Research Need Statement 641

I. Need Statement Champions and Information

I.A. Need Statement Champion Information

I.A.1. First and Last Name of Research Champion: Ken Graeve

I.A.2. Research Champion's Office: MnDOT Environmental Stewardship

I.A.3. Research Champion's Phone Number:

I.A.4. Research Champion's Email: Kenneth.graeve@state.mn.us

I.B. Research Co-Champion

I.A.1. First and Last Name of Research Co-Champion: Dwayne Stenlund

I.A.2. Research Co-Champion's Office: MnDOT Office of Environmental Stewardship

I.A.3. Research Co-Champion's Phone Number: 612-810-9409

I.A.4. Research Co-Champion's Email: Dwayne.stenlund@state.mn.us

I.C. Research Needs Title (115 Characters):

Time and Vegetation Effects on Infiltration and Filtration Performance

I.D. Project Sponsor: MnDOT Research Program

II. Research Need Background and Description

II.A. Research Need Background

II.A.1. Describe the problem or opportunity.

Infiltration of stormwater is one of three treatment options from new (and soon to be existing) impervious development, and is the preferred stormwater treatment method, as defined in the NPDES Construction Stormwater and MS4 Permits. These permits require a specific range of minimum and maximum stormwater infiltration rates, but that rate is difficult to predict and can vary significantly for many reasons. Traditional difficult to predict performance examples include sources of soil filter media, how blended or manufactured, how constructed, role of vegetation, and lastly how maintained during construction. New difficulties have developed to include time of year constructed, type of weather (climate impacts) and location. It is not known whether infiltration rates measured upon the completion of construction activity of an infiltration basin will remain constant, increase, or decrease, nor the role of vegetation on short and long-term performance. This has major implications for compliance with these permits and long-term cost controls to keep basins functional over the expected facility lifespan.

II.A.2. If applicable, describe how this project will build on previous research.

Previous research has focused on the chemical, physical and construction monitoring properties of infiltration design and implementation. This research will build on the solid foundation abiotic and behavior methodologies to examine establishment and performance of several biological factors on performance. No significant research has been performed on seasonal (timing), climatological (heat, flood, drought), or plant cover (diversity, density) effects on delivering both short-and-long term infiltration performance.

II.A.3. If applicable, include the title/s or previous research.

Design and Construction of Infiltration facilities (documents latest summary of previous research in Reference Section).
https://www.dot.state.mn.us/research/reports/2021/202114.pdf

Infiltration Basins: Standards and Procedures to Ensure Performance.
http://dot.state.mn.us/research/TRS/2018/TRS1801.pdf

The Cost and Effectiveness of Stormwater Management Practices.
http://www.lrrb.org/pdf/200523.pdf

II.A.4. What is the **objective** of the proposed research?

The purpose of this investigation is to determine the effects of 3876 regional seed mixtures, timing, and importance of establishing vegetation, role of various plant species, diversity and proper density of root and cover factors, and effects of time (plant succession) on the infiltration rate of stormwater treatment basins. In addition, the research should answer the following questions (focus on vegetative component):

- How does infiltration rate change with time, and what role does vegetation play in developing and maintaining acceptable range of infiltration rates?
- What factors influence performance for both volume and pollutant load reductions?
- How do snow loading, additional contributing impervious development, and large climatic rain events affect infiltration performance over time?
- Can potential facility aging events be predicted and estimated?
- What temporary or permanent electronic monitoring tools/equipment could be installed to aid in maintenance (CO_2/O_2 monitors, flow monitors and water level transducers) to help in visual quality assessments?
- What is the potential for biomass accumulations, vegetative debris, soil algae, etc. to seal up soil pores to constrict infiltration rates?
- What is the potential for different plant species on root macropores persistence to enhance or retard infiltration?
- What are ideal plant species/mixtures for extreme weather events from wet to dry conditions?
- Can basin resilience principles be incorporated into the design to construction?

III. Strategic Priorities, Benefits, and Expected Outcomes

Section III. is for MnDOT sponsored and co-sponsored projects only; all LRRB projects proceed to section IV.

III.A. MnDOT Strategic Priorities

Instructions: Briefly describe how the project aligns with the following MnDOT Research Strategic Priorities. Complete all that apply.

