RECLAMATION

Managing Water in the West

Colorado River Basin Operational Model Development

RiverWare User Group Meeting
February 11, 2009

U.S. Department of the Interior
Bureau of Reclamation

Colorado River Basin Operational Model Development

- Davis Parker Hourly Model
- 24-Month Study Expanded Model
  - Lower Basin Enhancements
  - Upper Basin Enhancements
- 24-Month Study Probabilistic Model

RECLAMATION

Lower Basin Colorado River Reservoir Management

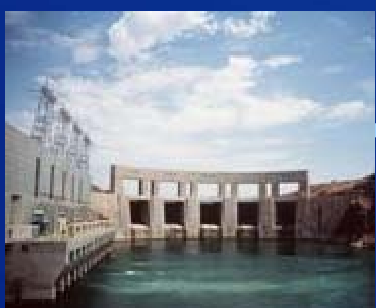
Lake Mead

Hoover Dam

Lake Mohave

Davis Dam

Lake Havasu



Parker Dam

- Parker and Davis Dams
  - Set daily releases to meet water demands
  - Set hourly releases within the day to meet peak power demands while still meeting daily water demands
- Hoover Dam
  - Set monthly release, convert to energy, and provide to Western Area Power Administration

RECLAMATION

Davis-Parker Hourly Model
Aka: The New MSU

- Use RiverWare's new Unit Power Method to replace outdated spreadsheet model
- Better utilize HDB by transferring and storing data with Database DMI
- Provide increased security for Continuity of Operations emergency plan
- Use RPL to verify guidelines for operating units have been met and to move between hourly and daily timeslots within the same model

RECLAMATION

MSU (Lotus 123)

PRINSCED | 'PARKER WATER SCHEDULE

PKR | DVS | C | D | E | F | G

PARKER WATER SCHEDULE | RUN | **CURRENT DAY** | 15-Feb

07:12 AM **Last Update**

MO	DAY	YEAR	
2	15	2006	WED

WAPA SHEET DONE!

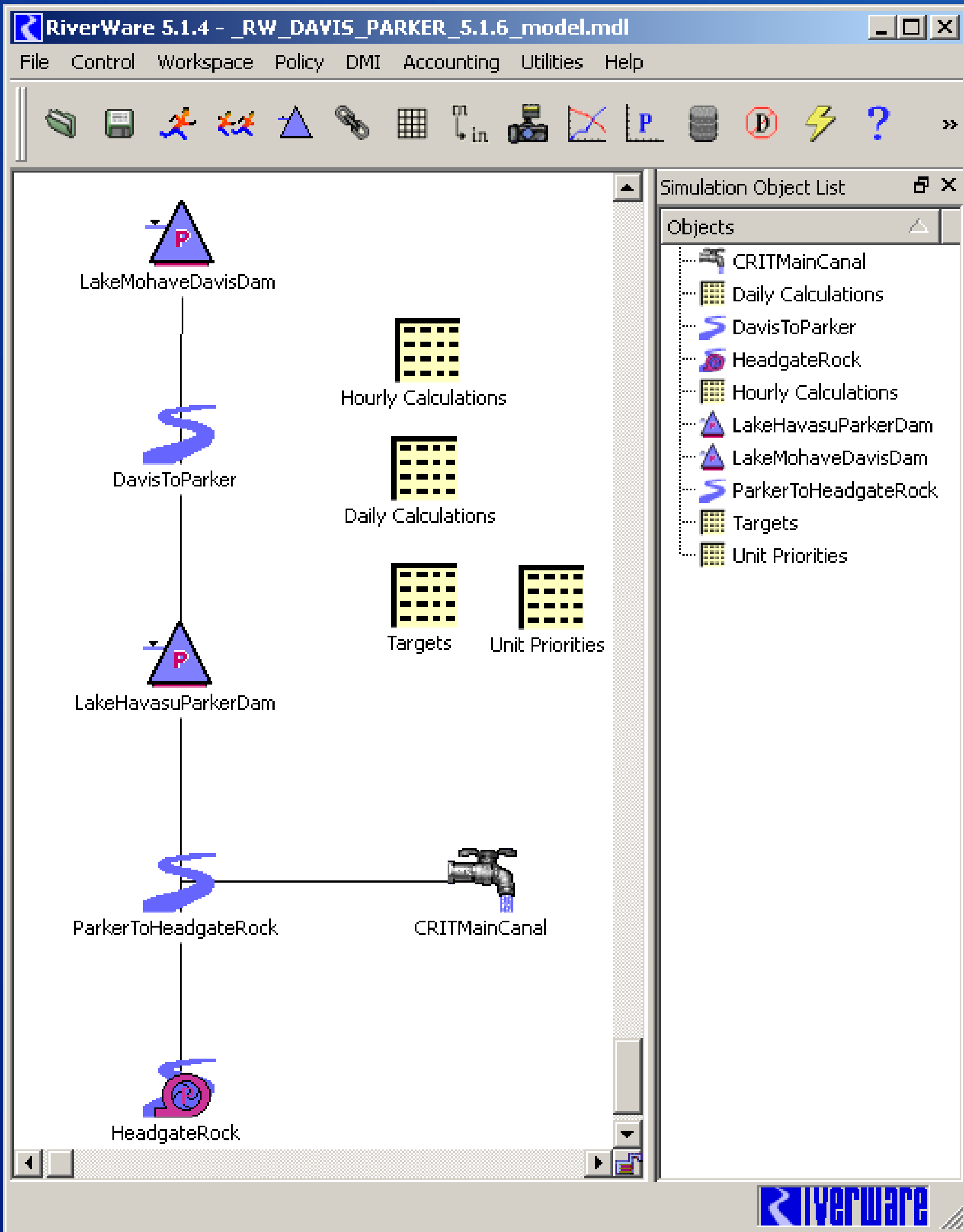
HR	P1	P2	P3	P4	FBAY	TRACE	HEAD	FLOW	sced MWH	act MWH	HR	DAY	rounded mwh equ.
1	-1	27	0	0	447.02	366.77	80.25	4.94	7	26	1	CUR	19
2	-1	15	0	0	447.01	366.27	80.74	3.18	7	15	2	CUR	8
3	-1	8	0	0	447.10	365.82	81.28	2.05	7	7	3	CUR	0
4	-1	8	0	0	447.12	364.95	82.17	2.05	7	7	4	CUR	0
5	-1	8	0	0	447.07	364.76	82.31	2.08	26	7	5	CUR	-19
6	-1	25	0	0	447.11	364.74	82.37	4.49	26	25	6		-1
7	0	27	0	0	447.14	365.47	81.67	5.05	26	27	7	CUR	1
8	22	27	0	0	447.12	366.07	81.05	9.17	54	49	8	CUR	-5
9	27	27	0	0	447.12	368.79	78.33	9.80	54	0	9	CUR	0
10	27	27	0	0	447.12	368.79	78.33	9.80	54	0	10	CUR	0
11	27	27	0	0	447.12	368.79	78.33	9.80	54	0	11	CUR	0
12	27	27	0	0	447.12	368.79	78.33	9.80	54	0	12	CUR	0
13	27	27	0	0	447.12	368.79	78.33	9.80	54	0	13	CUR	0
14	27	27	0	0	447.12	368.79	78.33	9.80	54	0	14	CUR	0
15	27	27	0	0	447.12	368.79	78.33	9.80	54	0	15	CUR	0
16	27	27	0	0	447.12	368.79	78.33	9.80	54	0	16	CUR	0
17	27	27	8	0	447.12	369.81	77.31	12.29	62	0	17	CUR	0
18	27	27	8	0	447.12	369.81	77.31	12.29	62	0	18	CUR	0
19	27	27	8	0	447.12	369.81	77.31	12.29	62	0	19	CUR	0
20	27	27	8	0	447.12	369.81	77.31	12.29	62	0	20	CUR	0
21	27	27	0	0	447.12	368.79	78.33	9.80	54	0	21	CUR	0
22	27	27	0	0	447.12	368.79	78.33	9.80	54	0	22	CUR	0
23	8	27	0	0	447.12	367.53	79.59	7.13	35	0	23	CUR	0
24	-1	27	0	0	447.12	366.17	80.95	4.73	26	0	24	CUR	0

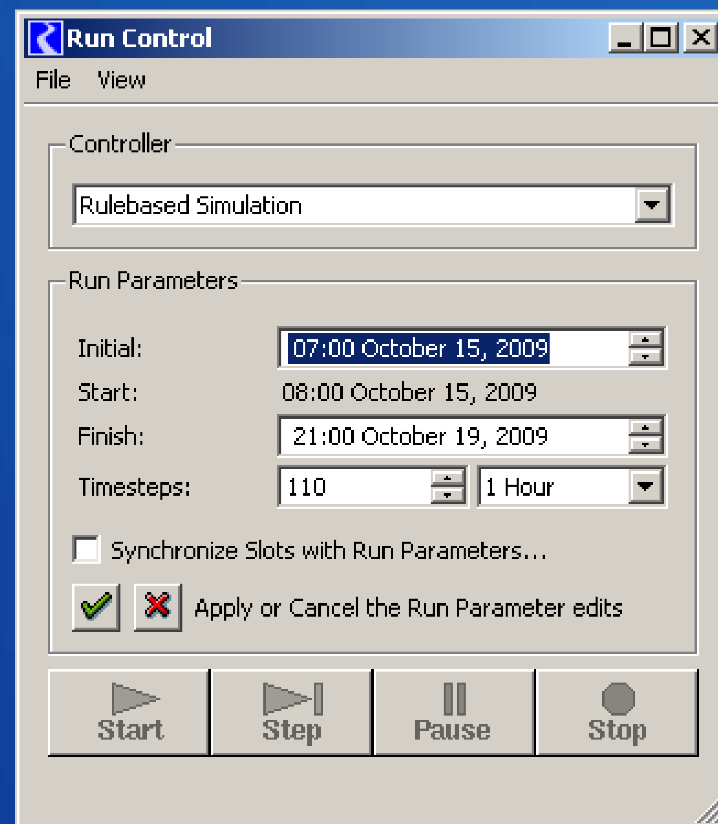
AVG RELEASE TOT	8.00	1006	3	total meg value 545
SCHED AVG RELE/	8.00			
SCHEDULE ERROF	-0.00			

