LEOPOLD CENTER
FOR SUSTAINABLE AGRICULTURE

Quantifying the effects of alternative surface inlet protection strategies on water quality

Abstract: Subsurface drainage systems with surface inlets are widely used to divert water in crop producing areas, but pose problems because they can allow unfiltered, sediment-laden water to travel quickly to other waterways. The project tested several modest, uncomplicated inlet protection practices with potential to keep nutrient and sediment flows in check.

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$34,192 for year one

ECOLOGY

Q Do surface inlets to tile drainage systems contribute to water quality problems in Iowa and are there viable alternative practices that can reduce their impact?

A Current designs of surface inlets can allow water with high concentrations of sediment, sediment-bound phosphorus, and dissolved phosphorus to enter the drainage system. Blind inlets and filter socks amended with alum can reduce these concerns, but choosing the best practice to use will depend on site-specific conditions.

Background

Subsurface drainage that removes excess water from soils is used to facilitate optimum crop production in many parts of the world including Iowa and much of the U.S. Corn Belt. As a result, the Iowa landscape has been extensively altered by stream channelization, terracing, and installation of subsurface drainage systems. Often these drainage systems contain surface intakes to collect surface water that accumulates in natural depressions and behind ditch banks and constructed terraces. Unfortunately, these surface inlets bypass the soil's filtering capacity and rapidly transmit water to streams and drainage channels. This can increase the amount of sediment and nutrients reaching these bodies of water and contribute substantially to declines in water quality.

The project objective was to quantify the effectiveness of three relatively simple, surface inlet protection practices for improving water quality:

1. Install a blind inlet,
2. Surround the surface inlets with 15-ft wide grass filters strips, or
3. Encircle surface inlets with woodchip-filled filter socks.

Approach and methods

Blind inlet: This consists of buried perforated drain pipes covered with gravel and separated from the overlying sand by a geotextile barrier. These infiltration galleries replace the surface inlets, thereby eliminating the need for risers. This allows for unimpeded passage of farm equipment and takes no crop land out of production.

Grass filter strips: Grass buffers have proven to be very effective in reducing the amount of sediment and sediment-bound nutrients entering ditches and streams when planted along riparian corridors. The disadvantage of buffer strips is that they take land out of production, can be difficult to manage within cropped fields, and may not be very effective for removing dissolved nutrients. (In this project, the investigators used Canada wild rye and switchgrass.)

Members of the SFWA assisting in the installation of a blind inlet. In this image the drain pipe has been installed and connected to the riser and is being covered with gravel.

Woodchip-filled filter socks: These are commonly used in construction areas to reduce sediment loss. Alum (aluminum sulfate) was mixed with the wood chips to increase their ability to retain dissolved phosphorus. A disadvantage is that filter socks need to be replaced each year to maintain their effectiveness. The fill material, however, can be readily and safely disposed of on-site by empting the sock and spreading the material on the field.

Demonstrating the effectiveness and impact of these strategies on farming operations and water quality is critical to getting Iowa producers to adopt such conservation practices. The researchers partnered with the Southfork Watershed Alliance (SFWA) to install these practices on five farms (2104) and nine farms (2015) within the south fork of the Iowa River Watershed. Leopold Center funds were used to sample and analyze surface water before and after it entered the inlets to determine the effect of each inlet type on water quality.

Results and discussion

There were advantages and disadvantages to each inlet protection strategy and no one approach performed well in all situations. The blind inlet worked well during the one crop year test in reducing the amount of sediment and sediment-bound phosphorus entering the drains. In some locations, however, high sediment loads may clog the blind inlets, slowing the entry of water, and prolonging the ponding of water. This may result in reduced crop growth or crop death and will require periodic maintenance or replacement of the blind inlet. The filter sock, when combined with a riser-type inlet, reduced the amount of sediment and sediment-bound phosphorus entering the drain and was the most effective practice for reducing dissolved phosphorus concentrations. Only limited information was collected on the effectiveness of the grass buffer since the newly sown buffers were killed by prolonged ponding. There probably are some locations where frequent ponding will limit the effectiveness of any of the alternative inlet designs.

