“Yuba Accord Plus”

FWN conceptual flow construct for lower Yuba flows consistent with Delta Flow Criteria

Chris Shutes
CA Sportfishing Protection Alliance
Foothills Water Network
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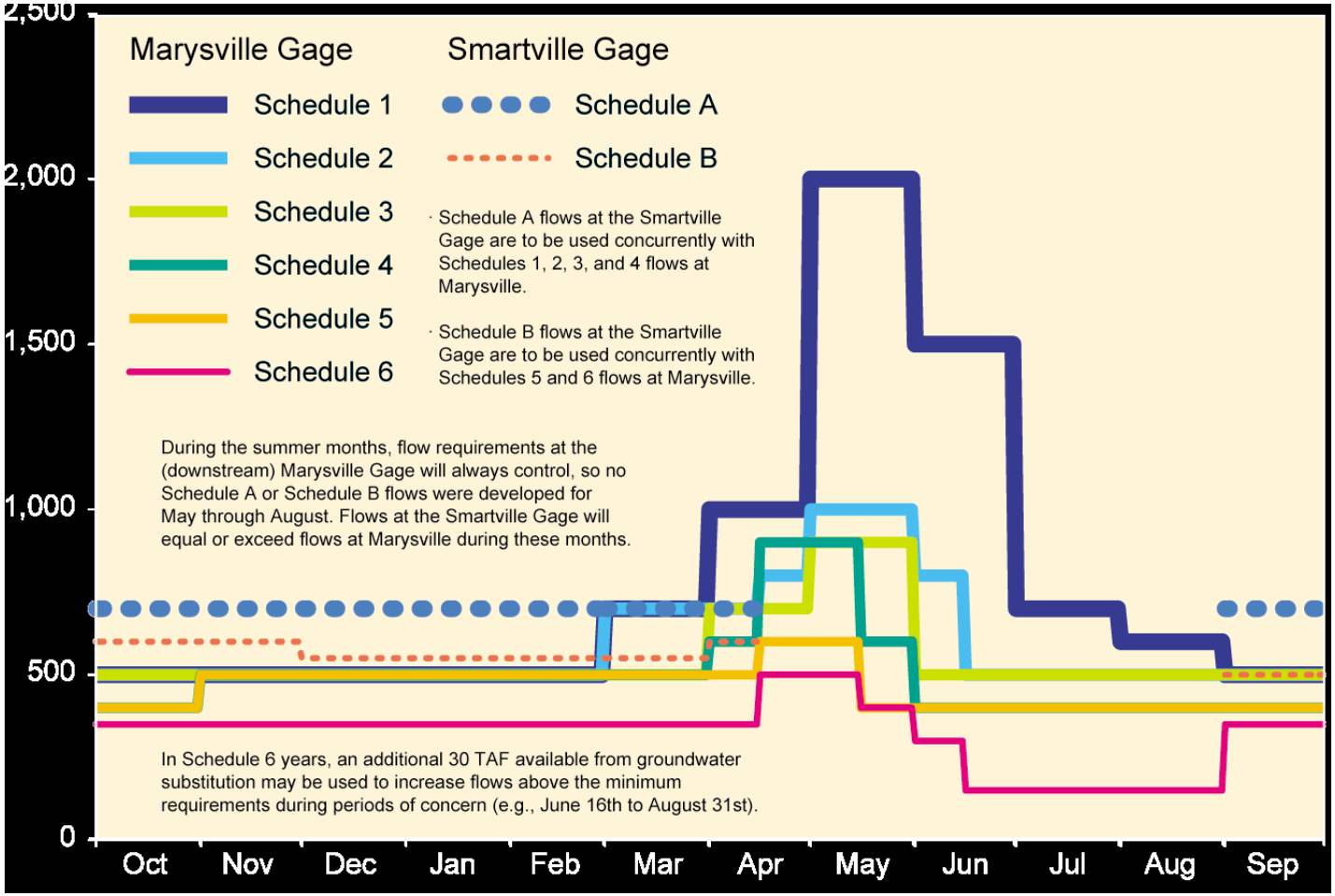
Yuba Accord 2007 (from 2011 YCWA PowerPoint)

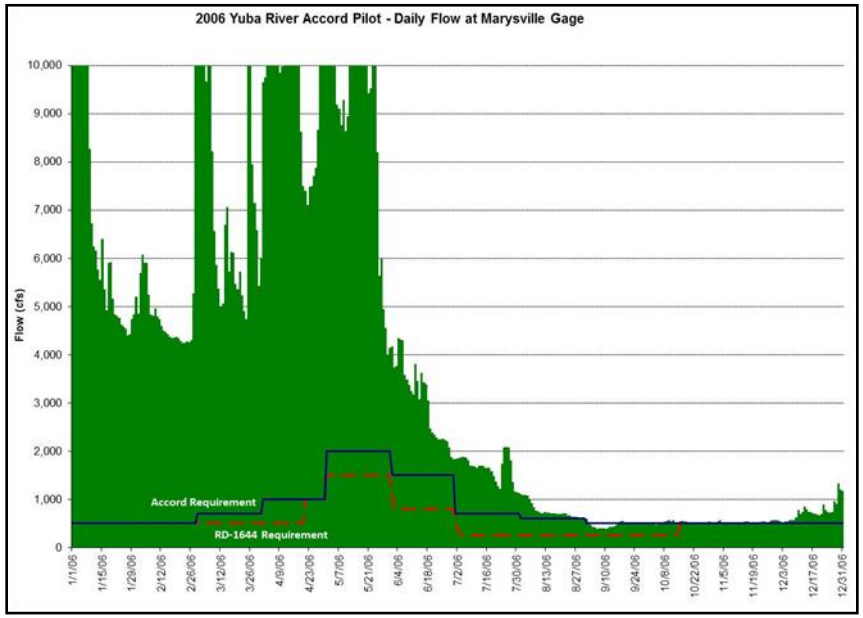
- *As long as flow is maintained in the lower Yuba River, temperatures will be within acceptable limits, as New Bullards Bar Reservoir has a large supply of cold water*
- *Natural flow alone is not enough to protect fish on the lower Yuba River in drier times of the year and in dry years: New Bullards Bar Reservoir stored water is needed to augment flows*

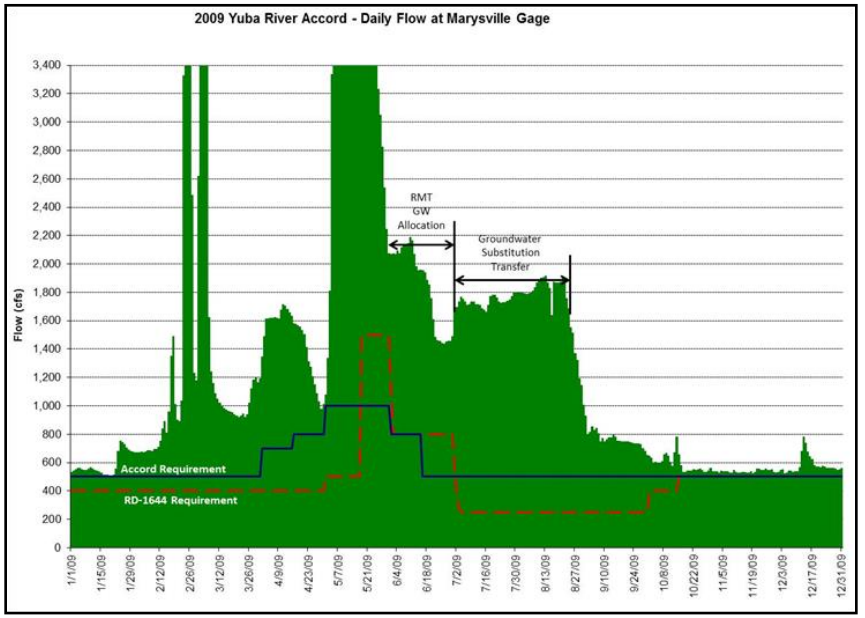
1. Maximize the number of years with "range of optimal flows" (schedule 1 and 2 years)
2. Preserve wet year storage to bolster dry year flows
3. Allocate all available water to instream flows for each schedule year, preserving the principles of 1 and 2
4. Augment the driest years (schedule 6) with conjunctive use/groundwater substitution pumping
5. Operate a conjunctive use program to firm up water supplies and to augment instream flows

Yuba Accord flows (from 2011 YCWA PowerPoint)



Yuba Accord required flows v. actual flows (from RMT interim report)





2010: SWRCB publishes Delta Flow Criteria Report, which says on p. 5:

- In order to preserve the attributes of a natural variable system to which native fish species are adapted, many of the criteria developed by the State Water Board are crafted as percentages of natural or unimpaired flows. These criteria include:
- 75% of unimpaired Delta outflow from January through June;
- 75% of unimpaired Sacramento River inflow from November through June
- http://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/deltaflow/docs/final_rpt080310.pdf.

Delta Flow Criteria
Different focus than Yuba Accord

- Yuba Accord manages limited water to increase benefits: cold water, physical habitat, May pulse, avoid dewatering of redds
- Yuba Accord direct benefits end at Marysville
- Delta Flow Criteria manage high flows to increase benefits: variability, migration cues, recession rate, floodplain inundation
- Delta Flow Criteria benefits extend past Sherman Island, for Yuba fish and for fish from other watersheds, esp. if other rivers also contribute

YCWA Modeling of Delta Flow Criteria

- YCWA's sophisticated and flexible water balance model allows careful analysis
- February-April 2011: YCWA presentations about effects of Delta Flow Criteria on Yuba Accord, including modeling of Lower Yuba
- April, 2012: YCWA files letter with SWRCB about Delta Flow Criteria and Yuba Accord, changing assumptions in modeling of Lower Yuba

FWN Modeling of Delta Flow Criteria

- October, 2013: YCWA declines CSPA request in relicensing for modeling of Lower Yuba flow scenarios structured on Delta Flow Criteria
- November 2013 – July 2014: FWN performs multiple iterations of model runs
- DFW staff provides technical support
- HDR staff provides limited technical support
- Technical support in no way implies agreement with the conceptual approach; product is FWN's alone

YCWA modeling of Delta Flow Criteria 2011: assumptions

- Release 75% unimpaired at Marysville from November through June
- Release Yuba Accord flows in July-October (Schedules would change July-Oct, lowering flows)
- Upstream diversions and reservoirs would also have to release 75% of unimpaired.

