Preliminary Report
Stroud Water Research Center

Preliminary Findings from Wireless Stream Monitoring Stations measuring
Conductivity-Temperature-Depth & Turbidity

for London Grove Township

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INTRODUCTION

The Stroud Water Research Center (SWRC) installed, under previous agreement with the London Grove Township, two wireless sensor stations for monitoring stream waters within London Grove Township. These sensor stations have been be constructed with open-source electronics hardware and software for data logging, data communication and sensor control functions (see http://envirodiy.org/next-generation-rugged-datalogger/). Data are streamed in near-real-time through the mobile phone network for display and are also stored on a onboard SD card as backup, in case the wireless transmission fails. Wireless transmission failure happened frequently during the summer of 2015 due to vegetation growing over the antennas.

These stations collect data from stream waters using two commercial, calibrated sensors:

- a Decagon Devices CTD sensor for conductivity, temperature and depth
- a Campbell Scientific OBS-3+ turbidity sensor

After working with London Grove Township to select locations, the two sensor stations were installed on July 3, 2015 at upstream and downstream locations on the small tributary of East Branch White Clay Creek that runs on the south side of East Baltimore Pike from West Grove to Avondale. The two stations are approximately ¾ of a mile apart on a stream reach that contains no perennial tributaries.

- **SWRC Logger 51 (SL051) is the upstream station**, located near the Avon Grove Little League baseball fields. Raw data from it are available in near-real-time from http://swrcsensors.dreamhosters.com/charts_main_SL051.php.
- **SWRC Logger 52 (SL052) is the downstream station**, located near Lake Road. Raw data from it are available in near-real-time from http://swrcsensors.dreamhosters.com/charts_main_SL052.php.

PRELIMINARY FINDINGS

Although the sensor stations have only collected data on a few small storms during the relative dry summer months (i.e. the upstream portion of the stream dried up for more than a month), we have observed a consistent pattern of differences between the upstream and downstream stations. See attached plots, which display only depth and conductivity data for clarity (filename: LGT_plots_DepthCond.pdf).

The upstream station exhibits patterns in depth, temperature, conductivity and turbidity that are typical of small streams in this region (see the upper plots in the attached figures). As storm waters enter the stream, water depth increases rapidly then decreases gradually as the stream returns to "baseflow" conditions over the next couple of days. Water conductivity, which is a measure of dissolved salts, is typically moderately high during baseflow due to natural rock dissolution by groundwaters, which feed streams during baseflow. During a storm, rainwater, which is lower in salt content, mixes in the stream with the groundwater inputs to dilute the salt content. Therefore, the typical pattern in our region is that conductivity rapidly decreases as waters rise and gradually return to baseflow conditions over the following couple of days, in a pattern that is the inverse of water depth.

The downstream station follows the patterns of the upstream station, with one major exception, for most of the storms that have been observed to date (see the lower plots in the attached figures). The major difference between the two stations is that in the downstream station, conductivity exhibits a 20-40 minute increase and trend reversal during the leading, rising edge of each storm peak. Furthermore, the conductivity of the downstream station typically does not drop to as low a level during the storm peak, where water depth is at a maximum and conductivity at a minimum.

These observed spikes in conductivity, as rainwaters are first entering the stream, along with an overall increase in stream conductivity at the storm peaks, are an unambiguous indication that there is an input of high-conductivity waters to the stream during each storm.

The observed differences in water conductivity between upstream and downstream stations are not, in and of themselves, a water quality issue. However, conductivity serves as an easy-to-measure indicator that there is a major source of storm water to the stream that has very different properties than typical stream waters. To further understand the impacts of this additional source of storm water to water quality would require targeted water sampling, during the leading edge and peaks of several storms, for further chemical and microbiological analyses.

PROJECTED COSTS FOR SAMPLE ANALYSES

The Stroud Water Research Center would be capable of receiving, processing and analyzing samples for the following chemical and microbiological properties:

- **Dissolved Organic Carbon (DOC)**, which adds biological oxygen demand to stream waters and is also regulated at drinking water intakes as a precursor for toxic compounds that are generated during chlorination (i.e. Disinfection ByProducts, or DBPs).
- **Anions, including Nitrate and Sulfate**. Nitrate is a source of nutrient pollution that leads to algal blooms and biological oxygen demand. Sulfate is one of the components of gypsum, which is used by the mushroom composting industry to reduce compose pH and improve aggregation and friability.
- **E**. coli and Fecal coliforms, which are potential human pathogens that grow at warm temperatures, such as within a mammalian body or within a compost pile.

We suggest collecting three samples from each site from each storm from a minimum of three storms. The samples would correspond to:

- Leading edge of rising waters, when conductivity temporarily peaks at the downstream site.
- The peak of each storm, when water depth is greatest
- Baseflow conditions, either in the day before the storm or 2-3 days after the storm

The costs of having SWRC process, analyze and interpret these 18 samples for the three analyses above would be $3,658. This cost does not include collecting the samples from the stream, which we suggest is best done by a township staff member or volunteer.

Collecting the samples from the stream at those exact times requires availability and close observation of stream conditions via the sensor websites, above. Unfortunately, during such storm events, SWRC staff have an exceptionally high workload. For our staff to do storm sampling would require us to purchase, place and maintain automated sampling devices which would cost $10,000 to $15,000. Fortunately, filling sample bottles does not require much skill. Anyone can fill the bottles and place them in a refrigerator for SWRC staff to pick up the following day.