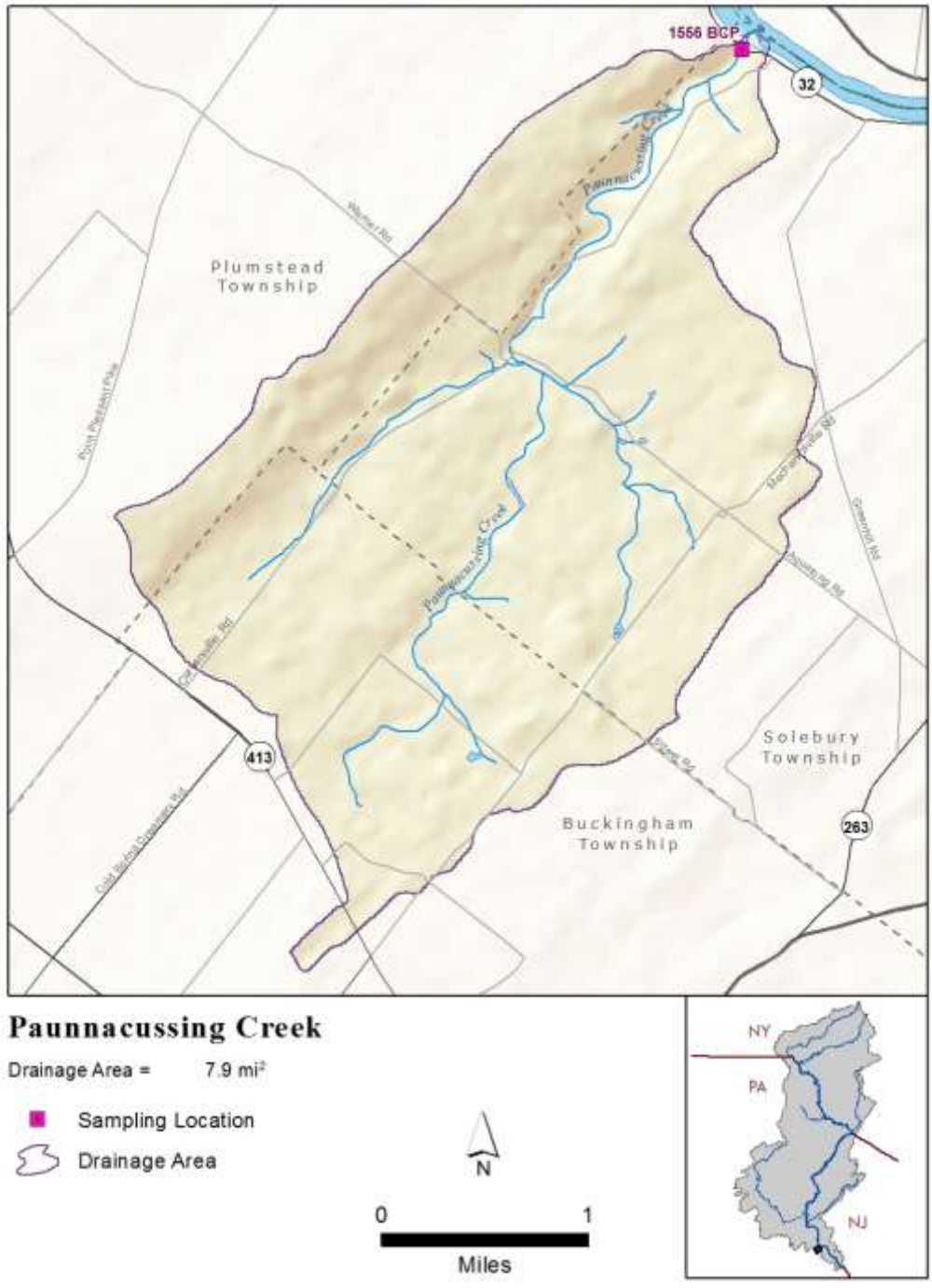
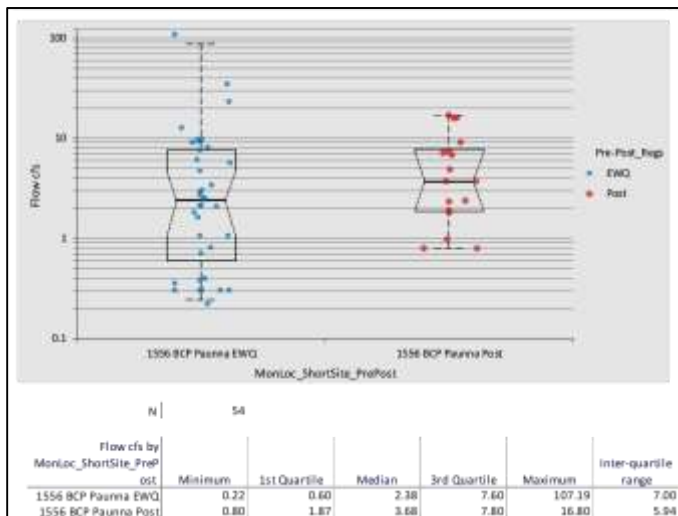


Chapter 8: 1556 BCP Paunacussing Creek, Bucks County, PA



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.

Kruskal-Wallis test

Flow cfs by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1556 BCP Paunna EWQ	37	134.3	3.63
1556 BCP Paunna Post	17	292.4	17.20

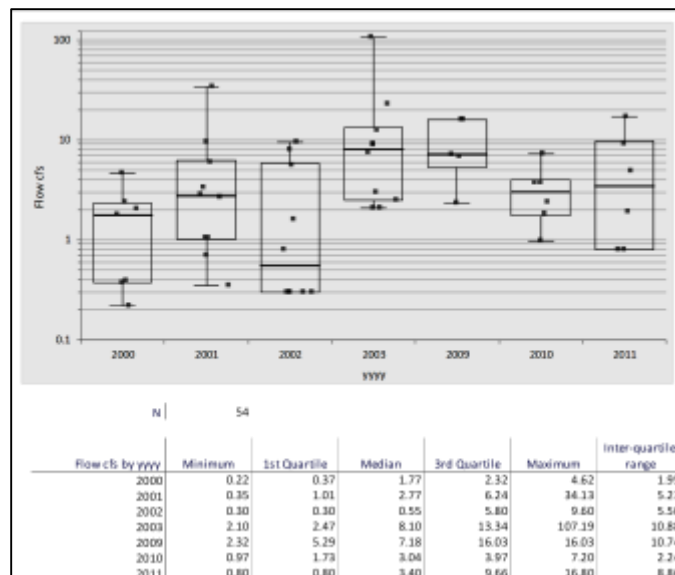
H statistic: 1.73
 X² approximation: 1.73
 DF: 1
 p-value: 0.1889¹

H0: $\theta_1 = \theta_2 = \dots$
 The median of the populations are all equal.
 H1: $\theta_i \neq \theta_j$ for at least one i, j
 The median of the populations are not all equal.

¹ Do not reject the null hypothesis at the 5% significance level.

The 7.9 square mile Paunacussing Creek watershed was included within the Wild and Scenic designation of the Lower Delaware. The watershed is about 50% forested, and less than 1% urban land cover. There is no carbonate bedrock in the watershed, so water quality should be similar to other Piedmont streams.

Upstream ICP: Delaware River at Milford 1677 ICP
 Downstream ICP: Del. River at Bulls Island 1554 ICP



Annual May to September flow statistics are plotted above. Flow is plotted on a logarithmic scale. These are flow measurements or sometimes estimates associated with the time of each water quality sample. “Normal” annual median flow is about 7.1 cfs at this location, but the summer seasonal flow is around 5 cfs. Though a wide range of flows were sampled by DRBC, these data sets appear to be most representative of low flow conditions. EWQ samples (2000-2003) were taken using a DRBC gage and rating curve established for Paunacussing Creek, but the rating was too difficult to maintain because of channel instability and bridge reconstruction. 2009-2011 flows corresponding to each water quality sample were estimated using the USGS BaSE program (Stuckey, M.H., Koerkle, E.H., and Ulrich, J.E., 2012, Estimation of baseline daily mean streamflows for ungaged locations on Pennsylvania streams, water years 1960–2008: U.S. Geological Survey Scientific Investigations Report 2012–5142, 61 p.). DRBC benchmarked water surface elevation measurements are still used to check BaSE estimates.

Chapter 8: 1556 BCP Paunacussing Creek, PA

Alkalinity as CaCO₃, Total mg/l

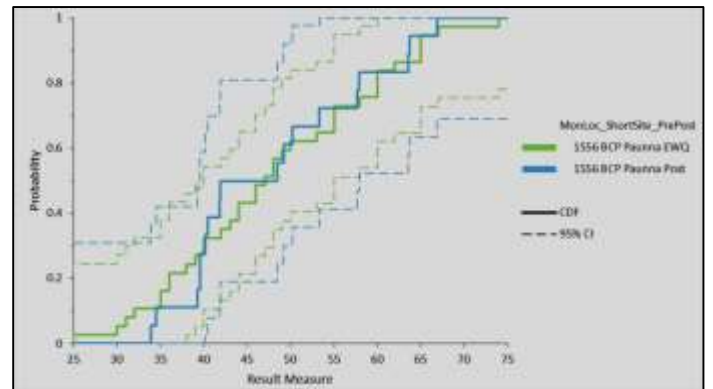
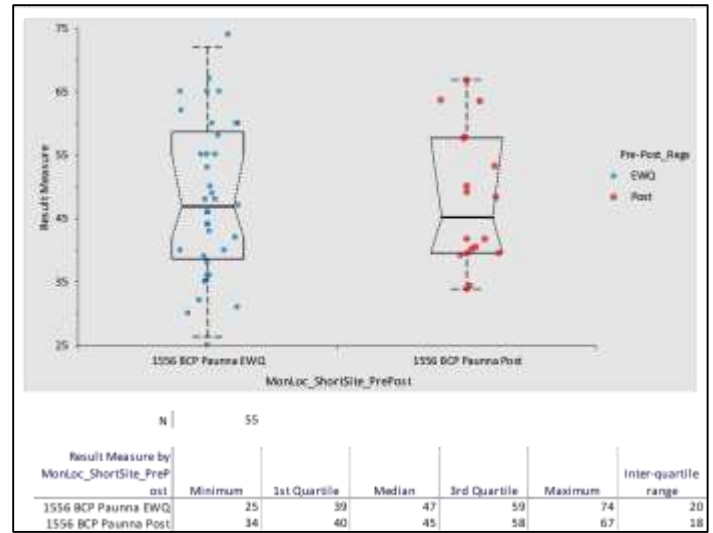
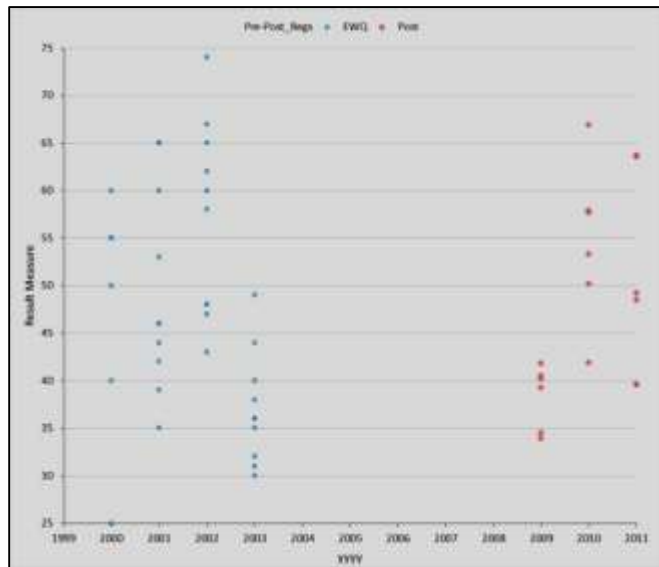
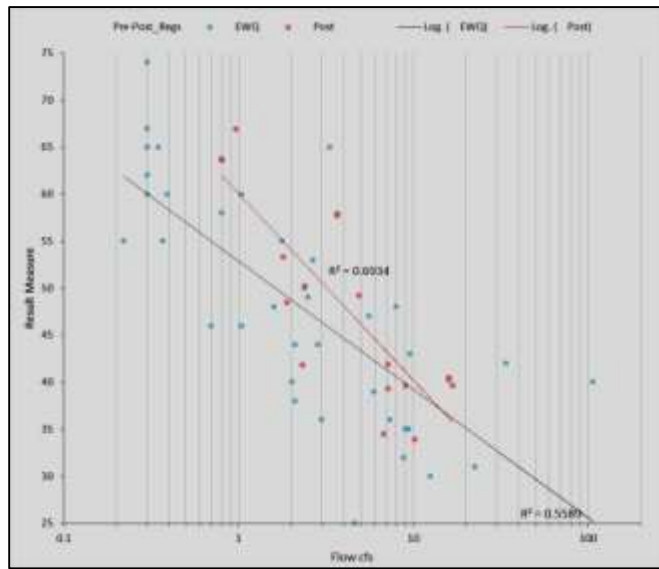
Existing Water Quality (Table 2S):

Median 47 mg/l

Lower 95% Confidence Interval 42 mg/l

Upper 95% Confidence Interval 55 mg/l

Defined in regulations as a flow-related parameter



Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1556 BCP Paunna EWQ	37	0.4	0.01
1556 BCP Paunna Post	18	0.9	0.05

H statistic	0.01
χ^2 approximation	0.01
DF	1
p-value	0.9428 ¹

H0: $\theta_1 = \theta_2 = \dots$
 The median of the populations are all equal.
 H1: $\theta_i \neq \theta_j$ for at least one i, j
 The median of the populations are not all equal.
¹ Do not reject the null hypothesis at the 5% significance level.

No water quality degradation is evident. Alkalinity did not measurably change between the EWQ and post-EWQ periods. 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.

