

# Regulatory Effectiveness Monitoring Project

## 2008-2009 Progress Update

"What we see is not nature itself, but  
nature exposed to our method of seeing"  
-Heisenberg

# Critical Areas Ordinances

(CAO)

*January 1,  
2005*

K.C.C. 21A  
Zoning code  
(Ord. 15051)

K.C.C. 16.82  
Stormwater  
(Ord. 15052)

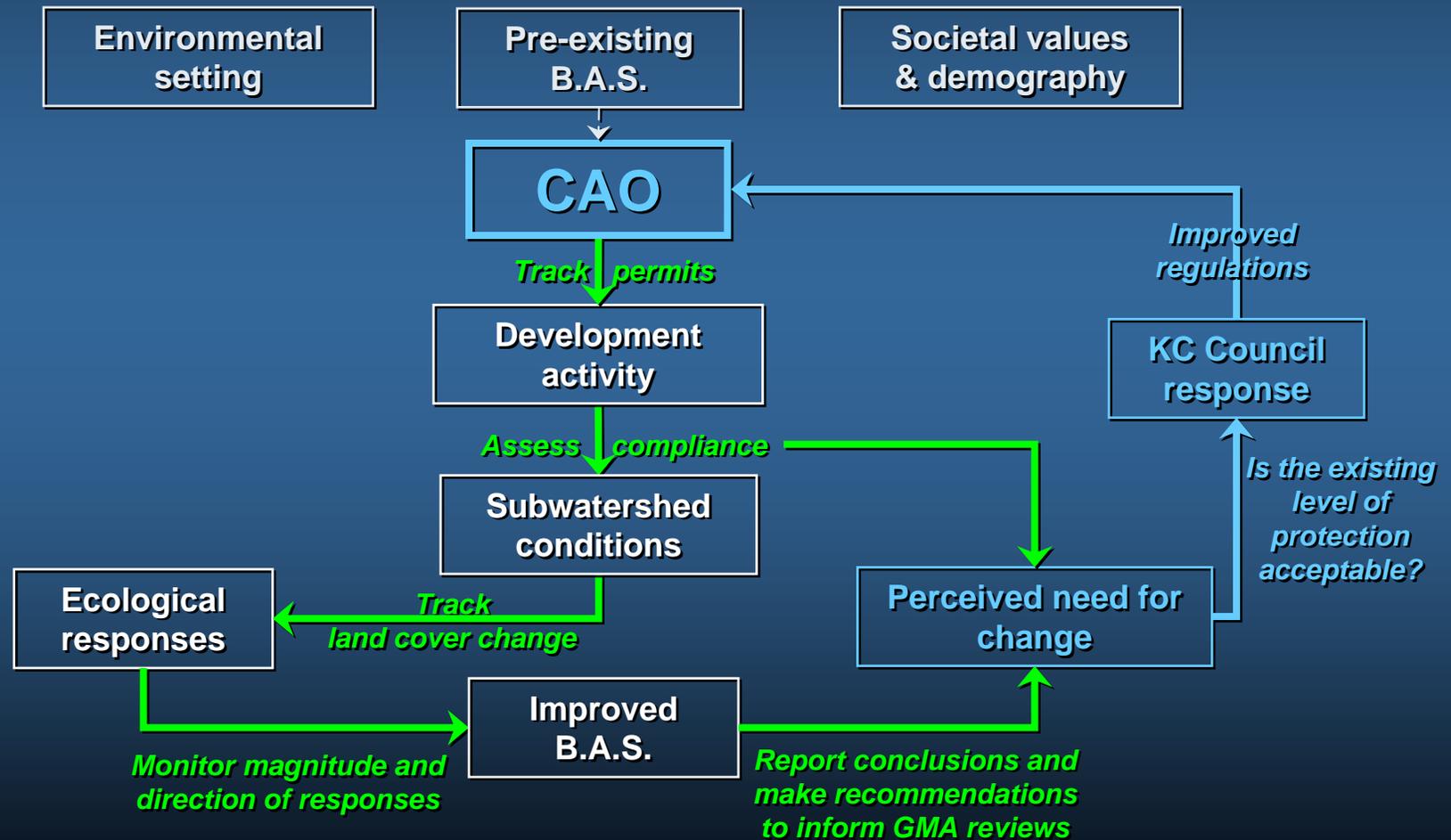
K.C.C. 16.82  
Clearing & Grading  
(Ord. 15053)

Best Available Science:

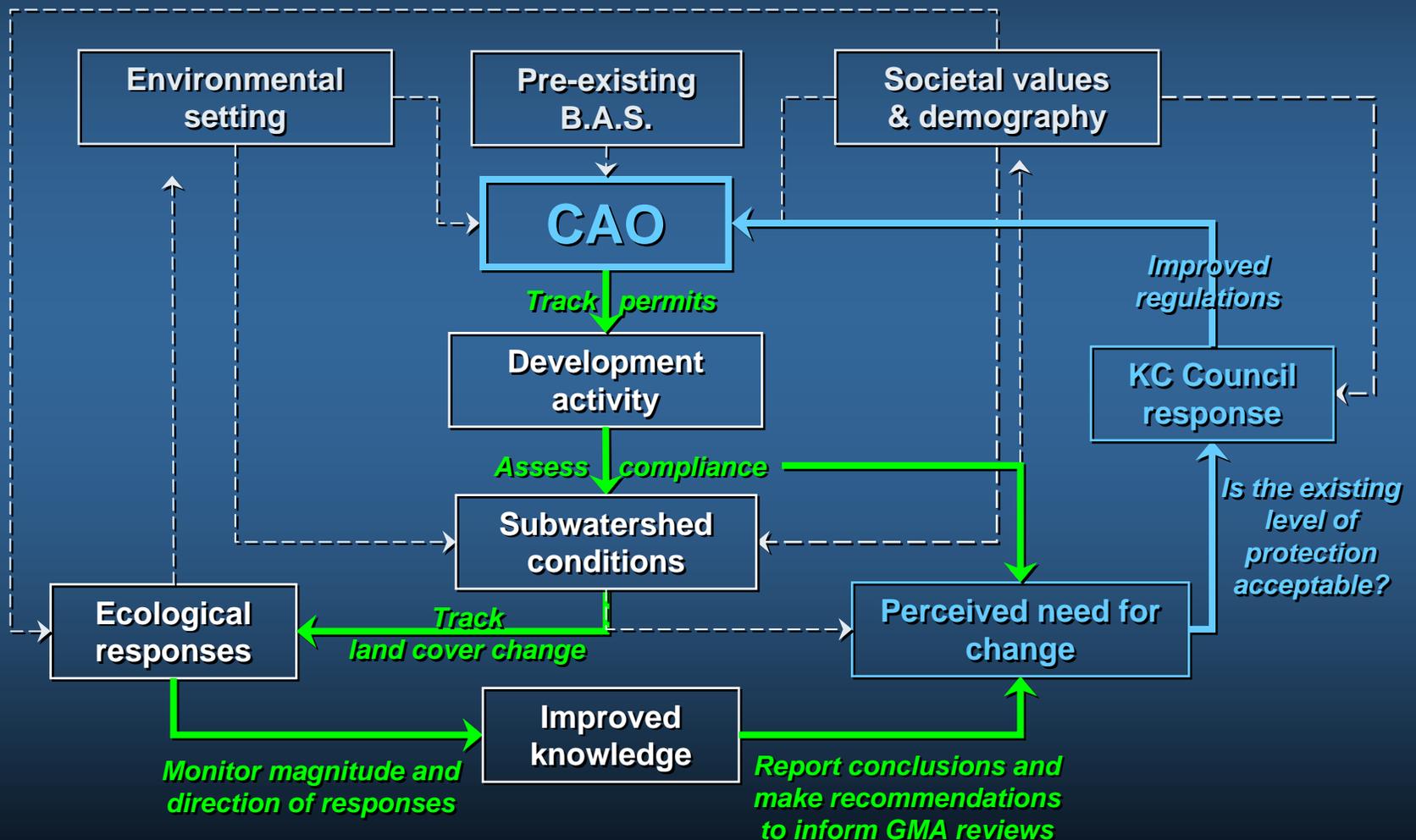
- Riparian and landscape measures are needed
- Effectiveness of previous regulations poorly known



