

# Broad River Basin Hydrologic Model Inflow Development

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Advancing the Management  
of Water Resources



# Project Timeline

- Components
  - Basin schematic: 1 - 2 months (complete)
  - Data collection (demands and discharges, including agricultural demands): 4 - 6 months (complete)
  - Inflow development: 6 – 10 months (complete)
  - Operating rules: 3 months
  - Current and future demand model runs: 2 - 4 months
  - Documentation and training: 1 month
  - Expected completion date: December 2011
- Model is available for preliminary drought forecasts

# Data Collection (HydroLogics)

- Reservoirs
  - Elevation-storage-area curve and operating rules
  - Historic elevation/release data when available
- Streamflow
- Precipitation/evaporation
  - Use stations nearest the reservoirs of interest
- Drought plans
- Interconnections

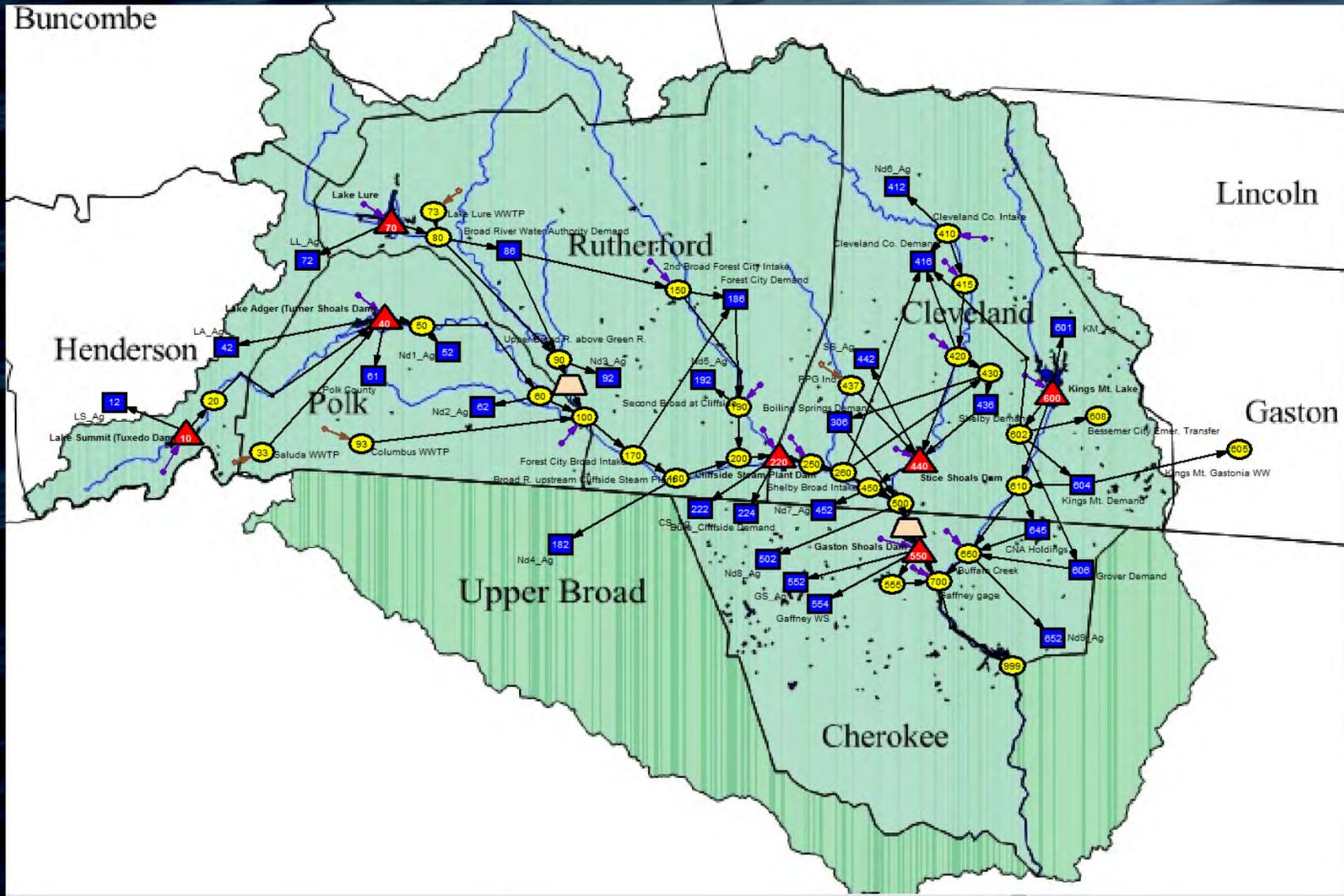
# Data Collection (Moffatt & Nichol)

