5/15/2020

Replacement and lifecycle costs of permeable pavements compared with standard impervious pavements

Proposal to the Stormwater Action Monitoring's 2020 Request for Proposals

Prepared by:
The Washington Stormwater Center, Washington State University

May 12, 2020

Dan Nordquist – Associate VP, Washington State University

PROJECT PURPOSE

SUPPORT OF PRIORITY TOPICS

From SWG's 2019 list of priority topics, the following two topics will be addressed here:

- 3. Quantify the benefit [in terms of dollars, water quantity, and water quality] of replacing traditional pavement with permeable pavement.
- 3.1. What are the lifecycle costs [dollars] of permeable pavement?

We have solicited support of this work from the Cities of Puyallup and Tacoma to be on a technical advisory committee, both have agreed and sent us letters of support.

THE IMPORTANCE OF PAVEMENTS IN MANAGING STORMWATER QUANTITY AND QUALITY

The 2019 Phase 1 Municipal Stormwater Permit has provided guidance for the Stormwater Management Action Planning (SMAP) program. SMAP is the first step in requiring stormwater retrofits in priority watersheds in permitted jurisdictions. With an increased focus on retrofitting existing MS4s there is a growing need for research on what retrofit methods will be most effective to implement. Phase 1 jurisdictions such as Pierce, Clark, King, and Snohomish Counties have hundreds of miles of roads that function as stormwater generating surfaces, adding pollutants and water to existing stormwater drainage networks. Recent research (Peter et al., 2018) suggests that road runoff is particularly toxic to aquatic organisms. Other research from the Washington Stormwater Center (WSC) shows that permeable pavements can mitigate stormwater quantity (Knappenberger et al., 2017) and quality, particularly in terms of particulate and particulate-associated pollutants (Jayakaran et al., 2019). However, the long-term performance of permeable pavements is critically dependent on maintenance of their ability to infiltrate rain falling on their surface through street sweeping/cleaning. The pores that enable the rainfall to infiltrate the surface of the pavement into the aggregate layers below, will get clogged without maintenance. The rate of pore-clogging is dependent on pavement age, wheel traffic, and pollutant accumulation on the pavement surface. Permeable pavements that are not swept/cleaned will, over time, end up with pores that are so clogged that the system effectively becomes impervious. We believe that adoption of permeable pavements in the Puget Sound Region remains low because of the perception that permeable pavements are more costly and difficult to construct, and costly to maintain. We seek to test this perception by quantifying the replacement and lifecycle costs of permeable pavements.

A jurisdiction or developer may reasonably ask: "compared with other actions I can take to meet my permit, is it worth replacing this stretch of regular pavement with a permeable variety?" The answer is complex and involves comparing both lifecycle costs (upfront construction and ongoing maintenance) as well as the expected benefits in terms of runoff and pollutant reduction. These will in turn depend on the pavement type, the volume and class of traffic on that road, and the frequency of maintenance. The objective of our study is to collect and synthesize data, then report findings to help permittees (and developers) answer this question. By generating information that a permittee can use to compare value between repairing a stretch of standard impervious pavement, or retrofitting it to a permeable pavement, we aim to put a critical decision tool in the hands of permittees.

PROJECT DESCRIPTION AND SCOPE OF WORK

This proposal outlines work to develop a white paper that can be used by permittees to determine if a standard impervious road pavement should be replaced with a permeable pavement. For the purposes of this proposal, we intend only to evaluate porous asphalt (PA) and pervious concrete (PC) pavements as likely types of permeable pavements that might be considered for retrofit. We strongly believe that the comparison of standard impervious against permeable pavements must include lifecycle costs AND the intrinsic stormwater mitigating properties of these systems. We therefore propose to track three metrics of “value” that are relevant: costs associated with maintenance and/or replacement, volumes of stormwater mitigated, and pollutant loads captured as Total Phosphorous (TP) and Total Suspended Solids (TSS).

