Oregon Department of Transportation

Research Stage 1 Problem Statement

Number 26-56 – "Survey of Stormwater Facilities for Contaminant 6PPD-Q to Identify Hotspots Locations and Assess Biofiltration Effectiveness"

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

6PPD-Q, a biproduct of the widely used antiozonant tire chemical 6PPD, has recently been identified as the primary cause of urban runoff mortality syndrome in coho salmon causing acute toxicity at trace levels (Tian et al., 2021). Coho salmon are primarily exposed by untreated stormwater runoff from road surfaces (Tian et al., 2021). A 6PPD-Q model suggests 6PPD-Q accumulates on higher trafficked roadways and is rapidly delivered during winter rains in the Pacific Northwest climate by stormwater system outfalls draining directly or adjacent to the stream (Halama, et al., 2024). Traffic density on Portland roadways (ODOT, Traffic Counting, 2024) and tests at ODOT's Stormwater Technology Testing Center (Herrera Consultants & WA Dpt of Ecology, 2024) suggests toxic levels of 6PPD-Q may be delivered to road adjacent streams, yet there is currently a lack of 6PPD-Q data from streams and groundwaters in the Portland metropolitan area.

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

The proposed research will survey 6PPD-Q concentrations in coho-bearing streams and in flow-through stormwater treatment facilities (biofiltration facilities) along ODOT right-of-way in the Portland metro area. Field data from Seattle [e.g., (Halama, et al., 2024)] suggests that 6PPD-Q is likely to be present in highway runoff, stormwater outfall flow, and stream water in Portland. Recent research has shown that highway runoff filtered through amended soils removes pollutants to levels no longer toxic to coho salmon (Spromberg et al., 2016); (McIntyre et al., 2015); (Seebacher et al., 2023). Our survey design (Table 1) will thus focus on two elements: **1. Hotspot identification;** and **2. Assessment of biofiltration effectiveness.**

ODOT has invested in an FHWA Pooled Fund to develop cost-effective design guidance for treatment of 6PPD-Q in stormwaters. This proposal supports ODOTs current efforts by acquiring the first field survey of potential 6PPD-Q hotspots and 6PPD-Q concentrations before and after bioswales at an Oregon location that represents the greatest contamination issue potential. The proposed sampling schedule is designed to capture the first flush from the fall/winter rains 2025 likely to contain the highest levels of 6PPD-Q, and to monitor 6PPD-Q levels under different flow conditions and at different stages of coho migration. The water sampling design allows for the measurement of several other stormwater contaminants of concern likely to be impacted by biofiltration, specifically toxic metals and nutrients. This dataset will provide critical information for best management practices to reduce the impact of 6PPD-Q and other contaminants in stormwaters. The sample results and summary report will:

1. **Identify 6PPD-Q hotspot locations along Johnson Creek – i.e., at and downstream from the stormwater outfall and proximal to high traffic areas.** Johnson Creek watershed is coho bearing (JCWC, 2024), and is the largest drainage basin in Portland receiving runoff from long

stretches of high tracked and low trafficked roadways directly from outfalls. Identification of hotspots will inform the best locations for future biofiltration efforts along sensitive waterways.

Stream sampling sites along Johnson Creek will be selected based on stormwater infrastructure, proximity to ODOT roadways, traffic flow (ODOT, ODOT TransGIS, 2024) and site accessibility. Flow will be monitored (USGS, 2024) to sample at first flush when concentrations are expected to spike, through the winter high stream/runoff flow, and in the spring when juvenile coho hatch.

2. **Identify if biofiltration facilities that meet current ODOT specifications filter 6PPD-Q to below the LC_{50} of sensitive species (0.04 µg/L for juvenile coho salmon,** (Lo, et al., 2023)**.** The ability of biofiltration to perform decontamination services is greatly influenced by the soil media composition (Carpenter and Hallam, 2009); (Hsieh and Davis, 2005); (O'Neill and Davis, 2010), which can range from simple compost additives to a strict prescribed mix of several organic and inorganic components [e.g., high performance biofiltration soil mixes currently adopted by WA Department of Ecology as a best management practice, (Howie & Lubliner, 2021)]. In addition, as the soil media ages biofiltration performance changes, impacting the media's ability to sorb organic contaminates (Hsieh and Davis, 2005). Soil media used in ODOT bioswale projects are native soils, or amended/imported soils if the native soil does not meet organic matter, infiltration, or quality standards (ODOT, Hydraulics Manual, 14-E, 2014). Given the cost and logistics of implementing or retrofitting facilities with high performance bioretention soil mixes, it is critical to first acquire baseline data on 6PPD-Q concentrations filtered through unaltered soils, and soil mixes within current ODOT biofiltration facilities.

