Executive Summary, Research Readiness Level Assessment, and Technology Transfer

Evaluation of NDOT's Sediment Barrier Practices Using Performance Data

Research Objectives

This project involves establishing a methodology and modeling process to assess the effectiveness of different buffer configurations encountered along NDOT highway construction sites. This includes factors such as buffer length, vegetation type, and soil composition. Following this, large-scale laboratory experiments will be conducted to evaluate the performance of sediment barrier practices employed by NDOT. These experiments will estimate soil losses and stormwater runoff volumes associated with NDOT highway construction projects. This data will serve to supplement buffers that do not meet the minimum 50-foot requirement, ensuring comprehensive mitigation measures.

Research Benefits

The project is expected to improve regulatory compliance and further demonstrate NDOTs commitment to environmentally friendly construction practices. Ultimately, the scientifically attained data generated through this research effort will provide designers, contractors, and NDOT inspectors with a comprehensive performance review of NDOTs sediment barrier practices and effective implementable strategies to improve their performance. In addition, recommendations for updates to current erosion and sediment control design tools that will allow NDOT designers to incorporate effective and innovative erosion and sediment control technologies into their stormwater management plans. Enhanced practices will protect water quality downstream of construction activities, reduce regulatory compliance issues, improve overall public perception, and save Nebraska taxpayer dollars. Erosion and sediment control research performed at the AU-ESCTF has led to immediate implementation through updated standard drawings and specification updates by the Alabama DOT.

Principal Investigator

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NDOT Lead TAC Member

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Background

Construction activities involve heavy earthmoving activities that typically disturb several acres of land. Due to the nature of construction activity, sediment is the predominant pollutant of concern during the clearing and grading stages, which typically exposes large un-vegetated and un-stabilized land areas to erosive elements. Sediment runoff rates from construction sites can be 10 to 20 times higher than those of agricultural lands and 1,000 to 2,000 times greater than those of forested lands. Construction sites have measured erosion rates of approximately 20 to 200 tons per acre (45 to 450 metric tons per ha) per year. In addition to environmental implications, sedimentation can cause vast economic problems. The loss of aquatic habitat and diminished water quality is often difficult to quantify, however some impacts (i.e., cost of dredging and disposing of accumulated sediment) are easier to assess. Furthermore, the cost of eroded soil replacement comes at a high price. Stormwater management has become an increasingly important aspect of construction activities in the state of Nebraska. The National Pollutant Discharge Elimination System Permit for Storm Water Discharges from Construction Sites (NPDES Permit) requires the Nebraska Department of Transportation (NDOT) to develop a stormwater pollution prevention plan (SWPPP) for all construction activities that are covered by the permit. The SWPPP includes the design, installation, and maintenance of erosion and sediment control practices to minimize downstream impact from stormwater discharges. Currently, NDOT has specifications, standard drawings, and guidance for the design of erosion and sediment control practices. Opportunities exist to better understand the performance of standard NDOT erosion and sediment control practices, improve the design and performance of practices, and to develop additional design manual guidance for the proper selection and design of practices.

Conclusion

To protect waterways adjacent to construction projects with disturbed land, a 50 ft (15 m) vegetated buffer or equivalent sediment controls are required. However, there is little guidance on the effectiveness of vegetated buffers in removing sediment or how sediment barriers can aid shorter buffers or replace buffers. A modeling methodology was developed and used to determine the performance of 11,664 50 ft (15 m) vegetated buffer configurations with Nebraska conditions; sediment capture averaged 92.6% and ranged from 18.5% to 99.5%. To determine the performance of Nebraska Department of Transportation standard and modified sediment barrier installations, a large-scale testing methodology was used that subjected silt fence, slash mulch berm, and wattle silt check installations to conditions commonly found on Nebraska highway construction sites. From deficiencies noted in testing of standard installations, modifications were developed and recommended that improved structural performance, provided additional water quality treatment, and increased sediment capture.

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Final report is available at:
NDOT Research Website

NDOT Recommendations Based Off Research Project

Modeling of vegetated buffers and testing Nebraska DOT standard and modified sediment barriers provides usable and implementable guidance to the Nebraska DOT and other regulatory agencies. The development of a repeatable modeling methodology for sediment capture of vegetated buffers allows for the analysis of not only 50 ft (15 m) vegetated buffers but also shorter buffers that can be supplemented by sediment barriers to reach regulatory requirements. Opportunities exist to enhance the performance of existing NDOT detention measures. As July 2024 NDOT will begin Phase II for this project Title – Evaluation of NDOT's Construction Stormwater Detention Measures using Full-Scale Techniques seeking to provide full-scale testing at the Auburn University – Stormwater Research Facility. Since silt traps and sediment traps seek to remove sediment through sedimentation, the same tactics used to improve sediment basins should be considered for improving silt traps and sediment traps. Therefore, to enhance the capture effectiveness of these detention-based practices, the following modifications will be considered: inclusion of an upstream forebay, stabilization of the channel and sediment basin with a geotextile liner, energy dissipation within the detention practices using an energy dissipator such porous baffles, and surface dewatering through use of a surface skimmer.

