APPENDICES

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Appendix A - Agricultural Management Practices

Vermont

Areas of corn, soybeans and hay were identified using the NLCD 2006 and CDL 2008 data layers. Areas of permanent corn, permanent hay and corn/hay rotation were then identified using a set of rules, which are presented below.

Table A-1. Procedure to determine permanent corn, permanent hay and corn/hay rotations in the Lake Champlain basin (Missisquoi CSA SWAT model methodology)

Crop type	Slope	Drainage class	HEL class	Soil phase	Soil texture	Bedrock depth
Permanent Corn	≤ 3%	Well drained	not HEL	Not stony	Sandy, loamy	
Permanent Hay	> 12%	Poorly drained		Stony		Shallow

Drainage class, HEL class, soil phase, soil texture and bedrock depth criteria were derived from the VTTop20 soil layer. Areas under permanent corn and corn/hay rotation differed in agricultural practices if the soil type was deemed clayey. Soils falling under drainage class D were assumed clayey for the SWAT model. Agricultural practices adopted for permanent corn, permanent hay and corn/hay rotation are provided below.

Table A-2. Agricultural practices for permanent corn crop

Permanent Corn on poorly drained soils	Permanent Corn on moderate/well-drained soils
5/10 - Tillage (disk plow) 5/15 - Fertilizer application (40 lbs/ac of nitrogen) 5/15 - Fertilizer application (40 lbs/ac of P_2O_5) 5/15 - Begin plant growing season 7/10 - Fertilizer application (95 lbs/ac of nitrogen) 10/1 - Harvest and kill 10/10 - Fertilizer application (8000 gals/ac of liquid dairy manure) (64 lb/ac N, 64 lb/ac P_2O_5) 10/15 - Tillage (chisel plow)(moldboard plow)	5/1 - Fertilizer application (6000 gals/ac of liquid dairy manure) (96 lb/ac N, 48 lb/ac P_2O_5) 5/5 - Tillage (chisel plow) 5/10 - Tillage (disk plow) 5/15 - Fertilizer application (40 lbs/ac of nitrogen) 5/15 - Fertilizer application (40 lbs/ac of P_2O_5) 5/15 - Begin plant growing season 7/10 - Fertilizer application (140 lbs/ac of nitrogen) 10/1 - Harvest and kill 10/2 - Fertilizer application (3000 gals/ac of liquid dairy manure) (24 lb/ac N, 24 lb/ac P_2O_5) 10/15 - plant cover crop

Table A-3. Agricultural practices for permanent hay crop

Permanent Hay on poorly drained soils	Permanent Hay on moderate/well-drained soils
5/1 - Begin plant growing season 5/2 - Fertilizer Application (60 lbs/ac nitrogen) 6/1 - Harvest 7/15 - Harvest 7/16 - Fertilizer application (3000 gals/ac of liquid dairy manure) (48 lb/ac N, 24 lb/ac P_2O_5) 8/30 - Harvest 9/1 - Fertilizer application (3000 gals/ac of liquid dairy manure) (24 lb/ac N, 24 lb/ac P_2O_5)	5/1 - Begin plant growing season 5/2 - Fertilizer Application (90 lbs/ac nitrogen) 6/1 - Harvest 6/2 - Fertilizer application (4000 gals/ac of liquid dairy manure) (64 lb/ac N, 32 lb/ac P_2O_5) 7/15 - Harvest 7/16 - Fertilizer application (4000 gals/ac of liquid dairy manure) (64 lb/ac N, 32 lb/ac P_2O_5) 7/17 - Fertilizer Application (90 lbs/ac nitrogen) 8/30 - Harvest

Table A-4. Agricultural practices for corn/hay rotation

Corn/Hay on poorly-drained soils (2 years corn followed by 4 years hay)	Corn/Hay on moderate/well-drained soils (4 years corn followed by 4 years hay)
Corn 5/10 - Tillage (disk plow) 5/15 - Fertilizer application (40 lbs/ac of nitrogen) 5/15 - Fertilizer application (40 lbs/ac of P_2O_5) 5/15 - Begin plant growing season 7/10 - Fertilizer application (95 lbs/ac of nitrogen) 10/1 - Harvest and kill 10/10 - Fertilizer application (8000 gals/ac of liquid dairy manure) (64 lb/ac N, 64 lb/ac P_2O_5) 10/15 - Tillage (chisel plow) **Hay** 5/1 - Begin plant growing season 5/2 - Fertilizer Application (60 lbs/ac nitrogen) manure) 6/1 - Harvest 7/15 - Harvest 7/16 - Fertilizer application (3000 gals/ac of liquid dairy manure) (48 lb/ac N, 24 lb/ac P_2O_5) 8/30 - Harvest 9/1 - Fertilizer application (3000 gals/ac of liquid dairy manure) (24 lb/ac N, 24 lb/ac P_2O_5)	**Corn** 5/1 - Fertilizer application (6000 gals/ac of liquid dairy manure) (64 lb/ac N, 32 lb/ac P_2O_5) 5/5 - Tillage (chisel plow) 5/10 - Tillage (disk plow) 5/15 - Fertilizer application (40 lbs/ac of nitrogen) 5/15 - Fertilizer application (40 lbs/ac of P_2O_5) 5/15 - Begin plant growing season 7/10 - Fertilizer application (140 lbs/ac of nitrogen) 10/1 - Harvest and kill 10/2 - Fertilizer application (3000 gals/ac of liquid dairy manure) (24 lb/ac N, 24 lb/ac P_2O_5) 10/15 - plant cover crop **Hay** 5/1 - Begin plant growing season 5/2 - Fertilizer Application (90 lbs/ac nitrogen) 6/1 - Harvest 6/2 - Fertilizer application (4000 gals/ac of liquid dairy manure) (64 lb/ac N, 32 lb/ac P_2O_5) 7/15 - Harvest 7/16 - Fertilizer application (4000 gals/ac of liquid dairy manure) (64 lb/ac N, 32 lb/ac P_2O_5) 8/30 - Harvest

New York

Areas of corn, soybeans and hay were identified using the NLCD 2006 and CDL 2008 data layers. Further breakdown of corn and hay land to corn/hay rotations was not carried out. Data pertaining to agricultural practices obtained from the New York Agricultural Extension Service were very similar to those developed for Vermont for lands under corn and hay crops. As a result, the agricultural management data developed for corn and hay were directly adopted (Table A-2 and Table A-3).

Appendix B - NPDES Facility Representation

Vermont

Table B-1. Vermont Wastewater discharges in the Lake Champlain Basin, Model Representation (SWAT or Bathtub) and HUC12 location

Facility	Model	HUC12	Watershed	Segment
Agrimark[a]	-	-	-	-
Alburg	BATHTUB	04081604	Lake Champlain	Isle La Motte
Barre City	SWAT	04030103	Winooski River	Main Lake
Benson	SWAT	04010306	Poultney River	South Lake B
Brandon	SWAT	04020303	Otter Creek	Otter Creek
Brown Ledge Camp	BATHTUB	04080902	Lake Champlain	Malletts Bay
Burlington East	SWAT	04030704	Winooski River	Main Lake
Burlington Electric	SWAT	04030704	Winooski River	Main Lake
Burlington Main[b]	BATHTUB	04081604	Lake Champlain	Burlington Bay
Burlington North	BATHTUB	04081604	Lake Champlain	Burlington Bay
Cabot	SWAT	04030201	Winooski River	Main Lake
Castleton	SWAT	04010304	Poultney River	South Lake B
Enosburg Falls	SWAT	04070402	Missisquoi River	Missisquoi Bay
Essex Junction	SWAT	04030704	Winooski River	Main Lake
Fair Haven	SWAT	04010304	Poultney River	South Lake B
Fairfax	SWAT	04050306	Lamoille River	Malletts Bay
Hardwick	SWAT	04050104	Lamoille River	Malletts Bay
Hinesburg	SWAT	04080801	LaPlatte River	Shelburne Bay
IBM	SWAT	04030704	Winooski River	Main Lake
Jeffersonville	SWAT	04050303	Lamoille River	Malletts Bay
Johnson	SWAT	04050301	Lamoille River	Malletts Bay
Marshfield	SWAT	04030202	Winooski River	Main Lake
Middlebury	SWAT	04020307	Otter Creek	Otter Creek
Milton	SWAT	04050306	Lamoille River	Malletts Bay
Montpelier	SWAT	04030402	Winooski River	Main Lake
Morrisville	SWAT	04050106	Lamoille River	Malletts Bay
Newport Center	SWAT	04070104	Missisquoi River	Missisquoi Bay
North Troy	SWAT	04070105	Missisquoi River	Missisquoi Bay
Northfield	SWAT	04030402	Winooski River	Main Lake
Northwest State Correctional	BATHTUB	04081201	Lake Champlain	St. Albans Bay
Orwell	BATHTUB	04080301	Lake Champlain	South Lake A
Otter Valley Union High School	SWAT	04020302	Otter Creek	Otter Creek
Pittsford	SWAT	04020301	Otter Creek	Otter Creek
Pittsford Fish Hatchery	SWAT	04020107	Otter Creek	Otter Creek
Plainfield	SWAT	04030202	Winooski River	Main Lake
Poultney	SWAT	04010302	Poultney River	South Lake B
Proctor	SWAT	04020109	Otter Creek	Otter Creek
Richford	SWAT	04070204	Missisquoi River	Missisquoi Bay
Richmond	SWAT	04030702	Winooski River	Main Lake
Rock Tenn	SWAT	04010304	Missisquoi River	Missisquoi Bay

Facility	Model	HUC12	Watershed	Segment
Rutland City	SWAT	04020109	Otter Creek	Otter Creek
Salisbury Fish Hatchery	SWAT	04020306	Otter Creek	Otter Creek
Shelburne #1	BATHTUB	04080802	Lake Champlain	Shelburne Bay
Shelburne #2	BATHTUB	04080801	Lake Champlain	Shelburne Bay
Sheldon Springs	SWAT	04070601	Missisquoi River	Missisquoi Bay
Shoreham	SWAT	04020402	Otter Creek	Otter Creek
South Burlington Airport Parkway	SWAT	04030704	Winooski River	Main Lake
South Burlington Bartlett's Bay	BATHTUB	04080802	Lake Champlain	Shelburne Bay
St. Albans City	BATHTUB	04081201	Lake Champlain	St. Albans Bay
Stowe	SWAT	04030602	Winooski River	Main Lake
Swanton	BATHTUB	04081102	Lake Champlain	Missisquoi Bay
Troy/Jay	SWAT	04070105	Missisquoi River	Missisquoi Bay
Vergennes	BATHTUB	04020501	Lake Champlain	Otter Creek
Wallingford	SWAT	04020103	Otter Creek	Otter Creek
Waterbury	SWAT	04030601	Winooski River	Main Lake
Weed Fish Culture Station	BATHTUB	04081604	Lake Champlain	Main Lake
West Pawlet	SWAT	04010203	Mettawee River	South Lake B
West Rutland	SWAT	04020108	Otter Creek	Otter Creek
Williamstown	SWAT	04030101	Winooski River	Main Lake
Winooski	SWAT	04030704	Winooski River	Main Lake
Wyeth (PBM Nutritionals)	SWAT	04050306	Lamoille River	Malletts Bay

a. No discharge after 1991

b. The Burlington CSO was explicitly represented as draining into the Burlington Bay in the BATHTUB model.

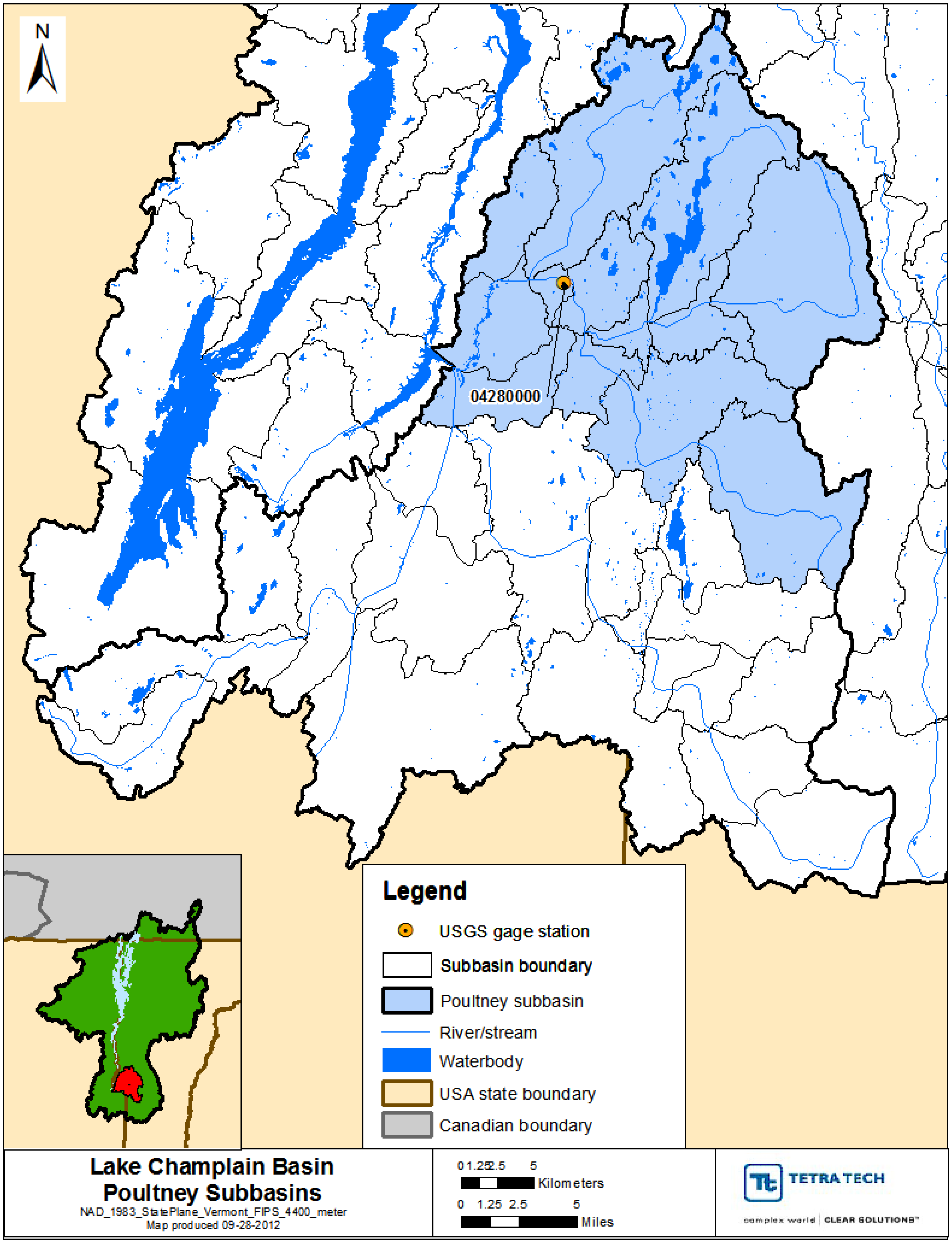
New York

Table B-2. New York Wastewater discharges in the Lake Champlain Basin, Model Representation (SWAT or Bathtub) and HUC12 location

Facility	Model	HUC12	Watershed	Segment
Adirondack Fish Hatchery	SWAT	04060102	Saranac River	Cumberland Bay
Altona Correctional	SWAT	04081504	Great Chazy River	Isle LaMotte
Au Sable Forks	SWAT	04040301	Ausable River	Main Lake
Cadyville	SWAT	04060503	Saranac River	Cumberland Bay
Champlain	SWAT	04081507	Great Chazy River	Isle LaMotte
Champlain Park	BATHTUB	04081604	Lake Champlain	Cumberland Bay
Chazy	SWAT	04081603	Little Chazy River	Isle LaMotte
Crown Point	BATHTUB	04080304	Lake Champlain	South Lake A
Dannemora	SWAT	04060502	Saranac River	Cumberland Bay
Fort Ann	SWAT	04010103	Mettawee River	South Lake B
Granville	SWAT	04010203	Mettawee River	South Lake B
Great Meadows Correctional	SWAT	04010105	Mettawee River	South Lake B
International Paper	BATHTUB	04080304	Lake Champlain	South Lake A
Keeseville	SWAT	04040302	Ausable River	Main Lake
Lake Placid	SWAT	04040201	Ausable River	Main Lake
Peru	SWAT	04081302	Little Ausable River	Main Lake
Peru/Valcour	BATHTUB	04081604	Lake Champlain	Main Lake
Plattsburgh	BATHTUB	04081604	Lake Champlain	Cumberland Bay
Port Henry	BATHTUB	04080303	Lake Champlain	Port Henry
Rouses Point	BATHTUB	04081604	Lake Champlain	Isle LaMotte

Facility	Model	HUC12	Watershed	Segment
Saranac Lake	SWAT	04060203	Saranac River	Cumberland Bay
St Armand	SWAT	04060202	Saranac River	Cumberland Bay
Ticonderoga	BATHTUB	04080206	Lake Champlain	South Lake A
Wadhams	SWAT	04080707	Boquet River	Main Lake
Washington Correctional	SWAT	04010105	Mettawee River	South Lake B
Westport	BATHTUB	04080602	Lake Champlain	Port Henry
Whitehall	SWAT	04010307	Mettawee River	South Lake B
Willsboro	SWAT	04080707	Boquet River	Main Lake
Wyeth Research	BATHTUB	04081604	Lake Champlain	Isle LaMotte

Appendix C - Poultney River Watershed



USGS 04280000 Poultney River below Fair Haven, VT - Calibration

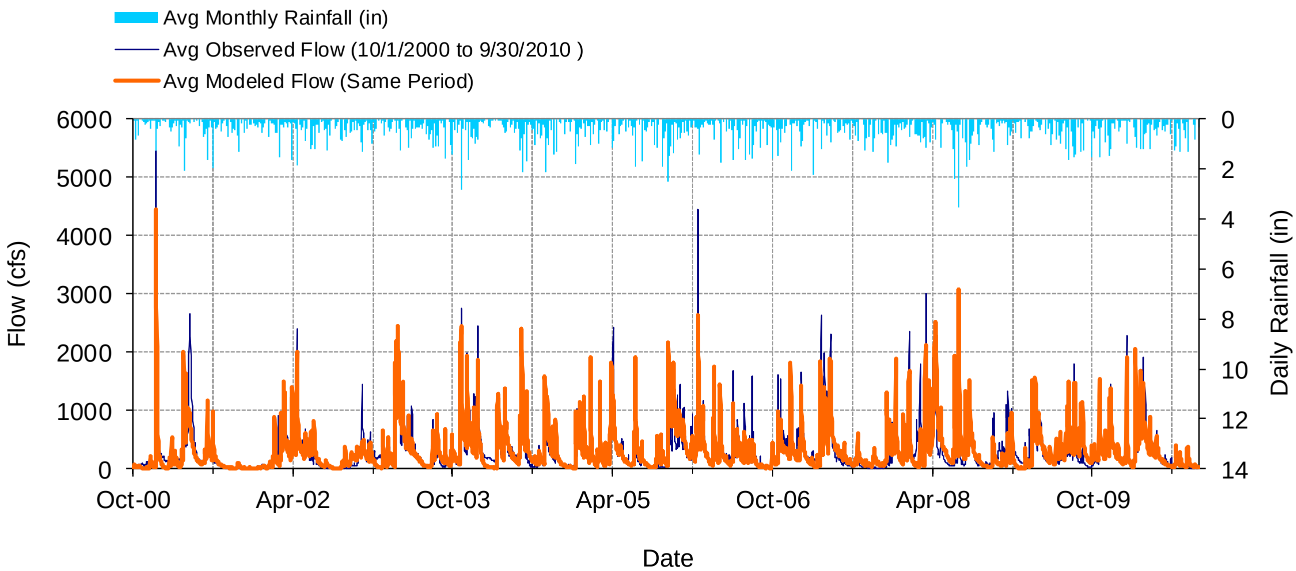


Figure C-1. Mean daily flow at USGS 04280000 Poultney River below Fair Haven, VT

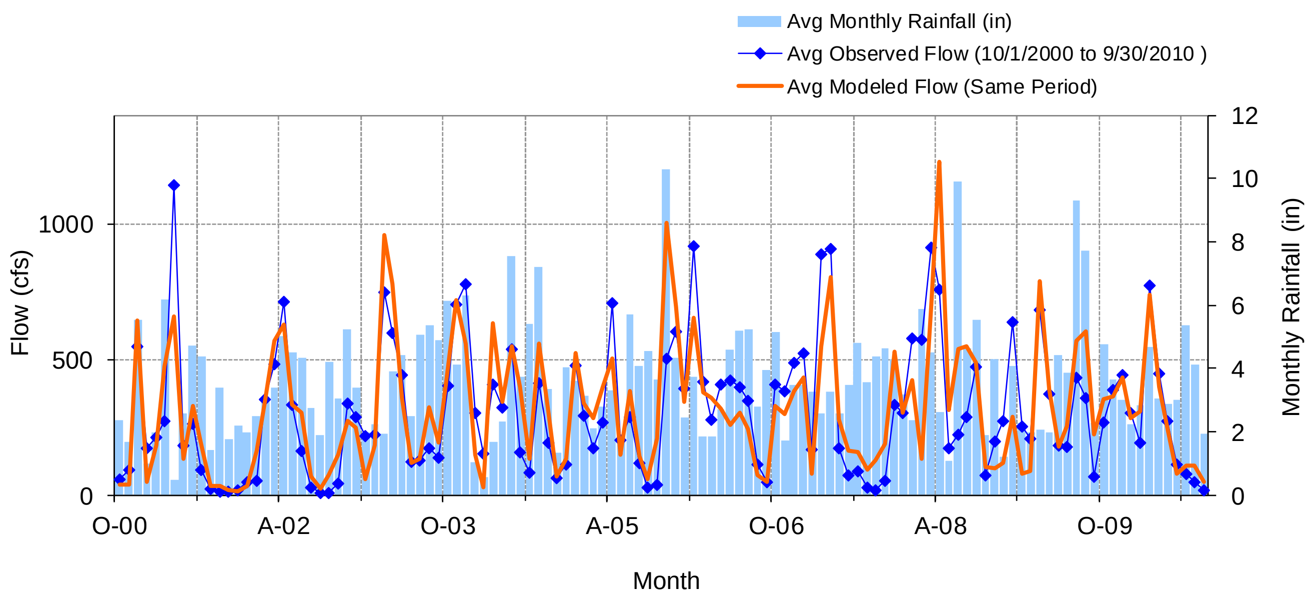


Figure C-2. Mean monthly flow at USGS 04280000 Poultney River below Fair Haven, VT

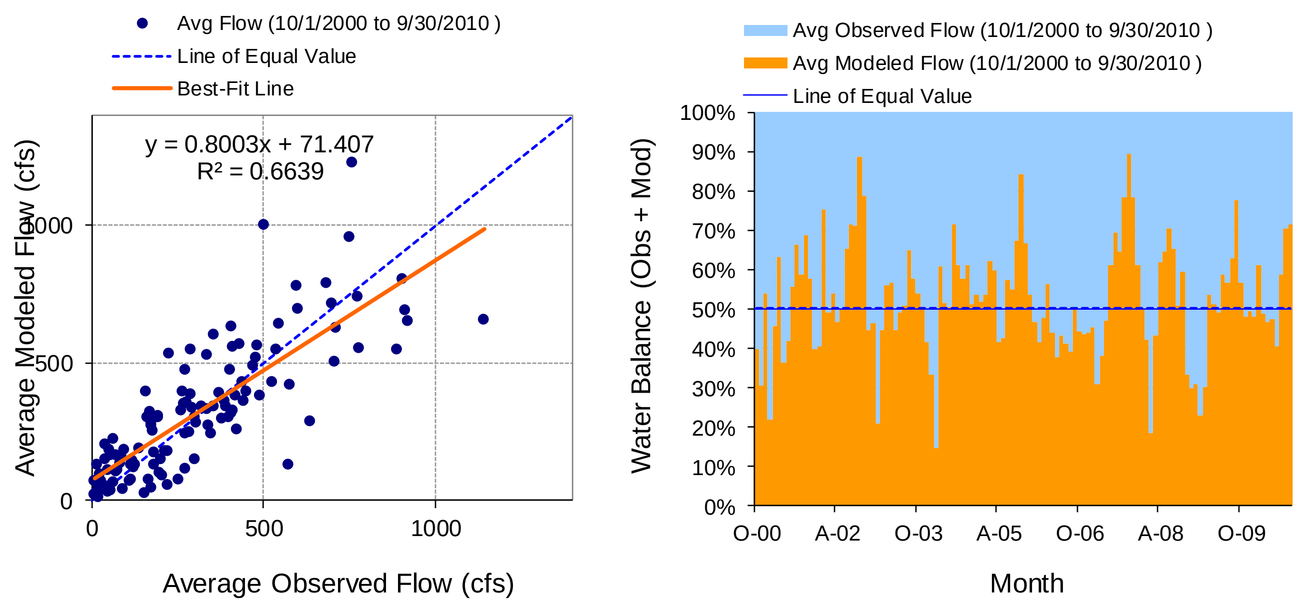


Figure C-3. Monthly flow regression and temporal variation at USGS 04280000 Poultney River below Fair Haven, VT

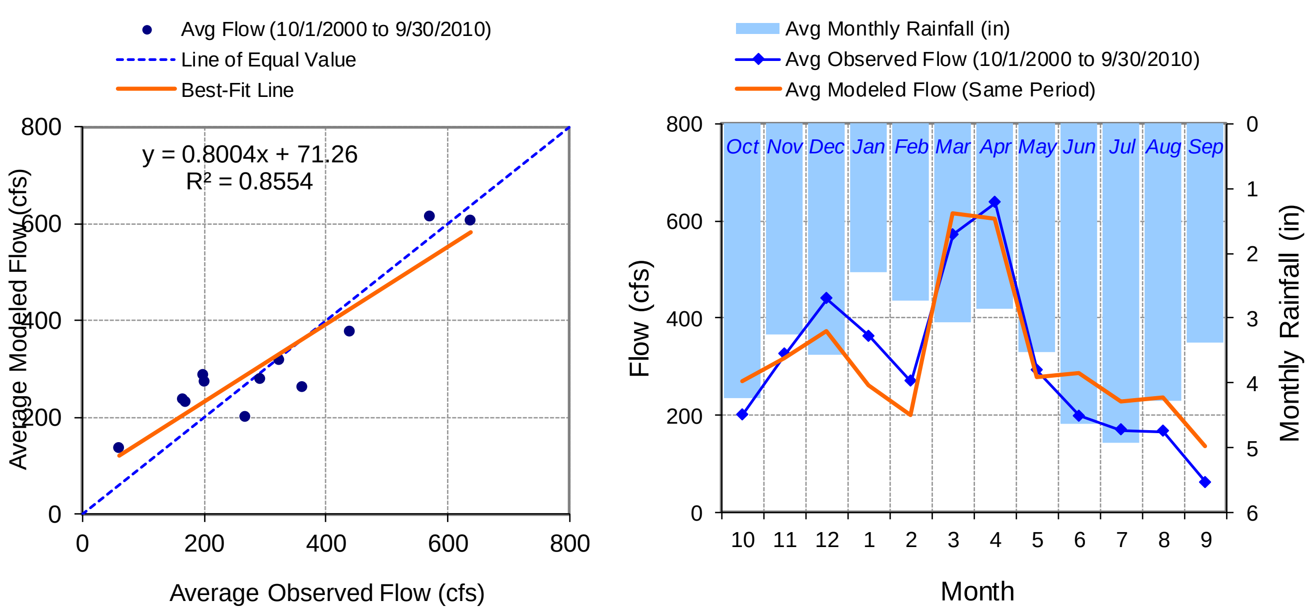


Figure C-4. Seasonal regression and temporal aggregate at USGS 04280000 Poultney River below Fair Haven, VT

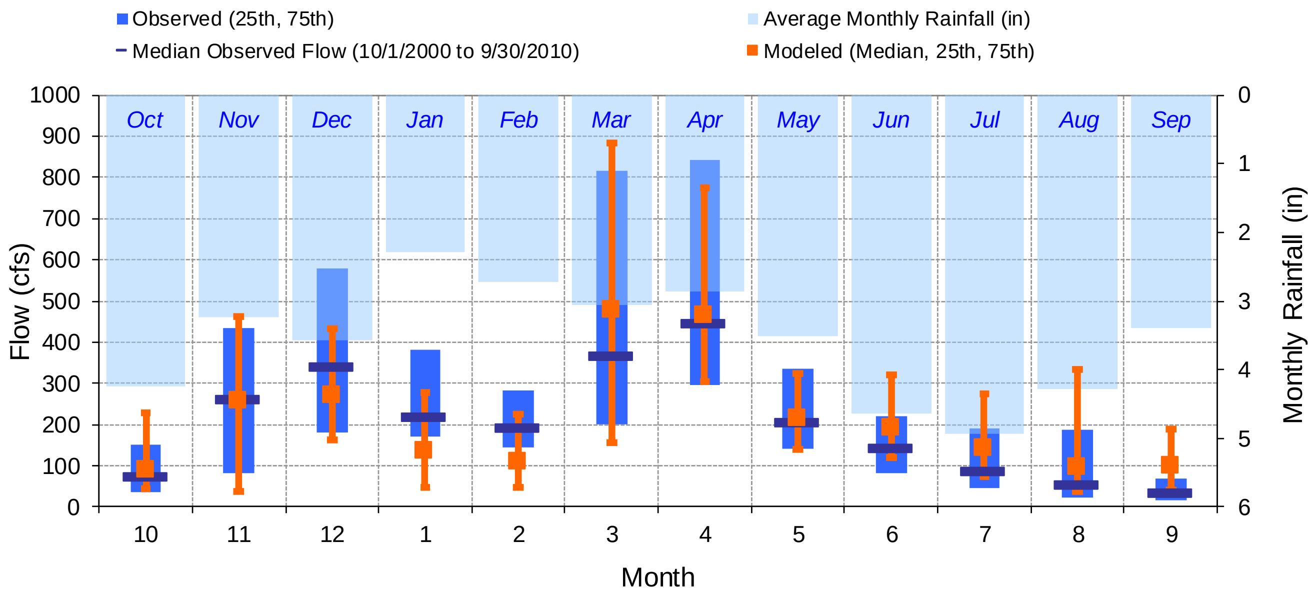


Figure C-5. Seasonal medians and ranges at USGS 04280000 Poultney River below Fair Haven, VT

Table C-1. Seasonal summary at USGS 04280000 Poultney River below Fair Haven, VT

MONTH	OBSERVED FLOW (CFS)				MODELED FLOW (CFS)			
	MEAN	MEDIAN	25TH	75TH	MEAN	MEDIAN	25TH	75TH
Oct	200.72	72.50	35.00	151.50	270.97	90.05	44.96	229.10
Nov	324.34	263.00	81.00	433.00	317.40	257.48	37.27	463.24
Dec	439.82	341.00	180.00	579.25	374.34	272.36	163.50	432.16
Jan	362.04	219.00	171.75	382.25	262.10	134.87	48.85	277.21
Feb	268.80	193.00	145.00	283.00	199.00	109.92	48.95	226.43
Mar	571.68	365.50	201.25	816.75	614.81	479.57	154.81	884.63
Apr	637.69	447.00	294.75	841.25	604.47	467.21	304.24	773.83
May	291.81	207.00	141.00	335.50	278.47	216.66	139.18	323.67
Jun	197.94	143.00	83.00	220.25	286.31	191.05	119.11	320.47
Jul	168.60	85.50	46.00	189.75	229.28	141.66	73.10	274.09
Aug	165.53	52.50	24.00	186.00	236.01	97.43	38.93	332.66
Sep	61.47	33.00	16.00	70.25	135.83	100.21	41.02	190.21

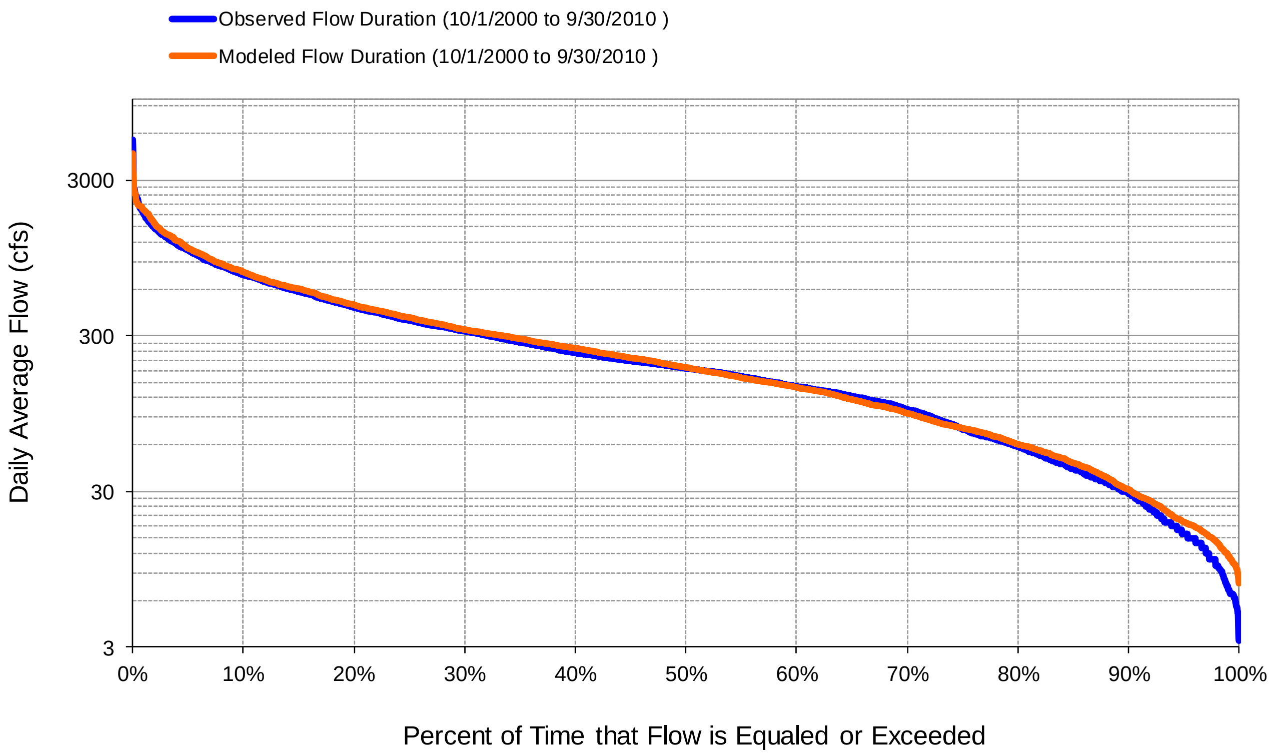


Figure C-6. Flow exceedence at USGS 04280000 Poultney River below Fair Haven, VT

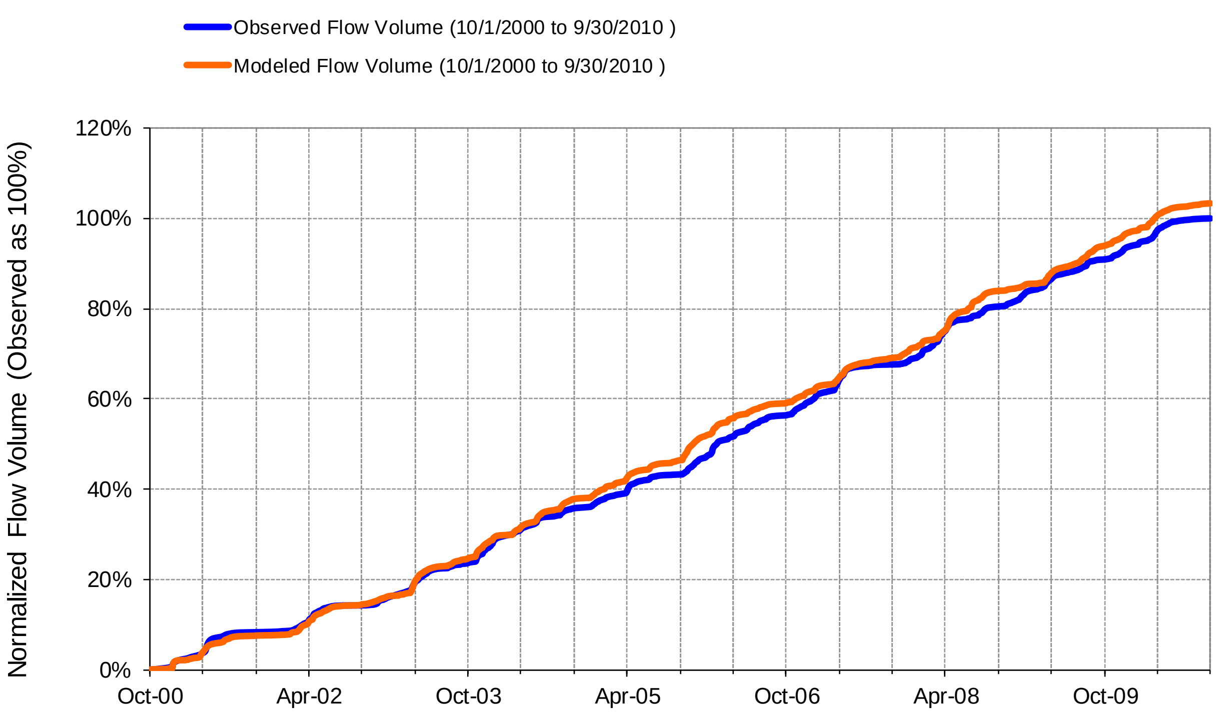


Figure C-7. Flow accumulation at USGS 04280000 Poultney River below Fair Haven, VT

Table C-2. Summary statistics at USGS 04280000 Poultney River below Fair Haven, VT

SWAT Simulated Flow		Observed Flow Gage	
REACH OUTFLOW FROM OUTLET 5 10-Year Analysis Period: 10/1/2000 - 9/30/2010 Flow volumes are (inches/year) for upstream drainage area		USGS 04280000 POULTNEY RIVER BELOW FAIR HAVEN, VT Hydrologic Unit Code: 2010001 Latitude: 43.6242324 Longitude: -73.3115011 Drainage Area (sq-mi): 187	
Total Simulated In-stream Flow:	**23.11**	Total Observed In-stream Flow:	**22.36**
Total of simulated highest 10% flows:	**9.12**	Total of Observed highest 10% flows:	**8.79**
Total of Simulated lowest 50% flows:	**3.08**	Total of Observed Lowest 50% flows:	**3.08**
Simulated Summer Flow Volume (months 7-9):	**3.68**	Observed Summer Flow Volume (7-9):	**2.43**
Simulated Fall Flow Volume (months 10-12):	**5.87**	Observed Fall Flow Volume (10-12):	**5.89**
Simulated Winter Flow Volume (months 1-3):	**6.52**	Observed Winter Flow Volume (1-3):	**7.27**
Simulated Spring Flow Volume (months 4-6):	**7.03**	Observed Spring Flow Volume (4-6):	**6.79**
Total Simulated Storm Volume:	**6.69**	Total Observed Storm Volume:	**5.92**
Simulated Summer Storm Volume (7-9):	**1.09**	Observed Summer Storm Volume (7-9):	**0.81**

Errors (Simulated-Observed)	*Error Statistics*	*Recommended Criteria*		
Error in total volume:	3.33	10		
Error in 50% lowest flows:	-0.23	10		
Error in 10% highest flows:	3.84	15		
Seasonal volume error - Summer:	51.60	30		
Seasonal volume error - Fall:	-0.21	>> 30		Clear
Seasonal volume error - Winter:	-10.21	30		
Seasonal volume error - Spring:	3.64	30		
Error in storm volumes:	13.02	20		
Error in summer storm volumes:	34.05	50		
Nash-Sutcliffe Coefficient of Efficiency, E:	0.525	Model accuracy increases		
Baseline adjusted coefficient (Garrick), E':	0.413	as E or E' approaches 1.0		
Monthly NSE	0.634			

USGS 04280000 Poultney River below Fair Haven, VT - Validation

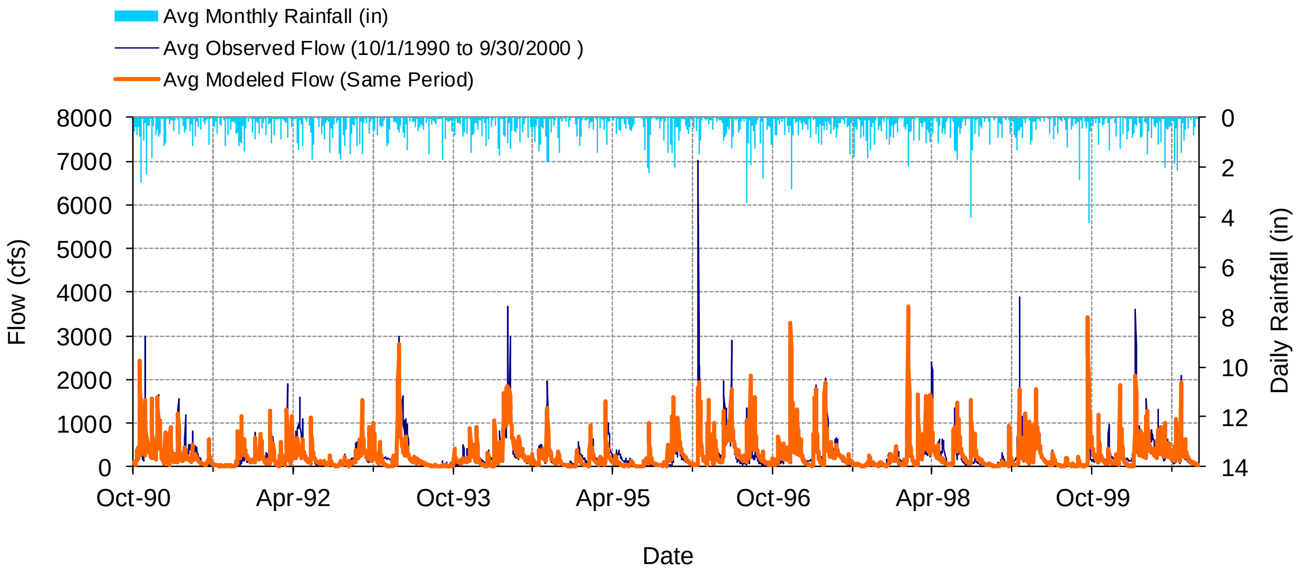


Figure C-8. Mean daily flow at USGS 04280000 Poultney River below Fair Haven, VT

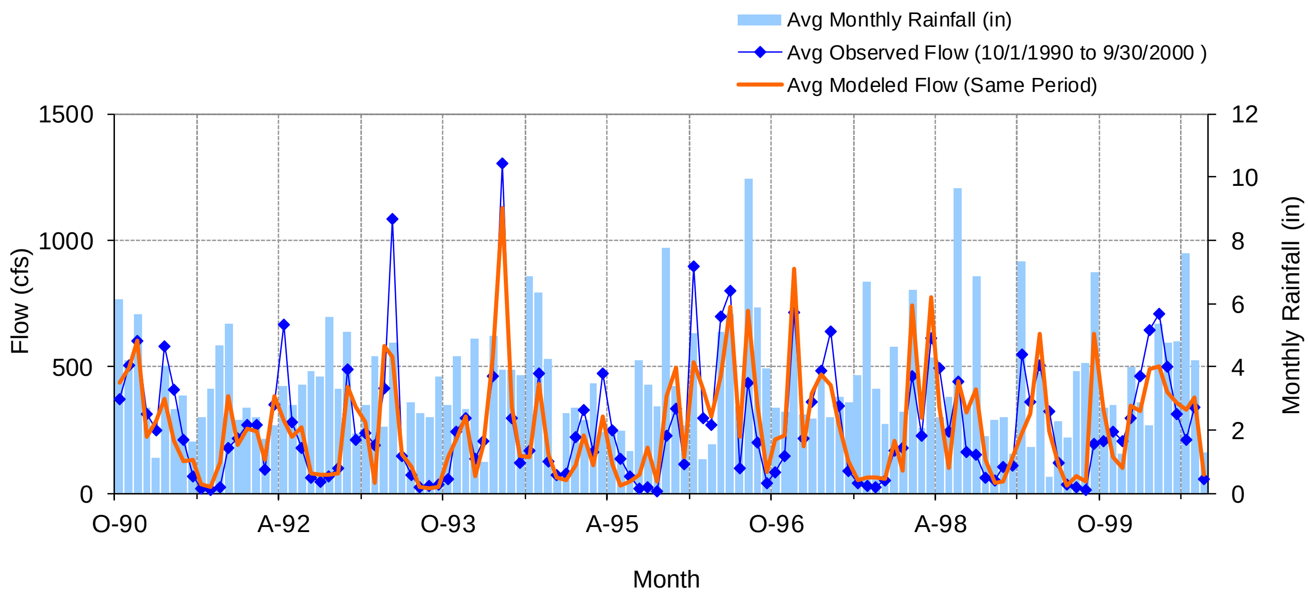
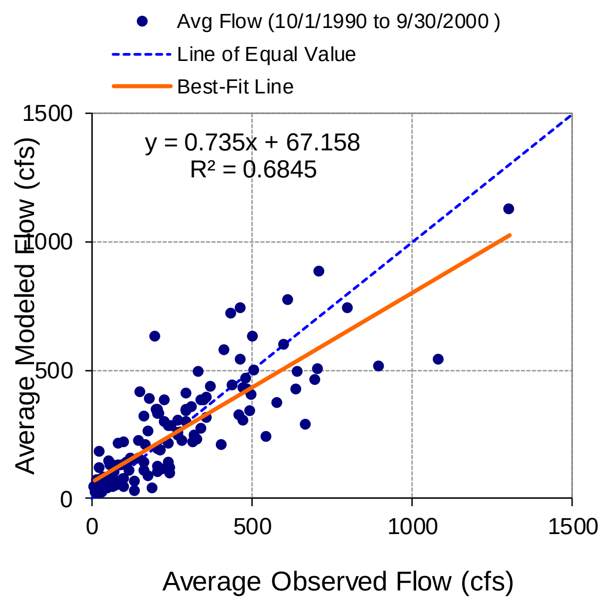


Figure C-9. Mean monthly flow at USGS 04280000 Poultney River below Fair Haven, VT



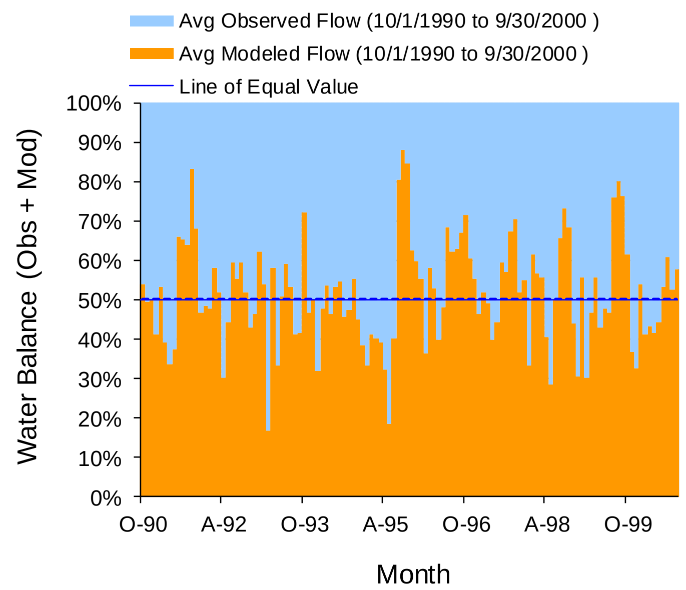
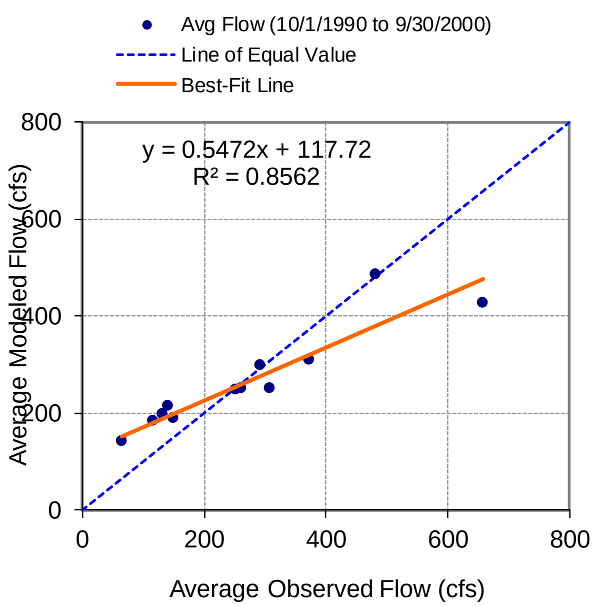


Figure C-10. Monthly flow regression and temporal variation at USGS 04280000 Poultney River below Fair Haven, VT



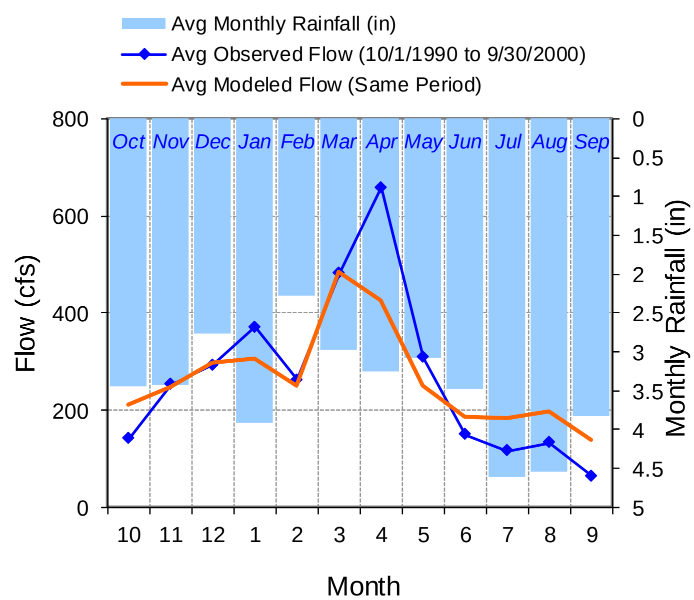


Figure C-11. Seasonal regression and temporal aggregate at USGS 04280000 Poultney River below Fair Haven, VT

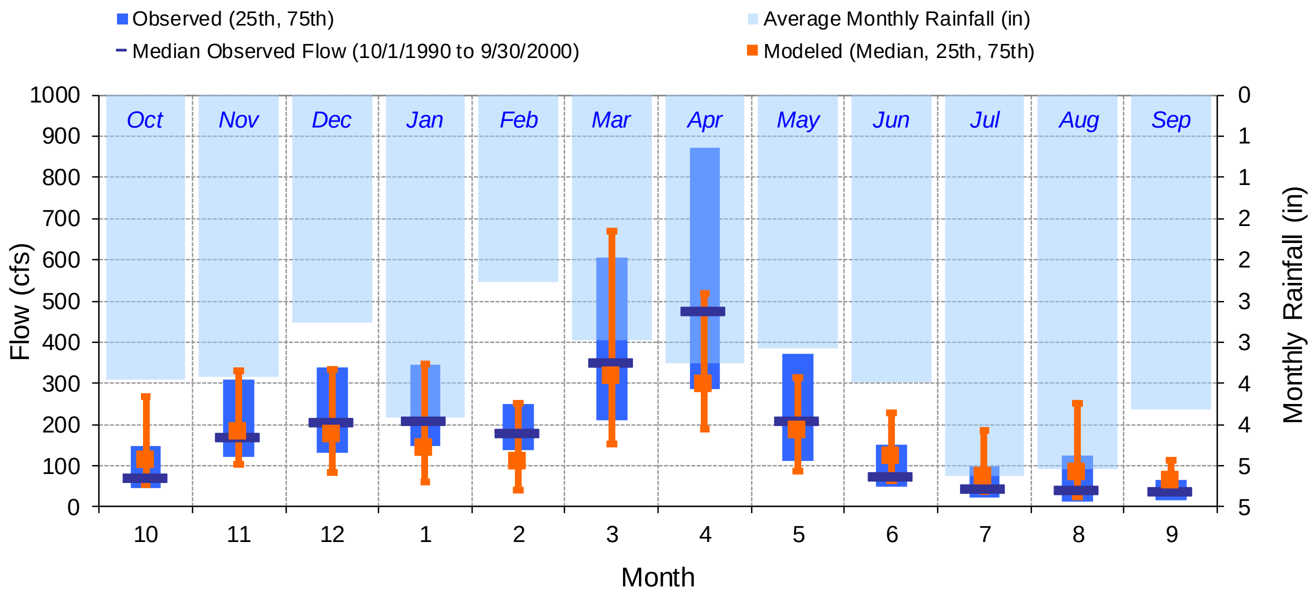


Figure C-12. Seasonal medians and ranges at USGS 04280000 Poultney River below Fair Haven, VT

Table C-3. Seasonal summary at USGS 04280000 Poultney River below Fair Haven, VT

MONTH	OBSERVED FLOW (CFS)				MODELED FLOW (CFS)			
	MEAN	MEDIAN	25TH	75TH	MEAN	MEDIAN	25TH	75TH
Oct	141.02	72.00	45.00	148.50	212.29	112.99	54.04	269.55
Nov	252.89	169.00	123.00	308.00	248.15	183.83	103.88	330.88
Dec	293.01	205.50	130.25	337.75	296.76	175.37	83.19	334.17
Jan	371.67	210.00	149.25	344.75	307.29	144.28	62.20	346.68
Feb	262.03	178.00	139.50	250.50	249.49	110.01	39.82	253.15
Mar	481.31	350.00	210.00	605.00	484.70	317.23	152.50	668.95
Apr	657.71	475.50	287.75	871.50	424.92	296.33	190.50	518.42
May	308.51	209.50	112.25	372.00	249.53	185.21	87.25	314.18
Jun	148.73	75.00	49.00	152.00	186.65	123.32	64.26	227.18
Jul	116.15	43.00	22.00	99.00	183.69	75.13	36.41	185.26
Aug	132.66	41.00	13.00	123.75	196.65	82.99	25.53	250.45
Sep	64.11	39.00	17.75	65.00	139.79	63.97	35.26	114.56

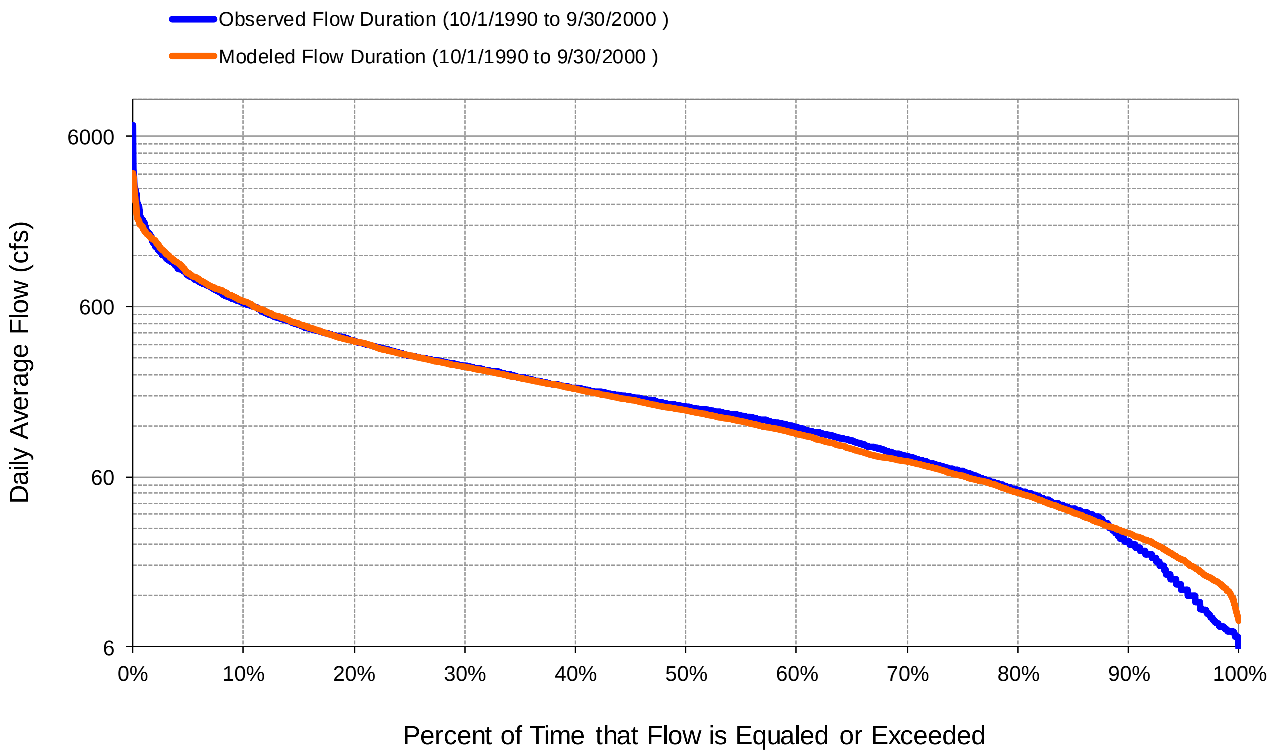


Figure C-13. Flow exceedence at USGS 04280000 Poultney River below Fair Haven, VT

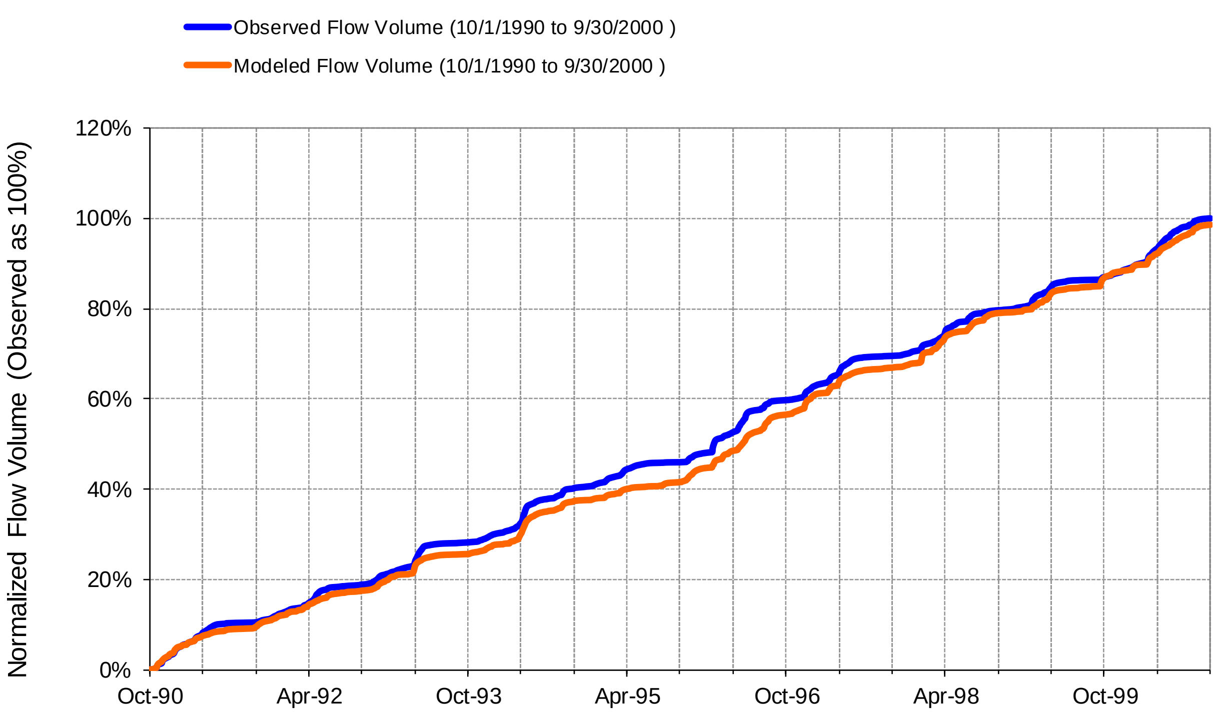


Figure C-14. Flow accumulation at USGS 04280000 Poultney River below Fair Haven, VT

Table C-4. Summary statistics at USGS 04280000 Poultney River below Fair Haven, VT

SWAT Simulated Flow		Observed Flow Gage	
REACH OUTFLOW FROM OUTLET 5 10-Year Analysis Period: 10/1/1990 - 9/30/2000 Flow volumes are (inches/year) for upstream drainage area		USGS 04280000 POULTNEY RIVER BELOW FAIR HAVEN, VT Hydrologic Unit Code: 4150401 Latitude: 43.6242324 Longitude: -73.3115011 Drainage Area (sq-mi): 187	
Total Simulated In-stream Flow:	**19.27**	Total Observed In-stream Flow:	**19.55**
Total of simulated highest 10% flows:	**8.13**	Total of Observed highest 10% flows:	**8.23**
Total of Simulated lowest 50% flows:	**2.42**	Total of Observed Lowest 50% flows:	**2.55**
Simulated Summer Flow Volume (months 7-9):	**3.18**	Observed Summer Flow Volume (7-9):	**1.92**
Simulated Fall Flow Volume (months 10-12):	**4.62**	Observed Fall Flow Volume (10-12):	**4.18**
Simulated Winter Flow Volume (months 1-3):	**6.29**	Observed Winter Flow Volume (1-3):	**6.73**
Simulated Spring Flow Volume (months 4-6):	**5.19**	Observed Spring Flow Volume (4-6):	**6.71**
Total Simulated Storm Volume:	**5.72**	Total Observed Storm Volume:	**5.33**
Simulated Summer Storm Volume (7-9):	**0.98**	Observed Summer Storm Volume (7-9):	**0.70**
Errors (Simulated-Observed)	*Error Statistics*	*Recommended Criteria*	
Error in total volume:	-1.41	10	
Error in 50% lowest flows:	-4.97	10	
Error in 10% highest flows:	-1.24	15	
Seasonal volume error - Summer:	65.87	30	
Seasonal volume error - Fall:	10.38	>> 30	Clear
Seasonal volume error - Winter:	-6.63	30	
Seasonal volume error - Spring:	-22.74	30	
Error in storm volumes:	7.25	20	
Error in summer storm volumes:	39.05	50	
Nash-Sutcliffe Coefficient of Efficiency, E:	0.500	Model accuracy increases	
Baseline adjusted coefficient (Garrick), E':	0.392	as E or E' approaches 1.0	
Monthly NSE	0.680		

TSS and TP distribution by channel and upland sources

Table C-5. TSS and TP distribution by source categories

Source	TSS		TP	
	Load(mt/year)	Percentage (%)	Load (kg/year)	Percentage (%)
Upland	29,042	82.1	28,481	80.7
Stream	6,353	17.9	6,829	19.3
Total	**35,395**	**100.0**	**35,310**	**100.0**

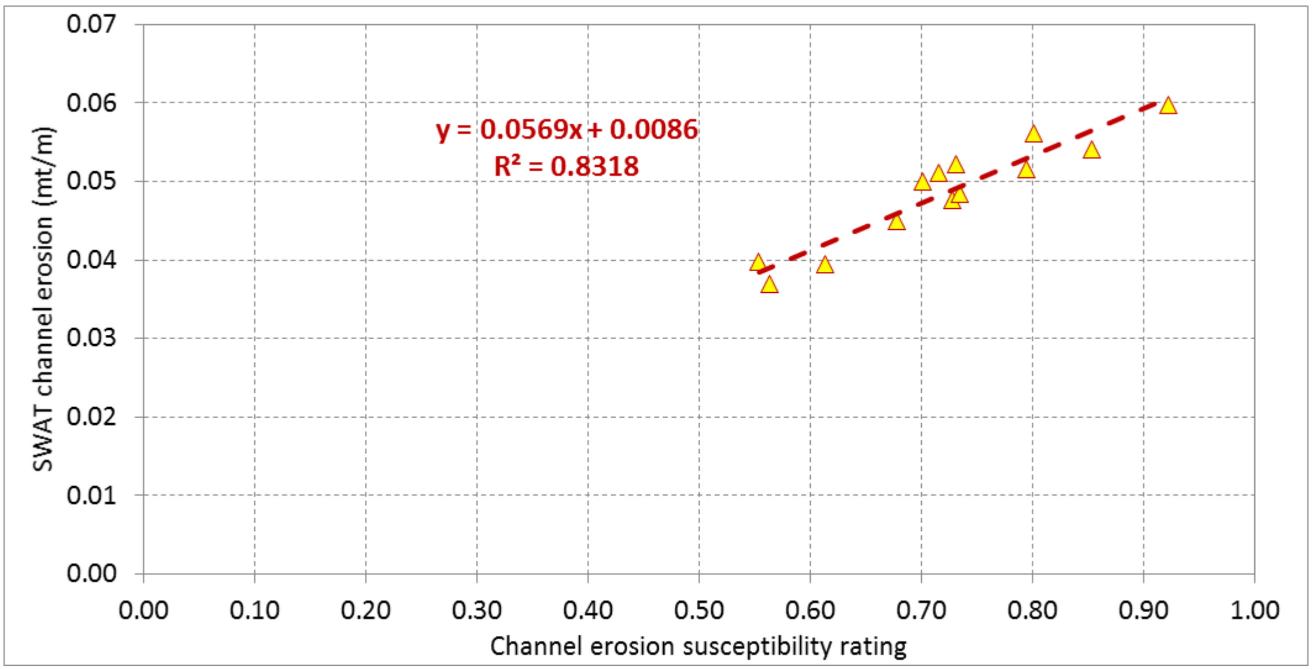


Figure C-15. SWAT simulated channel erosion relative to channel erosion susceptibility rating

TP distribution by landuse from upland sources

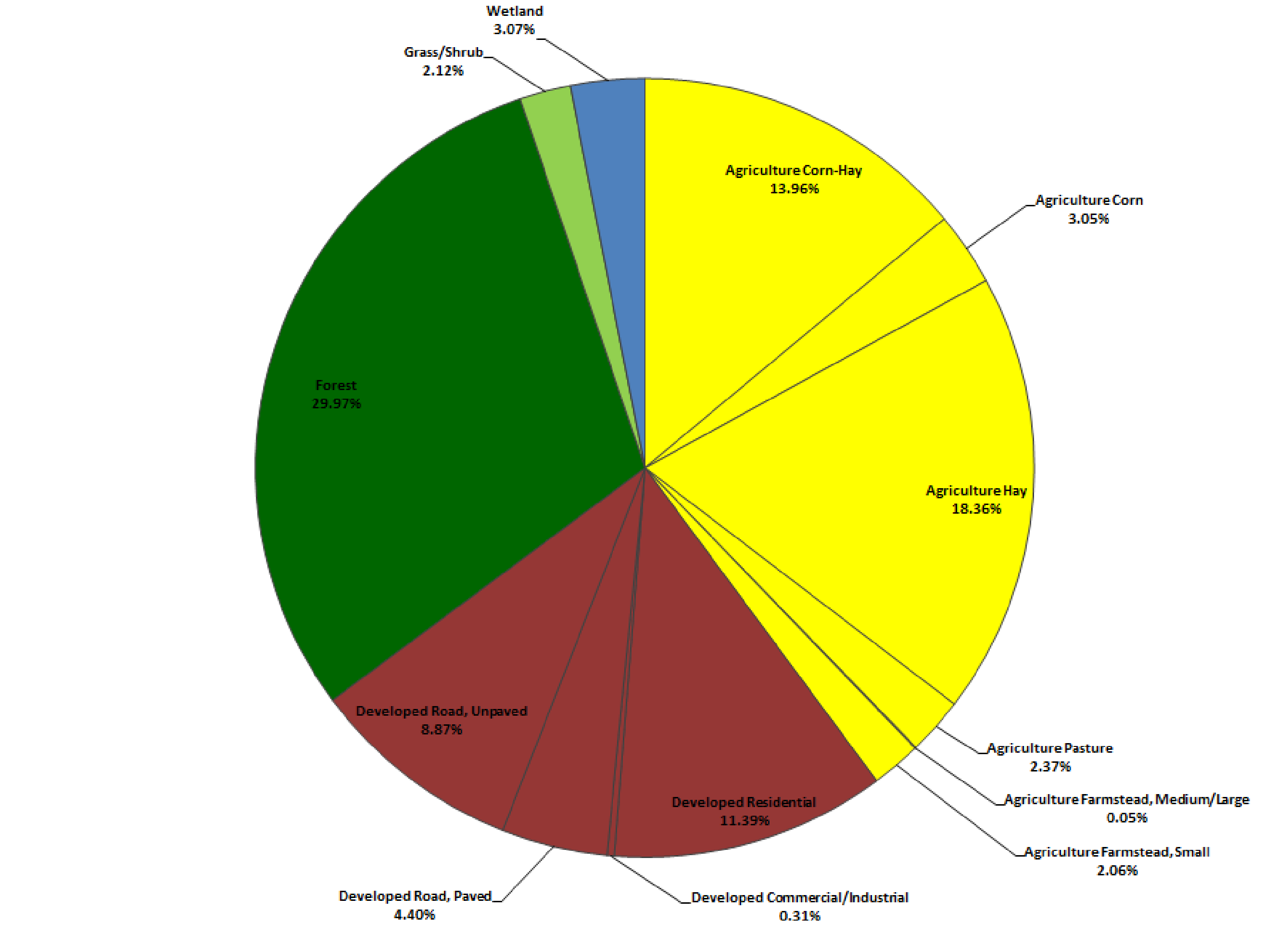


Figure C-16. Distribution of simulated total upland TP loads by landuse categories

Table C-6. TP export rates (kg/ha/yr) by landuse categories for the 30 year simulation period

Landuse	Classification	Area (ha)	Area (%)	Mean	Min	Q_{25}	Q_{50}	Q_{75}	Max
Agriculture	Corn-Hay	2,010	2.86	**1.98**	0.07	1.21	1.93	2.83	4.07
	Corn	413	0.59	**2.10**	0.71	1.30	1.96	2.87	5.16
	Hay	5,635	8.02	**0.93**	0.24	0.56	0.81	1.27	2.14
	Pasture	516	0.74	**1.31**	0.48	0.91	1.17	1.52	3.14
	Farmstead, Medium/Large	5	0.01	**3.08**	1.23	2.27	3.09	3.93	4.67
	Farmstead, Small	193	0.27	**3.04**	1.15	2.14	3.02	3.93	5.28
Urban	Residential	3,588	5.11	**0.90**	0.52	0.71	0.84	0.99	2.58
	Commercial/Industrial	56	0.08	**1.58**	1.17	1.41	1.58	1.71	2.05
	Road, Paved	608	0.87	**2.06**	1.68	1.93	2.04	2.18	2.55
	Road, Unpaved	453	0.64	**5.58**	4.92	5.25	5.65	5.79	6.63
Forest	Forest	48,607	69.20	**0.18**	0.09	0.13	0.16	0.21	0.40
Grass/Shrub	Grass/Shrub	3,338	4.75	**0.18**	0.08	0.14	0.17	0.20	0.43
Wetland	Wetland	4,817	6.86	**0.18**	0.06	0.11	0.17	0.21	0.72

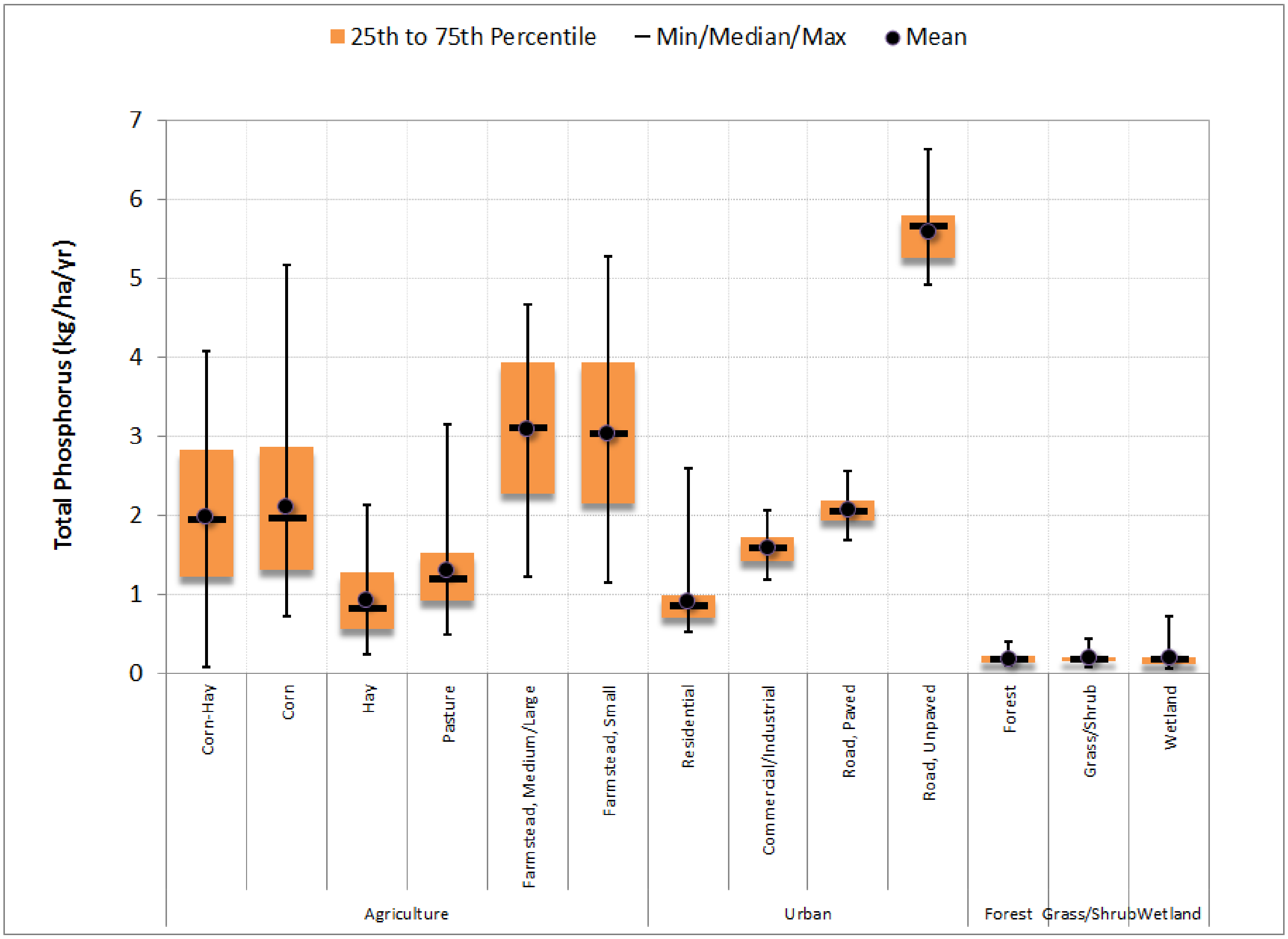


Figure C-17. TP export rates (kg/ha/yr) by landuse categories for the 30 year simulation period

Table C-7. TP export rates (kg/ha/yr) for the residential landuse categories for the 30 year simulation period

Residential Category	Area (ha)	Area (%)	Mean	Min	Q_{25}	Q_{50}	Q_{75}	Max
Low Density	2,061	63.18	**0.62**	0.24	0.44	0.56	0.73	2.55
Medium Density	878	26.93	**0.88**	0.46	0.67	0.80	0.98	2.87
High Density	323	9.89	**1.57**	1.16	1.34	1.56	1.71	2.35
Total	3,262	100.00	**0.79**	0.39	0.59	0.71	0.89	2.61

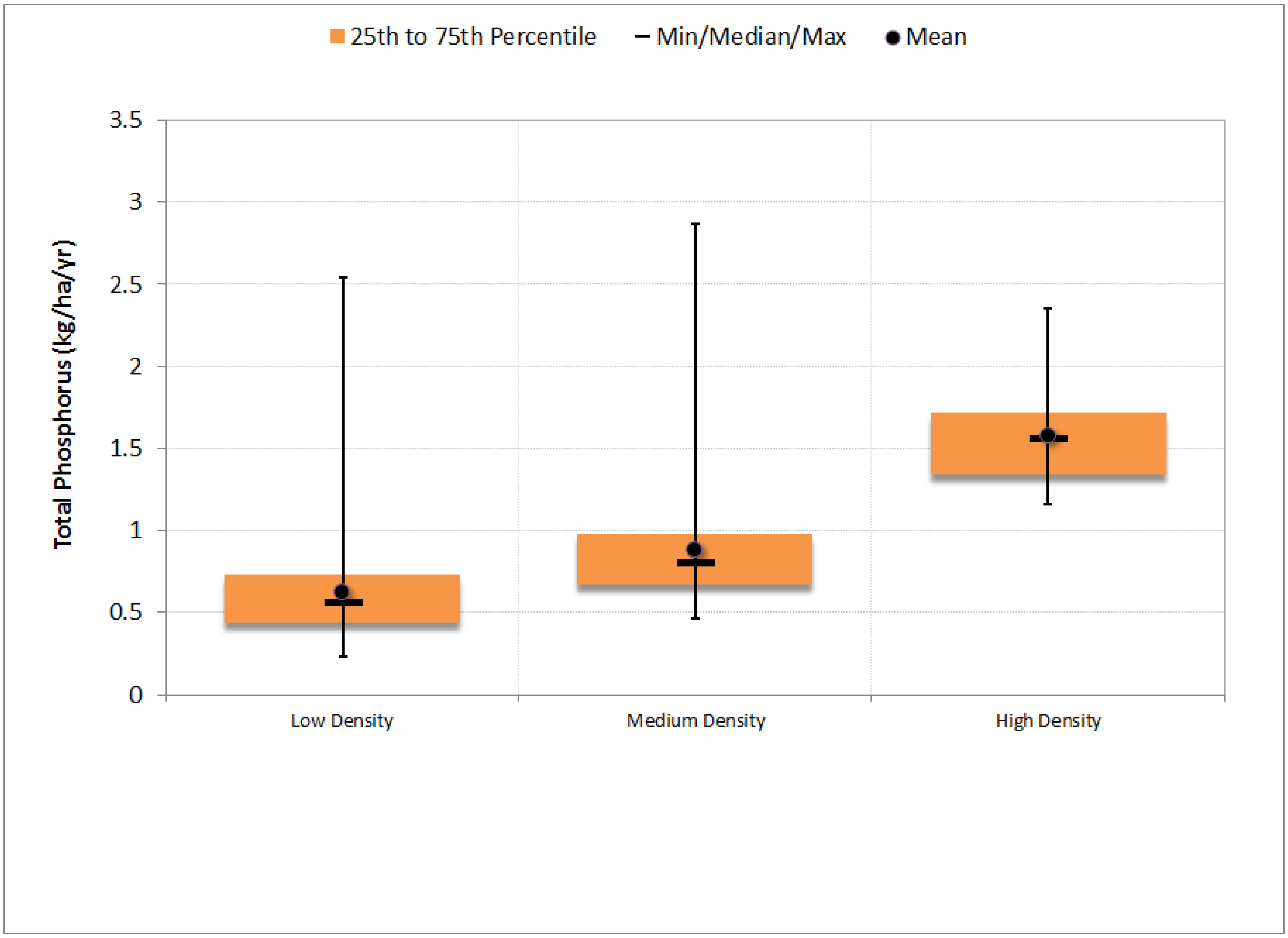


Figure C-18. TP export rates (kg/ha/yr) for the residential landuse categories for the 30 year simulation period

Segmented Regression

Table C-8. Summary statistics

Statistic	Calibration		Validation	
	TSS	TP	TSS	TP
Average absolute error (%)	51.7	55.5	56.5	62.3
Median absolute error (%)	27.1	29.6	21.1	27.5
Regression error (%)	13.5	17.4	14.7	13.3
NSE	0.489	0.382	0.468	0.297
NSE'	0.453	0.348	0.470	0.345

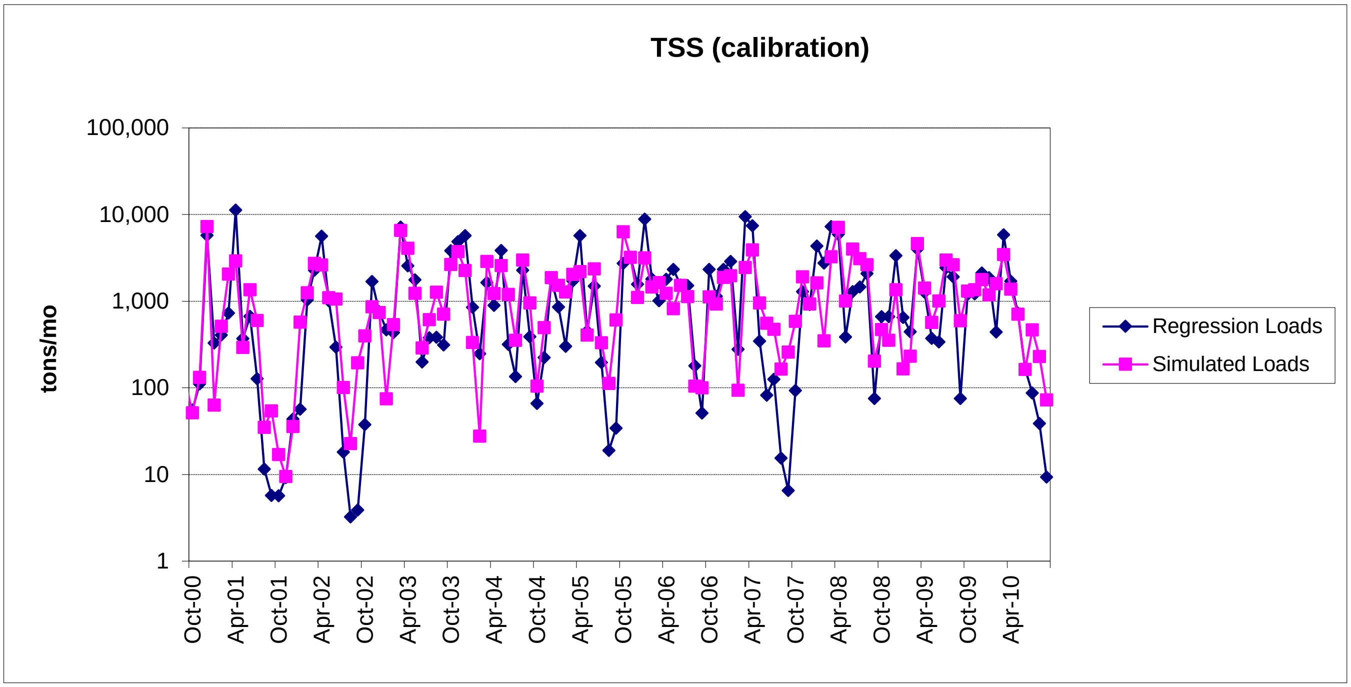


Figure C-19. Monthly simulated and estimated TSS load at Poultney River below Fair Haven, VT (calibration period)

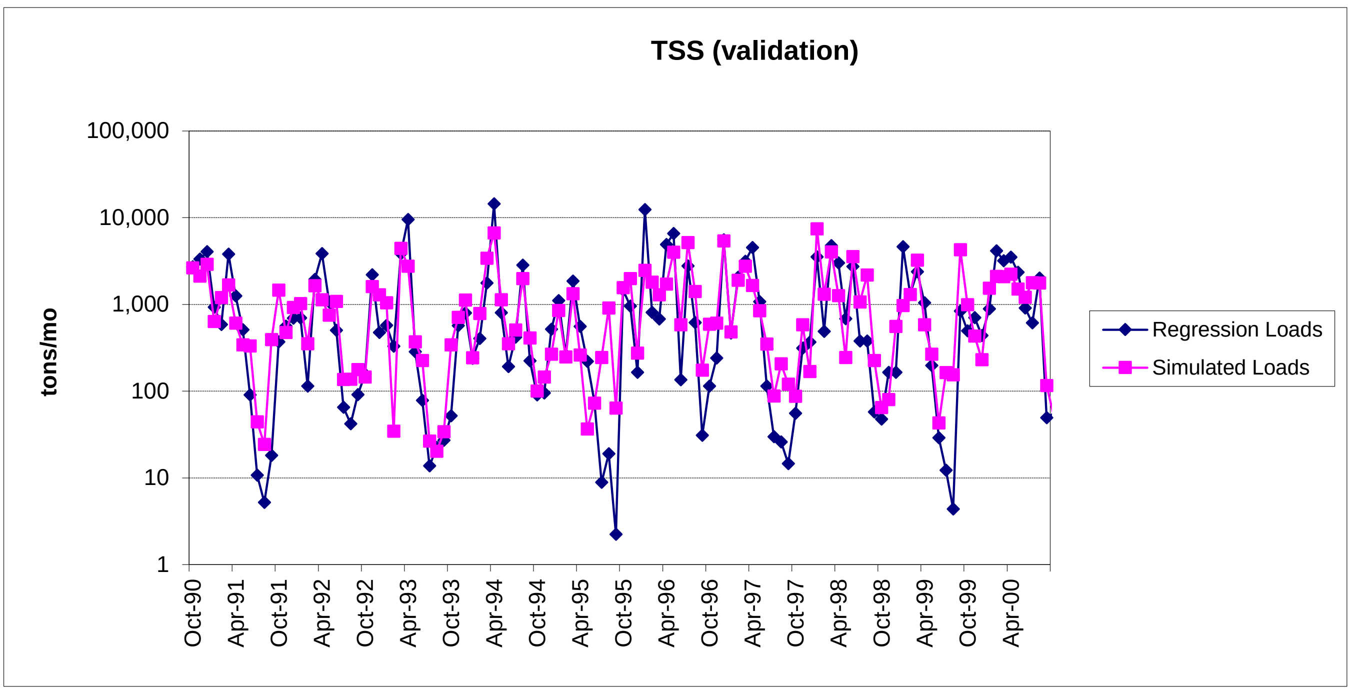


Figure C-20. Monthly simulated and estimated TSS load at Poultney River below Fair Haven, VT (validation period)

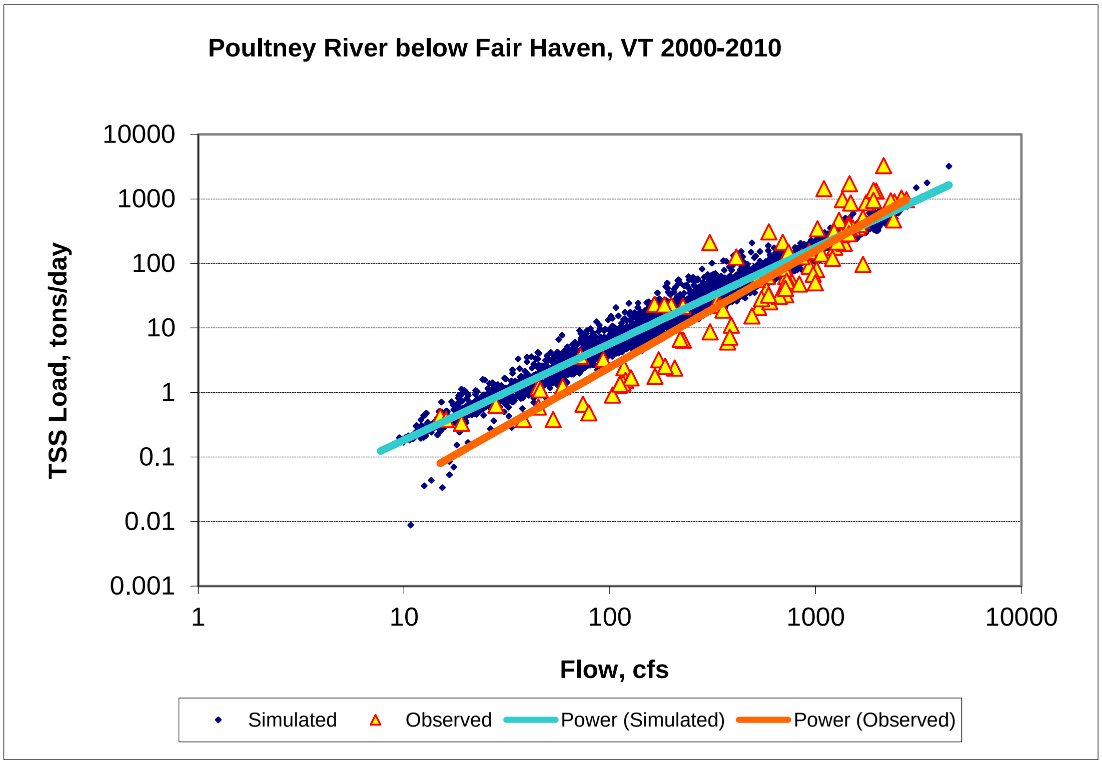


Figure C-21. Power plot of simulated and observed TSS load vs flow at Poultney River below Fair Haven, VT (calibration period)

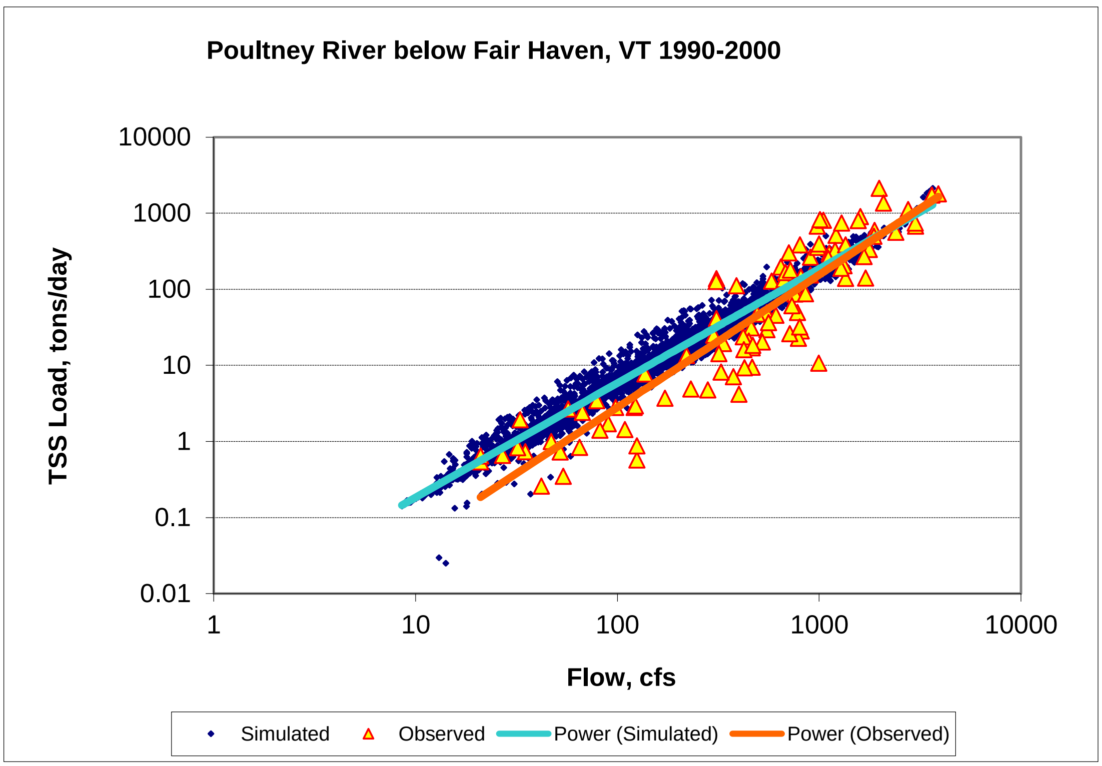


Figure C-22. Power plot of simulated and observed TSS load vs flow at Poultney River below Fair Haven, VT (validation period)

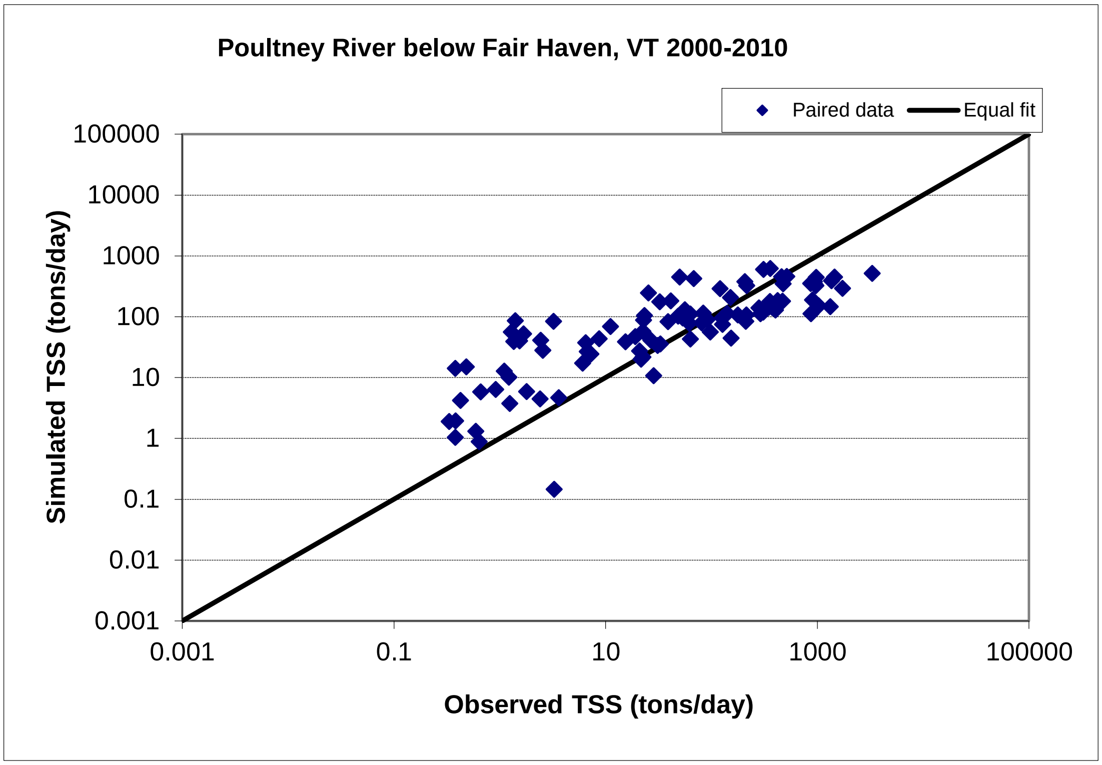


Figure C-23. Paired simulated vs observed TSS load at Poultney River below Fair Haven, VT (calibration period)

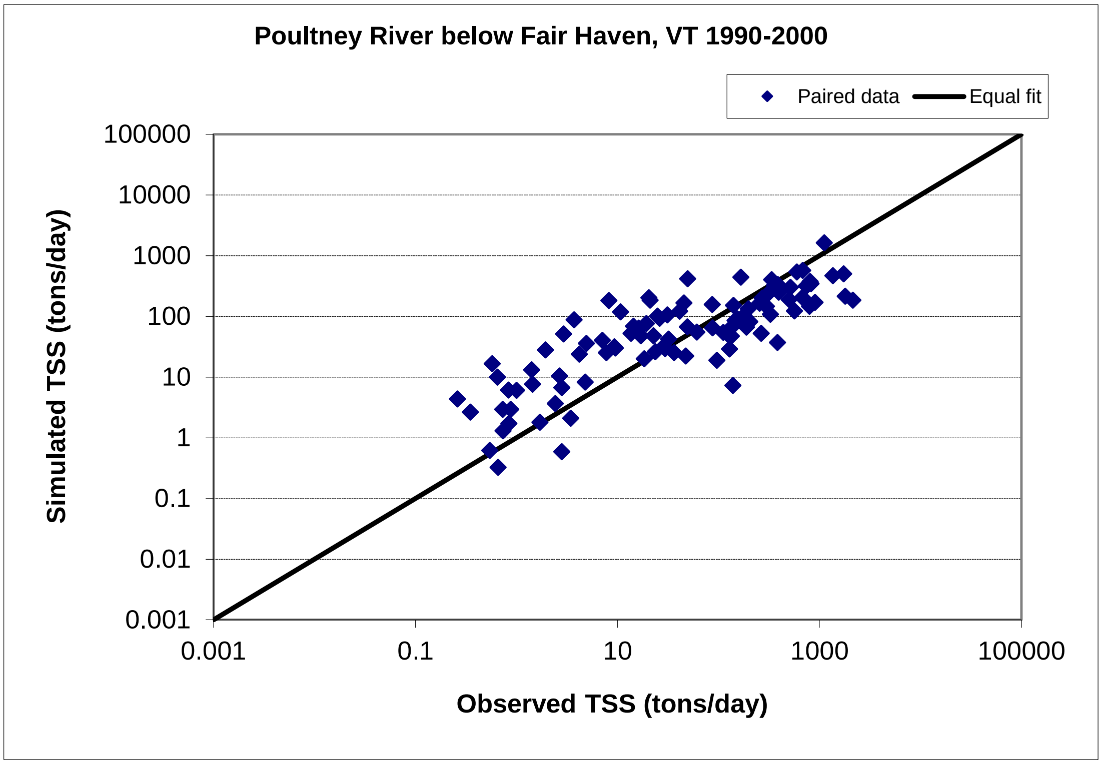


Figure C-24. Paired simulated vs observed TSS load at Poultney River below Fair Haven, VT (validation period)

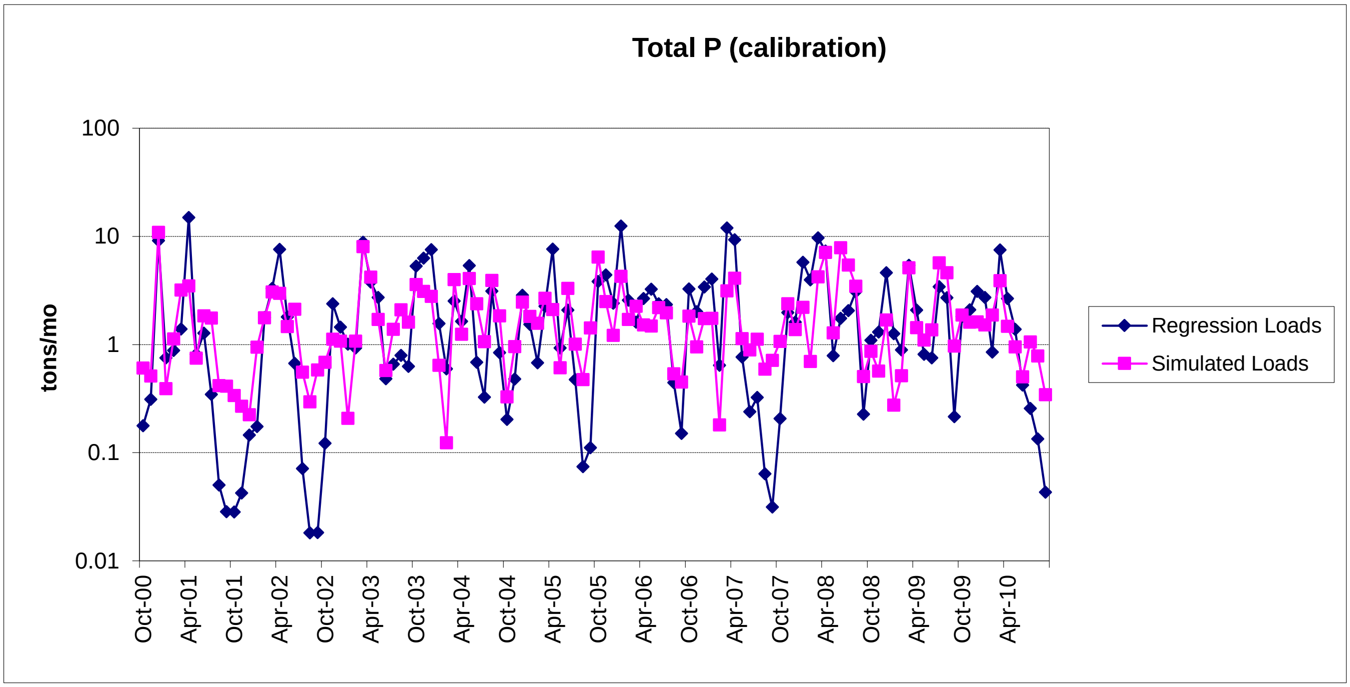


Figure C-25. Monthly simulated and estimated TP load at Poultney River below Fair Haven, VT (calibration period)

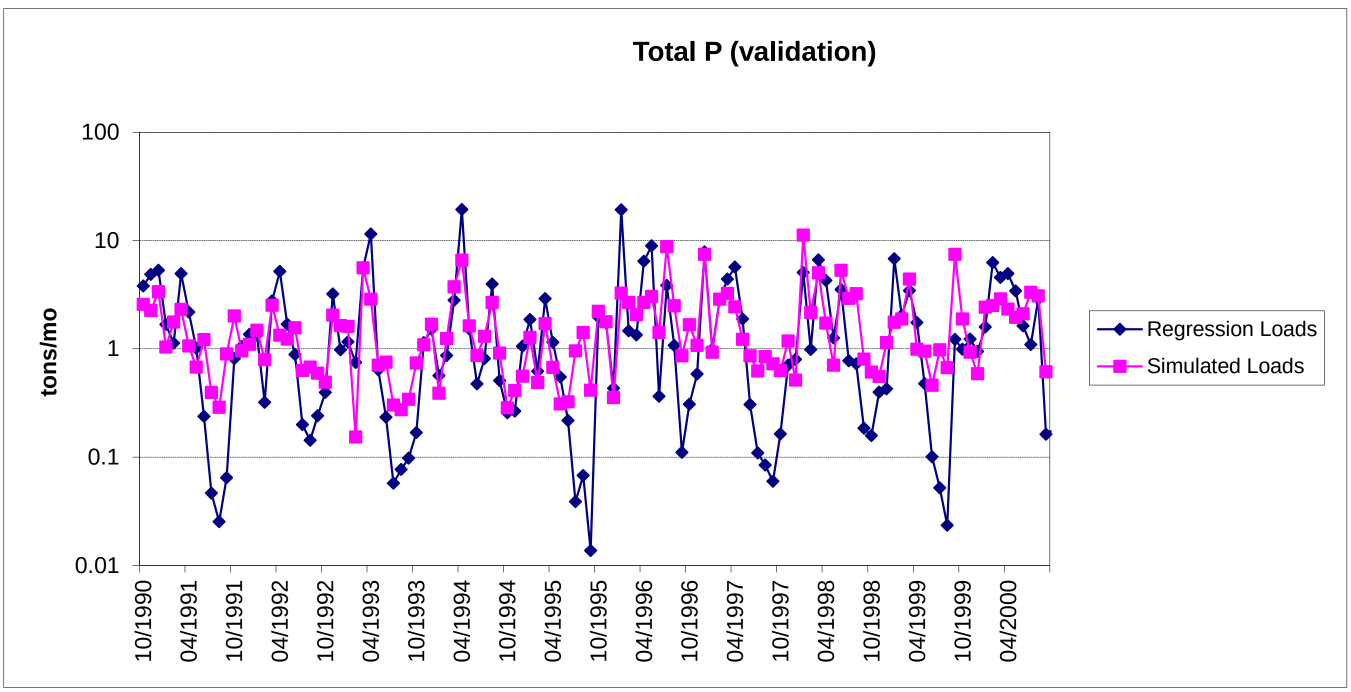


Figure C-26. Monthly simulated and estimated TP load at Poultney River below Fair Haven, VT (validation period)

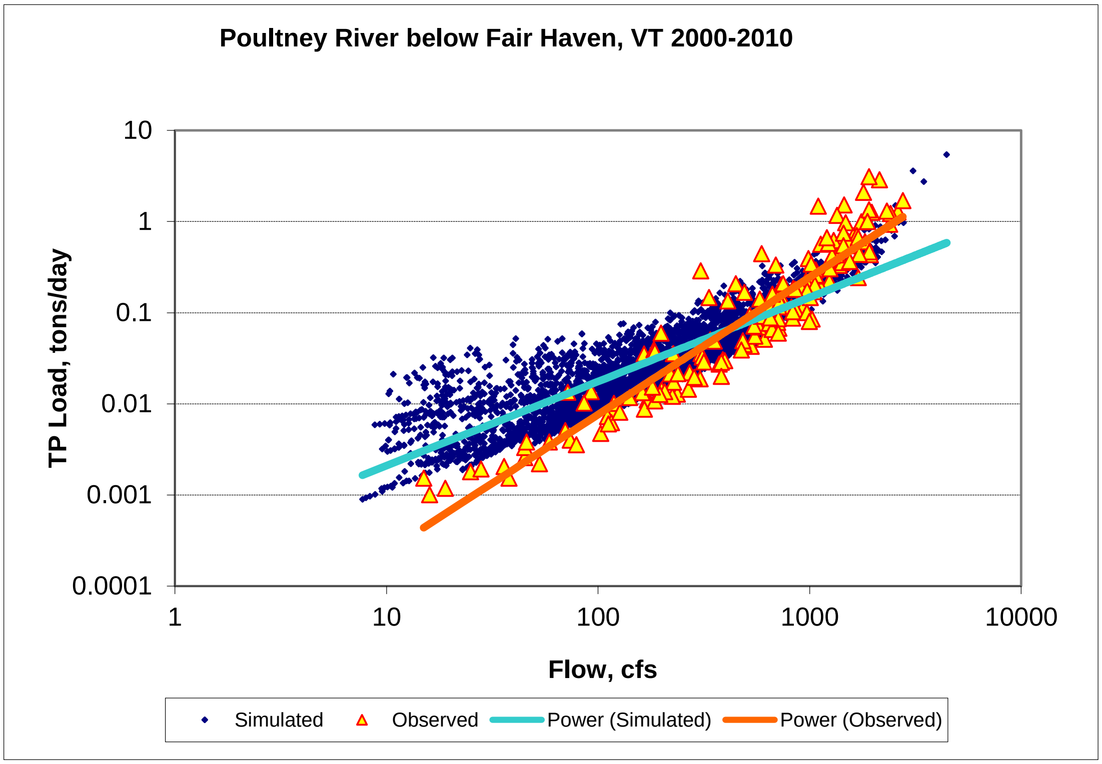


Figure C-27. Power plot of simulated and observed TP load vs flow at Poultney River below Fair Haven, VT (calibration period)

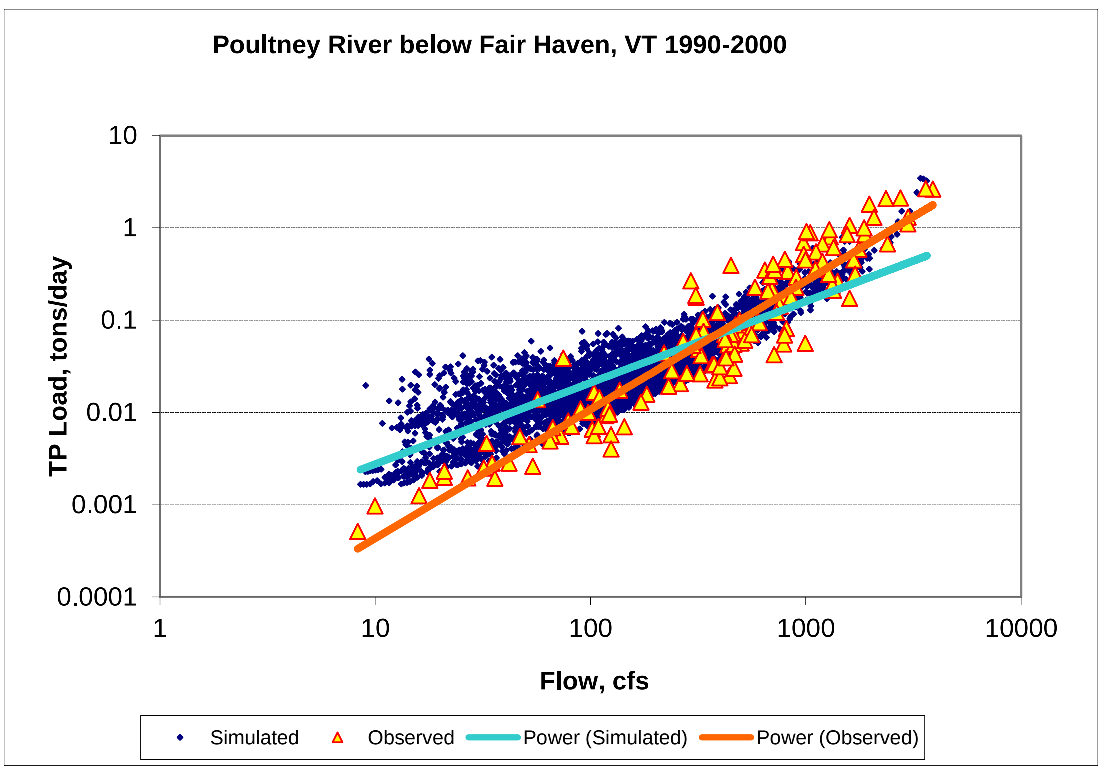


Figure C-28. Power plot of simulated and observed TP load vs flow at Poultney River below Fair Haven, VT (validation period)

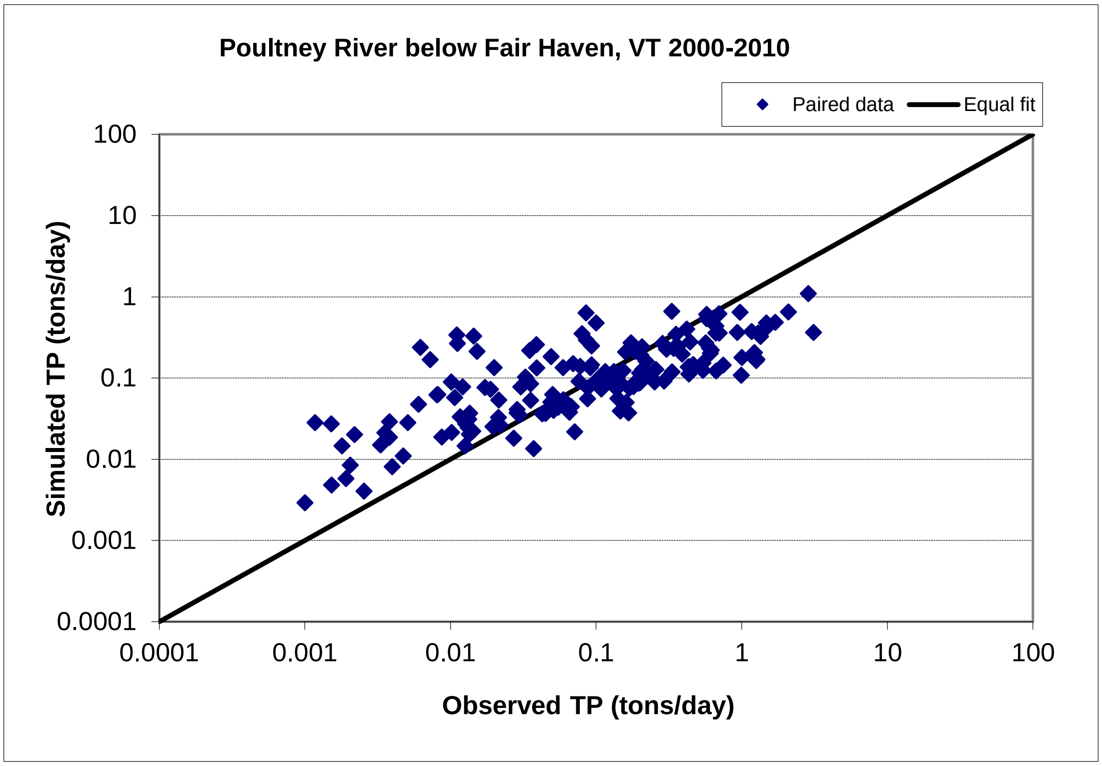


Figure C-29. Paired simulated vs observed TP load at Poultney River below Fair Haven, VT (calibration period)

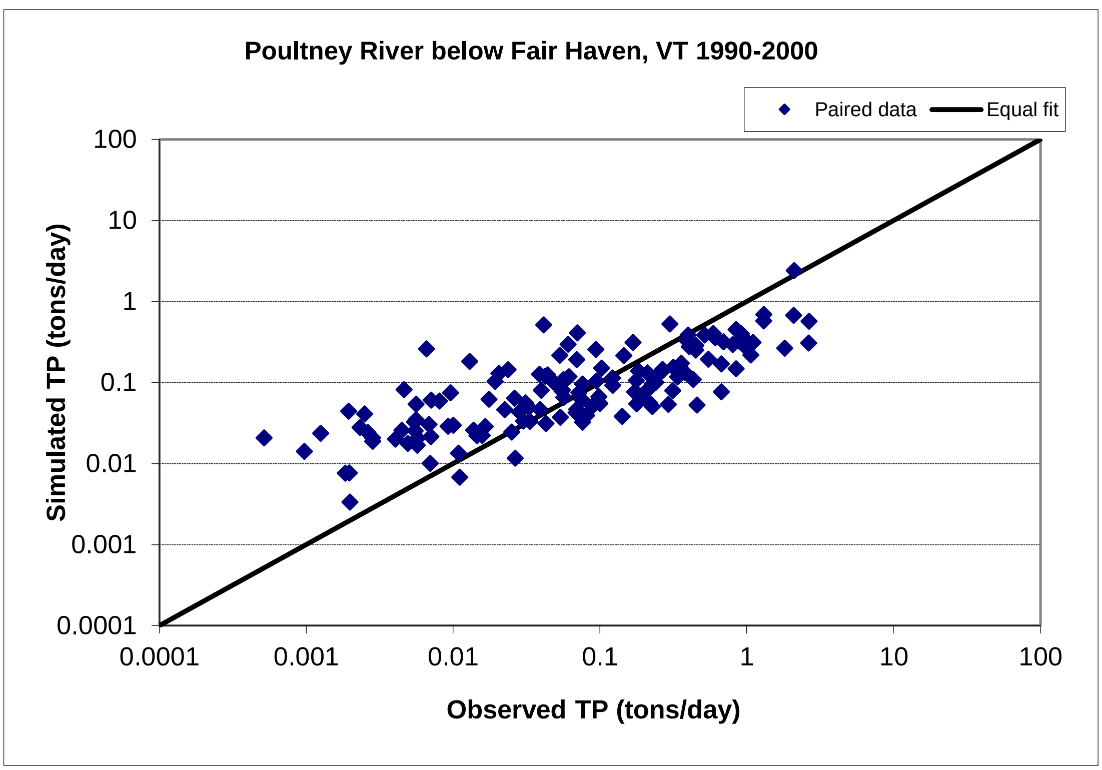


Figure C-30. Paired simulated vs observed TP load at Poultney River below Fair Haven, VT (validation period)

Comparison of simulated SWAT TP loads with FLUX estimates

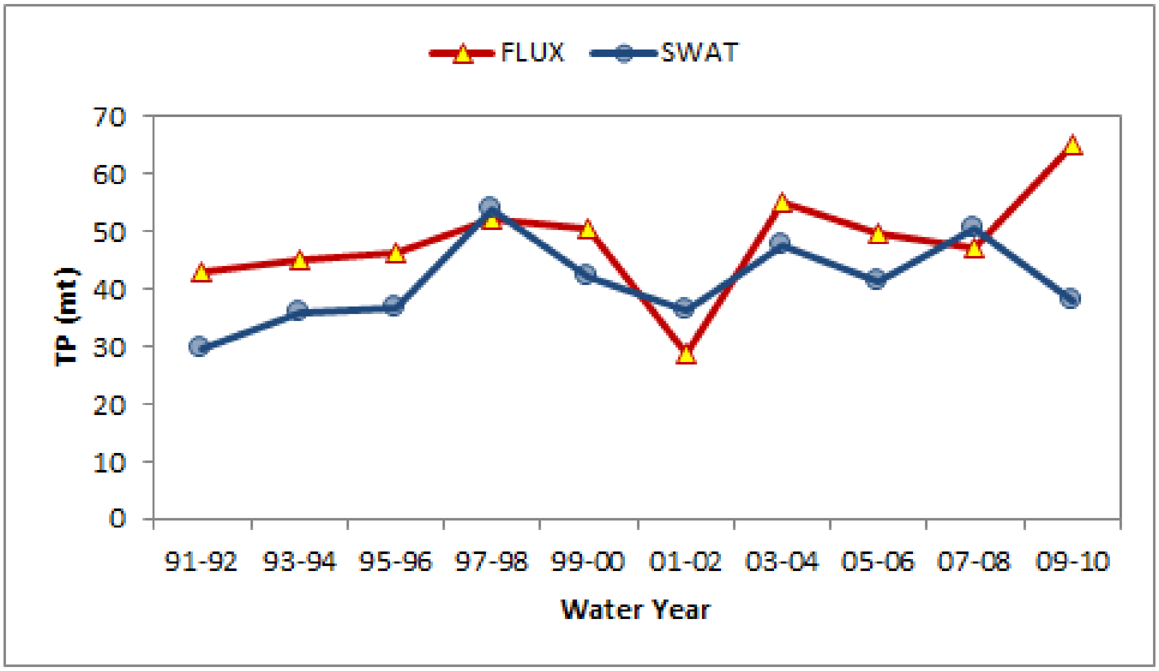


Figure C-31. Bi-annual TP loads on a water year basis as simulated by SWAT and estimated by FLUX (FLUX estimates from Smeltzer et al., 2009)

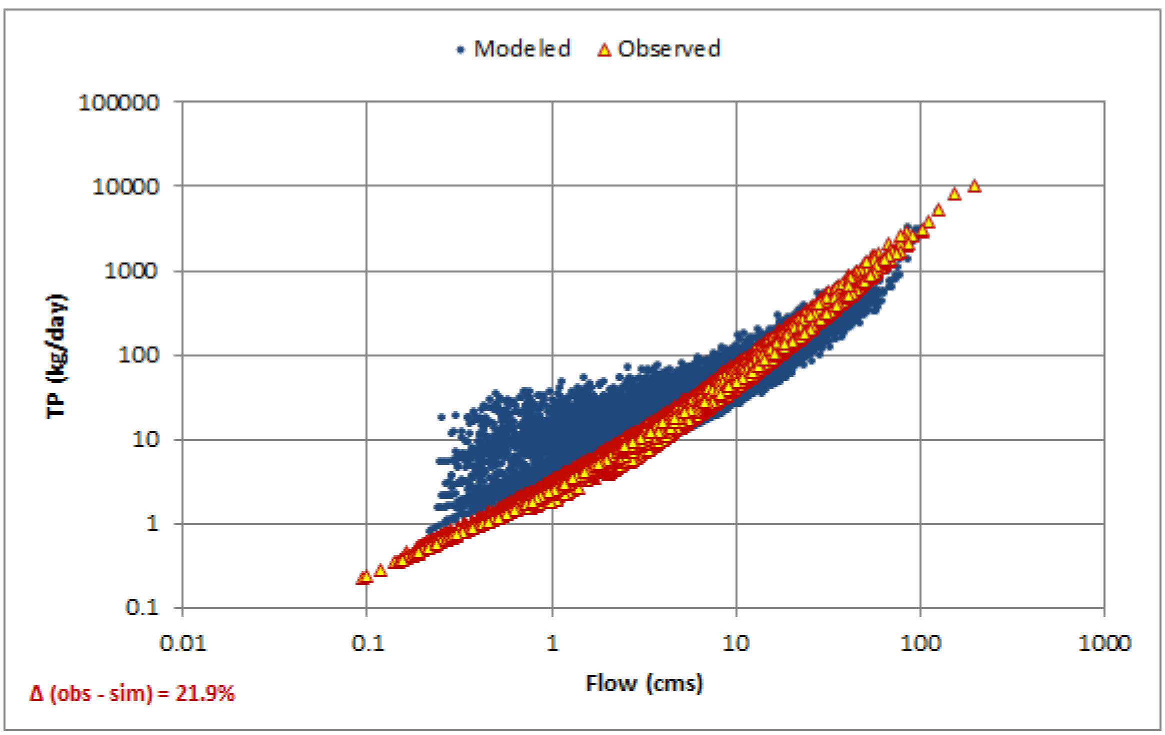
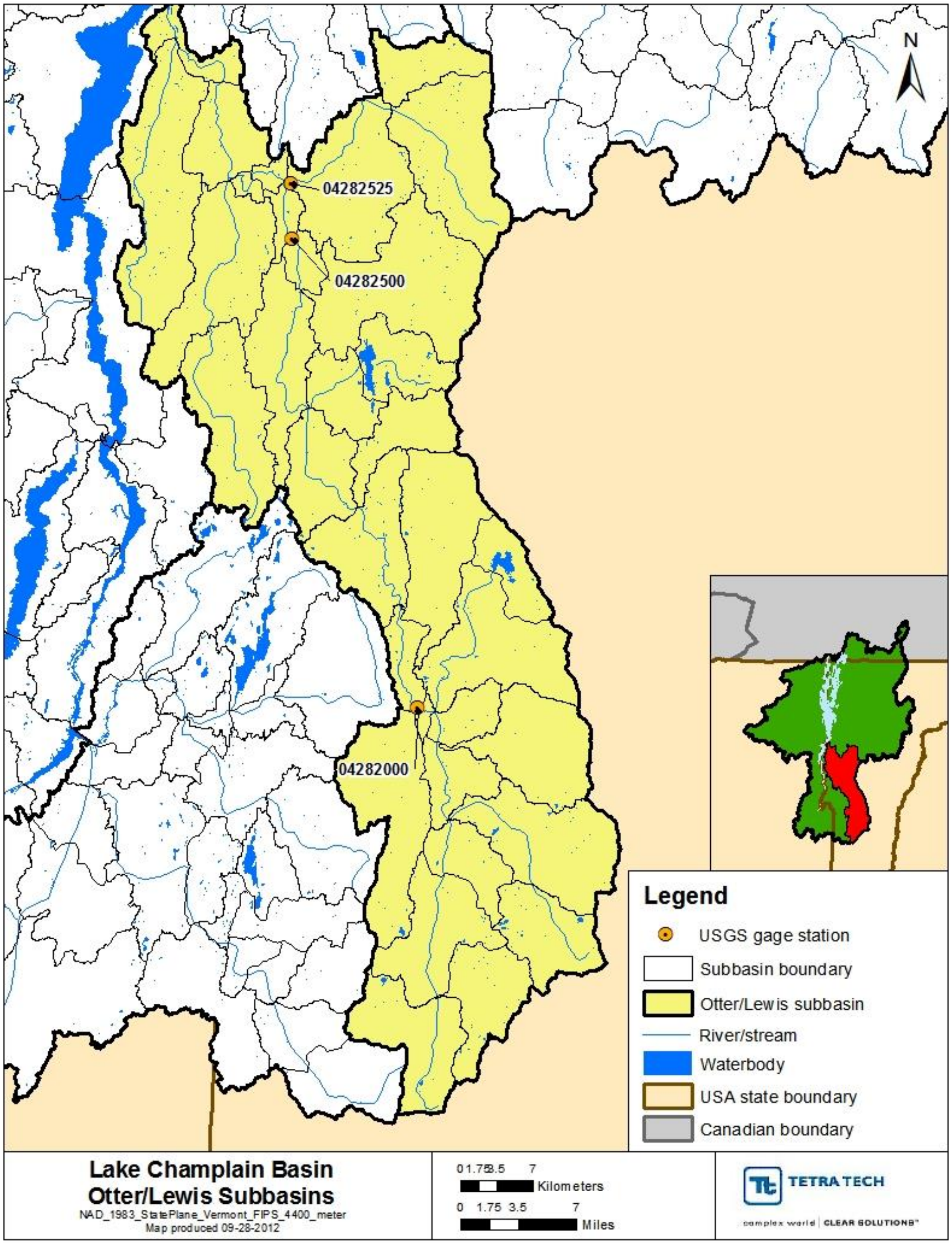


Figure C-32. Daily TP load versus flow as simulated by SWAT and estimated by FLUX (FLUX estimates from Medalie, 2013)

Appendix D - Otter Creek Watershed



USGS 04282000 Otter Creek at Center Rutland, VT - Calibration

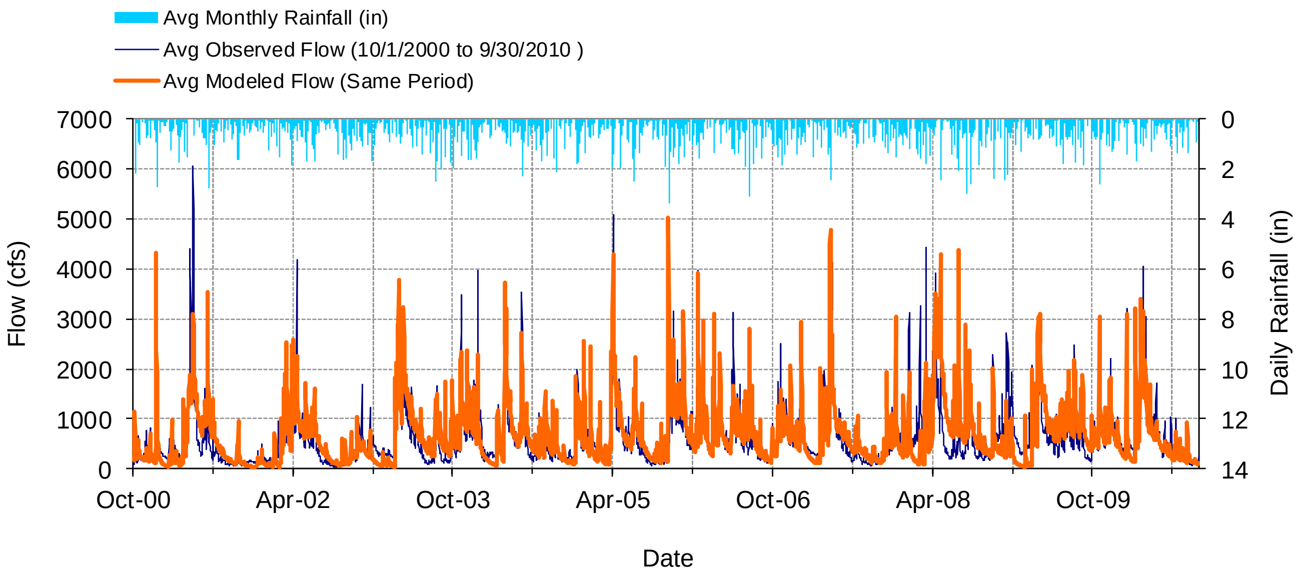


Figure D-1. Mean daily flow at USGS 04282000 Otter Creek at Center Rutland, VT

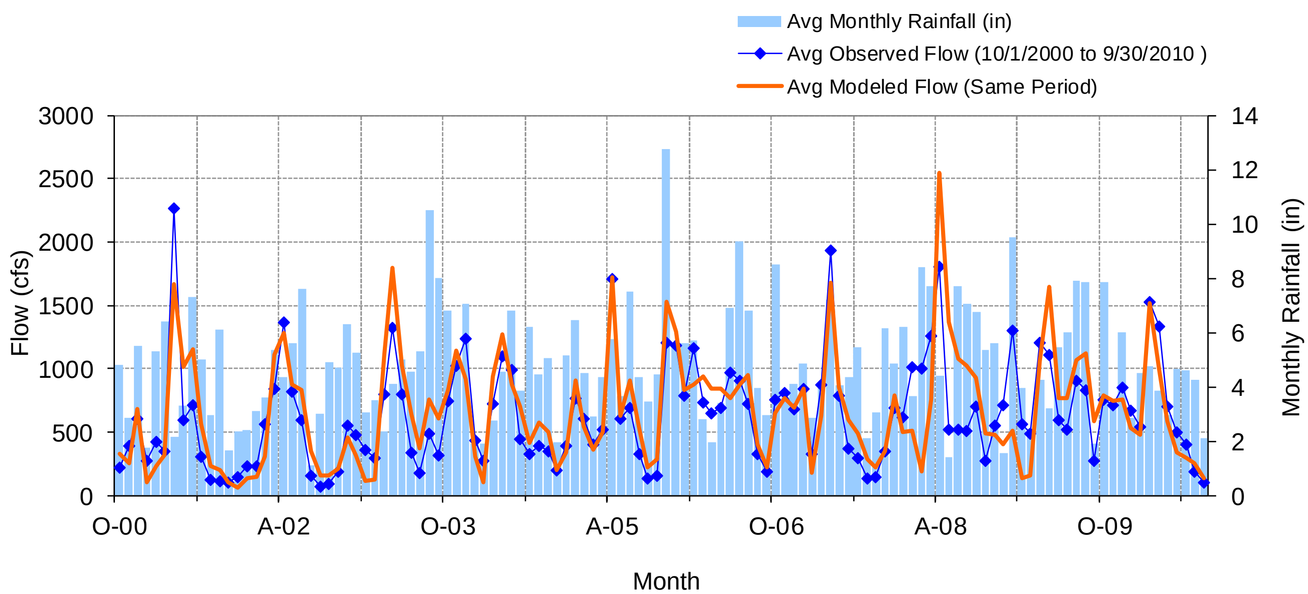


Figure D-2. Mean monthly flow at USGS 04282000 Otter Creek at Center Rutland, VT

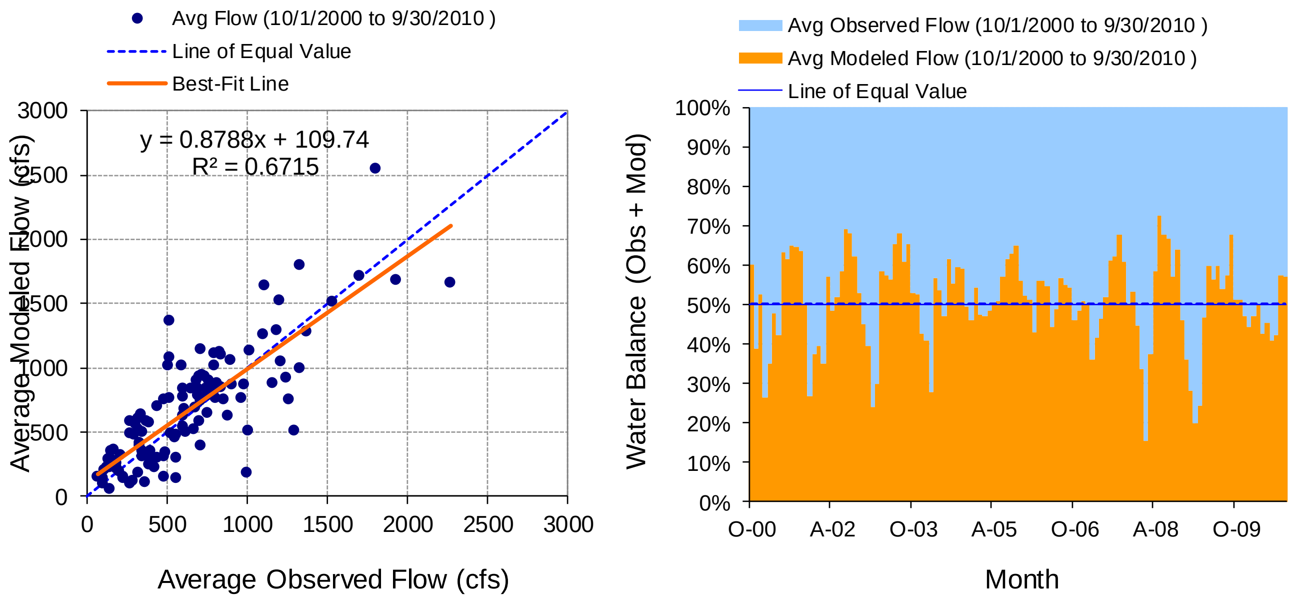


Figure D-3. Monthly flow regression and temporal variation at USGS 04282000 Otter Creek at Center Rutland, VT

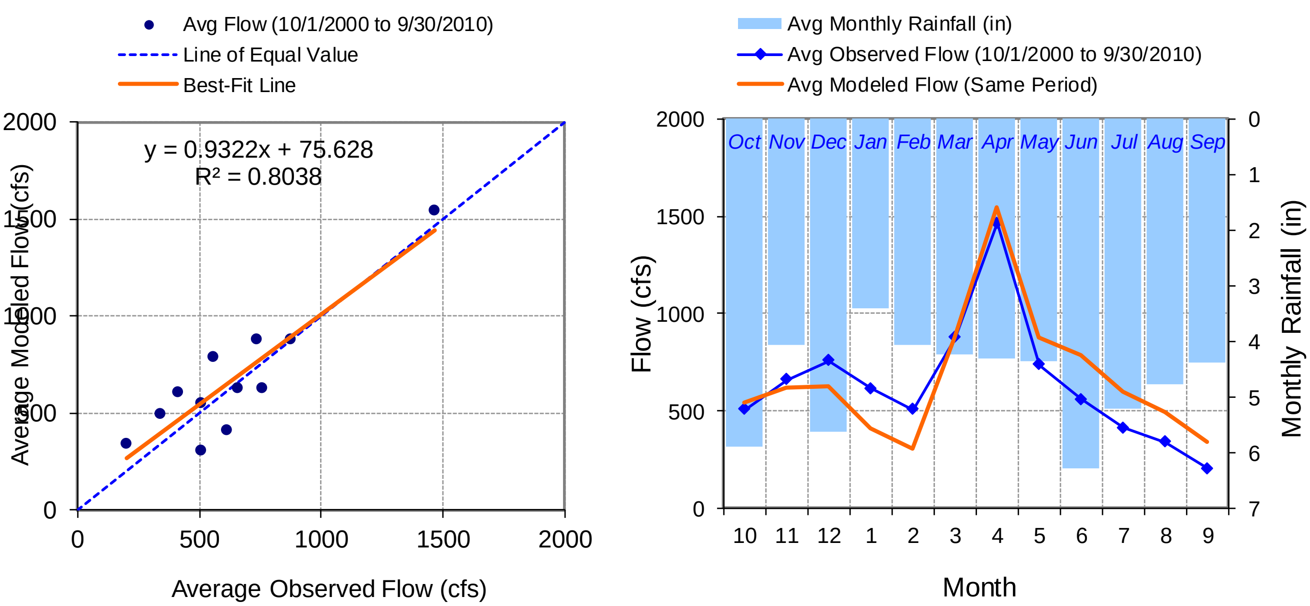


Figure D-4. Seasonal regression and temporal aggregate at USGS 04282000 Otter Creek at Center Rutland, VT

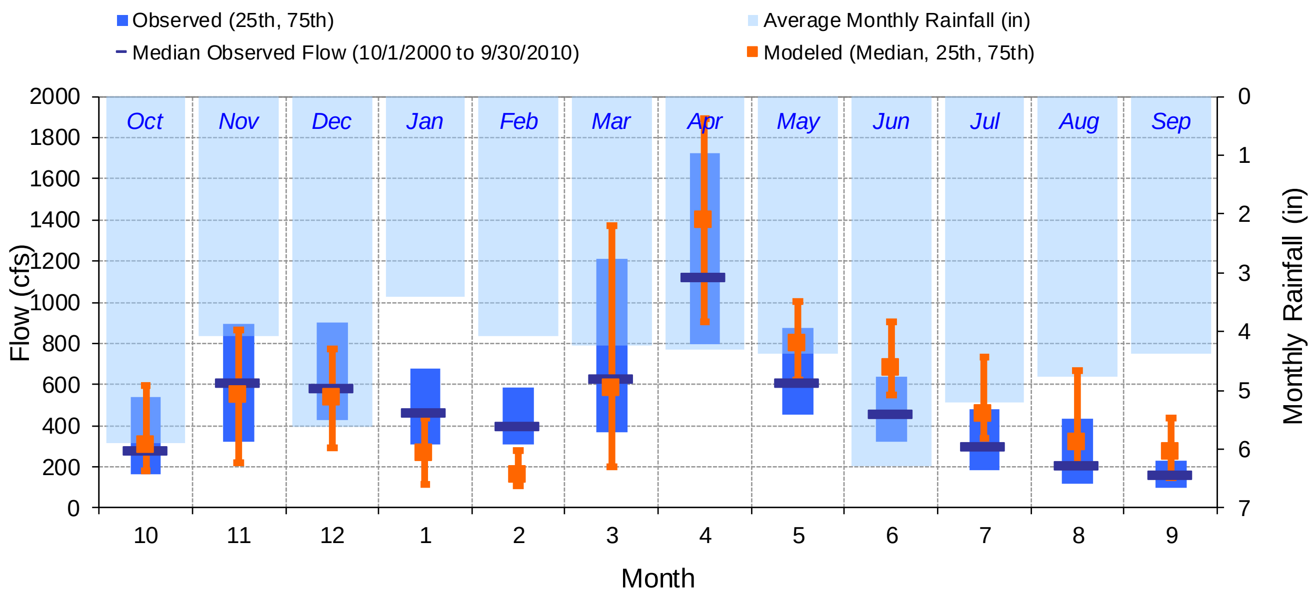


Figure D-5. Seasonal medians and ranges at USGS 04282000 Otter Creek at Center Rutland, VT

Table D-1. Seasonal summary at USGS 04282000 Otter Creek at Center Rutland, VT

MONTH	OBSERVED FLOW (CFS)				MODELED FLOW (CFS)			
	MEAN	MEDIAN	25TH	75TH	MEAN	MEDIAN	25TH	75TH
Oct	506.55	277.00	165.25	539.75	545.21	305.10	180.53	596.11
Nov	660.78	611.50	322.75	896.00	621.08	548.44	221.98	862.12
Dec	756.07	580.00	424.25	904.75	624.76	535.72	290.07	770.92
Jan	614.72	462.00	309.25	680.75	410.04	264.56	111.60	435.08
Feb	505.01	400.00	310.00	583.75	304.12	160.35	110.54	277.60
Mar	875.29	627.00	371.25	1210.00	876.06	581.81	199.67	1371.97
Apr	1464.16	1125.00	793.00	1725.00	1543.43	1397.93	905.29	1895.78
May	737.53	611.50	453.25	877.75	875.28	798.82	624.10	1004.88
Jun	558.99	454.00	324.50	640.75	787.74	681.40	549.85	907.76
Jul	411.28	301.50	182.25	480.50	601.31	458.74	336.46	736.49
Aug	339.18	205.00	118.25	431.00	492.15	319.07	208.26	666.12
Sep	201.78	160.00	100.75	232.00	340.13	273.99	147.99	434.81

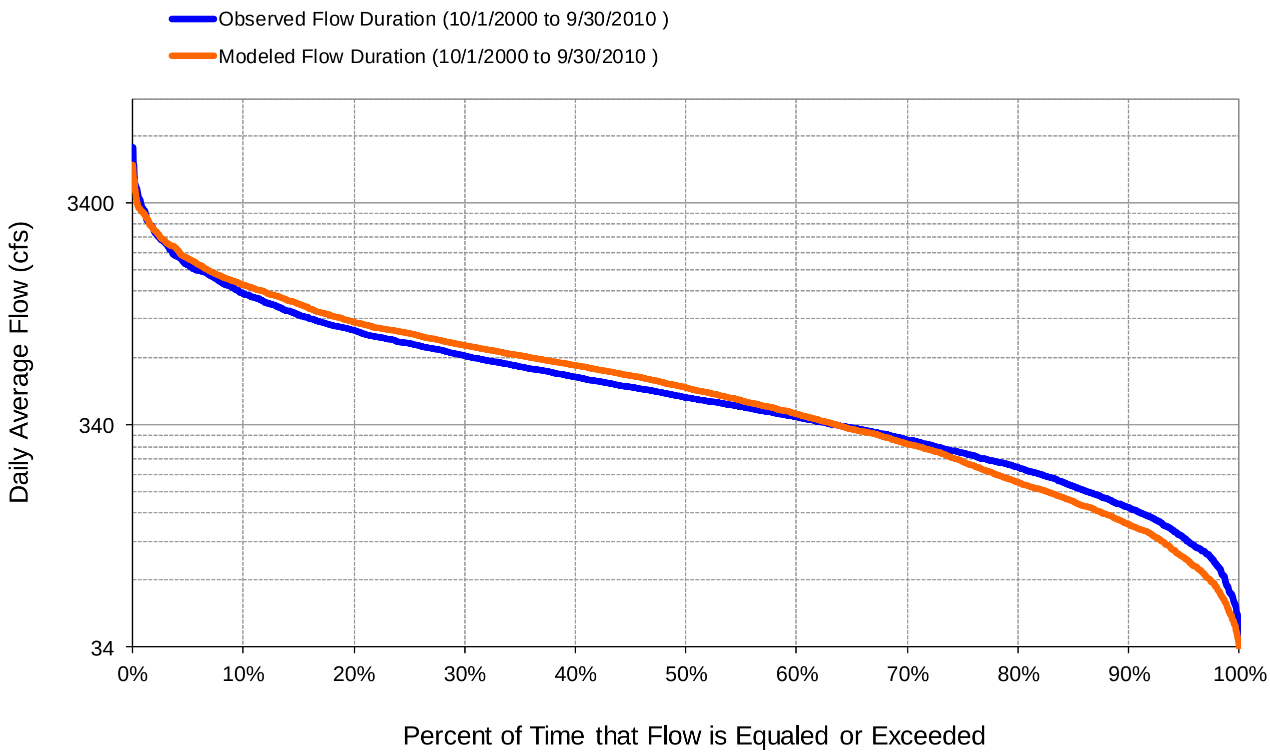


Figure D-6. Flow exceedence at USGS 04282000 Otter Creek at Center Rutland, VT

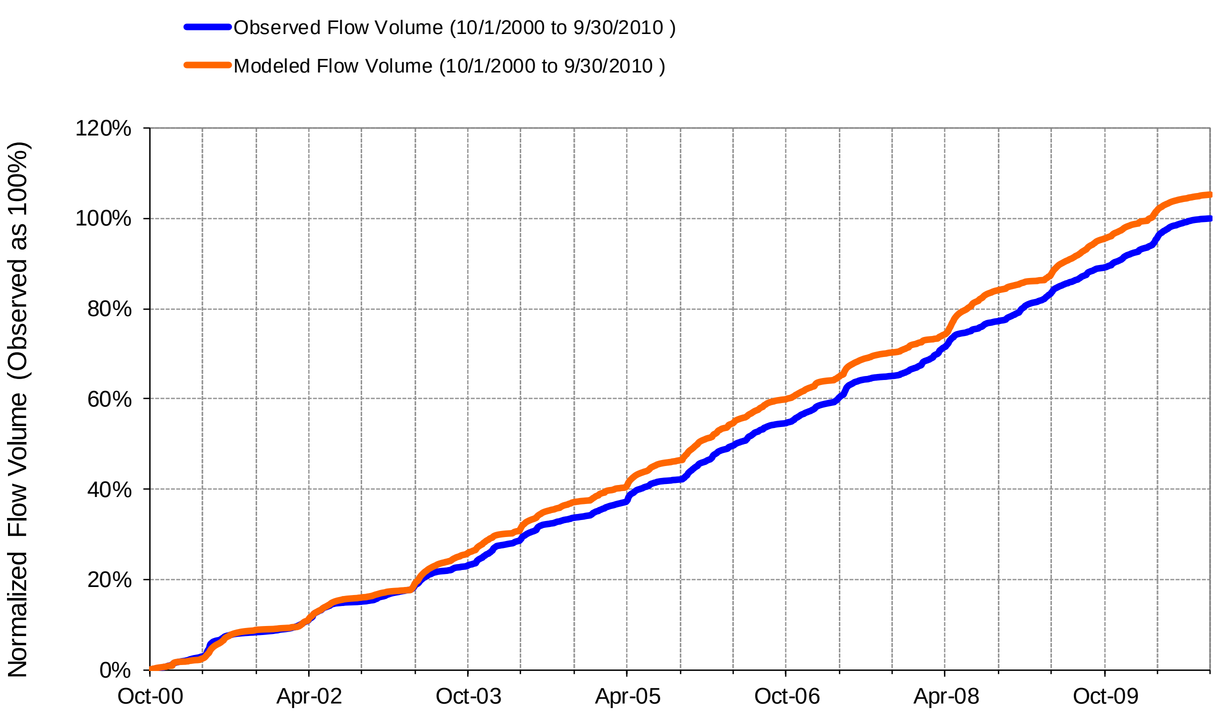


Figure D-7. Flow accumulation at USGS 04282000 Otter Creek at Center Rutland, VT

Table D-2. Summary statistics at USGS 04282000 Otter Creek at Center Rutland, VT

SWAT Simulated Flow		Observed Flow Gage	
REACH OUTFLOW FROM OUTLET 19		USGS 04282000 OTTER CREEK AT CENTER RUTLAND, VT	
10-Year Analysis Period: 10/1/2000 - 9/30/2010 Flow volumes are (inches/year) for upstream drainage area		Hydrologic Unit Code: 2010002 Latitude: 43.6036792 Longitude: -73.0131628 Drainage Area (sq-mi): 307	
Total Simulated In-stream Flow:	**29.62**	Total Observed In-stream Flow:	**28.14**
Total of simulated highest 10% flows:	**9.37**	Total of Observed highest 10% flows:	**9.19**
Total of Simulated lowest 50% flows:	**5.49**	Total of Observed Lowest 50% flows:	**5.67**
Simulated Summer Flow Volume (months 7-9):	**5.34**	Observed Summer Flow Volume (7-9):	**3.55**
Simulated Fall Flow Volume (months 10-12):	**6.65**	Observed Fall Flow Volume (10-12):	**7.14**
Simulated Winter Flow Volume (months 1-3):	**5.87**	Observed Winter Flow Volume (1-3):	**7.32**
Simulated Spring Flow Volume (months 4-6):	**11.76**	Observed Spring Flow Volume (4-6):	**10.12**
Total Simulated Storm Volume:	**8.24**	Total Observed Storm Volume:	**8.83**
Simulated Summer Storm Volume (7-9):	**1.44**	Observed Summer Storm Volume (7-9):	**1.27**

Errors (Simulated-Observed)	*Error Statistics*	*Recommended Criteria*		
Error in total volume:	5.27	10		
Error in 50% lowest flows:	-3.08	10		
Error in 10% highest flows:	1.92	15		
Seasonal volume error - Summer:	50.42	30		
Seasonal volume error - Fall:	-6.89 >>	30	Clear	
Seasonal volume error - Winter:	-19.83	30		
Seasonal volume error - Spring:	16.17	30		
Error in storm volumes:	-6.74	20		
Error in summer storm volumes:	13.93	50		
Nash-Sutcliffe Coefficient of Efficiency, E:	0.577	Model accuracy increases		
Baseline adjusted coefficient (Garrick), E':	0.372	as E or E' approaches 1.0		
Monthly NSE	0.601			

