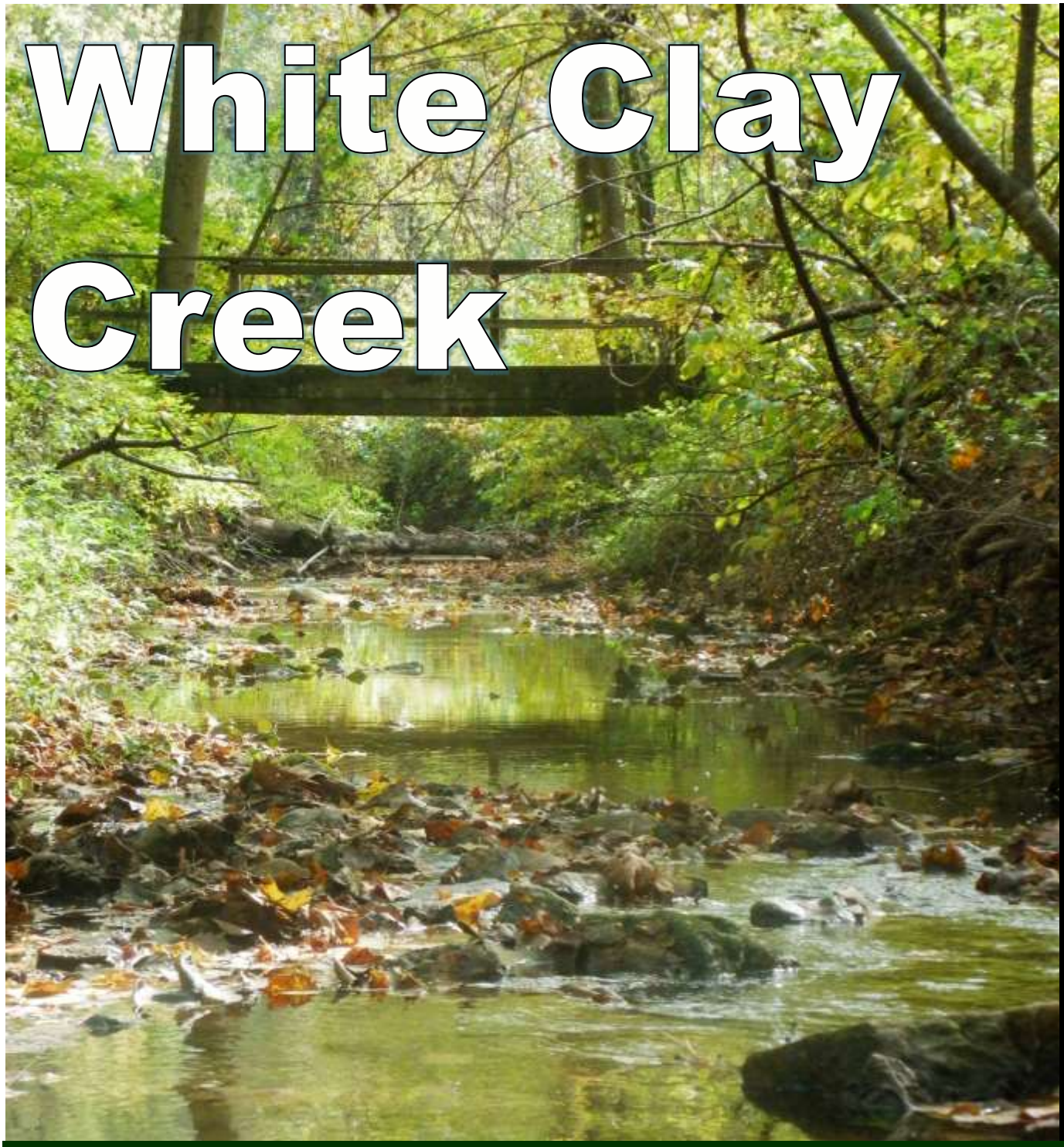
White Clay Creek



Delaware Stream Watch

Volunteer Data Summary

2006 - 2015

Delaware Nature Society

Delaware Stream Watch

Data Summary 2006 - 2015

Delaware Stream Watch was established in 1992 to engage volunteers in providing baseline chemical and physical data on waterways primarily in the Christina Basin in Northern Delaware.

