

The goal of these workshops is to give designers, builders and managers the technical details necessary to properly design, construct and maintain LID facilities.



LID research, data, guidelines, specifications, and regulations are evolving rapidly.

New and evolving permeable pavement guidelines.

New resources, including: SWMMWW, 2012 LID Manual, Rain Garden Handbook.

low impact development technical workshop series

Fundamental questions to consider during the workshops

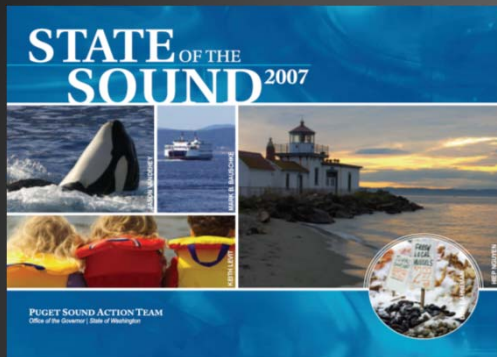


Where and how do we manage stormwater
| pollutants.

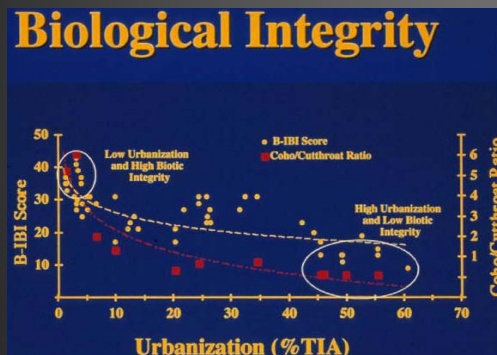


Many questions remain concerning water
quality treatment capabilities of
conventional and LID practices and the
| effects of water quality on aquatic biota.

Environmental conditions in Puget Sound and surrounding watersheds are in decline



The State of the Sound documents the precarious health of orcas, salmon and marine birds. New pollutants and synergistic effects emerging.



Stormwater a primary driver for decline...stream and wetland degradation can occur at very low levels of development...quantity and WQ implicated.



Structural stormwater approach alone has limitations for protecting streams, lakes wetlands, and Puget Sound. Some limitations include...

