

## DATA SUBMISSION FORM – 2024 Integrated Report

### PART 1. Identification of Waterbody

Waterbody Name: White Clay Creek Watershed.

Tributary to: White Clay Creek/Brandywine - Christina River Basin County: Chester  
Purpose of Study: To collect baseline stream data and follow trends over time. Additional research is being conducted to determine primary sources.

Please include a map of the waterbody and the coordinates of the sampling site(s).

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### PART 2. Investigator(s) Information

Name of group/individual which collected the data: White Clay Creek Watershed Association/Wild and Scenic River Program.

Contact Person(s) for Questions regarding the data: Shane Morgan  
Phone #: (484) 716-6836

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### PART 3. Data Submission Content

What type(s) of data is/are being submitted? (Check all that apply)

Water Chemistry:  Bacteriological:  Macroinvertebrate:  Fish:

Was a PADEP sampling method used? Yes  No

If yes, what method(s): PA DEP Bacteriological Data Collection Protocol - we were initially trained on-site on the recreational bacteria field sampling protocol by Megan Bradburn (2012-2014)

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### PART 4. Quality Assurance/Quality Control (QA/QC) Information

Was the data being submitted collected under a program with either a written study design completed in accordance with DEP's "Monitoring Book", a written quality assurance project plan completed in accordance with EPA's "The Volunteer Monitors Guide to Quality Assurance Project Plans" or a standard QA/QC protocol?

Yes  No  If yes, please submit a copy of the study design, QAPP or QA/QC protocol.

Please see our protocols at the end of this report.

Was the data collected under a program that adhered to a quality control plan that included external quality control checks such as split samples analyzed by an outside lab?

Yes  No  If yes, please submit a copy of the outside lab analysis for review.

Is the submitted data incorporated into a finalized report, document, or journal article?

Yes  No  If yes, please include a copy with this submission form.

White Clay wild and Scenic River Stream Watch Monitoring 2021-2022

If the data submitted is biological data, who is/are the source(s) of the taxonomic expertise? NA

Did this person(s) perform all the taxonomic work? Yes: \_\_\_\_\_ No: \_\_\_\_\_

If no, did they supervise? Yes: \_\_\_\_\_ No: \_\_\_\_\_

What are their credentials? Bacteria samples were analyzed by Laura Zgleszewski and Jinjun Kan at Stroud Water Research Center, Chemical analysis (CL, NO3N, and OP) were performed by Brandywine Science Center (a PADEP accredited lab.)

**PART 5. Comments**

Please provide any additional comments that might assist in DEP’s evaluation of your data. For example, possible impairment sources (i.e. agriculture, municipal sewer outfall, etc.) and causes (sediment, habitat alterations, nutrients, etc.):

Possible impairment sources include multiple non-point source pollution from failing septic, agricultural lands, mushroom grower operations, municipal roads, and suburban lands. We also believe wildlife such as Canadian Geese to be a contributing to bacterial sources. For the bacteria study we are working with Stroud Water Research Center (Dr. Jinjun Kan) to do microbial source tracking- a publish report on collected data from 2016-2020 should be completed in 2023.

We use R software to analyze our data, but exports to excel can be provided upon request.

Please submit this form and all supporting documentation to:

By mail:

By e-mail:

**Bureau of Clean Water  
Water Quality Division  
Attn: Heidi Biggs  
P. O. Box 8774  
Harrisburg, PA 17105-8774**

**RA-epwater@pa.gov**  
Place “Integrated Report Data Submission” in subject line.

Data should be in a usable, electronic format such as Excel. Anyone with questions regarding the completion of this form or the 303(d) listing process in general, may contact:

Dustin Shull, Environmental Group Manager  
Water Quality Division  
(717) 787-9637  
RA-epwater@pa.gov

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White Clay Wild and Scenic River Stream Watch Monitoring 2021-2022

Pennsylvania Active Site List

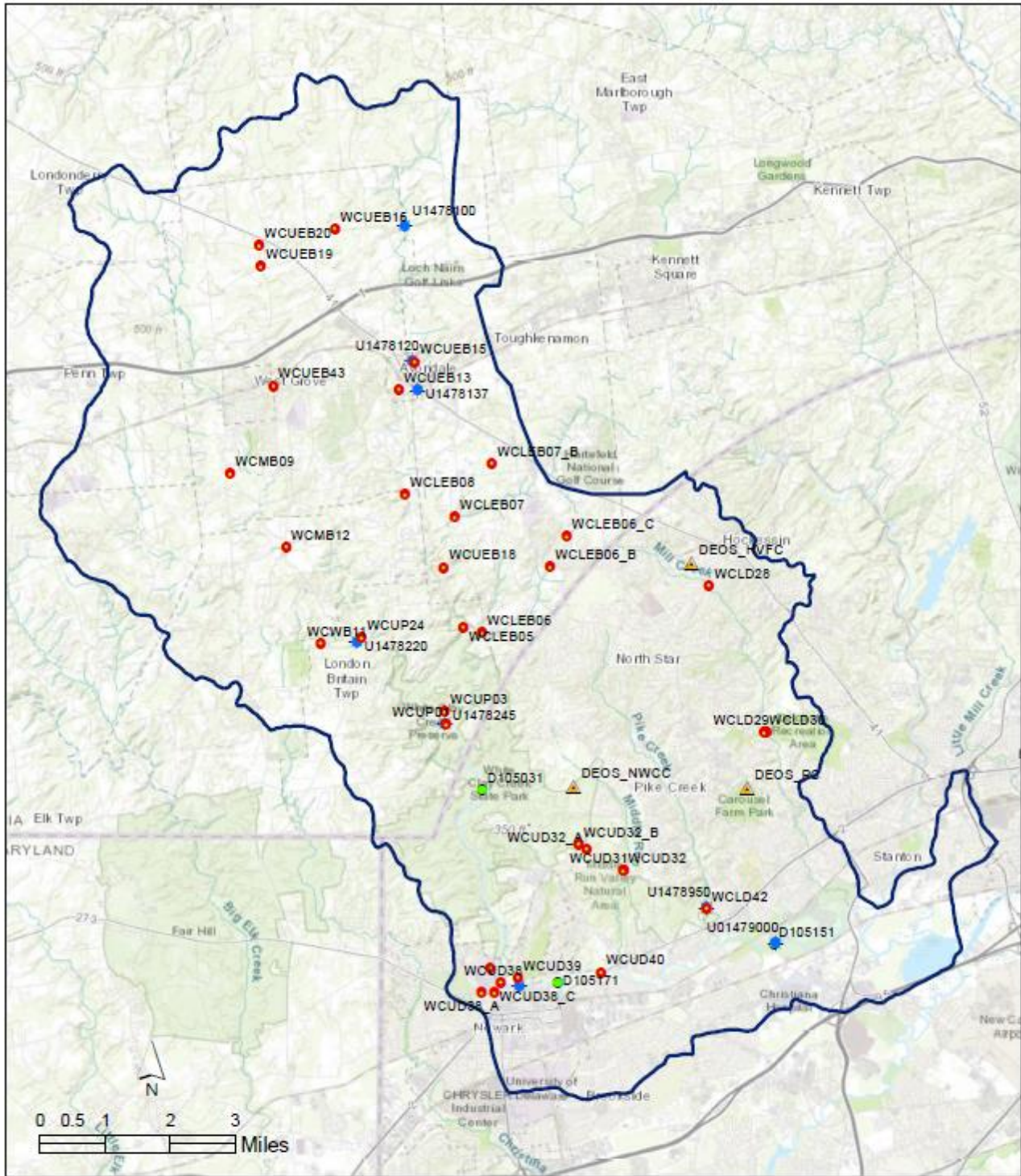
Site ID	Latitude	Longitude	Site Name	HUC 12	Continuous Monitoring Present
WCUP01	39.7473	-75.6949	Strickersville Main near USGS gage Upper WCC	20402050306	
WCUP03	39.7501	-75.7656	Sharpless Bridge Middle Branch Upper WCC	20402050306	
WCLEB05	39.7690	-75.7656	Good Hope East Branch	20402050303	
WCLEB06	39.7676	-75.7603	Watson's Mill East Branch	20402050303	Mayfly removed 5/2021; Hobo Temp Sensor installed 10/2022
WCLEB06_B	39.7825	-75.7409	Somerset out, East Branch	20402050303	
WCLEB06_C	39.7893	-75.7360	Somerset in, East Branch	20402050303	
WCLEB07	39.7935	-75.7683	Egypt Run East Branch	20402050303	Mayfly removed 5/2021; Hobo Temp Sensor installed 10/2022
WCLEB07_B	39.8055	-75.7578	Pelham East Branch	20402050303	
WCLEB08	39.7983	-75.7828	Clay Creek East Branch	20402050303	
WCMB09	39.8025	-75.8333	Guernsey Middle Branch	20402050301	
WCWB11	39.7651	-75.8067	Flint Hill West Branch	20402050302	
WCMB12	39.7871	-75.8194	Wickerton Middle Branch	20402050301	
WCUEB13	39.8217	-75.7849	Avondale WWTP East Branch	20402050303	
WCUEB15	39.8297	-75.7849	Avondale Playground East Branch	20402050303	
WCUEB16	39.8574	-75.8037	ELG East Branch	20402050303	
WCUEB18	39.7822	-75.7715	Laurel Woods East Branch	20402050303	
WCUEB19	39.8488	-75.8251	Loyd Road East Branch	20402050303	
WCUEB20	39.8535	-75.8256	WLG East Branch	20402050303	
WCUP24	39.7665	-75.7950	Mercer Mill on Middle Branch Upper WCC	20402050306	

