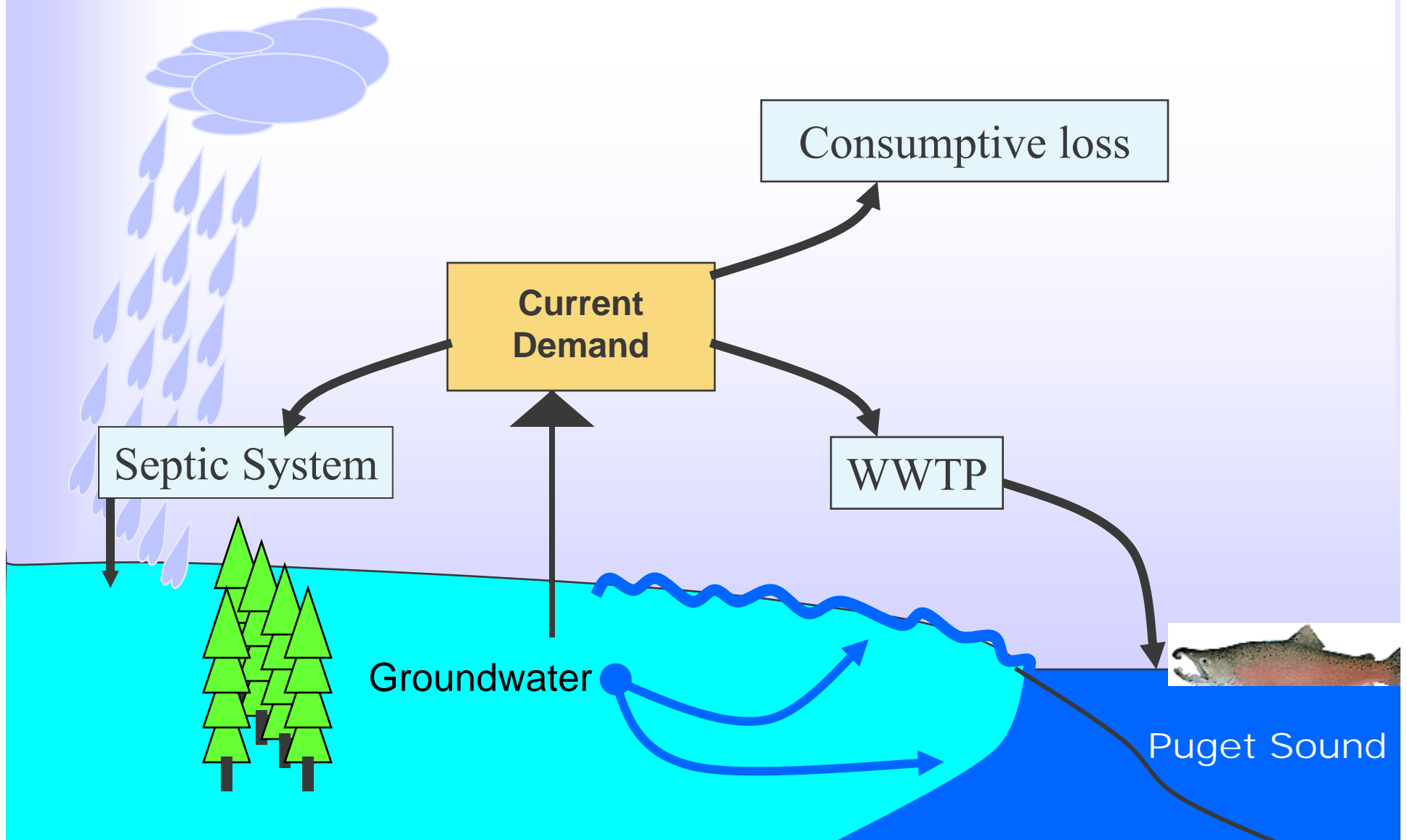


# WRIA 15 Water Balance



# What is a Water Balance?

- ◆ Water in = water out
- ◆ Many methods
  - Back of the envelop
  - Spreadsheet
  - Modeling
- ◆ Different applications
  - Engineering design
  - Water right decisions
- ◆ Supporting data (calibration)
- ◆ Verification
- ◆ Varying levels of confidence

