2024 DNREC Integrated Water Report Data Submission

Waterbody: White Clay Creek Watershed

Location: New Castle County, DE

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Date submitted: July 6, 2023

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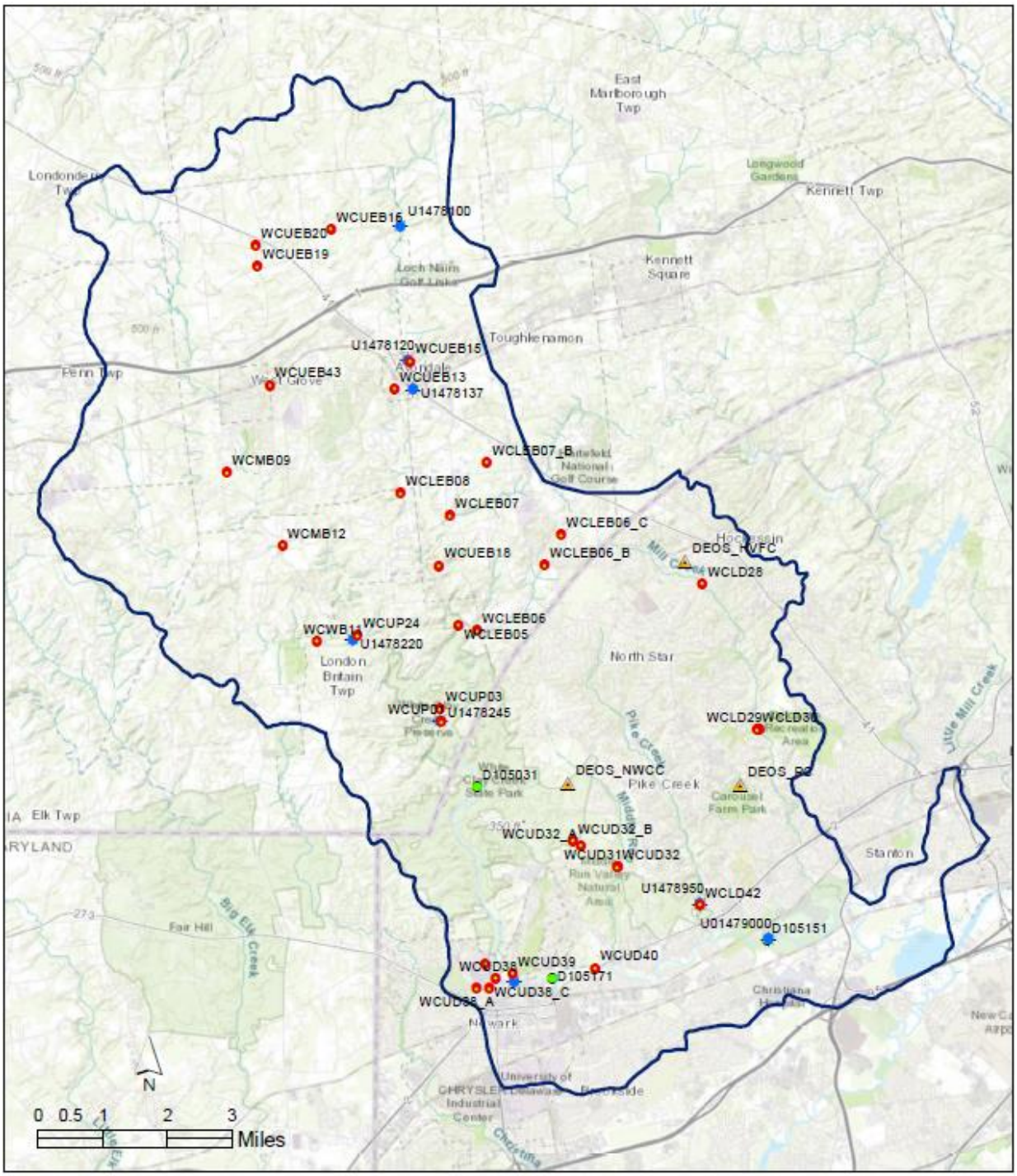
Delaware Active Site List

Site ID	Latitude	Longitude	Site Name	Continuous Monitoring Present
WCLD28	39.7787	-75.6949	Hickory Hill (Mill Creek)	Mayfly removed 9/2022; Hobo Temp Sensor installed 10/2022
WCLD29	39.7460	-75.6781	Northpoint Main (Mill Creek)	
WCLD30	39.7459	-75.6787	Northpoint Tributary (Mill Creek)	
WCUD31	39.715	-75.7188	Middle Run Main	
WCUD32	39.715	-75.7191	Unnamed Tributary to Middle Run	
WCUD32A	39.7197	-75.7297	Unnamed Tributary to Middle Run below Papermill Road	Mayfly present since 2018
WCUD32B	39.7209	-75.7320	Unnamed Tributary to Middle Run above Papermill Road	Mayfly present since 2021; Hobo Temp Sensor installed 9/2022
WCUD37	39.6931	-75.7572	Fairfield Run	
WCUD38	39.6899	-75.7540	Bogy Run/Blue Hen Creek	
WCUD39	39.6910	-75.7491	Jenney's Run	
WCUD40	39.6923	-75.7252	WCC Main Stem@ Capitol Trail and A street	
WCLD42	39.7068	-75.6949	Lower Pike Creek	

White Clay Creek Active Sites Map

(link to interactive map:
https://udel.maps.arcgis.com/apps/webappviewer/index.html?id=4bd6252384a44beca0105e5ed4cd64d0

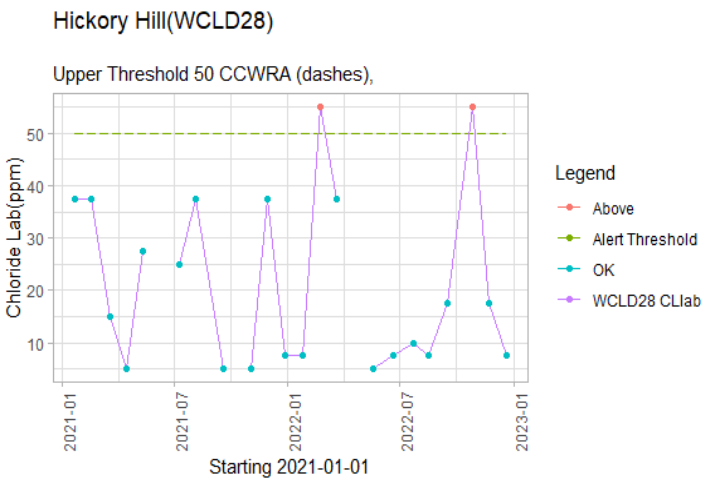


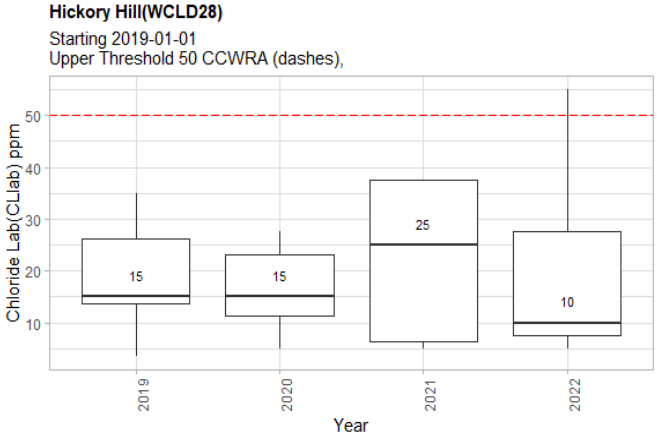
Stream Monitoring Sites in the White Clay Creek Watershed

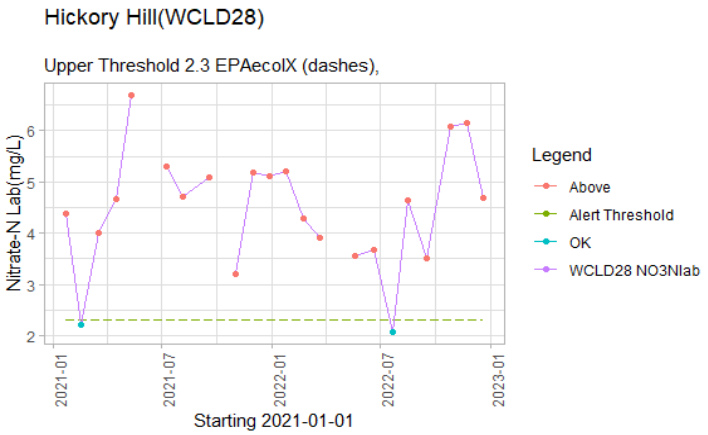
Map produced by the University of Delaware Water Resources Center, Updated April 2023.

