Considerations regarding Partial Accreditation of Dike, Drainage, and Irrigation District 12 Levee System

Chal Martin, P.E.
Public Works Director
City of Burlington

September 15, 2008

SKAGIT COUNTY
BOARD OF COMMISSIONERS

DON MUNKS, First District
KENNETH A. DAHLSTEDT, Second District
SHARON D. DILLON, Third District

June 16, 2008

Mayor Ed Brunz
City of Burlington
833 South Spruce Street
Burlington, WA 98233

RE: Memorandum of Understanding
Co-lead on Phased Environmental Review

Mayor Brunz:

We have your letter dated May 13, 2008, requesting that the County participate as co-lead in phased environmental review of a flood protection and land use project. It is our understanding that the City desires to plan for a standalone flood control project for the City of Burlington. As explained to County staff, it is our understanding this would involve levee setback and certification, a ring dike around the City, and a moderate expansion of the City's Urban Growth Area (UGA).

As you are aware, the Board of County Commissioners has charged the Flood Control Zone District (FCZD) advisory committee with basin-wide flood control planning. The FCZD advisory group sets up a carefully balanced stakeholder process involving representatives of cities, dike districts, environmental and agricultural groups, business interests, tribes, and state and federal agencies.

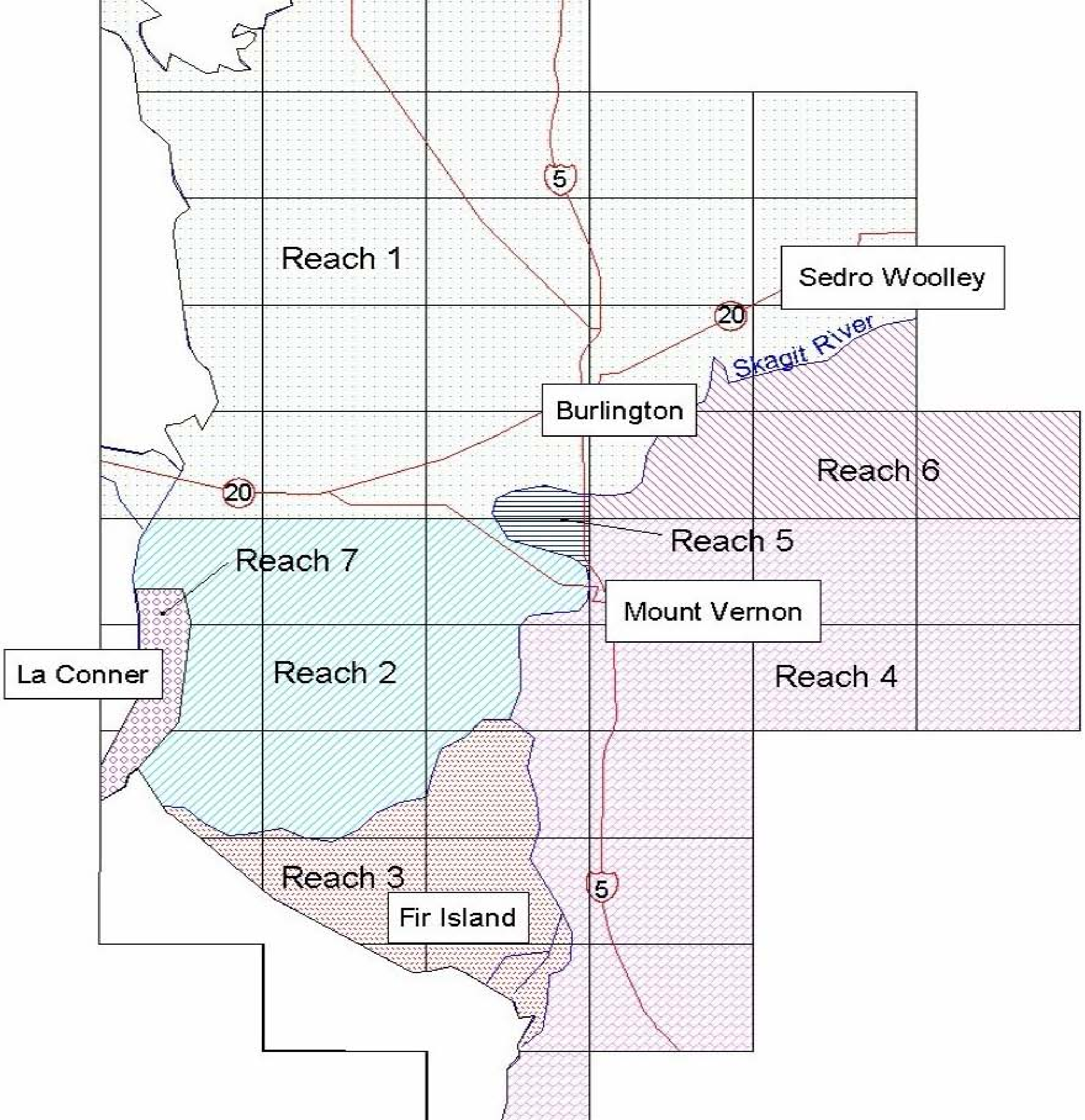
The Board of Commissioners intends to heavily rely on recommendations from the FCZD committees in flood planning going forward. Flood control projects within a river basin are necessarily interrelated. Accordingly, it is vitally important that the FCZD body furnish holistic flood control recommendations and plans that work for the entire community.

For these reasons, we would request that the City of Burlington present the concept of its proposal to the FCZD for their discussion, consideration and recommendation prior to County staff taking any action in furtherance of the City's proposal.

Overview

- Selected Information from COE / FEMA Work Products
- Hydrology: Corps vs. City/DD position
  - Update on latest investigation/modeling
- Levee certification concepts for Burlington
  - Critical affect of hydrology
- Questions

Selected COE / FEMA Work Products



Reach 1
5
Sedro Woolley
20
Skagit River
Burlington
Reach 6
20
Reach 5
Reach 7
Mount Vernon
La Conner
Reach 2
Reach 4
Reach 3
5
Fir Island

COE Theoretical Non-Damaging Flood Intervals (April 2006)

Reach	Average Years Between Damaging Flood
1	**9**
2	9
3	50
4	41
5	**500**
6	5
7	9
8	160
9	13
10	10

Expected Annual Damages

Expected Annual Damage for the Without Project Condition (Damage in $1,000's) (Analysis is based upon 5.375% discount rate, 2004 price level, and 50-year period of analysis)											
	Damage Categories										
	Residential			Public Assistance	TRA	Non-Residential			Agricultural Damages	Traffic Delays	Total
	Structure	Content	Cleanup			Structure	Content	Cleanup			
Reach 1	11,296	6,249	1,885	1,859	547	7,860	7,760	1,141	864	2,296	**41,757**
Reach 2	3,674	2,018	548	538	160	112	95	18	1,236	0	8,399
Reach 3	40	23	10	12	3	9	7	1	25	0	130
Reach 4	4,511	2,467	662	667	196	3,081	3,466	777	127	0	15,954
Reach 5	21	11	2	2	1	25	28	4	1	0	**95**
Reach 6	1,671	915	249	251	74	106	117	21	406	0	3,810
Reach 7	624	359	168	165	48	541	457	118	11	0	2,491
Reach 8	466	252	59	52	15	72	15	3	6	2	942
Reach 9	349	196	47	38	11	34	31	0	96	25	827
Reach 10	615	290	102	1,414	42	52	43	3	55	0	2,616
Road Damages											278
TOTAL	**23,267**	**12,780**	**3,732**	**4,998**	**1,097**	**11,892**	**12,019**	**2,086**	**2,827**	**2,323**	**77,299**

COE Flood Damage Assessment Hydrology Inputs

Exceedance Probability	Discharge (cfs)
0.9990	25,000
0.5000	72,900
0.2000	93,900
0.1000	120,400
0.0400	158,000
0.0200	192,100
0.0133	215,500
0.0100	235,400
0.0040	320,200
0.0020	386,900
0.0010	450,000

Equivalent Record Length: 106 years

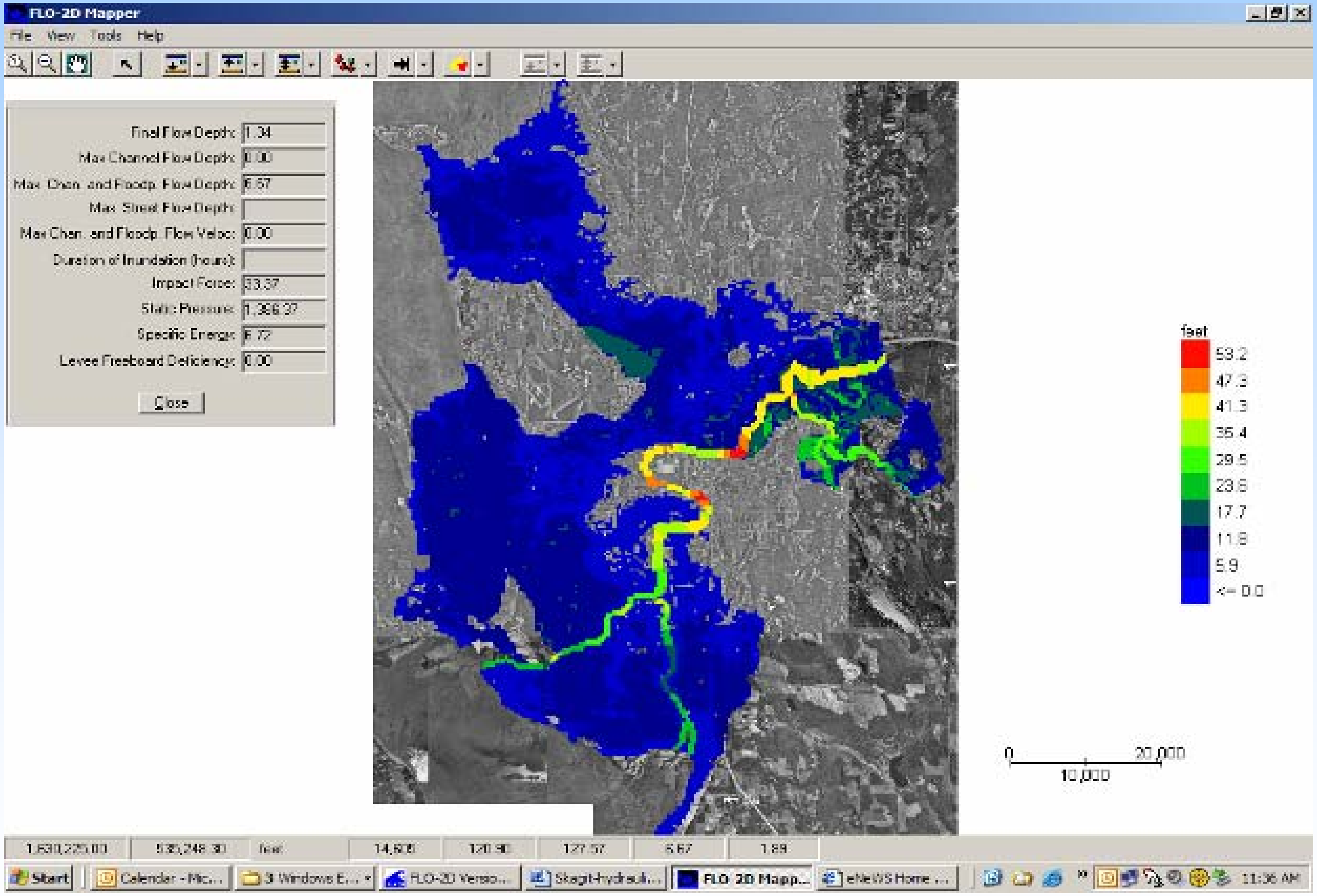
*"Economic Flood Damage Assessment of Without Project Conditions"
Seattle District, U.S. Army Corps of Engineers Draft Report, April 2006

U.S. Army Corps of Engineers
Seattle District

SKAGIT RIVER BASIN, WASHINGTON

REVISED FLOOD INSURANCE STUDY

HYDRAULICS SUMMARY



SKAGIT COUNTY, WA

Prepared For: Federal Emergency Management Agency

1 MAY 2008

Major Concern for Burlington: Base Flood Elevations and Floodway

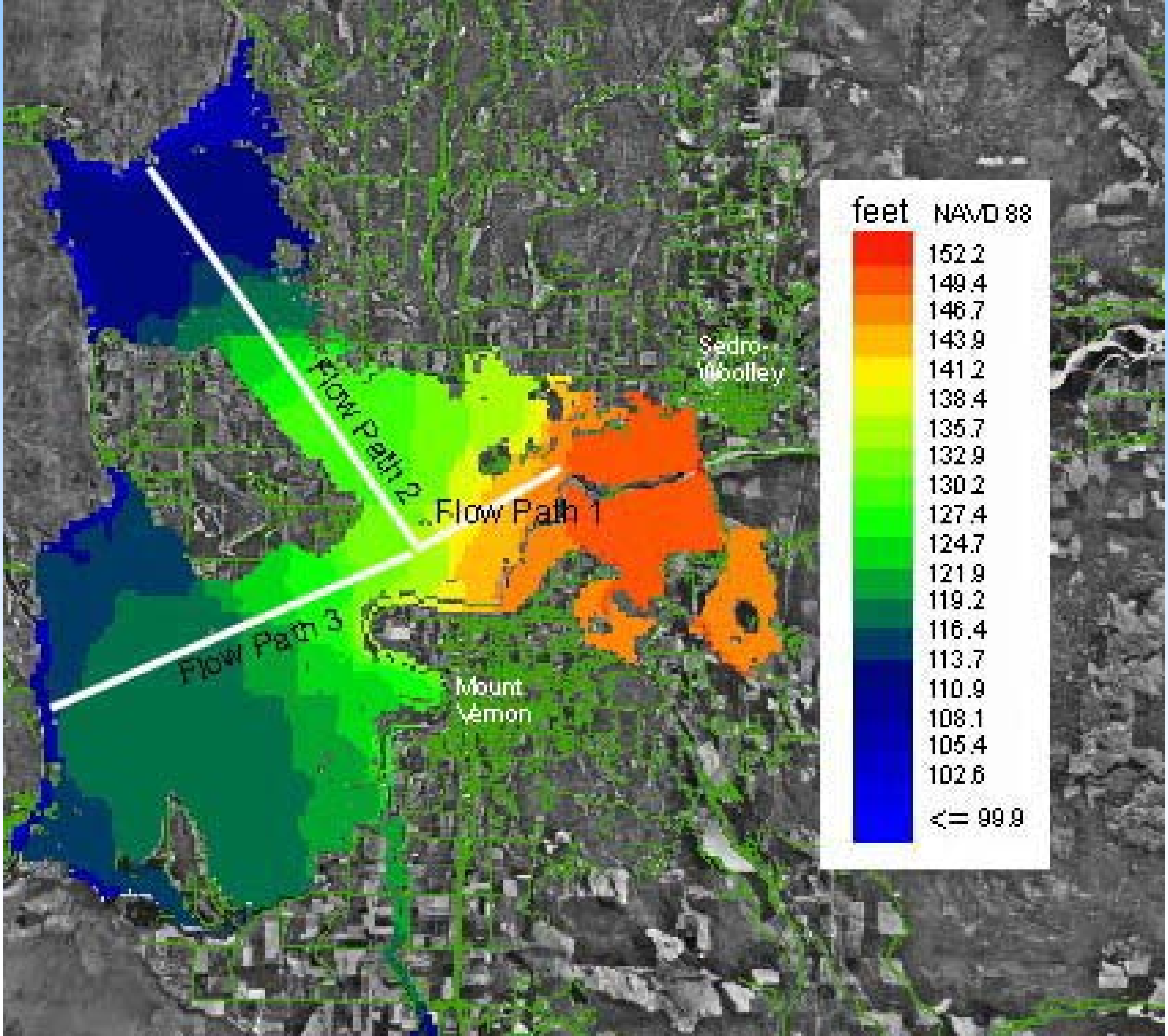
(From COE Revised Flood Insurance Study, Hydraulics Summary)

The 1984 study did not finalize a **floodway** on the Skagit River downstream of Sedro-Woolley. A reason for this is the complexity in determining the proper positioning and methodology for this downstream floodway when using a one-dimensional model when flows can head north to Samish Bay, south to Skagit Bay and West to Swinomish Slough and Padilla Bay. With the development of the two-dimensional FLO-2D model for this study, a floodway analysis is possible.

There are two approaches that will initially be attempted for the floodway analysis. The first is similar to the upstream methodology where an attempt will be made to do an equal conveyance floodway surrounding the existing river channel. A second approach will look at routing the water through the most logical overbank flow paths and determine the level of encroachments that can be made around these. **This work will be done in the next phase** and is not a part of this release.

