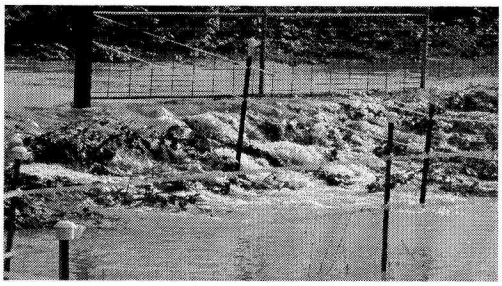
Floodplain Impacts of 2007 Farm Pad Demonstration Projects

- Protected Floodplain Functions (quick review)
- Snoqualmie Flood Study (NHC 2006)
  - Computational Tools
  - Suitability for Impact Analysis
- Impacts of Demonstration Project
  - Methods
  - Results

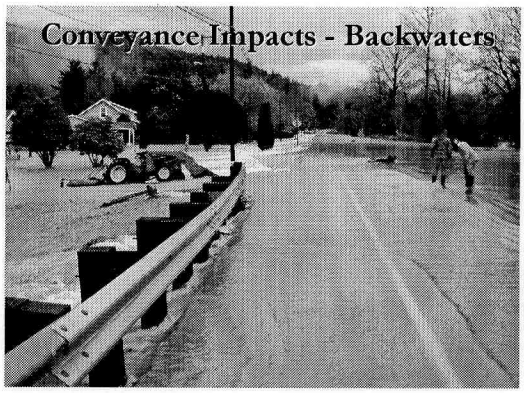
Protected Floodplain Capacities in King County

- Conveyance
  capacity to move a sustained flow in the downstream direction
- Storage
  capacity to retain inflow that exceeds the available conveyance

