Update
Skagit River Flood Issues

Presented To

The
Mount Vernon City Council

April 23, 2008

Chal A. Martin, P.E.
Burlington Public Works Director / City Engineer

Overview

- Status of ongoing research
  - Burlington
  - Sedro-Woolley
  - Hamilton
  - The Dalles
  - Concrete
- Map modeling / software issue
- Next steps
- Questions

Concept
Investigation of the Historic Floods

- Build on Stewart's observed and documented high water marks of the historic floods (1922 field notes)
- Use objective and tangible evidence, combined with reasonable interpretation of the historic record of the time and modern state-of-the-art hydraulic modeling methods to better estimate the peak discharges of those events

612 East Fairhaven
(Find what a 1921 flood mark looks like)

Fairhaven Ave. in 1921 Flood

Looking West

Flood of 1921 Fairhaven Street Looking West

1921 Flood 05 - Fairhaven Looking West.jpg

Fairhaven Ave. Today

Source: Skagit Information Management Systems, www.skagitIMS.biz


03/19/2008


GLASS
03/19/2008


HANDLE WI
STAND ON E
STAINLESS STEEL
04/02/2008


GLASS
HANDLE WITH CARE
STAND ON EDGE
F1
F2
F3
F4
04/02/2008

Summary: Burlington Info 1921

- Nothing yet

At Sedro-Woolley – 1909

1909 flood: Bigger in Sedro-Woolley than 2003 – (but not that much bigger)

- 190,000 cubic feet per second seems about right

At Sedro-Woolley – 2003

At Sedro-Woolley – 2003

Other Sedro-Woolley Information

- Stage readings give a good check for our assertion that the historic floods were similar to those of the last 15 years

Stage Elevations, Sedro-Woolley

Year	Stage
1909	47.6
1995*	46.2
1897	46.0
1921	45.4
1917	45.2
2003*	44.2
1990 (2)	43.9
1990 (1)	43.0

*w/ debris

Range of stages 4.6 feet

Issue

- 1897 coincident flow
  - 265,000 cfs Concrete (new USGS estimate)
  - 190,000 cfs Sedro-Woolley (Hwy 9 bridge)

- Was this a debris blockage flood?
  - P. 23 Stewart notes, 28 November 1922

BS	HI	FS	Elev	
.40	230.91		230.51	BM USGS
		5.34	225.57 / 11.24 / 214.33	Measured down 11.24' from this point on freight car to rail below (about 300 ft below depot)
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 at 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)

Dec 21 1922

	BS	HI	FS	Elev	
	10.5	20.5		10.00	1897 flood crest on stump at old [illegible] by bridge [illegible] Est by [illegible] Wilder [illegible] H W was 8½' below top of stump
TP			11.2 rod 4.6 top 15.8	4.7	
	4.7	9.4			
			3.0	6.4	1921 H W at stump

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

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 some slope between 1897 and 1909 mks. Est max at 0.2 [illegible] Call 1897 1 ft higher than 1909 and 3.4 ft higher than 1921

1897	10.00
1909	9.4
1921	6.4

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

Fig is wrong probably see bottom [illegible] bolt at [illegible] See bottom of page 19 [illegible]

Leonard Everett Interview

P. 23, Stewart's field notes:

"Leonard Everett says 1897 flood about 9 inches lower than 1909. Says that log jam in Dalles raised water 10 ft in 2 hrs."

Summary, Information from Sedro-Woolley

- Stage information available here gives a comparative check of the magnitude of the historic events compared to the recent floods
- If 1897 data point is retained for Concrete, it should be reduced to coincide with Sedro-Woolley
- Concrete discharge of 265,000 cfs is not supported by the written record or by flood modeling of the valley between Concrete and Sedro-Woolley

At Hamilton


Highway 20
Old School House
Smith House
CAP: Western WA Flooding

At Hamilton

Nov 27 1922

10 AM

	12.73	12.73		00.00	W.S.
TP			4.36	8.37	
	10.68	19.05			
			2.27	16.78	RP
	2.94	96.84		93.90	Top of GN rail
TP			2.40	94.44	
	4.21	98.65			
			3.03	95.62	1917 HW
TP			4.95	93.70	
	3.40	97.10			
TP			4.49	92.61	
	5.87	98.48			
			1.59	96.89	RP. described above

nail in 14" maple on river edge of old levee

Nov 28

in front of Hamilton Depot. { Elev from USGS Bulletin 670?

.55 above 17 = 1909 HW
.84 above 17 = 1921 HW

{ At AJ Jacobin cigar store. Bldg may have settled. [illegible]

95.62
.55
96.17 = 1909

95.62
.84
96.46 = 1921

95.62
80.11
15.51 = 1917 HW above stage 11/27/22

96.17
80.11
16.06 = 1909 HW above stage 11/27/22

96.46
80.11
16.35 = 1921 HW above 11/27/22 stage

96.89
16.78
80.11 Elev of WS Nov 27

Magnus Miller says 1897 flood came to door knob of James Smith's drug store (door of the drug store raised since then)

Hine across from Hamilton may have 1897 mark


GNRR Depot
93.90 Top of GN Rail
A. J. Jacobin
1921 HWM
96.46 feet
"Smith" House
2003 HWM 100.83
N
0
502ft
Includes material © Space Imaging LLC.

