Workshop on Water Supply Modeling and Aquifer Storage

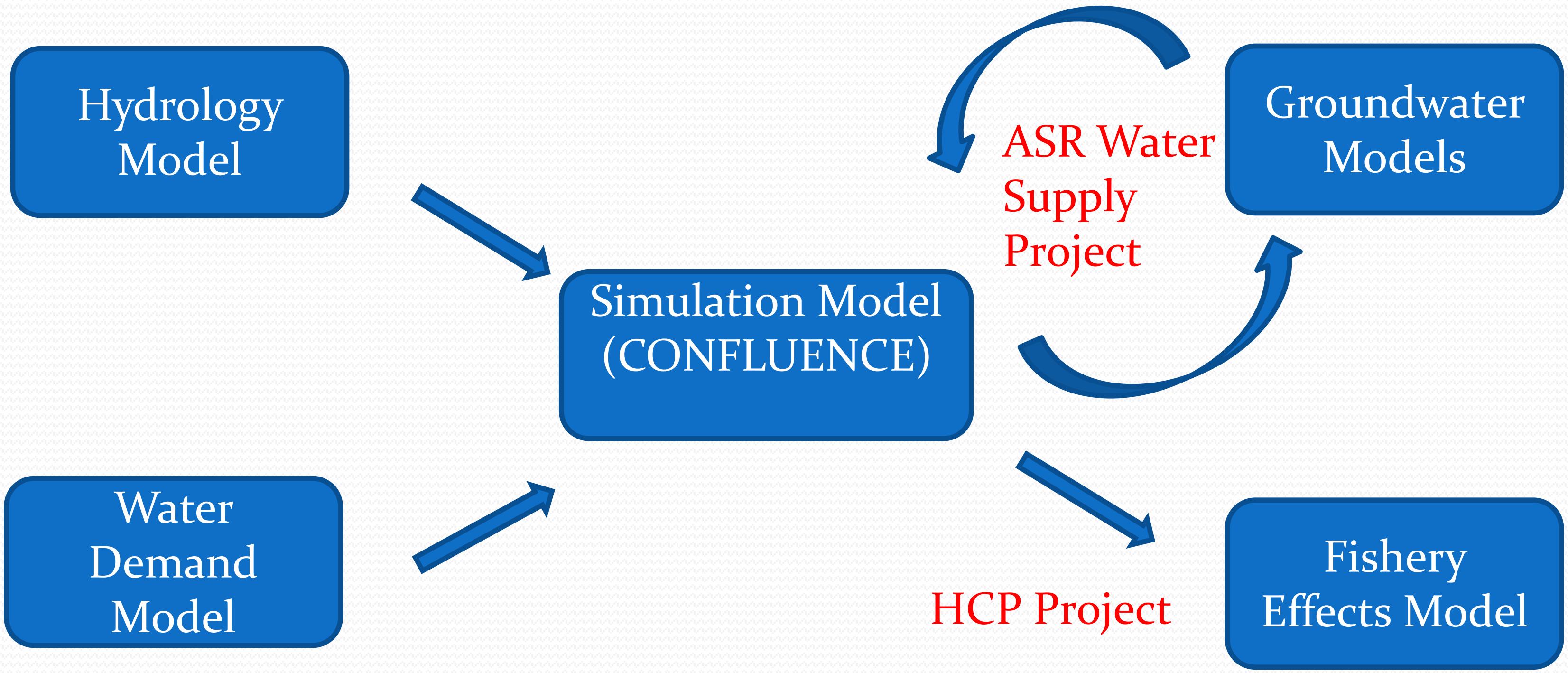
Workshop Part 1:

- Overview of Models
- Primer on Confluence
- Update on Supply Modeling

Workshop Part 2:

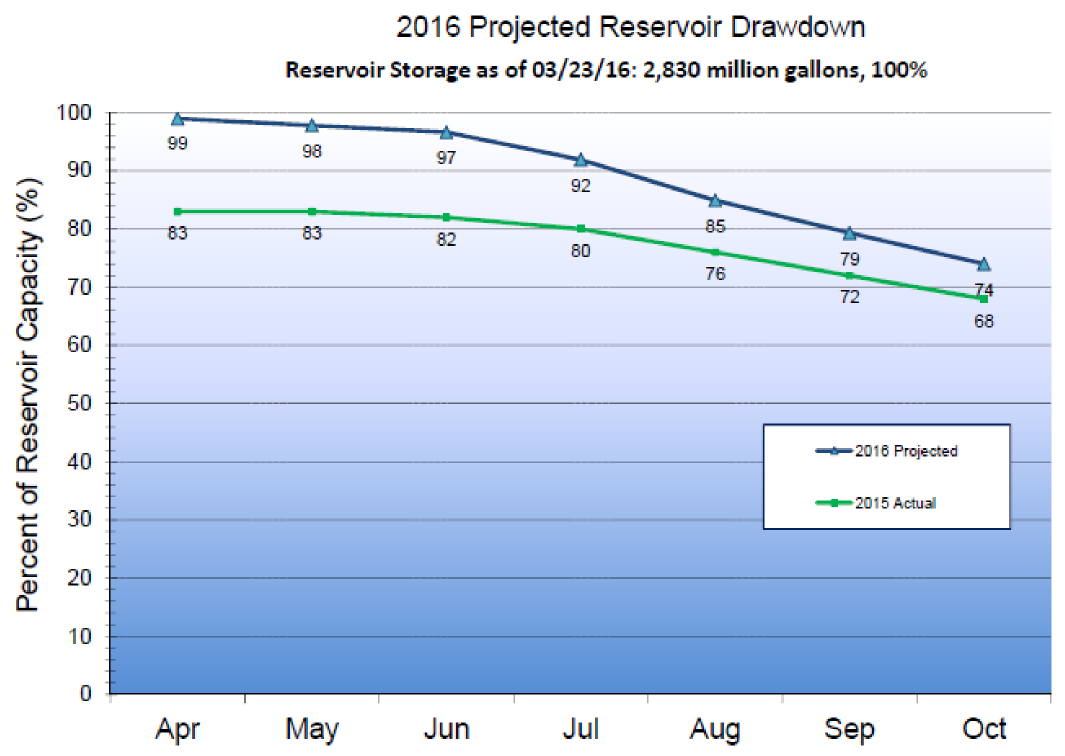
- ASR Investigation Update

Confluence is a Bridge Between Models



Operations Model

- Simple Spreadsheet Model, built by Toby Goddard
- Used to Develop Annual Supply Outlook each Spring