YCWA modeling of Delta Flow Criteria 2011 take homes (from YCWA P. Point)

- Increases March through June Yuba outflow, but mostly April and May
- Decreases summer and fall flows generally, and substantially in the driest 12% of years
- Increased outflow is mainly due to substantial reduction in out of upper basin diversions to the Bear and American River watersheds
- Depletes New Bullards Bar Reservoir Storage in most Critical years

YCWA 2011 modeling additional impacts described

- Reduces irrigation deliveries in most years; greater than 20% shortages in ½ of all years. Some of this is due to shorting irrigation when outlet capacity is too small to meet flow
- Reduced summer flows from reduced storage elevates temperatures
- “Extremely” elevated temps in 1 of 8 years
- Return to groundwater overdraft

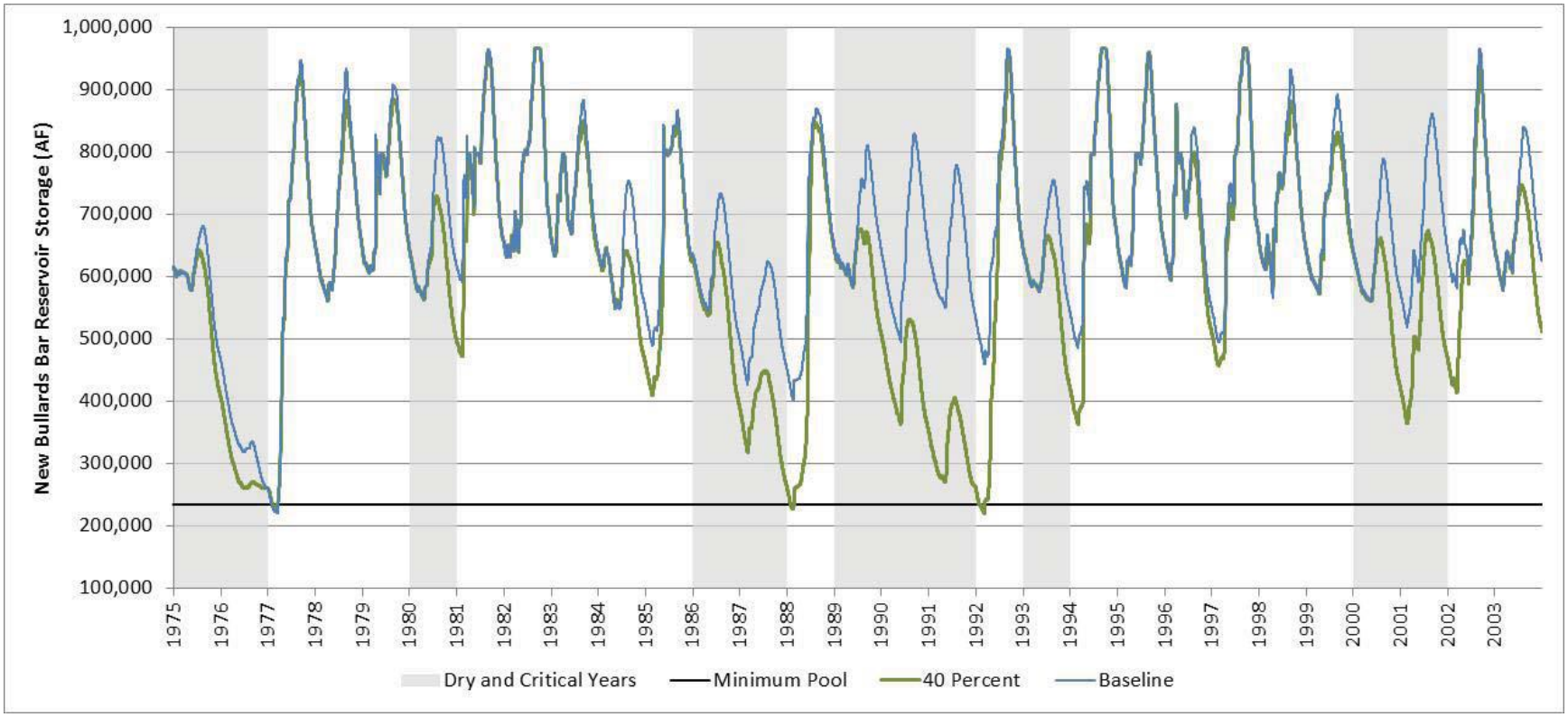
YCWA modeling of Delta Flow Criteria 2012

- Release 40% or 50% Yuba River unimpaired as Yuba River outflow January through June, or Yuba Accord requirement, whichever is greater
- Release Yuba Accord required flow July-Dec.
- “Assume that the SWRCB would not impose any of the burdens of implementing new Yuba River outflow criteria on the upstream projects”
- Releases limited by capacity of release works
- Irrigation deliveries shorted to make up all or part of flows if release works can’t fully meet both required flow and irrigation deliveries

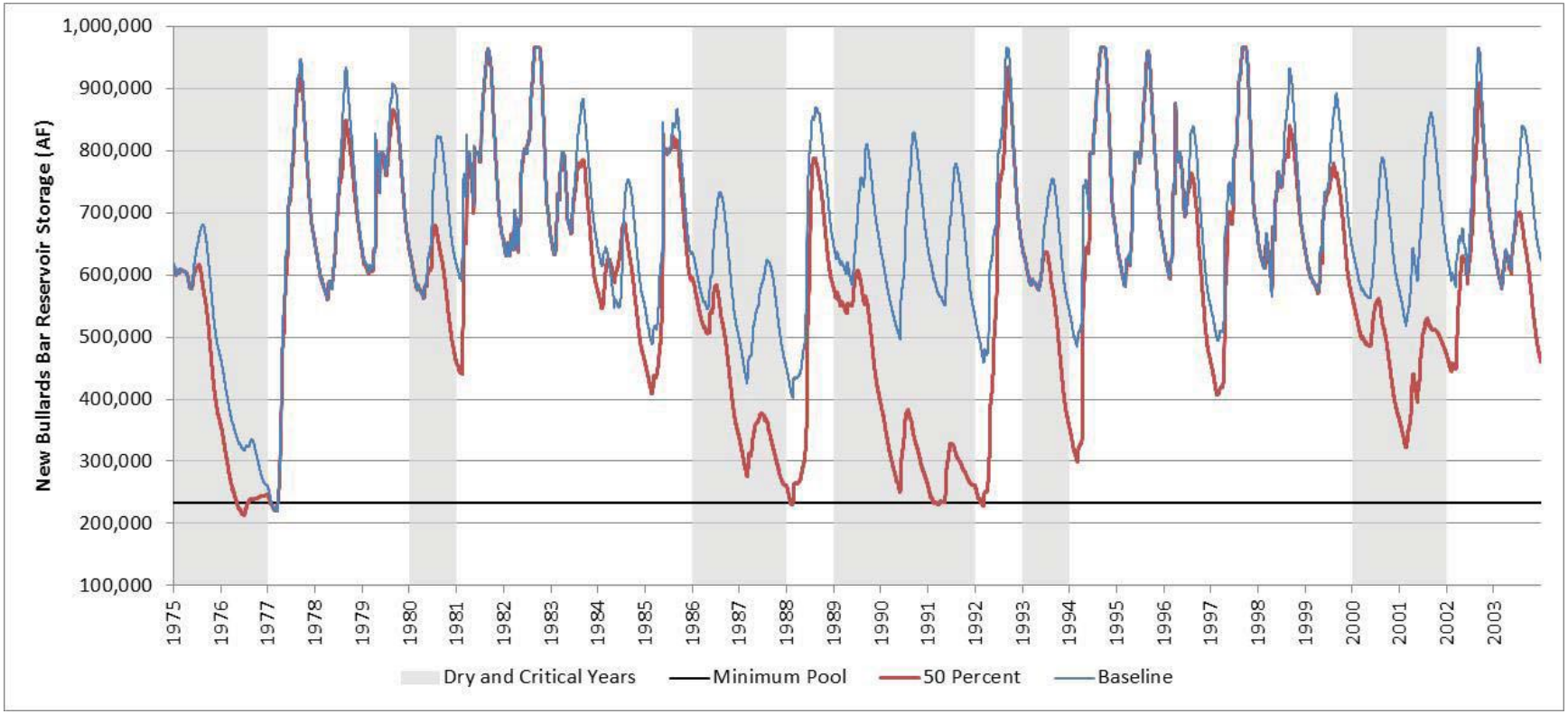
YCWA 2012 modeling: take home

- Significant flow increase over Yuba Accord only in April and May. Small increase in March and June in wetter years; small decrease in drier years. Some flow decrease in some years in January and February

YCWA modeling 2012 take home: Lower storage in Dry and CD years (from YCWA PowerPoint)



YCWA modeling 2012 take home: Lower storage in Dry and CD years (from YCWA PowerPoint)



FWN modeling 2013

- First task: get the model to run
- 1977 blows up model; start model runs in 1978 until issues with 1977 could be resolved
- Start with 30% & 40% of Jan-June unimpaired or Yuba Accord flows, whichever is higher
- Assume no added contribution from upstream projects
- Primary DSS metrics: Bullards storage, Marysville flow, irrigation shortages
- Other metric: generation impacts post-processor, especially shift in timing, using Smartsville water year type index from YBDS

Initial results and observations

- Similar conclusions as YCWA 2012 modeling for 40% Jan-June unimpaired
- Bullards storage much lower in Dry and CD yrs
- Generation shift to March and April, and February in drier years; little in AN and Wet yrs
- Not a lot of shift in Marysville flow in wetter years
- Pattern of unimpaired already present in reduced magnitude because of runoff from South Yuba and Deer Creek; shape of South Yuba and lower Yuba hydrographs similar Jan-June

Refinements

- Eliminate January from percent of unimpaired requirement so that water year type can be adjusted monthly with Bulletin 120
- Use Yuba Accord schedule for water year type
- Adjust model so that Yuba Accord schedule adjusts each month starting February
- Evaluate different percentages of unimpaired for different Yuba Accord schedules (WY type)

New model run iterations: Concepts

- Identify drier year schedule range for reduced percent of unimpaired
- Identify Yuba Accord schedules (WY) in which percent of unimpaired busts the system
- Iterate different percentages of unimpaired for wetter years.

