Delaware (DEL) NERR Water Quality Metadata
January 01 –December 31, 2024
Latest Update: April 04, 2025

Note: This is a provisional metadata document; it has not been authenticated as of its download date. Contents of this document are subject to change throughout the QAQC process and it should not be considered a final record of data documentation until that process is complete. Contact the CDMO (cdmosupport@baruch.sc.edu) or reserve with any additional questions.

I. Data Set and Research Descriptors

1) Principal investigator(s) and contact persons –

Mollie Yacano, PhD, Research Coordinator email: mollie.yacano@delaware.gov
Michael G. Mensinger, Environmental Scientist, email: mike.mensinger@delaware.gov – responsible for the design, implementation, continuation of the data set and data management

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2) 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 KOR Software in an Excel 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.

Michael G. Mensinger is responsible for the acquisition, editing, archiving, and all other aspects of data management. Data archival takes place on both the NERRS Centralized Data Management Office (CDMO) and State of Delaware servers.

3) Research objectives –

The principal objective of this study is to record long-term water quality data in order to observe any physical changes or trends in water quality over time. The four sites chosen for monitoring will assist in understanding the impacts of both urban and agricultural impacts on the respective watersheds. Scotton Landing, Lebanon Landing, and Division Street are located within the St. Jones River watershed, while the Blackbird Landing component is located in the Blackbird Creek watershed. The St. Jones River is impacted by urbanization upstream and extensive agricultural activity throughout the basin. The Blackbird Creek is one of the least impacted riverine systems in Delaware, although development pressures are currently increasing. Measurements are taken every 15 minutes over three week collecting periods at the Scotton Landing (SL), Blackbird Landing (BL), Lebanon Landing (LL), and Division Street (DS) sites.

4) Research methods –

The YSI data sonde monitoring program commenced in July 1995 at Scotton Landing (St. Jones River) and Blackbird Landing (Blackbird Creek). In June 1996 Penrose Branch (St. Jones River Basin) was added to the monitoring program. The Penrose Branch site was later discontinued on December 26, 2001. In January 2002 the Lebanon Landing and Division Street sites were added to the monitoring program. Prior to deployment, a 4" diameter schedule 80 PVC pipe was mounted to a piling at Scotton Landing and a bridge at Blackbird Landing using stainless steel brackets and bolts. These methods were also used to install a pipe to a piling at the Lebanon Landing dock and the pumping station bank wall at Division Street. Each YSI data sonde is lowered into the PVC pipe containing eight (8) two-inch diameter holes cut out at the bottom, affording the probes direct contact with the water column. A large stainless steel bolt was placed at the bottom end of the PVC pipe which maintained each YSI data sonde at each site exactly one foot (30 cm) above the river bottom.

Every 15 minutes over a three-week period, measurements of specific conductivity, salinity, percent saturation, dissolved oxygen, temperature, pH, and water level are recorded. Three-week sampling intervals were selected to minimize the effects of bio-fouling. At the end of each three-week interval, the deployed YSI data sonde is brought back to the office for downloading, post-deployment readings in known standards, and cleaning. A second YSI data sonde is immediately deployed for the next three-week interval when the previous unit is retrieved. This method alleviates the potential for lost data during calibration and data download times. Calibrations performed include: dissolved oxygen using 100% air saturated water, specific conductivity using Oakton 12,880 µS standard, turbidity using YSI 6073G Turbidity Standard at 124 FNU and distilled water at 0 FNU, pH using Fisher pH 4.00, 7.00 and 10.00 buffers, and water level. These procedures are carried out according to the methods described in the YSI EXO Operating and Service Manual and Xylem/YSI EXO Multi-Parameter Water Quality Monitoring Standard Operating Procedures document. Data files undergo automated QA/QC through the CDMO and undergo additional QA/QC checks using Excel macros provided by the CDMO to assist in graphing and data review.