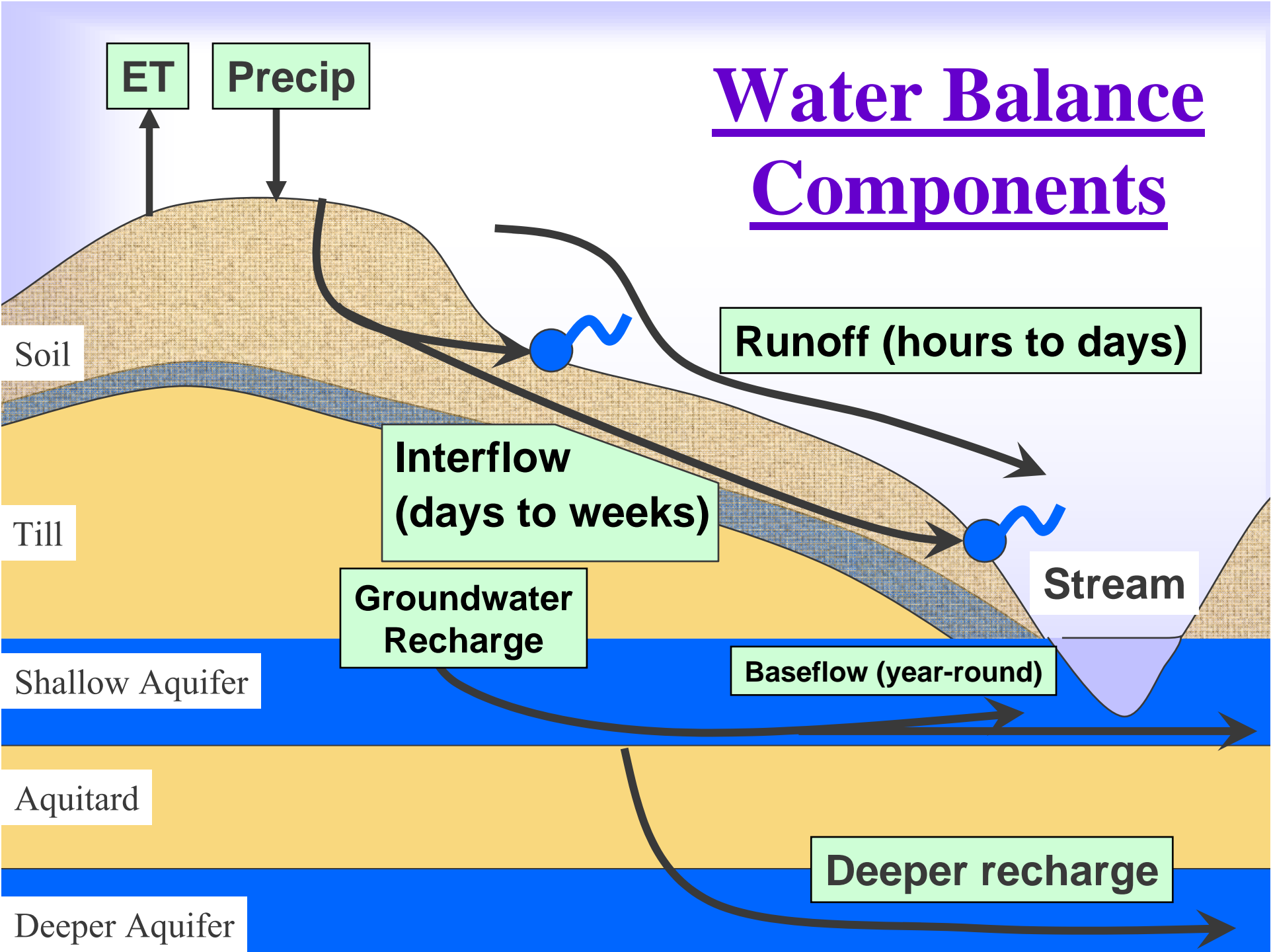
## WRIA 15:

- ◆ 23 subareas
- ◆ One size for all
- ◆ Groundwater focus
- ◆ Development sustainability
- ◆ Policy guidance
- ◆ Direct further efforts

# Presentation Outline

- ◆ Water balance analysis
  - Comparison of approaches of Level 1 & recent
  - Individual water balance components
  - Overview
- ◆ Pressures/mitigation analysis
  - Allocation
  - Groundwater withdrawals
  - Septic system returns
- ◆ Putting it together

