

Old Woman Creek (OWC) NERR Water Quality Metadata

January – December 2021

Latest Update: 02 July 2024

I. Data Set and Research Descriptors

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2. Entry verification:

Deployment data were directly uploaded from a YSI EXO sonde to a personal computer with Windows 7 or newer operating system. The data were graphed and visually checked for any obvious outliers. Notes were made of any unusual data or faulty probes. Files are exported from 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. Sebastian Mejia, Steven McMurray and Jacob Cianci-Gaskill were responsible for data QC at OWC in 2021.

3. Research Objectives:

Measurements are taken every 15 minutes over four- to six-week periods at four sites within Old Woman Creek. Three sites are in the estuary proper: one in the upper reaches at Darrow Road (DR); one near the mouth, south of State Route 6 (WM); and the third upstream from the WM site (Lower Estuary; OL). The final site (BR) is upstream of the first riffle zone above the estuary in Old Woman Creek proper. The purpose of this monitoring program is to document the role of this Great Lakes estuary in the Lake Erie ecosystem, particularly the estuary's role in mitigating storm flow that passes through it. The role of the OL site is to document the degree of intrusion by lake water during northerly winds and subsequent seiche events.

4. Research methods:

The 2021 YSI monitoring program began on 01/01/2021 at WM and on 03/05/2021 at all other sites. Sampling continued through 12/31/2021 for the DR, OL, and WM sites, and 12/07/2021 for the BR site. EXO sondes (models 2 & 3) were used at all four sites throughout this period. Sondes at BR, DR, and WM are deployed in 10 cm diameter PVC pipes, the first and last of which is clamped to a 2.4 m long metal post that had been driven into the sediment. The logger trap at site DR is not clamped to a 2.4 m metal post, but rather suspended from the north side of the road bridge by metal chain. Each pipe has 4 vertical slits 2 cm wide drilled into it spanning the area of the probe guard on the sonde to ensure that the probes have direct contact with the surrounding waters. The OL sonde is deployed on a deeply embedded steel pipe with a steel trap that has four vertical slits matching in length and width to the EXO sonde guard slits. Additional field readings for dissolved oxygen, pH, temperature, turbidity, and specific conductance were taken using an EXO2 sonde when the instruments were changed at each site (see the Other Remarks Section). The sondes were cleaned after two to three weeks of deployment to remove fouling and replaced in the field after a calendar month of deployment not to exceed 45 days. The data were retrieved from each sonde and underwent post deployment parameter checks. Each sonde was recalibrated (according to the directions in the YSI Operations Manual) before being returned to the field. Conductivity, turbidity (2-point calibration using distilled water for zero turbidity and a YSI standard for the other turbidity point), and pH (2 point-calibration) were calibrated using commercial standards. These standards were prepared prior to each deployment. Sonde readings were checked against these standards within 24 hours of retrieval. Sondes at all sites have non-vented depth sensors and optical DO sensors. Calibration logs provide sensor information.

In October, 2014 the Data Management Committee determined that barometric pressure readings used for producing the depth offset during water quality data sonde calibration should be taken from the same weather station where barometric pressure is used to correct depth/level for the cDepth/cLevel parameters. This is a requirement for NERRS Reserves (like Old Woman Creek) where that weather station is located significantly above sea level. Please be aware that this protocol was in place starting March, 2015 at the start of the sampling season and has been adhered to in subsequent years. Barometric pressure for sonde depth calibration was taken from the owcowmet weather station until November, 2020 and

with a Kestrel 4000 (not corrected for altitude) from within the lab starting December, 2020 until June, 2021 due to intermittent data gaps of the weather station.

A Sutron Sat-Link2 transmitter was installed at site OL during October, 2006. This system stopped transmitting data in 2017 and was replaced with a WaterLog Storm 3 in February, 2021, which transmits data to the NOAA Goes satellite NESDIS ID# 3B02849A. WaterLog Storm 3 sondes are also used at sites DR and WM installed since September, 2017. These systems transmit data to the NOAA Goes satellites NESDIS ID# 3B0009A8 and 3B001ADE, respectively. The transmissions are scheduled hourly and contain four (4) data sets reflecting fifteen-minute data sampling intervals. Upon receipt by the CDMO, the data undergo 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:

Old Woman Creek National Estuarine Research Reserve is located on the southern shore of Lake Erie, east of the city of Huron, Ohio (Latitude 41° 23'N; Longitude 82° 33'W). Land use in the Old Woman Creek watershed is primarily row crop agriculture. Other than the non-point source pollutants coming into the estuary from these agricultural practices and from the town of Berlin Heights, there are no other major pollution sources in the estuary. Salinity in Old Woman Creek is normally 2 psu or less, although it will rise, on occasion, to nearly 4 psu. The tidal range in Lake Erie (and therefore in the estuary) is 4 cm or less. Water levels in the estuary and in the creek are extremely variable, with changes occurring daily, seasonally, and annually due to changing lake levels, seiches on the lake, storm runoff, and the mouth closing and opening through the year. Changes to the status of the mouth (open versus closed) for 2021 are included in the comments section.

The sonde at the State Route 6 (WM) site (Latitude 41° 22' 57" N, Longitude 82° 30' 53" W; Table 1) is approximately 150 m from the mouth of Old Woman Creek. In this portion of the Reserve, the creek is shallow but extends over a large surface area. This site frequently experiences influx of Lake Erie waters. The bottom sediments at this site are silty clay with some cobble. Some rooted aquatic vegetation is now present directly adjacent to the site, along with both emergent and submerged vegetation within 3 m of the site. Historically, the sonde was 0.18 m above the bottom sediments, until 17 August 2016, when the sonde was repositioned due to high water levels. At that time, the height of the sonde was 0.28 m above the sediment. By 2019, the bottom 0.23-0.28 m of the deployment pipe had filled with mud and the bottom 5 cm of the sonde guard frequently filled with mud during deployments. On October 29, 2019, the deployment pipe was replaced with a setup that keeps the pipe well above the bottom, to prevent sediment build-up. Sonde depth after this modification was 0.29 m above the bottom, very close to the deployment depth in the previous housing, based on previous measurements. This places the sensors at 0.37 m above the bottom and the depth sensor at 0.52 m (Note: the distance from the bottom end of the sonde guard to the bottom/face of all sensors except the depth sensor is 0.08 m; the distance from the bottom end of the sonde guard to the depth sensor is 0.23 m). The intake tube for associated diel sampling (via Teledyne 5800 refrigerated autosampler) is suspended at between 0.23 m (bottom of intake guard) and 0.39 m (top of intake guard) from the bottom.

The sonde at site OL (Latitude 41° 22' 55" N, Longitude 82° 30' 51" W; Table 1) is in the lower reaches of the estuary. This site is not visible from the estuary mouth, so northerly winds and resulting seiche activities should be less noticeable at this site, although they do occur. The bottom sediments are silty clay. This site is located about 5 m north of a *Nelumbo lutea* bed, but no plants were immediately adjacent to the sonde. In March 2009, a new logger site was established 5 m north of the original site due to damage of the original site by a winter storm. In 2010, this temporary site became the new OL site. At this site, the base of the logger was 26 cm above the sediment at the time of installation. This site is telemetered to the GOES satellite. On December 1, 2016, the deployment fencepost and PVC trap were replaced with a steel pipe equipped with a steel trap to achieve a more vertically stable deployment platform. The height of the logger above the sediment was 0.42 m off the bottom. In early 2018, the height of the logger changed because the cable on which the trap was suspended slipped through a clamp, causing the trap to descend to where the depth sensor was 0.23 m above the sediment and the other sensors were 0.02 m above the sediment. The trap was re-set on May 23, 2018 at 10:45 EST to position the depth sensor to 0.45 m above the sediment and the other sensors to 0.32 m above the sediment (note: trap length is 0.73 m from top of trap to the top of the trap bottom, where the sonde guard rests; the distance from the bottom end of the sonde guard to the bottom/face of all sensors except the depth sensor is 0.08 m; the distance from the bottom end of the sonde guard to the depth sensor is 0.23 m).

