Tributary/Intermittent Stream Analysis Summary
Bone Lake, Polk County WI

During the spring and summer of 2010, the flow and nutrient loading was analyzed at eight culverts that drain key sub-watersheds into Bone Lake. During two (spring thaw) time periods and three rain events, the flow was measured at each culvert (if there was flow). A grab sample of water was then analyzed for total phosphorus (TP), soluble reactive phosphorus (SRP), total suspended solids (TSS) and total volatile solids (Vol).

The flow was measured using a flow meter in meters per second. The depth of the water was also recorded. Using the diameter measurement of the culvert, the cross sectional area of the water occupying the culvert was determined in square feet. The flow was then converted to feet per second. These two values were then multiplied to determine the flow in cubic feet per second (CFS).

The following table summarizes the flow amounts and nutrient loading at each measured event. The phosphorus loads are calculated as kg/day in order to compare different watershed impacts. The duration of the measured flow was not determined so these values do not quantify any amount of actual loading. The TSS is calculated as kg/hour since some events gave very large numbers for kg/day so it was adjusted to make the values smaller. Again, this can only be used for comparisons.

culverts	1	2	3	4	5	7	6	8	
area ft2	1.08	0	0.48	0	0.54	1.15	0	0	13-Mar
flow ft3/s	2.83	0	2.45	0	1.01	1.13	0	0	thaw
TP	0.119	0	0.144	0	0.122	0.17	0	0	
SRP	0.014	0	0.044	0	0.042	0.051	0	0	
TSS	9	0	4	0	20	5	0	0	
Vol TSS	5	0	3	0	6	0	0	0	
TP load	9.54	0	9.990238	0	3.489221	5.439696	0	0	
TP kg/day	0.82	0	0.863157	0	0.301469	0.46999	0	0	
SRP kg/day	0.08	0	0.26	0	0.1	0.14	0	0	
TSS kg/day	62	0	23.88	0	49.18	13.8	0	0	

culverts	1	2	3	4	5	7	6	8	
area ft2	0.34	0	0.128	0	4.52	0	0	0	
flow ft3/s	0.56	0	0.21	0	11.86	0	0	0	8-May
TP	0.061	0	0.087	0	0.12	0	0	0	spring
SRP	0.014	0	0.027	0	0.035	0	0	0	
TSS	2.5	0	5	0	0	0	0	0	
Vol TSS	2.5	0	0	0	0	0	0	0	

TP load	0.967411	0	0.517406	0	40.30502	0	0	0
TP kg/day	0.083584	0	0.044704	0	3.482354	0	0	0
SRP kg/day	0.02	0	0.01	0	1.01	0	0	0
TSS/ kgday	3.3	0	2.53	0	0	0	0	0

culverts	**1**	**2**	**3**	**4**	**5**	**7**	**6**	**8**	
area ft2	0.48	0	0.34	0	0.26	0.23	0	0	
flow ft3/s	1.1	0	1.33	0	0.43	0.15	0	0	6-Jul
TP	0.101	0	0.111	0	0.174	0.165	0	0	2.6 inches
SRP	0.025	0	0.029	0	0.076	0.061	0	0	
TSS	4	0	3	0	4	5	0	0	
Vol TSS	2	0	2	0	0	0	0	0	
TP load(mg/s)	3.146019	0	4.180439	0	2.118678	0.700846	0	0	
TP Kg/day	0.271816	0	0.36119	0	0.183054	0.060553	0	0	
SRP kg/day	0.07	0	0.09	0	0.08	0.02	0	0	
TSS kg/day	10.69	0	9.73	0	4.21	1.85	0	0	