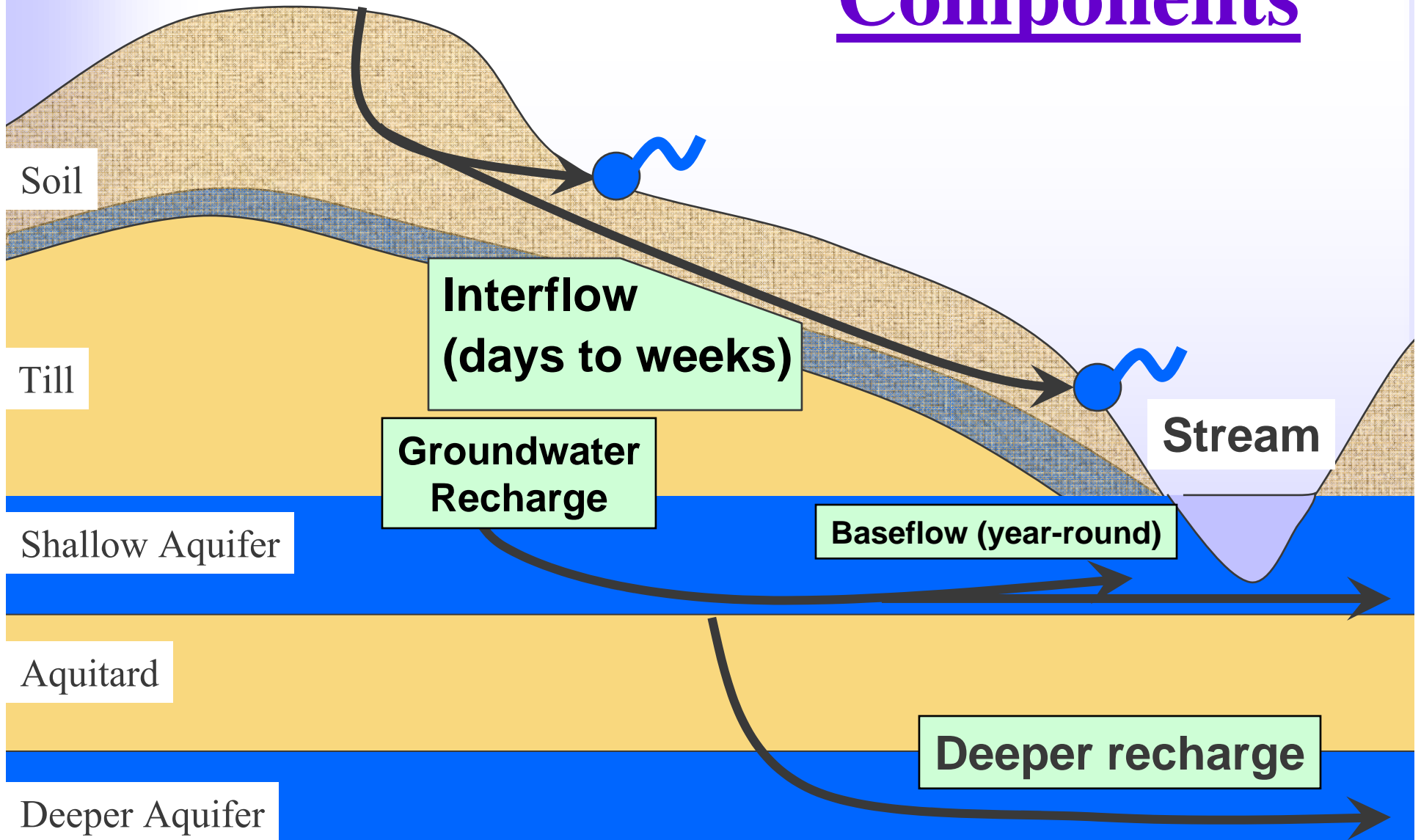
# Water Balance Components



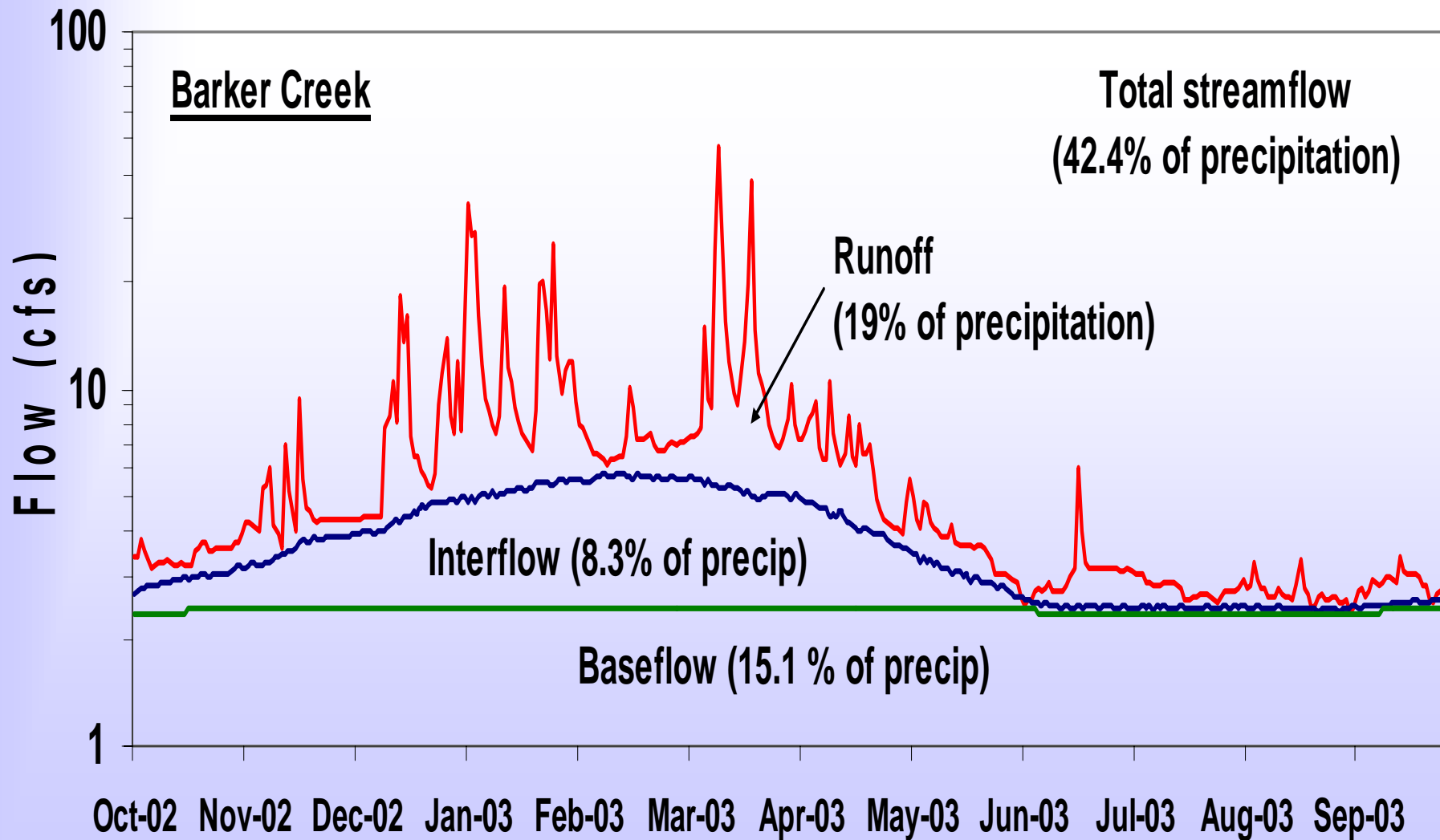
# Comparison of Recent Approaches

<u>Level 1</u>	<u>Water Balance Component</u>	<u>Latest</u>
◆ PRISM	◆ Precipitation	◆ PRISM
◆ B-C Eqn (grass)	◆ ET	◆ Best fit to dataset
◆ 20% of precip.	◆ <u>Runoff</u>	◆ <u>Runoff</u>
	◆ Interflow	(residual term)
◆ Groundwater (residual term)	◆ Baseflow	◆ Streamflow data
	◆ Deep GW recharge	◆ Darcy estimates

