

**Narragansett Bay (NAR) National Estuarine Research Reserve**

**Water Quality Metadata**

January to December 2021

Last updatedTuesday September 13, 2022

# I. Data Set and Research Descriptors

## Principal investigators and contact persons

Dr. Kenneth B. Raposa

Research Coordinator

E-mail: kenneth.raposa@dem.ri.gov

Ph (401) 683-7849

Dr. Daisy Durant, Marine Research Specialist II

SWMP Coordinator and Data Manager

E-mail: daisy.durant@dem.ri.gov

Ph (401) 683-7368

Address: Narragansett Bay NERR

55 South Reserve Drive

PO Box 151

Prudence Island, RI 02872

Phone: (401) 683-6780

Fax: (401) 682-7366

## Entry Verification

Deployment data are uploaded from the YSI data logger to a personal computer with Windows 7 or newer operating system. Files are exported from EcoWatch in a comma-delimited format (.CDF), EcoWatch Lite in a comma separated file (CSV) or KOR Software in a comma separated file (CSV) and uploaded to the CDMO where they undergo automated primary QAQC; automated Depth/Level corrections for changes in barometric pressure (cDepth or cLevel parameters); and become part of the CDMO’s online provisional database. All pre- and post-deployment data are removed from the file prior to upload. During primary QAQC, data are flagged if they are missing or out of sensor range. The edited file is then returned to the reserve for secondary QAQC where it is opened in Microsoft Excel and processed using the CDMO’s NERRQAQC Excel macro. The macro inserts station codes, creates metadata worksheets for flagged data and summary statistics, and graphs the data for review. It allows the user to apply QAQC flags and codes to the data, remove any overlapping deployment data, append files, and export the resulting data file for upload to the CDMO. Upload after secondary QAQC results in ingestion into the database as provisional plus data, recalculation of cDepth or cLevel parameters, and finally tertiary QAQC by the CDMO and assimilation into the CDMO’s authoritative online database. Where deployment overlap occurs between files, the data produced by the newly calibrated sonde is generally accepted as being the most accurate. For more information on QAQC flags and codes, see Sections 11 and 12.

Dr. Daisy Durant (Marine Research Specialist II) was responsible for compiling and error checking the January through December 2021 water quality data covered in this document.

## Research Objectives

YSI EXO2 data loggers (also known as ‘sondes’ and used interchangeably in this document) are being deployed off Prudence Island in Narragansett Bay as part of the Narragansett Bay National Estuarine Research Reserve's (NBNERR) System-Wide Monitoring Program (SWMP). The goal is to develop long-term data sets for representative estuarine systems to track changes in water quality over time. Because Prudence Island is in the geographic center of Narragansett Bay (Figure 1), it is an ideal location for monitoring the status and trends in water quality in the Bay over time. One NBNERR long-term water quality monitoring site has been established at Potter Cove since December 1995, on the Island's northeastern shore. This area is impacted by boat traffic and storm runoff from mainland urban and residential areas. The second NBNERR water quality monitoring site, T-Wharf, was established in September 1996 and is situated on the southeastern shore of the island, facing the open waters of Rhode Island Sound. It is approximately 6 miles south of the Potter Cove site. Boat traffic is sparse at this site and storm runoff is less likely to have a significant impact on water quality. A third monitoring site was added in March of 2002. This monitoring site is in Nag Creek, a salt marsh tidal creek that flows into the West Passage of Narragansett Bay. The addition of this site completes our representation of dominant habitat types occurring in Narragansett Bay (i.e., marsh, cove, and open water). In July of 2002, a new T-Wharf monitoring site was created a short distance from the original T-Wharf location because the original site was in line with a summertime pycnocline. It was decided to move the station further out and established T-Wharf Surface and T-Wharf Bottom to examine patterns of water column stratification. The new site has two water quality stations situated on either side of a wharf support piling. One data logger records water quality near the surface (approximately 1.0 m deep on low tide-T-Wharf Surface site) while the second records water quality parameters approximately 1.0 m off the bottom (T-Wharf Bottom site). This allows for the identification of both the frequency and duration of any stratification, which may occur in the open waters of Narragansett Bay.



Figure 1. Map showing Prudence Island in the geographic center of Narragansett Bay, land preserved by NBNERR (in green), and the location of the long-term water quality monitoring sites (Potter Cove, Nag Creek, T-Wharf Surface, and T-Wharf Bottom) and weather station.

## Research Methods

Calibrating procedures

One data logger is deployed at each of the long-term water quality monitoring sites at the Reserve on Prudence Island (Figure 1). The instruments are deployed for approximately three to four weeks at a time (depending on the season), at the end of which are retrieved, and newly calibrated sondes are deployed instead. During these extended deployments, the sondes collect data on water temperature, specific conductance, dissolved oxygen, pH, depth, turbidity conditions, and chlorophyll fluorescence, every 15-minutes; date-time-stamps are in Eastern Standard Time (UTC -5). Historically, data from all sites were collected at 30-minute sampling intervals. In 2004, the NBNERR became involved with a statewide Narragansett Bay Fixed Site Monitoring Network ([NBFSMN](http://www.dem.ri.gov/programs/emergencyresponse/bart/data.php)) water quality monitoring program, at which time, data collection at all sites were changed to a 15-minute sampling interval in order to be compliant with this local monitoring effort. Two years later, all Reserves within the Reserve System were also required to collect at 15-minutes sampling intervals.

For each sampling period, each instrument is calibrated against known standards following the methods recommended in the EXO User Manual-Advanced Water Quality Monitoring Platform. The specific conductivity probe is calibrated using conductivity calibrator 50,000 µS/cm; a two-point calibration is done for the pH probe using pH buffer 7, and 10; a two point calibration (0 and 124 with EXO2 sondes) is done for the turbidity probe using deionized water and YSI 6073G turbidity standard, respectively; a one-point calibration is done in air-saturated water for the optical dissolved oxygen (ODO) probe; and a one-point calibration (0.0) with deionized water is done for chlorophyll fluorescence probe (data available upon request).

A three-point calibration (4, 7 & 10) was implemented from 2012 to 2018 when using YSI 6600-V2 sondes due to a very slow pH response at the beginning of the deployments at the T-Wharf Bottom site (telemetry site); no other site presented this problem. The three-point pH calibration was adopted in February 2012 per YSI engineers advise for troubleshooting the T-Wharf Bottom site problem; however, it was done for all sites since the same protocol should be implemented for all. The T-Wharf Bottom 6600V2 sondes were retrofitted with a fast response pH probe (6589FR) in July 2013 as an additional step. With these steps, pH response at the beginning of the deployments at T-Wharf Bottom improved. In July 2018, the T-Wharf Bottom site was upgraded with new telemetry equipment compatible with the new EXO2 sonde from YSI, which has been deployed at the site since the upgrade. All the other sites have been upgraded to EXO2 sondes as well: Nag Creek and Potter Cove in 2014 and T-Wharf Surface in 2016. With the sonde upgrade at T-Wharf Bottom, a three-point calibration has not been necessary since the EXO2 sondes do not have a slow pH response problem, hence, a two-point calibration using pH buffer 7 and 10 was implemented once more for all water quality sites.

A two-point calibration method using deionized water (0.0) and rhodamine standard for chlorophyll fluorescence (RFU and µg/L), and a one-point calibration with deionized water (0.0) for phycoerythrin fluorescence (RFU and µg/L) was started with EXO2 for all sites in July 2021 to be compliant with the local [NBFSMN](http://www.dem.ri.gov/programs/emergencyresponse/bart/data.php) monitoring effort in Narragansett Bay (See Section 8. Associated researchers and projects); T-Wharf Surface and Bottom sondes are part of this network; however, this protocol has been implemented at all long-term water quality monitoring sites.

After calibration, the YSI 6600V2 data loggers were programmed to begin taking measurements approximately 10 hours in advance of planned deployment, keeping them in an aerated bucket with water to allow the optical dissolved oxygen (ODO) probe membrane to stabilize and hydrated. The day of deployment, the file was checked for ODO sensor drift and calibrated. Calibration of the ODO sensor was usually done within 2 hours of deployment. With the EXO2 data loggers, ODO probes are calibrated the same day the other sensors are calibrated, and the data loggers are programmed to start taking measurements at midnight. Otherwise, the program would have to be disrupted for the ODO calibration. The EXO2s are kept in an aerated bucket with water overnight and the ODO sensors are checked for drift in the lab before deployment. On both data logger types, the ODO probes and membranes were changed annually or when readings become unstable.