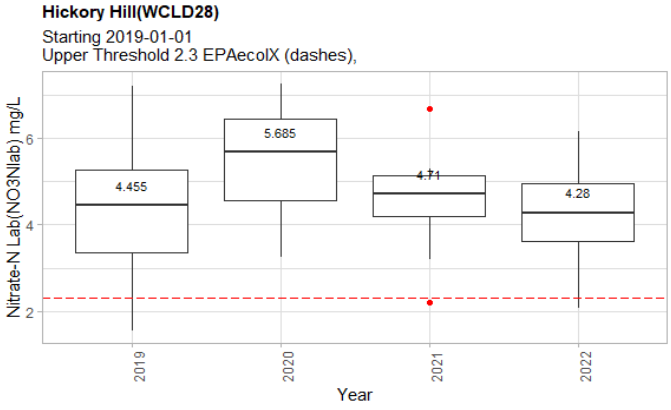
Hickory Hill Site on Mill Creek (WCLD28) Chlorides, Nitrates, and Orthophosphates

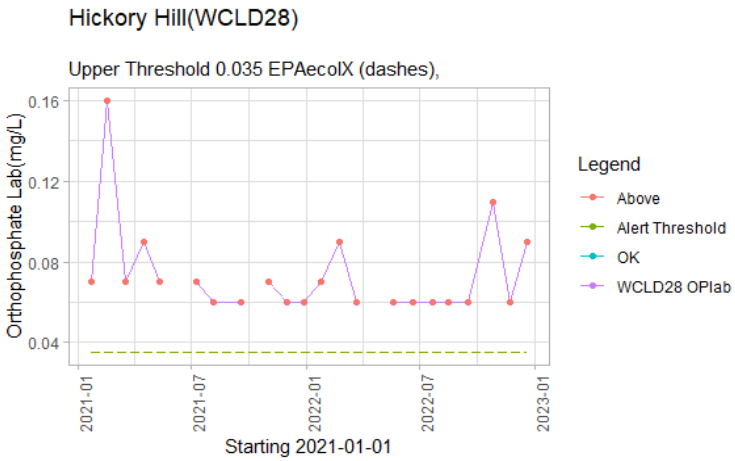
Graphic presentation of all data points for Chlorides (CL), Nitrates (NO3N), and Orthophosphate (OP) at baseflow (defined as <0.25" rain in a 48-hour period). Exceedance of standards indicates impairment. Individual site data for the 2-year reporting period are shown on the left. Box and whisker plots for the prior four-year period are shown on the right.

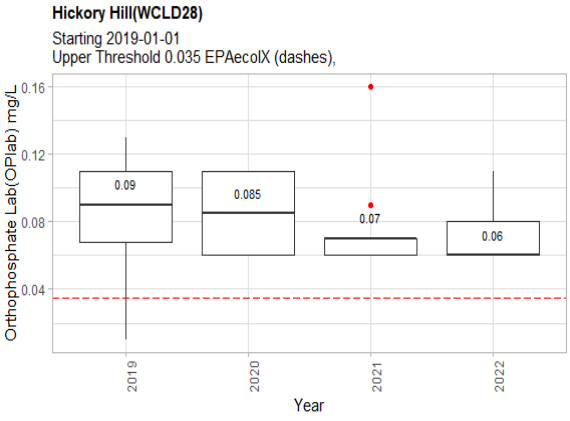






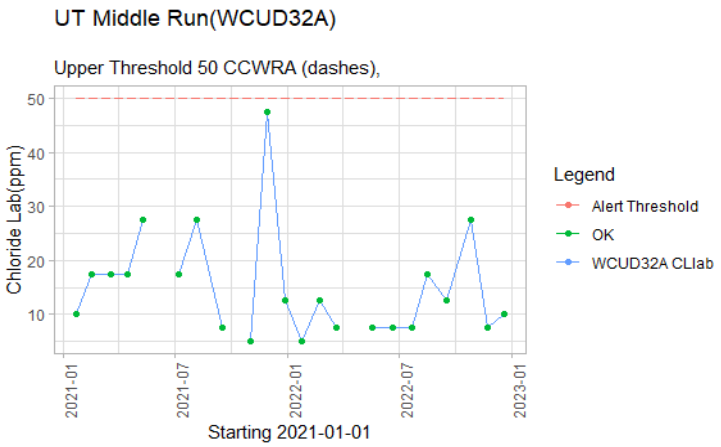


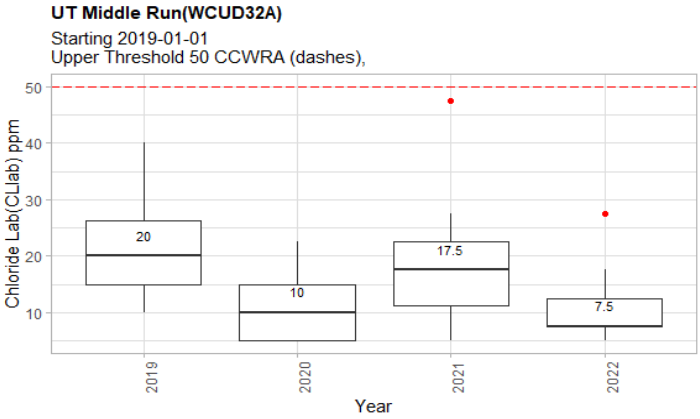


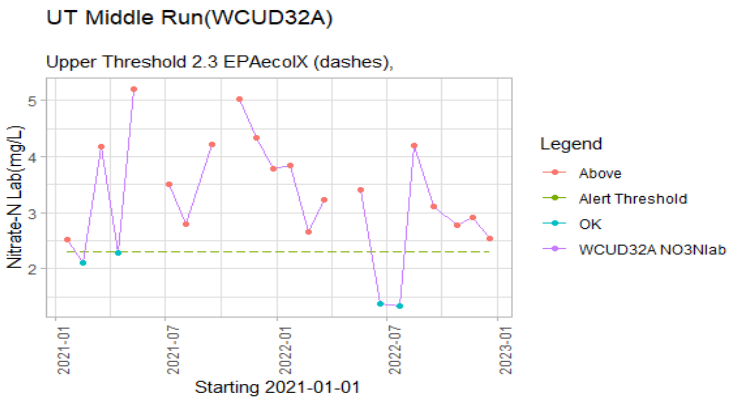


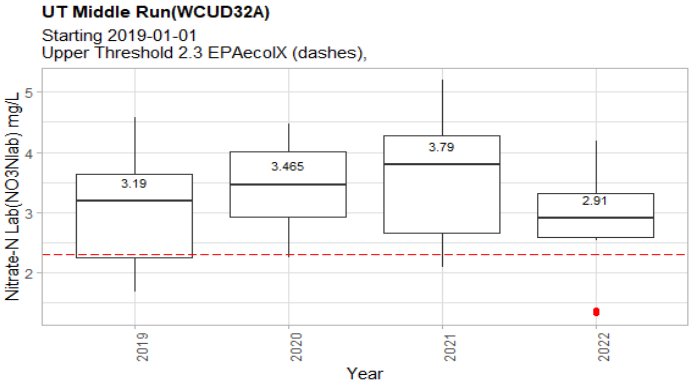
Unnamed Tributary to Middle Run Below Papermill Road (WCUD32A) Chlorides, Nitrates, and Orthophosphates

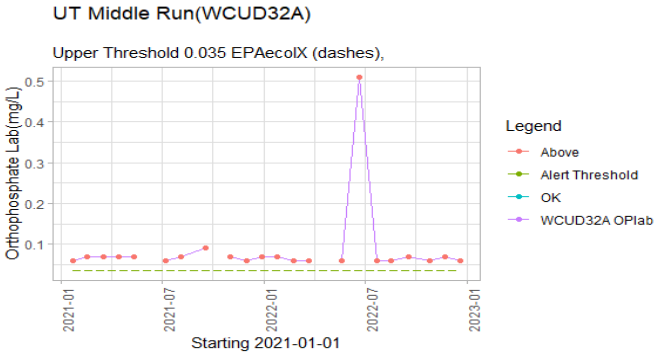
Graphic presentation of all data points for Chlorides (CL), Nitrates (NO3N), and Orthophosphate (OP) at baseflow (defined as <0.25" rain in a 48-hour period). Exceedance of standards indicates impairment. Individual site data for the 2-year reporting period are shown on the left. Box and whisker plots covering a 4-year period are shown on the right.