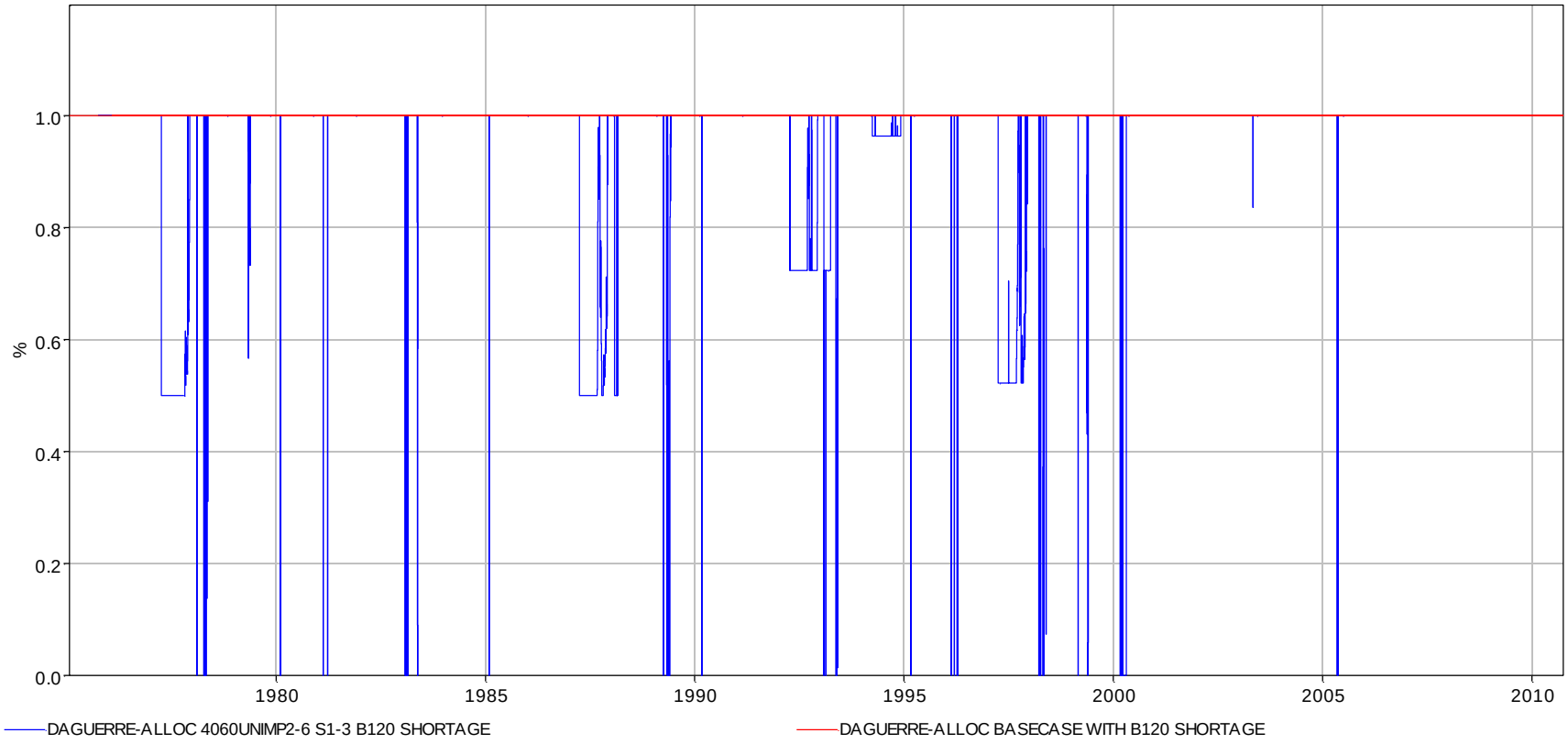
New model run iterations: Decisions

- 40% of Feb-Jun unimpaired appears sustainable for Schedules 2 and 3 (25%/12% total 37% of all years in period of record)
- Schedules 4-6 and conference years (13% of all years) cannot absorb higher flow requirements than Yuba Accord
- Evaluate 40%, 50%, 60% and 75% in Schedule 1 years (50% of all years)
- Cap percent-of-unimpaired flow requirement at 10,000 cfs

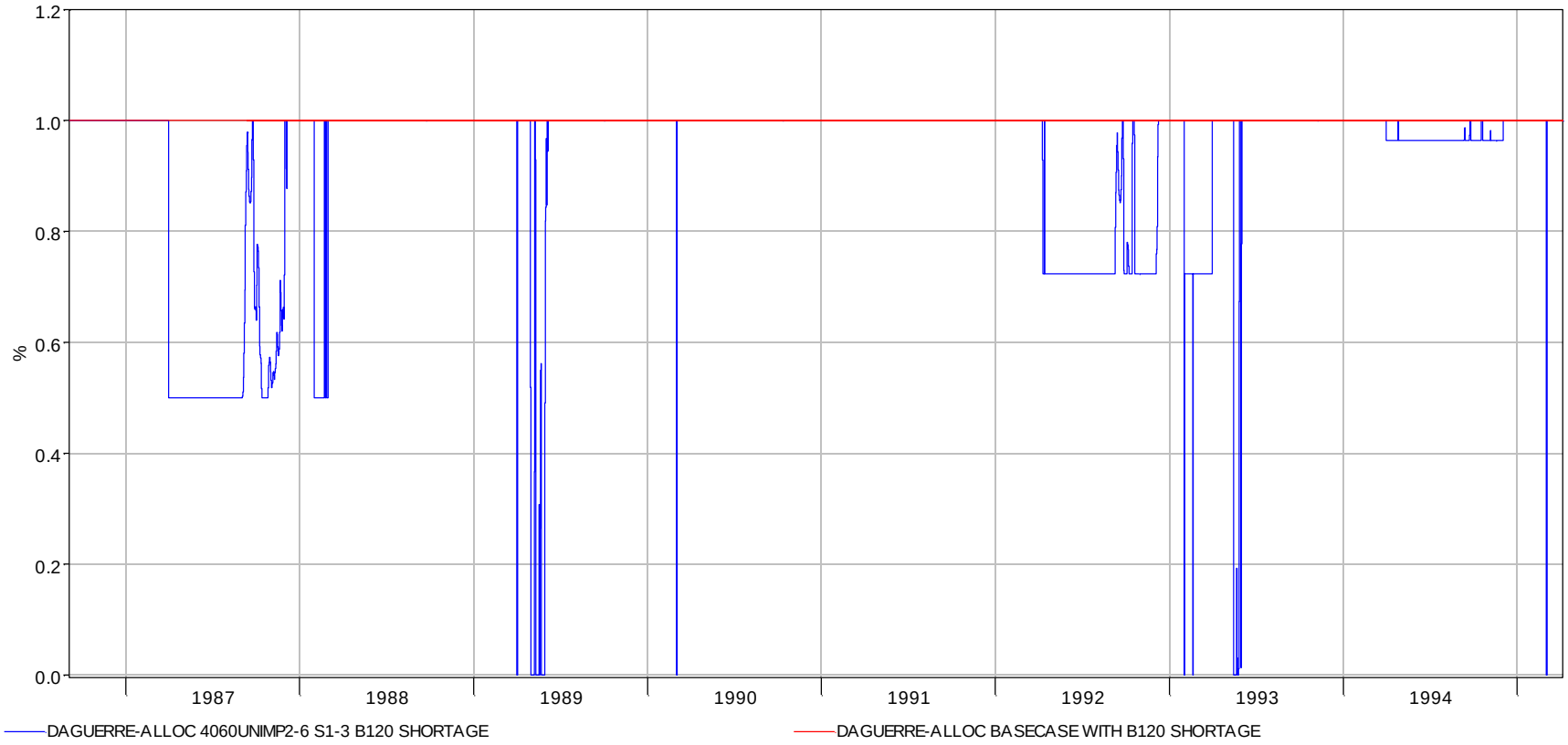
Outputs from 50 % - 60% - 75% runs: Irrigation Shortages General Notes

- Chatter in irrigation shortage graphs from model trying to meet flows with insufficient outlet capacity
- Chatter corresponds to a flow range where facilities cannot meet flow requirement
- Irrigation shortages also occur when Bullards hits minimum pool (1977 only, also in base case); and where full deliveries don't allow model to meet Bullards target storage

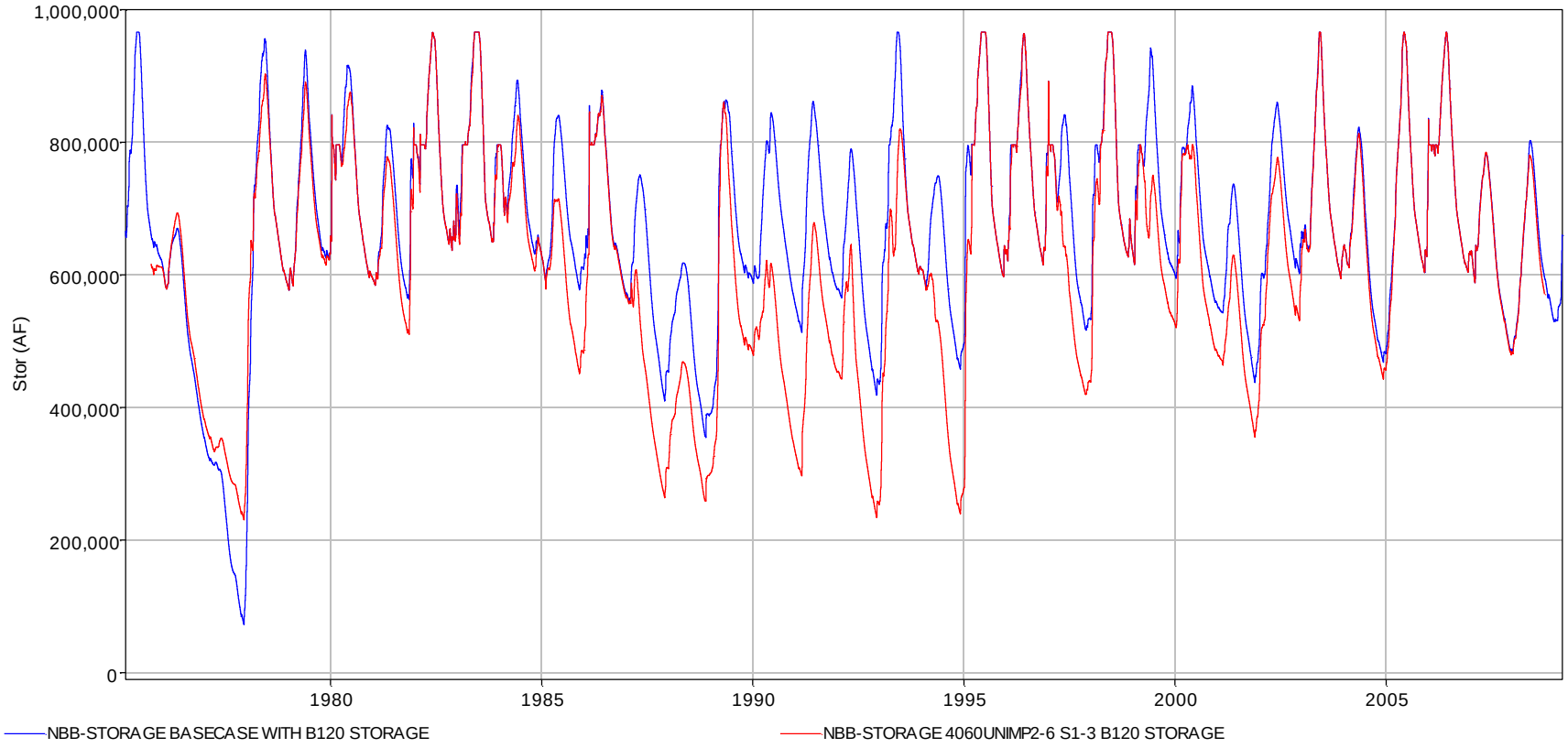
Representative Output from 60% run: Irrigation Shortages



