



TECHNICAL SUMMARY

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PROJECT COST:

\$138,000



Researchers fed sand and water from fire hydrants into stormwater systems to see how underground drainage systems distribute suspended solids.



RESEARCH
SERVICES SECTION

Performance Assessment of Underground Stormwater Treatment Devices

What Was the Need?

Federal regulations require state and local agencies to control pollution of watersheds by stormwater discharge. Various best management practices for stormwater control include detention ponds, bioretention systems and underground treatment devices (in metropolitan areas where tight space constraints require them).

Stormwater is channeled into these devices and held temporarily so that particulates carrying some of the metals and phosphorus that can harm downstream water sources may settle out. Minnesota agencies in charge of stormwater maintenance wanted performance information on these devices to better guide future practices.

Stormwater management devices are traditionally evaluated with on-site monitoring systems, but these are not effective at all sites, and site-specific results cannot be usefully projected to other sites. New methods needed to be developed beyond site-specific monitoring to evaluate the effectiveness of proprietary underground devices.

What Was Our Goal?

Investigators sought to develop and evaluate methods for testing specific underground stormwater treatment devices. Specific goals included:

- Determining the feasibility of using field testing for such evaluation
- Evaluating the impact of sediment size and stormwater flow rate on the performance of specific underground treatment systems
- Developing a universal approach to testing and predicting treatment system performance in any given application

What Did We Do?

Investigators identified six proprietary underground stormwater treatment devices to evaluate, and in this study tested four of these in the field. (A separate project, not funded by LRRB, tested the other two in a laboratory to confirm the field testing methodology used here.)

The field testing employed controlled, reproducible runoff simulations by using fire hydrants for water flow at predetermined discharges. Sand mixtures were fed into the water flow with precalibrated sediment feeders. For each test, researchers recorded water temperature, mass of solids employed and the duration. Following simulated stormwater flow at four discharge rates, times up to 20 minutes were allowed for sand particles to settle. The devices were then dewatered with sump pumps, and solids were removed, separated, dried and weighed.

Investigators then evaluated the functionality of each device, refined device parameters and developed performance models to identify particle settling behavior and turbulent resuspension of particles during stormwater events. Finally, they examined the implications of the study methodology for device design in an attempt to use these findings to identify the device parameters for meeting specified flow and solids retention goals.

“This research developed standardized testing procedures that can be effectively used in evaluating underground stormwater treatment systems directly and effectively.”

–**Sue McDermott**,
City Engineer, Avondale,
Arizona; Former Public
Works Director, City of
Mendota Heights

“This technique for testing underground stormwater treatment device performance is the first method to be endorsed by ASTM as a methodology for underground hydrodynamic separator performance evaluation.”

–**John Gulliver**,
Joseph T. and Rose S.
Ling Professor,
University of Minnesota
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The one-foot-diameter inflatable plug was loaned to researchers by the City of St. Louis Park to control simulated stormwater flow into tested channels.

What Did We Learn?

The methodology for controlled field testing of underground stormwater treatment was developed by this study and shown to work well. It is practical, repeatable and can assess performance of these devices in terms of particulate size distribution and density, water discharge rate and water temperature. The method was evaluated and endorsed by ASTM and can now be used by manufacturers, government agencies, consultants and others in evaluating stormwater treatment systems.

In the analysis of the results of this study, a function was developed that describes the settling capability of each device and allows performance prediction over a range of variables, including device size, storm characteristics and pollutant sizes. The study found that the removal efficiency of systems depends on the size and density of the solids involved and the size and design of the device.

The method also has design applications: It can be used to predict how the devices will perform in the field as well as help in sizing new installations. Designers can also specify runoff details and pollutant particle sizes to determine system needs before installation.

What's Next?

The method developed in this study for examining underground stormwater treatment systems can be applied to many such devices. In high flow stormwater events, however, sediments removed from stormwater may be washed out, and thus eliminate the benefit of the underground systems in heavy storms. A current LRRB study is evaluating high-flow performance of these systems using another newly developed testing methodology. That study will help transportation officials determine whether underground stormwater treatment devices will be of use in Minnesota, where high-flow stormwater events are common.

This study evaluated proprietary systems for underground treatment. Standard sumps may be effective at removing suspended solids, with or without modification, and so bear investigation. A second LRRB study is following this line of research.

This Technical Summary pertains to the LRRB-published Report 2007-46, “Performance Assessment of Underground Stormwater Treatment Devices,” published November 2007. The full report can be accessed at <http://www.lrrb.org/PDF/200746.pdf>.

The two current LRRB-sponsored studies mentioned above are being conducted by this same research team. For more information, contact Shirlee Sherkow at shirlee.sherkow@dot.state.mn.us.