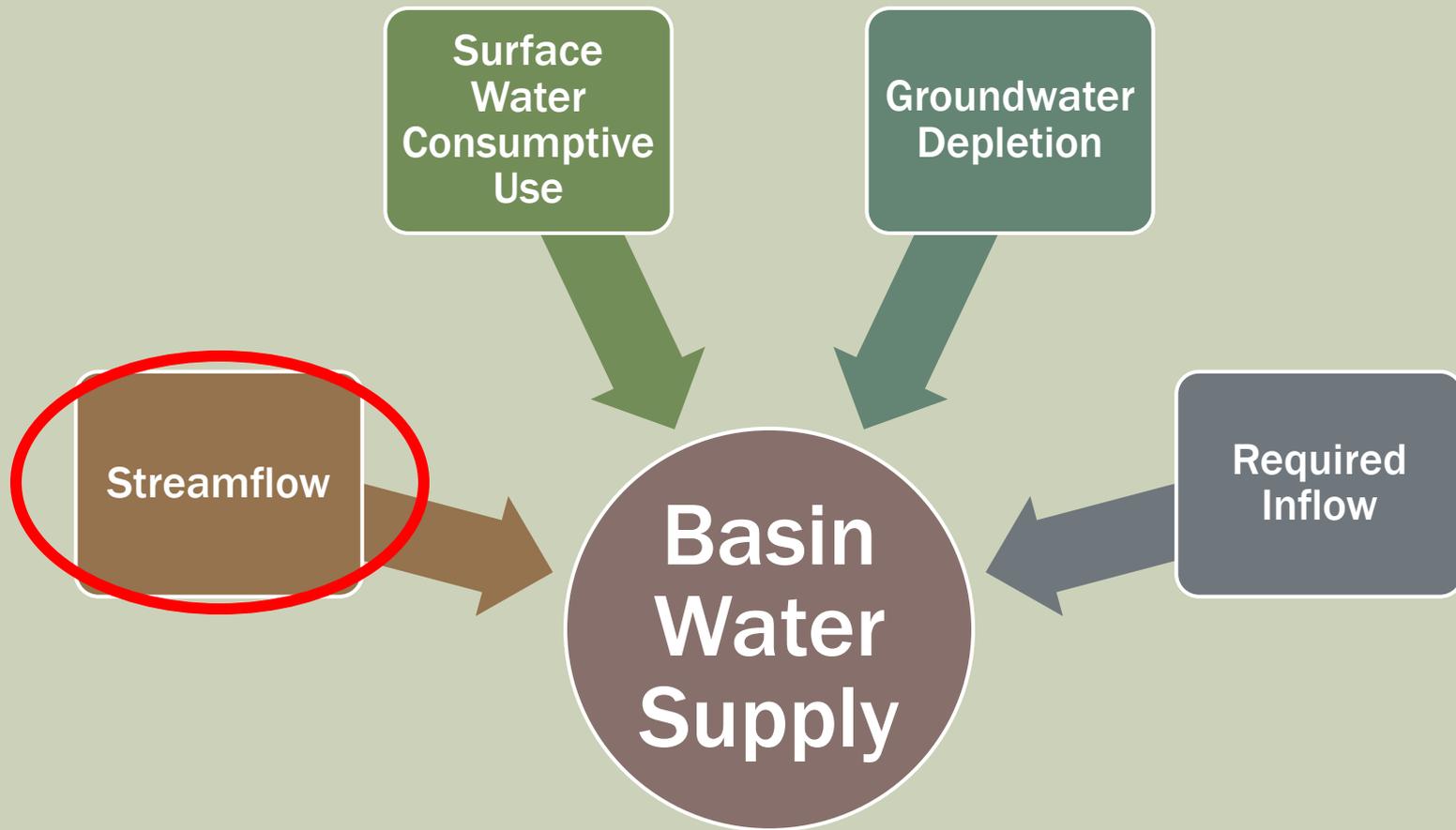


STREAMFLOW

**A Component
of the Basin
Water Supply
as Calculated
for INSIGHT**

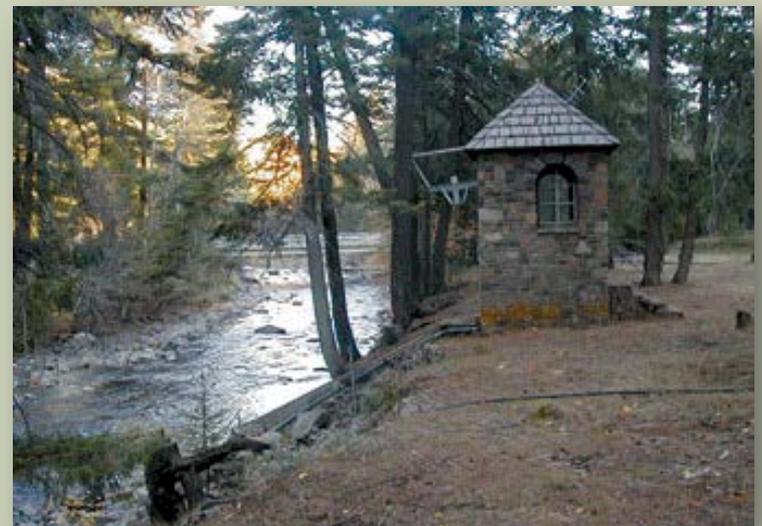


STREAMFLOW

- Streamflow is the “foundation” of the Basin Water Supply
 - However, impacted by human activity (surface water use, groundwater pumping) so need to add SWCU and GW depletions to get entire BWS
- Streamflow is obtained from gage records at USGS or DNR gaging stations



<http://www.upperloupnrd.org/upper-loup-nrd-stream-gaging-n/>



<http://pubs.usgs.gov/fs/fs-077-02/>

STREAMFLOW GAGES

16 gages that represent the INSIGHT subbasins

Gage ID	Gage Name	INSIGHT Basin	INSIGHT Subbasin
6882000	Big Blue River at Barneston, Nebr.	Big Blue	Big Blue River
6799000	Elkhorn River at Norfolk, Nebr.	Elkhorn	Elkhorn River Above Norfolk
6800500	Elkhorn River at Waterloo	Elkhorn	Elkhorn River Norfolk to Waterloo
6884025	Little Blue River at Hollenberg, KS	Little Blue	Little Blue River
6793000	Loup River near Genoa	Loup	Lower Loup River
6785000	Middle Loup River at Saint Paul, Nebr.	Loup	Middle Loup River
6790500	North Loup River near Saint Paul, Nebr.	Loup	North Loup River
6784000	South Loup River at Saint Michael, Nebr.	Loup	South Loup River
6805500	Platte River at Louisville, Nebr.	Lower Platte	Lower Platte River North Bend to Louisville