USGS 04282000 Otter Creek at Center Rutland, VT - Validation

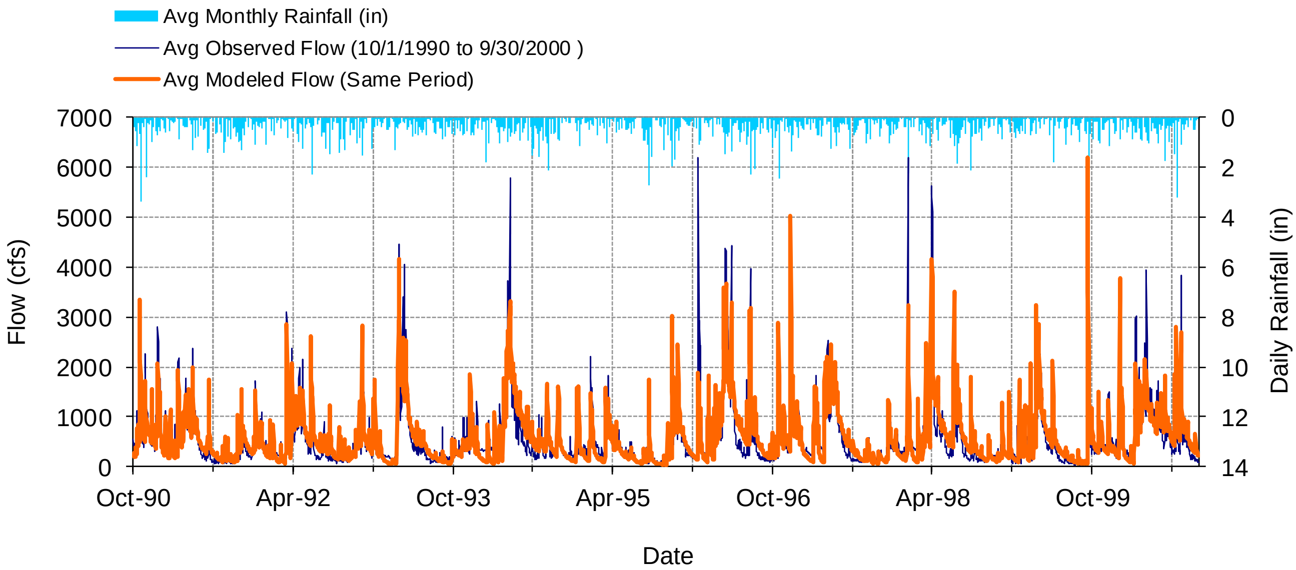


Figure D-8. Mean daily flow at USGS 04282000 Otter Creek at Center Rutland, VT

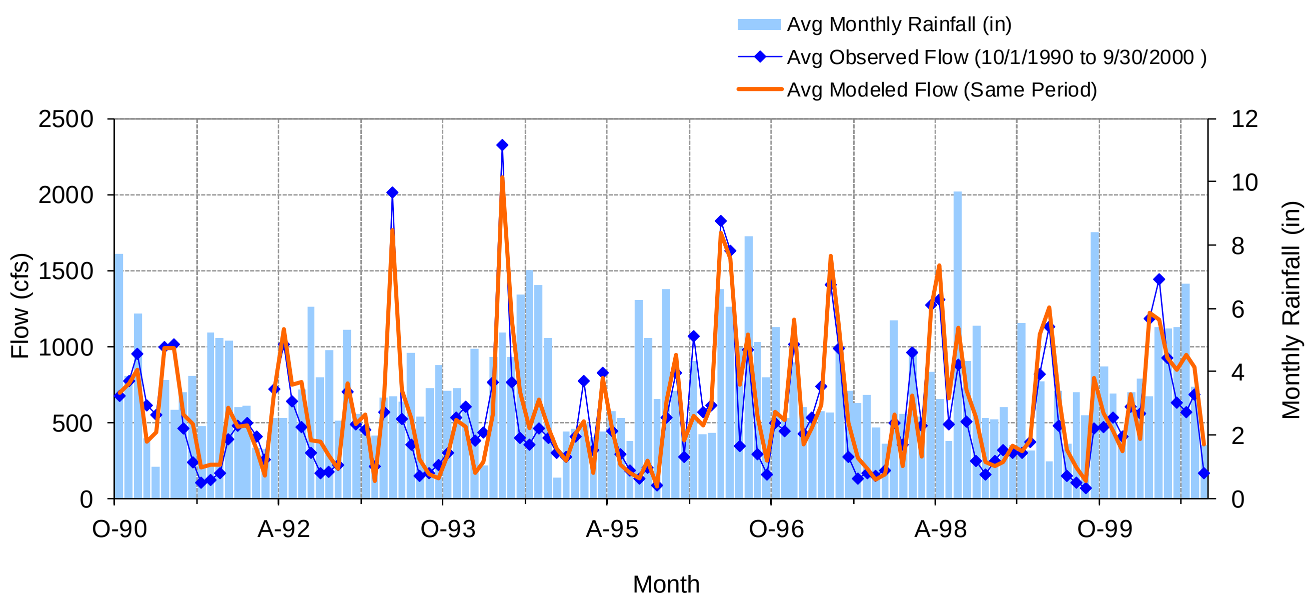


Figure D-9. Mean monthly flow at USGS 04282000 Otter Creek at Center Rutland, VT

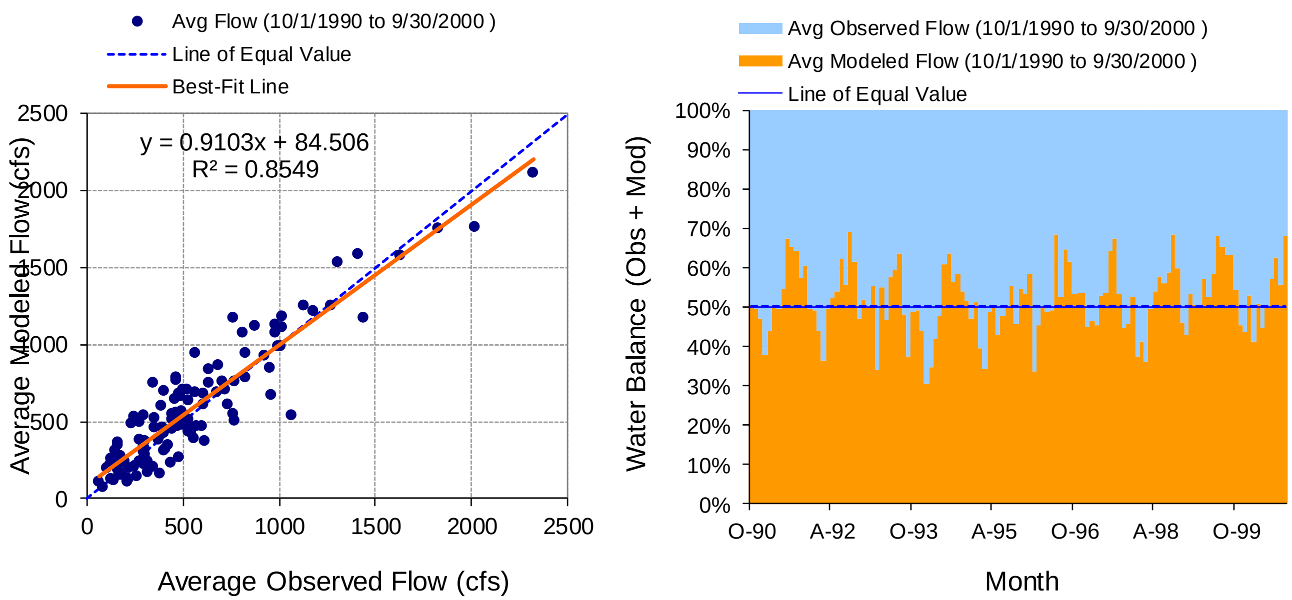


Figure D-10. Monthly flow regression and temporal variation at USGS 04282000 Otter Creek at Center Rutland, VT

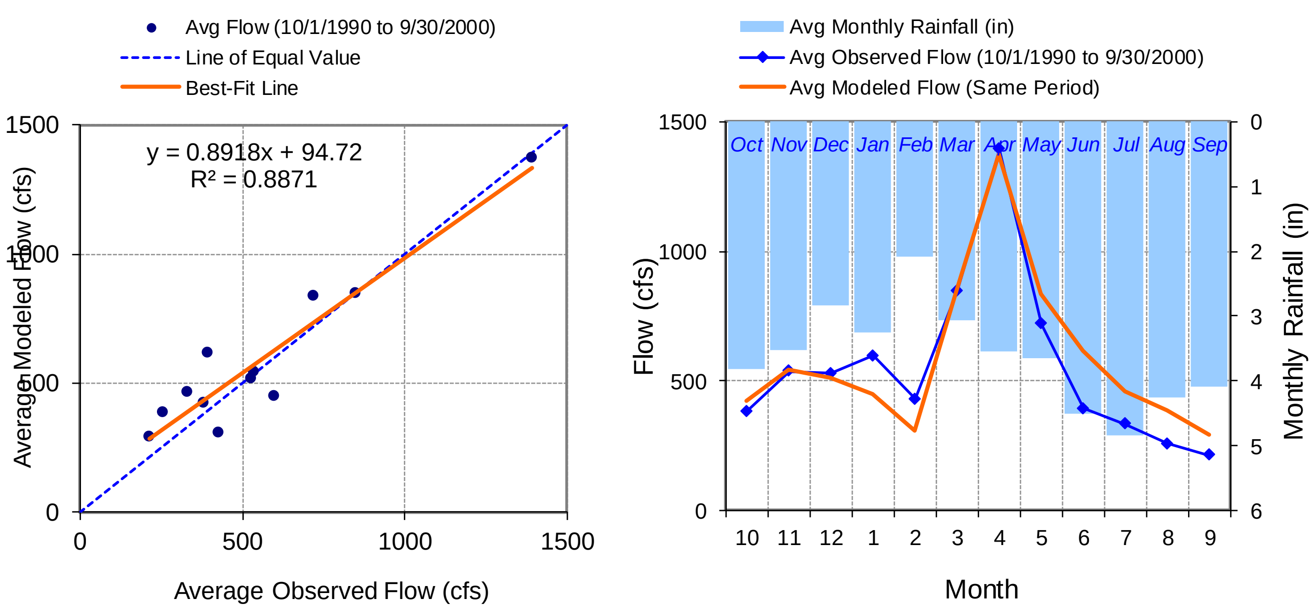


Figure D-11. Seasonal regression and temporal aggregate at USGS 04282000 Otter Creek at Center Rutland, VT

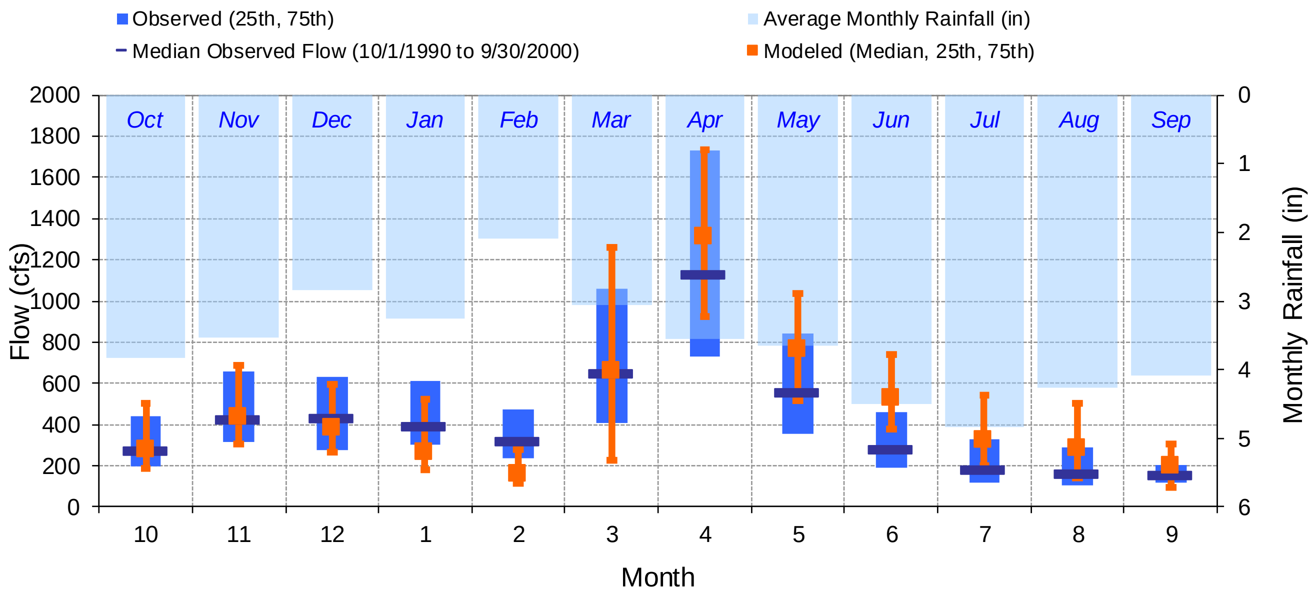


Figure D-12. Seasonal medians and ranges at USGS 04282000 Otter Creek at Center Rutland, VT

Table D-3. Seasonal summary at USGS 04282000 Otter Creek at Center Rutland, VT

MONTH	OBSERVED FLOW (CFS)				MODELED FLOW (CFS)			
	MEAN	MEDIAN	25TH	75TH	MEAN	MEDIAN	25TH	75TH
Oct	380.88	270.50	200.00	441.75	421.29	277.86	189.45	504.29
Nov	536.14	422.50	314.50	656.25	541.83	438.78	308.12	686.78
Dec	528.24	428.50	279.25	633.50	513.46	382.99	268.03	595.05
Jan	597.02	390.00	300.00	608.75	446.90	262.99	178.86	523.01
Feb	428.88	320.00	237.50	471.00	306.26	162.98	114.30	280.50
Mar	848.42	650.50	406.25	1060.00	848.65	659.15	224.90	1258.09
Apr	1392.64	1130.00	733.00	1730.00	1373.07	1315.12	925.33	1734.74
May	717.95	558.00	356.00	839.25	837.44	766.68	518.15	1036.40
Jun	391.95	277.00	188.25	459.00	616.57	527.42	375.75	738.52
Jul	331.78	179.50	117.00	331.25	461.12	325.74	199.28	544.20
Aug	257.24	161.50	106.00	289.00	386.42	287.25	137.84	500.67
Sep	212.51	152.00	117.00	204.50	290.75	202.87	95.97	305.28

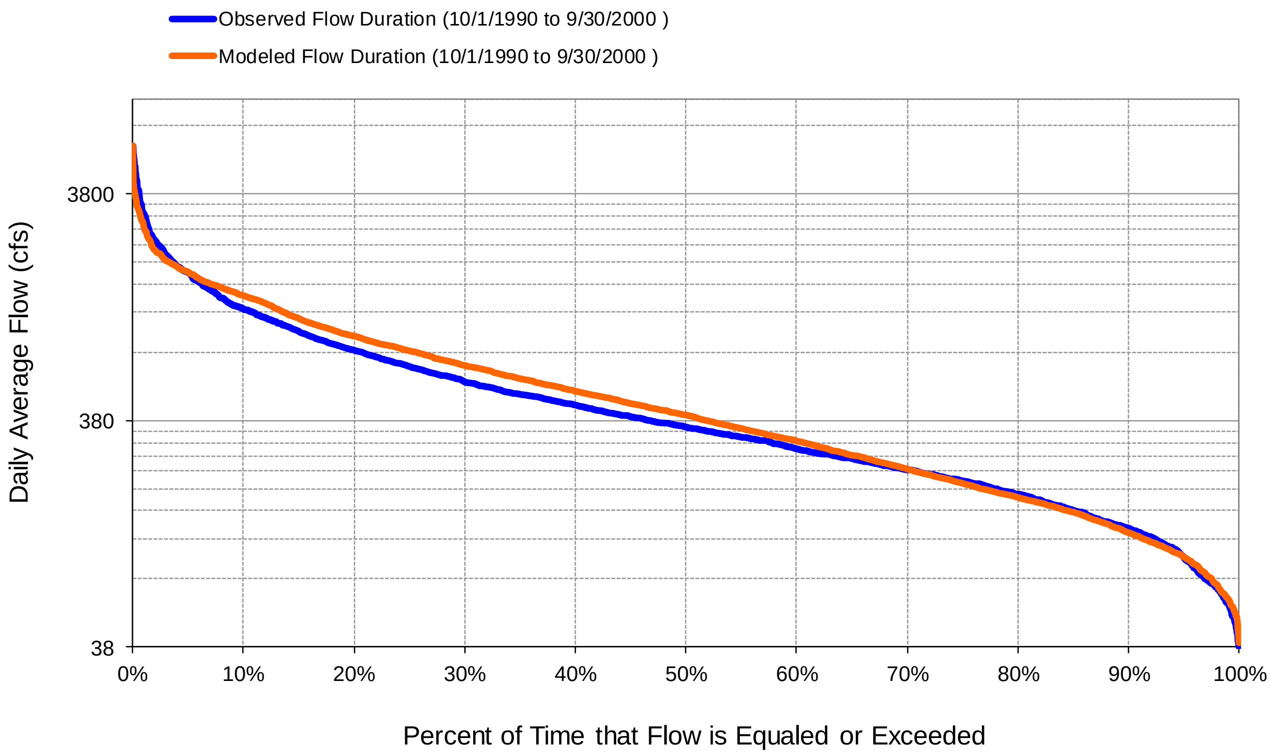


Figure D-13. Flow exceedence at USGS 04282000 Otter Creek at Center Rutland, VT

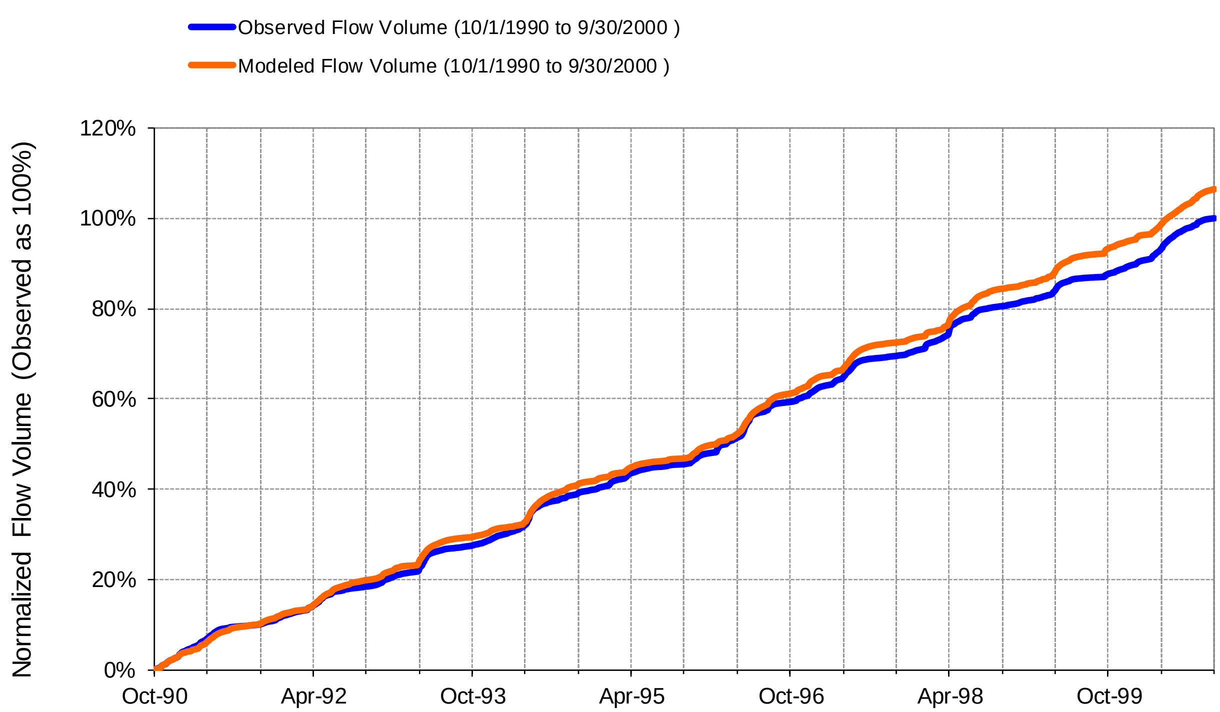


Figure D-14. Flow accumulation at USGS 04282000 Otter Creek at Center Rutland, VT

Table D-4. Summary statistics at USGS 04282000 Otter Creek at Center Rutland, VT

SWAT Simulated Flow		Observed Flow Gage	
REACH OUTFLOW FROM OUTLET 19 10-Year Analysis Period: 10/1/1990 - 9/30/2000 Flow volumes are (inches/year) for upstream drainage area		USGS 04282000 OTTER CREEK AT CENTER RUTLAND, VT Hydrologic Unit Code: 2010002 Latitude: 43.6036792 Longitude: -73.0131628 Drainage Area (sq-mi): 307	
Total Simulated In-stream Flow:	**26.01**	Total Observed In-stream Flow:	**24.42**
Total of simulated highest 10% flows:	**8.45**	Total of Observed highest 10% flows:	**8.76**
Total of Simulated lowest 50% flows:	**4.70**	Total of Observed Lowest 50% flows:	**4.55**
Simulated Summer Flow Volume (months 7-9):	**4.24**	Observed Summer Flow Volume (7-9):	**2.98**
Simulated Fall Flow Volume (months 10-12):	**5.48**	Observed Fall Flow Volume (10-12):	**5.36**
Simulated Winter Flow Volume (months 1-3):	**5.91**	Observed Winter Flow Volume (1-3):	**6.90**
Simulated Spring Flow Volume (months 4-6):	**10.37**	Observed Spring Flow Volume (4-6):	**9.18**
Total Simulated Storm Volume:	**7.44**	Total Observed Storm Volume:	**7.98**
Simulated Summer Storm Volume (7-9):	**1.29**	Observed Summer Storm Volume (7-9):	**1.18**

Errors (Simulated-Observed)	*Error Statistics*	*Recommended Criteria*		
Error in total volume:	6.48	10		
Error in 50% lowest flows:	3.31	10		
Error in 10% highest flows:	-3.62	15		
Seasonal volume error - Summer:	42.06	30		
Seasonal volume error - Fall:	2.18	>> 30		Clear
Seasonal volume error - Winter:	-14.25	30		
Seasonal volume error - Spring:	13.00	30		
Error in storm volumes:	-6.78	20		
Error in summer storm volumes:	9.55	50		
Nash-Sutcliffe Coefficient of Efficiency, E:	0.724	Model accuracy increases		
Baseline adjusted coefficient (Garrick), E':	0.491	as E or E' approaches 1.0		
Monthly NSE	0.844			

USGS 04282525 New Haven River @ Brooksville near Middlebury, VT - Calibration

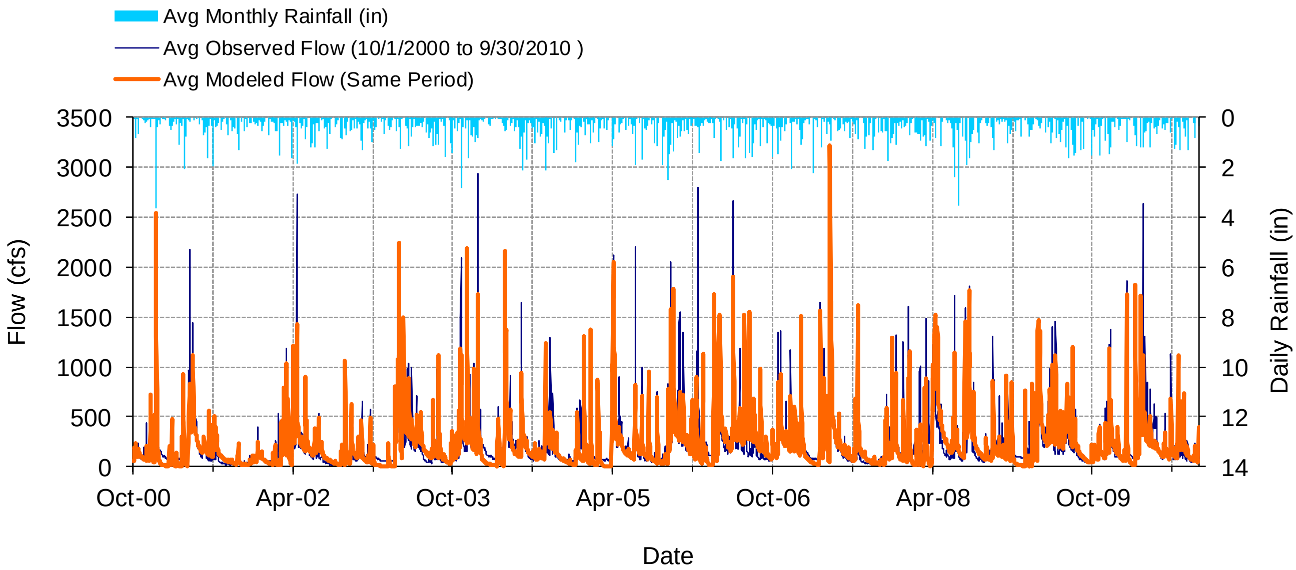


Figure D-15. Mean daily flow at USGS 04282525 New Haven River @ Brooksville near Middlebury, VT

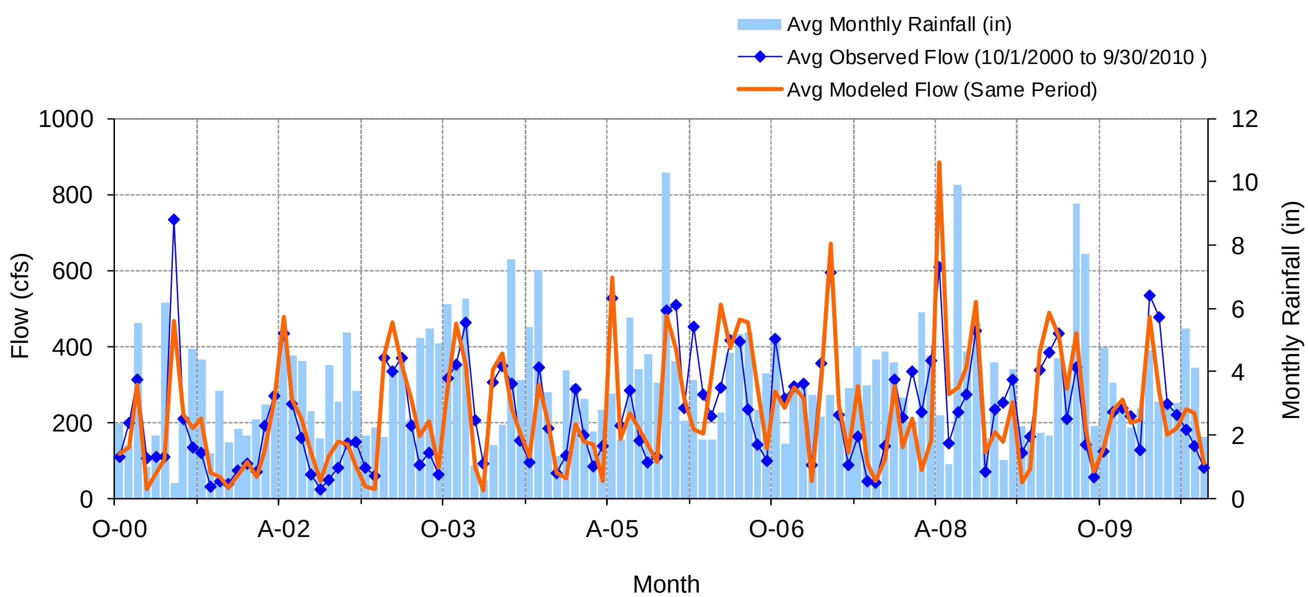


Figure D-16. Mean monthly flow at USGS 04282525 New Haven River @ Brooksville near Middlebury, VT

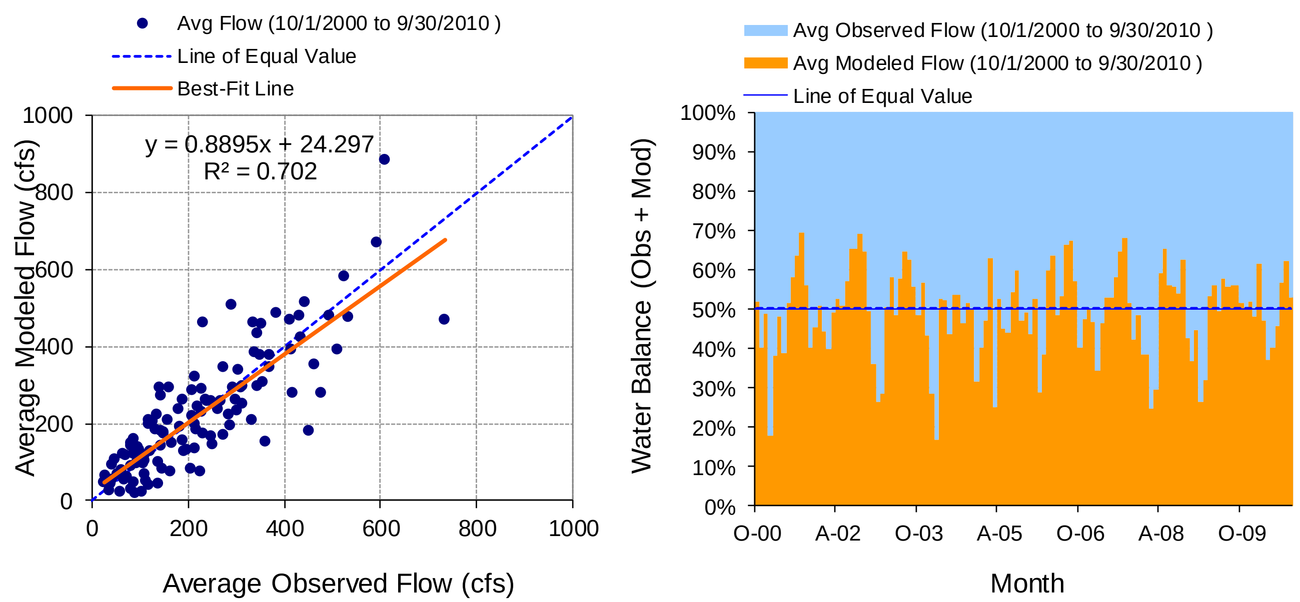


Figure D-17. Monthly flow regression and temporal variation at USGS 04282525 New Haven River @ Brooksville near Middlebury, VT

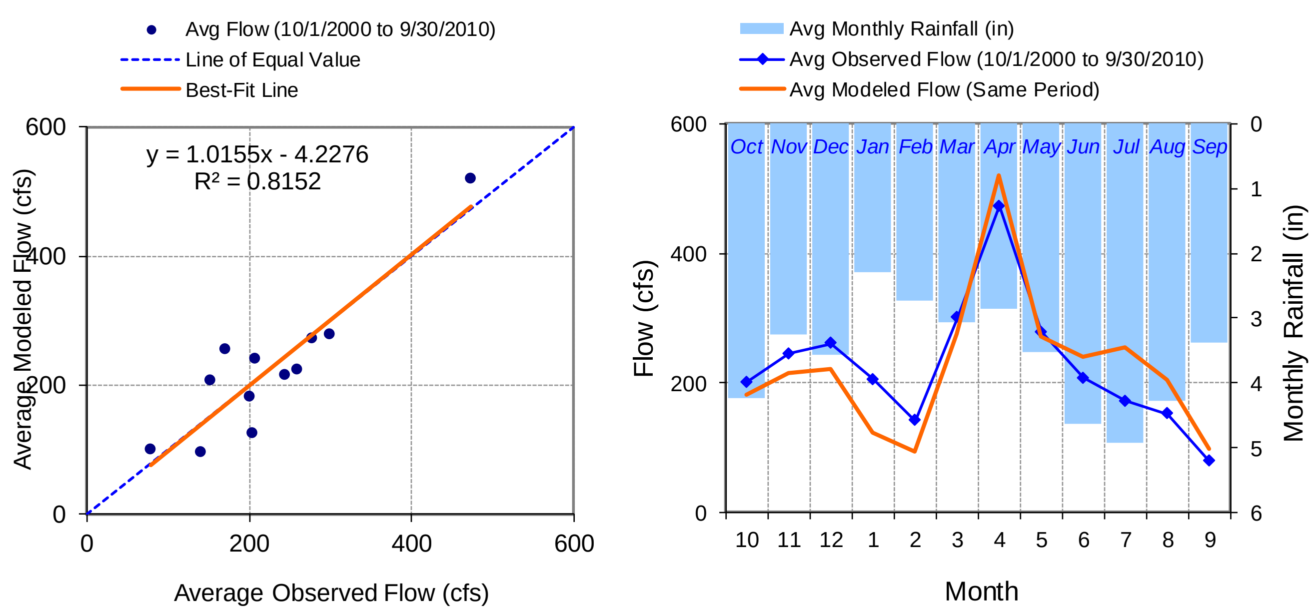


Figure D-18. Seasonal regression and temporal aggregate at USGS 04282525 New Haven River @ Brooksville near Middlebury, VT

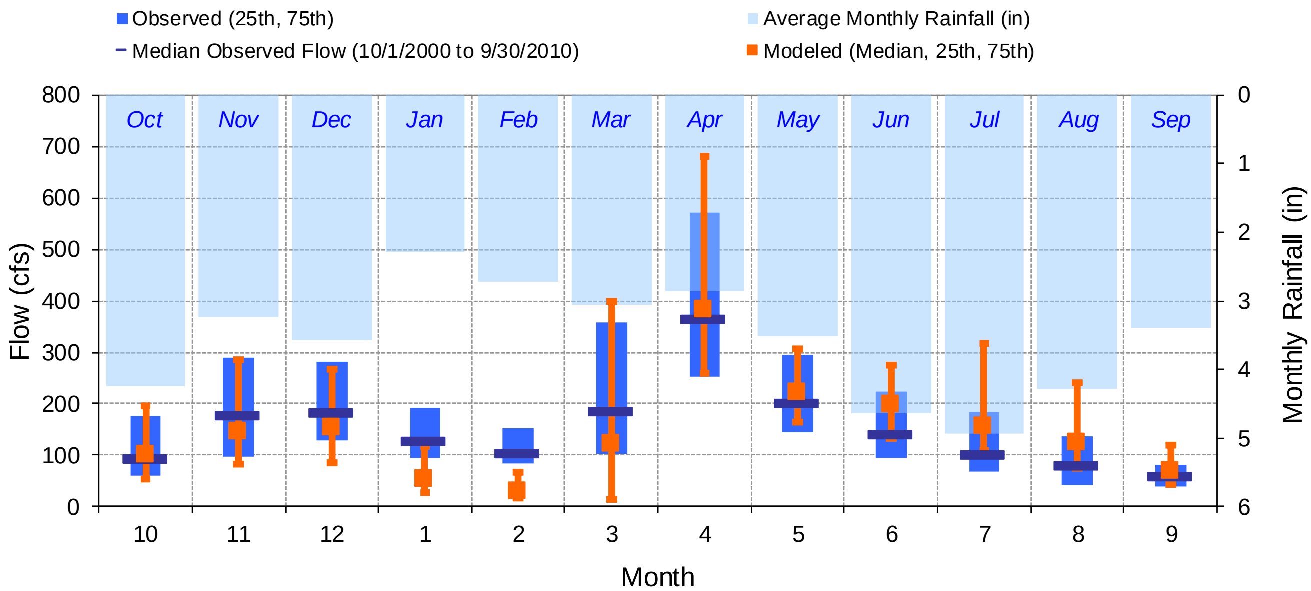


Figure D-19. Seasonal medians and ranges at USGS 04282525 New Haven River @ Brooksville near Middlebury, VT

Table D-5. Seasonal summary at USGS 04282525 New Haven River @ Brooksville near Middlebury, VT

MONTH	OBSERVED FLOW (CFS)				MODELED FLOW (CFS)			
	MEAN	MEDIAN	25TH	75TH	MEAN	MEDIAN	25TH	75TH
Oct	201.27	92.00	60.00	175.75	181.68	101.30	53.02	196.98
Nov	244.67	178.00	98.50	289.75	214.76	147.14	82.21	285.32
Dec	260.06	184.00	128.00	282.25	222.27	153.60	85.35	267.28
Jan	204.73	127.00	95.00	191.50	123.35	52.90	28.53	117.65
Feb	141.34	104.50	83.00	153.75	94.70	30.08	16.88	66.97
Mar	299.94	185.50	103.25	357.25	276.50	123.51	15.16	397.82
Apr	473.13	365.00	251.75	571.25	519.56	384.22	260.05	679.81
May	278.18	201.00	144.25	293.50	272.10	222.80	163.49	307.93
Jun	207.57	142.00	95.00	222.50	240.11	198.98	133.10	276.05
Jul	171.18	100.00	69.25	184.25	255.22	155.67	108.11	316.90
Aug	151.87	80.50	41.00	137.50	205.57	125.56	75.09	240.20
Sep	78.93	60.00	38.75	81.25	98.38	69.99	43.29	120.73

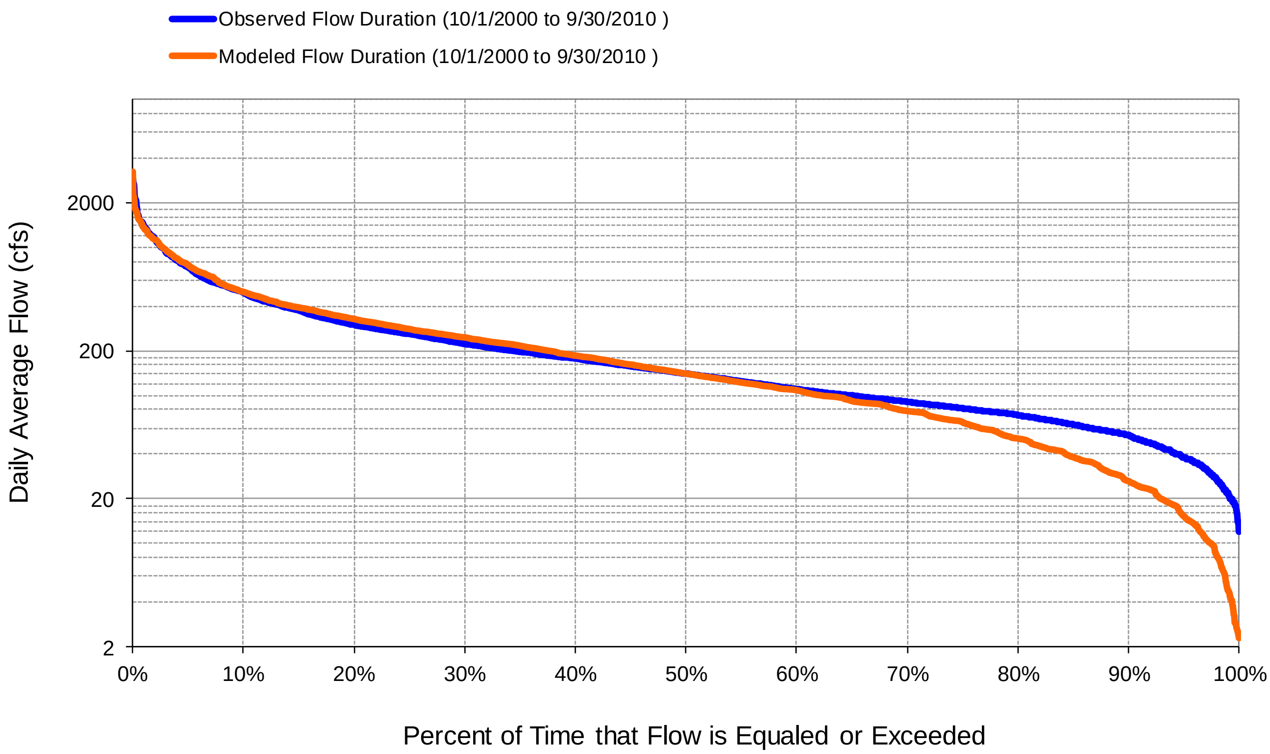


Figure D-20. Flow exceedence at USGS 04282525 New Haven River @ Brooksville near Middlebury, VT

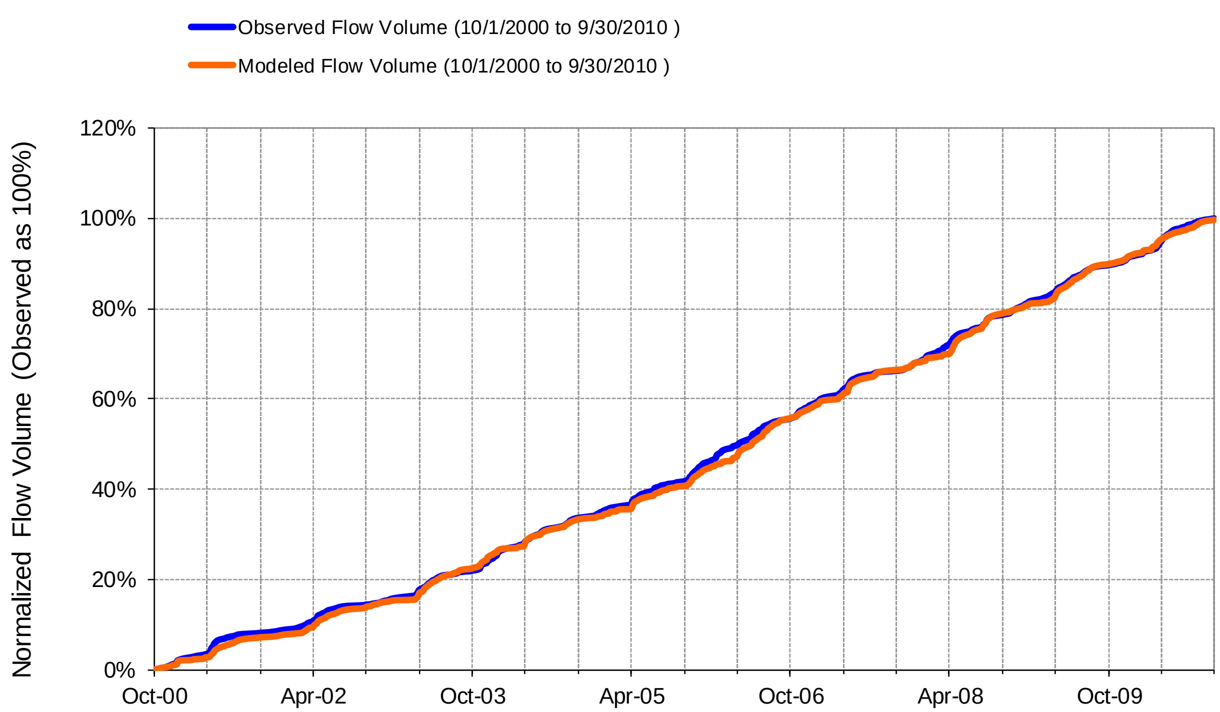


Figure D-21. Flow accumulation at USGS 04282525 New Haven River @ Brooksville near Middlebury, VT

Table D-6. Summary statistics at USGS 04282525 New Haven River @ Brooksville near Middlebury, VT

SWAT Simulated Flow		Observed Flow Gage	
REACH OUTFLOW FROM OUTLET 5 10-Year Analysis Period: 10/1/2000 - 9/30/2010 Flow volumes are (inches/year) for upstream drainage area		USGS 04282525 NEW HAVEN RIVER @ BROOKSVILLE, NR MIDDLEBURY, VT Hydrologic Unit Code: 2010002 Latitude: 44.0617249 Longitude: -73.17067429 Drainage Area (sq-mi): 115	
Total Simulated In-stream Flow:	**26.68**	Total Observed In-stream Flow:	**26.75**
Total of simulated highest 10% flows:	**10.27**	Total of Observed highest 10% flows:	**10.26**
Total of Simulated lowest 50% flows:	**3.95**	Total of Observed Lowest 50% flows:	**4.81**
Simulated Summer Flow Volume (months 7-9):	**5.57**	Observed Summer Flow Volume (7-9):	**4.00**
Simulated Fall Flow Volume (months 10-12):	**6.13**	Observed Fall Flow Volume (10-12):	**7.00**
Simulated Winter Flow Volume (months 1-3):	**4.87**	Observed Winter Flow Volume (1-3):	**6.35**
Simulated Spring Flow Volume (months 4-6):	**10.10**	Observed Spring Flow Volume (4-6):	**9.39**
Total Simulated Storm Volume:	**8.51**	Total Observed Storm Volume:	**9.04**
Simulated Summer Storm Volume (7-9):	**1.67**	Observed Summer Storm Volume (7-9):	**1.58**
Errors (Simulated-Observed)	*Error Statistics*	*Recommended Criteria*	
Error in total volume:	-0.25	10	
Error in 50% lowest flows:	-17.80	10	
Error in 10% highest flows:	0.15	15	
Seasonal volume error - Summer:	39.19	30	
Seasonal volume error - Fall:	-12.36	>> 30	Clear
Seasonal volume error - Winter:	-23.25	30	
Seasonal volume error - Spring:	7.51	30	
Error in storm volumes:	-5.90	20	
Error in summer storm volumes:	5.48	50	
Nash-Sutcliffe Coefficient of Efficiency, E:	0.500	Model accuracy increases	
Baseline adjusted coefficient (Garrick), E':	0.361	as E or E' approaches 1.0	
Monthly NSE	0.652		

USGS 04282525 New Haven River @ Brooksville near Middlebury, VT - Validation

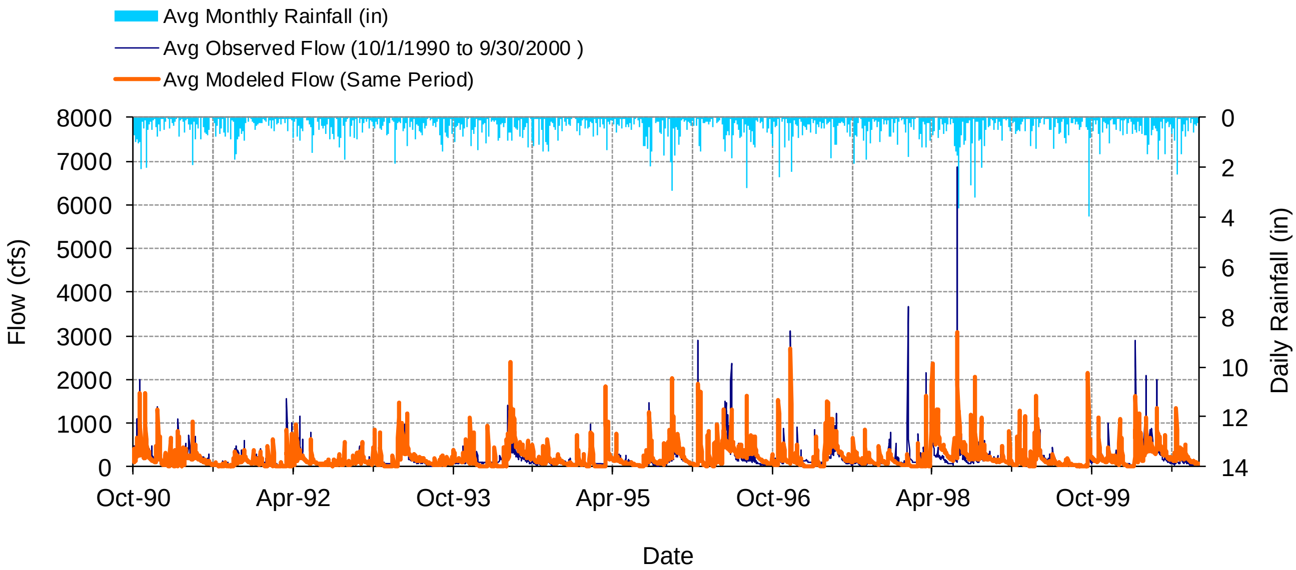


Figure D-22. Mean daily flow at USGS 04282525 New Haven River @ Brooksville near Middlebury, VT

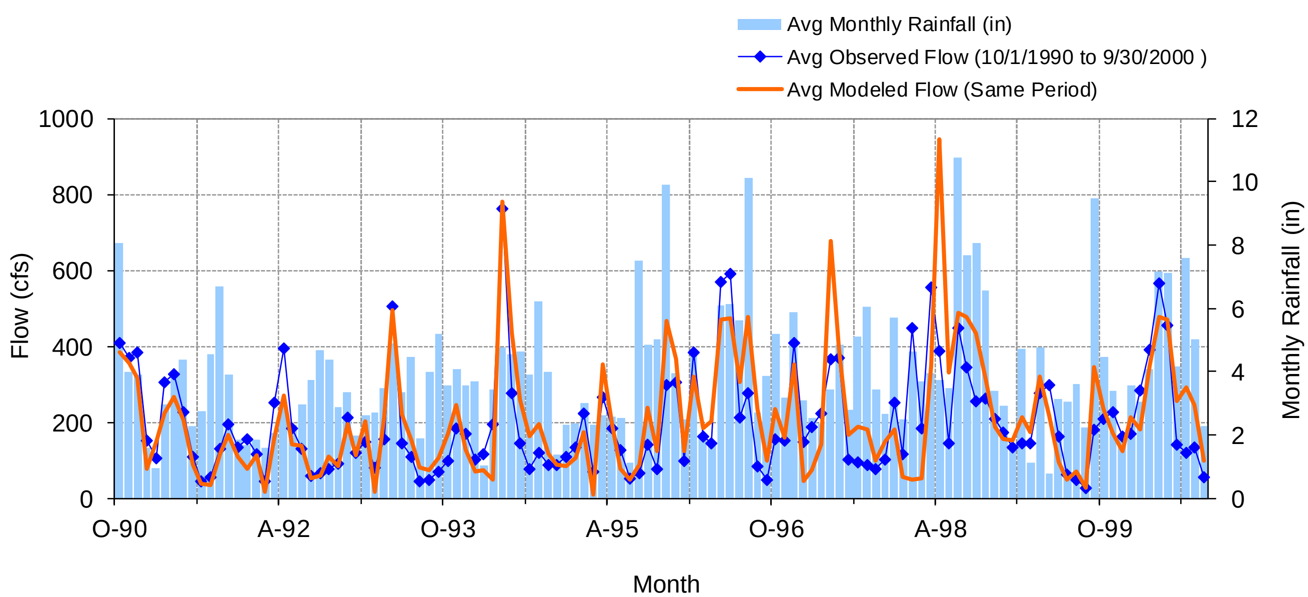


Figure D-23. Mean monthly flow at USGS 04282525 New Haven River @ Brooksville near Middlebury, VT

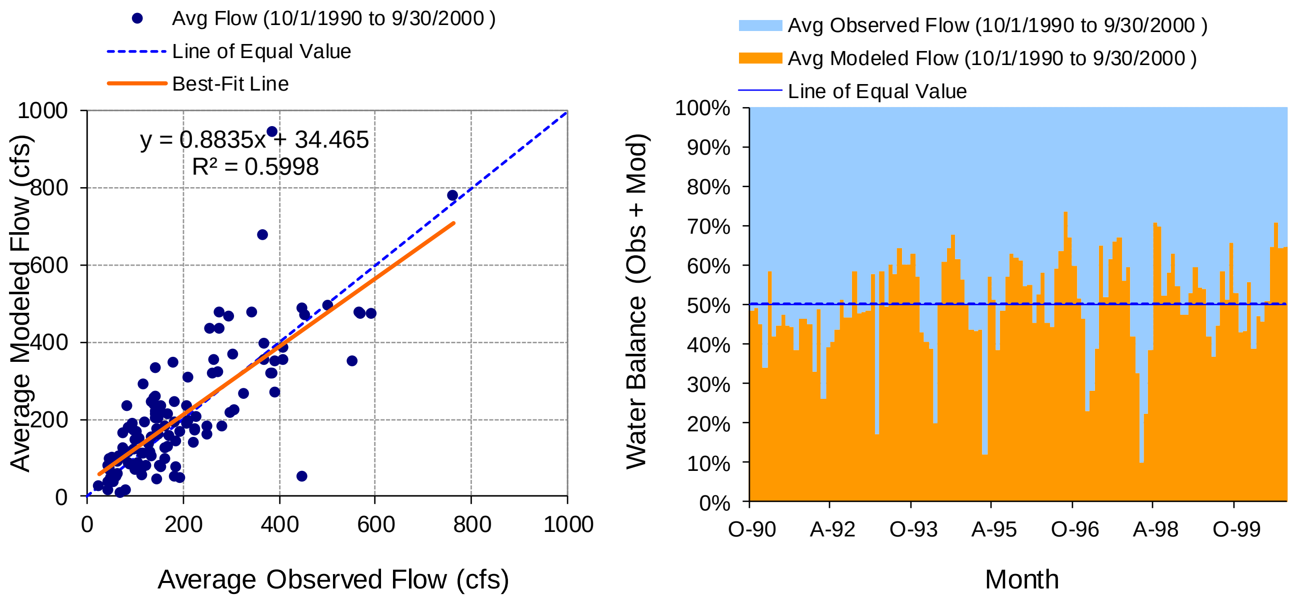


Figure D-24. Monthly flow regression and temporal variation at USGS 04282525 New Haven River @ Brooksville near Middlebury, VT

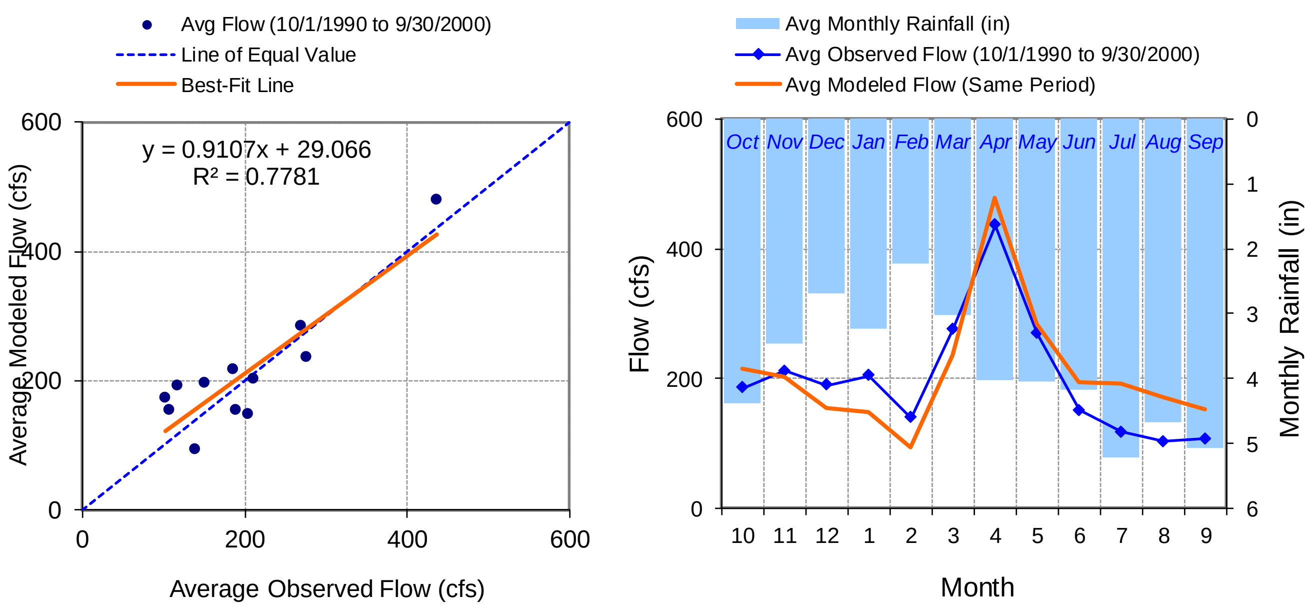


Figure D-25. Seasonal regression and temporal aggregate at USGS 04282525 New Haven River @ Brooksville near Middlebury, VT

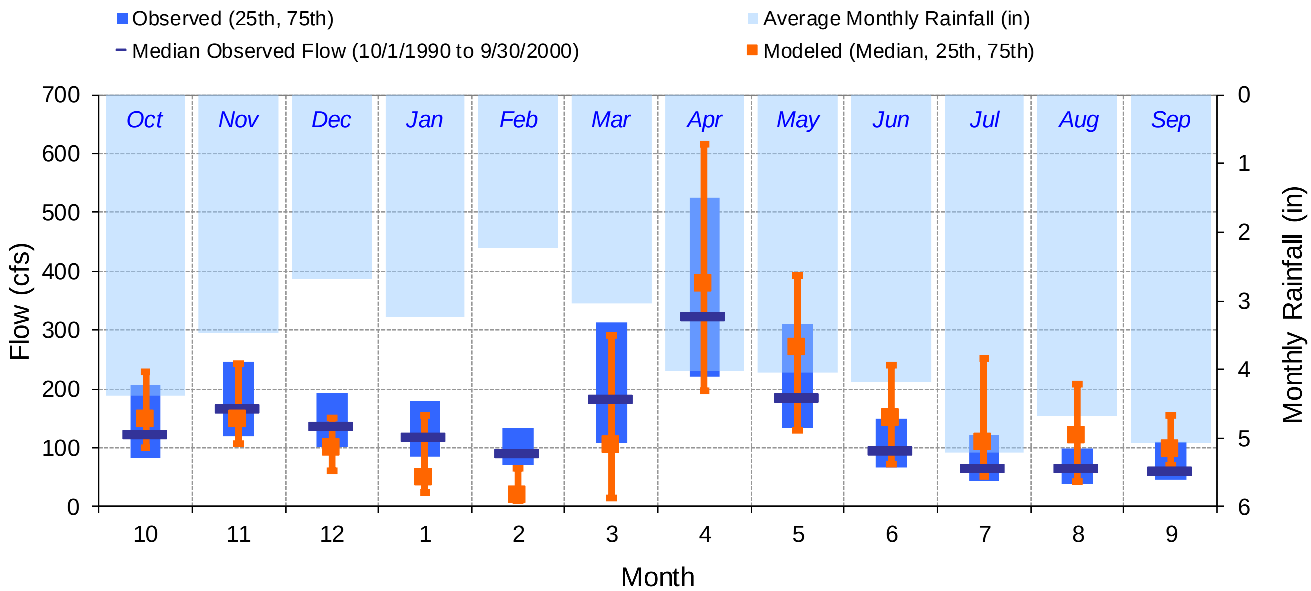


Figure D-26. Seasonal medians and ranges at USGS 04282525 New Haven River @ Brooksville near Middlebury, VT

Table D-7. Seasonal summary at USGS 04282525 New Haven River @ Brooksville near Middlebury, VT

MONTH	OBSERVED FLOW (CFS)				MODELED FLOW (CFS)			
	MEAN	MEDIAN	25TH	75TH	MEAN	MEDIAN	25TH	75TH
Oct	185.02	122.00	82.25	207.00	215.93	149.13	99.02	229.94
Nov	211.30	167.00	119.75	247.25	202.26	148.25	107.64	243.07
Dec	188.91	137.50	101.00	193.75	154.30	100.47	61.67	150.18
Jan	204.20	119.50	85.00	180.00	147.44	49.74	24.67	154.33
Feb	138.78	90.00	71.00	133.00	93.02	19.44	10.28	65.03
Mar	276.29	184.00	108.00	313.00	236.20	104.87	14.14	292.17
Apr	436.27	324.00	221.75	524.75	478.51	378.04	196.55	616.51
May	268.78	184.50	133.00	310.75	284.48	270.25	129.60	392.70
Jun	150.79	96.00	67.00	150.25	194.63	151.50	73.00	240.03
Jul	117.70	65.00	44.00	122.00	191.84	108.42	52.18	252.53
Aug	102.29	65.50	40.00	99.75	171.53	120.18	42.14	208.15
Sep	106.98	62.00	47.00	110.75	152.73	97.50	69.00	156.41

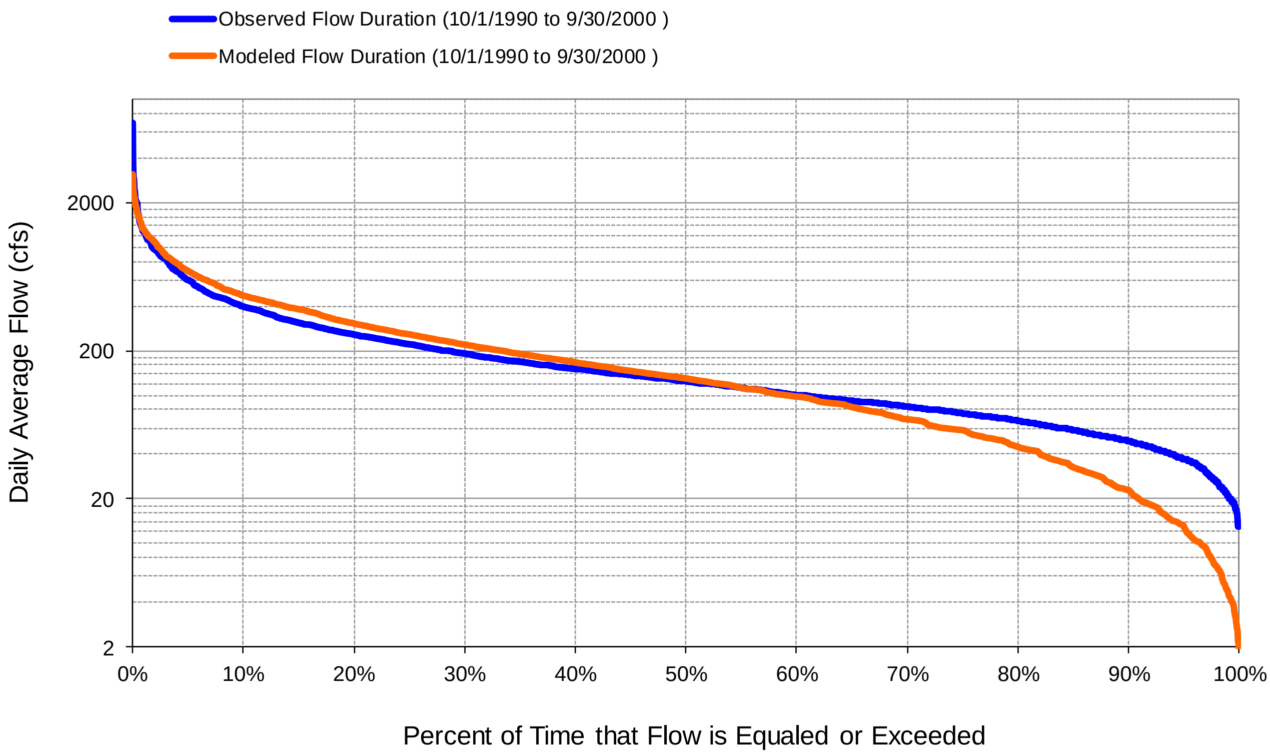


Figure D-27. Flow exceedence at USGS 04282525 New Haven River @ Brooksville near Middlebury, VT

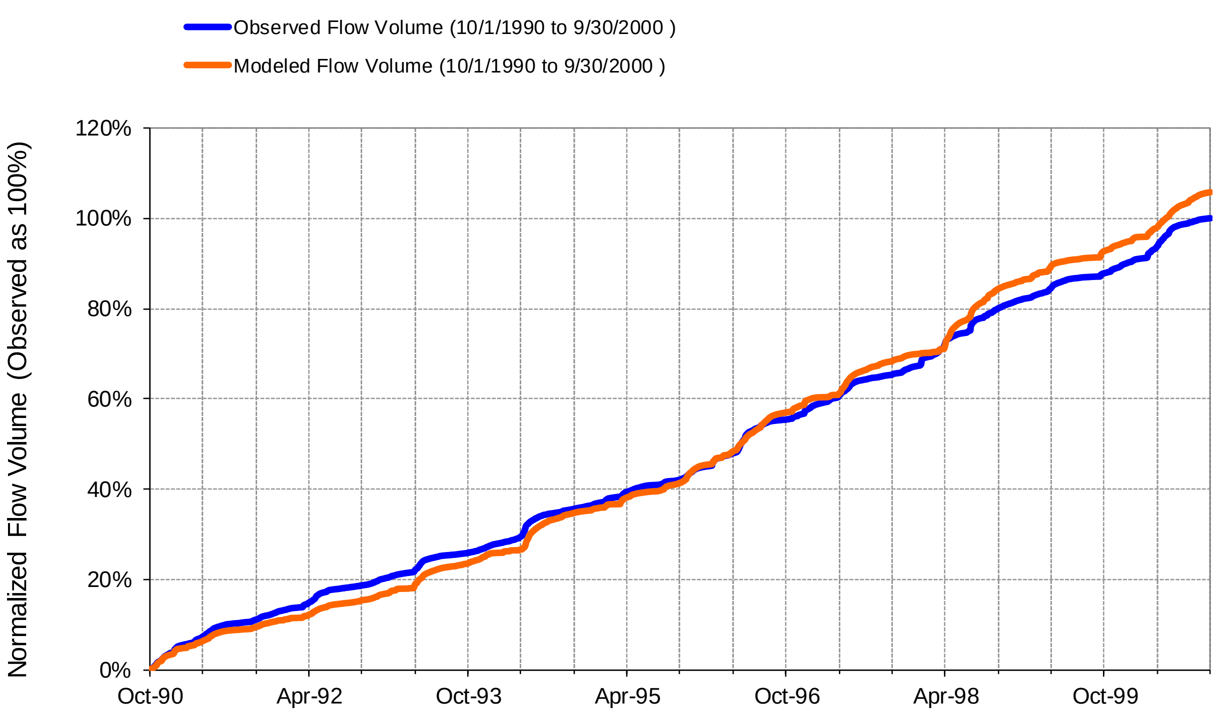


Figure D-28. Flow accumulation at USGS 04282525 New Haven River @ Brooksville near Middlebury, VT

Table D-8. Summary statistics at USGS 04282525 New Haven River @ Brooksville near Middlebury, VT

SWAT Simulated Flow		Observed Flow Gage		
REACH OUTFLOW FROM OUTLET 5		USGS 04282525 NEW HAVEN RIVER @ BROOKSVILLE, NR MIDDLEBURY, VT		
10-Year Analysis Period: 10/1/1990 - 9/30/2000 Flow volumes are (inches/year) for upstream drainage area		Hydrologic Unit Code: 2010002 Latitude: 44.0617249 Longitude: -73.17067429 Drainage Area (sq-mi): 115		
Total Simulated In-stream Flow:	**24.87**	Total Observed In-stream Flow:		**23.52**
Total of simulated highest 10% flows:	**9.79**	Total of Observed highest 10% flows:		**9.15**
Total of Simulated lowest 50% flows:	**3.54**	Total of Observed Lowest 50% flows:		**4.42**
Simulated Summer Flow Volume (months 7-9):	**5.12**	Observed Summer Flow Volume (7-9):		**3.24**
Simulated Fall Flow Volume (months 10-12):	**5.67**	Observed Fall Flow Volume (10-12):		**5.80**
Simulated Winter Flow Volume (months 1-3):	**4.70**	Observed Winter Flow Volume (1-3):		**6.09**
Simulated Spring Flow Volume (months 4-6):	**9.38**	Observed Spring Flow Volume (4-6):		**8.39**
Total Simulated Storm Volume:	**7.98**	Total Observed Storm Volume:		**7.60**
Simulated Summer Storm Volume (7-9):	**1.58**	Observed Summer Storm Volume (7-9):		**1.30**
Errors (Simulated-Observed)	*Error Statistics*	*Recommended Criteria*		
Error in total volume:	5.78	10		
Error in 50% lowest flows:	-19.90	10		
Error in 10% highest flows:	7.00	15		
Seasonal volume error - Summer:	58.00	30		
Seasonal volume error - Fall:	-2.15	>> 30		Clear
Seasonal volume error - Winter:	-22.83	30		
Seasonal volume error - Spring:	11.83	30		
Error in storm volumes:	4.87	20		
Error in summer storm volumes:	21.29	50		
Nash-Sutcliffe Coefficient of Efficiency, E:	0.426	Model accuracy increases		
Baseline adjusted coefficient (Garrick), E':	0.265	as E or E' approaches 1.0		
Monthly NSE	0.459			

USGS 04282500 Otter Creek at Middlebury, VT - Calibration

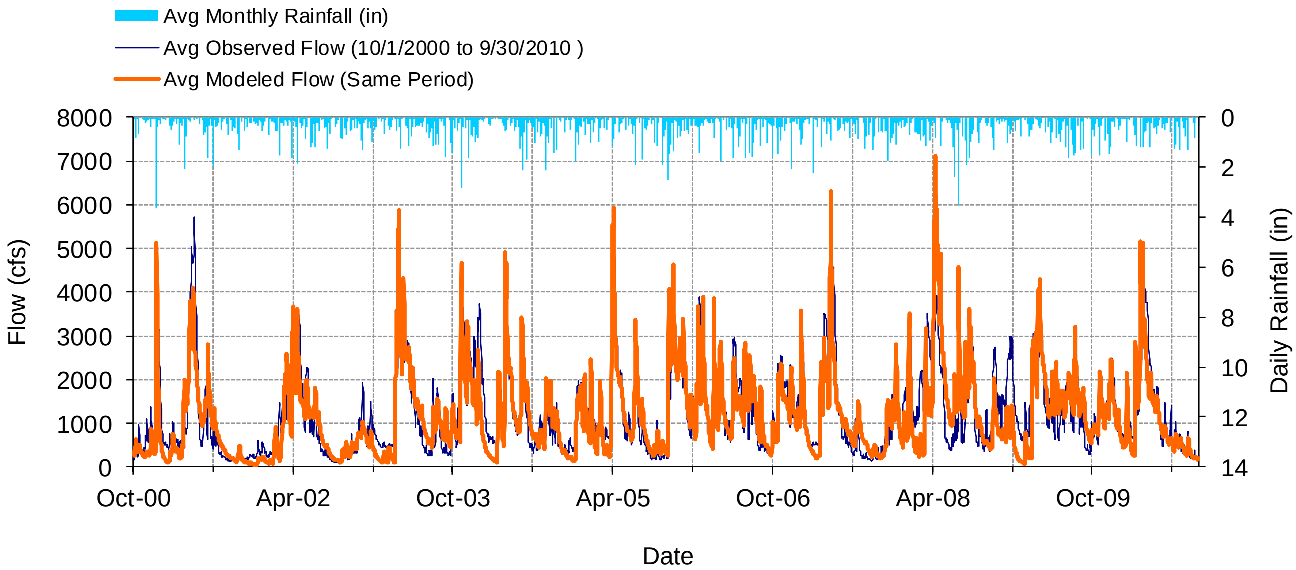


Figure D-29. Mean daily flow at USGS 04282500 Otter Creek at Middlebury, VT

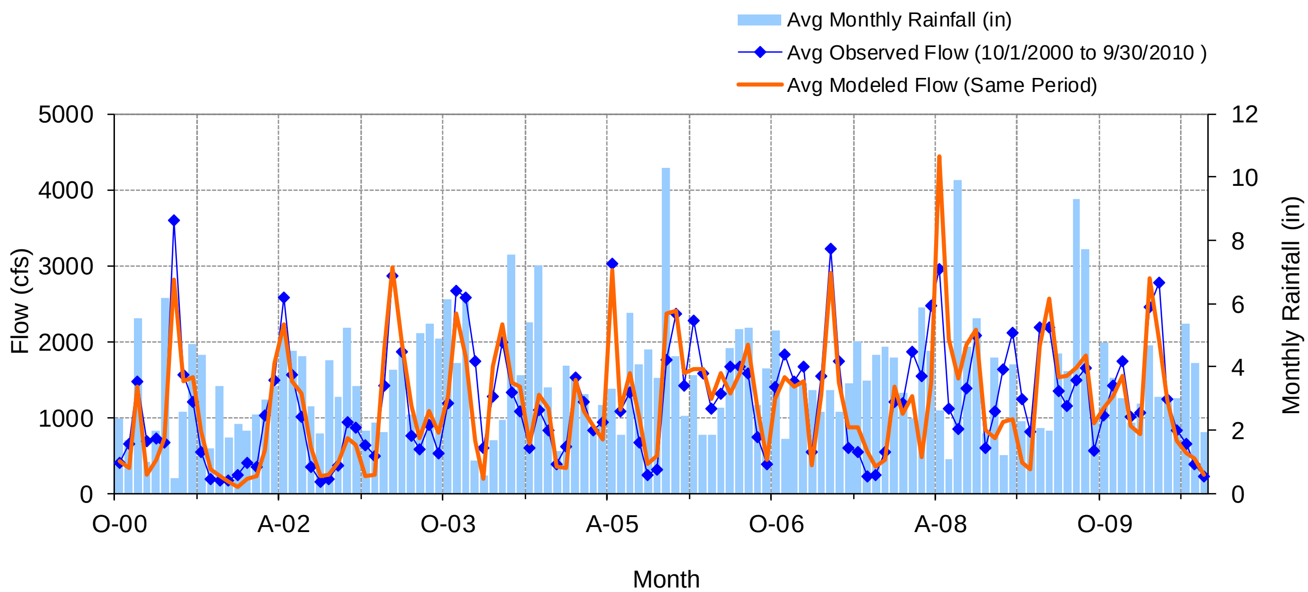


Figure D-30. Mean monthly flow at USGS 04282500 Otter Creek at Middlebury, VT

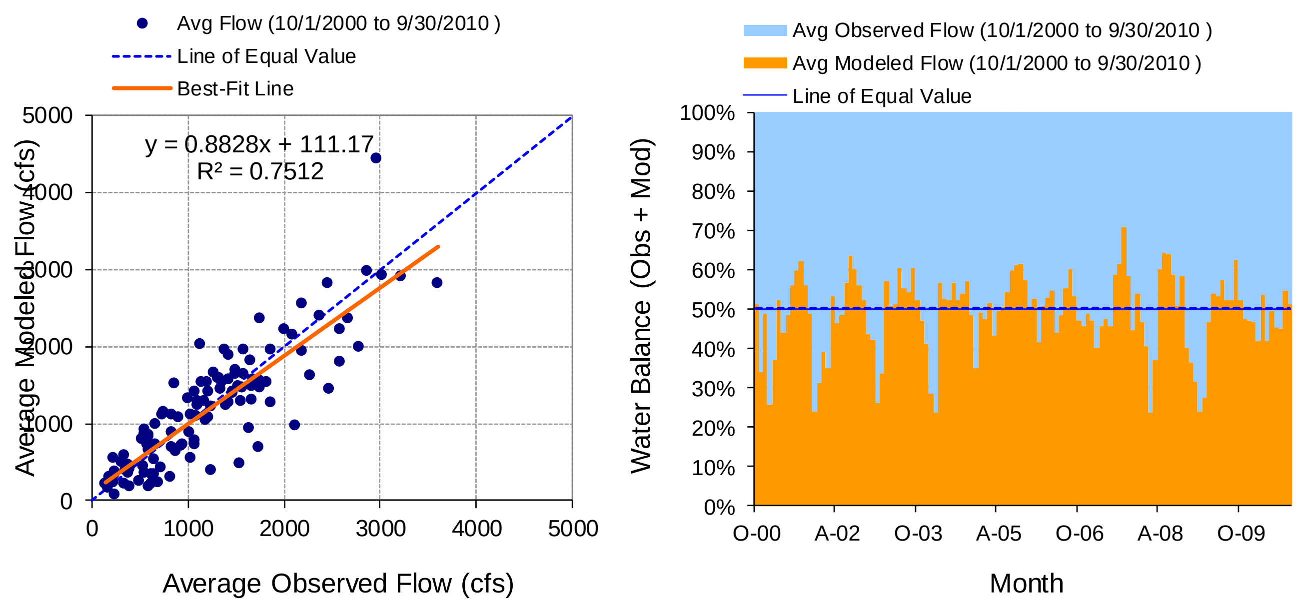


Figure D-31. Monthly flow regression and temporal variation at USGS 04282500 Otter Creek at Middlebury, VT

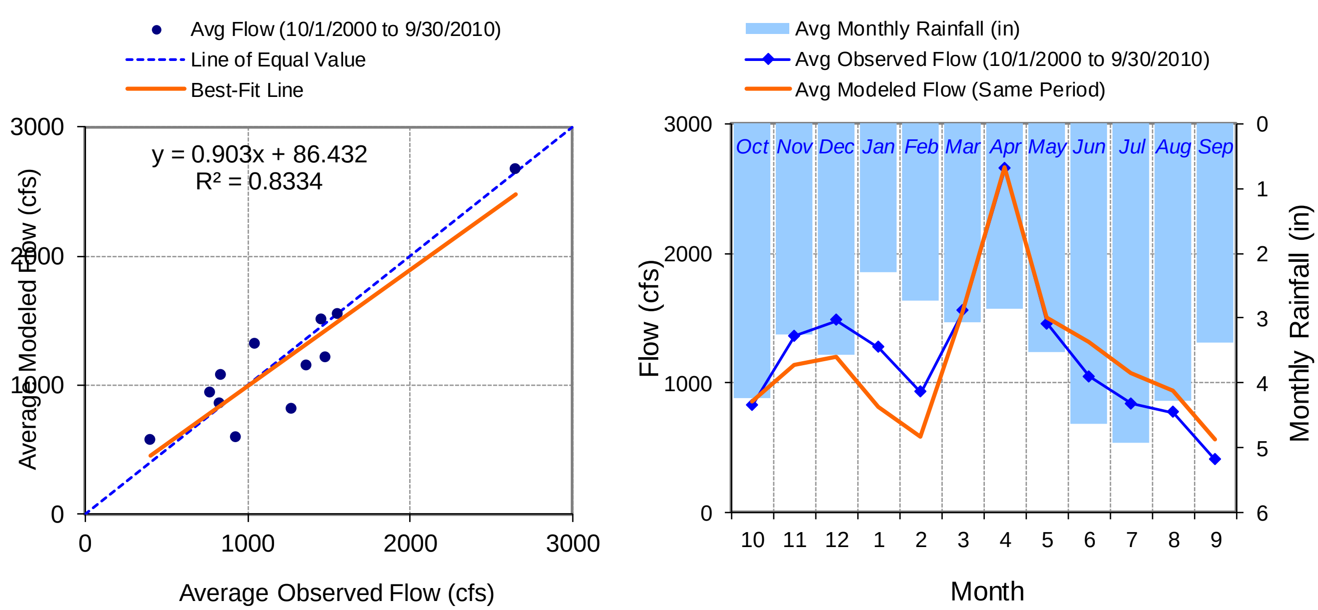


Figure D-32. Seasonal regression and temporal aggregate at USGS 04282500 Otter Creek at Middlebury, VT

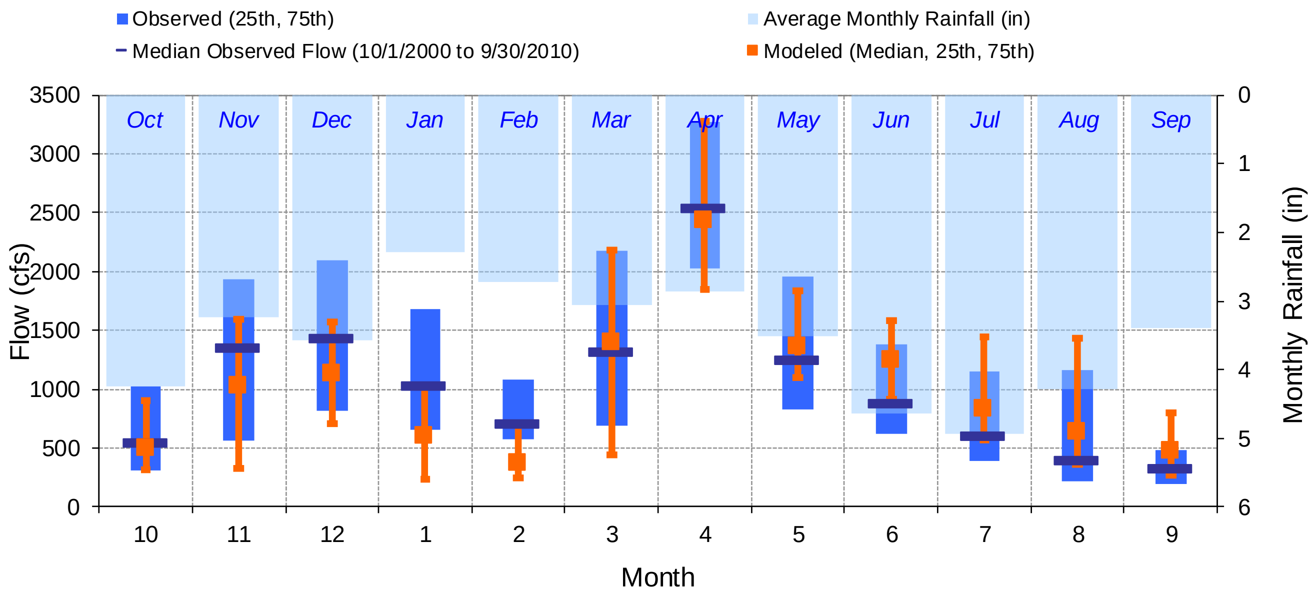


Figure D-33. Seasonal medians and ranges at USGS 04282500 Otter Creek at Middlebury, VT

Table D-9. Seasonal summary at USGS 04282500 Otter Creek at Middlebury, VT

MONTH	OBSERVED FLOW (CFS)				MODELED FLOW (CFS)			
	MEAN	MEDIAN	25TH	75TH	MEAN	MEDIAN	25TH	75TH
Oct	828.09	551.50	307.50	1027.50	850.81	497.94	319.64	898.93
Nov	1359.63	1350.00	564.75	1940.00	1140.87	1026.60	332.79	1597.55
Dec	1478.54	1430.00	820.00	2095.00	1204.67	1132.54	702.06	1571.41
Jan	1268.66	1025.00	660.00	1677.50	812.58	602.12	239.81	1020.15
Feb	925.03	710.00	580.00	1077.50	585.45	378.40	243.97	695.43
Mar	1555.85	1320.00	687.50	2172.50	1546.89	1402.70	442.32	2187.13
Apr	2653.84	2535.00	2030.00	3272.50	2668.40	2441.48	1842.98	3276.49
May	1456.42	1255.00	829.25	1957.50	1502.61	1370.39	1095.11	1836.10
Jun	1048.70	876.00	623.75	1380.00	1318.79	1243.96	918.71	1582.72
Jul	839.03	605.00	393.25	1150.00	1073.77	834.84	572.10	1445.25
Aug	766.91	400.00	215.25	1167.50	937.72	643.08	364.01	1437.13
Sep	405.45	332.00	194.75	488.00	565.84	478.69	270.28	798.55

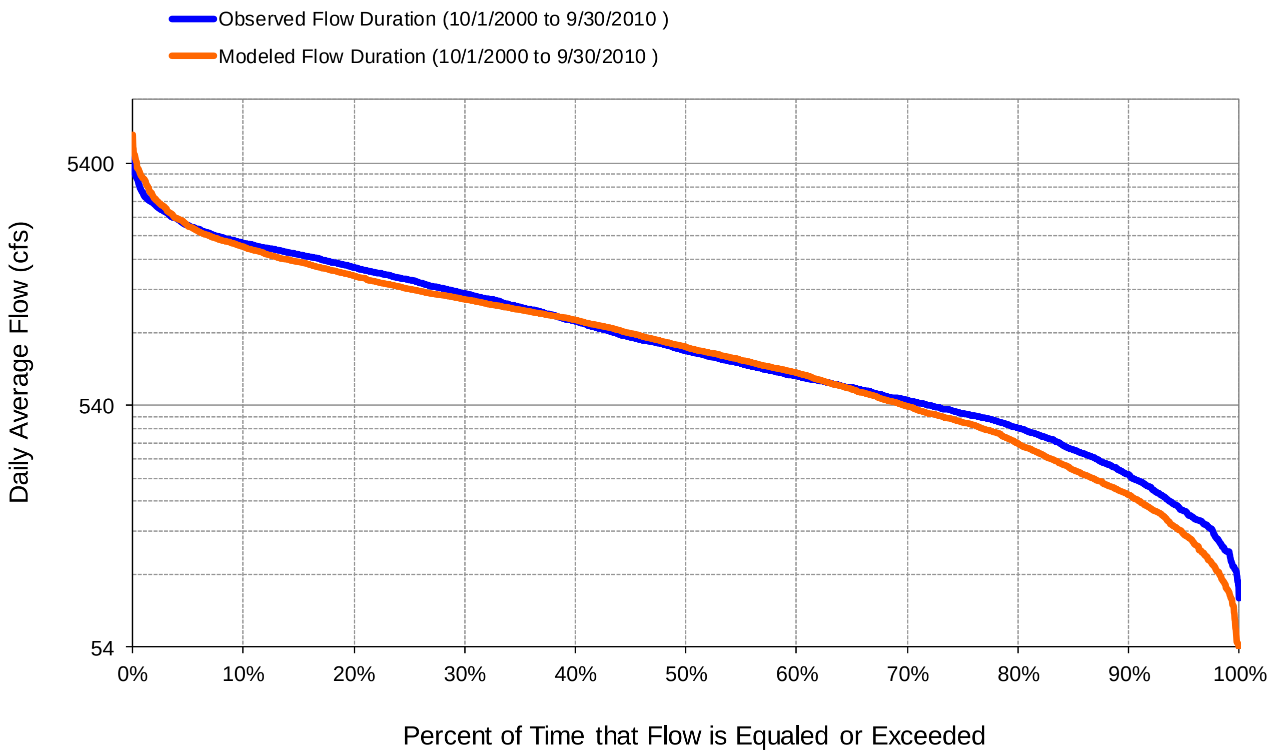


Figure D-34. Flow exceedence at USGS 04282500 Otter Creek at Middlebury, VT

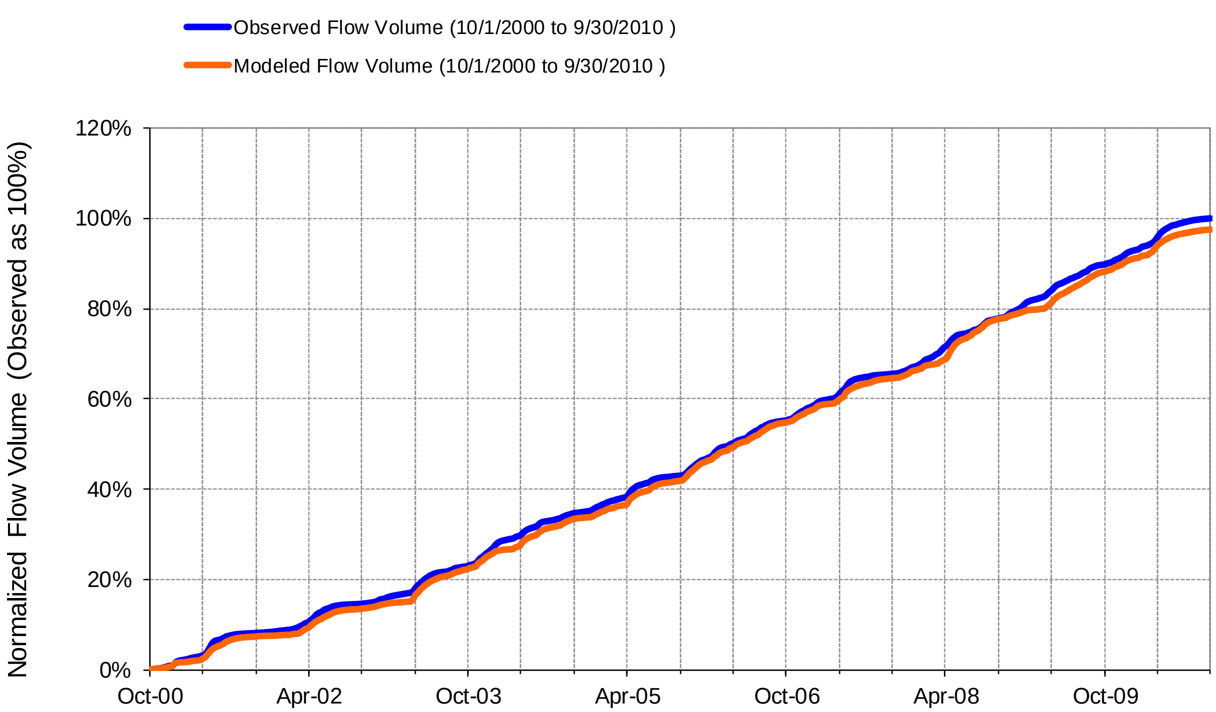


Figure D-35. Flow accumulation at USGS 04282500 Otter Creek at Middlebury, VT

Table D-10. Summary statistics at USGS 04282500 Otter Creek at Middlebury, VT

SWAT Simulated Flow		Observed Flow Gage	
REACH OUTFLOW FROM OUTLET 9 10-Year Analysis Period: 10/1/2000 - 9/30/2010 Flow volumes are (inches/year) for upstream drainage area		USGS 04282500 OTTER CREEK AT MIDDLEBURY, VT Hydrologic Unit Code: 2010002 Latitude: 44.01311488 Longitude: -73.1678954 Drainage Area (sq-mi): 628	
Total Simulated In-stream Flow:	**25.65**	Total Observed In-stream Flow:	**26.30**
Total of simulated highest 10% flows:	**7.15**	Total of Observed highest 10% flows:	**6.92**
Total of Simulated lowest 50% flows:	**5.14**	Total of Observed Lowest 50% flows:	**5.41**
Simulated Summer Flow Volume (months 7-9):	**4.70**	Observed Summer Flow Volume (7-9):	**3.67**
Simulated Fall Flow Volume (months 10-12):	**5.80**	Observed Fall Flow Volume (10-12):	**6.65**
Simulated Winter Flow Volume (months 1-3):	**5.31**	Observed Winter Flow Volume (1-3):	**6.73**
Simulated Spring Flow Volume (months 4-6):	**9.84**	Observed Spring Flow Volume (4-6):	**9.25**
Total Simulated Storm Volume:	**4.83**	Total Observed Storm Volume:	**4.70**
Simulated Summer Storm Volume (7-9):	**0.79**	Observed Summer Storm Volume (7-9):	**0.94**

Errors (Simulated-Observed)	*Error Statistics*	*Recommended Criteria*
Error in total volume:	-2.47	10
Error in 50% lowest flows:	-4.94	10
Error in 10% highest flows:	3.37	15
Seasonal volume error - Summer:	28.06	30
Seasonal volume error - Fall:	-12.78	30
Seasonal volume error - Winter:	-21.11	30
Seasonal volume error - Spring:	6.38	30
Error in storm volumes:	2.81	20
Error in summer storm volumes:	-15.81	50
Nash-Sutcliffe Coefficient of Efficiency, E:	0.610	Model accuracy increases
Baseline adjusted coefficient (Garrick), E':	0.473	as E or E' approaches 1.0
Monthly NSE	0.726	

>> Clear

USGS 04282500 Otter Creek at Middlebury, VT - Validation

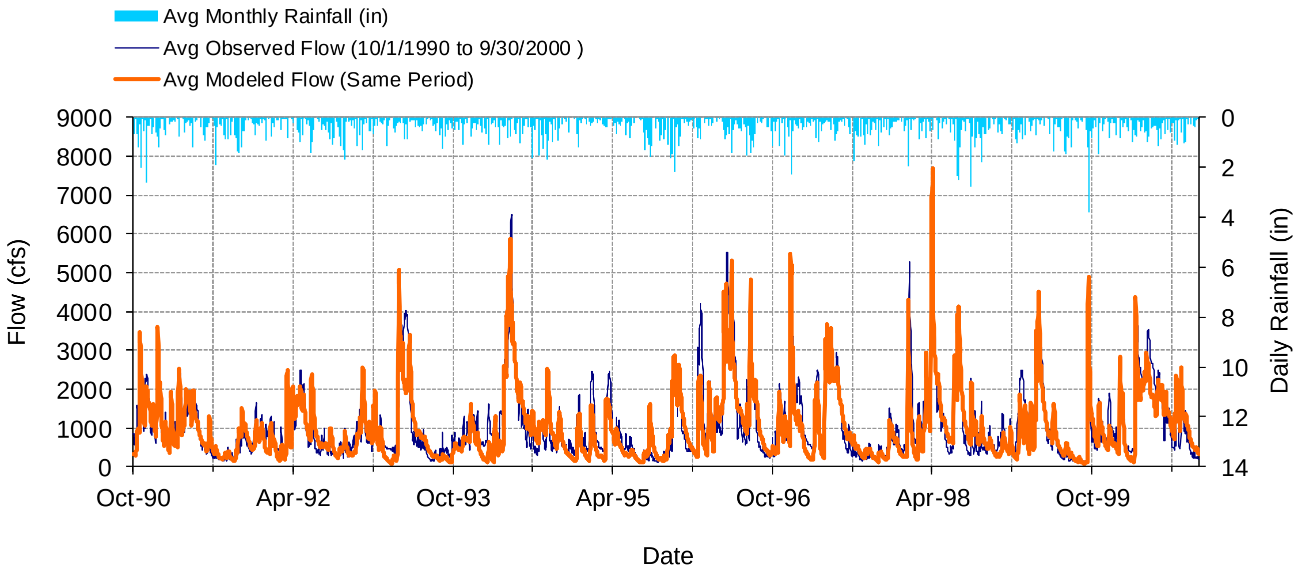


Figure D-36. Mean daily flow at USGS 04282500 Otter Creek at Middlebury, VT

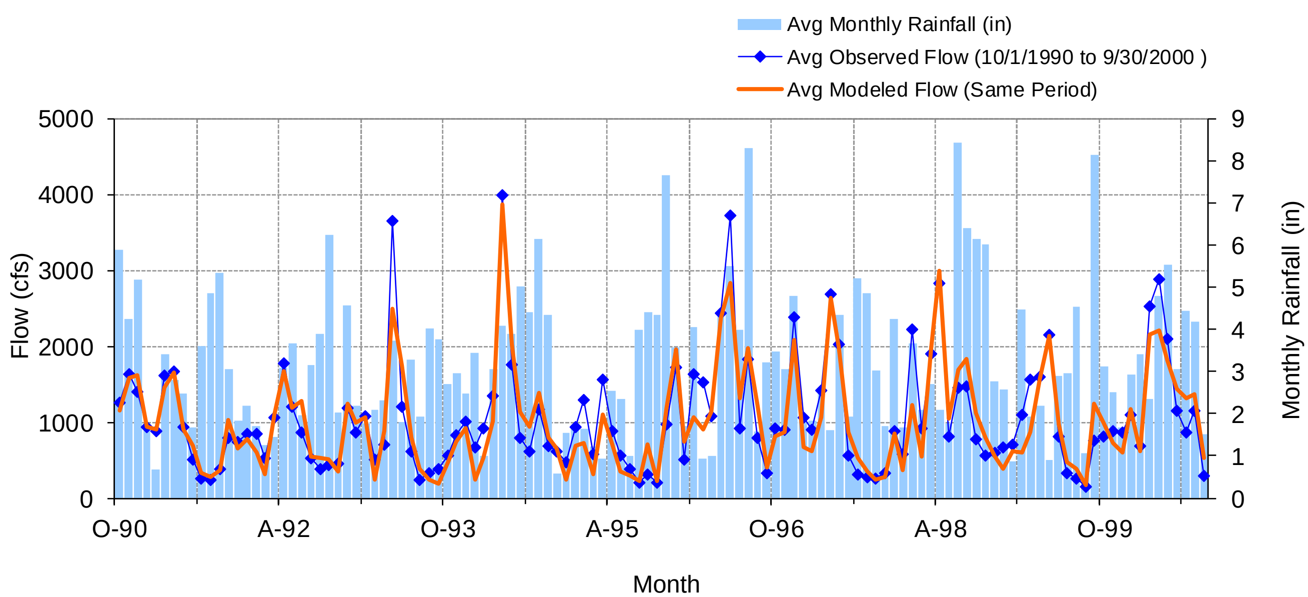


Figure D-37. Mean monthly flow at USGS 04282500 Otter Creek at Middlebury, VT

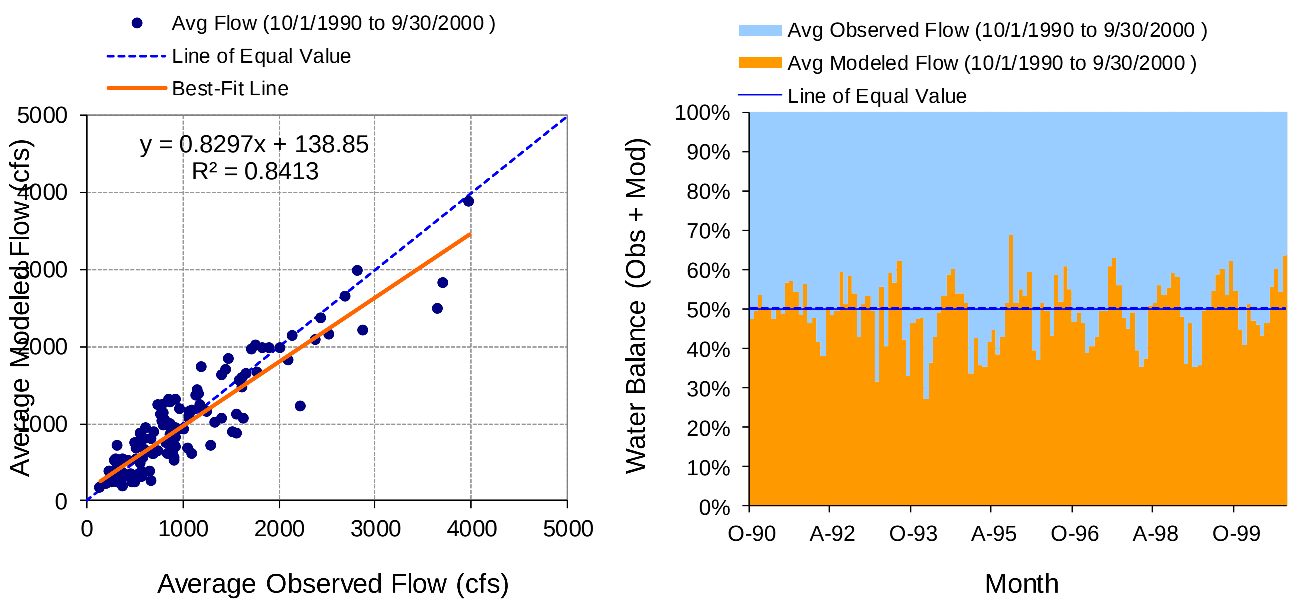


Figure D-38. Monthly flow regression and temporal variation at USGS 04282500 Otter Creek at Middlebury, VT

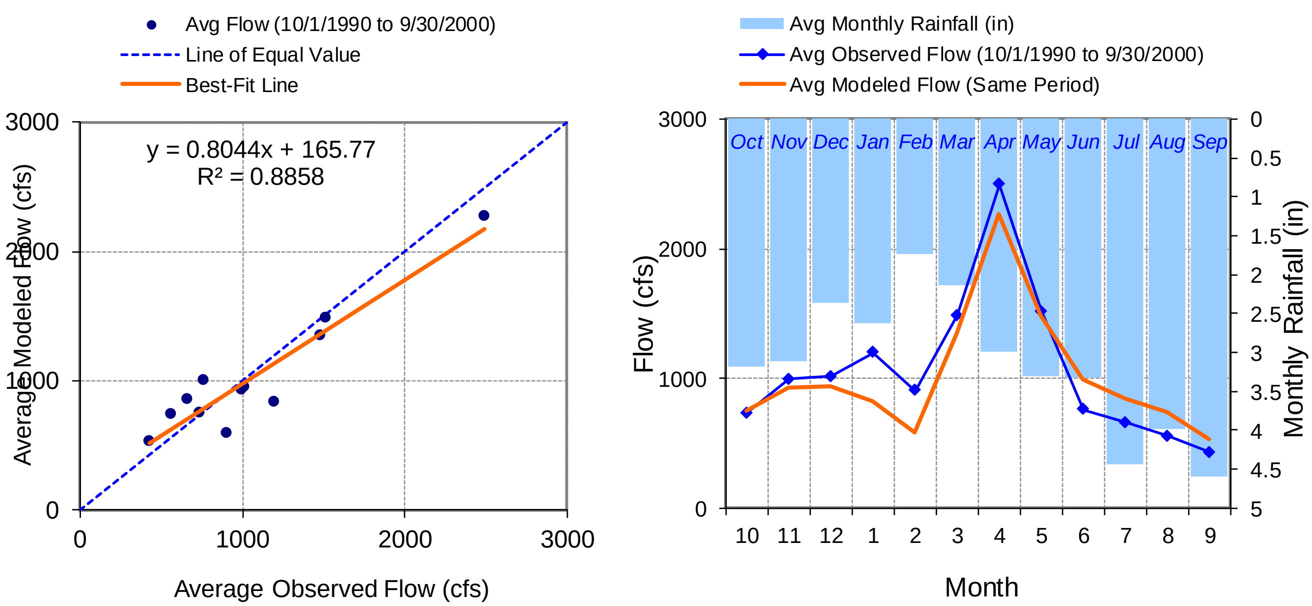


Figure D-39. Seasonal regression and temporal aggregate at USGS 04282500 Otter Creek at Middlebury, VT

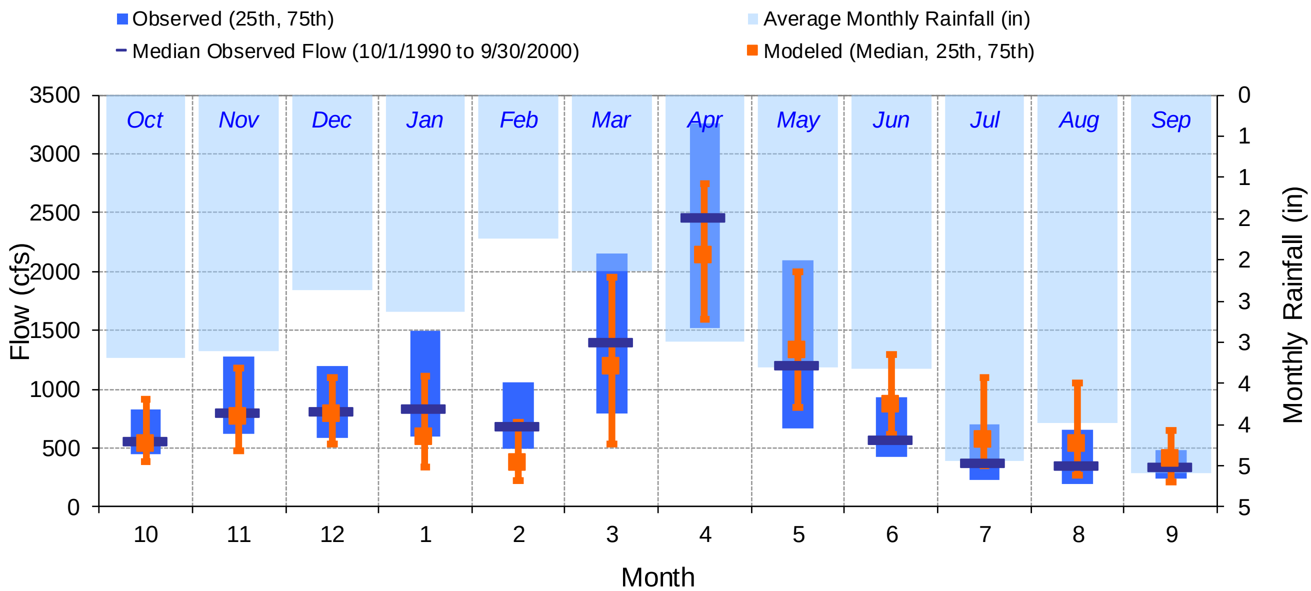


Figure D-40. Seasonal medians and ranges at USGS 04282500 Otter Creek at Middlebury, VT

Table D-11. Seasonal summary at USGS 04282500 Otter Creek at Middlebury, VT

MONTH	OBSERVED FLOW (CFS)				MODELED FLOW (CFS)			
	MEAN	MEDIAN	25TH	75TH	MEAN	MEDIAN	25TH	75TH
Oct	733.98	556.00	450.25	828.25	746.93	539.08	381.57	919.33
Nov	992.45	798.50	622.75	1282.50	924.05	762.62	482.22	1183.13
Dec	1014.05	814.00	591.00	1195.00	942.86	791.93	532.90	1102.70
Jan	1195.42	840.00	600.00	1500.00	829.15	591.34	339.98	1110.20
Feb	902.74	680.00	495.50	1055.00	585.09	375.04	223.89	715.48
Mar	1483.17	1400.00	795.50	2157.50	1346.10	1190.10	539.96	1947.25
Apr	2494.75	2460.00	1522.50	3260.00	2272.14	2138.48	1594.81	2748.81
May	1514.88	1205.00	667.50	2097.50	1482.13	1333.13	848.26	2001.64
Jun	760.50	574.50	425.75	927.75	996.37	869.09	614.30	1293.05
Jul	658.82	376.50	229.25	697.25	847.14	569.27	354.29	1095.20
Aug	557.49	350.50	200.00	656.50	735.74	533.96	266.47	1056.00
Sep	431.18	339.00	245.50	483.00	528.70	402.94	216.19	644.40

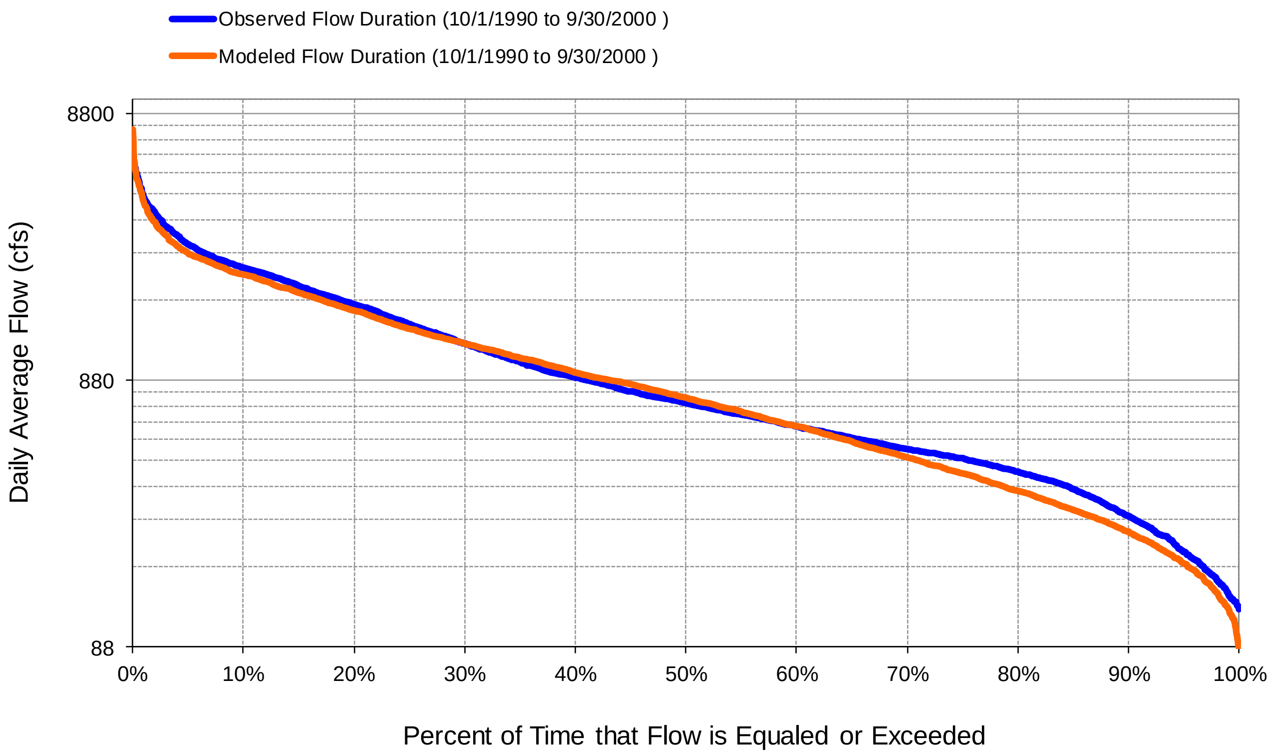


Figure D-41. Flow exceedence at USGS 04282500 Otter Creek at Middlebury, VT

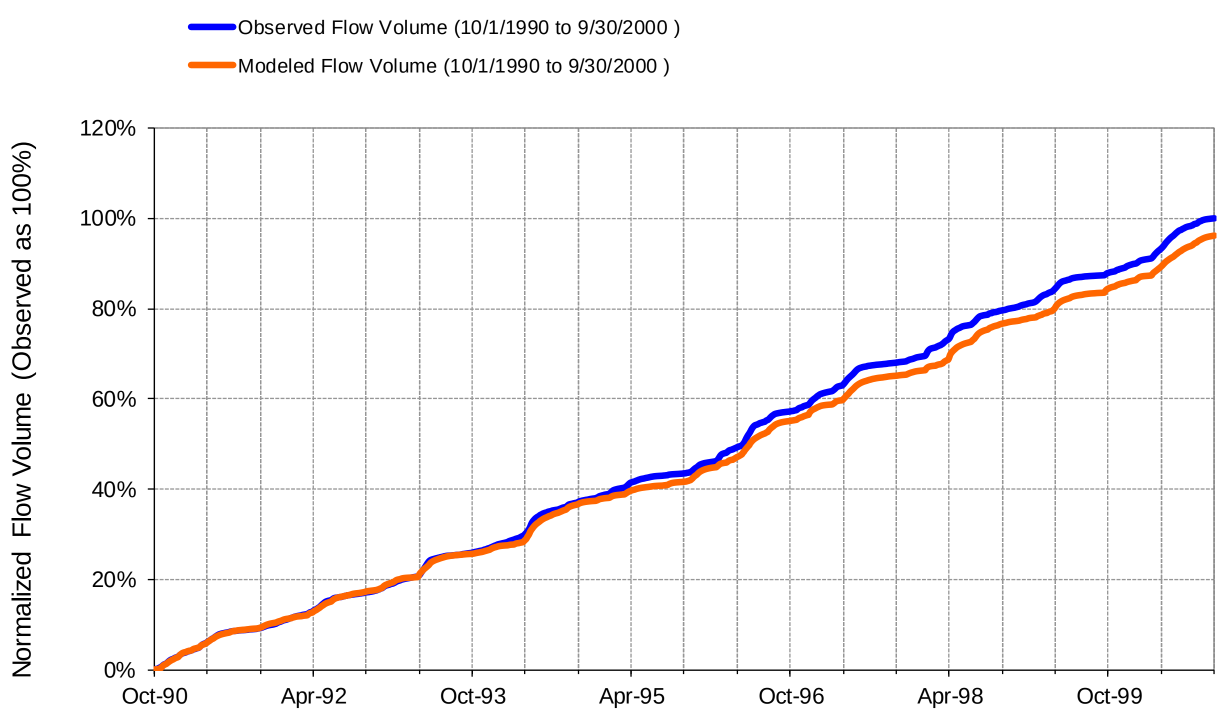


Figure D-42. Flow accumulation at USGS 04282500 Otter Creek at Middlebury, VT

Table D-12. Summary statistics at USGS 04282500 Otter Creek at Middlebury, VT

SWAT Simulated Flow		Observed Flow Gage		
REACH OUTFLOW FROM OUTLET 9		USGS 04282500 OTTER CREEK AT MIDDLEBURY, VT		
10-Year Analysis Period: 10/1/1990 - 9/30/2000 Flow volumes are (inches/year) for upstream drainage area		Hydrologic Unit Code: 2010002 Latitude: 44.01311488 Longitude: -73.1678954 Drainage Area (sq-mi): 628		
Total Simulated In-stream Flow:	**22.09**	Total Observed In-stream Flow:		**22.96**
Total of simulated highest 10% flows:	**6.42**	Total of Observed highest 10% flows:		**6.83**
Total of Simulated lowest 50% flows:	**4.44**	Total of Observed Lowest 50% flows:		**4.72**
Simulated Summer Flow Volume (months 7-9):	**3.84**	Observed Summer Flow Volume (7-9):		**3.00**
Simulated Fall Flow Volume (months 10-12):	**4.74**	Observed Fall Flow Volume (10-12):		**4.97**
Simulated Winter Flow Volume (months 1-3):	**4.97**	Observed Winter Flow Volume (1-3):		**6.43**
Simulated Spring Flow Volume (months 4-6):	**8.53**	Observed Spring Flow Volume (4-6):		**8.56**
Total Simulated Storm Volume:	**4.13**	Total Observed Storm Volume:		**4.51**
Simulated Summer Storm Volume (7-9):	**0.72**	Observed Summer Storm Volume (7-9):		**0.82**
Errors (Simulated-Observed)	*Error Statistics*	*Recommended Criteria*		
Error in total volume:	-3.81	10		
Error in 50% lowest flows:	-5.90	10		
Error in 10% highest flows:	-5.97	15		
Seasonal volume error - Summer:	28.22	30		
Seasonal volume error - Fall:	-4.59 >>	30		Clear
Seasonal volume error - Winter:	-22.65	30		
Seasonal volume error - Spring:	-0.43	30		
Error in storm volumes:	-8.36	20		
Error in summer storm volumes:	-11.73	50		
Nash-Sutcliffe Coefficient of Efficiency, E:	0.714	Model accuracy increases		
Baseline adjusted coefficient (Garrick), E':	0.537	as E or E' approaches 1.0		
Monthly NSE	0.838			

TSS and TP distribution by channel and upland sources

Table D-13. TSS and TP distribution by source categories

Source	TSS		TP	
	Load(mt/year)	Percentage (%)	Load (kg/year)	Percentage (%)
Upland	131,333	78.0	121,379	77.5
Stream	37,121	22.0	35,265	22.5
Total	**168,454**	**100.0**	**156,644**	**100.0**

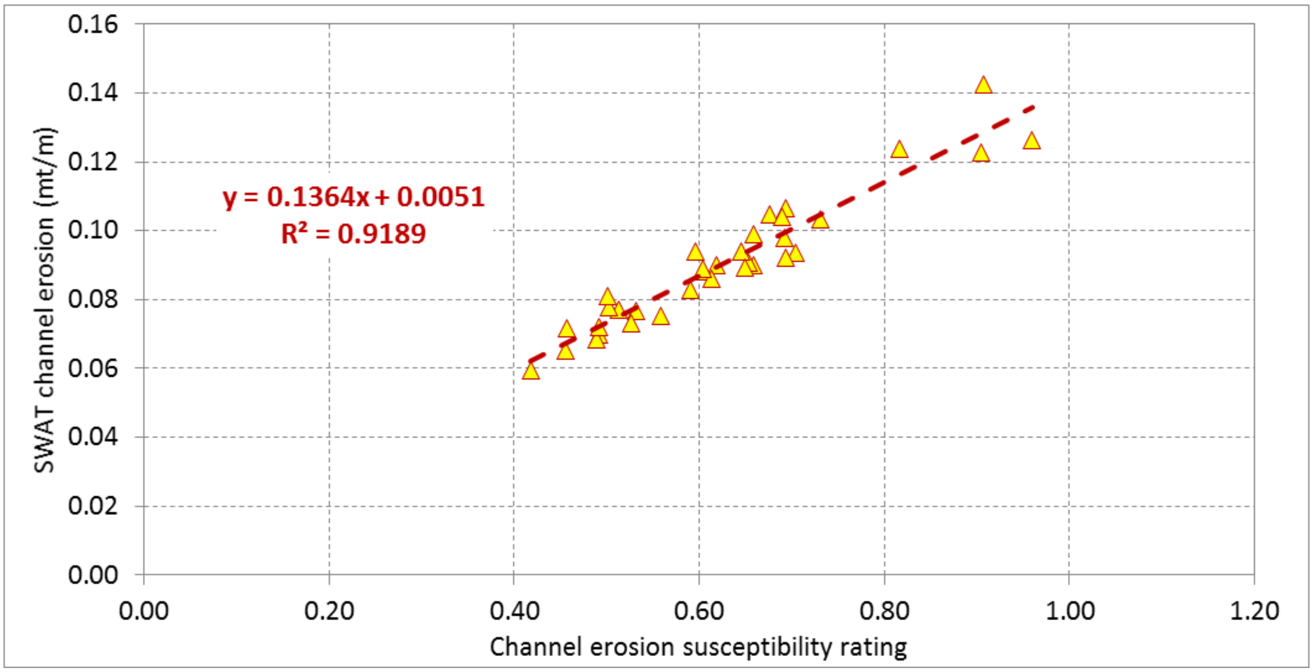


Figure D-43. SWAT simulated channel erosion relative to channel erosion susceptibility rating

TP distribution by landuse from upland sources

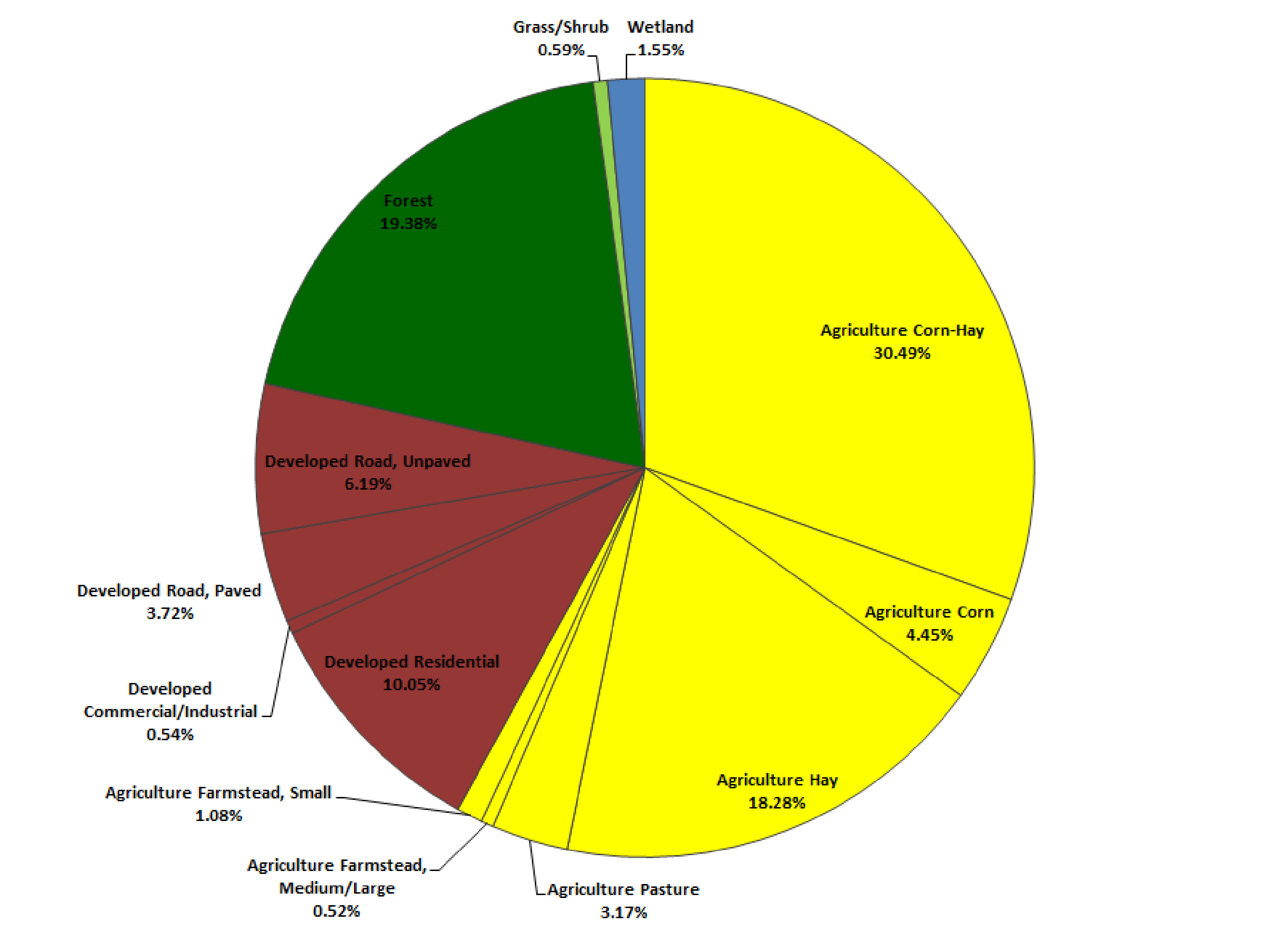


Figure D-44. Distribution of simulated total upland TP loads by landuse categories

Table D-14. TP export rates (kg/ha/yr) by landuse categories for the 30 year simulation period

Landuse	Classification	Area (ha)	Area (%)	Mean	Min	Q_{25}	Q_{50}	Q_{75}	Max
Agriculture	Corn-Hay	18,469	7.59	**2.00**	0.06	1.25	1.98	2.70	4.25
	Corn	2,684	1.10	**2.01**	0.88	1.33	2.07	2.53	4.08
	Hay	24,891	10.23	**0.89**	0.39	0.60	0.84	1.14	1.97
	Pasture	2,940	1.21	**1.31**	0.64	0.95	1.22	1.62	2.45
	Farmstead, Medium/Large	204	0.08	**3.09**	1.49	2.23	2.91	3.80	5.97
	Farmstead, Small	433	0.18	**3.04**	1.32	2.17	2.85	3.96	5.61
Urban	Residential	11,805	4.85	**1.03**	0.70	0.84	0.93	1.17	2.12
	Commercial/Industrial	320	0.13	**2.05**	1.66	1.90	2.02	2.17	2.83
	Road, Paved	2,239	0.92	**2.02**	1.67	1.91	2.01	2.08	2.41
	Road, Unpaved	1,447	0.59	**5.20**	4.43	4.97	5.19	5.39	6.09
Forest	Forest	162,313	66.70	**0.14**	0.09	0.12	0.13	0.17	0.23
Grass/Shrub	Grass/Shrub	3,554	1.46	**0.20**	0.09	0.15	0.19	0.24	0.43
Wetland	Wetland	12,036	4.95	**0.16**	0.06	0.11	0.14	0.18	0.29

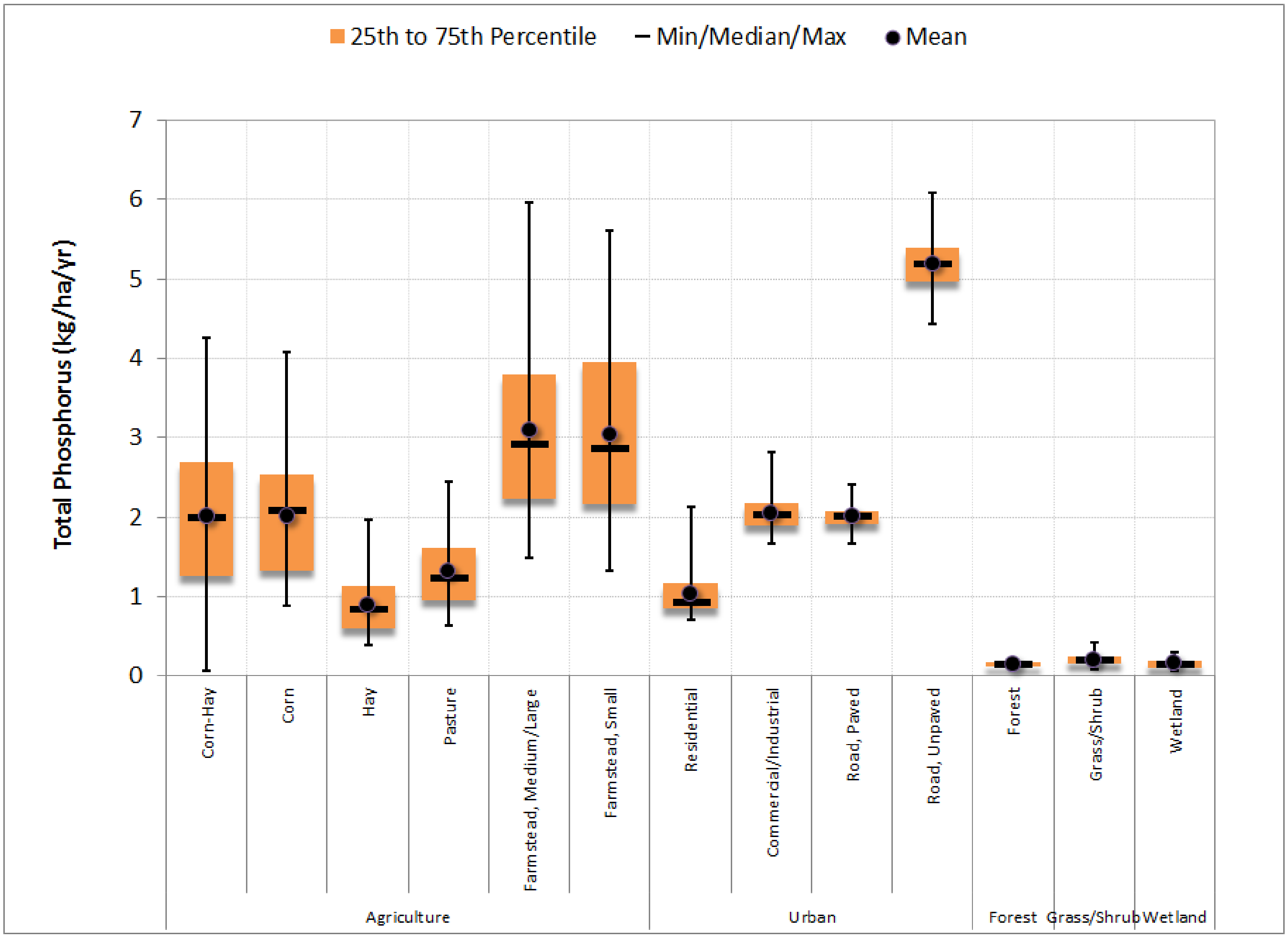


Figure D-45. TP export rates (kg/ha/yr) by landuse categories for the 30 year simulation period

Table D-15. TP export rates (kg/ha/yr) for the residential landuse categories for the 30 year simulation period

Residential Category	Area (ha)	Area (%)	Mean	Min	Q_{25}	Q_{50}	Q_{75}	Max
Low Density	6,079	58.08	**0.67**	0.36	0.49	0.58	0.83	1.52
Medium Density	2,936	28.06	**0.98**	0.60	0.72	0.83	1.11	2.60
High Density	1,450	13.86	**1.71**	1.21	1.47	1.65	1.89	3.32
Total	10,465	100.00	**0.90**	0.56	0.69	0.78	1.06	2.08

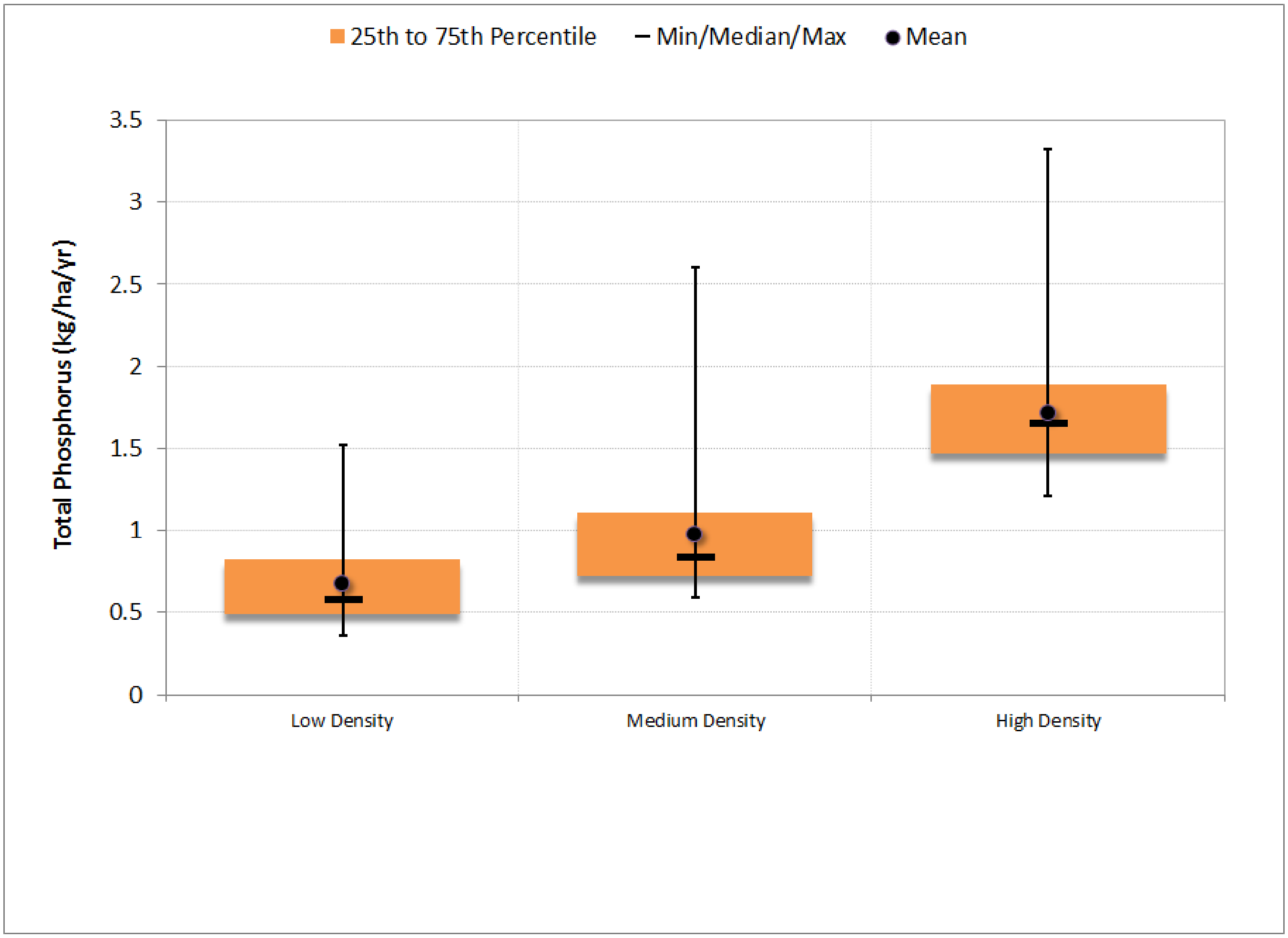


Figure D-46. TP export rates (kg/ha/yr) for the residential landuse categories for the 30 year simulation period

Segmented Regression

Table D-16. Summary statistics

Statistic	Calibration		Validation	
	TSS	TP	TSS	TP
Average absolute error (%)	41.9	38.1	47.8	38.6
Median absolute error (%)	20.4	22.7	17.7	22.4
Regression error (%)	4.9	19.2	4.4	7.0
NSE	0.629	0.530	0.636	0.579
NSE'	0.534	0.405	0.539	0.447

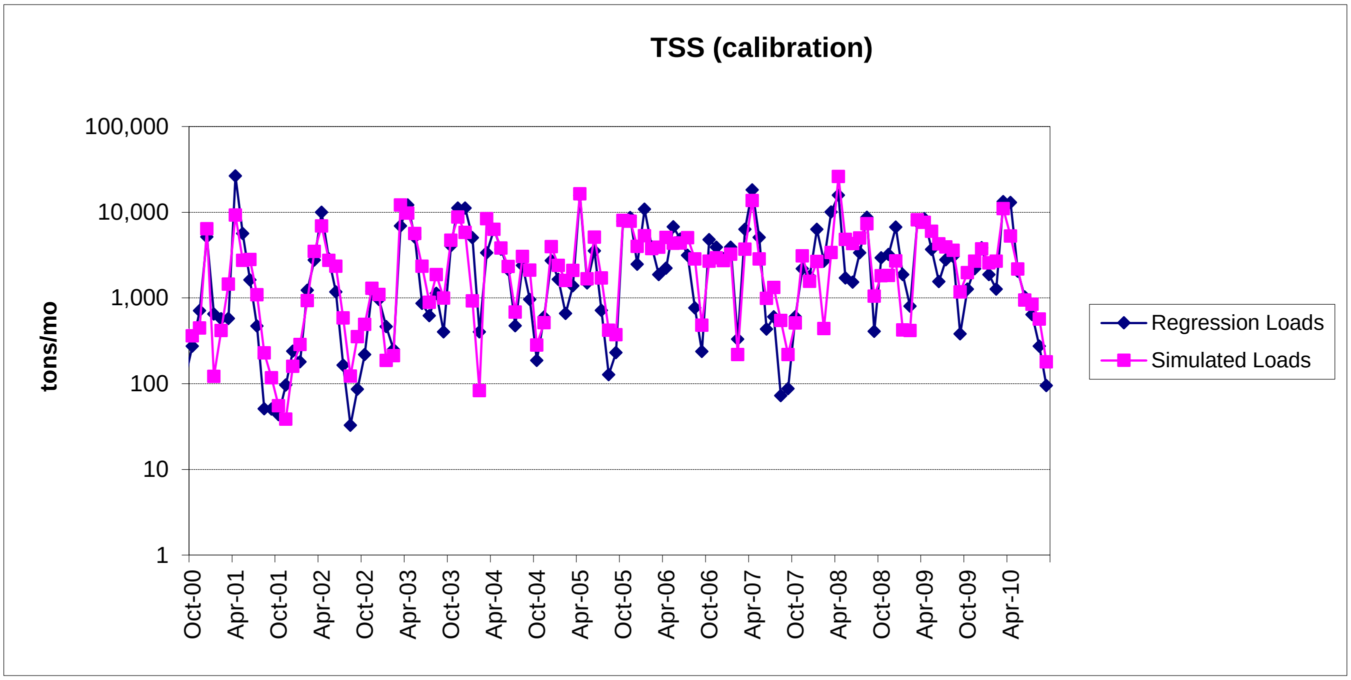


Figure D-47. Monthly simulated and estimated TSS load at Otter Creek (calibration period)

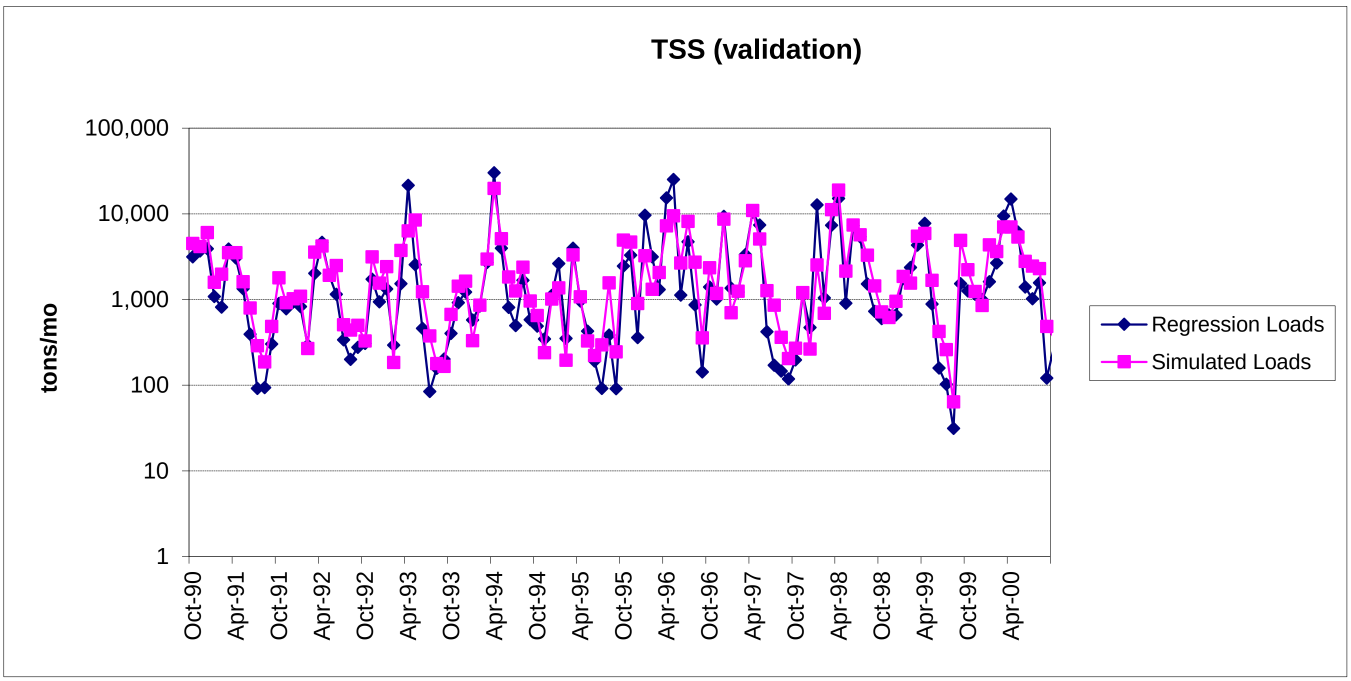


Figure D-48. Monthly simulated and estimated TSS load at Otter Creek (validation period)

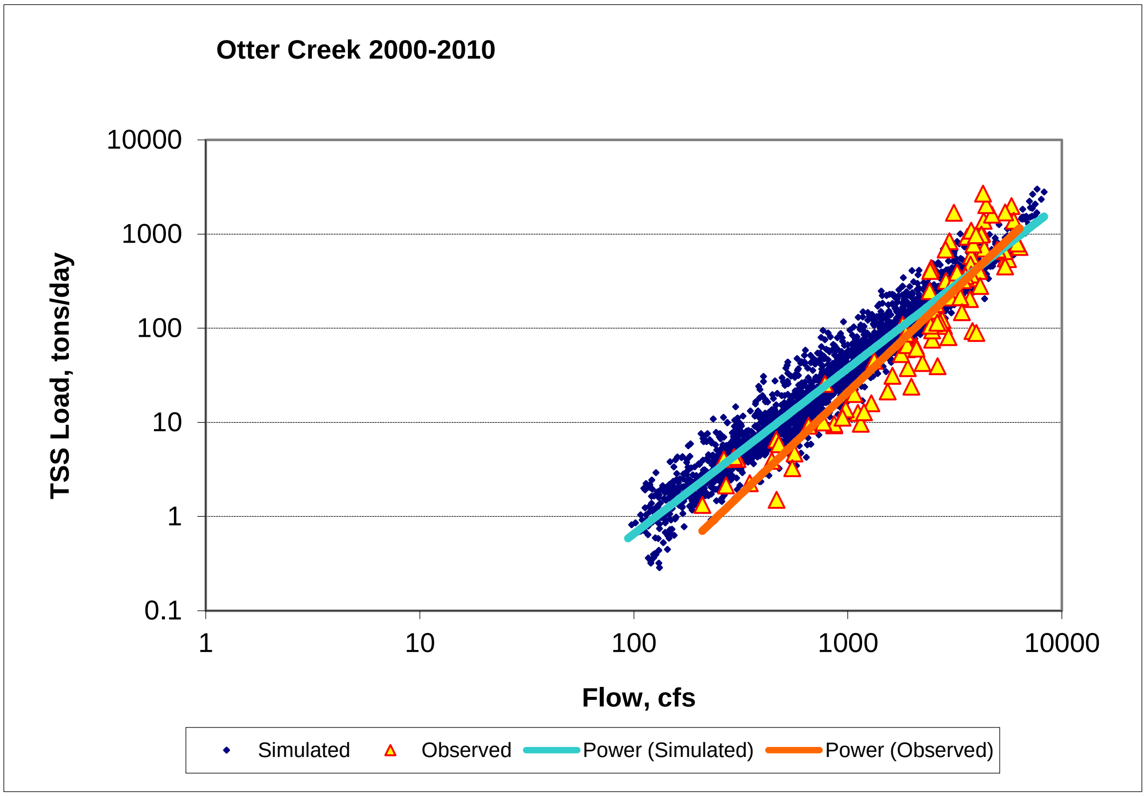


Figure D-49. Power plot of simulated and observed TSS load vs flow at Otter Creek (calibration period)

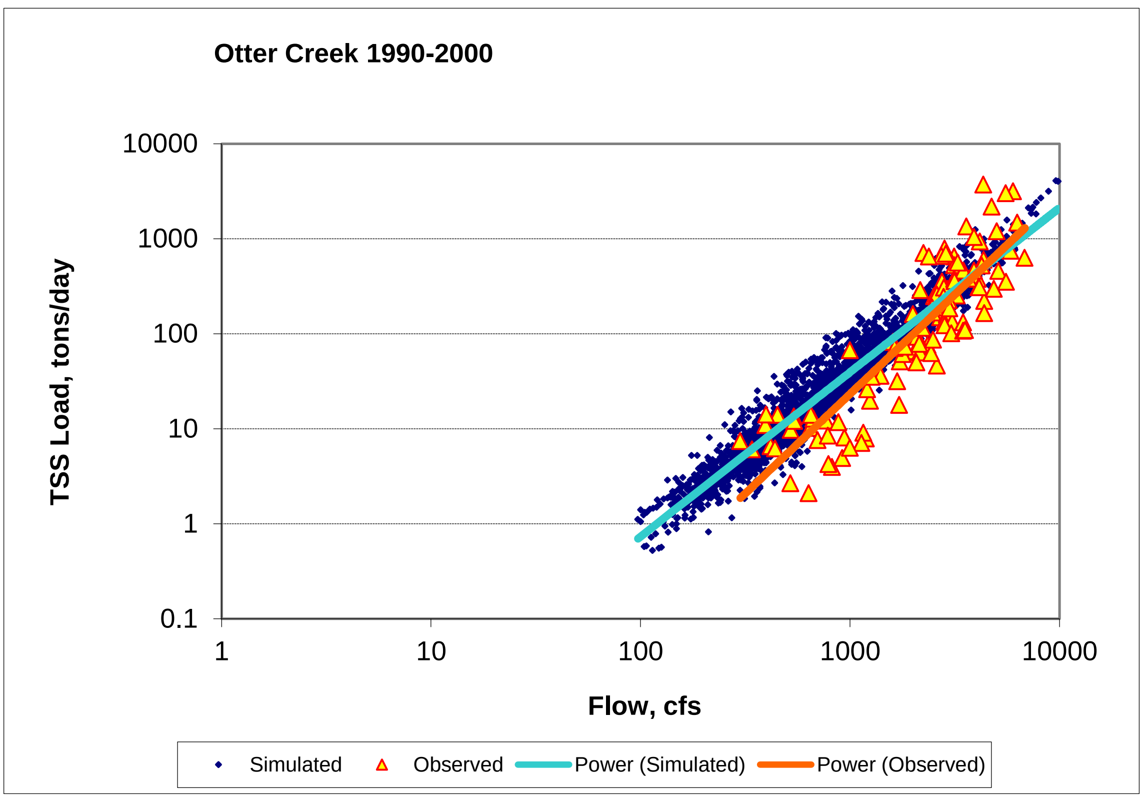


Figure D-50. Power plot of simulated and observed TSS load vs flow at Otter Creek (validation period)

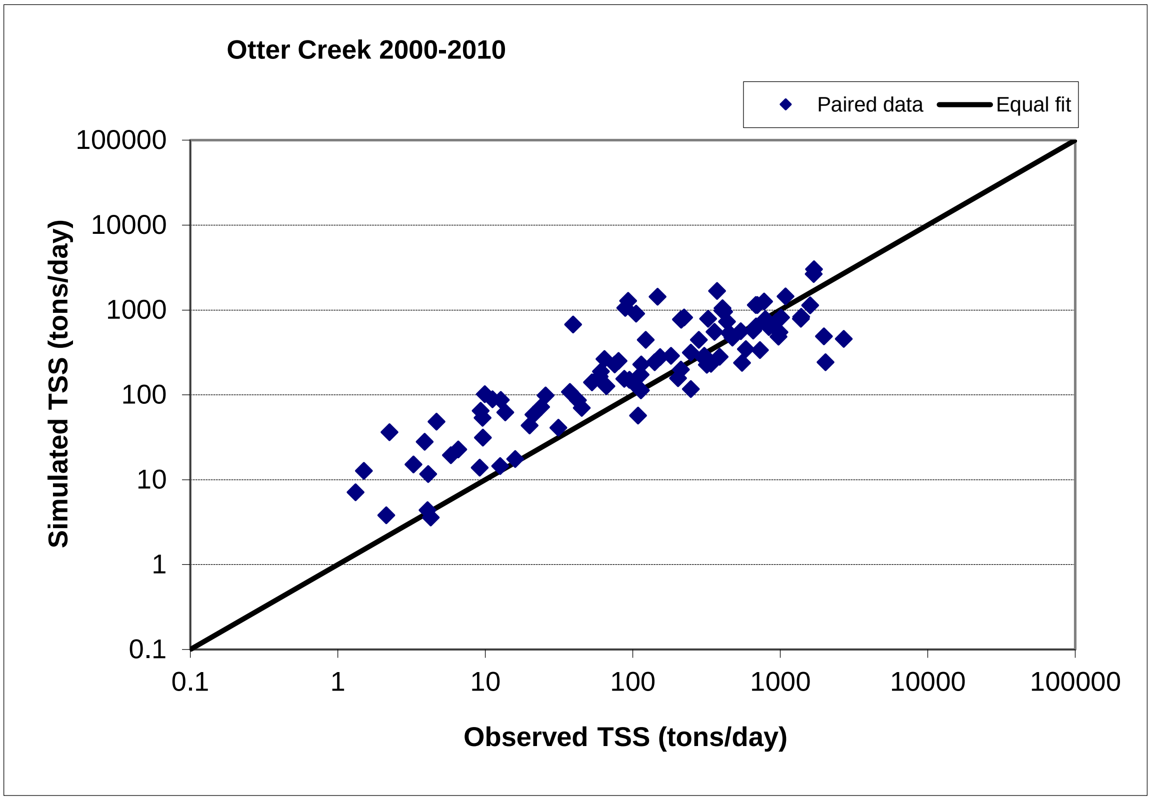


Figure D-51. Paired simulated vs observed TSS load at Otter Creek (calibration period)

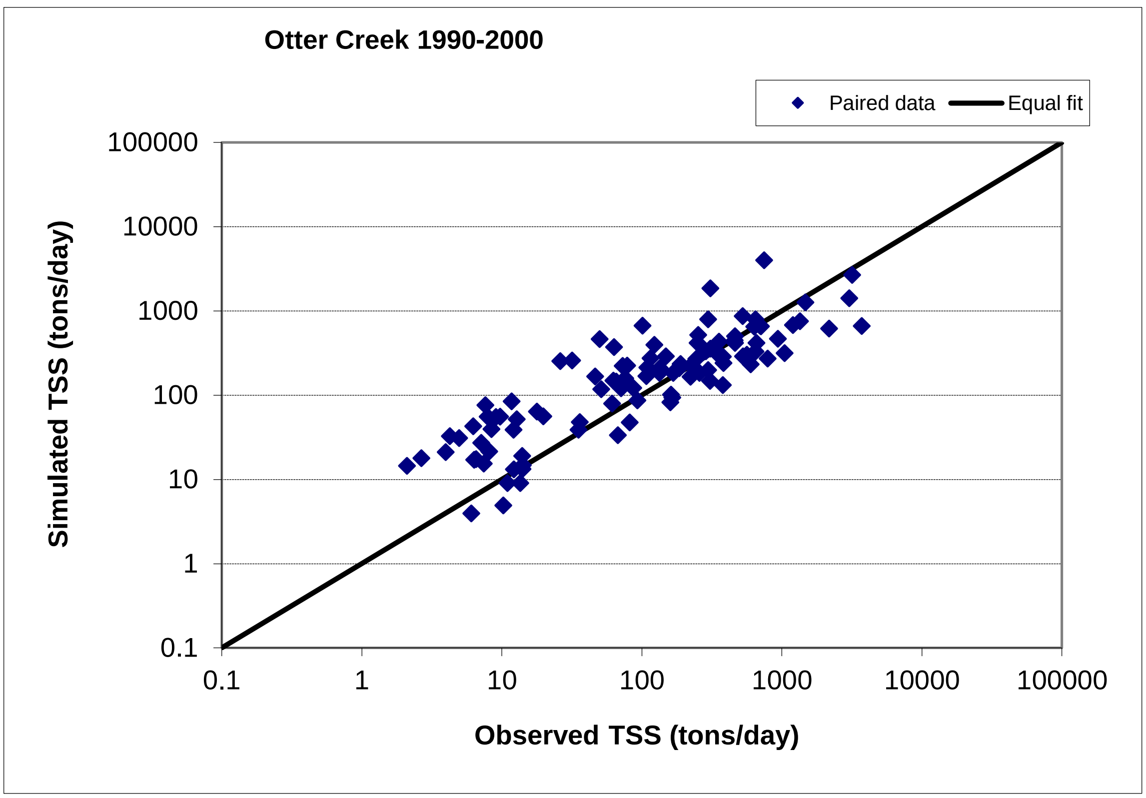


Figure D-52. Paired simulated vs observed TSS load at Otter Creek (validation period)