Confluence Discussion Outline

- What Confluence is (and what it’s not)
- Overview of model structure
- How Confluence has supported Santa Cruz water resources planning
- Key model inputs
- Key model outputs
- Use of Confluence to model in-lieu/ASR alternatives

Confluence: What it is and isn't

Confluence is:

- Planning model
- Simulation tool

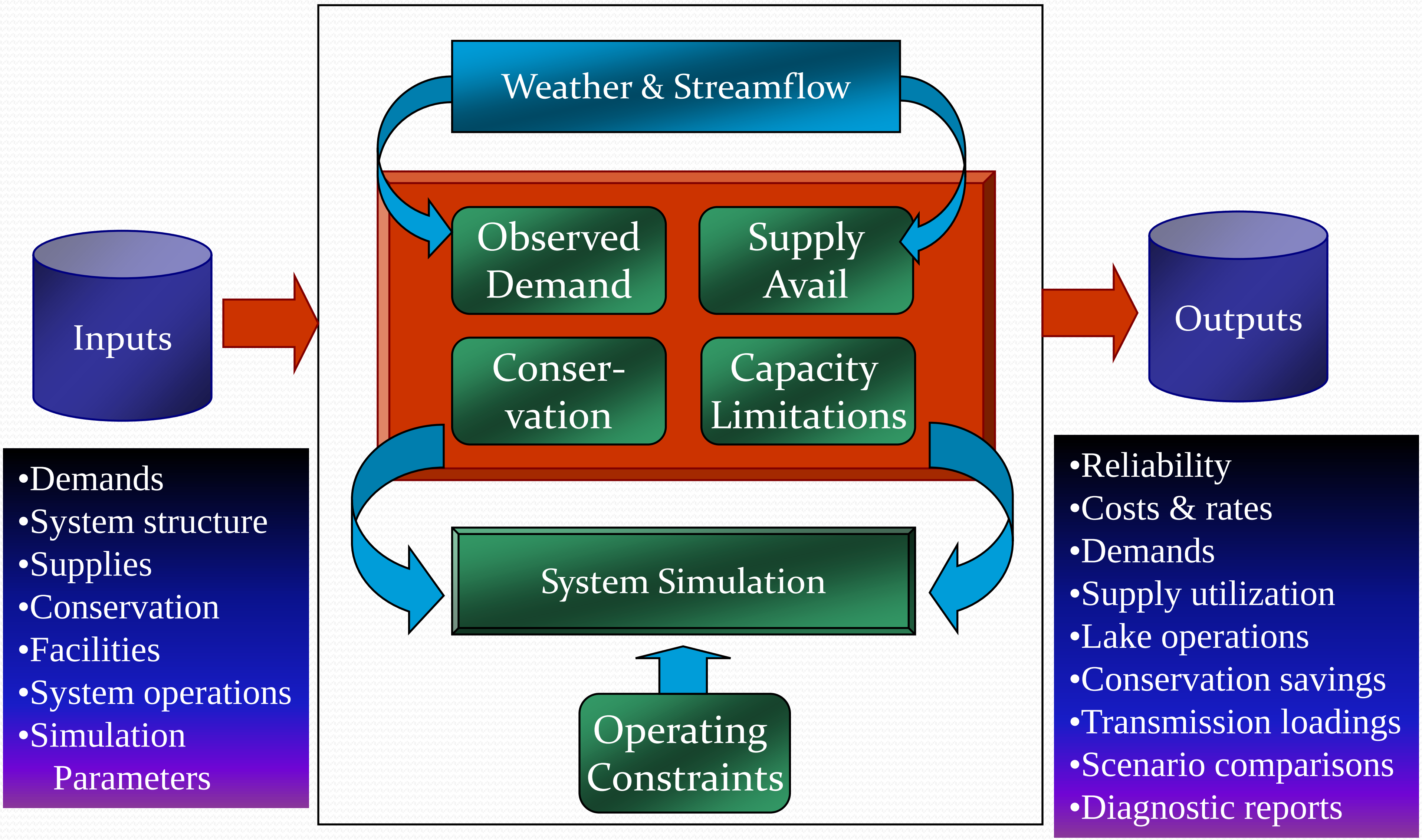
Confluence can compare scenarios

Confluence isn't:

- Operations model
- Optimization tool

Confluence can't identify the "best" scenario

Confluence® Model Structure



Confluence has a long history of supporting Santa Cruz water supply planning

- Integrated Water Plan (IWP)
- Water rights conformance
- Habitat Conservation Plan (HCP)
- Lake operations
- Felton operations
- Water transfer options
- Newell Creek Dam inlet/outlet project
- WSAC supply alternatives
- In-Lieu/ASR alternatives

Confluence input assumptions have been continually updated since the IWP to better simulate actual system operations