“Smith” House, built in 1908, Hamilton WA

“Smith” House, built in 1908, Hamilton WA

Smith House Exterior Flood Mark

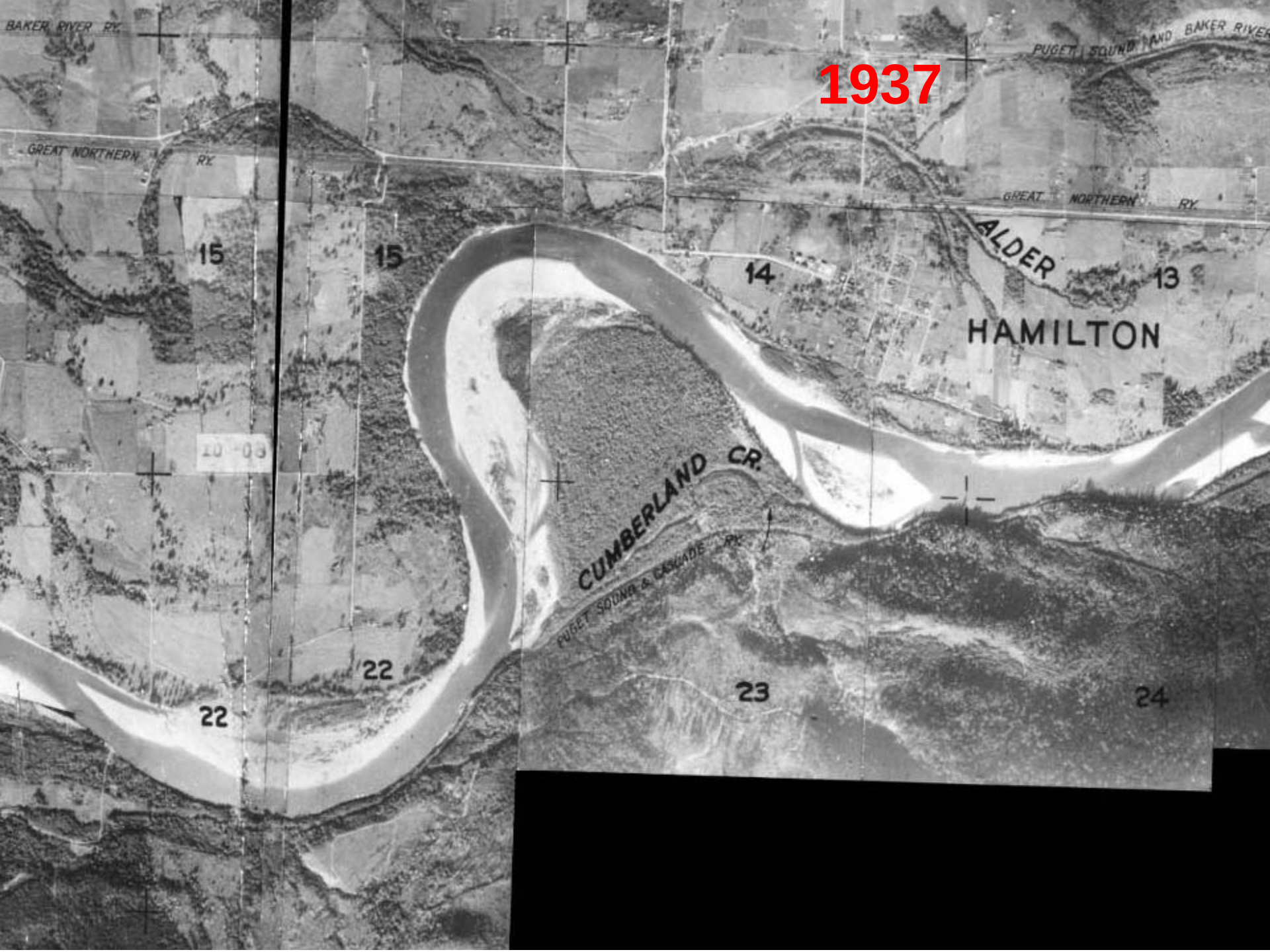
Hamilton Flood Elevations then and now

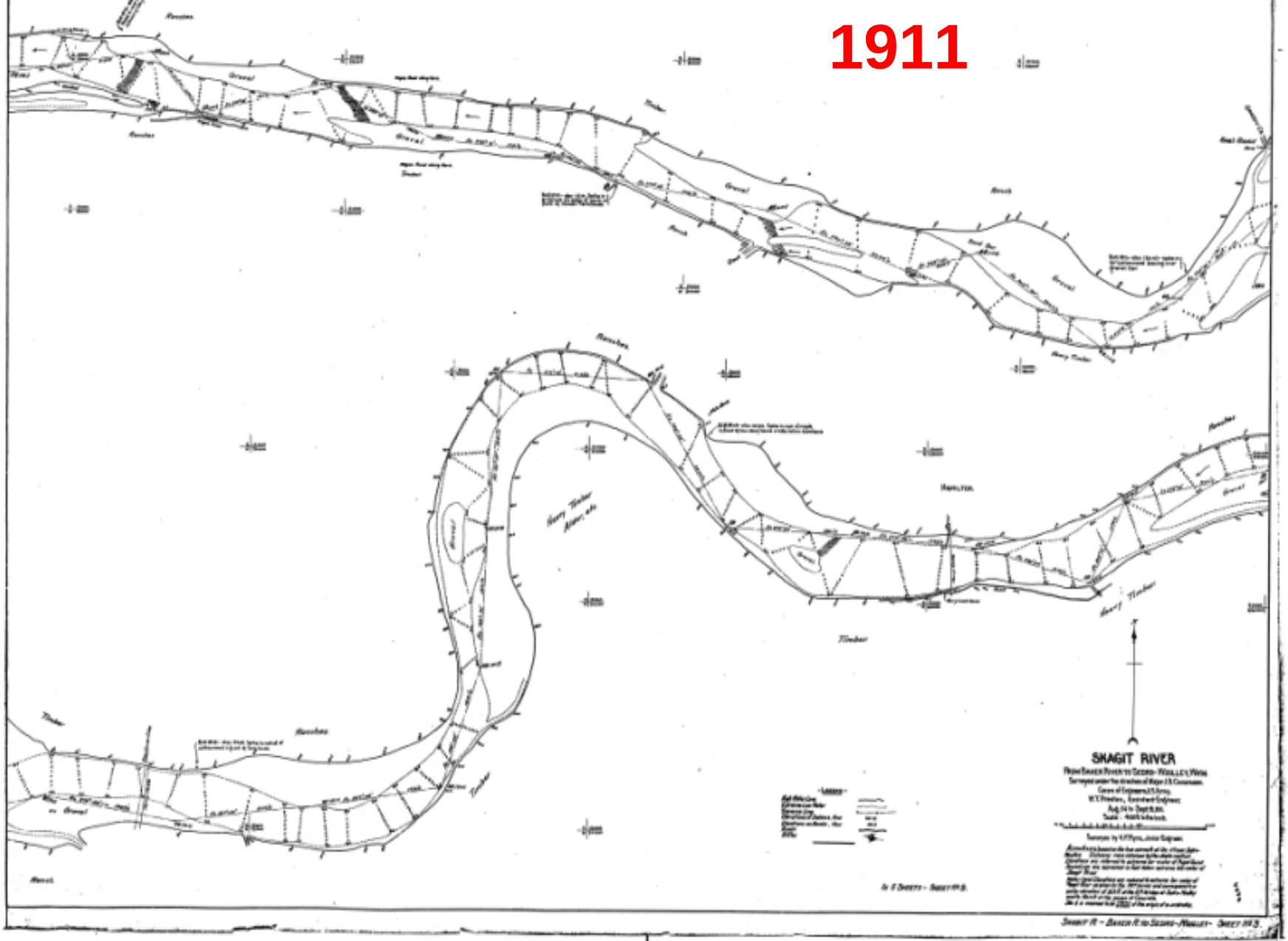
Year	Water Level in Hamilton, A. J. Jacobin Cigar Store And Smith House
1897	(no data)
1909	96.17
1917	95.62
1921	96.46
1995	101.00
2003	100.83

Issue: Was channel capacity much greater back then?

- Answer: probably – but not all that much
- Argument: if 1921 flood discharge was 228,000 cfs (USGS) and did not flood the Smith House, then how could the flood of 1932 (147,000 cfs) cover "nearly the whole of Hamilton at the height of the flood (Concrete Herald, March 3rd, 1932)"
- PI Engineering conclusion: 188,000 was the peak for 1909, 1917 and/or 1921 events at Hamilton
- FEMA / USGS / COE position: inconclusive


2007
N
0
0.4mi
Includes material © Space Imaging LLC.


1937
BAKER RIVER RY.
PUGET SOUND AND BAKER RIVER
GREAT NORTHERN RY.
GREAT NORTHERN RY.
15
15
14
13
ALDER
HAMILTON
CUMBERLAND CR.
PUGET SOUND & CASCADE RY.
22
22
23
24


1911
SKAGIT RIVER

Summary: Information from Hamilton

- Town was relocated after 1897 flood, but why relocate to a place that was flooded in 1897?
- Smith House, built in 1909, was never flooded above the first floor until 1995, and should have been if historic floods were as large as USGS states
- Estimate of largest flood: 188,000 cfs

At the Dalles

Nov 25 1922

At The Dalles

The man who lives at The Dalles showed the highest point 1921 flood reached. This point was 0.74 above sand we found in maple tree. We will use our levels on sand however as they are comparable with other points

Later levels show his mark nearer right. We found (error 0 that H.W. mark was .5' above sand in maple (See bottom page 175) Jgls 3/9/23

On R side of River above The Dalles and assumed at elev 100.00 1921 flood at elev 100.00 a short distance above BM 256 on opposite side of river

	101.15		100.00	
		7.08	94.07	
0.84	94.91			
		12.15	82.76	
0.78	83.54			106.00 − 72.12 = 27.88 1921 above H.W. today
		11.42	72.12	H.W. today

27.88 seemed small so ran level back

11.41	11.41		00.00
		.70	10.71
11.80	22.51	+ 5.9	28.40

This indicates .5 error in previous level. This also still looks low

measured up from line of sight today. Assuming pt on other side

Use 28.4 as 1921 above H.W. water of river at BM 256 was 1909 flood side of river we must add .07' for fall) To make this 28.4 comparable with other H.W. in little (see top of page 5) 28.4 + .7 = 29.1

1672 from 1856 flood down to axe helve
10.25 rod on axe helve
5.95 1856 flood above line of sight
1.15 1921 flood below line of sight
7.10 1856 above 1921 flood

This is much too low. Did not reach H.W. mark

30)

At Concrete Dec 22 n.

	5.90	236.41		230.51	USGS Bm
TP			11.43 rod 11.03 Hwr 22.47 Incl	213.94	
	1.78	215.72			
TP			8.22	207.50	car of sidewalk
	8.85	216.35			
TP			2.78	213.57	
	4.55	218.12			
TP			11.82	206.30	
	1.87	208.17			
TP			12.43	195.74	
	0.59	196.33			
TP			10.97	185.36	
	6.80	192.16			
			7.63	184.53	1921 Hwr.
TP			0.82	181.37	at Wolfs residence
	3.91	185.28			
TP			1.31	183.97	
	8.10	192.07			
TP			12.90	179.17	
	3.71	182.88			
TP			2.70	180.18	
	2.06	182.24			
TP			4.13	178.08	
	2.24	180.32			
TP			6.87	173.45	
	3.50	176.95			

See also pages 19 & 22

Contd on next page

		cont. from last page			
		176.95			
TP			3.28	173.67	
	3.45	177.12			
TP			0.14	176.98	
	10.50	187.48			
TP			1.16	186.32	
	11.96	198.28			
TP			8.08	190.20	
	11.27	201.47			
TP			11.13	190.34	
	0.54	190.88			
			2.66	188.22	B.M
TP			13.23	177.65	
	2.11	179.76			
			8.74	171.02	Top of lower gage board 20.45

177.65 171.02
150.57 20.45
Elev of RP 327.08 150.57 ← datum of gage
to zero of gage

Top of 60P bent spike in blaze on angle L side of road going to old ferry about 100yds from end of ferry road 60 or 70 ft downstream from gage.

RP 60P spike driven vertically in top of 5" fir stump 5' shoreward from 2nd gage tree

BM is marked 181.24 This is from unchecked level notes. True figure is 158.22

58) At upper end of The Dalles 59)

Jan 25 1923

	11.94	11.94		0.00	Ws today about 150 ft below gage at upper end of The Dalles
			1.27	10.67	
	11.64	22.31			
			1.58	20.73	
	12.21	32.94			
			8.09	24.85	R.P. marked 100.00 in levels page 5
			2.82	30.12	HW 1921 about as pointed out by man in cabin at Dalles
			2.71	30.23	HW 1921 mark previously made (Nov 25 page 5) at maple
			11.00	21.94	26.00 on vertical gage
Jan 25	2.19	14.19		12.00	on slope gage at upper end at Dalles
			10.21	3.98	Ws today upper Dalles gage
	4.25	104.25		100.00	R P in 10" fir upper end of Dalles
Jan 25			+1.13	106.38	1921 HW on R side of Dalles at maple about even with lower end of cabin
			+0.1	104.35	1921 HW on L side of Dalles about 30' below pt
		Near Lower end of Dalles			
					1921 HW
Jan 25	9.25	9.25		0.00	
			0.2	9.05	HW mark of Indian tradition { mark is plain on rock face … about 20 horizontal distance
Jan 26	2.5	102.50		100.00	{ old Flood sand bar about 30' upstream from cabin at Dalles. 1st trace ever found of this flood. either 1820 or pre tradition
			4.6	97.9	old HW mark or bar, same flood as other mks found in valley. either 1820 or 1860 (Scratching of chickens)
			4.9	97.6	do Raining mud in old burned maple stump (Use 97.9)
TP			12.07	90.43	(H.O. Stiles says small benches due to scratching of chickens. Mark in stump may be caused willow deposit) (Common plant dust)
	3.75	94.18 ~~~~			
				89.08 ~~~~	HW 55 ft downstr from stump (at maple tree mark)
			5.1	94.18 ~~~~	1921 on upper Dalles gage 39.39

94.18 / 89.07 / 5.1 — 39.39 / 5.1 / 34.29 ✓

These shots on sand bar show 1919 of level 1.3 above 1921 ... bottom of bar ... show ... 1921 sediment

Shots on sand bar at Dalles in front of Dalles Cabin. Start upper end bar ... lower end. Bar remains at ...

