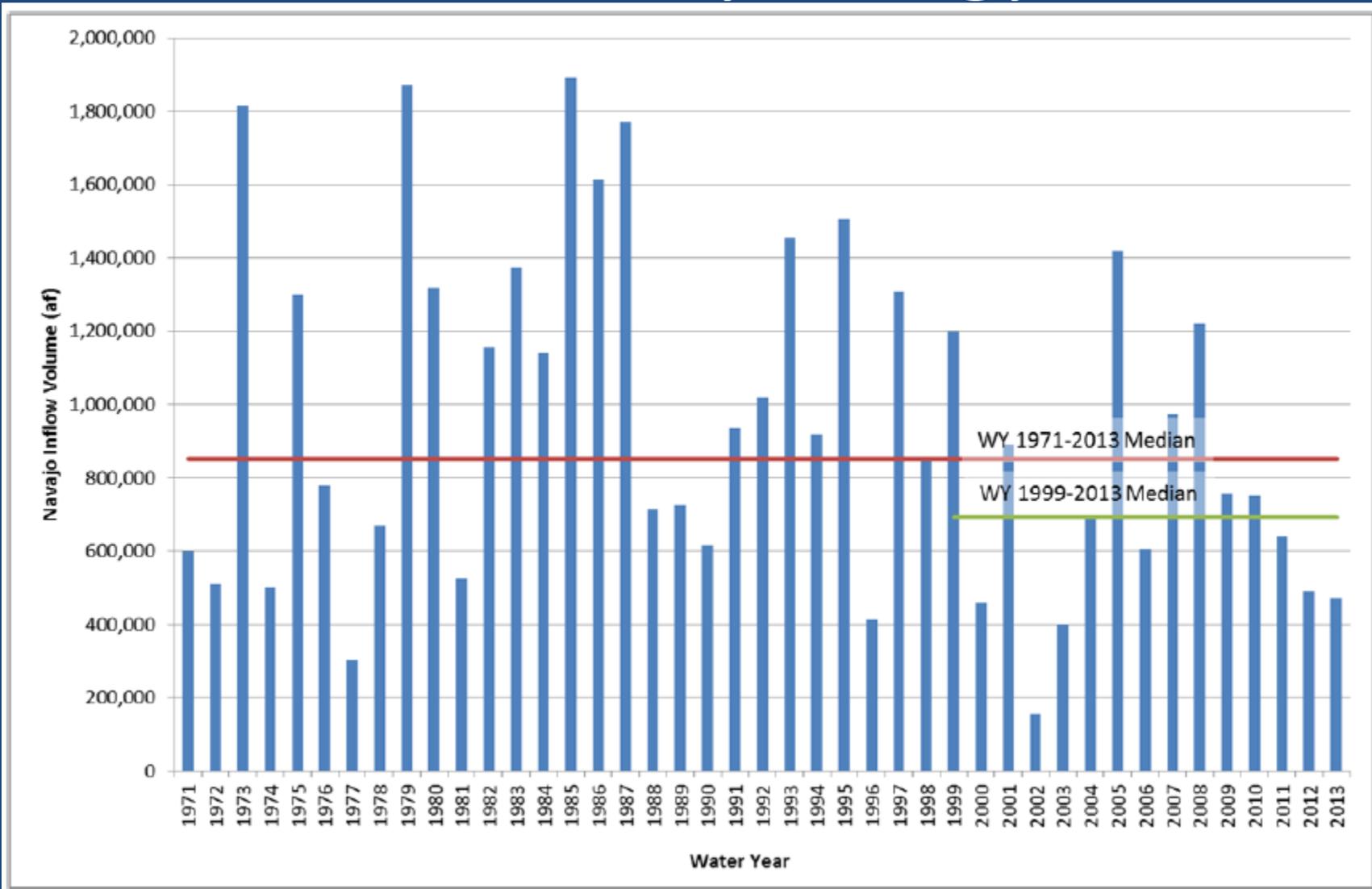


# SJRIP Environmental Flows Workshop

## Navajo Operations and Modeling

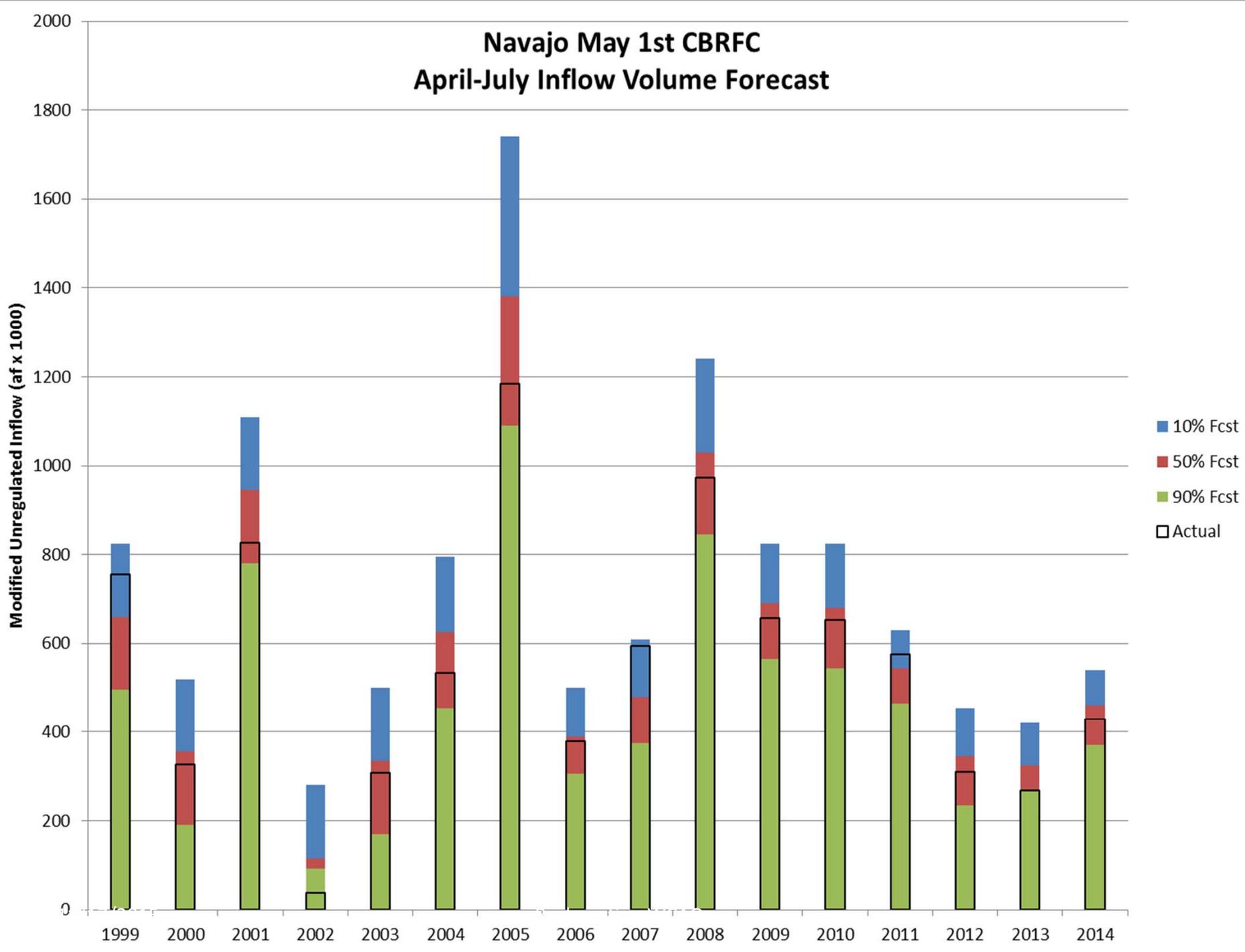
# Historic Hydrology



# Decision Tree Implementation Review

- What was the forecast at the time?
- What decision was made?
- How did the decision change as the forecast evolved?
- Was the decision tree followed?
- What was the effect on the flow recommendations?

