

APPENDIX J:

LSPC Hydrology Validation

Intermediate Network Locations

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Big Springs Creek Water Wheel
Station ID: 105SRBSWW
07/16/2013 – 01/28/2021

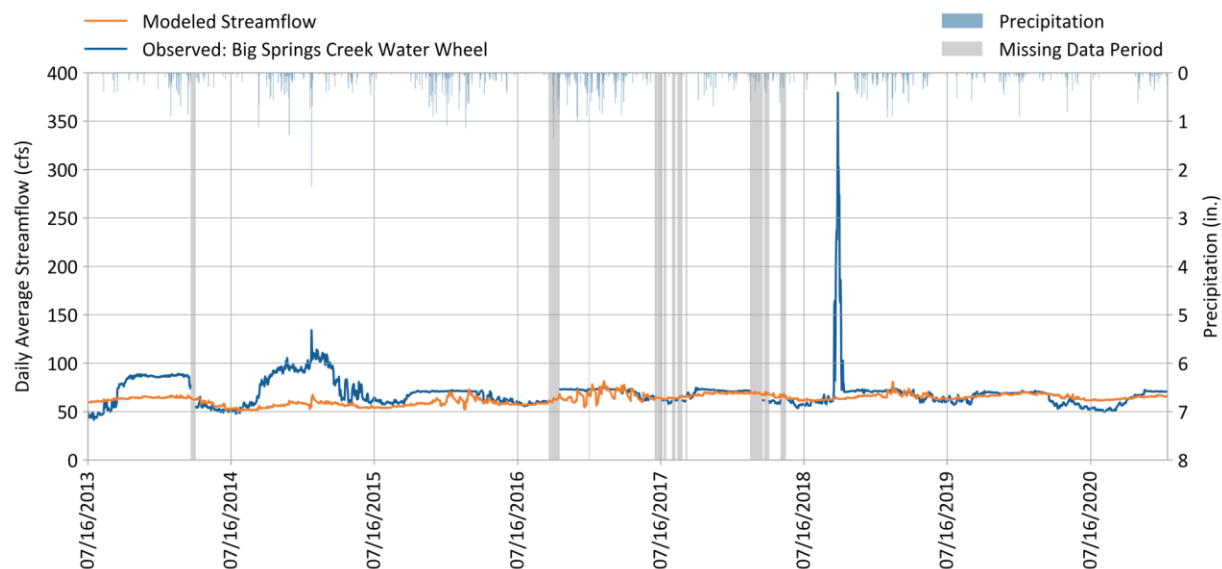


Figure J-1. Big Springs Creek Water Wheel (105SRBSWW) - Hydrology calibration: Simulated vs. daily observed streamflow.

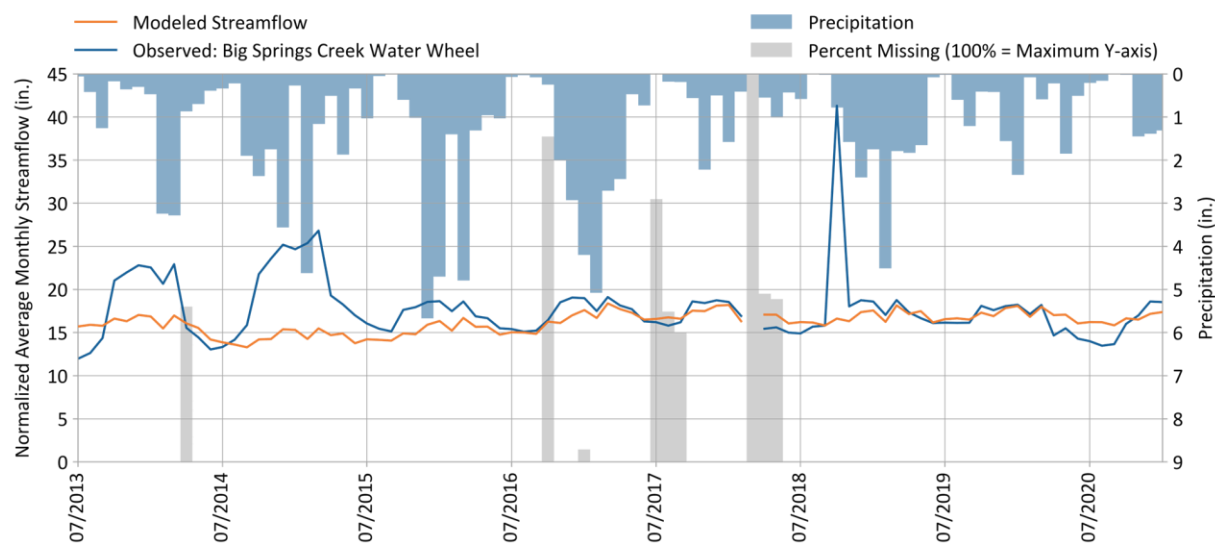


Figure J-2. Big Springs Creek Water Wheel (105SRBSWW) - Hydrology calibration: Simulated vs. observed normalized monthly streamflow.

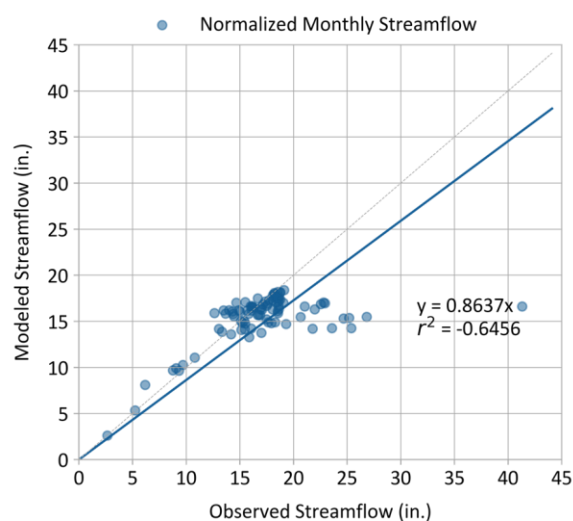
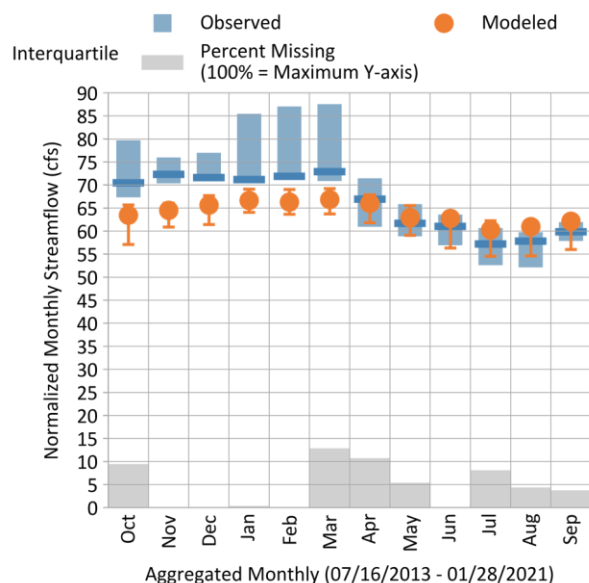


Figure J-3. Big Springs Creek Water Wheel (105SRBSWW)- Hydrology calibration: Simulated vs. observed normalized monthly streamflow.