Arial MT Black | 16 | No style | General | Ready

RECLAMATION

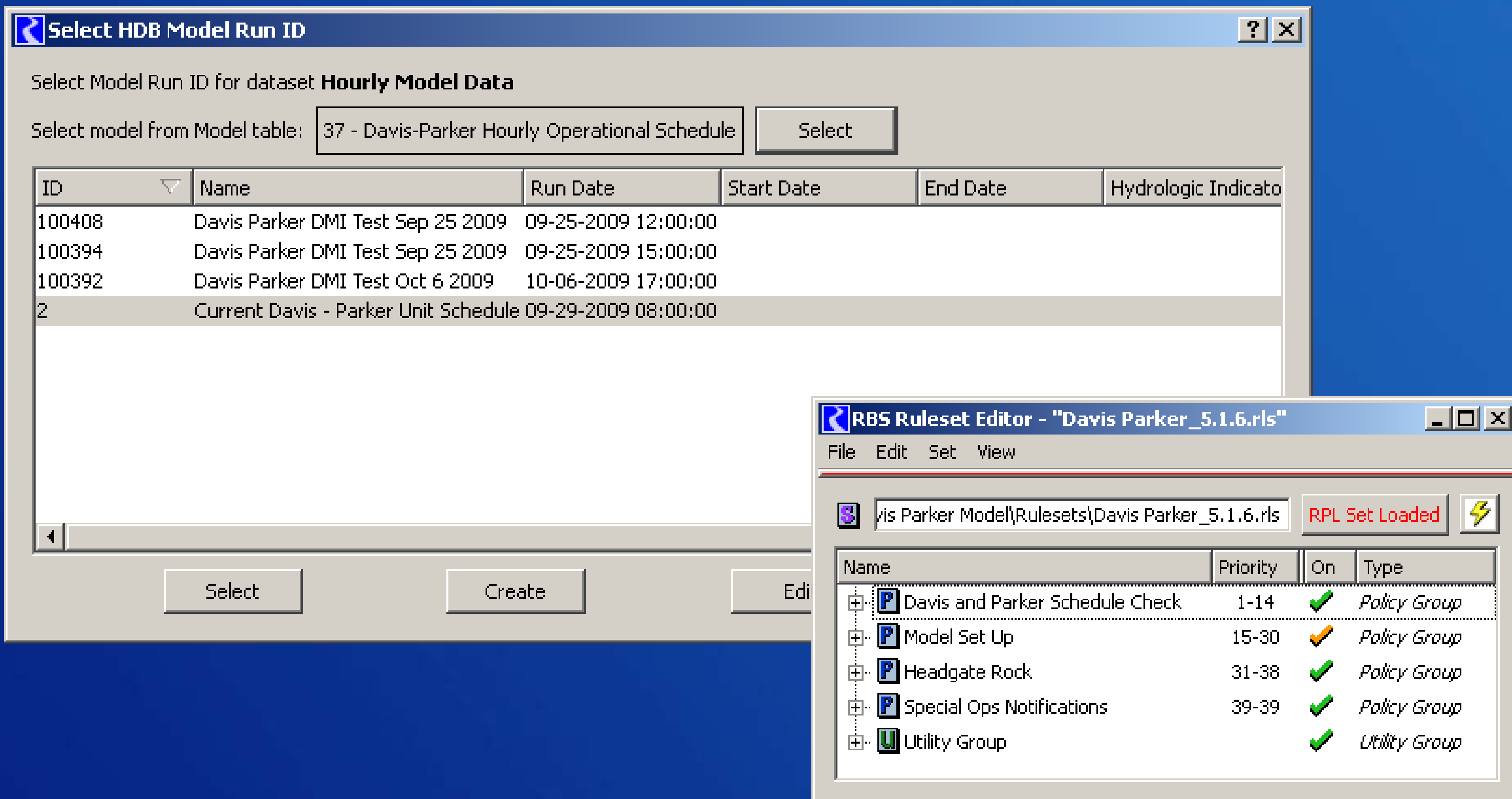
Davis-Parker Model (RiverWare)





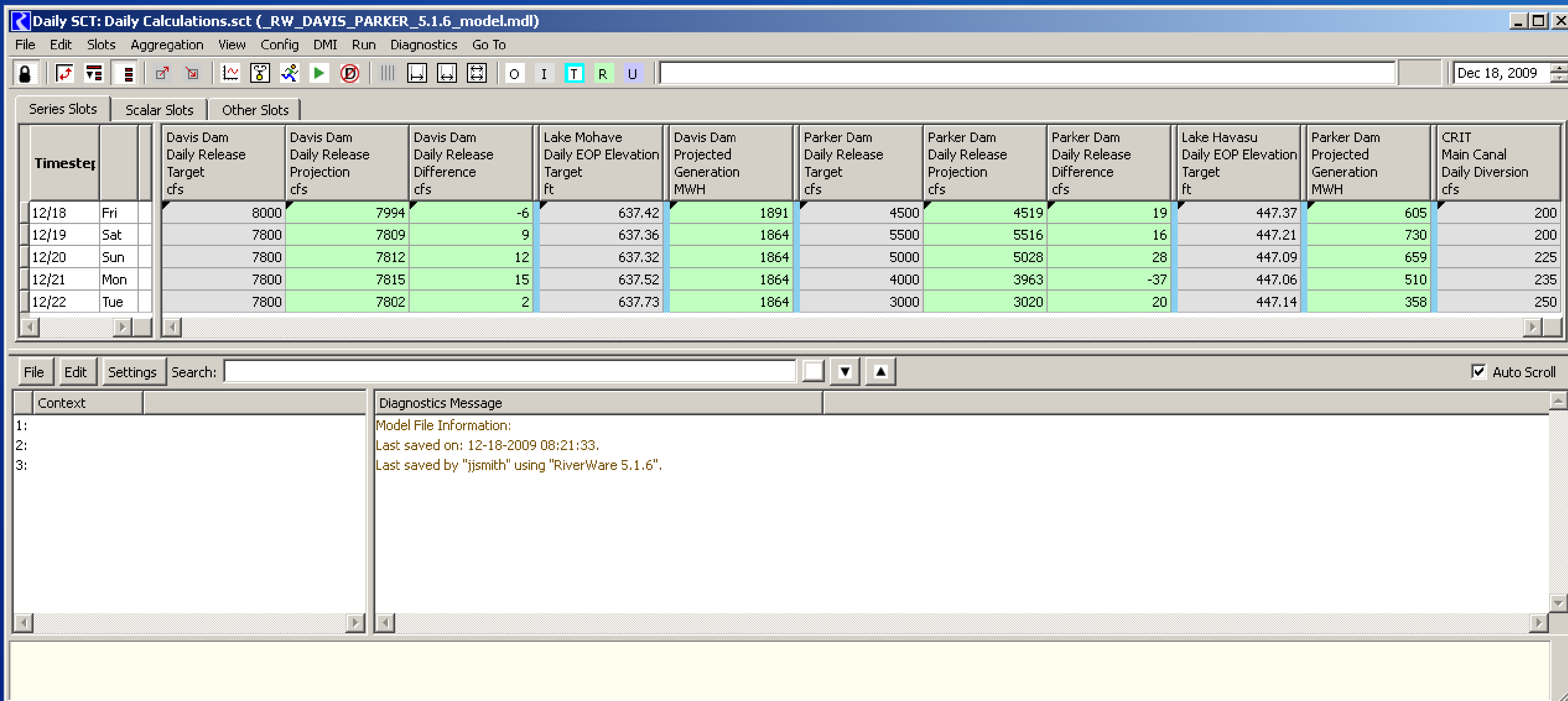
RECLAMATION

Davis-Parker Model



RECLAMATION

Davis-Parker Model



Timestep		Davis Dam Daily Release Target cfs	Davis Dam Daily Release Projection cfs	Davis Dam Daily Release Difference cfs	Lake Mohave Daily EOP Elevation Target ft	Davis Dam Projected Generation MWH	Parker Dam Daily Release Target cfs	Parker Dam Daily Release Projection cfs	Parker Dam Daily Release Difference cfs	Lake Havasu Daily EOP Elevation Target ft	Parker Dam Projected Generation MWH	CRIT Main Canal Daily Diversion cfs
12/18	Fri	8000	7994	-6	637.42	1891	4500	4519	19	447.37	605	200
12/19	Sat	7800	7809	9	637.36	1864	5500	5516	16	447.21	730	200
12/20	Sun	7800	7812	12	637.32	1864	5000	5028	28	447.09	659	225
12/21	Mon	7800	7815	15	637.52	1864	4000	3963	-37	447.06	510	235
12/22	Tue	7800	7802	2	637.73	1864	3000	3020	20	447.14	358	250

Davis-Parker Model

SCT Davis Dam Profile.sct (_RW_DAVIS_PARKER_5.1.4_model.mdl)

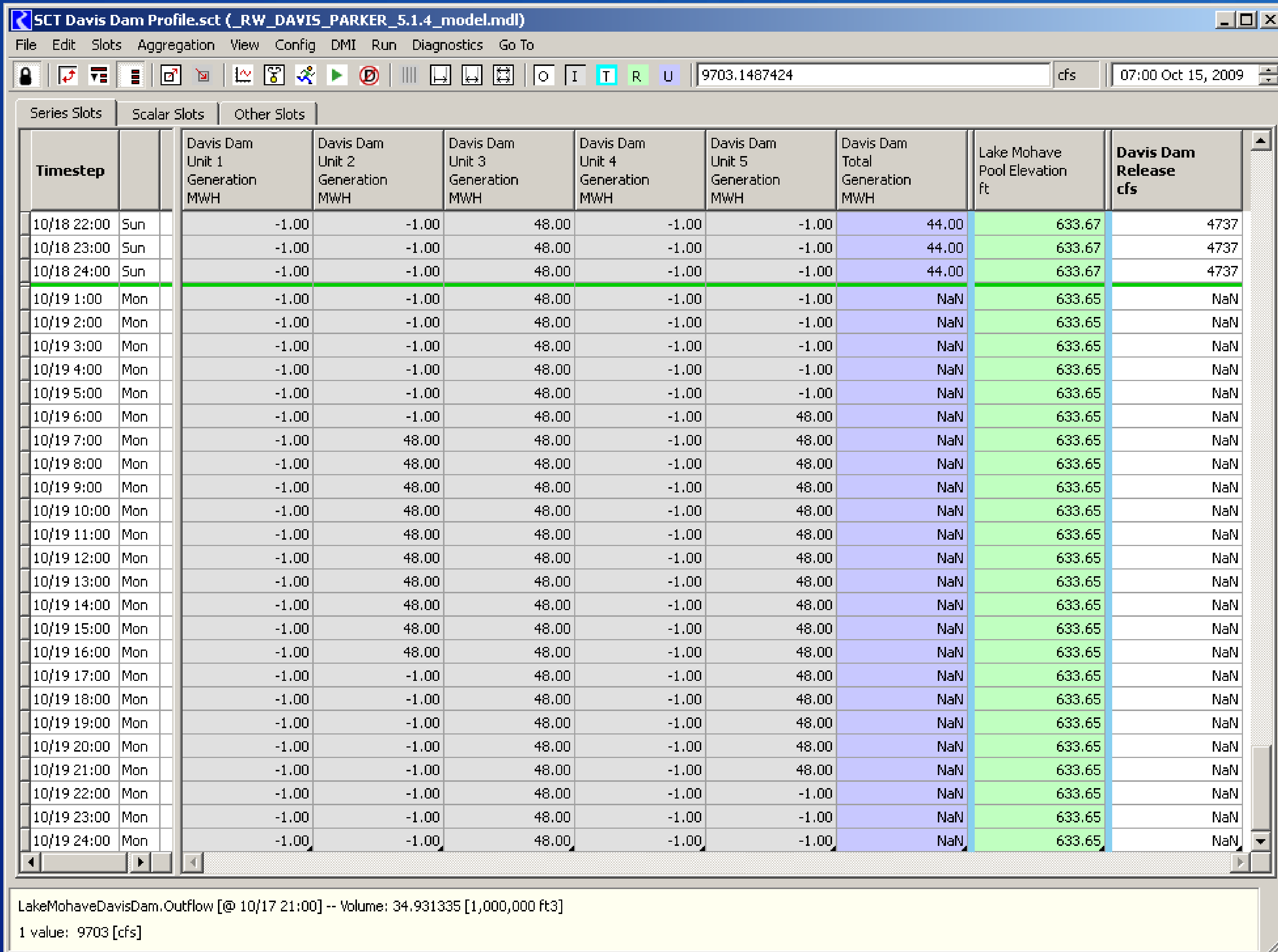
File Edit Slots Aggregation View Config DMI Run Diagnostics Go To