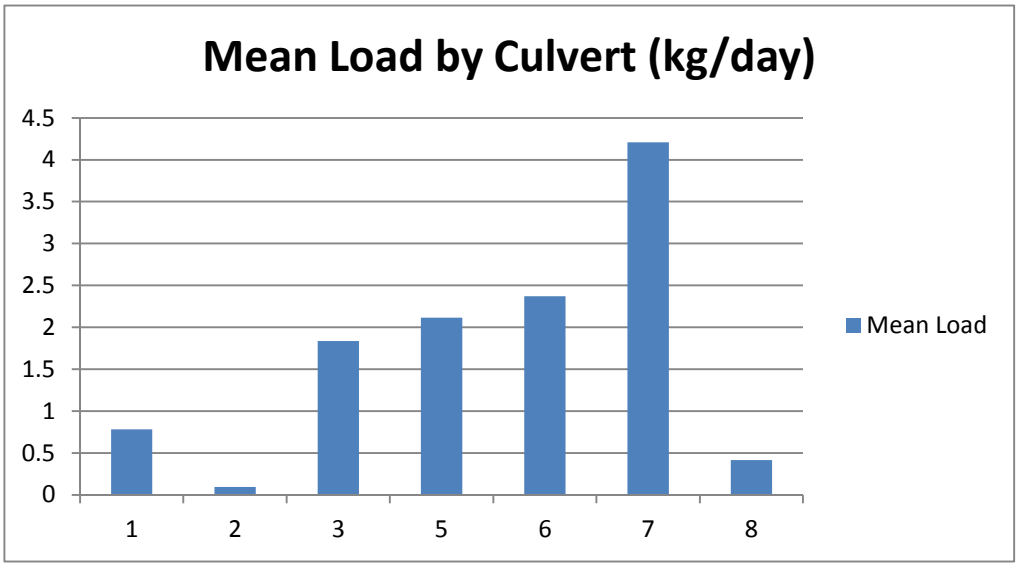
culverts	**1**	**2**	**3**	**4**	**5**	**7**	**6**	**8**	
area ft2	1.41	0.38	2.23	0	4.21	6.91	3.14	0.56	
flow ft3/s	9.39	1.81	27.43	0	16.57	24.93	14.42	3.12	14-Jul
TP	0.104	0.108	0.115	0	0.158	0.33	0.336	0.273	3+ inches
SRP	0.025	0.016	0.03	0	0.042	0.072	0.073	0.158	
TSS	5	17	6	0	34	205	209	6	
Vol TSS	3	5	3	0	6	24	25	3	
TP load	27.65325	5.535407	89.32456	0	74.13561	232.9611	137.1993	24.11929	
TP Kg/day	2.389241	0.478259	7.717642	0	6.405316	20.12784	11.85402	2.083906	
SRP kg/day	0.57	0.07	2.01	0	1.7	4.39	2.57	1.2	
TSS kg/day	114.09	75.24	402.68	0	1377.2	12498.8	7371	68.57	

culverts	**1**	**2**	**3**	**4**	**5**	**7e***	**7w***	**7 total**	
area ft2	0.76	0	0.23	0	0.195	0.28	0.23	0.51	12-Aug
flow ft3/s	1.1	0	0.56	0	0.32	0.18	0.45	0.63	1.3+ inches
TP	0.131	0	0.143	0	0.27	0.149	0.149		
SRP	0.048	0	0.066	0	0.146	0.069	0.069		
TSS	5	0	2.5	0	4	5	5		
Vol TSS	3	0	0	0	0	0	0		
TP load	4.08048	0	2.267625	0	2.446589	0.759462	1.898655	2.66	
TP Kg/day	0.352553	0	0.195923	0	0.211385	0.065618	0.164044	0.23	
SRP kg/day	0.13	0	0.09	0	0.11	0.03	0.08	0.11	
TSS kg/day	13.36	0	3.5	0	3.12	2.18	5.5	7.68	

