Preliminary Climate Change Impacts Assessment for SWP and CVP Operations

Daniel Easton, P.E.

CALFED Science Conference

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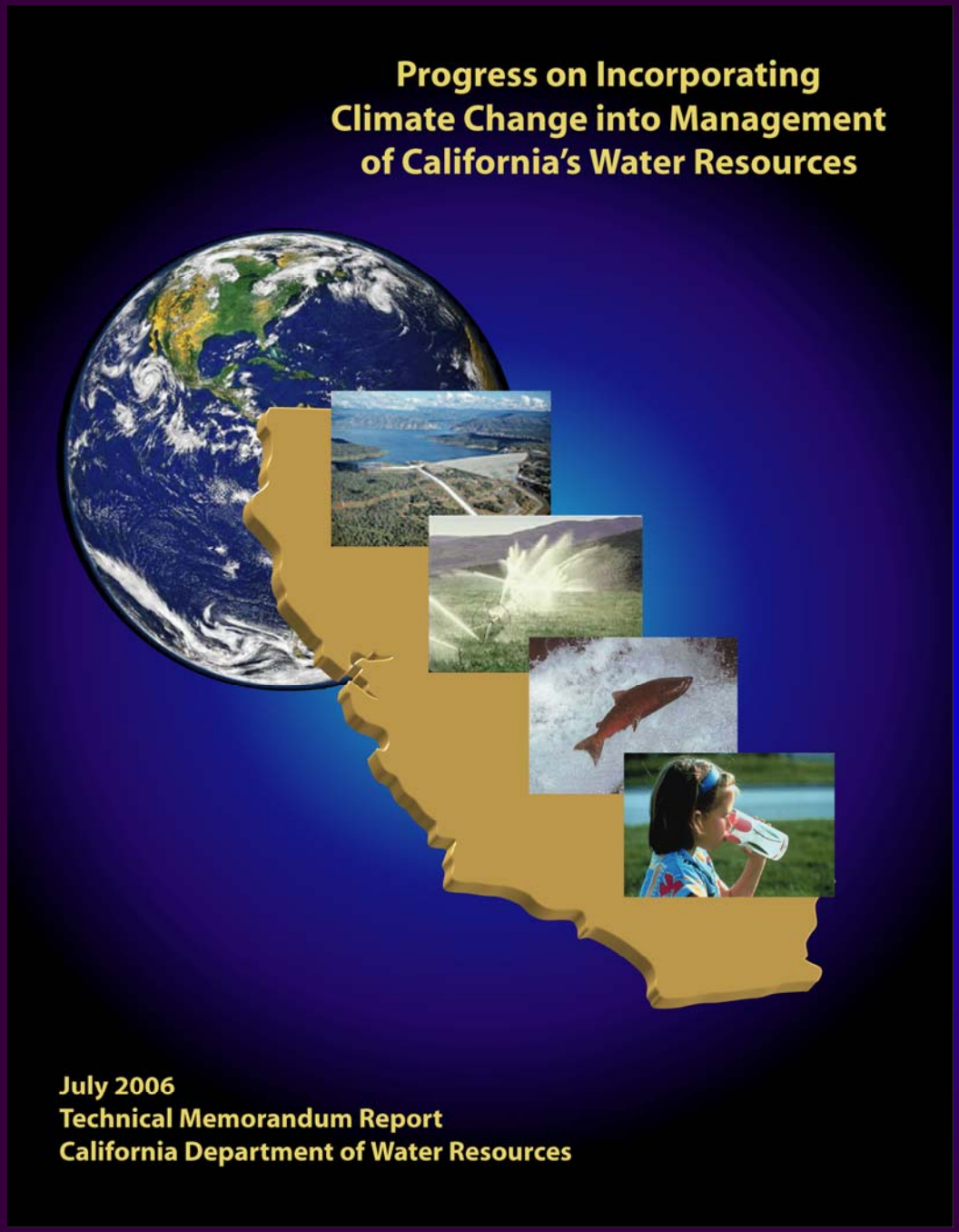
Modeling Support Branch
Bay Delta Office



CH1 Introduction

CH2 Background

CH3 DWR Studies

CH4 SWP-CVP Impacts

CH5 Delta Impacts

CH6 Flood Management

CH7 Evapotranspiration

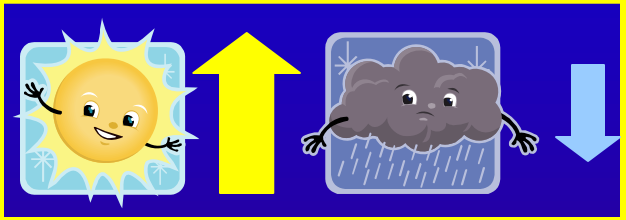
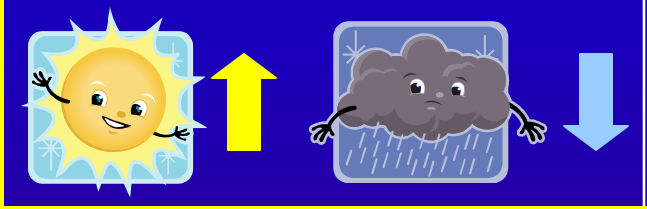
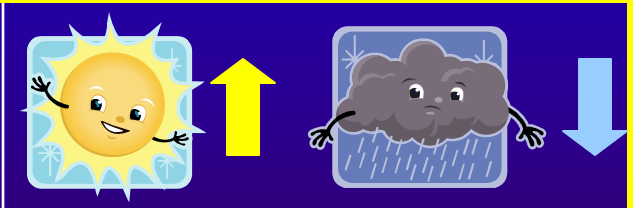
CH8 Future Directions


State Water Project
Central Valley Project
Local Projects
Shasta Reservoir
Redding
Oroville Reservoir
Folsom Reservoir
Sacramento
Delta
San Francisco
San Luis Reservoir
Fresno
Los Angeles
San Diego

What do we expect?

- Rising snowline and earlier snowmelt cause shifts in seasonal runoff patterns
- Rising sea level impacts Delta
- Increased evapotranspiration leads to increased demand

Precipitation and Air Temperature Projections

Scenario/ Model	A2	B1
GFDL		
PCM		

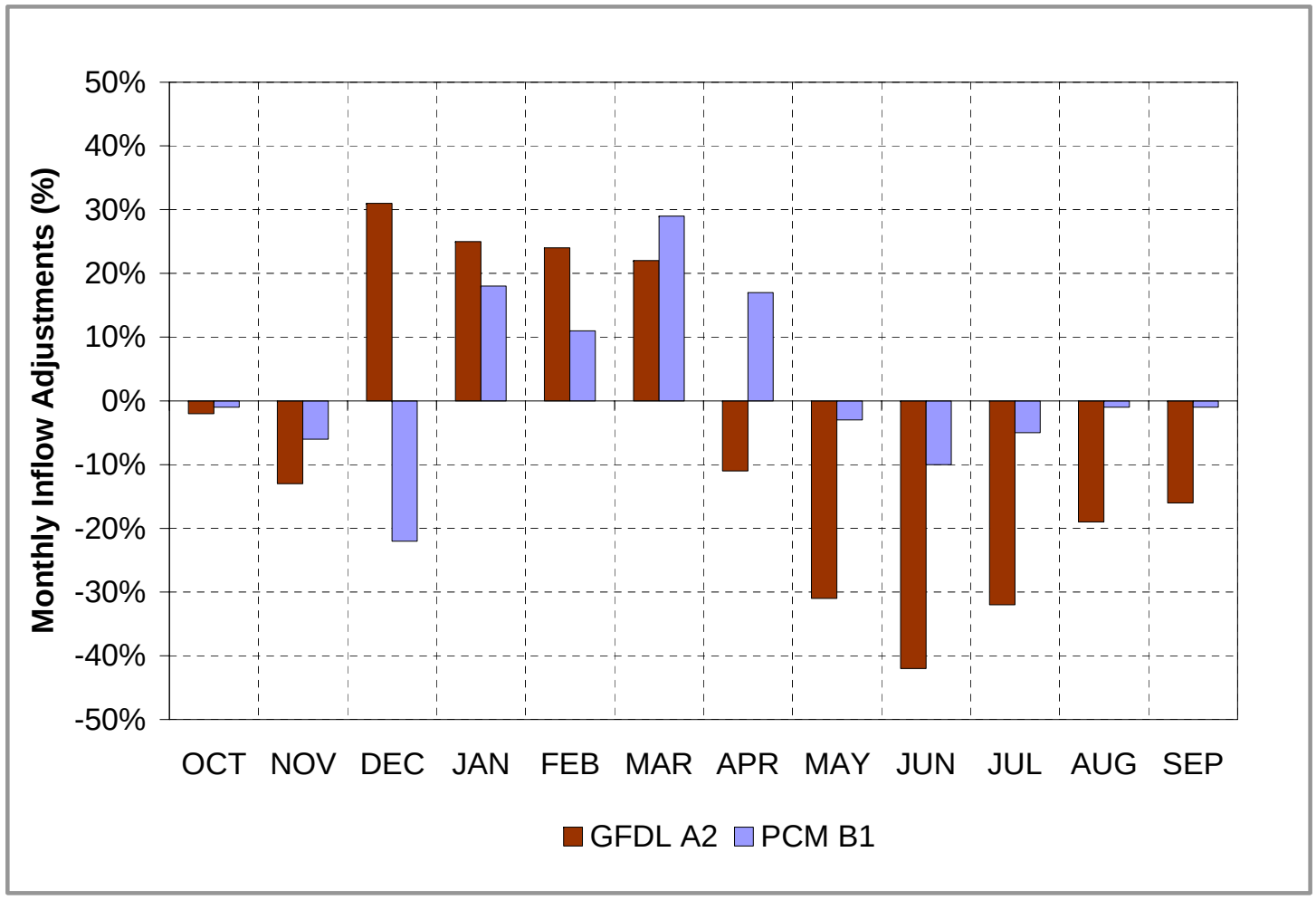
Four scenarios:

2 GCM models x 2 GHG emissions scenarios

Modeling Sequence

Global Modeling	Regional Downscaling	SWP & CVP Operations	Delta Flow & Water Quality
			
GFDL or PCM	VIC	CALSIM	DSM2
Air Temperature Precipitation Humidity Radiation	Streamflow Snowpack Snow melt Soil Moisture	Reservoir Ops Deliveries Storage Delta Outflow	Flow Salinity

Lake Oroville Inflow Adjustments for 2050 Climate Projection



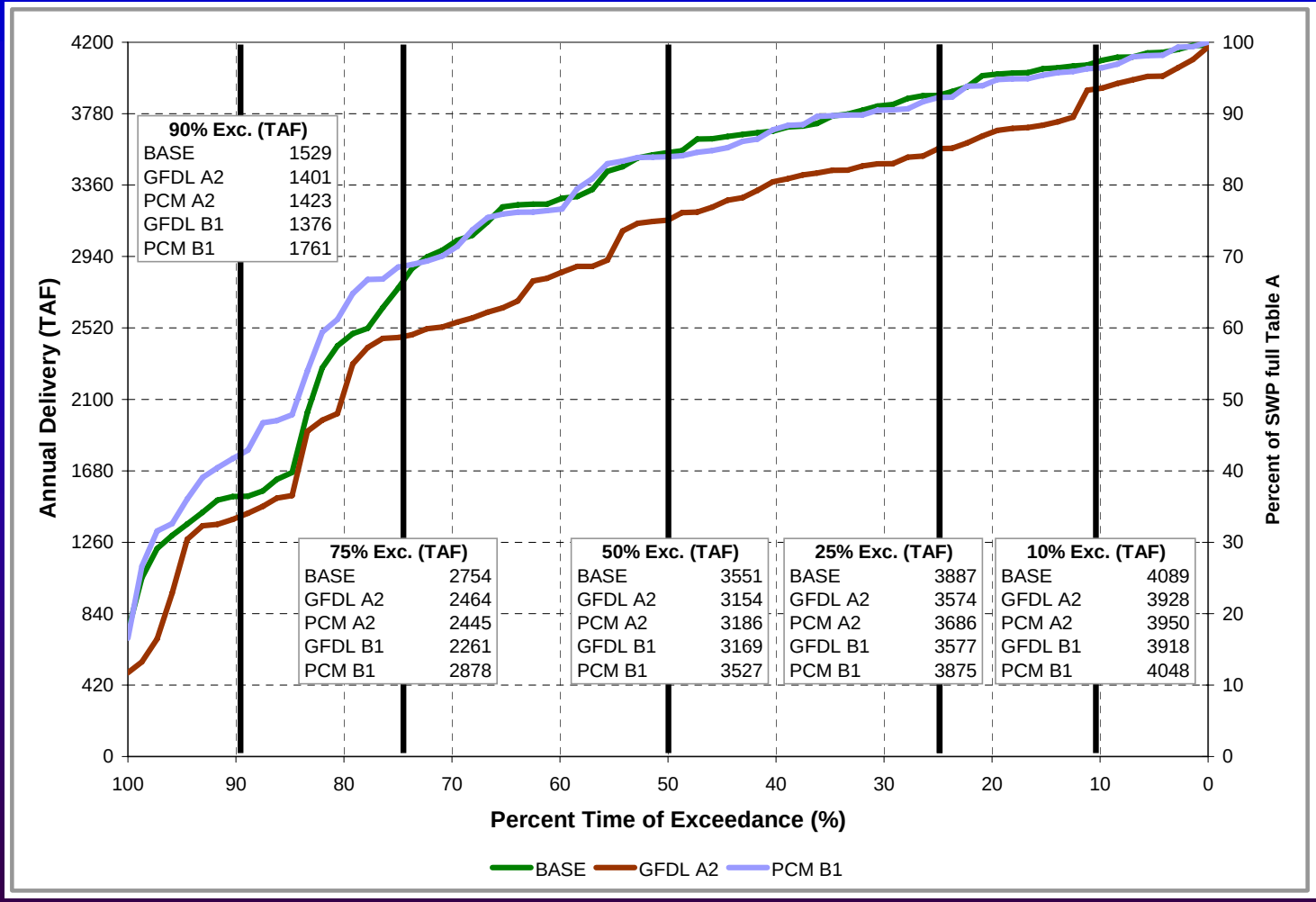
Study Assumptions

- Delta regulated by D1641
- CVPIA 3406 (b)(2) and EWA are not included
- 2020 level of development
- Climate change study inflows perturbed to reflect 2050 climate signal
- No changes in operating rules from base to climate change studies

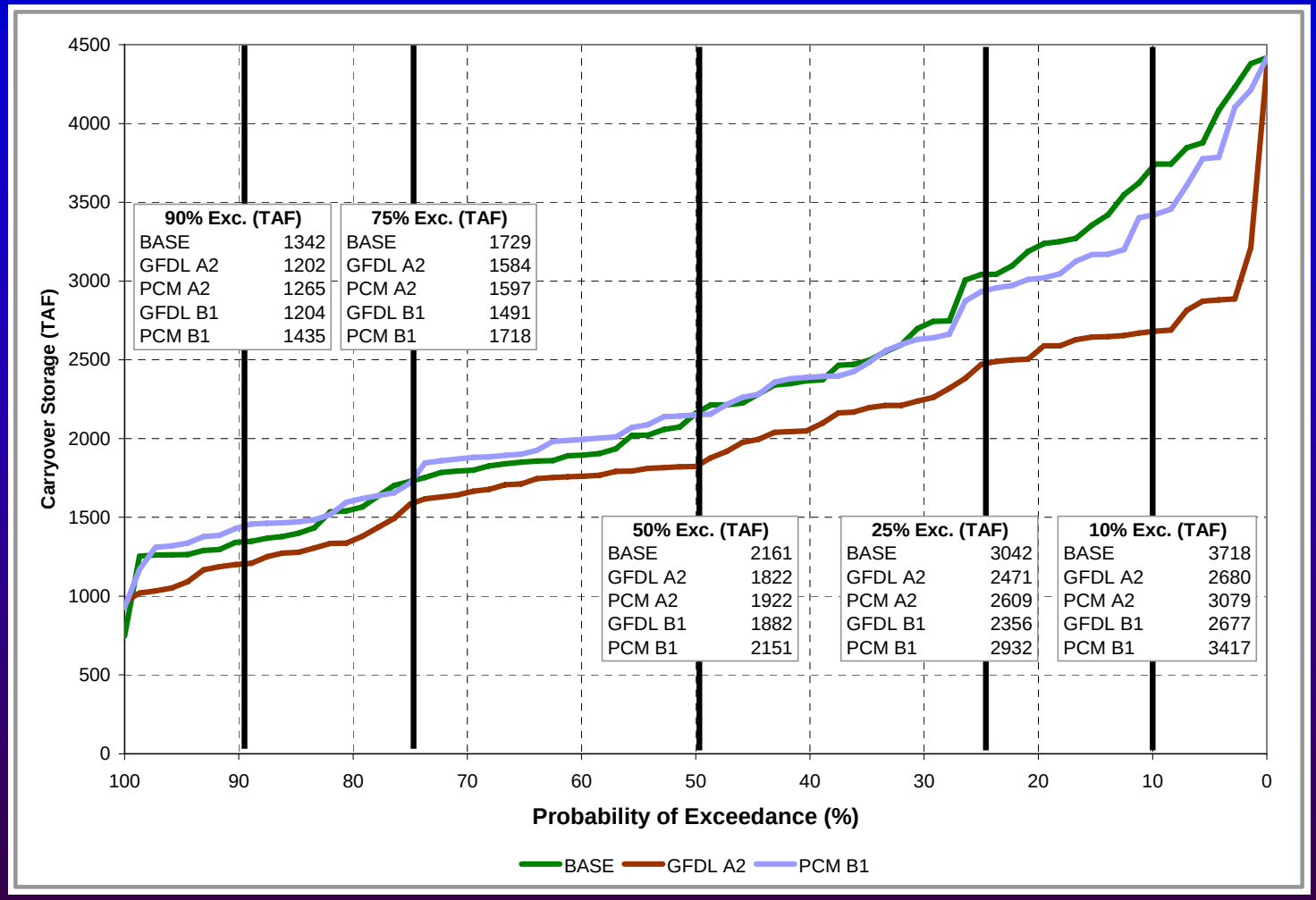
Qualification of Results

- Two climate scenarios with no probability of occurrence.
- Perturbation method accounts for seasonal shift in runoff, not potential changes in weather variability.
- Not accounting for sea level rise or changes in demand.

