



TECHNICAL SUMMARY

Technical Liaison:

Marilyn Jordahl-Larson, Mn/DOT
Marilyn.Jordahl@state.mn.us

Administrative Liaison:

Shirlee Sherkow, Mn/DOT
Shirlee.Sherkow@state.mn.us

Principal Investigator:

John Gulliver, University of Minnesota

LRRB PROJECT COST:

\$55,000



Because flotation devices can be submersed at high velocities, researchers invented a wing that lifts the sampler when water flows across it.



RESEARCH SERVICES

OFFICE OF POLICY ANALYSIS,
RESEARCH & INNOVATION

Improved Automatic Sampling for Suspended Solids

What Was the Need?

One common cause of water pollution is post-rain runoff from areas such as construction sites, highways and urban centers. This runoff can include sediments—silt and other solids suspended in the water—that can harm fish, plants and other aquatic organisms. Suspended solids can also lead to higher concentrations of other pollutants typically attached to sediment particles, including pesticides and heavy metals. Consequently, one important objective for Minnesota agencies managing stormwater is to monitor the concentrations of suspended solids in runoff water.

One method of conducting this monitoring involves the use of automated sampling devices, which often consist of a tube with an intake opening placed in the path of running water—typically facing downstream—and the other end attached to a compartment containing bottles for storing samples. When the device detects that the water level and flow are above preset thresholds, a pump is automatically activated to extract and store water samples at regular intervals.

However, using a single intake opening means that samples are only taken at one depth at a given time. Because larger sediment particles have a tendency to settle more rapidly, samples taken at a single depth will typically not reflect the average large sediment concentration for the water column as a whole, and so misrepresent suspended solids in the water. Consequently, automatic field samplers have been found to overestimate the concentrations of sediments in runoff water, especially for coarse silts and sands. Research was needed to improve the sampling process.

What Was Our Goal?

The objective of this project was to improve the performance of automatic water samplers for sampling coarse silts and sands.

What Did We Do?

Researchers began by evaluating a typical sampling device in the laboratory to test water flowing through an 18-inch sewer pipe before and after the addition of sediments of various sizes. Samplers were tested in various configurations reflecting combinations of the following options: with and without an intake manifold, facing upstream or downstream, and anchored to the sewer pipe or allowed to move freely within the flow.

For each configuration, automatic samplers substantially overestimated concentrations for coarse silts and sands. Consequently, researchers set out to increase the accuracy of sampling by using either a flotation device or a wing to hold the manifold up and keep it positioned across the water column. They also tested a modified manifold with holes of different sizes for different water column depths, designed to sample equal volumes of water and sediment from each part of the water column.

Researchers dramatically increased the accuracy of the automatic sampling of suspended solids by creating a device that mixes equal volumes of samples collected from multiple locations in the water column, yielding a combined sample that more closely reflects the average for the water column as a whole.

“We developed an automatic sampling device that dramatically increases the accuracy of sampling for suspended sediments, especially sands and coarse silt.”

—John Gulliver,
Professor, University of
Minnesota Department
of Civil Engineering

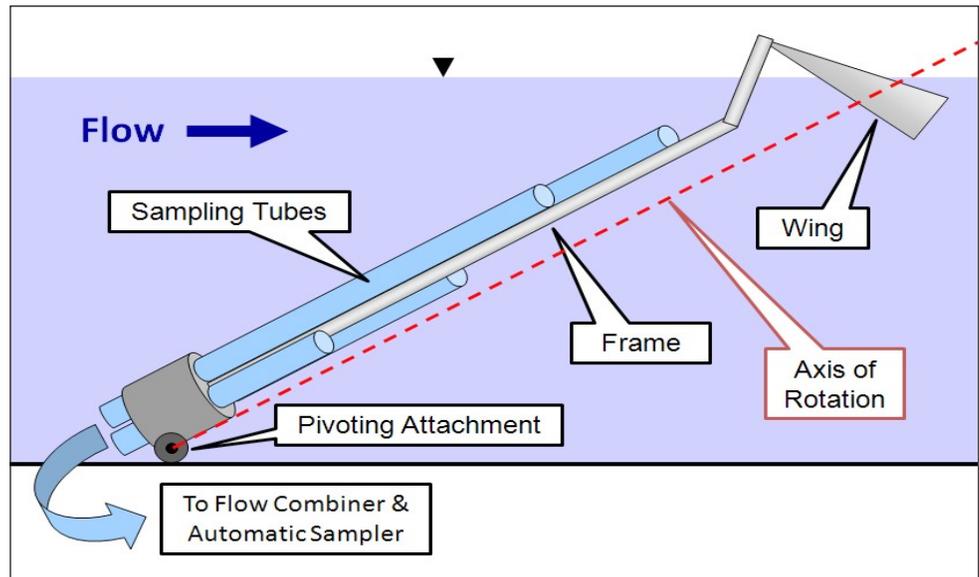
“This project is an important starting point for developing technologies that make stormwater sampling more accurate and efficient.”

—Marilyn
Jordahl-Larson,
Unit Chief, Mn/DOT
Environmental Modeling
& Testing

Produced by CTC & Associates for:

Minnesota Department
of Transportation
Research Services Section
MS 330, First Floor
395 John Ireland Blvd.
St. Paul, MN 55155-1899
(651) 366-3780

www.research.dot.state.mn.us



Researchers created the winged sampling arm—a design that replaces the intake manifold of typical sampling devices with four tubes that combine equal volumes of samples taken from different locations in the water column.

What Did We Learn?

The presence of the flotation device made the sampler prone to submersion under higher velocities by drag forces, making this design unsuitable for use in a sewer pipe. Consequently, researchers designed a wing that creates lift when water flows past it, allowing the sampler to maintain its position over a range of flow velocities.

While wing- and manifold-modified samplers displayed improved accuracy, these improvements were not consistent for all sediment sizes and flow rates. Researchers concluded that the manifold itself led to poor sampling, so they tested a design that eliminated it completely. This design used a wing attached to a frame holding four sampling tubes of different lengths and consequently different depths in the water column. These tubes were then combined using a device that ensures equal flow rates from each tube in order to mix the same volumes of samples from each level of the water column. The sampling mechanism was named the “winged sampling arm.”

The winged sampling arm dramatically increased the accuracy of sampling by collecting subsamples of equal volume, from multiple locations in the water column and across a range of flow conditions, yielding a combined sample that more closely reflects the average for the water column as a whole.

What's Next?

Researchers will be presenting the results of this project over the next year in three journal articles, at conferences and through other communication venues. As engineers continue to improve their knowledge of the role of suspended sediments in stormwater management, technologies that increase the accuracy of sampling will play a critical role.

This Technical Summary pertains to the LRRB-produced Report 2010-38, “Improved Automatic Sampling for Suspended Solids,” published November 2010. The full report can be accessed at <http://www.lrrb.org/PDF/201038.pdf>.