# Informing Decisions



# Informing Decisions



# Overview and Background

# Basic Approach

- Treatment – Control
- Multiple sites & multiple response indicators
- Spatial scale -- not too big or too small – 200 to 3,000 acre (~ 2<sup>nd</sup> order)
- Treatment (drivers) –development-driven changes in land cover, type and location of activity
- Controls – municipal watersheds
- Response – select variables known to be affected by development at the catchment scale

# Key Questions:

*What people may want to know in 2012 and beyond*

- Q1: Did critical areas change? If so, was change related to CAO implementation?
- Q2: How did the environment respond and what was the significance of those changes?
- Q3: If responses were significant, how might the CAO be modified to reduce future impact?
- Q4: To what extent was change due to poor implementation, i.e., how well did people follow the regulations?

# Hypothesis

If CAO is working, i.e., preventing change caused by development, then the *direction* and *magnitude* of change in response variables should:

- a) be similar as for areas with no additional future development,
- b) not be commensurate with the potential cumulative impact (PCI) of actions

# Objectives

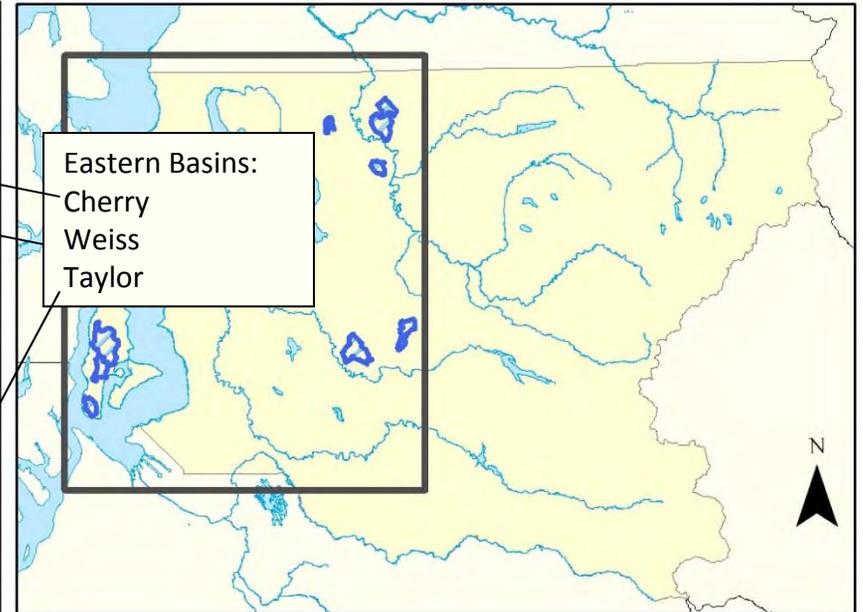
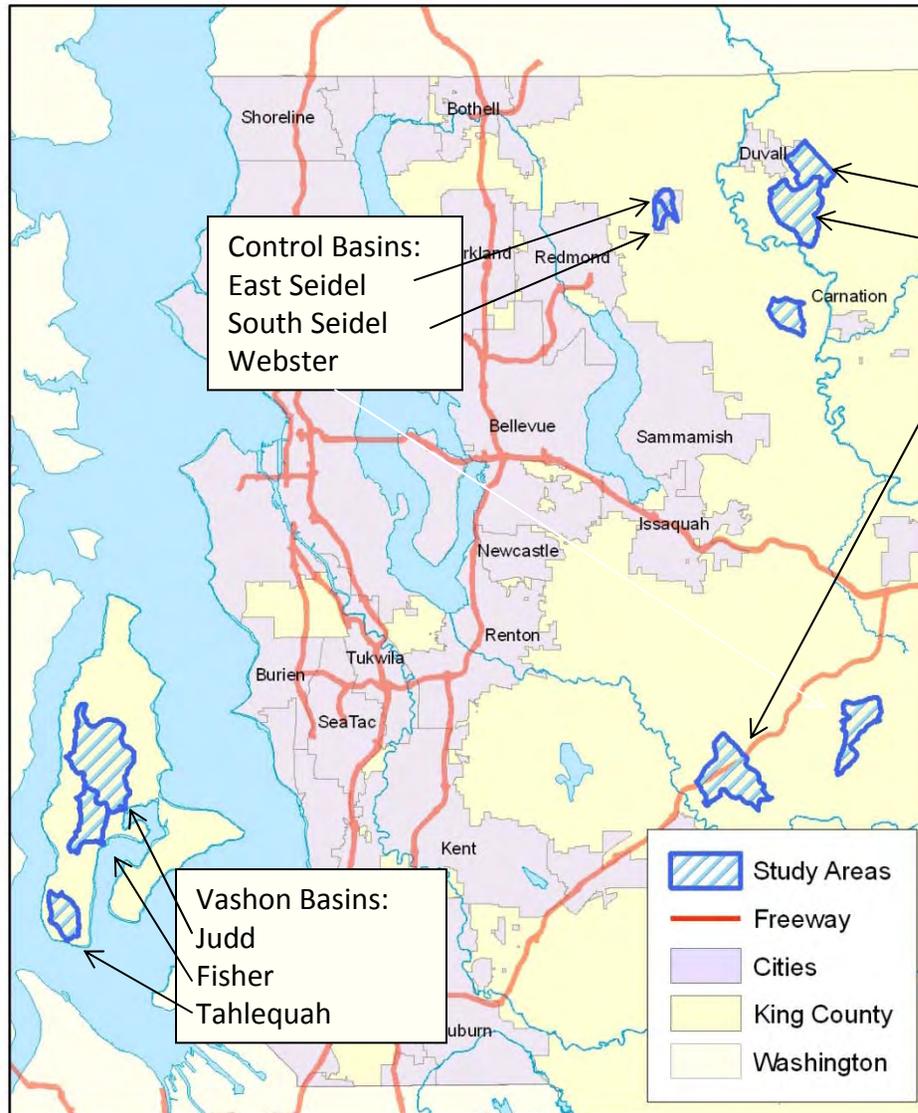
To...