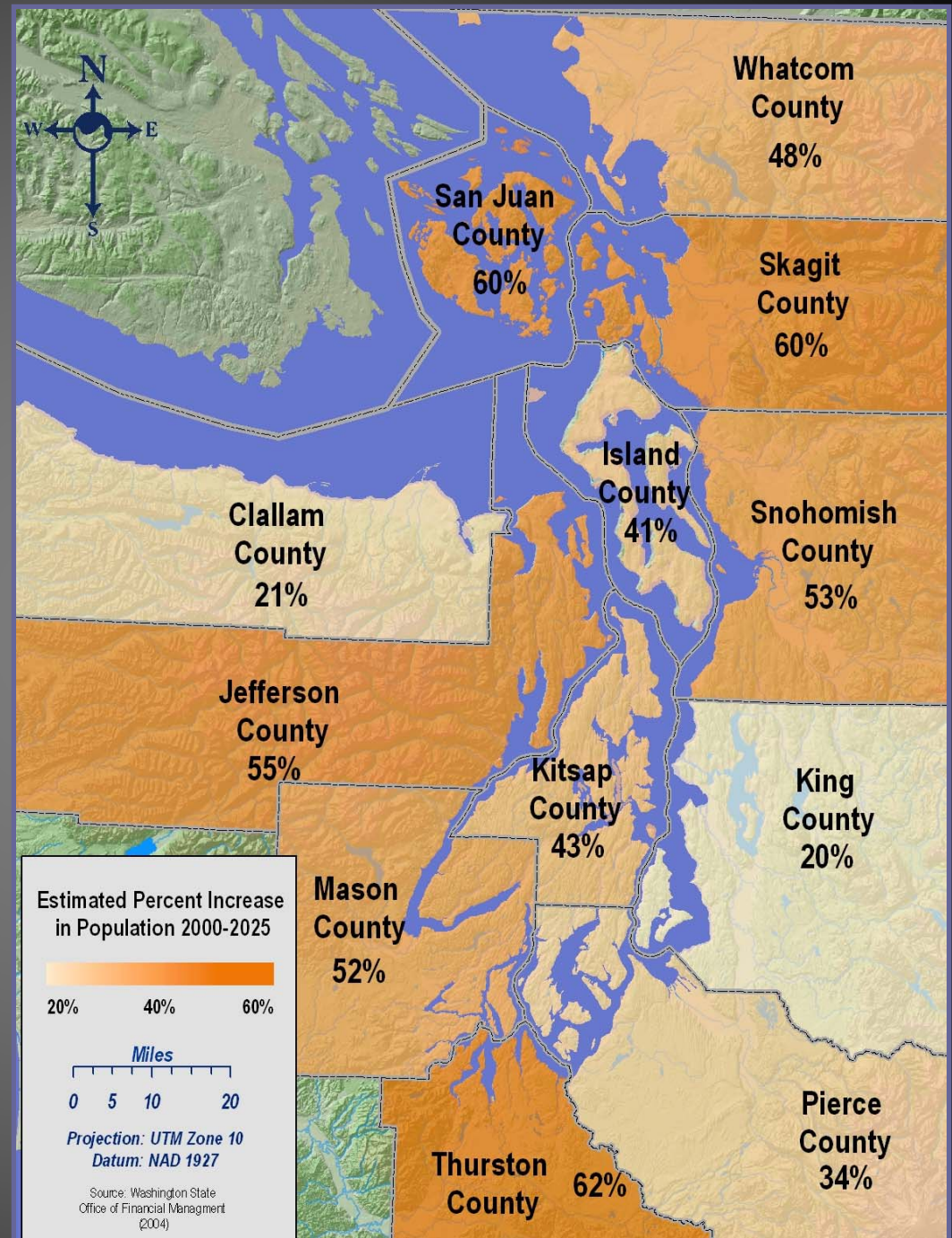
introduction

Puget Sound Population Growth 2000 - 2025

1.4 million new
residents projected
by 2025

2000-06: 315,000
more people in region

From State of the Sound, 2007



Puget Sound Conditions

Water Quality

- South Puget Sound Harbor seal pups seven times more contaminated with PCBs than pups from the Georgia Basin. PBDE levels in seals up from 50 parts per billion in fatty tissue to more than 1,000 ppb over the past 20 years.
- Pre-spawn mortality.
- Synergistic effects of pesticides.
- Emerging pollutants of concern.