# Inflow Development

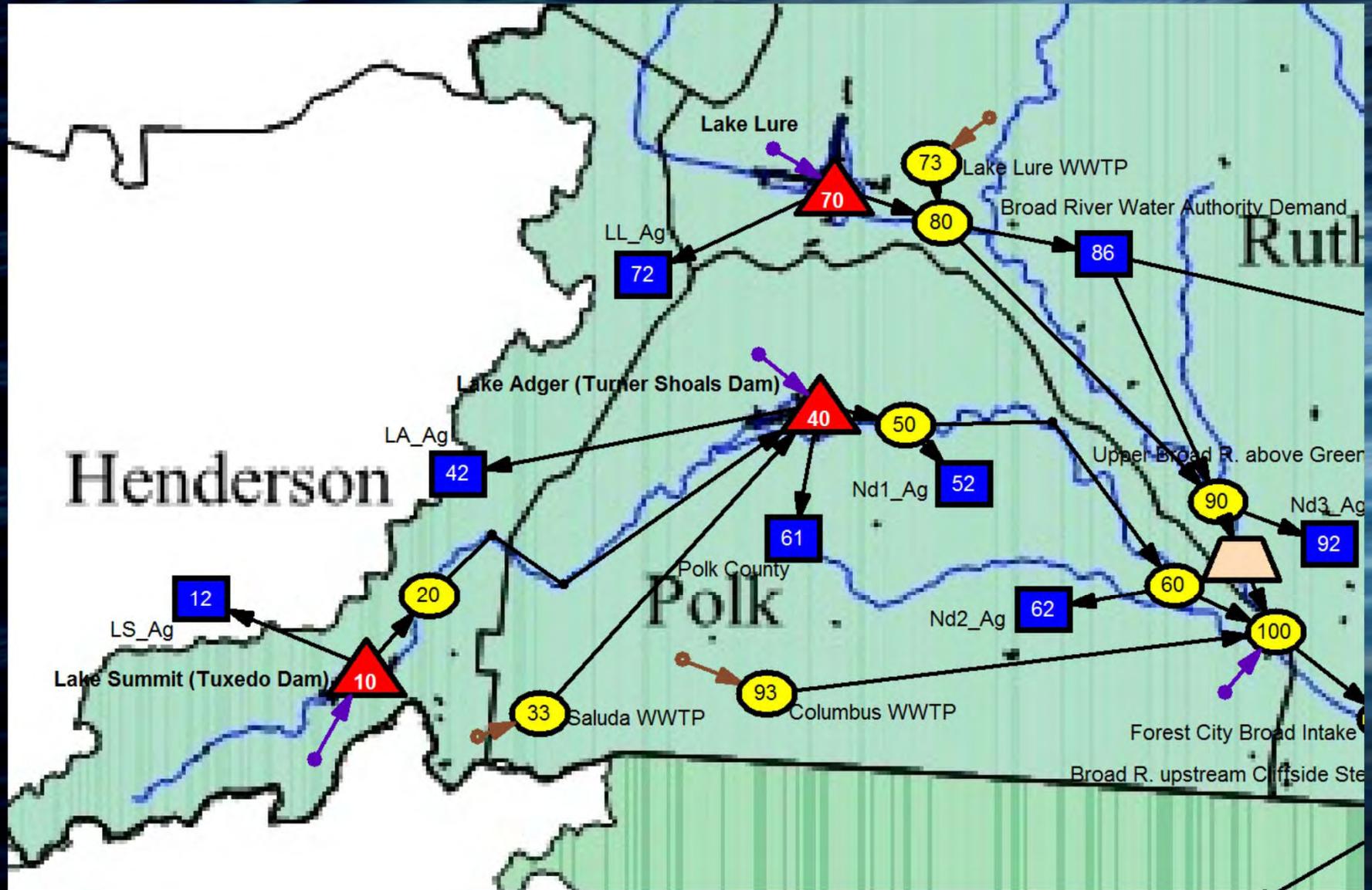
# Unimpairment

- Unimpaired inflows necessary for testing impacts of alternative operating policies, facilities, and demand levels
- Impairments include water withdrawals/discharges and reservoir regulation (including net evaporation)
- **Goal: Force inflows to match monthly unimpaired gage flows, meaning measurement error is embedded in impairments and not gage flows**
  - USGS gage data is treated as ground truth