## Navajo May 1st CBRFC April-July Inflow Volume Forecast



| Water Year | Spring Most Probable Forecast Values |         |          |                               |              | Actual  |          | Flow Recs |     |     |       | Notes   |
|------------|--------------------------------------|---------|----------|-------------------------------|--------------|---------|----------|-----------|-----|-----|-------|---|
|            | Avail Water                          | Spill   | SPR Path | SPR Rec                       | SPR Rank     | Perturb | SPR Rank | >10k      | >8k | >5k | >2.5k |   |
| 1999       | ?                                    |         |          |                               |              |         | 1        |           |     | X   | X     |   |
| 2000       | ?                                    |         |          |                               |              |         | 1        |           |     |     | X     |   |
| 2001       | 861,000                              | 106,000 | acfjimp  | Release > of 166,000 or Spill | max(2,spill) |         | 2        |           |     | X   | X     | Followed DT   |
| 2002       | 353,908                              | 0       | acghlo   | No Release                    | 0            | no      | 0        |           |     |     |       | Even in the late spring, there was AW forecast! DT changed to <b>ab</b> and followed. |
| 2003       | 1,388                                | 0       | ab       | No Release                    | 0            |         | 0        |           |     |     | X     | Followed DT   |
| 2004       | 39,889                               | 0       | ab       | No Release                    | 0            |         | 0        |           |     |     | X     | Followed DT   |
| 2005       | 956,000                              | 255,000 | acfjie   | Release Full Hydrograph       | 4            |         | 4        | X         | X   | X   | X     | Followed DT   |
| 2006       | 617,402                              | 0       | acgk     | Release 114k                  | 1            | yes     | 1        |           |     |     | X     | Followed DT   |
| 2007       | 725,000                              | 24,000  | acfjimp  | Release > of 166k or Spill    | max(2,spill) |         | 2        |           |     | X   | X     | Followed DT   |
| 2008       | 1,011,000                            | 309,400 | acfjimqp | Release > of 166k or Spill    | max(2,spill) | yes     | 3+       |           | X   | X   | X     | Added flood control nose to Hydrograph 3 (spill > 166k). Followed DT.                 |
| 2009       | 645,000                              | 0       | ackg     | 1 week                        | 1            | yes     | 1        |           |     |     | X     | Followed DT   |
| 2010       | 474,500                              | 0       | acghdb   | No Release                    | 0            | no      | 0        |           |     |     | X     | No release (look-back). Followed DT.  |
| 2011       | 500,426                              | 0       | acghlk   | Release 114k                  | 1            | no      | 1        |           |     |     | X     | Followed DT.  |
| 2012       | 374,000                              | 0       | acghlk   | Release 114k                  | 1            | no      | 1        |           |     |     | X     | Began timing peak with Animas. Followed DT.   |
| 2013       | -13,000                              | 0       | ab       | No Release                    | 0            |         | 0        |           |     |     |       | Followed DT.  |

# Proposal

- Operate Annually
- Change Available Water Calculation- EOWYST.
- Use Decision Tree hydrographs to utilize Available Water.
- Operate reservoir to end every water year at EOWYST.

# Modeling Aims- What do we want to know?

- Differences in Spring Peak Release frequency, size and timing between Original and Proposed Methods?
- What is the change in probability of shortage or spill?
- Which EOWYST will provide the most insurance against shortage while minimizing the probability of spill?