White Clay Wild and Scenic River Stream Watch Monitoring 2021-2022

<b>WCUEB43</b>	39.8223	-75.8211	Welcome and Rosehill East Branch	20402050303	Mayfly removed 5/2021; Hobo Temp Sensor installed 10/2022
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White Clay Creek Active Sites Map ([link to interactive map](#))

White Clay Wild and Scenic River Stream Watch Monitoring 2021-2022



## Stream Monitoring Sites in the White Clay Creek Watershed

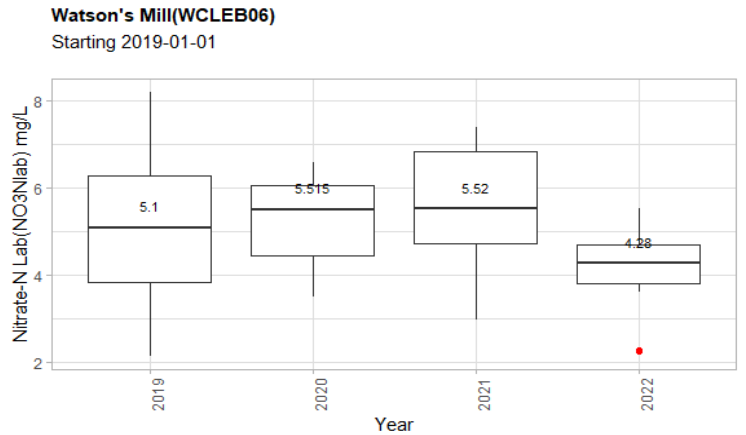
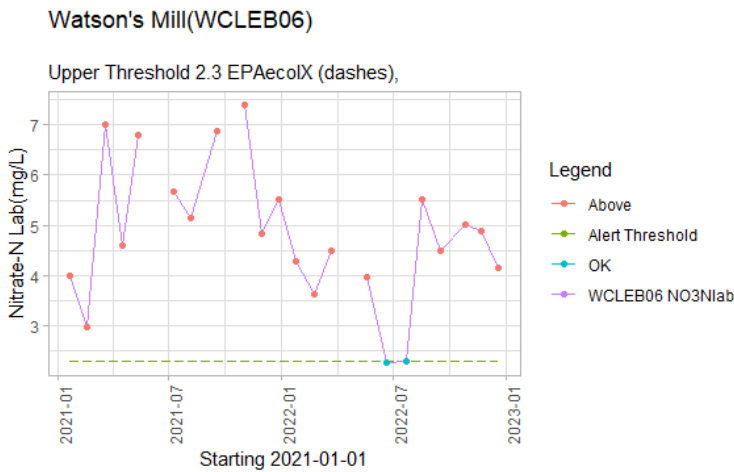
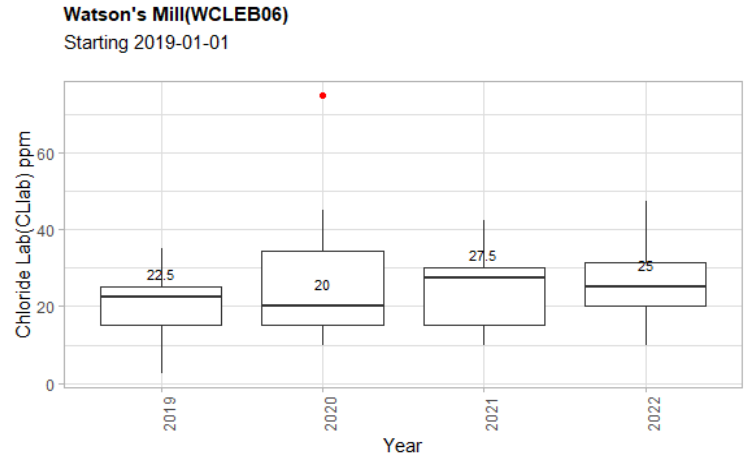
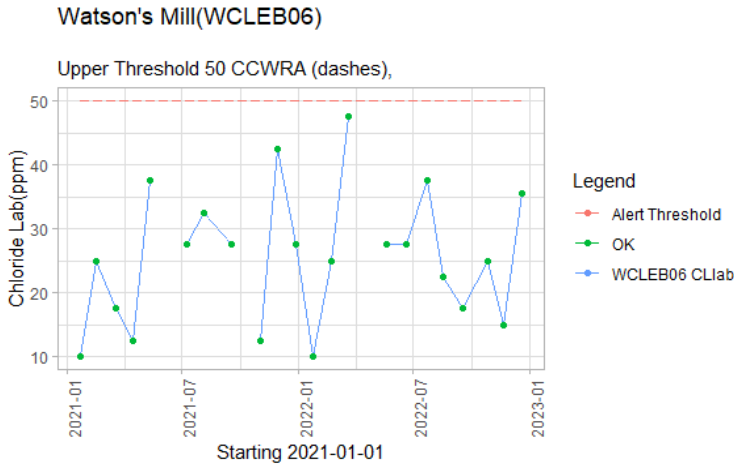
Map produced by the University of Delaware Water Resources Center, Updated April 2023.





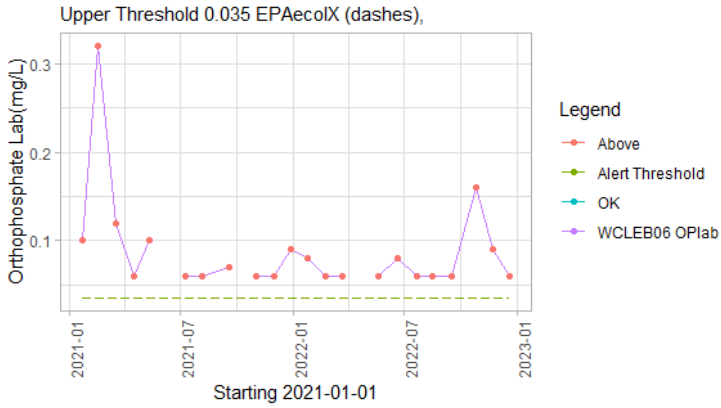
Watson's Mill Site on Broad Run to East Branch (WCLEB06) Chlorides, Nitrates, Orthophosphate

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.

