Tools and Guidelines for Pervious Concrete Sidewalks and Shared-use Paths to Improve Bicycle and Pedestrian Safety

{Mid-June 2015-Mid-May 2016}

1. Collaborators and Affiliations

Washington State University (WSU) is pleased to submit this proposal as the lead organization in response to PacTrans’ recent Call for collaborative multi-institution proposals. WSU is joined by Oregon State University (OSU) to form a strong multidisciplinary team for this proposal, which is directly focused on the topic area of “Safe Travel on Mixed-Use Roads.”

Based on our distinct expertise in different areas of safety, transportation, and winter road maintenance we are able to present a diverse and extensive scope of work, addressing the urgent research needs for winter road safety in the region. Our team members are introduced as follows,

**WSU Team**

**Dr. Somayeh Nassiri, P.Eng.** is an Assistant Professor at WSU and will be serving as the Principal Investigator (PI). She will be in charge of coordinating the efforts of all the PIs engaged in the project. Dr. Nassiri has years of experience in concrete pavement design, construction and maintenance and material characterization. Before joining WSU, she served as a Research Associate at the University of Alberta for nearly three years; during this period she led a multi-phase research project focusing on evaluating road safety conditions during prolonged Canadian winters. She will rely on her experience in winter road maintenance and safety to ensure the project is executed successfully, this is especially important since the project involves extensive field experiments.

**Dr. Liv Haselbach, P.E.** is an Associate Professor at WSU and an Associate Director of the United States Department of Transportation (USDOT) Center for Environmentally Sustainable Transportation in Cold Climates (CESTiCC) and will serve as a co-PI. She has been researching pervious concrete for more than a decade and has many publications on its environmental benefits. She has also been active in the development of testing standards to effect further acceptance of this technology.

**Dr. Xianming Shi, P.E.** is an Associate Professor at WSU and the Assistant Director of the CESTiCC. He will offer his expertise in winter road operations and assist the PI in research and outreach. Over the past 14 years, Dr. Shi has completed dozens of winter operation-related research projects sponsored by over 20 state DOTs and their consortia (i.e. Clear Roads, PNS Association and MDSS Pool Fund), the National Research Council (via NCHRP and ACRP) and Federal Highway Administration (FHWA). Prior to joining WSU, he was a Research Professor at the Montana State University and a Senior Research Scientist at the Western Transportation Institute, where he led the Winter Maintenance and Effects Program during 2005-2014 and served as an Associate Director for the CESTiCC during 2013-2014. His extensive research experience, expertise and connections will be an asset to this project.
OSU Team

Dr. Jason Ideker has over 14 years of experience working in the broad area of concrete durability. He has been an Assistant Professor (2008-2014) and Associate Professor (2014-present) at Oregon State University (OSU). He is also Co-Director of the Green Building Materials Research Laboratory at OSU. His research group focuses on the prediction of long-term durability and characterization of early-age volume change of cement-based materials. His group’s multi-scale approach results in translational research combining fundamental scientific understanding with the improvement and development of test methods and specifications that enhance concrete performance. Dr. Ideker and his team are recognized experts in concrete durability, alkali-silica reaction, early-age properties of calcium aluminate cements and characterization and prediction of drying shrinkage in high performance concrete.

Dr. Ideker is active in the American Concrete Institute serving on ACI Committees 201 – Durability, 236 – Material Science of Concrete and 231 – Early Age Properties. As Sub Committee Chair of ASTM C09.50, Dr. Ideker has led efforts at ASTM to the realization of a new standard ASTM C1778 Standard Guide for Reducing the Risk of Deleterious Alkali-Aggregate Reaction in Concrete. Most recently Dr. Ideker has joined RILEM TC AAA.

2. Project Goals

Objectives of this study are:
1: Test safety aspects of pervious concrete sidewalks/parking lots/bike lanes in winter conditions,
2: Develop a best-practice guideline for winter maintenance of pervious concrete installations.

3. Relevancy of Institutional Partnerships

Our team from WSU and OSU has combined expertise in the two broad areas of pervious and traditional concrete material characterization and winter maintenance safety. Our expertise will enable us to exactly target the proposed research focus. Equally important to our expertise is our access to several pervious sidewalks and parking lots on the WSU Pullman campus, which enables unique in-field experiments. Added to that is the support provided by WSU Facilities and WSU Police in conducting the field experiments required for this project.

