

Appendix A. Shasta Lake Model Results and Model Performance Statistics (Years 2000-2019)

Appendix A includes graphical and tabular results comparing simulated versus measured data, as well as tabulated model performance statistics for the Shasta Lake model. Specifically, a) Shasta Lake stage, b) Shasta Dam outflow, c) reservoir temperature profiles above Shasta Dam and d) Shasta Dam outflow temperature. The last section presents summary statistics of Shasta Lake elevation (stage), outflow, and outflow temperature for the period from May to October.

A.1. Reservoir Elevation (Stage)

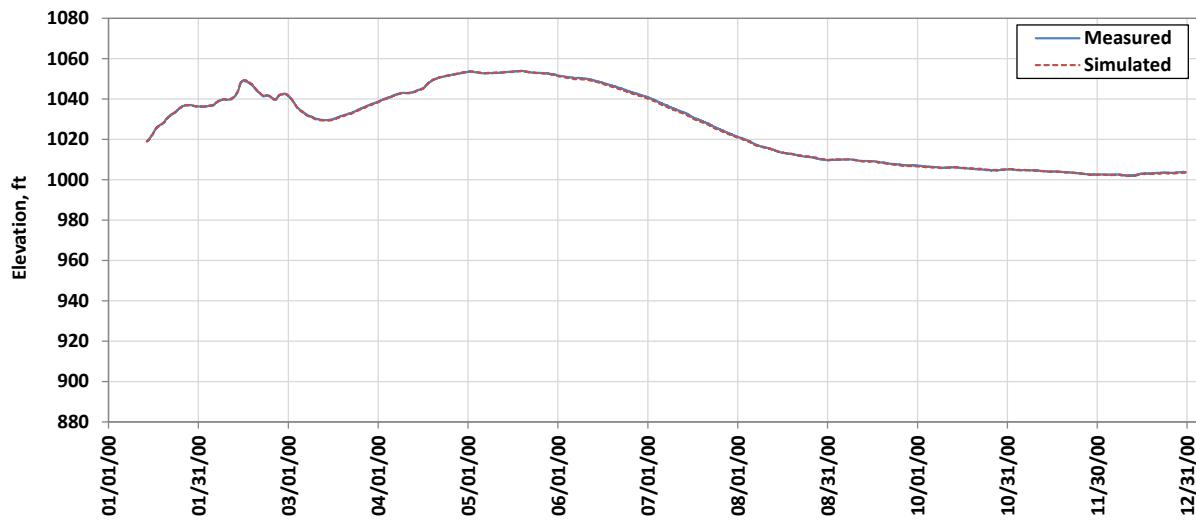


Figure A - 1. Shasta Lake simulated versus measured stage: 2000.

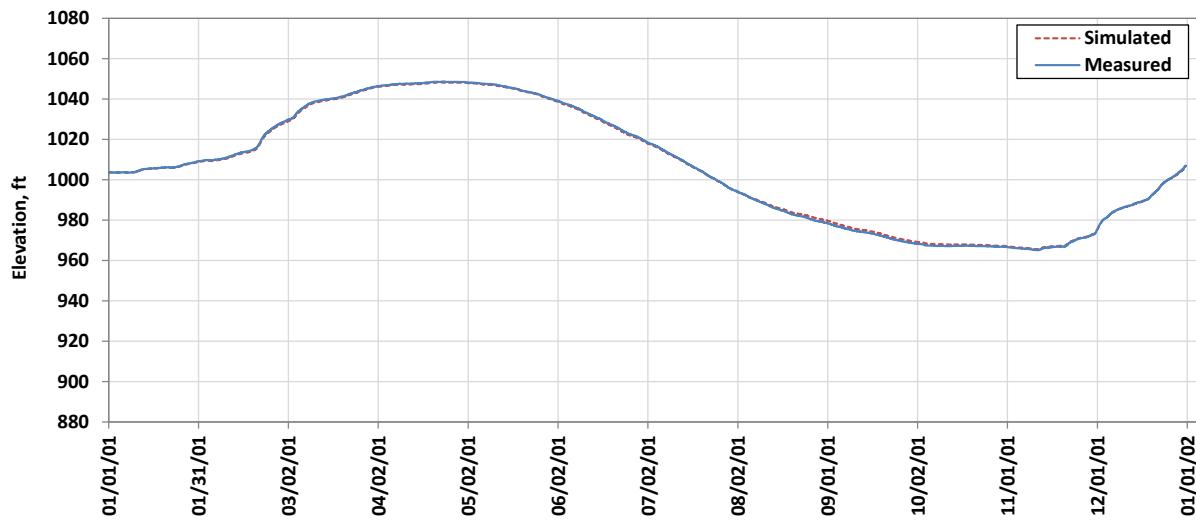


Figure A - 2. Shasta Lake simulated versus measured stage: 2001.

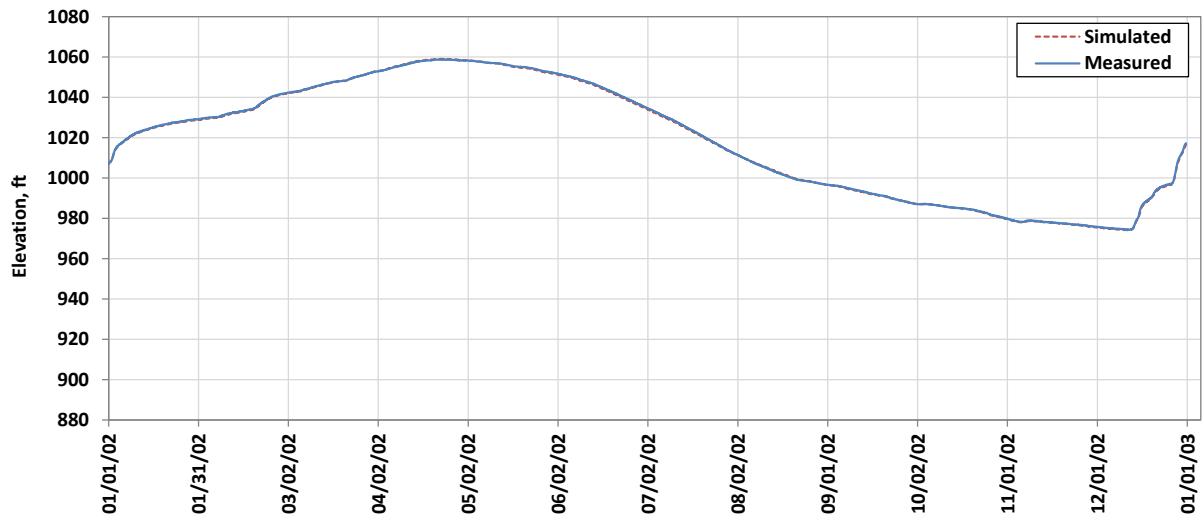


Figure A - 3. Shasta Lake simulated versus measured stage: 2002.

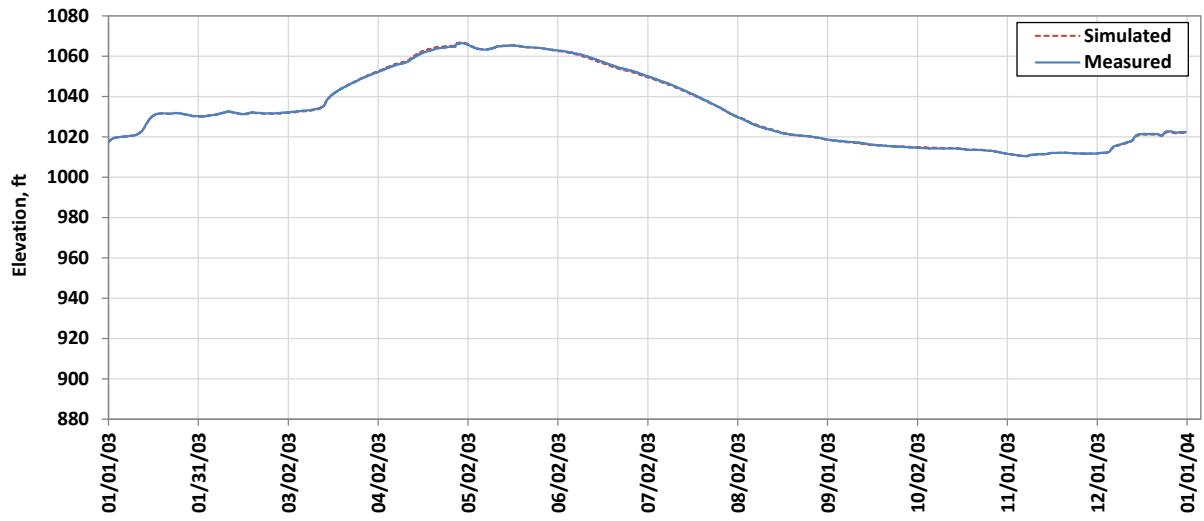


Figure A - 4. Shasta Lake simulated versus measured stage: 2003.

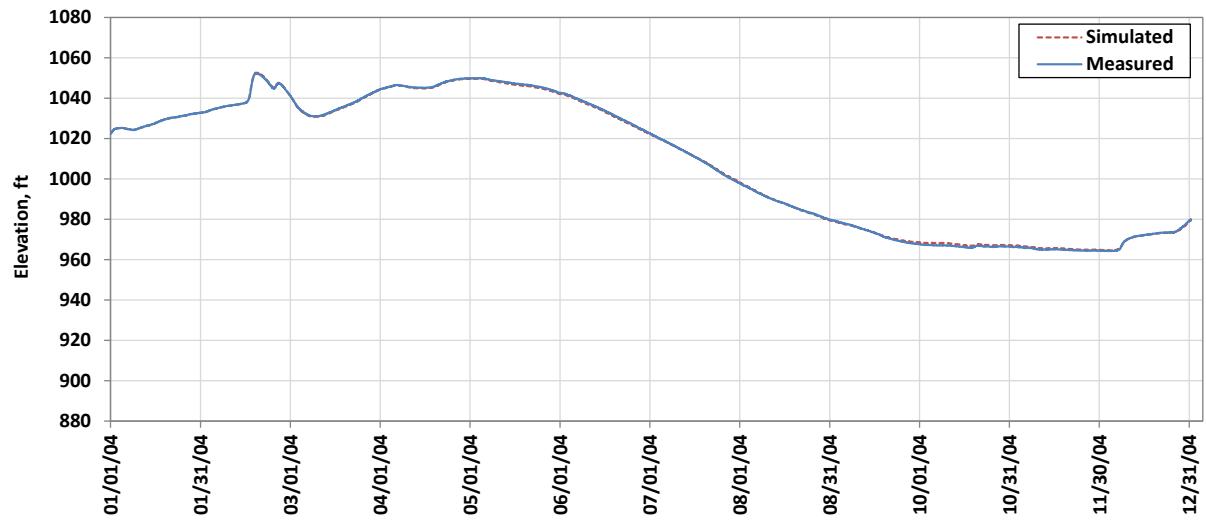


Figure A - 5. Shasta Lake simulated versus measured stage: 2004.

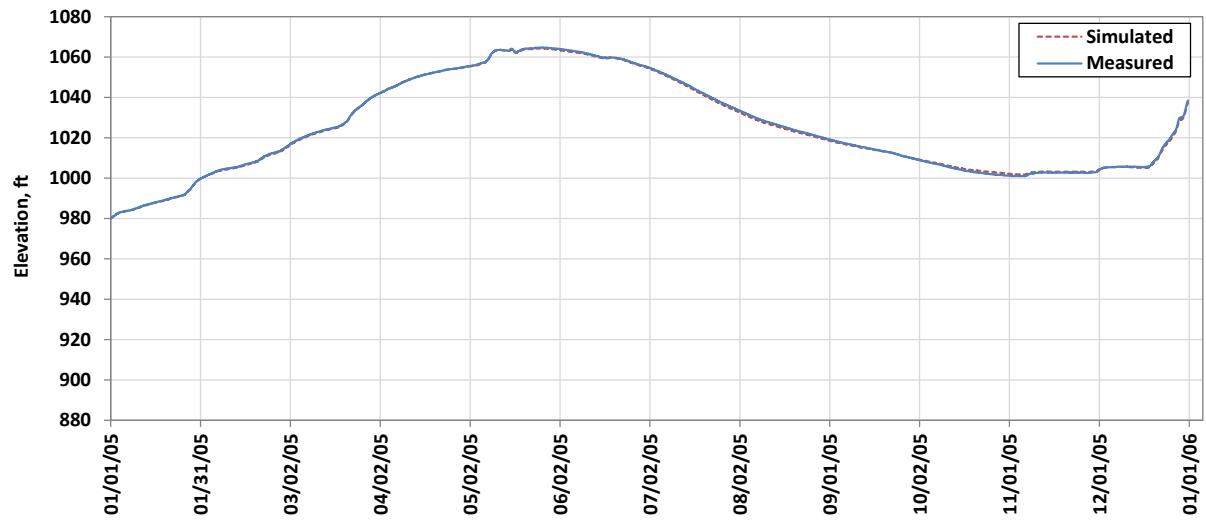


Figure A - 6. Shasta Lake simulated versus measured stage: 2005.

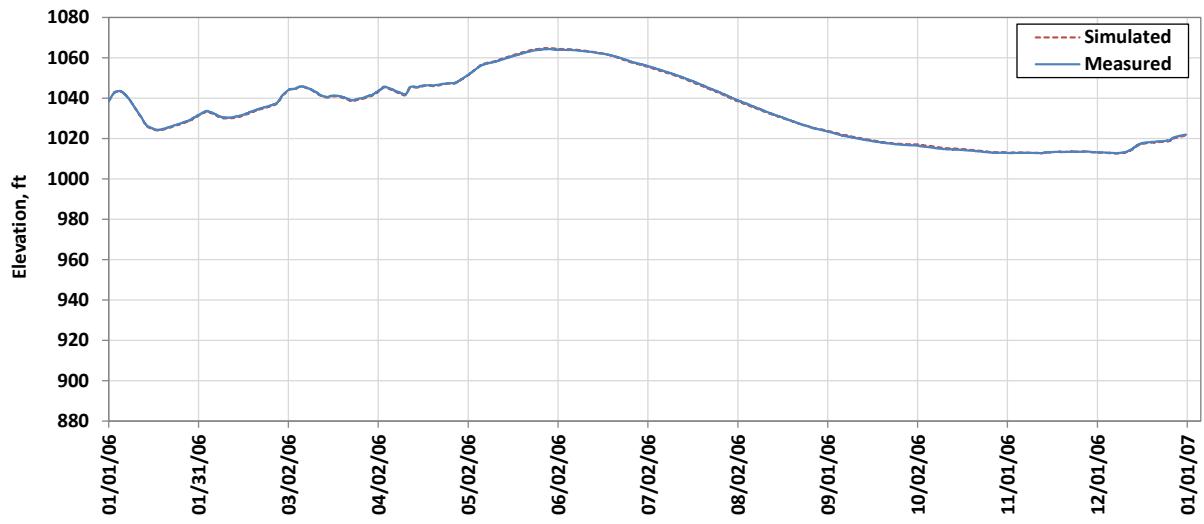


Figure A - 7. Shasta Lake simulated versus measured stage: 2006.

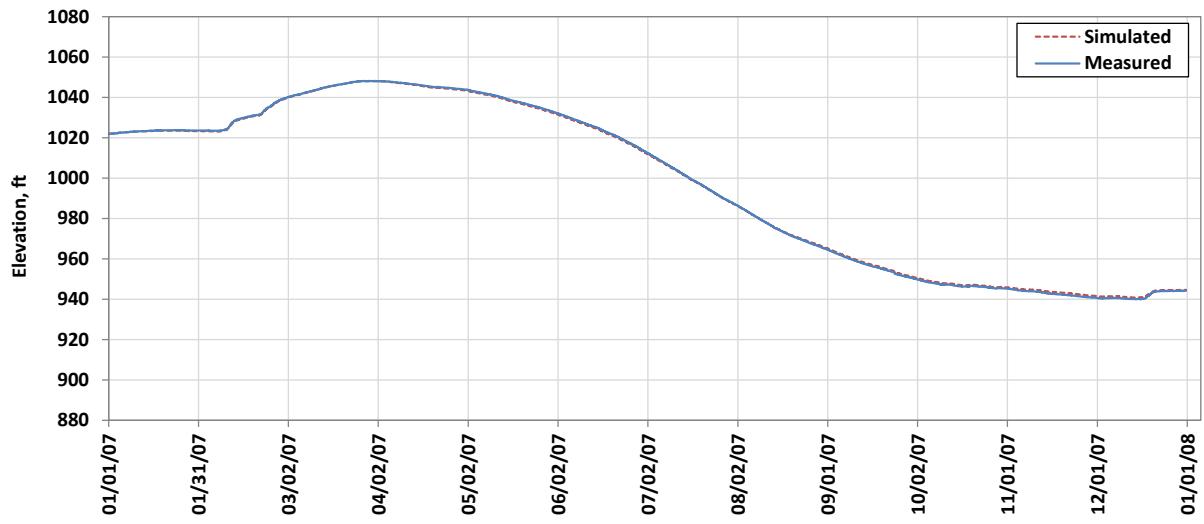


Figure A - 8. Shasta Lake simulated versus measured stage: 2007.

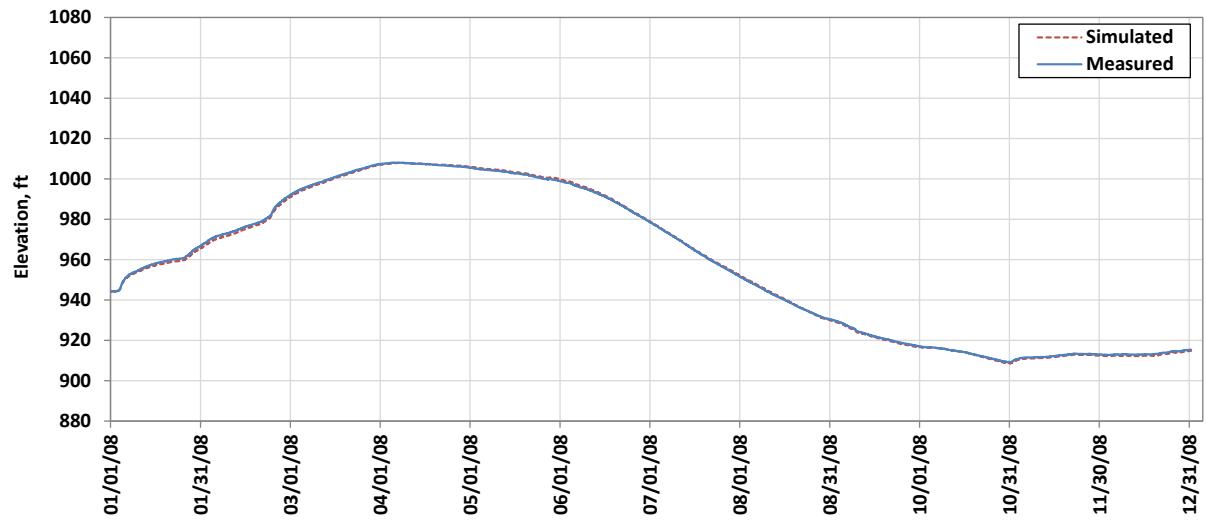


Figure A - 9. Shasta Lake simulated versus measured stage: 2008.

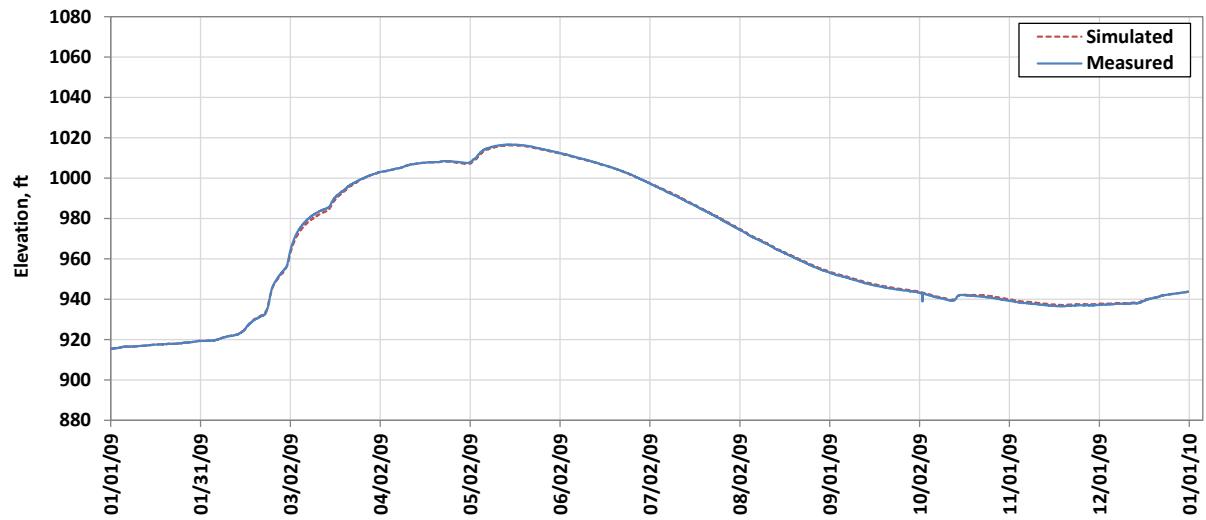


Figure A - 10. Shasta Lake simulated versus measured stage: 2009.

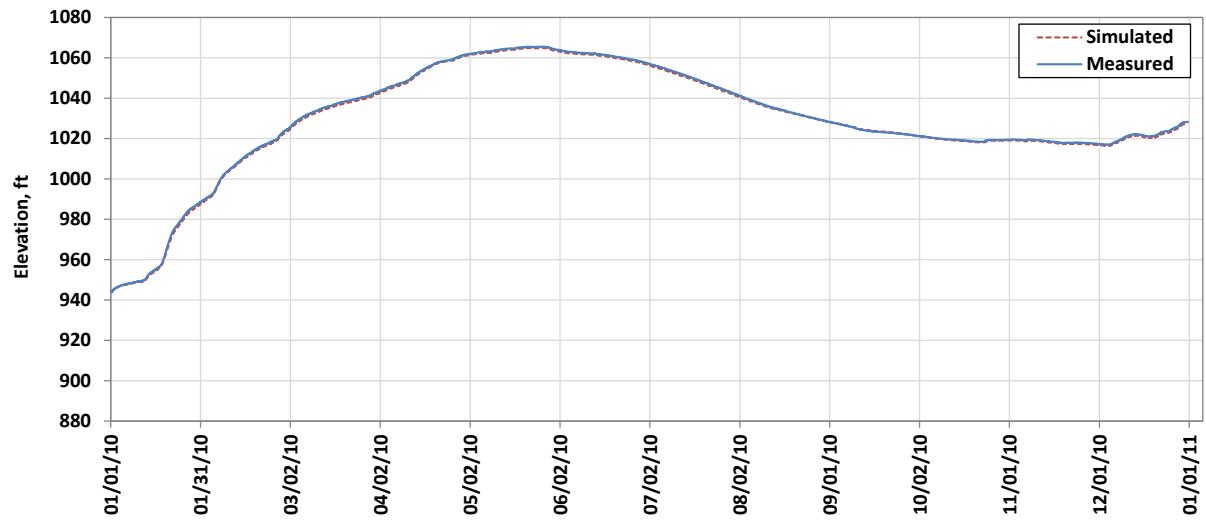


Figure A - 11. Shasta Lake simulated versus measured stage: 2010.

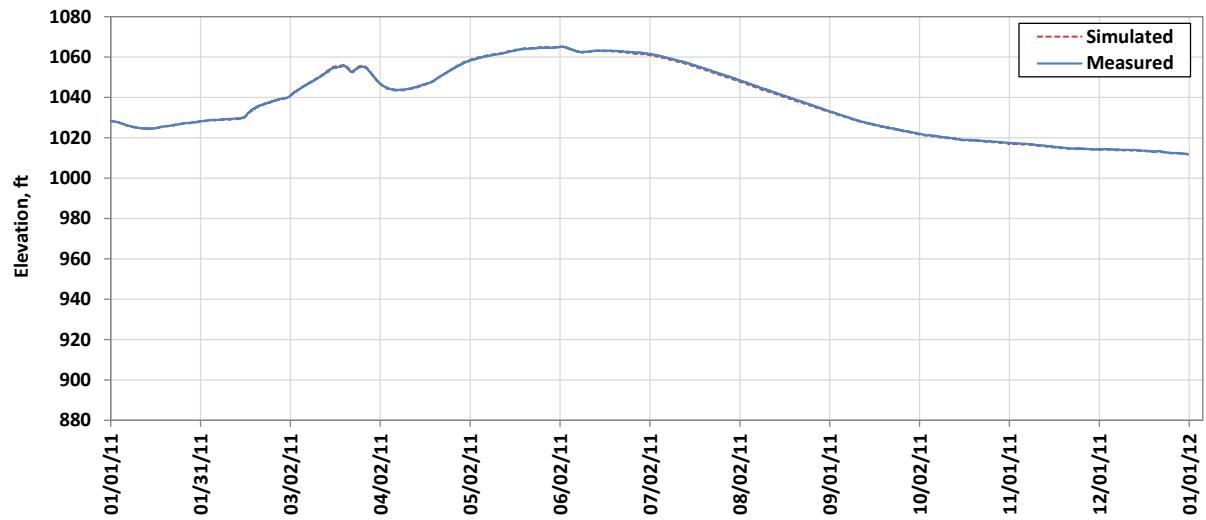


Figure A - 12. Shasta Lake simulated versus measured stage: 2011.

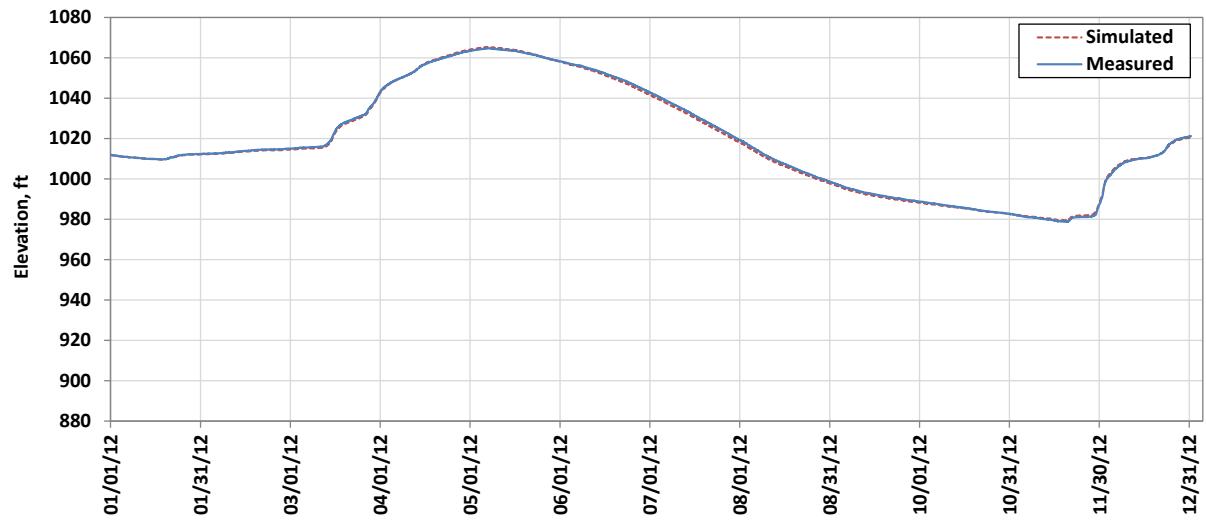


Figure A - 13. Shasta Lake simulated versus measured stage: 2012.

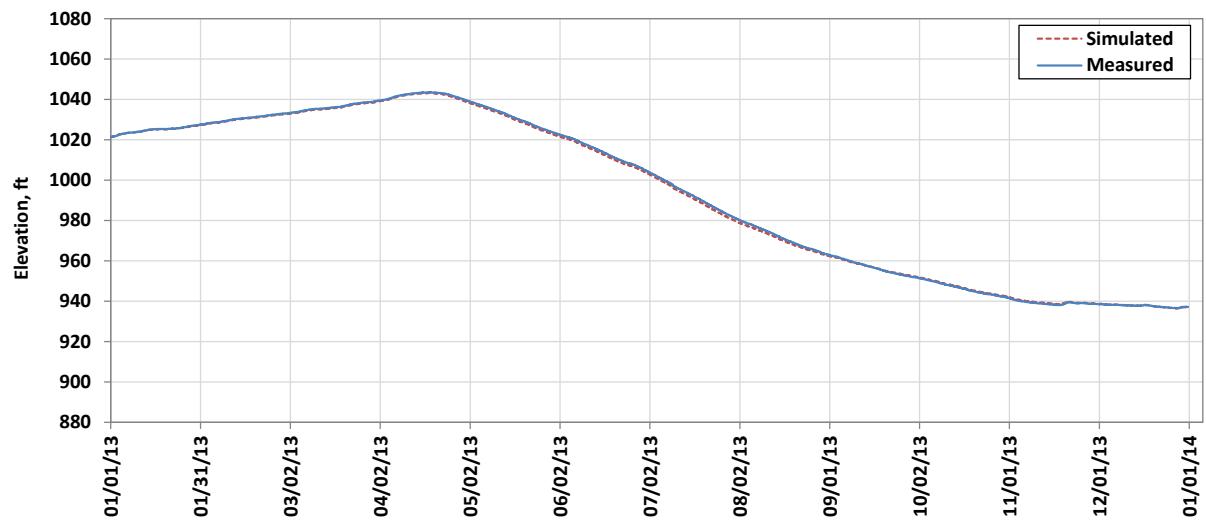


Figure A - 14. Shasta Lake simulated versus measured stage: 2013.

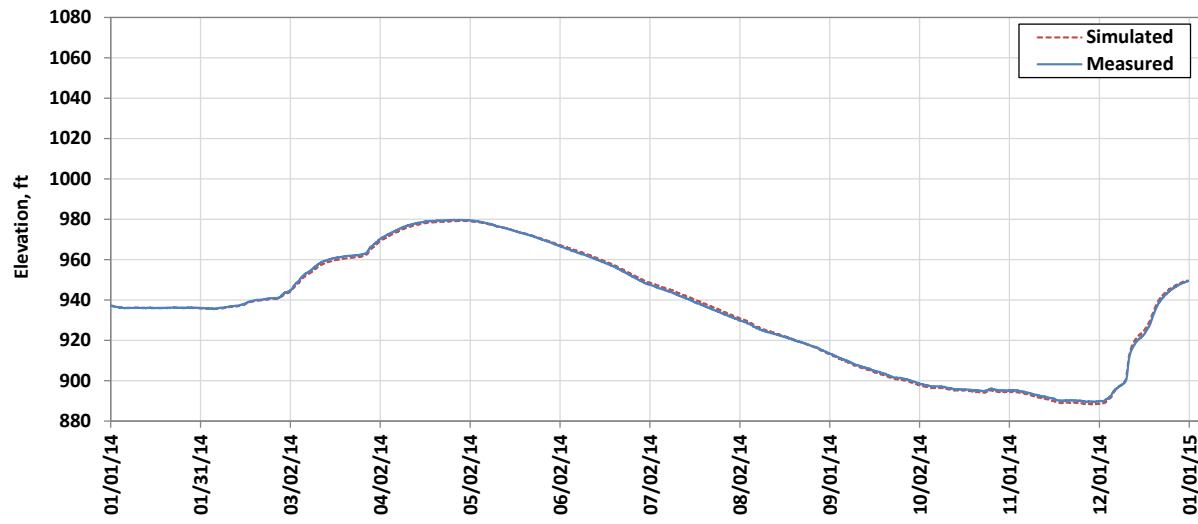


Figure A - 15. Shasta Lake simulated versus measured stage: 2014.

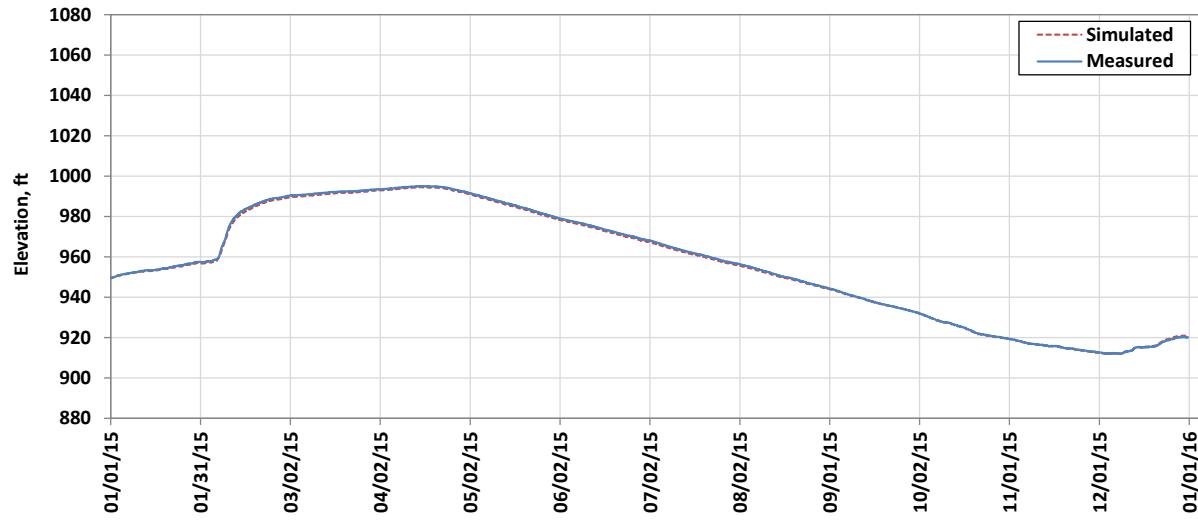


Figure A - 16. Shasta Lake simulated versus measured stage: 2015.

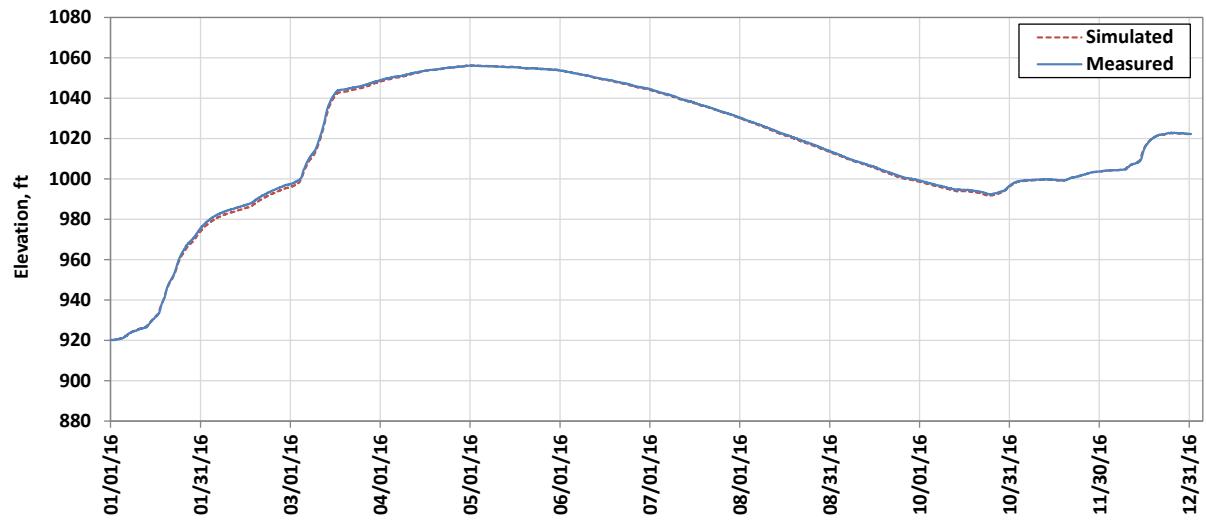


Figure A - 17. Shasta Lake simulated versus measured stage: 2016.