The sonde at site DR (Latitude 41° 21' 54" N, Longitude 82° 30' 17" W; Table 1) is at the southern boundary of the reserve. The logger trap is suspended from the western most of the two, center guard rail supports on the north side of the Darrow Road bridge near the deepest part of the creek channel. At this site, the creek is relatively narrow. Although water direction and flow are influenced at this site by changes in Lake Erie water levels, this site does not have direct contact with Lake Erie waters. The bottom sediments at this site are silty clay. No rooted aquatic vegetation is present near or upstream from this site. The trap was repaired and re-deployed in March 2016 and was 0.45 m above the bottom.

The sonde at site BR (Latitude 41° 20' 54" N, Longitude 82° 30' 30" W; Table 1) is located in the lower portion of the creek proper. Just upstream from the sonde, Berlin Road crosses Old Woman Creek. Site BR is upstream of the first riffle above the estuary. Unlike the other three sites, Lake Erie water levels have no impact on the BR site. The bottom of the creek at this site is a combination of rocks interspersed with some clay-silt that has been washed in from upstream. No aquatic macrophytes are present at or near this site. The logger was 18 cm above the bottom at this site when first installed. During Winter 2014, the logger distance above bottom was 14 cm above the stream bottom. During Summer 2020, the bottom of the sonde guard was 24 cm above the stream bottom (Note: The distance from the bottom end of the sonde guard to the bottom/face of all sensors except the depth sensor is 0.08 m; the distance from the bottom end of the sonde guard to the depth sensor is 0.23 m).

Table 1: Location of sites that are part of the Old Woman Creek System-wide Monitoring Program (SWMP). Station Code refers to seven-letter site notation used by the CDMO while Station Name is the short-hand name for each site. The Status of all sites is primary (P). The date that monitoring began at each site and, when applicable, the date that the site was decommissioned are listed. If a site has not been decommissioned, not applicable (NA) has been added to the Reason Decommissioned column.

Station Code	SWMP Status	Station Name	Location	Active Dates	Reason Decommissioned	Notes
owcbrwq	P	Berlin Road	Latitude 41° 20' 56.8" N, Longitude 82° 30' 44.6" W	03/01/2002 00:00 – current	NA	NA
owcdrwq	P	Darrow Road	Latitude 41° 21' 54" N, Longitude 82° 30' 17" W	08/01/2007 00:00 – current	NA	NA
owcolwq	P	Lower Estuary	Latitude 41° 22' 55" N, Longitude 82° 30' 51" W	04/01/2002 00:00 – current	NA	NA
owcwmwq	P	Route 6	Latitude 41° 22' 56.7" N, Longitude 82° 30' 52.7" W	05/01/1995 00:00 – current	NA	NA
owcsuwq	P	Route 2	Latitude 41° 22' 02" N, Longitude 82° 30' 26" W	05/01/1995 00:00 – 08/23/2007 13:15	Bridge repair; could not access site	NA

6. Data collection periods:

Sondes were initially deployed after freezing conditions were no longer forecasted and left in the estuary through the end of 2021 (Table 2). Note that for DR, OL, and WM, retrieval from the estuary occurred in early 2022, but exact days and times are reflected in the 2022 metadata. Sampling at BR began on 03/05/2021 at 11:30 EST, and data were last downloaded through 12/07/2021 at 09:45 EST. Sampling at DR began on 03/05/2021 at 11:00 EST, and data were last downloaded through 12/31/2021 at 23:45 EST. Sampling at OL began on 03/05/2021 at 09:45 EST, and data were last downloaded through 12/31/2021 at 23:45 EST. Sampling at WM began on 01/01/2021 at 00:00 EST, and data were last downloaded through 12/31/2021 at 23:45 EST.

Table 2: Deployment information for sondes used in 2021 water quality monitoring of Old Woman Creek. Sites are the four monitoring stations including Berlin Road (BR), Darrow Road (DR), Lower Estuary (OL), and Wetland Mouth (WM). Deploy Date and Deploy Time indicate when sondes were first set out in the estuary and began recording data. Retrieval Date and Retrieval Time are the last times in 2021 that data was recorded at each site. Sonde Model and Nickname reflect the type and individual identification for each of the sondes used in 2021 monitoring.

Site	Deploy Date	Deploy Time	Retrieval Date	Retrieval Time	Sonde Model (Nickname)
BR	03/05/2021	11:30	04/06/2021	9:00	EXO 3 (BR11)
BR	04/06/2021	9:15	05/04/2021	9:00	EXO 3 (BR12)
BR	05/04/2021	9:15	06/02/2021	7:15	EXO 3 (BR11)
BR	06/02/2021	7:30	06/29/2021	8:45	EXO 3 (BR12)
BR	06/29/2021	9:00	08/03/2021	9:30	EXO 3 (BR11)
BR	08/03/2021	9:45	09/08/2021	9:45	EXO 3 (BR12)
BR	09/08/2021	9:45	10/05/2021	8:30	EXO 3 (BR11)

BR	10/05/2021	8:45	11/02/2021	7:45	EXO 3 (BR12)
BR	11/02/2021	8:00	12/07/2021	9:45	EXO 3 (BR11)
DR	03/05/2021	11:00	04/06/2021	9:30	EXO 3 (OL11)
DR	04/06/2021	9:45	05/04/2021	9:30	EXO 3(OL12)
DR	05/04/2021	10:00	06/02/2021	7:30	EXO 3 (OL11)
DR	06/02/2021	7:45	06/29/2021	9:15	EXO 3 (OL12)
DR	06/29/2021	9:30	08/03/2021	10:00	EXO 3 (OL11)
DR	08/03/2021	10:15	09/08/2021	10:00	EXO 3 (OL12)
DR	09/08/2021	10:00	10/05/2021	9:00	EXO 3 (OL11)
DR	10/05/2021	9:15	11/02/2021	8:00	EXO 3 (OL12)
DR	11/02/2021	8:15	12/07/2021	10:00	EXO 3 (OL11)
DR	12/07/2021	10:15	01/04/2022	13:15	EXO 3 (OL12)
OL	03/05/2021	9:45	04/06/2021	10:45	EXO 2 (BR1)
OL	04/06/2021	11:00	05/04/2021	10:30	EXO 2 (BR2)
OL	05/04/2021	11:00	06/02/2021	8:30	EXO 2 (BR1)
OL	06/02/2021	9:00	06/29/2021	10:00	EXO 2 (Nelumbo)
OL	06/29/2021	10:15	08/03/2021	11:00	EXO 2 (Lepomis)
OL	08/03/2021	11:30	09/08/2021	11:00	EXO 2 (Nelumbo)
OL	09/08/2021	11:00	10/05/2021	9:30	EXO 2 (Lepomis)
OL	10/05/2021	9:45	11/02/2021	8:45	EXO 2 (Nelumbo)
OL	11/02/2021	9:00	12/07/2021	10:30	EXO 2 (Lepomis)
OL	12/07/2021	10:45	01/04/2022	13:45	EXO 2 (Nelumbo)
WM	12/15/2020	12:00	01/12/2021	9:45	EXO 2 (WM1)
WM	01/12/2021	10:00	02/23/2021	11:00	EXO 2 (WM2)
WM	02/23/2021	11:15	04/06/2021	11:00	EXO 2 (WM1)
WM	04/06/2021	11:15	05/04/2021	10:45	EXO 2 (WM2)
WM	05/04/2021	11:15	06/02/2021	9:00	EXO 2 (WM1)
WM	06/02/2021	9:15	06/29/2021	10:15	EXO 2 (WM2)
WM	06/29/2021	10:30	08/03/2021	11:30	EXO 2 (WM1)
WM	08/03/2021	11:45	09/08/2021	11:30	EXO 2 (WM2)
WM	09/08/2021	11:45	10/05/2021	10:00	EXO 2 (WM1)
WM	10/05/2021	10:15	11/02/2021	8:45	EXO 2 (WM2)
WM	11/02/2021	9:15	12/07/2021	10:45	EXO 2 (WM1)
WM	12/07/2021	11:00	01/04/2022	14:00	EXO 2 (WM2)