4. Problem Statement

Pervious concrete has been recommended as one of the Best Management Practices (BMP) by the United States’ Environmental Protection Agency (EPA) and other agencies for stormwater and runoff management. Runoff and snowmelt control, vehicle pollutant reduction, heat-island effect reduction, water spray/splash and hydroplaning reduction, and recharging of groundwater supplies are some of the firsthand advantages of pervious concrete over traditional mixtures. Such advantages have made pervious concrete a desirable product for various municipal applications such as bike lanes, pedestrian walkways, sidewalks, parking lots and low-volume roadways. Different municipalities in the Pacific Northwest have been experimenting with replacing traditional concrete with pervious concrete for such applications. Paramount to its growth in popularity is research on its possibly enhanced safety and skid-resistance in parking lots and bike lane applications and slip-resistance for sidewalks. Research is needed to identify the best winter maintenance practices to maintain safety while maintaining acceptable performance.
Pedestrian travel is increasing across the Pacific Northwest and safe sidewalks are critical to continue the trend (Milne and Melin, 2014). In 2012, pedestrians accounted for 14% of all traffic-related fatalities nationwide. Secretary Anthony Foxx has declared pedestrian safety a top priority for the USDOT and two months ago launched what he calls “the most innovative, forward-leaning, biking-walking safety initiative ever” (Foxx, 2014). The initiative will include increased funding for sidewalk construction and repair (USDOT, 2014). One of the cost-effective solutions for construction of new sidewalks and bike lanes or replacement of the old ones is pervious concrete pavement. Pervious concrete pavement is a permeable pavement that is commonly placed atop a stone reservoir to retain runoff and stormwater allowing it to naturally percolate into the subgrade soil (ACPA, 2006), see Fig. 1. The concrete mixture includes an appropriate amount of cement and water to carefully bind the coarse aggregate together (usually no sand is used in the mixture and the coarse aggregate is tightly controlled to a near uniform size to produce the permeable structure) to create a highly permeable structure with 15-25% voids and flow rates of 2-18 gal/min/ft² (FHWA, 2012).

Due to their advantages in stormwater and pavement runoff as stated previously, the number of pervious concrete installations is increasing in cold region and in the Pacific Northwest. King County in Seattle has numerous installations of pervious concrete for sidewalks (1,100 ft² in 2007, another 210 ft² in 2008). The City of Spokane has installed, and is in the process of installing several different pervious applications, including parking lots and bike lanes. The City of Olympia has used pervious concrete for sidewalk applications. Parking lot and sidewalk installations have been successful to the extent that cities of Chicago, Portland (Fig. 2) and Seattle have used pervious concrete for residential streets (City of Portland website; CDOT, 2009; Gwilym, 2006).

While new installation of pervious concrete is rapidly growing, it is essential that the unresolved issues regarding different aspects of their maintenance be addressed. One of the most critical maintenance operations for transportation infrastructure is regaining their safety during the winter in a timely fashion to avoid skids and car crashes and slip-related falls on pedestrian paths. Anecdotal evidence suggests that pervious concrete has advantages over traditional concrete in draining snow and ice melt faster and thereby reducing the need for winter treatment (ACPA, 2006). However, due its voided structure, pervious concrete has a lower thermal conductivity compared to traditional concrete and thereby presents a different thermal behavior. The air void system in the pervious concrete makes it a better insulator of heat resulting in the slab insulated from the underlayers (mainly the subgrade soil) and thereby 1) freezes faster, and 2) remain frozen...
for a longer duration during parts of the year, with a reverse behavior in other parts of the winter when the ground is frozen and the air is warming. Research has shown that porous surfaces remain 2 to 4°F colder than traditional pavements at temperature range of 23 to 32°F under some conditions (critical temperature range for winter maintenance operations) (Fay & Akin, 2013). Unique structure and thermal behavior of pervious concrete pavement necessitate alterations to routine winter maintenance operations conducted on traditional concrete surfaces.