At the end of each sampling period, the data loggers are retrieved, and freshly calibrated instruments are deployed. The retrieved data loggers are brought back to the laboratory, post-deployment evaluations of the instrument (Section 13) are carried out the same day of retrieval, and the device is cleaned and serviced by methods outlined in the service manuals mentioned above.

During every deployment, sea-truthing is conducted by measuring water quality parameters with a handheld unit taking real-time measurements at the time of deployment. This information is used to compare with the data collected by the data loggers to ensure accuracy of the readings. The data has been recorded using a YSI 556-MPS handheld data logger from 2008 to April 2019. Values for temperature, specific conductance (and salinity), dissolved oxygen (% saturation and mg/L), and pH were recorded real-time at either 0.5- or 1.0-meter intervals between the surface and bottom at each deployment site. In May 2019, the handheld datalogger and probes were upgraded to a new ProSolo Digital Water Quality data logger; the YSI 556 has been discontinued by the manufacturer. With this new data logger, values for temperature, specific conductance (and salinity), and dissolved oxygen (% saturation and mg/L) are recorded real-time at the same depth intervals mentioned above. This new equipment does not have a pH probe and, even though recording pH sea-truthing data is useful, it is not a requirement of the program in terms of sea-truthing. The calibration procedure, for both the YSI 556 and the ProSolo data loggers used in sea-truthing, follows the same general procedure as that for the data loggers used for extended deployments. Calibration of the handheld sensors is done the day before a scheduled deployment; dissolved oxygen is calibrated the day of deployment in air-saturated water. Data and calibrating logs for the YSI 556 and the ProSolo dataloggers are kept at the Reserve and available upon request.

Site Infrastructure

The monitoring site at Potter Cove was originally constructed in 1995, and it consisted of a PVC pipe mounted vertically on a piling located approximately 6 feet west of a floating dock. To facilitate water flow across the sensors, openings were cut into the PVC pipes. The pipes were positioned to ensure that the sensors were less than 1 meter from the bottom. In 2006, the infrastructure at Potter Cove was replaced. Currently, the deploying structure is a short PVC tube attached to the floating dock, with a line attached through the pipe to an anchor on the bottom. The sonde is attached to the anchor via a shackle and hook setup, and a float is attached to the top of the sonde to keep it approximately 0.75 m off the bottom. With this setup, the sonde is free and clear of any pipe affects since the pipe does not extend to the bottom and serves only as a “decoy pipe” to prevent vandalism.

In 1996, the original T-Wharf site was put into service using a PVC pipe mounted on a piling attached to the wharf. In 2002, the two replacement T-Wharf sites (Surface and Bottom) were also deployed in PVC pipes mounted to a piling. The sonde at the T-Wharf Surface site was maintained just below the surface by means of a buoy attached by rope to the adjacent wharf; the sonde at T-Wharf Bottom was maintained approximately 0.5 m off the bottom. On 10/11/06, the PVC deployment pipes and securing structures were replaced. The design was similar to the previous pipe design (following YSI recommendations) and consisted of holes drilled through the pipe and large slits at the bottom of the pipe to allow free water movement at the sonde. The T-Wharf Bottom pipe extends approximately 6 m though the water to the bottom of the site, where the sonde is kept approximately 1.0 m off the bottom. The T-Wharf Surface pipe extends approximately 2 m under the surface of the water (at low tide), where the sonde was attached to a float to keep it approximately 0.5 m below the surface of the water. After Tropical Storm Irene in August of 2011, the deploying structure was damaged; the PVC pipe was lost and, the piling where it was attached to, was damaged beyond repair. A temporary deploying structure was build consisting of a steel cable attached to the wharf with an anchor at the end to keep the cable straight and in place. The Surface and Bottom sondes were attached to the cable for each deployment and lowered into the water with a security line. The Reserve arranged to build a permanent deploying structure; a new piling was installed on February 2012, two 4” diameter PVC pipes were installed in June (following YSI recommendations), and the sondes were deployed in July in these new structures. The Surface sonde was deployed attached to a float to be approximately 1.0 m below the surface at low tide, and the Bottom sonde 1.0 m above the bottom substrate. Due to the narrow PVC pipes, the Surface sonde was getting jammed inside and not floating free; thus, the deployment was changed to a fixed one at approximately 0.5 m at low tide. As standard procedure, the pipes have been cleaned of biofouling monthly with a chimney brush mostly during the warm months (April to November) to reduce the impact of biofouling on the data. In May 2016, the chimney brush was replaced with a custom-made stainless steel, hollow cylinder on a rope called reamer, which turned to be more efficient than cleaning biofouling with a chimney brush. Cleaning schedule has changed to an all-year around cleaning.

The Nag Creek sonde was originally deployed in a metal cage, which was tethered to the bank. A permanent deployment structure was installed 12/31/02, consisting of a 4” x 4” pressure-treated post with a hinged 2” x 4” horizontal arm. On 09/08/06, the sonde deployment structure was redesigned and changed. The new structure consists of an L-shape wooden structure that held in place in the sediment by a large metal tripod sunk into the mud. The sonde is extended from the arm into the water via a cleat, eye and line system and hangs approximately 0.30 m off the bottom of the creek. In 2012, the deployment structure was changed for a wooden tripod sunken into the mud, which facilitated its removal in the winter when the low temperatures freeze up the creek.

**Real-time data transmission**

A Sutron Sat-Link2 transmitter was installed at the T-Wharf Bottom monitoring site on 07/27/06 and transmits data to the NOAA GOES satellite, NESDIS ID #3B0335EE. The transmissions are scheduled hourly and contain four (4) data sets reflecting fifteen-minute data sampling intervals. Upon receipt by the CDMO, the data undergoes the same automated primary QAQC process detailed in Section 2 above. The “real-time” telemetry data become part of the provisional dataset until undergoing secondary and tertiary QAQC and assimilation in the CDMO’s authoritative online database. Provisional and authoritative data are available at [www.nerrsdata.org](http://cdmo.baruch.sc.edu/).

## Site Location and Character

The NBNERR is located close to the geographic center of Narragansett Bay in Rhode Island (Figure 1). It consists of approximately 1802 hectares (4453 acres: 2544 acres of land plus 1909 acres of surrounding estuarine waters, approximately) of diverse estuarine and terrestrial habitats ranging from deep water to salt marshes to forested uplands. The land holdings include approximately 65% of Prudence Island, most of nearby Patience Island, and all of Hope and Dyer Islands (Figure 1). The last land acquisition was the Eugene Chase Farm property, made official by the end of year 2015.

The Narragansett Bay watershed consists of nine subwatersheds draining an area of approximately 4,836square km [[1]](#footnote-2)(Pilson, 1985) and numerous and substantial freshwater inputs to the Bay. Approximately 39% of the watershed lies in Rhode Island and 61% in Massachusetts. It is referred to as a shallow estuary; however, its water depth varies considerably. Depth averages approximately 9.0 m throughout the Bay, but it is deeper in the East Passage (approximately 15.2 m) and shallower in the West Passage (approximately 7.5 m). More information and a detailed description of the Narragansett Bay NERR and the Narragansett Bay watershed can be found in [[2]](#footnote-3)Raposa and Schwartz, available at <http://nbnerr.org/wp-content/uploads/2016/12/Ecol-Profile-CH04-Ecological-Geography1.pdf>.