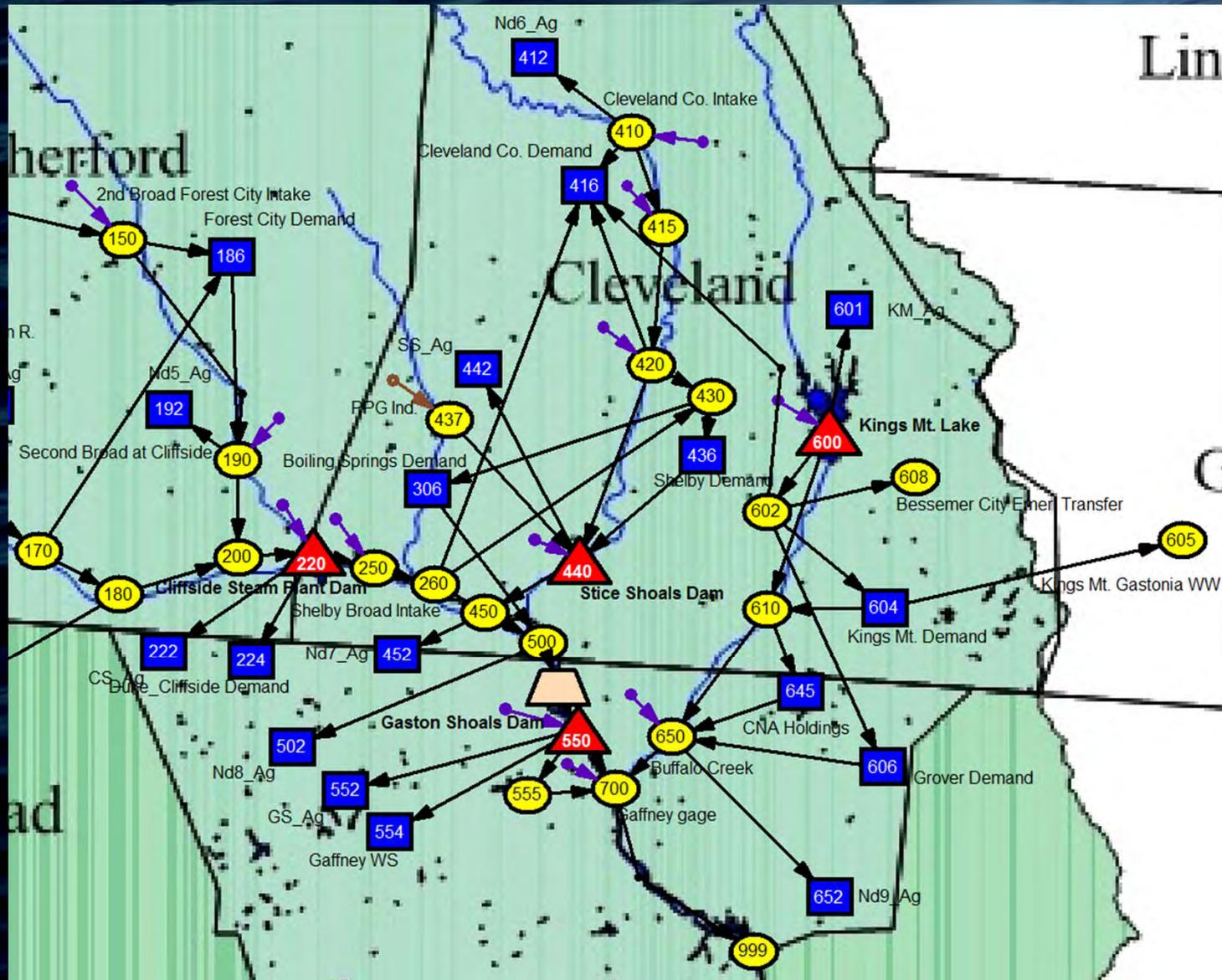
# Geographic Scope of Model



# Upper Basin



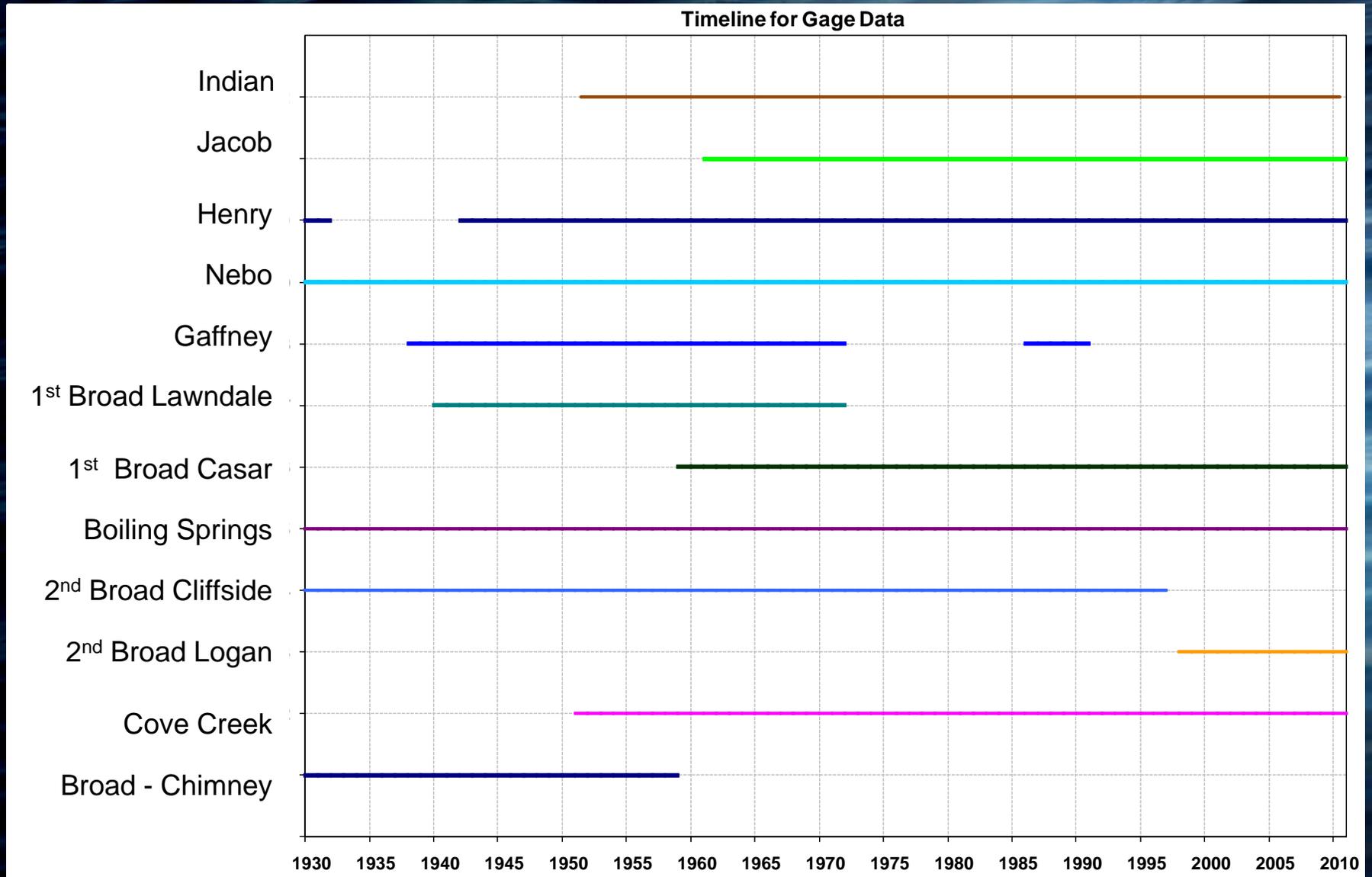
# Middle / Lower Basin



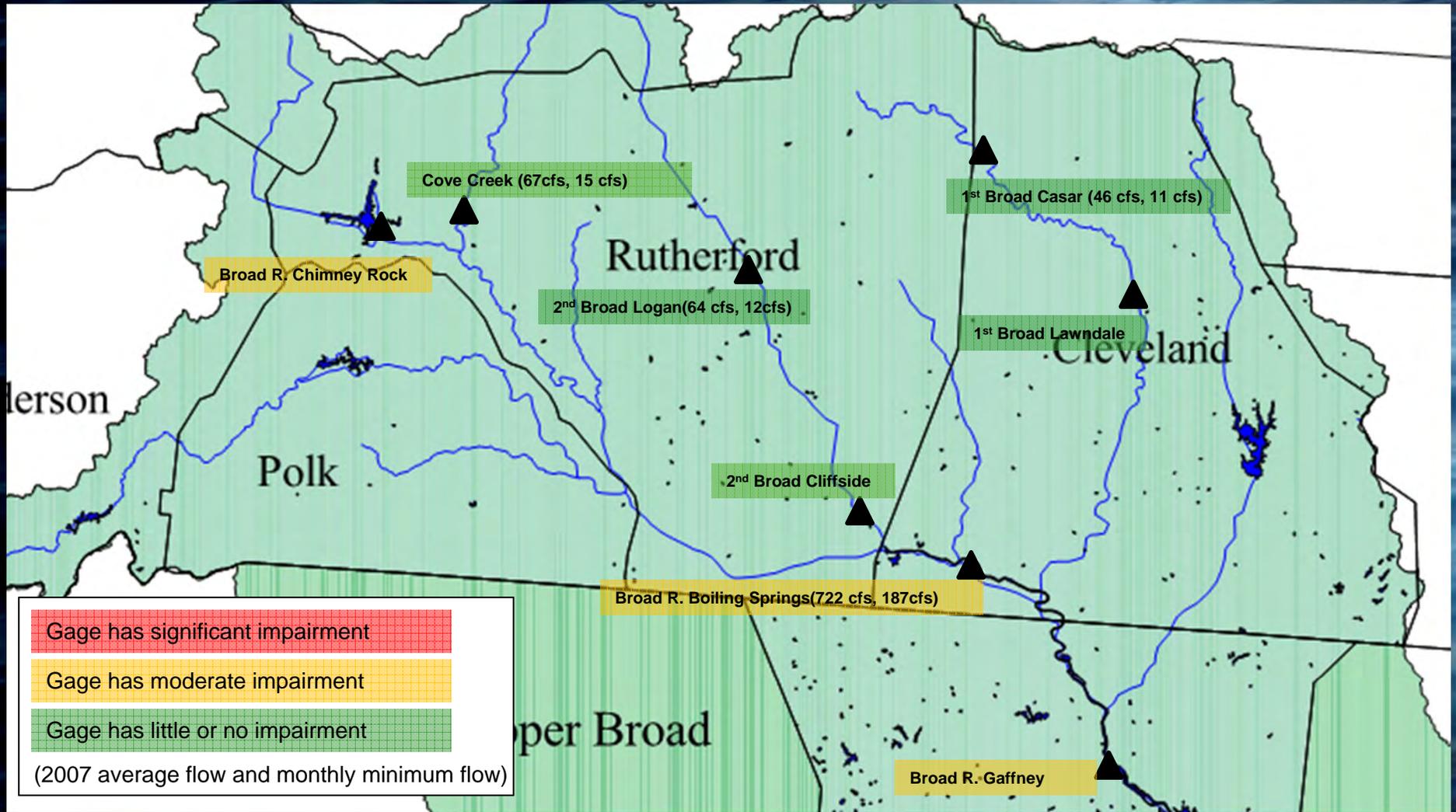
# Gages Used

USGS Number	Description	Period of Record	Drainage Area (sq. mi.)
<b>Basin Gages</b>			
02148500	BROAD RIVER NEAR CHIMNEY ROCK, NC	04/1927 - 09/1958	97
02149000	COVE CREEK NEAR LAKE LURE, NC	01/1951 - present	79
02150495	SECOND BROAD RIVER NEAR LOGAN, NC	10/1998 - present	86.2
02151000	SECOND BROAD RIVER AT CLIFFSIDE, NC	07/1925 - 12/1996	220
02151500	BROAD RIVER NEAR BOILING SPRINGS, NC	07/1925 - present	875
02152100	FIRST BROAD RIVER NEAR CASAR, NC	03/1959 - present	60.5
02152500	FIRST BROAD RIVER NEAR LAWNSDALE, NC	03/1940 - 09/1971	200
02153500	BROAD RIVER NEAR GAFFNEY, NC	12/1938 - 09/1971, 06/1986 - 09/1990	1,490
<b>Reference gages outside of the basin</b>			
02138500	LINVILLE RIVER NEAR NEBO, NC	07/1922 - present	66.7
02143000	HENRY FORK NEAR HENRY RIVER, NC	08/1925 - present	83.2
02143040	JACOB FORK AT RAMSEY, NC	10/1961 - present	25.7
02143500	INDIAN CREEK NEAR LABORATORY, NC	09/1951 - present	69.2

# Gage Timeline



# Gage Map



# Developing Inflow Records

- Reservoirs
  - Use unimpaired stream gages immediately upstream
  - Otherwise, use unimpaired reference gages
- Other nodes (e.g., stream gaging sites)
  - Adjust inflows for upstream impairments