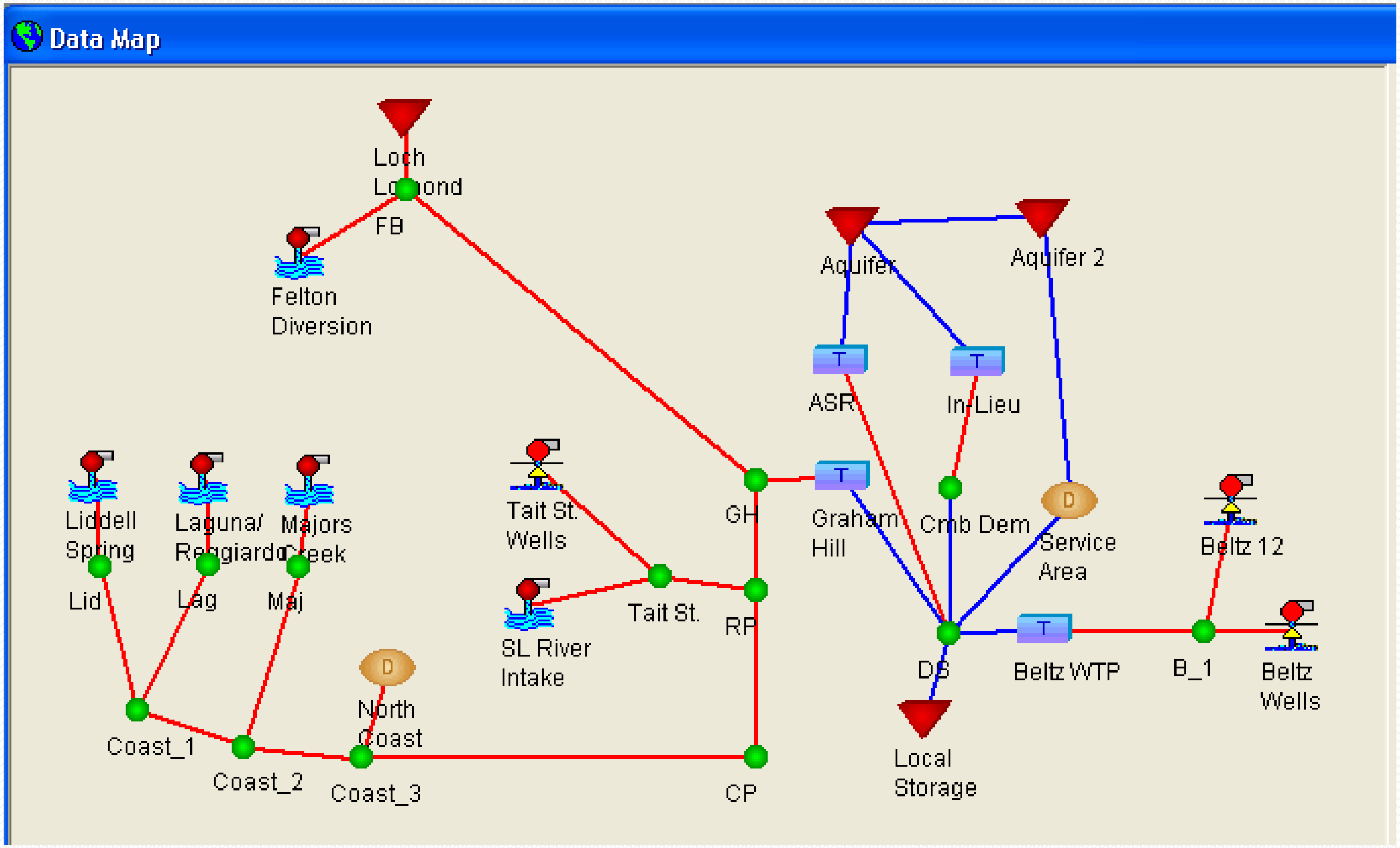
History of Confluence Inputs

Demands	**IWP**	**Updated IWP Assumptions**	**HCP pre-2013**	**Desal EIR**	**HCP 2015**	**WSAC Final**	**Post-WSAC**
Service Area Annual Demand (BG)	4.6-5.3	3.5-4.5	3.5-4.0	3.5-4.0	3.5	3.2	→
North Coast Annual Demand (BG)	31	81	81	81	40	→	→
Percent occuring in Peak Season	64%	→	→	→	59%	→	→
Hydrology							
Hydrologic Record	59 years	73 years	→	→	→		
Available Flows	Linsley- Kraeger	Balance	Multiple Scenarios	Tier 2/3 Tier 3	City Proposal (T3/2) & DFG5	Historical, Clim Chg DFG-5	Increased Felton Bypass; Dec/Apr adult migration; Potential revised CC
Diversions							
Turbidity Constraints	25 ntu	Updated 25 ntu	Updated 25 ntu; 200 ntu	Updated 25 ntu	Updated 25 ntu	→	→
Tait Street Buffer (cfs)	0	→	→	→	0.5	→	→
North Coast Transmission losses	15%=>1%	8%=>3%	→	→	→		
Groundwater Availability							
Beltz (mgd)	1.0-2.0	3 scenarios 0.3-1.0 in PS months	0.8 all years + 0.3 dry years in PS months	2 scenarios: (1) 0.8 all years + 0.3 dry years in PS months (2) 0.3 dry years in PS months	0.8 all years + 0.3 dry years in PS months	→	→
Tait Street Well Capacity (cfs)	1.78				1.29 off-pk; 0.78 pk	→	→
Loch Lomond							
Rule curves	Optimize to end of 1977	Optimize to end of 1977	Optimize to end of 1990	Optimize to end of 1977	Optimize to end of 1990	→	Joint with Aquifer
Max/usable capacity (mg)	2810/1710	2810/1740	→	→	→	→	→
Water rights:							
3200 AF withdrawal	Total Newell & Felton	→	→	→	Newell Only	None	→
Allowable diversion months	Oct-May	Nov-May			Sept - Jun		
Aquifer							
Capacity (mg)						3,000	→
Losses						20%	→
Treatment Plants							
GHWTP summer/winter capacity (mgd)	20/20	20/20	16.5/16.5	16.5/16.5	16.5/10	16.5/16.5	→
Desalination		Sharing w/ SqCWD	Sharing w/ SqCWD	Sharing w/ SqCWD & 2 operating modes	N/A	N/A	N/A