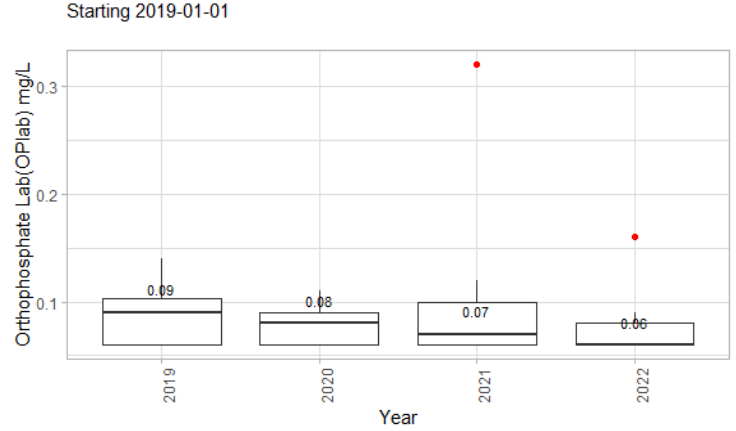


## White Clay Wild and Scenic River Stream Watch Monitoring 2021-2022

**Watson's Mill(WCLEB06)**



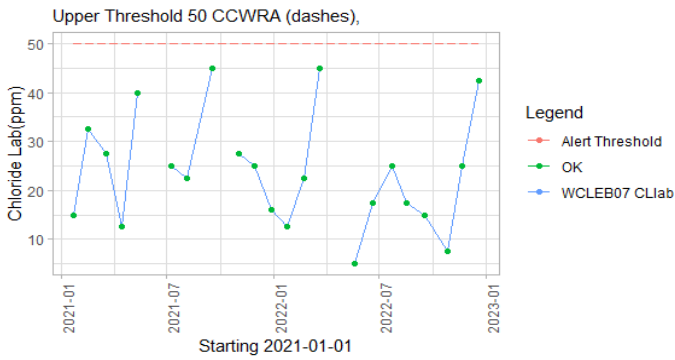
**Watson's Mill(WCLEB06)**



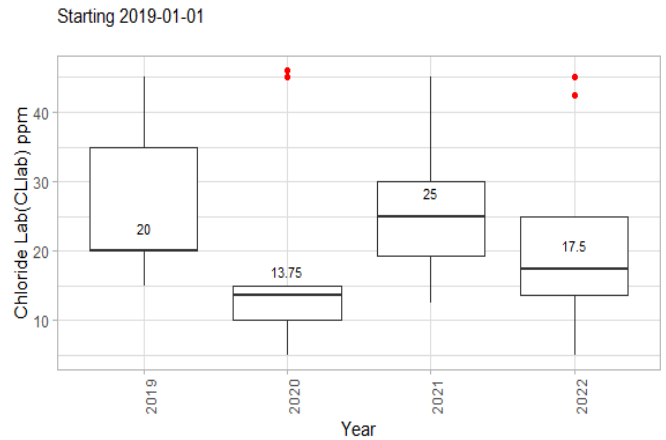
### Egypt Run Site on Egypt Run to East Branch (WCLEB07) Chlorides, Nitrates, Orthophosphate

Graphic presentation of all data points for Chlorides (CL), Nitrates (NO<sub>3</sub>N), 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.