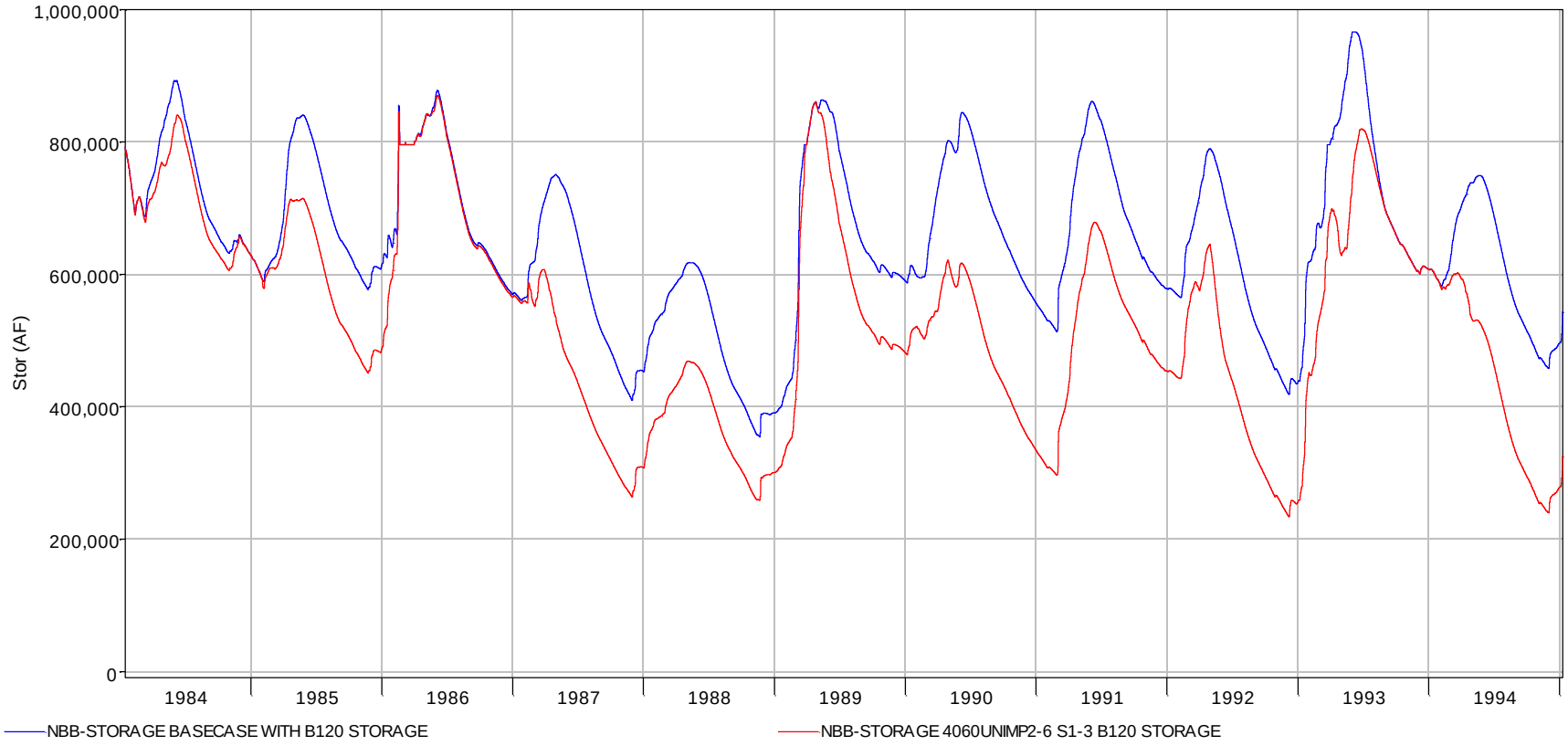
Outputs from 60% run: Irrigation Shortages 1987-1994



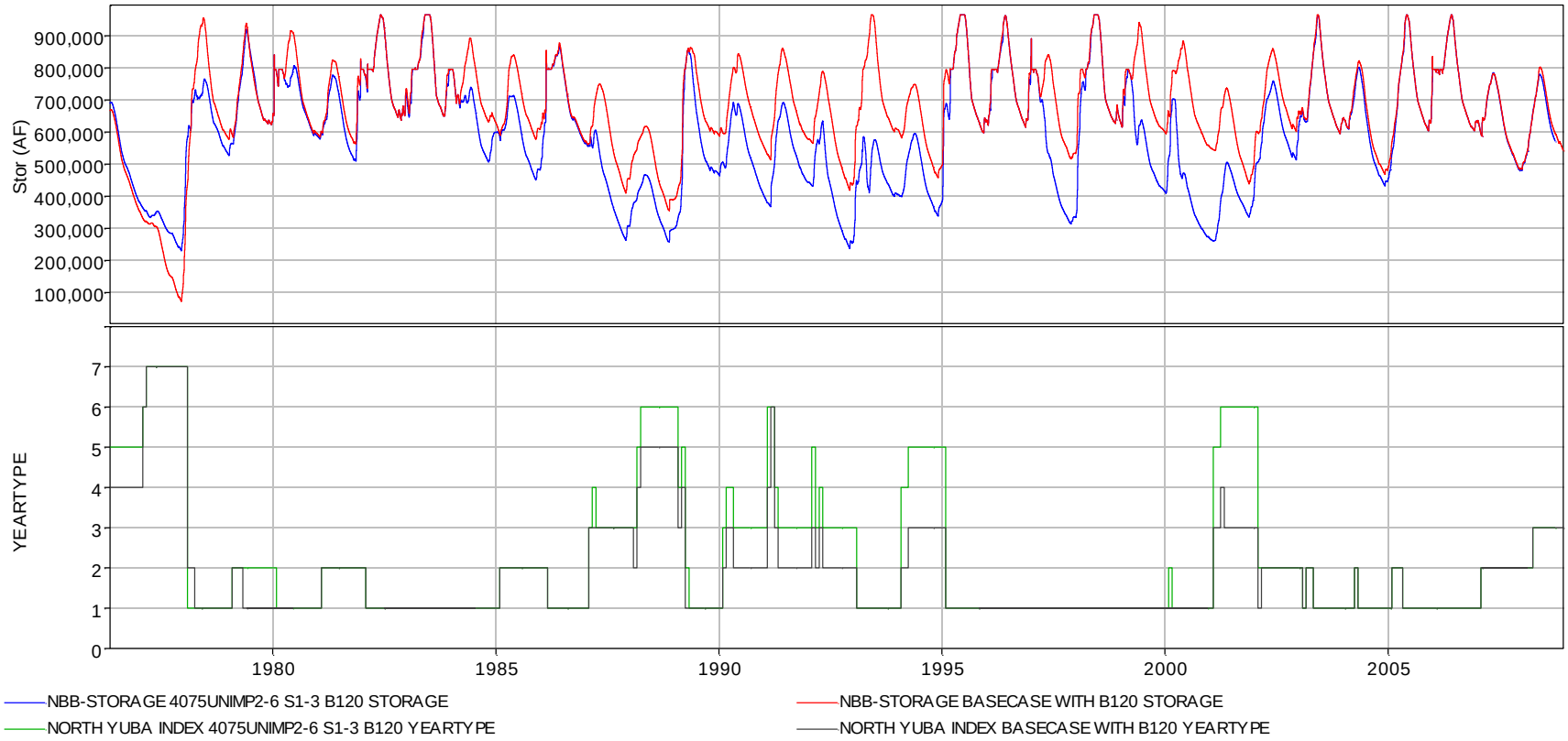
Representative Output from 60% run: Bullards storage



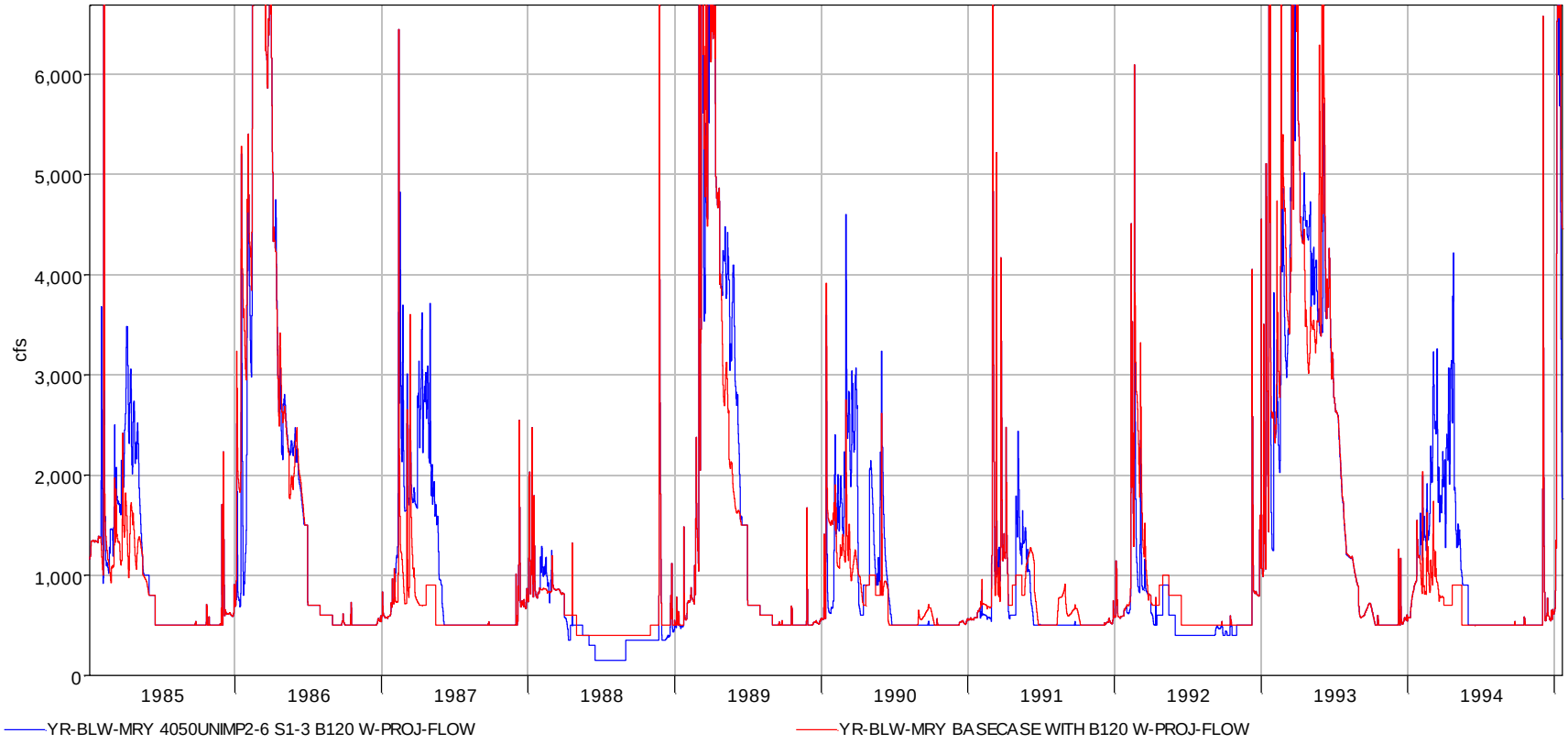
Outputs from 60% run: Bullards storage 1984-1994