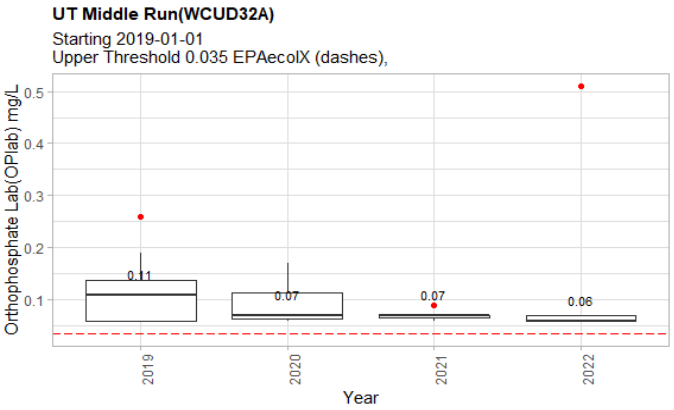






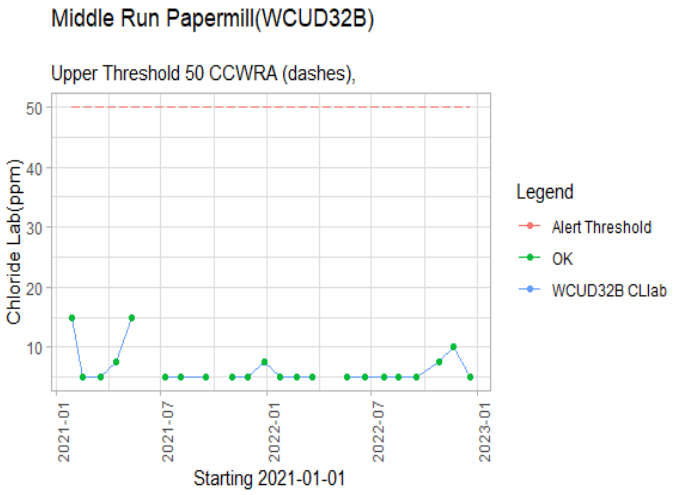


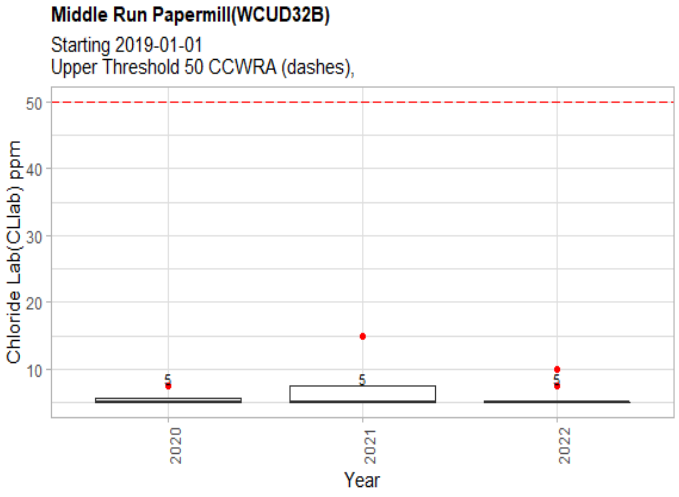


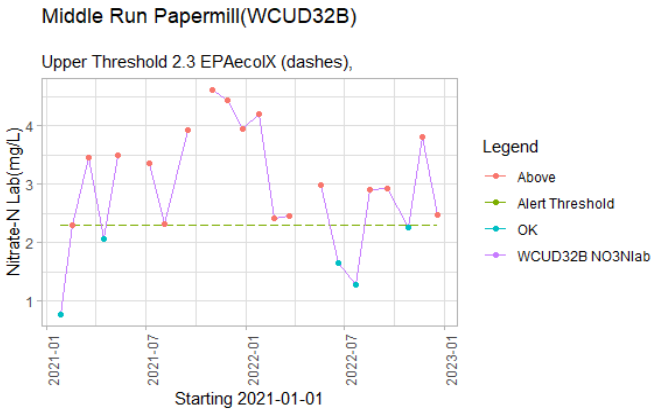


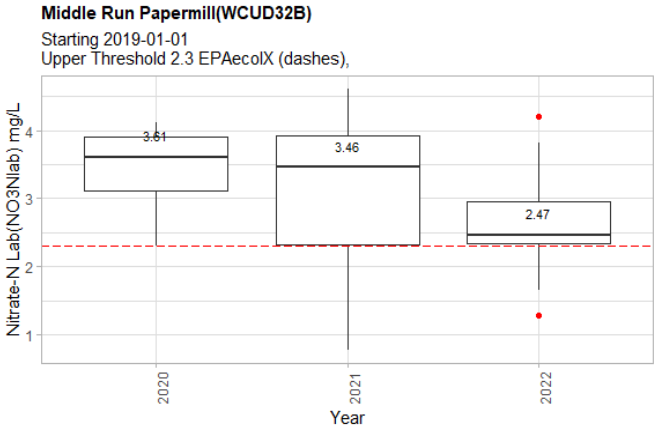
Unnamed Tributary to Middle Run Above Papermill Road (WCUD32B) Chlorides, Nitrates, and Orthophosphates

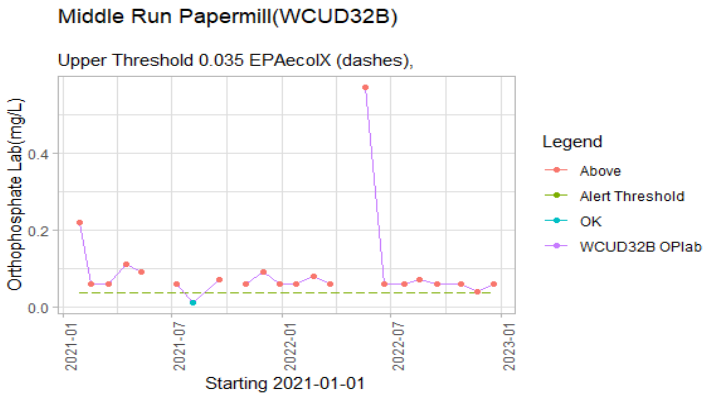
Graphic presentation of all data points for Chlorides (CL), Nitrates (NO3N), and Orthophosphate (OP) at baseflow (defined as <0.25" rain in a 48-hour period). Exceedance of standards indicates impairment. Individual site data for the 2-year reporting period are shown on the left. Box and whisker plots covering a 4-year period are shown on the right.