O I T R U -1.3 MWH 08:00 Oct 15, 2009

Series Slots | Scalar Slots | Other Slots

Timestep		Davis Dam Unit 1 Generation MWH	Davis Dam Unit 2 Generation MWH	**Davis Dam Unit 3 Generation MWH**	Davis Dam Unit 4 Generation MWH	Davis Dam Unit 5 Generation MWH	Davis Dam Total Generation MWH	Lake Mohave Pool Elevation ft	Davis Dam Release cfs
10/18 18:00	Sun	-1.00	-1.00	48.00	-1.00	48.00	93.00	633.67	9707
10/18 19:00	Sun	-1.00	-1.00	48.00	-1.00	48.00	93.00	633.67	9707
10/18 20:00	Sun	-1.00	-1.00	48.00	-1.00	48.00	93.00	633.67	9707
10/18 21:00	Sun	-1.00	-1.00	48.00	-1.00	48.00	93.00	633.67	9707
10/18 22:00	Sun	-1.00	-1.00	48.00	-1.00	-1.00	44.00	633.67	4737
10/18 23:00	Sun	-1.00	-1.00	48.00	-1.00	-1.00	44.00	633.67	4737
10/18 24:00	Sun	-1.00	-1.00	48.00	-1.00	-1.00	44.00	633.67	4737
10/19 1:00	Mon	-1.00	-1.00	48.00	-1.00	-1.00	NaN	633.65	NaN
10/19 2:00	Mon	-1.00	-1.00	48.00	-1.00	-1.00	NaN	633.65	NaN
10/19 3:00	Mon	-1.00	-1.00	48.00	-1.00	-1.00	NaN	633.65	NaN
10/19 4:00	Mon	-1.00	-1.00	48.00	-1.00	-1.00	NaN	633.65	NaN
10/19 5:00	Mon	-1.00	-1.00	48.00	-1.00	-1.00	NaN	633.65	NaN
10/19 6:00	Mon	-1.00	-1.00	48.00	-1.00	48.00	NaN	633.65	NaN
10/19 7:00	Mon	-1.00	48.00	48.00	-1.00	48.00	NaN	633.65	NaN
10/19 8:00	Mon	-1.00	48.00	48.00	-1.00	48.00	NaN	633.65	NaN
10/19 9:00	Mon	-1.00	48.00	48.00	-1.00	48.00	NaN	633.65	NaN
10/19 10:00	Mon	-1.00	48.00	48.00	-1.00	48.00	NaN	633.65	NaN
10/19 11:00	Mon	-1.00	48.00	48.00	-1.00	48.00	NaN	633.65	NaN
10/19 12:00	Mon	-1.00	48.00	48.00	-1.00	48.00	NaN	633.65	NaN
10/19 13:00	Mon	-1.00	48.00	48.00	-1.00	48.00	NaN	633.65	NaN
10/19 14:00	Mon	-1.00	48.00	48.00	-1.00	48.00	NaN	633.65	NaN
10/19 15:00	Mon	-1.00	48.00	48.00	-1.00	48.00	NaN	633.65	NaN
10/19 16:00	Mon	-1.00	48.00	48.00	-1.00	48.00	NaN	633.65	NaN
10/19 17:00	Mon	-1.00	-1.00	48.00	-1.00	48.00	NaN	633.65	NaN
10/19 18:00	Mon	-1.00	-1.00	48.00	-1.00	48.00	NaN	633.65	NaN
10/19 19:00	Mon	-1.00	-1.00	48.00	-1.00	48.00	NaN	633.65	NaN
10/19 20:00	Mon	-1.00	-1.00	48.00	-1.00	48.00	NaN	633.65	NaN
10/19 21:00	Mon	-1.00	-1.00	48.00	-1.00	48.00	NaN	633.65	NaN
10/19 22:00	Mon	-1.00	-1.00	48.00	-1.00	-1.00	NaN	633.65	NaN
10/19 23:00	Mon	-1.00	-1.00	48.00	-1.00	-1.00	NaN	633.65	NaN
10/19 24:00	Mon	-1.00	-1.00	48.00	-1.00	-1.00	NaN	633.65	NaN

Davis-Parker Model



Timestep		Davis Dam Unit 1 Generation MWH	Davis Dam Unit 2 Generation MWH	Davis Dam Unit 3 Generation MWH	Davis Dam Unit 4 Generation MWH	Davis Dam Unit 5 Generation MWH	Davis Dam Total Generation MWH	Lake Mohave Pool Elevation ft	**Davis Dam Release cfs**
10/18 22:00	Sun	-1.00	-1.00	48.00	-1.00	-1.00	44.00	633.67	4737
10/18 23:00	Sun	-1.00	-1.00	48.00	-1.00	-1.00	44.00	633.67	4737
10/18 24:00	Sun	-1.00	-1.00	48.00	-1.00	-1.00	44.00	633.67	4737
10/19 1:00	Mon	-1.00	-1.00	48.00	-1.00	-1.00	NaN	633.65	NaN
10/19 2:00	Mon	-1.00	-1.00	48.00	-1.00	-1.00	NaN	633.65	NaN
10/19 3:00	Mon	-1.00	-1.00	48.00	-1.00	-1.00	NaN	633.65	NaN
10/19 4:00	Mon	-1.00	-1.00	48.00	-1.00	-1.00	NaN	633.65	NaN
10/19 5:00	Mon	-1.00	-1.00	48.00	-1.00	-1.00	NaN	633.65	NaN
10/19 6:00	Mon	-1.00	-1.00	48.00	-1.00	48.00	NaN	633.65	NaN
10/19 7:00	Mon	-1.00	48.00	48.00	-1.00	48.00	NaN	633.65	NaN
10/19 8:00	Mon	-1.00	48.00	48.00	-1.00	48.00	NaN	633.65	NaN
10/19 9:00	Mon	-1.00	48.00	48.00	-1.00	48.00	NaN	633.65	NaN
10/19 10:00	Mon	-1.00	48.00	48.00	-1.00	48.00	NaN	633.65	NaN
10/19 11:00	Mon	-1.00	48.00	48.00	-1.00	48.00	NaN	633.65	NaN
10/19 12:00	Mon	-1.00	48.00	48.00	-1.00	48.00	NaN	633.65	NaN
10/19 13:00	Mon	-1.00	48.00	48.00	-1.00	48.00	NaN	633.65	NaN
10/19 14:00	Mon	-1.00	48.00	48.00	-1.00	48.00	NaN	633.65	NaN
10/19 15:00	Mon	-1.00	48.00	48.00	-1.00	48.00	NaN	633.65	NaN
10/19 16:00	Mon	-1.00	48.00	48.00	-1.00	48.00	NaN	633.65	NaN
10/19 17:00	Mon	-1.00	-1.00	48.00	-1.00	48.00	NaN	633.65	NaN
10/19 18:00	Mon	-1.00	-1.00	48.00	-1.00	48.00	NaN	633.65	NaN
10/19 19:00	Mon	-1.00	-1.00	48.00	-1.00	48.00	NaN	633.65	NaN
10/19 20:00	Mon	-1.00	-1.00	48.00	-1.00	48.00	NaN	633.65	NaN
10/19 21:00	Mon	-1.00	-1.00	48.00	-1.00	48.00	NaN	633.65	NaN
10/19 22:00	Mon	-1.00	-1.00	48.00	-1.00	-1.00	NaN	633.65	NaN
10/19 23:00	Mon	-1.00	-1.00	48.00	-1.00	-1.00	NaN	633.65	NaN
10/19 24:00	Mon	-1.00	-1.00	48.00	-1.00	-1.00	NaN	633.65	NaN

Davis-Parker Model

LakeMohaveDavisDam.Unit Power Table

File Edit Row Column View Adjust

Unit Power Table

Value: 122 ft

	Unit 1 Head ft	Unit 1 Flow cfs	Unit 1 Power MW	Unit 2 Head ft	Unit 2 Flow cfs	Unit 2 Power MW	Unit 3 Head ft	Unit 3 Flow cfs	Unit 3 Power MW	Unit 4 Head ft	Unit 4 Flow cfs	Unit 4 Power MW	Unit 5 Head ft	Unit 5 Flow cfs	Unit 5 Power MW
0	122.0	0	0	122.0	0	0	122.0	0	0	122.0	0	0	122.0	0	0
1	122.0	828	1	122.0	828	1	122.0	828	1	122.0	828	1	122.0	828	1
2	122.0	865	2	122.0	865	2	122.0	865	2	122.0	865	2	122.0	865	2
3	122.0	924	3	122.0	924	3	122.0	924	3	122.0	924	3	122.0	924	3
4	122.0	997	4	122.0	997	4	122.0	997	4	122.0	997	4	122.0	997	4
5	122.0	1080	5	122.0	1080	5	122.0	1080	5	122.0	1080	5	122.0	1080	5
6	122.0	1169	6	122.0	1169	6	122.0	1169	6	122.0	1169	6	122.0	1169	6
7	122.0	1262	7	122.0	1262	7	122.0	1262	7	122.0	1262	7	122.0	1262	7
8	122.0	1358	8	122.0	1358	8	122.0	1358	8	122.0	1358	8	122.0	1358	8
9	122.0	1454	9	122.0	1454	9	122.0	1454	9	122.0	1454	9	122.0	1454	9
10	122.0	1551	10	122.0	1551	10	122.0	1551	10	122.0	1551	10	122.0	1551	10
11	122.0	1647	11	122.0	1647	11	122.0	1647	11	122.0	1647	11	122.0	1647	11
12	122.0	1742	12	122.0	1742	12	122.0	1742	12	122.0	1742	12	122.0	1742	12
13	122.0	1837	13	122.0	1837	13	122.0	1837	13	122.0	1837	13	122.0	1837	13
14	122.0	1931	14	122.0	1931	14	122.0	1931	14	122.0	1931	14	122.0	1931	14
15	122.0	2024	15	122.0	2024	15	122.0	2024	15	122.0	2024	15	122.0	2024	15
16	122.0	2116	16	122.0	2116	16	122.0	2116	16	122.0	2116	16	122.0	2116	16
17	122.0	2207	17	122.0	2207	17	122.0	2207	17	122.0	2207	17	122.0	2207	17
18	122.0	2297	18	122.0	2297	18	122.0	2297	18	122.0	2297	18	122.0	2297	18
19	122.0	2387	19	122.0	2387	19	122.0	2387	19	122.0	2387	19	122.0	2387	19
20	122.0	2476	20	122.0	2476	20	122.0	2476	20	122.0	2476	20	122.0	2476	20
21	122.0	2564	21	122.0	2564	21	122.0	2564	21	122.0	2564	21	122.0	2564	21
22	122.0	2653	22	122.0	2653	22	122.0	2653	22	122.0	2653	22	122.0	2653	22
23	122.0	2741	23	122.0	2741	23	122.0	2741	23	122.0	2741	23	122.0	2741	23
24	122.0	2830	24	122.0	2830	24	122.0	2830	24	122.0	2830	24	122.0	2830	24
25	122.0	2918	25	122.0	2918	25	122.0	2918	25	122.0	2918	25	122.0	2918	25
26	122.0	3007	26	122.0	3007	26	122.0	3007	26	122.0	3007	26	122.0	3007	26

