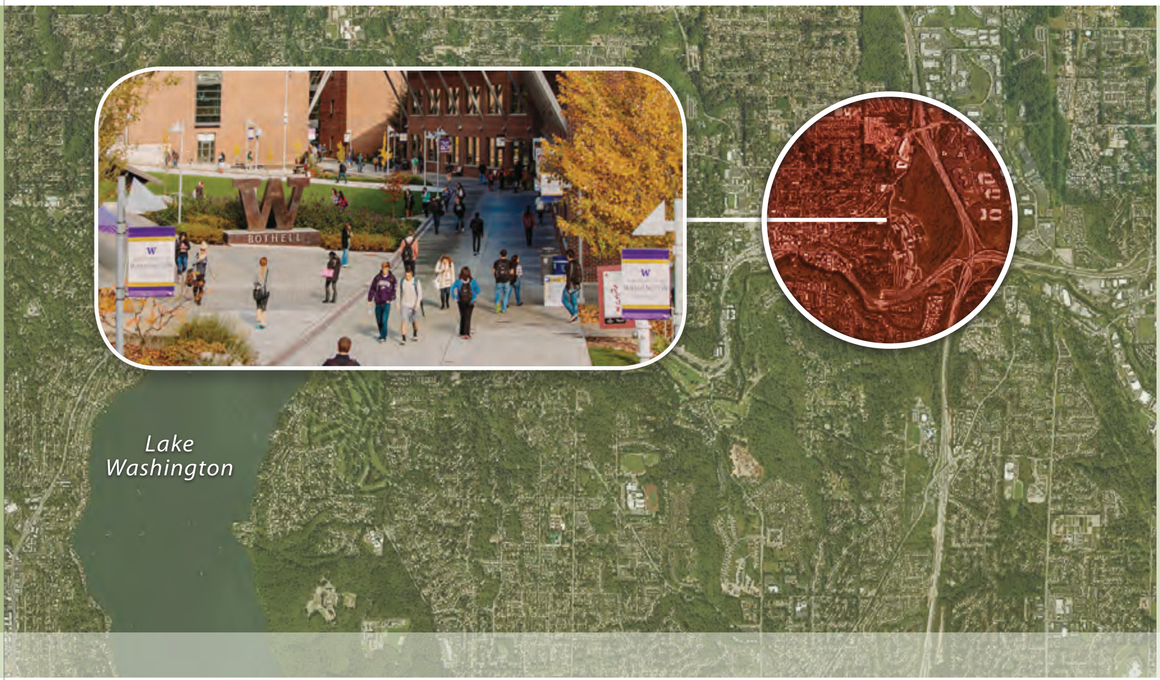
SALMON-SAFE INC.

REPORT OF THE SCIENCE TEAM REGARDING SALMON-SAFE RECERTIFICATION OF THE UNIVERSITY OF WASHINGTON BOTHELL CASCADIA COLLEGE CAMPUS BOTHELL, WASHINGTON

October 8, 2018



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RECOMMENDATION SUMMARY

The Salmon-Safe Science Team is pleased to recommend that the University of Washington Bothell (UWB)/Cascadia College campus in Bothell, Washington, be recertified Salmon-Safe, subject to the conditions detailed in this report. UWB and Cascadia College continue to demonstrate a high level of environmental stewardship in accordance with Salmon-Safe standards. Their continued commitment to enhance the functioning of the ecologically significant wetland under their jurisdiction serves as a regional and national example of environmental innovation by a university campus.

Background

In 2000, Salmon-Safe expanded beyond agricultural land certification to apply the Salmon-Safe assessment and certification process to land and water management within the urban realm. This initiative significantly advanced restoration efforts in urbanized watersheds by developing urban aquatic protection guidelines and a citizen education campaign throughout the Pacific Northwest.

Working closely with independent scientists and technical experts, Salmon-Safe developed a comprehensive certification framework oriented towards reducing impacts on water quality and fish habitat from urban land and water management practices. Since 2005, more than 40 urban sites have transitioned to Salmon-Safe certification in Oregon and Washington, including Nike World Headquarters, Toyota at the Port of Portland, University of Washington Seattle and Bothell Campuses, Oregon Convention Center, and other institutional, corporate, and residential development sites.

In 2014, Salmon-Safe developed certification standards for highly urbanized sites, which revised and updated the Campus Standards completed in 2005. These Urban Certification Standards (*https://www.salmonsafe.org/getcertified/development*) are applicable across a variety of urban development landscapes, ranging from high-density urban infill to corporate campuses. While the standards are designed as a stand-alone program, they can also complement other leading certification standards, such as LEED, Sustainable Sites, Envision and Earth Advantage, providing a water quality and habitat-focused bioregional overlay.

UW and Cascadia College's Bothell campus was first certified in 2008 as part of UW's 21st Century Campus Initiative, which included environmental sustainability as one of its seven key initiatives. The campus was then recertified in 2013. The campus is highly committed to sustaining the Salmon-Safe certification, as guided by their 2017 Campus Master Plan and Sustainability Action Plan.

OVERVIEW OF UW BOTHELL/CASCADIA COLLEGE ENVIRONMENT AND FACILITIES

The campus sits on a 135-acre plot of land that was once part of the Boone-Truly cattle ranch. The property was purchased by the State of Washington in 1995 in order to co-locate UWB and Cascadia College. The two institutions, founded in 1990 and 2000, respectively, collaborate in a number of areas related to planning (as evidenced by the joint 2017 Master Plan) and promotion of sustainable practices.