Volunteers in Delaware Stream Watch Technical Monitoring program monitor designated long-term monitoring sites on a monthly basis, testing for dissolved oxygen, pH, alkalinity, nitrate nitrogen, phosphates, conductivity, and temperature. Annual quality control helps to ensure consistency and control in sampling techniques. Data is collect through a combination of field test kits and meters.

Special thanks to the dedicated volunteers who take time out of their busy schedules to make a difference for our waterways!

Delaware Stream Watch

Delaware Stream Watch is a citizen science program, run by the Delaware Nature Society, that engages volunteers in monitoring the quality of local waters.

Data is shared on the Delaware Nature Society website and is used to inform watershed planning and outreach efforts.

Learn more & become involved:

Delnature.org/streamwatch

The White Clay Creek Watershed

The Watershed

The White Clay Creek, along with the Brandywine, Red Clay and Christina creeks combine to form the Christina Basin which flows into the Delaware River at Wilmington DE. These waterways are an important drinking water supply for residents of Chester County PA and New Castle County DE. The Christina Basin is part of the broader Delaware River Basin that supplies drinking water to over 15 million people.

The White Clay Creek watershed covers 107square miles in Delaware and Pennsylvania. The groundwater and waterways of the White Clay watershed provide drinking water to over 120,000 people and is the drinking water supply for Newark, DE.

In 2000, the White Clay Creek and its tributaries were added into the National Wild and Scenic Rivers System. It is the first entire watershed (rather than just a section of a river) designated into the Wild and Scenic federal system. This "beyond-the-riverbank" approach takes into consideration the variety of influences that affect river habitat and water quality.

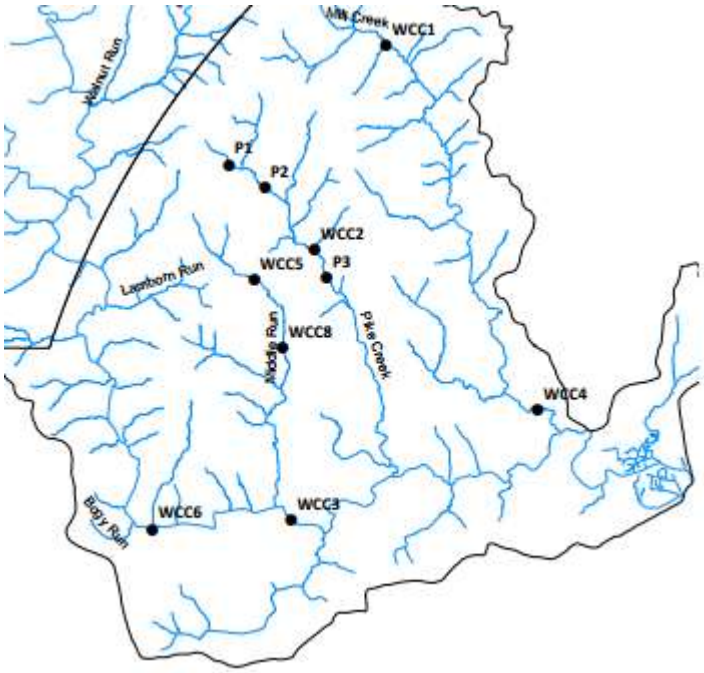
Major land uses in the watershed include agriculture (36%), forest/wetland (30%), and urban (34%).

The Monitoring Sites

Technical Monitoring volunteers monitored 10 locations along the White Clay Creek and its tributaries in Delaware collecting chemistry data on a monthly basis.

