KING COUNTY FLOOD CONTROL DISTRICT

King County

King County Flood Hazard Management Plan Update
Citizen Committee Kick-Off Meeting

December 13, 2011

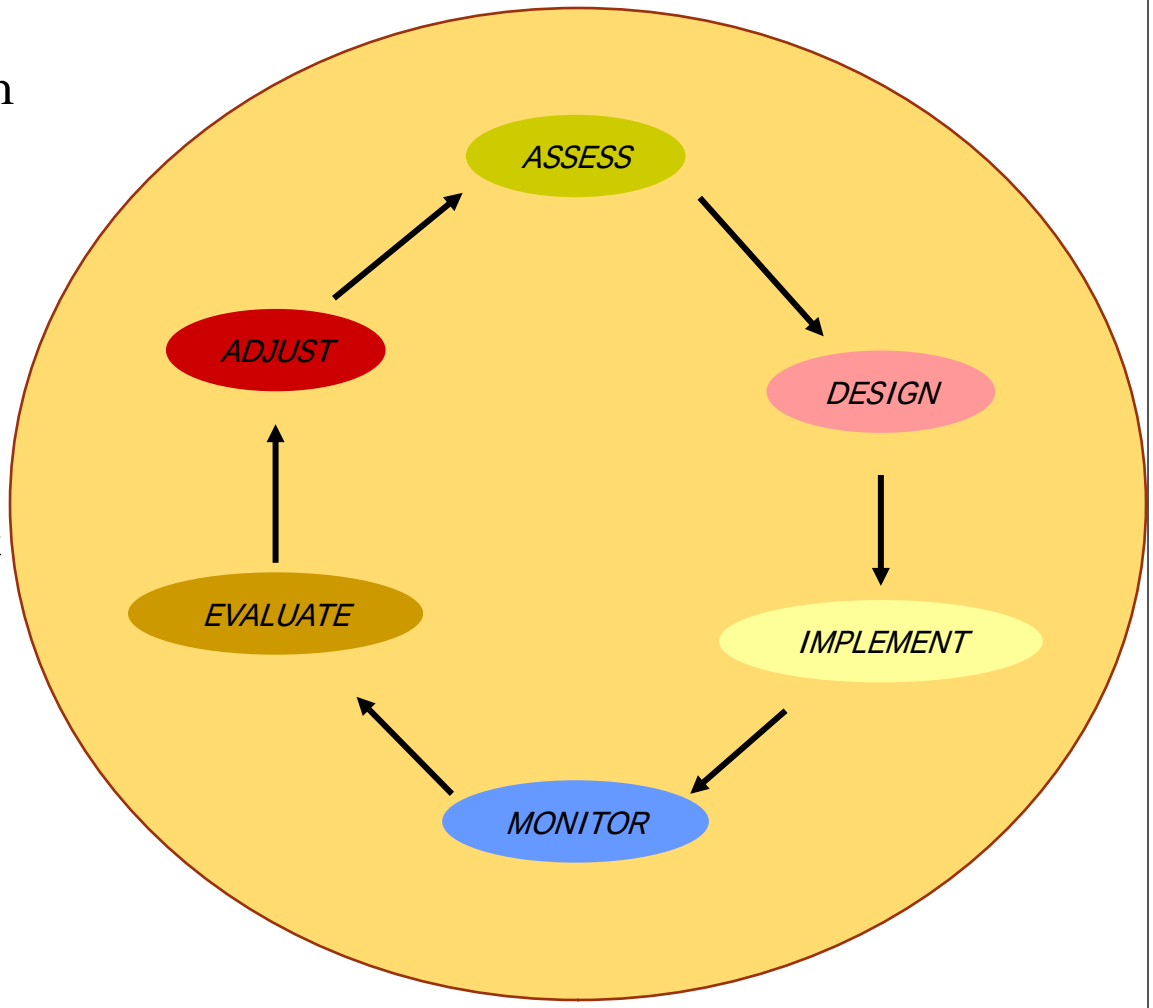
Protecting public safety, the regional economy and critical infrastructure.

King County Flood Hazard Management Plan Update: Scope of Work and Schedule

King County's
Flood Hazard Management Plan

Why are we updating the Plan?

- New information about flood and channel migration hazards
- New information about risks, vulnerabilities and economic impacts
- Updated Actions
  - What is complete and what remains to be done?
  - What lessons have we learned since 2006?
- Policy Issues



Timeline for the Plan Update

- **January:** Goals, Objectives, Guiding Principles, and Flood Risk Reduction Strategies
- **February:** Flooding: Major Rivers, Small Streams, and Coastal Flooding; Vulnerable population outreach
- **March:** Trees – On Levees and in Rivers
- **April:** 'Levels of Service' and levee design issues
- **May-June:** Risk assessment and Action Plan updates
- **July:** Public Meeting TBD
- **September**: Transmittal to the King County Council and FCD Board

Urban and Coastal Flooding

- What is the role of the River and Floodplain Management program in cities?
- How do we ensure that floodplain management is integrated and consistent across jurisdictions?

Outreach to Vulnerable Populations

- How should we improve our communication to vulnerable populations?

American Red Cross
Serving King & Kitsap Counties

KING COUNTY FLOOD CONTROL DISTRICT

Flood safety videos available in 25 languages

Flood Risk "Levels of Service" and Levee Certification

- "The 100-year standard may be woefully insufficient in some areas (such as highly urbanized environments) and perhaps overly protective in others (such as agricultural lands, undeveloped lands, etc), thus FEMA accreditation should include risk and economic analysis."
  - November 2010 Report to WA Legislature

Example of Flood Risk Tolerance

What is the probability of exceeding a design flow over different timeframes?

	30 Years	50 Years	75 Years	100 Years
1:100 (aka 'the 100-year flood)	26%	39%	53%	63%
1:140 (current USACE estimate of Green River flood control)	19%	30%	42%	51%
1:200	14%	22%	31%	39%
1:300	10%	15%	22%	28%
1:500	6%	10%	14%	18%

Key Questions Regarding Risk

- What level of flood risk are we willing to accept, or, What is the 'Design Flood'?
  - Near-term, 30 years, 50 years….
- What level of economic risk exposure are we willing to accept in the short-term and long-term?
- How much risk are we willing to accept regarding other river objectives?
- How much are we willing to pay in the short-term and in the long-term?

- …and who pays for it?

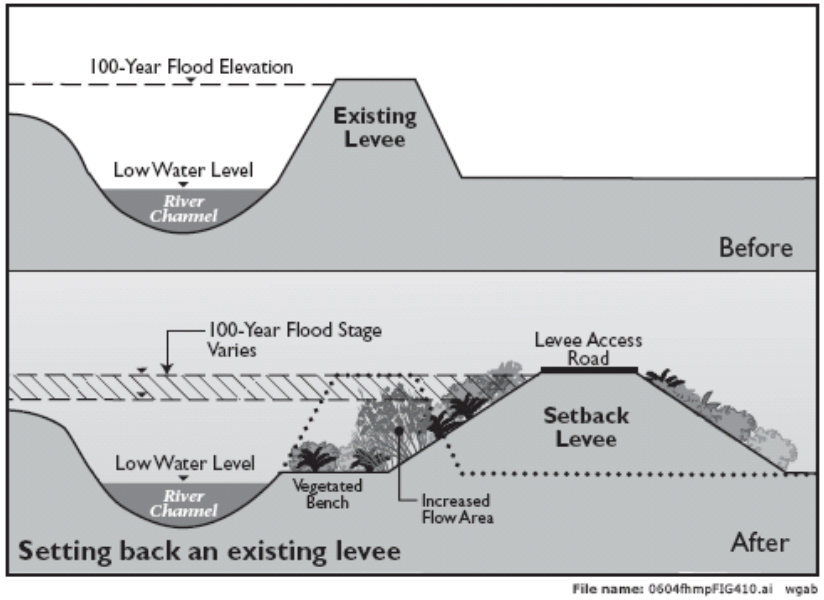
Levees: Bioengineering and Design Factors

Reasons for Current Approaches

- Better flood protection
- River is dynamic
- Permitting requirements
- Environmental benefits
- Cost effective

LEVEE SETBACK PROJECTS

2006 KING COUNTY FLOOD HAZARD MANAGEMENT PLAN



Bio-engineered levee setback - Lower Green River

Trees (Part 1): Levee Vegetation and Corps Emergency Assistance

U.S. Army Corps of Engineers, 2010

OR

Narita Bioengineered Levee, Green River, Washington 2004

How can we best maintain levees to ensure:

1. Safe and effective levees
2. Functional habitat
3. Cost-effective use of limited resources
4. Science-based approach

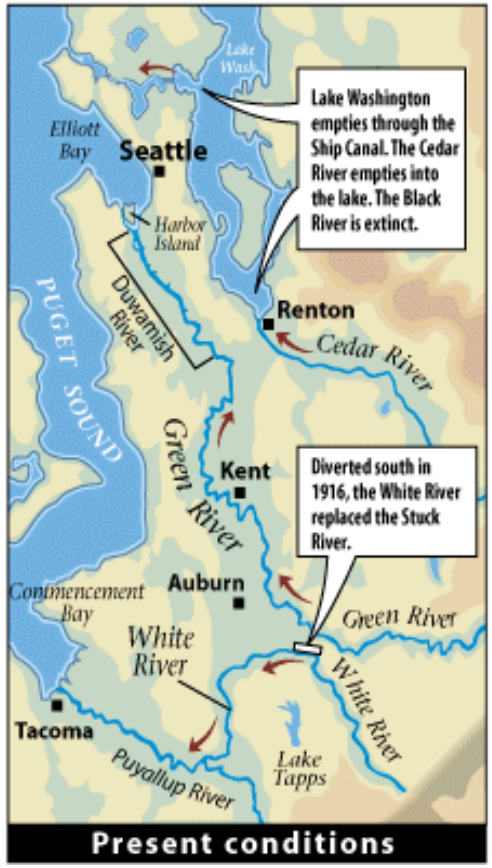
Trees (Part 2): Wood in Rivers

- Recreational river safety and….
  - Placed wood
  - Naturally-occurring wood
  - Naturally-occurring wood interacting with project sites

Floodplain Management in King County

Key King County River Engineering Activities and Dates

- 1899: Landsburg Diversion – Cedar River
- 1906: White River Diverted (permanently in 1912)
- 1912: Cedar River Diverted to Lake Washington
- 1913: Tacoma Public Utilities Headworks – Green R.
- 1914: Cedar River Masonry Dam
- 1948: Mud Mountain Dam – White River
- 1962: Howard Hanson Dam – Green River
- 1964: South Fork Tolt River Dam
- 1966: Sammamish River Channelization
- 1930s-1970s: 500 levees & revetments constructed



Residential Flooding – Cedar River

Cedar Grove Mobile Home Park 1975

Cedar Grove Mobile Home Park 1990

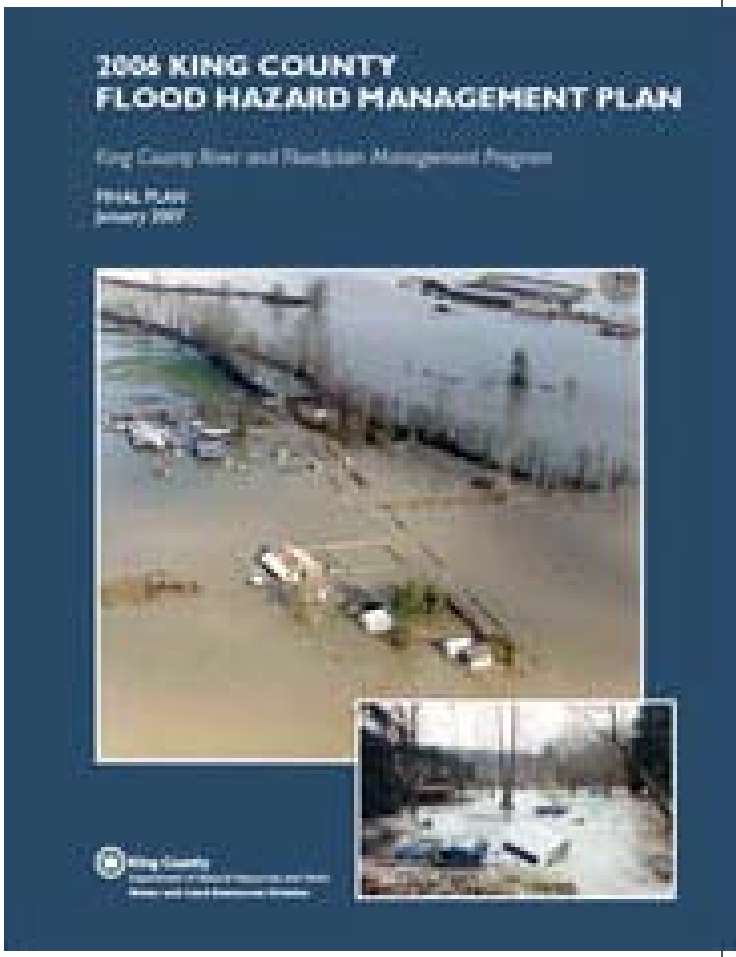
Ecomomic Impacts of Flooding: Countywide

- 32,000 Floodplain Residents
- 65,000 jobs
- $3.7 Billion in total income
- 30% of aerospace jobs
- 20% of manufacturing / wholesale trade jobs
- Critical Infrastructure

Adopted Flood Plan Goals

1. Reduce the risks from flood and channel migration hazards
2. Avoid or minimize the environmental impacts of flood hazard management
3. Reduce the long-term costs of flood hazard management