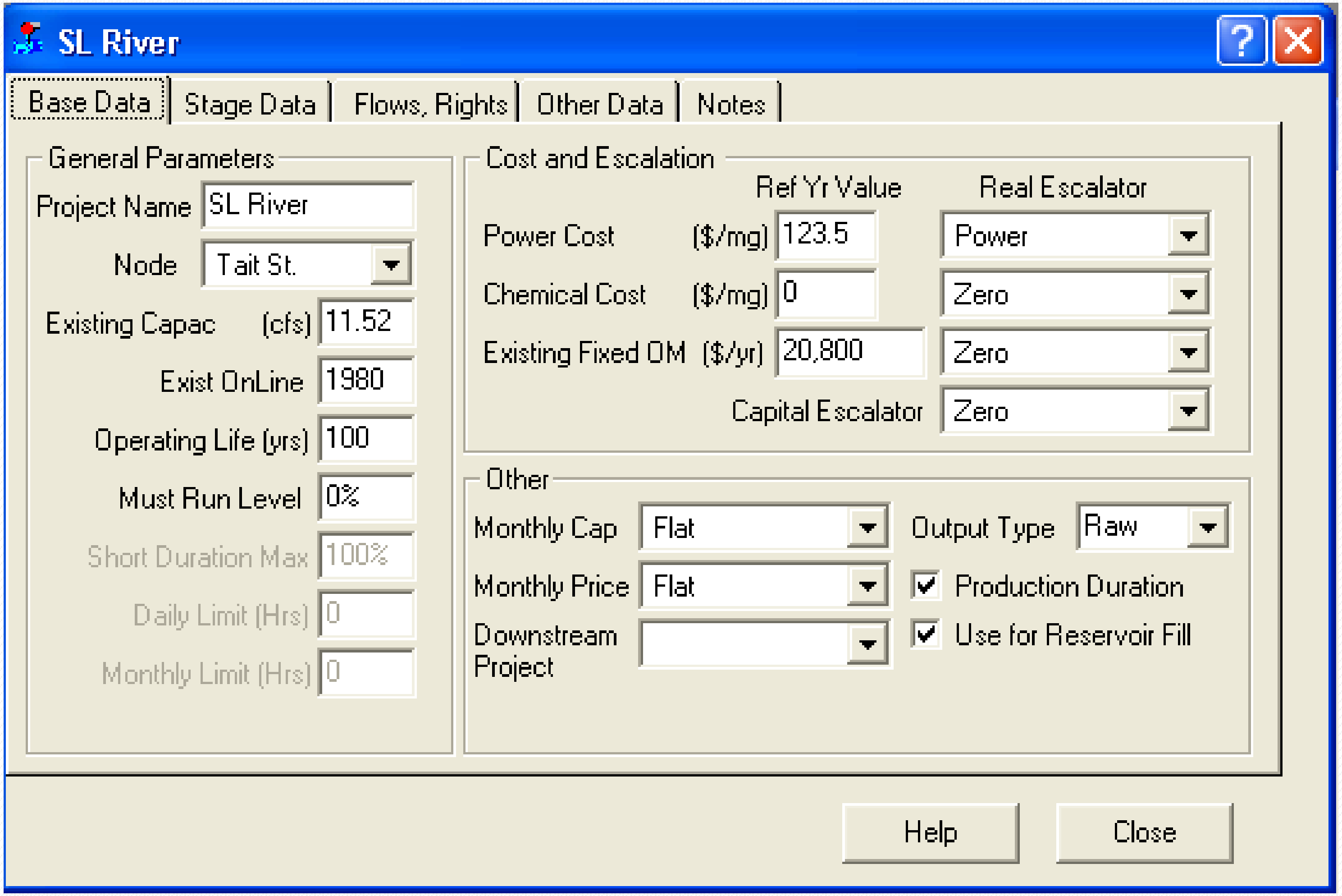
Assumptions and Inputs Evolve

- Available Flows-HCP/Updated Climate Change Model
- Water Rights
- Aquifer-Storage Capacity/Loss Rates
- Treatment Plant Capacity

Interactive Data Map



Defining Supply Sources



Daily Dispatch Order

1. North Coast
2. Tait Street Diversion
3. Tait Street Wells
4. Beltz Wells
5. Surface and GW Storage

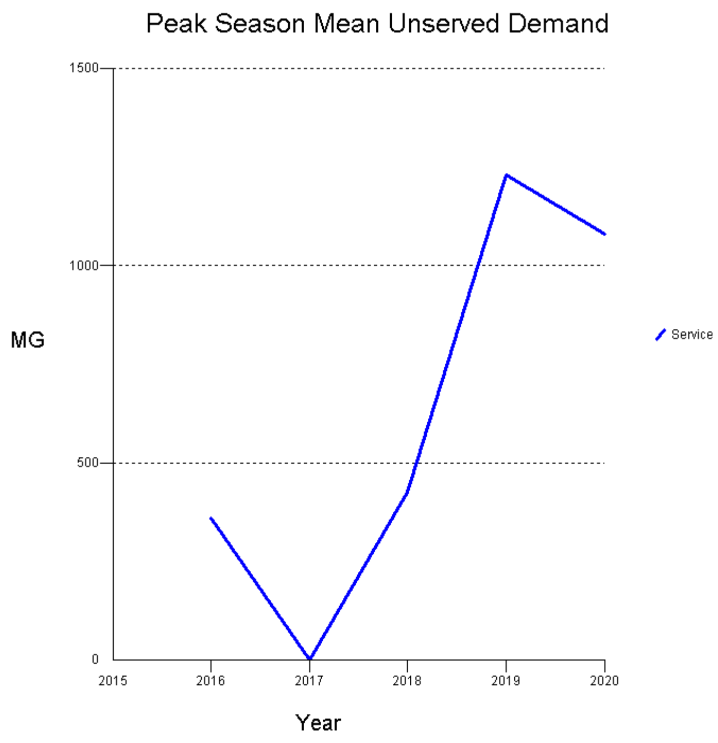
Daily source dispatch may be constrained by:

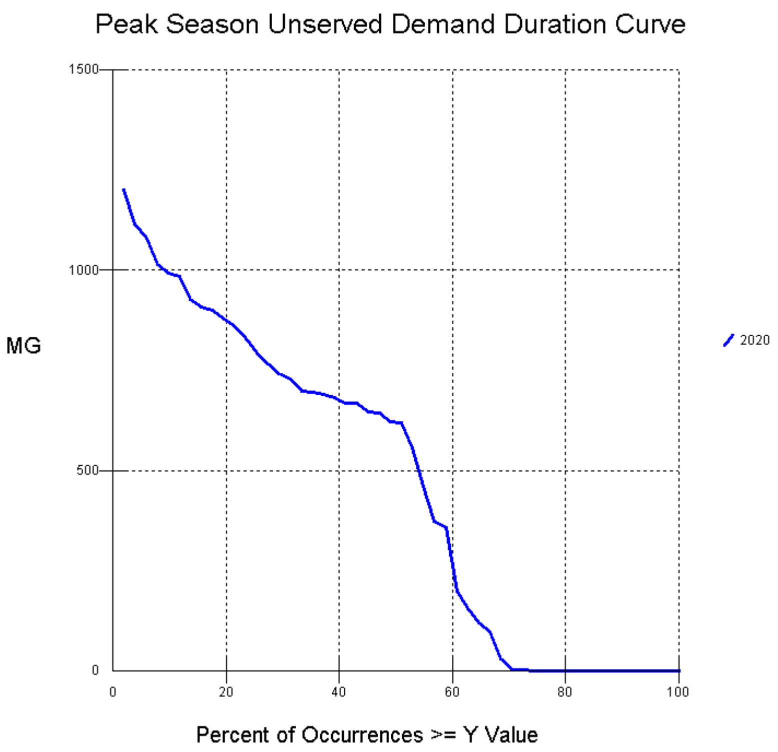
- Capacities
  - Diversion, transmission, treatment
- Available flows
- Water rights
- Turbidity
- Flush flows
- Production limits

Types of Output

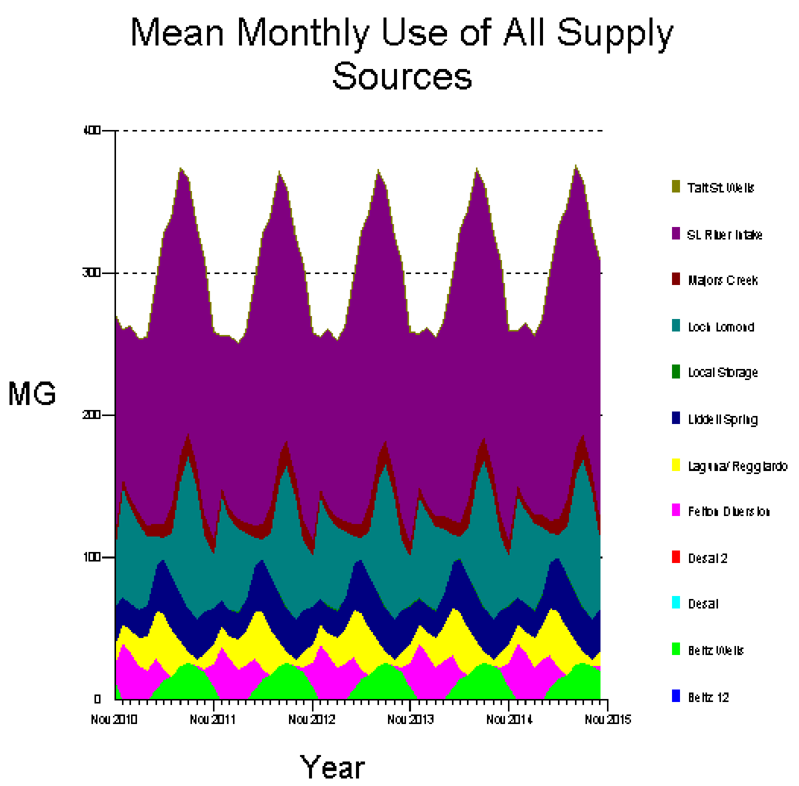
- Confluence charts (Data easily exported)
- Detail/Diagnostic text files (Data easily exported)
- Excel tables/charts from exported data
- Inputs to other models
  - Anadromous habitat effects model
  - Groundwater basin models

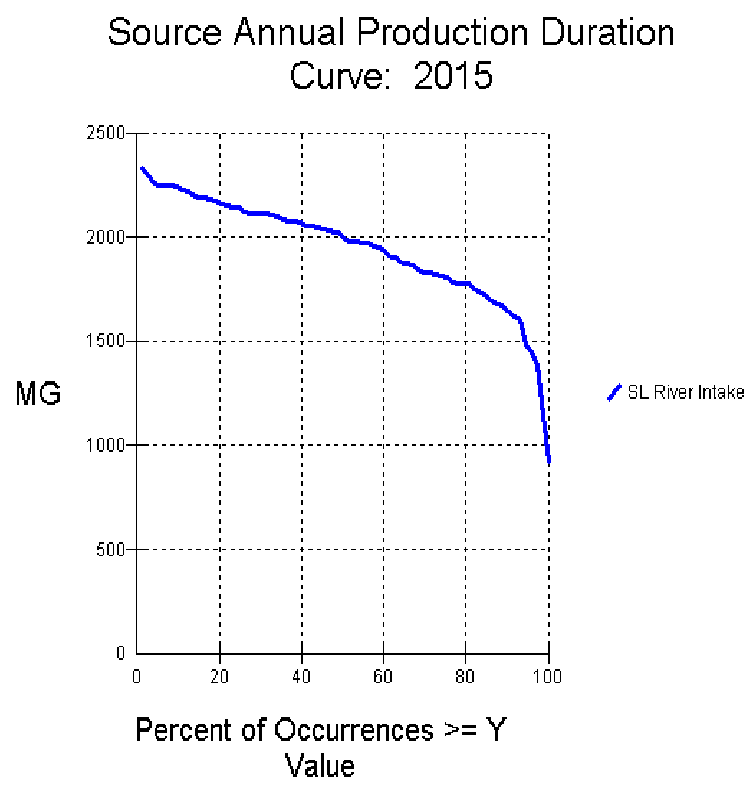
Sample Confluence Charts: Water Supply Reliability