PROJECT OBJECTIVES

Table 1: Scenarios, activities, and their frequencies of occurrence.

Frequency	**Type of activity**	**Scenarios**	
		Major repair of current pavement w/o replacement	*Replace with permeable pavement*
One time	$ Construction costs	Strip, then resurface impervious pavement, and fix associated drainage infrastructure	Remove old pavement and rebuild with permeable pavement
Dependent on pavement type	$ Maintenance costs	Chip seal, repave, maintain drainage infrastructure	Monthly, semi-annual, or annual maintenance
Storm events	Stormwater removed from stormwater network	No reduction in stormwater	Reduction dependent on infiltration rates, and infiltration rate-decay based on pollutant buildup, and maintenance frequency
Storm events	TP and TSS load removed from stormwater network	No reduction in TP or TSS	Load removed, dependent on infiltration rates, and infiltration rate-decay based on pollutant buildup, and maintenance frequency

$ = Dollar values associated with construction and maintenance of pavements.

= Stormwater gallons managed by permeable and regular pavements.

= Tons of TP and TSS loads mitigated by permeable and regular pavements.

To perform this type of analysis, one must compare stormwater and pollutant mitigation, along with construction and maintenance costs in a common framework. Suppose a jurisdiction is deciding whether to retrofit a section of standard impervious pavement to permeable pavement based purely on a cost perspective - they must first consider the incremental costs of permeable pavement, including any higher upfront construction costs (e.g. more aggregate for base storage layer, more sand for treatment credit, deeper excavation costs, etc.), and more intensive ongoing maintenance. They must also make assumptions about the useful life of the pavement which, along with maintenance costs, may be a function of annual average daily traffic counts (AADT). A property developer would make a similar set of calculations, except that construction costs may be different for greenfield sites (e.g. no retrofitting costs), while the costs of ongoing maintenance might be passed on to the jurisdiction, or a homeowner's association. If the lifecycle costs of permeable pavement are *lower*, the jurisdiction or developer would not need further analysis: they can minimize costs by simply constructing permeable pavement.

If, however, the lifecycle costs of permeable pavement are higher than standard impervious pavement, they must address how much permeable pavement can contribute to their stormwater permitting requirements. What are the benefits in reduced flows and improved water quality? And is the additional cost of installing permeable pavement a more cost-effective way to meet permit requirement than other traditional BMPs? This idea is further illustrated in Table 1, where we compare the two scenarios faced by a permittee when it comes time to repair or retrofit of a roadway.

To address these questions, our key project objectives therefore are two-fold: A) to calculate and compare the lifecycle costs of permeable and standard impervious pavement; and B) to calculate the cost-effectiveness of permeable pavements in reducing quantity and pollutants, compared with standard impervious pavement.

PROJECT DESIGN

Our basic framework for analyses is to develop common currency metrics to track value as a stormwater permittee goes through the decision process to determine if a permeable pavement is truly cost-effective over a certain design timeframe. To accomplish our objectives, we will collect construction and maintenance costs from permittees, developers and businesses who have installed permeable pavements for a broad range of road repair (standard impervious pavement) or replacement (permeable pavement) projects. We will also survey the existing literature for permeable pavement (PA & PC) surface infiltration rates, and pollutant (TSS and TP) accumulation rates, both of which will depend on pavement type, traffic, pavement age, and maintenance protocols. Lastly, we use published pollutant removal rates to estimate pollutant load mitigation once the pollutant laden stormwater has infiltrated the pavement surface.

To meet the two project objectives listed previously, we have broken up this study into three main tasks:

1. **Perform a comparative cost analysis of design, installation, and maintenance of permeable and standard impervious pavement.** Comparisons will be based on installation and life-cycle costs for several permeable and standard impervious pavement projects in the region. Data will be corrected for differences in materials and labor costs with year of construction and times of maintenance.

