


Christina River



State of the Watershed

REPORT



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Cover Photo: Christina Mainstem from Churchman's Boat Ramp
Photo Location: 39.710278° -75.608056°
Photo by Ginger North

The State of the Christina River Watershed

The Watershed

The Christina River encompasses 78 square miles in Delaware and Maryland and is one of the four sub-basins that make up the larger Christina Basin watershed. The other three sub-basins empty into the Christina River before it enters the Delaware River. The lower portion is tidal. The Christina River runs through downtown Wilmington and is the home of the Kalmar Nyckel, the tall ship of Delaware, which is a replica of the original ship that brought Swedish settlers to Delaware. It is also a critical part of the Riverfront revitalization in Wilmington and is the site of the Port of Wilmington, an important shipping link.

The Monitoring Sites

Technical Monitoring Volunteers currently monitor nine locations along the Christina River and its tributaries in Delaware. Most of the monitoring sites in the Christina River watershed are on the main stem of the river, with only two sites on tributaries.

Sites #1 and #2 are affected by the tide, as water is pushed from the ocean, up the Delaware River and then up the Christina River. Site #1 is located where Rt. 141 crosses the Christina River. This location is highly urban. Site #2 is located at the Churchman's boat ramp. This state-owned property is a tidal freshwater wetland and is frequently used for recreation.

Site #3, on Smalley's Dam Road, and site #4, on Walther Road, are within a rapidly growing residential area, as is common in Northern Delaware.

Sites #5 and #6 are the only two sites located on tributaries of the Christina River. Site #5 is on Muddy Run on Old Rt. 896. Site #6 is on Belltown Run on Rt. 40

Sites #7 and #8 are reserved for monitoring by students from the University of Delaware's Wildlife Conservation Club and are among the most pristine of the Christina River monitoring locations. The Christina River is relatively small at both sites, ranking more as a creek than a river. Strikingly different between the sites is the bottom type, as site #7 is on the coastal plain and site #8 is the only monitoring location in the piedmont.

As part of the coastal plain, the stream at site #7 is broad, shallow, and sandy. Site #7 is at Cooch's Bridge, the backdrop of a Revolutionary War skirmish that marked the beginning of the Philadelphia campaign in the fall of 1777.

Site #8 is located within Rittenhouse Park and is a densely shaded, rocky piedmont stream.

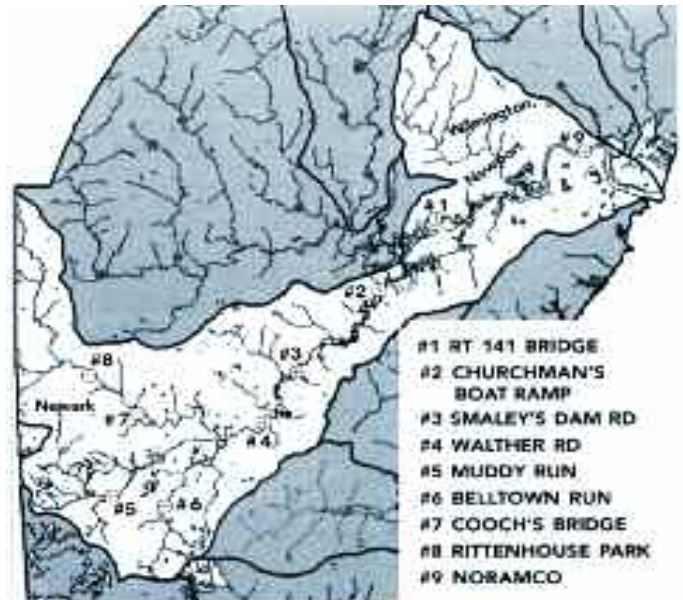
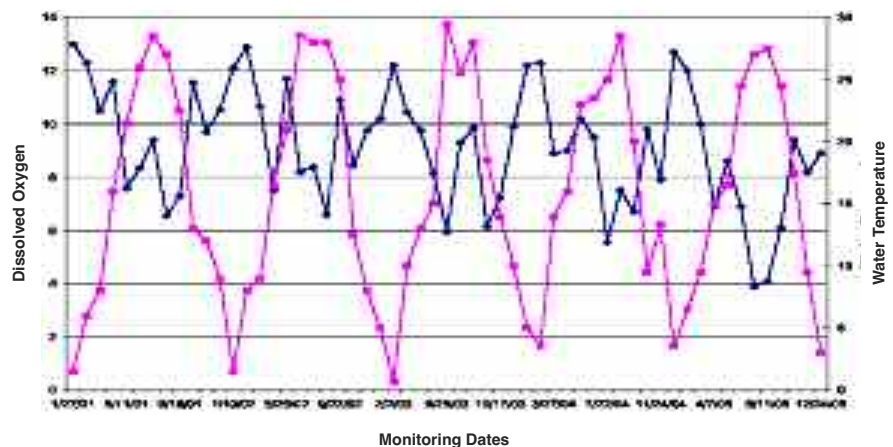