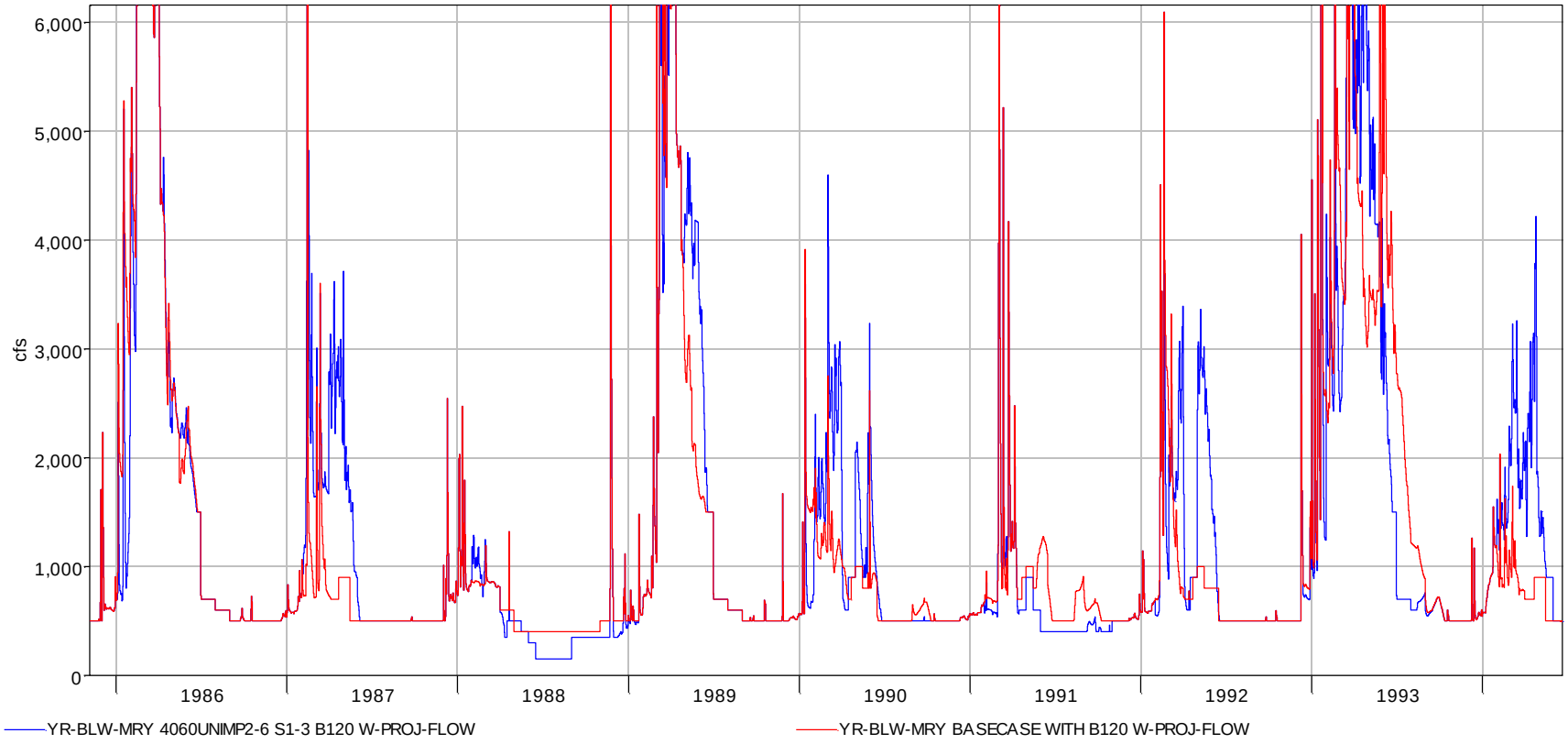
Outputs from 75% run: Bullards storage



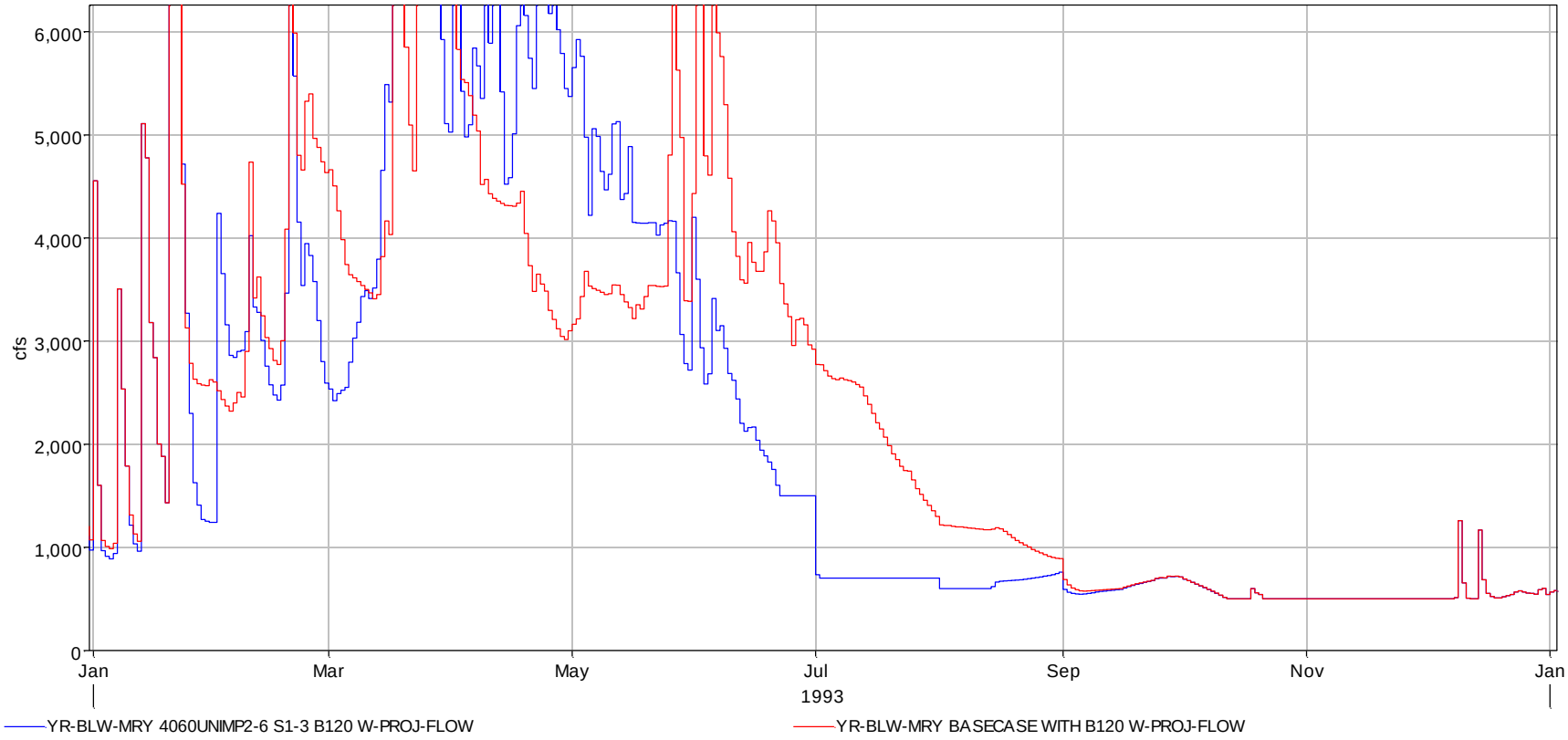
Outputs from 50% run: Marysville flow



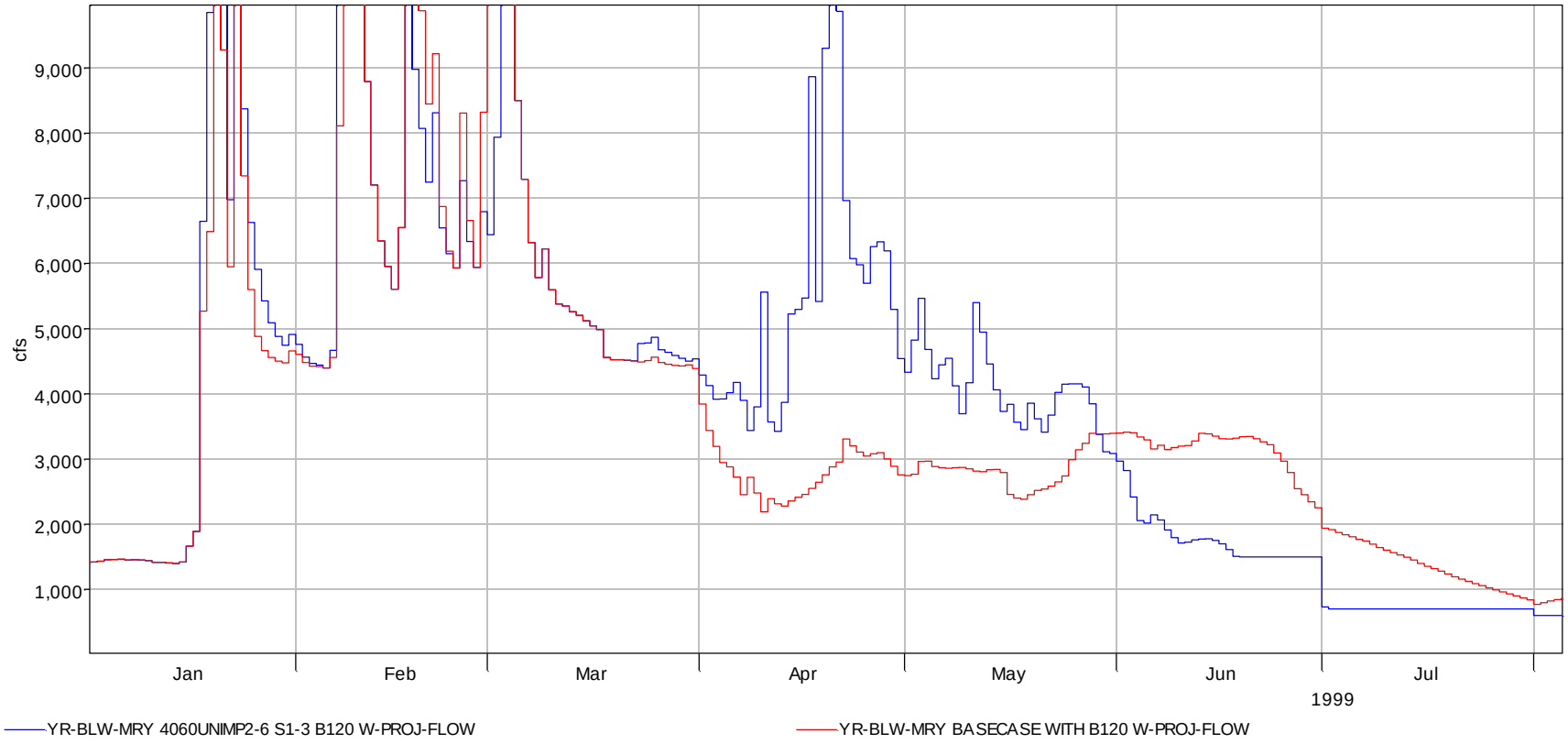
Outputs from 60% run: Marysville flow



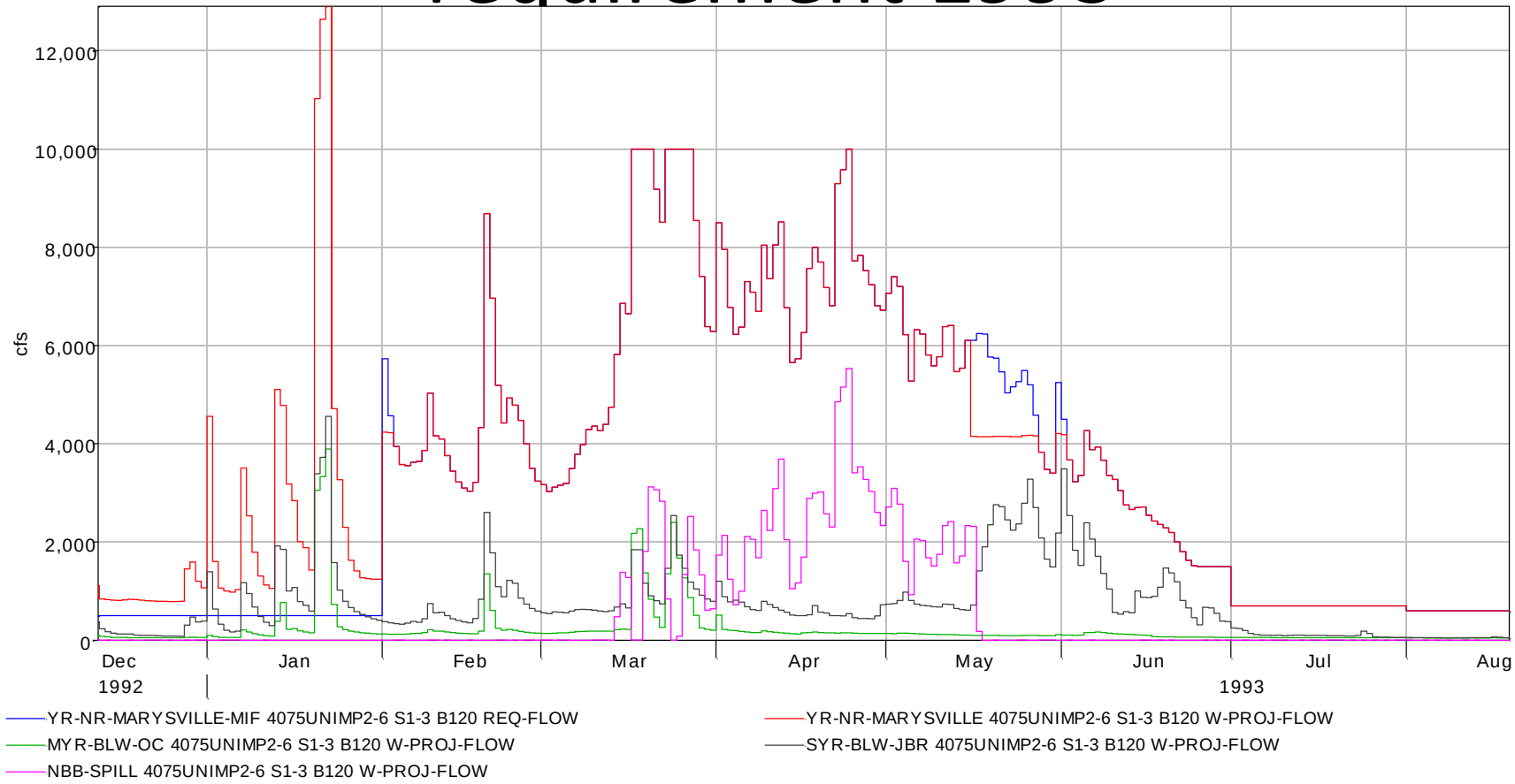