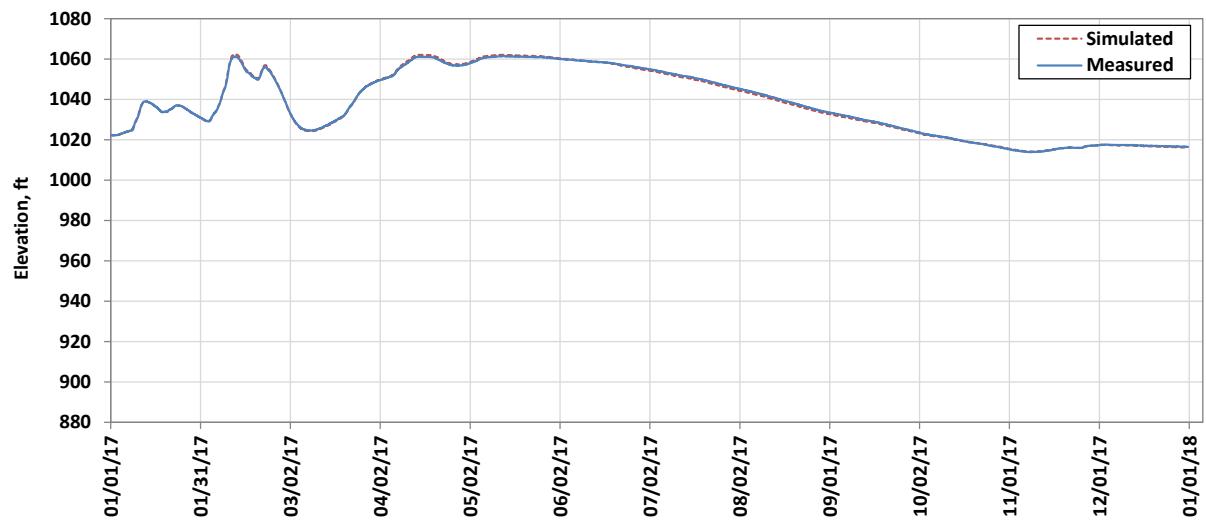


Figure A - 18. Shasta Lake simulated versus measured stage: 2017.

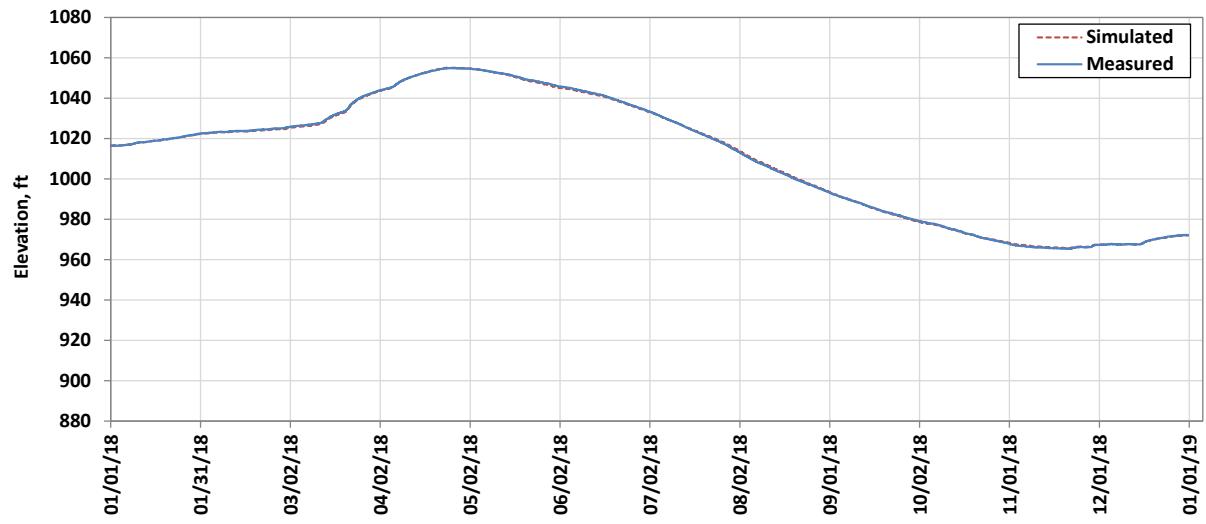


Figure A - 19. Shasta Lake simulated versus measured stage: 2018.

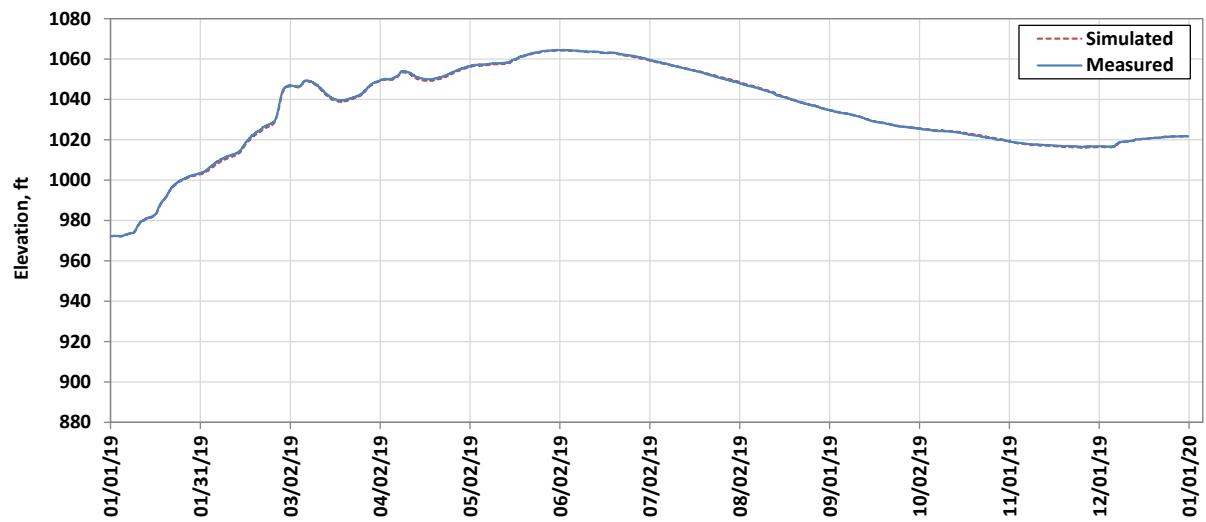


Figure A - 20. Shasta Lake simulated versus measured stage: 2019.

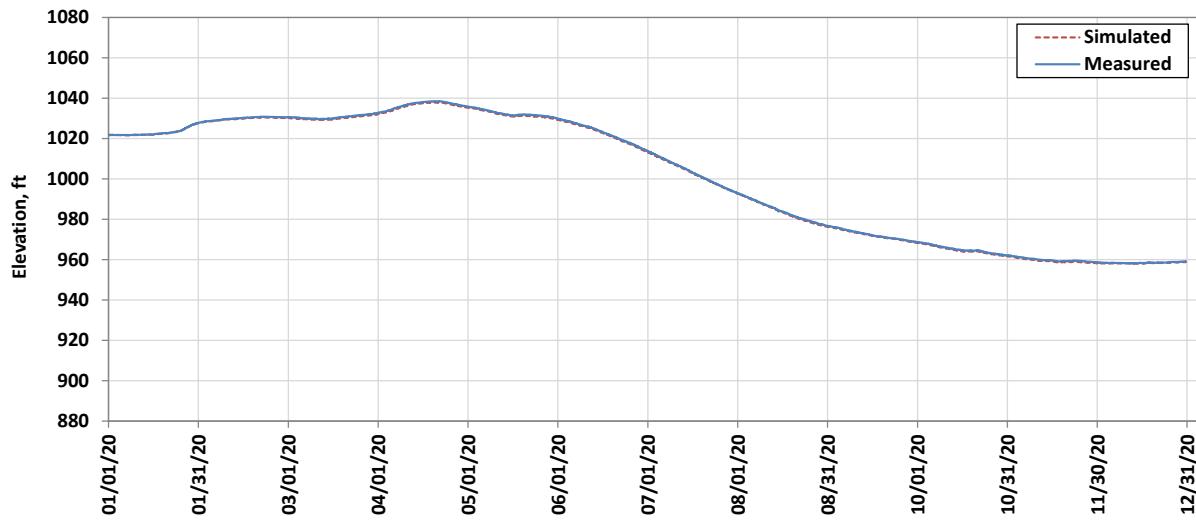


Figure A - 21. Shasta Lake simulated versus measured stage: 2020.

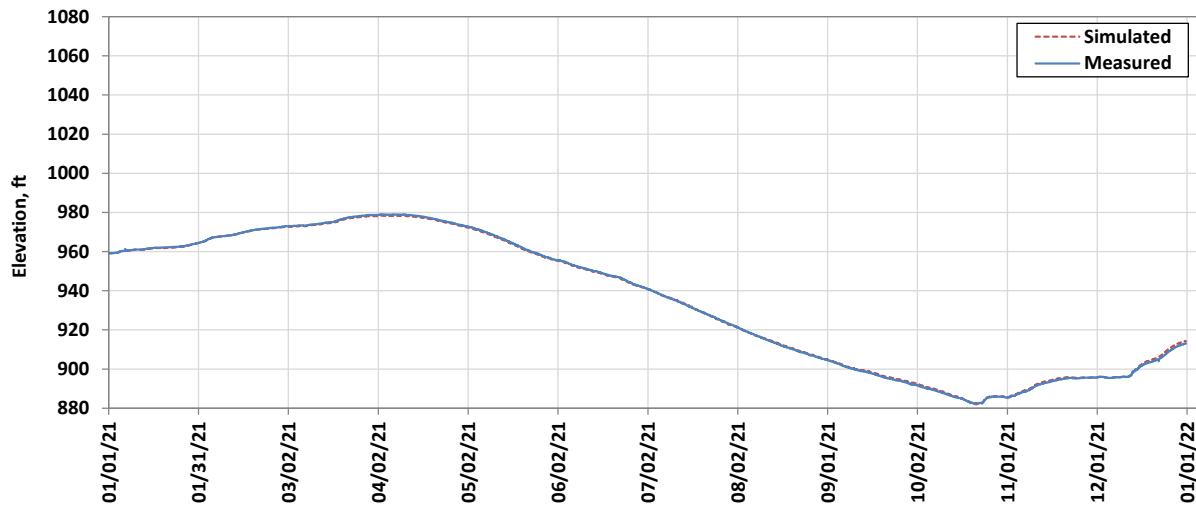


Figure A - 22. Shasta Lake simulated versus measured stage: 2021.

Table A - 1 Summary statistics of Shasta Lake elevation (stage): 2000-2008.

Statistic	2000	2001	2002	2003	2004	2005	2006	2007	2008
Mean Bias (ft)	-0.14	0.02	-0.19	-0.03	0.02	-0.17	-0.06	0.07	-0.22
MAE (ft)	0.22	0.44	0.26	0.23	0.34	0.39	0.29	0.42	0.53
RMSE (ft)	0.28	0.53	0.31	0.30	0.42	0.48	0.32	0.50	0.61
Nash-Sutcliffe (NSE)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
COUNT	8,472	8,760	8,760	8,760	8,784	8,760	8,760	8,760	8,784

Table A - 2 Summary statistics of Shasta Lake elevation (stage): 2009-2017.

Statistic	2009	2010	2011	2012	2013	2014	2015	2016	2017
Mean Bias (ft)	0.09	-0.54	-0.16	-0.31	-0.37	-0.13	-0.42	-0.41	-0.09
MAE (ft)	0.37	0.56	0.25	0.54	0.53	0.67	0.46	0.47	0.41
RMSE (ft)	0.49	0.63	0.29	0.65	0.66	0.78	0.54	0.66	0.50
Nash-Sutcliffe (NSE)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
COUNT	8,760	8,760	8,760	8,784	8,760	8,760	8,760	8,784	8,760

Table A - 3 Summary statistics of Shasta Lake elevation (stage): 2018-2021.

Statistic	2018	2019	2020	2021
Mean Bias (ft)	-0.06	-0.19	-0.36	0.01
MAE (ft)	0.28	0.34	0.36	0.35
RMSE (ft)	0.33	0.41	0.39	0.43
Nash-Sutcliffe (NSE)	1.00	1.00	1.00	1.00
COUNT	8760	8760	8,784	8,760

A.2. Outflow

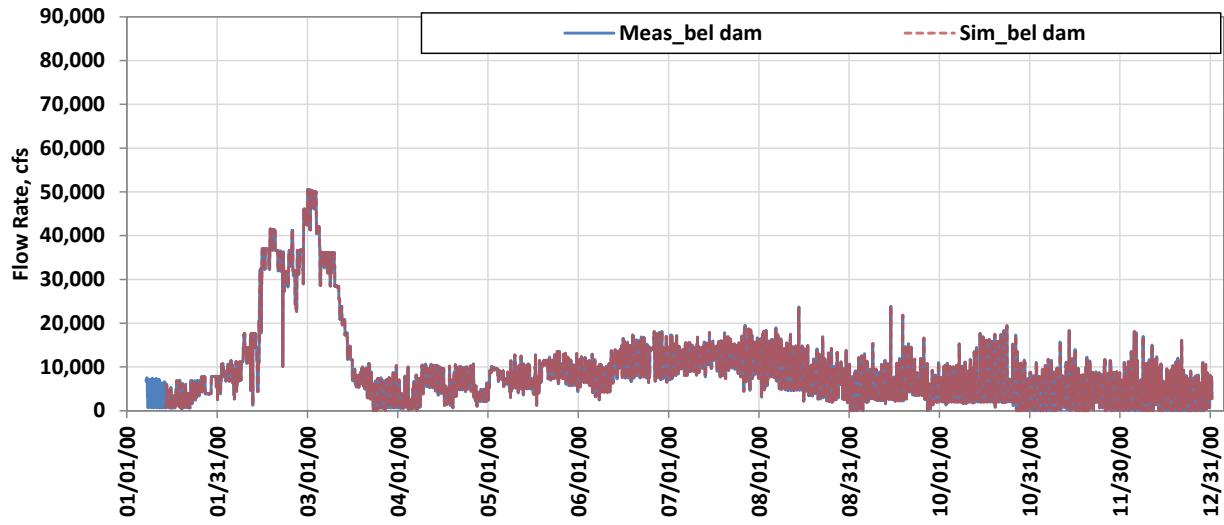


Figure A - 23. Shasta Lake total dam release, measured versus simulated flow: 2000.

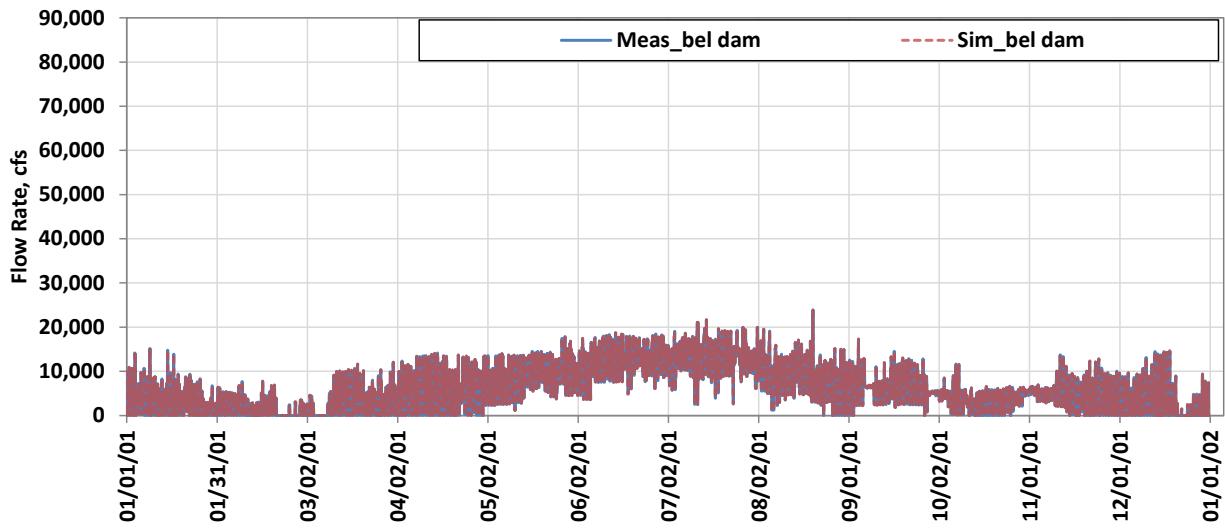


Figure A - 24. Shasta Lake total dam release, measured versus simulated flow: 2001.

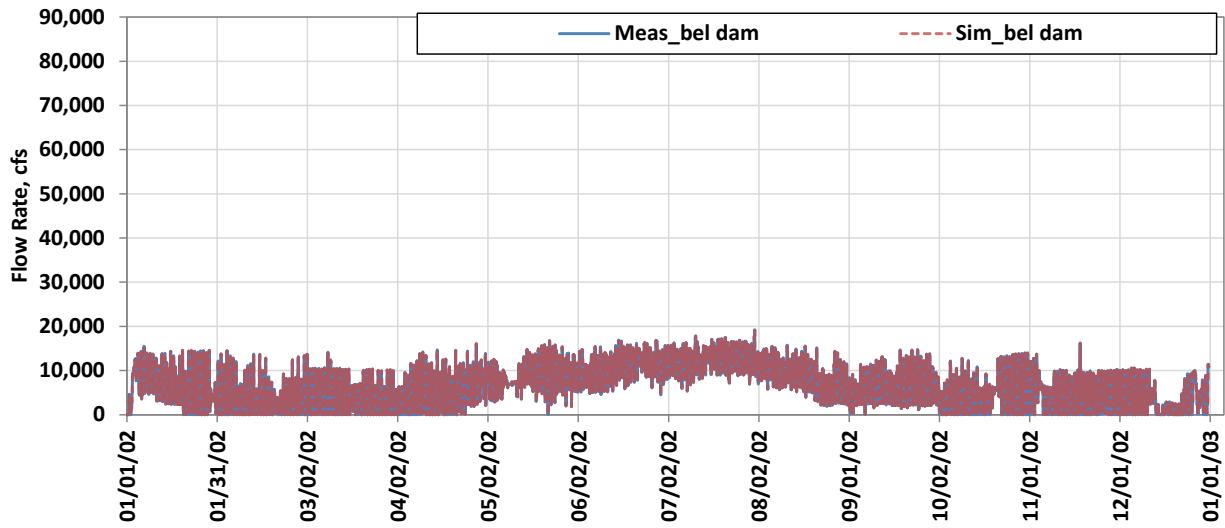


Figure A - 25. Shasta Lake total dam release, measured versus simulated flow: 2002.

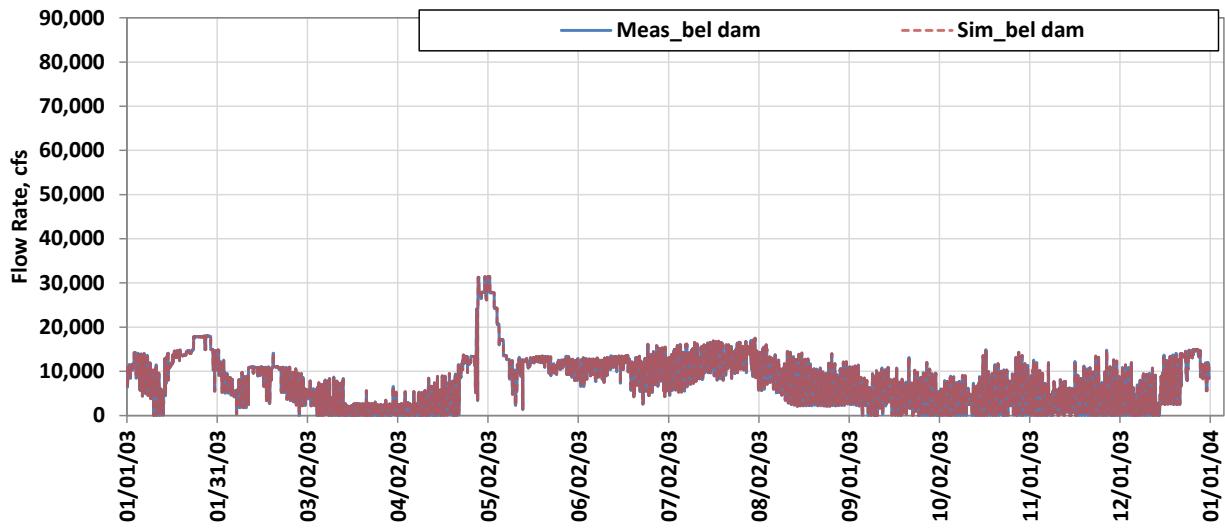


Figure A - 26. Shasta Lake total dam release, measured versus simulated flow: 2003.

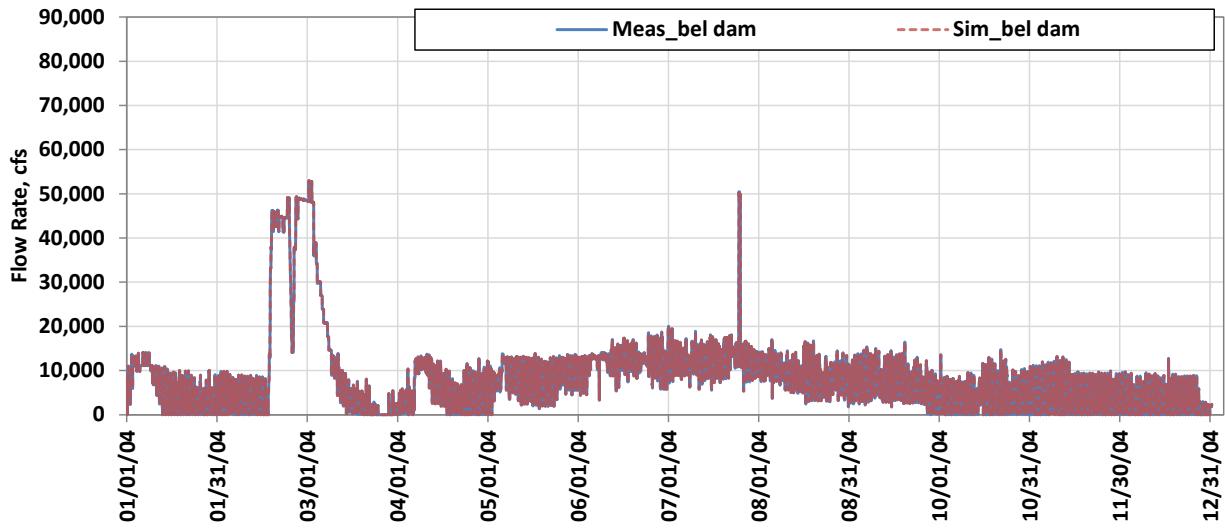


Figure A - 27. Shasta Lake total dam release, measured versus simulated flow: 2004.

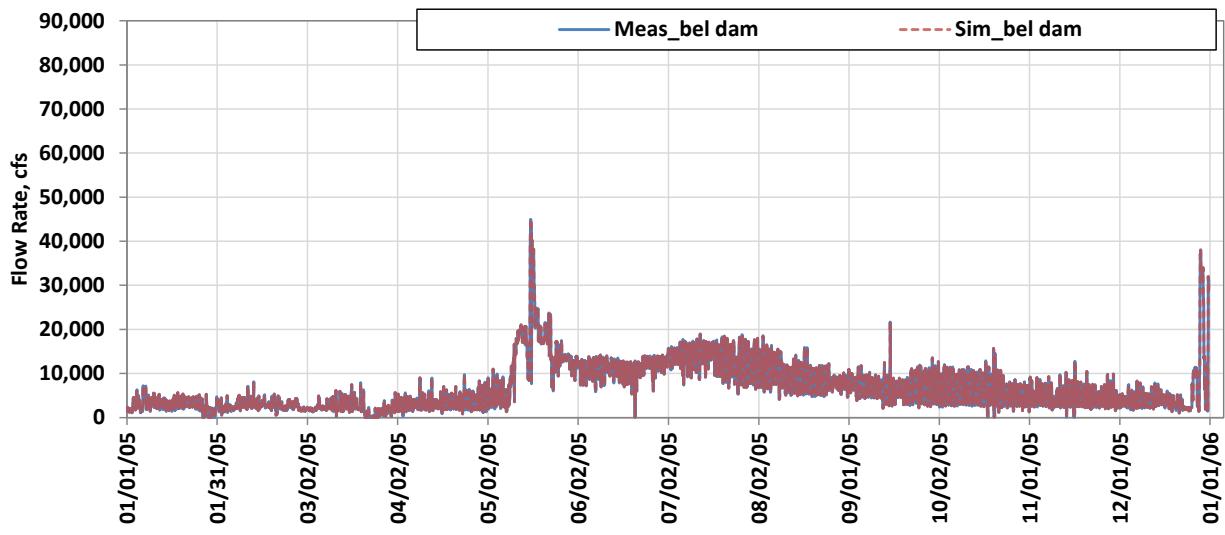


Figure A - 28. Shasta Lake total dam release, measured versus simulated flow: 2005.

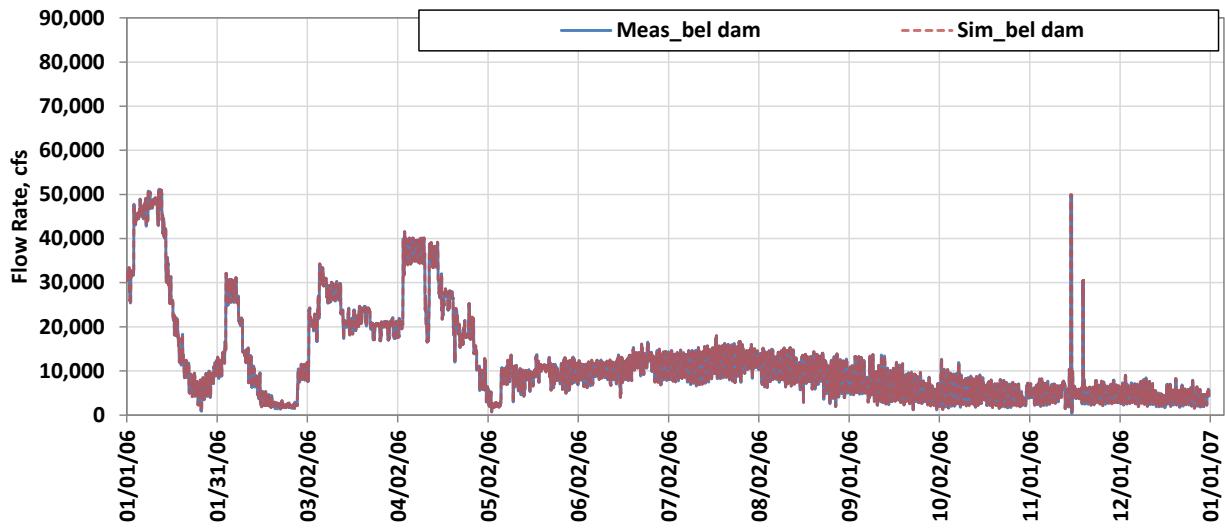


Figure A - 29. Shasta Lake total dam release, measured versus simulated flow: 2006.

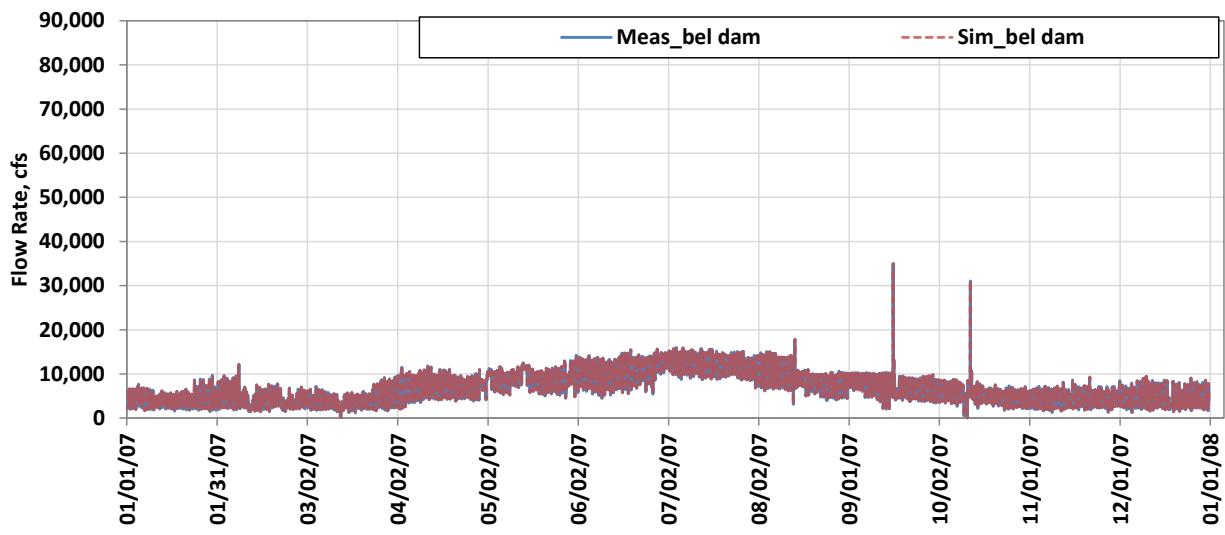


Figure A - 30. Shasta Lake total dam release, measured versus simulated flow: 2007.

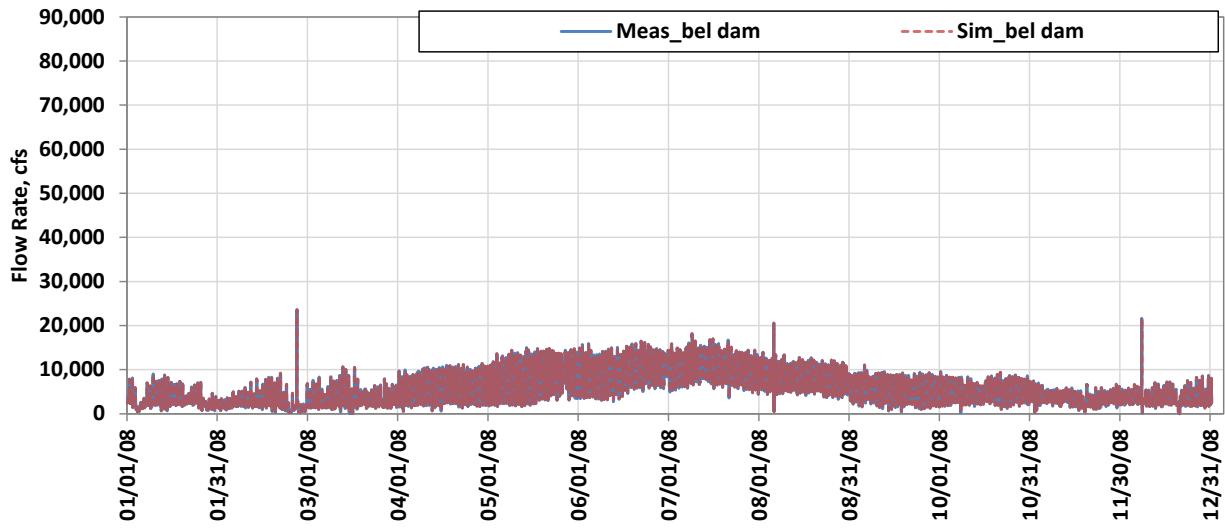


Figure A - 31. Shasta Lake total dam release, measured versus simulated flow: 2008.

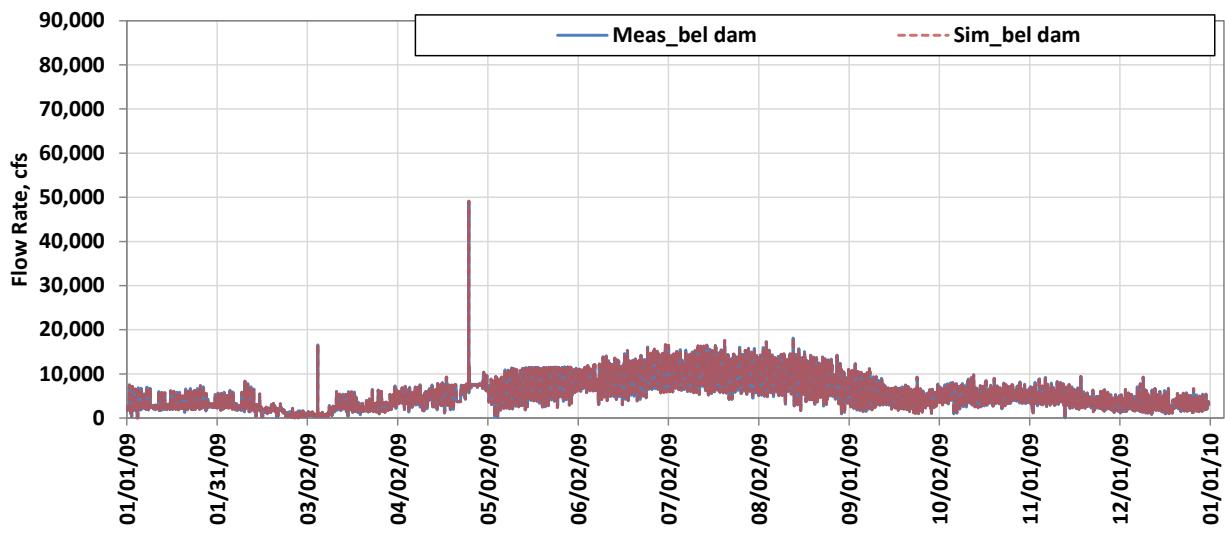


Figure A - 32. Shasta Lake total dam release, measured versus simulated flow: 2009.

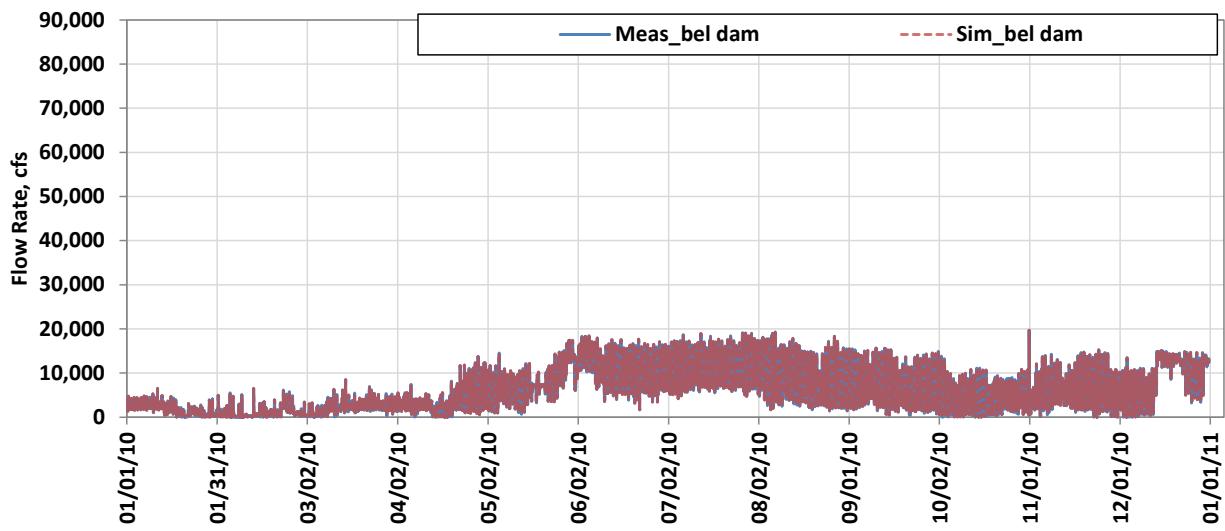


Figure A - 33. Shasta Lake total dam release, measured versus simulated flow: 2010.

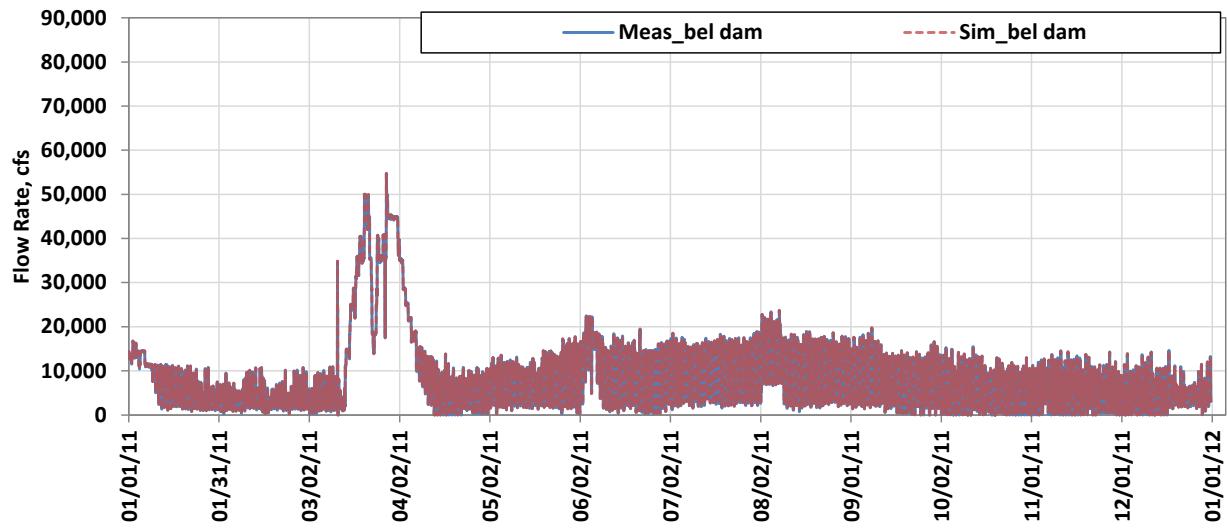


Figure A - 34. Shasta Lake total dam release, measured versus simulated flow: 2011.

