SPR RESEARCH PROGRAM
SECOND-STAGE PROPOSAL SUMMARY

PROBLEM NUMBER AND TITLE

27-24: Leveraging Existing Vegetated Roadside Areas for Efficient Stormwater Management.

PROBLEM SUMMARY

Stormwater runoff from transportation infrastructure presents a persistent challenge for Oregon's transportation system due to the requirement to treat highway stormwater runoff and protect downstream water quality. Current regulatory requirements compel project teams to demonstrate adequate stormwater treatment and infiltration performance during planning and design. However, limited understanding of how hydrologic data and roadside soil properties influence geochemical treatment capacity often prevents reliable evaluation of whether the natural roadside environment itself can meet objectives, providing an unrealized opportunity for potential savings on unnecessary facility installation and maintenance costs.

ODOT OBJECTIVES

The overall objective of the proposed work is to develop and validate an integrated hydrologic-geochemical decision-support tool that enables early-stage screening of existing roadside stormwater infiltration potential and treatment performance. The tool will provide ODOT with simulation capabilities to predict and quantify surface runoff routing, infiltration capacity, and subsurface geochemical dynamics. **The coupled hydrologic-geochemical framework will support quantitative evaluation of whether already existing roadside environments can meet stormwater performance metrics** and identify locations where built treatment facilities are actually necessary.

BENEFITS

The proposed project will provide ODOT with quantitative decision-support framework for early-stage screening of roadside stormwater infiltration and treatment feasibility. The framework directly addresses the current uncertainty in determining when existing roadside soils and vegetative cover can meet stormwater performance requirements and when engineered treatment facilities are necessary. By enabling systematic identification of locations where existing soils provide sufficient infiltration and contaminant attenuation, this project may assist with 1) reducing unnecessary engineered stormwater treatment facilities that require construction costs, operational costs and long-term maintenance commitments, and 2) reducing the need to acquire additional ROW to install engineered facilities, minimizing both project delivery and O&M costs. Even if additional ROW may be needed to fit the natural areas for treatment, long-term operation and maintenance costs will likely be reduced.

SCHEDULE, BUDGET AND AGENCY SUPPORT

Estimated Project Length: 42 months.
Estimated Project Budget: $490,000
ODOT Support: Alvin Shoblom (State Hydraulic Engineer) Jennie Morgan (Stormwater Asset Management Coordinator), Lu Saechao (Senior Stormwater Hydraulic Engineer)

FOR MORE INFORMATION

For additional detail, please see the complete STAGE 2 RESEARCH PROBLEM STATEMENT online at:
https://www.oregon.gov/odot/Programs/ResearchDocuments/27-24.pdf

SPR RESEARCH PROGRAM
SECOND-STAGE PROBLEM STATEMENT
FY 2027

PROBLEM NUMBER AND TITLE

27-24: Leveraging Existing Vegetated Roadside Areas for Efficient Stormwater Management

RESEARCH PROBLEM STATEMENT

Stormwater runoff from transportation infrastructure presents a persistent challenge for Oregon's transportation system due to the requirement to treat highway stormwater runoff and protect downstream water quality. Current regulatory requirements compel project teams to demonstrate adequate stormwater treatment and infiltration performance during planning and design. However, limited understanding of how hydrologic data and roadside soil properties influence geochemical treatment capacity often prevents reliable evaluation of whether the natural roadside environment itself can meet objectives, providing an unrealized opportunity for potential savings on unnecessary facility installation and maintenance costs.

At present, ODOT lacks a statewide methodology capable of evaluating roadside stormwater infiltration and treatment feasibility during early project scoping. Without a quantitative early-assessment tool, it is difficult for project teams, including engineers, environmental staff and planners to consistently determine: 1) if existing roadside soils and existing vegetation (i.e., dispersion areas) can provide adequate infiltration and treatment of highway stormwater runoff; 2) where engineered stormwater facilities are necessary; and 3) how hydrologic conditions and geochemical processes influence treatment performance over time.

The absence of such capabilities represents a critical decision-support gap. As a result, engineers, environmental staff and planners often default to prescribing engineered stormwater treatment facilities, even in locations where existing soils may provide adequate infiltration and treatment. This conservative approach increases project costs and long-term maintenance requirements, while missing opportunities to leverage natural systems in more sustainable and cost-effective ways.

RESEARCH OBJECTIVES

The overall objective of the proposed work is to develop and validate an integrated hydrologic-geochemical decision-support tool that enables early-stage screening of roadside stormwater infiltration potential and treatment performance. The tool will provide ODOT with simulation capabilities to predict and quantify surface runoff routing, infiltration capacity, and subsurface geochemical dynamics. The coupled hydrologic-geochemical framework will support quantitative evaluation of whether existing roadside environments can meet stormwater performance metrics and identify locations where treatment facilities are necessary. Specific objectives include:

1. **Develop and calibrate a distributed hydrologic modeling framework.**
   This objective will implement and calibrate hydrologic simulations to quantify runoff generation, infiltration potential, subsurface flow paths, and residence times across selected roadside environments under varying hydrologic conditions (e.g., precipitation intensity).
2. **Integrate geochemical processes to quantify stormwater treatment performance.**
   This goal will couple the hydrologic simulations with a geochemical reactive transport model to simulate contaminant transport (e.g., heavy metals), their reaction dynamics (e.g., sorption, redox transformations, etc.), and fate.
3. **Validate the integrated hydrologic-geochemical model as a screening methodology for decision-support.**
   Apply the coupled hydrologic-geochemical framework at selected Oregon field sites to compare

predicted and observed infiltration rates and water quality outcomes. Use these results to refine model parameters and establish uncertainty and performance metrics.