20 Years of Experience Reducing Flood Risk while Supporting Environmental Objectives



Flood Control District Overview

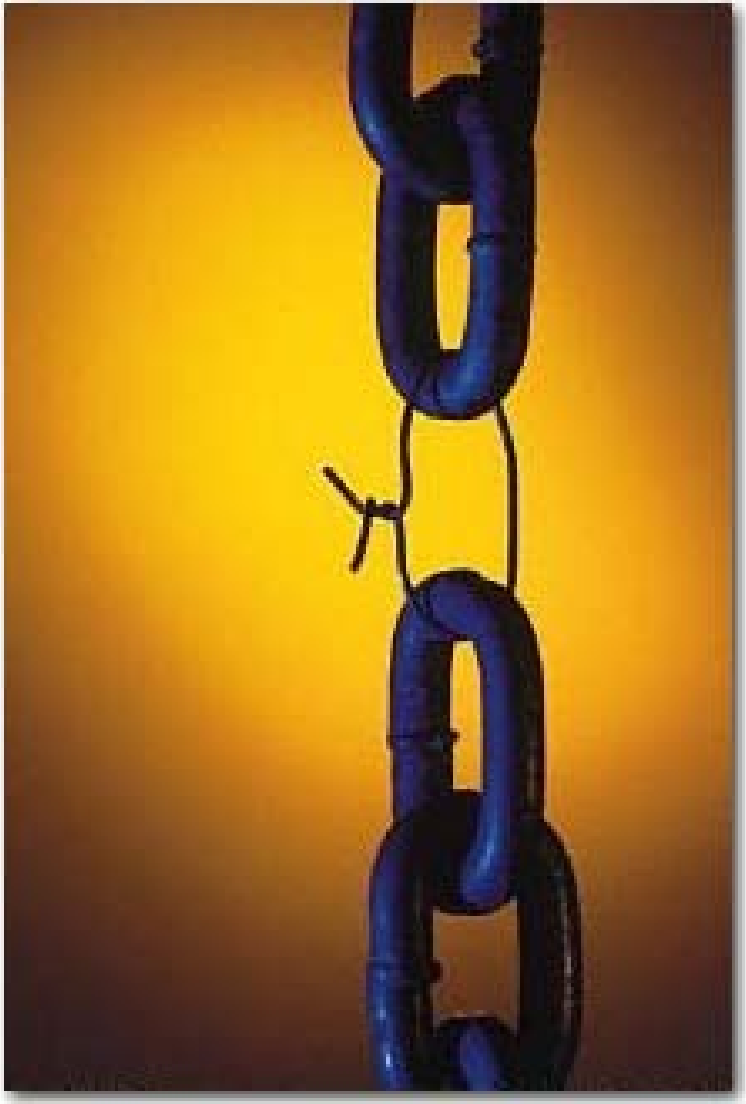
Investing in infrastructure is far less expensive than rebuilding entire communities after a catastrophe

- Protect the safety of thousands of floodplain residents
- Protect $46M/day in economic output; 65,000 jobs
- Protect warehouse distribution centers for Puget Sound Region
- Protect critical public infrastructure

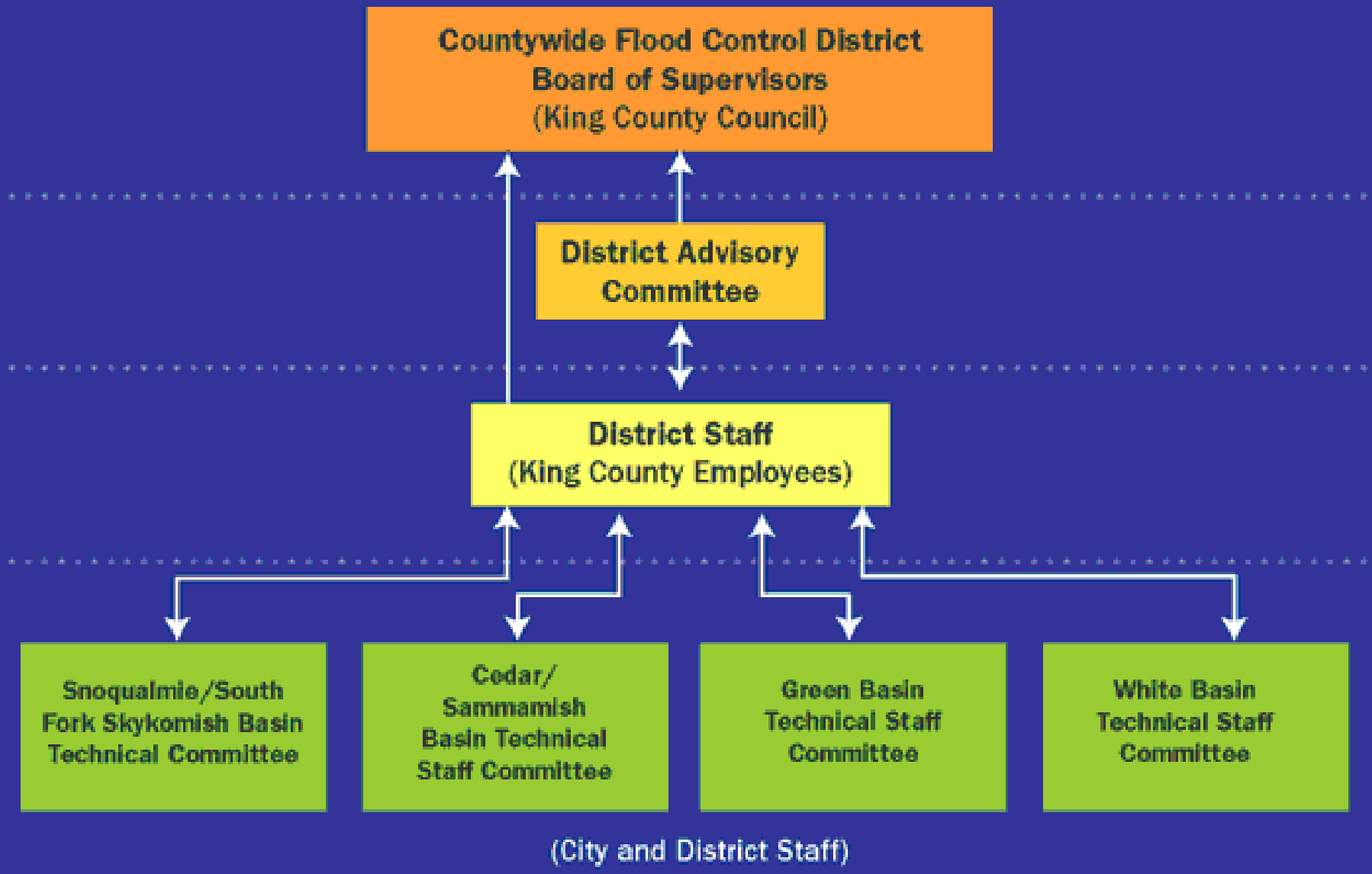
King County Flood Control District Funding

In the words of the Advisory Committee's report:

- "a lower rate was simply not adequate to get the job done"
- "It is important to demonstrate success to the public. . ."
- "the flood protection chain is only as strong as its weakest link"



FCD Governance Structure



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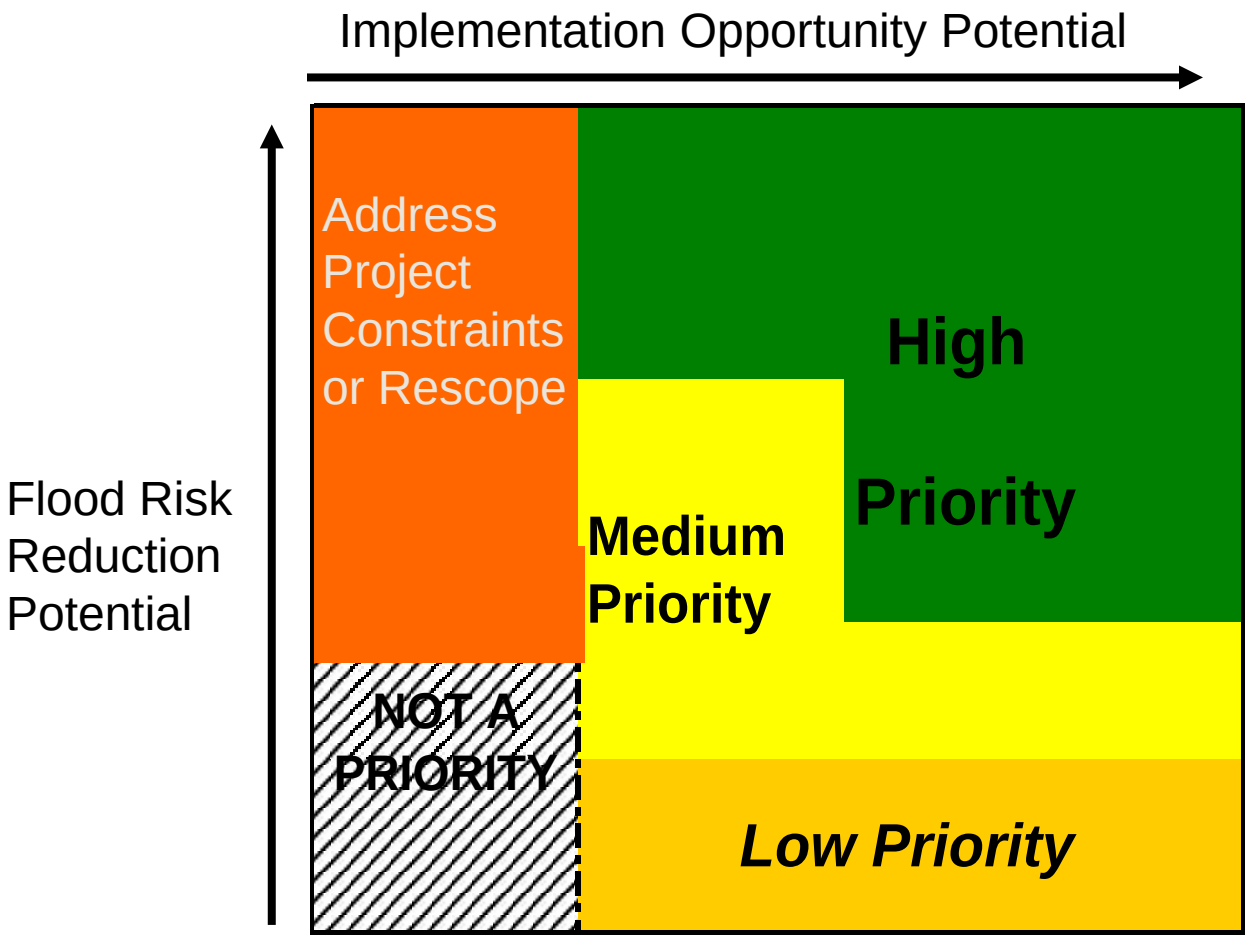
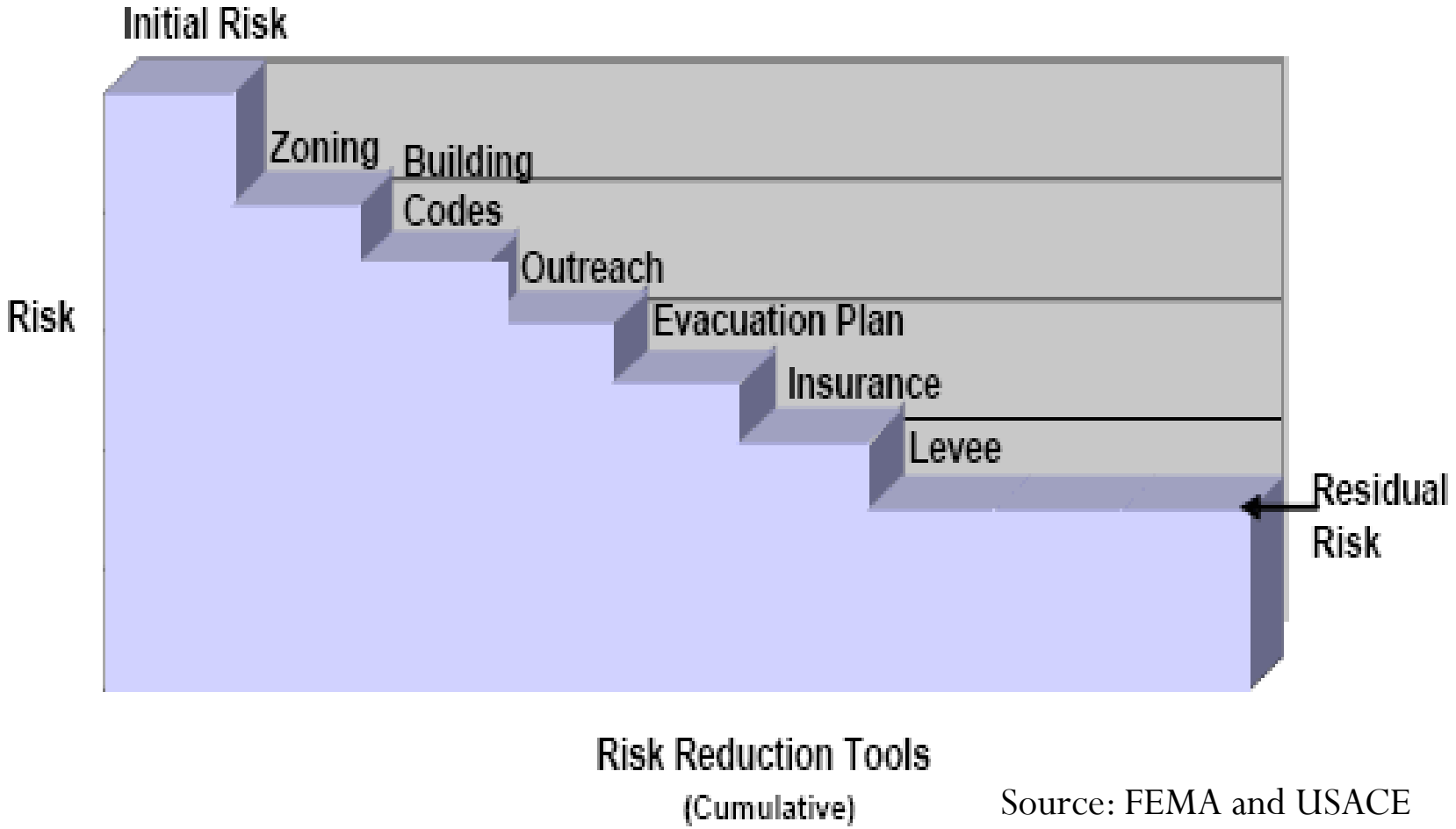
Evaluation Criteria: Project Evaluation Approach



NOTE: This is a conceptual diagram and is not intended to imply clear and distinct thresholds between these categories.

Tools to reduce but not eliminate risk:



Source: FEMA and USACE

King County Flood Control District
Overview

1. Take actions to reduce flood risk.
2. Understand flood risks and where we are vulnerable.
3. Build awareness of flood risks.

City of Snoqualmie

Actions to Reduce Flood Risk: Frequently Flooded Structures

Before: Homes and Residents at Risk

After: Tenants Relocated and Structures Removed

Rainbow Bend, Cedar River

Since 2008, **86** parcels and **178** acres were acquired in the floodplain from willing landowners. Over **175** tenants relocated to safer, superior housing.