LakeMohaveDavisDam.Tailwater Table

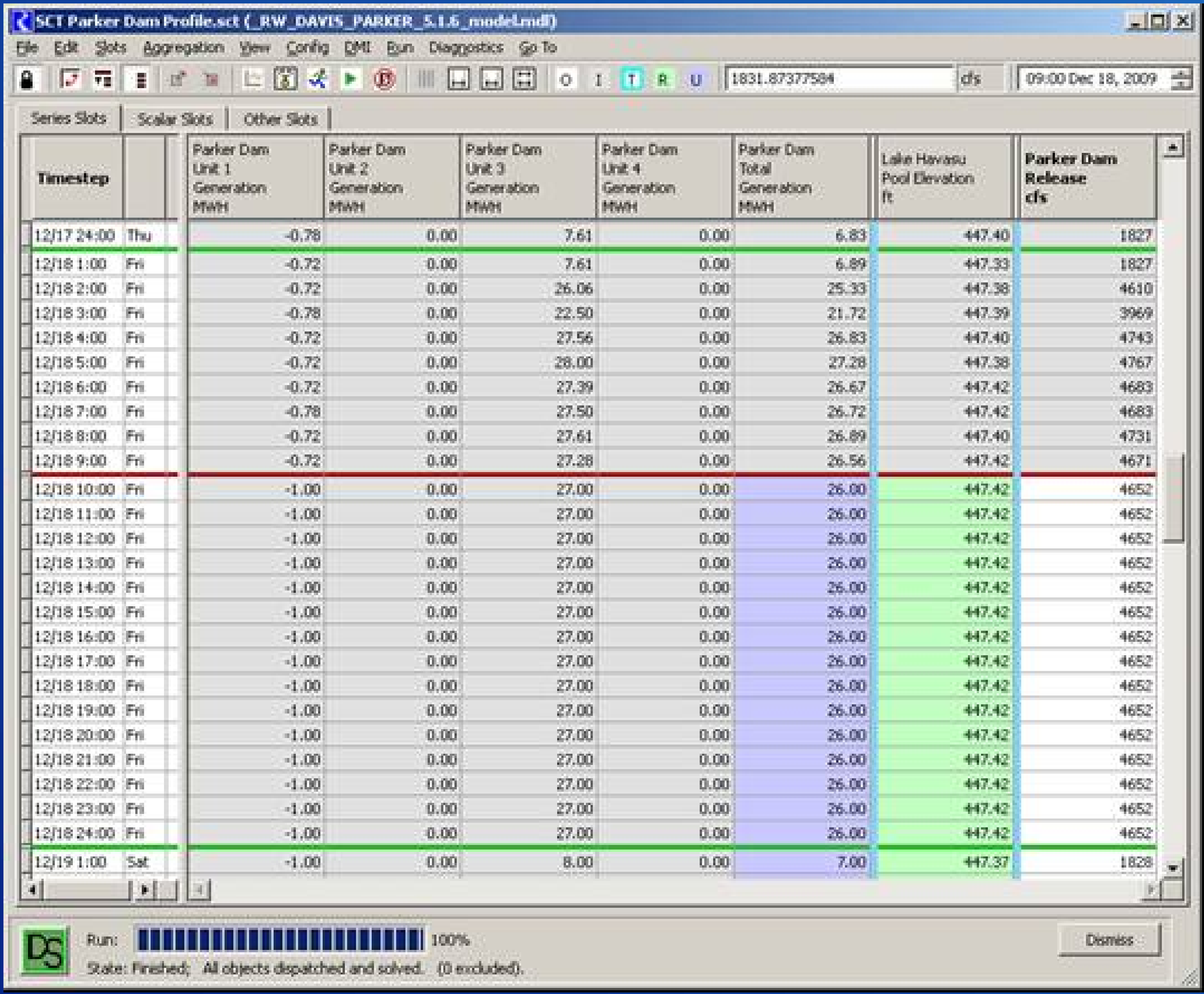
File Edit Row Column View Adjust

Tailwater Table

Value: 0 cfs

	Outflow cfs	TW Elevation ft
0: 0	0	495.90
1: 1	11	495.91
2: 2	29	495.92
3: 3	47	495.93
4: 4	66	495.94
5: 5	84	495.95
6: 6	102	495.96
7: 7	120	495.97
8: 8	139	495.98

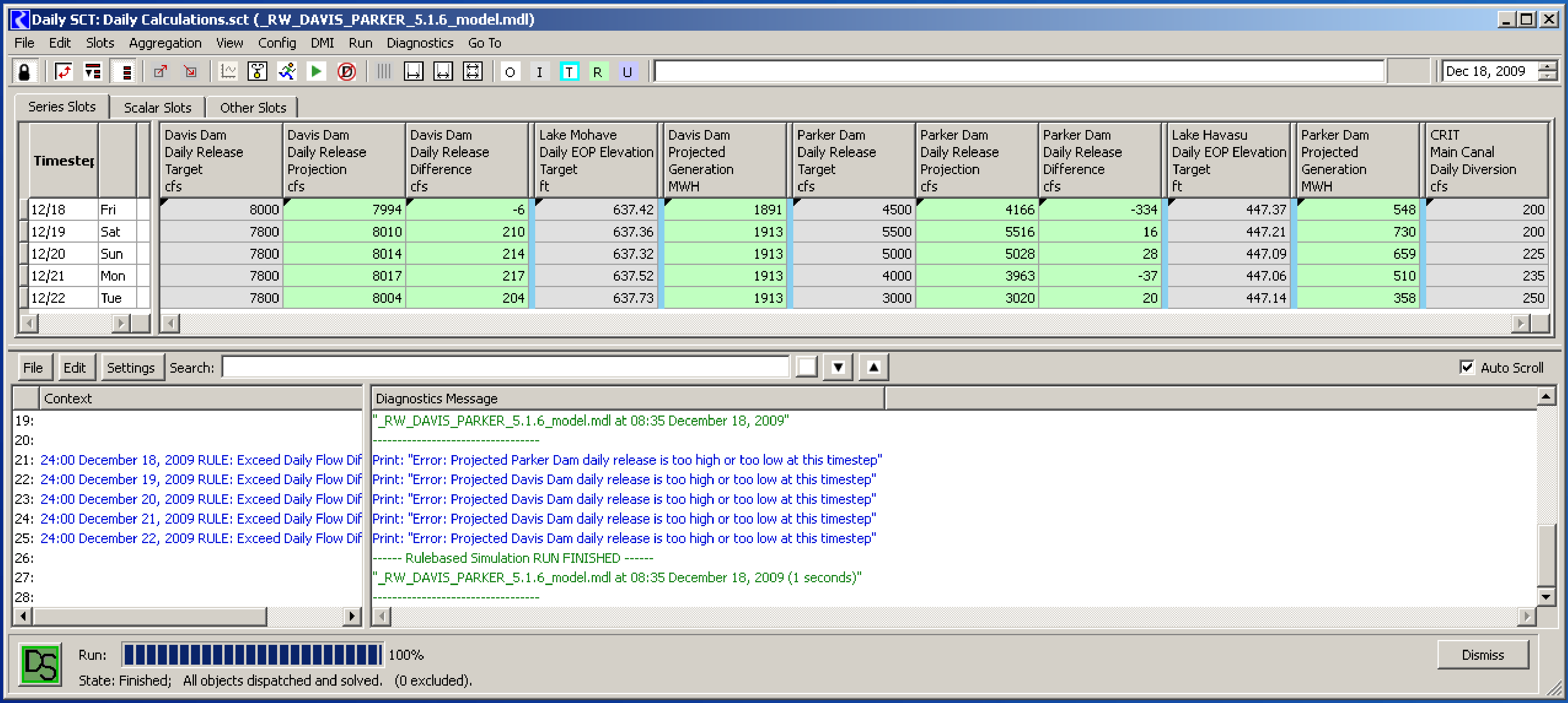
Davis-Parker Model



Timestep		Parker Dam Unit 1 Generation MWH	Parker Dam Unit 2 Generation MWH	Parker Dam Unit 3 Generation MWH	Parker Dam Unit 4 Generation MWH	Parker Dam Total Generation MWH	Lake Havasu Pool Elevation ft	**Parker Dam Release cfs**
12/17 24:00	Thu	-0.78	0.00	7.61	0.00	6.83	447.40	1827
12/18 1:00	Fri	-0.72	0.00	7.61	0.00	6.89	447.33	1827
12/18 2:00	Fri	-0.72	0.00	26.06	0.00	25.33	447.38	4610
12/18 3:00	Fri	-0.78	0.00	22.50	0.00	21.72	447.39	3969
12/18 4:00	Fri	-0.72	0.00	27.56	0.00	26.83	447.40	4743
12/18 5:00	Fri	-0.72	0.00	28.00	0.00	27.28	447.38	4767
12/18 6:00	Fri	-0.72	0.00	27.39	0.00	26.67	447.42	4683
12/18 7:00	Fri	-0.78	0.00	27.50	0.00	26.72	447.42	4683
12/18 8:00	Fri	-0.72	0.00	27.61	0.00	26.89	447.40	4731
12/18 9:00	Fri	-0.72	0.00	27.28	0.00	26.56	447.42	4671
12/18 10:00	Fri	-1.00	0.00	27.00	0.00	26.00	447.42	4652
12/18 11:00	Fri	-1.00	0.00	27.00	0.00	26.00	447.42	4652
12/18 12:00	Fri	-1.00	0.00	27.00	0.00	26.00	447.42	4652
12/18 13:00	Fri	-1.00	0.00	27.00	0.00	26.00	447.42	4652
12/18 14:00	Fri	-1.00	0.00	27.00	0.00	26.00	447.42	4652
12/18 15:00	Fri	-1.00	0.00	27.00	0.00	26.00	447.42	4652
12/18 16:00	Fri	-1.00	0.00	27.00	0.00	26.00	447.42	4652
12/18 17:00	Fri	-1.00	0.00	27.00	0.00	26.00	447.42	4652
12/18 18:00	Fri	-1.00	0.00	27.00	0.00	26.00	447.42	4652
12/18 19:00	Fri	-1.00	0.00	27.00	0.00	26.00	447.42	4652
12/18 20:00	Fri	-1.00	0.00	27.00	0.00	26.00	447.42	4652
12/18 21:00	Fri	-1.00	0.00	27.00	0.00	26.00	447.42	4652
12/18 22:00	Fri	-1.00	0.00	27.00	0.00	26.00	447.42	4652
12/18 23:00	Fri	-1.00	0.00	27.00	0.00	26.00	447.42	4652
12/18 24:00	Fri	-1.00	0.00	27.00	0.00	26.00	447.42	4652
12/19 1:00	Sat	-1.00	0.00	8.00	0.00	7.00	447.37	1828

