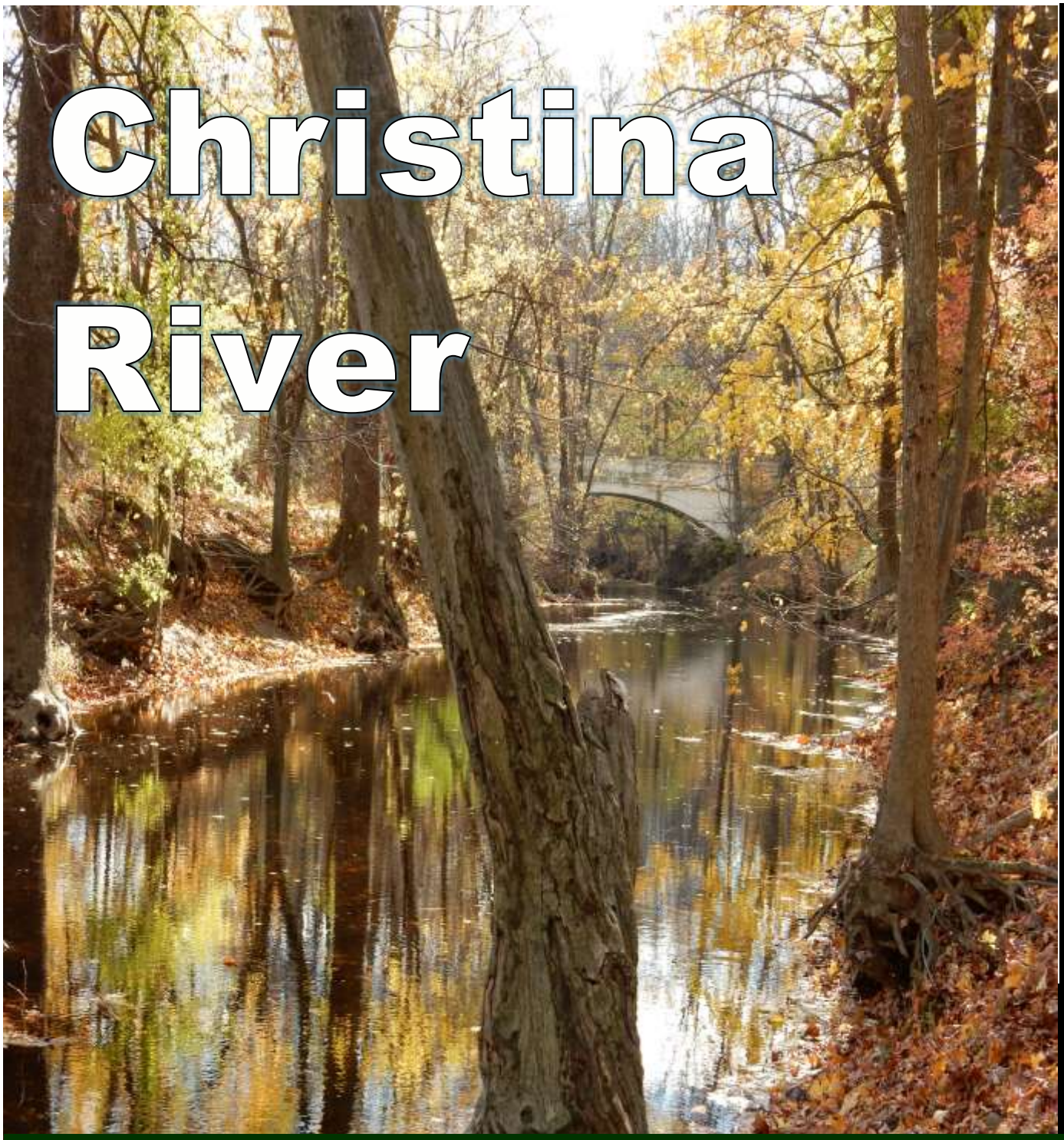


Christina River

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 Christina River Watershed

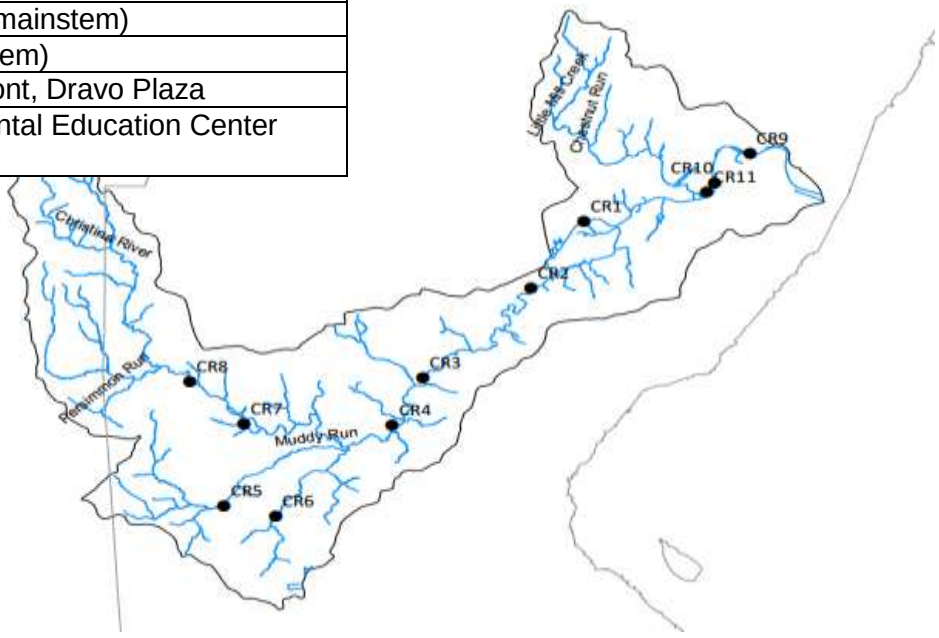
The Watershed
The Christina River, along with the Brandywine, Red Clay and White Clay creeks combine to form the Christina Basin which flows into the Delaware River at Wilmington DE. These waterways are an important drinking water supply for residents of Chester County PA and New Castle County DE. The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

The Christina River runs through downtown Wilmington. It is a critical part of the Riverfront revitalization in Wilmington, home of the Kalmar Nyckel and is the site of the Port of Wilmington, an important shipping link. The DuPont Environmental Education Center, operated by the Delaware Nature Society, is located on the Riverfront and provides visitors opportunities to learn about, and explore, the Christina River.

The Christina River drains approximately 78 square miles. Landuse is comprised of 59% urban, 25% forest/wetland, and 15% agriculture. The lower portion of the river are tidally influenced.

Site	Location
CR1	Rt 141 Boat Ramp (mainstem)
CR2	Churchmans Boat Ramp (mainstem)
CR3	Smalley's Run Road
CR4	Walther Road (mainstem)
CR5	Route 896 (Muddy Run)
CR6	Route 40 (Belltown Run)
CR7	Cooch's Bridge (mainstem)
CR8	Rittenhouse Park (mainstem)
CR9	Wilmington (mainstem)
CR10	Wilmington Riverfront, Dravo Plaza
CR11	DuPont Environmental Education Center (Tidal Gut)