**Specific characteristics of the Narragansett Bay National Estuarine Research Reserve**

Location: 41°38’ 30” N, 71°20’30” W

Tidal range: -0.2 to 1.7 meters MLW

Salinity: 15 to 32 ppt

Temperature: -1.0 to 26 C

Province: North temperate, Virginian bioregion

Specific characteristics of the Nag Creek site are:

Location: 41° 37’ 29.458” N, 71° 19’ 27.421” W

Depth: 0.1 to 1.4 meters

Bottom habitat: Organic mud

Pollutants: Negligible

Watershed: Narragansett Bay, West Passage

Specific characteristics of the Potter Cove site are:

Location: 41° 38’ 25.984” N, 71° 20’ 27.165” W

Depth: 0.9 to 3.9 meters

Bottom habitat: Sand, silt, some organic mud

Pollutants: Boaters’ wastes, storm runoff from mainland urban areas

Watershed: Narragansett Bay, North Prudence (4801 km2)

Specific characteristics of the T-Wharf Bottom site are:

Location: 41° 34’ 42.099” N, 71° 19’ 16.049” W

Depth: 4.6 to 6.9 meters

Bottom habitat: Sand, silt, some organic mud

Pollutants: Negligible

Watershed: Narragansett Bay, South Prudence

Specific characteristics of the T-Wharf Surface site are:

Location: 41° 34’ 42.099” N, 71° 19’ 16.049” W

Depth: 0.2 to 0.9 meters

Bottom habitat: Sand, silt, some organic mud

Pollutants: Negligible

Watershed: Narragansett Bay, South Prudence

**Details of NBNERR SWMP Long-Term Water Quality Monitoring Sites Timeline.**

SWMP Status Column: P = primary SWMP Station, Reason Decommissioned Column: NA = Not applicable.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Station Code | SWMP Status | | Station Name | | Location | | Active Dates | | Reason Decommissioned | Notes |
| narncwq | P | | Nag Creek | | 41° 37' 29.46 N  71° 19' 27.42 W | | 03/01/02 00:00 - present | | NA | NA |
| narpcwq | P | | Potter Cove | | 41° 38' 25.98 N  71° 20' 27.17 W | | 12/01/95 00:00 - present | | NA | NA |
| nartbwq | P | | T-Wharf Bottom | | 41° 34' 42.10 N  71° 19' 16.05 W | | 07/01/02 00:00 - present | | NA | NA |
| nartswq | P | | T-Wharf Surface | | 41° 34' 42.10 N  71° 19' 16.05 W | | 07/01/02 00:00 - present | | NA | NA |
| nartwwq | P | T-Wharf | | 41° 34' 45.18 N  71° 19' 17.10 W | | 09/01/96 00:00 - 07/01/02 00:00 | | This location was in line with a summertime pycnocline. | | It was decided to move the station further out and established T-Wharf Surface and T-Wharf Bottom to examine patterns of water column stratification. |

## Data collection period

Date and time of the first and last readings in each data file downloaded from the sondes deployed at each of the four water quality sites on Prudence Island for January to December 2021. Deploy time is 24-hour format, EST (UTC -5).

**Nag Creek** (Data collection ongoing since 2002).

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| First Reading | |  | Last Reading | | EXO2 Sonde |
| Deploy Date | Deploy Time |  | Retrieve Date | Retrieve Time | Serial Number |
| 1, 2 12/31/20 | 14:30 |  | 02/04/21 | 08:45 | 14A101166 |
| 3 03/10/21 | 12:45 |  | 04/19/21 | 06:00 | 14A101167 |
| 04/19/21 | 09:15 |  | 05/04/21 | 13:15 | 14A101167 |
| 05/04/21 | 13:30 |  | 06/04/21 | 08:45 | 14A101166 |
| 06/04/21 | 09:00 |  | 07/07/21 | 08:30 | 14A101167 |
| 07/07/21 | 08:45 |  | 07/27/21 | 08:00 | 14A101166 |
| 4 07/27/21 | 08:15 |  | 08/20/21 | 10:00 | 14A101167 |
| 08/26/21 | 09:30 |  | 09/22/21 | 12:00 | 14A101167 |
| 09/22/21 | 12:15 |  | 10/14/21 | 08:45 | 14A101166 |
| 5 10/14/21 | 09:00 |  | 11/16/21 | 00:15 | 14A101167 |
| 11/16/21 | 08:45 |  | 12/29/21 | 09:30 | 14A101166 |
| 6 12/29/21 | 09:45 |  | 01/13/22 | 10:45 | 14A101167 |

Notes

1 Deployment started on 12/31/2020 14:30 and was covered in the 2020 metadata document and corresponding dataset file until 12/31/2020 23:45. Hence, only data from 2021 are included in this metadata document and corresponding dataset file, which starts on 01/01/2021 00:00.

2 The sonde was retrieved at the end of this deployment and not deployed again because the creek was becoming frozen. No data was collected from 02/04 09:00 to 03/10 12:30 due to frozen creek.

3 No data were collected from 04/19 06:15 – 04/19 09:00. Data logger was being calibrated in the lab to be deployed the same day due to two data loggers being out for repair.

4 The sonde was retrieved on 08/20 10:00 due to tropical storm Henri. No data was collected from 08/20 10:15 to 08/26 09:15.

5 No data were collected from 11/16 00:15 – 11/16 08:30 due to power failure.

6 This deployment ended on 01/13/22 10:45. However, the data included in this metadata document and corresponding QAQC’d dataset file covers from January 01st 00:00 to December 31 23:45 2021; the rest of the data will be covered on the 2022 quarterly and annual reports.

**Potter Cove** (Data collection ongoing since 1995).

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| First Reading | |  | Last Reading | | EXO2 Sonde |
| Deploy Date | Deploy Time |  | Serial Number | Retrieve Time | Serial Number |
| 1 12/13/20 | 14:00 |  | 01/22/21 | 09:45 | 14A101164 |
| 01/22/21 | 10:00 |  | 03/03/21 | 13:30 | 14A101165 |
| 2 03/03/21 | 13:45 |  | 04/14/21 | 08:15 | 14A101166 |
| 04/14/21 | 11:30 |  | 05/04/21 | 08:00 | 14A101166 |
| 3 05/04/21 | 08:30 |  | 05/31/21 | 20:45 | 14A101164 |
| 06/17/21 | 10:00 |  | 07/07/21 | 09:15 | 14A101165 |
| 4 07/07/21 | 09:30 |  | 07/17/21 | 21:15 | 14A101164 |
| 5 07/27/21 | 09:00 |  | 08/20/21 | 09:30 | 14A101165 |
| 08/26/21 | 08:45 |  | 09/22/21 | 11:30 | 14A101164 |
| 09/22/21 | 11:45 |  | 10/14/21 | 08:15 | 14A101165 |
| 10/14/21 | 08:30 |  | 11/16/21 | 09:00 | 14A101164 |
| 11/16/21 | 09:30 |  | 12/29/21 | 10:15 | 14A101165 |
| 6 12/29/21 | 10:45 |  | 02/02/22 | 13:30 | 14A101164 |

Notes

1 Deployment stared on 12/13/2020 14:00 and was covered in the 2020 metadata document and corresponding dataset file until 12/31/2020 23:45. Hence, only data from 2021 are included in this metadata document and corresponding dataset file, which starts on 01/01/2021 00:00.

2 No data were collected from 04/14 08:30 – 04/14 11:15. Data logger was being calibrated in the lab to be deployed the same day due to data loggers being out for repair.

3 No data were collected from 05/31 21:00 – 06/04 09:45 due to battery failure.

4 No data were collected from 07/17 21:30 to 07/27/21 08:45 because a faulty probe shut down the sonde completely.

5 The sonde was retrieved on 08/20 09:30 due to tropical storm Henri. No data was collected from 08/20 09:45 - 08/26 08:30.

6 This deployment ended on 02/02/22 13:30. However, the data included in this metadata document and corresponding QAQC’d dataset file covers from January 01st 00:00 to December 31 23:45 2021; the rest of the data will be covered on the 2022 quarterly and annual reports.

**T-Wharf Bottom** (Data collection ongoing since 2002).

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| First Reading | |  | Last Reading | | EXO2 Sonde |
| Deploy Date | Deploy Time |  | Serial Number | Retrieve Time | Serial Number |
| 1 12/14/20 | 08:30 |  | 01/20/21 | 09:45 | 17J101742 |
| 01/20/21 | 10:00 |  | 03/03/21 | 14:15 | 17J101743 |
| 03/03/21 | 14:45 |  | 04/06/21 | 09:45 | 17J101742 |
| 04/06/21 | 10:00 |  | 05/03/21 | 12:30 | 17L101173 |
| 05/03/21 | 13:00 |  | 06/02/21 | 09:30 | 17L101172 |
| 06/02/21 | 09:45 |  | 06/29/21 | 09:15 | 17L101173 |
| 06/29/21 | 09:30 |  | 07/29/21 | 08:30 | 17L101172 |
| 07/29/21 | 09:00 |  | 08/31/21 | 08:45 | 17L101173 |
| 08/31/21 | 09:15 |  | 09/22/21 | 09:00 | 17L101172 |
| 09/22/21 | 09:45 |  | 10/12/21 | 08:15 | 17L101173 |
| 10/12/21 | 08:45 |  | 11/23/21 | 09:30 | 17L101172 |
| 2 11/23/21 | 10:15 |  | 01/06/22 | 10:00 | 17L101173 |

Notes

1 This deployment started on 12/14/20 08:30 and was covered in the 2020 metadata document and corresponding dataset file until 12/31/2020 23:45. Hence, only data from 2021 are included in this metadata document and corresponding dataset file, which starts on 01/01/2021 00:00.