Depth probe calibration procedures changed during 2007 and involved the inclusion of a depth offset based on data acquired from RTK unit work at each site in order. This calibration change greatly augments the depth data set by referencing it to a known vertical datum, in this case NAVD88. Depth data changed as a result of this work on the following dates/times at the following stations: Scotton Landing (10/16/2007, 09:45:00 EST), Lebanon Landing (10/16/2007, 14:00:00 EST), Division Street (10/16/2007, 13:30:00 EST), and Blackbird Landing (11/01/2007, 10:45:00 EST). All depth data collected in 2024 from Scotton Landing, Lebanon Landing and Division Street is considered "water level" data as opposed to the historic "depth data" collected before late 2007. Blackbird Landing was reverted to depth data in 2024 and will continue to report depth due to vertical relocation of the sonde tube after bridge work.

Site Name	Scotton Landing (delslwq)
Site infrastructure description	*The schedule 80 deployment tube is attached to a dock piling with stainless steel u-brackets. The tube has been affixed to this piling since 1995 and is stable*
Surveying equipment	*EOS Arrow Gold (Kinematic Surveying Specs: Horizontal: +/- 8 mm + 1 ppm HRMS, Vertical +/- 2 cm + 1 ppm RMS, Initialization Time: <60 seconds, Initialization Reliability: typically >99.9%*
Survey monument used	https://www.ngs.noaa.gov/cgi-bin/ds_mark.prl?PidBox=DQ0896
Survey occupation date	*11/04/2024*
Survey occupation duration	*5 minutes*
Ellipsoid height	-33.414 meters
"Quick Check" marker for deployment tube	*Distance from top of upper stainless-steel u-bracket to deployment tube top is measured (17.2 cm) as quick check*

"Quick Check" for sonde being deployed at the same location	*Distance from stainless steel stop bolt that sonde sits on inside the deployment tube to the top of the deployment tube (8.22 ft) is measured with a survey rod and used as the quick check*
Annual resurveying	*11/04/2024 (0.932 m NAVD88)*

Site Name	Lebanon Landing (delllwq)
Site infrastructure description	*Schedule 80 deployment tube is attached to dock piling and rail beam with modified pipe hangers, has been in place since 2002, and is stable.*
Surveying equipment	*EOS Arrow Gold (Kinematic Surveying Specs: Horizontal: +/- 8 mm + 1 ppm HRMS, Vertical +/- 2 cm + 1 ppm RMS, Initialization Time: <60 seconds, Initialization Reliability: typically >99.9%*
Survey monument used	https://www.ngs.noaa.gov/cgi-bin/ds_mark.prl?PidBox=DQ0899
Survey occupation date	*11/04/2024*
Survey occupation duration	*5 minutes*
Ellipsoid height	-30.509
"Quick Check" marker for deployment tube	*Distance from the top of the top bracket to the deployment tube top (2.96 ft) is measured as quick check. The well cap is removed during this measurement.*
"Quick Check" for sonde being deployed at the same location	*Distance from stainless steel stop bolt that sonde sits on inside the deployment tube to the top of the deployment tube (12.20 ft) is measured with a survey rod and used as the quick check*
Annual resurveying	*11/04/2024 (1.330 m NAVD88)*

Site Name	Division Street (deldswq)
Site infrastructure description	*The schedule 80 deployment tube is attached to a concrete embankment wall which is part of a USGS gauge station. The tube is held in place with modified pipe hangers, has been in place since 2002, and is stable.*
Surveying equipment	*EOS Arrow Gold (Kinematic Surveying Specs: Horizontal: +/- 8 mm + 1 ppm HRMS, Vertical +/- 2 cm + 1 ppm RMS, Initialization Time: <60 seconds, Initialization Reliability: typically >99.9%*
Survey monument used	https://www.ngs.noaa.gov/cgi-bin/ds_mark.prl?PidBox=AH4825
Survey occupation date	*02/21/2023*
Survey occupation duration	*5 minutes*
Ellipsoid height	-27.570 meters
"Quick Check" marker for deployment tube	*Distance from top of the top bracket to the deployment tube top (1.70 ft) is measured with a survey rod for this quick check. The well cap is removed during this measurement.*
"Quick Check" for sonde being deployed at the same location	*Distance from stainless steel stop bolt that sonde sits on inside the deployment tube to the top of the deployment tube (4.94 ft) is measured with a survey rod and used as the quick check*
Annual resurveying	*11/04/2024 (1.623 m NAVD88)*

A Sutron Sat-Link2 transmitter was installed at the Scotton Landing station on 11/16/05 and transmitted data to the NOAA GOES satellite, NESDIS ID #3B00E488. Due to corrosion damage, the Sutron unit was replaced with a YSI WaterLOG Storm 3 unit in May 2014. A second Sutron Sat-Link2 transmitter was installed at the Lebanon Landing station on 11/06/06 and previously transmitted data to the NOAA GOES satellite, NESDIS ID #3B03C56A. The Lebanon Landing telemetry station was destroyed by acts of vandalism in 2009, which resulted in its decommission as a telemetry site. 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 http://cdmo.baruch.sc.edu.

