Old Woman Creek (OWC) NERR Water Quality Metadata
January – December 2019
Latest Update: May 11, 2021

I. Data Set and Research Descriptors

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2. Entry verification:

Deployment data are directly uploaded from a YSI EXO2 data logger to a personal computer (IBM compatible). 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 an Excel file (.XLS) 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. The files are archived at OWC.

Dr. Kristi Arend and Sebastian Mejia were responsible for both data logger deployment and data management at Old Woman Creek NERR during 2019.

3. Research Objectives:

Measurements are taken every 15 minutes over two to four-week periods at four sites within

Old Woman Creek. Three sites are located in the estuary proper: one in the upper reaches at Darrow Road (DR); one near the mouth, just south of State Route 6 (WM); and the third upstream from the WM site (Lower Estuary; OL). The final site (BR) is just 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 2019 YSI monitoring program began at all sites on 03/26, shortly after thaw. Sampling continues through 11/01. EXO2 sondes were used at all four sites throughout this time period. Data loggers at BR, DR, and WM are deployed in 4-inch diameter PVC pipes, which are clamped to an 8-foot long metal post that had been driven into the sediment. The logger trap at site DR is not clamped to an 8-foot metal post, but rather is suspended from the north side of the road bridge by metal chain. Each pipe has 4 vertical slits ¾" wide drilled into it spanning the area of the probe guard on the data logger to ensure that the probes would 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 2 sonde guard slits. Additional field readings for dissolved oxygen, pH, temperature, turbidity, and specific conductance were taken using a EXO2 sonde when the instruments were changed at each site (see the Other Remarks Section). The data loggers were replaced in the field after a two to four-week deployment, depending on temperature and degree of fouling of the data loggers. The data were retrieved from each data logger and each data logger 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. The data loggers at all sites have non-vented depth sensors and optical DO sensors. The 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 began being followed in March 2015 at the start of sampling and was following throughout the 2016 field season.

A Sutron Sat-Link2 transmitter was installed at site OL during October 2006. This system transmits data to the NOAA Goes satellite, NESDIS ID# 3B02849A. WaterLog Storm3 data loggers were installed at sites DR and WM in 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 (OWC) 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 1 ppt. or less, although it will rise, on occasion, to nearly 2 ppt. The tidal range in Lake Erie (and therefore in the estuary) is on the order of 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) during a quarter or year are included in the comments section.

The data logger at the State Route 6 (WM) site (Latitude 41° 22' 57" N, Longitude 82° 30'54" W) is very close to the mouth of Old Woman Creek. In this portion of the Reserve, the creek is very 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. No rooted aquatic vegetation was present directly adjacent to the site, although both emergent and submerged vegetation were present within 3 meters of the site. The data logger was about 0.18 meters above the bottom sediments, until 17 August 2016, when the sonde was repositioned due to high water levels and the height was measured to be approximately 0.28 m above the bottom. By 2019, the bottom 0.23-0.28 m of the deployment pipe had completely filled with mud. The bottom 2" 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. The height of the sonde (bottom of the guard) was measured to be approximately 0.29 m off of the bottom; this was approximately 0.25 m higher than the previous setup, based on sonde depth data. This places the sensors at 0.37 m above the bottom and the depth sensor at (Note: the distance from the bottom end of the sonde guard to the bottom/face of all sensors except the depth sensor is 0.08m; the distance from the bottom end of the sonde guard to the depth sensor is 0.50 m). The intake tube for associated diel sampling (via autosampler) is suspended at between 0.23 m (bottom of intake guard) and 0.39 m (top of intake guard) from the bottom.

The data logger at site OL (Latitude 41° 22' 55" N, Longitude 82° 30'51" W) is in the lower reaches of the estuary. This site is not in direct sight of the 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 meters north of a Nelumbo lutea bed, but, no plants were immediately adjacent to the data logger. In March 2009, a new logger site was established 5 meters north of the original site due to damage of the original site by a winter storm. In 2010, this temporary site became the OL site. At this site, the base of the logger was 26 cm above the sediment. One or two leaves of N. lutea are adjacent to this logger site. This is the site that is telemetered to the GOES satellite. On 1 December 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 approximately 0.42m off the bottom. In early 2018, the height of the logger was

observed to have changed. The cable on which the trap was suspended slipped through a clamp, causing the trap to descend such that the depth sensor was positioned 0.23m above the sediment and the other sensors were positioned 0.02m above the sediment by 23 May 2018. The trap was re-set on 23 May 2018 at 10:45 EST to position the depth sensor 0.45m above the sediment and the other sensors 0.32m above the sediment (note: trap length is 0.73m 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 0.08m; the distance from the bottom end of the sonde guard to the depth sensor is 0.21m).

The data logger at site DR (Latitude 41° 21'54"N, Longitude 82° 30' 17"W) 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 is influenced at this site by changes in Lake Erie water levels, this site doesn't have direct contact with Lake Erie waters. The bottom sediments at his 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 measured to be at about 0.45 m above the bottom.

The data logger at site BR (Latitude 41° 20'54" N, Longitude 82° 30'30"W) is located in the lower portion of the creek proper. Just upstream from the data logger, Berlin Road crosses Old Woman Creek. Site BR is just upstream of the first riffle above the estuary. Unlike the other three sites, Lake Erie water levels have no impact on this 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. During winter 2014, the logger distance above bottom was measured as being about 14 cm above the stream bottom.