- *As provided by Ron Poe, Lead TAC Member*

Research Readiness Level (RRL) Assessment

Level: Field Development / Standard Practice Level

RRL 2

Technology Transfer

Transportation Research Board (TRB) papers and Publications

- Roche, B., Perez, M.A., Donald, W.N., and Whitman, J.B. (2024). Large-Scale Performance Evaluation of Various Woven Silt Fence Installations under Nebraska Highway Conditions, Water. https://www.mdpi.com/2073-4441/16/6/877
- Roche, B. (2023) Performance Evaluation of Sediment Control Practices. Auburn University Electronic Thesis and Dissertation Library. https://etd.auburn.edu/handle/10415/9110
- Roche, B., Perez, M.A., Donald, W.N., and Whitman, J.B. (2023). Efficacy of Undisturbed Vegetated Buffers in Capturing Suspended Sediment, Transportation Research Record. https://journals.sagepub.com/doi/full/10.1177/03611981231160541

Webinars/Presentations

- Roche, B., Perez, M.A., Donald, W.N., and Whitman, J.B., International Erosion Control Association Annual Conference, Large-Scale Performance Evaluation of Sediment Barriers, Spokane, WA, Feb. 27, 2024
- Roche, B., Perez, M.A., Donald, W.N., and Whitman, J.B., International Erosion Control Association Annual Conference Poster Session, Improving Sediment Barriers: Large-Scale Performance Evaluation under Nebraska Highway Conditions, Spokane, WA, Feb. 27, 2024
- Roche, B., Perez, M.A., Donald, W.N., and Whitman, J.B., Transportation Research Board Annual Meeting, Large-Scale Performance Evaluation of Various Woven Silt Fence Installations Under Nebraska Highway Conditions, Washington, D.C., Jan. 9, 2024
- Roche, B., Alabama Water Resources Conference (ALWRC), Performance Evaluation of Sediment Barrier Practices through Large-Scale Testing, Orange Beach, AL. Sep. 7, 2023
- Roche, B., International Erosion Control Association Municipal Wet Weather Stormwater Conference, Evaluation of Vegetated Buffers and Sediment Barriers as Sediment Control Measures, Chattanooga, TN. May 2, 2023.
- Perez, M.A. and Roche, B. Iowa Stormwater Education Partnership (ISWEP), Advances in Construction Site Runoff Control BMPs, Online Webinar, Apr. 6, 2023
- Roche, B., Perez, M.A., Donald, W.N., and Whitman, J.B., International Erosion Control Association Annual Conference, Modeling Vegetated Buffers and Evaluating Nebraska DOT Sediment Barrier Performance, Kansas City, MO, Feb. 8, 2023
- Roche, B., Perez, M.A., Donald, W.N., and Whitman, J.B., International Erosion Control Association Annual Conference Poster Session, Efficacy of Undisturbed Vegetated Buffers in Capturing Suspended Sediment through RUSLE2 Modeling, Kansas City, MO, Feb. 7, 2023
- Roche, B., Perez, M.A., Donald, W.N., and Whitman, J.B., Transportation Research Board Annual Meeting Poster Session, Efficacy of Undisturbed Vegetated Buffers in Capturing Suspended Sediment Through RUSLE2 Modeling, Washington, D.C., Jan. 9, 2023
- Roche, B., Perez, M.A., Donald, W.N., and Whitman, J.B, Great Rivers Regional International Erosion Control Association Conference, Efficacy of Undisturbed Vegetated Buffers in Capturing Suspended Sediment, Omaha, NE, Oct. 19, 2022
- Roche, B., Perez, M.A., Donald, W.N., and Whitman, J.B, International Erosion Control Association Annual Conference Poster Session, Full-Scale Performance Evaluation of Slash Mulch Berms as a Sediment Barrier Practice, Minneapolis, MN, Feb. 17, 2022

This brief summarizes Project SPR-FY22(006)
"Evaluation of NDOT's Sediment Barrier Practices Using Performance Data"
Nebraska Department of Transportation Research Program