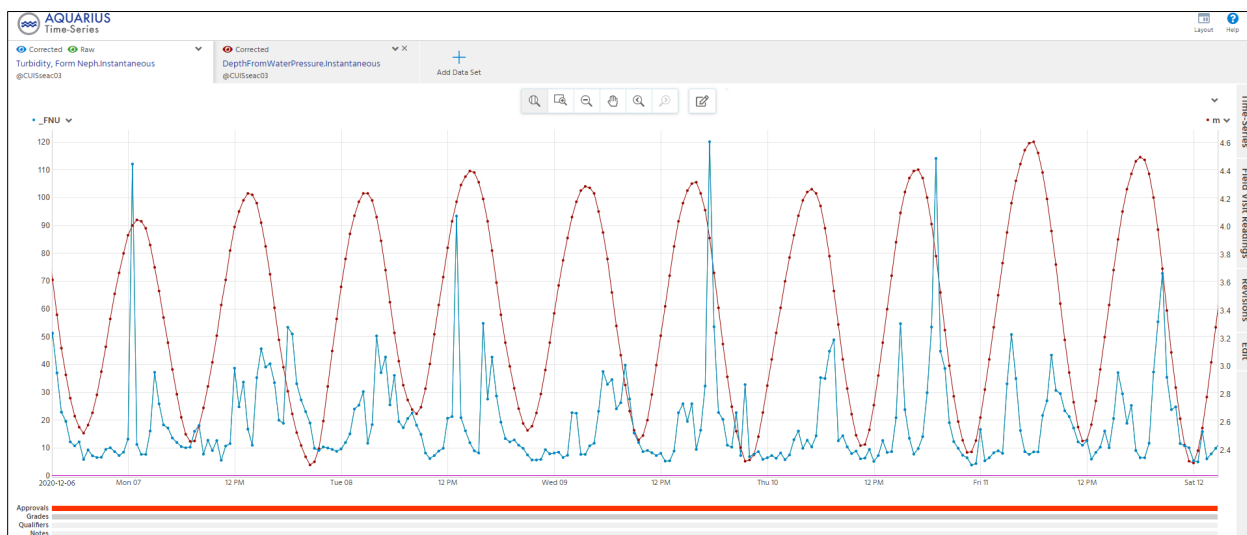


Figure 29. Turbidity and depth data from the Cumberland Island Sea Camp monitoring station (CUISseac03).

Drift Correction

Following the removal of outliers, data from a deployment period are corrected as needed for sensor calibration drift and fouling drift. These are the most common correction types applied to continuous water-quality data collected by the Southeast Coast Network. As described earlier in this SOP, the degree of calibration and fouling drift are estimated using field readings and post-deployment evaluation of sensors. These data are recorded in the SECN Estuarine Water-Quality Monitoring Database where the Deployment Summary Report (DSR) displays the suggested correction factors. Due to variability caused by site and sensor conditions, the correction factors shown in the DSR need to be interpreted situationally and may or may not need to be applied in Aquarius. In many cases, some level of professional judgment must be used to determine when a correction is necessary. The next section will help codify the decision-making process.

When to apply a drift correction?

The decision to apply calibration drift or fouling drift corrections is nuanced and based on the body of evidence in support of, or against, correction (Figure 18). Ideally, if the total suggested correction (fouling + drift) exceeds the criteria in Table 1, the time-series should be corrected. The correction would then bring the time-series into alignment with the previous and subsequent data. Due to the dynamic, high-fouling nature of estuaries and swapping sondes (*in situ* and field; See SOP 1.2.09 *Fixed-Station, Water-Quality Data Sonde Maintenance, Calibration, Deployment, and Retrieval—Version 3.0* [McCay et al. 2022]), the decision to correct or not correct for fouling and drift is rarely straight forward. Figure 30 depicts the basic decision-making process.

In addition, several important points to consider before application of drift corrections are:

- Error may have been introduced at any point throughout the data collection process (calibration, deployment, retrieval, transport, post-deployment) and may affect data quality.
- Field and post-deployment readings may indicate that the sensors functioned within tolerance, yet environmental conditions may affect data accuracy during part of or the entire deployment period.
- Suggested correction factors are only as good as the associated field and post-deployment readings. There are times when field readings are less reliable than others (e.g., bad weather, staffing issues, *in situ* or field sonde malfunction). While procedures are in place to minimize error, field reading irregularities may cause a deployment to be incorrectly flagged for correction; or conversely, indicate that the data are of “Excellent” quality despite obvious issues during the deployment.
- The data correction criteria, maximum allowable limits, and ratings of accuracy in Tables 1 – 3 are considered guidelines that should be adhered to in most circumstances. However, some deployments may dictate departure from these criteria, in which case a justification must be provided within the comment field associated with the correction or grade.

- In Aquarius, the comments field associated with drift correction is used to document the type of correction (i.e., fouling, drift or total; Figure 31). In addition, this field is used to explain and justify complex non-routine corrections. Other justifications and routine explanations are included in the comments field associated with the data grade (e.g., battery power lost, suggested correction not applied due to negative values). These comments and justifications are helpful to the person who will double check the record before final approval.
- Data from the previous and subsequent deployments can be used as a guide to determine if the application of a correction will reasonably align the time-series. However, do not assume that the subsequent time-series is correct; double check the deployment and retrieval records.
- If confidence in the correction factors is lacking or a correction cannot be applied, the time-series data quality rating can always be downgraded (e.g., Good to Fair, Fair to Poor). See the Data Quality Ratings section below.

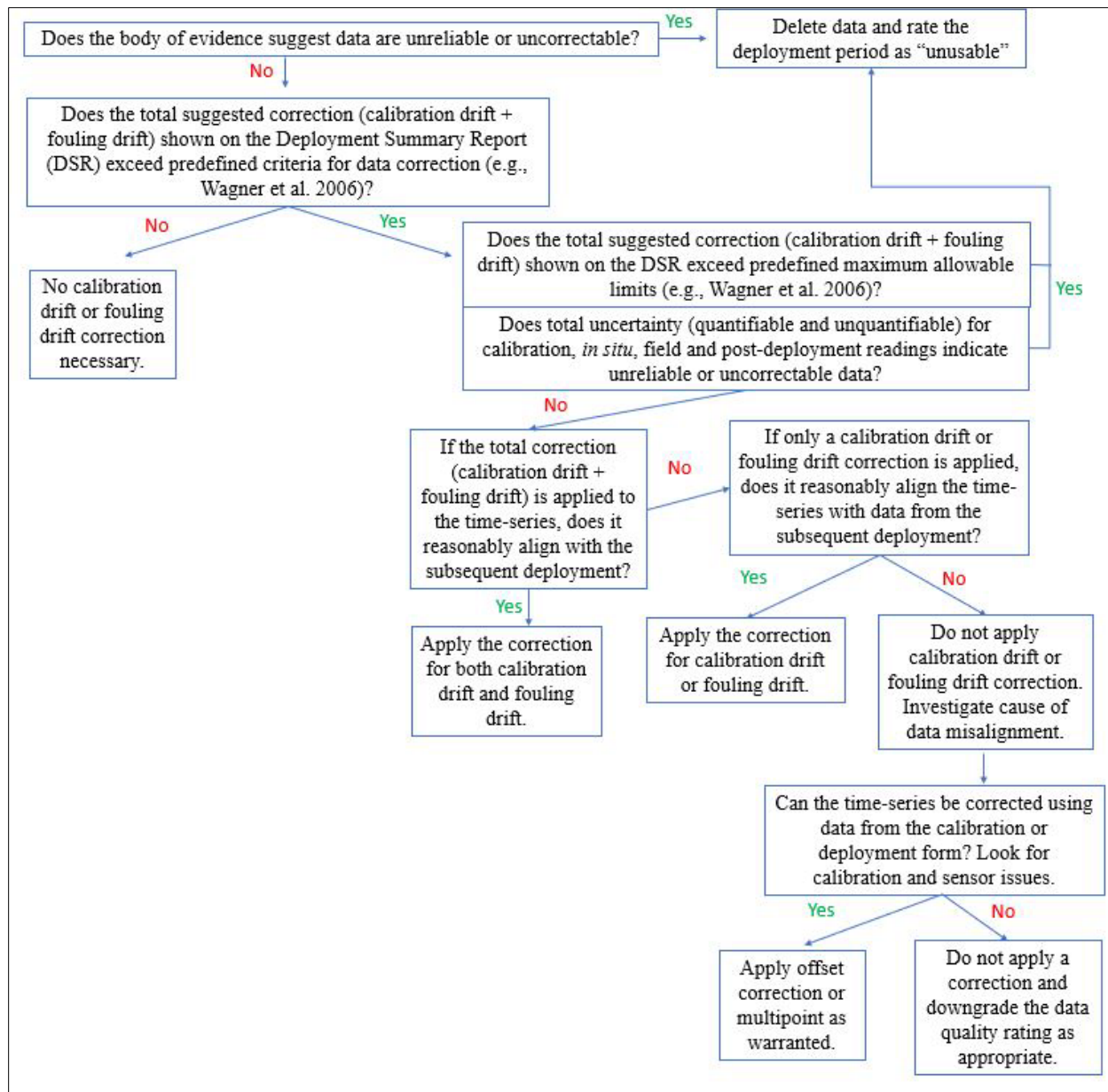


Figure 30. Decision tree for the application of calibration drift and fouling drift corrections in Aquarius.

Fouling, Calibration and Total Drift

Fouling Drift, Calibration Drift, and Total Drift are all applied using the “Drift” correction type found in the Editing pane’s drop-down menu. It is possible to apply multiple drift type corrections to the same deployment period, so it is important to denote the kind of drift correction being applied in the comments field. **Typically, fouling and calibration drift corrections are applied separately, although situations arise when these are applied together as a total drift correction. For all drift corrections, the processing priority is set to “Normal” (Table 5 and Figure 31).** If no drift correction is required, proceed to the next sections (Offset and Multipoint).