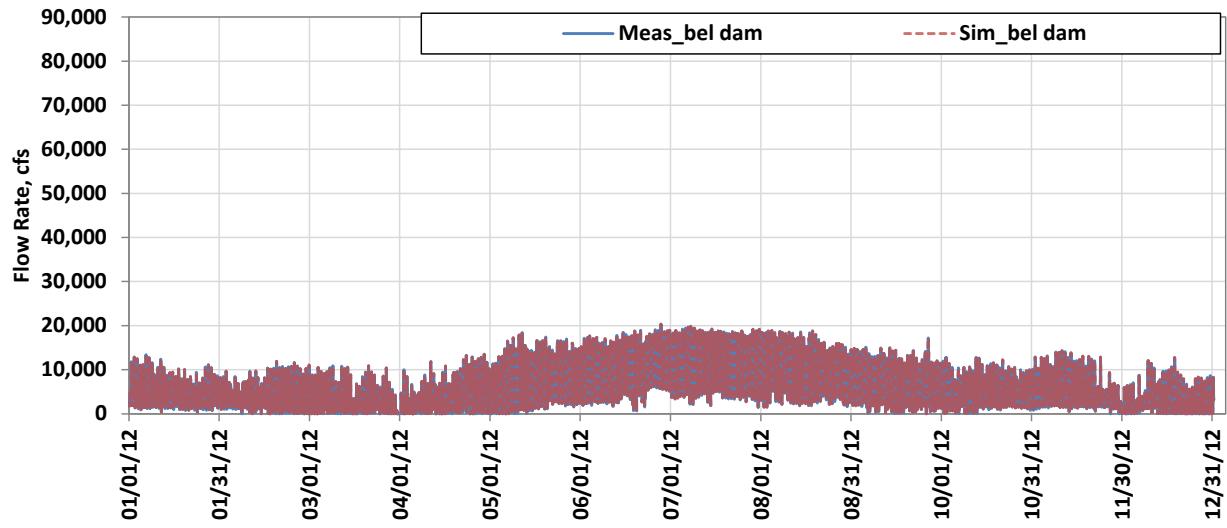


Figure A - 35. Shasta Lake total dam release, measured versus simulated flow: 2012.

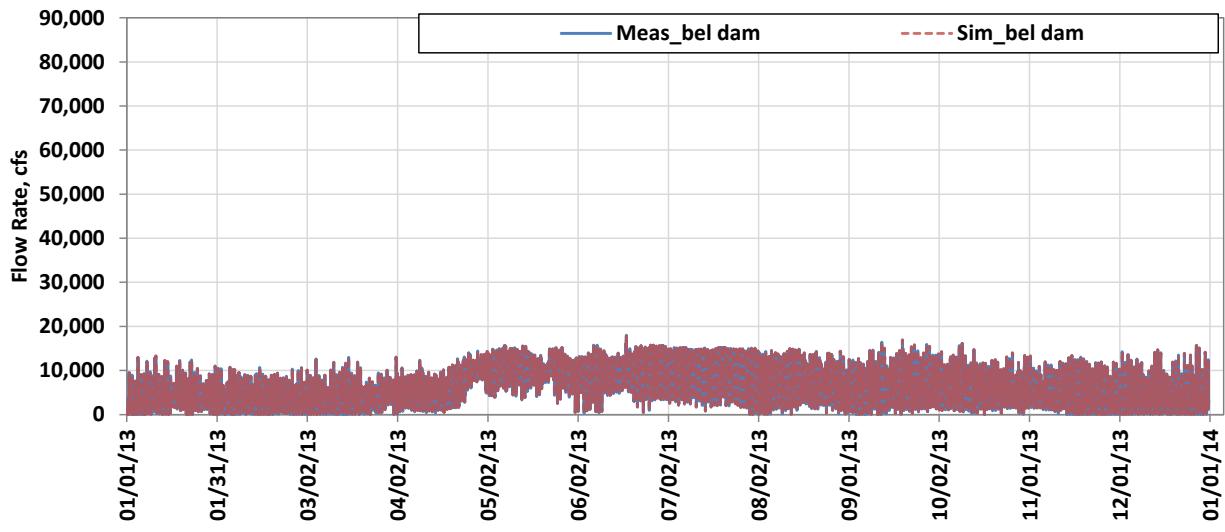


Figure A - 36. Shasta Lake total dam release, measured versus simulated flow: 2013.

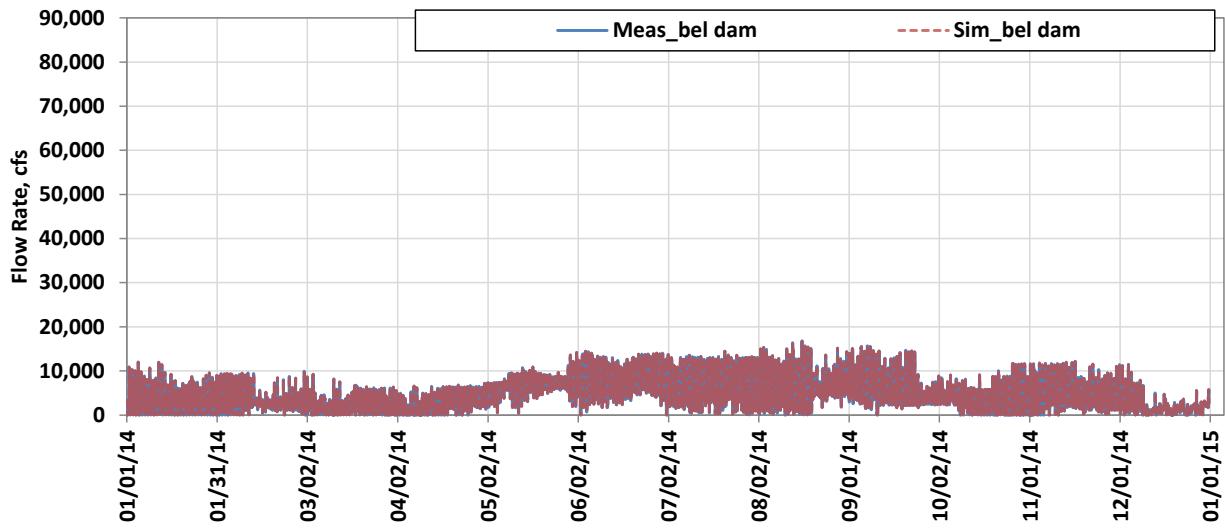


Figure A - 37. Shasta Lake total dam release, measured versus simulated flow: 2014.

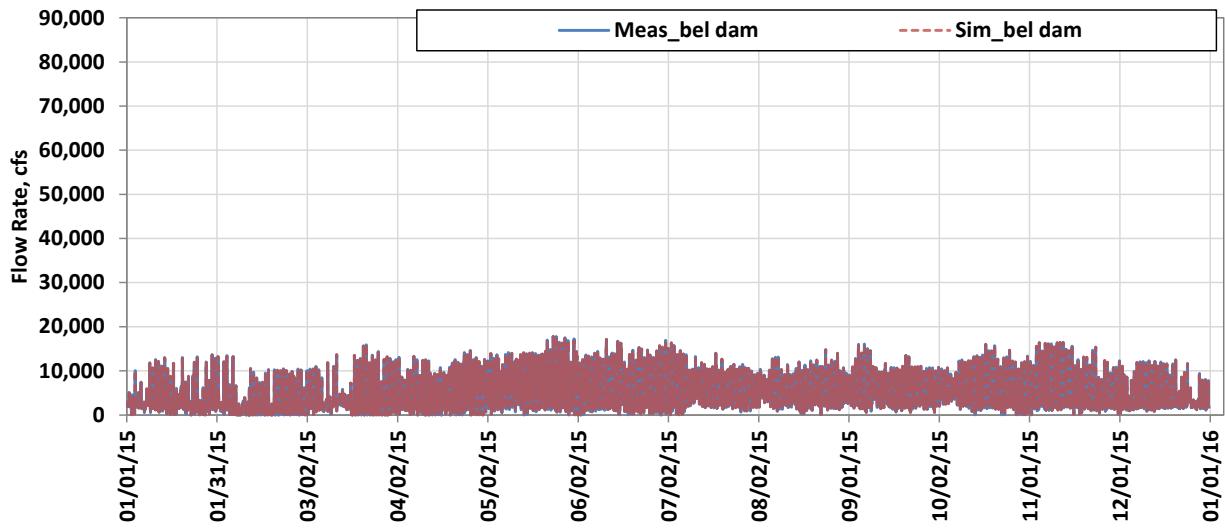


Figure A - 38. Shasta Lake total dam release, measured versus simulated flow: 2015.

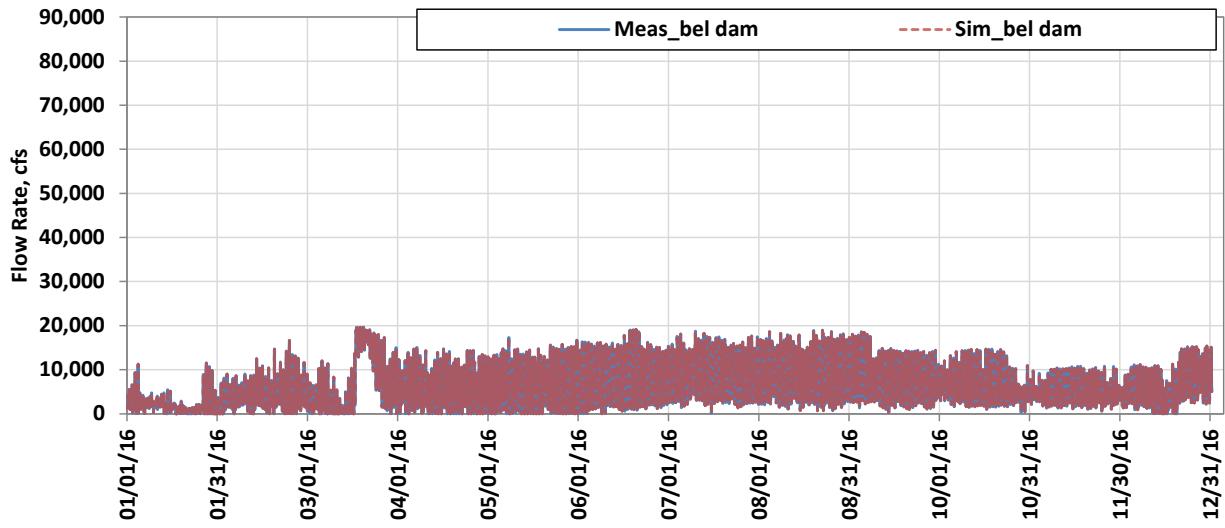


Figure A - 39. Shasta Lake total dam release, measured versus simulated flow: 2016.

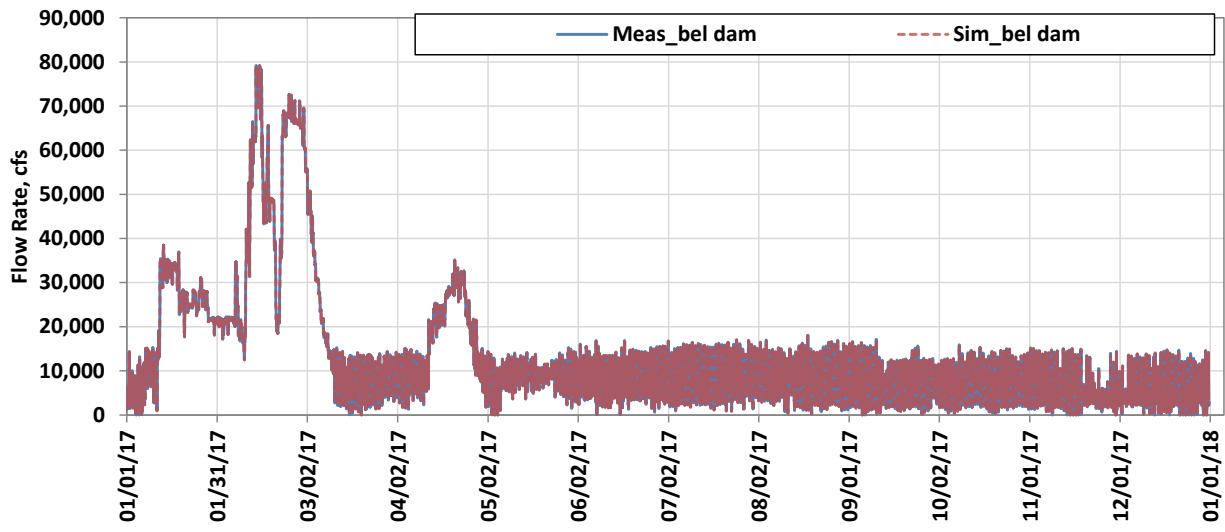


Figure A - 40. Shasta Lake total dam release, measured versus simulated flow: 2017.

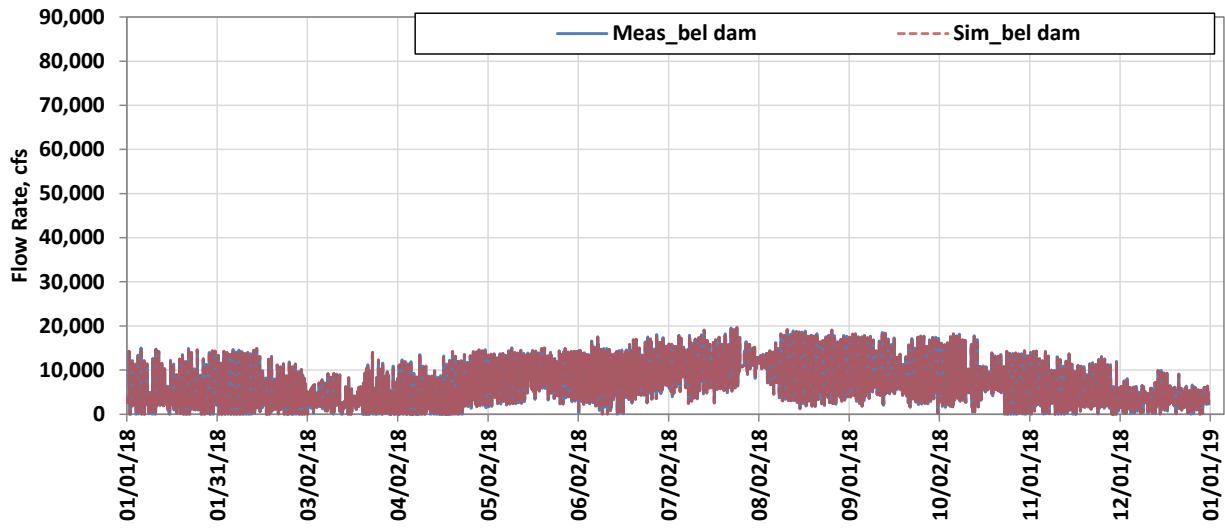


Figure A - 41. Shasta Lake total dam release, measured versus simulated flow: 2018.

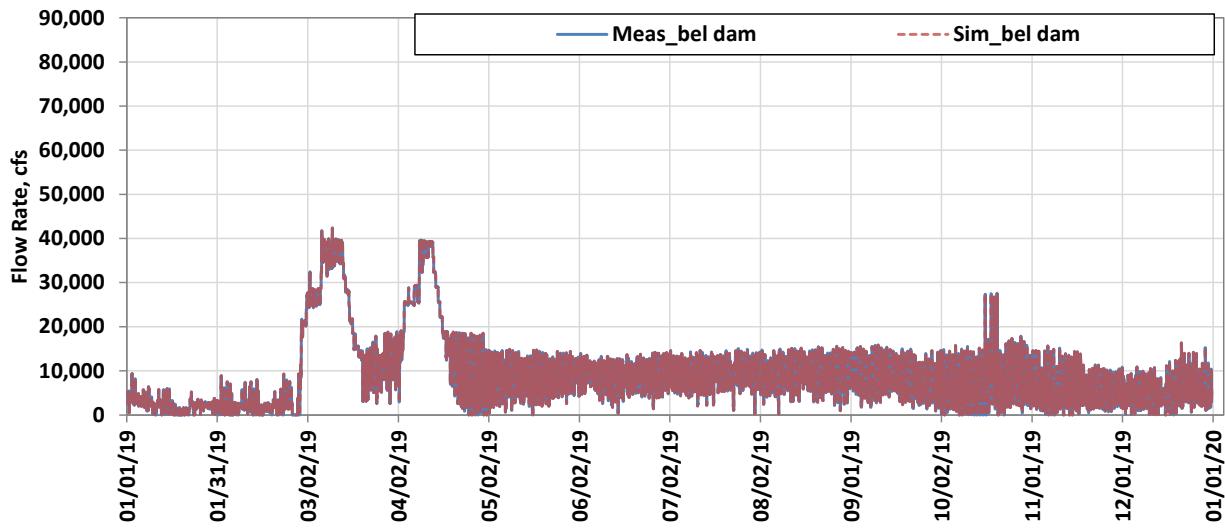


Figure A - 42. Shasta Lake total dam release, measured versus simulated flow: 2019.

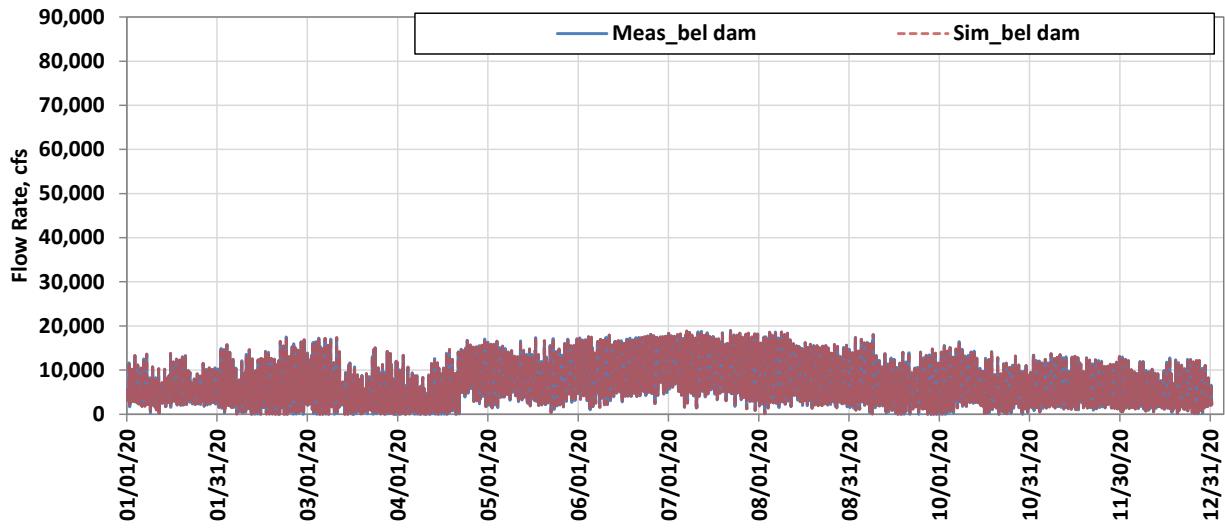


Figure A - 43. Shasta Lake total dam release, measured versus simulated flow: 2020.

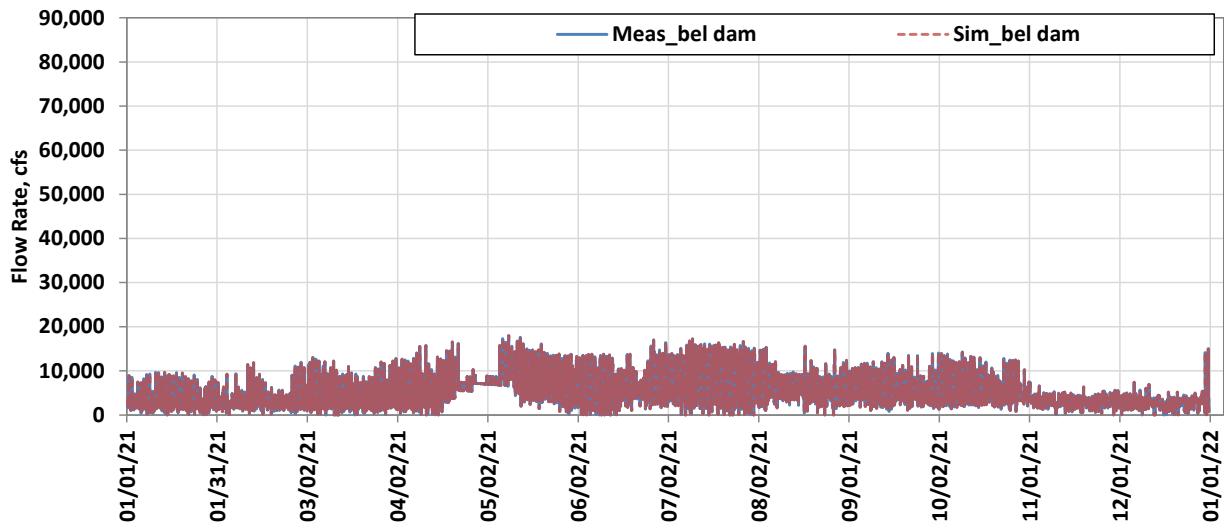


Figure A - 44. Shasta Lake total dam release, measured versus simulated flow: 2021.

Table A - 4 Summary statistics for Shasta Dam outflow: 2000-2008.

Statistic	2000	2001	2002	2003	2004	2005	2006	2007	2008
Mean Bias (cfs)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MAE (cfs)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RMSE (cfs)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nash-Sutcliffe (NSE)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
COUNT	8,472	8,760	8,760	8,760	8,784	8,760	8,760	8,760	8,784

Table A - 5 Summary statistics for Shasta Dam outflow: 2009-2017.

Statistic	2009	2010	2011	2012	2013	2014	2015	2016	2017
Mean Bias (cfs)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MAE (cfs)	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
RMSE (cfs)	0.2	0.1	0.0	0.0	0.2	0.1	0.4	0.1	0.0
Nash-Sutcliffe (NSE)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
COUNT	8,760	8,760	8,760	8,784	8,760	8,760	8,760	8,784	8,760

Table A - 6 Summary statistics for Shasta Dam outflow: 2018-2021.

Statistic	2018	2019	2020	2021
Mean Bias (cfs)	0.0	0.0	0.0	0.0
MAE (cfs)	0.0	0.2	0.0	0.0
RMSE (cfs)	0.0	0.3	0.0	0.1
Nash-Sutcliffe (NSE)	1.0	1.0	1.0	1.0
COUNT	8760	8760	8,784	8,760

A.3. Reservoir Temperature Profiles

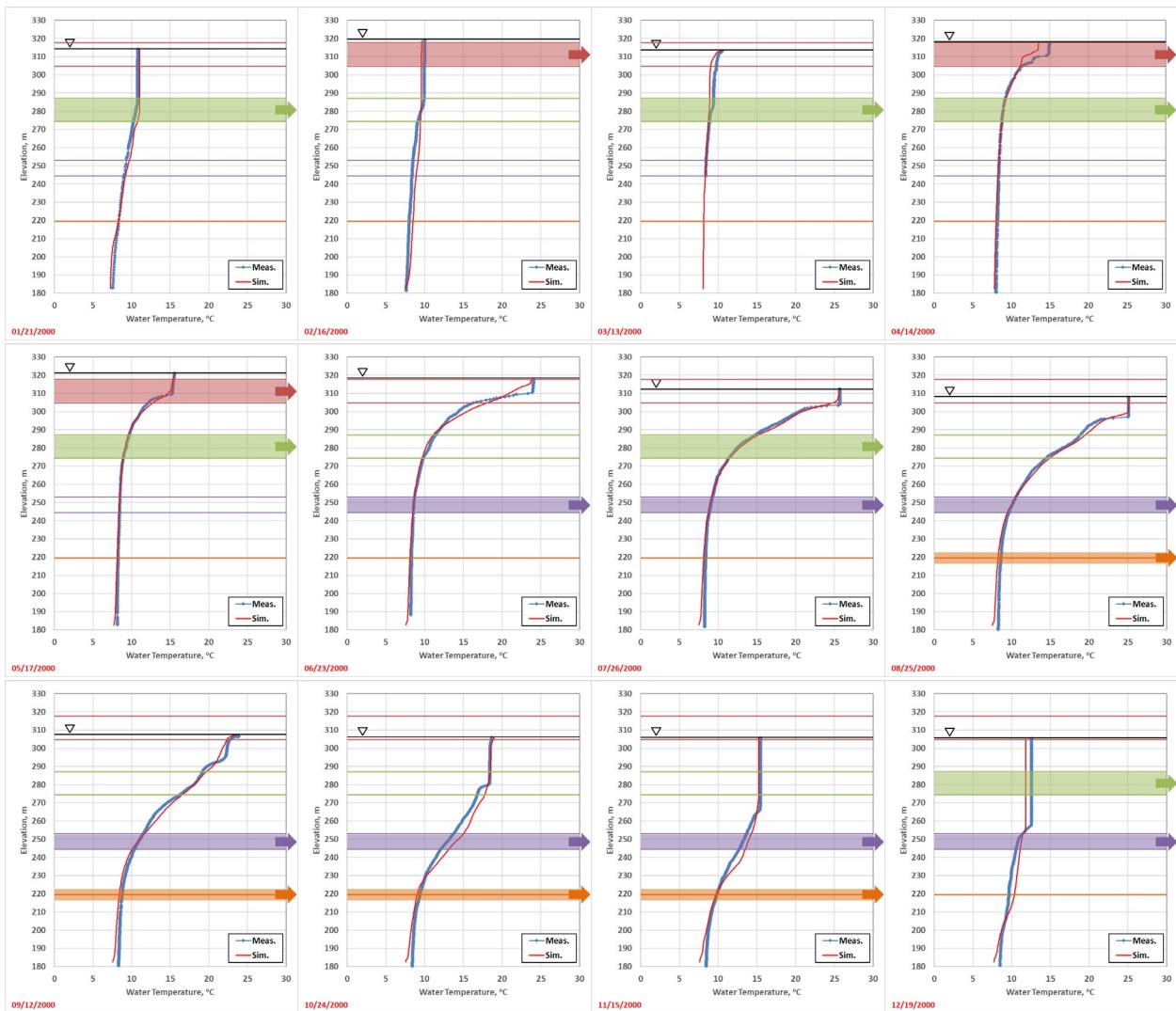


Figure A - 45. Shasta Lake monthly simulated versus measured temperature profiles including active TCD gate levels at date and time of each measured profile: 2000.

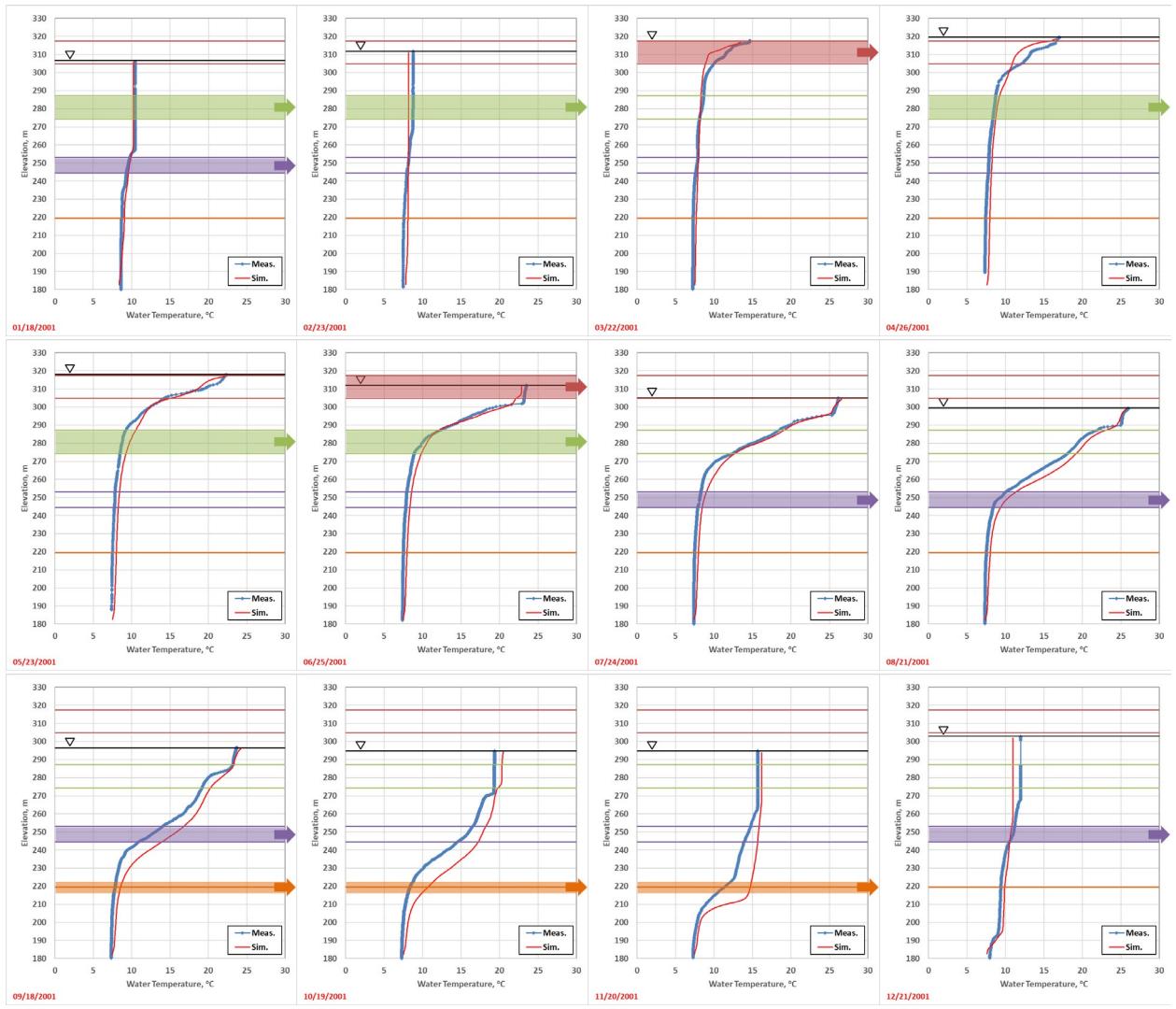


Figure A - 46. Shasta Lake monthly simulated versus measured temperature profiles including active TCD gate levels at date and time of each measured profile: 2001.

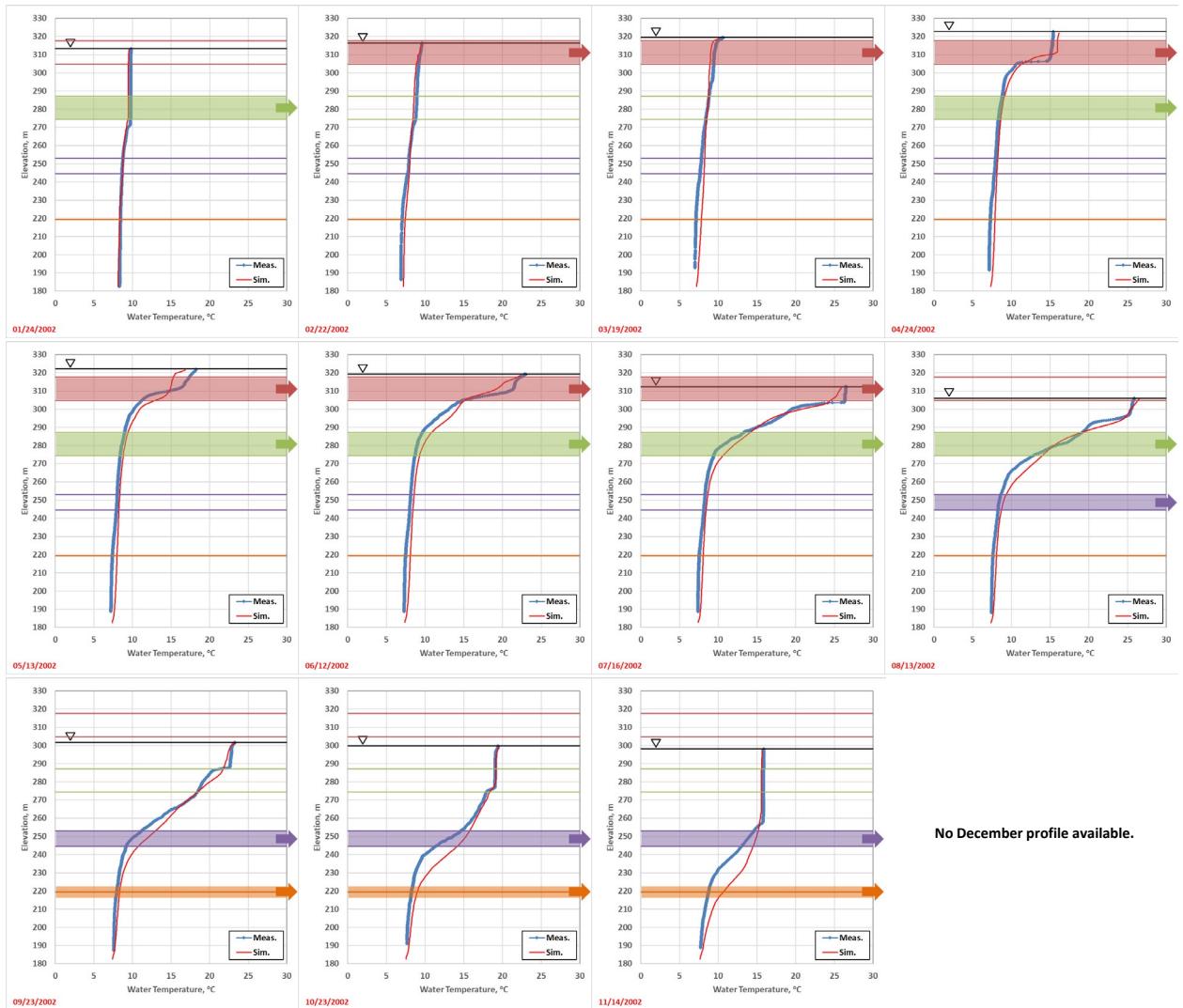


Figure A - 47. Shasta Lake monthly simulated versus measured temperature profiles including active TCD gate levels at date and time of each measured profile: 2002.

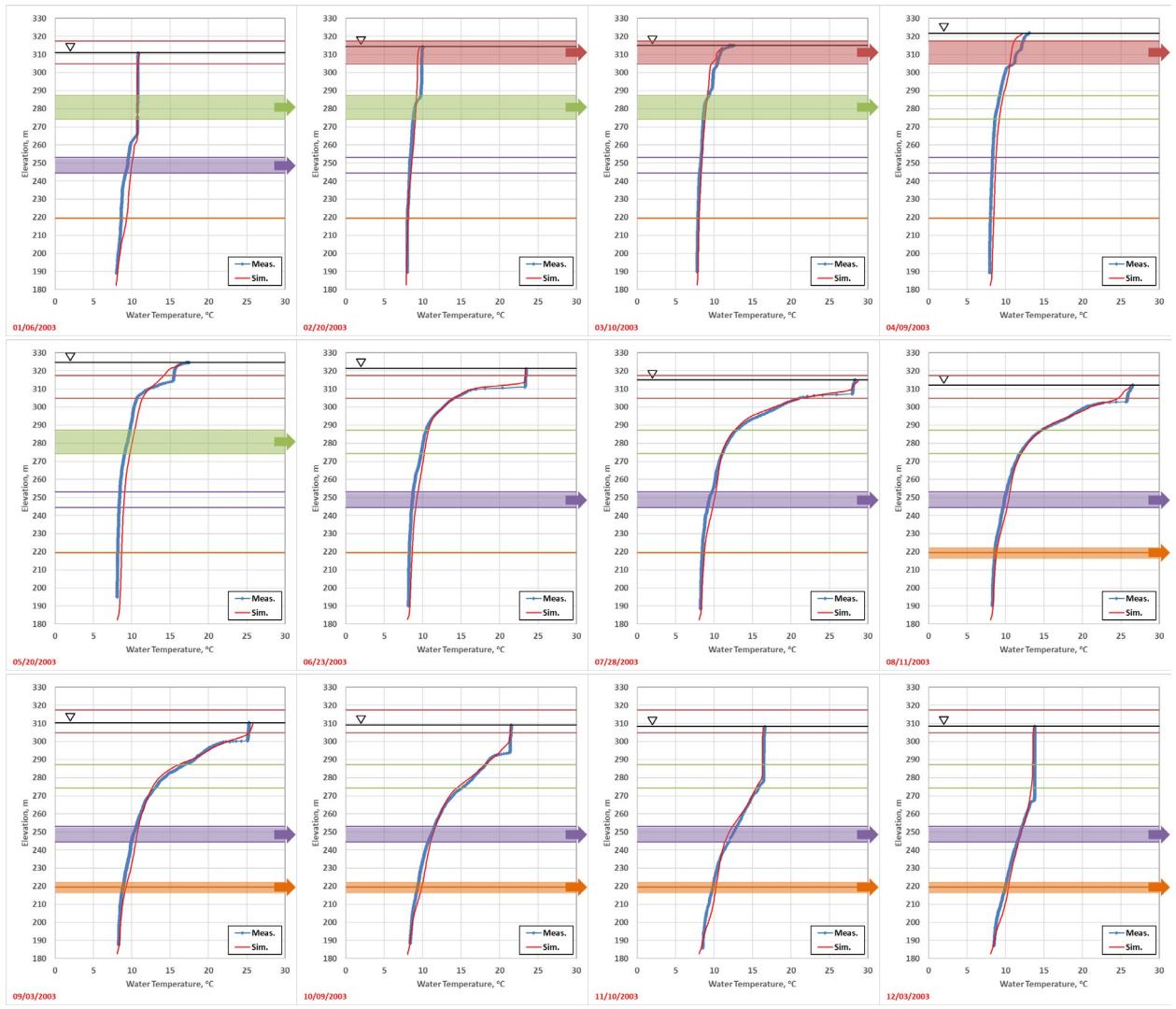


Figure A - 48. Shasta Lake monthly simulated versus measured temperature profiles including active TCD gate levels at date and time of each measured profile: 2003.