Outputs from 60% run: Marysville flow 1993 recession



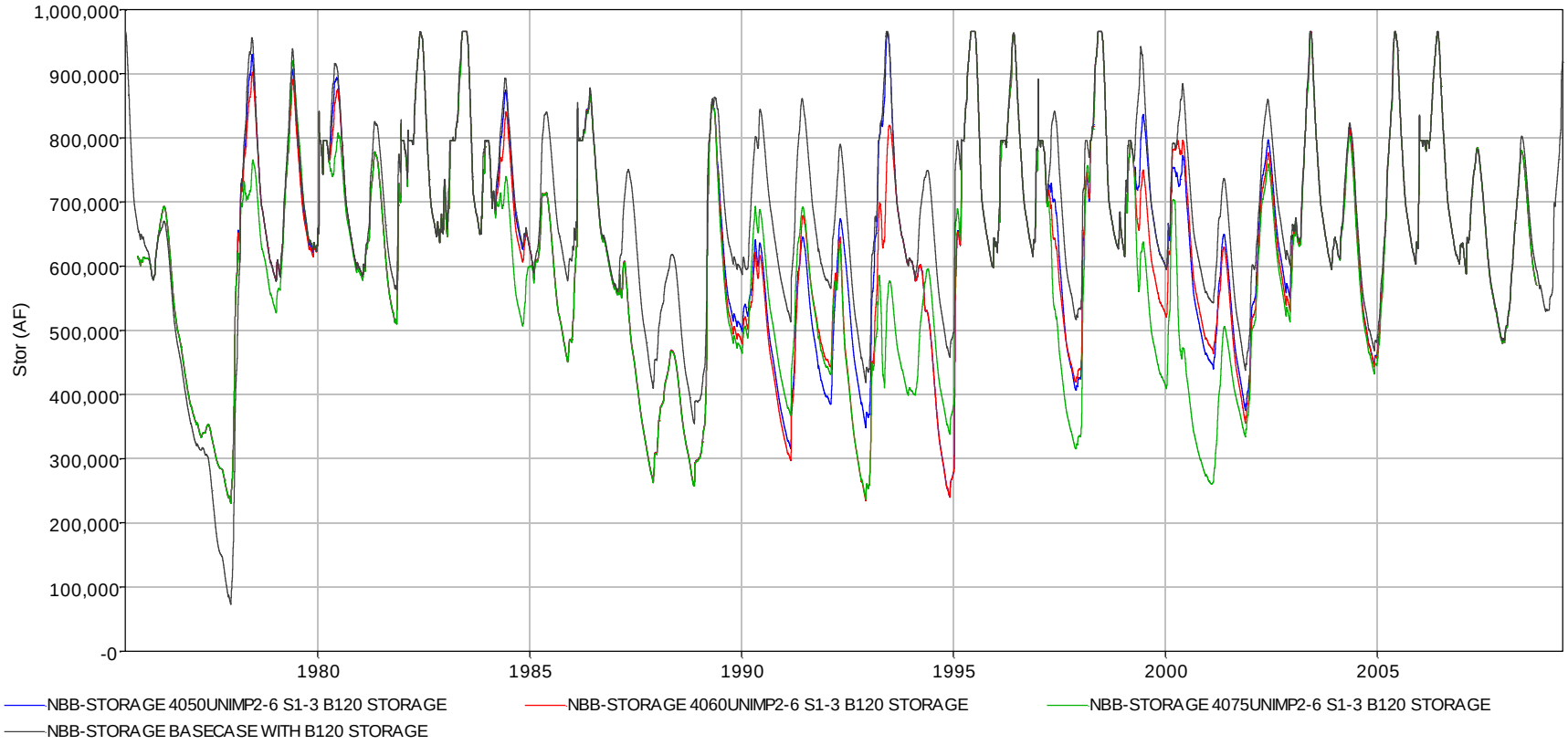
Outputs from 60% run: Marysville flow 1999 floodplain inundation, recession, generation shift



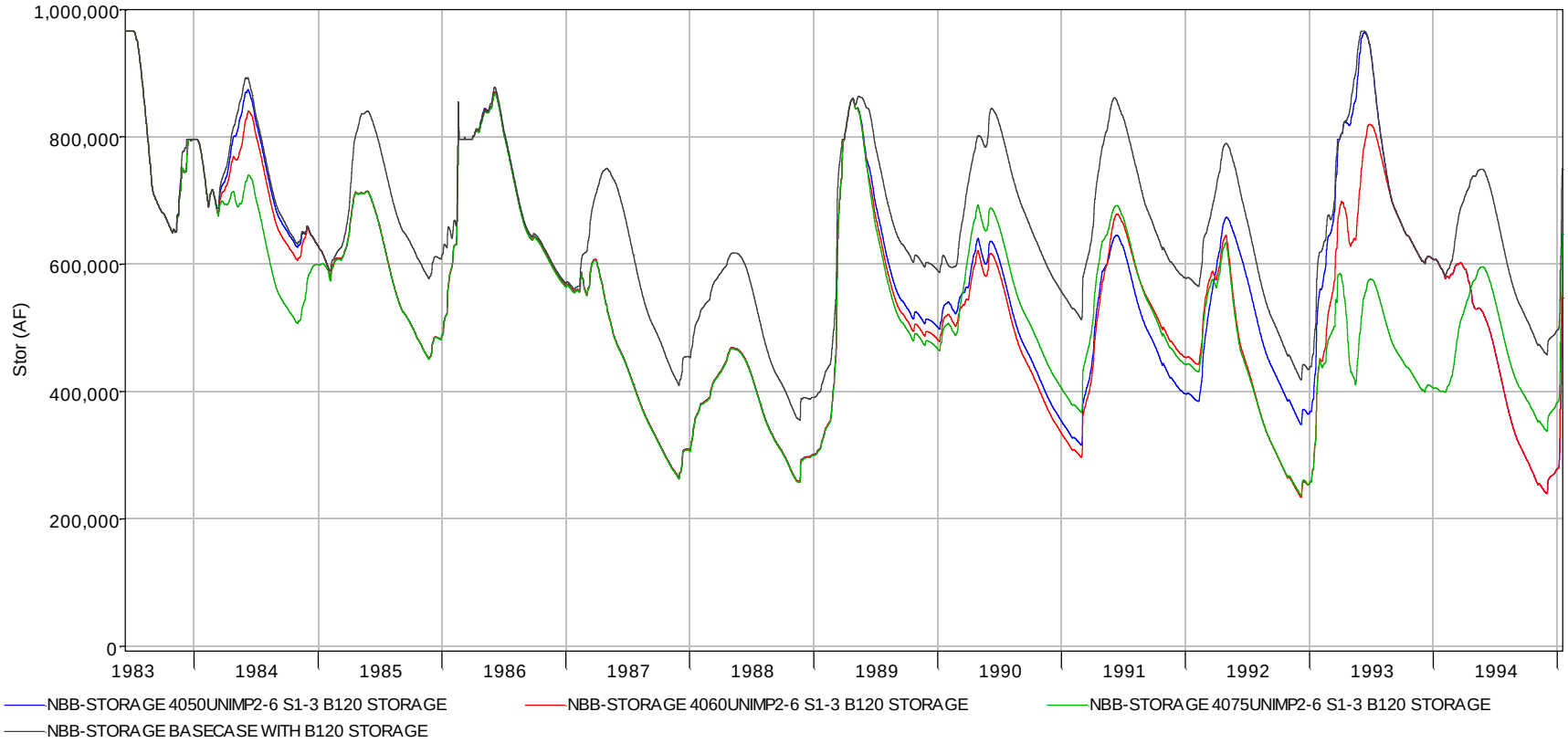
Outputs from 75% run: Where project can't meet flow requirement 1993