RECLAMATION

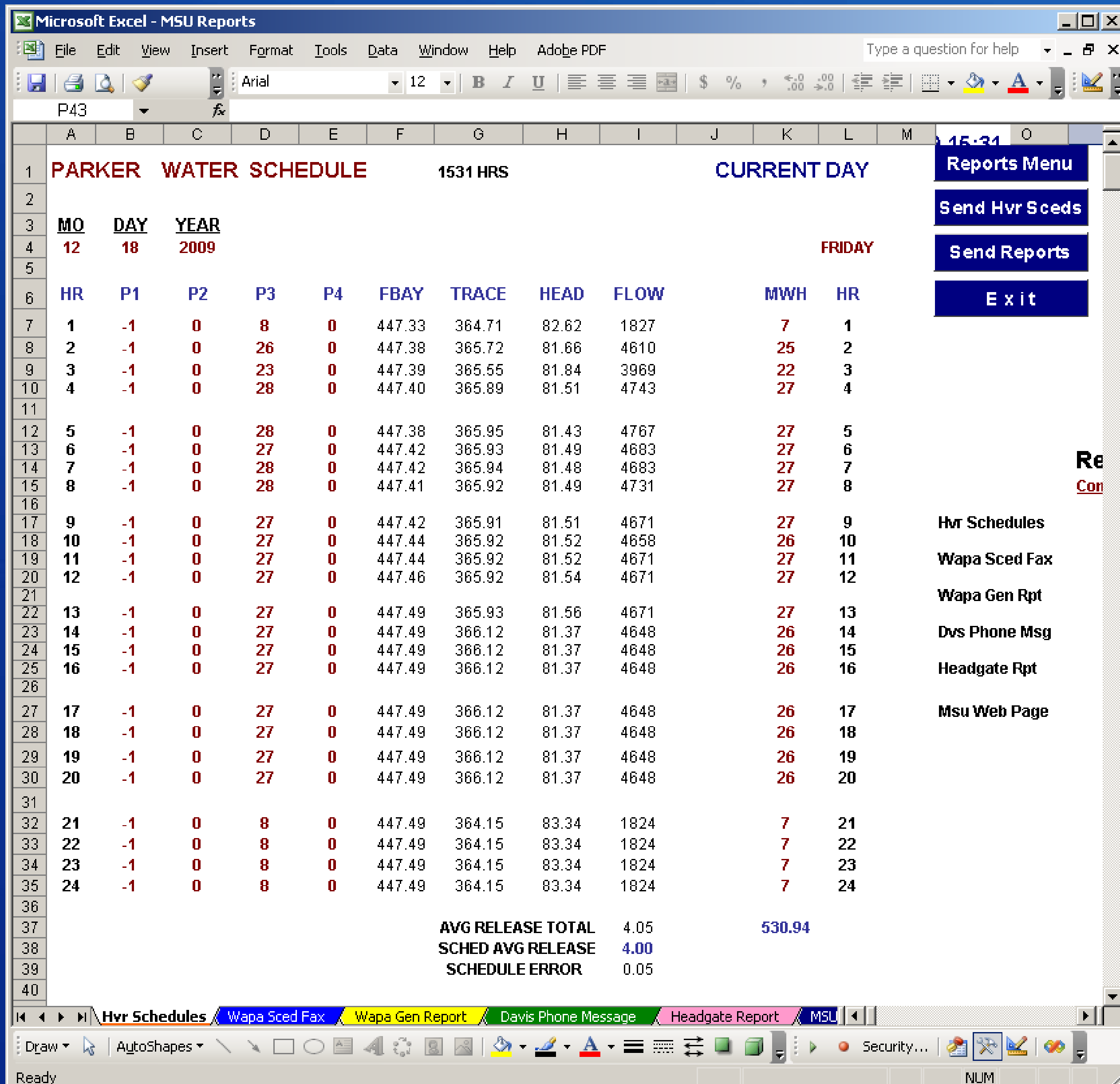
Davis-Parker Model



Timestep		Davis Dam Daily Release Target cfs	Davis Dam Daily Release Projection cfs	Davis Dam Daily Release Difference cfs	Lake Mohave Daily EOP Elevation Target ft	Davis Dam Projected Generation MWH	Parker Dam Daily Release Target cfs	Parker Dam Daily Release Projection cfs	Parker Dam Daily Release Difference cfs	Lake Havasu Daily EOP Elevation Target ft	Parker Dam Projected Generation MWH	CRIT Main Canal Daily Diversion cfs
12/18	Fri	8000	7994	-6	637.42	1891	4500	4166	-334	447.37	548	200
12/19	Sat	7800	8010	210	637.36	1913	5500	5516	16	447.21	730	200
12/20	Sun	7800	8014	214	637.32	1913	5000	5028	28	447.09	659	225
12/21	Mon	7800	8017	217	637.52	1913	4000	3963	-37	447.06	510	235
12/22	Tue	7800	8004	204	637.73	1913	3000	3020	20	447.14	358	250

RECLAMATION

Davis-Parker Report Output



Microsoft Excel - MSU Reports

PARKER WATER SCHEDULE 1531 HRS CURRENT DAY

MO	DAY	YEAR
12	18	2009

FRIDAY

HR	P1	P2	P3	P4	FBAY	TRACE	HEAD	FLOW	MWH	HR
1	-1	0	8	0	447.33	364.71	82.62	1827	7	1
2	-1	0	26	0	447.38	365.72	81.66	4610	25	2
3	-1	0	23	0	447.39	365.55	81.84	3969	22	3
4	-1	0	28	0	447.40	365.89	81.51	4743	27	4
5	-1	0	28	0	447.38	365.95	81.43	4767	27	5
6	-1	0	27	0	447.42	365.93	81.49	4683	27	6
7	-1	0	28	0	447.42	365.94	81.48	4683	27	7
8	-1	0	28	0	447.41	365.92	81.49	4731	27	8
9	-1	0	27	0	447.42	365.91	81.51	4671	27	9
10	-1	0	27	0	447.44	365.92	81.52	4658	26	10
11	-1	0	27	0	447.44	365.92	81.52	4671	27	11
12	-1	0	27	0	447.46	365.92	81.54	4671	27	12
13	-1	0	27	0	447.49	365.93	81.56	4671	27	13
14	-1	0	27	0	447.49	366.12	81.37	4648	26	14
15	-1	0	27	0	447.49	366.12	81.37	4648	26	15
16	-1	0	27	0	447.49	366.12	81.37	4648	26	16
17	-1	0	27	0	447.49	366.12	81.37	4648	26	17
18	-1	0	27	0	447.49	366.12	81.37	4648	26	18
19	-1	0	27	0	447.49	366.12	81.37	4648	26	19
20	-1	0	27	0	447.49	366.12	81.37	4648	26	20
21	-1	0	8	0	447.49	364.15	83.34	1824	7	21
22	-1	0	8	0	447.49	364.15	83.34	1824	7	22
23	-1	0	8	0	447.49	364.15	83.34	1824	7	23
24	-1	0	8	0	447.49	364.15	83.34	1824	7	24

AVG RELEASE TOTAL 4.05 530.94
SCHED AVG RELEASE 4.00
SCHEDULE ERROR 0.05

24-Month Study Model

- Monthly timestep model
  - Projects reservoir elevations, releases 24 – 30 months into the future throughout basin
- Deterministic model
- Coordination between Upper Colorado and Lower Colorado regions
- Run once a month

RECLAMATION

24-Month Study Expanded Model
Goals of LC Enhancements

- Move functions that calculate Parker Dam releases into RiverWare
- Explicitly account for all Lower Basin water users in RiverWare
- Improve HDB data access and storage
- Automate key policies using RPL
- Forecast Lower Basin operations when Shortage is projected in out-years

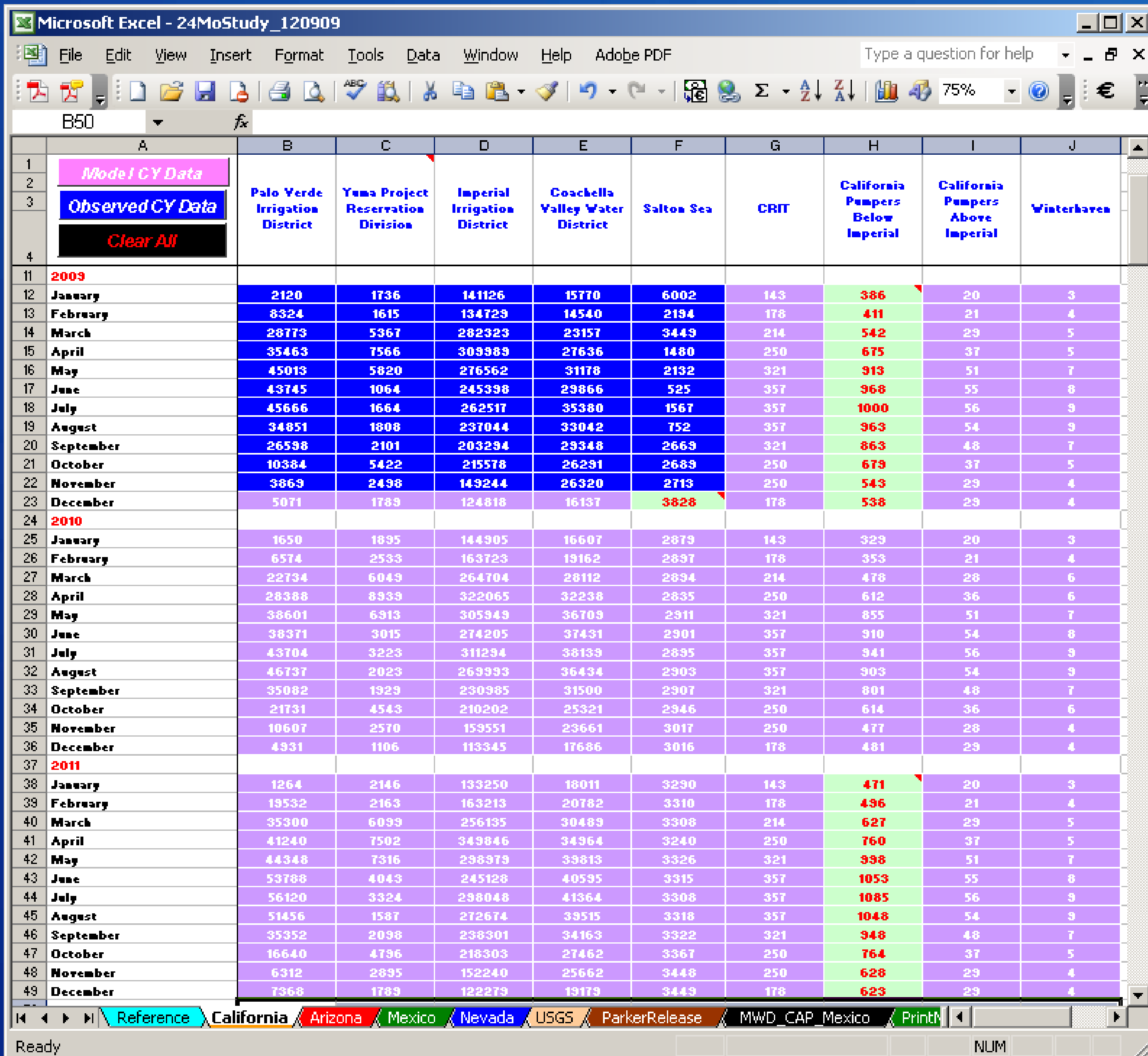
RECLAMATION

24-Month Study Expanded Model
Benefits of LC Enhancements

- Increased transparency of data and modeling assumptions
- All data easily accessible and stored in HDB
  - One stop for all data!
- Reduction of potential user error