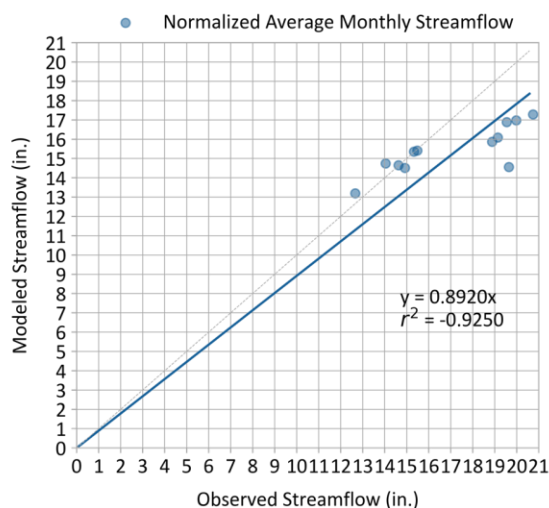
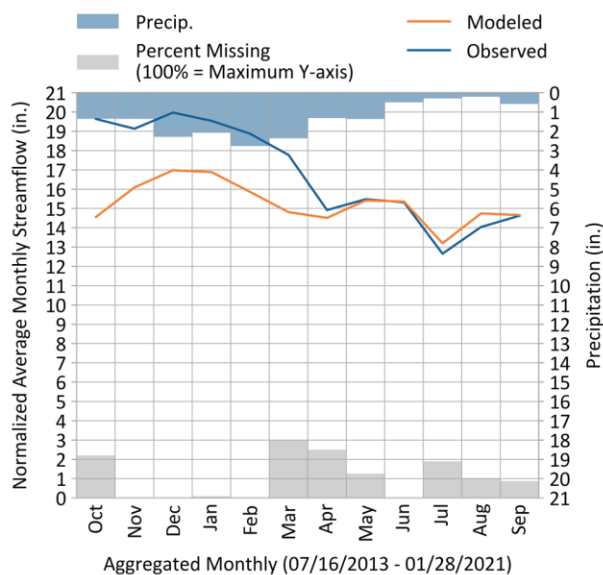


Figure J-4. Big Springs Creek Water Wheel (105SRBSWW)- Hydrology calibration: Average normalized monthly streamflow.

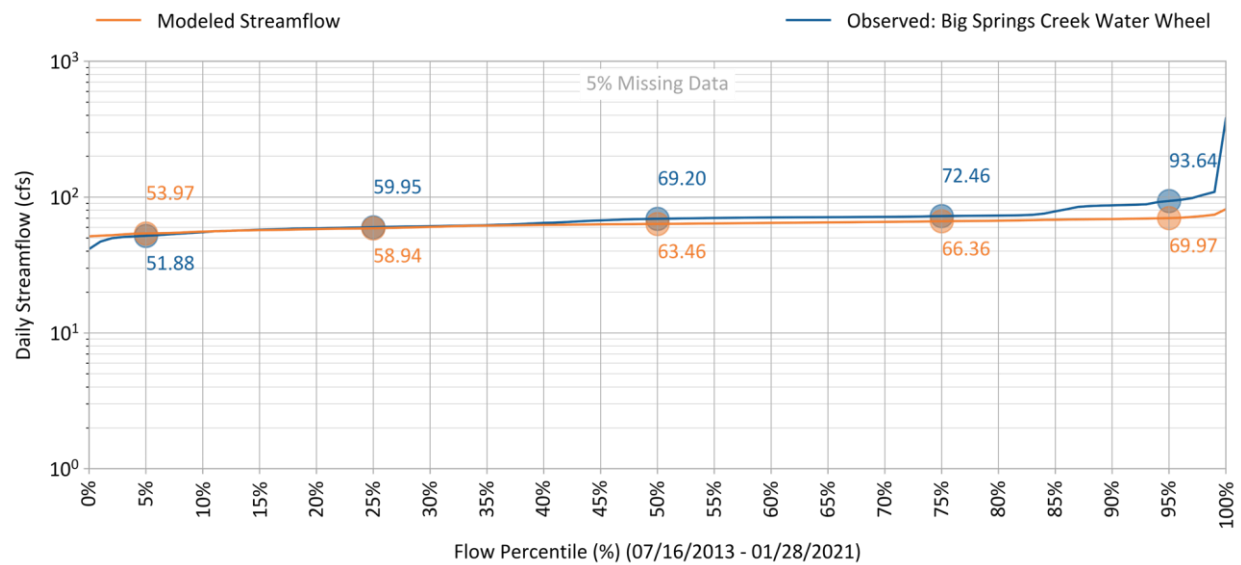


Figure J-5. Big Springs Creek Water Wheel (105SRBSWW)- Hydrology calibration: Simulated vs. observed streamflow duration curves.

Table J-1. Big Springs Creek Water Wheel (105SRBSWW)- Hydrology calibration: Percent bias statistical metric for predicted vs observed volumes

Calibration Metrics for Daily Flow (07/16/2013 - 01/28/2021)	Percent Bias (PBIAS)		
	All Seasons	Wet Season	Dry Season
All Conditions	9.4%	15.7%	-1.8%
Highest 10% of Daily Flow Rates	41.0%	41.0%	N/A
Lowest 50% of Daily Flow Rates	-2.4%	-0.2%	-3.1%
Days Categorized as Storm Flow	9.9%	16.4%	-1.3%
Days Categorized as Baseflow	9.1%	15.1%	-2.3%
Baseflow Recession Rate ¹	-0.6%	N/A	N/A

Calibration Metrics (07/16/2013 - 01/28/2021)	Recommended Error Criteria				Reference
	Very Good	Good	Fair	Poor	
All Conditions	<5%	5% - 10%	10% - 15%	>15%	Based on HSPF experience by A.A. Donigian, Jr., prepared for USEPA (2000)
Seasonal Flows	<10%	10% - 15%	15% - 25%	>25%	
Highest 10% of Daily Flow Rates					
Lowest 50% of Daily Flow Rates					
Days Categorized as Storm Flow					
Days Categorized as Baseflow					
Baseflow Recession Rate					

1: Sorted percentile values of recession rates were used.

Table J-2. Big Springs Creek Water Wheel (105SRBSWW)- Hydrology calibration: R² statistical metric for predicted vs observed volumes

Calibration Metrics for Daily Flow (07/16/2013 - 01/28/2021)	R-Squared (R ²)		
	All Seasons	Wet Season	Dry Season
All Conditions	0.01	0.05	0.03
Highest 10% of Daily Flow Rates	0.01	0.01	N/A
Lowest 50% of Daily Flow Rates	0.17	0.05	0.06
Days Categorized as Storm Flow	0.01	0.03	0.01
Days Categorized as Baseflow	0.01	0.06	0.08
Baseflow Recession Rate ¹	0.97	N/A	N/A

Calibration Metrics (07/16/2013 - 01/28/2021)	Recommended Error Criteria				Reference
	Very Good	Good	Fair	Poor	
All Conditions	>0.85	0.75 - 0.85	0.60 - 0.75	≤0.60	Moriassi et al. (2015)
Seasonal Flows	>0.75	0.60 - 0.75	0.50 - 0.60	≤0.50	
Highest 10% of Daily Flow Rates					
Lowest 50% of Daily Flow Rates					
Days Categorized as Storm Flow					
Days Categorized as Baseflow					
Baseflow Recession Rate					

1: Sorted percentile values of recession rates were used

Table J-3. Big Springs Creek Water Wheel (105SRBSWW)- Hydrology calibration: Nash-Sutcliffe efficiency statistical metric for predicted vs observed flow rates

Calibration Metrics for Daily Flow (07/16/2013 - 01/28/2021)	Nash-Sutcliffe Efficiency (NSE)		
	All Seasons	Wet Season	Dry Season
All Conditions	-0.15	-0.51	-0.29
Highest 10% of Daily Flow Rates	-1.3	-1.3	N/A
Lowest 50% of Daily Flow Rates	-0.06	-0.32	-0.41
Days Categorized as Storm Flow	-0.16	-0.5	-0.36
Days Categorized as Baseflow	-0.15	-0.53	-0.23
Baseflow Recession Rate ¹	0.59	N/A	N/A

Calibration Metrics (07/16/2013 - 01/28/2021)	Recommended Error Criteria				Reference
	Very Good	Good	Fair	Poor	
All Conditions	>0.80	0.70 - 0.80	0.50 - 0.70	≤0.50	Moriassi et al. (2015)
Seasonal Flows	>0.70	0.50 - 0.70	0.40 - 0.50	≤0.40	
Highest 10% of Daily Flow Rates					
Lowest 50% of Daily Flow Rates					
Days Categorized as Storm Flow					
Days Categorized as Baseflow					
Baseflow Recession Rate					

1: Sorted percentile values of recession rates were used

Table J-4. Big Springs Creek Water Wheel (105SRBSWW)- Hydrology calibration: Performance metrics for monthly predicted vs observed flow rates

Calibration Metrics for Monthly Flow (07/16/2013 - 01/28/2021)	Hydrological Condition		
	All (n = 90)	Wet Season (n = 52)	Dry Season (n = 38)
Percent Bias (PBIAS)	9.4%	15.7%	-1.8%
R-Squared (R ²)	0.36	0.23	0.73
Nash-Sutcliffe Efficiency (NSE)	0.25	-0.13	0.72
RMSE-Std-Dev_Ratio (RSR ¹)	0.87	1.06	0.53

