Oregon Department of Transportation

Stage 1 Research Problem Statement

Number*: 25-69*

Proposed Title: Assessment of Roadside Salt and Removal using Biochar Methods

1. Concisely describe the **transportation issue** (including problems, improvements, or untested solutions) that Oregon needs to research.

Salt contamination is permanent, costly and devastating to natural and human systems. The United States Environmental Protection Agency estimates that the damage caused by road salt costs approximately $5 billion dollars per year in repairs for cars, trucks, roads, and bridges. Environmental concerns are growing due to direct and indirect effects of road salts on soil, groundwater, surface water, aquatic species, and infrastructure. Salt is elemental, meaning there are no permanent natural processes that break down, metabolize, or take it up (e.g., vegetation up-take). As a result, consistent application of road salt accumulates over time and can contribute to toxic concentrations in soil, groundwater, and surface water systems. Salt stores in soil and groundwater increase over time, contributing to pulses and consistent releases into surface water bodies throughout the year. This poses the risk of harming or killing wildlife and permanently contaminating drinking water and irrigation sources. What's more, several heavy metals are mobilized and made more toxic by the presence of salt.[1] This includes pollutants like cadmium, copper, zinc and lead present in runoff, soil, groundwater, surface water bodies, and water pipes. Heavy metals are of particular interest in stormwater runoff due to their toxicity, ubiquitousness, and the fact that metals cannot be chemically transformed or destroyed. Biochar technology may be ideal given the combination of the fact that ODOT already disposes of large amounts of woody debris, which is currently neither cost effective nor environmentally friendly, but alternatively and fortuitously can be redirected as a revenue stream for the production of biochar for ODOT use. Given that ODOT must meet increasingly stringent regulations for stormwater runoff, together with biochar's abundant availability, low cost and efficacy for road salt and heavy metal filtration, research to evaluate the use of biochar for pollutant reduction for Oregon could be of great value.

Roadside filtration of salts is one method to help reduce contamination and damages. The research on road salt filtration is nascent and growing, however biochar has long been recognized for its cation and anion adsorption properties and is thus considered a strong candidate. The efficacy of biochar to filter metals from stormwater runoff is well established and attributed to its high pH, porosity and surface area, and ionic absorption capabilities.[2] [3] [4] The use of roadside biochar wattles for salt filtration represents a low-cost and low-tech approach to water quality improvement that may also reduce heavy metal concentrations and reduce the impact of mobilization from salt inputs.[5] Research is needed to define an optimal biochar medium and filter design, and to develop operating parameters. Specifically, testing the longevity of filter wattles and determining associated maintenance costs.

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[1] Schuler, M.S. and Relyea, R.A., 2018. A review of the combined threats of road salts and heavy metals to freshwater systems. *BioScience*, *68*(5), pp.327-335.

[2] Wang, H., Garg, A., Ping, Y., Sreedeep, S. and Chen, R., 2023. Effects of Biochar Derived from Coconut Shell on Soil Hydraulic Properties under Salt Stress in Roadside Bioretention. *Waste and Biomass Valorization*, *14*(3), pp.1005-1022.

[3] Kang, D.H., Al Tameemi, R., Lopez, S. and Qian, X., 2022. Evaluation of Deicing Salt Immobilization in Biochar Applied BMPs. In *World Environmental and Water Resources Congress* (pp. 87-94).

[4] Ouedraogo, A.S., Yuzhu Fu, G. and Yunus, A.I., 2023. Treatment of Highway Stormwater Runoff Using Sustainable Biochar: A Review. *Journal of Environmental Engineering*, *149*(2), p.03122005.

[5] King, A., 2022. Mitigating Roadway Deicing Salt Runoff: Utilizing Environmental Containment Socks to Sequester Na+ and Cl. (2022). https://vtechworks.lib.vt.edu/handle/10919/113087

2. Document how this **transportation issue** is important to Oregon and will meet the Oregon Research Advisory Committee Priorities

Issues of concern to DOTs include 1) Ground and surface water contamination that impacts wildlife and impairs or contaminates irrigation and or drinking water sources (private and municipal), including reduced risk of agency liability. 2) Roadside tree and vegetation damage, including increased wildfire risk, intensity and damage. 3) Salt corrosion of infrastructure; to address safety, longevity and potential cost savings. This research effort aligns with the RAC priorities of Stewardship and Sustainability

3. What **final product or information** needs to be produced to enable this research to be implemented?

A report that provides 1) guidance on identifying situations where salt targeted BMPs are appropriate to avoid toxic impacts, 2) an initial assessment of the potential, and 3) design criteria for salt-targeting BMPs. Research documenting salt concentration and heavy metal reductions by drainage systems and BMPs etc. should be prepared for peer reviewed publication.

Major tasks or activities:

- Literature review on 1) highway runoff toxicity, with an emphasis on salt and salt- metal mobilization/enhancement of runoff toxicity 2) effectiveness of treatment and stormwater management, including the effect of vegetated drainage system types on toxicity reduction.
- Field collection of highway runoff and laboratory analyses to:
  i. Characterize the prevalence and magnitude of salt in highway runoff.
  ii. Assess toxicity reduction of high traffic highway runoff routed through bare soil and biochar BMPs (alternative designs for biochar filtration bags or devices)
  iii. Design and conduct a laboratory study to determine filtration material characteristics and mechanisms (such as layer thickness, infiltration rate, contact times, etc.) necessary for effective salt concentration and/or selected heavy metal toxicity and other contaminant reduction by biochar BMPs
  iv. Stress test filtration materials to failure to assess field longevity and long-term maintenance costs. This task may use ODOT's Stormwater Technology Testing Center (STTC)
  v. Identify key areas vulnerable to road salt contamination and high risk to human and environmental health, including agency liability concerns (e.g. public and private drinking water sources, high value crop irrigation water sources).

4. (Optional) Are there any individuals in Oregon who will be instrumental to the success of implementing any solution that is identified by this research? If so, please list them below.

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5. Other comments:

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