{ 26.00 / 11.94 / gh 4.06 } — 30.23 / 4.06 / 34.29 = (gh 1921 ...)

{ Levels pages ... show this ... Water surface higher down ...

At the Dalles
Mar 9

Took samples of sand
1921 (certain) trial trips taken below 1921 HW
1907 do ½ feet above 1921 HW
This sand 1909 also
1897 Fairly certain taken for highest point on sand bar. Thought to be top high for 1909 but there looks the close together to be certain
1856 Above 1897 and probably below 1856

1820 (or before) Certain, taken from top of beach line.

00.00	40.00		40.00	on upper Dalles page
		0.45	39.63	
12.32	51.95			
		1.74	50.21	
9.43	59.64			
		4.5	55.14	old beach line very distinct, this apparently is the highest point reached by flood in hundreds if not thousands of years

Wright made it 56.4

Below The Dalles Mar 9

BS	H.I.	F.S.	Elev	
3.52	149.17		145.65	BP at on rock. BP Elev 145.65 page 68
		0.32	148.85	
5.16	154.01			
		0.00	154.01	on lower Dalles page

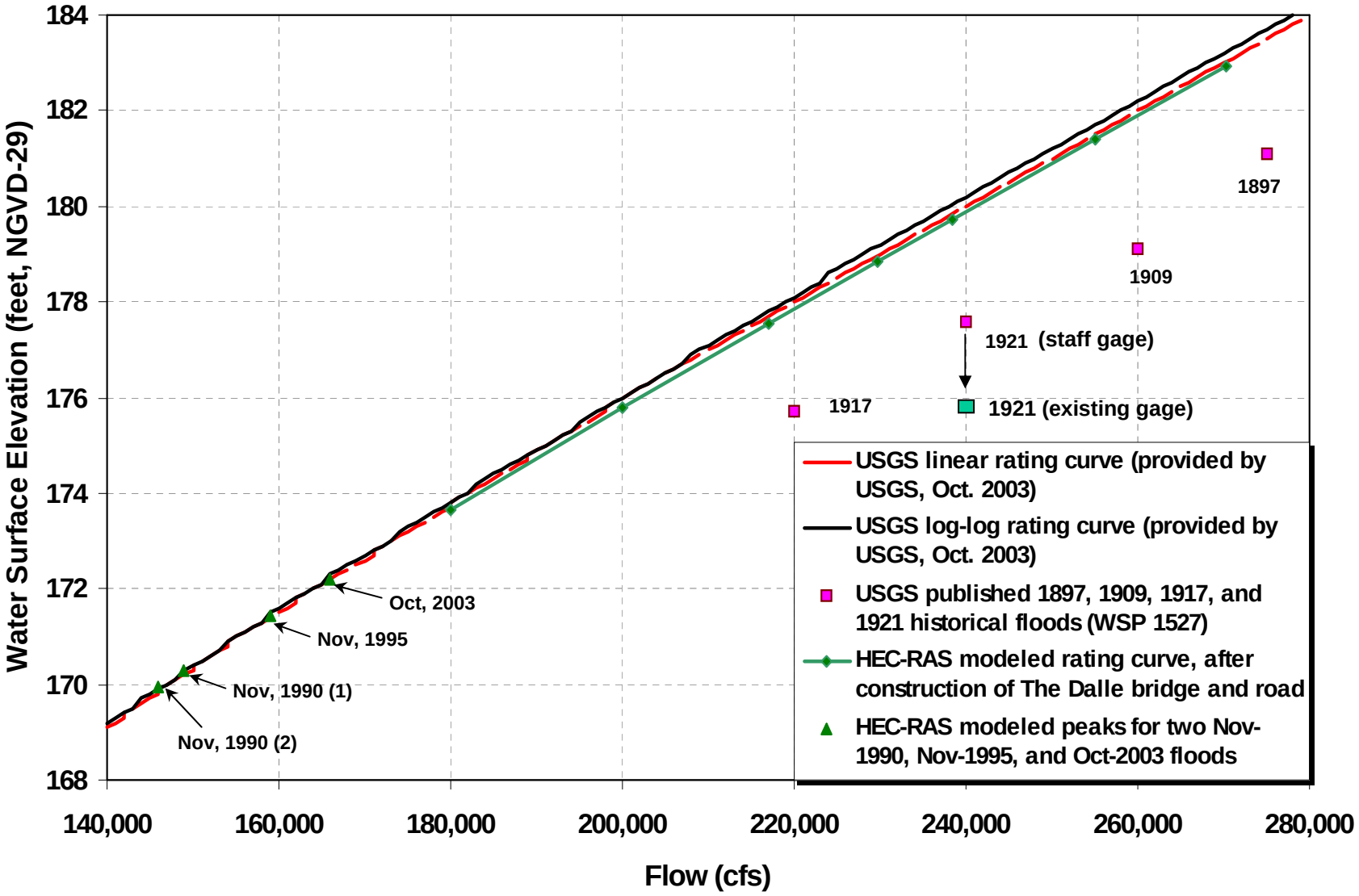
Found stump cut by Stiles to have 62 distinct rings

25 ft below upper Dalles Cross section found 1921 HW mk to be 0.57' above mk on maple used previously as 1921 HW. This maple is 25 ft above Cross section.

What is right?

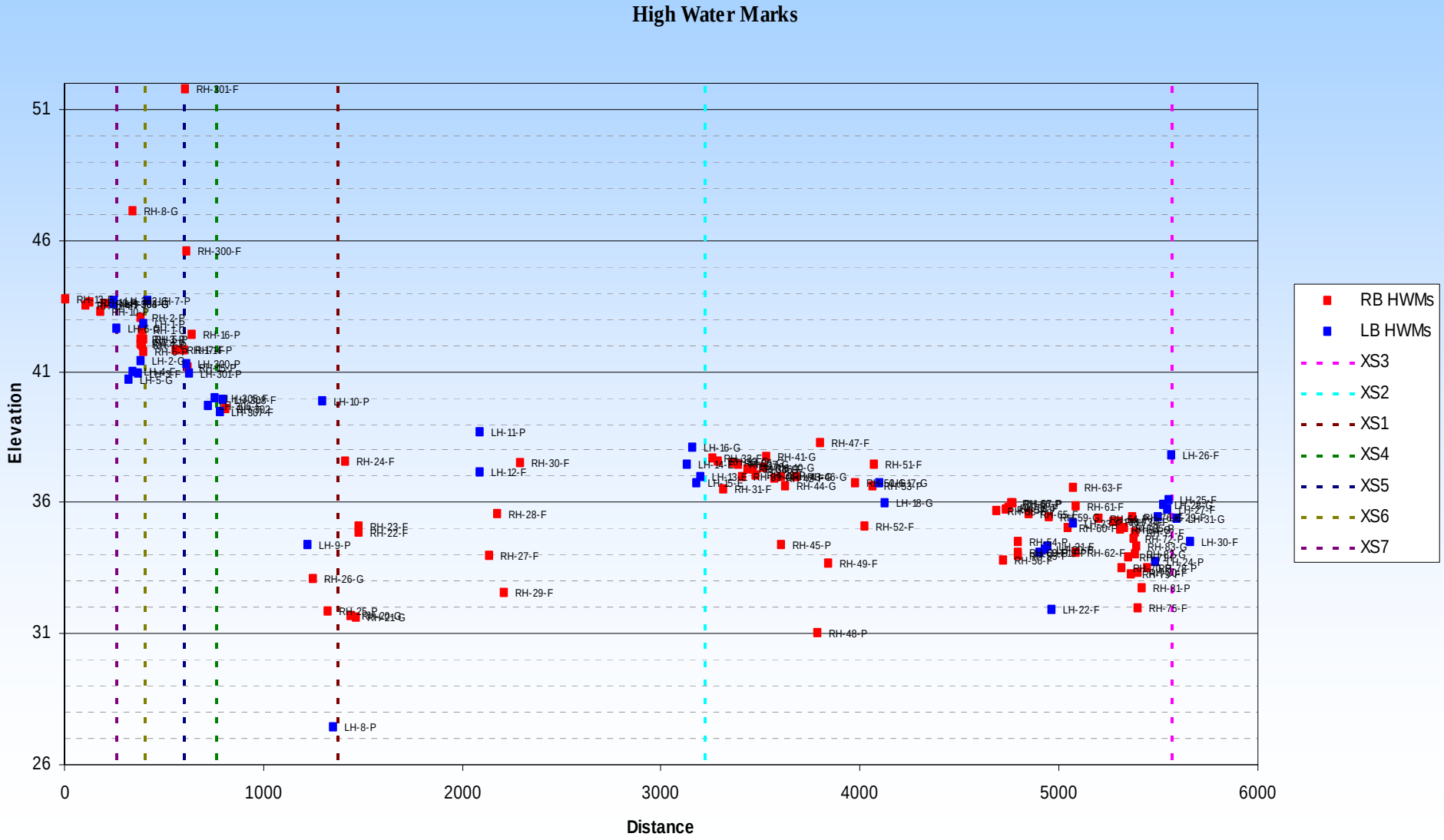
- Stewart Notes 47.6 feet (but discharge estimate 240,00 cfs (since reduced to 228,000 cfs by USGS) (unregulated)
- 2003 HWM 42.2 feet (166,000 cfs) (regulated) (this is accurate)
- Rating curve chart (not “appropriate” to extend the rating curve more than 20% or so -- but it could still be correct)

Rating Curves of the Skagit River near Concrete (Existing Gage) (PI Engineering, 2005)



Is the Concrete Reach right for the Slope/Area Method?