C. Floodplain Flow Paths

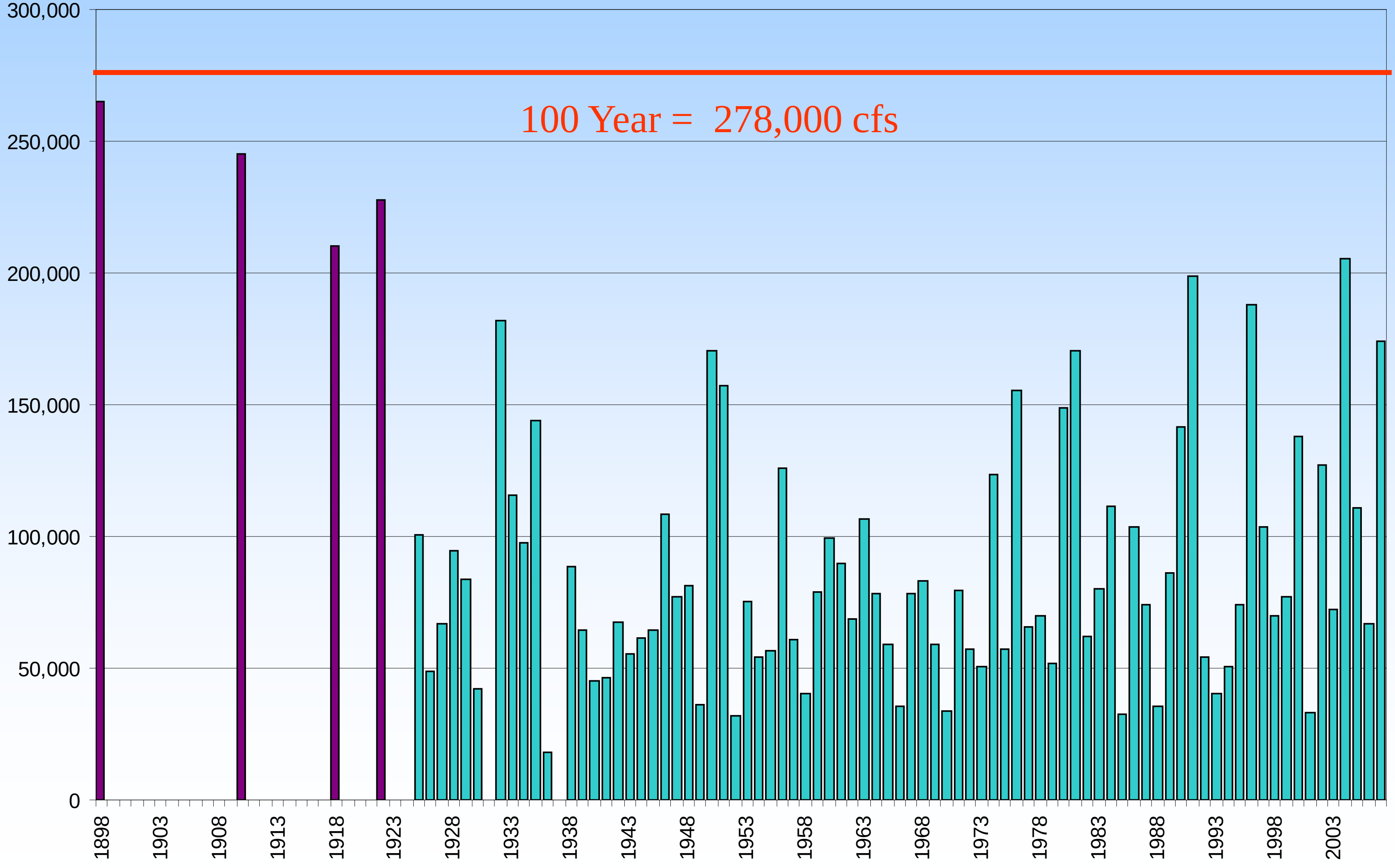
There are 5 floodplain flow paths that are used to develop water surface profiles in the overbank areas in the lower basin below Sedro-Woolley. Figures 24, 25, and 26 show the locations of these flow paths. These flow paths are delineated by attempting to follow the quickest drop to the sea which defines the most likely path the overbank flows will follow.



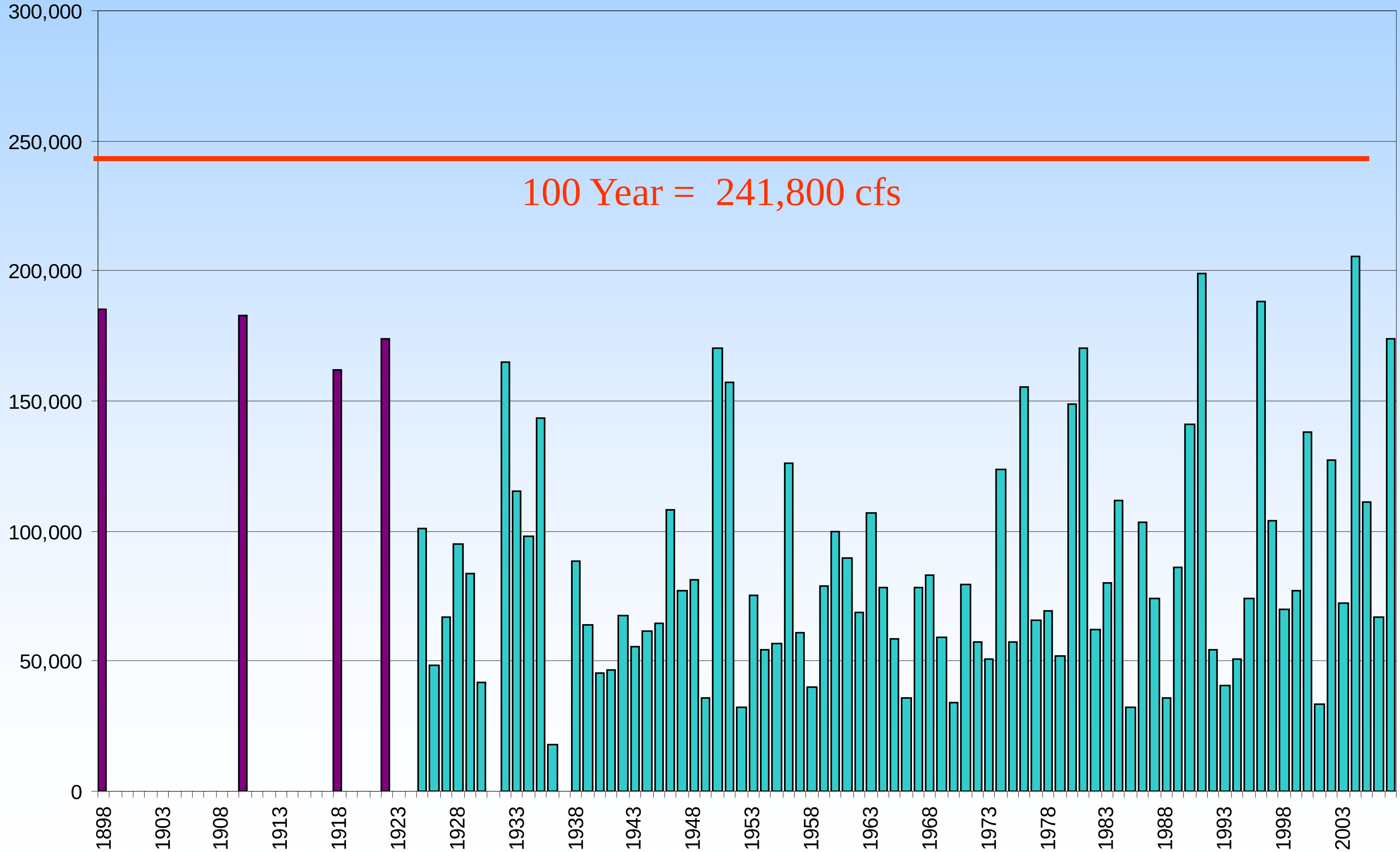
feet NAVD 88
152.2
149.4
146.7
143.9
141.2
138.4
135.7
132.9
130.2
127.4
124.7
121.9
119.2
116.4
113.7
110.9
108.1
105.4
102.6
<= 99.9
Sedro-Woolley
Flow Path 2
Flow Path 1
Flow Path 3
Mount Vernon

Hydrology

Skagit River Winter Unregulated Annual Peak Flows Concrete – COE Frequency Distribution (April 2008)



Winter Unregulated Annual Peak Flows Skagit River Near Concrete:
Draft PI Engineering July 2008



Concept

Investigation of the Historic Floods in the Crofoot's Addition to Concrete

- Build on Stewart's observed and documented high water marks of the historic floods (1922 field notes)
- Combine Stewart's 1922 interview/survey data with today's hydraulic modeling methods to determine the historic discharges
- Supplement the hydraulic modeling with a forensic investigation

Levels at Concrete

BS	HI	FS	Elev	
.40	230.91		230.51	BM USGS
		5.34	225.57 / 214.33	
1.31	215.64			
		8.30	207.34	
7.45	214.79			
		0.47	214.32	
2.96	217.28			
		12.82	204.46	
1.92	206.38			
		12.73	193.65	
0.91	194.56			
		12.33	182.23	
4.40	186.63			
		2.08	184.55	

Dec 21 1922

	BS	HI	FS	Elev	
	10.5	20.5		10.00	1897 flood crest on stump at old bridge site by est by [illegible] Miller [illegible] H W was [illegible] below top of stump
TP			11.2 rod 4.6 tape 15.8	4.7	
	4.7	9.4			
			3.0	6.4	1921 H W

These are relative figures only [illegible] at stump and Washington Cement Plant. The [illegible] are a [illegible] of [illegible] and [illegible] [illegible]

Nov 28

See pages 18 and 30 also

Measured down 11.24' from this point on freightcar to rail below (about 300 ft below depot)

{ Ground surface 4.9 ft below line of sight at this point. Near pt of zero flow for old channel. Coll low pt Elev 210 ft

1921 flood mark at Wolfs Residence

(McDaniels near Washington Cement plant can give 1909 flood)

Leonard Everett says 1897 flood about 9" lower than 1909, says that log jam in Dalles raised water 10 ft in 2 hrs. He says
1897 about highest midnight
1909 highest after midnight possibly 12:30
1921 highest about 1 am
considerable distance and slope between 1897 and 1909 mks. Est max at 0.2 ft (1909) coll 1897 1.4 ft higher than 1909 and 3.4 ft higher than 1921

{ 1897 10.00
1909 8.4
1921 6.4

Found line at 1909 HW 2.0' above 1921 at Washington Cement plant machine shop today

He is wrong probably see bottom of page 14 [illegible] [illegible]

See bottom of page 13 [illegible]

1921, Concrete Herald Newspaper

"About three o'clock in the afternoon it went over the banks in Crofoot addition and the residents of that part of town began to move out … The waters also crept up around some of the dwellings in East Concrete, and some of the residents moved out for the night. **In Crofoot addition** only three residences remained above the high water mark, **the water being to a depth of an inch to 14 inches in the others**. No particular damage was done, except for small articles outside being washed away, and the job of cleaning out the mud left by the flood. … **In East Concrete practically no damage was done.**" *Dec. 17, 1921 Concrete Herald "Skagit River Goes On Wild Rampage; Light Damage Here"*

L.E. Wolfe Residence, 1922

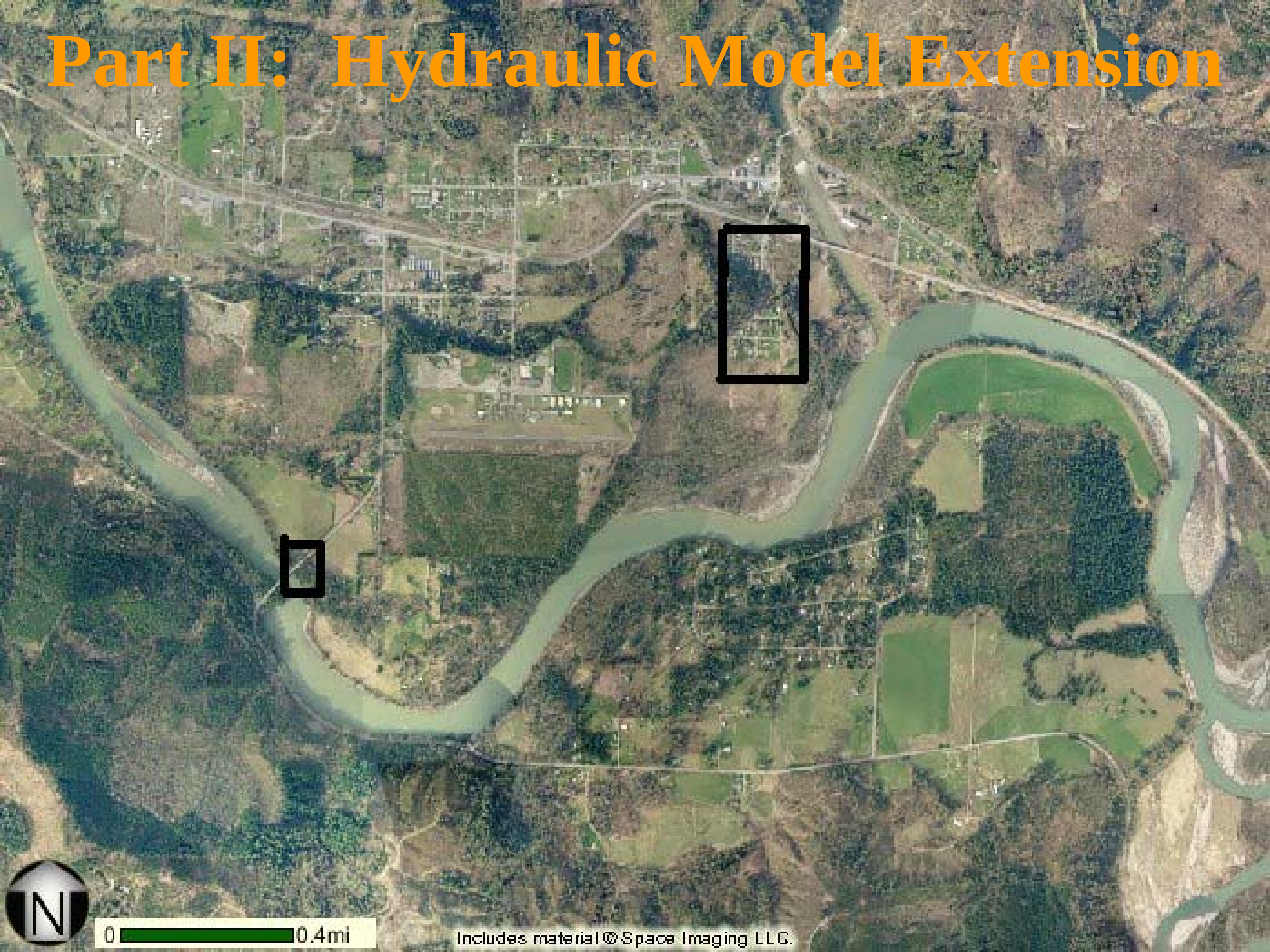
At Concrete, Crofoot’s Addition


04/03/2008 11:22

2^{nd} Ripple house, Built 1912
First Floor elevation 184.96

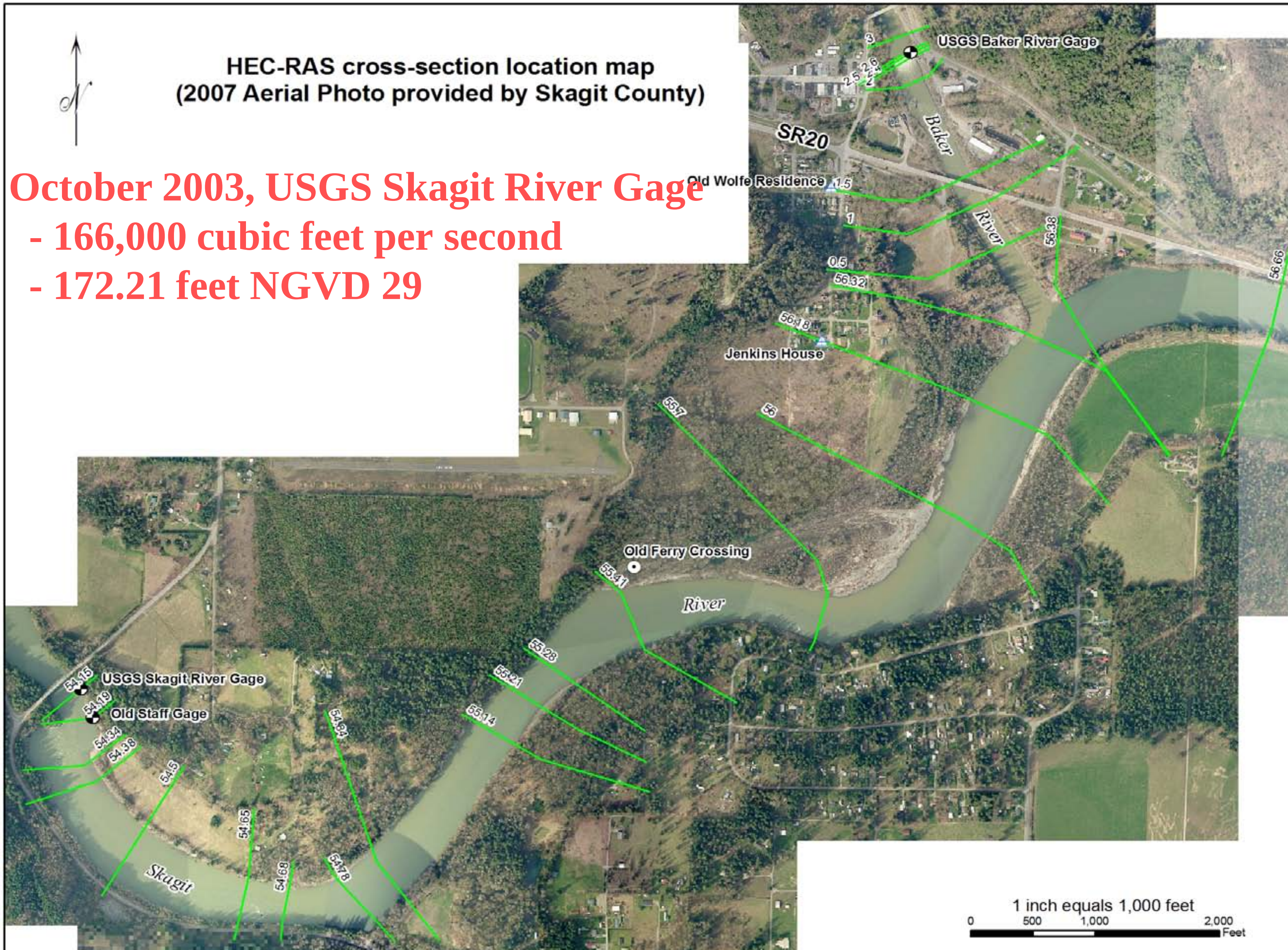

55
54
51
04/03/2008 12:17

Part II: Hydraulic Model Extension



October 2003, USGS Skagit River Gage

- 166,000 cubic feet per second
- 172.21 feet NGVD 29



October 2003 Flood

Jenkins House at 7752 South Dillard

(Photo provided by Allen Jenkins)

BS	HI	FS	Elev	
.40	230.91		230.51	BM USGS
			225.57	Measured down 11.24' from this point on freight car to rail below (about 300 ft below depot)
		5.34	214.33	
1.31	215.64			
		5.30	207.34	
7.45	214.79			Ground surface 4.9 ft below line of sight at this point. Near pt of zero flow for old channel. Call low pt Elev 210 ft
		0.47	214.32	
2.96	217.28			
		12.82	204.46	
1.92	206.38			
		12.73	193.65	
0.91	194.56			
		12.33	182.23	
4.40	186.63			
		2.08	184.55	1921 flood mark at Wolfs Residence

(McDaniels near Washington Cement plant can give 1909 flood)

Leonard Everett says 1897 flood about 9" lower than 1909, says that log jam in Dalles raised water 10 ft in 2 hrs. He says 1897 about highest midnight; 1909 highest after midnight possibly 12:30; 1921 highest about 1 am.

Dec 21 1922

	BS	HI	FS	Elev	
	10.5	20.5		10.00	1897 flood crest on stump at old bridge 5 to Est by Manger Miller. Flood H W was 9½" below top of stump
TP			11.2 rod 4.6 tape 15.8	4.7	
	4.7	9.4			
			3.0	6.4	1921 H W

These are relative figures only for at stump and Washington Cement Plant. The obs are a combination of 5 ... and ...