Volunteer monitoring site locations 2006 - 2015

Site	Location
P1	Beech Hill (Pike Creek)
P2	Beech Hill (Pike Creek)
P3	3 Little Bakers (Pike Creek)
WCC1	Hickory Hill Park (Mill Creek)
WCC2	Independence School (Pike Creek)
WCC3	Old Possum Park Road (Middle Run)
WCC4	Old Capital Trail (Mill Creek)
WCC5	Paper Mill Road (Middle Run)
WCC6	White Clay Drive
WCC8	Middle Run @ Smith Mill Rd



Summary Result

A ***Summary result*** of **Good**, **Average** or **Poor** is included next to each parameter. This rating is provided as a quick summary of the overall findings for that specific parameter across sites.

Chemical Data Collected 2006 - 2015 in the White Clay Creek Watershed

Dissolved Oxygen (DO) *Summary result: Good*

Dissolved oxygen (DO) is an important water quality indicator for aquatic life. DO levels below 3-5mg/L can harm or kill fish and other aquatic organisms. Temperature influences DO levels - the warmer the water is, the less dissolved oxygen it can hold. Cold water can hold more dissolved oxygen. Wind or wave action or turbulence from churning over rocks can add oxygen to water. Aquatic plants both add (photosynthesis) and consume (respiration) oxygen. DO levels can vary by time of day and by time of year.

Oxygen levels may be reduced by elevated water temperatures (e.g. removal of trees that shade the water or by industrial/municipal discharges) or by the excessive growth and subsequent oxygen depleting decomposition of algae. A DO reading measures how much oxygen is dissolved in the water but not how much oxygen the water is capable of holding at that time and temperature. When water holds all the DO it can hold at a given temperature, it is said to be 100% saturated with oxygen. Percent saturation therefor refers to the amount of DO in the water compared to the amount that could be present at the same temperature. Levels between 80 – 120% are ideal.

Data was collected using Fisher brand Traceable Dissolved Oxygen Meters. As data was collected during the daytime, the lowest dissolved oxygen levels (typically found near dawn) may not be truly reflected.

WCC low observed DO levels

Site	Date	DO mg/l
P1	9/10/2013	5.4
P1	8/16/2013	5.3
P1	8/9/2010	5.3
WCC1	9/26/2014	4.7
WCC3	9/30/2014	5
WCC5	7/17/2012	3.8
WCC5	6/28/2010	4
WCC5	9/24/2007	3.8
WCC5	8/27/2007	3.5
WCC5	8/19/2006	3.7
WCC6	8/21/2009	3.6

The DO standards set by the State of Delaware are a minimum of 4.0 mg/L for most waters. In general, DO levels were good throughout the watershed- all sites had an average DO value above 8.0 mg/l. Low levels where occasionally observed during summer months though indicating that additional monitoring during summer months might be useful.

WCC6: White Clay mainstem, Newark

pH *Summary result: Good*

pH is a measure of how acidic or basic the water is based on the hydrogen ion concentration of the water. The pH scale ranges from 0 to 14. A pH of 7 is neutral. A pH less than 7 is acidic while a pH greater than 7 is basic. Because values of pH are based on a logarithmic scale, each 1.0 change in pH represents a factor of ten change in acidity. This means that a pH of 3.0 is 10 times more acidic than a pH of 4.0.

LaMotte pH field kits were used for data collection.

pH readings in the White Clay Creek consistently fell within the target range of 6.5 – 8.5 across all sites over time with most sites averaging around 7.5. Several data points of 6.0 or 9.0 were observed but these were isolated and not considered problematic.

Alkalinity *Summary result: Good*

Alkalinity measures the acid neutralizing, or buffering, capacity of a solution. Most natural waters, based on their underlying geology, contain certain ions that can neutralize acidic ions. Streams that flow through limestone deposits have the highest alkalinity values and therefore the highest buffering capacity. The alkalinity of streams can vary due to the amount of rainfall, the season, as well as the geology of the watershed.

Data was collected using LaMotte Alkalinity field kits.

