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OFFICE OF TRANSPORTATION SYSTEM MANAGEMENT

TECHNICAL SUMMARY

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PROJECT COST:
$79,464

Adding flocculant (left) to a sample of water from the Minnesota River causes sediment to clump and sink.

Using Flocculants to Reduce Construction Pollution

This project identified three chemical flocculants that are effective at removing a broad range of Minnesota soils from water. The research will contribute to improved treatment of stormwater runoff from construction sites and reduce the amount of sediment pollution entering the state's rivers and lakes.

What Was the Need?

Stormwater runoff from construction sites can pick up a large amount of soil from the land disturbed by construction activity. This sediment is a serious pollutant to lakes and rivers that receive the runoff.

Recent MnDOT research has investigated monitoring the amount of sediment in stormwater runoff and using temporary ponds to let sediment settle out of stormwater before it runs off the construction site. MnDOT also wanted to examine the possibility of treating the construction runoff with flocculants, which are chemicals that cause the suspended sediment to form clumps that will quickly settle out of the solution.

Flocculants have been used to treat drinking water for more than 70 years, but there has been only limited testing of their use in treating construction runoff. Research was needed to evaluate the effectiveness of this approach.

What Was Our Goal?

The objective of this project was to determine which flocculants, if any, would be feasible for treating stormwater runoff from construction sites and to assemble best management practices for determining appropriate flocculant treatment approaches for specific sites.

What Did We Do?

Researchers first characterized 57 soil samples from around the state for properties such as grain size, acidity and organic content. Minnesota is a large, geographically diverse state, so the physical properties of soil can vary significantly from site to site and even in different soil layers at the same site. These properties can significantly affect a flocculant's effectiveness.

Next, researchers tested the effectiveness of 21 flocculant chemicals on samples of all 57 soils suspended in water. In the first phase of this test, they used the chemical manufacturer's recommended dosages. In a second phase, researchers chose seven chemicals as representatives of available chemical types to evaluate the impact of varying the dosage.

Researchers next conducted laboratory tests of several approaches for mixing flocculants into runoff to disperse them throughout the solution.

Finally, the investigators developed a set of best management practices for using flocculants to reduce the amount of sediment in stormwater runoff.

What Did We Learn?

Using flocculants to help remove sediment from stormwater runoff at construction sites is a promising but complex process. While no chemical was effective on all soils, three chemicals were broadly effective on a wide range of soils: ferric chloride, a metal salt commonly used in wastewater treatment; Aqua Hawk 6447, supplied by Hawkins, Inc.; and Tramfloc 865A, supplied by Tramfloc, Inc.

continued

"Water is leaving construction sites carrying too much sediment. Chemical treatment has been used to treat drinking water for 70 to 80 years, and our thought was to try it in construction as well."

—Steve Druschel,
Associate Professor, Minnesota State University, Mankato, Department of Environmental Engineering

"We're trying to develop a portable water treatment plant that can be applied to construction projects to deliver clean runoff water after a storm."

—Dwayne Stenlund,
Transportation Specialist, MnDOT Office of Environmental Services

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Adding flocculant to stormwater runoff can be as simple as drilling a hole in a bucket of the chemical and mounting it above the water (as shown here), although thorough mixing must be ensured. MnDOT hopes to develop a system that will automatically dispense a precise dose based on the amount of sediment in the water.

The most effective mixing techniques were passing the water over a 6-foot-long gravel path, passing water through an 8-foot-long corrugated pipe, and injecting pressurized air into the solution and a single-bladed mixer. However, due to the inconsistent conditions on a construction site, mixing technologies may not be practical for fieldwork.

The best management practices generated by this project specify a set of guiding objectives for water treatment: selecting the appropriate treatment chemical and dose, managing hydraulics, fostering optimal mixing conditions, preserving the contrast of high energy for mixing and low energy to allow sedimentation, and considering operational details. For each objective, researchers detailed the factors that influence success and the negative effects if success is not achieved. Researchers also created flowcharts describing the general process for designing a site's water treatment strategy.

What's Next?

An ultimate goal of this approach is to develop a portable water treatment plant that can be used in the field to determine an effective chemical flocculant and dosage for treating the stormwater runoff at a specific construction site. Achieving this goal poses significant engineering challenges, including verifying on-site that a selected flocculant and dose are appropriate to the soils encountered on the project, and testing the outflow discharge for residual sediment.

This research, however, helped to narrow the range of chemicals that should be considered for use in field applications. Any chemicals recommended for field usage will need to be approved by the Minnesota Pollution Control Agency, and methods for disposing of used chemicals will need to be identified as the environmental impacts of residual chemicals are unknown.

Since it is not feasible for workers to constantly monitor sediment concentration in stormwater runoff, MnDOT hopes to leverage the knowledge gained from this project to develop an automated system that measures the amount of sediment in runoff and automatically adds the appropriate dose of flocculant to treat the water.

This Technical Summary pertains to Report 2014-25, "Flocculation Treatment BMPs for Construction Water Discharges," published August 2014. The full report can be accessed at http://www.lrrb.org/PDF/201425.pdf.