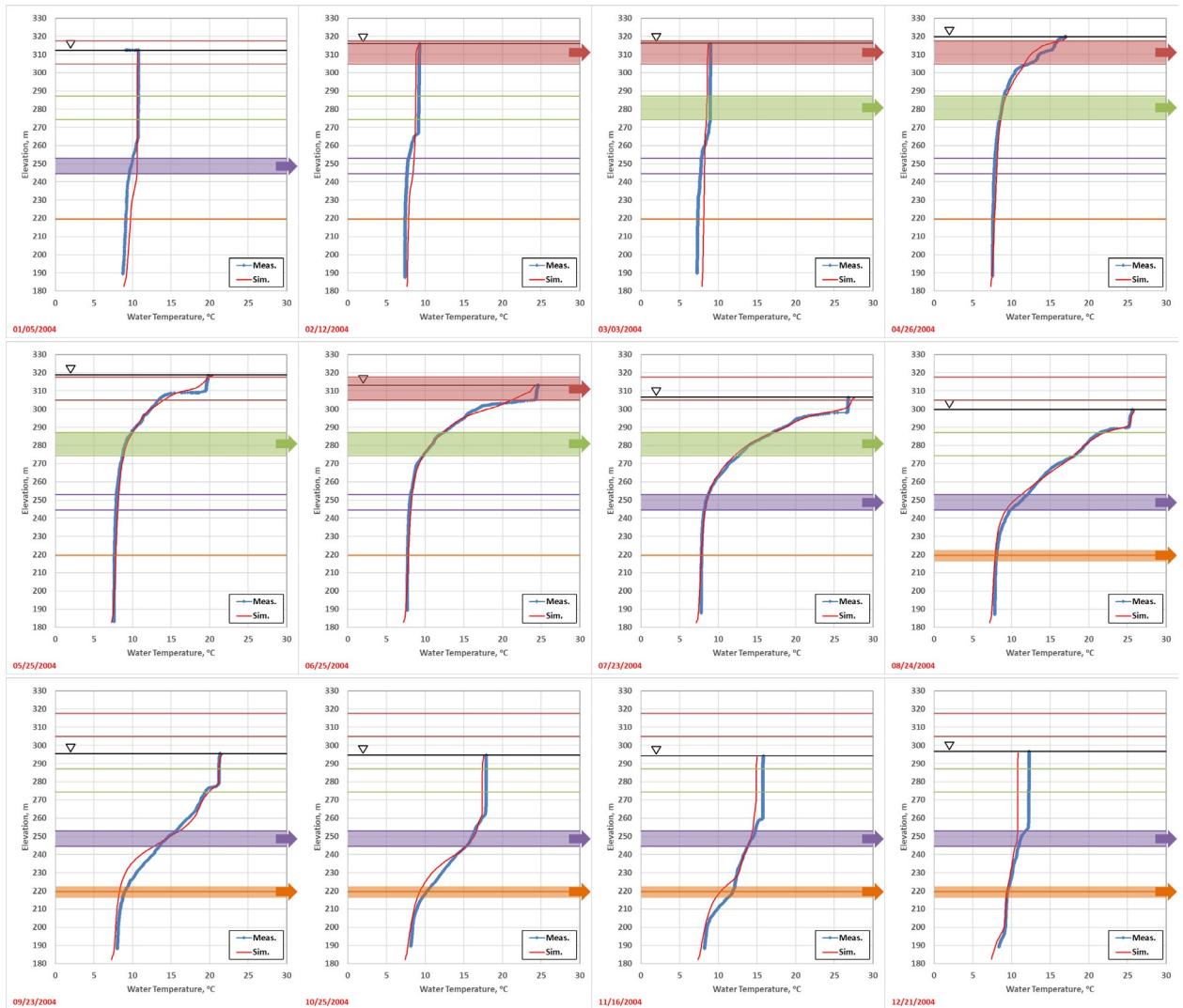


Figure A - 49. Shasta Lake monthly simulated versus measured temperature profiles including active TCD gate levels at date and time of each measured profile: 2004.

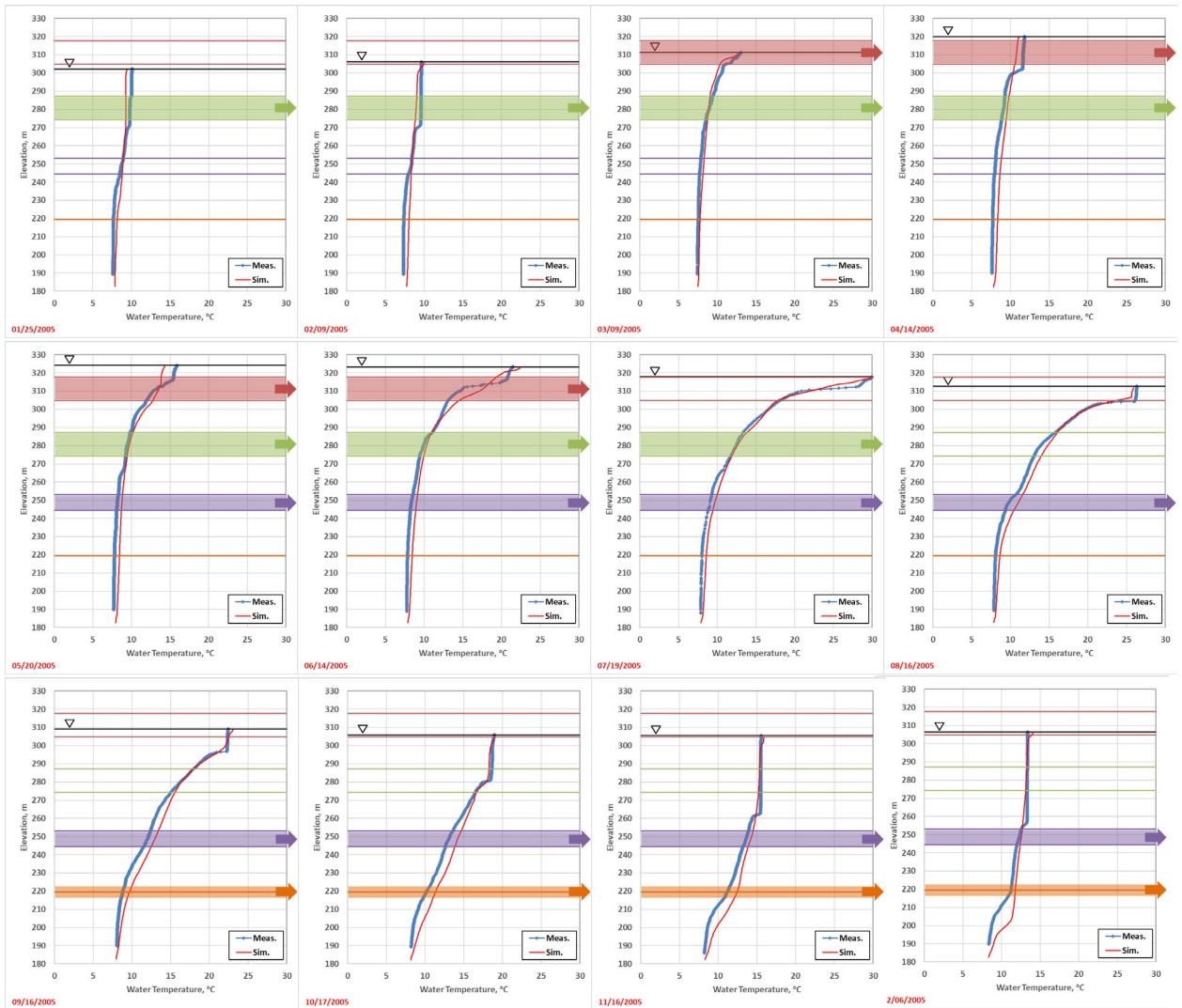


Figure A - 50. Shasta Lake monthly simulated versus measured temperature profiles including active TCD gate levels at date and time of each measured profile: 2005.

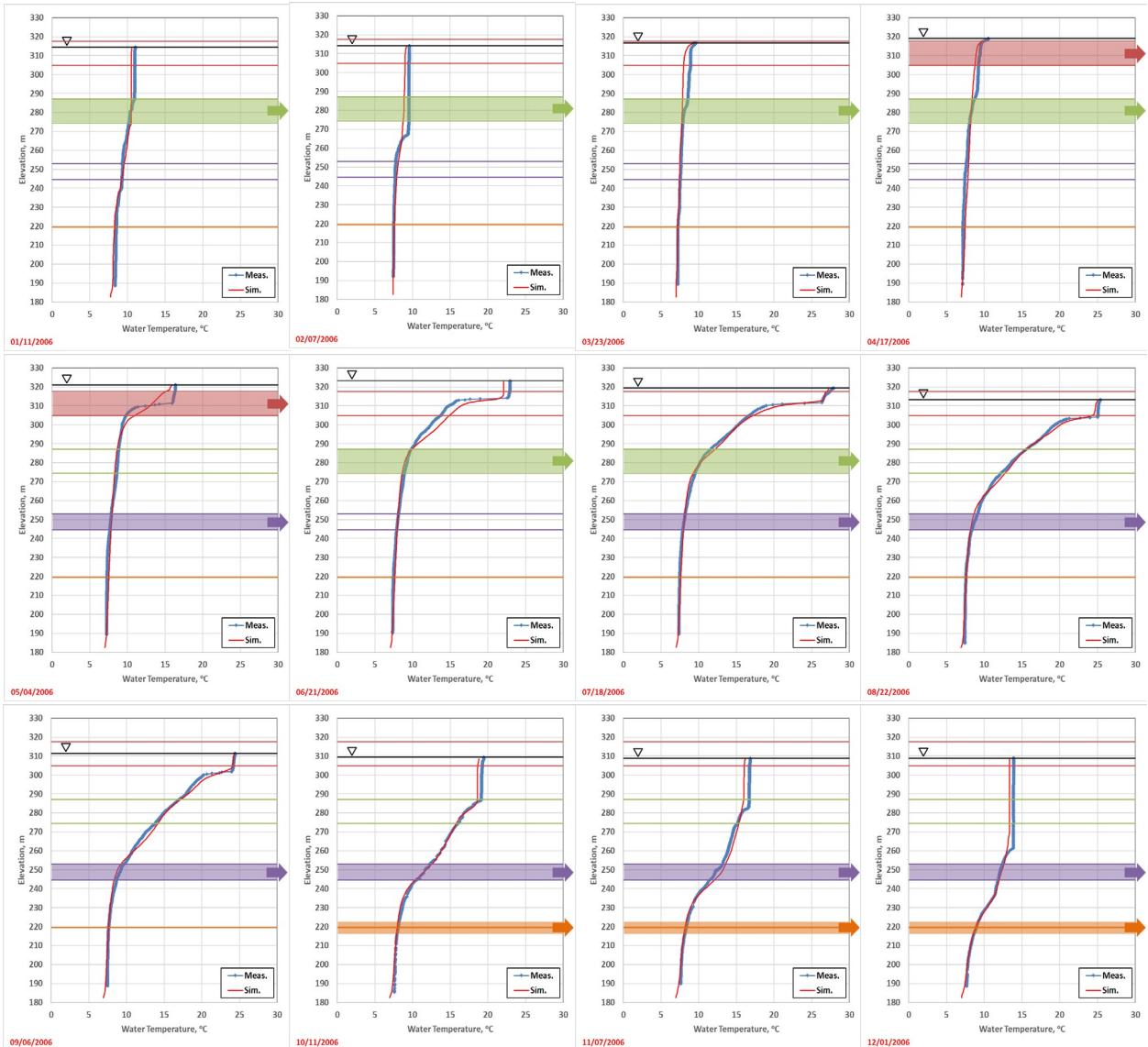


Figure A - 51. Shasta Lake monthly simulated versus measured temperature profiles including active TCD gate levels at date and time of each measured profile: 2006.

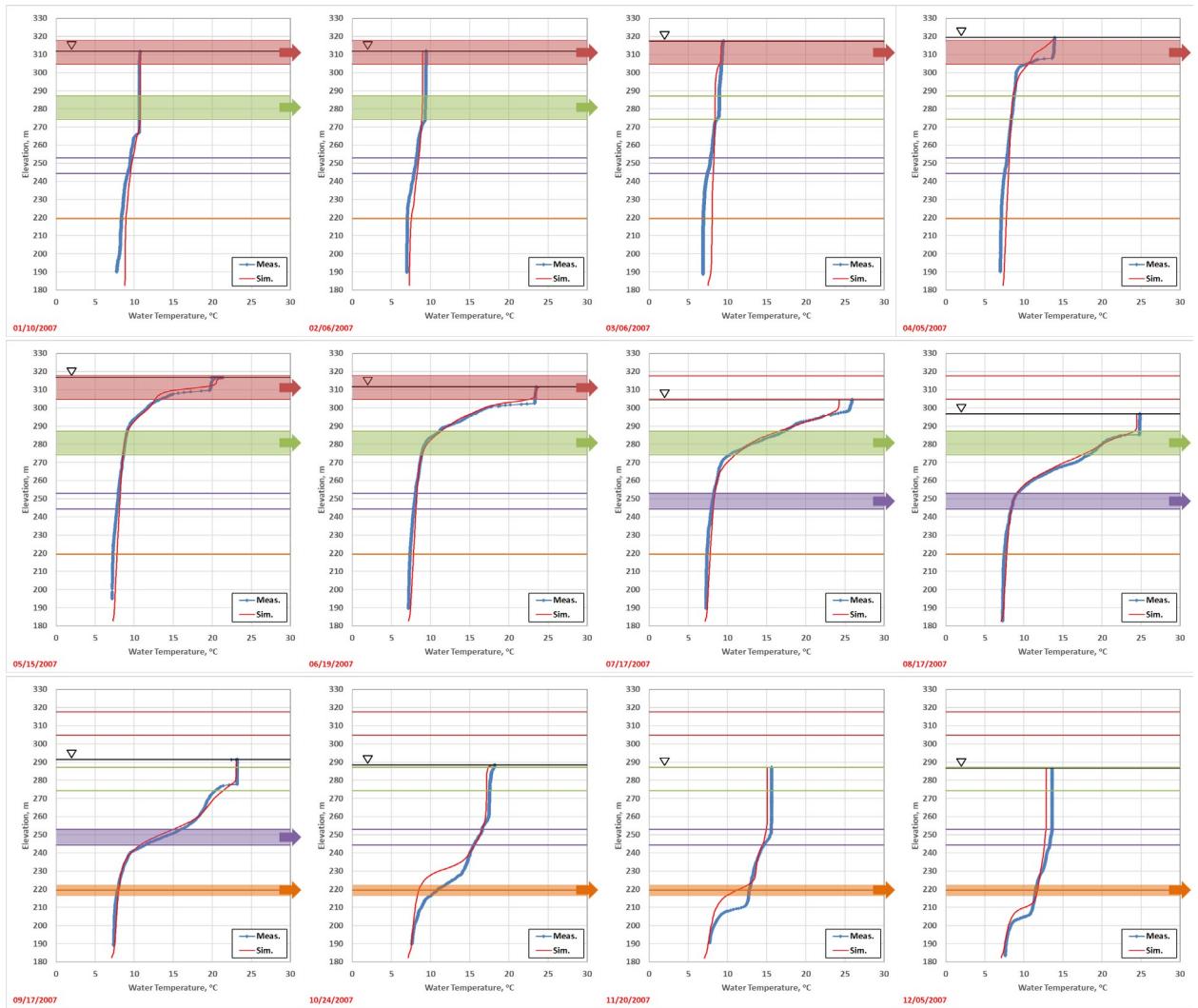


Figure A - 52. Shasta Lake monthly simulated versus measured temperature profiles including active TCD gate levels at date and time of each measured profile: 2007.

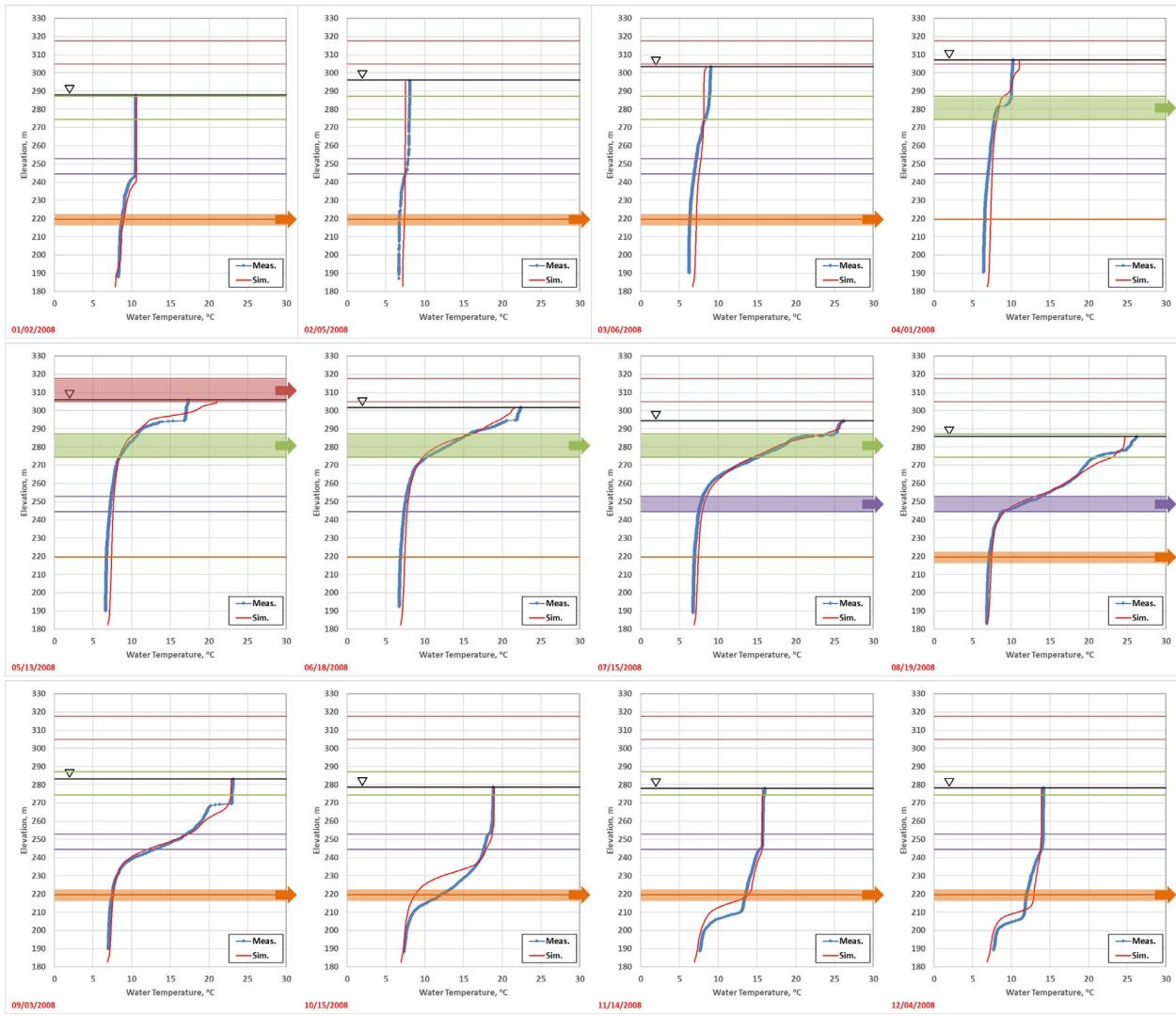


Figure A - 53. Shasta Lake monthly simulated versus measured temperature profiles including active TCD gate levels at date and time of each measured profile: 2008.

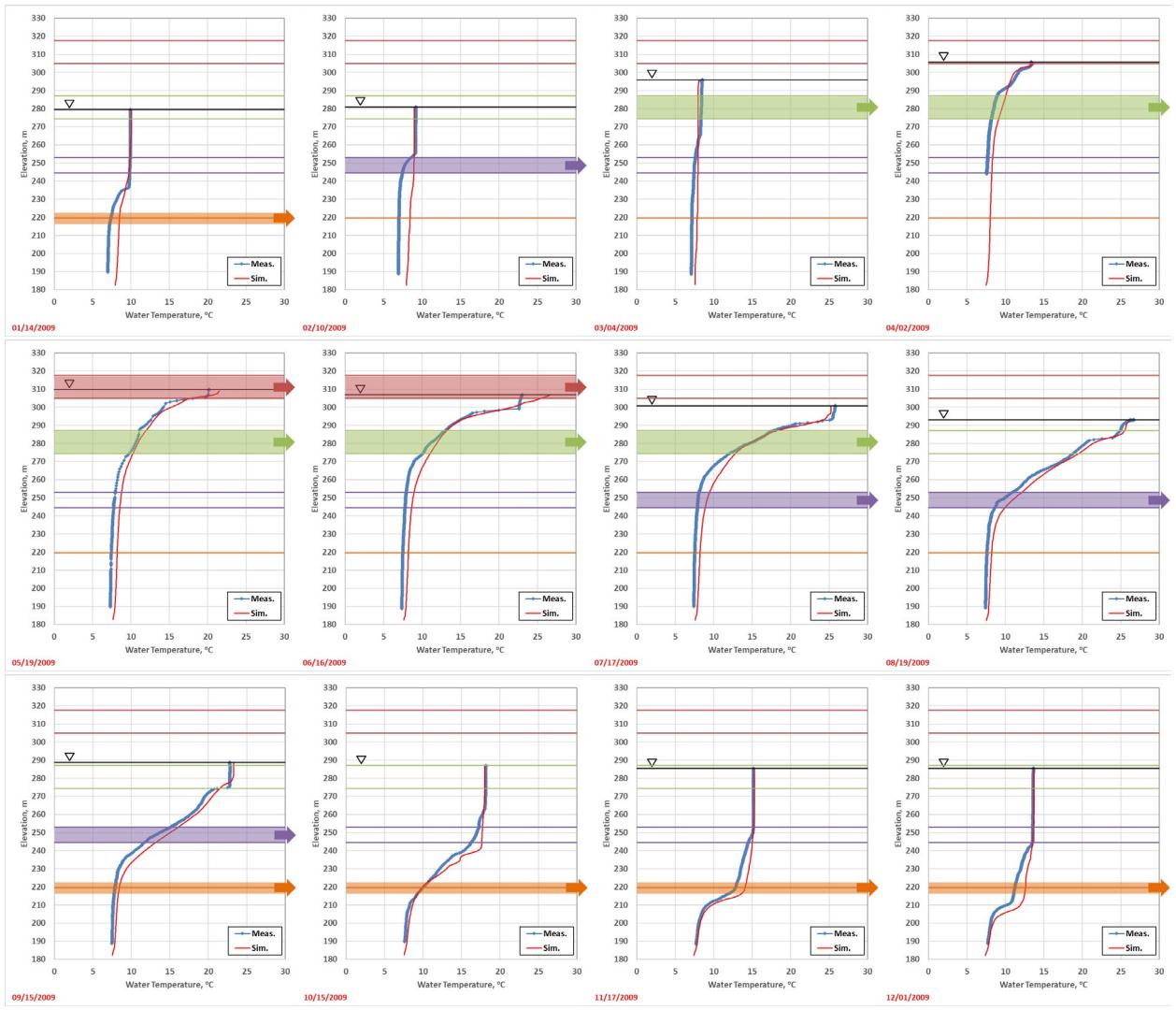


Figure A - 54. Shasta Lake monthly simulated versus measured temperature profiles including active TCD gate levels at date and time of each measured profile: 2009.

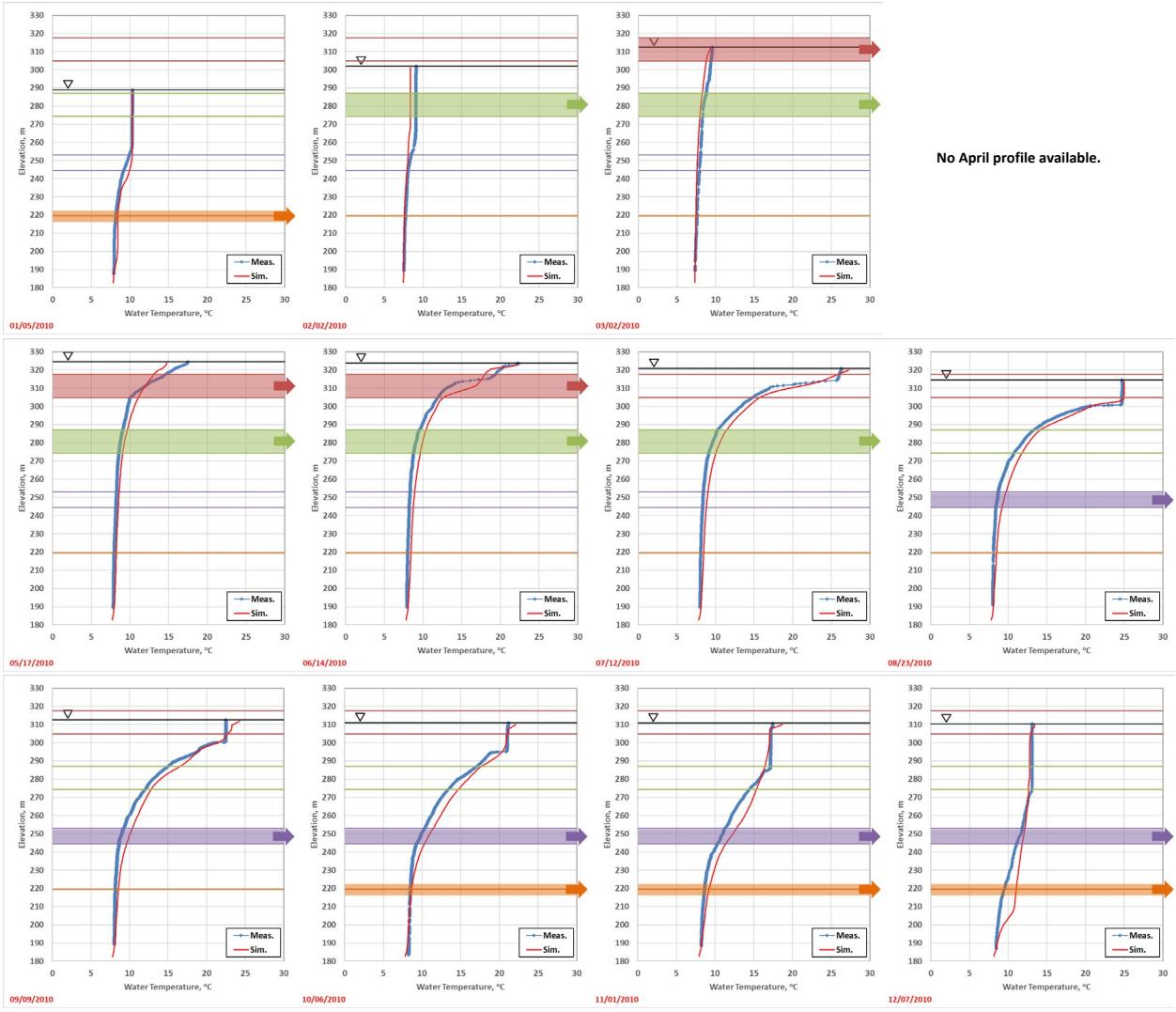


Figure A - 55. Shasta Lake monthly simulated versus measured temperature profiles including active TCD gate levels at date and time of each measured profile: 2010.

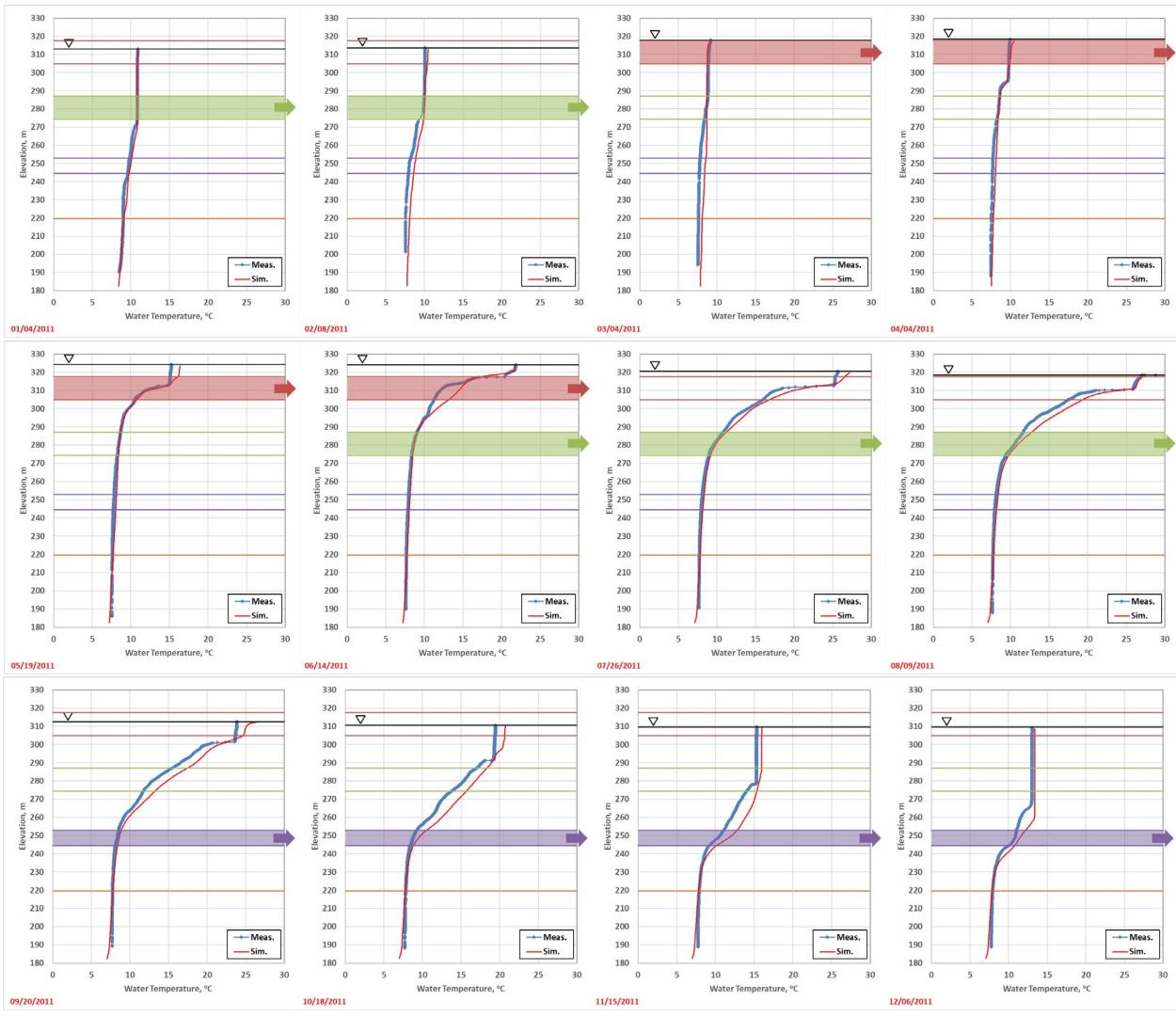


Figure A - 56. Shasta Lake monthly simulated versus measured temperature profiles including active TCD gate levels at date and time of each measured profile: 2011.

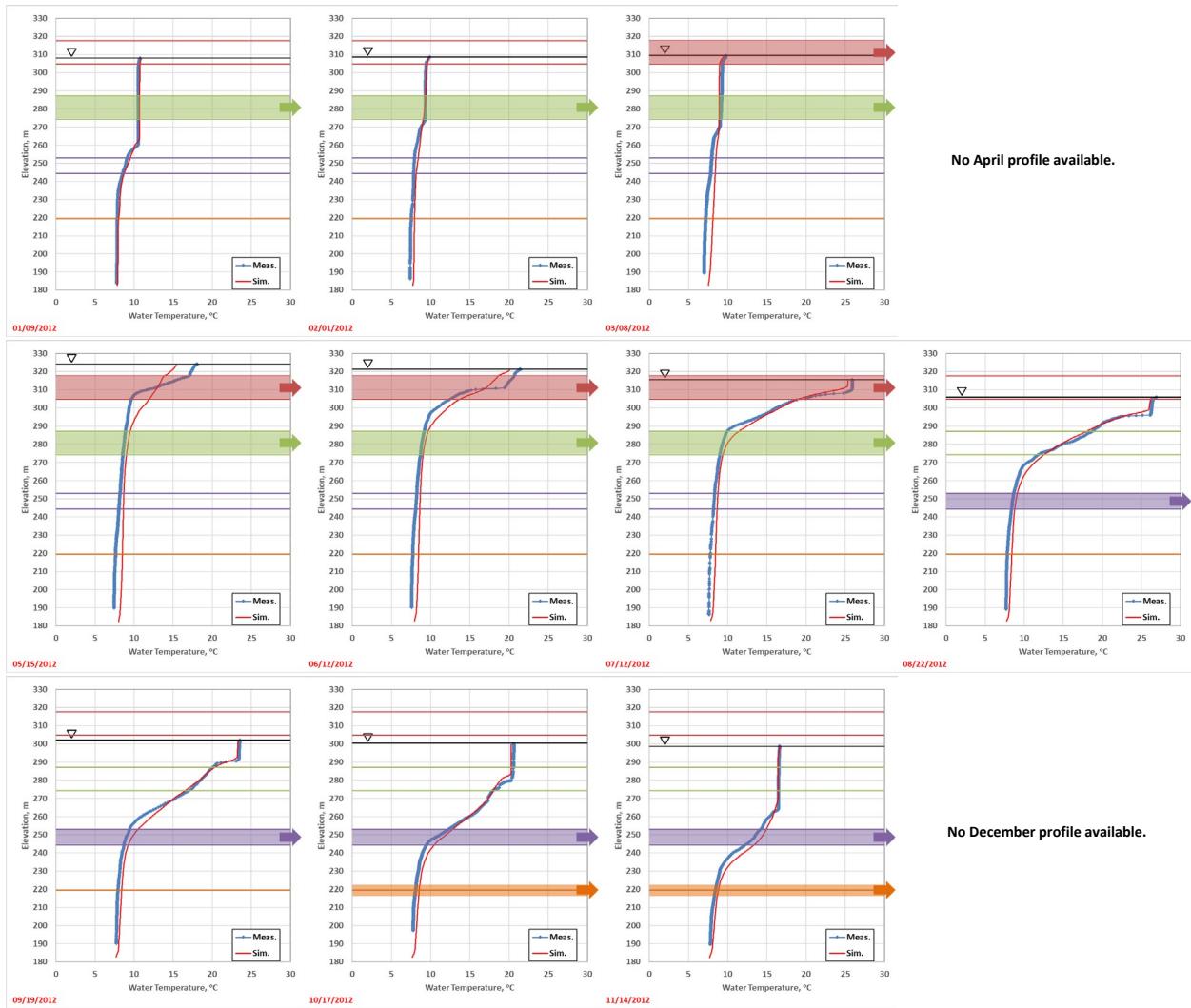


Figure A - 57. Shasta Lake monthly simulated versus measured temperature profiles including active TCD gate levels at date and time of each measured profile: 2012.