Considerable distance and some slope between 1897 and 1909 1921 mks. Est max at 0.2 ft Call 1897 1.4 ft higher than 1909 and 3.4 ft higher than 1921

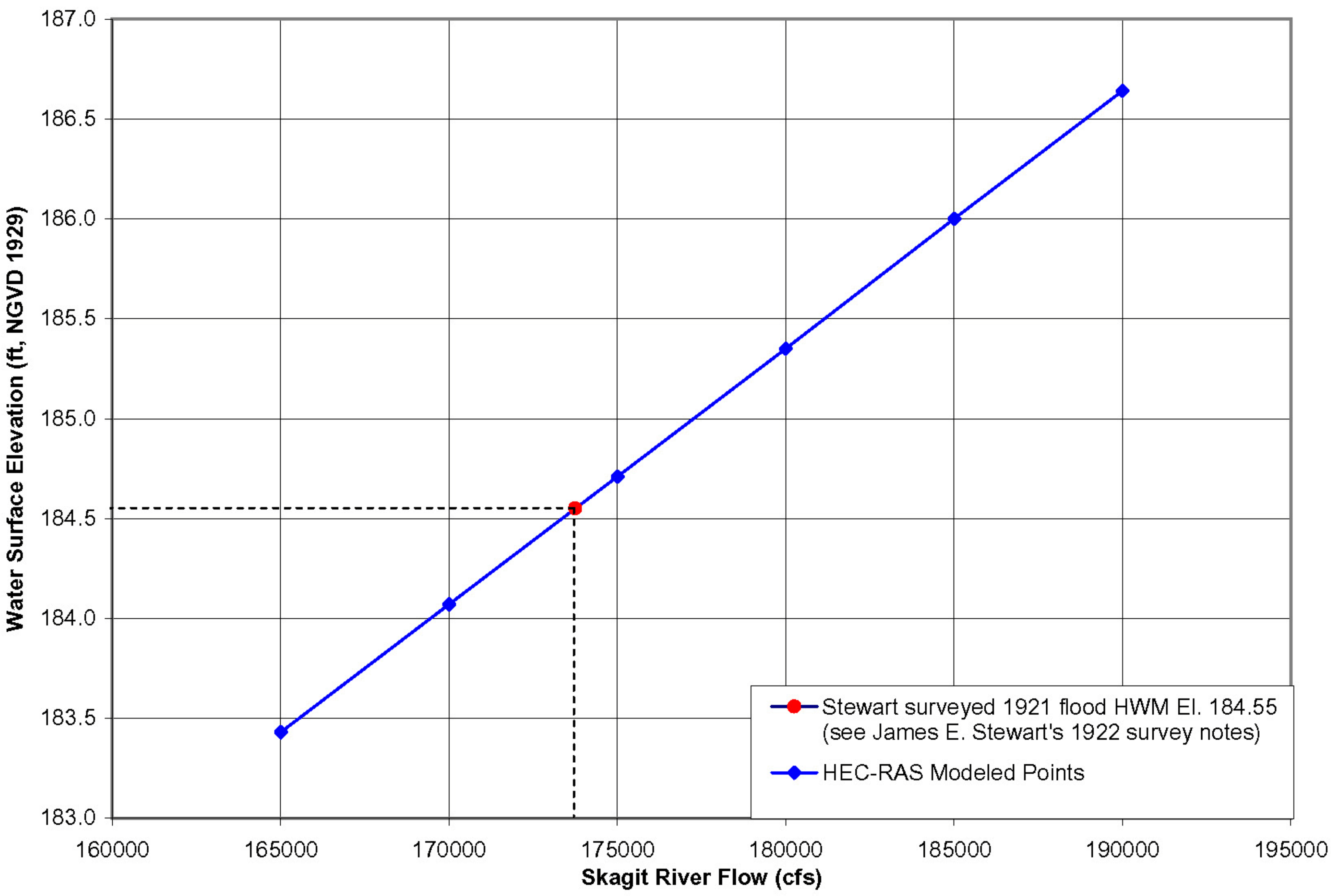
1897	10.00
1909	8.4
1921	6.4

Found line at 1909 H W 2.0' above 1921 at Washington Cement plant machine shop

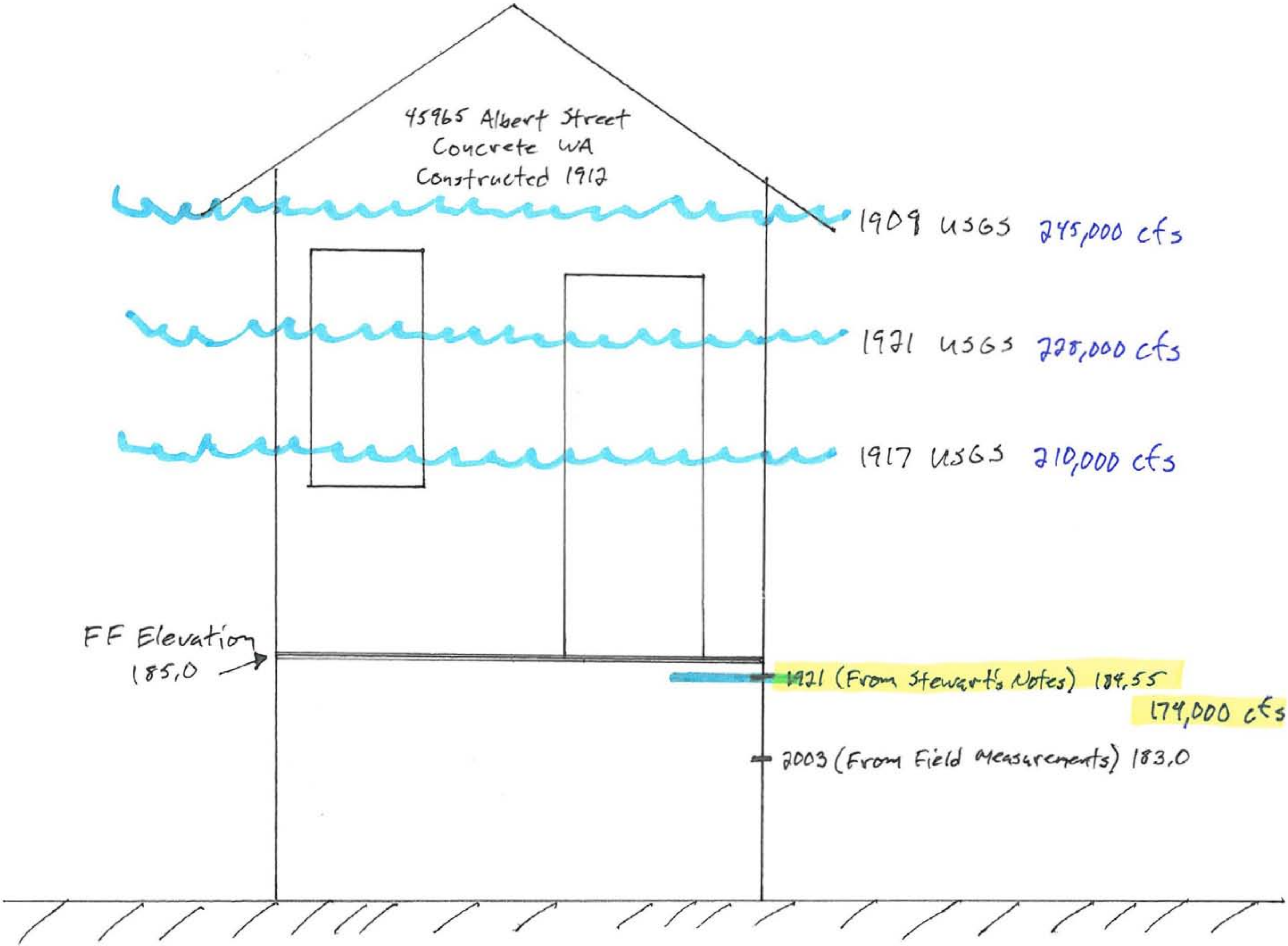
He is wrong probably see bottom of page 141 3/24/23 ... 1909 ...

See bottom of page 19 for ... comparison of 1909 ...

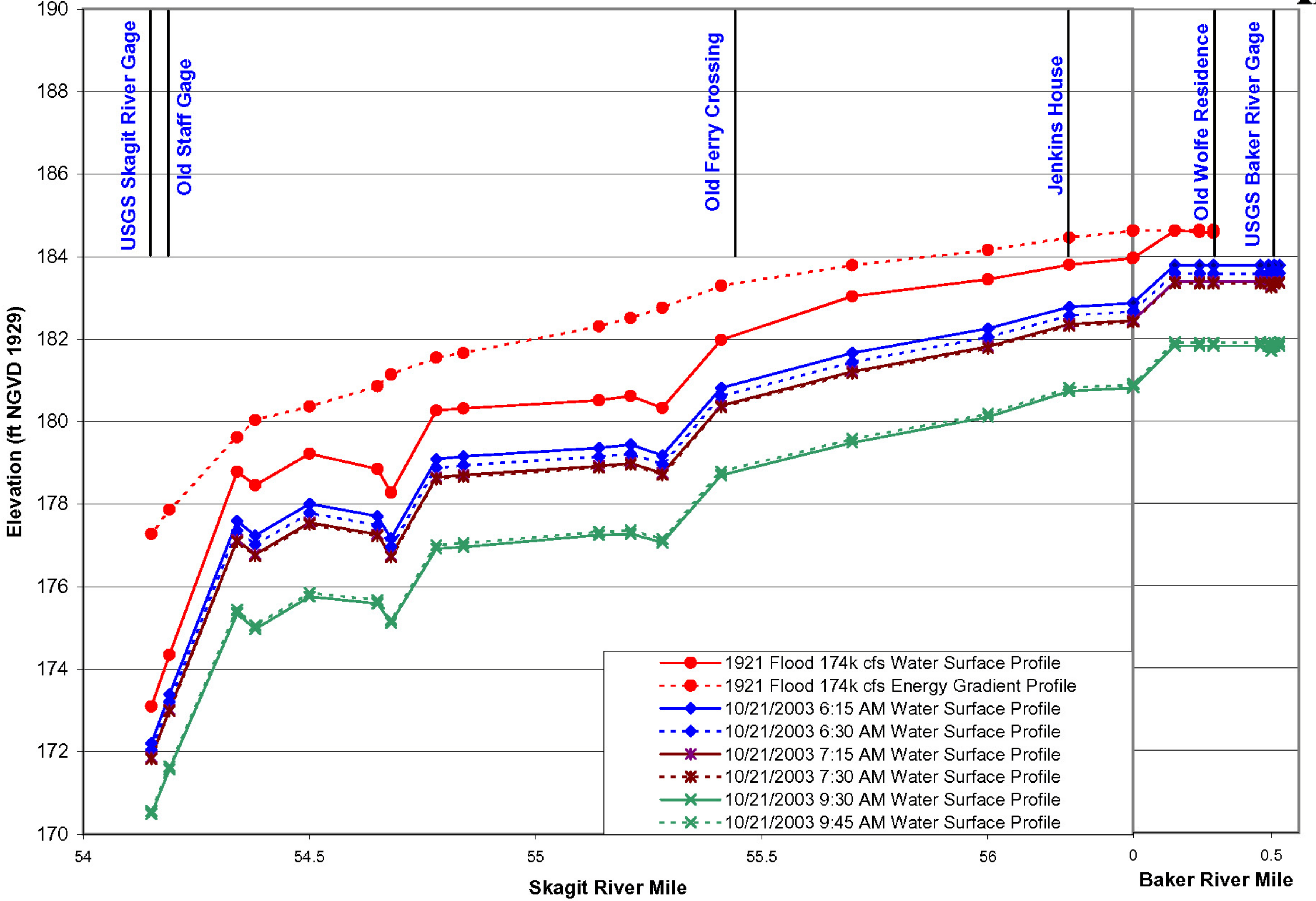
Flood Stage-Discharge Curve at Wolfe Residence in Concrete



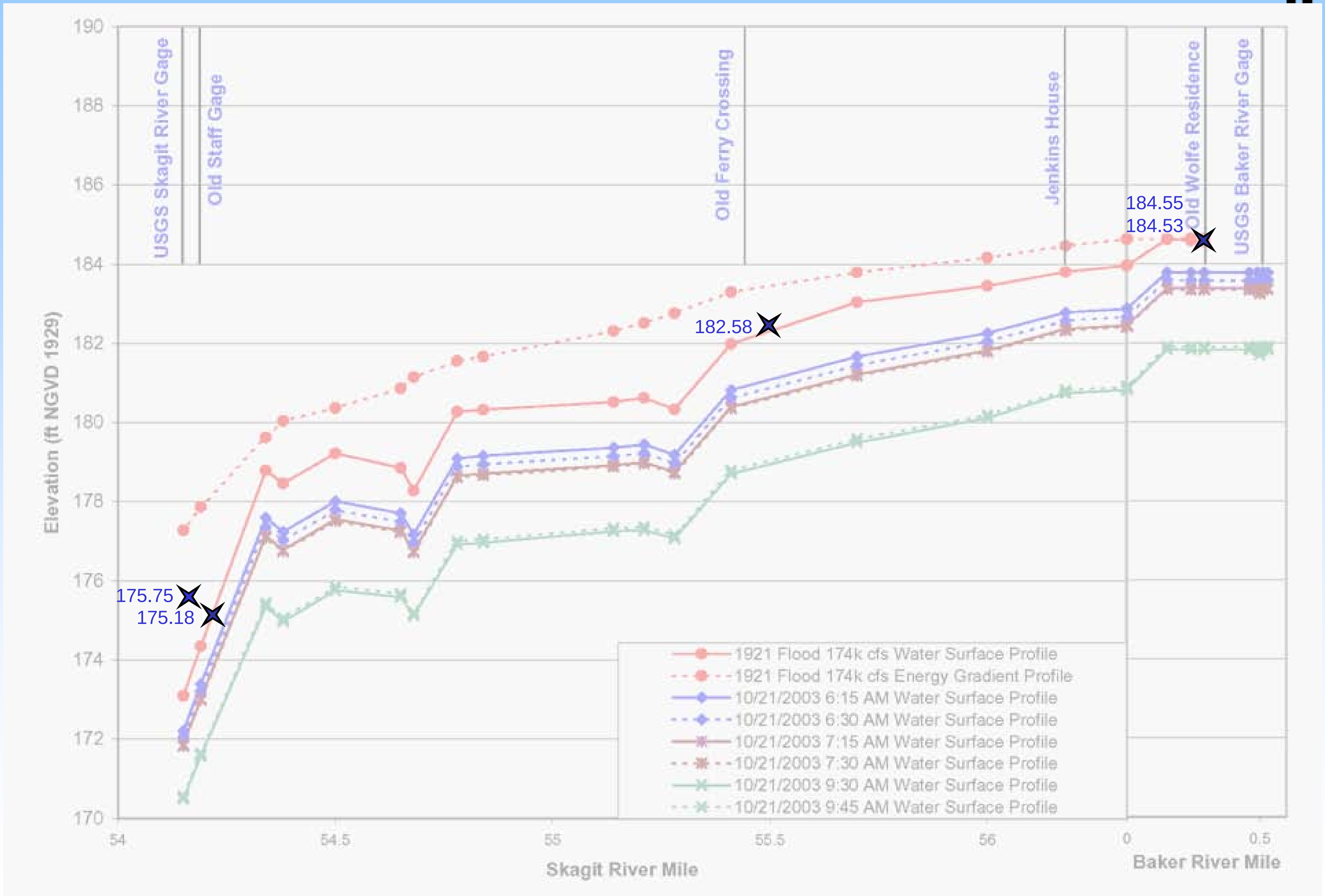
2nd Ripple house, Built 1912
First Floor elevation 184.96


45965 Albert Street
Concrete WA
Constructed 1912
1909 USGS 245,000 cfs
1921 USGS 228,000 cfs
1917 USGS 210,000 cfs
FF Elevation
185.0
1921 (From Stewart's Notes) 184.55
174,000 cfs
2003 (From Field Measurements) 183.0

HEC-RAS Modeled Flood Profiles



Stewart Surveyed 1921 High Water Marks



Preliminary Conclusion

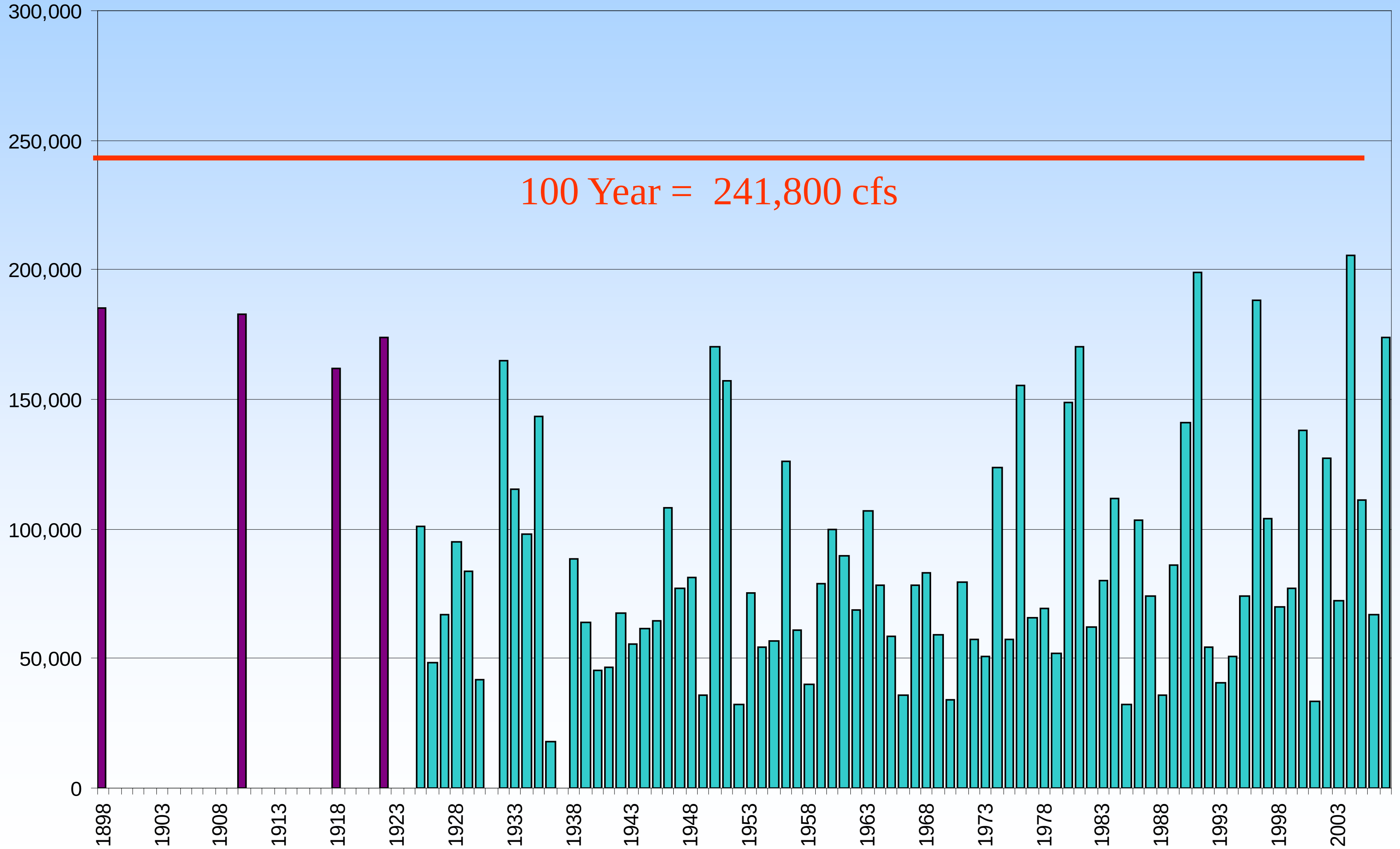
- Hydraulic model shows a peak discharge for the 1921 flood of **174,000 cfs**, based on Stewart's survey notes from 1922 –