Chapter 8: 1556 BCP Paunacussing Creek, PA

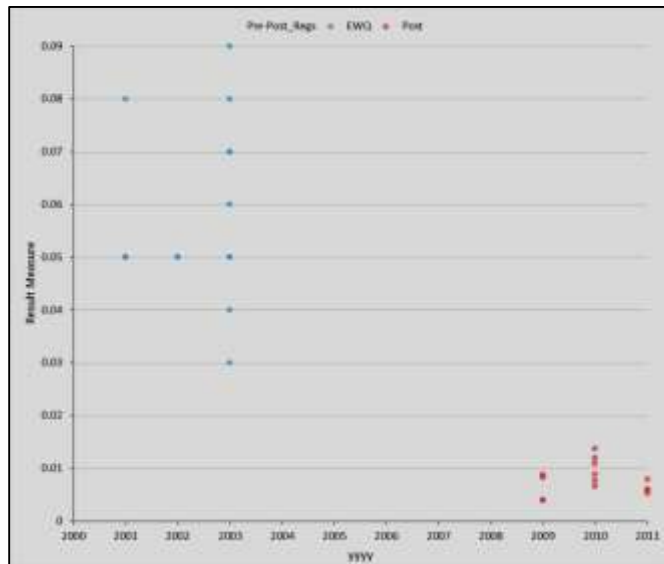
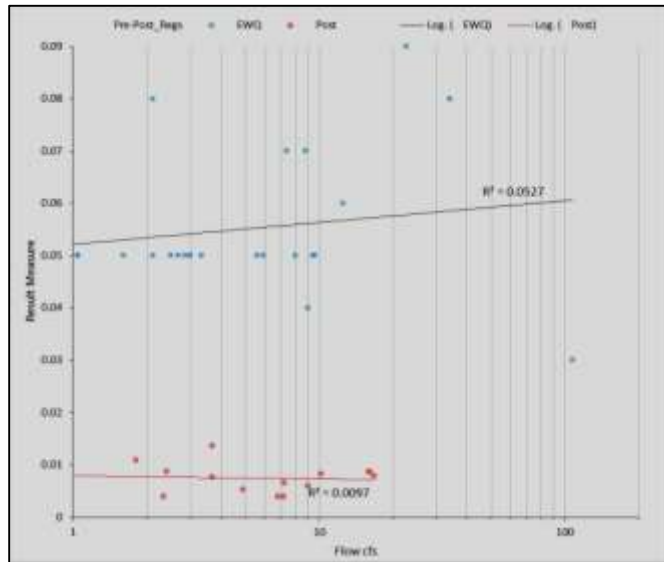
Ammonia Nitrogen as N, Total mg/l

Existing Water Quality (Table 2S):

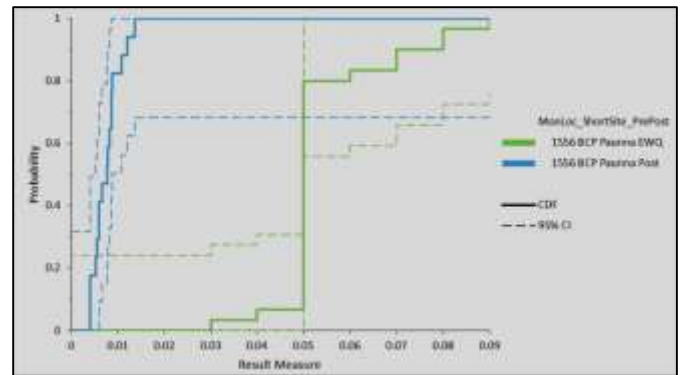
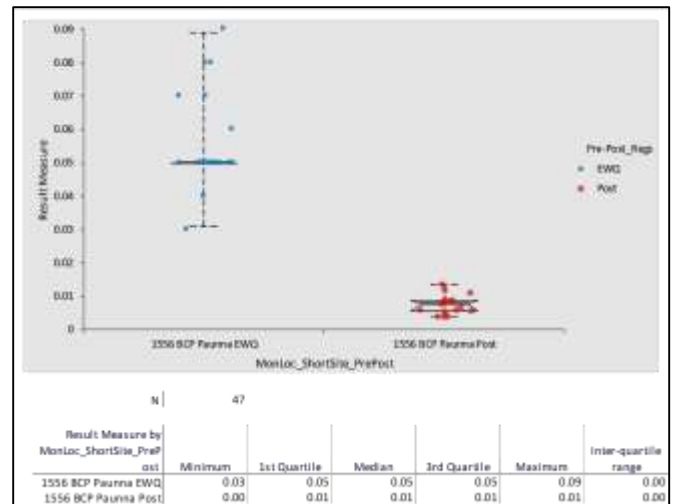
Median <0.05 mg/l

Lower 95% Confidence Interval <0.05 mg/l

Upper 95% Confidence Interval <0.05 mg/l



No water quality degradation is evident. Ammonia concentrations apparently declined. However, detection limit differences, potential laboratory artifacts, and insufficient post-EWQ sampling (n=17) introduced uncertainty to conclusions.



Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1556 BCP Paunna EWQ	30	2167.5	72.25
1556 BCP Paunna Post	17	3825.0	225.00

H statistic 35.53
 X² approximation 35.53
 DF 1
 p-value <0.0001¹

H0: $\theta_1 = \theta_2 = \dots$

The median of the populations are all equal.

H1: $\theta_i \neq \theta_j$ for at least one i,j

The median of the populations are not all equal.

¹ Reject the null hypothesis in favour of the alternative hypothesis at the 5% significance level.

Post-EWQ median concentration was below the EWQ lower 95% confidence interval. No independent data were available to validate the decline. DRBC's post-EWQ detection limit was lower than during the EWQ period. EWQ data set possessed many non-detect results (24 of 30 samples). Thus EWQ was established as "less than" 0.05 mg/l, the detection limit at the time. From 2009-2011 there were 4/17 non-detect results at detection limits of 0.004-0.006 mg/l. Now we can see what the real concentrations are, well-below 0.05 mg/l. Post-EWQ concentrations measured no higher than 0.014 mg/l, suggesting water quality improvement.

Chapter 8: 1556 BCP Paunacussing Creek, PA

Chloride, Total mg/l

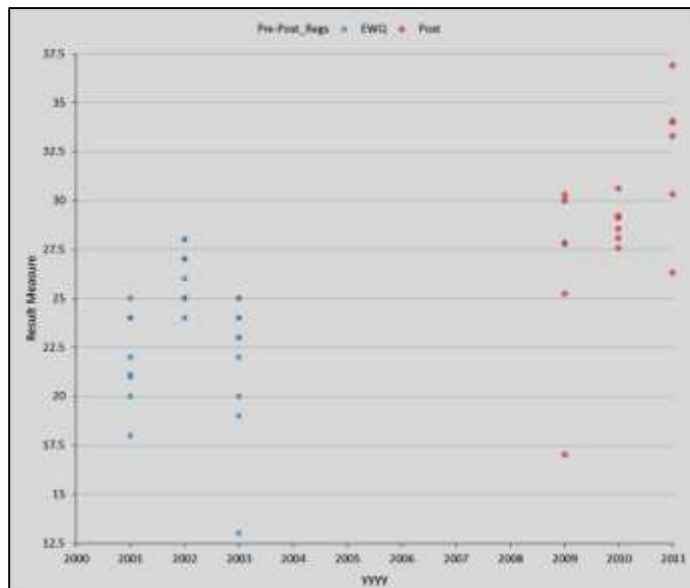
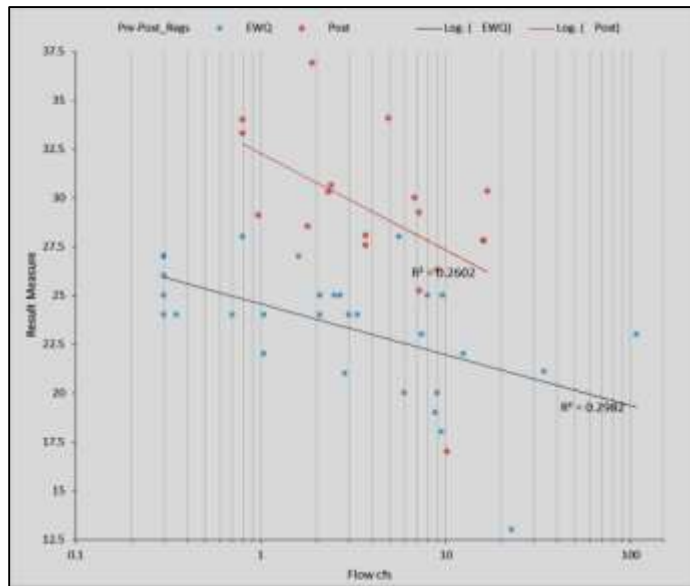
Existing Water Quality (Table 2S):

Median 24 mg/l

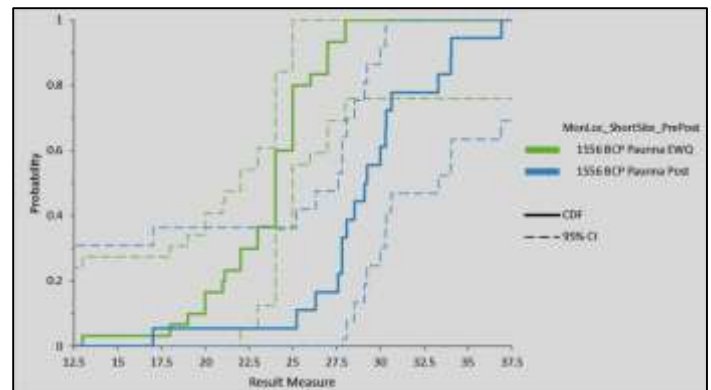
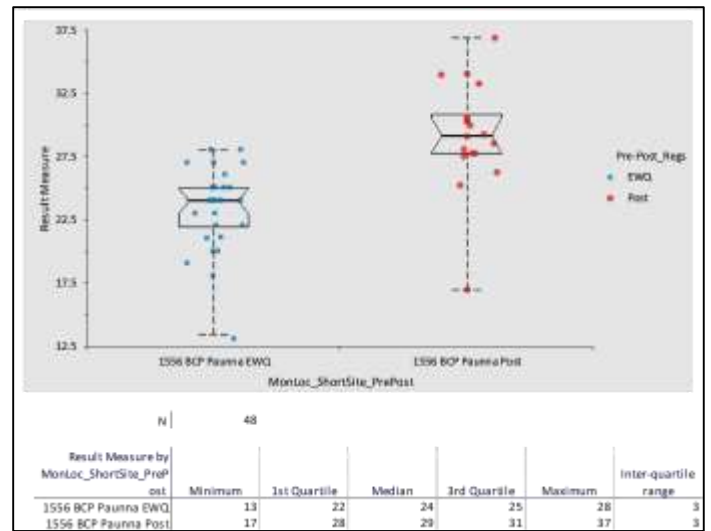
Lower 95% Confidence Interval 23 mg/l

Upper 95% Confidence Interval 25 mg/l

Defined in regulations as a flow-related parameter



Water quality degradation is evident. Chloride concentrations increased by 5 mg/l between the two periods. Post-EWQ median concentration rose above the EWQ upper 95% confidence interval.



Kruskal-Wallis test

Result Measure by MontLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1556 BCP Paunna EWQ	30	1672.5	55.75
1556 BCP Paunna Post	18	2787.6	154.86

H statistic	22.88
χ^2 approximation	22.88
DF	1
p-value	<0.0001 ¹

H0: $\theta_1 = \theta_2 = \theta_3 = \dots$

The median of the populations are all equal.

H1: $\theta_i \neq \theta_j$ for at least one i,j

The median of the populations are not all equal.

¹ Reject the null hypothesis in favour of the alternative hypothesis at the 5% significance level.

Chloride concentrations are weakly and inversely related to flow. We can only speculate at the reason for increasing chloride concentrations. There are no new discharge permits in the watershed. While these concentrations are far better than water quality criteria levels, such a large increase in so short a time deserves further investigation in this designated Wild and Scenic watershed.

Chapter 8: 1556 BCP Paunacussing Creek, PA

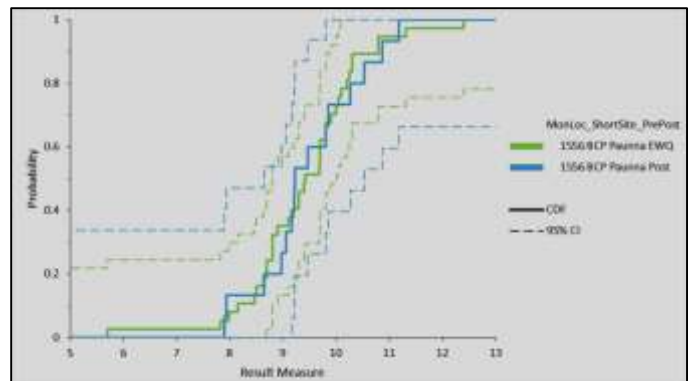
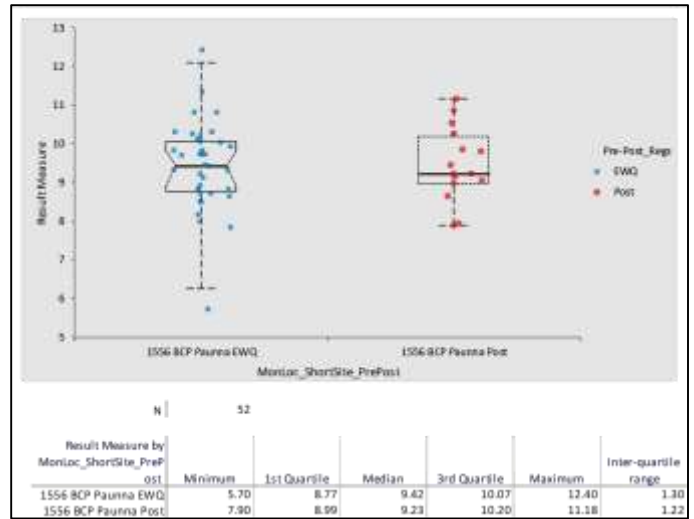
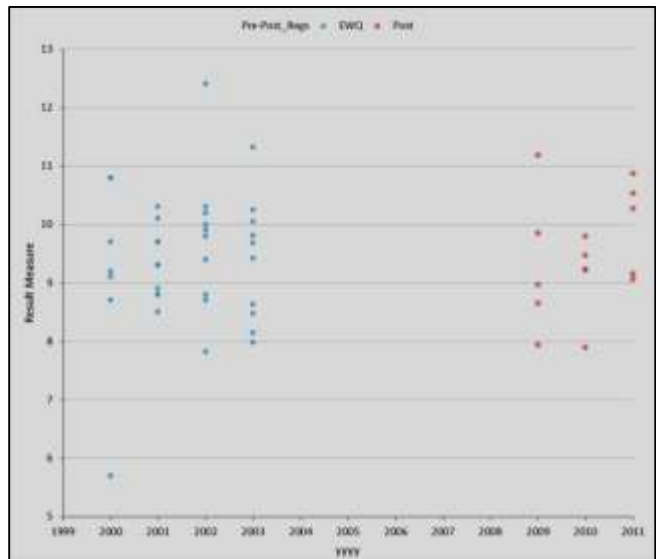
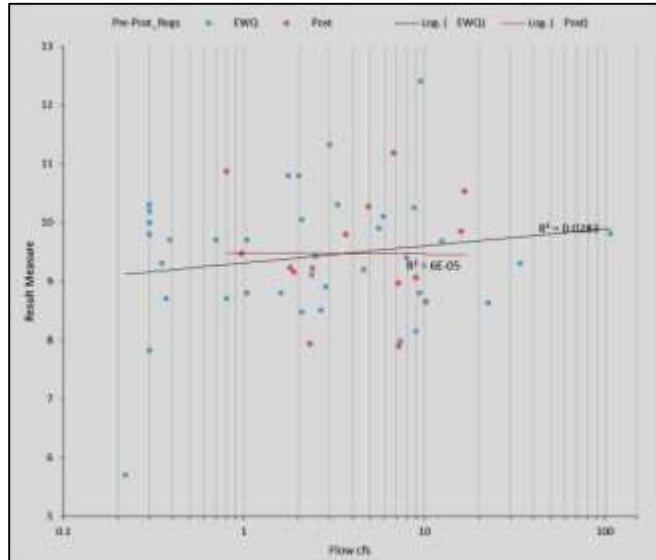
Dissolved Oxygen (DO) mg/l

Existing Water Quality (Table 2S):

Median 9.42 mg/l

Lower 95% Confidence Interval 8.90 mg/l

Upper 95% Confidence Interval 9.81 mg/l



Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1556 BCP Paunna EWQ	37	0.7	0.02
1556 BCP Paunna Post	15	1.7	0.11

H statistic: 0.01
 X² approximation: 0.01
 DF: 1
 p-value: 0.9195¹

H0: $\theta_1 = \theta_2 = \theta...$
 The median of the populations are all equal.
 H1: $\theta_i \neq \theta_j$ for at least one i,j
 The median of the populations are not all equal.

¹ Do not reject the null hypothesis at the 5% significance level.

No water quality degradation is indicated. No measurable change took place between the EWQ and Post-EWQ periods. 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. There was an extreme low DO value in the EWQ data set. That measurement was taken from a standing pool during dry conditions in July 2000 when flow in Paunacussing Creek was 0.2 cfs. The pool was full of decomposing organic matter that drove DO concentration to 5.7 mg/l.

