Great Flood of 1862

A Modern Perspective

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WEST Consultants, Inc.

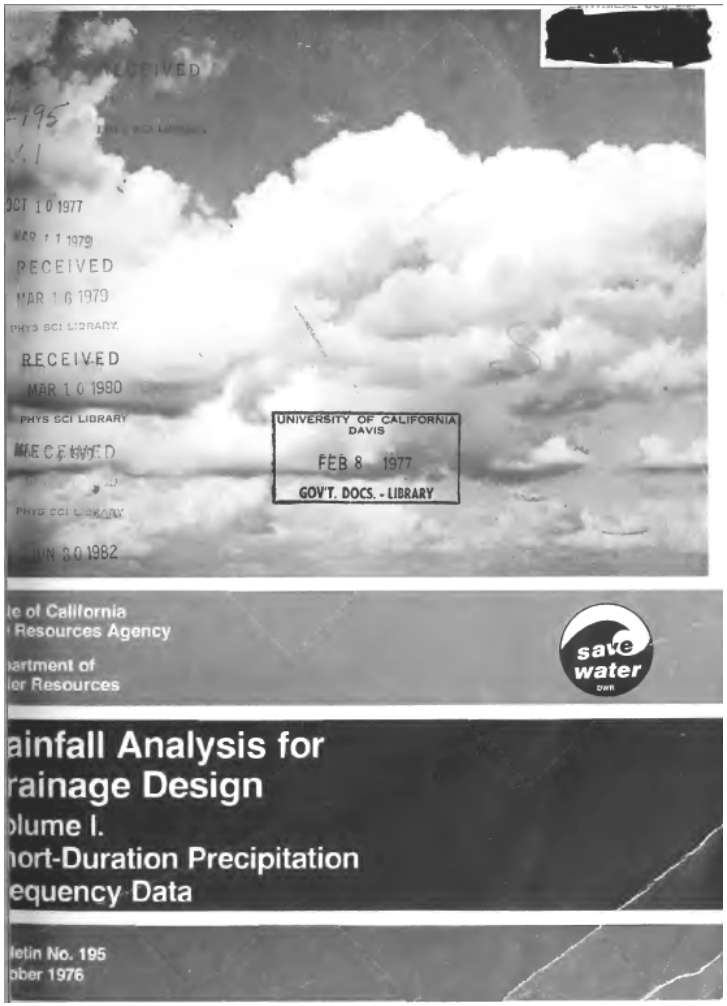
Battling the Inland Sea

Modern Perspective

- 1862 Precipitation
  - —Bulletin 195 and NOAA Atlas 14
- 1862 Flows Compared
  - —1955
  - —1964
  - —1986
  - —1997