  NOT 228,000 cfs

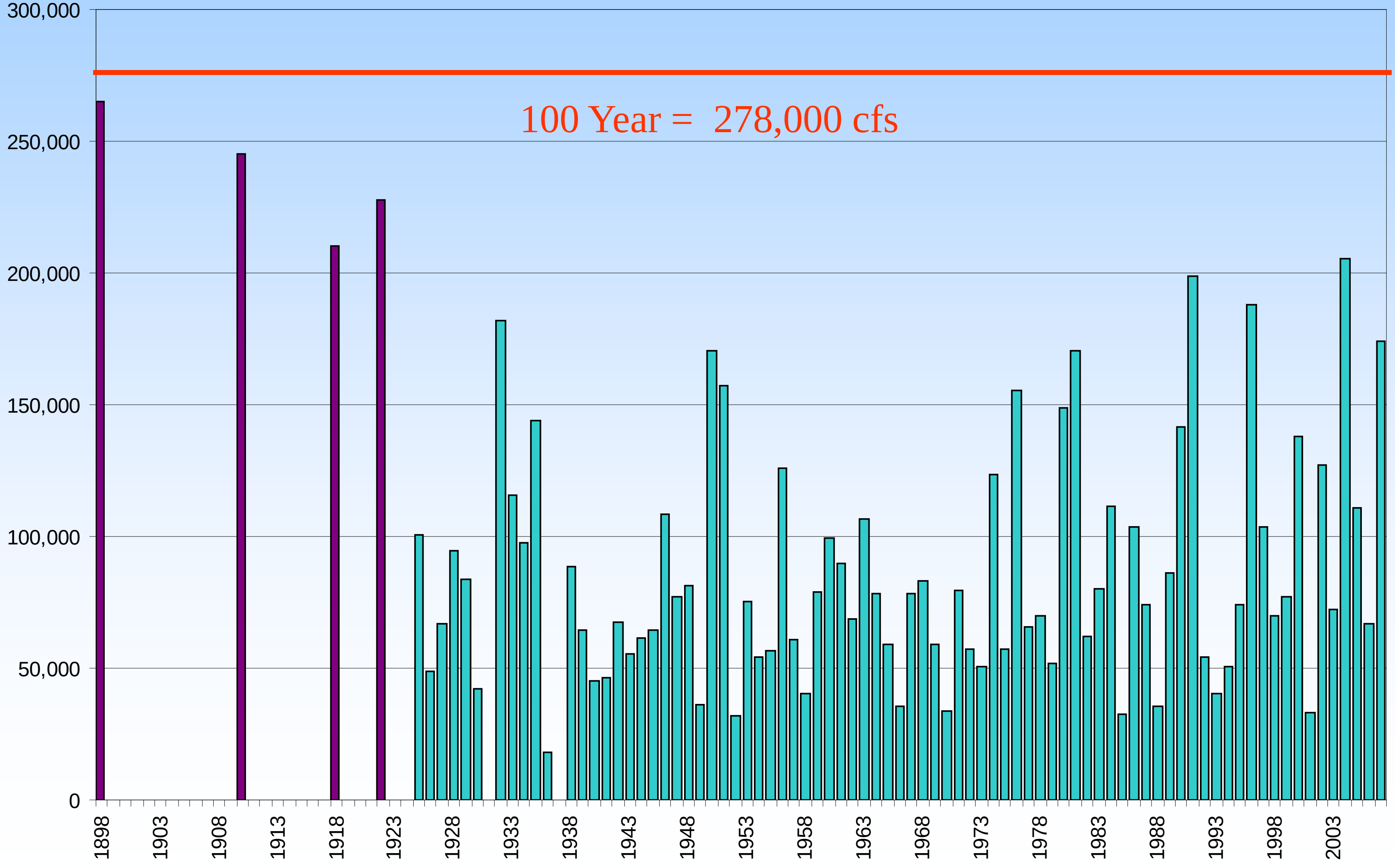
  Difference of 54,000 cfs

Winter Unregulated Annual Peak Flows Skagit River Near Concrete:

Draft PI Engineering July 2008

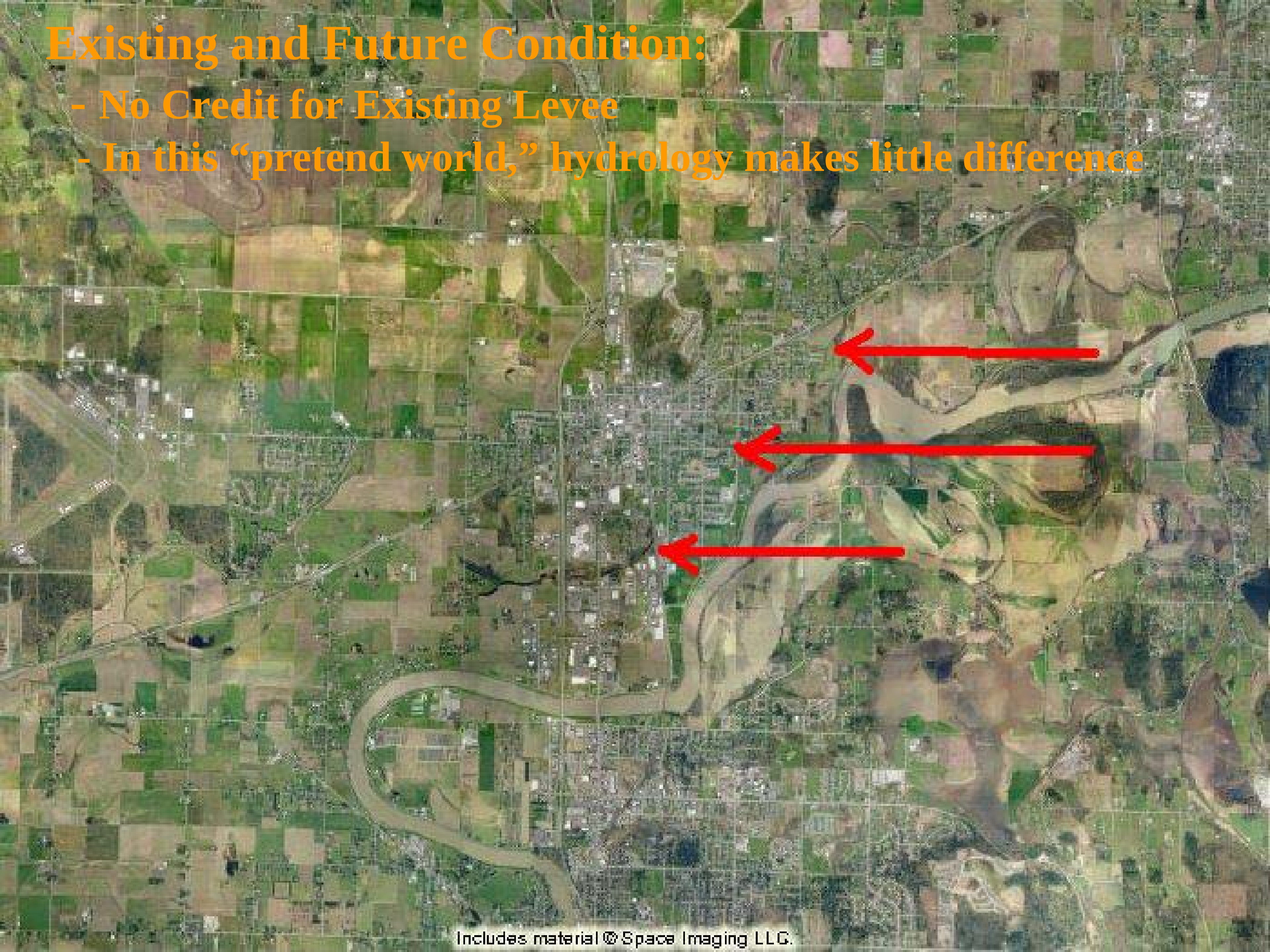


Skagit River <u>Winter Unregulated</u> Annual Peak Flows Concrete – COE Frequency Distribution (April 2008)

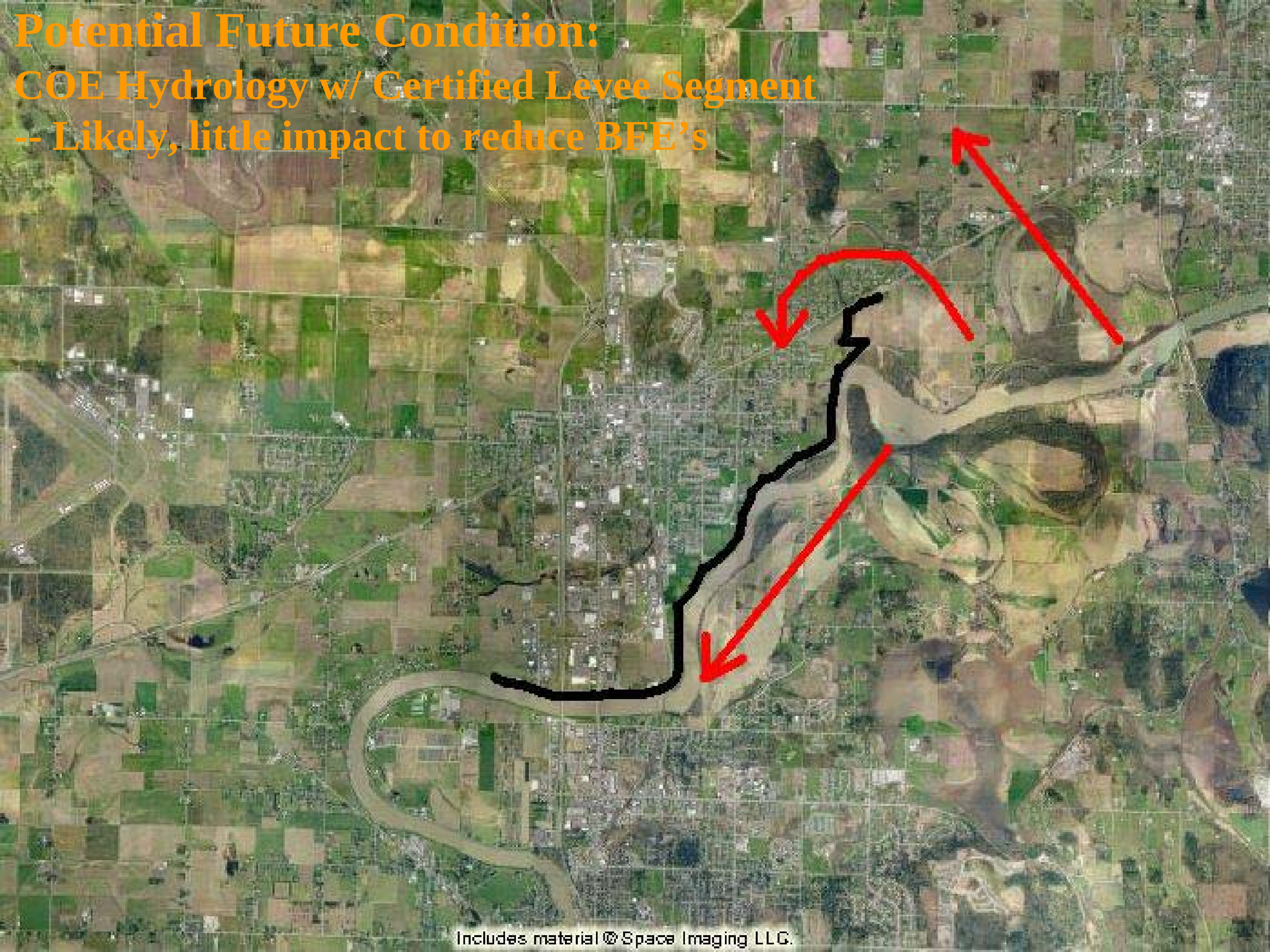


Levee certification concepts for Burlington

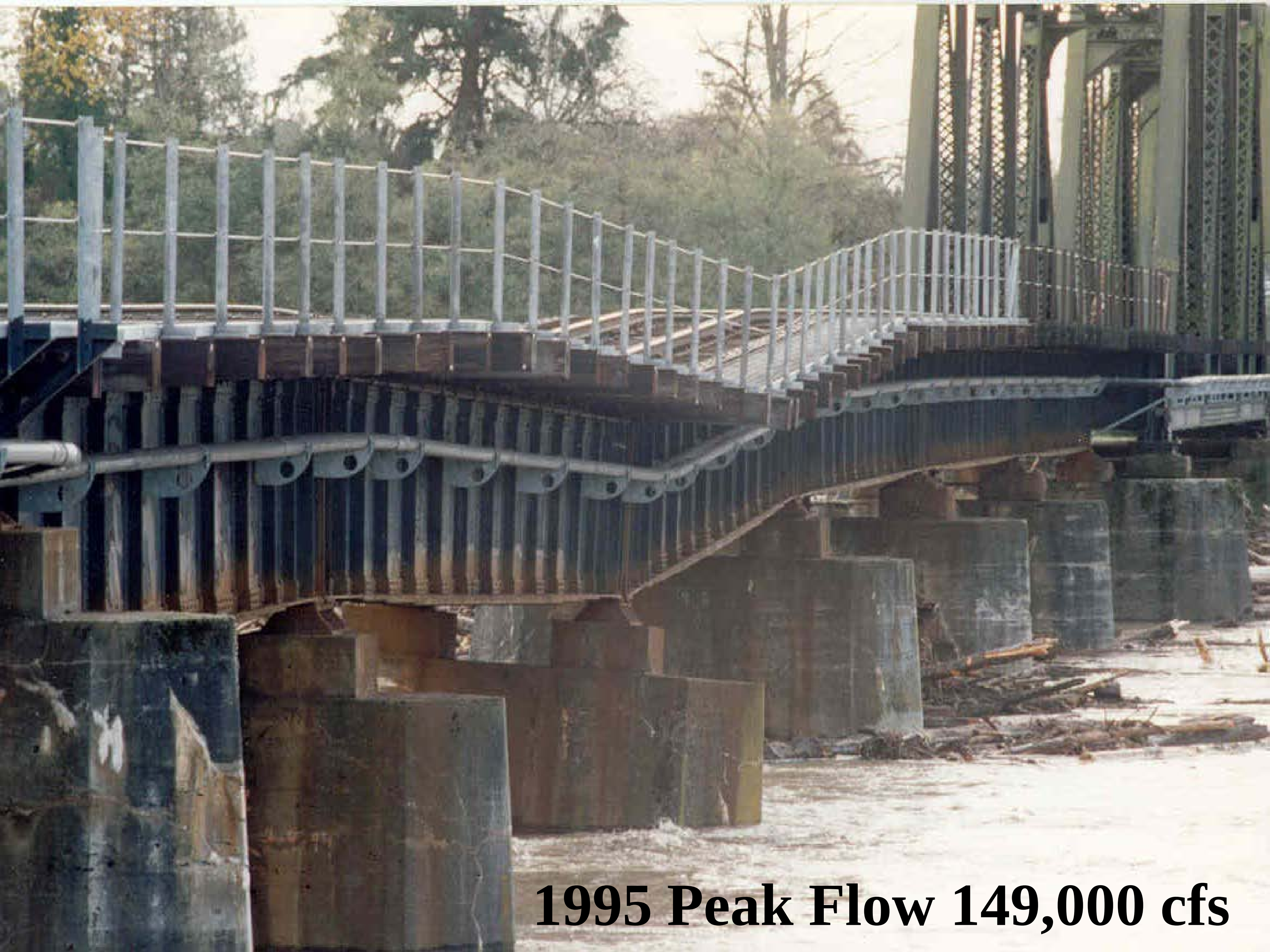
Critical affect of hydrology


Existing and Future Condition:
- No Credit for Existing Levee
- In this "pretend world," hydrology makes little difference
Includes material © Space Imaging LLC.