2. **Perform a simple hydrologic analysis of stormwater pollutant and volume mitigation by permeable pavements under varying infiltration rates.** A simple spreadsheet- based model will be used to calculate stormwater volume and pollutant (TSS and TP) load mitigation under various pavement infiltration rates over a period of 15 years. Several pavement infiltration rate conditions (low, medium, and high) will be simulated based on pavement-clogging associated with pavement age, wheel loads, typical pollutant accumulation rates, and maintenance frequency. A literature review will allow us to establish a range of surface infiltration rates for permeable pavements, changes in infiltration rates with age and maintenance frequency, and pollutant accumulation rates on the pavement surface based on vehicular traffic.
3. **Calculate the cost-effectiveness of permeable pavement.** Using metrics such as incremental dollars per gallons reduced, or per ton of pollutant removed, we aim to provide an illustrative comparison between of cost-effectiveness estimates between permeable pavements and standard impervious pavements.

Given the wide variability of possible pollutant accumulation rates associated with traffic and maintenance patterns, we will frame this work across several scenarios that combine high to low traffic conditions, and high to low frequencies of pavement cleaning (e.g. high vehicular traffic – low frequency maintenance, to, low-vehicular traffic – high frequency cleaning).

ANTICIPATED OUTCOMES

Based on this work, we anticipate realizing the following outcomes; A) a greater understanding of the benefits and costs associated with retrofitting a standard impervious road in the Puget Sound area, with a permeable pavement based on economic and stormwater mitigation metrics; and B) a simple customizable public-use model that estimates pollutant mitigation under various traffic and maintenance regimes that could be widely used across the region.

PROJECT TASKS

TASK 1: PROJECT MANAGEMENT (TOTAL COST = $9,552)

Project administration will be led by WSU. This includes initiating agreements and contracting with Ecology, tracking progress of deliverables, and invoicing based on detailed reports of deliverables, and semi-annual reports to Ecology.

WSU will develop a Technical Advisory Committee (TAC) for this project. The TAC will comprise representatives from the Cities of Tacoma, Puyallup. We will invite representatives from the permeable pavement industry, Ecology, other state agencies, and at least one permittee stormwater manager or coordinator. The TAC will advise the project team on technical issues and concerns by meeting as needed throughout the project.

Semi-annual reports will include status of the contract tasks and decisions related to the tasks made during the calls, meetings and coordination with the advisory committees and communication with Ecology as appropriate. The four semi-annual reports will include project updates, data quality assurance review, results, and findings to date.

Deliverable 1.1: Semi-annual report 1: Document activity, coordination with team, and communications with Ecology.
Cost = $2,388 Target date: 6 months after project start

Deliverable 1.2: Semi-annual report 2: Document activity, coordination with team, and communications with Ecology.
Cost = $2,388 Target date: 12 months after project start

Deliverable 1.3: Semi-annual report 3: Document activity, coordination with team, and communications with Ecology.
Cost = $2,388 Target date: 18 months after project start

Deliverable 1.4: Semi-annual report 4: Document activity, coordination with team, and communications with Ecology.
Cost =$2,388 Target date: 24 months after project start

TASK 2: DATA COLLECTION FROM PERMITTEES, AND CONTRACTORS (TOTAL COST = $51,044)

We will collect data on construction and maintenance costs of regular pavement, PA, and PC road retrofit projects. Our main focus will be working with the cooperating jurisdictions in our TAC (Tacoma, Puyallup, and hopefully a third jurisdiction) to obtain these data. We will also target developers and any private businesses known to have installed permeable pavements in those jurisdictions. We will also elicit this cost information from any other Phase I or II jurisdictions known to have installed permeable pavements on public roadways. For regular pavements, costs associated with construction and maintenance of road stormwater management system would also be gathered, though we should be able to rely more heavily on standard imperviously-reported costs estimates and guidance (i.e. WA DOT, National Highway Construction Cost Index).