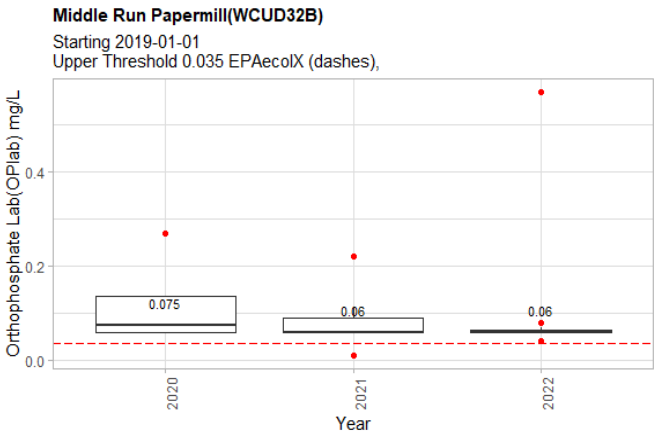






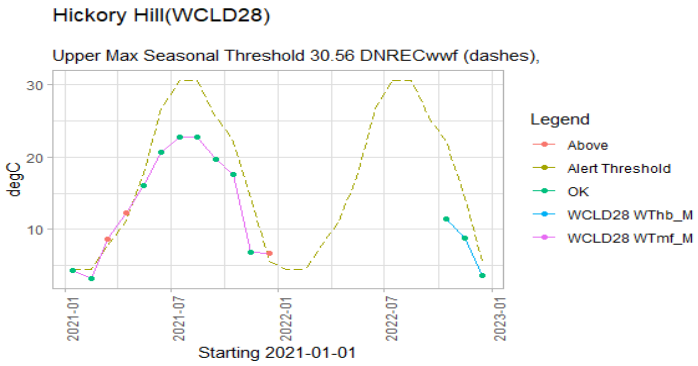


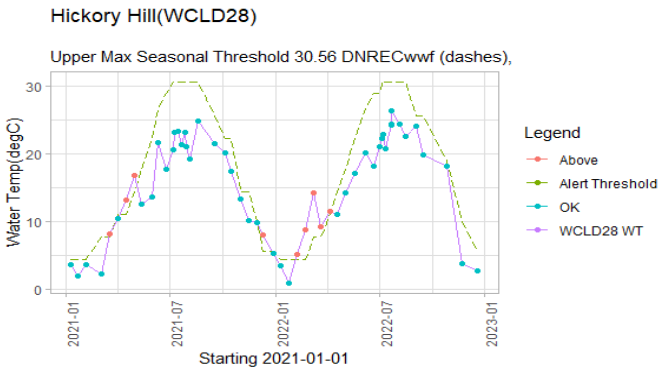




Hickory Hill Site on Mill Creek (WCLD28) Water Temperature

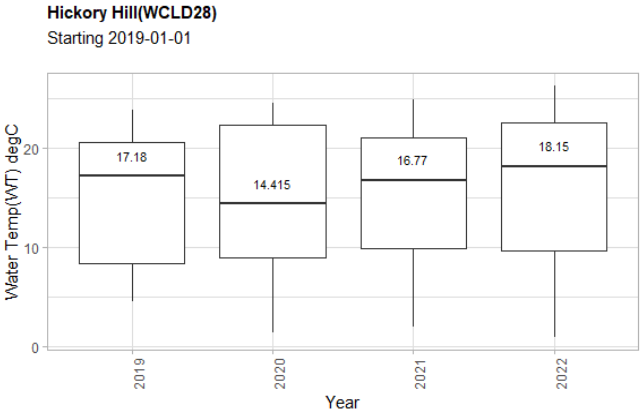
Graphic presentation of monthly average water temperature taken by in-stream continuous data loggers (left) and bimonthly field readings (right). Box and whisker plots covering an extended time are shown on the bottom left.





Date	WTmf_M	WThb_M
2021-01-15	4.3	
2021-02-15	3.2	
2021-03-15	8.7	
2021-04-15	12.3	
2021-05-15	16.1	
2021-06-15	20.6	
2021-07-15	22.7	
2021-08-15	22.7	
2021-09-15	19.7	
2021-10-15	17.6	
2021-11-15	6.8	
2021-12-15	6.7	
2022-10-15		11.4
2022-11-15		8.8
2022-12-15		3.6

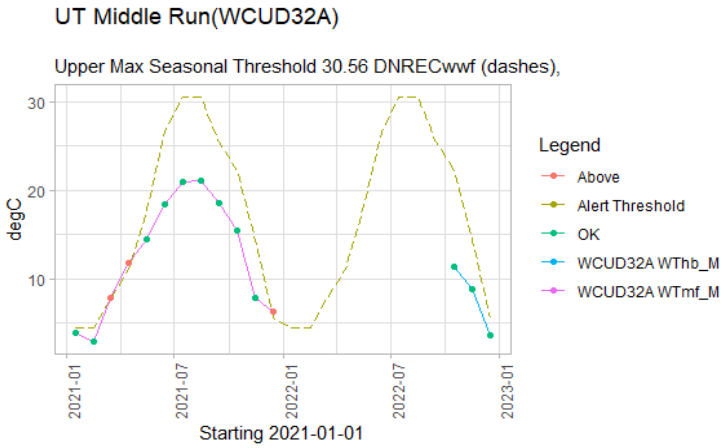
Four-year trend shown below.

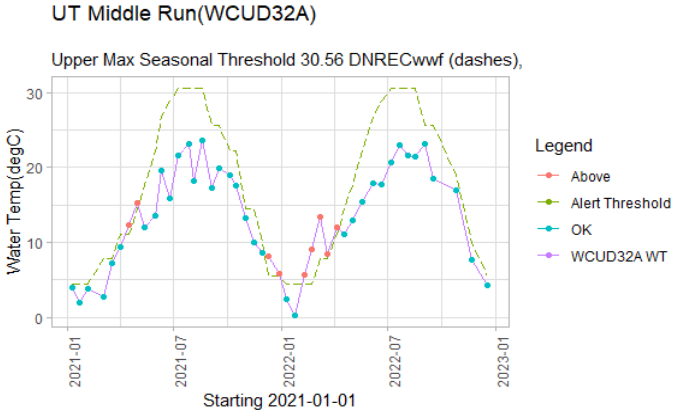


Date	WT	Date	WT
2021-01-09	3.72	2021-12-27	5.33
2021-01-21	2.00	2022-01-10	3.44
2021-02-04	3.61	2022-01-24	0.90
2021-03-02	2.22	2022-02-08	5.10
2021-03-18	8.17	2022-02-22	8.80
2021-04-01	10.50	2022-03-07	14.30
2021-04-15	13.11	2022-03-21	9.20
2021-04-29	16.77	2022-04-05	11.50
2021-05-11	12.50	2022-04-19	11.10
2021-05-31	13.67	2022-05-02	14.20
2021-06-10	21.72	2022-05-19	17.10
2021-06-24	17.72	2022-06-07	20.20
2021-07-06	20.60	2022-06-20	18.20
2021-07-08	23.17	2022-06-30	21.10
2021-07-14	23.30	2022-07-05	22.30
2021-07-20	21.30	2022-07-07	22.80
2021-07-27	23.22	2022-07-12	20.70
2021-07-28	21.10	2022-07-21	24.40
2021-08-04	19.20	2022-07-22	24.20
2021-08-05	19.17	2022-07-22	26.30
2021-08-19	24.89	2022-08-04	24.40
2021-09-17	21.44	2022-08-16	22.60
2021-10-04	20.11	2022-09-02	24.00
2021-10-15	17.39	2022-09-16	19.80
2021-11-01	13.39	2022-10-26	18.10
2021-11-14	10.17	2022-11-21	3.80
2021-11-29	9.83	2022-12-19	2.80
2021-12-10	8.06		

Unnamed Tributary to Middle Run Below Papermill Road (WCUD32A) Water Temperature

Graphic presentation of monthly average water temperature taken by in-stream continuous data loggers (left) and bimonthly field readings (right). Box and whisker plots covering an extended time are shown on the bottom left.