The campus includes a 58-acre wetland created from former cattle grazing pastures. The project included redirecting North Creek, a tributary to the Sammamish River, from a straight channel to a naturally-shaped river delta. The wetland reconstruction project was completed in 2002 and was the largest project of its kind in Washington State at that time.

There are eight existing buildings devoted primarily to academics (five used by UWB and three used by Cascadia College), plus eight other buildings and two parking garages that are shared by the two institutions (Figure 1). Three of these buildings (Discovery Hall, Sarah Simonds Green Conservatory, and the Activity and Recreation Center) were completed since the 2013 recertification, as were the adjacent sports complex and additional surface parking. Five new buildings are planned for the near-term (6-10 years), primarily within the campus core. An additional 10 buildings may be constructed over the long-term (10-20 years), largely in the northern part of the campus. One of the six guiding principles for future development is to enhance environmental and human health.

Campus topography generally falls away from west to east. The natural campus environments are organized by four campus zones that generally follow the topography: upland conifer forest, human-centric managed landscape, meadow, and the North Creek floodplain wetland in the northeastern portion of the campus. Ornamental shrub beds are also interspersed within the built environment.

Both existing and future developments are based on the long-term campus vision of integrating hydrological flows with existing vegetation. Accordingly, project-specific stormwater management strategies generally rely on at-grade, naturalized systems in lieu of below-grade piped systems.

The campus employs both gardeners and a wetlands team to maintain the entire campus landscape and outdoor built environments. The grounds and wetlands teams are also the first responders in the case of inclement weather such as ice, snow, flooding and windstorms. These teams have largely eliminated pesticides and fertilizers from the campus environment in favor of organic land care since the spring of 2006.