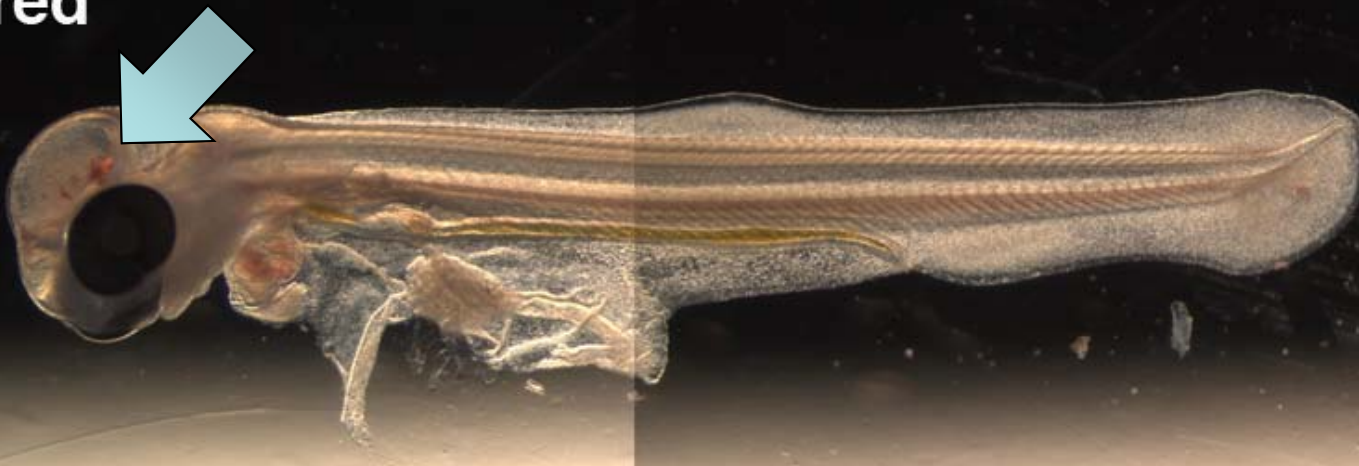


Urban runoff is toxic to coho embryos

filtered



unfiltered

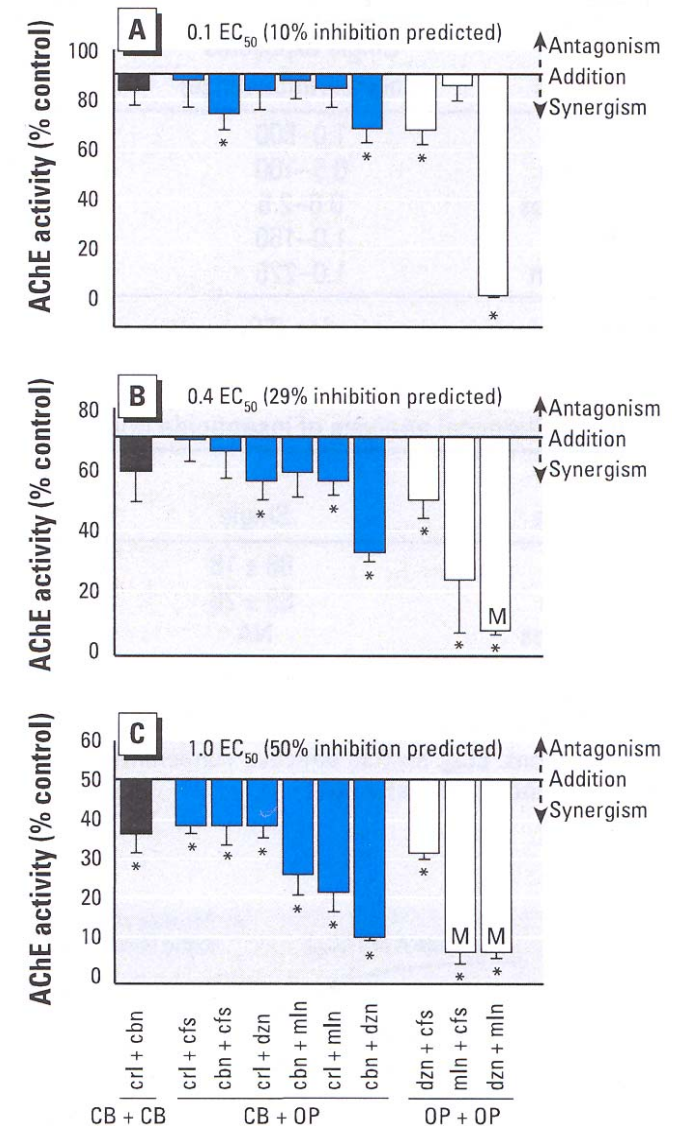


Longfellow Creek experimental facility, ~ 50 days of development

Pollutant Mixture Synergism

	Cu ($\mu\text{g/L}$)	Diazinon and Malathion
Level of concern	5 $\mu\text{g/L}$ Loss of olfactory function and behavioral impairment (predator avoidance and navigation)	Paired diazinon (7.3 $\mu\text{g/L}$) and malathion (3.7 $\mu\text{g/L}$) produced severe(>90%) AChE inhibition and anticholinesterase poisoning => synergism. Loss of ability to avoid predators.
Reported/estimated		
Puget Sound	4 $\mu\text{g/L}$ (median)	
San Joaquin basin		diazinon: 6 $\mu\text{g/L}$

Acetylcholinesterase: enzyme for neurotransmission. Organophosphate and N-methyl carbamate insecticides designed to inhibit anticholinesterase and effects fish and humans.