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"	04/01/2002 00:00 - current	NA	NA

			W			
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; couldn't access site	NA

6. Data collection periods:

Sondes were initially deployed after freezing was no longer a problem. Sampling at BR began on 03/26/2019 at 08:15 EST, and data were last downloaded on 12/10/2019 at 10:00 EST. Sampling at DR began on 03/26/2019 at 09:45 EST, and data were last downloaded on 12/10/2019 at 10:15 EST. Sampling at OL began on 03/26/2019 at 10:45 EST, and data were last downloaded on 12/10/2019 at 11:15 EST. Sampling at WM began on 03/26/2019 at 09:15 EST, and data were last downloaded on 12/10/2019 at 11:00 EST. Specific deployment dates are listed below.

Site	Deploy Date	Deploy Time	Retrieve Date	Retrieve Time	Sonde
BR	03/26/2019	8:15	4/18/2019	10:15	EXO2 (BR1)
BR	04/18/2019	10:30	5/15/2019	8:30	EXO2 (BR2)
BR	05/15/2019	8:45	6/5/2019	8:15	EXO2 (BR1)
BR	06/05/2019	8:30	6/19/2019	8:00	EXO2 (BR2)
BR	06/19/2019	8:15	7/2/2019	8:15	EXO2 (BR1)
BR	07/02/2019	8:30	7/16/2019	8:15	EXO2 (BR2)
BR	07/16/2019	8:30	7/31/2019	10:15	EXO2 (BR1)
BR	07/31/2019	10:30	8/26/2019	8:45	EXO2 (BR2)
BR	08/26/2019	9:00	9/24/2019	8:00	EXO2 (BR1)
BR	09/24/2019	8:15	10/15/2019	7:45	EXO2 (BR2)
BR	10/15/2019	8:00	11/12/2019	10:00	EXO2 (BR1)
BR	11/12/2019	10:15	12/10/2019	10:00	EXO2 (BR2)
DR	03/26/2019	9:45	4/18/2019	10:00	EXO2 (Nelumbo)
DR	04/18/2019	10:15	5/15/2019	9:00	EXO2 (Lepomis)
DR	05/15/2019	9:15	6/5/2019	8:45	EXO2 (Nelumbo)

DR	06/05/2019	9:00	6/19/2019	8:15	EXO2 (Lepomis)
DR	06/19/2019	8:30	7/2/2019	8:30	EXO2 (Nelumbo)
DR	07/02/2019	9:00	7/16/2019	8:45	EXO2 (Lepomis)
DR	07/16/2019	9:00	7/31/2019	10:30	EXO2 (Nelumbo)
DR	07/31/2019	11:00	8/26/2019	9:00	EXO2 (Lepomis)
DR	08/26/2019	9:30	9/24/2019	8:15	EXO2 (Nelumbo)
DR	09/24/2019	8:45	10/15/2019	8:00	EXO2 (Lepomis)
DR	10/15/2019	8:30	11/12/2019	10:15	EXO2 (Nelumbo)
DR	11/12/2019	10:45	12/10/2019	10:15	EXO2 (Lepomis)
OL	03/26/2019	10:45	4/18/2019	8:45	EXO2 (OL1)
OL	04/18/2019	7:00	5/15/2019	10:00	EXO2 (OL2)
OL	05/15/2019	10:15	6/5/2019	9:30	EXO2 (OL1)
OL	06/05/2019	9:45	6/19/2019	9:00	EXO2 (OL2)
OL	06/19/2019	9:15	7/2/2019	9:15	EXO2 (OL1)
OL	07/02/2019	9:30	7/16/2019	9:15	EXO2 (DR2)
OL	07/16/2019	9:30	7/31/2019	11:15	EXO2 (OL1)
OL	07/31/2019	11:45	8/26/2019	10:00	EXO2 (DR2)
OL	08/26/2019	10:15	9/24/2019	9:30	EXO2 (OL1)
OL	09/24/2019	9:45	10/15/2019	9:30	EXO2 (DR2)
OL	10/15/2019	9:45	11/12/2019	11:15	EXO2 (OL1)
OL	11/12/2019	11:45	12/10/2019	11:15	EXO2 (DR2)
WM	03/26/2019	11:00	4/18/2019	9:15	EXO2 (WM1)
WM	04/18/2019	9:30	5/15/2019	10:15	EXO2 (WM2)
WM	05/15/2019	10:45	6/5/2019	10:00	EXO2 (WM1)
WM	06/05/2019	10:15	6/19/2019	9:15	EXO2 (WM2)
WM	06/19/2019	9:45	6/23/2019	22:15	EXO2 (WM1)
WM	06/25/2019	10:45	7/2/2019	9:30	EXO2 (WM2)
WM	07/02/2019	16:15	7/16/2019	9:30	EXO2 (DR1)
WM	07/16/2019	9:45	7/31/2019	11:45	EXO2 (Amia)
WM	07/31/2019	12:00	8/26/2019	10:15	EXO2 (WM2)
WM	08/26/2019	10:30	9/24/2019	10:00	EXO2 (Amia)
WM	09/24/2019	10:15	10/15/2019	9:45	EXO2 (WM2)
WM	10/15/2019	10:00	11/12/2019	11:30	EXO2 (WM1)
WM	11/12/2019	12:00	12/10/2019	11:00	EXO2 (WM2)

7. Distribution

NOAA retains the right to analyze, synthesize, and publish summaries of the NERRS System-wide Monitoring Program data. The NERRS and OWC Research Coordinator (RC) retain the right to be fully credited for having collected and processed the data. Following academic courtesy standards, the RC and the NERR site 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:
National Estuarine Research Reserve System (NERRS). 2012. System-wide Monitoring Program. Data accessed from the NOAA NERRS Centralized Data Management Office website: http://www.nerrsdata.org/; *accessed* 12 October 2012.