However, a recent survey of literature on the subject showed that currently no consensus exists on how to treat pervious installations to maintain their winter safety and at the same time assure their structural integrity (Fay & Akin, 2013). To take advantage of the porous structure of the pervious concrete for stormwater and runoff control and other drainage-related applications, the porosity of the structure needs to be maintained throughout its service life. Liquid de-icers can drain quickly through the pervious structure, leaving the surface vulnerable to bonding to snow and ice. The few existing guidelines on winter maintenance of porous surfaces are contradictory, for instance the guideline by the National Ready Mixed Concrete Association (NRMCA) warns against the use of chemical de-icers on less than one-year old installations and only sparingly on older installations (NRMCA, 2004). On the other hand, a brief guideline published by the University of New Hampshire Stormwater Center calls for “excessive application of deicing chemicals” (UNH-SC, undated). Timely application of de-icers is especially critical since a laboratory observation of pervious specimens showed that the pervious surface, due to its rougher macro-texture, can sometimes strongly bond to snow and ice (Edens & Adams, 2001). To break this bond and plow the pervious surface to attain a “bare pavement” condition, the snowplow operator will have to rigorously plow the surface several times, which can induce structural damage and abrasion to the surface (PCA website). A guideline developed by the Washington State Department of Ecology recommends using plastic-tipped snowplow blades, or to slightly elevate the plow blades using skids (Guttman, undated).

The number of studies that investigated the skid-resistance of pervious concrete under winter conditions and the effectiveness of winter treatments is very limited. A study conducted in 2012 investigated the biomechanical slip-resistance of pervious and traditional concrete under wet and icy conditions (Kevern et al., 2012). They found that pedestrian contact pressure is twice on pervious compared to traditional concrete. They concluded that pervious concrete due to its surface characteristics, combined with high permeability, offers superior skid-resistance in comparison to
traditional concrete. The Oregon Department of Transportation conducted a study to evaluate the effect of anti-icing on skid number of open-graded pavements (Martinez & Poecker, 2006). After testing the pavement in three conditions of non-treated, treated with 15 gallon/mile-lane of deicer, and 30 gallon/mile-lane of deicer, they concluded that the deicer did not influence the skid number of the surface. They also noted the skid number in all conditions stays within the recommended limits by the FHWA. The authors called for further laboratory experiments to validate their findings in the field.

Further research is needed to investigate the effectiveness of different de-icers, the proper time of application, and the frequency of application of de-icer agents to prevent ice and snow bonding to the pervious surface. For this study, we propose a field skid resistance (friction) experimental procedure to evaluate WSU pervious installations before and after de-icing over a wide range of temperature, ice and snow conditions. We will extend our field study to the laboratory, where we can further research the influence of de-icers in a more controlled environment.

5. Approach

5.1. Tasks Description

Our research approach includes field (conducted at WSU) and laboratory (conducted at WSU & OSU) components. In the field, we will measure the friction coefficient and stopping distance on several pervious installations on WSU campus. Our target will be focused on evaluating the effectiveness of de-icers on prohibiting snow and ice bonding to the pervious surface.

We will extend this study to laboratory-cast specimens of pervious concrete, which will be exposed to ambient conditions in both Pullman, Washington and Corvallis, Oregon. WSU and OSU are also equipped with temperature-controlled chambers, which will enable replicating the field conditions in the laboratory for validation and extended analysis. We will establish the effectiveness of de-icer application to the specimens through friction measurements and X-ray tomography imaging. Please see below for a more detailed description of the tasks in the project.

Task 1-Literature Survey

Our preliminary survey of literature shows that only a few studies focused on characterizing surface texture and skid resistance of pervious concrete. We will continue our literature survey on the subject and review past laboratory and field research relating to surface macro- and microtexture of pervious concrete in different conditions of dry, wet, snow and ice.

Task 2- Laboratory Surface Safety Examination

Surface Finishing and Friction Testing

Under this task, we will focus on experimenting with different finishing techniques in the laboratory to gain a better surface friction. Some of the potential trial surface finishing methods that we have identified to-date include:

- brooming,
- application of a layer of fine and angular sand, and
- application of chemicals developed particularly for better grip.
We will test the surface skid resistance characteristics of each of the above finishing methods using two laboratory devices, Mango Spot Spring Balance (Fig. 3a) and Dynamic Friction Tester (DFT) (Fig. 3b). Any notable difference in surface friction of the different surface finished under dry, wet and icy conditions will be statistically established before and after application of different de-icers.

These experiments will be conducted in the WSU temperature controlled chamber to replicate winter icy conditions for the specimens and evaluate the effectiveness of the different surface finishing. The same experiments will also be replicated on specimens exposed to Pullman, Washington climatic conditions year-round.