**Egypt Run(WCLEB07)**



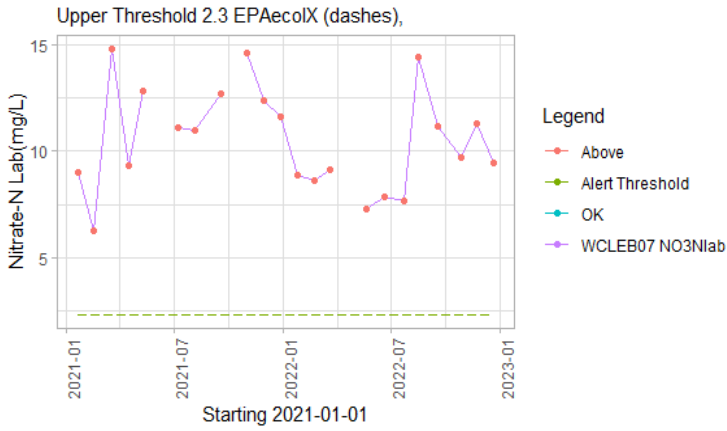
**Egypt Run(WCLEB07)**



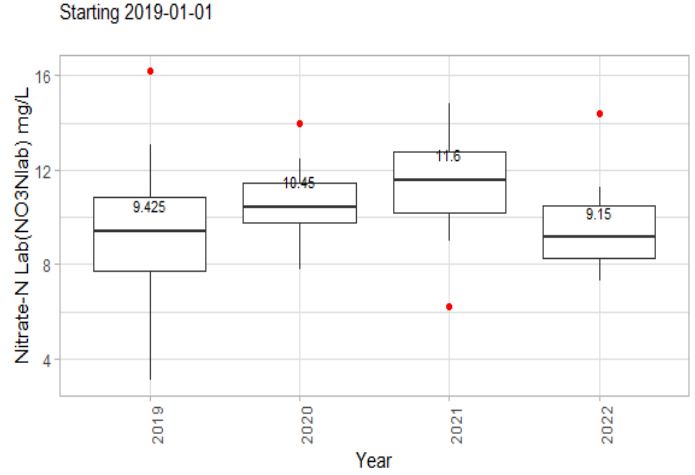


# White Clay Wild and Scenic River Stream Watch Monitoring 2021-2022

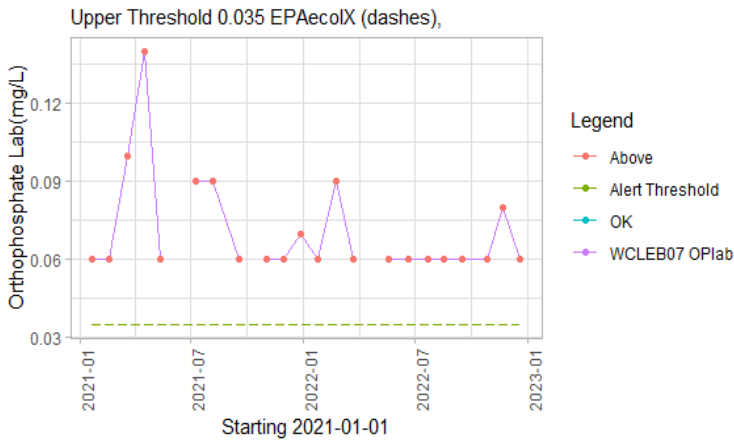
**Egypt Run(WCLEB07)**



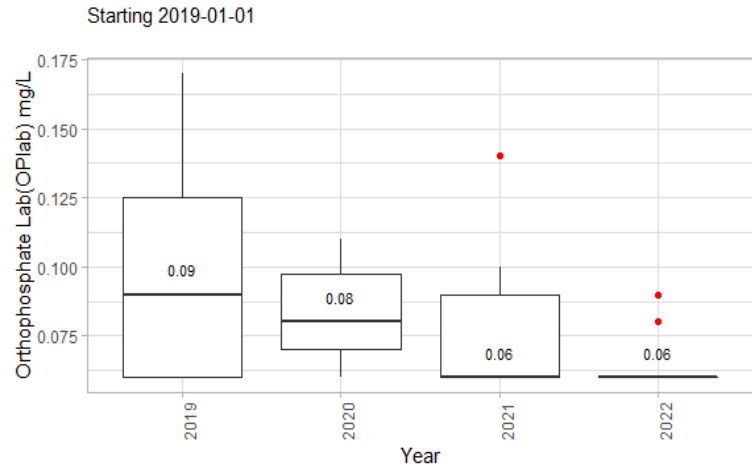
**Egypt Run(WCLEB07)**



**Egypt Run(WCLEB07)**



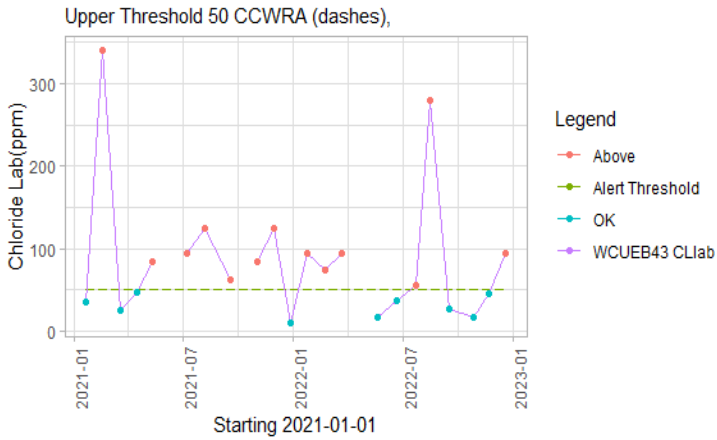
**Egypt Run(WCLEB07)**



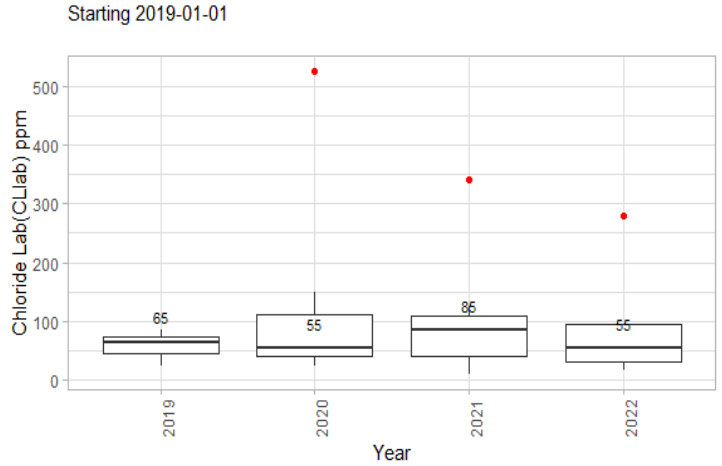
Welcome and Rosehill Site on Unnamed Tributary to East Branch (WCUEB43) Chlorides, Nitrates, Orthophosphate

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.

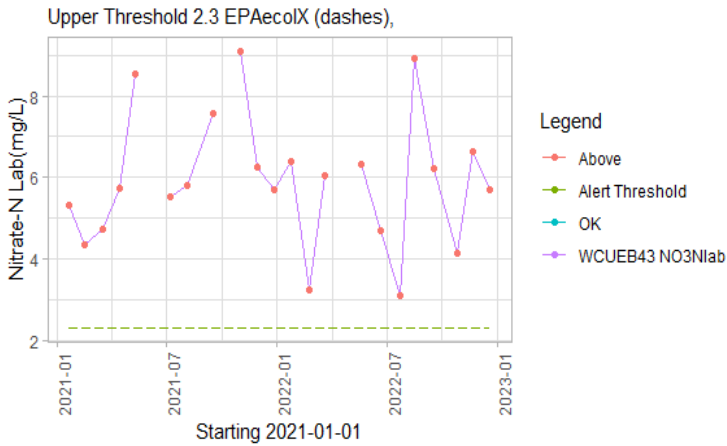
Rosehill(WCUEB43)



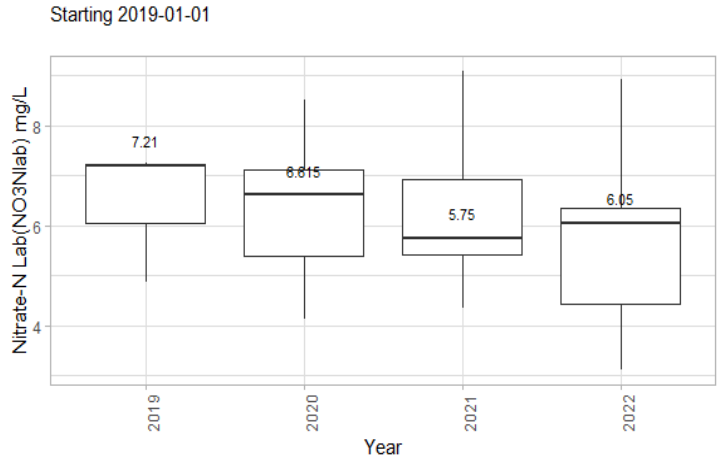
Rosehill(WCUEB43)



Rosehill(WCUEB43)



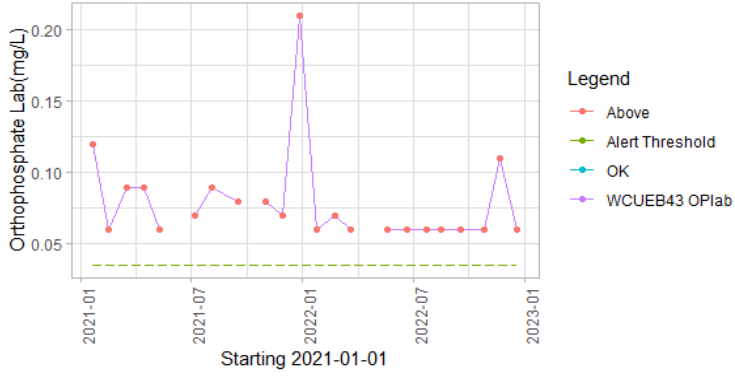
Rosehill(WCUEB43)



# White Clay Wild and Scenic River Stream Watch Monitoring 2021-2022

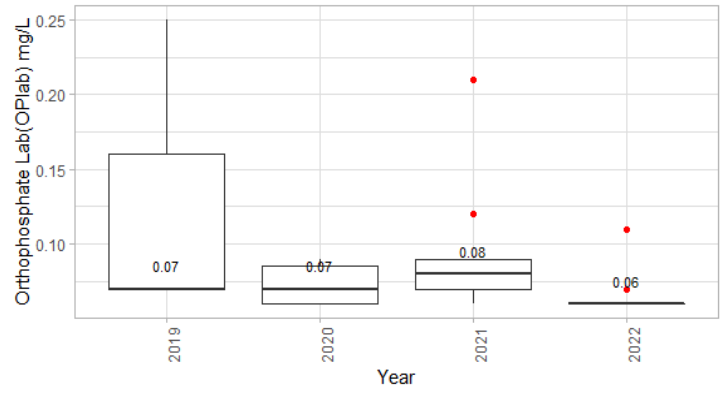
**Rosehill(WCUEB43)**

Upper Threshold 0.035 EPAeolX (dashes),



**Rosehill(WCUEB43)**

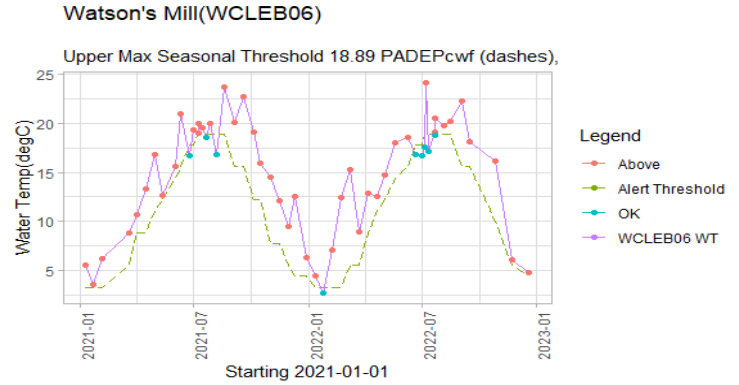
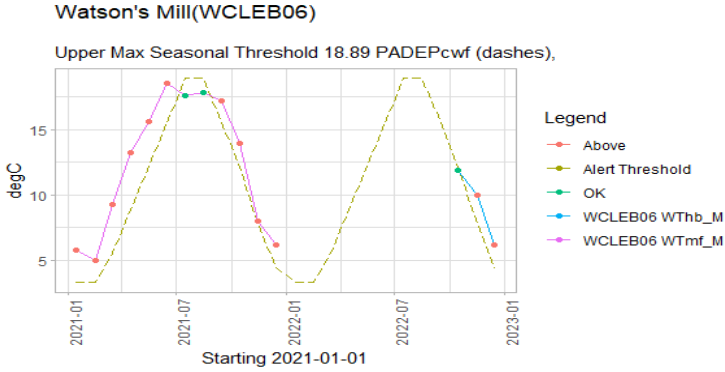
Starting 2019-01-01