Chapter 8: 1556 BCP Paunacussing Creek, PA

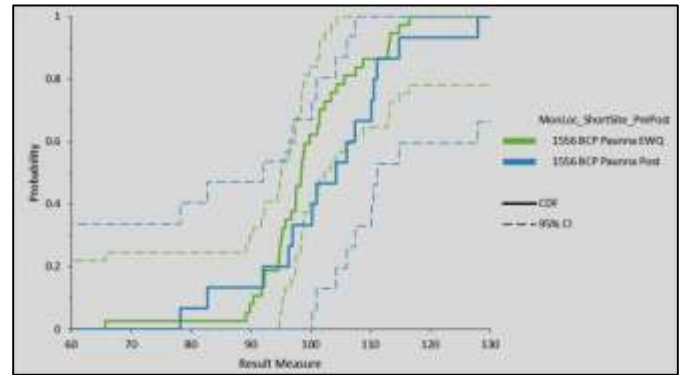
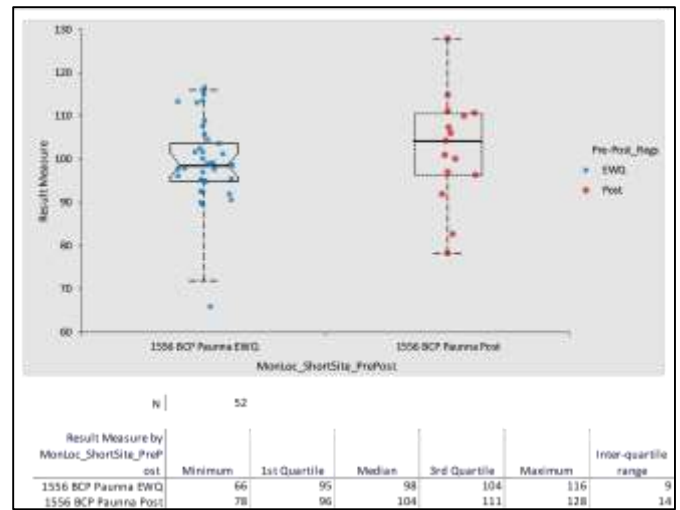
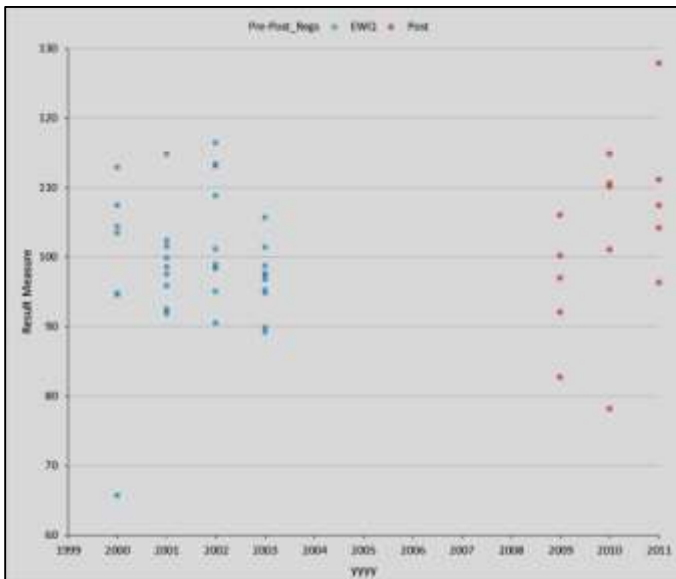
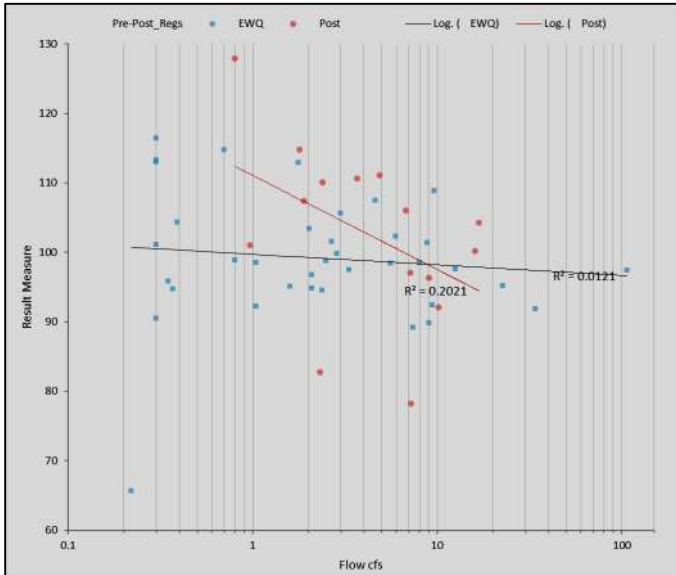
Dissolved Oxygen Saturation %

Existing Water Quality (Table 2S):

Median 98%

Lower 95% Confidence Interval 96%

Upper 95% Confidence Interval 101%



Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1556 BCP Paunna EWQ	37	95.7	2.59
1556 BCP Paunna Post	15	236.0	15.73

H statistic	1.44
X ² approximation	1.44
DF	1
p-value	0.2295 ¹

H₀: θ₁ = θ₂ = θ_{...}
 The median of the populations are all equal.
 H₁: θ_i ≠ θ_j for at least one i, j
 The median of the populations are not all equal.
¹ Do not reject the null hypothesis at the 5% significance level.

Some riparian trees were removed during bridge reconstruction between the EWQ and post-EWQ periods. This may account for the slight increase in DO saturation. Upon tree removal more light strikes the stream and promotes algal production. During mid-day hours the plants produce oxygen super-saturation conditions, thus the observed median value of 104%.

There was an extreme low DO saturation value in the EWQ data set. That measurement was taken from a standing pool during dry conditions in July 2000 when flow in Paunacussing Creek was estimated at 0.2 cfs. The pool contained decomposing organic matter that drove DO to 5.7 mg/l, and DO saturation to 65%.

No water quality degradation is indicated. DO Saturation is unrelated to flow, and did not measurably change between the EWQ and post-EWQ periods. Post-EWQ median DO saturation rose to the EWQ upper 95% confidence interval, but not significantly. Flow is plotted on a logarithmic scale.

Chapter 8: 1556 BCP Paunacussing Creek, PA

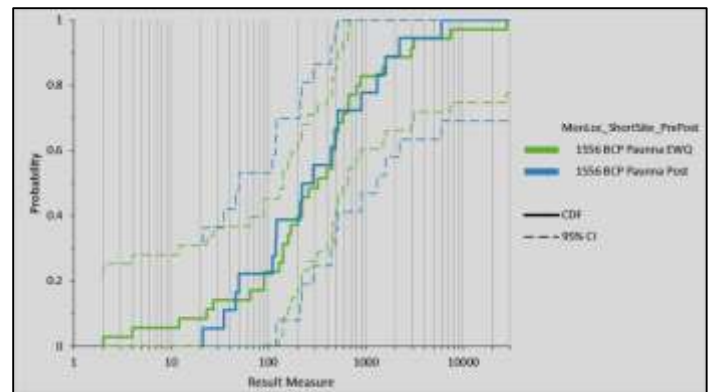
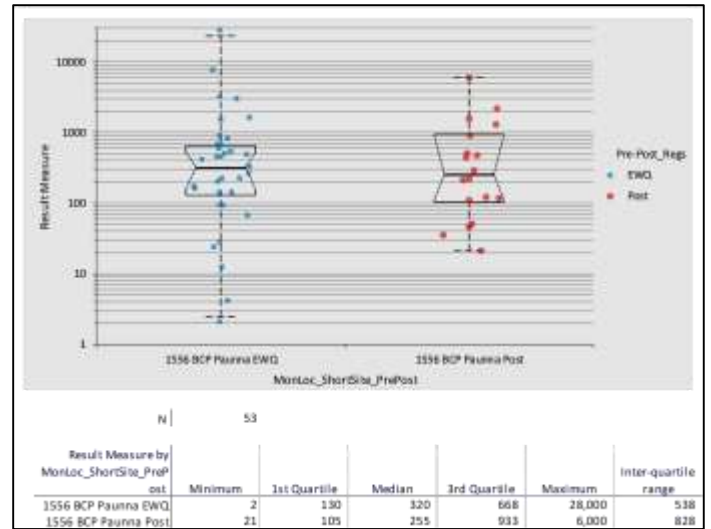
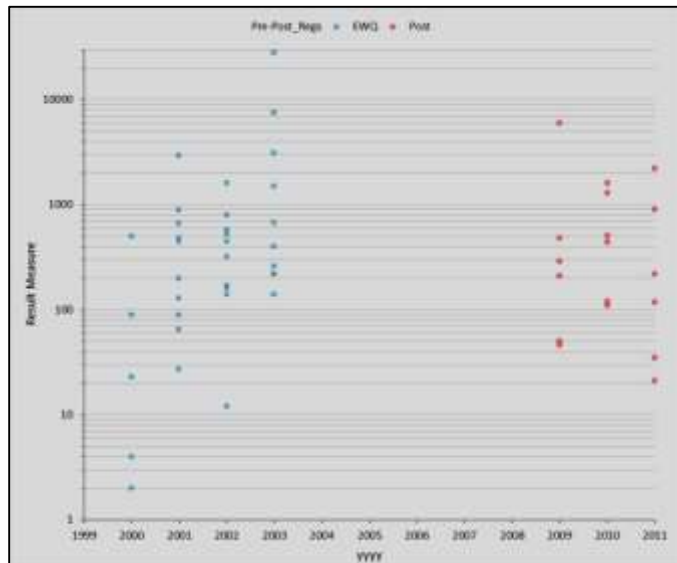
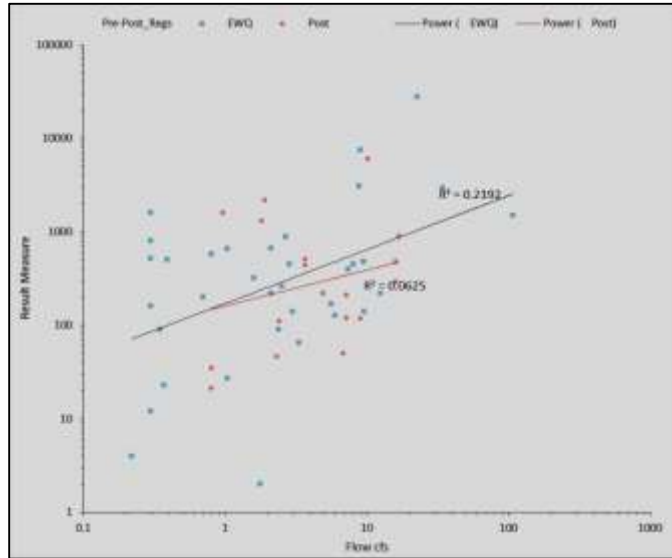
Enterococcus colonies/100 ml

Existing Water Quality (Table 2S):

Median 320/100 ml

Lower 95% Confidence Interval 160/100 ml

Upper 95% Confidence Interval 520/100 ml



Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1556 BCP Paunna EWQ	35	3.5	0.10
1556 BCP Paunna Post	18	6.7	0.37

H statistic	0.04
χ^2 approximation	0.04
DF	1
p-value	0.8363 ¹

H0: $\theta_1 = \theta_2 = \theta_3 \dots$
 The median of the populations are all equal.
 H1: $\theta_i \neq \theta_j$ for at least one i, j .
 The median of the populations are not all equal.
¹ Do not reject the null hypothesis at the 5% significance level.

No water quality degradation is evident. Enterococci did not measurably change between the EWQ and Post-EWQ periods. Enterococcus concentrations are unrelated to flow in both data sets. Note that concentrations and flows are plotted on a logarithmic scale. Post-EWQ median enterococcus concentrations were within the EWQ 95% confidence intervals.

Chapter 8: 1556 BCP Paunacussing Creek, PA

Escherichia coli colonies/100 ml

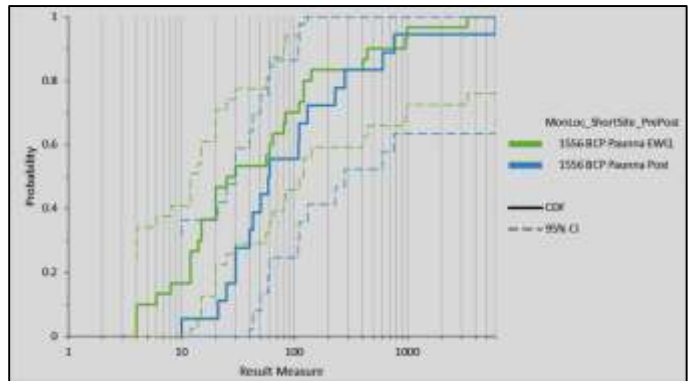
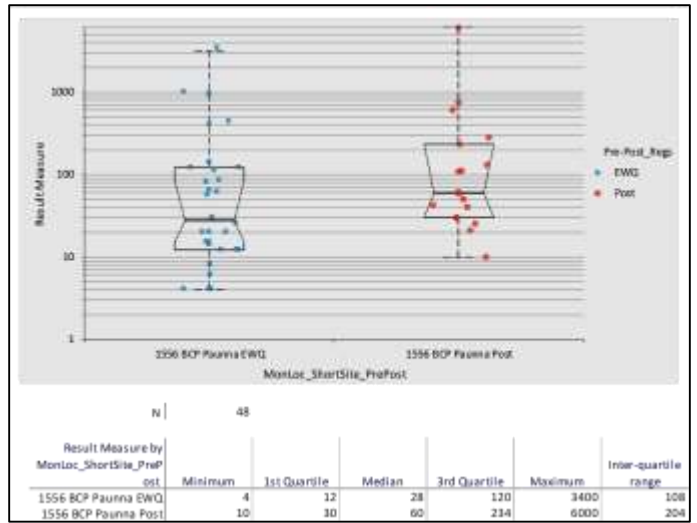
Existing Water Quality (Table 2S):

Median 28/100 ml

Lower 95% Confidence Interval 15/100 ml

Upper 95% Confidence Interval 84/100 ml

Defined in regulations as a flow-related parameter

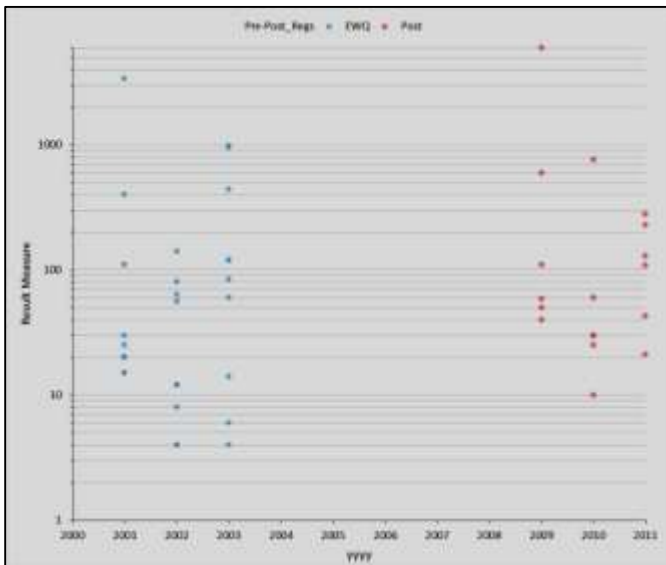
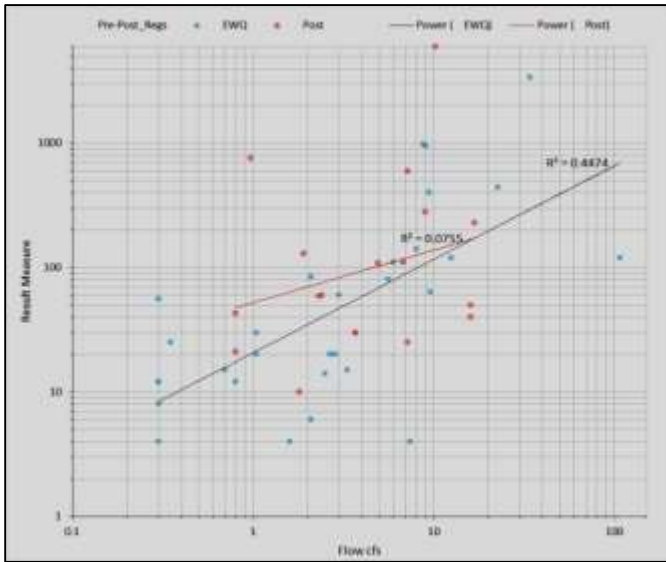


Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1556 BCP Paunna EWQ	30	200.2	6.67
1556 BCP Paunna Post	18	333.7	18.54

H statistic: 2.73
 X² approximation: 2.73
 DF: 1
 p-value: 0.0987¹

H0: $\theta_1 = \theta_2 = \theta...$
 The median of the populations are all equal.
 H1: $\theta_i \neq \theta_j$ for at least one i, j
 The median of the populations are not all equal.
¹ Do not reject the null hypothesis at the 5% significance level.