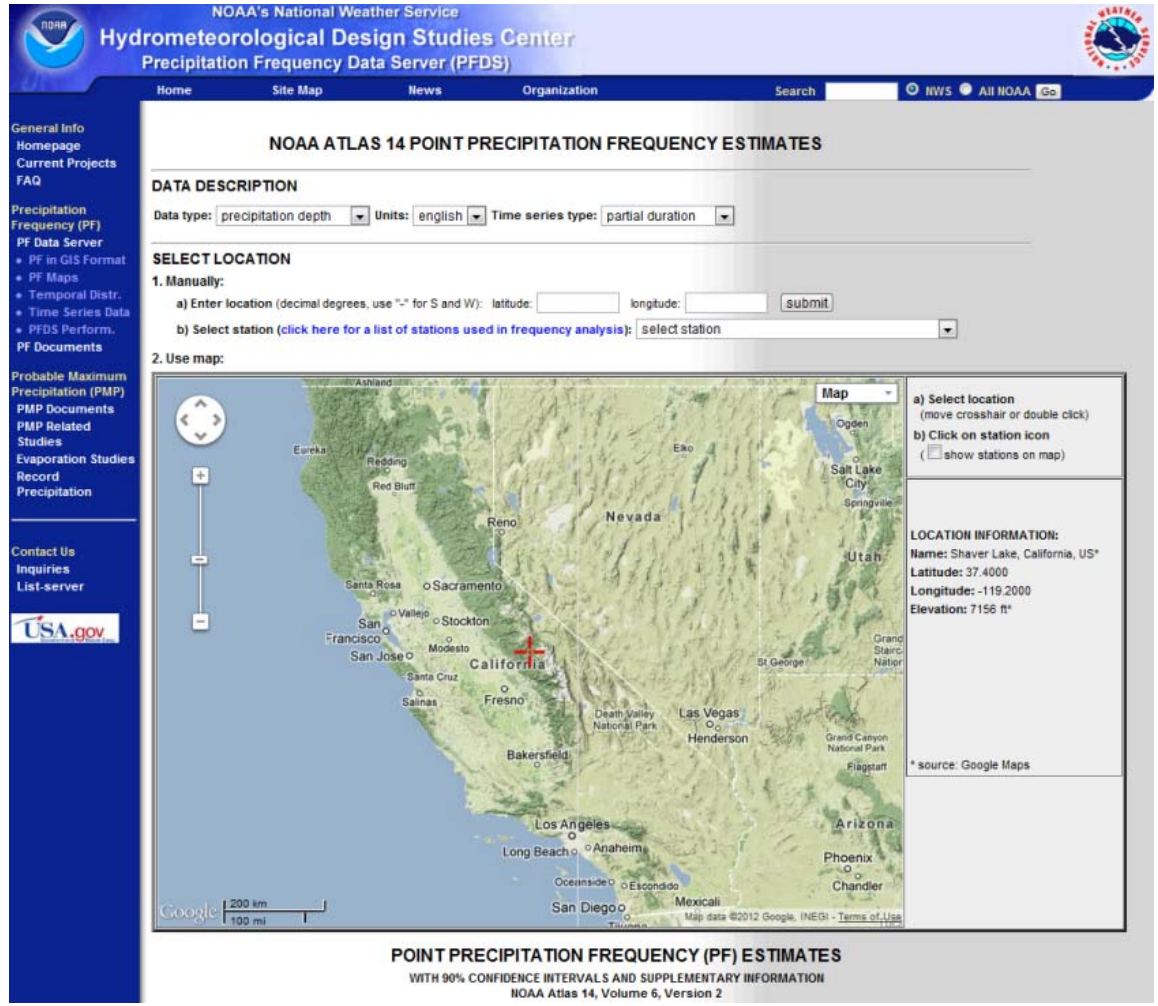
Bulletin 195

1976



NOAA Atlas 14

2011

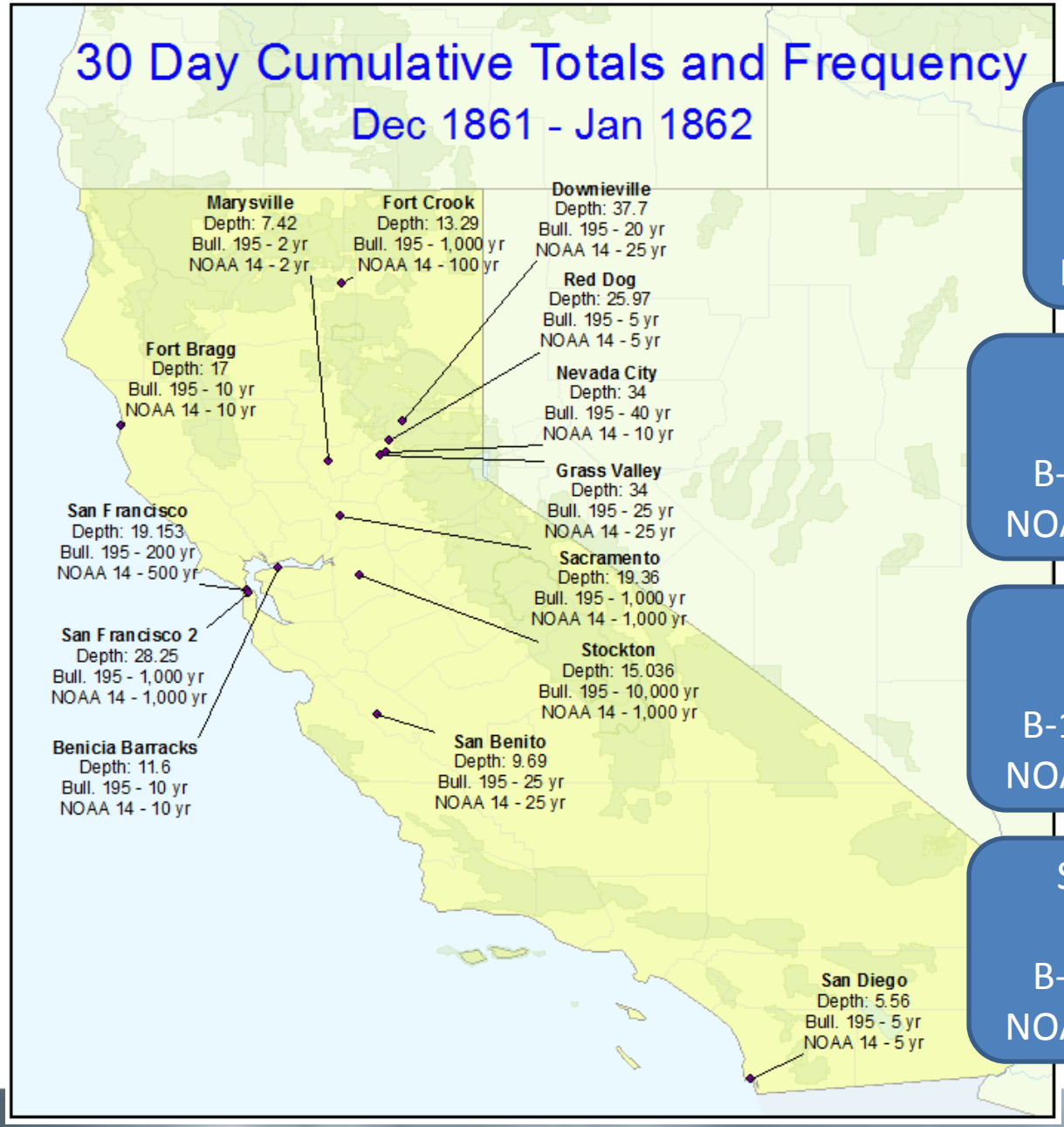


Precipitation Records

RAINFALL IN STOCKTON SINCE 1849

From records kept by the late Major J. D. Peters and the Stockton State Hospital

Stockton State Hospital – ca. 1910