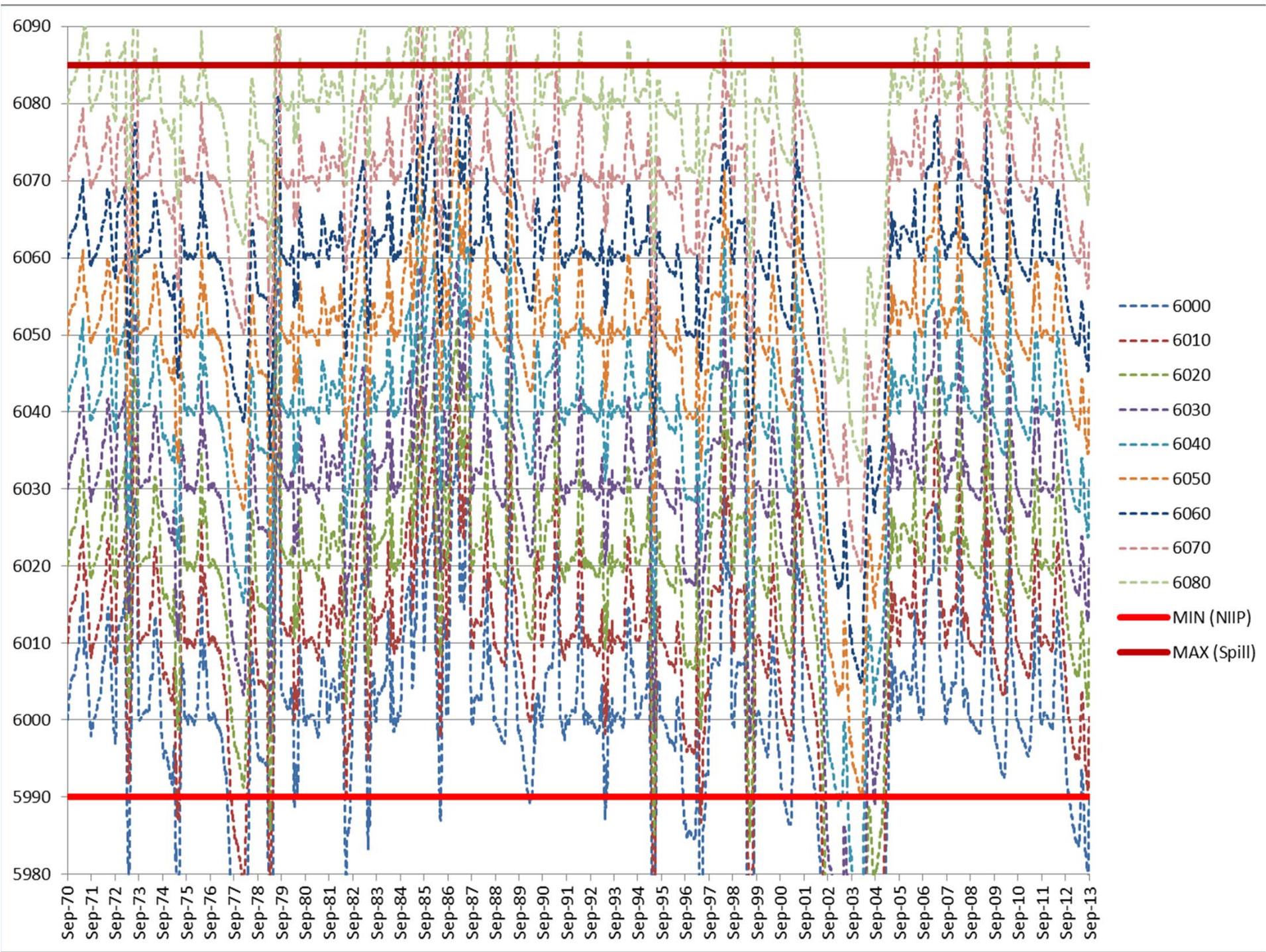
# Modeling Analysis #1

- Original Method (one run)
  - Variable
    - Uses original 1999 Flow Recommendations Available Water Calculation and Decision Tree
- Proposed Method (many runs)
  - Variable
    - Uses Proposed Available Water Calculation and varying EOWYSTs

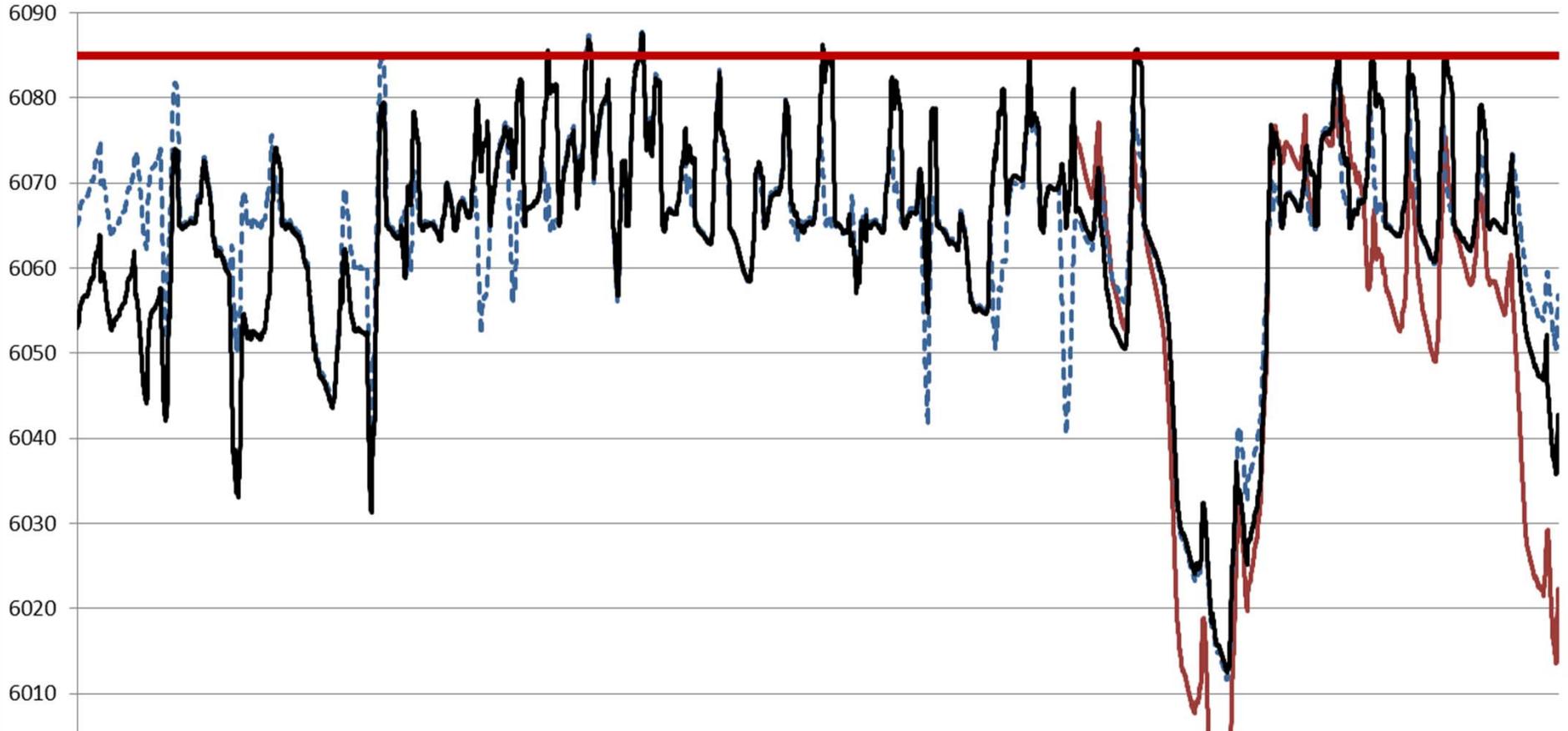
# ...Modeling Analysis #1

## Constants for both methods:

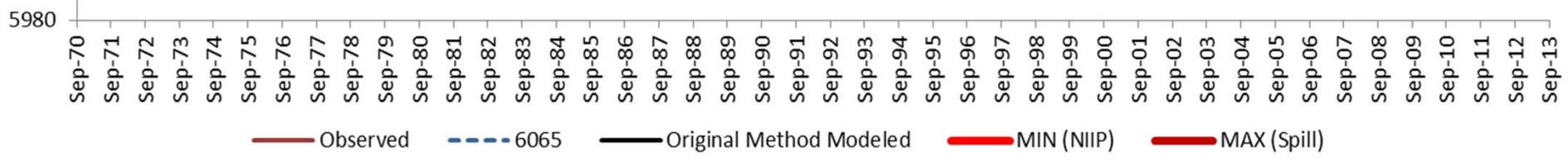
- 1971-2013 Inflow Hydrology
- 1971-2013 Losses 75% Exceedance Probability (assumes drier-than-average)
- 2012 NIIP diversions
- ROD goal base release of 350 cfs
- TBF 500-1000 cfs