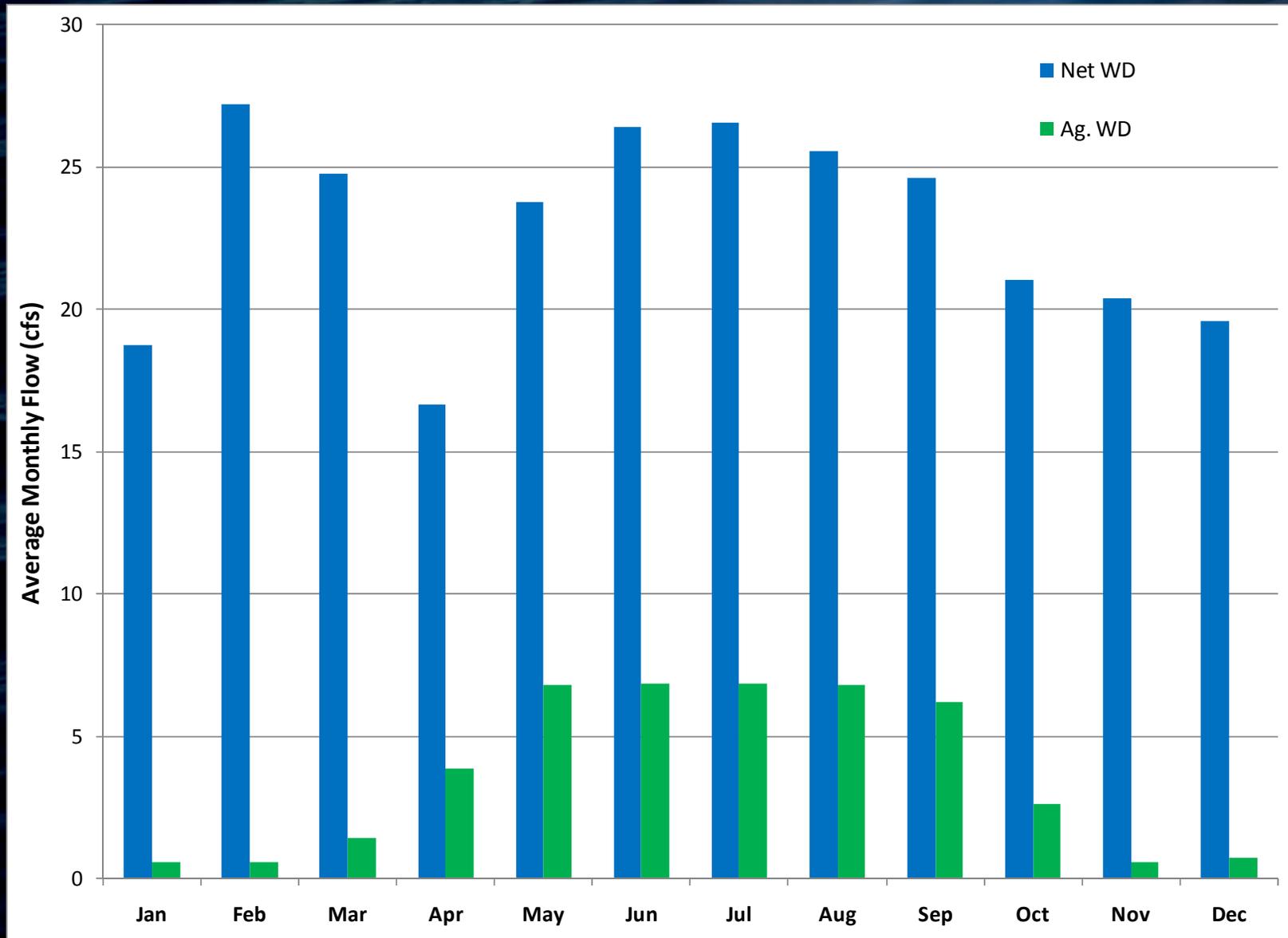
# Developing Inflow Records (cont'd.)

- Inflow records modified to eliminate negatives caused by time of travel issues and errors in impairments
- Fill in missing inflow records by correlating with unimpaired inflows at other nodes
  - USGS Fillin program computes correlations on a monthly basis
  - Filled-in records must be scaled to ensure that actual unimpaired flow at downstream points is preserved
- Monthly flows/gains disaggregated to daily flows using local unimpaired gage to preserve natural variation
  - Impairment data is mostly monthly and can therefore cause noise on a daily basis
  - Reservoir operations on the river impact daily flows but not monthly averages
  - Goal: to build daily flows whose variation is representative of history while preserving monthly gage flows as ground truth