NERR water quality data and metadata can be obtained from the Research Coordinator at the individual NERR site (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:

A Nile microwave water level sensor is located in close proximity to the WM site and at the DR site. These provide more 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.

As part of the SWMP long-term monitoring program, replicate samples for chemical analysis of the water are collected at least monthly. Samples for phytoplankton determination are collected at the same time at sites near two of the data logger deployment sites (DR and WM). A 26-hour water sampling regime (samples are collected at 2-hour intervals over the 26 hours) is conducted at the WM site once during each month. Additionally, a meteorological station collects 15-minute data. These data are available at www.nerrsdata.org.

II. Physical Structure and Descriptors:

9. Sensor specifications:

OWC NERR deployed eight EXO2 sondes in 2019. A ninth YSI EXO2 sonde was used for to collect simultaneous field measurements when sondes were exchanged.

YSI EXO2 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: $\pm$ 0.01 °C; 35 to 50 °C: $\pm$ 0.05 °C

Resolution: 0.01 °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 autoranging
Model #: 599870 (owcbrwq, owcolwq, owcwmwq)
Range: 0 to 200 mS/cm
Accuracy: 0 to 100 mS/cm: ± 0.5% of reading or + 0.001 mS/cm, whichever is greater; 100 to 200 mS/cm: ± 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: ± 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: ± 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: ± 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: ± 1% of reading or 0.1 psu, whichever is greater
Resolution: 0.01 psu

Sensor Type: 599827 (owcdrwq)
Range: 0 to 70 psu
Accuracy: ± 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
Range: 0 to 500% air saturation
Accuracy: 0 to 200% air saturation- ± 1% of the reading or 1% air saturation, whichever is greater; 200 to 500% air saturation- ± 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
Range: 0 to 50 mg/L
Accuracy: 0 to 20 mg/L- ± 1% of the reading or 0.1 mg/L, 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 #: 599702 (wiped)
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
Range: 0 to 4000 FNU
Accuracy: 0 to 999 FNU: 0.3 FNU or ± 2% of reading (whichever is greater); 1000 to 4000 FNU: ± 15% of reading
Resolution: 0 to 999 FNU: 0.01 FNU; 1000 to 4000 FNU: 0.1 FNU

Dissolved Oxygen Qualifier (Rapid Pulse / Clark type sensor):

The reliability of dissolved oxygen (DO) data collected with the rapid pulse / Clark type sensor after 96 hours post-deployment for non-EDS (Extended Deployment System) data sondes may be problematic due to fouling which forms on the DO probe membrane during some deployments (Wenner et al. 2001). Some Reserves use the YSI 6600 EDS data sondes, which increase DO accuracy and longevity by reducing the environmental effects of fouling. Optical DO probes have further improved data reliability. The user is therefore advised to

consult the metadata for sensor type information and to exercise caution when using rapid pulse / Clark type sensor DO data beyond the initial 96-hour time period. Potential drift is not always problematic for some uses of the data, i.e. periodicity analysis. It should also be noted that the amount of fouling is very site specific and that not all data are affected. If there are concerns about fouling impacts on DO data beyond any information documented in the metadata and/or QAQC flags/codes, please contact the Research Coordinator at the specific NERR site regarding site and seasonal variation in fouling of the DO sensor.

Depth Qualifier

The NERRS System-Wide Monitoring Program uses 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 site can be corrected. At OWC NERR in 2018, all sites employed non-vented depth sensors.

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 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 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
State Route 6	WM	owcwmwq
Lower Estuary	OL	owcolwq
Darrow Road	DR	owcdrwq
Berlin Road	BR	owcbrwq

11. QAQC flag

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 are 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 Open- reserved for later flag
0 Good Data
1 Suspect Data
2 Data Outside 2 Standard Deviations from the historical seasonal mean
3 Data Outside 3 Standard Deviations from the historical seasonal mean
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 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:

End of Deployment Readings in Standard Solutions

Date is the date logger was deployed. Dissolved oxygen readings are the readings after retrieval, with the sonde place in a bucket of aerated water. All loggers were unvented; therefore, the depth reading in parentheses after the first depth reading is the expected depth reading when correcting for changes in barometric pressure. The specific conductivity standard is indicated in parenthesis (1.413 mS/cm). The pH standards are 7.00 and 10.00 (both are corrected for temperature). The turbidity standards are indicated in parenthesis (0.0, 124.0 FNU). The depth offset, based on current barometric pressure is indicated in parenthesis. Complete post deployment data are in the calibration sheets.