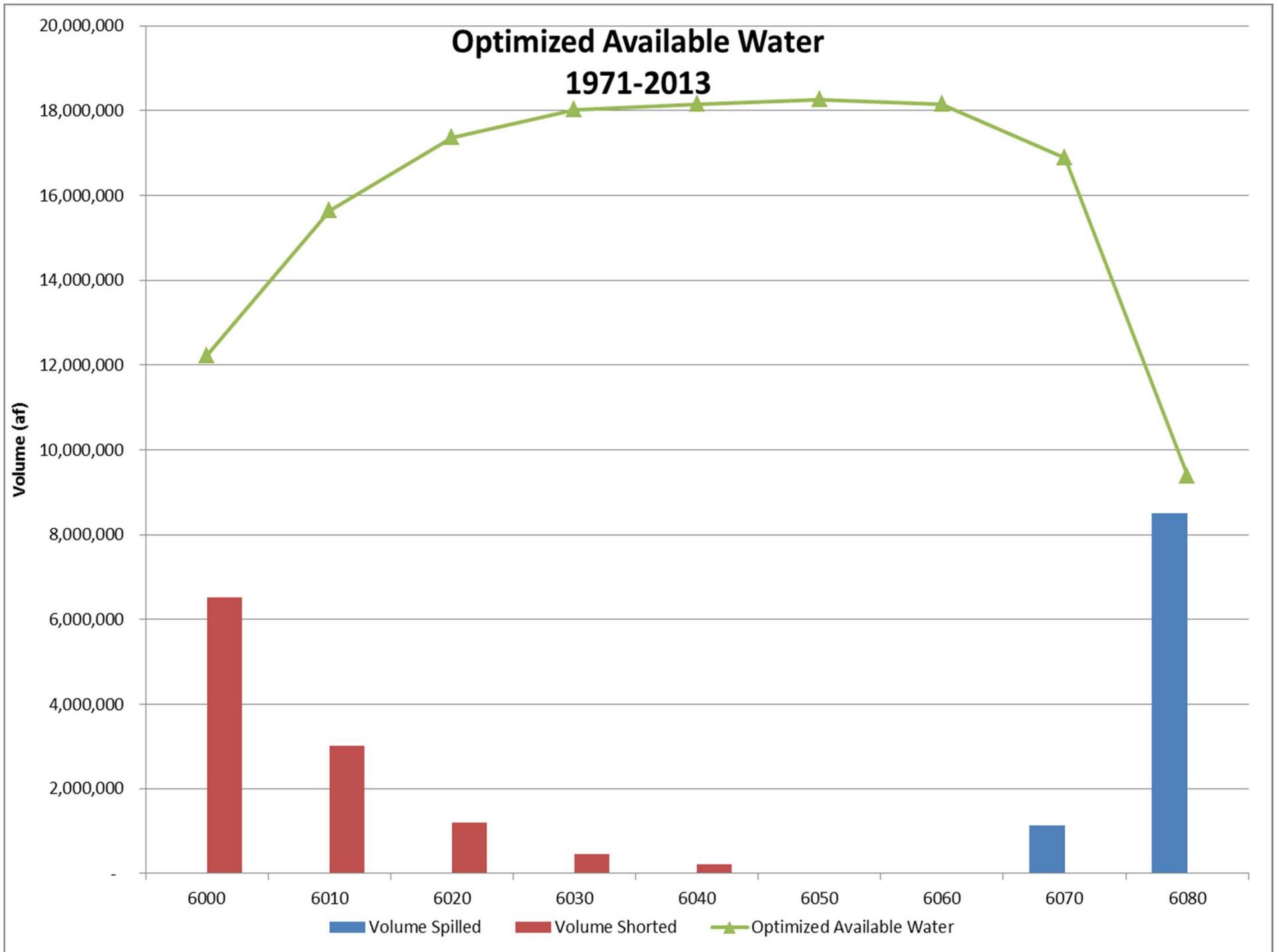


# Navajo Modeled Reservoir Elevations 1970-2013

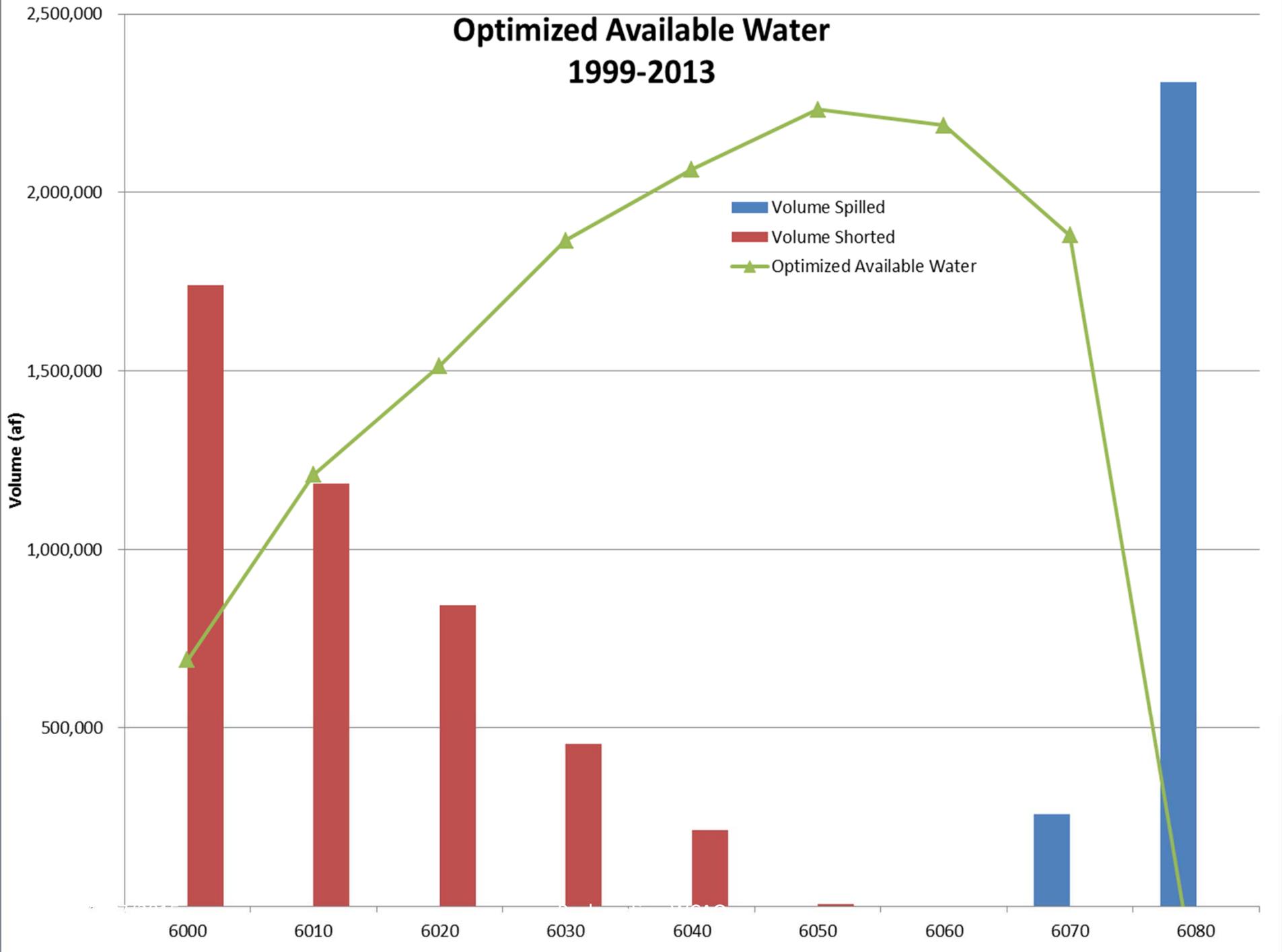


| Water Yr      |      |      |      |      |      |      |      |      |      | Original Method |
|---------------|------|------|------|------|------|------|------|------|------|-----------------|
|               | 6000 | 6010 | 6020 | 6030 | 6040 | 6050 | 6060 | 6070 | 6080 |                 |
| Shortage Risk | 49%  | 26%  | 16%  | 7%   | 5%   | 2%   | 0%   | 0%   | 0%   | 0%              |
| Spill Risk    | 0%   | 0%   | 0%   | 0%   | 0%   | 0%   | 0%   | 21%  | 72%  | 16%             |