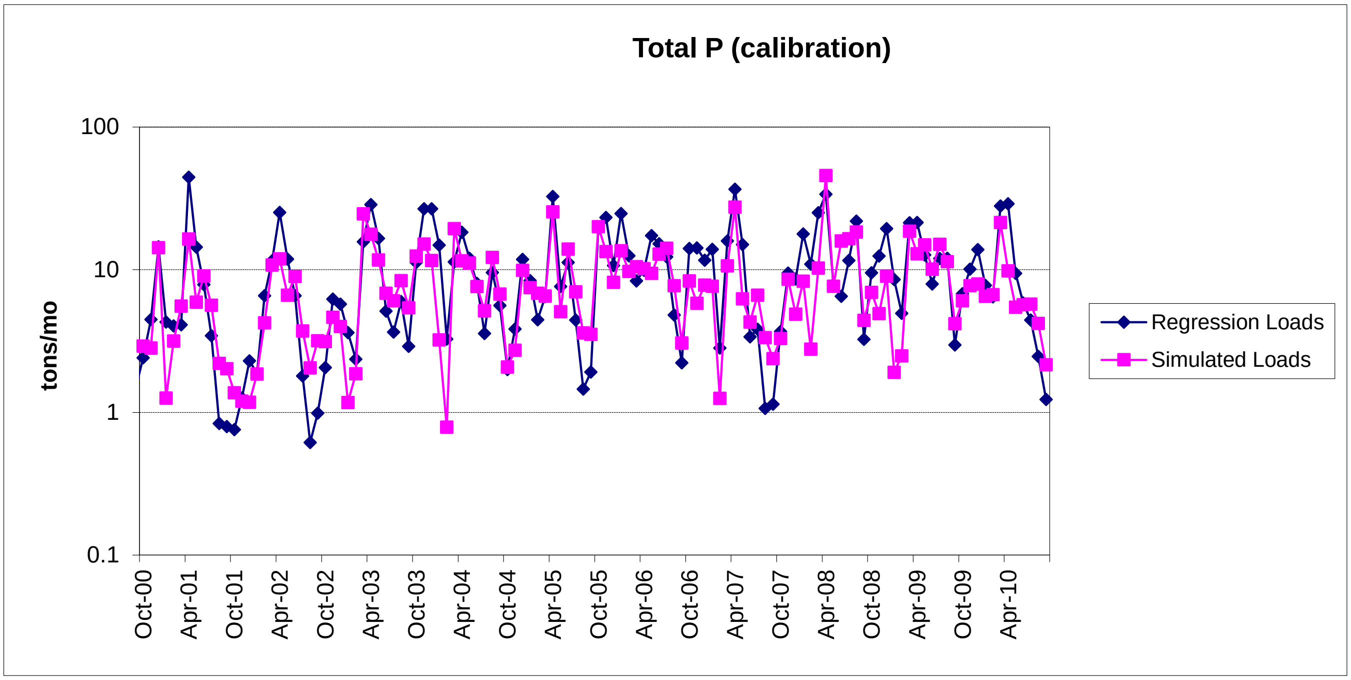


Figure D-53. Monthly simulated and estimated TP load at Otter Creek (calibration period)

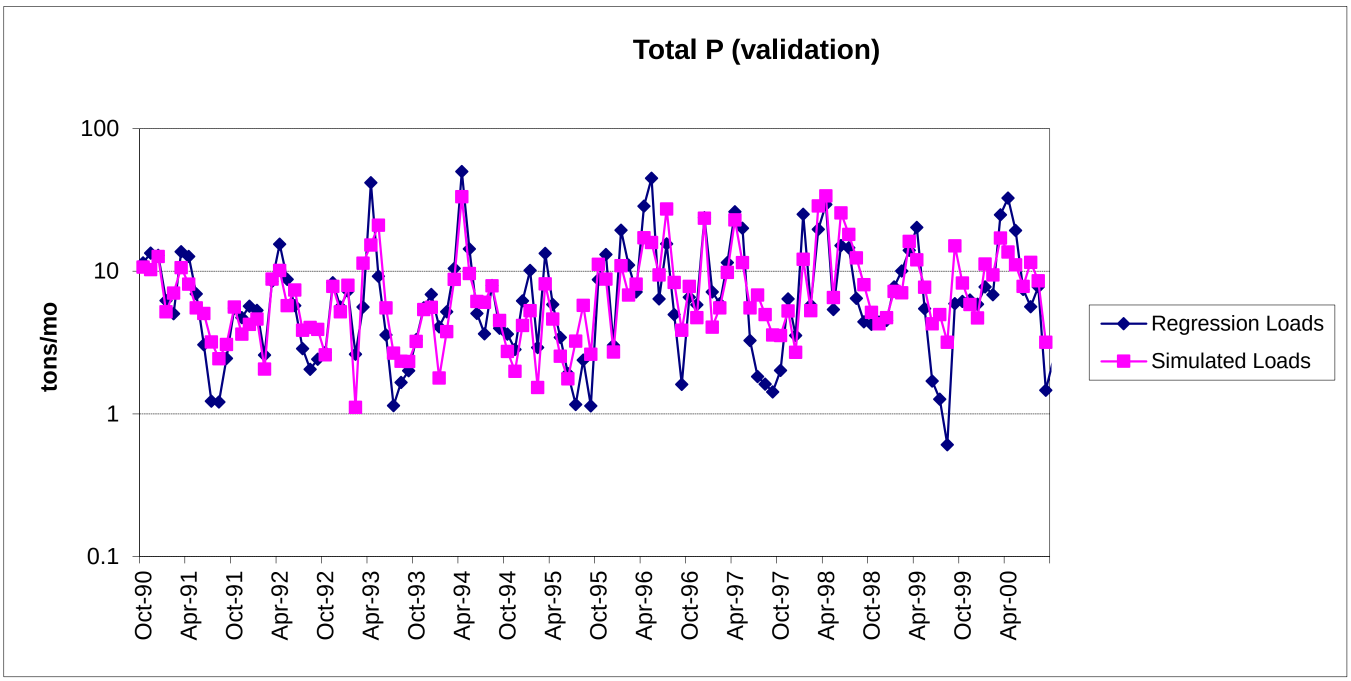


Figure D-54. Monthly simulated and estimated TP load at Otter Creek (validation period)

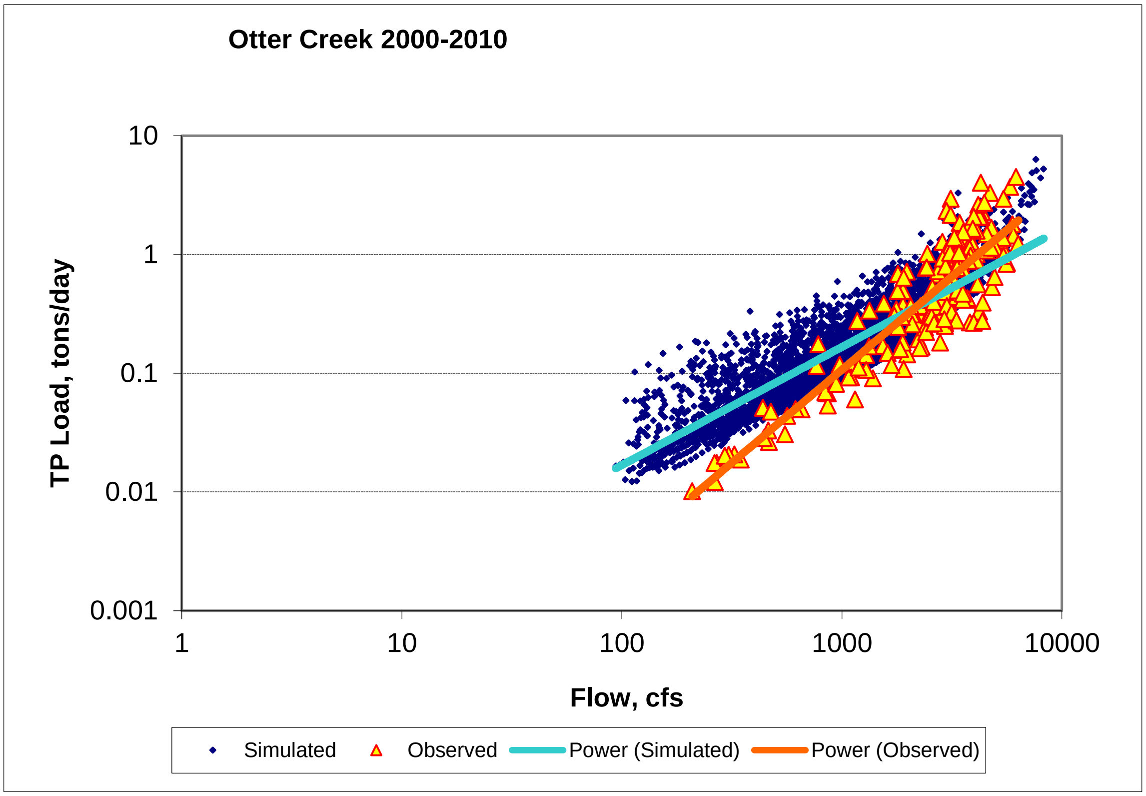


Figure D-55. Power plot of simulated and observed TP load vs flow at Otter Creek (calibration period)

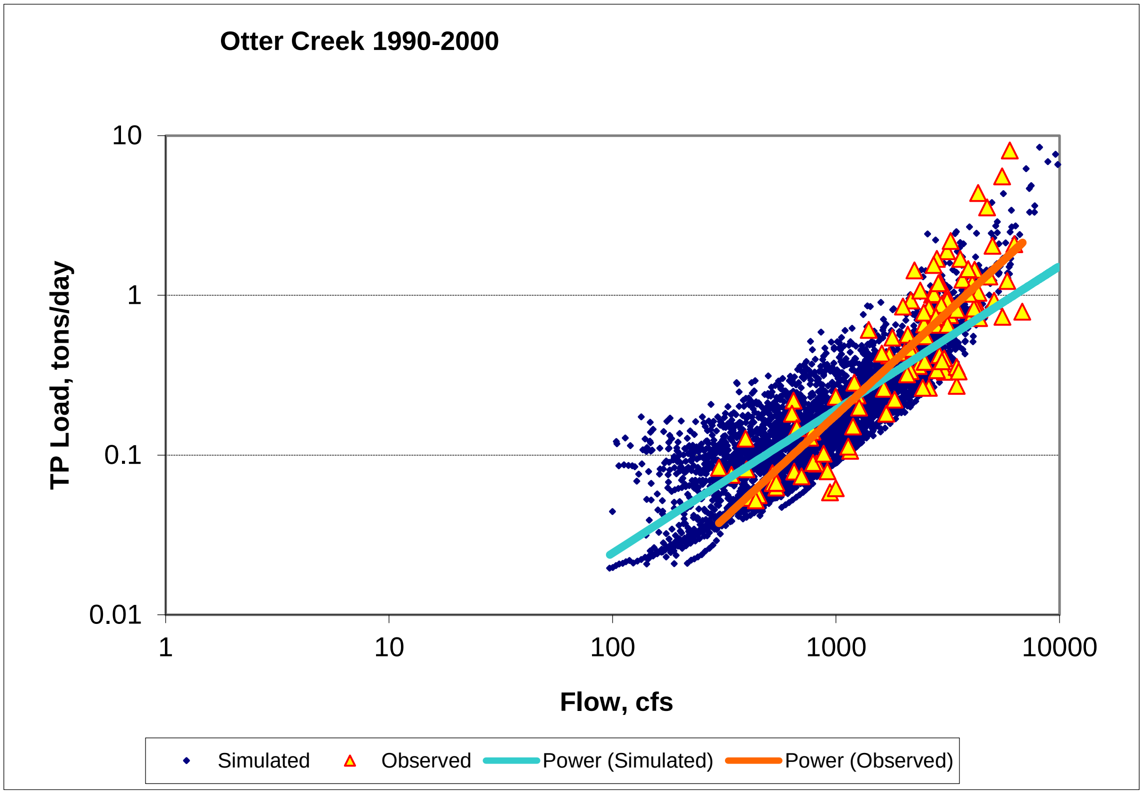


Figure D-56. Power plot of simulated and observed TP load vs flow at Otter Creek (validation period)

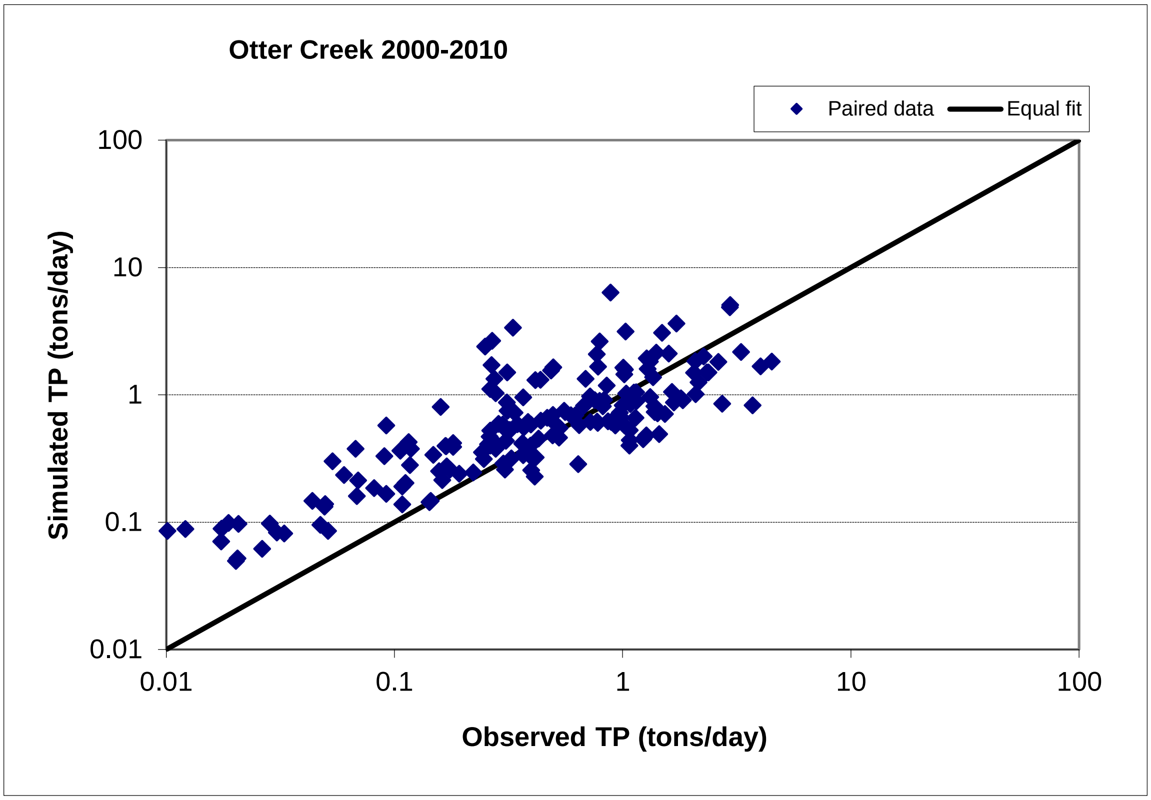


Figure D-57. Paired simulated vs observed TP load at Otter Creek (calibration period)

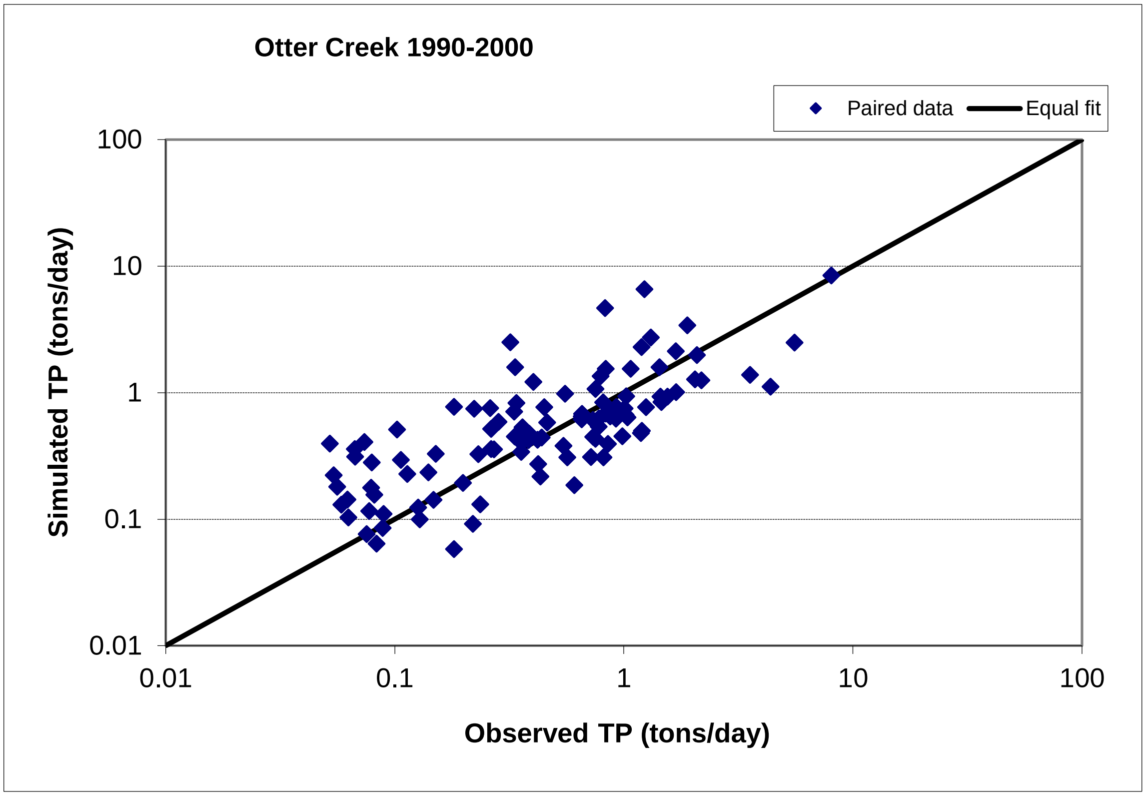


Figure D-58. Paired simulated vs observed TP load at Otter Creek (validation period)

Comparison of simulated SWAT TP loads with FLUX estimates

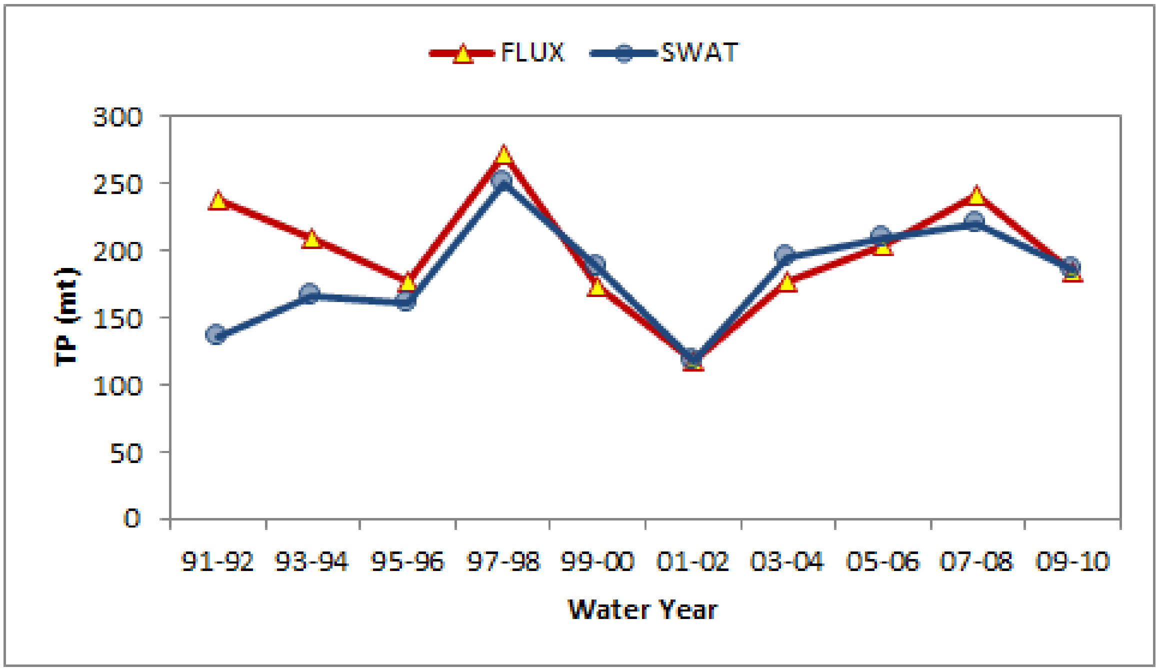


Figure D-59. Bi-annual TP loads on a water year basis as simulated by SWAT and estimated by FLUX (FLUX estimates from Smeltzer et al., 2009)

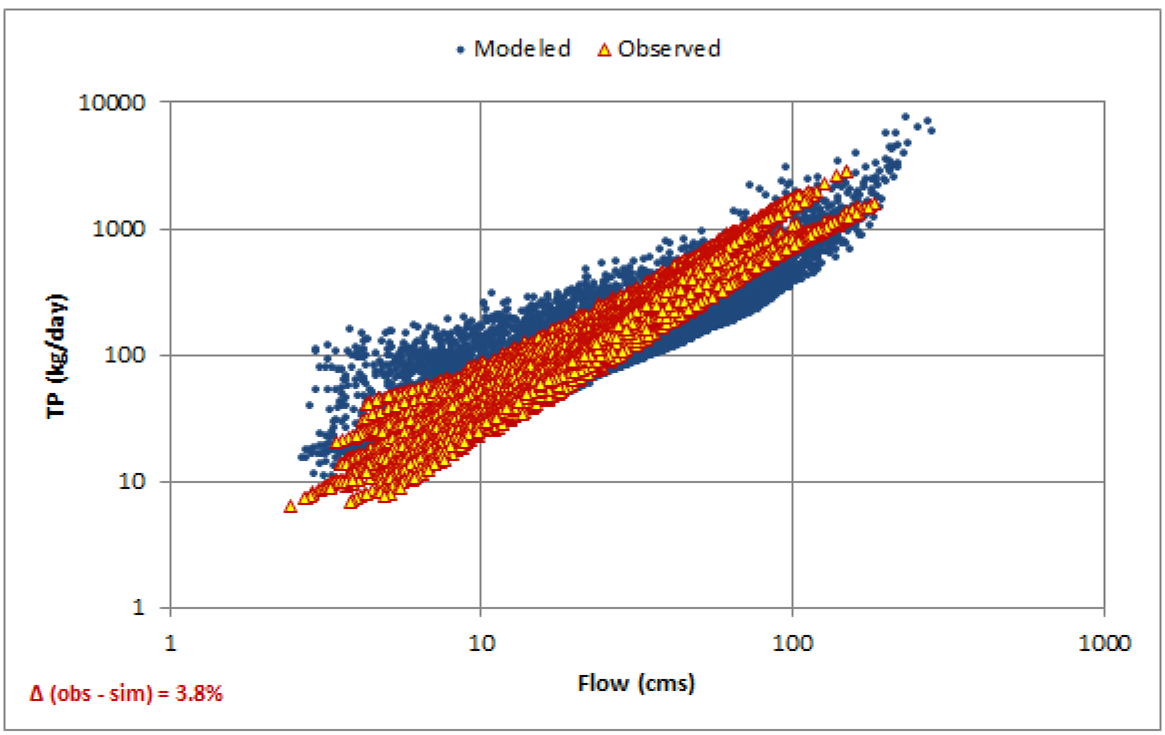
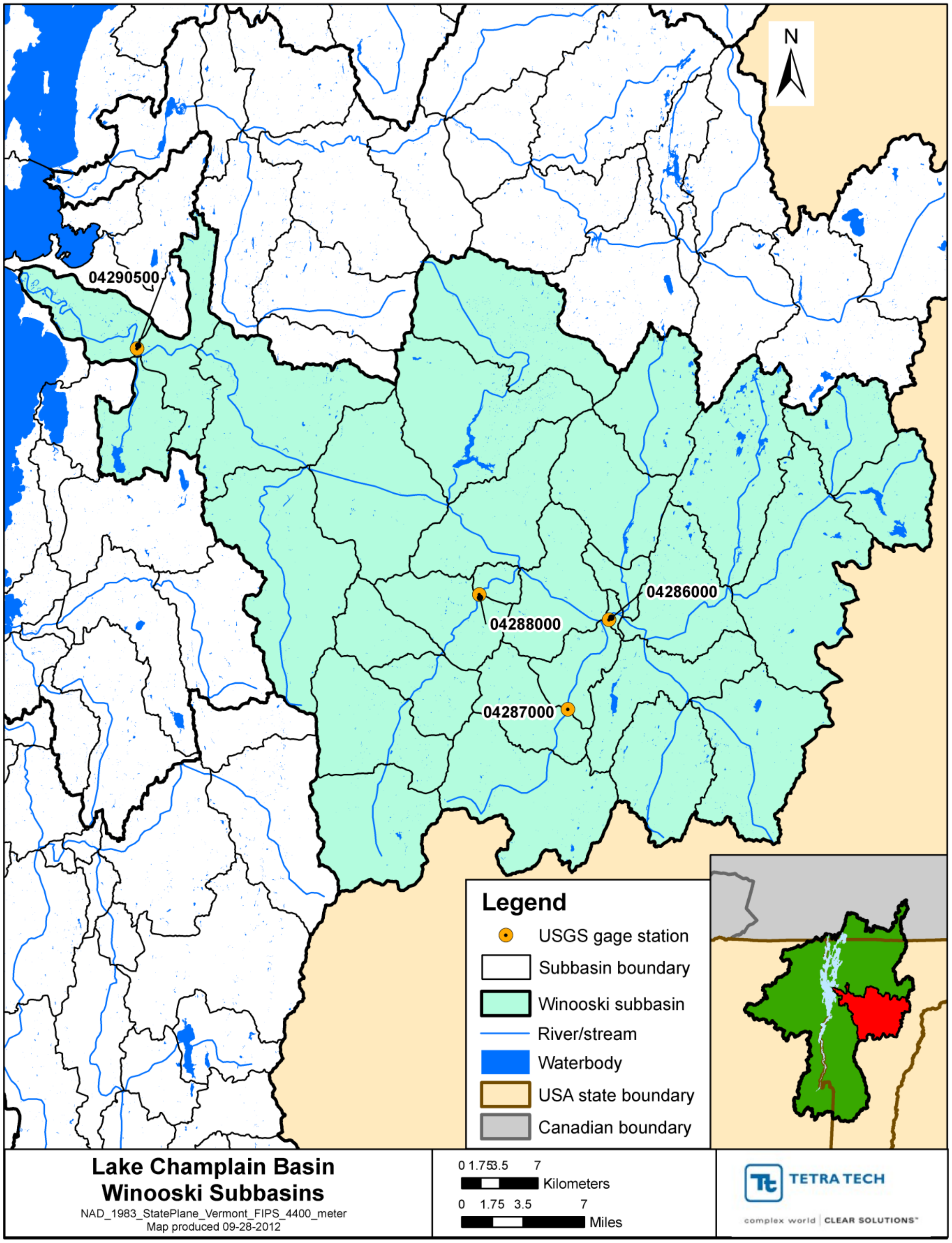


Figure D-60. Daily TP load versus flow as simulated by SWAT and estimated by FLUX (FLUX estimates from Medalie, 2013)

Appendix E - Winooski River Watershed



HYDROLOGY

USGS 04287000 Dog River at Northfield Falls, VT - Calibration

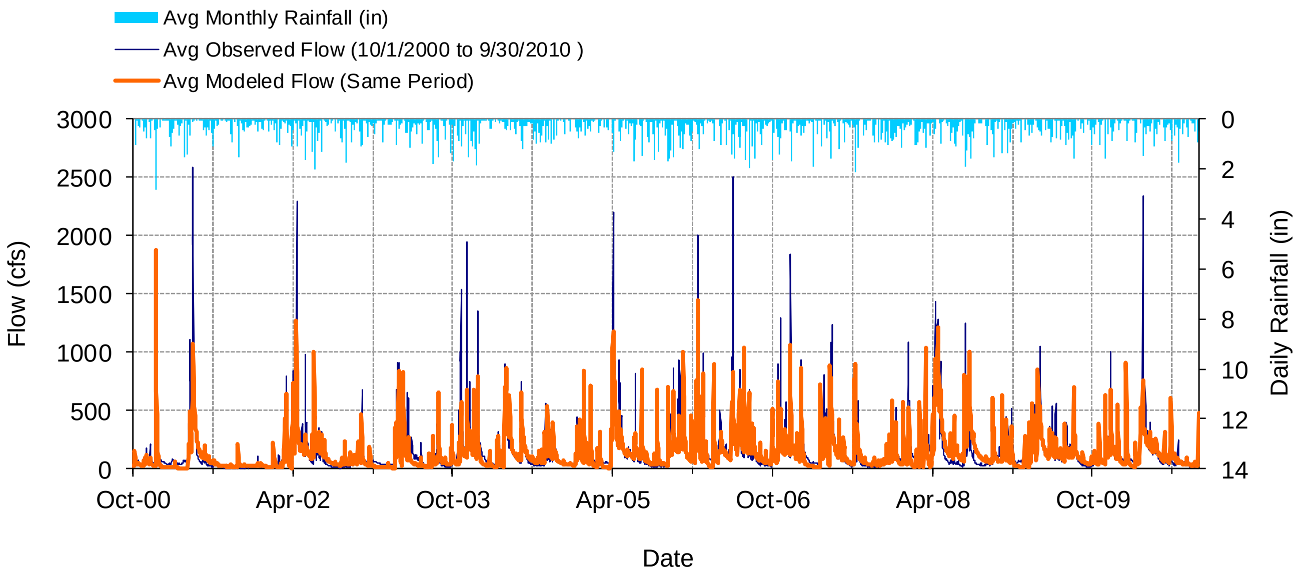


Figure E-1. Mean daily flow at USGS 04287000 Dog River at Northfield Falls, VT

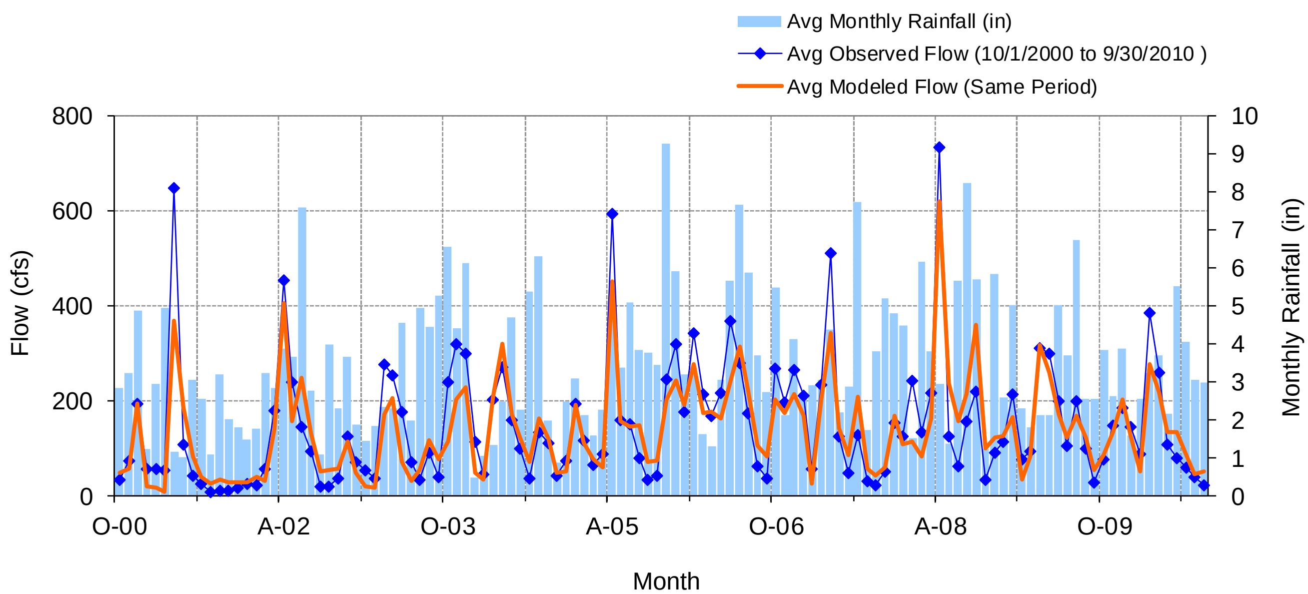


Figure E-2. Mean monthly flow at USGS 04287000 Dog River at Northfield Falls, VT

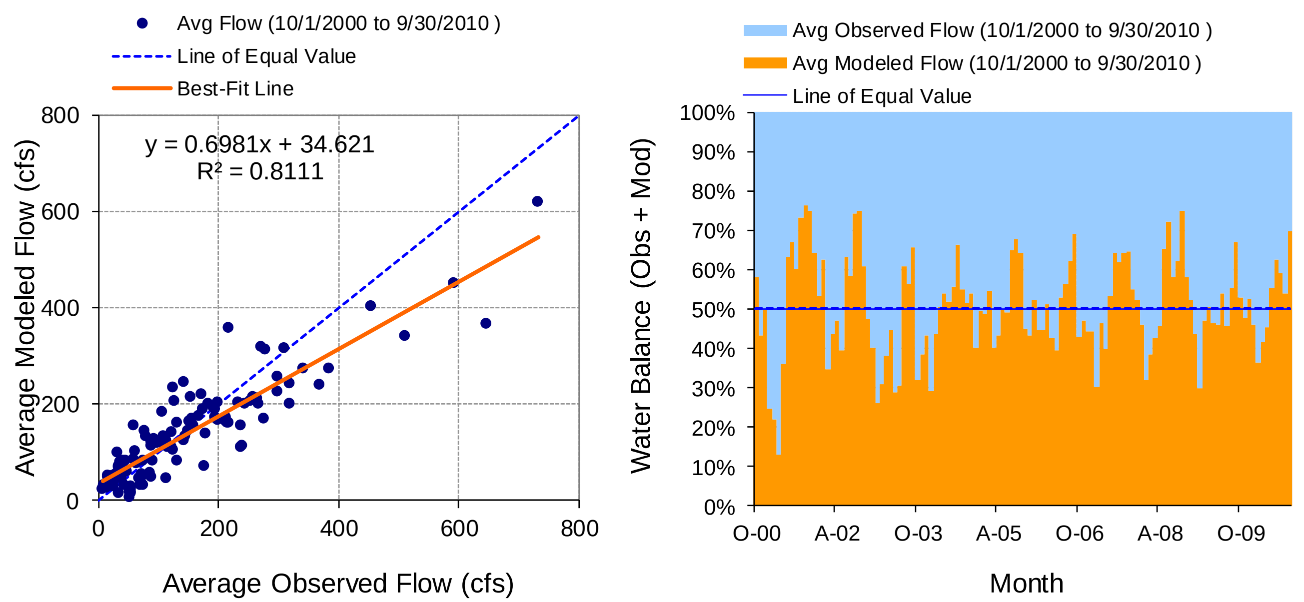


Figure E-3. Monthly flow regression and temporal variation at USGS 04287000 Dog River at Northfield Falls, VT

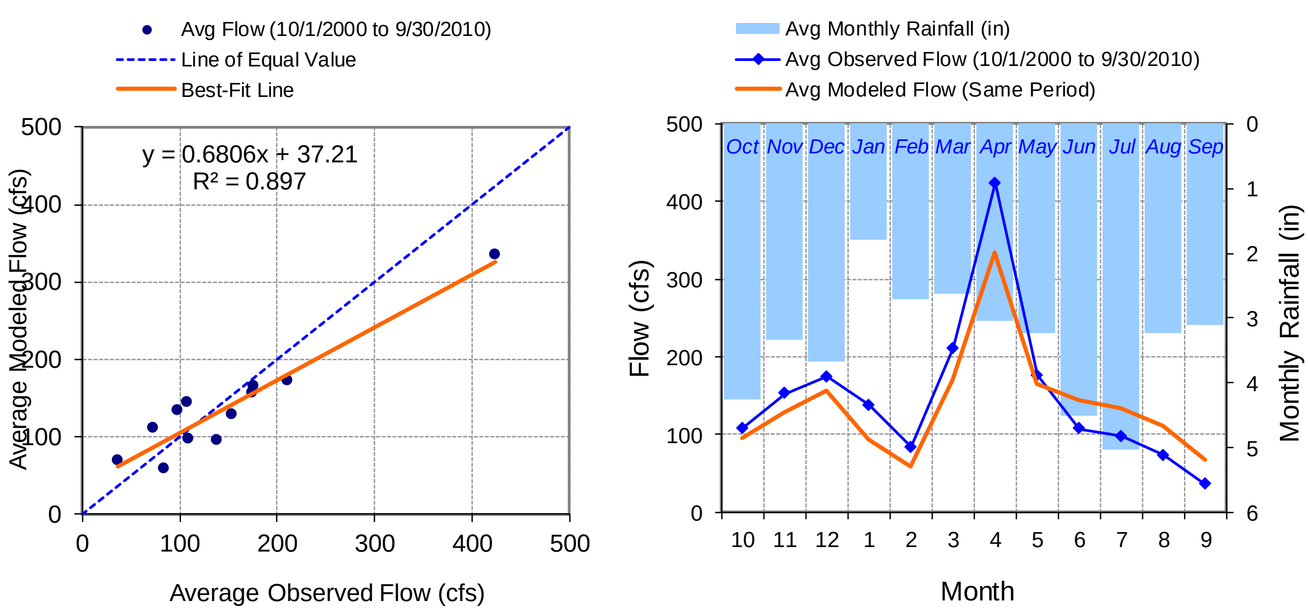


Figure E-4. Seasonal regression and temporal aggregate at USGS 04287000 Dog River at Northfield Falls, VT

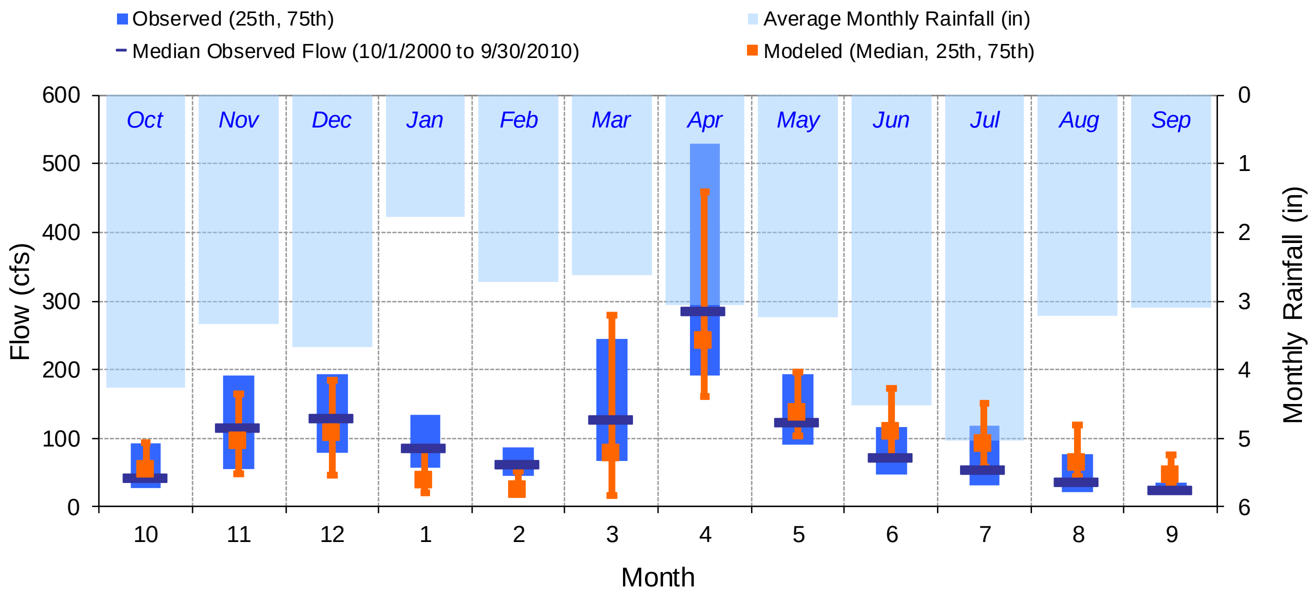


Figure E-5. Seasonal medians and ranges at USGS 04287000 Dog River at Northfield Falls, VT

Table E-1. Seasonal summary at USGS 04287000 Dog River at Northfield Falls, VT

MONTH	OBSERVED FLOW (CFS)				MODELED FLOW (CFS)			
	MEAN	MEDIAN	25TH	75TH	MEAN	MEDIAN	25TH	75TH
Oct	108.53	43.00	28.00	92.00	95.96	53.66	40.41	93.33
Nov	152.89	116.00	55.00	191.50	128.33	95.35	47.85	163.90
Dec	174.10	130.00	78.25	192.50	155.95	106.92	46.05	185.17
Jan	137.42	86.00	58.00	133.75	94.32	38.56	21.02	83.28
Feb	83.52	62.00	46.00	86.75	58.19	24.10	17.77	52.45
Mar	210.90	127.50	66.25	244.00	171.09	78.36	16.84	279.75
Apr	423.54	285.50	192.00	528.75	334.21	242.36	160.59	459.97
May	175.95	123.00	90.00	193.00	165.51	136.99	103.87	195.64
Jun	107.32	71.00	47.00	116.25	143.83	109.83	71.13	172.30
Jul	98.02	53.50	31.00	117.75	133.09	91.77	58.41	151.57
Aug	72.96	37.00	22.00	76.00	110.60	63.48	43.36	119.15
Sep	35.92	24.00	16.75	35.25	67.65	46.86	35.28	76.52

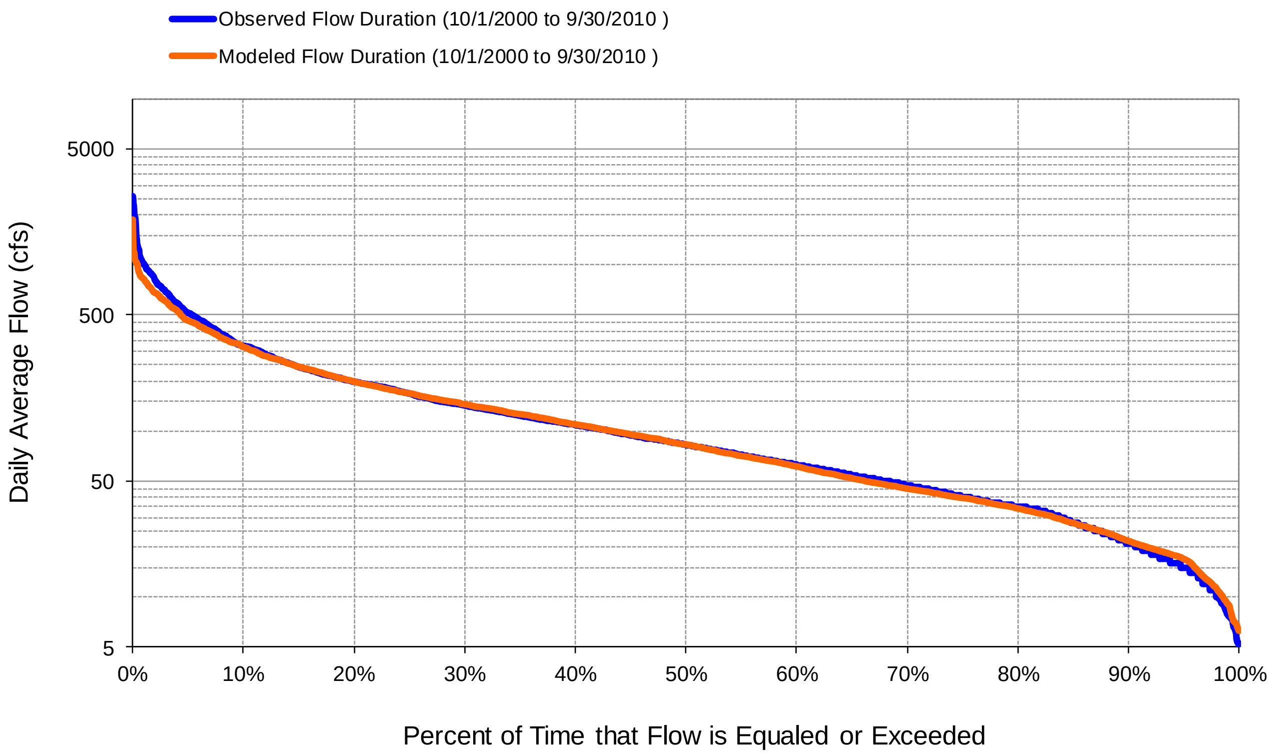


Figure E-6. Flow exceedence at USGS 04287000 Dog River at Northfield Falls, VT

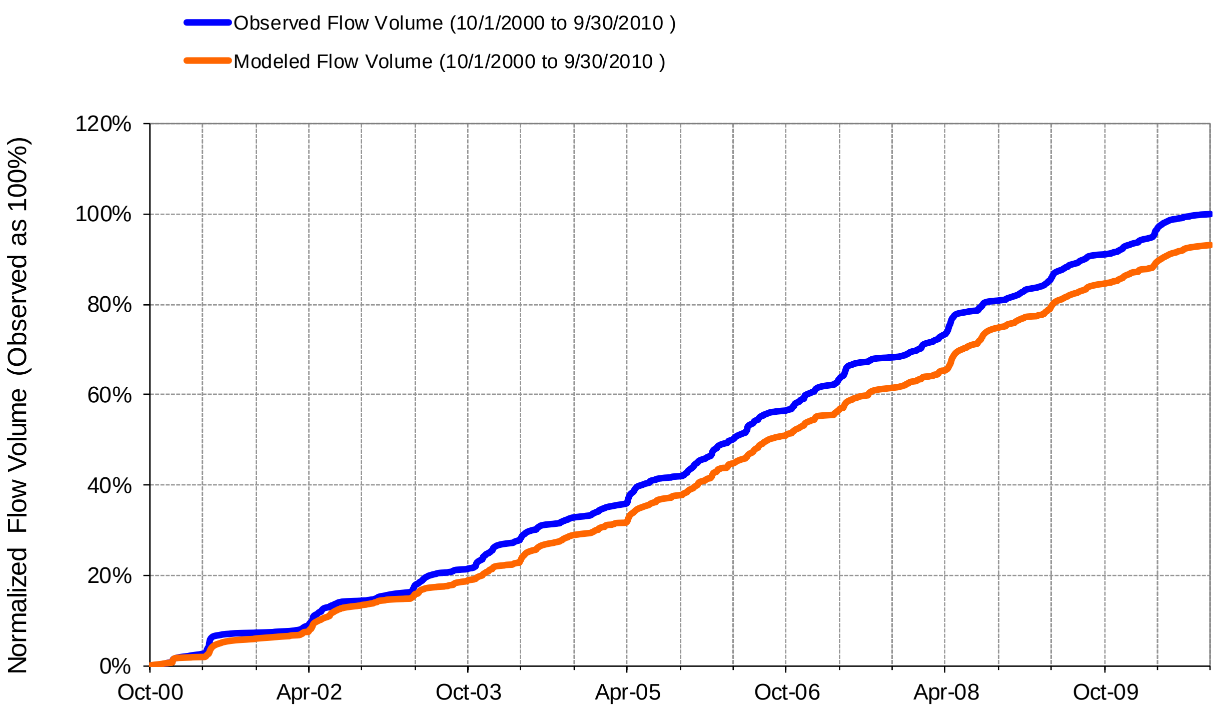


Figure E-7. Flow accumulation at USGS 04287000 Dog River at Northfield Falls, VT

Table E-2. Summary statistics at USGS 04287000 Dog River at Northfield Falls, VT

SWAT Simulated Flow		Observed Flow Gage		
REACH OUTFLOW FROM OUTLET 23		USGS 04287000 DOG RIVER AT NORTHFIELD FALLS, VT		
10-Year Analysis Period: 10/1/2000 - 9/30/2010 Flow volumes are (inches/year) for upstream drainage area		Hydrologic Unit Code: 2010003 Latitude: 44.1825606 Longitude: -72.6406655 Drainage Area (sq-mi): 76.1		
Total Simulated In-stream Flow:	**24.72**	Total Observed In-stream Flow:		**26.52**
Total of simulated highest 10% flows:	**9.60**	Total of Observed highest 10% flows:		**11.37**
Total of Simulated lowest 50% flows:	**3.70**	Total of Observed Lowest 50% flows:		**3.76**
Simulated Summer Flow Volume (months 7-9):	**4.68**	Observed Summer Flow Volume (7-9):		**3.12**
Simulated Fall Flow Volume (months 10-12):	**5.70**	Observed Fall Flow Volume (10-12):		**6.52**
Simulated Winter Flow Volume (months 1-3):	**4.82**	Observed Winter Flow Volume (1-3):		**6.43**
Simulated Spring Flow Volume (months 4-6):	**9.52**	Observed Spring Flow Volume (4-6):		**10.45**
Total Simulated Storm Volume:	**7.15**	Total Observed Storm Volume:		**8.12**
Simulated Summer Storm Volume (7-9):	**1.23**	Observed Summer Storm Volume (7-9):		**1.10**
Errors (Simulated-Observed)	*Error Statistics*	*Recommended Criteria*		
Error in total volume:	-6.77	10		
Error in 50% lowest flows:	-1.52	10		
Error in 10% highest flows:	-15.60	15		
Seasonal volume error - Summer:	50.26	30		
Seasonal volume error - Fall:	-12.65 >>	30		Clear
Seasonal volume error - Winter:	-24.97	30		
Seasonal volume error - Spring:	-8.93	30		
Error in storm volumes:	-12.02	20		
Error in summer storm volumes:	11.67	50		
Nash-Sutcliffe Coefficient of Efficiency, E:	0.623	Model accuracy increases		
Baseline adjusted coefficient (Garrick), E':	0.464	as E or E' approaches 1.0		
Monthly NSE	0.789			

USGS 04287000 Dog River at Northfield Falls, VT - Validation

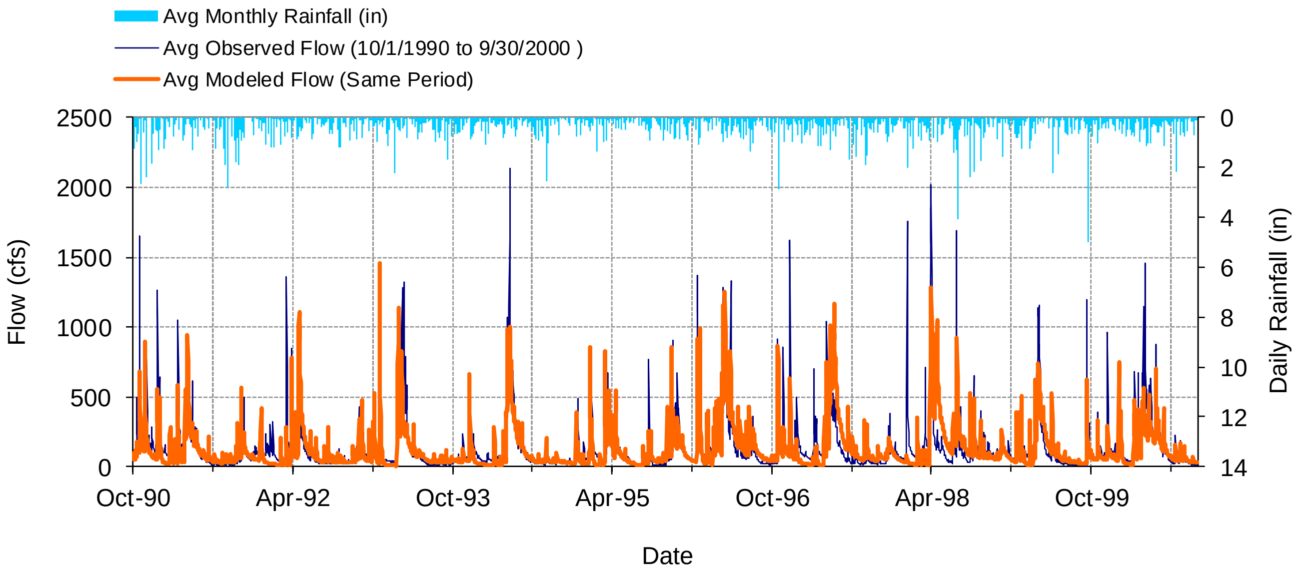


Figure E-8. Mean daily flow at USGS 04287000 Dog River at Northfield Falls, VT

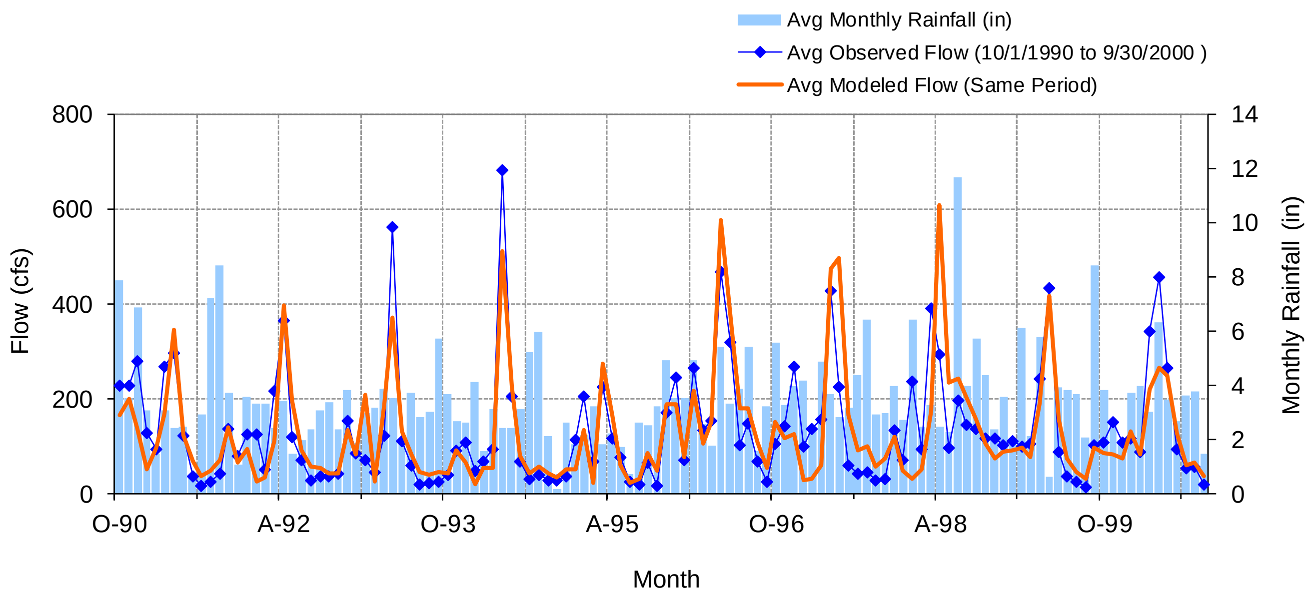


Figure E-9. Mean monthly flow at USGS 04287000 Dog River at Northfield Falls, VT

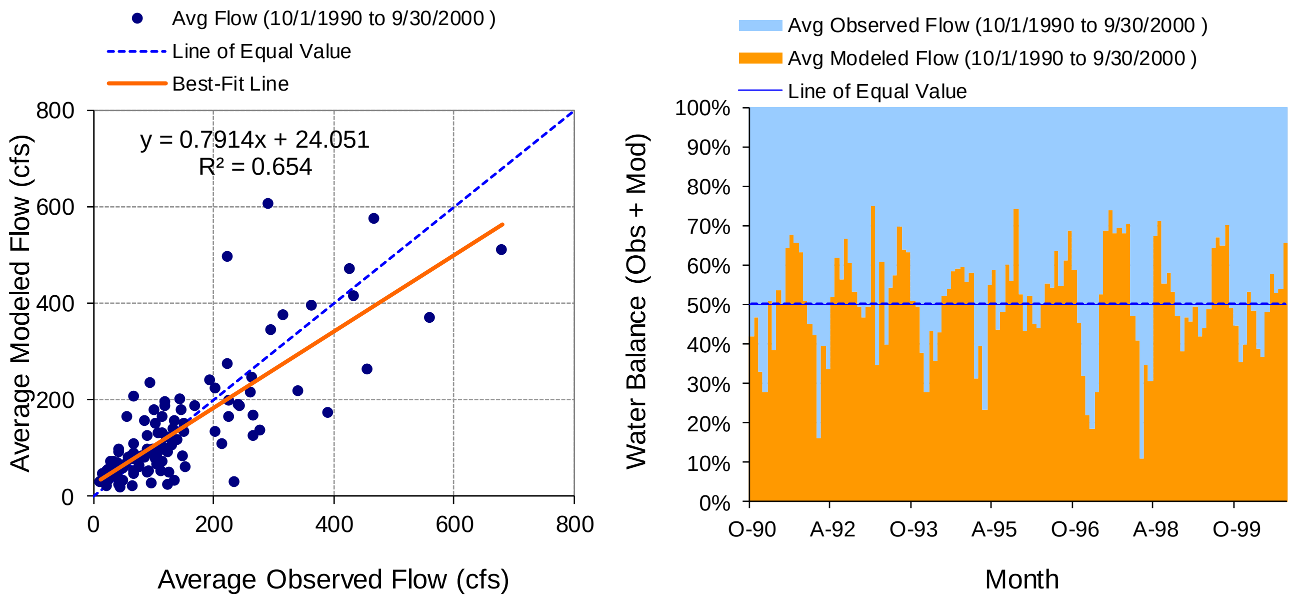


Figure E-10. Monthly flow regression and temporal variation at USGS 04287000 Dog River at Northfield Falls, VT

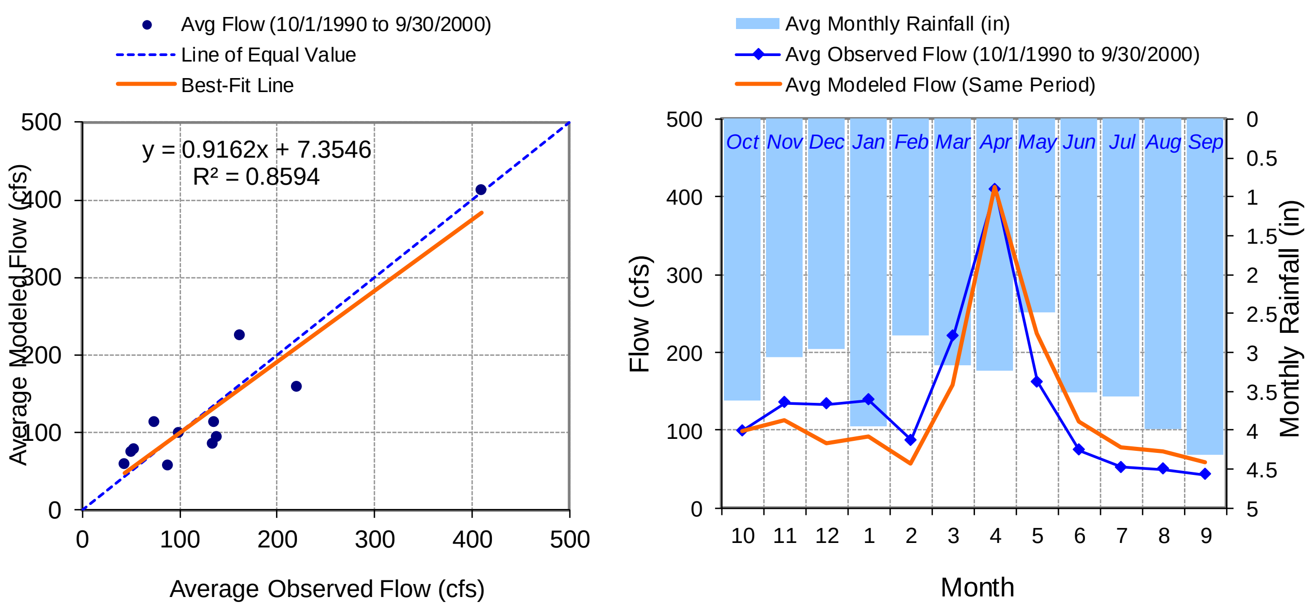


Figure E-11. Seasonal regression and temporal aggregate at USGS 04287000 Dog River at Northfield Falls, VT

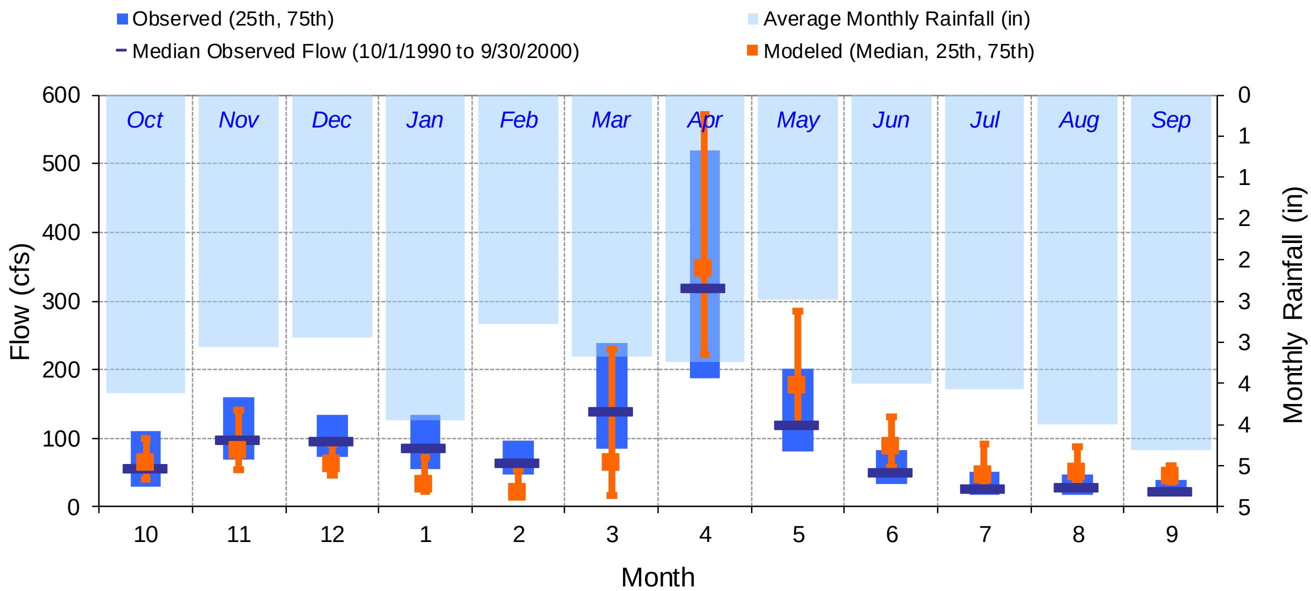


Figure E-12. Seasonal medians and ranges at USGS 04287000 Dog River at Northfield Falls, VT

Table E-3. Seasonal summary at USGS 04287000 Dog River at Northfield Falls, VT

MONTH	OBSERVED FLOW (CFS)				MODELED FLOW (CFS)			
	MEAN	MEDIAN	25TH	75TH	MEAN	MEDIAN	25TH	75TH
Oct	99.75	55.50	30.00	109.75	98.50	63.74	39.67	99.27
Nov	135.33	98.00	69.75	160.25	112.41	81.45	54.49	141.89
Dec	133.28	96.00	72.00	135.00	83.97	62.93	46.18	92.29
Jan	138.48	86.00	55.25	133.75	92.81	31.74	22.20	71.67
Feb	87.65	65.00	47.00	96.50	56.91	20.67	15.87	54.35
Mar	220.28	139.00	84.00	239.25	157.91	63.09	16.63	230.48
Apr	409.98	319.50	188.00	518.75	412.12	346.15	222.69	571.39
May	162.29	119.50	80.00	201.00	223.89	176.82	117.07	285.73
Jun	73.91	49.50	33.00	82.00	111.72	87.53	58.69	131.79
Jul	52.57	27.00	18.00	52.00	78.06	46.05	36.02	91.27
Aug	49.85	29.00	17.00	47.75	73.09	49.28	36.50	87.04
Sep	43.24	22.50	17.00	39.00	58.79	43.88	35.89	60.41

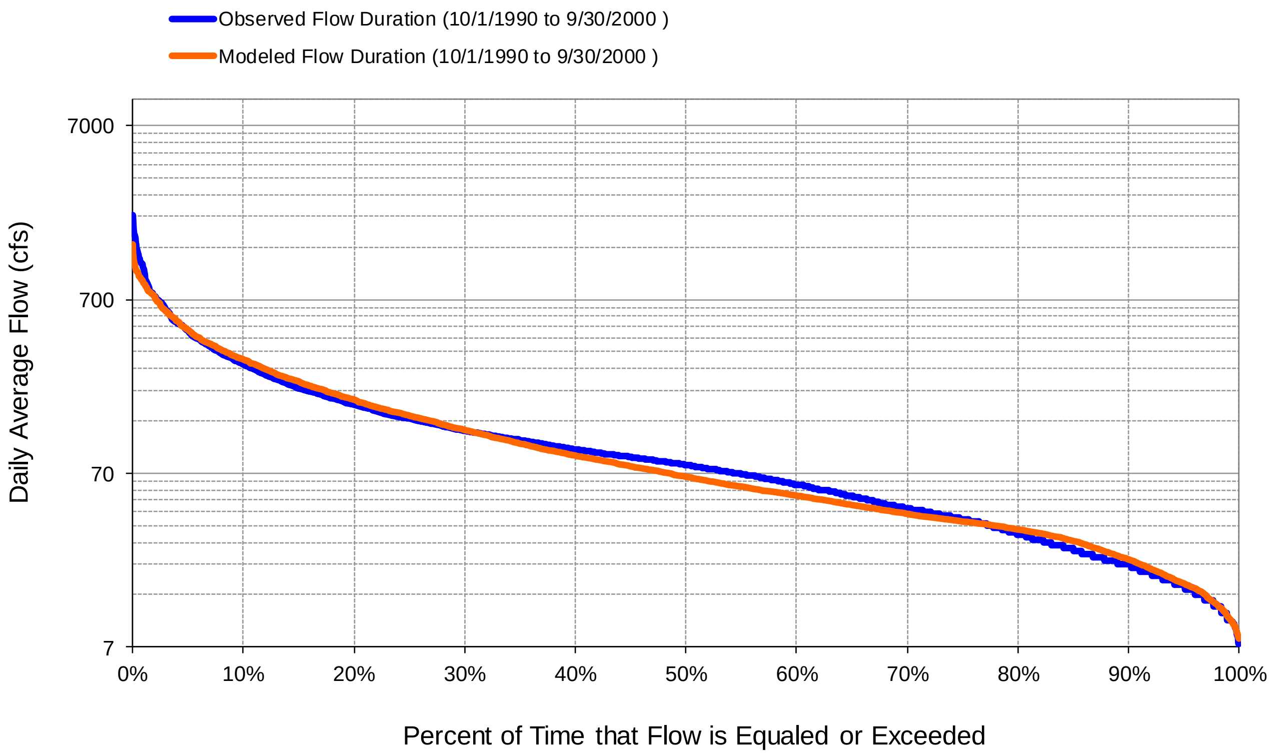


Figure E-13. Flow exceedence at USGS 04287000 Dog River at Northfield Falls, VT

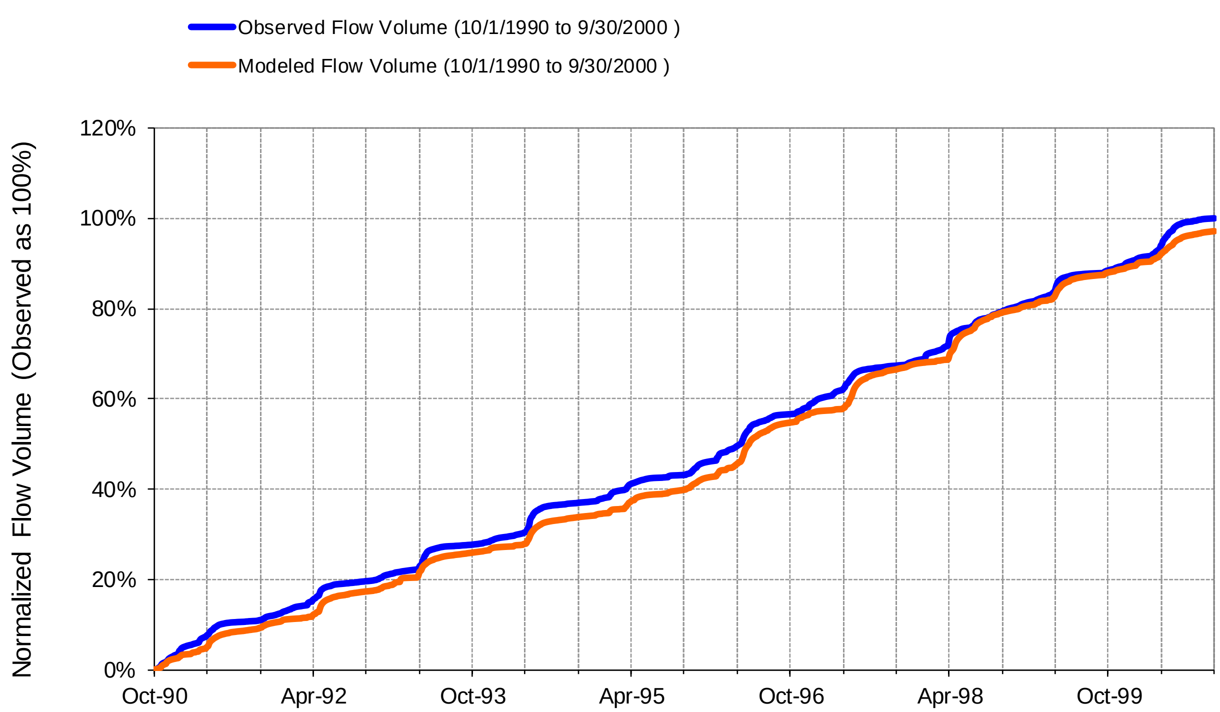


Figure E-14. Flow accumulation at USGS 04287000 Dog River at Northfield Falls, VT

Table E-4. Summary statistics at USGS 04287000 Dog River at Northfield Falls, VT

SWAT Simulated Flow		Observed Flow Gage	
REACH OUTFLOW FROM OUTLET 23 10-Year Analysis Period: 10/1/1990 - 9/30/2000 Flow volumes are (inches/year) for upstream drainage area		USGS 04287000 DOG RIVER AT NORTHFIELD FALLS, VT Hydrologic Unit Code: 2010003 Latitude: 44.1825606 Longitude: -72.6406655 Drainage Area (sq-mi): 76.1	
Total Simulated In-stream Flow:	**23.22**	Total Observed In-stream Flow:	**23.90**
Total of simulated highest 10% flows:	**9.66**	Total of Observed highest 10% flows:	**10.26**
Total of Simulated lowest 50% flows:	**3.33**	Total of Observed Lowest 50% flows:	**3.57**
Simulated Summer Flow Volume (months 7-9):	**3.15**	Observed Summer Flow Volume (7-9):	**2.19**
Simulated Fall Flow Volume (months 10-12):	**4.41**	Observed Fall Flow Volume (10-12):	**5.51**
Simulated Winter Flow Volume (months 1-3):	**4.58**	Observed Winter Flow Volume (1-3):	**6.65**
Simulated Spring Flow Volume (months 4-6):	**11.07**	Observed Spring Flow Volume (4-6):	**9.55**
Total Simulated Storm Volume:	**5.80**	Total Observed Storm Volume:	**6.82**
Simulated Summer Storm Volume (7-9):	**0.71**	Observed Summer Storm Volume (7-9):	**0.80**
Errors (Simulated-Observed)	*Error Statistics*	*Recommended Criteria*	
Error in total volume:	-2.84	10	
Error in 50% lowest flows:	-6.78	10	
Error in 10% highest flows:	-5.81	15	
Seasonal volume error - Summer:	44.21	30	
Seasonal volume error - Fall:	-19.99	>> 30	Clear
Seasonal volume error - Winter:	-31.02	30	
Seasonal volume error - Spring:	15.90	30	
Error in storm volumes:	-14.99	20	
Error in summer storm volumes:	-10.84	50	
Nash-Sutcliffe Coefficient of Efficiency, E:	0.503	Model accuracy increases	
Baseline adjusted coefficient (Garrick), E':	0.379	as E or E' approaches 1.0	
Monthly NSE	0.624		

USGS 04286000 Winooski River at Montpelier, VT - Calibration

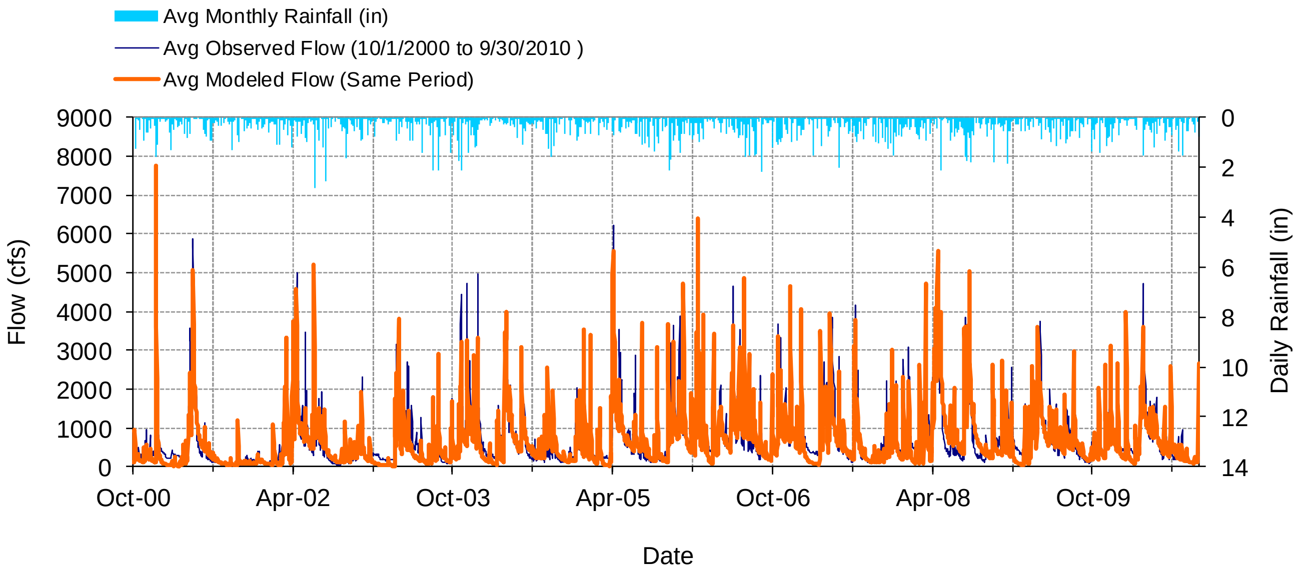


Figure E-15. Mean daily flow at USGS 04286000 Winooski River at Montpelier, VT

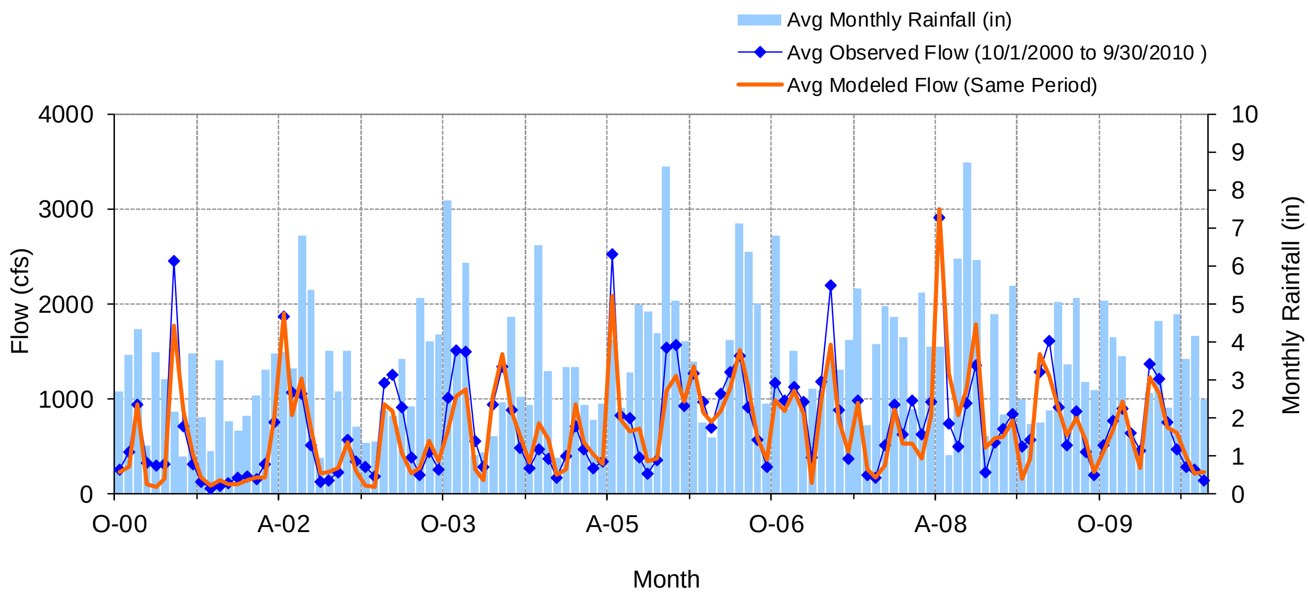


Figure E-16. Mean monthly flow at USGS 04286000 Winooski River at Montpelier, VT

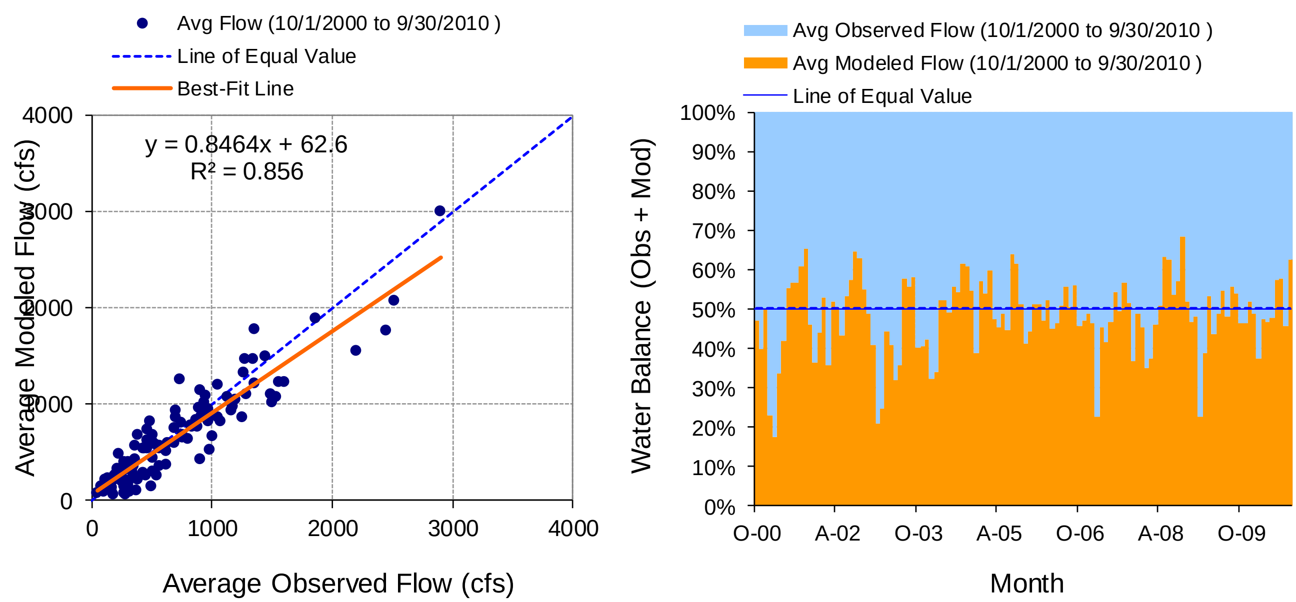


Figure E-17. Monthly flow regression and temporal variation at USGS 04286000 Winooski River at Montpelier, VT

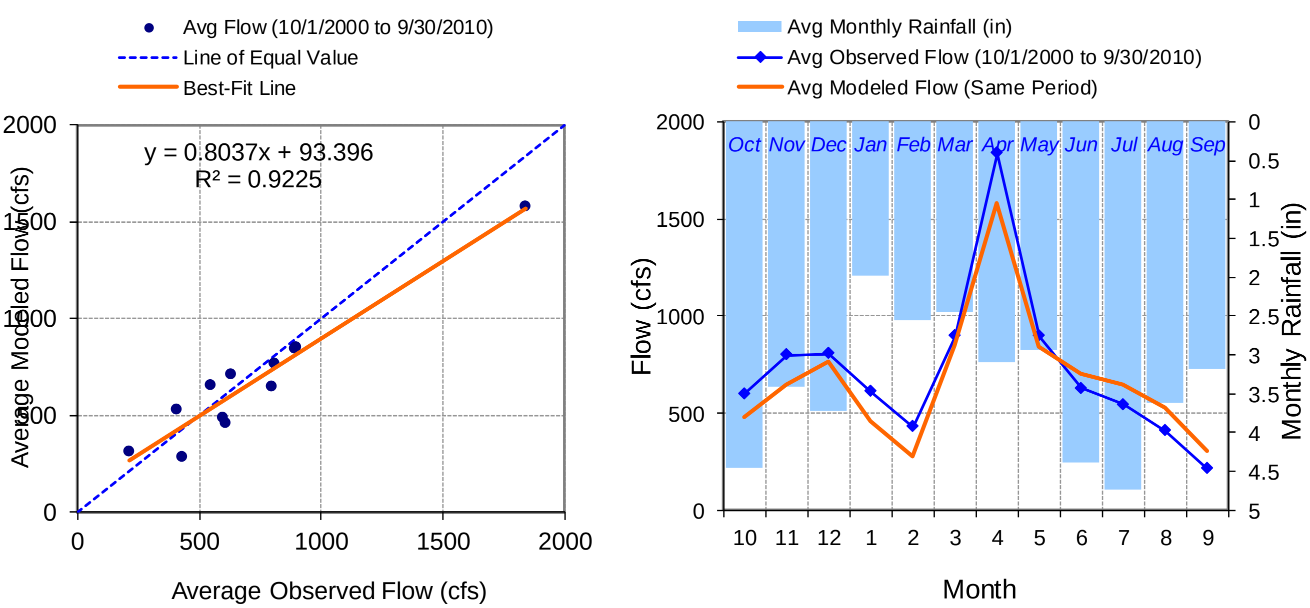


Figure E-18. Seasonal regression and temporal aggregate at USGS 04286000 Winooski River at Montpelier, VT

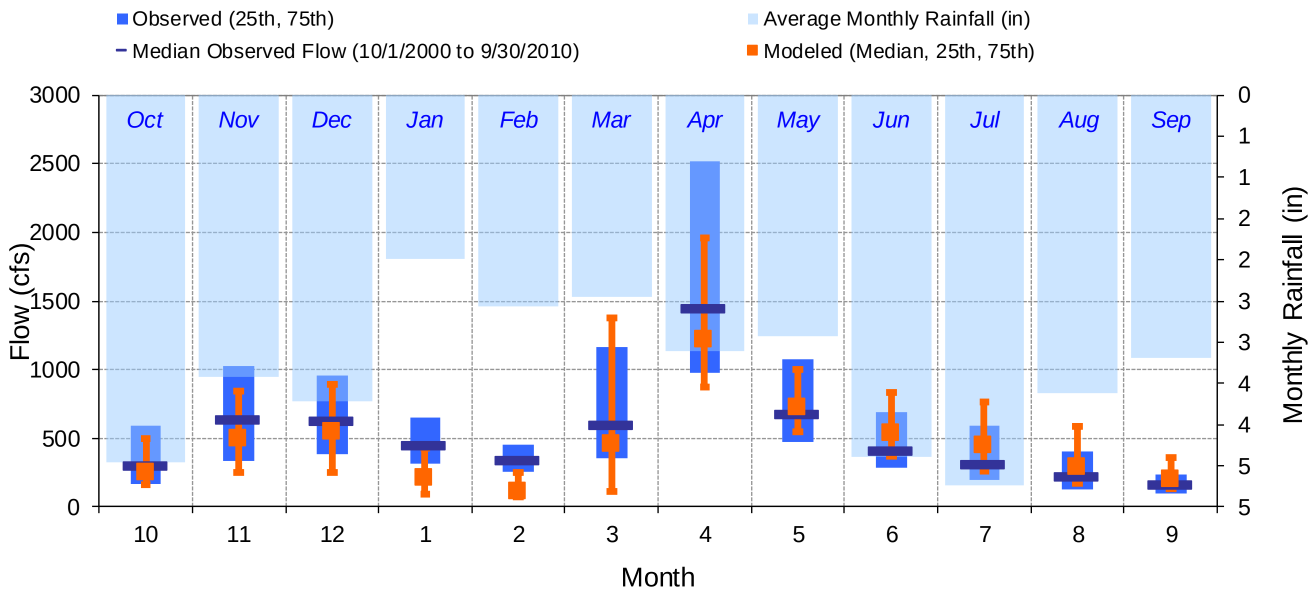


Figure E-19. Seasonal medians and ranges at USGS 04286000 Winooski River at Montpelier, VT

Table E-5. Seasonal summary at USGS 04286000 Winooski River at Montpelier, VT

MONTH	OBSERVED FLOW (CFS)				MODELED FLOW (CFS)			
	MEAN	MEDIAN	25TH	75TH	MEAN	MEDIAN	25TH	75TH
Oct	599.27	302.50	164.00	593.50	481.66	246.23	166.74	501.56
Nov	797.17	633.50	332.75	1030.00	643.75	499.70	247.50	843.49
Dec	805.92	628.50	382.75	952.50	763.59	550.73	250.62	892.67
Jan	609.57	445.00	311.00	656.00	457.85	209.20	91.97	430.75
Feb	430.68	343.00	251.25	450.00	280.43	115.25	72.37	250.75
Mar	897.31	592.00	350.25	1165.00	846.79	460.15	114.58	1374.45
Apr	1838.01	1445.00	974.50	2515.00	1577.99	1217.47	872.89	1963.50
May	894.60	671.00	477.50	1080.00	843.81	722.71	546.94	998.52
Jun	629.16	411.50	289.75	690.50	706.13	537.31	364.80	838.11
Jul	545.15	307.50	193.25	595.00	648.92	451.67	264.22	759.97
Aug	406.67	217.50	130.25	399.50	528.39	295.05	175.35	584.72
Sep	214.60	165.50	100.00	236.25	308.21	203.20	128.21	354.91

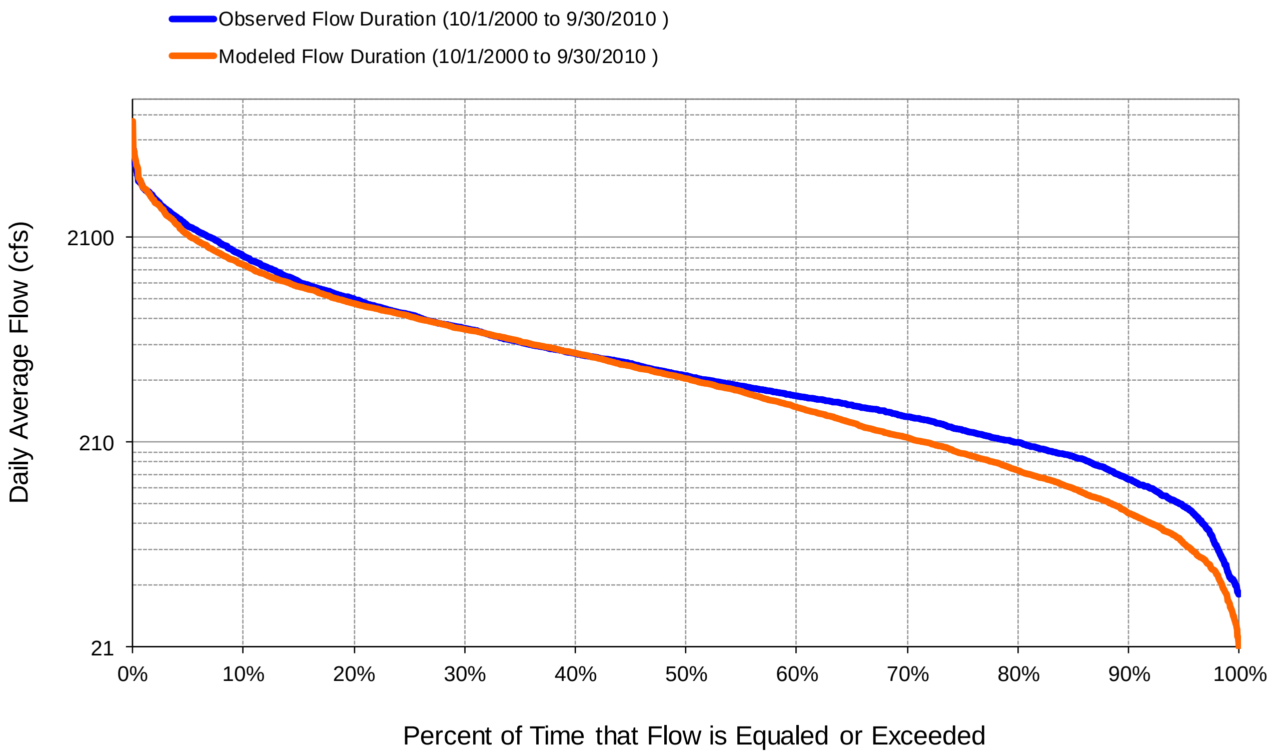


Figure E-20. Flow exceedence at USGS 04286000 Winooski River at Montpelier, VT

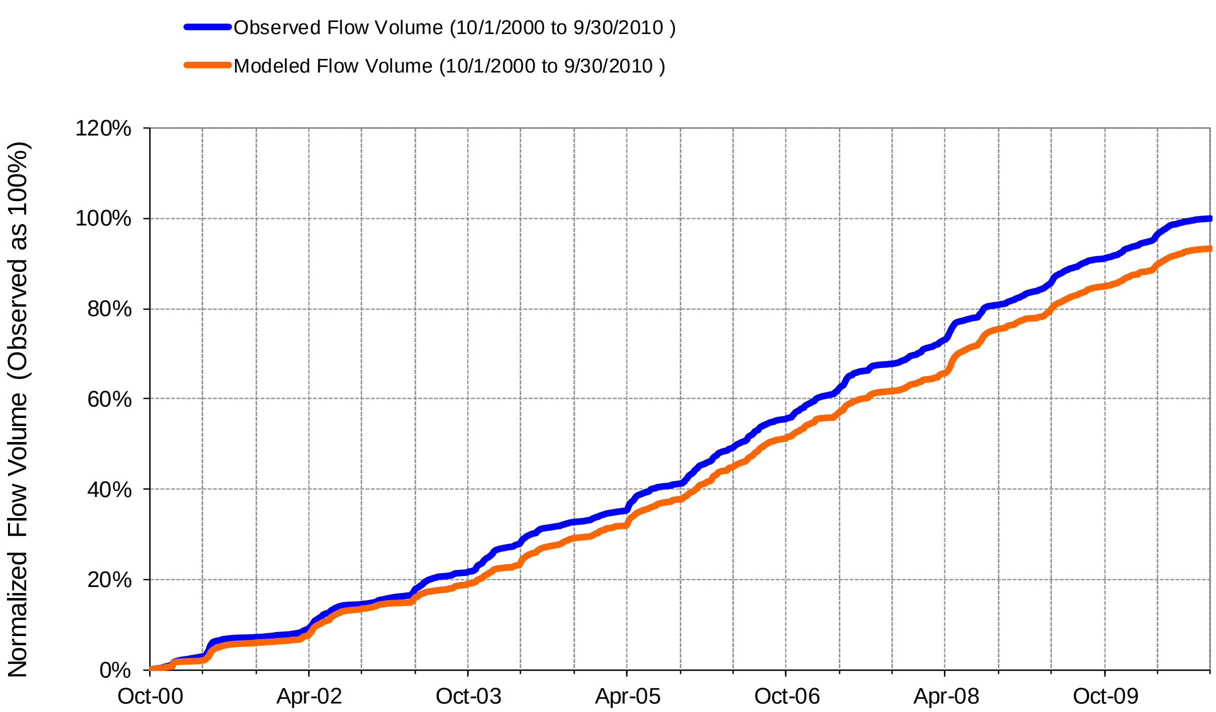


Figure E-21. Flow accumulation at USGS 04286000 Winooski River at Montpelier, VT

Table E-6. Summary statistics at USGS 04286000 Winooski River at Montpelier, VT

SWAT Simulated Flow		Observed Flow Gage	
REACH OUTFLOW FROM OUTLET 9 10-Year Analysis Period: 10/1/2000 - 9/30/2010 Flow volumes are (inches/year) for upstream drainage area		USGS 04286000 WINOOSKI RIVER AT MONTPELIER, VT Hydrologic Unit Code: 2010003 Latitude: 44.25672595 Longitude: -72.59344318 Drainage Area (sq-mi): 397	
Total Simulated In-stream Flow:	**23.11**	Total Observed In-stream Flow:	**24.74**
Total of simulated highest 10% flows:	**8.54**	Total of Observed highest 10% flows:	**9.03**
Total of Simulated lowest 50% flows:	**3.46**	Total of Observed Lowest 50% flows:	**4.21**
Simulated Summer Flow Volume (months 7-9):	**4.29**	Observed Summer Flow Volume (7-9):	**3.37**
Simulated Fall Flow Volume (months 10-12):	**5.43**	Observed Fall Flow Volume (10-12):	**6.32**
Simulated Winter Flow Volume (months 1-3):	**4.53**	Observed Winter Flow Volume (1-3):	**5.51**
Simulated Spring Flow Volume (months 4-6):	**8.87**	Observed Spring Flow Volume (4-6):	**9.53**
Total Simulated Storm Volume:	**8.41**	Total Observed Storm Volume:	**8.32**
Simulated Summer Storm Volume (7-9):	**1.48**	Observed Summer Storm Volume (7-9):	**1.35**

Errors (Simulated-Observed)	*Error Statistics*	*Recommended Criteria*
Error in total volume:	-6.57	10
Error in 50% lowest flows:	-17.92	10
Error in 10% highest flows:	-5.47	15
Seasonal volume error - Summer:	27.26	30
Seasonal volume error - Fall:	-14.17	30
Seasonal volume error - Winter:	-17.85	30
Seasonal volume error - Spring:	-6.94	30
Error in storm volumes:	1.09	20
Error in summer storm volumes:	9.40	50
Nash-Sutcliffe Coefficient of Efficiency, E:	0.644	Model accuracy increases
Baseline adjusted coefficient (Garrick), E':	0.480	as E or E' approaches 1.0
Monthly NSE	0.848	

>> Clear

USGS 04286000 Winooski River at Montpelier, VT - Validation

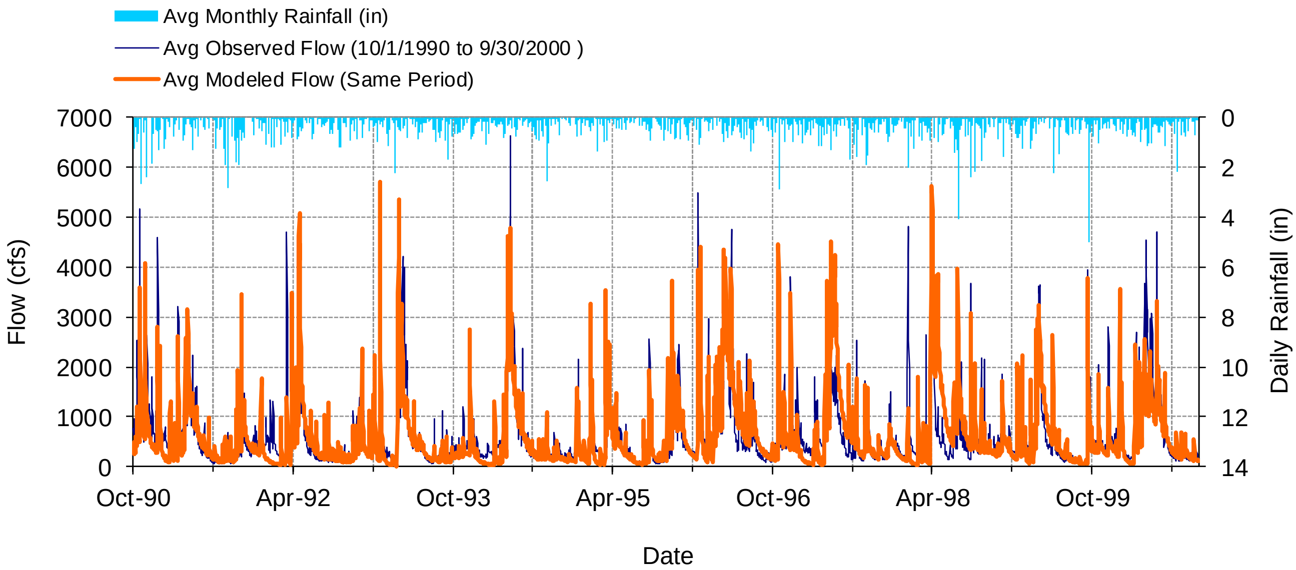


Figure E-22. Mean daily flow at USGS 04286000 Winooski River at Montpelier, VT

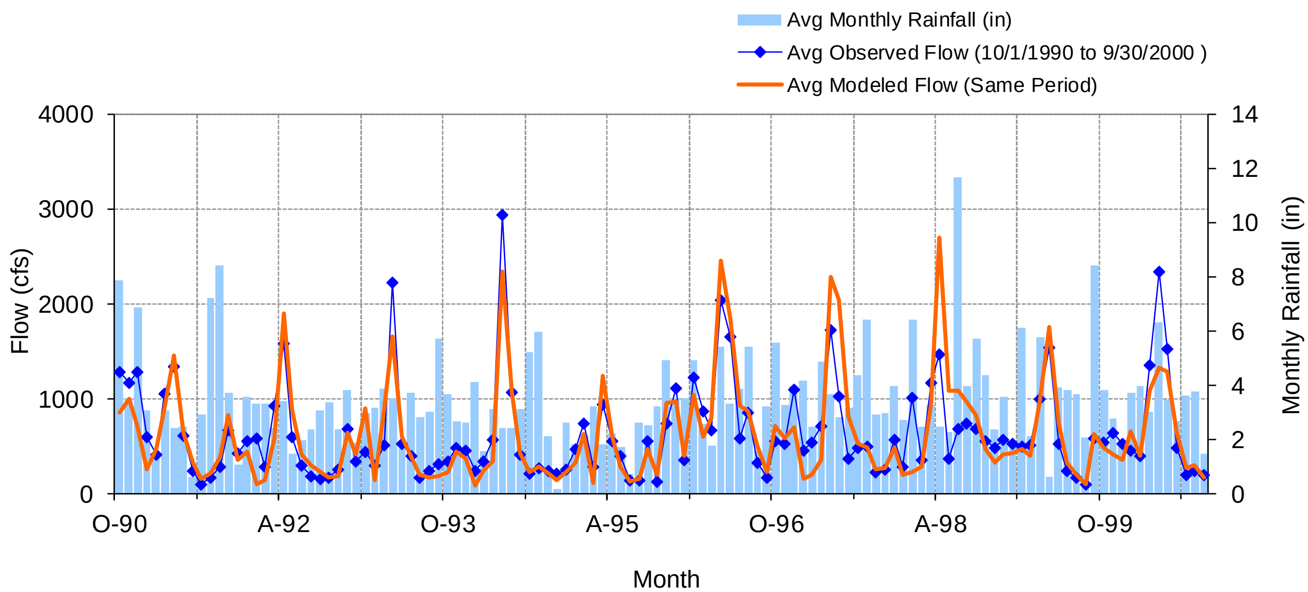


Figure E-23. Mean monthly flow at USGS 04286000 Winooski River at Montpelier, VT

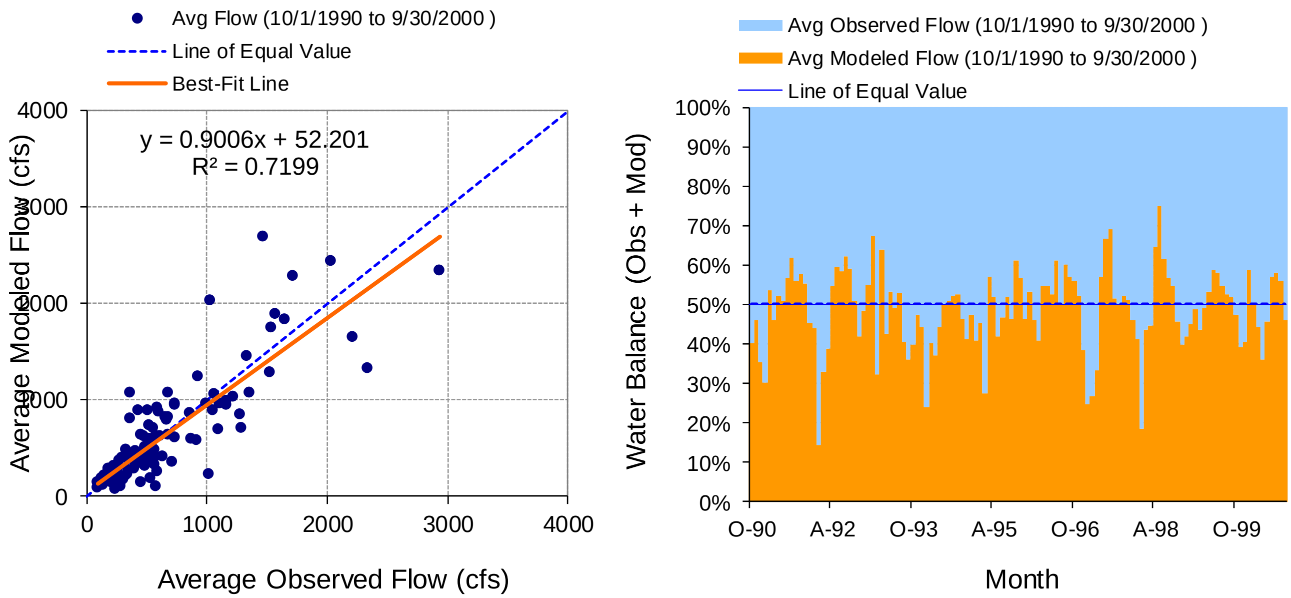


Figure E-24. Monthly flow regression and temporal variation at USGS 04286000 Winooski River at Montpelier, VT

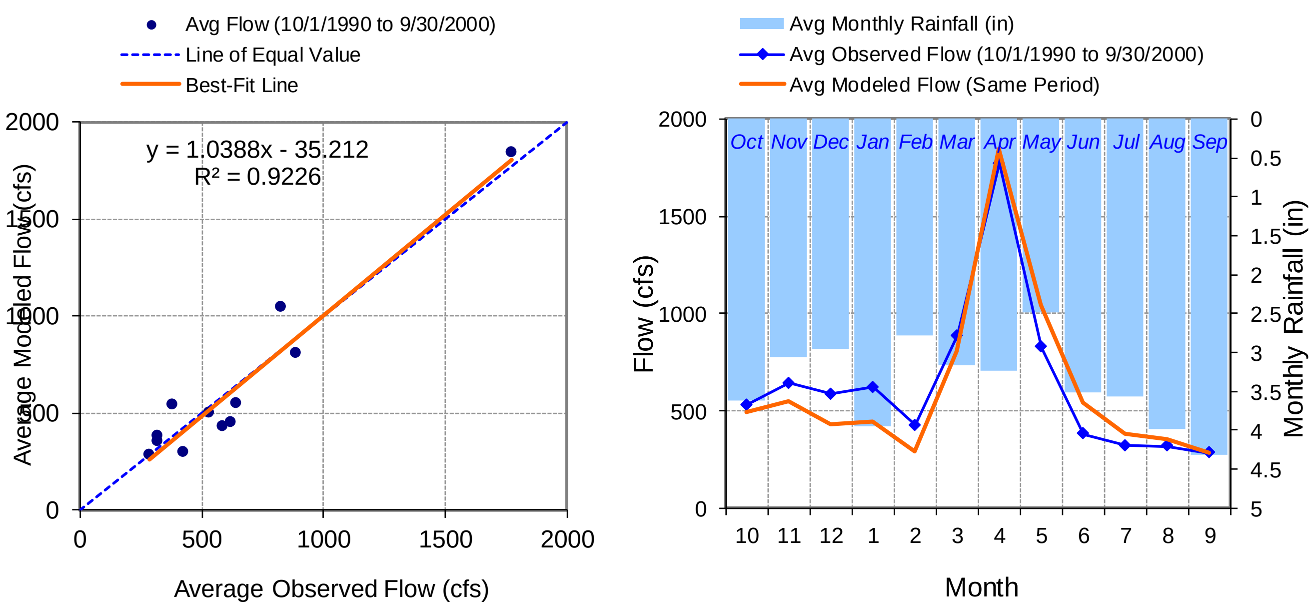


Figure E-25. Seasonal regression and temporal aggregate at USGS 04286000 Winooski River at Montpelier, VT

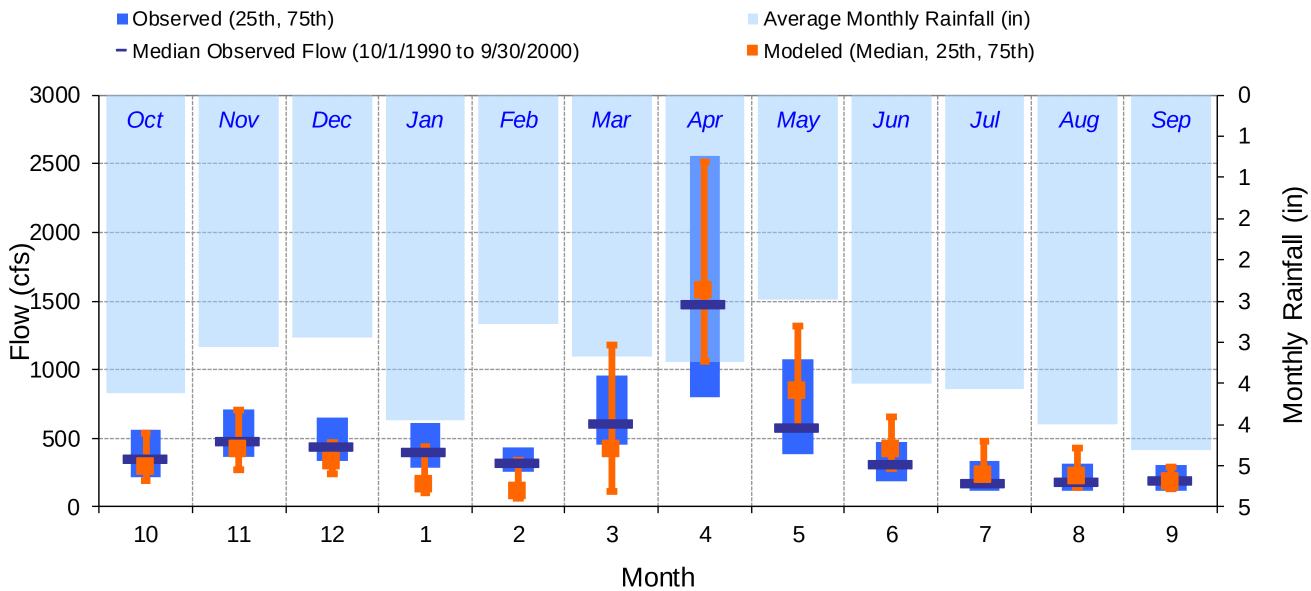


Figure E-26. Seasonal medians and ranges at USGS 04286000 Winooski River at Montpelier, VT

Table E-7. Seasonal summary at USGS 04286000 Winooski River at Montpelier, VT

MONTH	OBSERVED FLOW (CFS)				MODELED FLOW (CFS)			
	MEAN	MEDIAN	25TH	75TH	MEAN	MEDIAN	25TH	75TH
Oct	528.56	351.00	219.25	559.00	494.50	293.77	190.15	533.43
Nov	640.47	473.50	366.00	713.00	547.87	414.77	274.33	706.12
Dec	587.54	443.00	335.00	650.25	429.42	332.88	240.45	469.42
Jan	621.80	399.00	290.00	609.00	446.40	164.85	98.02	438.26
Feb	426.16	322.00	255.00	435.50	293.72	117.56	62.03	335.82
Mar	885.44	604.50	450.00	958.75	808.24	416.89	113.79	1181.10
Apr	1771.86	1475.00	803.75	2560.00	1842.59	1572.92	1061.29	2514.76
May	826.64	578.00	384.50	1080.00	1041.64	845.96	566.01	1321.74
Jun	379.43	309.00	190.75	471.75	539.25	422.72	278.09	652.53
Jul	320.49	174.50	113.25	332.50	379.26	228.79	157.70	479.57
Aug	317.61	177.00	120.00	314.00	353.98	223.81	140.52	426.07
Sep	282.32	192.00	117.75	302.25	283.28	185.33	132.18	290.63

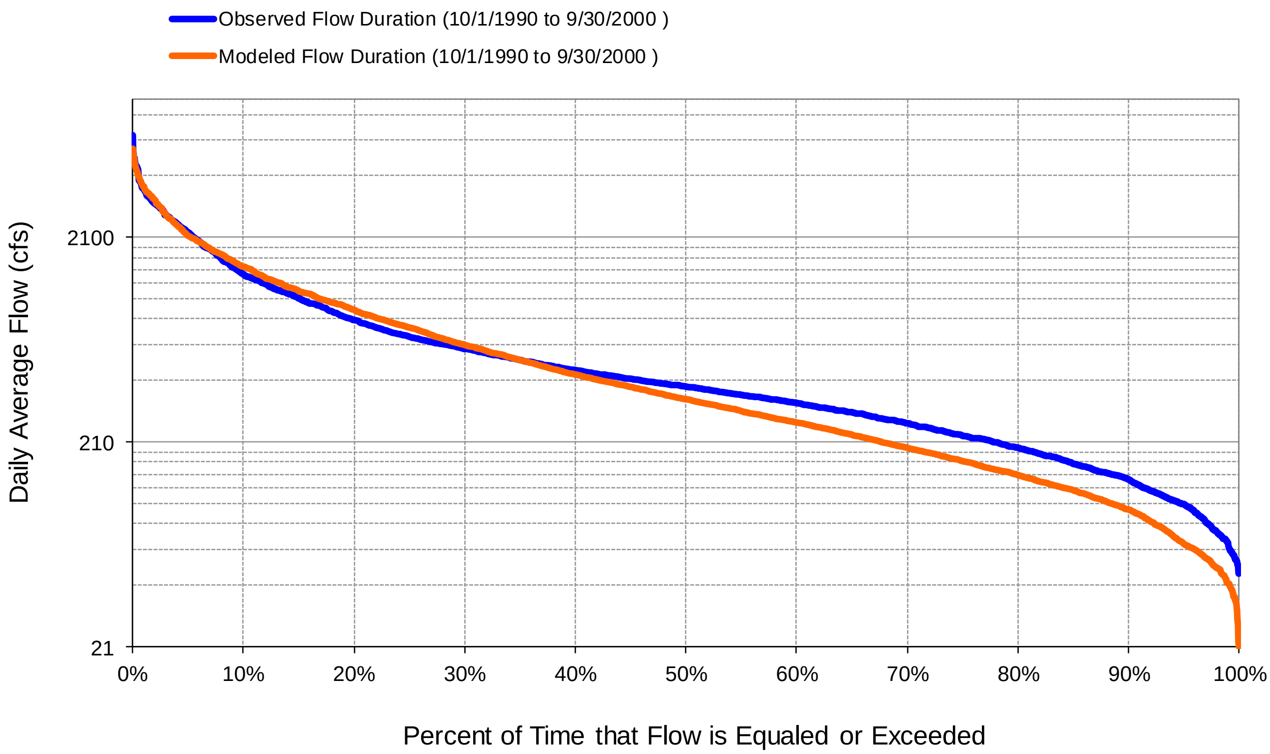


Figure E-27. Flow exceedence at USGS 04286000 Winooski River at Montpelier, VT

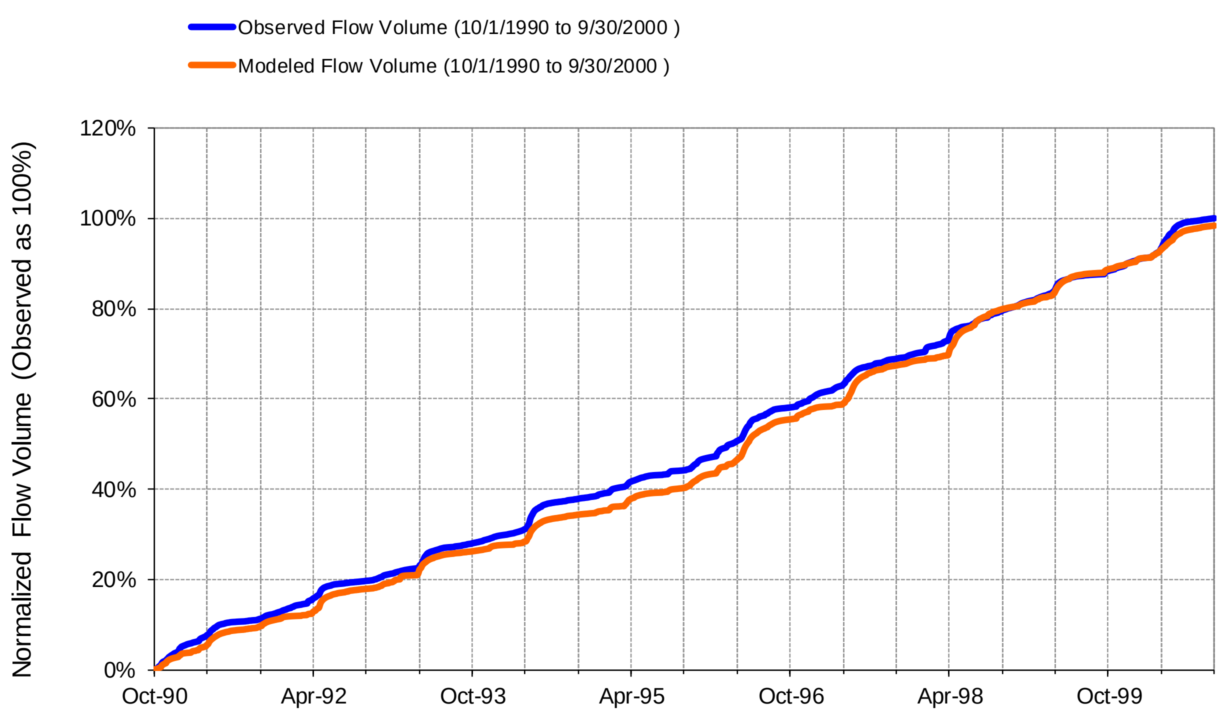


Figure E-28. Flow accumulation at USGS 04286000 Winooski River at Montpelier, VT

Table E-8. Summary statistics at USGS 04286000 Winooski River at Montpelier, VT

SWAT Simulated Flow		Observed Flow Gage		
REACH OUTFLOW FROM OUTLET 9 10-Year Analysis Period: 10/1/1990 - 9/30/2000 Flow volumes are (inches/year) for upstream drainage area		USGS 04286000 WINOOSKI RIVER AT MONTPELIER, VT Hydrologic Unit Code: 2010003 Latitude: 44.25672595 Longitude: -72.59344318 Drainage Area (sq-mi): 397		
Total Simulated In-stream Flow:	**21.29**	Total Observed In-stream Flow:		**21.64**
Total of simulated highest 10% flows:	**8.43**	Total of Observed highest 10% flows:		**8.35**
Total of Simulated lowest 50% flows:	**3.04**	Total of Observed Lowest 50% flows:		**3.93**
Simulated Summer Flow Volume (months 7-9):	**2.93**	Observed Summer Flow Volume (7-9):		**2.65**
Simulated Fall Flow Volume (months 10-12):	**4.22**	Observed Fall Flow Volume (10-12):		**5.04**
Simulated Winter Flow Volume (months 1-3):	**4.42**	Observed Winter Flow Volume (1-3):		**5.51**
Simulated Spring Flow Volume (months 4-6):	**9.72**	Observed Spring Flow Volume (4-6):		**8.45**
Total Simulated Storm Volume:	**6.99**	Total Observed Storm Volume:		**7.27**
Simulated Summer Storm Volume (7-9):	**1.02**	Observed Summer Storm Volume (7-9):		**1.18**
Errors (Simulated-Observed)	*Error Statistics*	*Recommended Criteria*		
Error in total volume:	-1.62	10		
Error in 50% lowest flows:	-22.46	10		
Error in 10% highest flows:	0.99	15		
Seasonal volume error - Summer:	10.54	30		
Seasonal volume error - Fall:	-16.23	>> 30		Clear
Seasonal volume error - Winter:	-19.70	30		
Seasonal volume error - Spring:	15.06	30		
Error in storm volumes:	-3.87	20		
Error in summer storm volumes:	-13.50	50		
Nash-Sutcliffe Coefficient of Efficiency, E:	0.536	Model accuracy increases		
Baseline adjusted coefficient (Garrick), E':	0.401	as E or E' approaches 1.0		
Monthly NSE	0.704			

USGS 04288000 Mad River near Moretown, VT - Calibration

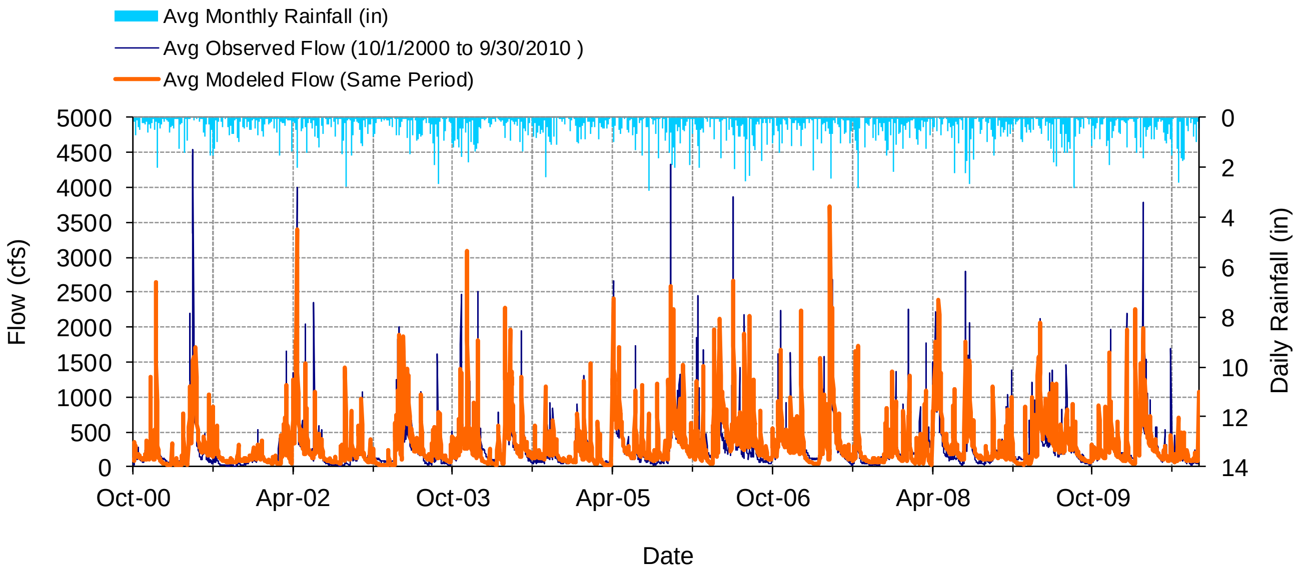


Figure E-29. Mean daily flow at USGS 04288000 Mad River near Moretown, VT

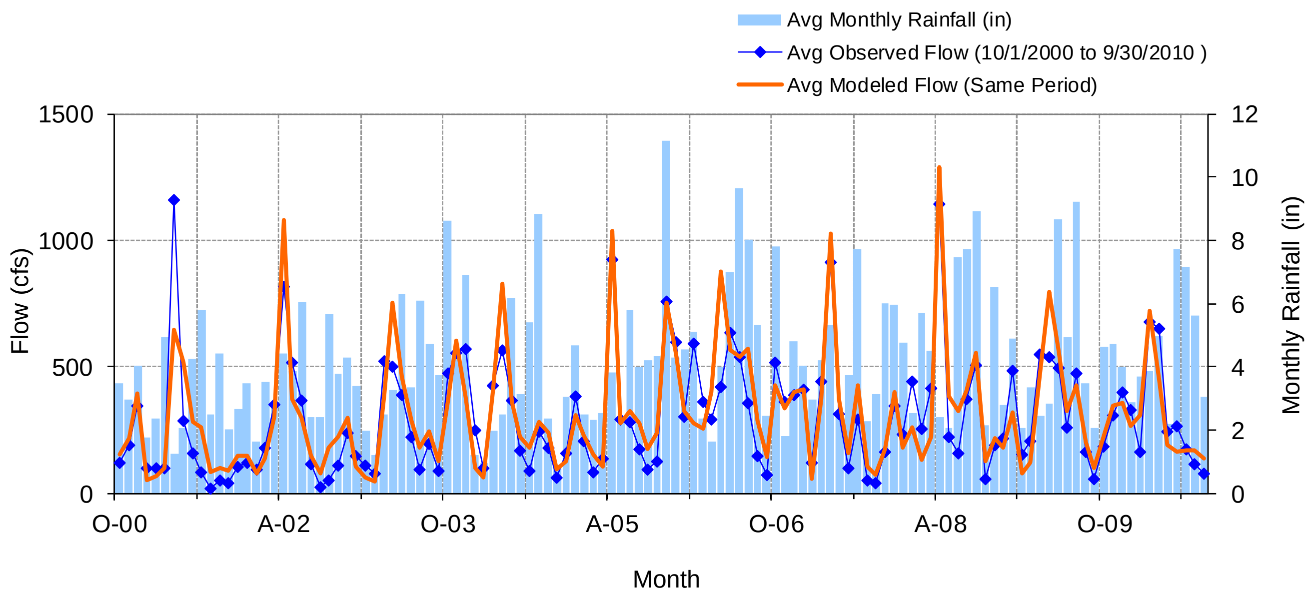


Figure E-30. Mean monthly flow at USGS 04288000 Mad River near Moretown, VT

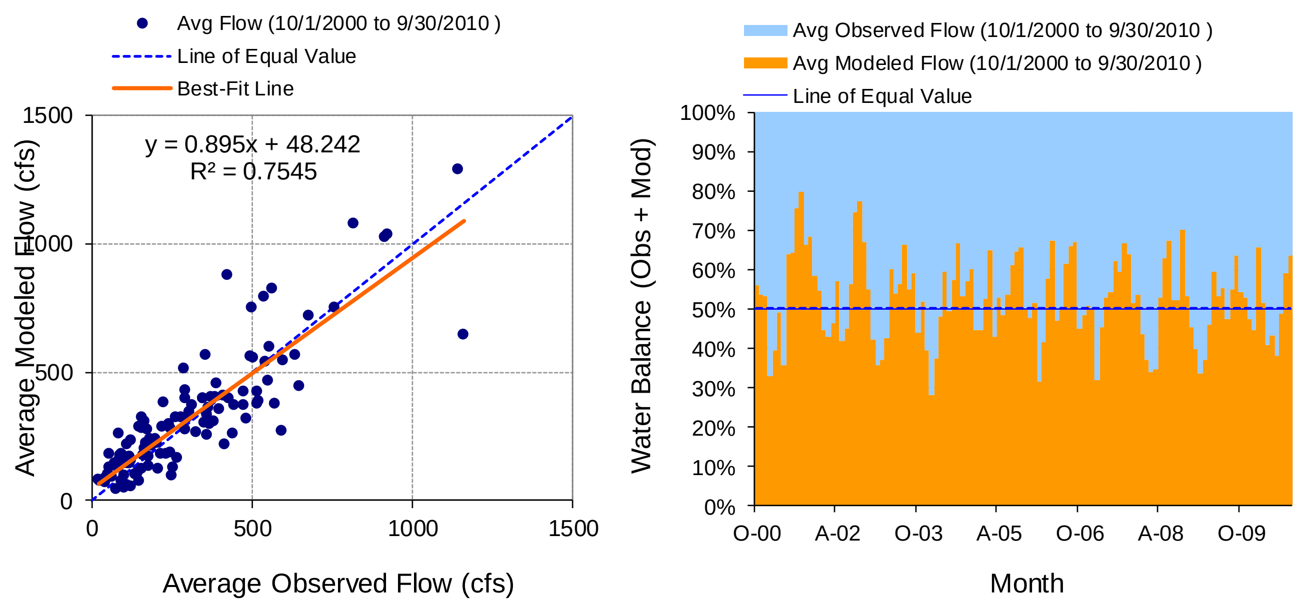


Figure E-31. Monthly flow regression and temporal variation at USGS 04288000 Mad River near Moretown, VT

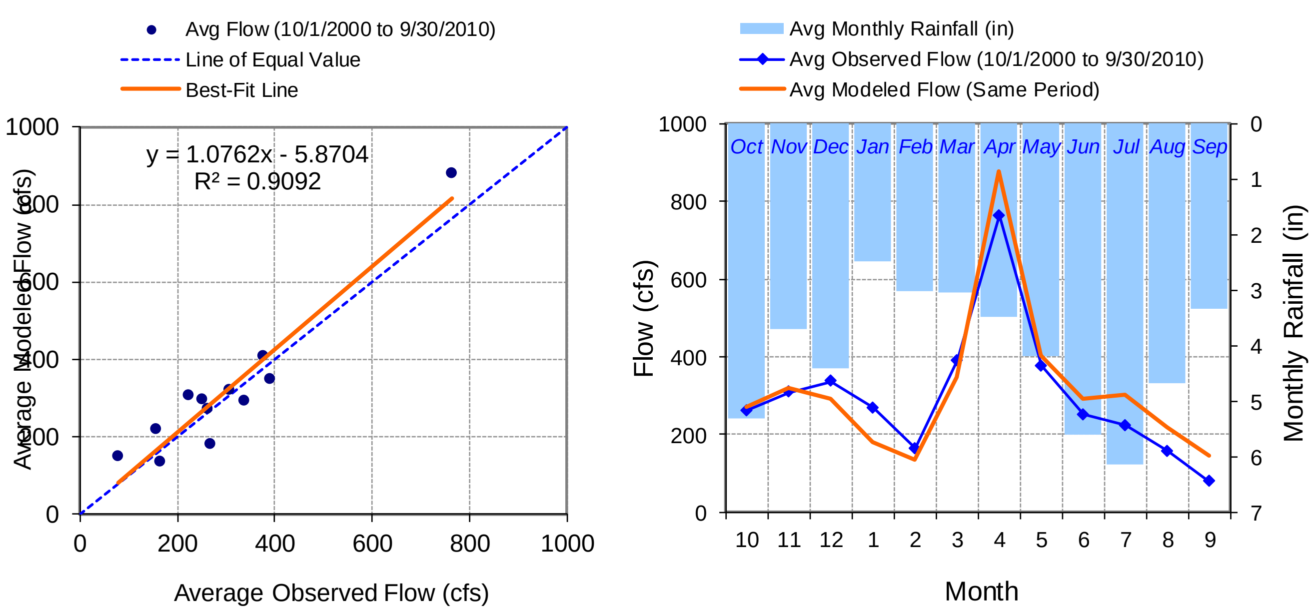


Figure E-32. Seasonal regression and temporal aggregate at USGS 04288000 Mad River near Moretown, VT

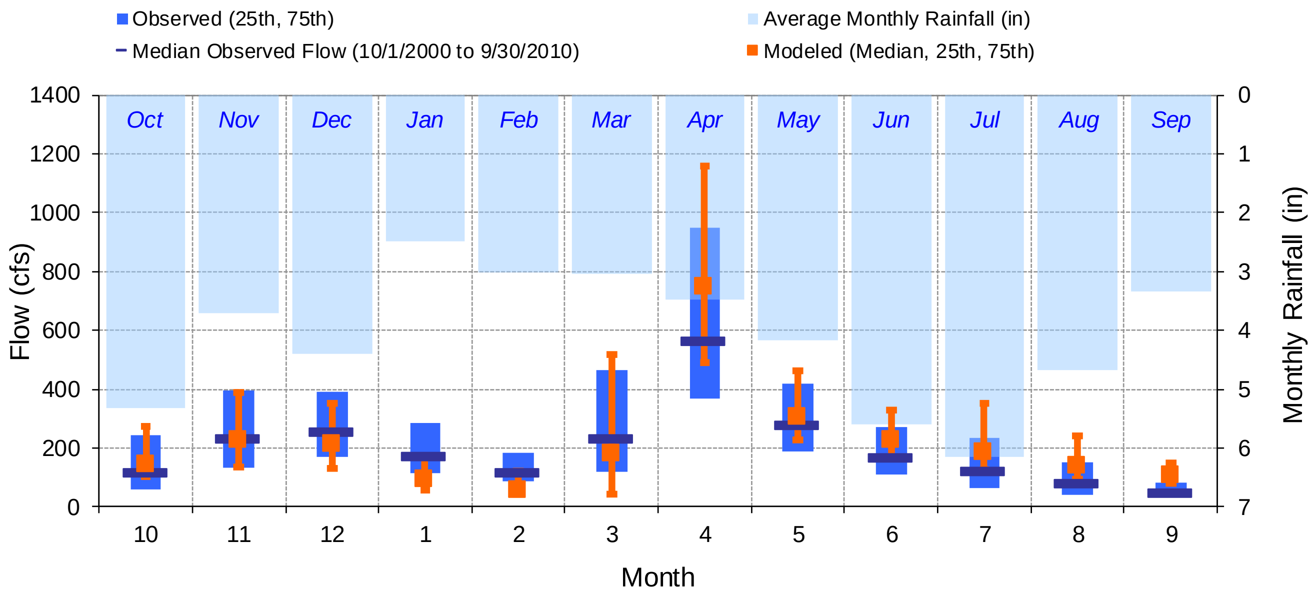


Figure E-33. Seasonal medians and ranges at USGS 04288000 Mad River near Moretown, VT

Table E-9. Seasonal summary at USGS 04288000 Mad River near Moretown, VT

MONTH	OBSERVED FLOW (CFS)				MODELED FLOW (CFS)			
	MEAN	MEDIAN	25TH	75TH	MEAN	MEDIAN	25TH	75TH
Oct	261.76	115.50	58.00	242.50	271.23	144.98	101.29	275.35
Nov	307.83	230.50	134.75	394.25	319.93	228.36	136.08	388.99
Dec	337.00	257.00	172.00	389.25	291.09	213.14	130.59	353.61
Jan	268.33	173.00	113.50	285.25	180.01	93.53	57.45	169.65
Feb	164.93	118.00	89.00	182.00	133.74	57.53	42.21	120.56
Mar	391.39	232.50	120.00	464.75	346.51	181.41	43.21	519.74
Apr	763.25	566.00	368.50	947.25	877.83	749.91	490.87	1159.38
May	377.08	277.50	188.00	420.50	404.95	308.19	225.93	462.80
Jun	251.46	168.50	108.75	270.25	292.91	227.20	164.49	330.97
Jul	222.46	120.00	66.25	236.25	303.63	188.02	125.44	353.87
Aug	157.37	82.00	41.00	150.75	217.29	139.46	95.51	239.77
Sep	79.52	50.00	34.75	83.00	145.73	106.61	80.42	149.29

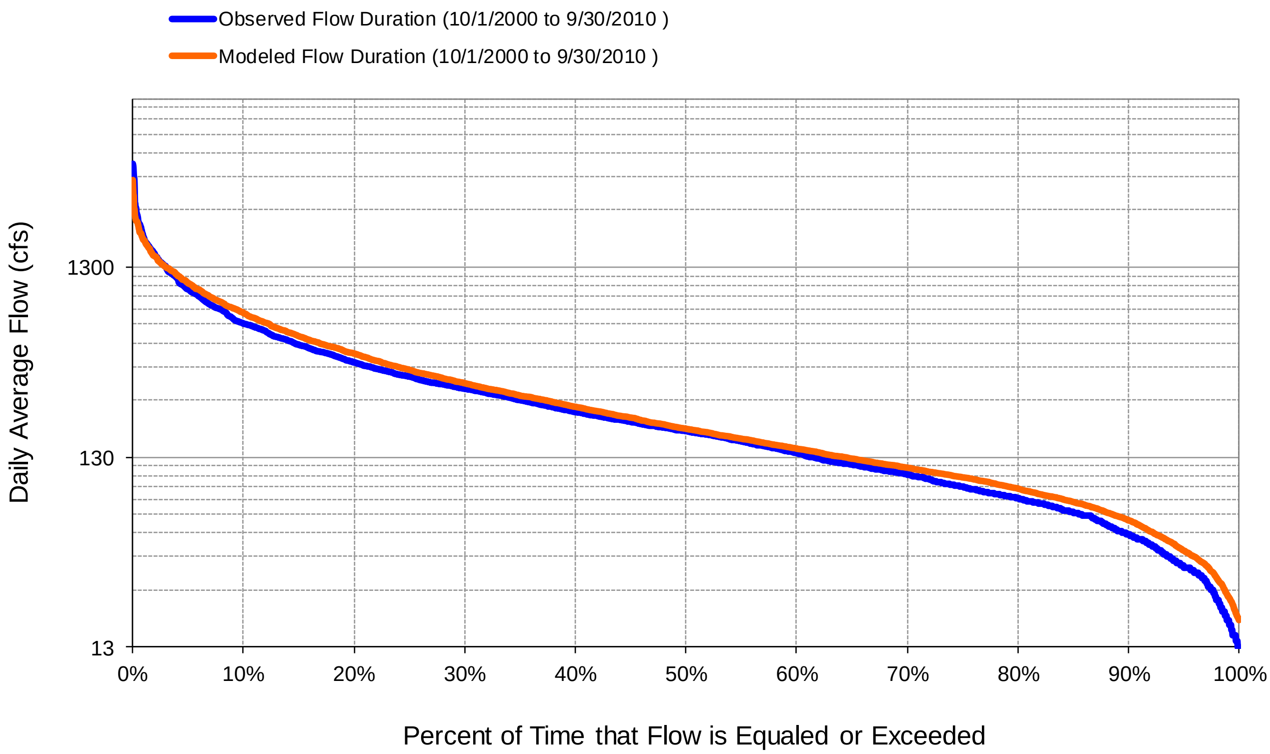


Figure E-34. Flow exceedence at USGS 04288000 Mad River near Moretown, VT

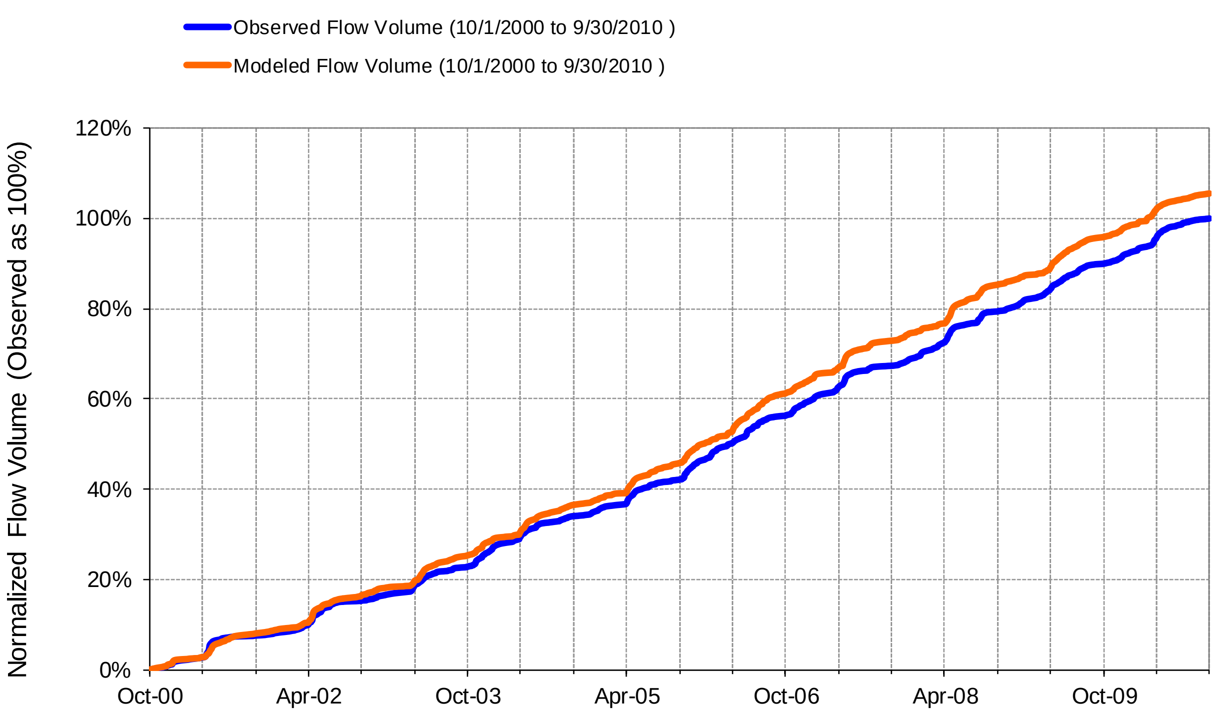


Figure E-35. Flow accumulation at USGS 04288000 Mad River near Moretown, VT

Table E-10. Summary statistics at USGS 04288000 Mad River near Moretown, VT

SWAT Simulated Flow		Observed Flow Gage	
REACH OUTFLOW FROM OUTLET 26 10-Year Analysis Period: 10/1/2000 - 9/30/2010 Flow volumes are (inches/year) for upstream drainage area		USGS 04288000 MAD RIVER NEAR MORETOWN, VT Hydrologic Unit Code: 2010003 Latitude: 44.2772802 Longitude: -72.7426163 Drainage Area (sq-mi): 139	
Total Simulated In-stream Flow:	**30.86**	Total Observed In-stream Flow:	**29.22**
Total of simulated highest 10% flows:	**11.83**	Total of Observed highest 10% flows:	**11.70**
Total of Simulated lowest 50% flows:	**4.98**	Total of Observed Lowest 50% flows:	**4.58**
Simulated Summer Flow Volume (months 7-9):	**5.49**	Observed Summer Flow Volume (7-9):	**3.79**
Simulated Fall Flow Volume (months 10-12):	**7.23**	Observed Fall Flow Volume (10-12):	**7.44**
Simulated Winter Flow Volume (months 1-3):	**5.38**	Observed Winter Flow Volume (1-3):	**6.72**
Simulated Spring Flow Volume (months 4-6):	**12.76**	Observed Spring Flow Volume (4-6):	**11.27**
Total Simulated Storm Volume:	**9.27**	Total Observed Storm Volume:	**9.46**
Simulated Summer Storm Volume (7-9):	**1.64**	Observed Summer Storm Volume (7-9):	**1.57**

Errors (Simulated-Observed)	*Error Statistics*	*Recommended Criteria*		
Error in total volume:	5.61	10		
Error in 50% lowest flows:	8.86	10		
Error in 10% highest flows:	1.05	15		
Seasonal volume error - Summer:	44.91	30		
Seasonal volume error - Fall:	-2.76	>> 30		Clear
Seasonal volume error - Winter:	-19.95	30		
Seasonal volume error - Spring:	13.16	30		
Error in storm volumes:	-2.02	20		
Error in summer storm volumes:	4.43	50		
Nash-Sutcliffe Coefficient of Efficiency, E:	0.576	Model accuracy increases		
Baseline adjusted coefficient (Garrick), E':	0.425	as E or E' approaches 1.0		
Monthly NSE	0.723			

USGS 04288000 Mad River near Moretown, VT - Validation

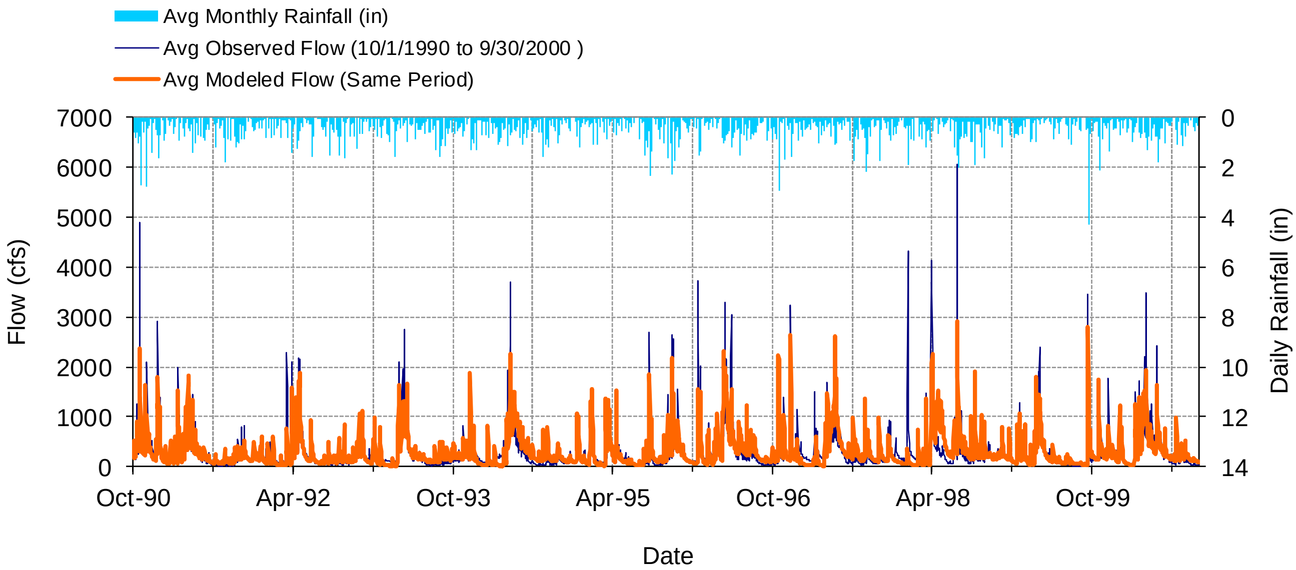


Figure E-36. Mean daily flow at USGS 04288000 Mad River near Moretown, VT

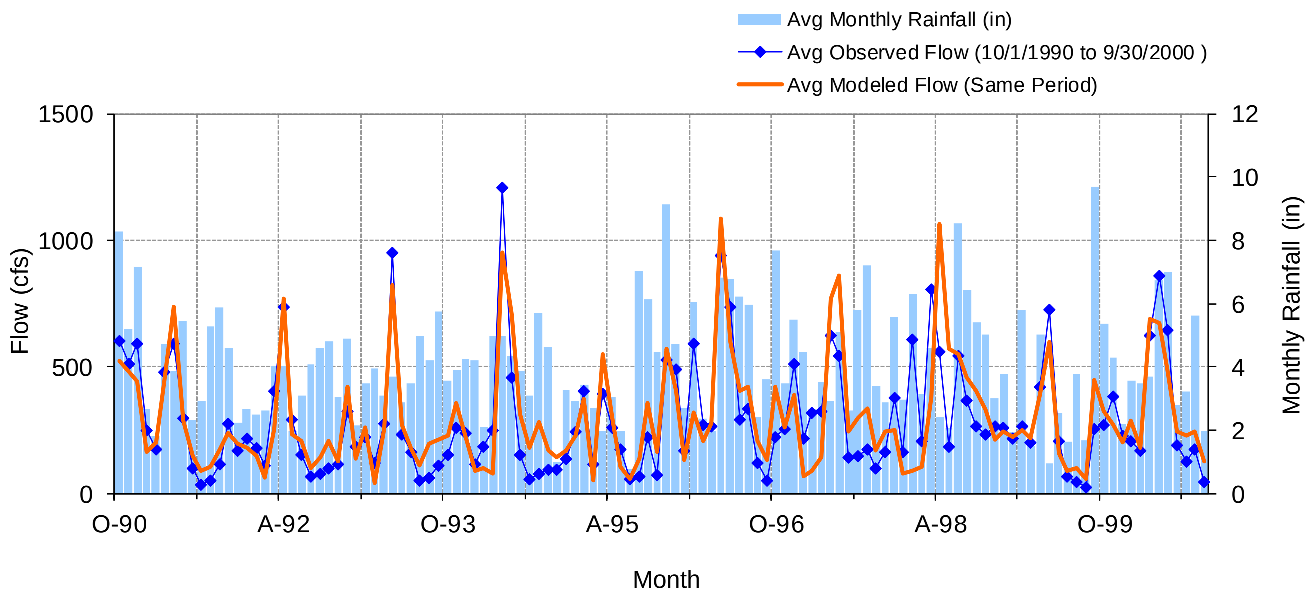


Figure E-37. Mean monthly flow at USGS 04288000 Mad River near Moretown, VT

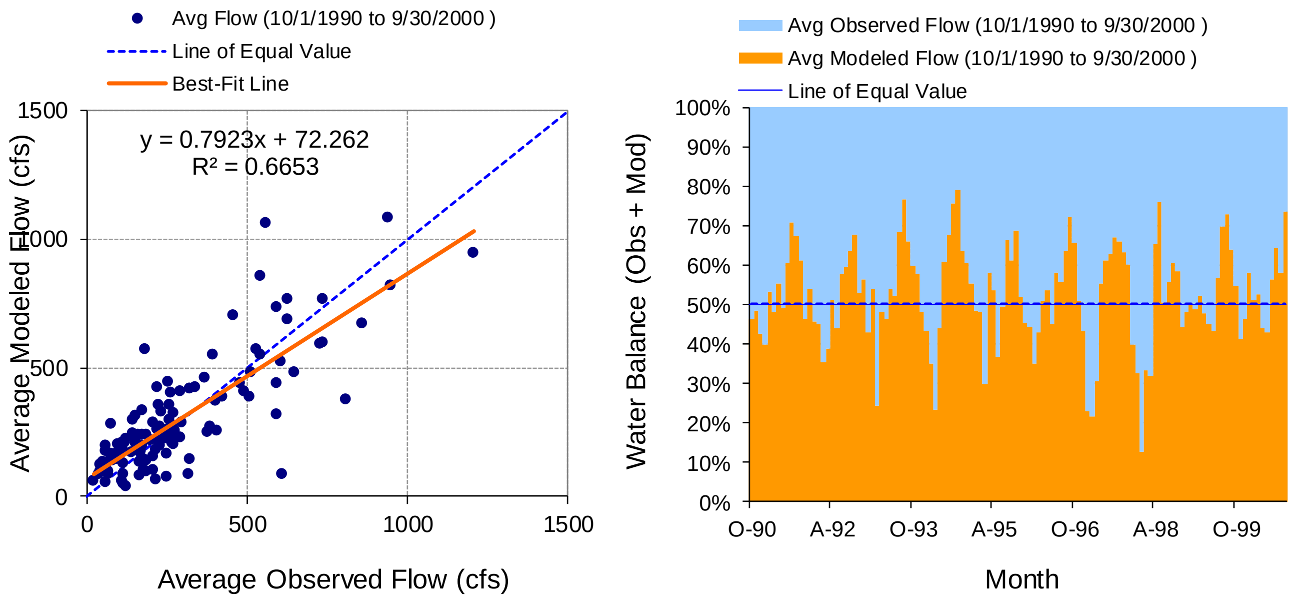


Figure E-38. Monthly flow regression and temporal variation at USGS 04288000 Mad River near Moretown, VT

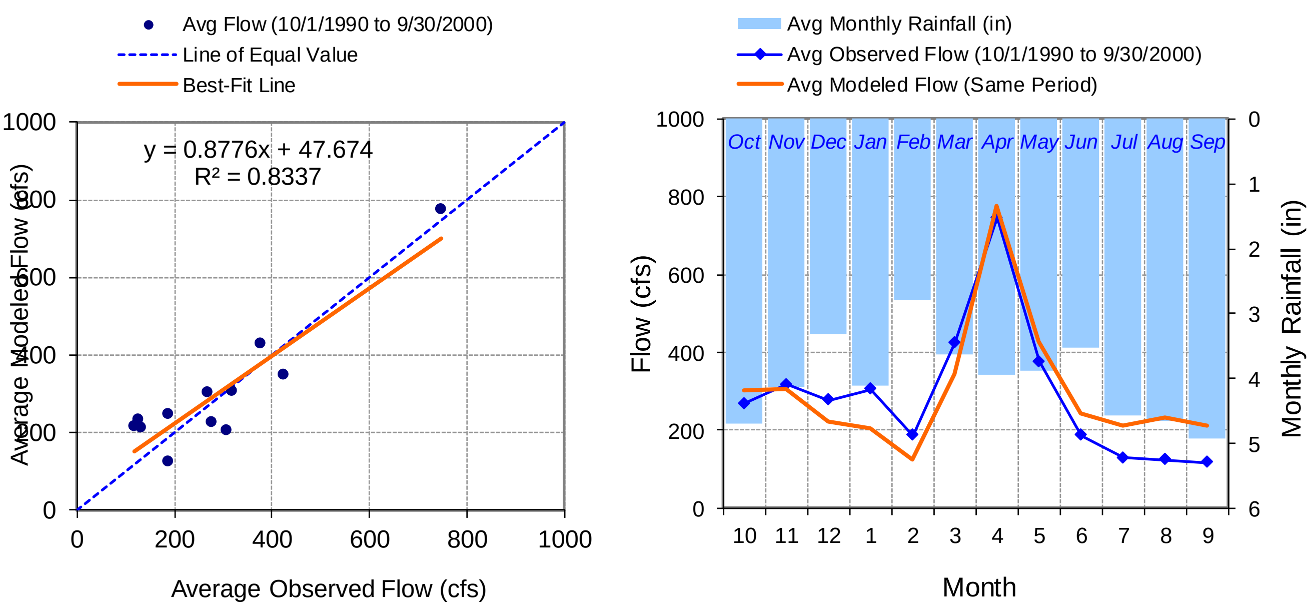


Figure E-39. Seasonal regression and temporal aggregate at USGS 04288000 Mad River near Moretown, VT