Alkalinity values were all above the minimum DNREC target of 20 mg/l. Middle Run sites had slightly lower average alkalinities compared to other sites, which could in part be due to local geology.

Nitrate-Nitrogen *Summary result: Average*

Nitrogen makes up about 80% of the air we breathe. It is an essential component of proteins and is found in the cells of all living things. Inorganic nitrogen may exist as a gas, or as nitrites, nitrates, or ammonia. Nitrate represent the most completely oxidized state of nitrogen commonly found in water. Nitrates in water come from soil, fertilizer runoff, malfunctioning septic systems, sewage treatment plants, manure from livestock animal wastes and from car exhausts. In abundance, these nitrates become detrimental to aquatic systems through a process called eutrophication. Eutrophication refers to the natural aging process of a water body that may be greatly accelerated by human activities, causing algal blooms and a corresponding decrease in dissolved oxygen.

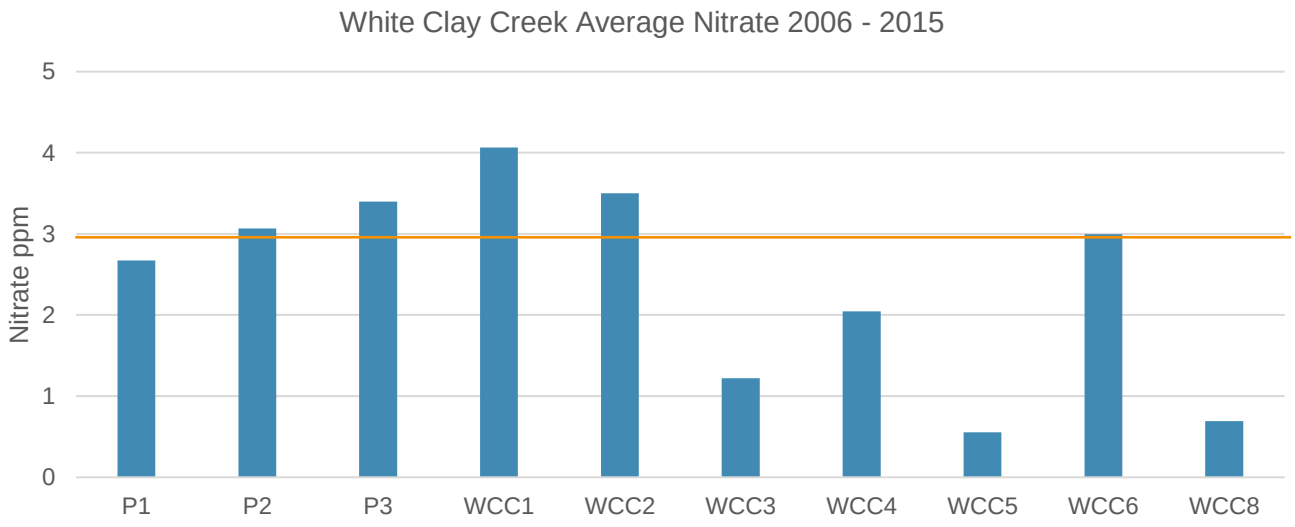
Data was collected using LaMotte Nitrate Nitrogen Field Kits.

The target level for total nitrogen (all forms of nitrogen combined) in Delaware freshwater is below 3.0 mg/L. Delaware Nature Society volunteers measure nitrate-nitrogen, which is only one component of total nitrogen.

Higher nitrate values were observed in Mill and Pike Creek while Middle Run sites averaged the lowest values. Upstream land use is less developed in Middle Run then it is in Mill and Pike Creek.