No water quality degradation is evident. E. coli concentrations did not measurably change between the EWQ and Post-EWQ periods. Post-EWQ median E. coli fell within the EWQ 95% confidence intervals.

E. coli concentrations were positively related to flow in the EWQ data set, but unrelated to flow in the post-EWQ data set – possibly due to too few post-EWQ samples (n=18). No independent data from other agencies were available at this site to validate DRBC’s conclusion.

Chapter 8: 1556 BCP Paunacussing Creek, PA

Fecal coliform colonies/100 ml

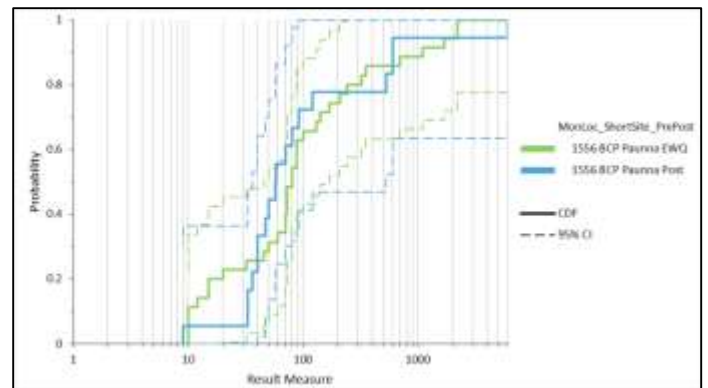
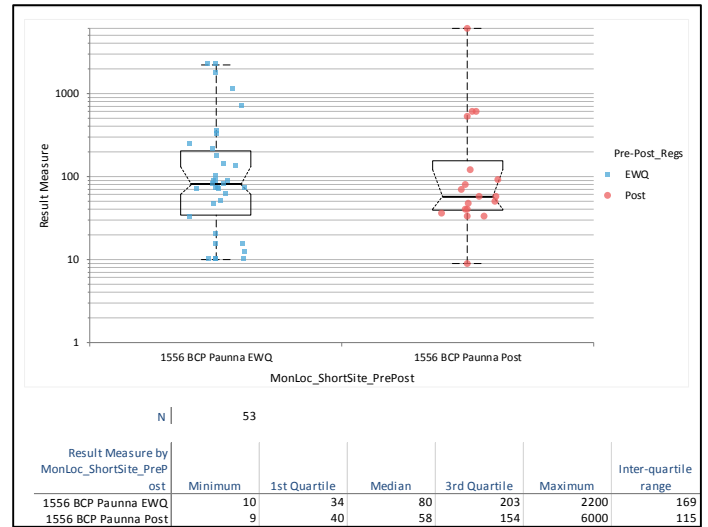
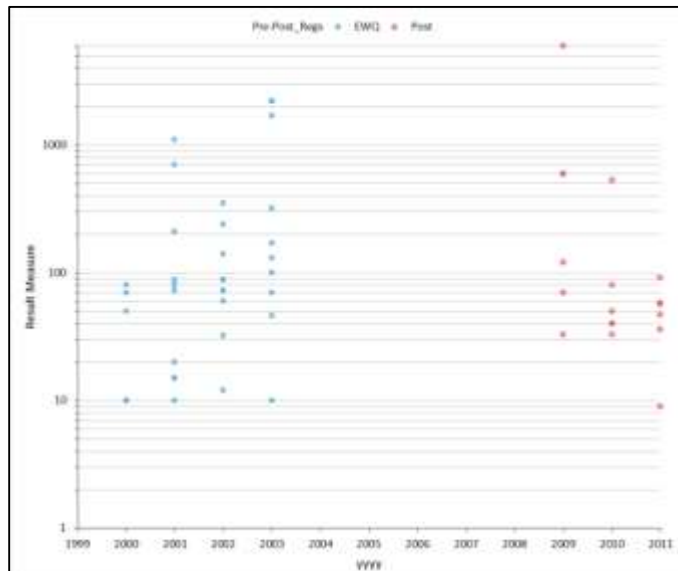
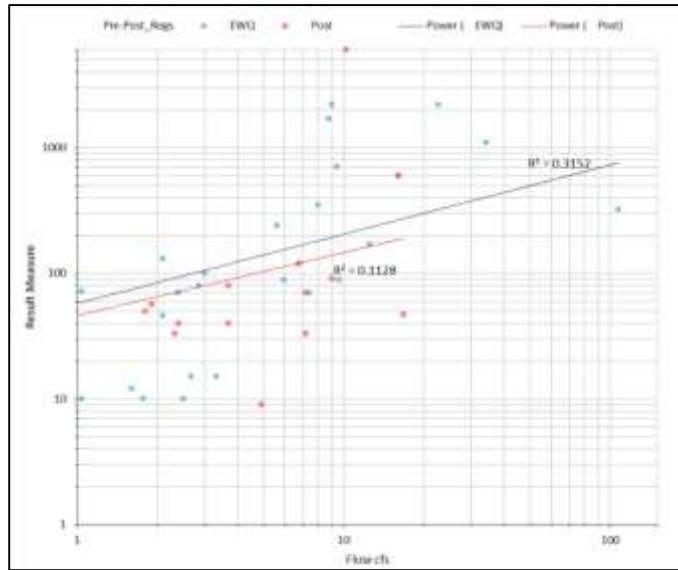
Existing Water Quality (Table 2S):

Median 80/100 ml

Lower 95% Confidence Interval 60/100 ml

Upper 95% Confidence Interval 130/100 ml

Defined in regulations as a flow-related parameter



Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost			
ost	n	Rank sum	Mean rank
1556 BCP Paunna EWQ	35	20.1	0.57
1556 BCP Paunna Post	18	39.0	2.17

H statistic: 0.25
 X² approximation: 0.25
 DF: 1
 p-value: 0.6185¹

H0: $\theta_1 = \theta_2 = \dots$
 The median of the populations are all equal.
 H1: $\theta_i \neq \theta_j$ for at least one i,j
 The median of the populations are not all equal.
¹ Do not reject the null hypothesis at the 5% significance level.

No water quality degradation is evident. Fecal coliform concentrations did not measurably change between the EWQ and post-EWQ periods. Fecal coliform concentrations are positively related to flow in the EWQ data set, but not in the post-EWQ data set - because of too few post-EWQ samples (n=18).

Post-EWQ median concentrations fell just below the EWQ lower 95% confidence interval, but the data were naturally variable and post-EWQ N was low so no real change could be measured. Note that concentrations and flows are plotted on a logarithmic scale.

Chapter 8: 1556 BCP Paunacussing Creek, PA

Hardness as CaCO₃, Total mg/l

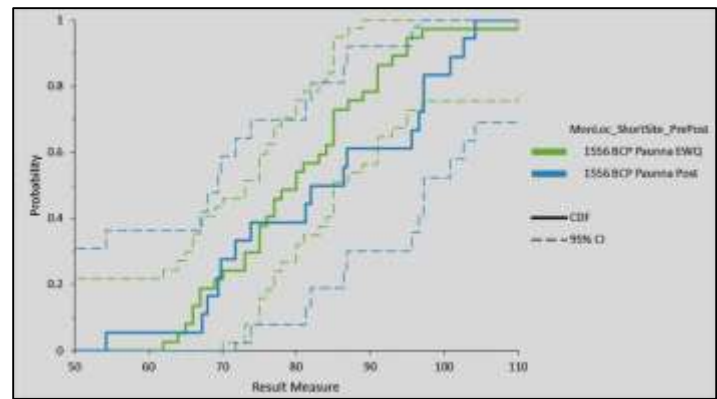
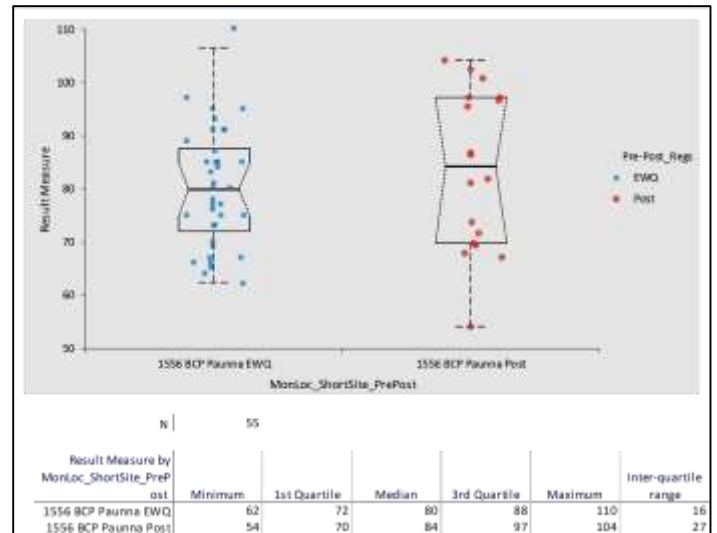
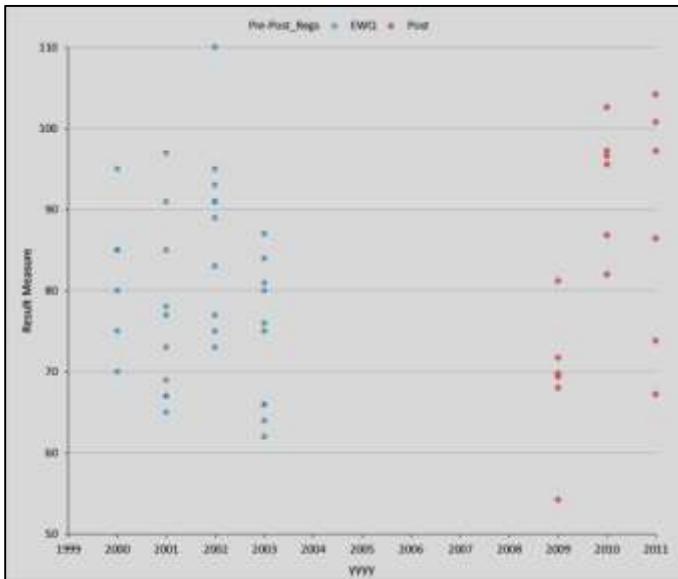
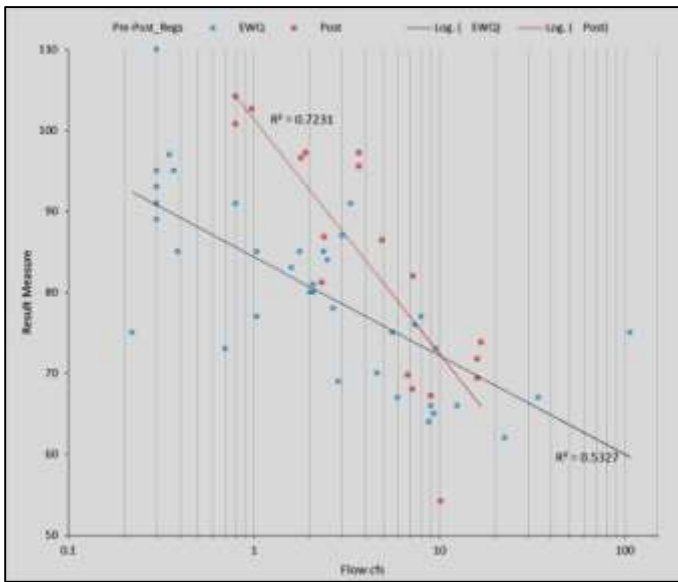
Existing Water Quality (Table 2S):

Median 80 mg/l

Lower 95% Confidence Interval 75 mg/l

Upper 95% Confidence Interval 85 mg/l

Defined in regulations as a flow-related parameter



Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost		n	Rank sum	Mean rank
1556 BCP Paunna EWQ	ost	37	107.3	2.90
1556 BCP Paunna Post	ost	18	220.5	12.25

H statistic	1.28
X ² approximation	1.28
DF	1
p-value	0.2582 ¹

H₀: θ₁ = θ₂ = 0...

The median of the populations are all equal.

H₁: θ_i ≠ θ_j for at least one i, j

The median of the populations are not all equal.

¹ Do not reject the null hypothesis at the 5% significance level.

No water quality degradation is evident. Hardness did not measurably change between the EWQ and post-EWQ periods. Hardness is inversely related to flow in both data sets. Post-EWQ median hardness fell within the EWQ 95% confidence intervals. Note that flows are plotted on a logarithmic scale.