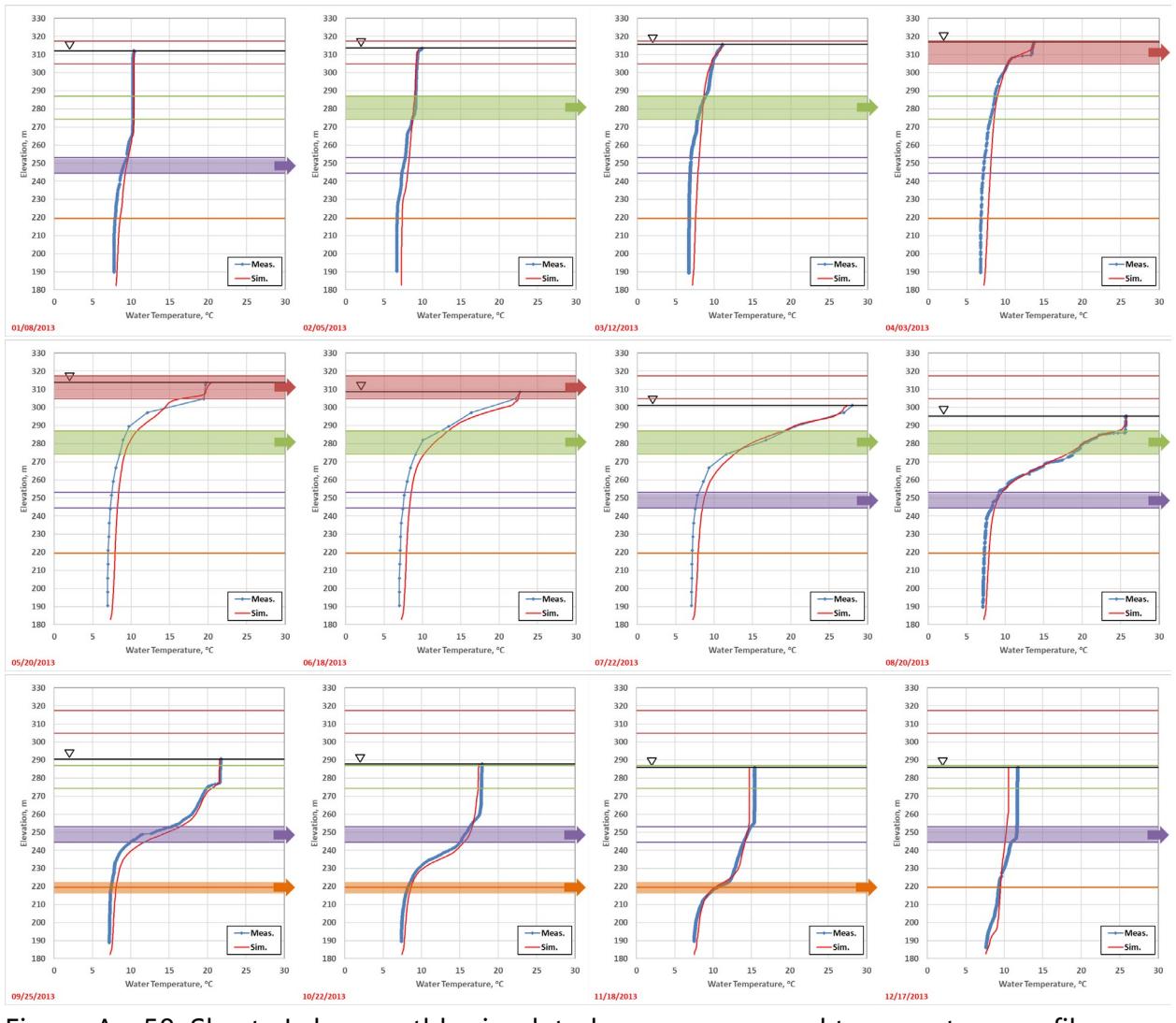


Figure A - 58. Shasta Lake monthly simulated versus measured temperature profiles including active TCD gate levels at date and time of each measured profile: 2013.

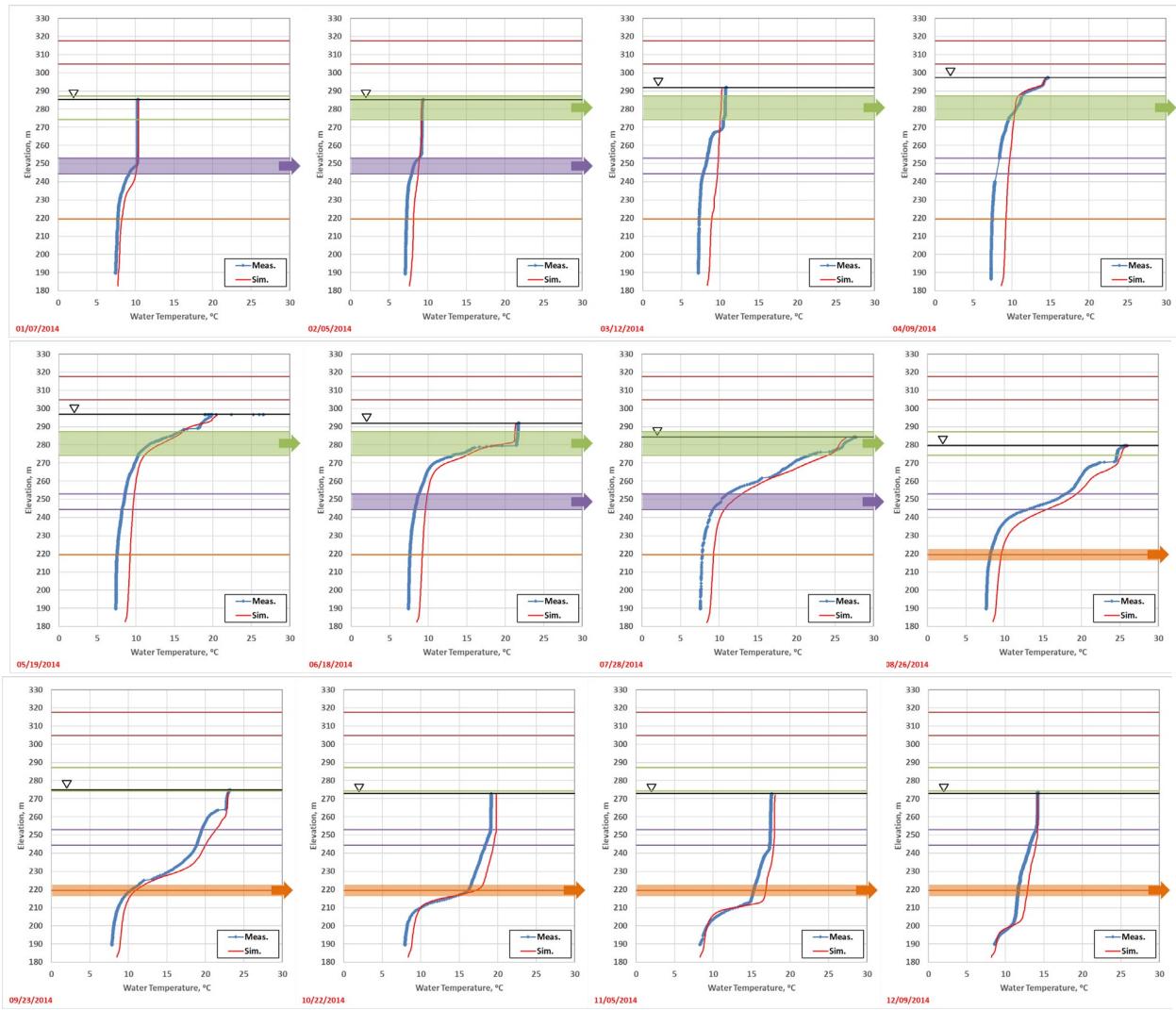


Figure A - 59. Shasta Lake monthly simulated versus measured temperature profiles including active TCD gate levels at date and time of each measured profile: 2014.

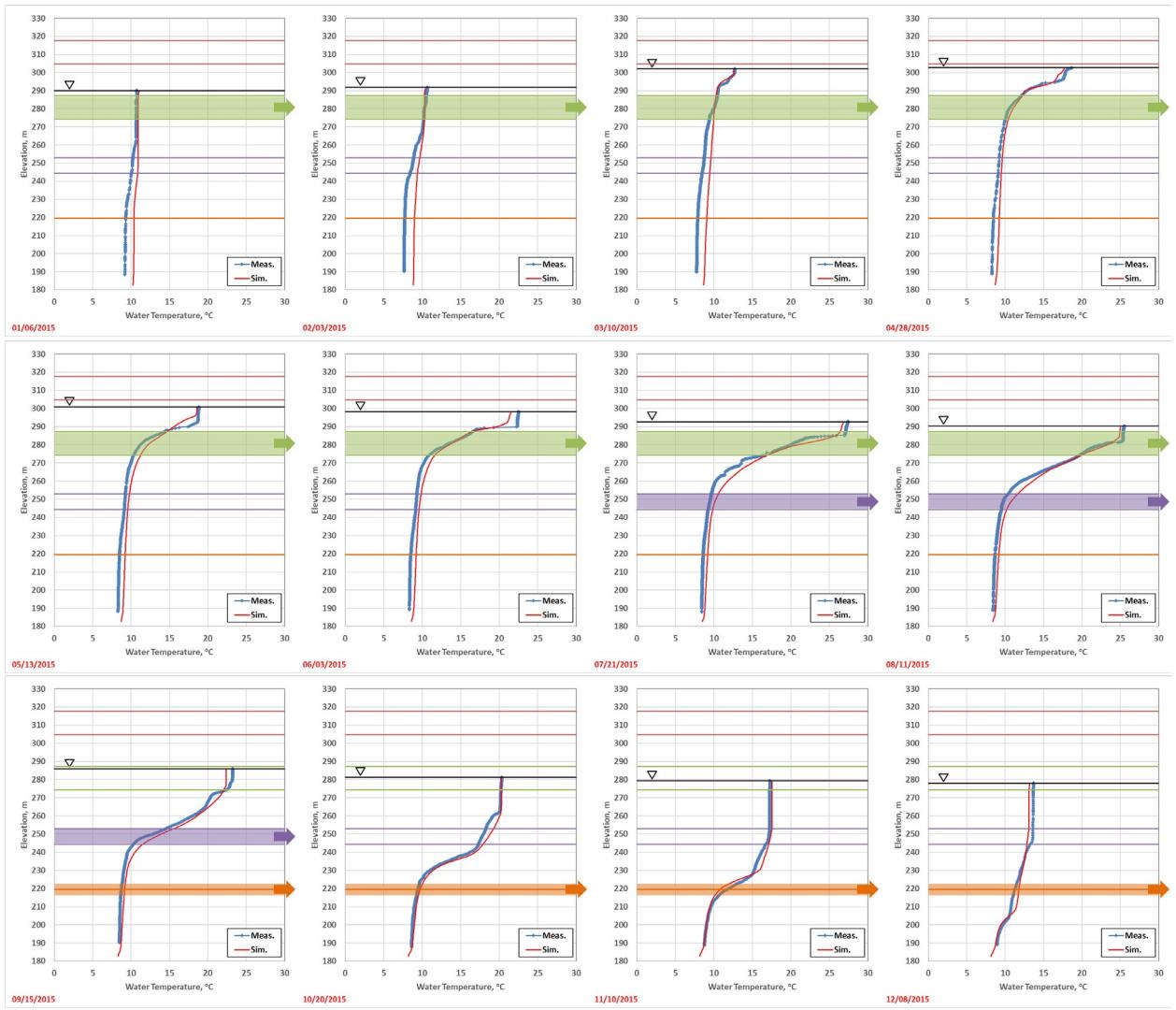


Figure A - 60. Shasta Lake monthly simulated versus measured temperature profiles including active TCD gate levels at date and time of each measured profile: 2015.

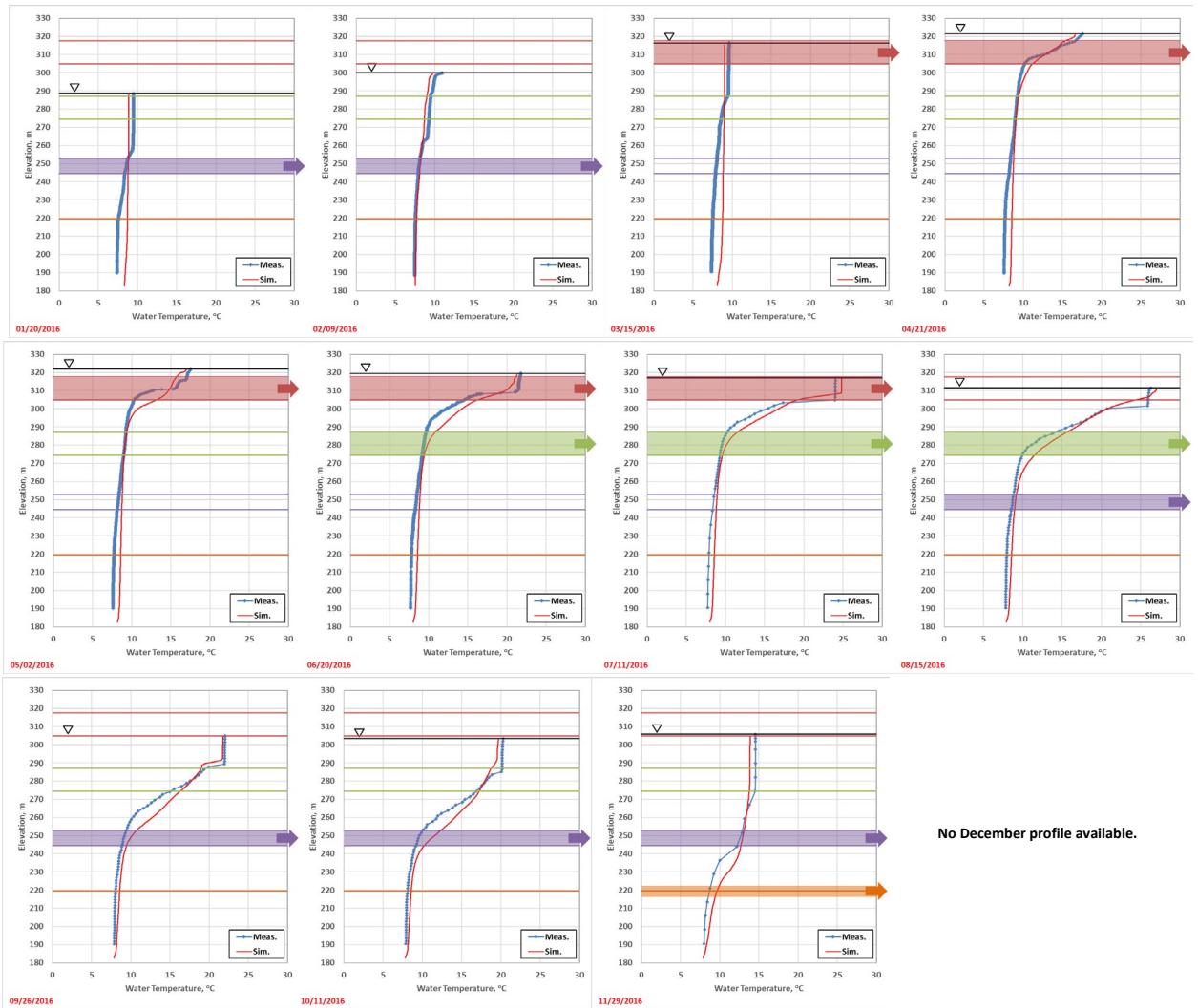


Figure A - 61. Shasta Lake monthly simulated versus measured temperature profiles including active TCD gate levels at date and time of each measured profile: 2016.

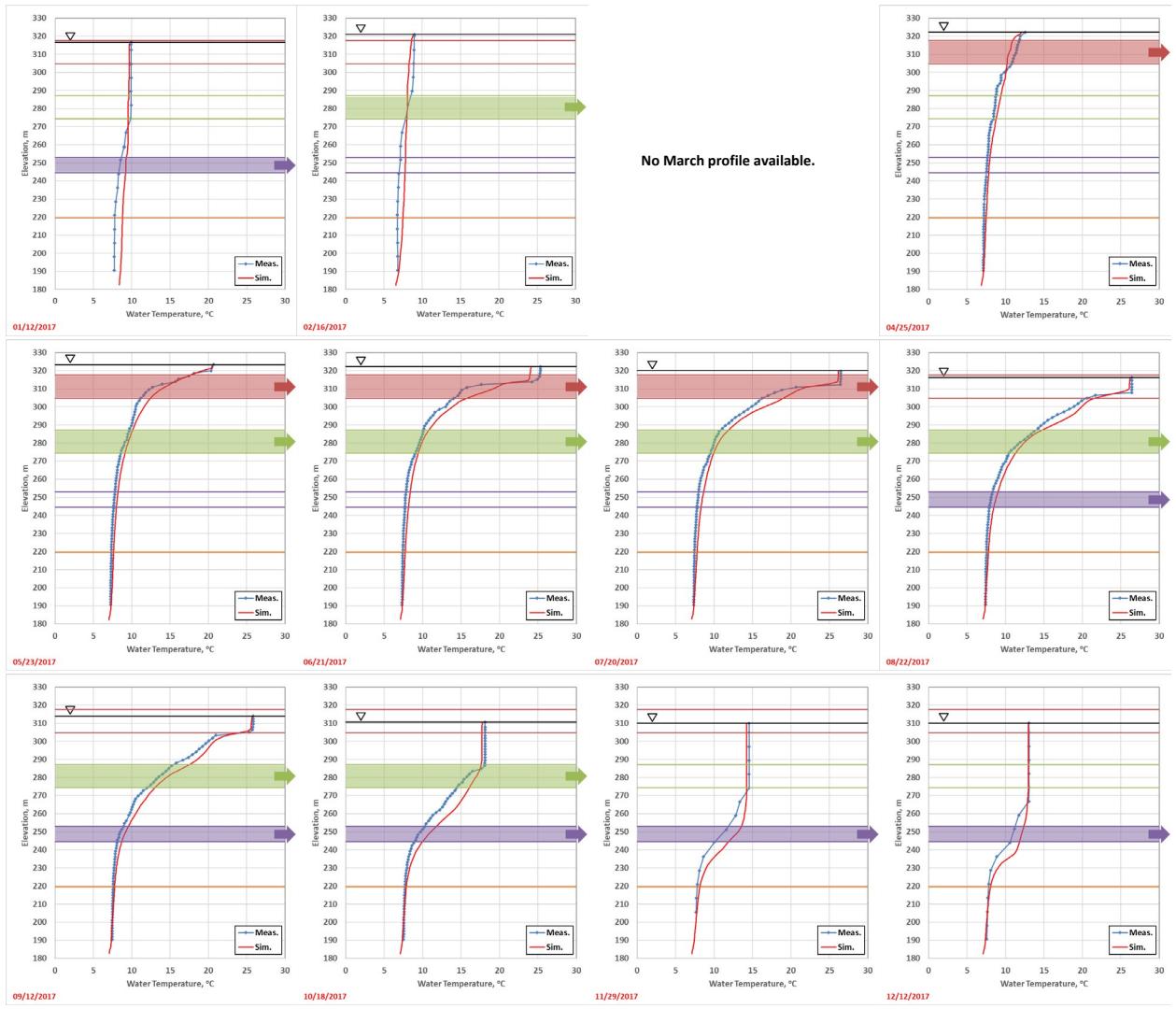


Figure A - 62. Shasta Lake monthly simulated versus measured temperature profiles including active TCD gate levels at date and time of each measured profile: 2017.

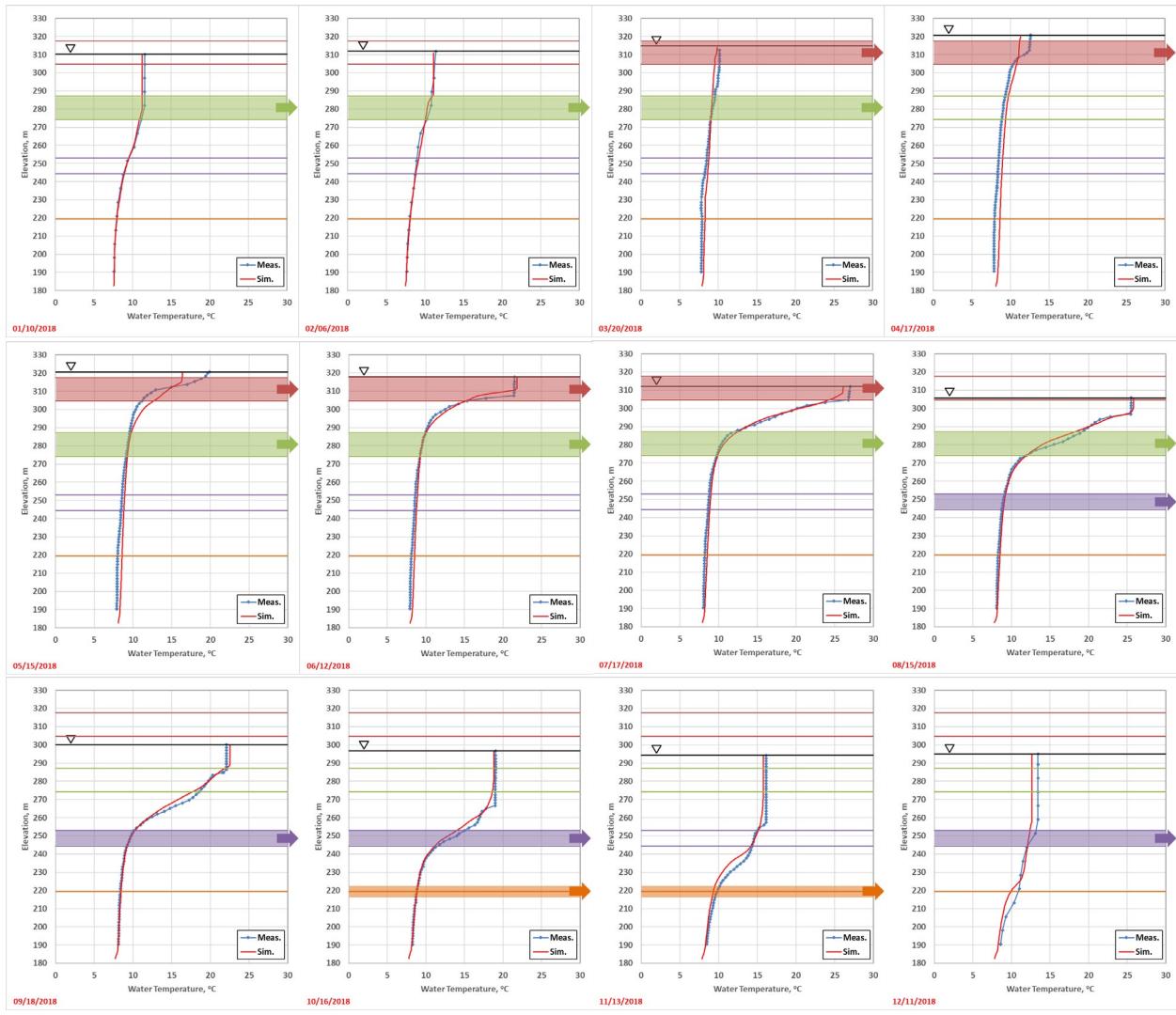


Figure A - 63. Shasta Lake monthly simulated versus measured temperature profiles including active TCD gate levels at date and time of each measured profile: 2018.

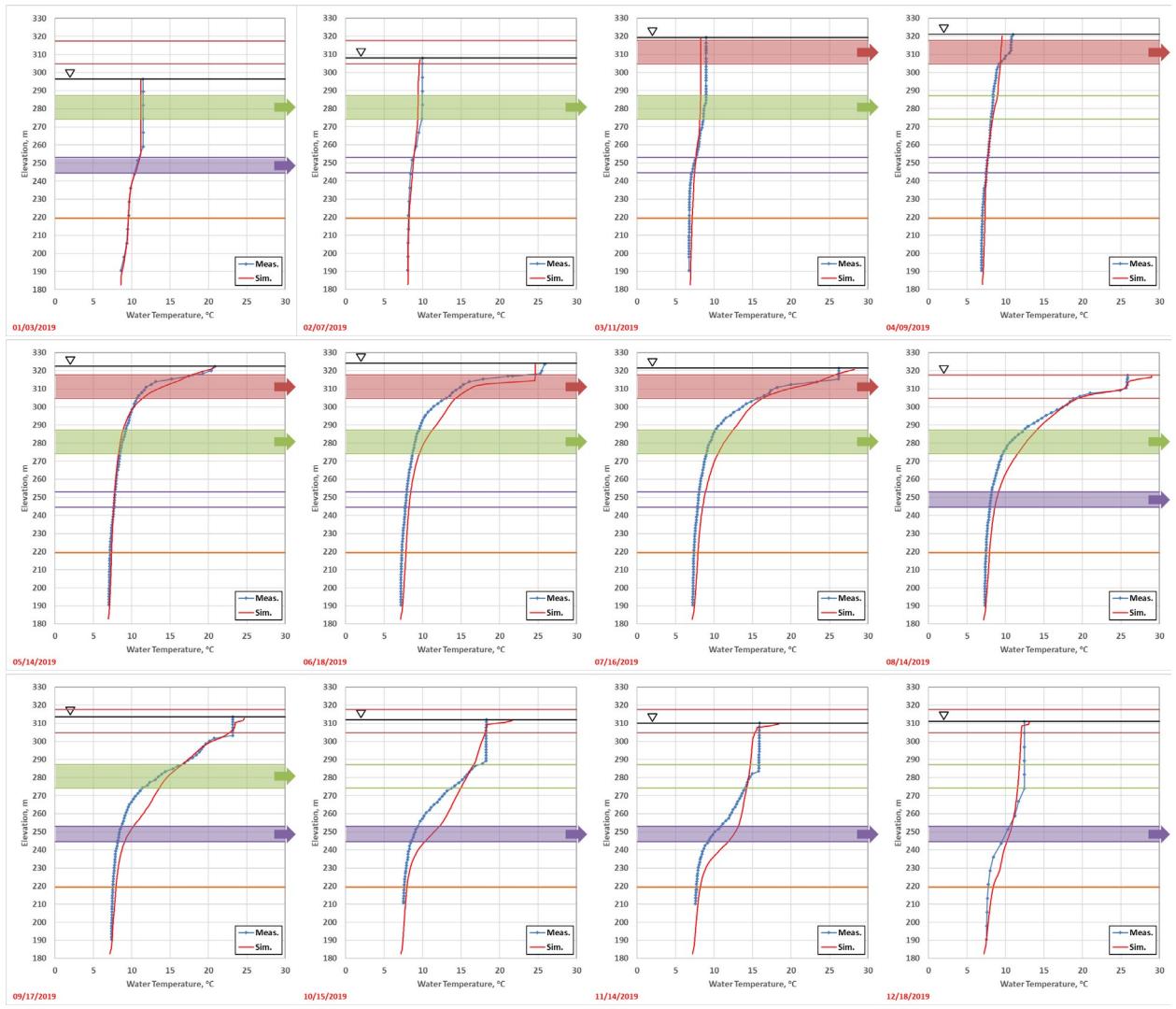


Figure A - 64. Shasta Lake monthly simulated versus measured temperature profiles including active TCD gate levels at date and time of each measured profile: 2019.

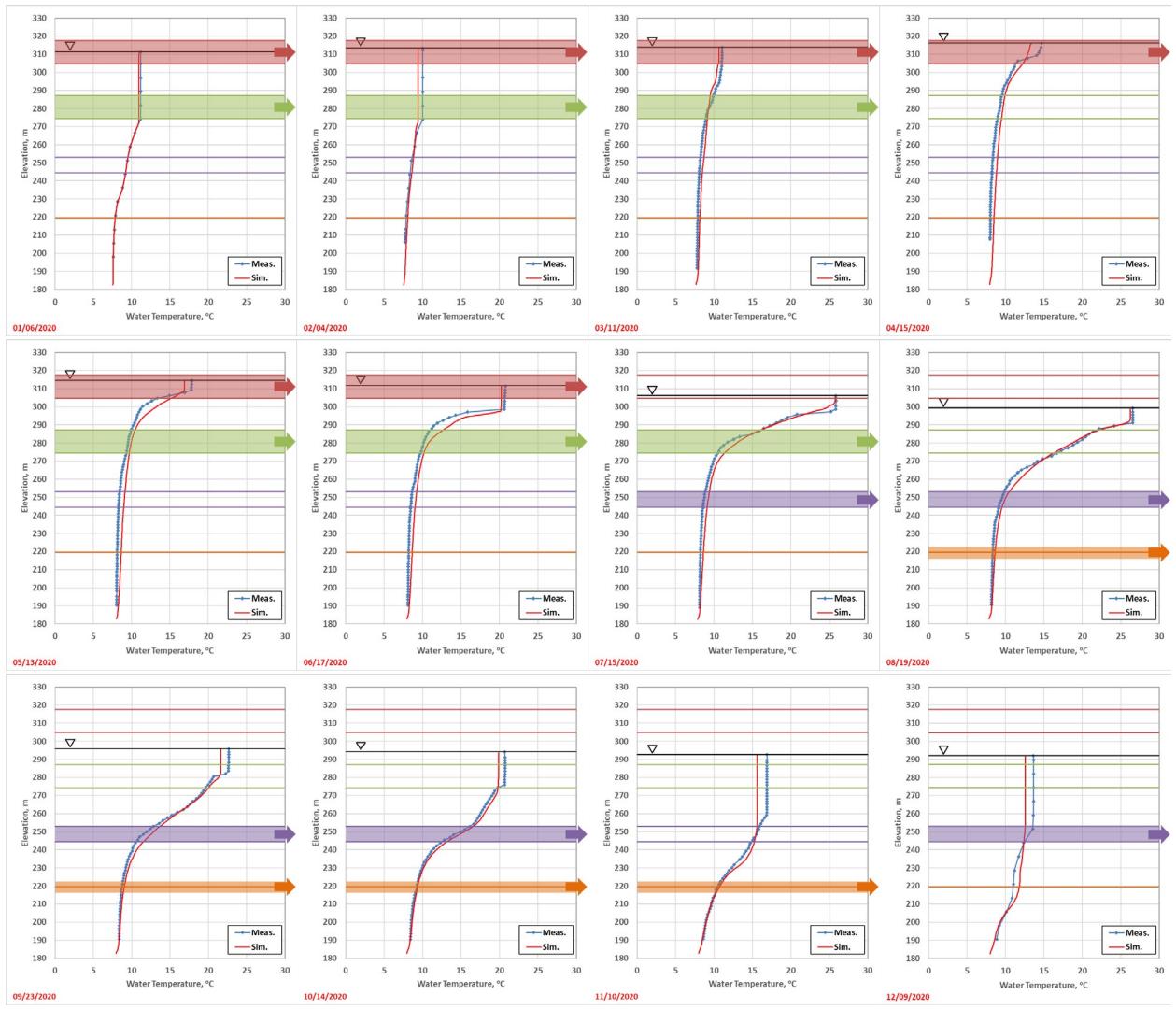


Figure A - 65. Shasta Lake monthly simulated versus measured temperature profiles including active TCD gate levels at date and time of each measured profile: 2020.

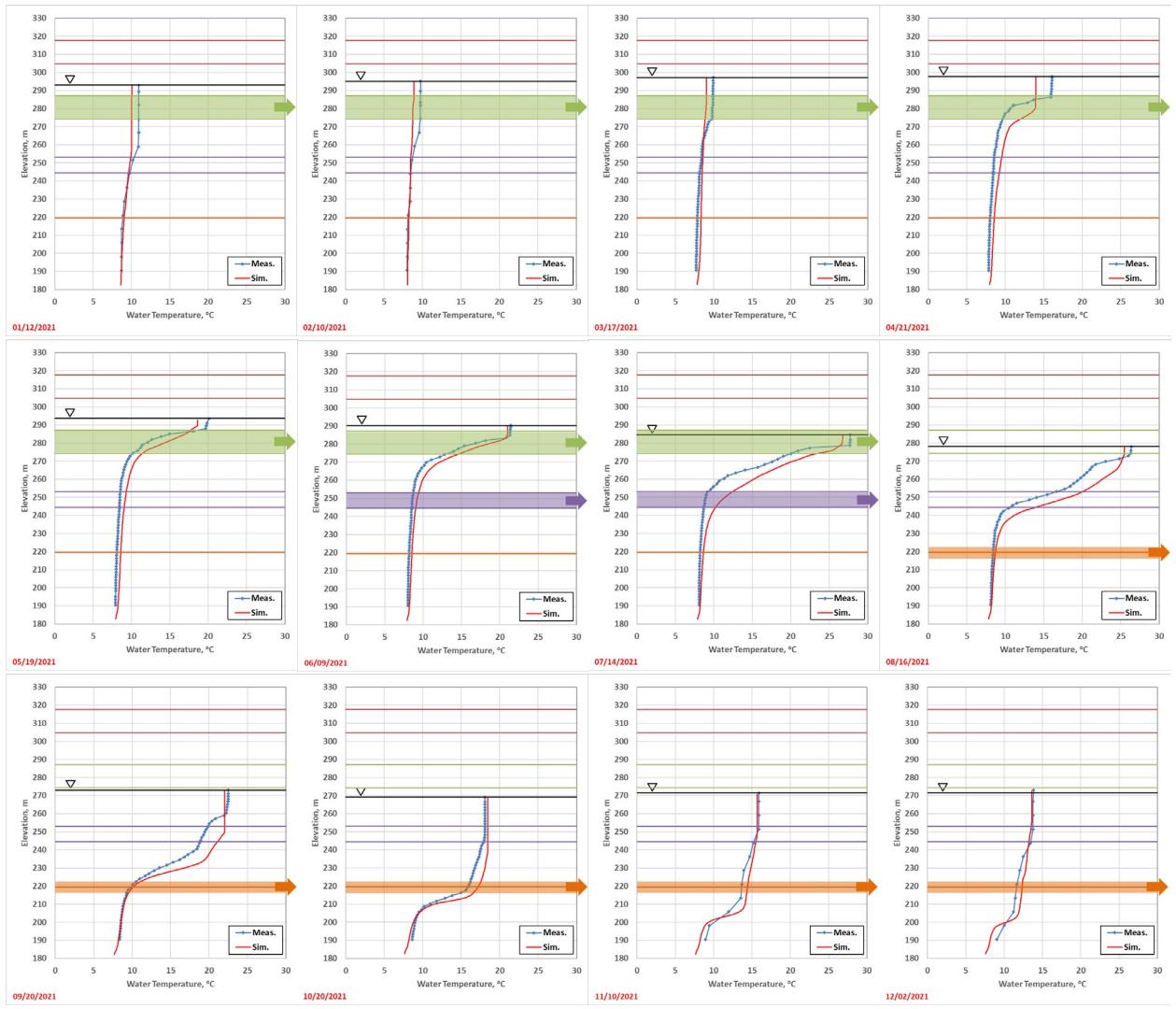


Figure A - 66. Shasta Lake monthly simulated versus measured temperature profiles including active TCD gate levels at date and time of each measured profile: 2021.

Table D-1. Summary Statistics of temperature profiles for Shasta Lake above Shasta Dam (Mean Bias, MAE, and RMSE are in °C): 2000-2005.