- 1) Select a set of critical areas
- 2) Assess potential direction and magnitude of PCI
- 3) Assess concurrent changes in environmental conditions and response variables for a select set of critical areas;
- 4) Estimate degree of compliance with CAO;
- 5) Provide conclusions and management recommendations based on findings.

# Measuring

Where  
&  
What?

# Study Areas



## Selection Criteria:

- Small watersheds - 2<sup>nd</sup> or 3<sup>rd</sup> order streams (60 to 1260 hectares)
- Common post-glacial geology (Elevation range 44 to 7933 ft)
- Single jurisdictions
- Treatment basins: high development potential

# Field Work

- Hydrology
- Biology
- Water Quality
- Channel Complexity
- Site characterization (photo, video, physical surveys)
- Landowner approvals/interactions

# Response Indicators

## Benthic macroinvertebrates

- BIBI, taxa abundance

## Flow

- High/low pulse ct, TQmean, R-B index, Peak flow, low flow

## Water quality

- Conductivity (semi-monthly, monthly, seasonal average)
- Temperature (7 Dadmax)

## Hydraulic complexity

- Velocity (cm/sec)
- Flushing ratio (time to peak/time to 95% of background)
- substrate, *thalweg length*, *pool/channel width & depth*, *LWD*

# Drivers

- Land development
  - Land cover (Impervious, vegetation), type of land use (urban, rural, PCI index), permit activity and compliance
- Climate
  - Precipitation, air temp
- Catchment Morphology/Geology
  - geology, elevation, aspect, stream network structure, forest type

CONTEXT

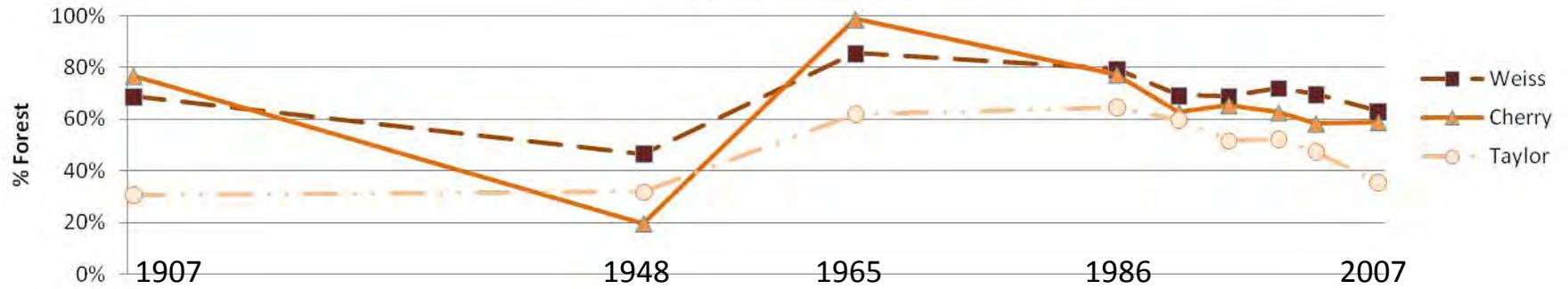
HISTORIC  
&  
FUTURE SCENARIOS

# UW UERL

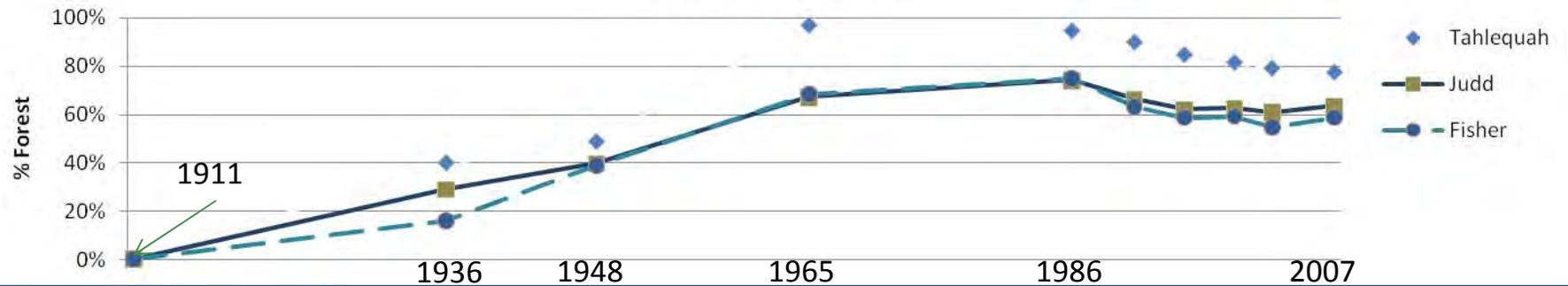
- Dr. Marina Alberti,
- Dr. Lucy Hutyra,
- Matt Marsik, Post-Doc
- Julia Michalak, PhD Candidate