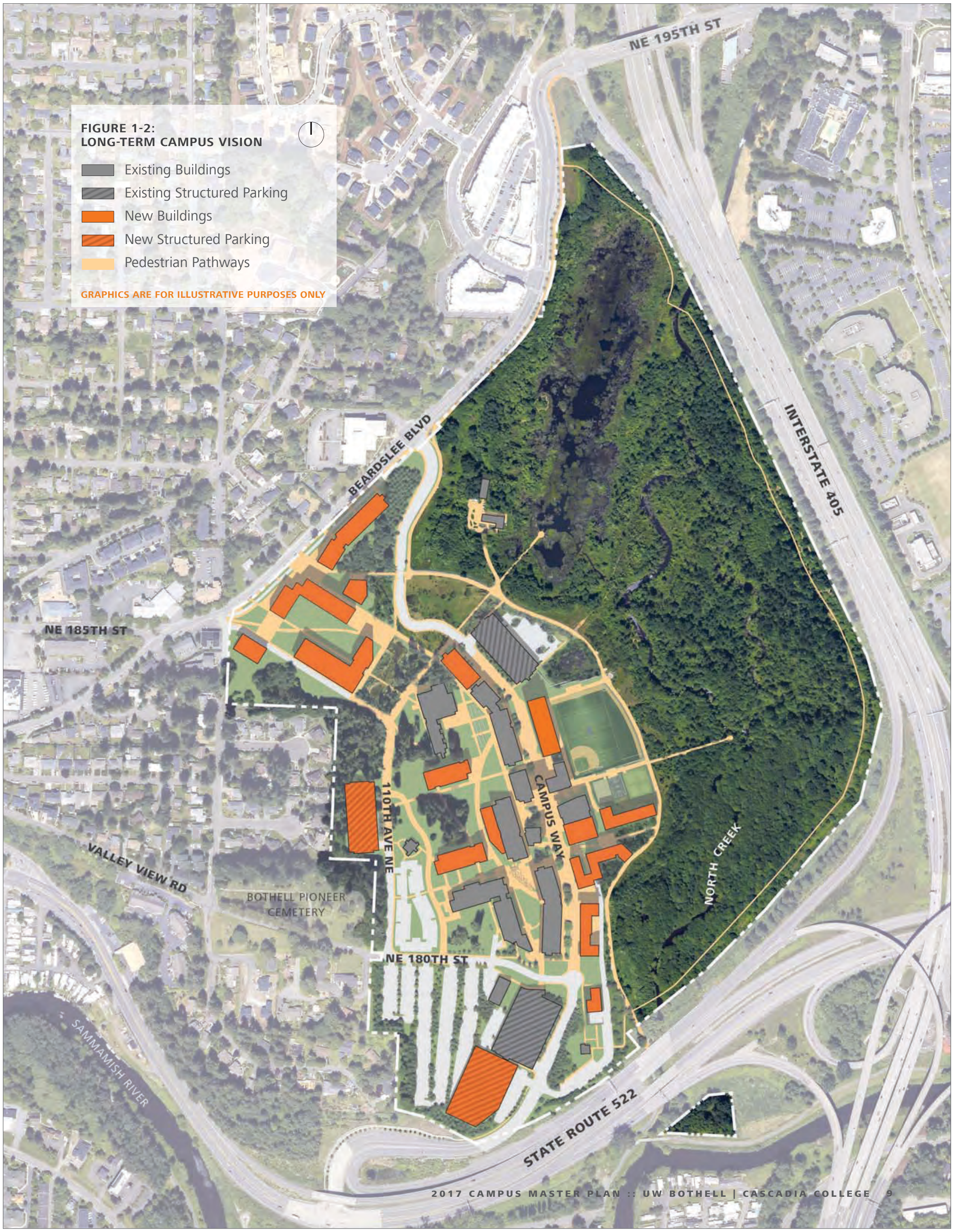

Figure 1. Long-term campus vision

THE ASSESSMENT PROCESS

To maintain Salmon-Safe certification, an urban site is re-assessed every five years. For this Salmon-Safe recertification, the assessment process consisted of a desktop review of documentation on how conditions contained in the previous certification report were addressed and a field review, culminating in a certification report (this document). These tasks were conducted by Salmon-Safe staff and an interdisciplinary team of scientists (the Science Team) with expertise in aquatic ecosystems, innovative stormwater management, land management, and integrated pest management (IPM), as summarized below.

Science Team

The Science Team for this project was composed of Tad Deshler, Dr. Richard Horner, José Carrasquero and Carrie Foss. Dr. Horner and Ms. Foss were part of the team that conducted the original 2008 assessment and the 2013 recertification.

Tad Deshler: *Environmental Scientist, Coho Environmental*

Mr. Deshler's practice focuses on environmental assessment and impact analysis, with particular focus on the interaction between built and natural environments. Much of his project work has centered around aquatic sites, or at the interface between aquatic sites and the adjacent upland environments, where understanding the transport mechanisms that connect upland and in-water environments is paramount. Tad earned a BA degree in Aquatic Biology from the University of California at Santa Barbara and an MS degree in Animal Science from the University of California at Davis. Tad also has specialized expertise in sediment assessment and management, risk assessment, and chemical transport and fate studies.

Dr. Richard Horner: *Stormwater Management Expert, University of Washington*

Dr. Horner received engineering BS and MS degrees from the University of Pennsylvania and a PhD in civil and environmental engineering from the University of Washington in 1978. Following 13 years of college teaching and professional practice, he joined the University of Washington research faculty in 1981, where he held appointments in Civil and Environmental Engineering, Landscape Architecture, and the Center for Urban Horticulture. His principal research interests involve analyzing the effects of human activities, especially in urban areas, on freshwater ecosystems and solutions that protect these resources. Dr. Horner founded the Center for Urban Water Resources Management in 1990 to advance applied research and education in these areas. He is now emeritus research associate professor and splits his time between private practice and some continuing university research.

José Carrasquero: *Fisheries and Marine Biologist, BA & MS – University of Washington*

Mr. Carrasquero brings 27 years of experience to his work. He performs feasibility assessments for instream, riparian, and floodplain salmon habitat projects. He reviews construction projects to assess whether they comply with local, state, and federal laws. Through these project reviews, he evaluates construction plans and recommends best management practices and mitigation measures. As a technical expert, José has participated in the development of guidance documents supporting planning and regulation under the Growth Management and Shoreline Management Acts. For the Puget Sound Partnership, José reviews and scores projects submitted for funding through the Puget Sound Acquisition and Restoration program, and the Recovery Funding Board. He also provides feedback on local Chinook recovery planning and adaptive management through review of watershed's work plans and project lists.

Carrie Foss: *Urban IPM Director, WSU Puyallup*

Ms. Foss manages the WSU IPM Certification Program and the Pesticide Safety Education Program in western Washington. Landscape maintenance personnel are trained in plant problem diagnosis, integrated pest management, personal safety, and environmental protection through lectures and workshops. Carrie earned a BS degree in botany from the University of Washington and an MS degree in plant pathology from the University of Hawaii. Her background includes plant problem diagnosis, research on beneficial microorganisms, and management strategies for turf and ornamental diseases.

Field Review

The field review was conducted on September 13, 2018. UWB facilities staff assembled documentation that was reviewed by the Science Team prior to, during, and after the field inspection phase of the assessment process. The Science Team, with the exception of Carrie Foss, met with UWB staff on campus, then toured the site and had an opportunity to discuss specific site attributes. At the end of the field review, the Science Team, supported by Salmon-Safe staff, met to review the certification criteria against notes taken during the process. On October 5, 2018 the Science Team and Salmon-Safe staff finalized conditions for certification and reached a final unanimous decision on certification.

UWB staff and faculty stop to discuss the rock- lined ditch south of the sports field with the Salmon-Safe Science Team. The ditch will be reconstructed in the coming year.

The Salmon-Safe Science Team gets a look at the bottom of a cascading rain garden constructed as part of Discovery Hall.

GENERAL OBSERVATIONS AND CONCLUSIONS

In the judgment of the Science Team, UWB and Cascadia College continue to demonstrate a high level of environmental stewardship in accordance with Salmon-Safe standards. This is demonstrated by UW's 21st Century Campus Initiative, the Sustainability Action Plan, their continued commitment to enhance the functioning of the ecologically significant wetland under their jurisdiction, and the meaningful manner in which students are engaged in the study and protection of the wetland area.

Significant growth is anticipated for the campus, as detailed in the 2017 Campus Master Plan. One of the central philosophical principles for this expansion is to replace or mitigate for any environmental functionality that is lost.

UWB and Cascadia College have made significant progress in meeting the conditions included in the previous recertification assessment that was completed in 2013, as outlined below.