USGS High Water Marks Profile Plot at the Dalles, 2003 Flood



Summary, Information from the Dalles

- It would have been difficult for Stewart to accurately ascertain the stage of the 1921 flood at the Dalles.
- We will not be able to resolve our differences with USGS / COE on the Dalles stages, so we are focusing on other flood marks in Concrete instead

At Concrete, Crofoot's Addition

Levels at Concrete

BS	HI	FS	Elev	
.40	230.91		230.51	BM USGS
			225.57	
		5.34	214.33	
1.31	215.64			
		5.3	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	11.2 rod 4.6 top 15.8	10.00	1897 flood crest on stump at old bar by bridge site Est by Roman Miller 9 not H.W. was 3 ft below top of stump
TP	4.7	9.4		4.7	
			3.0	6.4	1921 H.W.

These are relative figures only, Aerial stump and Washington Cement Plant. The gh. are a continuation of Schmidt and Oak... [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. Nose of zero flow for old channel. Call 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 marks. Est. max at 0.2 ft. Call 1897 1.4 ft higher than 1909 and 3.4 ft higher than 1921

1897	10.0
1909	8.4
1921	6.4

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

See bottom of page 18 for the comparison of marks at Everett. This is wrong. Probably see bottom half of page 17 and 31 and 2 4/5

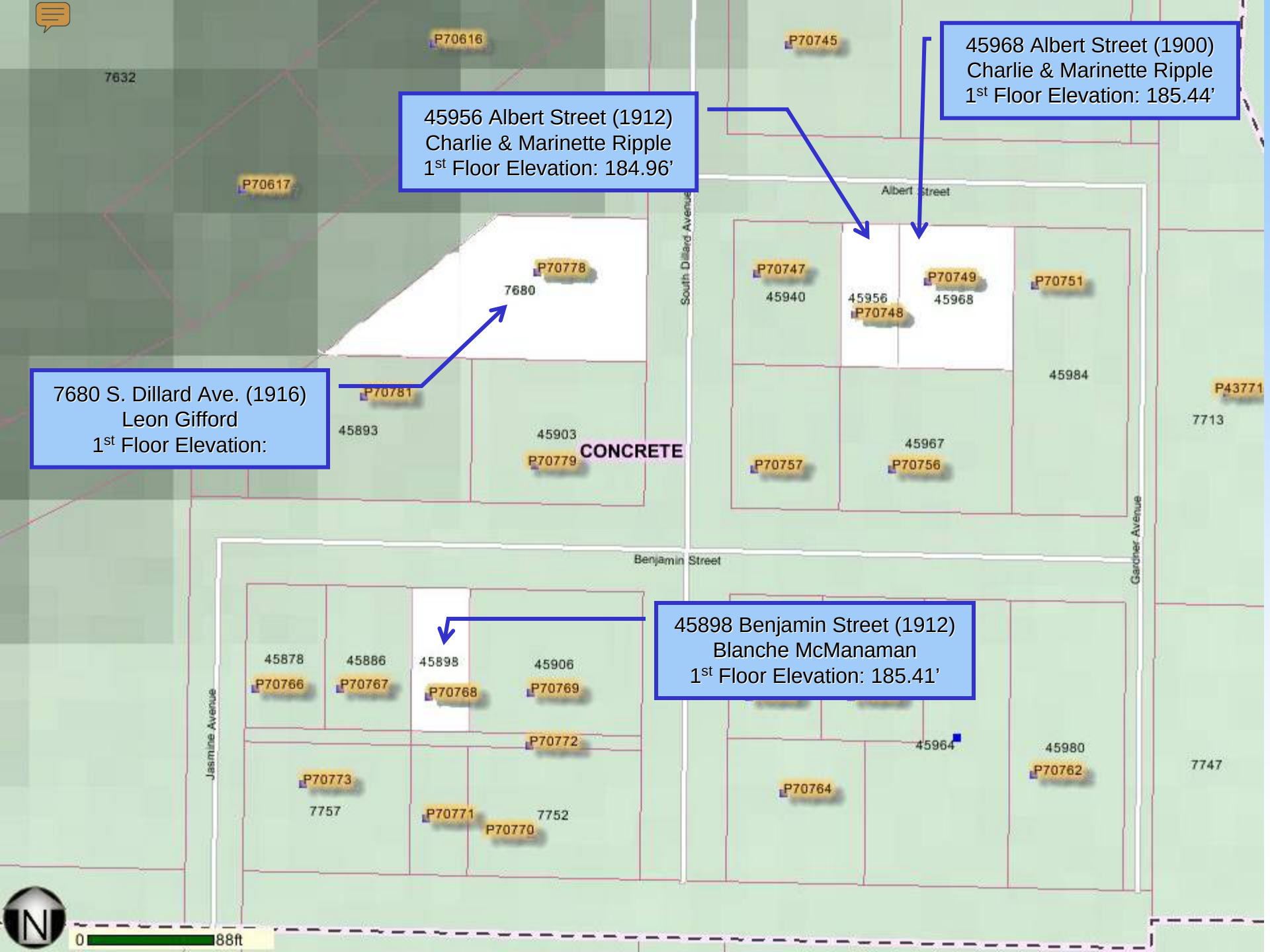

P70645
P70866
Crofoot's
PARCELS OWNED
BY L.E. WOLFE
1921
Sources
1) 1921 Real Property Tax Roll And Assessment, State Archives, Bellingham
2) Skagit County on-line Assessor Database
3) Assessor Parcel Map Section 11 Township 35 Range 08
Research conducted by Josef Knazler and Chel Martin 30 Mar 08
P70647
P70771
off map P70613
Copyright ©2007 Pictometry

Concrete 1937

L.E. Wolfe Residence, 1922

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"*


45968 Albert Street (1900)
Charlie & Marinette Ripple
1st Floor Elevation: 185.44'
45956 Albert Street (1912)
Charlie & Marinette Ripple
1st Floor Elevation: 184.96'
7680 S. Dillard Ave. (1916)
Leon Gifford
1st Floor Elevation:
45898 Benjamin Street (1912)
Blanche McManaman
1st Floor Elevation: 185.41'
CONCRETE
Albert Street
Benjamin Street
South Dillard Avenue
Gardner Avenue
Jasmine Avenue
P70616
P70745
P70617
P70778
7680
P70747
45940
45956
P70748
P70749
45968
P70751
45984
P43771
7713
P70781
45893
45903
P70779
P70757
45967
P70756
45878
P70766
45886
P70767
45898
P70768
45906
P70769
P70772
P70773
7757
P70771
7752
P70770
45964
45980
P70762
P70764
7747
0
88ft


STOP


7680
04/03/2008


04/03/2008

G20

04/03/2008 10:22


45898


M14
M13
M12
M11
M10
04/03/2008 15:02


M14
M13
M12
M11
M10
04/03/2008 15:01


PANCAKE MIX
04/03/2008 15:13


M8
M7
M6
M5
M4
M3
M2
$M1
04/03/2008 14:48


M8
M7
M6
M5
M4
M3
M2
M1
04/03/2008 15:12

Ripple House, Built 1900
First Floor Elevation 185.44
(1921 Stewart mark at Wolfe residence 183.55)
1909 Theoretical Water Level – 190.00