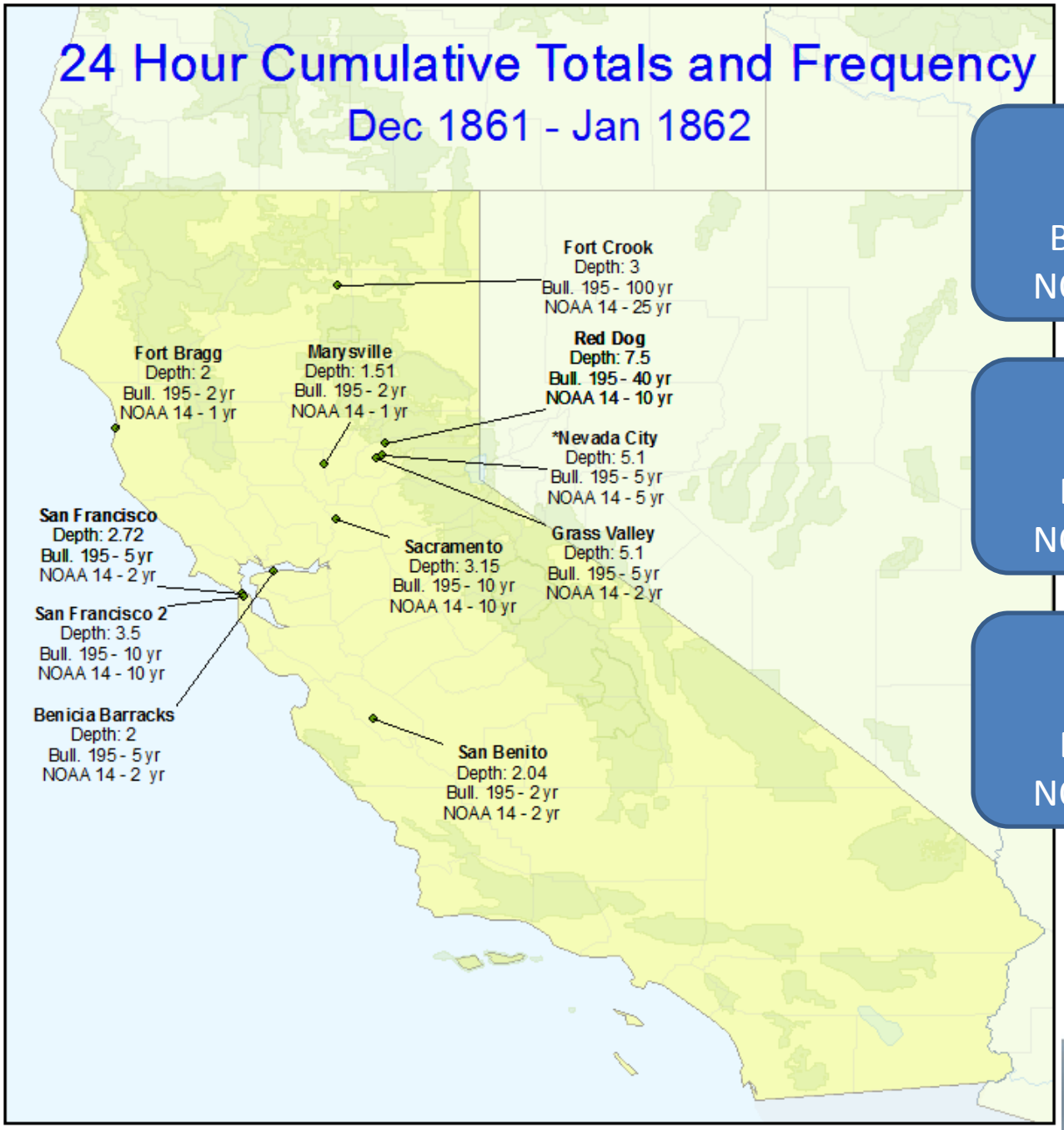


Grass Valley
34 inches
B-195 – 25 yr
NOAA 14 – 25 yr

Sacramento
19.36 inches
B-195 – 1,000 yr
NOAA 14 – 1,000 yr

Stockton
15.04 inches
B-195 – 10,000 yr
NOAA 14 – 1,000 yr

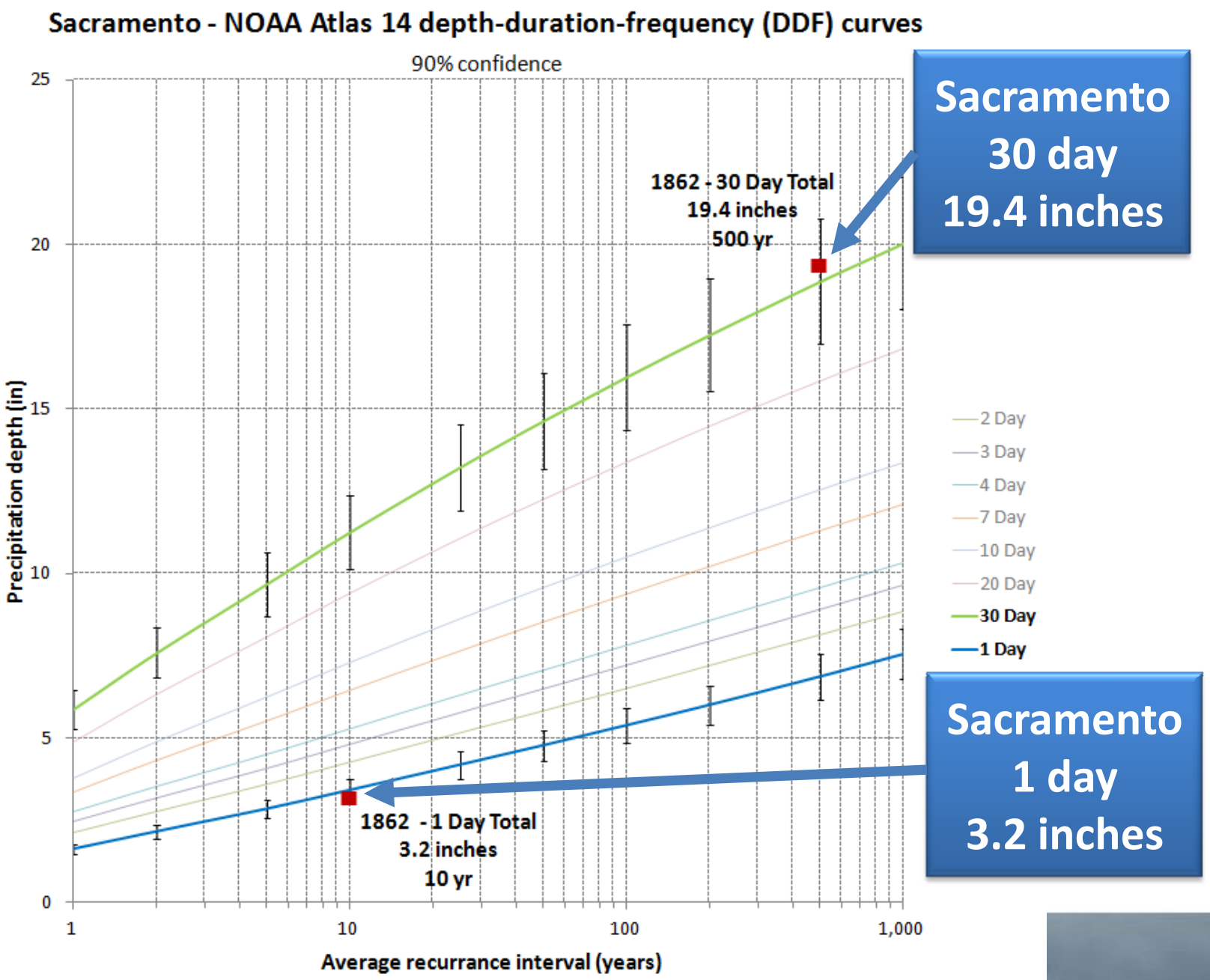
San Francisco
28.25 inches
B-195 – 1,000 yr
NOAA 14 – 1,000 yr