5) Site location and character –

The Delaware National Estuarine Research Reserve is comprised of two component sites, the St. Jones River and Blackbird Creek components. Both components are located along the Delaware Bay Coast. The St. Jones River Component is located in central Kent County Delaware, east of the state capital city, Dover. The Blackbird Creek component is located in the unincorporated area of Southern New Castle County. There are four sampling sites, three located in the St. Jones component and one in the Blackbird Creek component.

Site name	Scotton Landing
Latitude and longitude	Latitude : 39º 05' 05.9160" N Longitude : 75º 27' 38.1049" W
Tidal range *(meters)*	1.26
Salinity range *(psu)*	1-30
Type and amount of freshwater input	The site is influenced by freshwater runoff from the relatively urbanized area upstream
Water depth (*meters, MLW*)	1.9 - estimated
Sonde distance from bottom (*meters*)	0.5
Bottom habitat or type	Sediment is clayey silt with no bottom vegetation
Pollutants in area	PCB's, PAH's, and pesticides.
Description of watershed	The St. Jones watershed drainage area is 228.1 km2 (22810 ha) and Scotton Landing's drainage area is 196.2 km2 (19620 ha)

Site name	Blackbird Landing
Latitude and longitude	Latitude : 39º 23' 19.5196" N Longitude : 75º 38' 09.5882" W
Tidal range *(meters)*	1.12
Salinity range *(psu)*	0-9
Type and amount of freshwater input	The site is influenced by freshwater runoff from unimpacted forested areas intermixed with agricultural land uses and a small amount of low-density development.
Water depth (*meters, MLW*)	0.7 estimated

Sonde distance from bottom (*meters*)	0.5
Bottom habitat or type	The sediment is silty clay with no bottom vegetation.
Pollutants in area	There is very little pollutant presence in the area.
Description of watershed	The Blackbird watershed drainage area is 90.6 km2 (9060 ha) and Blackbird Landing's drainage area is 48.3 km2 (4830 ha).

Site name	Lebanon Landing
Latitude and longitude	Latitude: 39º 06' 51.8" N Longitude: 75º 29' 57.1" W
Tidal range *(meters)*	1.12
Salinity range *(psu)*	0-28
Type and amount of freshwater input	). The site is influenced by freshwater runoff from the relatively urbanized area upstream.
Water depth (*meters, MLW*)	2.1 - estimated
Sonde distance from bottom (*meters*)	0.5
Bottom habitat or type	The sediment is clayey silt with no bottom vegetation.
Pollutants in area	PCB's, PAH's, and pesticides.
Description of watershed	The St. Jones watershed drainage area is 228.1 km2 (22810 ha) and Lebanon Landing's drainage area is 171.6 km2 (17160 ha).

Site name	Division Street
Latitude and longitude	Latitude : 39º 09' 49.4" N Longitude : 75º 31' 08.7" W
Tidal range *(meters)*	Not applicable, freshwater
Salinity range *(psu)*	0.1
Type and amount of freshwater input	The site is fresh water and is influenced by urban freshwater runoff.
Water depth (*meters, MLW*)	Non-tidal site
Sonde distance from bottom (*meters*)	0.5
Bottom habitat or type	The sediment is clayey silt with no bottom vegetation.
Pollutants in area	PCB's, PAH's, and pesticides
Description of watershed	The St. Jones watershed drainage area is 228.1 km2 (22810 ha) and Division Street's drainage area is 81.2 km2 (8120 ha).