Calibration Metrics (07/16/2013 - 01/28/2021)	Recommended Error Criteria				Reference
	Very Good	Good	Fair	Poor	
PBIAS (All Conditions)	<5%	5% - 10%	10% - 15%	>15%	Based on HSPF experience by A.A. Donigian, Jr., prepared for USEPA (2000); Moriasi et al. (2015)
PBIAS (Seasonal Flows)	<10%	10% - 15%	15% - 25%	>25%	
R ² (All Conditions)	>0.85	0.75 - 0.85	0.60 - 0.75	≤0.60	
R ² (Seasonal Flows)	>0.75	0.60 - 0.75	0.50 - 0.60	≤0.50	
NSE (All Conditions)	>0.80	0.70 - 0.80	0.50 - 0.70	≤0.50	
NSE (Seasonal Flows)	>0.70	0.50 - 0.70	0.40 - 0.50	≤0.40	
RSR (All Conditions)	≤0.50	0.50 - 0.60	0.60 - 0.70	>0.70	
RSR (Seasonal Flows)	≤0.60	0.60 - 0.70	0.70 - 0.80	>0.80	

1: RSR is the ratio of the root mean square error to the standard deviation of observations

Shasta River near Grenada CA
Station ID: F21370
01/27/2005 - 09/25/2005

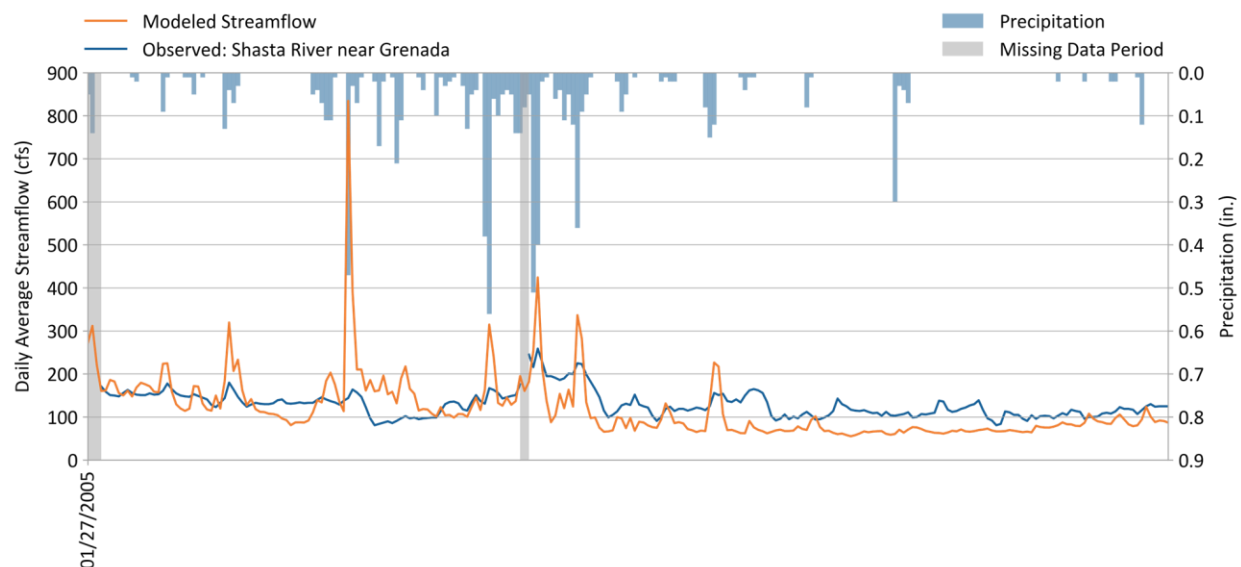


Figure J-6. Shasta River near Grenada (F21370) - Hydrology calibration: Simulated vs. daily observed streamflow.

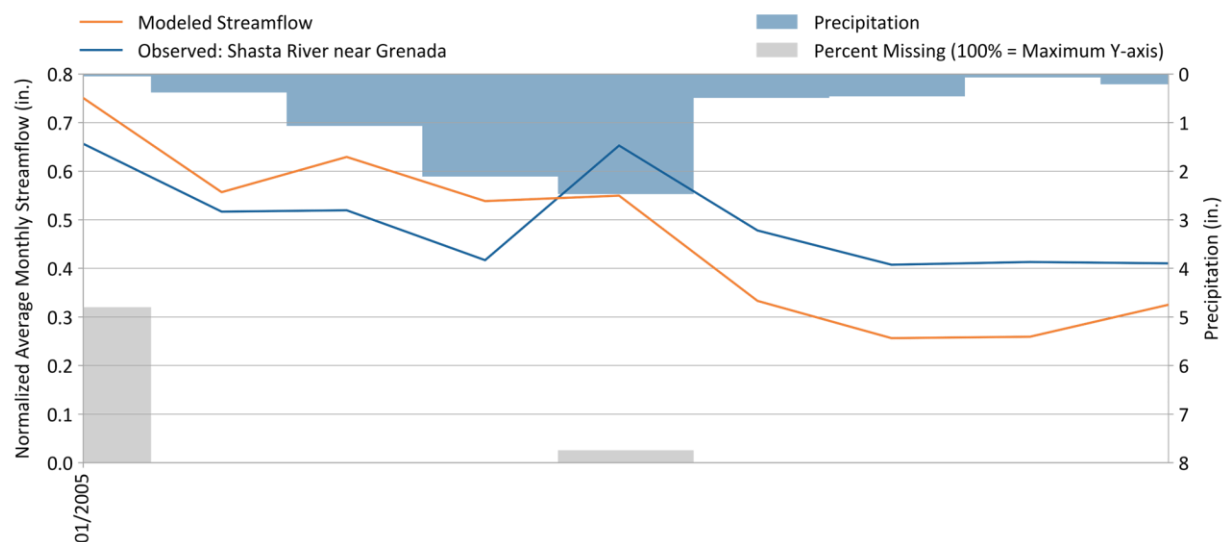


Figure J-7. Shasta River near Grenada (F21370) - Hydrology calibration: Simulated vs. observed normalized monthly streamflow.

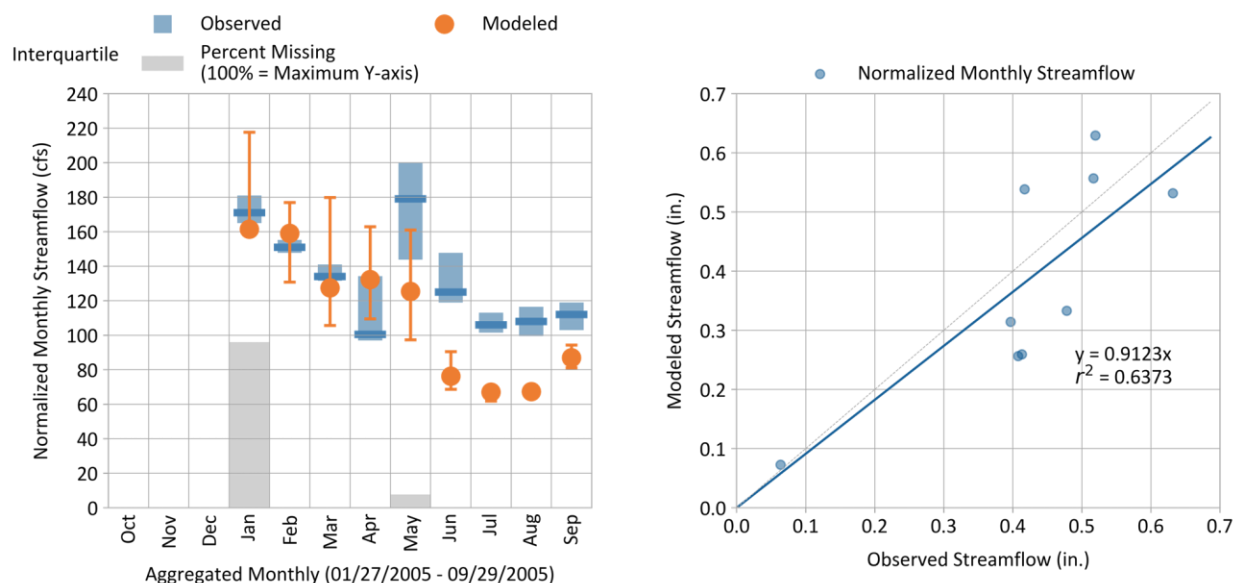


Figure J-8. Shasta River near Grenada (F21370) - Hydrology calibration: Simulated vs. observed normalized monthly streamflow.