Deliverable 2.1: Draft database - This will take the form of a draft spreadsheet that calculates the lifecycle costs of permeable and standard impervious pavement to ensure that all relevant variables and costs that are feasible to collect have been included. It will also include a list of developers and private businesses in our study area to be contacted, and a list of Phase I and Phase II jurisdictions who have installed permeable pavements.
Cost = $12,761 Target date: Month 3

Deliverable 2.2: Final Database - All costs associated with construction and maintenance of pavements by type, and by traffic conditions (85th percentile speed, AADT, Annual Average Daily Truck Traffic (AADTT), etc.)
Cost = $12,761 Target date: Month 5

Deliverable 2.3: Draft Report - Based on data collected, a draft report will be prepared for the TAC (meeting #1) that reports average and median construction and maintenance costs per linear mile of roadway, organized by traffic conditions (light, medium, heavy), and by pavement type (PA, PC, and regular pavement). We will also compare our estimates of the incremental lifecycle costs of permeable pavement to other published estimates from elsewhere in the U.S., though we believe this literature to be thin.
Cost = $12,761 Target date: Month 7

Deliverable 2.4: Final Report - Revised analysis and revised report shared with TAC (meeting # 2)
Cost = $12,761 Target date: Month 9

TASK 3: LITERATURE REVIEW (TOTAL COST = $28,856)

This task will include a literature search of published studies on permeable pavements, specifically PA and PC pavements, and their ability to manage stormwater quantity, and improve stormwater quality. In terms of stormwater quantity, published values of infiltration rates for newly constructed pavements, and the decay of infiltration rates under various traffic and maintenance regimes will be synthesized. In terms of stormwater quality, published removal rates of TSS and TP associated with PA or PC will be identified. The accumulation of TSS and TP on pavements under between storm events, and traffic patterns will be synthesized.

1. Infiltration rates for PA and PC.
2. Decay of infiltration rates under differing maintenance and traffic regimes.
3. Pollutant build up on roadways under varying traffic conditions.

Deliverable 3.1: Draft Lit Review
Cost = $14,428 Target date: Month 5
Deliverable 3.2: Final Lit Review
Cost = $14,428 Target date: Month 9

TASK 4: WATER QUANTITY AND QUALITY MITIGATION BY PERMEABLE PAVEMENTS ($52,750)

Using published infiltration rates, and decay of those infiltration rates under four maintenance conditions (monthly, six-monthly, annual, and never), the volumes of stormwater managed by the three types of pavement (PA, PC, and standard impervious) will be evaluated over a 15-year period using a simple spreadsheet model that we will develop. That model will simulate 15-years of rainfall falling on a section of pavement, calculating how much infiltrates the permeable pavement, and how much runs off the surface. The 15-year period will be simulated using daily rainfall totals for a representative location in Puget Sound. Infiltration rates will decay between maintenance events, with reductions of infiltration rates (decay) being greater for high traffic roadways compared to low traffic roadways i.e. high traffic = high infiltration decay rate. By tracking how much water infiltrates the pavement surface over a 15-year period with rainfall, traffic, and maintenance; we will effectively be able to estimate how much stormwater the pavement can mitigate. Initial infiltration and infiltration-decay rates will be based on the literature review (Task 2).

Similarly, pollutant accumulation on the pavement will increase between maintenance and storm events. Pollutant accumulation rates will also be dependent on frequency of pavement maintenance and vehicular traffic. Based on published studies of pollutant build up on roadway surfaces, infiltration rates, and likely remediation rates of stormwater quality by permeable pavement, total load removals of TSS and TP over a 15-year period by permeable pavements, will be estimated. The model structure will be simplistic, and is intended solely as a comparative framework for allocating stormwater volume and pollutant loads between what runs off the surface (therefore into the stormwater drainage network), and what is mitigated after infiltration into the permeable pavement.