The Monitoring Sites: Technical Monitoring volunteers monitored 11 locations along the Christina River and its tributaries in Delaware collecting chemistry data on a monthly basis.



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 Christina 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.

The DO standards set by the State of Delaware are a minimum of 4.0 mg/L for most waters. As data was collected during the daytime, the lowest dissolved oxygen levels (typically found near dawn) may not be truly reflect.

Average DO levels 2006 - 2015

	DO (mg/l)	% DO Saturation
CR1	7.6	73.9
CR2	6.8	65.2
CR3	8.6	83.6
CR4	8.6	83.6
CR5	7.8	76.2
CR6	8.5	83.5
CR7	8.9	86.5
CR8	9.2	89.7
CR9	7.8	69.7
CR10	8.7	76.9
CR11	10.0	112.1

All sites averaged over 6.8 mg/l of dissolved oxygen between 2006 – 2015. Site CR2 (mainstem, Churchmans Boat Ramp) had the lowest average DO of 6.8 mg/l and lowest percent saturation (65%).

Several sites had observed low dissolved oxygen readings below 4.0, typically during summer months. Percent saturation averages were also low at several sites indicating that dissolved oxygen levels may be lower than desired, especially during hot summer months.

While the overall DO results were considered good, additional monitoring in the mid-lower mainstem would be useful to better understand the periodic low values.

CR8: Rittenhouse Park, 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 Christina River consistently fell within the target range of 6.5 – 8.5 across all sites with most sites averaging 7.2. 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. Values average from 30 - 85 mg/l.