# Groundwater Components

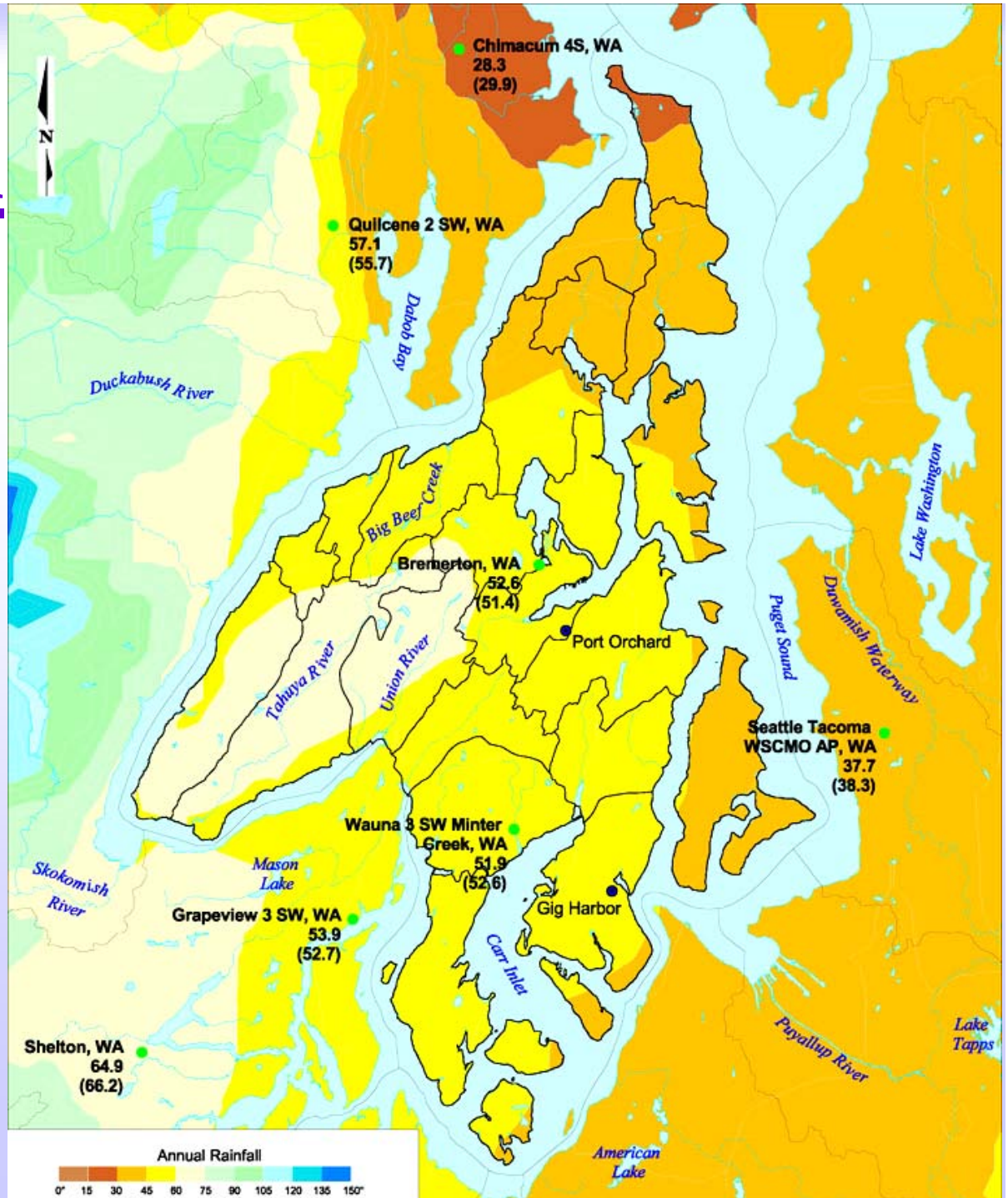


# Streamflow Components

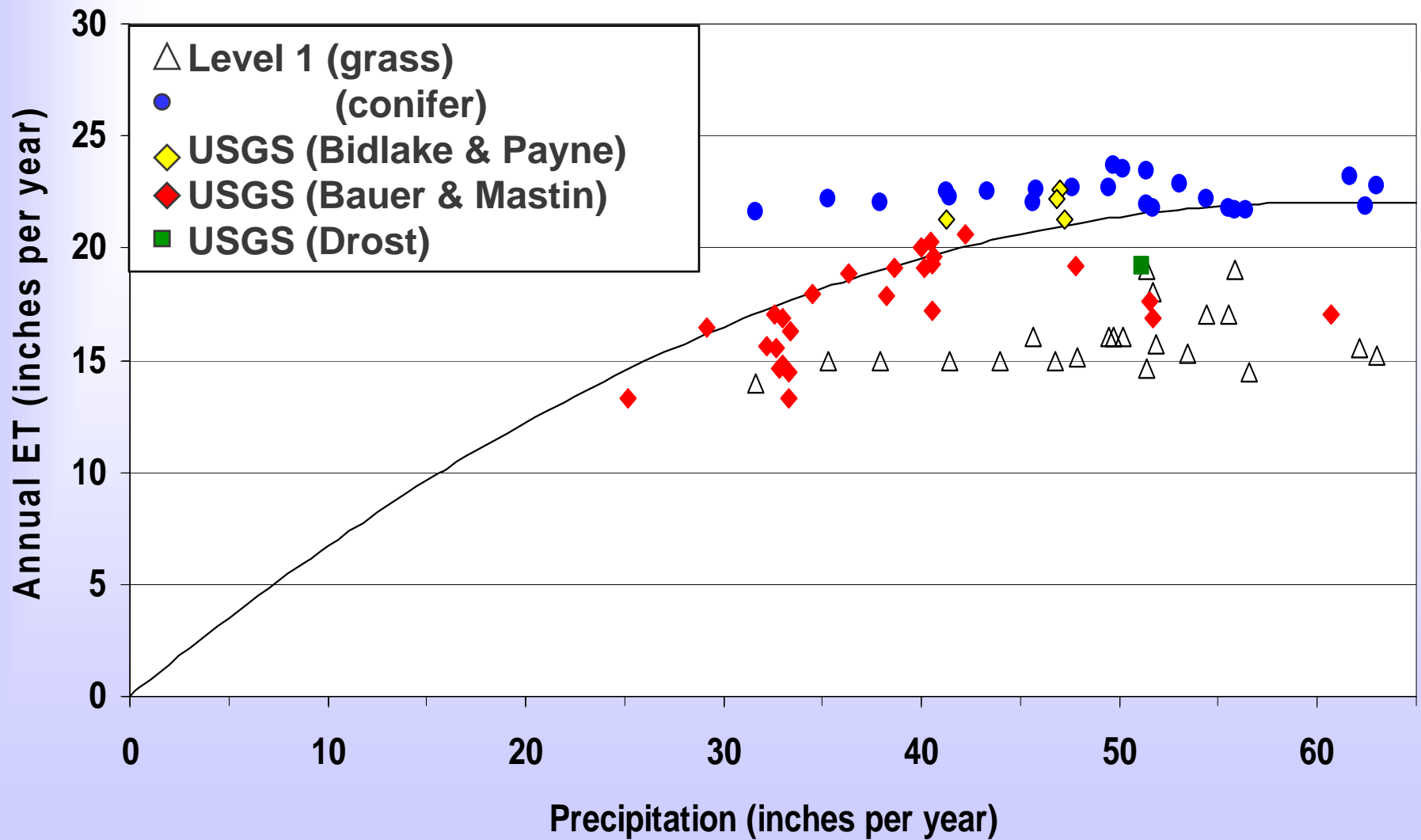


# Precipitation

- ◆ PRISM data
- ◆ Historical average
- ◆ Changes by
  - Season
  - Year
  - Decades
  - Future



# Evapotranspiration

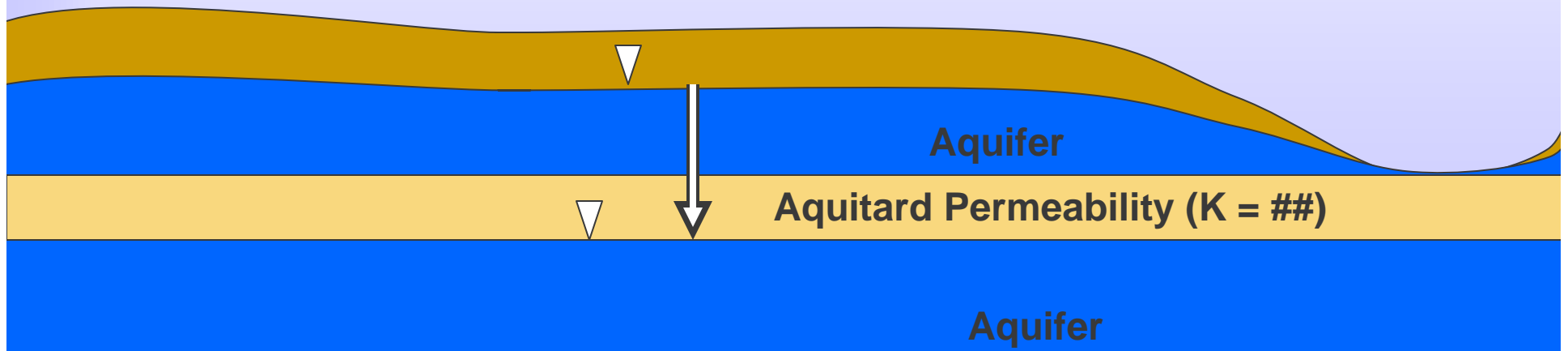