This correction type is used to apply a pro-rated correction from beginning to end of a selected period of record. The selected period generally corresponds to the entire deployment period for a given sonde and sensor. Selection of a time-period shorter than the deployment period is acceptable in some cases; however, a drift correction must never be applied across multiple deployments. **Selection of a time period shorter than the deployment period may be acceptable when there is a defined and clear onset of fouling that does not correspond to the deployment date.**

1. Review the Deployment Summary Report (DSR) and time-series data for the deployment period (See example DSR in Appendix B). Based on the correction criteria and body of evidence, determine if a fouling, calibration, or total drift correction is appropriate (Tables 1 and 3).
2. With a region of data selected, open the Edit pane on the right side of the screen and select “Drift” from the drop-down menu (Figure 31). When the drift correction type has been selected a purple line will appear with end points at the beginning and end of the selected region (Figure 31). These end points correspond to offset points 1 and 2 mentioned in step 4.
3. Change the processing priority to “Normal” (Figure 31).
4. For a standard pro-rated correction leave Offset 1 set to zero (i.e., no adjustment) (Figure 31).
5. Enter the correction factor into the Offset 2 field (Figure 31).
6. Enter “Fouling Drift”, “Calibration Drift” or “Total Drift” in the comments field to denote which type of drift correction was applied. In addition, explain atypical corrections.
7. Click “Apply.”
8. If fouling and calibration drift corrections will be applied separately, repeat steps 1 through 7 until all corrections have been applied.

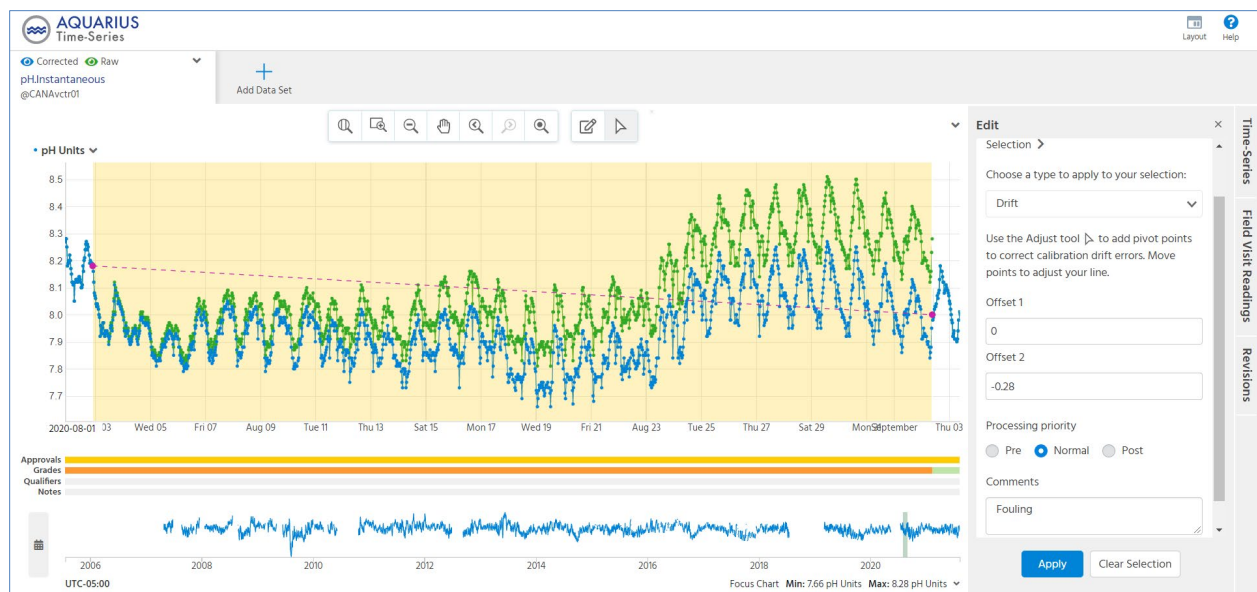


Figure 31. Fouling drift correction applied to pH collected at the CANAvctr01 monitoring station.

Drift Correction Examples

Figure 32 shows a simple fouling drift correction for specific conductance data collected at Canaveral National Seashore monitoring station (CANAvctr01). Field readings indicate that a correction of 2.43 mS/cm is necessary. When the correction is applied, the time-series cleanly aligns with the subsequent deployment. Note that the outliers (downward spikes) for this time-period were removed in a previous step.

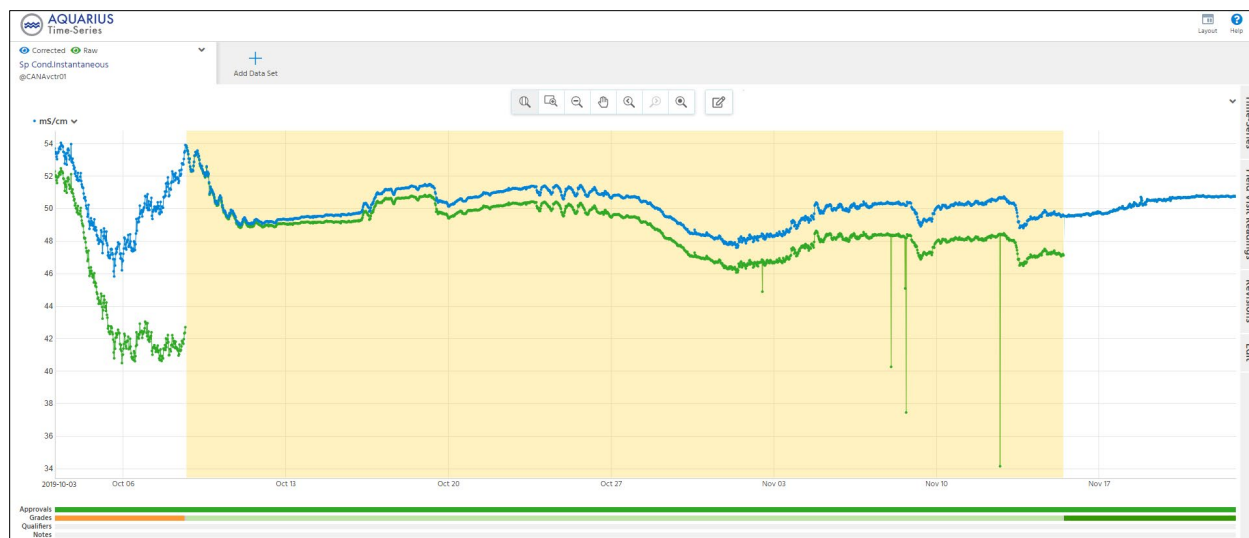


Figure 32. Fouling drift correction of 2.43 mS/cm based on field readings applied to specific conductance data collected at the CANAvctr01 monitoring station.

Figure 33 shows a more complicated example for turbidity data collected at Canaveral National Seashore monitoring station (CANAvctr01). In this situation, the deployment summary report indicated that a correction was necessary: -0.30 FNU calibration drift correction and 0.90 FNU fouling drift correction, for a total correction of 0.60 FNU. When the sonde was retrieved, it was noted that the sensor guard was highly fouled and was restricting water exchange with the environment. There was a high degree of confidence in the on-site field readings with a clean sonde and the initial data from the subsequent deployment. For this reason, the final drift correction of 1.5 FNU was based on a combination of the documented fouling, data from the subsequent deployment, and professional judgement. Data for this deployment period was rated as “Fair.” Note how the combination of field readings, post-deployment evaluation, subsequent deployment data, and site observations was used to correct the data.

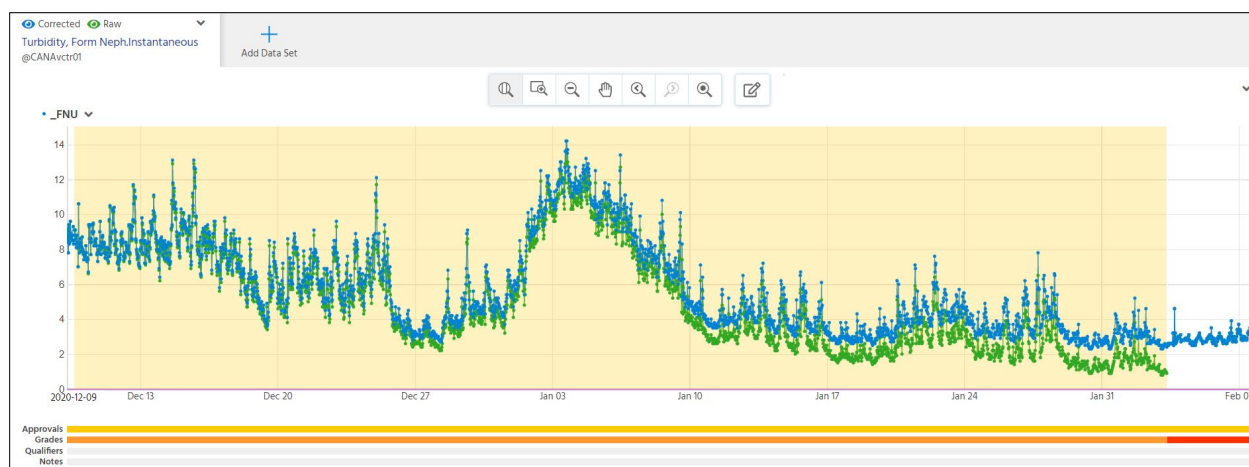


Figure 33. Turbidity drift correction of 1.5 FNU based on field reading, subsequent deployment and on-site observations.

Offset

Offset corrections are used when the entire range of selected data needs to be shifted up or down by a constant amount. In general, it is relatively easy to identify when this type of correction is necessary because the data are misaligned with the preceding and subsequent time-series. The most common cause of this misalignment is calibration error. The appropriate correction factor can often be determined using data recorded on the pre-deployment/calibration form (Appendix A) and the post-deployment readings recorded on the retrieval/post-deployment form (Appendix A). The total error shown in the Deployment Summary Report will also indicate if an offset correction is appropriate (Appendix B).

1. Review the Deployment Summary Report (DSR) and time-series data for the deployment period (See example DSR in Appendix B). Based on the correction criteria and body of evidence, determine if an offset correction is appropriate (Tables 1 and 3).
2. With a region of data selected, open the Edit pane on the right side of the screen and select “Offset” from the drop-down menu (Figure 34).
3. Change the processing priority to “Post” (Figure 34).
4. Enter the desired “Offset.”
5. Enter “Comments” as necessary.
6. Click “Apply.”