# Change in % Forest Cover - 1907-11 to 2007

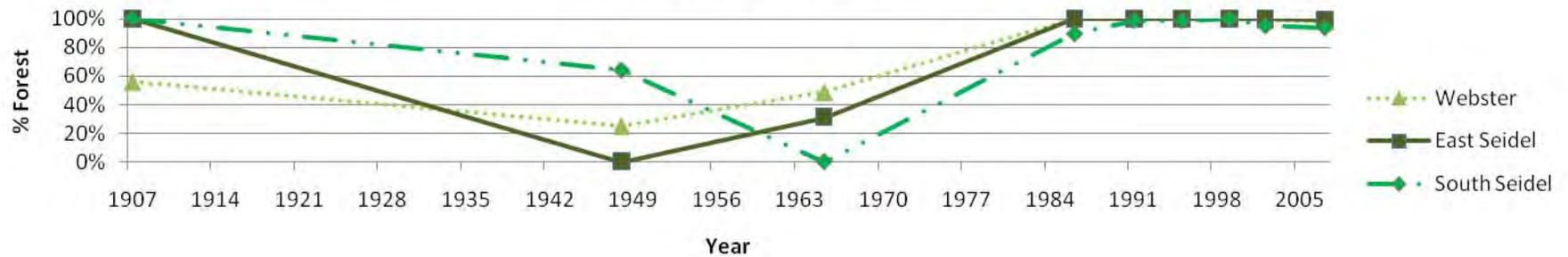
## Eastern Basins



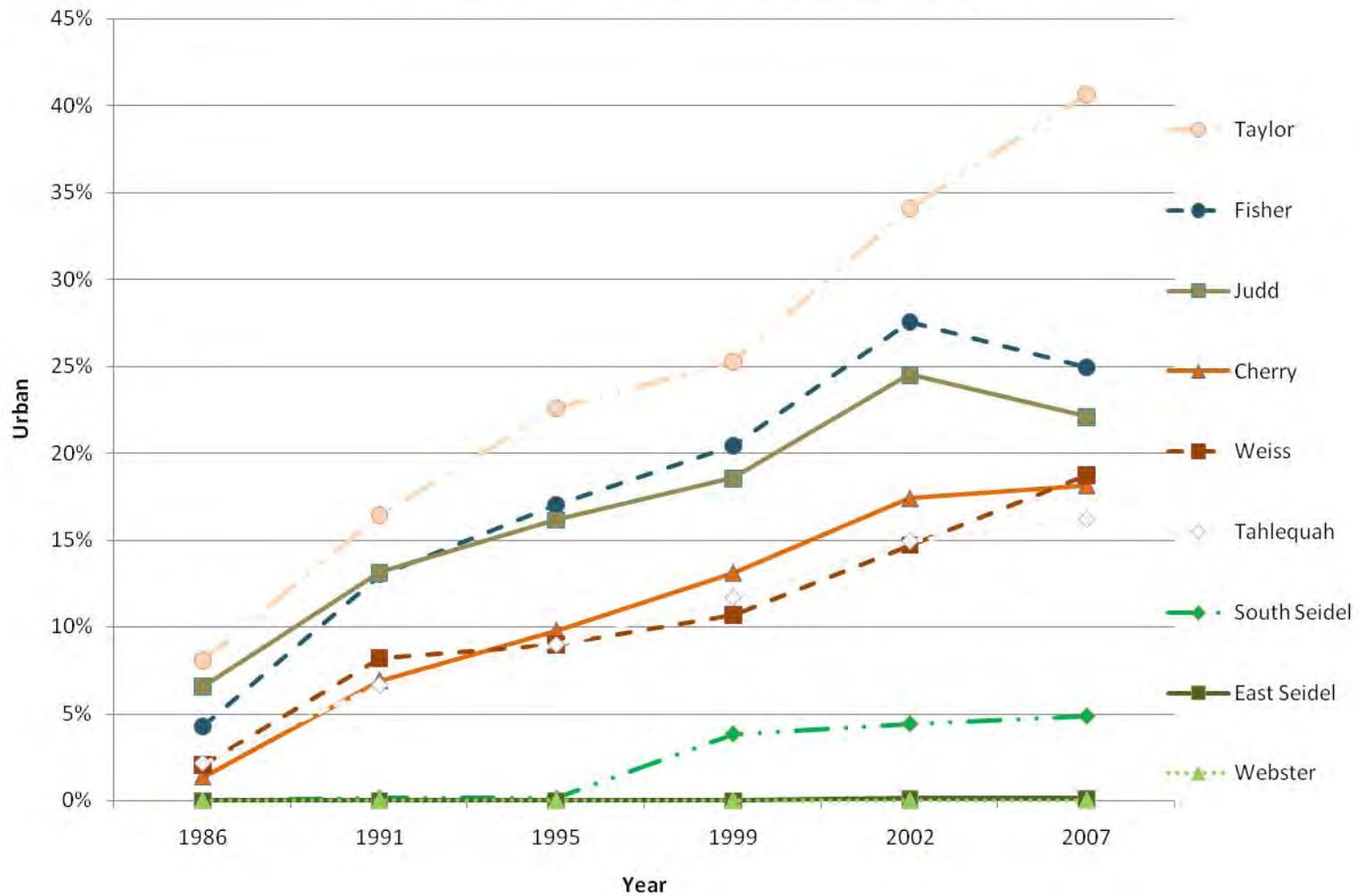
## Vashon Basins



## Control Basins



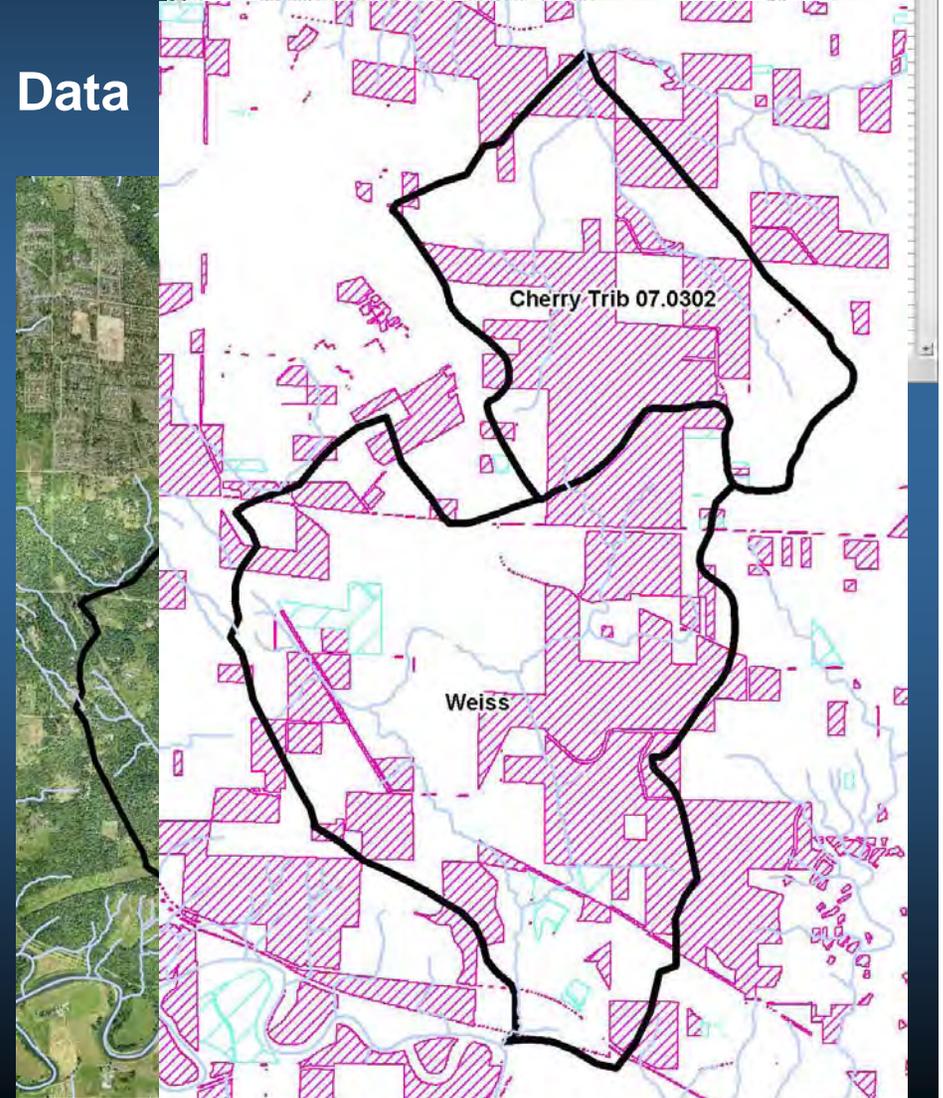
### % Total Urban (H+M+L) 1986-2007



# Permit