Actions to Reduce Flood Risk: Home Elevations

- 48 homes elevated above flood height
- 17 home elevations in progress
- Federal and state grants mean minimal costs to homeowner

Snoqualmie Home Elevation Before and After

Actions to Reduce Flood Risk: Farm Pads and Barn Elevations

- 20 farm pads constructed since 2008
- 5 farm pads in development for 2012
- 2 barn elevations in 2012 as pilot project

Lower Snoqualmie Valley

Actions to Reduce Risk: Rebuilding Levees

- 60+ levee projects completed
- 5-7 major levee rehabilitations scheduled for construction in 2013
- 25-30 major projects programmed during 6-year CIP

Cedar River (top)
Lower Green River (bottom)

Actions to Reduce Risk: Partnerships and Grants

- Since 2008, 37 grants from FEMA, Corps, State of Washington, KCD, and Conservation Futures
- $42.5M in external funds for flood risk reduction
- $2.50 in local, state, and federal funds leveraged for each $1 in FCD match
- Funding to 40 jurisdictions through the Opportunity Fund

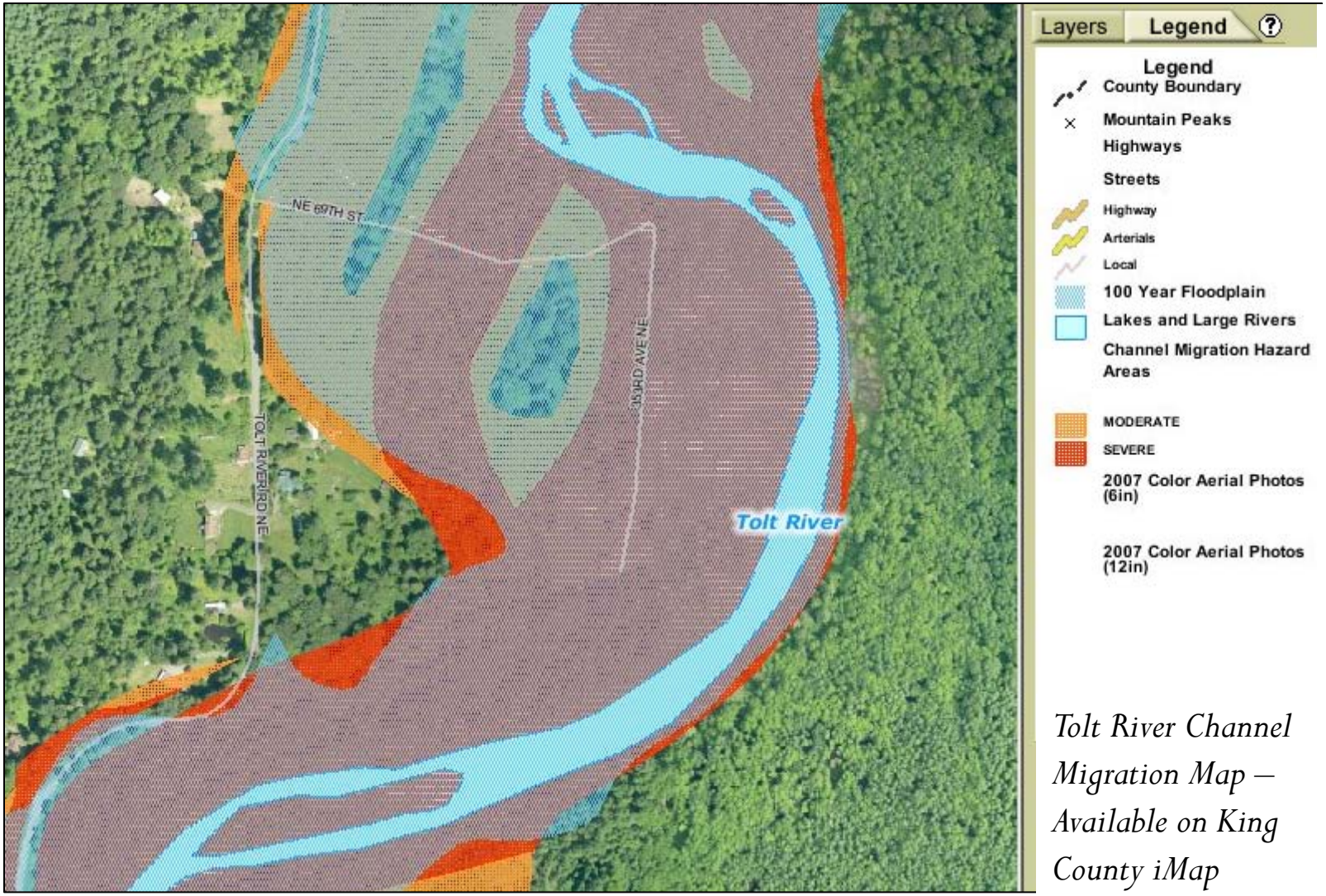
Lower Green River – Horseshoe Bend

Actions to Reduce Risk: Maintaining Levees

- 500 levees and revetments along 120 miles of river
- Inspection and access for flood season
- 600 acres of property to maintain
- Demolish 15-20 structures per year

Vegetation removal, Tukwila (top)
Home demolition, Cedar River (bottom)

Improving Understanding of Flood Risk: Consequence, Severity, and Urgency



Tolt River Channel Migration Map – Available on King County iMap

Building Awareness of Flood Risks

King County
Department of Natural Resources and Parks
Water and Land Resources Division
201 South Jackson Street, Suite 600
Seattle, WA 98104

PRESORTED
STANDARD
US POSTAGE
PAID
SEATTLE WA
PERMIT NO 6013

2011-2012
FLOODUPDATE
Flood Warning Information for Major Rivers in King County

In this issue:
- Flood phases, including new flood phases for the Cedar and Tolt rivers
- King County Flood Alerts

On the Web:
- Floodplain maps
- Sandbag information
- River gages
- Translated materials

Go to: www.kingcounty.gov/flood

Snoqualmie River Valley flooding 2010

Flood Update mailed to 5,200 floodplain addresses each year

Flood information available in multiple languages

Green River Flooding
ARE YOU READY?
Prepare now for a higher risk of flooding

PREPARE NOW
1. Make an emergency plan for your family, pets or livestock.
2. Assemble an emergency kit.
3. Buy flood insurance now – it takes 30 days to take effect. www.floodsmart.gov
4. Get a radio and keep fresh batteries.

IN THE EVENT OF A FLOOD
1. Monitor area news.
2. Move vehicles and equipment to higher ground.
3. Do not walk or drive through standing water or closed roads.
4. Listen for alerts about evacuation notices and routes. Heed evacuation instructions.
5. Bring medications and supplies with you.
6. Relocate animals and livestock, if needed.

KING COUNTY FLOOD CONTROL DISTRICT
King County
gov/floodplans

Antes,
durante y
después de una inundación

Esta información sobre cómo proceder ante una inundación le ayudará a reducir el riesgo para su familia y sus bienes.

KING COUNTY FLOOD CONTROL DISTRICT
King County
Public Health

King County FLOOD ALERT

Over 4,900 flood alert subscribers and flood safety videos available in 21 languages

You Tube

Flooding services

King County, Washington

Flooding services
How to prepare for a flood
Flood phone numbers
Flood warnings and alerts
About
Flood alerts
Rain gages
Sandbag distribution
Floodplain maps
Flooding documents
Historical floods
Flood buyouts and elevation
Flood Control District
Bank stabilization projects
Community Rating System
Archived news
Site map

To offer a suggestion or report an error on the King County flooding services and information website, please contact **Fred Bentler**, webmaster.

Flood warnings and alerts

King County, Washington

Current flood conditions for King County rivers. Click on a river name for more maps, data and local flood references.

River/creek	Flood conditions
Cedar River	none
Green River	none
Issaquah Creek	none
Raging River	Gage information only
Skykomish River	Gage information only
Snoqualmie River	none
Tolt River	none
White River	none

River locations in King County

Related information

- Flooding services and information
- Rivers and Floodplain Management Section
- Stormwater services

King County FLOOD ALERT

Related agencies

- Department of Natural Resources and Parks
- Water and Land Resources Division

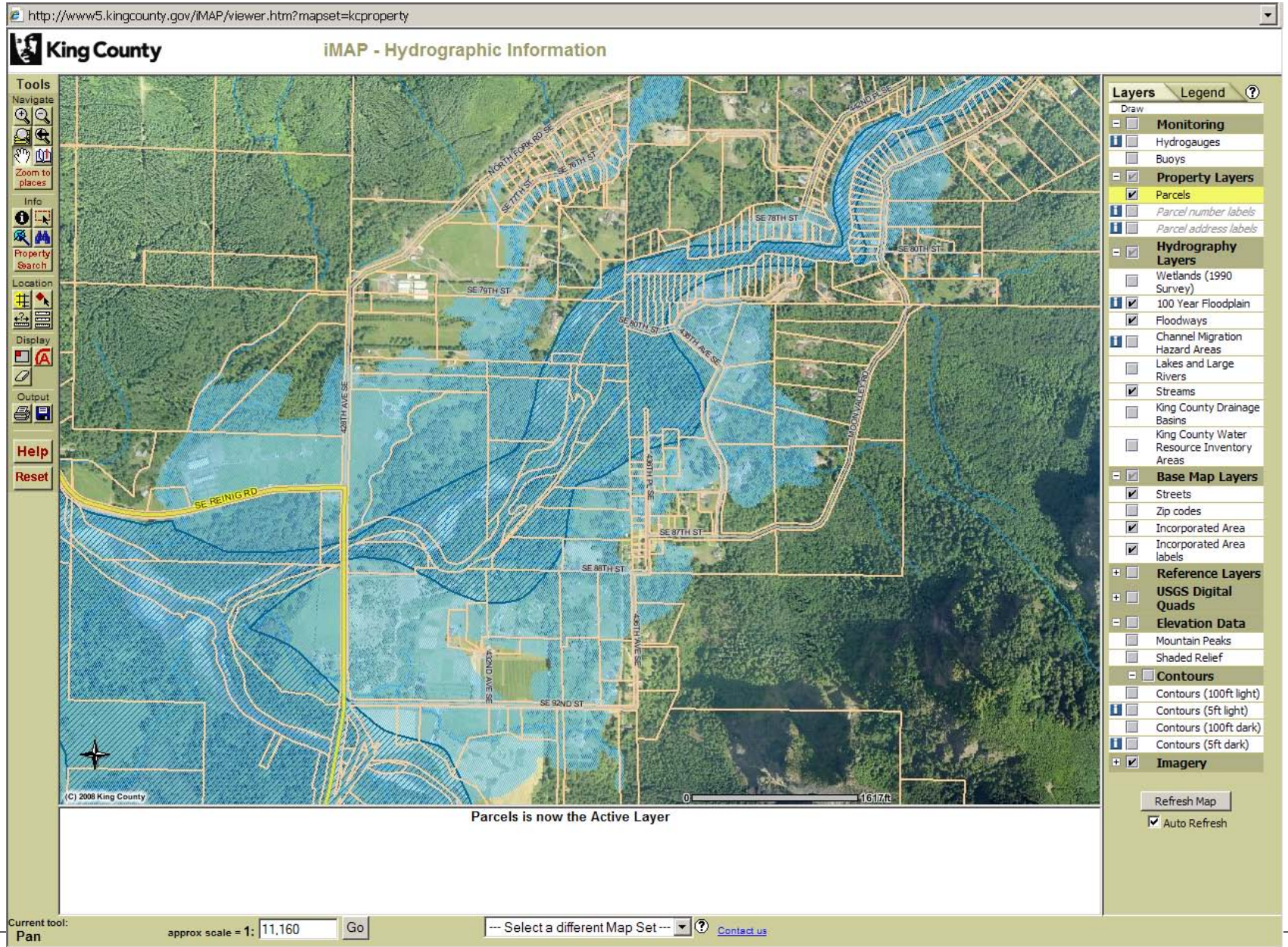
News and announcements

Fall 2011
New flood phases on Cedar, Tolt rivers
King County has adjusted the flood phases on the Cedar and Tolt rivers to more accurately reflect observed flooding impacts during high river flows. Flood Alerts will be issued using the latest flood phase thresholds.

River Management Survey
Let us know what you think about salmon & trout, recreation, flooding and safety

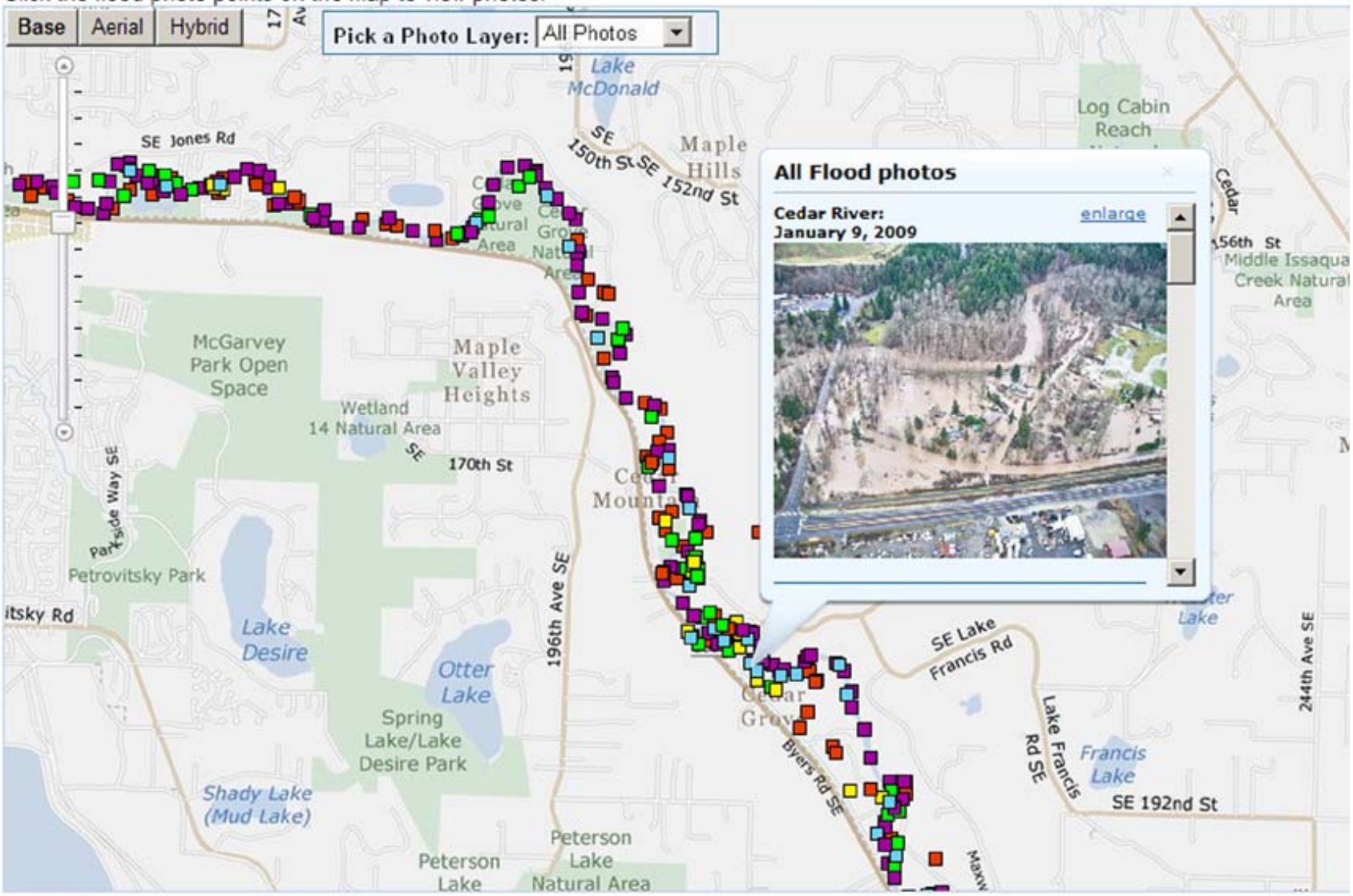
July 28, 2010
King County wins four awards for excellence in Information Technology

King County iMAP: Interactive Mapping Tool



Flood Photo Viewer

Click the flood photo points on the map to view photos.