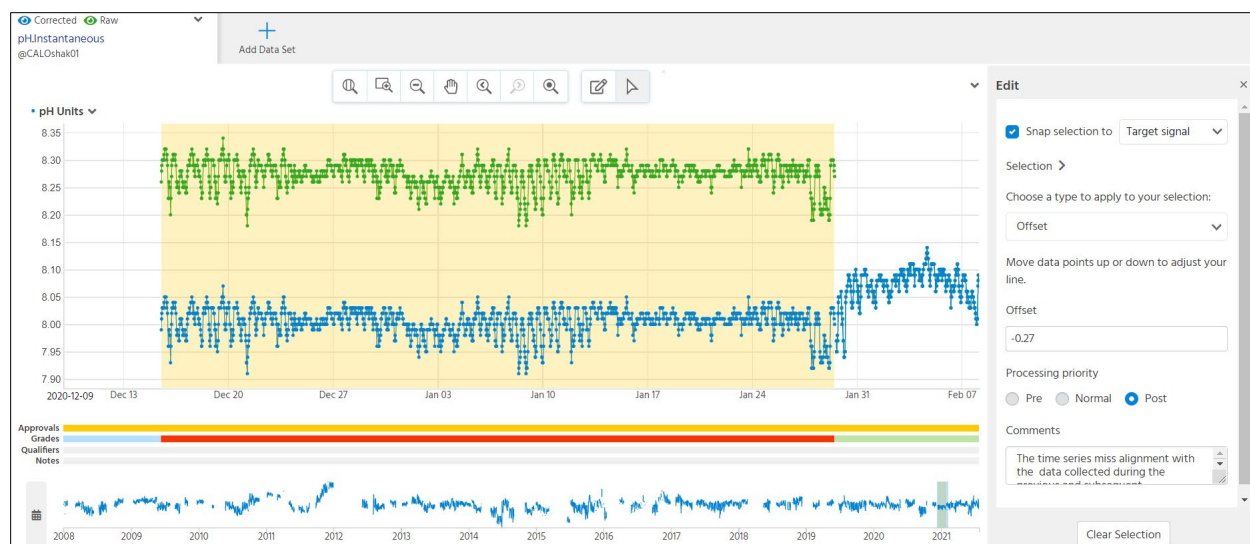


Figure 34. Offset correction applied with the Offset correction type.

Multipoint

This correction type can be used to simultaneously apply up to three corrections. When applying simple drift and offset corrections, the Southeast Coast Network preferentially uses the “Drift” and “Offset” correction types rather than “Multipoint” due to their simple user interface. However, the multipoint grid interface offers more flexibility for situations that require complex corrections and helps avoid entering compound corrections. Examples of how to use the “multipoint” correction type to apply drift and offset corrections are provided below.

In general, the multipoint correction “is used when the sensor/measuring device correction varies depending on the magnitude of what is being measured (Aquatic Informatics 2019).” In other words, the user can specify if the sensor measured values between 0 and X, the correction to apply is A but if the sensor measured above X, then the correction is B. This use is outlined in the advanced calibration correction section below.

More information about the multipoint correction type can be found in the Aquarius documentation and guidance documents on the NPS Water Resources Data Management SharePoint site <https://doimspp.sharepoint.com/sites/nps-nrss-wrd/data/Pages/AquariusNG.aspx> (Accessed November 2021).

Offset correction

1. With a region of data selected, open the Edit pane on the right side of the screen and select “MultiPoint” from the drop-down menu (Figure 35).
2. Expand the “Advanced” correction box (Figure 35).
3. Change the “Processing priority” to “Post (Set 3).”
4. Set the “Status” to “Normal.”
5. Leave the “Start Point” “Input” set to zero (Figure 35).
6. Enter the desired offset factor in the “Start Point” “Point” box.
7. No entry is necessary for the “End Point.”
8. Click “Apply.” The correction factor should be applied and be visible. If all looks OK, “Save” the revision.

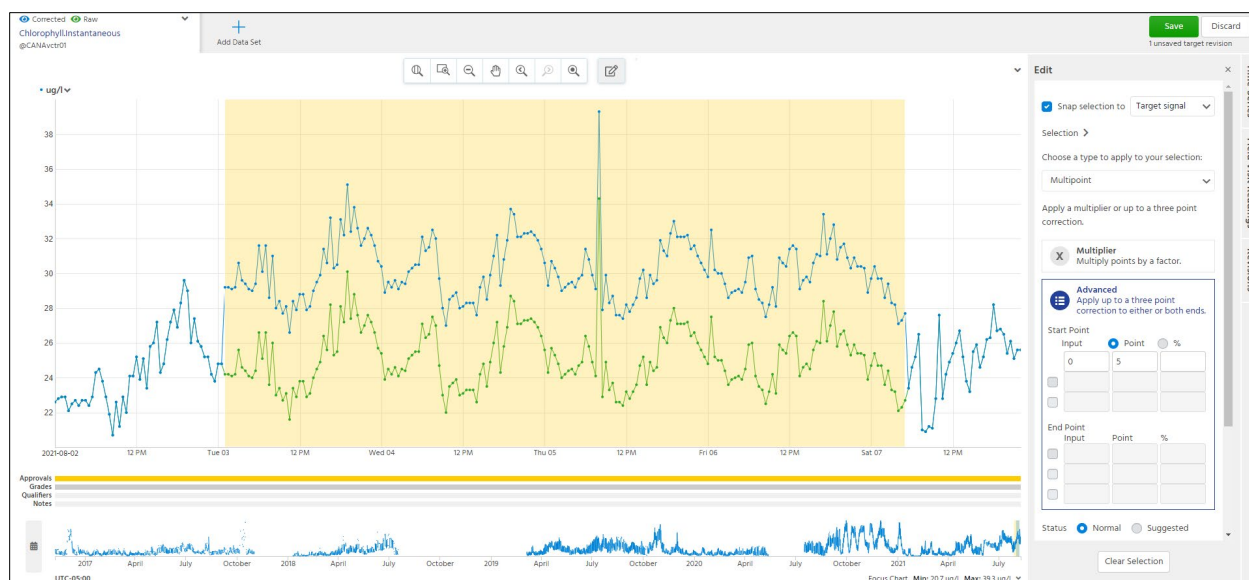


Figure 35. Advanced multipoint correction settings to apply an offset. Note that this correction was applied for demonstration only and does not represent data in need of a real offset correction.

Pro-rated correction for drift or fouling

1. With a region of data selected, open the Edit pane on the right side of the screen and select “MultiPoint” from the drop-down menu (Figure 36).
2. Expand the “Advanced” correction box (Figure 36).
3. Change the “Processing priority” to “Normal (Set 2).”
4. Set the “Status” to “Normal.”
5. Leave the “Start Point” “Input” and “Point” set to zero (Figure 36).
6. Check the first box next to “End Point” “Input” to make the row editable. For the “End Point” “Input,” enter an arbitrary value above the maximum for the deployment period. This is done to encompass all data collected during the deployment.
7. For the “End Point” “Point,” enter the desired correction factor.
8. Click “Apply.” The correction factor should be applied and be visibly pro-rated from the beginning to the end of the selected region. If all looks OK, “Save” the revision.

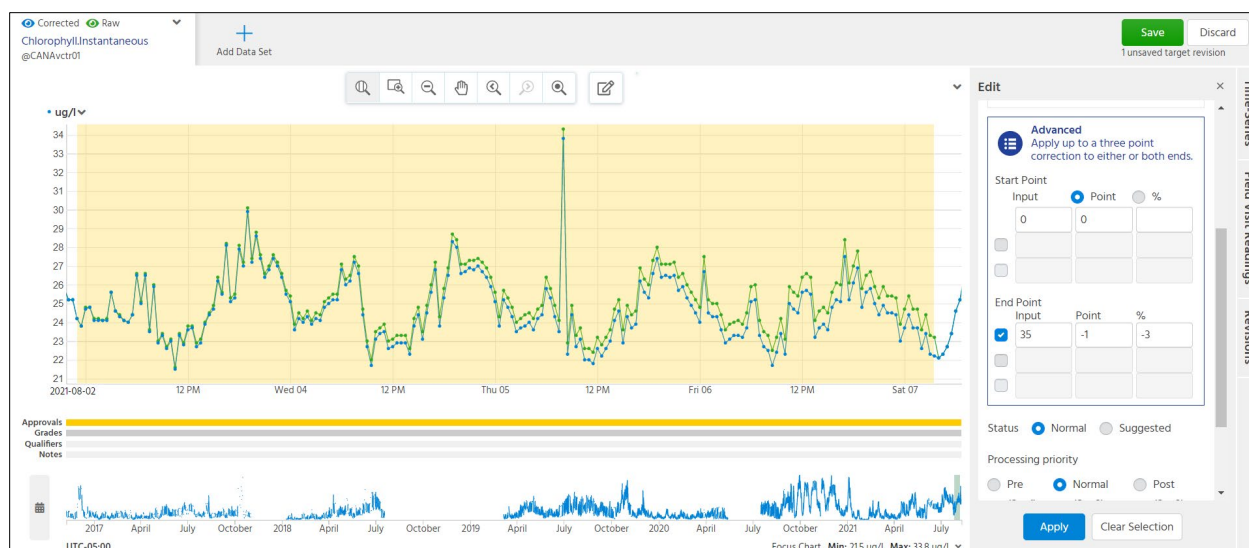


Figure 36. Advanced multipoint correction settings to apply a pro-rated correction.

Advanced Calibration Correction

The Multipoint correction type is useful for adjusting parameters that require a 2-point calibration such as pH, turbidity, chlorophyll and blue-green algae. In the example shown in Figure 37, chlorophyll data on the high end (near the calibration standard of 66 ug/l) required a correction of 4.5 ug/l. No correction was required on the low end (near zero). In other words, the magnitude of correction increases as the observed in situ reading increases.

1. With a region of data selected, open the Edit pane on the right side of the screen and select “MultiPoint” from the drop-down menu (Figure 37).
2. Expand the “Advanced” correction box (Figure 37).
3. Change the “Processing priority” to “Normal (Set 2).”
4. Set the “Status” to “Normal.”
5. Enter the desired low end “Start Point” “Input” and “Point.” In Figure 37 these are zero and zero. This means that at zero ug/l, no correction is needed.
6. Check the first box next to “End Point” “Input” to make the row editable. Enter the desired low end “End Point” “Input” and “Point.” In Figure 37 these are zero and zero. This means that at zero ug/l no correction is needed.
7. Check the first box next to “Start Point” “Input” to make the row editable. Enter the desired high end “Start Point” “Input” and “Point.” In Figure 37 these are 66 and 4.5 ug/l. This means that at 66 ug/l a correction of 4.5 ug/l is needed.