# White Clay Wild and Scenic River Stream Watch Monitoring 2021-2022

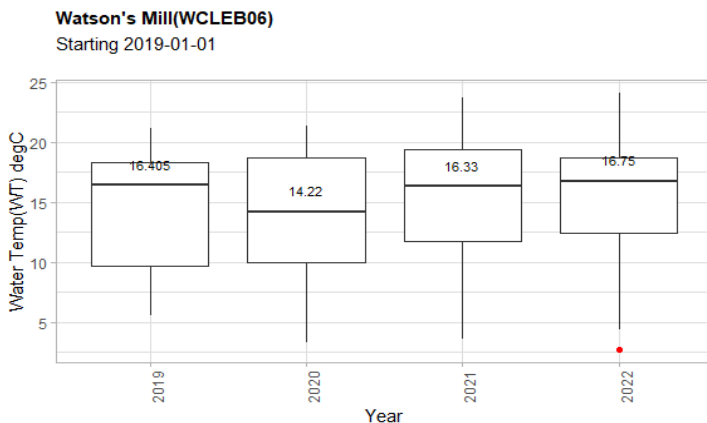
## Watson's Mill Site on Broad Run to East Branch (WCLEB06) Water Temperature

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.



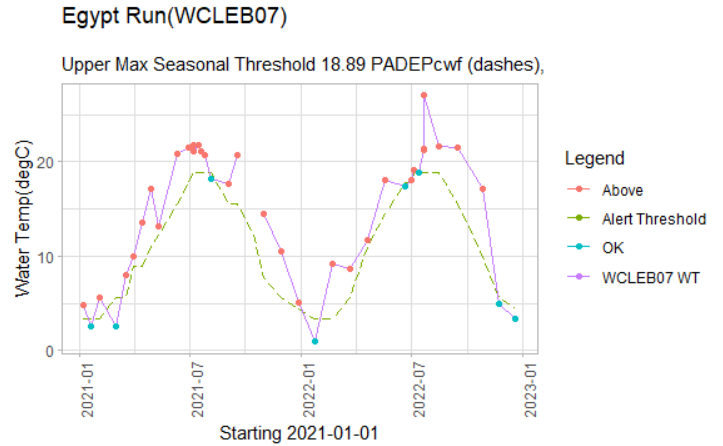
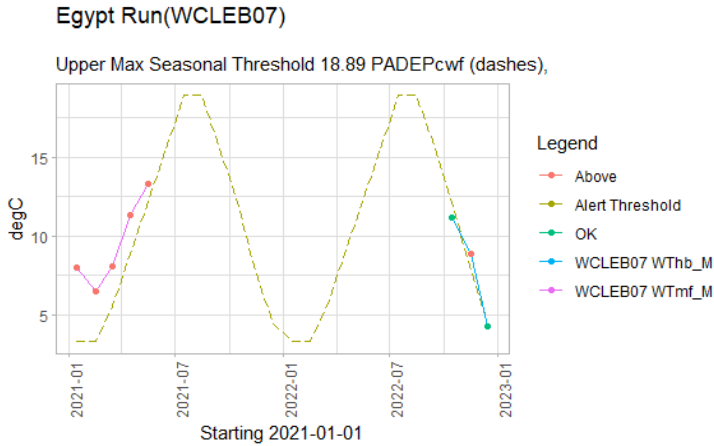
Date	Wtmf_M	WThb_M
2021-01-15	5.8	
2021-02-15	5.0	
2021-03-15	9.3	
2021-04-15	13.2	
2021-05-15	15.6	
2021-06-15	18.5	
2021-07-15	17.6	
2021-08-15	17.8	
2021-09-15	17.2	
2021-10-15	13.9	
2021-11-15	8.0	
2021-12-15	6.2	
2022-10-15		11.9
2022-11-15		10.0
2022-12-15		6.2

Date	WT	Date	WT
2021-01-09	5.61	2022-01-10	4.44
2021-01-21	3.61	2022-01-24	2.72
2021-02-04	6.27	2022-02-08	7.10
2021-03-18	8.89	2022-02-22	12.40
2021-04-01	10.72	2022-03-07	15.30
2021-04-15	13.33	2022-03-21	8.90
2021-04-29	16.77	2022-04-05	12.90
2021-05-11	12.61	2022-04-19	12.50
2021-05-31	15.56	2022-05-02	14.70
2021-06-10	21.00	2022-05-19	18.00
2021-06-24	16.72	2022-06-07	18.60
2021-06-29	19.30	2022-06-20	16.80
2021-07-08	19.00	2022-06-30	16.70
2021-07-08	19.94	2022-07-05	17.60
2021-07-15	19.50	2022-07-07	24.10
2021-07-21	18.60	2022-07-12	17.10
2021-07-27	19.94	2022-07-21	19.10
2021-08-05	16.78	2022-07-22	18.80
2021-08-19	23.70	2022-07-22	20.50
2021-09-03	20.06	2022-08-04	19.80
2021-09-17	22.67	2022-08-16	20.20
2021-10-04	19.11	2022-09-02	22.30
2021-10-15	15.94	2022-09-16	18.10
2021-11-01	14.56	2022-10-26	16.10
2021-11-14	12.06	2022-11-21	6.10
2021-11-29	9.50	2022-12-19	4.80
2021-12-10	12.50	2022-01-10	4.44
2021-12-27	6.33	2022-01-24	2.72



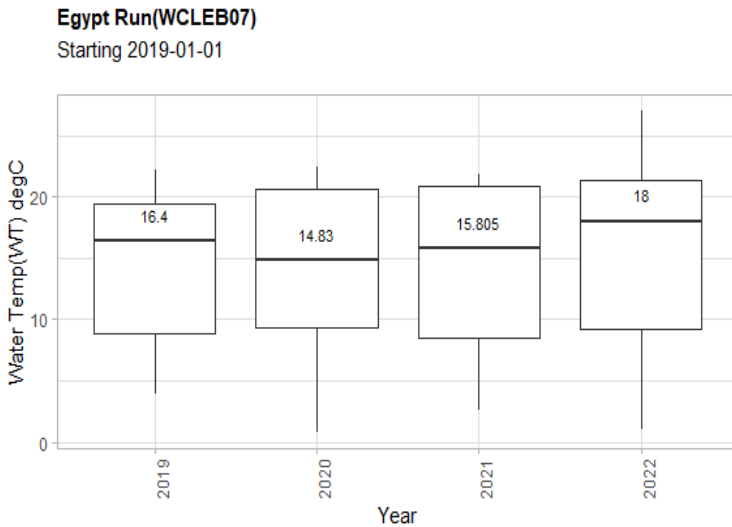
### Egypt Run Site on Egypt Run to East Branch (WCLEB07) Water Temperature

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.



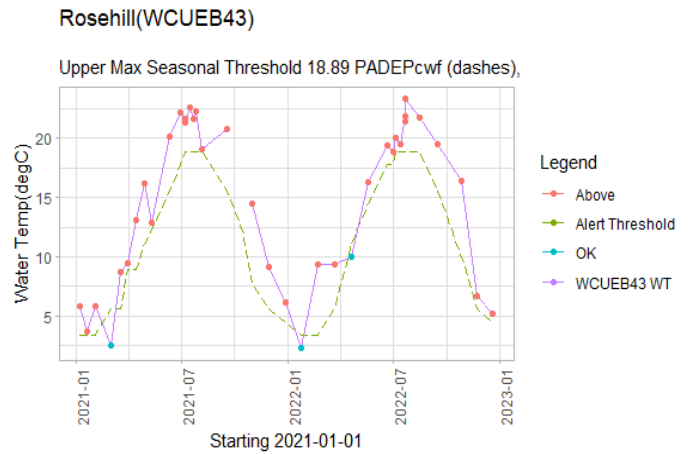
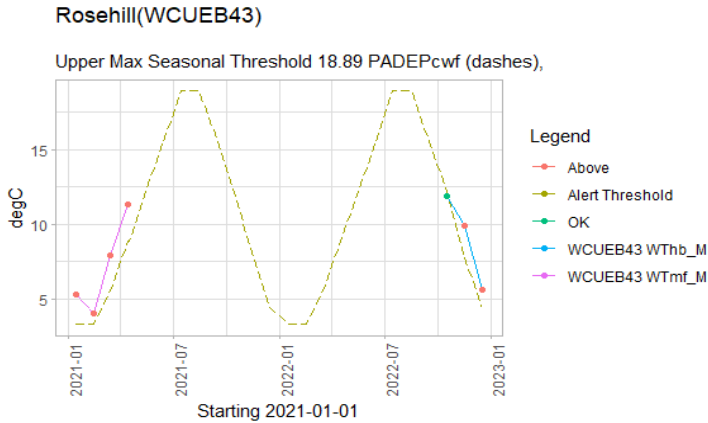
Date	WTmf_M	WThb_M
2021-01-15	8.0	
2021-02-15	6.5	
2021-03-15	8.1	
2021-04-15	11.3	
2021-05-15	13.3	
2022-10-15		11.2
2022-11-15		8.9
2022-12-15		4.3