04/03/2008 11:22


04/03/2008 11:25


D10
04/03/2008 11:45

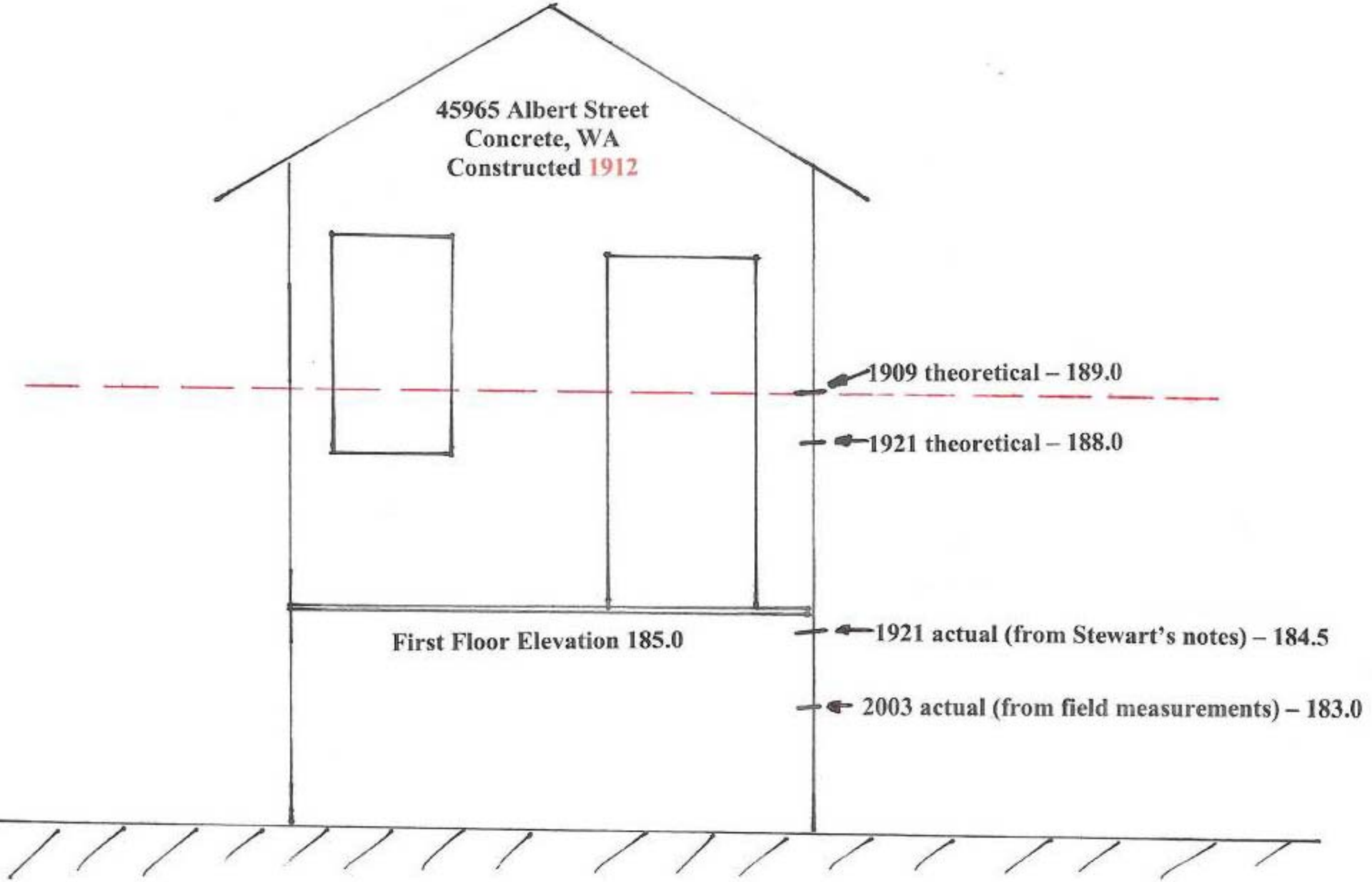
2nd Ripple house, Built 1912
First Floor elevation 184.96


04/03/2008 12:07


S2
04/03/2008 12:17


S5
S4
S1
04/03/2008 12:17

2nd Ripple house, Built 1912
First Floor elevation 184.96


45965 Albert Street
Concrete, WA
Constructed 1912
1909 theoretical – 189.0
1921 theoretical – 188.0
First Floor Elevation 185.0
1921 actual (from Stewart's notes) – 184.5
2003 actual (from field measurements) – 183.0

Summary of the Crofoot's numbers

- 2003 High Water Mark 183.0
  - (166,000 cfs)
- 1921 High Water Mark 184.5
  - (228,000cfs?)
- 1983 Flood insurance Study: 188.0
  - (230,000 cfs)


10
Wolfe
Ripples
N
0
481ft
Includes material © Space Imaging LLC.


N
0
0.4mi
Includes material © Space Imaging LLC.

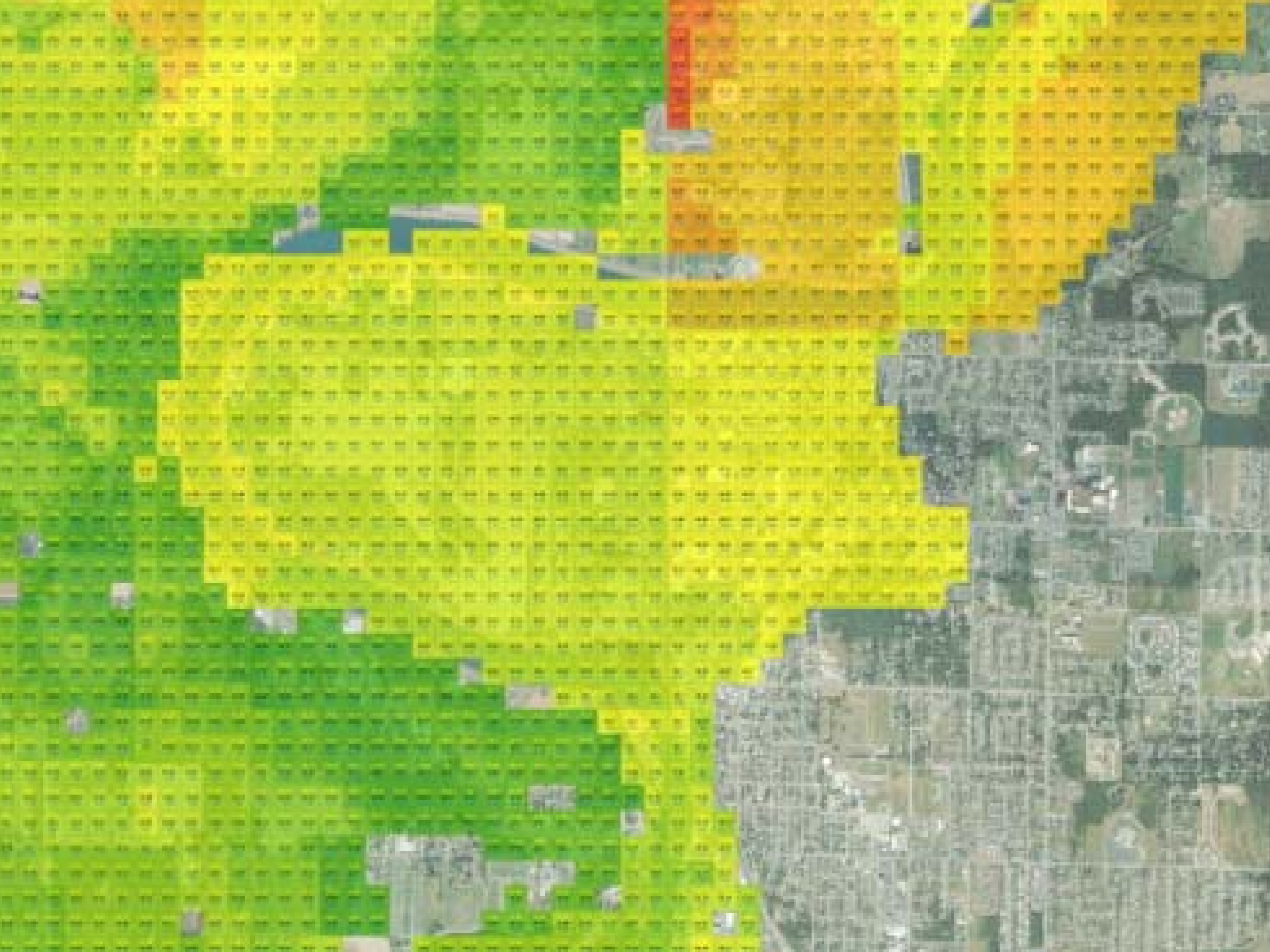

N
0
0.4mi
Includes material © Space Imaging LLC.

Summary of the Crofoot's numbers

- If extension of hydraulic model from the Dalles shows surface water elevations in Crofoot's addition similar to Stewart's notes, combined with newspaper reports of the times, combined with no evidence of flooding above the first floors: this is compelling
- Also, assuming 1909 flood was 245,000 (newest USGS estimate), why would so many houses be built here if it was flooded to 4 feet above the FF level of these houses?
- **This is our argument**

Map modeling / software issue

1. COE Flo-2d model of lower basin (Sedro-Woolley to Skagit Bay) is complex
2. Older version of Flo-2d software didn't work right
3. COE had no way to know
4. But, based on faulty output, COE told County the hydrology differences between it and PI Engineering made almost no difference in base flood elevation levels