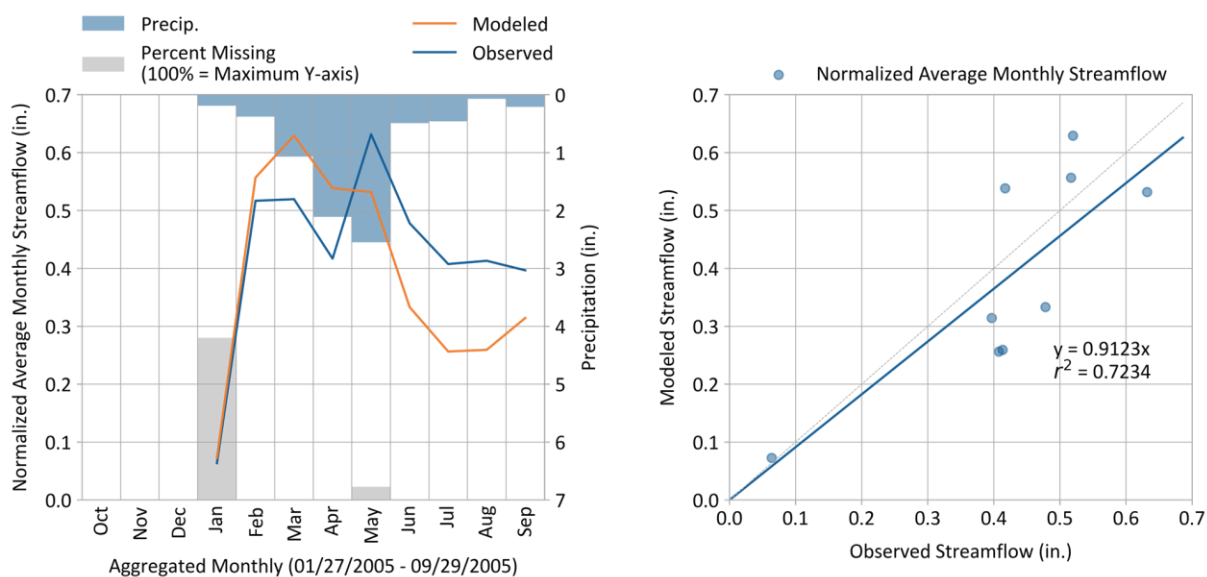


Figure J-9. Shasta River near Grenada (F21370) - Hydrology calibration: Average normalized monthly streamflow.

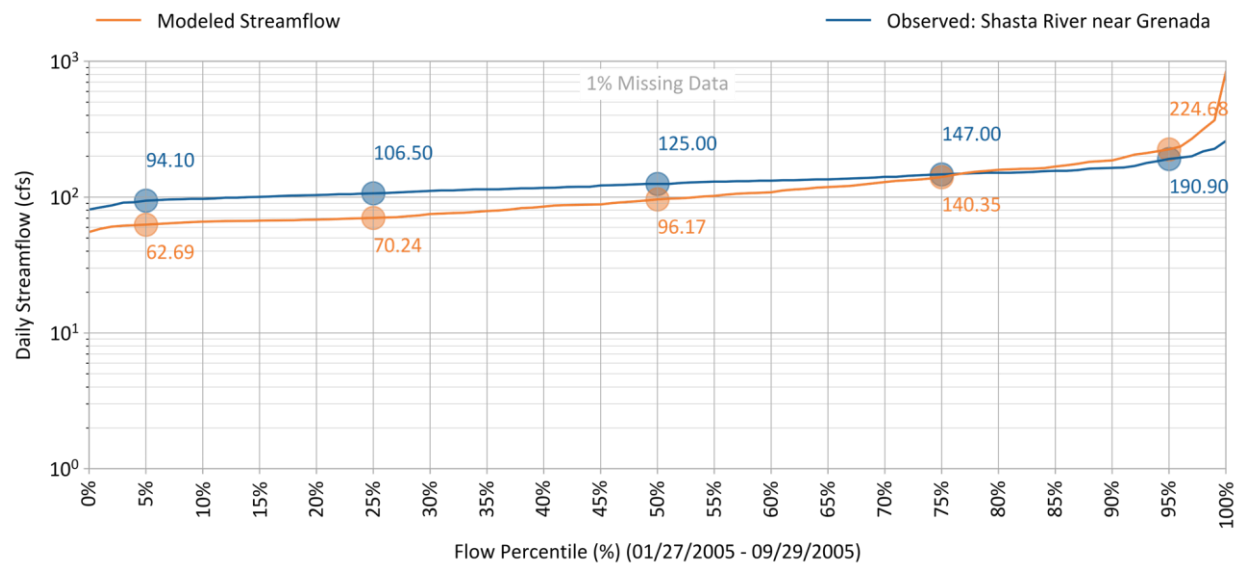


Figure J-10. Shasta River near Grenada (F21370) - Hydrology calibration: Simulated vs. observed streamflow duration curves.

Table J-5. Shasta River near Grenada (F21370) - Hydrology calibration: Percent bias statistical metric for predicted vs observed volumes

Calibration Metrics for Daily Flow (01/27/2005 - 09/29/2005)	Percent Bias (PBIAS)		
	All Seasons	Wet Season	Dry Season
All Conditions	9.1%	-18.5%	27.2%
Highest 10% of Daily Flow Rates	1.1%	-38.1%	12.4%
Lowest 50% of Daily Flow Rates	16.8%	-44.6%	29.0%
Days Categorized as Storm Flow	9.2%	-19.8%	27.6%
Days Categorized as Baseflow	9.0%	-15.2%	26.0%
Baseflow Recession Rate ¹	-1.4%	N/A	N/A

Calibration Metrics (01/27/2005 - 09/29/2005)	Recommended Error Criteria				Reference
	Very Good	Good	Fair	Poor	
All Conditions	<5%	5% - 10%	10% - 15%	>15%	Based on HSPF experience by A.A. Donigian, Jr., prepared for USEPA (2000)
Seasonal Flows	<10%	10% - 15%	15% - 25%	>25%	
Highest 10% of Daily Flow Rates					
Lowest 50% of Daily Flow Rates					
Days Categorized as Storm Flow					
Days Categorized as Baseflow					
Baseflow Recession Rate					

1: Sorted percentile values of recession rates were used

Table J-6. Shasta River near Grenada (F21370) - Hydrology calibration: Performance metrics for monthly predicted vs observed flow rates

Calibration Metrics for Monthly Flow (01/27/2005 - 09/29/2005)	Hydrological Condition		
	All (n = 9)	Wet Season (n = 4)	Dry Season (n = 5)
Percent Bias (PBIAS)	9.1%	N/A	27.2%
R-Squared (R ²)	0.64	N/A	0.92
Nash-Sutcliffe Efficiency (NSE)	0.42	N/A	-1.18
RMSE-Std-Dev_Ratio (RSR ¹)	0.76	N/A	1.48

Calibration Metrics (01/27/2005 - 09/29/2005)	Recommended Error Criteria				Reference
	Very Good	Good	Fair	Poor	
PBIAS (All Conditions)	<5%	5% - 10%	10% - 15%	>15%	Based on HSPF experience by A.A. Donigian, Jr., prepared for USEPA (2000); Moriasi et al. (2015)
PBIAS (Seasonal Flows)	<10%	10% - 15%	15% - 25%	>25%	
R ² (All Conditions)	>0.85	0.75 - 0.85	0.60 - 0.75	≤0.60	
R ² (Seasonal Flows)	>0.75	0.60 - 0.75	0.50 - 0.60	≤0.50	
NSE (All Conditions)	>0.80	0.70 - 0.80	0.50 - 0.70	≤0.50	
NSE (Seasonal Flows)	>0.70	0.50 - 0.70	0.40 - 0.50	≤0.40	
RSR (All Conditions)	≤0.50	0.50 - 0.60	0.60 - 0.70	>0.70	
RSR (Seasonal Flows)	≤0.60	0.60 - 0.70	0.70 - 0.80	>0.80	