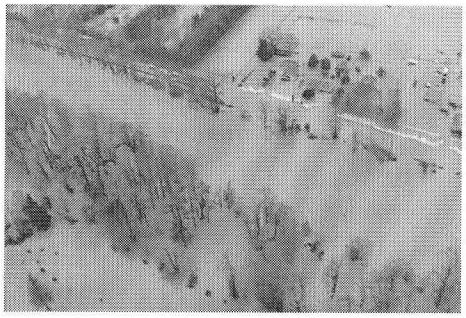
Conveyance Impacts - Backwaters



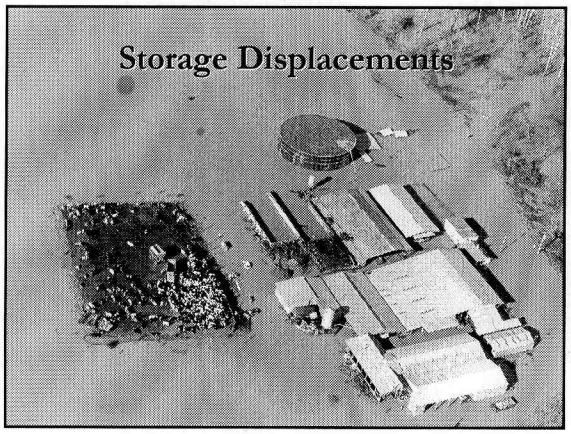
Conveyance Impacts - Backwaters



Conveyance Impacts - Backwaters



Storage Displacements



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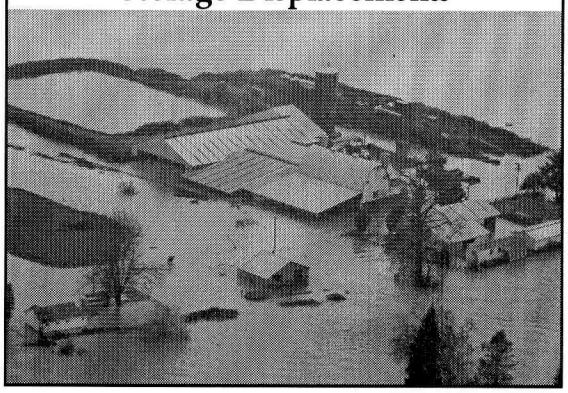
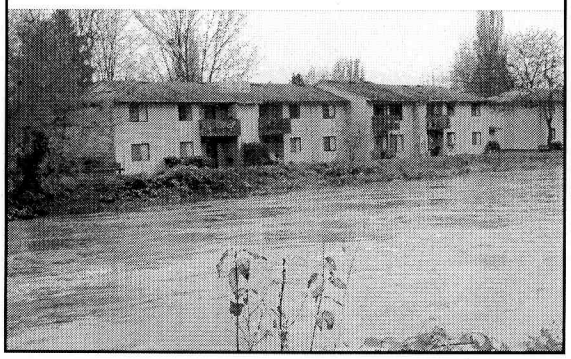
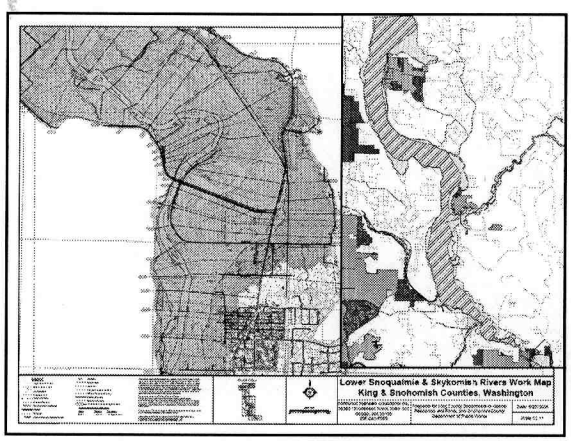


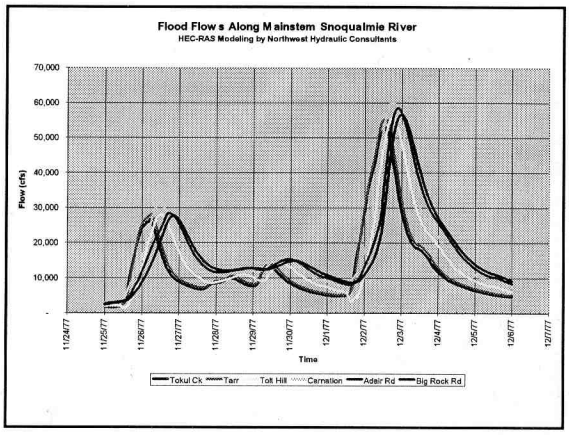
Storage Displacements

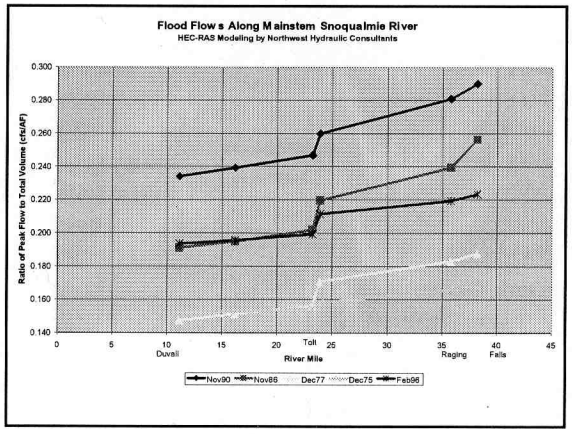


Snoqualmie River Flood Study
(NHC 2006)

- HEC-RAS Model
- Unsteady Analysis (hydrograph routing)
- Flow Distributions in Parallel Branches
- Analysis of Both Protected Functions
  - Conveyance
  - Storage







Flood Storage Protection in Floodways and Flood Fringe Areas

- Identify flood storage volume
  - Pre-project conditions
  - Post-project conditions
- Fully compensate for any displacement
  - Equivalent volume
  - Equivalent elevations
- Preserves function
- Prevents cumulative impacts

Unsteady routing in HEC-RAS can identify any impacts associated with storage displacements.