Legend

- 2009 Flood Photos
- 2006 Flood Photos
- 1996 Flood Photos
- 1995 Flood Photos
- 1990 Flood Photos

Map navigation

Drag mouse to pan
Mouse scroll forward to zoom in
Mouse scroll backward to zoom out
SHIFT + drag to zoom in
SHIFT + CTRL + drag the mouse to zoom out

SHIFT + click to recenter
Use arrow keys to pan
Use + key to zoom in a level
Use - key to zoom out a level

SNOHOMISH CO.
KING CO.
SHORELINE
KIRKLAND
SEATTLE
REDMOND
BELLEVUE
SAMMAMISH
SEATTLE
RENTON
KENT
FEDERAL WAY
AUBURN
KING CO.
PIERCE CO.
Snoqualmie/ South Fork Skykomish Basin
Cedar River Basin
Green River Basin
White River Basin
Snoqualmie/ South Fork Skykomish Basin
River/Stream
Other Basin Boundaries
Lake
Incorporated Area
Snoqualmie/S. Fork Skykomish Basin
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1/22/09
Produced by: King County DNRP
GIS, Visual Communications & Web Unit
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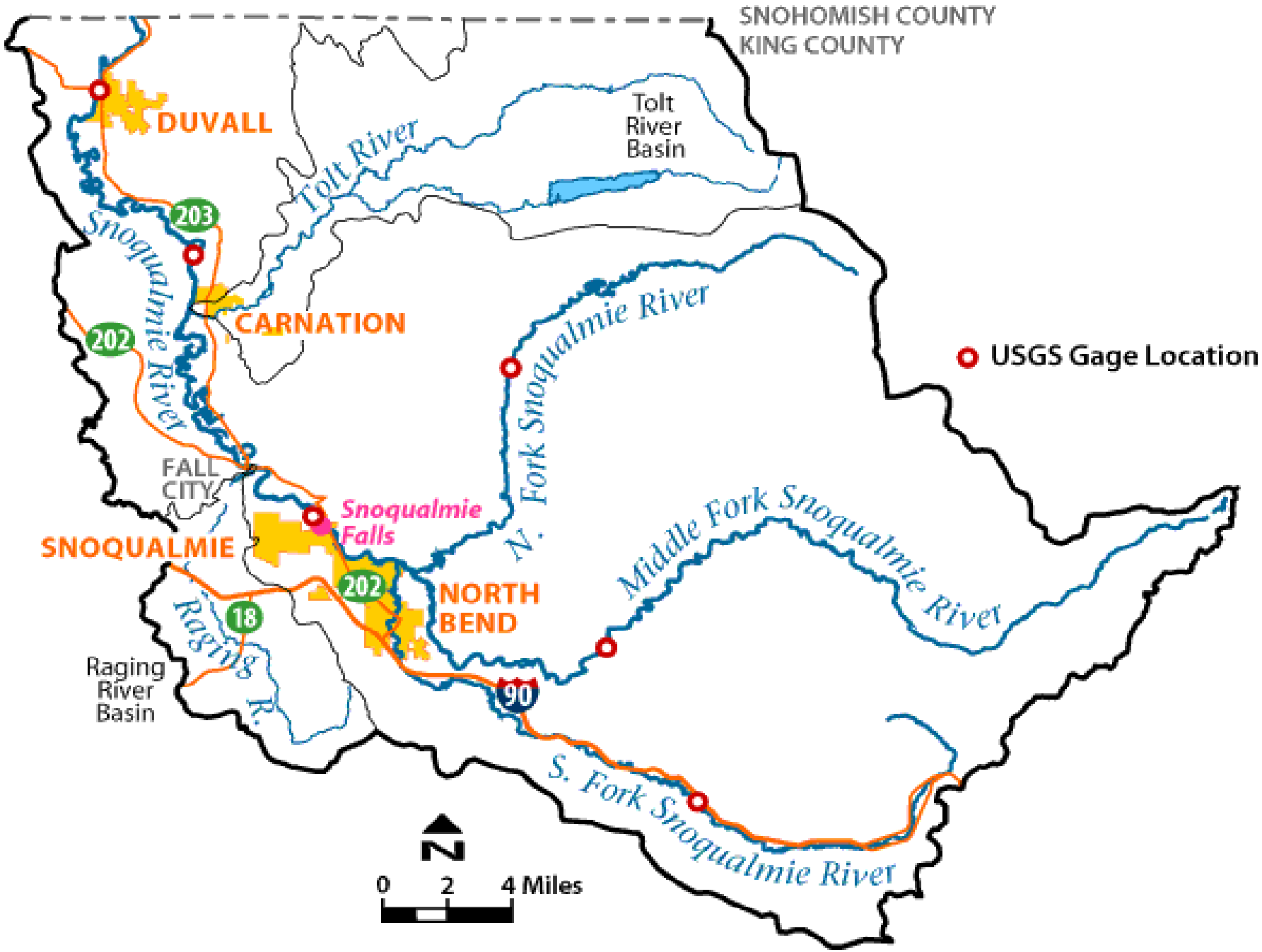
King County


SNOHOMISH COUNTY
KING COUNTY
DUVALL
Tolt River
Tolt River Basin
203
Snoqualmie River
CARNATION
202
N. Fork Snoqualmie River
USGS Gage Location
FALL CITY
Snoqualmie Falls
SNOQUALMIE
202
NORTH BEND
Middle Fork Snoqualmie River
18
Raging R.
Raging River Basin
90
S. Fork Snoqualmie River
N
0 2 4 Miles

Upper Snoqualmie Flood Risks
January 2009, City of Snoqualmie

Upper Snoqualmie Flood Risks
North Bend / Shamrock Park

- S. Fork Snoqualmie levee overtopped
- Ribary and Clough Creeks flooded
- Extensive flooding in neighborhood
- Standing water, difficult access

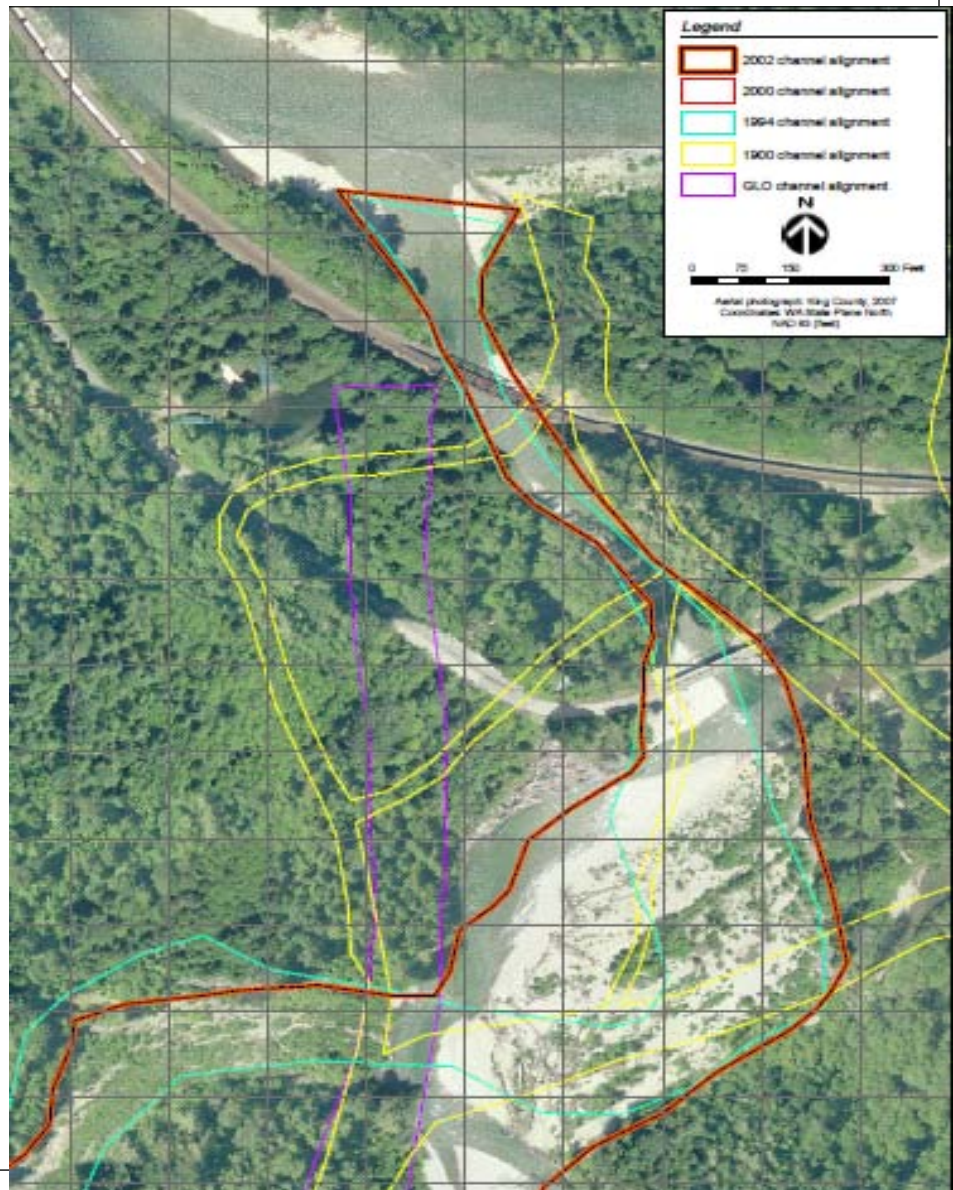
Upper Snoqualmie Flood Risks: Rehabilitating Levee Resilience

Lower Snoqualmie Flood Risks and Agriculture

Flooding and Channel Migration Risks: Tolt River January 2009

Miller River Channel Migration

- Highly dynamic channel, subject to sudden channel change
- January flood caused river to switch channels – 90% of flow now goes through former side-channel



Where the Miller River used to be…..

….and where it is now:

Miller River– January 19, 2011

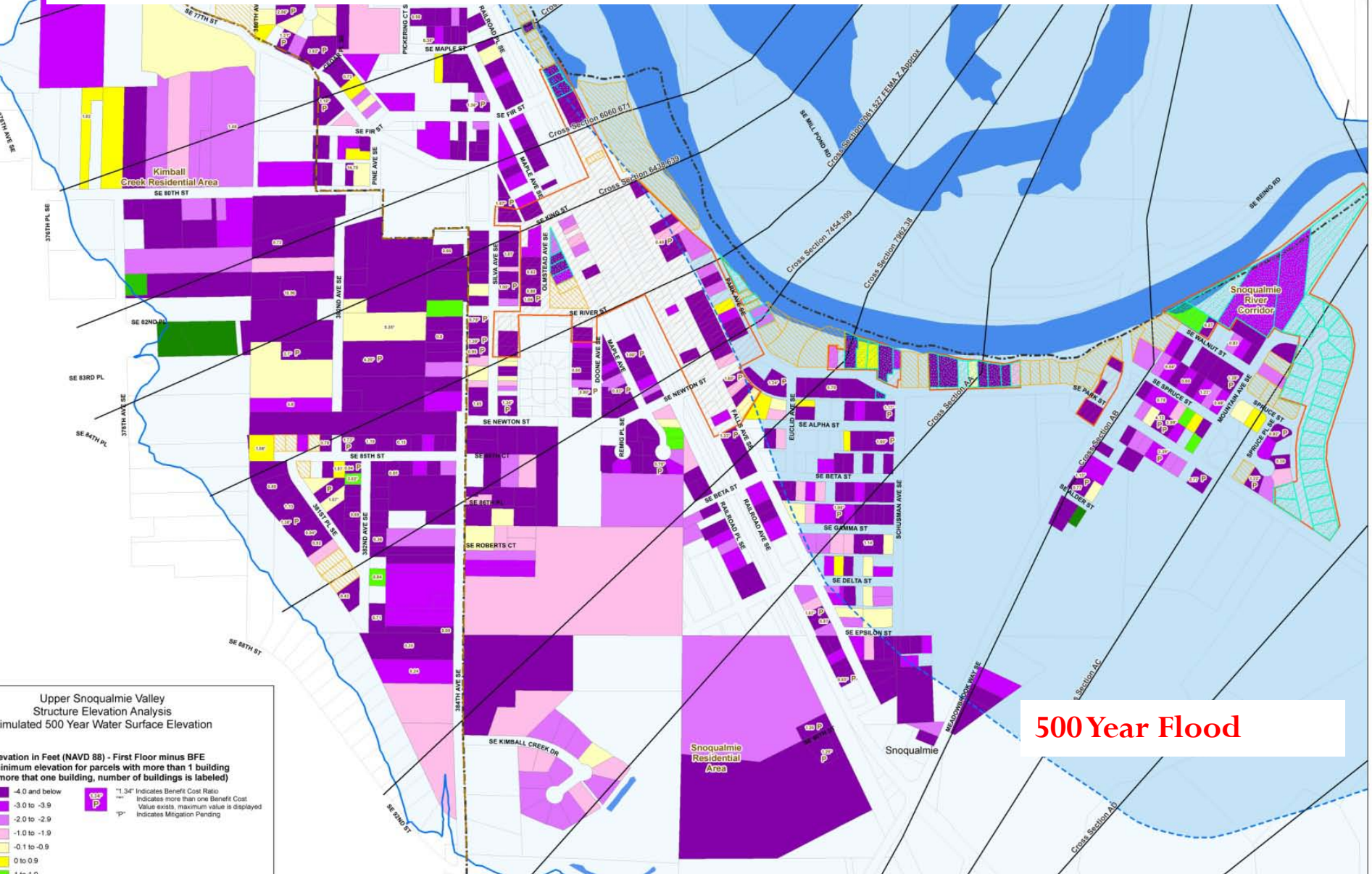
Snoqualmie/ S. Fk. Skykomish Overall Approach