1: RSR is the ratio of the root mean square error to the standard deviation of observations

Shasta River near Edgewood (lower)
Station ID: F21675
10/01/2004 - 09/30/2005

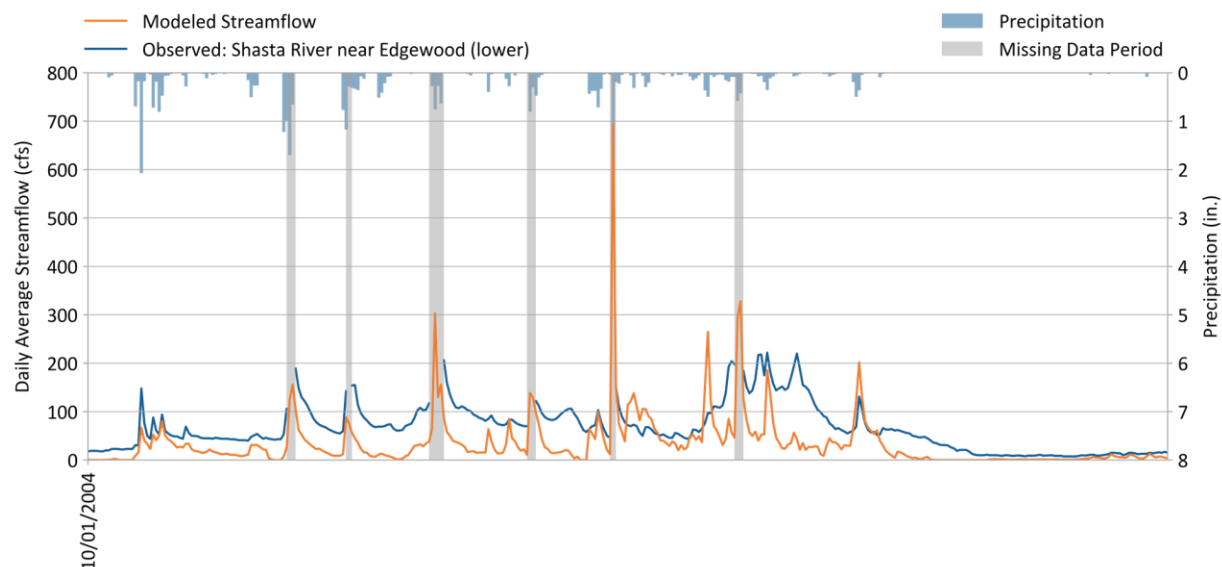


Figure J-11. Shasta River near Edgewood (lower) (F21675)- Hydrology calibration: Simulated vs. daily observed streamflow.

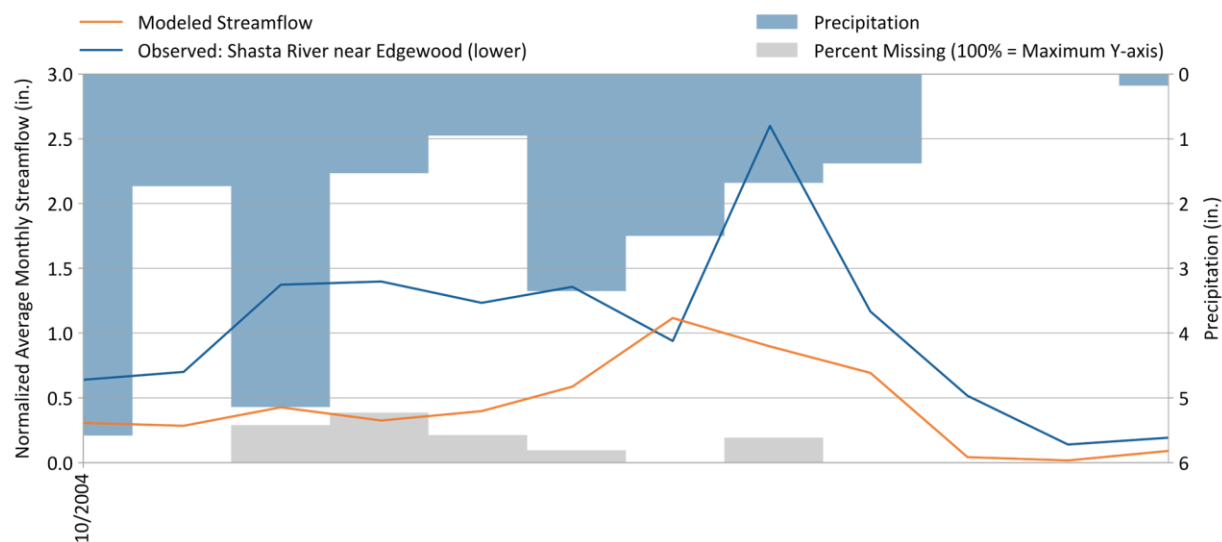


Figure J-12. Shasta River near Edgewood (lower) (F21675)- Hydrology calibration: Simulated vs. observed normalized monthly streamflow.

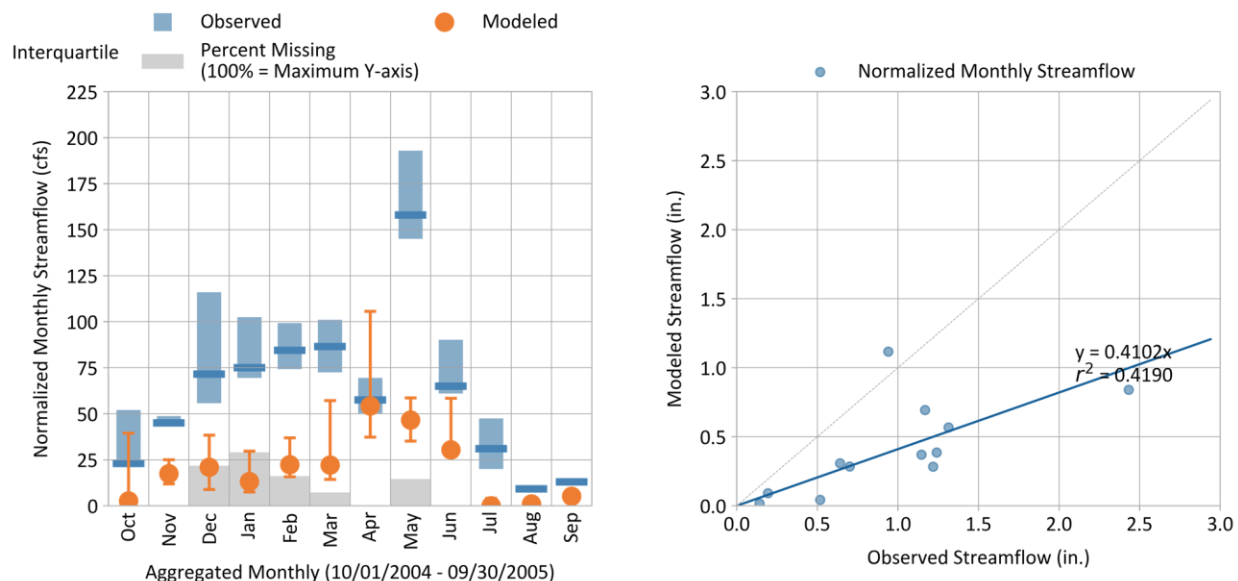


Figure J-13. Shasta River near Edgewood (lower) (F21675)- Hydrology calibration: Simulated vs. observed normalized monthly streamflow.