Sample Confluence Charts: Source Production





Sample Excel Table: Average Monthly Source Production

		Beltz				Desal				Felton				Laguna			
		Beltz	Beltz	Beltz	Beltz	Desal	Desal	Desal	Desal	Felton	Felton	Felton	Felton	aguna	aguna	aguna	aguna
		Av	Med	Max	Min	Av	Med	Max	Min	Av	Med	Max	Min	Av	Med	Max	Min
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Aug	Crit Dry	34	34	34	34	0	0	0	0	0	0	0	0	3	0	12	0
	Dry	25	25	25	25	0	0	0	0	0	0	0	0	5	3	16	0
	Normal	25	25	25	25	0	0	0	0	0	0	0	0	8	7	25	1
	Wet	25	25	25	24	0	0	0	0	0	0	0	0	30	31	52	12
	All	26	25	34	19	0	0	0	0	0	0	0	0	15	9	69	0
Sep	Crit Dry	24	24	24	23	0	0	0	0	0	0	0	0	3	1	13	0
	Dry	24	24	24	24	0	0	0	0	0	0	0	0	3	1	12	0
	Normal	23	24	24	18	0	0	0	0	3	0	34	0	7	4	24	1
	Wet	22	23	24	15	0	0	0	0	0	0	0	0	24	22	42	10
	All	23	24	24	13	0	0	0	0	0	0	34	0	12	8	45	0
Oct	Crit Dry	22	25	25	15	0	0	0	0	6	0	55	0	5	0	21	0
	Dry	22	23	25	15	0	0	0	0	0	0	0	0	9	8	27	1
	Normal	20	21	25	9	0	0	0	0	9	0	97	0	19	16	49	6
	Wet	11	12	19	2	0	0	0	0	2	0	24	0	38	38	54	27
	All	19	21	25	1	0	0	0	0	3	0	97	0	17	14	54	0
ANNUAL AVERAGE	Crit Dry	195				0				282				90			
	Dry	161				0				239				137			
	Normal	142				0				133				250			
	Wet	107				0				86				531			
	All	144				0				152				298			
PEAK-SEASON AVERAGE	Crit Dry	178				0				19				20			
	Dry	140				0				11				48			
	Normal	128				0				20				99			
	Wet	93				0				3				279			
	All	128				0				9				136			

		Liddell				Loch Lomond				Majors				SL River @ Tait St			
		Liddel	Liddel	Liddel	Liddel	Loch	Loch	Loch	Loch	Majors	Majors	Majors	Majors	SL	SL	SL	SL
		Av	Med	Max	Min	Av	Med	Max	Min	Av	Med	Max	Min	Av	Med	Max	Min
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Aug	Crit Dry	31	30	39	28	101	110	177	0	11	9	21	5	169	171	226	92
	Dry	32	30	37	28	97	101	136	61	12	11	16	9	205	208	231	162
	Normal	28	33	35	15	101	75	245	47	13	12	29	6	207	230	231	96
	Wet	33	33	43	22	42	34	125	8	29	31	31	23	225	231	231	177
	All	31	30	43	15	79	74	245	0	18	15	31	5	207	228	231	92
Sep	Crit Dry	30	29	37	27	86	96	153	0	11	9	19	8	161	160	211	119
	Dry	31	31	34	27	72	69	117	34	11	11	14	9	197	201	223	159
	Normal	27	28	36	18	76	55	151	31	13	11	26	8	200	219	223	132
	Wet	31	31	41	23	32	29	60	3	27	28	30	21	217	223	223	205
	All	29	29	41	18	64	57	162	0	17	14	30	5	197	209	223	118
Oct	Crit Dry	32	31	37	30	39	39	96	0	12	10	22	9	192	203	223	131
	Dry	33	33	38	31	30	25	64	2	12	12	19	10	210	217	231	151
	Normal	31	33	36	20	29	18	88	4	13	12	25	6	214	223	231	175
	Wet	30	28	39	23	12	4	70	0	23	24	31	8	215	217	229	172
	All	29	30	39	18	34	19	143	0	16	14	31	4	203	214	231	114
ANNUAL AVERAGE	Crit Dry	352				592				145				2135			
	Dry	346				542				140				2227			
	Normal	346				578				138				2145			
	Wet	372				449				194				1977			
	All	349				546				158				2086			
PEAK-SEASON AVERAGE	Crit Dry	189				380				73				1144			
	Dry	196				338				84				1287			
	Normal	194				336				88				1278			
	Wet	220				123				157				1276			
	All	198				279				106				1253			