Biological Effectiveness

Biological effectiveness

- Are reductions in contaminant concentrations sufficient to prevent lethal/sublethal effects?
- STEP 1: Test effectiveness using high through-put surrogates for salmon and their prey
- STEP 2: Focus on salmon-specific direct and indirect impacts



Comprehensive Stormwater Management Program

- Land use planning
- Standards equal to Ecology's
- Site plan review
- Construction site inspections
- Maintenance
- Source control
- Illicit discharges & problem response
- Existing problems
- Public education & involvement
- Watershed or basin planning
- Monitoring
- Stable funding
- Low impact development

From Puget Sound Water Quality Management Plan

Low Impact Development Principles and Practices



A land use development strategy that emphasizes protection and use of on-site natural features to manage stormwater.



Integrated engineered, small scale stormwater controls. WQ treatment integral in all controls.

Low Impact Development Principles and Practices



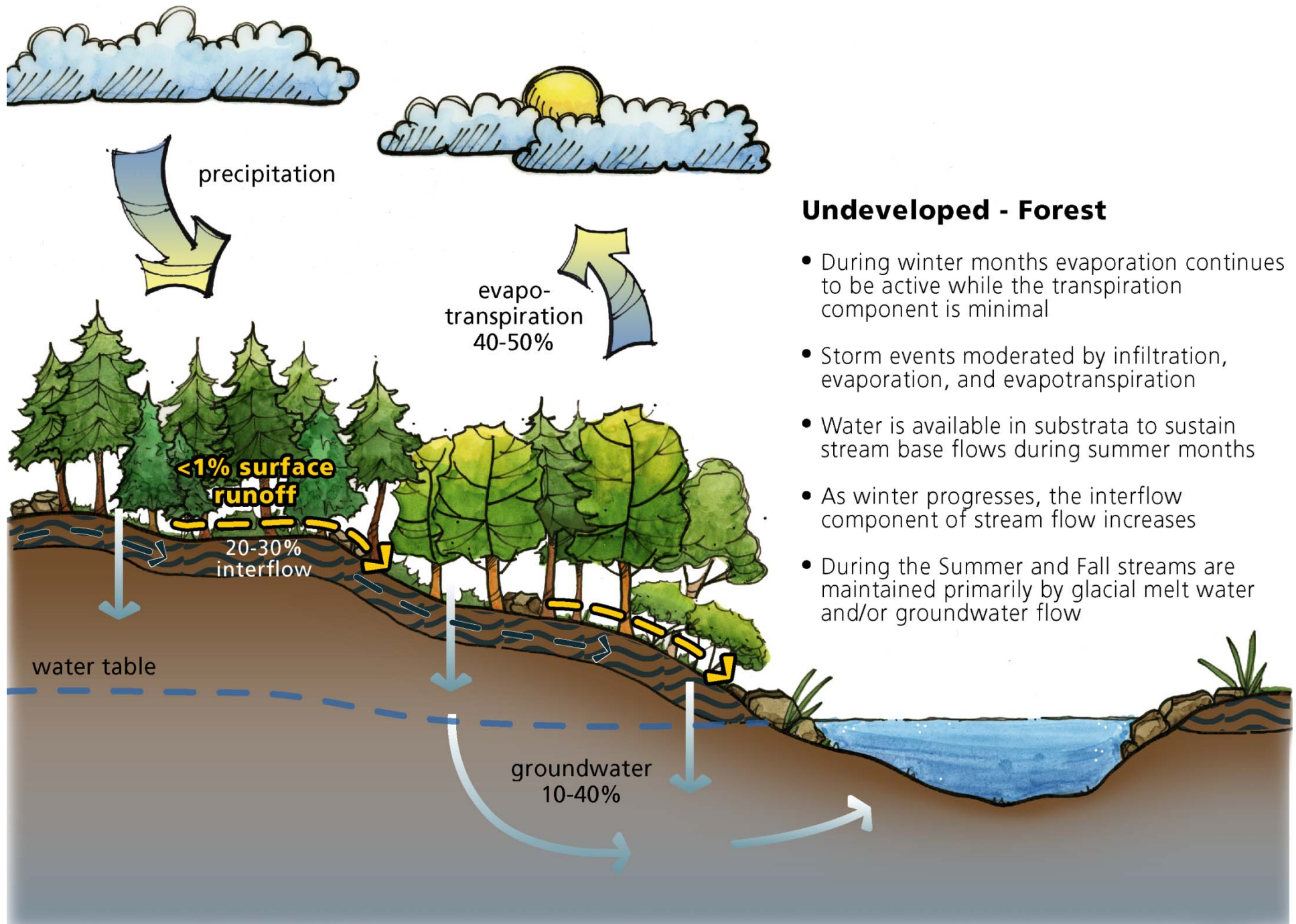
Used at the parcel and subdivision scale: site scale necessary but not sufficient...regional land use planning critical for effective stormwater management.