SWMP Station Timeline

Station Code	SWMP Status	Station Name	Location	Active Dates	Reason Decommissioned	Notes
delblwq	P	Blackbird Landing	39° 23' 19.54 N, 75° 38' 9.60 W	08/01/1995 00:00 -current	NA	NA
deldswq	P	Division Street	39° 9' 49.32 N, 75° 31' 8.76 W	01/01/2002 00:00 –current	NA	NA
delllwq	P	Lebanon Landing	39° 6' 51.84 N, 75° 29' 57.12 W	01/01/2002 00:00 –current	NA	NA
delslwq	P	Scotton Landing	39° 5' 5.93 N, 75° 27' 38.09 W	07/01/1995 00:00 - current	NA	NA
delpbwq	P	Penrose Branch	39° 9' 52.92 N, 75° 39' 1.44 W	06/01/1996 00:00 - 12/01/2001 00:00	Site composition	Site suffered from copious out of water readings due to insufficient water volume; resources were better served at the newly established 2002 sites (Lebanon Landing and Division Street)

6) Data collection period –
Data collection began for these sites on the following dates:

a) Scotton Landing: July 1, 1995
b) Blackbird Landing: August 1, 1995
c) Lebanon Landing: January 01, 2002
d) Division Street: January 31, 2002

All sampling is ongoing. The deployment/retrieval dates and times for 2024 are as follows:

Scotton Landing:

Deployment Date/Time	Retrieval Date/Time
11/27/2023, 14:45	01/08/2024, 09:15
01/08/2024, 09:30	02/20/2024, 11:15
02/20/2024, 11:30	03/27/2024, 07:30
03/27/2024, 07:45	04/29/2024, 09:00
04/29/2024, 09:15	06/04/2024, 12:30
06/04/2024, 12:45	07/16/2024, 08:45
07/16/2024, 09:00	08/19/2024, 12:15
08/19/2024, 12:30	09/23/2024, 09:15
09/23/2024, 09:30	10/30/2024, 08:45
10/30/2024, 09:00	12/04/2024, 10:45
12/04/2024, 11:15	01/13/2025, 12:30

Lebanon Landing:

Deployment Date/Time	Retrieval Date/Time
12/12/2023, 09:00	01/16/2024, 10:45
01/16/2024, 11:00	02/19/2024, 14:00

02/19/2024, 14:15	03/19/2024, 08:15
03/19/2024, 08:30	04/23/2024, 10:00
04/23/2024, 10:15	05/28/2024, 08:45
05/28/2024, 09:00	07/02/2024, 07:15
07/02/2024, 07:30	08/12/2024, 10:45
08/12/2024, 11:00	09/16/2024, 09:00
09/16/2024, 09:15	10/21/2024, 09:45
10/21/2024, 10:00	11/26/2024, 10:15
11/26/2024, 10:30	01/08/2025, 09:45

Division Street:

Deployment Date/Time	Retrieval Date/Time
12/12/2023, 09:30	01/17/2024, 11:00
01/17/2024, 11:15	02/19/2024, 14:30
02/19/2024, 14:45	03/19/2024, 08:30
03/19/2024, 08:45	04/23/2024, 10:15
04/23/2024, 10:30	05/28/2024, 09:00
05/28/2024, 09:15	07/01/2024, 12:30
07/01/2024, 12:45	08/12/2024, 10:00
08/12/2024, 10:15	09/16/2024, 09:15
09/16/2024, 09:30	10/21/2024, 13:15
10/21/2024, 13:30	11/26/2024, 10:45
11/26/2024, 11:00	01/08/2025, 10:15

Blackbird Landing:

Deployment Date/Time	Retrieval Date/Time
Sonde & deployment tube removal from 2023 continued to 01/24/2024 due to bridge work	
01/24/2024, 17:00	02/26/2024, 13:00
02/26/2024, 13:15	04/03/2024, 08:45
04/03/2024, 09:00	05/06/2024, 10:00
05/06/2024, 10:15	06/04/2024, 07:30
06/04/2024, 07:45	07/16/2024, 12:45
07/16/2024, 13:00	08/20/2024, 10:30
08/20/2024, 10:45	09/24/2024, 09:15
09/24/2024, 09:30	11/04/2024, 10:45
11/04/2024, 11:00	12/10/2024, 11:15
12/10/2024, 11:30	01/15/2024, 10:00

7) Distribution –

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 processed 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 2023.

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. Data are available in comma delimited format.