7. Distribution

NOAA retains the right to analyze, synthesize, and publish summaries of the National Estuarine Research Reserve System (NERRS) System-wide Monitoring Program data. The NERRS and the Old Woman Creek Research Coordinator retain the right to be fully credited for having collected and processed the data. Following academic courtesy standards, the Research Coordinator and the NERRS location where the data were collected will 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 in the enclosed metadata reporting

statement. The user bears all responsibility for its subsequent use/misuse in any further analyses or comparisons. The Federal government and the State of Ohio do not assume liability to the Recipient or third persons, nor will the Federal government or the State of Ohio 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.

NERRS water quality data and metadata can be obtained from the Research Coordinator at the individual NERRS location (please see section 1, Principal Investigators and Contact Persons), from the Data Manager at the Centralized Data Management Office (please see personnel directory under general information link on CDMO homepage) and online at the CDMO homepage www.nerrsdata.org. Data are available in comma delimited format.

8. Associated projects:

Two Nile microwave water level sensors are located in Old Woman Creek. One is 34 m northeast of the WM site while the other is 4 m west of the DR site. These water level sensors provide accurate water level data at the southern and northern bounds of the estuary. Water level data are transmitted to each site's respective GOES satellite simultaneously with the sonde data. In addition, a Sontek Acoustic Doppler Current Profiler (ADCP) has been installed to allow for measurement of water velocity at the Route 6 bridge constriction point of the estuary, 27 m northeast of the WM site.

As part of the System-wide monitoring program, Old Woman Creek National Estuarine Research Reserve also collects 15-minute meteorological data and monthly grab and diel samples for nutrient/pigment data which may be correlated with this water quality dataset. These data are available at www.nerrsdata.org.

II. Physical Structure and Descriptors:

9. Sensor specifications:

Old Woman Creek National Estuarine Research Reserve deployed eight EXO sondes (YSI Inc., Yellow Springs, OH) through December 2021. A ninth EXO2 sonde was used to collect simultaneous field measurements when sondes were exchanged. EXO3 sondes were deployed at BR and DR sites, while EXO2 sondes were deployed at OL and WM sites.

YSI EXO datalogger

Parameter: Temperature

Units: Celsius (°C)

Sensor Type: CT2 Probe, Thermistor

Model #: 599870 (owcbrwq, owcolwq, owcwmwq)

Range: -5 to 50 °C

Accuracy: -5 to 35 °C: ± 0.01 °C; 35 to 50 °C: ± 0.05 °C

Resolution: 0.001 °C

Model #: 599827 (owcdrwq)

Range: -5 to 50 °C

Accuracy: ± 0.2 °C

Resolution: 0.001 °C

Parameter: Conductivity

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

Sensor Type: CT2 probe, 4-electrode cell with auto-ranging

Model #: 599870 (owcbrwq, owcolwq, owcwmwq)

Range: 0 to 200 mS/cm

Accuracy: 0 to 100 mS/cm: $\pm 0.5\%$ of reading or + 0.001 mS/cm, whichever is greater; 100 to 200 mS/cm: $\pm 1\%$ of reading

Resolution: 0.001 mS/cm to 0.01 mS/cm (range dependent)

Model #: 599827 (owcdrwq)

Range: 0 to 100 mS/cm

Accuracy: $\pm 1\%$ of reading or + 0.002 mS/cm, whichever is greater

Resolution: 0.0001 mS/cm to 0.01 mS/cm (range dependent)

Parameter: Specific Conductance

Units: mS/cm

Sensor Type: CT2 probe; Calculated from conductivity and temperature

Model #: 599870 (owcbrwq, owcolwq, owcwmwq)

Range: 0 to 200 mS/cm

Accuracy: $\pm 0.5\%$ of reading or 0.001 mS/cm, whichever is greatest

Resolution: 0.001, 0.01, 0.1 mS/cm (auto-scaling)

Model #: 599827 (owcdrwq)

Range: 0 to 100 mS/cm

Accuracy: $\pm 1\%$ of reading or + 0.002 mS/cm, whichever is greater

Resolution: 0.0001 mS/cm to 0.01 mS/cm (range dependent)

Parameter: Salinity

Units: practical salinity units (psu)

Sensor Type: 599870 probe (owcbrwq, owcolwq, owcwmwq); Calculated from conductivity and temperature

Range: 0 to 70 psu

Accuracy: $\pm 1\%$ of reading or 0.1 psu, whichever is greater

Resolution: 0.01 psu

Sensor Type: 599827 (owcdrwq)

Range: 0 to 70 psu

Accuracy: $\pm 2\%$ of reading or 0.2 psu, whichever is greater

Resolution: 0.01 psu

Parameter: Dissolved Oxygen % saturation

Units: percent air saturation (%)

Sensor Type: Optical probe w/ mechanical cleaning
Model #: 599100-01 (owcbrwq, owcolwq, owcwmwq, owcdrwq)
Range: 0 to 500% air saturation
Accuracy: 0 to 200% air saturation- $\pm 1\%$ of the reading or 1% air saturation, whichever is greater; 200 to 500% air saturation- $\pm 5\%$ of the reading
Resolution: 0.1% air saturation

Parameter: Dissolved Oxygen mg/L (Calculated from % air saturation, temperature, and salinity)

Units: milligrams per Liter (mg/L)
Sensor Type: Optical probe w/ mechanical cleaning
Model #: 599100-01 (owcbrwq, owcolwq, owcwmwq, owcdrwq)
Range: 0 to 50 mg/L
Accuracy: 0 to 20 mg/L- $\pm 1\%$ of the reading or 0.1 mg/L, whichever is greater; 20 to 50 mg/L- $\pm 5\%$ 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; owcbrwq, owcolwq, owcwmwq, owcdrwq)
Range: 0 to 14 units
Accuracy: ± 0.1 pH units within ± 10 °C of calibration temp; ± 0.2 pH units for entire temp range
Resolution: 0.01 units

Parameter: Turbidity

Units: formazin nephelometric units (FNU)
Sensor Type: Optical, 90 degree scatter
Model #: 599101-01 (owcbrwq, owcolwq, owcwmwq, owcdrwq)
Range: 0 to 4000 FNU
Accuracy: 0 to 999 FNU: 0.3 FNU or $\pm 2\%$ of reading (whichever is greater); 1000 to 4000 FNU: $\pm 15\%$ of reading
Resolution: 0 to 999 FNU: 0.01 FNU; 1000 to 4000 FNU: 0.1 FNU

Depth Qualifier

The NERRS System-wide Monitoring Program uses 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 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.