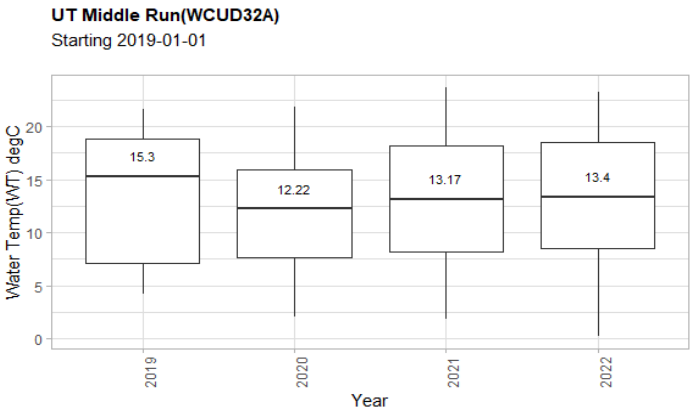




Date	WTmf_M	WThb_M
2021-01-15	3.9	
2021-02-15	2.9	
2021-03-15	7.9	
2021-04-15	11.8	
2021-05-15	14.5	
2021-06-15	18.4	
2021-07-15	21.0	
2021-08-15	21.1	
2021-09-15	18.6	
2021-10-15	15.5	
2021-11-15	7.9	
2021-12-15	6.3	
2022-10-15		11.4
2022-11-15		8.8
2022-12-15		3.6

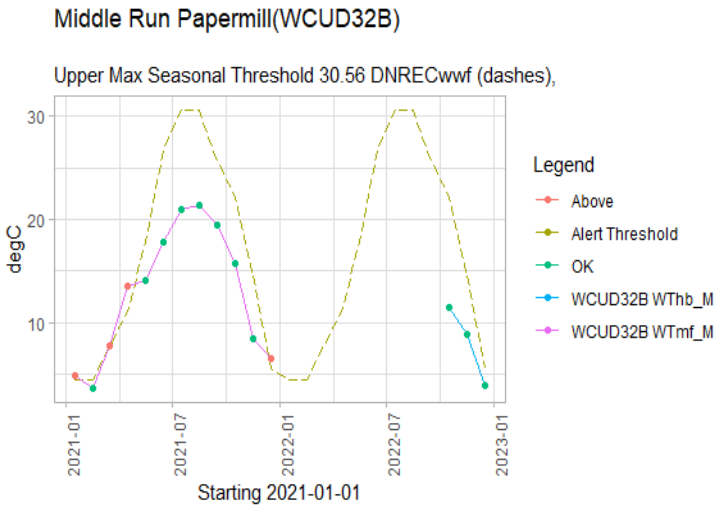
Date	WT	Date	WT
2021-01-09	4.00	2021-12-10	8.17
2021-01-21	1.89	2021-12-27	5.83
2021-02-04	3.78	2022-01-10	2.39
2021-03-02	2.78	2022-01-24	0.22
2021-03-18	7.28	2022-02-08	5.60
2021-04-01	9.44	2022-02-22	9.10
2021-04-15	12.33	2022-03-07	13.40
2021-04-29	15.27	2022-03-21	8.50
2021-05-11	11.94	2022-04-05	12.00
2021-05-31	13.56	2022-04-19	11.10
2021-06-10	19.56	2022-05-02	12.90
2021-06-24	15.94	2022-05-19	15.40
2021-07-08	21.56	2022-06-07	17.90
2021-07-27	23.11	2022-06-20	17.70
2021-08-05	18.17	2022-07-07	20.70
2021-08-19	23.67	2022-07-22	23.00
2021-09-03	17.33	2022-08-04	21.60
2021-09-17	19.83	2022-08-16	21.50
2021-10-04	18.94	2022-09-02	23.20
2021-10-15	17.50	2022-09-16	18.50
2021-11-01	13.17	2022-10-26	17.00
2021-11-14	10.00	2022-11-21	7.60
2021-11-29	8.61	2022-12-19	4.30

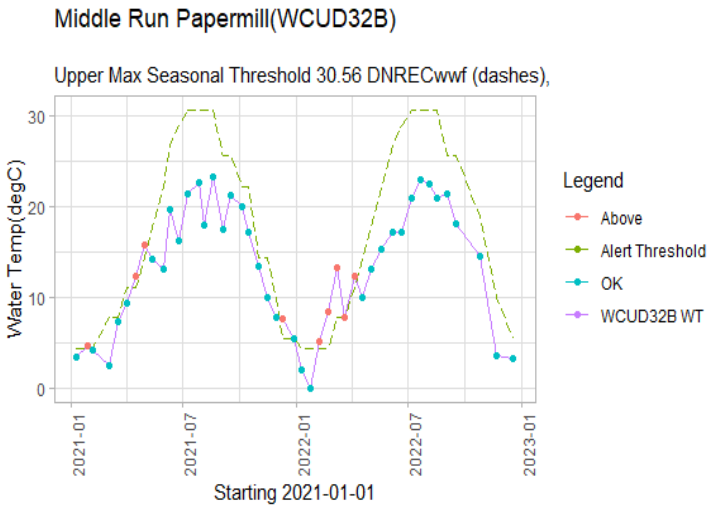
Four-year trend shown below.



Unnamed Tributary to Middle Run Above Papermill Road (WCUD32B) Water Temperature

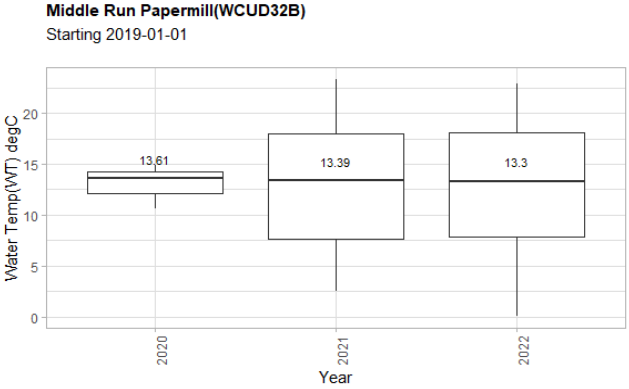
Graphic presentation of monthly average water temperature taken by in-stream continuous data loggers (left) and bimonthly field readings (right).). Box and whisker plots covering an extended time are shown on the bottom left.





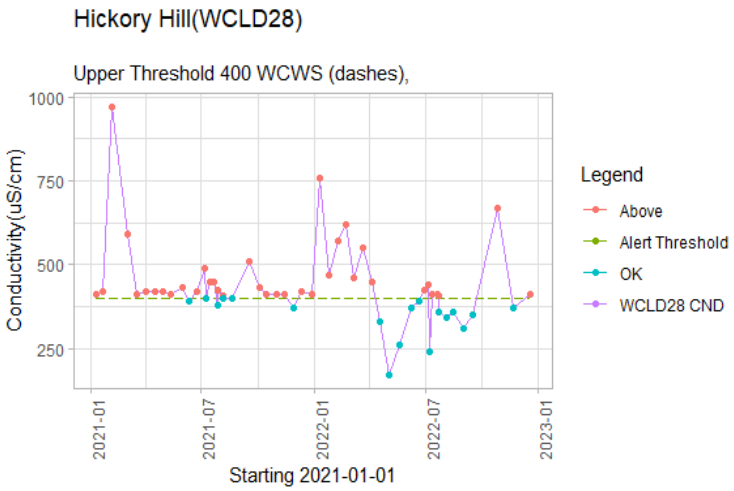
Date	WTmf_M	WThb_M
2021-01-15	4.9	
2021-02-15	3.6	
2021-03-15	7.8	
2021-04-15	13.5	
2021-05-15	14.1	
2021-06-15	17.8	
2021-07-15	20.9	
2021-08-15	21.3	
2021-09-15	19.4	
2021-10-15	15.7	
2021-11-15	8.4	
2021-12-15	6.5	
2022-10-15		11.5
2022-11-15		8.9
2022-12-15		3.9