Development History

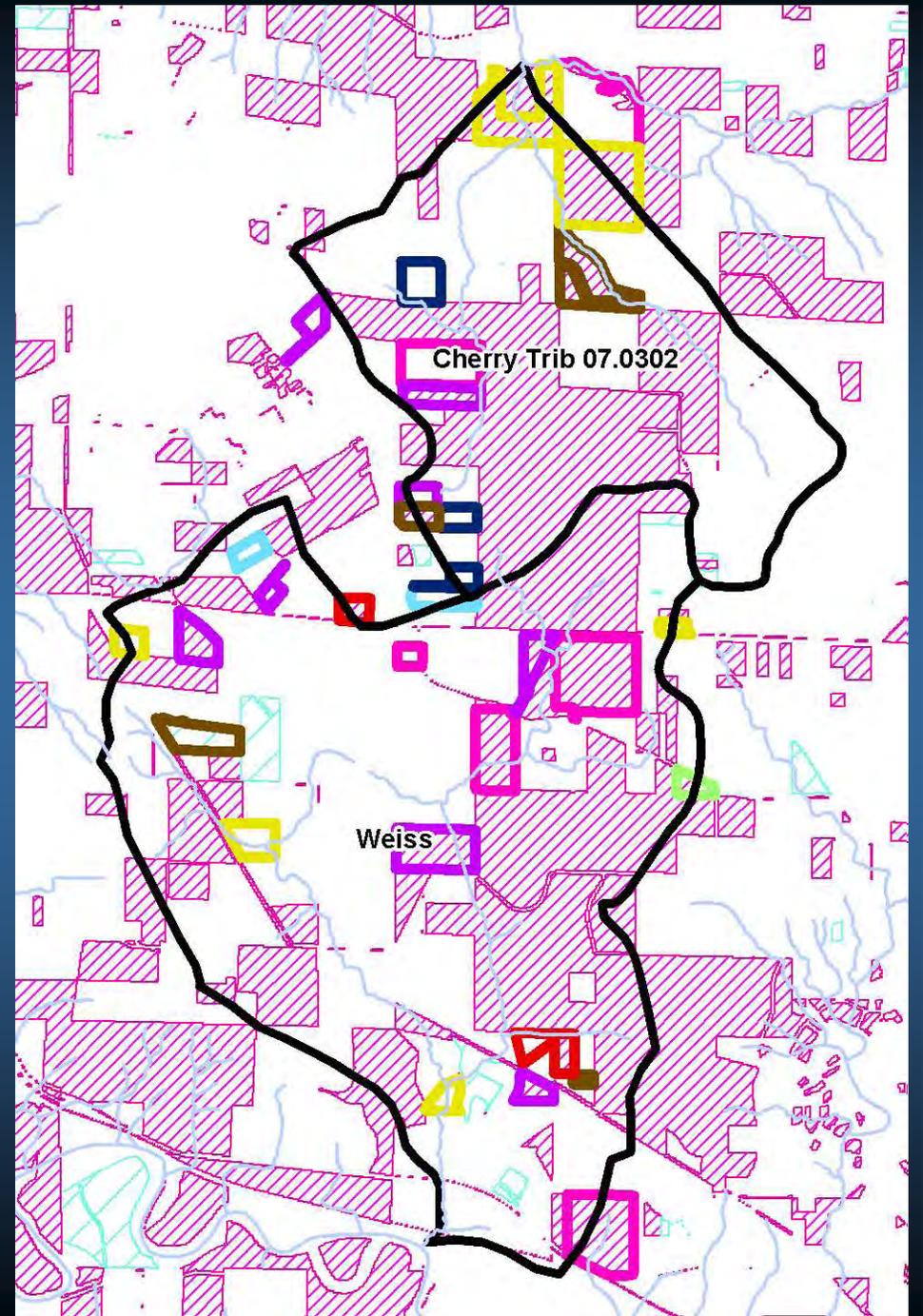
- Historic Permit Data from DDES Data Warehouse
- Digital Aerial Photography from KCGIS Spatial Data Warehouse
- Previous GIS Analysis of Pre-CAO Development & Development Potential to Identify Basins to Monitor