2 This deployment ended on 10/12/21 08:15. However, the data included in this metadata document and corresponding QAQC’d dataset file covers from January 01st 00:00 to December 31 23:45 2021; the rest of the data will be covered on the 2022 quarterly and annual reports.

**T-Wharf Surface** (Data collection ongoing since 2002).

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| First Reading | |  | Last Reading | | EXO2 Sonde |
| Deploy Date | Deploy Time |  | Serial Number | Retrieve Time | Serial Number |
| 1 12/14/20 | 08:30 |  | 01/20/21 | 09:30 | 16J102353 |
| 01/20/21 | 10:00 |  | 03/03/21 | 14:00 | 16J102354 |
| 03/03/21 | 14:30 |  | 04/06/21 | 09:15 | 16J102353 |
| 04/06/21 | 09:45 |  | 05/03/21 | 12:30 | 16J102354 |
| 05/03/21 | 12:45 |  | 06/02/21 | 09:30 | 16J102353 |
| 06/02/21 | 09:45 |  | 06/29/21 | 09:00 | 16J102354 |
| 06/29/21 | 09:30 |  | 07/29/21 | 08:30 | 16J102353 |
| 07/29/21 | 09:00 |  | 08/31/21 | 08:30 | 16J102354 |
| 08/31/21 | 08:45 |  | 09/22/21 | 09:00 | 16J102353 |
| 09/22/21 | 09:45 |  | 10/12/21 | 08:15 | 16J102354 |
| 10/12/21 | 08:45 |  | 11/23/21 | 09:30 | 16J102353 |
| 2 11/23/21 | 09:45 |  | 01/06/22 | 09:45 | 16J102354 |

Notes

1 This deployment started on 12/14/20 08:30 and was covered in the 2020 metadata document and corresponding dataset file until 12/31/2020 23:45. Hence, only data from 2021 are included in this metadata document and corresponding dataset file, which starts on 01/01/2021 00:00.

2 This deployment ended on 01/06/22 10:00. However, the data included in this metadata document and corresponding QAQC’d dataset file that covers from January 01st 00:00 to December 31 23:45 2021; the rest of the data will be covered on the 2022 quarterly and annual reports.

## Distribution

According to the Ocean and Coastal Resource Management Data Dissemination Policy for the NERRS System-wide Monitoring Program,

NOAA retains the right to analyze, synthesize and publish summaries of the NERRS System-wide Monitoring Program data. The NERRS retains the right to be fully credited for having collected and process the data. Following academic courtesy standards, the NERR site where the data were collected should be contacted and fully acknowledged in any subsequent publications in which any part of the data are used. The data set enclosed within this package/transmission is only as good as the quality assurance and quality control procedures outlined by the enclosed metadata reporting statement. The user bears all responsibility for its subsequent use/misuse in any further analyses or comparisons. The Federal government does not assume liability to the Recipient or third persons, nor will the Federal government reimburse or indemnify the Recipient for its liability due to any losses resulting in any way from the use of this data.

**Requested citation format**

NOAA National Estuarine Research Reserve System (NERRS). System-wide Monitoring Program. Data accessed from the NOAA NERRS Centralized Data Management Office website: <http://www.nerrsdata.org/>; *accessed* 12 October 2021.

NERR water quality data and metadata can be obtained from the Research Coordinator at the individual NERR site (please see Principal Investigators and Contact Persons), from the Data Manager at the Centralized Data Management Office (please see personnel directory under the general information link on the CDMO home page) and online at the CDMO home page [www.nerrsdata.org](http://www.nerrsdata.org). Data are available in comma delimited format.

## Associated researchers and projects

Complementary to the existing long-term water quality monitoring program, the NERRS implemented a new nutrient and chlorophyll monitoring program in 2002. The two sub-components of this program include monthly grab sampling at each of the four water quality sites, and diel sampling once a month at one site. The grab sampling program requires the collection of duplicate water samples every month from each of the four long-term water quality monitoring sites with the purpose of quantify seasonal patterns of nutrient and chlorophyll concentrations in different estuarine habitats (marsh creek, cove, surface open water, bottom open water).

The diel sampling program requires to collect a series of samples from one site over an approximately 24-hour period each month to examine how nutrient and chlorophyll concentrations change over diel and tidal cycles. Previously (from 2002 to 2010) the diel site was located at T-Wharf. However, after analyzing the historic data from the site, no significant trends or patterns were found over time. Therefore, the diel site was moved to Potter Cove in January of 2011 in order to characterize nutrients and chlorophyll from this site. All collected grab and diel samples are analyzed for concentrations of phosphates (PO4), ammonia (NH4), nitrite (NO2), nitrate (NO3), NO2+NO3, dissolved inorganic nitrogen (DIN), silicates (SiO4) and chlorophyll *a* and pheophytin *a*.

Since 2001, meteorological data has been collected as part of the SWMP at the weather station (see image below) located on Prudence Island, approximately 389 m south of Potter Cove (41o 38’ 13.703” N, 71o 20’ 21.790” W, Trimble Geo XT, GeoExplorer 2008 Series; see map on section 5, Site Location and Character). Data on air temperature, relative humidity, barometric pressure, wind speed and direction, photosynthetic active radiation, and precipitation are collected. Meteorological data is continually used to complement the water quality, biological monitoring and scientific research efforts at the Reserve, as well as to assist stewardship, training, and educational activities around the Bay.

All this information is available through the CDMO website [www.nerrsdata.org](http://www.nerrsdata.org), [NBNERR](http://nbnerr.org/), or directly contacting the Research Coordinator or the Marine Research Specialist II.

In 2004, the NBNERR became involved in the Bay Window Monitoring Program (BWMP). The BWMP housed several programs under different state and federal agencies to study Narragansett Bay’s fish and fisheries, sediment pollution, currents, and hydrography. Even though Bay Window ended in 2010, some programs where able to keep their monitoring with other funding source. Currently, NBNERR continues to be an essential part of the original network of fixed-sites recording water quality data in the Bay as part of the Rhode Island Department of Environmental Management, Bay Assessment and Response Team, Narragansett Bay Fixed-Site Monitoring Network ([RIDEM BART, NBFSMN](http://www.dem.ri.gov/programs/emergencyresponse/bart/data.php)). The program was created for a rapid and effective response to environmental incidents in Narragansett Bay using the water quality data collected by the NBFSMN. NBNFSM is a collaborative monitoring effort of several agencies and organizations (NBNERR, Office of Water Resources, Narragansett Bay Commission, URI Graduate School of Oceanography, Roger Williams University, Narragansett Bay Estuary Program, and URI Coastal Institute, Brown University) to monitor water quality with over a dozen fixed-site monitoring network in the Bay. The NBNERR SWMP sites (T-Wharf Surface and Bottom) provided the only year-round water quality data in the Bay network, and without these sites, the program would have a large gap in the mid/lower East Passage of the Bay. Data from all sites can be found at [RIDEM BART, NBFSMN](http://www.dem.ri.gov/programs/emergencyresponse/bart/data.php).

Dr. Candace Oviatt at URI-GSO is using NAR NERR chlorophyll data to track the timing and magnitude of winter/spring blooms in Narragansett Bay.

Mrs. Heather Stoffel at RIDEM and URI-GSO compiles NAR NERR dissolved oxygen data from T-Wharf Surface, T-Wharf Bottom sites together with data from NBFSMN to study hypoxia in the Bay.

The following are peer reviewed articles that have used water quality data from the Reserve for research:

Oviat, C. H. Stoffel, K. Huizenga, L. Reed, D. Codiga, L. Fields. 2022. A tale of two spring blooms in a northeast estuary of the USA: how storms impact nutrients, multiple trophic levels and hypoxia. Hydrobiología. 1-18. 10.1007/s10750-021-04768-7.

Narragansett Bay Estuary Program. 2017. State of Narragansett Bay and Its Watershed (Chapter 15, Dissolved Oxygen, pages 276-296). Technical Report. Providence, RI.

Codiga, D. L., H. E. Stoffel, C. F. Deacutis, S. Kiernan, and C. A. Oviatt. 2009. Narragansett Bay Hypoxic Event Characteristics Based on Fixed-Site Monitoring Network Time Series: Intermittency, Geographic Distribution, Spatial Synchronicity, and Interannual Variability. Estuaries and Coasts 32: 621-641.