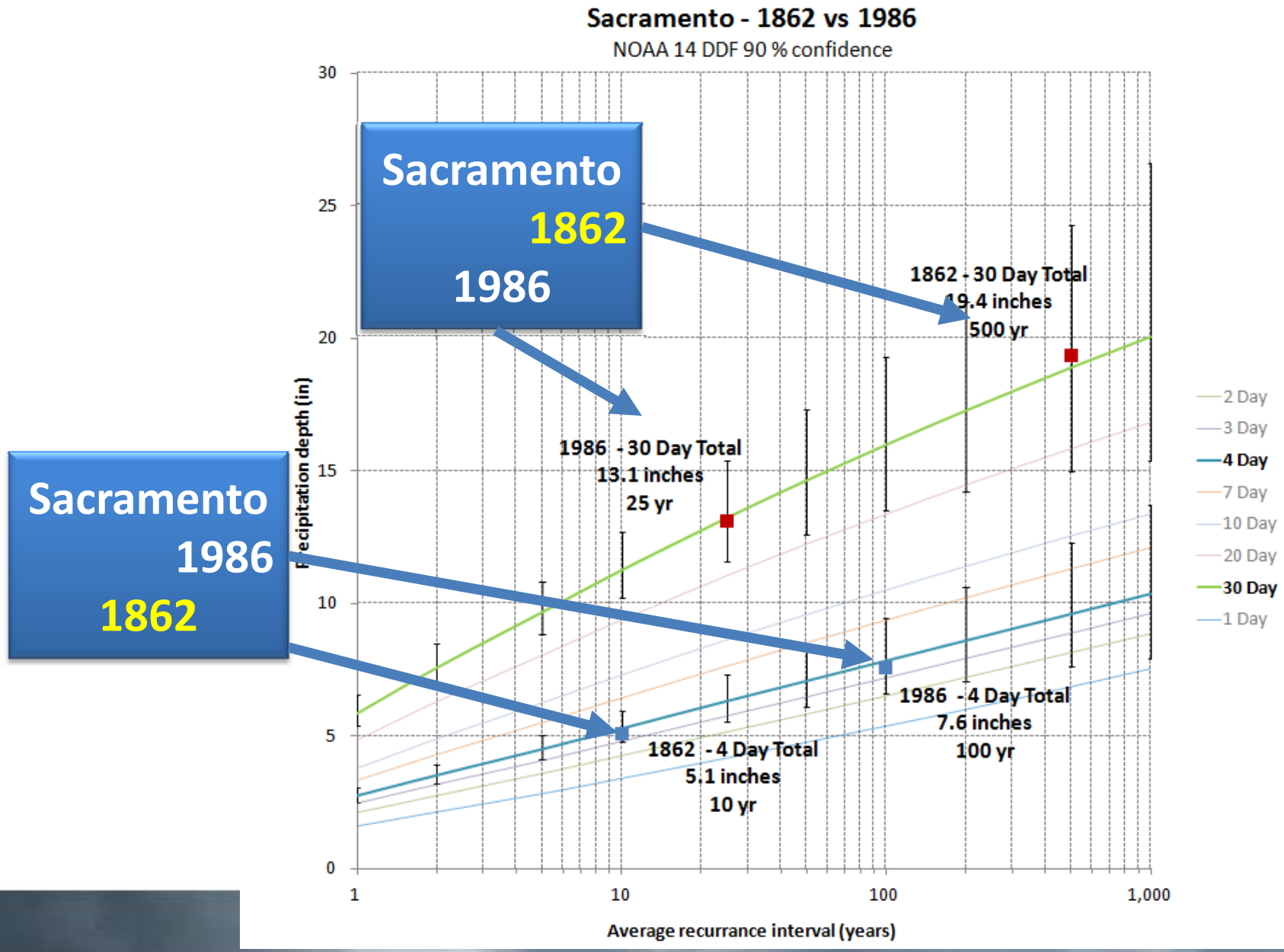


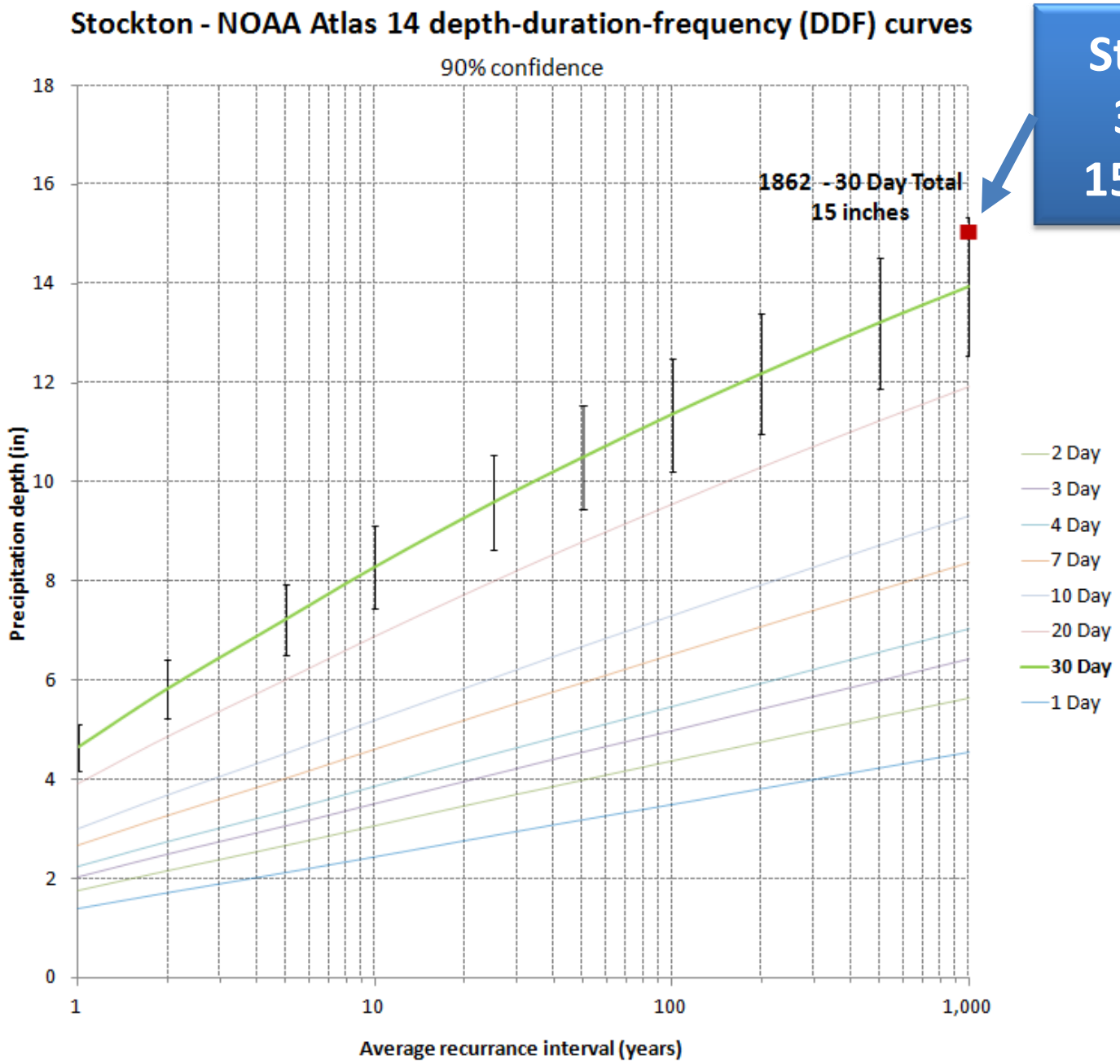
Fort Crook
3 inches
B-195 – 100 yr
NOAA 14 – 25 yr

Red Dog
7.5 inches
B-195 – 40 yr
NOAA 14 – 10 yr

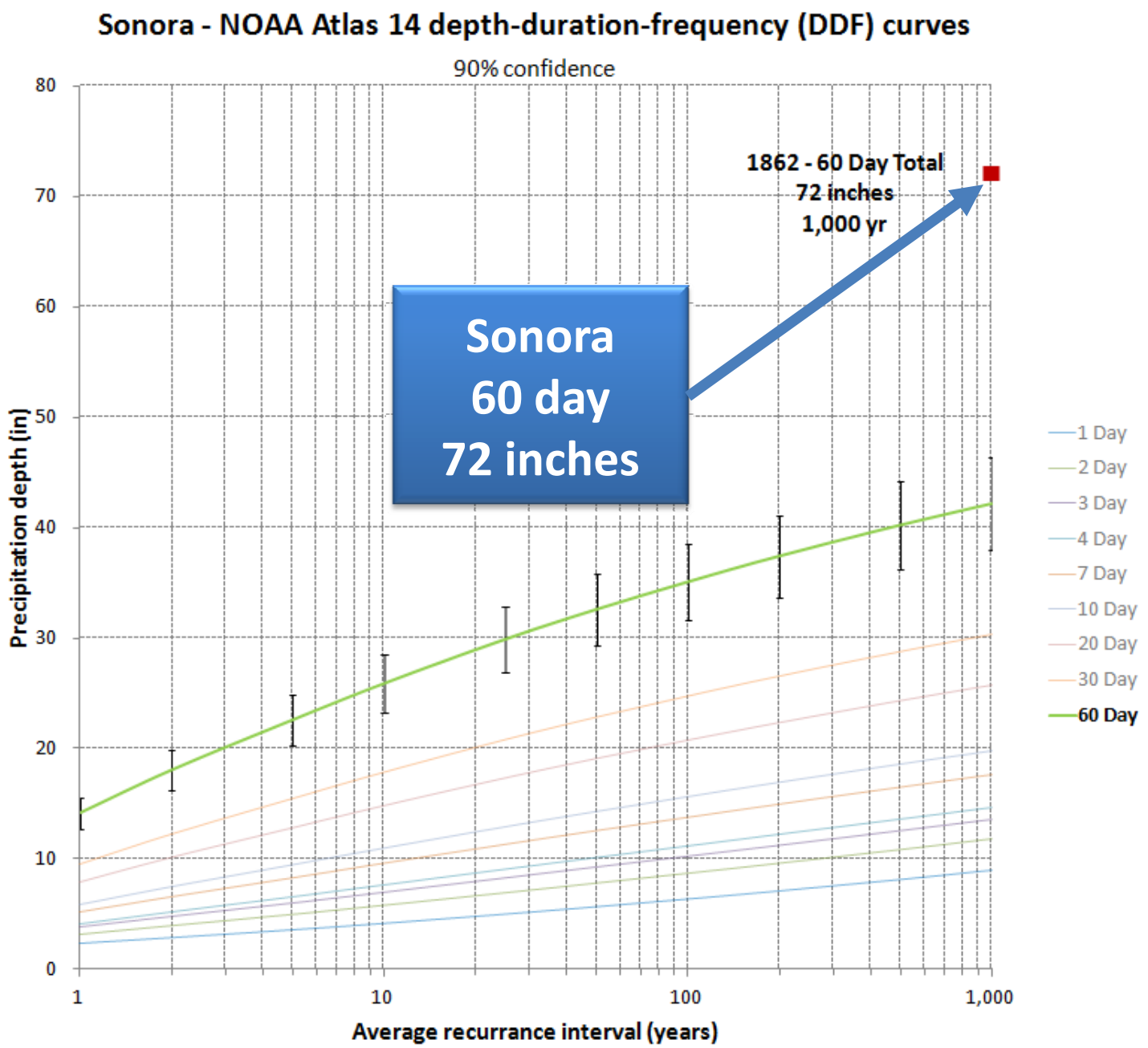
Sacramento
3.15 inches
B-195 – 10 yr
NOAA 14 – 10 yr


Sacramento - NOAA Atlas 14 depth-duration-frequency (DDF) curves
90% confidence
Precipitation depth (in)
Average recurrance interval (years)
25
20
15
10
5
0
1
10
100
1,000
1862 - 30 Day Total
19.4 inches
500 yr
1862 - 1 Day Total
3.2 inches
10 yr
2 Day
3 Day
4 Day
7 Day
10 Day
20 Day
30 Day
1 Day
Sacramento
30 day
19.4 inches
Sacramento
1 day
3.2 inches


Sacramento - 1862 vs 1986
NOAA 14 DDF 90 % confidence
Sacramento
1862
1986
Sacramento
1986
1862
1862 - 30 Day Total
19.4 inches
500 yr
1986 - 30 Day Total
13.1 inches
25 yr
1986 - 4 Day Total
7.6 inches
100 yr
1862 - 4 Day Total
5.1 inches
10 yr
Precipitation depth (in)
Average recurrance interval (years)
0
5
10
15
20
25
30
1
10
100
1,000
2 Day
3 Day
4 Day
7 Day
10 Day
20 Day
30 Day
1 Day