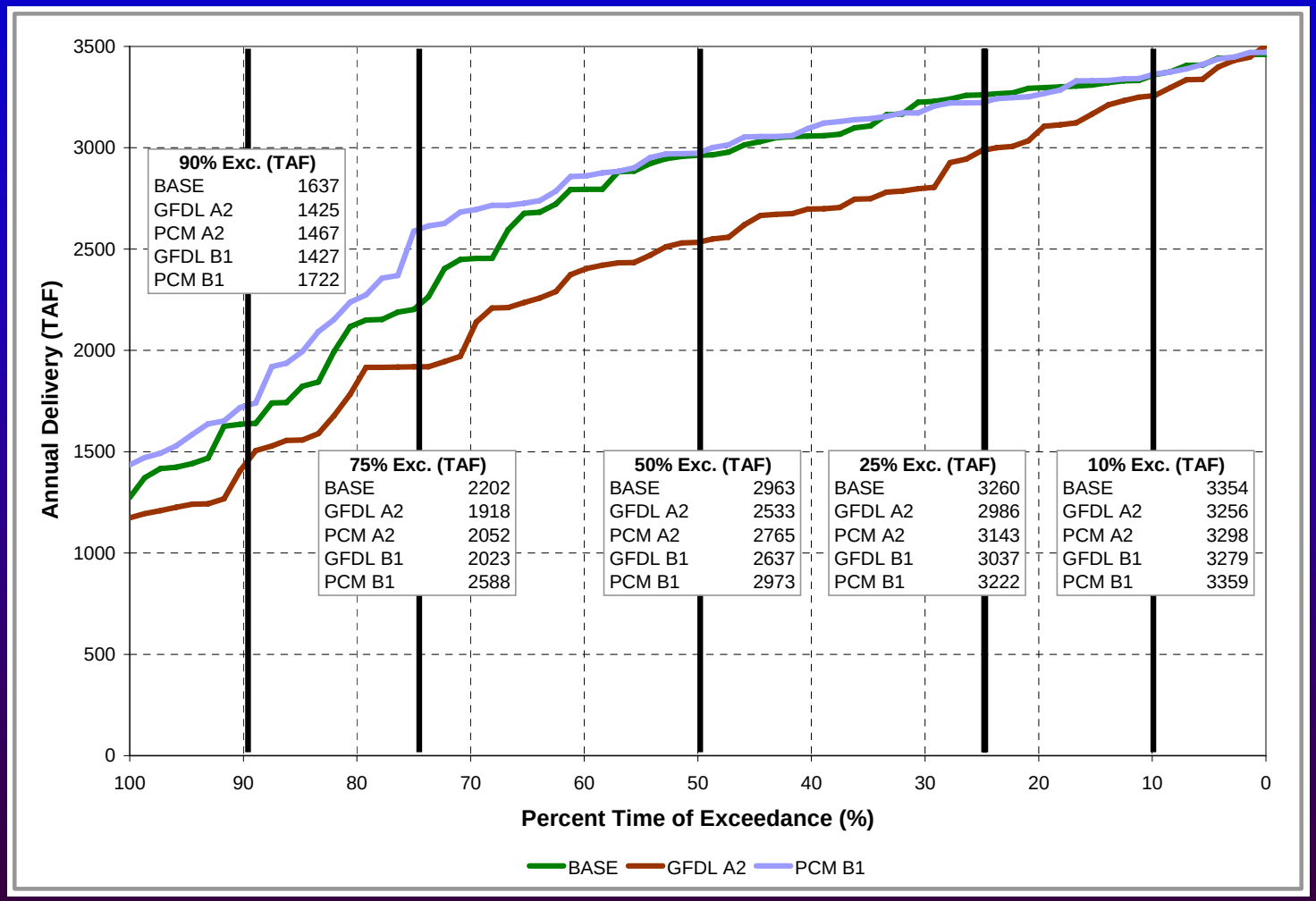
Exceedance Plot for SWP Annual Table A Deliveries



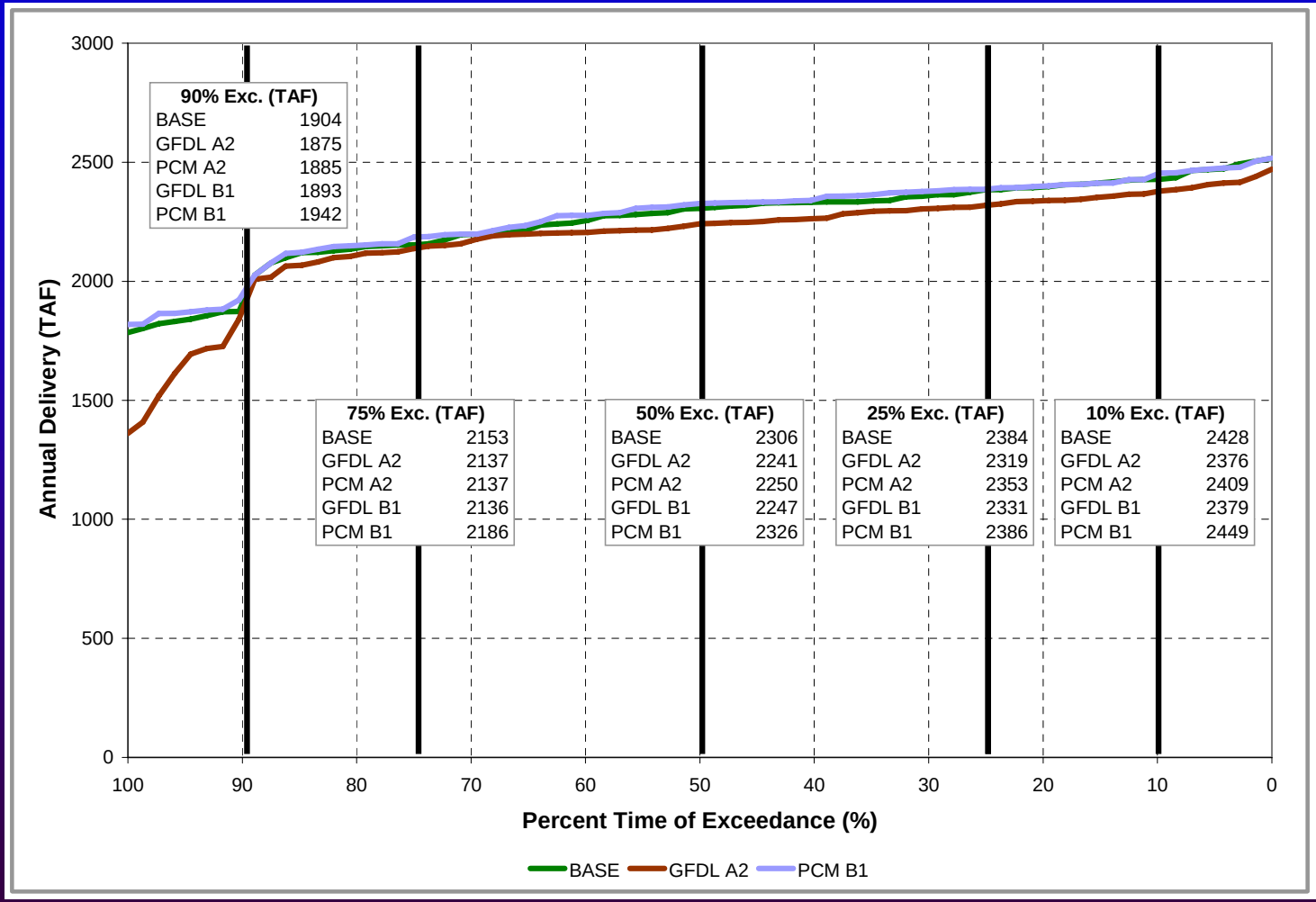
Exceedance Plot for SWP Carryover Storage