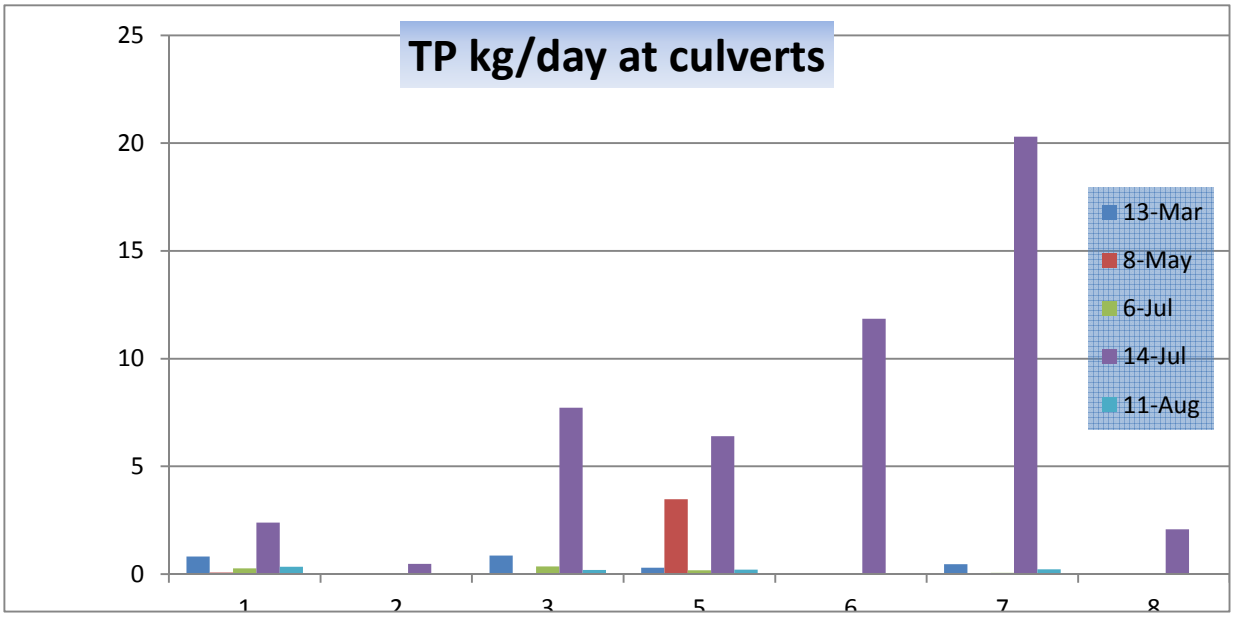
Culvert 6 No flow

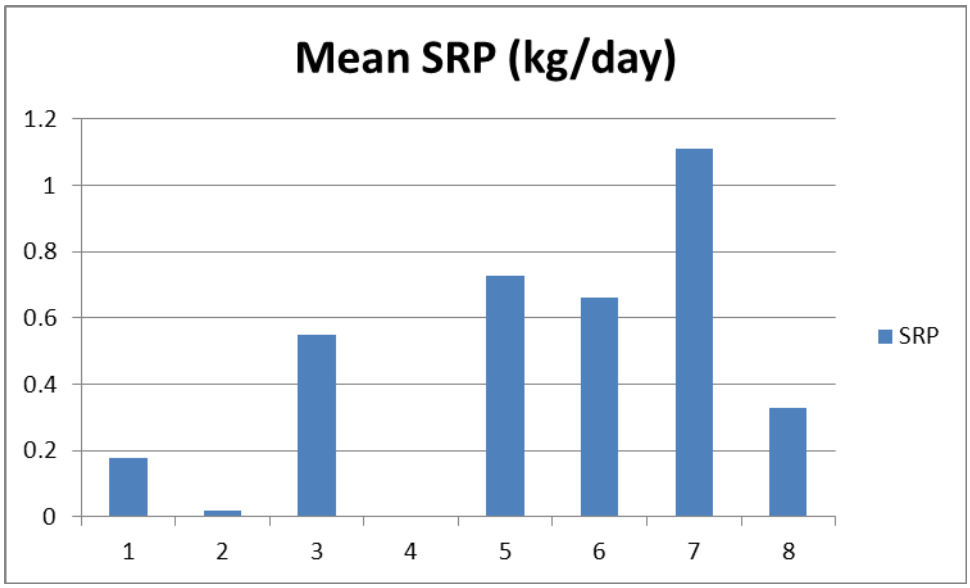
*2 culverts adjacent-one sample but used for both flow totals.

The graphs below show the total phosphorus loading at each culvert. The first graph is the mean loading from all time periods. This shows the culverts that contribute the most phosphorus on average over the sampling period. However, this can be somewhat misleading as culvert 7 had such a high load on July 14.

