APPENDIX 3

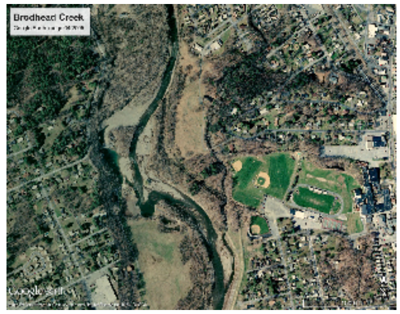
POLLUTANT LOADING AND WATER QUALITY PARAMETERS

When discussing the treatment of stormwater, the terms "pollutant load," "load," or "load reduction" are often used, especially when relating to types of impairments in streams and types of green infrastructure proposed to reduce pollutants. Pollutant loads are critical components to the treatment of stormwater and designing adequate green infrastructure. Pollutant loads are assessed by determining the maximum amount of pollution a stream can handle while still meeting water quality standards. Calculating pollutant loads is essentially determining a "diet" for a stream with the understanding that some pollutants are tolerable at certain levels but increased pollutant loading over the long-term eventually degrades water quality. Although this Green Infrastructure Plan is not creating a model of the watershed to determine the pollutant loads the local streams are capable of handling, this plan is discussing types of green infrastructure and specifically how green infrastructure reduces the pollutant load to local streams.

Common pollutant loads adversely affecting the water quality in the lower Brodhead watershed are sediments and nutrients (nitrogen and phosphorus). Effective planning and implementation of green infrastructure can reduce the amount of these pollutant loads entering the streams.

Most often, the general public becomes aware of stormwater problems after significant rain events when local streams are flowing at higher velocities and are "muddy" due to sediments. Unfortunately, not every observer attributes the sediment laden water to the effects of increased impervious surfaces and the resultant increase in stormwater runoff. The increased volume of stormwater reaching the streams forces the streams to carry a larger volume of water downstream. More often than not, the increase in volume is too large for the stream to carry within its banks and bank erosion occurs. These sediments are then carried downstream resulting in discolored water, deposition of sediments, and stream channel changes. Aside from the negative aesthetics noticeable during increased flows and the subsequent streambank erosion, high levels of sediment in stormwater result in the loss of aquatic habitat and a reduction in the quantities and types of aquatic animals and macroinvertebrates (crustaceans, worms, and aquatic insects). Increased stormwater volumes also threaten public health and safety as evidenced in the below figure. The images below depict a segment of the Brodhead Creek, within the project area, that experienced a significant change in the stream channel over a relatively short period of time (less than a decade). This depiction is important because it shows what can happen when development takes place within close proximity to streams and their floodplains, and more importantly, it shows the potential for catastrophic loss of property and potentially life, when streams change their course. As discussed in the Green Infrastructure Plan, protection of stream corridors not only aids in the protection of public health and safety, but is another form of green infrastructure (riparian buffer protection and restoration) that filters pollution, helps maintain cooler water temperatures, and promotes streambank stability.

Brodhead Creek, west of East Stroudsburg High School. Google Earth Image April 1999.



Brodhead Creek, west of East Stroudsburg High School. Google Earth Image April 2005.

Brodhead Creek, west of East Stroudsburg High School. Google Earth Image October 2008.

Brodhead Creek realignment. Images beginning April 1999 (left) to October 2008 (right). The Brodhead Creek's channel moved over 500 feet in some sections over a 9 year period.

Less obvious to the casual observer are the pollutants that are not as easily seen. Nutrients, specifically nitrogen and phosphorus, are some of the most common pollutants found in urban stormwater runoff. These pollutants are typically associated with pet and other animal waste, excess fertilizers, and pesticides. More importantly, many of these pollutants can be reduced just by educating residents and business owners, since many of these pollutants tend to be the result of human activities. Excess nutrients in streams results in excessive algae growth and subsequent lower oxygen levels in the streams, both of which adversely impact aquatic life.

Along with sediments, nitrogen and phosphorus are specifically targeted when designing green infrastructure. The Green Infrastructure Plan discusses the specific pollutant removal abilities of certain green infrastructure, but it is important to emphasize the sediment capturing capacity, the ability to remove nutrients through infiltration, and promoting plants to filter pollutants, are all key components to treating stormwater through the use of green infrastructure.

To better understand how stormwater runoff adversely affects water quality, the table below compares the common constituents evaluated when testing for water quality in both stormwater runoff and domestic wastewater. Even though domestic wastewater is treated before being discharged, it is perhaps the most relatable form of discharge known to most people. Almost everyone can relate to the types of pollutants generated in their own homes and businesses, e.g. human and pet wastes, detergents, cleaning products, etc. What this table shows is many of the constituent amounts found in urban stormwater runoff are comparable to those found in untreated domestic wastewater. (Bastian, 1997) Imagining if domestic wastewater was just discharged, untreated to local streams, is essentially what is happening when stormwater runoff is discharged.

Comparison of Water Quality Parameters in Urban Runoff with Domestic Wastewater (mg/L)					
Constituent	**Urban Runoff**		**Domestic Wastewater**		
	Separate Sewers		**Before Treatment**		**After Secondary**
	Range	**Typical**	**Range**	**Typical**	**Typical**
COD	200-275	75	250-1,000	500	80
TSS (Total Suspended Solids)	20-2,890	150	100-350	200	20
Total P	0.02-4.30	0.36	4-15	8	2
Total N (Nitrogen)	0.4-20.0	2	20-85	40	30
Lead	0.01-1.20	0.18	0.02-0.94	0.10	0.05
Copper	0.01-0.40	0.05	0.03-1.19	0.22	0.03
Zinc	0.01-2.90	0.02	0.02-7.68	0.28	0.08
Fecal Coliform per 100 ml	400-50,000		10^6-10^8		200

Comparison of Water Quality Parameters in Urban Runoff with Domestic Wastewater (mg/L). Adapted from *Effects of Water Development and Management on Aquatic Ecosystems*, by R.K. Bastian, 1997, New York, NY: Proceedings of an Engineering Foundation Conference. L.A. Roesner, ed. American Society of Civil Engineers.

Testing for these water quality parameters is important when determining the health of streams, but water samples taken on any given day indicate what was present at that specific time. When chemical grab samples are taken, they are really a snapshot of the water at that moment, that can change rapidly, but the macroinvertebrates are living there all the time. Their composition will be affected by either periodic episodes of poor water quality or continuous poor water quality. Benthic macroinvertebrates (bottom-dwelling organisms including aquatic insects, crayfish, clams, snails, and worms) are often used in studies to determine the quality of waters because of their high numbers, known pollution tolerances, limited mobility, wide range of feeding habits, varied life spans, and dependence on the land environment around the stream. (Oleson, M.S., Diane. January 14, 2013. Macroinvertebrates as Indicators of Water Quality. http://extension.psu.edu/natural-resources/water/news/2013/macroinvertebrates-as-indicators-of-water-quality)