8) Associated researchers and projects –

The Delaware NERRS' nutrient monitoring component of SWMP comprises six stations, 4 primary sites (Scotton Landing, Lebanon Landing, Division Street, and Blackbird Landing) and 2 secondary sites (Beaver Branch and Taylors Bridge), located within the Delaware NERR. The objective of this monitoring program is to provide baseline information on inorganic nutrient and Chla water quality status in the Delaware NERR while also contributing to baseline information nationally. Grab samples are collected monthly at each of the six sites and diel samples are collected monthly at Scotton Landing.

The meteorological monitoring component of SWMP features one primary station located at the St. Jones component and a secondary station located at the Blackbird Creek component. The principal objective is to record long-term meteorological data for both components of the Delaware National Estuarine Research Reserve in order to observe any environmental changes or trends over time. The data are also used for specific research studies relating to atmospheric deposition of nutrients and pesticides, and nutrient runoff influences from encroaching urbanization on estuarine systems. The meteorological data also serves a supporting role for the SWMP water quality and nutrient data sets since meteorological conditions directly impact these projects.

A number of biological monitoring efforts are also taking place at DNERR to assess changes in species diversity and abundance. Emergent vegetation monitoring takes place in both reserve components. Secretive marsh bird monitoring is taking place in the St. Jones component while a long-term nekton study is taking place within Blackbird Creek.

The 15-minute meteorological along with monthly grab samples and diel sampling for nutrient data which may be correlated with this water quality dataset are available at www.nerrsdata.org. Biological data are available by contacting the Delaware NERR directly.

II. Physical Structure Descriptors

9) Sensor specifications –

DEL NERR deployed EXO2 data sondes in 2024.

YSI EXO2 Sonde:

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: +/- 0.05
Resolution: 0.001 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: 0.0001 to 0.01 mS/cm (range dependent)

Parameter: Salinity
Units: practical salinity units (psu)/parts per thousand (ppt)
Model#: 599827
Sensor Type: Wiped probe; Calculated from conductivity and temperature
Range: 0 to 70 ppt
Accuracy: ±2% of the reading or 0.2 ppt, whichever is greater
Resolution: 0.01 psu

Parameter: Dissolved Oxygen % 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 mg/L (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 to 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#: 599701(guarded) or 599702(wiped)
Range: 0 to 14 units
Accuracy: +/- 0.1 units within +/- 10° of calibration temperature, +/- 0.2 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 to 999 FNU: 0.3 FNU or +/-2% of reading (whichever is greater); 1000 to 4000 FNU +/-5% of reading
Resolution: 0 to 999 FNU: 0.01 FNU, 1000 to 4000 FNU: 0.1 FNU

Parameter: Chlorophyll
Units: micrograms/Liter
Sensor Type: Optical probe
Model#: 599102-01
Range: 0 to 400 ug/Liter
Accuracy: Dependent on methodology
Resolution: 0.01 ug/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.

10) Coded variable definitions –

Sampling station:	Sampling site code:	Station code:
Scotton Landing	SL	delslwq
Lebanon Landing	LL	delllwq
Division Street	DS	deldswq
Blackbird Landing	BL	delblwq

11) 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.

-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

12) 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

13) Post deployment information –

a) End of Deployment Post-calibration Readings in Standard Solution:

SCOTTON LANDING 2024 POST CALIBRATION VALUES

Deploy Date	SpCond mS/cm3	ODO1 %	ODO2 %	pH7 7	pH10 10	pH4 4	Turb 0	Turb 124	Level m
01/08/2024	13.17	112.0	111.9	7.06	10.06	4.14	1.38	131.30	-1.202
02/20/2024	13.01	101.4	101.3	7.03	10.03	4.00	0.09	125.88	-1.312
03/27/2024	13.16	100.5	100.6	7.12	10.10	4.14	0.44	125.60	-1.350
04/29/2024	12.76	98.4	98.2	7.19	10.19	4.22	0.26	128.60	-1.360
06/04/2024	12.94	98.0	98.0	7.09	10.10	4.19	2.06	125.57	-1.422
07/16/2024	12.49	98.8	98.8	6.93	9.92	4.02	0.06	125.18	-1.313
08/19/2024	13.02	98.2	98.2	7.15	10.20	4.11	0.65	126.96	-1.314
09/23/2024	12.97	108.8	108.8	7.10	10.11	4.14	0.46	118.02	-1.239
10/30/2024	12.93	100.4	100.2	7.01	10.04	4.01	-0.11	116.35	-1.314
12/04/2025	12.89	104.0	104.0	7.14	10.15	4.14	0.47	126.21	-1.365