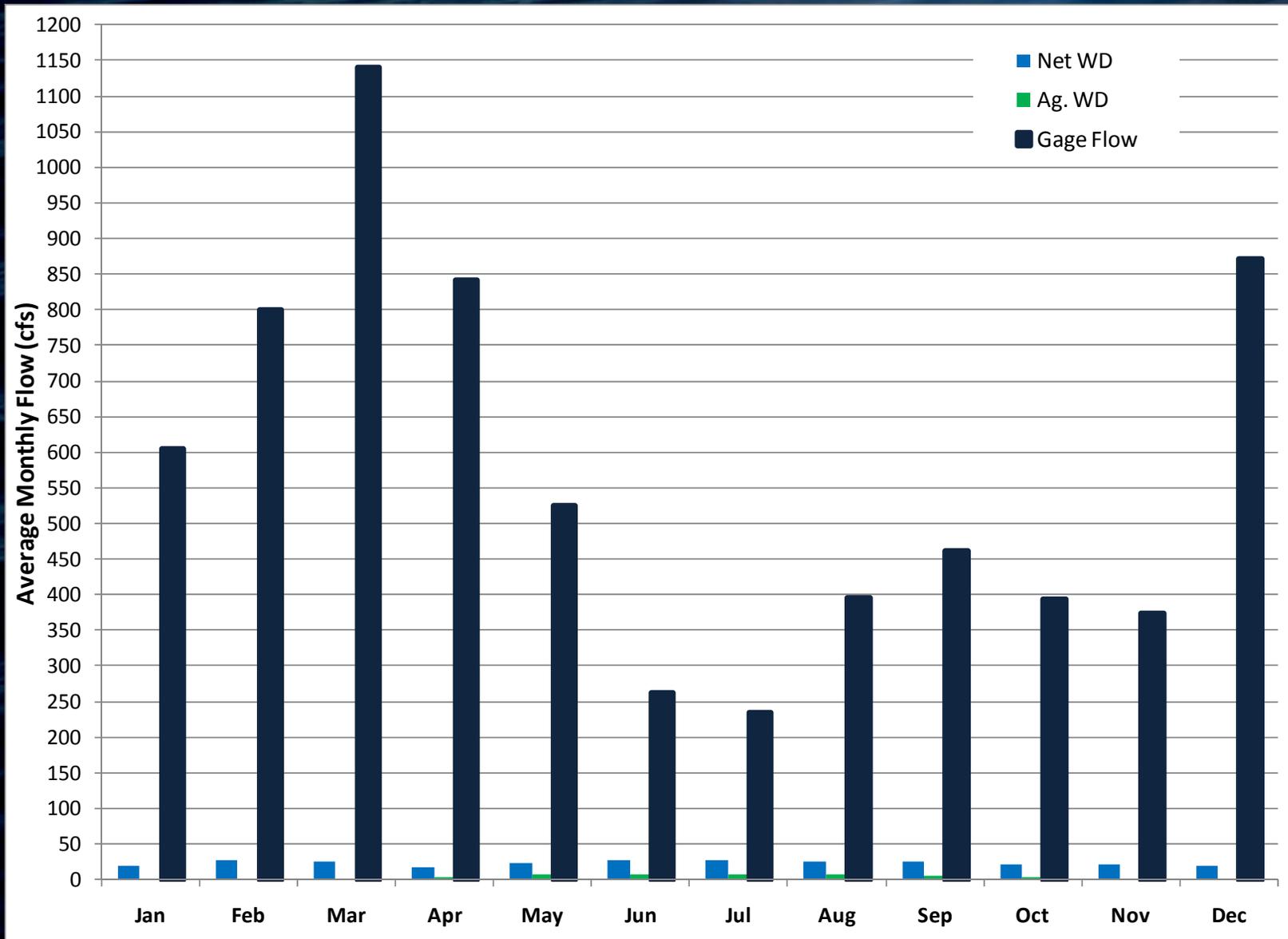
# Spreadsheet Showing Gage Unimpairment

02151500 - Broad River nr Boiling Springs - All flows in cfs unless otherwise noted														
Date	WW Discharges						Withdrawals		Ag WD					
	Lake			Harris	Cliffside	Cliffside		Cliffside		Total	Total Adjustment	Broad	Unregulated	
	Lure	Columbus	Ruthefordt	Plant	Sanitary	Steam	BRWA	Plant		Adjustment	Upstream	nr Boiling	gage	
	WWTP	WWTP	WWTP	WWTP	WWTP	WWTP	WTP	WD		this	Subbasin	Springs	Broad nr	
										Subbasin		gage	Boiling Springs	
4/16/2009	0.87	0.27	0.61	0.07	0.02	12.23	8.14	31.28	4.27	29.62	29.44	1070	1099.44	
4/17/2009	0.83	0.28	0.60	0.07	0.02	12.23	8.14	31.28	4.07	29.45	29.42	1130	1159.42	
4/18/2009	0.95	0.29	0.58	0.07	0.05	12.23	8.14	31.28	4.07	29.31	29.32	1390	1419.32	
4/19/2009	0.89	0.32	0.72	0.07	0.05	12.23	8.14	31.28	4.07	29.20	29.47	851	880.47	
4/20/2009	0.79	0.32	0.45	0.07	0.04	12.23	8.14	31.28	4.07	29.57	28.73	1230	1258.73	
4/21/2009	0.90	0.23	0.58	0.07	0.06	12.23	8.14	31.28	4.07	29.40	28.93	1750	1778.93	
4/22/2009	0.79	0.23	0.71	0.07	0.10	12.23	8.14	31.28	4.07	29.35	29.07	1280	1309.07	
4/23/2009	0.80	0.26	0.71	0.07	0.15	12.23	8.14	31.28	4.07	29.25	28.93	1290	1318.93	
4/24/2009	0.81	0.27	0.77	0.07	0.10	12.23	8.14	31.28	4.07	29.23	28.36	1350	1378.36	
4/25/2009	0.92	0.29	0.77	0.07	0.01	12.23	8.14	31.28	4.07	29.18	29.75	1100	1129.75	
4/26/2009	0.91	0.28	0.74	0.07	0.01	12.23	8.14	31.28	4.07	29.23	30.22	799	829.22	
4/27/2009	0.73	0.31	0.81	0.07	0.01	12.23	8.14	31.28	4.07	29.32	29.19	752	781.19	
4/28/2009	0.79	0.29	0.80	0.07	0.01	12.23	8.14	31.28	4.74	29.95	30.12	1020	1050.12	
4/29/2009	0.80	0.33	0.78	0.07	0.01	12.23	8.14	31.28	4.74	29.93	30.26	957	987.26	
4/30/2009	0.76	0.33	0.72	0.07	0.01	12.23	8.14	31.28	4.74	30.03	29.85	992	1021.85	
5/1/2009	0.78	0.32	0.80	0.07	0.01	11.62	8.35	31.11	4.88	30.71	31.70	920	951.70	
5/2/2009	0.79	0.31	0.78	0.07	0.02	11.62	8.35	31.11	5.03	30.89	32.33	1080.00	1112.33	