OSU will use their Modular Multi-Chamber Environmental Conditioning System (MCMEC) to simulate winter conditions to evaluate the impact of deicing/anti-icing chemicals on pervious concrete surface characteristics. Magnesium chloride solution, ~30 wt.% in concentration (with corrosion inhibitor added), and sodium chloride solid will be used in the study as these are the most common anti-icing and deicing products used, respectively, by the State DOTs in the Pacific Northwest (Oregon, Washington, Idaho, etc.). The large size of the chamber (8.5’× 8.5’× 8.5’), makes it possible to take in-situ measurements so that realistic environmental conditions can be maintained throughout the testing period. Samples will also be placed in their outdoor exposure site for monitoring. The pervious concrete samples will be the same size and constructed from the same materials and curing procedures as those used at WSU. The same type of analytical equipment outlined above will be used by the researchers at OSU.

OSU will also cast samples of pervious concrete with different finishing techniques for freeze-thaw evaluation. From a safety perspective it is important to ensure that the pervious concrete surface applications not only provide superior skid resistant, but that they are also durable. If the surface of the concrete becomes compromised due to freeze-thaw cycling it is possible that flaking, scaling and loosened particles could provide conditions to decrease the skid resistance and thus the safety of pervious concrete in winter conditions. A modified ASTM C 666 (freeze-thaw durability) and ASTM C 672 test will form the basis for the testing approach. The research team at OSU has extensive experience with freeze-thaw testing using these techniques and is well-equipped to do this part of the experimental research program. Samples for X-ray computed tomography will be sent to WSU for evaluation there.

![Fig. 3. Pictures of (a) Mango Spot Spring Balance, and (b) Dynamic Friction Tester.](image)
Effect of anti-icing (X-ray tomography imaging)

WSU is equipped with X-ray Flat panel Amorphous Silicon High-resolution Computed Tomography (X-ray FlashCT). Using the X-ray FlashCT system, we will use digital image analysis to non-destructively evaluate the extent of bonding of snow and ice to different surface finishes as well as after application of different anti-ice and deicing chemicals. The X-ray FlashCT system has proved promising in a previous project that focused on evaluating the clogging of pervious concrete over time (Fig. 4). A special procedure will be developed to transfer the specimens from the field to the X-ray FlashCT room without changing the state of the specimens.

![Images of clogged pervious concrete](image1.jpg)

*Fig. 4. Use of X-ray FlashCT for identifying clogging issues for pervious concrete, (a) no clogging, (b) top 1-inch clogged and (c) bottom 3.7 inch clogged.*

Task 4- In-Field Safety Testing

In this task, we will use an accelerometer installed on the inside windshield of a vehicle (Fig. 6). The accelerometer will be used to measure the stopping distance of the Police vehicle on a pervious concrete parking lot, to be installed as part of the new PACCAR Environmental Technology Building. The tests will be repeated before and after application of de-icers under icy and snowy conditions. We will also investigate the effect of traffic on pushing the snow into the pervious surface voids and potentially changing its friction characteristics.

![Accelerometer on windshield](image2.jpg)

*Fig. 5. Accelerometer to be installed on the inside windshield for friction testing.*
5.2. Schedule and Milestones

The table below shows the schedule for the project tasks, deliverables and milestones.

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6. Research Outcomes and Technology Transfer Plan

Two of the PIs are from an under-represented group in Civil Engineering. With the support from this project we will be able to support the salary of a female Ph.D. student (Milena Rangelov). Also, the PI and the PhD student will present the findings of the project to the Society of Women Engineers (SWE) at WSU to attract more graduate and undergraduate students to research from this under-represented group.

Expected technology transfer for this project will include:

- Final project report to PacTrans
- Technical paper and presentation at PacTrans regional conference

7. Amount of UTC Funds Requested

The total $180k is requested for this project. Out of the requested budget, $102,651 is allocated to WSU and the remaining $77,349 is allocated to OSU.

8. Non-federal Match

Non-federal in-kind match is provided by WSU Facilities and by Oregon State University. Please refer to the enclosed letters of support. The project is also of great interest to the City of Spokane, please refer to the letter provided by the City of Spokane in support of this study.
9. References


Edens, M.Q. and E.E. Adams (2001) The Application of CT Technology to the Experimental Study of Highway Icing, Montana State University, Bozeman, MT.


Gwilym, K. City of Seattle Porous Pavement Case Study. SvR Design Company, Seattle, WA.


National Ready Mixed Concrete Association (NRMCA). Pervious Concrete Pavement Maintenance Guideline. Silver Spring, MD.


Somayeh Nassiri, Ph.D., P.Eng.