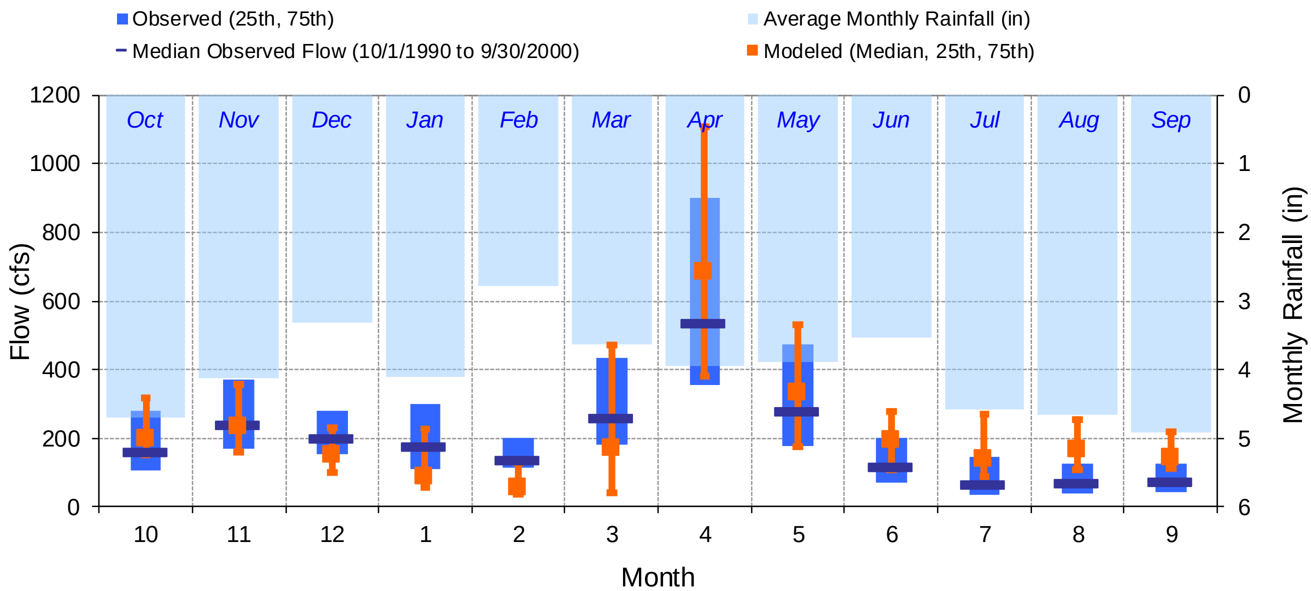


Figure E-40. Seasonal medians and ranges at USGS 04288000 Mad River near Moretown, VT

Table E-11. Seasonal summary at USGS 04288000 Mad River near Moretown, VT

MONTH	OBSERVED FLOW (CFS)				MODELED FLOW (CFS)			
	MEAN	MEDIAN	25TH	75TH	MEAN	MEDIAN	25TH	75TH
Oct	268.58	160.50	108.25	278.50	302.93	197.59	150.30	317.48
Nov	317.13	239.00	170.00	372.25	305.20	235.46	160.78	355.72
Dec	277.07	200.00	155.00	280.75	223.56	150.19	101.78	230.91
Jan	305.47	175.00	109.25	300.00	204.26	87.49	57.96	228.61
Feb	187.24	135.00	115.00	200.00	124.07	56.01	36.92	127.95
Mar	424.86	257.50	180.00	433.00	345.37	171.74	42.55	471.72
Apr	745.84	535.50	356.75	901.75	775.49	684.57	382.37	1106.59
May	376.61	277.50	176.00	474.00	427.18	331.80	174.36	529.37
Jun	185.88	116.00	69.00	201.25	243.98	194.20	110.13	277.83
Jul	130.04	63.50	37.00	147.25	211.33	139.74	88.16	270.20
Aug	124.78	68.50	38.25	126.00	233.04	167.85	109.78	254.95
Sep	117.18	71.00	42.00	125.50	212.90	142.94	111.00	218.92

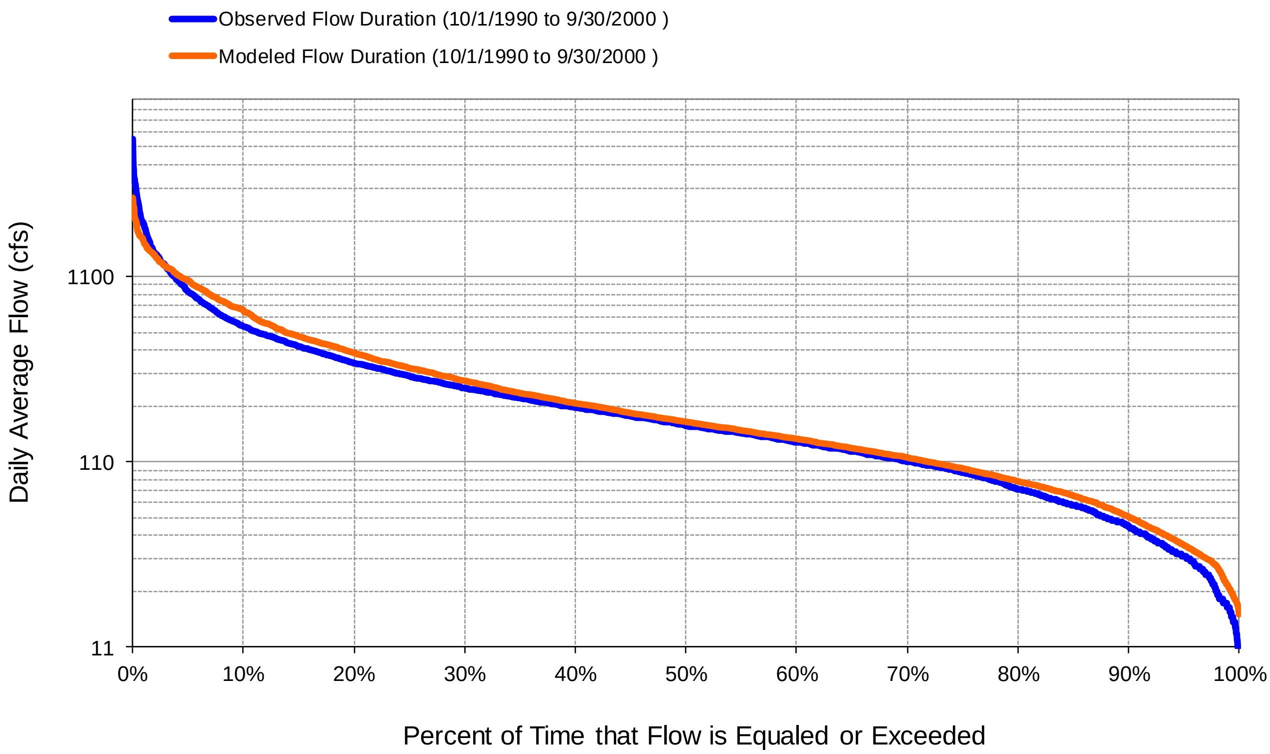


Figure E-41. Flow exceedence at USGS 04288000 Mad River near Moretown, VT

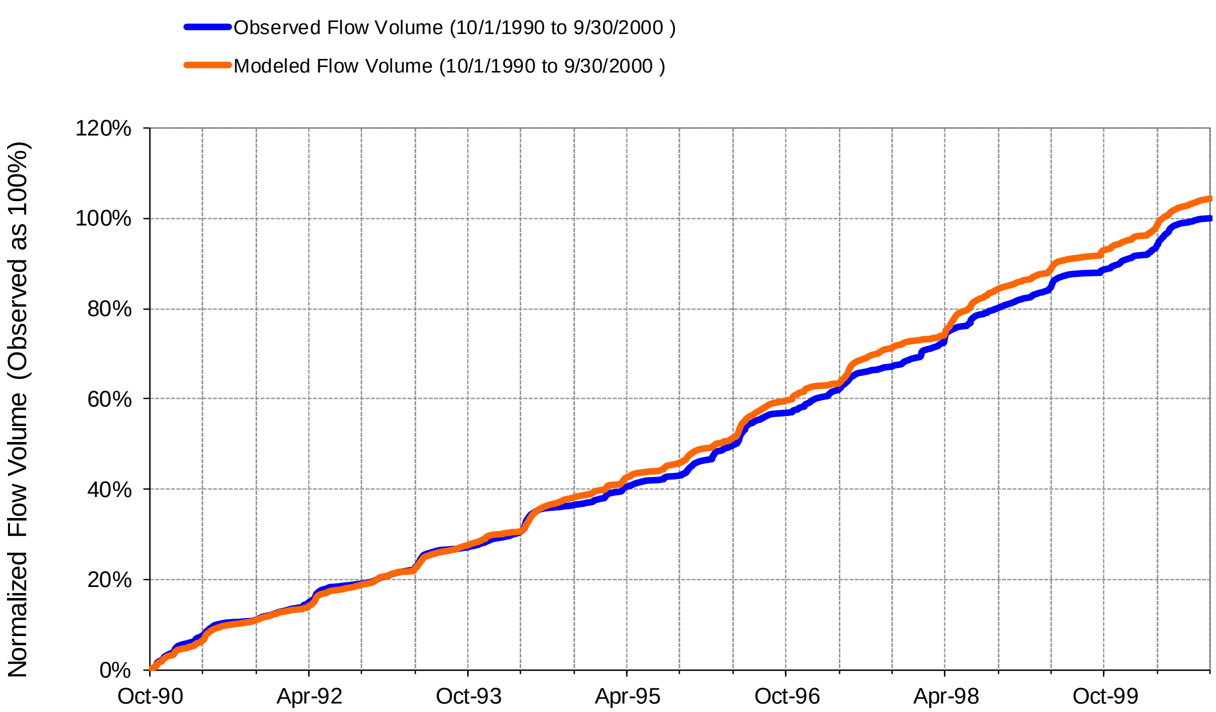


Figure E-42. Flow accumulation at USGS 04288000 Mad River near Moretown, VT

Table E-12. Summary statistics at USGS 04288000 Mad River near Moretown, VT

SWAT Simulated Flow		Observed Flow Gage	
REACH OUTFLOW FROM OUTLET 26 10-Year Analysis Period: 10/1/1990 - 9/30/2000 Flow volumes are (inches/year) for upstream drainage area		USGS 04288000 MAD RIVER NEAR MORETOWN, VT Hydrologic Unit Code: 2010003 Latitude: 44.2772802 Longitude: -72.7426163 Drainage Area (sq-mi): 139	
Total Simulated In-stream Flow:	**29.43**	Total Observed In-stream Flow:	**28.20**
Total of simulated highest 10% flows:	**11.23**	Total of Observed highest 10% flows:	**11.56**
Total of Simulated lowest 50% flows:	**4.94**	Total of Observed Lowest 50% flows:	**4.64**
Simulated Summer Flow Volume (months 7-9):	**5.39**	Observed Summer Flow Volume (7-9):	**3.05**
Simulated Fall Flow Volume (months 10-12):	**6.82**	Observed Fall Flow Volume (10-12):	**7.07**
Simulated Winter Flow Volume (months 1-3):	**5.50**	Observed Winter Flow Volume (1-3):	**7.47**
Simulated Spring Flow Volume (months 4-6):	**11.72**	Observed Spring Flow Volume (4-6):	**10.60**
Total Simulated Storm Volume:	**8.62**	Total Observed Storm Volume:	**9.15**
Simulated Summer Storm Volume (7-9):	**1.64**	Observed Summer Storm Volume (7-9):	**1.31**

Errors (Simulated-Observed)	*Error Statistics*	*Recommended Criteria*
Error in total volume:	4.37	10
Error in 50% lowest flows:	6.36	10
Error in 10% highest flows:	-2.90	15
Seasonal volume error - Summer:	76.63	30
Seasonal volume error - Fall:	-3.60	30
Seasonal volume error - Winter:	-26.45	30
Seasonal volume error - Spring:	10.60	30
Error in storm volumes:	-5.84	20
Error in summer storm volumes:	25.35	50
Nash-Sutcliffe Coefficient of Efficiency, E:	0.571	Model accuracy increases
Baseline adjusted coefficient (Garrick), E':	0.388	as E or E' approaches 1.0
Monthly NSE	0.638	

>> Clear

USGS 04290500 Winooski River near Essex Junction, VT - Calibration

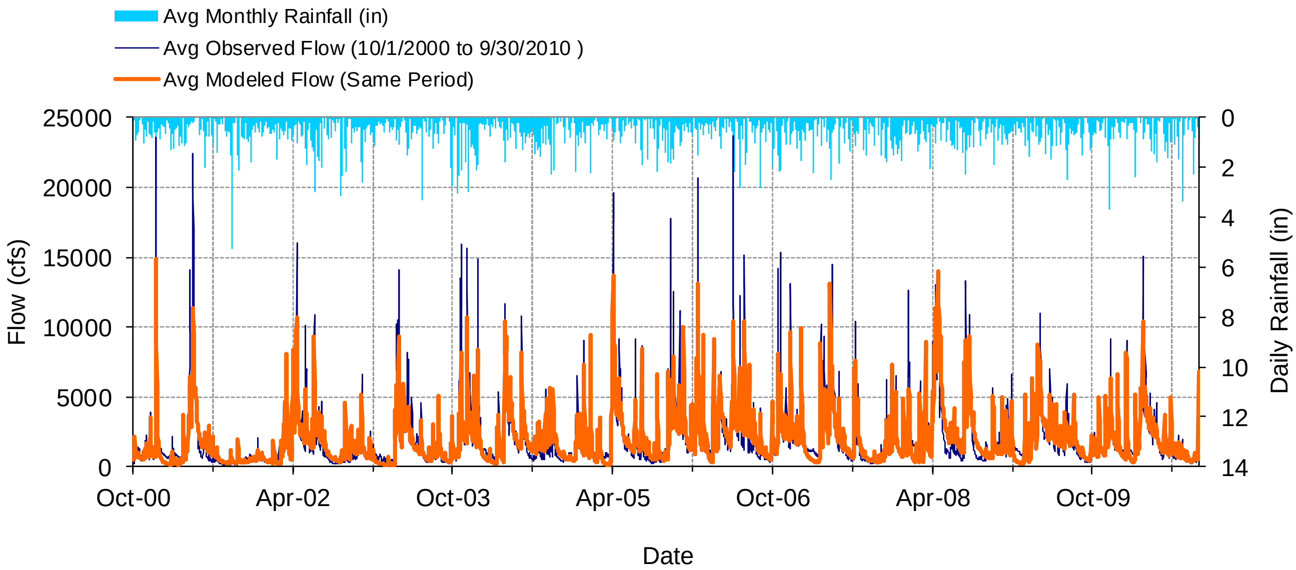


Figure E-43. Mean daily flow at USGS 04290500 Winooski River near Essex Junction, VT

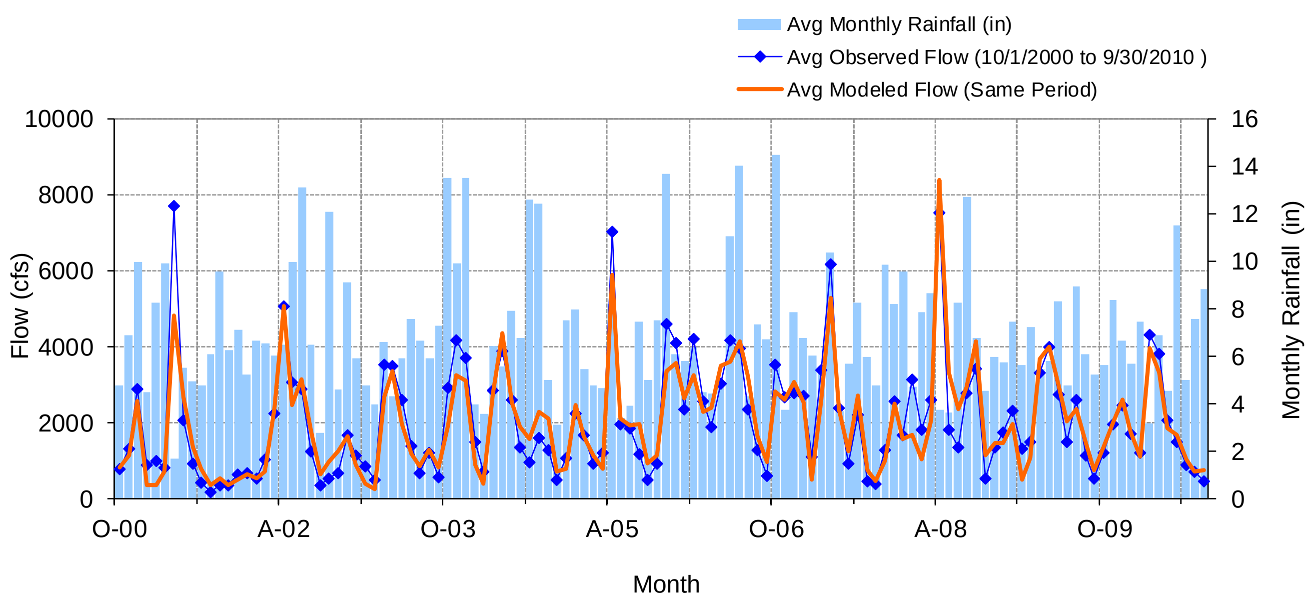


Figure E-44. Mean monthly flow at USGS 04290500 Winooski River near Essex Junction, VT

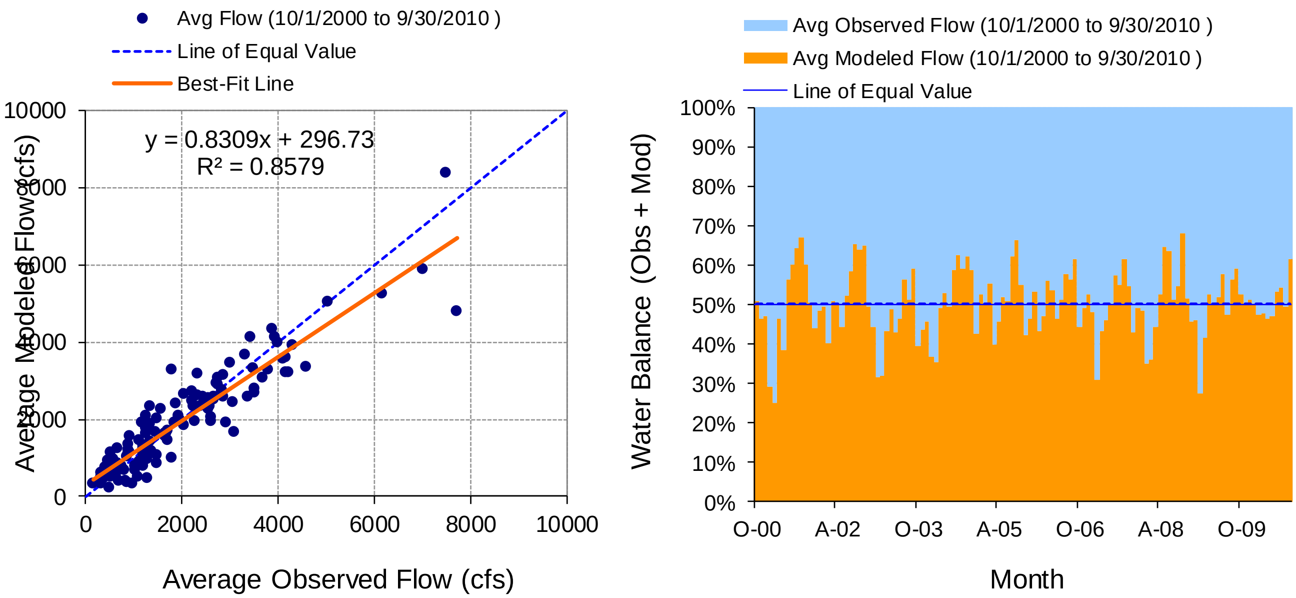


Figure E-45. Monthly flow regression and temporal variation at USGS 04290500 Winooski River near Essex Junction, VT

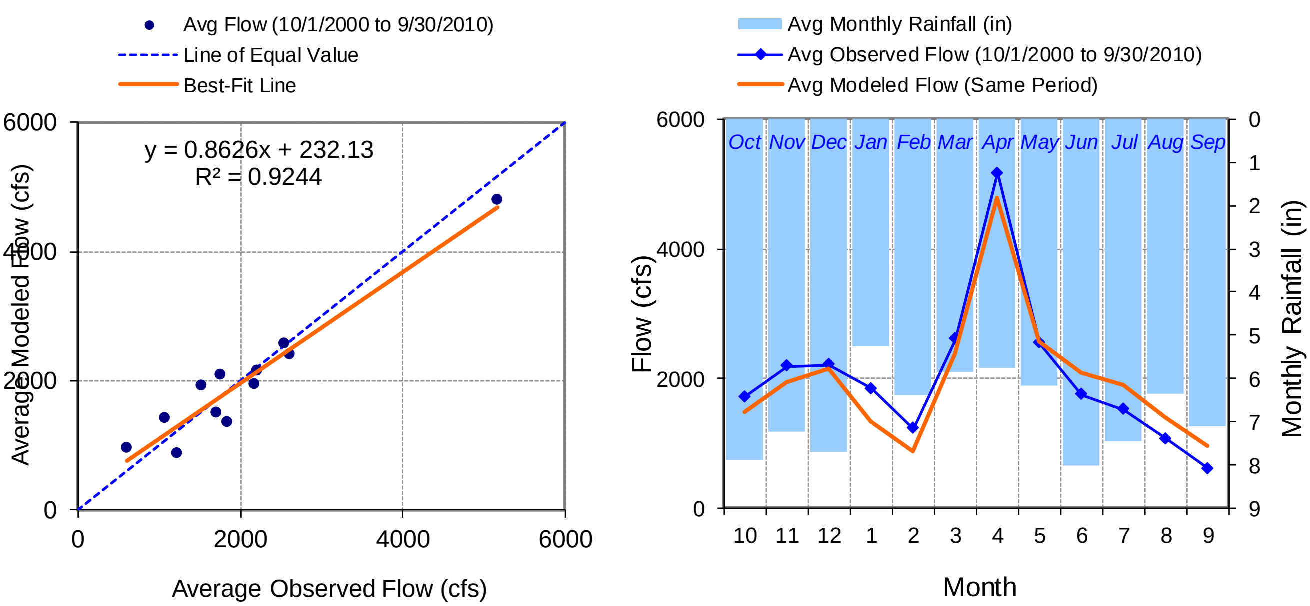


Figure E-46. Seasonal regression and temporal aggregate at USGS 04290500 Winooski River near Essex Junction, VT

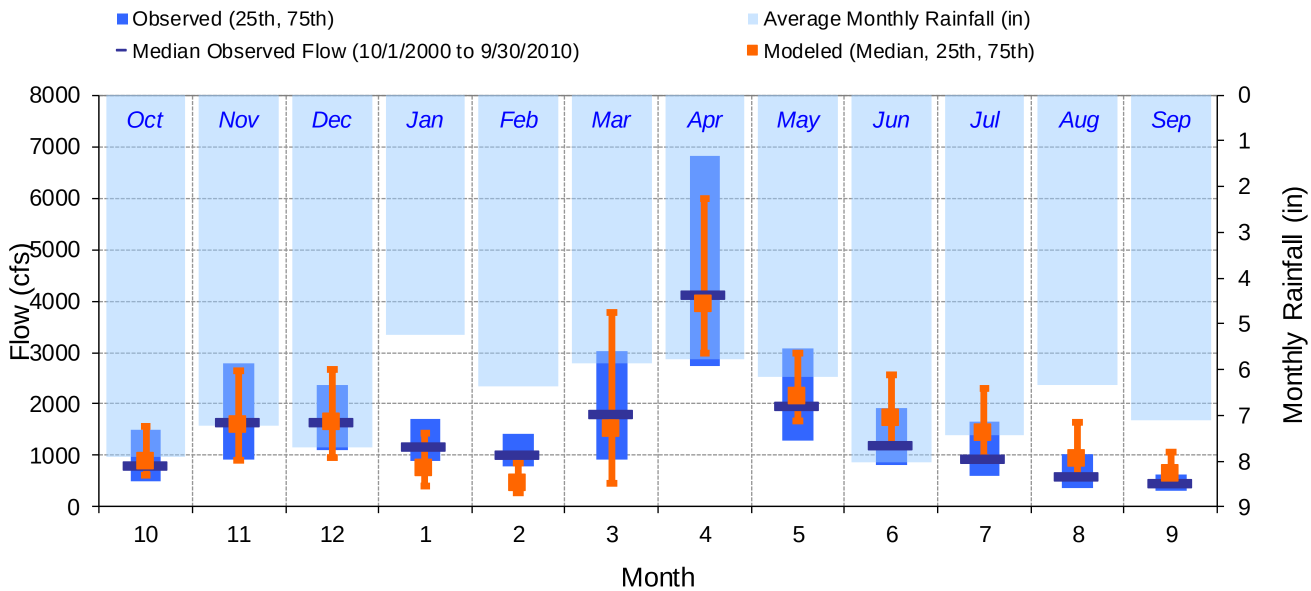


Figure E-47. Seasonal medians and ranges at USGS 04290500 Winooski River near Essex Junction, VT

Table E-13. Seasonal summary at USGS 04290500 Winooski River near Essex Junction, VT

MONTH	OBSERVED FLOW (CFS)				MODELED FLOW (CFS)			
	MEAN	MEDIAN	25TH	75TH	MEAN	MEDIAN	25TH	75TH
Oct	1713.28	788.50	496.75	1500.00	1488.23	878.72	617.07	1552.20
Nov	2183.05	1640.00	923.00	2782.50	1932.56	1587.54	902.93	2640.09
Dec	2206.97	1645.00	1100.00	2357.50	2144.10	1651.45	958.80	2665.48
Jan	1838.89	1180.00	890.00	1717.50	1338.74	744.20	397.03	1428.56
Feb	1228.73	1000.00	780.00	1420.00	868.94	449.36	286.89	858.58
Mar	2610.03	1800.00	931.75	3015.00	2389.32	1503.80	461.87	3785.80
Apr	5163.60	4110.00	2737.50	6807.50	4782.24	3946.78	2985.92	5985.60
May	2542.80	1960.00	1280.00	3075.00	2568.59	2157.24	1682.24	2999.75
Jun	1749.36	1200.00	819.50	1932.50	2089.13	1727.00	1196.50	2562.82
Jul	1521.81	928.50	599.50	1662.50	1909.17	1441.68	968.24	2309.81
Aug	1071.01	597.50	364.50	1020.00	1405.87	929.96	572.48	1644.89
Sep	612.00	448.50	326.75	634.75	951.61	639.57	446.68	1062.86

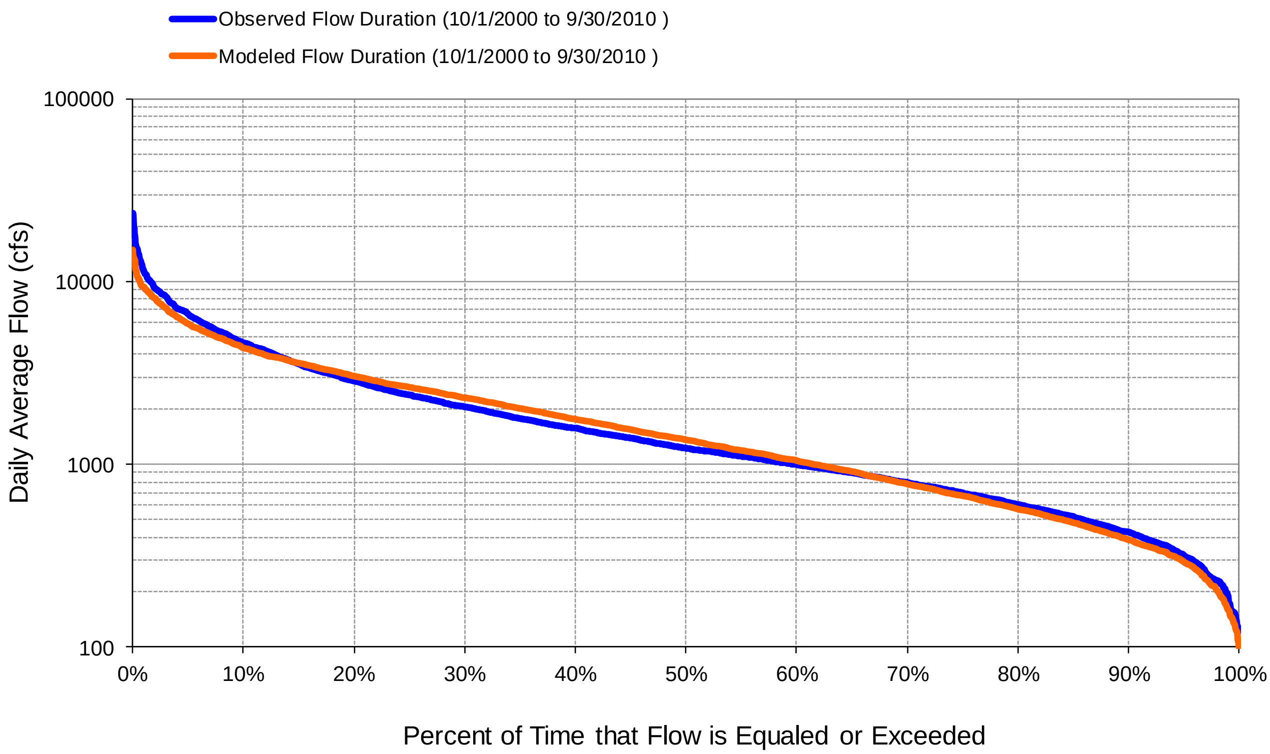


Figure E-48. Flow exceedence at USGS 04290500 Winooski River near Essex Junction, VT

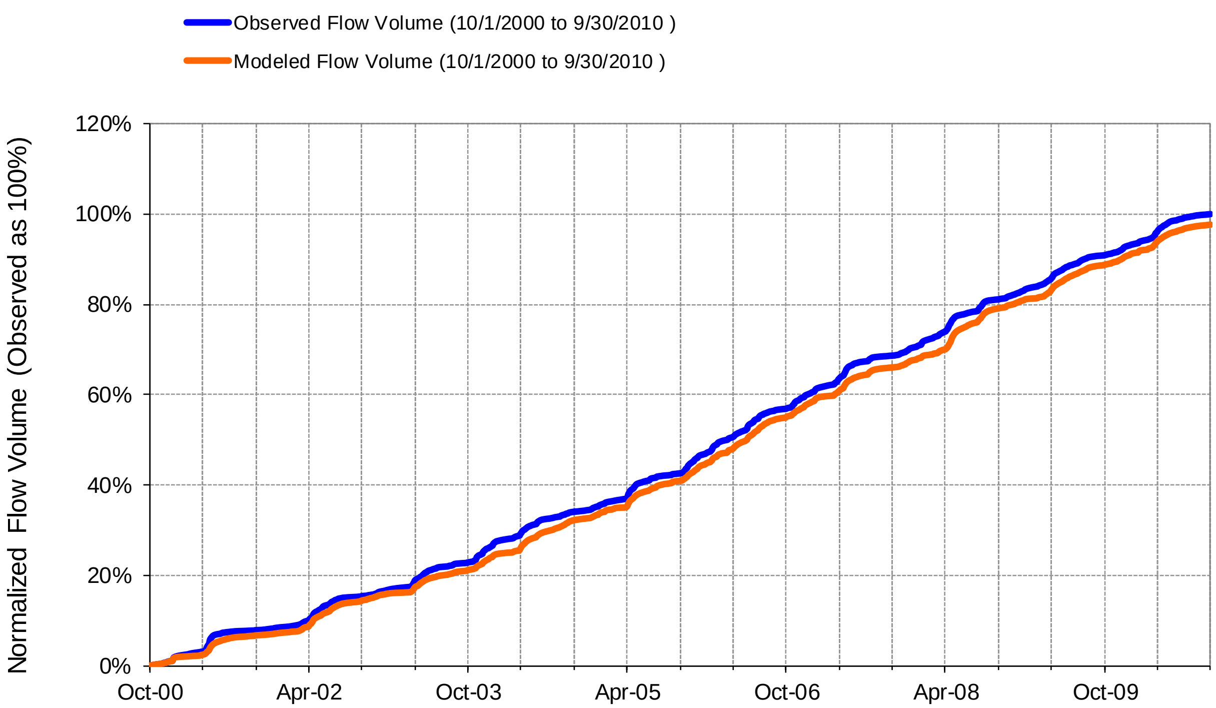


Figure E-49. Flow accumulation at USGS 04290500 Winooski River near Essex Junction, VT

Table E-14. Summary statistics at USGS 04290500 Winooski River near Essex Junction, VT

SWAT Simulated Flow		Observed Flow Gage		
REACH OUTFLOW FROM OUTLET 2		USGS 04290500 WINOOSKI RIVER NEAR ESSEX JUNCTION, VT		
10-Year Analysis Period: 10/1/2000 - 9/30/2010 Flow volumes are (inches/year) for upstream drainage area		Hydrologic Unit Code: 2010003 Latitude: 44.47893867 Longitude: -73.1387381 Drainage Area (sq-mi): 1044		
Total Simulated In-stream Flow:	**25.93**	Total Observed In-stream Flow:		**26.53**
Total of simulated highest 10% flows:	**8.52**	Total of Observed highest 10% flows:		**9.96**
Total of Simulated lowest 50% flows:	**4.61**	Total of Observed Lowest 50% flows:		**4.59**
Simulated Summer Flow Volume (months 7-9):	**4.68**	Observed Summer Flow Volume (7-9):		**3.52**
Simulated Fall Flow Volume (months 10-12):	**6.08**	Observed Fall Flow Volume (10-12):		**6.66**
Simulated Winter Flow Volume (months 1-3):	**4.99**	Observed Winter Flow Volume (1-3):		**6.15**
Simulated Spring Flow Volume (months 4-6):	**10.18**	Observed Spring Flow Volume (4-6):		**10.20**
Total Simulated Storm Volume:	**9.33**	Total Observed Storm Volume:		**10.79**
Simulated Summer Storm Volume (7-9):	**1.56**	Observed Summer Storm Volume (7-9):		**1.53**
Errors (Simulated-Observed)	*Error Statistics*	*Recommended Criteria*		
Error in total volume:	-2.26	10		
Error in 50% lowest flows:	0.42	10		
Error in 10% highest flows:	-14.45	15		
Seasonal volume error - Summer:	32.99	30		
Seasonal volume error - Fall:	-8.79	>> 30		Clear
Seasonal volume error - Winter:	-18.83	30		
Seasonal volume error - Spring:	-0.16	30		
Error in storm volumes:	-13.51	20		
Error in summer storm volumes:	2.29	50		
Nash-Sutcliffe Coefficient of Efficiency, E:	0.688	Model accuracy increases		
Baseline adjusted coefficient (Garrick), E':	0.514	as E or E' approaches 1.0		
Monthly NSE	0.856			

USGS 04290500 Winooski River near Essex Junction, VT - Validation

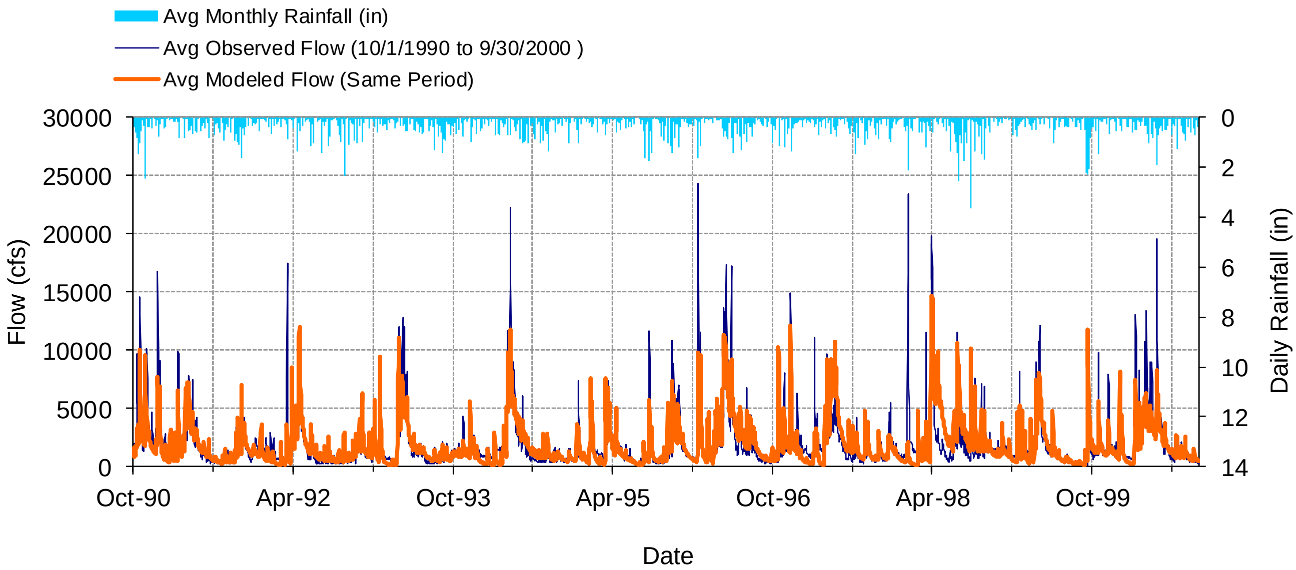


Figure E-50. Mean daily flow at USGS 04290500 Winooski River near Essex Junction, VT

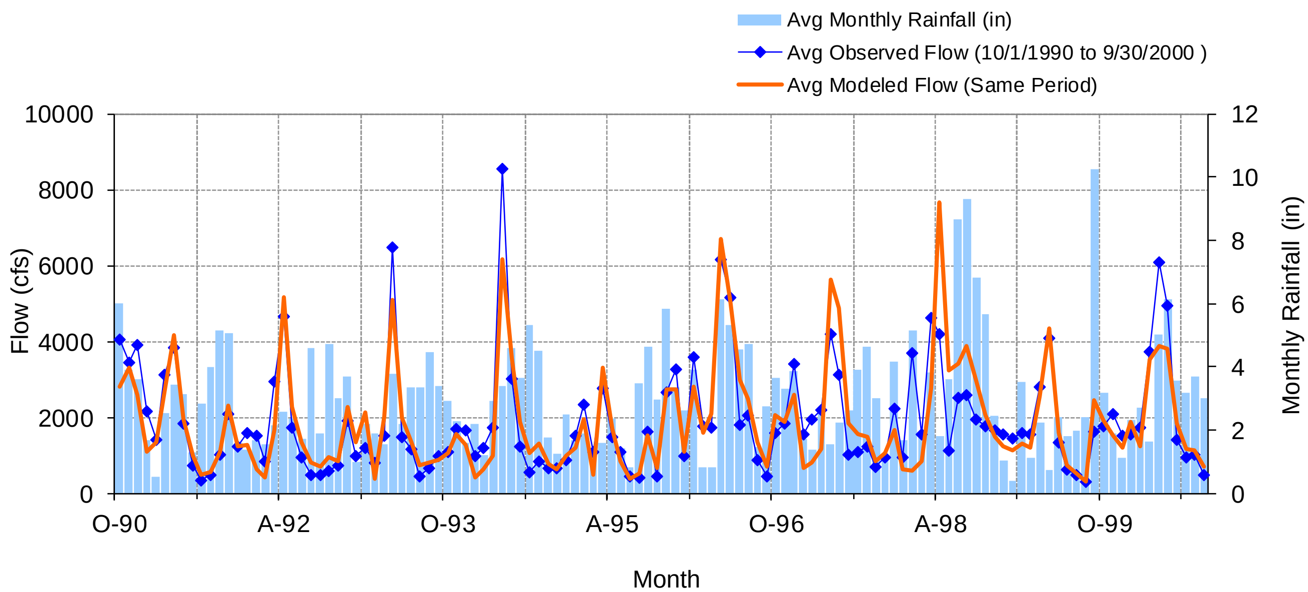


Figure E-51. Mean monthly flow at USGS 04290500 Winooski River near Essex Junction, VT

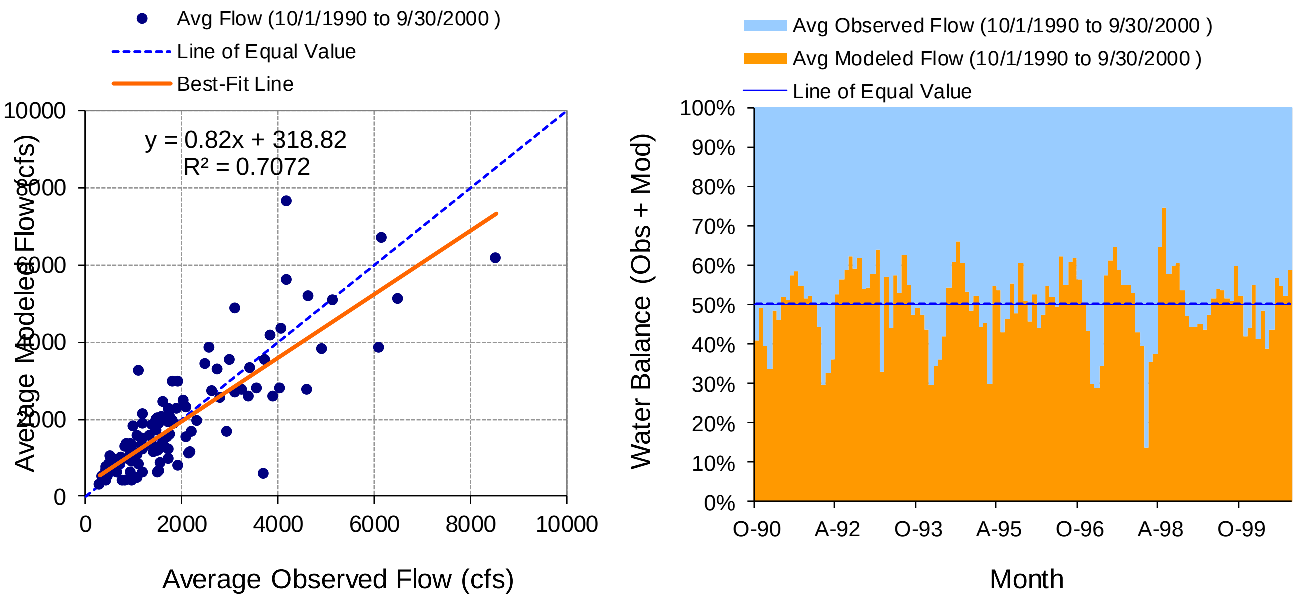


Figure E-52. Monthly flow regression and temporal variation at USGS 04290500 Winooski River near Essex Junction, VT

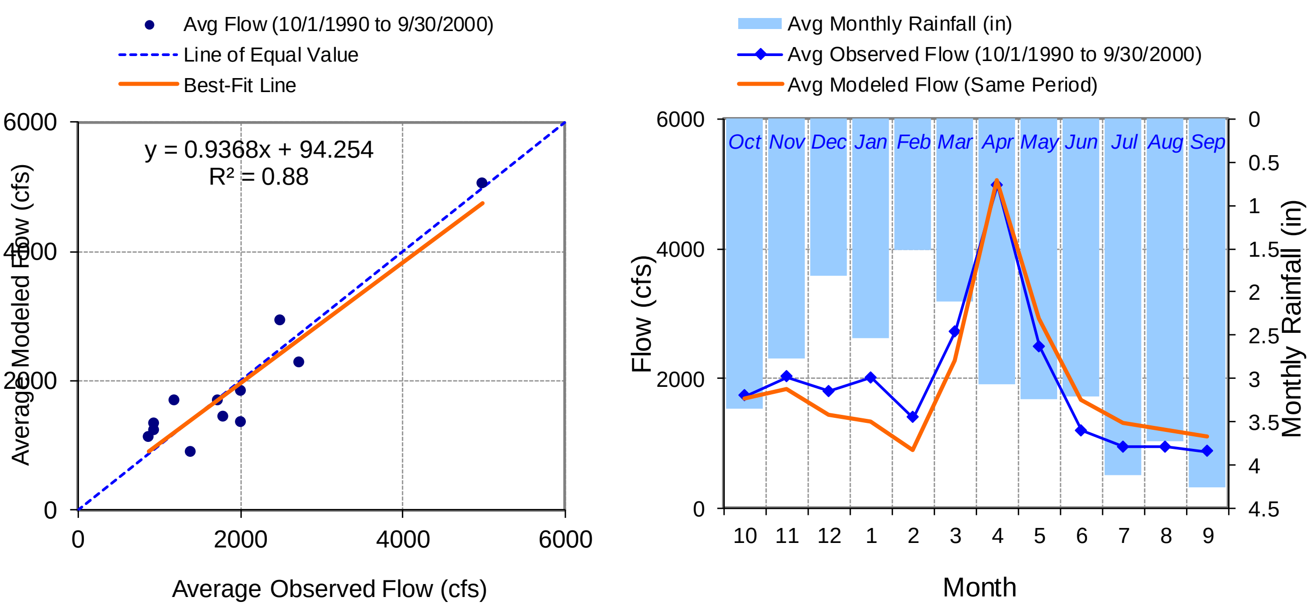


Figure E-53. Seasonal regression and temporal aggregate at USGS 04290500 Winooski River near Essex Junction, VT

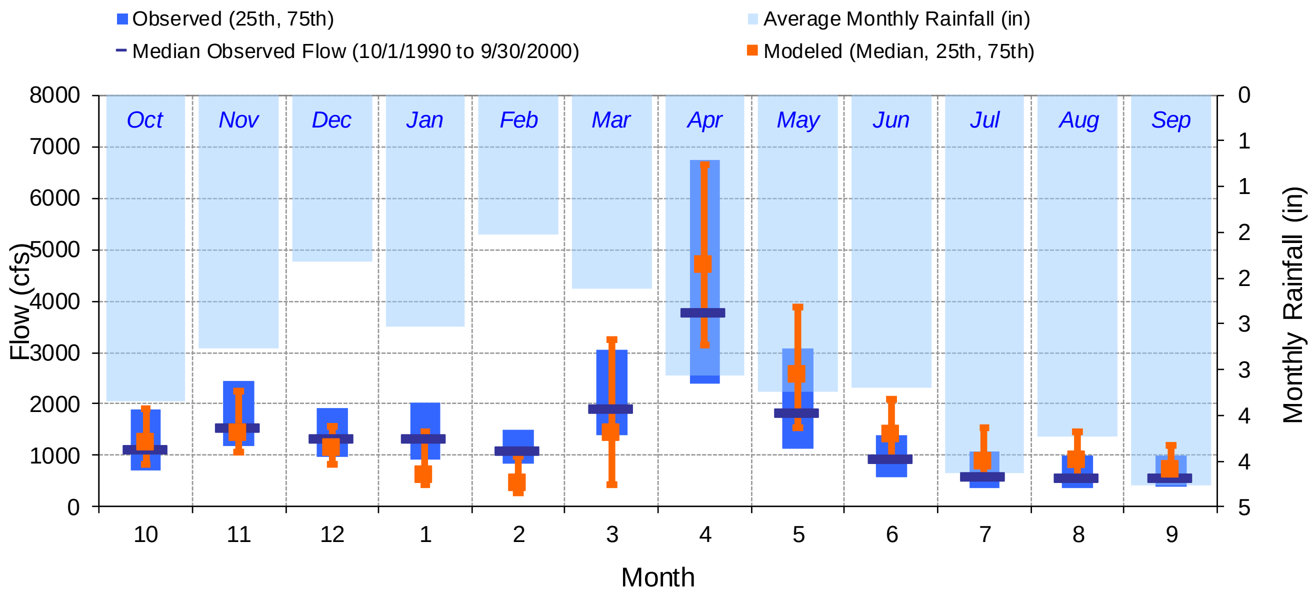


Figure E-54. Seasonal medians and ranges at USGS 04290500 Winooski River near Essex Junction, VT

Table E-15. Seasonal summary at USGS 04290500 Winooski River near Essex Junction, VT

MONTH	OBSERVED FLOW (CFS)				MODELED FLOW (CFS)			
	MEAN	MEDIAN	25TH	75TH	MEAN	MEDIAN	25TH	75TH
Oct	1723.09	1125.00	714.75	1885.00	1688.98	1254.11	823.65	1899.83
Nov	2015.52	1530.00	1170.00	2435.00	1838.96	1425.74	1076.74	2252.72
Dec	1795.77	1340.00	974.00	1927.50	1432.17	1143.13	829.54	1566.25
Jan	2013.78	1330.00	928.50	2022.50	1343.92	626.44	443.63	1456.24
Feb	1389.98	1100.00	830.00	1510.00	890.70	461.97	277.94	980.13
Mar	2720.93	1900.00	1392.50	3057.50	2267.38	1428.84	443.01	3255.92
Apr	4976.48	3775.00	2407.50	6752.50	5049.28	4702.77	3158.68	6645.40
May	2486.54	1830.00	1125.00	3087.50	2914.90	2572.69	1544.76	3891.12
Jun	1189.59	929.50	581.00	1392.50	1675.42	1412.33	900.62	2082.72
Jul	938.23	578.50	361.50	1090.00	1316.84	867.19	559.99	1532.03
Aug	945.71	565.00	375.75	988.00	1213.44	893.77	545.97	1464.23
Sep	872.43	561.50	387.00	995.75	1110.18	732.91	584.19	1188.73

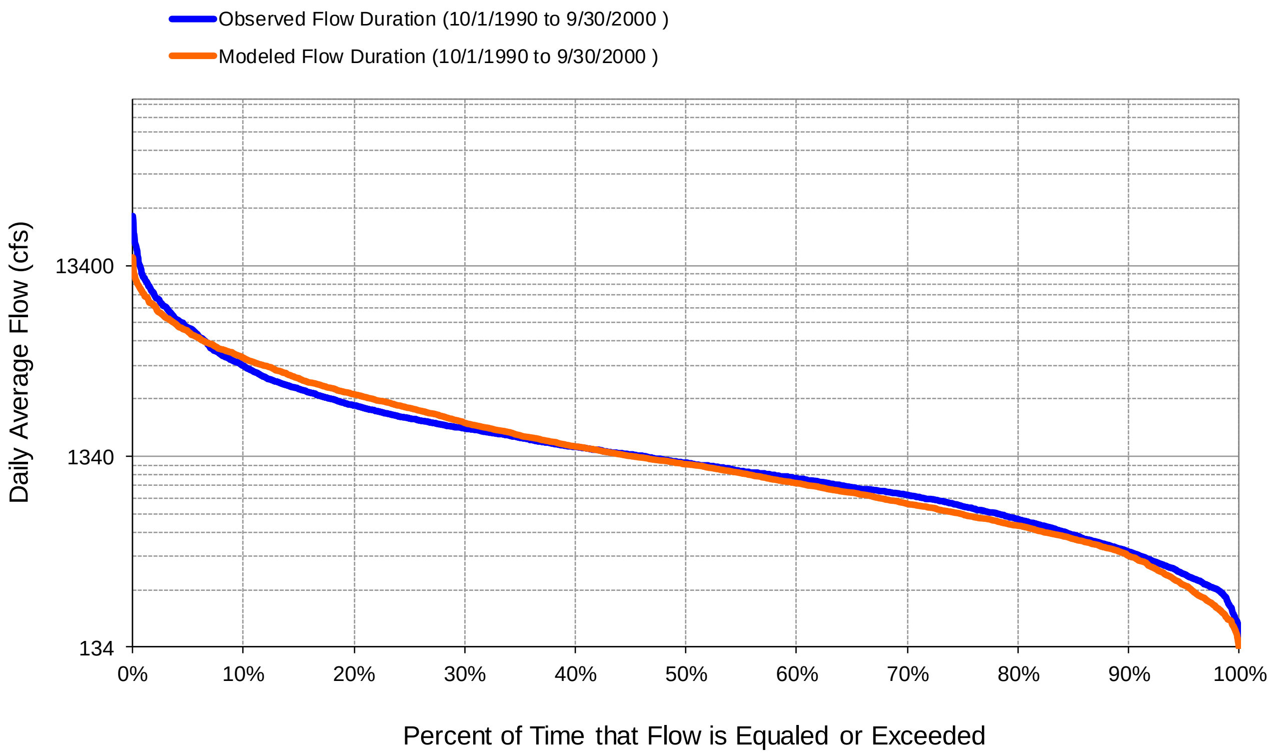


Figure E-55. Flow exceedence at USGS 04290500 Winooski River near Essex Junction, VT

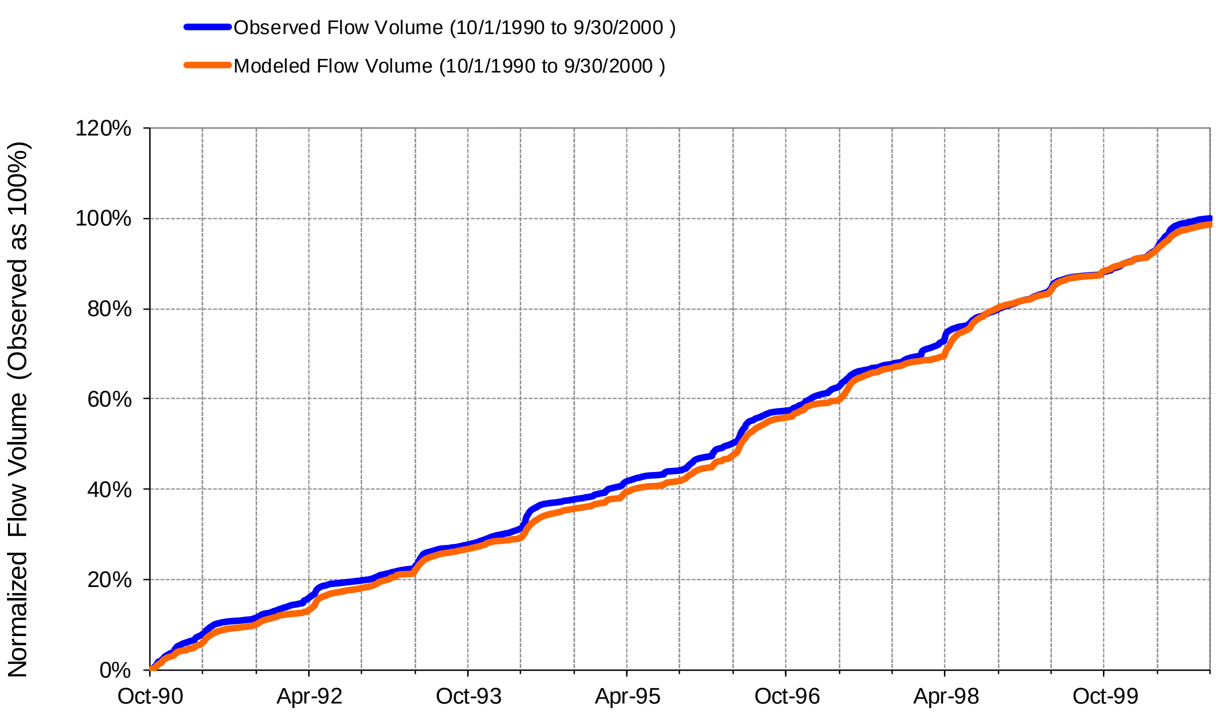


Figure E-56. Flow accumulation at USGS 04290500 Winooski River near Essex Junction, VT

Table E-16. Summary statistics at USGS 04290500 Winooski River near Essex Junction, VT

SWAT Simulated Flow		**Observed Flow Gage**		
REACH OUTFLOW FROM OUTLET 5 10-Year Analysis Period: 10/1/1990 - 9/30/2000 Flow volumes are (inches/year) for upstream drainage area		USGS 04290500 WINOOSKI RIVER NEAR ESSEX JUNCTION, VT Hydrologic Unit Code: 2010003 Latitude: 44.47893867 Longitude: -73.1387381 Drainage Area (sq-mi): 1044		
Total Simulated In-stream Flow:	**24.68**	Total Observed In-stream Flow:		**25.01**
Total of simulated highest 10% flows:	**8.57**	Total of Observed highest 10% flows:		**9.55**
Total of Simulated lowest 50% flows:	**4.42**	Total of Observed Lowest 50% flows:		**4.73**
Simulated Summer Flow Volume (months 7-9):	**3.98**	Observed Summer Flow Volume (7-9):		**3.01**
Simulated Fall Flow Volume (months 10-12):	**5.41**	Observed Fall Flow Volume (10-12):		**6.04**
Simulated Winter Flow Volume (months 1-3):	**4.89**	Observed Winter Flow Volume (1-3):		**6.63**
Simulated Spring Flow Volume (months 4-6):	**10.40**	Observed Spring Flow Volume (4-6):		**9.33**
Total Simulated Storm Volume:	**8.25**	Total Observed Storm Volume:		**9.82**
Simulated Summer Storm Volume (7-9):	**1.33**	Observed Summer Storm Volume (7-9):		**1.36**
Errors (Simulated-Observed)	*Error Statistics*	*Recommended Criteria*		
Error in total volume:	-1.33	10		
Error in 50% lowest flows:	-6.48	10		
Error in 10% highest flows:	-10.26	15		
Seasonal volume error - Summer:	32.12	30		
Seasonal volume error - Fall:	-10.40	>> 30		Clear
Seasonal volume error - Winter:	-26.30	30		
Seasonal volume error - Spring:	11.46	30		
Error in storm volumes:	-15.95	20		
Error in summer storm volumes:	-1.77	50		
Nash-Sutcliffe Coefficient of Efficiency, E:	0.603	Model accuracy increases		
Baseline adjusted coefficient (Garrick), E':	0.429	as E or E' approaches 1.0		
Monthly NSE	0.820			

TSS and TP distribution by channel and upland sources

Table E-17. TSS and TP distribution by source categories

Source	TSS		TP	
	Load(mt/year)	Percentage (%)	Load (kg/year)	Percentage (%)
Upland	104,895	52.1	101,530	58.8
Stream	96,463	47.9	71,093	41.2
Total	**201,357**	**100.0**	**172,623**	**100.0**

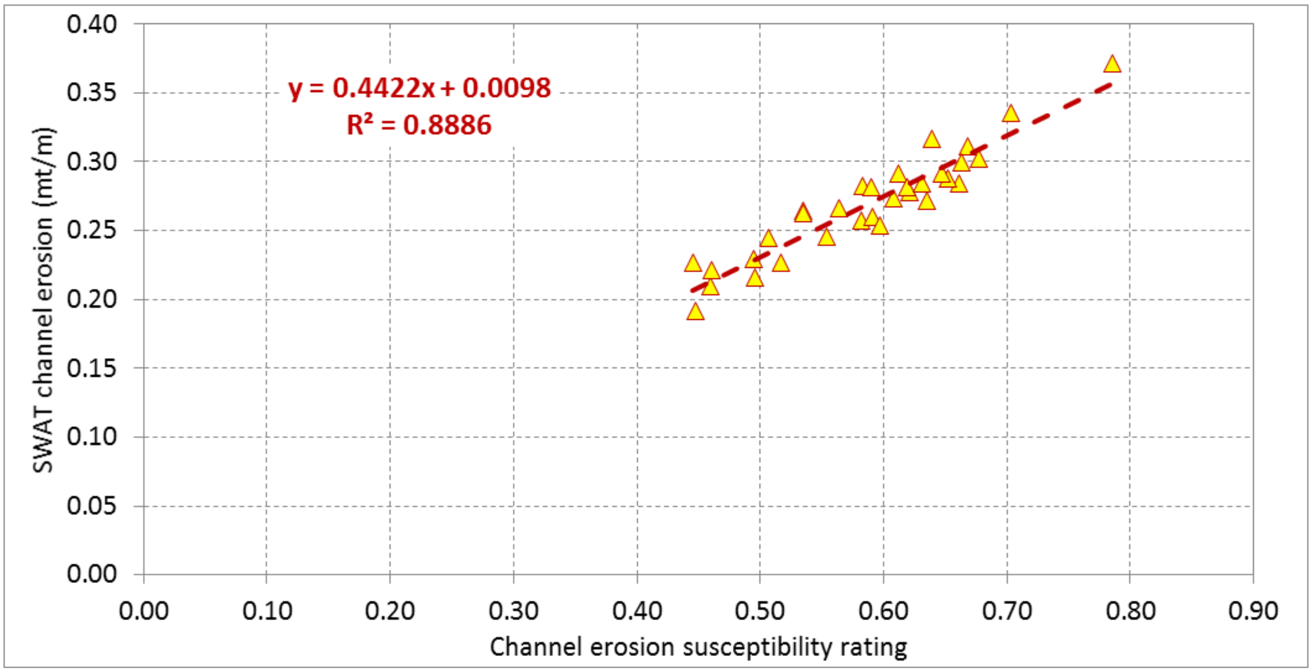


Figure E-57. SWAT simulated channel erosion relative to channel erosion susceptibility rating

TP distribution by landuse from upland sources

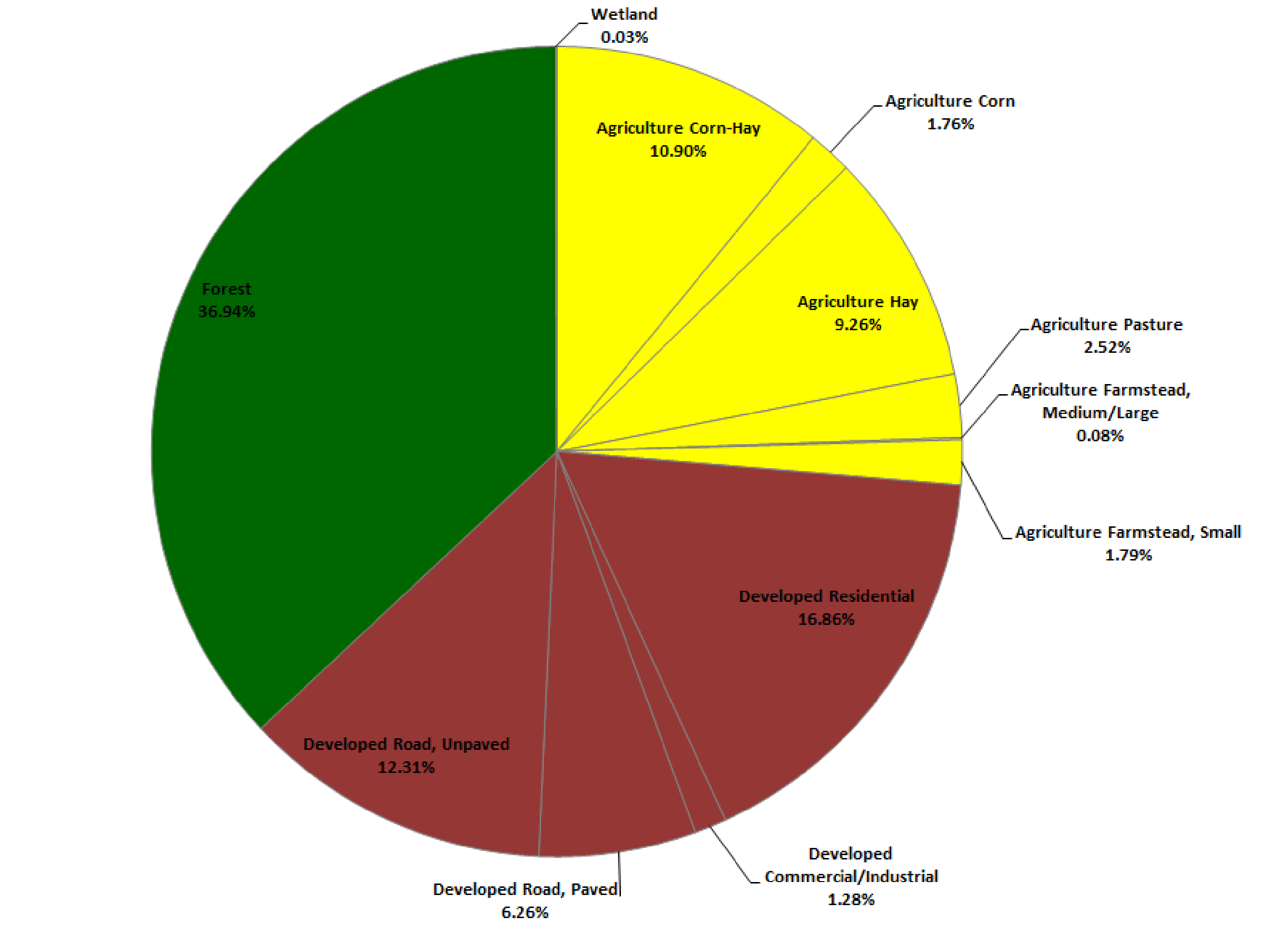


Figure E-58. Distribution of simulated total upland TP loads by landuse categories

Table E-18. TP export rates (kg/ha/yr) by landuse categories for the 30 year simulation period

Landuse	Classification	Area (ha)	Area (%)	Mean	Min	Q_{25}	Q_{50}	Q_{75}	Max
Agriculture	Corn-Hay	5,760	2.10	**1.92**	0.05	1.38	1.92	2.68	4.38
	Corn	841	0.31	**2.12**	0.90	1.39	2.06	2.47	4.59
	Hay	10,598	3.86	**0.89**	0.37	0.68	0.85	1.06	1.60
	Pasture	1,951	0.71	**1.31**	0.54	1.02	1.32	1.54	2.20
	Farmstead, Medium/Large	27	0.01	**3.11**	1.54	2.40	2.95	3.71	5.25
	Farmstead, Small	599	0.22	**3.04**	1.41	2.31	2.94	3.69	5.26
Urban	Residential	19,001	6.92	**0.90**	0.54	0.76	0.87	1.00	1.31
	Commercial/Industrial	745	0.27	**1.75**	1.26	1.58	1.74	1.86	2.25
	Road, Paved	3,166	1.15	**2.01**	1.47	1.87	1.97	2.07	2.49
	Road, Unpaved	2,307	0.84	**5.42**	4.21	5.29	5.37	5.68	6.32
Forest	Forest	228,680	83.29	**0.16**	0.09	0.14	0.16	0.18	0.26
Wetland	Wetland	870	0.32	**0.04**	0.02	0.03	0.03	0.05	0.09

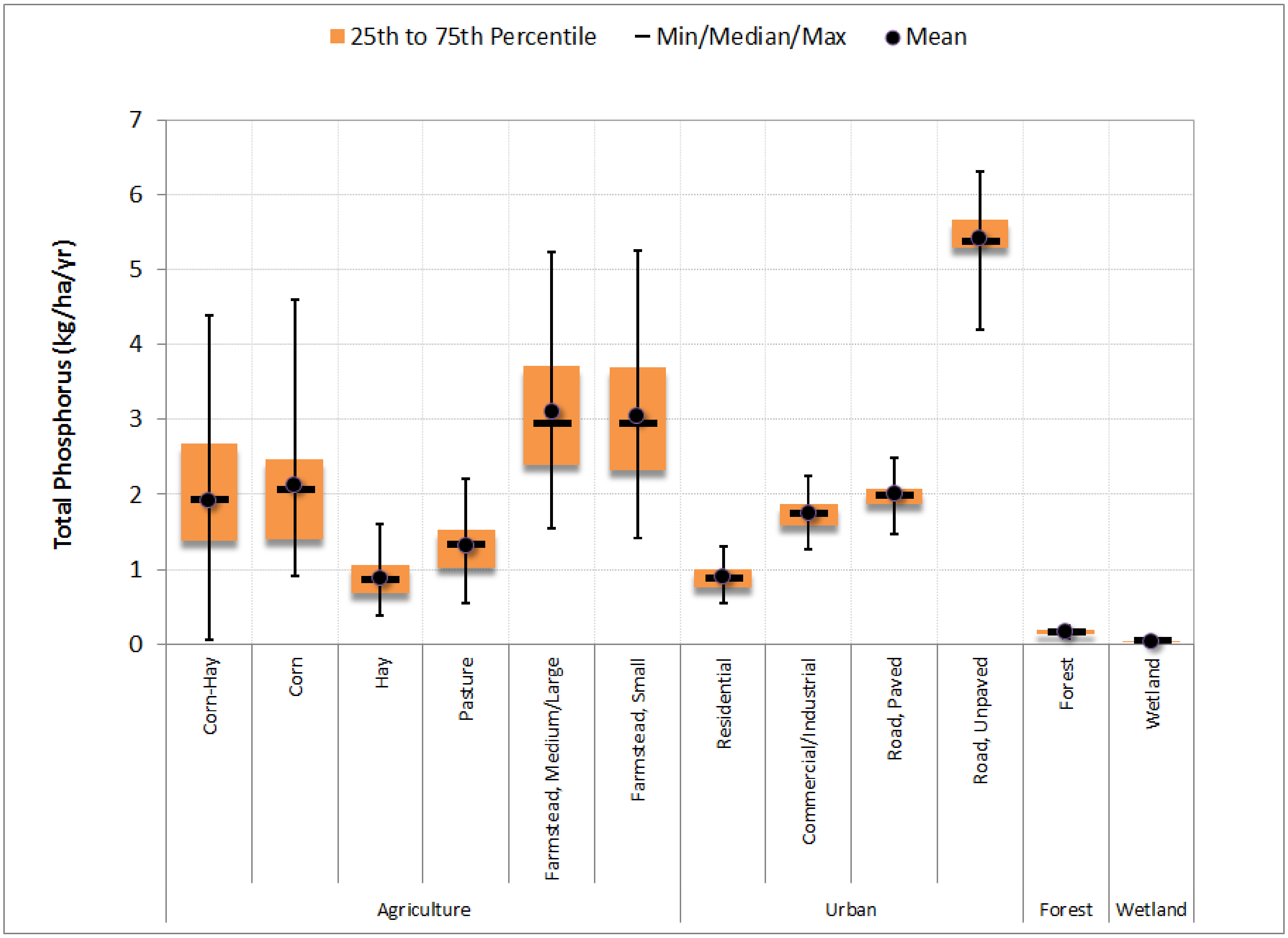


Figure E-59. TP export rates (kg/ha/yr) by landuse categories for the 30 year simulation period

Table E-19. TP export rates (kg/ha/yr) for the residential landuse categories for the 30 year simulation period

Residential Category	Area (ha)	Area (%)	Mean	Min	Q_{25}	Q_{50}	Q_{75}	Max
Low Density	9,906	59.39	**0.54**	0.29	0.43	0.51	0.63	0.91
Medium Density	4,697	28.16	**0.83**	0.40	0.67	0.79	0.96	1.37
High Density	2,077	12.45	**1.36**	0.88	1.16	1.37	1.50	1.87
Total	16,680	100.00	**0.73**	0.39	0.59	0.69	0.84	1.16

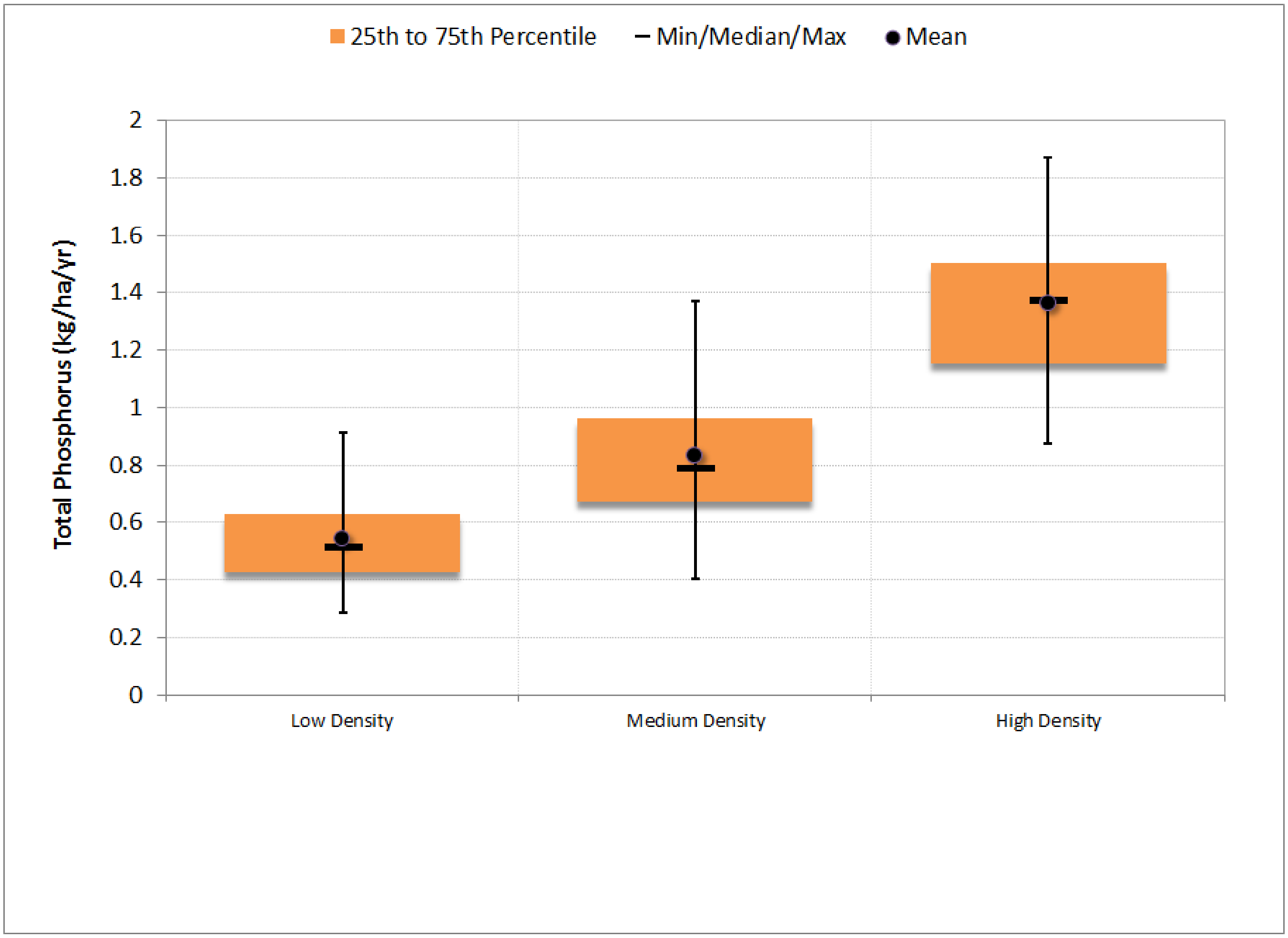


Figure E-60. TP export rates (kg/ha/yr) for the residential landuse categories for the 30 year simulation period

Segmented Regression

Table E-20. Summary statistics

Statistic	Calibration		Validation	
	TSS	TP	TSS	TP
Average absolute error (%)	55.4	47.9	65.9	60.3
Median absolute error (%)	18.5	25.4	18.5	23.7
Regression error (%)	5.4	3.6	-6.3	2.6
NSE	0.608	0.603	0.434	0.482
NSE'	0.497	0.502	0.436	0.401

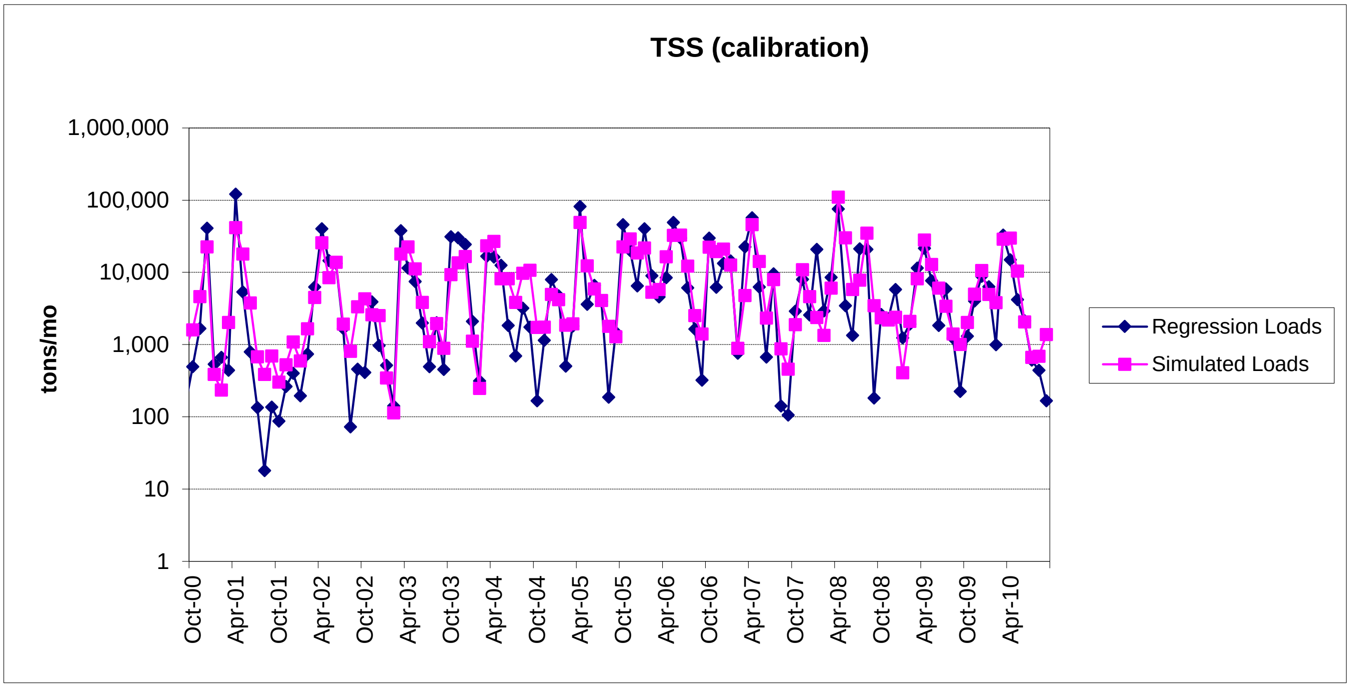


Figure E-61. Monthly simulated and estimated TSS load at Winooski River near Essex Junction, VT (calibration period)

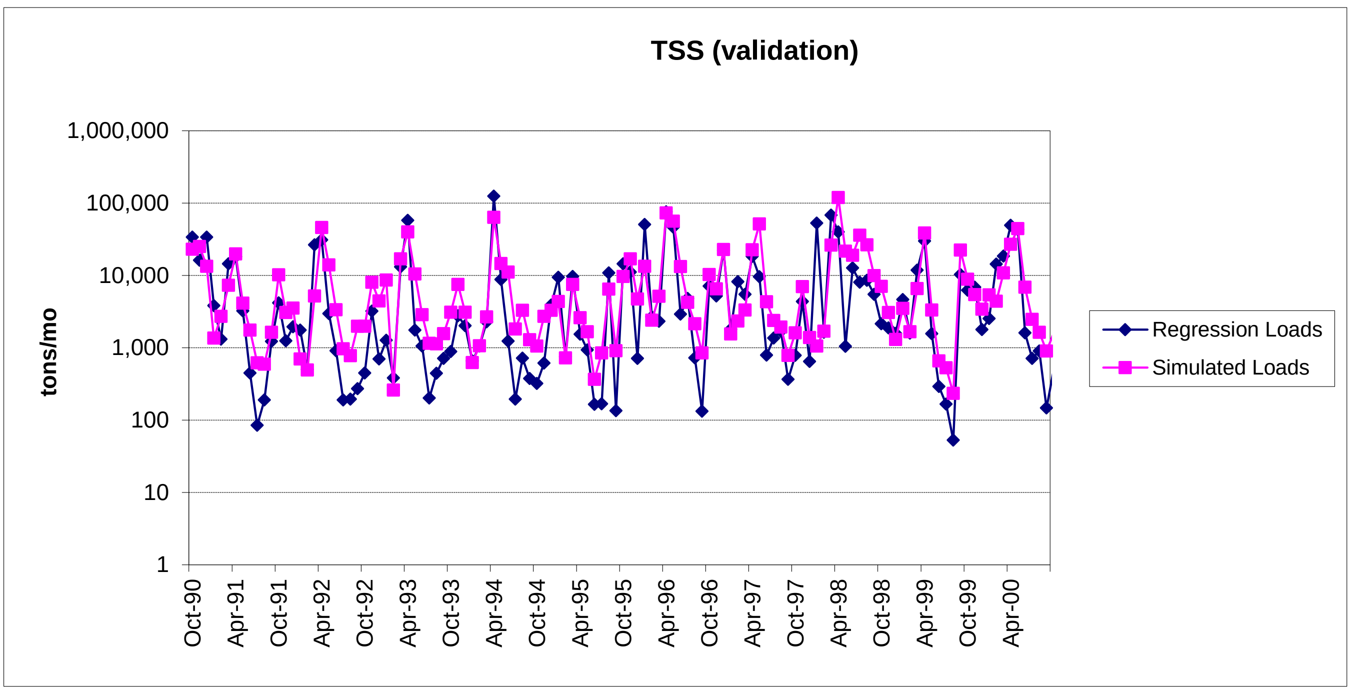


Figure E-62. Monthly simulated and estimated TSS load at Winooski River near Essex Junction, VT (validation period)

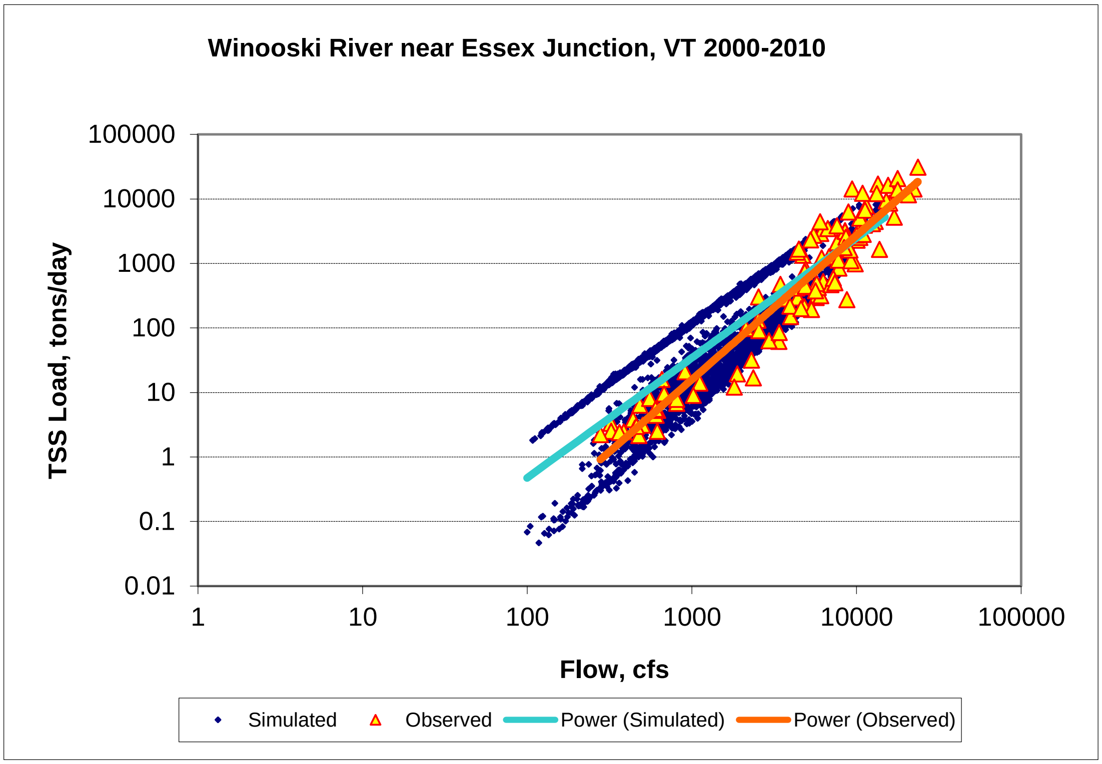


Figure E-63. Power plot of simulated and observed TSS load vs flow at Winooski River near Essex Junction, VT (calibration period)

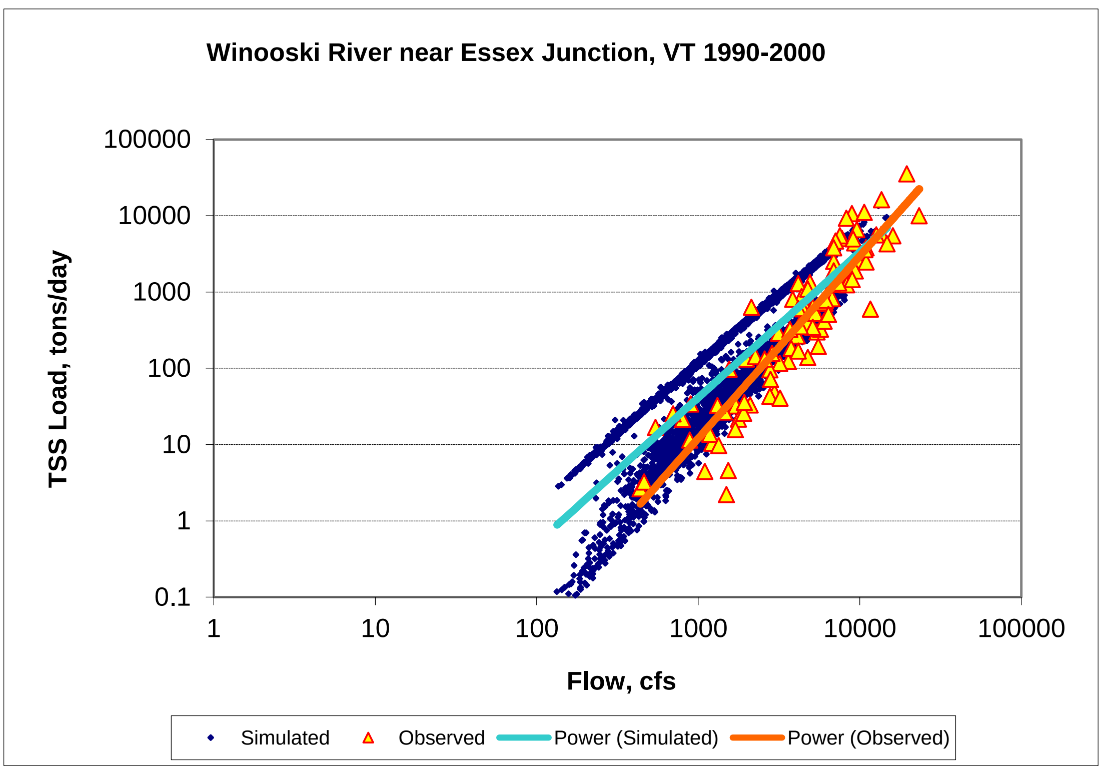


Figure E-64. Power plot of simulated and observed TSS load vs flow at Winooski River near Essex Junction, VT (validation period)

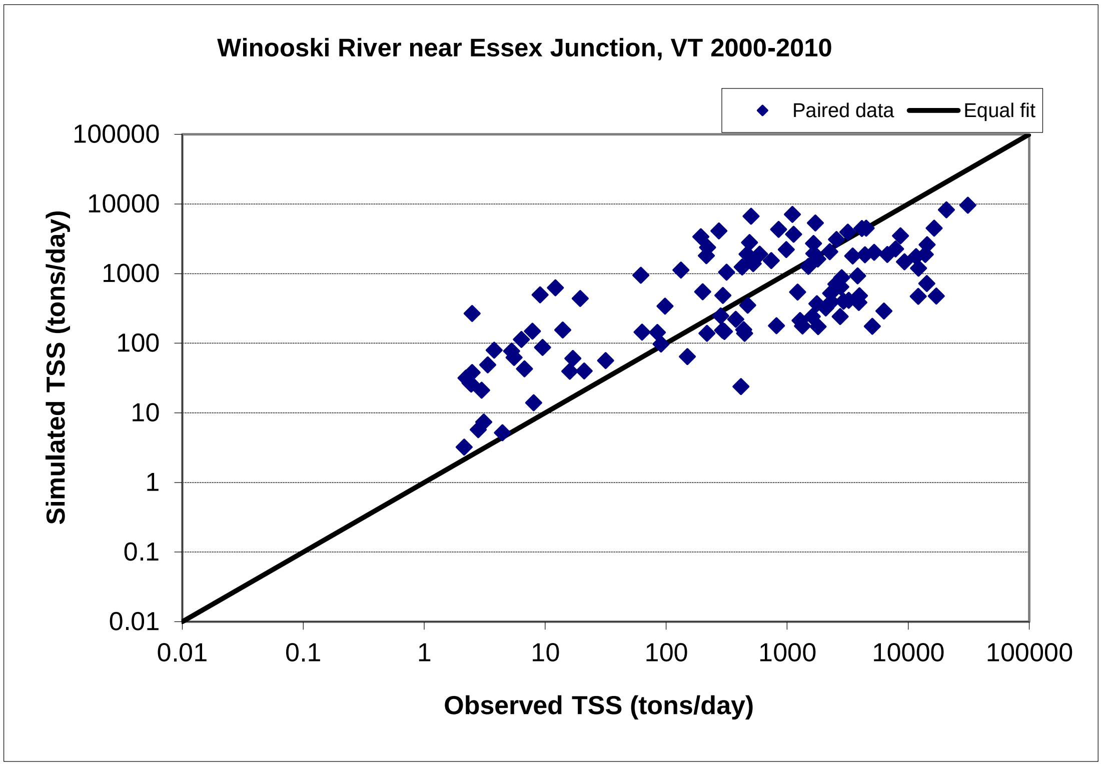


Figure E-65. Paired simulated vs observed TSS load at Winooski River near Essex Junction, VT (calibration period)

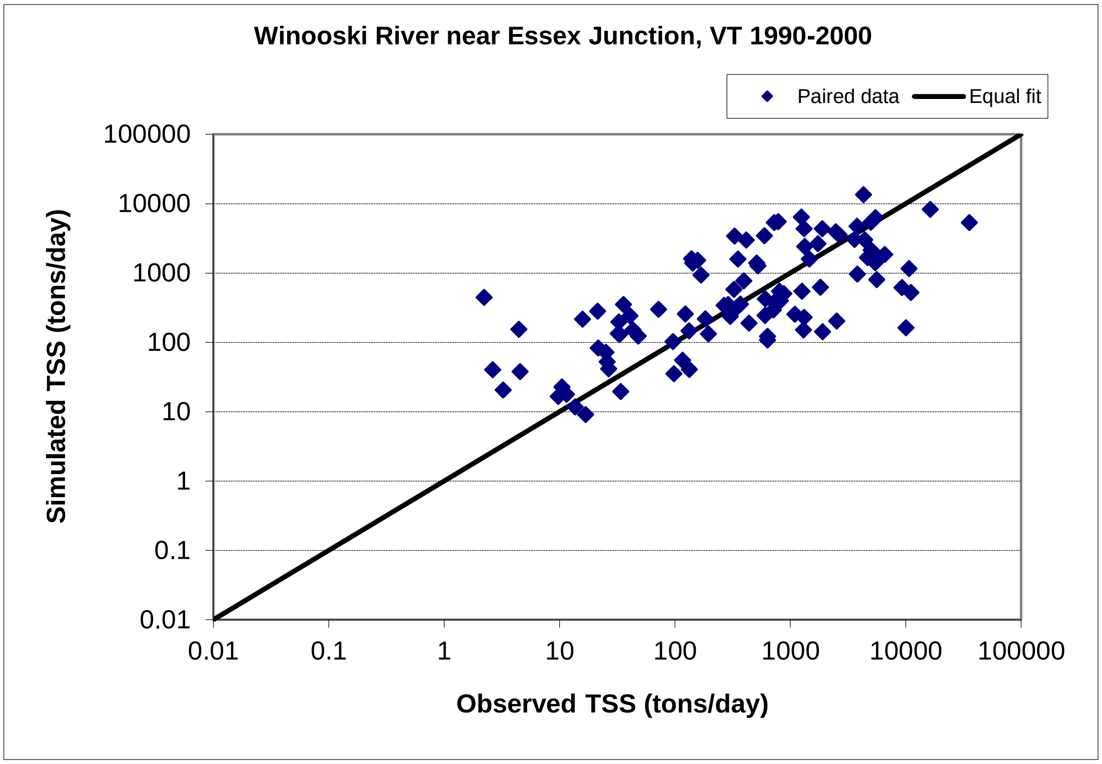


Figure E-66. Paired simulated vs observed TSS load at Winooski River near Essex Junction, VT (validation period)

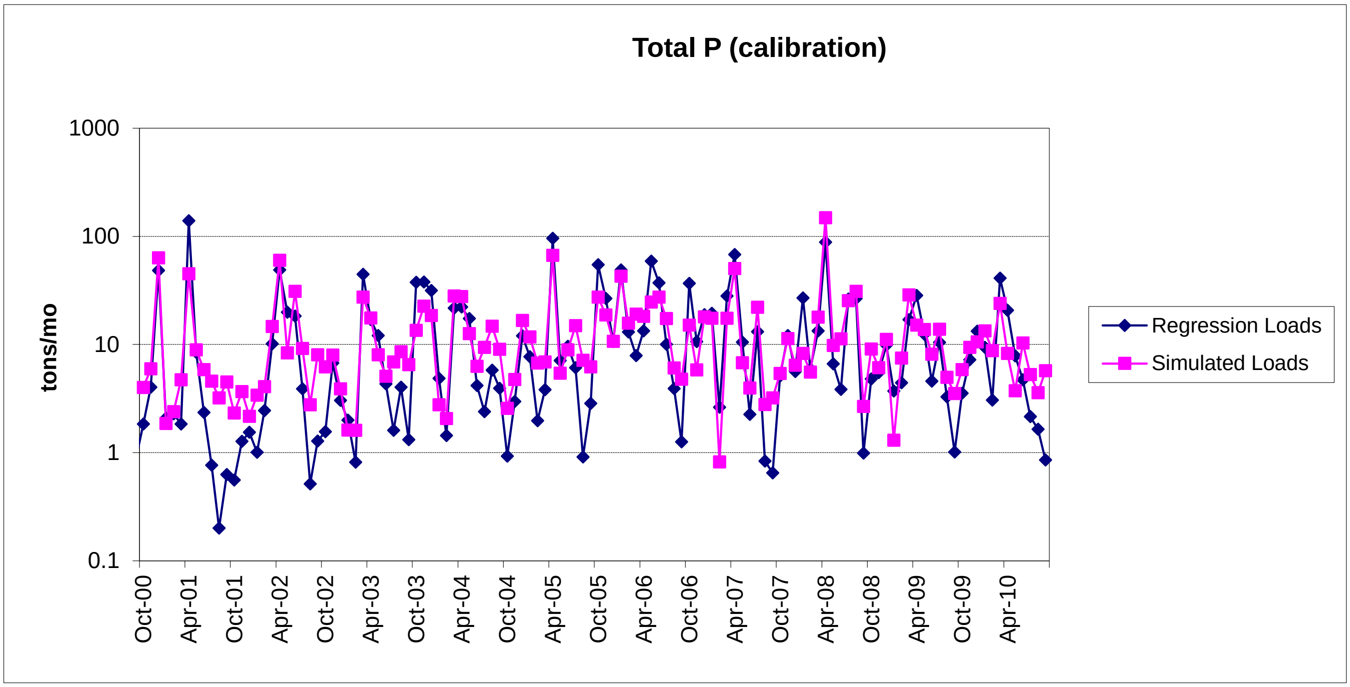


Figure E-67. Monthly simulated and estimated TP load at Winooski River near Essex Junction, VT (calibration period)

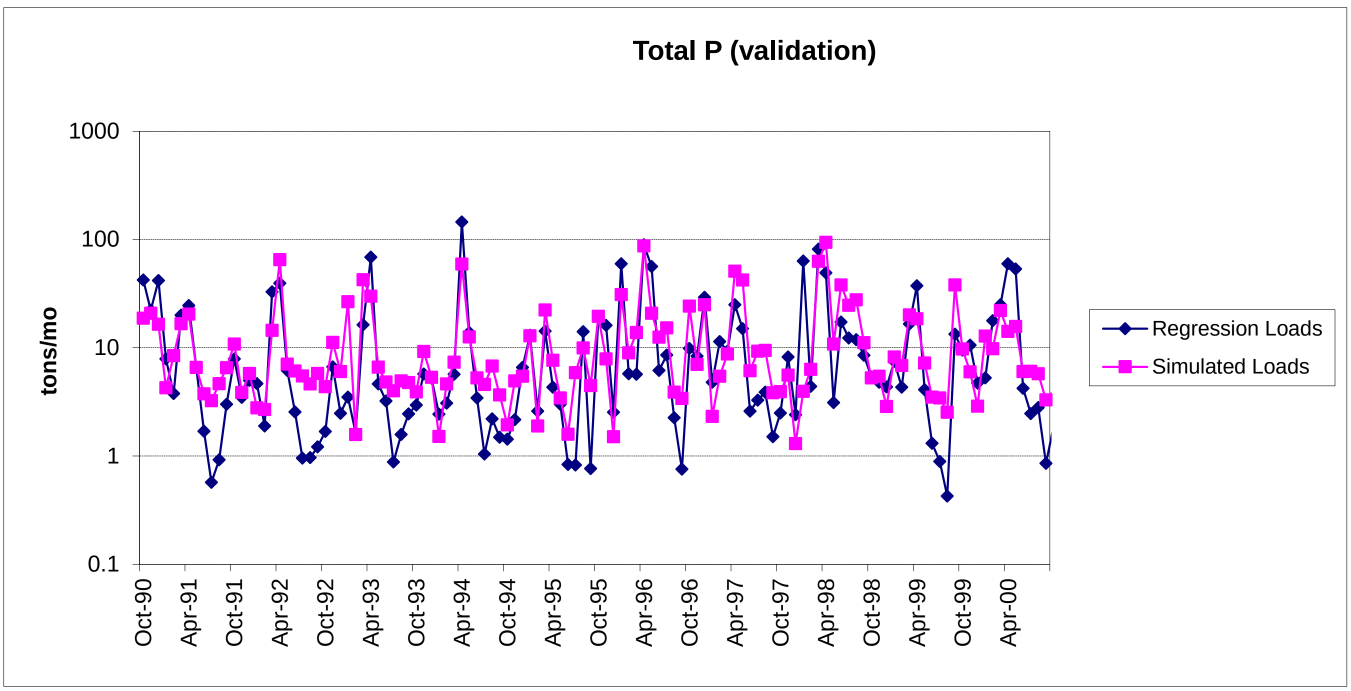


Figure E-68. Monthly simulated and estimated TP load at Winooski River near Essex Junction, VT (validation period)

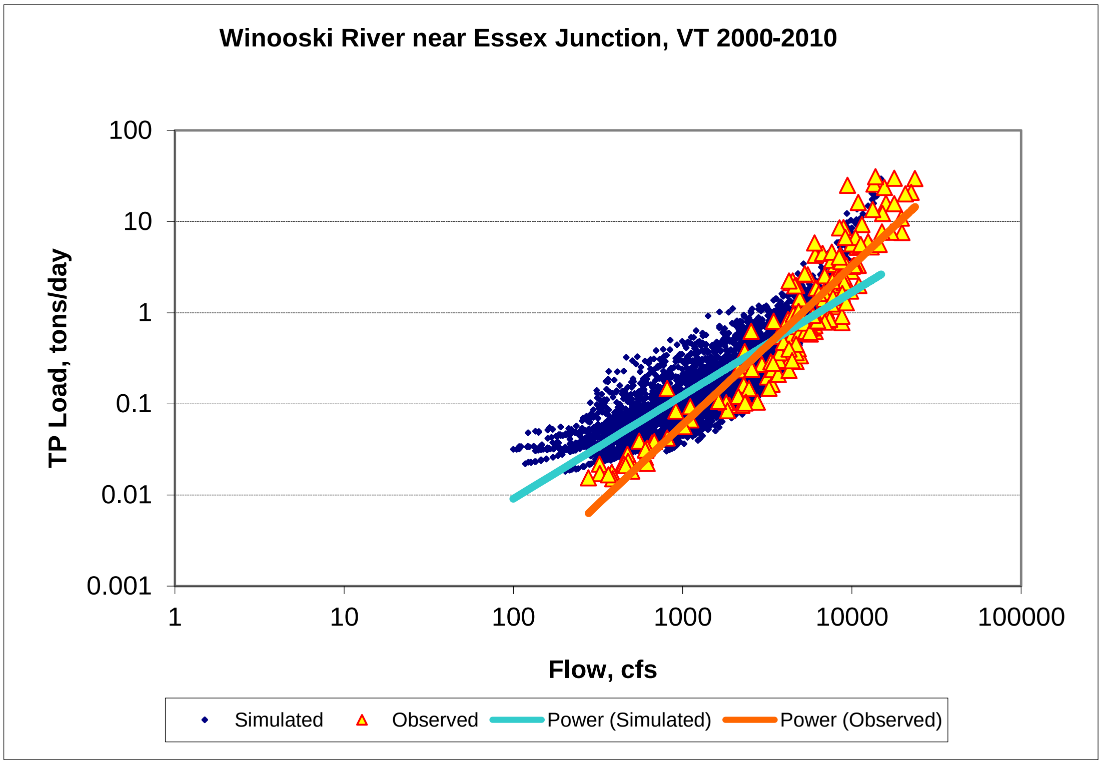


Figure E-69. Power plot of simulated and observed TP load vs flow at Winooski River near Essex Junction, VT (calibration period)

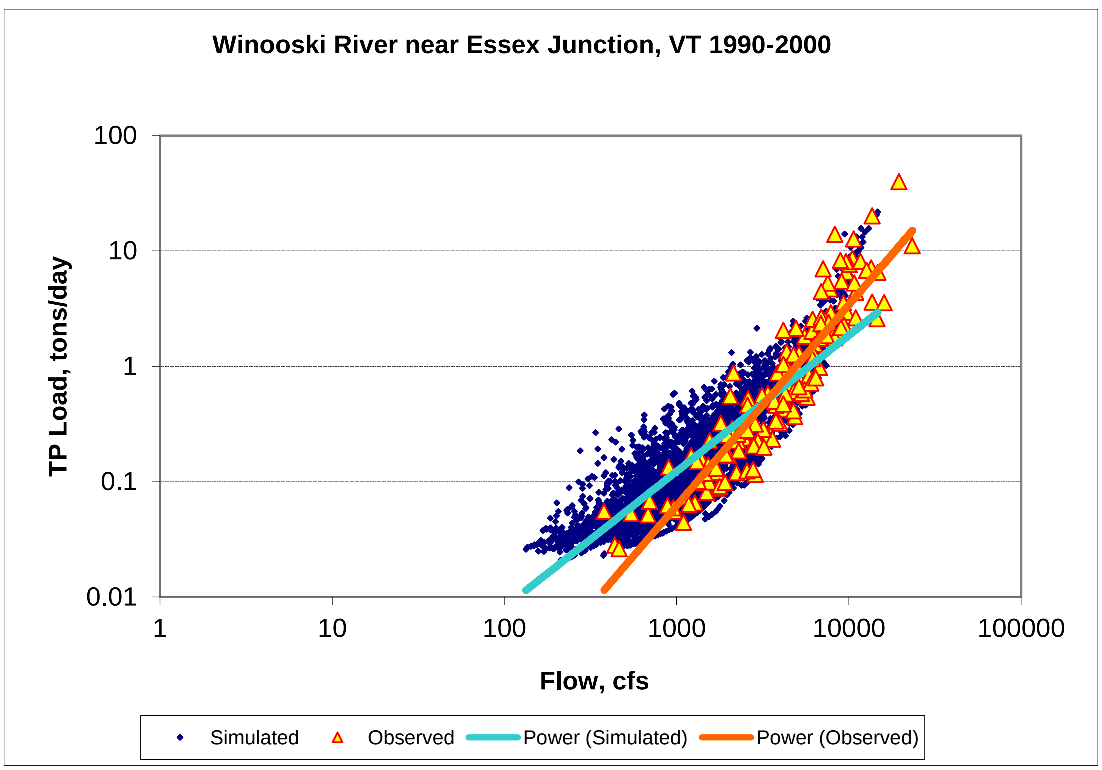


Figure E-70. Power plot of simulated and observed TP load vs flow at Winooski River near Essex Junction, VT (validation period)

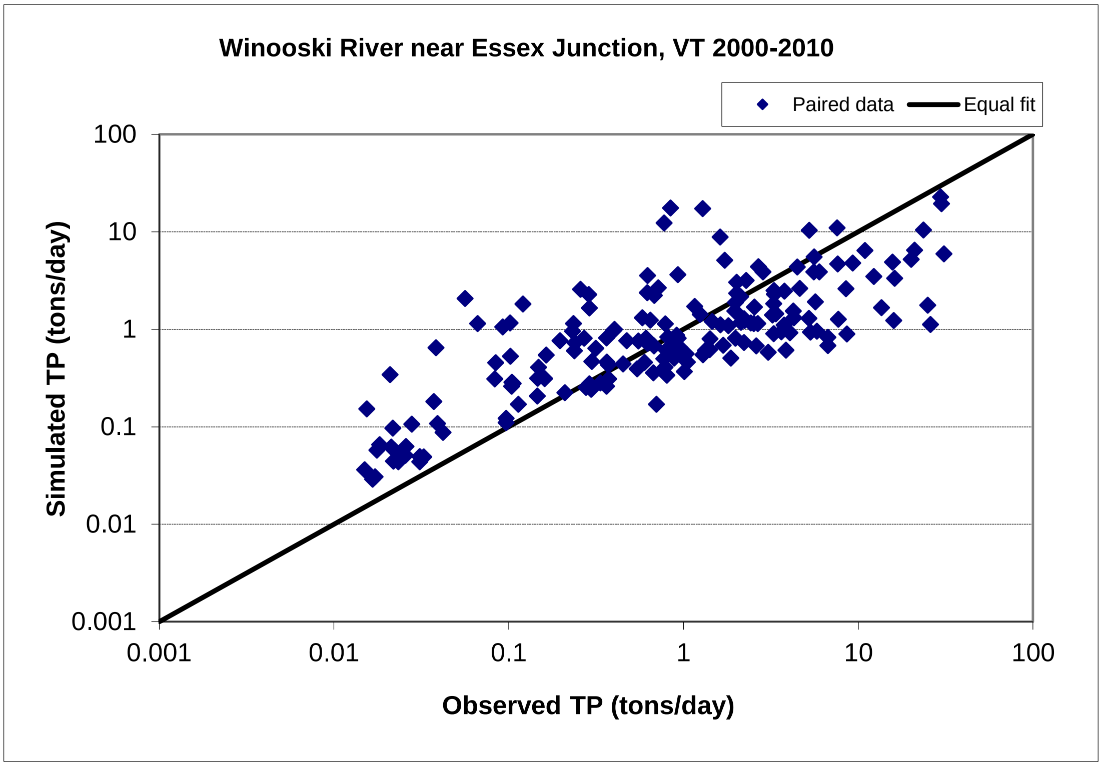


Figure E-71. Paired simulated vs observed TP load at Winooski River near Essex Junction, VT (calibration period)

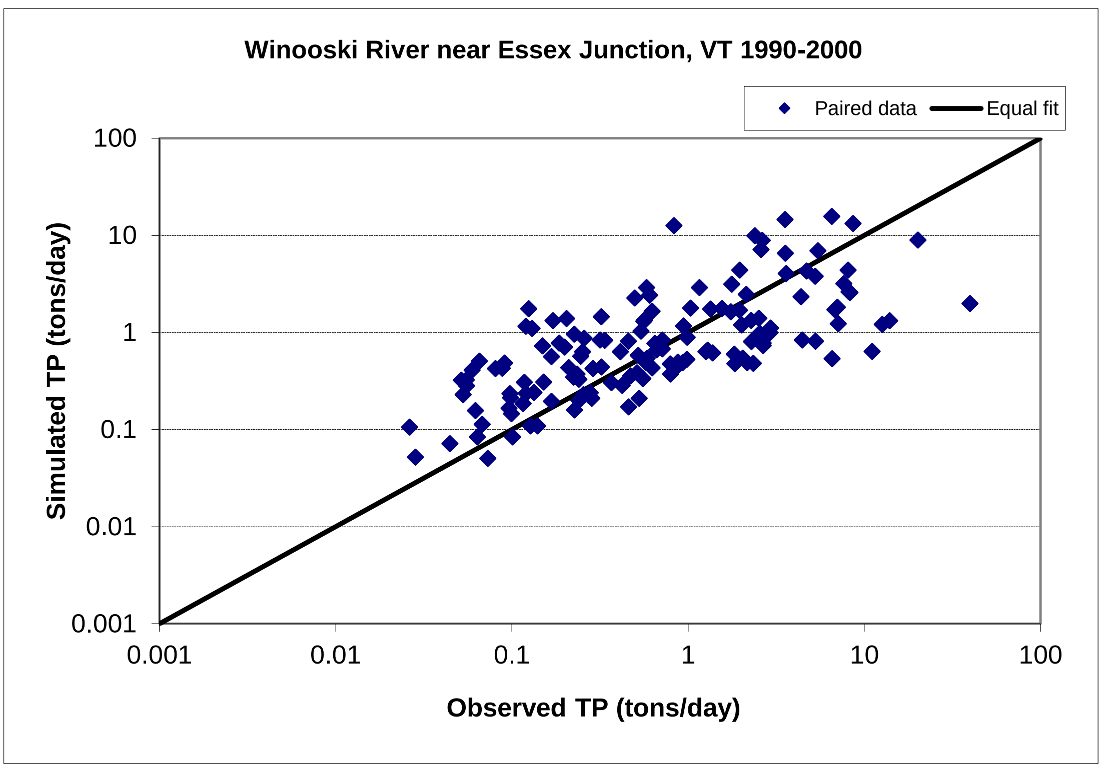


Figure E-72. Paired simulated vs observed TP load at Winooski River near Essex Junction, VT (validation period)

Comparison of simulated SWAT TP loads with FLUX estimates

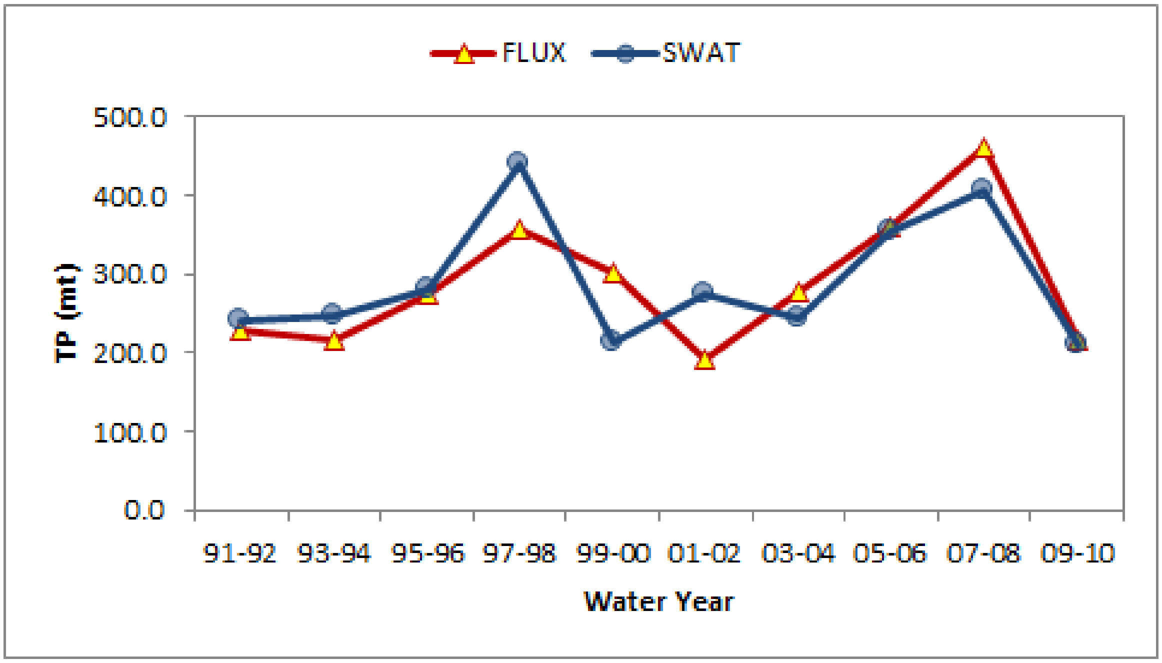


Figure E-73. Bi-annual TP loads on a water year basis as simulated by SWAT and estimated by FLUX (FLUX estimates from Smeltzer et al., 2009)

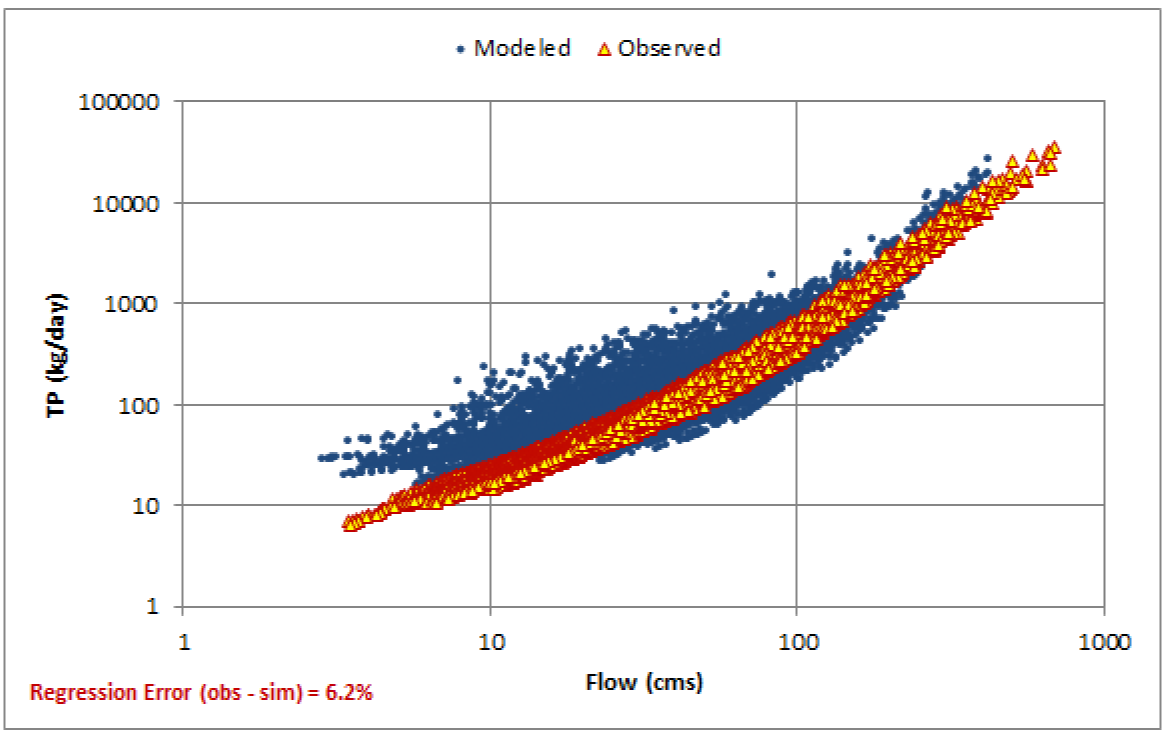
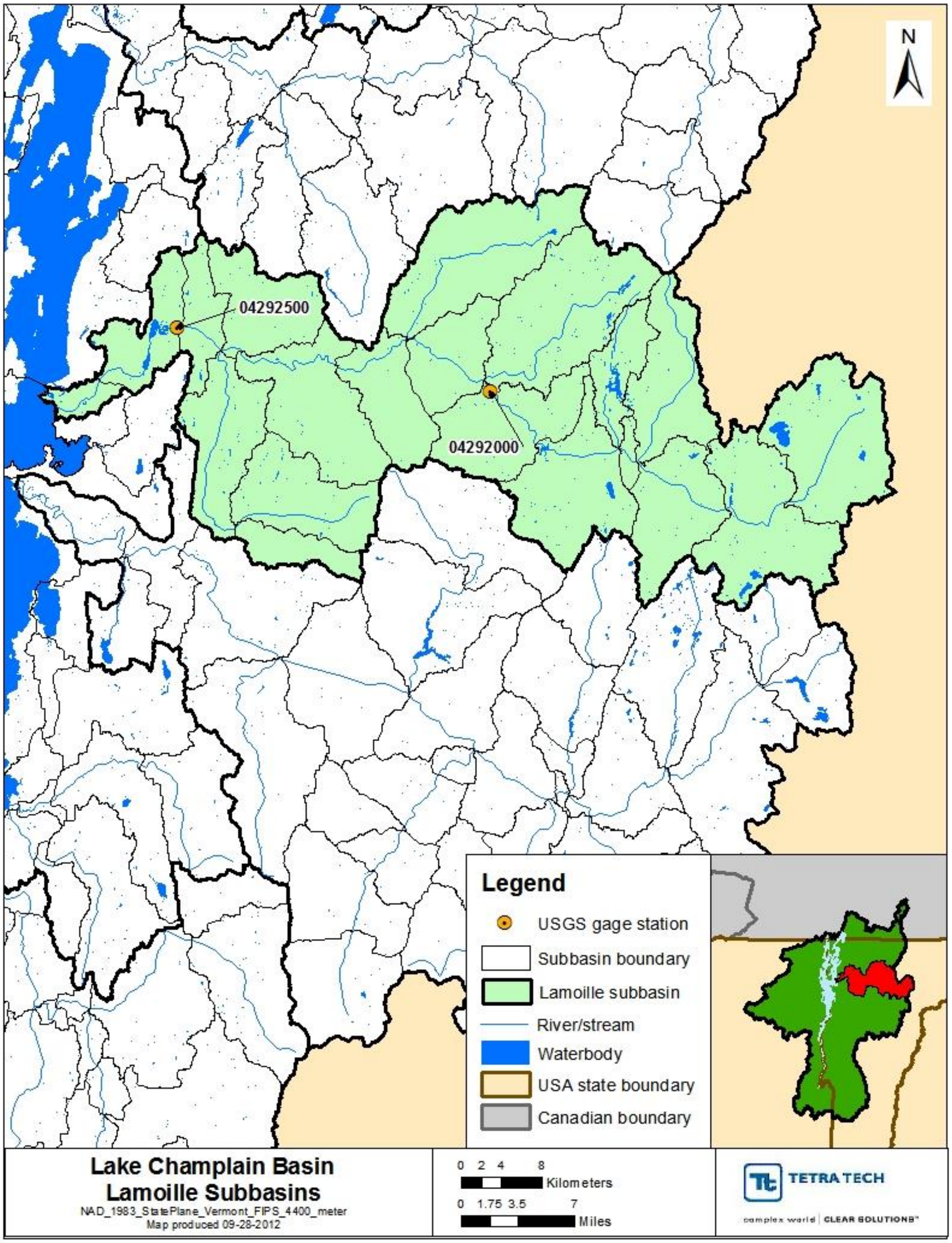


Figure E-74. Daily TP load versus flow as simulated by SWAT and estimated by FLUX (FLUX estimates from Medalie, 2013)

Appendix F - Lamoille River Watershed



HYDROLOGY

USGS 04292000 Lamoille River at Johnson, VT - Calibration

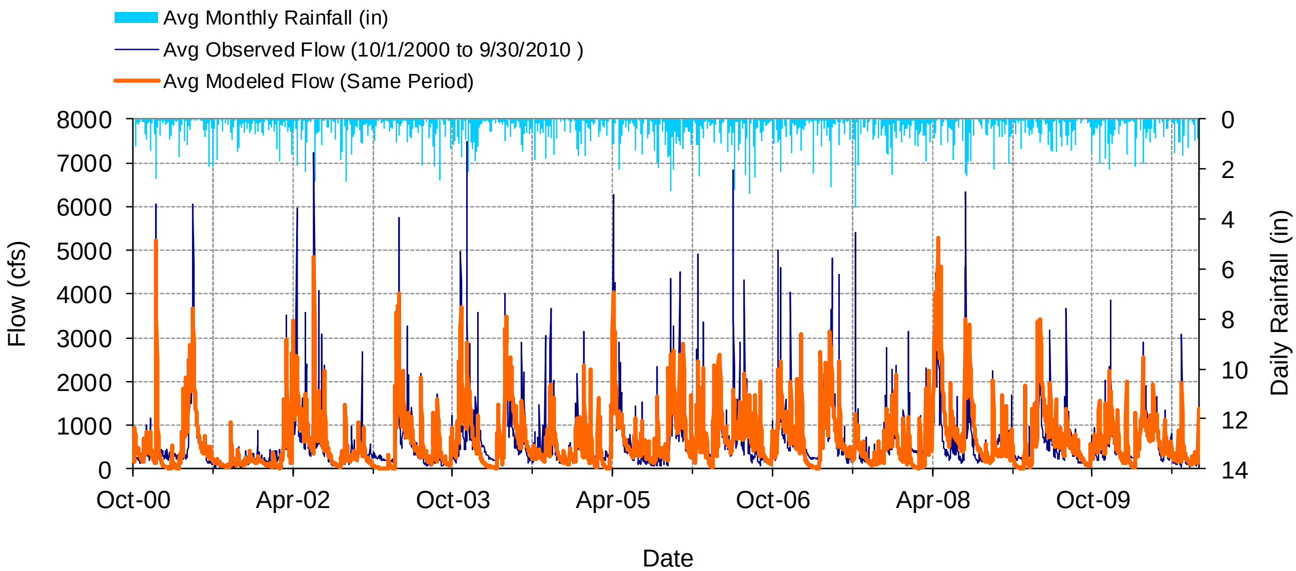


Figure F-1. Mean daily flow at USGS 04292000 Lamoille River at Johnson, VT

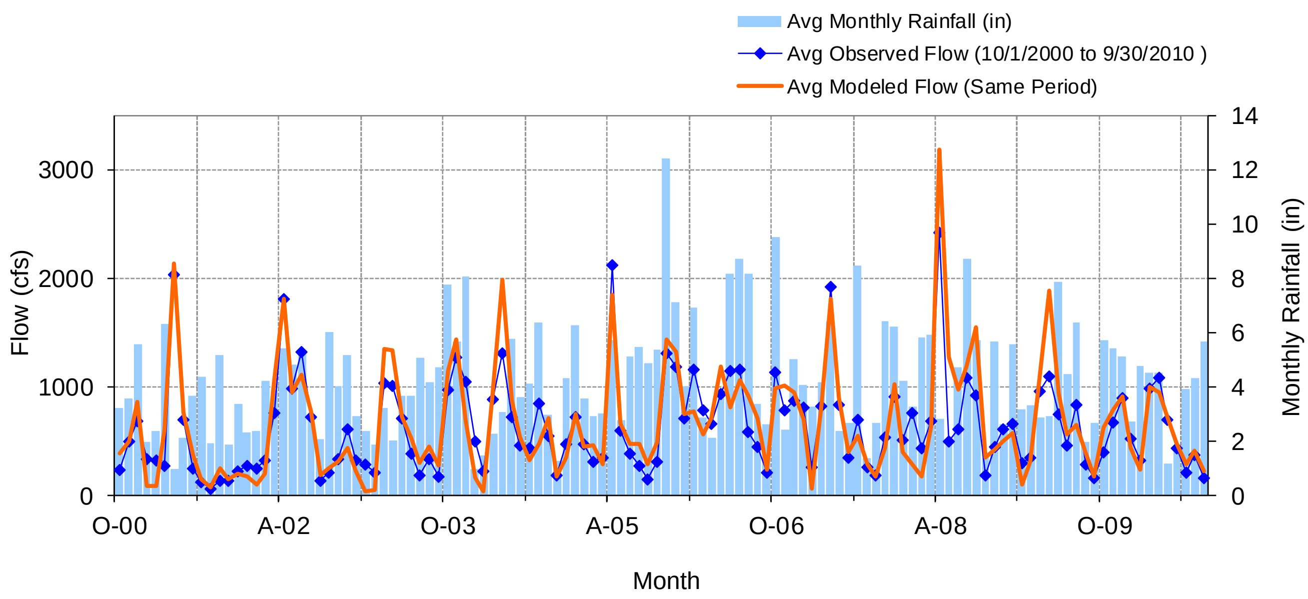


Figure F-2. Mean monthly flow at USGS 04292000 Lamoille River at Johnson, VT

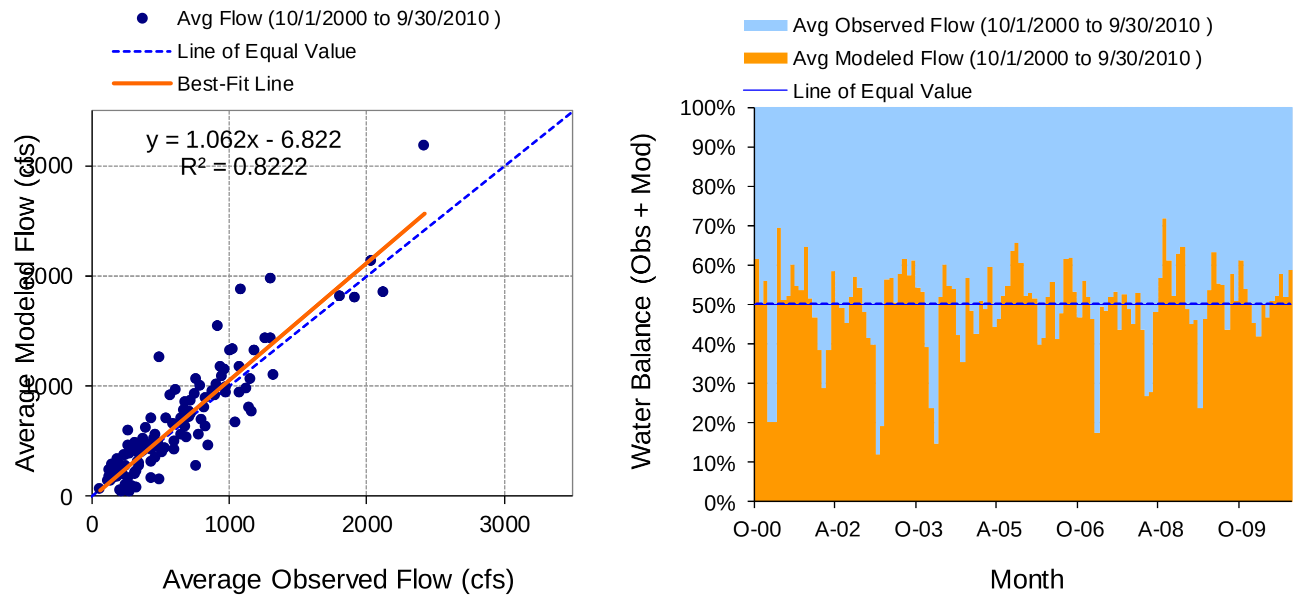


Figure F-3. Monthly flow regression and temporal variation at USGS 04292000 Lamoille River at Johnson, VT

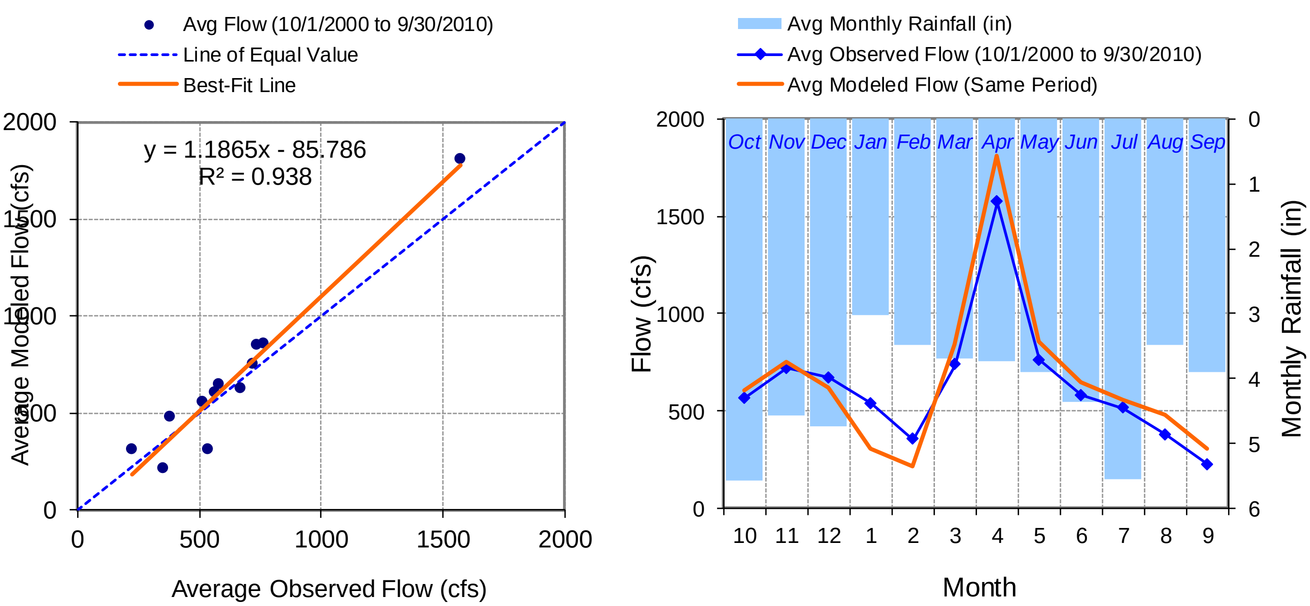


Figure F-4. Seasonal regression and temporal aggregate at USGS 04292000 Lamoille River at Johnson, VT

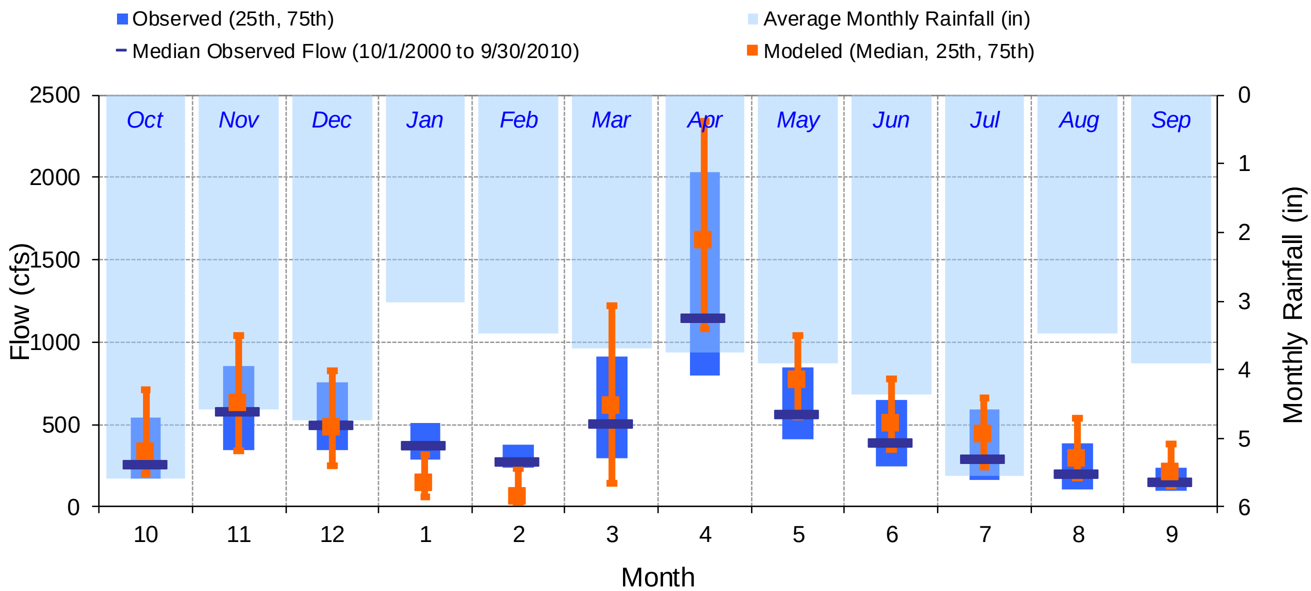


Figure F-5. Seasonal medians and ranges at USGS 04292000 Lamoille River at Johnson, VT

Table F-1. Seasonal summary at USGS 04292000 Lamoille River at Johnson, VT

MONTH	OBSERVED FLOW (CFS)				MODELED FLOW (CFS)			
	MEAN	MEDIAN	25TH	75TH	MEAN	MEDIAN	25TH	75TH
Oct	566.27	262.50	168.75	539.00	605.36	334.89	198.36	714.24
Nov	719.43	578.00	348.75	859.25	751.81	625.78	342.29	1043.37
Dec	667.96	498.50	341.25	758.50	622.54	478.69	253.66	829.28
Jan	536.17	377.50	285.25	513.50	308.74	141.06	64.43	317.91
Feb	350.90	271.00	236.00	377.75	212.25	63.99	31.69	236.11
Mar	736.62	506.00	295.25	914.50	845.45	608.65	141.85	1223.21
Apr	1573.33	1145.00	795.50	2030.00	1807.57	1617.06	1082.31	2339.68
May	761.85	561.00	412.50	846.50	857.50	766.68	547.20	1044.61
Jun	579.71	389.00	242.75	645.50	644.05	506.41	346.43	774.10
Jul	511.31	287.50	163.75	593.50	556.19	436.14	243.50	663.56
Aug	377.83	197.50	109.25	385.25	476.33	290.07	179.83	537.05
Sep	224.56	152.00	96.00	239.25	307.05	209.75	124.53	383.43

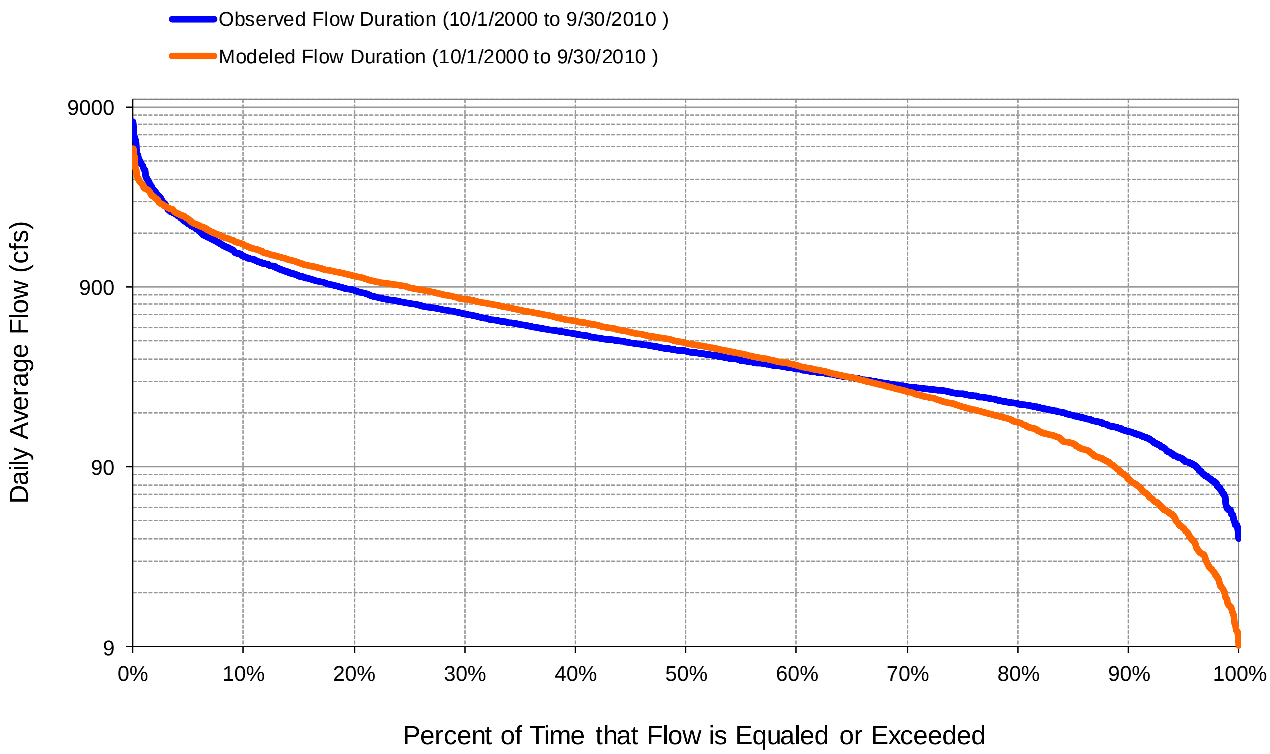


Figure F-6. Flow exceedence at USGS 04292000 Lamoille River at Johnson, VT

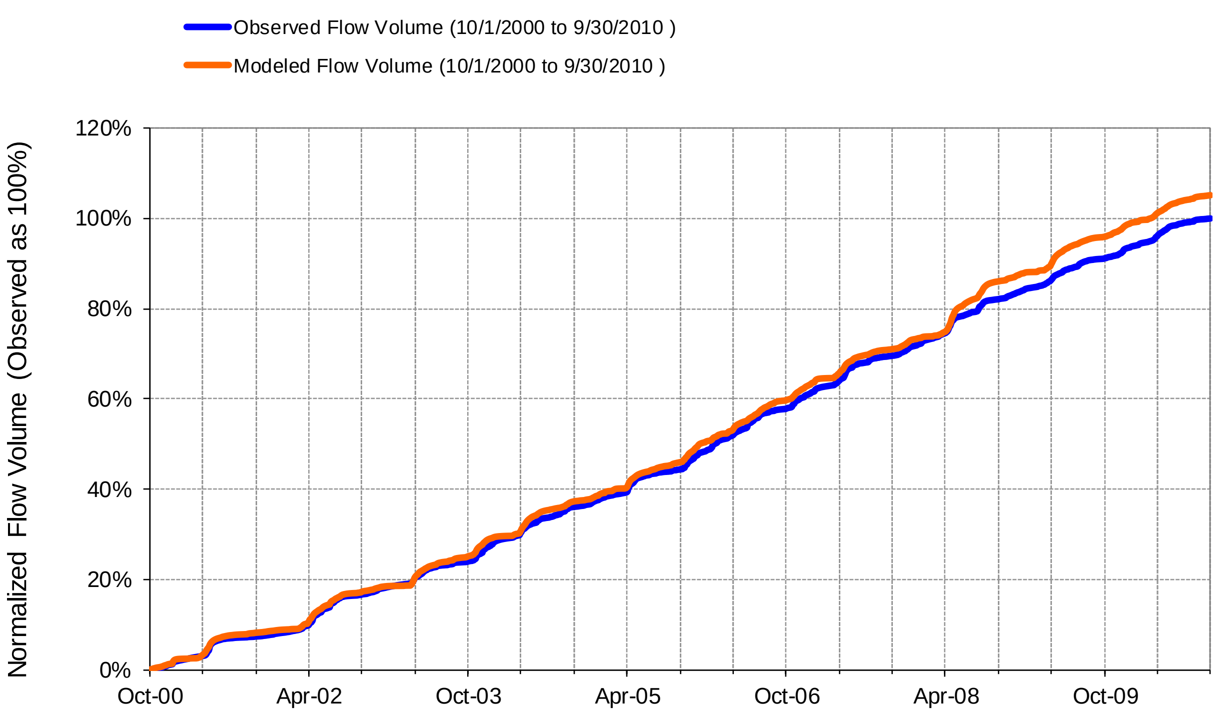


Figure F-7. Flow accumulation at USGS 04292000 Lamoille River at Johnson, VT

Table F-2. Summary statistics at USGS 04292000 Lamoille River at Johnson, VT

SWAT Simulated Flow		Observed Flow Gage	
REACH OUTFLOW FROM OUTLET 12 10-Year Analysis Period: 10/1/2000 - 9/30/2010 Flow volumes are (inches/year) for upstream drainage area		USGS 04292000 LAMOILLE RIVER AT JOHNSON, VT Hydrologic Unit Code: 4150405 Latitude: 44.6228287 Longitude: -72.6762308 Drainage Area (sq-mi): 310	
Total Simulated In-stream Flow:	**29.24**	Total Observed In-stream Flow:	**27.80**
Total of simulated highest 10% flows:	**10.19**	Total of Observed highest 10% flows:	**10.55**
Total of Simulated lowest 50% flows:	**4.49**	Total of Observed Lowest 50% flows:	**4.99**
Simulated Summer Flow Volume (months 7-9):	**4.95**	Observed Summer Flow Volume (7-9):	**4.12**
Simulated Fall Flow Volume (months 10-12):	**7.27**	Observed Fall Flow Volume (10-12):	**7.18**
Simulated Winter Flow Volume (months 1-3):	**5.01**	Observed Winter Flow Volume (1-3):	**5.92**
Simulated Spring Flow Volume (months 4-6):	**12.01**	Observed Spring Flow Volume (4-6):	**10.58**
Total Simulated Storm Volume:	**8.85**	Total Observed Storm Volume:	**10.69**
Simulated Summer Storm Volume (7-9):	**1.51**	Observed Summer Storm Volume (7-9):	**1.92**

Errors (Simulated-Observed)	*Error Statistics*	*Recommended Criteria*		
Error in total volume:	5.19	10		
Error in 50% lowest flows:	-9.90	10		
Error in 10% highest flows:	-3.47	15		
Seasonal volume error - Summer:	20.17	30		
Seasonal volume error - Fall:	1.30	>> 30	Clear	
Seasonal volume error - Winter:	-15.37	30		
Seasonal volume error - Spring:	13.52	30		
Error in storm volumes:	-17.23	20		
Error in summer storm volumes:	-21.60	50		
Nash-Sutcliffe Coefficient of Efficiency, E:	0.620	Model accuracy increases		
Baseline adjusted coefficient (Garrick), E':	0.403	as E or E' approaches 1.0		
Monthly NSE	0.747			

USGS 04292000 Lamoille River at Johnson, VT - Validation

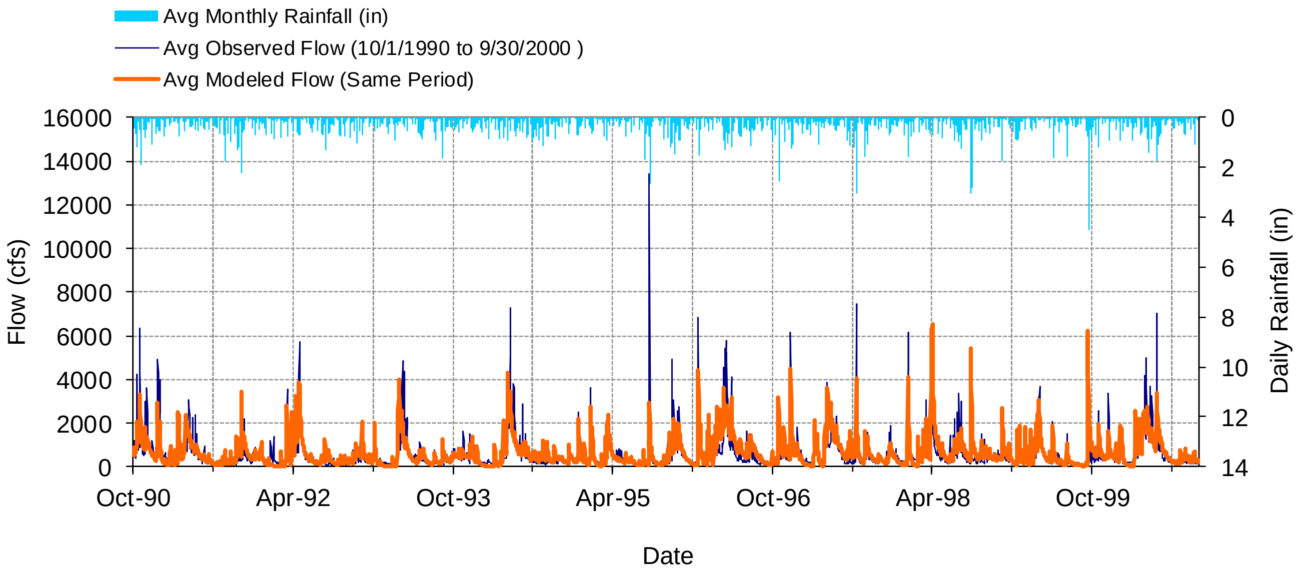


Figure F-8. Mean daily flow at USGS 04292000 Lamoille River at Johnson, VT

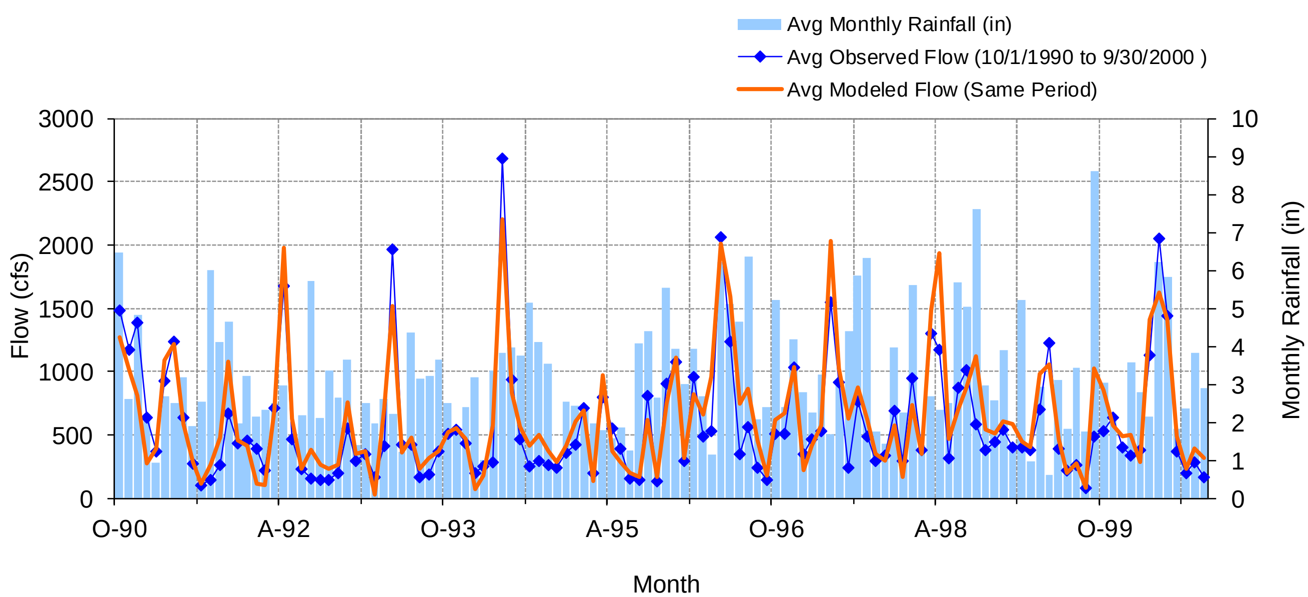


Figure F-9. Mean monthly flow at USGS 04292000 Lamoille River at Johnson, VT

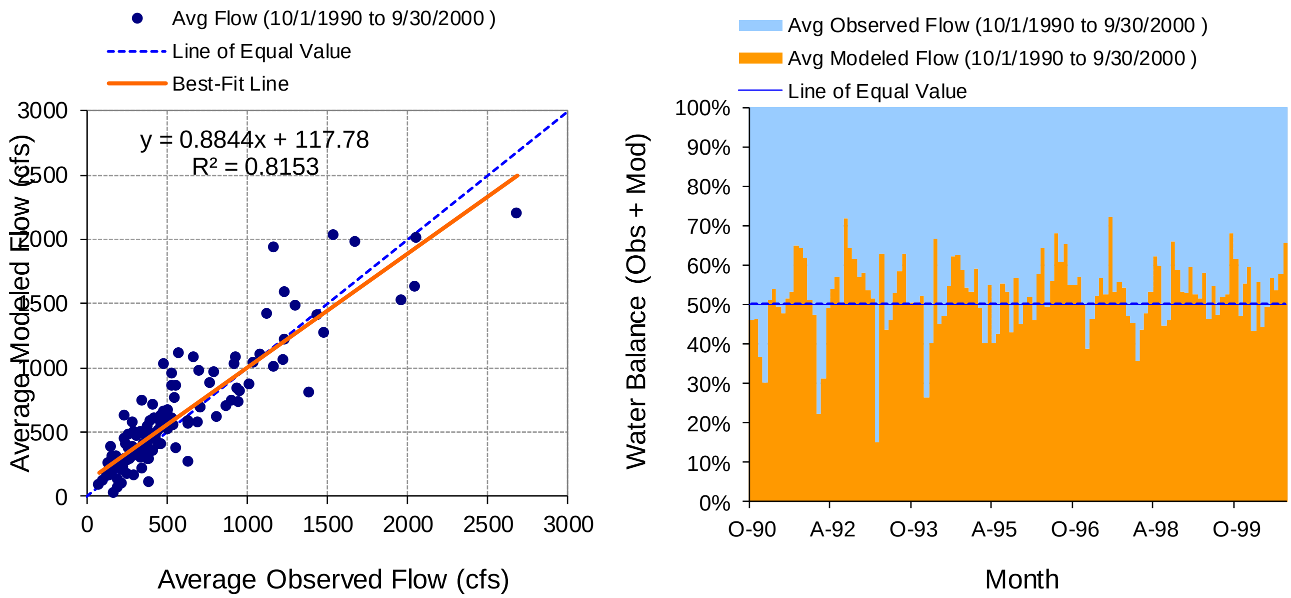


Figure F-10. Monthly flow regression and temporal variation at USGS 04292000 Lamoille River at Johnson, VT