Since 2006, NERRS System-wide Monitoring Program 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 System-wide Monitoring Program calibration sheet or Digital Calibration Log. This offset procedure standardizes each depth calibration for the entire NERRS. If accurate atmospheric pressure data are available, non-vented sensor depth measurements at any NERRS location can be corrected. At the Old Woman Creek National Estuarine Research Reserve, non-vented depth sensors were deployed at all sites throughout 2021.

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. (See **Other Remarks for 2021 specific considerations**).

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:
$$(1013 - BP) * 0.0102 + (\text{Depth} / \text{Level}) = \text{cDepth} / \text{cLevel}.$$

Salinity Units Qualifier

In 2013, EXO sondes were approved for System-wide Monitoring Program 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 NERRS will assign psu salinity units for all data regardless of sonde type.

Turbidity Qualifier

In 2013, EXO sondes were approved for System-wide Monitoring Program use and began to be used 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 System-wide Monitoring Program purposes they are considered equivalent. Since 2013, the NERRS uses FNU/NTU as the designated units for all turbidity data regardless of sonde type. If turbidity units and sensor methodology are of concern, see the Sensor Specifications portion of the metadata.

10. Coded variable definitions:

Sampling Station:	Sampling site code:	Station code:
State Route 6	WM	owcwmwq
Lower Estuary	OL	owcolwq
Darrow Road	DR	owcdrwq

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 different code categories including general, sensor, and comment. General errors document general problems with the deployment or YSI sonde, 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 QAQC checks
- GSM See metadata

Corrected Depth / Level Data Codes

- GCC Calculated with data that were corrected during QAQC
- 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:

End of Deployment Readings in Standard Solutions

Post deployment information for each sonde is recorded to determine whether sensor drift occurs while the sonde is in the estuary (Table 3). When the sonde is brought back to the lab, it is placed in a bucket of aerated water for 30 minutes to verify that the dissolved oxygen sensor has not drifted by placing it in a saturated environment. Specific conductance is checked against a 1.413 mS/cm standard post-deployment. A 2-point calibration is used for pH with 7.00 and 10.00 standards, both of which are corrected for temperature, and both of which are used to verify the pH sensor has not drifted post deployment. Turbidity is also calibrated with a 2-point calibration and is checked against both post deployment. The low turbidity standard is a 0.00 NTU deionized water blank while the high standard is 124.00 NTU. All sondes are unvented. Therefore, the expected depth reading is corrected for changes in barometric pressure.

Table 3: Post-deployment information for each sonde. The location of each Site is Berlin Road (BR), Darrow Road (DR), Lower Estuary (OL) or Wetland Mouth (WM). Deploy Date is the beginning date when sondes were first set out in the estuary. Post-deployment values for specific conductance (Sp. Cond.), pH, and turbidity are listed above, while the standard value for each parameter is listed in parentheses below. For depth, the top value is the post-deployment value while the bottom value in parentheses is the expected depth offset reading corrected for changes in barometric pressure. Standards for pH were corrected for temperature, and both pH and turbidity are checked against a high and low standard post-deployment because both were originally calibrated using a 2-point calibration. Post deployment dissolved oxygen is checked by placing the sonde in an aerated bucket of water and recording two readings.

Site	Deploy Date	Sp. Cond. (mS/cm)	Dissolved Oxygen 1 (%)	Dissolved Oxygen 2 (%)	pH 7	pH 10	Low Turbidity Standard (NTU)	High Turbidity Standard (NTU)	Depth (m)
BR	03/05/2021	1.42 (1.413)	99.1	99.0	7.12 (7.01)	10.15 (10.04)	0.25 (0.00)	112.30 (124.00)	-0.044 (-0.239)
BR	04/06/2021	1.396 (1.413)	96.5	96.6	7.04 (7.01)	10.04 (10.04)	0.15 (0.00)	101.36 (124.00)	-0.300 (-0.298)
BR	05/04/2021	1.410 (1.413)	104	103.3	7.05 (7.01)	10.12 (10.04)	0.09 (0.00)	121.39 (124.00)	-0.151 (-0.154)
BR	06/02/2021	1.390 (1.413)	98.1	98.2	7.05 (7.01)	10.06 (10.04)	0.14 (0.00)	116.31 (124.00)	-0.136 (0.079)
BR	06/29/2021	1.448 (1.413)	96.3	96.1	7.07 (7.01)	10.07 (10.04)	0.12 (0.00)	120.45 (124.00)	0.075 (0.078)
BR	08/03/2021	0.111 (1.413)	96.7	96.7	7.09 (7.01)	10.06 (10.04)	0.40 (0.00)	118.50 (124.00)	-0.006 (-0.013)
BR	09/08/2021	1.345 (1.413)	98.2	98.2	7.02 (7.01)	10.02 (10.04)	0.36 (0.00)	86.20 (124.00)	0.136 (0.120)
BR	10/05/2021	1.378 (1.413)	100.0	100.1	7.12 (7.01)	10.10 (10.04)	0.74 (0.00)	121.31 (124.00)	0.115 (0.120)
BR	11/02/2022	1.451 (1.413)	97.0	96.4	7.02 (7.01)	10.01 (10.04)	4.04 (0.00)	123.55 (124.00)	0.085 (0.110)
DR	03/05/2021	1.405 (1.413)	99.2	99.3	7.17 (7.01)	10.16 (10.04)	0.25 (0.00)	118.64 (124.00)	-0.029 (-0.239)
DR	04/06/2021	1.419 (1.413)	97.9	98.1	7.06 (7.01)	10.04 (10.04)	0.28 (0.00)	121.52 (124.00)	-0.310 (-0.296)
DR	05/04/2021	1.410 (1.413)	97.4	97.4	7.03 (7.01)	10.04 (10.04)	0.37 (0.00)	120.33 (124.00)	-0.160 (-0.171)
DR	06/02/2021	1.424 (1.413)	94.5	94.8	7.14 (7.01)	10.16 (10.04)	0.23 (0.00)	121.81 (124.00)	-0.140 (0.079)
DR	06/29/2021	1.464	96.3	96.1	7.00	10.01	-0.06	126.97	0.077