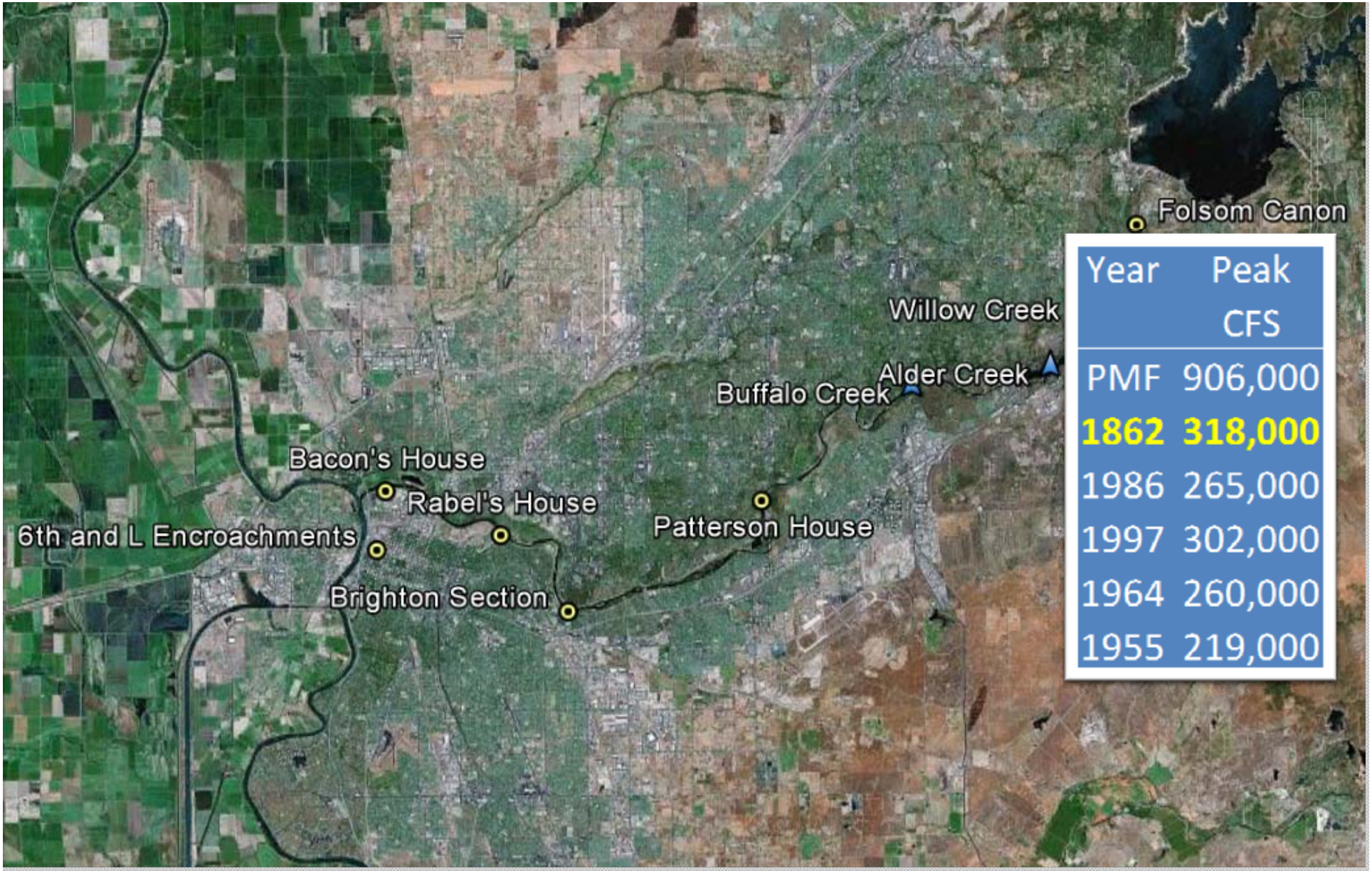


Stockton
30 day
15 inches


Sonora - NOAA Atlas 14 depth-duration-frequency (DDF) curves
90% confidence
Precipitation depth (in)
Average recurrance interval (years)
0
10
20
30
40
50
60
70
80
1
10
100
1,000
1862 - 60 Day Total
72 inches
1,000 yr
Sonora
60 day
72 inches
1 Day
2 Day
3 Day
4 Day
7 Day
10 Day
20 Day
30 Day
60 Day

Historic Floods

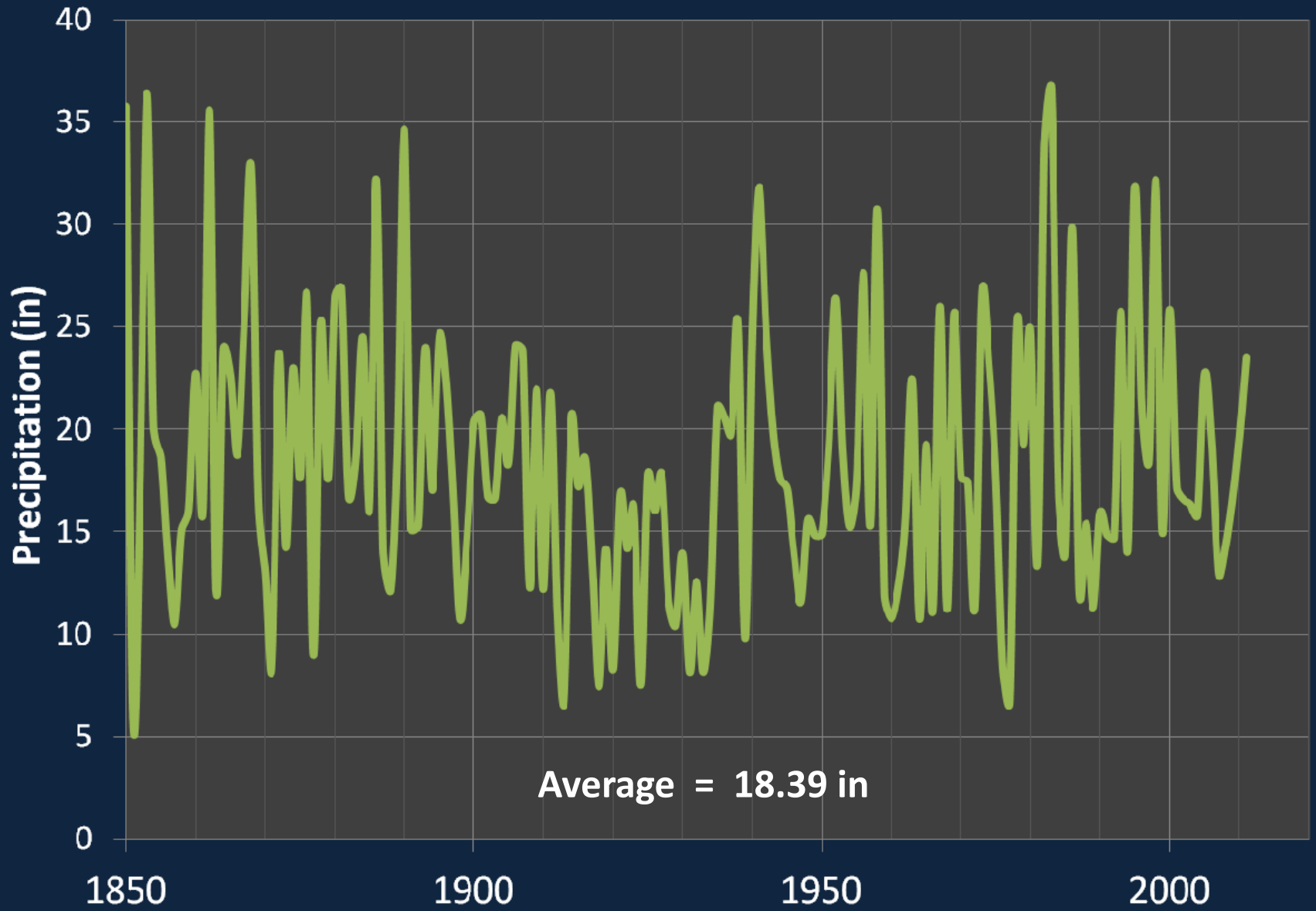
- 1862 Discharge in Lower American River
  - Swampland Minutes
  - Compare unregulated flows
  - Compare to similar drainage basins