Site	Deploy Date	SpCond	ODO1	ODO2	pH7	pH10	Turb	Turb	Depth
BR	03/26/2019	1.466(1.413)	99.1	99.1	7.11	10.11	0.86(0.0)	125.3(124.0)	-0.11(-0.105)
BR	04/18/2019	1.417(1.413)	100.2	100.1	7.08	10.13	0.31(0.0)	124.81(124.0)	0.02(0.0080)
BR	05/15/2019	1.395(1.413)	97.7	97.4	6.69	9.98	-0.08(0.0)	119.33(124.0)	-0.07(-0.064)
BR	06/05/2019	1.3787(1.413)	96.6	96.5	7.07	10.07	0.92(0.0)	138.1(124.0)	-0.034(-0.033)
BR	06/19/2019	1.423(1.413)	105.1	105	7.1	10.11	0.92(0.0)	135.92(124.0)	0.0(-0.0030)
BR	07/02/2019	1.375(1.413)	99.3	99.5	6.99	10.01	-0.05(0.0)	122.85(124.0)	0.038(0.038)
BR	07/16/2019	1.403(1.413)	99.1	99.1	6.85	9.9	0.95(0.0)	130.2(124.0)	0.061(0.069)
BR	07/31/2019	1.411(1.413)	100.6	100.7	7.07	10.1	0.49(0.0)	122.61(124.0)	0.018(0.028)
BR	08/26/2019	1.418(1.413)	99.9	99.8	7.06	10.04	0.08(0.0)	130.2(124.0)	0.0080(0.028)
BR	09/24/2019	1.413(1.413)	101.2	101.1	7.01	10.04	0.02(0.0)	124.09(124.0)	0.026(0.038)
BR	10/15/2019	1.413(1.413)	101.3	101.4	7	10.04	0.15(0.0)	123.06(124.0)	0.163(0.161)
BR	11/12/2019	1.401(1.413)	97.7	97.7	7.02	10.11	0.1(0.0)	125.9(124.0)	0.145(0.14)
DR	03/26/2019	1.45(1.413)	98.7	98.7	6.98	9.99	0.66(0.0)	124.9(124.0)	-0.101(-0.105)
DR	04/18/2019	1.421(1.413)	99.6	99.5	7.2	10.19	1.19(0.0)	123.35(124.0)	-0.022(-0.013)
DR	05/15/2019	1.4208(1.413)	97.1	97.5	7.01	10.06	-0.34(0.0)	120.26(124.0)	-0.082(-0.064)
DR	06/05/2019	1.4209(1.413)	96.8	96.8	7.1	10.13	0.92(0.0)	121.03(124.0)	-0.022(-0.033)
DR	06/19/2019	1.423(1.413)	107.1	107.2	7.12	10.1	1.04(0.0)	131.26(124.0)	0.0(-0.0030)
DR	07/02/2019	1.408(1.413)	97.2	97.3	7.18	10.11	0.02(0.0)	122.35(124.0)	0.033(0.038)
DR	07/16/2019	1.4(1.413)	98.6	98.6	7.07	10.03	1.0(0.0)	119.5(124.0)	0.06(0.069)
DR	07/31/2019	1.4216(1.413)	97.7	97.9	7.09	10.03	-0.07(0.0)	128.7(124.0)	0.011(0.018)
DR	08/26/2019	1.421(1.413)	99.3	99.3	7.12	10.12	0.13(0.0)	144.8(124.0)	0.0020(0.018)
DR	09/24/2019	1.413(1.413)	99.4	99.3	7.01	10.04	0.01(0.0)	124.16(124.0)	-0.01(0.018)
DR	10/15/2019	1.4236(1.413)	100.5	100.5	7.02	10	0.18(0.0)	129.4(124.0)	0.163(0.161)
DR	11/12/2019	1.398(1.413)	97.5	97.5	6.96	10.02	0.26(0.0)	134.8(124.0)	0.147(0.14)

