Assessment of Measurable Water Quality Changes in the Lower Delaware Special Protection Waters

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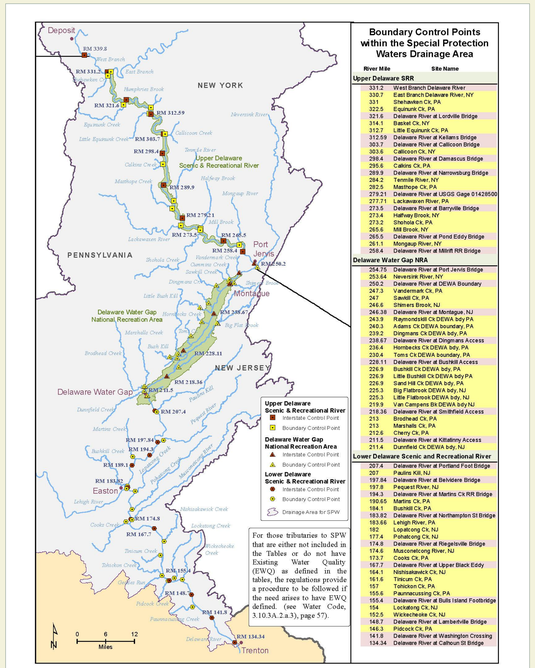
ABSTRACT

The Delaware River Basin Commission's Special Protection Waters (SPW) program provides anti-degradation protection to the majority of the non-tidal Delaware River. SPW rules require "no measurable change in existing water quality except towards natural conditions." Site-specific Existing Water Quality (EWQ) targets for 24 river and tributary locations were defined through sampling and analysis in 2000 through 2004 for the Lower Delaware. We wanted to determine whether SPW was effective at protecting EWQ. To do this, we collected new measurements in 2009 through 2011 to compare to the EWQ baseline. Results showed that EWQ was maintained at most sites for most parameters. In addition, we noted improvements in nutrient concentrations at most sites. Changes to EWQ were noted for chlorides and conductivity, consistent with national trends and usually attributed to road de-icing.

BACKGROUND



SPW rules cover 6,780 of the 13,800 sq. mi. Delaware River Basin watershed area

Monitored by the DRBC/NPS

OBJECTIVES

- To assess the effectiveness of Special Protection Waters rules and implementation measures;
- To assess "measurable change" from baseline Existing Water Quality using multiple statistical evaluations;
- To ensure that good water quality is maintained.

CONCLUSIONS

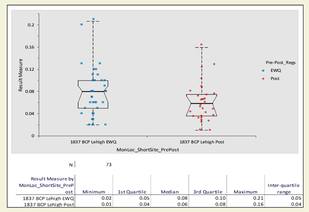
- **Most tests revealed no evidence of water quality degradation and suggest water quality improvement especially for nutrients.**
- **Based upon these results, Special Protection Waters rules appear to be effective in controlling nutrients. Discharge permits were designed with more stringent effluent limits using EWQ anti-degradation targets.**
- Chlorides and Specific Conductance increased at almost all locations (Road salting is most likely cause). Further studies are in development; we want to work with co-regulators on issue. These results are consistent with national trends wherever road de-icing is performed.
- E. Coli concentrations increased from Nishisakawick Creek (Frenchtown) southward. Bacteria source tracking and BMP implementation are recommended.
- Full report for all Delaware River and tributary monitoring sites available at:

  http://www.state.nj.us/drbc/quality/reports/biological/lower-delaware_EWQassessment2016.html

RESULTS

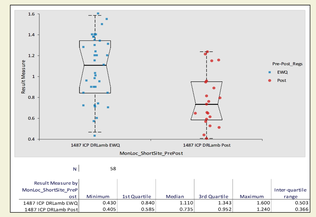
Example of Results: Improvements in Nutrients

Lehigh River
Ammonia Nitrogen as N, Total mg/L



Result Measure by Monloc_ShortSite_PrePost	N	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
1837 BCP Lehigh EWQ	73	0.02	0.05	0.08	0.10	0.21	0.05
1837 BCP Lehigh Post		0.01	0.04	0.06	0.08	0.16	0.04

Delaware River at Lambertville/New Hope
Nitrate + Nitrite as N, Total mg/L



Result Measure by Monloc_ShortSite_PrePost	N	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
1487 ICP DRLamb EWQ	58	0.430	0.840	1.110	1.343	1.600	0.503
1487 ICP DRLamb Post		0.405	0.585	0.735	0.952	1.240	0.366

Delaware River at Trenton
Nitrate + Nitrite as N, Total mg/L

Result Measure by Monloc_ShortSite_PrePost	N	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
1343 ICP DRTren EWQ	66	0.430	0.743	1.050	1.330	2.250	0.587
1343 ICP DRTren Post		0.436	0.520	0.598	0.772	0.991	0.252