Table A - 7. Summary Statistics of temperature profiles for Shasta Lake above Shasta Dam (Mean Bias, MAE, and RMSE are in °C): 2000

Statistic	01/21	02/16	03/13	04/14	05/17	06/23	07/26	08/25	09/12	10/24	11/15	12/19
Mean Bias	0.11	0.21	-0.30	-0.28	-0.11	-0.20	-0.13	-0.13	-0.19	0.16	-0.05	-0.16
MAE	0.28	0.41	0.30	0.28	0.18	0.41	0.32	0.39	0.46	0.51	0.37	0.58
RMSE	0.30	0.43	0.40	0.52	0.22	0.62	0.39	0.45	0.50	0.61	0.43	0.63
NSE	0.93	0.74	0.46	0.91	0.99	0.98	0.99	0.99	0.99	0.98	0.98	0.84
COUNT	131	137	70	136	138	130	130	126	126	124	124	123

Table A - 8. Summary Statistics of temperature profiles for Shasta Lake above Shasta Dam (Mean Bias, MAE, and RMSE are in °C): 2001

Statistic	01/18	02/23	03/22	04/26	05/23	06/25	07/24	08/21	09/18	10/19	11/20	12/21
Mean Bias	0.03	0.01	-0.01	0.21	0.48	0.40	0.52	0.74	1.19	1.57	1.30	-0.16
MAE	0.24	0.44	0.41	0.61	0.62	0.54	0.55	0.79	1.19	1.57	1.30	0.60
RMSE	0.26	0.47	0.56	0.75	0.69	0.59	0.62	0.95	1.48	1.86	1.70	0.67
NSE	0.90	0.26	0.83	0.88	0.96	0.98	0.99	0.98	0.94	0.85	0.71	0.74
COUNT	124	129	135	130	130	130	123	118	115	113	112	120

Table A - 9. Summary Statistics of temperature profiles for Shasta Lake above Shasta Dam (Mean Bias, MAE, and RMSE are in °C): 2002

Statistic	01/24	02/22	03/19	04/24	05/13	06/12	07/16	08/13	09/23	10/23	11/14
Mean Bias	-0.15	0.08	0.24	0.38	0.36	0.45	0.39	0.56	0.56	0.84	0.80
MAE	0.17	0.29	0.44	0.51	0.66	0.73	0.63	0.66	0.67	0.84	1.00
RMSE	0.20	0.32	0.49	0.60	0.81	0.84	0.74	0.84	0.85	1.20	1.36
NSE	0.88	0.87	0.71	0.94	0.92	0.96	0.98	0.98	0.98	0.93	0.83
COUNT	130	130	126	130	133	131	124	118	115	109	109

Table A - 10. Summary Statistics of temperature profiles for Shasta Lake above Shasta Dam (Mean Bias, MAE, and RMSE are in °C): 2003

Statistic	01/06	02/20	03/10	04/09	05/20	06/23	07/28	08/11	09/03	10/09	11/10	12/03
Mean Bias	0.33	-0.04	0.02	0.27	0.43	0.25	0.11	0.16	0.12	0.07	-0.03	0.07
MAE	0.36	0.23	0.23	0.50	0.62	0.40	0.37	0.31	0.39	0.32	0.30	0.28
RMSE	0.48	0.30	0.28	0.53	0.66	0.59	0.51	0.40	0.48	0.40	0.35	0.33
NSE	0.79	0.82	0.91	0.83	0.90	0.98	0.99	0.99	0.99	0.99	0.99	0.97
COUNT	122	125	124	133	129	131	126	122	122	121	122	121

Table A - 11. Summary Statistics of temperature profiles for Shasta Lake above Shasta Dam (Mean Bias, MAE, and RMSE are in °C): 2004

Statistic	01/05	02/12	03/03	04/26	05/25	06/25	07/23	08/24	09/23	10/25	11/16	12/21
Mean Bias	0.32	0.13	0.19	0.09	0.09	0.01	-0.09	-0.16	-0.30	-0.44	-0.59	-0.74
MAE	0.42	0.44	0.52	0.33	0.25	0.29	0.22	0.33	0.56	0.48	0.63	0.74
RMSE	0.52	0.46	0.56	0.47	0.41	0.57	0.35	0.39	0.73	0.58	0.76	0.95
NSE	0.56	0.68	0.41	0.95	0.98	0.99	1.00	1.00	0.98	0.98	0.92	0.50
COUNT	123	129	126	131	136	124	119	113	108	105	106	107

Table A - 12. Summary Statistics of temperature profiles for Shasta Lake above Shasta Dam (Mean Bias, MAE, and RMSE are in °C): 2005

Statistic	01/25	02/09	03/09	04/14	05/20	06/14	07/19	08/16	09/16	10/17	11/16	12/06
Mean Bias	0.04	0.13	0.09	0.39	0.36	0.52	0.34	0.51	0.64	0.69	0.52	0.42
MAE	0.43	0.46	0.35	0.66	0.59	0.66	0.54	0.64	0.68	0.80	0.67	0.58
RMSE	0.48	0.52	0.39	0.68	0.66	0.81	0.70	0.73	0.78	0.91	0.81	0.83
NSE	0.74	0.70	0.91	0.75	0.91	0.95	0.98	0.98	0.97	0.94	0.90	0.75
COUNT	113	117	122	130	134	134	130	123	119	116	119	116

Table A - 13. Summary Statistics of temperature profiles for Shasta Lake above Shasta Dam (Mean Bias, MAE, and RMSE are in °C): 2006

Statistic	01/11	02/07	03/23	04/17	05/04	06/21	07/18	08/22	09/06	10/11	11/07	12/01
Mean Bias	-0.15	-0.17	-0.28	0.03	0.00	0.19	0.10	0.00	0.06	-0.19	-0.06	-0.22
MAE	0.27	0.32	0.28	0.29	0.36	0.42	0.24	0.22	0.26	0.25	0.37	0.28
RMSE	0.29	0.41	0.40	0.33	0.61	0.69	0.38	0.32	0.36	0.30	0.45	0.36
NSE	0.91	0.80	0.60	0.84	0.93	0.97	0.99	1.00	1.00	1.00	0.98	0.98
COUNT	126	122	128	129	132	133	130	128	123	124	119	120

Table A - 14. Summary Statistics of temperature profiles for Shasta Lake above Shasta Dam (Mean Bias, MAE, and RMSE are in °C): 2007

Statistic	01/10	02/06	03/06	04/05	05/15	06/19	07/17	08/17	09/17	10/24	11/20	12/05
Mean Bias	0.37	0.12	0.38	0.20	0.13	0.12	0.08	-0.08	0.00	-0.78	-0.68	-0.50
MAE	0.37	0.40	0.66	0.50	0.41	0.34	0.42	0.31	0.32	0.80	0.74	0.55
RMSE	0.46	0.42	0.76	0.68	0.69	0.54	0.56	0.43	0.45	1.29	1.14	0.68
NSE	0.81	0.82	0.35	0.87	0.96	0.99	0.99	1.00	0.99	0.88	0.81	0.90
COUNT	121	122	128	129	122	123	115	114	103	99	97	103

Table A - 15. Summary Statistics of temperature profiles for Shasta Lake above Shasta Dam (Mean Bias, MAE, and RMSE are in °C): 2008

Statistic	01/02	02/05	03/06	04/01	05/13	06/18	07/15	08/19	09/03	10/15	11/14	12/04
Mean Bias	0.20	-0.02	0.32	0.45	0.29	0.08	0.27	0.14	0.13	-0.70	-0.31	-0.10
MAE	0.22	0.50	0.66	0.58	0.68	0.54	0.47	0.45	0.40	0.91	0.59	0.55
RMSE	0.26	0.52	0.69	0.63	1.01	0.64	0.50	0.62	0.60	1.54	1.03	0.73
NSE	0.92	0.21	0.55	0.78	0.90	0.98	0.99	0.99	0.99	0.88	0.86	0.88
COUNT	99	108	113	116	116	109	105	103	93	91	88	89

Table A - 16. Summary Statistics of temperature profiles for Shasta Lake above Shasta Dam (Mean Bias, MAE, and RMSE are in °C): 2009

Statistic	01/14	02/10	03/04	04/02	05/19	06/16	07/17	08/19	09/15	10/15	11/17	12/01
Mean Bias	0.56	0.90	0.26	0.57	0.71	0.82	0.71	0.75	0.73	0.41	0.47	0.54
MAE	0.62	1.02	0.49	0.72	0.73	0.85	0.82	0.76	0.76	0.47	0.47	0.54
RMSE	0.82	1.16	0.52	0.76	0.76	0.98	0.91	0.82	0.84	0.68	0.66	0.80
NSE	0.60	-0.44	0.01	0.77	0.93	0.95	0.97	0.98	0.98	0.97	0.95	0.85
COUNT	89	92	107	61	119	118	111	104	100	97	98	97

Table A - 17. Summary Statistics of temperature profiles for Shasta Lake above Shasta Dam (Mean Bias, MAE, and RMSE are in °C): 2010

Statistic	01/05	02/02	03/02	05/17	06/14	07/12	08/23	09/09	10/06	11/01	12/07
Mean Bias	0.26	-0.38	-0.31	0.23	0.60	0.64	0.60	0.67	0.54	0.57	0.47
MAE	0.26	0.38	0.31	0.50	0.71	0.69	0.68	0.69	0.62	0.71	0.65
RMSE	0.34	0.48	0.36	0.65	0.89	0.83	0.79	0.81	0.79	0.86	0.85
NSE	0.88	0.43	0.70	0.90	0.91	0.96	0.98	0.97	0.97	0.94	0.76
COUNT	100	112	123	135	133	131	123	123	126	122	122

Table A - 18. Summary Statistics of temperature profiles for Shasta Lake above Shasta Dam (Mean Bias, MAE, and RMSE are in °C): 2011

Statistic	01/04	02/08	03/04	04/04	05/19	06/14	07/26	08/09	09/20	10/18	11/15	12/06
Mean Bias	0.13	0.45	0.34	0.23	0.18	0.26	0.34	0.45	0.62	0.67	0.58	0.33
MAE	0.14	0.45	0.42	0.24	0.23	0.36	0.40	0.51	0.71	0.79	0.71	0.46
RMSE	0.21	0.49	0.48	0.27	0.34	0.72	0.62	0.80	0.99	1.04	0.93	0.62
NSE	0.94	0.77	0.25	0.90	0.97	0.95	0.98	0.97	0.96	0.94	0.91	0.93
COUNT	123	112	123	130	138	134	131	130	124	123	121	120

Table A - 19. Summary Statistics of temperature profiles for Shasta Lake above Shasta Dam (Mean Bias, MAE, and RMSE are in °C): 2012

Statistic	01/09	02/01	03/08	05/15	06/12	07/12	08/22	09/19	10/17	11/14
Mean Bias	0.18	0.27	0.39	0.55	0.49	0.44	0.29	0.36	0.21	0.38
MAE	0.19	0.30	0.59	0.93	0.79	0.64	0.54	0.50	0.46	0.44
RMSE	0.21	0.34	0.65	1.11	0.91	0.73	0.60	0.58	0.53	0.57
NSE	0.97	0.82	0.48	0.79	0.93	0.98	0.99	0.99	0.99	0.99
COUNT	124	122	120	134	131	129	117	112	103	109

Table A - 20. Summary Statistics of temperature profiles for Shasta Lake above Shasta Dam (Mean Bias, MAE, and RMSE are in °C): 2013

Statistic	01/08	02/05	03/12	04/03	05/20	06/18	07/22	08/20	09/25	10/22	11/18	12/17
Mean Bias	0.35	0.35	0.54	0.58	0.71	0.93	0.56	0.25	0.66	0.20	-0.11	-0.41
MAE	0.35	0.44	0.67	0.64	0.93	0.93	0.76	0.46	0.69	0.52	0.43	0.77
RMSE	0.42	0.50	0.73	0.71	1.03	1.00	0.81	0.52	0.85	0.56	0.48	0.87
NSE	0.84	0.77	0.64	0.82	0.92	0.94	0.98	0.99	0.98	0.98	0.97	0.62
COUNT	122	123	126	127	124	118	111	106	102	98	96	100

Table A - 21. Summary Statistics of temperature profiles for Shasta Lake above Shasta Dam (Mean Bias, MAE, and RMSE are in °C): 2014

Statistic	01/07	02/05	03/12	04/09	05/19	06/18	07/28	08/26	09/23	10/22	11/05	12/09
Mean Bias	0.39	0.56	1.09	1.21	1.24	1.16	1.28	1.55	1.06	0.82	0.65	0.57
MAE	0.39	0.61	1.31	1.31	1.29	1.30	1.38	1.55	1.07	0.91	0.76	0.62
RMSE	0.48	0.73	1.41	1.43	1.35	1.36	1.43	1.65	1.19	0.98	0.89	0.77
NSE	0.84	0.37	-0.14	0.37	0.83	0.91	0.94	0.93	0.95	0.95	0.92	0.74
COUNT	95	96	102	111	107	102	95	90	86	84	83	83

Table A - 22. Summary Statistics of temperature profiles for Shasta Lake above Shasta Dam (Mean Bias, MAE, and RMSE are in °C): 2015

Statistic	01/06	02/03	03/10	04/28	05/13	06/03	07/21	08/11	09/15	10/20	11/10	12/08
Mean Bias	0.75	0.81	0.76	0.44	0.50	0.42	0.70	0.51	0.46	0.38	0.09	-0.12
MAE	0.75	0.86	0.82	0.54	0.71	0.67	0.79	0.61	0.63	0.39	0.35	0.41
RMSE	0.83	0.98	0.90	0.58	0.78	0.73	0.93	0.70	0.71	0.50	0.46	0.46
NSE	-0.93	0.18	0.48	0.95	0.94	0.97	0.97	0.98	0.98	0.99	0.98	0.92
COUNT	102	101	112	114	113	109	104	102	96	93	90	89

Table A - 23. Summary Statistics of temperature profiles for Shasta Lake above Shasta Dam (Mean Bias, MAE, and RMSE are in °C): 2016

Statistic	01/20	02/09	03/15	04/21	05/02	06/20	07/11	08/15	09/26	10/11	11/29
Mean Bias	0.36	-0.12	0.57	0.47	0.56	0.67	0.59	0.54	0.61	0.53	0.31
MAE	0.75	0.27	0.82	0.57	0.71	0.81	0.77	0.78	0.82	0.84	0.75
RMSE	0.82	0.35	0.89	0.66	0.94	0.98	0.98	1.02	1.08	1.06	0.89
NSE	0.03	0.84	-0.19	0.91	0.85	0.93	0.96	0.97	0.96	0.95	0.89
COUNT	98	111	125	131	132	129	127	121	115	113	114

Table A - 24. Summary Statistics of temperature profiles for Shasta Lake above Shasta Dam (Mean Bias, MAE, and RMSE are in °C): 2017

Statistic	01/12	02/16	04/25	05/23	06/21	07/20	08/22	09/12	10/18	11/29	12/12
Mean Bias	0.41	0.27	0.19	0.43	0.51	0.59	0.50	0.56	0.54	0.48	0.36
MAE	0.61	0.57	0.40	0.46	0.68	0.67	0.57	0.62	0.73	0.72	0.43
RMSE	0.69	0.61	0.45	0.56	0.96	0.89	0.73	0.80	0.97	0.92	0.68
NSE	0.43	0.50	0.91	0.96	0.96	0.97	0.98	0.98	0.95	0.90	0.91
COUNT	126	130	133	132	132	130	126	124	121	104	119

Table A - 25. Summary Statistics of temperature profiles for Shasta Lake above Shasta Dam (Mean Bias, MAE, and RMSE are in °C): 2018

Statistic	01/10	02/06	03/20	04/17	05/15	06/12	07/17	08/15	09/18	10/16	11/13	12/11
Mean Bias	-0.09	0.02	0.09	0.39	0.32	0.17	0.09	0.04	-0.08	-0.25	-0.44	-0.51
MAE	0.14	0.13	0.35	0.60	0.62	0.38	0.34	0.31	0.27	0.28	0.46	0.59
RMSE	0.19	0.17	0.39	0.64	0.88	0.66	0.47	0.47	0.45	0.43	0.57	0.65
NSE	0.99	0.98	0.79	0.75	0.89	0.97	0.99	0.99	0.99	0.99	0.97	0.85
COUNT	120	121	124	129	131	128	122	116	110	107	104	105

Table A - 26. Summary Statistics of temperature profiles for Shasta Lake above Shasta Dam (Mean Bias, MAE, and RMSE are in °C): 2019

Statistic	01/03	02/07	03/11	04/09	05/14	06/18	07/16	08/14	09/17	10/15	11/14	12/18
Mean Bias	-0.07	-0.12	-0.10	0.10	0.12	0.96	0.91	0.84	0.79	0.86	0.63	0.10
MAE	0.15	0.25	0.43	0.33	0.31	1.04	0.98	0.84	0.86	1.17	1.11	0.55
RMSE	0.19	0.31	0.47	0.45	0.55	1.50	1.16	1.06	1.15	1.50	1.34	0.63
NSE	0.96	0.85	0.75	0.83	0.96	0.88	0.94	0.96	0.95	0.88	0.83	0.91
COUNT	105	117	129	131	132	133	131	128	123	101	100	121

Table A - 27. Summary Statistics of temperature profiles for Shasta Lake above Shasta Dam (Mean Bias, MAE, and RMSE are in °C): 2020

Statistic	01/06	02/04	03/11	04/15	05/13	06/17	07/15	08/19	09/23	10/14	11/10	12/09
Mean Bias	-0.09	-0.17	0.10	0.38	0.54	0.52	0.35	0.19	0.19	0.09	-0.35	-0.30
MAE	0.09	0.34	0.34	0.57	0.64	0.64	0.48	0.39	0.46	0.39	0.63	0.69
RMSE	0.15	0.41	0.36	0.62	0.73	0.82	0.58	0.46	0.56	0.48	0.81	0.78
NSE	0.99	0.80	0.90	0.87	0.91	0.96	0.99	0.99	0.99	0.99	0.94	0.76
COUNT	113	107	122	108	125	122	117	109	105	104	103	101

Table A - 28. Summary Statistics of temperature profiles for Shasta Lake above Shasta Dam (Mean Bias, MAE, and RMSE are in °C): 2021

Statistic	01/12	02/10	03/17	04/21	05/19	06/09	07/14	08/16	09/20	10/20	11/10	12/02
Mean Bias	-0.30	-0.29	0.03	0.63	0.59	0.62	1.28	1.30	0.96	0.73	0.26	0.13
MAE	0.42	0.36	0.46	1.06	0.76	0.66	1.41	1.41	1.09	0.82	0.55	0.50
RMSE	0.56	0.52	0.52	1.32	0.89	0.83	1.95	2.02	1.59	1.04	0.66	0.59
NSE	0.66	0.41	0.58	0.72	0.92	0.95	0.89	0.89	0.91	0.92	0.90	0.82
COUNT	103	104	107	108	103	100	95	87	83	79	80	83

A.4. Outflow Temperature

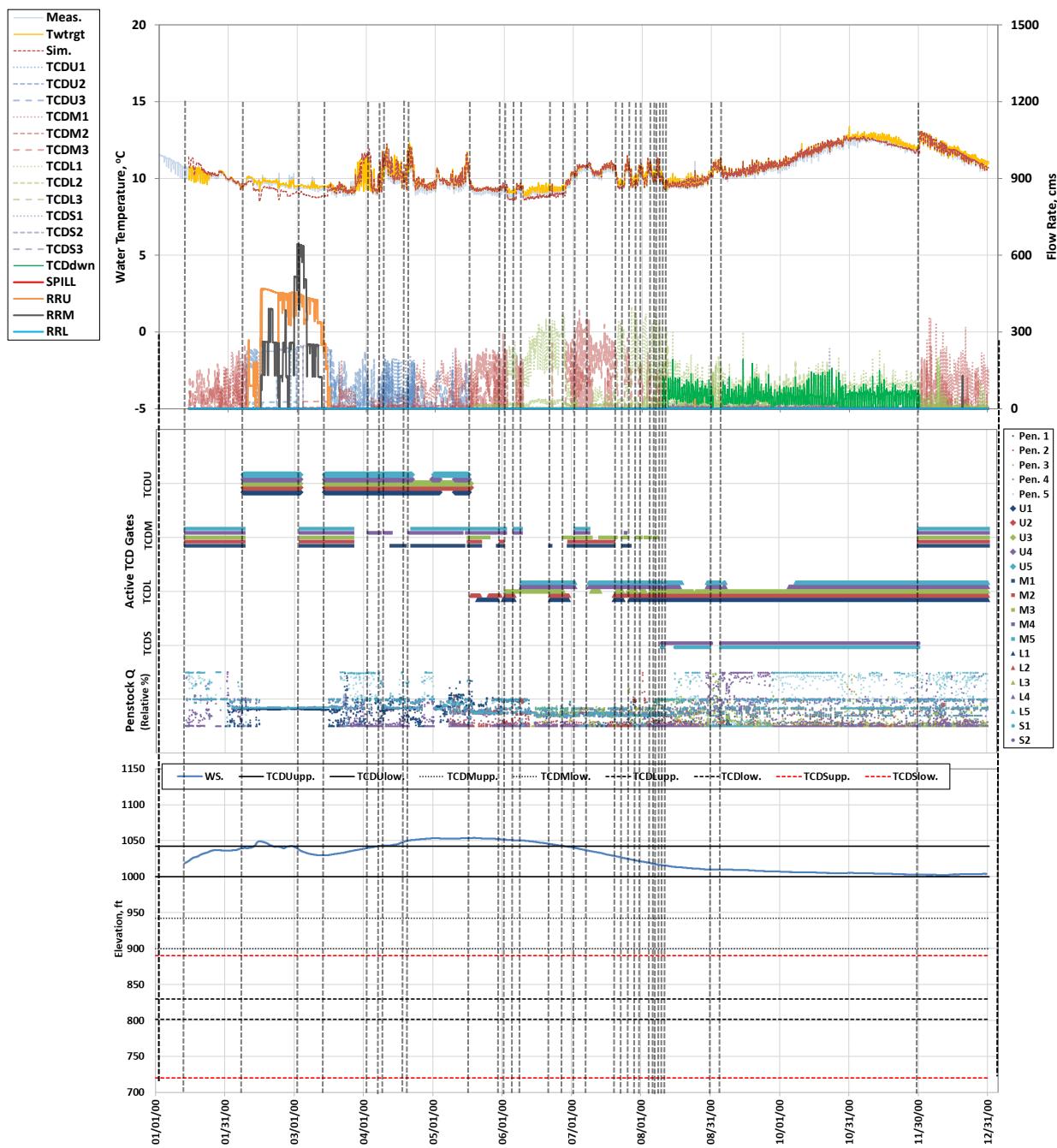


Figure A - 67. Shasta Dam simulated release temperature, target temperature, and measured temperatures; gate settings and simulated outflow; active powerhouse units, and reservoir stage: 2000.

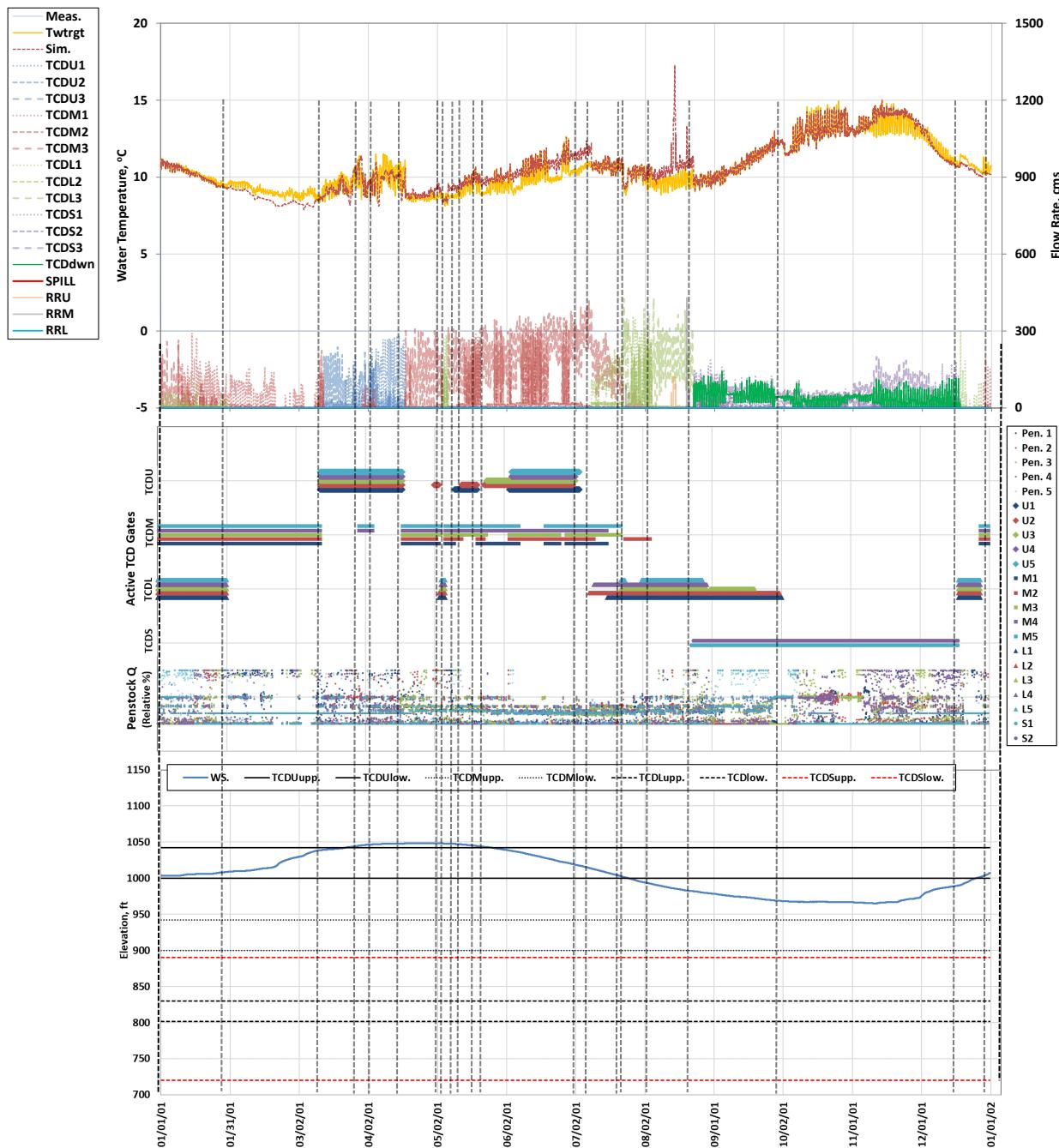


Figure A - 68. Shasta Dam simulated release temperature, target temperature, and measured temperatures; gate settings and simulated outflow; active powerhouse units, and reservoir stage: 2001.

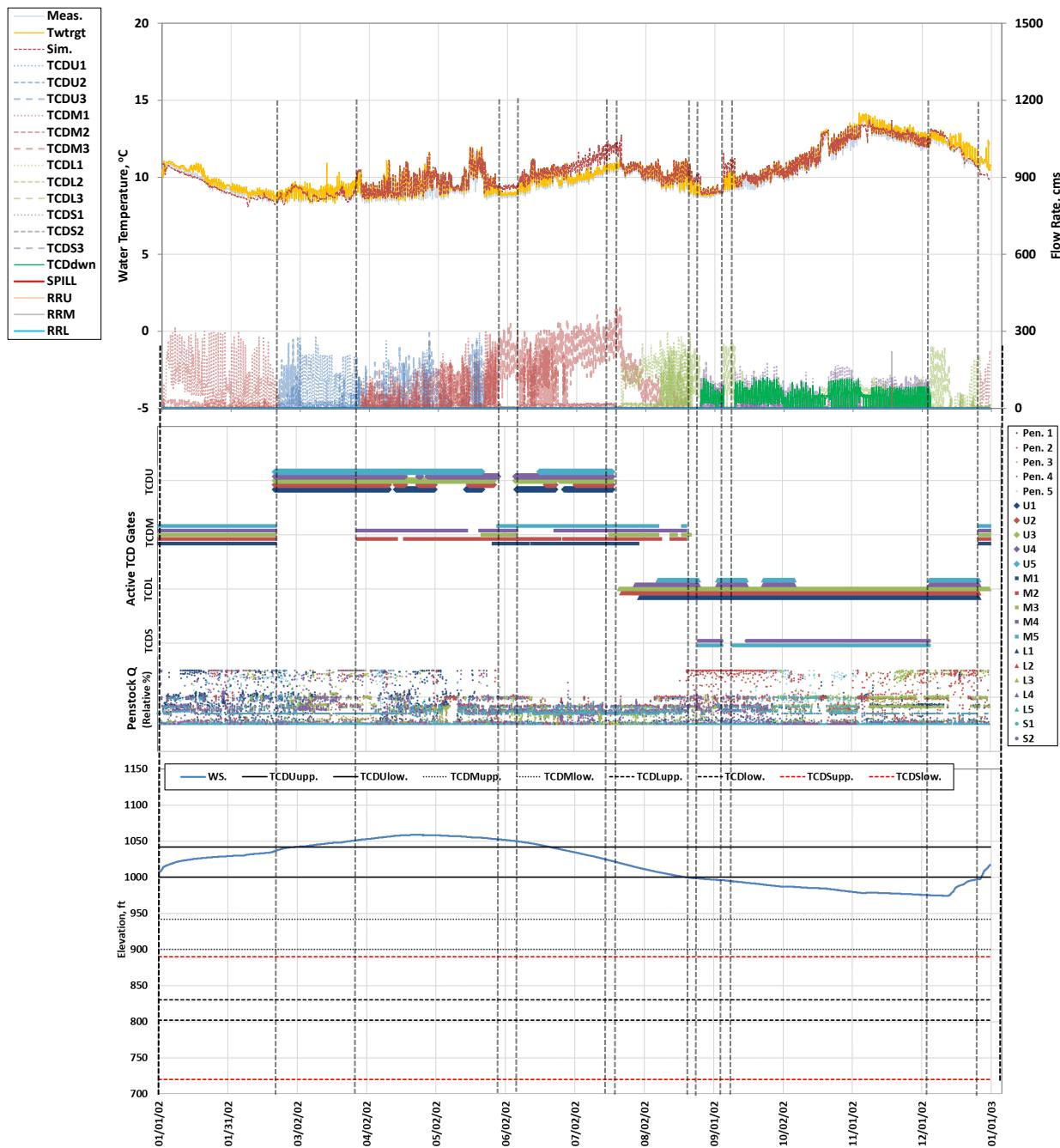


Figure A - 69. Shasta Dam simulated release temperature, target temperature, and measured temperatures; gate settings and simulated outflow; active powerhouse units, and reservoir stage: 2002.

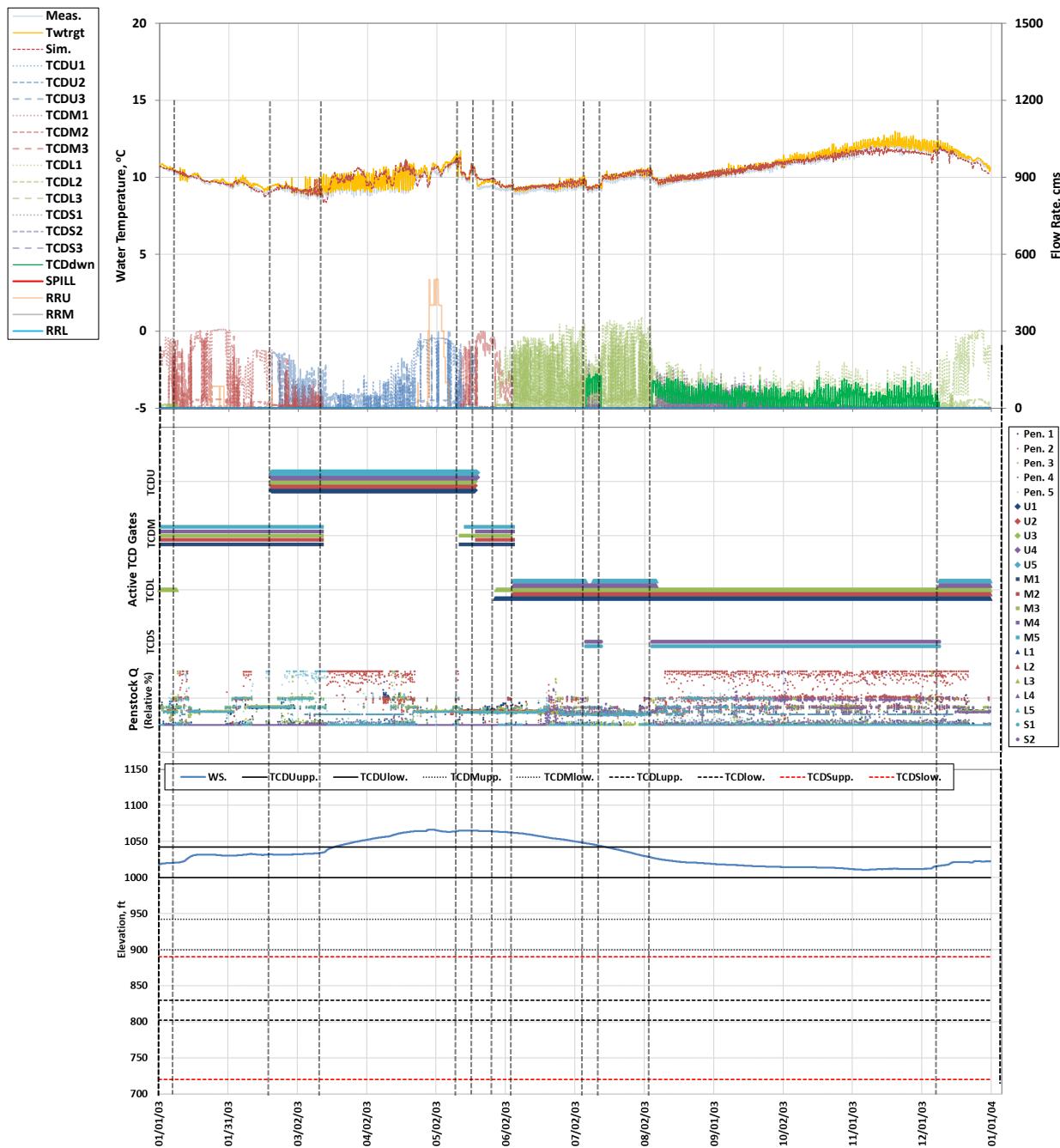


Figure A - 70. Shasta Dam simulated release temperature, target temperature, and measured temperatures; gate settings and simulated outflow; active powerhouse units, and reservoir stage: 2003.

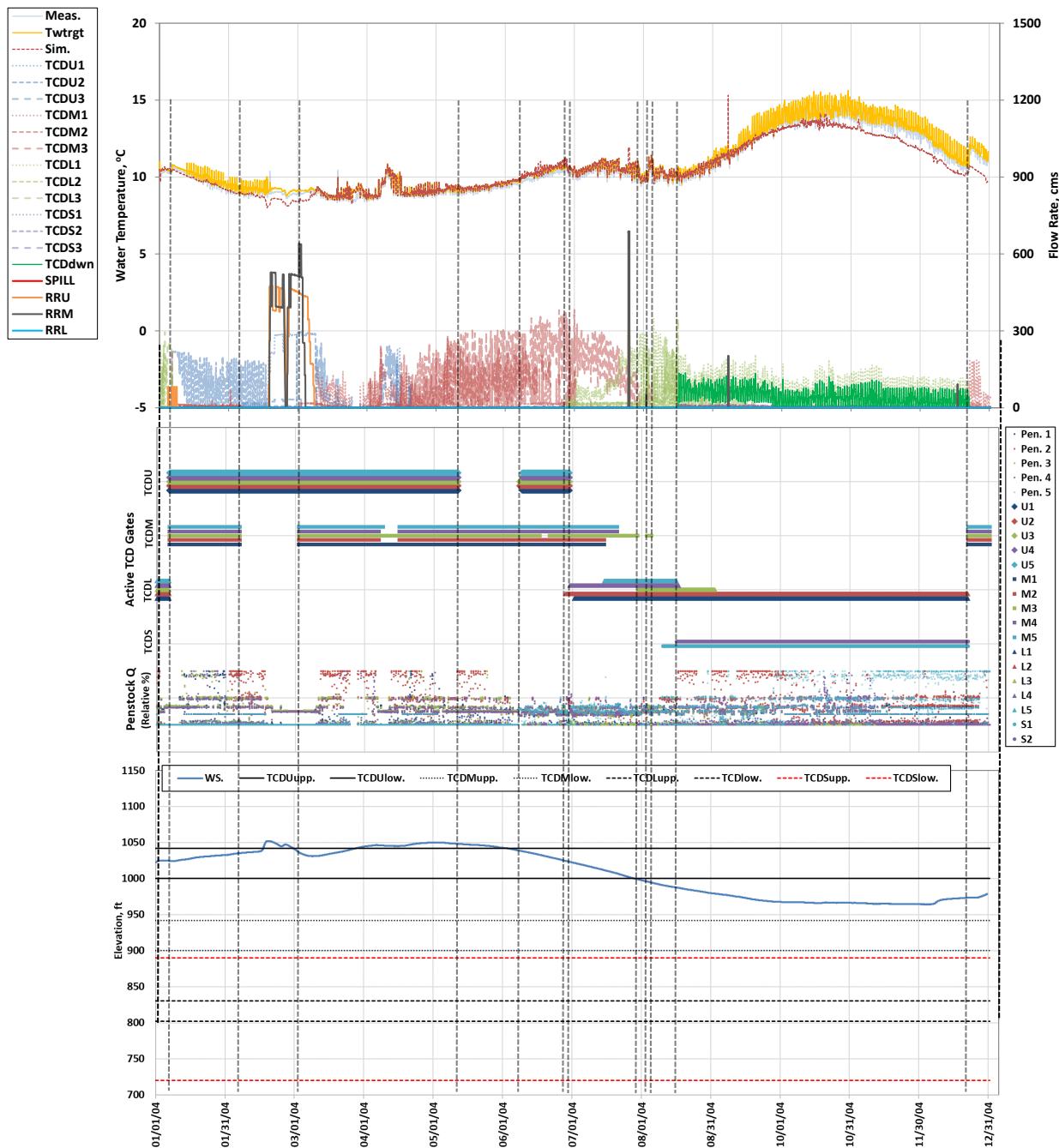


Figure A - 71. Shasta Dam simulated release temperature, target temperature, and measured temperatures; gate settings and simulated outflow; active powerhouse units, and reservoir stage: 2004.