OL	03/26/2019	1.423(1.413)	98.8	98.8	7.18	10.1	0.92(0.0)	125.7(124.0)	-0.097(-0.105)
OL*	04/18/2019	-1.413					0	-124	0
OL	05/15/2019	1.3857(1.413)	95.8	96.3	6.84	9.89	-0.16(0.0)	120.48(124.0)	-0.087(-0.064)
OL*	06/05/2019	-1.413					0	-124	0
OL	06/19/2019	1.374(1.413)	108.9	108.8	7.01	9.94	0.91(0.0)	124.73(124.0)	-0.01(-0.0030)
OL	07/02/2019	1.404(1.413)	99.3	99.4	7.05	10.01	0.01(0.0)	124.05(124.0)	0.022(0.038)
OL	07/16/2019	1.368(1.413)	98.4	98.3	7.14	10.04	0.05(0.0)	125.99(124.0)	0.048(0.069)
OL	07/31/2019	1.418(1.413)	99	99.2	7.1	10.11	0.65(0.0)	121.44(124.0)	0.021(0.018)
OL	08/26/2019	1.402(1.413)	99.3	99.3	7.18	10.06	0.13(0.0)	125.4(124.0)	-0.0010(0.018)
OL	09/24/2019	1.4084(1.413)	99.8	99.7	6.93	10.05	0.31(0.0)	114.06(124.0)	-0.091(-0.094)
OL	10/15/2019	1.4156(1.413)	100.9	101	6.98	10.03	0.2(0.0)	121.32(124.0)	0.158(0.161)
OL	11/12/2019	1.409(1.413)	98.3	98.3	7	10.1	0.32(0.0)	131.5(124.0)	0.157(0.14)
WM	03/26/2019	1.434(1.413)	100.5	100.6	6.87	9.85	1.55(0.0)	125.5(124.0)	-0.087(-0.105)
WM	04/18/2019	1.408(1.413)	100.7	100.6	6.99	10.08	0.05(0.0)	124.6(124.0)	-0.029(-0.013)
WM	05/15/2019	1.3987(1.413)	98	98.2	7.13	10.13	-0.29(0.0)	120.4(124.0)	-0.085(-0.064)
WM	06/05/2019	14.01(1.413) §	96.8	97.3	6.99	10.05	-2.85(0.0)	121.75(124.0)	-0.033(-0.033)
WM*	06/19/2019	-1.413					0	-124	0
WM	06/25/2019	1.413(1.413) §	98.6	98.9	7.12	10.16	1.18(0.0)	121.44(124.0)	(-0.0030)
WM	07/02/2019	1.297(1.413)	98.8	98.9	7.12	10.09	-1.07(0.0)	127.8(124.0)	0.045(0.038)
WM	07/16/2019	1.325(1.413) §	98.8	98.6	6.88	9.88	0.72(0.0)	122.58(124.0)	0.064(0.069)
WM	07/31/2019	1.3395(1.413)	98.4	98.6	7.09	10	-0.24(0.0)	122.08(124.0)	-0.008
WM	08/26/2019	1.437(1.413) §	99.2	99.1	7.12	10.1	0.02(0.0)	123.2(124.0)	-0.032(-0.023)
WM	09/24/2019	1.414(1.413)	100	99.9	7.01	10.04	-0.01(0.0)	123.93(124.0)	-0.089(-0.084)
WM	10/15/2019	1.4154(1.413)	100.8	101.3	7.17	10.19	0.2(0.0)	127.39(124.0)	0.165(0.161)
WM	11/12/2019	1.44(1.413)	98.3	98.2	7.01	10.06	0.34(0.0)	125.2(124.0)	0.16(0.14)

* sonde malfunction

§ sensor malfunction

14. Other Remarks:

QAQC Flagging notes

Barrier Beach Status and Water Exchange

The water quality of the OL and WM sites at OWC are influenced by whether or not the barrier beach is breached/open (i.e., surface 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 the water quality data. The change from closed to open can be rapid and dramatic, usually as a result 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 for Q1-Q4 are below.

Changes to mouth status

Jan. 01 – May 08: open

May 09 – May 24: closed

May 24 – July 08: open (mouth opened by excavator)
July 08 – Aug 02: closed
Aug 02 – Aug 09: open (mouth opened by excavator)
Aug 10 – Oct 18: closed
Oct 18 – Nov 8: open (mouth opened by excavator)
Nov 8 – Dec 10: closed

Rain and weather events

For rain events that affect water quality parameters, the "F_Record" column is flagged for the time period over which the precipitation occurred (not the time period over which the parameters were affected). Sometimes, the parameters themselves are flagged during the time period over which they were affected. Rainfall is frequently heavier further south of the OWC NERR meteorological station in the watershed. 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. These are marked as rain events for the entire day they occur, because specific start and end times are not available.

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 marked because of difficulty in identifying the exact start and end times of seiche events). Impacted parameter "F_" column(s) may also be marked, 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 weren't reading similar values). Seiches occurred: April 3-4, 11, 14, and 17; and June 3.

Darrow Road (DR): 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. This may have occurred during the following rain events, as the result of heavy rain and flow: 31 March; 20 April; 2 May; 5-6 June; 10 June; 13-16 June; 20-21 June.

Darrow Road (DR): During snow and ice conditions, roads are generally salted leading to observed spikes in SpCond and Sal, which are anthropogenic evemts and not typical of the system: 13-14 November, 2-3 December.

Other Events

Culvert work on a small tributary where it crosses Deehr Road occurred intermittently from October through December 2019; the tributary flows into Old Woman Creek north of owcbrwq and south of owcdrwq.

Depth (non-weather related)

Darrow Road (DR): Starting with the first deployment on 03/26 09:45:00 EST through 03/27 10:30 EST, the sonde was positioned shallower than its normal depth because the pipe

suspension system required repair. Other data were unaffected due to a well-mixed water column. Depth rapidly decreased and then rapidly increased on 04/10 at 22:00 and 04/12 at 04:15, respective. The cause is unknown. Depth differed noticeably between the following deployments: 07/16 and 07/31(date exchanged), 08/26 (date exchanged. The sonde was also pulled up and cleaned on 09/09. The chain that holds the sonde housing was mistakenly tensioned on a bolt on the DR bridge, preventing the housing from fully descending. During flow events, the housing would force the chain off the bolt allowing the housing to fully descend. Other data were unaffected due to a well-mixed water column.

Lower Estuary (OL): The sonde was out of water for maintenance on 02 April from 8:30-12:00 to trouble-shoot the satellite transmission tower.

Rte 6 (WM): A problem with the telemetry cable caused the sonde to stop recording depth during the 25 June deployment and from 07/02 16:15 – 07/03 08:30. When the telemetry cable was disconnected on 07/03, depth recording resumed.