8. Check the second box below “End Point” “Input” to make the row editable. Enter the desired high end “End Point” “Input” and “Point.” In Figure 37 these are 66 and 4.5 ug/l. This means that at 66 ug/l a correction of 4.5 ug/l is needed.

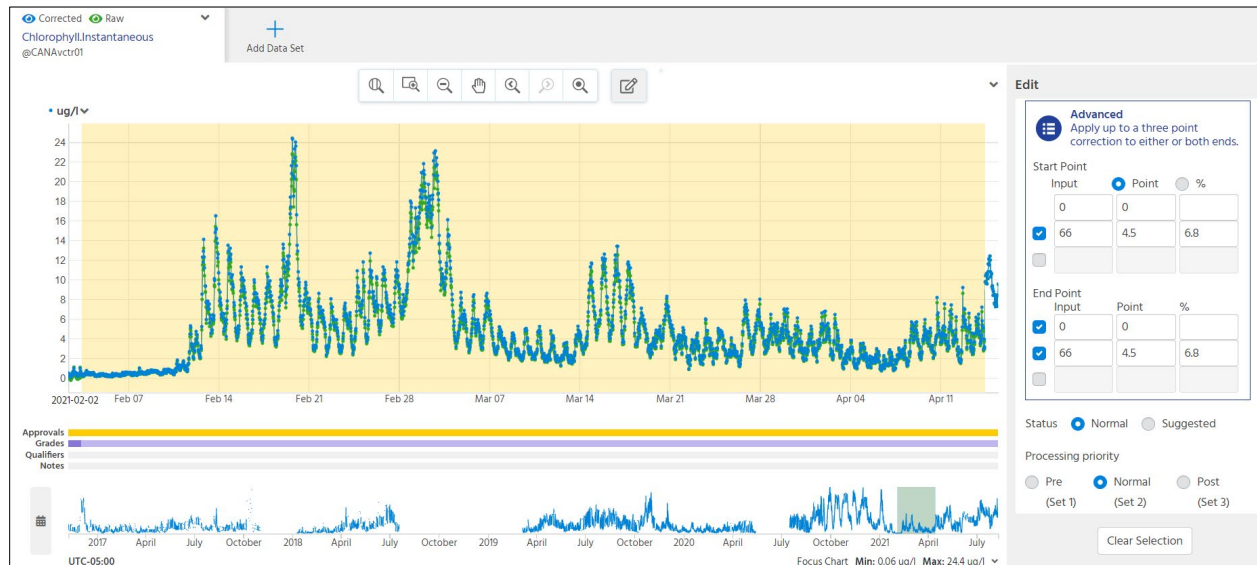


Figure 37. Advanced multipoint correction settings to apply a two-point calibration correction.

3. Data Quality Ratings (Grades)

After data corrections have been applied to a parameter for a given deployment period, the data are assigned a data quality rating (grade). As described earlier in this SOP, the Deployment Summary Report (DSR), generated from the SECN Estuarine Water-Quality Monitoring Database, suggests data grades based on the total suggested drift and fouling correction (Appendix B and Table 2). Due to variability caused by site conditions and sensor performance, the final data grade assigned in Aquarius is based on both the degree of correction and professional judgement. Professional judgement is required because there are factors besides sensor calibration drift and fouling drift that may influence data quality. Some factors to consider include: the number of outliers removed, alignment with adjacent time-series, variability of the data across the deployment, and site conditions.

Sectioning

- To prevent overlapping grades:
 - Grades start between the last data point from the previous deployment and the first data point for the current deployment (Figure 38).
 - Grades end between the last data point from the current deployment and the first data point for the next deployment (Figure 38).
- Data grades are applied to the entire deployment period unless:

- There was an obvious sensor failure during the deployment (i.e., data went from “Good” to “Unusable” at an easily identifiable point in time)
- There are data gaps greater than 24 hours (Figure 39).



Figure 38. Grade sectioning between points/deployment periods. The colored bars at the bottom represent the grades, Orange = Fair, Light Green = Good.

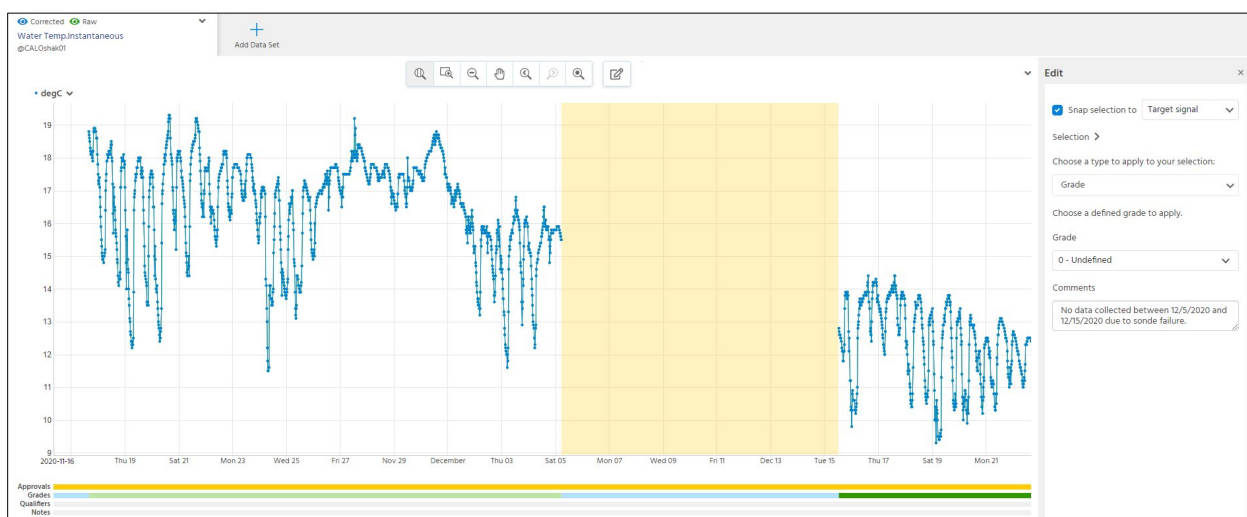


Figure 39. Data grade of “Undefined”(light blue) applied to a time-period with missing data due to a sonde failure.

Grades and Estimated Grades

- Standard data grades consist of Excellent, Good, Fair, and Poor. As indicated in Table 2, the total correction is the primary indicator of the data grade that should be assigned in Aquarius. In addition, “Unusable” and “Undefined” are grades that are available and frequently used in Aquarius. Data grades are represented by colored bars at the bottom of the time series (Figure 38).

- Data are rated as “Unusable” when the total correction exceeds the maximum allowable limits in Table 3 or for other reasons that would cause the data to be unrepresentative of field conditions (e.g., sensor failure, sonde failure). Note that the “Unusable” rating must be applied before data are “deleted” (suppressed).
- Data are rated as “Undefined” when (1) Information is completely lacking about sensor and sonde performance throughout the deployment period, or (2) No data were collected for more than 24 hours (Figure 39). Example: When a sonde fails mid-deployment, it will create a data gap longer than 24 hours. In this case, apply the downgraded rating to the existing data and apply 0-Undefined to the gap.
- When a parameter has unpublished data quality rating criteria, estimated data grades are used (e.g., chlorophyll *a* and blue green algae; Table 2). Estimated data grades in Aquarius consist of Estimated Excellent, Estimated Good, Estimated Fair and Estimated Poor.
- **The Southeast Coast Network will not rate any data as Estimated Excellent. In other words, all estimated data will be considered less than excellent.**
- The Southeast Coast Network may assign estimated data grades if there is a lack of data or unreliable data for the calculation of correction factors.

Downgrading

In some situations, it may be necessary to assign a lower data grade than what was suggested by the total correction and DSR. In other words, the selected data may be downgraded due to factors other than the total correction. Professional judgement will be used when downgrading data and a justification should always be provided in the “Comments.” For example, if the DSR suggests a grade of “Good” for turbidity, yet one hundred outliers (>500 FNU) were removed and the last two data points were negative, the data will be downgraded. In this situation, it is justifiable to rate data for this time-period as “Fair” or “Poor” due to erratic sensor readings. The data are still useable, but the body of evidence suggests that it should be used with less confidence than a period with no outliers.

Situations in which data are always downgraded:

- **If battery power is lost during the deployment, all parameters are downgraded one level from the suggested grade.**
- **If the central wiper is lost during the deployment, turbidity and possibly other parameters are downgraded one level from the suggested grade.**
- **If the temperature sensor is faulty or failed during the deployment, dissolved oxygen, pH, and specific conductance should be downgraded.**

Grade Comments

Data graded less than “Excellent” will have an associated comment. Descriptive comments serve to document professional judgement and help the final reviewer understand what was done to the data.

Comments will describe:

- Why the data received the assigned grade.
- What correction if any was applied and why.
- Any justifications necessary to explain processing.
- Any irregularities that occurred during the deployment (e.g., lost battery power, hurricane, sonde out of water).

Examples of detailed comments:

Set Grade: 31 - GOOD: Rated good due to low noise, few spikes, and no correction required. Some uncertainty because field readings indicate the sensor is reading low, but subsequent deployment and post deployment readings show the sensor to be reading accurately.

*Set Grade: 21 - FAIR: Rated fair due to moderate noise and spikes. Continuing variability leading up to and following high tide. *Rapid rise at the beginning of the period; field readings confirm retrieved sensor, but calibration records show deployed sensor to be within specifications, no action taken.*

Set Grade: 21 - FAIR: Rated fair due to moderate noise, moderate number of spikes, and no applied correction. All readings indicate the sensor was reading within tolerances for a fair record and no correction was required. Some spikes below 25FNU were left intact because they followed a routine signature of elevated values during falling tide.

Set Grade: 11 - POOR: Rated poor due to high noise and many spikes. High variability around high tide. Hurricane Irma likely had some influence from 9/9 - 9/12/2017.

Set Grade: 11 - POOR: Rated poor due to uncertainty with a large, applied correction. Correction applied based on subsequent deployment and field readings.

*Set Grade: 10 – EST. POOR: Rated estimated poor due to extreme noise, possible fouling, and no field readings. Sonde appears to be too far down in the water column causing spikes and fouling to occur often. *Beginning of the COVID-19 pandemic. Sonde died during deployment and only post deployment readings were taken months later.*

Set Grade: 0 - UNDEF: Sensor malfunction likely caused the sonde batteries to fail on 3/27.