   Several flow-through stormwater treatment facilities (bioslopes and bioswales) within highway adjacent right-of-way will be assessed (ODOT, Hydraulics Manual, 14-C, 2014). Biofiltration facility sites will be selected based on: soil media mix and age of media, traffic flow along adjacent roadways, proximity to sensitive river ecosystems, amount of stormwater input, and accessibility of sampling inlet/groundwater/outlet. Unaltered soils near the biofiltration facilities will be tested as a negative control and to determine the effectiveness of unaltered and unamended roadside embankments/right-of-way. Samples will be taken after winter storm events by sampling: a). at the inlet, b). groundwater within the facility, and c). at the outlet. Remaining water will be preserved and sampled for metals toxins, phosphorus, and other stormwater contaminants of concern.

Table 1. Proposed Sampling Plan.

Sample Type		**Sample Site Purpose**						
		Negative control; Above outfall, lower traffic	**Outfall, lower traffic**	**Negative control; Above outfall, high traffic**	**Outfall, high traffic**	**Negative control; Unaltered soil**	**Bioswale**	**Bioslope**
Road Runoff / Inlet	Grab samples[1]	x	x	x	x	x	x	x
Groundwater	Rhizon extracted[2] / Lysimeter collection[2]					x	x	x

Stormwater Outfall / Outlet	Grab samples[1]	x	x	x	x	x	x	x
Stream	Grab samples[1]	x	x	x	x			
Seasons		3 (1st flush, Winter, Spring)	3 (1st flush, Winter, Spring)	3 (1st flush, Winter, Spring)	3 (1st flush, Winter, Spring)	1 (Winter)	1 (Winter)	1 (Winter)
Number of Events per Season		2	2	2	2	3	3	3
Total Samples		12	12	12	12	9	9	9

[1]500 mL samples will be field collected then lab filtered through a 0.7 µm GF/F filter and stored at 4°C in amber bottles prior to overnight shipping to EuroFins Environment Testing Northwest for 6PPD-Q analysis following EPA Method 1634. Hold time of analysis is 14 days.
[2]250 mL samples of porewaters will be collected from saturated soils with a 0.15 µm Rhizon sampler or from a collection tube installed in a drainage lysimeter, and stored at 4°C in amber bottles prior to sending for 6PPD-Q analysis in the same manner as grab samples. Remaining water will be preserved and stored for metals, phophorous, and other water quality analysis.

3. (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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Kira Glover-Cutter	Research Analyst and Coordinator	Kira.M.Glover-Cutter@odot.oregon.gov	
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4. Decision making lenses

Please complete the following three sections. Your answers to these questions will be applied on a programmatic basis to support agency decisions. Answering yes to the questions below is not required. Resolving a narrowly focused technical research problem may meet agency needs without answering yes to any of the following questions. The ODOT Research Section will seek a balanced portfolio some projects will answer yes to one of the three categories below (e.g. climate, equity, and/ or safety) and other projects in a different category.

We are looking for an overall program balance and no one project is expected to balance all categories. Generally, a research problem statement is expected to be able to answer yes with clear and verifiable information in only one of the three categories below, some projects may be able to answer yes in two or even three categories. Some projects (i.e. needs focused on specific elements of infrastructure design), may have no yes answers but may still be high value research need.

Climate
Oregon recognizes the climate crisis and makes systemic changes to reduce emissions caused by travel. Every mile driven in Oregon is powered by a clean source of fuel. We seek research that supports construction and maintenance operations are carbon neutral and investments in mobility that support travel by low and no emission modes. While every research project may not result in a reduction in

emissions, transportation investments overall support emission reductions to achieve state goals. Oregon envisions a transportation system that is resilient in the face of seismic and climate events and impacts to the degradation of the natural environment are reduced. Our vision includes a transportation infrastructure is built in a way that avoids impacts on key habitat and results in better environmental conditions for wildlife and native vegetation. For definitions and details please review the equity vision, goals, and objectives of the ODOT Strategic Action Plan and Oregon Transportation Plan.

4f. Will addressing the **transportation issue** identified as a need in Question 1 develop, or validate methods for the estimation, measurement, or monitoring of transportation generated greenhouse gasses (GHG)?

☐Yes ☐No ☐Unsure

4g. If climate or GHG is not the focus of this **transportation issue** identified in this problem statement, will the research apply a GHG analysis to transportation infrastructure, planning, operations, maintenance, or materials?

☒Yes ☐No ☐Unsure

4h. Will the addressing the **transportation issue** include development or testing of construction practices, methods, or materials to establish potential reductions in greenhouse gas emissions?

☐Yes ☐No ☐Unsure

4i. Will the solving the **transportation issue** in question 1 study or support the reduction of vehicle miles traveled and single occupancy vehicle travel or support transition to electric vehicles (or other types of zero emission vehicles) or low-carbon alternative fuels?

☐Yes ☐No ☐Unsure

4j. Will the solving the **transportation issue** in question 1 lead to work that will support, measure, monitor, transportation system resilience in response to expected climate events, effects, or natural disasters in general?

☐Yes ☐No ☐Unsure

4k. Will the solving the **transportation issue** in question 1 lead to work that may result in better environmental conditions for wildlife and native vegetation?