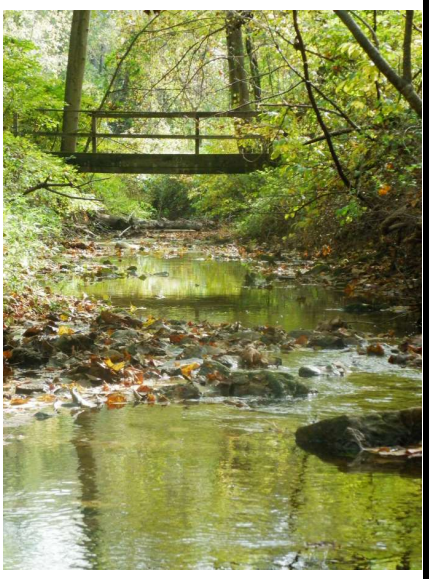
White Clay sites with high nitrate values

Site	% of values greater than 3.0 mg/l
WCC1 (Mill Creek)	77%
P3 (Pike Creek)	59%
WCC2 (Pike Creek)	51%



Phosphate — *Summary result: Good*

Phosphorus is an essential nutrient. Excess phosphates in water come from a variety of sources including fertilizer, sewage, manure from livestock, air pollution and industrial discharges. Since this nutrient is usually found in small amounts, even small increases can have large effects on aquatic systems. Excess phosphates can cause extensive algal blooms and a corresponding decrease in dissolved oxygen.



Middle Run

Hach Orthophosphate Field Kits were used to collect the data.

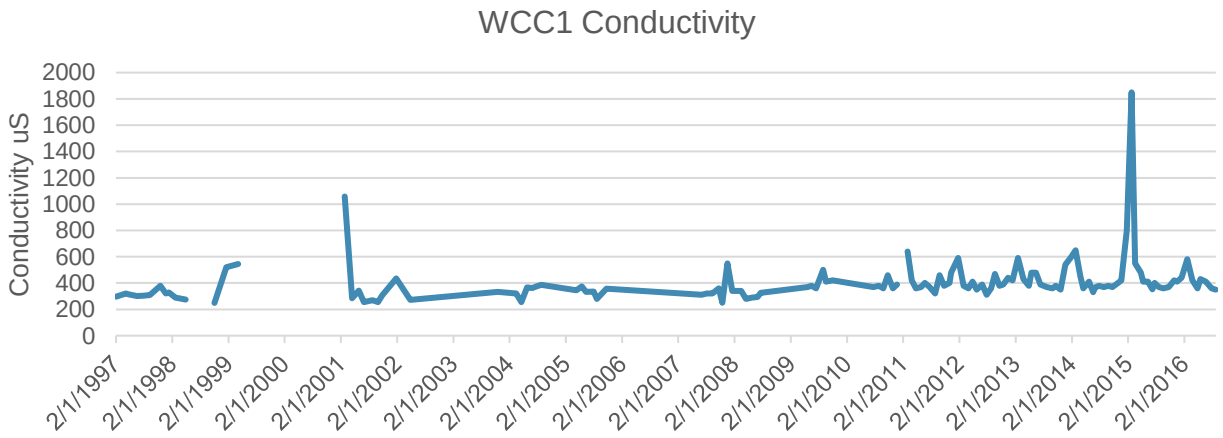
Delaware considers total phosphorus (which includes organic phosphorus) levels higher than 0.2 mg/l as a potential problem. Stream Watch measures orthophosphate, the inorganic dissolved form of phosphate that is readily available to aquatic plants. As our results only measure a component of total phosphorus, values approaching 0.2 mg/l would be considered high.