# II. Physical Structure Descriptors

## Sensor specifications

From January to December 2021, NBNERR deployed EXO2 sondes with wiped conductivity and temperature (CT) probe at Nag Creek, Potter Cove, T-Wharf Surface, and T-Wharf Bottom. All the sondes deployed at all sites were equipped with optical dissolved oxygen (ODO) probes.

YSI EXO2 data sondes configuration

Parameter: **Temperature**

Units: Celsius (C)

Sensor Type: CT2 Probe, Thermistor

Model#: 599870

Range: -5 to 50 C

Accuracy: -5 to -35: ± 0.01, -35 to -50: ± .005

Resolution: 0.01 C

Parameter: **Conductivity**

Units: milli-Siemens per cm (mS/cm)

Sensor Type: CT2 Probe, 4-electrode cell with autoranging

Model#: 599870

Range: 0 to 200 mS/cm

Accuracy: 0 to 100: ± 0.5% of reading or 0.001 mS/cm; 100 to 200: ± 1% of reading

Resolution: 0.001 mS/cm to 0.1 mS/cm (range dependent)

Parameter: **Salinity**

Units: practical salinity units (psu)/parts per thousand (ppt)

Sensor Type: CT2 probe, Calculated from conductivity and temperature

Range: 0 to 70 psu

Accuracy: ± 1.0% of reading pr 0.1 ppt, whichever is greater

Resolution: 0.01 psu

-OR-

Parameter: **Temperature**

Units: Celsius (C)

Sensor Type: Wiped probe; Thermistor

Model#: 599827

Range: -5 to 50 C

Accuracy: ±0.2 C

Resolution: 0.001 C

Parameter: **Conductivity**

Units: milli-Siemens per cm (mS/cm)

Sensor Type: Wiped probe; 4-electrode cell with autoranging

Model#: 599827

Range: 0 to 100 mS/cm

Accuracy: ±1% of the reading or 0.002 mS/cm, whichever is greater

Resolution: 0.01

Parameter: **Salinity**

Units: practical salinity units (psu)/parts per thousand (ppt)

Sensor Type: Calculated from conductivity and temperature

Range: 0 to 70 psu

Accuracy: ± 1.0% of reading pr 0.1 ppt, whichever is greater

Resolution: 0.01 psu

-AND-

Parameter: **Dissolved Oxygen % Saturation**

Units: Percent saturation

Sensor Type: Optical probe w/ mechanical cleaning

Model#: 599100-01

Range: 0 to 500% air saturation

Accuracy: 0-200% air saturation: ± 1% of the reading or 1% air saturation, whichever is

greater 200-500% air saturation: ± 5% or reading

Resolution: 0.1% air saturation

Parameter: **Dissolved Oxygen** (Calculated from % air saturation, temperature, and salinity)

Units: milligrams/Liter (mg/L)

Sensor Type: Optical probe w/ mechanical cleaning

Model#: 599100-01

Range: 0 to 50 mg/L

Accuracy: 0-20 mg/L: ± 0.1 mg/l or 1% of the reading, whichever is greater 20-50 mg/L:

± 5% of the reading

Resolution: 0.01 mg/L

Parameter: **Non-vented Level - Shallow (Depth)**

Units: feet or meters (ft. or m)

Sensor Type: Stainless steel strain gauge

Range: 0 to 33 ft. (10 m)

Accuracy: ± 0.013 ft. (0.004 m)

Resolution: 0.001 ft. (0.001 m)

Parameter: **pH**

Units: pH units

Sensor Type: Glass combination electrode

Model#: 599702 (wiped)

Range: 0 to 14 units

Accuracy: ± 0.01 units within ± 10° of calibration temperature, ± 0.02 units for entire

temperature range

Resolution: 0.01 units

Parameter: **Turbidity**

Units: formazin nephelometric units (FNU)

Sensor Type: Optical, 90-degree scatter

Model#: 599101-01

Range: 0 to 4000 FNU

Accuracy: 0-999 FNU: 0.3 FNU or ± 2% of reading (whichever greater); 1000-4000 FNU

± 5% of reading

Resolution: 0 to 999 FNU: 0.01 FNU, 1000 to 4000 FNU: 0.1 FNU

Parameter: **Chlorophyll Fluorescence**

Units: micrograms/Liter

Sensor Type: Optical probe

Model#: 599102-01

Range: 0 to 400 µg/Liter

Accuracy: Dependent on methodology

Resolution: 0.1 µg/L chl a, 0.1% FS

### Depth Qualifier:

The NERR System-Wide Monitoring Program utilizes YSI data sondes that can be equipped with either vented or non-vented depth/level sensors. Readings for both vented and non-vented sensors are automatically compensated for water density change due to variations in temperature and salinity; but for all non-vented depth measurements, changes in atmospheric pressure between calibrations appear as changes in water depth. The error is equal to approximately 1.02 cm for every 1 millibar change in atmospheric pressure and is eliminated for vented sensors because they are vented to the atmosphere throughout the deployment time interval.

Beginning in 2006, NERR SWMP standard calibration protocol calls for all non-vented depth sensors to read 0 meters at a (local) barometric pressure of 1013.25 mb (760 mm/hg). To achieve this, each site calibrates their depth sensor with a depth-offset number, which is calculated using the actual atmospheric pressure at the time of calibration and the equation provided in the SWMP calibration sheet or digital calibration log. This offset procedure standardizes each depth calibration for the entire NERR System. If accurate atmospheric pressure data are available, non-vented sensor depth measurements at any NERR can be corrected.

In 2010, the CDMO began automatically correcting depth/level data for changes in barometric pressure as measured by the Reserve’s associated meteorological station during data ingestion. These corrected depth/level data are reported as cDepth and cLevel and are assigned QAQC flags and codes based on QAQC protocols. Please see sections 11 and 12 for QAQC flag and code definitions.

**NOTE: older depth data cannot be corrected without verifying that the depth offset was in place and whether a vented or non-vented depth sensor was in use. No SWMP data prior to 2006 can be corrected using this method.** The following equation is used for corrected depth/level data provided by the CDMO beginning in 2010:

((1013-BP)\*0.0102)+Depth/Level = cDepth/cLevel.

### Salinity Units Qualifier:

In 2013, EXO sondes were approved for SWMP use and began to be utilized by Reserves. While the 6600 series sondes report salinity in parts per thousand (ppt) units, the EXO sondes report practical salinity units (psu). These units are essentially the same and for SWMP purposes are understood to be equivalent, however psu is considered the more appropriate designation. Moving forward the NERR System will assign psu salinity units for all data regardless of sonde type.

### Turbidity Qualifier:

In 2013, EXO sondes were approved for SWMP use and began to be utilized by Reserves. While the 6600 series sondes report turbidity in nephelometric turbidity units (NTU), the EXO sondes use formazin nephelometric units (FNU). These units are essentially the same but indicate a difference in sensor methodology, for SWMP purposes they will be considered equivalent. Moving forward, the NERR System will use FNU/NTU as the designated units for all turbidity data regardless of sonde type. If turbidity units and sensor methodology are of concern, please see the Sensor Specifications portion of the metadata.

### ****Chlorophyll Fluorescence Disclaimer:****

YSI chlorophyll sensors (6025 or 599102-01) are designed to serve as a proxy for chlorophyll concentrations in the field for monitoring applications and complement traditional lab extraction methods; therefore, there are accuracy limitations associated with the data that are detailed in the YSI manual including interference from other fluorescent species, differences in calibration method, and effects of cell structure, particle size, organism type, temperature, and light on sensor measurements.

