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DEPARTMENT OF TRANSPORTATION

RESEARCH SERVICES & LIBRARY

TECHNICAL SUMMARY

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PROJECT COST:
$178,051

For field tests, researchers created small plots using either peat or compost mixed with native soil.

Managing Stormwater Runoff with Recycled Peat and Taconite Tailings

What Was the Need?

During rainstorms, water flows across the impervious surfaces of highway pavements until it reaches a stream or patch of soil. Along the way, this stormwater runoff often picks up pollutants, including heavy metals, organic compounds from sewage and industrial chemicals, and sediment from pavement wear and winter plowing.

The vegetation and soil in drainage ditches along highways help absorb the stormwater and filter its pollutants before they reach streams and other bodies of water. During roadway construction, MnDOT sometimes amends these ditches with materials—usually a mixture of compost and sand—that optimize their ability to support plant growth, absorb water and filter pollutants. In these cases, the slope of the ditch is designated a bioslope and the bottom of the ditch a bioswale.

Finding alternatives to commercial compost and sand for use in bioswales will help MnDOT meet regulatory requirements for stormwater runoff, while reducing the costs and environmental effects of transporting and storing these materials.

However, hauling sand and compost to roadway construction sites can be very expensive. MnDOT is interested in finding alternative materials that are just as effective for biofiltration, but can be sourced close to construction sites and recycled from construction or industrial byproducts. In northeastern Minnesota, two byproducts often generated by excavation during roadway construction have some promise for replacing compost in bioswales and bioslopes: peat, a mixture of soil and decomposed plant matter, and muck, a mixture of organic matter and clay. Also available in this region are taconite tailings, a mining byproduct that could potentially replace sand. MnDOT was interested in testing these materials to determine whether they are suitable for use in bioswales and bioslopes.

What Was Our Goal?

The objective of this project was to evaluate peat and muck excavated from construction activities, taconite tailings from area mining operations, and other stormwater quality filter media for use in bioswales and bioslopes along Minnesota highways. Laboratory and field tests of these products would examine their capacity to absorb water, retain pollutants and support plant growth to determine if they are beneficial and practicable in these designs.

What Did We Do?

Researchers began by conducting a comprehensive literature review on the use of bioslopes and bioswales as stormwater treatment best management practices. Then they collected peat and muck near a highway construction project, as well as locally sourced sand, compost, taconite tailings and commercial peat.

These materials, as well as various combinations of materials, were used in laboratory experiments to determine how well they:

- Absorbed water, using a falling head test to measure saturated hydraulic conductivity, which indicates the rate at which water infiltrates a material.
- Retained pollutants, using leaching experiments to quantify how well they removed copper, lead, zinc, nitrate and phosphate.

continued

"The results of this project will very much facilitate the development of green infrastructure by reducing its cost to MnDOT and Minnesota local agencies, helping them to do more with less."

—Dwayne Stenlund,
Erosion Control Specialist, MnDOT Erosion Control and Stormwater Management

"Ultimately, a combination of peat and taconite tailings will compare favorably with current MnDOT specifications for bioslope and bioswale design."

—Kurt Johnson,
Research Fellow, University of Minnesota Duluth Natural Resources Research Institute

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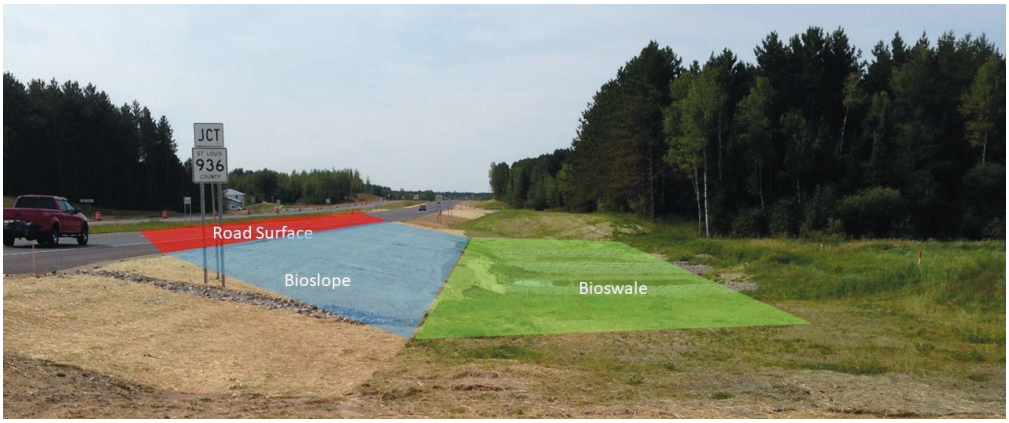

Bioslopes and bioswales provide a natural mechanism for meeting national and state pollution regulations, which require retaining the first inch of runoff during rainstorms.

- Sustained plant growth, using bioassays and greenhouse studies.

Finally, researchers conducted pilot field tests on three plots containing a 50/50 percent peat and sand mixture, and another three plots with a 50/50 percent compost and sand mixture. Between April and August of 2017, they monitored water infiltration, discharge water quality and vegetation establishment for these sites.

What Did We Learn?

Researchers found that peat has a strong potential for replacing commercial compost in MnDOT's standard bioslope and bioswale designs, and that taconite tailings also performed comparably to the sand currently specified in these designs. However, muck has little potential to replace commercial compost or peat due to its low permeability, poor infiltration and filtration properties, and lack of support for plant growth.

Results for the three properties of interest follow:

- **Infiltration rate:** While muck had an unacceptably low hydraulic conductivity, peat performed at least as well as compost, and taconite tailings as well as sand. Pilot tests showed that a 50/50 mix of peat and taconite tailings had a similar water storage capacity to a 50/50 mix of compost and sand.
- **Pollution retention:** Muck absorbed only 50 percent of metals; salvaged peat, commercial peat and compost performed well, absorbing more than 80 percent. However, only taconite tailings showed the potential to remove phosphate. None of the materials removed nitrate.
- **Plant growth:** Mixtures of compost or peat with sand or taconite tailings all performed well in providing a viable substrate for plant growth. Mixes containing compost performed the best in plant growth trials. Muck was difficult to mix with any other material, and its value for plant growth was minimal. Greenhouse study results showed no difference between sand and taconite tailings in their effect on plant growth response.

What's Next?

In a second phase of this project, "Development and Regionalization of In Situ Bioslopes and Bioswales," MnDOT will conduct further laboratory tests on alternative materials for bioslopes and bioswales, and expand field tests to several sites in Minnesota that have been constructed using these materials. Researchers also recommend the development of specifications and detail drawings for the use of these materials.

This Technical Summary pertains to Report 2017-46, "Comparing Properties of Water Absorbing/Filtering Media for Bioslope/Bioswale Design," published November 2017. The full report can be accessed at mndot.gov/research/reports/2017/201746.pdf.