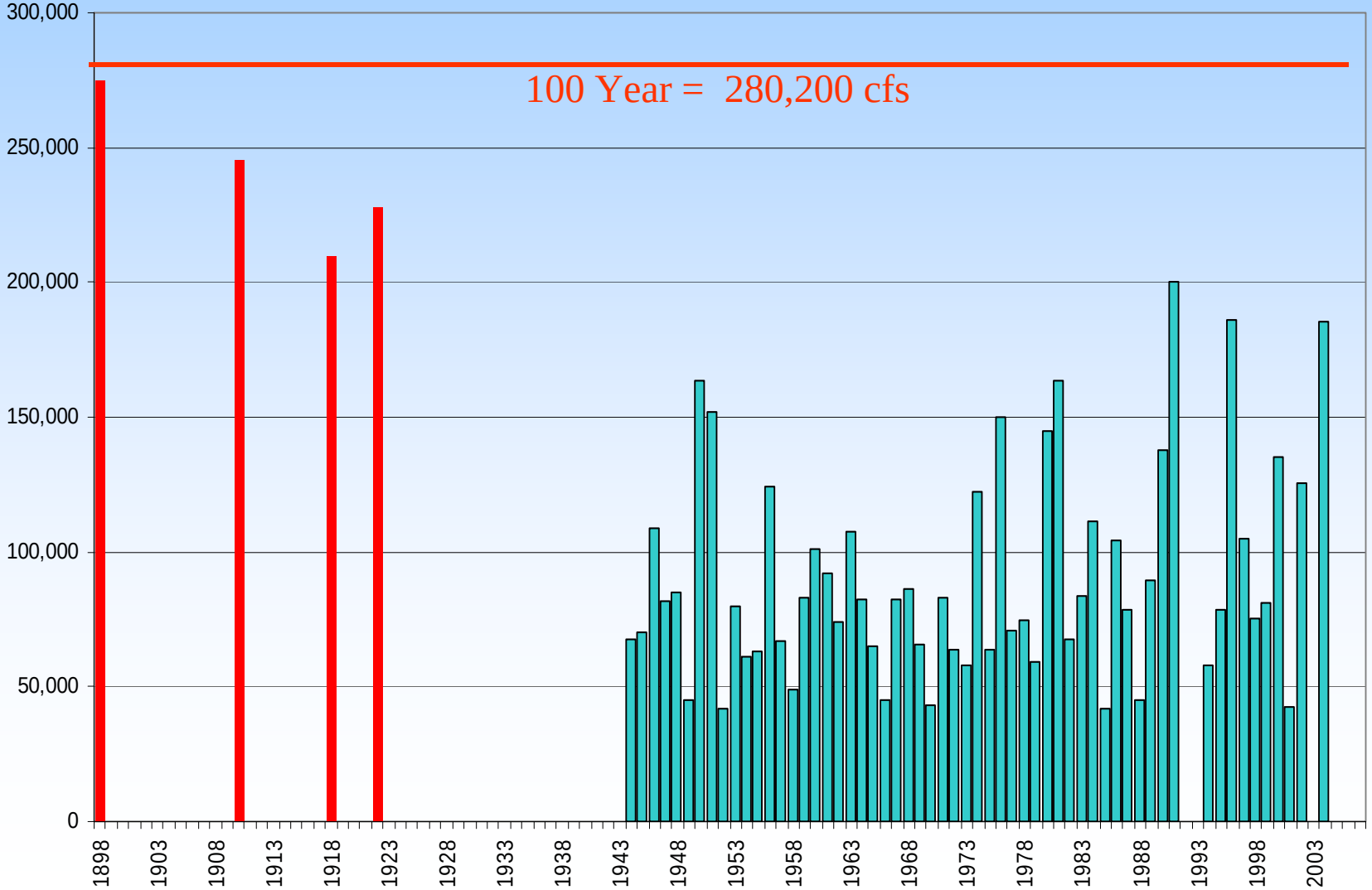


Map modeling / software issue

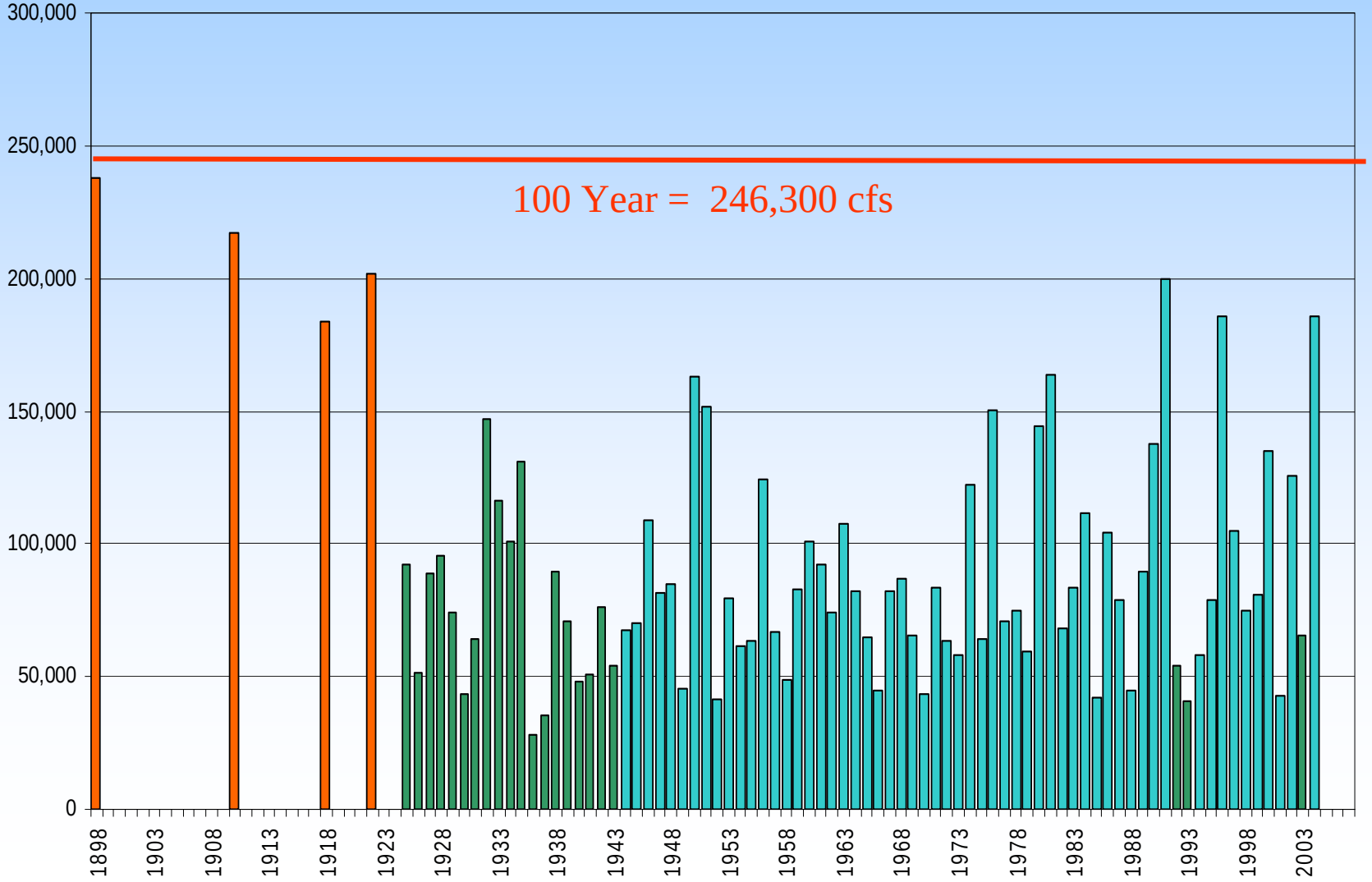
5. Turns out, PI Engineering's modeling was correct.
6. COE is now updating its hydrology and maybe the model somewhat. We do not yet have many details.
7. It does appear COE has revised its peak-to-one-day flow ratios to better match 82 years of gage data; also, COE will include the 1925-43 data.

   - both of these points have been requested by PI Engineering

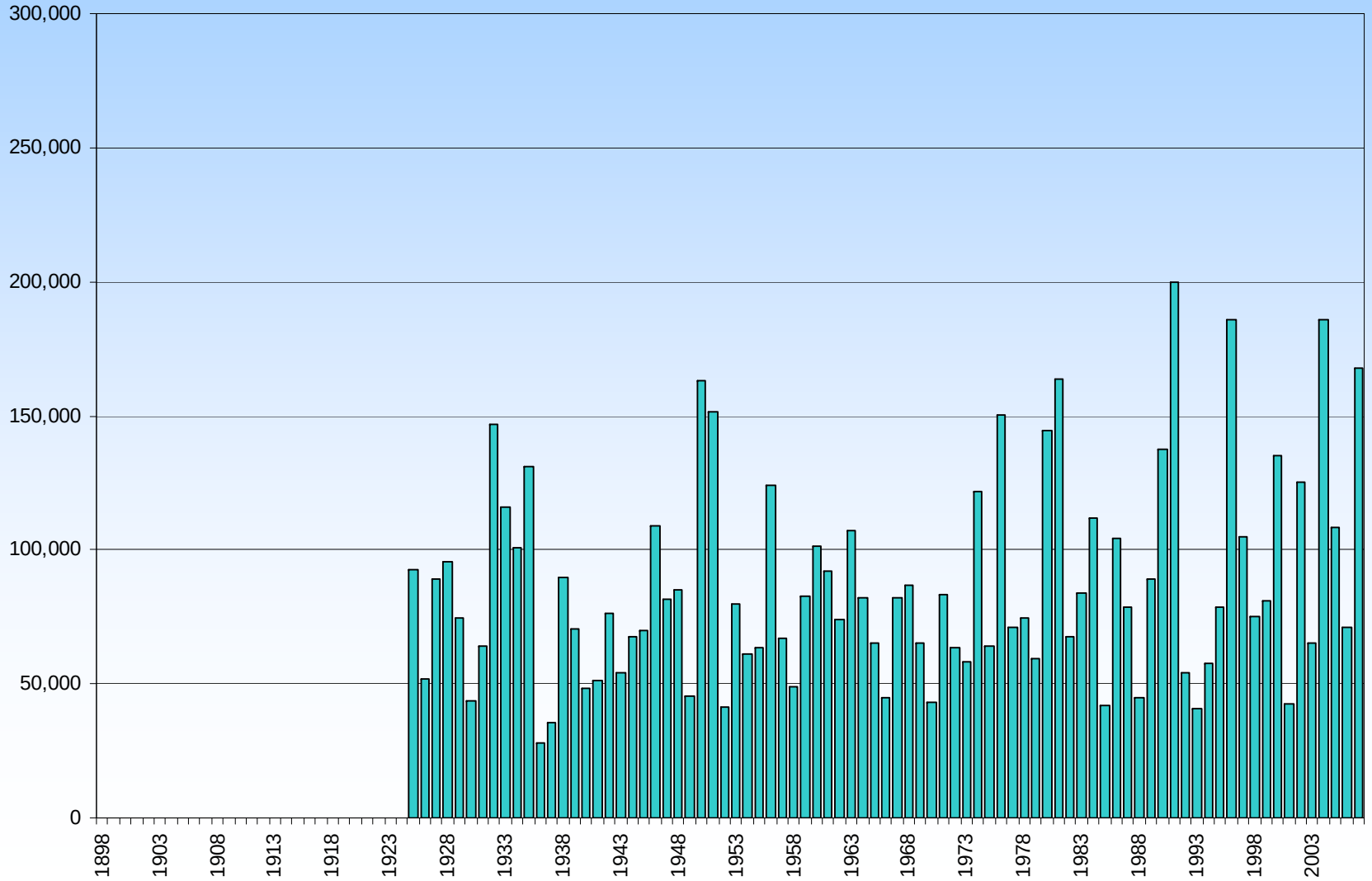
Winter Unregulated Annual Peak Flows Skagit River Near Concrete: Corps of Engineers Data Set (February 2007)