We will combine these benefit estimates with the incremental life cycle cost estimates developed above, where "incremental" means the additional lifecycle costs above and beyond the cost of traditional pavement. We will calculate three sets of metrics: incremental cost per volume of stormwater runoff reduced ($ per gallon), incremental costs per kilogram of TSS removed ($/kg) and incremental costs per kilogram of TP removed ($/kg). Finally, we will provide a set of comparisons between those cost-effectiveness estimates and the cost-effectiveness of other traditional stormwater BMPs like detention ponds, infiltration basins, etc. This set of comparisons is meant to illustrative, not comprehensive, and will rely on existing published cost-effectiveness estimates, ideally from around the Puget Sound or the Pacific Northwest.

Deliverable 4.1: A memo outlining all assumptions made from literature review of initial infiltration rates, infiltration decay rates, pollutant accumulation under varying traffic conditions, and maintenance conditions.
Cost = $10,550 Target date: Month 9

Deliverable 4.2: Draft report outlining model runs with stormwater quantity and quality remediation
Cost = $10,550 Target date: Month 11

Deliverable 4.3: Final report outlining model runs with stormwater quantity and quality remediation
Cost = $10,550 Target date: Month 13

Deliverable 4.4: Draft cost-effectiveness report, including table of three measures of incremental cost-effectiveness of permeable pavement ($ per gal reduced, $ per kg TP reduced, $ per kg TSS reduced) under three traffic scenarios (low, med, and high) and four maintenance scenarios (monthly, six-monthly, annual, and never) or 36 calculations in total. Report will also include comparison with the cost-effectiveness of at least three other stormwater BMPs, and a synthesis section interpreting these comparisons.
Cost = $10,550 Target date: Month 15

Deliverable 4.5: Final cost-effectiveness report.
Cost = $10,550 Target date: Month 17

TASK 5: COMMUNICATION ($9,552)

Deliverable 5.1: Draft white paper of the whole study that integrates replacement construction and maintenance costs, water quantity and quality remediation pavement types and traffic conditions evaluated. The draft will also include a data quality review and usability statement
Cost = $2,388 Target date: Month 18

Deliverable 5.2: Final white paper with complete appendices and Excel file of all QAQC'd data collected over the project period.
Cost = $2,388 Target date: Month 21

Deliverable 5.3: Two presentations – one for the Stormwater Work Group, and another for regional stormwater related conference or workshop.
Cost = $2,388 Target date: Month 22

Deliverable 5.4: Draft fact sheet per SAM format for stormwater managers who seek information on the project.
Cost = $2,388 Target date: Month 24

PROJECT TEAM AND PROJECT MANAGEMENT

Task	Lead	Support
1 - Project Management	Jayakaran	Cook
2 – Data collection and synthesis on road construction and maintenance costs from permittees	Cook	Jayakaran
3 – Literature Review	Jayakaran	Cook
4 – Water quantity and quality mitigation by permeable pavements	Jayakaran	Cook
5 – Communication	Jayakaran	Cook

A graduate student from Economic Sciences will work with Prof. Cook to collect cost data from permittees and synthesize findings. The project will also require a temporary student worker who will work with Dr. Jayakaran who will assist with model creation. The project will be managed by Washington State University. The team will meet on a quarterly basis to discuss project status (with an initial in-person kickoff meeting), share preliminary data analyses, and assess and strategize solutions around potential pitfalls.

WASHINGTON STATE UNIVERSITY TEAM

ANAND “ANI” JAYAKARAN | PHD PE will serve as the project lead and will be responsible for meeting project deliverables and communications between the project team and SAM.

Education: PhD Agricultural and Biological Engineering; MS Civil Engineering, Ohio State University; BE Civil Engineering, Bangalore University, India

Licenses/Registrations: Civil Engineer WA #53011, SC#30732

Qualifications: Ani is an Associate Professor with WSU Extension and the WSC. His role is to meet education and research needs in a region experiencing the impacts of high urbanization, and a changing climate. His work involves disseminating strategies to manage water resources using Green Stormwater Infrastructure (GSI) and improving current engineering designs using ecological engineering principles.