Previous Condition 1:
Reconstruct rock-lined ditch to south of sports field

> A preliminary design for this project has been completed and an engineering firm has been contracted to update the design. The Science Team noted during the field review that environmental conditions around this ditch have improved significantly since the last assessment. Current conditions should be assessed against performance criteria for any planned construction activities, as discussed in more detail in the Conditions and Recommendations section below.

Previous Condition 2:
Reconstruct the bioswale that directs primary outflow from detention vault

> This project has been bundled together with the project discussed under Condition 1 and is on the same schedule for implementation.

Previous Condition 3:
Provide pesticide application records for initial 5-year certification cycle

> UWB has provided full records for the initial certification cycle (2008-2013) as well as the current cycle (2013-2018). The records were complete according to Washington State Department of Agriculture (WSDA) recommendations, but could be improved by including a field for target pest to the application record form.

Previous Condition 4:
Expand IPM plan to include knotweed strategy and reduction of pesticide use through zone approach

UWB expanded its IPM plan to include the requested measures and also provided a pesticide application zone map with zone descriptions. The 2013 condition also stated that pesticide applicators using Rodeo for knotweed control should have an aquatic endorsement on their pesticide license. Tyson Kemper, UWB's grounds supervisor, has such an endorsement and has supervised all applications of this pesticide. Knotweed control methods are described in a 2008 memo by Arcadis, but they are not yet incorporated into the IPM plan.

Previous Condition 5:
Clarify fertilizer use plan with zoned approach

UWB provided maps and a description of zones, as well as application records for 2013-2018. The amount of fertilizer applied has not decreased, but organic fertilizer is only being applied to irrigated lawns twice a year. According to the fertilizer summary, they have been applying Hendrikus Seasons 8-2-4 fertilizer on turf areas at a rate of 1 pound of fertilizer/100 square feet, which is equivalent to 0.8 pounds nitrogen/1,000 square feet. This application rate exceeds the Salmon-Safe standard of 0.5 pounds nitrogen/1,000 square feet, as specified in Appendix D of the Urban Standards. Until recently, this fertilizer was formulated to contain 2% phosphorus. Phosphorus-containing fertilizer is only allowed for turf renovations or new lawns, according to Washington State law.[1] Hendrikus has reformulated this fertilizer to exclude phosphorus and has renamed it to Seasons 8-0-4 (the "0" representing the phosphorus percentage). Consequently, future applications of this fertilizer will be fully compliant with the law.

In addition, UWB and Cascadia College have followed two of Salmon-Safe's recommendations from the 2013 recertification report. New rain gardens have been installed with several of the newly constructed buildings or hardscapes and these rain gardens have been registered with the 12,000 Rain Garden campaign.

[1] ESHB 1489, which became effective January 1, 2013.

CERTIFICATION CONDITIONS AND RECOMMENDATIONS

Certification Recommendation: The Science Team recommends that UWB and Cascadia College be certified as Salmon-Safe subject to one pre-condition and five conditions listed below. All conditions are subject to annual verification by Salmon-Safe. Timelines for accomplishing objectives are measured from the official date of this Salmon-Safe conditional certification.

Pre-Condition 1: *Commitment to adhere to Salmon-Safe standards for expansion or redevelopment*

The UWB and Cascadia College shall provide a signed letter to Salmon-Safe confirming that they have a mechanism in place to ensure that Salmon-Safe standards, including model permanent (see Appendix A) and construction-phase (see Appendix F of the Urban Standards) stormwater guidelines, are adhered to for expansion or redevelopment of campus properties. UWB and Cascadia College may opt to select Salmon-Safe accredited contractors to ensure that construction-phase pollution prevention measures are adhered to.

TIMELINE

Compliance is a pre-condition of certification, then subject to annual verification by Salmon Safe.

Condition 1: *Assess the rock-lined ditch located south of the sports field against performance criteria*

As noted above in the observations section, the environmental conditions around this ditch have improved significantly since the last assessment. Before undertaking any construction project for this ditch, UWB and Cascadia College shall establish design criteria relative to stormwater management and habitat functionality. The current conditions shall then be assessed against those design criteria. It may also be appropriate to account for any naturally occurring improvements in the vegetation in this area that are anticipated in the near-term.

If the current or near-term conditions do not or will not meet the design criteria, then plans should be completed to improve the functionality of this structure. Conversely, if the design criteria have been or soon will be met, then it may be appropriate to limit additional work in this area to maintenance and to forego any significant construction activities in this area.

TIMELINE

An assessment of current and anticipated near-term functionality of the ditch compared to performance criteria shall be completed within six months of certification and submitted to Salmon-Safe for review.

Condition 2: *Continue to improve IPM plan*

UWB's recently revised IPM plan, which is divided into separate policy and procedures documents, is generally consistent with Salmon-Safe standards. However, the Science Team identified several topics which could be addressed more completely in the plan. Accordingly, UWB shall make the following changes to the existing IPM plan:

- Add additional documentation on procedures (e.g., application rate, schedule) that apply to fertilizer and pesticide application and specific conditions under which such applications are warranted. Currently much of this information is undocumented institutional knowledge residing with senior members of the grounds crew.
- Incorporate the knotweed control methods that are described in a 2008 Arcadis memo
- Reduce the fertilizer application rate to comply with Salmon-Safe standards for nitrogen (i.e., 0.5 pounds nitrogen/1,000 square feet).
- Record the pest targeted in an added field on the application record for all pesticide applications conducted after the re-certification date.
- To prevent the spread of invasive and nonnative plant and other species, include procedures for decontaminating personal gear (e.g., boots and chest waders) and equipment used in areas where such species occur, or when applying pesticides, particularly if such gear or equipment are also used for other purposes or areas.