		(1.413)			(7.01)	(10.04)	(0.00)	(124.00)	(0.079)
DR	08/03/2021	1.457 (1.413)	95.4	95.8	7.01 (7.01)	10.04 (10.04)	1.30 (0.00)	139.26 (124.00)	0.001 (-0.013)
DR	09/08/2021	1.396 (1.413)	98.4	98.4	7.15 (7.01)	10.08 (10.04)	-2.46 (0.00)	106.63 (124.00)	0.132 (0.120)
DR	10/05/2021	1.432 (1.413)	99.7	99.5	7.00 (7.01)	9.92 (10.04)	2.16 (0.00)	124.09 (124.00)	0.113 (0.120)
DR	11/02/2022	1.442 (1.413)	98.6	98.5	7.18 (7.01)	10.19 (10.04)	2.89 (0.00)	124.60 (124.00)	0.075 (0.110)
DR	12/07/2022	1.417 (1.413)	100	99.9	7.03 (7.01)	9.99 (10.04)	0.73 (0.00)	122.93 (124.00)	0.016 (0.069)
OL	03/05/2021	1.403 (1.413)	98.2	98.8	7.2 (7.01)	10.25 (10.04)	0.74 (0.00)	122.16 (124.00)	-0.043 (-0.239)
OL	04/06/2021	1.424 (1.413)	60.0	82.6	7.04 (7.01)	10.04 (10.04)	2.95 (0.00)	108.72 (124.00)	-0.305 (-0.292)
OL	05/04/2021	1.396 (1.413)	97.8	98	7.04 (7.01)	10.06 (10.04)	0.28 (0.00)	122.24 (124.00)	-0.156 (-0.316)
OL	06/02/2021	1.411 (1.413)	94.5	95.6	7.05 (7.01)	10.10 (10.04)	0.39 (0.00)	124.74 (124.00)	-0.139 (0.079)
OL	06/29/2021	1.458 (1.413)	93.2	92.1	6.91 (7.01)	9.85 (10.04)	-0.14 (0.00)	117.81 (124.00)	0.075 (0.077)
OL	08/03/2021	1.449 (1.413)	96.4	96.3	6.92 (7.01)	10.00 (10.04)	-0.23 (0.00)	127.84 (124.00)	0.008 (-0.013)
OL	09/08/2021	1.383 (1.413)	97.2	97.2	6.98 (7.02)	10.06 (10.04)	2.17 (0.00)	120.45 (124.00)	0.158 (0.120)
OL	10/05/2021	1.415 (1.413)	100.0	100.1	7.20 (7.01)	10.15 (10.04)	3.67 (0.00)	122.28 (124.00)	0.095 (0.120)
OL	11/02/2022	1.422 (1.413)	95.8	96.0	7.29 (7.01)	10.20 (10.04)	1.18 (0.00)	122.73 (124.00)	0.097 (0.110)
OL	12/07/2022	1.387 (1.413)	99.9	99.9	7.19 (7.01)	10.13 (10.04)	1.52 (0.00)	123.83 (124.00)	-0.002 (0.069)
WM	12/15/2020	1.408 (1.413)	99.6	99.6	7.14 (7.01)	10.26 (10.04)	-0.27 (0.00)	123.05 (124.00)	0.060 (-0.152)
WM	01/12/2021	1.407 (1.413)	98.3	98.3	6.98 (7.01)	10.07 (10.04)	-0.01 (0.00)	122.60 (124.00)	-0.147 (-0.064)
WM	02/23/2021	1.309 (1.413)	97.9	97.9	7.10 (7.01)	10.17 (10.04)	0.06 (0.00)	120.62 (124.00)	0.005 (-0.211)

WM	04/06/2021	1.318 (1.413)	95.6	94.9	6.99 (7.01)	10.04 (10.04)	0.19 (0.00)	123.10 (124.00)	-0.229 (-0.220)
WM	05/04/2021	1.412 (1.413)	96.9	96.9	6.98 (7.01)	10.12 (10.04)	0.40 (0.00)	106.05 (124.00)	-0.165 (-0.324)
WM	06/02/2021	1.401 (1.413)	95.4	95.6	7.09 (7.01)	10.09 (10.04)	0.32 (0.00)	138.58 (124.00)	-0.146 (0.079)
WM	06/29/2021	1.338 (1.413)	96.1	96.0	6.96 (7.01)	10.00 (10.04)	-0.07 (0.00)	124.91 (124.00)	0.056 (0.061)
WM	08/03/2021	1.399 (1.413)	97.0	97.1	7.05 (7.01)	10.03 (10.04)	0.61 (0.00)	131.59 (124.00)	-0.041 (-0.054)
WM	09/08/2021	1.287 (1.413)	98.1	97.9	6.86 (7.01)	10.02 (10.04)	-0.78 (0.00)	120.8 (124.00)	0.166 (0.120)
WM	10/05/2021	1.403 (1.413)	99.5	99.5	6.98 (7.01)	9.97 (10.04)	2.53 (0.00)	100.99 (124.00)	0.101 (0.120)
WM	11/02/2022	1.425 (1.413)	99.3	99.1	7.02 (7.01)	9.98 (10.04)	0.66 (0.00)	124.40 (124.00)	0.085 (0.110)
WM	12/07/2022	1.413 (1.413)	100.0	100.3	7.01 (7.01)	10.05 (10.04)	0.41 (0.00)	122.99 (124.00)	0.000 (0.069)

14. Other Remarks:

All times are Eastern Daylight Time (EDT; UTC-4). 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.

QAQC Flagging notes

Barrier Beach Status and Water Exchange

The water quality of the OL and WM sites at OWC are influenced by whether the barrier beach is breached/open (i.e., surface water exchange is occurring between the estuary and the lake). When the barrier is open, wind-driven surface water exchange usually results in cycles of water inflow from the lake and outflow to the lake that can be detected in water quality data. The change from closed to open can be rapid and dramatic, usually because of precipitation. Sometimes, this can be followed by seiche events, depending on winds during the storm. The transition from open to closed is gradual and usually marked by a gradual increase in water depth and specific conductivity. The opening of the mouth (and sometimes closing) is indicated in the “F_Record” column as “CSM” (see metadata). Mouth status data through 2021 are below:

Status	Date From	Date To
Open	01/01/2021	03/19/2021
Closed	03/20/2021	03/20/2021
Open	03/21/2021	04/01/2021
Closed	04/02/2021	04/11/2021
Open	04/12/2021	04/14/2020
Closed	04/15/2021	04/25/2021
Open	04/26/2021	06/21/2021
Closed	06/22/2021	06/28/2021
Open*	06/29/2021	07/01/2021
Closed	07/02/2021	07/17/2021
Open	07/17/2021	07/29/2021
Closed	07/30/2021	08/27/2021
Open	08/28/2021	08/31/2021
Closed	09/01/2021	10/08/2021
Open*	10/09/2021	10/28/2021
Closed	10/29/2021	11/01/2021
Open	11/02/2021	12/02/2021
Closed	12/03/2021	12/07/2021
Open	12/08/2021	12/31/2021

*Channel unnaturally created by digging

Rain and weather events

For rain events that affect water quality parameters, the “F_Record” column is flagged for the entire day(s) that parameters are affected. This is not necessarily when precipitation occurs. For example, rainfall in the watershed is frequently heavier further south of the Old Woman Creek NERRS meteorological station. Occasionally, no rain is observed at the

meteorological station, but effects are evident in the water quality data and are reported by volunteer rain gauge observers through the [CoCoRaHS website](#). A southerly storm can cause a delay between when parameters are affected at the southern BR site and at the northern WM site. In these instances, a storm event may be flagged a day later for WM than BR.

Weather events include periods of high wind, which can result in the inflow of water from Lake Erie into the estuary (e.g., true seiche, wind-induced water exchange, waves overtopping the barrier beach into the estuary) or outflow of water from the estuary (e.g., large decrease in water level not associated with a breach of the barrier beach). Lake water inflow events are usually evident at the OL and WM sites and can be most easily detected by plotting both specific conductivity and water depth. The intrusion of lake water into the estuary both increases depth and decreases conductivity. Other parameters may or may not change. These are labeled as a weather event in the “F_Record” column for the duration of the event, in 24-hour periods (i.e., full days are flagged because of difficulty in identifying the exact start and end times of seiche events). Impacted parameter “F_” column(s) may also be flagged, as deemed useful (e.g., if a seiche coincides with retrieval and deployment of sondes, causing the data to look like the retrieved and deployed sondes were not reading similar values). Notable seiche events for 2021 occurred on 05/28-29 and 12/11-12.