## Coded variable definitions

|  |  |  |
| --- | --- | --- |
| Water Quality Sampling Station | Sampling Site Code | Station Code |
| Nag Creek | NC | narncwq |
| Potter Cove | PC | narpcwq |
| T-Wharf Surface | TS | nartswq |
| T-Wharf Bottom | TB | nartbwq |

## QAQC flag definitions

QAQC flags provide documentation of the data and are applied to individual data points by insertion into the parameter’s associated flag column (header preceded by an F\_). During primary automated QAQC (performed by the CDMO), -5, -4, and -2 flags are applied automatically to indicate data that is missing and above or below sensor range. All remaining data are then flagged 0, passing initial QAQC checks. During secondary and tertiary QAQC 1, -3, and 5 flags may be used to note data as suspect, rejected due to QAQC, or corrected.

|  |  |
| --- | --- |
| Flag | Description |
| -5 | Outside High Sensor Range |
| -4 | Outside Low Sensor Range |
| -3 | Data Rejected due to QAQC |
| -2 | Missing Data |
| -1 | Optional SWMP Supported Parameter |
| 0 | Data Passed Initial QAQC Checks |
| 1 | Suspect Data |
| 2 | Open-reserved for later flag |
| 3 | Calculated data: non-vented depth/level sensor correction for changes in barometric pressure |
| 4 | Historical Data: Pre-Auto QAQC |
| 5 | Corrected Data |

## QAQC code definitions

QAQC codes are used in conjunction with QAQC flags to provide further documentation of the data and are also applied by insertion into the associated flag column. There are three (3) different code categories, general, sensor, and comment. General errors document general problems with the deployment or YSI datasonde, sensor errors are sensor specific, and comment codes are used to further document conditions or a problem with the data. Only one general or sensor error and one comment code can be applied to a particular data point, but some comment codes (marked with an \* below) can be applied to the entire record in the F\_Record column.

General Errors

GIC No instrument deployed due to ice

GIM Instrument malfunction

GIT Instrument recording error; recovered telemetry data

GMC No instrument deployed due to maintenance/calibration

GNF Deployment tube clogged / no flow

GOW Out of water event

GPF Power failure / low battery

GQR Data rejected due to QA/QC checks

GSM See metadata

Corrected Depth/Level Data Codes

GCC Calculated with data that were corrected during QA/QC

GCM Calculated value could not be determined due to missing data

GCR Calculated value could not be determined due to rejected data

GCS Calculated value suspect due to questionable data

GCU Calculated value could not be determined due to unavailable data

Sensor Errors

SBO Blocked optic

SCF Conductivity sensor failure

SCS Chlorophyll spike

SDF Depth port frozen

SDG Suspect due to sensor diagnostics

SDO DO suspect

SDP DO membrane puncture

SIC Incorrect calibration / contaminated standard

SNV Negative value

SOW Sensor out of water

SPC Post calibration out of range

SQR Data rejected due to QAQC checks

SSD Sensor drift

SSM Sensor malfunction

SSR Sensor removed / not deployed

STF Catastrophic temperature sensor failure

STS Turbidity spike

SWM Wiper malfunction / loss

Comments

CAB\* Algal bloom

CAF Acceptable calibration/accuracy error of sensor

CAP Depth sensor in water, affected by atmospheric pressure

CBF Biofouling

CCU Cause unknown

CDA\* DO hypoxia (<3 mg/L)

CDB\* Disturbed bottom

CDF Data appear to fit conditions

CFK\* Fish kill

CIP\* Surface ice present at sample station

CLT\* Low tide

CMC\* In field maintenance/cleaning

CMD\* Mud in probe guard

CND New deployment begins

CRE\* Significant rain event

CSM\* See metadata

CTS Turbidity spike

CVT\* Possible vandalism/tampering

CWD\* Data collected at wrong depth

CWE\* Significant weather event

## Post deployment information

Post-deployment readings of sondes deployed at each site. The readings are made using calibration standards the same day the sonde comes back from the field. Header abbreviations: PDR=post-deployment readings, Cal=calibration, Sp Cond=specific conductivity, Chl Fl=chlorophyll fluorescence, Rh=rhodamine. pH post-deployment readings are temperature dependent and minor variations are expected as a result.

**Nag Creek**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Deploy Date | PDR Date | EXO 2 Sonde | Sp Cond. | Dissolved Oxygen | | pH | | Turbidity | | Depth | Chl Fl | |
| mS/cm | Percent saturation | | units | | NTU | | Reading (Offset) | µg L-1 | |
| mm/dd/yy | mm/dd/yy | Serial No. | 50 | Reading 1 | & 2 | 7 | 10 | 0 | 124 | (m) | 0 | Rh |
| 12/13/20 | 02/04/21 | 14A101166 | 49.9 | 102.4 | 102.4 | 7.0 | 10.1 | 0.0 | 123.6 | -0.007 (-0.072) | -0.1 |  |
| 03/10/20 | 04/19/20 | 14A101167 | 50.1 | 100.6 | 100.6 | 7.1 | 10.1 | 0.0 | 124.0 | -0.029 (-0.029) | 0.0 |  |
| 04/19/21 | 05/04/21 | 14A101167 | 49.9 | 99.9 | 99.9 | 7.0 | 10.0 | 0.0 | 122.9 | -0.065 (-0.064) | 0.0 |  |
| 05/04/21 | 06/04/21 | 14A101166 | 49.9 | 100.1 | 100.1 | 7.1 | 10.1 | 0.8 | 124.4 | -0.007 (-0.008) | 0.0 |  |
| 06/04/21 | 07/07/21 | 14A101167 | 50.3 | 98.5 | 98.5 | 7.1 | 10.1 | 0.2 | 124.6 | -0.002 (-0.008) | 0.0 |  |
| 07/07/21 | 07/27/21 | 14A101166 | 50.1 | 99.2 | 99.2 | 7.1 | 10.1 | -0.1 | 123.7 | -0.008 (-0.008) | 0.0 |  |
| 07/27/21 | 08/26/21 | 14A101167 | 50.0 | 99.4 | 99.4 | 7.1 | 10.0 | 0.0 | 123.3 | -0.023 (-0.029) | 0.0 | 64.6 |
| 1 08/26/21 | 09/23/21 | 14A101167 | 50.0 | 100.7 | 100.7 | 7.1 | 10.0 | 0.2 | 124.7 | 0.045 (0.045) | 0.0 |  |
| 09/22/21 | 10/14/21 | 14A101166 | 50.0 | 99.2 | 99.2 | 7.3 | 10.1 | 0.0 | 123.7 | -0.018 (-0.020) | 0.0 | 67.3 |
| 10/14/21 | 11/16/21 | 14A101167 | 50.3 | 100.8 | 100.8 | 7.1 | 10.1 | 0.0 | 123.6 | 0.023 (0.022) | 0.4 | 57.9 |
| 11/16/21 | 12/29/21 | 14A101166 | 50.2 | 101.1 | 101.1 | 7.0 | 10.1 | 0.0 | 122.5 | -0.024 (-0.020) | 0.0 | 68.6 |
| 12/29/21 | 01/13/22 | 14A101167 | 50.0 | 100.9 | 100.9 | 7.0 | 10.2 | 0.0 | 123.5 | 0.009 (0.014) | 0.0 | 68.1 |

Notes

1 PDR was done one day after retrieving the sonde.

**Potter Cove**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Deploy Date | PDR Date | EXO 2 Sonde | Sp Cond. | Dissolved Oxygen | | pH | | Turbidity | | Depth | Chl Fl | |
| mS/cm | Percent saturation | | units | | NTU | | Reading (Offset) | µg L-1 | |
| mm/dd/yy | mm/dd/yy | Serial No. | 50 | Reading 1 | & 2 | 7 | 10 | 0 | 124 | (m) | 0 | Rh |
| 12/13/20 | 01/22/21 | 14A101164 | 50.1 | 100.7 | 100.7 | 7.1 | 10.1 | 0.0 | 124.5 | -0.123 (-0.118) | -0.1 |  |
| 01/22/21 | 03/03/21 | 14A101165 | 49.7 | 100.1 | 100.1 | 7.1 | 10.1 | 0.0 | 123.9 | -0.008 (-0.084) | 0.0 |  |
| 03/03/21 | 04/14/21 | 14A101166 | 50.1 | 106.4 | 106.4 | 7.1 | 10.0 | 0.0 | 124.3 | 0.037 (0.038) | 0.0 |  |
| 04/14/21 | 05/04/21 | 14A101166 | 50.0 | 100.0 | 100.0 | 7.0 | 10.1 | -0.1 | 123.4 | -0.068 (-0.064) | 0.0 |  |
| 05/04/21 | 06/17/21 | 14A101164 | 50.0 | 101.8 | 101.8 | 7.1 | 10.1 | 0.1 | 125.2 | -0.003 (-0.004) | 0.0 |  |
| 06/17/21 | 07/07/21 | 14A101165 | 50.1 | 99.9 | 99.9 | 7.1 | 10.0 | 0.0 | 123.5 | -0.014 (-0.012) | 0.0 |  |
| 1 07/07/21 | 07/27/21 | 14A101164 |  |  |  |  |  |  |  |  |  |  |
| 07/27/21 | 08/26/21 | 14A101165 | 50.0 | 99.7 | 99.7 | 7.1 | 10.1 | 0.0 | 123.5 | -0.022 (-0.029) | 0.0 | 64.8 |
| 2 08/26/21 | 09/22/21 | 14A101164 | 50.0 | 100.0 | 100.0 | 7.1 | 10.1 | 0.1 | 124.8 | 0.040 (0.045) |  |  |
| 09/22/21 | 10/14/21 | 14A101165 | 50.1 | 99.6 | 99.6 | 7.0 | 10.0 | 0.0 | 124.1 | -0.025 (-0.023) | 0.0 | 66.7 |
| 2 10/14/21 | 11/16/21 | 14A101164 | 50.3 | 99.8 | 99.8 | 7.0 | 10.0 | 0.1 | 123.8 | 0.026 (0.029) |  |  |
| 11/16/21 | 12/29/21 | 14A101165 | 50.2 | 100.6 | 100.6 | 6.9 | 10.0 | 0.0 | 123.9 | -0.017 (-0.016) | 0.0 | 68.0 |
| 2 12/29/21 | 02/02/22 | 14A101164 |  |  |  |  |  |  |  |  |  |  |