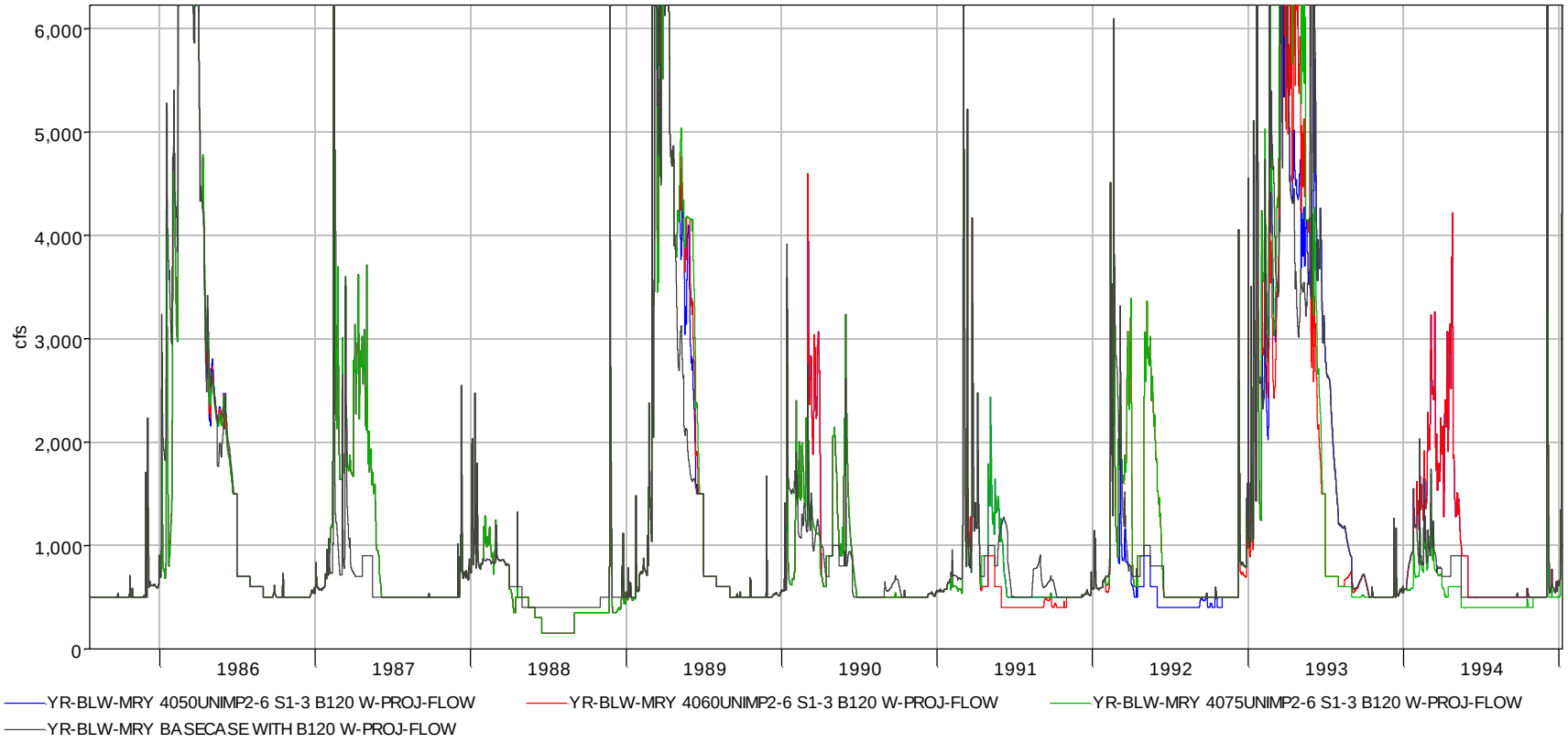
4 run comparison: Bullards storage



4 run comparison:
Bullards storage 1984-1994



4 run comparison: Marysville flow



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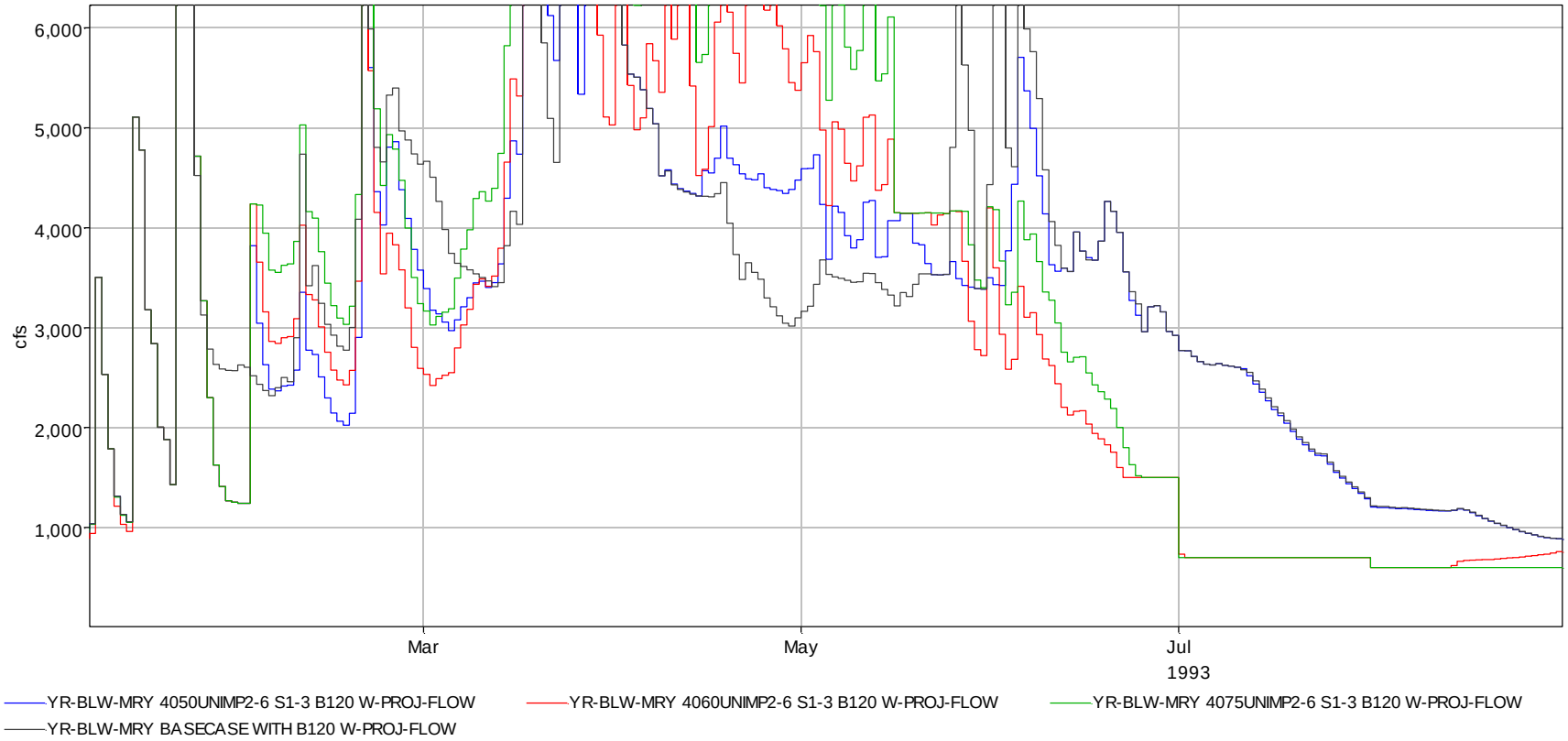
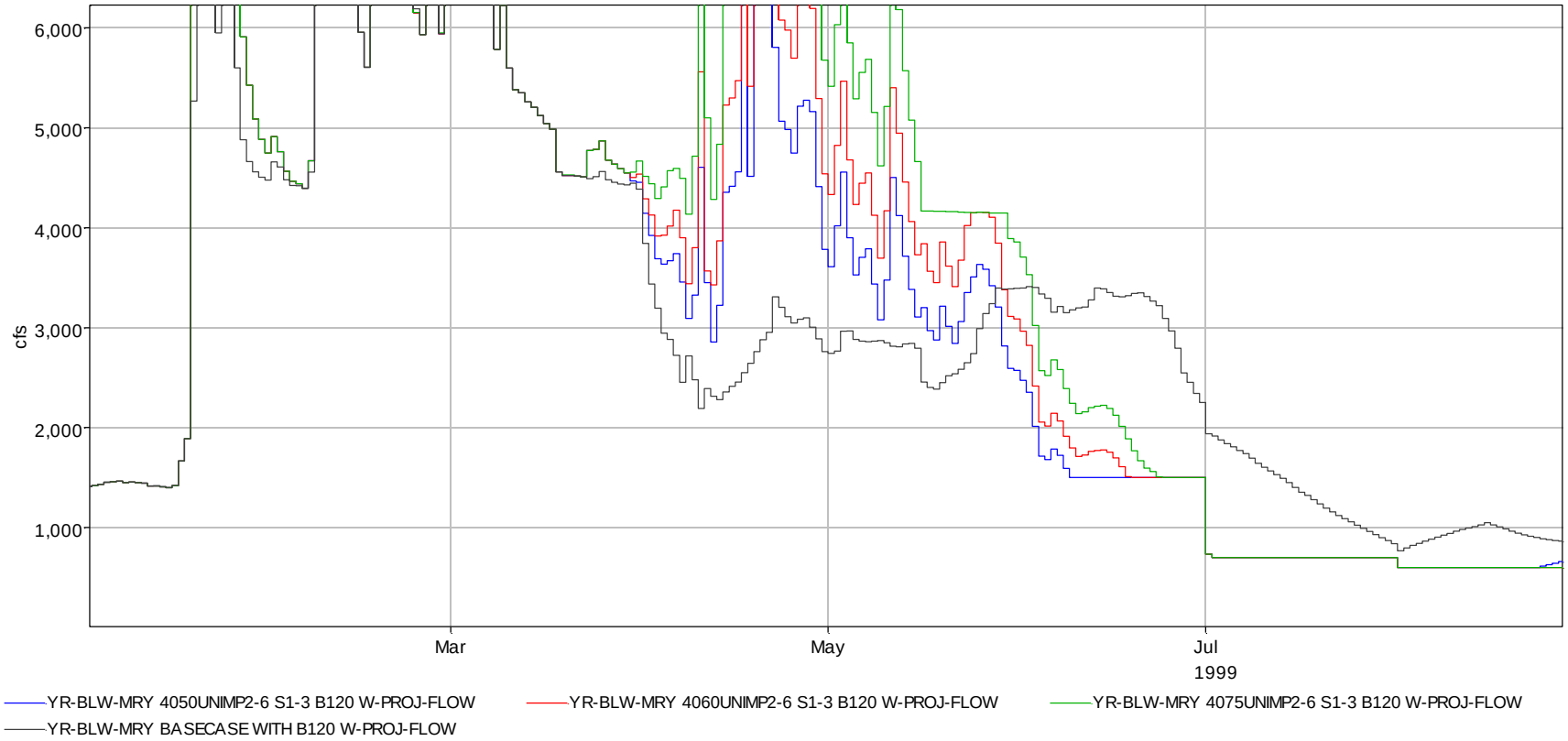


4 run comparison: Marysville flow 1999



Generation shift: 50%-60%-75% runs

New Colgate Powerhouse Generation (Average Monthly MWh)