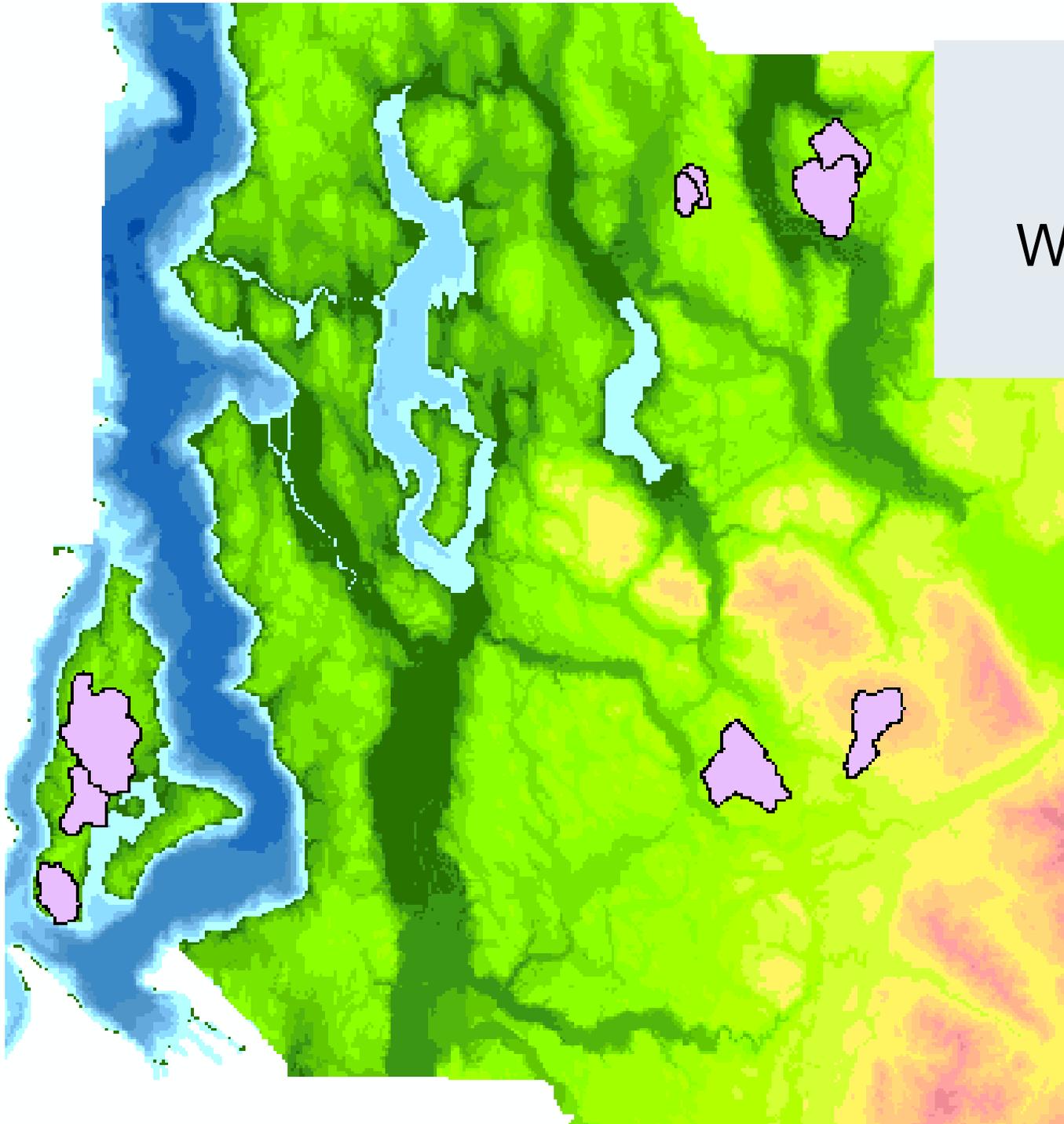
CD	BASIN	PM	PR	HUMNR	PERMIT_TY	SUBTYPE	STATUS	DA_START	DESCRIPTION	TITLE	P	ConvertedCategory
72	Taylor	0223268343	1	001L1017	DMELLING	MOBILE	CANCELLED	06/02/2001	INGALL NEW'S BEDROOM DOUBL		U	Undeveloped Addition
83	Middle Ames	182579002	1	L0400312	GRADE	CLEARING	CANCELLED	10/08/2004	Conversion Opdon Hill west Pk to DLACK		A	Undeveloped Addition
82	Middle Ames	0207101101	2	L07SA093	SENGDESG	DESIGNAT	COMPLETE	02/12/2007	Workshops for construction	SENG SA	A	Undeveloped Addition
10	Middle Ames	2025079008	2	A01P0229	PREAPP-O	FEASBLTY	COMPLETE	10/05/2001	TDR Sending Site Approval		T	TDR
10	Middle Ames	1725079009	2	A01P0229	PREAPP-O	FEASBLTY	COMPLETE	10/05/2001	TDR Sending Site Approval		T	TDR
10	Middle Ames	2025079000	2	A01P0229	PREAPP-O	FEASBLTY	COMPLETE	10/05/2001	TDR Sending Site Approval		T	TDR
10	Middle Ames	2025079001	2	A01P0229	PREAPP-O	FEASBLTY	COMPLETE	10/05/2001	TDR Sending Site Approval		T	TDR
10	Middle Ames	2025079006	2	A01P0229	PREAPP-O	FEASBLTY	COMPLETE	10/05/2001	TDR Sending Site Approval		T	TDR
10	Middle Ames	1625070001	2	A01P0229	PREAPP-O	FEASBLTY	COMPLETE	10/05/2001	TDR Sending Site Approval		T	TDR
11	Middle Ames	1725079004	2	A01P0229	PREAPP-O	FEASBLTY	COMPLETE	10/05/2001	TDR Sending Site Approval		T	TDR
11	Middle Ames	1725079067	2	A01P0229	PREAPP-O	FEASBLTY	COMPLETE	10/05/2001	TDR Sending Site Approval		T	TDR
11	Middle Ames	1825079016	1	A01P0229	PREAPP-O	FEASBLTY	COMPLETE	10/05/2001	TDR Sending Site Approval		T	TDR
21	Middle Ames	1825079014	1	L09RS004	STEVPLN	RURLDEV	PENDING	04/14/2006				Stewardship
41	Taylor	0922891104	1	L09RS026	STEVPLN	RURLDEV	PENDING	08/02/2006				Stewardship
41	Weiss	2025079007	1	L09RS026	STEVPLN	RURLDEV	PENDING	08/02/2006				Stewardship
41	Fisher	1225079064	1	L09RS031	STEVPLN	RURLDEV	PENDING	11/11/2005	feasibility analysis re development			Stewardship
41	Judd	3125079029	1	L09RS038	STEVPLN	RURLDEV	PENDING	12/13/2006				Stewardship
41	Middle Ames	1825079071	1	L09RS003	STEVPLN	RURLDEV	PENDING	03/28/2006				Stewardship