Notes

1 No post-deployment readings were done.

2 No chlorophyll fluorescence probe on the sonde. Out for repair.

**T-Wharf Bottom**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Deploy Date | PDR Date | EXO 2 Sonde | Sp Cond. | Dissolved Oxygen | | pH | | Turbidity | | Depth | Chl Fl | |
| mS/cm | Percent saturation | | units | | NTU | | Reading (Offset) | µg L-1 | |
| mm/dd/yy | mm/dd/yy | Serial No. | 50 | Reading 1 | & 2 | 7 | 10 | 0 | 124 | (m) | 0 | Rh |
| 12/14/20 | 01/20/21 | 17L101172 | 49.9 | 99.8 | 99.8 | 7.1 | 10.1 | 0.2 | 123.9 | -0.063 (-0.054) | 0.1 |  |
| 1 01/20/21 | 03/04/21 | 17L101173 | 49.9 | 100.6 | 100.6 | 7.1 | 10.2 | 0.0 | 123.9 | -0.086 (-0.084) | 0.0 |  |
| 03/03/21 | 04/06/21 | 17L101172 | 50.0 | 102.0 | 102.0 | 7.0 | 10.0 | 0.1 | 124.1 | -0.039 (-0.033) | 0.1 |  |
| 04/06/21 | 05/03/21 | 17L101173 | 49.9 | 100.8 | 100.8 | 7.1 | 10.1 | 0.0 | 123.8 | -0.071 (-0.077) | 0.2 |  |
| 05/03/21 | 06/02/21 | 17L101172 | 49.8 | 101.0 | 101.0 | 7.1 | 10.1 | 0.0 | 123.5 | 0.094 (0.098) | 0.4 |  |
| 06/02/21 | 06/29/21 | 17L101173 | 50.0 | 100.0 | 100.0 | 7.1 | 10.0 | 0.0 | 124.3 | 0.065 (0.058) | 0.0 |  |
| 06/29/21 | 07/29/21 | 17L101172 | 49.9 | 100.8 | 100.8 | 7.1 | 10.0 | 0.0 | 121.4 | 0.021 (0.019) | 0.2 | 65.4 |
| 07/29/21 | 08/31/21 | 14A101165 | 50.1 | 99.6 | 99.6 | 7.0 | 10.0 | 0.1 | 123.0 | -0.065 (-0.069) | 0.0 | 67.1 |
| 08/31/21 | 09/22/21 | 14A101164 | 49.8 | 100.4 | 100.4 | 7.1 | 10.1 | 0.0 | 124.9 | 0.074 (0.072) | -0.1 | 65.2 |
| 09/22/21 | 10/12/21 | 14A101165 | 50.1 | 100.3 | 100.3 | 7.0 | 9.9 | -0.1 | 119.0 | 0.065 (0.060) | -0.1 | 67.8 |
| 10/12/21 | 11/23/21 | 17L101172 | 50.2 | 100.0 | 100.0 | 7.1 | 10.0 | 0.2 | 123.5 | -0.030 (-0.027) | 0.0 | 30.4 |
| 11/23/21 | 01/06/22 | 17L101173 | 50.1 | 100.1 | 100.1 | 7.1 | 10.2 | 0.0 | 123.6 | -0.045 (-0.041) | 0.2 | 66.8 |

Notes

1Post-deployment readings done a day after retrieval.

**T-Wharf Surface**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Deploy Date | PDR Date | EXO 2 Sonde | Sp Cond. | Dissolved Oxygen | | pH | | Turbidity | | Depth | Chl Fl | |
| mS/cm | Percent saturation | | units | | NTU | | Reading (Offset) | µg L-1 | |
| mm/dd/yy | mm/dd/yy | Serial No. | 50 | Reading 1 | & 2 | 7 | 10 | 0 | 124 | (m) | 0 | Rh |
| 12/14/20 | 01/20/21 | 16J102353 | 49.9 | 100.2 | 100.2 | 7.0 | 10.0 | 0.1 | 123.7 | -0.053 (-0.045) | 0.1 |  |
| 1 01/20/21 | 03/04/21 | 16J102354 | 49.8 | 100.3 | 100.3 | 7.1 | 10.1 | 0.0 | 124.0 | -0.083 (-0.084) | 0.0 |  |
| 03/03/21 | 04/06/21 | 16J102353 | 50.3 | 101.3 | 101.3 | 7.1 | 10.1 | 0.0 | 124.0 | -0.031 (-0.027) | 0.0 |  |
| 04/06/21 | 05/03/21 | 16J102354 | 50.1 | 101.7 | 101.7 | 7.1 | 10.0 | 0.1 | 123.7 | -0.061(-0.033) | 0.0 |  |
| 05/03/21 | 06/02/21 | 16J102353 | 49.9 | 101.9 | 101.9 | 7.1 | 10.0 | 0.0 | 124.3 | 0.096 (0.103) | 0.0 |  |
| 06/02/21 | 06/29/21 | 16J102354 | 50.0 | 101.0 | 101.0 | 7.1 | 10.0 | 0.1 | 124.4 | 0.061 (0.079) | 0.0 |  |
| 06/29/21 | 07/29/21 | 16J102353 | 49.9 | 100.3 | 100.3 | 7.0 | 10.0 | -0.2 | 124.6 | 0.016 (0.019) | 0.0 | 66.0 |
| 07/29/21 | 08/31/21 | 16J102354 | 50.0 | 99.4 | 99.4 | 7.0 | 10.1 | 0.1 | 123.1 | -0.063 (-0.064) | 0.1 | 68.7 |
| 08/31/21 | 09/22/21 | 16J102353 | 49.9 | 100.2 | 100.2 | 7.0 | 10.0 | 0.0 | 129.7 | 0.078 (0.080) | 0.0 | 65.3 |
| 09/22/21 | 10/11/21 | 16J102354 | 50.0 | 100.5 | 100.5 | 7.1 | 10.1 | 0.0 | 123.4 | 0.069 (0.072) | 0.0 | 67.0 |
| 10/12/21 | 11/23/21 | 16J102353 | 50.1 | 99.3 | 99.3 | 7.0 | 9.9 | 0.2 | 123.6 | -0.027(-0.024) | 0.0 | 30.1 |
| 11/23/21 | 01/06/22 | 16J102354 | 50.0 | 99.7 | 99.7 | 6.9 | 10.0 | 0.0 | 123.6 | -0.052(-0.045) | 0.0 | 65.7 |

Notes

1Post-deployment readings done a day after retrieval.

## Other Remarks / Notes

Data are missing due to equipment or associated specific probes not being deployed, equipment failure, time of maintenance or calibration of equipment, or repair/replacement of a sampling station platform. Any NANs in the dataset stand for “not a number” and are the result of low power, disconnected wires, or out of range readings. If additional information on missing data is needed, contact the Research Coordinator at the reserve submitting the data.

Chlorophyll and fluorescence data were collected along with the data presented in this document, but because chlorophyll and fluorescence are not part of the NERR SWMP Water Quality Program requirements, the data are not reported within this dataset but are available upon request by contacting the Reserve.