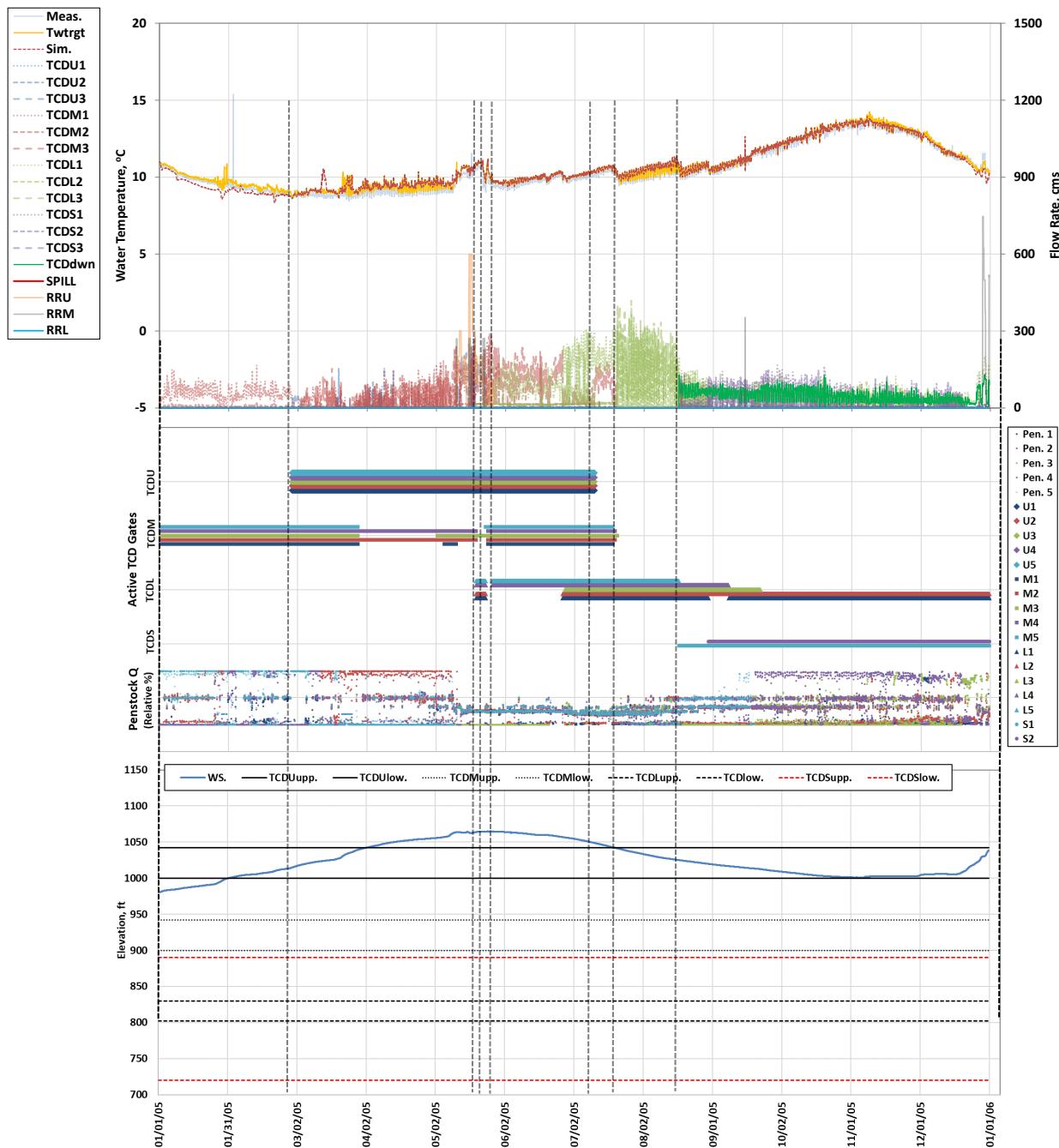


Figure A - 72. Shasta Dam simulated release temperature, target temperature, and measured temperatures; gate settings and simulated outflow; active powerhouse units, and reservoir stage: 2005.

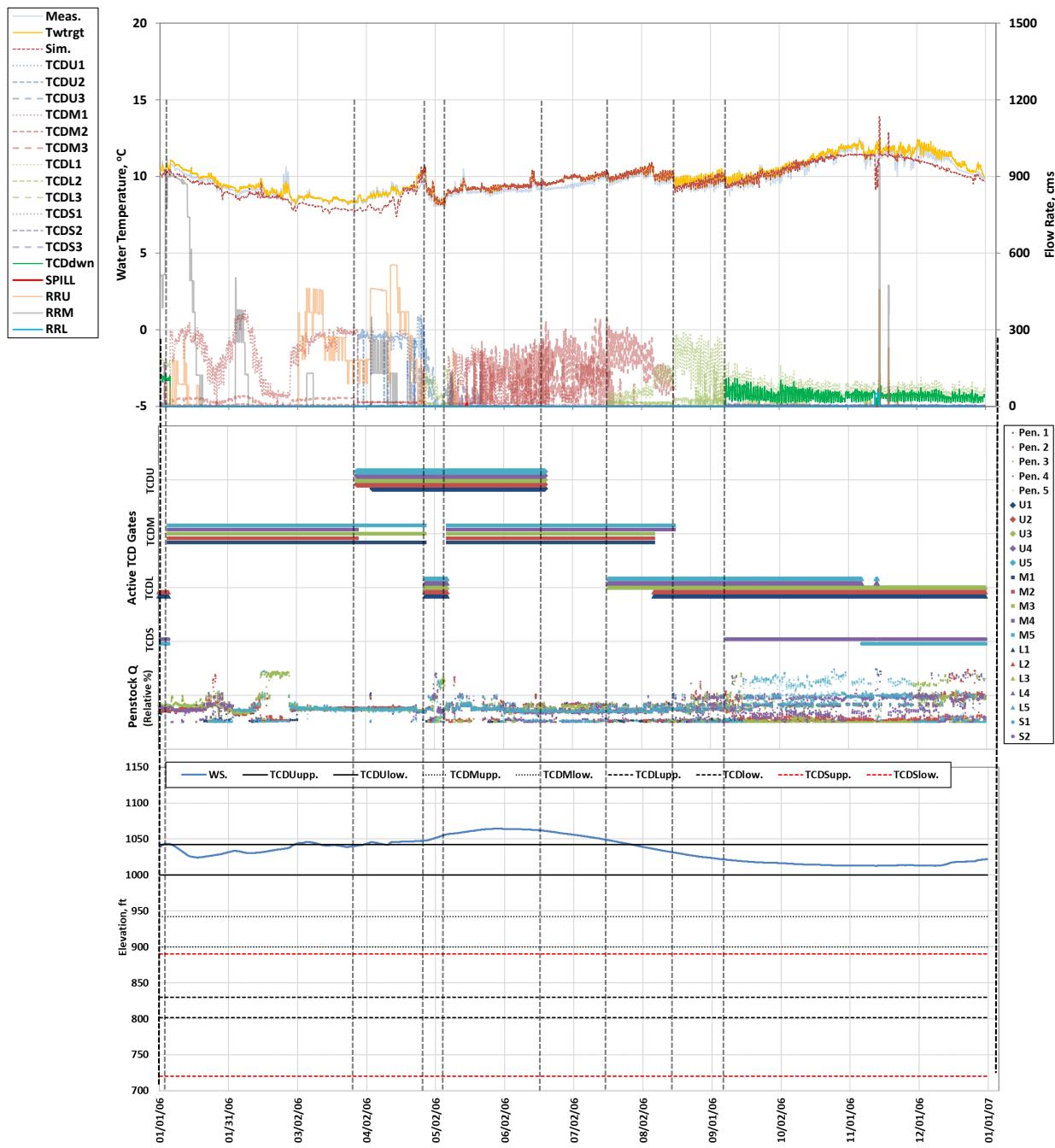


Figure A - 73. Shasta Dam simulated release temperature, target temperature, and measured temperatures; gate settings and simulated outflow; active powerhouse units, and reservoir stage: 2006.

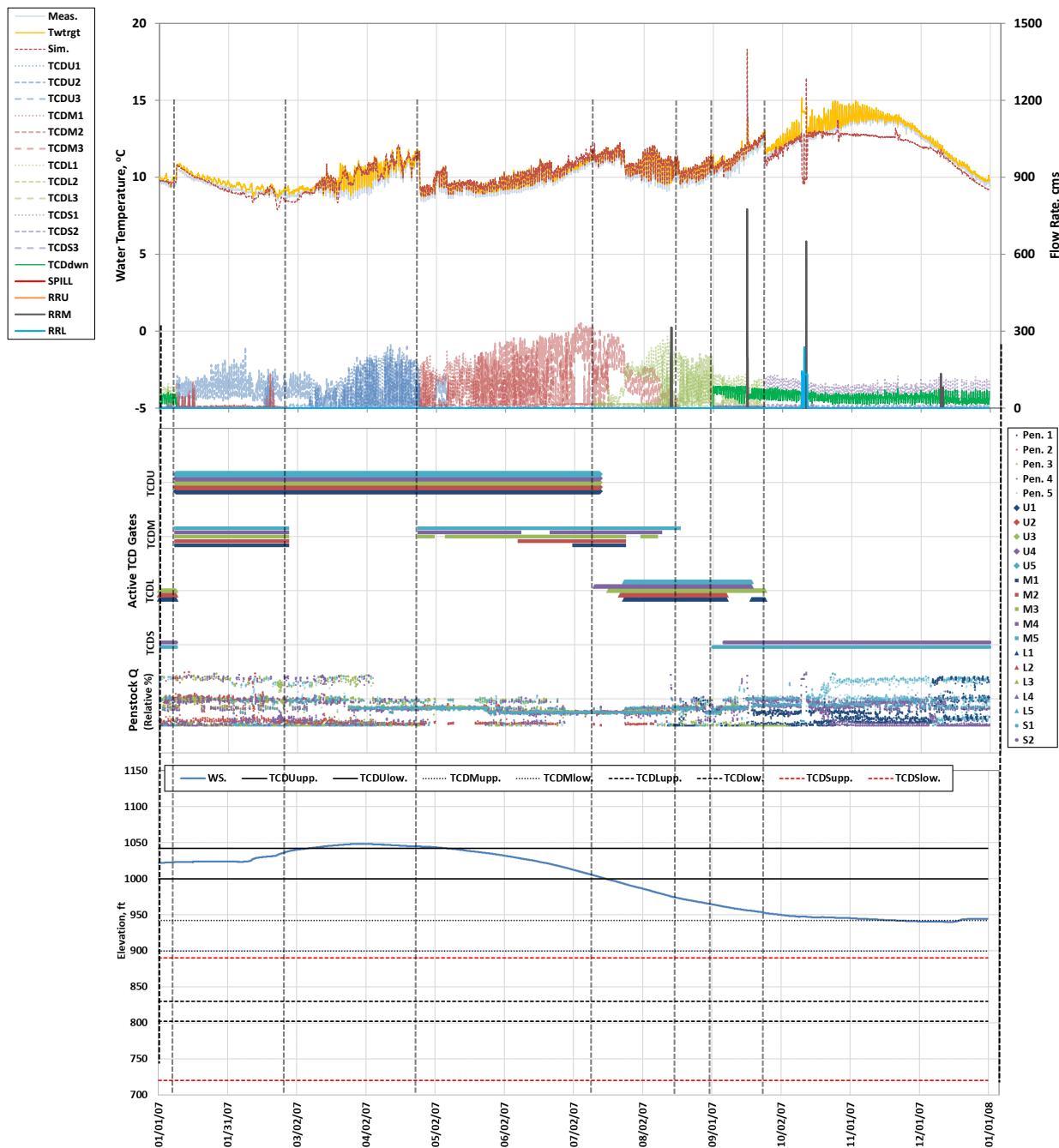


Figure A - 74. Shasta Dam simulated release temperature, target temperature, and measured temperatures; gate settings and simulated outflow; active powerhouse units, and reservoir stage: 2007.

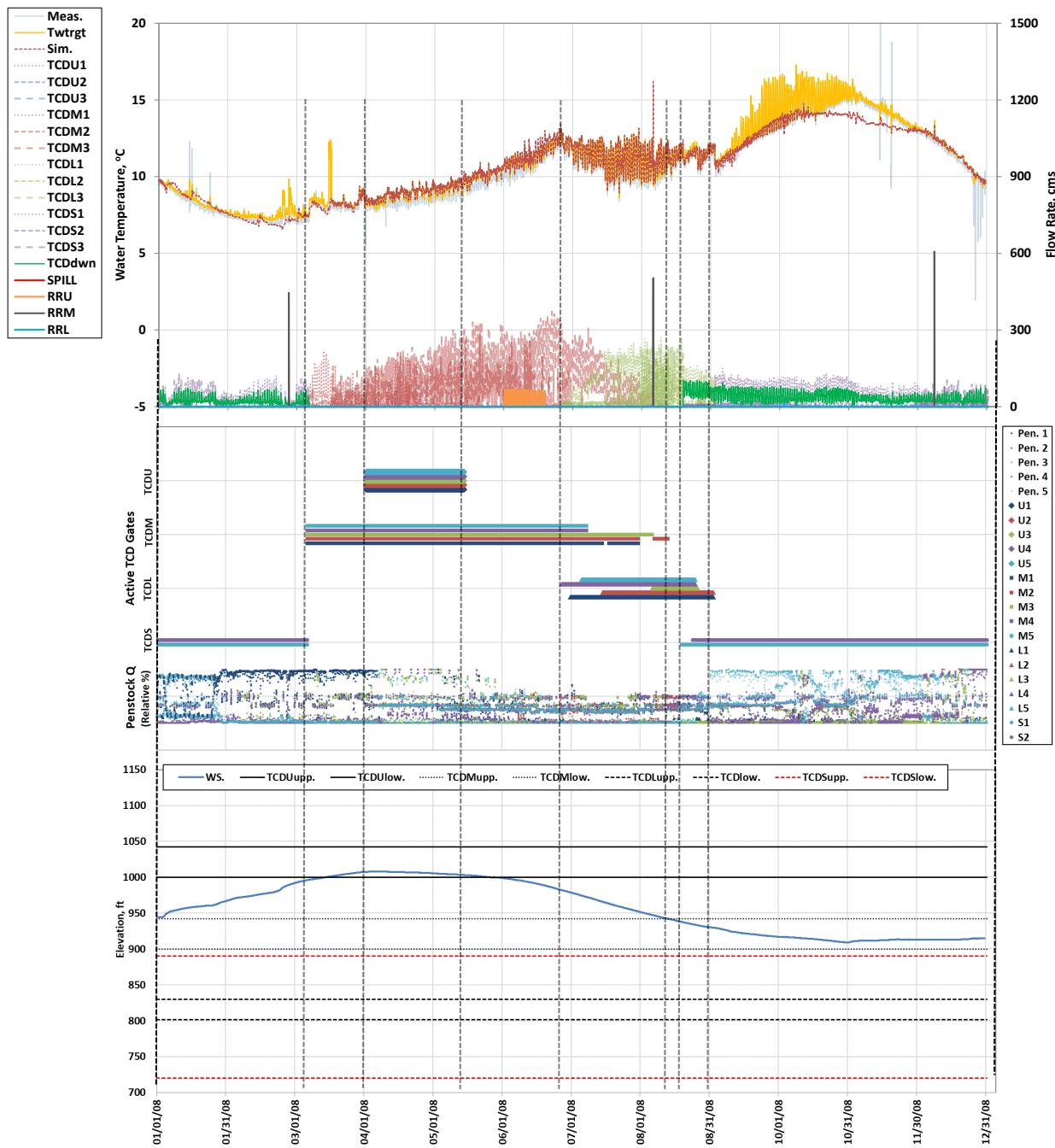


Figure A - 75. Shasta Dam simulated release temperature, target temperature, and measured temperatures; gate settings and simulated outflow; active powerhouse units, and reservoir stage: 2008.

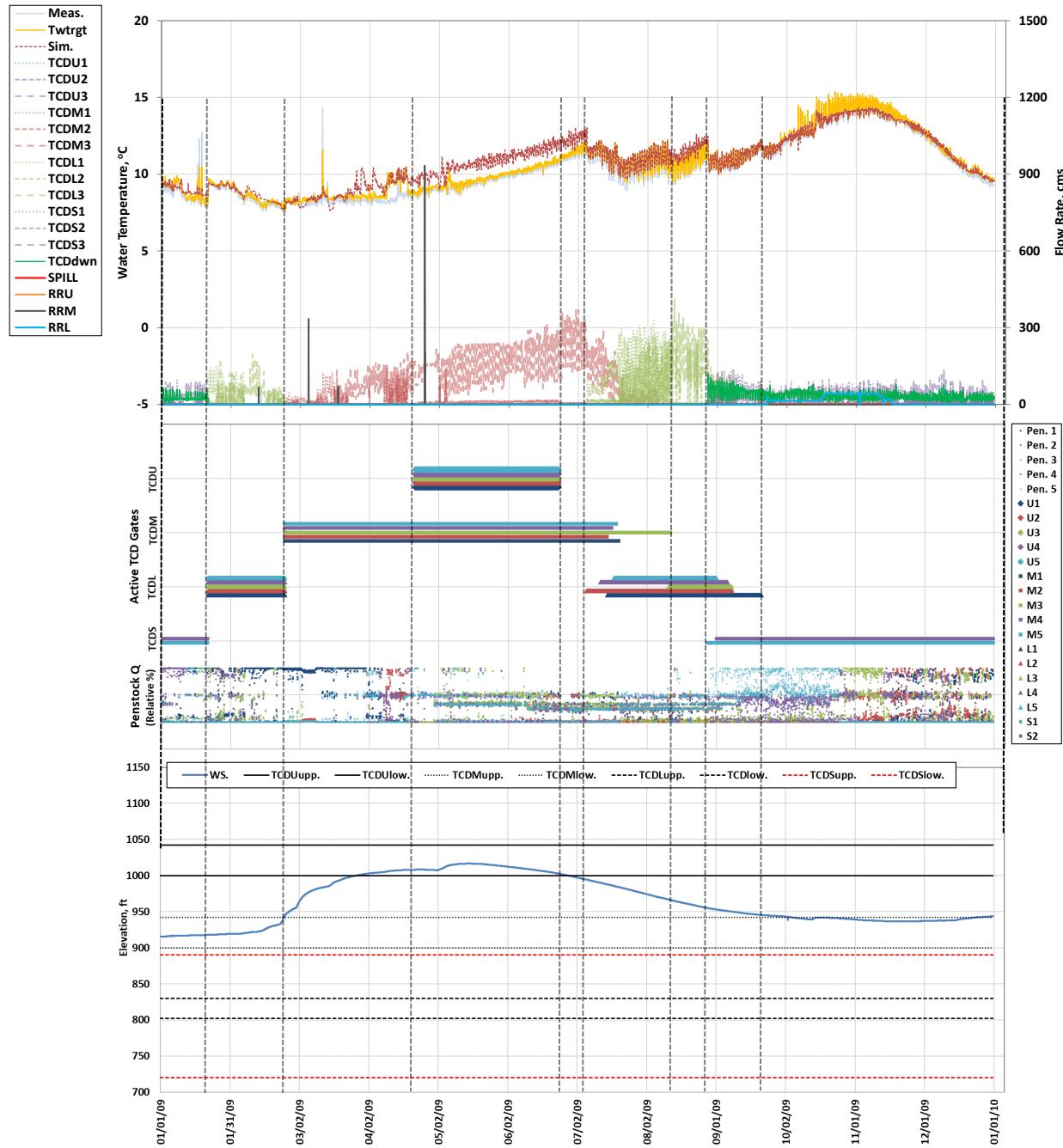


Figure A - 76. Shasta Dam simulated release temperature, target temperature, and measured temperatures; gate settings and simulated outflow; active powerhouse units, and reservoir stage: 2009.

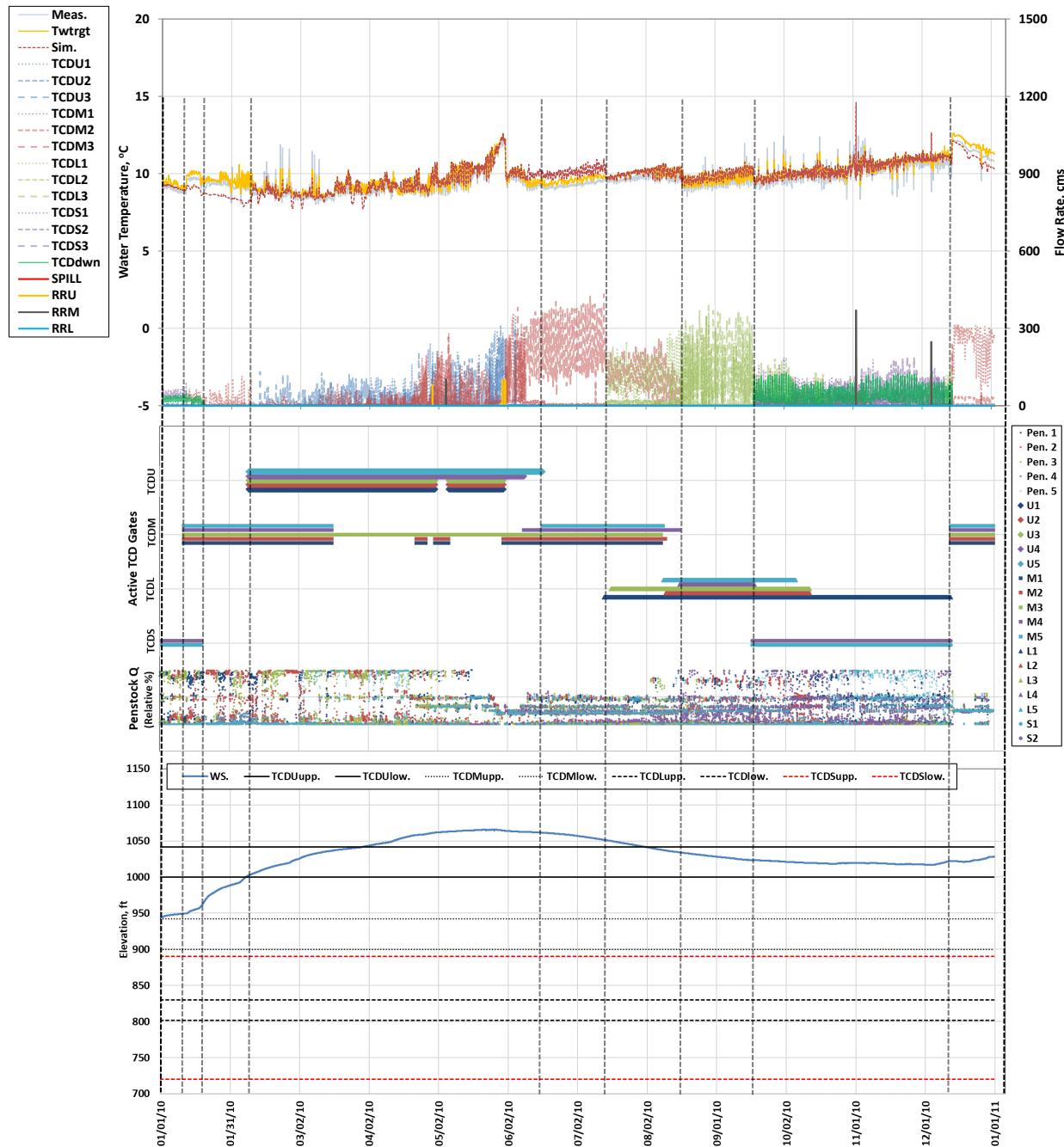


Figure A - 77. Shasta Dam simulated release temperature, target temperature, and measured temperatures; gate settings and simulated outflow; active powerhouse units, and reservoir stage: 2010.

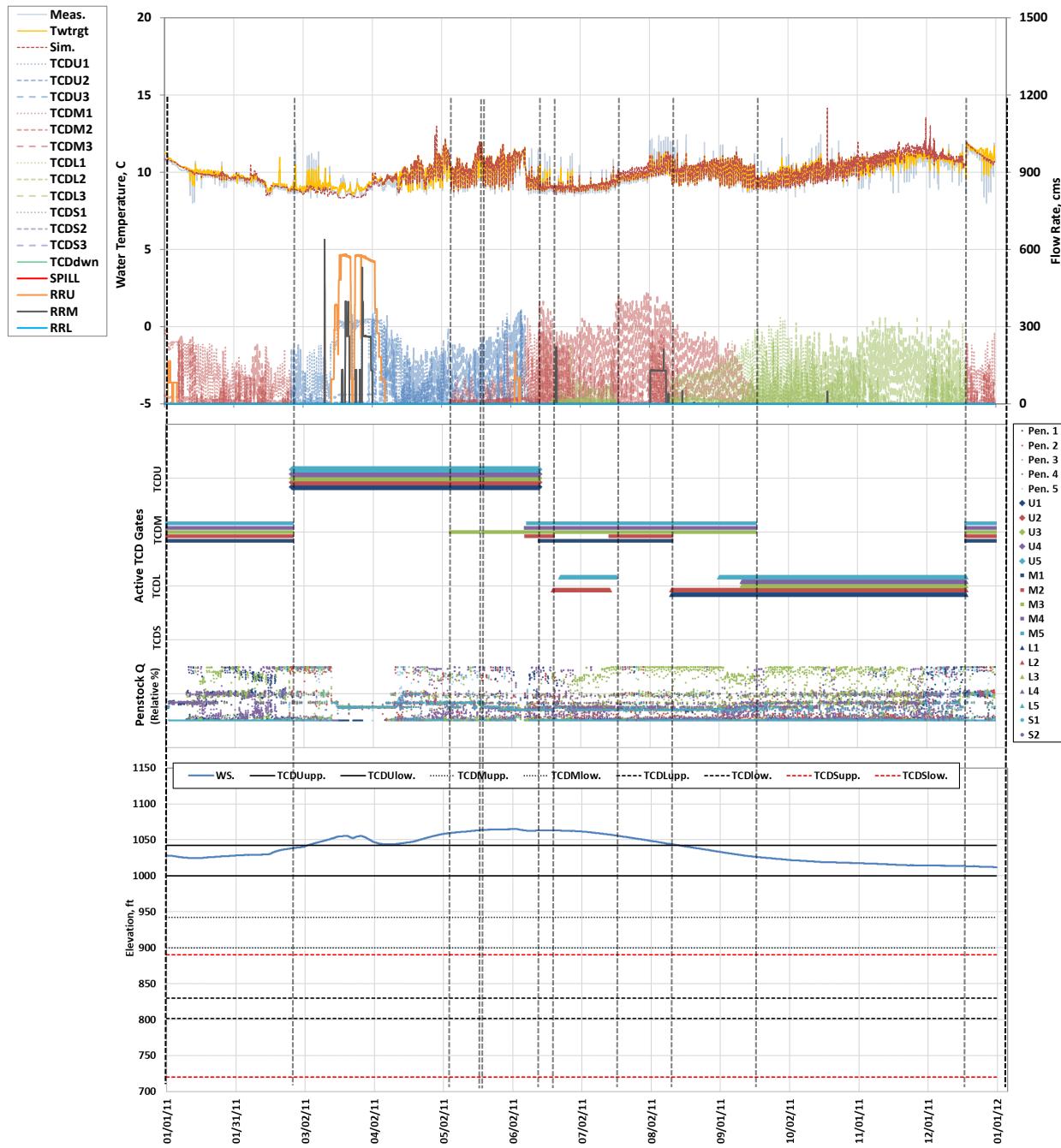


Figure A - 78. Shasta Dam simulated release temperature, target temperature, and measured temperatures; gate settings and simulated outflow; active powerhouse units, and reservoir stage: 2011.

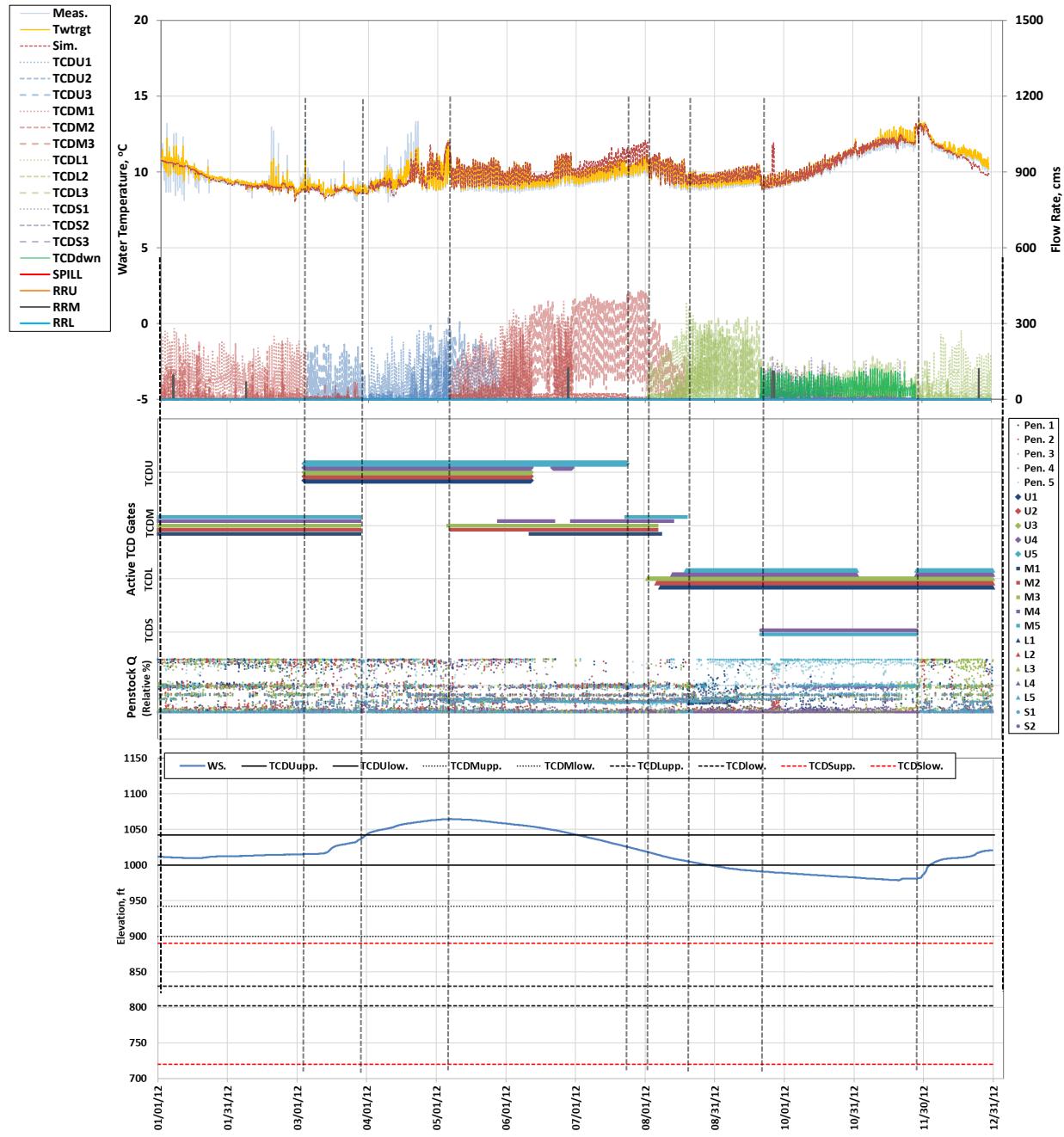


Figure A - 79. Shasta Dam simulated release temperature, target temperature, and measured temperatures; gate settings and simulated outflow; active powerhouse units, and reservoir stage: 2012.

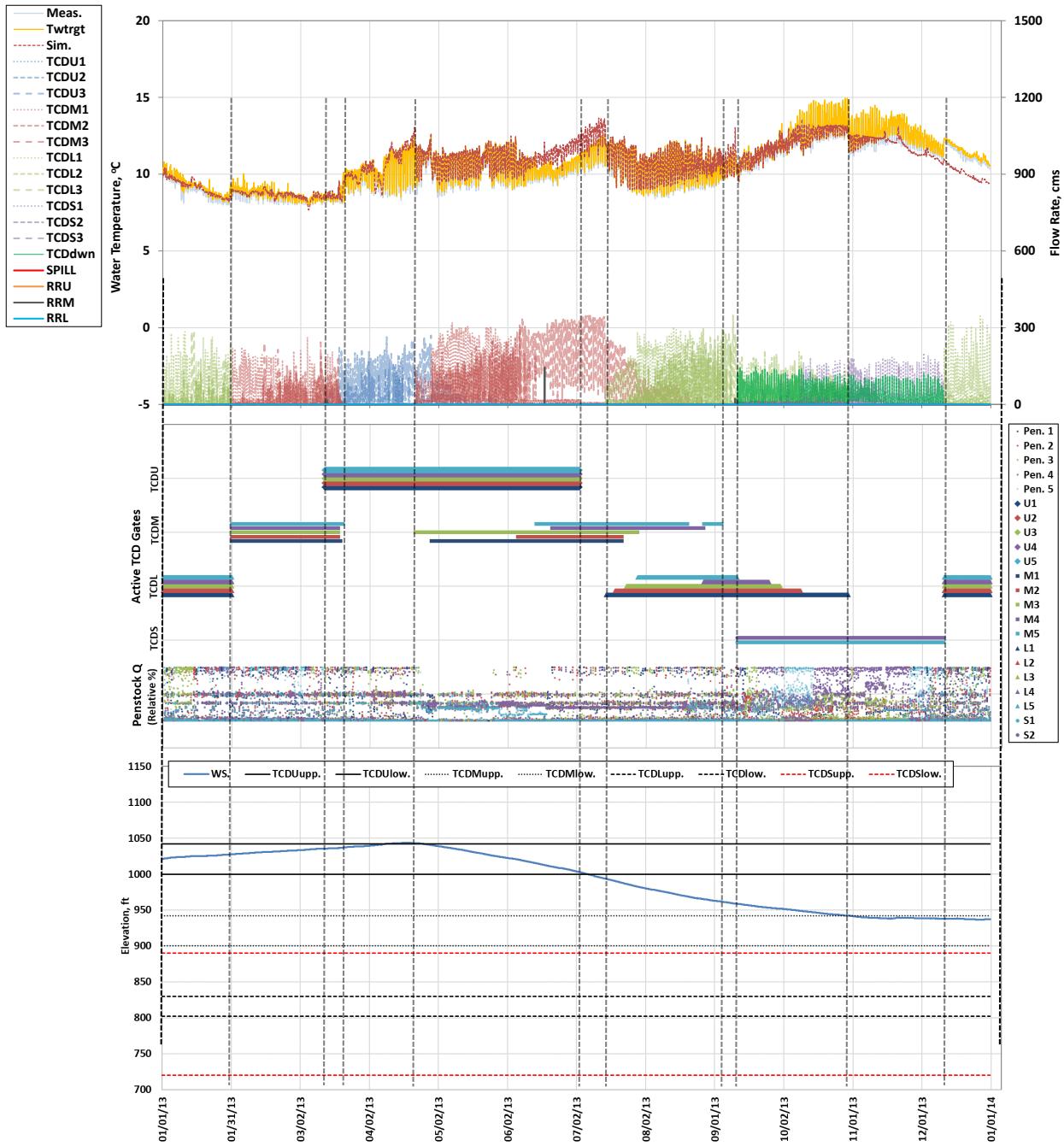


Figure A - 80. Shasta Dam simulated release temperature, target temperature, and measured temperatures; gate settings and simulated outflow; active powerhouse units, and reservoir stage: 2013.