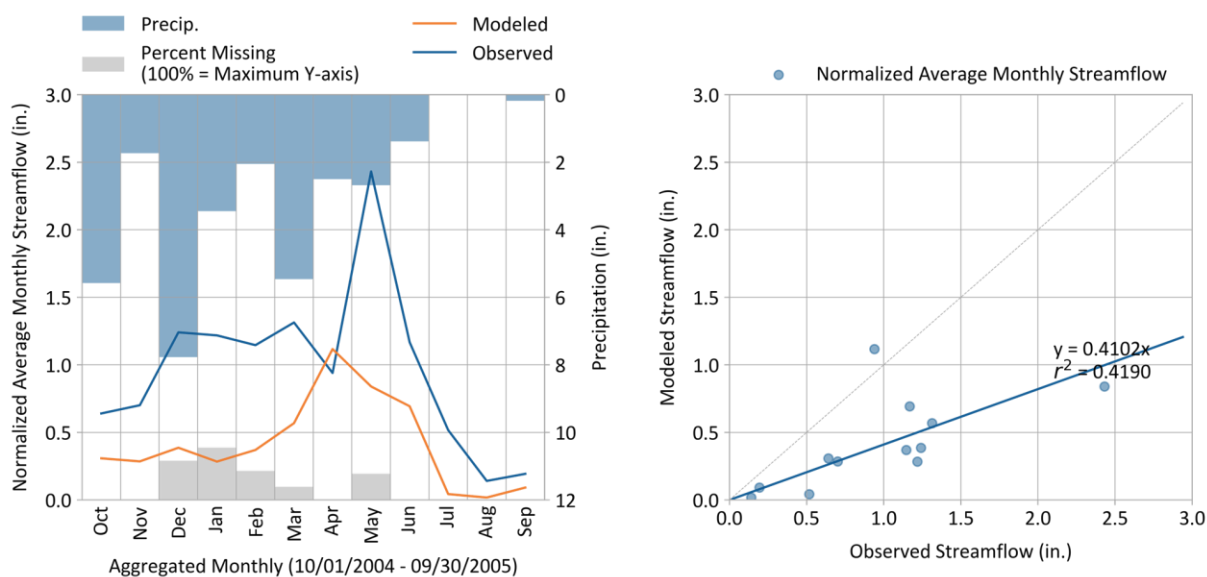


Figure J-14. Shasta River near Edgewood (lower) (F21675)- Hydrology calibration: Average normalized monthly streamflow.

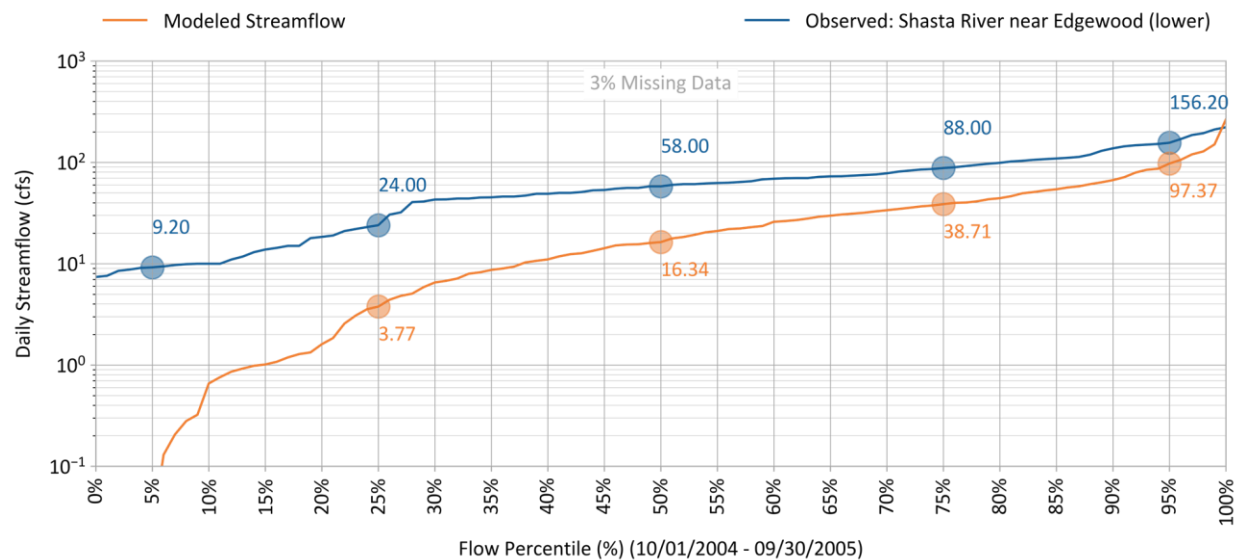


Figure J-15. Shasta River near Edgewood (lower) (F21675)- Hydrology calibration: Simulated vs. observed streamflow duration curves.

Table J-7. Shasta River near Edgewood (lower) (F21675)- Hydrology calibration: Percent bias statistical metric for predicted vs observed volumes

Calibration Metrics for Daily Flow (10/01/2004 - 09/30/2005)	Percent Bias (PBIAS)		
	All Seasons	Wet Season	Dry Season
All Conditions	57.0%	53.9%	62.1%
Highest 10% of Daily Flow Rates	62.6%	50.4%	66.5%
Lowest 50% of Daily Flow Rates	59.9%	53.6%	71.4%
Days Categorized as Storm Flow	51.2%	46.4%	58.2%
Days Categorized as Baseflow	62.8%	60.8%	66.3%
Baseflow Recession Rate ¹	17.4%	N/A	N/A

Calibration Metrics (10/01/2004 - 09/30/2005)	Recommended Error Criteria				Reference
	Very Good	Good	Fair	Poor	
All Conditions	<5%	5% - 10%	10% - 15%	>15%	Based on HSPF experience by A.A. Donigian, Jr.,prepared for USEPA (2000)
Seasonal Flows	<10%	10% - 15%	15% - 25%	>25%	
Highest 10% of Daily Flow Rates					
Lowest 50% of Daily Flow Rates					
Days Categorized as Storm Flow					
Days Categorized as Baseflow					
Baseflow Recession Rate					

1: Sorted percentile values of recession rates were used

Table J-8. Shasta River near Edgewood (lower) (F21675)- Hydrology calibration: Performance metrics for monthly predicted vs observed flow rates

Calibration Metrics for Monthly Flow (10/01/2004 - 09/30/2005)	Hydrological Condition		
	All (n = 12)	Wet Season (n = 7)	Dry Season (n = 5)
Percent Bias (PBIAS)	57.0%	53.9%	62.1%
R-Squared (R ²)	0.43	0.0	0.85
Nash-Sutcliffe Efficiency (NSE)	-0.47	-5.96	0.17
RMSE-Std-Dev_Ratio (RSR ¹)	1.21	2.64	0.91

Calibration Metrics (10/01/2004 - 09/30/2005)	Recommended Error Criteria				Reference
	Very Good	Good	Fair	Poor	
PBIAS (All Conditions)	<5%	5% - 10%	10% - 15%	>15%	Based on HSPF experience by A.A. Donigian, Jr., prepared for USEPA (2000); Moriasi et al. (2015)
PBIAS (Seasonal Flows)	<10%	10% - 15%	15% - 25%	>25%	
R ² (All Conditions)	>0.85	0.75 - 0.85	0.60 - 0.75	≤0.60	
R ² (Seasonal Flows)	>0.75	0.60 - 0.75	0.50 - 0.60	≤0.50	
NSE (All Conditions)	>0.80	0.70 - 0.80	0.50 - 0.70	≤0.50	
NSE (Seasonal Flows)	>0.70	0.50 - 0.70	0.40 - 0.50	≤0.40	
RSR (All Conditions)	≤0.50	0.50 - 0.60	0.60 - 0.70	>0.70	
RSR (Seasonal Flows)	≤0.60	0.60 - 0.70	0.70 - 0.80	>0.80	

1: RSR is the ratio of the root mean square error to the standard deviation of observations