Date	WT	Date	WT
2021-01-09	4.89	2022-01-24	1.00
2021-01-21	2.55	2022-02-22	9.20
2021-02-04	5.61	2022-03-21	8.70
2021-03-02	2.61	2022-04-19	11.70
2021-03-18	8.00	2022-05-19	18.10
2021-04-01	10.00	2022-06-20	17.40
2021-04-15	13.56	2022-06-30	18.00
2021-04-29	17.17	2022-07-05	19.10
2021-05-11	13.11	2022-07-12	18.80
2021-06-10	20.89	2022-07-21	21.40
2021-06-29	21.50	2022-07-22	21.30
2021-07-08	21.10	2022-07-22	27.00
2021-07-08	21.72	2022-08-16	21.60
2021-07-15	21.80	2022-09-16	21.50
2021-07-21	21.10	2022-10-26	17.20
2021-07-27	20.70	2022-11-21	4.90
2021-08-05	18.16	2022-12-19	3.40
2021-09-03	17.72		
2021-09-17	20.67		
2021-11-01	14.44		
2021-11-29	10.50		
2021-12-27	5.06		



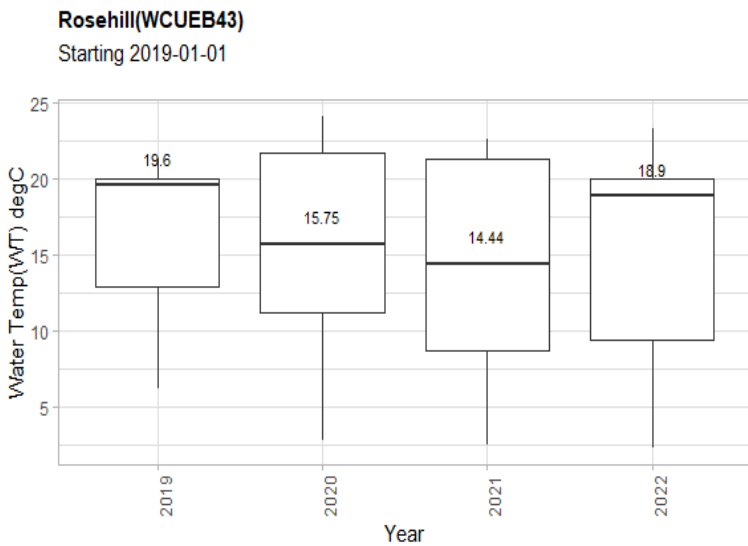
## Welcome and Rosehill Site on Unnamed Tributary to East Branch Water Temperature

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	5.3	
2021-02-15	4.0	
2021-03-15	7.9	
2021-04-15	11.3	
2022-10-15		11.9
2022-11-15		9.9
2022-12-15		5.6

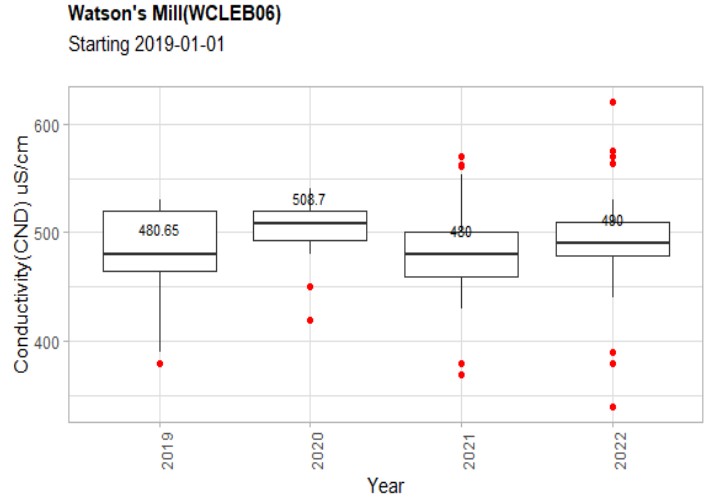
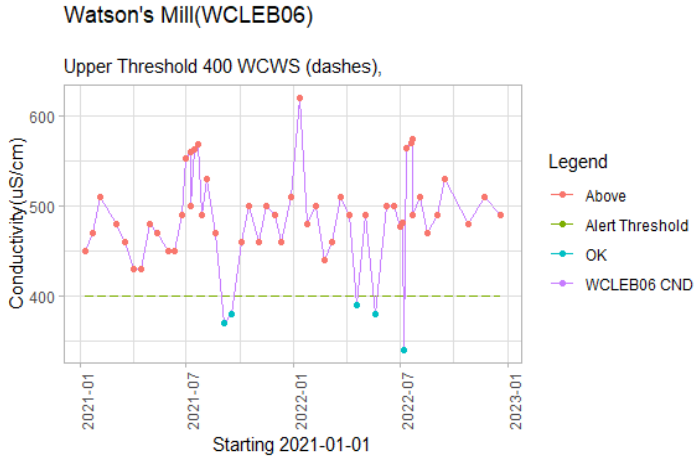
Date	WT	Date	WT
2021-01-09	5.83	2022-01-24	2.30
2021-01-21	3.67	2022-02-22	9.40
2021-02-04	5.83	2022-03-21	9.30
2021-03-02	2.50	2022-04-19	10.00
2021-03-18	8.72	2022-05-19	16.30
2021-04-01	9.50	2022-06-20	19.40
2021-04-15	13.05	2022-06-30	18.90
2021-04-29	16.22	2022-07-05	20.00
2021-05-11	12.89	2022-07-12	19.50
2021-06-10	20.11	2022-07-21	21.90
2021-06-29	22.20	2022-07-22	21.40
2021-07-08	21.30	2022-07-22	23.30
2021-07-08	21.67	2022-08-16	21.80
2021-07-15	22.60	2022-09-16	19.50
2021-07-21	21.60	2022-10-26	16.40
2021-07-27	22.30	2022-11-21	6.70
2021-08-05	19.05	2022-12-19	5.20
2021-09-17	20.83		
2021-11-01	14.44		
2021-11-29	9.17		
2021-12-27	6.17		