# Deep Groundwater Recharge

- ◆ From Step C Instream Flow Assessment (Artondale & Barker)
- ◆ Flow (Q) calculated from:
  - Aquitard permeability (K) from USGS Bangor studies
  - Aquitard thicknesses & Water levels (i; hydraulic gradient)

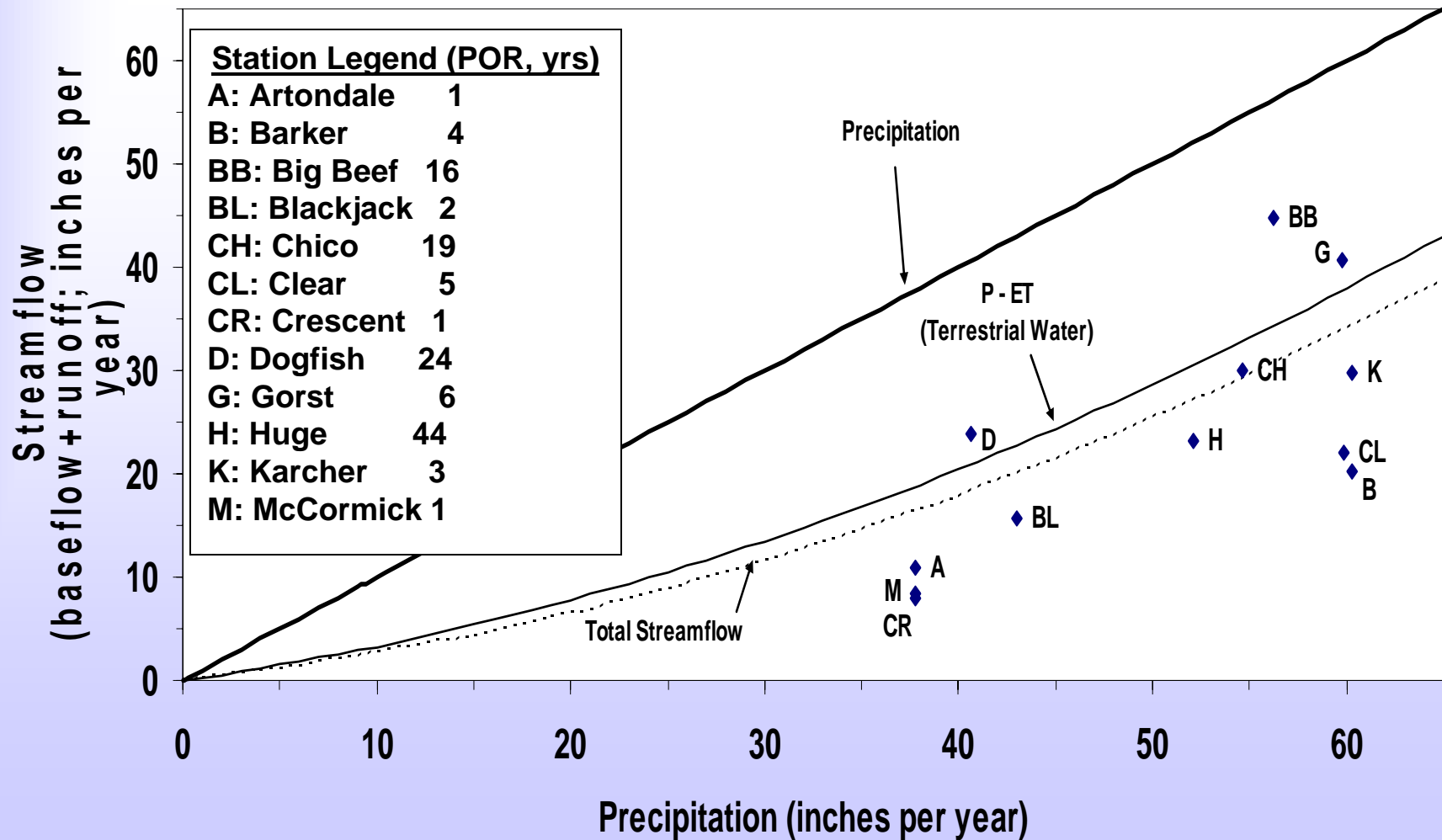
**Step C:**  $Q = K i = 6.2\%$  (Artondale)  
 $= 6.8\%$  (Barker)