Little Shasta River Nr Montague
Station ID: 11516900
07/21/2017 – 09/29/2023

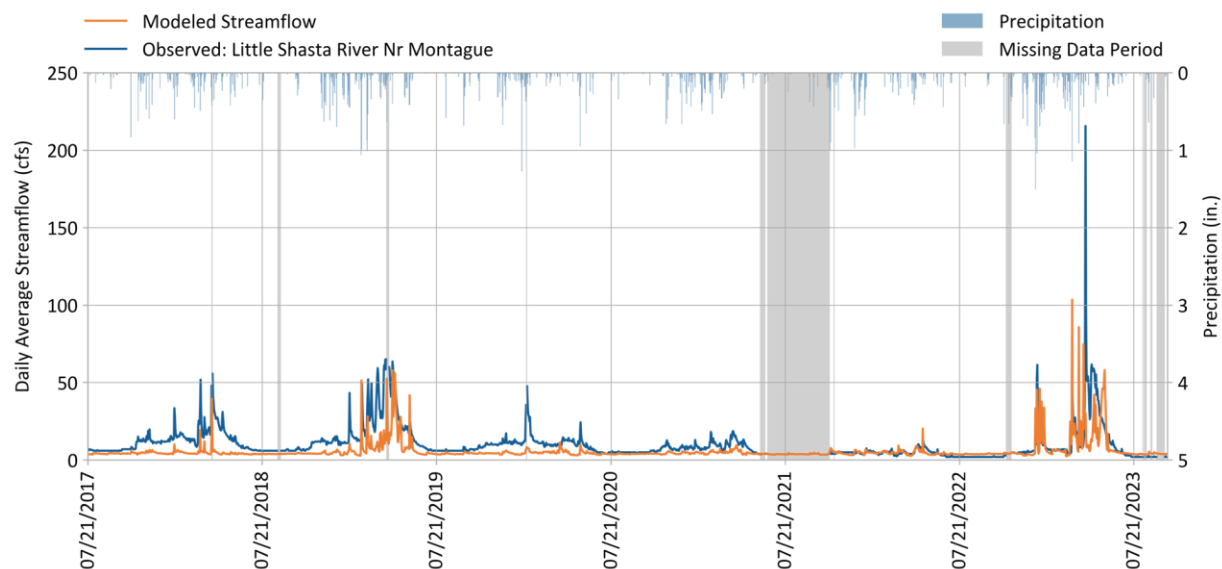


Figure J-16. Little Shasta River Nr Montague (11516900)- Hydrology calibration: Simulated vs. daily observed streamflow.

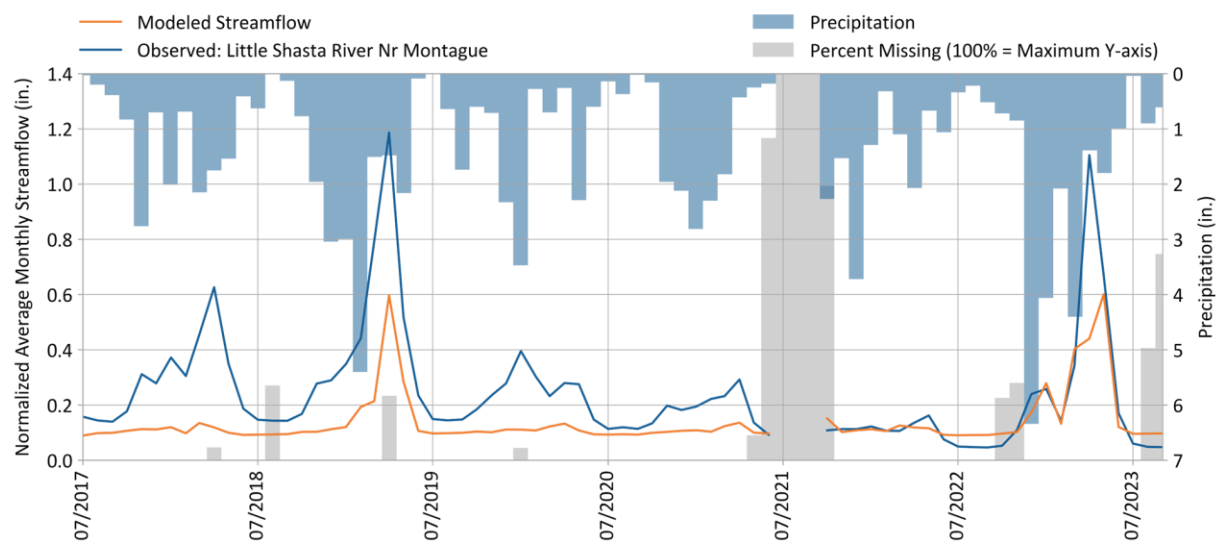


Figure J-17. Little Shasta River Nr Montague (11516900) - Hydrology calibration: Simulated vs. observed normalized monthly streamflow.

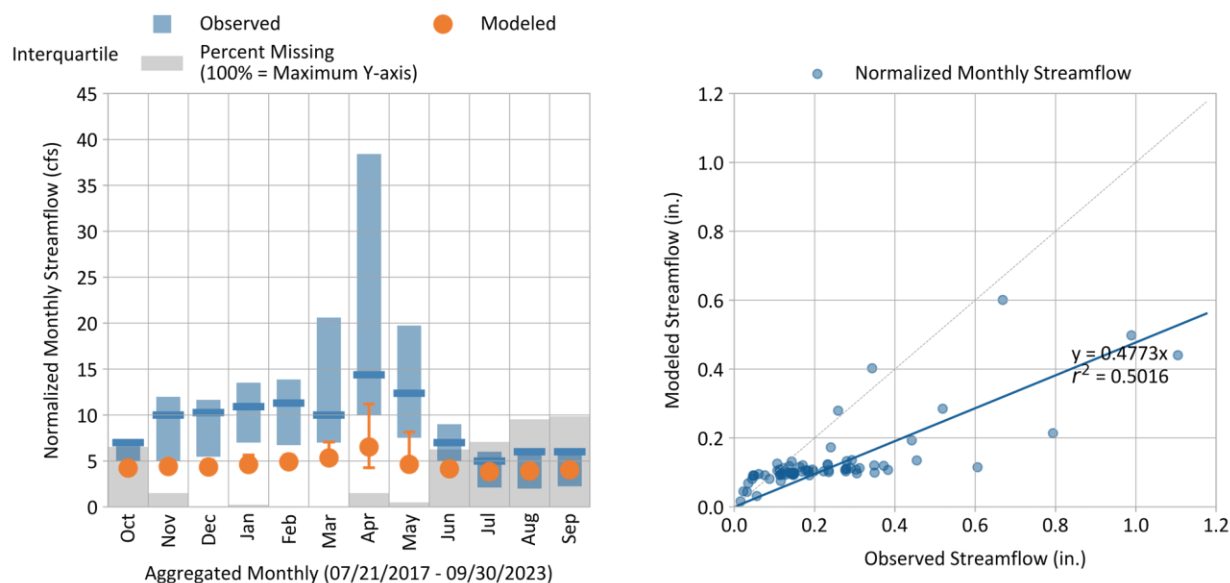


Figure J-18. Little Shasta River Nr Montague (11516900) - Hydrology calibration: Simulated vs. observed normalized monthly streamflow.

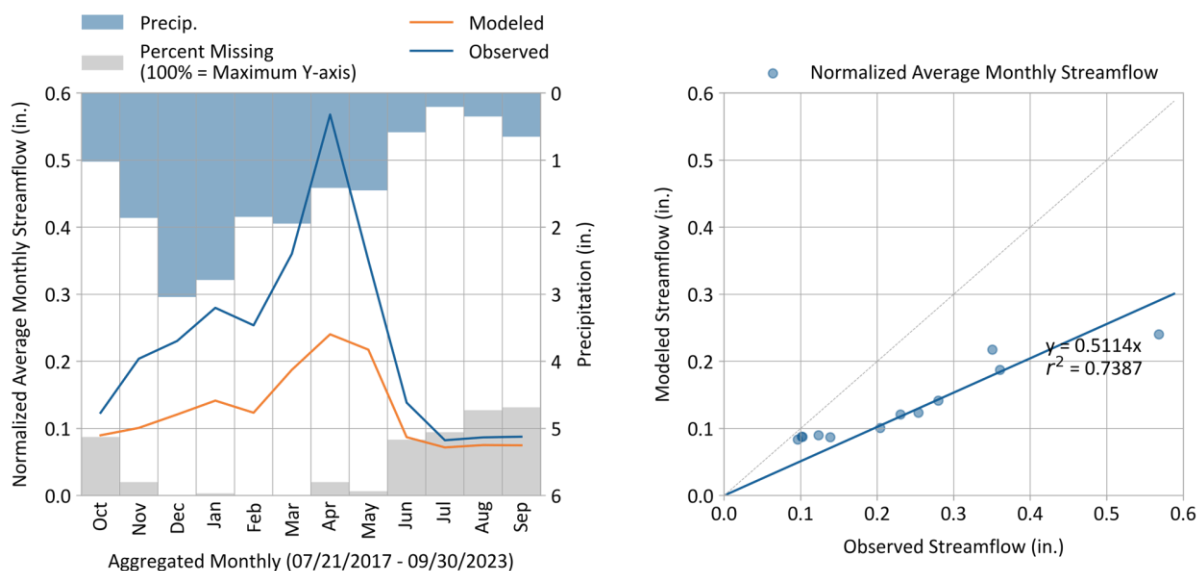


Figure J-19. Little Shasta River Nr Montague (11516900) - Hydrology calibration: Average normalized monthly streamflow.