Past Project Performance:

- **The Effectiveness of Trees in Mitigating Stormwater Runoff in Western Washington:** Ani is technical lead of a SAM project measuring the hydrologic budget of several native tree species, in order to quantify the role individual trees play in the management of urban stormwater runoff.
- **The Effects of Mulch on Stormwater Treatment and Maintenance Effort in Bioretention Systems:** Ani is the lead PI of a SAM project that is evaluating the role that mulch plays in altering flow and treatment in urban bioretention systems.
- **Urban Stormwater Characterization, Control and Treatment:** Ani is part of a national team that reviews GSI articles published the previous year. These review articles are published annually in the journal *Water Environment Research*.

JOSEPH COOK|PHD, will serve as task lead for Task 2 and a support role on all other tasks.

Education: PhD, MS, Environmental Sciences and Engineering, University of North Carolina at Chapel Hill; BS, Natural Resources, Cornell University.

Licenses/Registrations: Associate Professor (School of Economics), Washington State University, partial extension appointment on the economics and policy of green stormwater infrastructure.

Qualifications: Prof. Cook has over 20 years of experience as an environmental economist studying the preferences and behavior of households around the world. He joined WSU after ten years at the Evans School of Public Policy at the University of Washington. He has conducted 12 household surveys in six countries and was involved in two large randomized controlled trials (in California and Reno, Nevada) exploring how social comparisons reduce household water use. In addition to the Washington-focused consulting work described below, he has consulted for the U.S. Millennium Challenge Corporation, the Asian Development Bank, the Hopi Tribe in Arizona, and Global Water Challenge.

Past Project Performance:

- **Streamflow Restoration Technical Guidance (to implement ESSB 6091), Department of Ecology.** Co-wrote report section on the potential role of economics in determining "Net Ecological Benefit" standard, including extensive annotated bibliography on valuing increased stream flows for fish.
- **Benefit-cost analysis of the Yakima Basin Integrated Plan (YBIP) Projects, Washington Legislature.** Team examined the benefits and costs of the components of the multi-billion-dollar YBIP. Cook led section on assessing the economic value of increased fish returns.
- **Technology for Trade**: new tools and new rules for water use efficiency in agriculture and beyond, USDA National Institute of Food and Agriculture. Co-PI leading component on simulation games to identify how irrigators interact with technologies and institutional innovations, and test behavioral responses and outcomes; manage direct budget ~$550,000, 2018-2022.

PROJECT BUDGET AND SCHEDULE

BUDGET TABLE

Task Description		Salaries	Benefits	Supplies	Travel	Indirect	**Total Task**
Task 1	Project mgmt.	$5,655	$1,693	$0	$0	$2,204	**$9,552**
Task 2	Data collection from permittees	$30,995	$6,731	$0	$2,000	$11,318	**$51,044**
Task 3	Literature review	$19,837	$2,360	$0	$0	$6,659	**$28,856**
Task 4	Water quantity & quality mitigation by pollutant type	$25,402	$15,175	$0	$0	$12,173	**$52,750**
Task 5	Communication	$5,655	$1,693	$0	$0	$2,204	**$9,552**
	Total by Object	**$87,544**	**$27,652**	**$0**	**$2,000**	**$34,559**	**$151,755**

BUDGET DESCRIPTION

Overall funds requested to support this work is $**151,755**

Support requested for 2 months of Dr. Jayakaran's time and 1.5 months of Dr. Cook's salary. Support is also requested for summer salary (2.5 months) for a doctoral student in the School of Economic Sciences (SES). We are also requesting support for a temporary hourly worker, and a temporary student worker, both based in Puyallup. Details of salary including benefits rates are outlined in the budget table above. WSU requires an annual 4% inflation for faculty and technician salary that has been included.