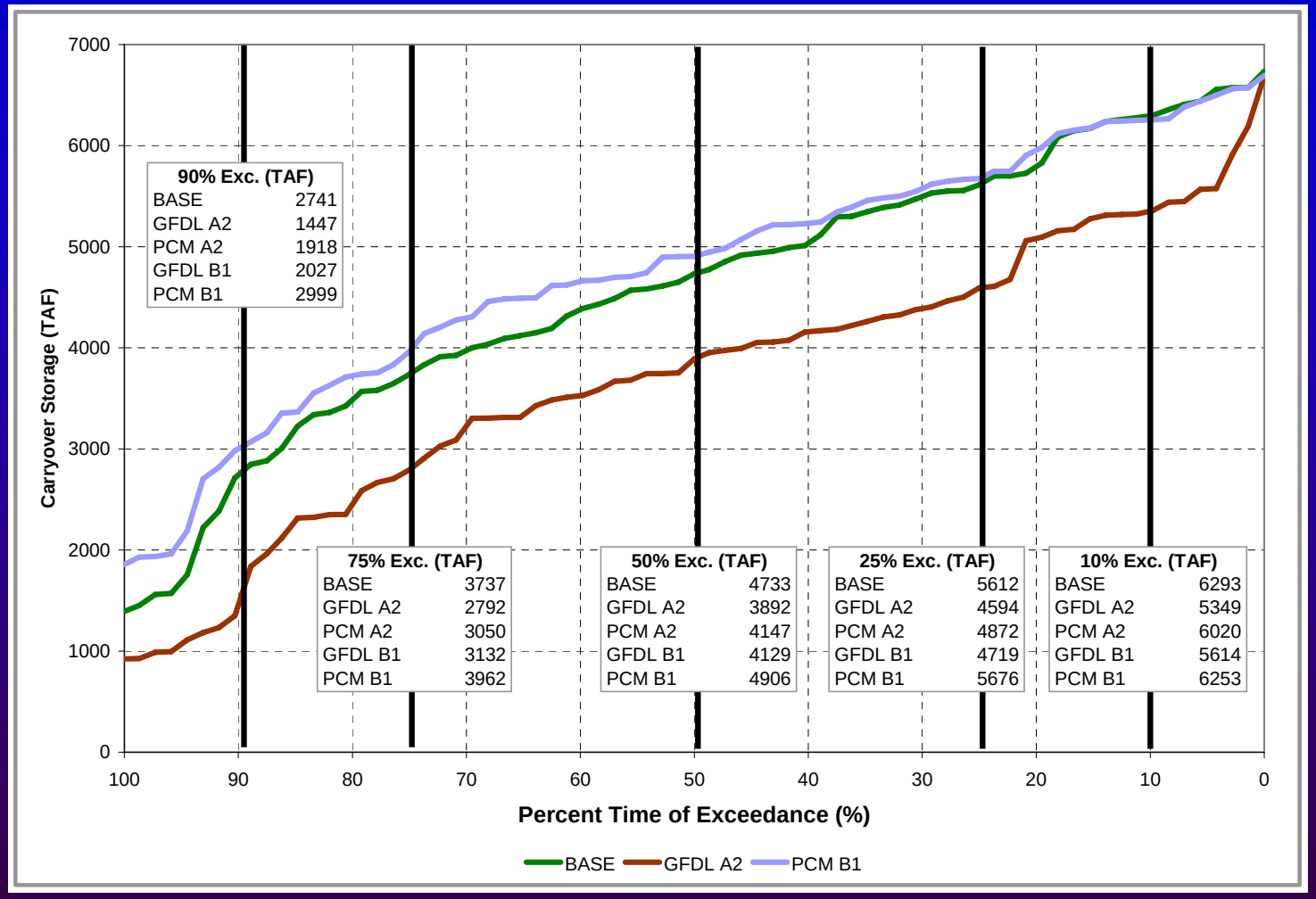
Exceedance Plot for CVP Annual South of Delta Deliveries



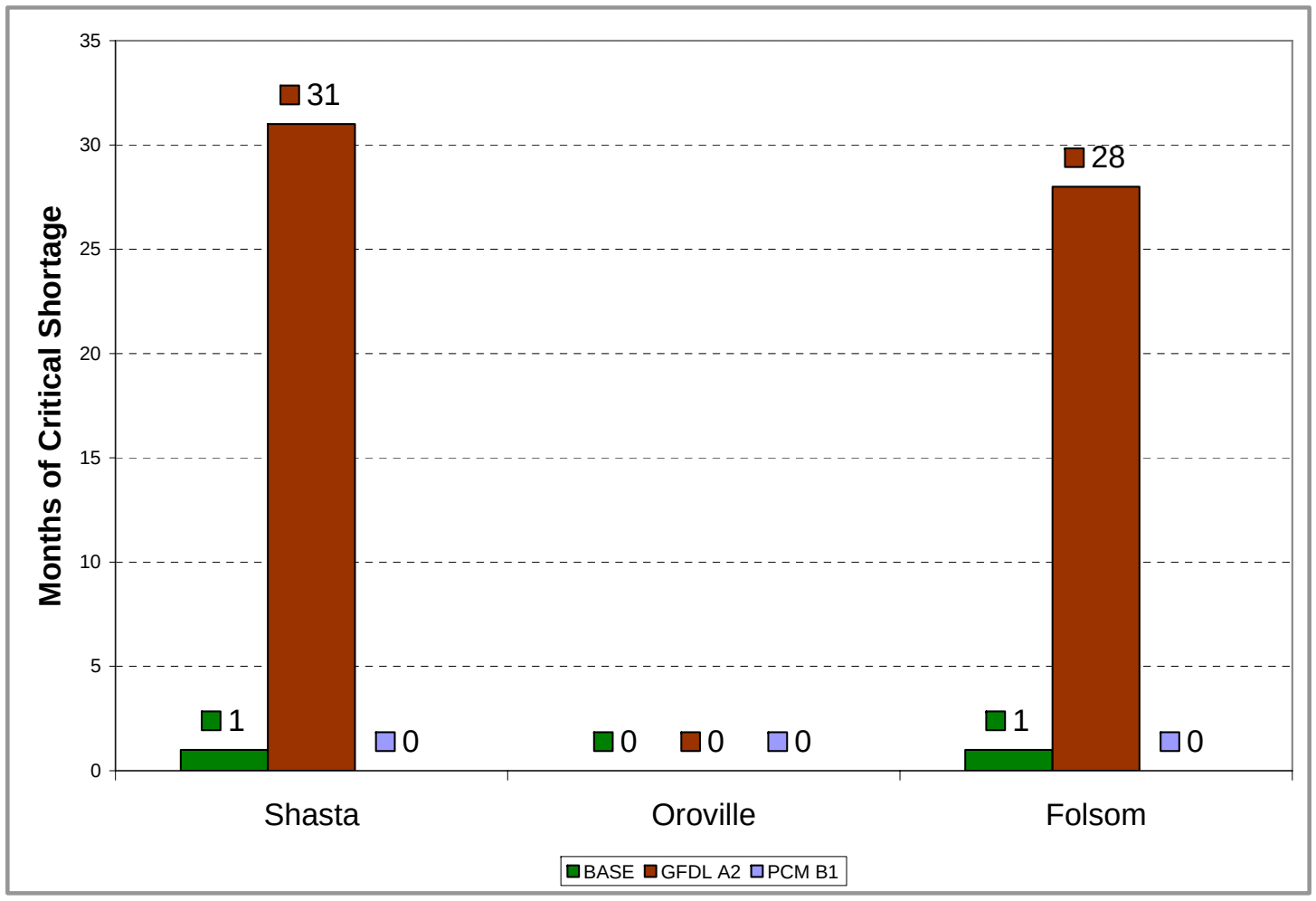
Exceedance Plot for CVP Annual North of Delta Deliveries



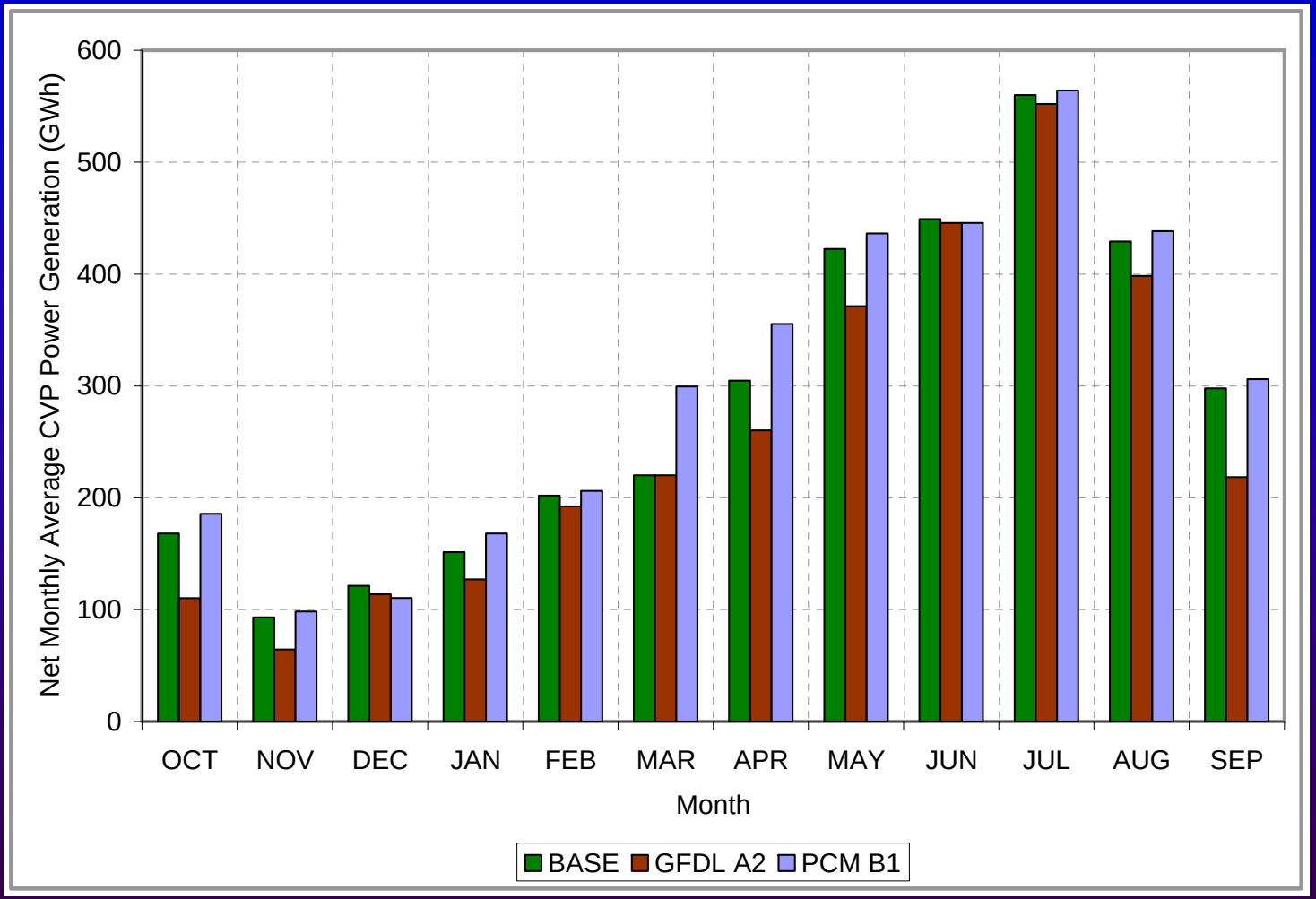
Exceedance Plot for CVP Carryover Storage