### Watson's Mill Site on Broad Run to East Branch (WCLEB06) 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).



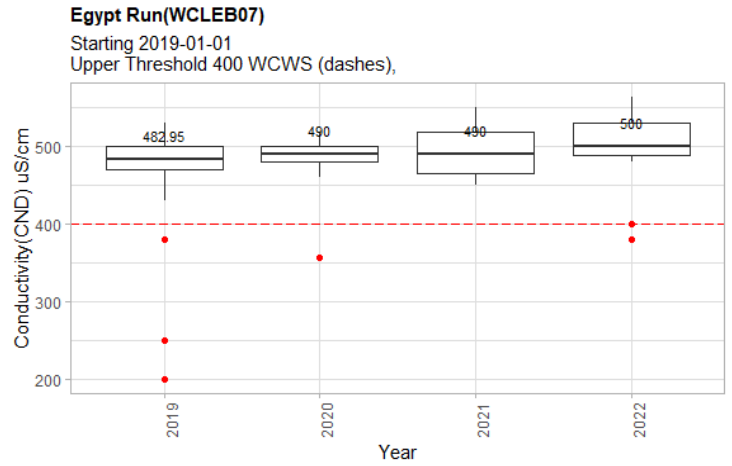
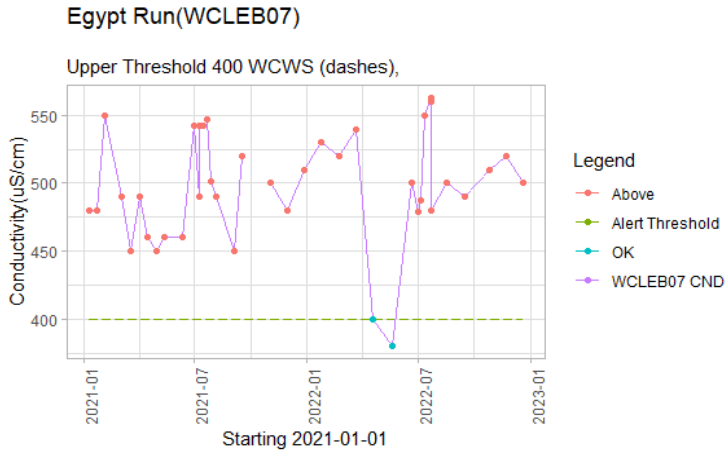
Date	CND (uS/cm)	Date	CND (uS/cm)	Date	CND (uS/cm)
2021-01-09	450.0	2021-11-29	490.0	2022-09-16	530.0
2021-01-21	470.0	2021-12-10	460.0	2022-10-26	480.0
2021-02-04	510.0	2021-12-27	510.0	2022-11-21	510.0
2021-03-02	480.0	2022-01-10	620.0	2022-12-19	490.0
2021-03-18	460.0	2022-01-24	480.0		
2021-04-01	430.0	2022-02-08	500.0		
2021-04-15	430.0	2022-02-22	440.0		
2021-04-29	480.0	2022-03-07	460.0		
2021-05-11	470.0	2022-03-21	510.0		
2021-05-31	450.0	2022-04-05	490.0		
2021-06-10	450.0	2022-04-19	390.0		
2021-06-24	490.0	2022-05-02	490.0		
2021-06-29	552.8	2022-05-19	380.0		
2021-07-08	560.4	2022-06-07	500.0		
2021-07-08	500.0	2022-06-20	500.0		
2021-07-15	562.6	2022-06-30	477.5		
2021-07-21	569.3	2022-07-05	481.5		
2021-07-27	490.0	2022-07-07	340.0		
2021-08-05	530.0	2022-07-12	563.9		
2021-08-19	470.0	2022-07-21	570.2		
2021-09-03	370.0	2022-07-22	574.6		
2021-09-17	380.0	2022-07-22	490.0		
2021-10-04	460.0	2022-08-04	510.0		

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2021-10-15	500.0	2022-08-16	470.0		
2021-11-01	460.0	2022-09-02	490.0		

Egypt Run Site on Egypt Run to East Branch (WCLEB07) 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).



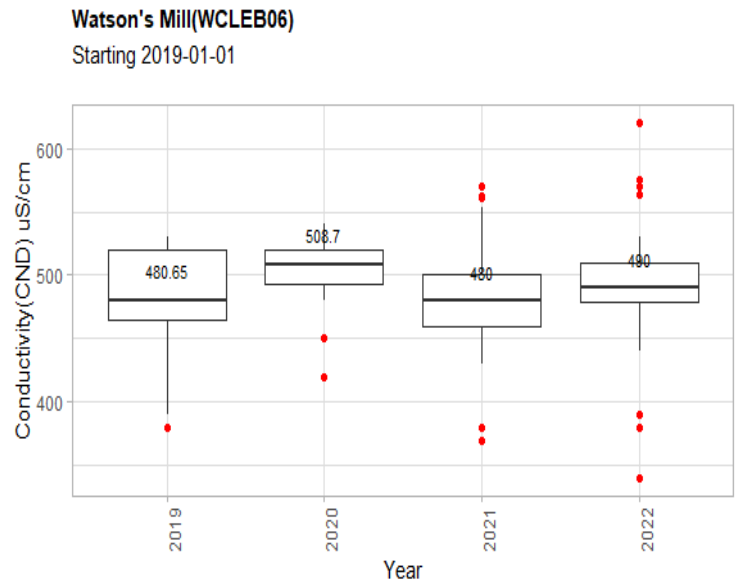
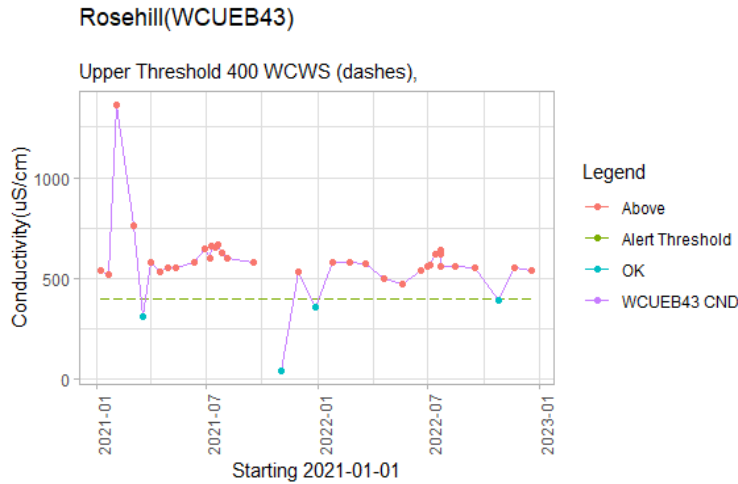
Date	CND (uS/cm)	Date	CND (uS/cm)
2021-01-09	480.0	2022-01-24	530.0
2021-01-21	480.0	2022-02-22	520.0
2021-02-04	550.0	2022-03-21	540.0
2021-03-02	490.0	2022-04-19	400.0
2021-03-18	450.0	2022-05-19	380.0
2021-04-01	490.0	2022-06-20	500.0
2021-04-15	460.0	2022-06-30	479.3
2021-04-29	450.0	2022-07-05	487.7
2021-05-11	460.0	2022-07-12	549.7
2021-06-10	460.0	2022-07-21	562.8
2021-06-29	542.0	2022-07-22	560.3
2021-07-08	542.8	2022-07-22	480.0
2021-07-08	490.0	2022-08-16	500.0
2021-07-15	542.5	2022-09-16	490.0
2021-07-21	546.6	2022-10-26	510.0
2021-07-27	501.7	2022-11-21	520.0
2021-08-05	490.0	2022-12-19	500.0
2021-09-03	450.0	2022-08-16	500.0
2021-09-17	520.0		
2021-11-01	500.0		
2021-11-29	480.0		

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2021-12-27	510.0		
2022-01-24	530.0		
2022-02-22	520.0		

Welcome and Rosehill Site on Unnamed Tributary to East Branch (WCUEB43) 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	540.0	2022-02-22	580.0
2021-01-21	520.0	2022-03-21	570.0
2021-02-04	1360.0	2022-04-19	500.0
2021-03-02	760.0	2022-05-19	470.0
2021-03-18	310.0	2022-06-20	540.0
2021-04-01	580.0	2022-06-30	558.6
2021-04-15	530.0	2022-07-05	568.1
2021-04-29	550.0	2022-07-12	621.3
2021-05-11	550.0	2022-07-21	619.2
2021-06-10	580.0	2022-07-22	639.4
2021-06-29	647.0	2022-07-22	560.0
2021-07-08	658.9	2022-08-16	560.0
2021-07-08	600.0	2022-09-16	550.0
2021-07-15	656.7	2022-10-26	390.0
2021-07-21	668.8	2022-11-21	550.0
2021-07-27	629.8	2022-12-19	540.0
2021-08-05	600.0		

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2021-09-17	580.0		
2021-11-01	40.0		
2021-11-29	530.0		
2021-12-27	360.0		
2022-01-24	580.0		

White Clay Wild and Scenic River Stream Watch Monitoring 2021-2022

Table of Recreational Season Fecal Indicator Bacteria Geometric Means.