Apply the Grade

1. With a region of data selected (See Sectioning above), open the Edit pane on the right side of the screen and select “Grade” from the drop-down menu.

2. From the “Grade” drop down menu select the appropriate grade (Figure 40).
3. Add a detailed comment in the “Comments” field.
4. Click “Apply.”

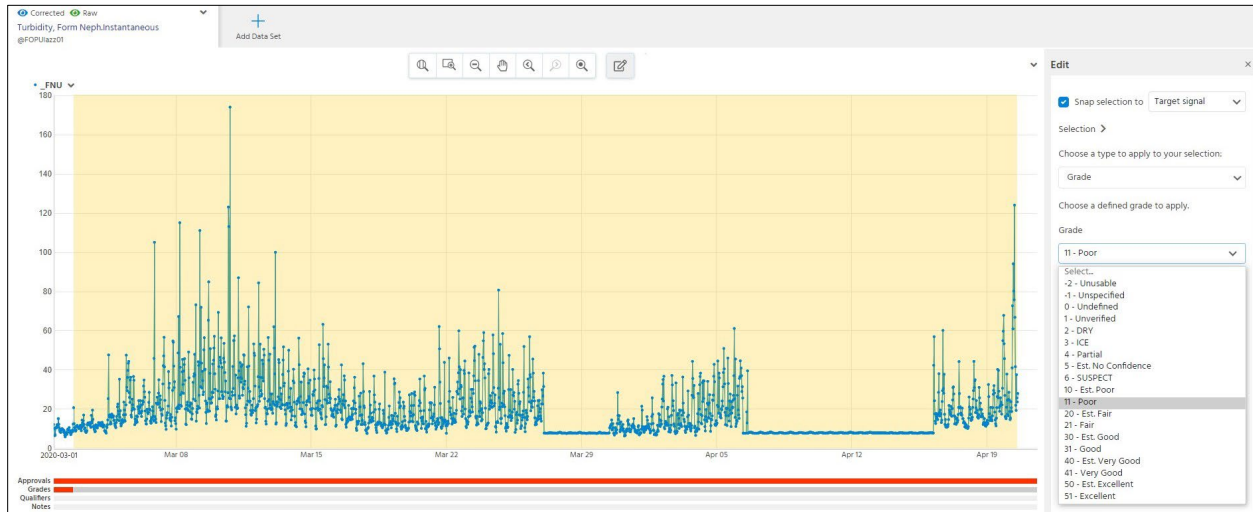


Figure 40. Application of a “poor” data grade to turbidity data.

4. Data Processing (Approval) Levels and Final Review (QA)

Data processing levels are called “Approval Levels” in Aquarius and are an indicator of the status and level of review the data have undergone. Data can be moved from one approval level to the next depending on status. The Southeast Coast Network uses approval levels as a means of approving the data and the data processing. Before final approval an independent reviewer must determine if the data have been sufficiently processed to ensure that they reasonably represent what are thought to be true field conditions. The following is how the Southeast Coast Network defines each approval level.

- | | |
|------------|---|
| Rejected: | Use of this approval level is extremely rare since the Southeast Coast Network opts to use the grade of “Unusable” for most egregious data. When used, “rejected” means that the data are so erroneous that they should not be used in any form or fashion. |
| Working: | Data have been loaded but have received no further review or are currently being processed. Data are initially brought into Aquarius at this level. |
| In Review: | Data have undergone initial review and, where necessary, been corrected. Data grades, comments and justifications have been applied. The initial reviewer has concluded that the data reasonably represent true field conditions. Awaiting approval from an independent reviewer. |
| Approved: | An independent observer has checked all corrections and grades against the original paper forms and Deployment Summary Report (DSR). The reviewer has concluded that the processing is complete and acceptable, and that the |

data are free of correctable error. Considered the final review. Data are “locked” to prevent changes. **Note that when data are graded as “Unusable” they can still be “Approved” if the initial reviewer has provided sufficient justification for the grade. Approval of these data indicates that the time-series has been processed.**

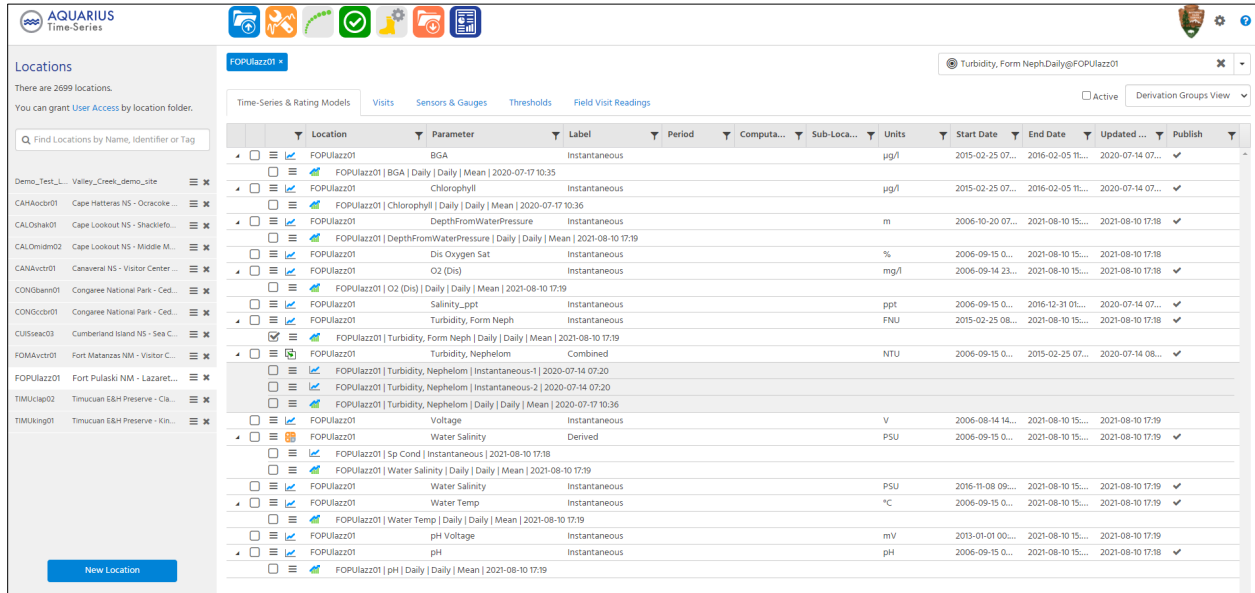
The approval level is changed from “Working” to “In Review” upon completion of data corrections and grades for all parameters at a monitoring station. The process is the same for changing approvals from “In Review” to “Approved.” Prior to covering the steps to change approvals there are several overarching considerations:

- Approvals will ideally be applied at the deployment event scale, meaning that each deployment period has its own approval. However, it is permissible to apply approvals in blocks as wide as a year.
- As with data grades, approvals break between deployments/data points (see Sectioning above). This prevents overlapping approvals.
- **Approval levels that are moving forward (i.e., Working to In Review and In Review to Approved) are applied to statistically derived (📊) (e.g., daily mean water temperature) or calculated derived (🧮) (e.g., salinity) time-series and should not be applied separately to the basic time-series (📈).** The reason for this is that when the user is moving an approval forward the approval propagates from the derived time-series to the basic time-series because Aquarius enforces a rule that data must have at least as strict an approval level as the data derived from it.
- **Approval levels that are being moved back (i.e., Approved to In Review, and In Review to Working) must be applied to BOTH the basic time-series (📈) AND the derived time-series (📊 🧮).** The approval does not propagate from the derived to the basic time-series when being moved back. Always double check the approval level for both the basic time-series and the derived time-series so that they match.

Apply the Approval Level

1. From the Aquarius Springboard location and time-series selection screen, while in the “Derivation Group View,” click the arrow next to the check box for a basic-time series (📈) to expand the group and view the derived time-series (📊) underneath (Figure 41).
2. Select the derived time-series and click the “Approval Levels” Icon (✅). See the section above regarding moving approval levels forward and backward.
3. From the “Approval Levels” screen, change the “Choose Date” slider to “Yes” (Figure 42).

4. Enter the Start Date, Start Time, End Date, and End Time to select the appropriate region for approval. Check that the dates and times align with existing deployment dates/times and data grade intervals (see Sectioning above; Figure 42).
5. Select the appropriate approval level from the drop-down menu.
6. The affected data sets will be displayed in the lower half of the screen. In other words, the current selected time-series and any time-series affected by propagation of the approval will be displayed (Figure 43).
7. Click “Save.”
8. Open the selected time-series in the Data Review Tool  to ensure that the approval was applied.
9. Check all potentially affected time-series’ to ensure the change propagated correctly.



The screenshot shows the Aquarius Time-Series interface. On the left, there is a sidebar with a search bar and a list of locations. The main area displays a table of time-series data for the location 'FOPulazz01'. The table has columns for Location, Parameter, Label, Period, Computation, Sub-Location, Units, Start Date, End Date, Updated Date, and Publish status. The data is filtered by 'Turbidity, Form Neph.Daily@FOPulazz01'.