The sonde deployment housing (PVC pipe) was replaced on 10/29; the sonde depth was measured as 0.29 m above the bottom, very close to the deployment depth in the previous housing, based on previous measurements. However, the sonde depth data show an increase in depth (off of the bottom) of 0.25 m (from 0.95 m to 0.70 m). From 10/27-28 there was also a seiche event, which may have contributed to the changes in depth seen during this time.

Turbidity

Approximately 2” of mud in the bottom of the guard at site WM caused very high turbidity levels from 04/13-04/18, 05/08-05/15, and 05/29 -06/05; 07/15 20:30-07/16 09:30; 07/23 00:00-07/31 11:45; 08/10 00:00-08/12 11:15; and 10/05 00:00-10/15 9:45. Data were rejected.

Approximately 1" of mud in sonde guard was removed during a sonde cleaning. This light bio-fouling on sonde body, probes and sonde tube (inside and out) was removed by scrubbing. Cleaning occurred between 11:16-11:25 EST on 12 August. Turbidity data prior to cleaning was impacted by mud fouling.

Turbidity spikes at sites OL and WM, particularly from April through June, could be due to biological activity, especially activity of *Cyprinus carpio L*.

DO

Approximately 2” of mud in the bottom of the guard at site WM likely caused low DO levels during the following time periods: 04/14-04/18; 05/11-05/15; 07/11 00:00-07/16 09:30; 07/23 00:00-07/31 11:45; and 08/10 00:00-08/12 11:15. Data were marked as suspect.

DO appeared to drift at the BR site at the end of the 05 June deployment; the start date/time of the drift could not be identified.

pH

EXO2 sonde pH sensors can appear to drift $\leq$ 0.1 pH units during deployment. This occurred starting 15 April at 11:00 through the end of the deployment; data were flagged <1>[SSD].

Approximately 2” of mud in the bottom of the guard at site WM caused decreased pH

readings from 10-15 May.

Specific conductivity / Salinity

Unusually low and erratic specific conductivity and salinity readings were measured at the owcwmwq site during the 06/05, 06/19, and 06/25 deployments due to a malfunctioning sensor. The sensor used during the 06/05 and 06/25 deployments was determined to be bad; the sensor during the 06/19 deployment may have been affected by interference from the telemetry cable. Low and erratic specific conductivity readings also occurred from 07/29 15:00 – 07/31 11:45 (end of deployment) and 09/24 03:45 – 09/24 09:45 (end of deployment) for unknown reasons, as both pre- and post-deployment diagnostics were acceptable. Specific conductivity and all dependent parameters (sal, DO mg/L, depth) were flagged as <-3>[SCF](CSM).

Specific conductivity data at the owcwmwq site from 10/29 10:00 – 23:45 show two rapid decreases, which is unusual; however, this occurred during the replacement of the deployment pipe, which coincided with two weather events, rain and a seiche. Therefore, the data may reflect conditions in the estuary at the time. However, the data at owcolwq, which typically experiences similar conditions to owcwmwq, did not show a similar drop in specific conductivity.

Missing Data

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. If additional information on missing data is needed, contact the Research Coordinator at the reserve submitting the data.

A problem with the telemetry cable at the WM site caused the sonde to stop collecting data from 23 June at 22:30 through the end of the deployment (25 June 10:30).

No data were collected at the OL site during the 18 April and 05 June deployments due to an SD card failure.

On 09/26, the sonde incorrectly recorded some time stamps between 12:00-16:00. All data during that time period were rejected.

Field verification

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

Site	*Data sonde*	*Date (m/d/y)*	*Time (hh:mm:ss)*	*Temp (C)*	*SpCond (mS/cm)*	*Sal (ppt)*	*pH*	*Turbid (NTU, FNU)*	*ODOsat (%)*	*ODO (mg/L)*	*Depth (meters)*
BR	deployed	3/26/2019	8:07:00	2.94	0.6051	0.29	7.84	4.76	98.8	13.29	0.447
BR	retrieved	4/18/2019	10:19:50	12.73	0.5697	0.28	7.95	3.90	97.3	10.29	0.355
BR	deployed	4/18/2019	10:24:50	12.79	0.5695	0.28	7.95	4.18	97.9	10.35	0.355
BR	retrieved	5/15/2019	8:30:00	11.51	0.4869	0.24	7.80	13.97	94.0	10.22	0.336
BR	deployed	5/15/2019	8:37:00	11.54	0.4869	0.24	7.82	13.88	94.3	10.26	0.340
BR	retrieved	6/5/2019	8:20:00	16.24	0.5130	0.25	7.69	56.90	88.2	8.65	0.440