LEBANON LANDING 2024 POST CALIBRATION VALUES

Deploy Date	SpCond mS/cm3	ODO1 %	ODO2 %	pH7 7	pH10 10	pH4 4	Turb 0	Turb 124	Level m
01/16/2024	13.17	101.7	101.7	7.03	10.03	4.06	0.35	123.99	-2.090
02/19/2024	12.74	100.1	100.1	6.79	9.71	3.71	0.22	132.00	-2.308
03/19/2024	12.91	100.5	100.6	7.04	10.03	4.06	0.06	125.30	-2.222
04/23/2024	12.99	98.4	98.4	7.16	10.16	4.15	0.63	123.58	-2.267
05/28/2024	12.52	100.4	99.8	7.16	10.20	4.20	1.36	125.38	-2.178
07/02/2024	12.91	93.9	95.7	7.17	10.08	4.19	1.77	128.04	-2.251
08/12/2024	12.82	99.1	99.4	7.19	10.18	4.13	2.29	124.63	-2.172
09/16/2024	13.07	100.6	100.6	7.08	10.14	3.93	1.35	119.03	-2.196
10/21/2024	12.93	99.0	98.9	7.09	10.08	4.20	1.07	125.82	-2.235

11/26/2024	12.94	104.2	104.3	8.28	11.61	5.75	0.9	126.71	-2.273

DIVISION STREET 2024 POST CALIBRATION VALUES

Deploy Date	SpCond mS/cm3	ODO1 %	ODO2 %	pH7 7	pH10 10	pH4 4	Turb 0	Turb 124	Level m
01/17/2024	13.22	101.8	101.7	7.07	10.07	4.04	0.65	128.40	0.501
02/19/2024	12.78	101.5	101.5	7.27	10.32	4.22	0.88	128.46	0.273
03/19/2024	12.88	101.3	101.4	7.13	10.15	3.92	1.02	121.00	0.368
04/23/2024	12.94	100.7	100.6	7.12	10.09	4.12	1.01	126.48	0.315
05/28/2024	12.83	99.7	99.3	7.13	10.12	3.98	0.06	125.09	0.366
07/01/2024	12.75	98.3	98.2	7.16	10.08	4.16	1.13	126.67	0.335
08/12/2024	12.85	100.2	100.1	7.19	10.02	4.06	-0.13	130.50	0.415
09/16/2024	13.07	103.3	103.2	7.09	10.13	4.05	-0.86	118.67	0.437
10/21/2024	12.83	104.5	104.5	7.03	10.07	4.00	2.60	129.21	0.381
11/26/2024	12.85	105.1	105.2	7.21	10.24	4.12	1.45	130.63	0.322

BLACKBIRD LANDING 2024 POST CALIBRATION VALUES

Deploy Date	SpCond mS/cm3	ODO1 %	ODO2 %	pH7 7	pH10 10	pH4 4	Turb 0	Turb 124	Depth m
01/24/2024	12.88	101.1	101.1	7.06	10.10	4.05	0.64	130.08	0.014
02/26/2024	13.10	101.8	101.8	7.08	10.09	3.98	-0.24	130.68	0.095
04/03/2024	12.93	98.8	98.8	7.12	10.11	4.18	1.14	128.46	0.014
05/06/2024	12.33	99.7	99.8	7.15	10.10	4.18	0.93	123.87	0.026
06/04/2024	12.75	99.4	99.2	7.16	10.14	4.13	0.13	125.85	-0.042
07/16/2024	12.48	100.3	100.2	7.08	10.04	4.20	0.12	123.88	0.066
08/20/2024	13.04	109.7	109.7	7.06	10.13	4.07	0.04	129.41	0.051
09/24/2024	12.89	105.3	105.3	7.03	10.07	3.96	0.28	113.66	0.173
11/04/2024	13.09	103.5	103.7	7.03	10.07	3.98	0.54	125.37	0.024
12/10/2024	13.07	102.2	102.3	7.04	10.11	3.96	1.02	126.48	0.100

*Note: pH post-deployment readings are temperature dependent and minor variations are expected as a result.