**WB:** Average = 6.5%



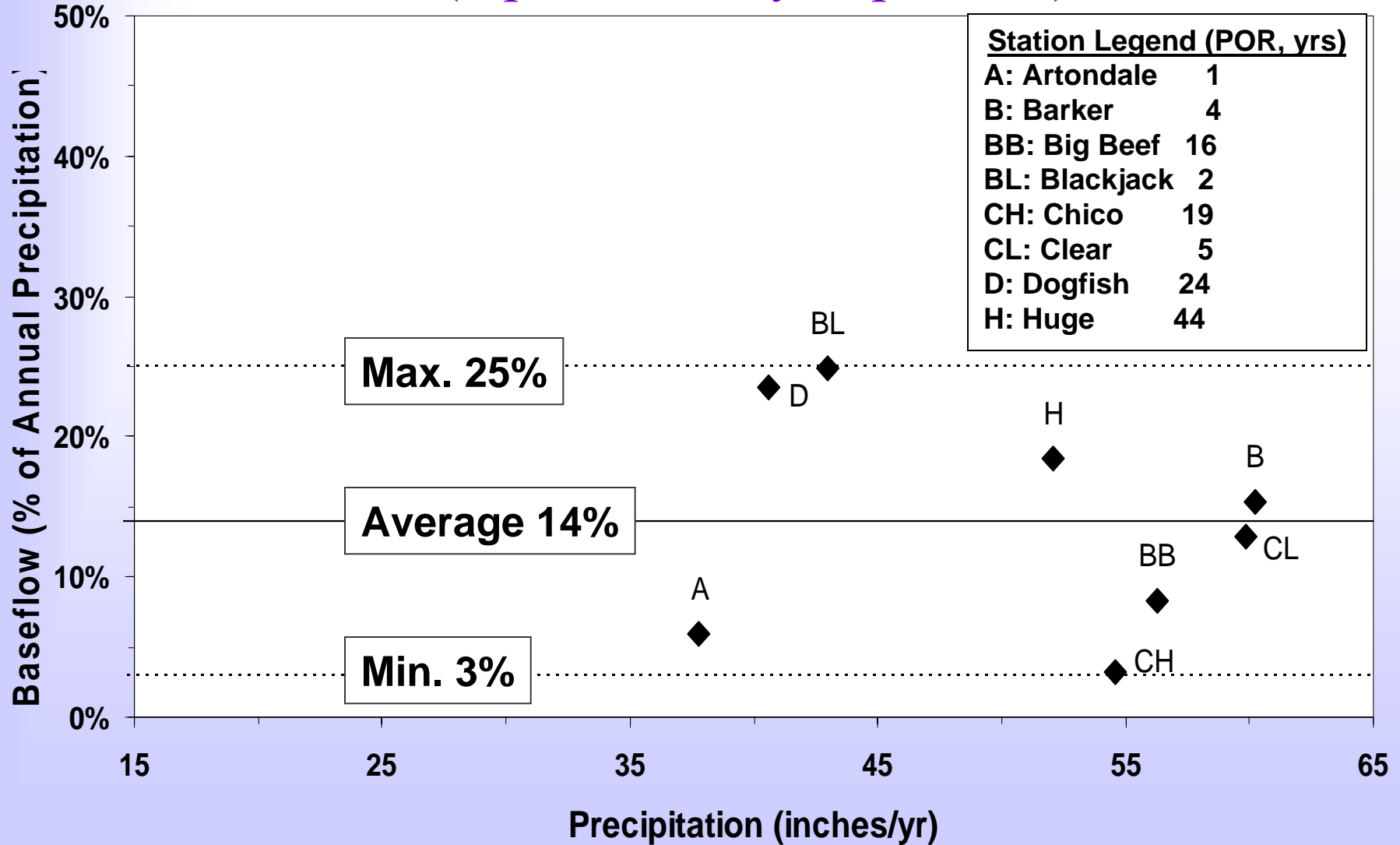
# Total Streamflow

$$(SF = P - ET - GWR)$$



# Baseflow

(represented by Sept. flow)