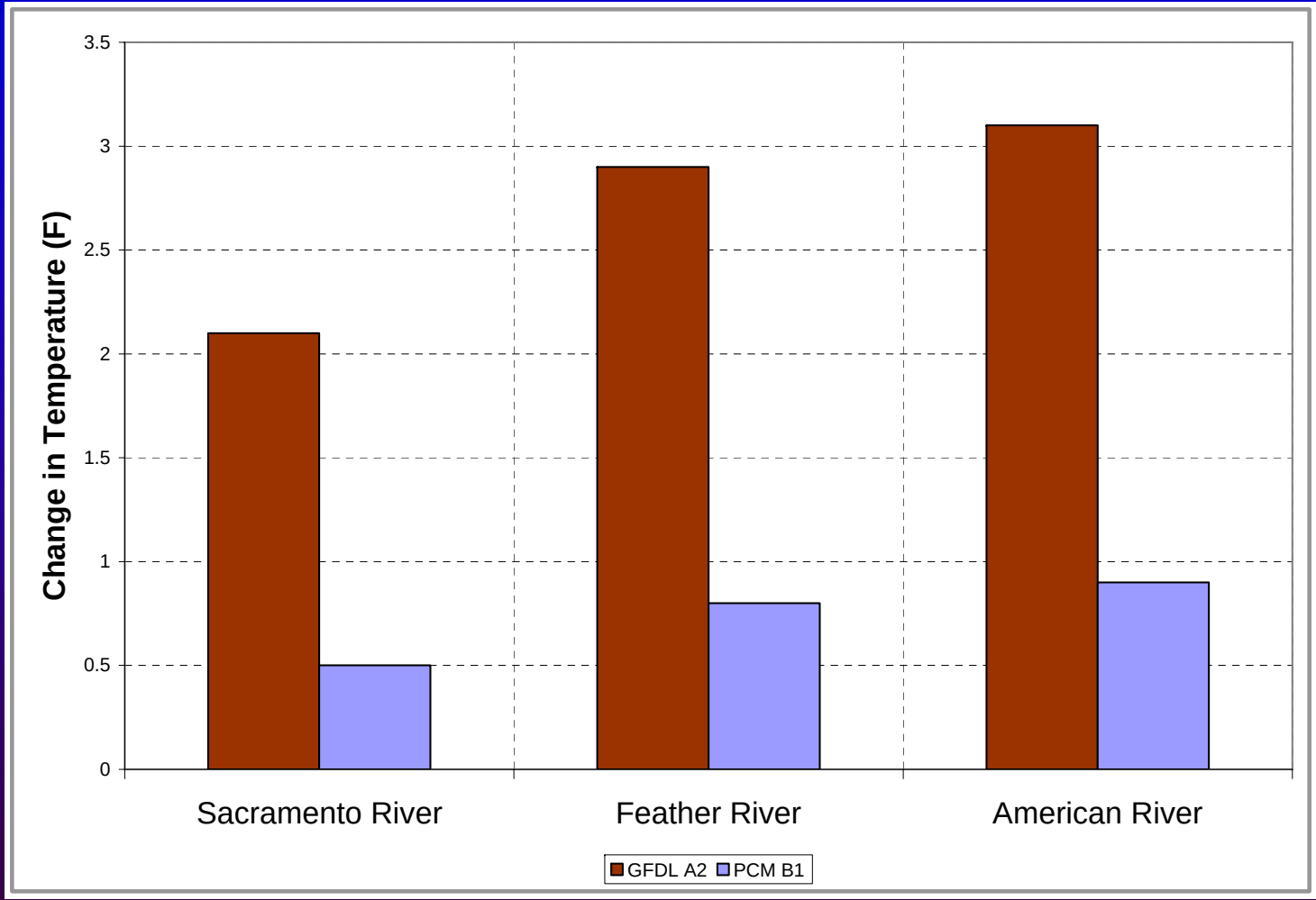
Months of NOD Critical Shortages (Storage at Dead Pool)



Net CVP Power Generation



Change in Water Temperature



Summary

- Lower water supply reliability in drier climate scenario (GFDL A2)
- Slightly higher water supply reliability in wetter climate scenario (PCM B1)
- Reduced net power generation in drier scenario, slightly higher in wet
- River temperatures increase in both scenarios

Acknowledgements

Co-Authors

Messele Ejeta, Ph.D., P.E., Alan Olson, P.E.

California Department of Water Resources, Bay-Delta Office, Modeling Support Branch, Sacramento.

Russell Yaworsky

U.S. Bureau of Reclamation, Sacramento.

Peer Review

Richard Palmer, Ph.D., University of Washington

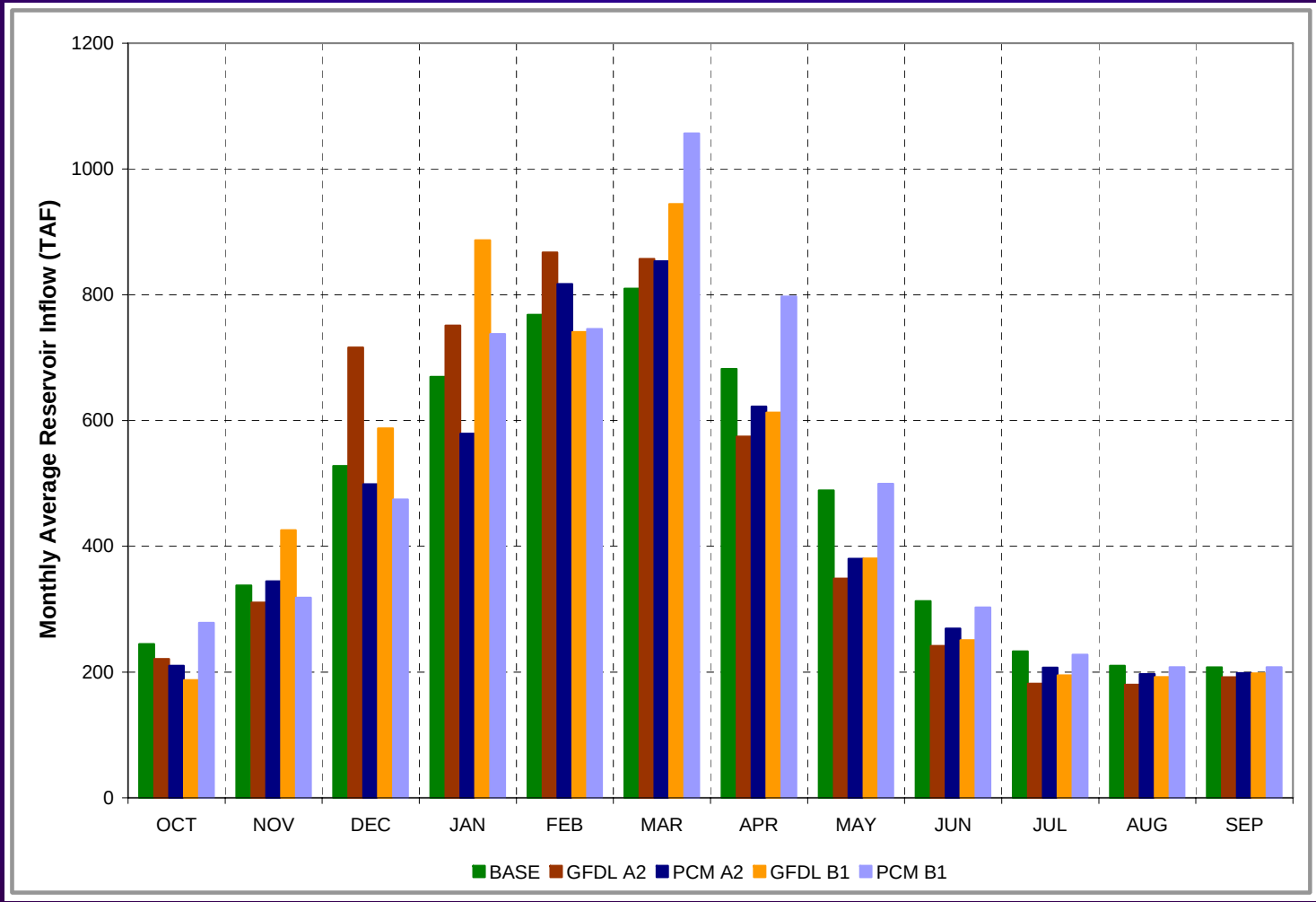
Nancy Parker, U.S. Bureau of Reclamation, Denver, CO.


deaston@water.ca.gov
http://baydeltaoffice.water.ca.gov/climatechange.cfm
www.climatechange.ca.gov