Nitrate-Nitrogen — *Summary result: Good*

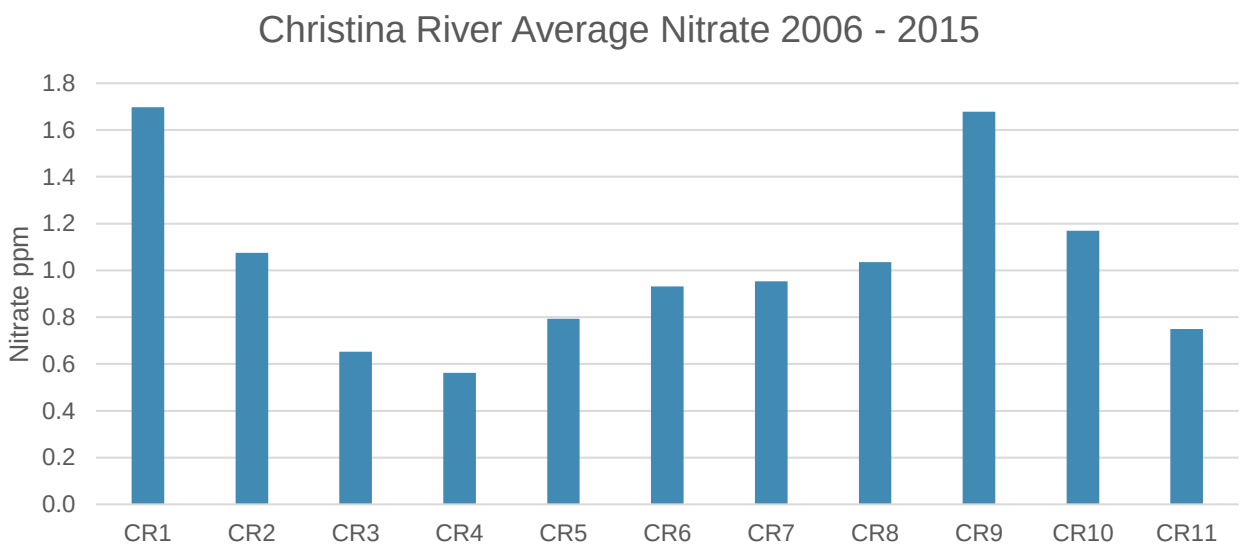
Nitrogen makes up about 80% of the air we breathe. It is an essential component of proteins and is found in the cells of all living things. Inorganic nitrogen may exist as a gas, or as nitrites, nitrates, or ammonia. Nitrate represent the most completely oxidized state of nitrogen commonly found in water. 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.

Nitrate values observed in the Christina River were consistently low with all sites averaging below 2.0 mg/l.



Phosphate ***Summary result: Good***

Phosphorus is an essential nutrient. Phosphates in water come from a variety of sources such as soil, fertilizer runoff, malfunctioning septic systems, sewage treatment plants, and manure from livestock animals. 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.

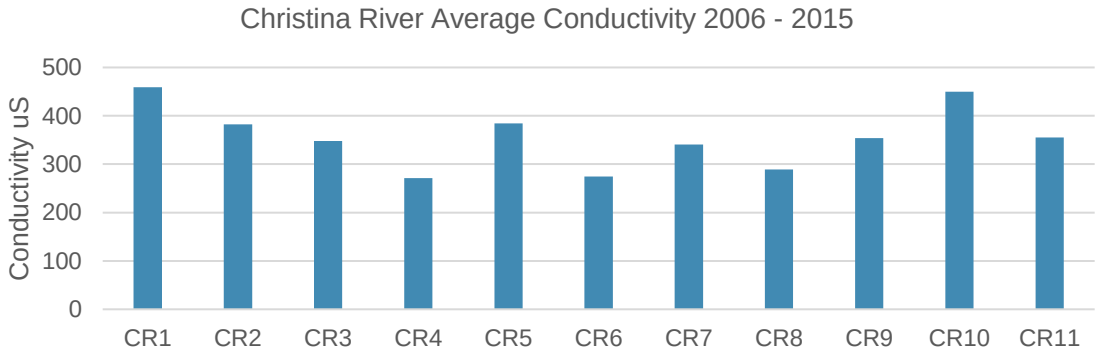
Hach Orthophosphate Field Kits were used to collect the data.

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.