RECLAMATION

Parker Release Spreadsheet Model

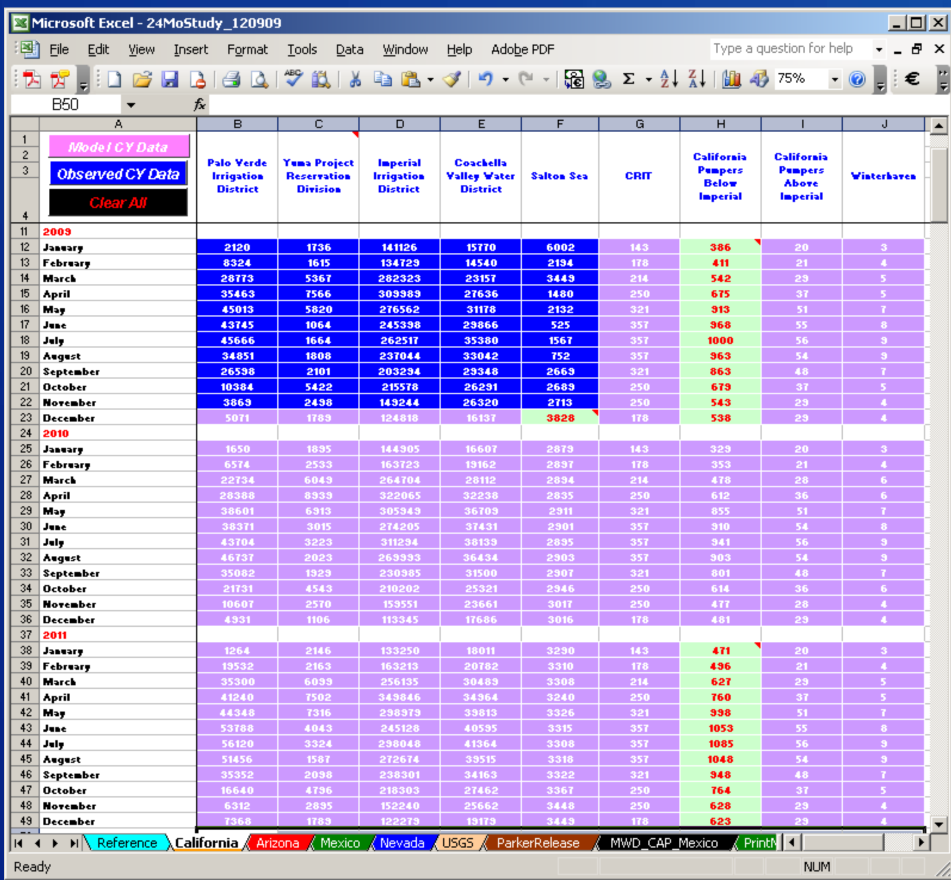


	A	B	C	D	E	F	G	H	I	J
1–4		Palo Verde Irrigation District	Yuma Project Reservation Division	Imperial Irrigation District	Coachella Valley Water District	Salton Sea	CRIT	California Pumpers Below Imperial	California Pumpers Above Imperial	Winterhaven
11	2009									
12	January	2120	1736	141126	15770	6002	143	386	20	3
13	February	8324	1615	134729	14540	2194	178	411	21	4
14	March	28773	5367	282323	23157	3449	214	542	29	5
15	April	35463	7566	309989	27636	1480	250	675	37	5
16	May	45013	5820	276562	31178	2132	321	913	51	7
17	June	43745	1064	245398	29866	525	357	968	55	8
18	July	45666	1664	262517	35380	1567	357	1000	56	9
19	August	34851	1808	237044	33042	752	357	963	54	9
20	September	26598	2101	203294	29348	2669	321	863	48	7
21	October	10384	5422	215578	26291	2689	250	679	37	5
22	November	3869	2498	149244	26320	2713	250	543	29	4
23	December	5071	1789	124818	16137	3828	178	538	29	4
24	2010									
25	January	1650	1895	144905	16607	2879	143	329	20	3
26	February	6574	2533	163723	19162	2897	178	353	21	4
27	March	22734	6049	264704	28112	2894	214	478	28	6
28	April	28388	8939	322065	32238	2835	250	612	36	6
29	May	38601	6913	305949	36709	2911	321	855	51	7
30	June	38371	3015	274205	37431	2901	357	910	54	8
31	July	43704	3223	311294	38139	2895	357	941	56	9
32	August	46737	2023	269993	36434	2903	357	903	54	9
33	September	35082	1929	230985	31500	2907	321	801	48	7
34	October	21731	4543	210202	25321	2946	250	614	36	6
35	November	10607	2570	159551	23661	3017	250	477	28	4
36	December	4931	1106	113345	17686	3016	178	481	29	4
37	2011									
38	January	1264	2146	133250	18011	3290	143	471	20	3
39	February	19532	2163	163213	20782	3310	178	496	21	4
40	March	35300	6099	256135	30489	3308	214	627	29	5
41	April	41240	7502	349846	34964	3240	250	760	37	5
42	May	44348	7316	298979	39813	3326	321	998	51	7
43	June	53788	4043	245128	40595	3315	357	1053	55	8
44	July	56120	3324	298048	41364	3308	357	1085	56	9
45	August	51456	1587	272674	39515	3318	357	1048	54	9
46	September	35352	2098	238301	34163	3322	321	948	48	7
47	October	16640	4796	218303	27462	3367	250	764	37	5
48	November	6312	2895	152240	25662	3448	250	628	29	4
49	December	7368	1789	122279	19179	3449	178	623	29	4

RECLAMATION

Parker Release Spreadsheet Model

- Aggregates Monthly Parker Releases



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21	October	10384	5422	215578	26291	2689	250	679	37	5
22	November	3869	2498	149244	26320	2713	250	543	29	4
23	December	5071	1789	124818	16137	3828	178	538	29	4
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36	December	4931	1106	113345	17686	3016	178	481	29	4
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39	February	19532	2163	163213	20782	3310	178	496	21	4
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47	October	16640	4796	218303	27462	3367	250	764	37	5
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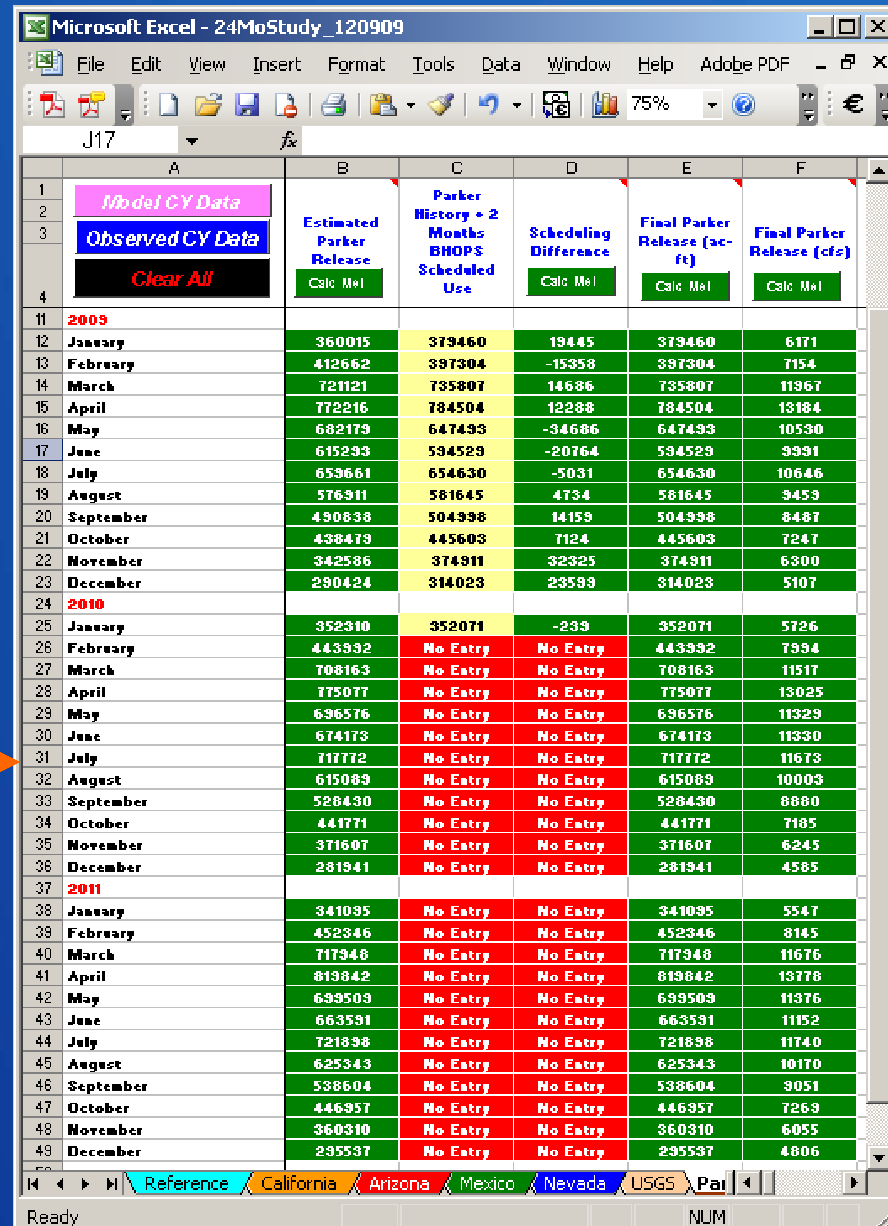
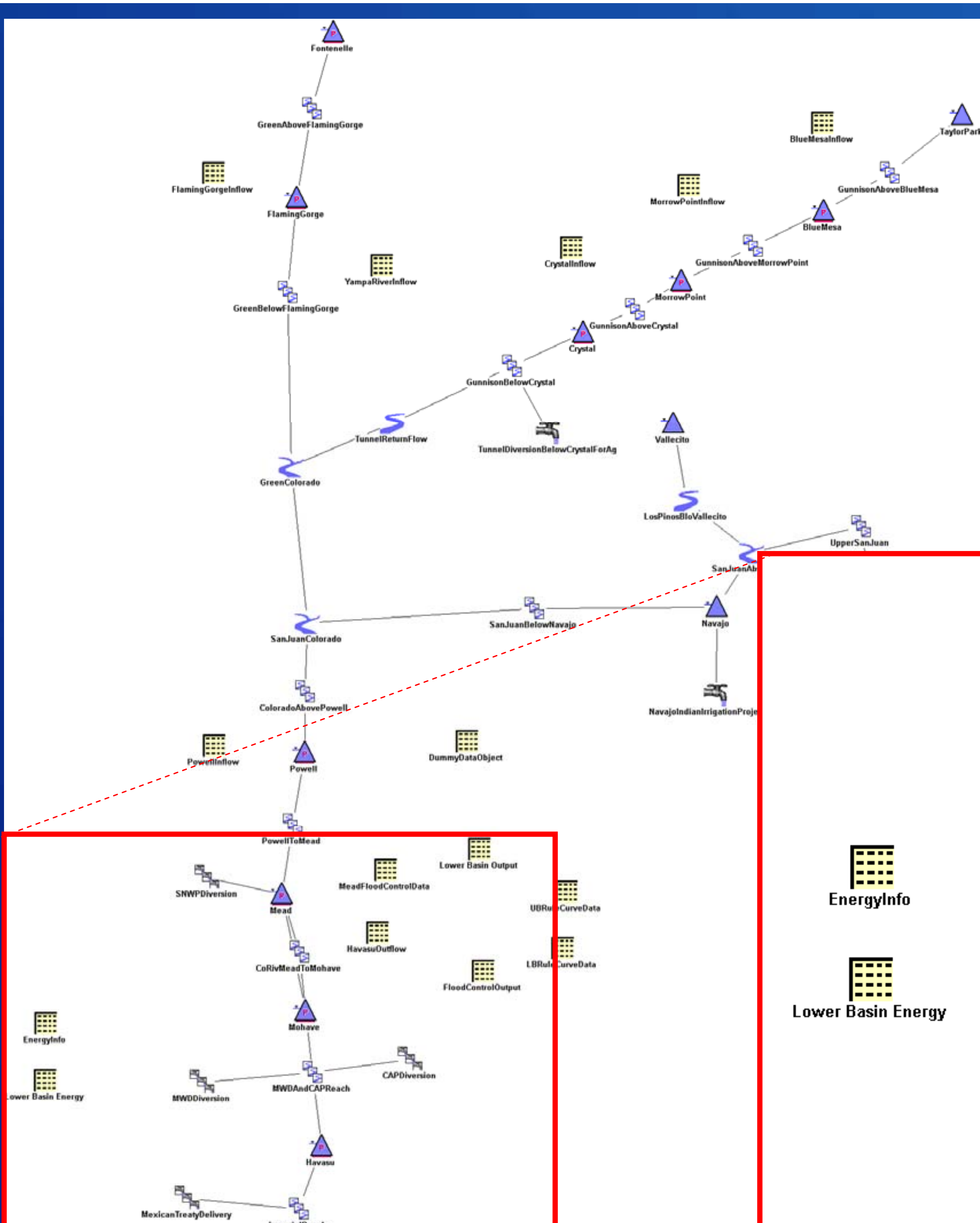
49	December	7368	1789	122279	19179	3449	178	623	29	4