Location	Parameter	Label	Period	Computation	Sub-Location	Units	Start Date	End Date	Updated ...	Publish
FOPulazz01	BGA	Instantaneous				µg/l	2015-02-25 07...	2016-02-05 11...	2020-07-14 07...	✓
FOPulazz01	BGA Daily Mean 2020-07-17 10:35									
FOPulazz01	Chlorophyll	Instantaneous				µg/l	2015-02-25 07...	2016-02-05 11...	2020-07-14 07...	✓
FOPulazz01	Chlorophyll Daily Mean 2020-07-17 10:36									
FOPulazz01	DepthFromWaterPressure	Instantaneous				m	2006-10-20 07...	2021-08-10 15...	2021-08-10 17:38	✓
FOPulazz01	DepthFromWaterPressure Daily Mean 2021-08-10 17:19									
FOPulazz01	Dis Oxygen Sat	Instantaneous				%	2006-09-15 0...	2021-08-10 15...	2021-08-10 17:38	✓
FOPulazz01	Dis Oxygen Sat Daily Mean 2021-08-10 17:19									
FOPulazz01	O2 (Dis)	Instantaneous				mg/l	2006-09-14 23...	2021-08-10 15...	2021-08-10 17:38	✓
FOPulazz01	O2 (Dis) Daily Mean 2021-08-10 17:19									
FOPulazz01	Salinity_ppt	Instantaneous				ppt	2006-09-15 0...	2016-12-31 01...	2020-07-14 07...	✓
FOPulazz01	Turbidity, Form Neph	Instantaneous				FNU	2015-02-25 08...	2021-08-10 15...	2021-08-10 17:38	✓
FOPulazz01	Turbidity, Form Neph Daily Mean 2021-08-10 17:19									
FOPulazz01	Turbidity, Nephelom	Combined				NTU	2006-09-15 0...	2015-02-25 07...	2020-07-14 08...	✓
FOPulazz01	Turbidity, Nephelom Instantaneous-1 2020-07-14 07:20									
FOPulazz01	Turbidity, Nephelom Instantaneous-2 2020-07-14 07:20									
FOPulazz01	Turbidity, Nephelom Daily Mean 2020-07-17 10:36									
FOPulazz01	Voltage	Instantaneous				V	2006-08-14 14...	2021-08-10 15...	2021-08-10 17:38	✓
FOPulazz01	Water Salinity	Derived				PSU	2006-09-15 0...	2021-08-10 15...	2021-08-10 17:38	✓
FOPulazz01	Sp Cond Instantaneous 2021-09-10 17:38									
FOPulazz01	Water Salinity Daily Mean 2021-08-10 17:19									
FOPulazz01	Water Salinity	Instantaneous				PSU	2016-11-08 09...	2021-08-10 15...	2021-08-10 17:38	✓
FOPulazz01	Water Temp	Instantaneous				°C	2006-09-15 0...	2021-08-10 15...	2021-08-10 17:38	✓
FOPulazz01	Water Temp Daily Mean 2021-08-10 17:19									
FOPulazz01	pH Voltage	Instantaneous				mV	2013-01-01 00...	2021-08-10 15...	2021-08-10 17:38	✓
FOPulazz01	pH	Instantaneous				pH	2006-09-15 0...	2021-08-10 15...	2021-08-10 17:38	✓
FOPulazz01	pH Daily Mean 2021-08-10 17:19									

Figure 41. Aquarius location and time-series selection screen with visible derived time-series.



The screenshot shows the Aquarius Approval Levels screen. It displays a timeline for the period from 2020-09-15 (UTC-05:00) to 2021-09-15 (UTC-05:00). The timeline is divided into sections for Approval Levels and Field Visits. The current selection is set to 'None'. A legend at the bottom indicates the status of the data: Rejected (purple), Working (red), In Review (yellow), and Approved (green). The affected data sets are listed at the bottom.

Figure 42. Aquarius Approval Levels screen.

Water Temp.Daily@CANAvctr01

Approval Levels
Select a time period and change approval level for related data sets.

Start Date * 2020-01-22 Start Time (UTC-05:00) * 17:10 End Date * 2021-08-10 End Time (UTC-05:00) * 07:40

Choose Date **YES** Select a date and time

Comments

800 Working Save

Affected Data Sets
Changing the Approval Level of the selected time period will affect the data marked Change below.
Data must have at least as strict an approval level as the data derived from it.

Change	Type	Parameter	Location	Label	Computation	Period
✓	Water Temp	Canaveral NS - Visitor Ce...	Instantaneous		Mean	Daily

Figure 43. Aquarius Approval Levels screen, date selection view.

Final Review of Data (QA)

Final review and approval of each parameter’s time-series is conducted by a knowledgeable independent reviewer not involved with the initial review and data correction. The reviewer must be adequately familiar with continuous water-quality data processing and site conditions for each monitoring station. Currently, the SECN aquatic ecologist checks time-series records processed by the SECN hydrological technician and vice versa.

If staffing issues arise and the hydrologic technician is no longer able to process data, the SECN aquatic ecologist will conduct both the initial and final reviews. However, the final review and approval will occur more than two weeks after the initial data processing. This will allow the SECN aquatic ecologist to review the data with a fresh perspective.

The final review includes critical evaluation of the following:

- Have all time-series been set to “In-Review” by the initial reviewer?
- Do the deployment and retrieval dates and times on the paper forms match time-series start and end points in Aquarius?
- Is the time-series free of correctable errors and does it reasonably represent what are thought to be true field conditions?
- Have all data grades been applied?
- Are corrections and data grades sufficiently documented?

When issues are encountered with data, corrections, or grades, all areas of interpretation and disagreement will be discussed, resolved, and documented prior to final approval.

Following the detailed final review, the reviewer will apply the approval level of “Approved.” See the “Apply the Approval Level” section in this SOP.

5. Parameter-Specific Processing Considerations

This section outlines parameter-specific details that are important to consider when processing associated records. Monitoring station specific considerations are discussed in Appendix D.

Water Temperature

- Very stable sensor that does not require calibration.
- Data correction for fouling may occur but sensor calibration drift should not occur. If the data require more than a minor correction for fouling, the sensor is likely faulty and needs to be replaced.
- Other parameters are temperature-compensated so a faulty sensor has broad implications for all parameters.

Specific Conductance

- Stable sensor but prone to fouling.

Salinity

The salinity time-series is “derived from a calculation formula” using the specific conductance time-series as the input. The derived salinity time-series is not processed separately because all corrections pass through to the derived salinity. The following formula is used in Aquarius to derive salinity (page 36 of Wagner et al. [2006]). For more information on creating a derived time-series see the New Derived Time-Series section in Appendix C.

```
// calculateSalinity
var conductivity = x1; // Conductivity mS/cm
var salinity = Double.NaN;

if (!Double.IsNaN(conductivity))
{
    var specificConductivity = conductivity;

    const double K1 = 0.0120;
    const double K2 = -0.2174;
    const double K3 = 25.3283;
    const double K4 = 13.7714;
    const double K5 = -6.4788;
    const double K6 = 2.5842;

    var y1 = specificConductivity/53.087;

    salinity = K1 + K2 * pow(y1, 0.5) + K3 * y1 + K4 * pow(y1, 1.5) + K5 * pow(y1, 2) + K6 *
    pow(y1, 2.5);
}

y = salinity; // WS PSU
```

Dissolved Oxygen

- Optical sensor.

- The Southeast Coast Network maintains both dissolved oxygen concentration (mg/L) and dissolved oxygen percent saturation (%Sat) in Aquarius. However, only dissolved oxygen concentration is processed.

pH

- Electrical resistance measurement based on internal reference solution. Very few spikes, but prone to routine drift as the reference solution slowly degrades.
- Very stable sensor.
- Refer to the pH slope and mv readings to help determine confidence in the data. Departure of pH slope from approximately 180 may indicate sensor failure. pH sensors have limited lifespan and generally fail within two years of manufacture.

Turbidity

- The optical sensor is very stable but extremely sensitive to anomalies such as bubbles. This may cause “noisy” data and increases the potential for outliers.
- Negative values are not possible. If they occur in the dataset it is an indication of a calibration issue.
- Due to known issues measuring turbidity, it probably should not be rated better than “Good.”

Depth

- Generally considered a very stable sensor. If the readings require a correction it may have been calibrated incorrectly or the sensor is defective.
- Grades are “estimated.”

Chlorophyll

- Optical sensor with a two-point calibration.
- Multipoint corrections are useful due to the two-point calibration and potential for increased error in the “high” standard. The high standard is made by the Southeast Coast Network with a dilution of rhodamine dye.
- Grades are “estimated.”

Blue Green Algae

- Optical sensor with a two-point calibration.
- Multipoint corrections are useful due to the two-point calibration and potential for increased error in the “high” standard. The high standard is made by the Southeast Coast Network with a dilution of rhodamine dye.
- Grades are “estimated.”

Literature Cited

- Aquatic Informatics. 2019. Aquarius Time-Series 2019.3 Water-quality Record Computation Training Manual. November 2019.
- Gregory, M. Brian, J. C. DeVivo, E. M. DiDonato, C. J. Wright, and E. Thompson. 2013. Protocol for monitoring estuarine water and sediment quality in selected Southeast Coast Network parks. Natural Resource Report NPS/SECN/NRR—2013/644. National Park Service, Fort Collins Colorado. Available at: [DataStore - Published Report - \(Code: 2194106\) \(nps.gov\)](#) (last accessed June 2022).
- McCay, D., and E. N. Starkey. 2022. Fixed-station remote sonde deployment and water sample collection quick guide—Version 2.0. Southeast Coast Network Standard Operating Procedure NPS/SECN/SOP—1.2.10. Southeast Coast Network, Athens, Georgia. Available at: <https://irma.nps.gov/DataStore/Reference/Profile/2284574> (last accessed June 2022).
- McCay, D. L., E. N. Starkey, and M. B. Gregory. 2022. Fixed-station, water-quality data sonde maintenance, calibration, deployment, and retrieval—Version 3.0. Southeast Coast Network Standard Operating Procedure NPS/SECN/SOP—1.2.09. Southeast Coast Network, Athens, Georgia. Available at: <https://irma.nps.gov/DataStore/Reference/Profile/2284553> (last accessed June 2022).
- Starkey, E. N., and D. McCay. 2022. Fixed-station installation of water-quality data sonde housing—Version 3.0. Southeast Coast Network Standard Operating Procedure NPS/SECN/SOP—1.2.08. Southeast Coast Network, Athens, Georgia. Available at: <https://irma.nps.gov/DataStore/Reference/Profile/2284578> (last accessed June 2022).
- Wagner, R.J., R.W. Boulger Jr., C.J. Oblinger, B.A. Smith. 2006. Guidelines and Standard Procedures for Continuous Water-Quality Monitors: Station Operation, Record Computation, and data reporting: U.S. Geological Survey Techniques and Methods 1–D3, 51. Available at: <https://pubs.usgs.gov/tm/2006/tm1D3> (Accessed September 2021)
- YSI Incorporated. 2014. EXO User Manual: Advanced Water-quality Monitoring Platform, Revision E. Yellow Springs, Ohio.