- Home buyouts and elevations
- Levee repairs to address flood damages
- Large levee rehabilitations and reconfigurations to reduce flood risks
- Programmatic efforts to educate and inform, protect citizens from flood hazards
- Monitoring and mapping, modifying strategies based on results

Lower Snoqualmie Home Acquisitions

- All of the structures in this photo have been purchased and will be demolished
- FEMA disaster mitigation grant

Upper Snoqualmie Flood Mitigation: Prioritizing Acquisitions and Elevations



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Snoqualmie Home Elevation Before and After

Actions to Reduce Flood Risk: Farm Pads and Barn Elevations

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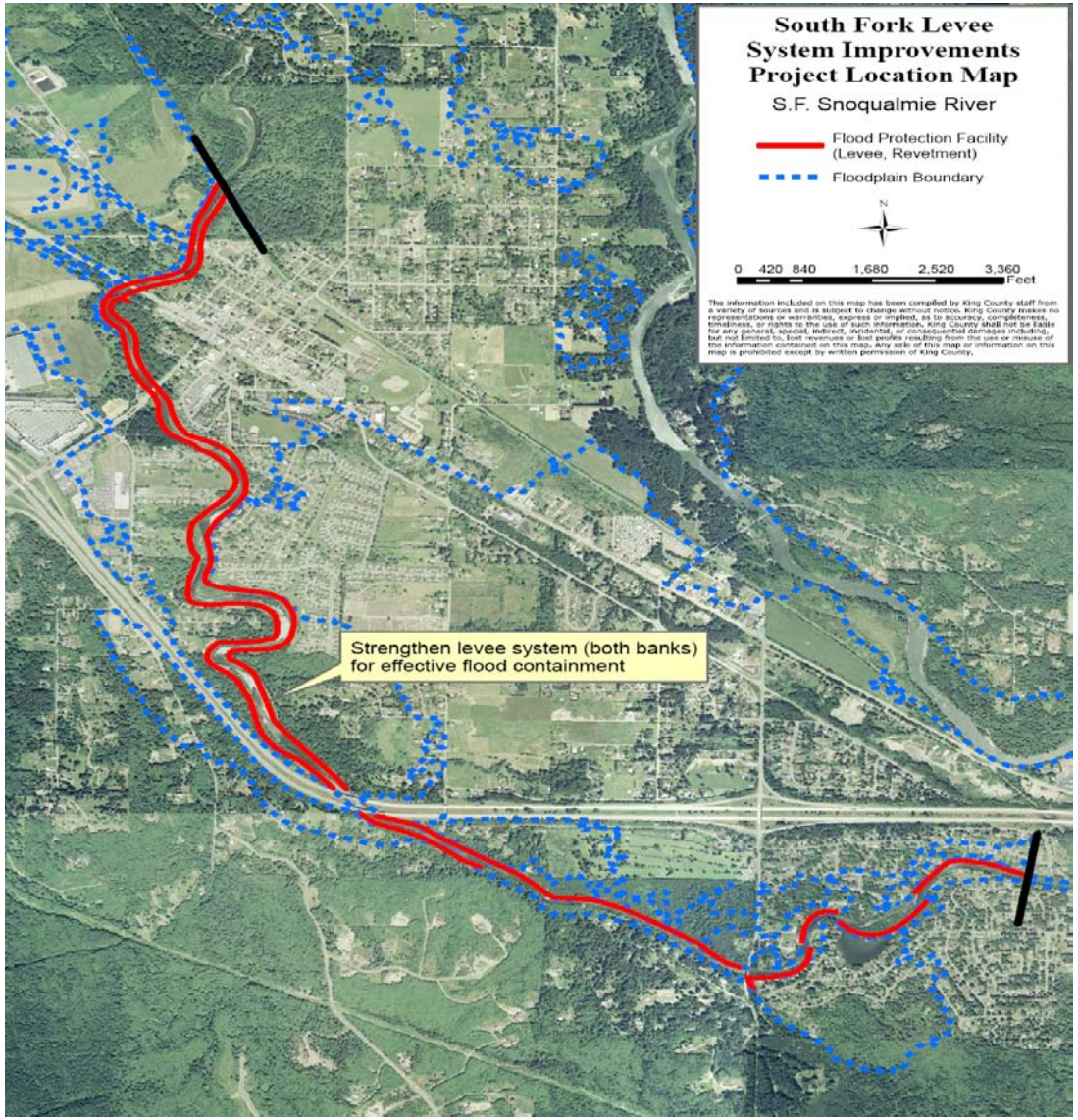
Lower Snoqualmie Valley

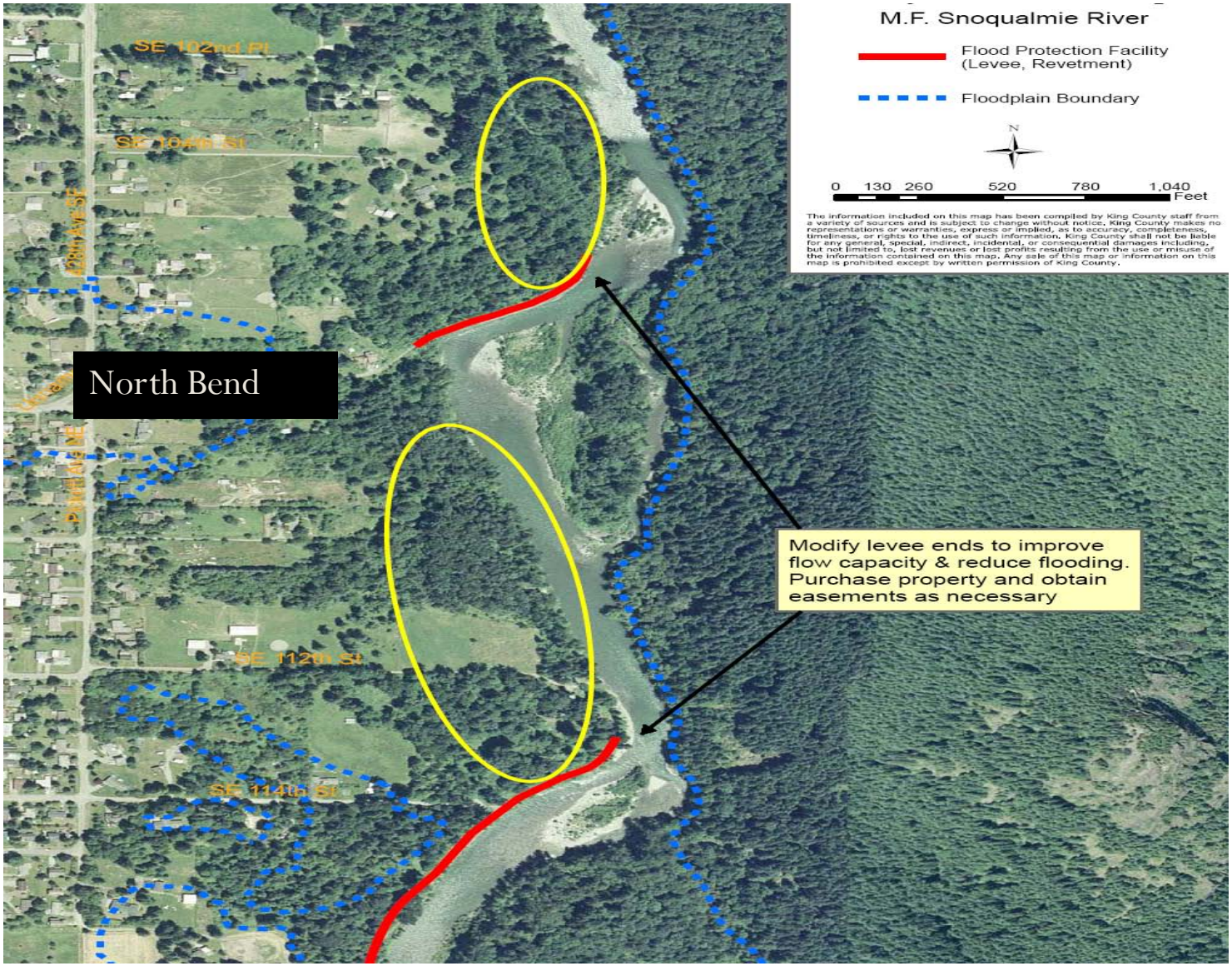
Completed Emergency Repair

Tolt River January 2009

Underway:
South Fork Snoqualmie River Corridor



Underway:
Middle Fork Snoqualmie Corridor



Cedar River Basin

- River/Stream
- Other Basin Boundaries
- Lake
- Incorporated Area
- Cedar River Basin

Produced by: King County DNRP
GIS, Visual Communications & Web Unit
File Name: 0901_KCwriasPPT.ai lpre

King County

Cedar River Residential Flood Risks: Byers Bend, Dorre Don and Repetitive Loss Properties

Cedar River, 2001

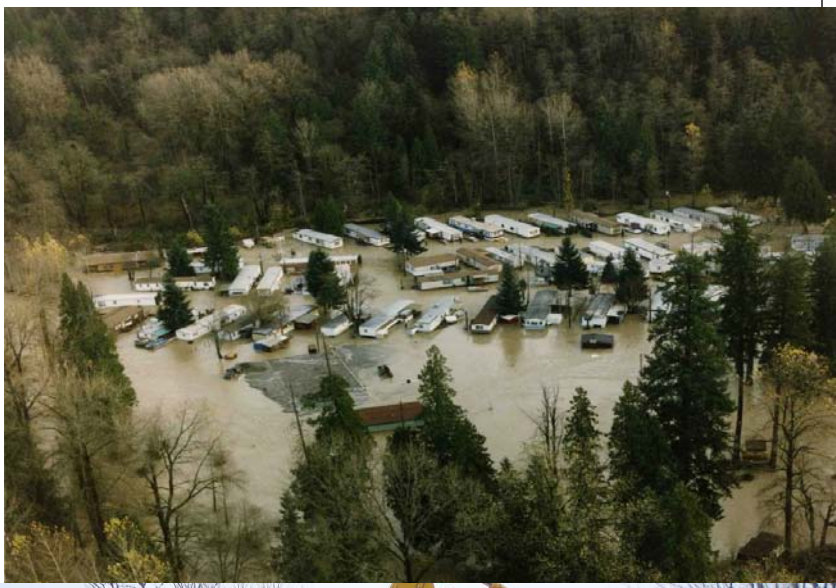
Byers Bend 2009

Cedar River Flood Risks:
Erosive Flows and Critical Public Facilities

Belmondo: Scour threatened the trail, a regional fiber optic line, and SR-169. Similar problems at multiple locations.

Cedar-Sammamish Strategy

- Reduce flood velocities and volumes that threaten critical public infrastructure, residential dwellings, and block sole-access roads
- Reduce public safety risks associated with neighborhood-scale flooding and channel migration



Completed Acquisition Project:
Cedar Grove / Rainbow Bend (Levee Setback Upcoming)

2009

1990

- 38 acres
- 50+ homes
- Over 175 residents relocated to safer housing
- $12M total from multiple funding sources

Completed Project:
Cedar Rapids Floodplain Reconnection and Levee Setback
RM 7.5 Left and Right Bank

- Flooding reduced for downstream properties.
- Insufficiently ballasted logs moved beyond project area.
- Lessons Learned