Conveyance Protection Within King County's Zero-Rise Floodway

- Demonstrate that post-project WSE, EGL will be no higher than pre-project WSE, EGL
- Calculate to nearest 0.01 foot
- Difference of 0.0049 ft. rounds to 0.00 ft.
- Each project is evaluated individually
- Cumulative impacts are not evaluated
- Extent of a small backwater impact is limited

HEC-RAS is the standard tool for this analysis

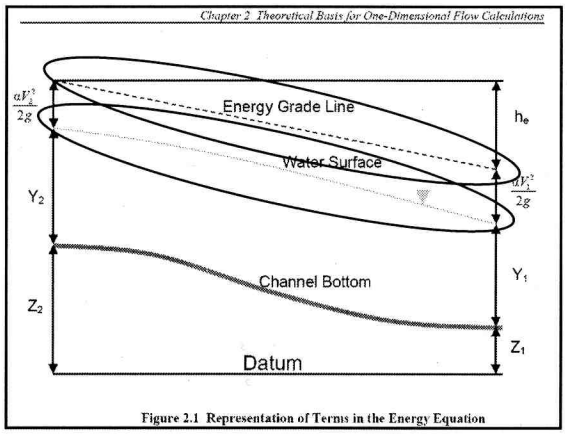
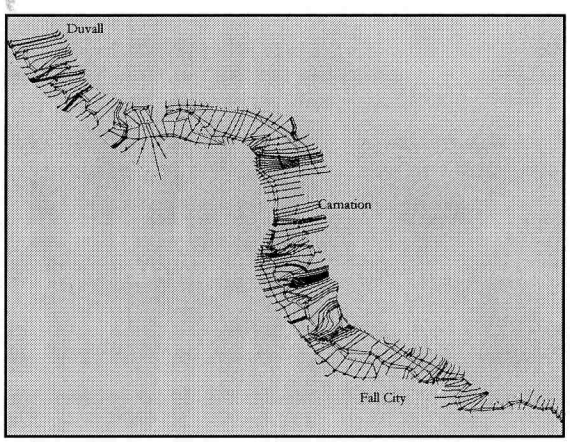
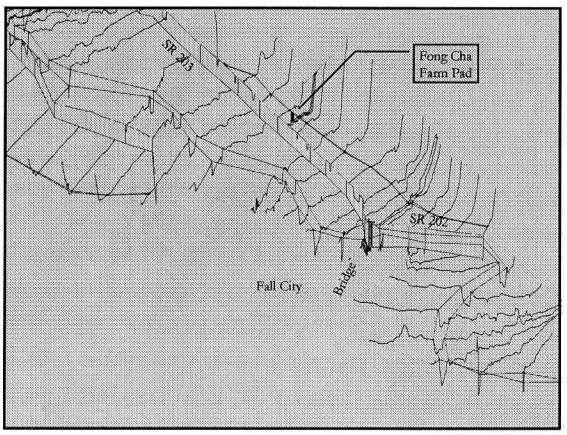
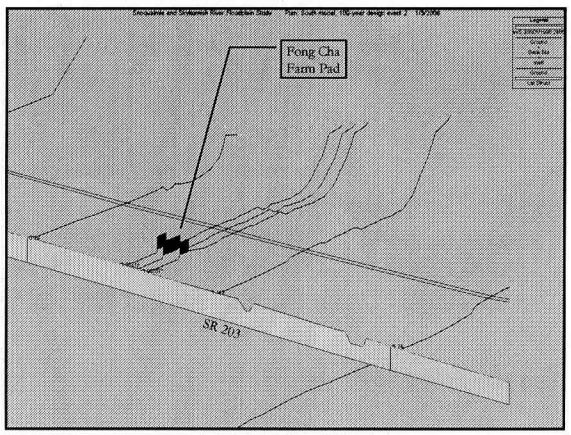
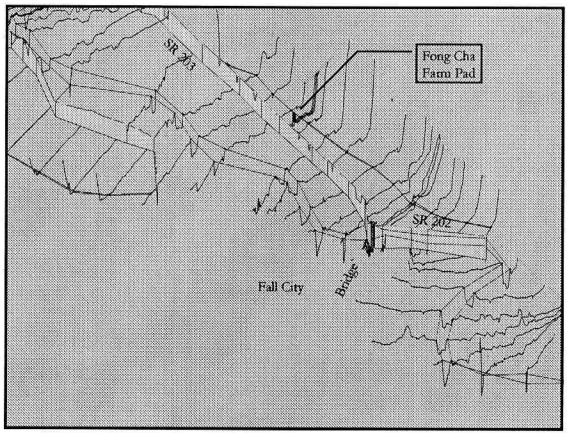