Chapter 8: 1556 BCP Paunacussing Creek, PA

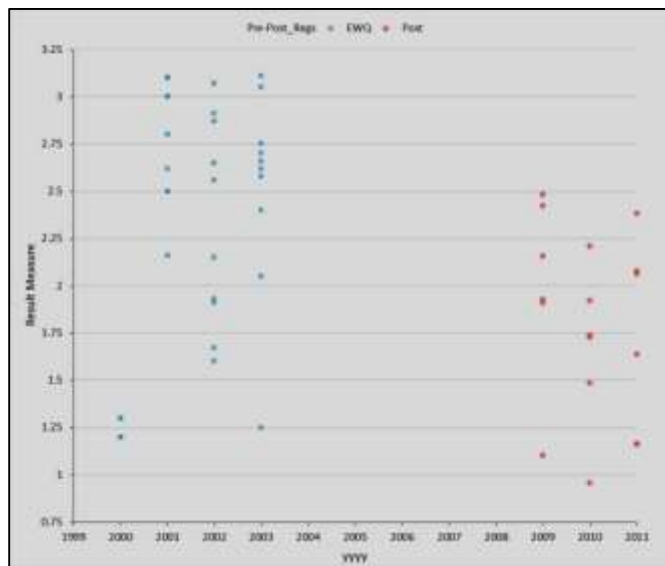
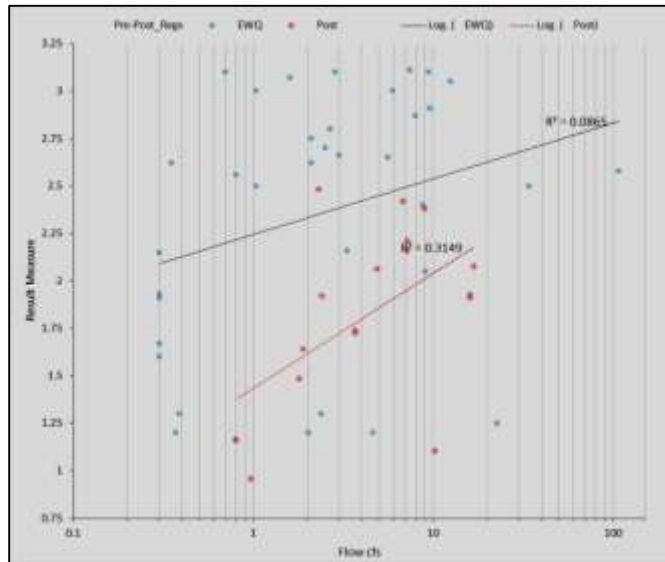
Nitrate + Nitrite as N, Total mg/l

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

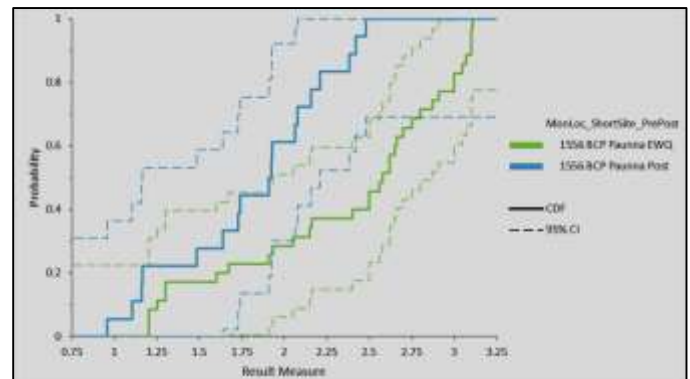
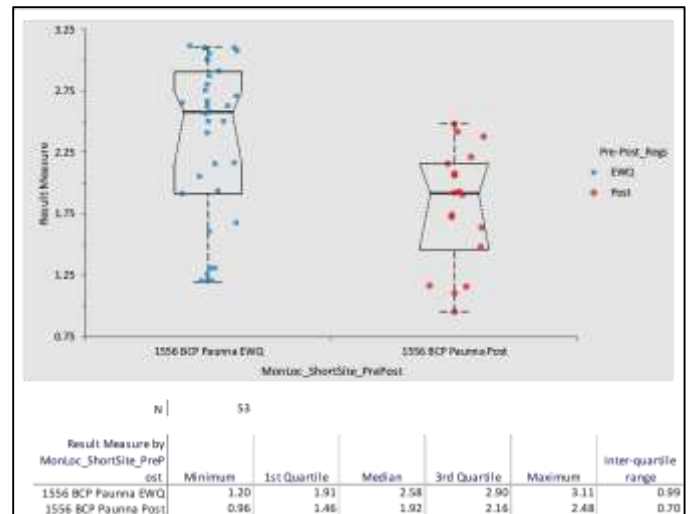
Median 2.58 mg/l

Lower 95% Confidence Interval 2.15 mg/l

Upper 95% Confidence Interval 2.75 mg/l



No water quality degradation is evident. Nitrate concentrations apparently declined between the EWQ and post-EWQ periods. However, analytical uncertainty sources included potential laboratory artifacts, insufficient post-EWQ sampling (n=18), and under-representation of post-EWQ flow conditions.



Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1556 BCP Paunna EWQ	35	845.3	24.15
1556 BCP Paunna Post	18	1643.6	91.31

H statistic | 10.44
 X² approximation | 10.44
 DF | 1
 p-value | 0.0012¹

H0: $\theta_1 = \theta_2 = \dots$

The median of the populations are all equal.

H1: $\theta_i \neq \theta_j$ for at least one i, j

The median of the populations are not all equal.

¹ 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 positively related to flow in the post-EWQ data set. 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 results. Post-EWQ median nitrate + nitrite concentrations fell below the EWQ lower 95% confidence interval.

Chapter 8: 1556 BCP Paunacussing Creek, PA

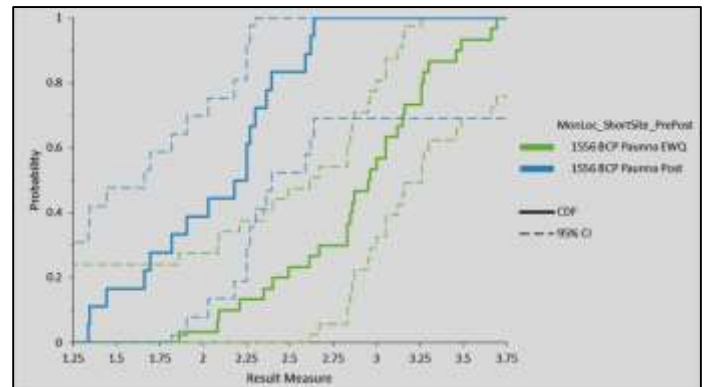
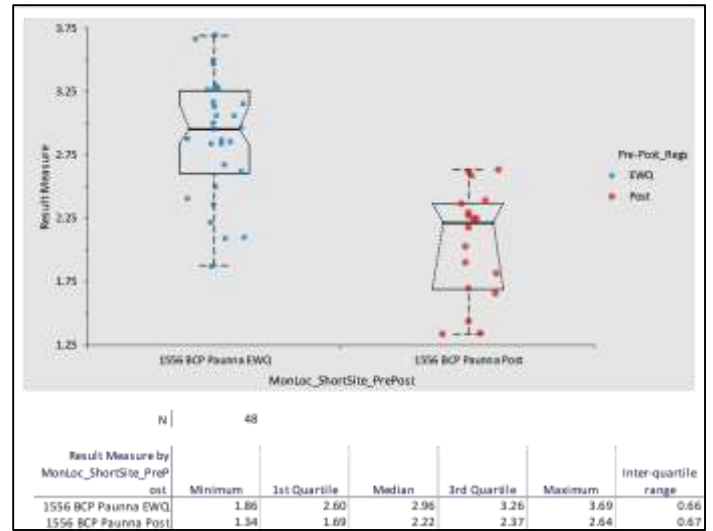
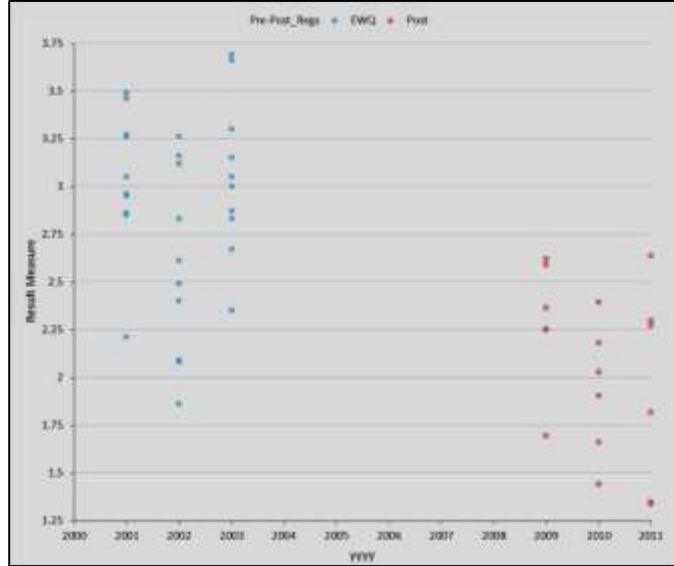
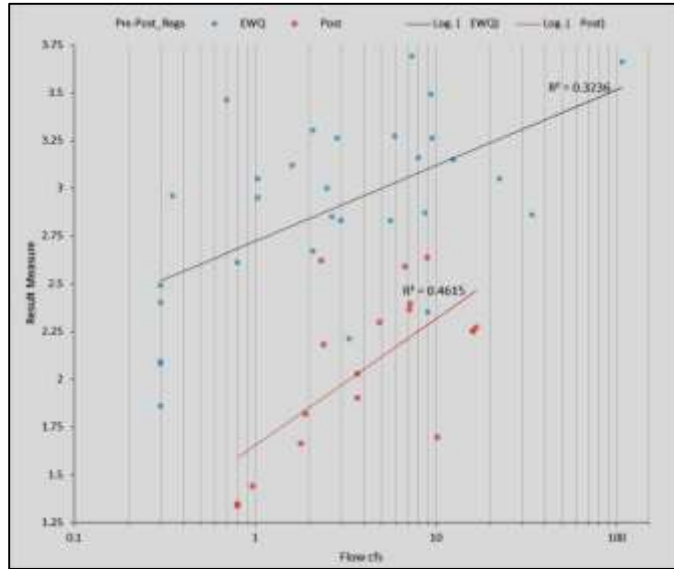
Nitrogen as N, Total (TN) mg/l

Existing Water Quality (Table 2S):

Median 2.96 mg/l

Lower 95% Confidence Interval 2.83 mg/l

Upper 95% Confidence Interval 3.15 mg/l



Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1556 BCP Paunacussing Creek EWQ	30	1555.2	51.84
1556 BCP Paunacussing Creek Post	18	2592.0	144.00

H statistic: 21.16
 X² approximation: 21.16
 DF: 1
 p-value: <0.0001¹

H0: $\theta_1 = \theta_2 = \dots$
 The median of the populations are all equal.
 H1: $\theta_i \neq \theta_j$ for at least one i, j.
 The median of the populations are not all equal.

¹ Reject the null hypothesis in favour of the alternative hypothesis at the 5% significance level.

No water quality degradation is evident. Total Nitrogen concentrations declined between the EWQ and post-EWQ periods. However, potential laboratory artifacts introduce uncertainty into conclusions. TN is positively related to flow in both data sets. TN should have been designated as a flow-related parameter for this site in Table 2S of DRBC water quality regulations. Note that flows are plotted on a logarithmic scale. DRBC results could not be independently validated. Post-EWQ median TN concentrations fell well below the EWQ lower 95% confidence interval.

Chapter 8: 1556 BCP Paunacussing Creek, PA

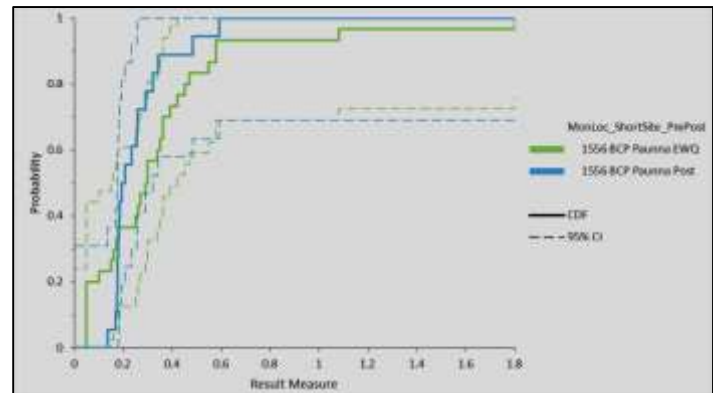
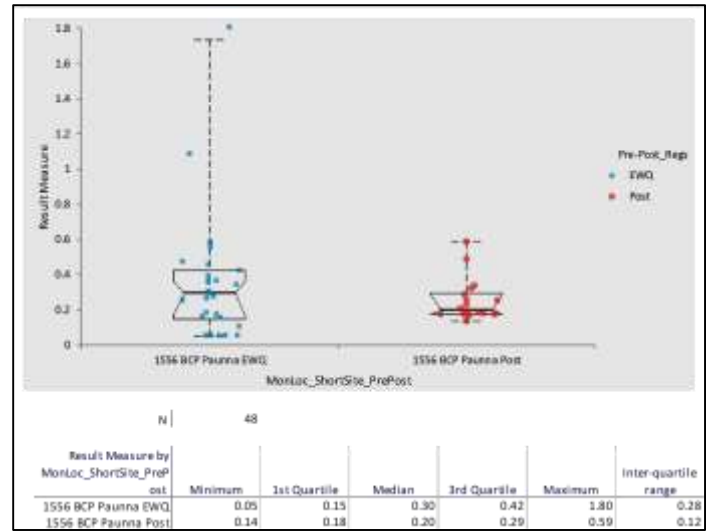
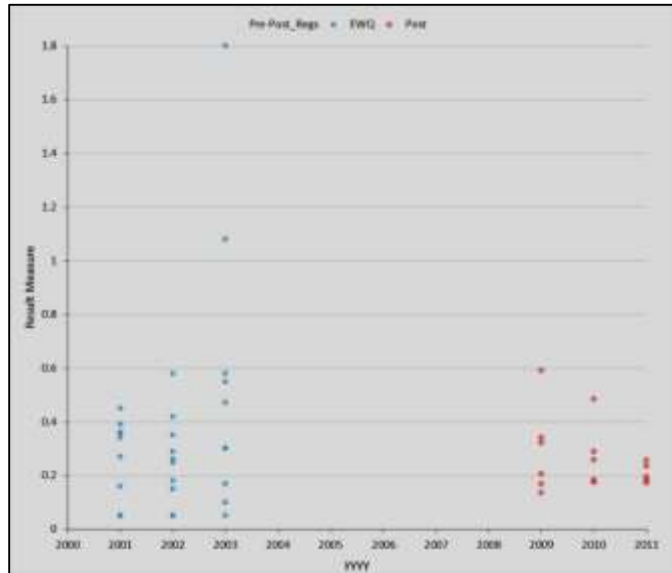
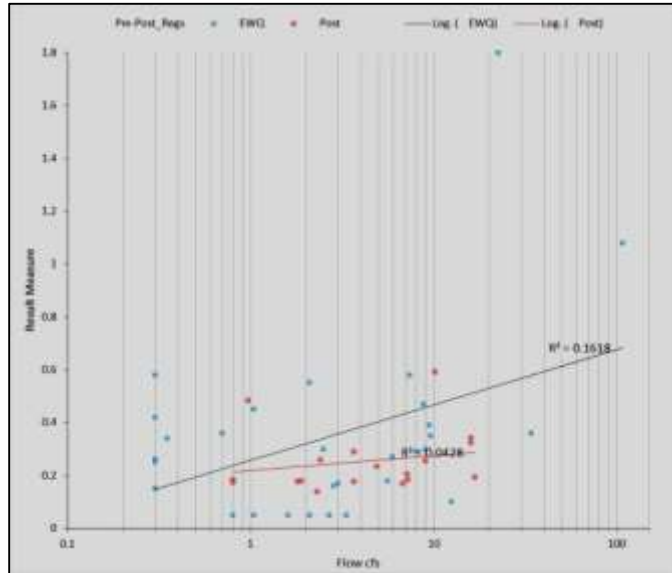
Nitrogen, Kjeldahl as N, Total (TKN) mg/l

Existing Water Quality (Table 2S):

Median 0.30 mg/l

Lower 95% Confidence Interval 0.17 mg/l

Upper 95% Confidence Interval 0.36 mg/l



Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1556 BCP Paunacussing EWQ	30	36.3	1.21
1556 BCP Paunacussing Post	18	60.5	3.36

H statistic	0.49
χ^2 approximation	0.49
DF	1
p-value	0.4818 ¹

H0: $\theta_1 = \theta_2 = \dots$
 The median of the populations are all equal.
 H1: $\theta_i \neq \theta_j$ for at least one i, j
 The median of the populations are not all equal.
¹ Do not reject the null hypothesis at the 5% significance level.

No water quality degradation is evident. TKN concentrations did not measurably change between the EWQ and post-EWQ periods. Potential laboratory artifacts introduce some uncertainty into stronger conclusions. TKN concentration is unrelated to flow in both data sets. TKN ranges less widely and is less variable in the post-EWQ data set. Note that flows are plotted on a logarithmic scale. Post-EWQ median TKN fell to just above the EWQ lower 95% confidence interval, though the decline was statistically insignificant due to insufficient post-EWQ data (n=18).