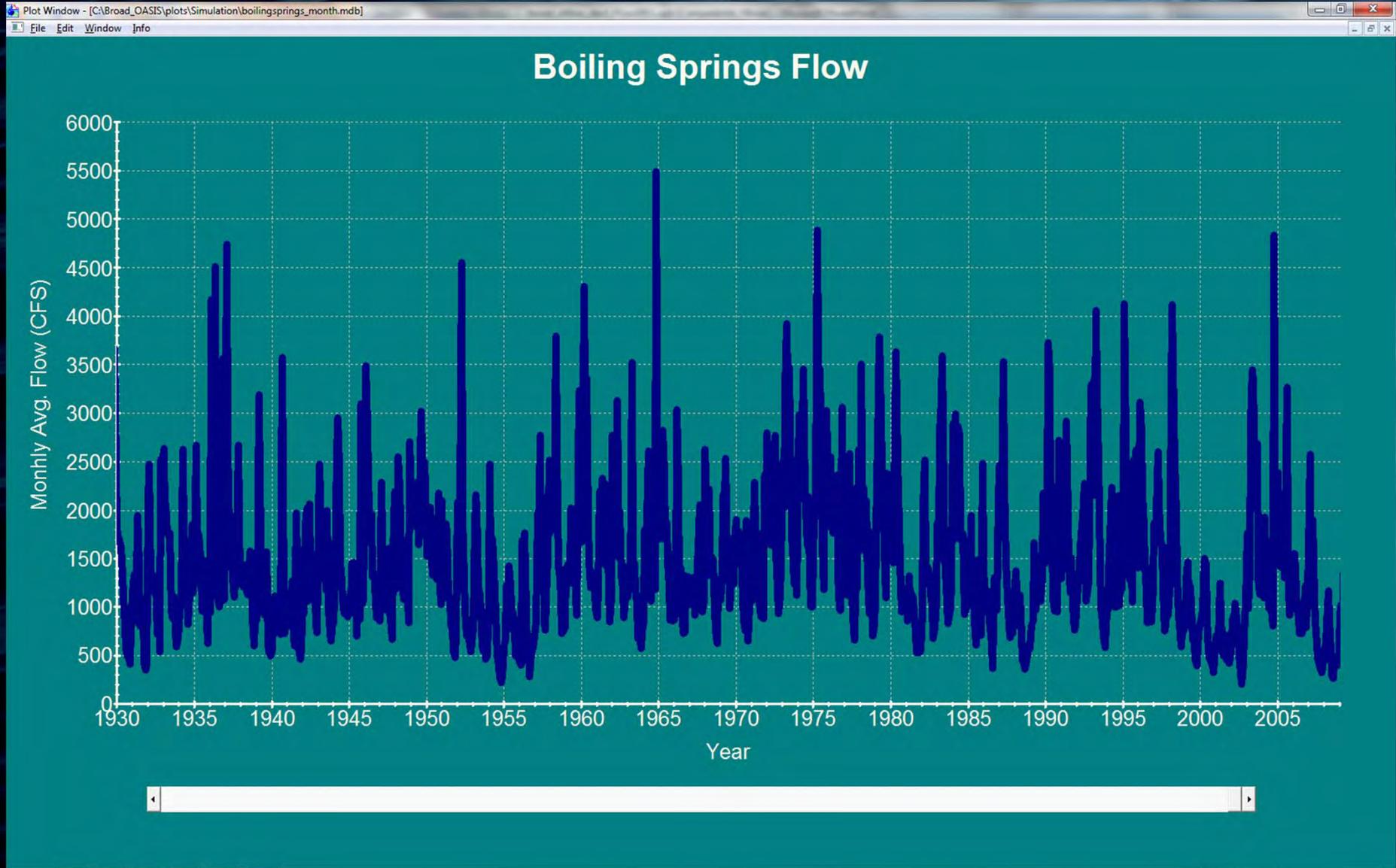
# Monthly Impairments at Boiling Springs (2008)



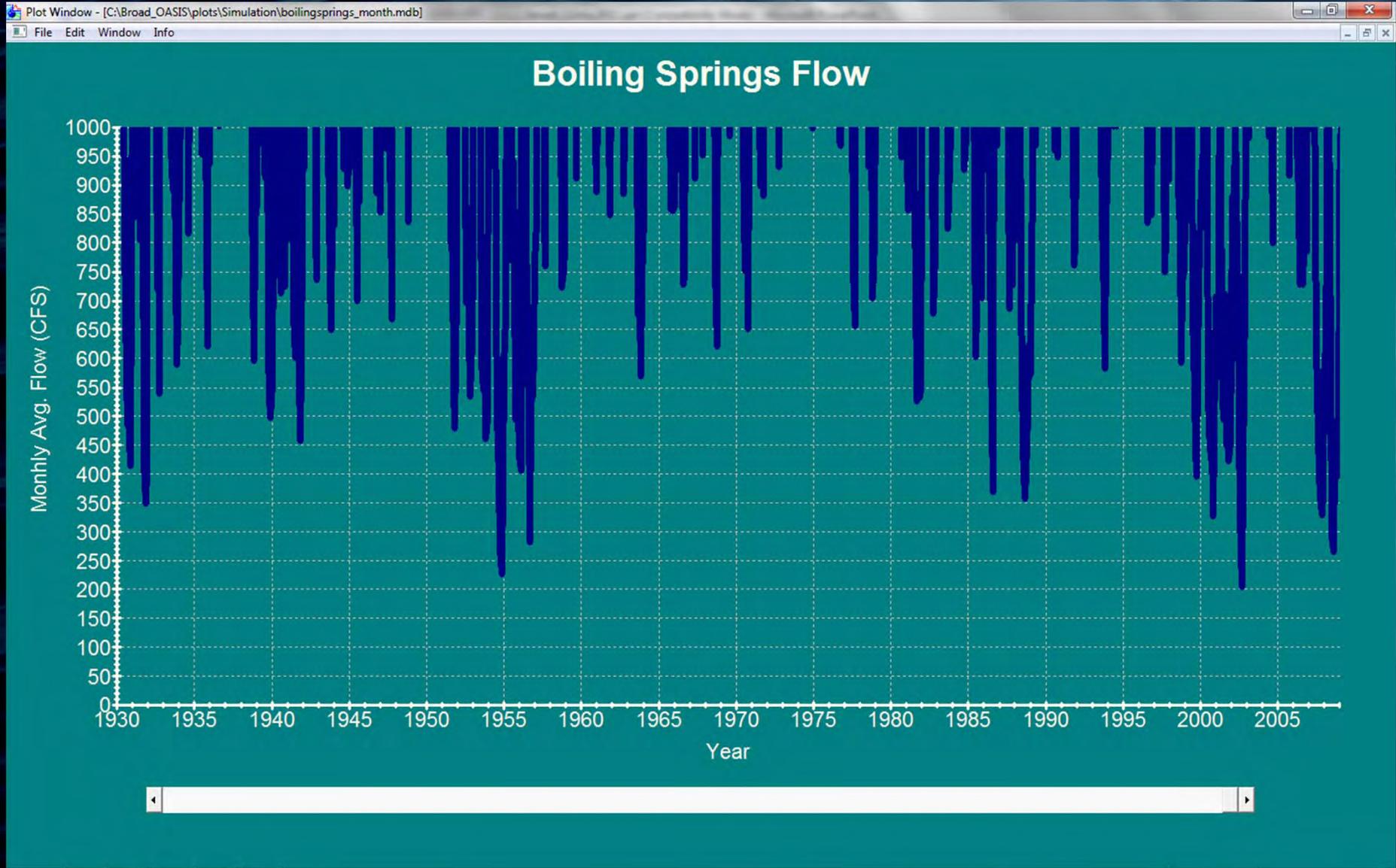
# Monthly Impairments at Boiling Springs (2008)