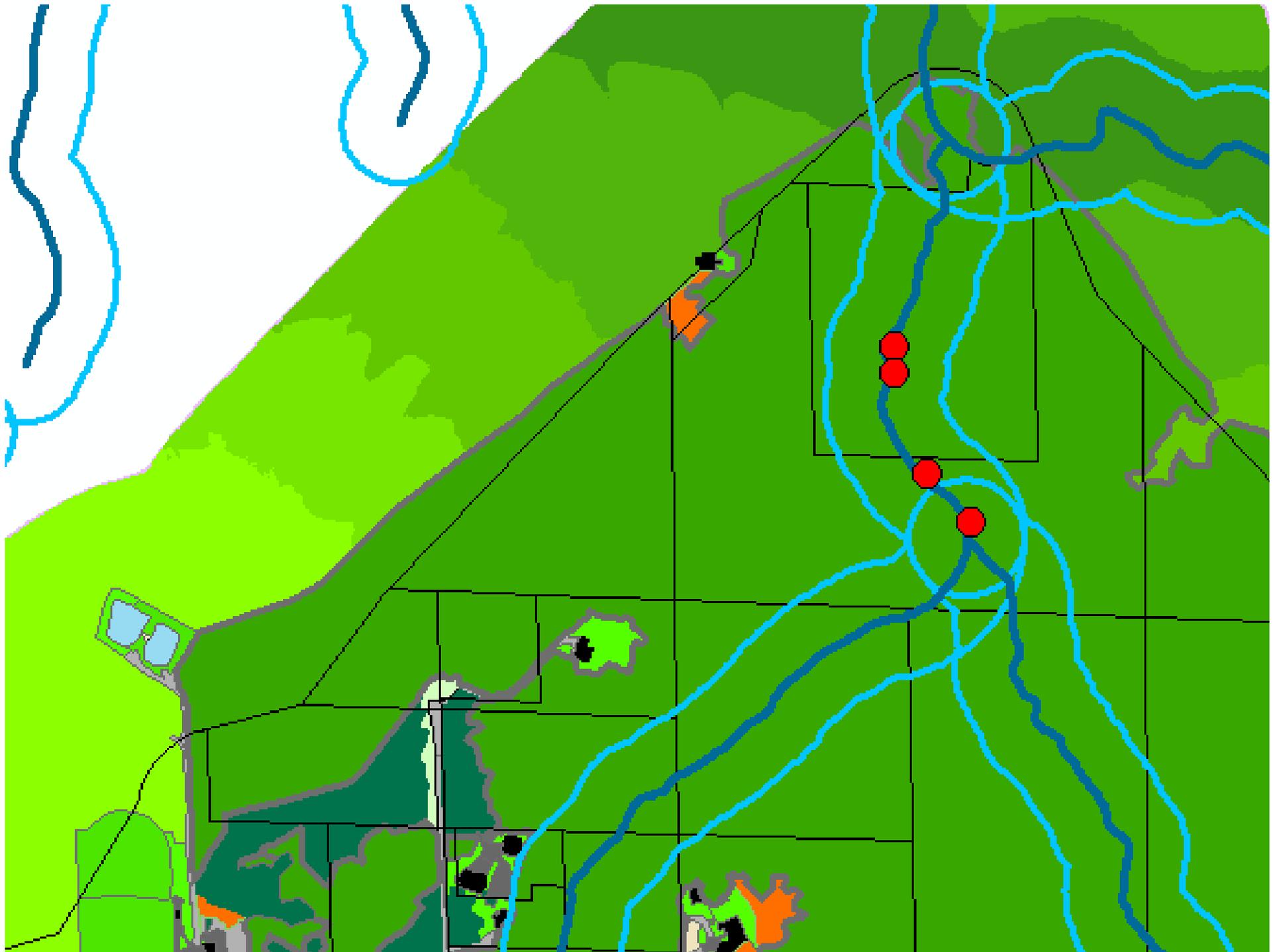
# Permits with Actual Impact

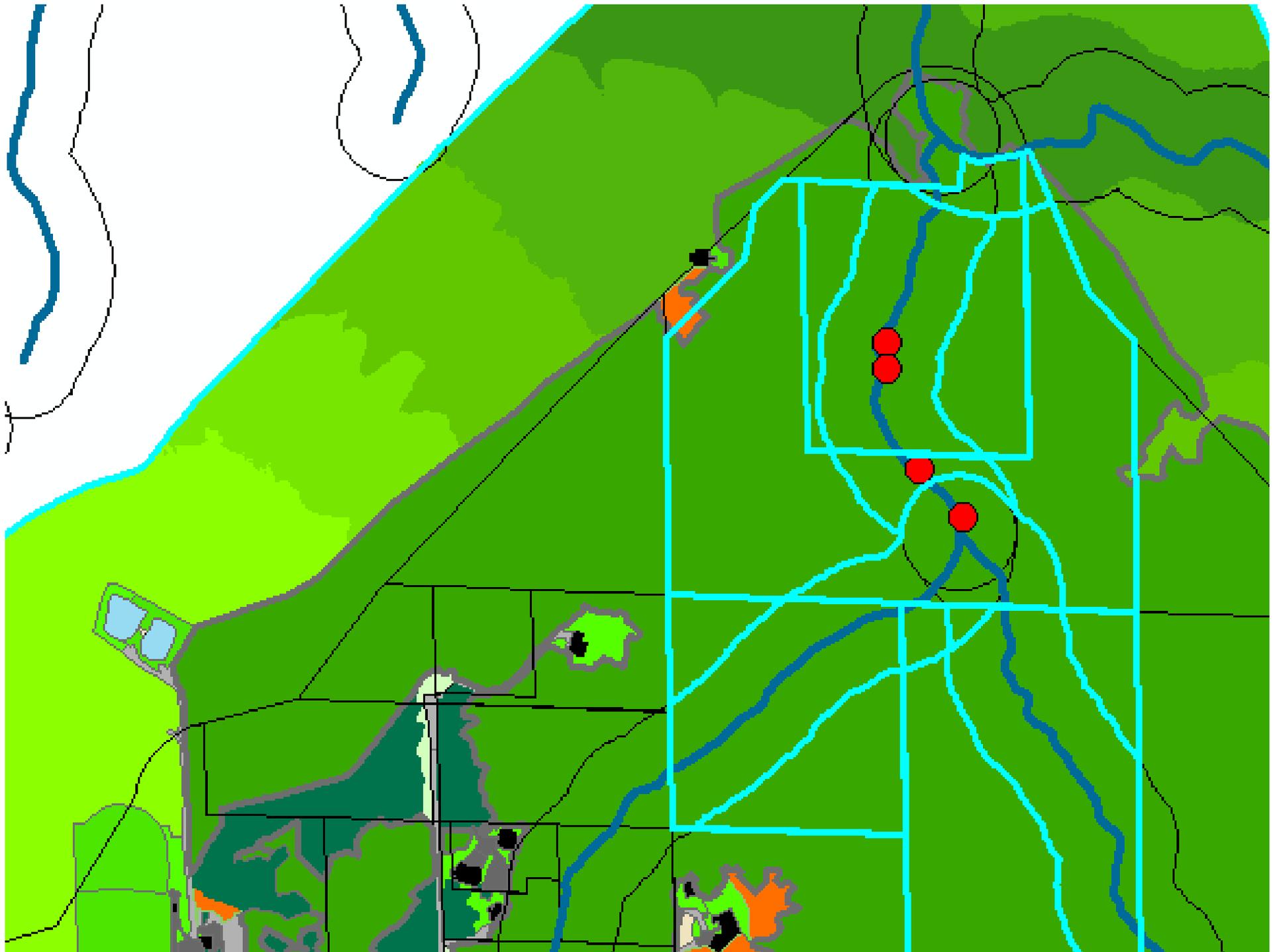
- Locate Permits 2000 to 2004
- Locate Permits 2005 to 2008
- Locate Invasive Plant Clearing Permits, Stewardship Plans, and Enforcement Activities