# Comparison and Ranges

	<b>Level 1</b>	<b>Most recent</b>
<b>Rain</b>	51''	51''
<b>ET</b>	30%	44% (35%-54%)
<b>Runoff</b>	20% <b>(excludes interflow)</b>	35% <b>(10-45%; includes interflow)</b>
<b>Groundwater (total)</b>	50% <b>(includes interflow)</b>	21% <b>(10-32%; excludes interflow)</b>
<b>Baseflow</b>	n/a	14% (3-25%)
<b>Deeper recharge</b>	n/a	7%

# Refined Water Balance Estimate

## Means of Improving

### **ET estimates:**

- ◆ Distributed soil, land cover, precip (GIS)
- ◆ Fancier equation (Penman-Montieth/Hargreaves)

### **Streamflow estimates:**

- ◆ Gaging data
- ◆ Spot/manual measurements

### **Groundwater Recharge:**

- ◆ Geological mapping
- ◆ Environmental tracers
- ◆ Calibrated model

# Take Home Messages

- ◆ Limited quantitative data.
- ◆ Streams across the Kitsap basin are very different from each other.
- ◆ Generalized water balance has been advanced to its limit.
- ◆ Next step is individual subarea analyses.

# Allocation

- ◆ WRATS
  - Level 1 Assessment (2001 database)
  - Vashon (2003 database)
- ◆ Query parameters
  - Only groundwater (certificates, permits, claims)
  - Only active documents

# Water Use

	Level 1	Purveyor Supplied All Uses	Self-Supplied Domestic
<b>Kitsap</b>	115	107	107
<b>King</b>	-	103	103
<b>Mason</b>	142	110	110
<b>Pierce</b>	142	106	118

Major  
Purveyors

No industrial  
water use

1998 Vashon-  
Maury Island  
Ground Water  
Management  
Plan

# Inter-Subarea Transfers

## North Peninsula

Port Gamble & Kingston → Hansville

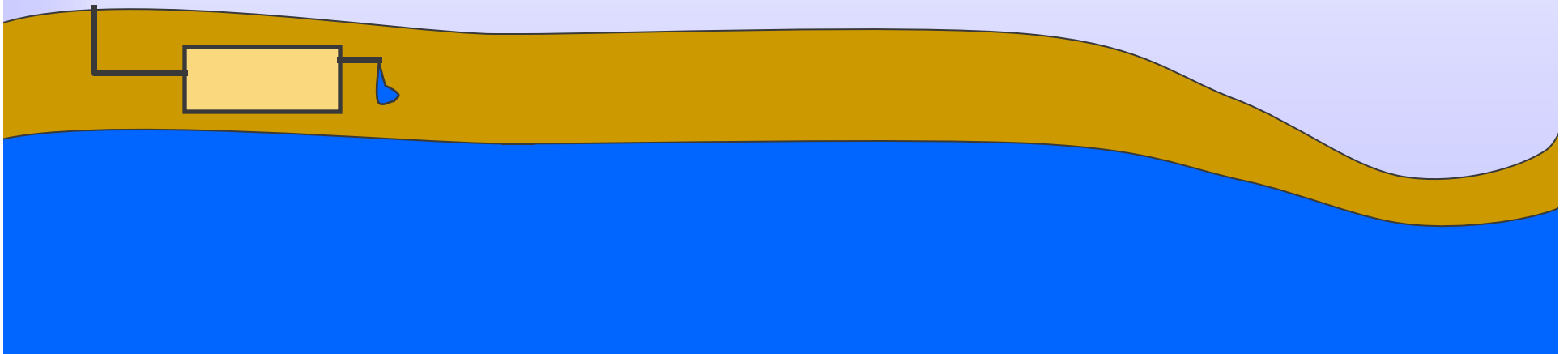
## Bremerton

Sources: Union R. (surface water) & groundwater

Distribution: Gorst, Manette, Chico (Manchester)

# Septic

- ◆ Interior Use = 84% of total water use
- ◆ (Interior Use – WWTP) = Septic Return
- ◆ 10% ET loss from septic systems
- ◆ Bremerton Combined Sewer 25% - addressed soon



# Putting it all Together

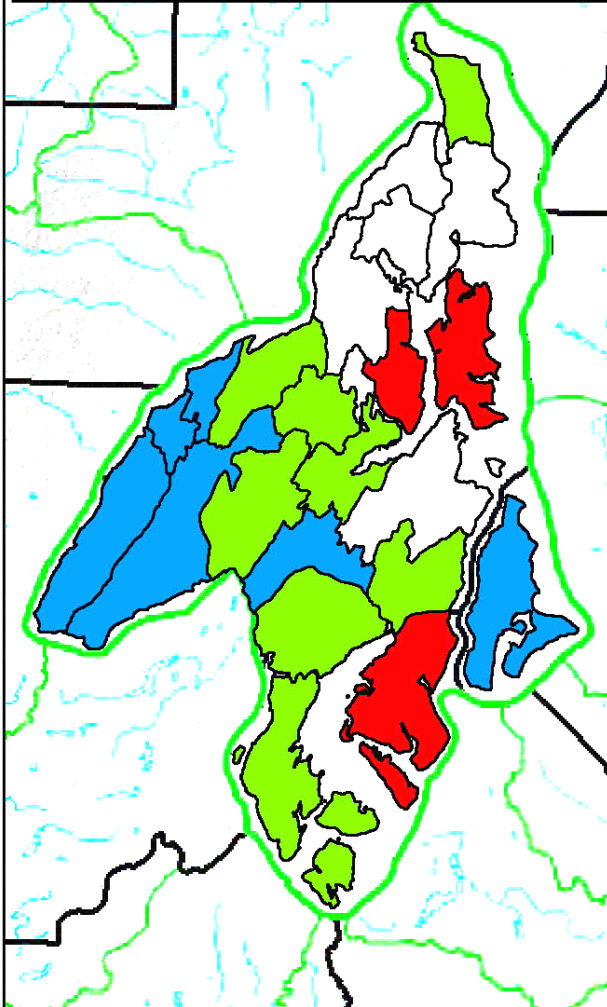
- ◆ Focus is on groundwater
- ◆ Total groundwater (Baseflow + deep recharge)
- ◆ Compared in 3 ways:
  - Allocation
  - Total withdrawals
  - Total withdrawals w/ septic system returns