Chapter 8: 1556 BCP Paunacussing Creek, PA

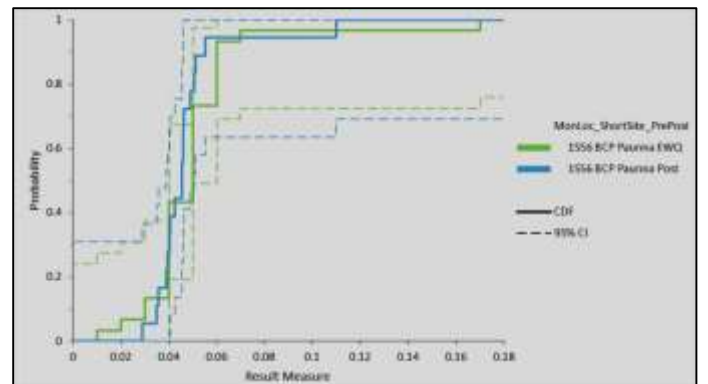
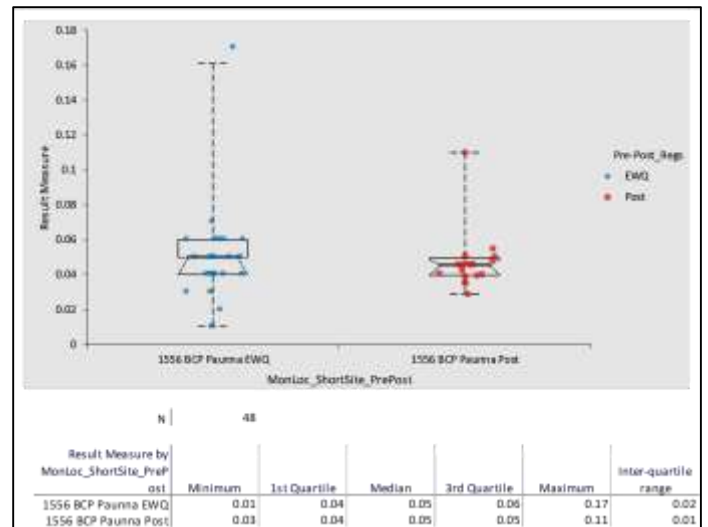
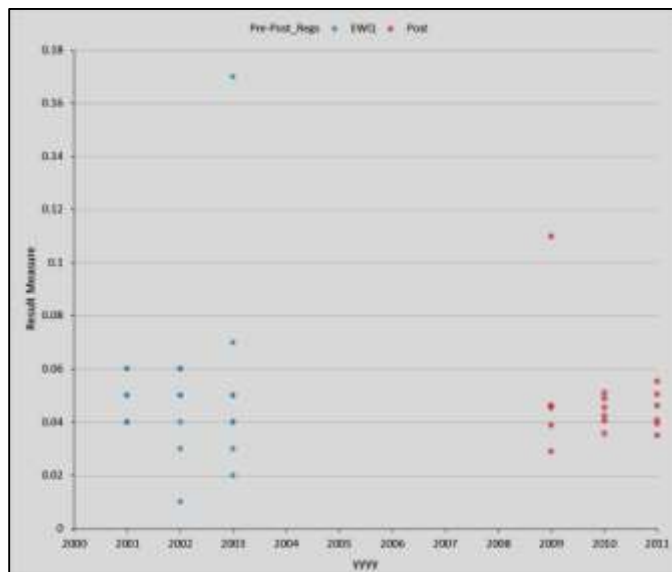
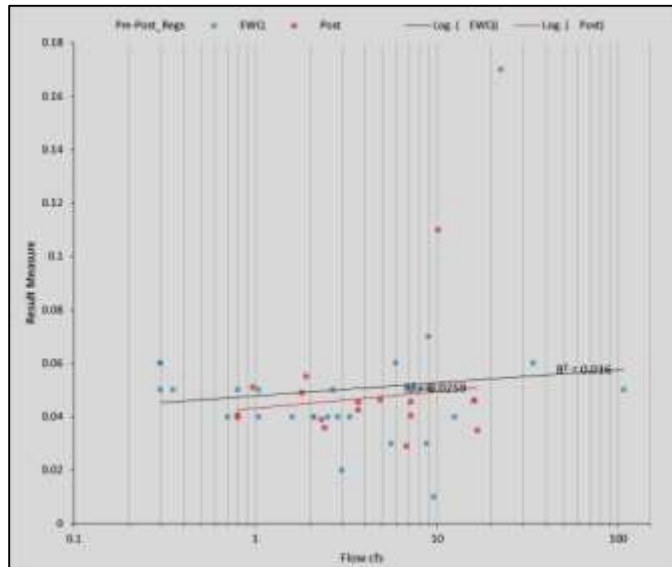
Orthophosphate as P, Total mg/l

Existing Water Quality (Table 2S):

Median 0.05 mg/l

Lower 95% Confidence Interval 0.04 mg/l

Upper 95% Confidence Interval 0.05 mg/l



Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1556 BCP Paunacussing EWQ	30	53.3	1.78
1556 BCP Paunacussing Post	18	88.9	4.94

H statistic	0.74
χ^2 approximation	0.74
DF	1
p-value	0.3907 ¹

H0: $\theta_1 = \theta_2 = \dots$

The median of the populations are all equal.

H1: $\theta_i \neq \theta_j$ for at least one i, j

The median of the populations are not all equal.

¹ Do not reject the null hypothesis at the 5% significance level.

No water quality degradation is evident.

Orthophosphate concentrations did not change between the EWQ and post-EWQ periods. Potential laboratory artifacts and insufficient post-EWQ sampling frequency produced uncertainty in conclusions.

Orthophosphate is unrelated to flow in both data sets. Note that flows are plotted on a logarithmic scale. Post-EWQ median orthophosphate was within EWQ 95% confidence intervals. There were no independent data to confirm DRBC results.

Chapter 8: 1556 BCP Paunacussing Creek, PA

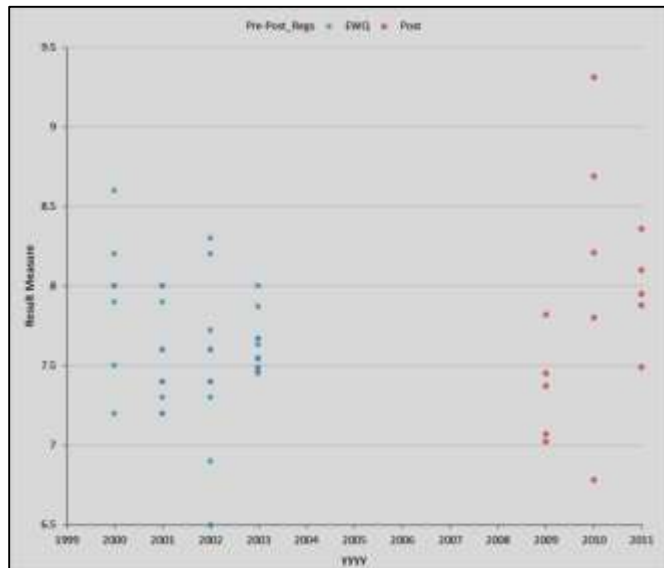
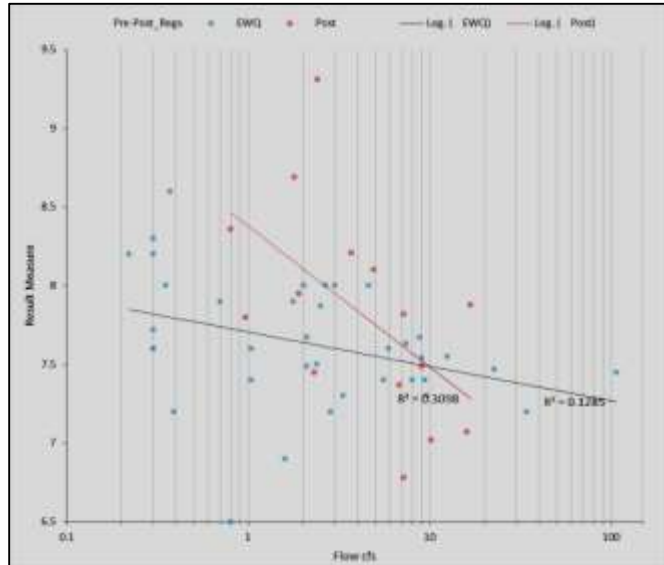
pH, units

Existing Water Quality (Table 2S):

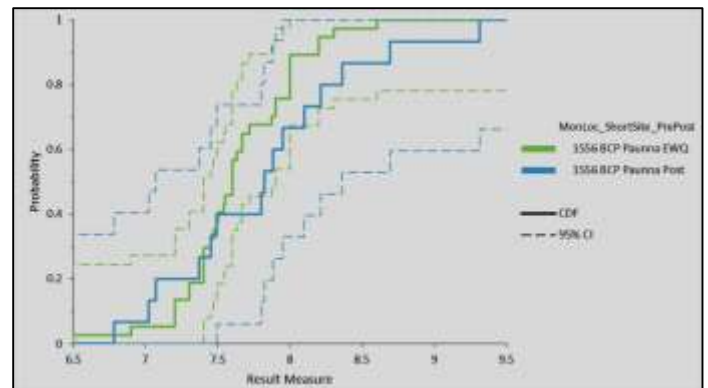
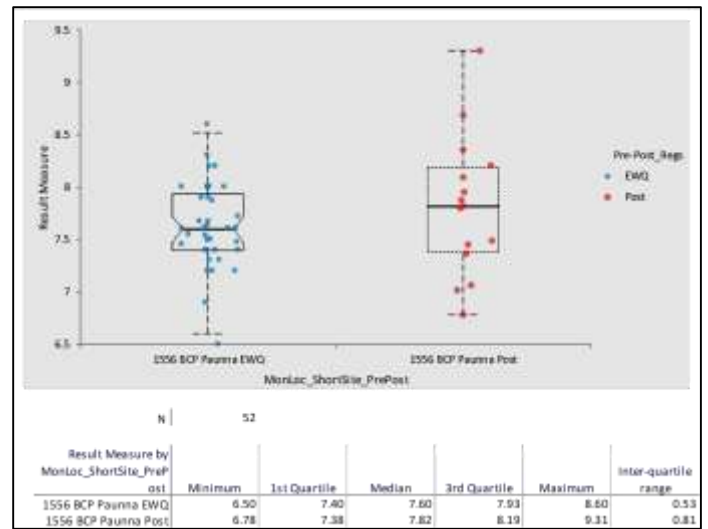
Median 7.60 standard units

Lower 95% Confidence Interval 7.47 standard units

Upper 95% Confidence Interval 7.72 standard units



Slight evidence is shown of water quality degradation, though pH did not measurably change between the EWQ and post-EWQ periods. pH is unrelated to flow in the EWQ data set, and weakly related to flow in the post-EWQ data set, tending toward neutral during higher flow conditions.



Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1556 BCP Paunacussing EWO	37	46.5	1.26
1556 BCP Paunacussing Post	15	114.8	7.65

H statistic: 0.70
 X² approximation: 0.70
 DF: 1
 p-value: 0.4014¹

H0: $\theta_1 = \theta_2 = \dots$
 The median of the populations are all equal.
 H1: $\theta_i \neq \theta_j$ for at least one i,j
 The median of the populations are not all equal.
¹ Do not reject the null hypothesis at the 5% significance level.

Post-EWQ median pH was just above the EWQ upper 95% confidence interval, but the increase was not significant due to insufficient post-EWQ data (n=15). pH ranged more widely in the post-EWQ data set, where minimum and maximum values occurred in the dry 2010 season. The wide range displayed in 2010 indicates higher algal productivity and less scouring away of the algae by storms. Without regular scouring events, the algal biomass can build up to problematic levels. In the post-EWQ data, increased algal activity is also associated with removal of riparian trees for bridge reconstruction, which increased sunlight to the stream.

Chapter 8: 1556 BCP Paunacussing Creek, PA

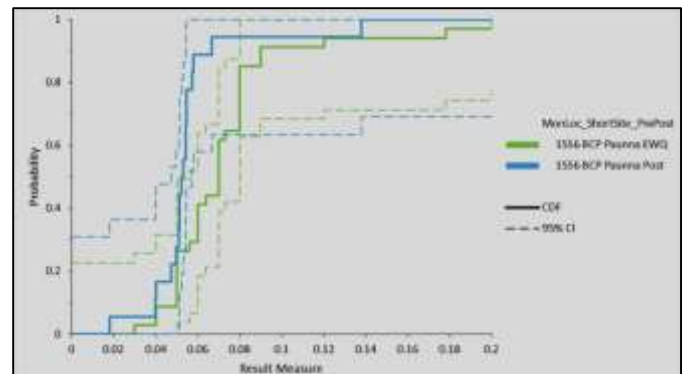
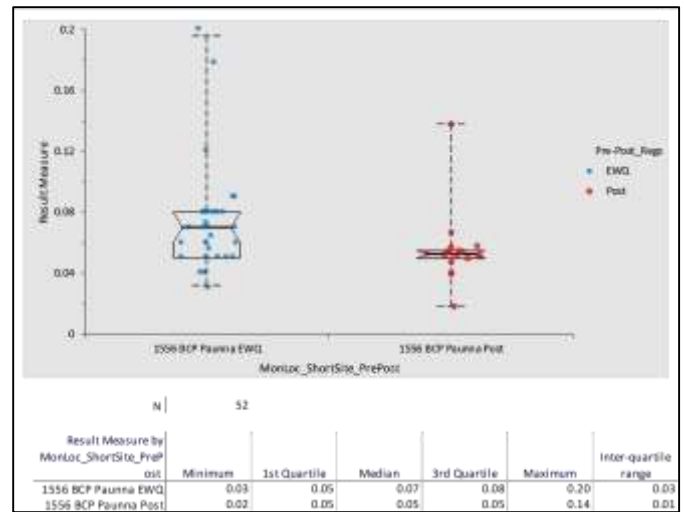
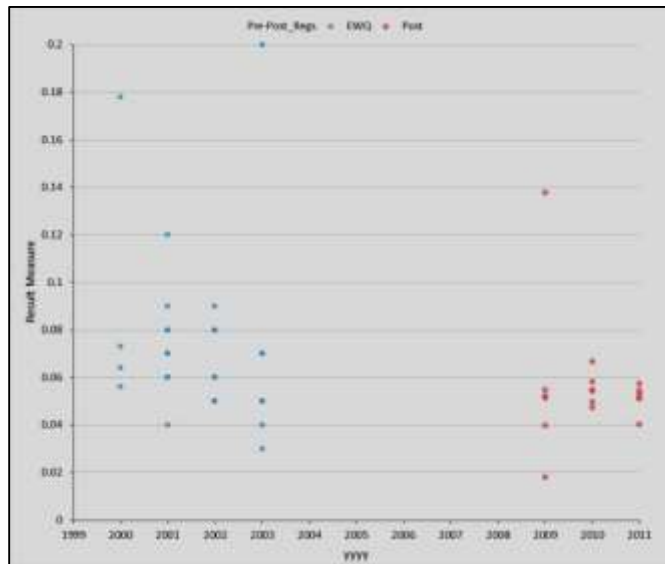
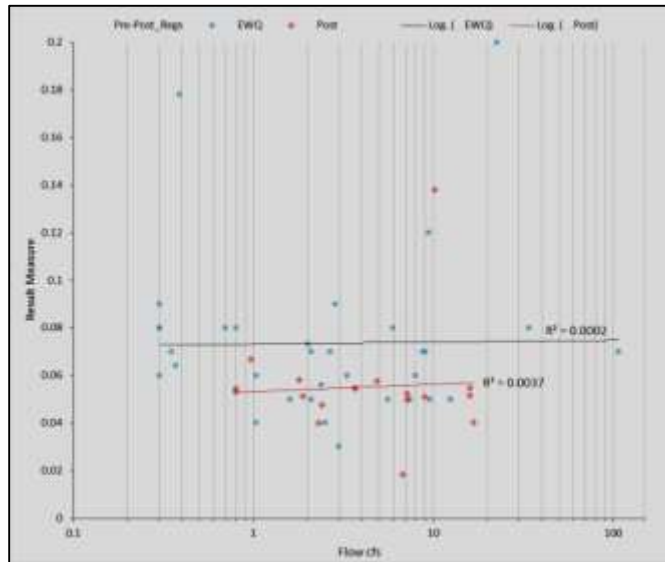
Phosphorus as P, Total (TP) mg/l

Existing Water Quality (Table 2S):

Median 0.07 mg/l

Lower 95% Confidence Interval 0.06 mg/l

Upper 95% Confidence Interval 0.08 mg/l



Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1556 BCP Paunacussing EWQ	34	644.2	18.95
1556 BCP Paunacussing Post	18	1216.9	67.60

H statistic	8.15
χ^2 approximation	8.15
DF	1
p-value	0.0043 ¹

H0: $\theta_1 = \theta_2 = \dots$

The median of the populations are all equal.