Cedar River Upcoming Project:
Elliott Bridge Acquisition and Levee Setback

RM 5 Left and Right Bank

Potential Site for SR 520 Bridge Mitigation

January 2009

Cedar River Upcoming Project: Renton Channel Sediment Removal

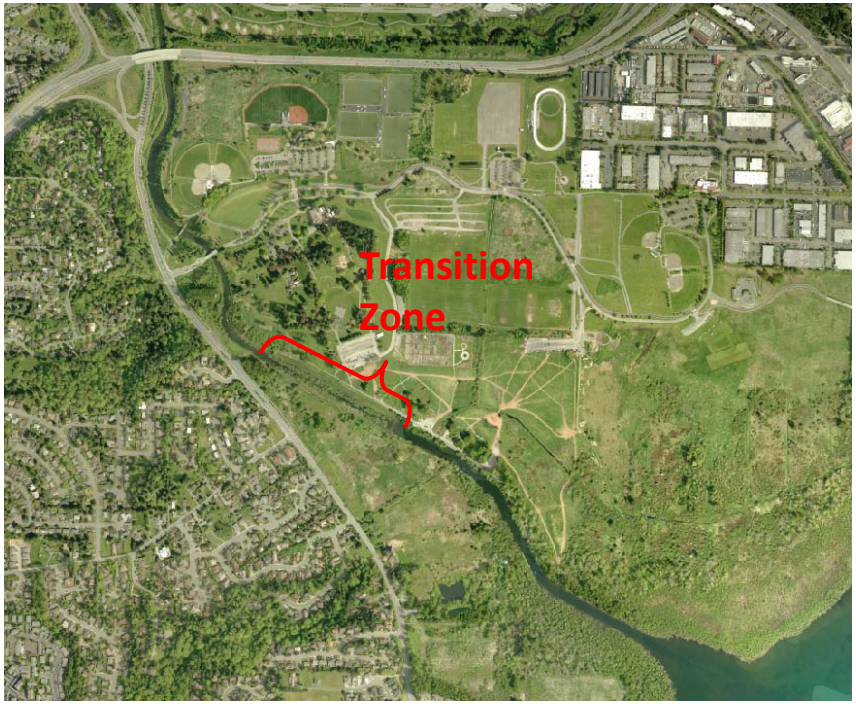
February 1996

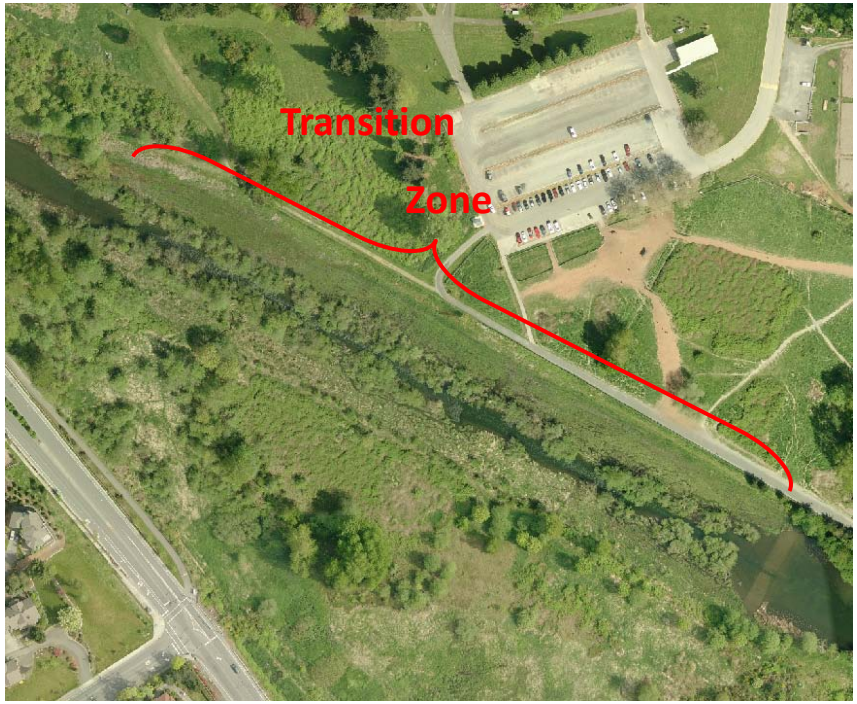
Flood peak 7520 cfs in Renton

January 2009

Flood peak 9470 cfs in Renton

Lake Sammamish and the Sammamish River





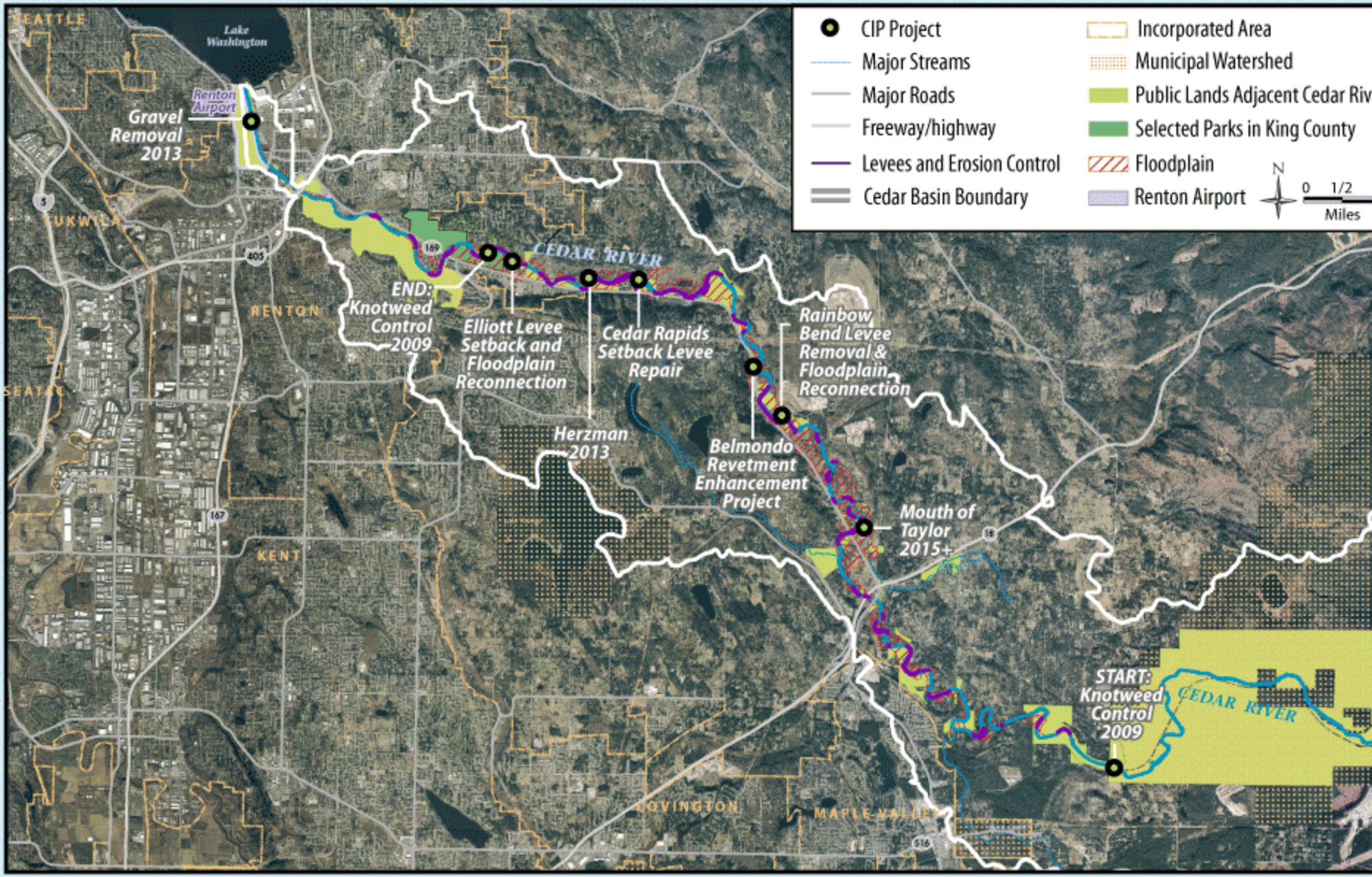
Cedar River Accomplishments to Date

- Flood Damage Reduction through Acquisition since 2006
  - 115 Homes Acquired
  - 153 acres

- Levees and Revetments
  - 10 miles of facilities maintained
  - 2 emergency repairs
  - 38 bank stabilizations over 2,459 LF
- Emergency flood response
  - November 2006
  - January 2009
  - January 2011

Major Cedar River Projects - 2012 to 2016

King County



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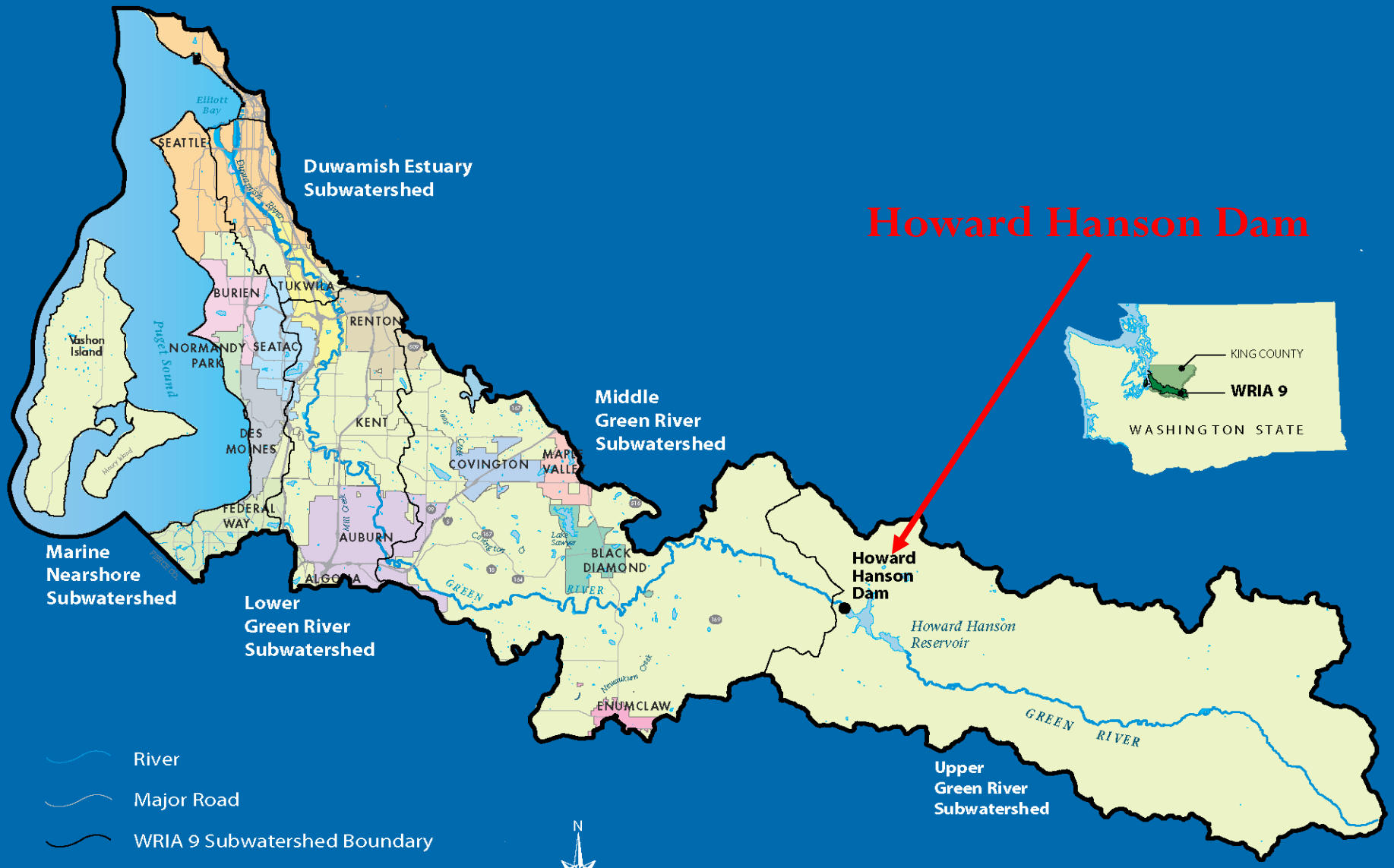
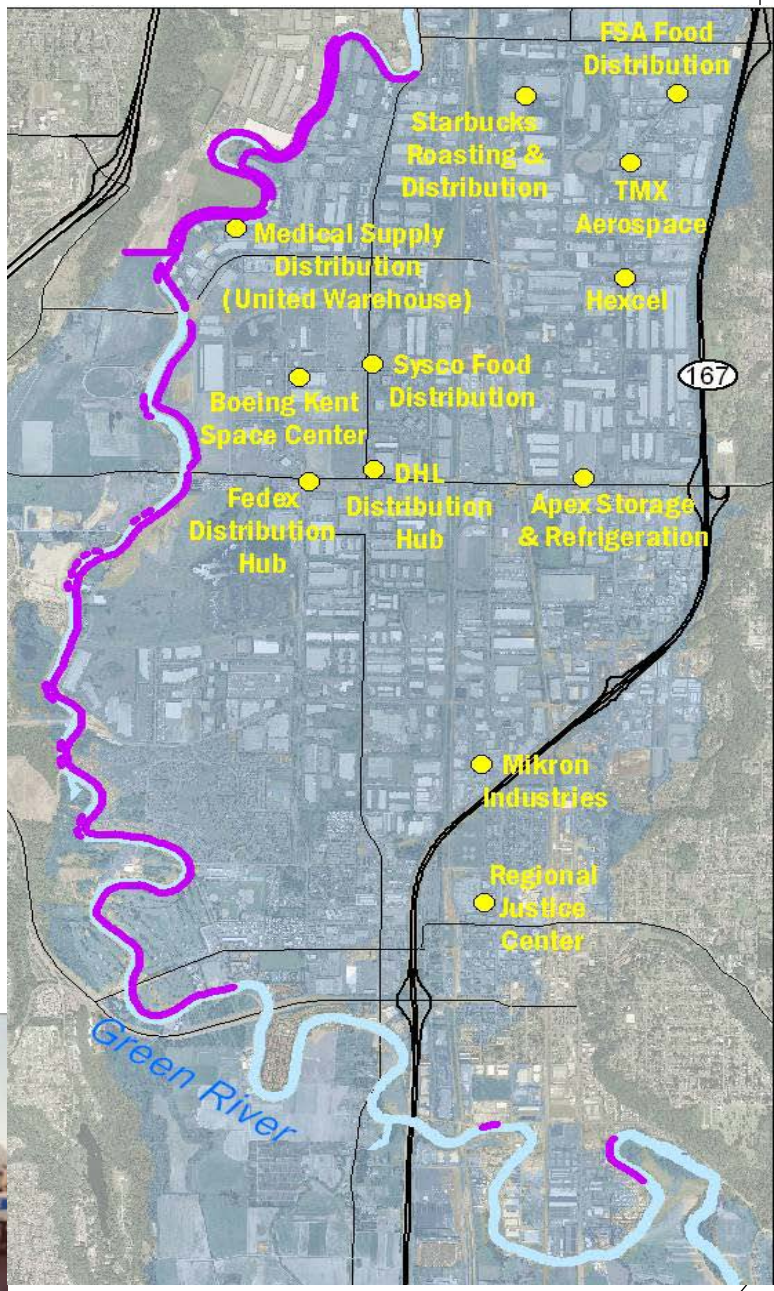

Howard Hanson Dam
Duwamish Estuary Subwatershed
Middle Green River Subwatershed
Marine Nearshore Subwatershed
Lower Green River Subwatershed
Upper Green River Subwatershed
Howard Hanson Dam
Howard Hanson Reservoir
GREEN RIVER
SEATTLE
Elliott Bay
Duwamish Bay
BURIEN
TUKWILA
RENTON
NORMANDY PARK
SEATAC
Vashon Island
Puget Sound
KENT
DES MOINES
COVINGTON
MAPLE VALLEY
FEDERAL WAY
AUBURN
ALGONA
BLACK DIAMOND
Lake Sawyer
ENUMCLAW
KING COUNTY
WRIA 9
WASHINGTON STATE
River
Major Road
WRIA 9 Subwatershed Boundary
WRIA 9 Boundary
Open Water
Unincorporated King County
N
0 2 4 6 Miles
March 2009
King County
Department of Natural Resources and Parks
0903_W9MAPppt.ai LPRE