Potential Future Condition:
COE Hydrology w/ Certified Levee Segment
-- Likely, little impact to reduce BFE's



Problem: BNSF Railroad Bridge
Maximum Channel Capacity 160,000 cfs

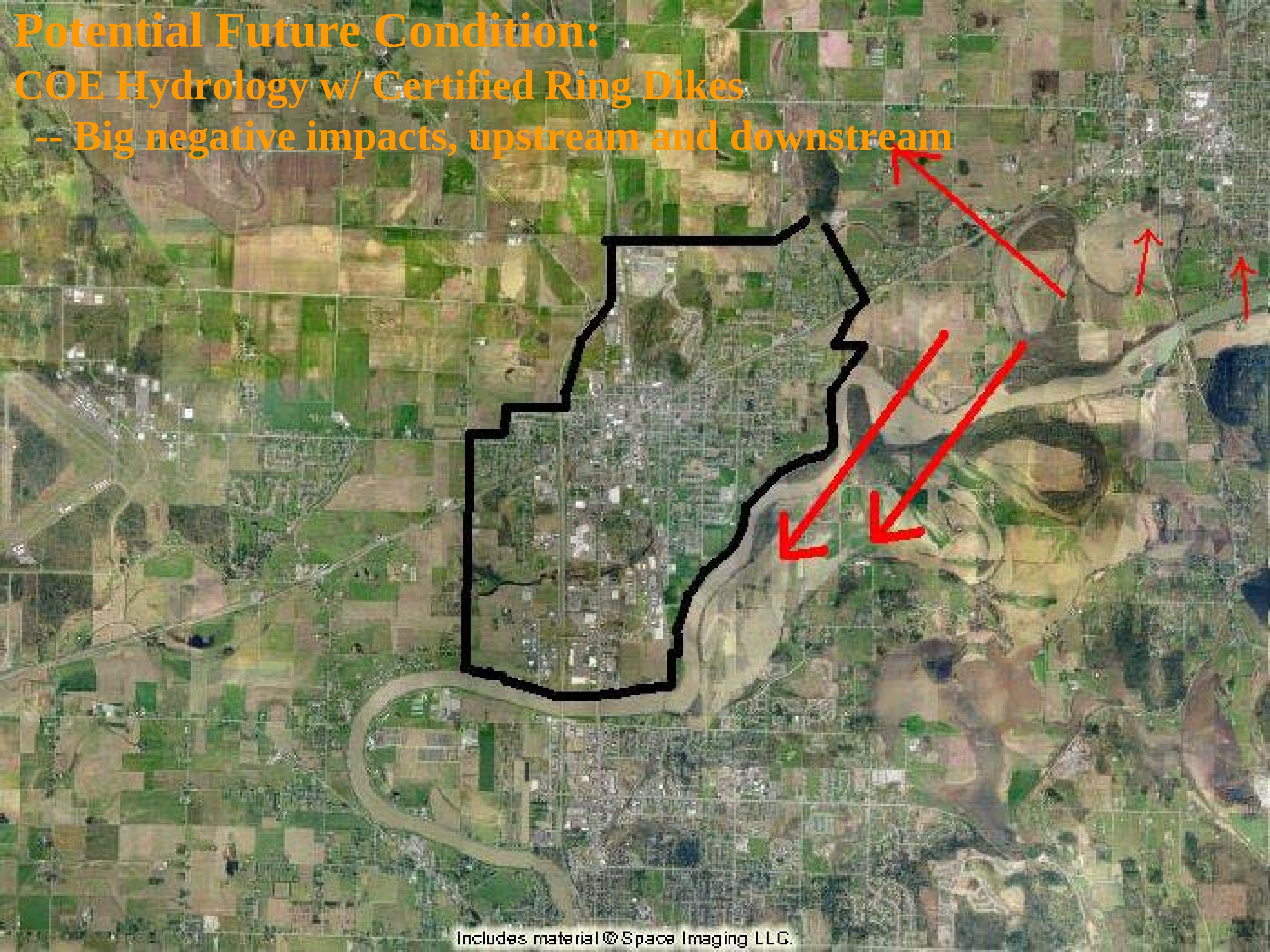


1995 Peak Flow 149,000 cfs

Potential Future Condition:

COE Hydrology w/ Certified Ring Dikes

-- Big negative impacts, upstream and downstream



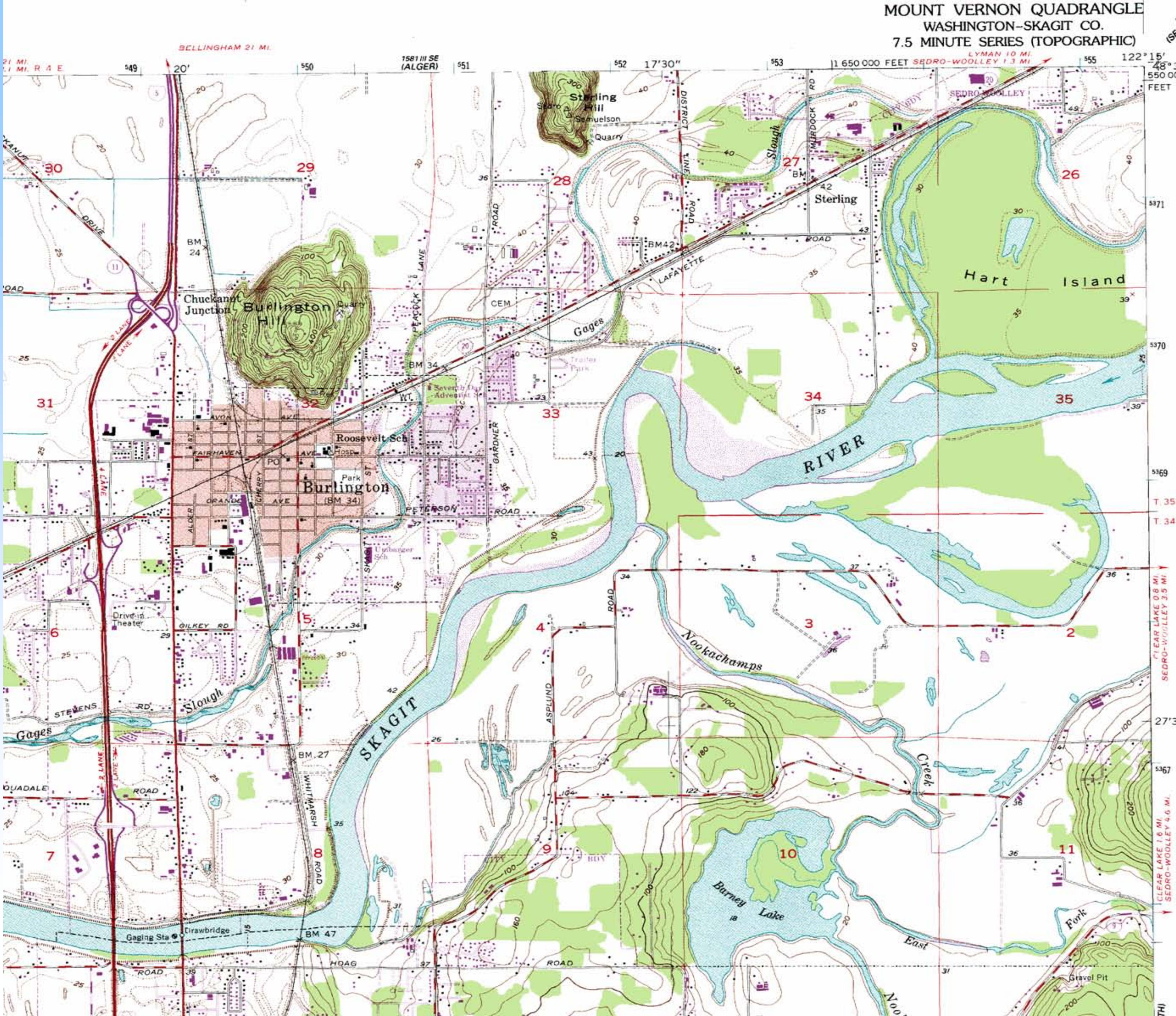
Levee Segment, Corrected Hydrology

What Path for Burlington?

- Incorrect COE hydrology will force Burlington into a “ring dike” concept that will cause worse flooding upstream and downstream, and leave the City with only 1 option: total removal from flood plain
- Correct hydrology <u>could</u> enable Burlington to avoid a “ring dike”, leaving the City in the flood plain but with workable base flood elevations
  - Much friendlier to neighbors (won’t raise their flood elevations significantly)
  - Much better environmentally (Burlington will still be in the flood plain and will take water in a large flood event)
  - Communicates flood risk better to Burlington residents and businesses – i.e., everyone will still be paying for flood insurance

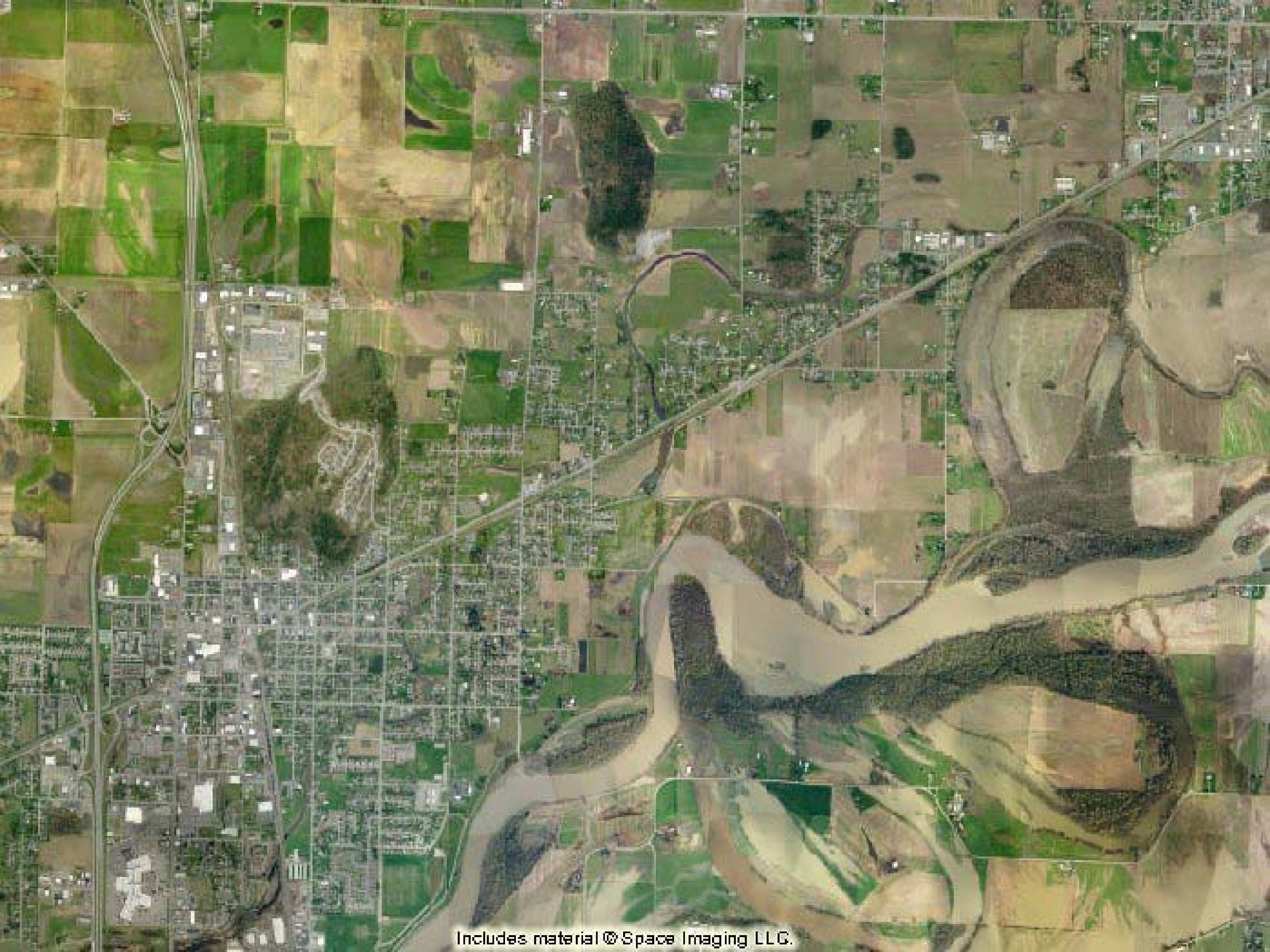
Questions

Backup / reference slides follow



MOUNT VERNON QUADRANGLE
WASHINGTON–SKAGIT CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)
Sterling Hill
Burlington Hill
Chuckanut Junction
Burlington
Roosevelt Sch
Sterling
SEDRO-WOOLLEY
Hart Island
SKAGIT RIVER
Gages Slough
Nookachamps Creek
Barney Lake
East Fork
Drive-in Theater
Gaging Sta
Drawbridge
Gravel Pit
Quarry
CEM
Park
HOAG ROAD
PETERSON ROAD
GILKEY RD
STEVENS RD
QUADALE ROAD
WHITMARSH ROAD
ASPLUND
GARDNER
DISTRICT LINE ROAD
MURDOCK RD
PEACOCK LANE
LAFAYETTE ROAD
T. 35 N.
T. 34 N.

Includes material © Space Imaging LLC.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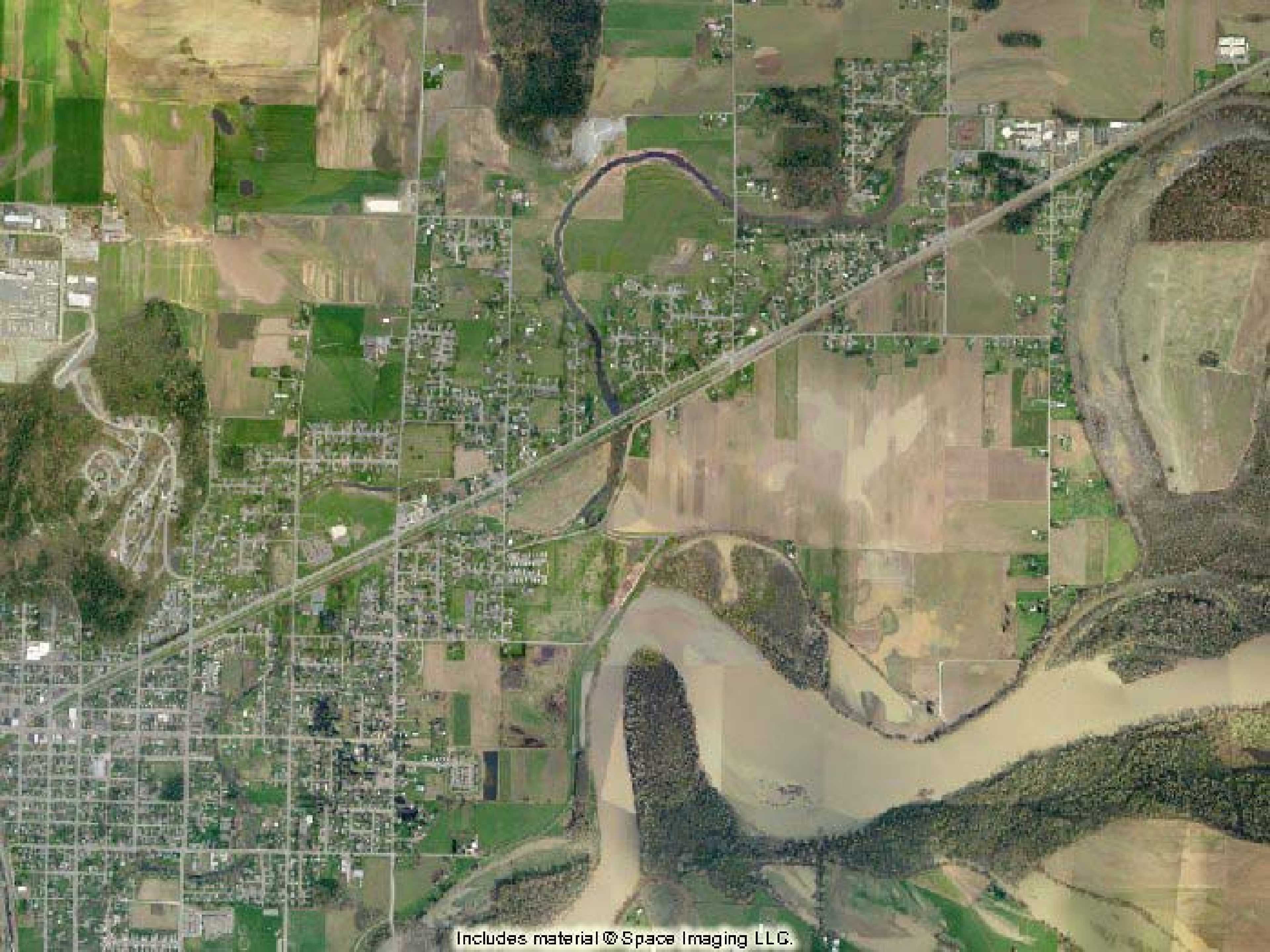
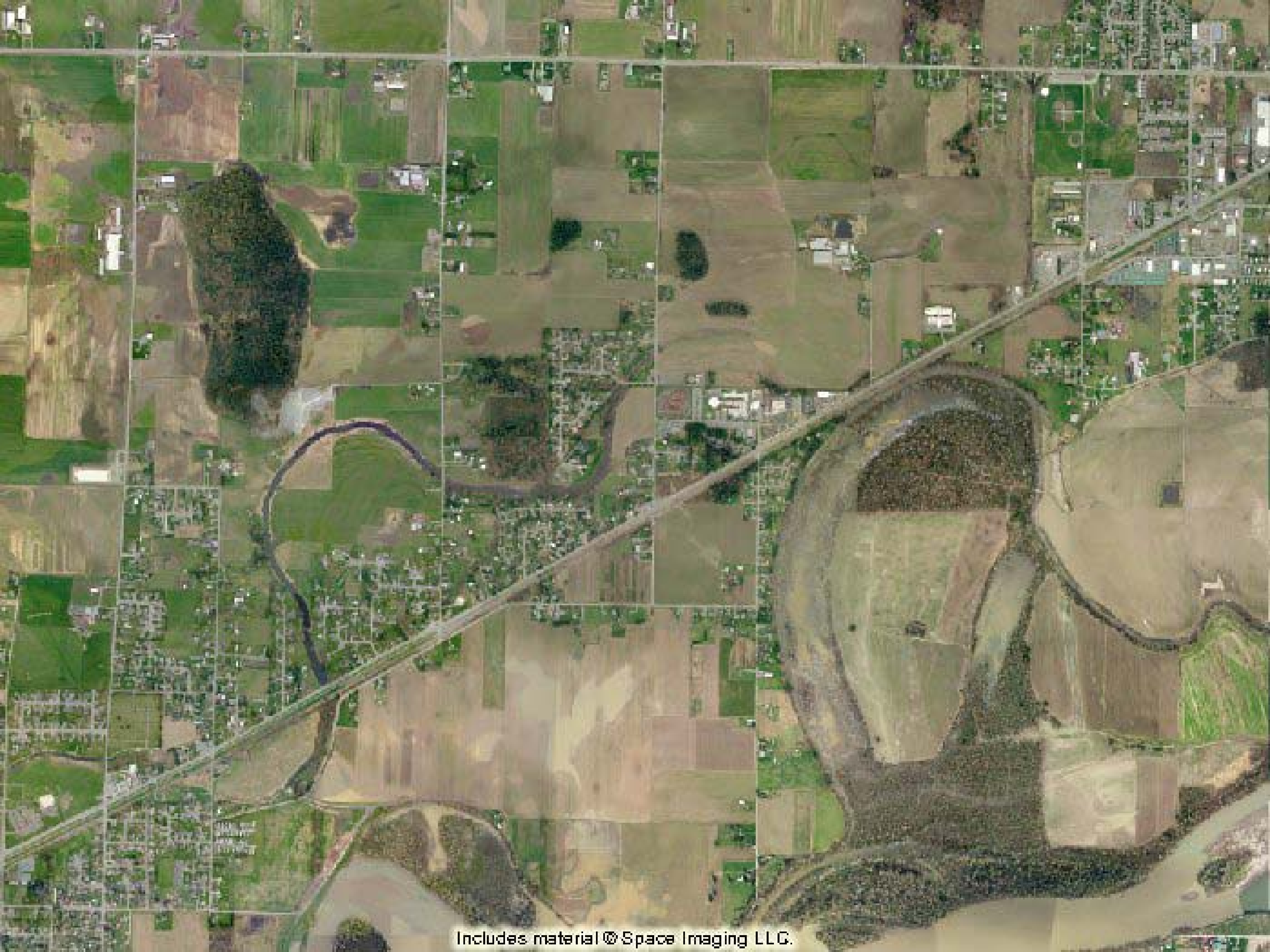

Includes material © Space Imaging LLC.