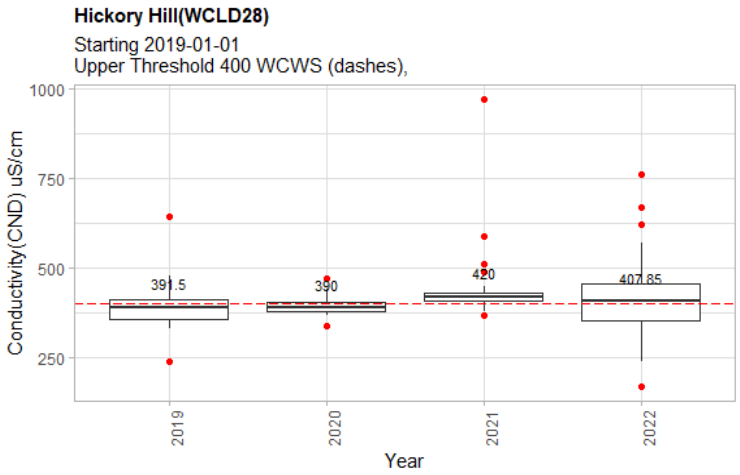
Date	WT	Date	WT
2021-01-09	3.56	2021-12-10	7.67
2021-01-27	4.67	2021-12-27	5.56
2021-02-04	4.28	2022-01-10	2.11
2021-03-02	2.50	2022-01-24	0.05
2021-03-18	7.44	2022-02-08	5.20
2021-04-01	9.39	2022-02-22	8.40
2021-04-15	12.44	2022-03-07	13.30
2021-04-29	15.83	2022-03-21	7.80
2021-05-11	14.16	2022-04-05	12.30
2021-05-31	13.22	2022-04-19	10.00
2021-06-10	19.72	2022-05-02	13.10
2021-06-24	16.22	2022-05-19	15.30
2021-07-08	21.44	2022-06-07	17.20
2021-07-27	22.61	2022-06-20	17.20
2021-08-05	17.94	2022-07-07	20.90
2021-08-19	23.33	2022-07-22	22.90
2021-09-03	17.55	2022-08-04	22.50
2021-09-17	21.17	2022-08-16	20.90
2021-10-04	19.94	2022-09-02	21.40
2021-10-15	17.17	2022-09-16	18.10
2021-11-01	13.39	2022-10-26	14.50
2021-11-14	10.11	2022-11-21	3.70
2021-11-29	7.89	2022-12-19	3.40



Hickory Hill Site on Mill Creek (WCLD28) Conductivity

Graphic presentation of conductivity taken by bimonthly field measurements over the 2-year reporting period (left) and Box and whisker plots covering an extended time (right).

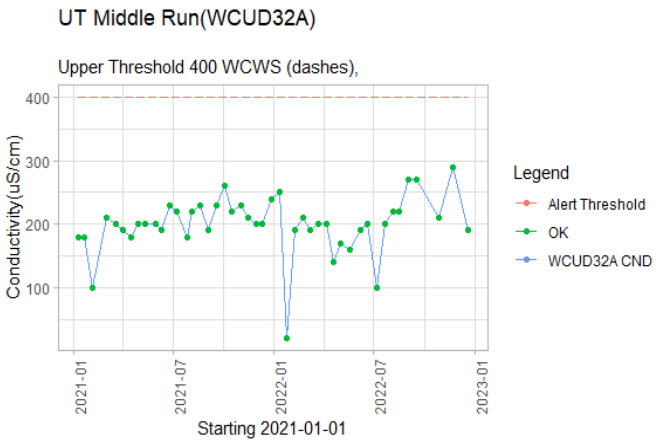


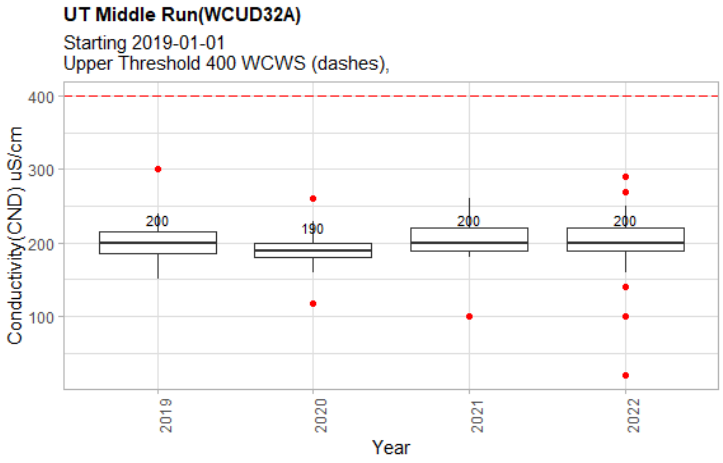


Date	CND (uS/cm)	Date	CND (uS/cm)	Date	CND (uS/cm)
2021-01-09	410.0	2021-11-01	410.0	2022-08-16	360.0
2021-01-21	420.0	2021-11-14	410.0	2022-09-02	310.0
2021-02-04	970.0	2021-10-15	410.0	2022-09-16	350.0
2021-03-02	590.0	2022-01-10	760.0	2022-10-26	670.0
2021-03-18	410.0	2022-01-24	470.0	2022-11-21	370.0
2021-04-01	420.0	2022-02-08	570.0	2022-12-19	410.0
2021-04-15	420.0	2022-02-22	620.0		
2021-04-29	420.0	2022-03-07	460.0		
2021-05-11	410.0	2022-03-21	550.0		
2021-05-31	430.0	2022-04-05	450.0		
2021-06-10	390.0	2022-04-19	330.0		
2021-06-24	420.0	2022-05-02	170.0		
2021-07-06	488.0	2022-05-19	260.0		
2021-07-08	400.0	2022-06-07	370.0		
2021-07-14	448.0	2022-06-20	390.0		
2021-07-20	448.0	2022-06-30	425.0		
2021-07-27	380.0	2022-07-05	441.1		
2021-07-28	425.0	2022-07-07	240.0		
2021-08-04	406.0	2022-07-12	412.7		
2021-08-05	400.0	2022-07-21	409.9		
2021-08-19	400.0	2022-07-22	405.8		
2021-09-17	510.0	2022-07-22	360.0		
2021-10-04	430.0	2022-08-04	340.0		

Unnamed Tributary to Middle Run Below Papermill Road (WCUD32A) Conductivity

Graphic presentation of conductivity taken by bimonthly field measurements over the 2-year reporting period (left) and Box and whisker plots covering an extended time (right).