☒Yes ☐No ☐Unsure

4l. If you answered yes to any of the climate questions above or can provide alternative details related to climate, please provide additional information:

4g Justification: This work will provide data that informs the effectiveness of the current best management practice for soils in bioswales. An update to best management practices may include, for example, biofiltration media within the high performance biofiltration soil mixes currently adopted by WA Department of Ecology (Howie & Lubliner, 2021). The sourcing of this media, particularly the product coconut coir which is not locally available, is likely to have a climate impact that will need to be assessed.

4l Justification: 6PPD-Q from highway runoff has been identified as the primary cause of urban runoff mortality syndrome in coho salmon causing acute toxicity at trace levels (Tian et al., 2021); 2022), and demonstrates the potential for wider effects to aquatic ecosystem health (DTSC, 2022); (Klauschies and Isanta-Navarro, 2022).

Equity

Equity can have many dimensions and impacts relating to communities, and transportation. It is important that problem statement proposals clearly explain in what capacities are equity dimensions or impacts being examined within problem statements. It is a goal of the OTP to "Improve access to safe and affordable transportation for all, recognizing the unmet mobility needs of people who have been systemically excluded and underserved. Create an equitable and transparent engagement and communications decision-making structure that builds public trust". Proposed research may have the intent of studying elements of this goal or apply analysis to specific transportation topics to ensure the resulting research recommendations is consistent with our equity goals. For definitions and details please review the equity vision, goals, and objectives of the ODOT Strategic Action Plan and Oregon Transportation Plan.

4a Is the **transportation issue** identified as a need in Question 1 specifically focused on transportation equity?

☐Yes ☐No ☐Unsure

4b If the **transportation issue** is not focused on transportation equity, will the primary topic be assessed for equity benefits or impacts within the research project?

☒Yes ☐No ☐Unsure

4c Is the implementation of potential findings from this research likely to directly involve participation from an identified group that would benefit from an equitable process or outcome?

☐Yes ☐No ☐Unsure

4d Is the intended final product or information expected to support ODOT's equity efforts (Including but not limited to supporting one of the equity related objectives of the ODOT's Strategic Action Plan or Oregon Transportation Plan) ?

☒Yes ☐No ☐Unsure

4e If you answered yes to any of the equity questions above or can provide alternative details related to equity, please provide additional information:

4b and 4e Justification: This research aims to survey hotspot locations and assess current strategies to filter out the toxic tire-derived chemical 6PPD-Q from entering coho bearing streams in metro Portland. This sampling will provide the first insights into the extent and magnitude of 6PPD-Q contamination in metro Portland. Our study aims support ODOT priorities for social equity: to invest in the protection of marginalized communities from environmental hazards. 6PPD-Q from highway runoff has been identified as the primary cause of urban runoff mortality syndrome in coho salmon causing acute toxicity at trace levels (Tian et al., 2021); 2022), and demonstrates the potential for wider effects to aquatic ecosystem health (DTSC, 2022); (Klauschies and Isanta-Navarro, 2022). Although little is known of its effects on human health (ITRC, 2024; (Hua & Wang, 2023), 6PPD-Q has been measured in adults, pregnant people,

and children (Du et al., 2022); (Fang et al., 2024) and has reproductive toxicity in mammals with prolonged exposure (Yao, et al., 2024). If adverse impacts of human exposure to 6PPD-Q are found, there is likely a direct environmental justice concern for near roadway communities already impacted by air pollutant exposure (Rowangould, 2013); (N Tian, 2013). The loss of coho salmon and potential food web and ecosystem effects have direct and indirect impact to communities, in particular Pacific Northwest Tribal Nations for which salmon have cultural and economic importance (CFITFC, 2024). This proposal will help identify best management practices for reducing environmental and human exposures through biofiltration along ODOT roadways.

Safety

Research outcomes may include interventions and countermeasures to prevent or reduce the frequency of crashes or other causes of transportation-related injury or death; or may include measures to reduce severity of injury (including prevention of death) after a crash or other injurious event. For definitions and details please review the equity vision, goals, and objectives of the ODOT Strategic Action Plan, Oregon Transportation Safety Action Plan and Oregon Transportation Plan.

4m. Will solving the **transportation issue** in question 1 support improving **safety culture** for either transportation workers or the traveling public?

☐Yes ☐No ☐Unsure

4n. Will the solving the **transportation issue** support improving safety through **healthy and livable communities**?

☐Yes ☐No ☐Unsure

4o. Will solving the **transportation issue** support improving safety through using **best available technologies**?

☐Yes ☐No ☐Unsure

4p. Will solving the **transportation issue** support improving safety through **communication and collaboration**?

☐Yes ☐No ☐Unsure

4q. Will the solving the **transportation issue** support improving safety through **investing strategically**?

☐Yes ☐No ☐Unsure

4r. If you answered yes to any of the safety questions above or can provide alternative details related to safety, please provide additional information:

5. Other comments:

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