Chapter 12: 1677 ICP Delaware River at Milford/Upper Black Eddy

1677 ICP
Delaware River at Upper Black Eddy Bridge
Analysis of flow differences between the EWQ and post-EWQ periods:

Flow was roughly the same between the EWQ and post-EWQ periods. Fewer samples were collected in the post-EWQ period, and the range of flow conditions sampled was narrower. Flow is plotted on a logarithmic scale.

For many of the water quality parameters to follow, there were an insufficient number of samples taken to set up a good statistical comparison between the two periods. For the next assessment round biweekly instead of monthly sampling is recommended.

Annual flow statistics are plotted above. These are May to September flow measurements associated with the time of each water quality sample. Flow is interpolated at this location using drainage area weighting based on the USGS continuous stream gage at Trenton, NJ. “Normal” flow is about 9,000 cfs at this location on the Delaware River, but median summer flows are typically around 5,000 cfs.

Upstream ICP: Delaware River at Riegelsville 1748 ICP
Downstream ICP: Del. River at Bulls Island 1554 ICP

Tributary BCP Watersheds in Upstream Reach:
Musconetcong River, NJ – 1746 BCP
Cooks Creek, PA – 1737 BCP

All other tributary watersheds are less than 20 square miles and have little effect upon the Delaware River.
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Alkalinity as CaCO3, Total mg/l

Existing Water Quality (Table 2O):

Median 44 mg/l
Lower 95% Confidence Interval 37 mg/l
Upper 95% Confidence Interval 49 mg/l
Defined in regulations as a flow-related parameter

No water quality degradation is evident here. Alkalinity apparently did not measurably change between the EWQ and post-EWQ periods. Potential laboratory artifacts and insufficient post-EWQ sampling introduced analytical uncertainty. Alkalinity is inversely related to flow in both data sets. Post-EWQ median alkalinity fell within EWQ 95% confidence intervals. Flow is plotted on a logarithmic scale.
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Ammonia Nitrogen as N, Total mg/l

Existing Water Quality (Table 20):

Median <0.05 mg/l
Lower 95% Confidence Interval <0.05 mg/l
Upper 95% Confidence Interval 0.05 mg/l

No water quality degradation is evident here. Ammonia concentrations apparently declined. However, potential laboratory artifacts, detection limit differences, and insufficient post-EWQ sampling frequency (n=14) introduced analytical uncertainty.

Post-EWQ median ammonia concentration was below the EWQ lower 95% confidence interval. No independent data were available to validate results. EWQ data possessed 25/40 undetected results which interfered with calculation of the median value. Thus EWQ was established as <0.05 mg/l. Under 2009-2011 lower detection levels there was only one undetected result, revealing actual low-level ammonia concentrations. Some evidence for water quality improvement exists as post-EWQ data contained no concentrations above 0.04 mg/l. Flow is plotted on a logarithmic scale.
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Chloride, Total mg/l

Existing Water Quality (Table 20):

Median 17 mg/l
Lower 95% Confidence Interval 15 mg/l
Upper 95% Confidence Interval 20 mg/l
Defined in regulations as a flow-related parameter

Water quality degradation is evident here. Chloride concentrations apparently rose by about 5 mg/l between the two periods. Potential laboratory artifacts and insufficient post-EWQ sampling frequency (n=14) introduced analytical uncertainty. Post-EWQ median concentration rose above the EWQ upper 95% confidence interval. Both data sets are inversely flow-related. The post-EWQ data are not fully representative of flow conditions, as few samples were collected under high flow conditions. Bi-weekly instead of monthly sampling is recommended for the next assessment.
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Dissolved Oxygen (DO) mg/l

Existing Water Quality (Table 20):

Median 8.74 mg/l
Lower 95% Confidence Interval 8.20 mg/l
Upper 95% Confidence Interval 8.96 mg/l

No water quality degradation is evident here. No measurable change took place between the EWQ and Post-EWQ periods. There were too few post-EWQ samples (n=12). Post-EWQ median DO concentration fell within the EWQ 95% confidence intervals. Flow is plotted on a logarithmic scale. DO concentration is unrelated to flow in both data sets.
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Dissolved Oxygen Saturation %

Existing Water Quality (Table 20):

Median 96%
Lower 95% Confidence Interval 95%
Upper 95% Confidence Interval 97%

No water quality degradation is evident here. Dissolved Oxygen Saturation is unrelated to flow, and did not measurably change between the EWQ and post-EWQ periods. Post-EWQ median DO saturation fell below the lower EWQ 95% confidence interval, though the difference was not significant due to insufficient post-EWQ sampling (n=12). Flow is plotted on a logarithmic scale.
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Enterococcus colonies/100 ml

Existing Water Quality (Table 20):
Median 45/100 ml
Lower 95% Confidence Interval 28/100 ml
Upper 95% Confidence Interval 98/100 ml