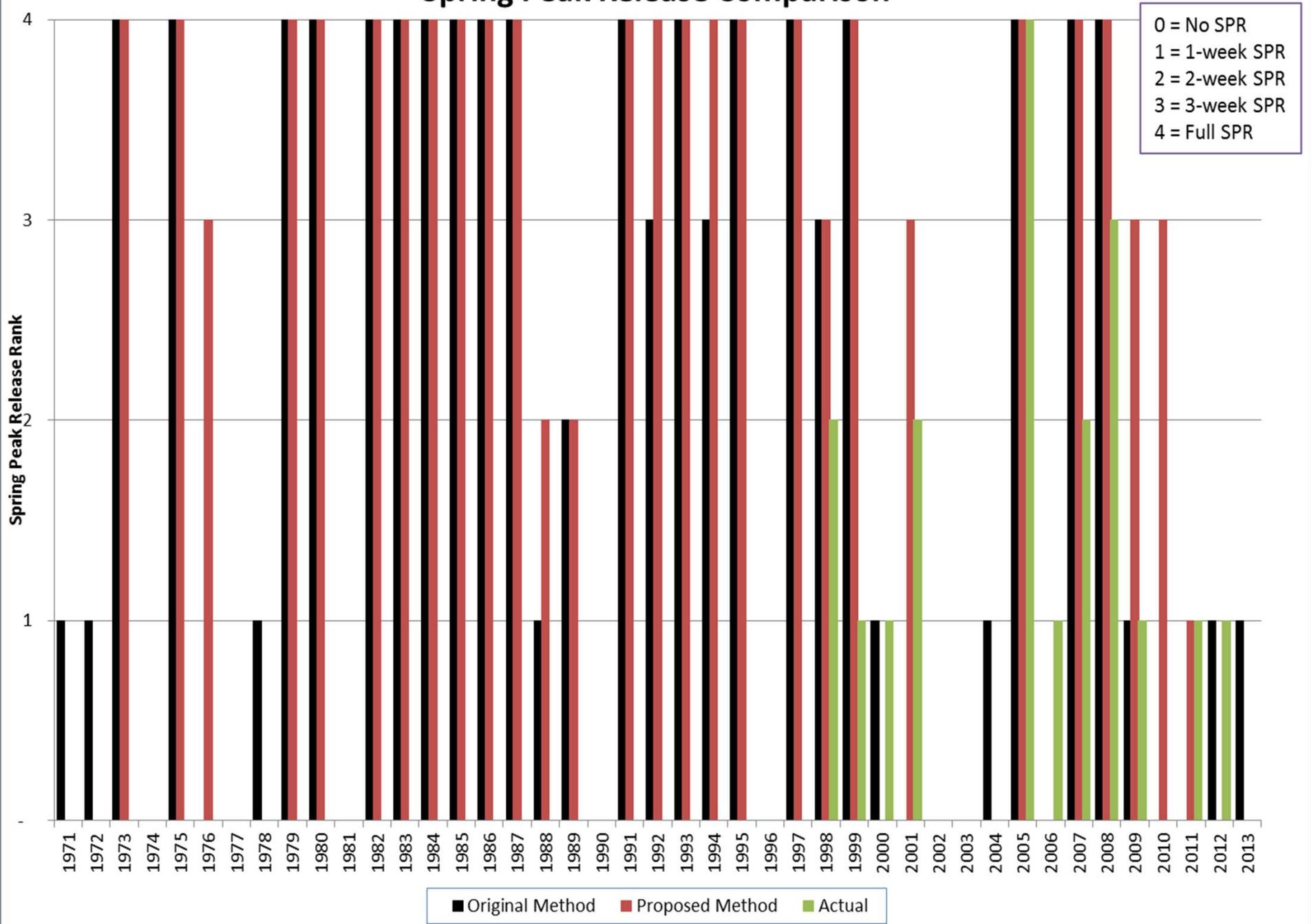




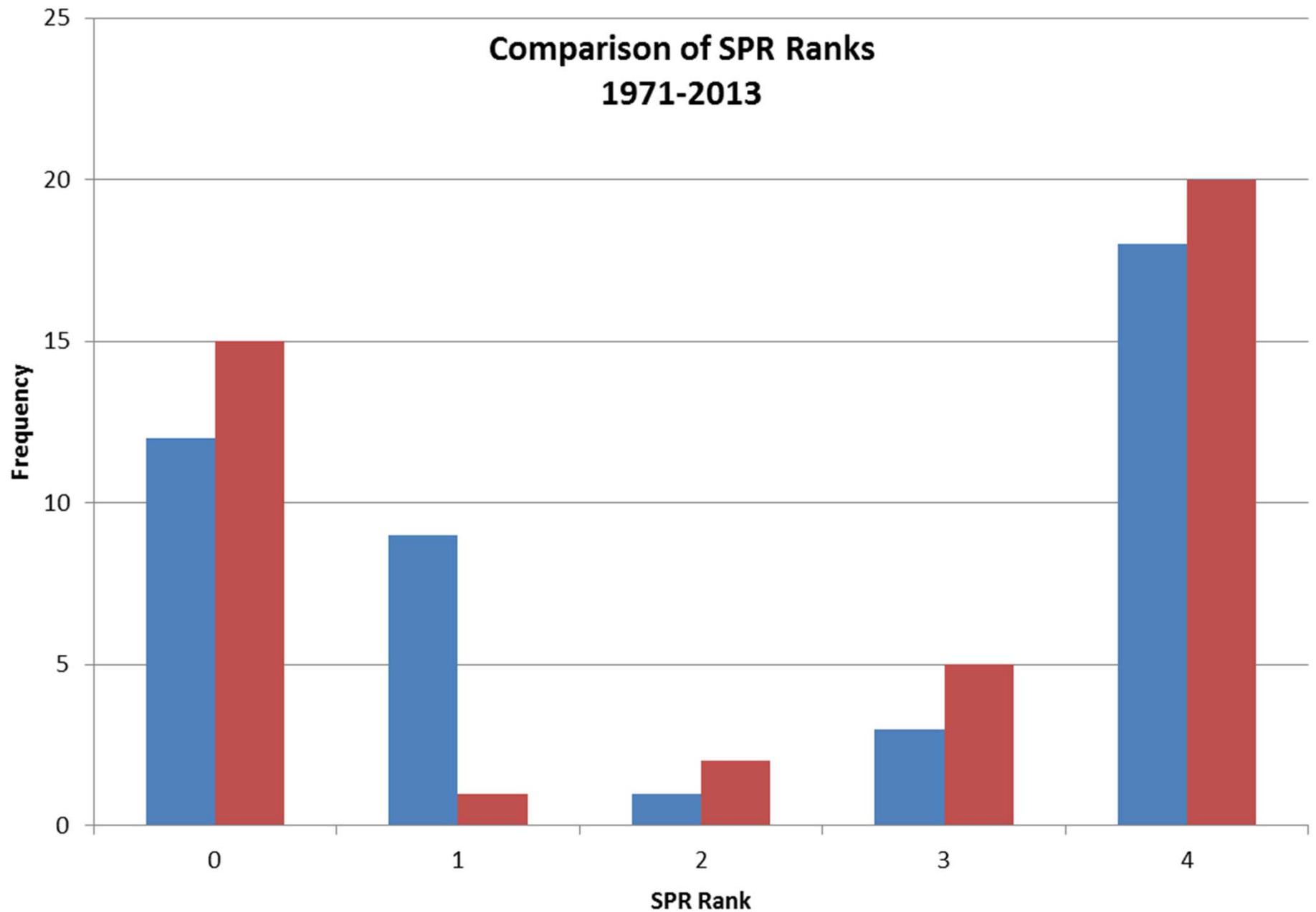
# Optimized Available Water 1999-2013



# Spring Peak Release Comparison



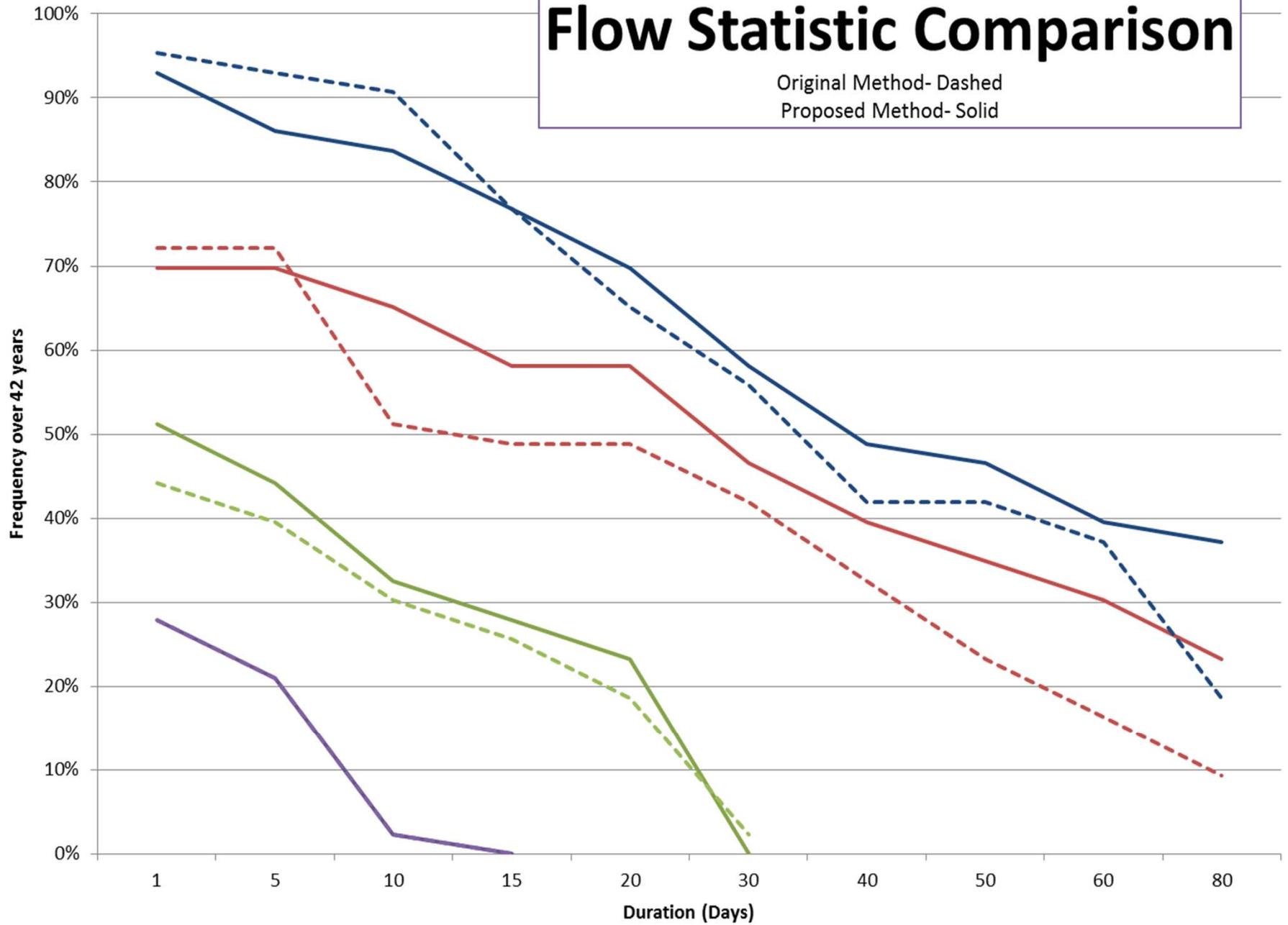
### Comparison of SPR Ranks 1971-2013



■ Original Method ■ Proposed Method

# Flow Statistic Comparison

Original Method- Dashed  
Proposed Method- Solid

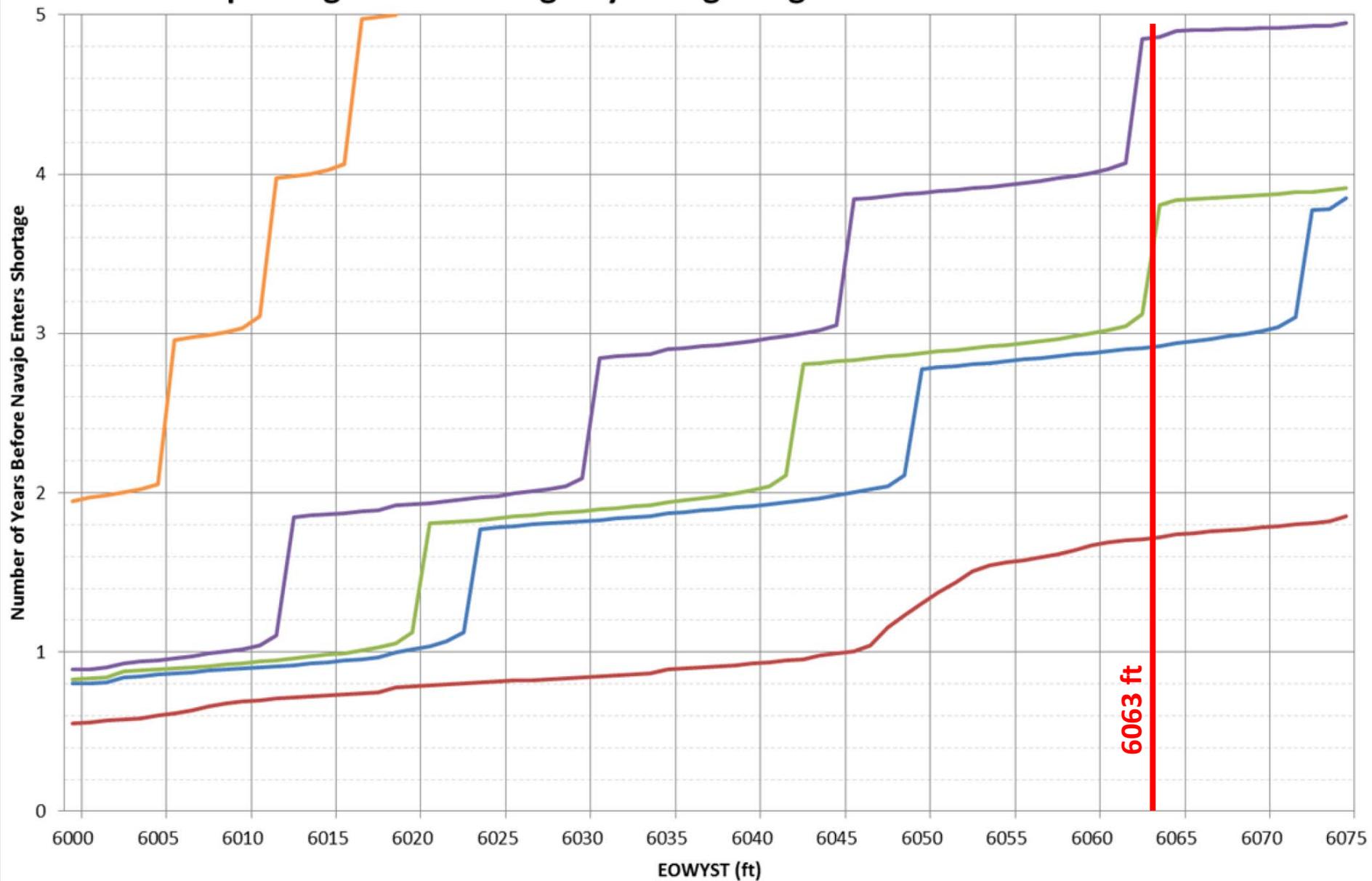


— >2500 cfs — >5,000 cfs — >8,000 cfs — >10,000 cfs

# Modeling Analysis #2

- 5-year drought scenario
  - Five levels of drought were assessed with water year volumes ranging from 150,000 AFY to just over 600,000 AFY.
  - The last four years (2010-2014) annual inflow fall near this range (and 2015 looks similar so far)
  - Optimum EOWYST is between 6063 ft and 6068 ft to avoid shortage and spill

## Number of Years of Storage in Navajo Reservoir Under Repeating Below Average Hydrologic Regimes and Initial EOWYSTs



— 2002 Year   
 — 90% Exceedance of 1999-2013   
 — 90% Exceedance of 1971-2013   
