

FHWA Transportation Pooled Fund Solicitation

1. Problem Title:

Stormwater Management to Address Highway Runoff Toxicity Due to 6PPD-Quinone from Tire Rubber

2. Study Description

The current method for extending tire longevity by preventing tire-rubber cracking and degradation includes the addition of the chemical additive 6PPD. With tire wear and atmospheric ozone exposure 6PPD oxidizes to form 6PPD-quinone (6PPD-q). Recent research has demonstrated toxicity of 6PPD-q for at least one Endangered Species Act listed aquatic threatened and endangered species,¹ coho salmon, with potential for toxic impacts to other aquatic species^{2,3} including rainbow trout/steelhead and brook trout. These findings will likely result in regulatory agencies imposing stormwater treatment requirements for 6PPD-q on highway projects as well as raising questions regarding state DOTs' use of pavements containing recycled-tire-rubber materials.

This proposed research will 1) develop a methodology/tool for DOTs to identify high-priority areas along roadway infrastructure to add stormwater treatment to address 6PPD-q, 2) evaluate drainage characteristics relating to fate and transport of 6PPD-q, 3) identify currently-approved, cost-effective stormwater management techniques, best management practices (BMPs), and design options to reduce or eliminate highway run-off toxicity due to 6PPD-q, and 4) assess recycled tire paving products for 6PPD-q runoff contribution.

Without this research regulatory requirements may be based on incomplete or insufficient information, resulting in overly generalized requirements that do not consider site specific parameters, site limitations, DOT efficiencies, and actual efficacy of selected treatment for 6PPD-q reduction. In sum, this research will help enable cost-effective solutions for DOTs to address 6PPD-q as well as inform appropriate regulatory requirements.

¹ Tian, Z., Gonzalez, M., Rideout, C.A., Zhao, H.N., Hu, X., Wetzel, J., Mudrock, E., James, C.A., McIntyre, J.K., & Kolodziej, E.P., (2022). 6PPD-quinone: revised toxicity assessment and quantification with a commercial standard. *Environmental Science & Technology Letters*, 9(2), 140-146. <https://doi.org/10.1021/acs.estlett.1c00910>

² McIntyre, J., (2021). Mystery Solved: Tires Kill Coho Salmon. In *Stormwater Summit*, Oregon Association of Clean Water Agencies

³ Halle, L. L., Palmqvist, A., Kampmann, K., & Khan, F. R. (2020). Ecotoxicology of micronized tire rubber: Past, present and future considerations. *Science of the Total Environment*, 706. <https://doi.org/10.1016/j.scitotenv.2019.135694>

3. Objectives

This research aims to equip DOTs with a targeted approach for effectively managing 6PPD-q in highway runoff by 1) developing methods/criteria for identifying locations that need focused treatment, 2) developing a better understanding of the fate and transport of 6PPD and 6PPD-q, 3) developing cost-effective design guidance for stormwater treatment and management techniques with a focus on reducing the effects of 6PPD-q on receiving waters, and 4) evaluating the degree of 6PPD-q release from pavement products made from recycled tire materials. This research will also assist with providing regulatory agencies with a better understanding of DOT management options including the feasibility, limitations, and effectiveness of treatment methods.

4. Scope of Work

Tasks:

- Task 1: Prepare literature review that informs development of research methodology (Task 2) that at least covers: 1) Highway runoff toxicity due to 6PPD-q and parameters that affect its chemical longevity. This should also include predicted site-specific factors that may influence 6PPD-q concentration and stormwater management performance, 2) Current information on the performance of treatment methods and stormwater management techniques for 6PPD-q reduction, and 3)

Relevant precedent work regarding chemical leaching from pavements containing recycled-tire-rubber materials.

- Task 2: Develop research methodology/field plan that evaluates site attributes that result in various levels of 6PPD-q inputs into adjacent, receiving waters. This research methodology design will likely include AADT of the roadway, parameters that influence braking incidence (terrain/slope, road geometry, intersection versus roundabout), land uses surrounding the roadway like urban, sub-urban, rural, and amount of contributing impervious surfaces. The research design should also consider the presence and effectiveness of existing stormwater management methods for each site selected.
- Task 3: Perform field collection of highway runoff with associated in situ and laboratory analyses to:
 - i. Characterize the prevalence, magnitude, and half-life of 6PPD-q in highway runoff as influenced by different attributes, including various levels of AADT, roadway geometry, pavement type, and other influencing variables.
 - ii. Assess 6PPD-q reduction in high-traffic highway-runoff that is routed through varying pavement adjacent conditions such as, for example, bare soil, compost amended soil, or vegetated conveyances.
 - iii. Design and conduct laboratory and field studies to compare 6PPD-q removal by stormwater management facilities that function via infiltration, filtration, dispersion, or sedimentation. This study will include an evaluation of the media depth, chemical characteristics, infiltration and filtration rates, and hydraulic retention time for each facility.
 - iv. Conduct selected 6PPD-q leachability tests for pavements containing recycled-tire-rubber materials.
- Task 4: Develop a methodology to target optimal locations to deploy BMPs based on components and features of the highway system and receiving waters that affect 6PPD-q fate and transport.
- Task 5: Evaluate the effectiveness of stormwater management methods for reducing 6PPD-q and provide recommendation/design guidance for implementation.
- Task 6: Provide recommendations regarding the use of pavements containing recycled-tire-rubber materials, or if pavements containing recycled-tire-rubber materials should be avoided entirely. If available and applicable, indicate what mitigation methods may be effective at reducing or eliminating 6PPD-q from new or existing pavements containing recycled-tire-rubber materials.

Deliverables:

- A report that provides 1) guidance and tools to identify priority locations along DOT roadway infrastructure for adding BMPs that treat 6PPD-q, 2) a summary of drainage and highway characteristics relating to the fate and transport of 6PPD-q, and 3) design criteria for cost-effective BMPs which treat 6PPD-q, and 4) an initial assessment of the potential for pavements containing recycled-tire-rubber materials to contribute 6PPD-q to receiving waters and what mitigation measures may be needed to reduce or eliminate 6PPD-q effects.
- Peer-reviewed publications.
- Present results at conferences.

5. Comments

The annual commitment is \$30,000 per DOT for four years. This is expected to be a 4-year effort. For additional information, please feel free to reach out to Kira Glover-Cutter of ODOT at kira.m.glover-cutter@odot.oregon.gov.

Solicitation request: at least \$600,000 for 4 years.