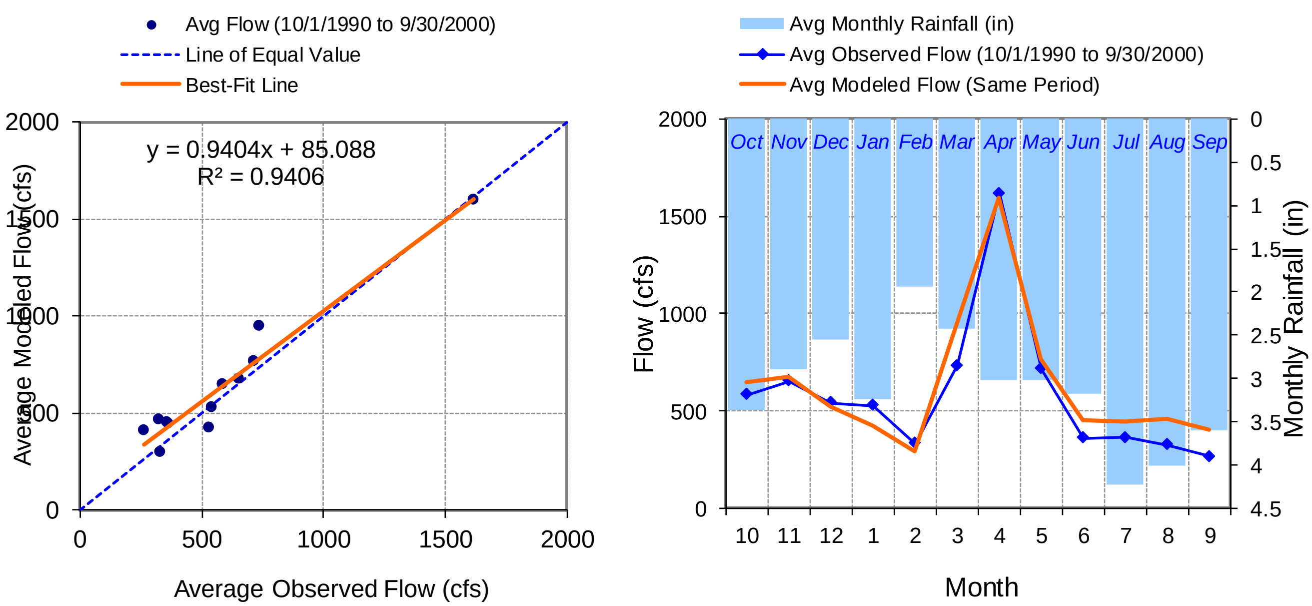


Figure F-11. Seasonal regression and temporal aggregate at USGS 04292000 Lamoille River at Johnson, VT

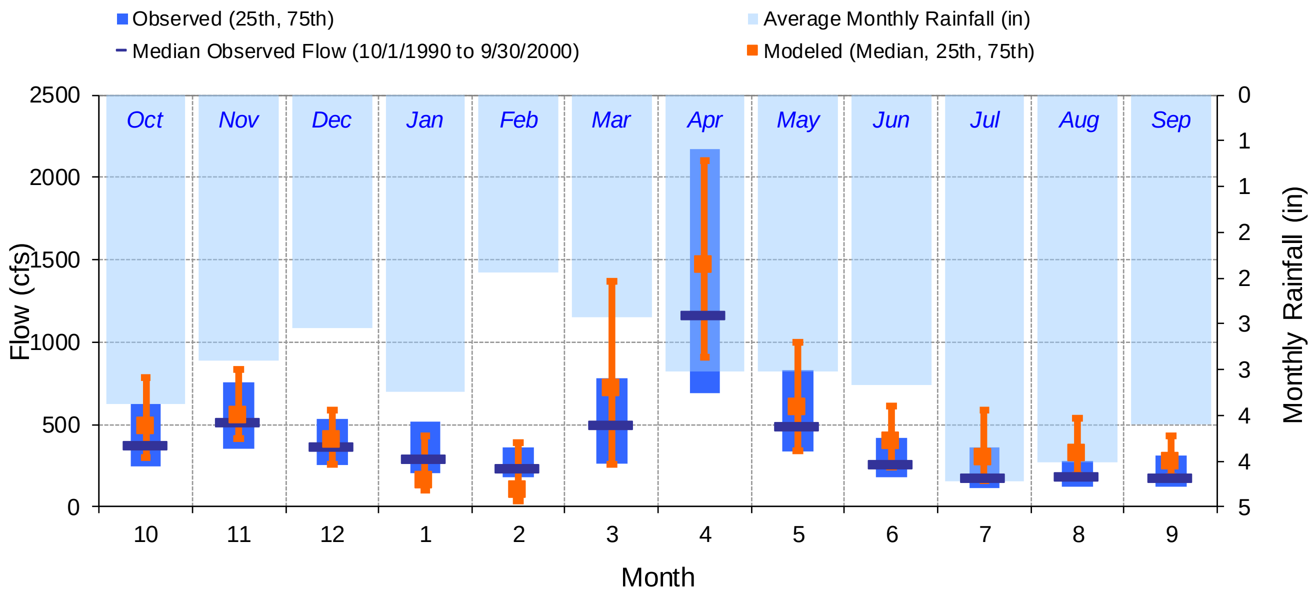


Figure F-12. Seasonal medians and ranges at USGS 04292000 Lamoille River at Johnson, VT

Table F-3. Seasonal summary at USGS 04292000 Lamoille River at Johnson, VT

MONTH	OBSERVED FLOW (CFS)				MODELED FLOW (CFS)			
	MEAN	MEDIAN	25TH	75TH	MEAN	MEDIAN	25TH	75TH
Oct	583.28	370.00	244.00	623.00	644.65	492.82	296.21	787.34
Nov	651.18	512.00	353.50	755.50	672.02	555.15	413.80	834.75
Dec	541.70	363.00	253.50	535.25	522.63	403.47	261.76	591.52
Jan	528.16	295.00	205.00	520.00	423.47	159.59	98.25	435.52
Feb	331.58	230.00	180.00	364.00	294.24	98.28	35.00	393.41
Mar	733.91	494.00	260.00	778.00	943.87	719.01	258.84	1370.92
Apr	1617.37	1165.00	689.25	2170.00	1594.64	1467.15	910.24	2098.66
May	714.97	485.00	337.25	830.00	763.36	607.94	343.50	998.96
Jun	359.88	259.50	179.75	419.75	451.61	394.46	239.63	612.18
Jul	361.57	178.50	116.00	360.25	442.18	297.54	156.02	587.90
Aug	325.58	180.50	123.25	280.75	460.40	325.09	190.75	537.31
Sep	264.47	179.00	121.75	311.50	403.73	277.52	186.64	432.34

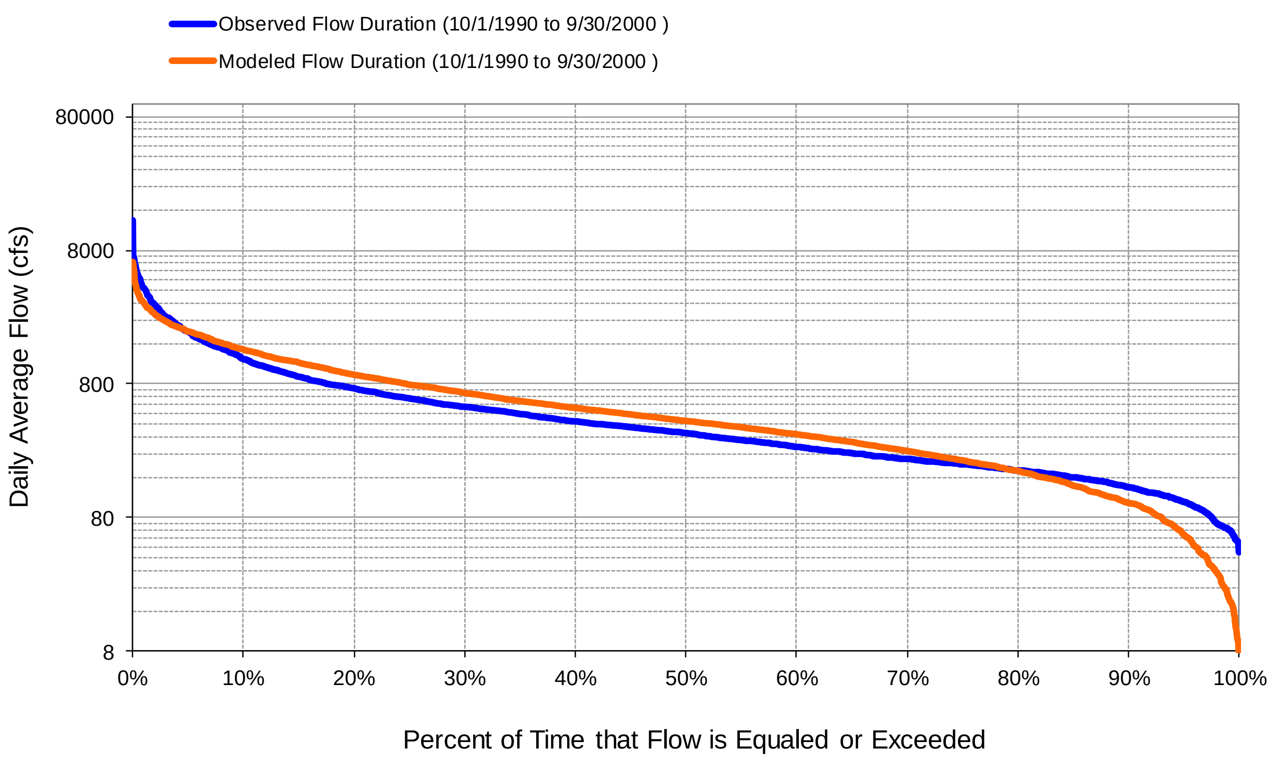


Figure F-13. Flow exceedence at USGS 04292000 Lamoille River at Johnson, VT

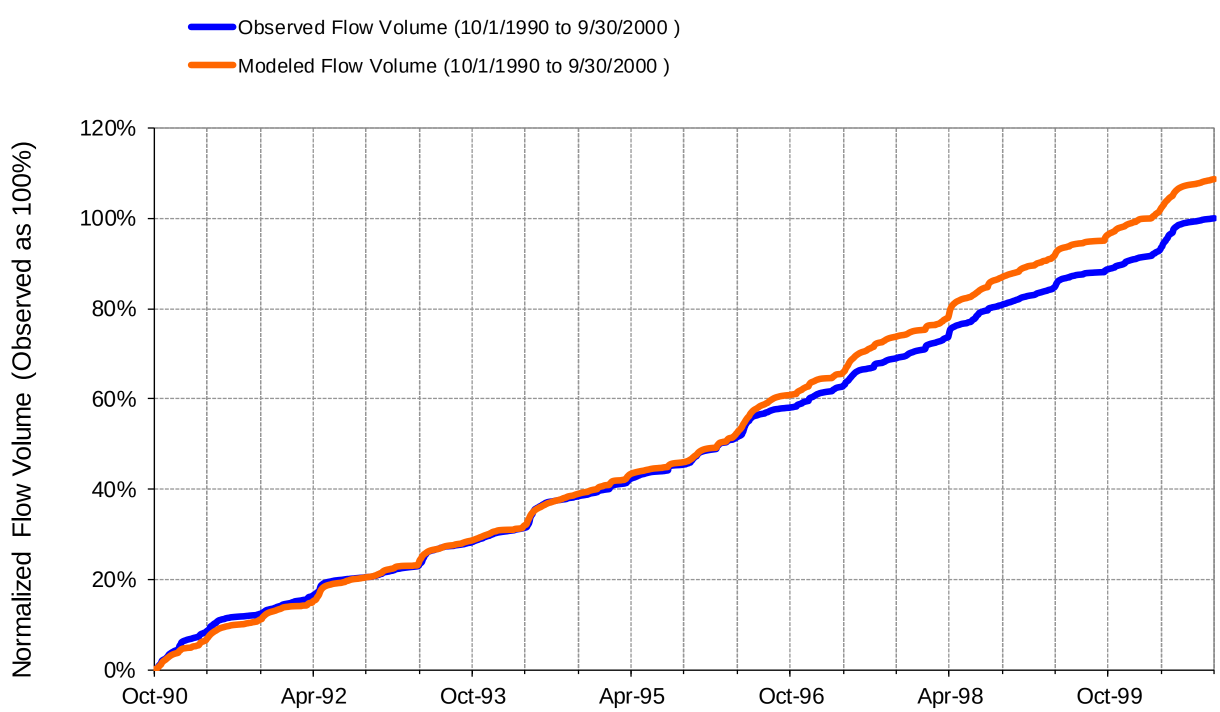


Figure F-14. Flow accumulation at USGS 04292000 Lamoille River at Johnson, VT

Table F-4. Summary statistics at USGS 04292000 Lamoille River at Johnson, VT

SWAT Simulated Flow		Observed Flow Gage	
REACH OUTFLOW FROM OUTLET 12 10-Year Analysis Period: 10/1/1990 - 9/30/2000 Flow volumes are (inches/year) for upstream drainage area		USGS 04292000 LAMOILLE RIVER AT JOHNSON, VT Hydrologic Unit Code: 4150405 Latitude: 44.6228287 Longitude: -72.6762308 Drainage Area (sq-mi): 310	
Total Simulated In-stream Flow:	**27.85**	Total Observed In-stream Flow:	**25.63**
Total of simulated highest 10% flows:	**9.79**	Total of Observed highest 10% flows:	**10.63**
Total of Simulated lowest 50% flows:	**4.76**	Total of Observed Lowest 50% flows:	**4.42**
Simulated Summer Flow Volume (months 7-9):	**4.81**	Observed Summer Flow Volume (7-9):	**3.51**
Simulated Fall Flow Volume (months 10-12):	**6.76**	Observed Fall Flow Volume (10-12):	**6.53**
Simulated Winter Flow Volume (months 1-3):	**6.08**	Observed Winter Flow Volume (1-3):	**5.82**
Simulated Spring Flow Volume (months 4-6):	**10.20**	Observed Spring Flow Volume (4-6):	**9.77**
Total Simulated Storm Volume:	**8.67**	Total Observed Storm Volume:	**10.17**
Simulated Summer Storm Volume (7-9):	**1.62**	Observed Summer Storm Volume (7-9):	**1.72**

Errors (Simulated-Observed)	*Error Statistics*	*Recommended Criteria*		
Error in total volume:	8.69	10		
Error in 50% lowest flows:	7.67	10		
Error in 10% highest flows:	-7.91	15		
Seasonal volume error - Summer:	37.13	30		
Seasonal volume error - Fall:	3.56	>> 30		Clear
Seasonal volume error - Winter:	4.55	30		
Seasonal volume error - Spring:	4.38	30		
Error in storm volumes:	-14.72	20		
Error in summer storm volumes:	-6.26	50		
Nash-Sutcliffe Coefficient of Efficiency, E:	0.610	Model accuracy increases		
Baseline adjusted coefficient (Garrick), E':	0.424	as E or E' approaches 1.0		
Monthly NSE	0.798			

USGS 04292500 Lamoille River at East Georgia, VT - Calibration

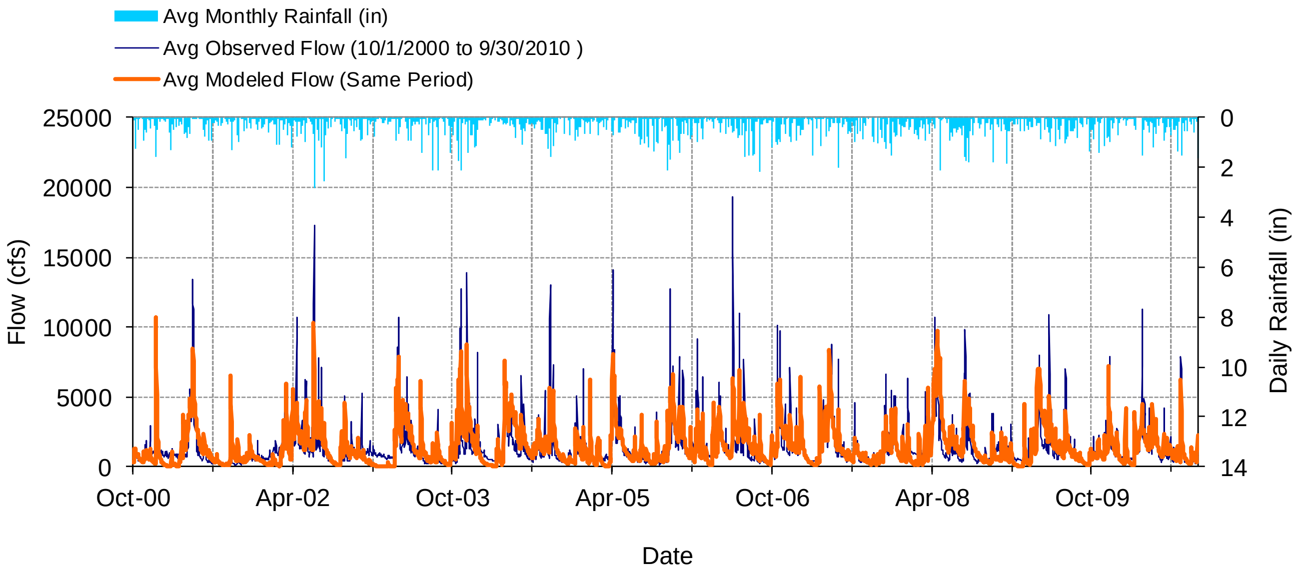


Figure F-15. Mean daily flow at USGS 04292500 Lamoille River at East Georgia, VT

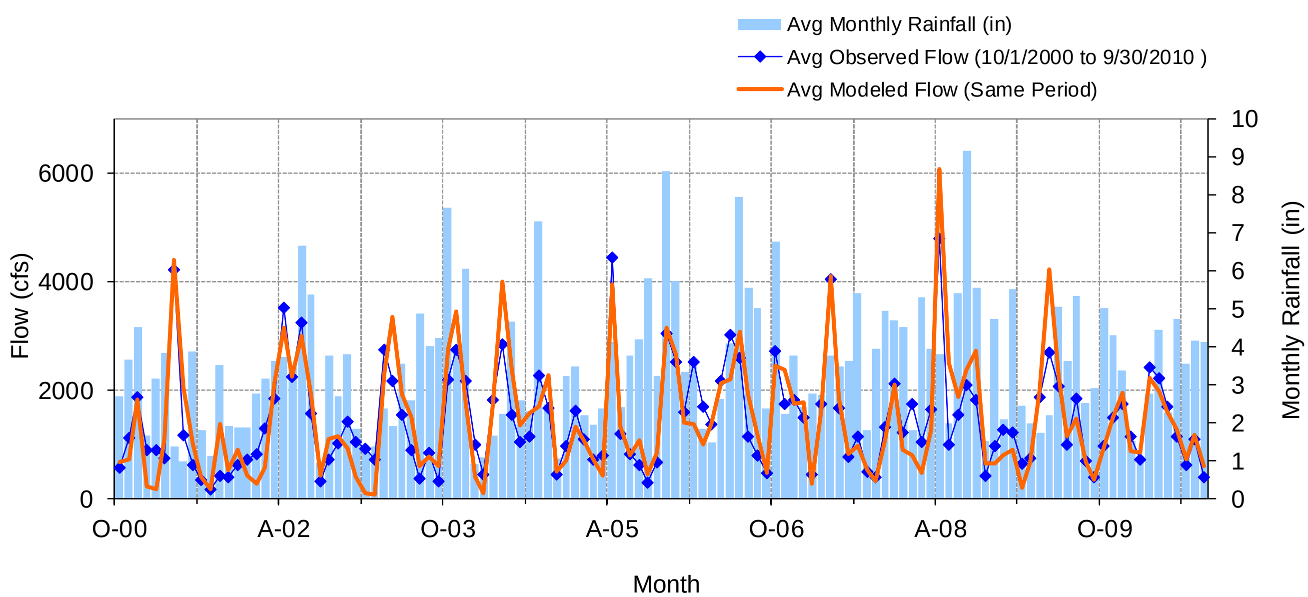


Figure F-16. Mean monthly flow at USGS 04292500 Lamoille River at East Georgia, VT

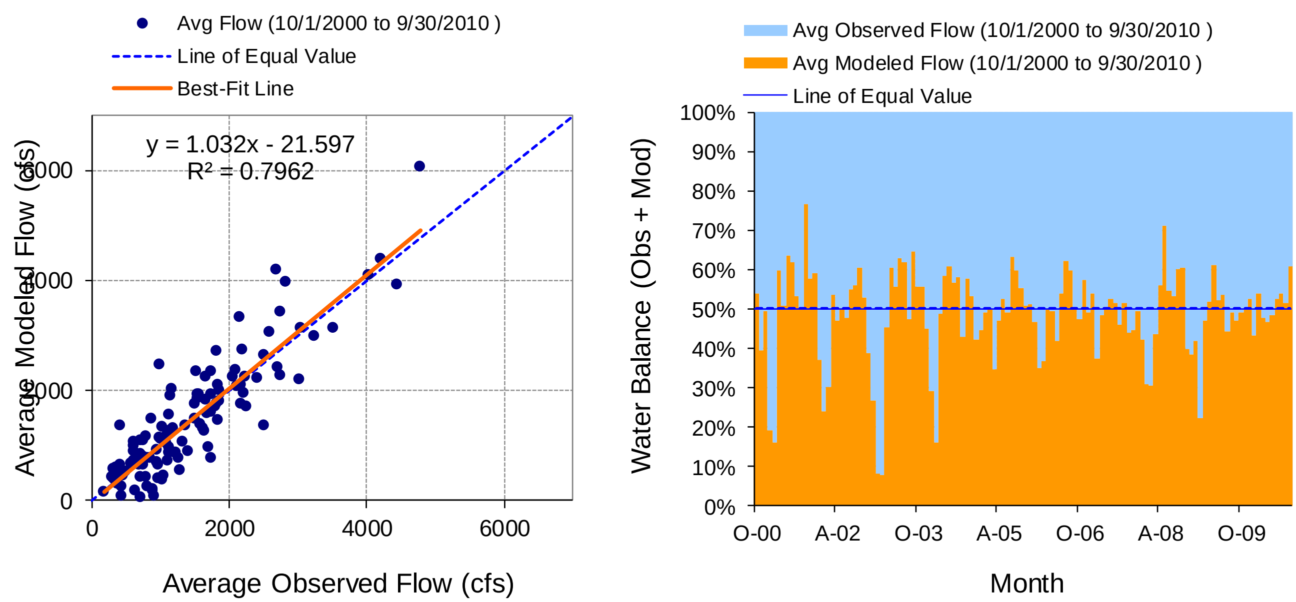


Figure F-17. Monthly flow regression and temporal variation at USGS 04292500 Lamoille River at East Georgia, VT

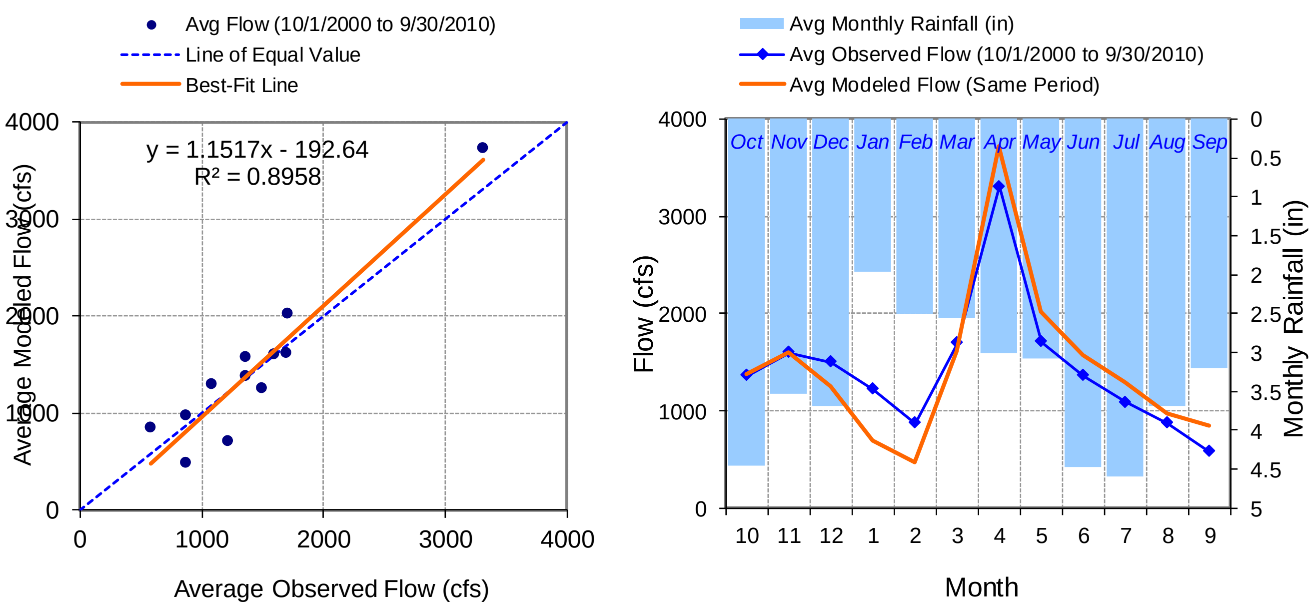


Figure F-18. Seasonal regression and temporal aggregate at USGS 04292500 Lamoille River at East Georgia, VT

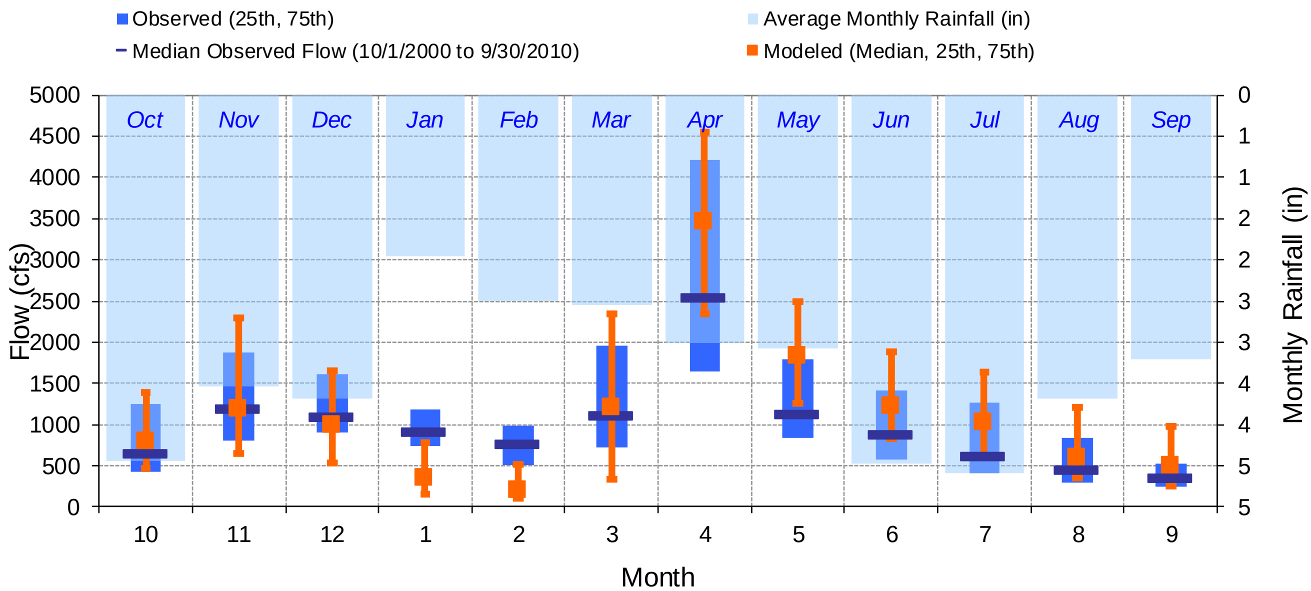


Figure F-19. Seasonal medians and ranges at USGS 04292500 Lamoille River at East Georgia, VT

Table F-5. Seasonal summary at USGS 04292500 Lamoille River at East Georgia, VT

MONTH	OBSERVED FLOW (CFS)				MODELED FLOW (CFS)			
	MEAN	MEDIAN	25TH	75TH	MEAN	MEDIAN	25TH	75TH
Oct	1357.71	656.00	419.00	1242.50	1375.42	802.88	461.12	1385.22
Nov	1596.59	1195.00	798.50	1870.00	1600.65	1196.11	654.20	2293.60
Dec	1498.13	1100.00	912.25	1617.50	1252.70	996.05	529.01	1646.55
Jan	1218.43	920.00	731.25	1180.00	695.92	356.32	156.30	773.66
Feb	868.91	768.00	507.50	993.75	477.83	207.03	104.05	516.57
Mar	1693.08	1115.00	720.00	1962.50	1609.31	1209.00	329.20	2347.98
Apr	3306.18	2535.00	1647.50	4215.00	3720.32	3459.95	2347.45	4548.53
May	1708.58	1130.00	832.25	1797.50	2023.00	1841.48	1262.41	2496.84
Jun	1360.81	878.00	580.50	1420.00	1573.33	1220.47	822.21	1887.48
Jul	1085.23	620.00	410.75	1272.50	1295.33	1029.78	592.84	1637.01
Aug	875.58	443.50	293.25	839.25	971.06	595.23	360.30	1203.70
Sep	579.88	359.00	246.00	525.00	843.42	505.00	255.63	982.19

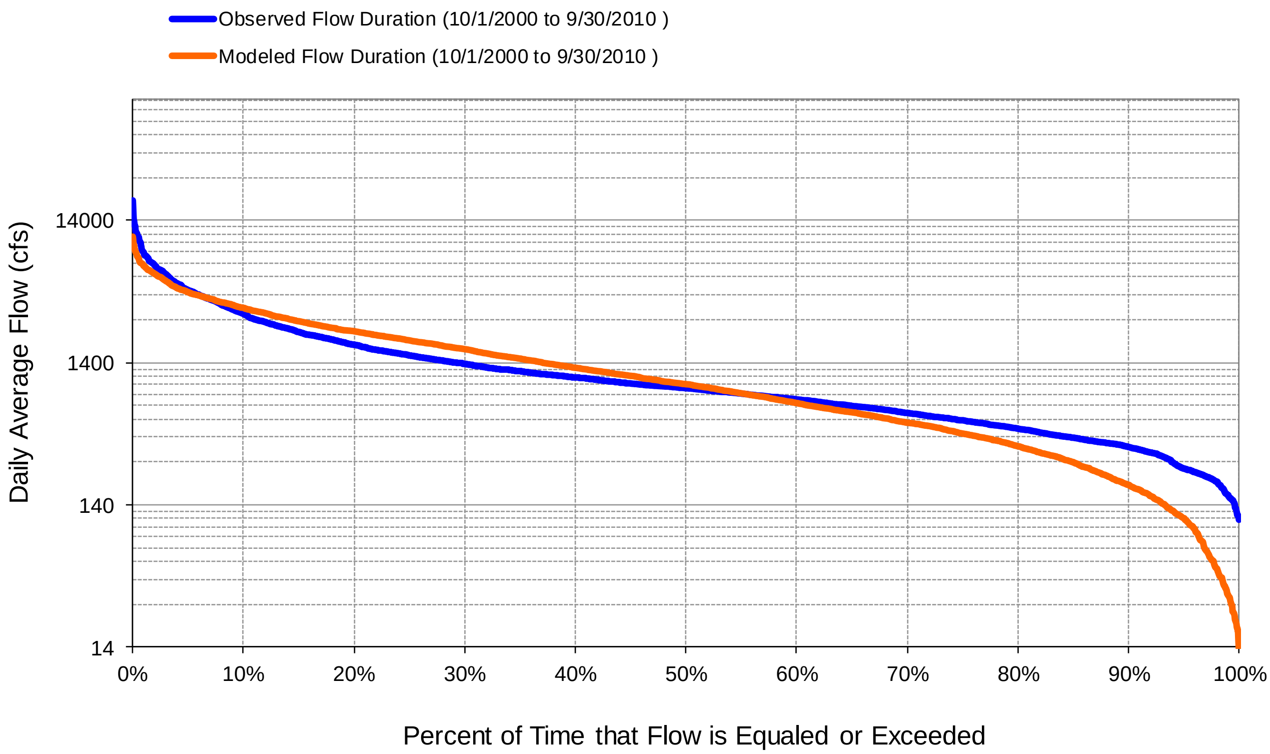


Figure F-20. Flow exceedence at USGS 04292500 Lamoille River at East Georgia, VT

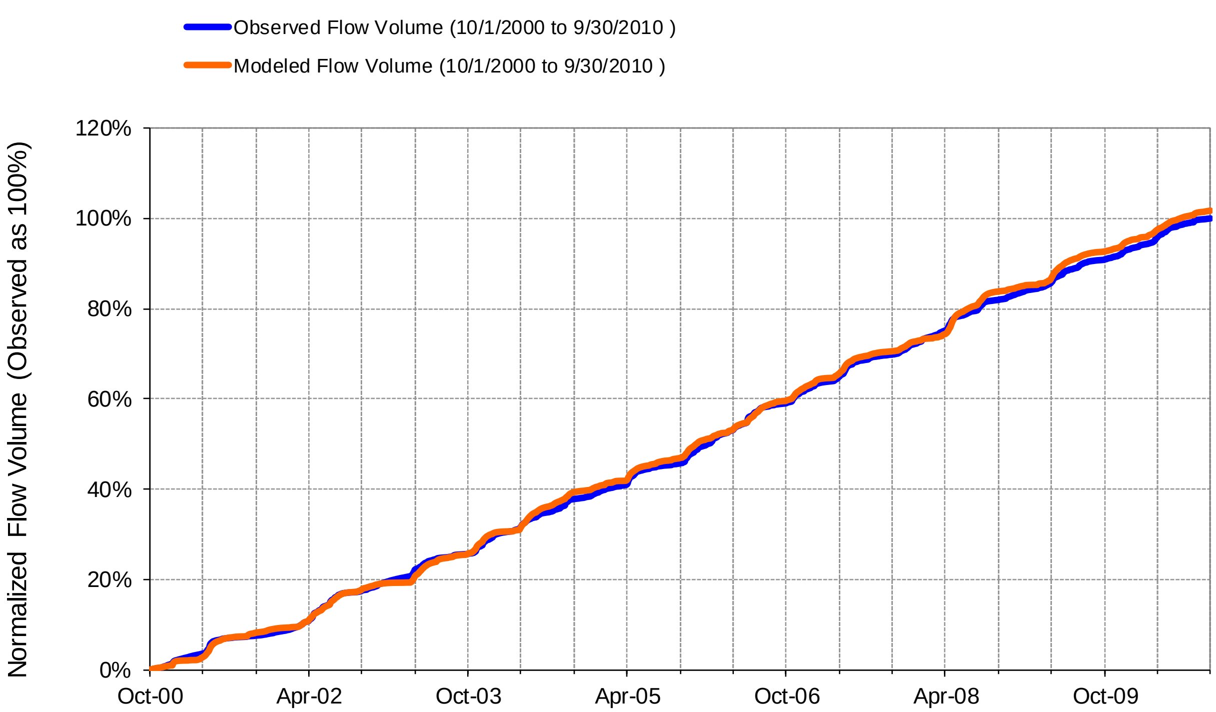


Figure F-21. Flow accumulation at USGS 04292500 Lamoille River at East Georgia, VT

Table F-6. Summary statistics at USGS 04292500 Lamoille River at East Georgia, VT

SWAT Simulated Flow		Observed Flow Gage	
REACH OUTFLOW FROM OUTLET 5 10-Year Analysis Period: 10/1/2000 - 9/30/2010 Flow volumes are (inches/year) for upstream drainage area		USGS 04292500 LAMOILLE RIVER AT EAST GEORGIA, VT Hydrologic Unit Code: 4150405 Latitude: 44.67921477 Longitude: -73.0726365 Drainage Area (sq-mi): 686	
Total Simulated In-stream Flow:	**28.82**	Total Observed In-stream Flow:	**28.32**
Total of simulated highest 10% flows:	**9.60**	Total of Observed highest 10% flows:	**10.66**
Total of Simulated lowest 50% flows:	**4.58**	Total of Observed Lowest 50% flows:	**5.48**
Simulated Summer Flow Volume (months 7-9):	**5.18**	Observed Summer Flow Volume (7-9):	**4.24**
Simulated Fall Flow Volume (months 10-12):	**7.02**	Observed Fall Flow Volume (10-12):	**7.40**
Simulated Winter Flow Volume (months 1-3):	**4.61**	Observed Winter Flow Volume (1-3):	**6.22**
Simulated Spring Flow Volume (months 4-6):	**12.01**	Observed Spring Flow Volume (4-6):	**10.46**
Total Simulated Storm Volume:	**8.25**	Total Observed Storm Volume:	**10.96**
Simulated Summer Storm Volume (7-9):	**1.57**	Observed Summer Storm Volume (7-9):	**1.90**

Errors (Simulated-Observed)	*Error Statistics*	*Recommended Criteria*		
Error in total volume:	1.75	10		
Error in 50% lowest flows:	-16.45	10		
Error in 10% highest flows:	-10.00	15		
Seasonal volume error - Summer:	22.23	30		
Seasonal volume error - Fall:	-5.09	>> 30		Clear
Seasonal volume error - Winter:	-25.99	30		
Seasonal volume error - Spring:	14.79	30		
Error in storm volumes:	-24.76	20		
Error in summer storm volumes:	-17.60	50		
Nash-Sutcliffe Coefficient of Efficiency, E:	0.618	Model accuracy increases		
Baseline adjusted coefficient (Garrick), E':	0.374	as E or E' approaches 1.0		
Monthly NSE	0.726			

USGS 04292500 Lamoille River at East Georgia, VT - Validation

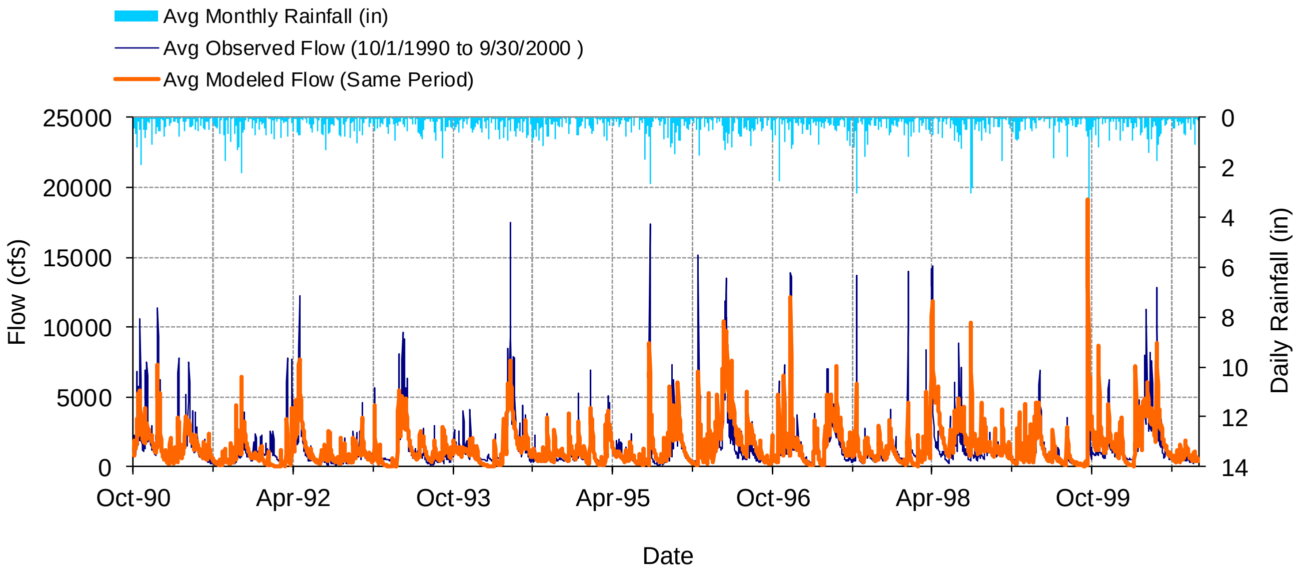


Figure F-22. Mean daily flow at USGS 04292500 Lamoille River at East Georgia, VT

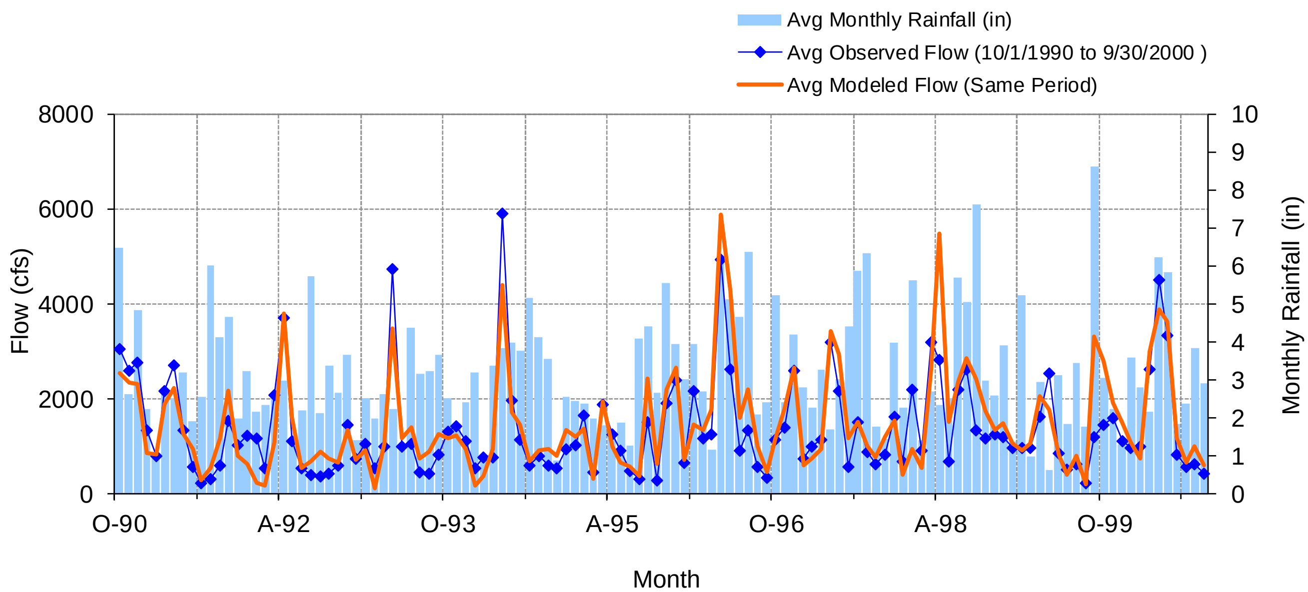
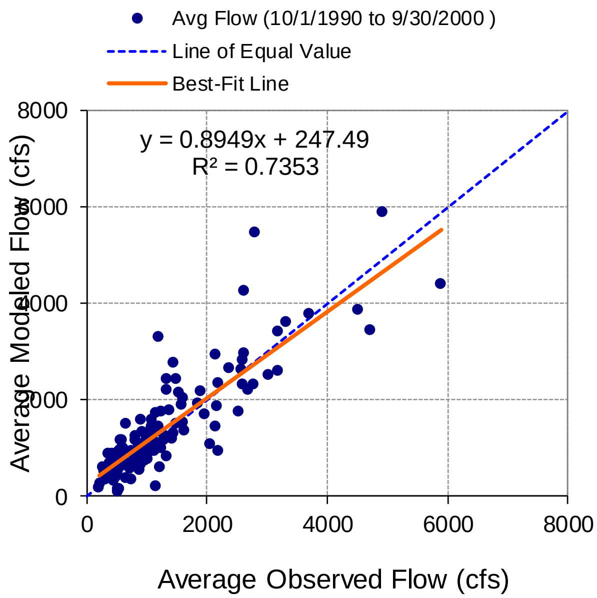


Figure F-23. Mean monthly flow at USGS 04292500 Lamoille River at East Georgia, VT



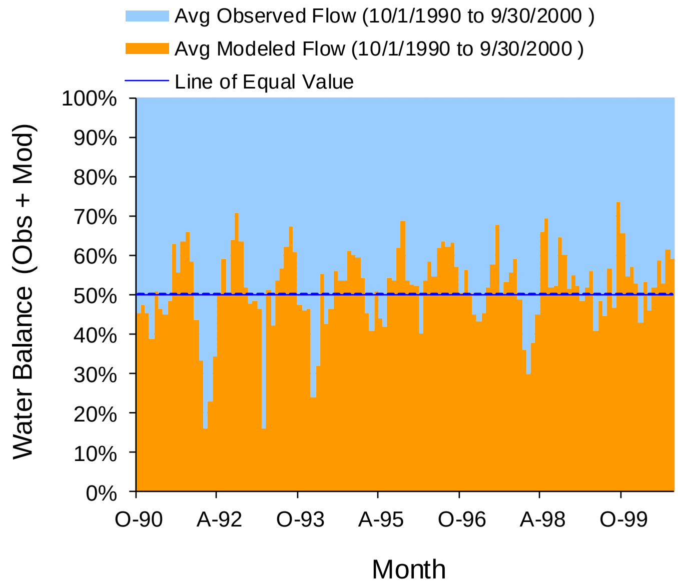
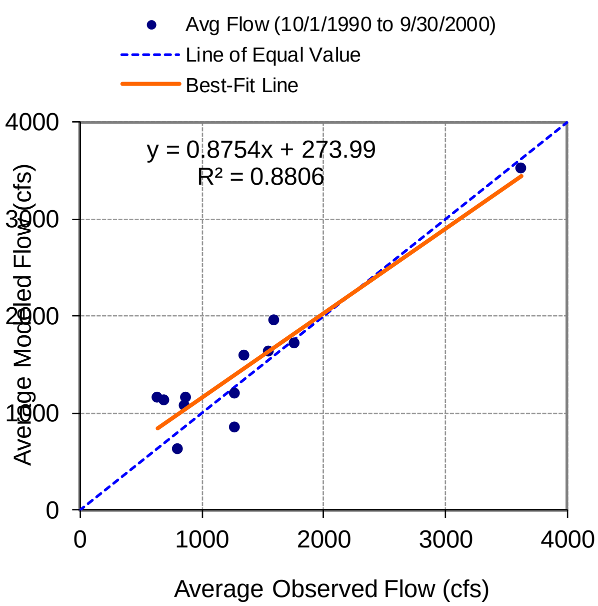


Figure F-24. Monthly flow regression and temporal variation at USGS 04292500 Lamoille River at East Georgia, VT



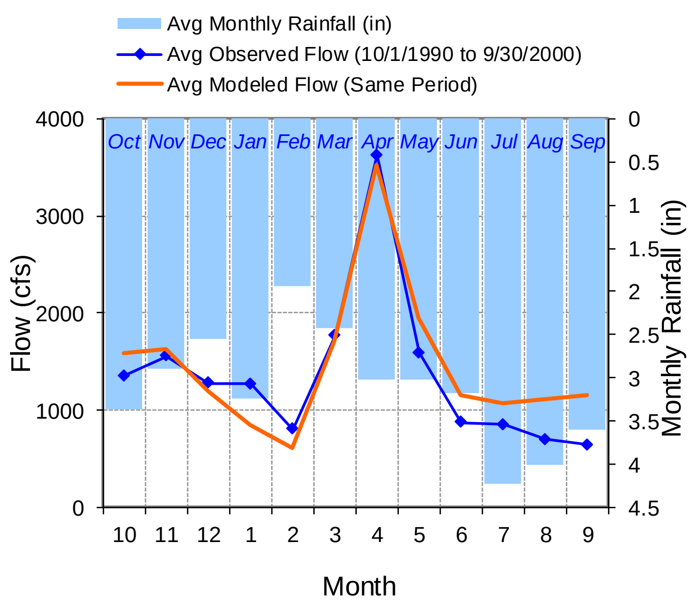


Figure F-25. Seasonal regression and temporal aggregate at USGS 04292500 Lamoille River at East Georgia, VT

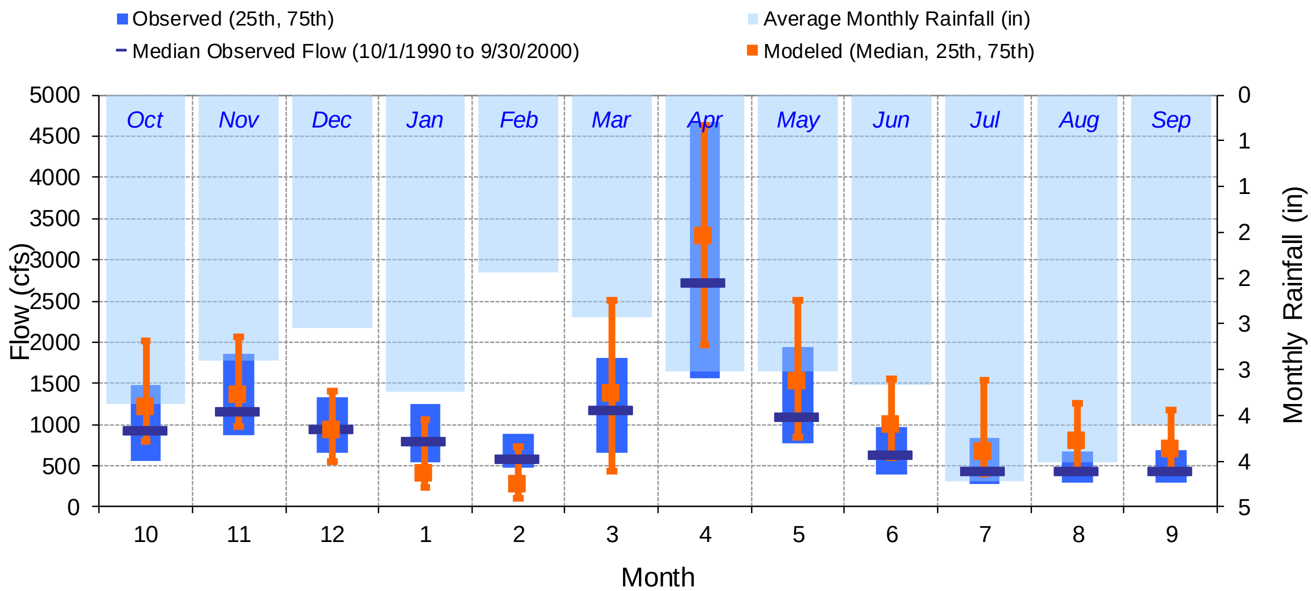


Figure F-26. Seasonal medians and ranges at USGS 04292500 Lamoille River at East Georgia, VT

Table F-7. Seasonal summary at USGS 04292500 Lamoille River at East Georgia, VT

MONTH	OBSERVED FLOW (CFS)				MODELED FLOW (CFS)			
	MEAN	MEDIAN	25TH	75TH	MEAN	MEDIAN	25TH	75TH
Oct	1350.22	926.00	563.00	1482.50	1585.33	1212.53	804.64	2012.05
Nov	1551.97	1155.00	873.50	1862.50	1628.08	1354.67	982.37	2066.35
Dec	1275.69	947.50	650.00	1325.00	1196.63	930.36	556.65	1413.65
Jan	1268.87	795.00	540.00	1247.50	843.72	395.35	231.49	1065.09
Feb	801.96	575.00	470.00	885.00	615.66	274.71	100.89	735.60
Mar	1762.54	1175.00	653.75	1817.50	1716.73	1376.39	432.16	2509.28
Apr	3622.89	2720.00	1567.50	4670.00	3523.34	3279.50	1964.20	4638.58
May	1590.12	1090.00	770.50	1937.50	1945.15	1529.30	838.64	2510.96
Jun	870.74	635.50	401.50	974.25	1150.83	987.40	599.55	1562.14
Jul	854.57	427.00	274.50	840.75	1067.44	661.09	397.38	1541.04
Aug	696.61	437.00	287.00	665.75	1119.24	790.17	457.41	1261.88
Sep	640.89	433.00	296.25	697.25	1153.95	704.88	448.76	1180.66

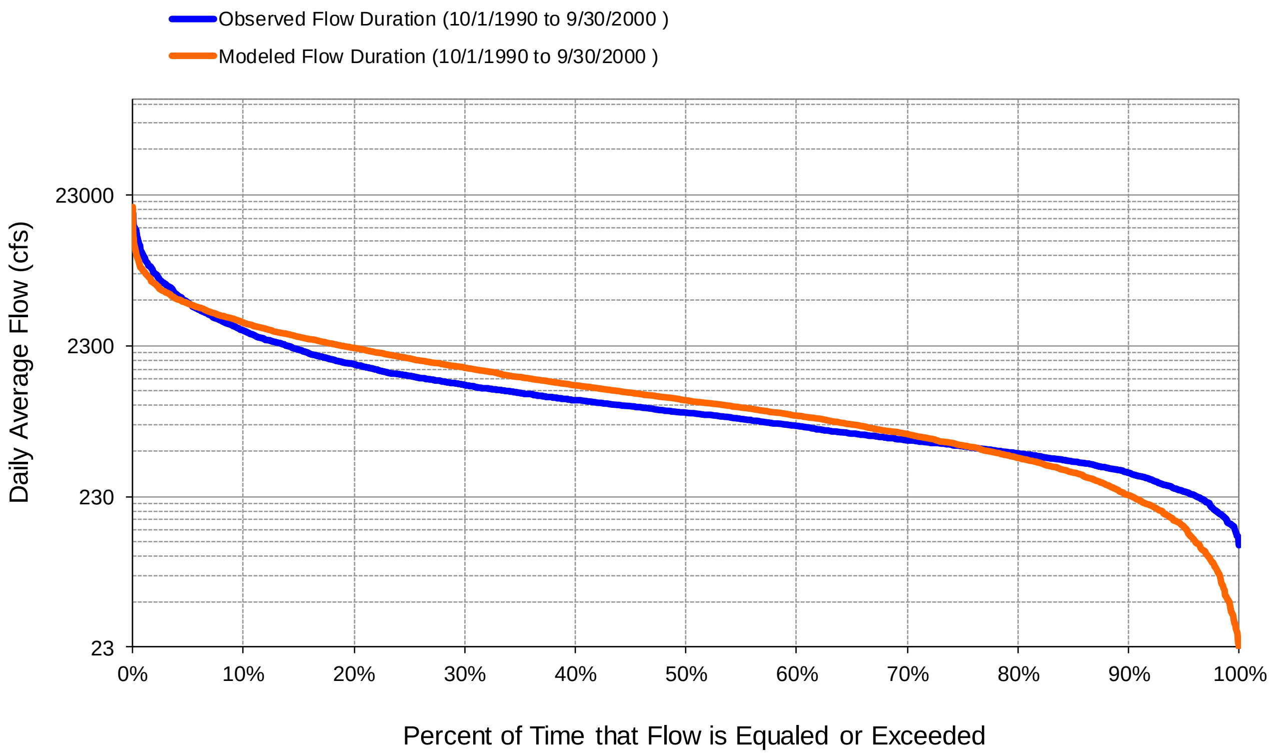


Figure F-27. Flow exceedence at USGS 04292500 Lamoille River at East Georgia, VT

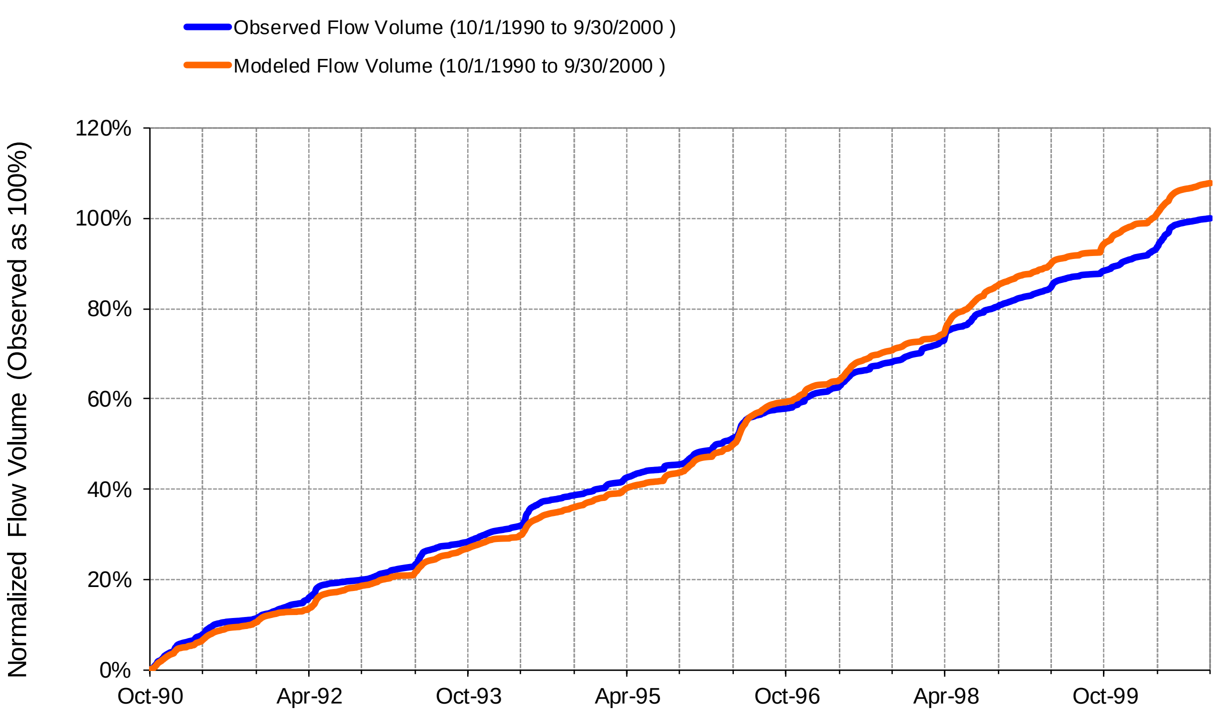


Figure F-28. Flow accumulation at USGS 04292500 Lamoille River at East Georgia, VT

Table F-8. Summary statistics at USGS 04292500 Lamoille River at East Georgia, VT

SWAT Simulated Flow		Observed Flow Gage		
REACH OUTFLOW FROM OUTLET 5 10-Year Analysis Period: 10/1/1990 - 9/30/2000 Flow volumes are (inches/year) for upstream drainage area		USGS 04292500 LAMOILLE RIVER AT EAST GEORGIA, VT Hydrologic Unit Code: 4150405 Latitude: 44.67921477 Longitude: -73.0726365 Drainage Area (sq-mi): 686		
Total Simulated In-stream Flow:	**28.99**	Total Observed In-stream Flow:		**26.89**
Total of simulated highest 10% flows:	**9.82**	Total of Observed highest 10% flows:		**10.71**
Total of Simulated lowest 50% flows:	**5.06**	Total of Observed Lowest 50% flows:		**4.91**
Simulated Summer Flow Volume (months 7-9):	**5.55**	Observed Summer Flow Volume (7-9):		**3.65**
Simulated Fall Flow Volume (months 10-12):	**7.32**	Observed Fall Flow Volume (10-12):		**6.94**
Simulated Winter Flow Volume (months 1-3):	**5.25**	Observed Winter Flow Volume (1-3):		**6.32**
Simulated Spring Flow Volume (months 4-6):	**10.87**	Observed Spring Flow Volume (4-6):		**9.98**
Total Simulated Storm Volume:	**8.45**	Total Observed Storm Volume:		**10.23**
Simulated Summer Storm Volume (7-9):	**1.90**	Observed Summer Storm Volume (7-9):		**1.70**
Errors (Simulated-Observed)	*Error Statistics*	*Recommended Criteria*		
Error in total volume:	7.81	10		
Error in 50% lowest flows:	2.92	10		
Error in 10% highest flows:	-8.24	15		
Seasonal volume error - Summer:	52.13	30		
Seasonal volume error - Fall:	5.57	>> 30		Clear
Seasonal volume error - Winter:	-17.03	30		
Seasonal volume error - Spring:	8.92	30		
Error in storm volumes:	-17.36	20		
Error in summer storm volumes:	11.96	50		
Nash-Sutcliffe Coefficient of Efficiency, E:	0.596	Model accuracy increases		
Baseline adjusted coefficient (Garrick), E':	0.387	as E or E' approaches 1.0		
Monthly NSE	0.690			

TSS and TP distribution by channel and upland sources

Table F-9. TSS and TP distribution by source categories

Source	TSS		TP	
	Load(mt/year)	Percentage (%)	Load (kg/year)	Percentage (%)
Upland	62,957	75.6	57,292	78.4
Stream	20,343	24.4	15,766	21.6
Total	**83,300**	**100.0**	**73,058**	**100.0**

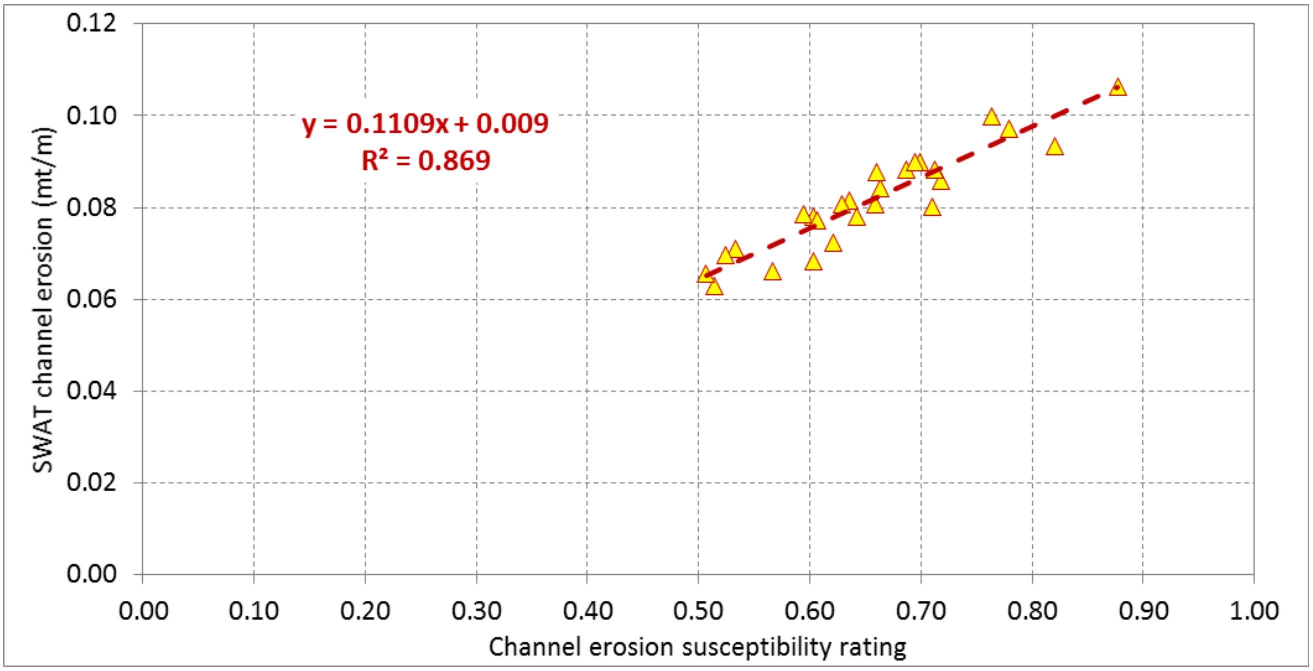


Figure F-29. SWAT simulated channel erosion relative to channel erosion susceptibility rating

TP distribution by landuse from upland sources

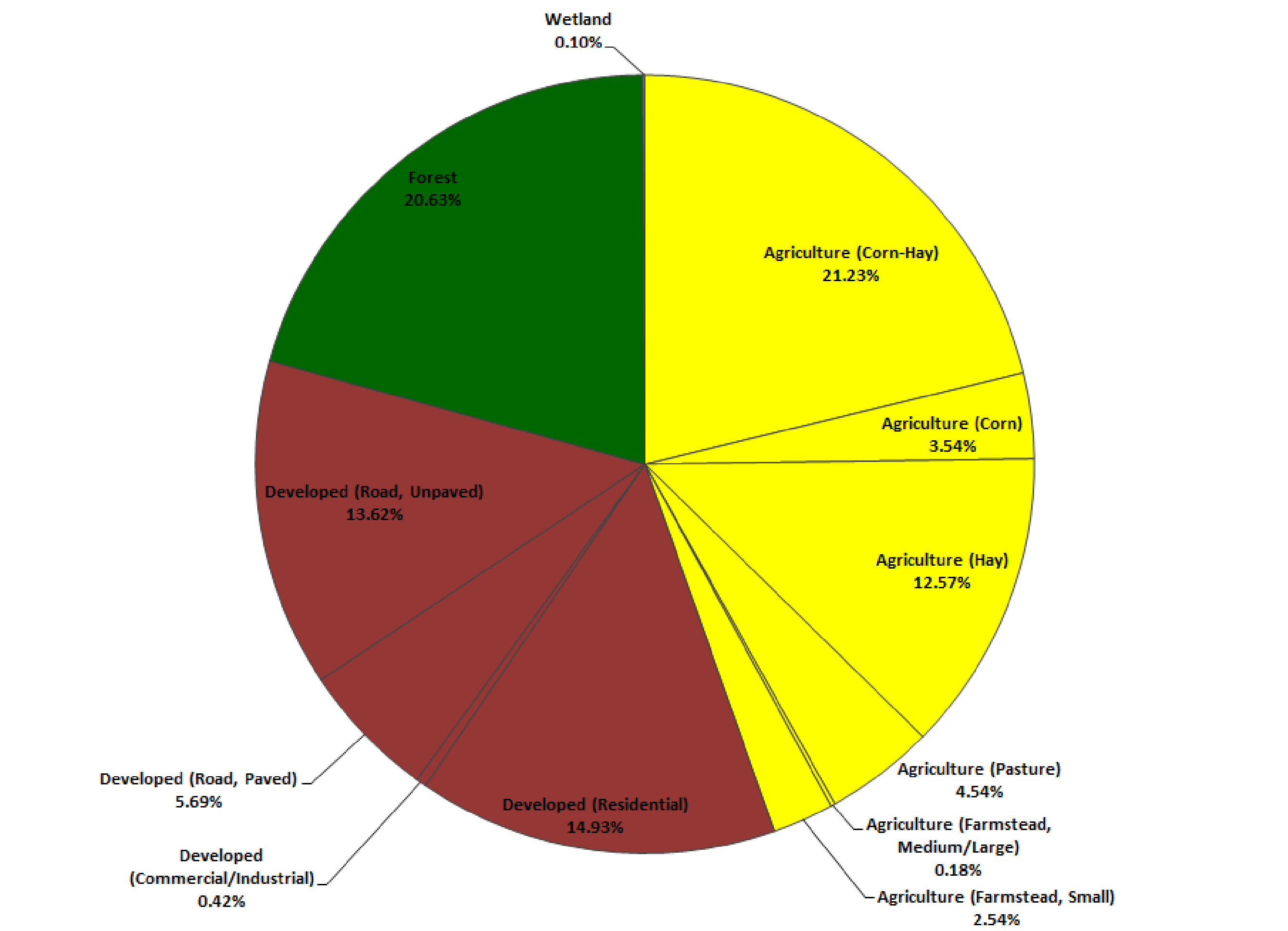


Figure F-30. Distribution of simulated total upland TP loads by landuse categories

Table F-10. TP export rates (kg/ha/yr) by landuse categories for the 30 year simulation period

Landuse	Classification	Area (ha)	Area (%)	Mean	Min	Q_{25}	Q_{50}	Q_{75}	Max
Agriculture	Corn-Hay	6,287	3.38	**1.93**	0.09	1.12	1.91	2.75	4.74
	Corn	1,015	0.55	**2.00**	0.76	1.37	1.84	2.45	4.28
	Hay	8,286	4.45	**0.87**	0.45	0.61	0.81	1.08	1.87
	Pasture	2,001	1.07	**1.30**	0.77	0.98	1.27	1.50	2.45
	Farmstead, Medium/Large	33	0.02	**3.11**	1.57	2.36	2.88	3.83	5.08
	Farmstead, Small	481	0.26	**3.03**	1.35	2.20	3.00	3.74	5.02
Urban	Residential	9,087	4.88	**0.94**	0.70	0.79	0.92	1.05	1.36
	Commercial/Industrial	125	0.07	**1.92**	1.56	1.77	1.87	2.03	2.38
	Road, Paved	1,614	0.87	**2.02**	1.73	1.93	1.97	2.09	2.42
	Road, Unpaved	1,537	0.83	**5.08**	4.44	4.88	4.97	5.28	6.03
Forest	Forest	154,806	83.14	**0.08**	0.04	0.06	0.07	0.08	0.12
Wetland	Wetland	932	0.50	**0.06**	0.02	0.04	0.06	0.08	0.12

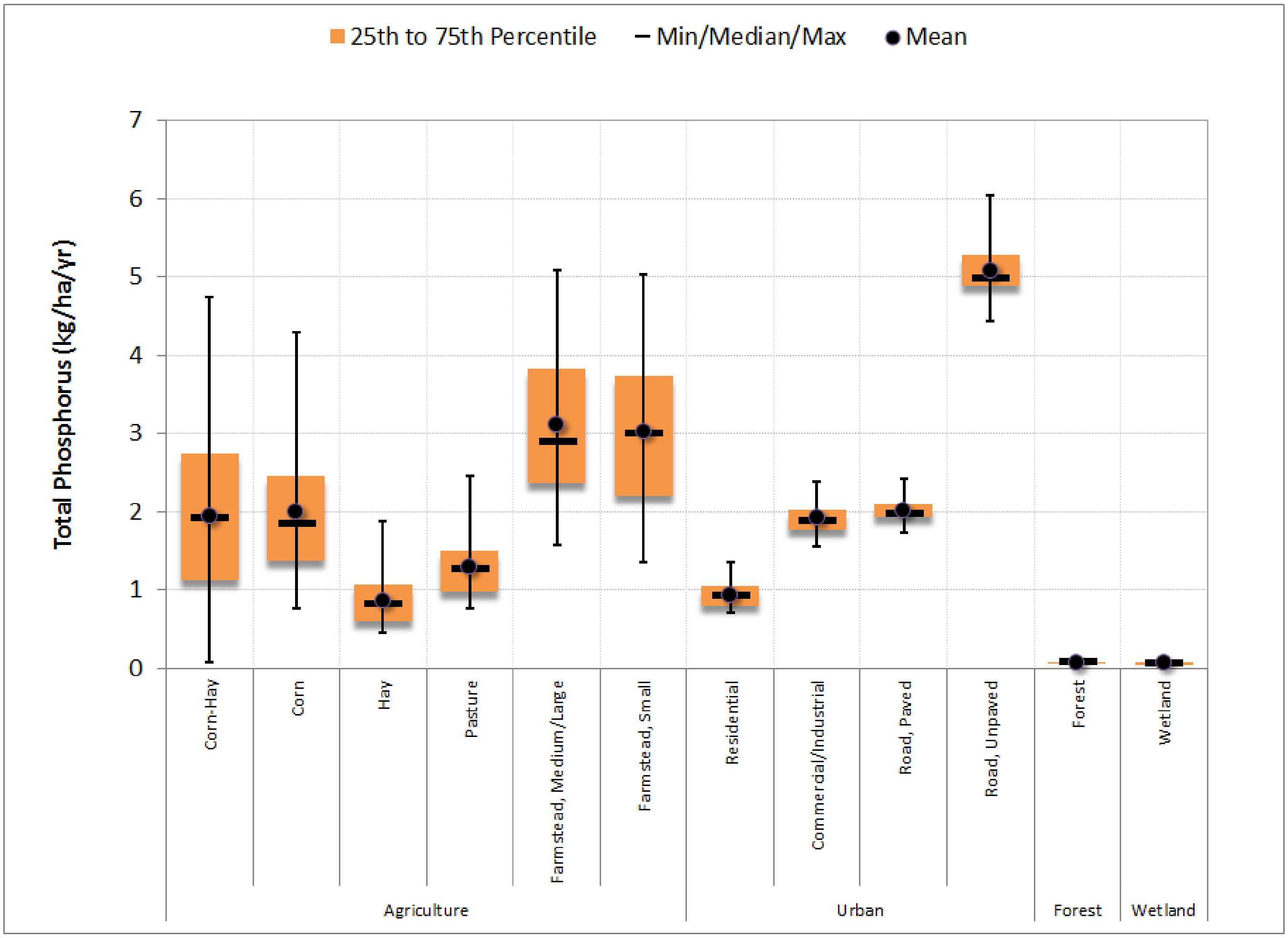


Figure F-31. TP export rates (kg/ha/yr) by landuse categories for the 30 year simulation period

Table F-11. TP export rates (kg/ha/yr) for the residential landuse categories for the 30 year simulation period

Residential Category	Area (ha)	Area (%)	Mean	Min	Q25	Q50	Q75	Max
Low Density	5,186	65.37	**0.65**	0.39	0.50	0.61	0.77	1.02
Medium Density	2,227	28.06	**0.92**	0.64	0.73	0.94	1.03	1.41
High Density	521	6.57	**1.45**	1.08	1.25	1.44	1.59	1.98
Total	7,934	100.00	**0.77**	0.51	0.61	0.75	0.90	1.20

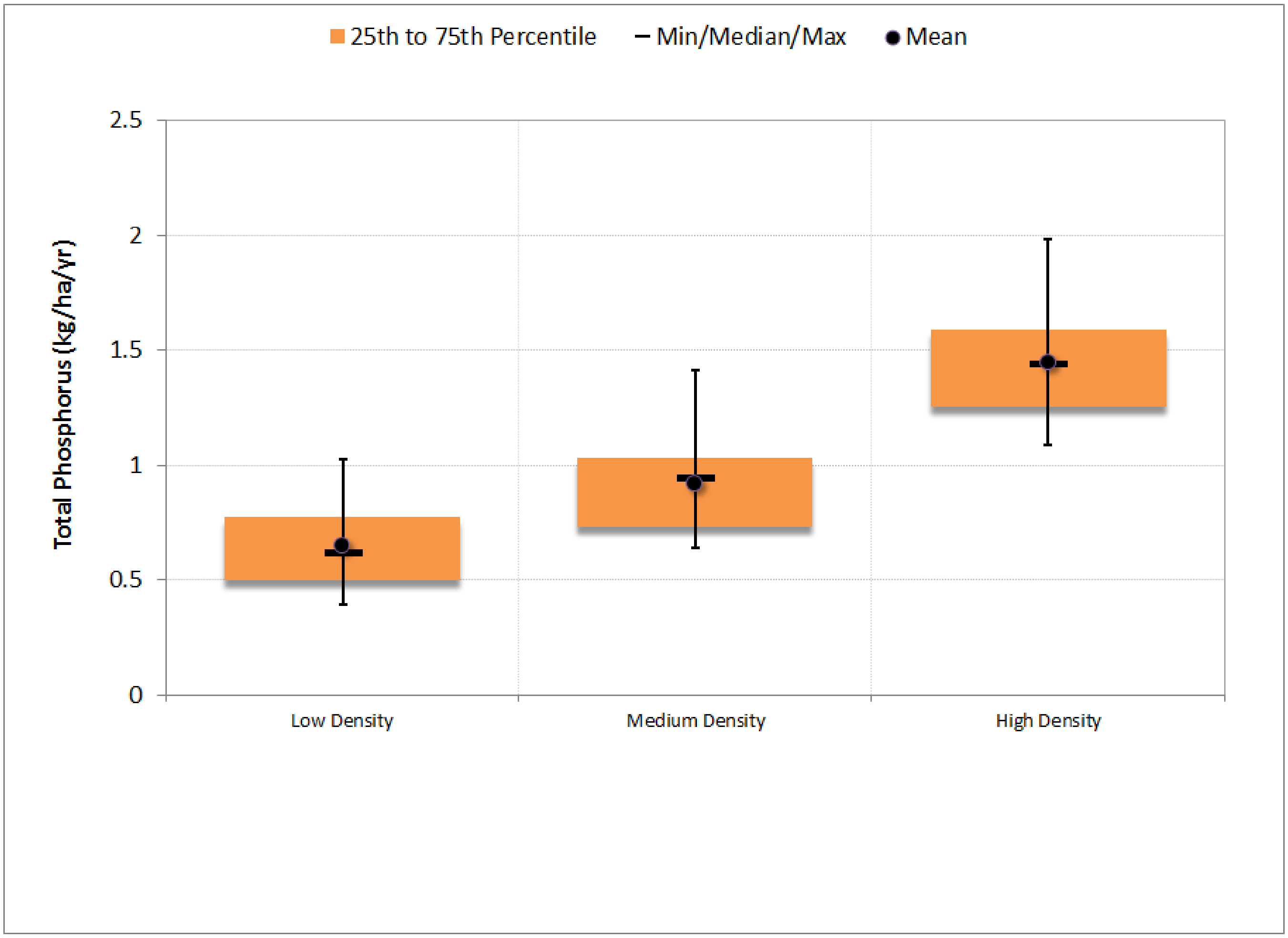


Figure F-32. TP export rates (kg/ha/yr) for the residential landuse categories for the 30 year simulation period

Segmented Regression

Table F-12. Summary statistics

Statistic	Calibration		Validation	
	TSS	TP	TSS	TP
Average absolute error (%)	48.1	50.2	54.6	66.1
Median absolute error (%)	18.2	31.6	14.9	45.9
Regression error (%)	14.2	-9.5	17.8	-22.5
NSE	0.581	0.561	0.601	0.310
NSE'	0.521	0.375	0.521	0.284

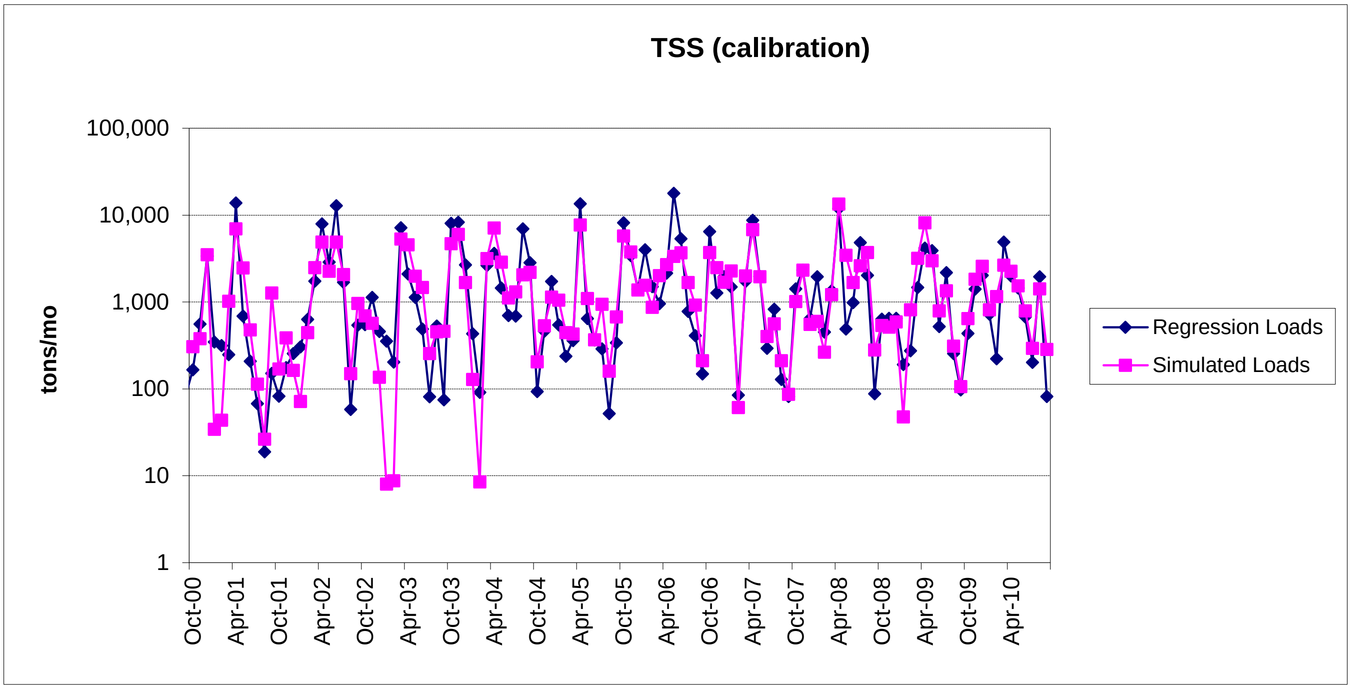


Figure F-33. Monthly simulated and estimated TSS load at Lamoille River at East Georgia, VT (calibration period)

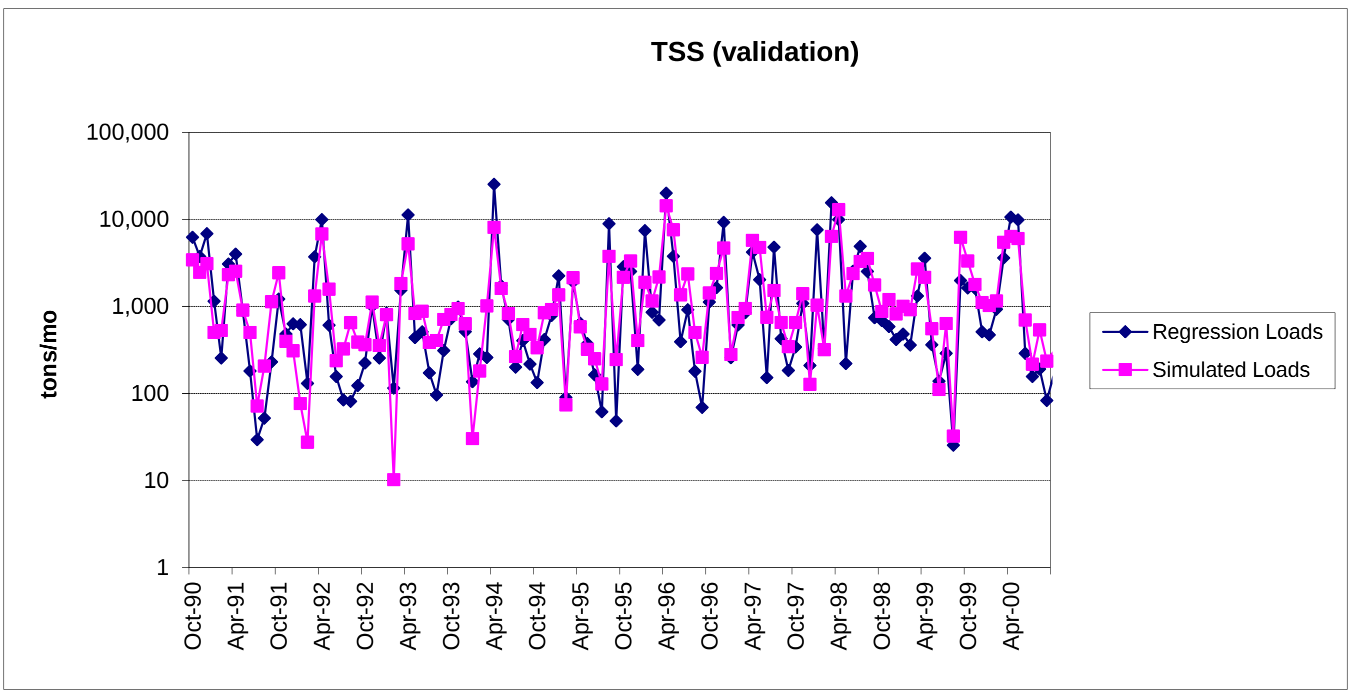


Figure F-34. Monthly simulated and estimated TSS load at Lamoille River at East Georgia, VT (validation period)

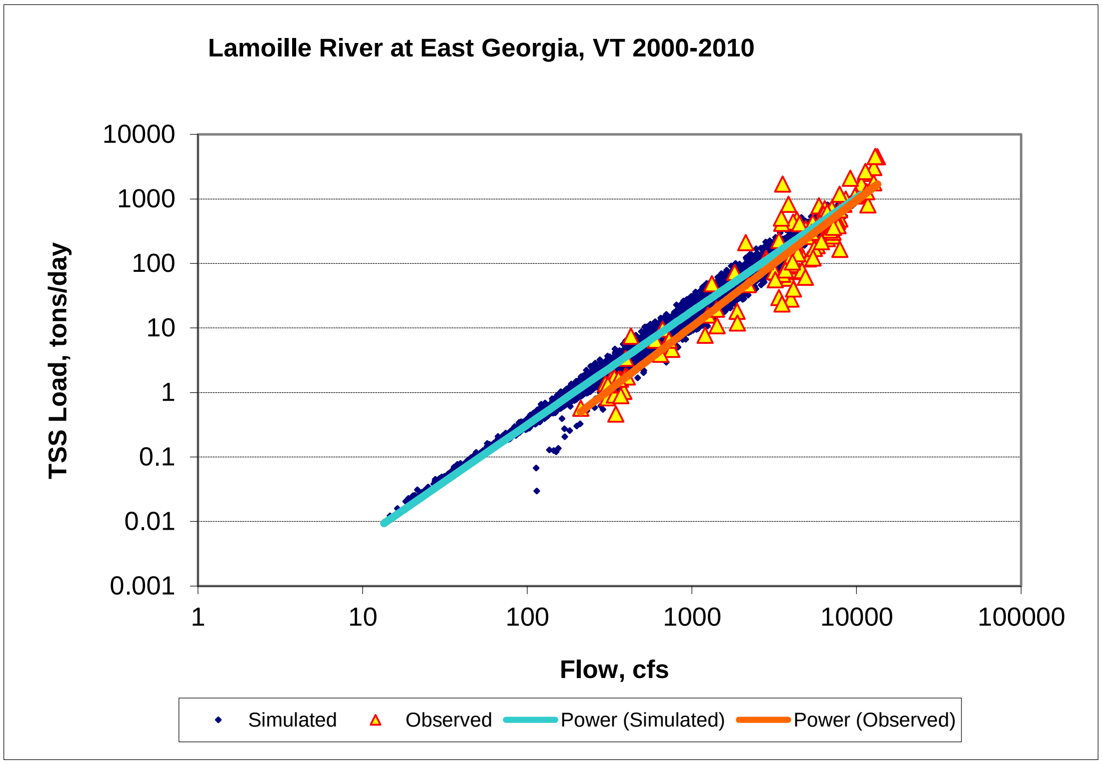


Figure F-35. Power plot of simulated and observed TSS load vs flow at Lamoille River at East Georgia, VT (calibration period)

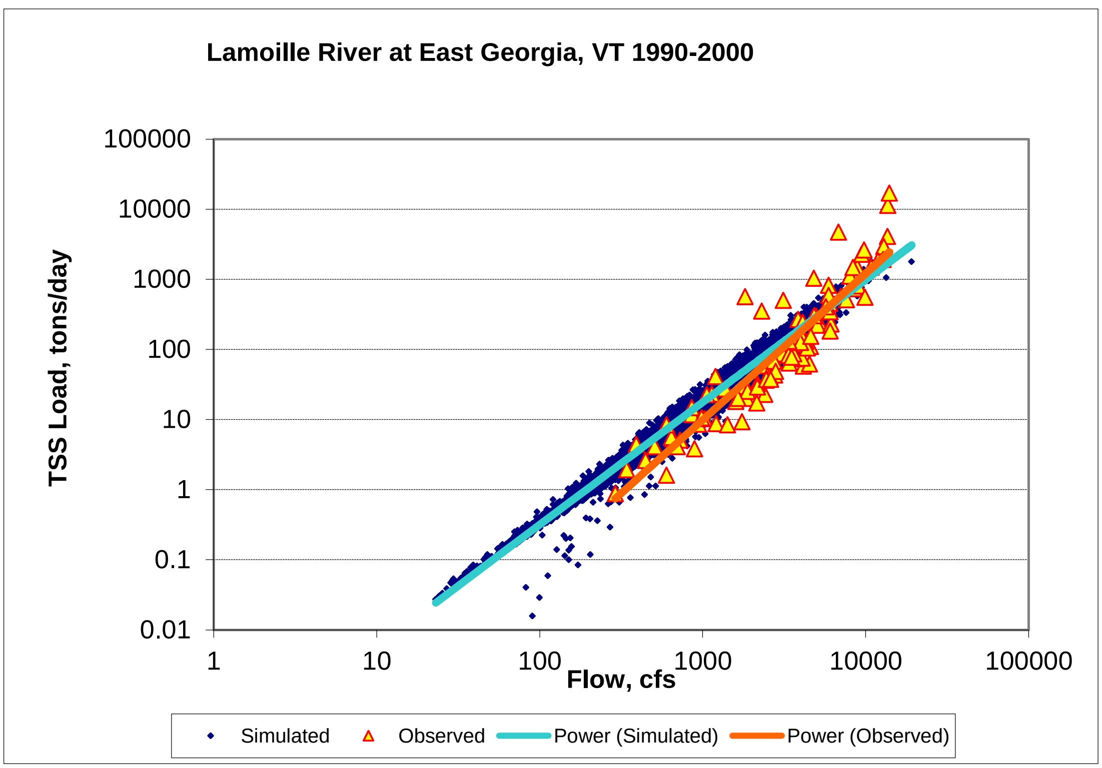


Figure F-36. Power plot of simulated and observed TSS load vs flow at Lamoille River at East Georgia, VT (validation period)

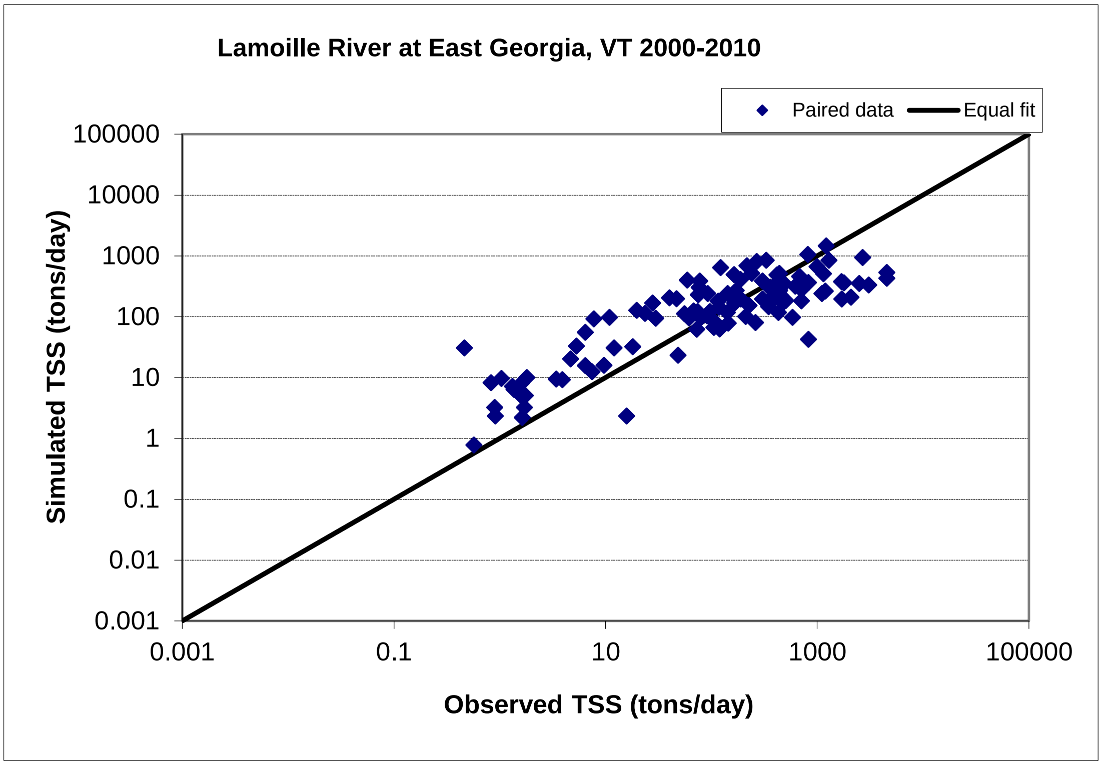


Figure F-37. Paired simulated vs observed TSS load at Lamoille River at East Georgia, VT (calibration period)

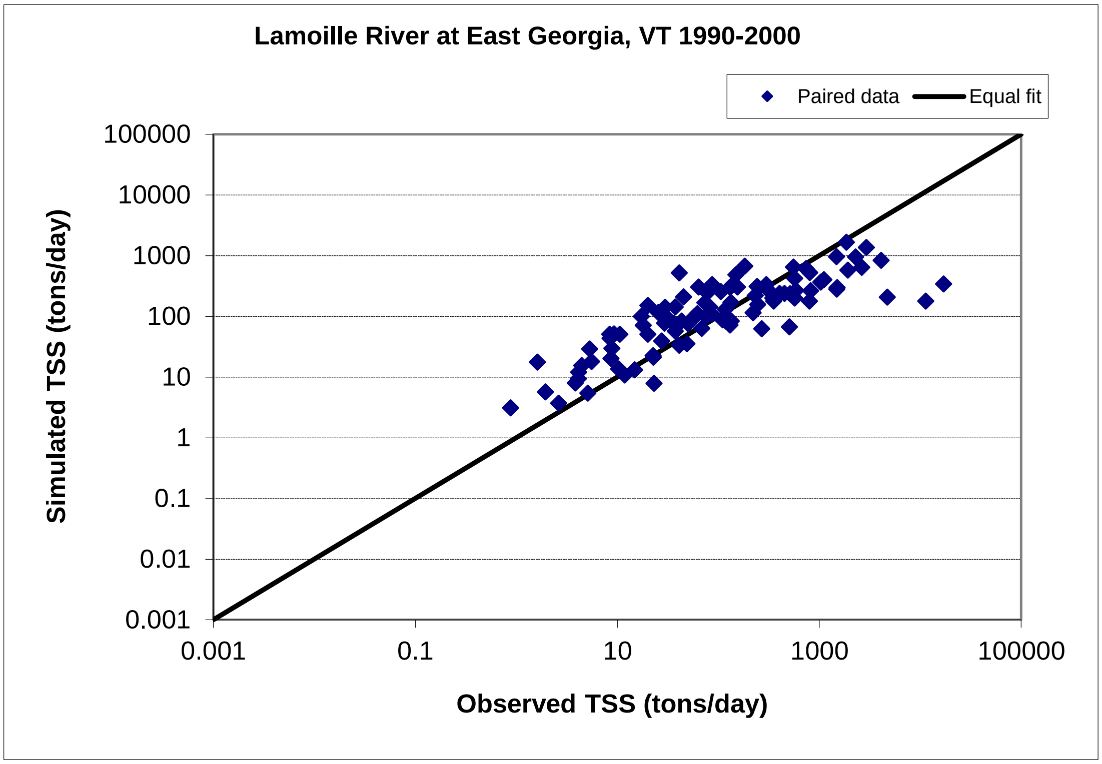


Figure F-38. Paired simulated vs observed TSS load at Lamoille River at East Georgia, VT (validation period)

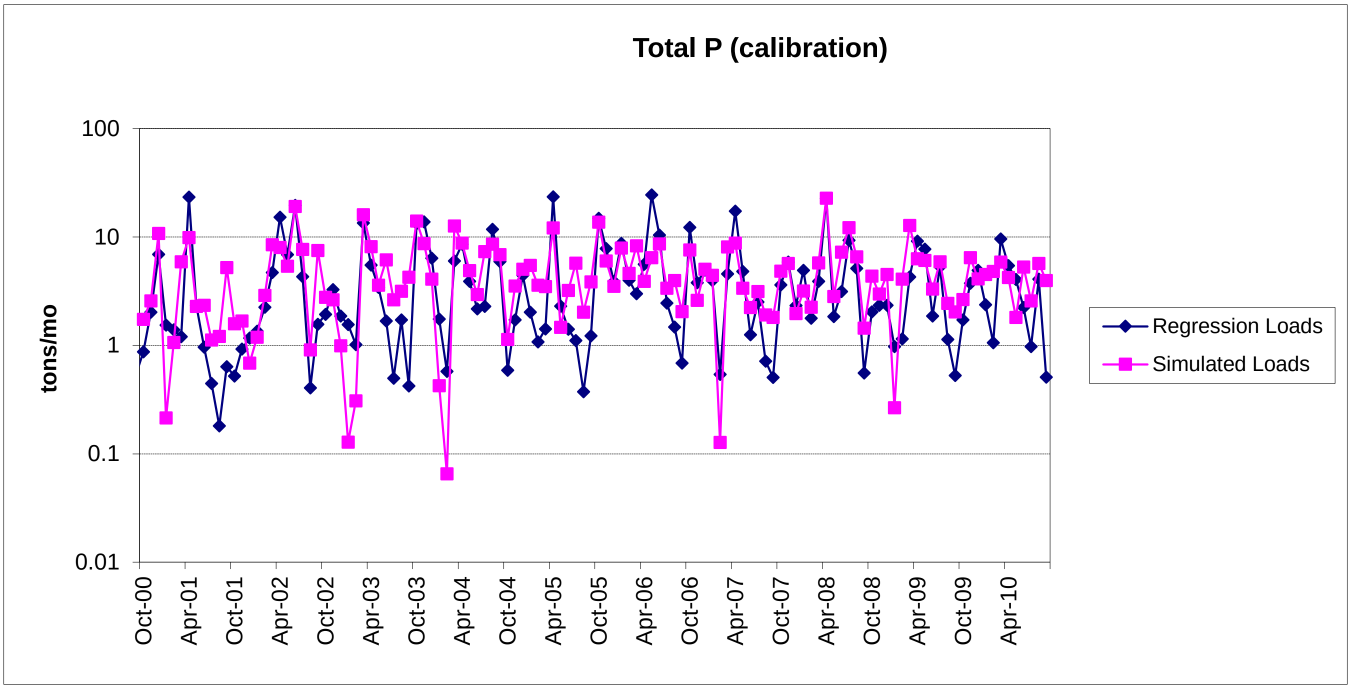


Figure F-39. Monthly simulated and estimated TP load at Lamoille River at East Georgia, VT (calibration period)

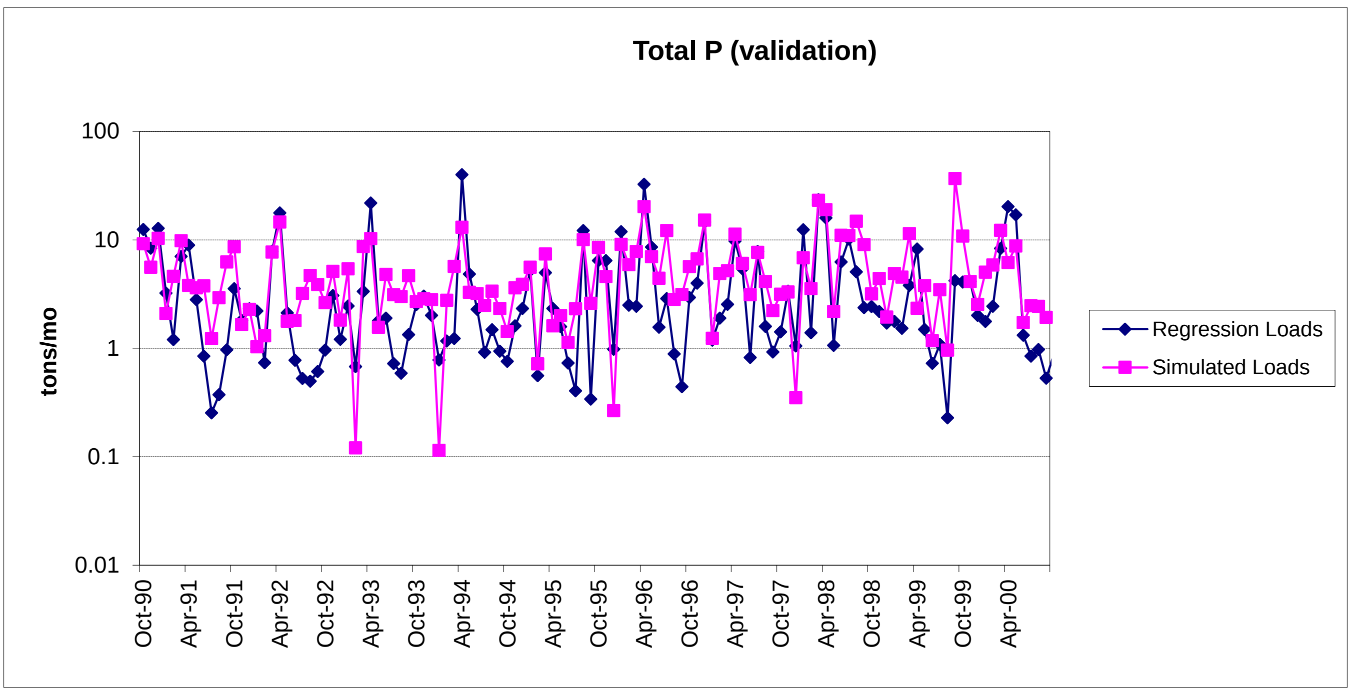


Figure F-40. Monthly simulated and estimated TP load at Lamoille River at East Georgia, VT (validation period)

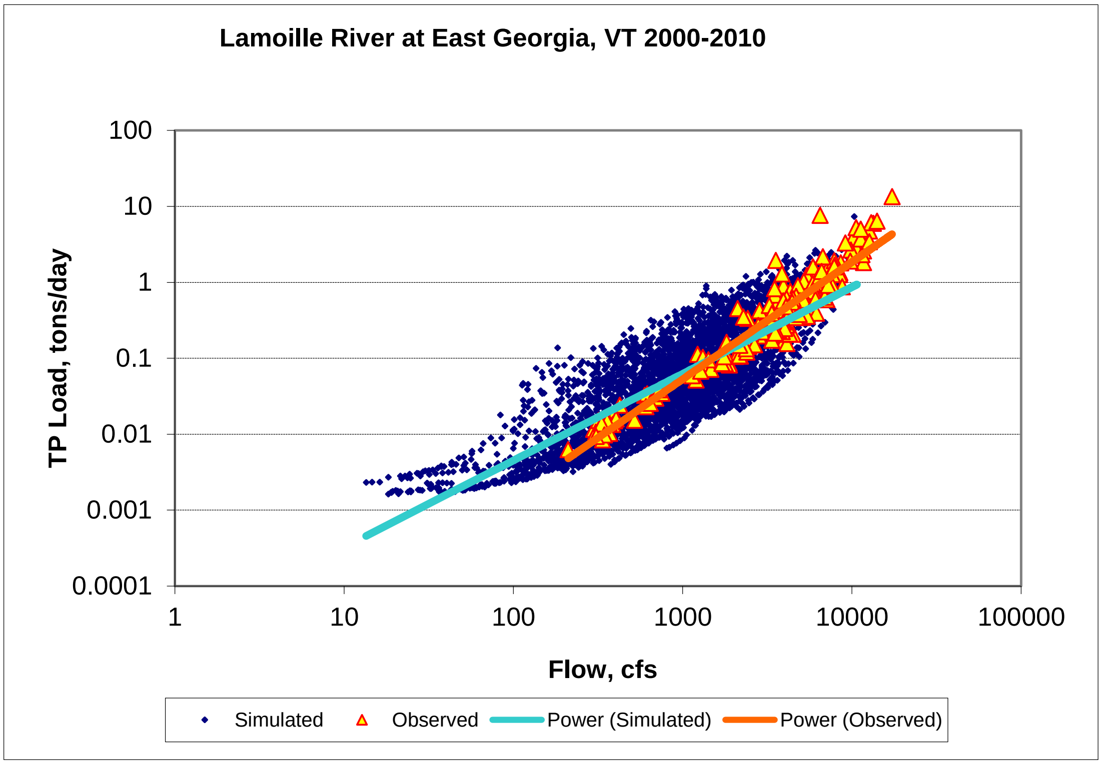


Figure F-41. Power plot of simulated and observed TP load vs flow at Lamoille River at East Georgia, VT (calibration period)

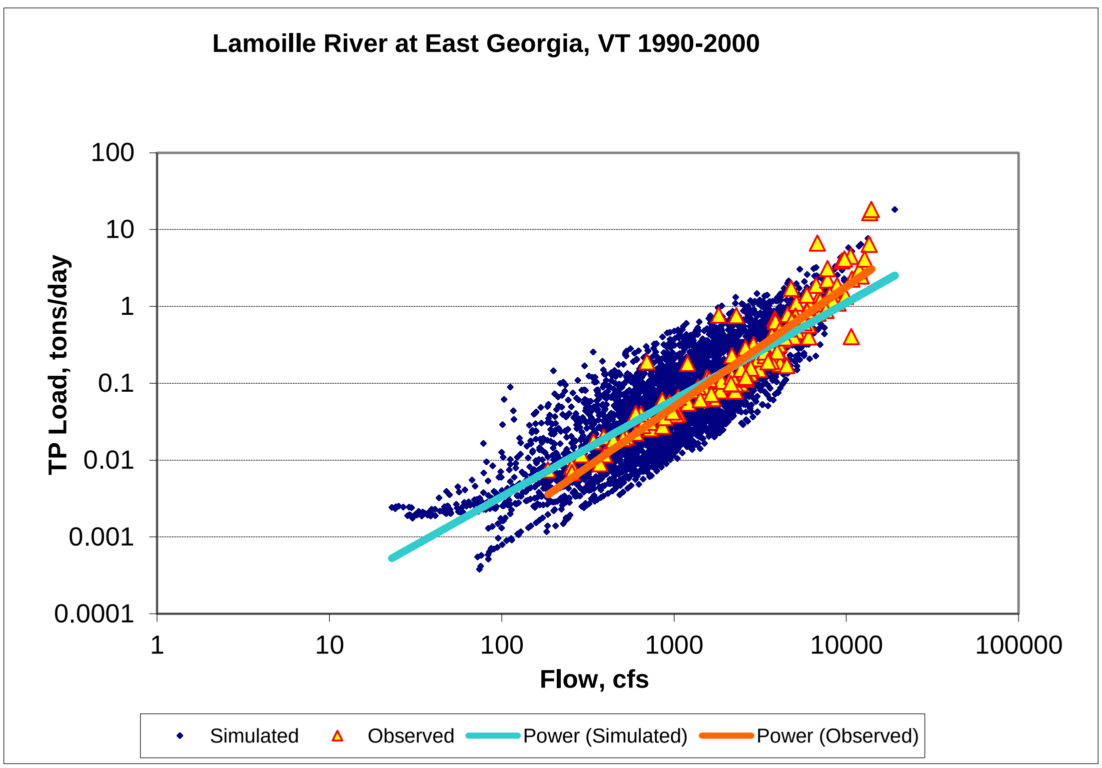


Figure F-42. Power plot of simulated and observed TP load vs flow at Lamoille River at East Georgia, VT (validation period)

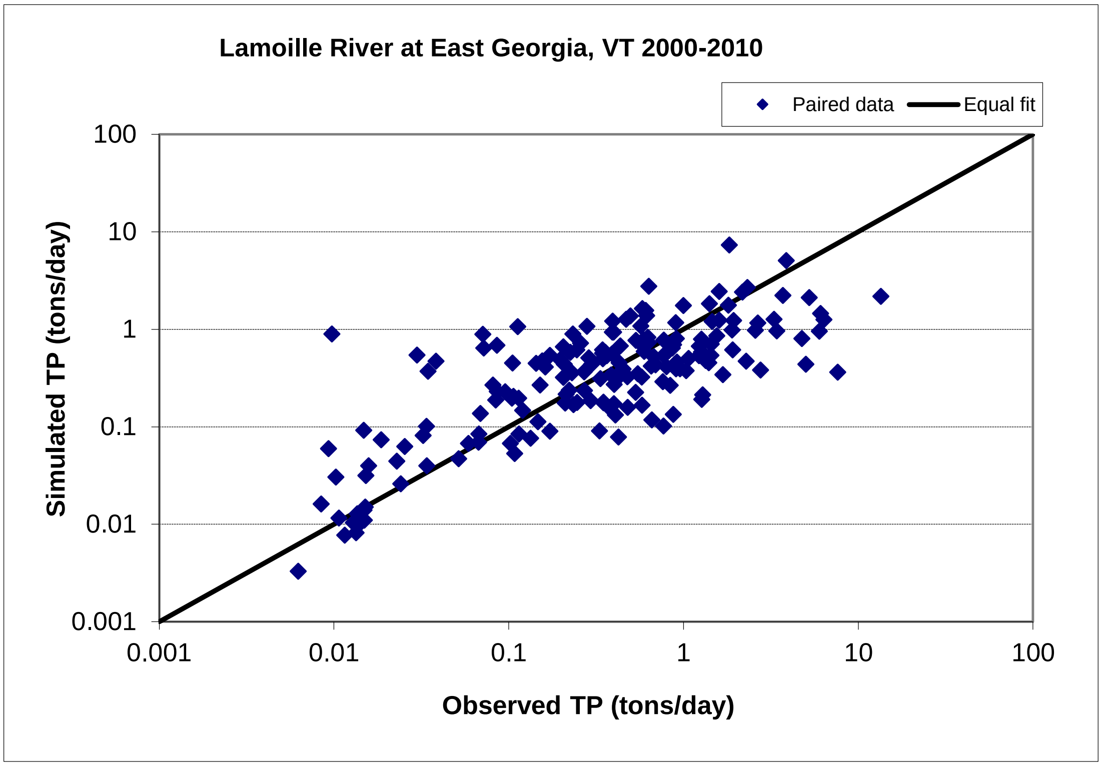


Figure F-43. Paired simulated vs observed TP load at Lamoille River at East Georgia, VT (calibration period)

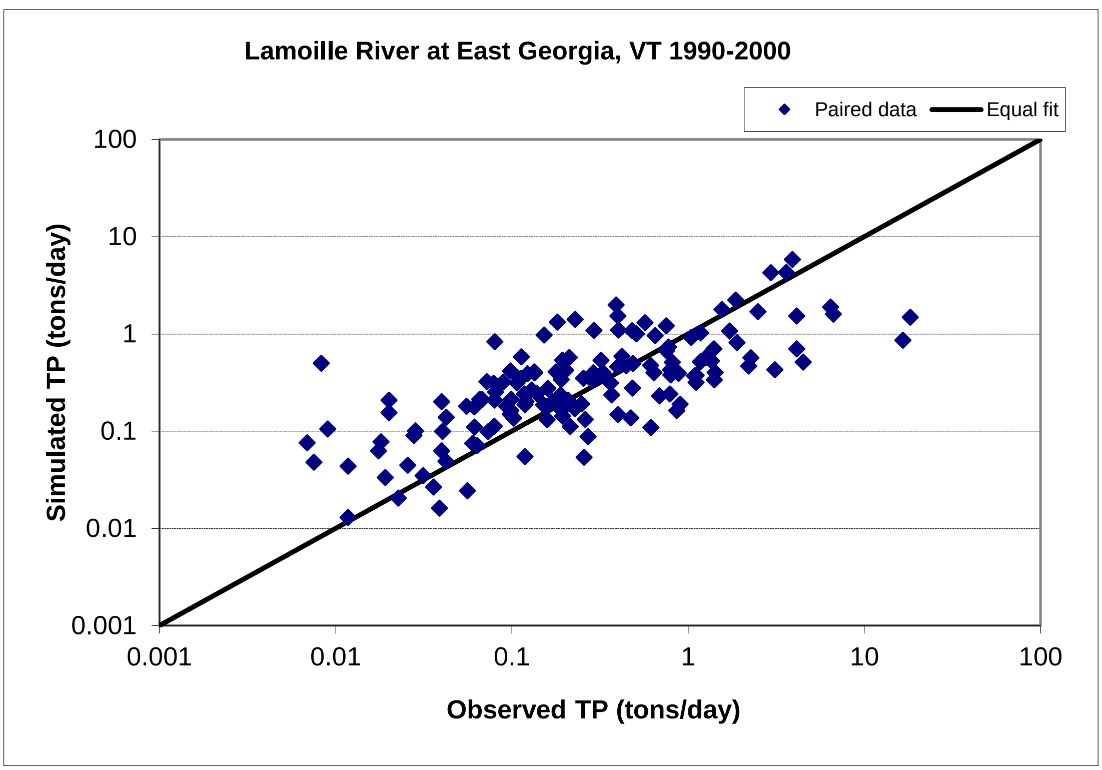


Figure F-44. Paired simulated vs observed TP load at Lamoille River at East Georgia, VT (validation period)

Comparison of simulated SWAT TP loads with FLUX estimates

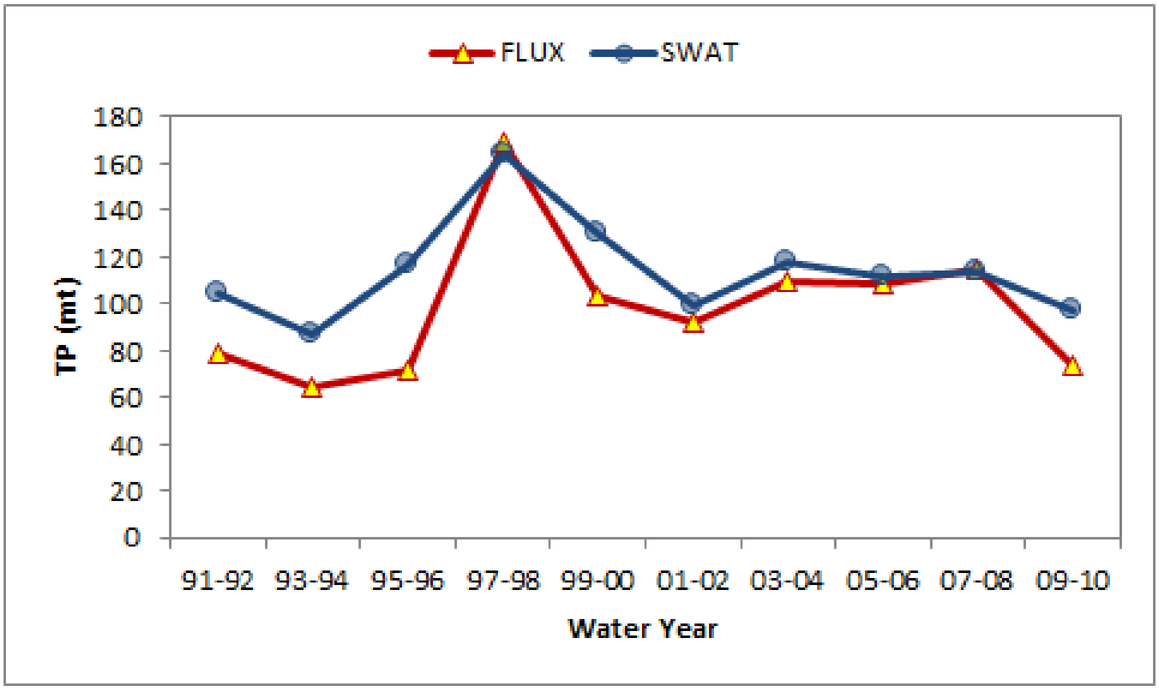


Figure F-45. Bi-annual TP loads on a water year basis as simulated by SWAT and estimated by FLUX (FLUX estimates from Smeltzer et al., 2009)

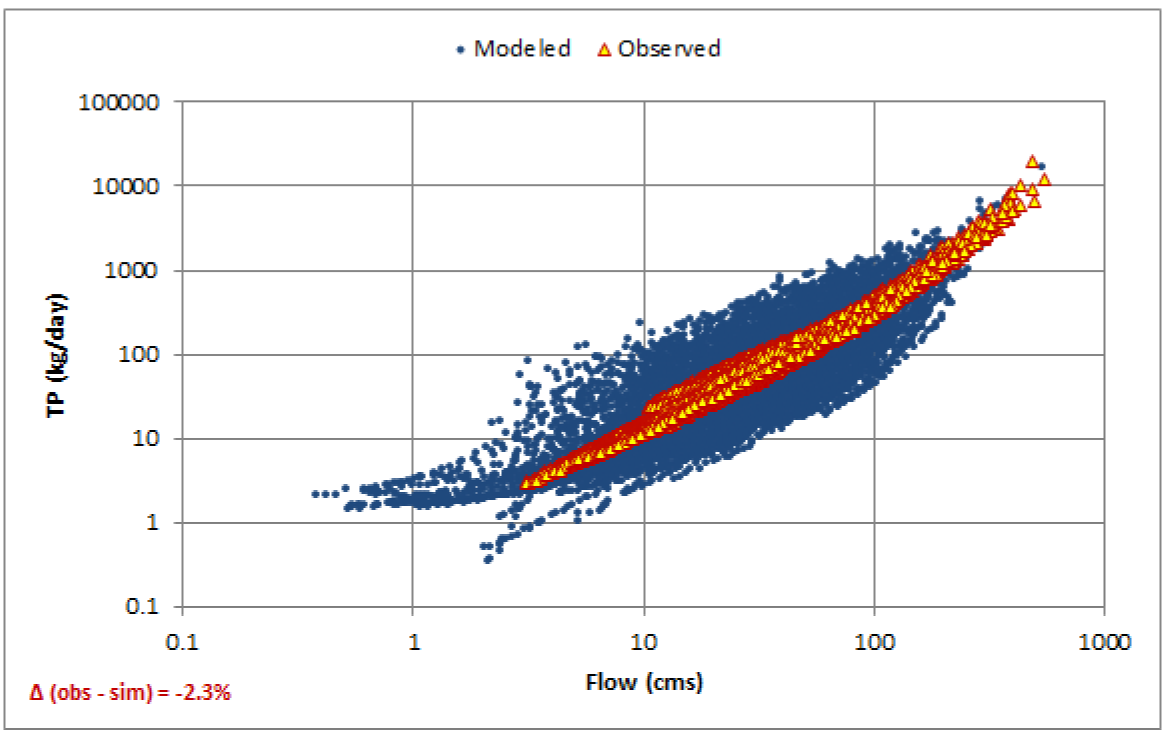
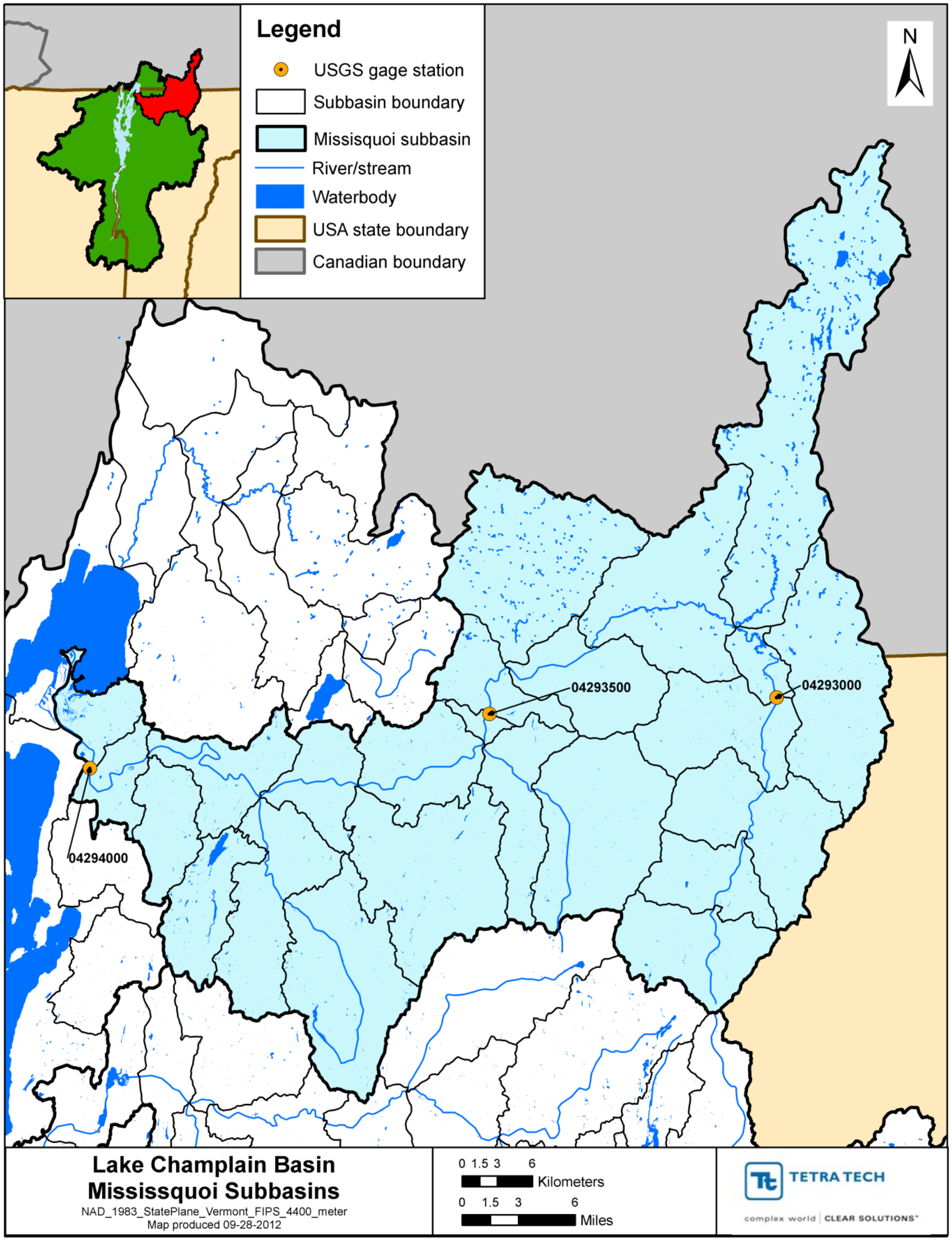


Figure F-46. Daily TP load versus flow as simulated by SWAT and estimated by FLUX (FLUX estimates from Medalie, 2013)

Appendix G - Missisquoi River Watershed



USGS 04293000 Missisquoi River near Troy, VT - Calibration

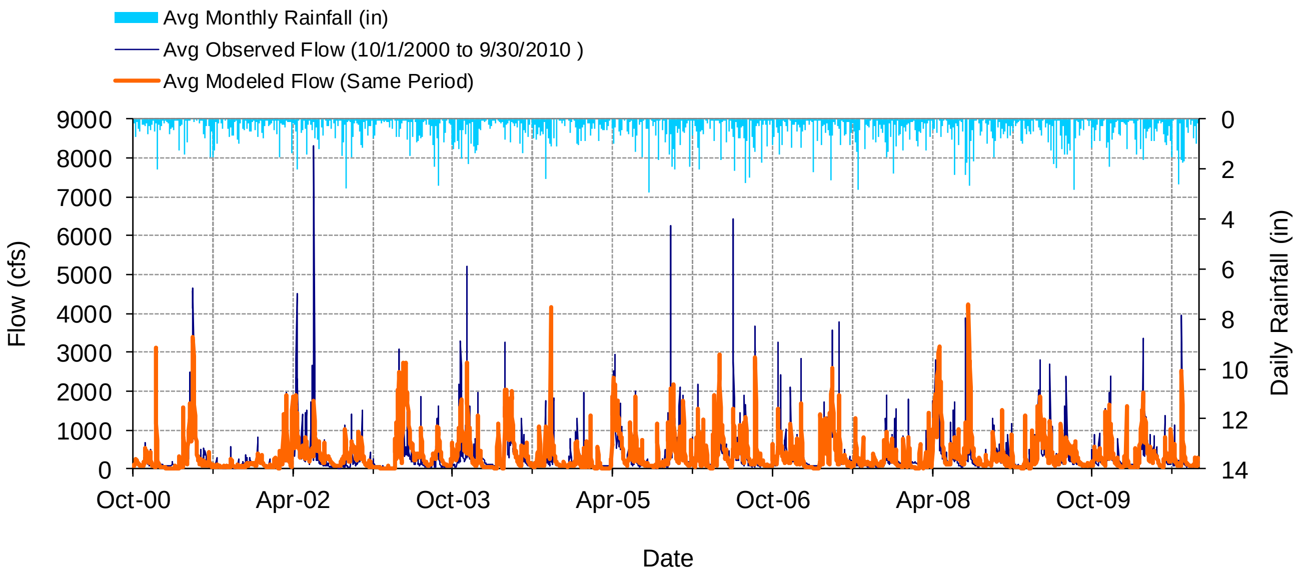


Figure G-1. Mean daily flow at USGS 04293000 Missisquoi River near Troy, VT

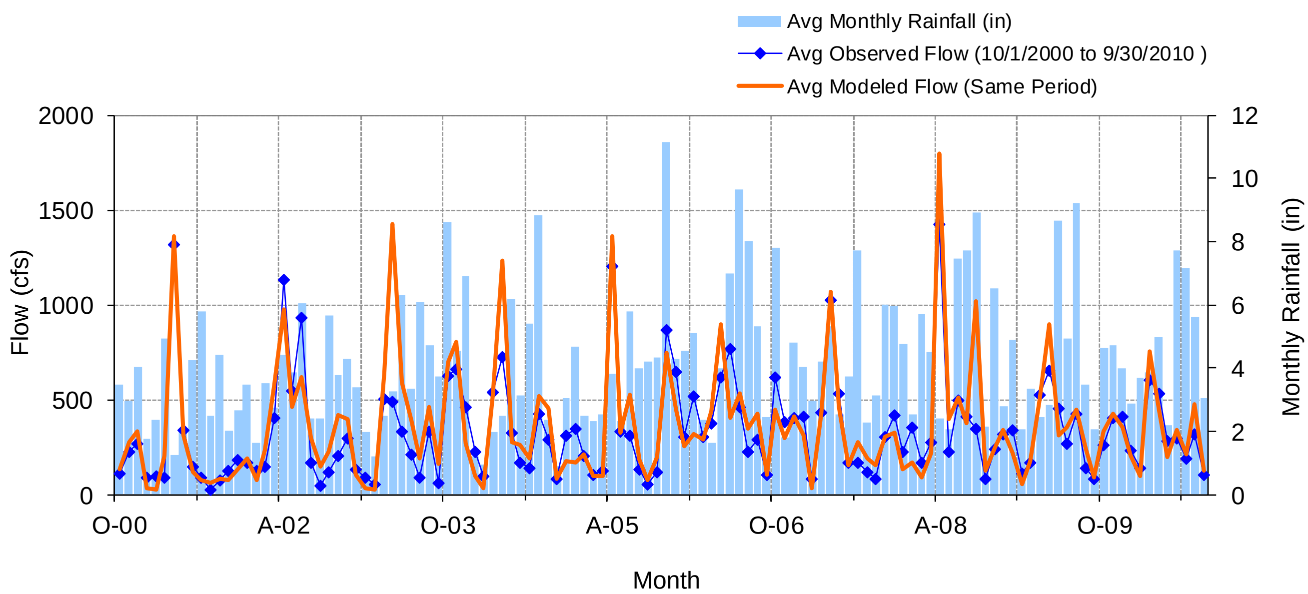


Figure G-2. Mean monthly flow at USGS 04293000 Missisquoi River near Troy, VT

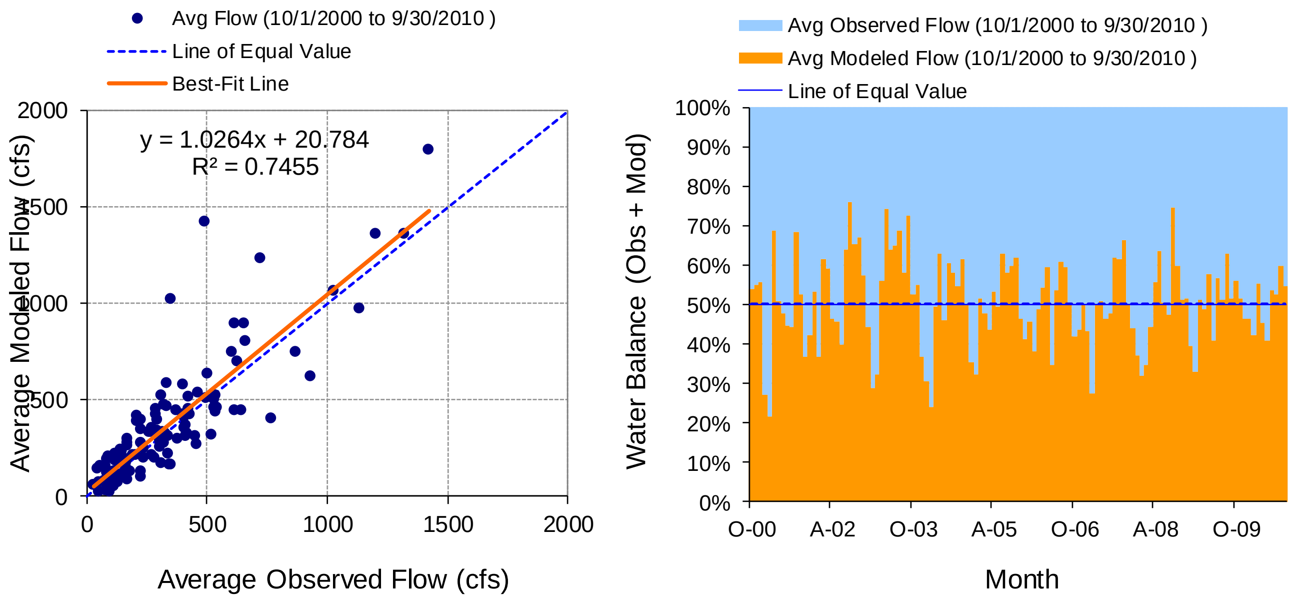


Figure G-3. Monthly flow regression and temporal variation at USGS 04293000 Missisquoi River near Troy, VT

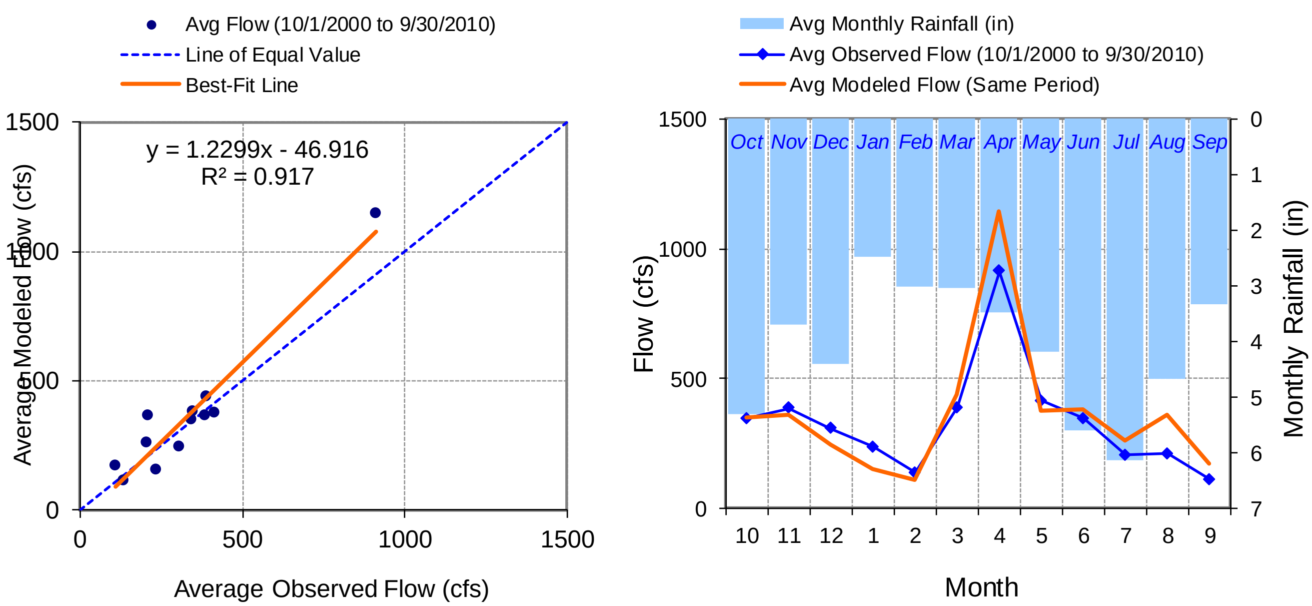


Figure G-4. Seasonal regression and temporal aggregate at USGS 04293000 Missisquoi River near Troy, VT

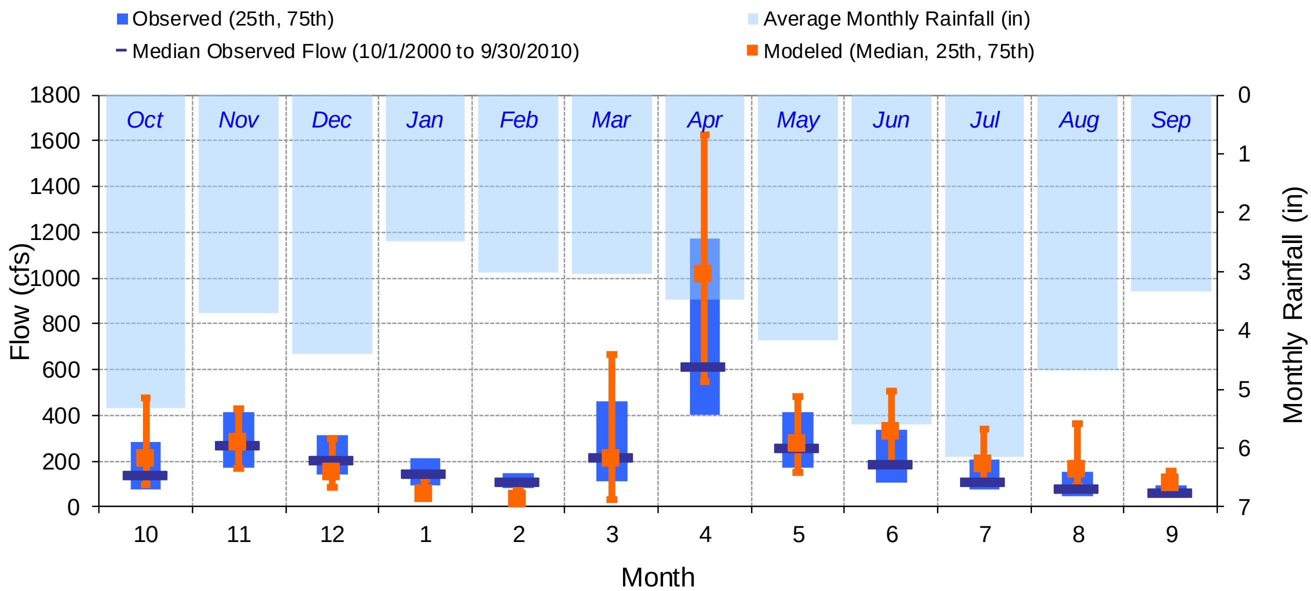


Figure G-5. Seasonal medians and ranges at USGS 04293000 Missisquoi River near Troy, VT

Table G-1. Seasonal summary at USGS 04293000 Missisquoi River near Troy, VT

MONTH	OBSERVED FLOW (CFS)				MODELED FLOW (CFS)			
	MEAN	MEDIAN	25TH	75TH	MEAN	MEDIAN	25TH	75TH
Oct	344.44	136.50	77.00	282.50	348.27	210.48	97.80	476.75
Nov	384.03	267.50	169.00	412.50	362.30	283.52	168.55	430.49
Dec	305.85	203.50	141.00	314.25	243.80	148.06	86.09	296.59
Jan	236.37	145.50	96.00	215.50	151.24	55.71	38.27	121.76
Feb	135.70	108.00	80.00	145.75	109.54	32.49	25.21	85.62
Mar	387.61	217.00	110.50	459.50	438.82	207.67	34.80	665.95
Apr	912.88	611.00	401.25	1172.50	1145.57	1014.24	547.91	1623.94
May	412.68	259.00	171.25	416.00	373.08	277.03	147.80	481.78
Jun	346.24	183.50	109.00	338.75	380.68	327.26	178.22	505.53
Jul	203.85	108.00	75.00	207.00	259.55	184.20	107.62	338.69
Aug	210.06	81.50	48.00	154.75	360.90	164.83	94.26	362.25
Sep	110.64	63.00	44.00	97.00	170.94	102.57	80.93	157.69

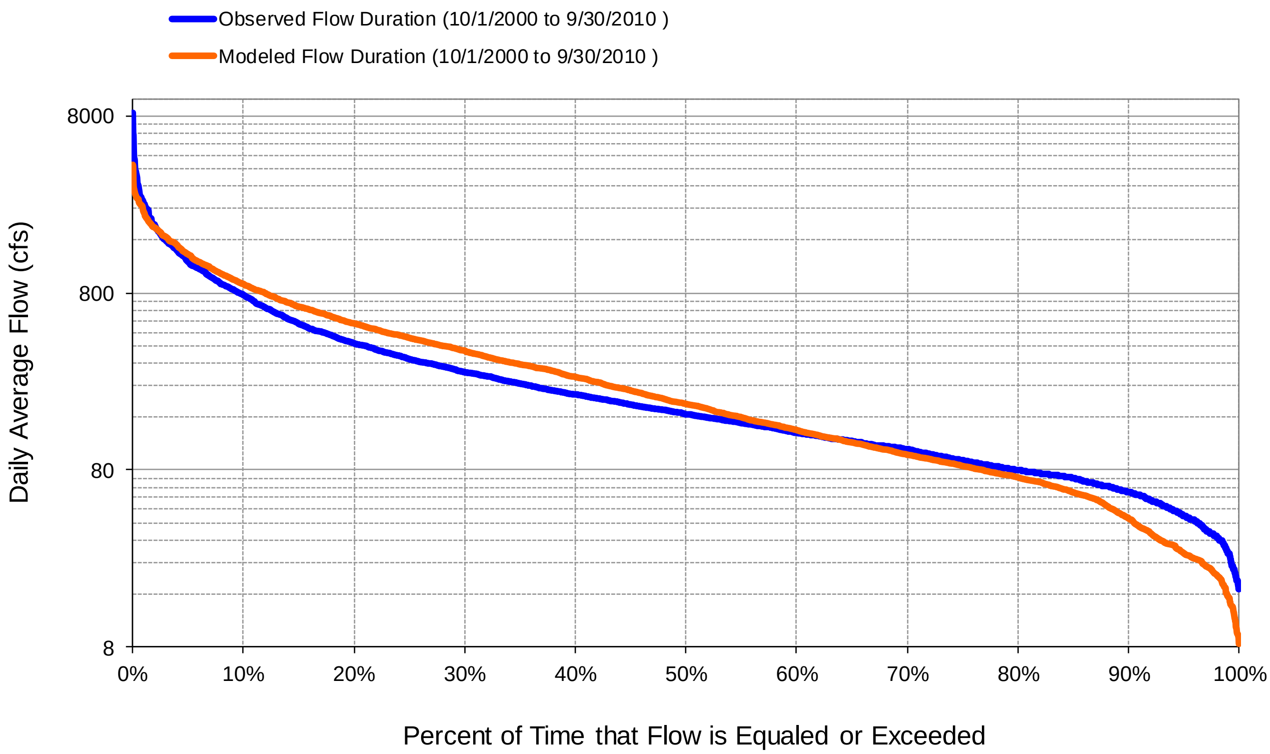


Figure G-6. Flow exceedence at USGS 04293000 Missisquoi River near Troy, VT

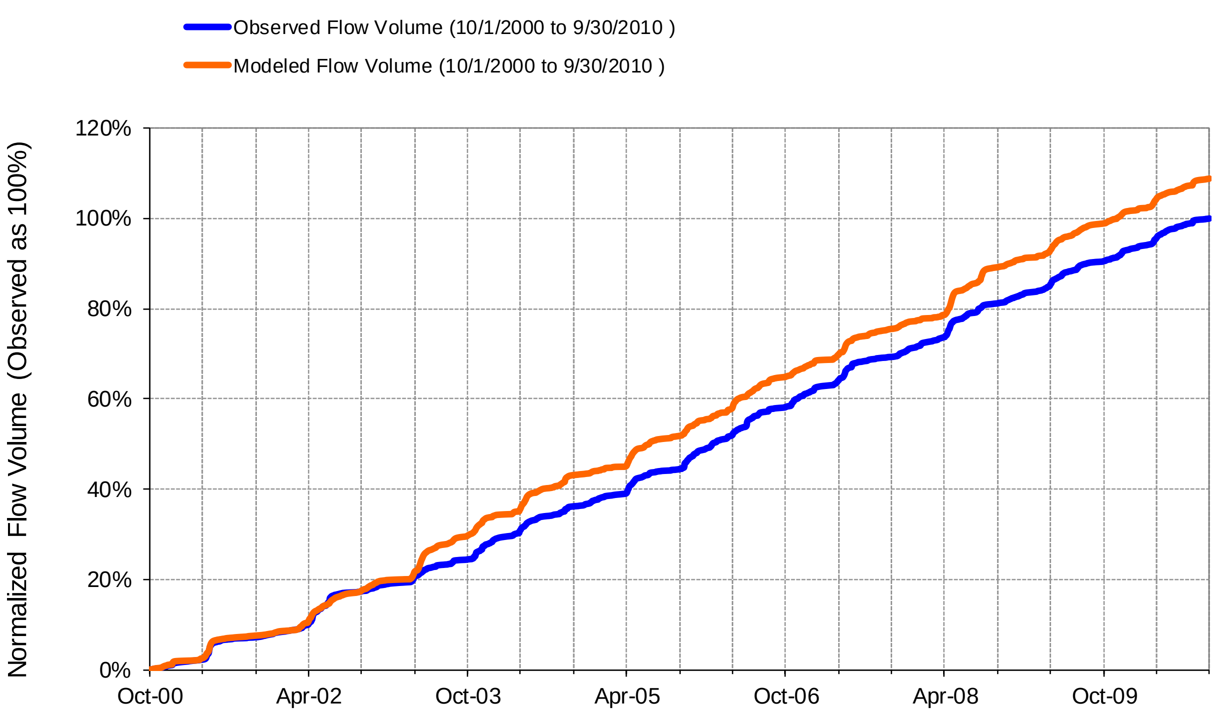


Figure G-7. Flow accumulation at USGS 04293000 Missisquoi River near Troy, VT

Table G-2. Summary statistics at USGS 04293000 Missisquoi River near Troy, VT

SWAT Simulated Flow		Observed Flow Gage	
REACH OUTFLOW FROM OUTLET 14 10-Year Analysis Period: 10/1/2000 - 9/30/2010 Flow volumes are (inches/year) for upstream drainage area		USGS 04293000 MISSISQUOI RIVER NEAR NORTH TROY, VT Hydrologic Unit Code: 4150407 Latitude: 44.97282337 Longitude: -72.38538628 Drainage Area (sq-mi): 131	
Total Simulated In-stream Flow:	**37.57**	Total Observed In-stream Flow:	**34.52**
Total of simulated highest 10% flows:	**15.51**	Total of Observed highest 10% flows:	**15.77**
Total of Simulated lowest 50% flows:	**4.63**	Total of Observed Lowest 50% flows:	**4.88**
Simulated Summer Flow Volume (months 7-9):	**6.92**	Observed Summer Flow Volume (7-9):	**4.59**
Simulated Fall Flow Volume (months 10-12):	**8.30**	Observed Fall Flow Volume (10-12):	**8.99**
Simulated Winter Flow Volume (months 1-3):	**6.07**	Observed Winter Flow Volume (1-3):	**6.58**
Simulated Spring Flow Volume (months 4-6):	**16.28**	Observed Spring Flow Volume (4-6):	**14.36**
Total Simulated Storm Volume:	**10.85**	Total Observed Storm Volume:	**14.22**
Simulated Summer Storm Volume (7-9):	**2.05**	Observed Summer Storm Volume (7-9):	**2.26**

Errors (Simulated-Observed)	*Error Statistics*	*Recommended Criteria*		
Error in total volume:	8.84	10		
Error in 50% lowest flows:	-5.04	10		
Error in 10% highest flows:	-1.69	15		
Seasonal volume error - Summer:	50.85	30		
Seasonal volume error - Fall:	-7.75	>> 30		Clear
Seasonal volume error - Winter:	-7.72	30		
Seasonal volume error - Spring:	13.42	30		
Error in storm volumes:	-23.72	20		
Error in summer storm volumes:	-9.40	50		
Nash-Sutcliffe Coefficient of Efficiency, E:	0.491	Model accuracy increases		
Baseline adjusted coefficient (Garrick), E':	0.360	as E or E' approaches 1.0		
Monthly NSE	0.627			