No water quality degradation is evident here. Enterococci did not measurably change between the EWQ and Post-EWQ periods. Uncertainty is introduced into comparisons by potential laboratory artifacts and insufficient post-EWQ sampling frequency. Both data sets are unrelated to flow. Post-EWQ samples were not representative of the full range of flow conditions. Note that concentrations and flows are plotted on a logarithmic scale. Post-EWQ median enterococcus concentrations fell within the EWQ 95% confidence intervals.
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Escherichia coli colonies/100 ml

Existing Water Quality (Table 20):

Median 28/100 ml
Lower 95% Confidence Interval 15/100 ml
Upper 95% Confidence Interval 60/100 ml
Defined in regulations as a flow-related parameter

No water quality degradation is evident here. E. coli concentrations apparently did not change between the EWQ and Post-EWQ periods. Uncertainty is introduced into comparisons by potential laboratory artifacts and insufficient post-EWQ sampling frequency (n=12). Post-EWQ median E. coli fell within the EWQ 95% confidence intervals. Note that concentrations and flows are plotted on a logarithmic scale.

E. coli concentrations were positively but weakly related to flow in the EWQ data set, but unrelated to flow in the post-EWQ data set. Post-EWQ data were not fully representative of flow conditions. No independent data were available for validation.
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Fecal coliform colonies/100 ml

Existing Water Quality (Table 20):

Median 60/100 ml
Lower 95% Confidence Interval 40/100 ml
Upper 95% Confidence Interval 120/100 ml
Defined in regulations as a flow-related parameter

No water quality degradation is evident here. Fecal coliform concentrations apparently did not measurably change between the EWQ and post-EWQ periods. Uncertainty is introduced into comparisons by potential laboratory artifacts and insufficient post-EWQ sampling frequency (n=14). Fecal coliform concentrations are weakly related to flow in the EWQ data set, and positively related to flow in the post-EWQ data set. Post-EWQ median concentrations were within the EWQ 95% confidence intervals. Note that concentrations and flows are plotted on a logarithmic scale.
No water quality degradation is evident here. Hardness apparently did not measurably change between the EWQ and post-EWQ periods. Uncertainty is introduced into comparisons by potential laboratory artifacts and insufficient post-EWQ sampling frequency (n=14). Hardness is inversely related to flow in both data sets. Post-EWQ median hardness was at the EWQ upper 95% confidence interval, but the increase was not significant. Flows are plotted on a logarithmic scale.
Nitrate + Nitrite as N, Total mg/l

Existing Water Quality (Table 2O, as Nitrate only):

Median 1.09 mg/l
Lower 95% Confidence Interval 0.96 mg/l
Upper 95% Confidence Interval 1.25 mg/l

No water quality degradation is evident here. Nitrate concentrations apparently declined between the EWQ and post-EWQ periods. Uncertainty is introduced into comparisons by potential laboratory artifacts, different detection limits and insufficient post-EWQ sampling frequency (n=14).

Kruskal-Wallis test

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<td>1677 ICP DRMilford Post</td>
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H statistic 8.96
p-value 0.0028

Reject the null hypothesis in favour of the alternative hypothesis at the 5% significance level.

Nitrate is unrelated related to flow in the EWQ data set, but inversely related to flow in the post-EWQ data set. Post-EWQ concentrations fell below the EWQ lower 95% confidence interval. Post-EWQ nitrate + nitrite concentrations were assumed equivalent for comparison with EWQ nitrate concentrations since EWQ nitrite concentrations were never detected. Flow is plotted on a logarithmic scale. Independent data were not available for validation of DRBC data.
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Nitrogen as N, Total (TN) mg/l

Existing Water Quality (Table 2O):
Median 1.48 mg/l
Lower 95% Confidence Interval 1.23 mg/l
Upper 95% Confidence Interval 1.68 mg/l

No water quality degradation is evident here. Total Nitrogen concentrations apparently declined between the EWQ and post-EWQ periods. Uncertainty is introduced into comparisons by potential laboratory artifacts, different detection limits and insufficient post-EWQ sampling frequency (n=14). TN is inversely related to flow in the post-EWQ data set, but unrelated to flow in the EWQ data set. Flow is plotted on a logarithmic scale. DRBC results could not be independently validated. Post-EWQ median TN concentrations fell below the EWQ lower 95% confidence interval.
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Nitrogen, Kjeldahl as N, Total (TKN) mg/l

Existing Water Quality (Table 2O):
Median 0.34 mg/l
Lower 95% Confidence Interval 0.26 mg/l
Upper 95% Confidence Interval 0.46 mg/l

No water quality degradation is evident here. TKN concentrations apparently did not measurably change between the EWQ and post-EWQ periods, though the post-EWQ range was far narrower and all concentrations were less than 0.5 mg/l. Uncertainty is introduced into comparisons by potential laboratory artifacts and insufficient post-EWQ sampling frequency (n=14). TKN concentration is unrelated to flow in both data sets. Flow is plotted on a logarithmic scale. Post-EWQ median TKN was within the EWQ 95% confidence intervals but very near the lower interval.
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Orthophosphate as P, Total mg/l