H1: $\theta_i \neq \theta_j$ for at least one i, j

The median of the populations are not all equal.

¹ Reject the null hypothesis in favour of the alternative hypothesis at the 5% significance level.

No water quality degradation is evident. Total Phosphorus (TP) concentrations declined between the EWQ and post-EWQ periods. However, potential laboratory artifacts and insufficient post-EWQ sampling frequency produced uncertainty in conclusions. Post-EWQ median total phosphorus fell below the EWQ lower 95% confidence interval. TP is unrelated to flow in both data sets. Note that flows are plotted on a logarithmic scale. No independent data were available to confirm these results.

Chapter 8: 1556 BCP Paunacussing Creek, PA

Specific Conductance $\mu\text{mho/cm}$

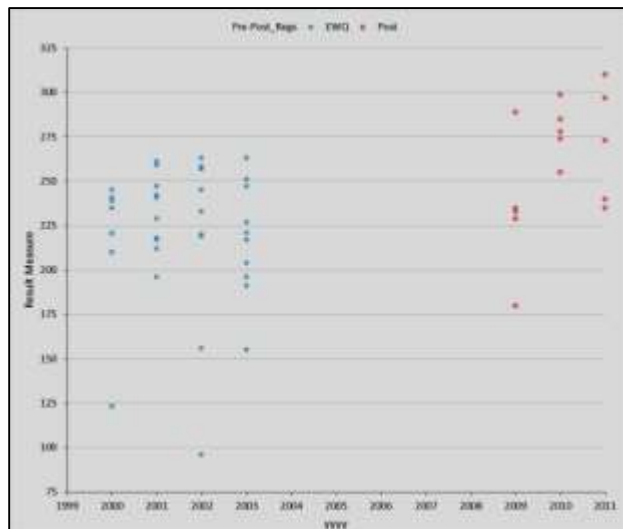
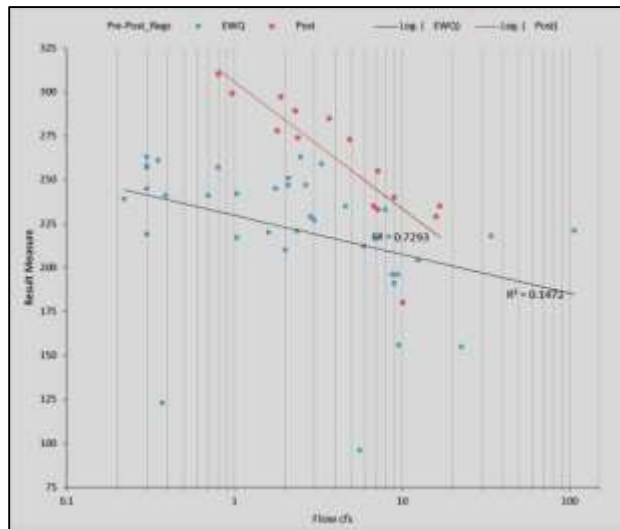
Existing Water Quality (Table 2S):

Median 229 $\mu\text{mho/cm}$

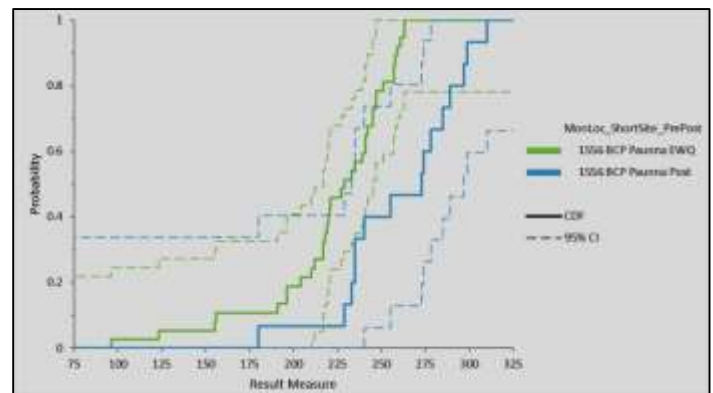
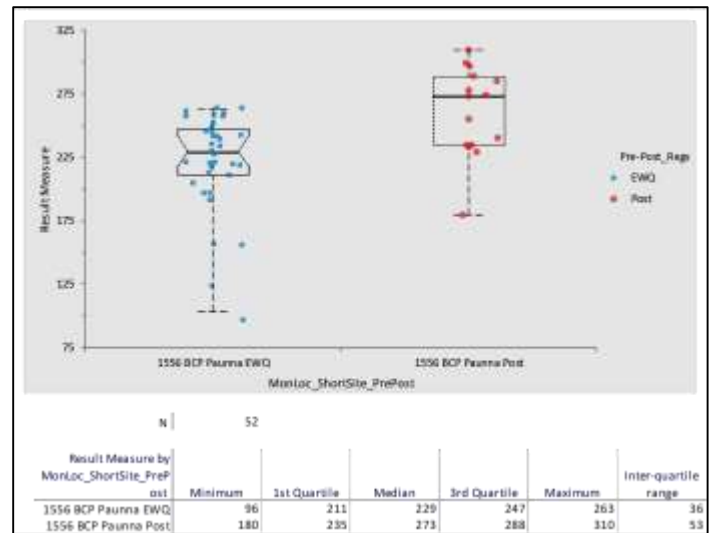
Lower 95% Confidence Interval 218 $\mu\text{mho/cm}$

Upper 95% Confidence Interval 242 $\mu\text{mho/cm}$

Defined in regulations as a flow-related parameter



Water quality degradation is evident. Specific conductance rose above the EWQ upper 95% confidence interval between the EWQ and post-EWQ periods. Specific conductance is inversely related to flow in the post-EWQ data set. Note that flows are plotted on a logarithmic scale.



Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1556 BCP Paunacussing Creek EWQ	37	636.8	17.21
1556 BCP Paunacussing Creek Post	15	1570.8	104.72

H statistic	9.62
χ^2 approximation	9.62
DF	1
p-value	0.0019 ¹

H0: $\theta_1 = \theta_2 = \dots$
 The median of the populations are all equal.
 H1: $\theta_i \neq \theta_j$ for at least one i, j
 The median of the populations are not all equal.
¹ Reject the null hypothesis in favour of the alternative hypothesis at the 5% significance level.

Specific conductance was defined as a flow-related parameter in the EWQ data set (DRBC water quality regulations Table 2S), even though the relationship was very weak at this site. The rise in specific conductance may be attributable to the concurrent rise in chloride concentrations. No new dischargers are present in the watershed. We speculate that winter application of road salt may have contributed to the increase. Median specific conductance has risen from 229 to 273 $\mu\text{mhos/cm}$, a 19% increase.

Chapter 8: 1556 BCP Paunacussing Creek, PA

Total Dissolved Solids (TDS) mg/l

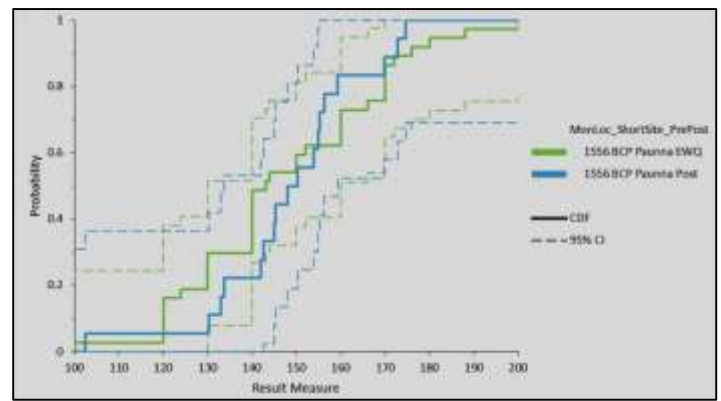
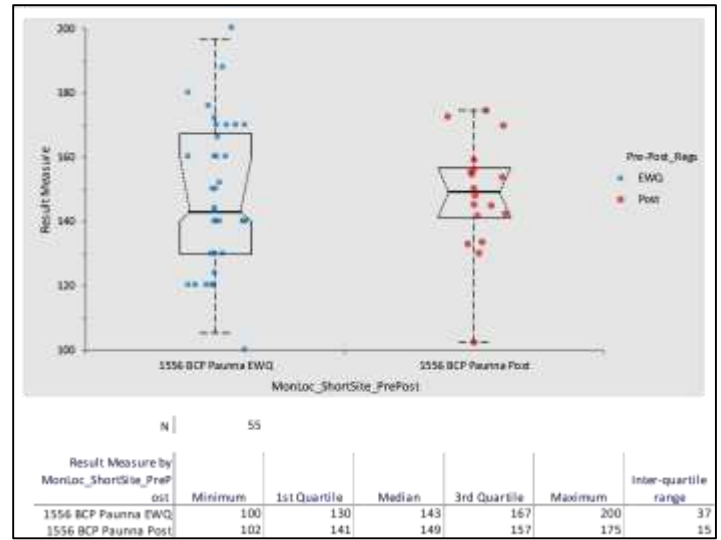
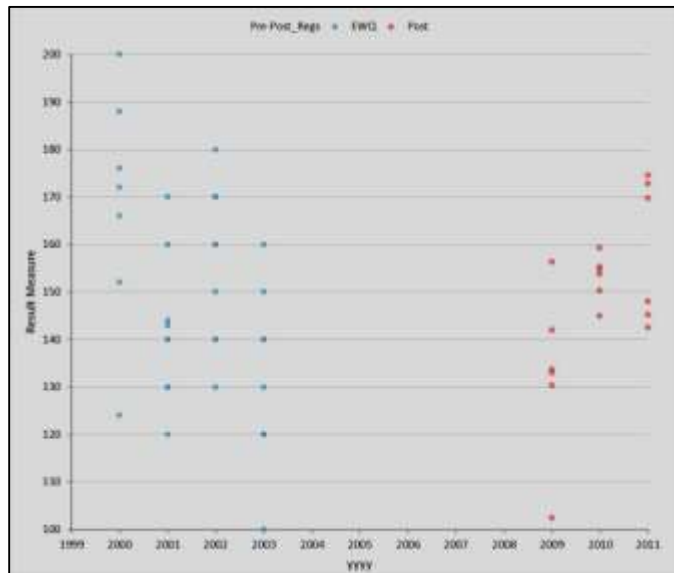
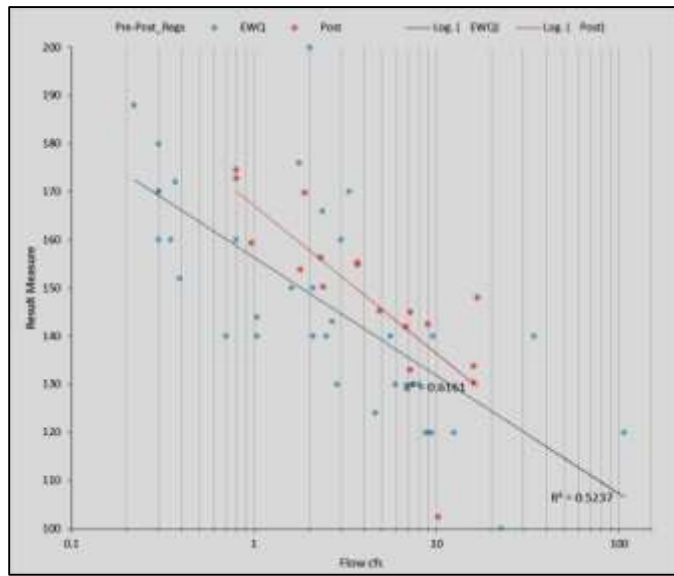
Existing Water Quality (Table 2S):

Median 130 mg/l

Lower 95% Confidence Interval 120 mg/l

Upper 95% Confidence Interval 144 mg/l

Defined in regulations as a flow-related parameter



Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1556 BCP Paunna EWQ	37	21.2	0.57
1556 BCP Paunna Post	18	43.6	2.42

H statistic: 0.25
 X² approximation: 0.25
 DF: 1
 p-value: 0.6148¹

H0: $\theta_1 = \theta_2 = \theta_3 = \dots$
 The median of the populations are all equal.
 H1: $\theta_i \neq \theta_j$ for at least one i, j.
 The median of the populations are not all equal.

¹ Do not reject the null hypothesis at the 5% significance level.

No water quality degradation is evident. TDS did not measurably change between the EWQ and post-EWQ periods. Potential laboratory artifacts produced uncertainty in comparisons. TDS is inversely and strongly related to flow in both data sets. Post-EWQ median TDS was above the EWQ upper 95% lower confidence interval, but the increase was not statistically significant. Post-EWQ detection limits were lower than EWQ detection limits, though there were no non-detect results at any time. Note that flows are plotted on a logarithmic scale.