TIMELINE

The revised IPM plan shall be submitted to Salmon-Safe for review within one year of certification.

Condition 3: *Conduct inventory of metal siding, cladding and roofing on campus buildings*

Metal building materials such as roofs, siding, or cladding are potential sources of metals, particularly zinc and copper, to the environment when they are subjected to rainfall.[2] The Science Team was unable to determine the prevalence of such materials on the UWB and Cascadia College campus during their field review. Therefore, UWB and Cascadia College shall prepare an inventory of buildings where metal roofs, siding, or cladding are used, focusing in particular on uncoated zinc or copper. The inventory should include the building name, material name, location on the building, the metal(s) used in the material, and the approximate square footage of each material. The Science Team will review the inventory and offer guidance, if necessary, on appropriate monitoring or mitigation.

TIMELINE

The inventory of metal roofs, siding and cladding shall be submitted to Salmon-Safe for review within one year of certification.

[2] The Washington Department of Ecology recently published a study that included both a literature review and newly collected data on runoff from metal roofs. Visit *https://fortress.wa.gov/ecy/publications/SummaryPages/1403003.html*.

Condition 4: *Improve deicing plan*

UWB's *Stormwater Operations and Maintenance Plan* includes a short section on deicing. While the information in this document is generally consistent with Salmon-Safe standards, it does not provide sufficiently detailed guidance to inform facilities staff on the appropriate use of such materials.

The plan shall be improved to take into consideration impacts on aquatic life, including:

- specifically assessing existing or potential salmon habitat in relation to snow and ice control;
- encouraging caution to carefully use the minimum needed with any deicer in the drainage of any water body or groundwater recharge area;
- avoiding chloride-based deicers where runoff can flow to a headwaters (third-order or smaller) salmon spawning or rearing stream, unless runoff passes through green stormwater infrastructure; and
- directing use of highly targeted application of calcium magnesium acetate, if providing adequate GSI treatment is impossible and deicing is still essential. (See Appendix B for Salmon-Safe guidelines for alternative road deicers.)

TIMELINE

An updated section of the *Stormwater Operations and Maintenance Plan* that describes deicing shall be submitted to Salmon-Safe for review within one year of certification.

Condition 5: *Assess ecosystem services provided by campus forests potentially impacted by development*

There are significant development plans for the UWB and Cascadia College campus. UWB and Cascadia College are committed to evaluating the potential environmental impacts from those developments. During the field review, the Science Team learned of a modeling tool called i-Tree Eco that UWB faculty is using to evaluate the ecosystem services of campus trees and forests. Such analyses are consistent with Salmon-Safe standards U.5.4 and U.7.6. Therefore, UWB shall continue to utilize this, or similar, tool to guide future development such that ecosystem services from existing trees are maximally preserved. This tool can also be used for mitigation planning in the event that significant impacts to trees or forests from developments are identified.

UWB shall prepare a report summarizing the manner in which i-Tree Eco, or a similar tool, has been used to assess ecosystem services provided by existing trees or forests potentially impacted by such developments. The report should also describe how the modeling results have been, or will be, used to influence the design of the planned developments and mitigation sites.

TIMELINE

The report documenting the use of and results from i-Tree Eco, or similar tool, shall apply to developments designed within the next five-year certification cycle. The report shall be submitted to Salmon-Safe for review by the end of the five-year cycle.

Recommendations

In addition to the conditions for certification listed above, Salmon-Safe offers the following continuing improvement recommendation, adoption of which is not mandatory to achieve certification, but is considered Salmon-Safe best practice:

- Increase visibility of Salmon-Safe certification status using educational signage

  The UWB and Cascadia College campus was one of the first university campuses to be certified Salmon-Safe. While this significant accomplishment is discussed in the 2017 Master Plan and mentioned on the UWB environmental sustainability website, there does not appear to be any signs around the campus to highlight specific site attributes that led to this certification. Given the focus on environmental education at this campus, we recommend creating such educational signage to foster environmental stewardship among students, faculty, and visitors. Salmon-Safe can assist UWB and Cascadia College by providing examples of appropriate signage.

CONCLUSIONS

Salmon-Safe and the Science Team commend UWB and Cascadia College for their commitment to implement the conditions listed in this report, and to manage the campus to continue to improve water quality and urban habitat over the next five years. We extend appreciation and congratulations to the UWB and Cascadia College team for their work in preparing for the certification assessment and assisting the Science Team in its assessment.

APPENDIX A

Model Stormwater Management Guidelines
for Ultra-Urban Redevelopment

May 2018

SALMON-SAFE INC.

MODEL STORMWATER MANAGEMENT GUIDELINES FOR ULTRA-URBAN REDEVELOPMENT

MAY 2018

Introduction

Polluted stormwater is the largest threat to the health of the Pacific Northwest's urban watersheds. Pollutants targeted by Salmon-Safe's urban initiative such as heavy metals, petroleum products, pesticide runoff and construction sediment have an adverse impact on the watershed and severely compromise downstream marine health. With the goal of inspiring design that has a positive impact in our watersheds, Salmon-Safe offers stormwater design guidance for ultra-urban areas, which we define as typically those densely developed "downtown" locations mostly covered by structures and pavement. Generally first developed long ago, many such areas are brownfields now undergoing redevelopment, mostly for commercial and residential purposes.

