Standard Sumps and the SAFL Baffle as Economical Solutions for Stormwater Treatment

What Was the Need?
As part of their commitment to the environment, MnDOT and local agencies implement programs to minimize the effects of stormwater runoff on regional surface waters and groundwater. Runoff occurs when water from rainstorms or melting snow flows over surfaces such as paved streets and parking lots, collecting sediments that can carry pollutants such as phosphorus and heavy metals.

One of MnDOT’s management practices for stormwater involves the use of pollution control devices within the storm sewer system to reduce runoff sediment. However, the proprietary devices available for these purposes can be expensive. MnDOT was interested in learning how effectively sediments can be removed by the significantly cheaper standard sumps, which are cylindrical tanks that are already a common feature of stormwater infrastructure.

These sumps are typically part of manholes that provide maintenance access to sewers. As water flows into these tanks, its velocity is reduced, causing some sediments to drop to the bottom of the tank as the water leaves through an outgoing pipe. Showing sumps to be effective as a sedimentation device would significantly lower the cost of complying with federal and state environmental regulations.

What Was Our Goal?
The goal of this project was to evaluate the effectiveness of standard sumps for stormwater management, including sumps retrofitted with the SAFL Baffle, a device designed to increase the effectiveness of sumps for removing and retaining sediments from stormwater runoff.

What Did We Do?
Researchers evaluated how well each of four laboratory sump configurations—4x4, 4x2, 6x6 and 6x3 feet—removed sediments from water moving through them at a number of different flow rates. To do this, they fed a known amount of sediment into a pipe carrying water into the sump, and at the conclusion of the test, they dried and weighed the sediment that remained at the bottom. Researchers then performed a similar test to evaluate washout rates for each configuration, or how well sumps retained captured sediments when water moved through them at high flow rates. Then they calculated the removal efficiencies and washout rates for sumps under a variety of conditions, including diameter and depth, sediment type, storm severity, water temperature and watershed size.

In a second phase of the project, researchers designed a retrofit to improve the performance of standard sumps in treating stormwater runoff. Called the SAFL Baffle, this retrofit consists of a porous grate that dissipates energy from water flowing into the sump, preventing a pattern of water circulation that increases washout. Researchers then repeated tests to evaluate sumps of various configurations for how well they
Captured and retained sediment. Some tests were conducted with the baffle clogged by debris such as trash and vegetation.

What Did We Learn?
Results showed that while standard sumps are effective for removing sediment from stormwater flowing at low flow rates, before installation of the SAFL Baffle they were unable to prevent captured sediments from washing out under high flow rates. The greater the depth of sumps and the larger their diameters, the greater their removal efficiency rates and the lower their washout rates. The formulas developed for calculating the efficiency of sumps can be used to determine how often they should be maintained and cleaned.

Tests of the SAFL Baffle showed that it dissipated the energy of water entering the sump, improving sediment capture by 10 percent to 15 percent and decreasing washout by a factor of 16, to nearly zero at high flow rates. Shallow sumps with baffles clogged by debris had significant washout, but this can be mitigated by increasing baffle hole diameters. Washout was also high in sumps with outlet pipes angled at 90 degrees to inlet pipes, but could be decreased by installing the baffle at an angle of 90 to 120 degrees to the inlet pipe. Additionally, researchers developed recommendations for using the SAFL Baffle in sumps receiving water from both inlet pipes and grates.

What’s Next?
In 2011 the SAFL Baffle was installed in more than 50 sumps by MnDOT, Minnesota cities and counties, and private entities, and many more are on order in 2012. On average, a sump equipped with the SAFL Baffle reduced the cost of removing sediment to one-fourth its prior cost. Researchers are continuing to share the results of this project in journals and at conferences.