Chapter 8: 1556 BCP Paunacussing Creek, PA

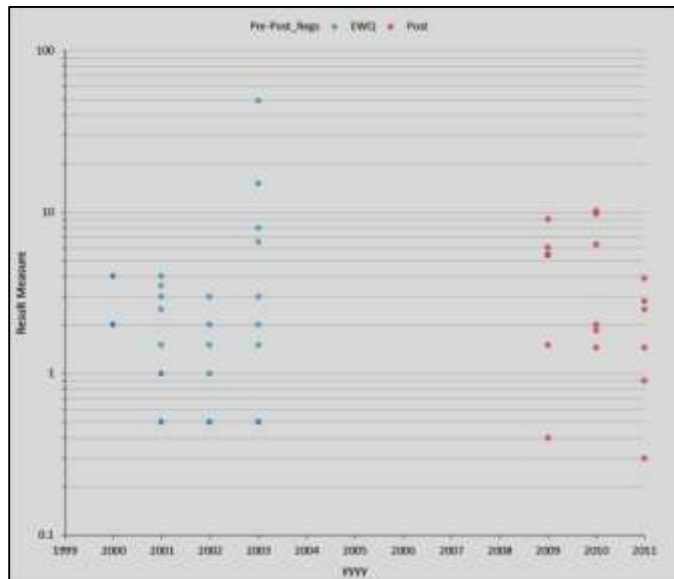
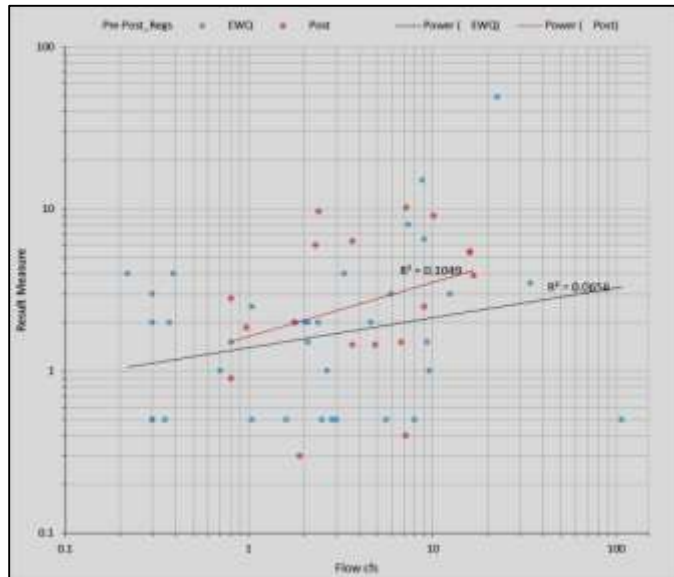
Total Suspended Solids (TSS) mg/l

Existing Water Quality (Table 2S):

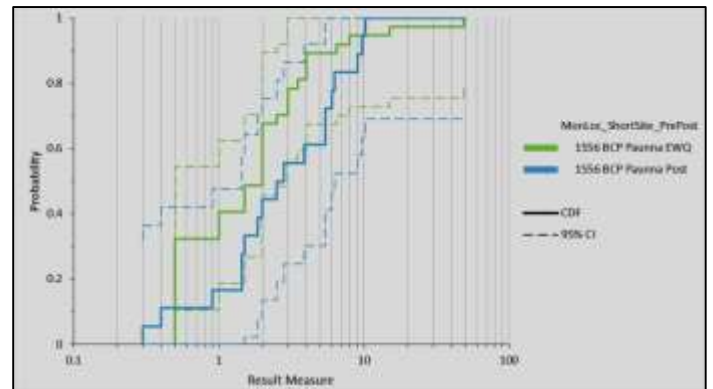
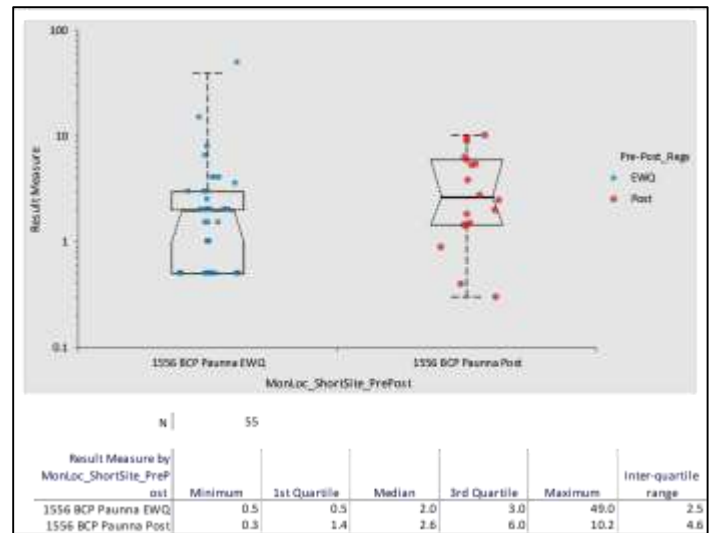
Median 1.0 mg/l

Lower 95% Confidence Interval 1.0 mg/l

Upper 95% Confidence Interval 2.0 mg/l



No water quality degradation is evident. TSS did not measurably change between the EWQ and post-EWQ periods. TSS is unrelated to flow in both data sets.



Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1556 BCP Paunna EWQ	37	209.3	5.66
1556 BCP Paunna Post	18	430.2	23.90

H statistic: 2.52
 χ^2 approximation: 2.52
 DF: 1
 p-value: 0.1121¹

H0: $\theta_1 = \theta_2 = \dots$
 The median of the populations are all equal.
 H1: $\theta_i \neq \theta_j$ for at least one i, j
 The median of the populations are not all equal.

¹ Do not reject the null hypothesis at the 5% significance level.

Post-EWQ median TSS was above the EWQ upper 95% confidence interval, but the increase was statistically insignificant.

Note: in DRBC water quality regulations Table 2S, the published median and confidence intervals are incorrect, and should read:

- Median 2.0 mg/l (not 1.0 mg/l)
- Lower 95% confidence interval 1.0 mg/l
- Upper 95% confidence interval 2.0 mg/l

Chapter 8: 1556 BCP Paunacussing Creek, PA

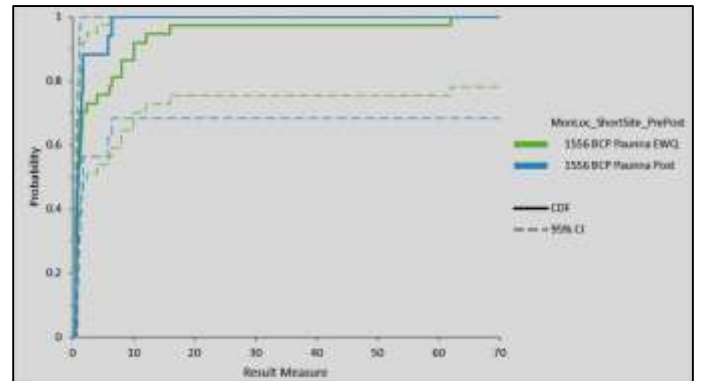
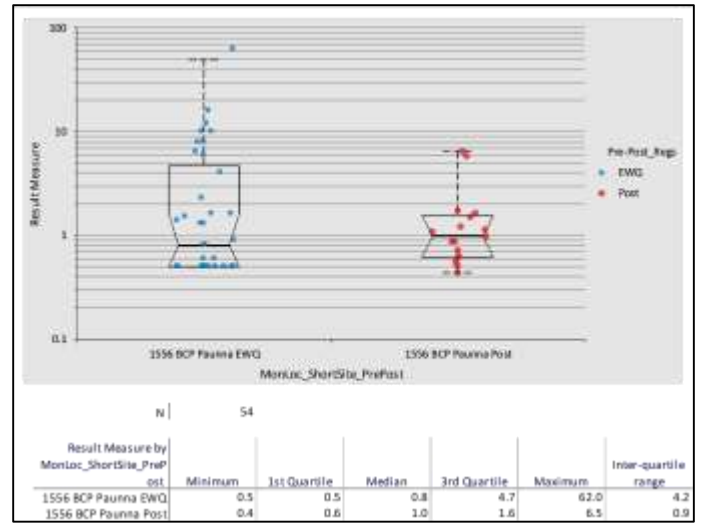
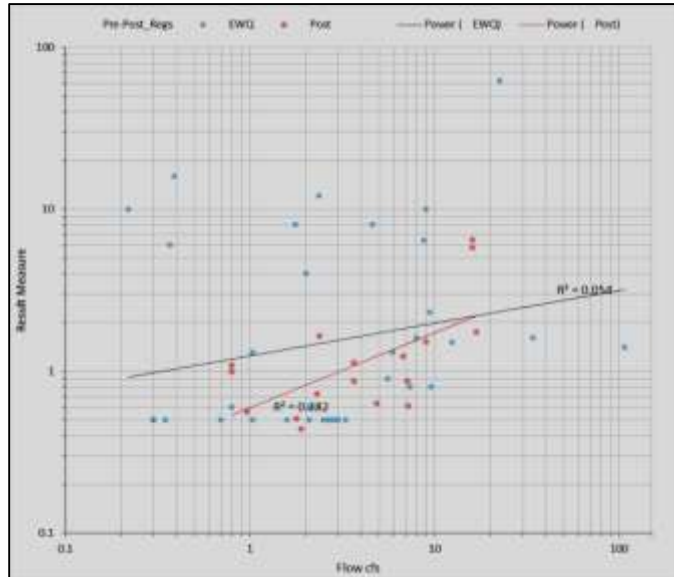
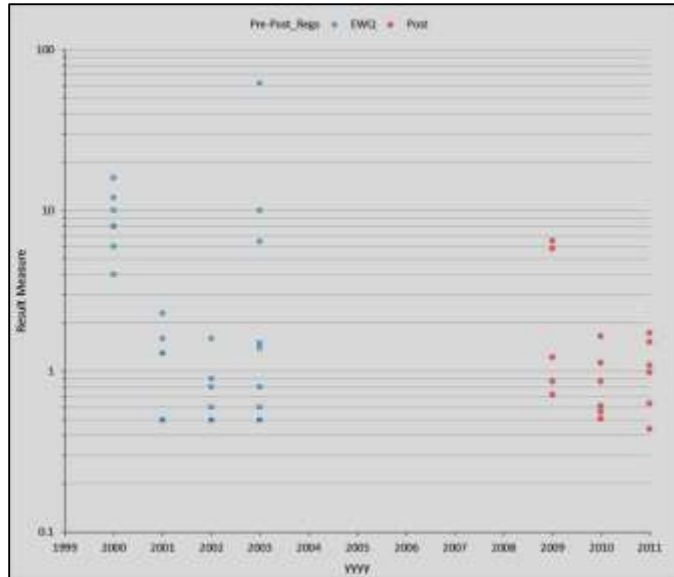
Turbidity NTU

Existing Water Quality (Table 2S):

Median 0.8 NTU

Lower 95% Confidence Interval 0.5 NTU

Upper 95% Confidence Interval 1.6 NTU



Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost			
	n	Rank sum	Mean rank
1556 BCP Paunna EWQ	37	9.3	0.25
1556 BCP Paunna Post	17	20.1	1.18

H statistic	0.12
χ^2 approximation	0.12
DF	1
p-value	0.7276 ¹

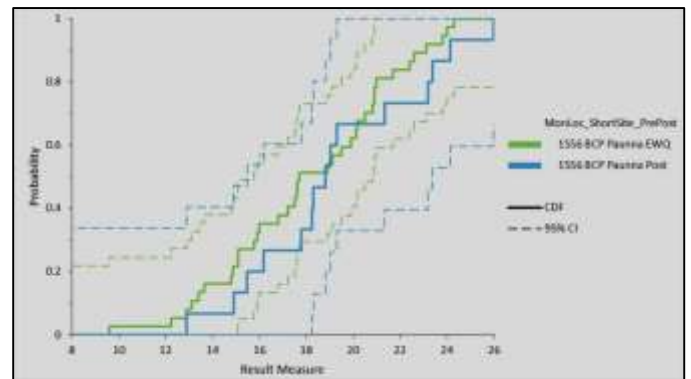
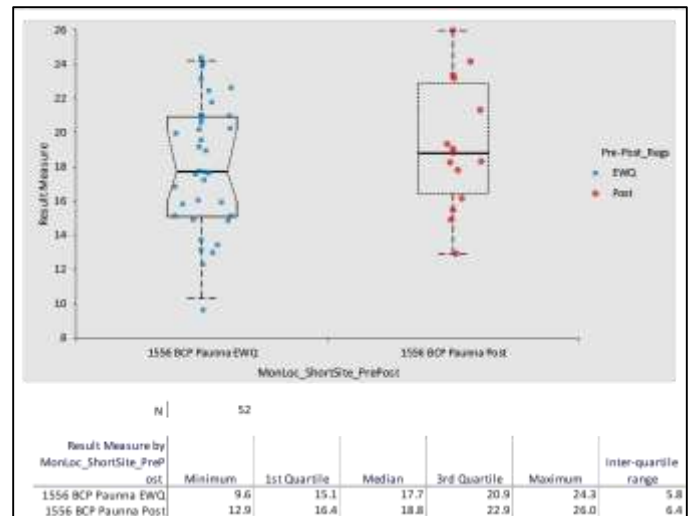
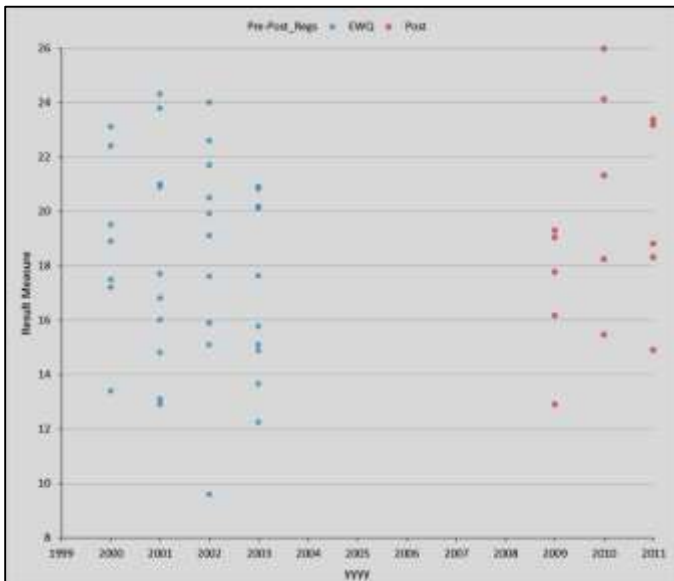
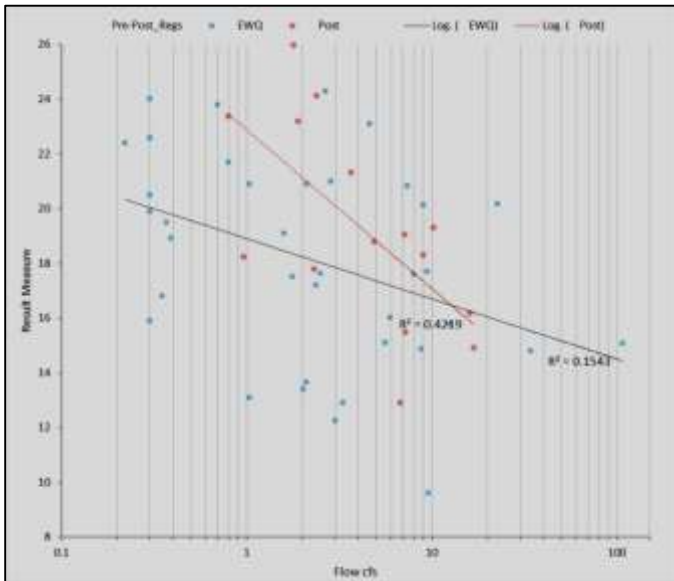
H0: $\theta_1 = \theta_2 = \dots$
 The median of the populations are all equal.
 H1: $\theta_i \neq \theta_j$ for at least one i, j.
 The median of the populations are not all equal.
¹ Do not reject the null hypothesis at the 5% significance level.

No water quality degradation is evident. Turbidity did not measurably change between the EWQ and post-EWQ periods. The post-EWQ median turbidity fell within the EWQ 95% confidence intervals of the median. Turbidity is related to flow in the post-EWQ data set, but unrelated to flow in the EWQ data set. There were insufficient post-EWQ data to fully represent Paunacussing Creek’s flow regime (n=17). Note that concentration and flow is represented on logarithmic scale.

Chapter 8: 1556 BCP Paunacussing Creek, PA

Water Temperature, degrees C

Not included in DRBC Existing Water Quality rules



Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1556 BCP Paunacussing EWQ	37	52.3	1.41
1556 BCP Paunacussing Post	15	129.1	8.60

H statistic: 0.79
 X² approximation: 0.79
 DF: 1
 p-value: 0.3742¹

H0: $\theta_1 = \theta_2 = \dots$
 The median of the populations are all equal.
 H1: $\theta_i \neq \theta_j$ for at least one i, j
 The median of the populations are not all equal.

¹ Do not reject the null hypothesis at the 5% significance level.

No water quality degradation is evident. Water temperature did not measurably change between the EWQ and post-EWQ periods. Water temperature is related to flow in both data sets, though weakly related in the EWQ data set. There were less cool temperatures and less temperature measurements overall in the post-EWQ data set (n=15). Some temperature increase may be attributed to riparian tree removal discussed previously. Note that flows are plotted on a logarithmic scale.