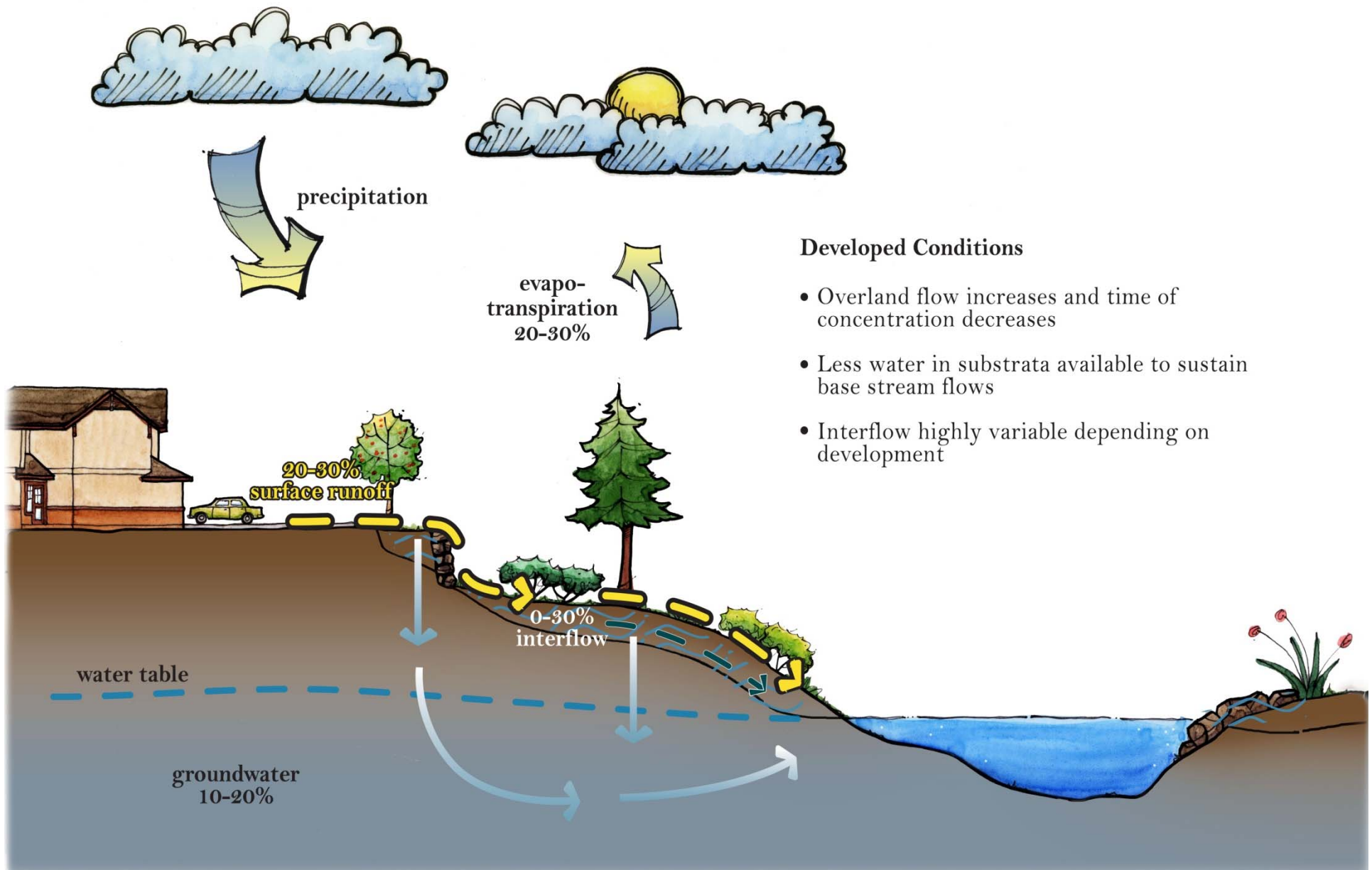


Primary goals: 1) no measurable impacts to receiving waters; and 2) maintain or more closely approximate pre-development surface flow volumes and durations.

LID Objectives

- Protect and restore native soils/vegetation.
- Reduce the development envelope.
- Reduce impervious surfaces and eliminate effective impervious area.
- Manage stormwater as close to its origin as possible.
- Integrate stormwater controls into the design—create a multifunctional landscape.
- Reduce concentrated surface flow, minimize stormwater contact with impervious surfaces, and increase stormwater contact with soils and vegetation.