Existing Water Quality (Table 20):

- Median 0.04 mg/l
- Lower 95% Confidence Interval 0.04 mg/l
- Upper 95% Confidence Interval 0.07 mg/l

No water quality degradation is evident here. Orthophosphate concentrations apparently declined. Uncertainty in comparisons was introduced by potential laboratory artifacts, declining detection limits and insufficient post-EWQ sampling frequency. Both data sets are weakly and inversely related to flow. Post-EWQ median orthophosphate fell below the EWQ lower 95% confidence interval. A water quality improvement is evidenced in that there were no post-EWQ concentrations higher than 0.07 mg/l. There were no independent data to confirm DRBC results.
No water quality degradation is evident here. pH did not measurably change between the EWQ and post-EWQ periods. pH is weakly related to flow in both data sets. Note that flows are plotted on a logarithmic scale. Post-EWQ median pH was just above the EWQ upper 95% confidence interval, but the increase was statistically insignificant. There were too few samples collected in the post-EWQ period. This is a wide, shallow reach of the Delaware, where primary productivity is high – indicated by occasional spikes above pH 9.
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Phosphorus as P, Total (TP) mg/l

Existing Water Quality (Table 20):

Median 0.09 mg/l
Lower 95% Confidence Interval 0.07 mg/l
Upper 95% Confidence Interval 0.12 mg/l

No water quality degradation is evident here. Total Phosphorus (TP) concentrations apparently declined between the EWQ and post-EWQ periods. Uncertainty in comparisons was introduced by potential laboratory artifacts, declining detection limits and insufficient post-EWQ sampling frequency (n=14). Post-EWQ median total phosphorus fell below the EWQ lower 95% confidence interval. TP is unrelated to flow in both data sets. Flow is plotted on a logarithmic scale. No independent data were available to confirm these results.
Specific Conductance µmho/cm

Existing Water Quality (Table 20):
Median 189 µmho/cm
Lower 95% Confidence Interval 159 µmho/cm
Upper 95% Confidence Interval 203 µmho/cm
Defined in regulations as a flow-related parameter

Water quality degradation is evident here. Specific conductance rose by 26 µmhos/cm; above the EWQ upper 95% confidence interval. However, uncertainty is introduced by insufficient post-EWQ sampling frequency and under-sampling of the full range of flow conditions. Specific conductivity is inversely related to flow in both data sets. Flow is plotted on logarithmic scale. The rise in specific conductance may be associated with the concurrent rise in chloride concentrations. Median specific conductance has risen from 189 to 215 µmhos/cm; a 14% increase.
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Total Dissolved Solids (TDS) mg/l

Existing Water Quality (Table 2O):

Median 149 mg/l
Lower 95% Confidence Interval 130 mg/l
Upper 95% Confidence Interval 160 mg/l

Defined in regulations as a flow-related parameter.

No water quality degradation is evident here. TDS apparently declined between the EWQ and post-EWQ periods. Uncertainty in comparisons was introduced by potential laboratory artifacts and insufficient post-EWQ sampling frequency (n=14). TDS is inversely related to flow in both data sets. Post-EWQ median TDS fell below the EWQ lower 95% lower confidence interval. Post-EWQ TDS was much less variable than the baseline samples as well. There were no undetected results at any time. Flow is plotted on a logarithmic scale.
Total Suspended Solids (TSS) mg/l

Existing Water Quality (Table 20):

Median 6.0 mg/l
Lower 95% Confidence Interval 4.5 mg/l
Upper 95% Confidence Interval 7.0 mg/l
Defined in regulations as a flow-related parameter

No water quality degradation is evident here. TSS apparently declined between EWQ and post-EWQ periods. Uncertainty in comparisons was introduced by potential laboratory artifacts, insufficient post-EWQ sampling frequency, and under-representation of post-EWQ flow conditions. TSS is positively related to flow in both data sets. Post-EWQ median TSS fell below the lower EWQ 95% confidence interval. Both flow and concentration are plotted on a logarithmic scale.
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Turbidity NTU

Existing Water Quality (Table 20):

Median 2.9 NTU
Lower 95% Confidence Interval 2.2 NTU
Upper 95% Confidence Interval 3.8 NTU
Defined in regulations as a flow-related parameter

No water quality degradation is evident here. Turbidity appeared to decline between the EWQ and post-EWQ periods. Uncertainty in comparisons was introduced by insufficient post-EWQ sampling frequency (n=13). Post-EWQ median turbidity fell below the EWQ 95% confidence interval. Turbidity is weakly related to flow in both data sets. Both concentration and flow are represented on logarithmic scales.
No water quality degradation is evident here. Water temperature did not measurably change between the EWQ and post-EWQ periods. Uncertainty in comparisons was introduced by insufficient post-EWQ sampling frequency (n=12). Water temperature is weakly related to flow in both data sets. Flow is plotted on a logarithmic scale.