Delaware River at Lambertville/New Hope
Orthophosphate as P, Total mg/L

Result Measure by Monloc_ShortSite_PrePost	N	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
1487 ICP DRLamb EWQ	58	0.010	0.030	0.040	0.060	0.120	0.050
1487 ICP DRLamb Post		0.012	0.024	0.030	0.044	0.080	0.020

OVERALL ASSESSMENT

Site Color Key: Dark Blue = Interstate Control Point (ICP); Dark Red = Pennsylvania Tributary Boundary Control Point (BCP); Dark Green = New Jersey Tributary Boundary Control Point (BCP)

Parameter	Site--->	Del. River at Trenton	Del. River at Washngtn Crossing	Pidcock Creek, PA	Delaware River at Lambrtvlle	Wicke-cheoke Creek, NJ	Lockatong Creek, NJ	Delaware River at Bulls Island	Paunа-cussing Creek, PA	Tohickon Creek, PA	Tinicum Creek, PA	Nishi-sakawick Creek, NJ	Del. River at Milford	Cooks Creek, PA	Musco-netcong River, NJ	Del. River at Rieglsvll	Pohatcong Creek, NJ	Lehigh River, PA	Del. River at Easton	Bushkill Creek, PA	Martins Creek, PA	Pequest River, NJ	Del. River at Belvidere	Paulins Kill River, NJ	Del. River at Portland
	Site Number--->	1343 ICP	1418 ICP	1463 BCP	1487 ICP	1525 BCP	1540 BCP	1554 ICP	1559 BCP	1570 BCP	1616 BCP	1641 BCP	1677 ICP	1737 BCP	1746 BCP	1748 ICP	1774 BCP	1837 BCP	1838 ICP	1841 BCP	1907 BCP	1978 BCP	1978 ICP	2070 BCP	2074 ICP
Field	Dissolved Oxygen (DO) mg/l											~													
	Dissolved Oxygen Saturation %											~													
	pH, units																								
	Water Temperature, degrees C																								
Nutrients	Ammonia Nitrogen as N, Total mg/l																								
	Nitrate + Nitrite as N, Total mg/l																**								
	Nitrogen as N, Total (TN) mg/l																**								
	Nitrogen, Kjeldahl as N, Total (TKN) mg/l																								
	Orthophosphate as P, Total mg/l																								
	Phosphorus as P, Total (TP) mg/l																								
Bacteria	Enterococcus colonies/100 ml	~			~																				
	Escherichia coli colonies/100 ml	**	**	**	**	**	**			**	**	**													
	Fecal coliform colonies/100 ml																								
Conventionals	Alkalinity as CaCO3, Total mg/l																								
	Hardness as CaCO3, Total mg/l											~													
	Chloride, Total mg/l			**		**	**	**	**	**		**	**	**	**	**	**	**	~	**	**	**	**		**
	Specific Conductance µmho/cm			**		**	**	~	**	**	**	**	**	**	**	~	**	**	~	~	~	**	~		
	Total Dissolved Solids (TDS) mg/l																								
	Total Suspended Solids (TSS) mg/l																								
	Turbidity NTU																								

RESULT KEY⟶ : = No indication of measurable change to EWQ; ** = Indication of measurable water quality change toward more degraded status; ~ = Weak indication of measurable water quality change toward more degraded status

Downstream ⟵ ⟶ Upstream

METHODS

Monitoring Methods

- May through September sampling, some monthly, some bi-weekly
- 22 parameters
- Nutrients (TP, Orthophosphate, TN, Ammonia, TKN, Nitrate+Nitrite)
- Conventional parameters (Alkalinity, Hardness, Chlorides, TDS, TSS, Turbidity)
- Bacteria (Fecal coliforms, Enterococcus, E. coli)
- Field parameters (DO, DO%, pH, Specific Conductance, Temperature)
- Flow monitoring (Gage Height, Discharge)
- All EPA or USGS methods, EPA-Approved QAPP
- QA sampling included Replicates, Field Blanks, and Sample Equipment Rinsate Blanks
- Note: a copy of the QAPP is available at:

http://www.state.nj.us/drbc/library/documents/SRMP_QAPP2013.pdf

Assessment Methods

5 techniques were used at each to assess for changes between the EWQ and post-EWQ time periods:

1. Scatter Plot of Concentration vs. Stream Flow (cfs), EWQ vs. Post-EWQ
2. Scatter Plot of Annual Concentration, 2000-2011
3. Box Plot Comparison of EWQ vs. Post-EWQ Concentrations
4. Cumulative Distribution Function (CDF) Comparison of EWQ vs. Post-EWQ
5. Kruskal-Wallis Statistical Test of Difference between EWQ and Post-EWQ