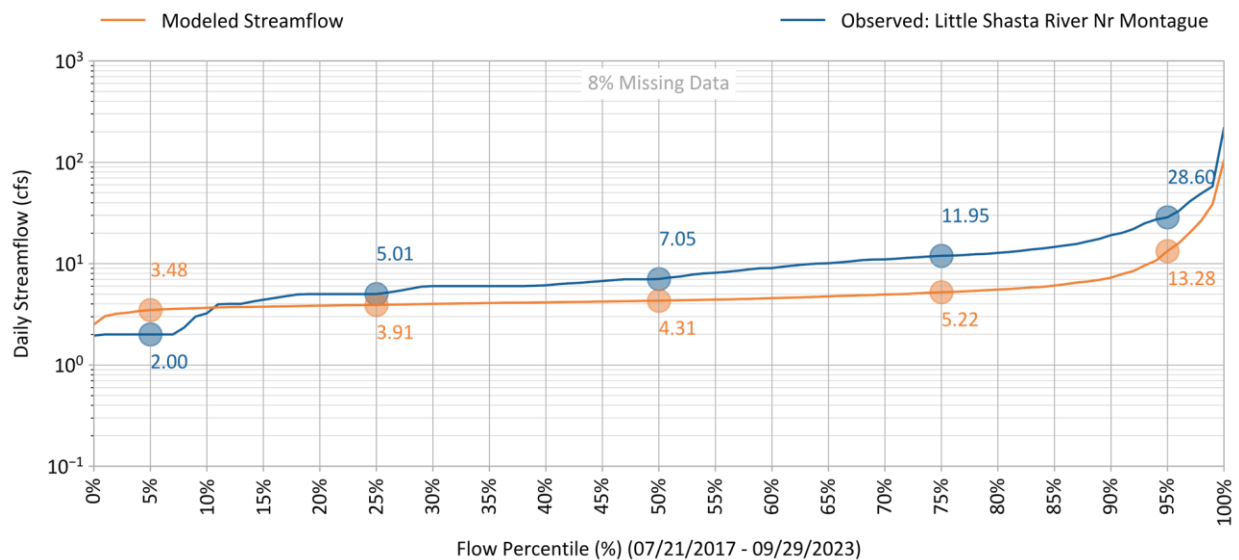


Figure J-20. Little Shasta River Nr Montague (11516900) - Hydrology calibration: Simulated vs. observed streamflow duration curves.

Table J-9. Little Shasta River Nr Montague (11516900) - Hydrology calibration: Percent bias statistical metric for predicted vs observed volumes

Calibration Metrics for Daily Flow (07/21/2017 - 09/30/2023)	Percent Bias (PBIAS)		
	All Seasons	Wet Season	Dry Season
All Conditions	44.2%	50.3%	28.6%
Highest 10% of Daily Flow Rates	56.1%	62.7%	27.5%
Lowest 50% of Daily Flow Rates	13.6%	12.9%	14.1%
Days Categorized as Storm Flow	49.5%	51.5%	37.6%
Days Categorized as Baseflow	39.1%	48.6%	25.6%
Baseflow Recession Rate ¹	-2.0%	N/A	N/A

Calibration Metrics (07/21/2017 - 09/30/2023)	Recommended Error Criteria				Reference
	Very Good	Good	Fair	Poor	
All Conditions	<5%	5% - 10%	10% - 15%	>15%	Based on HSPF experience by A.A. Donigian, Jr., prepared for USEPA (2000)
Seasonal Flows	<10%	10% - 15%	15% - 25%	>25%	
Highest 10% of Daily Flow Rates					
Lowest 50% of Daily Flow Rates					
Days Categorized as Storm Flow					
Days Categorized as Baseflow					
Baseflow Recession Rate					

1: Sorted percentile values of recession rates were used.

Table J-10. Little Shasta River Nr Montague (11516900) - Hydrology calibration: R² statistical metric for predicted vs observed volumes

Calibration Metrics for Daily Flow (07/21/2017 - 09/30/2023)	R-Squared (R ²)		
	All Seasons	Wet Season	Dry Season
All Conditions	0.27	0.26	0.38
Highest 10% of Daily Flow Rates	0.07	0.13	0.01
Lowest 50% of Daily Flow Rates	0.02	0.01	0.05
Days Categorized as Storm Flow	0.27	0.26	0.43
Days Categorized as Baseflow	0.29	0.26	0.39
Baseflow Recession Rate ¹	0.77	N/A	N/A

Calibration Metrics (07/21/2017 - 09/30/2023)	Recommended Error Criteria				Reference
	Very Good	Good	Fair	Poor	
All Conditions	>0.85	0.75 - 0.85	0.60 - 0.75	≤0.60	Moriassi et al. (2015)
Seasonal Flows	>0.75	0.60 - 0.75	0.50 - 0.60	≤0.50	
Highest 10% of Daily Flow Rates					
Lowest 50% of Daily Flow Rates					
Days Categorized as Storm Flow					
Days Categorized as Baseflow					
Baseflow Recession Rate					

1: Sorted percentile values of recession rates were used

Table J-11. Little Shasta River Nr Montague (11516900) - Hydrology calibration: Nash-Sutcliffe efficiency statistical metric for predicted vs observed flow rates

Calibration Metrics for Daily Flow (07/21/2017 - 09/30/2023)	Nash-Sutcliffe Efficiency (NSE)		
	All Seasons	Wet Season	Dry Season
All Conditions	0.09	0.0	0.22
Highest 10% of Daily Flow Rates	-1.27	-1.31	-3.3
Lowest 50% of Daily Flow Rates	-0.39	-1.26	-0.1
Days Categorized as Storm Flow	0.06	0.02	0.21
Days Categorized as Baseflow	0.1	-0.05	0.21
Baseflow Recession Rate ¹	0.42	N/A	N/A

Calibration Metrics (07/21/2017 - 09/30/2023)	Recommended Error Criteria				Reference
	Very Good	Good	Fair	Poor	
All Conditions	>0.80	0.70 - 0.80	0.50 - 0.70	≤0.50	Moriassi et al. (2015)
Seasonal Flows	>0.70	0.50 - 0.70	0.40 - 0.50	≤0.40	
Highest 10% of Daily Flow Rates					
Lowest 50% of Daily Flow Rates					
Days Categorized as Storm Flow					
Days Categorized as Baseflow					
Baseflow Recession Rate					

1: Sorted percentile values of recession rates were used

Table J-12. Little Shasta River Nr Montague (11516900) - Hydrology calibration : Performance metrics for monthly predicted vs observed flow rates

Calibration Metrics for Monthly Flow (07/21/2017 - 09/30/2023)	Hydrological Condition		
	All (n = 72)	Wet Season (n = 42)	Dry Season (n = 30)
Percent Bias (PBIAS)	44.2%	50.3%	28.6%
R-Squared (R ²)	0.59	0.57	0.76
Nash-Sutcliffe Efficiency (NSE)	0.24	0.03	0.63
RMSE-Std-Dev_Ratio (RSR ¹)	0.87	0.99	0.61

Calibration Metrics (07/21/2017 - 09/30/2023)	Recommended Error Criteria				Reference
	Very Good	Good	Fair	Poor	
PBIAS (All Conditions)	<5%	5% - 10%	10% - 15%	>15%	Based on HSPF experience by A.A. Donigian, Jr., prepared for USEPA (2000); Moriasi et al. (2015)
PBIAS (Seasonal Flows)	<10%	10% - 15%	15% - 25%	>25%	
R ² (All Conditions)	>0.85	0.75 - 0.85	0.60 - 0.75	≤0.60	
R ² (Seasonal Flows)	>0.75	0.60 - 0.75	0.50 - 0.60	≤0.50	
NSE (All Conditions)	>0.80	0.70 - 0.80	0.50 - 0.70	≤0.50	
NSE (Seasonal Flows)	>0.70	0.50 - 0.70	0.40 - 0.50	≤0.40	
RSR (All Conditions)	≤0.50	0.50 - 0.60	0.60 - 0.70	>0.70	
RSR (Seasonal Flows)	≤0.60	0.60 - 0.70	0.70 - 0.80	>0.80	

1: RSR is the ratio of the root mean square error to the standard deviation of observations