The very extensive impervious surfaces in ultra-urban spaces create a hydrologic environment dominated by surface runoff, with little of the soil infiltration and evapotranspiration predominating in a natural landscape. Vehicle traffic drawn to such areas and the activities occurring there deposit contaminants like heavy metals, oils and other petroleum derivatives, pesticides and fertilizers (nutrients). These pollutants wash off of the surfaces with the stormwater runoff and drain into the piping typically installed to convey water away rapidly. If the piping network is a combined sanitary-storm sewer system, the large stormwater runoff volumes draining from an ultra-urban area exceed the capacity of the wastewater treatment plant at the end of the line in some storms, resulting in releases of untreated, mixed sewage and stormwater to a water body. If the piping network is a separated storm sewer system, the runoff and the pollutants it carries enter a receiving water body without treatment, to the detriment of water quality and the aquatic life there. Although salmon-spawning and rearing streams are rarely present in an ultra-urban location, if they are, the elevated runoff quantity itself is damaging to the downstream habitat that salmon and their food sources rely on and directly to the fish themselves.

Many of the pollutants conveyed by stormwater runoff are toxic to salmon and their invertebrate food sources. The toxicity of heavy metals like copper and zinc to aquatic life has been well studied. However, salmon face many more potentially toxic pollutants in both their freshwater and saltwater life stages. These contaminants include other heavy metals; petroleum products; combustion by-products; and industrial, commercial, and household chemicals. Emerging science from NOAA Fisheries shows that these agents collectively create both lethal and non-lethal impacts, the latter negatively affecting salmon life-sustaining functions to the detriment of their migration, reproduction, feeding, growth and avoidance of predators.

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Despite these challenges, an array of options exists to reduce, or even in the utmost application, eliminate the negative impacts of ultra-urban development stemming from the large quantities of contaminated stormwater runoff potentially generated there. This management category addresses practices to control ultra-urban stormwater runoff to reduce both water quantity and water quality impacts with the following goal.

Goal

Any development or redevelopment project with a footprint that exceeds 5,000 square feet shall use low-impact site planning, design, and operational strategies[1] for the property to maintain or restore, to the maximum extent technically feasible, the predevelopment hydrology of the property with regard to the water quality, rate, volume, and duration of flow.

Objectives

1. Prime objective

   Implement low-impact practices, especially runoff retention[2] practices,addressing both water quantity and water quality control to the maximum extent technically feasible in redeveloping ultra-urban parcels to achieve the stated goal of restoring the predevelopment hydrology. Provide documentation of how the objective will be achieved. If full achievement of the goal is technically infeasible, assemble documentation demonstrating why it is not and proceed to consider Objective 2A and/or 2B, as appropriate to the site.

2. Alternative objectives

   Assess if achieving Objective 1 is documented to be technically infeasible.

   2A **Alternative water quantity control objective when the site discharges to a combined sanitary-storm sewer or a stream**—Start with the low-impact practices identified in the assessment pursuant to Objective 1. To the extent that they cannot prevent the generation of stormwater runoff peak flow rates and volumes greater than in the predeveloped condition[3,4], implement effective alternative measures to diminish and/or slow the release of runoff to the maximum extent technically feasible, with the minimum objective of reducing the quantity discharged to comply with any applicable water quantity control requirement[5] and, in any case, below the amount released in the preceding developed condition.[6]

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[1] Collectively termed "low-impact practices" in the following points.

[2] Retention means keeping runoff from flowing off the site on the surface by preventing its generation in the first place, capturing it for a water supply purpose, releasing it via infiltration to the soil or evapotranspiration to the atmosphere, or some combination of these mechanisms.

[3] A predeveloped condition is the natural state of the site as it typically would be for the area prior to any modification of vegetation or soil.

[4] As determined through hydrologic modeling of the previously developed and modified conditions.

[5] Specified for discharges to combined sewers by the municipal jurisdiction; specified for discharges to Western Washington streams by the Washington Department of Ecology's Stormwater Management Manual for Western Washington, Minimum Technical Requirement #7.

[6] As determined through hydrologic modeling of the previously developed and modified conditions.

2B **Alternative water quality control objective when the site discharges to a water body or a separate storm sewer leading to a water body**—Start with the low-impact practices identified in the assessment pursuant to Objective 1. To the extent that they cannot prevent the generation of stormwater runoff containing pollutants, implement alternative effective measures to reduce contaminants in stormwater to the maximum extent technically feasible, with the minimum objective of complying with the regulatory requirements for water quality control applying to the location.[7]

Plan Elements

1. **Inventory and analysis**—Narrative, mapping, data, and quantitative results that summarize: (1) site land uses and land covers in the redeveloped and preceding developed conditions; (2) results of hydrologic modeling of the undeveloped, previously developed and modified conditions, as the basis for pursuing quantity control objectives; and (3) stormwater drainage sub-basins, conveyance routes, and locations of receiving stormwater drains and natural water bodies in the redeveloped state.

2. **Low-impact practices**—Low-impact practices are systematic methods intended to reduce the quantity of stormwater runoff produced and improve the quality of the remaining runoff by controlling pollutants at their sources, collecting precipitation and putting it to a beneficial use, and utilizing or mimicking the hydrologic functioning of natural vegetation and soil in designing drainage systems.