Year	Peak CFS
PMF	906,000
1862	**318,000**
1986	265,000
1997	302,000
1964	260,000
1955	219,000

Swamp & Overland Flow Commissioners Minutes
May 15, 1862

Sacramento Annual Precipitation



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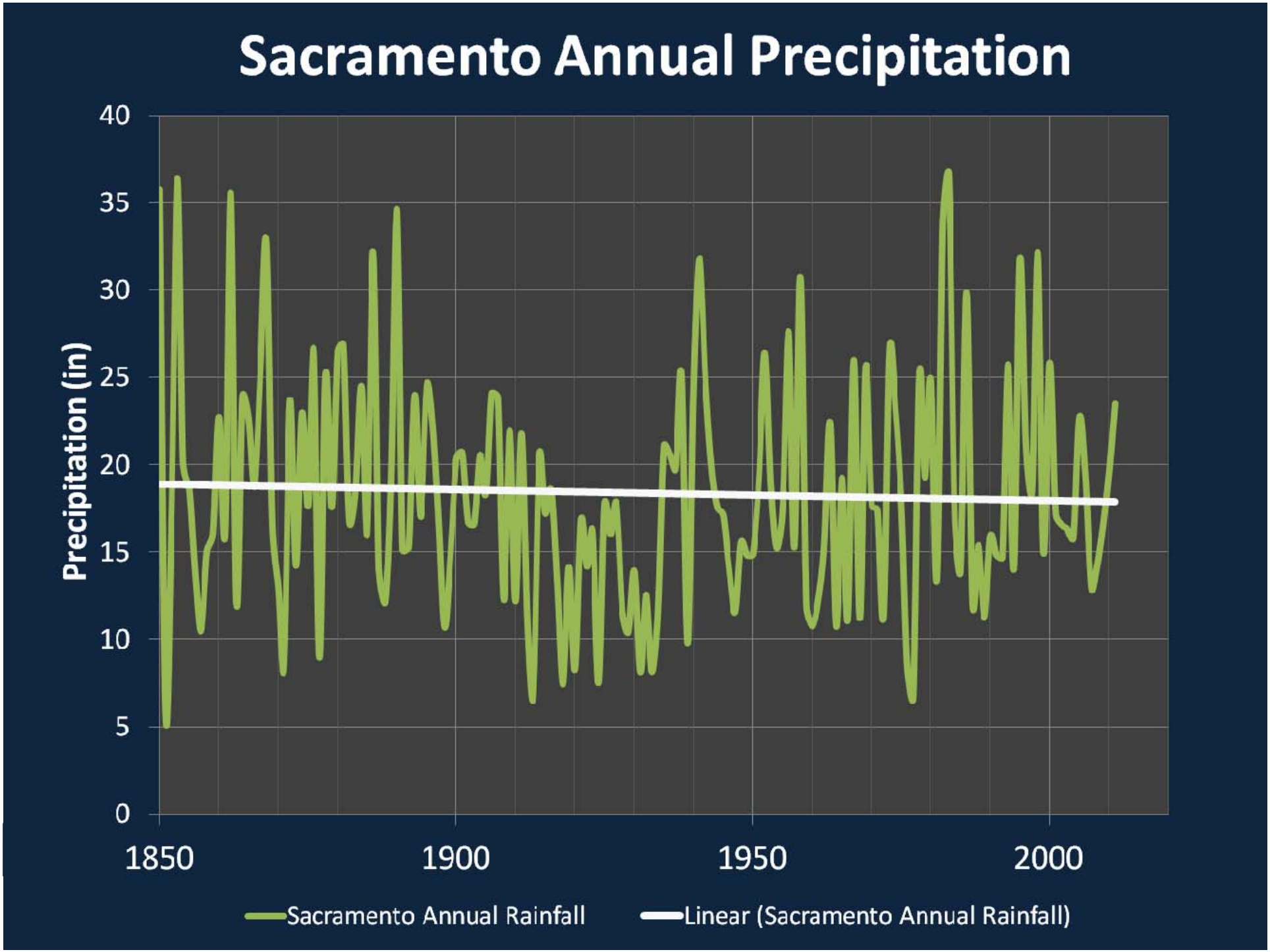
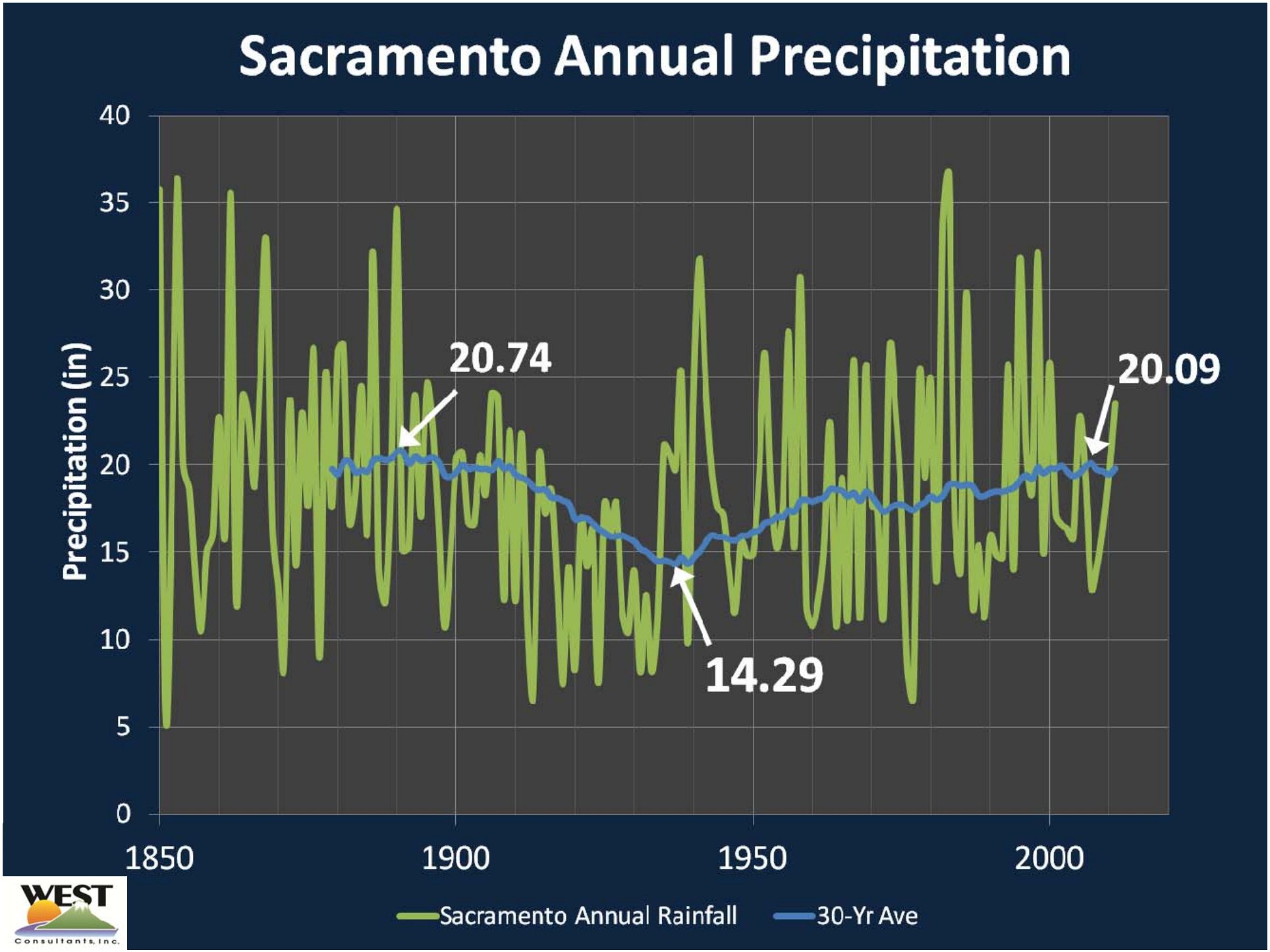

Sacramento Annual Precipitation
Precipitation (in)
40
35
30
25
20
15
10
5
0
1850
1900
1950
2000
Sacramento Annual Rainfall
Linear (Sacramento Annual Rainfall)


Sacramento Annual Precipitation
Precipitation (in)
40
35
30
25
20
15
10
5
0
1850
1900
1950
2000
20.74
14.29
20.09
Sacramento Annual Rainfall
30-Yr Ave
WEST
Consultants, Inc.

