Research Summary

Center for Dirt and Gravel Road Studies

Sediment Reductions from Environmentally Sensitive Maintenance Practices on Unpaved Roads

6/2008

Research Overview:

Pennsylvania's Dirt and Gravel Road Maintenance Program has long advocated Environmentally Sensitive Maintenance (ESM) Practices to reduce stream pollution from unpaved roads. Penn State's Center for Dirt and Gravel Road Studies (Center) has recently completed a research project with funding from the Chesapeake Bay Commission that begins to quantify sediment reductions from several commonly used ESM practices.

This document is a summary only, full report is available at www.dirtandgravelroads.org under "research".

research funded by…

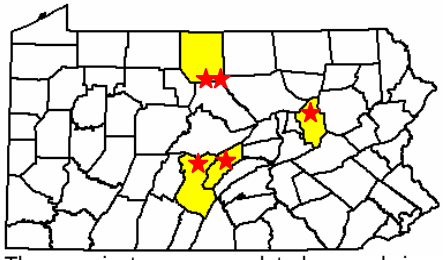
ESM Practices Tested:

Five Environmentally Sensitive Maintenance Practices were tested in this study:

- **Driving Surface Aggregate**: a specific aggregate mixture designed as a wearing course for unpaved roads;
- **Raising the Road Profile**: raising road elevation to eliminate lower ditch & restore sheet flow;
- **Grade Breaks**: elongated humps in the road surface designed to shed water to each side of the road;
- **Additional Drainage Outlets**: creating new outlets in ditchline to reduce channelized flow; and
- **Berm Removal**: removing unnecessary berm and ditch on down slope side of road to encourage sheet flow.

Methods:

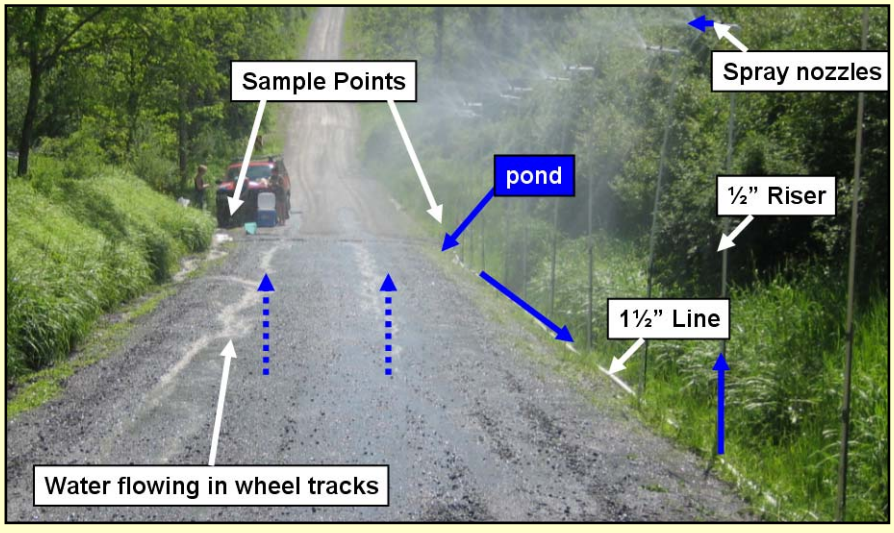
In order to determine sediment reductions of the five practices, it was necessary to collect sediment data both before and after each practice was implemented. The Rainmaker (see description below) was used to create a controlled and repeatable rainfall event on a 100' section of road. Each test consisted of three 30-minute runs of the rainmaker, both before and after ESM practice implementation. Flow and sediment samples were taken at regular intervals to determine the total sediment loss for each section of road. The three test runs were combined for each section of road to determine the average sediment loss for one 30 minute event. By comparing the flow and sediment differences from before and after ESM practice implementation, the sediment reduction from each practice can be determined.



These projects were completed on roads in Potter, Columbia, Huntingdon, and Mifflin Counties as illustrated by the stars above.

Meet the Rainmaker, a Rainfall Simulator for Roadways…

The "rainmaker" is a rainfall simulator developed by the Center that creates a 0.55" rainfall event in 30 minutes over a 100' length of road. This is equivalent to a 1-month return interval for a 30 minute storm for most of Pennsylvania. The rainmaker creates a controlled, repeatable rainfall event that is run both before and after ESM practices are installed on the road. By comparing runoff and sediment concentrations, sediment reductions can be calculated for the various ESM practices. Rainmaker layout and components are illustrated to the right.