   The following low-impact practices are particularly relevant to ultra-urban sites:

   - source control practices
     - √ minimizing pollutant introduction by building materials (especially zinc- and copper-bearing) and activities conducted on the site
     - √ isolating pollutants from contact with rainfall or runoff by segregating, covering, containing, and/or enclosing pollutant-generating materials, wastes and activities
     - √ conserving water to reduce non-stormwater discharges
   - constructing vehicle travel ways, sidewalks and uncovered parking lot aisles to the minimum widths necessary, provided that public safety and a walkable environment for pedestrians are not compromised
   - harvesting precipitation and putting it to a use such as irrigation, toilet flushing, vehicle or surface washing, or cooling system make-up water
   - constructing low-traffic areas with permeable surfaces, such as porous asphalt, open-graded Portland cement concrete, coarse granular materials, concrete or plastic unit pavers, and plastic grid systems (Areas particularly suited for permeable surfaces

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[7] In Western Washington, specified by the Washington Department of Ecology's Stormwater Management Manual for Western Washington, Minimum Technical Requirement #6, which is equivalent to the City of Seattle's SMC, Section 22.805.090.B.1.a.

are driveways, walkways and sidewalks, alleys, and overflow or otherwise lightly-used uncovered parking lots not subject to much leaf fall or other deposition.)

- draining runoff from roofs, pavements, other impervious surfaces, and landscaped areas into one or more of the following green stormwater infrastructure (GSI) systems:
  - √ bioretention area* (also known as a rain garden)[8]
  - √ planter box*, tree pit* (bioretention areas on a relatively small scale)
  - √ vegetated swale[9] *
  - √ vegetated filter strip*
  - √ infiltration trench
  - √ green roof

  ** signifies compost-amended soils as needed to maximize soil storage and infiltration*

The following low-impact practices are of limited applicability to ultra-urban sites but may contribute to meeting objectives in some circumstances:

- conserving natural areas including existing trees, other vegetation and soils
- minimizing soil excavation and compaction and vegetation disturbance
- minimizing impervious rooftops and building footprints
- designing drainage paths to increase the time before runoff leaves the site by emphasizing sheet instead of concentrated flow, increasing the number and lengths of flow paths, maximizing non-hardened drainage conveyances and maximizing vegetation in areas that generate and convey runoff

3. Alternatives—When on-site low-impact practices alone cannot achieve Objectives 2A and/or 2B, implement one or more of the following strategies to meet at least the minimum water quantity and quality control objectives stated above:

   - For runoff quantity and/or quality control—
     - √ contribute materially to a neighborhood project using low-impact practices and serving the stormwater control needs of multiple properties in the same receiving water drainage basin, with the contribution commensurate with the shortfall in meeting objectives on the site itself.
     - √ implement low-impact practices on-site to manage the quantity and quality of stormwater generated in a location off the redevelopment site but in the same receiving water drainage basin, with the scope of the project commensurate with the shortfall in meeting objectives using practices applied to stormwater generated by the site itself.

[8,9] Preferably with an open bottom for the fullest infiltration, but with a liner and underdrain if the opportunity for deep infiltration is highly limited or prohibited for some specific reason, e.g., bedrock or seasonal high-water table near the surface, very restrictive soil (e.g., clay, silty clay) that cannot be adequately amended to permit effective infiltration, non-remediable contamination below ground in the percolating water pathway.

- **For runoff quantity control**—install a vault or tank[10] to store water for delayed release after storms to help avoid combined sewer overflows or high flows damaging to a stream.
- **For runoff quality control**—install an advanced engineered treatment system suitable for an ultra-urban site.[11]

Considerations for Salmon-Safe Certification

Fulfilling the stormwater component of the Salmon-Safe certification process requires submission of documentation of how Objective 1 will be achieved based on the inventory and analysis conducted for the site. On the other hand, if Objective 1 has been judged to be unachievable, pursuing certification requires documentation establishing the technical infeasibility of doing so. Relevant documentation includes, but is not necessarily limited to, site data, calculations, modeling results, and qualitative reasoning. If achieving Objective 1 is demonstrably technically infeasible, the certification process then requires similar documentation of how Objectives 2A and/or 2B, as appropriate to the site, will be achieved.

Prepared for Salmon-Safe Inc. by Dr. Richard Horner, et. al.

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[10] While useful for runoff quantity control, passive vaults and tanks provide very little water quality benefit.

[11] The most effective candidate treatment systems now available are chitosan-enhanced sand filtration and advanced media filtration coupled with ion exchange and/or carbon adsorption. Basic sand filtration is another option suitable to an ultra-urban site but is less effective than the more advanced alternatives.

APPENDIX B

A Comparison of Alternative Road Deicers
Information Sheet

May 2018

SALMON-SAFE INC.

SALMON-SAFE INFORMATION SHEET

A Comparison of Alternative Road Deicers

Salmon-Safe recognizes the wintertime balance between public safety on ice- or snow-covered roads and environmental protection. We seek to inform companies and institutions that have achieved Salmon-Safe accreditation and certification, including road maintenance departments, about options for reducing toxicity of road deicing chemicals and potential negative effects on salmon and other aquatic life in water bodies receiving road runoff.