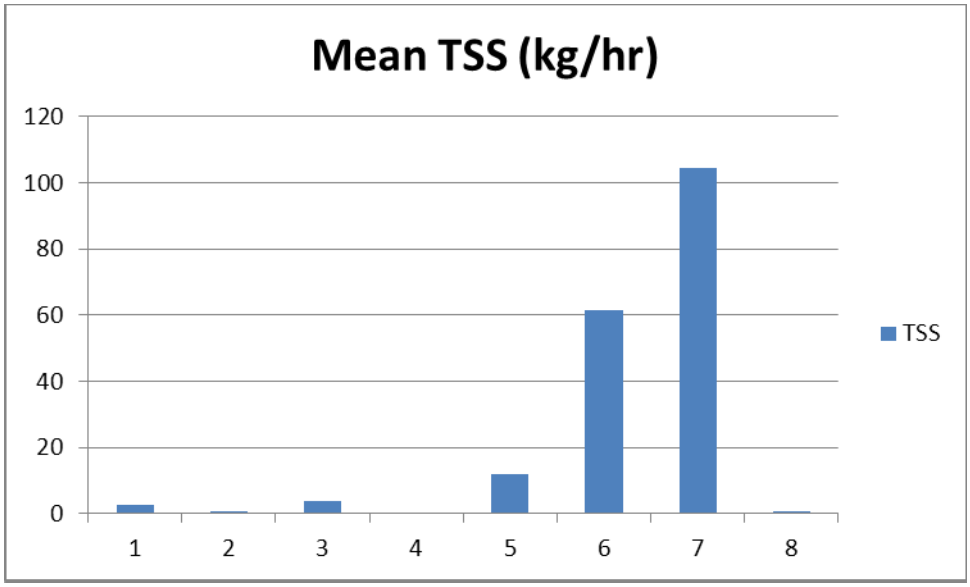


The second graph shows the loading of phosphorus (kg/day) at each time period sampling was conducted. This allows one to observe the culverts that had phosphorus loading on a more consistent basis.





Soluble reactive phosphorus (SRP) is phosphorus dissolved in the water that is immediately available for plant/algae uptake. Common sources of high SRP would be inorganic fertilizers and sewage. The quantity is measured to see what portion of the total phosphorus is SRP. If most of the total phosphorus is SRP, it can indicate certain potential sources. Organic debris and/or sediment due to erosion are not generally high in SRP. There are no SRP values to indicate most of the phosphorus is coming from a fertilizer or sewage source (or other). The daily load calculations for SRP are consistent with the total phosphorus except for culvert 5 being higher in SRP loading than culvert 6 (which was higher for total phosphorus loading).