Figure 1. Dissolved oxygen and water temperature at Christina River site #1 (Jan. 2001 to Dec. 2005)



Site #9 is located in downtown Wilmington, just upstream of the confluence of Brandywine Creek and Christina River. This is the furthest downstream site monitored and is also affected by the tide. This site is at the Winchester Bridge, adjacent to the Noramco of Delaware, Inc. facility. Noramco of Delaware, Inc. provides financial support as well as volunteers to monitor this location.

Chemical Data Collected 2001 to 2005 in the Christina River Watershed

Dissolved Oxygen (DO)

The DO standards set by the State of Delaware are a minimum of 4.0 mg/L and a seasonal average of greater than 5.5 mg/L in the months June to September. Based on data collected through the Technical Monitoring program, the minimum state standards of DO were met at all sampling sites on the Christina River from 2001 to 2005 (Table 1). Average DO levels at the monitoring sites were between 4.7 mg/L and 8.4 mg/L during summer months. The furthest downstream mainstem site (Noramco) was the only site that did not meet state seasonal average standards. The seasonal average for this site was 4.7 mg/L. The relationship of dissolved oxygen and water temperature is clearly illustrated by year-round data collected under the Route 141 bridge (Figure 1).

Site lows for dissolved oxygen ranged from 2.4 mg/L (Noramco) to 7.9 mg/L (Rittenhouse Park). It is important to note that samples were taken during the day for the safety of our volunteers and may not reflect the lowest DO values possible at the sites.

Site highs for DO ranged from 8.25 mg/L (Smalley's Dam Rd.) to 10.9 mg/L (Rt. 141 Bridge).

Site lows for pH ranged from 6.0 to 6.7 for all of the monitoring sites on the Christina River (Table 1). Site highs for pH ranged from 6.5 (Belltown Run) to 8.5 (Cooch's Bridge, Noramco). The average pH levels in the Christina River fell within the standard range of 6.5 to 8.5 and tended not to vary drastically over time because of the buffering effect of alkaline ions in the water (Figure 2).

Alkalinity

The alkalinity standard set by the State of Delaware is greater than 20 mg/L. This standard was generally met at each of the Christina River sites (Table 1). Site lows for alkalinity ranged from 0 mg/L (Noramco) to 39 mg/L (Rt. 141 Bridge). All but two sites (Rt. 141 Bridge and Churchman's Boat Ramp) had minimum alkalinity values below the state standard, however, the average alkalinity at all sites was above the standard (Table 1).

Site highs for alkalinity ranged from 43 mg/L (Belltown Run) to 91 mg/L (Churchman's Boat Ramp).

Nitrate-Nitrogen

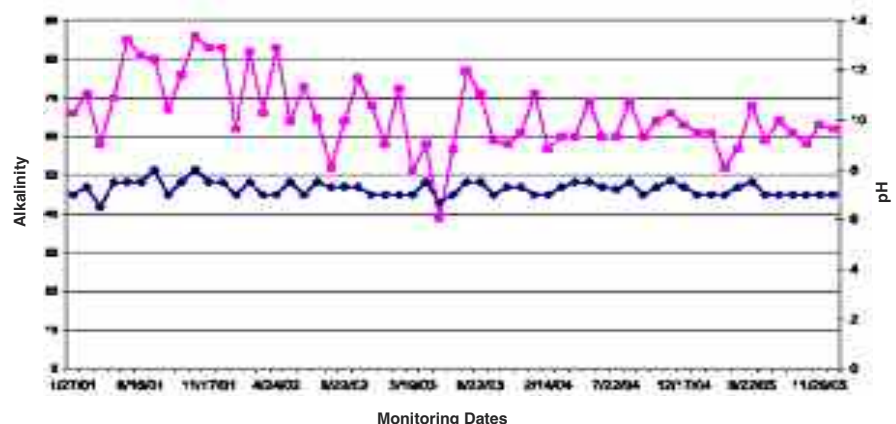
The target level for total nitrogen (all forms of nitrogen combined) in Delaware freshwater is 1.0 to 3.0 mg/L. Delaware Nature Society volunteers measure nitrate-nitrogen, which is only one component of total nitrogen. Nitrate-nitrogen averages at all sites were within or below the target level for total nitrogen (Table 1). Five of the sites did have maximum nitrate-nitrogen values that exceeded the upper limit of the target level.