Streamflow Perturbation Factors for Scenario GFDL A2

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Smith R at Jed Smith State Park	0.66	0.80	1.19	1.12	1.06	1.01	0.76	0.64	0.62	0.67	0.78	0.85
Stanislaus R at New Melones Dam	0.97	0.78	1.30	1.34	1.20	1.37	1.07	0.72	0.57	0.43	0.64	0.84
Kings R at Pine Flat Dam	0.81	0.83	1.35	1.33	1.36	1.35	1.24	1.00	0.61	0.38	0.52	0.72
Merced R at Lake McClure	0.81	0.56	2.04	1.30	1.10	1.38	1.26	0.83	0.48	0.25	0.39	0.69
Yuba R System Outflow	1.16	0.80	1.37	1.16	1.20	1.24	0.86	0.62	0.49	0.47	0.64	0.77
NF American R at NF Dam	1.34	0.73	1.43	1.07	1.17	1.25	0.83	0.56	0.40	0.26	0.48	0.69
Sacramento R at Shasta Dam	0.90	0.92	1.36	1.12	1.13	1.06	0.84	0.71	0.77	0.78	0.86	0.92
Feather R at Oroville	0.98	0.87	1.31	1.25	1.24	1.22	0.89	0.69	0.58	0.68	0.81	0.84
American R at Folsom Dam	1.22	0.70	1.35	1.13	0.95	1.28	0.77	0.48	0.45	0.44	0.67	0.83
Tuolumne R at New Don Pedro	0.88	0.80	1.36	1.31	1.08	1.31	1.19	0.84	0.49	0.48	0.68	0.81

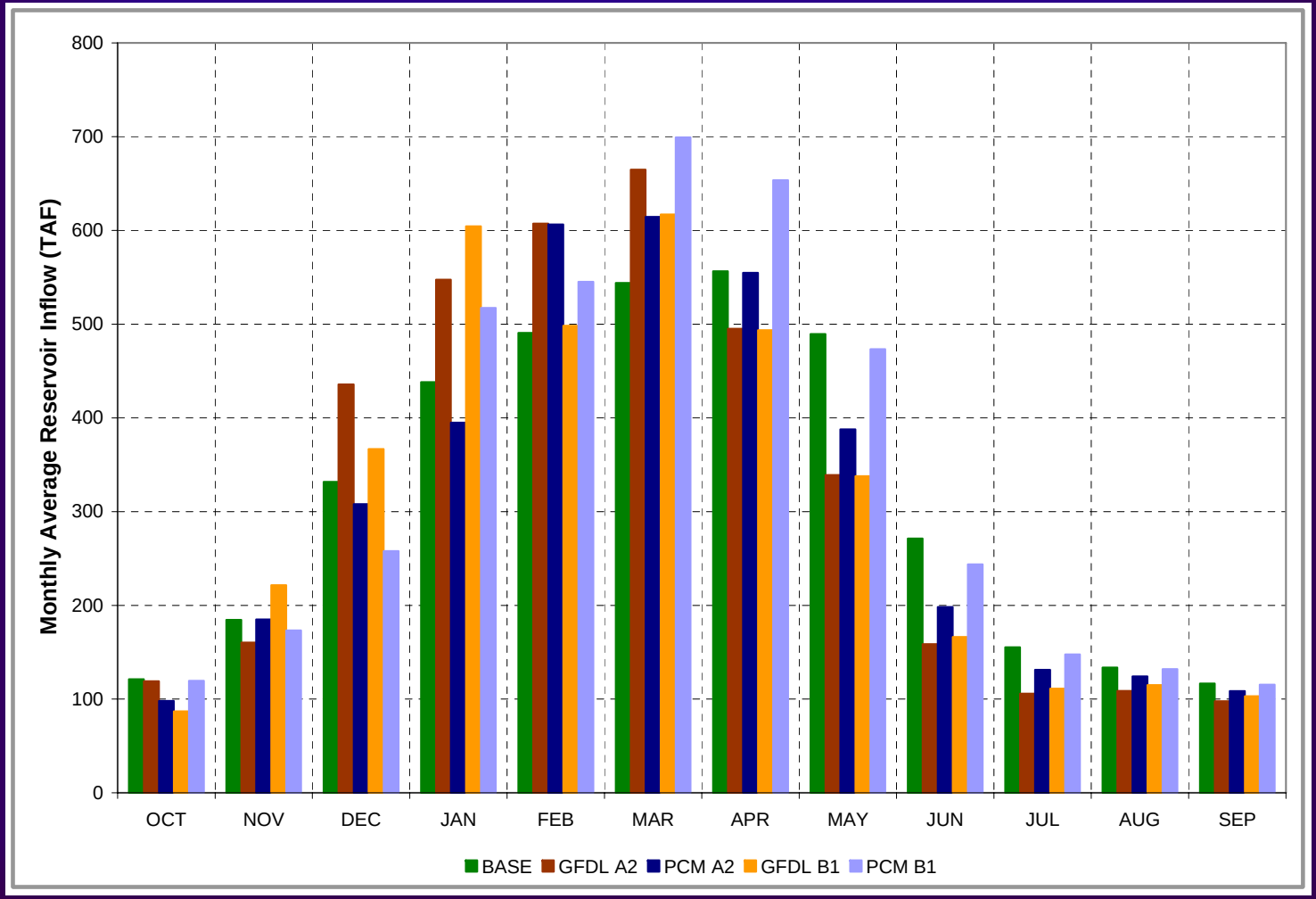
Lake Shasta Average Monthly Inflow (1922-1994)



Lake Shasta Annual Average Inflow (TAF)

		BASE	GFDL A2	PCM A2	GFDL B1	PCM B1
Long-term (1922 – 1994)	Value	5492	5442	5177	5601	5854
	Change	--	-51	-315	109	362
May 1928 - Oct 1934	Value	3332	3227	3114	3321	3545
	Change	--	-106	-219	-12	213
WY 1987 - WY 1992	Value	3817	3720	3603	3859	4115
	Change	--	-97	-214	42	299
WY 1980 - WY 1983 (Wet Period)	Value	7582	7599	7223	7829	8143
	Change	--	17	-359	247	561

Lake Oroville Average Monthly Inflow (1922-1994)



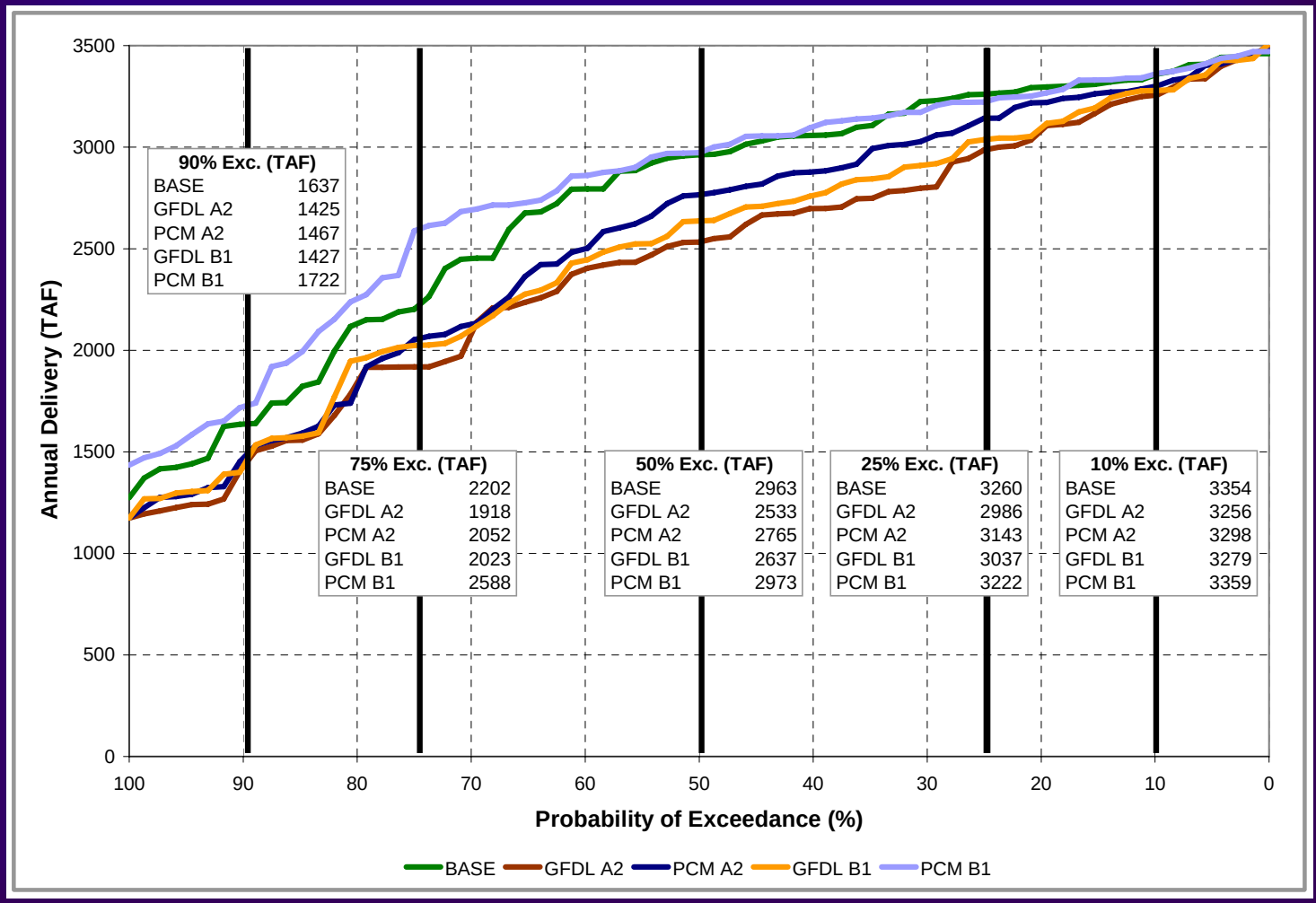
Lake Oroville Annual Average Inflow (TAF)