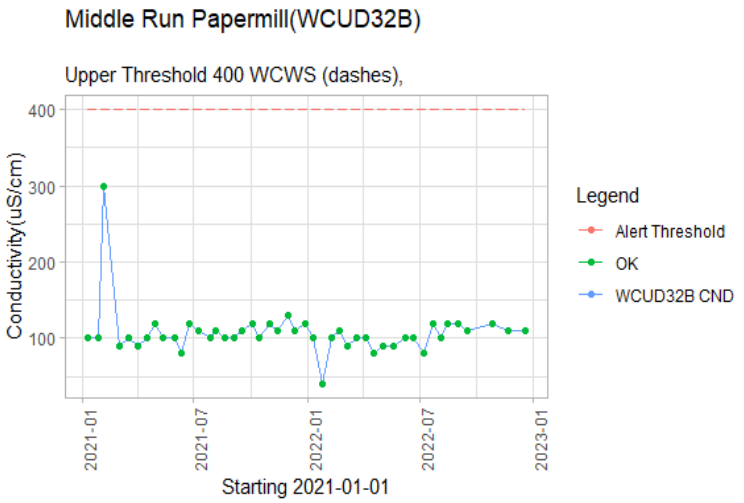


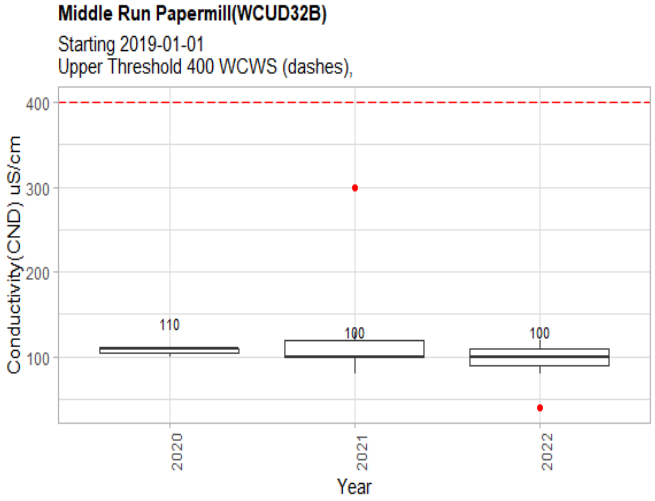


Date	CND (uS/cm)	Date	CND (uS/cm)
2021-01-09	180	2022-01-10	250
2021-01-21	180	2022-01-24	20
2021-02-04	100	2022-02-08	190
2021-03-02	210	2022-02-22	210
2021-03-18	200	2022-03-07	190
2021-04-01	190	2022-03-21	200
2021-04-15	180	2022-04-05	200
2021-04-29	200	2022-04-19	140
2021-05-11	200	2022-05-02	170
2021-05-31	200	2022-05-19	160
2021-06-10	190	2022-06-07	190
2021-06-24	230	2022-06-20	200
2021-07-08	220	2022-07-07	100
2021-07-27	180	2022-07-22	200
2021-08-05	220	2022-08-04	220
2021-08-19	230	2022-08-16	220
2021-09-03	190	2022-09-02	270
2021-09-17	230	2022-09-16	270
2021-10-04	260	2022-10-26	210
2021-10-15	220	2022-11-21	290
2021-11-01	230	2022-12-19	190
2021-11-14	210		
2021-11-29	200		
2021-12-10	200		
2021-12-27	240		

Unnamed Tributary to Middle Run Above Papermill Road (WCUD32B) Conductivity

Graphic presentation of conductivity taken by bimonthly field measurements over the 2-year reporting period (left) and Box and whisker plots covering an extended time (right).





Date	CND (uS/cm)	Date	CND (uS/cm)
2021-01-09	100	2021-12-10	110
2021-01-27	100	2021-12-27	120
2021-02-04	300	2022-01-10	100
2021-03-02	90	2022-01-24	40
2021-03-18	100	2022-02-08	100
2021-04-01	90	2022-02-22	110
2021-04-15	100	2022-03-07	90
2021-04-29	120	2022-03-21	100
2021-05-11	100	2022-04-05	100
2021-05-31	100	2022-04-19	80
2021-06-10	80	2022-05-02	90
2021-06-24	120	2022-05-19	90
2021-07-08	110	2022-06-07	100
2021-07-27	100	2022-06-20	100
2021-08-05	110	2022-07-07	80
2021-08-19	100	2022-07-22	120
2021-09-03	100	2022-08-04	100
2021-09-17	110	2022-08-16	120
2021-10-04	120	2022-09-02	120
2021-10-15	100	2022-09-16	110
2021-11-01	120	2022-10-26	120
2021-11-14	110	2022-11-21	110
2021-11-29	130	2022-12-19	110

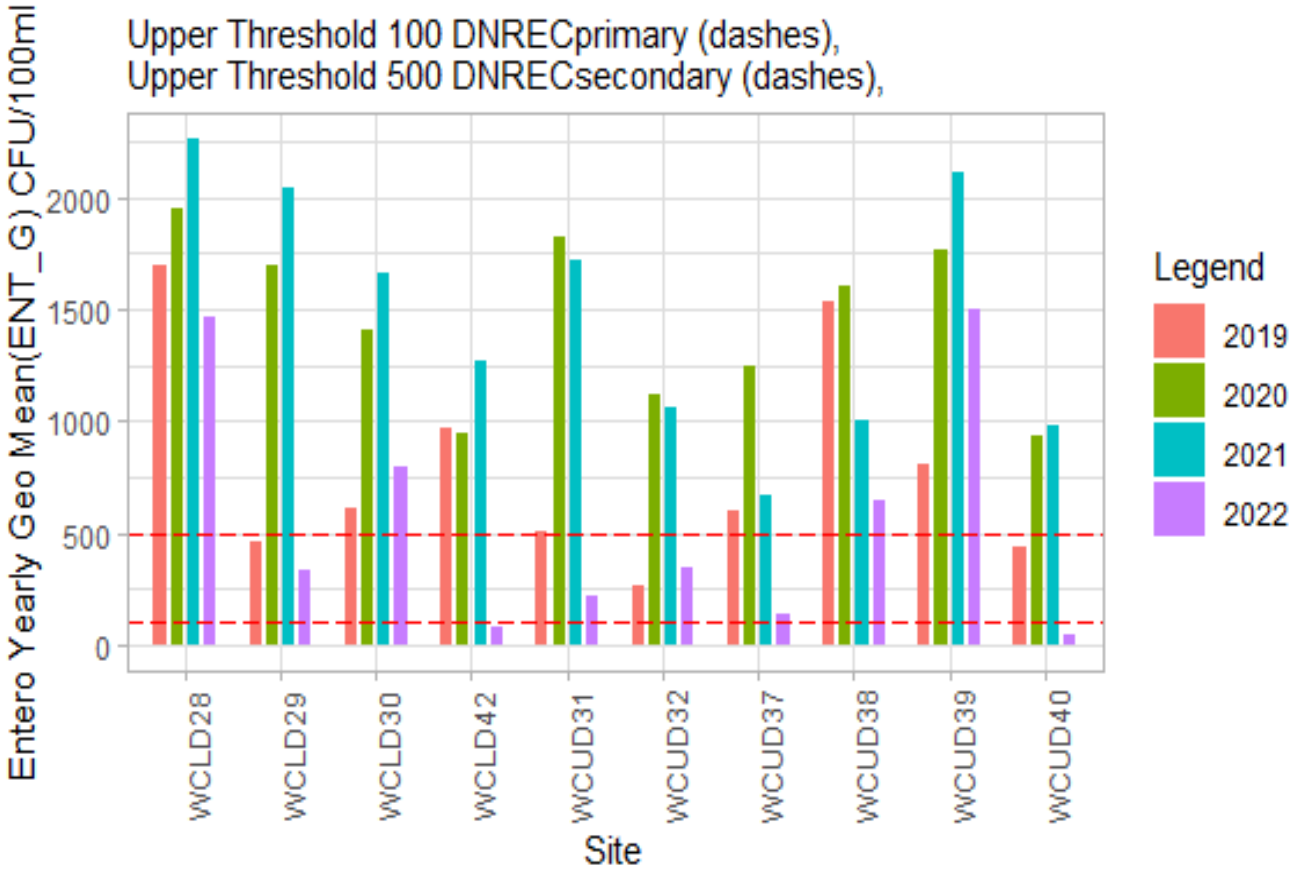
Table of Recreational Season Fecal Indicator Bacteria Geometric Means.

Table of geometric means for Enterococcus readings taken during multiple recreational seasons. The table is color coded to show sites that exceed DNRECs recreational water quality threshold for secondary contact 500 cfu/100ml (red); sites that exceed DNRECs threshold for primary contact 100 cfu/100ml (yellow), and sites that meet DNRECs threshold for primary contact (green).

SiteName	Site	Year2016	Year2017	Year2018	Year2019	Year2020	Year2021	Year2022
Hickory Hill	WCLD28	490.4	1956.6	1401.8	1696.3	1947.0	2263.3	1466.7
Northpointe Main Stem	WCLD29	113.5	774.5	504.0	463.1	1693.1	2046.1	331.2
Northpointe Tributary	WCLD30	194.4	1103.2	386.4	609.3	1406.7	1657.3	796.3
Middle Run Main Stem	WCUD31	243.8	1145.5	1046.1	505.6	1824.7	1721.2	221.2
Middle Run Tributary	WCUD32	253.0	731.9	392.4	270.7	1120.4	1057.8	342.1
Fairfield Run	WCUD37	NA	NA	874.2	603.7	1243.0	672.9	139.6
Blue Hen Run (Bogy Run)	WCUD38	NA	NA	1405.1	1540.6	1608.1	1008.2	644.6
Jenney's Run	WCUD39	NA	NA	899.3	807.2	1760.8	2117.2	1505.9
Main Stem Kirkwood	WCUD40	NA	NA	NA	442.3	934.6	981.3	45.7
Lower Pike Creek	WCLD42	NA	NA	NA	964.9	944.9	1275.2	81.4

Graphical Presentation of Recreational Season Fecal Indicator Bacteria Geometric Means

Enterococcus (ENT) samples were taken during multiple recreational seasons at baseflow (defined as <0.25" rain in a 48-hour period). A minimum of five samples were collected at each site within a 30-day period during the month of July to calculate geometric means (ENT_G). Exceedance of standards indicates impairment. All samples were processed at Stroud Water Research Center using the IDEXX Colilert method.