BR	deployed	6/5/2019	8:29:00	16.28	0.4947	0.24	7.70	72.29	88.1	8.63	0.442
BR	retrieved	6/19/2019	7:59:00	16.56	0.4779	0.23	7.71	14.12	103.0	10.03	0.446
BR	deployed	6/19/2019	8:03:00	16.57	0.4778	0.23	7.72	13.50	103.0	10.03	0.492
BR	retrieved	7/2/2019	8:15:00	22.63	0.5706	0.28	7.65	13.05	82.3	7.09	0.317
BR	deployed	7/2/2019	8:25:00	22.61	0.5707	0.28	7.63	13.27	81.9	7.07	0.319
BR	retrieved	7/16/2019	8:15:00	22.88	0.6177	0.30	7.57	11.24	76.5	6.56	
BR	deployed	7/16/2019	8:29:00	22.90	0.6174	0.30	7.59	11.87	76.5	6.56	
BR	retrieved	7/31/2019	10:15:00	22.71	0.5890	0.29	7.72	6.29	77.9	6.71	0.244
BR	deployed	7/31/2019	10:19:00	22.72	0.5923	0.29	7.77	5.89	77.1	6.64	0.244
BR	retrieved	8/26/2019	8:53:00	18.30	0.4940	0.24	7.76	7.21	83.50	7.84	0.156
BR	deployed	8/26/2019	8:56:00	18.30	0.4940	0.24	7.76	10.83	83.20	7.82	0.161
BR	retrieved	9/24/2019	no data								
BR	deployed	9/24/2019	no data								
BR	retrieved	10/15/2019	7:45:00	10.60	0.7569	0.37	7.48	3.91	66.70	7.41	0.113
BR	deployed	10/15/2019	7:53:00	10.63	0.7581	0.37	7.50	4.72	66.20	7.34	0.112
BR	retrieved	11/12/2019	10:04:00	1.24	0.8790	0.43	7.52	7.73	89.00	12.53	0.580
BR	deployed	11/12/2019	10:07:00	1.24	0.8784	0.43	7.52	7.58	88.80	12.50	0.582
BR	retrieved	12/10/2019	10:00:00	5.89	0.6570	0.32	7.69	27.04	93.3	11.62	0.502
DR	deployed	3/26/2019	9:45:00	5.25	0.6232	0.30	8.05	16.68	106.40	13.48	1.473
DR	retrieved	4/18/2019	10:00:50	12.23	0.5640	0.28	7.94	27.55	95.00	10.17	0.963
DR	deployed	4/18/2019	10:06:50	12.19	0.5656	0.28	7.93	26.47	94.60	10.13	0.969
DR	retrieved	5/15/2019	9:00:00	13.30	0.4742	0.23	7.81	57.11	89.40	9.35	1.719
DR	deployed	5/15/2019	9:14:00	13.25	0.4801	0.23	7.81	55.60	89.50	9.37	1.719
DR	retrieved	6/5/2019	8:45:00	15.75	0.5179	0.25	7.58	23.87	78.40	7.77	1.132
DR	deployed	6/5/2019	9:00:00	15.81	0.5169	0.25	7.59	21.96	81.20	8.04	1.148
DR	retrieved	6/19/2019	8:15:00	18.12	0.4726	0.23	7.61	27.91	90.10	8.49	1.360
DR	deployed	6/19/2019	8:30:00	18.08	0.4717	0.23	7.60	28.71	89.10	8.41	1.352
DR	retrieved	7/2/2019	8:34:00	22.92	0.5933	0.29	7.32	8.08	51.70	4.43	1.218
DR	deployed	7/2/2019	8:45:00	22.66	0.6319	0.31	7.29	6.45	43.40	3.74	1.226
DR	retrieved	7/16/2019	8:45:00	23.27	0.5717	0.28	7.16	13.96	14.10	1.20	
DR	deployed	7/16/2019	8:57:00	23.19	0.5727	0.28	7.17	16.61	16.40	1.40	
DR	retrieved	7/31/2019	10:38:00	22.43	0.4853	0.23	7.25	12.90	11.00	0.95	1.698
DR	deployed	7/31/2019	10:47:00	22.38	0.4855	0.23	7.24	14.38	5.60	0.48	1.700
DR	retrieved	8/26/2019	9:07:00	19.94	0.3533	0.17	7.35	27.51	49.30	4.48	1.040
DR	deployed	8/26/2019	9:18:00	19.97	0.3548	0.17	7.39	28.21	47.40	4.31	1.044
DR	retrieved	9/24/2019	no data								
DR	deployed	9/24/2019	no data								
DR	retrieved	10/15/2019	8:09:00	13.39	0.6117	0.30	7.45	13.49	43.50	4.54	1.409
DR	deployed	10/15/2019	8:17:00	13.48	0.6141	0.30	7.42	16.28	41.90	4.36	1.410
DR	retrieved	11/12/2019	10:30:00	3.77	0.6585	0.32	7.39	13.55	57.60	7.58	1.330
DR	deployed	11/12/2019	10:40:00	3.77	0.6593	0.32	7.39	13.32	57.80	7.61	1.340
DR	retrieved	12/10/2019	10:23:00	4.25	0.6625	0.32	7.65	6.11	93.30	12.12	1.792
OL	deployed	3/26/2019	10:40:00	5.52	0.5035	0.24	7.91	37.19	96.00	12.07	1.067