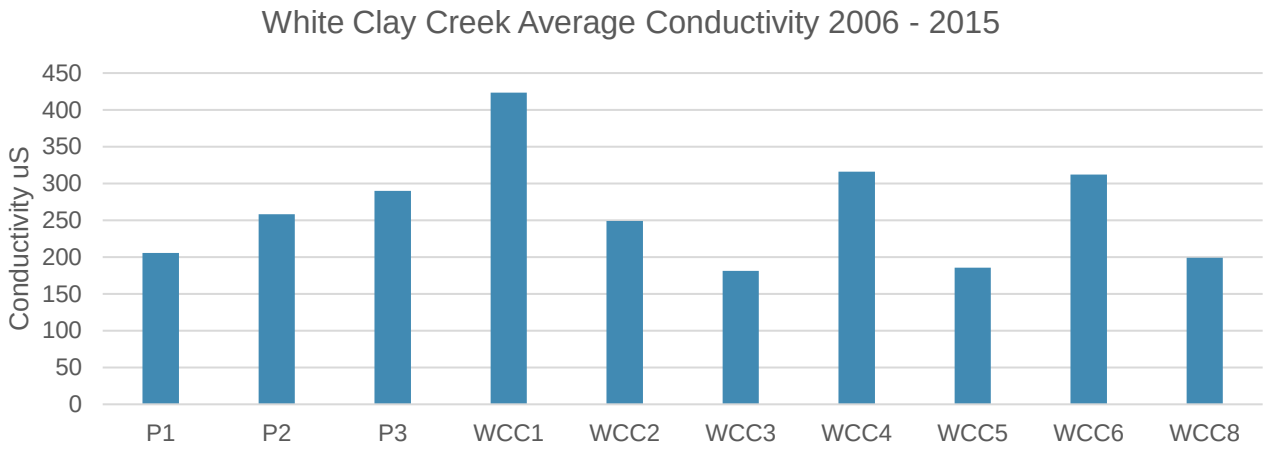
Over the time frame, site WCC2 showed a slightly decreasing trend while P1 & WCC4 exhibited a slight increase.

Conductivity — *Summary result: Good*

Conductivity is a measure of water's capability to pass electrical flow. This ability is directly related to the concentration of ions in the water. These conductive ions come from dissolved salts and inorganic materials such as chlorides, sulfides and carbonate compounds. Geology can naturally influence the base conductivity level of streams. The application of road salt during winter months and runoff from urbanized areas can result in high conductivity levels. National and regional data sets point to winter road salt application as a potential concern as salts may accumulate in soils and shallow groundwater and slowly enter streams throughout the year.

No significant increase or decrease where observed over time. Site WCC1 had the highest average and median conductivity values along with the highest maximum values. These higher values (>500uS) were during winter months and attributed to road salt application.





Water Quality Trends in the White Clay Creek Watershed in Delaware

In general, most sites stayed fairly consistent across the monitored parameters over the 9 year period.

While no significant decreases in nitrate and phosphate trend was observed, the fact that site values stayed fairly consistent over the time frame can be viewed in a positive light as the population in the watershed has increased. That said, volunteers were not able to measure all forms of nitrogen and phosphorous so the true amount of these nutrients passing through the sites may be underestimated.

The highest nitrate and conductivity values were observed at Site WCC1, Mill Creek just downstream of Hockessin, while Middle Run monitoring sites (WCC3, WCC5, WCC8) were consistently low.

While not reported here, habitat and macroinvertebrates were surveyed at a subset of sites between 2010 –2015. Combined with the chemistry, these data point to the negative impact of stormwater runoff (e.g., eroded streambanks, low diversity of pollution sensitive taxa) associated with non-point source pollution.

2006 – 2015 Site Averages

	Alkalinity (mg/l)	ph	Conductivity µS	Nitrate N (mg/l)	Phosphate (mg/l)	Water Temp (°C)	DO (mg/l)	% DO Saturation
P1	48	7.1	205	2.7	0.11	14	8.2	78.3
P2	48	7.2	258	3.1	0.14	13	9.0	79.3
P3	71	7.6	290	3.4	0.07	14	9.8	93.7
WCC1	70	7.7	424	4.1	0.22	14	9.1	87.2
WCC2	46	7.4	249	3.5	0.11	13	9.5	89.5
WCC3	28	7.2	181	1.2	0.12	14	8.8	84.8
WCC4	44	7.5	316	2.0	0.14	15	8.8	85.7
WCC5	40	7.0	186	0.6	0.21	14	8.0	75.4
WCC6	71	7.6	312	3.0	0.20	13	8.4	79.4
WCC8	37	7.4	199	0.7	0.12	16	8.9	89.1