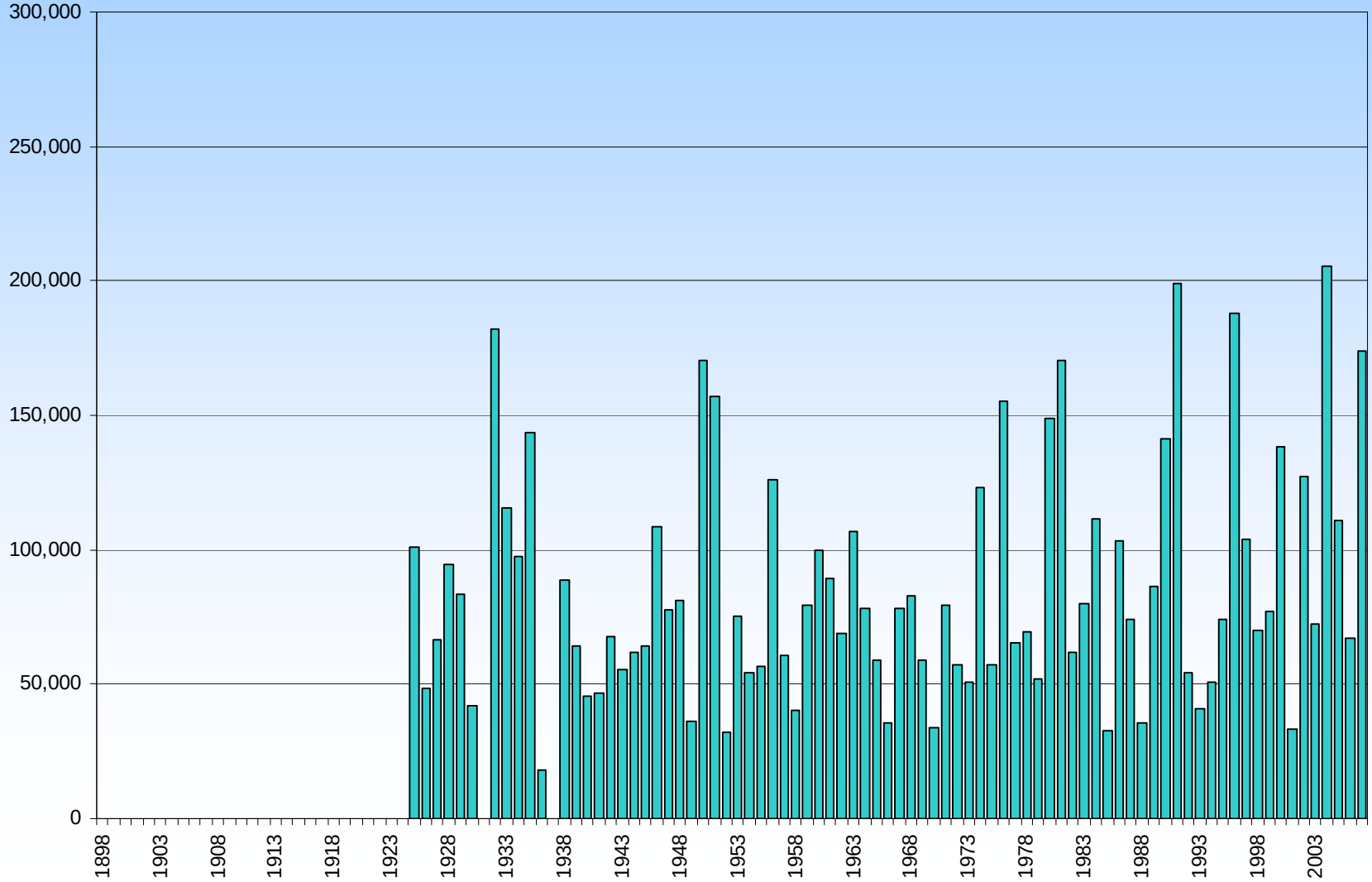
Winter Unregulated Annual Peak Flows Skagit River Near Concrete: PI Engineering Data Set (December 2005)



Winter Unregulated Annual Peak Flows
Skagit River Near Concrete – 82 year "Systematic Record"



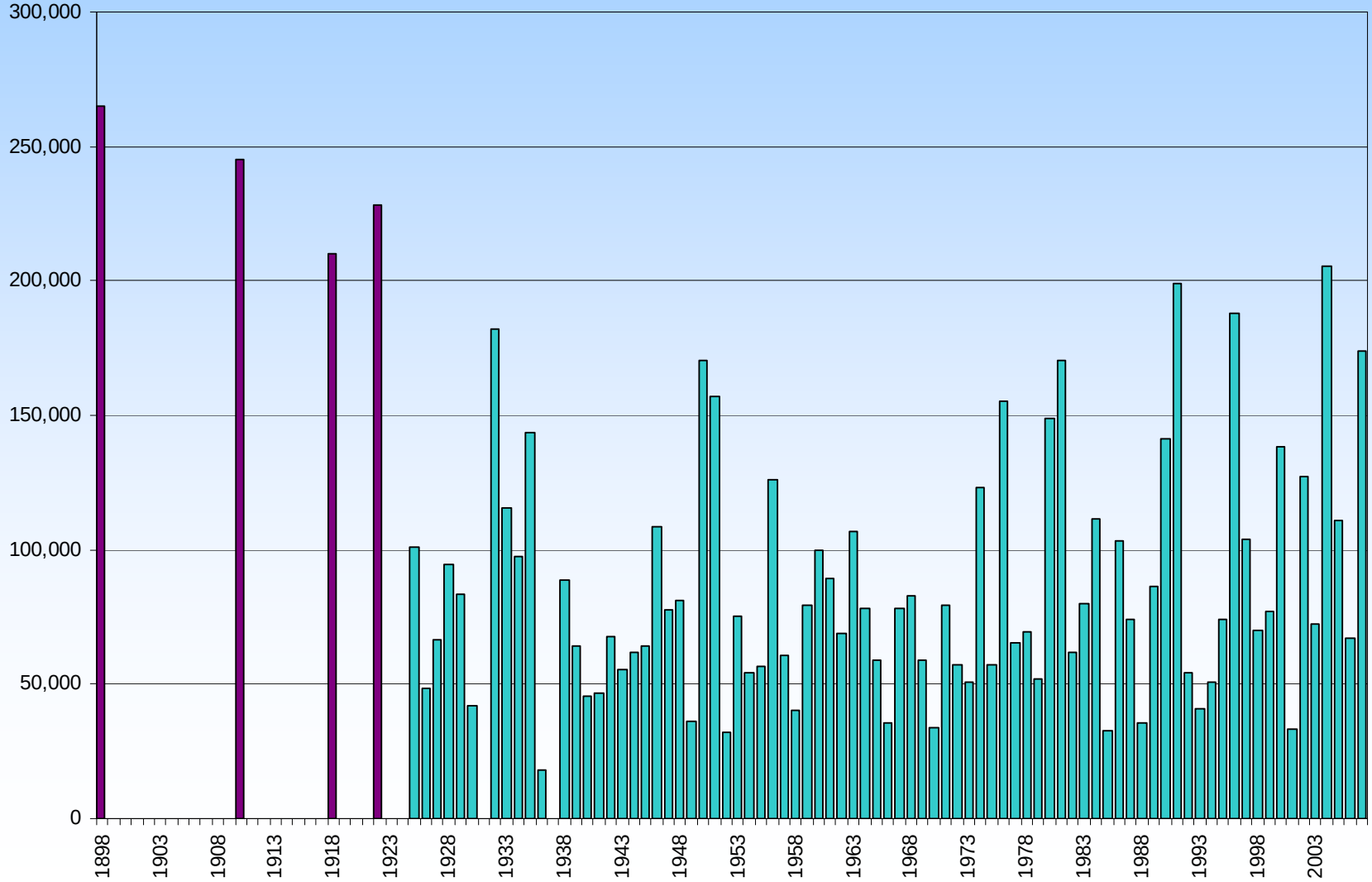
Skagit River Winter Unregulated Annual Peak Flows
Concrete – COE 82 year "Systematic Record" April 2008