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Results

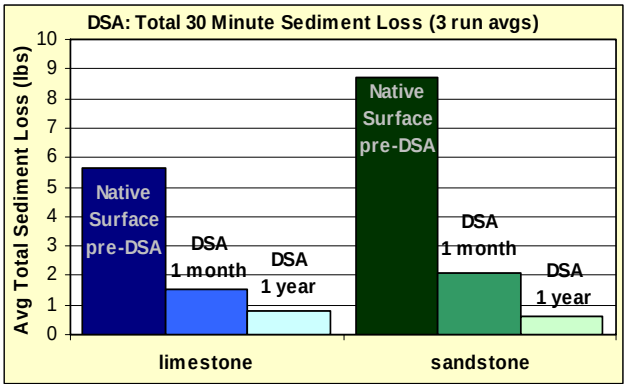
***Special Note**: This study provides a valuable initial look at sediment reductions from ESM practices. However, due to the limited number of sample points, and the infinite variability of road conditions in the field, sediment reductions for specific practices found in this study should NOT be considered blanket or universal reductions for each practice.*

Runoff Rates from Existing Roads:

The five "existing condition" tests done for this study found sediment production rates ranging from 0.7-12 pounds of sediment runoff in a single 30 minute, 0.55 inches simulated rainfall. The 0.7 pound event was generated from a flat and narrow farm lane with grass growing between the wheel tracks. The 12 pound event was generated from a wider, mixed limestone/clay township road at a 4-5% slope. This highlights the great variability in erosion rates based on specific site conditions. Using the average sediment runoff rate of 5.6 pounds per event, a single 30 minute 0.55 inch rain event moving across Pennsylvania can be conservatively expected to generate over 3,000 tons* of sediment form the State's 20,000+ miles of public unpaved road. **For illustrative purposes only, more testing on varied roads is needed to substantiate this extrapolation.*

Driving Surface Aggregate:

Two separate DSA placements were tested on Lebo Road in Potter County. The aggregates, one limestone and one sandstone, were placed according to Dirt and Gravel Road Program standards (one 8" lift, placed using a paver, compacted to 6"). Rainfall simulations were run before placement, and at intervals of 1 month and one year after placement. The graph to the right summarizes the results in total sediment loss per 30 minute rainfall simulation. Compared to their respective native surfaces, Limestone DSA reduce sediment by 73% after one month and 86% after one year, while Sandstone DSA reduced sediment by 76% after one month and 93% after one year. Parent material did not significantly affect sediment generation rates.



Drainage Control Practices:

Unlike DSA which reduces sediment generation from the road surface, the four remaining practices reduce sediment by reducing and controlling the volume of road runoff.

Raising the Road Profile:

Diehl Road in Columbia County was filled approximately 5 feet in order to completely eliminate the ditch on the down slope side of the road. Sheet flow into a vegetative filter was achieved off the down slope side of the road after it was filled. This practice reduced the amount of sediment entering the stream by 78% after one month, and 81% after one year. Some infiltration of runoff into the new road fill may have accounted for the higher than expected reductions on Diehl Road.

Grade Break:

Two grade breaks were tested in this study, one in Huntingdon County, and one in Mifflin County. The grade breaks showed sediment reductions of 57% and 43% respectively. *Note that the grade breaks were placed in the middle of the 100' test section, therefore sediment reductions of 50% indicate the gradebreak was 100% effective in eliminating upslope sediment.*

Additional Drainage Outlets:

The effect of adding a turnout was tested on Pine Swamp Road in Huntingdon County. The new turnout discharged into a vegetative filter and did not affect the stream. A turnout was used instead of a culvert for cost effectiveness and simplicity. The turnout showed sediment reductions of 48% for the down slope ditch alone, or 31% when factoring in the up slope ditch that was unaffected by the turnout. *Note that, as with the "grade-break", the turnout was placed in the middle of the 100' test section, so a 50% sediment reduction indicates a 100% efficiency.*

Berm Removal:

The effect of berm removal was tested on Pine Swamp Road in Huntingdon County. Removing the berm effectively eliminated the down slope ditch and allowed water to sheet flow into a vegetative filter area. Berm removal showed sediment reductions of 94% for the down slope ditch alone, or 59% when factoring in the up slope ditch that was unaffected by the practice.

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