Appendix A. Data sonde Deployment and Retrieval Datasheets

SECN Coastal Water Quality Monitoring Datasonde Datasheet v1.44 (01/2022)— DEPLOYMENT						Station Name	
Calibration / Pre-Deployment							
Instrument (Sonde) # (SN)							
Calibration Date		Calibrated By					
Battery Voltage Pre-Calibration		Battery Voltage >5.3		Y / N		Battery Voltage Post-Calibration	
Central Wiper Replaced		Y / N		Central Wiper Parking 180°		Y / N	
Barometric Pressure (mmHg)		Conductivity Cell Constant		ODO Gain			
pH7 (mv)		pH10 (mv)		pH4 (mv) (optional)		pH Slope	
Parameter	Temp (°C)	Sp. Cond. (mS/cm)	Depth (m)	ODO (% Sat.)	ODO (mg/l)	pH7	pH10
Standard							
Measured							
Calibrated							
Parameter	pH4 (optional)	Turbidity Low (FNU)	Turbidity High (FNU)	Chl Low (µg/l)	Chl High (µg/l)	BGA-PE Low (µg/l)	BGA-PE High (µg/l)
Standard							
Measured							
Calibrated							
Deployment							
Deployed By:		File Name: _____ (Station name _YYYYMMDD)					
Sonde Start Date:		Sonde Start Time: _____ Eastern Standard Time (EST)					
Actual Deployment Date:		Actual Time Placed in Water: _____ (EST)					
Comments: 							
Site Observations: Fish Kill ☐ Algal Bloom ☐ Debris ☐ Hurricane / Tropical Storm ☐ Other ☐							
Observation Description: 							
Computer Entry By / Date:				Accepted By / Date:			

Figure A-1. Example of Data sonde Datasheet v1.44 for deployment.

SECN Coastal Water Quality Monitoring YSI Datasonde Datasheet v1.44 (01/2022) — RETRIEVAL										Station Name	
Retrieval											
In situ Sonde # (SN)						Retrieved By					
Retrieval Date						Retrieval Time		(EST)			
Field Meter # (SN)						Field Meter Calibration Date					
On Site Readings											
	Temp (°C)	Baro. Pres. (mmHg)	ODO (% Sat.)	ODO (mg/l)	Sp. Cond. (mS/cm)	Salinity (psu)	pH	Turb. (FNU)	Depth (m)	Chla (µg/l)	BGA- PE (µg/l)
Field Meter											
In situ Sonde											
Fouling presence: Please record <u>type</u> of fouling AND <u>amount</u> (e.g. A, B, E, / H). Types A= Algae, B= Barnacles, C= Crabs, E= Eggs, F= Fish, O= Other, N= none, S = Sediment / Amount H=Heavy, M= Moderate, L= Light, N= None Sonde/Guard: _____ Temp/Cond: _____ ODO Probe: _____ pH Probe: _____ Turbidity: _____											
Post Deployment											
Post Deployment Reading Date				Battery Voltage				Central Wiper Parking 180°		Y / N	
Barometric Pressure (mmHg)				Conductivity Cell Constant							
pH7 (mv)				pH10 (mv)				pH4 (mv) (optional)			
pH Slope											
Parameter	Temp (°C)	Sp. Cond. (mS/cm)	Depth (m)	ODO (% Sat.)	ODO (mg/l)	pH7	pH10				
Standard											
Measured (clean sensors)											
Parameter	pH4 (optional)	Turbidity Low (FNU)	Turbidity High (FNU)	Chl Low (µg/l)	Chl High (µg/l)	BGA-PE Low (µg/l)	BGA-PE High (µg/l)				
Standard											
Measured (clean sensors)											
Any Probe Malfunctions?		Y / N		Checked By _____							
If Y, describe in the comments.											
Comments:											
Computer Entry By / Date _____ Accepted By / Date _____											

Figure A-2. Example of Data sonde Datasheet v1.44 for retrieval.

Appendix B. Example Deployment Summary QC Report

Station Name	CANAvctr01	Input required from SECN deployment/retrieval forms											
Date of Deployment	12/9/2019	Calculated											
Time of Deployment (EST)	17:30	Bold values are used in Aquarius as suggested correction factors											
Date of Retrieval	1/22/2020												
Time of Retrieval (EST)	17:10												
Instrument Serial Number	16J102930												
Field Meter Readings	Temp (°C)	Baro. Pres. (mmHg)	ODO (% Sat.)	ODO (mg/l)	Sp. Cond. (mS/cm)	Salinity (psu)	pH	Turb. (FNU)	Depth (m)	Chl a (µg/l)	BGA (µg/l)		
	13.52	764.00	101.80	8.55	52.70	34.72	8.01	4.70	0.08	2.90	3.60		
In situ Sonde Readings	13.55	764.00	104.00	8.73	52.80	34.80	8.11	4.10	0.17	2.70	8.50		
Standard Measured (clean sensors)	Temp (°C)	Sp. Cond. (mS/cm)	Depth (m)	ODO (% Sat.)	ODO (mg/l)	pH7	pH10	Turbidity Low (FNU)	Turbidity High (FNU)	Chl Low (µg/l)	Chl High (µg/l)	BGA-PE Low (µg/l)	BGA-PE High (µg/l)
	23.62	50.00	-0.24	97.60	8.52	7.00	10.01	0.00	124.00	0.00	66.00	0.00	126.00
	23.58	50.40	-0.25	98.70	8.62	7.08	10.06	0.40	124.20	0.00	56.80	0.00	109.80
		Temp	DO	SpCond	pH	Turb.	Depth	Chl	BGA				
Total Correction		-0.03	-0.18	-0.10	-0.10	0.60	-0.09	0.20	-4.90				
Calibration Drift Correction		0.04	-0.10	-0.40	-0.07	-0.30	0.00	4.60	8.10				
Fouling Drift Correction		-0.07	-0.08	0.30	-0.03	0.90	-0.09	-4.40	-13.00				
Correction Needed?		No	No	No	No	Yes	No	Yes	Reject				
Data Rating Based on Values		Excellent	Excellent	N/A	Excellent	Good	Estimated Good	N/A	N/A				
Data Rating Based on %		N/A	Excellent	Excellent	N/A	Fair	N/A	Estimated Good	Unusable				

Figure B-1. Example deployment summary QC report.

Appendix C. Setting up a new location and Time-Series in Aquarius

New Location

1. From the Aquarius Springboard location and time-series selection screen, click “New Location.”
2. Populate all Location Details (Table C-1, Figures C-1 and C-2).
3. Upload Attachments such as a site photo.
4. Click “Save.”

Table C-1. Location Details.

Field	Description	Example
Location Identifier	The site name using standard SECN convention of PARKxxxx##, where PARK is the 4-letter park abbreviation, xxxx is a station location identifier, and ## is the two-digit station installation specific number (ex. CANAvctr01).	CANAvctr01
Type	Estuary or River/Stream for all established SECN stations.	Estuary
Name	Park name spelled out followed by the station location description	Canaveral National Seashore - Visitor Center Dock
Source	Auto populated	AQUARIUS Location
Location Folder	Location of SECN fixed-station data within Aquarius.	National Park Service.Southeast Coast Network.Fixed-station WQ
Location Unique ID	Auto populated	803e4466e1e241e1a4ece7d42f39d853
Description	Unique description about the site including any important location information.	Tidal Creek (Lazaretto Creek) dock just off mainstem of the Savannah River.
Latitude (WGS 84)	Northing	28.9268045
Longitude (WGS 84)	Easting	-80.8250293

Field	Description	Example
Elevation	Distance above average mean sea level. Define units. Most SECN sites are at sea level	0.0000
UTC Offset	All SECN data are recorded in Eastern Standard Time (-05:00)	-05:00
Publish	Select "Yes" to Publish to Aquarius Web Portal	Yes
Tags	SECN data should be tagged with the following: Fixed-station WQ National Park Service Southeast Coast Network	Fixed-station WQ National Park Service Southeast Coast Network
Park Name	Park name can be selected from the drop-down menu	Canaveral National Seashore
Sensitivity	Set to Public unless there are sensitive data. Otherwise NPS Only or Restricted	Public
Status	Is the monitoring station Active or Retired or Inactive?	Active
Waterbody Code	Optional	
Waterbody Name	Name of sound or stream/river	Lazaretto Creek
Date Established	Month, Day and Year when possible. Year at minimum	2006
Travel Directions	Directions from the nearest easy point of reference. Such as a visitor center or bridge.	Take right onto old US 80 off US 80 0.5 miles east of Fort Pulaski National Monument Park Entrance (Ft. Pulaski Rd). Dock is 0.5 miles from intersection at end of road.
Make Location Visible in Aquarius WebPortal?	1= Yes and 0=No This field and the Publish field must be set to Yes for data to publish to Aquarius Web Portal.	1



CANAvctr01 - Canaveral NS - Visitor Center Dock

Location Details

Sub-Locations

User Roles

Attachments

Documents

Images and Video

Trash

Reference Datums

Reference Points

Location Notes

Upload

Location Details

Location Identifier *

CANAvctr01

Type

Estuary

Name *

Canaveral NS - Visitor Center Dock

Source

AQUARIUS Location

Location Folder

Location Unique ID

803e4466e1e241e1a4ece7d42f39d853

The SECN coastal fixed station water quality monitoring network was established in 2006 to help park resource managers understand the temporal dynamics of water quality in the parks estuarine areas. Stations are managed by SECN staff and operated by network staff or local partners using YSI data sondes (6600 or EXO models) and record water level, dissolved oxygen, salinity, temperature, pH, and turbidity at 15- or 30-minute interval. Data are retrieved monthly and are available to NPS via the Aquarius Web Data Portal at the Integrated Resource Management Application webpage (<https://irma.nps.gov/App/Portal/Home>).

Description

The station is located in Mosquito Lagoon, a wide, shallow brackish estuary on the back side of a barrier island. Water quality is designated as Fair and Class II, which is suitable for shellfish propagation and harvesting. Normal tide

Latitude (WGS 84)

28.926804

28°55'36.5"N

Longitude (WGS 84)

-80.825029

80°49'30.1"W

Elevation

0.0000

Units

m

UTC Offset

- 05:00

Publish

☒ Yes
☐ No

Figure C-1. Location Manager screenshot of Location Details.

Tags

Tags can be used to find and group locations (e.g. by project, region, user)

Fixed Station WQ
National Park Service
Southeast Coast Network

Additional Attributes

Park Name	Canaveral National Seashore
Sensitivity	Public
Status	Active
Waterbody Code	03080202
Waterbody Name	Mosquito Lagoon
Gage Number	
Date Established	7/21/2005
Travel Directions	The station is located at Canaveral National Seashore on t
Make Location Visible in Aquarius WebPortal (1=Yes; 0=No) *	1

Figure C-2. Location Manager screenshot of Tags and Additional Attributes

New Basic Time-Series

1. After creating a new location, click the “hamburger” (☰) menu next to the location (Figure C-3.)
2. Select New Basic Time-Series (Figure C-3).