		BASE	GFDL A2	PCM A2	GFDL B1	PCM B1
Long-term (1922 – 1994)	Value	3833	3840	3712	3722	4079
	Change	--	6	-122	-111	245
May 1928 - Oct 1934	Value	2174	2109	2061	2038	2282
	Change	--	-66	-113	-136	108
WY 1987 - WY 1992	Value	2002	2032	1968	1964	2163
	Change	--	30	-34	-38	161
WY 1980 - WY 1983 (Wet Period)	Value	6064	6170	5936	5995	6465
	Change	--	106	-128	-69	401

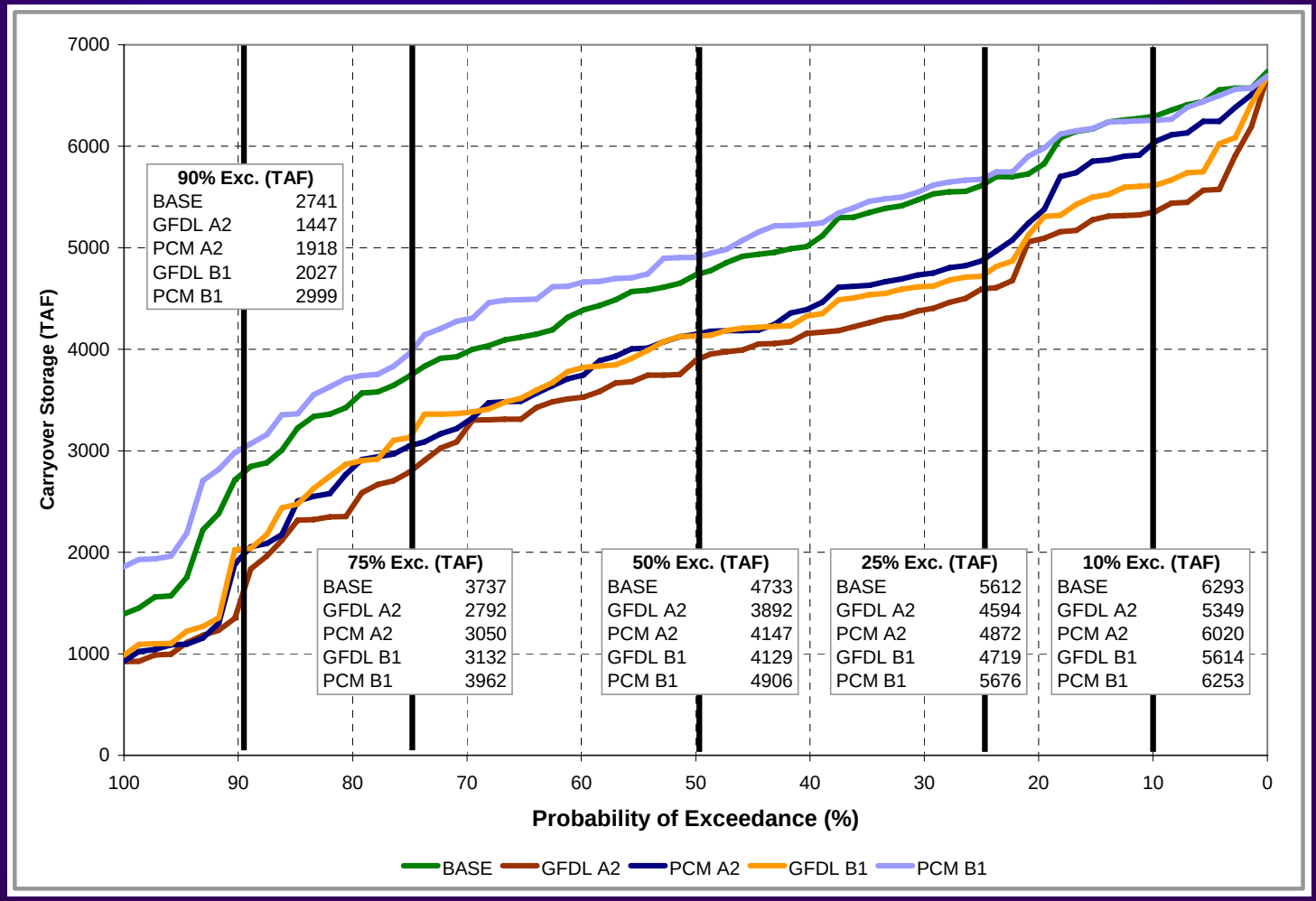
CVP South-of-Delta contractor deliveries (TAF)

	Average	*Single dry year 1977*	*2-year drought 1976-1977*	*4-year drought 1931-1934*	*6-year drought 1987-1992*	*6-year drought 1929-1934*
BASE	2716	1358	1704	1362	1806	1538
GFDL A2	2435	1108	1434	1217	1529	1320
PCM A2	2545	1243	1583	1225	1580	1341
GFDL B1	2489	1217	1546	1240	1634	1344
PCM B1	2785	1354	1686	1541	1953	1688

Exceedance Probability Plot of CVP South-of-Delta Deliveries



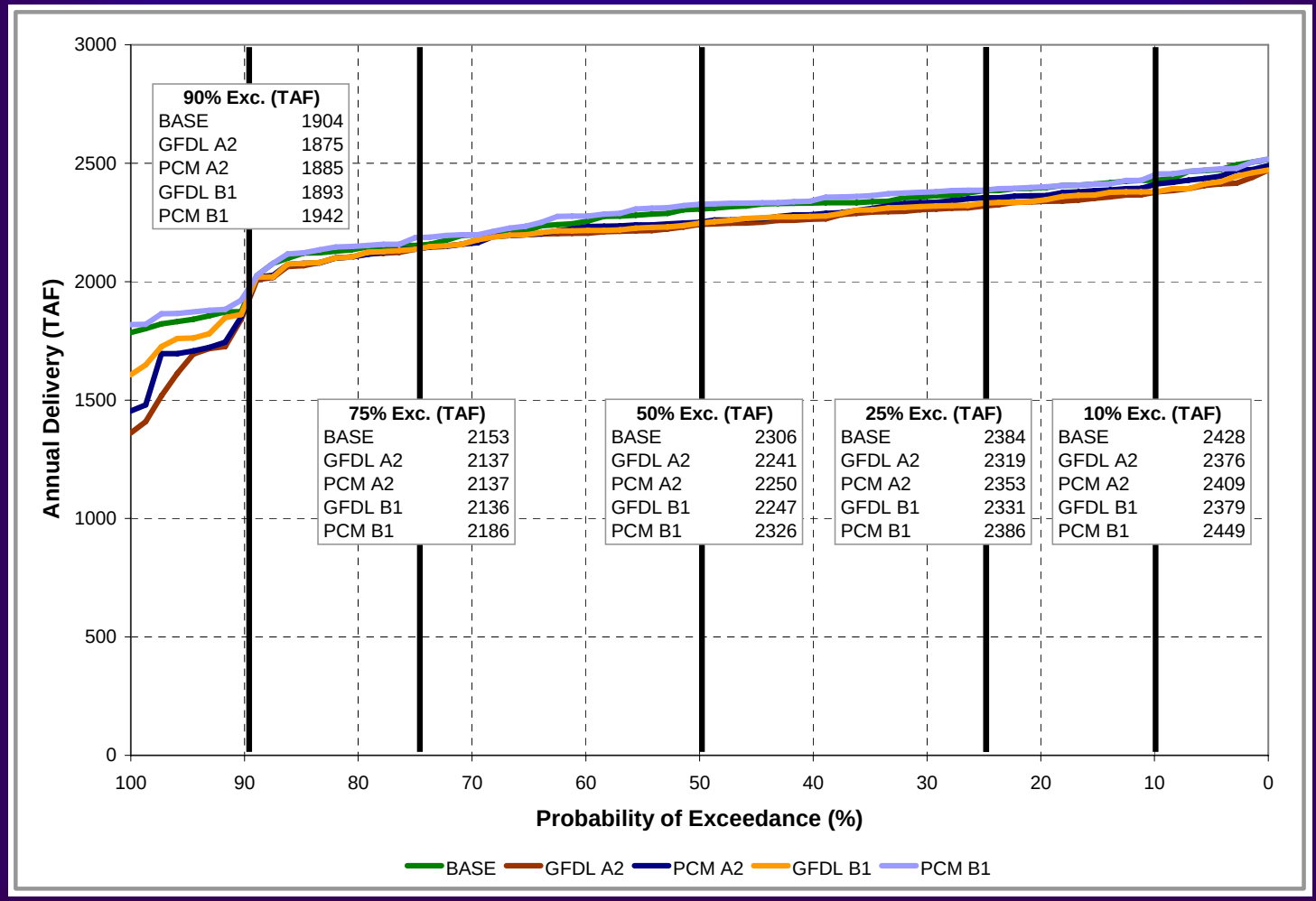
Exceedance Probability Plot of CVP Carryover Storage