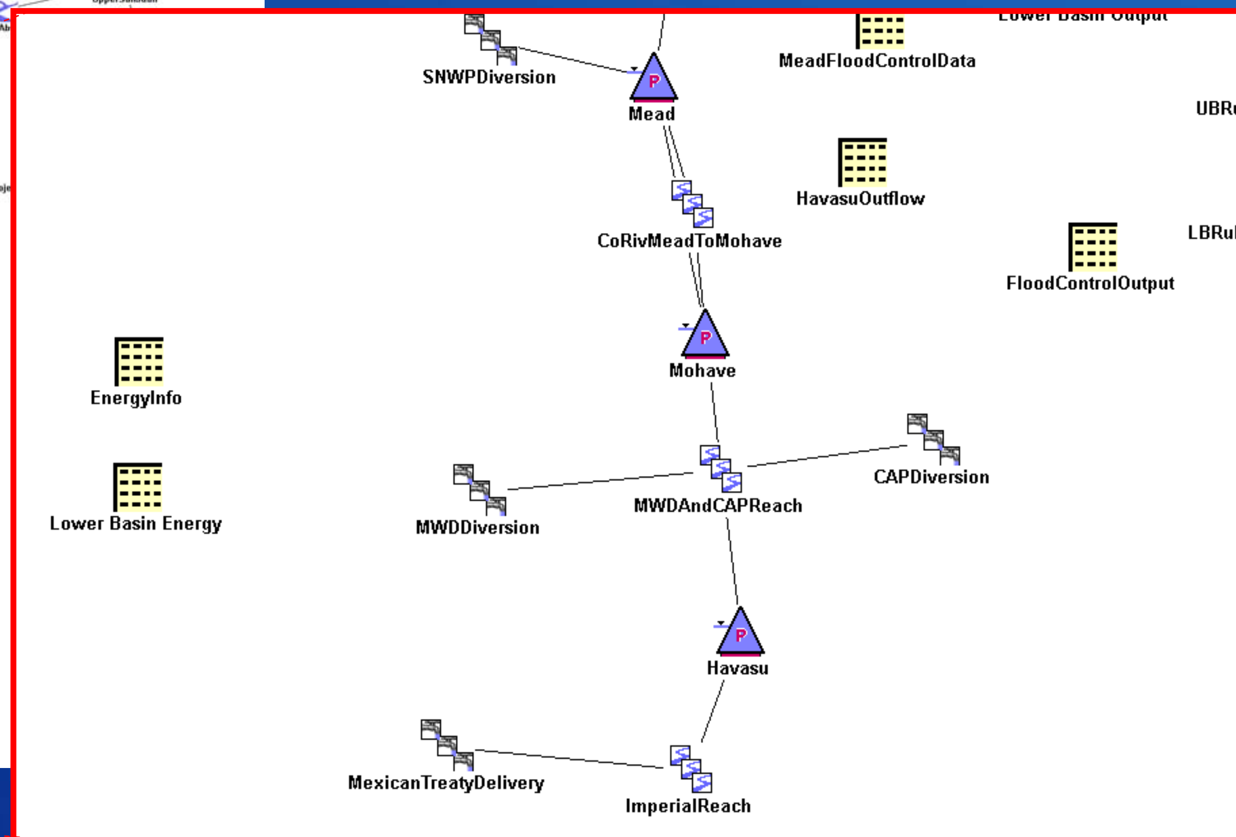


	A	B	C	D	E	F
1–4		Estimated Parker Release	Parker History + 2 Months BHOPS Scheduled Use	Scheduling Difference	Final Parker Release (ac-ft)	Final Parker Release (cfs)
11	2009					
12	January	360015	379460	19445	379460	6171
13	February	412662	397304	-15358	397304	7154
14	March	721121	735807	14686	735807	11967
15	April	772216	784504	12288	784504	13184
16	May	682179	647493	-34686	647493	10530
17	June	615293	594529	-20764	594529	9991
18	July	659661	654630	-5031	654630	10646
19	August	576911	581645	4734	581645	9459
20	September	490838	504998	14159	504998	8487
21	October	438479	445603	7124	445603	7247
22	November	342586	374911	32325	374911	6300
23	December	290424	314023	23599	314023	5107
24	2010					
25	January	352310	352071	-239	352071	5726
26	February	443992	No Entry	No Entry	443992	7994
27	March	708163	No Entry	No Entry	708163	11517
28	April	775077	No Entry	No Entry	775077	13025
29	May	696576	No Entry	No Entry	696576	11329
30	June	674173	No Entry	No Entry	674173	11330
31	July	717772	No Entry	No Entry	717772	11673
32	August	615089	No Entry	No Entry	615089	10003
33	September	528430	No Entry	No Entry	528430	8880
34	October	441771	No Entry	No Entry	441771	7185
35	November	371607	No Entry	No Entry	371607	6245
36	December	281941	No Entry	No Entry	281941	4585
37	2011					
38	January	341095	No Entry	No Entry	341095	5547
39	February	452346	No Entry	No Entry	452346	8145
40	March	717948	No Entry	No Entry	717948	11676
41	April	819842	No Entry	No Entry	819842	13778
42	May	699509	No Entry	No Entry	699509	11376
43	June	663591	No Entry	No Entry	663591	11152
44	July	721898	No Entry	No Entry	721898	11740
45	August	625343	No Entry	No Entry	625343	10170
46	September	538604	No Entry	No Entry	538604	9051
47	October	446357	No Entry	No Entry	446357	7269
48	November	360310	No Entry	No Entry	360310	6055
49	December	295537	No Entry	No Entry	295537	4806

RECLAMATION

Previous 24-Month Study Model





RECLAMATION

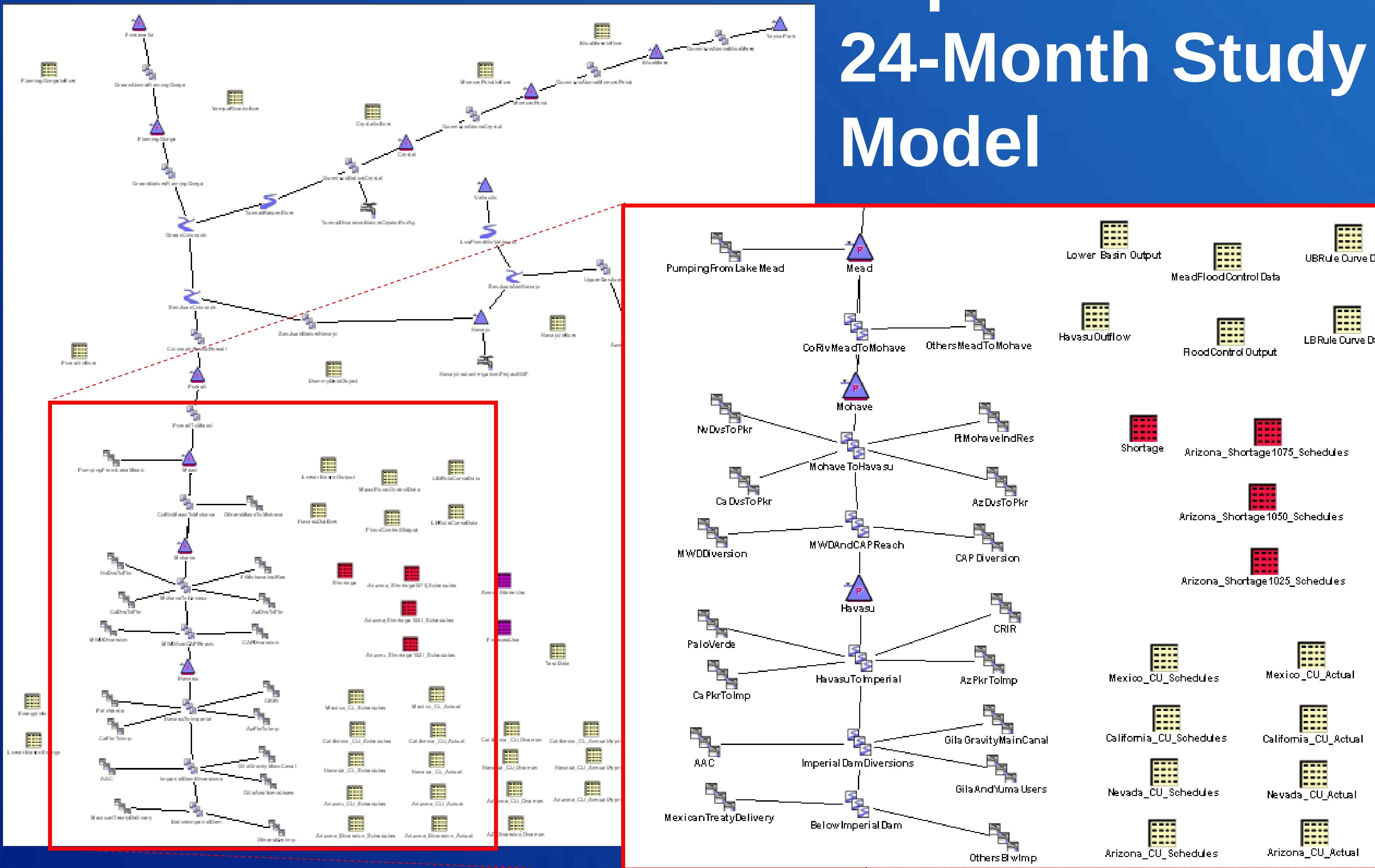
24-Month Study Expanded Model
LC Enhancements

- Schedules and actual use data for all water users transferred between RiverWare and HDB
- Use RPL to adjust schedules of lower priority users based on water use trends
- Calculate forecasted annual use by water user and compare to approved schedules
- Aggregate annual water use by state and compare to adjusted state apportionments

24-Month Study Expanded Model
LC Enhancements

- Use RPL to automate schedule changes if Shortage is projected in future years
  - Initial schedules provided by LC Water Accounting Group
  - Reductions based on Interim Guidelines criteria and shortage schedules provided by Arizona
- Lake Mohave and Lake Havasu evaporation, diversion, and side inflow modeled separately
  - Previous model lumped these into gainloss value