Conclusions

- 1862 Precipitation
  - Relentless
  - Some extreme 30-60 day totals
- Recent Discharges ~1862
- Climate change
  - (That's what climates do!)


Questions?

Fort Crook

Fort Crook	24HR	2day	3day	4day	10day	30day
1862	3	3.35	4.05	4.5	6.32	13.29
1955	1.7	2.38	2.38	2.61	4.74	5.09
1964	1.75	2.64	2.95	3.17	3.75	6.25
1986	2.6	3.28	4.03	4.47	7.43	10.43
B 195						
1862	100yr	20yr	10-20yr	10yr	25yr	1000 yr
1955	2 yr	5 yr	2 yr	2 yr	5 yr	2 yr
1964	2 yr	5 yr	5 yr	5 yr	2 yr	5 yr
1986	10 yr	10 yr	10 yr	10 yr	50 yr	100 yr
NOAA 14						
1862	25 yr	10 yr	25yr	25yr	25yr	100 yr
1955	2 yr	5 yr	2 yr	2 yr	5 yr	2 yr
1964	2 yr	5 yr	5 yr	5 yr	2 yr	2 yr
1986	10 yr	10 yr	10 yr	10 yr	50 yr	25 yr

Sierra Nevadas Region

Downieville	30day
1862	37.70
1955	17.74
1964	15.58
1986	35.73
1997	44.84
B 195	
1862	20yr
1955	
1964	
1986	20 yr
1997	100 yr
NOAA 14	
1862	10-25yr
1955	1 yr
1964	
1986	10 yr
1997	50 yr

Nevada City	24HR	2day	3day	4day	30day
1862	5.10	9.43	12.20	12.33	34.00
1955	3.09	3.51	4.33	4.38	13.76
1964	2.99	4.46	5.95	7.42	12.47
1986	7.49	14.44	17.95	20.63	35.47
1997	7.75	11.62	15.15	18.19	44.62
B 195					
1862	5 yr	10 yr	20 yr	10 yr	40 yr
1955	1 yr	1 yr	1 yr	1yr	1 yr
1964	1 yr	1 yr	1yr	1 yr	1yr
1986	40 yr	200 yr	200 yr	200 yr	40 yr
1997	40 yr	40 yr	50 yr	100 yr	200 yr
NOAA 14					
1862	5 yr	10 yr	10 yr	5 yr	10 yr
1955	1 yr	1 yr	1 yr	1 yr	1 yr
1964	1 yr	2 yr	1yr	1 yr	1 yr
1986	25 yr	100 yr	100 yr	100 yr	25 yr
1997	25 yr	25 yr	50 yr	50 yr	100 yr

Sierra Nevadas Cont…

Grass Valley	24HR	2day	3day	4day	10day	30day
1862	5.10	9.43	12.20	12.33	21.07	34.00
1955	3	3.42	3.67	5.46	8.54	12.67
1964	4.33	5.55	6.66	8.06	9.97	12.24
1986	6.77	12.27	15.13	16.96	22.47	28.07
1997	6.31	9.94	12.06	14.73	20.13	37.41
B 195						
1862	5 yr	10 yr	10 yr	10 yr	20 yr	25 yr
1955	2 yr	-	-	-	-	-
1964	2 yr	2 yr	2 yr	2 yr	-	-
1986	10 yr	40 yr	40 yr	50 yr	25 yr	10 yr
1997	10 yr	10 yr	10 yr	20 yr	20 yr	50 yr
NOAA 14						
1862	2 yr	10 yr	10 yr	5 yr	25 yr	25 yr
1955	1 yr	1 yr	-	1 yr	1 yr	-
1964	2 yr	1 yr	1 yr	2 yr	1 yr	-
1986	5 yr	25 yr	25 yr	25 yr	25 yr	10 yr
1997	5 yr	5 yr	10 yr	10 yr	10 yr	50 yr

Old Records, Modern Methods

- Manning's Equation
  - Channel
  - Roughness
- Other Methods

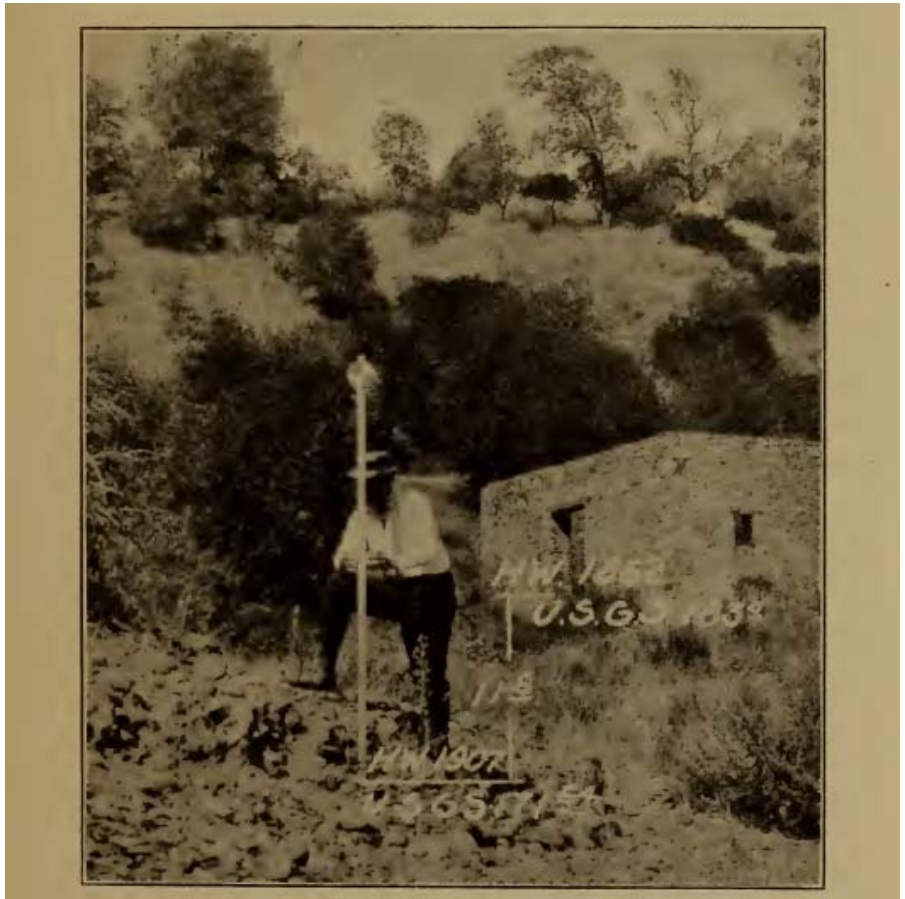


FIG. 44.—High water near Folsom in 1862.