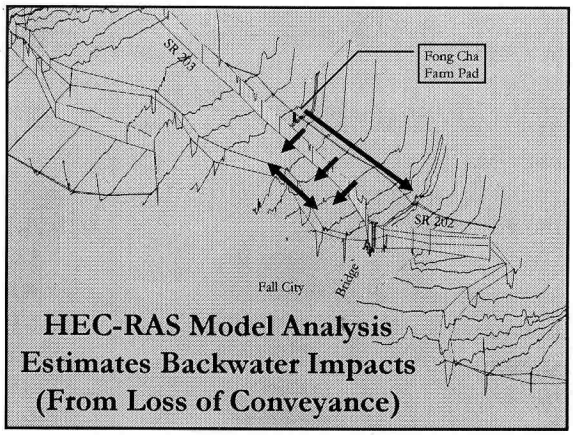
Figure 2.1 Representation of Terms in the Energy Equation

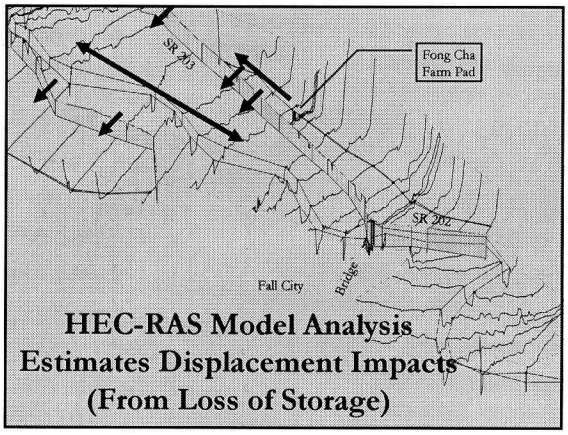


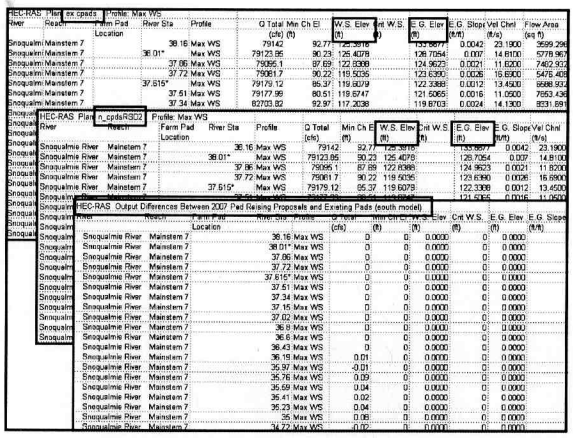












HEC-RAS Plan: ex cpds Profile: Max WS

River	Reach	Farm Pad Location	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)
Snoqualmi	Mainstem 7		38.16	Max WS	79142	92.77	125.3816		133.8607	0.0042	23.1900	3599.296
Snoqualmi	Mainstem 7		38.01*	Max WS	79123.85	90.23	125.4078		126.7054	0.007	14.8100	5778.967
Snoqualmi	Mainstem 7		37.86	Max WS	79095.1	87.69	122.8388		124.9623	0.0021	11.8200	7402.932
Snoqualmi	Mainstem 7		37.72	Max WS	79061.7	90.22	119.5035		123.6390	0.0026	16.6900	5476.408
Snoqualmi	Mainstem 7		37.615*	Max WS	79179.12	85.37	119.6079		122.3389	0.0012	13.4500	6688.932
Snoqualmi	Mainstem 7		37.51	Max WS	79177.99	80.51	119.6747		121.5065	0.0016	11.0500	7653.436
Snoqualmi	Mainstem 7		37.34	Max WS	82703.82	92.97	117.2036		119.8703	0.0024	14.1300	8531.691

HEC-RAS Plan: n_cpds RS02 Profile: Max WS

River	Reach	Farm Pad Location	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)
Snoqualmie River	Mainstem 7		38.16	Max WS	79142	92.77	125.3816		133.8607	0.0042	23.1900
Snoqualmie River	Mainstem 7		38.01*	Max WS	79123.85	90.23	125.4078		126.7054	0.007	14.8100
Snoqualmie River	Mainstem 7		37.86	Max WS	79095.1	87.69	122.8388		124.9623	0.0021	11.8200
Snoqualmie River	Mainstem 7		37.72	Max WS	79061.7	90.22	119.5035		123.6390	0.0026	16.6900
Snoqualmie River	Mainstem 7		37.615*	Max WS	79179.12	85.37	119.6079		122.3389	0.0012	13.4500