WORK TASKS, COST ESTIMATE AND DURATION

Task 1: Technical Advisory Committee formation.
Convene a Technical advisory committee (TAC) composed of ODOT Hydraulic Engineering and Stormwater representatives and academic partners. Additional partners, such as regulatory stakeholders, like the Department of Environmental Quality, will be considered for inclusion in the TAC as appropriate. The TAC will guide model development, identify specific Oregon roadside locations for analysis and validation, and provide feedback on data availability and implementation needs.

Task 2: Data compilation and model parameterization.
Work with the TAC to identify, compile, and preprocess datasets necessary to parameterize the hydrologic-geochemical modeling framework at the selected Oregon sites. Preliminary datasets will include soil properties (e.g., hydraulic and geochemical information), vegetation, slope, precipitation data for model parameterization, groundwater depth, and depth to bedrock. Data on highway stormwater runoff quality before and after treatment will be used for model validation. All datasets will undergo quality control and formatting for integration with the numerical framework.

Task 3: Development and calibration of hydrologic model.
Develop and calibrate a distributed hydrologic modeling framework using ParFlow, a 3D integrated hydrologic model that simulates coupled surface- subsurface flow [1]. ParFlow solves the Richards equation for subsurface flow and integrates overland flow to realistically represent runoff-infiltration interactions under spatially variable soil and precipitation conditions.

The ParFlow simulations planned for this task will quantify surface runoff generation, infiltration capacity and rates, and subsurface flow and residence times under varying hydrologic conditions. Calibration will use available hydrologic field data obtained in task 1. Outputs will include infiltration metrics (e.g., rates) and 3D spatial maps that show runoff flow paths and identify locations with sufficient/insufficient hydraulic capacity for stormwater infiltration.

Task 4: Integration of reactive transport modeling
Integrate reactive transport processes by coupling ParFlow with CrunchFlow, a geochemical reactive transport model capable of simulating multicomponent chemical reactions [2]. CrunchFlow solves the advection-dispersion-reaction equation to model sorption, transformation, and other geochemical reactions, and has been successfully coupled with ParFlow to simulate subsurface water quality evolution [3].

The coupled ParFlow-CrunchFlow will be used in this task to simulate contaminant transport under transient flow conditions and determine their transport and fate that impacts stormwater quality evolution. The specific chemical pollutants of interest, such as heavy metals, suspended solids, among others, will be determined by the established TAC in task 1.

Task 5: Field validation and implementation
Conduct Parflow-CrunchFlow simulations that target model-field validation at selected roadside sites to compare simulation predictions with observed infiltration rates and water quality data. Validation results will be used to refine model parameters, quantify uncertainty, and establish practical performance metrics. The successful completion of this task will allow for the framework to be applied statewide.

Task 6: Communication and Outreach
A final report will be delivered together with the decision support tool and manual. Workshop for ODOT will

also be delivered.

Key Deliverables: Decision support tool, framework for statewide application, workshop.

Estimated Project Length: 42 months
Estimated Project Budget: $490,000

EXPECTED ODOT IMPLEMENTATION ACTIONS

If this research is successful, the tool and supporting documentation will be made available to the Hydraulic Engineering Section to be incorporated into the Stormwater Design Manual.

POTENTIAL BENEFITS

The proposed project will provide ODOT with quantitative decision-support framework for early-stage screening of roadside stormwater infiltration and treatment feasibility. The framework directly addresses the current uncertainty in determining when existing roadside soils and vegetative cover can meet stormwater performance requirements and when engineered treatment facilities are necessary. By enabling systematic identification of locations where existing soils provide sufficient infiltration and contaminant attenuation, this project may assist with 1) reducing unnecessary engineered stormwater treatment facilities that require construction costs, operational costs and long-term maintenance commitments, and 2) reducing the need to acquire additional ROW to install engineered facilities, minimizing both project delivery and O&M costs. Even if additional ROW may be needed to fit the natural areas for treatment, long-term operation and maintenance costs will likely be reduced.

PEOPLE

ODOT champion(s): Alvin Shobolm (Statewide Hydraulic Engineer)

Problem Statement Contributors: Lazaro Perez (OSU), Jennie Morgan (Stormwater Asset Management Coordinator), Lu Saechao (Senior Stormwater Hydraulic Engineer), Kira Glover-Cutter (Principal Research Analyst)

STAFF REVIEW PAGE

LITERATURE CHECK

TRID&RIP

☒ A review of TRID & RIP databases found no existing research that answers the research question

ODOT DECISION LENSES

Climate: The research promotes resilience by treating stormwater efficiently and reducing pollutants loading through natural infiltration, supporting climate adaptation and improved environmental conditions.

Equity: This research is not focused on equity and will not include analysis of equity.

Safety: Successful research product will reduce time on the ground for maintenance and operations.

TECHNOLOGY & DATA ASSESSMENT

☒ No Identified T&D output

☒ At the end of this project, the implementing unit(s) within ODOT will need to coordinate the adoption of new technology or data in order to realize the full potential of this research.

CROSS-AGENCY IMPACTS

- List ODOT partners or impacted units. Hydraulic Engineering, MOB
- Identify any issues of concern raised by an ODOT partners. Note expected mitigation that addresses these concerns. No