Research Stage 1 Problem Statement

PROPOSED TITLE: USING ARTIFICIAL INTELLIGENCE TO IMPROVE PAVEMENT SMOOTHNESS AND REDUCE COSTS AND EMISSIONS THROUGH MORE ACCURATE ROUGHNESS CORRECTION

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

According to an ODOT/FHWA research study (Coleri et al. 2025) recently completed by the OSU-Asphalt Materials and Pavements (AMaP) research group, the cost of fuel and tire wear that can be saved by reducing current pavement roughness levels on ODOT roads by 20% is around $73 million/year for the road users. The associated annual emissions savings are around 193,000 MT CO2/year, while ODOT's total annual emissions from all operations, including material production and construction, were calculated to be 182,592 MT CO2/year (Proudfoot and Toneys 2022). This important result shows that maintaining low roadway roughness and rolling resistance is crucial for reducing greenhouse gas (GHG) emissions and road user costs, making uniform construction and achieving consistent surface quality along the roadways essential.

The roughness of roadways is measured using an inertial profiler system equipped with lasers and accelerometers to measure surface profile and a quarter-car model *(a dynamic vehicle model with a spring and dashpot representing the suspension system of the vehicle and another spring representing the tire stiffness)* to determine the amount of vertical movement observed by the vehicle when traveling on the measured surface profile. This vertical movement, measured along the length of the segment, is the International Roughness Index (IRI), which represents the roughness of the roadway surface. For instance, the ASTM E950 specification sets a limit of 60 in/mile IRI value for newly constructed pavement, which means a surface profile that allows up to 60 inches of vertical movement of the vehicle's axle over a 1-mile segment.

Localized bumps and high-profile areas on the pavement surface increase the IRI values and increase the rolling resistance for traveling vehicles. This increased rolling resistance results in higher fuel consumption and tire wear for vehicles (Coleri et al. 2025). In addition, higher roughness increases the dynamic loads applied to the pavement due to the higher vertical acceleration and creates significantly more damage to the pavement structure. For instance, according to Smith et al. (1997), a 25% reduction in pavement surface roughness can increase the pavement service life by up to 28%.

For all the reasons discussed above, correcting localized roughness and high-profile areas is critical to improving road users' comfort, reducing vehicle energy costs and emissions, and minimizing damage to the pavement structure to improve service life. However, current field practices heavily rely on manual identification of high-profile locations based on profile data and suggestions from a software called ProVAL, or purely based on visual inspections. This manual process can lead to the misidentification of problem areas, which prevents the proper correction of the surface profile via a grinding process to lower the high-profile locations. The on-the-spot decisions made by ODOT crews for grinding can be misleading due to the use of noisy or incomplete surface profile data, without having an automated and computer-aided process. Unnecessary grinding of slightly higher profiles also wastes time and resources for ODOT without creating any significant improvement to the surface IRI levels. For all these reasons, developing a

practical yet accurate decision-making process for selecting the best grinding locations, which will result in significant improvements in surface roughness levels, is critical.

The laser and accelerometer-based inertial profiler data collection processes and technologies must be carefully assessed to determine their accuracy and effectiveness in identifying areas on the pavement surface that lead to high roughness levels. The potential use of artificial intelligence (AI) tools and methods to improve the accuracy of the problem spot locations should also be investigated in a comprehensive research study. The possibility and effectiveness of integrating AI-based models and processes with automated grinding systems should also be assessed to achieve a more streamlined process for the ODOT crews. The contributions of this proposed research study will allow ODOT to significantly reduce rework, project delays, and material waste, all of which translate into lower costs and emissions for ODOT and the public.

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

To develop tools and processes to achieve accurate AI-based identification of high-profile areas on pavements, a comprehensive research study focusing on the assessment of the current data collection technologies and processes is required. The outcomes of this proposed research study are expected to include i) a more accurate data collection technology, ii) a more robust and effective data processing methodology, iii) detailed guidelines and tools (likely to include software packages) for grinding area identification by not just focusing on the wheelpaths but also the adjacent locations to create a 2D surface profile, and iv) integration of all those processes, guidelines, and tools in a grinding system for rapid decision making in the field. The expected final deliverables from this proposed research study include:

1) Suggestions and guidelines to improve the current “dot” or “line” based laser system technologies and their data collection processes to improve data quality.

2) An AI model (potentially in a software package form) capable of rapidly detecting and classifying localized bumps and high-profile areas on the pavement surface.

3) Based on the assessments of the collected field data, a series of thresholds and decision criteria for triggering localized repair or grinding correction processes in the field.

4) Field validation of the developed tools, updated technologies, guidelines, and software packages using ground truth measurements either from calibrated inertial profilers or measurements from a more accurate walk behind rolling surface profiler system (commonly called SurPRO).