6796000	Platte River at North Bend, Nebr.	Lower Platte	Lower Platte River Above North Bend
6466500	Bazile Creek near Niobrara, Nebr.	Missouri Tribs	Bazile Creek
6465500	Niobrara River near Verdel, Nebr.	Niobrara	Niobrara River Spencer to Niobrara
6465000	Niobrara River near Spencer, Nebr.	Niobrara	Niobrara River Sparks to Spencer
6461500	Niobrara River near Sparks, Nebr.	Niobrara	Niobrara River Gordon to Sparks
6454500	Niobrara River above Box Butte Reservoir	Niobrara	Niobrara River Above Box Butte
6457500	Niobrara River near Gordon	Niobrara	Niobrara River Box Butte to Gordon

STREAMFLOW

- Gages records contain daily flow in cubic feet per second
- Timeframe of data available depends on funding for gage operation
- Regressions done to fill in major gaps in data
 - Gordon gage
 - Bazile gage
- Daily records indexed for FAB Year and peak/non-peak season using MATLAB
- High flow events eliminated, flow converted to volume, then summed to season

ELIMINATING HIGH FLOWS

- Extreme/high flows cannot be used or stored so not included in calculating BWS
- Analyze flow probabilities to determine frequency of high flow events and eliminate those exceeded less than or equal to 5% of the time
 - Done for entire time series available for each gage