OL	retrieved	4/18/2019	8:56:50	12.95	0.4827	0.23	7.76	43.43	92.50	9.74	0.734
OL	deployed	4/18/2019	9:10:50	12.98	0.4819	0.23	7.79	43.13	92.70	9.76	0.772
OL	retrieved	5/15/2019	10:00:00	14.93	0.4283	0.21	8.07	26.95	111.10	11.21	1.027
OL	deployed	5/15/2019	10:11:00	14.82	0.4278	0.21	8.04	28.62	106.80	10.79	1.060
OL	retrieved	6/5/2019	9:30:00	19.45	0.4069	0.20	7.44	36.64	64.00	5.88	0.715
OL	deployed	6/5/2019	9:45:00	19.48	0.4073	0.20	7.42	38.88	63.60	5.83	0.702
OL	retrieved	6/19/2019	9:00:00	19.41	0.3619	0.17	7.29	46.37	54.10	4.97	1.046
OL	deployed	6/19/2019	9:14:00	19.46	0.3574	0.17	7.29	46.13	54.90	5.05	1.051
OL	retrieved	7/2/2019	9:15:00	23.88	0.3105	0.15	7.75	9.83	81.10	6.83	0.944
OL	deployed	7/2/2019	9:30:00	23.90	0.3110	0.15	7.68	13.02	78.90	6.65	0.940
OL	retrieved	7/16/2019	9:17:00	26.87	0.4114	0.20	7.64	30.87	85.50	6.82	
OL	deployed	7/16/2019	9:26:00	26.98	0.4105	0.20	7.66	28.10	88.80	7.07	
OL	retrieved	7/31/2019	11:25:00	26.43	0.4221	0.20	7.82	11.96	101.60	8.17	0.881
OL	deployed	7/31/2019	11:37:00	26.43	0.4224	0.20	7.78	11.93	97.60	7.85	0.913
OL	retrieved	8/26/2019	9:59:00	21.93	0.4066	0.19	7.33	11.52	51.90	4.54	0.720
OL	deployed	8/26/2019	10:12:00	21.94	0.4069	0.20	7.33	12.06	49.30	4.31	0.709
OL	retrieved	9/24/2019	no data								
OL	deployed	9/24/2019	no data								
OL	retrieved	10/15/2019	9:30:00	13.27	0.4320	0.21	7.52	13.54	72.70	7.60	0.473
OL	deployed	10/15/2019	9:43:00	13.32	0.4320	0.21	7.48	13.41	73.50	7.68	0.467
OL	retrieved	11/12/2019	11:30:00	3.69	0.3334	0.16	7.74	14.22	90.50	11.95	0.876
OL	deployed	11/12/2019	11:34:00	3.71	0.3336	0.16	7.74	14.47	90.40	11.93	0.886
OL	retrieved	12/10/2019	11:21:00	4.61	0.5082	0.25	8.34	5.55	111.80	14.40	0.685
WM	deployed	3/26/2019	10:52:00	5.59	0.4823	0.23	7.91	25.09	100.30	12.60	0.782
WM	retrieved	4/18/2019	9:19:50	12.96	0.4736	0.23	7.73	50.02	88.70	9.34	0.745
WM	deployed	4/18/2019	9:30:50	13.01	0.4745	0.23	7.75	80.64	89.20	9.39	0.790
WM	retrieved	5/15/2019	10:20:00	14.66	0.4386	0.21	8.01	25.87	107.00	10.85	0.988
WM	deployed	5/15/2019	10:40:00	14.83	0.4294	0.21	8.08	26.80	112.00	11.32	1.042
WM	retrieved	6/5/2019	10:00:00	19.52	0.3908	0.19	7.56	28.92	76.40	7.01	0.706
WM	deployed	6/5/2019	10:14:00	19.62	0.3911	0.19	7.57	29.12	77.50	7.10	0.716
WM	retrieved	6/19/2019	9:20:00	19.93	0.3455	0.17	7.39	40.28	68.90	6.26	0.975
WM	deployed	6/19/2019	9:33:00	20.06	0.3443	0.16	7.38	36.99	70.60	6.40	0.977
WM	retrieved	7/2/2019	9:34:00	24.44	0.3147	0.15	7.73	12.61	81.80	6.82	0.569
WM	deployed	7/2/2019	14:05:00	NA	NA	NA	NA	NA	NA	NA	NA
WM	retrieved	7/16/2019	9:30:00	27.14	0.4103	0.20	7.90	16.97	107.70	8.55	
WM	deployed	7/16/2019	9:40:00	27.20	0.4101	0.20	7.93	18.22	110.60	8.78	
WM	retrieved	7/31/2019	11:45:00	26.16	0.4237	0.20	7.58	10.17	74.50	6.02	0.838
WM	deployed	7/31/2019	11:55:00	26.15	0.4238	0.20	7.57	10.53	74.10	5.99	0.844
WM	retrieved	8/26/2019	10:18:00	22.11	0.4066	0.19	7.35	10.85	56.10	4.89	0.668
WM	deployed	8/26/2019	10:30:00	22.20	0.4071	0.20	7.36	11.30	57.40	5.00	0.694
WM	retrieved	9/24/2019	no data								
WM	deployed	9/24/2019	no data								
WM	retrieved	10/15/2019	9:51:00	13.51	0.4314	0.21	7.38	11.77	63.70	6.62	0.766
WM	deployed	10/15/2019	9:56:00	13.48	0.4316	0.21	7.38	12.76	65.70	6.84	0.790

WM	retrieved	11/12/2019	0.489583	4.57	0.3169	0.15	7.71	17.38	89.20	11.51	0.877
WM	deployed	11/12/2019	11:51:00	4.62	0.3161	0.15	7.69	18.58	89.10	11.48	0.878
WM	retrieved	12/10/2019	11:10:00	4.72	0.5052	0.24	8.36	5.28	111.60	14.33	0.688