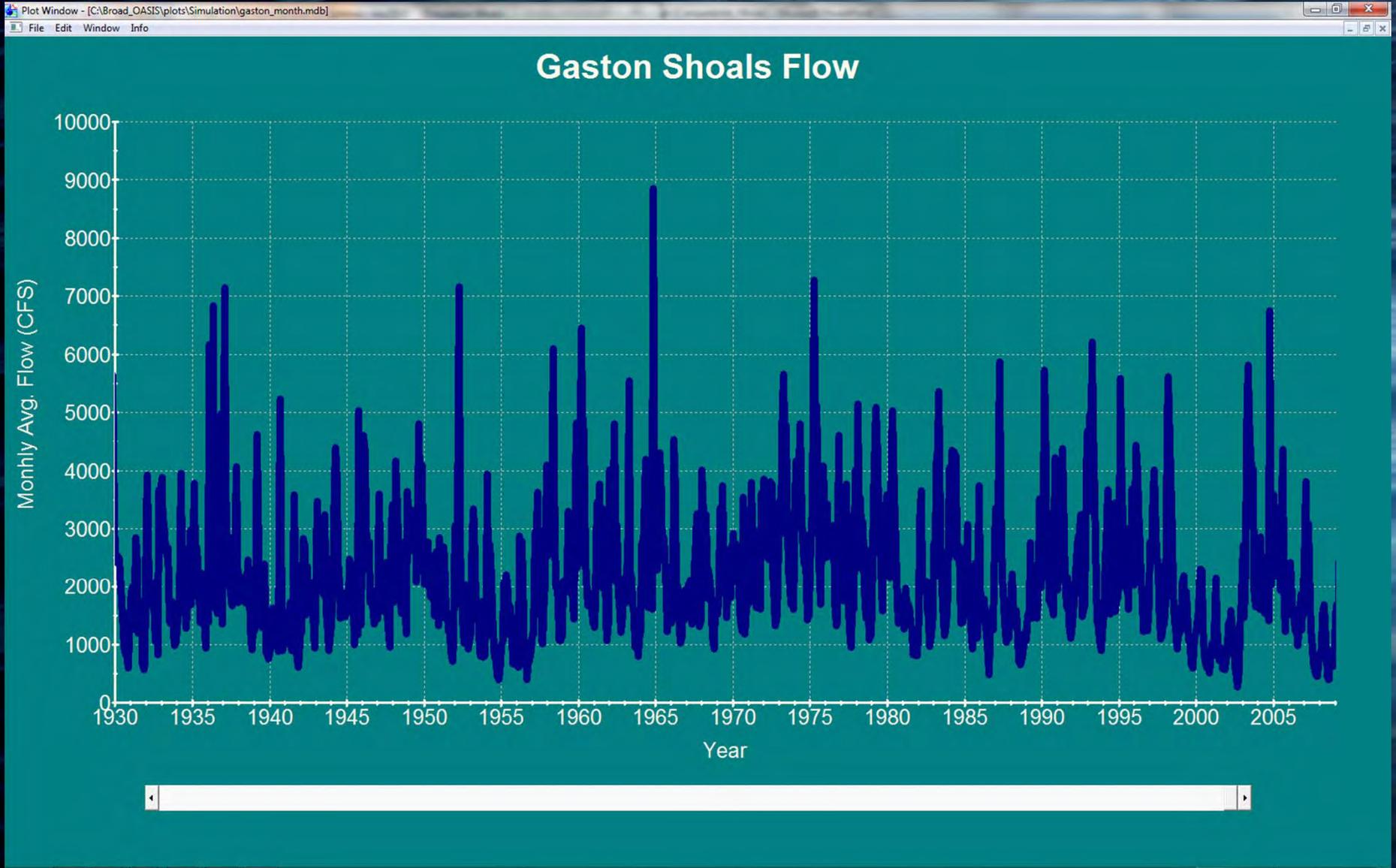
# Boiling Springs Flows



# Boiling Springs Flows



# Gaston Shoals Flows



# Gaston Shoals Flows