14) 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.

Key to abbreviations:

* N/A: reading for parameter is not available-explanations usually found on field data sheets, but are not all included in this document for length reasons.

a) In-situ Readings Taken During Sonde Retrieval

SCOTTON LANDING 2024 RETRIEVAL VALUES

Retr. Date	H20 Temp(C)	Sp. Cond(ms)	Salinity(ppt)	DO (%sat)	DO (mg/l)	Tide
01/08/2024	5.01	21.97	13.05	93.6	10.95	Ebb
02/20/2024	4.72	18.07	10.56	92.4	11.09	Ebb
03/27/2024	10.36	2.55	1.32	74.2	8.23	Ebb
04/29/2024	17.14	6.79	3.74	77.6	7.31	Slack Low
06/04/2024	25.56	22.64	13.63	46.6	3.53	Ebb
07/16/2024	33.92	3.90	2.03	142.3	9.96	Slack Low
08/19/2024	25.98	29.73	18.37	47.0	3.43	Ebb
09/23/2024	22.24	33.21	20.82	31.4	2.42	Ebb
10/30/2024	14.16	35.84	22.64	87.1	7.78	Slack High
12/04/2024	3.92	36.15	22.35	94.4	10.67	Slack High
01/13/2025	0.38	41.34	25.37	101.7	12.33	Ebb

LEBANON LANDING 2024 RETRIEVAL VALUES

Retr. Date	H20 Temp(C)	Sp. Cond(ms)	Salinity(ppt)	DO (%sat)	DO (mg/l)	Tide
01/16/2024	3.29	0.28	0.13	81.5	10.87	Flood
02/19/2024	6.43	0.37	0.18	91.9	11.30	Slack Low
03/19/2024	12.02	2.87	1.50	65.7	7.02	Slack High
04/23/2024	14.82	2.84	1.48	86.1	8.63	Flood
05/28/2024	24.38	6.63	3.62	80.0	6.55	Ebb
07/02/2024	25.62	8.79	4.90	27.7	2.20	Slack High
08/12/2024	27.15	4.46	2.37	86.7	6.79	Ebb
09/16/2024	22.84	29.32	18.13	41.5	3.19	Slack High
10/21/2024	14.24	20.13	12.06	108.5	10.33	Flood
11/26/2024	9.21	20.94	12.52	81.0	8.60	Ebb
01/08/2025	-0.09	4.18	2.17	96.1	13.67	Slack Low

DIVISION STREET 2024 RETRIEVAL VALUES

Retr. Date	H20 Temp(C)	Sp. Cond(ms)	Salinity(ppt)	DO (%sat)	DO (mg/l)	Tide
01/17/2024	2.14	0.12	0.05	93.7	12.82	NA
02/19/2024	6.56	0.18	0.09	97.9	12.01	NA
03/19/2024	11.95	0.15	0.07	88.8	9.49	NA
04/23/2024	16.46	0.18	0.08	105.5	10.30	NA
05/28/2024	23.42	0.21	0.10	75.0	6.38	NA
07/01/2024	27.42	0.20	0.10	110.0	8.69	NA
08/12/2024	26.30	0.21	0.10	45.4	3.63	NA
09/16/2024	21.01	0.42	0.20	33.7	2.98	NA
10/21/2024	14.98	2.22	1.15	58.8	5.90	NA
11/26/2024	11.14	0.28	0.13	81.6	8.96	NA
01/08/2025	2.13	0.25	0.12	91.7	12.54	NA

BLACKBIRD LANDING 2024 RETRIEVAL VALUES

Retr. Date	H20 Temp(C)	Sp. Cond(ms)	Salinity(ppt)	DO (%sat)	DO (mg/l)	Tide
02/26/2024	5.96	1.75	0.88	86.3	10.70	Slack High
04/03/2024	9.81	0.13	0.06	85.7	9.71	Slack High
05/06/2024	18.00	1.48	0.75	53.9	5.08	Flood
06/04/2024	25.84	4.02	2.12	69.1	5.56	Flood
07/16/2024	29.49	18.41	10.83	31.2	2.24	Ebb
08/20/2024	25.41	7.55	4.16	72.0	5.76	Flood
09/24/2024	22.03	12.09	6.93	58.1	4.89	Ebb
11/04/2024	12.51	15.19	8.88	67.3	6.78	Flood
12/10/2024	3.75	14.22	8.12	98.8	12.36	Ebb