Includes material © Space Imaging LLC.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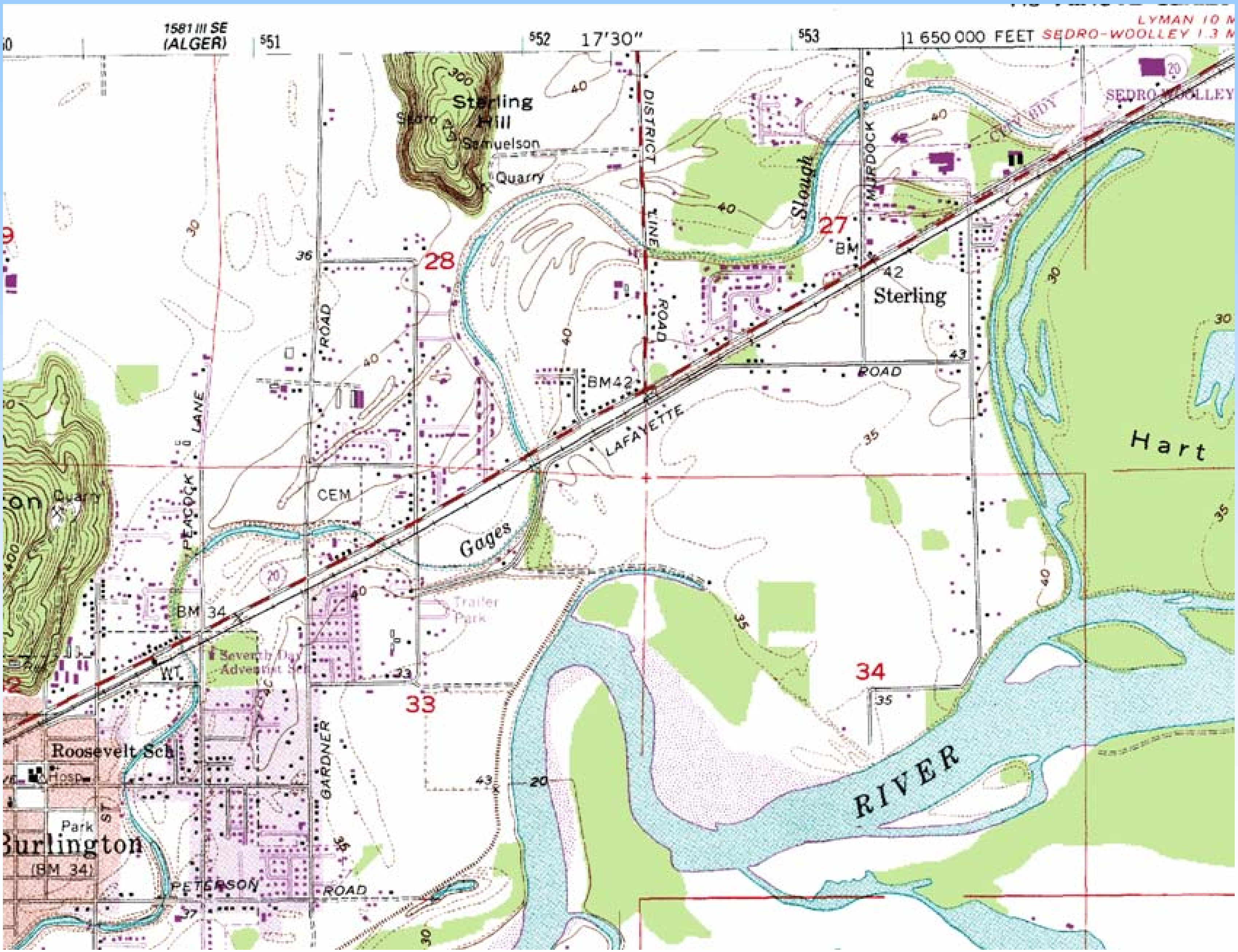
1581 III SE
(ALGER)
551
552
17'30"
553
1 650 000 FEET
LYMAN 10 MI
SEDRO-WOOLLEY 1.3 MI
Sterling Hill
Samuelson
Quarry
DISTRICT LINE ROAD
Slough
MURDOCK RD
SEDRO-WOOLLEY
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ROAD
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BM42
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ROAD
LAFAYETTE
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Hart
PEACOCK LANE
CEM
Gages
Trailer Park
BM 34
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Seventh Day Adventist Sch
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GARDNER
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Roosevelt Sch
Hosp
Park
Burlington
(BM 34)
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Quarry
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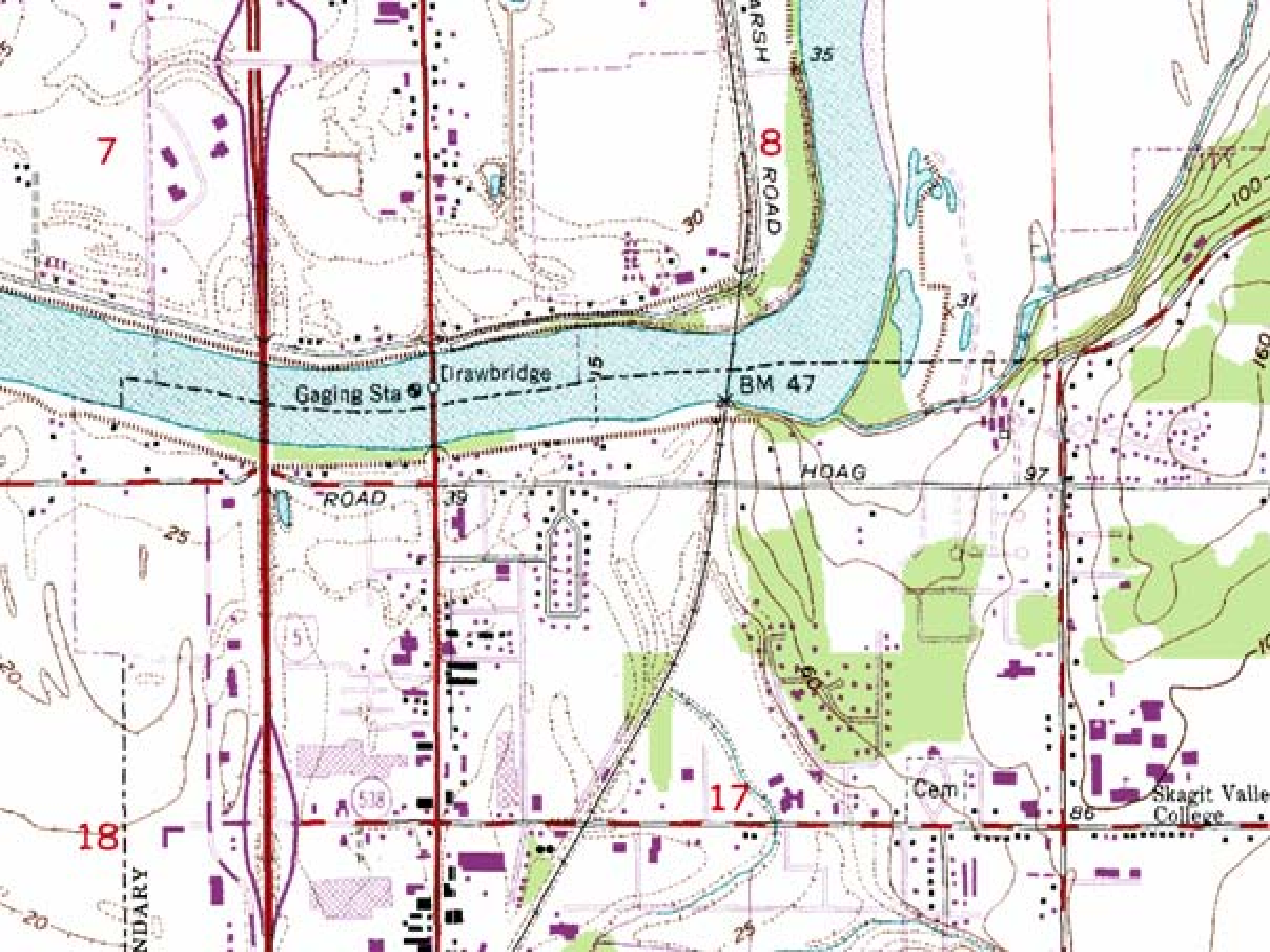

7
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18
MARSH ROAD
Drawbridge
Gaging Sta
BM 47
HOAG
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Skagit Valley College
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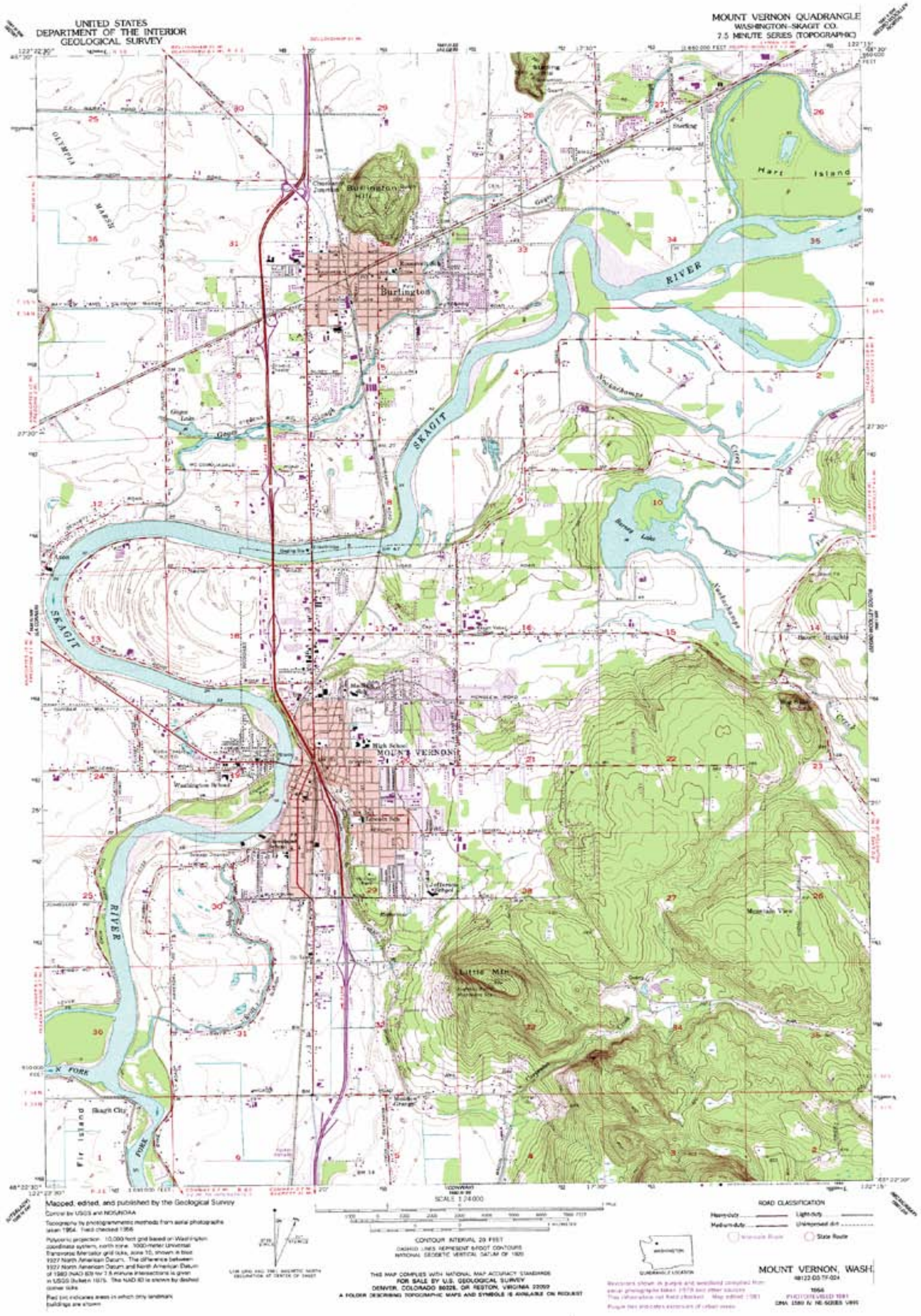
160

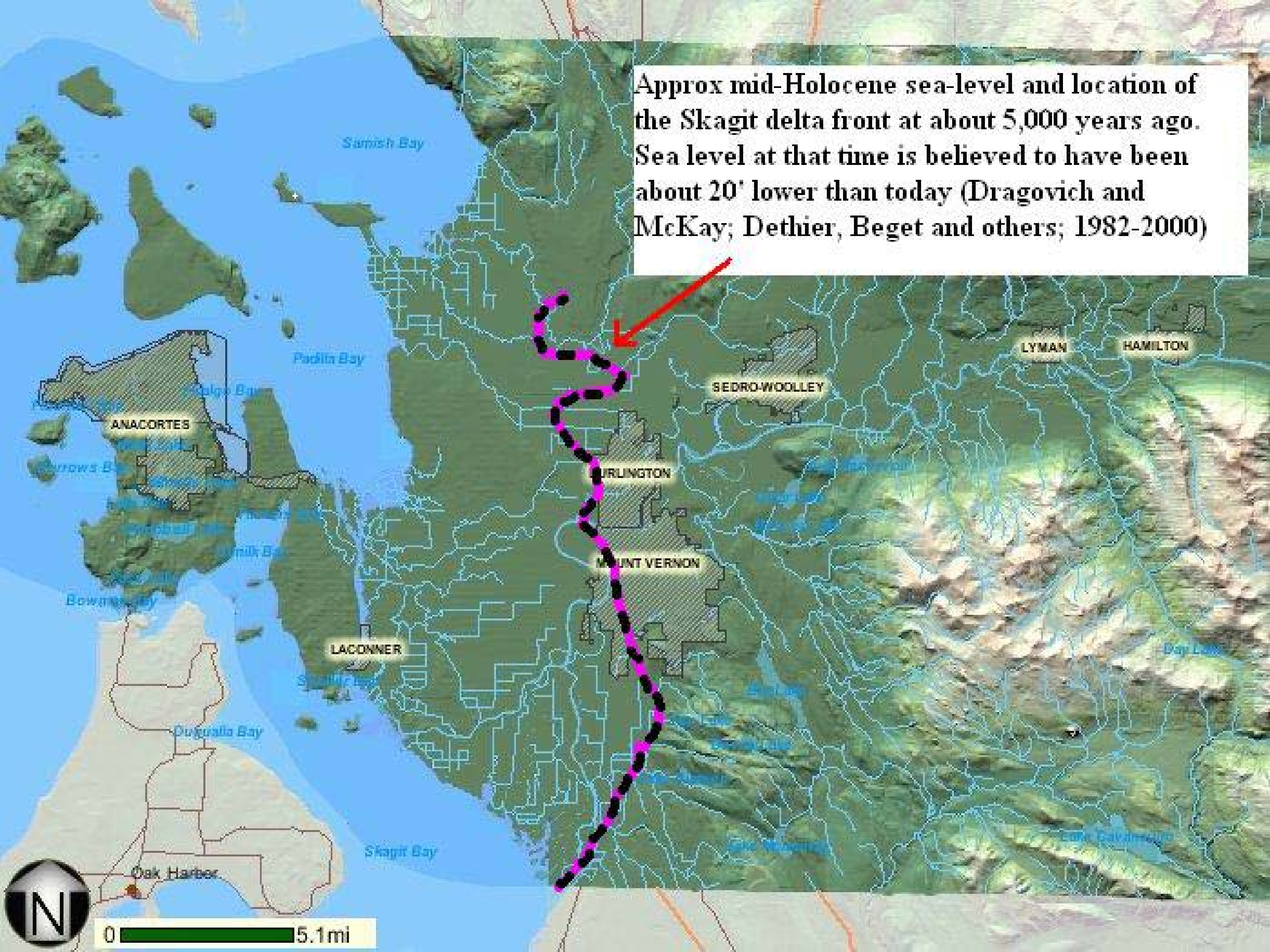

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
MOUNT VERNON QUADRANGLE
WASHINGTON–SKAGIT CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)
Burlington
MOUNT VERNON
SKAGIT
RIVER
Hart Island
Little Mtn
Skagit City
Fir Island
SCALE 1:24000
CONTOUR INTERVAL 20 FEET
Mapped, edited, and published by the Geological Survey
ROAD CLASSIFICATION
MOUNT VERNON, WASH.