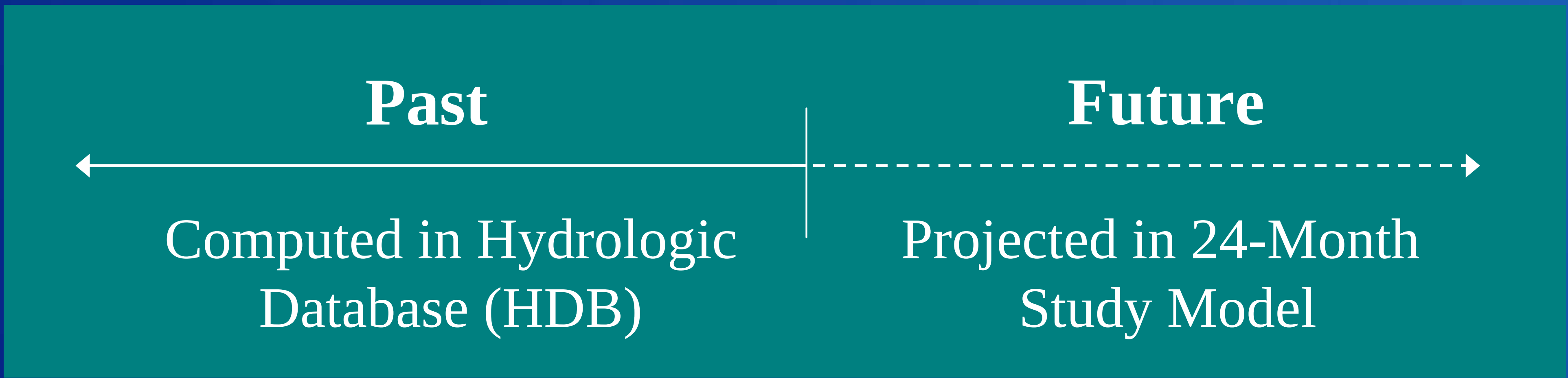
Expanded 24-Month Study Model



RECLAMATION

Upper Basin Enhancements to 24-Month Study

- Powell Evaporation method
  - The issue: Evaporation was computed differently in the 24-Month Study model (future) and in Reclamation's Hydrologic Database (HDB) (observed/past)



Powell Evaporation: the issue

- Evaporation = *f* (reservoir surface area)

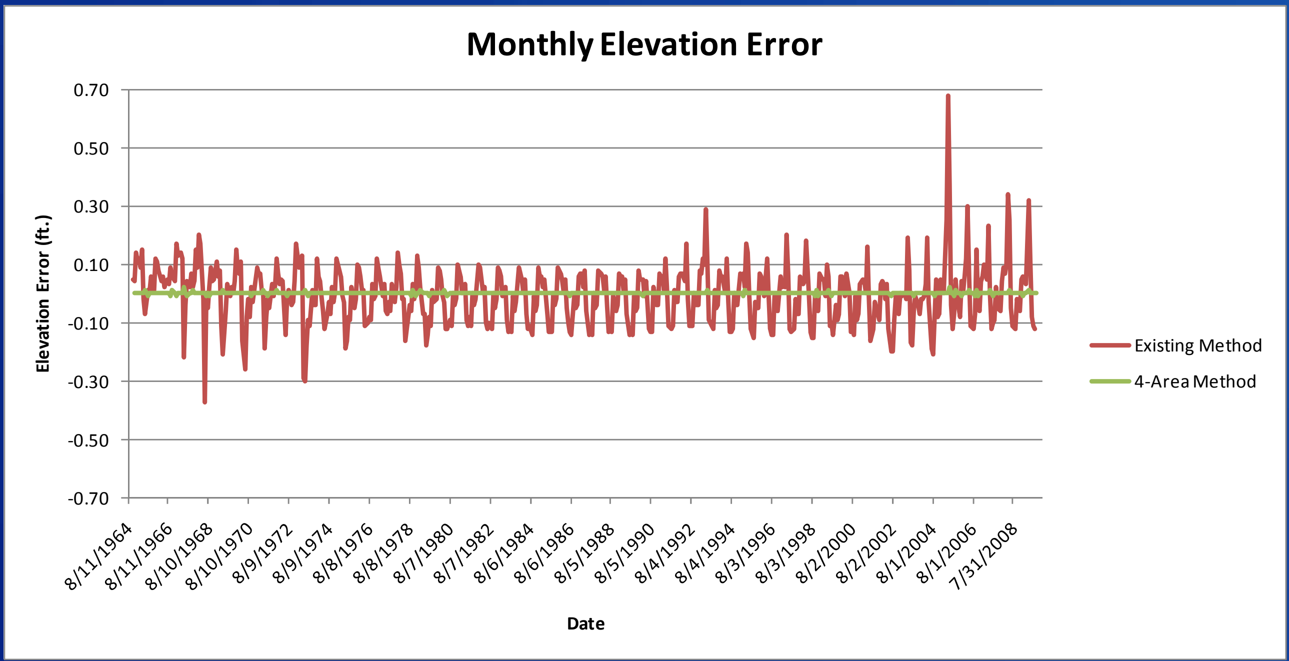
HDB	**24-Month Study**
HDB Method	24-Month Method
4 areas in reservoir	1 lumped area

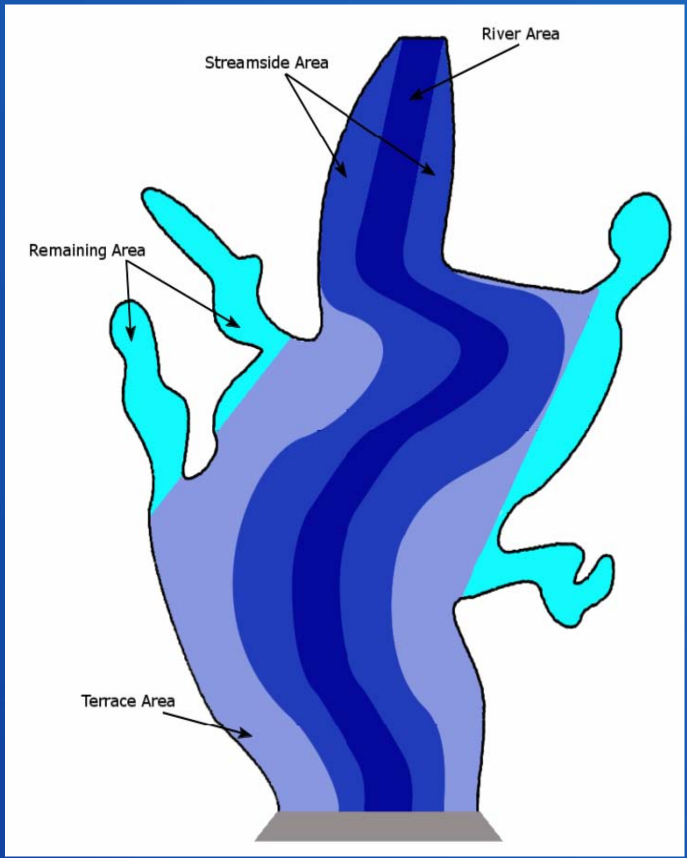
- HDB Method: monthly coefficients for each of four different locations in the reservoir
- 24-Month Method: single monthly coefficient for entire reservoir

- Resulted in modeled evap not matching observed even if all other inputs were the same

Powell Evaporation: the solution

- Keep past and future methodologies consistent!
- Periodic net evaporation method in RiverWare
- Model results greatly improved



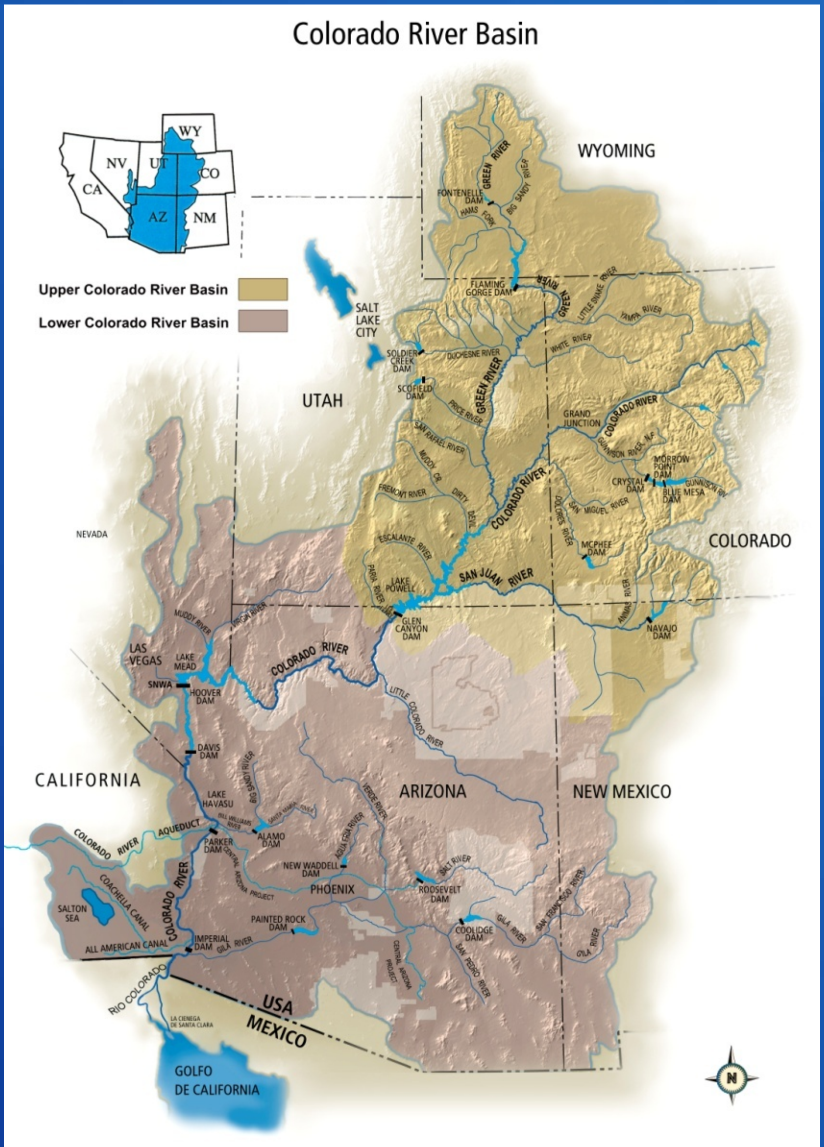


RECLAMATION

Probabilistic 24-Month Study

- 24-Month Study currently a deterministic model
  - Upper Basin driven by most probable inflow forecast
  - Lower Basin driven by scheduled demands

- Jan, Apr, Aug, Oct, inflow scenarios: min(10th), most (50th), max (90th)
  - This provides a range of possible operations, but the max inflow scenario does not translate to the max probable elevation



RECLAMATION

Probabilistic 24-Month Study

- Need to better quantify range of possible operations in the Colorado River Basin
  - Better asses risk and uncertainty
    - e.g., probability of Lake Mead being below key elevation on July 4th weekend
  - Stakeholders need this now more than ever
- Currently developing model to produce probabilistic output

RECLAMATION

Probabilistic 24-Month Study

- Inflow is greatest source of uncertainty
- Model input is range of probable inflows
  - CBRFC's ESP forecasts will drive first and second years of model
  - Ongoing research to develop forecasting techniques for beyond 2 years (CADSWES grad student work)
    - 2-10 year range

RECLAMATION

Probabilistic 24-Month Study

- Currently, UC operators manually input operations (releases) into the model
  - Probabilistic nature requires rules to drive the simulation
- CADSWES grad student working w/ UC operators to develop UB rules
  - Fontenelle done
  - Working on Flaming Gorge

RECLAMATION

Probabilistic 24-Month Study

- Model currently uses "unregulated inflow" forecasts
  - Depletions are implicit in the forecast
- Want to move to "natural inflow"
  - ESP forecast is natural flow
  - Can explicitly model demands

RECLAMATION

Implementation Timeframes

- LC Expanded Water Users
  - January 2010
  - Provides stakeholders an opportunity to review prior to April 24-Month Study
- Updated Lake Powell Evaporation Method
  - February 2010
- Probabilistic Model with RPL of UC Reservoir Operations
  - January 2011

RECLAMATION

Questions?

RECLAMATION