III.A.1. Innovation & Future Needs: This directly applies to SWAT analysis applied to volume reduction due to floods, functional performance between rain events when the basin is essentially dry, and opportunities for better pollutant management at proper timeframes. The innovation may include developing methods for active monitoring, improved seed mixture diversity for resource multi-utilization of space.

IIIA.2. Advancing Equity: In general, stormwater treatment systems have a poor history of installation in economically disadvantaged locations, or if built, maintained in manner that appears neglected. This research will include visual quality values to ensure that selected vegetation works as intended, and volume is infiltrated.

III.A.3. Asset Management: Expect better maintenance time scheduling based on visual assessment and soil/root profile performance tools.

III.A.4. Safety:

III.A.5 Climate Change & Environment: A better understanding of temporal changes in infiltration rates (basin aging) will allow more effective construction specifications and enable more cost-effective compliance with environmental requirements, add climate resilience, and increased sustainability with programed maintenance (cleaning for function).

III.B. Expected Outcomes

Instructions: Check all expected direct outcomes of this research.

☒ New or improved technical standard, plan, or specification
☒ New or improved manual, handbook, guidelines, or training
☐ New or improved policy, rules, or regulations
☒ New or improved business practices, procedure, or process
☐ New or improved tool or equipment
☒ New or improved decision support tool, simulation, or model/algorithm (software)
☐ Evaluation of a new commercial product
☒ New or improved technical standard, plan, or specification
☐ Other. Please specify below:

III.C. Expected Benefits

Instructions: Select all expected benefits that may be realized if the findings and recommendations from this research is adopted or implemented

III.C.1. Construction Savings Cost savings from reduced labor

Vegetation typically does not establish quickly or well in infiltration basins. If roots play a role in retention of infiltration function after constructed, cost savings from reseeding to meet NPDES permit requirements will be reduced.

III.C.2. Decrease Engineering/Administrative Costs Choose an item.

III.C.3. Environmental Aspects Other environmental impact. Please describe below.

Enable more cost-effective compliance with environmental requirements

III.C.4. MnDOT Policy Choose an item.

III.C.5. Lifecycle Other lifecycle impacted. Please describe below.

Not sure what to expect until research is completed, but projected lifecycle cost that retains functional and visual performance in changing climate and usage patterns of transportation for design intent between maintenance operations allocates true cost of the basin system.

III.C.6. Operations and Maintenance Savings Other operation and maintenance savings. Please describe below.

Nothing built and used by the public is maintenance free. The same is true for stormwater infiltration basins. Due to lack of dollar cost averaging, missing Operations and Maintenance manuals, repairs are done more on an emergency basis rather than routine maintenance for vegetation persistence and sediment load removals. The intent is to develop an implementation process to capture low-cost maintenance actions rather than delayed and escalated costs to retain basin function over time.

III.C.7. Reduce Risk Other reduced risk. Please describe below

Properly vegetated basins should reduce exposure to pollutants, mosquitoes, and hazard trees. Basins that retain infiltration capacity over long service life are more resilient for flood peak flow control and preserved transportation system.

III.C.8. Reduce Road User Cost Choose an item.

III.C.9. Safety Other safety benefit. Please describe below.

A properly functioning basin will have standing water for approximately 48 hours after the cessation of the rain event. This draw-down time range limits accidental drowning of vehicle occupants than leave the road surface.

III.C.10. Technology Transfer

Based on previous research, chemical & physical properties and monitoring methods of infiltration basins are becoming clearer. The biological properties are poorly understood, nor what may happen over time as the basins age. The research is intended to develop implementable products and methodologies for better life span cost estimates.

III.C.11. Other, please describe below:

IV. Technical Advisory Panel

Instructions: Please list the name and affiliation of individuals to consider for the Technical Advisory Panel.

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Jason Swenson, PE, MS4 Engineer, MnDOT Metro Region, Jason.swenson@state.mn.us

Your assigned Project Advisor is available to answer questions and provide guidance (assigned by the Office of Research & Innovation).
Your Project Advisor is: Marcus Bekele, (651)366-3903, marcus.bekele@state.mn.us