Site lows for nitrate-nitrogen ranged from 0.0 mg/L (Smalley's Dam Rd., Walther Rd., Noramco) to 0.35 mg/L (Belltown Run). Site highs for nitrate-nitrogen ranged from 2.0 mg/L (Smalley's Dam Rd., Walther Rd., Muddy Run) to 6.0 mg/L (Noramco).

Conductivity

The typical range of conductivity for Delaware piedmont streams is 120 to 400 ms. Higher conductivity values would be expected in coastal plain streams, such as those monitored in this study. The average conductivity values in the Christina River watershed fell within this range, with the exception of higher conductivity values at the three sites furthest downstream (Rt. 141 Bridge, Noramco, and Churchman's Boat Ramp sites (Table 1)). All three sites are tidal and occasionally have salinity values of 1 to 3 ppt, which is consistent with higher conductivity values. The average amount of dissolved salts in the downstream sites was low in comparison to seawater, the conductivity of which is 17,500 ms.

Figure 2. Alkalinity and pH at Rt. 141 Bridge (Jan. 2001 – Dec. 2005)



Site lows for conductivity ranged from 115.7 ms (Noramco) to 201 ms (Rt. 141 Bridge). Site highs for conductivity ranged from 440 ms (Belltown Run) to 5200 ms (Rt. 141 Bridge).

Phosphate

Testing for phosphate was added to the Technical Monitoring program in March of 2002. The target range for phosphate in Delaware freshwater is 0.3 to 0.6 mg/L. Phosphate averages at all sites on the Christina River were below the target range.

Site lows ranges from <0.02 mg/L (Rt. 141 Bridge, Churchman's Boat Ramp, Smalley's Dam Rd., Walther Rd., Rittenhouse Park) to 0.03 mg/L (Muddy Run). Site highs for phosphate ranged from 0.12 mg/L (Muddy Run) to 0.7 mg/L (Churchman's Boat Ramp).

Conclusions on the Water Quality of the Christina River Watershed in Delaware

Nitrate-nitrogen averages at all sites on the Christina River were within the recommended target range while five of the sites did have maximum values that exceeded upper limit of target. If the suggested levels for total nitrogen are being exceeded in the Christina River, it is not due only to nitrate-nitrogen. Overall, the average nitrate-nitrogen levels were lower during this study period (2001-2005) than in the previous study period (1995-2000). This is an encouraging development and it will be interesting to see if this trend continues. This is an even more encouraging trend when the phosphate data results are considered. The average phosphate levels at all sites were at or below the minimum target level. With the addition of phosphate data, the nitrate levels are seen in a different context. Since both phosphate and nitrate are needed for growth, a high level of one without a high level of the other will not produce the algae blooms that are the cause for concern. Phosphate is a limiting factor in this system as it is present in very low levels. The few samples that did exceed the upper target level of nitrate will not cause the problems associated with nutrient loading without higher levels of phosphate available.

The data collected through this program indicate that dissolved oxygen values in the watershed generally meet state standards during the day, except for the site located the furthest downstream (Noramco) where 45% of the seasonal samples were below the minimum state standard. The Noramco site is a wide unshaded main stem site so higher water temperatures and therefore lower DO values are expected, the levels of DO that water can hold at these temperatures is still higher than those seen. It is not known what is causing the low DO levels at the Noramco site. The DO levels at the other sites even though they met the State standards may provide a false sense of security because the daylight sampling performed by this program does not

capture pre-dawn minimums that occur in most waterbodies during the summer months. Even if daily averages meet the required standards, oxygen may fall to deadly levels for a few hours each day. This time is all that is required to diminish the diversity of organisms that can live in a given waterway and potentially cause fish kills. No conclusions can be drawn for the two sites located on tributaries as there was only one sample recorded during the summer months.

The data collected showed that the conductivity levels were frequently above the typical range for piedmont streams. The three sites with the highest individual conductivity levels are all tidal and can be expected to have higher than the typical range for conductivity since they are influenced by the tide and occasionally have salinity values of 1 to 3 ppt. This level of salinity corresponds to higher values of conductivity by several orders of magnitude. The average levels of conductivity for all other sites were all within the typical range, and most of the individual data recorded above the range for these sites was recorded in the winter months suggesting it was due to increased salt run-off from the roads.