White Clay Creek Summary Data 2006 - 2015

SITE P1: Beech Hill (Pike Creek)

	Alkalinity (mg/l)	ph	Conductivity µS	Nitrate N (mg/l)	Phosphate (mg/l)	Water Temp (°C)	DO (mg/l)	% DO Saturation
Minimum	32	6.25	150	0.25	0.00	-3	5.3	44.3
Maximum	68	7.5	380	6	0.50	26.5	14.2	119.0
Average	48	7	205	3	0.11	14	8.2	78
Median	46	7	200	3	0.10	12	8.0	78
# samples	81	80	79	79	81	72	70	69

SITE P2: Beech Hill (Pike Creek)

	Alkalinity (mg/l)	ph	Conductivity µS	Nitrate N (mg/l)	Phosphate (mg/l)	Water Temp (°C)	DO (mg/l)	% DO Saturation
Minimum	36	6.8	180	0.25	0.00	1	5.6	71.6
Maximum	60	7.8	320	7.0	0.63	29	13.9	95.1
Average	48	7.2	258	3.1	0.14	13	9.0	79.3
Median	48	7.3	260	3.0	0.14	13	9.0	81.6
# samples	74	74	65	73	74	62	51	81

SITE P3: 3 Little Bakers (Pike Creek)

	Alkalinity (mg/l)	ph	Conductivity µS	Nitrate N (mg/l)	Phosphate (mg/l)	Water Temp (°C)	DO (mg/l)	% DO Saturation
Minimum	40	7.3	180	0.25	0.00	2.8	6.9	73.8
Maximum	104	8.5	370	7.0	0.16	24	12.9	116.7
Average	71	7.6	290	3.4	0.07	14	9.8	94
Median	70	7.5	295	4.0	0.06	14	9.8	91
# samples	23	22	22	22	23	23	23	23

SITE 1: WCC1 - Village of Manley (Mill Creek)

	Alkalinity (mg/l)	ph	Conductivity µS	Nitrate N (mg/l)	Phosphate (mg/l)	Water Temp (°C)	DO (mg/l)	% DO Saturation
Minimum	48	6.0	250	0.5	0.00	1	4.7	39.1
Maximum	94	9.0	1850	7.0	1.00	29	15.5	142.0
Average	70	7.7	424	4.1	0.22	14	9.1	87
Median	71	7.5	380	4.0	0.20	14	8.7	87
# samples	86	86	85	86	86	86	84	84

SITE 2: WCC2 - Independence School (Pike Creek)

	Alkalinity (mg/l)	ph	Conductivity µS	Nitrate N (mg/l)	Phosphate (mg/l)	Water Temp (°C)	DO (mg/l)	% DO Saturation
Minimum	32	7.3	210	3.0	0.00	4.5	6.2	68.3
Maximum	128	8.0	335	4.0	0.18	23.5	12.2	108.8
Average	46	7.4	249	3.5	0.11	13.1	9.5	89.5
Median	44	7.3	240	3.5	0.12	12.4	9.2	89.9
# samples	51	51	51	51	51	51	49	49

SITE 3: WCC3 - Old Possum Park Road (Middle Run)

	Alkalinity (mg/l)	ph	Conductivity µS	Nitrate N (mg/l)	Phosphate (mg/l)	Water Temp (°C)	DO (mg/l)	% DO Saturation
Minimum	20	6.0	90	0.3	0.00	0	2.9	21.6
Maximum	49	7.5	230	2.0	0.30	26	14.3	154.1
Average	28	7.2	181	1.2	0.12	14	8.8	84.8
Median	28	7.0	180	1.0	0.10	15	8.7	86.3
# samples	90	90	83	82	85	90	80	80

SITE 4: WCC4 - Old Capital Trail (Mill Creek)