Department of Civil & Environmental Engineering, Washington State University, 405 Spokane St., 26 Sloan Hall, Pullman WA 99164 snassiri@wsu.edu, +1(509) 335 7455

EDUCATIONAL BACKGROUND

Ph.D. in Civil Engineering, University of Pittsburgh, Pittsburgh, PA 2011
M.S. in Civil Engineering, University of Tehran, Tehran, Iran 2007
B.S. in Civil Engineering, University of Tabriz, Tabriz, Iran 2004

RESEARCH EXPERIENCE

Assistant Professor
Washington State University, Pullman, WA
Aug 2014- Present

Research Associate
University of Alberta, Edmonton, AB
2011-present

Graduate Research Assistant
University of Pittsburgh, Pittsburgh, PA
2008-2011

SELECT PROFESSIONAL SERVICE

Board of Directors, International Society for Concrete Pavements (ISCP) 2012-present
Young Member, TRB Standing Committees: AFD50: Rigid Pavement Design and AFN20: Properties of Concrete 2012-present
Friend and Reviewer, TRB Standing Committees: AFD70: Pavement Rehabilitation, AHD20: Pavement Maintenance, and AFN30: Durability of Concrete 2009-present

SELECT PUBLICATIONS

Liv M. Haselbach

EDUCATION

Ph.D. Environmental Engineering University of Connecticut, Storrs, CT December 2000
M.S. Chemical Engineering University of California, Berkeley, CA May 1981
B.S. Civil and Environmental Engineering (With Distinction), Cornell University January 1979

PROFESSIONAL WORK EXPERIENCE

- Washington State University (WSU), Pullman, WA
  Associate Professor of Civil and Environmental Engineering (CEE) August 2008 -
- University of South Carolina (USC), Columbia, SC
  Assistant Professor in Civil and Environmental Engineering 2002-2008
- Yale University, New Haven, CT: Lecturer: Environmental Engineering Fall 2001
- Brakewood Planning & Design Civil and Environmental Engineering (Founding Owner)
  Monroe and Shelton, CT 1989-2002
- Consultant for Sunoco, Bridgeport, CT 1987-1989

SELECTED RELEVANT RESEARCH and PUBLICATIONS

- USDA – NW Advanced Renewables Alliance, Liaison to Imagine Tomorrow (2012- date)
- WSDOT – Below Pavement Water Storage (2013)
- PacTRANS/WSDOT – Media Filter Drain: Modified & Existing Design Evaluation (2012-14)
- Mentor 2012 EPA Campus Rainworks Competition: Low Impact Development Snowshelf
- NSF - Preliminary Analyses of Heat Storage in Pervious Concrete Systems
- TransNOW – Low Impact Development (LID) and Transportation Stormwater Practices
- TransNOW - Finite Element Evaluation of Pervious Concrete Pavement
- NSF – Pervious/Impervious Comparative Site Base Study

- Thomle, J. and Haselbach, L. (2011), The Declining pH of Waters Exfiltrated through Pervious Concrete, ACI SP-282, The Leading Edge of Pervious Concrete, ACI
Select Project Experience

Center for Environmentally Sustainable Transportation in Cold Climates. Funded by the USDOT as a Tier 1 University Transportation Center. $2,816,300. Oct. 2013 – Sept. 2017. Associate Director to lead a team at MSU-Bozeman (until July 2014). Now an Assistant Director.


Cost Benefit for Weather Information in Winter Maintenance - Funded by the Aurora pooled-fund led by the Iowa DOT. $125,000. March 2007 - March 2009. PI.


Select Professional Services and Publications

- Chair, TRB Subcommittee on Cost Benefit Analysis of Winter Operations and New Technology, Committee on Winter Maintenance (AHD65). July 2011 – Present

More than 120 peer-reviewed publications and other credentials: www.coe.montana.edu/me/faculty/Shi/
(a) Professional Preparation
Georgia Institute of Technology Civil Engineering B.S.C.E., High Honor, 2002
The University of Texas at Austin Civil Engineering M.S.E., 2004
The University of Texas at Austin Civil Engineering Ph.D., 2008
The University of Texas at Austin Civil Engineering Post-Doc May-Aug, 2008

(b) Appointments
2014-Present Associate Professor, School of Civil and Construction Engineering Oregon State University
2008-2014 Assistant Professor and Kearney Faculty Scholar, School of Civil and
Construction Engineering Oregon State University
1998-2000 Engineering Aide, Willmer Engineering, Inc. Atlanta, Georgia