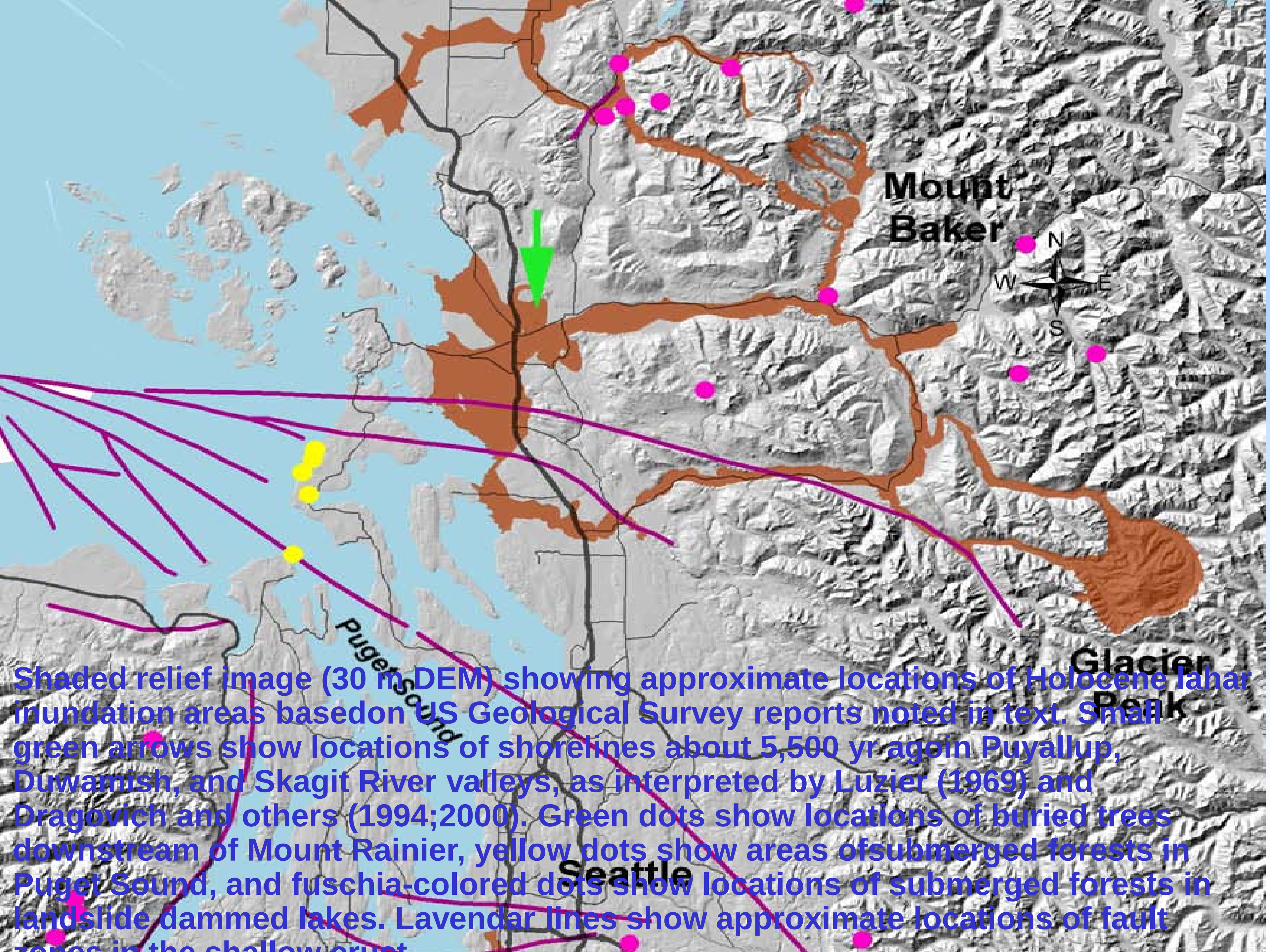
Preliminary Synopsis of Forensic Information, Crofoot's Addition to Concrete

Home	Year Built	FF Elevation	Elevated ?	Indication of Flooding above FF?	Max Silt	Corresponding Flood Discharge
Ripple #1	1900	185.44	Unsure	Possible	**186.11**	**190,000 cfs**
Ripple #2	**1912**	184.96	No	Unlikely	**184.96**	**182,000 cfs**
McManaman	1912	185.41	Unsure	Possible	185.58	186,500 cfs
Gifford	1916	186.74	No	Not Consistent	N/A	N/A
Jenkins					182.75	166,000 cfs
	Stewart's High Water Mark 1921, translated to Ripple vicinity				**183.8**	**174,000 cfs**

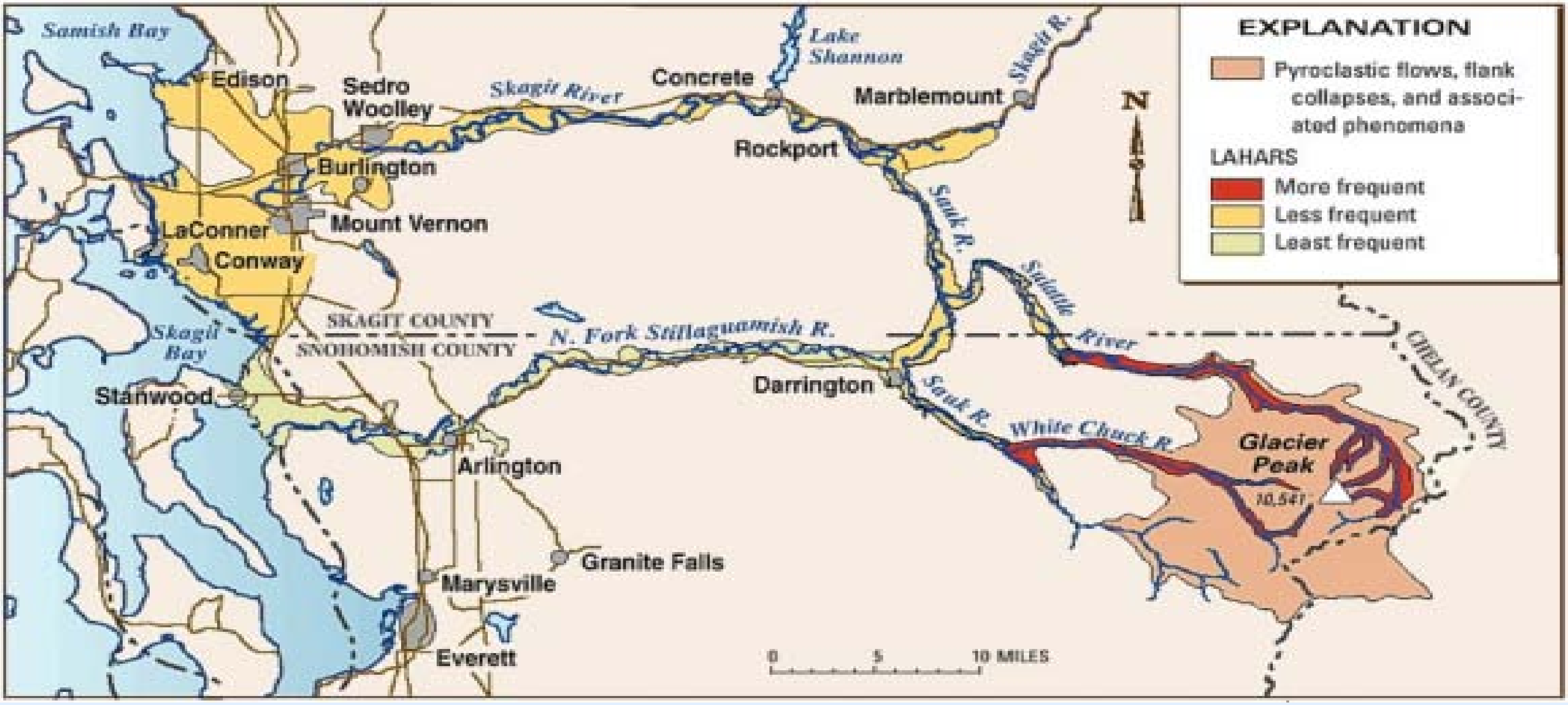
Arguments

- Extension of hydraulic model, based on known stage/discharge at the Dalles to Concrete, based on Stewart's surveyed high water mark estimate in 1922 for the 1921 flood, indicates a 1921 discharge of 174,000 cfs.
- Forensic evidence is not conclusive; but, viewed in its worst light, would seem to indicate a max discharge for any flood event since 1900 of less than 190,000 cfs.
- We also have the Hamilton study results, which are consistent
- Also, common sense argument: why would Hamilton have been moved, and new houses built in Crofoot's Addition, in an area that must have been devastatingly flooded just a few years earlier?
- USGS counter argument to this methodology is: Stewart's indirect slope/area discharge work validated by USGS in 2007


Approx mid-Holocene sea-level and location of the Skagit delta front at about 5,000 years ago. Sea level at that time is believed to have been about 20' lower than today (Dragovich and McKay; Dethier, Beget and others; 1982-2000)
Samish Bay
Padilla Bay
ANACORTES
SEDRO-WOOLLEY
LYMAN
HAMILTON
URLINGTON
LACONNER
Dugualla Bay
Skagit Bay
Oak Harbor
N
0
5.1mi



Shaded relief image (30 m DEM) showing approximate locations of Holocene lahar inundation areas basedon US Geological Survey reports noted in text. Small green arrows show locations of shorelines about 5,500 yr agoin Puyallup, Duwamish, and Skagit River valleys, as interpreted by Luzier (1969) and Dragovich and others (1994;2000). Green dots show locations of buried trees downstream of Mount Rainier, yellow dots show areas ofsubmerged forests in Puget Sound, and fuschia-colored dots show locations of submerged forests in landslide dammed lakes. Lavendar lines show approximate locations of fault zones in the shallow crust.



About 13,100 years ago, dozens of eruption-generated lahars churned down the White Chuck, Suiattle, and Sauk Rivers, inundating valley floors. Lahars then flowed down both the North Fork Stillaguamish (then an outlet of the upper Sauk River) and Skagit Rivers to the sea. In the Stillaguamish River valley at Arlington, more than 60 miles downstream from Glacier Peak, lahars deposited more than seven feet of sediment. Shortly after the eruptions ended, the upper Sauk 's course via the Stillaguamish was abandoned and the Sauk River began to drain only into the Skagit River, as it does today.

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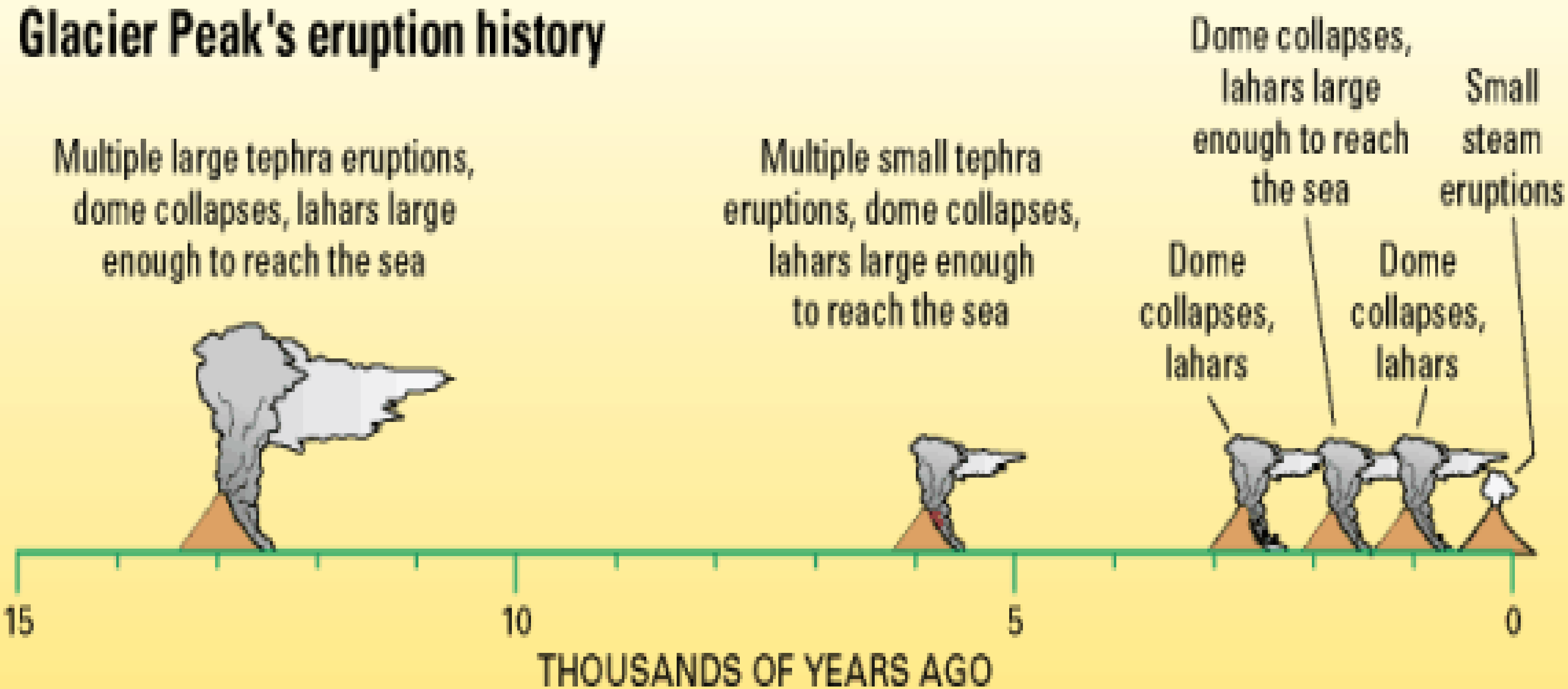
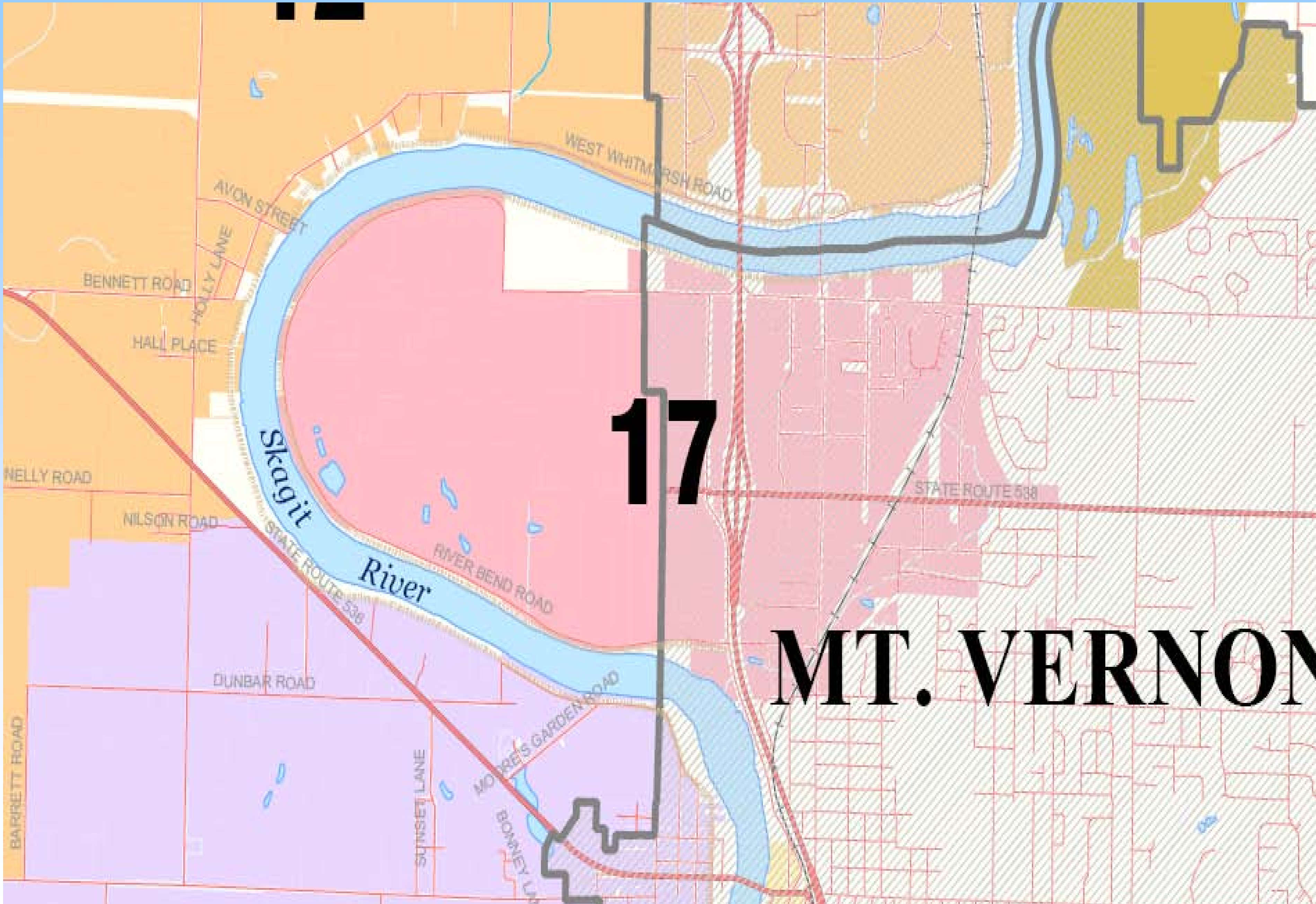


Known eruptive episodes at Glacier Peak during the past 15,000 years. Each episode (depicted by a single icon) represents many individual eruptions. The ages of these episodes, in calendar years before present are corrected from dates based on a radiocarbon time scale. The uncorrected radiocarbon ages for these episodes, which appear in some publications, are 11,200, 5,100, 2,800, 1,800, 1,100, and 300 years before present.

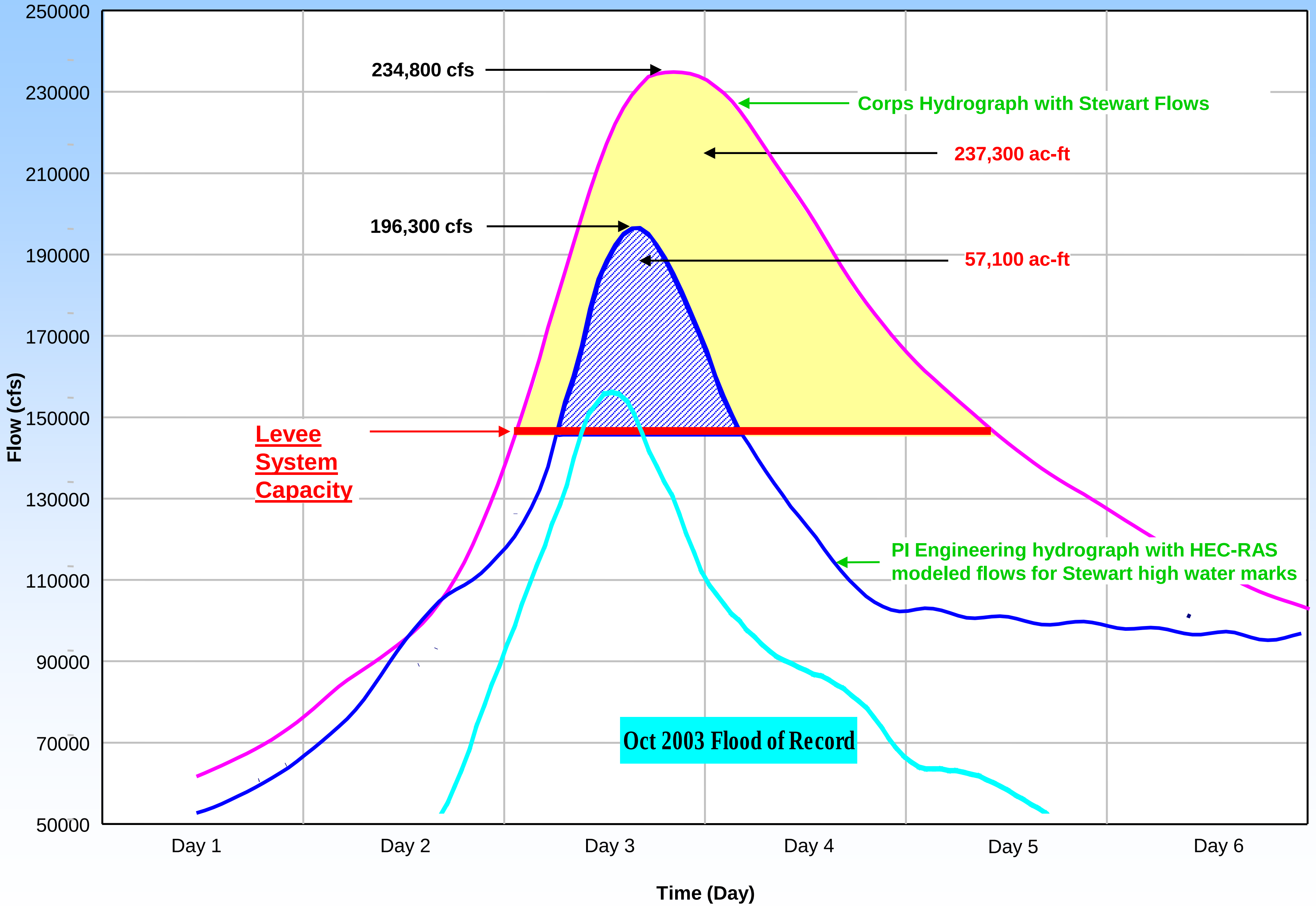
U.S. Geological Survey Fact Sheet 058-00

Shaded relief image (30 m DEM) showing approximate locations of Holocene lahar inundation areas base don US Geological Survey reports noted in text. Small green arrows show locations of shorelines about 5,500 yr ago in Puyallup, Duwamish, and Skagit River valleys, as interpreted by Luzier (1969) and Dragovich and others (1994;2000). Green dots show locations of buried trees downstream of Mount Rainier, yellow dots show areas of submerged forests in Puget Sound, and fuschia-colored dots show locations of submerged forests in landslide dammed lakes. Lavendar lines show approximate locations of fault zones in the shallow crust.