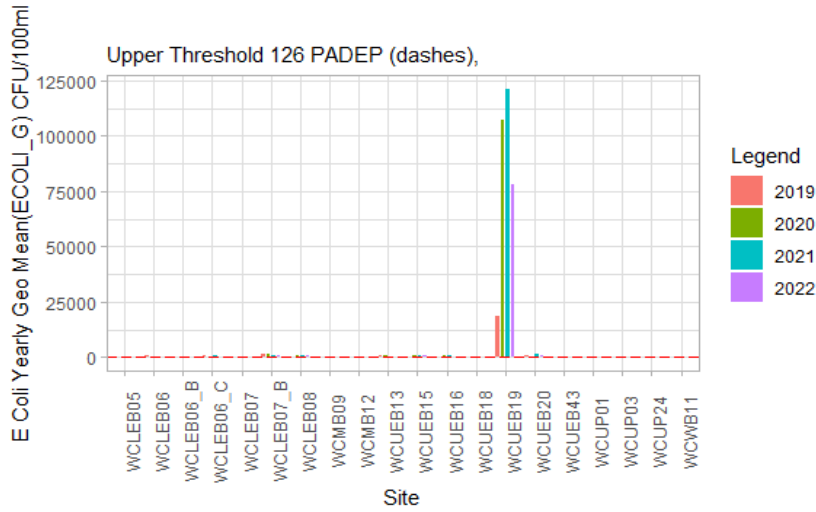
Table of geometric means for E. coli (cfu/100ml) taking during multiple recreational seasons. The table is color coded to show sites that are highly impaired > or = 300 cfu/100ml (red), slightly impaired between 127 – 299 cfu/ml (yellow) or as meeting the recommended EPA recreational water quality standard of < or = 126 cfu/ml (green).

SiteName	Site	Year2016	Year2017	Year2018	Year2019	Year2020	Year2021	Year2022
Strickersville Main	WCUP01	242.9	235.2	195.7	252.1	235.6	245.3	NA
Sharpless Bridge	WCUP03	182.6	284.5	192.4	194.8	131.2	179.1	177.1
Good Hope	WCLEB05	421.5	278.6	209.1	456.7	203.0	219.5	406.7
Watson's Mill	WCLEB06	654.9	600.4	282.7	776.2	325.6	NA	295.4
Somerset Out	WCLEB06_B	NA	304.2	115.9	28.9	53.0	130.4	74.5
Somerset In	WCLEB06_C	NA	594.3	366.8	827.5	274.0	1162.0	300.3
Egypt Run	WCLEB07	452.6	744.5	341.0	407.5	367.3	265.6	386.0
Pelham	WCLEB07_B	NA	1572.3	531.8	1244.1	1246.1	825.8	765.7
Clay Creek	WCLEB08	808.2	889.6	757.0	520.8	587.5	569.5	687.8
Guernsey	WCMB09	211.4	310.1	215.9	349.0	214.1	448.4	252.5
Flint Hill	WCWB11	408.3	768.5	237.1	372.4	265.5	352.7	217.1
Wickerton	WCMB12	136.2	392.4	110.9	206.7	253.8	200.0	184.4
Avondale WWTP	WCUEB13	938.2	771.4	1498.5	618.4	838.8	149.3	310.2
Avondale Playground	WCUEB15	616.7	1120.1	523.1	348.3	620.2	901.9	721.2
ELG west	WCUEB16	414.2	597.6	517.4	428.6	576.0	640.5	447.0
Laurel Woods	WCUEB18	436.0	429.4	343.8	222.6	350.9	105.7	139.3
Loyd Road Stroud	WCUEB19	NA	24738.6	51375.1	18587.3	107152.2	121174.9	78193.3
WLG SUEZ Stroud	WCUEB20	NA	525.3	557.3	678.7	358.1	1702.3	759.8
Mercer Mill	WCUP24	NA	NA	114.1	131.3	139.0	147.3	147.5
Rosehill	WCUEB43	NA	NA	NA	272.4	413.3	403.6	287.3

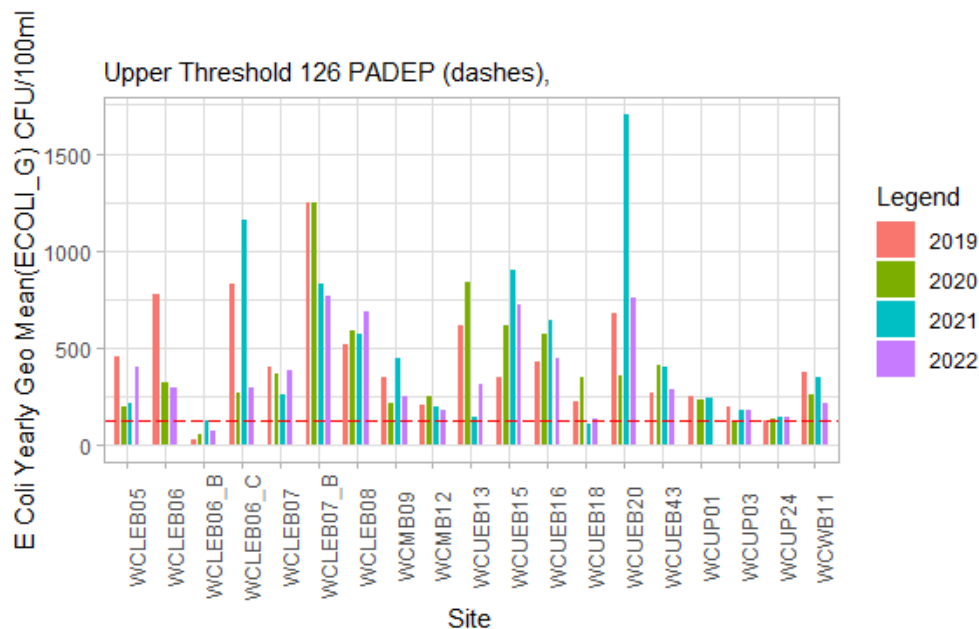
### Graphical Presentation of Recreational Season Fecal Indicator Bacteria Geometric Means

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

The graph below shows that site WCUEB19 has very high bacteria readings as compared to all the other sites (note the scale on the left).



The same graph below with site WCUEB19 removed making all the other sites bacteria readings are visible (note the scale on the left as compared to above). It should be noted that stie WCUEB19 is just below a dairy farm without stream fencing to keep cattle out of the creek, and no stream buffer present.





## 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](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

**Nitrates:** The PADEP standard for the maximum concentration of nitrates and nitrites in a PWS is 10 mg/L.<sup>1</sup> 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.<sup>2</sup> 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 is what we selected for this report.<sup>3</sup>

**Phosphates:** Total phosphorus is the total concentration of all phosphorus-containing compounds in streams. Natural background concentrations of total phosphorus are estimated to be 0.025 - 0.060 mg/L for this region.<sup>4</sup> 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.<sup>3</sup>

**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.<sup>5</sup>

**Chlorides:** The PADEP maximum for Cl<sup>-</sup> is 250 mg/L for a Potable Water Supply (PWS)<sup>1</sup>. While there are no instream standards, a threshold of 50 mg/L was selected based off 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.<sup>6</sup>

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1. Pennsylvania Department of Environmental Protection. 25 Pa. Code Chapter 93. Water Quality Standards § 93.7. Specific Water Quality Criteria (2020). <http://www.pacodeandbulletin.gov/Display/pacode?file=/secure/pacode/data/025/chapter93/chap93toc.html&d=reduce>
  2. USEPA. Ambient Water Quality Criteria Recommendations: Rivers and Streams in Ecoregion IX. 108 (2000).
  3. 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).
  4. 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).
  5. USEPA. Recreational Water Quality Criteria. <https://www.epa.gov/sites/default/files/2015-10/documents/rwqc2012.pdf> (2012).
  6. 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>

## Acknowledgements

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