5) Training materials and implementation guidelines for ODOT and the contractors to help them adapt to updated data collection and processing methods and guidelines.

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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4. Other comments:

5. State of Oregon Decision Making Lenses

State decision making lenses are a part of the state of Oregon's policy structure. State policy and federal policy are not always aligned. The state will prioritize research according to state policy, however ODOT may be required to skip prioritized proposals based on constraints placed on the use of federal funds. If state funds are available ODOT will attempt to fund prioritized research that is deemed ineligible for federal funding.

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 a high value research need.

Climate

Oregon recognizes the climate crisis and makes systemic changes to reduce emissions caused by travel. To that end, we seek research that reduces carbon emissions from construction activities and materials, and from maintenance equipment and operations. Oregon envisions a transportation system that is resilient, this means a system that is durable in the face of seismic events and extreme weather to avoid negative impacts, withstand them or bounce back quickly to resume system function. We seek research that improves the ability of the transportation system to adapt or cope with more frequent and extreme weather events. This may include innovations in data and data sharing, construction materials and project design, communication, emergency planning and response, and more. Similarly, we seek research that avoids negative impacts on key habitats and ecosystems that can buffer or reduce damage to infrastructure and improve 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.

5a. 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 gases (GHG)?

☐Yes ☒No ☐Unsure

5b. 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

5c. Will 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

5d. Will 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

5e. Will the solving the **transportation issue** in question 1 lead to work that will support, measure, or monitor, transportation system resilience in response to expected climate events, effects, or natural disasters in general?

☐Yes ☒No ☐Unsure

5f. Will 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

5g. If you answered yes to any of the climate questions above or can provide alternative details related to climate, please provide additional information:

According to an ODOT/FHWA research study (Coleri et al. 2025) recently completed by the OSU-Asphalt Materials and Pavements (AMaP) research group, the cost of fuel and tire wear that can be saved by reducing current pavement roughness levels on ODOT roads by 20% is around $73 million/year for the road users. The associated annual emissions savings are around 193,000 MT CO2/year, while ODOT's total annual emissions from all operations were calculated to be 182,592 MT CO2/year (Proudfoot and Toneys 2022). This important result demonstrates that maintaining low roadway roughness and rolling resistance is crucial for reducing greenhouse gas (GHG) emissions and road user costs, making uniform construction and consistent surface quality along the roadways essential. This proposed research study will provide methods, tools, guidelines, and updated technologies to improve the roughness data collection and rough area detection processes. The outcomes of the study will also enhance the accuracy of measurements, which will help reduce rework, project delays, and material waste, all of which translate into lower costs and emissions for ODOT and the public.

Equity

Equity can have many dimensions and impacts relating to communities and transportation. It is important that problem statement proposals clearly explain the equity dimensions or impacts being examined. Oregon commits to social equity in the OTP, specifically 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*. We seek research that studies elements of this goal or applies analysis to specific transportation topics to ensure the resulting research recommendation is consistent with agency equity goals. For definitions and details please review the equity vision, goals, and objectives of the ODOT Strategic Action Plan and Oregon Transportation Plan.

5h. Is the **transportation issue** identified as a need in Question 1 specifically focused on transportation equity?

☐Yes ☒No ☐Unsure

5i. 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

5j. 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

5k. 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

5l. If you answered yes to any of the equity questions above or can provide alternative details related to equity, please provide additional information:

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.

5m. Will solving the **transportation issue** in question 1 support improving **safety culture** for either transportation workers or the traveling public?

☐Yes ☒No ☐Unsure

5n. Will the solving the **transportation issue** support improving safety through **healthy and livable communities**?

☐Yes ☒No ☐Unsure

5o. Will solving the **transportation issue** support improving safety through using **best available technologies**?

☒Yes ☐No ☐Unsure

5p. Will solving the **transportation issue** support improving safety through **communication and collaboration**?

☐Yes ☒No ☐Unsure

5q. Will solving the **transportation issue** support improving safety through **investing strategically**? 5r. If you answered yes to any of the safety questions above or can provide alternative details related to safety, please provide additional information:

The integration of laser technologies and the associated AI-based tools with the grinding system is expected to eliminate or reduce the need for manual/visual inspections. Thus, eliminating or reducing the need to leave the vehicle to inspect high roughness areas and high surface profiles will improve the safety of the grinding crews.

6. Corresponding Submitter's Contact Information:

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7. ODOT Sponsor Contact Information (Required if Submitter is not an ODOT employee)

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This form is not a grant application or contract document. Please do not include proprietary information on this form. Once this form is received ODOT may revise and publish the problem statement. If selected, ODOT will assign investigator(s) of the department's choosing to conduct research.