## Study Watersheds





# Potential Cumulative Impact (PCI)

## Landcover Classes

Photo interpretation

Hydrologic  
Correction

Study Watersheds

Sample sheds

Buffer sheds

Parcel sheds

PCI index

$$PCI = \sum_{g=1}^n D_{x,w,p} + \sum_{g=1}^n E_{x,w,p}$$

## Land Cover Classes

	Bare
	Building
	Coniferous Forest
	Deciduous Forest
	Grass
	Lawn
	Mixed Forest
	Open Water
	Pasture
	Paved Road
	Pavement
	Shrub
	Unpaved Road
	Wetland

# Analysis and Interpretation

Relate PCI to...

# Hydrology – Flow Dynamics

High pulse count

Low pulse ct

TQmean

R-B index

Peak flow

Low flow



# Water Quality

Conductivity (semi-monthly, monthly and seasonal averages)

Temperature (7 Dadmax)

# Benthic Index of Biotic Integrity

## Taxa Richness & Composition

- Mayflies
- Stoneflies
- Caddisflies
- Total taxa
- Long-lived taxa

## Population

- % Dominance

## Tolerance

- Intolerant richness
- % tolerant

## Feeding and habits

- Percent predator
- Clinger richness



# Physical Habitat

- Pebble count
- Water velocity and depth
- Riparian characteristics
- Large wood
- Pools (frequency, length, depth)
- Bank stability



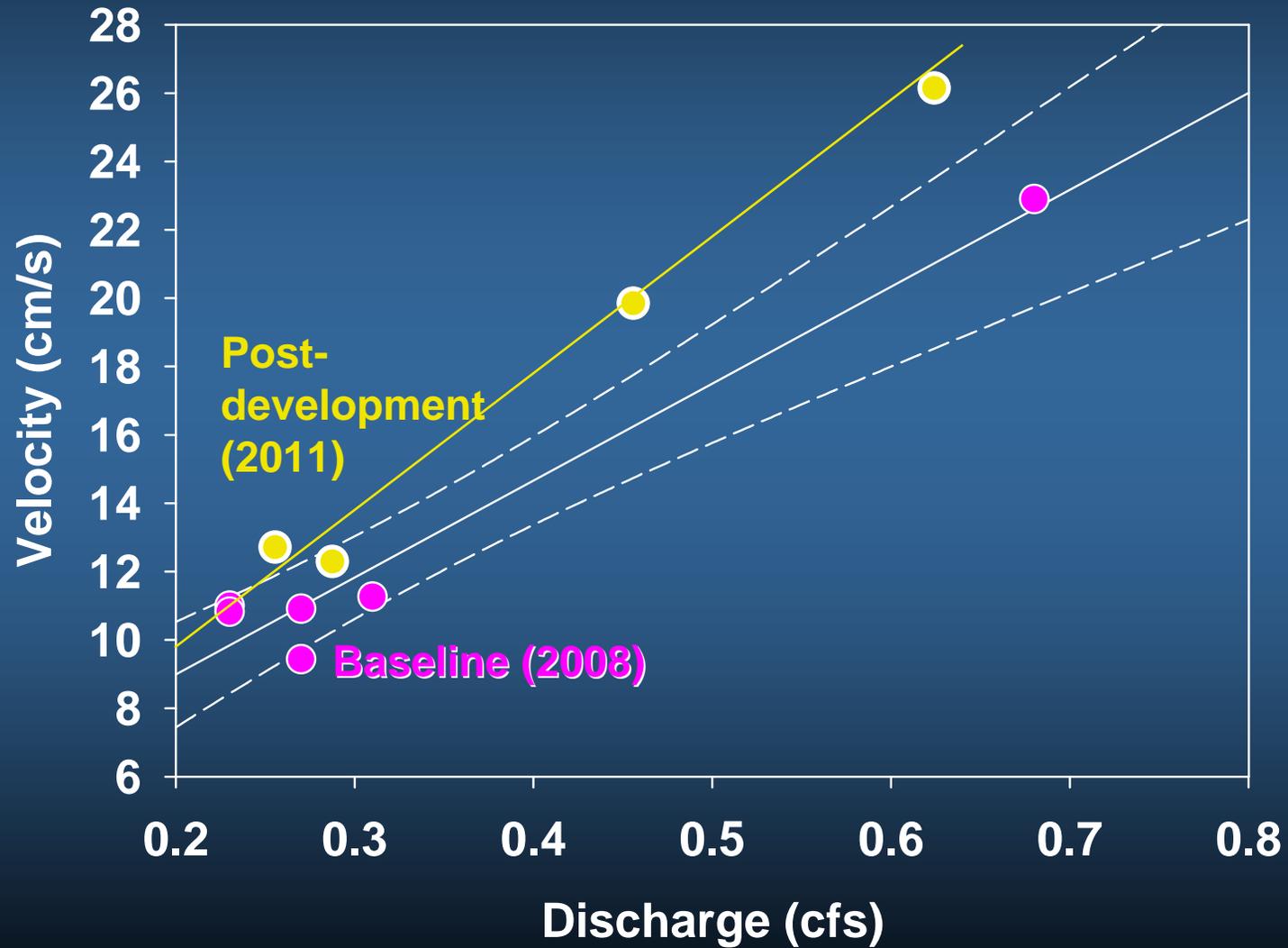
# Channel Complexity (Salt Tracers)

Velocity  
(cm/sec)

Flushing ratio  
(time to  
peak/time to  
1% of peak)



# S Seidel Creek



# Acknowledgements

- Funders: EPA & King County
- Tech Collaborators: EPA, UW UERL, USGS (Torgersen)
- Assistance: VCC, GRCC GIS Lab, KC Interns
- Project Team; DNRP, DDES
  - Josh Latterell, Ray Timm, Bob Fuerstenberg, Klaus Richter, Paul McCombs, Harry Reinert, The Gager and Data Dan Smiths, David Funke, Stephanie Hess, Jo Wilhelm