 — 75% Exceedance of 1999-2013   
 — 75% Exceedance of 1971-2013

# Recommendation EOWYST

- Minimum to avoid shortage: 6052 ft
- Maximum to avoid spill: 6063 ft
- Preference on high side due to change in recent hydrology and higher risk of shortage.

# What if implemented now?....

- Based on February 3<sup>rd</sup> CBRFC forecast
- Choose final EOWYST for Sept 30<sup>th</sup>
- Reclamation continues producing twice-monthly calculations of Available Water

# Potential Spring Peak Releases

Feb 3 CBRFC Forecast

## Original Method

| <b>Most Probable</b> | <b>2015</b> | <b>2016</b> |
|----------------------|-------------|-------------|
|                      | 1-week      | 1-week      |

## Proposed Method

| <b>EOWYST</b> | <b>2015</b> | <b>2016</b> |
|---------------|-------------|-------------|
| <b>6030</b>   | 2-week      | Full        |
| <b>6040</b>   | 86,000      | Full        |
| <b>6050</b>   | 0           | Full        |
| <b>6060</b>   | 0           | 3-week      |
| <b>6070</b>   | 0           | 3-week      |



# Forecast Available Water

Feb 3 CBRFC Forecast

| Original Method |        |        |        |
|-----------------|--------|--------|--------|
| Current         | MIN    | MOST   | MAX    |
| 2015            | 0      | 1-week | 1-week |
| 2016            | 1-week | 1-week | Full   |

| Proposed Method |        |        |        |
|-----------------|--------|--------|--------|
| 2015            | MIN    | MOST   | MAX    |
| 6030            | 0      | 2-week | Full   |
| 6040            | 0      | 86,000 | Full   |
| 6050            | 0      | 0      | 3-week |
| 6060            | 0      | 0      | 2-week |
| 6070            | 0      | 0      | 76,000 |
|                 |        |        |        |
| 2016            | MIN    | MOST   | MAX    |
| 6030            | 2-week | Full   | Full   |
| 6040            | 76,000 | Full   | Full   |
| 6050            | 0      | Full   | Full   |
| 6060            | 0      | 3-week | Full   |
| 6070            | 0      | 3-week | Full   |