Most sites averaged near, or lower than, 0.1 mg/l. Only one site - CR4 - had a high average of .30 mg/l. This average though was skewed by one high reported value which might make the site average median of 0.07 mg/l a better indicator.

Conductivity

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.



Water Quality Trends in the Christina River Watershed in Delaware

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

No significant (r-squared > 0.5) change in trends were determined for any parameter. 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. Nitrate values were generally low. Within the Christina Basin, lower nitrate values were measured in the Christina and Brandywine then at White and Red Clay Creek sites.

Dissolved oxygen readings where generally good at most sites within the Christina River, and broader Christina watershed. Site CR2 (mainstem, Churchmans Boat Ramp) though had the lowest average dissolved oxygen levels observed and should be considered for more intensive DO monitoring.

2006 – 2015 Averages

	Alkalinity (mg/l)	ph	Conductivity µS	Nitrate N (mg/l)	Phosphate (mg/l)	Water Temp (°C)	DO (mg/l)	% DO Saturation
CR1	68	7.3	459	1.7	0.10	15.1	7.6	73.9
CR2	58	7.1	382	1.1	0.12	15.1	6.8	65.2
CR3	39	6.9	348	0.7	0.10	15.4	8.6	83.6
CR4	34	6.9	271	0.6	0.30	15.3	8.6	83.6
CR5	32	6.9	384	0.8	0.11	15.7	7.8	76.2
CR6	31	6.8	275	0.9	0.13	15.2	8.5	83.5
CR7	37	7	341	1.0	0.08	15.4	8.9	86.5
CR8	37	7.2	289	1.0	0.08	14.7	9.2	89.7
CR9	85	7.6	354	1.7	0.22	14.4	7.8	69.7
CR10	59	7.4	467	1	0.06	15.0	8.1	78.5
CR11	57	7.8	355	0.8	0.09	19.6	10.0	112.1

Christina Creek Summary Data 2006 - 2015

SITE 1: CR1 - Rt 141 Boat Ramp (mainstem)

	Alkalinity (mg/l)	ph	Conductivity µS	Nitrate N (mg/l)	Phosphate (mg/l)	Water Temp (°C)	DO (mg/l)	% DO Saturation
Minimum	43	6.5	190	0.3	0.00	0.0	4.3	48.7
Maximum	90	8.5	1190	3.5	0.40	29.0	13.1	135.4
Median	68.5	7.3	370	2.0	0.10	16.0	7.3	72.7
# Data points	112	112	112	110	113	113	113	113.0

SITE 2: CR2 - Churchmans Boat Ramp (mainstem)

	Alkalinity (mg/l)	ph	Conductivity µS	Nitrate N (mg/l)	Phosphate (mg/l)	Water Temp (°C)	DO (mg/l)	% DO Saturation
Average	58	7.1	382	1.1	0.12	15.1	6.8	65.2
Minimum	30	6.3	130	0.3	0.00	0.0	2.8	35.8
Maximum	82	9.0	980	3.0	1.00	29.5	13.0	113.8
Median	57.5	7.0	330	0.5	0.10	15.5	6.7	64.9
# Data points	112	111	111	110	112	112	109	109

SITE 3: CR3 - Smalley's Run Road (mainstem)

	Alkalinity (mg/l)	ph	Conductivity µS	Nitrate N (mg/l)	Phosphate (mg/l)	Water Temp (°C)	DO (mg/l)	% DO Saturation
Average	39	6.9	348	0.7	0.10	15.4	8.6	83.6
Minimum	26	6.5	150	0.3	0.00	1.5	4.2	54.5
Maximum	56	7.5	1180	3.0	0.30	28.9	14.2	121.2
Median	40	7.0	320	0.5	0.10	15.9	8.0	80.7
# Data points	26	25	25	23	26	26	26	26

SITE 4: CR4 - Walther Road (mainstem)

	Alkalinity (mg/l)	ph	Conductivity µS	Nitrate N (mg/l)	Phosphate (mg/l)	Water Temp (°C)	DO (mg/l)	% DO Saturation
Average	34	6.9	271	0.6	0.30	15.3	8.6	83.6
Minimum	19	6.5	155	0.3	0.00	3.7	5.1	58.3
Maximum	44	7.5	563	1.0	2.80	27.0	15.2	125.9
Median	35	7.0	236	0.5	0.07	16.4	8.3	80.5
# Data points	13	12	13	12	12	13	13	13

SITE 5: CR5 - Route 896 (Muddy Run)

