

MODEL STORMWATER MANAGEMENT GUIDELINES FOR CAMPUS NEW DEVELOPMENT AND REDEVELOPMENT

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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 watersheds 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 educational and commercial campuses and residential communities.

Development of these projects usually converts formerly forested or agricultural land to buildings, roads, parking lots and other impervious surfaces, plus landscaped areas with soils often compacted and missing much of the original topsoil. The result is a hydrologic environment with surface runoff replacing much of the soil infiltration and evapotranspiration that occurred under the predevelopment conditions. Vehicles, landscaping care, other site maintenance and domestic animals deposit contaminants like heavy metals, oils and other petroleum derivatives, pesticides, fertilizers (nutrients) and bacteria. 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 development discharges to a stream, either directly or via a storm sewer leading to one, the excess surface runoff compared to predevelopment conditions increases the magnitude and frequency of stream peak flows and lengthens the durations of high flows. These flow regime alterations degrade stream habitat by eroding the channel bed and banks, scouring spawning gravels and removing stream structures. Higher flows, extending longer, also directly impact salmon through the stress associated with functioning in higher velocities, impeding migration and sweeping away organisms that serve as food sources.

Many of the pollutants conveyed by stormwater runoff are toxic to salmon and their invertebrate food sources. The toxicity of heavy metals, such as 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.

If the development discharges to a combined sanitary-storm sewer system, the large stormwater runoff volumes can exceed the capacity of the wastewater



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treatment plant at the end of the line in some storms. In that case flows beyond capacity are directed to overflow points, resulting in releases of untreated, mixed sewage and stormwater to a water body.

Despite these challenges, an array of options exists to reduce, or even in the utmost application, eliminate the negative impacts of campus and residential developments stemming from the large quantities of contaminated stormwater runoff potentially generated there. New phases of development and redevelopment of existing facilities offer opportunity to apply these options. This management category addresses practices to control campus and residential 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 strategies¹ 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 retention² practices, addressing both water quantity and water quality control to the maximum extent technically feasible in developing and redeveloping campus and residential community 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 stream or combined sanitary-storm sewer—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

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.



of runoff to the maximum extent technically feasible, with the minimum objective of complying with the regulatory requirements for water quantity control applying to the location.⁵ If the site is exempt from a standard flow control requirement, the minimum objective shall be reducing the quantity discharged below the amount released in the immediately preceding condition.⁶

- 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 newly developed or redeveloped condition and the immediately preceding condition; (2) results of hydrologic modeling of the undeveloped, preceding 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 modified 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 campus and residential 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

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

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

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.



- conserving natural areas including existing trees, other vegetation and soils
- minimizing soil excavation and compaction and vegetation disturbance
- minimizing structure footprints
- constructing streets, driveways, 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 are low-traffic streets, 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:
 - ✓ infiltration basin
 - ✓ bioretention area* (also known as a rain garden)⁸
 - ✓ planter box*, tree pit* (bioretention areas on a relatively small scale)
 - ✓ vegetated swale⁹*
 - ✓ vegetated filter strip*
 - ✓ infiltration trench
 - ✓ roof downspout dispersion system
 - ✓ green roof

** signifies compost-amended soils as needed to maximize soil storage and infiltration*
- maintaining natural drainage patterns (e.g., depressions, natural swales) as much as possible, and 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
 - ✓ maximizing vegetation in areas that generate and convey runoff

^{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.



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 campus or residential 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.
- **For runoff quantity control**—install a pond, vault or tank¹⁰ to store water for delayed release after storms to help avoid high flows damaging to a stream or contributing to combined sewer overflows.
- **For runoff quality control**—install a stormwater treatment system suitable for a campus or residential site:
 - ✓ treatment pond;
 - ✓ treatment wetland
 - ✓ conventional swale
 - ✓ conventional filter strip
 - ✓ basic sand filtration
 - ✓ chitosan-enhanced sand filtration¹¹
 - ✓ advanced media filtration coupled with ion exchange and/or carbon adsorption¹²

¹⁰ While useful for runoff quantity control, passive vaults, tanks and ponds not specifically designed for treatment provide very little water quality benefit.

^{11,12} 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. These devices are, however, more appropriate for industrial sites than campuses or residential communities.



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.

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