Developed Conditions

- Overland flow increases and time of concentration decreases
- Less water in substrata available to sustain base stream flows
- Interflow highly variable depending on development

Kensington Estates

Total acres:

23.92

Lots:

103 (4,143 sq ft ave.)

Open space:

15 acres (63%)

Effective impervious area:

approaching 0%















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Five Critical Design and Construction Factors



| Site assessment.

| Correct design specifications.

| Qualified installers!



| Erosion and sediment control.

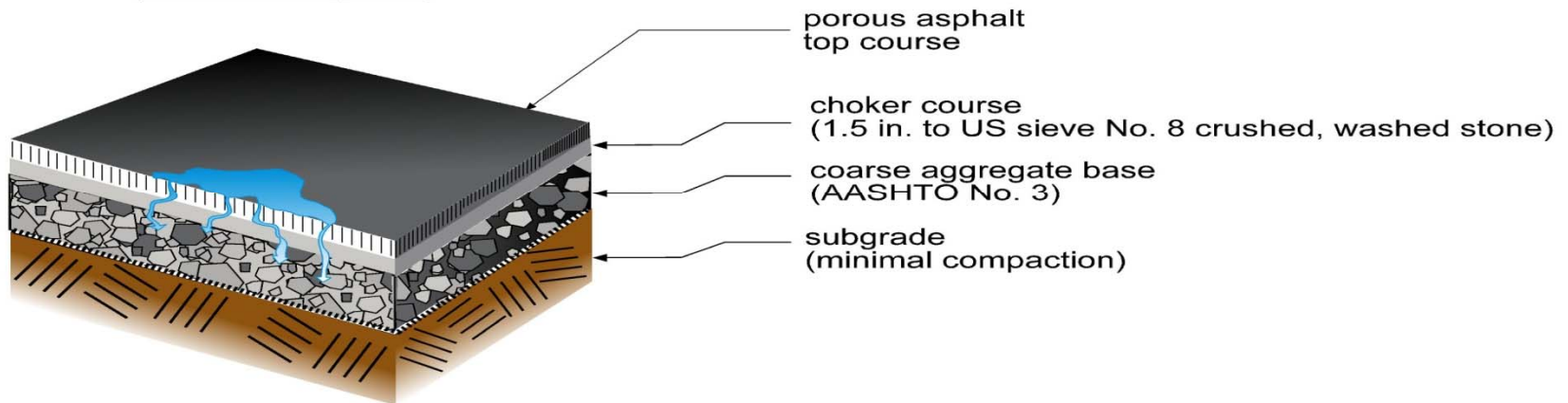
| Maintenance.