01/15/2025 -0.16 8.03 4.32 93.6 13.35 Flood

b) Lebanon Landing pH readings from 09/28/2024 (13:15 – 23:00 EST) increase from 6.9/7.0 to a range of 7.3 to 7.7 then return to 6.9. These data are considered suspect due to the sudden jump from the preceding and proceeding trends, however the exact cause is unknown.

c) Lebanon Landing pH readings from 10/06/2024 (06:30-06:45 EST) are suspect due to a jump from 7.4 (06:15 EST) to 7.9 (06:30 EST) and 7.8 (06:45 EST) followed by a return to 7.4 (07:00 EST). The exact cause is unknown.

d) Lebanon Landing pH readings from 10/20/2024 (18:00 EST) to 10/21/2024 (00:30 EST) are considered suspect due to a sudden jump from 7.6 (10/20/2024 17:45 EST) to 9.7 (10/20/2024 18:00 EST) followed by a decline from 9.6 (10/24/2024 18:15 EST) to 7.7 (10/21/2024 00:30 EST). The exact cause is unknown.

e) Division Street pH values from 01/17/2024 (11:15) to 02/19/2024 (14:30 EST) are lower that the preceding and proceeding deployments and have been marked suspect. Post-deployment readings taken on 02/20/2024 were mostly within spec with the exception of pH4 millivolts which were 2.6 mV outside the lower 130 mV threshold.

f) Division Street: A new pH probe tip was installed for the deployment beginning on 03/19/2024 (08:45). The prior deployment's probe tip was older and reading 6.9 prior to retrieval while the new pH tip and probe read in the 7.3-7.4 range once settled. This likely explains the pH shift at the 03/19/2024 sonde exchange.

g) Division Street turbidity values from 06/24/2024 (00:00 EST) to 07/02/2024 (15:30 EST) are elevated above the normal range for this site. Significant rainfall took place from 06/30/2024 (03:45 – 23:15 EST) offering explanation for a portion of the overall timeframe, but readings before the 06/30/2024 rainfall do not correlate to precipitation events. The elevated values continue after the sonde exchange on 07/01/2024 (12:45) for a brief time and do not appear biofouling related. Post-deployment readings from both deployments were satisfactory as well. The data during this timeframe have been marked suspect due to an absence of explanation for the increased readings with the exception of select readings that were rejected due to their erroneous nature. Readings during the rainfall period have also been flagged since they are part of this time period, yet do correspond to an explanation.

h) Division Street specific conductivity and salinity values from 09/03/2024 (12:00 EST) to 11/22/2024 (02:15 EST) are mostly elevated from the normal range. The site has been experiencing more frequent tidal oscillations signaling it is being more impacted by tidal flow than in the past. The higher readings are likely attributed to those tidal impacts along with elevated specific conductivity/salinity in that tidal water due to drought conditions.

i) Blackbird Landing was re-established on 01/24/2024 (17:00 EST) after being temporarily removed during 2023 and the early portion of 2024 as per orders from the Delaware Department of Transportation (DelDOT) while bridge work was being conducted. The installation of rockwork to prevent bridge footer scouring during repair work required the sonde tube to be re-installed 0.517 m higher than its previous vertical location. Relocation of the sonde tube farther into the channel was not permitted by DelDot, so the original location remained the only viable option. The 0.517 m vertical re-orientation of the tube causes periodic out of water instances during low tides, however out of water readings represent a miniscule fraction (~2%) of the total readings. Blackbird Landing is one of the two oldest monitoring sites at the Delaware NERR dating back to 1995 when the site was originally established in its current location, so the out-of-water instances were deemed acceptable as opposed to the alternate option of decommissioning the site entirely since no additional mounting structure is available in this area. Re-surveying of the site was

originally planned for continuation with water level reporting, but a decision was made to change back to depth data collection from 2024 onwards to assist with out-of-water reading identification.