(c) Products
Related to project

Others of significance

(d) Synergistic Activities
1. RILEM TC-AAA, 2014-2019, “Avoiding Alkali Aggregate Reactions in Concrete - Performance Based Concept”
3. ICAAR 2012 International Conference on Alkali-Aggregate Reactivity, Austin, Texas, USA
Member of the Organizing Committee, Co-Editor of Conference Proceedings.
4. ACI 2012 American Concrete Institute Spring Convention 2012, Dallas, Texas, USA
Co-Session Moderator “Recent Advances in understanding the Mechanisms of ASR, Mitigation Methods and Testing Procedures”.

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October 29, 2014

Somayeh Nassiri
Assistant Professor
Department of Civil & Environmental Engineering
Washington State University
405 Spokane St., 26 Sloan Hall
Pullman WA 99164
Phone: (509)335-7455

Dear Dr. Somayeh Nassiri,

I am writing in support of your proposal to research the safety and winter maintenance required of pervious concrete. By this letter, I approve the request to use $108,600 from project construction funds to place pervious concrete for the new PACCAR Environmental Technology Building as match for the PacTrans project being conducted by Dr. Somayeh Nassiri titled “Tools and Guidelines for Pervious Concrete Sidewalks and Shared-use Paths to Improve Bicycle and Pedestrian Safety”. As WSU has several pervious installations across campus, we support your study and look forward to the results.

Please call if you need further information.

Sincerely,

[Signature]

Jeff Lunnigan, PE
Project Manager
Facilities Services – Capital
Washington State University
110 Commons
Pullman WA 99164
Phone: (509) 335-7221

Cc: file
January 16, 2015

Dr. Somayeh Nassiri  
Assistant Professor, Civil and Environmental Engineering  
Washington State University  
405 Spokane Street, Sloan 26  
Pullman, WA 99164-2910

RE: Research Project Proposal

Dear Dr. Nassiri,

The City of Spokane is pleased to submit this letter of support for the “Tools and Guidelines for Pervious Concrete Sidewalks and Shared-use Paths to Improve Bicycle and Pedestrian Safety” research proposal for PacTrans. The City of Spokane has developed an Integrated Clean Water Plan with elements of green infrastructure to reduce stormwater flows to the Spokane River, and is experimenting with the use of porous pavement in various capital projects throughout the City to achieve this goal.

The City of Spokane currently has a pervious concrete sidewalk installation at the Hazel’s Creek Regional Infiltration Facility located near 42nd and Freya. In 2015, porous asphalt shoulders will be installed on Havana Street near the southern City limits. The City also plans to install a porous asphalt parking lot at the Finch Arboretum in 2015. The existing standard asphalt parking lot will remain in place, and an equally sized porous asphalt parking lot will be installed adjacent to the existing lot. Additionally, the City has applied for a grant to install various porous asphalt and concrete sections on Sharp Avenue to assess safety, durability, water quality, and water quantity benefits.

One concern with the installation of porous asphalt and concrete is pedestrian safety, particularly during winter conditions when snow and ice are prevalent in the region. The proposed research project would be beneficial in understanding these safety aspects and incorporating future design considerations. We look forward to working with you on this research project.

Sincerely,

Rick Romero  
Director, Utilities Division  
City of Spokane  
808 West Spokane Falls Boulevard  
Spokane, WA 99201
April 17, 2015

To Whom It May Concern,

Oregon State University is pleased to submit the subaward proposal to Washington State University for the PacTrans project titled “Tools and Guidelines for Pervious Concrete Sidewalks and Shared-use Paths to Improve Bicycle and Pedestrian Safety.”

The appropriate programmatic and administrative officials have reviewed and approved this proposal in the amount of $77,258. Non-federal cost share committed to this project totals $71,349. The period of performance for this project will be July 1, 2015 through June 30, 2016. My signature below, as the authorized institutional official, indicates institutional approval for the proposed project.

OSU has a conflict of interest policy that is compliant with the PHS Financial Conflict of Interest Regulations (42 CFR Part 50 Subpart F).

Oregon State University is prepared to perform the work as outlined in the proposal, subject to the State of Oregon – Oregon State University regulations. Dr. Jason Ideker will serve as Oregon State University’s investigator on this project.

Approved:

[Signature]
Patricia A. Hawk
Institutional Authorizing Official