CALCULATING EXCEEDENCE PROBABILITY

- Exceedence probability is calculated by the following steps
 - Rank flows from descending order
 - Assign each value a rank, R , with largest being 1
 - Determine N , the number of observations
 - Calculate the exceedence probability: $\frac{R}{N+1}$
 - The streamflow value corresponding to the R that gives 0.05 (5%) for the exceedence probability will be the capping value
- Make flows greater than the 5% exceedence equal to that value

EXCEEDENCE PROBABILITY EXAMPLE

Original time series data
(truncated for example)

Date	Flow (cfs)
9/1/1987	204
9/2/1987	195
9/3/1987	180
9/4/1987	176
9/5/1987	177
.....
7/10/1994	852
7/11/1994	1650
7/12/1994	1840
7/13/1994	1600
7/14/1994	1370
.....
8/27/2012	72
8/28/2012	77
8/29/2012	75
8/30/2012	69
8/31/2012	66

Flows of this size are exceeded 0.011% of the time

5% exceedence value, which will be the cap

Flows of this size are exceeded 99.99% of the time

Ranked flow values
(N = 9132) $\text{Exceed Prob} = R/(9132+1)$

Flow (cfs)	Rank (R)	Exceed. Prob.
33800	1	0.000109
29600	2	0.000219
21600	3	0.000328
17500	4	0.000438
16300	5	0.000547
.....
1620	456	0.049929
1610	457	0.050038
1610	458	0.050148
1610	459	0.050257
1610	460	0.050367
.....
50	9128	0.999453
49	9129	0.999562
48	9130	0.999672
47	9131	0.999781
47	9132	0.999891