Old Records, Modern Methods

- Results
  - Folsom: ~250,000 cfs
    - n = 0.02 to 0.05
  - Brighton: ~200,00 cfs
    - n = 0.06 to 0.08-0.1

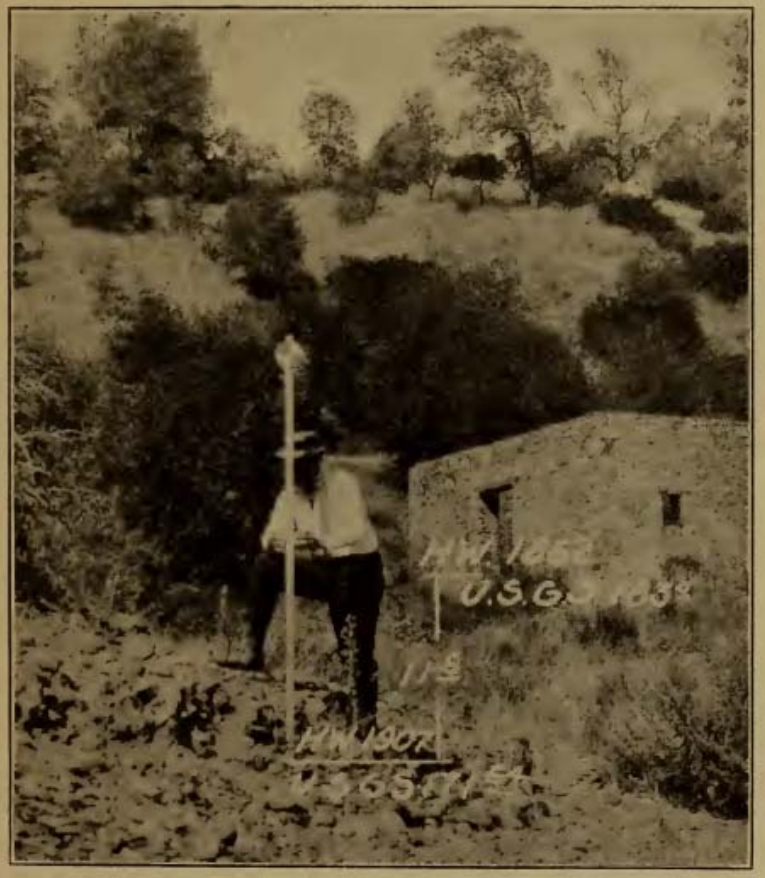


FIG. 44.—High water near Folsom in 1862.

American River at Fair Oaks

PMF and Maximum Unregulated Historic Rain Floods

Ordered by Maximum 3-day Flow				
Water Year	Date of Peak	Peak cfs	1-day cfs	3-day cfs
PMF	Dec-Jan	906,000	698,000	472,000
1862	9-Jan	300,000 est.	208,000 est.	180,000est
1986	9-Jan	265,000	160,000	166,000
1997 [1]	2-Feb	302,000 [2]	252,500 [1]	165,000
1997 [3]	2-Feb	300,000 [2]	248,900 [3]	164,200 [3]
1965	23-Dec	260,000	183,200	140,300
1956	23-Dec	219,000	189,100	127,400

Notes:

[1] Derived from USGS Water-Data Report published in 1998.

[2] COE peak estimate for the 1997 flood.

[3] Data provided by DWR's CDEC database used in the latest COE frequency analysis and results from 2001 Folsom PMF Report.

American River at Fair Oaks

PMF and Maximum Unregulated Historic Rain Floods

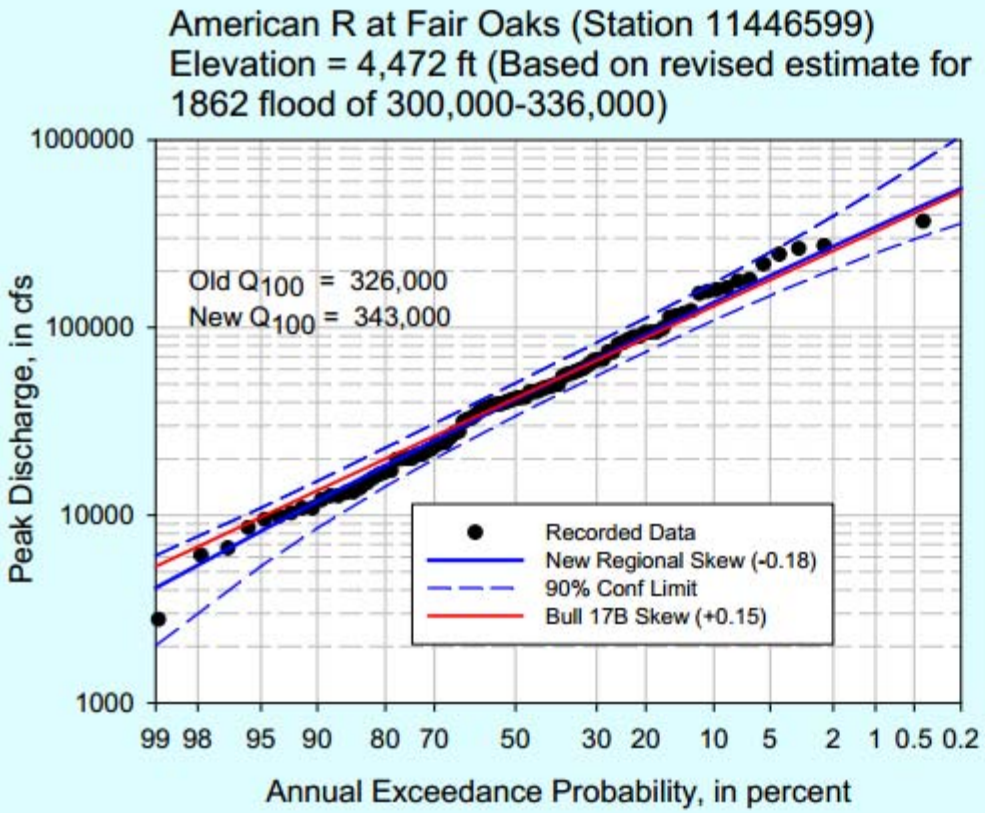
Ordered by Maximum 3-day Flow				
Water Year	Date of Peak	Peak cfs	1-day cfs	3-day cfs
PMF	Dec-Jan	906,000	698,000	472,000
1862	9-Jan	300,000 est.	208,000 est.	180,000est
1986	9-Jan	265,000	160,000	166,000
1997 [1]	2-Feb	302,000 [2]	252,500 [1]	165,000
1997 [3]	2-Feb	300,000 [2]	248,900 [3]	164,200 [3]
1965	23-Dec	260,000	183,200	140,300
1956	23-Dec	219,000	189,100	127,400

Notes:

[1] Derived from USGS Water-Data Report published in 1998.

[2] COE peak estimate for the 1997 flood.

[3] Data provided by DWR's CDEC database used in the latest COE frequency analysis and results from 2001 Folsom PMF Report.



Recorded peaks 1905-1954

Simulated peaks 1955-1998

Revised estimate For 1862 = 318,000

USGS science for a changing world

Im not sure what we should share here yet. There are a lot of interesting things to explain

Location	Year	Drainage Area (sq mi)	Qp (cfs)	Qp/DA (cfs/sq mi)
Original Folsom Cañon	1862	1861	501294	269
Adjusted Folsom Cañon 1	1862	1861	240187	129
Adjusted Folsom Cañon 2	1862	1861	208000	112
Coastal Region				
Eel River At Fort Seward, CA	1965	2107	561000	266
Northern Region				
Trinity River at Burnt Ranch, Ca	1956	1439	172000	120
Sierras				
American River Fair Oaks	1862	1888	318000	168
American River Fair Oaks	1997	1888	309000	164
Stanislaus River Knights Ferry	1862	980	100000	102
Yuba River at Smartsville, CA	1928	1200	120000	100
NF Feather River at NR Rich Bar	1997	1025	88800	87
Tolumne River La Grange	1862	1532	130000	85
Feather River	1955	1341	104000	78
Kings River at Trimmer, Ca	1956	1342	85200	63
Feather River Oroville	1904	3624	230000	63
Sacramento River Hamilton City	1940	10833	350000	32