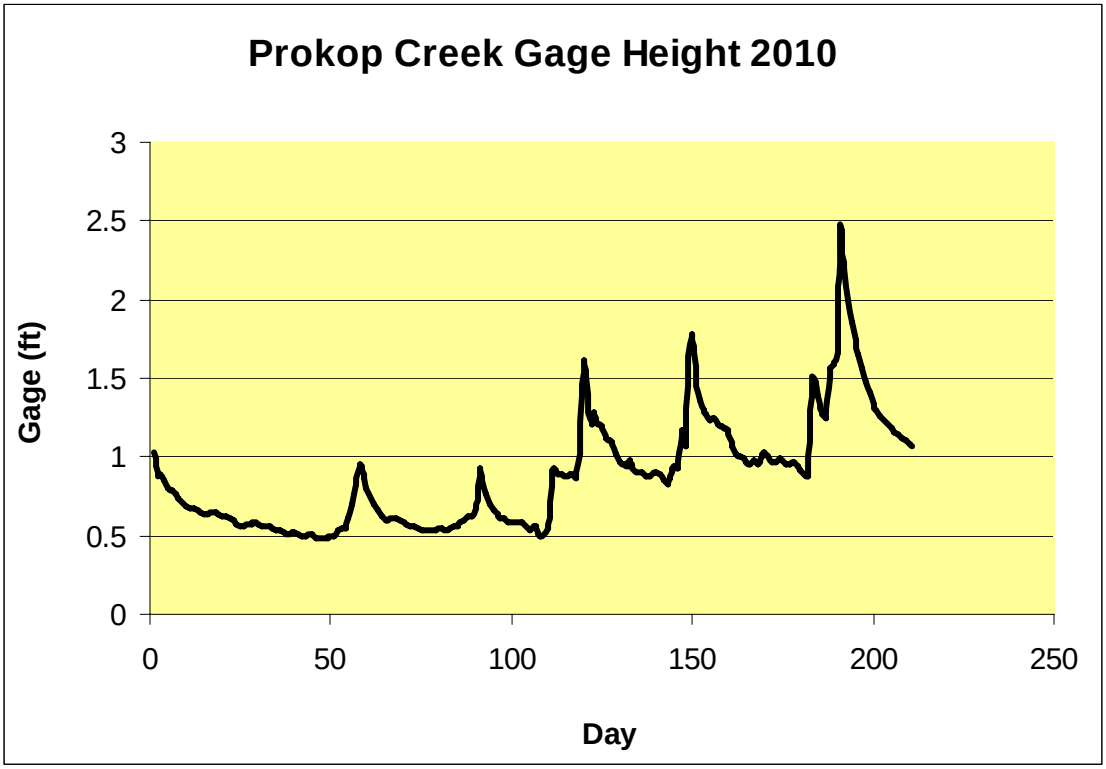


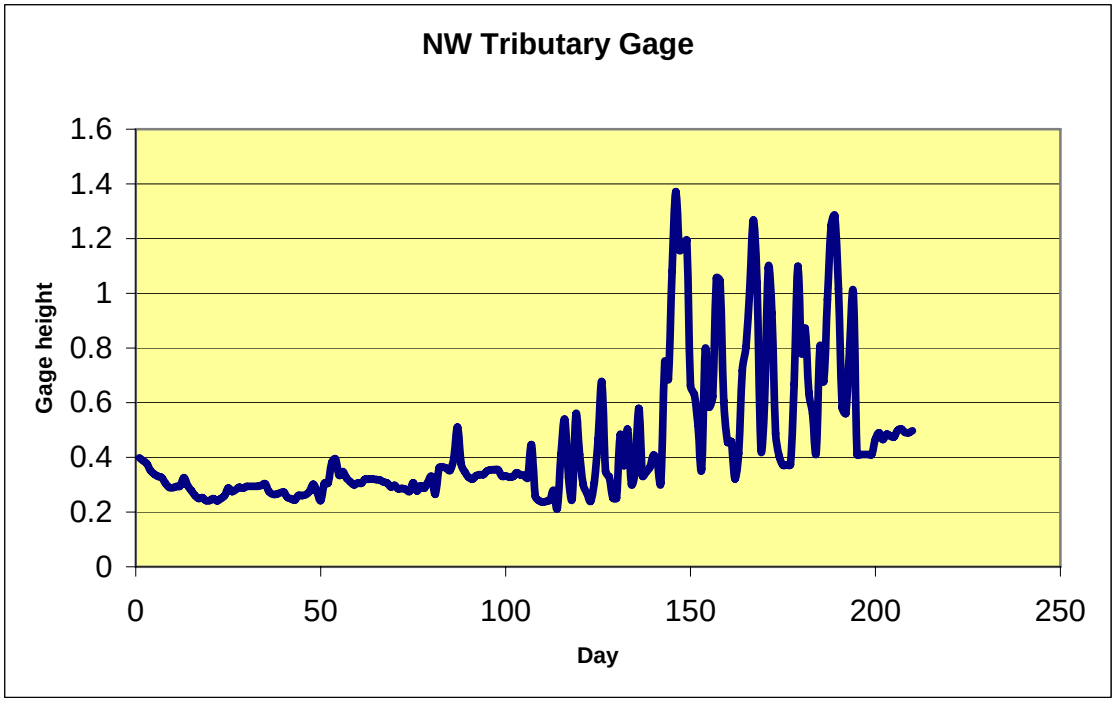
Total suspended solids (TSS) are the solids that can be filtered out of the water. This is a good indication of the amount of sediment and/or organic debris. In order to determine if the solids are sediment (inorganic) or organic, a volatile suspended solid test is conducted. If the TSS and volatile suspended solid values are very close, it indicates the solids are mostly organic. All water samples had a small fraction of volatile suspended solids compared to the TSS. This indicates that the majority of the sediment is inorganic. The volatile solids did follow the same trends. When the TSS was higher, so was the volatile solids value.