The graph above shows DNREC's thresholds for primary contact (100 CFU/100ml) and secondary contact (500 CFU/100ml). Bars above the dashed red lines exceed the thresholds for the associated recreational contact.

Bacteria Sampling Protocol

1. Check Precipitation. We are looking for less than .25 inches in the previous 48 hours. Visit: http://www.deos.udel.edu/
   Data>current conditions AND
   Data>daily summaries
   Look at data for nearest DEOS site to sampling location
2. Sample the furthest downstream site first and then move to the upstream sites.
3. Fill out the Field Notebook, including weather information.
4. Make sure that sample vessels are labeled as seen below with black indelible ink before sampling.

Name of responsible organization:	WCWA
Test(s) to be run:	E. coli, Enterococcus
Stream Name:	White Clay Creek
Date:	08082012
Site ID:	WCLEB06
Time (military time):	1320
Samplers Name:	Kelly Jacobs

5. Collecting the sample:
   a) Face upstream, and sample mid-channel, mid-depth. Avoid stagnant water and eddies.
   b) Do not disturb the bottom sediment. Do not collect sediment in your stream sample. If sediment is disturbed, wait a period before sampling.
   c) Open the sterile 1L whirl Pak bag just before sampling. Make sure nothing – including your fingers – encounters the inside surfaces of the bag.
   d) Hold the open bag from the top ties with the opening facing directly downward at the water. Then plunge the bag, open end first, below the water surface, and collect the water sample from 8-12" beneath the surface, but not against the substrate. If the stream is not that deep, collect the sample at mid-depth. Do this by facing the submerged bag into the current and away from you in an upstream dipping motion.
   e) Try to leave a little air space in the bag, but not more than a few inches. If the bag comes up completely full, pour off the excess water.
   f) Secure the bag using the yellow ties and place it into the cooler.
6. For every ten water samples you collect and send to a lab for analysis, you must collect one "replicate." Label the replicated by placing a -R after the site ID.
7. All samples must go on ice immediately and be brought to the lab within 6 hours from sampling time.

Monthly Year-Round Sampling Protocol

1. Visit all year-round monitoring stations once a month or every four weeks at baseflow (no more than .25" rain in last 48 hours). Check precipitation data at local DEOS site for rainfall before going out to sample. http://www.deos.udel.edu/data/monthly_retrieval.php

2. Label all grab sample containers with a sharpie prior to taking sample:
   White Clay Watershed Association (WCWA)
   Site ID
   date of collection
   time of collection (in military time)

   *if the sample is a replicate use SITE ID SL182 and make note of the actual SITE ID in the filed notes. Replicates should be taken every 10 samples.

3. Take instream measurements of water temperature and conductivity with handheld meter. Do not stir up dirt or if can't be avoided wait for it to settle before taking any measurements.

4. Take grab samples for lab analysis of nitrate, orthophosphate, and chloride at all sites (NO3N, OP, CL). Samples should be taken in a labeled 1 L container and brought to Brandywine Science Center, 204 Line Road, Kennett Square, PA 19348, 610-444-9850 – You will need to fill out a Chain of Custody Sheet obtained at the lab when dropping off samples (see sample in google folder)

5. Upload data from HOBO sensors: When out in the field, you will need to pull up the sensor (out of the water) and press down firmly on the center. If you are successful, you will see a red-light flash – this pairs the sensor with your mobile device. Make sure the Bluetooth on your phone is on. Open Hobo Connect App and select download data. Data goes in the data folder – you can open that folder, select the files, and email to Shane (smorgan@whiteclay.org) from on-site. Once data is downloaded, check battery strength and place it back into the water. If the battery is low, make a note of it in the field notes.

6. Complete Data Entry (after you return from every visit)

   - After every sampling event, when you return, upload data to the Google folder WQ_UD_INTERNS in the card uploads folder and share new files via email (to smorgan@whiteclay.org)
   - Field data should be input into the Field_Data_Entry_Sheet located in the Google folder WQ_UD_INTERNS. Enter data directly into the Google sheet online.
   - Upload any photos to the Google folder WQ_UD_INTERNS Photos Folder. Label each photo as SiteID_yyyymmdd_exposure (i.e., facing N, S, E, W, etc.)

Definitions of Water Quality Thresholds

Chlorides: While there are no instream standards, a threshold of 50 mg/L was selected based on Chester County Water Resources Authority and USGS data that correlates this threshold with poor index of biological integrity (IBI) scores. Furthermore, the DRBC also uses 50 mg/L as its threshold for interstate streams.[1]

Nitrates: DNREC does not have a water quality standard for Nitrate, but they have a water quality target set for TN between 1-3mg/ml. However, based on an analysis of nutrient concentrations from 1990 to 1998, for a stream that is not impaired by nutrients in this ecoregion (ecoregion IX), the EPA recommended a TN threshold of 2.225 mg/L.[3] More recent analysis, based on nutrient concentrations in Southeastern Pennsylvania streams from 2000 to 2019, raises this TN threshold slightly to 2.3 mg/L, which we selected for this report.[4]

Phosphates: DNREC does not have a water quality standard for Total Phosphorus, but they have a water quality target level of Total Phosphorus in DE Freshwater of 0.05-0.1mg/L. Natural background concentrations of total phosphorus are estimated to be 0.025 - 0.060 mg/L for this region.[5] An analysis of nutrient concentrations from 2000 to 2019 in streams in Southeastern Pennsylvania found that the maximum total phosphorus concentration for a stream that is not impaired by nutrients is 0.035 mg/L which is what we selected for this report.[4]

Fecal Indicator Bacteria - Enterococcus (ENT) and Escherichia coli (ECOLI): The US EPA has recommended recreational water quality standards for fecal indicator bacteria. We used these standards for this report.[5]

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1. Delaware River Basin Commission (DRBC), Administrative Manual – Part III WATER QUALITY REGULATIONS WITH AMENDMENTS THROUGH DECEMBER 7, 2022, 18 CFR PART 410. https://www.nj.gov/drbc/library/documents/WQregs.pdf

2. Delaware Department of Natural Resources and Environmental Control (DNREC), Division of Watershed Stewardship, 7401 Surface Water Quality Standards. https://regulations.delaware.gov/AdminCode/title7/5000/7400/7401.shtml

3. USEPA. Ambient Water Quality Criteria Recommendations: Rivers and Streams in Ecoregion IX. 108 (2000). https://www.epa.gov/sites/default/files/documents/rivers9.pdf

4. Clune, J. W., Crawford, J. K. & Boyer, E. W. Nitrogen and Phosphorus Concentration Thresholds toward Establishing Water Quality Criteria for Pennsylvania, USA. Water 12, 3550 (2020).

5. Smith, R. A., Alexander, R. B. & Schwarz, G. E. Natural Background Concentrations of Nutrients in Streams and Rivers of the Conterminous United States. Environ. Sci. Technol. 37, 3039–3047 (2003). https://pubmed.ncbi.nlm.nih.gov/12901648/

6. USEPA. Recreational Water Quality Criteria. https://www.epa.gov/sites/default/files/2015-10/documents/rwqc2012.pdf (2012).

Acknowledgments

We gratefully acknowledge the National Park Service for their generous support, which makes this work possible. We want to thank the Water Resources Center at the University of Delaware for their assistance with GIS mapping and sampling and the Stroud Water Research Center for their technical support of the bacteria collection and analysis. We also enthusiastically thank citizen scientist Rob Tuttle for his valuable contributions to collecting, organizing, analyzing, and reporting our data using R software.