# Top 5 Subareas

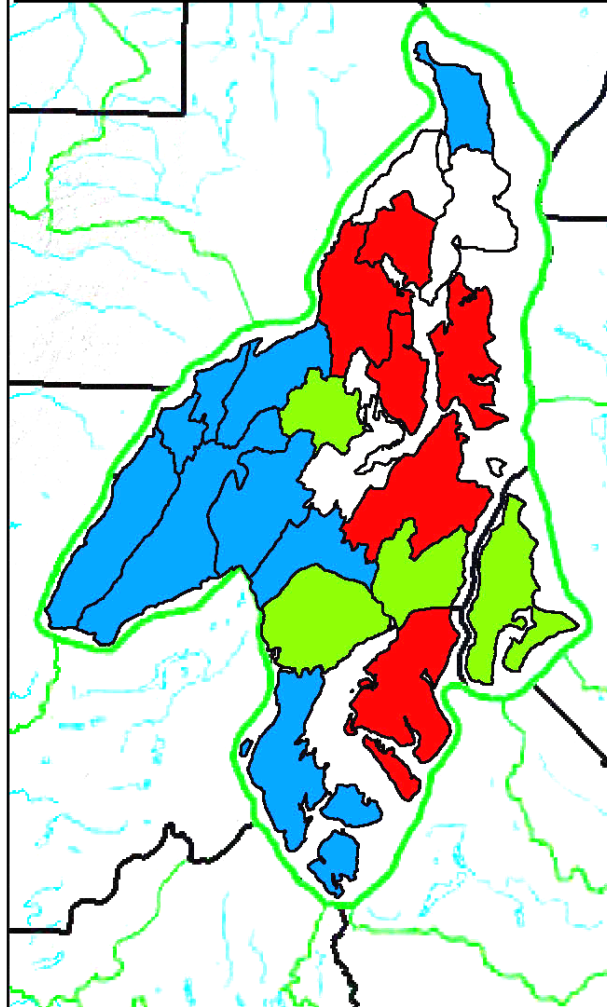
<b>Allocation</b>	<b>Withdrawals</b> (considering intersub-area transfers)	<b>Net Groundwater Balance</b> (considering intersub-area transfers and septic system return flow)
<b>Bangor</b>	<b>Bangor</b>	<b>Bangor</b>
<b>Gig Harbor</b>	<b>Gig Harbor</b>	<b>Gig Harbor</b>
<b>Manette</b>	<b>Manette</b>	<b>Manette</b>
<b>Bainbridge Island</b>	<b>Bainbridge Island</b>	<b>Bainbridge Island</b>
<b>Port Gamble</b>	<b>Manchester</b>	<b>Manchester</b>

# Results

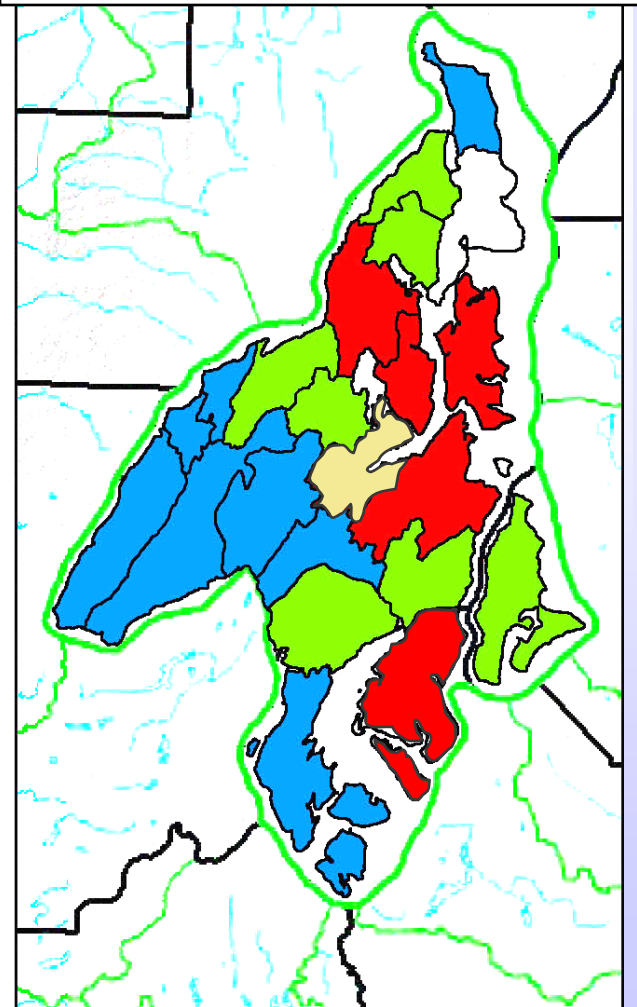
## Allocation



## Withdrawals



## Septic Returns



# Implications for Planning

- ◆ Better, consistent with other studies
- ◆ Focus efforts on select subareas
- ◆ Types of topics to undertake:
  - Technically challenging
  - Politically challenging
  - Workable in the short-term

# Workable in the Short-Term

- ◆ Conservation
- ◆ Monitoring/analysis
  - Stream gaging, groundwater
  - Data management
- ◆ Stormwater management
- ◆ Reclaimed water/reuse
- ◆ ASR (particularly in the Manette area)
- ◆ Regional water supply