From the salmon perspective, the specification of a deicer should be especially carefully evaluated when a road drains to any relatively small, salmon-supporting water body. If deicer use cannot be avoided in such cases, the best protection would be to channel runoff through an extensive vegetated area to capture and hold the potentially harmful deicer components.

Sodium chloride is by far the most common deicer for roads. Magnesium and calcium chlorides are in some use, being effective to lower temperatures although more expensive and requiring greater application mass because of decreased freezing point depression. All chloride-based deicers are potentially toxic to aquatic life, damage roadside vegetation, and corrode metals in bridge structures and concrete reinforcing bars. Sodium can diminish human cardiovascular health when contaminating wells and other water supplies. Chloride is usually not a threat to human health but can cause taste and odor problems in drinking water. Magnesium, especially, but also sodium, calcium and potassium damage concrete. All of these light metals can release potentially toxic heavy metals from contaminated soils through ion exchange reactions. Additives to counter corrosion, concrete damage, and the tendency of the products to cake can also be toxic to aquatic life. The potential impact of all of these negative effects is dependent on the concentration of the chemical, pointing out the importance of using the minimum needed. In proper use, elevated potential for aquatic toxicity problems should only occur in relatively small water bodies.

Exhaustive research on calcium magnesium acetate (CMA) has demonstrated the only potential environmental problems at any anticipated environmental concentration are aquatic dissolved oxygen reduction and soil metal release (Horner 1988).[1] The concentration necessary to depress oxygen, however, is sufficiently high that it would only be expected to occur in small, poorly flushed lakes and small, slowly flowing streams. Metals in soils were not mobilized in sufficient quantities to be a concern but could be if CMA meltwater flows over a highly contaminated soil, as with any deicing option other than urea. Because of its high cost, CMA use is mostly limited to locations sensitive to aquatic toxicity or corrosion. It has, for example, been the choice for new bridges to avoid the beginning of progressive chloride corrosion. The University of Oregon, a campus transitioning to Salmon-Safe certification, uses CMA exclusively for its deicing.

Road deicers on the market differ in their deicing ability, negative effects on the environment, price and secondary costs resulting from damage to roadway materials. The following table is a summary comparison of alternative

[1] Horner, R.R. 1988. "Environmental Monitoring and Evaluation of Calcium Magnesium Acetate (CMA)", *National Cooperative Highway Research Program Report 305*. Transportation Research Board, Washington, DC.

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road deicers with respect to these factors. In general, Salmon-Safe recommends avoiding all chloride-based deicers where the runoff can flow to a headwaters (third-order or smaller[2]) salmon spawning or rearing stream, unless it passes through green stormwater infrastructure (GSI) designed to reduce the discharge quantity through infiltration and evaporation and decreases chloride in the remaining runoff through plant and soil contact. If providing adequate GSI treatment is impossible and deicing is still essential, Salmon-Safe recommends highly targeted application of CMA, using the minimum amount, number of applications, and area coverage necessary for safety. With respect to any deicer involved in the drainage of any water body or groundwater recharge area, careful use of the minimum needed is the best rule.

A Comparison of Alternative Road Deicers[3]

Deicer	Aquatic Ecosystem Effects	Other Environmental Effects	Material Effects	Low Temperature Limit (°F)	Freezing Point Depression (°C/unit weight)	Usage Consistent with Salmon-Safe Certification	Cost Relative to Sodium Chloride
Sodium chloride (rock salt)	Chloride and additive toxicity	Sodium contamination of drinking water source; vegetation damage; mobilization of heavy metals in soil	Corrosive; concrete damage	20	1	Avoided in drainages to headwater streams unless adequate GSI treatment; used in minimum needed amounts in drainages to larger water bodies and groundwater recharge areas	$1.00
Magnesium chloride	Chloride and additive toxicity	Vegetation damage; mobilization of heavy metals in soil	Corrosive; concrete damage	5	0.29		$2.40
Calcium chloride	Chloride and additive toxicity	Vegetation damage; mobilization of heavy metals in soil	Corrosive; concrete damage	-25	0.53		$5.70
Potassium chloride	Chloride and additive toxicity	Vegetation damage; mobilization of heavy metals in soil	Corrosive; concrete damage	12	0.78		$1.60
Calcium magnesium acetate	Dissolved oxygen reduction	Mobilization of heavy metals in soil	Concrete damage	0	0.30	Targeted usage in minimum needed amounts in drainages to headwaters streams	$19.30
Potassium acetate	Dissolved oxygen reduction	Mobilization of heavy metals in soil	Concrete damage	-15	0.60		$26.30
Urea	Ammonia and additive toxicity; eutrophication			15	0.97	same as chloride deicers	$1.80

[2] When two first-order streams come together, they form a second-order stream. When two second-order streams come together, they form a third-order stream. Streams of lower order joining a higher order stream do not change the order of the higher stream.

[3] After: (1) Kelly, V.R., Findlay, S.E.G., Schlesinger, W.H., Chatrchyan, A.M., Menking, K. 2010. "Road Salt: Moving Toward the Solution", *The Cary Institute of Ecosystem Studies*, Milbrook, NY. (2) Public Sector Consultants, Inc. 1993. "The Use of Selected Deicing Materials on Michigan Roads: Environmental and Economic Impacts", Michigan Department of Transportation, Lansing, MI.

UWB staff and faculty lead the Salmon-Safe Science Team on a tour of the garden outside Truly House, plus other campus areas that have changed or been developed in the past five years.

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