	Alkalinity (mg/l)	ph	Conductivity µS	Nitrate N (mg/l)	Phosphate (mg/l)	Water Temp (°C)	DO (mg/l)	% DO Saturation
Minimum	22	7.0	130	0.3	0.00	0.0	4.9	48.6
Maximum	62	8.5	530	4.0	0.50	28.0	13.0	149.2
Average	44	7.5	316	2.0	0.14	14.9	8.8	85.7
Median	44	7.5	310	2.0	0.14	15.0	8.5	85.6
# samples	88	88	82	80	86	88	75	75

SITE 5: WCC5 - Paper Mill Road (Middle Run)

	Alkalinity (mg/l)	ph	Conductivity µS	Nitrate N (mg/l)	Phosphate (mg/l)	Water Temp (°C)	DO (mg/l)	% DO Saturation
Minimum	20	6.0	100	0.3	0.00	0.4	2.7	26.0
Maximum	72	8.5	315	3.0	0.90	30.0	14.5	140.6
Average	40	7.0	186	0.6	0.21	14.0	8.0	75.4
Median	40	7.0	180	0.3	0.17	13.9	7.8	73.4
# samples	113	114	113	112	113	112	106	105

SITE 6: WCC6 - White Clay Drive

	Alkalinity (mg/l)	ph	Conductivity µS	Nitrate N (mg/l)	Phosphate (mg/l)	Water Temp (°C)	DO (mg/l)	% DO Saturation
Minimum	36	7.0	143	0.3	0.00	0.0	3.6	38.7
Maximum	94	8.0	410	6.0	1.00	25.5	13.9	142.6
Average	71	7.6	312	3.0	0.20	13.0	8.4	79.4
Median	70	7.5	324	3.0	0.15	13.5	8.3	79.7
# samples	117	116	118	115	116	118	110	110

SITE 8: WCC8 - Middle Run @ Smith Mill Rd

	Alkalinity (mg/l)	ph	Conductivity µS	Nitrate N (mg/l)	Phosphate (mg/l)	Water Temp (°C)	DO (mg/l)	% DO Saturation
Minimum	20	6.0	87	0.3	0.00	0.0	6.3	65.1
Maximum	58	8.0	304	2.0	0.50	27.0	12.7	115.1
Average	37	7.4	199	0.7	0.12	15.7	8.9	89.1
Median	40	7.5	200	0.5	0.10	16.5	8.5	89.2
# samples	77	77	77	76	77	78	75	75

Making a Difference

Healthy waterways are important community assets providing opportunities for recreation, a source of drinking water, and habitat for wildlife. Stream monitoring provides data on the quality of these waters but each of us can also play a part in improving the health of our waterways.

Many opportunities exist to directly improve the health of our local streams – join us in making a difference!

- **Go green to help protect blue (water that is):** Make protecting water part of your everyday life – little changes in our behavior can go a long way to improving our environment. Many opportunities exist to help the environment so go wild naturally**.** delnature.org/greenlivingguide
    - Choose household cleaners that are the least toxic
    - Pick-up pet poo
    - Volunteer at a stream clean-up

- **Branch out:** Native trees, shrubs, and plants help to improve water quality by filtering pollutants and helping to absorb excess water. An added bonus, native plants are adapted to our climate and need little extra care including extra water or fertilizers.
    - Volunteer at a local tree planting or other habitat restoration project. Establishing a restoration project such a rain garden is wonderful for our waterways but these projects need to be maintained over time. Contact Delaware Nature Society or other local conservation organization to help maintain a habitat or restoration project.
    - Improve water while supporting wildlife by creating a ***Certified Wildlife Habitat*** at your home, school, business or place of worship – learn more: delnature.org/CWH
    - Install a raingarden or rain barrel

- **Voice it!** Let your elected officials know that you care about clean water. Sign-up for the Delaware Nature Society's **Voice It!** alerts for information on upcoming policy changes that might impact water, the protection of our natural lands and other environmental issues.
    - Follow and participate in the **Clean Water: Delaware's Clear Choice Campaign** cleanwaterdelaware.org/

Water Connect Us All