Locations

There are 2696 locations.
You can grant [User Access](#) by location folder.

TIMUclap02

Timucuan E&H Pr...

TIMUking01

Timucuan E&H Pr...

Location Details

New Visit

New Basic Time-Series

New Derived Time-Series

New Rating Model

New Sensor/Gauge

Append Data

New Threshold

New Location

CANAvctr01

Time-Series & Rating Models

Visits

Sensors & Gauges

Thresholds

Field Visit Readings

☐ Active
 Derivation Groups View

Location	Parameter	Label	Per...	Co...	Su...	Units	Sta...	En...	Up...	Pu...
CANAvctr01	BGA	Instantaneous				µg/l	2016-11...	2021-0...	2021-0...	✓
CANAvctr01	Chlorophyll	Instantaneous				µg/l	2016-11...	2021-0...	2021-0...	✓
CANAvctr01	DepthFromWaterPressure	Instantaneous				m	2011-04...	2021-0...	2021-0...	✓
CANAvctr01	Dis Oxygen Sat	Instantaneous				%	2007-0...	2021-0...	2021-0...	✓
CANAvctr01	O2 (Dis)	Instantaneous				mg/l	2007-0...	2021-0...	2021-0...	✓
CANAvctr01	Salinity_ppt	Instantaneous				ppt	2007-0...	2017-01...	2020-0...	✓
CANAvctr01	Sp Cond	Instantaneous				mS/cm	2007-0...	2021-0...	2021-0...	✓
CANAvctr01	Turbidity, Form Neph	Instantaneous				FNU	2013-01...	2021-0...	2021-0...	✓
CANAvctr01	Turbidity, Nephelom	Instantaneous				NTU	2007-0...	2012-12...	2020-0...	✓
CANAvctr01	Voltage	Instantaneous				V	2006-0...	2021-0...	2021-0...	✓
CANAvctr01	Water Salinity	Derived				PSU	2007-0...	2021-0...	2021-0...	✓
CANAvctr01	Water Salinity	Instantaneous				PSU	2017-01...	2021-0...	2021-0...	✓
CANAvctr01	Water Temp	Instantaneous				°C	2007-0...	2021-0...	2021-0...	✓
CANAvctr01	pH Voltage	Instantaneous				mV	2013-01...	2021-0...	2021-0...	✓
CANAvctr01	pH	Instantaneous				pH	2007-0...	2021-0...	2021-0...	✓

Figure C-3. Locations screen with the “hamburger” menu open.

3. From the Time-Series Details Screen define the following:

a. Time Series Attributes (Figure C-4)

The screenshot shows a web application window titled "CANAvctr01 - Time-Series Details". The "Time-Series Attributes" section is expanded, showing a list of fields with red arrows pointing to specific values:

- Label ***: Instantaneous
- Parameter ***: Water Temp
- Units ***: °C
- Interpolation**: Instantaneous Values
- Sub-Location**: (empty dropdown)
- UTC Offset**: - 05:00
- Computation**: (empty dropdown)
- Period**: (empty dropdown)
- Publish**: ☒ Yes ☐ No
- Description**: (empty text area)

Below the attributes section are three expandable sections: "Set Measurement Method", "Set Gap Tolerance", and "Extended Attributes". At the bottom right, there are two buttons: "No changes to save" and "Cancel". A legend at the bottom left indicates that an asterisk (*) denotes a required field.

Figure C-4. New basic time-series, define Time-Series Attributes.

- i. Label. Should be “Instantaneous” for all basic time-series.
 - ii. Parameter. Select the correct parameter.
 - iii. Units. Select the correct units.
 - iv. UTC Offset. Should be -05:00 for all SECN monitoring stations.
 - v. Do not populate the Computation and Period fields unless it is a derived time-series.
 - vi. Publish is set to “Yes” for all SECN monitoring stations.
 - vii. The Description and Comment fields are optional.
- b. Set Measurement Method (Figure C-5)

CANAvctr01 - Time-Series Details

Time-Series Attributes

Set Measurement Method

Create Period

You can create a new period that will replace all or a portion of the existing periods.

Measurement Method

Effective From
UTC-05:00

List of Measurement Methods for the time-series

Start Time UTC-05:00	Measurement Method
Beginning of Record	None

Set Gap Tolerance

Extended Attributes

* Required field

No changes to save
Cancel

Figure C-5. New basic time-series, Set Measurement Method.

- i. Select Measurement Method from the drop-down menu. Note that time-series established in earlier versions of Aquarius may not have a method selected.

c. Set Gap Tolerance (Figure C-6)

CANAvctr01 - Time-Series Details

Time-Series Attributes

Set Measurement Method

Set Gap Tolerance

Create Period

You can create a new period that will replace all or a portion of the existing periods.

Define Gaps

☒ Define a gap when data points are distant from one another.

Gap Tolerance (mins)
31

☐ No gap tolerance

Effective From
UTC-05:00

List of Gap Tolerances for the time-series

Start Time UTC-05:00	Gap Tolerance (mins)
Beginning of Record	31

Extended Attributes

* Required field

Save Changes
Cancel

Figure C-6. New basic time-series, Set Gap Tolerance.

- i. Gap Tolerance (mins) is set to 1 minute greater than the collection interval. In other words, data collected every 30 minutes has a gap tolerance of 31 minutes and data collected every 15 minutes has a gap tolerance of 16 minutes.

d. Extended Attributes (Figure C-7)

The screenshot shows a web form titled "CANAvctr01 - Time-Series Details". It has a close button (X) in the top right corner. The form contains several sections: "Time-Series Attributes" with a right-pointing arrow, "Set Measurement Method" with a right-pointing arrow, "Set Gap Tolerance" with a right-pointing arrow, and "Extended Attributes" with a down-pointing arrow. Under the "Extended Attributes" section, there is a label "Make Time Series Visible in Aquarius WebPortal (1=Yes; 0=No)" followed by a text input field containing the value "1". At the bottom left, there is a red asterisk and the text "* Required field". At the bottom right, there are two buttons: "Save Changes" (green) and "Cancel" (white with a grey border).

Figure C-7. Basic new time-series, Extended Attributes.

- i. Set “Make Time Series Visible in Aquarius Web Portal” to “1” to publish approved data.

New Derived Time-Series

The procedures are largely the same as those shown above for creating a new basic time-series, however the Processing Periods must be set.

1. After creating a new location, click the “hamburger” (≡) menu next to the location (Figure C-3).
2. Select New Derived Time-Series (Figure C-3).
3. From the Time-Series Details Screen define the following:
 - a. Processing Periods
 - i. Click “Add Processing Period” (this may also show up as “Edit Processing Period”) and define the Start Date, Time and select the Process Type.

1. Process Type is set to “Statistic Computation” for Daily Means, Minimums, Maximums, etc. and “Calculation” for time-series that will be derived based on a formula (e.g., Salinity). Depending on the selection, the required input may change (Figures C-8 and C-9).

The screenshot shows the 'Process Settings' dialog box. At the top, the 'Processing Type and Time Period' section has a dropdown menu and a label 'Type: Statistic/Computation'. Below this, the 'Start Date' and 'Time (UTC-05:00)' fields are present, both marked as required. The 'Process Type' dropdown is set to 'Statistic/Computation'. Below it, there is another dropdown menu. A 'Description' text area is also visible. At the bottom, there are three expandable sections: 'Process Inputs', 'Computation Details', and 'Coverage and Grading'. The 'OK' and 'Cancel' buttons are at the bottom right.

Figure C-8. Process Settings screen with Statistic/Computation selected as the Process Type.

The screenshot shows the 'Process Settings' dialog box with 'Calculation' selected as the 'Process Type'. The 'Processing Type and Time Period' section now shows 'Type: Calculation'. The 'Start Date' and 'Time (UTC-05:00)' fields remain. Below the 'Process Type' dropdown, there is a 'Description' text area. The 'Process Inputs' section is expanded, showing a link 'More information about Calculation Processor settings' and a yellow warning box that reads: 'Warning! All numeric constants defined in the formula should be defined as decimal numbers.' Below this, the 'Formula' field is populated with 'ie. y = x1 + x2 / 2'. A 'Validate' button is located below the formula field. The 'OK' and 'Cancel' buttons are at the bottom right.

Figure C-9. Process Settings screen with Calculation selected as the Process Type.

2. Define the Process Inputs by indicating the location and time-series to be used in the computation or calculation.
3. Define the Computation Details. Note that the Southeast Coast Network opts to “Place each computed value” “At the beginning of the Days” and start each day at 00:00.
4. When defining “Coverage and Grading” the Southeast Coast Network requires 80% minimum data coverage to allow computation. In addition, the “Automatic grade for coverage from minimum to 100%” is set to “-1 Unspecified.”
5. Click “OK.”

b. Time Series Attributes

1. Label is prefixed with “Daily” for all time-series that are daily statistic computations (e.g., DailyMean, DailyMax) and are prefixed with “Derived” for time-series that are calculations (e.g., DerivedSalinity).
2. All other settings for a basic time series apply.

Appendix D. Station-Specific Processing Considerations

This appendix outlines monitoring station details that are important when processing continuous data. Monitoring stations with no specific considerations have been included as a place holder for future revisions.

- CAHAocbr01
 - Cooperator deployment and retrieval.
 - Hard fouling is a frequent issue.
- CALOshak01
 - Cooperator deployment and retrieval.
 - Hard fouling is a frequent issue.
- CALOmidm02
 - Cooperator deployment and retrieval.
 - Hard fouling is a frequent issue.
- CANAvctr01
 - Relatively high bio-fouling location. Soft fouling is more common than hard fouling.
- CONGbann01
 - Freshwater non-estuarine.
 - Black-water, low gradient.
- CONGccbr01
 - Freshwater non-estuarine.
 - Black-water, low gradient.
 - Frequent inundation and backflow from the Congaree River.
- CUISseac03
 - Turbidity is rarely over 150 FNU. Anything over this value should be checked closely.
 - Monitoring station is subject to plumes of sediment from bank erosion. This is especially apparent in the data when the tide is switching.

- FOMAvctr01
 - No station specific processing considerations.
- FOPUlazz01
 - No station specific processing considerations.
- TIMUking01
 - Relatively high current velocities.