The two sites located on tributaries (Belltown Run and Muddy Run) had several pH samples below the state standard. For the Belltown Run site, this could be due to the lower alkalinity levels present in tributaries. Tributary sites tend to have lower values of alkalinity because their watersheds are smaller, decreasing the opportunity for ions to become dissolved in the water. Higher alkalinity levels offer increased buffering capacity stabilizing the pH.



Table 1. Summary of data collected Jan. 2001 to Dec. 2005 at monitoring sites on the Christina River and its tributaries.

SITE #1 - RT 141 BRIDGE

	Air Temp (oC)	Water Temp (oC)	*DO (mg/L)	pH	Alkalinity (mg/L)	Nitrate-N (mg/L)	Conductivity (microS)	Phosphate (mg/L)
minimum	3.5	0.7	3.9	6.5	39	0.25	201	0
maximum	34	29.5	10.9	8	86	4	5200	0.3
average	19.29	16.07	7.36	7.24	65.72	1.83	789	0.12
median	19.5	16.0	7.10	7.3	64.0	2.0	315	0.1
# of samples	55	55	20	56	57	56	57	40

SITE #2 - CHURCHMAN'S BOAT RAMP

	Air Temp (oC)	Water Temp (oC)	*DO (mg/L)	pH	Alkalinity (mg/L)	Nitrate-N (mg/L)	Conductivity (microS)	Phosphate (mg/L)
minimum	3.5	0.7	4.3	6.5	29	0.25	165	0
maximum	35	29	10.5	8	91	4	4330	0.7
average	19.20	15.93	7.61	7.08	57.06	1.19	633	0.12
median	19	16	7.90	7	58.5	1	301	0.09
# of samples	54	55	19	56	56	55	56	39

SITE #3 - SMALLEY'S DAM ROAD

	Air Temp (oC)	Water Temp (oC)	*DO (mg/L)	pH	Alkalinity (mg/L)	Nitrate-N (mg/L)	Conductivity (microS)	Phosphate (mg/L)
minimum	-2	0.5	4.5	6	16	0	172.8	0
maximum	36	30	8.25	8	58	2	1203	0.5
average	20.87	17.71	6.61	7.00	36.95	0.75	297	0.10
median	23.00	19.20	6.65	7.00	38.00	0.50	259	0.08
# of samples	38	38	15	38	37	38	38	25

SITE #4 - WALTHER ROAD

	Air Temp (oC)	Water Temp (oC)	*DO (mg/L)	pH	Alkalinity (mg/L)	Nitrate-N (mg/L)	Conductivity (microS)	Phosphate (mg/L)
minimum	0	3.3	5.4	6.5	20	0	147.7	0
maximum	36	27.5	7.95	7.5	64	2	454	0.5
average	20.48	16.45	6.87	6.98	37.84	1.09	273	0.1
median	23	17.7	6.90	7	40	1	260.5	0.1
# of samples	38	37	15	38	38	38	38	24

SITE #5 - MUDDY RUN

	Air Temp (oC)	Water Temp (oC)	*DO (mg/L)	pH	Alkalinity (mg/L)	Nitrate-N (mg/L)	Conductivity (microS)	Phosphate (mg/L)
minimum	6.4	2.6	**	6	20	0.25	170	0.03
maximum	30	20	**	7	54	2	932	0.12
average	16.82	9.89	**	6.47	36.53	0.73	375	0.08
median	17	10	**	6.50	40	0.50	256	0.06
# of samples	17	17	1	17	17	17	15	11

SITE #6 - BELLTOWN RUN

	Air Temp (oC)	Water Temp (oC)	*DO (mg/L)	pH	Alkalinity (mg/L)	Nitrate-N (mg/L)	Conductivity (microS)	Phosphate (mg/L)
minimum	7	1	**	6	10	0.35	180	0.02
maximum	28	20	**	6.5	43	4	440	0.2
average	16.76	10.08	**	6.24	30.44	1.84	266	0.09
median	17	11	**	6	32	2	250	0.08
# of samples	17	17	1	17	17	17	15	12