CVP North-of-Delta contractor deliveries (TAF)

	Average	*Single dry year 1977*	*2-year drought 1976-1977*	*4-year drought 1931-1934*	*6-year drought 1987-1992*	*6-year drought 1929-1934*
BASE	2251	1847	2076	1815	2061	1940
GFDL A2	2181	1803	2026	1551	1937	1742
PCM A2	2204	1798	2040	1572	1999	1759
GFDL B1	2204	1823	2048	1669	2024	1823
PCM B1	2265	1847	2073	1849	2089	1967

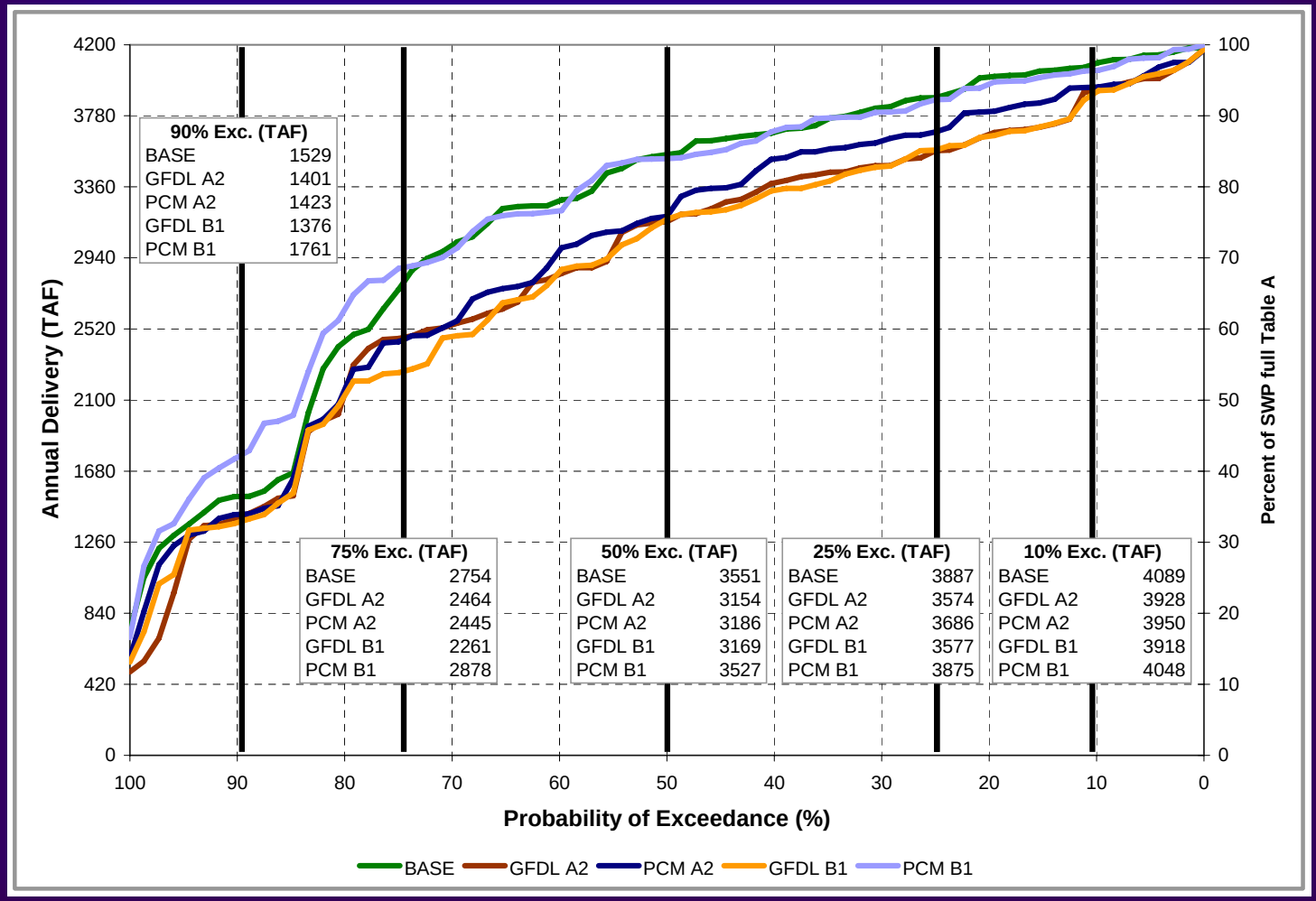
Exceedance Probability Plot of CVP North-of-Delta Deliveries



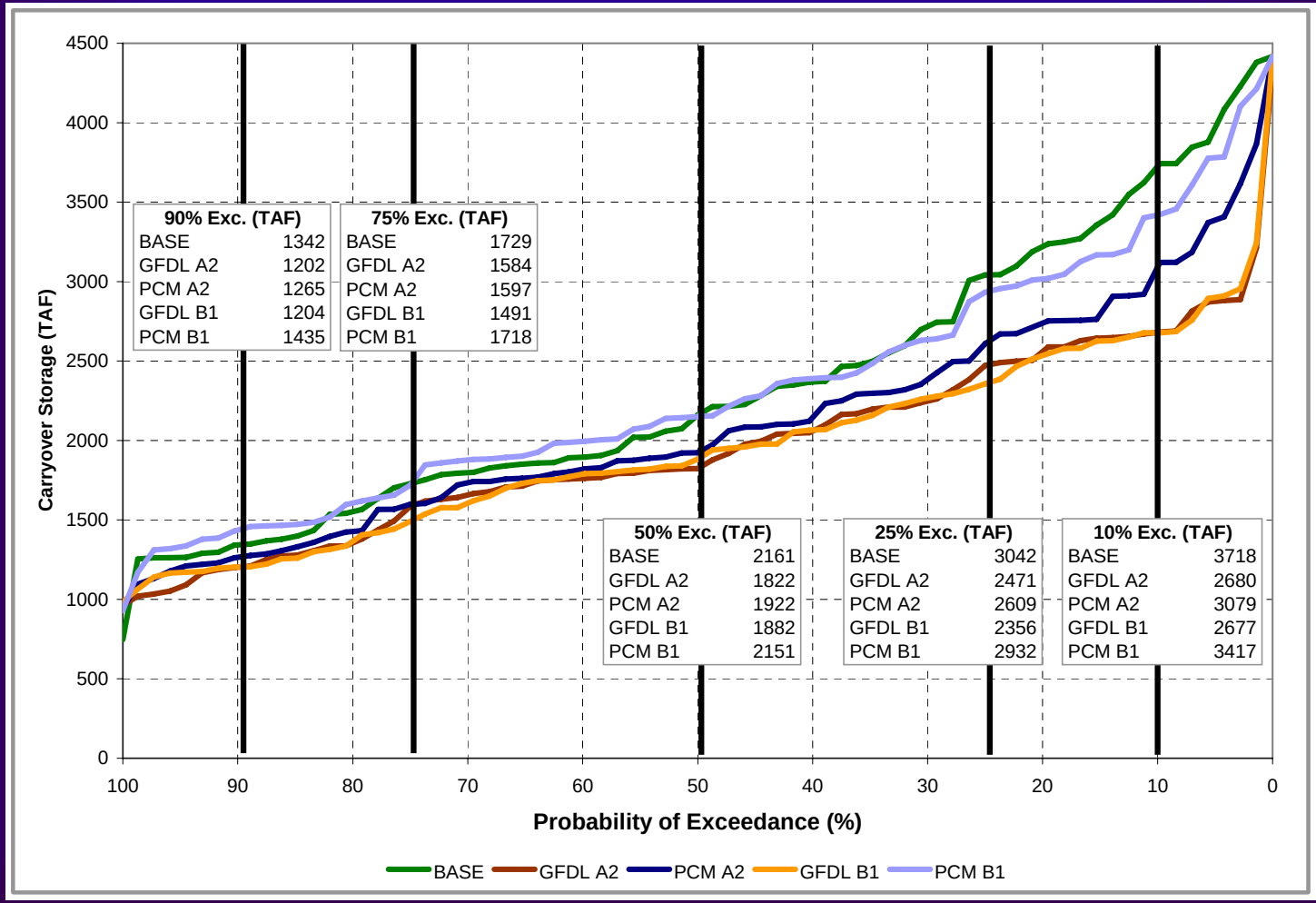
SWP average and dry year Table A deliveries (TAF)

	Average	*Single dry year 1977*	*2-year drought 1976-1977*	*4-year drought 1931-1934*	*6-year drought 1987-1992*	*6-year drought 1929-1934*
BASE	3186	222	1620	1521	1786	1679
GFDL A2	2879	229	892	1355	1396	1554
PCM A2	2964	279	1049	1343	1651	1458
GFDL B1	2861	285	952	1386	1502	1507
PCM B1	3224	267	1413	1870	1807	1949

Exceedance Probability Plot of SWP Table A Deliveries



Exceedance Probability Plot of SWP Carryover Storage



SWP average and dry year Article 21 deliveries (TAF)

	Average	*Single dry year 1977*	*2-year drought 1976-1977*	*4-year drought 1931-1934*	*6-year drought 1987-1992*	*6-year drought 1929-1934*
BASE	99	0	0	157	34	111
GFDL A2	106	0	0	188	119	133
PCM A2	103	0	0	194	27	149
GFDL B1	101	0	0	170	52	132
PCM B1	88	0	0	54	39	42

Exceedance Probability Plot of SWP Article Deliveries