HEC-RAS Output Differences Between 2007 Pad Raising Proposals and Existing Pads (south model)

River	Reach	Farm Pad Location	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)
Snoqualmie River	Mainstem 7		38.16	Max WS	0	0	0.0000	0	0.0000	
Snoqualmie River	Mainstem 7		38.01*	Max WS	0	0	0.0000	0	0.0000	
Snoqualmie River	Mainstem 7		37.86	Max WS	0	0	0.0000	0	0.0000	
Snoqualmie River	Mainstem 7		37.72	Max WS	0	0	0.0000	0	0.0000	
Snoqualmie River	Mainstem 7		37.615*	Max WS	0	0	0.0000	0	0.0000	
Snoqualmie River	Mainstem 7		37.51	Max WS	0	0	0.0000	0	0.0000	
Snoqualmie River	Mainstem 7		37.34	Max WS	0	0	0.0000	0	0.0000	
Snoqualmie River	Mainstem 7		37.15	Max WS	0	0	0.0000	0	0.0000	
Snoqualmie River	Mainstem 7		37.02	Max WS	0	0	0.0000	0	0.0000	
Snoqualmie River	Mainstem 7		36.8	Max WS	0	0	0.0000	0	0.0000	
Snoqualmie River	Mainstem 7		36.6	Max WS	0	0	0.0000	0	0.0000	
Snoqualmie River	Mainstem 7		36.43	Max WS	0	0	0.0000	0	0.0000	
Snoqualmie River	Mainstem 7		36.19	Max WS	0.01	0	0.0000	0	0.0000	
Snoqualmie River	Mainstem 7		35.97	Max WS	-0.01	0	0.0000	0	0.0000	
Snoqualmie River	Mainstem 7		35.76	Max WS	0.09	0	0.0000	0	0.0000	
Snoqualmie River	Mainstem 7		35.69	Max WS	0.04	0	0.0000	0	0.0000	
Snoqualmie River	Mainstem 7		35.41	Max WS	0.02	0	0.0000	0	0.0000	
Snoqualmie River	Mainstem 7		35.23	Max WS	0.04	0	0.0000	0	0.0000	
Snoqualmie River	Mainstem 7		35	Max WS	0.08	0	0.0000	0	0.0000	
Snoqualmie River	Mainstem 7		34.72	Max WS	0.02	0	0.0000	0	0.0000	