Turbidity

During rain events, there may be several high values that exceed a reasonable range of other values and these are flagged <-3>(STS)(CRE).

Corrected Data

BR & DR raw file transfer to export of .csv file had timestamps in the improper time zone (GMT). All timestamps were changed to (EST) using code {CSM}; other parameters were not affected (June 3rd deployments).

Some timestamps have a “WiperPositionVolt” column value omitted in Excel which causes cells to shift into different columns. These values are shifted back over and flagged <5>(CSM).

pH

Seasonally high values were observed between 03/05/2021 and 05/19/2021. An unconfirmed but possible explanation for these high values could be that they are from pesticide and fertilizer inputs, because agriculture constitutes ~65% of land use in the Old Woman Creek watershed. Deployed sensors were properly calibrated, did not appear to drift, and passed post deployment checks. Historical data widgets can be accessed at [SWMPrats.net](#) for further review.

Site specific events:

Berlin Road (BR)

During the summer months, dry conditions typically result in low flow at the BR site in which water level falls below the depth sensor and some or all sensors. For periods where some but not all sensors are out of water, <-3>(SOW) may be used in conjunction with <1>(CSM) for sensors believed to still be submerged. Periods containing <-3>(GOW) signify that all sensors were out of water.

YSI issued an advisory that the LEDs on turbidity sensors manufactured within a certain time range required a longer “burn-in” period and may therefore be more susceptible to drifting over the course of deployment. This affects turbidity timestamps between 03/05/2021 at 11:00 and 10/05/2021 at 08:30, which are flagged <1>[SSM](CSM).

Due to the weather station (OWCOWMET) not collecting or transmitting data, depth could not be corrected for barometric pressure (cDepth). Timestamps affected began 03/06/2021 at 8:45 and go through 06/01/2021 at 12:30. All instances where depth is ≤ 0.0 m are flagged <1>[SNV](CSM).

Specific conductivity between 04/21/2021 at 08:00 and 04/22/2021 at 11:00 spiked to unnaturally high values. Deployed sensors were properly calibrated, did not appear to drift, and passed post deployment checks. It, along with salinity, is flagged as <0>[GSM](CCU) between these timestamps.

Sonde field maintenance on 07/15/2021 at 09:00 caused all parameters to be rejected. This timestamp is flagged <-3>[GSM](CMC).

Darrow Road (DR)

The DR sonde was hooked up to the telemetry station cable on 03/05/2021 at 11:00. Depth and dissolved oxygen were stabilizing and flagged as <1>(CND) other data were unaffected due to a well-mixed water column and flagged <0>(CND).

Large storm events can cause the sonde to swing up or to swing up and down, alternately, due to high flows. As a result, shallower depths or more variable depths are recorded and flagged as <1>[GSM](CWD) with the F_Record containing the {CRE} code. All other parameters are flagged <0>[GSM](CWD). This may have occurred during the following rain events in 2021, as the result of heavy rain and flow: 03/18/2021 at 22:30 through 03/19/2021 at 0:15, 04/29/2021 between 11:30 and 23:45, 05/09/2021 at 14:00 through 05/10/2021 at 03:00, 05/28/2021 between 00:15 and 05:00, 07/17/2021 between 06:30 and 22:30, and 08/25/2021 between 18:00 and 18:15.

On occasion, the chain on which the sonde tube is suspended was not fully extended after the monthly infield maintenance or deployment. In these instances, depth was flagged <1>[GSM](CWD) while all other parameters were flagged <0>[GSM](CWD). This occurred between 03/24/2021 at 10:45 through 04/06/2021 at 09:30, between 06/15/2021 at 11:30 through 06/29/2021 at 09:15, and between 11/02/2021 at 08:15 through 12/07/2021 at 10:00.

There was a sharp spike in specific conductivity observed on 04/22/2021 between 04:15 and 18:45, which seems to be accurate, but the cause is unknown. Deployed sensors were properly calibrated, did not appear to drift, and passed post deployment checks. Specific conductivity and salinity were flagged <0>[GSM](CCU).

Elevated turbidity values at the following timestamps might have been impacted by a wiper issue but we cannot say this with any certainty. These values have been flagged <1>[GSM](CCU); 06/12/2021 12:15-12:30, 13:00-13:15.

The DR sonde was cleaned on 07/15/2021 between 09:15 and 09:30. Prior to the cleaning the pH data was impacted by fouling noted on the sonde and probes seen at the cleaning. pH data

from 07/11/2021 21:30 to 0715/2021 09:15 are marked <1> (CBF).

The DR sonde was cleaned on 12/21/2021, after which there was a discontinuity in depth which subsequently leveled out. All sensors for 09/21/2021 13:45 were flagged <-3>[GSM](CMC).

The wiper was blocking the specific conductivity sensor on 12/08/2021 at 17:15 and it blocked the turbidity sensor on 12/08/2021 from 17:15 to 20:00. Specific conductivity, salinity, and turbidity at these times were flagged <-3>[SWM](CSM).

Anomalies in the sonde's recording occurred on 12/19/2021 from 18:45 to 19:15. Data recorded during these timestamps was nonsensical. All data before and after these timestamps were normal, indicating that this anomaly was related to the sonde's recording and not sensor function. All data collected on 12/19/2021 from 18:45 to 19:15 were rejected <-3>[GIM].

Lower Estuary (OL)

From 04/06/2021 to 06/29/2021 the sonde at OL was not seated in the tube correctly causing data to be collected at the wrong depth. This covers multiple deployments (04/06, 05/04, 06/02). The depth data are flagged <1> [GSM] (CWD) and other parameters are marked <0> [GSM] (CWD).

During routine cleaning on 04/23/2021, the wiper brush was parked over the turbidity sensor. The wiper brush was moved back to the wiper garage, but turbidity may have been affected since atypical peaks were observed in the data. All timestamps between 04/11/2021 at 00:00 through 05/04/2021 at 10:30 are flagged <-3>[SWM](CSM).

The F_Record column on 04/23/2021 at 12:00 is flagged {CMC} because infield maintenance occurred at this time.

The sonde was not replaced into its correct position in time during infield maintenance on 05/13/2021 at 14:30. All parameters on this timestamp are flagged <-3>(CMC).

The OL telemetry station was found to have a faulty cable and replacement was conducted on 05/27/2021 between 14:00 and 17:30. All timestamps were rejected <-3>(CMC) until work was completed.

Infield maintenance of the sonde on 09/21/2021 at 14:15 caused a discontinuity in depth. All parameters on this timestamp are flagged <-3>[GSM](CMC).

During infield maintenance on 10/05/2021 at 09:45, the wire cable holding the sonde suspended at the correct depth snapped. Data collected between 10/05/2021 at 09:45 through 10/15/2021 at 10:30 are flagged <0>[GSM](CWD), except for depth which is flagged <1>[GSM](CWD). The cable was repaired on 10/15/2021 between 10:45 and 12:00; during this time the sonde was out of water and data collected during this 75-minute interval are flagged <-3>[GSM](CMC).