Travel funds are requested for the following: Cook will travel from Pullman, WA to attend the in-person project kickoff meeting with the TAC in the Puget Sound region (approx. cost = $500, including flight and two nights hotel). Cook and the SES student will take a second trip to the Puget Sound region to meet with transportation staff, developers and businesses in relevant jurisdictions (approx. cost =$1000, incl. driving from Pullman in WSU Pool car and three nights hotel for each). Cook requests travel funding to attend a subsequent in-person outreach meeting in the Puget Sound region to disseminate the results of the study (approx. cost = $500, including flight and two nights hotel). Indirect costs are calculated at 30% on salaries and benefits per Ecology stipulations.

DETAILED SCHEDULE

A timeline over 24 months for the FIVE principal tasks is presented below. Deliverables associated with these five tasks are shown by deliverable number.

Months ->	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Project mgmt.						2.1						2.2						2.3						2.4
Data collection from permittees			2.1		2.2		2.3		2.4															
Literature review					3.1				3.2															
Water quantity & quality mitigation by pollutant type									4.1		4.2		4.3		4.4		4.5							
Communication																		5.1		5.2		5.3		5.4

REFERENCES

Jayakaran, A.D., Knappenberger, T., Stark, J.D. and Hinman, C., 2019. Remediation of Stormwater Pollutants by Porous Asphalt Pavement. Water, 11(3), p.520. doi.org/10.3390/w11030520.

Knappenberger, T., Jayakaran, A.D., Stark, J.D. and Hinman, C.H., 2017. Monitoring Porous Asphalt Stormwater Infiltration and Outflow. Journal of Irrigation and Drainage Engineering, 143(8), p.04017027.

Peter, K.T., Tian, Z., Wu, C., Lin, P., White, S., Du, B., McIntyre, J.K., Scholz, N.L. and Kolodziej, E.P., 2018. Using high-resolution mass spectrometry to identify organic contaminants linked to urban stormwater mortality syndrome in coho salmon. Environmental science & technology, 52(18), pp.10317-10327.

City of Puyallup

OFFICE OF THE CITY ENGINEER

Hans Hunger, PE

253.435.3640

May 6, 2020

Dr. Anand Jayakaran
Washington State University
2606 W Pioneer Ave
Puyallup WA 98371

Dear Dr. Jayakaran:

The City of Puyallup endorses the Washington Stormwater Center proposal to the 2020 Stormwater Action Monitoring RFP focusing on *Replacement and lifecycle costs of permeable pavements compared with conventional pavements.* We value the opportunity to partner with the Washington Stormwater Center to implement this project.

The importance of using permeable pavements as a way of reducing roadway pollutants to receiving waters is critical. Our organization sees the need for better information on the cost tradeoffs associated with standard and permeable pavements.

We look forward to the opportunity to partner with the Washington Stormwater Center on this project. The City of Puyallup will provide project support by serving on a Technical Advisory Committee and providing cost data on road construction and maintenance projects in our jurisdiction.

Sincerely,

Hans Hunger, P.E., City Engineer

cc: Steve Kirkelie, City Manager; Jim Kastama, Councilmember

City of Tacoma
Environmental Services Department

05/05/2020

Dr. Anand Jayakaran
Washington State University
2606 W Pioneer Ave
Puyallup WA 98371

Dear Dr. Jayakaran:

The City of Tacoma endorses the Washington Stormwater Center proposal to the 2020 Stormwater Action Monitoring RFP focusing on replacement and lifecycle costs of permeable pavements compared with conventional pavements. We value the opportunity to partner with the Washington Stormwater Center to implement this project.

The importance of using permeable pavements as a way of reducing roadway pollutants to receiving waters is critical. Our organization sees the need for better information on the cost tradeoffs associated with standard and permeable pavements.

We look forward to the opportunity to partner with the Washington Stormwater Center on this project. The City of Tacoma will provide project support by serving on a Technical Advisory Committee and providing cost data on road construction and maintenance projects in our jurisdiction.

Sincerely,

Angela Gallardo
City of Tacoma
Assistant Division Manager
Environmental Services
Science & Engineering