SITE #7 - COOCH'S BRIDGE

	Air Temp (oC)	Water Temp (oC)	*DO (mg/L)	pH	Alkalinity (mg/L)	Nitrate-N (mg/L)	Conductivity (microS)	Phosphate (mg/L)
minimum	-7	1	7.4	6.5	12	0.25	170	0.02
maximum	63	23	9	8.5	81.5	4	1013	0.14
average	14.64	11.79	8.19	7.04	43.88	1.10	350	0.09
median	14.00	11.50	8.18	7.00	40.50	0.75	300	0.09
# of samples	23	20	4	24	24	22	18	15

SITE #8 - RITTENHOUSE PARK

	Air Temp (oC)	Water Temp (oC)	*DO (mg/L)	pH	Alkalinity (mg/L)	Nitrate-N (mg/L)	Conductivity (microS)	Phosphate (mg/L)
minimum	-7	1	7.9	6.25	18	0.25	190	0
maximum	24	23	8.9	7.5	70	3	546	0.42
average	11.13	10.68	8.39	6.97	42.17	1.11	293	0.11
median	13	10.50	8.38	7	39.25	0.75	270	0.09
# of samples	25	22	4	26	26	22	19	14

SITE #9 - NORAMCO

	Air Temp (oC)	Water Temp (oC)	*DO (mg/L)	pH	Alkalinity (mg/L)	Nitrate-N (mg/L)	Conductivity (microS)	Phosphate (mg/L)
minimum	-1	0.7	2.4	6.7	0	0	115.7	0.02
maximum	47	27.3	8.5	8.5	88	6	4914	0.66
average	19.67	15.54	4.70	7.50	62.09	1.79	879.24	0.26
median	19	15.1	5.20	7.5	64	1.5	325.35	0.27
# of samples	29	26	11	31	32	32	28	12

* Average, median, and # of samples for Dissolved Oxygen data are for the months of June through September only.

**insufficient number of samples to perform statistics

Table 2. Summary of site-by-site compliance with Delaware standards and recommendations

	Dissolved Oxygen	pH (SU)	Alkalinity	Nitrate-Nitrogen	Conductivity	Phosphate
State standard or guidelines	>4.0 mg/L and a seasonal average >5.5 mg/L	6.5 to 8.5	>20 mg/L	Target level: Total nitrogen 1.0 to 3.0 mg/L	Typical range for Delaware piedmont streams: 120 to 400 μ S Seawater: 17,500 μ S	Target level: 0.3 to 0.6 mg/L
Rt 141 Bridge	Single sample below 4.0mg/L	Standards met	Single sample <20 mg/L	22% of samples \geq 3.0 mg/l of nitrate-nitrogen**	Tidal portion of stream and not piedmont	All samples within or below target range
Churchman's Boat Ramp	Standards met*	Standards met	Single sample <20 mg/L	6% of samples \geq 3.0 mg/l of nitrate-nitrogen**	Tidal portion of stream and not piedmont	Single sample above target range
Smalley's Dam Road	Standards met*	Single sample outside range	Standards met	2% of samples \geq 3.0 mg/l of nitrate-nitrogen**	13% of samples >400 ms	All samples within or below target range
Walther Road	Standards met*	Standards met	Standards met	2% of samples \geq 3.0 mg/L of nitrate-nitrogen**	5% of samples >400 ms all during winter months	All samples within or below target range
Muddy Run	Insufficient seasonal samples to determine if standards met	18% of samples <6.5	Standards met	19% of samples \geq 3.0 mg/l of nitrate-nitrogen**	33% of samples >400 ms all during winter months	All samples below target range
Belltown Road	Insufficient seasonal samples to determine if standards met	53% of samples <6.5	18% of samples <20 mg/L	15% of samples \geq 3.0 mg/l of nitrate-nitrogen**	13% of samples >400 ms all during winter months	All samples below target range
Cooch's Bridge	Standards met*	Standards met	Single sample <20 mg/L	Single sample \geq 3.0 mg/l of nitrate-nitrogen**	17% of samples >400 ms	All samples below target range
Rittenhouse Park	Standards met*	Single sample outside range	Single sample <20 mg/L	0% of samples \geq 3.0 mg/L of nitrate-nitrogen**	11% of samples >400 ms	All samples within or below target range
Noramco	45% of seasonal samples below 4.0 mg/L	Standards met	Single sample <20 mg/L	0% of samples \geq 3.0 mg/L of nitrate-nitrogen**	Tidal portion of stream and not piedmont	Single sample above target range

* Based on daytime dissolved oxygen levels. These results do not reflect the lowest dissolved oxygen levels possible.

** Nitrate-nitrogen was the only form of nitrogen measured. It is assumed that values of total nitrogen would be even higher.

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