On 10/20/2021 at 13:30, the sonde was taken out of the water for infield maintenance too early. This timestamp is flagged <-3>[GSM](CMC).

Data collected between 11/14/2021 at 11:00 and 12/07/2021 at 10:30 could not be downloaded from the sonde due to an “SD card error.” Therefore, telemetered data transmitted to the CDMO at the time they were measured is reported during this period. It should be noted that the .bin file reported to the CDMO will not contain data during these timestamps because data were not recorded on the sonde. All parameters in this period are flagged <1>[GIT](CSM).

For an unknown reason, no data was recorded nor telemetered between 15:15 to 16:00 on 11/26/2021, and between 23:15 on 11/29/2021 to 01:00 on 11/30/2021. All parameters were flagged <-2>[GIT](CSM) for these timestamps.

Wetland Mouth (WM):

The sonde was not fully descended in its deployment pipe between 01/12/2021 at 10:00 through 02/23/2021 at 11:00. The depth column was flagged <1>[GSM](CWD) and all other parameters were flagged <0>[GSM](CWD) throughout this period.

There was a sharp spike in specific conductivity, the cause of which was unknown, between 02/05/2021 at 11:15 and 02/06/2021 at 02:00. Specific conductivity and salinity between these timestamps were flagged <0>(GSM)(CCU).

For the timestamp 04/22/2021 11:30, there was no “Wiper Position Volt” reading, which led to a shift in other readings. Cells were corrected and flagged <5>(CSM).

The sonde was not fully descended in its deployment pipe between 04/06/2021 at 11:15 through 05/04/2021 at 10:45. The depth column was flagged <1>[GSM](CWD) and all other parameters were flagged <0>[GSM](CWD) throughout this period.

The sonde was not fully descended in its deployment pipe between 05/04/2021 at 11:15 through 06/02/2021 at 09:00. The depth column was flagged <1>[GSM](CWD) and all other parameters were flagged <0>[GSM](CWD) throughout this period.

The sonde was not fully descended in its deployment pipe between 06/02/2021 at 9:15 through 06/29/2021 at 10:15. The depth column was flagged <1>[GSM](CWD) and all other parameters were flagged <0>[GSM](CWD) throughout this period.

The sonde was not fully descended in its deployment pipe between 10/20/2021 at 14:15 through 11/18/2021 at 11:00. The depth column was flagged <1>[GSM](CWD) and all other parameters were flagged <0>[GSM](CWD) throughout this period.

The sonde was pulled before it had recorded its timestamp on 09/08/2021 at 11:45, and the new sonde was not placed into the water until after this timestamp. All parameters are flagged <-3>(CMC) for this timestamp.

During in-field maintenance on 10/05/2021, the sonde was not redeployed all of the way in the tube. This was corrected on 11/18/2021 when tubing was replaced for a nearby ISCO sampler. Depth is flagged <1> [GSM](CWD) and all other parameters are flagged <0> [GSM](CWD) between 10/05/2021 at 10:15 through 11/18/2021 at 11:00.

For an unknown reason, no data was recorded on 10/30/2021 at 17:45. All parameters are flagged <-2>[GSM](CWD) for this timestamp.

Field verification

Field data collected at time of sonde retrieval and deployment are reported (Table 4). Data were collected using a field sonde (EXO2) that was deployed simultaneous to the retrieved and newly deployed sondes.

Table 4: Water quality parameters for the field sonde deployed during each sonde swap. Site is the System-Wide Monitoring Program site, including Berlin Road (BR), Darrow Road (DR), Lower Estuary (OL), and Wetland Mouth (WM). Temperature (Temp), specific conductance (SpCond), salinity (Sal), pH, turbidity (Turbid), dissolved oxygen percent saturation (ODOsat), dissolved oxygen concentration (ODO), and depth were all recorded by the field sonde and are reported for the Date and Time the Sonde was deployed into and retrieved from the water.

Site	Sonde	Date (m/d/y)	Time (hh:mm)	Temp (°C)	SpCond (mS/cm)	Sal (ppt)	pH	Turbid (NTU)	ODOsat (%)	ODO (mg/L)	Depth (meters)
BR	deployed	3/5/2021	11:18 AM	0.430	0.551	0.26	7.85	7.15	100.6	14.51	0.108
BR	retrieved	3/5/2021	11:31 AM	0.282	0.015	0.01	7.7	28.65	101.4	14.67	0.111
BR	deployed	4/6/2021	8:55 AM	9.698	0.647	0.32	7.68	4.02	86.9	9.86	-0.054
BR	retrieved	4/6/2021	9:04 AM	9.708	0.647	0.32	7.63	4.07	87.2	9.89	-0.05
BR	deployed	5/4/2021	9:03 AM	14.170	0.536	0.26	7.7	8.82	89.7	9.2	-0.238
BR	retrieved	5/4/2021	9:10 AM	14.174	0.536	0.26	7.74	8.55	89.7	9.19	-0.197
BR	deployed	6/2/2021	7:17 AM	16.093	0.5877	0.29	7.65	7.92	85.1	8.37	-0.128
BR	retrieved	6/2/2021	7:24 AM	16.077	0.5879	0.29	7.52	7.97	84.6	8.32	-0.124
BR	deployed	6/29/2021	8:44 AM	23.700	0.598	0.29	7.59	13.88	79.3	6.7	0.327
BR	retrieved	6/29/2021	8:55 AM	23.750	0.599	0.29	7.6	13.62	79.1	6.68	0.326
BR	deployed	8/3/2021	9:22 AM	18.529	0.673	0.33	7.55	8.42	81.1	7.58	0.154
BR	retrieved	8/3/2021	9:30 AM	18.539	0.673	0.33	7.58	6.46	80.3	7.5	0.154
BR	deployed	9/8/2021	9:48 AM	19.653	0.579	0.28	7.53	4.5	67.9	6.21	0.038
BR	retrieved	9/8/2021	9:52 AM	19.607	0.578	0.28	7.53	4.39	66.1	6.05	0.038
BR	deployed	10/5/2021	8:30 AM	17.407	0.691	0.34	7.5	2.88	69.7	6.66	0.288
BR	retrieved	10/5/2021	8:37 AM	17.416	0.691	0.34	7.49	6.41	69.5	6.65	0.291
DR	deployed	3/5/2021	10:32 AM	1.560	0.542	0.26	7.69	8.03	101.3	14.16	0.784
DR	retrieved	3/5/2021	11:04 AM	1.668	0.539	0.26	7.83	7.78	96.3	13.42	0.803
DR	deployed	4/6/2021	9:20 AM	10.051	0.676	0.33	7.71	16.51	91.2	10.26	0.447
DR	retrieved	4/6/2021	9:53 AM	10.009	0.672	0.33	7.67	16.64	90.9	10.24	0.494
DR	deployed	5/4/2021	9:39 AM	14.534	0.577	0.28	7.59	22.86	81.6	8.3	0.468
DR	retrieved	5/4/2021	9:50 AM	14.540	0.576	0.28	7.53	24.79	81.6	8.29	0.467
DR	deployed	6/2/2021	7:40 AM	16.513	0.5794	0.28	7.39	14.46	70.6	6.88	0.453
DR	retrieved	6/2/2021	7:52 AM	16.553	0.5806	0.28	7.4	14.48	69.1	6.73	0.464
DR	deployed	6/29/2021	9:15 AM	23.591	0.6790	0.33	7.27	16.92	37.50	3.18	0.905