Confluence modeling of In-lieu/ASR Alternatives

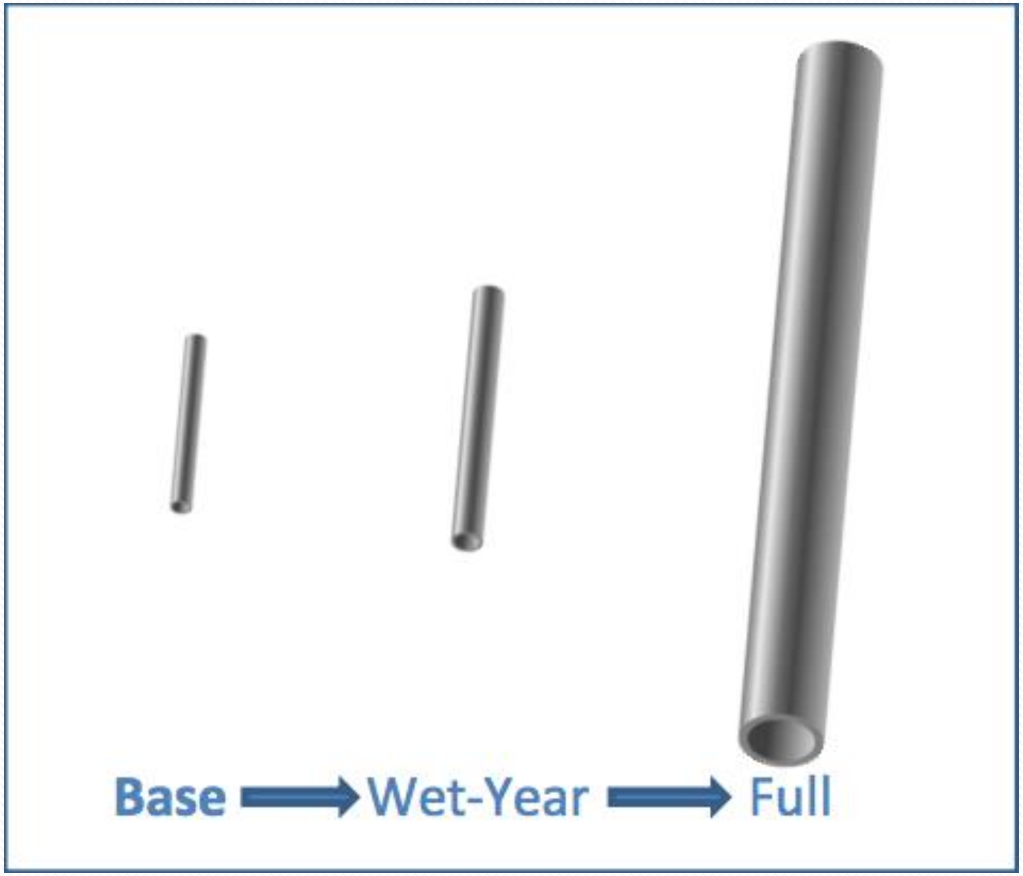
Modeling Steps

- How to model ASR and in-lieu
- Model against historical flows and climate change
- Key assumptions:
  - 3 billion gallons aquifer storage capacity
  - 20% losses
- Goal is to determine what infrastructure is necessary to achieve zero-worst-year-shortage

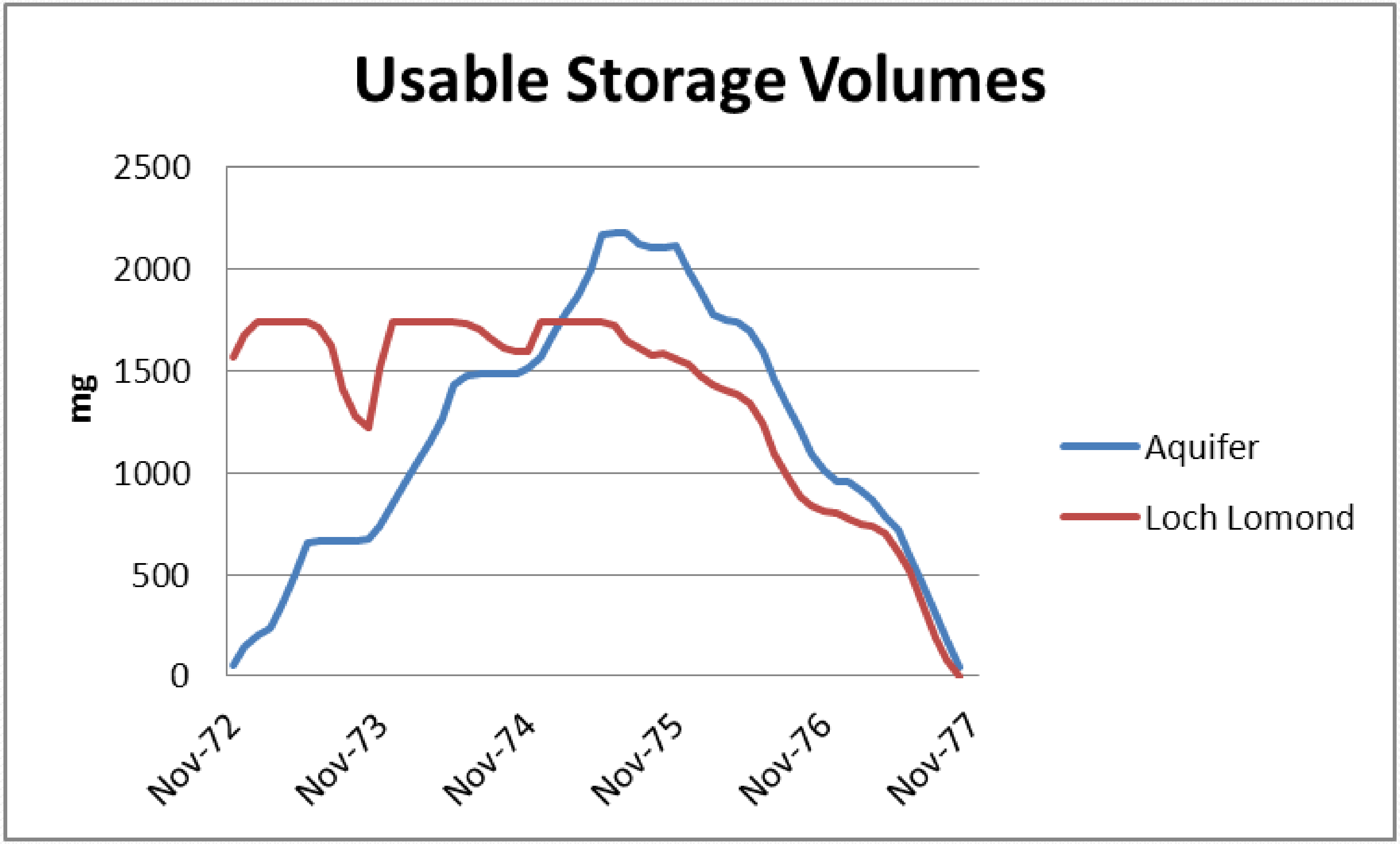
Modeling Steps (continued)

- Integration with HCP process
- Impacts of new flow rules
  - Felton bypass
  - December/April adult migration flows
- Impacts of alternate operating assumptions
  - Joint operation of surface water and groundwater storage
  - 3-year vs. 7-year aquifer fill prior to worst drought
- Impacts of climate change vs. historical flows
  - Updated climate change flow scenario?