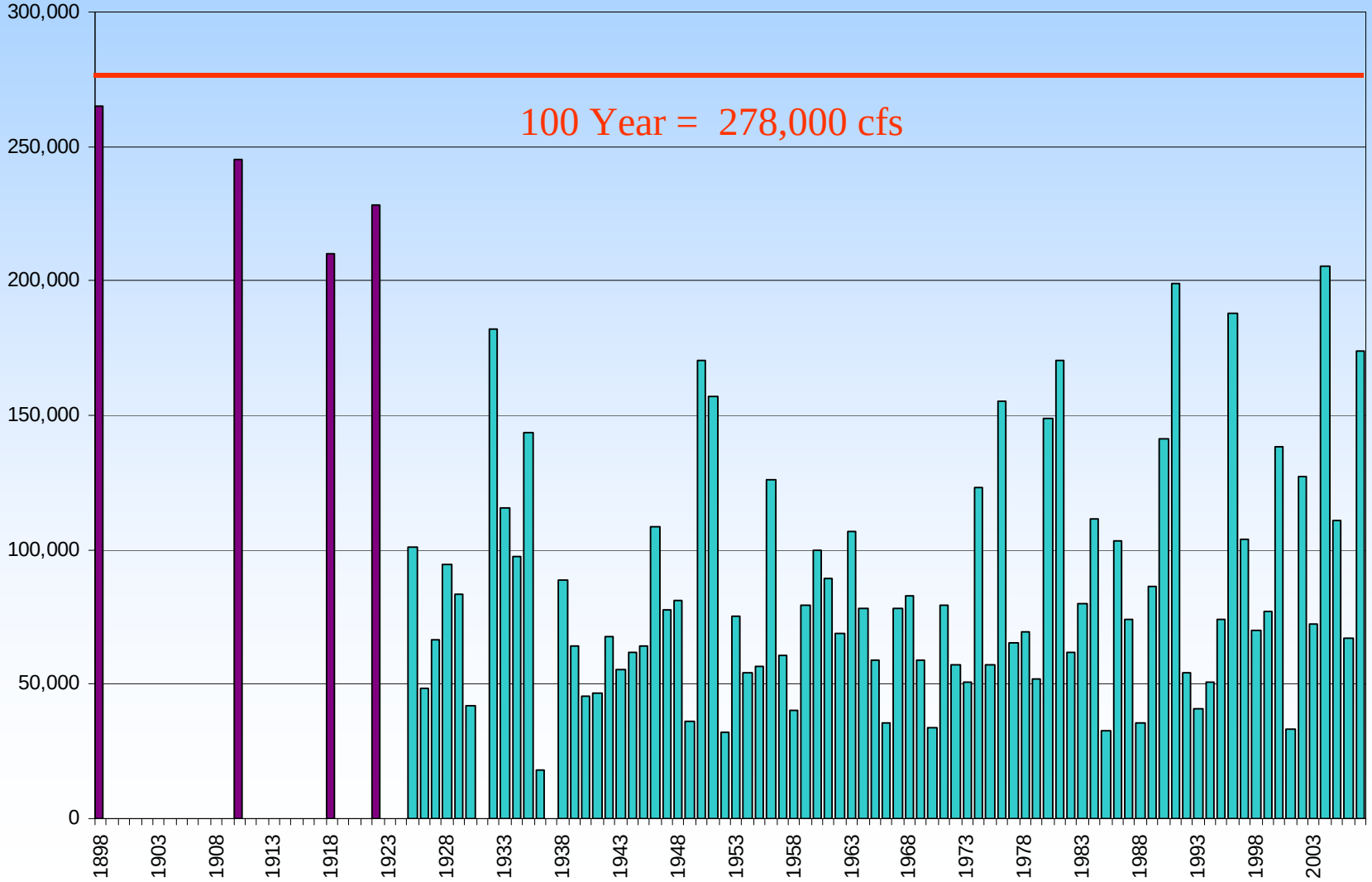
1932 Data Point

- COE Uses 182,000 cfs unregulated peak flow number based on WSP1527
- But the gage data shows 24-hour average for Feb 27, 1932 of 129,000 cfs
  - 69,400 cfs average the day before
  - 105,000 cfs average the day after
  - 59,300 cfs average the 2nd day after

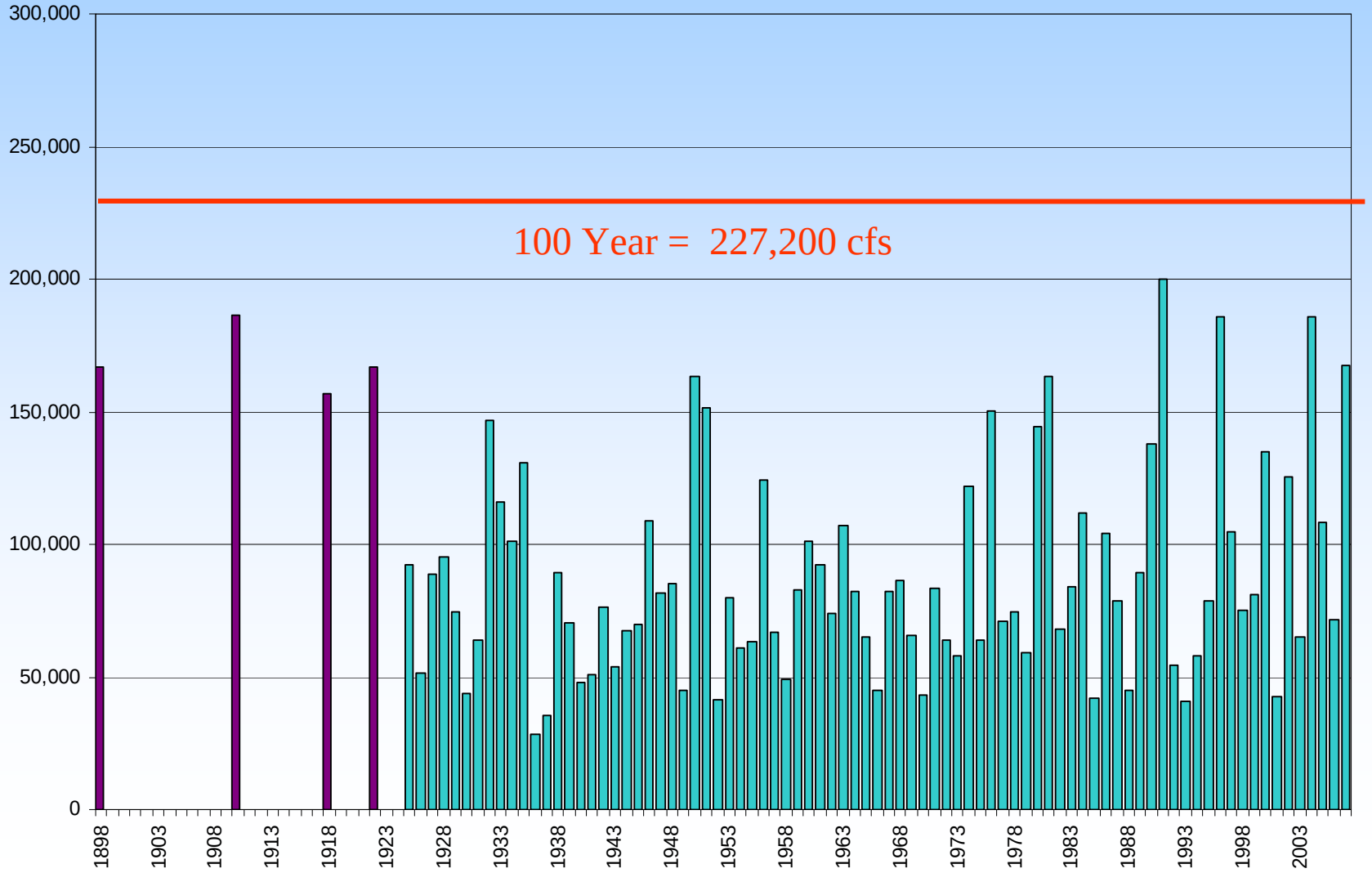
Skagit River Winter Unregulated Annual Peak Flows
Concrete – COE Frequency Distribution (April 2008)



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 August 2007



Next Steps

- Finalize hydrology report, based on current investigatory effort
- Finalize our work product (including the new base flood elevation maps based on the correct hydrology)
- Prepare for appeal of the FEMA flood maps

Next Steps

- Moving forward, this issue needs political push-back and leadership.
- There is no “constituency” for maintaining and growing the tax base, BUT IT IS ESSENTIAL TO OUR KIDS AND GRANDKIDS.
- On the technical arguments: trust what you have seen here, and your own common sense.

Not Discussed Tonight

- Likely new base flood elevations, and impacts
- Flood Insurance
- Baker Project flood storage
- Corps of Engineers General Investigation Study
- FEMA and COE process to certify / accredit levees
- Strategies for project development and funding
- Impacts of accredited levees outside of the protected areas, <u>especially if hydrology is not corrected</u>

Final Note

- We are already better off than almost every other community, due to the tremendous body of substantive competing technical work we have compiled.
- Getting the technical analysis right is the first of 10,000 steps. The difficulty of this first step is an indication of the challenge ahead.
- But we have made progress

Questions