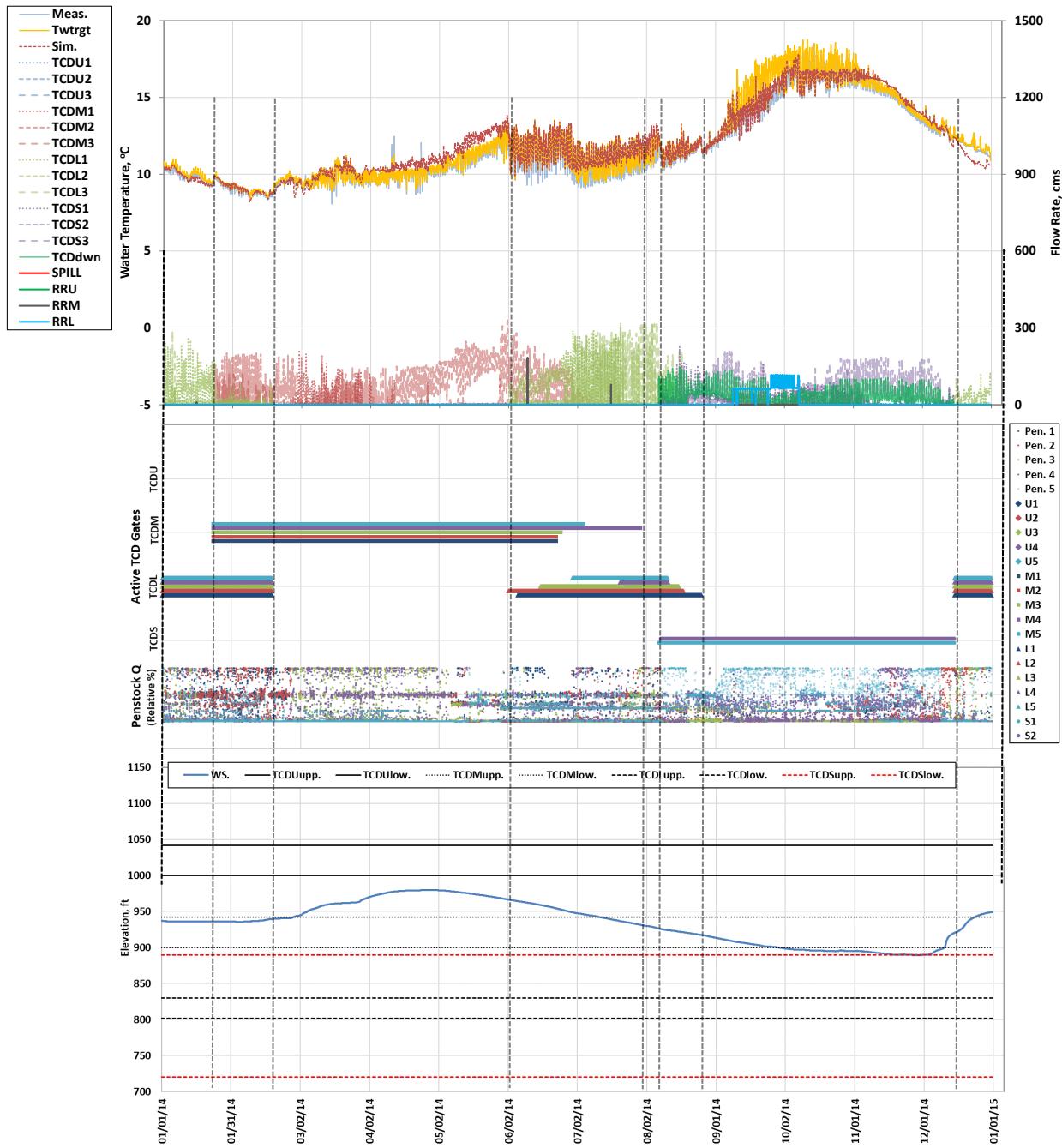


Figure A - 81. Shasta Dam simulated release temperature, target temperature, and measured temperatures; gate settings and simulated outflow; active powerhouse units, and reservoir stage: 2014.

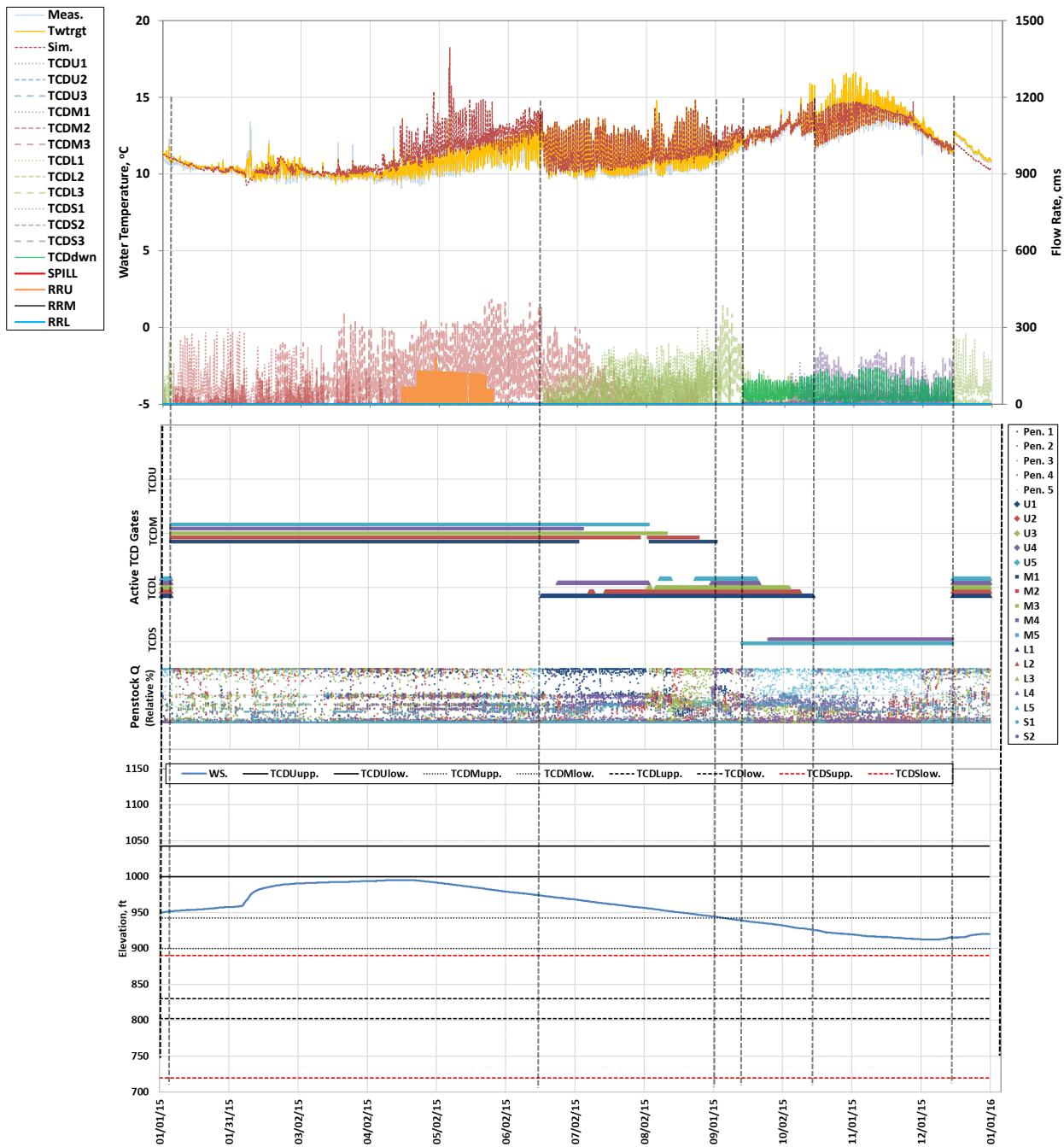


Figure A - 82. Shasta Dam simulated release temperature, target temperature, and measured temperatures; gate settings and simulated outflow; active powerhouse units, and reservoir stage: 2015.

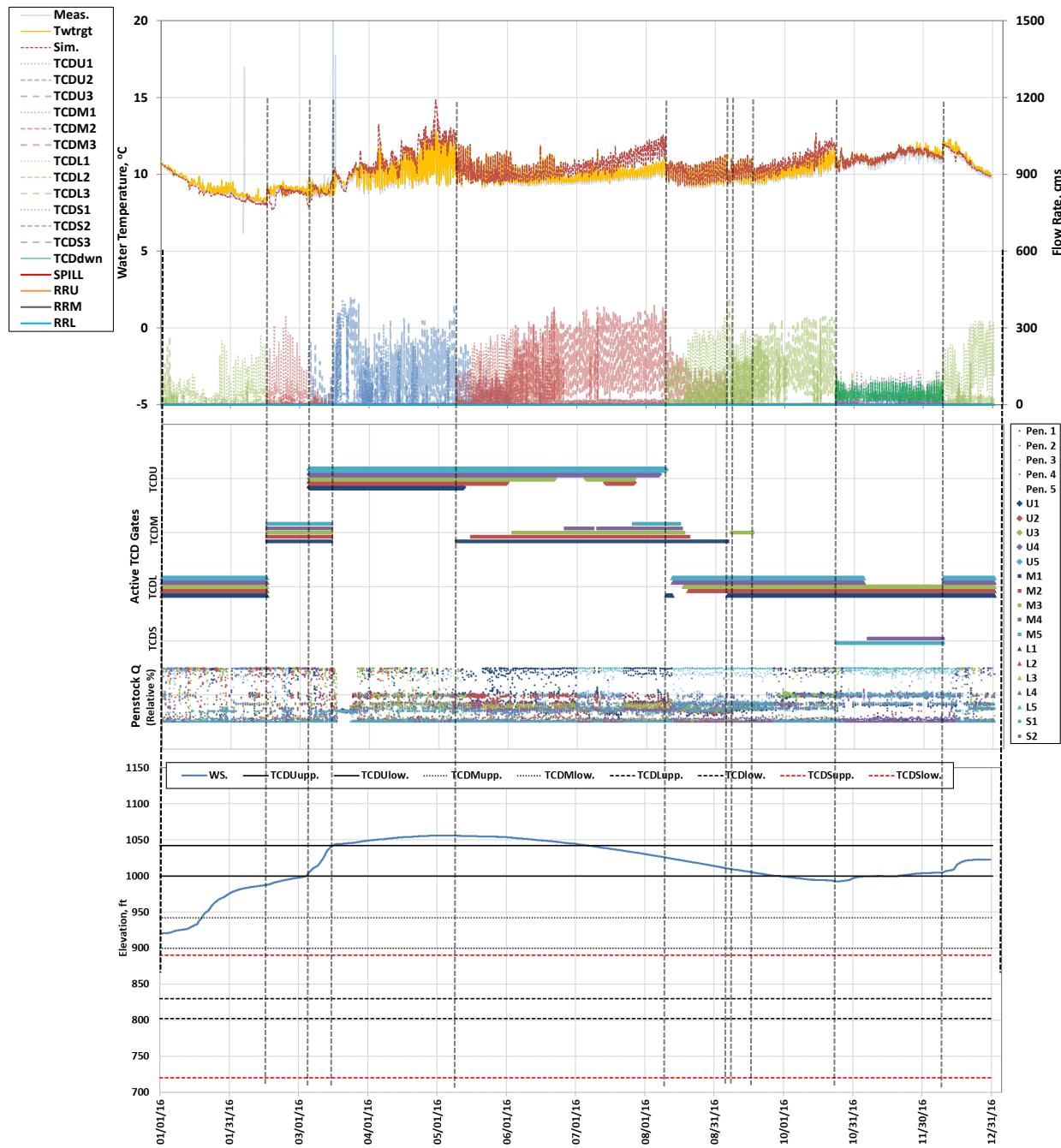


Figure A - 83. Shasta Dam simulated release temperature, target temperature, and measured temperatures; gate settings and simulated outflow; active powerhouse units, and reservoir stage: 2016.

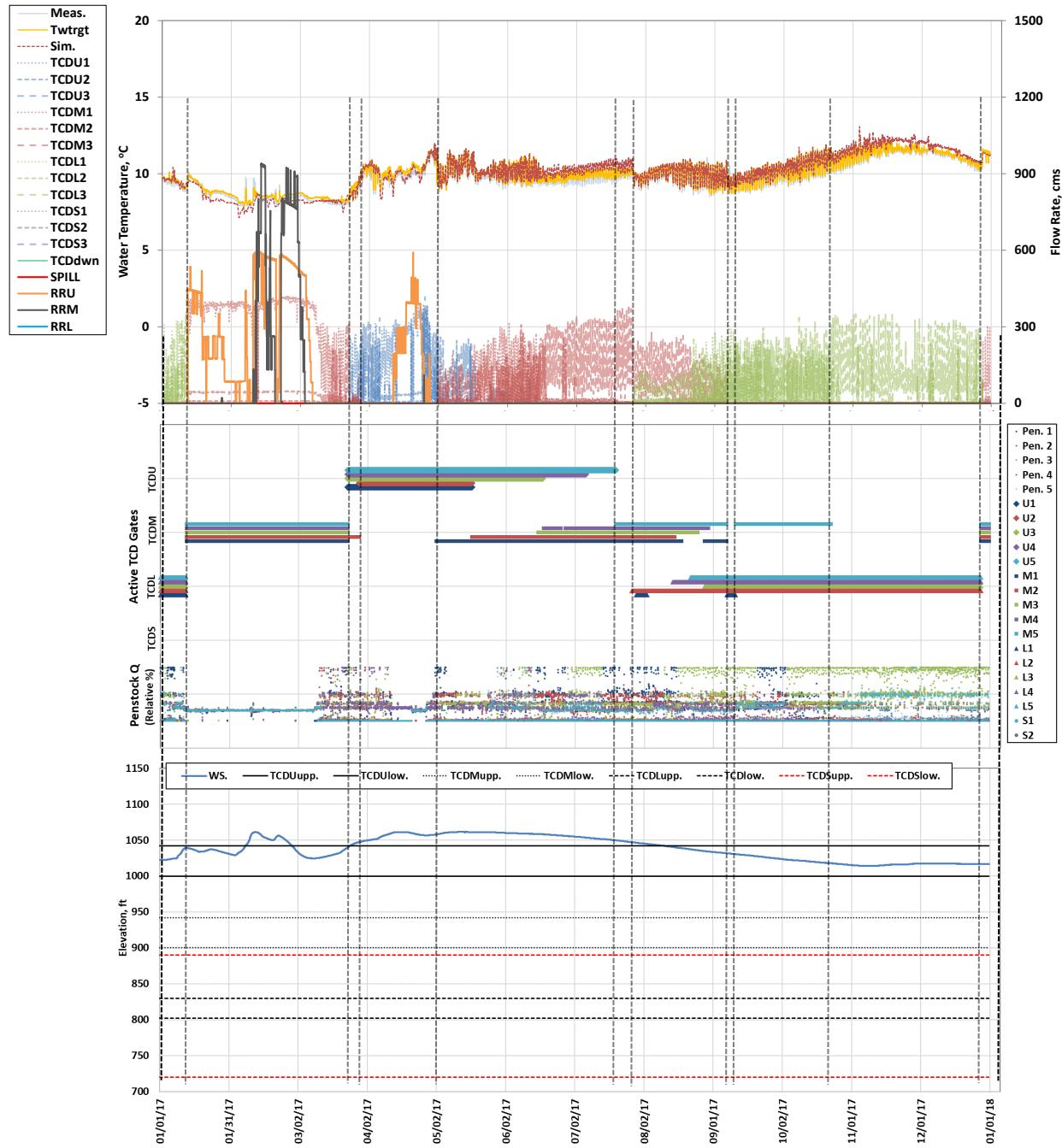


Figure A - 84. Shasta Dam simulated release temperature, target temperature, and measured temperatures; gate settings and simulated outflow; active powerhouse units, and reservoir stage: 2017.

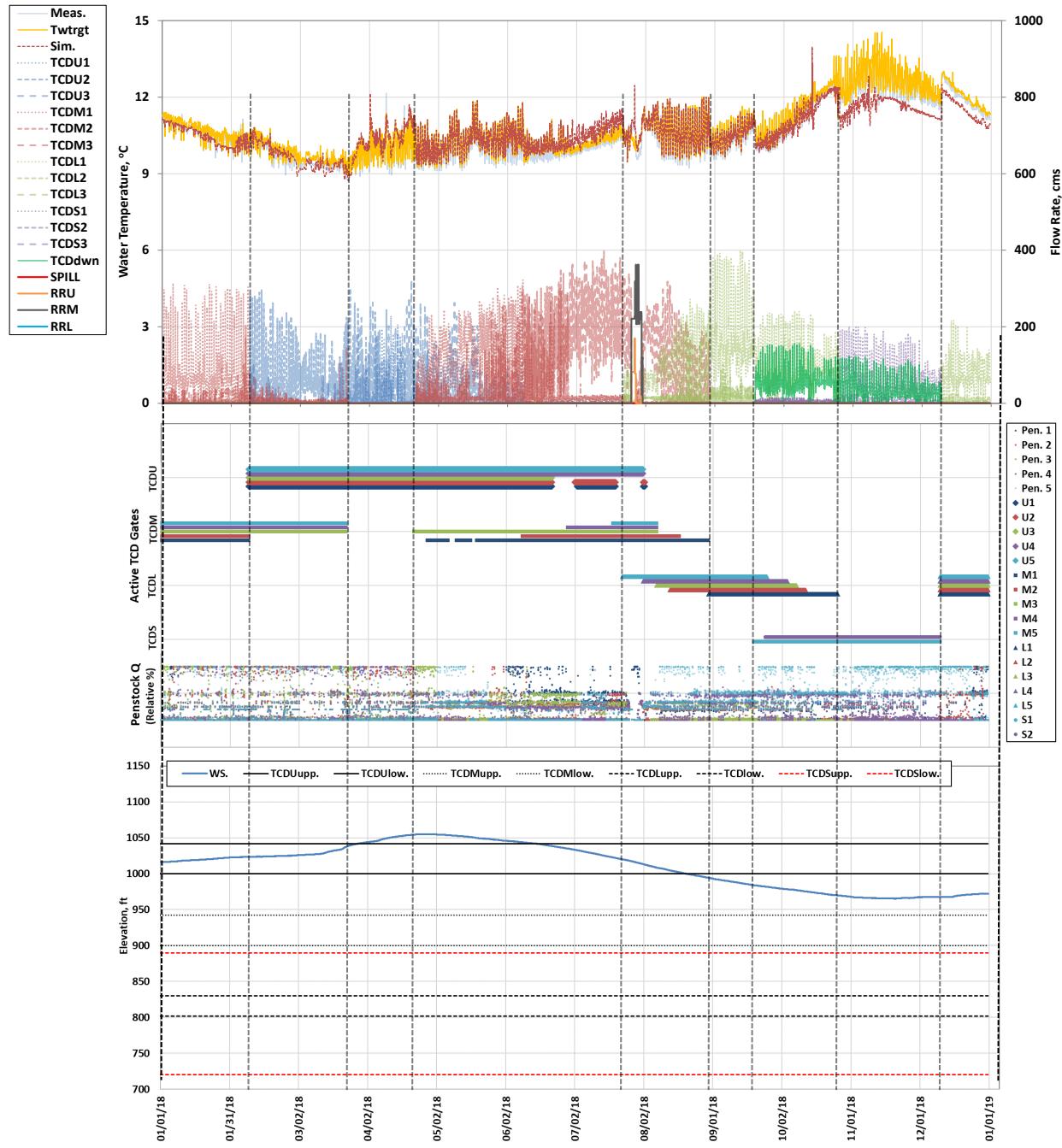


Figure A - 85. Shasta Dam simulated release temperature, target temperature, and measured temperatures; gate settings and simulated outflow; active powerhouse units, and reservoir stage: 2018.

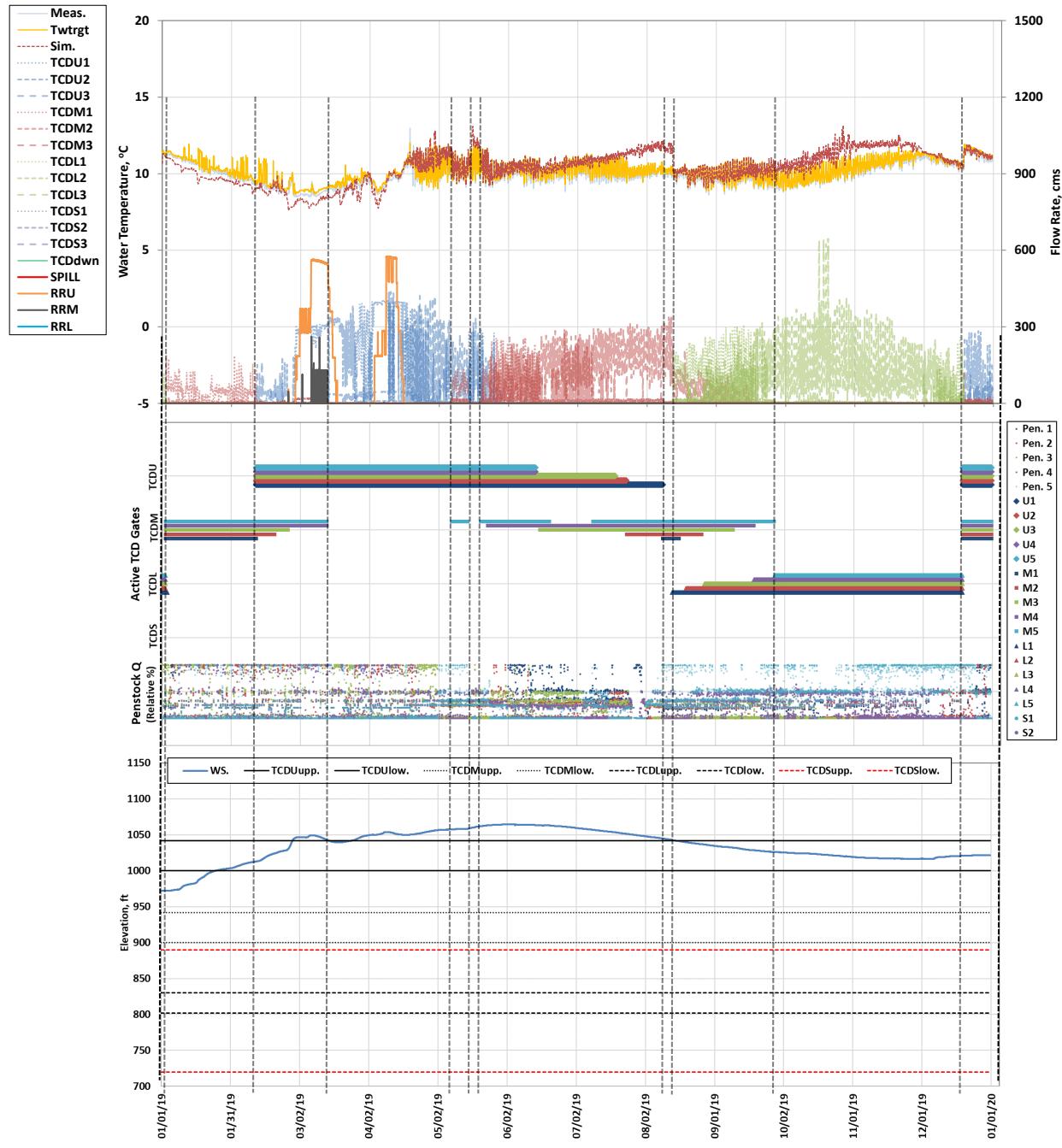


Figure A - 86. Shasta Dam simulated release temperature, target temperature, and measured temperatures; gate settings and simulated outflow; active powerhouse units, and reservoir stage: 2019.

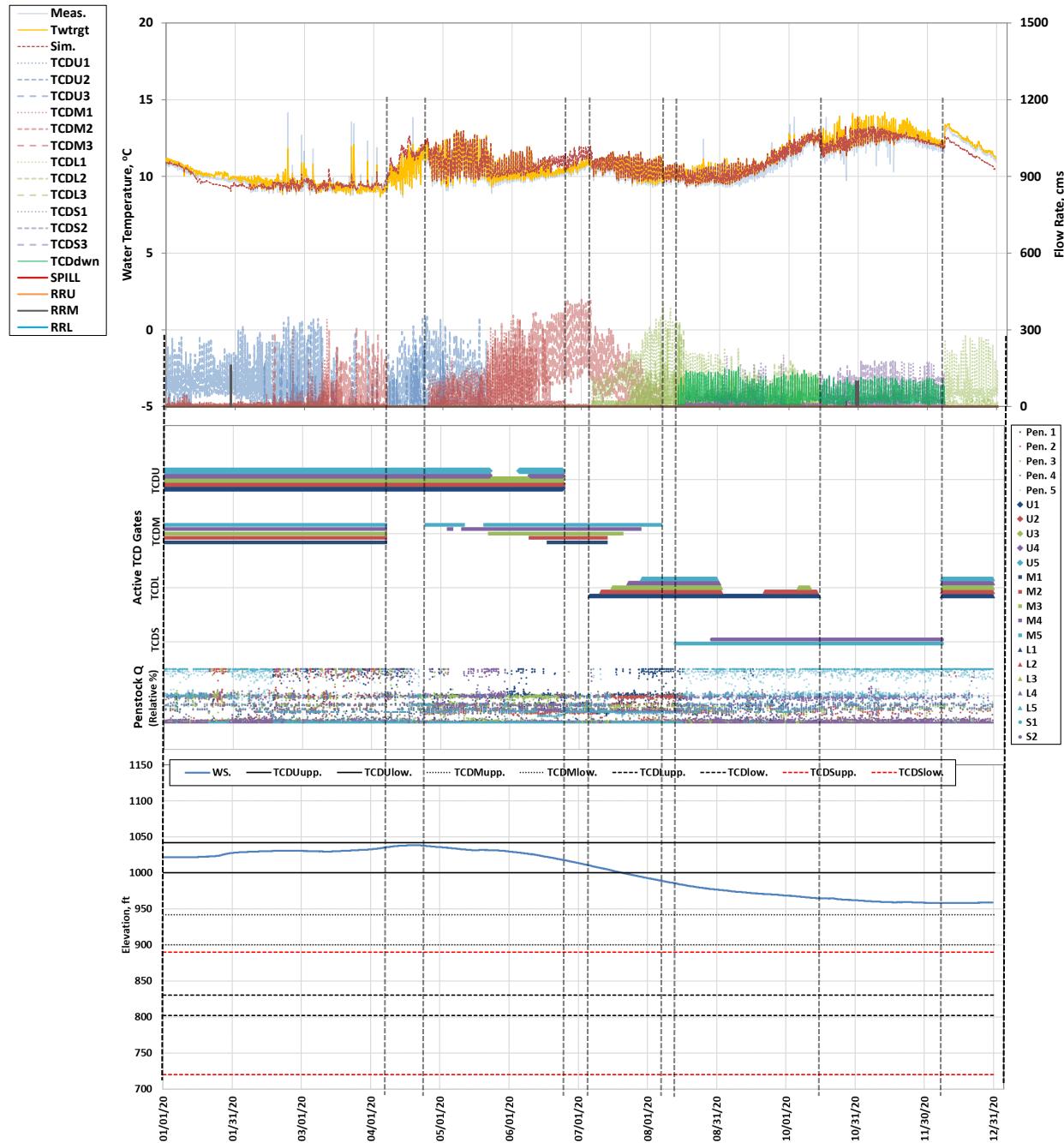


Figure A - 87. Shasta Dam simulated release temperature, target temperature, and measured temperatures; gate settings and simulated outflow; active powerhouse units, and reservoir stage: 2020.

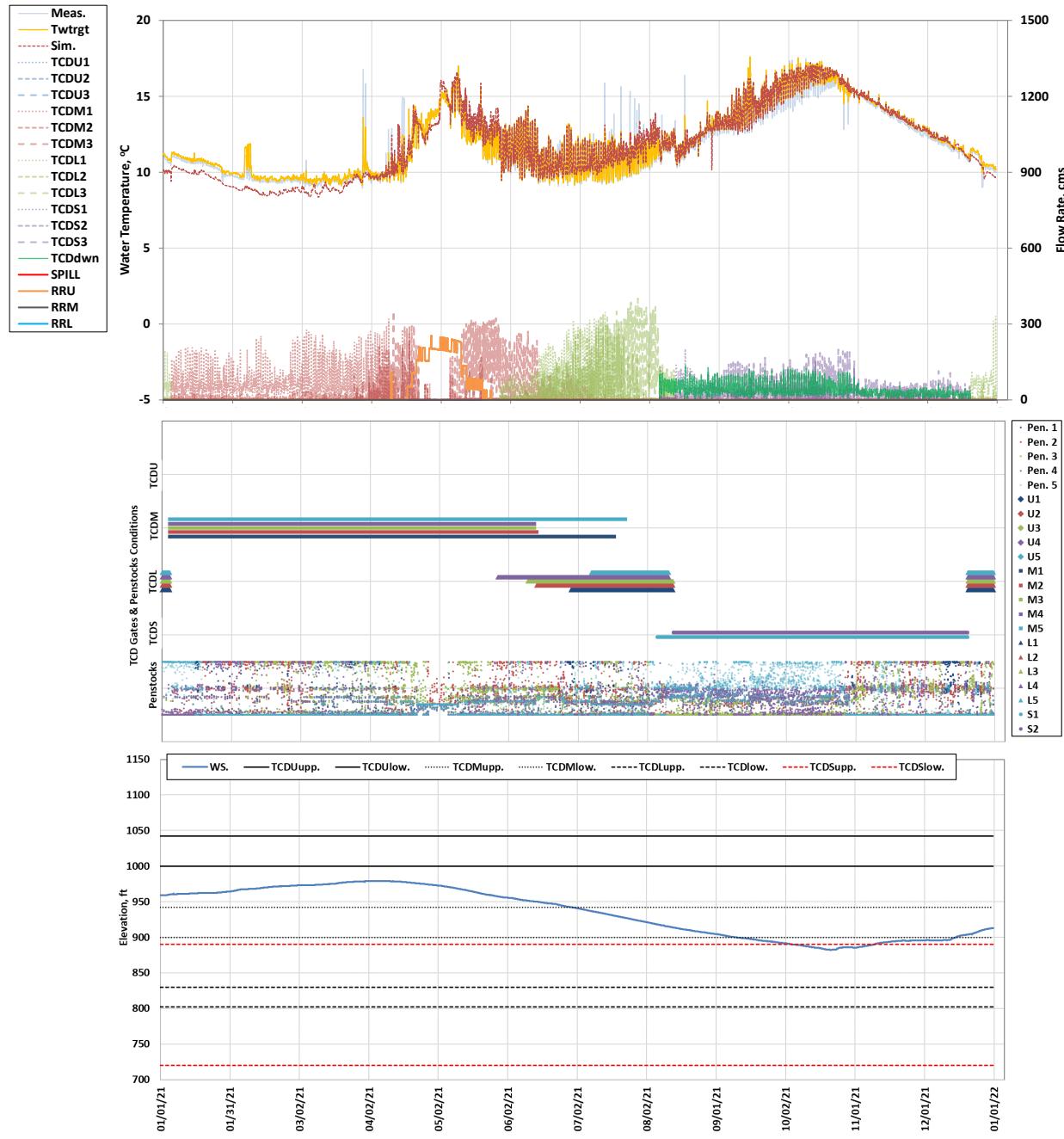


Figure A - 88. Shasta Dam simulated release temperature, target temperature, and measured temperatures; gate settings and simulated outflow; active powerhouse units, and reservoir stage: 2021.

Table A - 29. Summary statistics of Shasta Dam outflow temperature: 2000-2008.

Statistic	2000	2001	2002	2003	2004	2005	2006	2007	2008
Mean Bias (°C)	-0.09	0.09	-0.01	-0.11	-0.42	-0.06	-0.31	-0.29	-0.25
MAE (°C)	0.61	0.36	0.31	0.20	0.47	0.15	0.33	0.38	0.37
RMSE (°C)	0.75	0.59	0.45	0.31	0.73	0.25	0.47	0.64	0.68
Nash-Sutcliffe (NSE)	0.53	0.85	0.88	0.88	0.85	0.97	0.78	0.82	0.92
COUNT	8,472	8,760	8,760	8,760	8,784	8,760	8,760	8,760	8,784

Table A - 30. Summary statistics of Shasta Dam outflow temperature: 2009-2017.

Statistic	2009	2010	2011	2012	2013	2014	2015	2016	2017
Mean Bias (°C)	0.23	-0.19	-0.03	0.00	-0.06	0.01	0.20	0.21	0.06
MAE (°C)	0.41	0.29	0.18	0.25	0.46	0.43	0.43	0.39	0.29
RMSE (°C)	0.60	0.45	0.29	0.38	0.69	0.64	0.65	0.61	0.38
Nash-Sutcliffe (NSE)	0.90	0.70	0.86	0.86	0.78	0.93	0.78	0.47	0.85
COUNT	8,760	8,760	8,760	8,784	8,760	8,760	8,760	8,784	8,760

Table A - 31. Summary statistics of Shasta Dam outflow temperature: 2018-2021.

Statistic	2018	2019	2020	2021
Mean Bias (°C)	-0.19	0.19	-0.05	-0.13
MAE (°C)	0.37	0.59	0.31	0.46
RMSE (°C)	0.54	0.79	0.46	0.65
Nash-Sutcliffe (NSE)	0.73	-0.25	0.85	0.91
COUNT	8,760	8,760	8,784	8,760

A.5. **Summary Statistics for May - October**

Table A - 32. Summary statistics of Shasta Lake elevation (stage) (May-October(incl.) period): 2000-2017.

Statistic	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Mean Bias (ft)	-0.19	0.23	-0.19	-0.07	0.04	-0.25	0.09	0.01	0.16	0.19
MAE (ft)	0.28	0.56	0.27	0.24	0.44	0.48	0.33	0.46	0.41	0.36
RMSE (ft)	0.34	0.66	0.32	0.30	0.52	0.55	0.36	0.50	0.45	0.41
Nash-Sutcliffe (NSE)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
COUNT	4,416	4,416	4,416	4,416	4,416	4,416	4,416	4,416	4,416	4,416
Statistic	2010	2011	2012	2013	2014	2015	2016	2017		
Mean Bias (ft)	-0.40	-0.23	-0.59	-0.61	0.14	-0.45	-0.29	-0.29		
MAE (ft)	0.45	0.31	0.72	0.79	0.64	0.46	0.33	0.52		
RMSE (ft)	0.51	0.35	0.81	0.87	0.71	0.53	0.38	0.58		
Nash-Sutcliffe (NSE)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
COUNT	4,416	4,416	4,416	4,416	4,416	4,416	4,416	4,416		

Table A - 33. Summary statistics of Shasta Lake elevation (stage) (May-October(incl.) period): 2018-2021.

Statistic	2018	2019	2020	2021
Mean Bias (ft)	-0.04	0.03	-0.38	0.04
MAE (ft)	0.32	0.26	0.38	0.33
RMSE (ft)	0.37	0.29	0.40	0.38
Nash-Sutcliffe (NSE)	1.00	1.00	1.00	1.00
COUNT	4,416	4,416	4,416	4,416

Table A - 34. Summary statistics for Shasta Dam outflow (May-October(incl.) period): 2000-2017.

Statistic	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Mean Bias (cfs)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MAE (cfs)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
RMSE (cfs)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
Nash-Sutcliffe (NSE)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
COUNT	4,416	4,416	4,416	4,416	4,416	4,416	4,416	4,416	4,416	4,416
Statistic	2010	2011	2012	2013	2014	2015	2016	2017		
Mean Bias (cfs)	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0		
MAE (cfs)	0.0	0.0	0.0	0.1	0.0	0.1	0.0	0.0		
RMSE (cfs)	0.0	0.0	0.0	0.3	0.0	0.6	0.0	0.0		
Nash-Sutcliffe (NSE)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0		
COUNT	4,416	4,416	4,416	4,416	4,416	4,416	4,416	4,416		

Table A - 35. Summary statistics for Shasta Dam outflow (May-October(incl.) period): 2018-2021.

Statistic	2018	2019	2020	2021
Mean Bias (cfs)	0.0	0.0	0.0	0.0
MAE (cfs)	0.0	0.2	0.0	0.0
RMSE (cfs)	0.0	0.3	0.0	0.1
Nash-Sutcliffe (NSE)	1.0	1.0	1.0	1.0
COUNT	4,416	4,416	4,416	4,416

Table A - 36. Summary statistics of Shasta Dam outflow temperature (May-October(incl.) period): 2000-2017.

Statistic	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Mean Bias (°C)	0.09	0.32	0.23	-0.04	-0.23	0.03	-0.08	-0.16	-0.26	0.38
MAE (°C)	0.57	0.37	0.30	0.09	0.30	0.07	0.11	0.27	0.41	0.53
RMSE (°C)	0.69	0.67	0.47	0.16	0.56	0.13	0.19	0.63	0.75	0.73
Nash-Sutcliffe (NSE)	0.13	0.76	0.75	0.95	0.91	0.99	0.93	0.78	0.85	0.71
COUNT	4,416	4,416	4,416	4,416	4,416	4,416	4,416	4,416	4,416	4,416
Statistic	2010	2011	2012	2013	2014	2015	2016	2017		
Mean Bias (°C)	0.13	0.00	0.19	0.20	-0.02	0.39	0.40	0.17		
MAE (°C)	0.21	0.13	0.25	0.41	0.53	0.53	0.45	0.25		
RMSE (°C)	0.31	0.21	0.40	0.59	0.79	0.77	0.67	0.34		
Nash-Sutcliffe (NSE)	0.68	0.90	0.60	0.75	0.90	0.57	-0.40	0.64		
COUNT	4,416	4,416	4,416	4,416	4,416	4,416	4,416	4,416		

Table A - 37. Summary statistics of Shasta Dam outflow temperature (May-October(incl.) period): 2018-2021.

Statistic	2018	2019	2020	2021
Mean Bias (°C)	-0.03	0.55	0.08	0.19
MAE (°C)	0.24	0.60	0.21	0.37
RMSE (°C)	0.38	0.83	0.33	0.56
Nash-Sutcliffe (NSE)	0.76	-1.60	0.87	0.94
COUNT	4,416	4,416	4,416	4,416