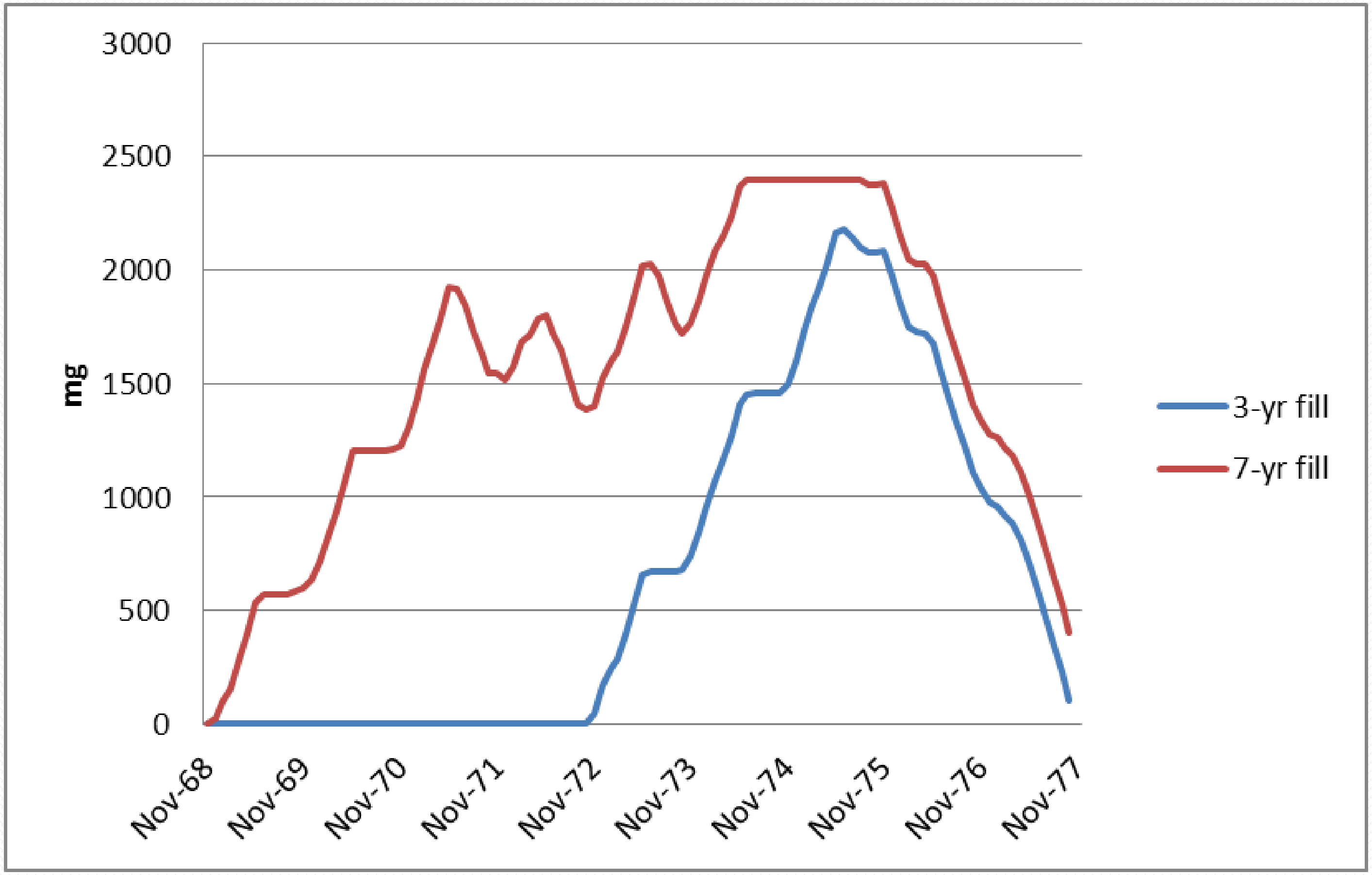
Impacts on required infrastructure of application of December/April adult migration flow rules



Joint Storage Operations



Usable aquifer storage (with same infrastructure)



REDUCED INFRASTRUCTURE REQUIREMENTS WITH 7-YR FILL

Infrastructure Needs & Remaining Worst-Year Shortages: In-lieu only

Flows	Fill Period	Infrastructure/ Shortage	Pre-Drought Hydrology
Historic	3-Year	Injection (mgd)	N/A
		Drawdown (mgd)	2.75
		Shortage (mg)	500
	7-Year	Injection (mgd)	N/A
		Drawdown (mgd)	4.5
		Shortage (mg)	0
Climate Change	3-Year	Injection (mgd)	N/A
		Drawdown (mgd)	4.0
		Shortage (mg)	500
	7-Year	Injection (mgd)	N/A
		Drawdown (mgd)	5.0
		Shortage (mg)	350

Infrastructure Needs & Remaining Worst-Year Shortages : ASR only

Flows	Fill Period	Infrastructure/ Shortage	Pre-Drought Hydrology
Historic	3-Year	Injection (mgd)	5.5
		Drawdown (mgd)	4.5
		Shortage (mg)	0
	7-Year	Injection (mgd)	3.0
		Drawdown (mgd)	4.0
		Shortage (mg)	0
Climate Change	3-Year	Injection (mgd)	7.0
		Drawdown (mgd)	6.0
		Shortage (mg)	0
	7-Year	Injection (mgd)	7.0
		Drawdown (mgd)	7.0
		Shortage (mg)	0

Infrastructure Needs & Remaining Worst-Year Shortages : In-lieu/ASR

Flows	Fill Period	Infrastructure/ Shortage	Pre-Drought Hydrology
Historic	3-Year	Injection (mgd)	2.0
		Drawdown (mgd)	4.5
		Shortage (mg)	0
	7-Year	Injection (mgd)	0.0
		Drawdown (mgd)	4.5
		Shortage (mg)	0
Climate Change	3-Year	Injection (mgd)	3.0
		Drawdown (mgd)	6.5
		Shortage (mg)	0
	7-Year	Injection (mgd)	4.0
		Drawdown (mgd)	6.5
		Shortage (mg)	0

Questions? Comments?