Permeable Asphalt

- Flexible.
- Similar to conventional asphalt, but fines < No. 30 sieve reduced.
- Typically used for parking and light traffic loads; however, has been used for medium and heavy applications.
- ~16 percent voids typical (2-3 for conventional).
- Less experience and industry engagement in Puget Sound region.



Porous Asphalt





Permeable Concrete



| Rigid.

| 1/4 to 5/8 round or crushed aggregate typical, portland cement, and admixtures (optional) to increase workability and strength.

| Conventional testing methods (compression) not applicable.

| 15 to 20 percent voids typical.

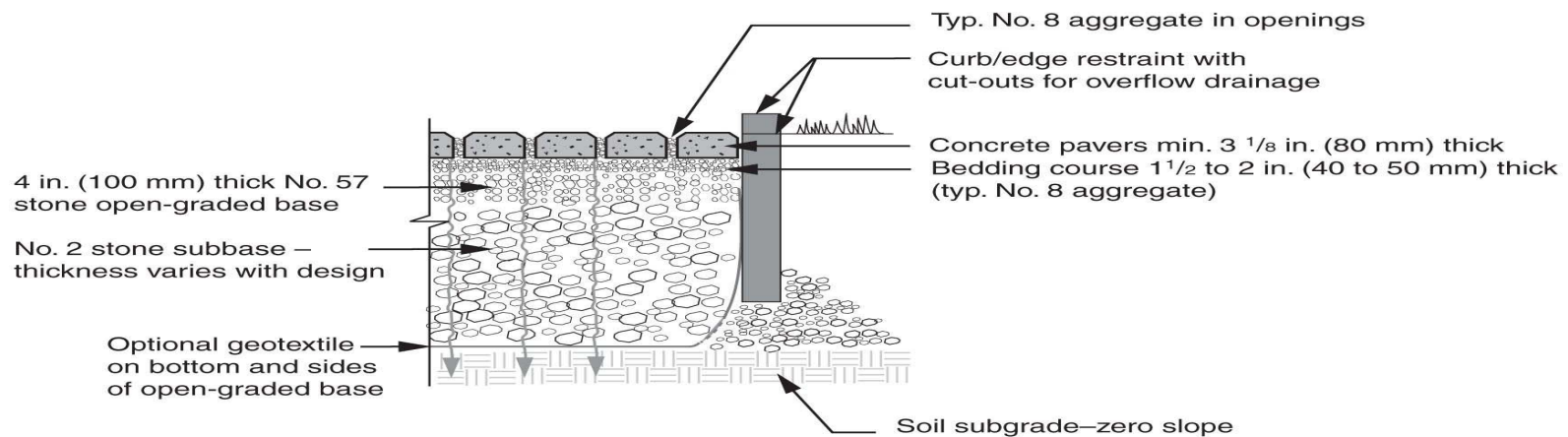
| Good experience and industry engagement in Puget Sound region.





Permeable Pavers

- Flexible.
- Capable of high vehicle loads. Used for lower speeds.
- High-density concrete that interlock and transfer vertical loads to surrounding pavers.
- 12 percent voids typical.
- Good experience and industry engagement in Puget Sound region.





Flexible Plastic Grid Systems

- Flexible.
- Plastic grid filled with gravel or soil and planted with grass.
- Capable of high vehicle loads. Used for lower speeds.
- Highest percent voids.
- Good experience and industry engagement in Puget Sound region.