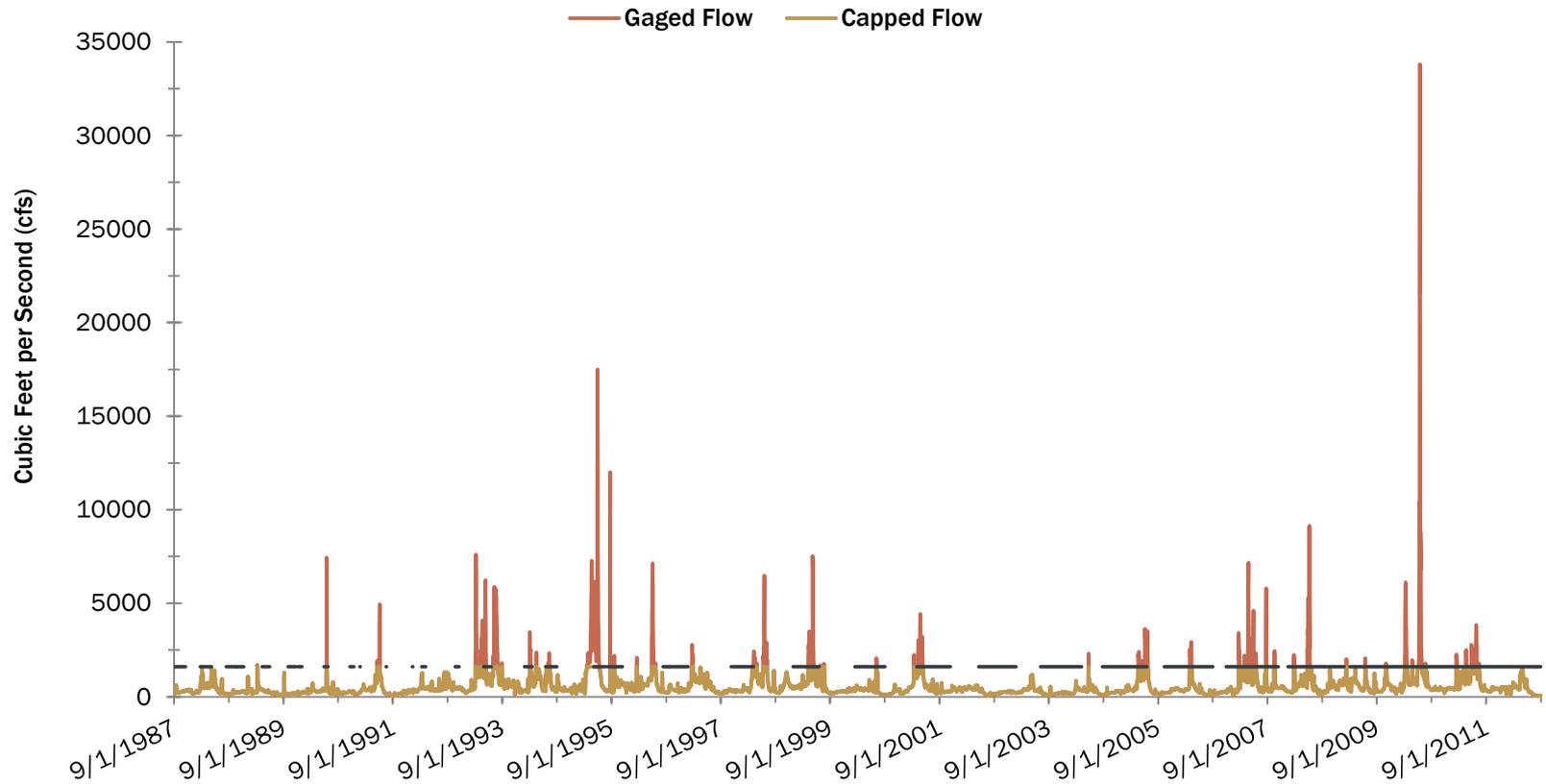
Flows greater than cap are replaced

Capped time series data
(truncated for example)

Date	Flow (cfs)
9/1/1987	204
9/2/1987	195
9/3/1987	180
9/4/1987	176
9/5/1987	177
.....
7/10/1994	852
7/11/1994	1610
7/12/1994	1610
7/13/1994	1600
7/14/1994	1370
.....
8/27/2012	72
8/28/2012	77
8/29/2012	75
8/30/2012	69
8/31/2012	66

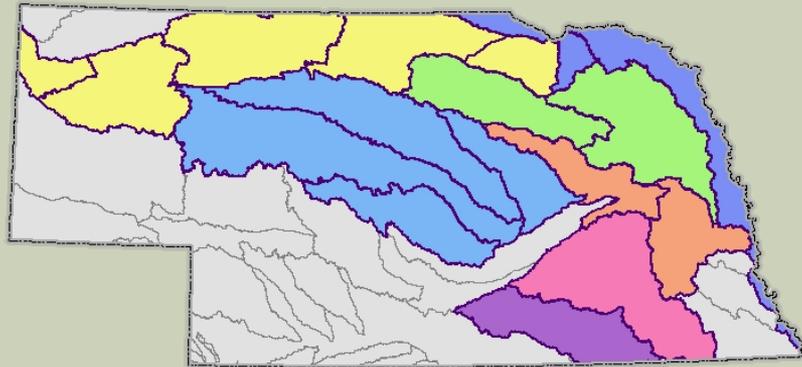
GAGED AND CAPPED STREAMFLOW

Elkhorn River At Norfolk



REACH-GAINS

- To avoid double counting water supplies, reach-gains calculated for subbasins with upstream subbasins
- Flow from upstream subbasin gage subtracted from flow at the downstream subbasin of interest
 - Capping done on reach-gains
- For example, to find reach-gain for Niobrara Box Butte to Gordon, flow from the Niobrara above Box Butte gage was subtracted from the Box Butte to Gordon gage.



- Flows from upstream subbasins were considered required inflows in the BWS calculations

REACH-GAINS

This table shows subbasins without upstream subbasins where streamflow was used for the calculation and subbasins with upstream subbasins where reach-gains had to be considered.

Streamflow	Reach-gains
Bazile Creek	Niobrara River Box Butte to Gordon
Niobrara River above Box Butte	Niobrara River Gordon to Sparks
Elkhorn River above Norfolk	Niobrara River Sparks to Spencer
Big Blue River	Niobrara River Spencer to Verdel
Little Blue River	Elkhorn River Norfolk to Waterloo
North Loup River	Middle Loup River
South Loup River	Lower Loup River
	Lower Platte River above North Bend
	Lower Platte River North Bend to Louisville