King County

Green River Flood Risks

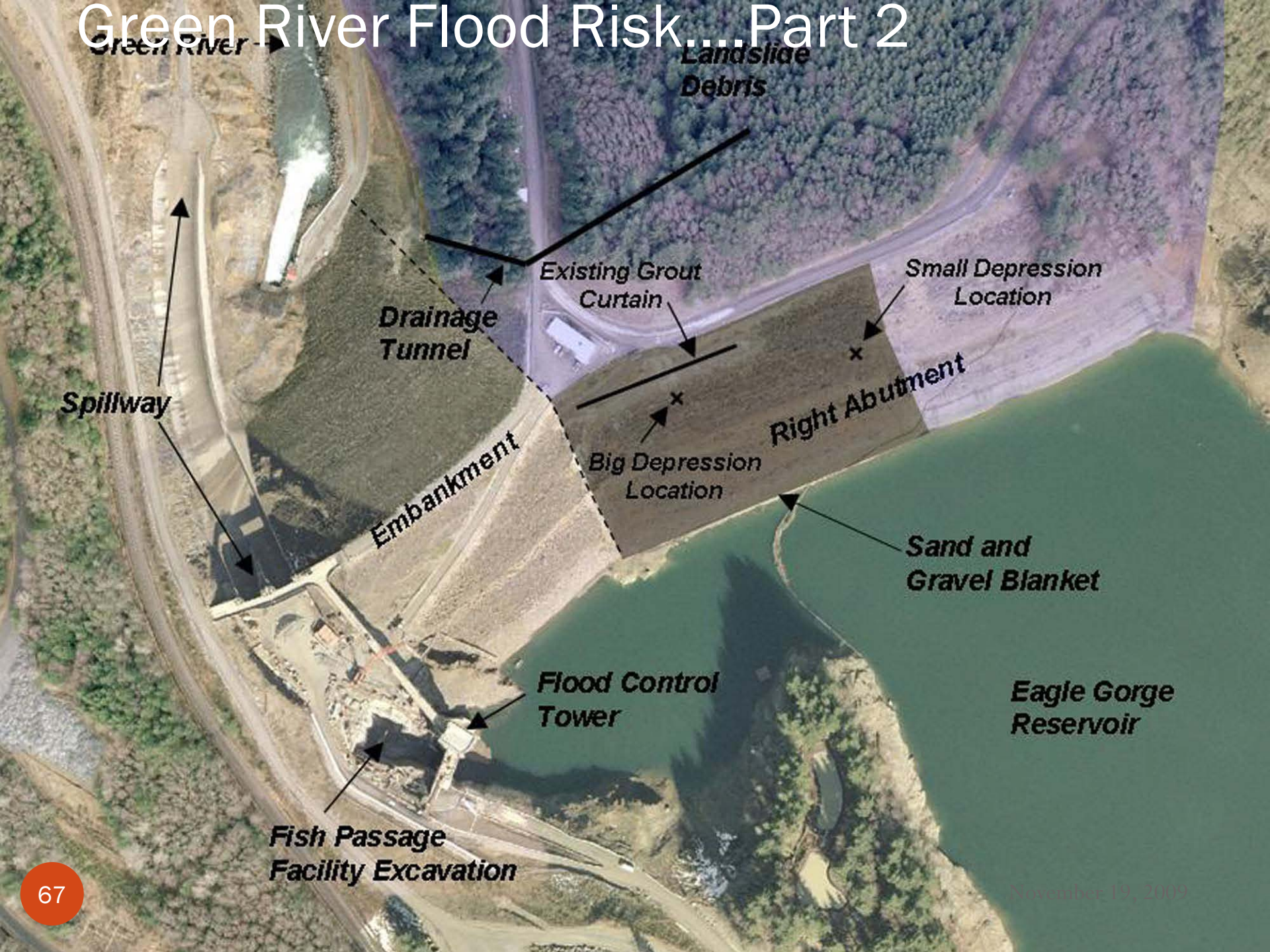
- over 100,000 jobs
- includes 100 million square feet of warehousing and distribution space (the 2nd largest complex on the West Coast; 4th-largest in the nation)
- an annual payroll of $2.8 Billion
- comprises fully 1/8th of the entire Gross Domestic Product of the State of Washington,
- annual taxable revenue of $8 billion.



Green River Flood Facilities

- Built to control Howard Hanson Dam outflow
- 138 existing flood facilities along almost 40 river miles
- Extensive urban land use behind levee system
- While the percentage risk of flooding is low given the flood control features, damages as a result of just one flood event without levee containment would be significant.

Green River Flood Risk….Part 2



Green River Temporary Containment

- Installed along 26 miles of levees
- Inspection and Maintenance by KCFCD
- Ongoing coordination with Cities
- Removal after March 2012

Howard Hanson Dam: Fully Functional, but New Recognition

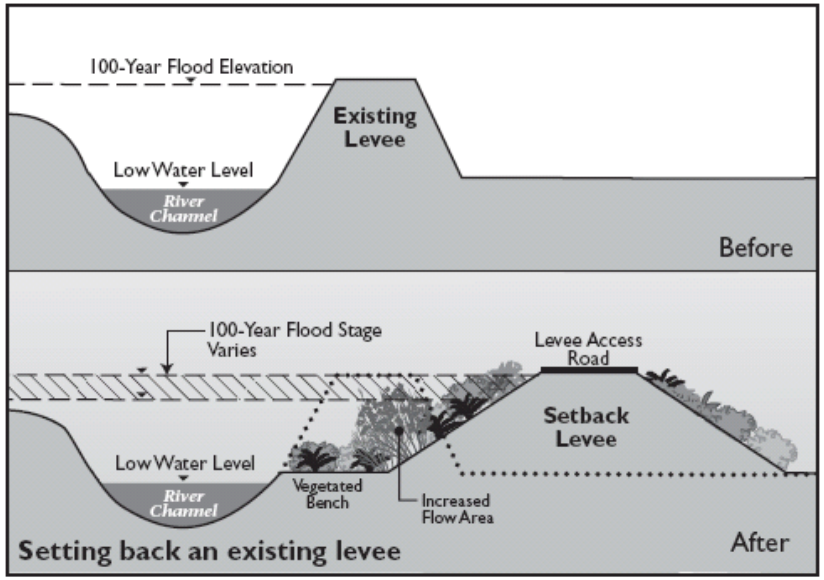
(assuming 1:140 annual chance that flow >12,000 cfs)

Number of Years	Cumulative Probability
1	0.7%
10	6.9%
15	10.2%
25	16.4%
50	30.1%
100	51.2%

Green River Strategy

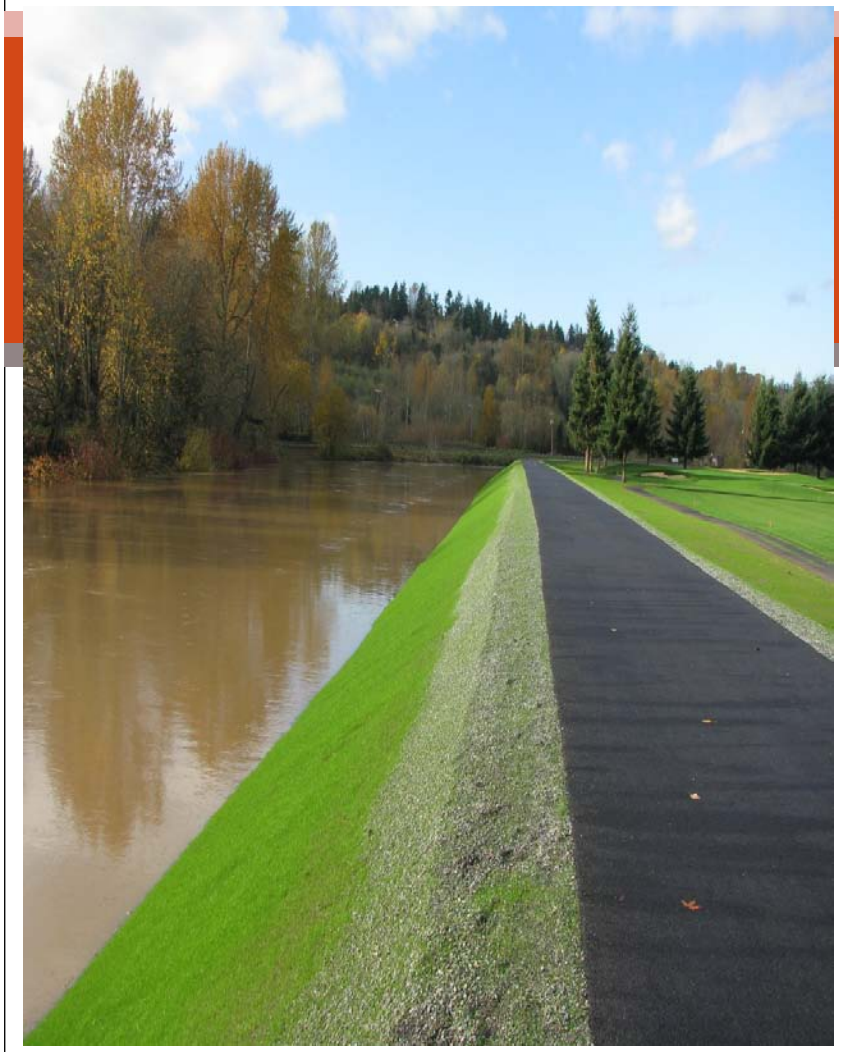
- Rehabilitate levees to current engineering designs to protect critical public infrastructure and regional distribution centers
- In many places this means setting back the levees to meet necessary geometry for a stable slope and installation of habitat features.
- Implementation Constraints:
  - Land ownership issues influence implementation ability
  - High costs of land acquisition and ROW

LEVEE SETBACK PROJECTS
2006 KING COUNTY FLOOD HAZARD MANAGEMENT PLAN



Bio-engineered levee setback - Lower Green River

Overview of Green River Work Completed and Underway



Capital Projects and Levee Repairs:

- 600 Feet – Briscoe Levee #4 in 2007
- Over 12,000 linear feet rebuilt 2008-09
- Critical repairs at 3 other sites to protect critical public infrastructure and commercial and industrial land uses

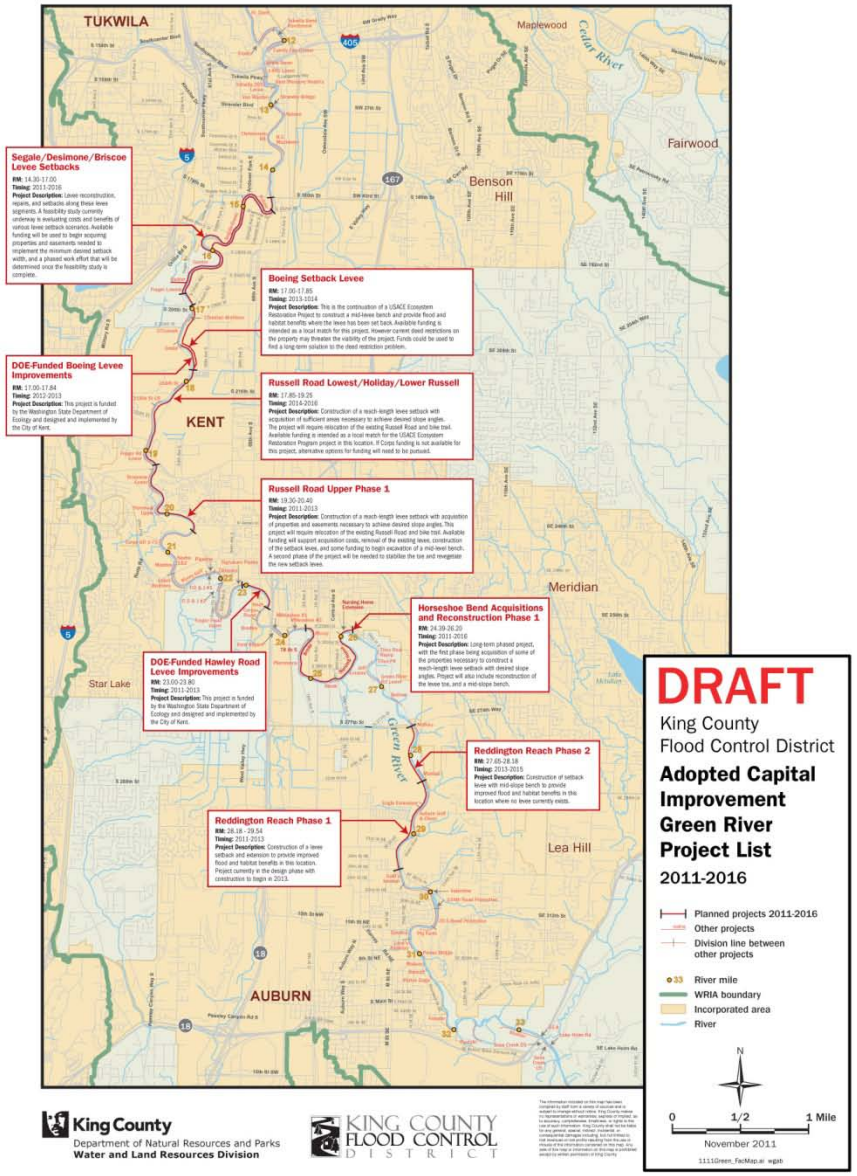
Engineering Design

- 180th-200th Street Levee Setback Feasibility Study (Kent/Tukwila)
- Reddington Levee Setback and Extension Feasibility Study (Auburn)
- Coordination with City of Kent on their efforts to receive FEMA accreditation of levee's in City limits.

Land and Right of Way Acquisitions

- Tuefel Nursery Site (Kent)
- Horseshoe Bend parcels (Kent)
- Pursue additional ROW acquisitions based on engineering designs

Overview of Green River 6 Year CIP



- Over $64 million In funding planned in the next six years.
- Projects are planned between RM 14.3 and 29.3 in the Lower Green River.
- 7 projects primarily consist of levee reconstruction, repairs and setbacks with the inclusion of benches to accommodate habitat.
- First project to be initiated is the Reddington Levee Setback and Extension.
  - First phase to start construction in 2013
  - Length of the project: 1.3 Miles
  - Received $1.03 million in State funding to help with the project.
- Two additional State funded projects along the Boeing Levee ($2.07 million) and Hawley Road Levee ($900,000) are primarily to achieve freeboard levels that meet FEMA standards for accreditation of these levees in the City of Kent.