USGS 04293000 Missisquoi River near Troy, VT - Validation

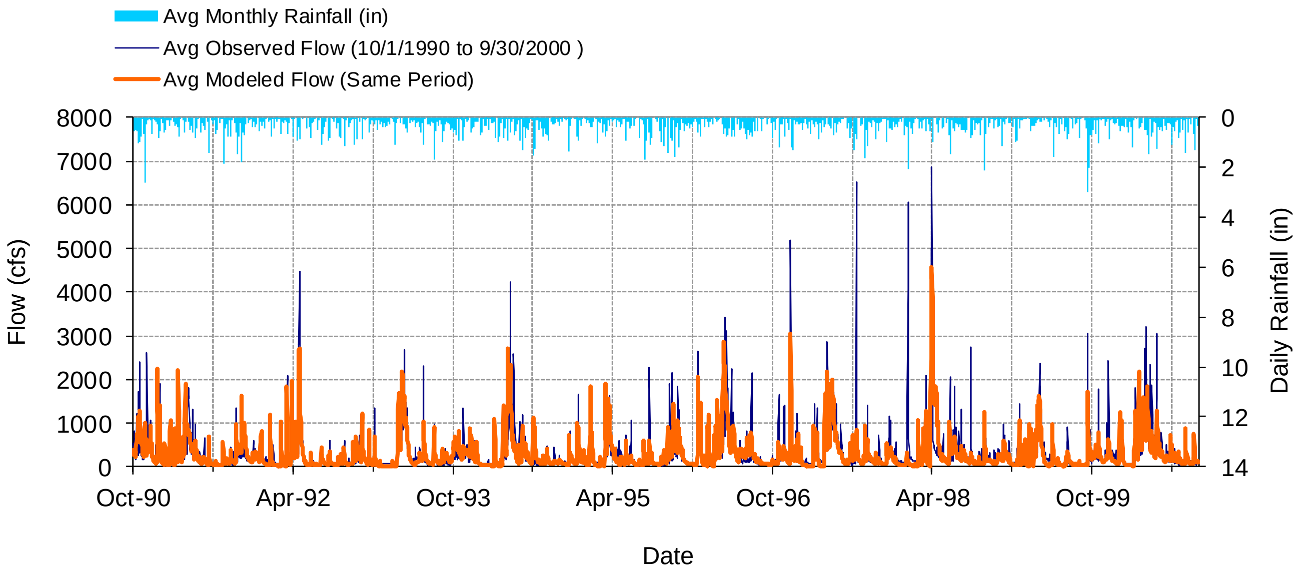


Figure G-8. Mean daily flow at USGS 04293000 Missisquoi River near Troy, VT

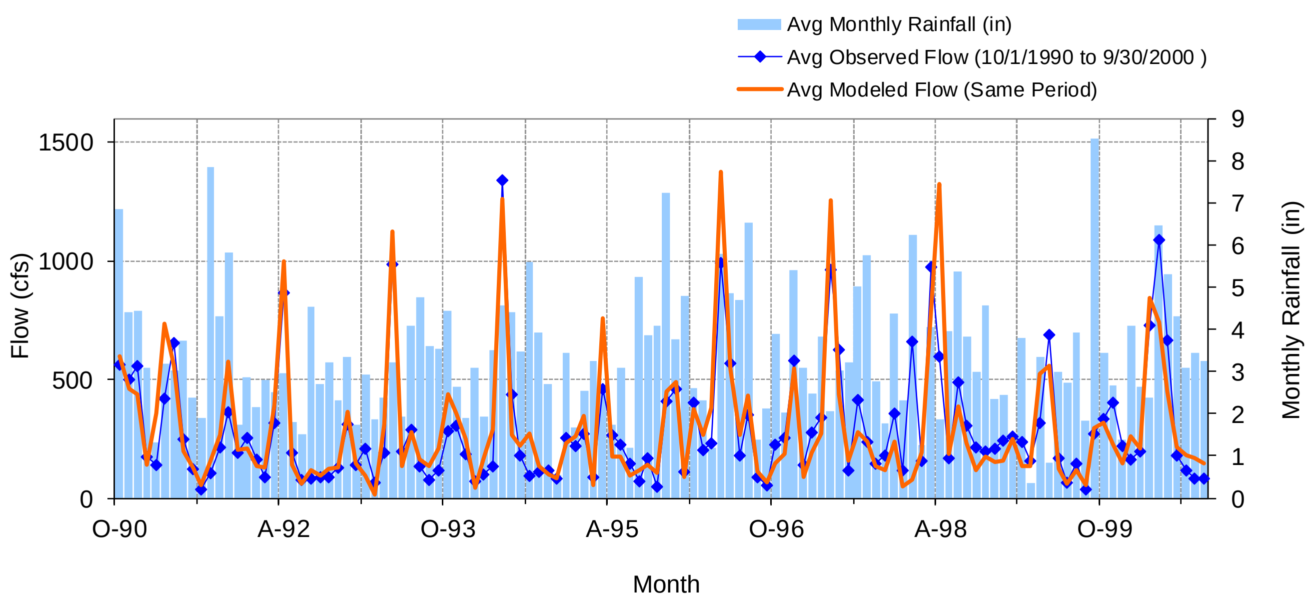


Figure G-9. Mean monthly flow at USGS 04293000 Missisquoi River near Troy, VT

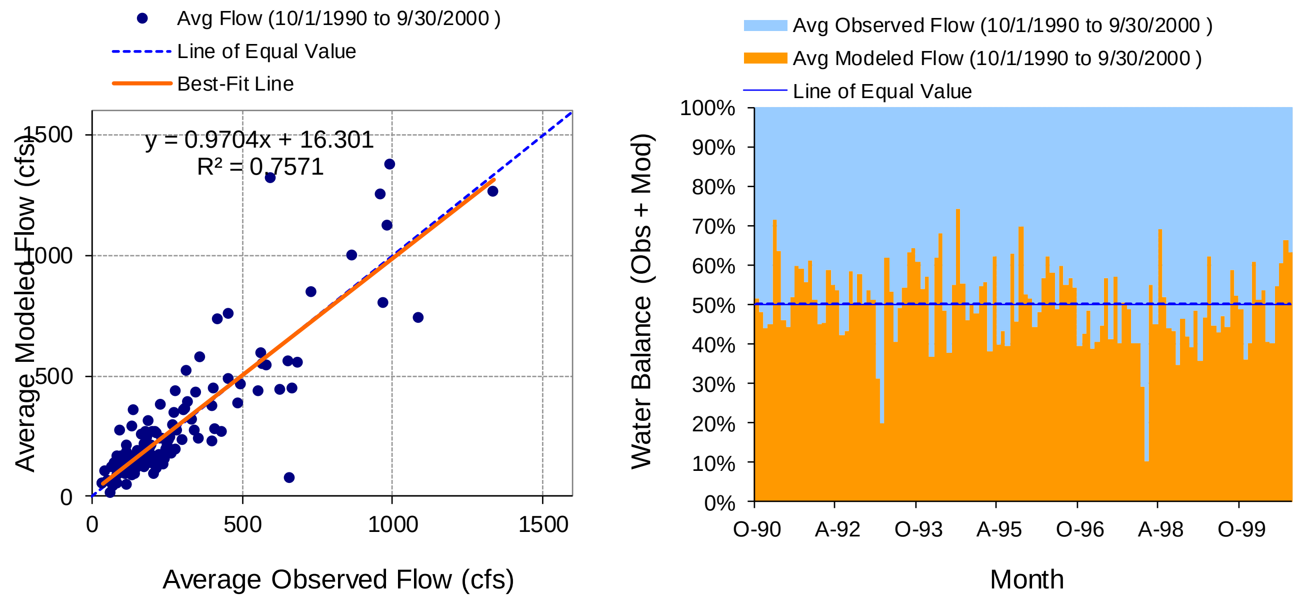


Figure G-10. Monthly flow regression and temporal variation at USGS 04293000 Missisquoi River near Troy, VT

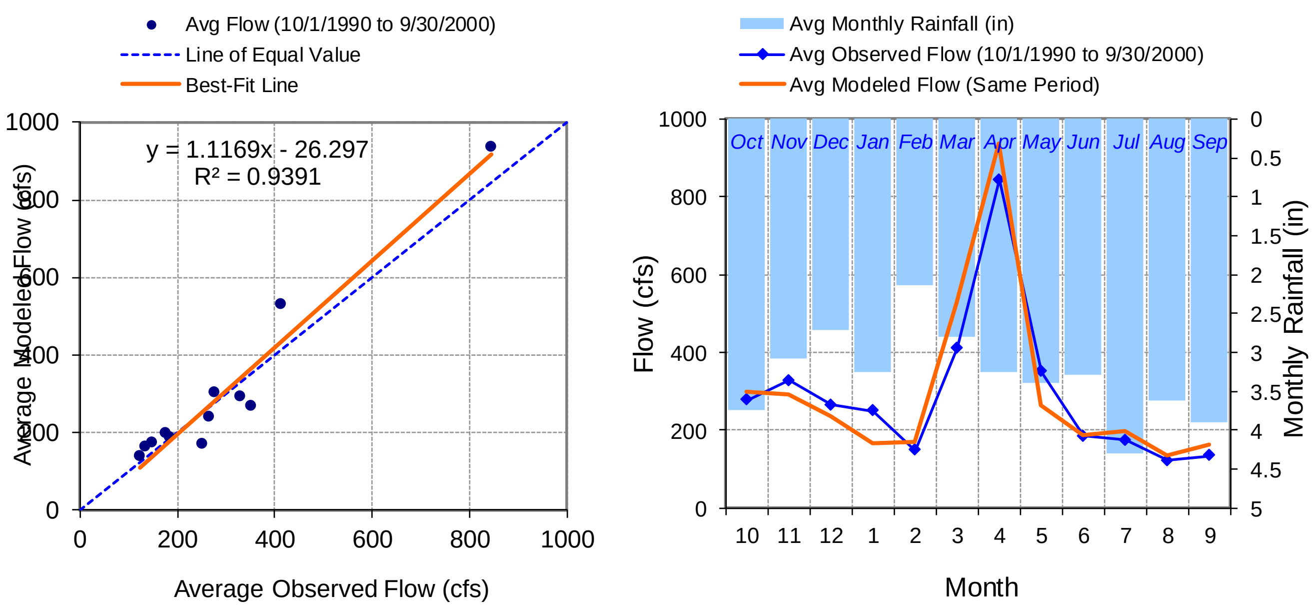


Figure G-11. Seasonal regression and temporal aggregate at USGS 04293000 Missisquoi River near Troy, VT

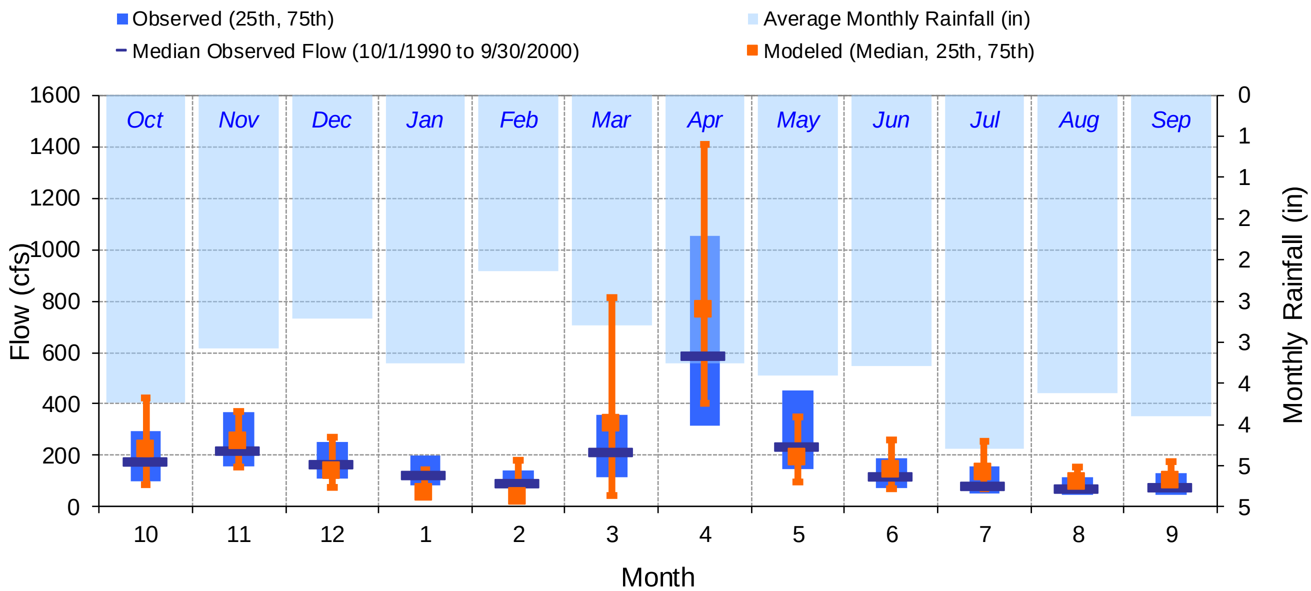


Figure G-12. Seasonal medians and ranges at USGS 04293000 Missisquoi River near Troy, VT

Table G-3. Seasonal summary at USGS 04293000 Missisquoi River near Troy, VT

MONTH	OBSERVED FLOW (CFS)				MODELED FLOW (CFS)			
	MEAN	MEDIAN	25TH	75TH	MEAN	MEDIAN	25TH	75TH
Oct	277.50	173.50	98.00	293.25	300.27	221.23	85.13	421.48
Nov	328.15	217.50	157.75	369.25	291.62	255.36	156.95	369.39
Dec	264.49	163.50	112.00	254.75	237.47	137.44	77.06	271.15
Jan	249.73	125.00	86.25	197.25	168.30	53.33	38.85	146.96
Feb	148.02	90.00	73.50	140.00	171.52	40.08	24.89	180.90
Mar	411.68	214.00	117.00	356.75	530.35	323.29	46.17	811.44
Apr	843.67	585.50	317.00	1052.50	935.79	764.21	403.21	1411.00
May	350.21	234.00	146.25	453.50	265.15	192.11	97.64	348.18
Jun	184.25	115.50	73.75	187.50	186.33	145.30	68.11	257.78
Jul	175.17	82.00	50.25	158.75	196.29	135.06	72.67	254.74
Aug	121.76	69.00	49.00	115.75	135.42	94.57	73.63	153.04
Sep	134.01	78.00	46.00	133.25	162.53	100.47	70.65	177.32

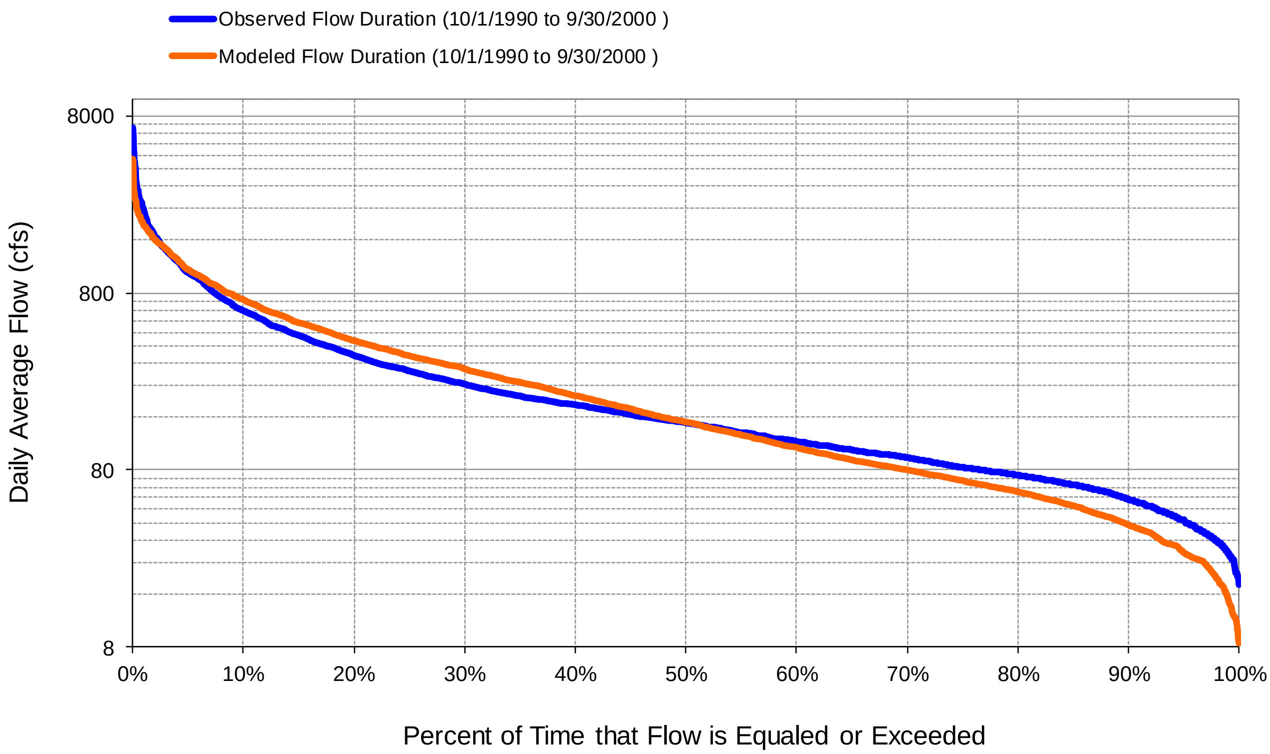


Figure G-13. Flow exceedence at USGS 04293000 Missisquoi River near Troy, VT

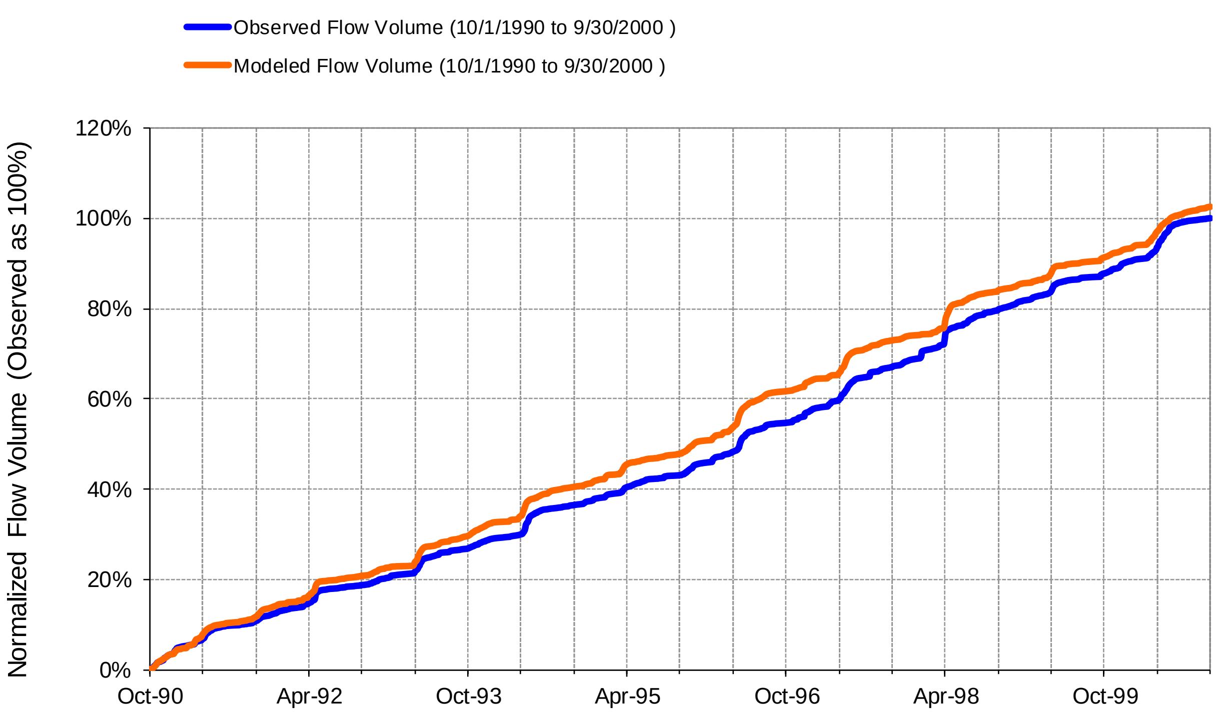


Figure G-14. Flow accumulation at USGS 04293000 Missisquoi River near Troy, VT

Table G-4. Summary statistics at USGS 04293000 Missisquoi River near Troy, VT

SWAT Simulated Flow		Observed Flow Gage	
REACH OUTFLOW FROM OUTLET 14		USGS 04293000 MISSISQUOI RIVER NEAR NORTH TROY, VT	
10-Year Analysis Period: 10/1/1990 - 9/30/2000 Flow volumes are (inches/year) for upstream drainage area		Hydrologic Unit Code: 4150407 Latitude: 44.97282337 Longitude: -72.38538628 Drainage Area (sq-mi): 131	
Total Simulated In-stream Flow:	**30.93**	Total Observed In-stream Flow:	**30.16**
Total of simulated highest 10% flows:	**13.20**	Total of Observed highest 10% flows:	**13.92**
Total of Simulated lowest 50% flows:	**3.80**	Total of Observed Lowest 50% flows:	**4.41**
Simulated Summer Flow Volume (months 7-9):	**4.30**	Observed Summer Flow Volume (7-9):	**3.75**
Simulated Fall Flow Volume (months 10-12):	**7.22**	Observed Fall Flow Volume (10-12):	**7.56**
Simulated Winter Flow Volume (months 1-3):	**7.53**	Observed Winter Flow Volume (1-3):	**7.01**
Simulated Spring Flow Volume (months 4-6):	**11.89**	Observed Spring Flow Volume (4-6):	**11.84**
Total Simulated Storm Volume:	**9.39**	Total Observed Storm Volume:	**11.94**
Simulated Summer Storm Volume (7-9):	**1.29**	Observed Summer Storm Volume (7-9):	**1.88**

Errors (Simulated-Observed)	*Error Statistics*	*Recommended Criteria*		
Error in total volume:	2.55	10		
Error in 50% lowest flows:	-13.95	10		
Error in 10% highest flows:	-5.21	15		
Seasonal volume error - Summer:	14.62	30		
Seasonal volume error - Fall:	-4.61	>> 30		Clear
Seasonal volume error - Winter:	7.37	30		
Seasonal volume error - Spring:	0.45	30		
Error in storm volumes:	-21.35	20		
Error in summer storm volumes:	-31.67	50		
Nash-Sutcliffe Coefficient of Efficiency, E:	0.460	Model accuracy increases		
Baseline adjusted coefficient (Garrick), E':	0.358	as E or E' approaches 1.0		
Monthly NSE	0.696			

USGS 04293500 Missisquoi River near East Berkshire, VT - Calibration

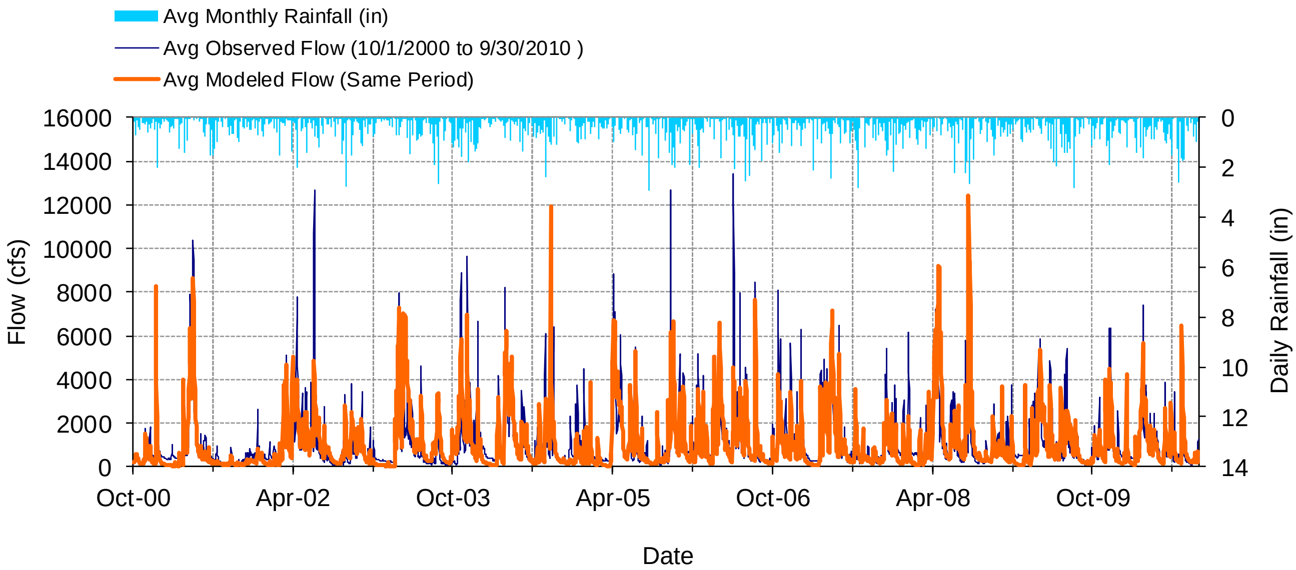


Figure G-15. Mean daily flow at USGS 04293500 Missisquoi River near East Berkshire, VT

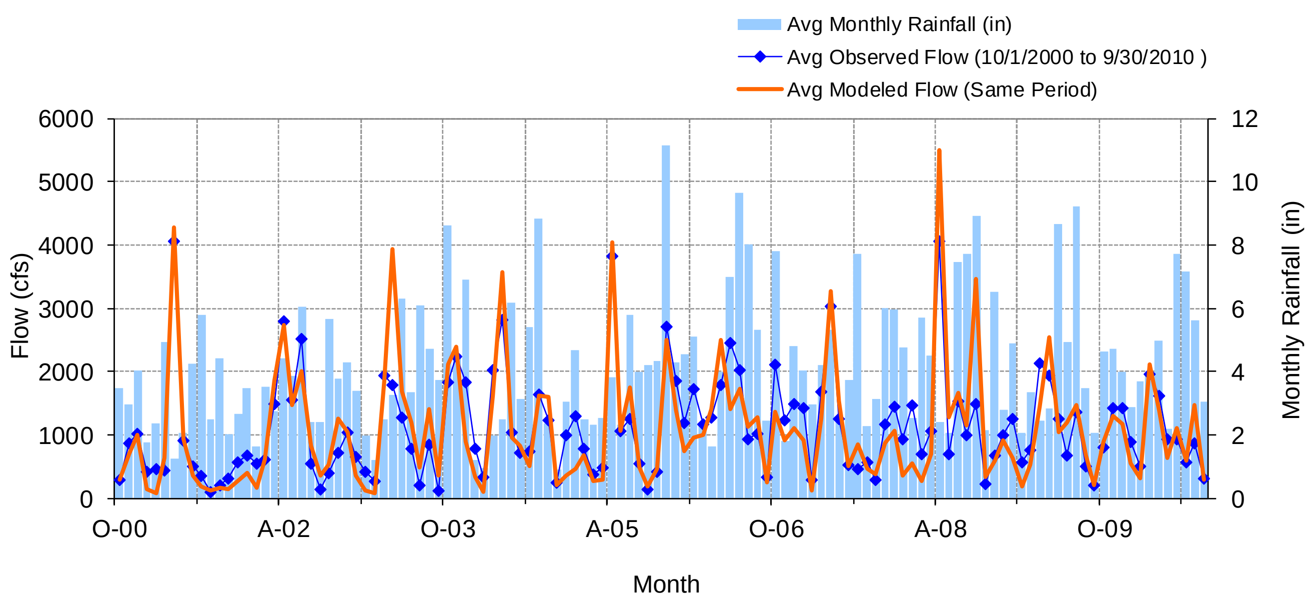


Figure G-16. Mean monthly flow at USGS 04293500 Missisquoi River near East Berkshire, VT

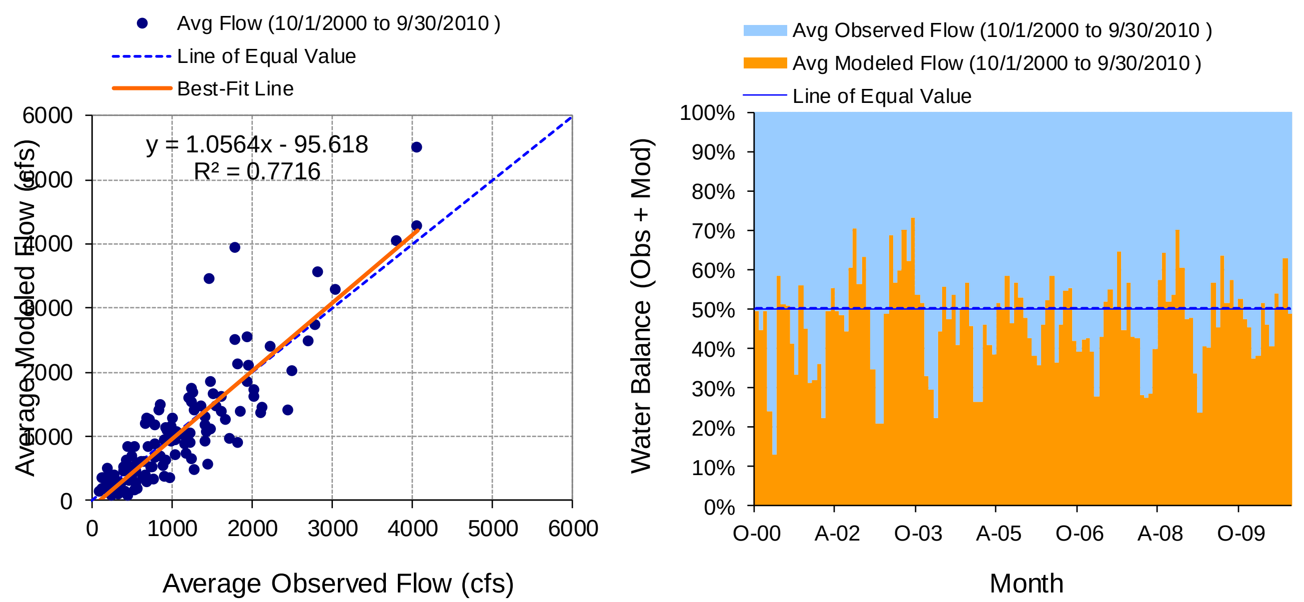


Figure G-17. Monthly flow regression and temporal variation at USGS 04293500 Missisquoi River near East Berkshire, VT

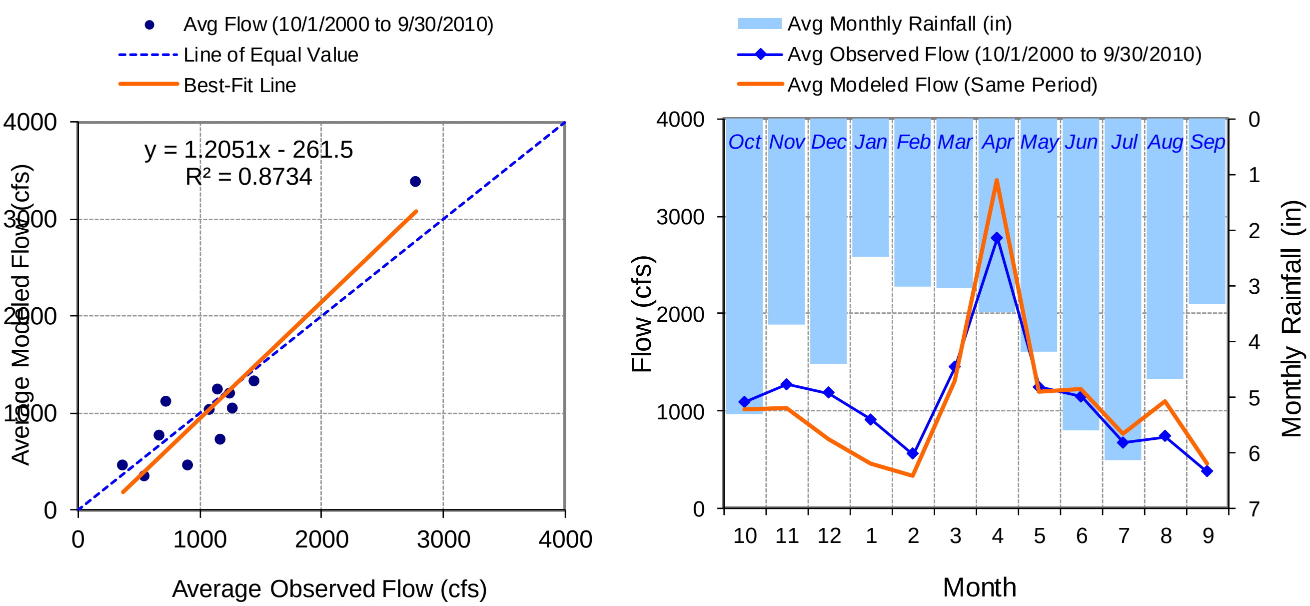


Figure G-18. Seasonal regression and temporal aggregate at USGS 04293500 Missisquoi River near East Berkshire, VT

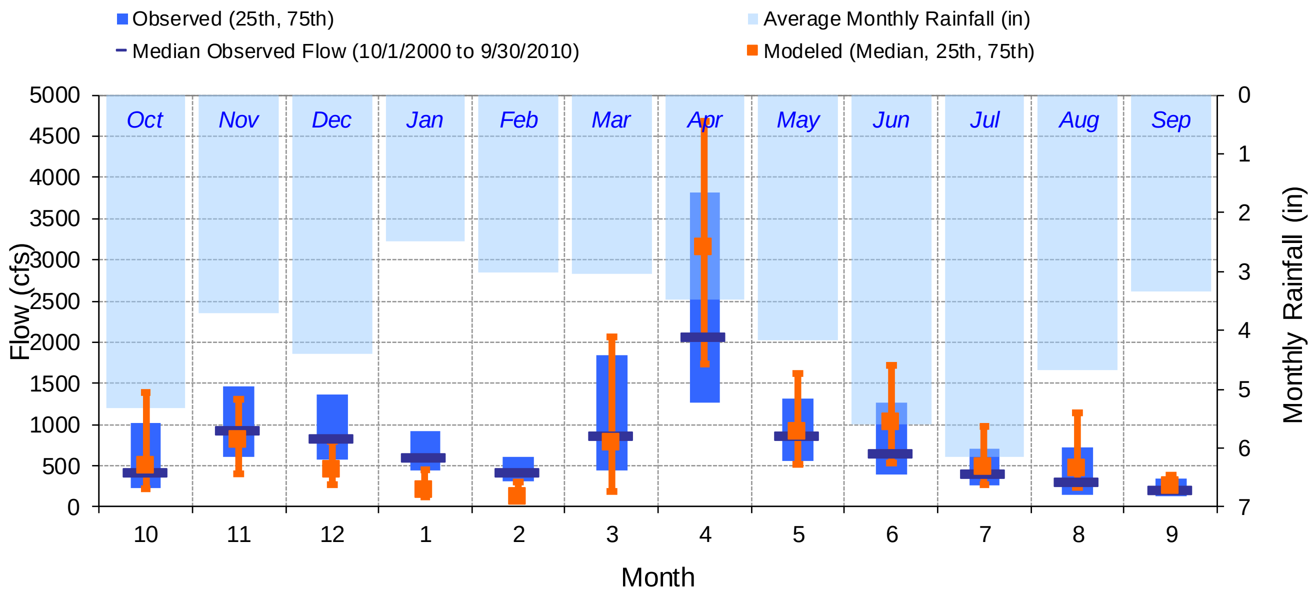


Figure G-19. Seasonal medians and ranges at USGS 04293500 Missisquoi River near East Berkshire, VT

Table G-5. Seasonal summary at USGS 04293500 Missisquoi River near East Berkshire, VT

MONTH	OBSERVED FLOW (CFS)				MODELED FLOW (CFS)			
	MEAN	MEDIAN	25TH	75TH	MEAN	MEDIAN	25TH	75TH
Oct	1087.85	415.00	228.25	1019.00	1021.96	503.23	225.94	1381.77
Nov	1267.04	928.00	605.50	1462.50	1031.02	816.83	408.68	1309.82
Dec	1176.47	831.00	582.50	1367.50	710.75	453.26	268.38	793.26
Jan	905.06	595.00	440.00	924.50	455.27	197.32	121.85	446.82
Feb	549.49	425.00	317.50	605.00	332.36	116.38	77.80	309.67
Mar	1451.27	870.00	437.50	1845.00	1313.81	774.45	194.36	2059.73
Apr	2775.28	2060.00	1265.00	3815.00	3375.40	3147.77	1733.95	4683.61
May	1244.26	866.00	566.25	1317.50	1195.08	915.71	512.42	1615.82
Jun	1147.42	655.00	393.25	1260.00	1228.93	1025.36	538.28	1722.56
Jul	671.63	409.00	263.00	709.50	764.64	492.29	275.01	974.42
Aug	730.79	298.00	150.25	721.25	1100.97	463.33	233.72	1144.46
Sep	372.65	197.00	127.75	342.25	455.18	251.30	190.81	388.99

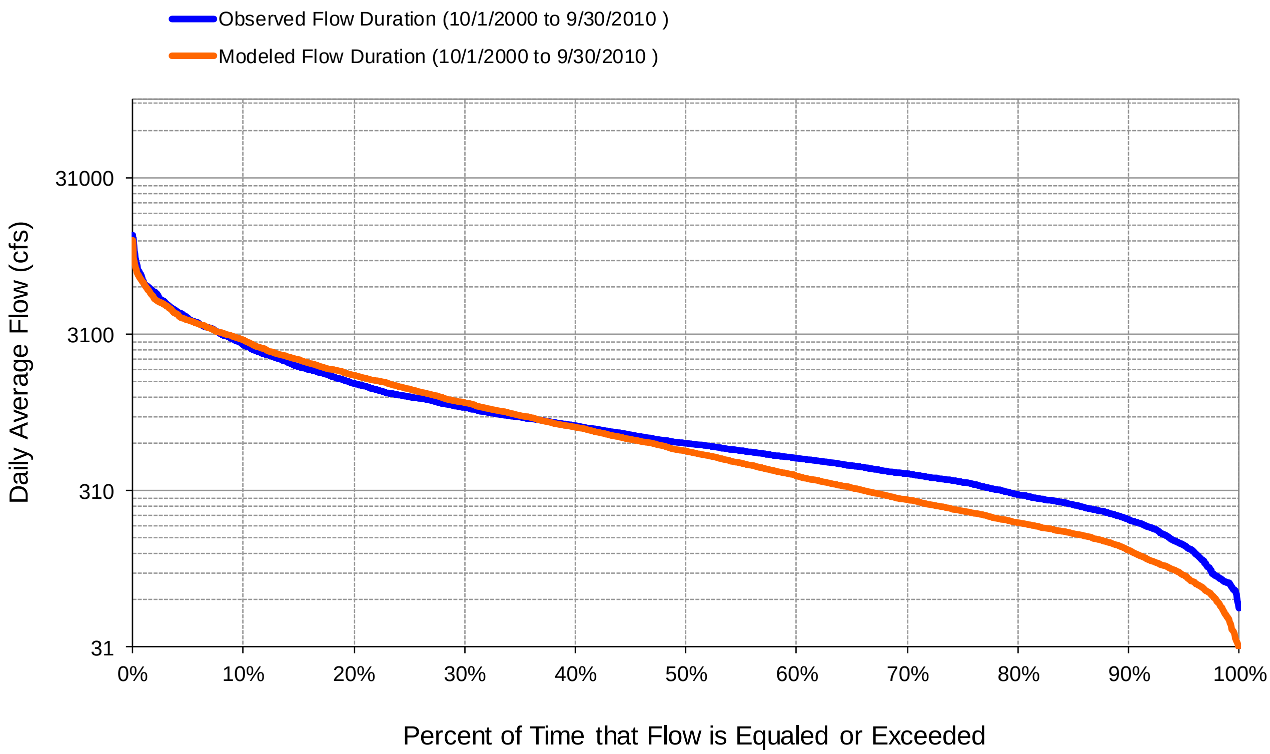


Figure G-20. Flow exceedence at USGS 04293500 Missisquoi River near East Berkshire, VT

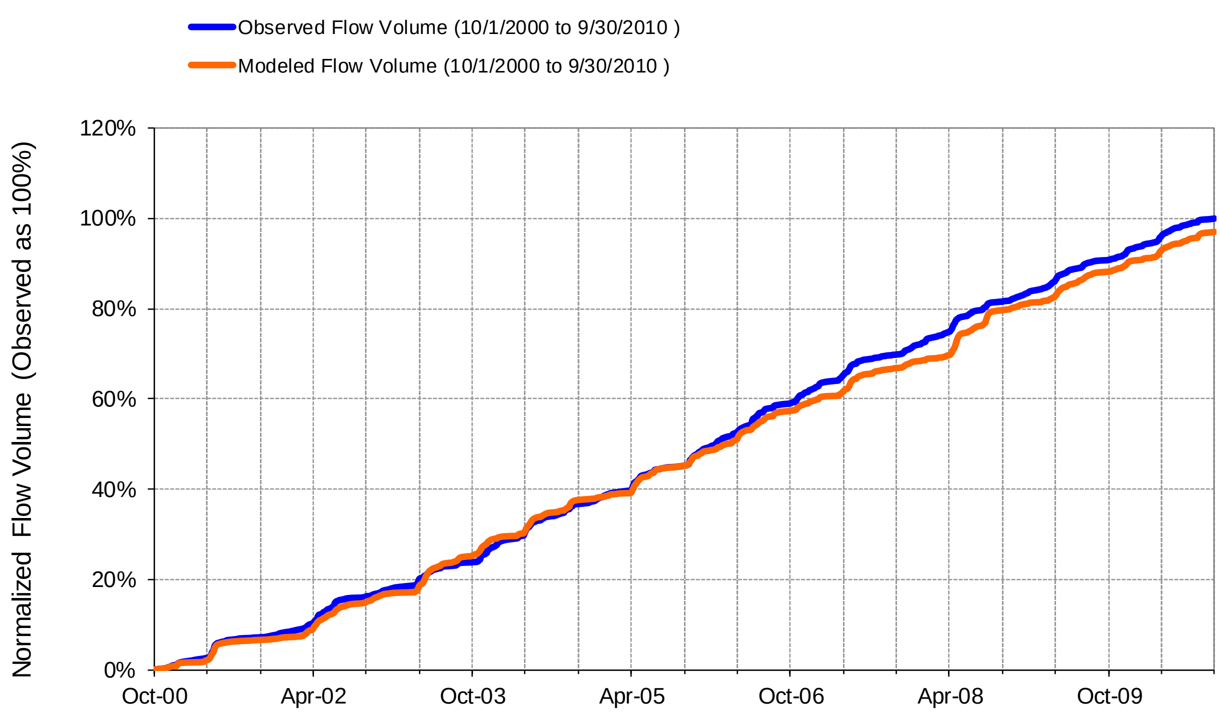


Figure G-21. Flow accumulation at USGS 04293500 Missisquoi River near East Berkshire, VT

Table G-6. Summary statistics at USGS 04293500 Missisquoi River near East Berkshire, VT

SWAT Simulated Flow		Observed Flow Gage		
REACH OUTFLOW FROM OUTLET 7 10-Year Analysis Period: 10/1/2000 - 9/30/2010 Flow volumes are (inches/year) for upstream drainage area		USGS 04293500 MISSISQUOI RIVER NEAR EAST BERKSHIRE, VT Hydrologic Unit Code: 4150407 Latitude: 44.96004599 Longitude: -72.696521 Drainage Area (sq-mi): 479		
Total Simulated In-stream Flow:	**30.71**	Total Observed In-stream Flow:		**31.66**
Total of simulated highest 10% flows:	**12.42**	Total of Observed highest 10% flows:		**12.89**
Total of Simulated lowest 50% flows:	**3.62**	Total of Observed Lowest 50% flows:		**4.96**
Simulated Summer Flow Volume (months 7-9):	**5.55**	Observed Summer Flow Volume (7-9):		**4.24**
Simulated Fall Flow Volume (months 10-12):	**6.57**	Observed Fall Flow Volume (10-12):		**8.40**
Simulated Winter Flow Volume (months 1-3):	**4.99**	Observed Winter Flow Volume (1-3):		**6.88**
Simulated Spring Flow Volume (months 4-6):	**13.60**	Observed Spring Flow Volume (4-6):		**12.13**
Total Simulated Storm Volume:	**11.09**	Total Observed Storm Volume:		**13.63**
Simulated Summer Storm Volume (7-9):	**2.08**	Observed Summer Storm Volume (7-9):		**2.18**
Errors (Simulated-Observed)	*Error Statistics*	*Recommended Criteria*		
Error in total volume:	-2.98	10		
Error in 50% lowest flows:	-26.98	10		
Error in 10% highest flows:	-3.66	15		
Seasonal volume error - Summer:	30.80	30		
Seasonal volume error - Fall:	-21.77 >>	30		Clear
Seasonal volume error - Winter:	-27.48	30		
Seasonal volume error - Spring:	12.11	30		
Error in storm volumes:	-18.67	20		
Error in summer storm volumes:	-4.43	50		
Nash-Sutcliffe Coefficient of Efficiency, E:	0.577	Model accuracy increases		
Baseline adjusted coefficient (Garrick), E':	0.415	as E or E' approaches 1.0		
Monthly NSE	0.665			

USGS 04293500 Missisquoi River near East Berkshire, VT - Validation

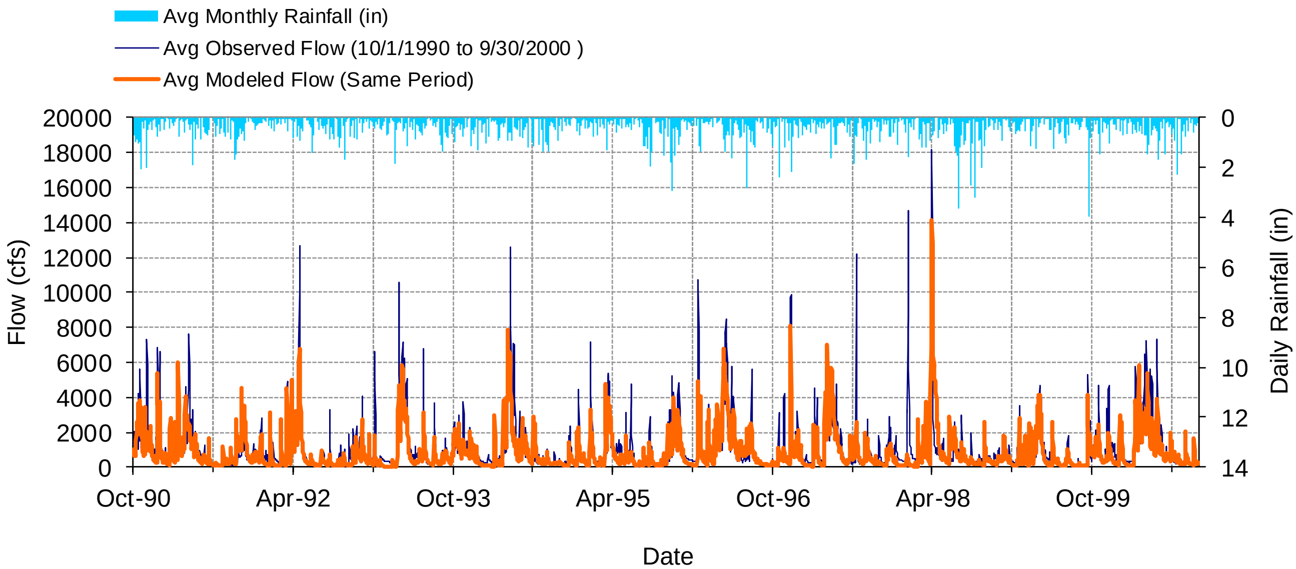


Figure G-22. Mean daily flow at USGS 04293500 Missisquoi River near East Berkshire, VT

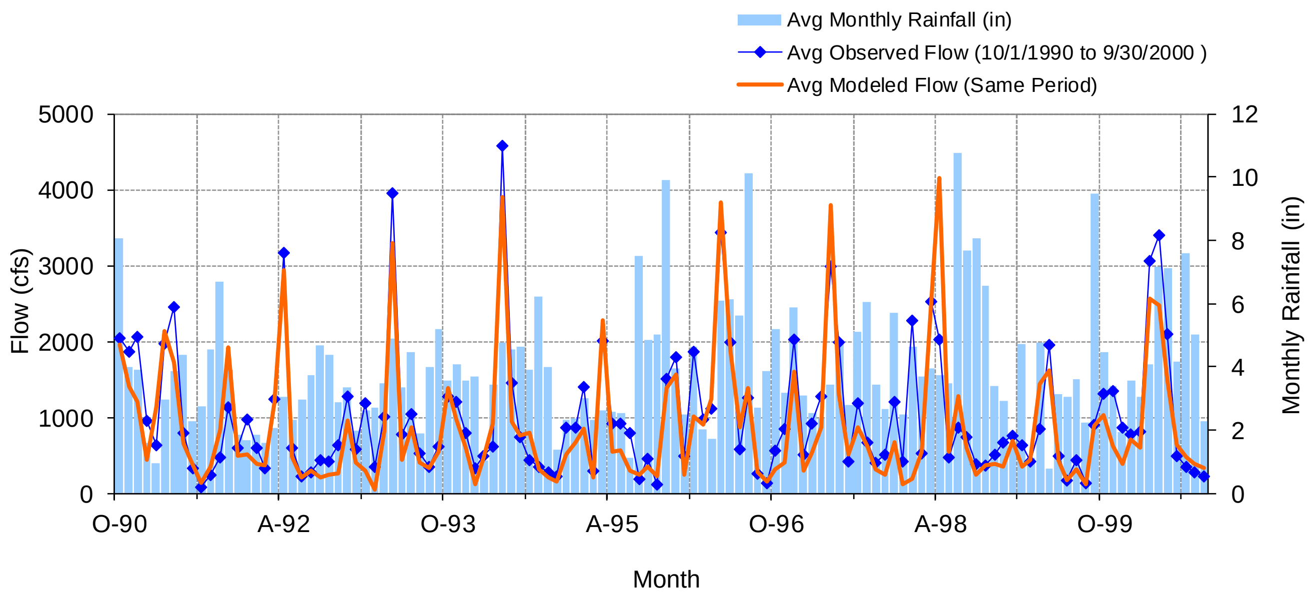


Figure G-23. Mean monthly flow at USGS 04293500 Missisquoi River near East Berkshire, VT

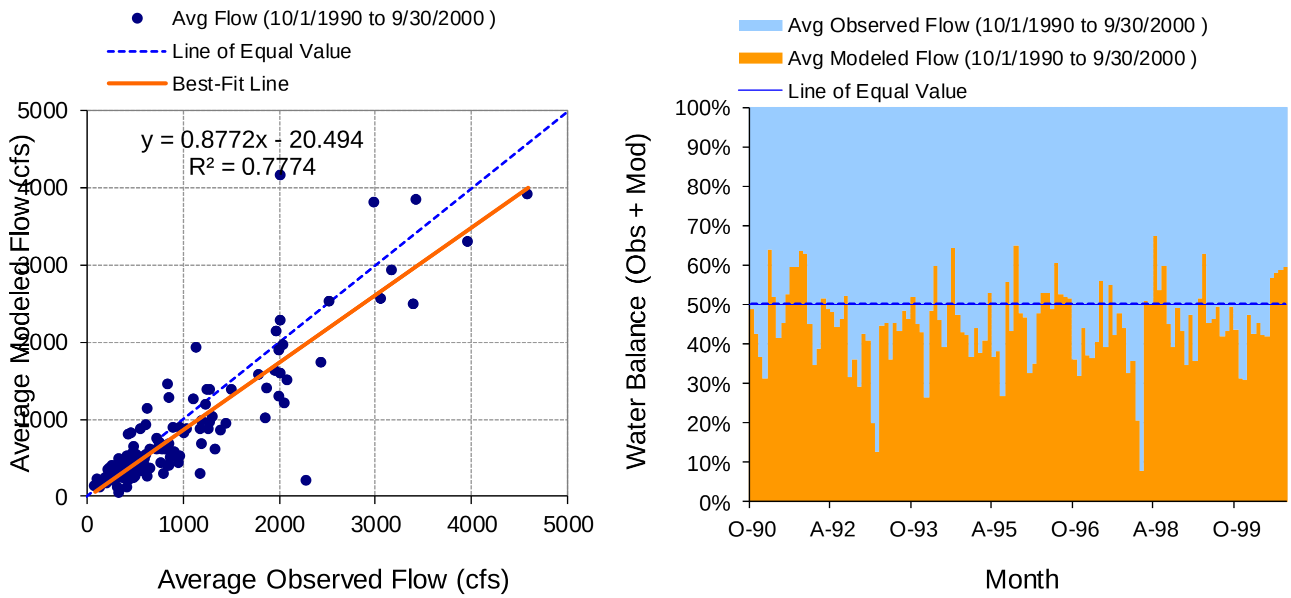


Figure G-24. Monthly flow regression and temporal variation at USGS 04293500 Missisquoi River near East Berkshire, VT

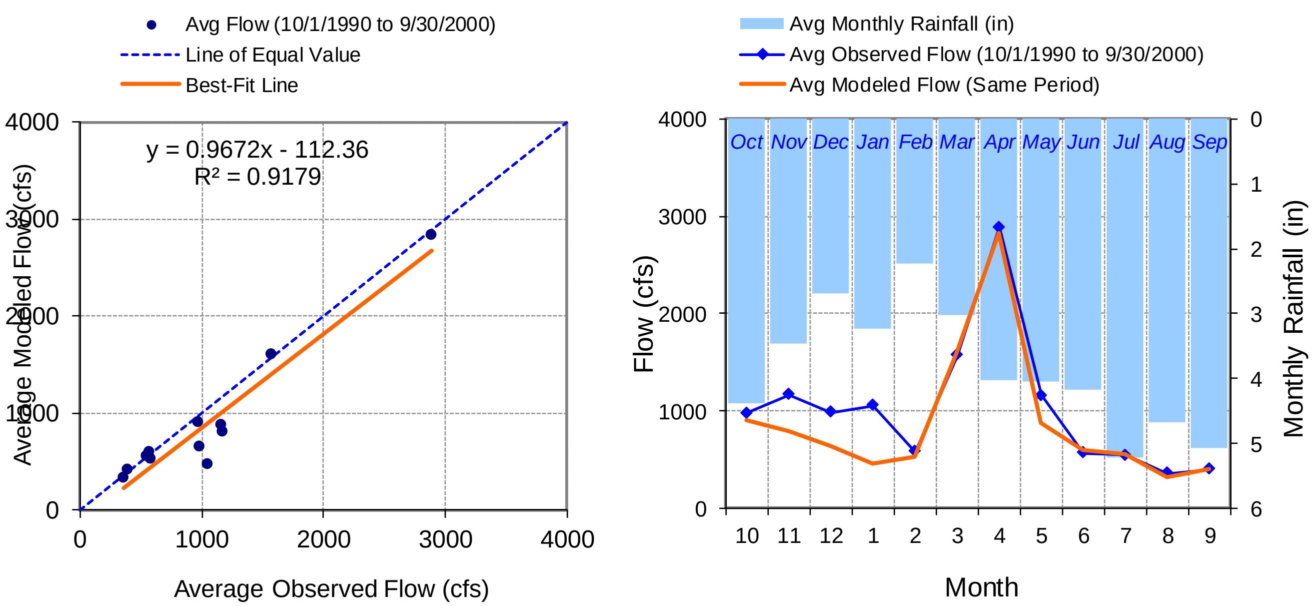


Figure G-25. Seasonal regression and temporal aggregate at USGS 04293500 Missisquoi River near East Berkshire, VT

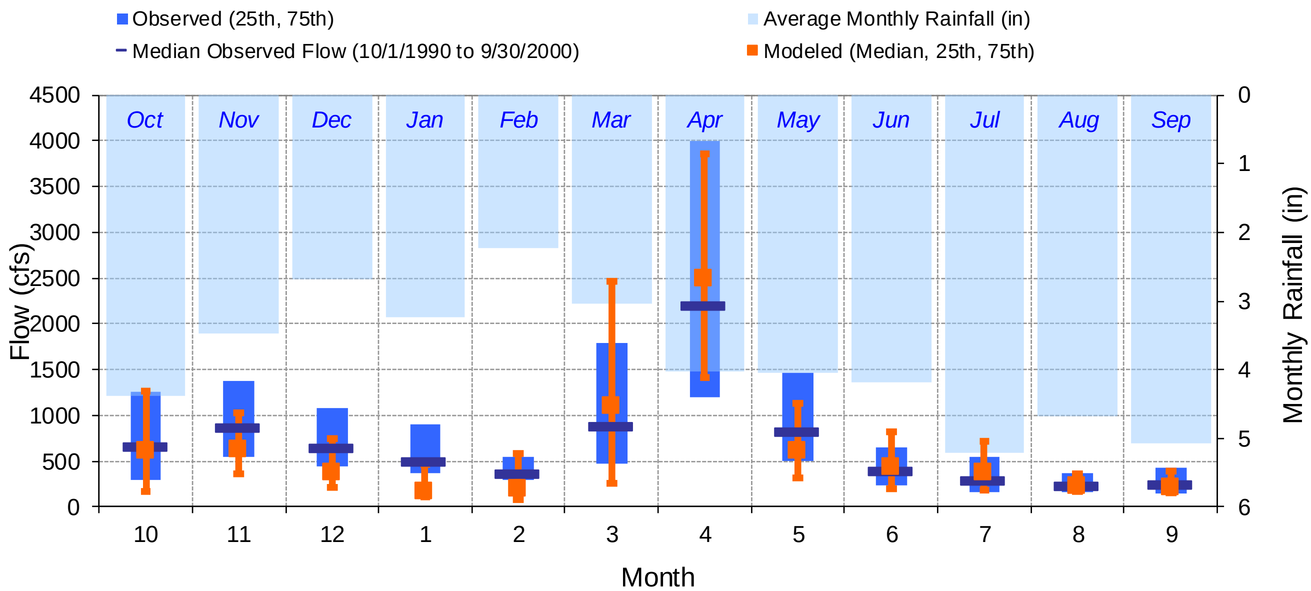


Figure G-26. Seasonal medians and ranges at USGS 04293500 Missisquoi River near East Berkshire, VT

Table G-7. Seasonal summary at USGS 04293500 Missisquoi River near East Berkshire, VT

MONTH	OBSERVED FLOW (CFS)				MODELED FLOW (CFS)			
	MEAN	MEDIAN	25TH	75TH	MEAN	MEDIAN	25TH	75TH
Oct	974.61	654.00	302.00	1255.00	904.34	616.59	174.78	1259.14
Nov	1168.21	859.00	547.00	1380.00	793.03	634.78	356.32	1028.72
Dec	984.74	650.00	450.00	1075.00	641.22	379.46	209.42	741.87
Jan	1053.71	490.00	365.00	907.50	463.49	168.95	117.06	465.36
Feb	576.23	365.00	302.50	540.00	522.09	192.25	76.12	584.46
Mar	1570.58	879.00	476.25	1795.00	1595.58	1098.99	252.28	2468.76
Apr	2889.14	2205.00	1195.00	4000.00	2828.22	2496.39	1406.76	3857.24
May	1159.41	819.50	499.50	1460.00	872.24	621.01	321.85	1130.33
Jun	566.84	387.00	232.75	648.25	596.42	440.37	204.60	824.16
Jul	546.15	282.50	160.25	544.25	550.28	370.63	179.80	724.66
Aug	354.56	223.50	159.50	366.00	316.90	223.49	171.96	360.47
Sep	395.52	238.00	142.75	424.00	406.73	218.77	152.66	398.35

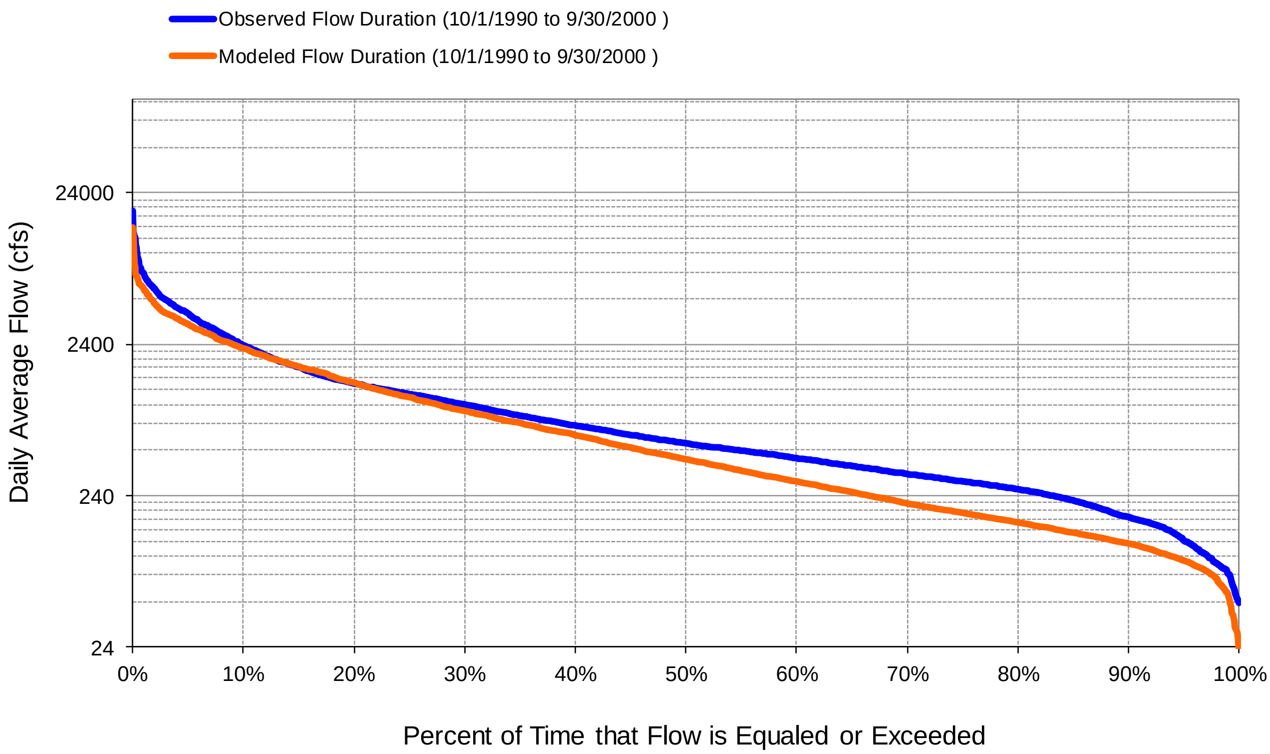


Figure G-27. Flow exceedence at USGS 04293500 Missisquoi River near East Berkshire, VT

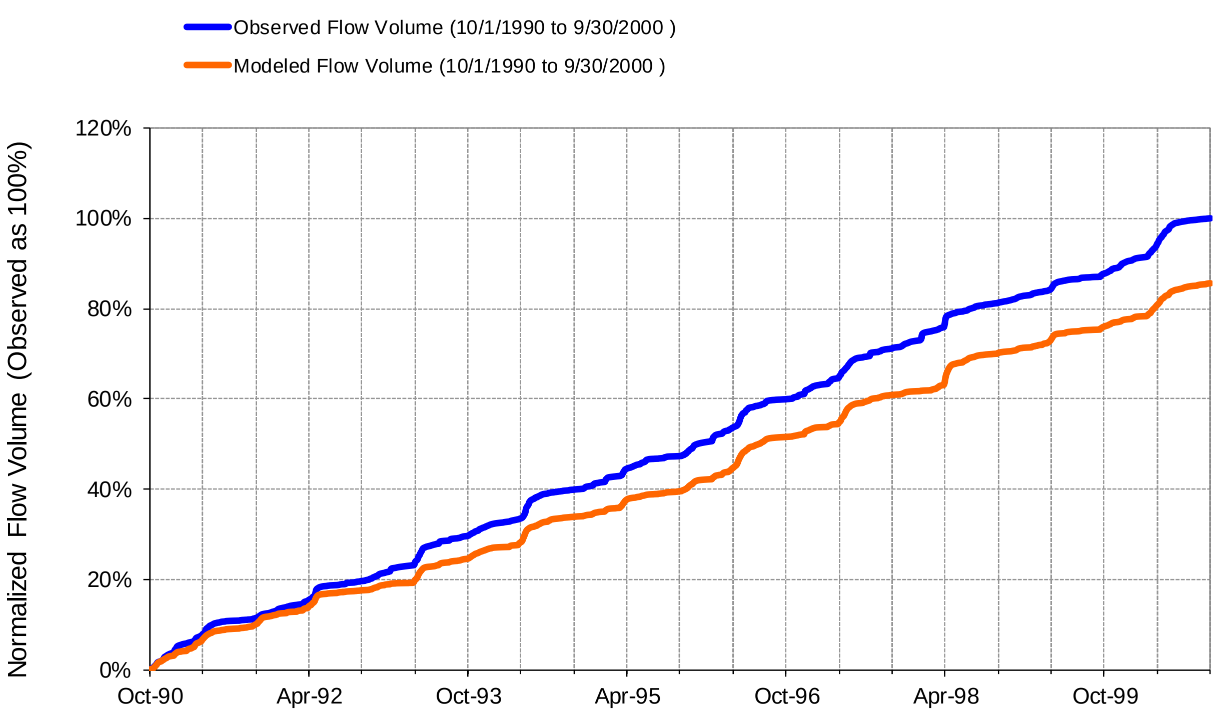


Figure G-28. Flow accumulation at USGS 04293500 Missisquoi River near East Berkshire, VT

Table G-8. Summary statistics at USGS 04293500 Missisquoi River near East Berkshire, VT

SWAT Simulated Flow		Observed Flow Gage	
REACH OUTFLOW FROM OUTLET 7		USGS 04293500 MISSISQUOI RIVER NEAR EAST BERKSHIRE, VT	
10-Year Analysis Period: 10/1/1990 - 9/30/2000 Flow volumes are (inches/year) for upstream drainage area		Hydrologic Unit Code: 4150407 Latitude: 44.96004599 Longitude: -72.696521 Drainage Area (sq-mi): 479	
Total Simulated In-stream Flow:	**24.78**	Total Observed In-stream Flow:	**28.94**
Total of simulated highest 10% flows:	**10.46**	Total of Observed highest 10% flows:	**12.57**
Total of Simulated lowest 50% flows:	**2.88**	Total of Observed Lowest 50% flows:	**4.24**
Simulated Summer Flow Volume (months 7-9):	**3.03**	Observed Summer Flow Volume (7-9):	**3.09**
Simulated Fall Flow Volume (months 10-12):	**5.57**	Observed Fall Flow Volume (10-12):	**7.44**
Simulated Winter Flow Volume (months 1-3):	**6.10**	Observed Winter Flow Volume (1-3):	**7.58**
Simulated Spring Flow Volume (months 4-6):	**10.07**	Observed Spring Flow Volume (4-6):	**10.84**
Total Simulated Storm Volume:	**9.12**	Total Observed Storm Volume:	**12.11**
Simulated Summer Storm Volume (7-9):	**1.10**	Observed Summer Storm Volume (7-9):	**1.55**

Errors (Simulated-Observed)	*Error Statistics*	*Recommended Criteria*		
Error in total volume:	-14.40	10		
Error in 50% lowest flows:	-32.12	10		
Error in 10% highest flows:	-16.80	15		
Seasonal volume error - Summer:	-1.77	30		
Seasonal volume error - Fall:	-25.14	>> 30		Clear
Seasonal volume error - Winter:	-19.51	30		
Seasonal volume error - Spring:	-7.05	30		
Error in storm volumes:	-24.69	20		
Error in summer storm volumes:	-28.60	50		
Nash-Sutcliffe Coefficient of Efficiency, E:	0.556	Model accuracy increases		
Baseline adjusted coefficient (Garrick), E':	0.434	as E or E' approaches 1.0		
Monthly NSE	0.735			

USGS 04294000 Missisquoi River at Swanton, VT - Calibration

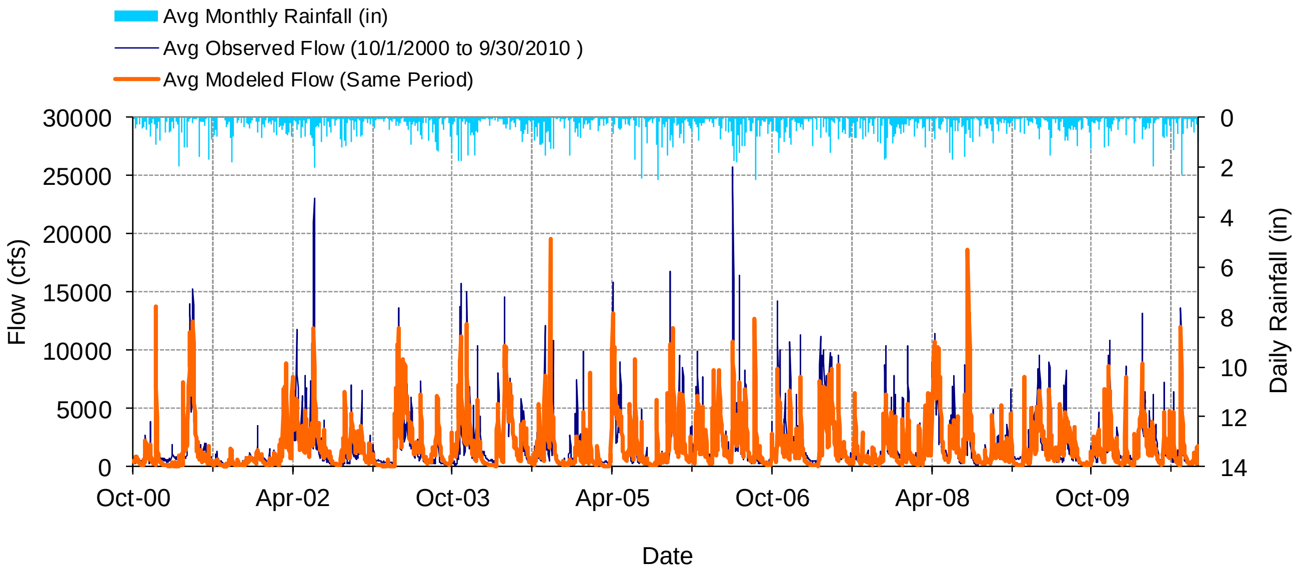


Figure G-29. Mean daily flow at USGS 04294000 Missisquoi River at Swanton, VT

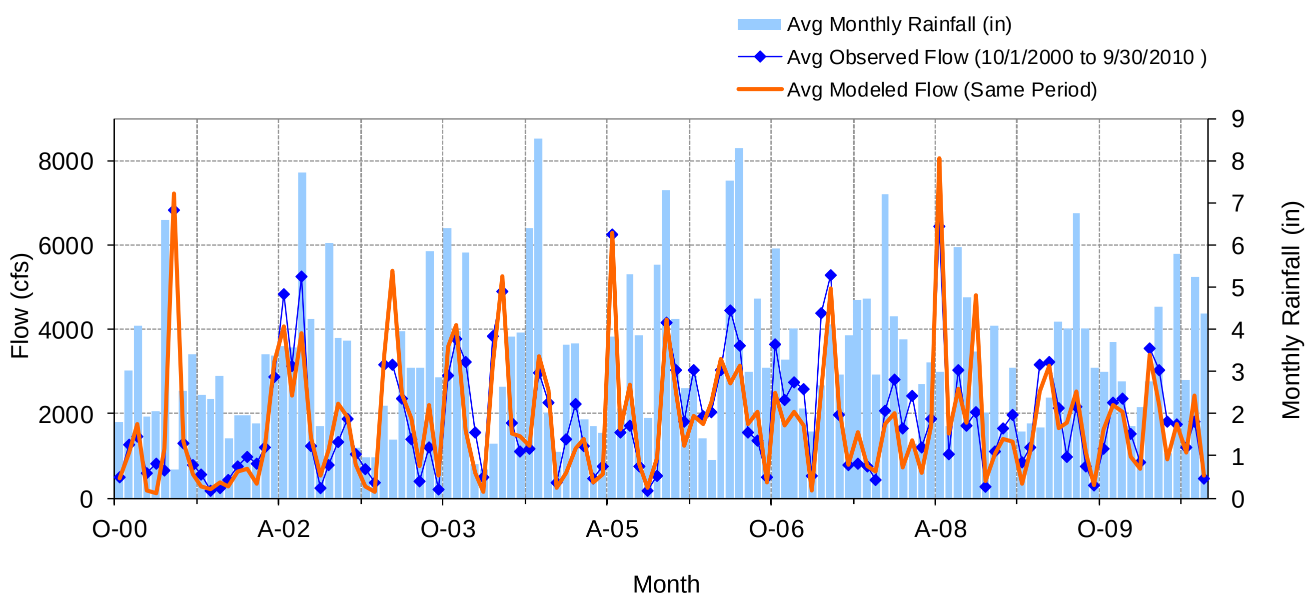


Figure G-30. Mean monthly flow at USGS 04294000 Missisquoi River at Swanton, VT

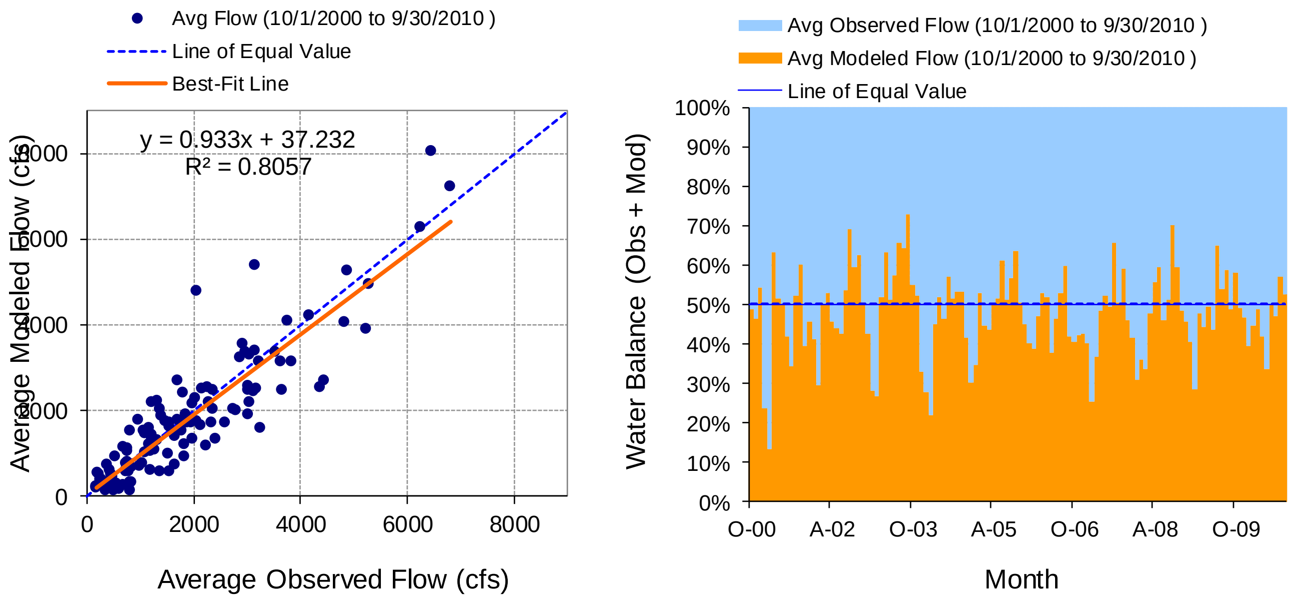


Figure G-31. Monthly flow regression and temporal variation at USGS 04294000 Missisquoi River at Swanton, VT

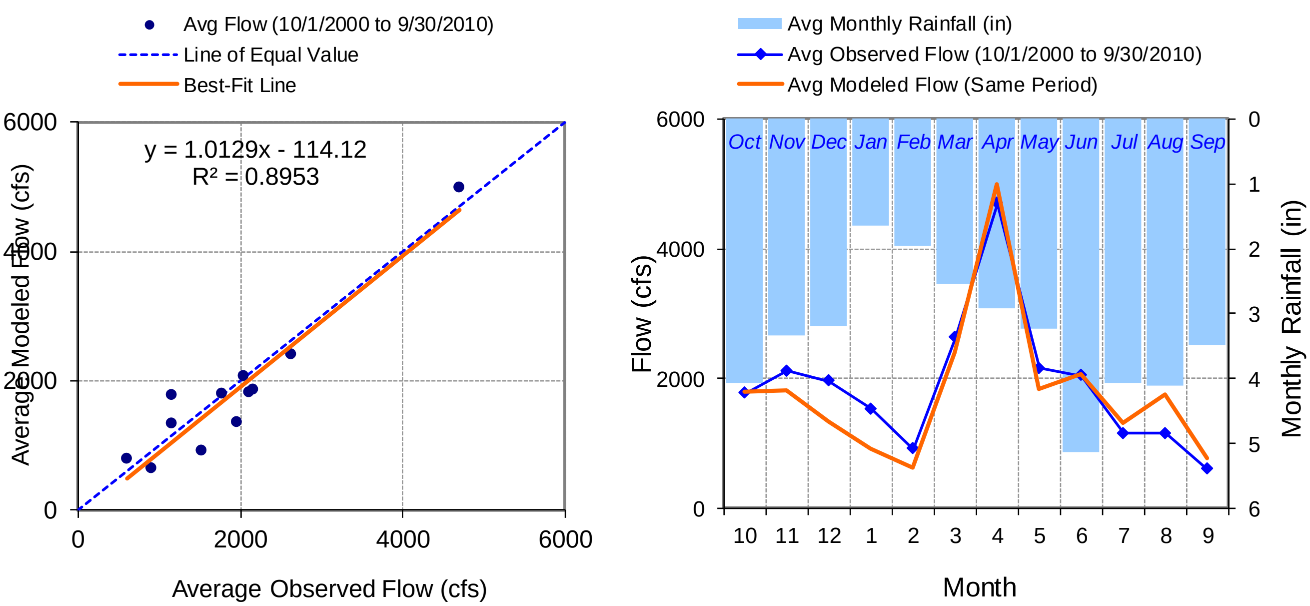


Figure G-32. Seasonal regression and temporal aggregate at USGS 04294000 Missisquoi River at Swanton, VT

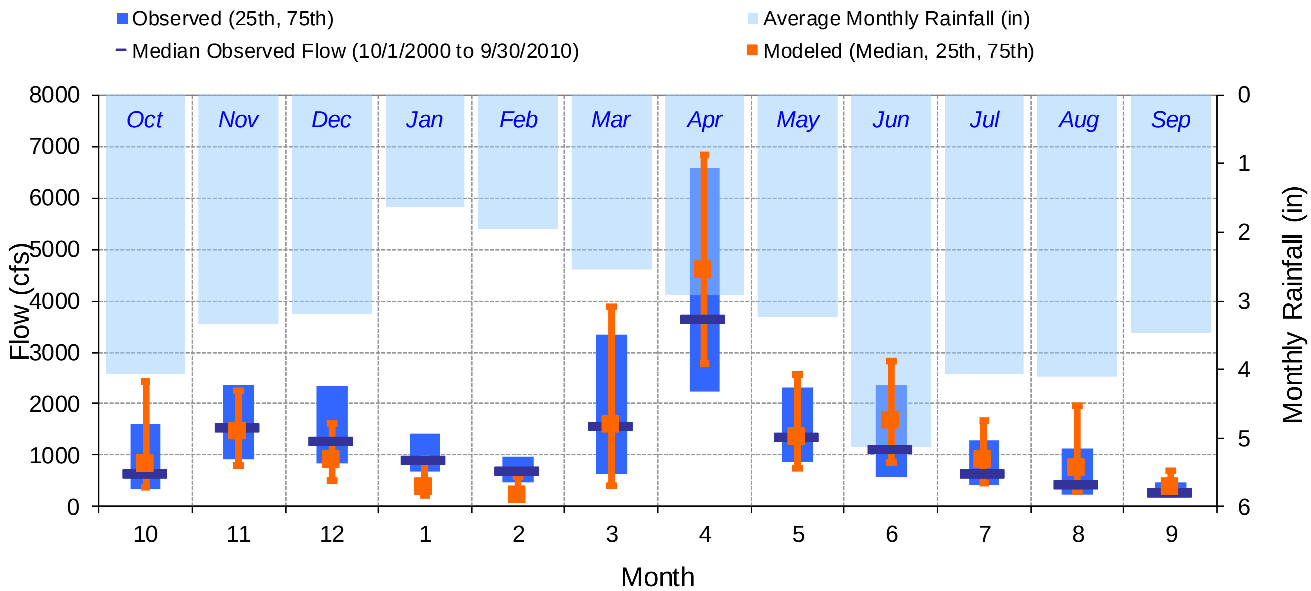


Figure G-33. Seasonal medians and ranges at USGS 04294000 Missisquoi River at Swanton, VT

Table G-9. Seasonal summary at USGS 04294000 Missisquoi River at Swanton, VT

MONTH	OBSERVED FLOW (CFS)				MODELED FLOW (CFS)			
	MEAN	MEDIAN	25TH	75TH	MEAN	MEDIAN	25TH	75TH
Oct	1767.25	632.00	352.00	1615.00	1792.15	838.02	369.48	2436.09
Nov	2111.52	1545.00	931.00	2372.50	1810.41	1450.55	793.17	2248.93
Dec	1955.87	1280.00	840.25	2350.00	1341.80	903.70	510.65	1609.82
Jan	1529.31	900.00	670.75	1420.00	913.89	379.10	226.38	929.13
Feb	909.38	701.50	477.50	960.00	628.75	212.88	131.29	589.14
Mar	2627.81	1555.00	627.00	3335.00	2400.83	1598.87	393.05	3872.25
Apr	4698.35	3640.00	2225.00	6587.50	4989.53	4583.84	2772.29	6832.51
May	2159.67	1350.00	861.75	2320.00	1843.07	1346.37	758.03	2554.31
Jun	2043.35	1125.00	569.50	2362.50	2059.02	1675.33	853.11	2839.39
Jul	1154.18	638.00	409.75	1277.50	1315.66	898.41	456.00	1682.39
Aug	1150.94	441.00	232.50	1140.00	1760.47	760.68	311.58	1949.37
Sep	600.32	286.50	186.75	471.50	776.19	369.92	237.69	708.50

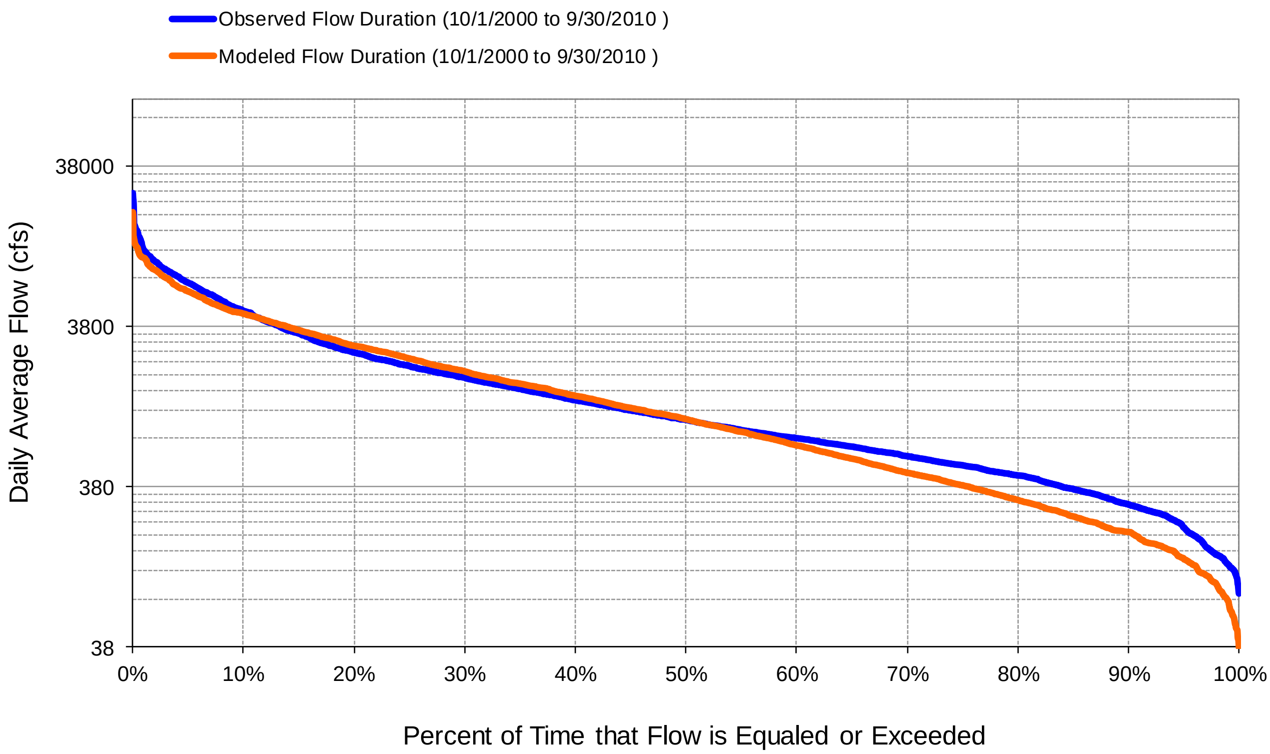


Figure G-34. Flow exceedence at USGS 04294000 Missisquoi River at Swanton, VT

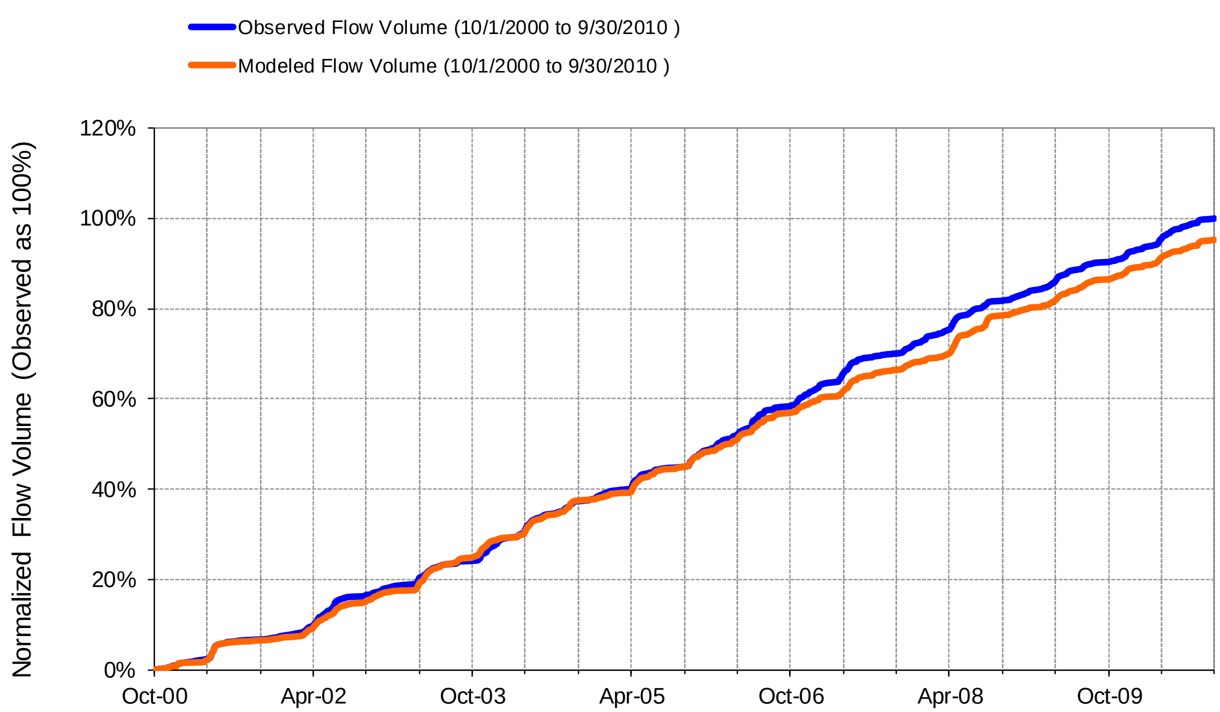


Figure G-35. Flow accumulation at USGS 04294000 Missisquoi River at Swanton, VT

Table G-10. Summary statistics at USGS 04294000 Missisquoi River at Swanton, VT

SWAT Simulated Flow		Observed Flow Gage		
REACH OUTFLOW FROM OUTLET 2 10-Year Analysis Period: 10/1/2000 - 9/30/2010 Flow volumes are (inches/year) for upstream drainage area		USGS 04294000 MISSISQUOI RIVER AT SWANTON, VT Hydrologic Unit Code: 4150407 Latitude: 44.91670937 Longitude: -73.1284645 Drainage Area (sq-mi): 850		
Total Simulated In-stream Flow:	**28.85**	Total Observed In-stream Flow:		**30.28**
Total of simulated highest 10% flows:	**11.10**	Total of Observed highest 10% flows:		**12.71**
Total of Simulated lowest 50% flows:	**3.49**	Total of Observed Lowest 50% flows:		**4.21**
Simulated Summer Flow Volume (months 7-9):	**5.19**	Observed Summer Flow Volume (7-9):		**3.92**
Simulated Fall Flow Volume (months 10-12):	**6.63**	Observed Fall Flow Volume (10-12):		**7.82**
Simulated Winter Flow Volume (months 1-3):	**5.27**	Observed Winter Flow Volume (1-3):		**6.76**
Simulated Spring Flow Volume (months 4-6):	**11.75**	Observed Spring Flow Volume (4-6):		**11.78**
Total Simulated Storm Volume:	**10.83**	Total Observed Storm Volume:		**13.71**
Simulated Summer Storm Volume (7-9):	**2.14**	Observed Summer Storm Volume (7-9):		**2.14**
Errors (Simulated-Observed)	*Error Statistics*	*Recommended Criteria*		
Error in total volume:	-4.73	10		
Error in 50% lowest flows:	-17.19	10		
Error in 10% highest flows:	-12.69	15		
Seasonal volume error - Summer:	32.61	30		
Seasonal volume error - Fall:	-15.27	>> 30		Clear
Seasonal volume error - Winter:	-22.02	30		
Seasonal volume error - Spring:	-0.23	30		
Error in storm volumes:	-20.99	20		
Error in summer storm volumes:	0.02	50		
Nash-Sutcliffe Coefficient of Efficiency, E:	0.675	Model accuracy increases		
Baseline adjusted coefficient (Garrick), E':	0.501	as E or E' approaches 1.0		
Monthly NSE	0.782			

USGS 04294000 Missisquoi River at Swanton, VT - Validation

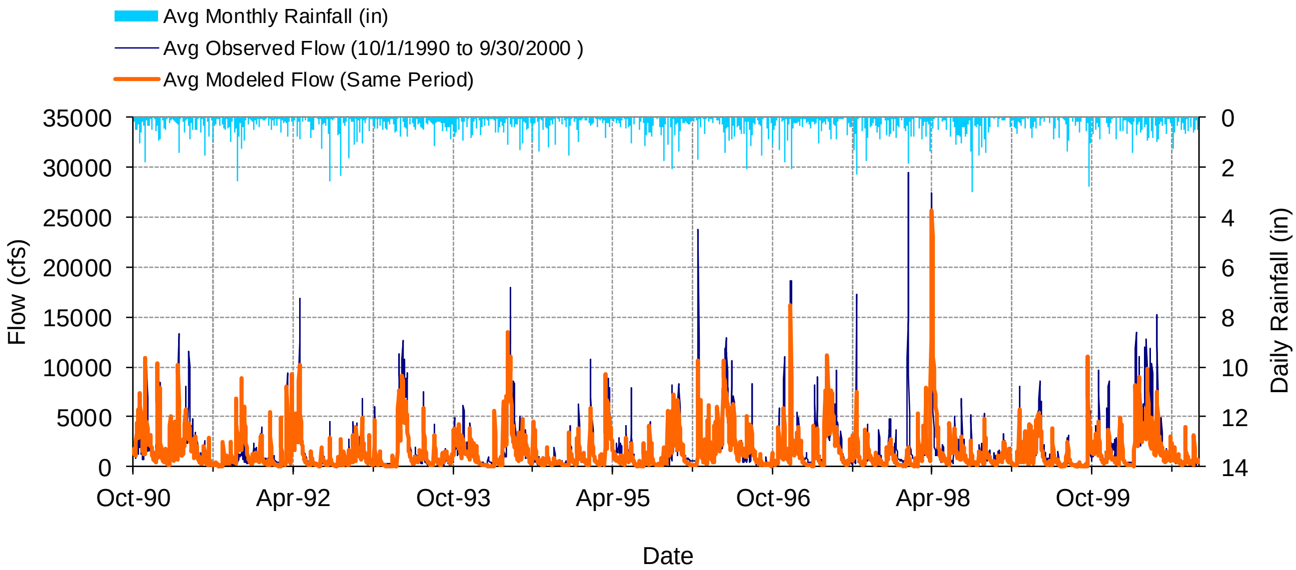


Figure G-36. Mean daily flow at USGS 04294000 Missisquoi River at Swanton, VT

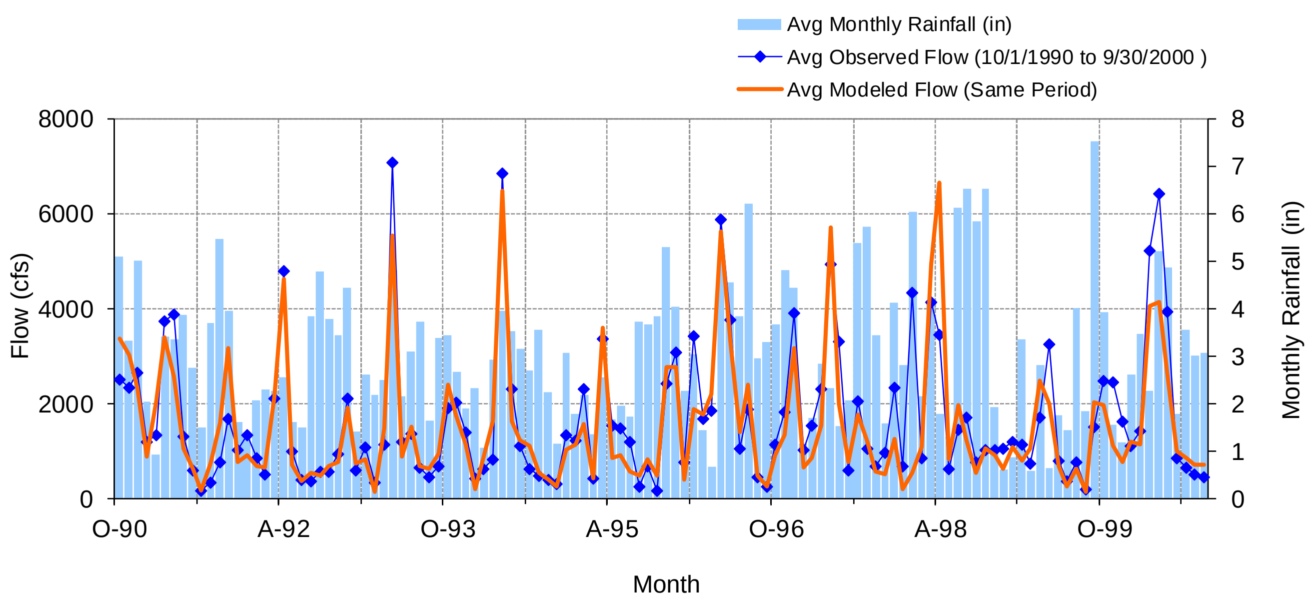


Figure G-37. Mean monthly flow at USGS 04294000 Missisquoi River at Swanton, VT

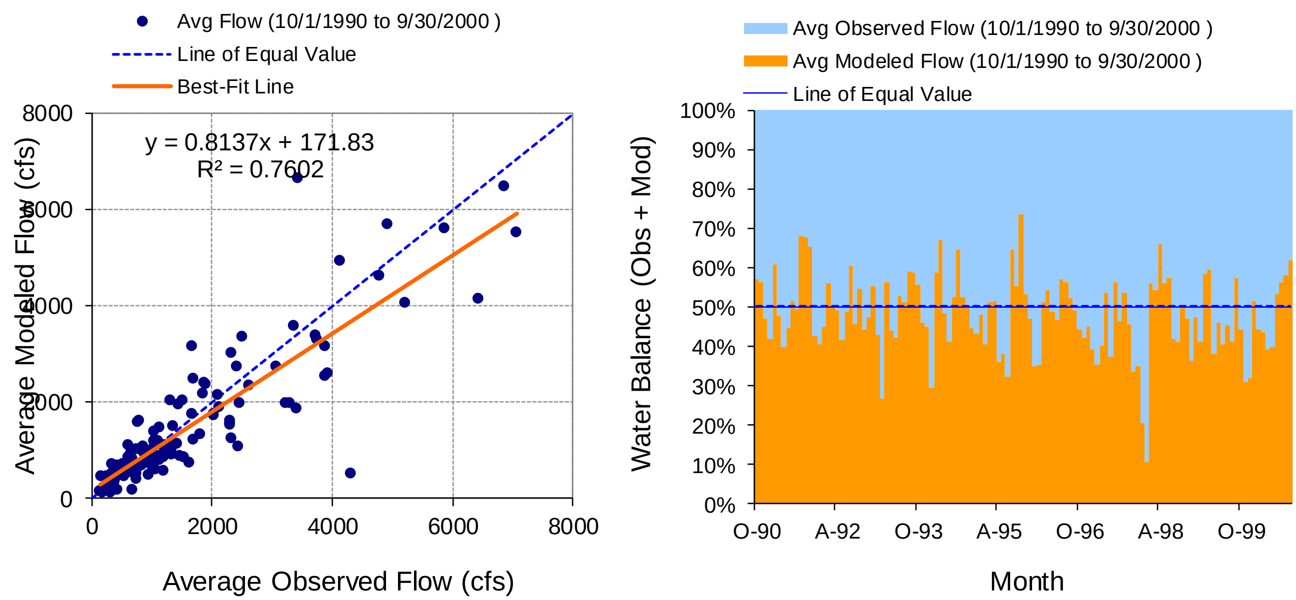


Figure G-38. Monthly flow regression and temporal variation at USGS 04294000 Missisquoi River at Swanton, VT

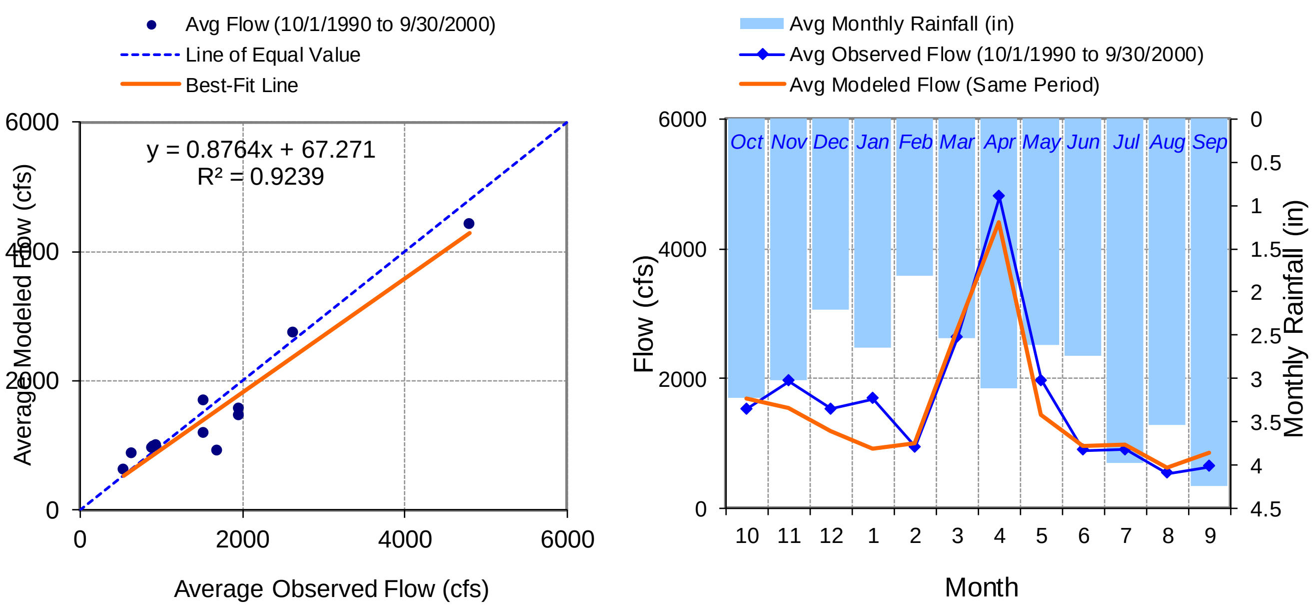


Figure G-39. Seasonal regression and temporal aggregate at USGS 04294000 Missisquoi River at Swanton, VT

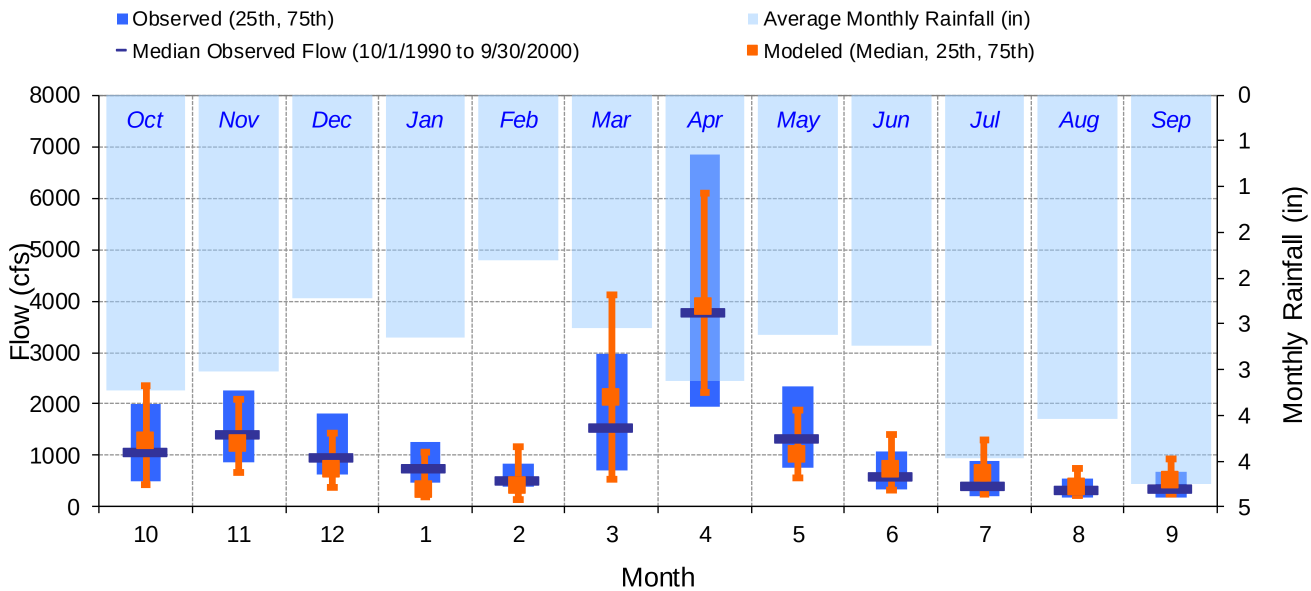


Figure G-40. Seasonal medians and ranges at USGS 04294000 Missisquoi River at Swanton, VT

Table G-11. Seasonal summary at USGS 04294000 Missisquoi River at Swanton, VT

MONTH	OBSERVED FLOW (CFS)				MODELED FLOW (CFS)			
	MEAN	MEDIAN	25TH	75TH	MEAN	MEDIAN	25TH	75TH
Oct	1528.41	1070.00	486.75	2000.00	1687.97	1274.15	420.77	2353.72
Nov	1954.46	1405.00	860.50	2250.00	1547.58	1231.95	671.42	2088.42
Dec	1530.09	965.00	630.50	1807.50	1181.44	717.06	372.66	1441.01
Jan	1682.36	745.00	470.00	1265.00	909.86	336.99	200.85	1074.71
Feb	940.27	510.00	387.50	853.50	996.21	402.23	134.50	1160.09
Mar	2631.02	1550.00	700.00	2975.00	2742.17	2120.82	528.66	4112.39
Apr	4804.99	3785.00	1940.00	6835.00	4410.88	3895.21	2222.44	6093.55
May	1965.39	1340.00	763.75	2350.00	1449.42	1015.12	558.59	1876.62
Jun	887.61	602.00	347.75	1090.00	956.98	710.53	328.37	1403.23
Jul	901.80	410.00	206.25	906.00	978.40	638.31	257.39	1302.49
Aug	537.14	316.00	185.25	555.00	618.36	370.80	230.92	752.20
Sep	639.45	362.50	180.75	677.50	859.59	500.06	250.32	925.95

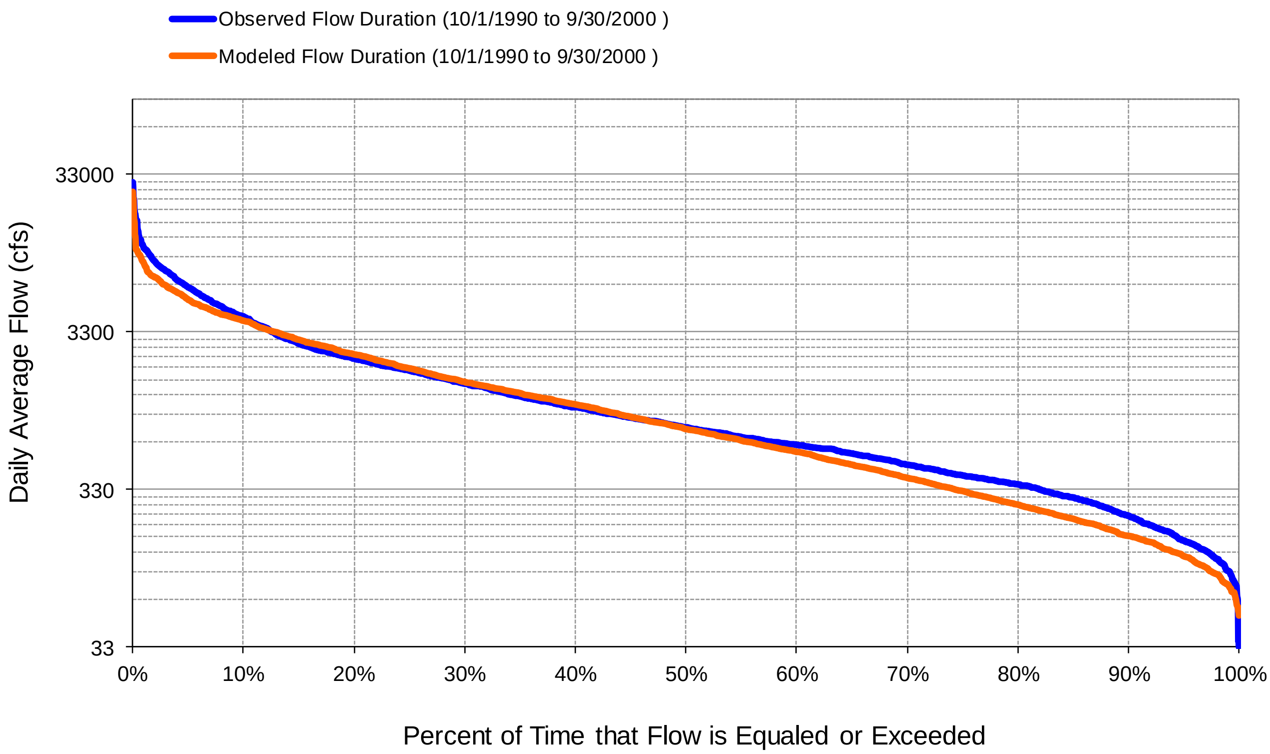


Figure G-41. Flow exceedence at USGS 04294000 Missisquoi River at Swanton, VT

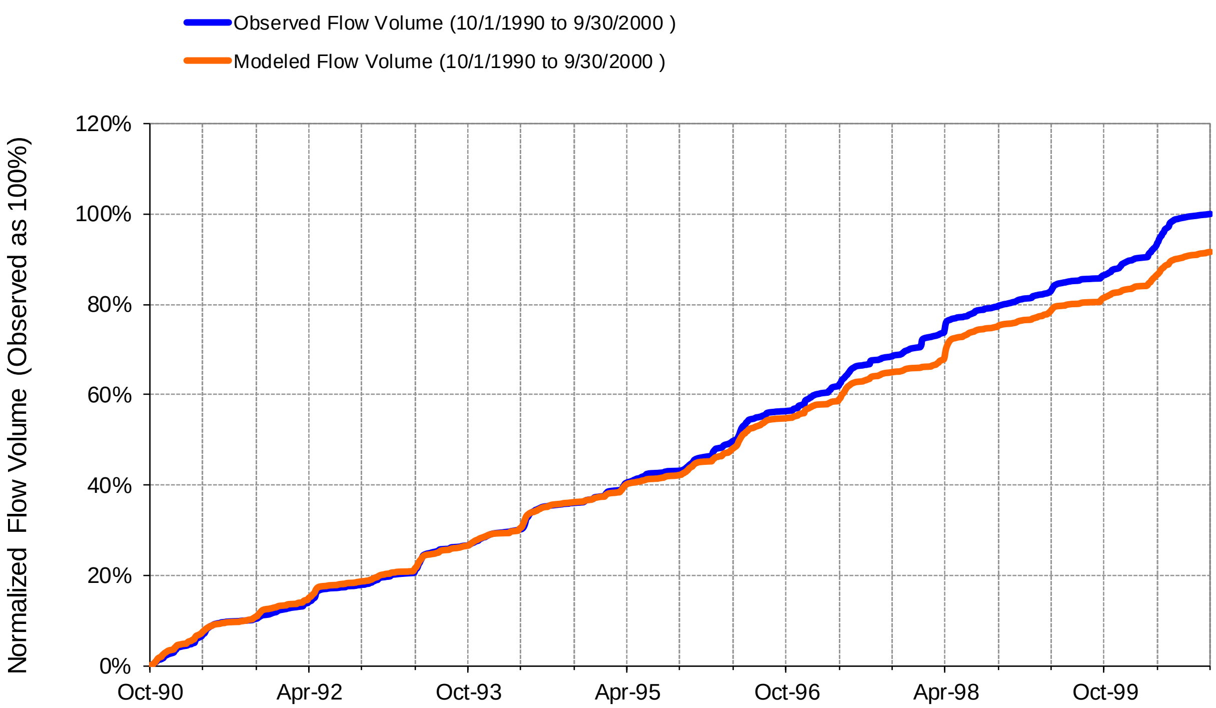


Figure G-42. Flow accumulation at USGS 04294000 Missisquoi River at Swanton, VT

Table G-12. Summary statistics at USGS 04294000 Missisquoi River at Swanton, VT

SWAT Simulated Flow		Observed Flow Gage	
REACH OUTFLOW FROM OUTLET 2 10-Year Analysis Period: 10/1/1990 - 9/30/2000 Flow volumes are (inches/year) for upstream drainage area		USGS 04294000 MISSISQUOI RIVER AT SWANTON, VT Hydrologic Unit Code: 4150407 Latitude: 44.91670937 Longitude: -73.1284645 Drainage Area (sq-mi): 850	
Total Simulated In-stream Flow:	**24.41**	Total Observed In-stream Flow:	**26.65**
Total of simulated highest 10% flows:	**9.84**	Total of Observed highest 10% flows:	**11.95**
Total of Simulated lowest 50% flows:	**2.91**	Total of Observed Lowest 50% flows:	**3.41**
Simulated Summer Flow Volume (months 7-9):	**3.29**	Observed Summer Flow Volume (7-9):	**2.79**
Simulated Fall Flow Volume (months 10-12):	**5.92**	Observed Fall Flow Volume (10-12):	**6.71**
Simulated Winter Flow Volume (months 1-3):	**6.19**	Observed Winter Flow Volume (1-3):	**7.01**
Simulated Spring Flow Volume (months 4-6):	**9.01**	Observed Spring Flow Volume (4-6):	**10.14**
Total Simulated Storm Volume:	**9.53**	Total Observed Storm Volume:	**11.92**
Simulated Summer Storm Volume (7-9):	**1.44**	Observed Summer Storm Volume (7-9):	**1.59**

Errors (Simulated-Observed)	*Error Statistics*	*Recommended Criteria*		
Error in total volume:	-8.41	10		
Error in 50% lowest flows:	-14.72	10		
Error in 10% highest flows:	-17.66	15		
Seasonal volume error - Summer:	18.02	30		
Seasonal volume error - Fall:	-11.77	>> 30		Clear
Seasonal volume error - Winter:	-11.80	30		
Seasonal volume error - Spring:	-11.11	30		
Error in storm volumes:	-20.02	20		
Error in summer storm volumes:	-9.61	50		
Nash-Sutcliffe Coefficient of Efficiency, E:	0.564	Model accuracy increases		
Baseline adjusted coefficient (Garrick), E':	0.458	as E or E' approaches 1.0		
Monthly NSE	0.747			

TSS and TP distribution by channel and upland sources

Table G-13. TSS and TP distribution by source categories

Source	TSS		TP	
	Load(mt/year)	Percentage (%)	Load (kg/year)	Percentage (%)
Upland	160,224	59.4	94,785	63.1
Stream	109,336	40.6	55,434	36.9
Total	**269,560**	**100.00**	**150,218**	**100.00**

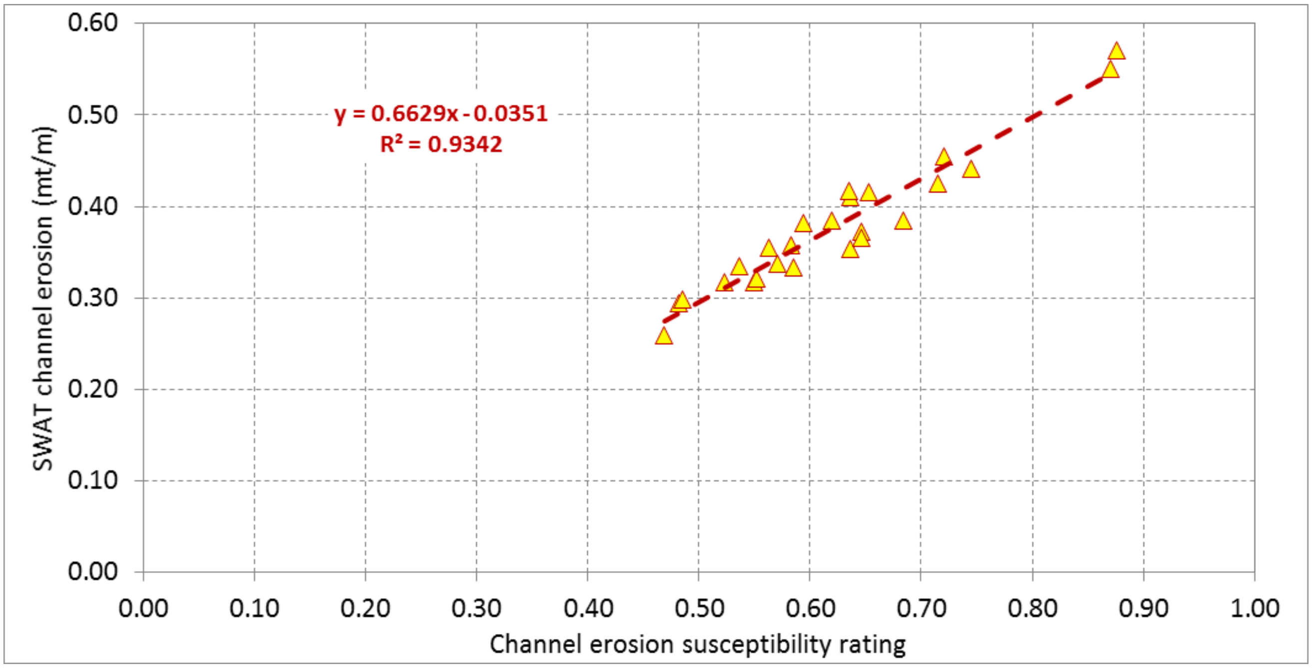


Figure G-43. SWAT simulated channel erosion relative to channel erosion susceptibility rating

TP distribution by landuse from upland sources

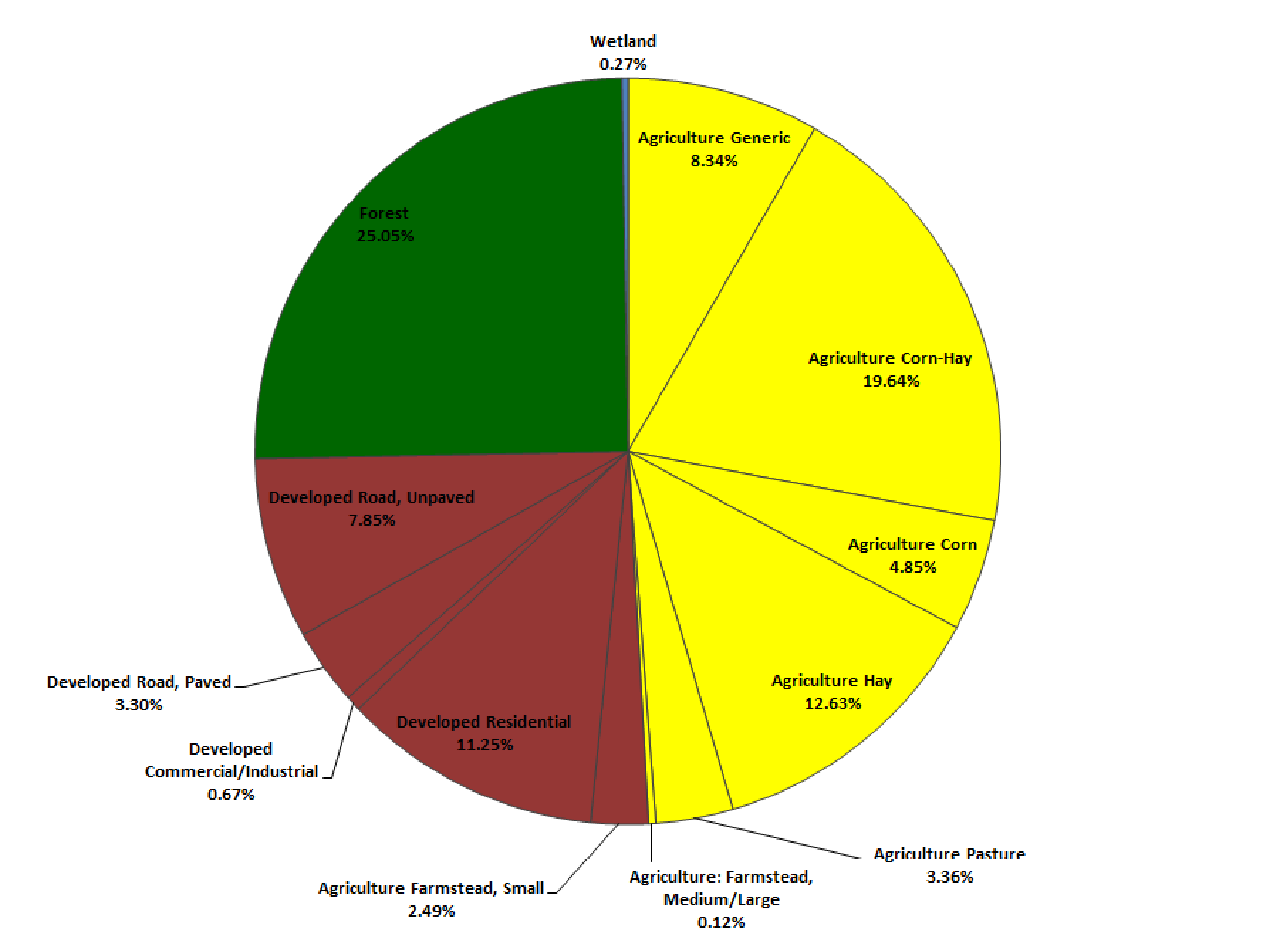


Figure G-44. Distribution of simulated total upland TP loads by landuse categories

Table G-14. TP export rates (kg/ha/yr) by landuse categories for the 30 year simulation period

Landuse	Classification	Area (ha)	Area (%)	Mean	Min	Q_{25}	Q_{50}	Q_{75}	Max
Agriculture	Generic	4,118	1.84	1.92	1.12	1.61	1.76	2.32	3.17
	Corn-Hay	9,184	4.11	2.03	0.09	1.41	2.22	2.74	4.16
	Corn	2,191	0.98	2.10	0.95	1.49	1.96	2.72	3.87
	Hay	13,813	6.18	0.87	0.49	0.64	0.78	1.11	1.48
	Pasture	2,397	1.07	1.33	0.79	1.10	1.22	1.61	1.98
	Farmstead, Medium/Large	92	0.04	3.11	1.65	2.34	2.85	3.89	4.84
	Farmstead, Small	777	0.35	3.03	1.61	2.27	2.76	3.79	4.66
Urban	Residential	9,933	4.44	1.07	0.75	0.95	1.01	1.22	1.51
	Commercial/Industrial	296	0.13	2.14	1.82	1.95	2.05	2.31	2.60
	Road, Paved	1,553	0.69	2.01	1.70	1.94	1.97	2.08	2.48
	Road, Unpaved	1,462	0.65	5.09	4.24	4.88	5.06	5.29	6.18
Forest	Forest	174,082	77.88	0.14	0.08	0.12	0.13	0.16	0.19
Wetland	Wetland	3,626	1.62	0.07	0.04	0.05	0.07	0.08	0.11

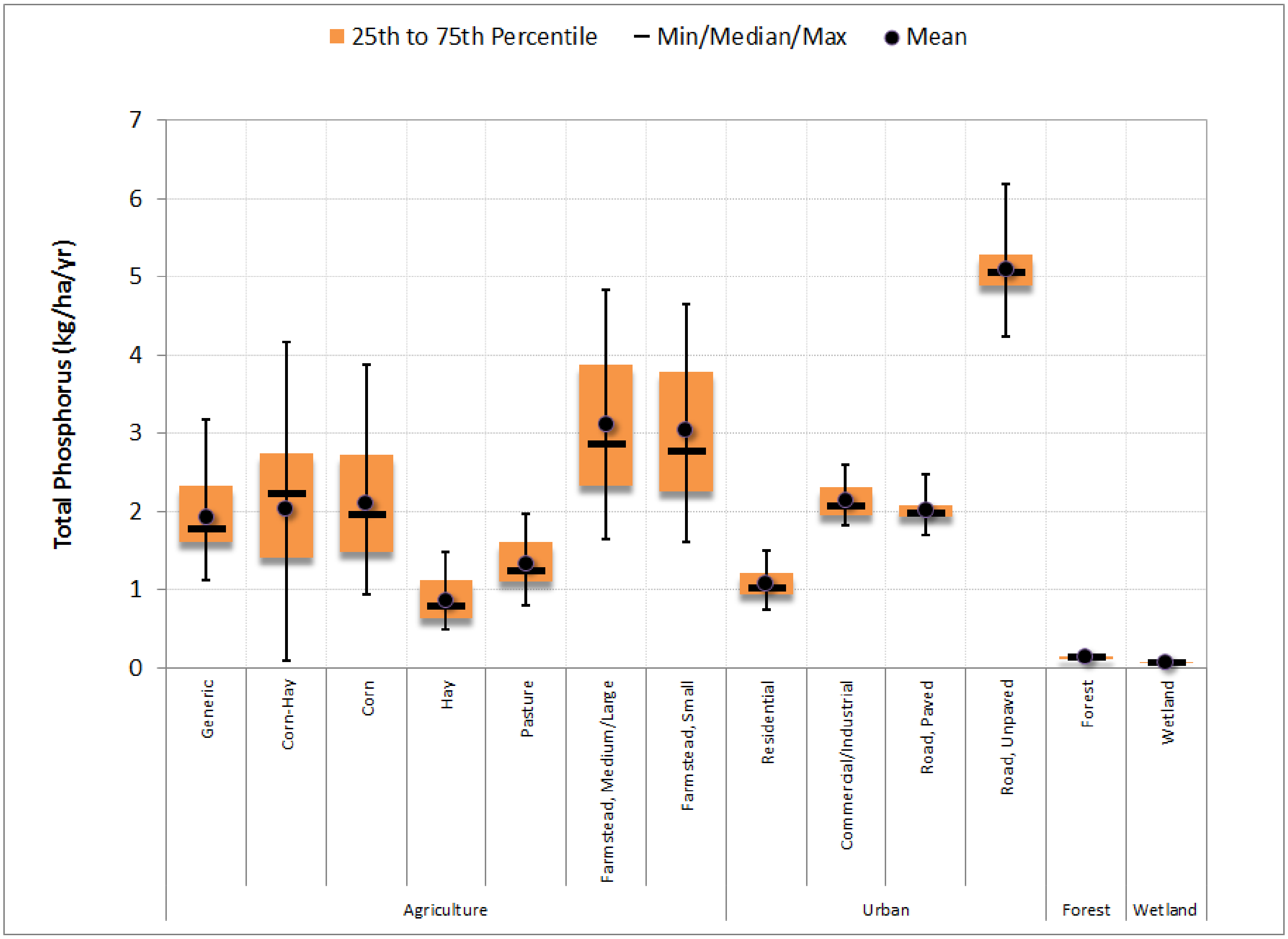


Figure G-45. TP export rates (kg/ha/yr) by landuse categories for the 30 year simulation period

Table G-15. TP export rates (kg/ha/yr) for the residential landuse categories for the 30 year simulation period

Residential Category	Area (ha)	Area (%)	Mean	Min	Q_{25}	Q_{50}	Q_{75}	Max
Low Density	4,238	46.43	**0.63**	0.41	0.52	0.55	0.76	1.04
Medium Density	4,253	46.60	**1.28**	0.85	1.12	1.19	1.46	1.81
High Density	636	6.97	**1.42**	1.04	1.27	1.40	1.57	1.79
Total	9,127	100.00	**0.99**	0.66	0.85	0.91	1.14	1.44

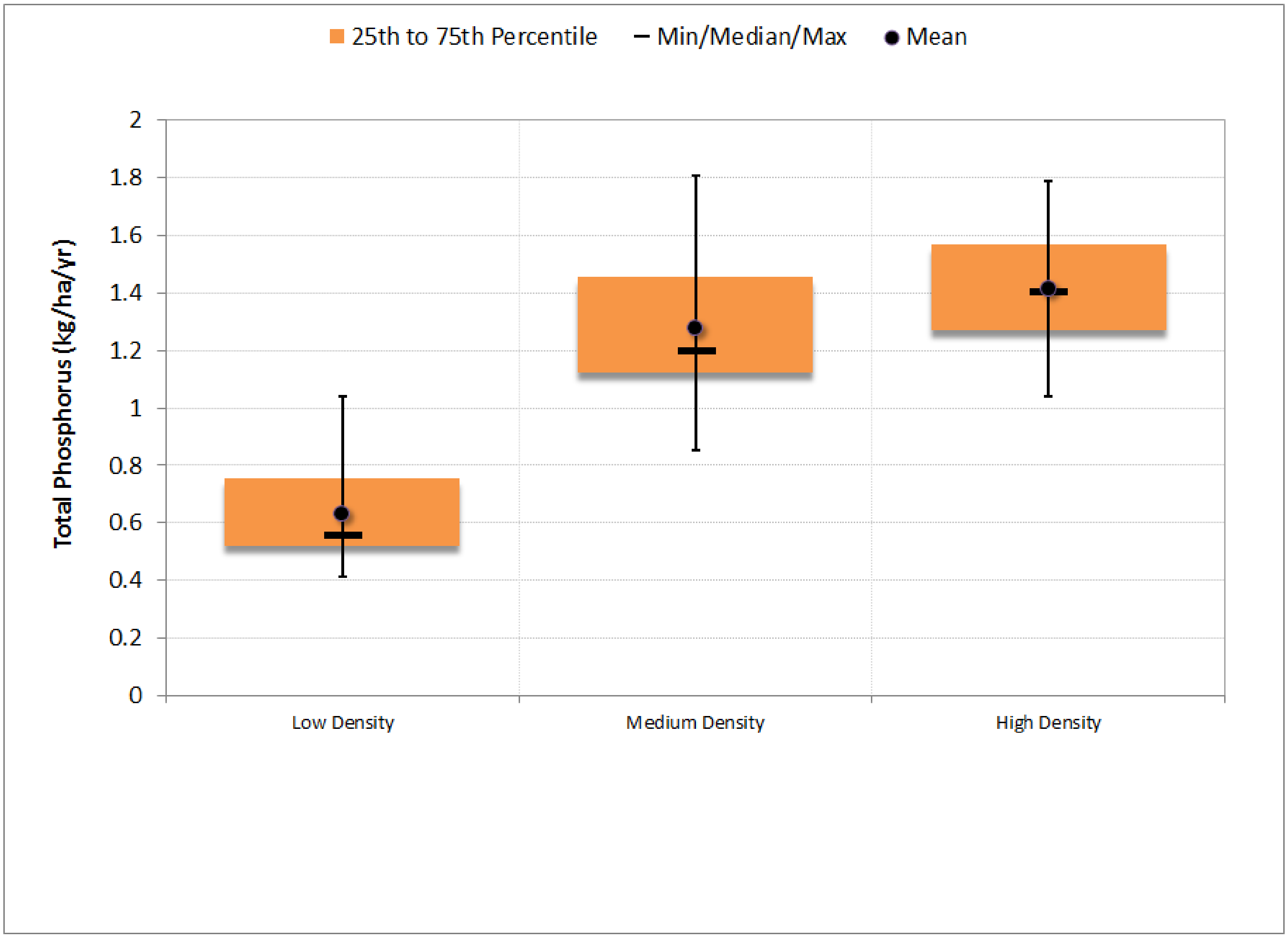


Figure G-46. TP export rates (kg/ha/yr) for the residential landuse categories for the 30 year simulation period

Segmented Regression

Table G-16. Summary statistics

Statistic	Calibration		Validation	
	TSS	TP	TSS	TP
Average absolute error (%)	51.6	52.6	59.1	59.0
Median absolute error (%)	17.1	25.0	17.2	24.6
Regression error (%)	-1.4	5.4	15.8	9.5
NSE	0.526	0.461	0.458	0.504
NSE'	0.523	0.417	0.532	0.438

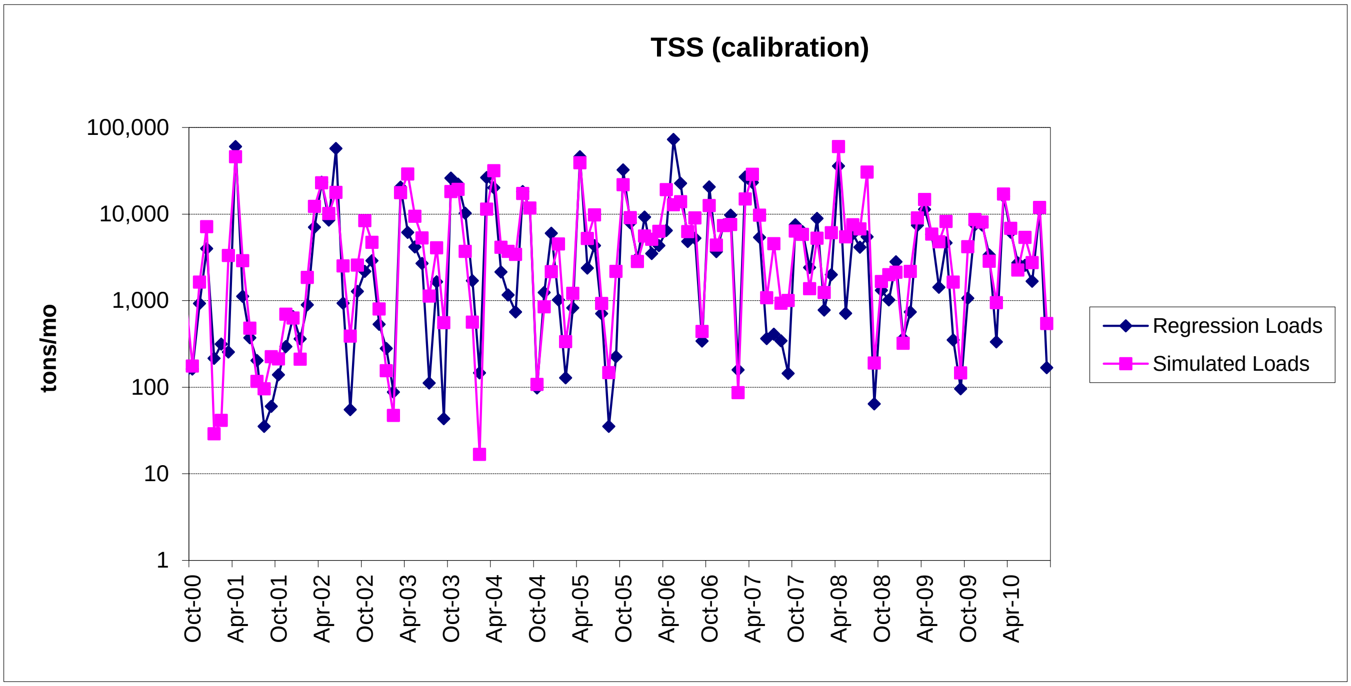


Figure G-47. Monthly simulated and estimated TSS load at Missisquoi River at Swanton, VT (calibration period)

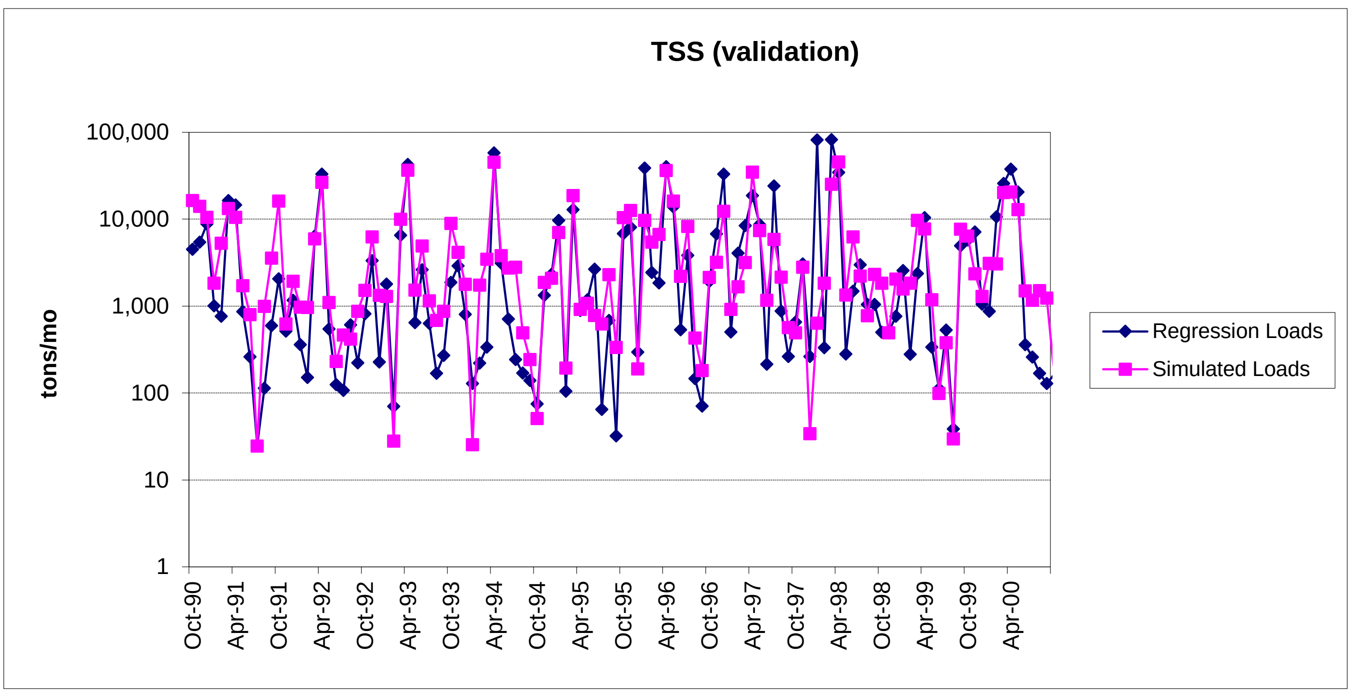


Figure G-48. Monthly simulated and estimated TSS load at Missisquoi River at Swanton, VT (validation period)

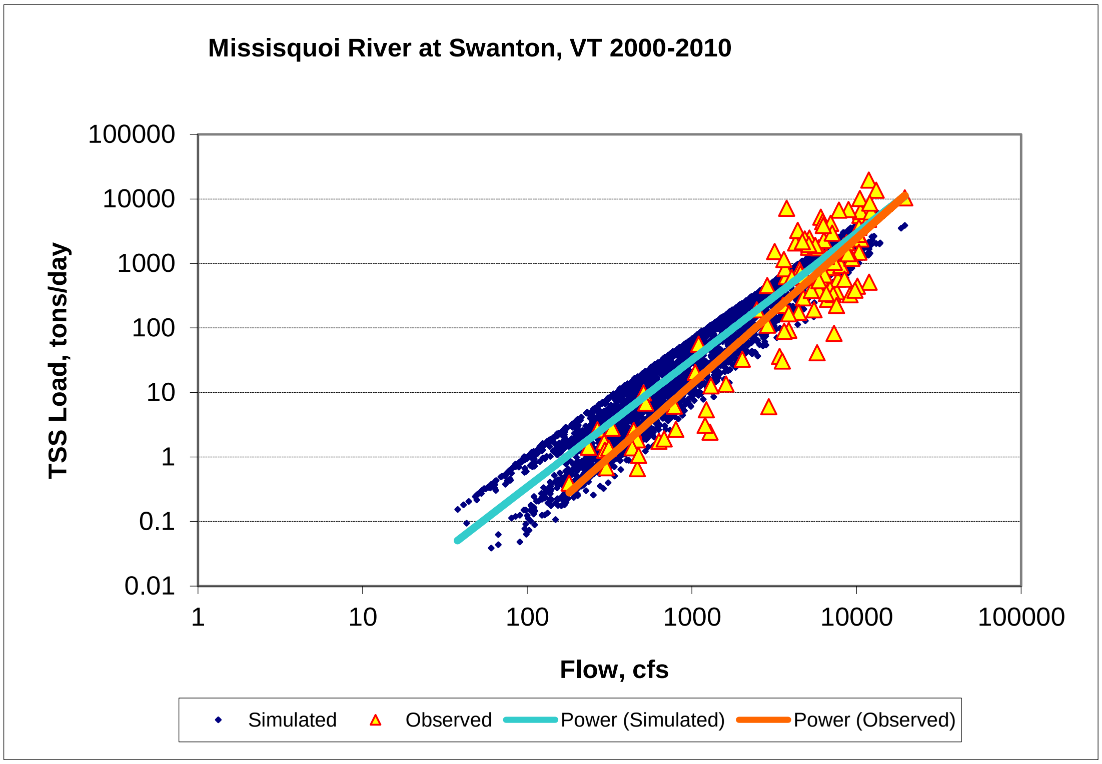


Figure G-49. Power plot of simulated and observed TSS load vs flow at Missisquoi River at Swanton, VT (calibration period)

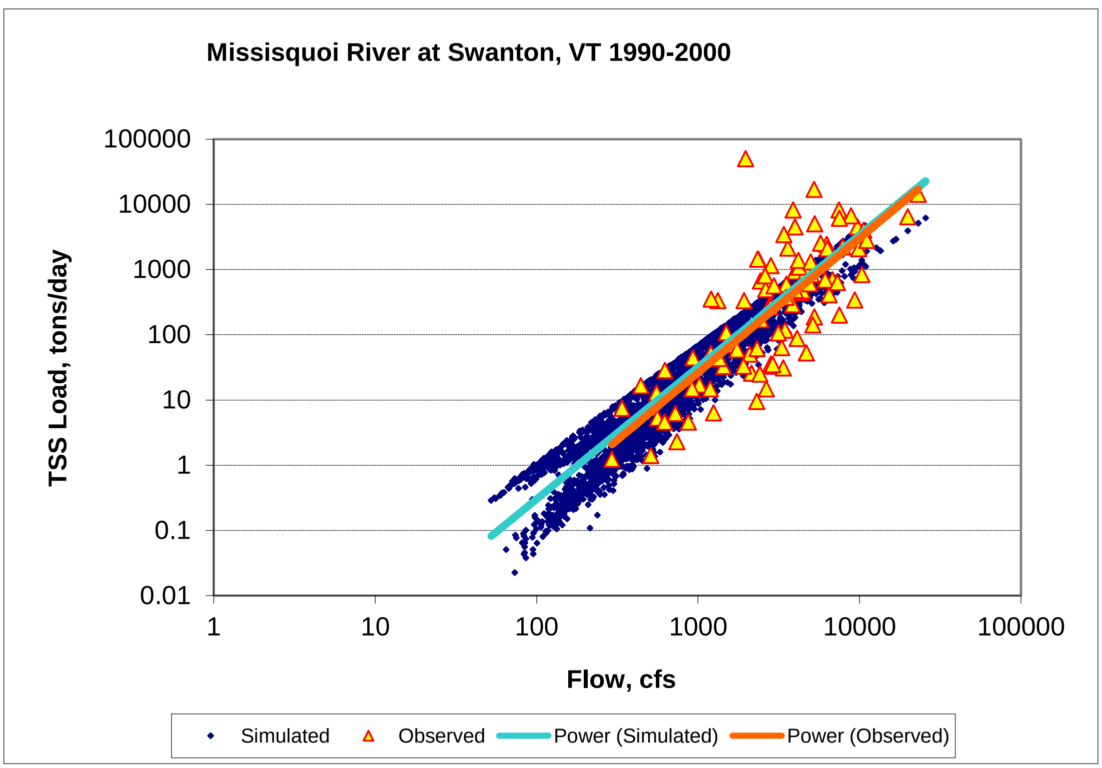


Figure G-50. Power plot of simulated and observed TSS load vs flow at Missisquoi River at Swanton, VT (validation period)

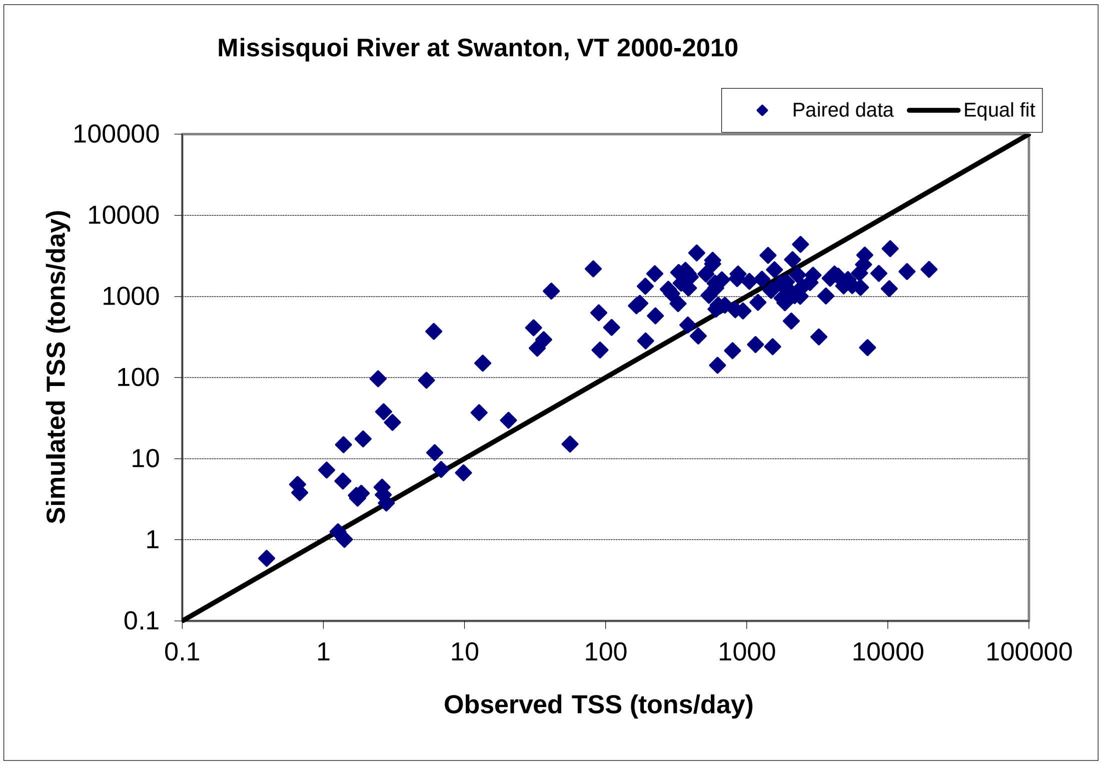


Figure G-51. Paired simulated vs observed TSS load at Missisquoi River at Swanton, VT (calibration period)

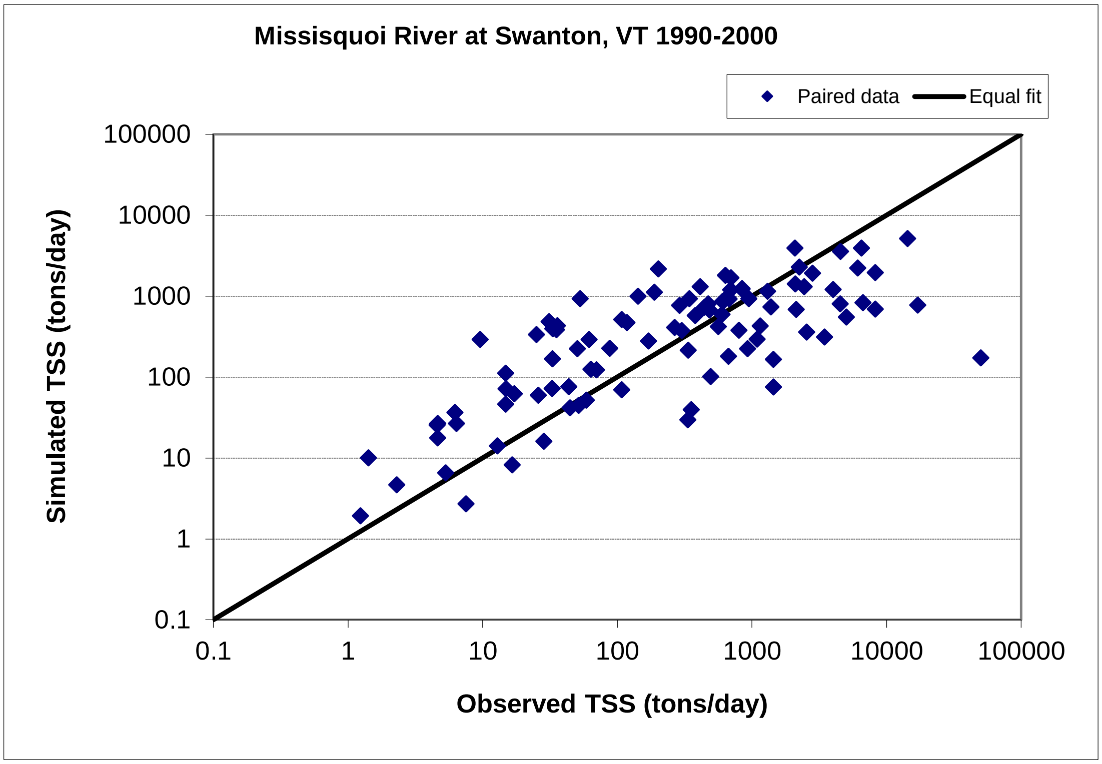


Figure G-52. Paired simulated vs observed TSS load at Missisquoi River at Swanton, VT (validation period)

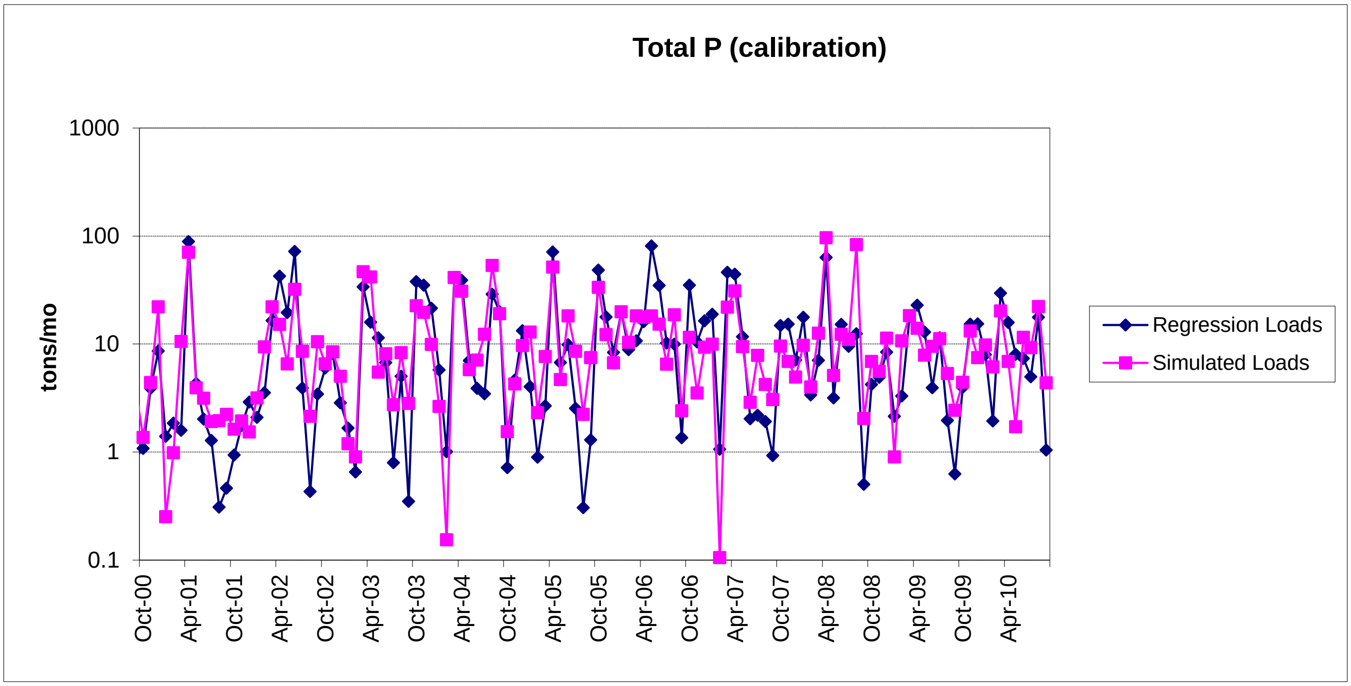


Figure G-53. Monthly simulated and estimated TP load at Missisquoi River at Swanton, VT (calibration period)