DR	retrieved	6/29/2021	9:24 AM	23.690	0.677	0.33	7.27	19.14	36.7	3.1	0.909
DR	deployed	8/3/2021	9:59 AM	21.937	0.631	0.31	7.49	14.73	76.9	6.72	0.833
DR	retrieved	8/3/2021	10:14 AM	21.944	0.632	0.31	7.51	15.12	76.1	6.65	0.837
DR	deployed	9/8/2021	10:02 AM	21.557	0.427	0.2	7.5	10.45	69.4	6.11	0.84
DR	retrieved	9/8/2021	10:15 AM	21.592	0.427	0.21	7.45	11.5	6938	6.14	0.847
DR	deployed	10/5/2021	8:59 AM	17.178	0.441	0.21	7.04	2.23	32.3	3.11	1.059
DR	retrieved	10/5/2021	9:07 AM	17.152	0.44	0.21	7.07	2.51	29.6	2.85	1.072
DR	deployed	11/2/2022	8:02 AM	10.263	0.479	0.23	7.58	27.83	84.7	9.49	0.978
DR	retrieved	11/2/2022	8:12 AM	10.578	0.485	0.24	7.59	27.22	78.3	8.7	0.986
DR	deployed	12/7/2021	9:59 AM	3.772	0.456	0.22	7.69	176.52	92.1	12.13	1.506
DR	retrieved	12/7/2021	10:07 AM	3.862	0.455	0.22	7.68	195.82	87.8	11.54	1.51
DR	retrieved	1/4/2022	1:14 PM	1.115	0.559	0.27	7.59	25.85	94.5	13.38	1.162
OL	deployed	3/5/2021	9:35 AM	1.831	0.478	0.23	7.85	19.75	98.4	13.65	0.634
OL	retrieved	3/5/2021	9:44 AM	1.805	0.483	0.23	7.78	19.45	97.1	13.49	0.64
OL	deployed	4/6/2021	10:38 AM	11.614	0.431	0.21	7.81	43.36	96.6	10.49	1.104
OL	retrieved	4/6/2021	10:54 AM	10.856	0.426	0.21	7.67	108.72	87.3	9.65	1.158
OL	deployed	5/4/2021	10:39 AM	17.057	0.467	0.23	7.44	58.14	64.4	6.2	0.386
OL	retrieved	5/4/2021	10:48 AM	17.068	0.473	0.23	7.42	56.68	63.2	6.09	0.427
OL	deployed	6/2/2021	8:34 AM	18.018	0.412	0.2	7.45	27.2	80.8	7.63	0.396
OL	retrieved	6/2/2021	8:47 AM	18.308	0.425	0.2	7.44	29.42	77.9	7.32	0.432
OL	deployed	6/29/2021	10:01 AM	26.078	0.434	0.21	7.3	45.06	54.9	4.44	1.307
OL	retrieved	6/29/2021	10:10 AM	26.060	0.433	0.21	7.29	62.71	50.4	4.08	1.284
OL	deployed	8/3/2021	10:59 AM	23.028	0.353	0.17	7.32	20.49	66.5	5.7	0.861
OL	retrieved	8/3/2021	11:16 AM	23.046	0.354	0.17	7.3	20.81	62.7	5.37	0.851
OL	deployed	9/8/2021	11:01 AM	22.402	0.32	0.15	7.22	53.84	55.8	4.83	1.145
OL	retrieved	9/8/2021	11:14 AM	22.420	0.344	0.16	7.02	61.24	7.2	0.63	1.147
OL	deployed	10/5/2021	9:38 AM	18.638	0.376	0.18	7.17	8.39	44.9	4.19	1.119
OL	retrieved	10/5/2021	9:50 AM	18.632	0.376	0.18	7.14	8.44	43.4	4.05	1.178
OL	deployed	11/2/2022	8:47 AM	11.214	0.409	0.2	7.48	23.66	67.7	7.42	1.232
OL	retrieved	11/2/2022	9:01 AM	11.152	0.41	0.2	7.48	18.9	68.1	7.47	1.302
OL	deployed	12/7/2021	10:43 AM	2.817	0.639	0.31	7.9	39.58	91.7	12.38	1.231
OL	retrieved	12/7/2021	10:45 AM	2.815	0.637	0.31	7.91	345.44	91.6	12.37	1.142
OL	retrieved	1/4/2022	1:45 PM	2.147	0.382	0.18	7.69	49.37	96.5	13.28	0.702

WM	deployed	1/12/2021	9:49 AM	0.346	0.3613	0.17	7.79	51.64	95.1	13.58	0.84
WM	retrieved	1/12/2021	9:59 AM	0.378	0.1914	0.17	7.79	16.14	93.8	13.56	0.861
WM	deployed	2/23/2021	11:03 AM	0.426	0.882	0.43	7.41	6.29	69.3	9.98	0.395
WM	retrieved	2/23/2021	11:10 AM	0.217	0.898	0.43	7.3	6.37	68	68.2	0.409
WM	deployed	4/6/2021	10:59 AM	11.837	0.425	0.21	8.09	30.52	112.2	12.13	0.614
WM	retrieved	4/6/2021	11:09 AM	11.887	0.423	0.2	8.09	30.08	113.3	12.23	0.527
WM	deployed	5/4/2021	10:52 AM	16.817	0.456	0.22	7.44	51.79	68.9	6.68	0.491
WM	retrieved	5/4/2021	11:04 AM	16.929	0.46	0.22	7.41	51.92	64.4	6.23	0.358
WM	deployed	6/2/2021	9:00 AM	18.462	0.401	0.19	7.54	24.6	85.9	8.05	0.529
WM	retrieved	6/2/2021	9:15 AM	18.639	0.411	0.2	7.53	30.79	85.1	7.95	0.544
WM	deployed	6/29/2021	10:20 AM	26.277	0.421	0.2	7.28	41.3	52	4.19	1.185
WM	retrieved	6/29/2021	10:28 AM	26.263	0.421	0.2	7.3	44.08	54.1	4.36	1.19
WM	deployed	8/3/2021	11:26 AM	23.197	0.347	0.17	7.3	16.56	61	5.21	0.752
WM	retrieved	8/3/2021	11:39 AM	23.119	0.346	0.17	7.27	16.5	57.7	4.93	0.749
WM	deployed	9/8/2021	11:34 AM	22.581	0.318	0.15	7.24	13.86	55.8	4.82	0.947
WM	retrieved	9/8/2021	11:48 AM	22.642	0.318	0.15	7.26	22.34	55.5	4.79	0.661
WM	deployed	10/5/2021	10:00 AM	18.634	0.375	0.18	7.2	3.83	52.9	4.94	1.167
WM	retrieved	10/5/2021	10:07 AM	18.626	0.375	0.18	7.2	3.81	53.8	5.03	1.145
WM	deployed	11/2/2022	9:05 AM	11.339	0.408	0.2	7.47	16.21	67.3	7.36	1.219
WM	retrieved	11/2/2022	9:16 AM	11.335	0.408	0.2	7.47	17.28	66.4	7.26	1.278
WM	deployed	12/7/2021	10:53 AM	3.732	0.634	0.31	7.9	19.27	90.3	11.89	1.238
WM	retrieved	12/7/2021	11:01 AM	3.735	0.634	0.31	7.9	59.69	89.7	11.82	1.383
WM	retrieved	1/4/2022	1:59 PM	2.513	0.3680	0.18	7.66	55.18	97.80	13.33	0.870