The Agi-Drain inlet was similar to the alternative inlets in its ability to reduce sediment and sedment-bound phosphorus, but had no apparent effect on the loss of dissolved P.

Conclusions

Project findings conclusively showed that the water entering tile line surface inlets was impaired in terms of water quality. The alternative inlets tested were mixed in their effectiveness. Standpipe-type inlets used alone can improve water quality by slowing water entry into the drains thus increasing ponding and reducing Total Suspended Solids (TSS) and Total P (TP) concentrations due to sedimentation. They were less effective in reducing Total Dissolved P (TDP) concentrations. Surrounding the inlets with a 15-ft grass buffer was ineffective in improving water quality mainly because the grass could not survive prolonged inundation. A more well-established buffer may have eliminated this problem, but there will probably be sites and years during which the conditions may be unfavorable for survival of even well-established buffers. The blind inlets were effective in reducing the TP and TSS reaching the drain

A filter sock-protected inlet after the ponding has subsided. Note the trapping of crop residue and the deposition of sediment outside the sock.

tiles, but were less effective than the filter socks in reducing TDP.

The filter socks also have the advantage of being cheaper and easier to install than the blind inlets, but need to be replaced every year to remain effective. The team observed that in locations where there was considerable erosion, sediment accumulated on top of the blind inlets and will reduce their infiltration rate to the point where they will require maintenance or eventual replacement. These results are based on the conditions present for only one crop year and thus may not reflect the long-term effectiveness of these practices. The researchers plan to resume sampling in the 2015 crop year and will add more sites in collaboration with other farmers and the South Fork Watershed Alliance.

Impact of results

It is unlikely that any single alternative inlet design will be suitable for all locations and circumstances. The project results indicate, however, that tile line surface inlets can be a significant contributor to water quality problems in Iowa. Installing surface risers can reduce this concern, but other modifications should be considered. Selection of alternative inlets will be dependent on site characteristics and the contaminants of concern. Blind inlets will function longest in sites with limited erosion, but will not be as effective as filter socks in reducing TDP. Grass buffers may be difficult to establish and maintain in some locations, but also should be effective in reducing TSS and TP transport. In areas where prolonged inundation is a regular occurrence, it is unlikely that filter socks and grass buffers will be effective in improving water quality. Additionally, it may be uneconomical to produce row crops in these areas due to depressed crop yields. Consideration should be given to taking these areas out of row crop production.

Education and outreach

Iowa River Greenbelt – Conservation Symposium, July 2014, Calkins Nature Area, Iowa Falls, Iowa; 50 local farmers and members of conservation groups attended.

SERA-17 Annual Meeting July 2014, Des Moines, Iowa. A poster entitled “Tile Inlet Protection Strategies: A collaborative research and demonstration project” was presented at this meeting of the Southern Extension and Research Activity (SERA)-17, Information Exchange Group (IEG).

Water Quality Showcase August 2014, Steamboat Rock, Iowa. PowerPoint presentation to 75 members of conservation and agricultural organizations.

North Central Iowa Crop and Land Stewardship Clinic December 2014, Iowa Falls, Iowa. Two sessions for farmers and crop consultants.

Iowa Water Conference March 2015 Ames, Iowa, Poster highlighting the project and a display including a blind inlet model.

A field day/workshop is planned for summer 2016 in conjunction with the South Fork Watershed Alliance to present the findings of the project as part of a farmer-led outreach effort. (See http://www.southforkwatershed.org/tile-inlet-project.html

Leveraged funds

The South Fork Watershed Alliance was awarded a $24,475, two-year, Education/ Demonstration grant by the Iowa Department of Agriculture and Land Stewardship for the purpose of installing the alternative inlets. In addition, Soil-Tek (Grimes, Iowa) made an in-kind contribution of ~$900 by providing the custom-made filter socks used in the study. Agri Drain Corporation (Adair, Iowa) made an in-kind contribution of ~$500 by providing and installing one of their Water Quality Inlets at the experimental site.

For more information, contact:
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