Stage Differences

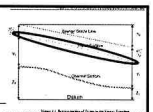


Table 1. Farm Pad Proposals
Maximum Computed 100-yr Flood Elevations Upstream of Farm Pads

Location Description –N ame/Parcel #)	Model cross-section	Existing farm pad (feet)	Proposed farm pad (feet)	Difference[1] (ft)
Beyers / # 2925079047	26.2503	79.6136	79.6138	+0.000
Decker / #2526069015	15.08	54.4211	54.4212	+0.000
Majerle / #7339500005	2.5549	49.6633	49.6633	+0.000
PCC Land Trust / #0125069002	0.625	55.7056	55.7057	+0.000
Roestsensender/#0626079010	1.81043	49.5536	49.5538	+0.000
Fong Cha/#1024079030	1.115	92.2657	92.2699	+0.004
Michael Boudreaux/#2925079039	0.83762	79.6767	79.6770	+0.000
Casey/#3225079001	27.3442	80.2109	80.2113	+0.000
Hueblie/#0424079024	29.5933	82.9206	82.9213	+0.001
Ransom/#0424079033	31.67	85.1285	85.1289	+0.000
Borden/#2326069008	11.47	52.1136	52.1136	+0.000
Seana/#3225079023	2.1832	81.3726	81.3737	+0.001
Strom/	26.6139	79.7505	79.7507	+0.000

[1]Only differences in computed water surface elevations greater than +0.001 were considered significant and exclusive of numerical modeling errors.

Energy Grade Differences

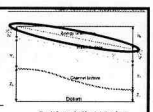


Table 2. Farm Pad Proposals
Maximum Computed 100-yr Energy Grade Elevations Upstream of Farm Pads

Location Description –N ame/Parcel #)	Model cross-section	Existing farm pad (feet)	Proposed farm pad (feet)	Difference[1] (ft)
Beyers / # 2925079047	26.2081	79.6626	79.6630	+0.000
Decker / #2526069015	15.08	54.4936	54.4937	+0.000
Majerle / #7339500005	2.5549	49.6697	49.6697	+0.000
PCC Land Trust / #0125069002	0.625	55.7205	55.7207	+0.001
Roestsensender/#0626079010	1.81043	49.5569	49.5570	+0.000
Fong Cha/#1024079030	1.115	92.3207	92.3244	+0.004
Michael Boudreaux/#2925079039	0.83762	79.6811	79.6814	+0.000
Casey/#3225079001	27.2957	80.2678	80.2684	+0.001
Hueblie/#0424079024	29.23	82.9810	82.9836	+0.003
Ransom/#0424079033	31.67	85.1802	85.1806	+0.000
Borden/#2326069008	11.47	52.1461	52.1461	+0.000
Seana/#3225079023	2.1832	81.4011	81.4021	+0.001
Strom/	26.6343	79.9020	79.9023	+0.000

[1]Only differences in computed water surface elevations greater than +0.001 were considered significant, and exclusive of numerical modeling errors.

Zero-Rise Summary for Farm Pad Demonstration Project

- Pads Satisfy Backwater Test
  - Water Surface Changes Round to 0.00 ft
  - Energy Grade Changes Round to 0.00 ft
- Cumulative Impacts Considered
  - Each Pad Modeled Individually
  - All Pads Modeled Together
- Conservative Modeling Assumptions
  - All Displacements Modeled
  - No Mitigations Modeled
  - Safety Margin Available for Construction Phase

Snoqualmie Basin Flood Facts

- 100-year flood flow volume ~356,000 acre-feet
- 100-year flood storage ~157,000 acre-feet
- Permits in 1990s -- 21 Critter Pads
  - Average pad size ~39,000 sq ft
  - Average pad height ~8 ft
  - Average pad volume ~13,000 CY
  - Cumulative volume estimate ~171 acre-feet