Slight depth anomalies frequently occur at the Nag Creek deployment location. Depth at this site may have been influenced to some extent by changes in atmospheric pressure because the sonde was situated in very shallow waters. On occasion, the combination of low atmospheric pressure and shallow water resulted in negative depth values. Weather station data appear to support this theory. It is also suspected that due to its shallow location and location in a salt marsh, freshwater runoff from the island may affect specific conductivity/salinity readings several days after a rain event has occurred. Specific conductivity, salinity, and dissolved oxygen can also vary greatly in Nag Creek over tidal and diel cycles. Nag creek is a very shallow site and is highly affected by tides and rain events. On some occasions, dissolved oxygen (DO) is recorded as negative values at the Nag Creek deployment location. Dissolved oxygen frequently ranges between supersaturation and complete anoxic conditions (DO = 0 % saturation) at this site during the summer months. Ice is also common in Nag Creek. There have been occasions where ice has affected all sonde parameters and are marked in the data as “see metadata”.

It is likely that some of the variability in specific conductivity at Nag Creek is due to freshwater entering the marsh from the red maple swamp abutting it to the east (across the road). The amount of fresh groundwater inflow has not been quantified, but evidence for it comes in the form of 1) the presence of brackish vegetation species along the upland borders of the marsh in areas abutting the swamp, and 2) new data from a salinity mapping project conducted by Dr. Rick McKinney (EPA Atlantic Ecology Division) that quantifies lower salinities along those same borders. The variability is surely exacerbated due to the shallow nature of the creek in which the sonde is located. After rain events, salinities are likely to be relatively high at high tide due to the influx of Bay water, and then correspondingly low at low tide when the surface freshwater predominates.

The following are description of different events that happened during deployments, and explanations to the CSM (Comment-See Metadata) code for the four water quality site data files from January to December of 2021.

Nag Creek

Throughout the year there are small turbidity spikes marked 1 STS CSM. Due to the sonde being deployed in a horizontal position, there is, at times, drift algae that gets caught up on the station and affects the turbidity data (see picture at right).

Deployment period 01/23 17:45 – 02/04 08:45. Due to the on and off formation of ice in the creek during this period, the deploying structure fell in the water and the sonde sat at the bottom of the creek. However, the sonde continued to collect data. After close examination of the data, it was considered suspect and flagged and coded 1 GSM CWD.

Deployment period 02/04 09:00 – 03/10 12:30. No data were collected during this period because the creek was frozen, and the sonde was kept in the lab. Missing data were flagged and coded -2 GIC CSM.

Deployment period 03/10 12:45-13:00. The bottom sediment was disturbed while in the creek installing the deploying structure at Nag Creek after the creek has thawed out. The sonde was deployed during the installation/security check process and the bottom was visibly disturbed. Turbidity data were flagged and coded -3 GSM CDB.

Deployment period 04/19 06:15 – 04/19 09:00. The sonde at Nag was retrieved, taken to the lab for post-deployment readings, and cleaned. Subsequently, it was calibrated to be redeployed at Nag the same day. During this period, no data were collected at Nag. Nag’s second sonde was deployed at Potter Cove. This was done to keep collecting data at Potter Cove since both Potter sondes were out for repair. Missing data were flagged and coded -2 GMC CSM.

Deployment 08/05 06:15 – 08/05 16:30. Significant precipitation was recorded at the weather station on Prudence Island starting 08/04/21 16:30 to 08/05/21 10:15, for a total of 2.79 inches (1.0”, 1.79”, respectively). The rain event affected water quality parameters slightly different in terms of time. As a result, parameters affected were flagged and coded 1 GSM CRE. Parameters not affected, were flagged and coded as 0 GSM CRE.

* Specific conductivity and salinity 08/05 06:30 – 16:15
* pH 08/04 21:00 – 08/05 16:15
* Dissolved oxygen 08/05 01:15 – 16:15
* Turbidity 08/05 06:30 – 16:00

Deployment period 08/20 10:15 – 08/26 09:15. The sonde at Nag Creek was retrieved to avoid loss or damage due to tropical storm Henri over the New England region. Missing data were flagged and coded -2 GSM CWE.

Deployment period 11/16 00:30 – 11/16 08:30. Sonde batteries failed in the field. No data were collected during this period. Missing data were flagged and coded -2 GPF CSM.

Potter Cove

Deployment period 02/12 20:30 – 03/03 13:30. The specific conductivity and salinity data seemed not typical of the site. Upon inspection of the sonde and probe, it was found the probe had malfunctioned due to corrosion. Even though specific conductivity and temperature are together in the same probe, temperature data was not affected. Specific conductivity and salinity data were rejected and flagged and coded -3 SSM CSM.

Deployment period 04/14 08:30 – 04/14 11:15. Both sondes from Potter Cove were out for repairs. To keep collecting data at all sites, one of Nag sondes was deployed at Potter’s. The sonde was retrieved, taken to the lab for post-deployment readings, and cleaned. Subsequently, it was calibrated to be redeployed the same day. During this period, no data were collected. This arrangement was done to keep collecting data at Potter Cove while both sondes were out for repair. Missing data were flagged and coded -2 GMC CSM.

Deployment period 05/31 21:00 – 06/17 09:45. Batteries failed; no data were collected during this period. Missing data were flagged and coded -2 GPF CSM.

Deployment period 07/17 21:30 – 07/27 08:45. Due to a faulty probe, the sonde malfunction and stopped collecting data. Missing data were flagged and coded -2 GIM CSM.

Deployment 08/20 09:45 – 08/26 08:30. The sonde at Potter Cove was retrieved to avoid loss or damage due to tropical storm Henri over the New England region. Missing data were flagged and coded -2 GSM CWE.

Deployment period 09/02 12:00 – 20:30 and 09/05 03:30 – 09:30. Depth data were collected at a wrong depth during these periods. The security line got tangled with the floating dock and the sonde was slightly pulled up with the floating dock during high tide. Depth data collected during these incidents were flagged and coded 1 GSM CWD. Potter Cove is a shallow, well mixed site and other water quality parameters were not affected. Data not affected were flagged and coded 0 GSM CWD.

T-Wharf Bottom

Telemetry station equipment was lost due to a powerful storm in November 2020. By June 2021, the station was replaced. During this period, no data was telemetered, but water quality data were collected. For any data request, please contact Dr. Daisy Durant (See Section 1 for contact info).

Deployment period 03/02 01:30 – 06:30. Depth recorded during this period seem shallower than the rest of the year. This was due to a strong Northwest wind coinciding with low tide (03:20), which push the tide even further. The shallowest depth recorded was 4.41 m (03:45). Water quality parameters seemed not to be affected. Since the depth data collected fit the environmental conditions prevailing at the time, depth data were flagged and coded 0 GSM CDF.

Deployment period 06/10 09:00 – 09:30. Sonde collected data while out of the water to connect telemetry cable. Data were rejected and flagged and coded -3 GSM CMC.

Deployment period 08/17 07:00 – 08/31 08:45. Turbidity data was high during this period due to biofouling. Mussel recruits, calcareous bryozoan, and five small crabs were found in the guard after retrieving the sonde. Turbidity data were considered suspect and flagged and coded 1 GSM CBF.

**T-Wharf Surface**

Deployment period 03/02 02:30 – 05:00. Depth recorded during this period seem shallower than the rest of the year. This was due to a strong Northwest wind coinciding with low tide (03:20), which push the tide even further. The shallowest depth recorded was 0.30 m (03:45). Water quality parameters seemed not to be affected. Since the depth data collected fit the environmental conditions prevailing at the time, depth data were flagged and coded 0 GSM CDF.

T-Wharf Bottom and T-Wharf Surface

At T-Wharf Surface and Bottom sites, sondes are deployed inside a 4” diameter PVC tube with slits and holes to aid in the water circulation. To clean the inside of the tubes of biofouling that can affect the water quality parameters, a reamer (see image at left) attached to a rope is sent down the tube right before each deployment. If there is any debris still floating inside the tube by the time the sondes are deployed, that can be mistaken for an increase in turbidity at the site. In this case the following data are suspect and flagged and coded 1 GSM CND.

Deployment period 10/06 08:30 – 09:00. Sondes were pulled out of the water, while still collecting data, to allow divers to clean biofouling off of the deploying structures on the outside for T-Wharf Surface and Bottom. Data collected were flagged and coded -3 GSM CMC.

1. Pilson, M.E.Q. 1985. On the residence time of water in Narragansett Bay. *Estuaries* 8:2–14. [↑](#footnote-ref-2)
2. Narragansett Bay National Estuarine Research Reserve. 2007. An Ecological Profile of the Narragansett Bay National Estuarine Research Reserve. K.B. Raposa and M.L. Schwartz (eds.), *Rhode Island Sea Grant*, Narragansett, R.I. 176pp. [↑](#footnote-ref-3)