White River Basin

- River/Stream
- Other Basin Boundaries
- Lake
- Incorporated Area
- White River Basin

Produced by: King County DNRP
GIS, Visual Communications & Web Unit
File Name: 0901_KCwriasPPT.ai lpre

King County

Shaughnessy Park
Rotary Park - Auburn
AUBURN WAY S
R ST SE
29TH ST SE
Algona
1ST AVE S
ALGONA BLVD S
A ST SE
Auburn
37TH ST SE
Ballard Park
New R St. gage
ELLINGSON RD
Roegner Park
Mill Pond Park
KERSEY WAY
3RD AVE SE
Pacific
167
WEST VALLEY HWY
Pacific Park
UTTE AVE
53RD ST SE
Lakeland Hills Park
King-Pierce Boundary
Bowman Lake
Hille Lake

Flooding on the Lower White River

(January 9, 2009)

White River Estates (Pacific)

Pacific Park

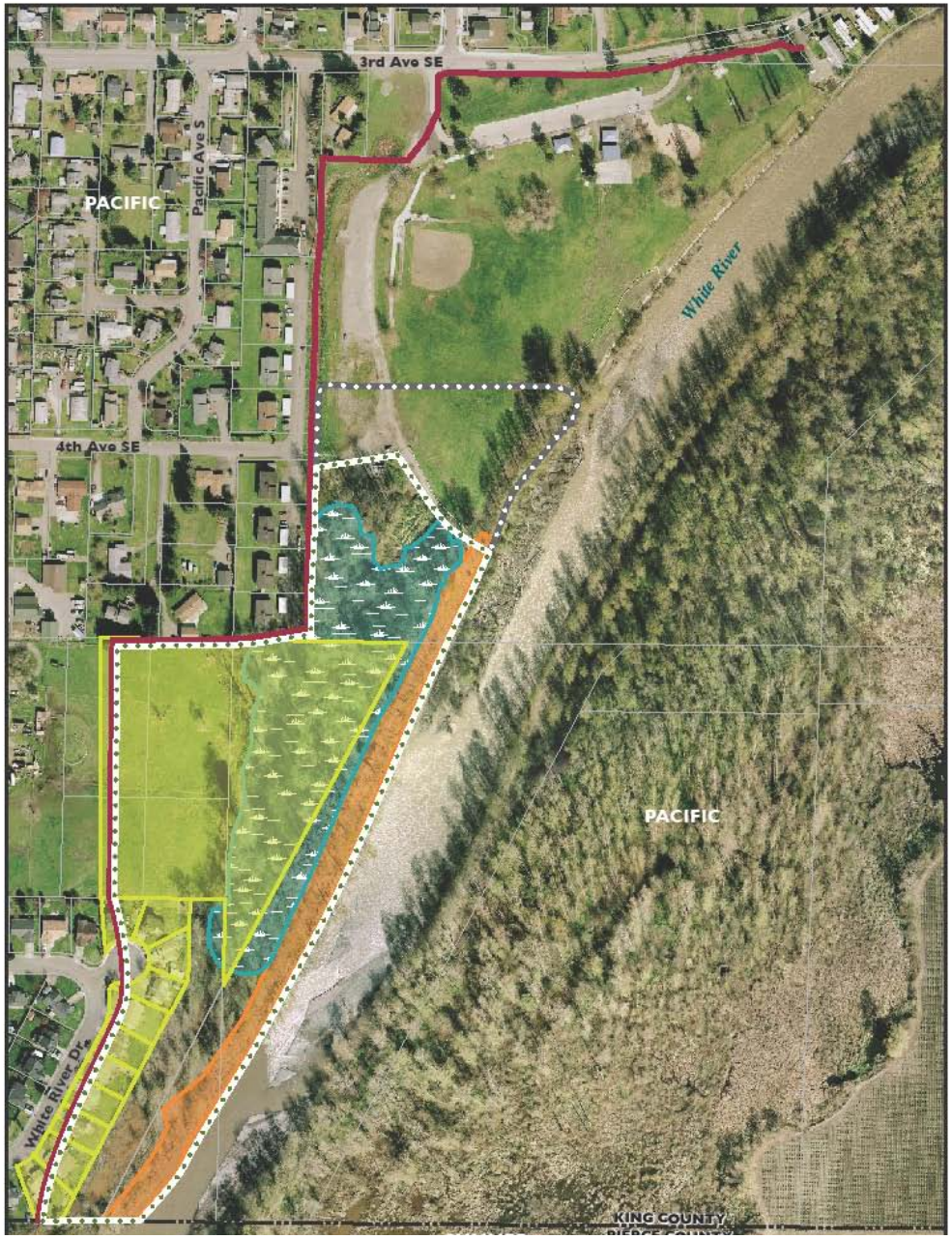
- Corps Mud Mountain Dam flow release - 11,700 cfs; Congressional authorization is 17,500
- Flooding extended beyond mapped 100-yr floodplain boundaries
- Estimated 60 homes damaged, 15 families displaced, 7 businesses closed
- $5 million in residential damages, $10 million in commercial damages

White River Strategy

- Reduce risks to public safety by setting back levees to increase flood storage and conveyance capacity
- Buyout residential structures at risk of flooding and rapid channel migration

Vicinity Map

White River:
City of Pacific Temporary Flood Protection



Right Bank Levee Setback Project

Construct setback levee --------
Acquire land rights
Remove existing revetment
Enhance wetland areas

Temporary HESCO flood barrier installed in 2009

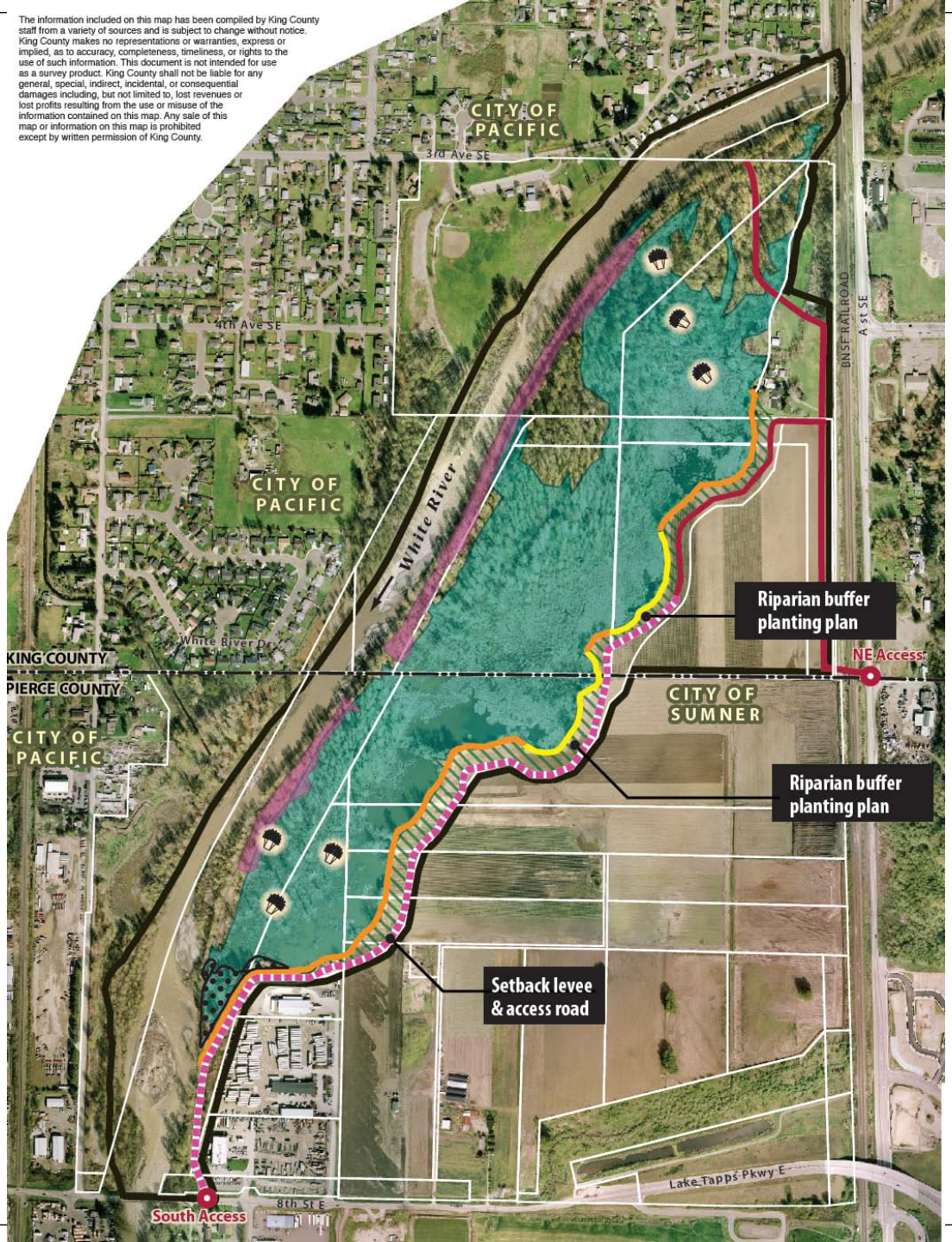
Eleven SF homes / two vacant parcels purchased 2010/2011

Feasibility Analysis 2013
Complete Design 2014 Target
Construction 2015 and 2016 Target

Continue collaboration with City of Pacific project to modify storm drainage outfalls and pond for White River Estates neighborhood

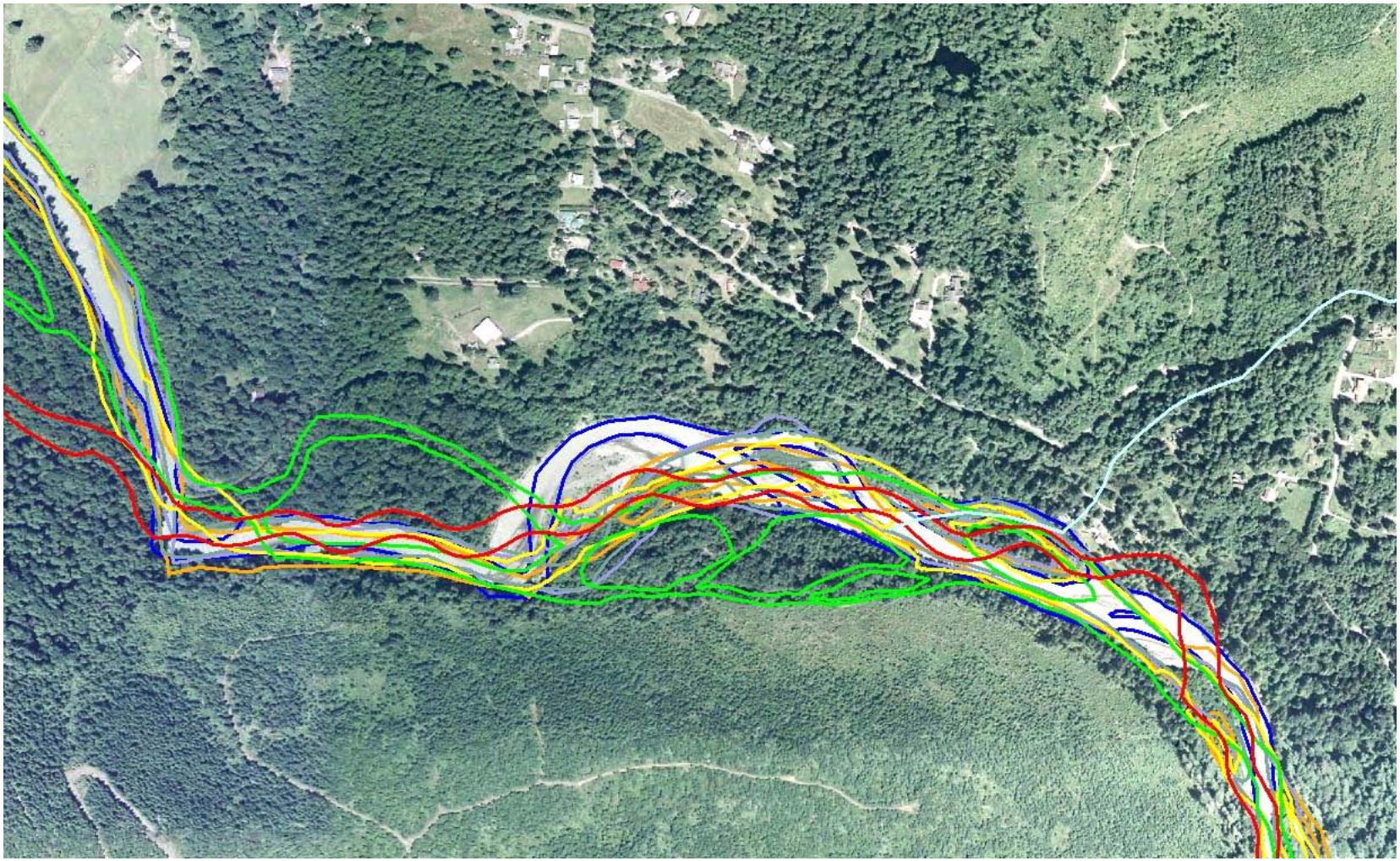
Left Bank Levee Setback Project

"Countyline Project"



- Parcel of Interest
- Wetland
- Revetment & Levee Removal
- Planting Plan Area
- Culvert Removal, Outlet Channel & Fill Removal
- Project Ingress/Egress
- Engineered log structure
- Setback Levee & Access Road
- Access Road
- Bank Roughening
- Bioengineered revetment
- Project Area Boundary

White River historic channel locations near Red Creek



Technical Work to Guide Future Actions

- White River Flood Map (2009)
- USGS Sediment Study Part 1 (2010) – Channel Conveyance and Sediment Transport
- USGS Sediment Study Part 2 (2012)– Sediment movement and delivery
- USGS Sediment Study Part 3 (2012): Flood Management, Habitat, and Fish Bioenergetics
- USGS Radar Gages on Lower White (2012)
- Channel Migration Study and Mapping (2012-2013)