	Alkalinity (mg/l)	ph	Conductivity µS	Nitrate N (mg/l)	Phosphate (mg/l)	Water Temp (°C)	DO (mg/l)	% DO Saturation
Average	32	6.9	384	0.8	0.11	15.7	7.8	76.2
Minimum	18	6.3	174	0.3	0.00	0.0	4.5	49.6
Maximum	60	7.3	3100	2.0	0.24	31.3	12.9	111.8
Median	30.5	7.0	280	0.8	0.10	15.2	7.6	75.6
# Data points	42	41	43	41	43	43	42	42

SITE 6: CR6 - Route 40 (Belltown Run)

	Alkalinity (mg/l)	ph	Conductivity µS	Nitrate N (mg/l)	Phosphate (mg/l)	Water Temp (°C)	DO (mg/l)	% DO Saturation
Average	31	6.8	275	0.9	0.13	15.2	8.5	83.5
Minimum	18	6.0	175	0.3	0.02	1.1	4.8	34.2
Maximum	72	7.3	630	2.0	0.30	31.8	13.9	123.3
Median	31	7.0	270	1.0	0.10	15.8	8.0	81.4
# Data points	40	41	41	40	41	40	38	38

SITE 7: CR7 - Cooch's Bridge (mainstem)

	Alkalinity (mg/l)	ph	Conductivity µS	Nitrate N (mg/l)	Phosphate (mg/l)	Water Temp (°C)	DO (mg/l)	% DO Saturation
Average	37	7	341	1.0	0.08	15.4	8.9	86.5
Minimum	20	6.0	110	0.3	0.00	0.8	5.6	64.1
Maximum	63	7.8	1000	3.0	0.33	29.0	13.3	112.7
Median	36	7.3	320	0.8	0.06	16.0	8.7	87.0
# Data points	69	70.0	63	69.0	70.00	69.0	65.0	65

SITE 8: CR8 - Rittenhouse Park (mainstem)

	Alkalinity (mg/l)	ph	Conductivity µS	Nitrate N (mg/l)	Phosphate (mg/l)	Water Temp (°C)	DO (mg/l)	% DO Saturation
Average	37	7.2	289	1.0	0.08	14.7	9.2	89.7
Minimum	20	5.5	30	0.3	0.00	0.0	5.8	64.8
Maximum	60	7.8	660	3.0	0.29	28.0	15.4	123.7
Median	38	7.3	300	0.8	0.06	14.3	8.7	90.5
# Data points	78	78	72	79	77	79	65	65

SITE 9: CR 9 - Wilmington (mainstem)

	Alkalinity (mg/l)	ph	Conductivity µS	Nitrate N (mg/l)	Phosphate (mg/l)	Water Temp (°C)	DO (mg/l)	% DO Saturation
Average	85	7.6	354	1.7	0.22	14.4	7.8	69.7
Minimum	45	7.3	120	1.0	0.00	0.0	1.8	22.3
Maximum	173	8.0	768	5.0	0.50	28.3	13.0	101.8
Median	72	7.5	333	1.3	0.19	14.3	8.3	83.1
# Data points	15	9.0	11	14	15	15	12	12

SITE 10: CR10 - Wilmington Riverfront (mainstem)

	Alkalinity (mg/l)	ph	Conductivity µS	Nitrate N (mg/l)	Phosphate (mg/l)	Water Temp (°C)	DO (mg/l)	% DO Saturation
Average	59	7.4	467	1	0.06	15.0	8.1	78.5
Minimum	43	6.3	112	0.25	0.00	0.0	4.0	48.7
Maximum	76	8.0	1370	3.0	0.29	32.2	13.8	114.0
Median	60	7.5	370	1.0	0.00	16.0	7.9	78.2
# Data points	35	40	34	34	35	35	33	33

SITE 11: CR11 - DuPont Environmental Education Center (Tidal Gut)

	Alkalinity (mg/l)	ph	Conductivity µS	Nitrate N (mg/l)	Phosphate (mg/l)	Water Temp (°C)	DO (mg/l)	% DO Saturation
Average	57	7.8	355	0.8	0.09	19.6	10.0	112.1
Minimum	53	7.5	350	0.5	0.08	18.2	10.0	112.1
Maximum	60	8.0	360	1.0	0.10	21.0	10.0	112.1
Median	56.5	7.8	355	0.8	0.09	19.6	10.0	112.1
# Data points	2	2	2	2	2	2	1	1

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/