EWYST

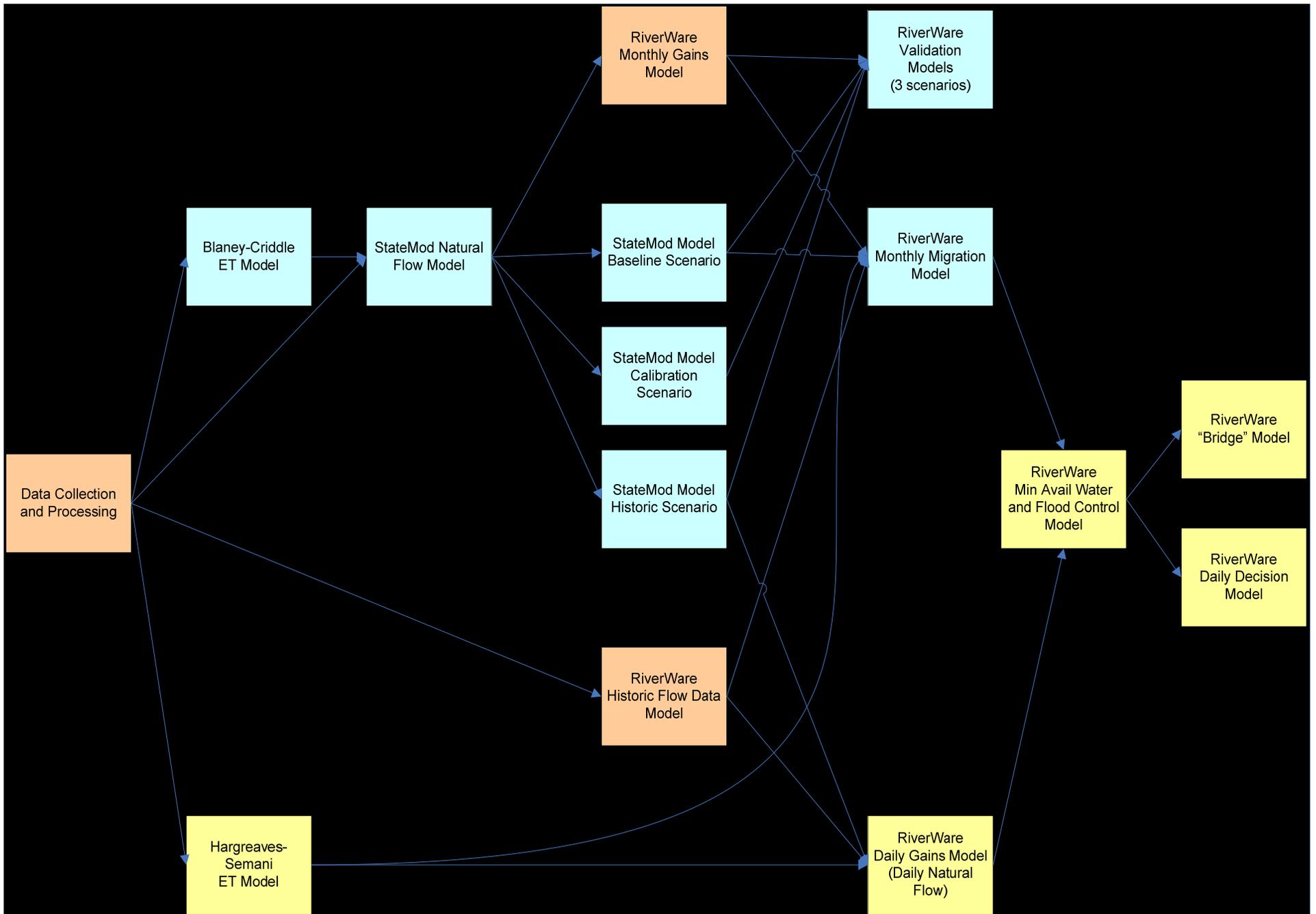
EWYST

# Baseline Hydrology Model Update

Feb 2015

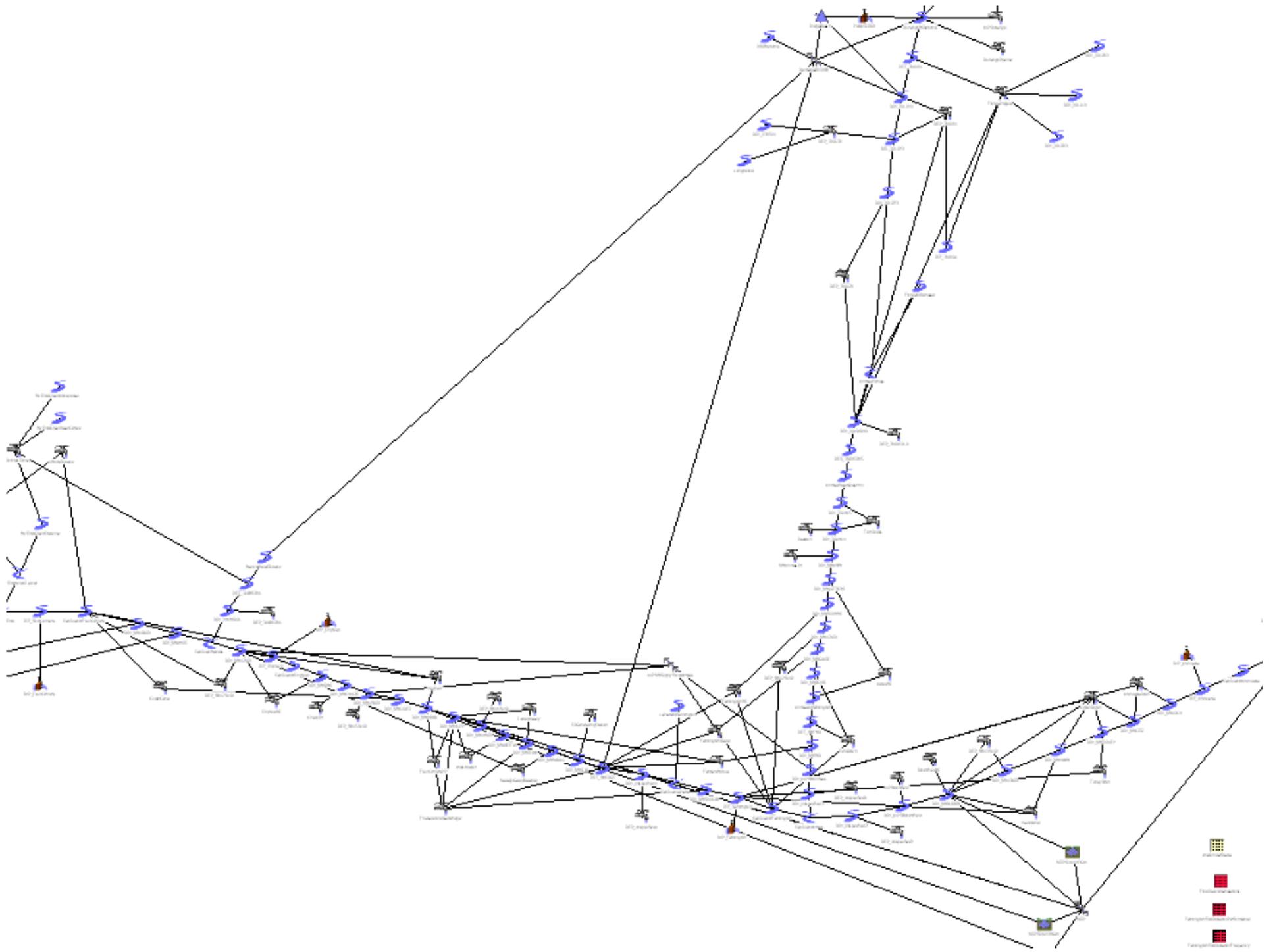
# Past

- Gen 2- Monthly Timestep Model
- Gen 3- Multi-modal approach, conversion to daily timestep for application to flow recommendations
  - Difficult to maintain
  - Impractical to operate
- Gen 4- Simplification process began
  - Use StateMod natural inflows.
  - States provide their own ET data and Irrigated Acres (ET-AC).
  - Riverware calculates depletions (implemented upstream of Navajo). Everything above Navajo consolidated to Pine, Piedra, and San Juan.



# Present

- ET-AC method being implemented downstream of Navajo.
  - Implementation underway
    - CO- Ray Alvarado retired. Andy Moore is coordinating data delivery. State has database issues- delaying update of western slope models. Mid-March soonest for Natural Flow data.
    - NM- Coordination with ISC.
- Further simplifications for user
  - Riverware updates and improvements to simplify interface for transparency and ease of facilitating data updates. Will not change calculations or results.
  - Documentation underway



# Future

## Timeline

- Updated Natural Flow data (StateMod runs) and ET-AC data from States- Mid March 2015
- Implementation of ET-AC downstream of Navajo- Spring 2015
- Potential HBWG Meeting- Spring 2015
- Calibrate over incidental losses- Spring/Summer 2015
- Hydrology Annual Meeting – Summer 2015
- Further simplifications to user interface and model transparency- Summer 2015
- Documentation- Summer 2015
- Review- Summer/Fall 2015
- Loose ends- end of Fiscal Year 2015