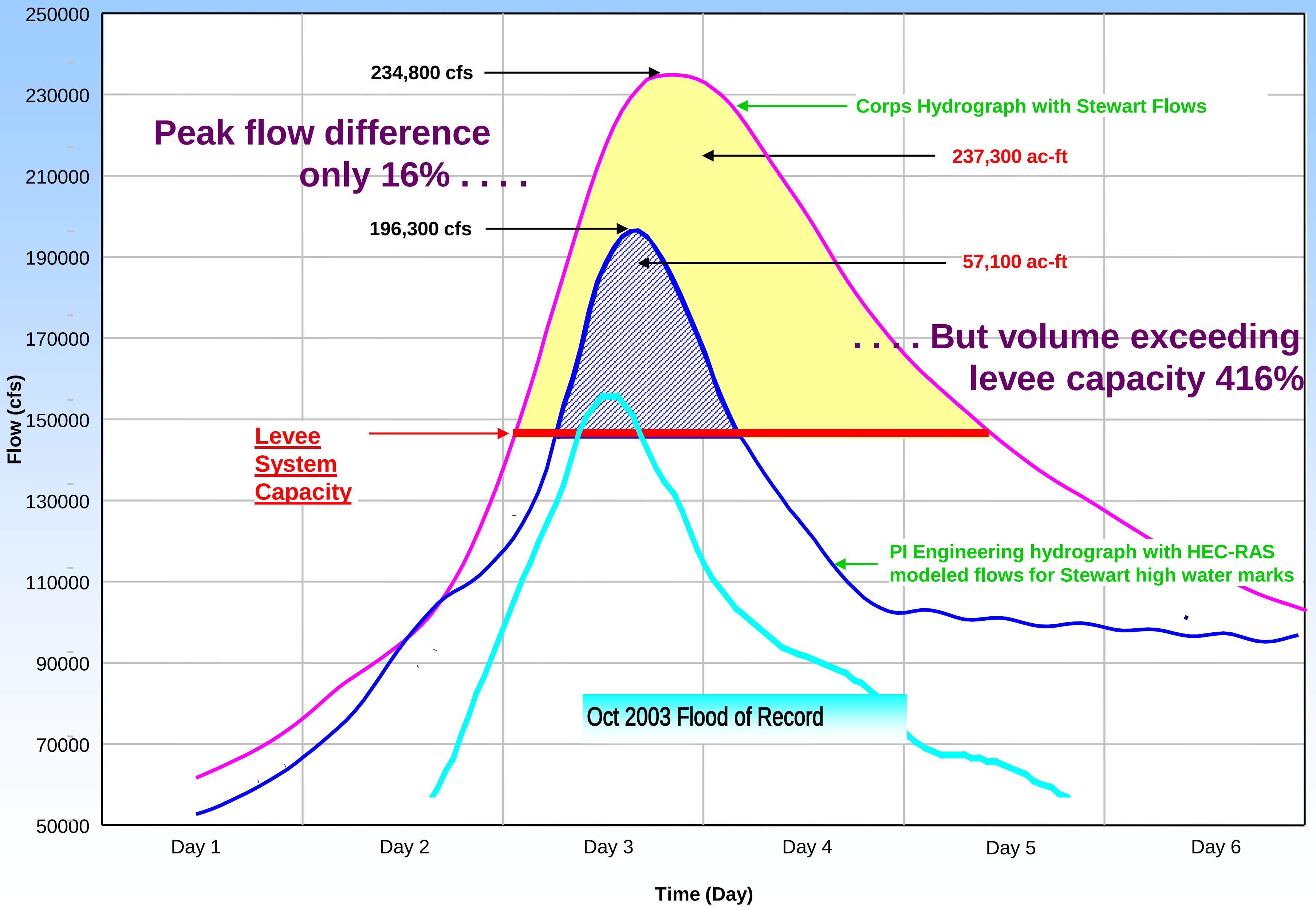


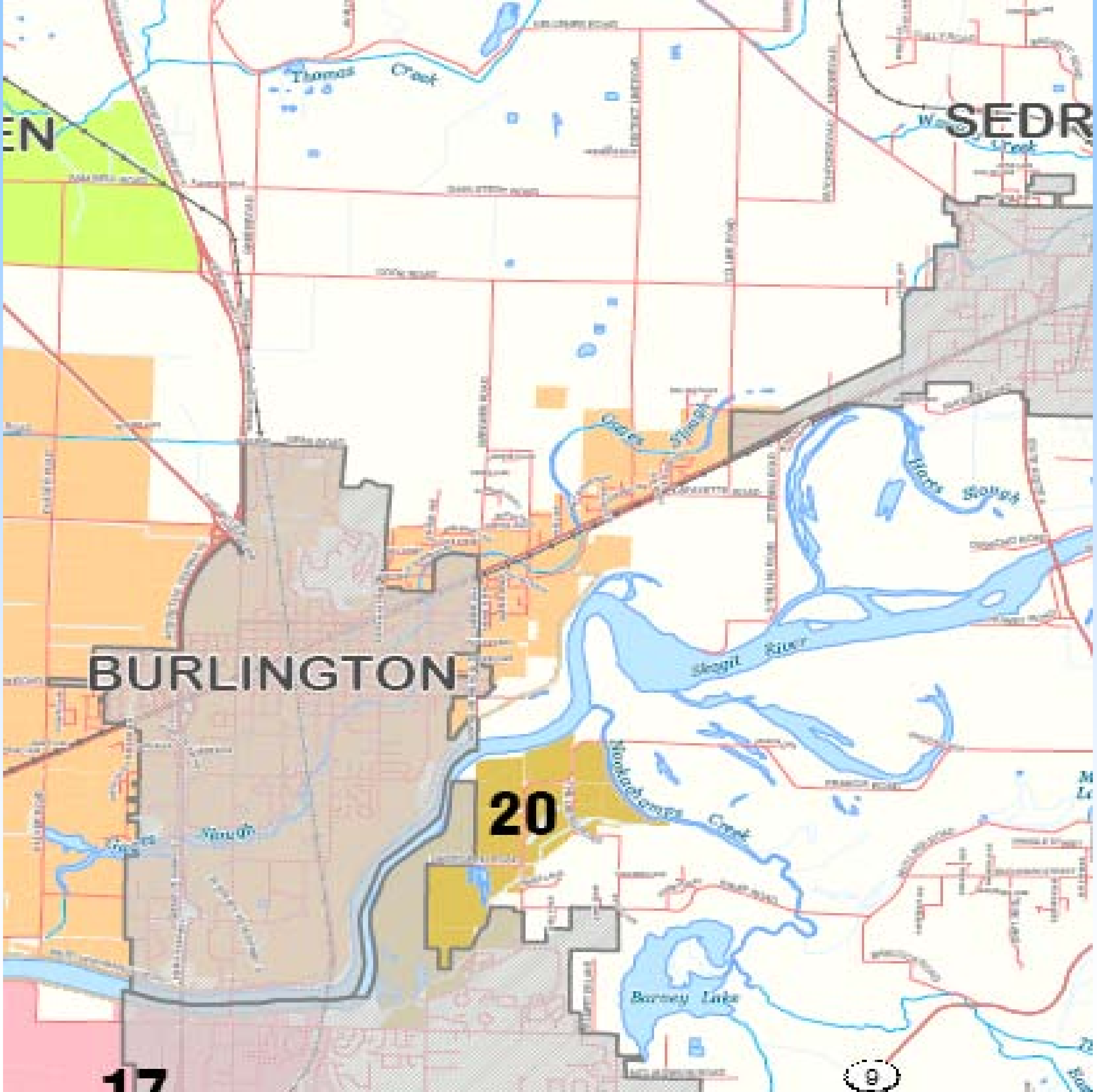
17
MT. VERNON
Skagit River
WEST WHITMARSH ROAD
AVON STREET
HOLLY LANE
BENNETT ROAD
HALL PLACE
NELLY ROAD
NILSON ROAD
STATE ROUTE 538
RIVER BEND ROAD
DUNBAR ROAD
MOORE'S GARDEN ROAD
SUNSET LANE
BARRETT ROAD
STATE ROUTE 538

FEMA 100-year Flood Hydrographs at Sedro Woolley (with existing flood storage)

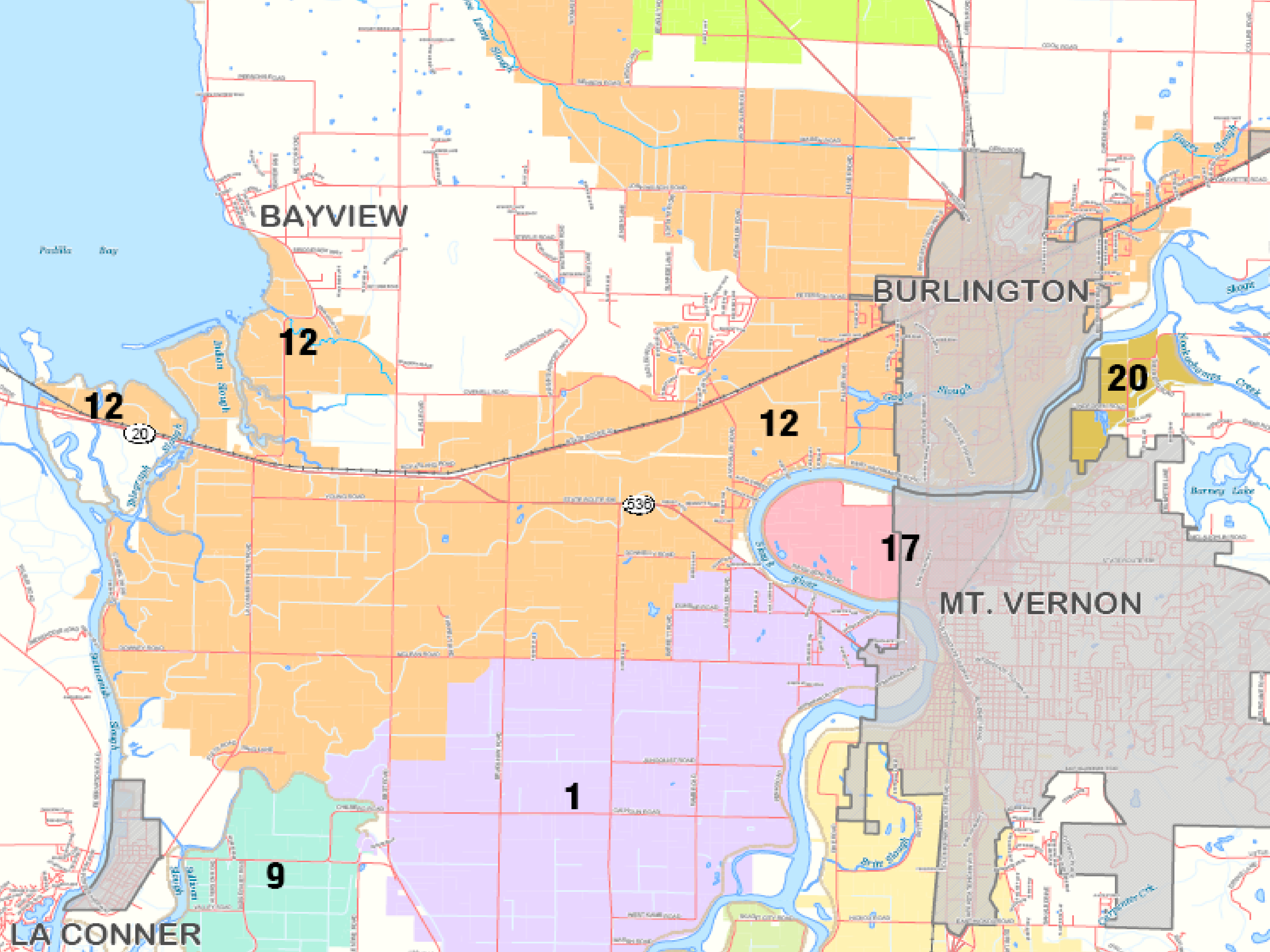


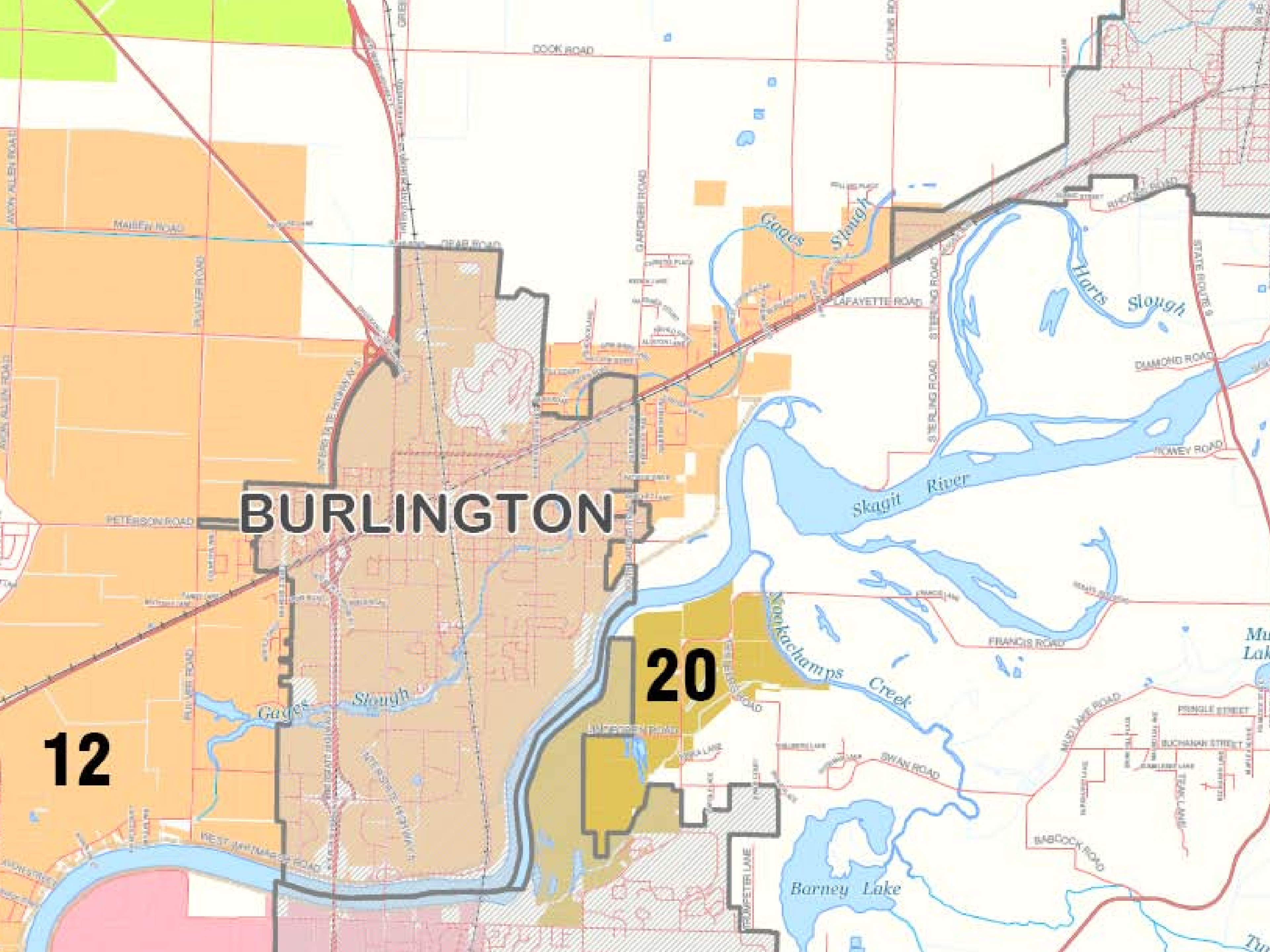
FEMA 100-year Flood Hydrographs at Sedro Woolley (with existing flood storage)





EN
SEDR
Thomas Creek
BURLINGTON
Skagit River
Gages Slough
Hart's Slough
Nookachamps Creek
Barney Lake
Gages Slough
20
17
9


BAYVIEW
BURLINGTON
MT. VERNON
LA CONNER
12
12
12
12
20
17
1
9
20
536


BURLINGTON
12
20
Skagit River
Gages Slough
Harts Slough
Nookachamps Creek
Barney Lake
COOK ROAD
MAIBEN ROAD
OGAR ROAD
PETERSON ROAD
LAFAYETTE ROAD
DIAMOND ROAD
ROWEY ROAD
FRANCIS ROAD
STERLING ROAD
GARDNER ROAD
STATE ROUTE 9
MUD LAKE ROAD
PRINGLE STREET
BUCHANAN STREET
SWAN ROAD
BABCOCK ROAD
WEST WHITMARSH ROAD
PEAVEY ROAD
PULVER ROAD