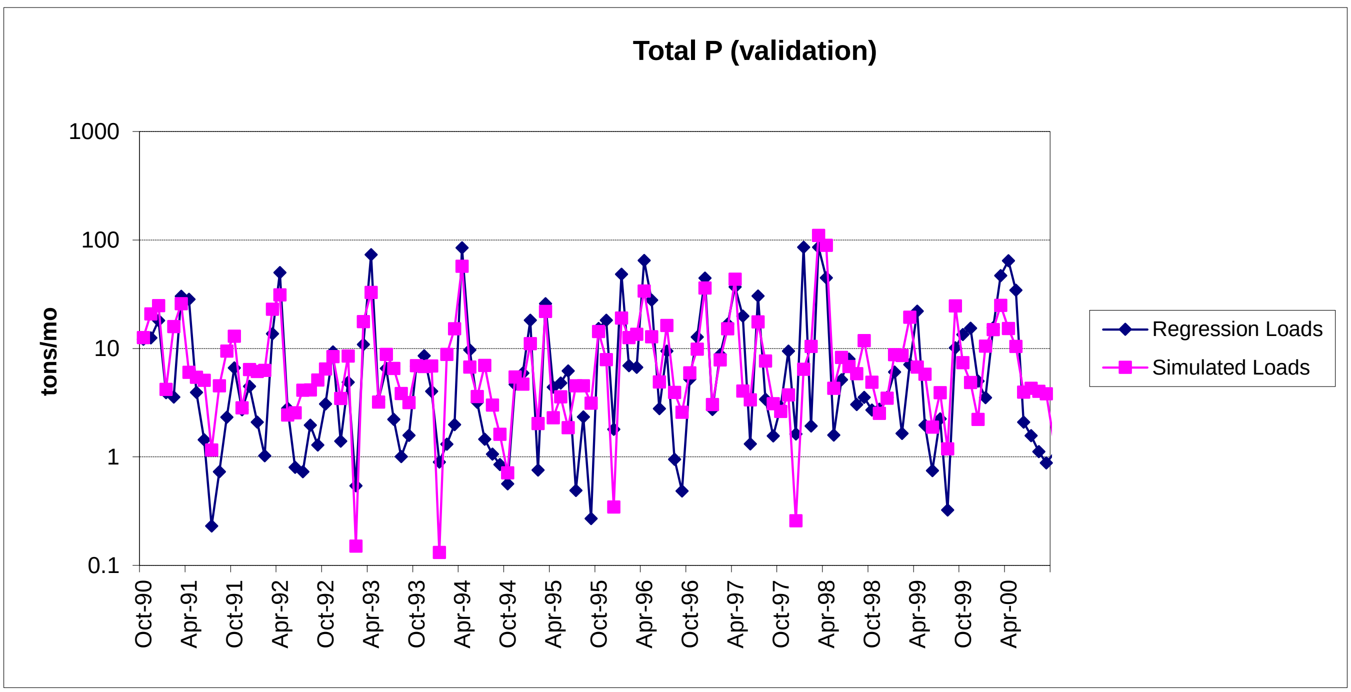


Figure G-54. Monthly simulated and estimated TP load at Missisquoi River at Swanton, VT (validation period)

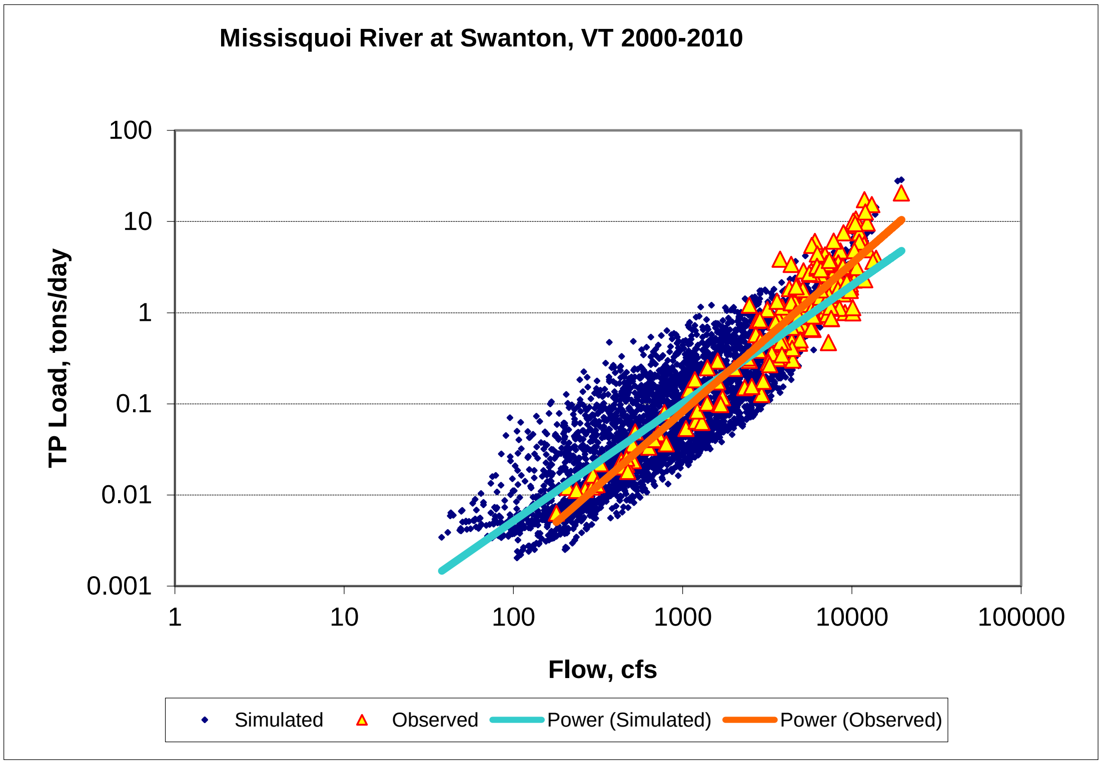


Figure G-55. Power plot of simulated and observed TP load vs flow at Missisquoi River at Swanton, VT (calibration period)

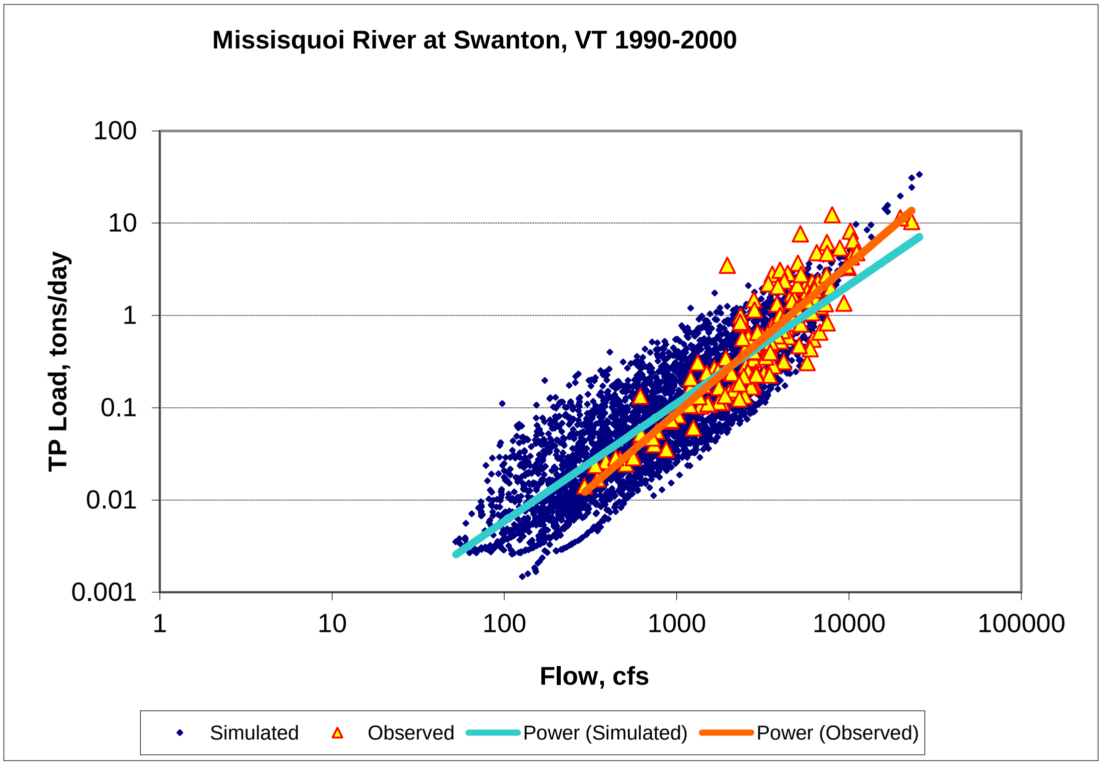


Figure G-56. Power plot of simulated and observed TP load vs flow at Missisquoi River at Swanton, VT (validation period)

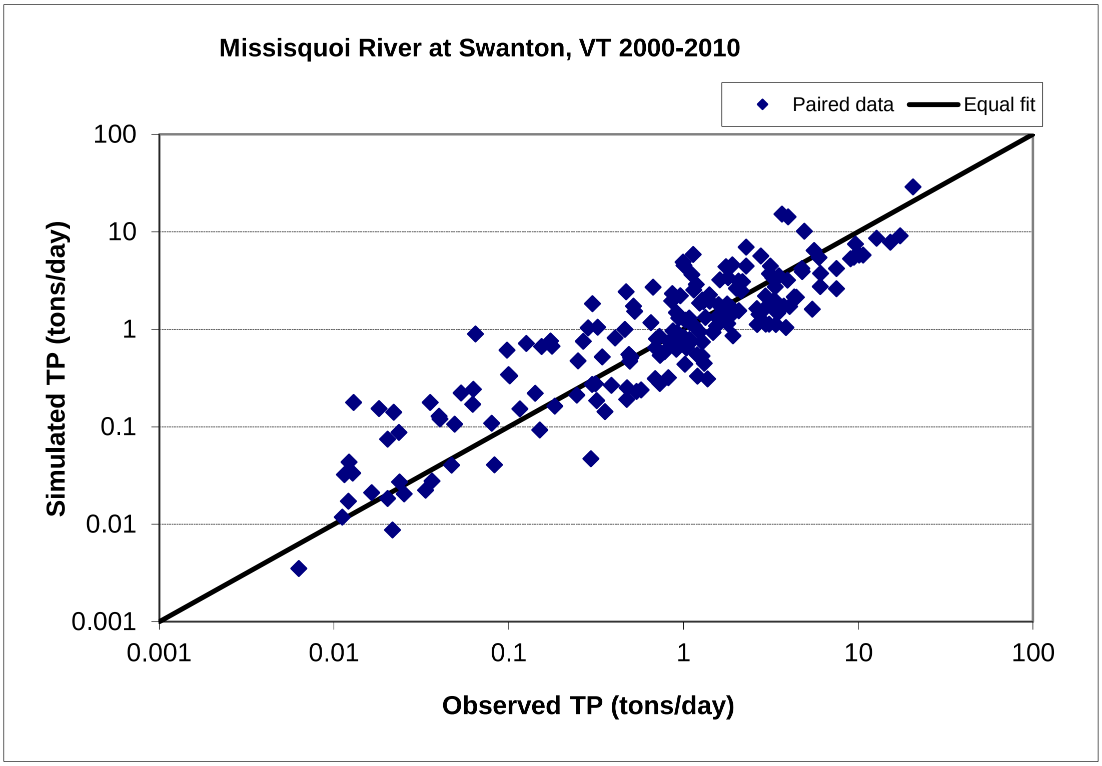


Figure G-57. Paired simulated vs observed TP load at Missisquoi River at Swanton, VT (calibration period)

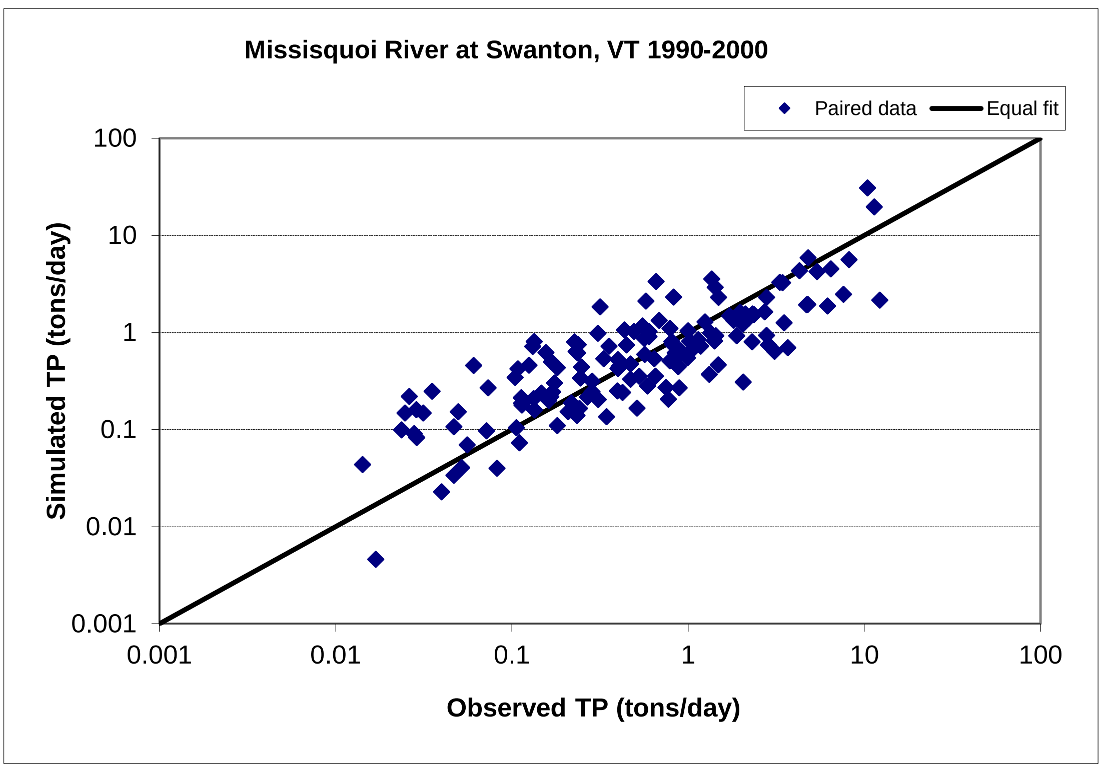


Figure G-58. Paired simulated vs observed TP load at Missisquoi River at Swanton, VT (validation period)

Comparison of simulated SWAT TP loads with FLUX estimates

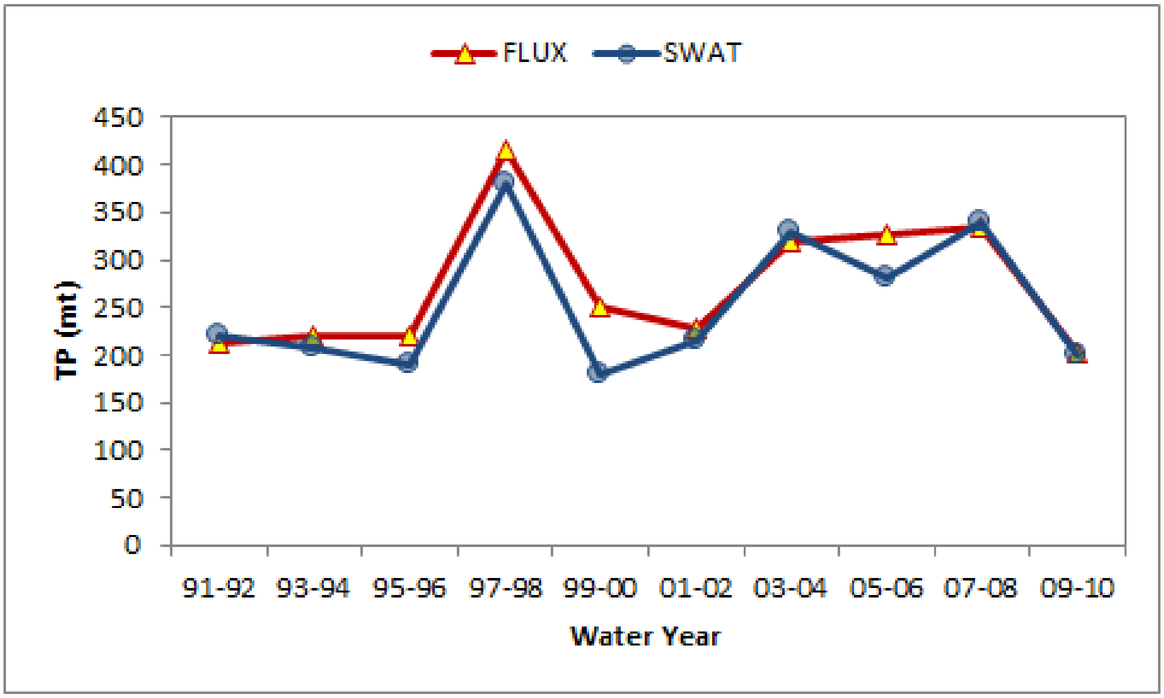


Figure G-59. Bi-annual TP loads on a water year basis as simulated by SWAT and estimated by FLUX (FLUX estimates from Smeltzer et al., 2009)

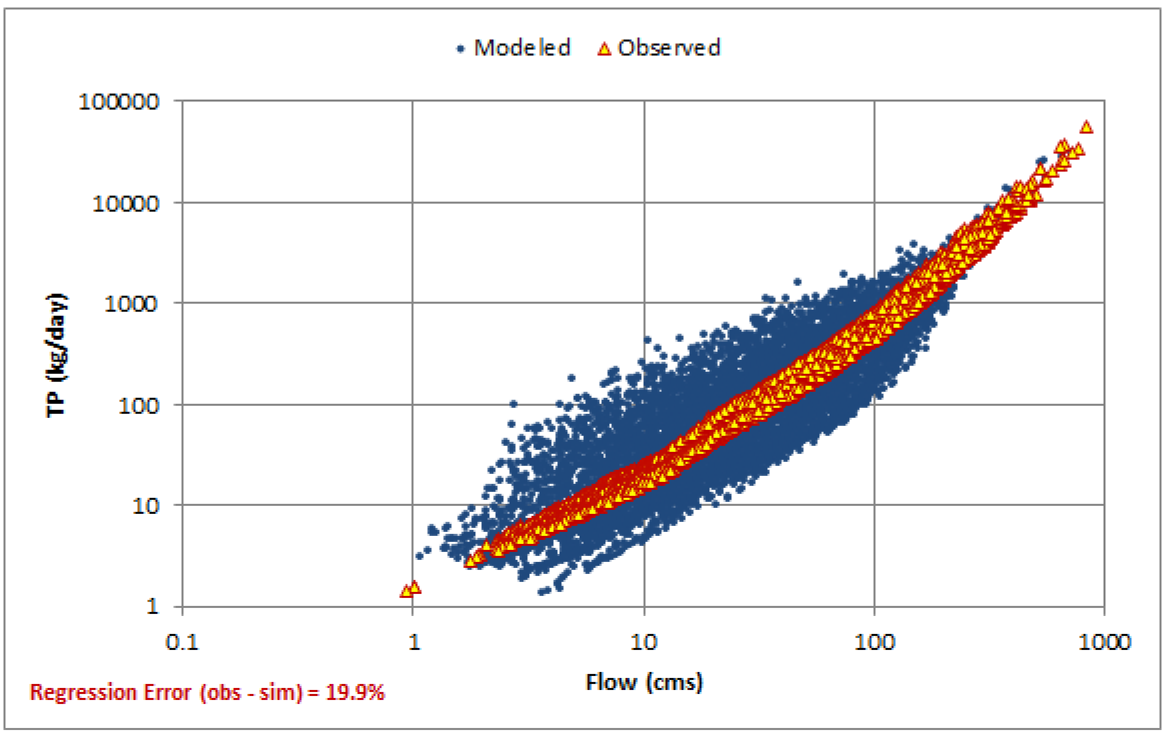
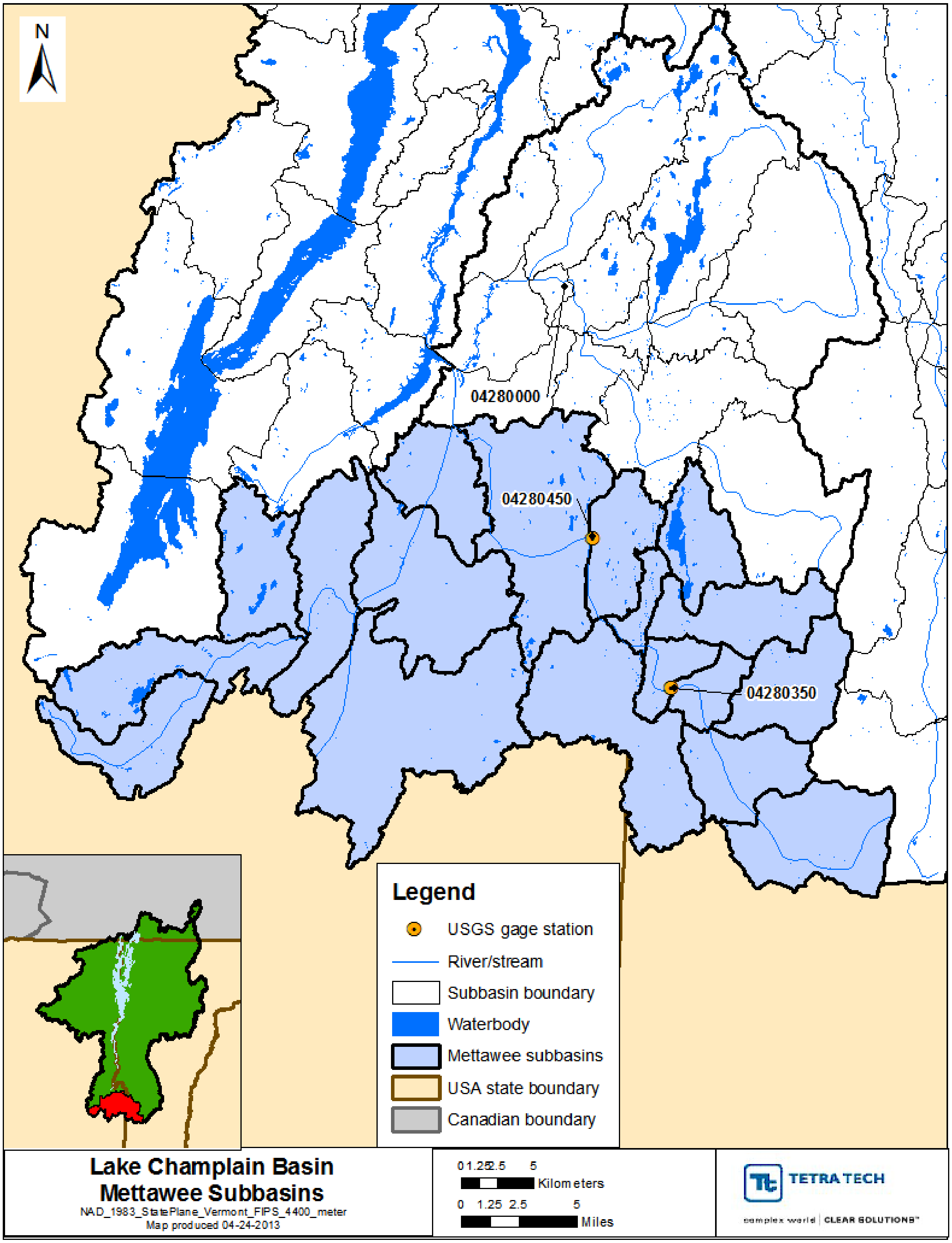


Figure G-60. Daily TP load versus flow as simulated by SWAT and estimated by FLUX (FLUX estimates from Medalie, 2013)

Appendix H - Mettawee River Watershed



USGS 04280350 Mettawee River near Pawlet, VT - Calibration

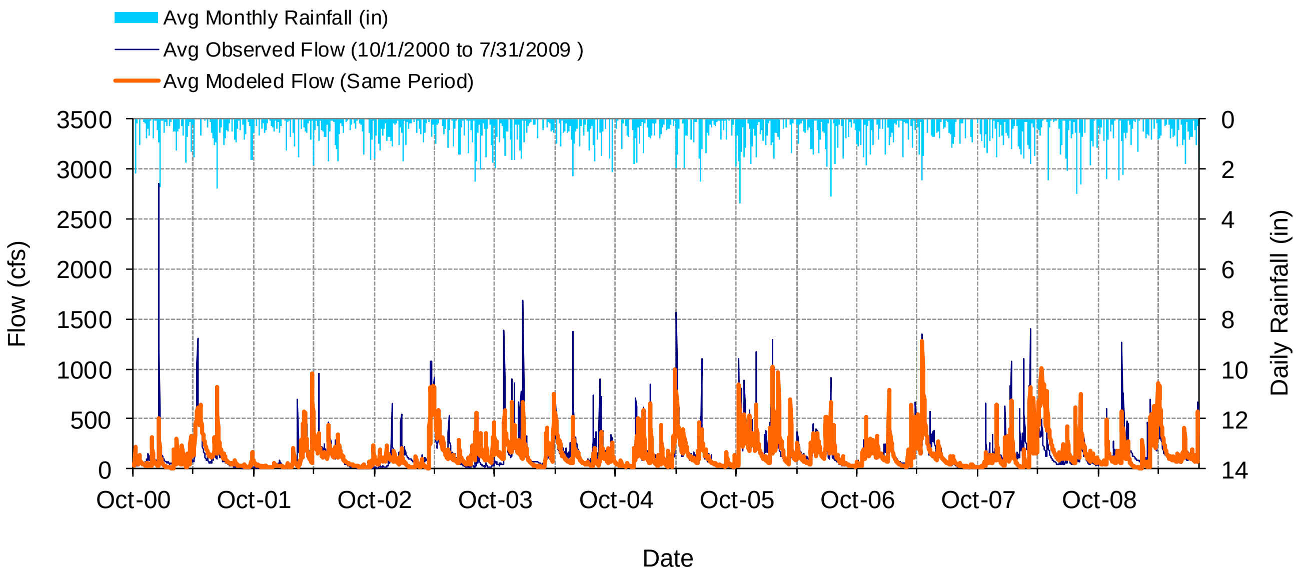


Figure H-1. Mean daily flow at USGS 04280350 Mettawee River near Pawlet, VT

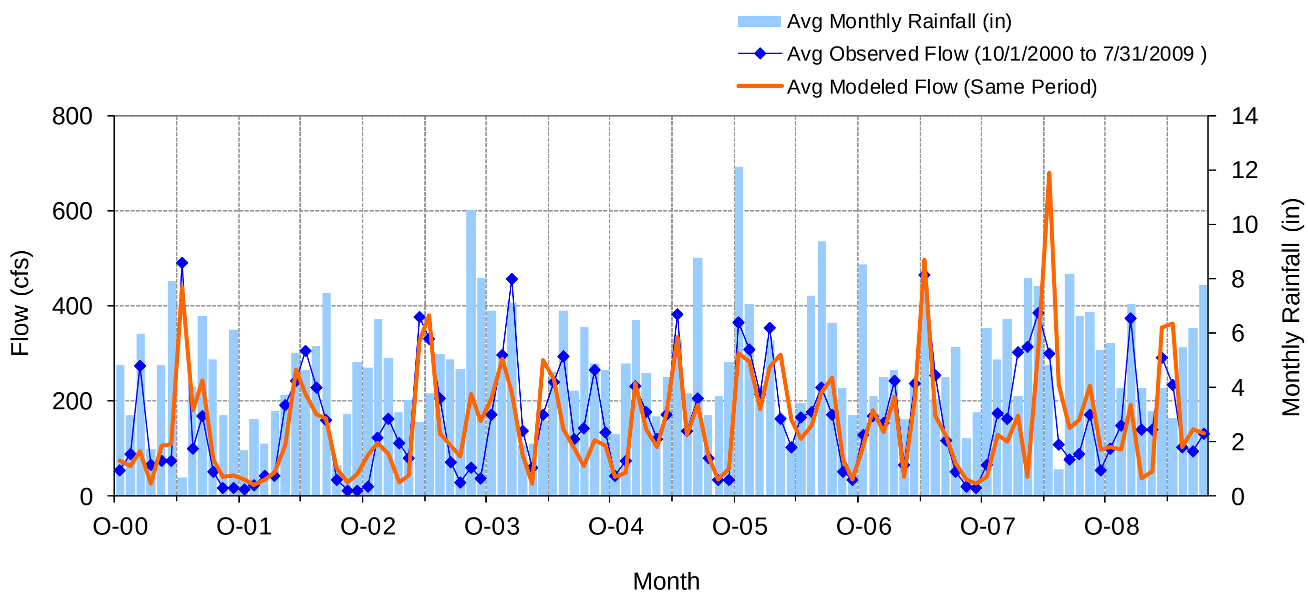


Figure H-2. Mean monthly flow at USGS 04280350 Mettawee River near Pawlet, VT

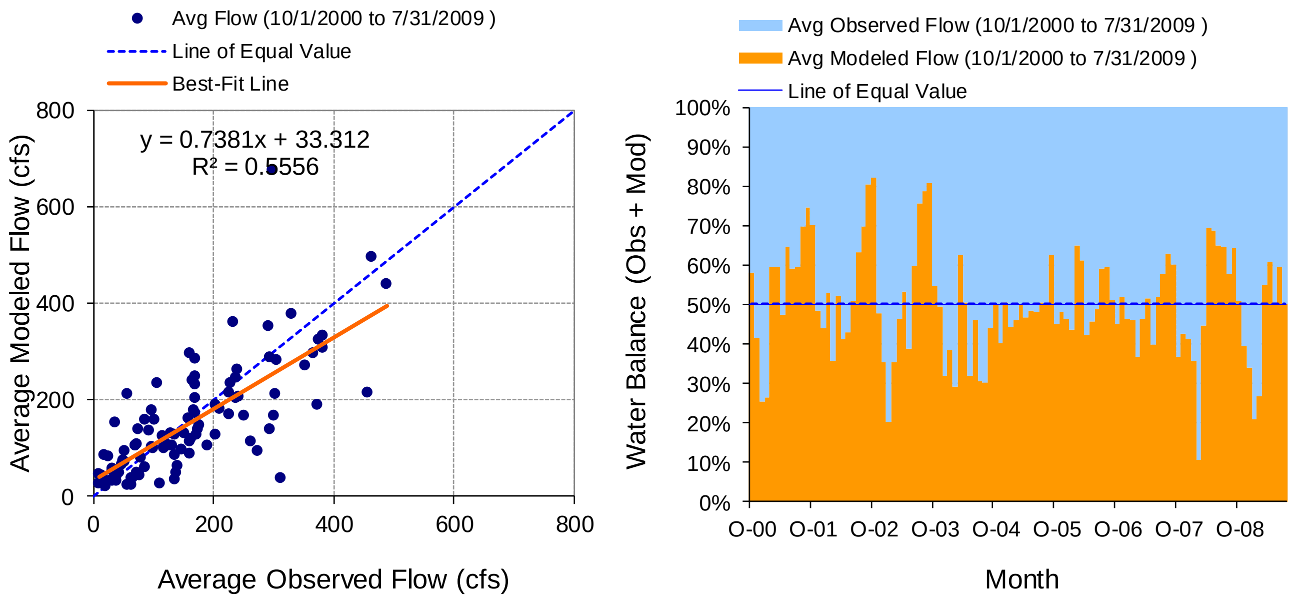


Figure H-3. Monthly flow regression and temporal variation at USGS 04280350 Mettawee River near Pawlet, VT

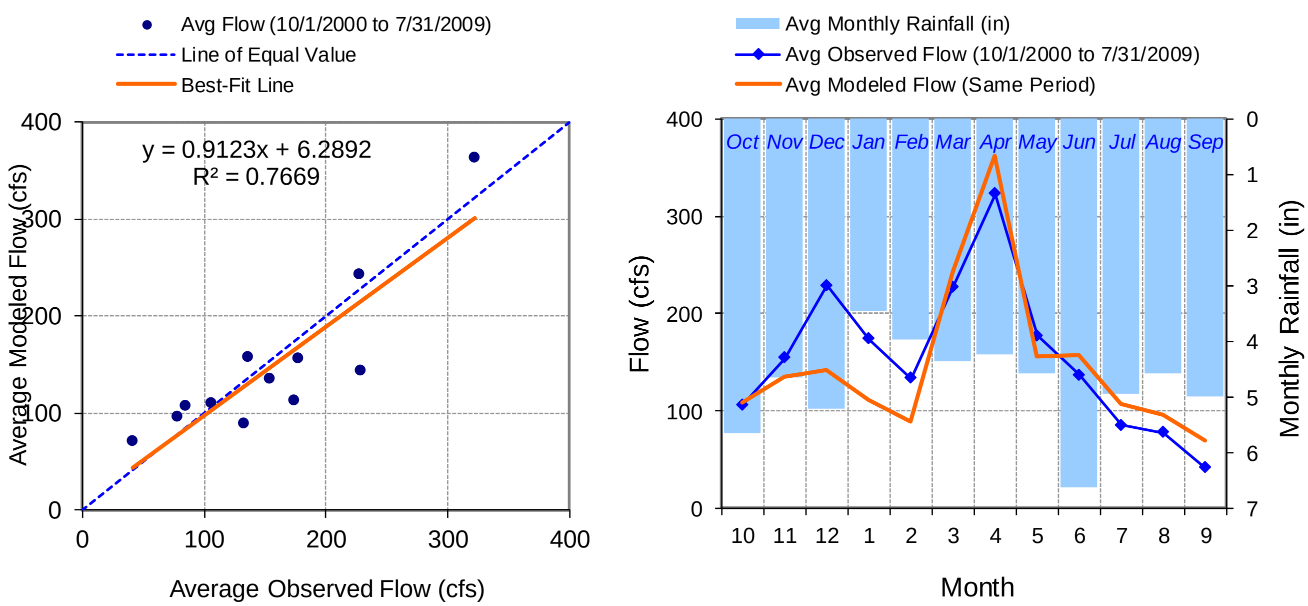


Figure H-4. Seasonal regression and temporal aggregate at USGS 04280350 Mettawee River near Pawlet, VT

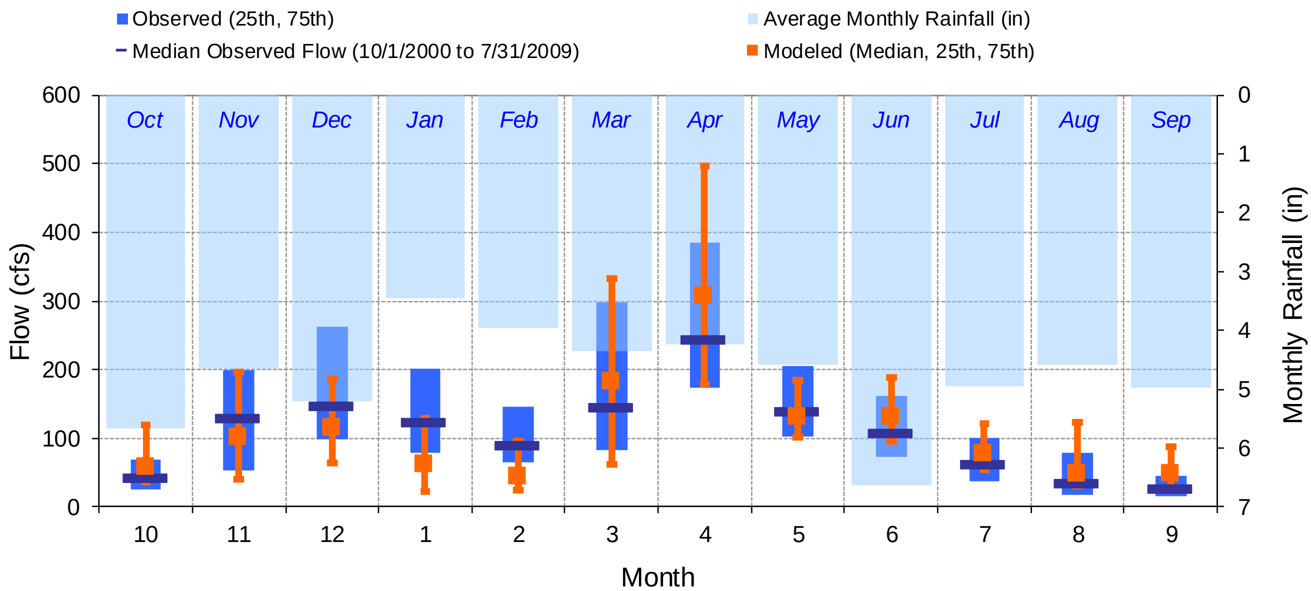


Figure H-5. Seasonal medians and ranges at USGS 04280350 Mettawee River near Pawlet, VT

Table H-1. Seasonal summary at USGS 04280350 Mettawee River near Pawlet, VT

MONTH	OBSERVED FLOW (CFS)				MODELED FLOW (CFS)			
	MEAN	MEDIAN	25TH	75TH	MEAN	MEDIAN	25TH	75TH
Oct	105.97	43.00	25.00	68.00	108.87	57.25	36.30	119.12
Nov	154.34	129.50	52.25	199.00	135.09	101.64	40.22	196.31
Dec	228.89	147.00	99.50	262.00	142.51	115.55	63.53	185.54
Jan	173.80	123.00	78.50	200.50	111.64	61.77	23.18	130.10
Feb	132.98	89.50	65.25	147.00	88.34	44.64	25.45	96.01
Mar	227.42	145.00	82.50	299.00	242.29	181.87	62.24	332.95
Apr	322.69	244.50	173.00	384.75	362.73	307.64	178.95	497.50
May	177.33	139.00	103.00	205.50	155.27	131.94	100.63	184.40
Jun	136.61	107.00	72.25	161.00	157.64	130.89	95.43	188.24
Jul	85.41	62.00	38.00	100.00	106.86	76.92	53.18	120.67
Aug	77.68	34.50	18.00	79.00	95.47	48.29	30.66	123.99
Sep	41.18	27.00	15.75	46.25	69.52	47.52	26.42	88.66

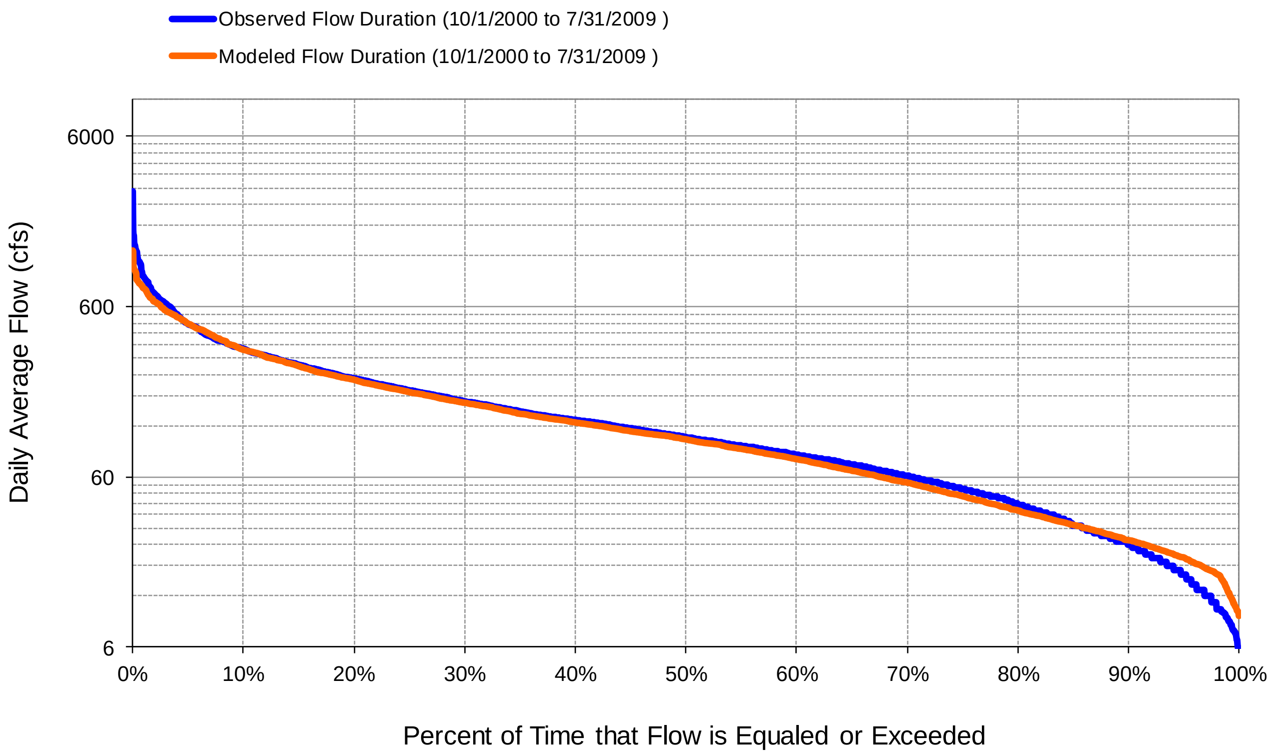


Figure H-6. Flow exceedence at USGS 04280350 Mettawee River near Pawlet, VT

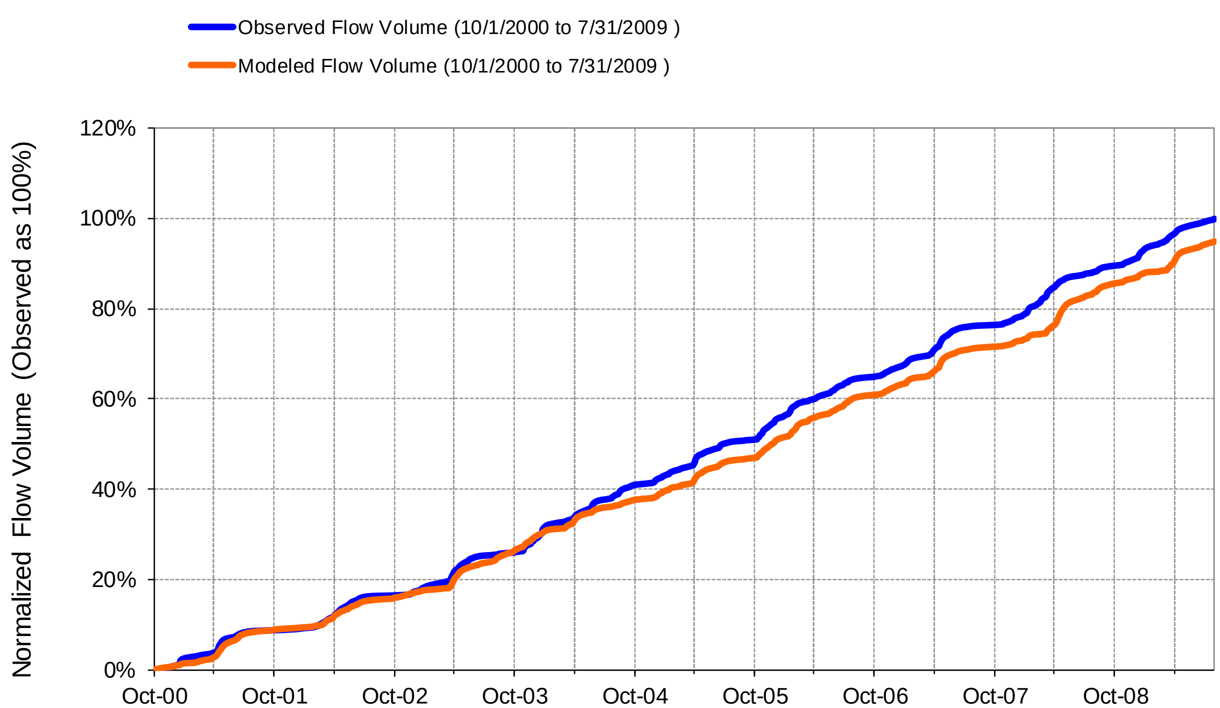


Figure H-7. Flow accumulation at USGS 04280350 Mettawee River near Pawlet, VT

Table H-2. Summary statistics at USGS 04280350 Mettawee River near Pawlet, VT

SWAT Simulated Flow		Observed Flow Gage	
REACH OUTFLOW FROM OUTLET 7 8.83-Year Analysis Period: 10/1/2000 - 7/31/2009 Flow volumes are (inches/year) for upstream drainage area		USGS 04280350 METTAWEE RIVER NEAR PAWLET, VT Hydrologic Unit Code: 2010001 Latitude: 43.37062828 Longitude: -73.21621889 Drainage Area (sq-mi): 70.2	
Total Simulated In-stream Flow:	**28.90**	Total Observed In-stream Flow:	**30.43**
Total of simulated highest 10% flows:	**10.19**	Total of Observed highest 10% flows:	**11.19**
Total of Simulated lowest 50% flows:	**4.85**	Total of Observed Lowest 50% flows:	**5.07**
Simulated Summer Flow Volume (months 7-9):	**4.21**	Observed Summer Flow Volume (7-9):	**3.18**
Simulated Fall Flow Volume (months 10-12):	**6.39**	Observed Fall Flow Volume (10-12):	**8.10**
Simulated Winter Flow Volume (months 1-3):	**7.27**	Observed Winter Flow Volume (1-3):	**8.74**
Simulated Spring Flow Volume (months 4-6):	**11.03**	Observed Spring Flow Volume (4-6):	**10.41**
Total Simulated Storm Volume:	**6.54**	Total Observed Storm Volume:	**7.64**
Simulated Summer Storm Volume (7-9):	**0.94**	Observed Summer Storm Volume (7-9):	**0.80**

Errors (Simulated-Observed)	*Error Statistics*	*Recommended Criteria*		
Error in total volume:	-5.02	10		
Error in 50% lowest flows:	-4.25	10		
Error in 10% highest flows:	-8.90	15		
Seasonal volume error - Summer:	32.47	30		
Seasonal volume error - Fall:	-21.09	>> 30		Clear
Seasonal volume error - Winter:	-16.83	30		
Seasonal volume error - Spring:	5.96	30		
Error in storm volumes:	-14.41	20		
Error in summer storm volumes:	17.88	50		
Nash-Sutcliffe Coefficient of Efficiency, E:	0.459	Model accuracy increases		
Baseline adjusted coefficient (Garrick), E':	0.375	as E or E' approaches 1.0		
Monthly NSE	0.546			

USGS 04280350 Mettawee River near Pawlet, VT - Validation

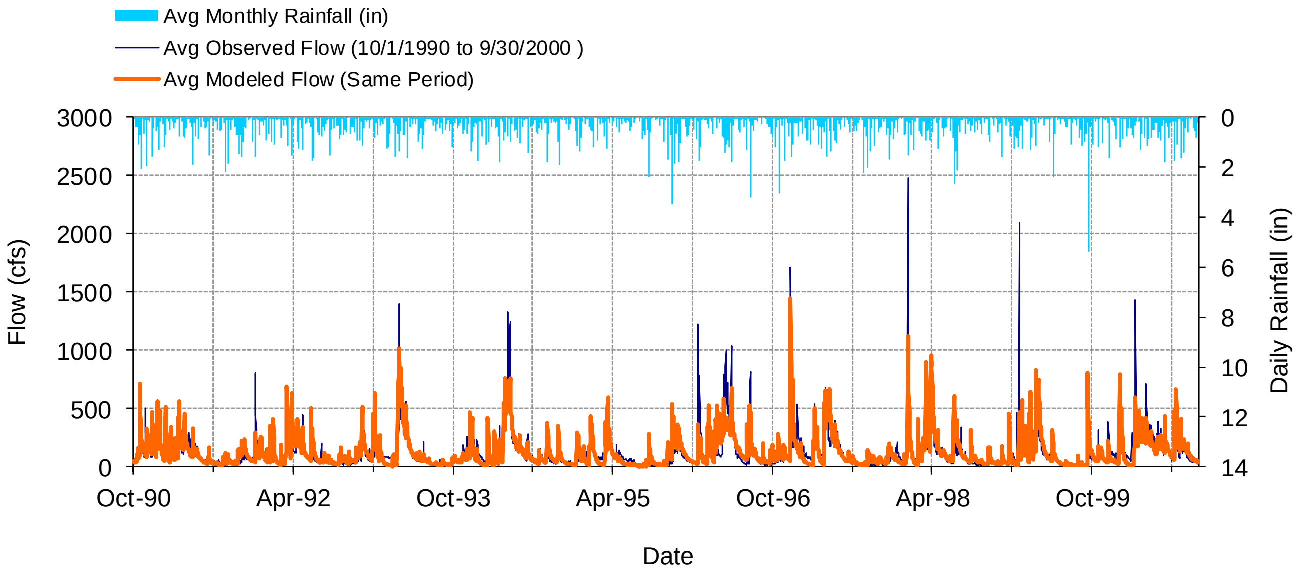


Figure H-8. Mean daily flow at USGS 04280350 Mettawee River near Pawlet, VT

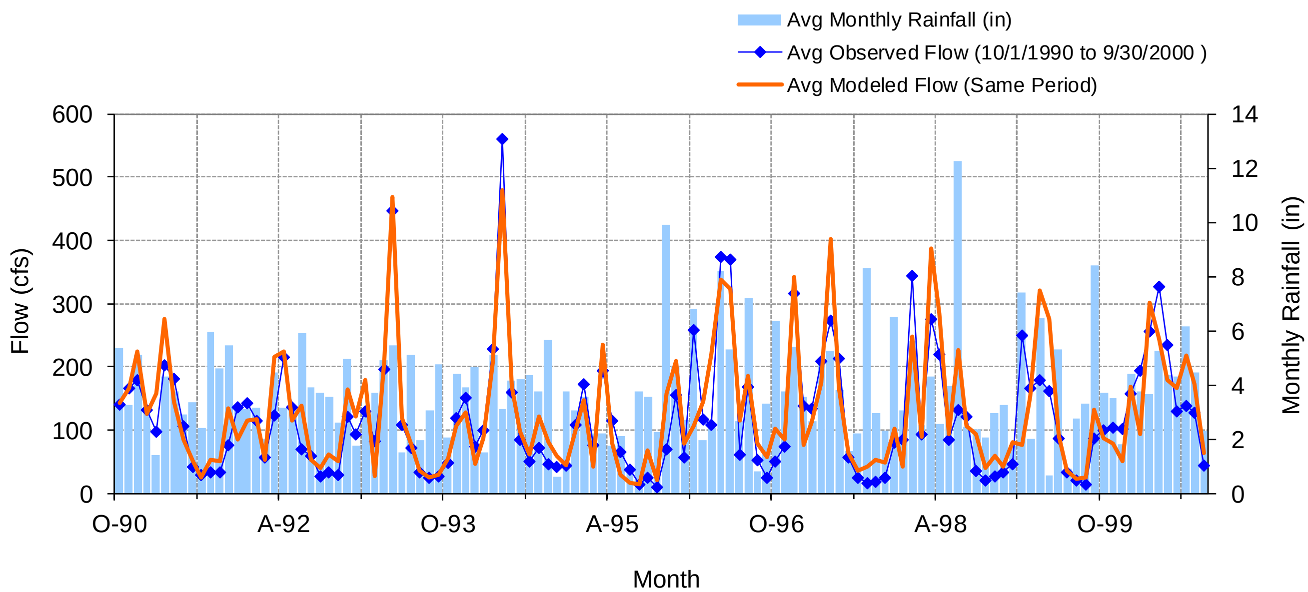


Figure H-9. Mean monthly flow at USGS 04280350 Mettawee River near Pawlet, VT

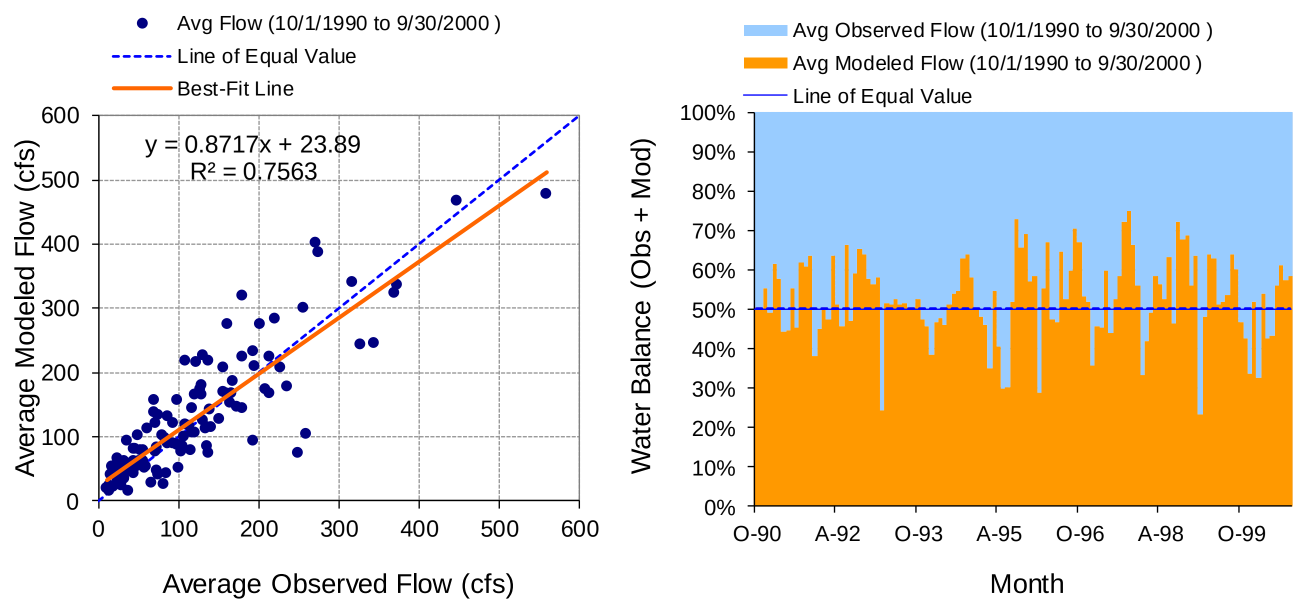


Figure H-10. Monthly flow regression and temporal variation at USGS 04280350 Mettawee River near Pawlet, VT

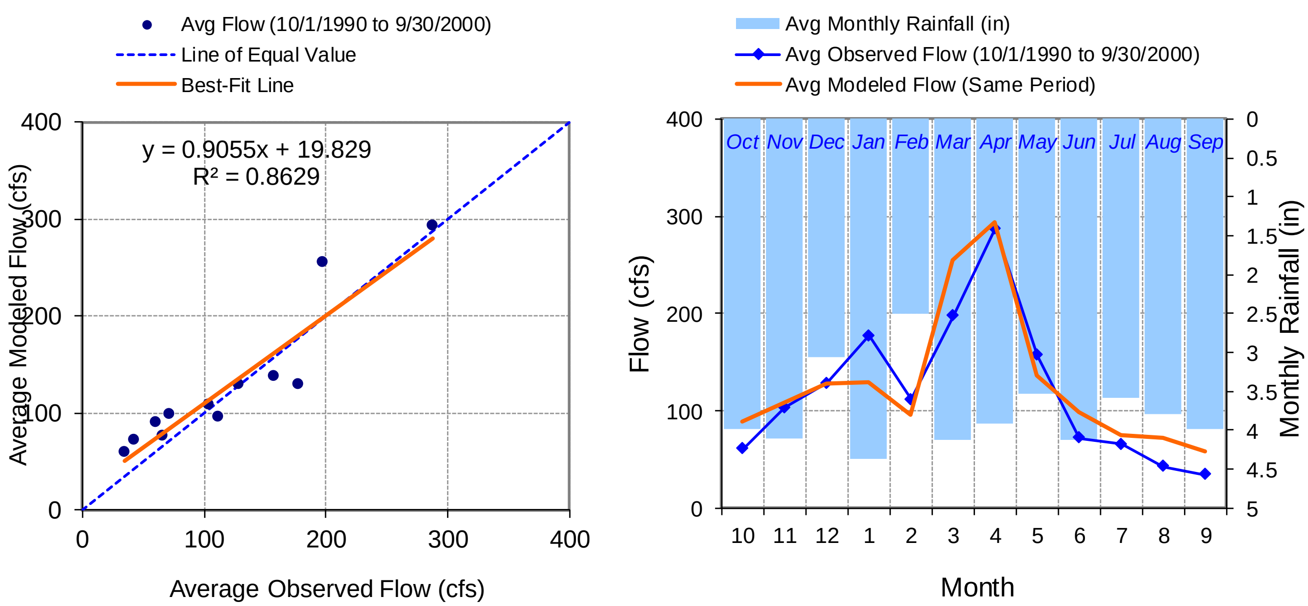


Figure H-11. Seasonal regression and temporal aggregate at USGS 04280350 Mettawee River near Pawlet, VT

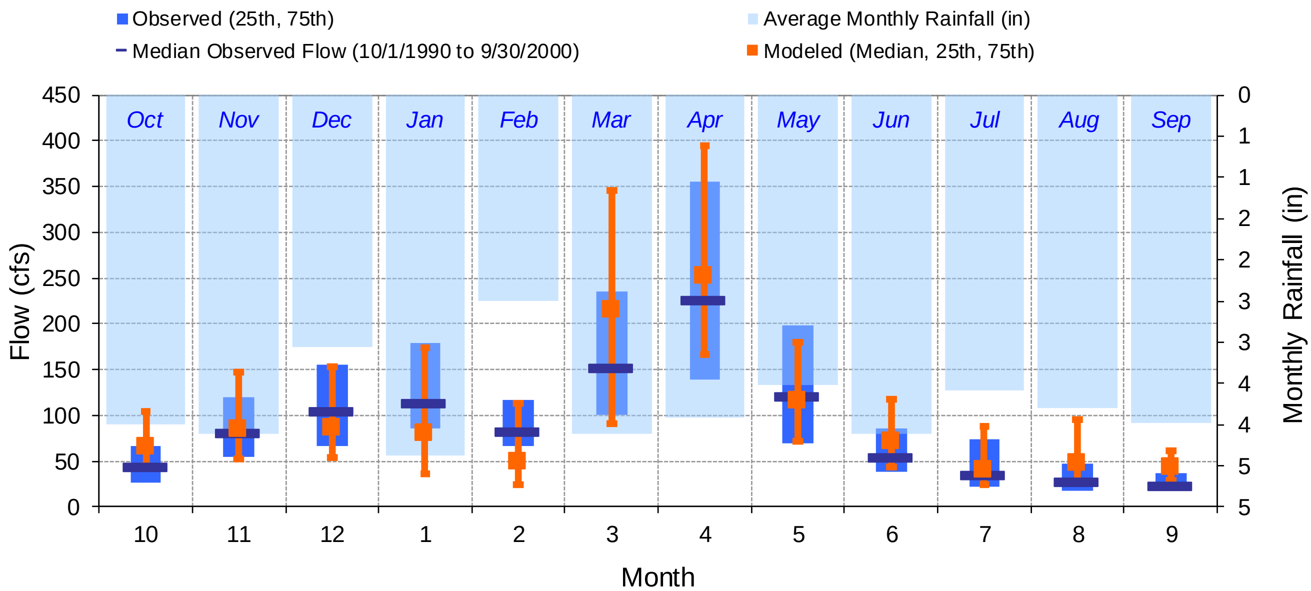


Figure H-12. Seasonal medians and ranges at USGS 04280350 Mettawee River near Pawlet, VT

Table H-3. Seasonal summary at USGS 04280350 Mettawee River near Pawlet, VT

MONTH	OBSERVED FLOW (CFS)				MODELED FLOW (CFS)			
	MEAN	MEDIAN	25TH	75TH	MEAN	MEDIAN	25TH	75TH
Oct	60.55	43.00	26.00	66.00	89.13	66.37	44.68	104.47
Nov	103.32	80.00	55.00	120.25	108.12	84.76	52.79	147.74
Dec	128.05	105.00	67.00	154.75	128.35	86.01	53.70	153.62
Jan	177.04	113.50	86.00	179.25	128.74	80.61	36.89	173.89
Feb	111.88	82.00	66.00	117.50	95.78	49.44	24.31	113.34
Mar	197.28	151.50	100.00	235.75	254.54	215.83	90.35	345.71
Apr	287.20	225.50	138.50	355.00	293.37	251.90	167.04	394.91
May	156.87	120.00	70.25	199.00	137.03	116.04	71.07	179.81
Jun	71.99	53.50	38.00	85.50	98.47	72.02	44.28	118.38
Jul	65.91	34.00	22.25	73.50	75.49	40.89	24.31	87.47
Aug	42.84	28.00	17.00	47.00	71.71	47.71	25.61	95.31
Sep	34.29	23.00	17.75	36.25	58.70	43.54	28.09	61.95

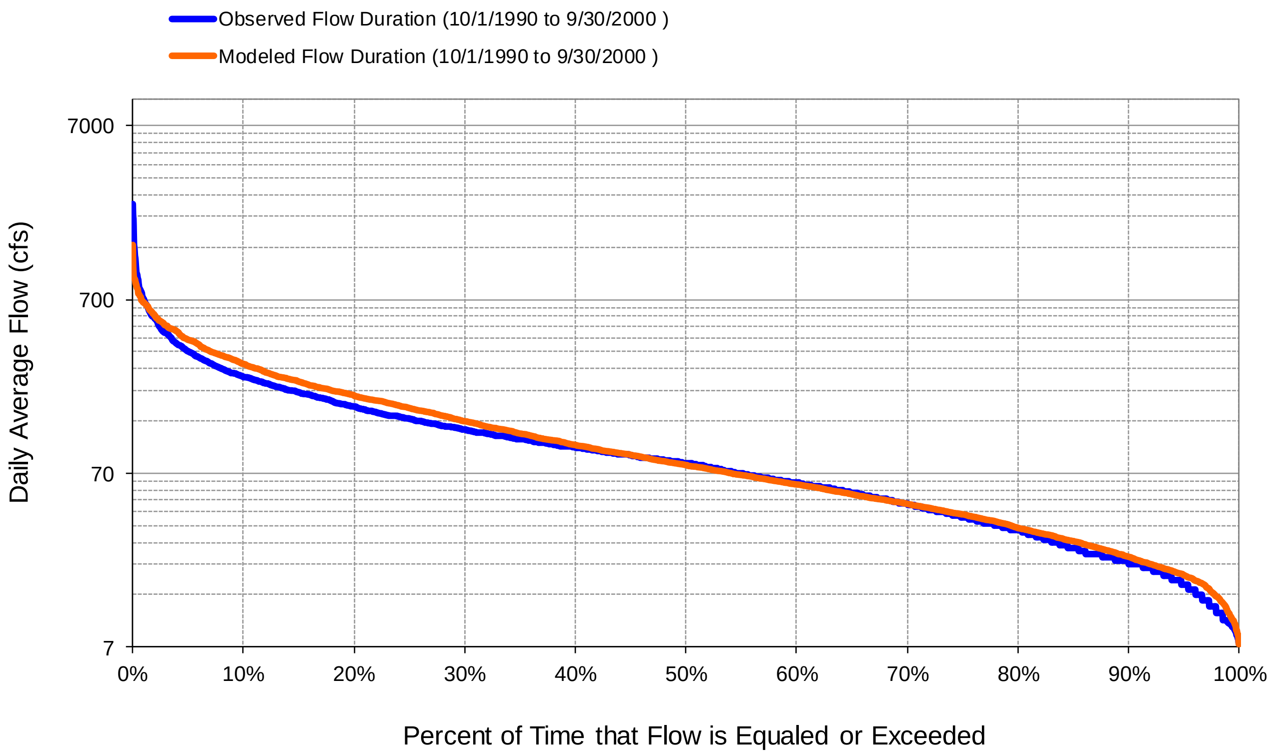


Figure H-13. Flow exceedence at USGS 04280350 Mettawee River near Pawlet, VT

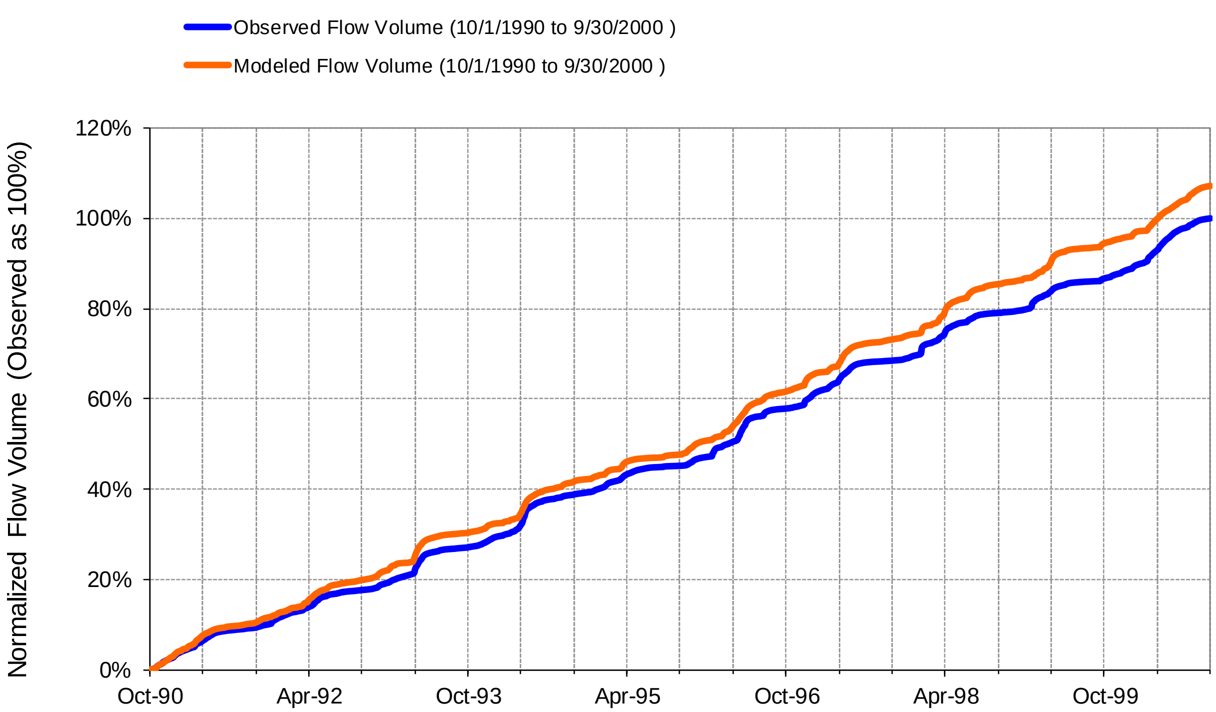


Figure H-14. Flow accumulation at USGS 04280350 Mettawee River near Pawlet, VT

Table H-4. Summary statistics at USGS 04280350 Mettawee River near Pawlet, VT

SWAT Simulated Flow		Observed Flow Gage	
REACH OUTFLOW FROM OUTLET 7 10-Year Analysis Period: 10/1/1990 - 9/30/2000 Flow volumes are (inches/year) for upstream drainage area		USGS 04280350 METTAWEE RIVER NEAR PAWLET, VT Hydrologic Unit Code: 2010001 Latitude: 43.37062828 Longitude: -73.21621889 Drainage Area (sq-mi): 70.2	
Total Simulated In-stream Flow:	**24.85**	Total Observed In-stream Flow:	**23.18**
Total of simulated highest 10% flows:	**8.94**	Total of Observed highest 10% flows:	**8.55**
Total of Simulated lowest 50% flows:	**4.03**	Total of Observed Lowest 50% flows:	**3.98**
Simulated Summer Flow Volume (months 7-9):	**3.35**	Observed Summer Flow Volume (7-9):	**2.33**
Simulated Fall Flow Volume (months 10-12):	**5.29**	Observed Fall Flow Volume (10-12):	**4.74**
Simulated Winter Flow Volume (months 1-3):	**7.73**	Observed Winter Flow Volume (1-3):	**7.82**
Simulated Spring Flow Volume (months 4-6):	**8.48**	Observed Spring Flow Volume (4-6):	**8.28**
Total Simulated Storm Volume:	**5.71**	Total Observed Storm Volume:	**5.20**
Simulated Summer Storm Volume (7-9):	**0.79**	Observed Summer Storm Volume (7-9):	**0.63**
Errors (Simulated-Observed)	*Error Statistics*	*Recommended Criteria*	
Error in total volume:	7.20	10	
Error in 50% lowest flows:	1.26	10	
Error in 10% highest flows:	4.46	15	
Seasonal volume error - Summer:	43.72	30	
Seasonal volume error - Fall:	11.62	>> 30	Clear
Seasonal volume error - Winter:	-1.20	30	
Seasonal volume error - Spring:	2.33	30	
Error in storm volumes:	9.76	20	
Error in summer storm volumes:	25.50	50	
Nash-Sutcliffe Coefficient of Efficiency, E:	0.568	Model accuracy increases	
Baseline adjusted coefficient (Garrick), E':	0.397	as E or E' approaches 1.0	
Monthly NSE	0.731		

USGS 04280450 Mettawee River near Middle Granville, NY - Calibration

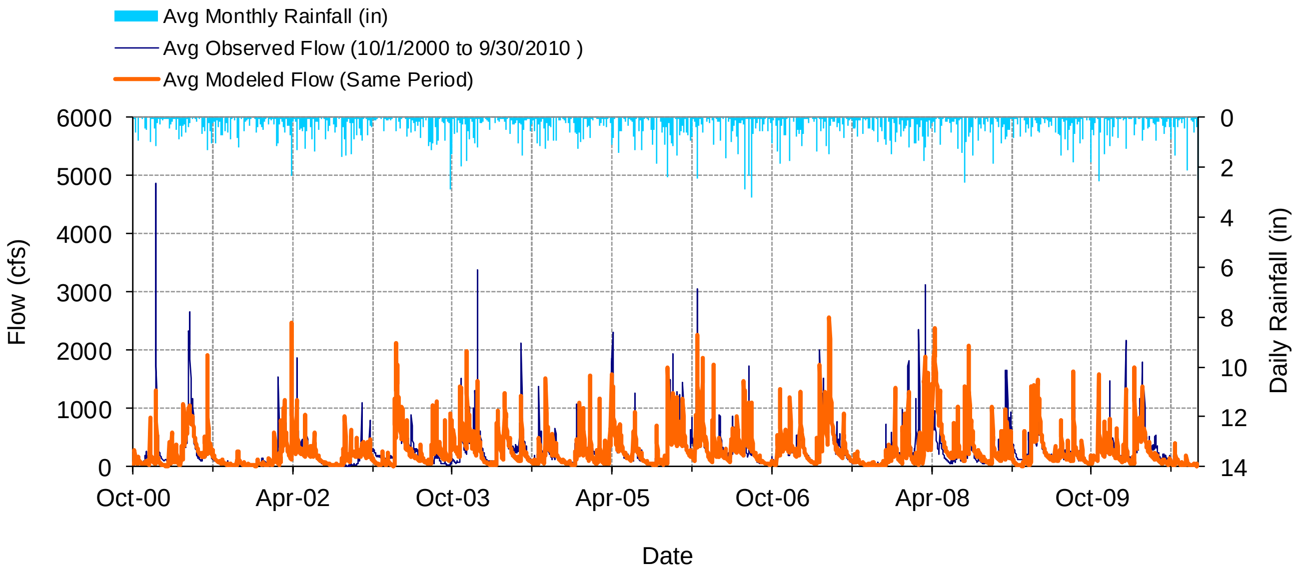


Figure H-15. Mean daily flow at USGS 04280450 Mettawee River near Middle Granville, NY

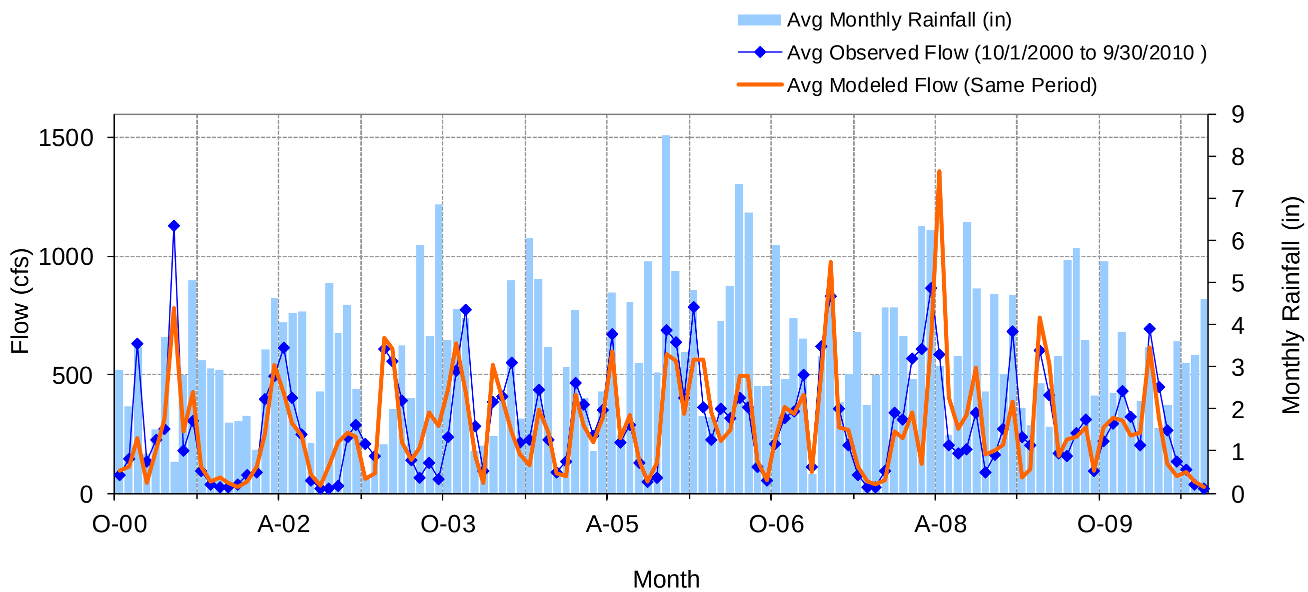


Figure H-16. Mean monthly flow at USGS 04280450 Mettawee River near Middle Granville, NY

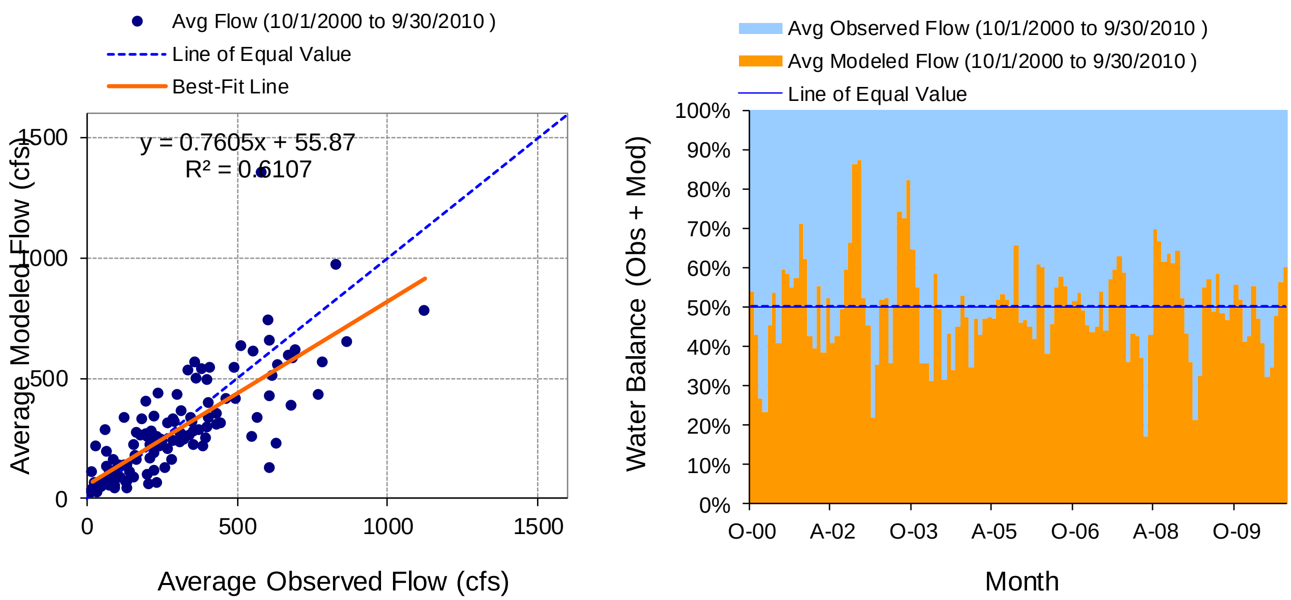


Figure H-17. Monthly flow regression and temporal variation at USGS 04280450 Mettawee River near Middle Granville, NY

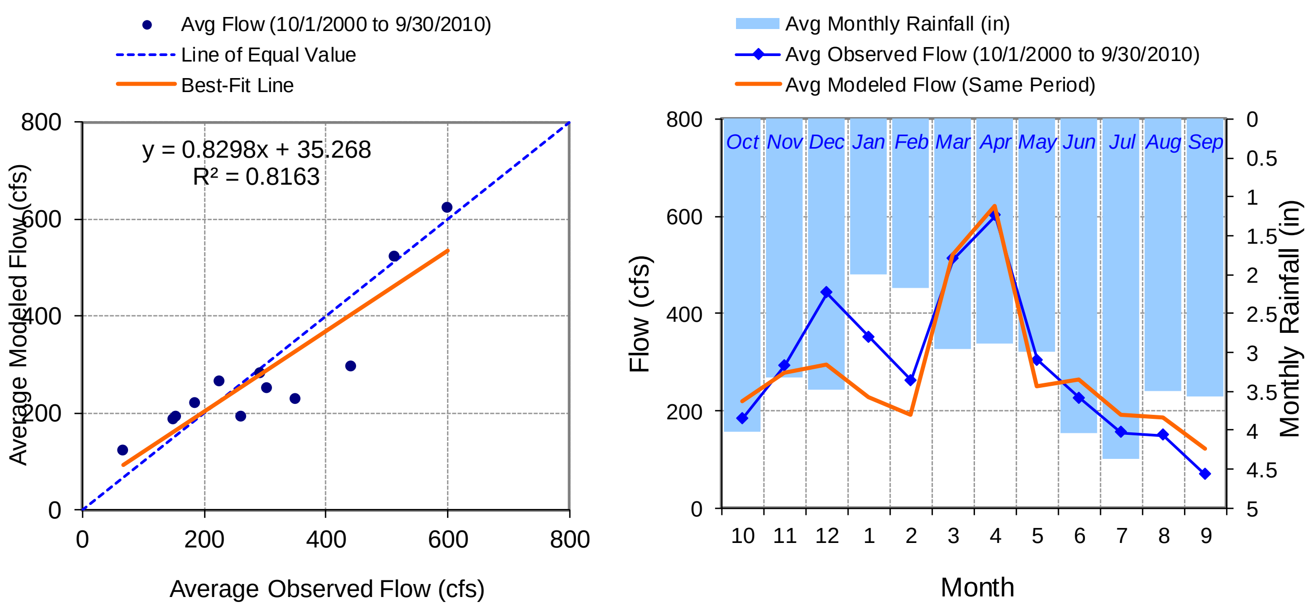


Figure H-18. Seasonal regression and temporal aggregate at USGS 04280450 Mettawee River near Middle Granville, NY

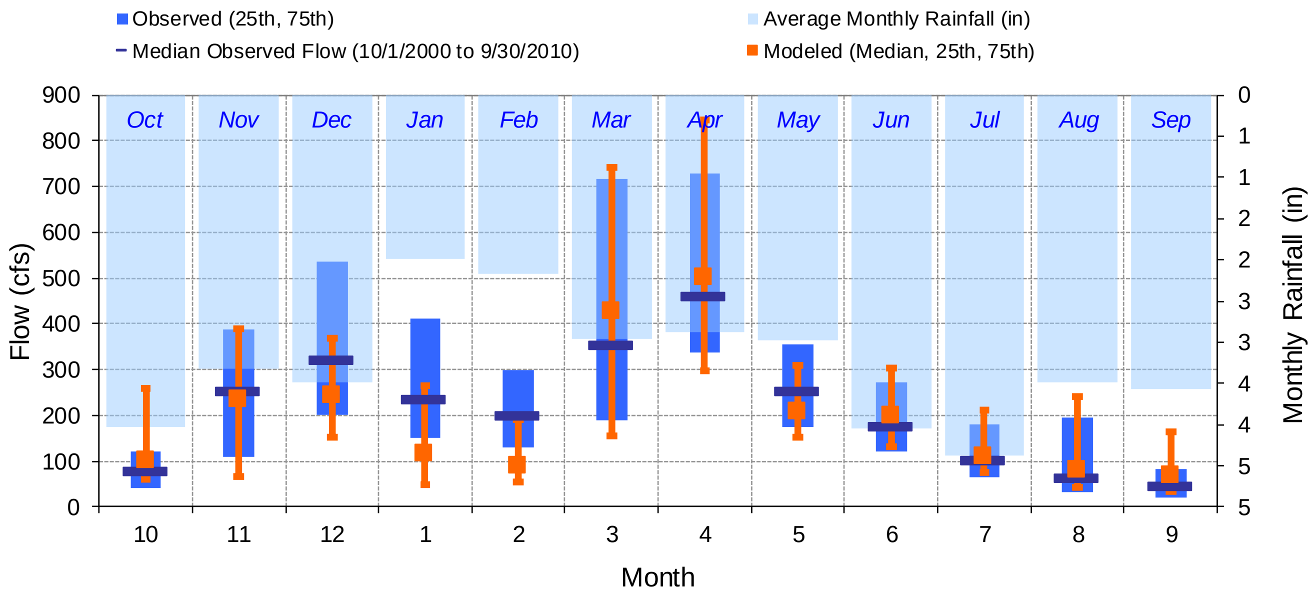


Figure H-19. Seasonal medians and ranges at USGS 04280450 Mettawee River near Middle Granville, NY

Table H-5. Seasonal summary at USGS 04280450 Mettawee River near Middle Granville, NY

MONTH	OBSERVED FLOW (CFS)				MODELED FLOW (CFS)			
	MEAN	MEDIAN	25TH	75TH	MEAN	MEDIAN	25TH	75TH
Oct	184.81	79.00	42.00	122.00	218.72	101.90	59.15	260.23
Nov	292.60	252.00	108.75	386.50	279.62	234.56	67.15	388.73
Dec	441.84	320.00	200.50	535.50	295.55	243.81	152.40	368.24
Jan	351.09	236.00	150.00	410.25	227.49	117.83	49.40	265.43
Feb	262.16	200.00	130.00	300.00	190.96	88.82	54.22	189.68
Mar	512.16	352.50	190.00	716.25	522.22	428.01	153.85	740.73
Apr	600.83	460.00	337.00	729.50	621.11	501.12	298.16	845.26
May	304.05	254.00	175.00	355.25	249.70	207.53	152.38	308.51
Jun	225.70	176.50	122.00	271.75	263.03	198.56	130.29	303.06
Jul	154.80	103.00	65.00	179.75	190.61	111.29	74.88	210.33
Aug	149.68	62.00	31.25	194.25	186.49	80.82	43.25	240.01
Sep	68.00	46.50	21.00	81.25	121.76	70.54	33.58	162.82

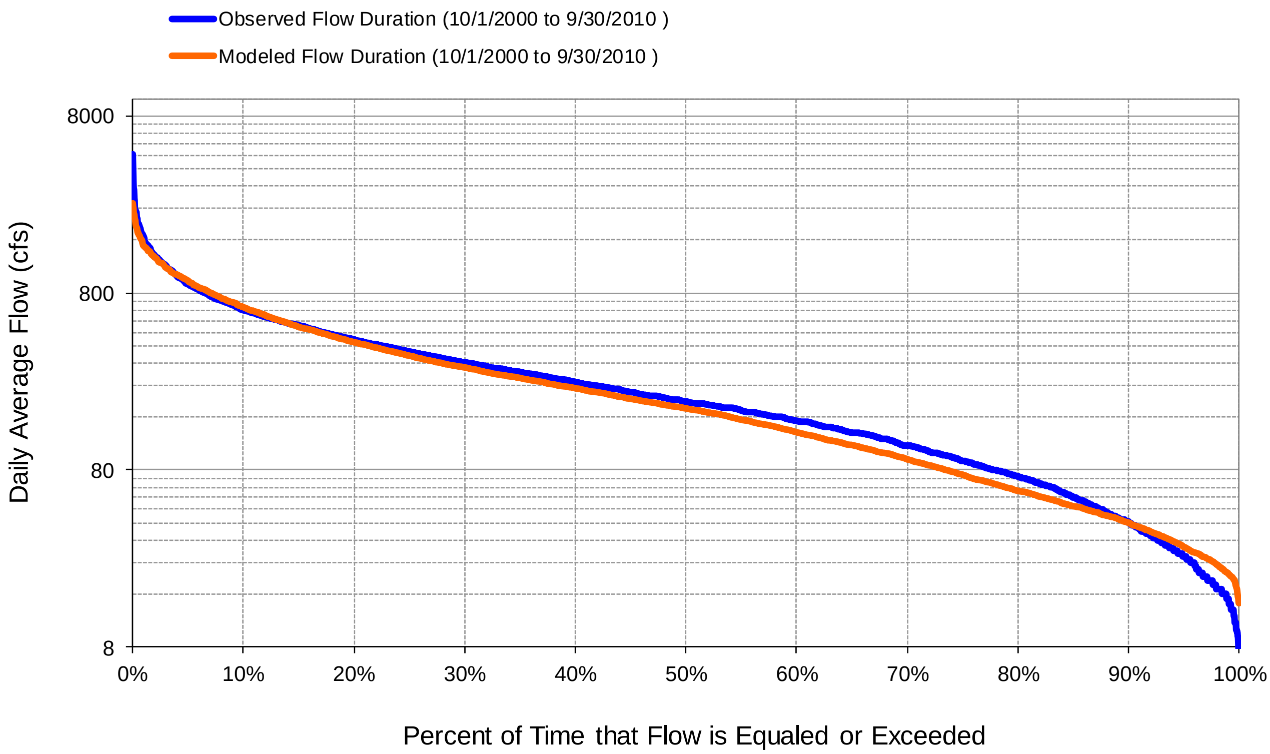


Figure H-20. Flow exceedence at USGS 04280450 Mettawee River near Middle Granville, NY

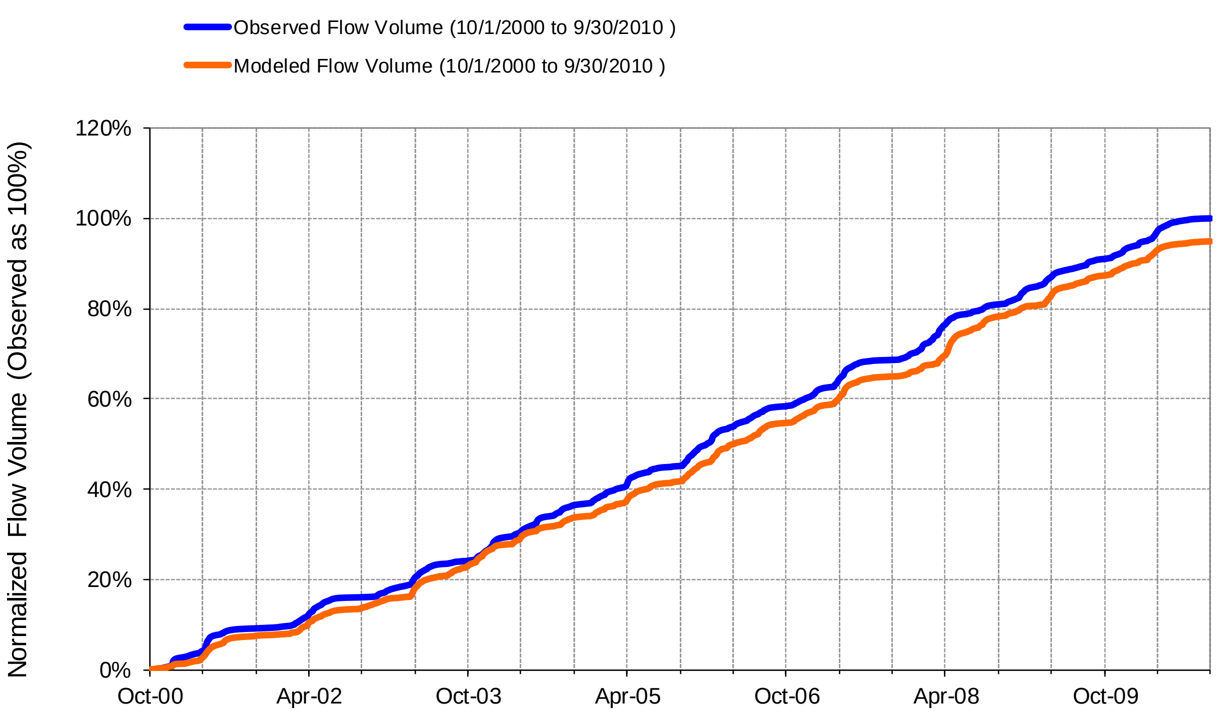


Figure H-21. Flow accumulation at USGS 04280450 Mettawee River near Middle Granville, NY

Table H-6. Summary statistics at USGS 04280450 Mettawee River near Middle Granville, NY

SWAT Simulated Flow		Observed Flow Gage	
REACH OUTFLOW FROM OUTLET 3		USGS 04280450 METTAWEE RIVER NEAR MIDDLE GRANVILLE NY	
10-Year Analysis Period: 10/1/2000 - 9/30/2010 Flow volumes are (inches/year) for upstream drainage area		Hydrologic Unit Code: 2010001 Latitude: 43.463959 Longitude: -73.2842757 Drainage Area (sq-mi): 167	
Total Simulated In-stream Flow:	**22.84**	Total Observed In-stream Flow:	**24.07**
Total of simulated highest 10% flows:	**8.44**	Total of Observed highest 10% flows:	**8.70**
Total of Simulated lowest 50% flows:	**3.43**	Total of Observed Lowest 50% flows:	**3.90**
Simulated Summer Flow Volume (months 7-9):	**3.42**	Observed Summer Flow Volume (7-9):	**2.56**
Simulated Fall Flow Volume (months 10-12):	**5.42**	Observed Fall Flow Volume (10-12):	**6.28**
Simulated Winter Flow Volume (months 1-3):	**6.38**	Observed Winter Flow Volume (1-3):	**7.61**
Simulated Spring Flow Volume (months 4-6):	**7.63**	Observed Spring Flow Volume (4-6):	**7.62**
Total Simulated Storm Volume:	**5.92**	Total Observed Storm Volume:	**5.69**
Simulated Summer Storm Volume (7-9):	**0.93**	Observed Summer Storm Volume (7-9):	**0.68**

Errors (Simulated-Observed)	*Error Statistics*	*Recommended Criteria*		
Error in total volume:	-5.08	10		
Error in 50% lowest flows:	-12.05	10		
Error in 10% highest flows:	-3.03	15		
Seasonal volume error - Summer:	33.66	30		
Seasonal volume error - Fall:	-13.73	>> 30		Clear
Seasonal volume error - Winter:	-16.18	30		
Seasonal volume error - Spring:	0.13	30		
Error in storm volumes:	4.00	20		
Error in summer storm volumes:	36.81	50		
Nash-Sutcliffe Coefficient of Efficiency, E:	0.515	Model accuracy increases		
Baseline adjusted coefficient (Garrick), E':	0.409	as E or E' approaches 1.0		
Monthly NSE	0.569			

USGS 04280450 Mettawee River near Middle Granville, NY - Validation

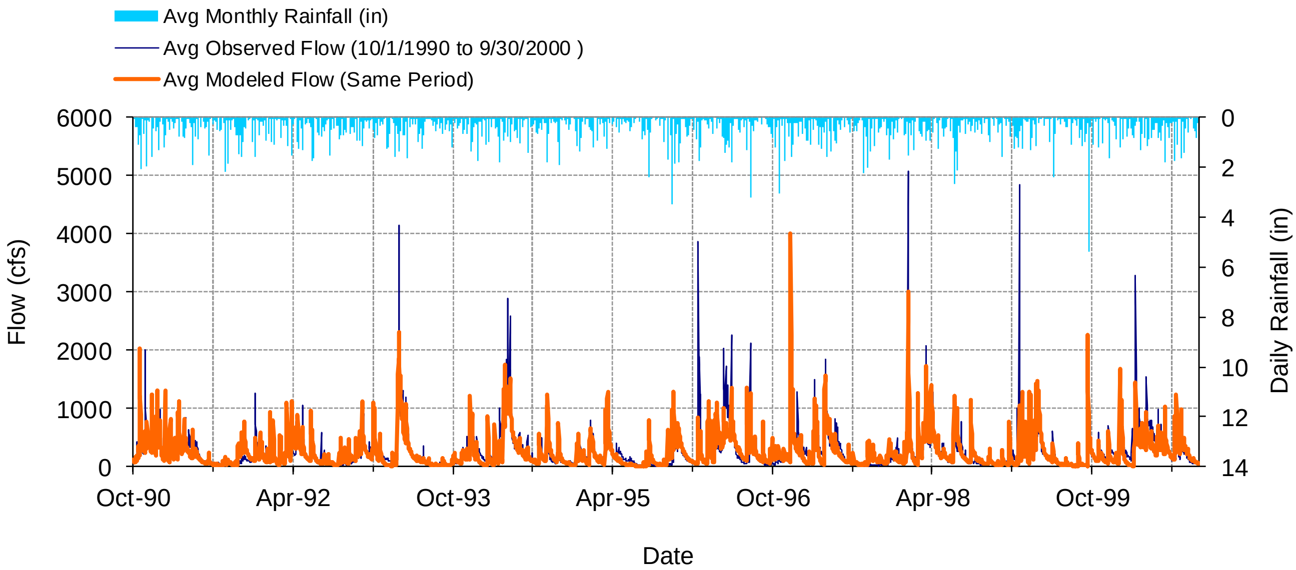


Figure H-22. Mean daily flow at USGS 04280450 Mettawee River near Middle Granville, NY

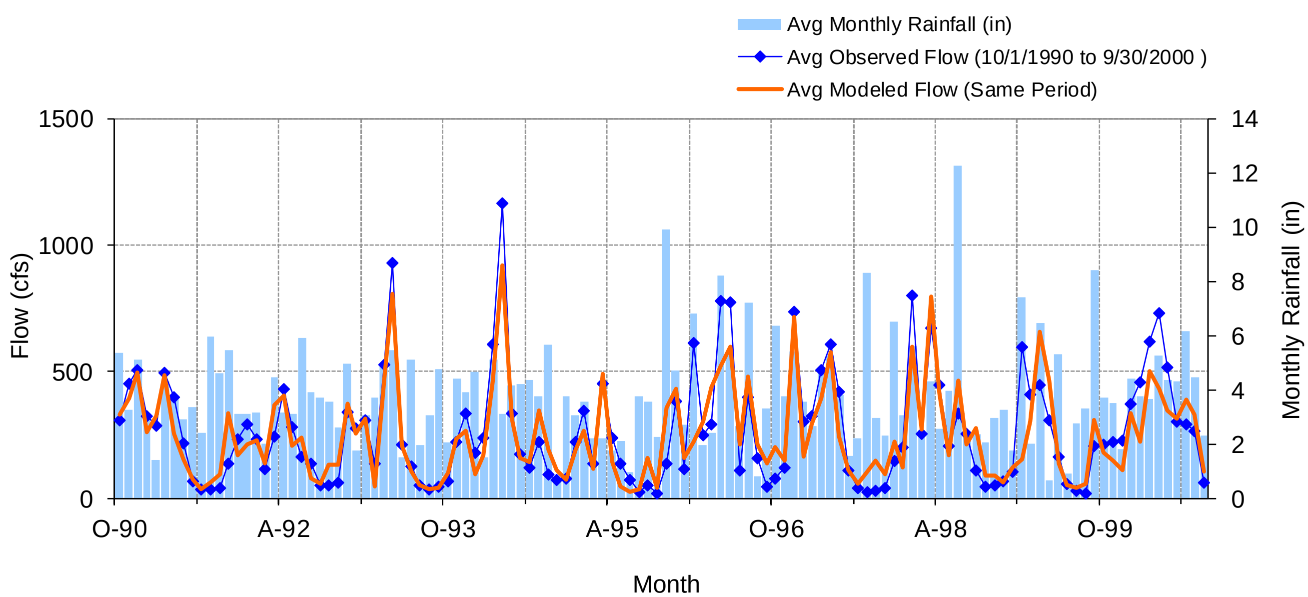


Figure H-23. Mean monthly flow at USGS 04280450 Mettawee River near Middle Granville, NY

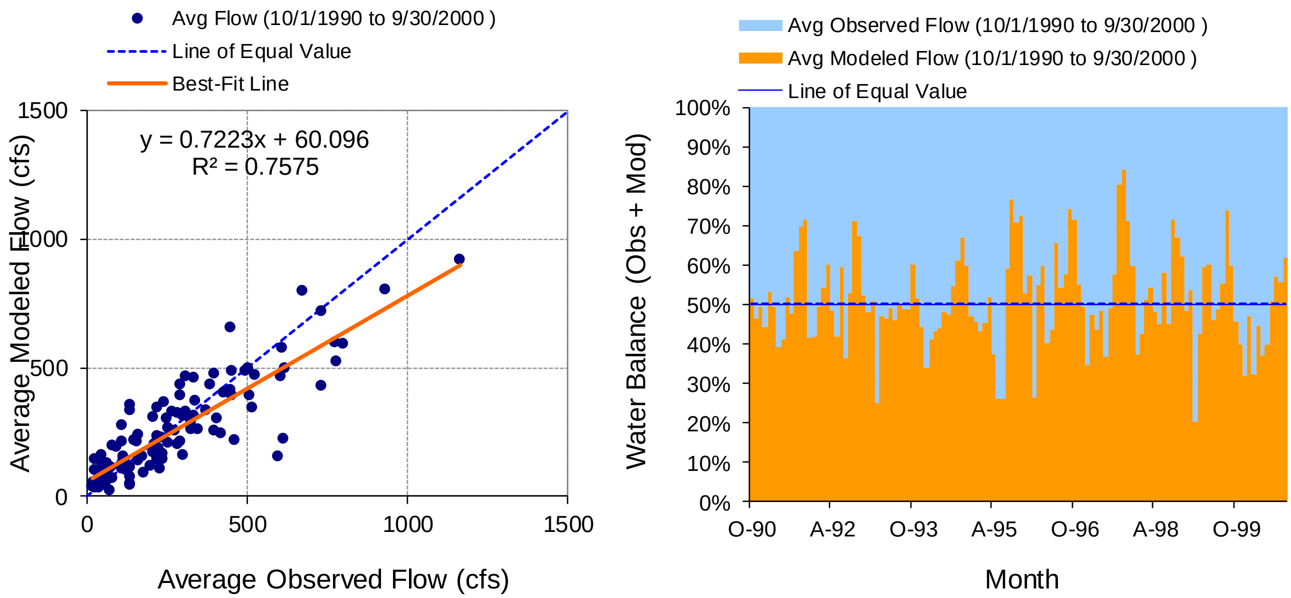


Figure H-24. Monthly flow regression and temporal variation at USGS 04280450 Mettawee River near Middle Granville, NY

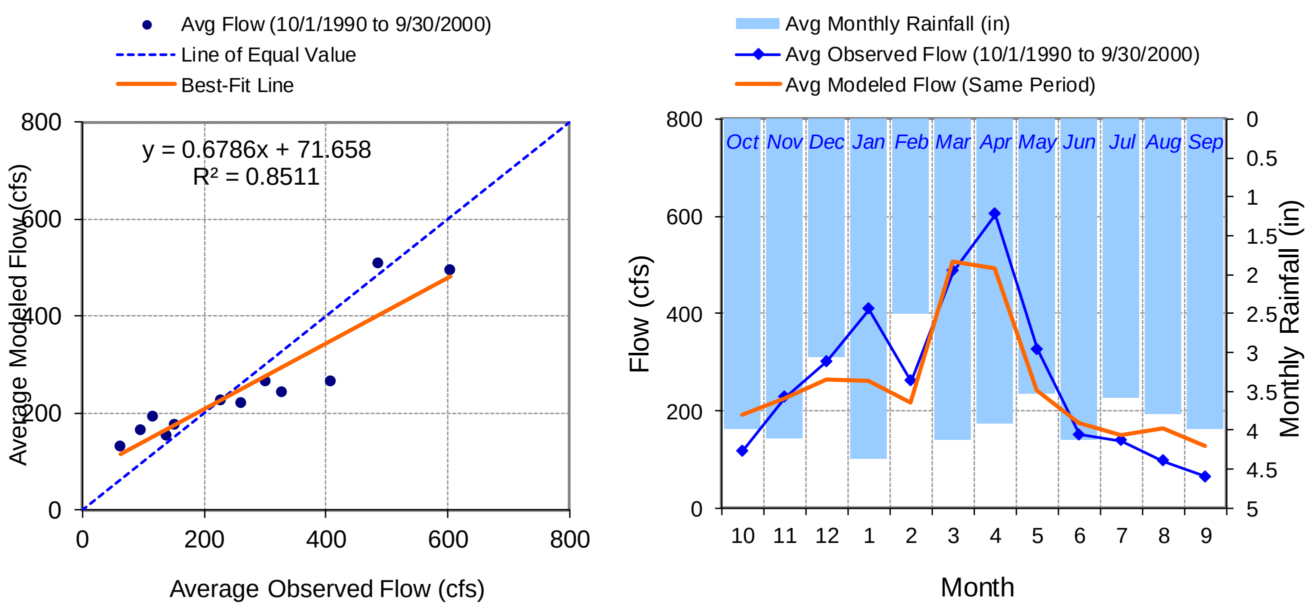


Figure H-25. Seasonal regression and temporal aggregate at USGS 04280450 Mettawee River near Middle Granville, NY

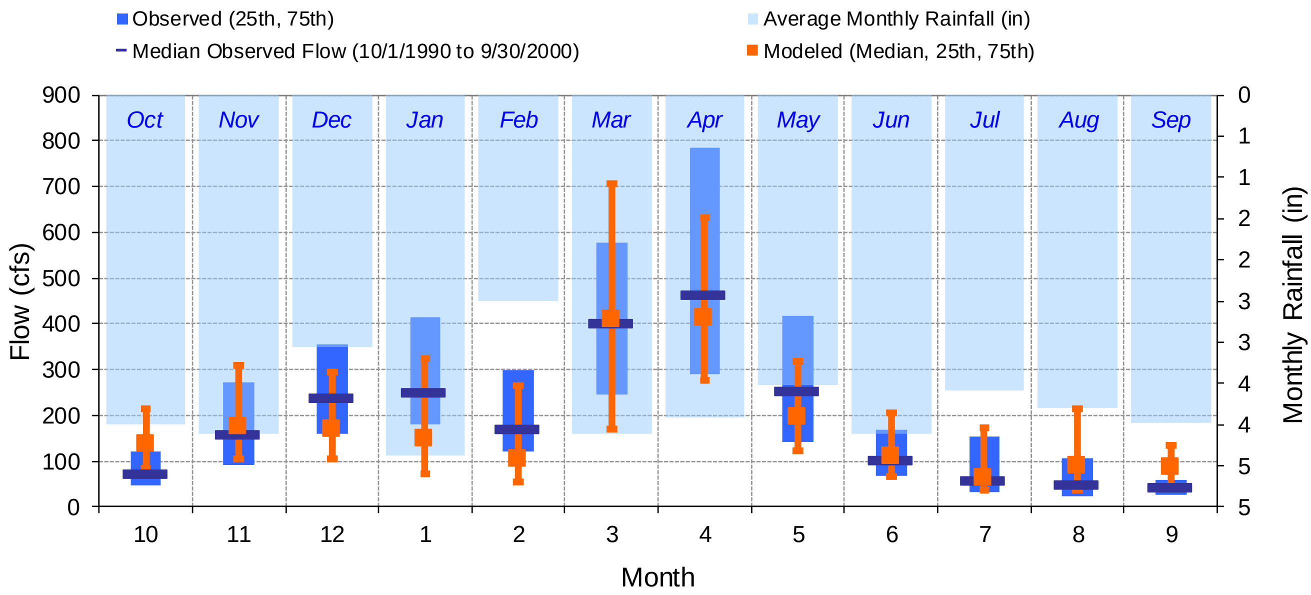


Figure H-26. Seasonal medians and ranges at USGS 04280450 Mettawee River near Middle Granville, NY

Table H-7. Seasonal summary at USGS 04280450 Mettawee River near Middle Granville, NY

MONTH	OBSERVED FLOW (CFS)				MODELED FLOW (CFS)			
	MEAN	MEDIAN	25TH	75TH	MEAN	MEDIAN	25TH	75TH
Oct	116.62	72.00	48.25	120.00	192.02	136.44	82.74	214.49
Nov	226.78	158.50	93.00	271.25	224.33	176.94	104.34	309.10
Dec	301.27	239.00	160.50	356.00	263.72	170.75	105.88	295.96
Jan	408.14	250.00	180.00	413.50	262.27	150.05	71.11	324.46
Feb	261.12	170.00	120.00	300.00	217.83	104.21	53.48	263.99
Mar	486.53	400.00	245.50	577.75	505.97	410.53	171.33	705.85
Apr	603.71	465.00	290.75	783.75	493.62	413.89	277.04	631.07
May	327.06	253.50	141.75	416.50	241.80	197.20	123.31	318.01
Jun	151.15	102.50	66.75	167.25	174.57	111.70	67.52	205.79
Jul	138.71	58.00	33.00	154.00	151.32	63.35	35.57	172.72
Aug	96.95	50.00	23.00	107.75	163.88	88.71	36.73	214.99
Sep	63.80	41.50	27.00	59.00	127.85	88.46	42.48	134.86

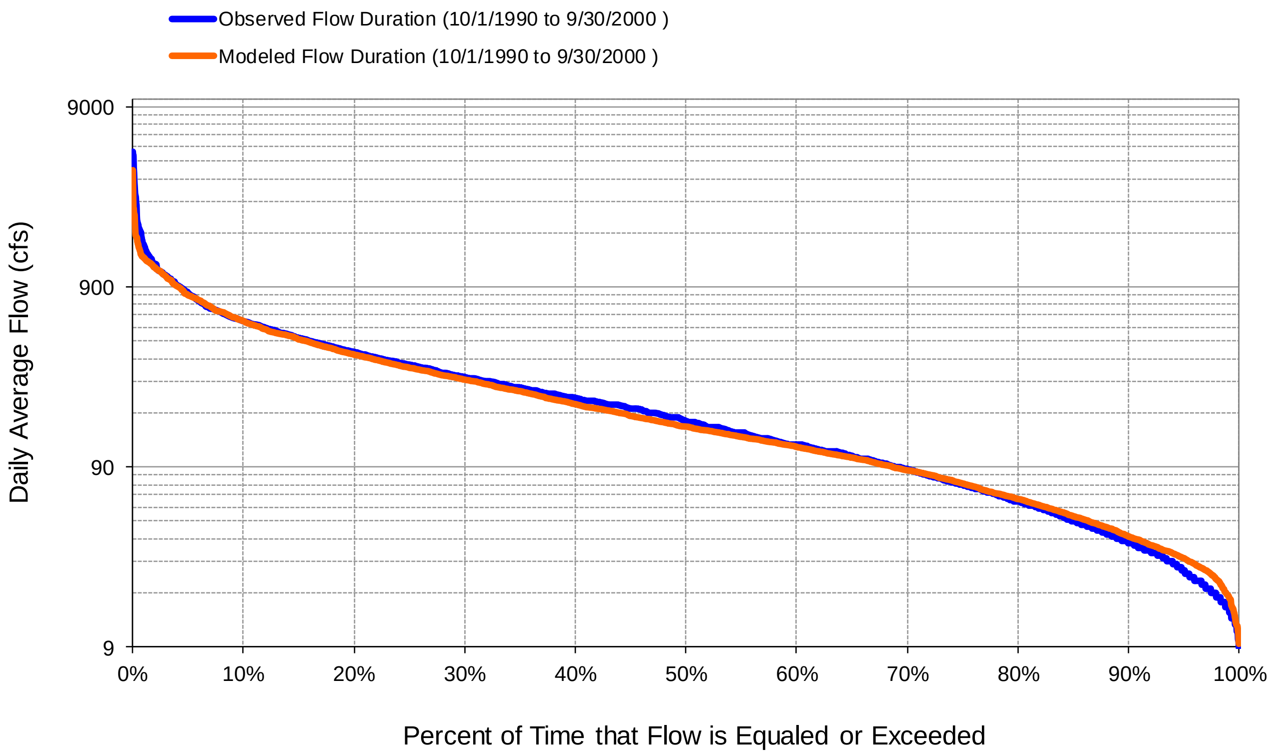


Figure H-27. Flow exceedence at USGS 04280450 Mettawee River near Middle Granville, NY

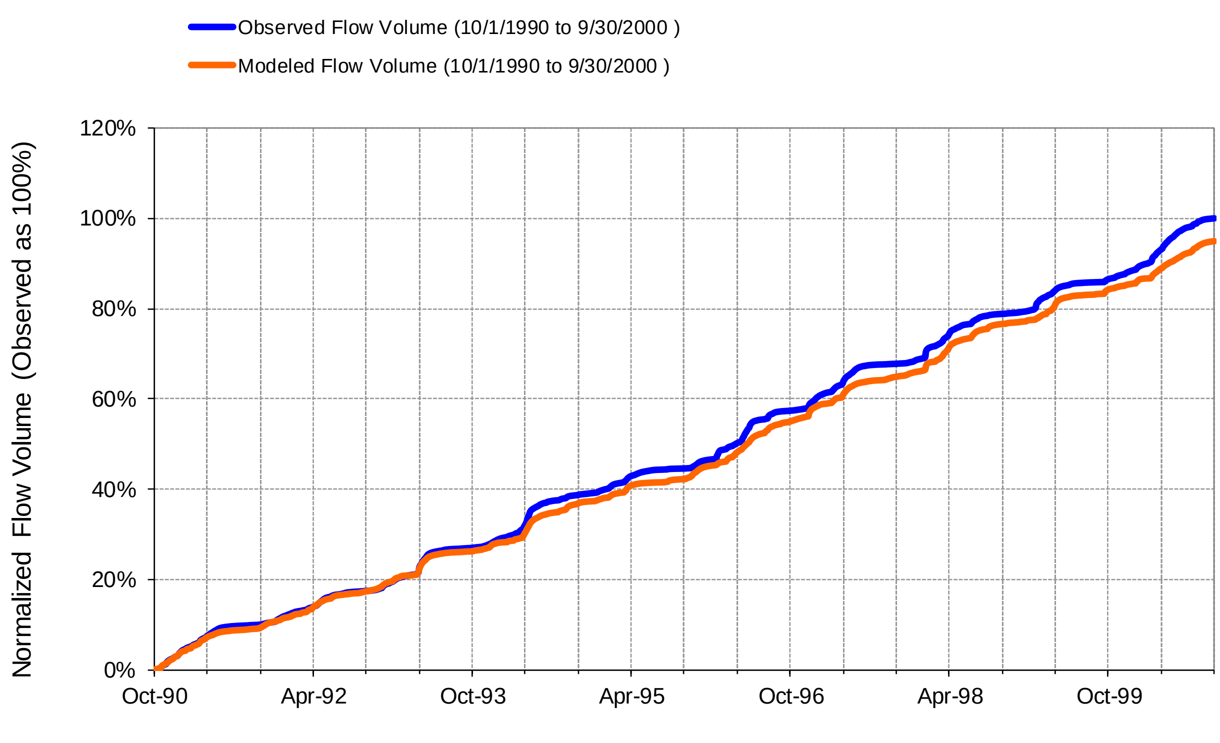


Figure H-28. Flow accumulation at USGS 04280450 Mettawee River near Middle Granville, NY

Table H-8. Summary statistics at USGS 04280450 Mettawee River near Middle Granville, NY

SWAT Simulated Flow		Observed Flow Gage	
REACH OUTFLOW FROM OUTLET 3 10-Year Analysis Period: 10/1/1990 - 9/30/2000 Flow volumes are (inches/year) for upstream drainage area		USGS 04280450 METTAWEE RIVER NEAR MIDDLE GRANVILLE NY Hydrologic Unit Code: 2010001 Latitude: 43.463959 Longitude: -73.2842757 Drainage Area (sq-mi): 167	
Total Simulated In-stream Flow:	**20.48**	Total Observed In-stream Flow:	**21.57**
Total of simulated highest 10% flows:	**7.59**	Total of Observed highest 10% flows:	**8.28**
Total of Simulated lowest 50% flows:	**3.12**	Total of Observed Lowest 50% flows:	**3.13**
Simulated Summer Flow Volume (months 7-9):	**3.03**	Observed Summer Flow Volume (7-9):	**2.05**
Simulated Fall Flow Volume (months 10-12):	**4.64**	Observed Fall Flow Volume (10-12):	**4.40**
Simulated Winter Flow Volume (months 1-3):	**6.68**	Observed Winter Flow Volume (1-3):	**7.82**
Simulated Spring Flow Volume (months 4-6):	**6.13**	Observed Spring Flow Volume (4-6):	**7.30**
Total Simulated Storm Volume:	**5.39**	Total Observed Storm Volume:	**5.13**
Simulated Summer Storm Volume (7-9):	**0.89**	Observed Summer Storm Volume (7-9):	**0.62**

Errors (Simulated-Observed)	*Error Statistics*	*Recommended Criteria*		
Error in total volume:	-5.06	10		
Error in 50% lowest flows:	-0.41	10		
Error in 10% highest flows:	-8.29	15		
Seasonal volume error - Summer:	47.59	30		
Seasonal volume error - Fall:	5.57	>> 30		Clear
Seasonal volume error - Winter:	-14.65	30		
Seasonal volume error - Spring:	-15.99	30		
Error in storm volumes:	5.21	20		
Error in summer storm volumes:	44.68	50		
Nash-Sutcliffe Coefficient of Efficiency, E:	0.620	Model accuracy increases		
Baseline adjusted coefficient (Garrick), E':	0.461	as E or E' approaches 1.0		
Monthly NSE	0.752			

WATER QUALITY

TSS and TP distribution by channel and upland sources

Table H-9. TSS and TP distribution by source categories

Source	TSS		TP	
	Load(mt/year)	Percentage (%)	Load (kg/year)	Percentage (%)
Upland	40,675	85.5	45,213	87.1
Stream	6,883	14.5	6,677	12.9
Total	**47,558**	**100.0**	**51,890**	**100.0**

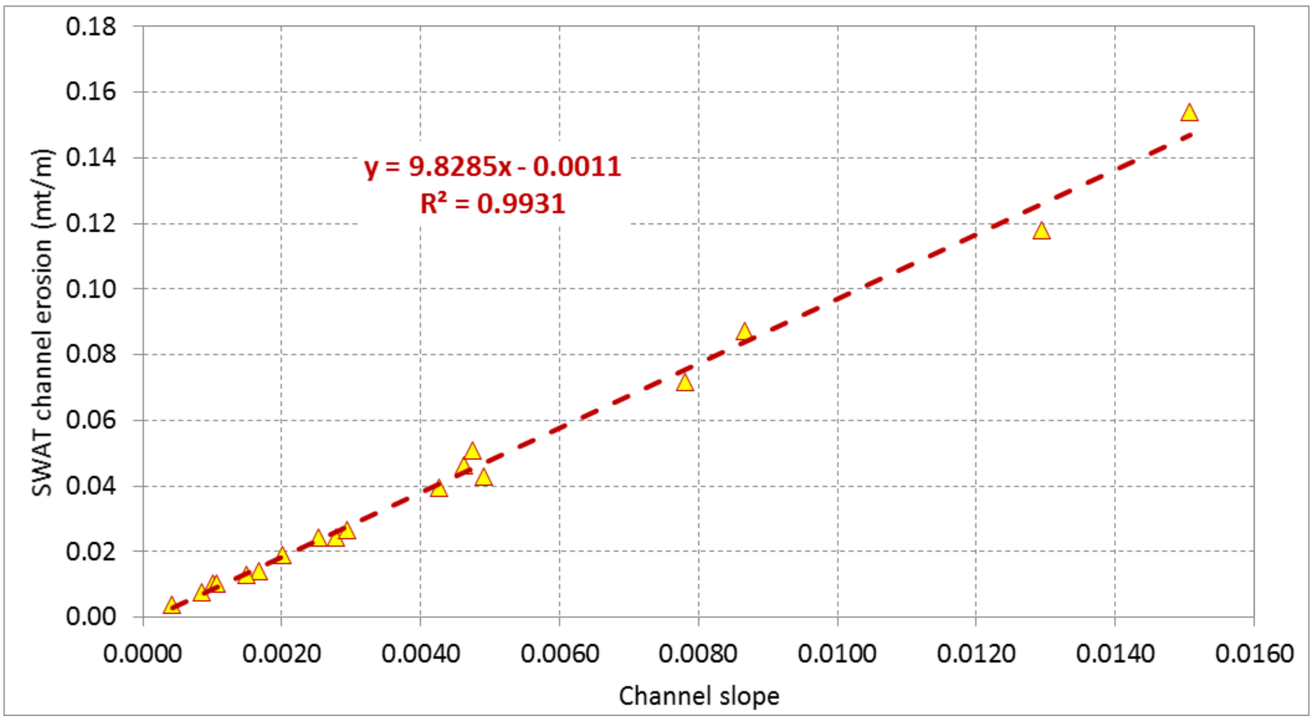


Figure H-29. SWAT simulated channel erosion relative to channel slope

TP distribution by landuse from upland sources

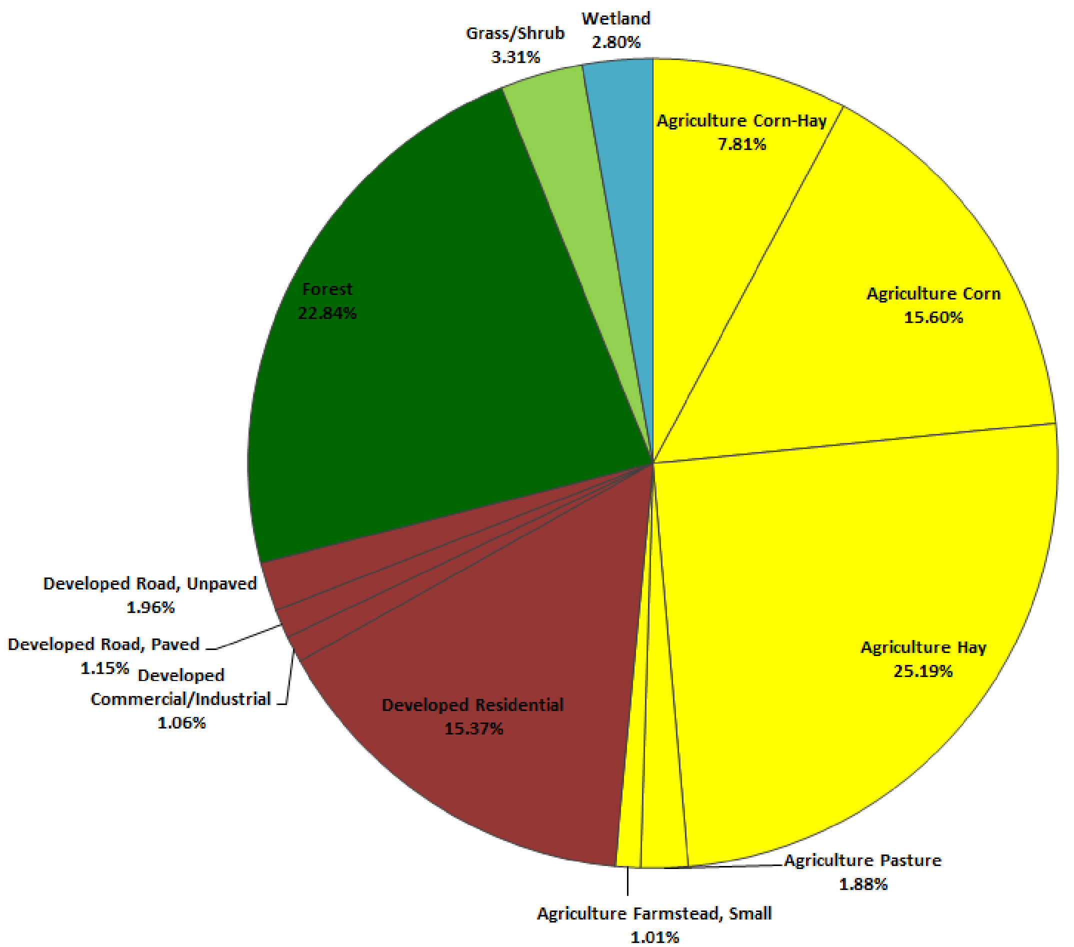


Figure H-30. Distribution of simulated total upland TP loads by landuse categories

Table H-10. TP export rates (kg/ha/yr) by landuse categories for the 30 year simulation period

Landuse	Classification	Area (ha)	Area (%)	Mean	Min	Q_{25}	Q_{50}	Q_{75}	Max
Agriculture	Corn-Hay	1,736	1.64	1.93	0.10	1.00	1.58	3.15	4.25
	Corn	3,170	2.99	2.11	0.57	1.44	2.11	2.58	4.87
	Hay	12,340	11.63	0.88	0.27	0.67	0.80	1.06	1.84
	Pasture	637	0.60	1.27	0.43	0.96	1.19	1.50	2.56
	Farmstead, Small	142	0.13	3.05	0.86	2.37	2.98	3.80	5.55
Urban	Residential	9,196	8.67	0.72	0.35	0.60	0.68	0.83	1.27
	Commercial/Industrial	265	0.25	1.73	1.25	1.55	1.72	1.85	2.16
	Road, Paved	244	0.23	2.02	1.77	1.92	2.01	2.11	2.48
	Road, Unpaved	149	0.14	5.65	4.93	5.37	5.62	5.90	6.88
Forest	Forest	62,616	59.00	0.16	0.08	0.12	0.15	0.19	0.27
Grass/Shrub	Grass/Shrub	8,362	7.88	0.17	0.07	0.14	0.17	0.20	0.32
Wetland	Wetland	7,270	6.85	0.17	0.06	0.13	0.15	0.19	0.31

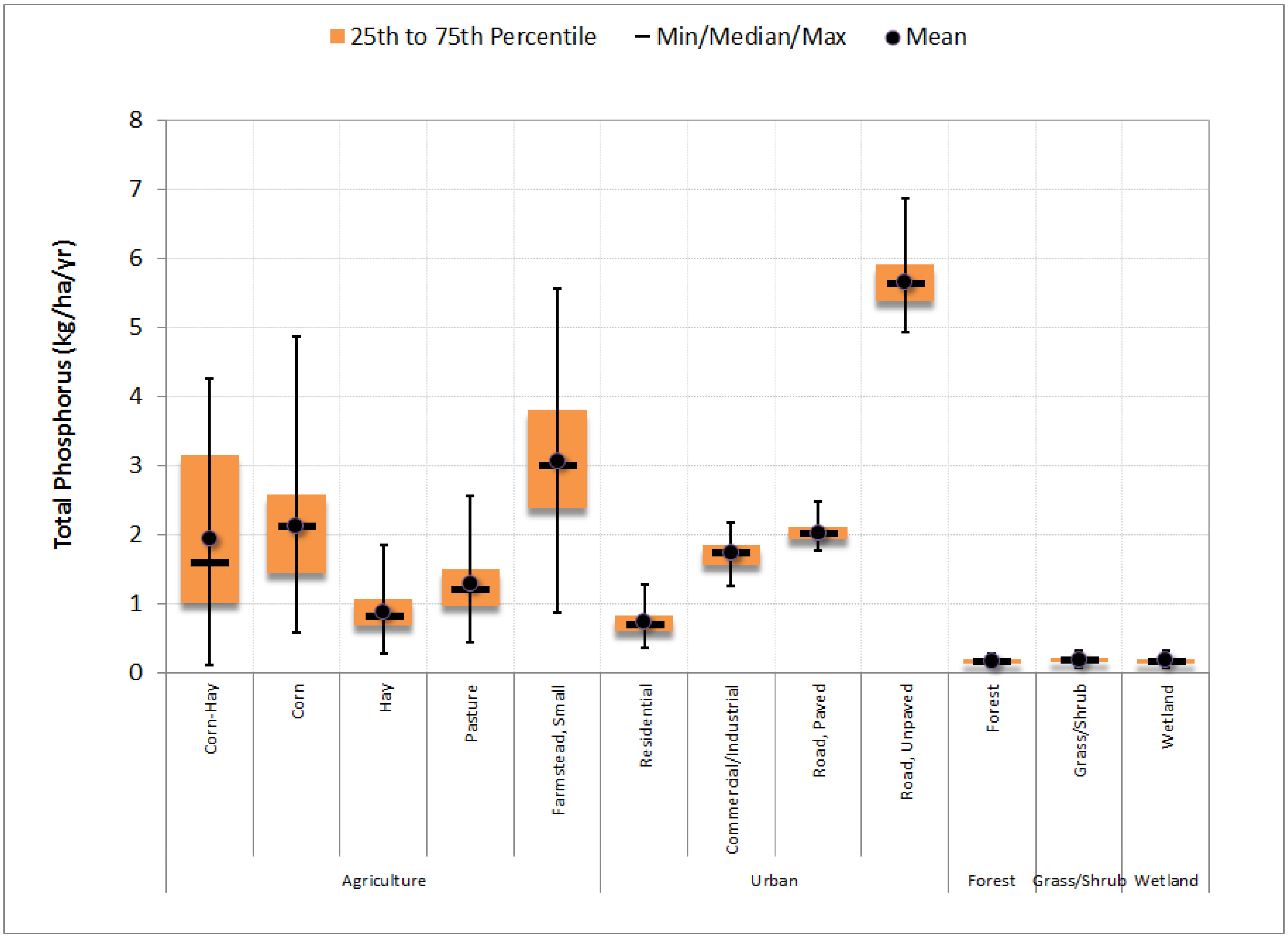


Figure H-31. TP export rates (kg/ha/yr) by landuse categories for the 30 year simulation period

Table H-11. TP export rates (kg/ha/yr) for the residential landuse categories for the 30 year simulation period

Residential Category	Area (ha)	Area (%)	Mean	Min	Q_{25}	Q_{50}	Q_{75}	Max
Low Density	5,280	58.60	**0.49**	0.17	0.37	0.46	0.59	1.06
Medium Density	2,858	31.71	**0.82**	0.39	0.67	0.78	0.93	1.38
High Density	873	9.69	**1.11**	0.67	0.94	1.08	1.23	1.62
Total	9,011	100.00	**0.66**	0.29	0.54	0.61	0.76	1.21

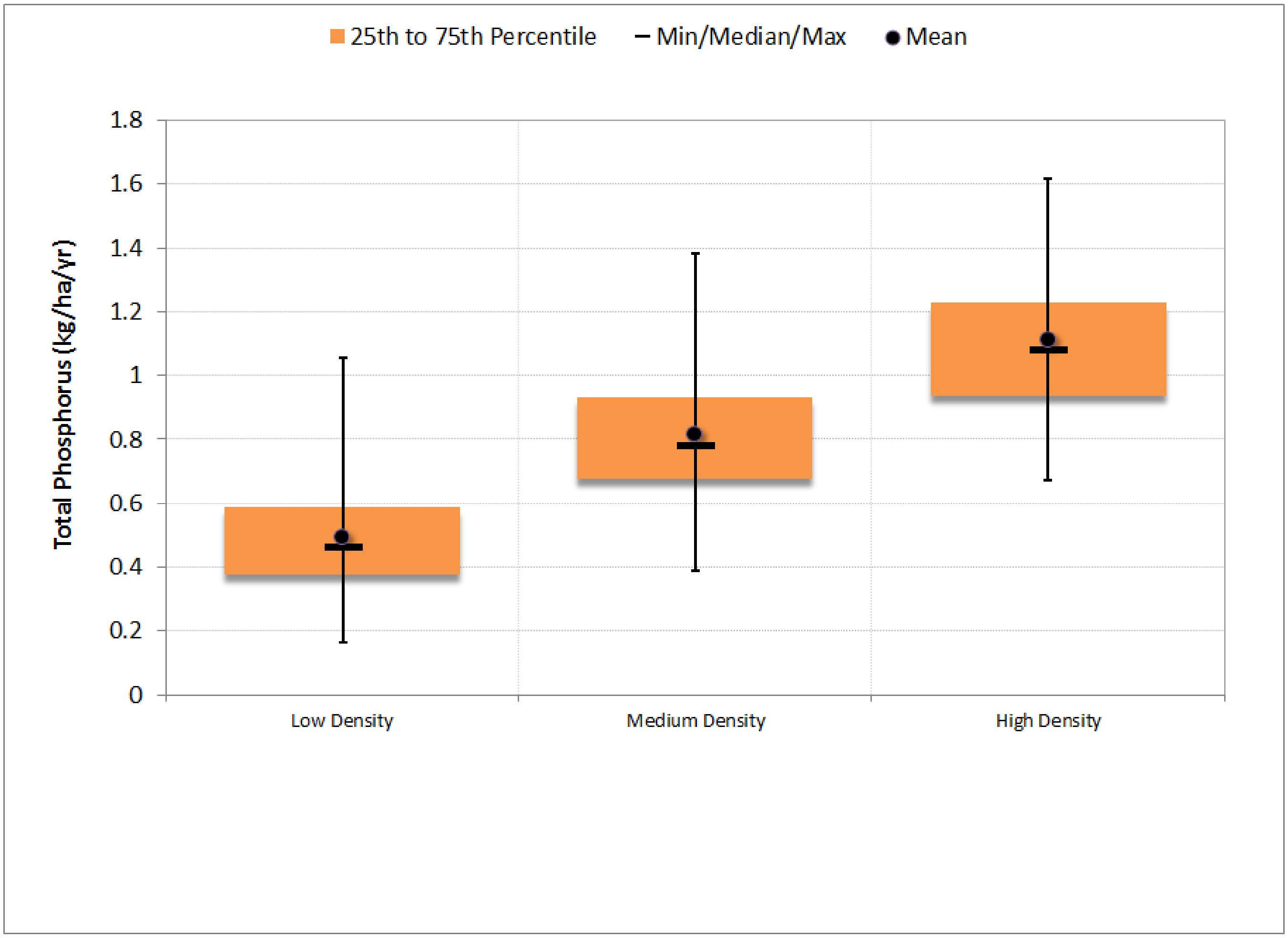


Figure H-32. TP export rates (kg/ha/yr) for the residential landuse categories for the 30 year simulation period

Segmented Regression

Table H-12. Summary statistics

Statistic	Calibration		Validation	
	TSS	TP	TSS	TP
Average absolute error (%)	68.4	58.5	59.0	61.5
Median absolute error (%)	19.8	34.9	13.4	32.1
Regression error (%)	6.6	-1.8	22.5	-5.8
NSE	0.162	0.307	0.461	0.368
NSE'	0.353	0.257	0.504	0.290

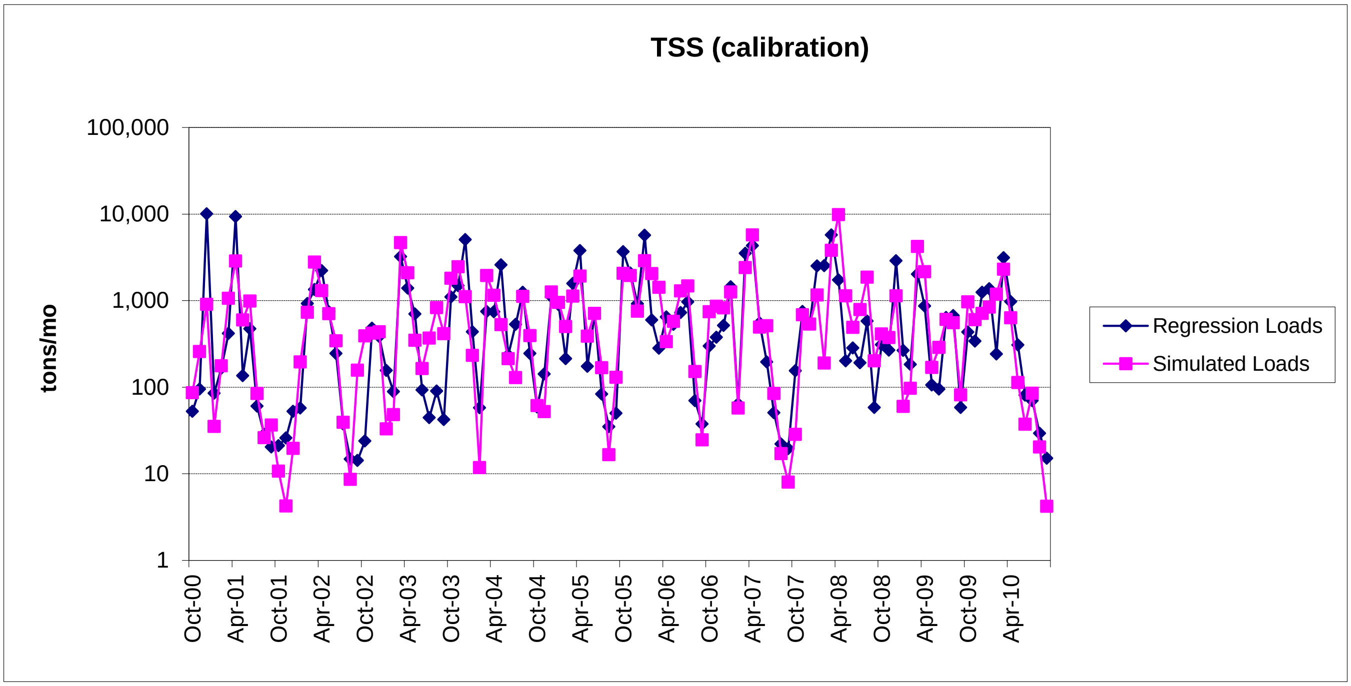


Figure H-33. Monthly simulated and estimated TSS load at Mettawee River near Middle Granville, NY (calibration period)

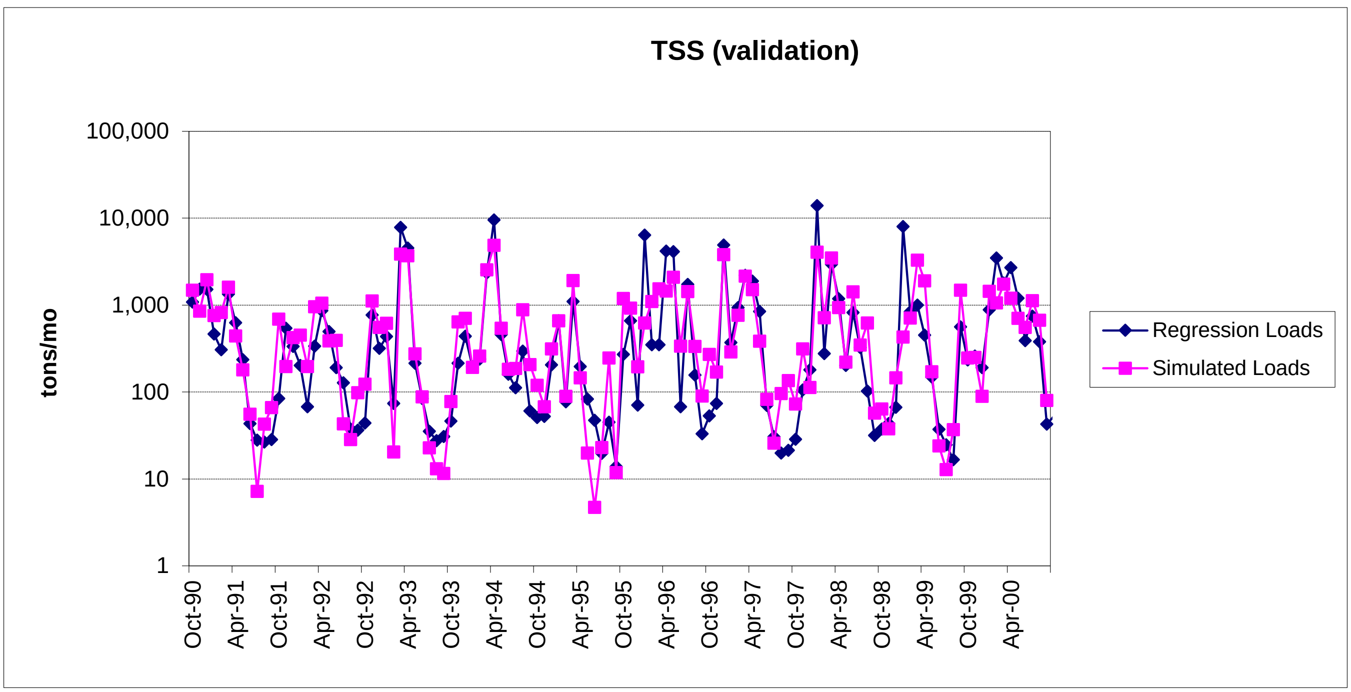


Figure H-34. Monthly simulated and estimated TSS load at Mettawee River near Middle Granville, NY (validation period)

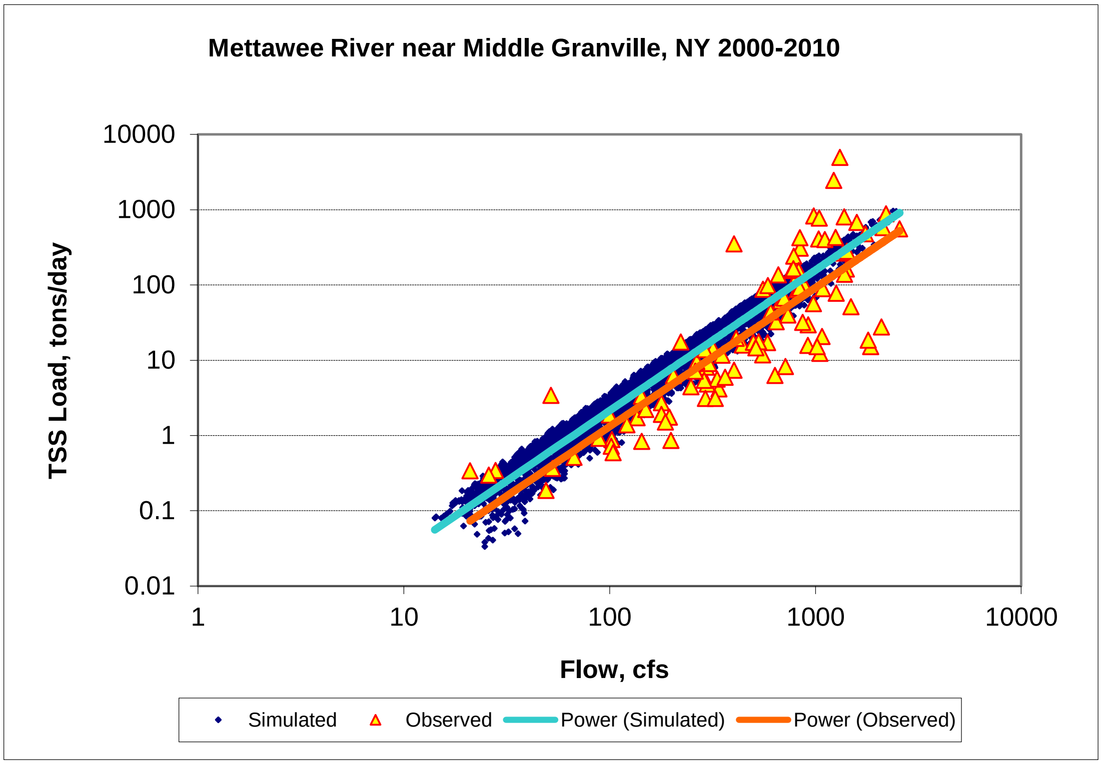


Figure H-35. Power plot of simulated and observed TSS load vs flow at Mettawee River near Middle Granville, NY (calibration period)

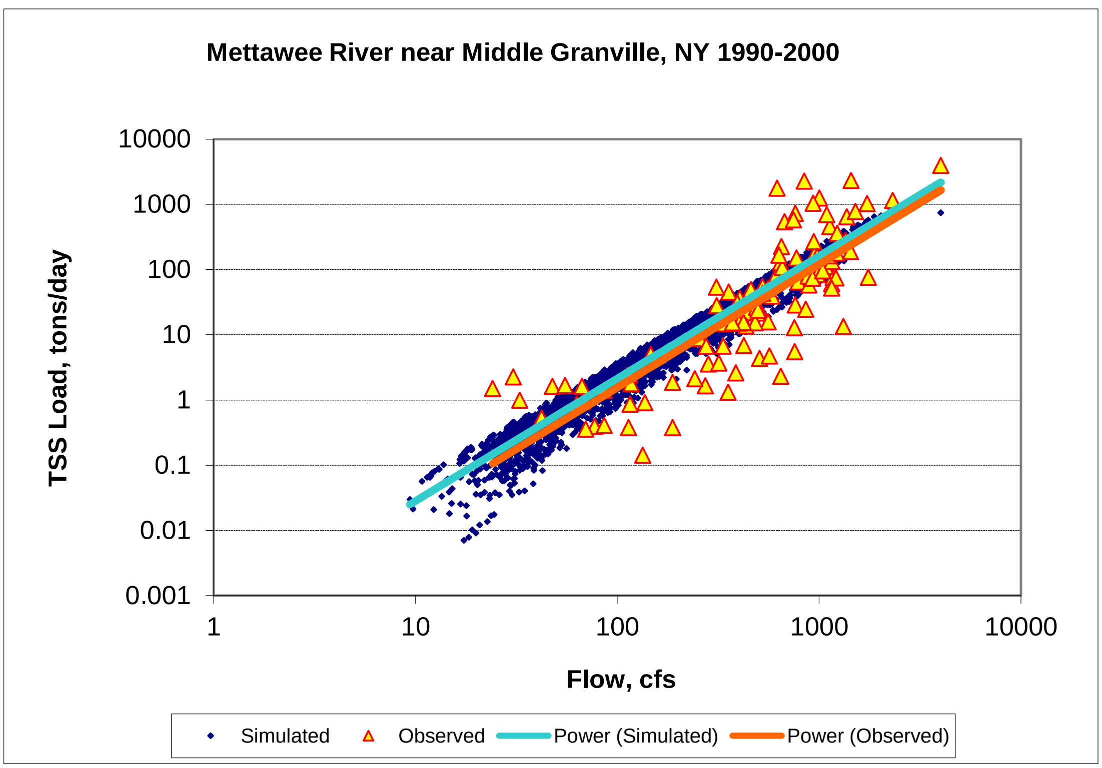


Figure H-36. Power plot of simulated and observed TSS load vs flow at Mettawee River near Middle Granville, NY (validation period)

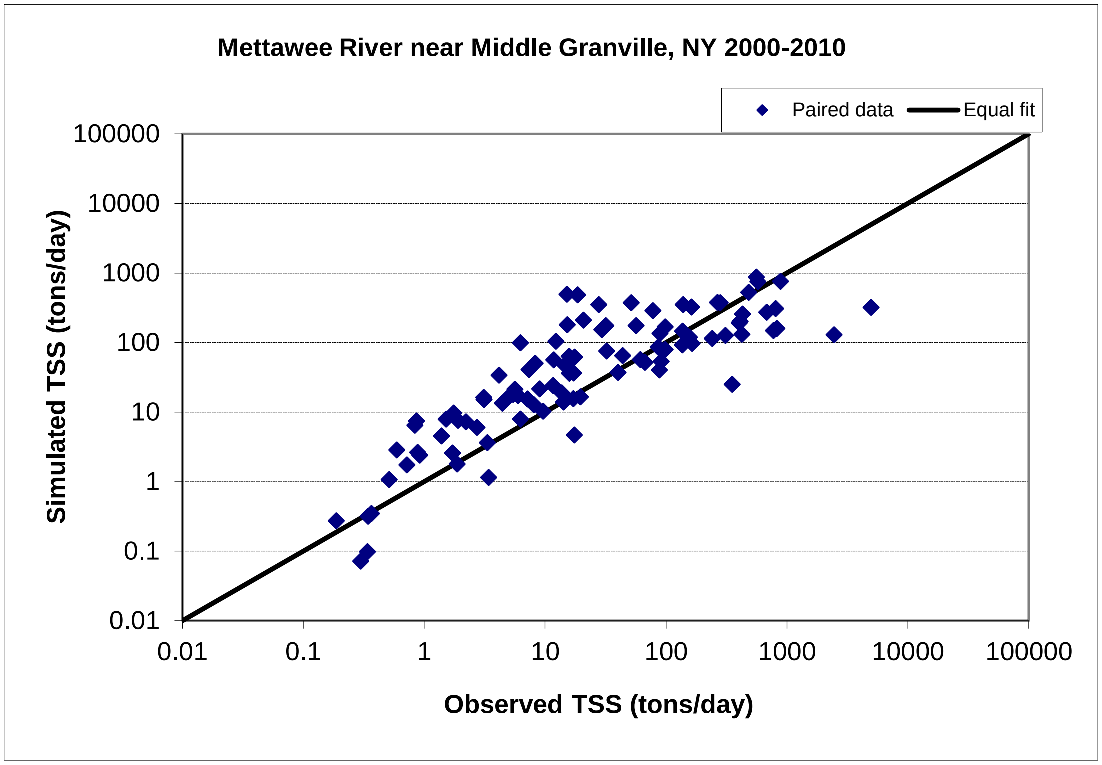


Figure H-37. Paired simulated vs observed TSS load at Mettawee River near Middle Granville, NY (calibration period)