	Wet			Above Normal			Below Normal			Dry			Critical			Extremely Critical			Average All Years		
Month	Base	Alt	Change	Base	Alt	Change	Base	Alt	Change	Base	Alt	Change	Base	Alt	Change	Base	Alt	Change	Base	Alt	Change
October	51,675	49,675	-3.9%	49,299	47,665	-3.3%	53,132	50,946	-4.1%	50,979	47,417	-7.0%	49,339	47,135	-4.5%	44,698	45,185	1.1%	50,546	48,260	-4.5%
November	56,885	52,506	-7.7%	54,801	53,536	-2.3%	44,478	44,064	-0.9%	48,700	45,430	-6.7%	51,921	44,555	-14.2%	45,705	46,602	2.0%	52,166	49,188	-5.7%
December	104,337	102,920	-1.4%	68,759	64,025	-6.9%	31,975	31,854	-0.4%	43,649	42,135	-3.5%	40,380	35,757	-11.4%	38,623	38,273	-0.9%	63,699	61,209	-3.9%
January	167,068	140,228	-16.1%	97,896	94,756	-3.2%	66,324	64,860	-2.2%	45,057	40,555	-10.0%	49,651	46,231	-6.9%	34,671	29,753	-14.2%	91,082	81,898	-10.1%
February	202,039	193,634	-4.2%	127,360	141,911	11.4%	58,712	55,545	-5.4%	38,209	41,047	7.4%	24,358	56,408	131.6%	35,301	22,241	-37.0%	102,603	107,568	4.8%
March	223,360	222,044	-0.6%	163,846	152,572	-6.9%	80,296	82,645	2.9%	24,737	36,446	47.3%	16,911	60,678	258.8%	37,667	39,149	3.9%	115,558	119,595	3.5%
April	185,866	202,476	8.9%	139,732	170,775	22.2%	82,128	108,320	31.9%	39,330	49,053	24.7%	48,030	117,734	145.1%	15,607	15,349	-1.7%	106,199	130,054	22.5%
May	216,452	218,793	1.1%	196,850	196,137	-0.4%	173,145	165,618	-4.3%	99,588	101,305	1.7%	99,333	96,101	-3.3%	23,001	21,840	-5.0%	158,788	158,616	-0.1%
June	216,039	214,081	-0.9%	204,234	186,113	-8.9%	154,425	144,441	-6.5%	93,184	86,229	-7.5%	85,051	67,579	-20.5%	33,183	32,166	-3.1%	156,263	146,423	-6.3%
July	190,769	188,779	-1.0%	160,527	152,450	-5.0%	108,211	107,193	-0.9%	96,999	89,902	-7.3%	94,157	74,367	-21.0%	28,630	27,257	-4.8%	135,746	129,192	-4.8%
August	157,659	155,942	-1.1%	115,373	111,818	-3.1%	82,792	81,433	-1.6%	77,707	70,007	-9.9%	72,471	58,337	-19.5%	20,189	19,346	-4.2%	105,605	100,685	-4.7%
September	60,025	59,406	-1.0%	55,691	54,867	-1.5%	50,722	46,447	-8.4%	46,895	42,089	-10.2%	43,713	38,453	-12.0%	7,554	7,275	-3.7%	51,343	48,783	-5.0%
Average MWh/yr	1,832,174	1,800,482	-1.7%	1,434,368	1,426,624	-0.5%	986,338	983,367	-0.3%	705,033	691,615	-1.9%	675,315	743,334	10.1%	364,829	344,435	-5.6%	1,189,598	1,181,469	-0.7%

New Colgate Powerhouse Generation (Average Monthly MWh)

	Wet			Above Normal			Below Normal			Dry			Critical			Extremely Critical			Average All Years		
Month	Base	Alt	Change	Base	Alt	Change	Base	Alt	Change	Base	Alt	Change	Base	Alt	Change	Base	Alt	Change	Base	Alt	Change
October	51,675	49,093	-5.0%	49,299	46,589	-5.5%	53,132	50,781	-4.4%	50,979	46,769	-8.3%	49,339	47,104	-4.5%	44,698	45,185	1.1%	50,546	47,631	-5.8%
November	56,885	51,825	-8.9%	54,801	52,133	-4.9%	44,478	43,905	-1.3%	48,700	43,323	-11.0%	51,921	44,551	-14.2%	45,705	46,602	2.0%	52,166	48,051	-7.9%
December	104,337	102,892	-1.4%	68,759	61,902	-10.0%	31,975	31,808	-0.5%	43,649	41,868	-4.1%	40,380	35,754	-11.5%	38,623	38,273	-0.9%	63,699	60,546	-4.9%
January	167,068	141,385	-15.4%	97,896	88,223	-9.9%	66,324	64,777	-2.3%	45,057	40,642	-9.8%	49,651	46,180	-7.0%	34,671	29,753	-14.2%	91,082	80,409	-11.7%
February	202,039	194,528	-3.7%	127,360	137,870	8.3%	58,712	56,050	-4.5%	38,209	40,852	6.9%	24,358	56,401	131.6%	35,301	22,241	-37.0%	102,603	106,671	4.0%
March	223,360	224,194	0.4%	163,846	149,466	-8.8%	80,296	84,274	5.0%	24,737	50,364	103.6%	16,911	60,674	258.8%	37,667	39,149	3.9%	115,558	123,213	6.6%
April	185,866	206,635	11.2%	139,732	179,589	28.5%	82,128	105,922	29.0%	39,330	50,944	29.5%	48,030	117,712	145.1%	15,607	15,349	-1.7%	106,199	133,761	26.0%
May	216,452	218,902	1.1%	196,850	199,767	1.5%	173,145	170,266	-1.7%	99,588	107,131	7.6%	99,333	96,069	-3.3%	23,001	21,840	-5.0%	158,788	161,641	1.8%
June	216,039	211,426	-2.1%	204,234	167,112	-18.2%	154,425	141,277	-8.5%	93,184	85,085	-8.7%	85,051	67,543	-20.6%	33,183	32,166	-3.1%	156,263	139,994	-10.4%
July	190,769	185,754	-2.6%	160,527	137,292	-14.5%	108,211	106,810	-1.3%	96,999	87,227	-10.1%	94,157	74,328	-21.1%	28,630	27,257	-4.8%	135,746	123,557	-9.0%
August	157,659	153,439	-2.7%	115,373	106,754	-7.5%	82,792	81,114	-2.0%	77,707	68,094	-12.4%	72,471	58,311	-19.5%	20,189	19,346	-4.2%	105,605	98,145	-7.1%
September	60,025	58,869	-1.9%	55,691	53,392	-4.1%	50,722	45,725	-9.9%	46,895	41,417	-11.7%	43,713	38,452	-12.0%	7,554	7,275	-3.7%	51,343	48,001	-6.5%
Average MWh/yr	1,832,174	1,798,942	-1.8%	1,434,368	1,380,090	-3.8%	986,338	982,710	-0.4%	705,033	703,716	-0.2%	675,315	743,079	10.0%	364,829	344,435	-5.6%	1,189,598	1,171,619	-1.5%

New Colgate Powerhouse Generation (Average Monthly MWh)

	Wet			Above Normal			Below Normal			Dry			Critical			Extremely Critical			Average All Years		
Month	Base	Alt	Change	Base	Alt	Change	Base	Alt	Change	Base	Alt	Change	Base	Alt	Change	Base	Alt	Change	Base	Alt	Change
October	51,675	48,795	-5.6%	49,299	46,739	-5.2%	53,132	48,401	-8.9%	50,979	45,899	-10.0%	49,339	44,938	-8.9%	44,698	45,185	1.1%	50,546	46,948	-7.1%
November	56,885	52,295	-8.1%	54,801	53,050	-3.2%	44,478	43,332	-2.6%	48,700	39,569	-18.7%	51,921	43,241	-16.7%	45,705	46,602	2.0%	52,166	47,220	-9.5%
December	104,337	102,339	-1.9%	68,759	62,623	-8.9%	31,975	31,451	-1.6%	43,649	34,774	-20.3%	40,380	34,849	-13.7%	38,623	38,273	-0.9%	63,699	58,560	-8.1%
January	167,068	149,084	-10.8%	97,896	84,102	-14.1%	66,324	56,480	-14.8%	45,057	37,157	-17.5%	49,651	39,343	-20.8%	34,671	29,753	-14.2%	91,082	78,825	-13.5%
February	202,039	196,415	-2.8%	127,360	140,906	10.6%	58,712	51,191	-12.8%	38,209	39,012	2.1%	24,358	43,388	78.1%	35,301	22,241	-37.0%	102,603	105,824	3.1%
March	223,360	230,542	3.2%	163,846	155,506	-5.1%	80,296	85,060	5.9%	24,737	34,782	40.6%	16,911	30,107	78.0%	37,667	39,149	3.9%	115,558	119,442	3.4%
April	185,866	211,197	13.6%	139,732	184,657	32.2%	82,128	101,808	24.0%	39,330	51,225	30.2%	48,030	78,352	63.1%	15,607	15,349	-1.7%	106,199	132,374	24.6%
May	216,452	218,038	0.7%	196,850	201,913	2.6%	173,145	161,407	-6.8%	99,588	99,585	0.0%	99,333	83,825	-15.6%	23,001	21,840	-5.0%	158,788	158,040	-0.5%
June	216,039	207,431	-4.0%	204,234	155,136	-24.0%	154,425	138,105	-10.6%	93,184	86,268	-7.4%	85,051	67,197	-21.0%	33,183	32,166	-3.1%	156,263	135,762	-13.1%
July	190,769	181,112	-5.1%	160,527	117,395	-26.9%	108,211	104,803	-3.1%	96,999	89,882	-7.3%	94,157	74,350	-21.0%	28,630	27,257	-4.8%	135,746	117,549	-13.4%
August	157,659	149,470	-5.2%	115,373	92,842	-19.5%	82,792	88,245	6.6%	77,707	69,996	-9.9%	72,471	58,050	-19.9%	20,189	19,346	-4.2%	105,605	94,531	-10.5%
September	60,025	58,754	-2.1%	55,691	47,834	-14.1%	50,722	49,727	-2.0%	46,895	41,725	-11.0%	43,713	37,532	-14.1%	7,554	7,275	-3.7%	51,343	46,822	-8.8%
Average MWh/yr	1,832,174	1,805,473	-1.5%	1,434,368	1,342,704	-6.4%	986,338	960,010	-2.7%	705,033	669,873	-5.0%	675,315	635,171	-5.9%	364,829	344,435	-5.6%	1,189,598	1,141,897	-4.0%

Outputs from 50%-60%-75% runs: Marysville flow

- Project currently has limited control of flows in the ~4000-6000 cfs range (recession rates, duration, fluctuations) except during flood release/spill; generally a large drop when control of system is regained
- Must decide how to address “doughnut hole” where flows cannot be achieved
- Options to manage this flow range: do nothing, induce and control spill at Englebright, change outlet works, release more water down Middle Yuba

Outputs from 50%-60%-75% runs: Generation shift

- Moves generation into April; also March in Dry years; also February and March in CD years
- Issue SWRCB must address if percent of unimpaired is widely applied: utility companies must not flood market with power during high flow releases from rim dams

Outputs from 50%-60%-75% runs: Impacts to water sales

- Required flow cannot be sold
- Little to no water is sold in Wet years
- Little water is sold in AN years
- Less discretionary (generally summer) water available for sale outside of service area
- WQCP likely to reduce statewide volume of transfer water, increasing price of remaining water
- Water can be diverted at Freeport and Contra Costa Canal at some times Feb-June when Delta pumps are generally not available to serve transfers

Next steps

- Sensitivity analyses removing Schedule 3 from percent-of-unimpaired requirement
- Evaluate biological importance of 3000-8000 cfs and importance of recession through range
- Evaluate limitations of facilities in shaping recession in the 3000-8000 cfs range of flows
- Evaluate possible infrastructure improvements to allow more control over higher releases
- Evaluate how project could comply with percent-of-unimpaired requirement
- Evaluate range of water and power costs to YCWA
- Develop rules to eliminate irrigation shortages
- Temperature modeling of selected ops model runs

Summary: Yuba Accord Plus Modified Delta Flow Criteria

- Minimum flow benefits plus high flow benefits
- Preserves Yuba Accord benefits, especially in drier years
- Reduces water and power impacts of Delta Flow Criteria in dry years
- Allows greater Delta Flow benefits in wetter years
- Provides structure to high flows, management for fisheries & riparian recruitment
- Manages for Yuba River and for downstream
- Offers unified solution for multiple proceedings