Tributary Loading (Prokop Creek and unnamed creek (NW Tributary))

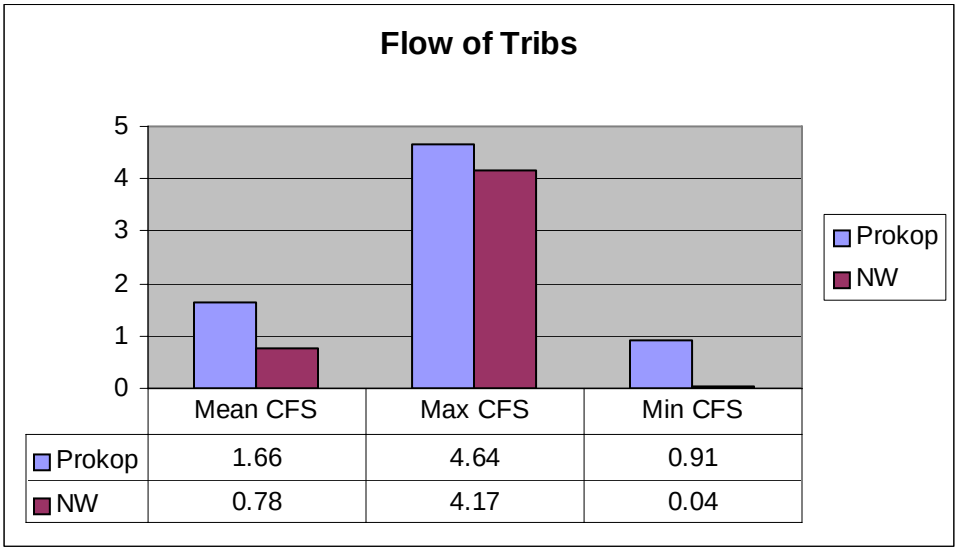
In addition to monitoring the culvert flow, two tributaries that flow continuously (in most years) were monitored. Only the flow and total phosphorus were measured in order to calculate the water and phosphorus loads from each tributary.

The flow is measured with a gage logger that monitors the depth of the stream every 30 minutes. This is then correlated with many flow measurements in order to calculate flow from gage height. The following graphs show the gage height means for each day of the sampling period. It can be observed that the gage (and therefore flow) had an increasing flow trend over the course of sampling. There are also several major spikes, showing the numerous large rain events that occurred during the sample period. Finally, it appears that Prokop Creek responds more slowly to these rain events with a smoother gage curve compared to the NW tributary.

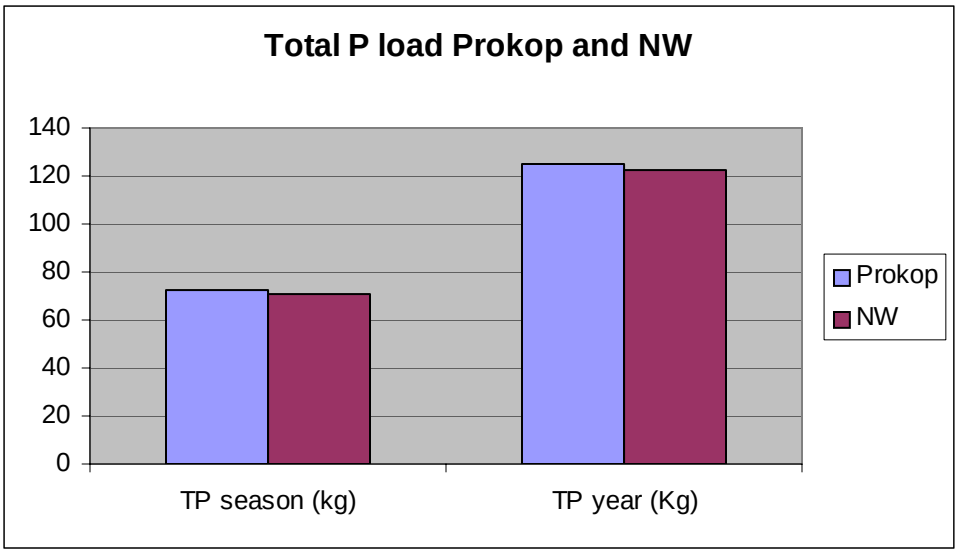




When comparing the two tributaries, it is evident that Prokop Creek has a much higher mean flow and therefore higher water load. However, the NW Tributary has a similar phosphorus load since the mean phosphorus values were much higher. Even though the NW Creek has much lower flow, it has a similar nutrient load due to a much higher phosphorus concentration in the water.



	Mean CFS	Max CFS	Min CFS
Prokop	1.66	4.64	0.91
NW	0.78	4.17	0.04



The calculation for the total phosphorus load per year is assuming the remaining portion of the year will have similar flow and phosphorus concentrations. This is unlikely, but allows for a valid comparison and an estimate of phosphorus loading.