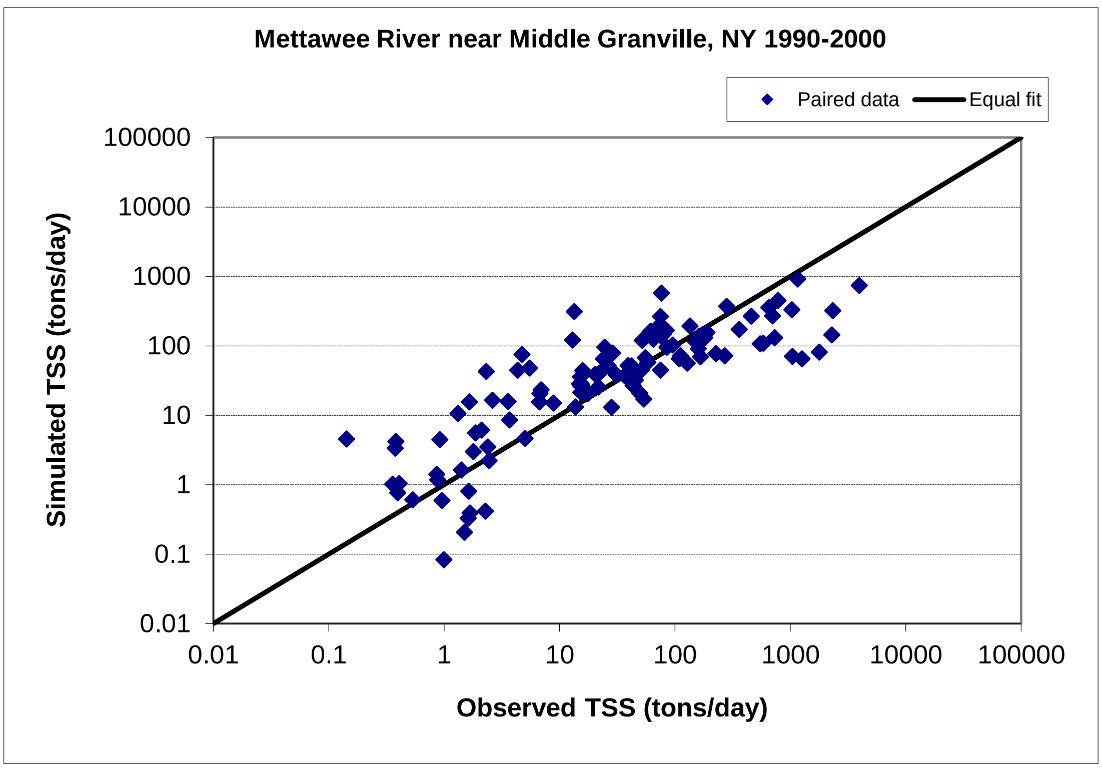


Figure H-38. Paired simulated vs observed TSS load at Mettawee River near Middle Granville, NY (validation period)

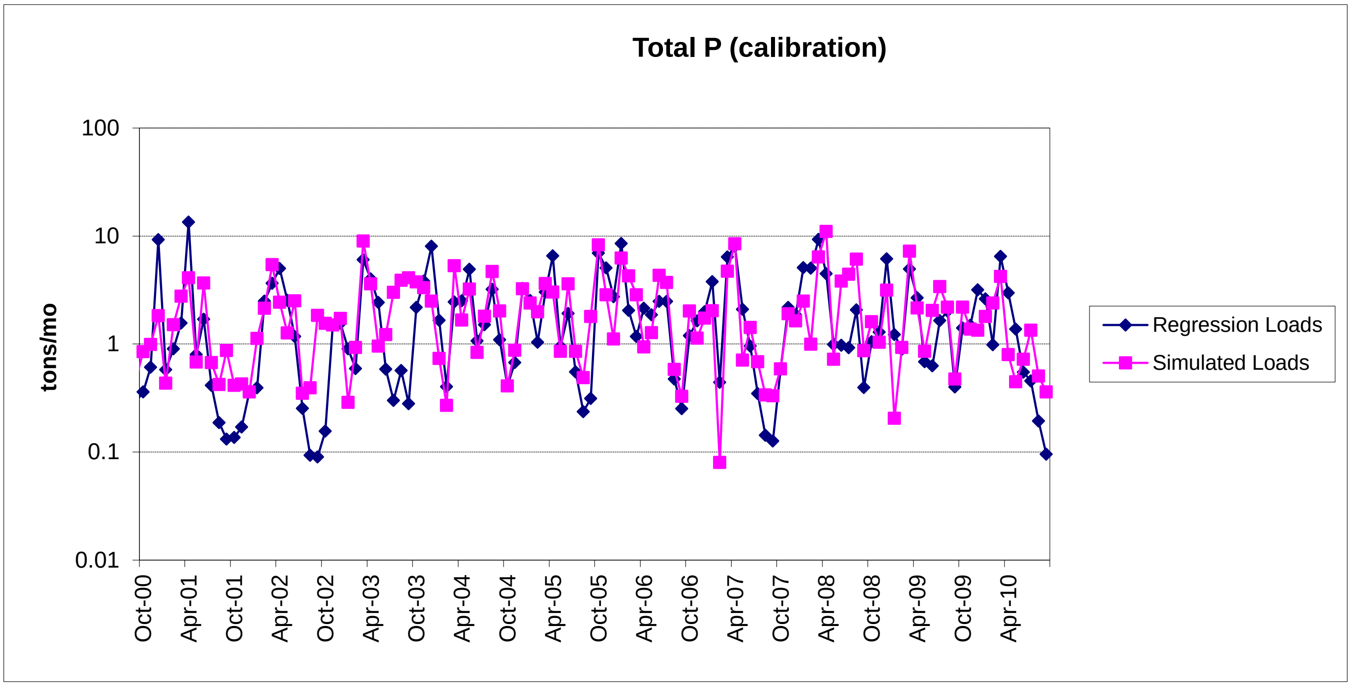


Figure H-39. Monthly simulated and estimated TP load at Mettawee River near Middle Granville, NY (calibration period)

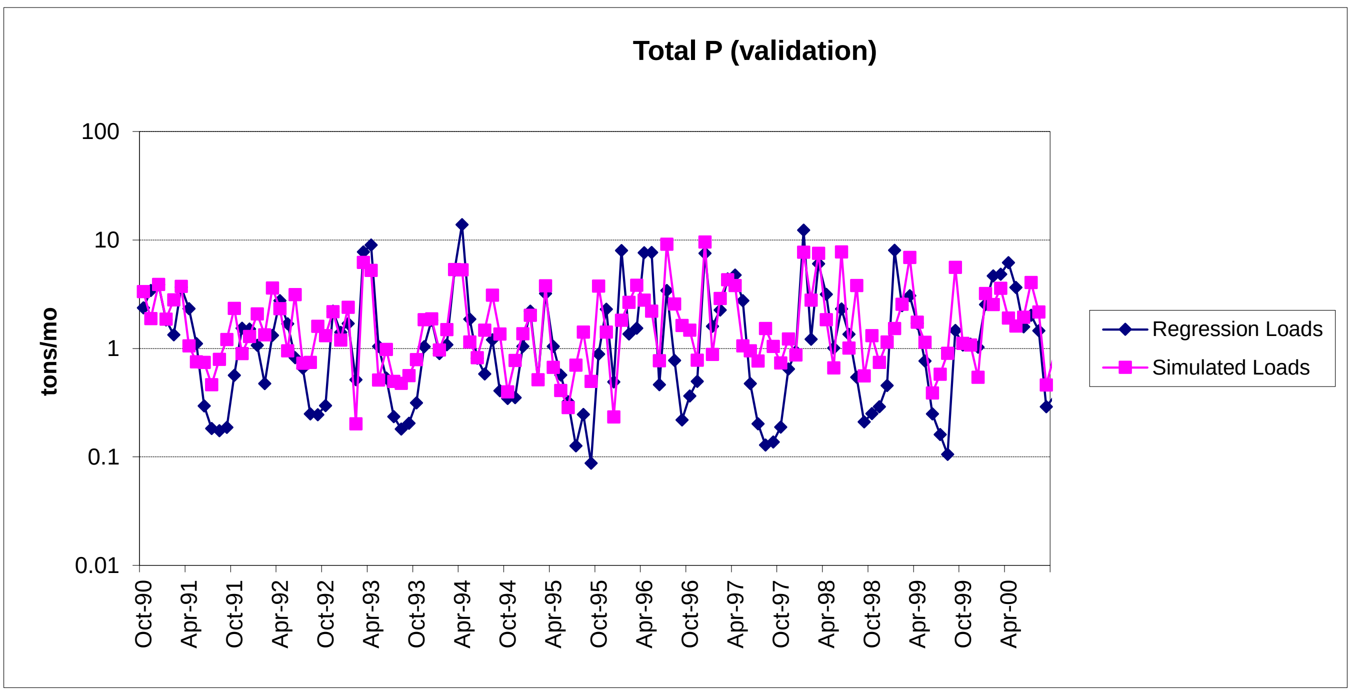


Figure H-40. Monthly simulated and estimated TP load at Mettawee River near Middle Granville, NY (validation period)

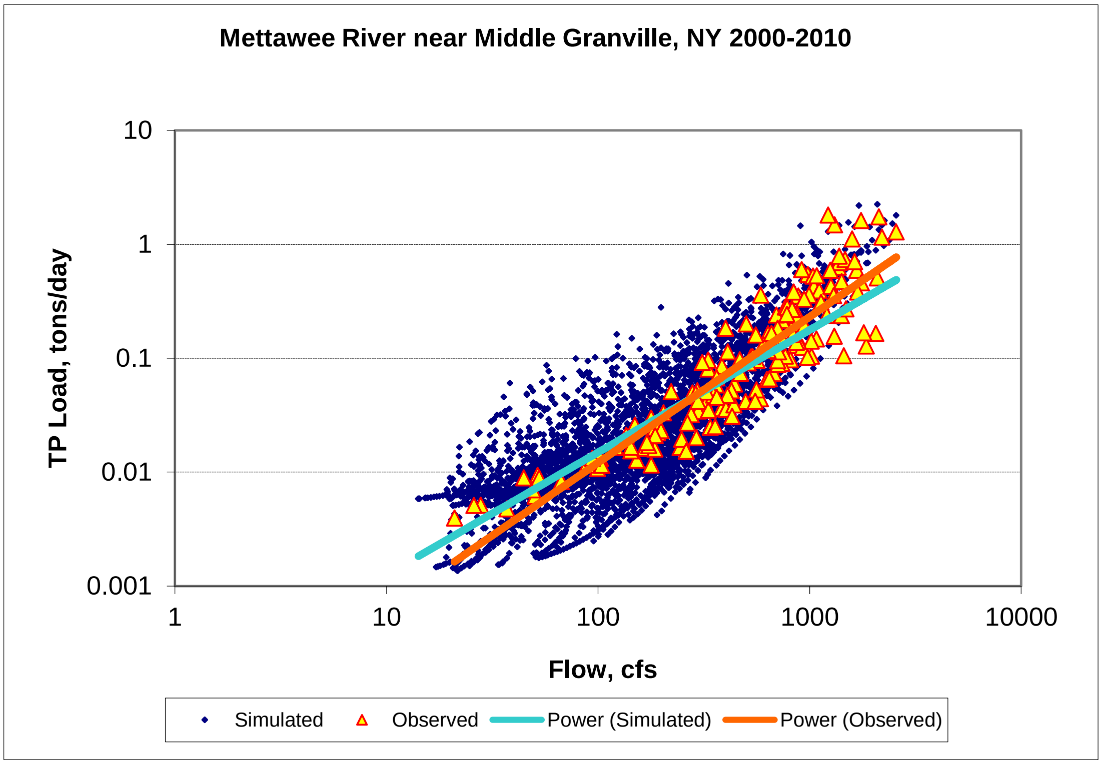


Figure H-41. Power plot of simulated and observed TP load vs flow at Mettawee River near Middle Granville, NY (calibration period)

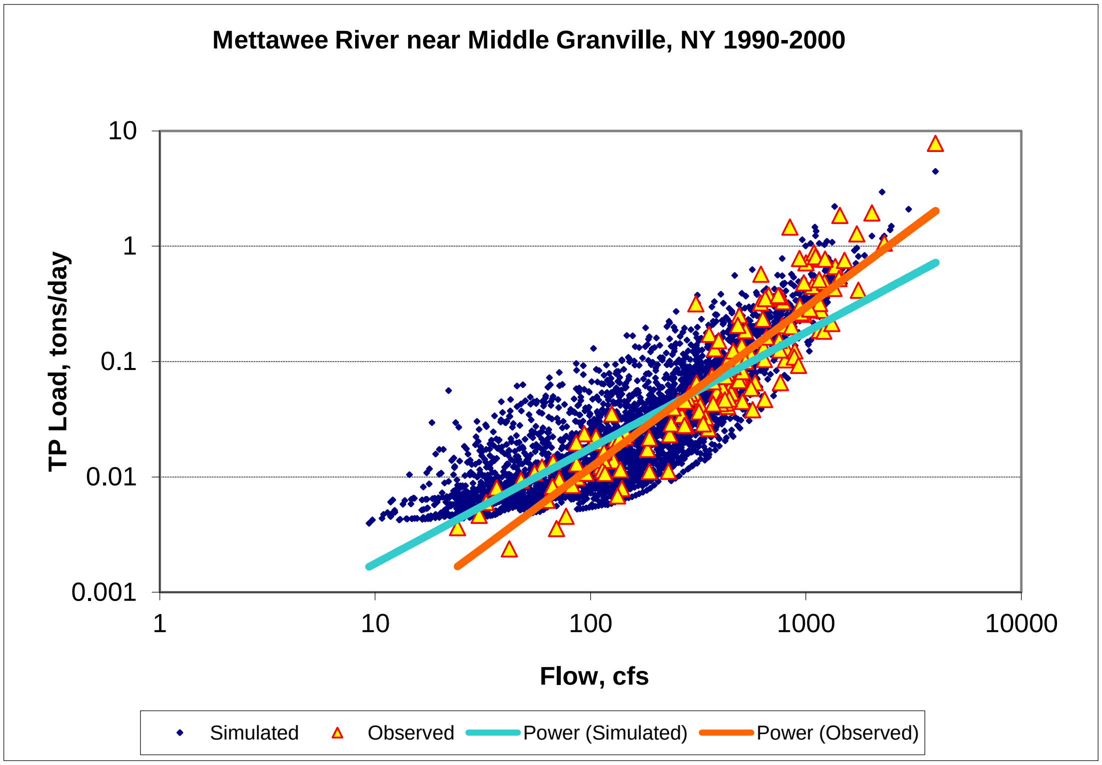


Figure H-42. Power plot of simulated and observed TP load vs flow at Mettawee River near Middle Granville, NY (validation period)

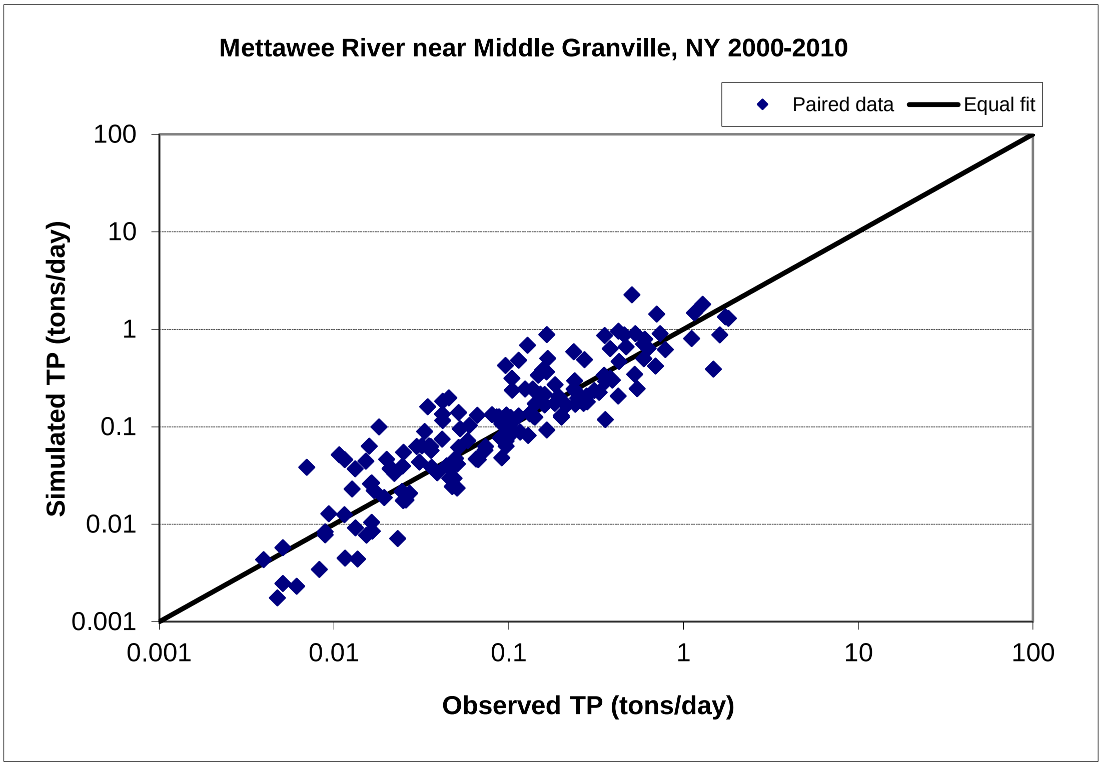


Figure H-43. Paired simulated vs observed TP load at Mettawee River near Middle Granville, NY (calibration period)

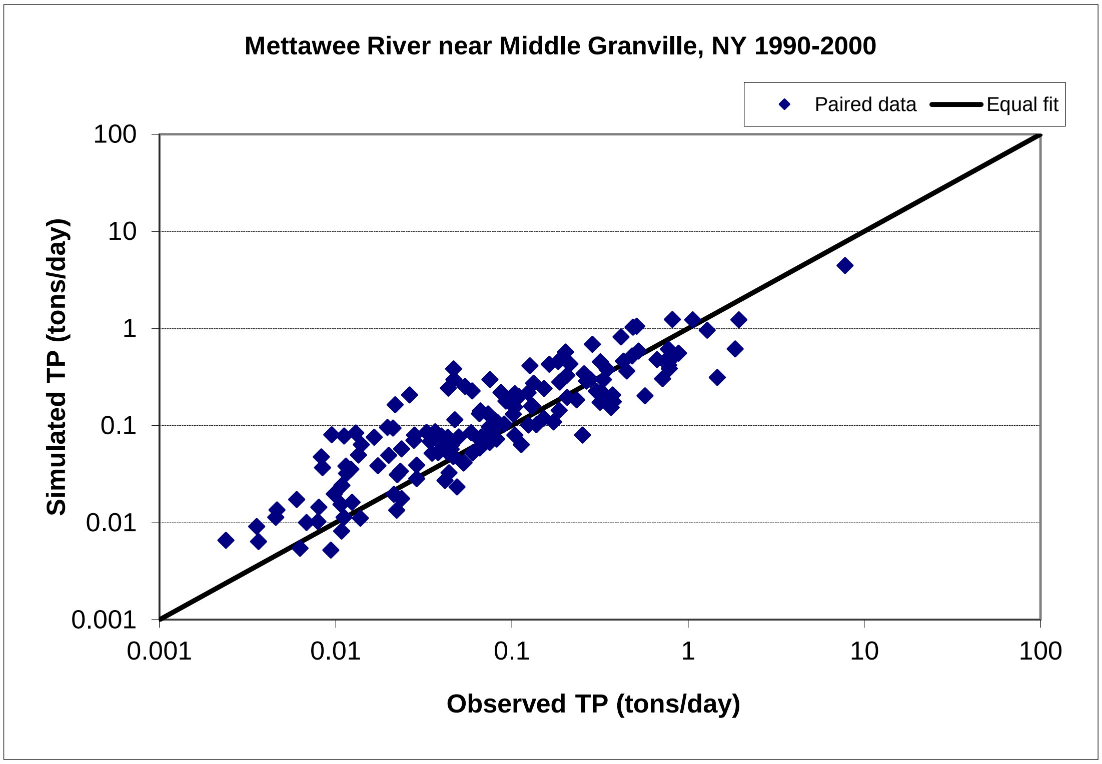


Figure H-44. Paired simulated vs observed TP load at Mettawee River near Middle Granville, NY (validation period)

Comparison of simulated SWAT TP loads with FLUX estimates

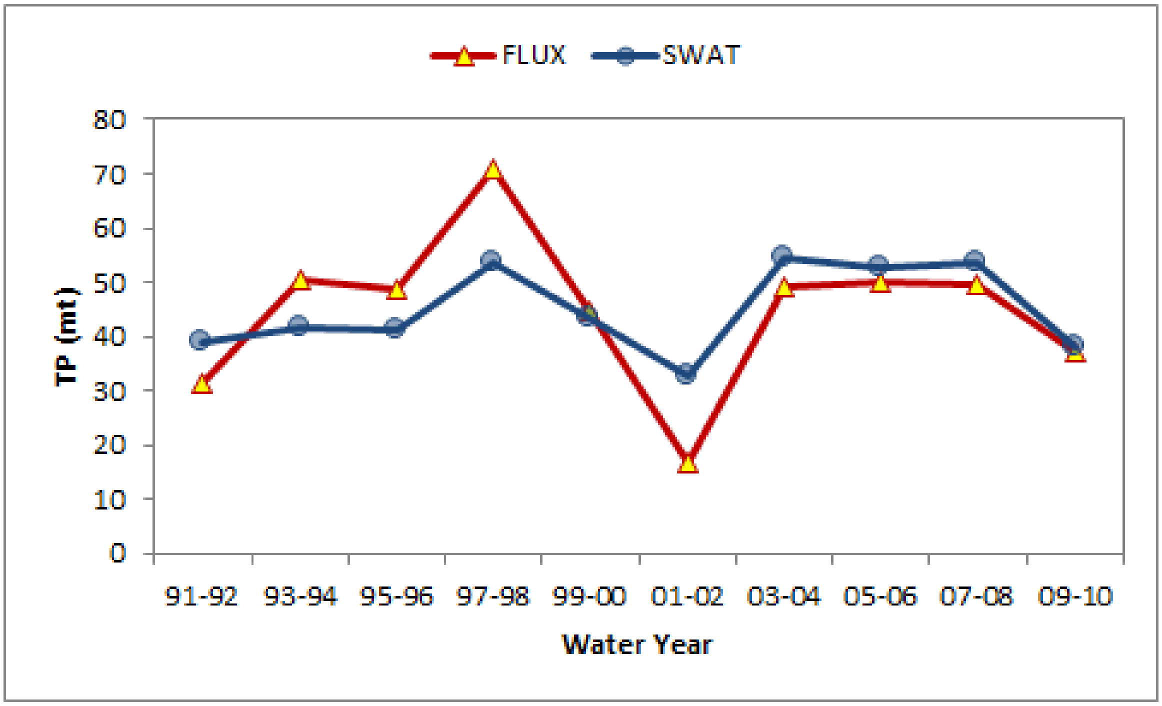


Figure H-45. Bi-annual TP loads on a water year basis as simulated by SWAT and estimated by FLUX (FLUX estimates from Smeltzer et al., 2009)

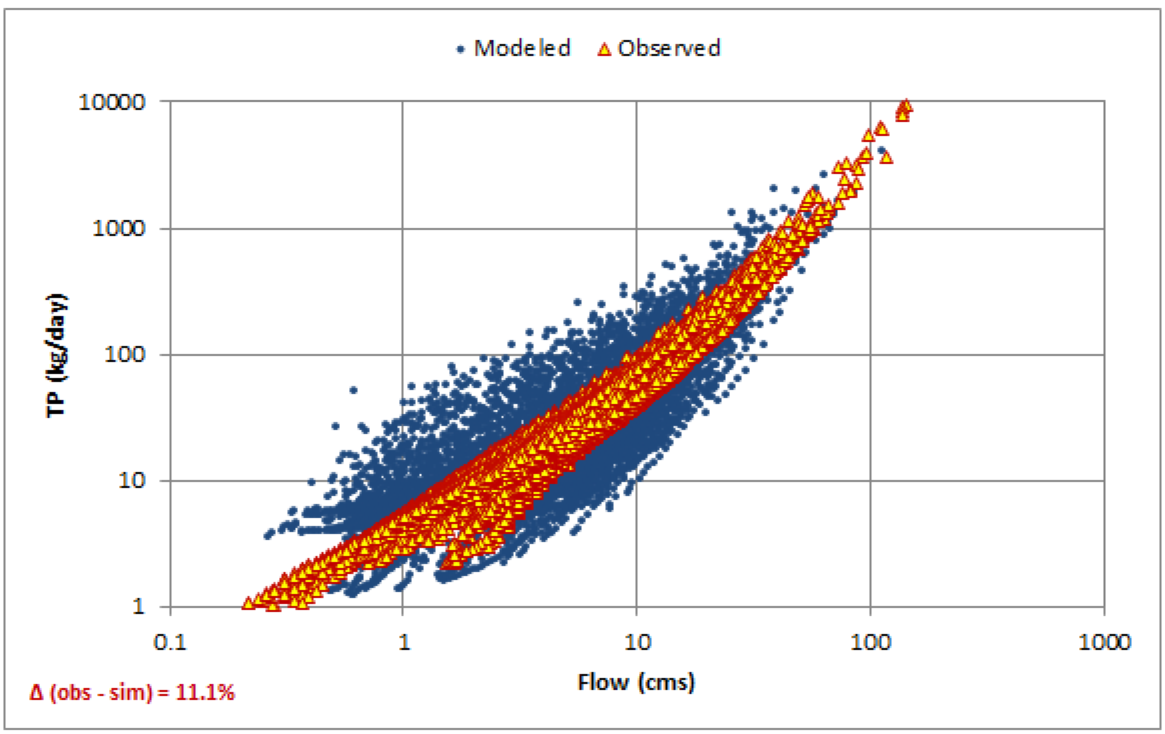
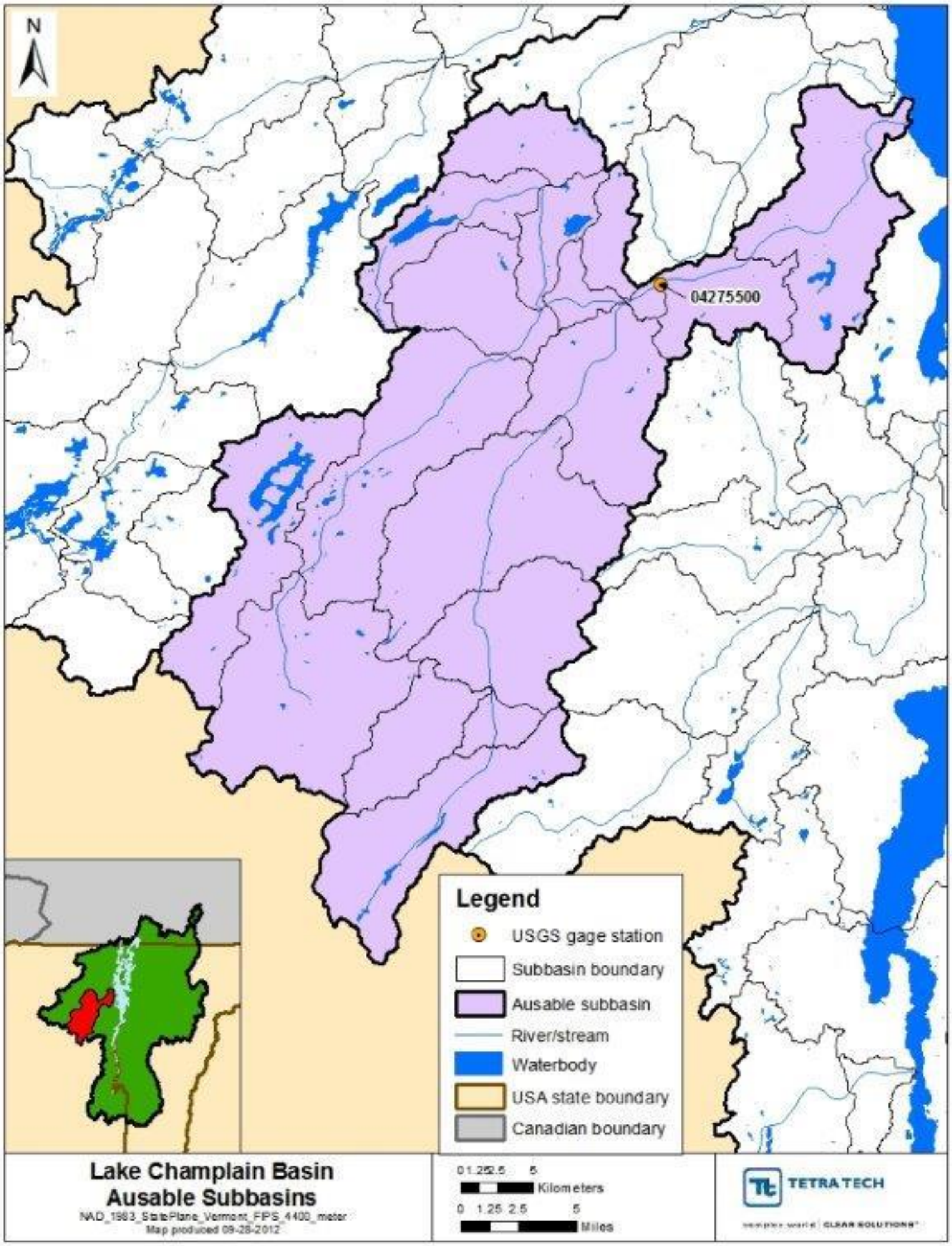


Figure H-46. Daily TP load versus flow as simulated by SWAT and estimated by FLUX (FLUX estimates from Medalie, 2013)

Appendix I - Ausable River Watershed



HYDROLOGY

USGS 04275500 Ausable River near Ausable Forks, NY - Calibration

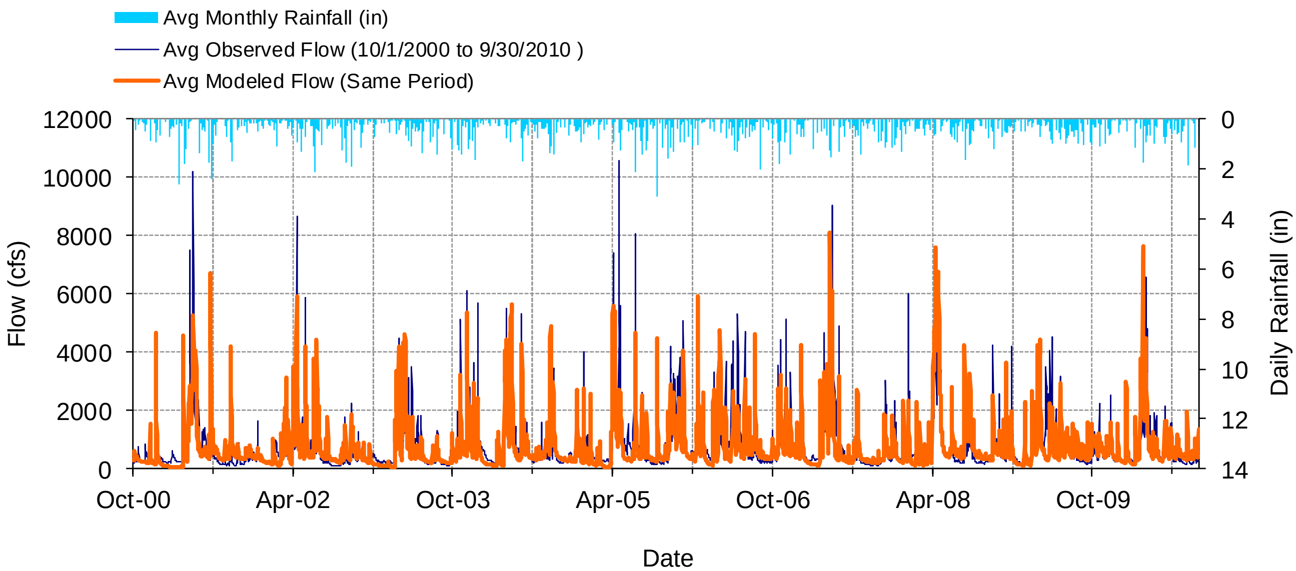


Figure I-1. Mean daily flow at USGS 04275500 Ausable River near Ausable Forks, NY

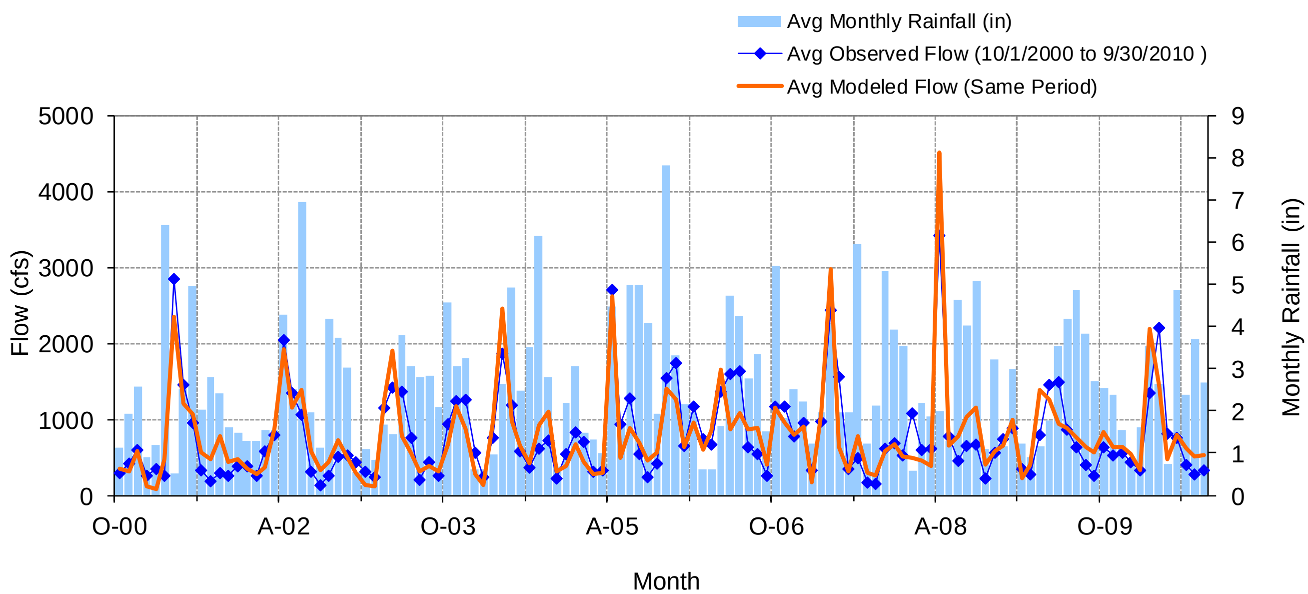


Figure I-2. Mean monthly flow at USGS 04275500 Ausable River near Ausable Forks, NY

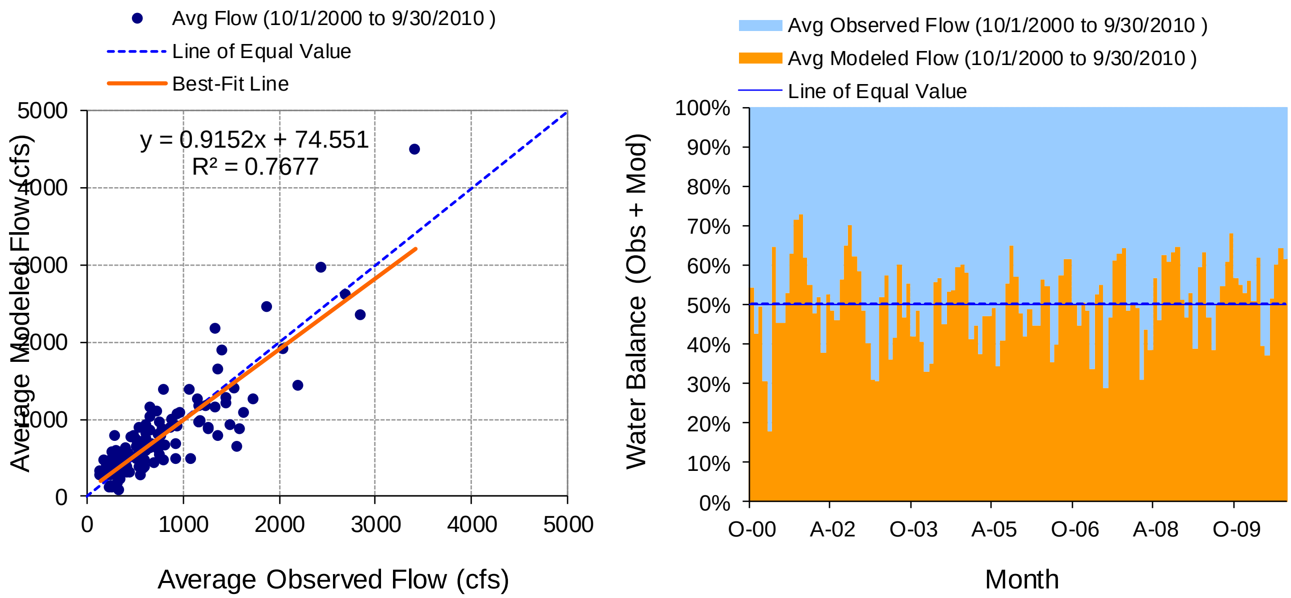


Figure I-3. Monthly flow regression and temporal variation at USGS 04275500 Ausable River near Ausable Forks, NY

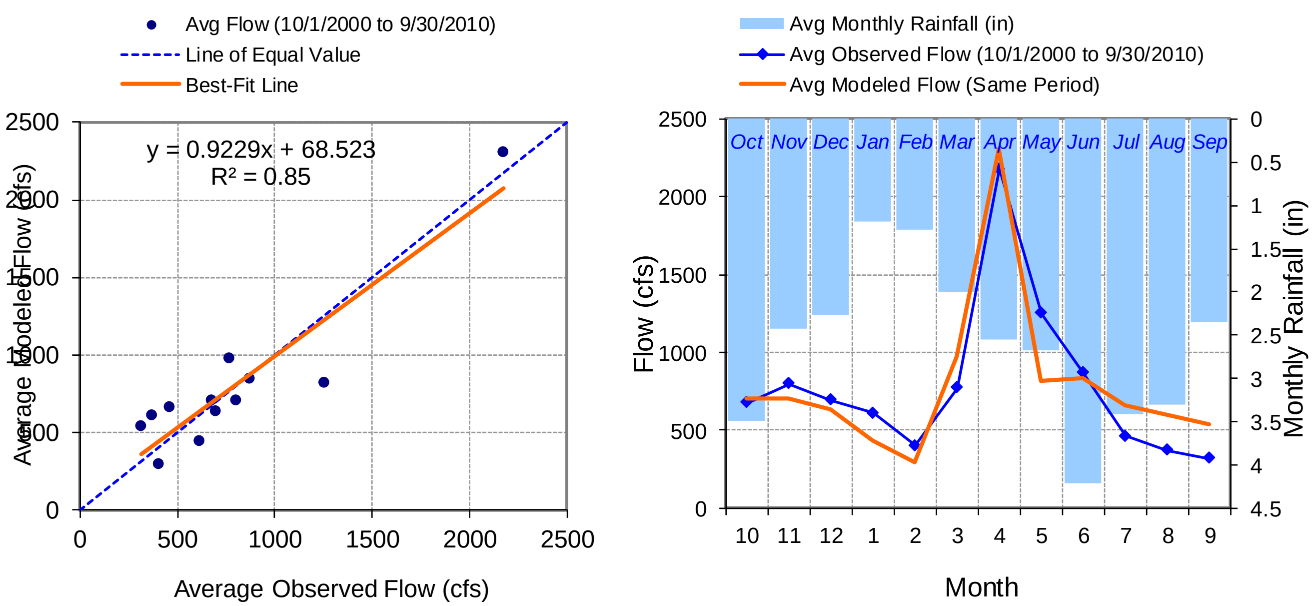


Figure I-4. Seasonal regression and temporal aggregate at USGS 04275500 Ausable River near Ausable Forks, NY

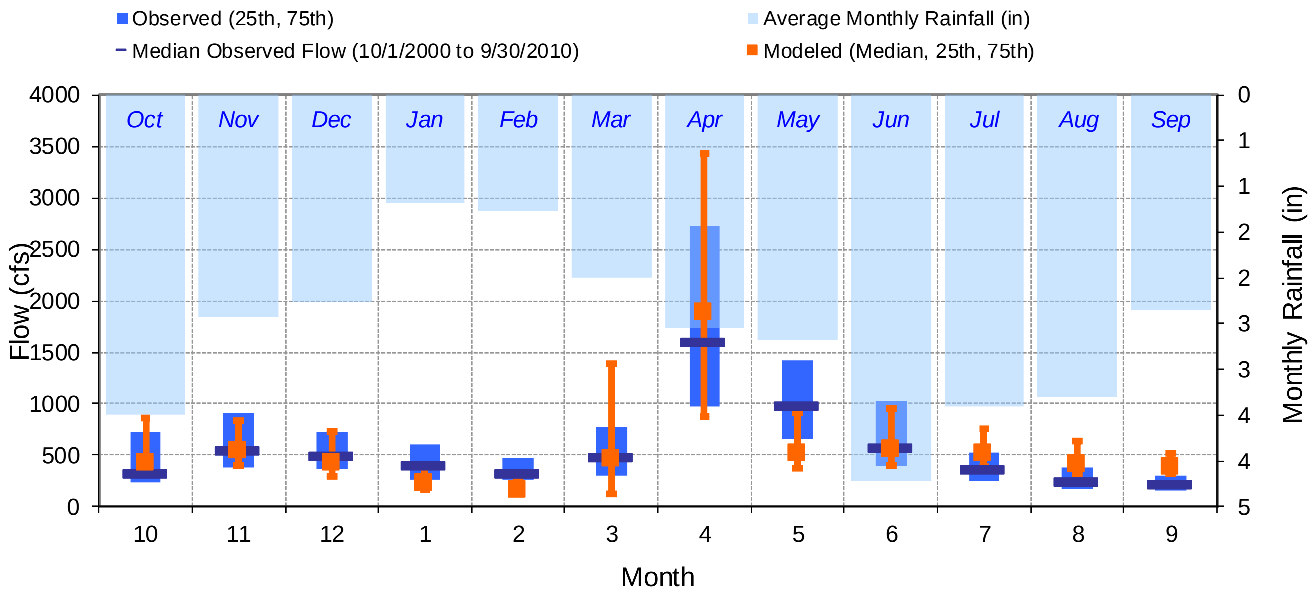


Figure I-5. Seasonal medians and ranges at USGS 04275500 Ausable River near Ausable Forks, NY

Table I-1. Seasonal summary at USGS 04275500 Ausable River near Ausable Forks, NY

MONTH	OBSERVED FLOW (CFS)				MODELED FLOW (CFS)			
	MEAN	MEDIAN	25TH	75TH	MEAN	MEDIAN	25TH	75TH
Oct	674.66	316.50	238.50	719.50	703.95	432.07	330.40	857.97
Nov	799.35	543.50	380.75	909.50	701.77	551.26	402.94	836.52
Dec	693.98	498.00	370.00	720.00	633.56	423.60	292.20	726.42
Jan	611.48	400.00	264.25	601.50	435.57	225.66	163.97	387.14
Feb	402.64	320.00	265.00	470.00	293.24	159.92	122.09	278.10
Mar	770.19	482.00	300.00	780.75	973.85	462.09	130.18	1386.98
Apr	2176.89	1600.00	969.75	2722.50	2305.08	1891.81	880.84	3432.32
May	1252.00	981.50	658.25	1417.50	815.70	518.42	378.04	914.39
Jun	869.36	571.50	395.25	1020.00	836.89	561.86	400.82	955.70
Jul	460.54	367.00	253.25	521.00	660.27	513.65	390.93	752.29
Aug	371.28	237.50	166.25	379.75	602.35	411.59	318.17	632.84
Sep	316.96	220.00	163.00	299.25	534.85	390.23	322.85	514.98

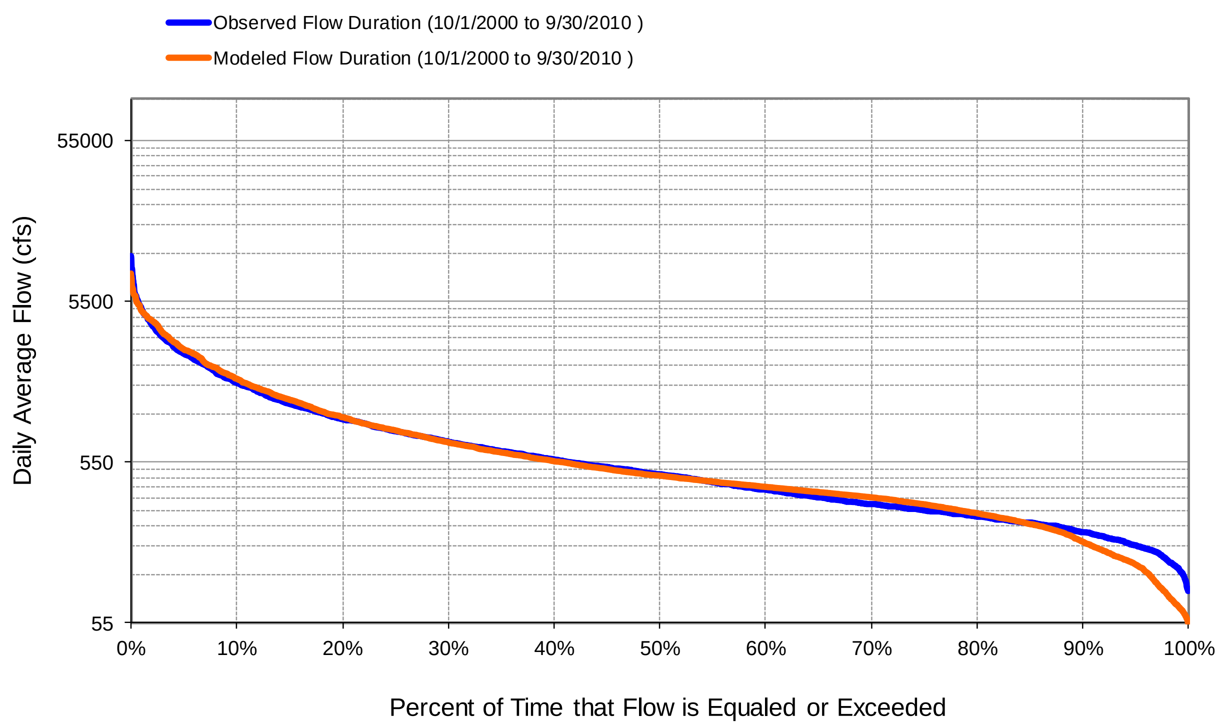


Figure I-6. Flow exceedence at USGS 04275500 Ausable River near Ausable Forks, NY

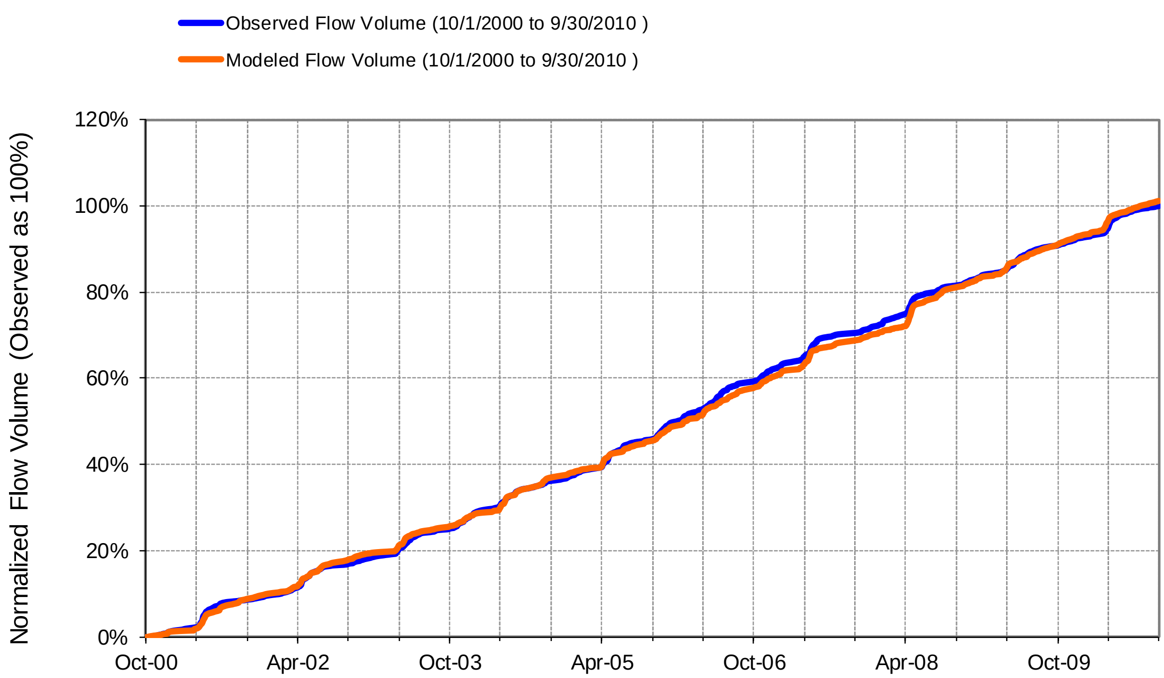


Figure I-7. Flow accumulation at USGS 04275500 Ausable River near Ausable Forks, NY

Table I-2. Summary statistics at USGS 04275500 Ausable River near Ausable Forks, NY

SWAT Simulated Flow		Observed Flow Gage	
REACH OUTFLOW FROM OUTLET 3 10-Year Analysis Period: 10/1/2000 - 9/30/2010 Flow volumes are (inches/year) for upstream drainage area		USGS 04275500 AUSABLE RIVER NEAR AU SABLE FORKS NY Hydrologic Unit Code: 2010004 Latitude: 44.45138889 Longitude: -73.6425 Drainage Area (sq-mi): 446	
Total Simulated In-stream Flow:	**24.12**	Total Observed In-stream Flow:	**23.86**
Total of simulated highest 10% flows:	**9.59**	Total of Observed highest 10% flows:	**9.44**
Total of Simulated lowest 50% flows:	**4.32**	Total of Observed Lowest 50% flows:	**4.30**
Simulated Summer Flow Volume (months 7-9):	**4.60**	Observed Summer Flow Volume (7-9):	**2.94**
Simulated Fall Flow Volume (months 10-12):	**5.21**	Observed Fall Flow Volume (10-12):	**5.54**
Simulated Winter Flow Volume (months 1-3):	**4.33**	Observed Winter Flow Volume (1-3):	**4.52**
Simulated Spring Flow Volume (months 4-6):	**9.97**	Observed Spring Flow Volume (4-6):	**10.86**
Total Simulated Storm Volume:	**9.03**	Total Observed Storm Volume:	**9.07**
Simulated Summer Storm Volume (7-9):	**1.47**	Observed Summer Storm Volume (7-9):	**1.05**

Errors (Simulated-Observed)	*Error Statistics*	*Recommended Criteria*		
Error in total volume:	1.09	10		
Error in 50% lowest flows:	0.58	10		
Error in 10% highest flows:	1.59	15		
Seasonal volume error - Summer:	56.36	30		
Seasonal volume error - Fall:	-5.86 >>	30	Clear	
Seasonal volume error - Winter:	-4.11	30		
Seasonal volume error - Spring:	-8.18	30		
Error in storm volumes:	-0.45	20		
Error in summer storm volumes:	40.28	50		
Nash-Sutcliffe Coefficient of Efficiency, E:	0.541	Model accuracy increases		
Baseline adjusted coefficient (Garrick), E':	0.387	as E or E' approaches 1.0		
Monthly NSE	0.739			

USGS 04275500 Ausable River near Ausable Forks, NY - Validation

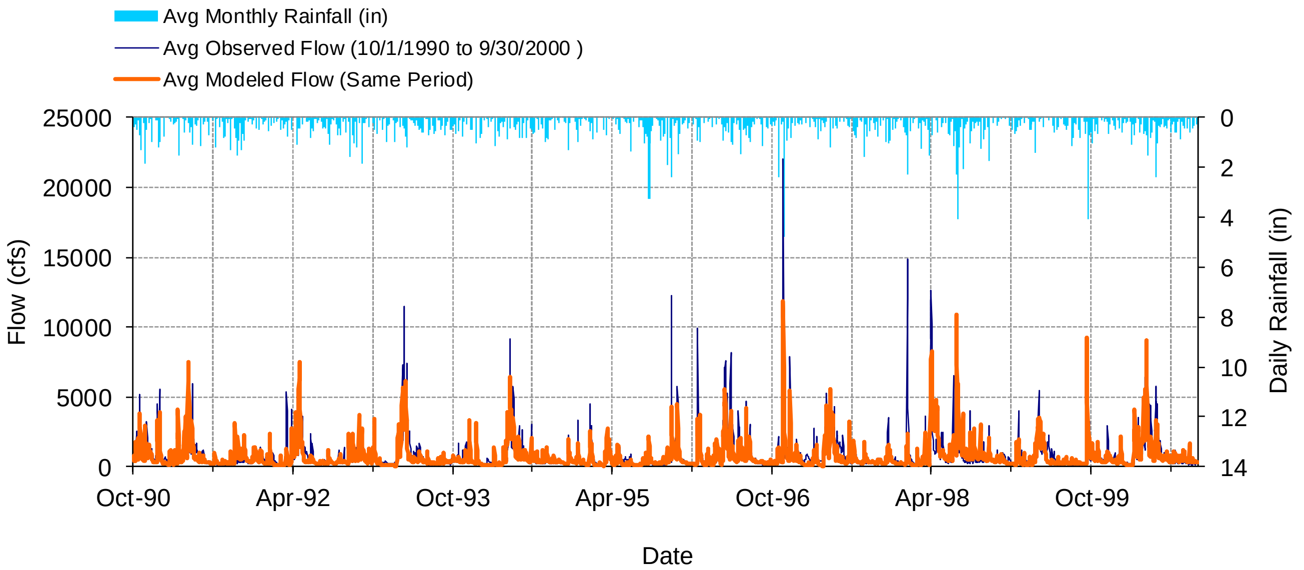


Figure I-8. Mean daily flow at USGS 04275500 Ausable River near Ausable Forks, NY

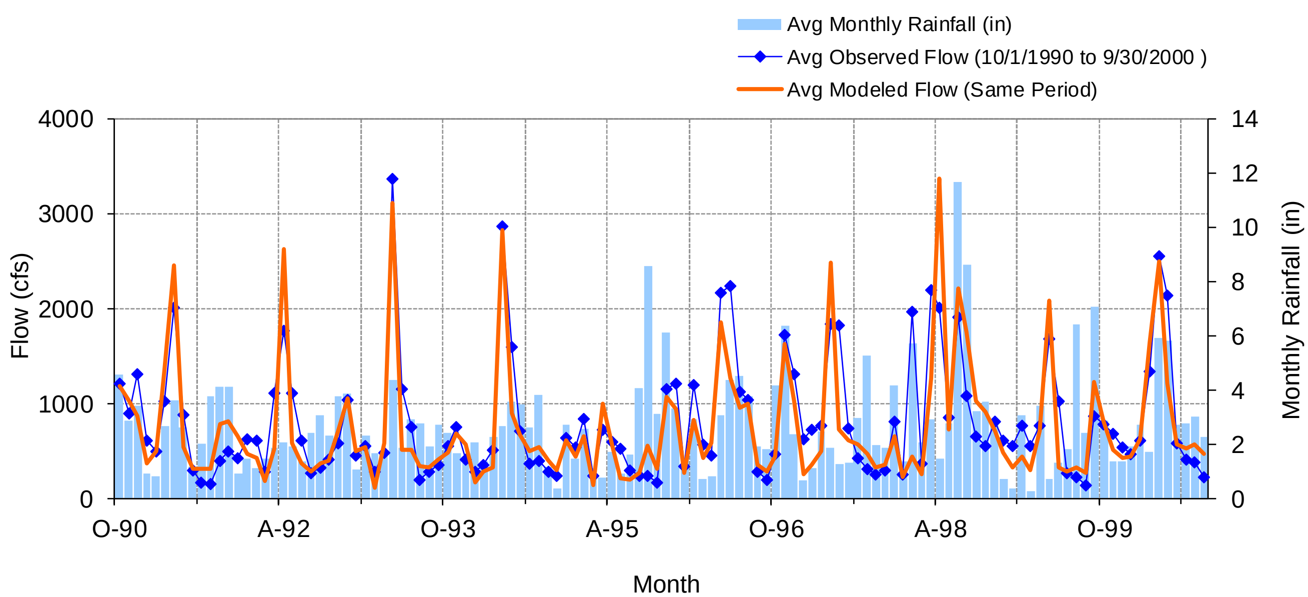


Figure I-9. Mean monthly flow at USGS 04275500 Ausable River near Ausable Forks, NY

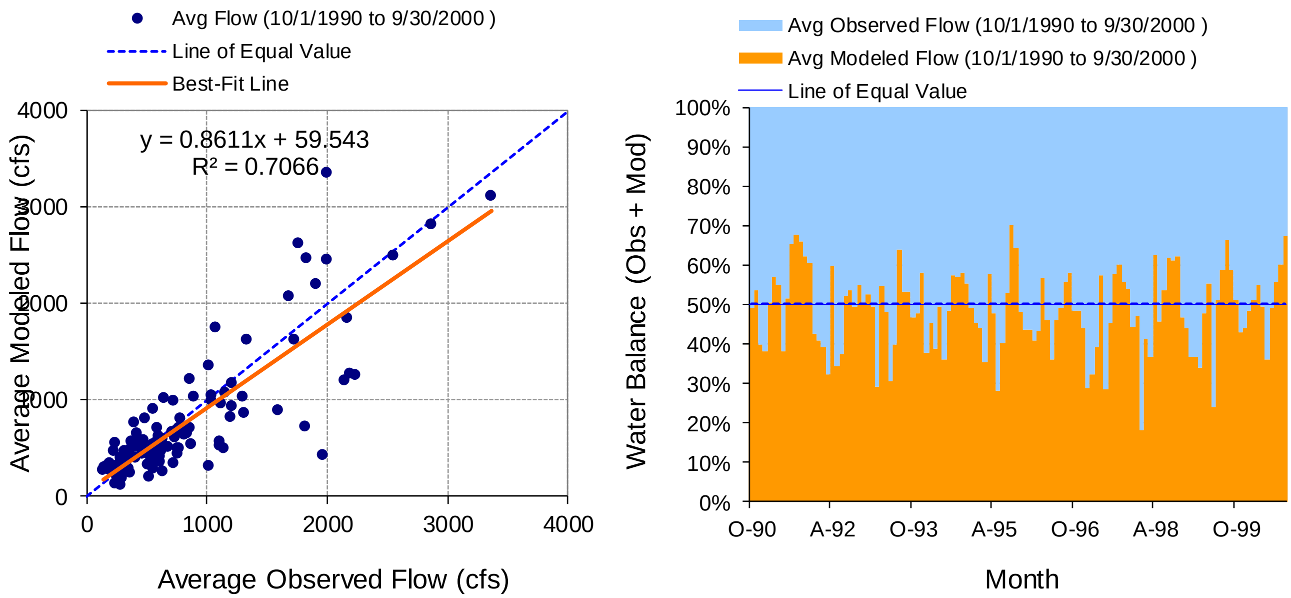


Figure I-10. Monthly flow regression and temporal variation at USGS 04275500 Ausable River near Ausable Forks, NY

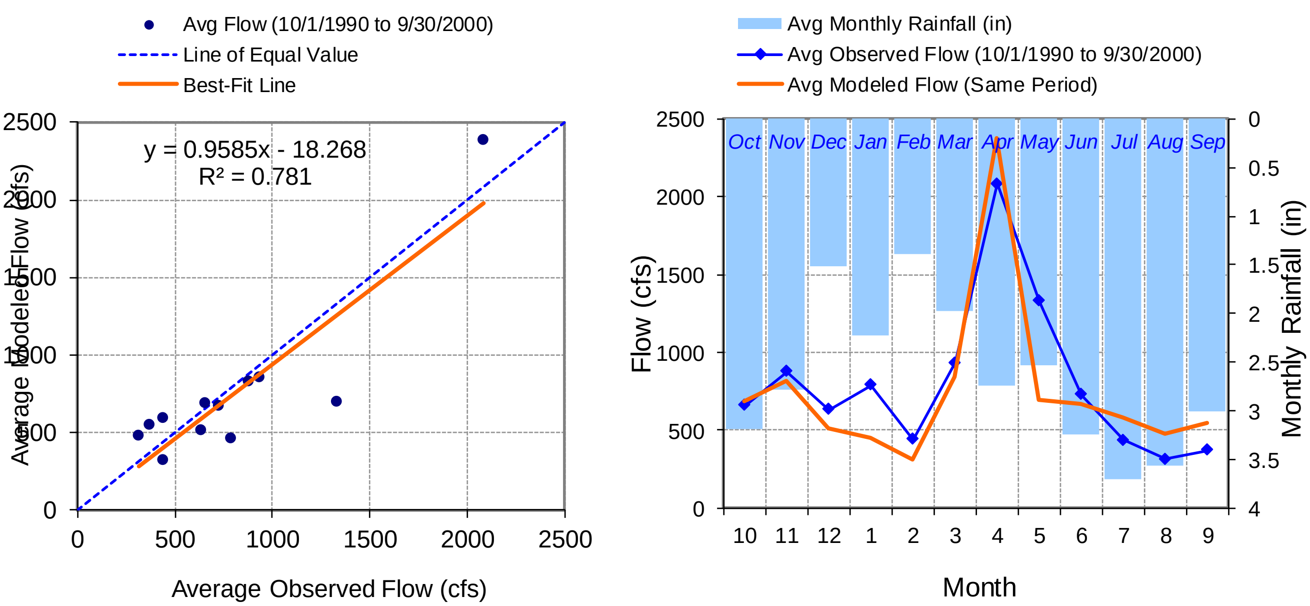


Figure I-11. Seasonal regression and temporal aggregate at USGS 04275500 Ausable River near Ausable Forks, NY

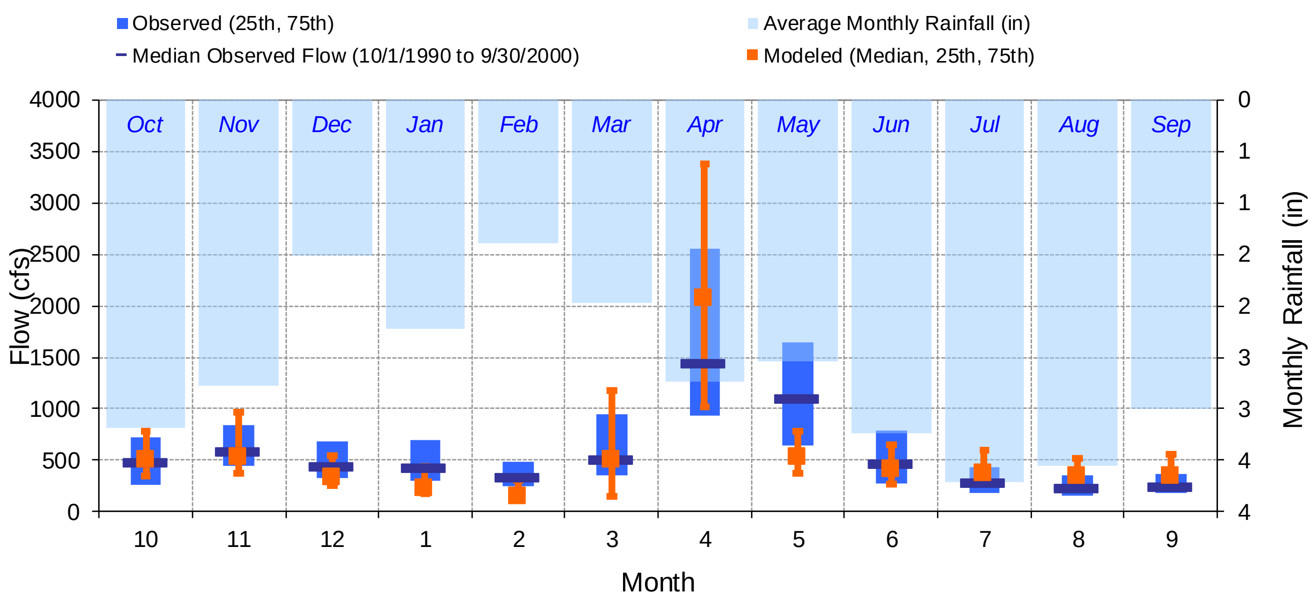


Figure I-12. Seasonal medians and ranges at USGS 04275500 Ausable River near Ausable Forks, NY

Table I-3. Seasonal summary at USGS 04275500 Ausable River near Ausable Forks, NY

MONTH	OBSERVED FLOW (CFS)				MODELED FLOW (CFS)			
	MEAN	MEDIAN	25TH	75TH	MEAN	MEDIAN	25TH	75TH
Oct	657.60	480.00	266.50	726.50	683.86	503.59	353.32	788.40
Nov	876.59	591.50	447.75	843.25	819.95	535.90	373.89	964.88
Dec	631.51	445.50	330.00	679.75	509.68	332.35	253.86	551.09
Jan	789.17	430.00	300.00	695.00	454.62	224.72	173.51	439.76
Feb	442.77	340.00	250.00	480.00	315.21	144.40	116.93	306.57
Mar	933.87	501.50	350.00	946.75	846.10	499.88	147.96	1176.86
Apr	2083.45	1445.00	931.75	2560.00	2379.20	2073.50	1025.89	3374.76
May	1330.10	1100.00	642.25	1650.00	694.79	532.02	369.74	785.57
Jun	727.17	468.50	272.50	786.25	665.56	416.71	269.19	646.35
Jul	437.52	276.50	185.75	434.75	583.94	368.86	270.71	600.53
Aug	313.75	235.50	157.25	350.00	477.07	348.33	270.93	520.54
Sep	369.57	237.50	185.00	362.75	545.75	343.82	287.39	554.26

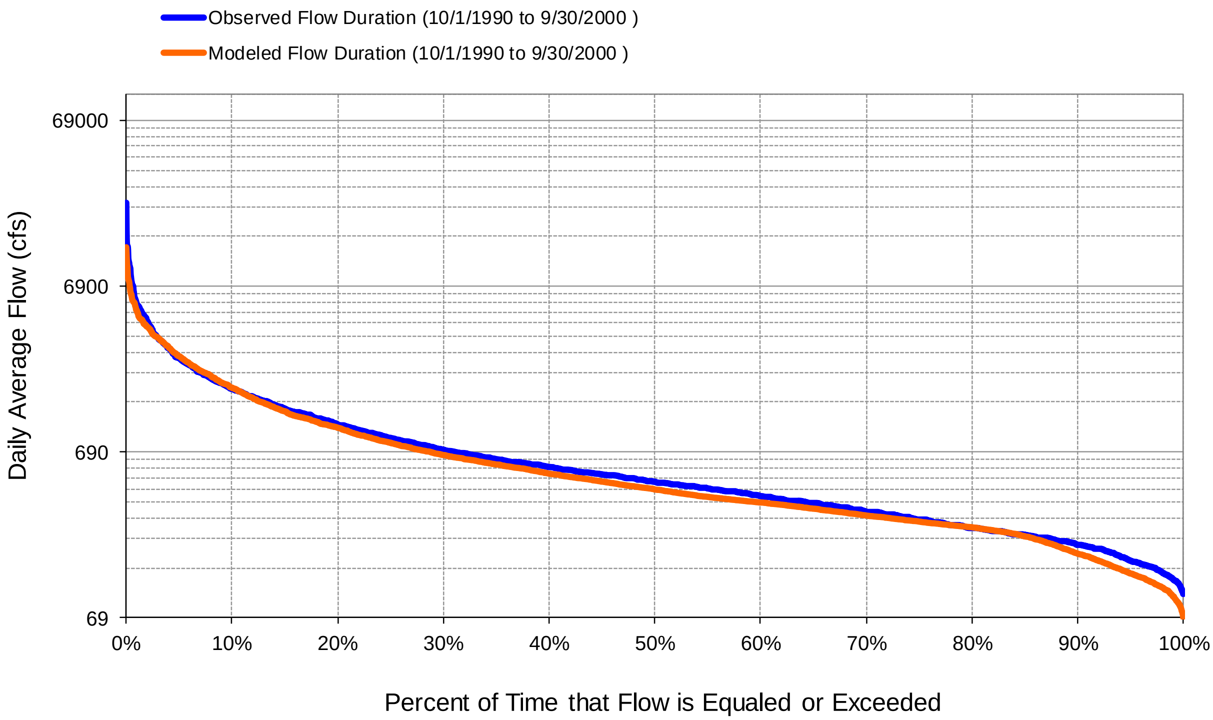


Figure I-13. Flow exceedence at USGS 04275500 Ausable River near Ausable Forks, NY

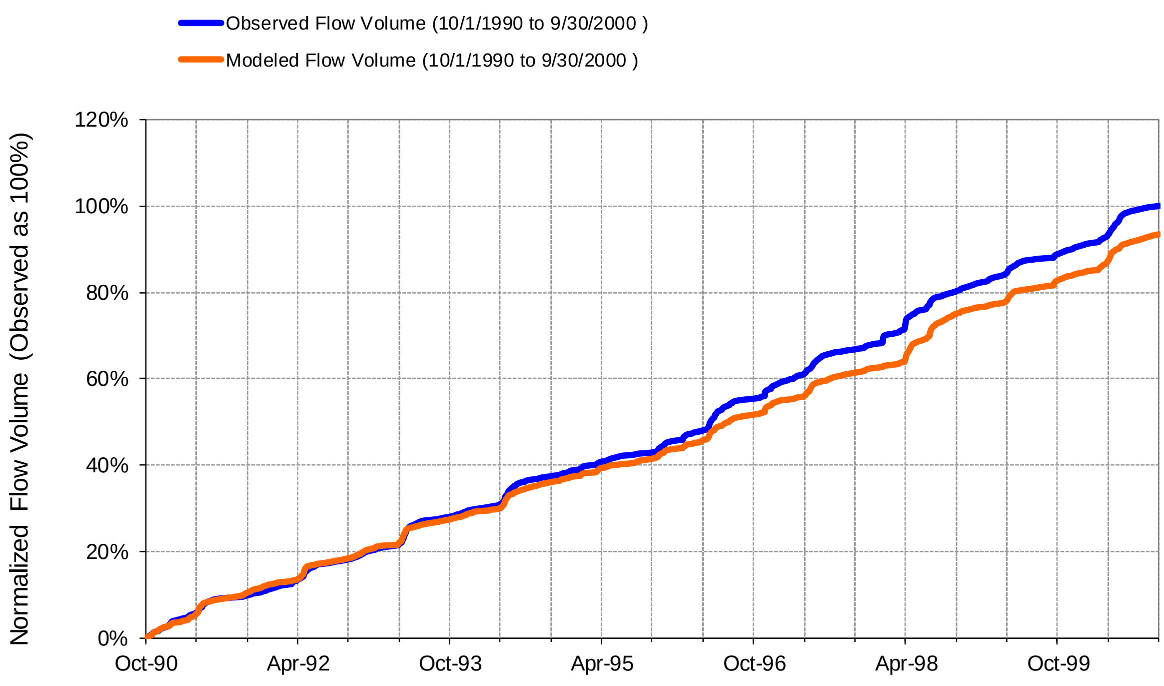


Figure I-14. Flow accumulation at USGS 04275500 Ausable River near Ausable Forks, NY

Table I-4. Summary statistics at USGS 04275500 Ausable River near Ausable Forks, NY

SWAT Simulated Flow		Observed Flow Gage	
REACH OUTFLOW FROM OUTLET 3 10-Year Analysis Period: 10/1/1990 - 9/30/2000 Flow volumes are (inches/year) for upstream drainage area		USGS 04275500 AUSABLE RIVER NEAR AU SABLE FORKS NY Hydrologic Unit Code: 2010004 Latitude: 44.45138889 Longitude: -73.6425 Drainage Area (sq-mi): 446	
Total Simulated In-stream Flow:	**22.76**	Total Observed In-stream Flow:	**24.36**
Total of simulated highest 10% flows:	**9.45**	Total of Observed highest 10% flows:	**10.12**
Total of Simulated lowest 50% flows:	**3.92**	Total of Observed Lowest 50% flows:	**4.26**
Simulated Summer Flow Volume (months 7-9):	**4.11**	Observed Summer Flow Volume (7-9):	**2.87**
Simulated Fall Flow Volume (months 10-12):	**5.14**	Observed Fall Flow Volume (10-12):	**5.52**
Simulated Winter Flow Volume (months 1-3):	**4.11**	Observed Winter Flow Volume (1-3):	**5.50**
Simulated Spring Flow Volume (months 4-6):	**9.41**	Observed Spring Flow Volume (4-6):	**10.47**
Total Simulated Storm Volume:	**8.54**	Total Observed Storm Volume:	**9.57**
Simulated Summer Storm Volume (7-9):	**1.30**	Observed Summer Storm Volume (7-9):	**1.05**

Errors (Simulated-Observed)	*Error Statistics*	*Recommended Criteria*		
Error in total volume:	-6.55	10		
Error in 50% lowest flows:	-7.83	10		
Error in 10% highest flows:	-6.63	15		
Seasonal volume error - Summer:	43.31	30		
Seasonal volume error - Fall:	-7.04	>> 30		Clear
Seasonal volume error - Winter:	-25.33	30		
Seasonal volume error - Spring:	-10.09	30		
Error in storm volumes:	-10.74	20		
Error in summer storm volumes:	23.67	50		
Nash-Sutcliffe Coefficient of Efficiency, E:	0.580	Model accuracy increases		
Baseline adjusted coefficient (Garrick), E':	0.415	as E or E' approaches 1.0		
Monthly NSE	0.666			

WATER QUALITY

TSS and TP distribution by channel and upland sources

Table I-5. TSS and TP distribution by source categories

Source	TSS		TP	
	Load(mt/year)	Percentage (%)	Load (kg/year)	Percentage (%)
Upland	12,050	42.3	27,737	78.9
Stream	16,466	57.7	7,410	21.1
Total	**28,516**	**100.0**	**35,147**	**100.0**

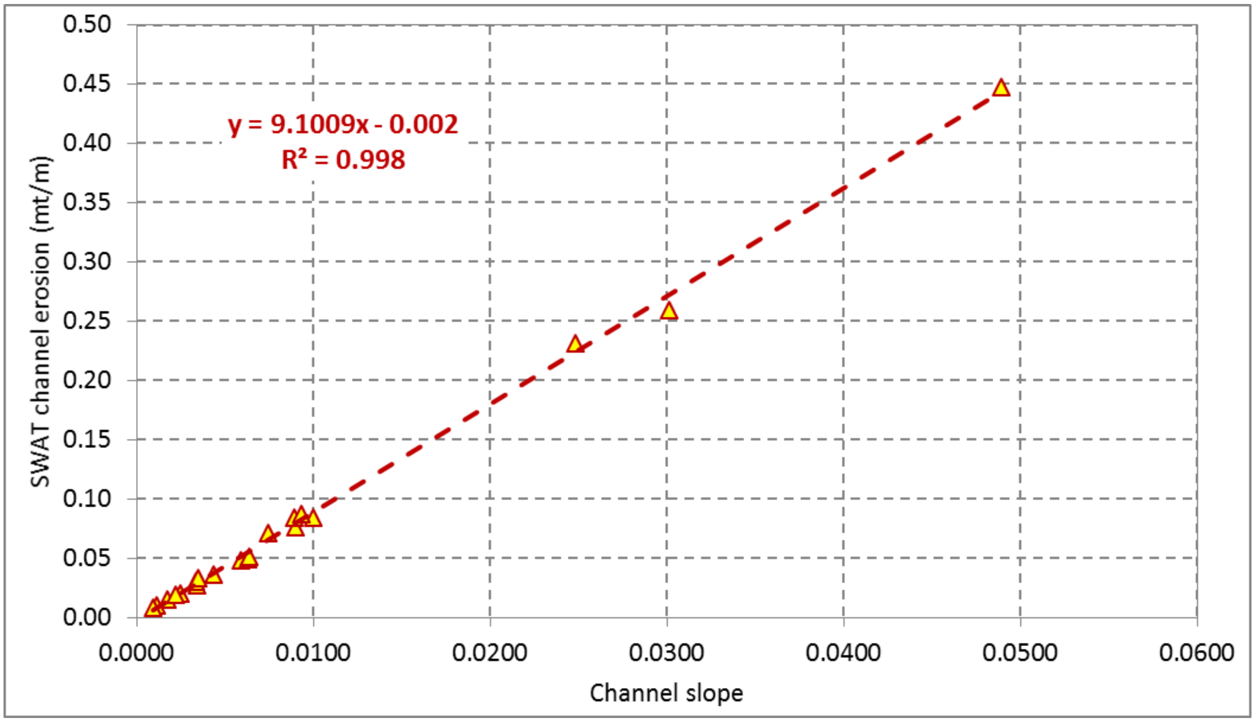


Figure I-15. SWAT simulated channel erosion relative to channel slope

TP distribution by landuse from upland sources

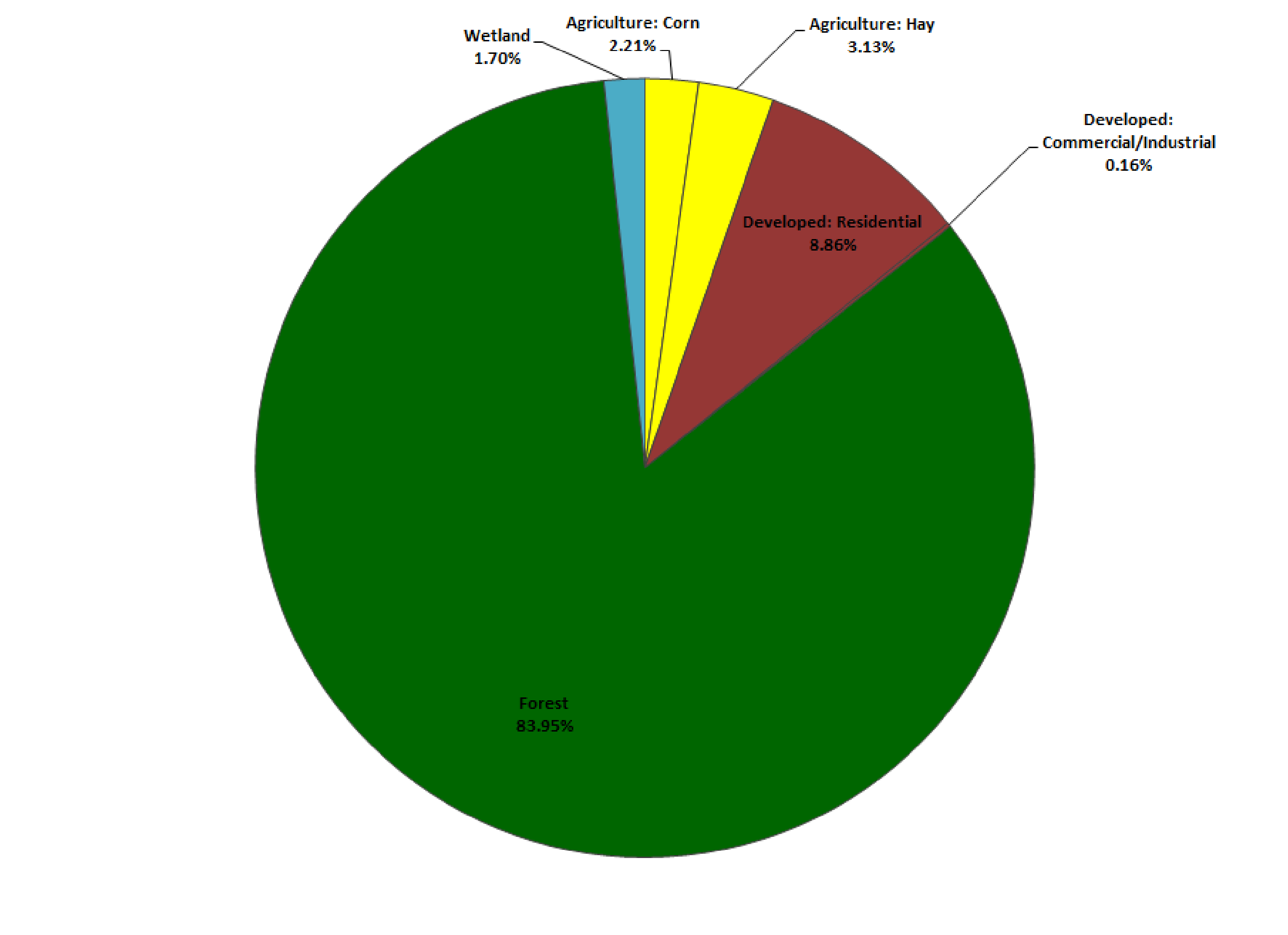


Figure I-16. Distribution of simulated total upland TP loads by landuse categories

Table I-6. TP export rates (kg/ha/yr) by landuse categories for the 30 year simulation period

Landuse	Classification	Area (ha)	Area (%)	Mean	Min	Q_{25}	Q_{50}	Q_{75}	Max
Agriculture	Corn	338	0.26	**1.81**	0.45	0.99	1.46	2.09	9.68
	Hay	925	0.71	**0.94**	0.25	0.52	0.72	1.32	2.61
Urban	Residential	4,765	3.65	**0.52**	0.36	0.45	0.51	0.56	0.88
	Commercial/Industrial	24	0.02	**1.88**	1.62	1.76	1.83	1.98	2.21
Forest	Forest	123,039	94.25	**0.19**	0.11	0.16	0.19	0.20	0.27
Wetland	Wetland	1,456	1.12	**0.17**	0.09	0.13	0.17	0.19	0.24

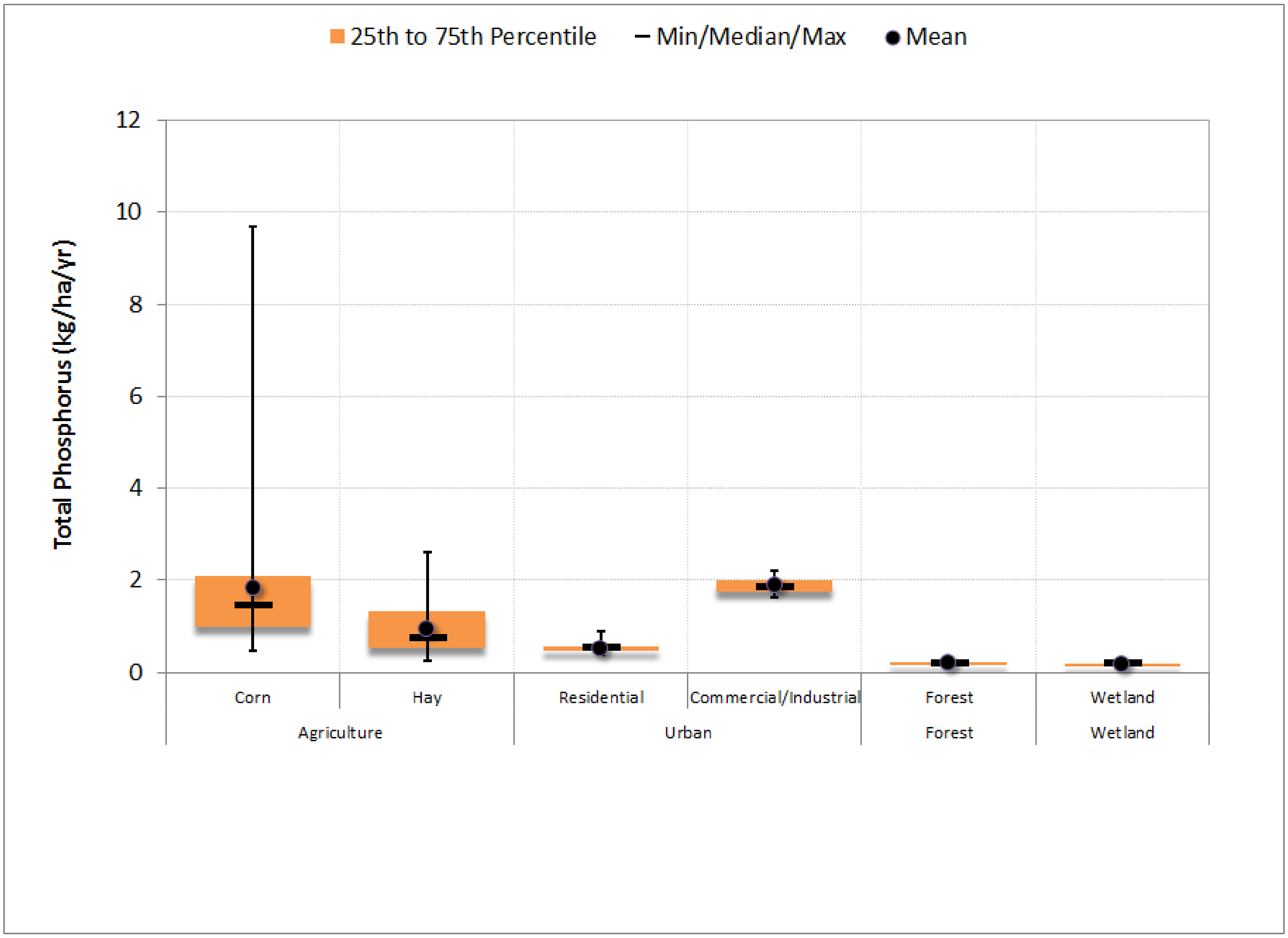


Figure I-17. TP export rates (kg/ha/yr) by landuse categories for the 30 year simulation period

Table I-7. TP export rates (kg/ha/yr) for the residential landuse categories for the 30 year simulation period

Residential Category	Area (ha)	Area (%)	Mean	Min	Q_{25}	Q_{50}	Q_{75}	Max
Low Density	3,683	77.30	**0.34**	0.21	0.28	0.33	0.36	0.66
Medium Density	937	19.66	**1.02**	0.78	0.90	1.00	1.10	1.51
High Density	145	3.03	**1.83**	1.49	1.66	1.79	1.95	2.42
Total	4,765	100.00	**0.52**	0.36	0.45	0.51	0.56	0.88

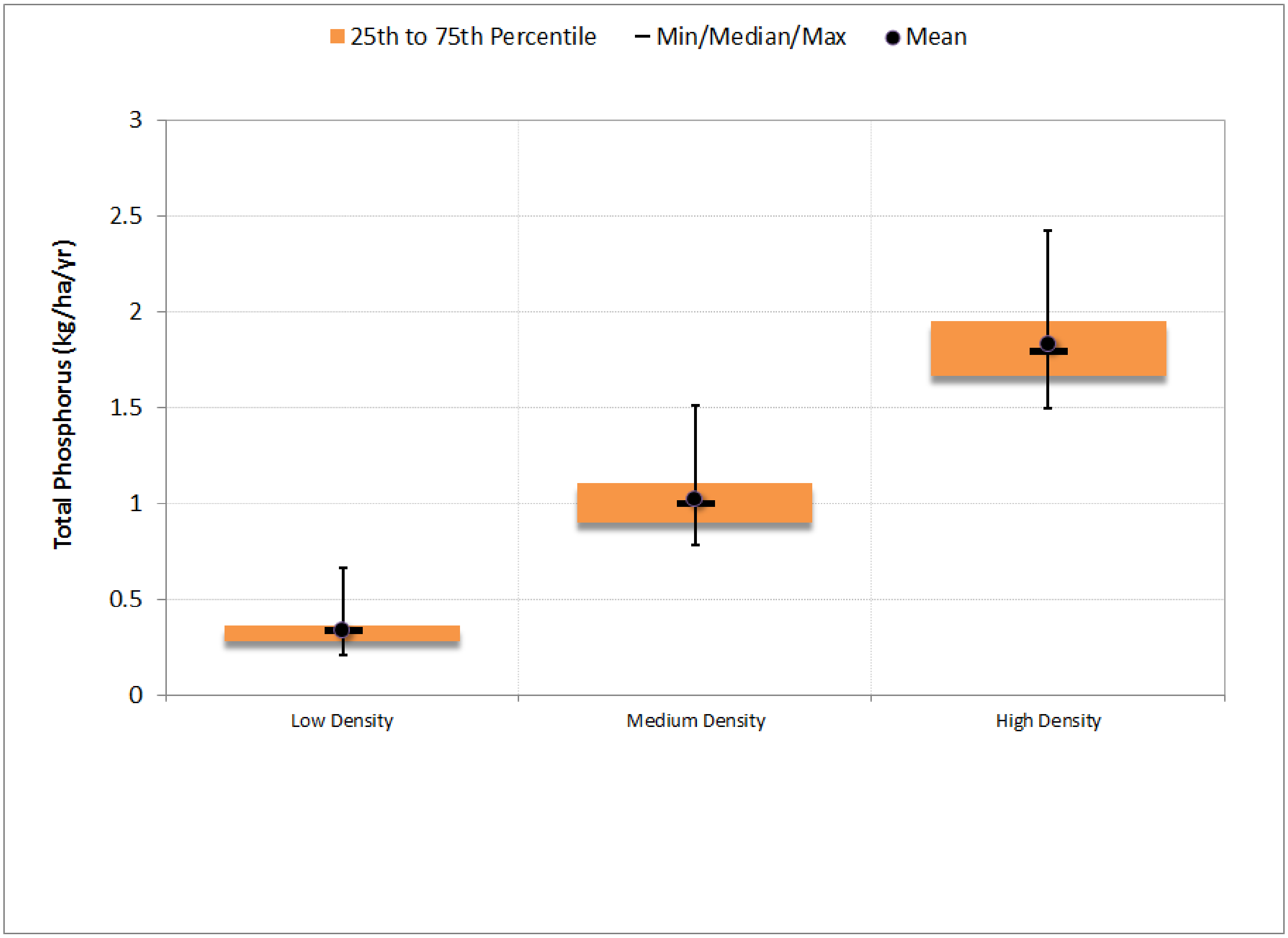


Figure I-18. TP export rates (kg/ha/yr) for the residential landuse categories for the 30 year simulation period

Segmented Regression

Table I-8. Summary statistics

Statistic	Calibration		Validation	
	TSS	TP	TSS	TP
Average absolute error (%)	60.1	56.4	68.0	59.9
Median absolute error (%)	17.3	33.8	8.7	22.5
Regression error (%)	9.3	-10.6	37.3	10.9
NSE	0.569	0.617	0.320	0.465
NSE'	0.477	0.412	0.489	0.455

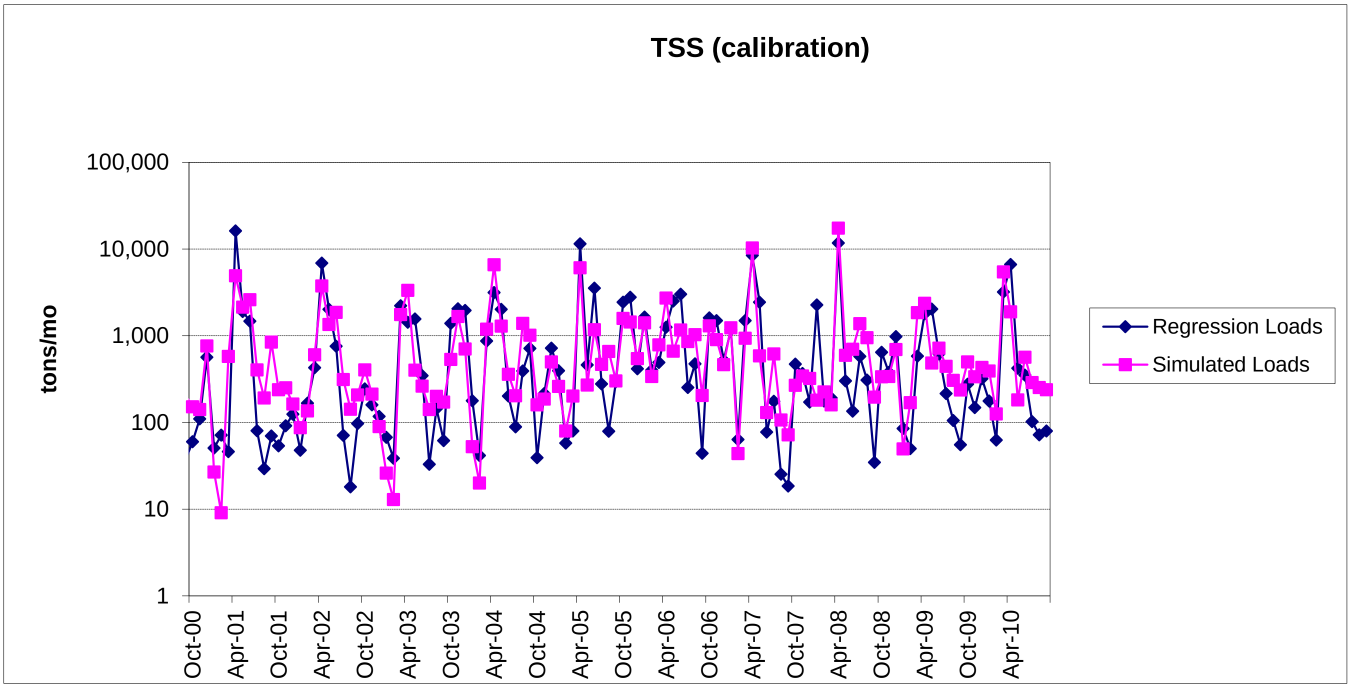


Figure I-19. Monthly simulated and estimated TSS load at Ausable River near Ausable Forks, NY (calibration period)

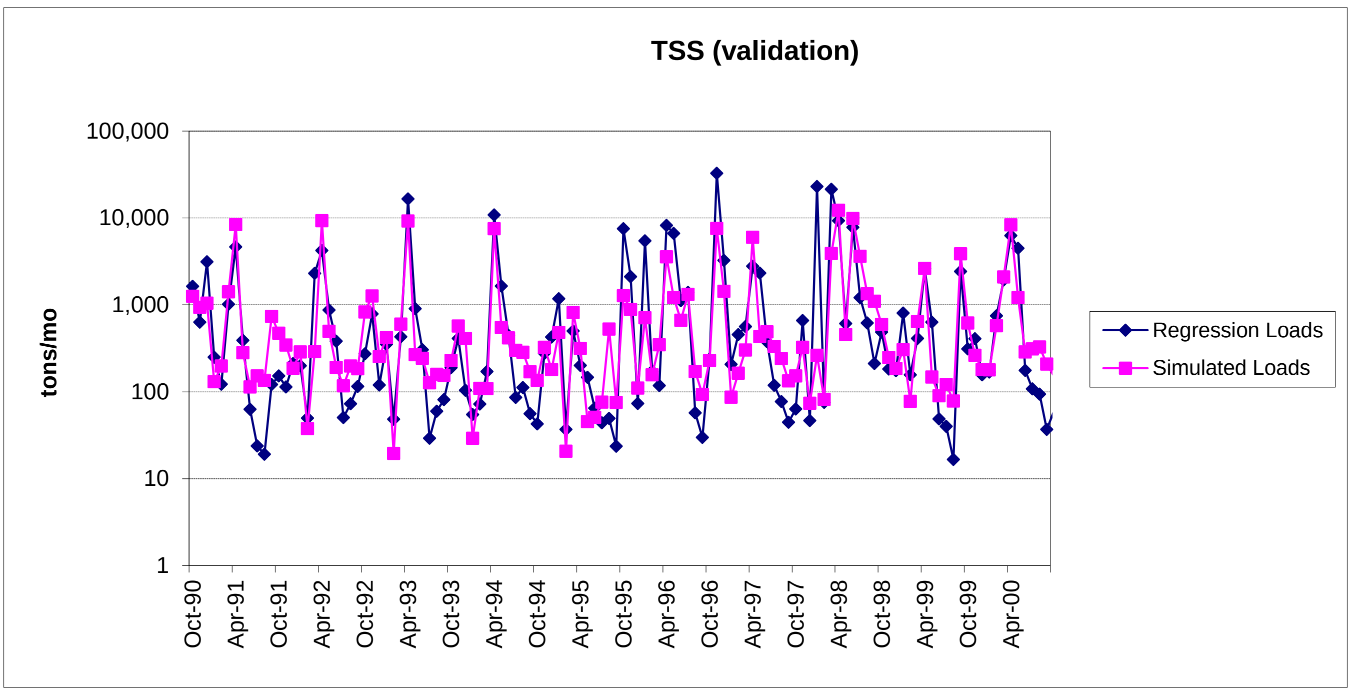


Figure I-20. Monthly simulated and estimated TSS load at Ausable River near Ausable Forks, NY (validation period)

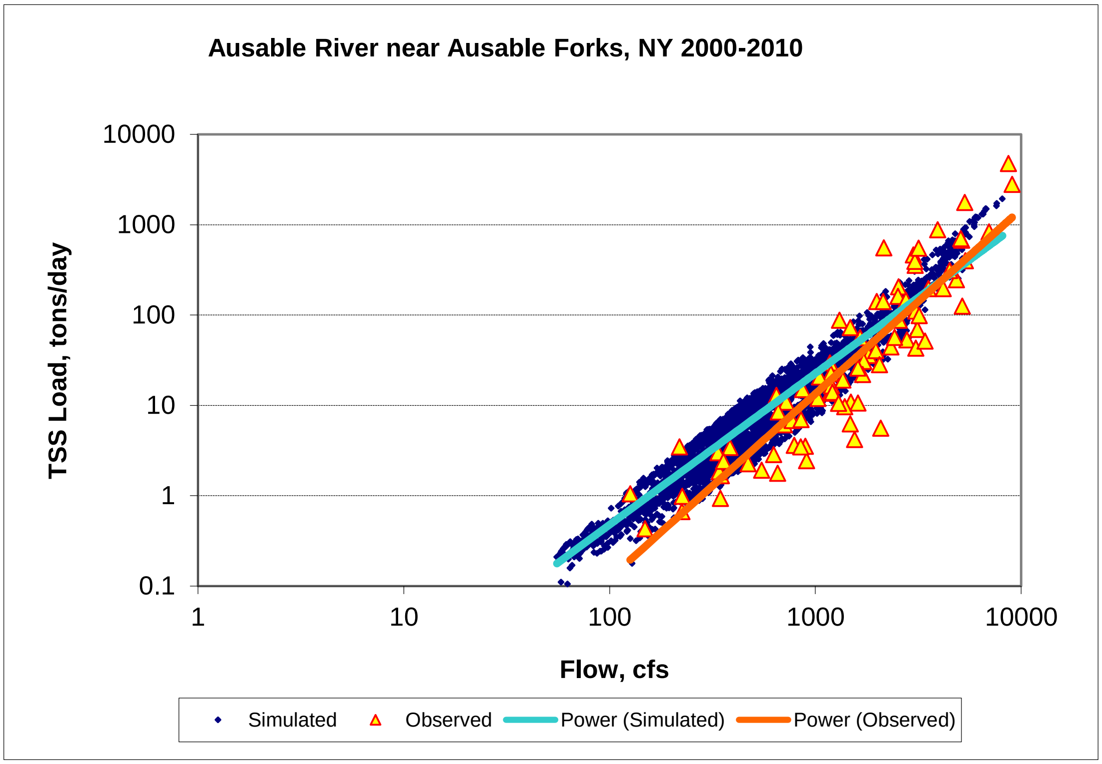


Figure I-21. Power plot of simulated and observed TSS load vs flow at Ausable River near Ausable Forks, NY (calibration period)

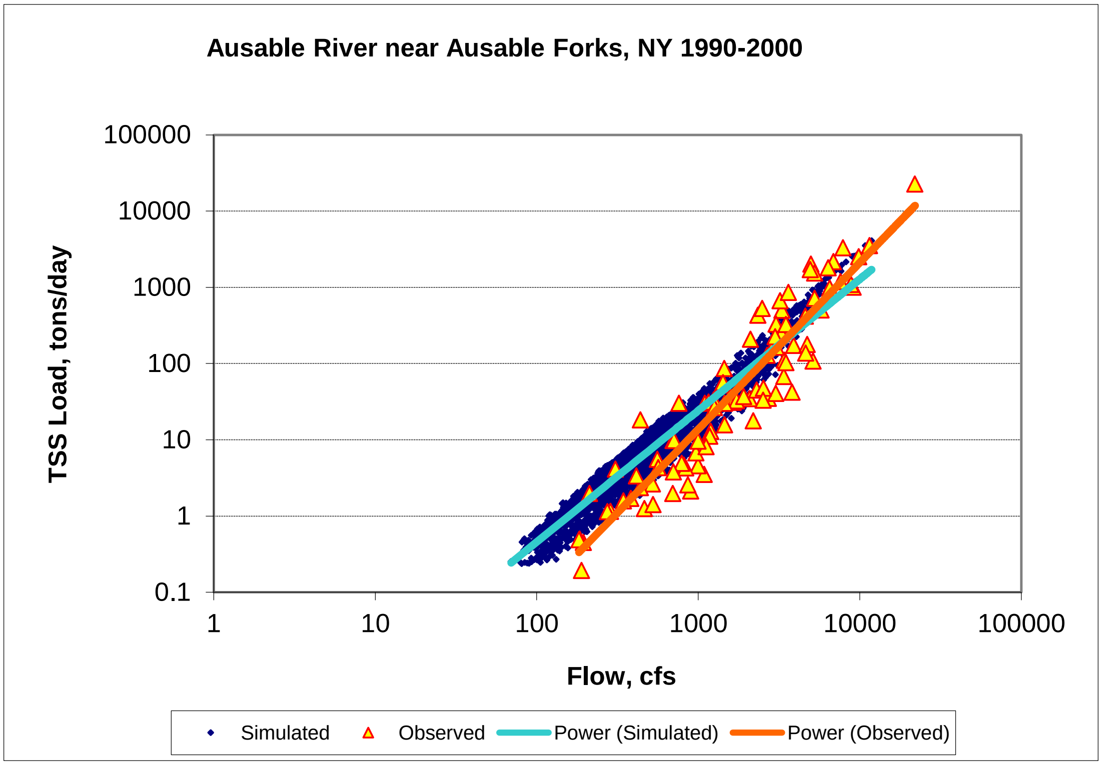


Figure I-22. Power plot of simulated and observed TSS load vs flow at Ausable River near Ausable Forks, NY (validation period)

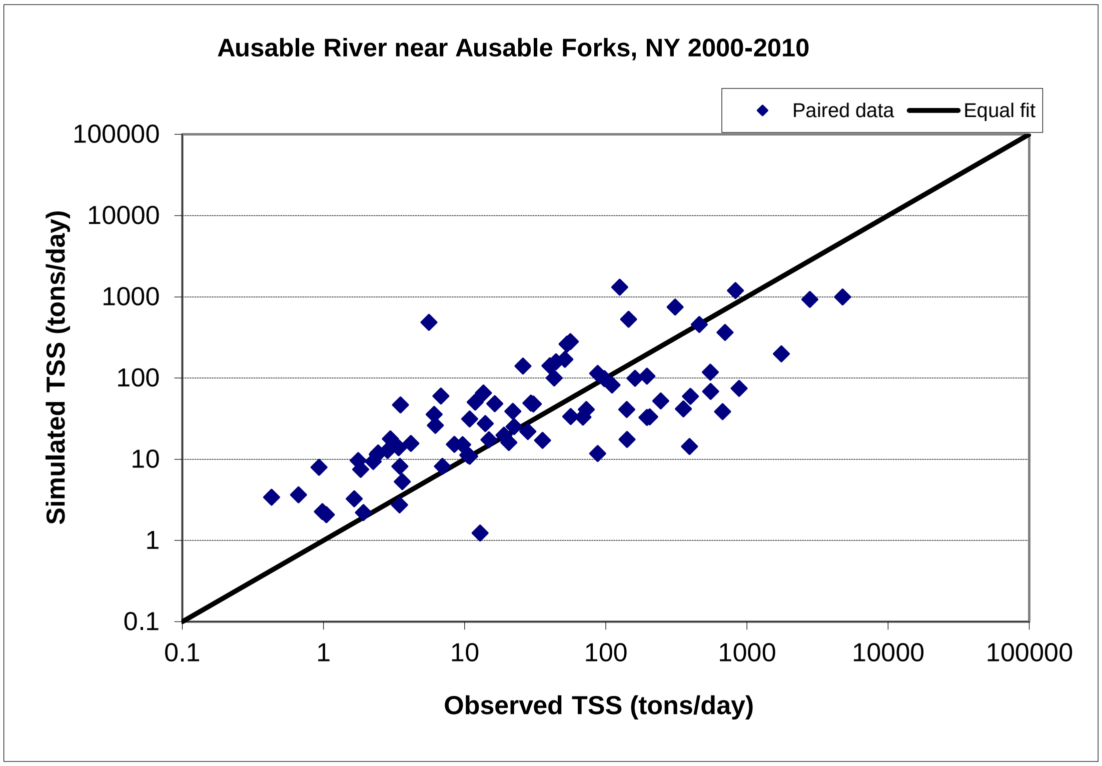


Figure I-23. Paired simulated vs observed TSS load at Ausable River near Ausable Forks, NY (calibration period)

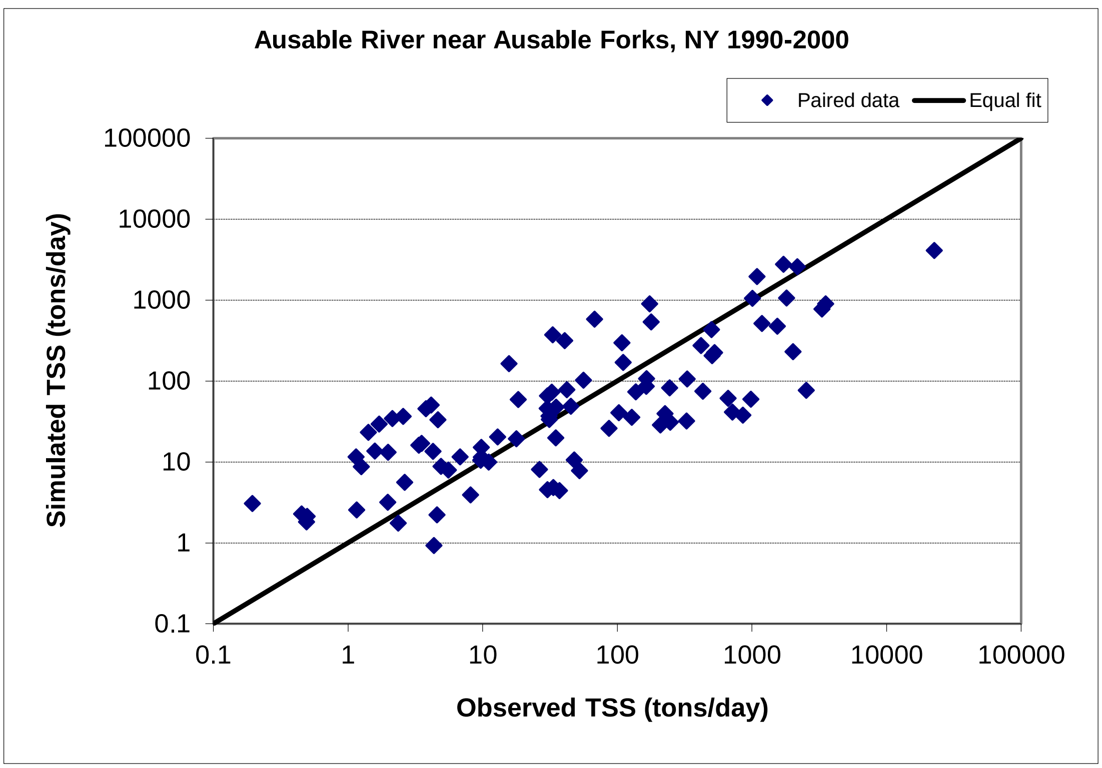


Figure I-24. Paired simulated vs observed TSS load at Ausable River near Ausable Forks, NY (validation period)

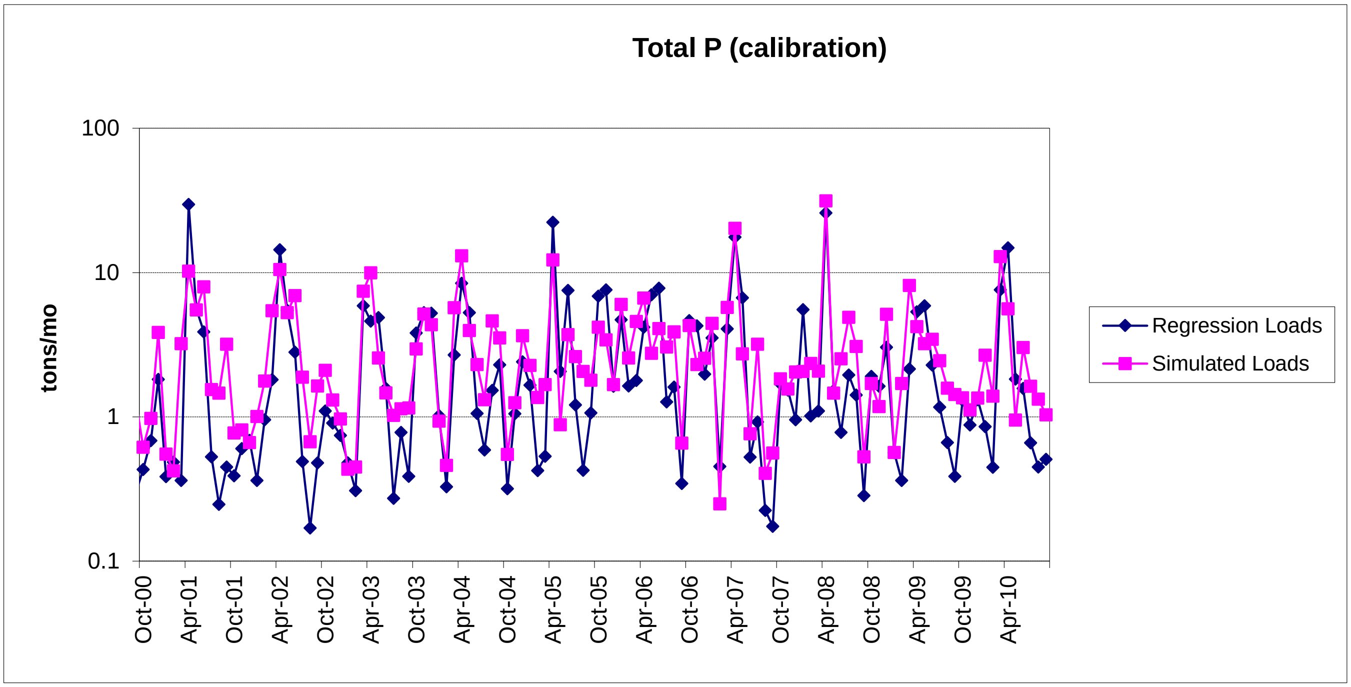


Figure I-25. Monthly simulated and estimated TP load at Ausable River near Ausable Forks, NY (calibration period)

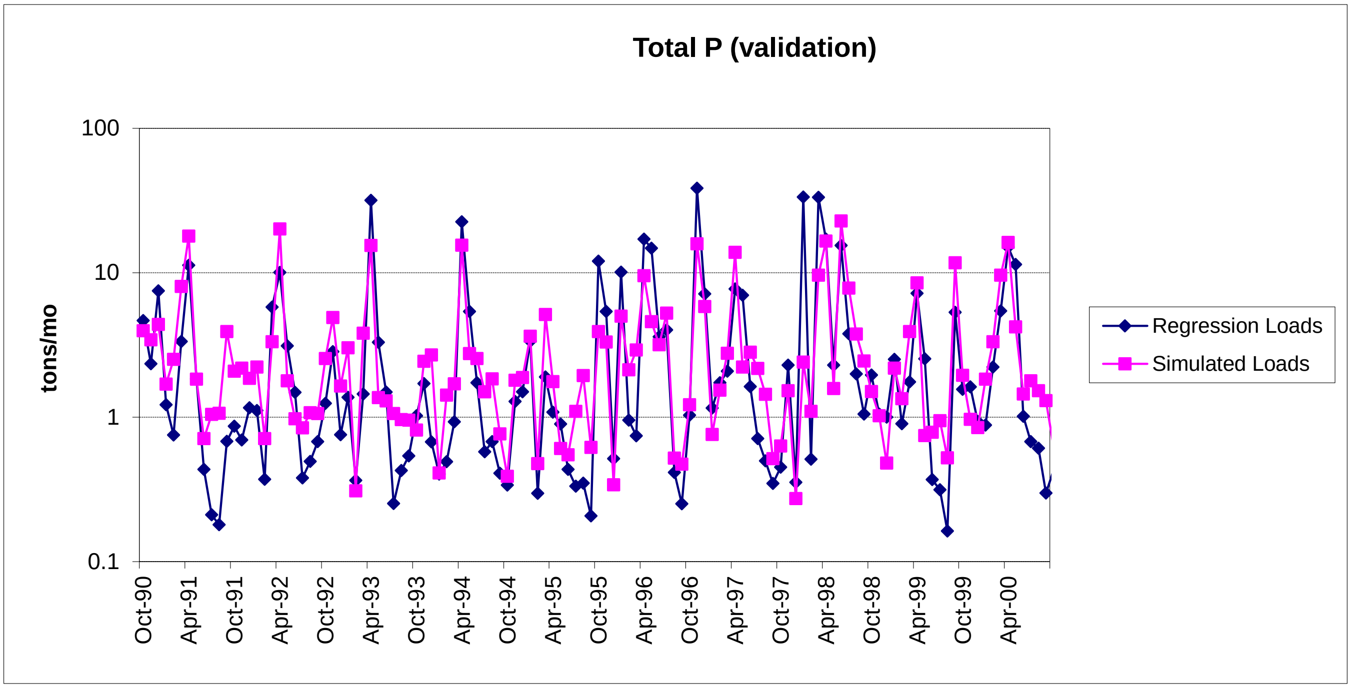


Figure I-26. Monthly simulated and estimated TP load at Ausable River near Ausable Forks, NY (validation period)

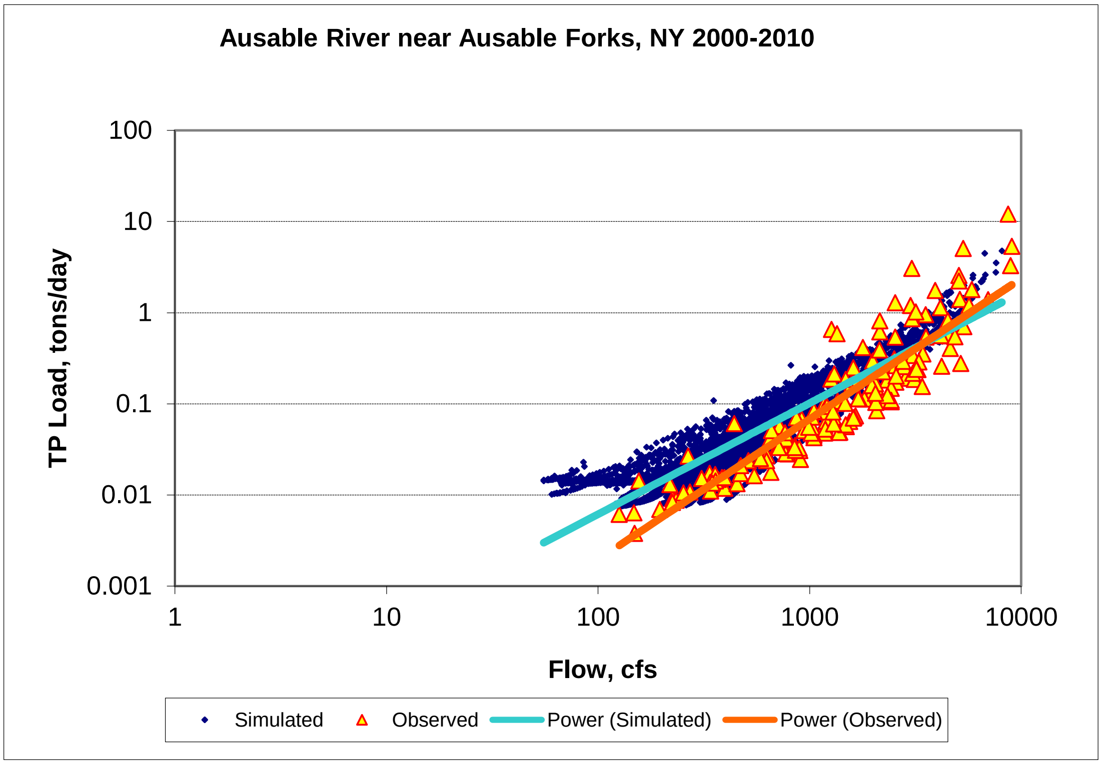


Figure I-27. Power plot of simulated and observed TP load vs flow at Ausable River near Ausable Forks, NY (calibration period)

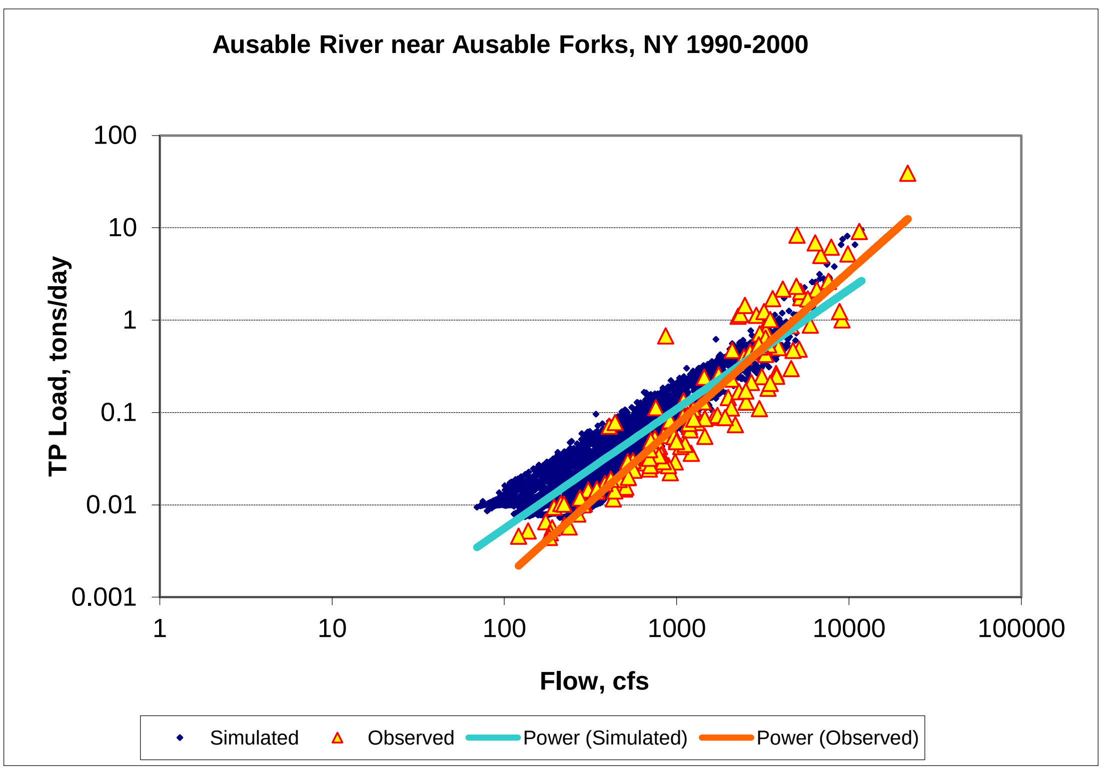


Figure I-28. Power plot of simulated and observed TP load vs flow at Ausable River near Ausable Forks, NY (validation period)

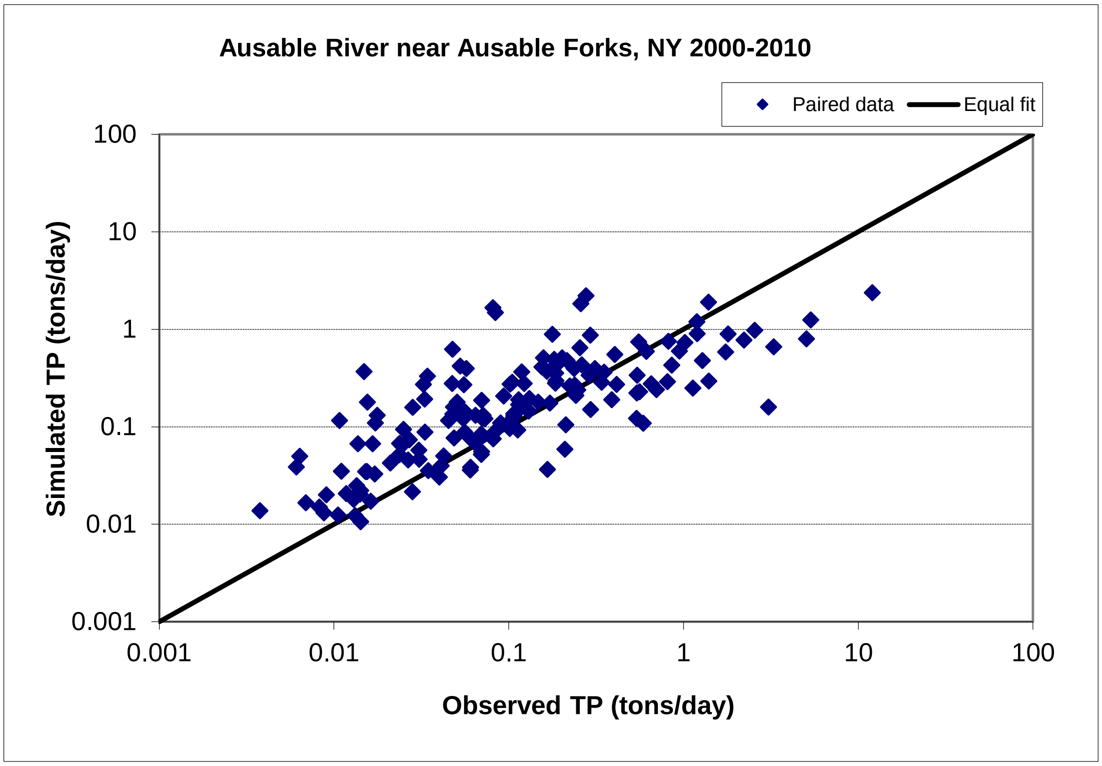


Figure I-29. Paired simulated vs observed TP load at Ausable River near Ausable Forks, NY (calibration period)

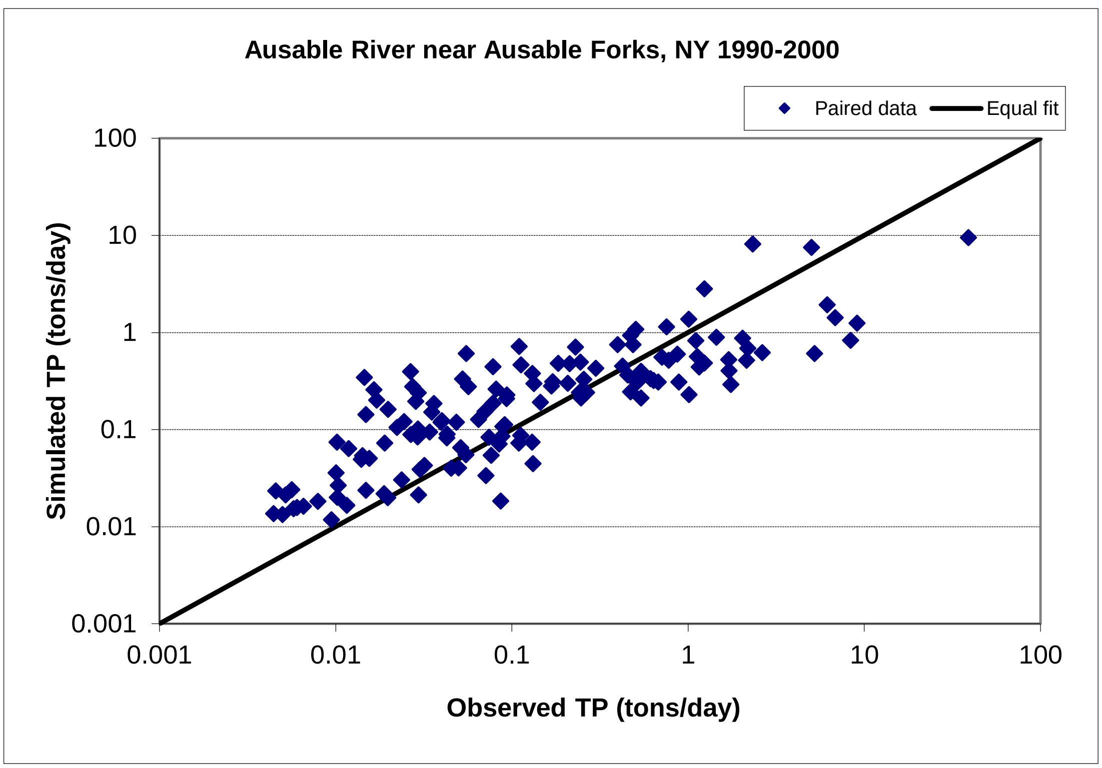


Figure I-30. Paired simulated vs observed TP load at Ausable River near Ausable Forks, NY (validation period)

Comparison of simulated SWAT TP loads with FLUX estimates

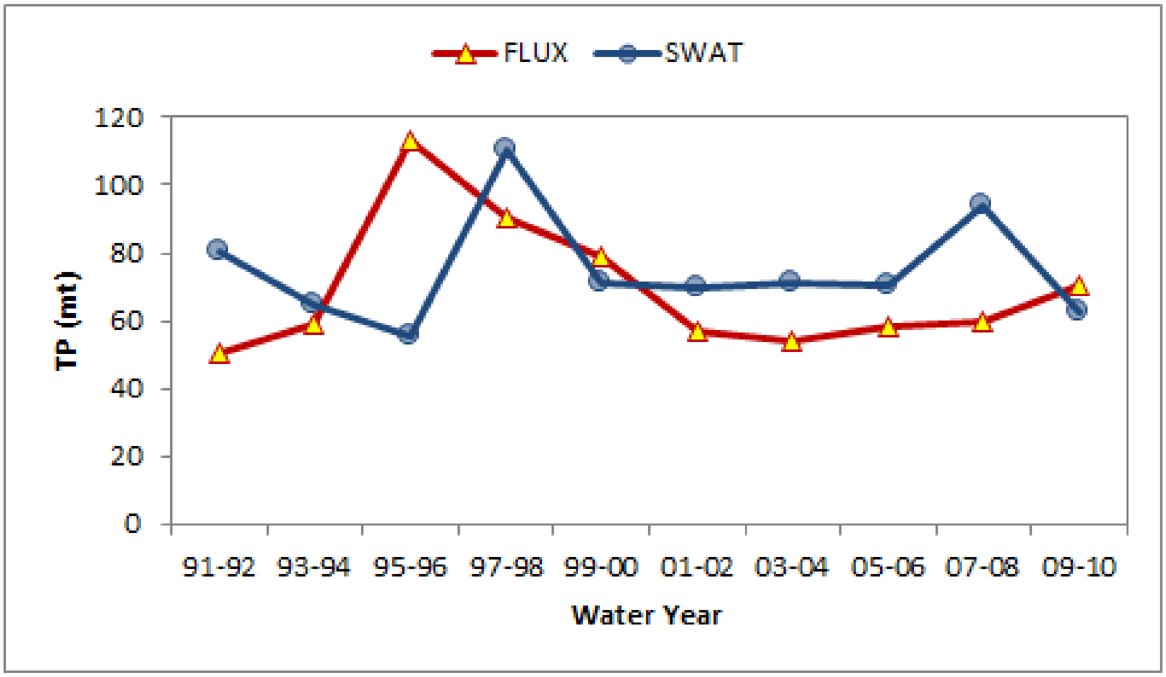


Figure I-31. Bi-annual TP loads on a water year basis as simulated by SWAT and estimated by FLUX (FLUX estimates from Smeltzer et al., 2009)

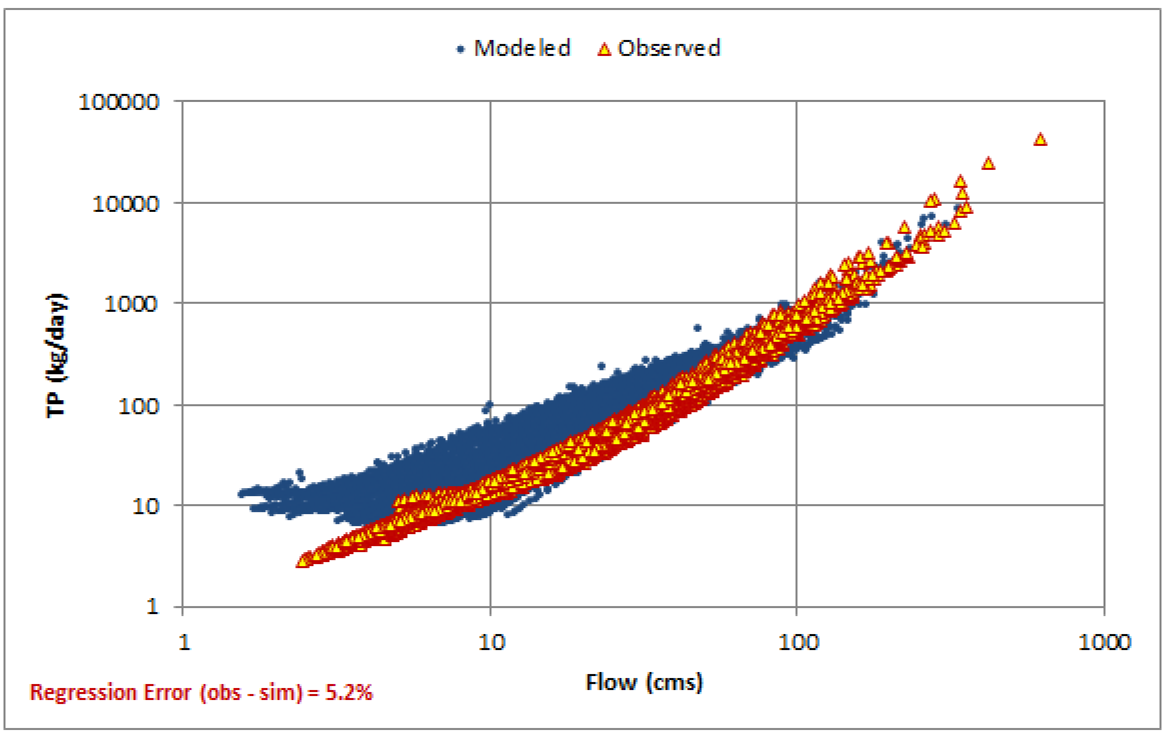
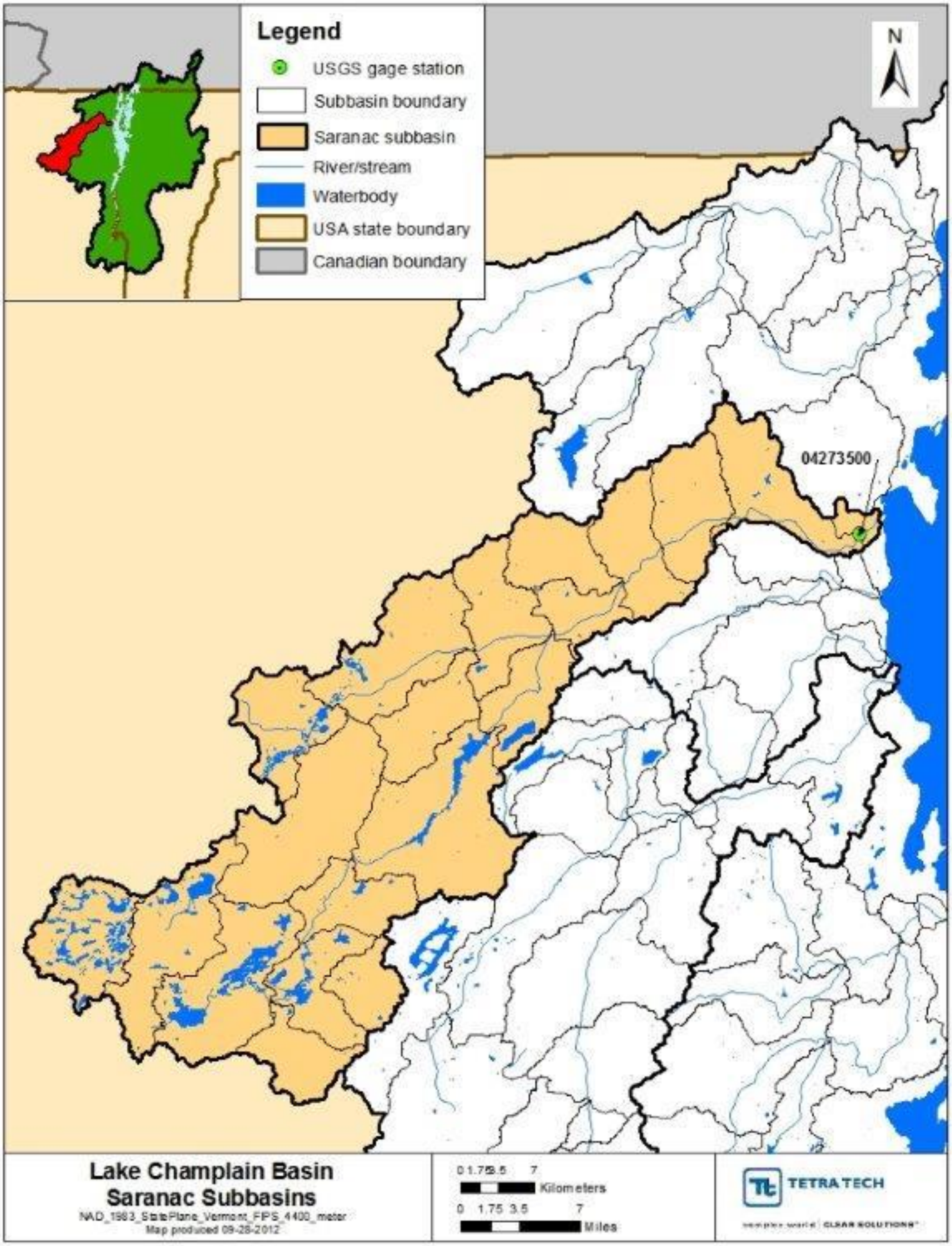


Figure I-32. Daily TP load versus flow as simulated by SWAT and estimated by FLUX (FLUX estimates from Medalie, 2013)

Appendix J - Saranac River Watershed



USGS 04273500 Saranac River at Plattsburgh, NY - Calibration

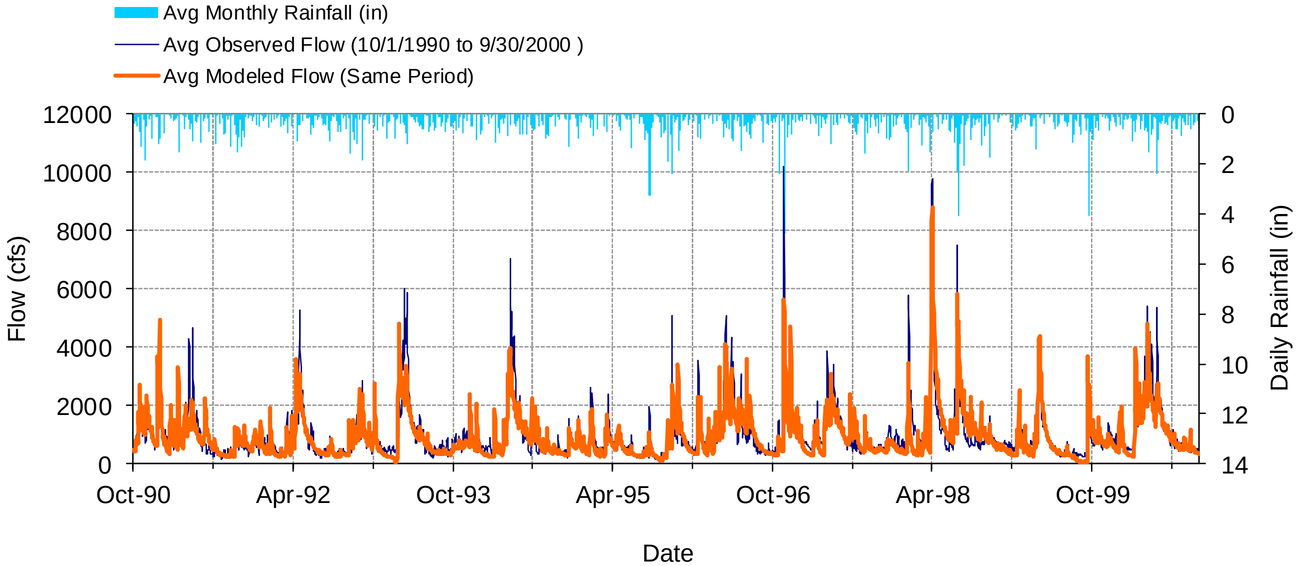


Figure J-1. Mean daily flow at USGS 04273500 Saranac River at Plattsburgh, NY

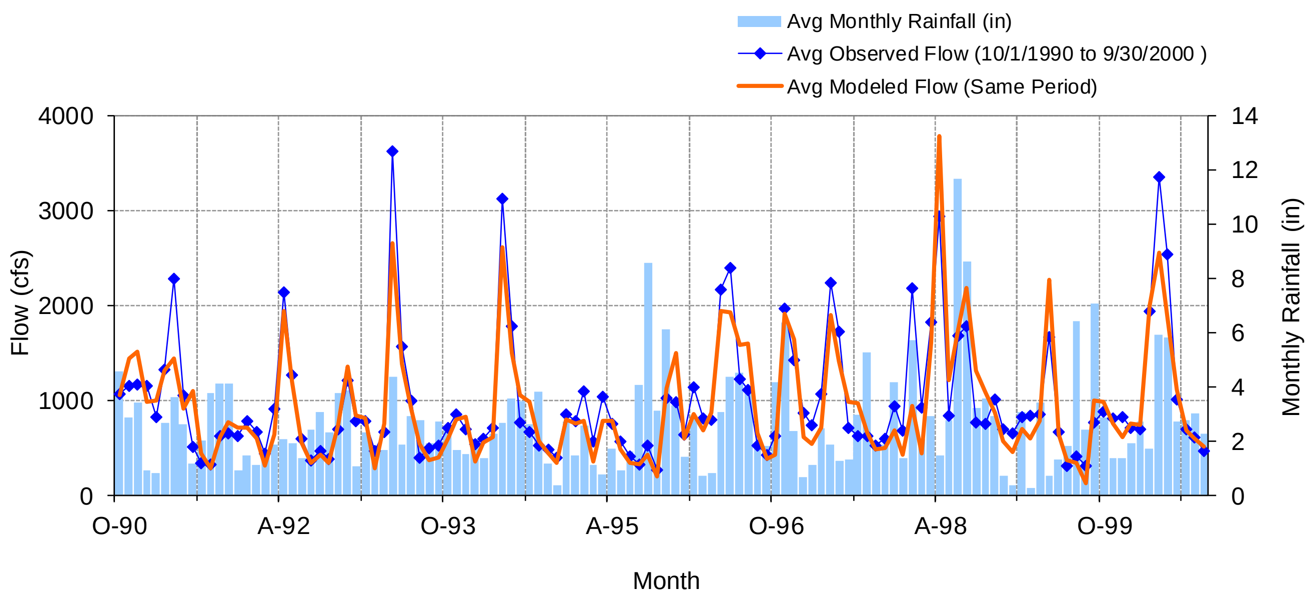


Figure J-2. Mean monthly flow at USGS 04273500 Saranac River at Plattsburgh, NY

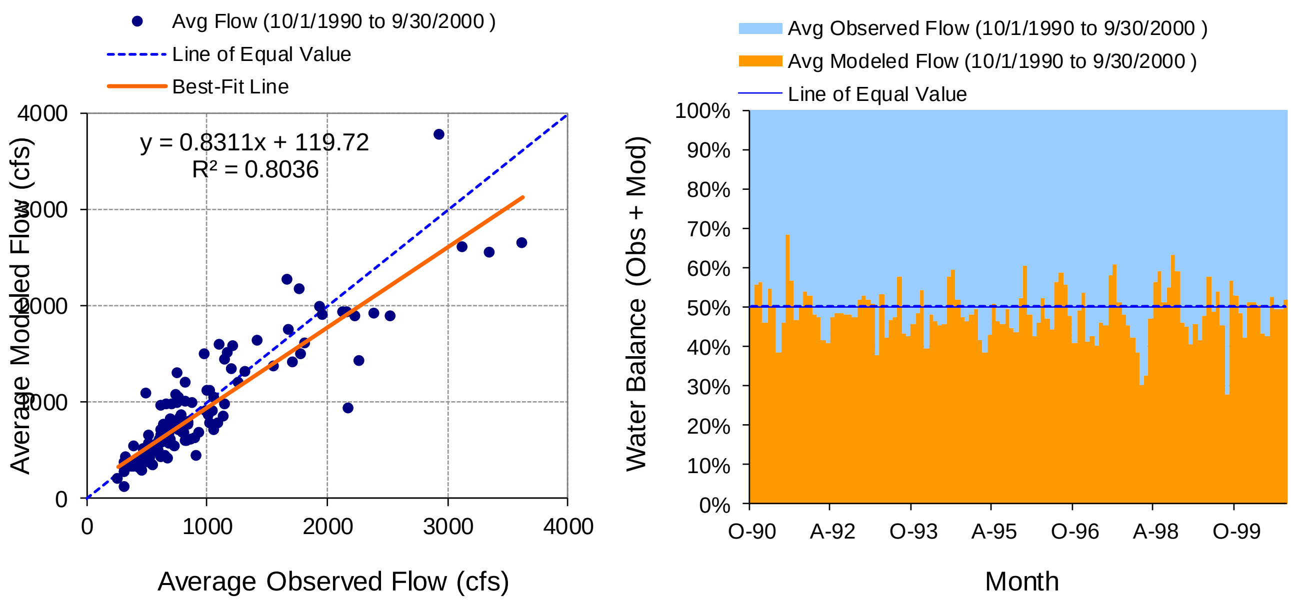


Figure J-3. Monthly flow regression and temporal variation at USGS 04273500 Saranac River at Plattsburgh, NY

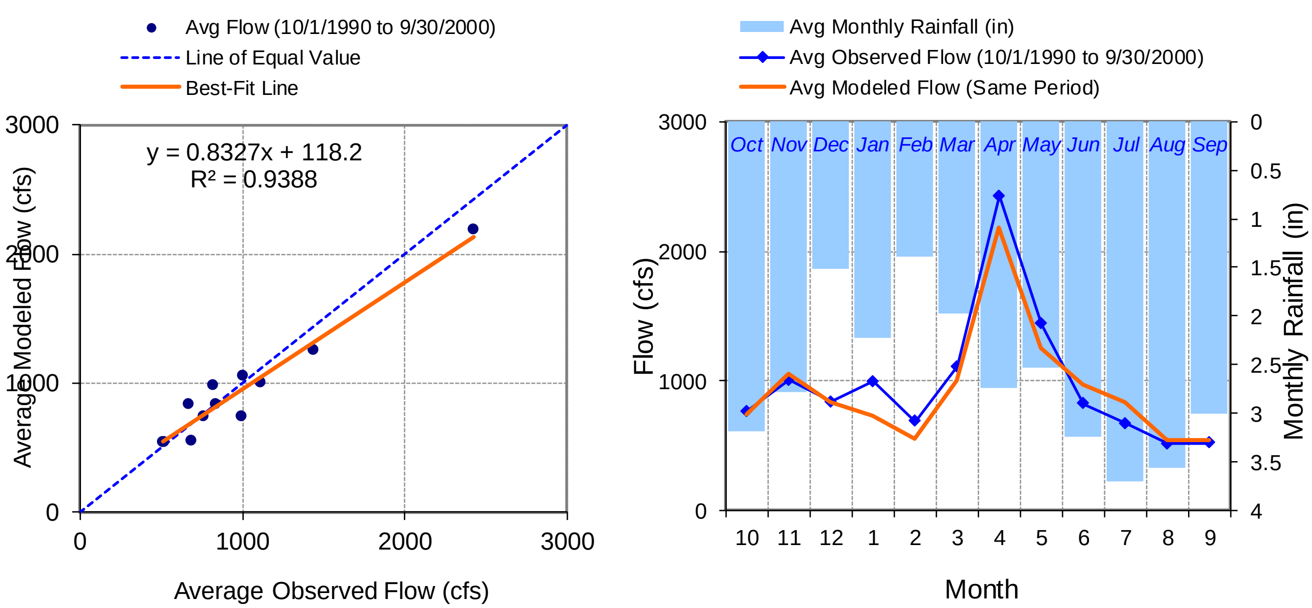


Figure J-4. Seasonal regression and temporal aggregate at USGS 04273500 Saranac River at Plattsburgh, NY

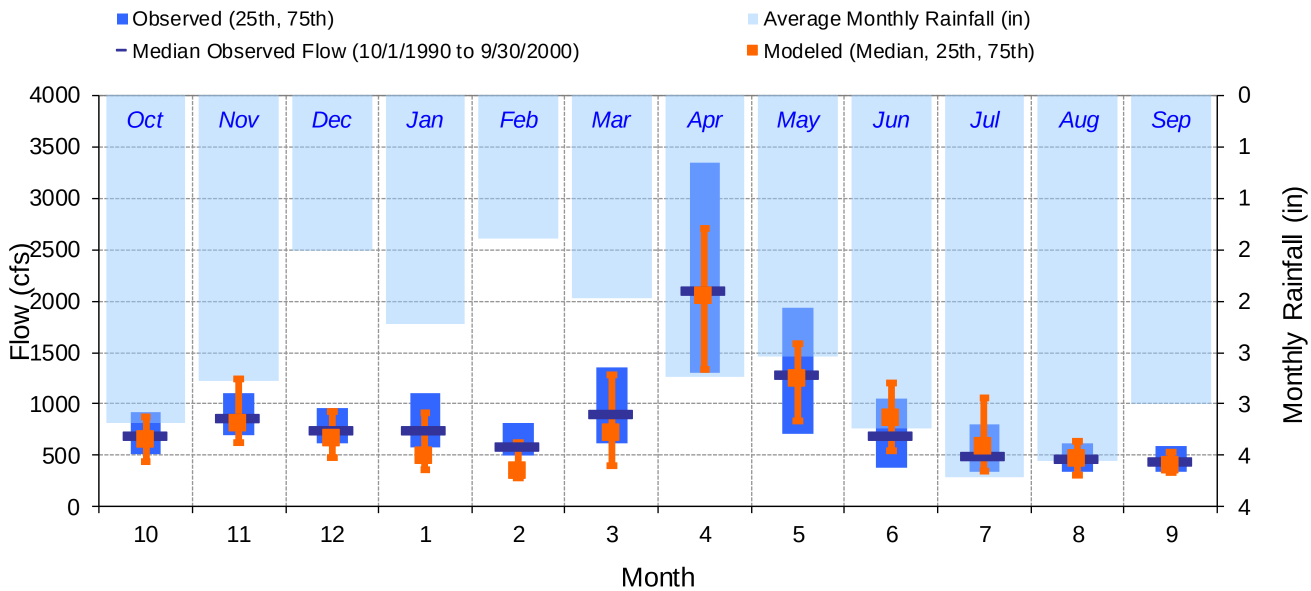


Figure J-5. Seasonal medians and ranges at USGS 04273500 Saranac River at Plattsburgh, NY

Table J-1. Seasonal summary at USGS 04273500 Saranac River at Plattsburgh, NY

MONTH	OBSERVED FLOW (CFS)				MODELED FLOW (CFS)			
	MEAN	MEDIAN	25TH	75TH	MEAN	MEDIAN	25TH	75TH
Oct	762.62	689.50	507.00	919.00	738.02	646.79	443.73	877.48
Nov	1006.27	863.50	699.25	1100.00	1048.94	812.94	626.75	1243.52
Dec	838.91	739.00	617.00	966.00	832.77	659.68	477.01	927.36
Jan	993.71	749.00	580.00	1110.00	733.27	496.52	364.18	908.91
Feb	687.76	581.00	500.00	817.50	550.41	345.24	288.50	627.01
Mar	1109.28	900.00	620.00	1350.00	1003.95	722.36	398.61	1281.39
Apr	2426.21	2095.00	1297.50	3347.50	2182.00	2047.01	1338.43	2707.49
May	1436.55	1280.00	706.50	1935.00	1250.17	1248.20	835.46	1592.51
Jun	820.48	693.50	378.75	1052.50	974.42	860.80	538.99	1208.38
Jul	668.14	494.50	347.00	802.50	833.74	581.46	352.10	1056.00
Aug	514.01	463.00	343.25	623.50	538.89	463.68	309.01	638.67
Sep	517.39	436.00	340.50	589.50	541.65	398.88	329.72	527.60

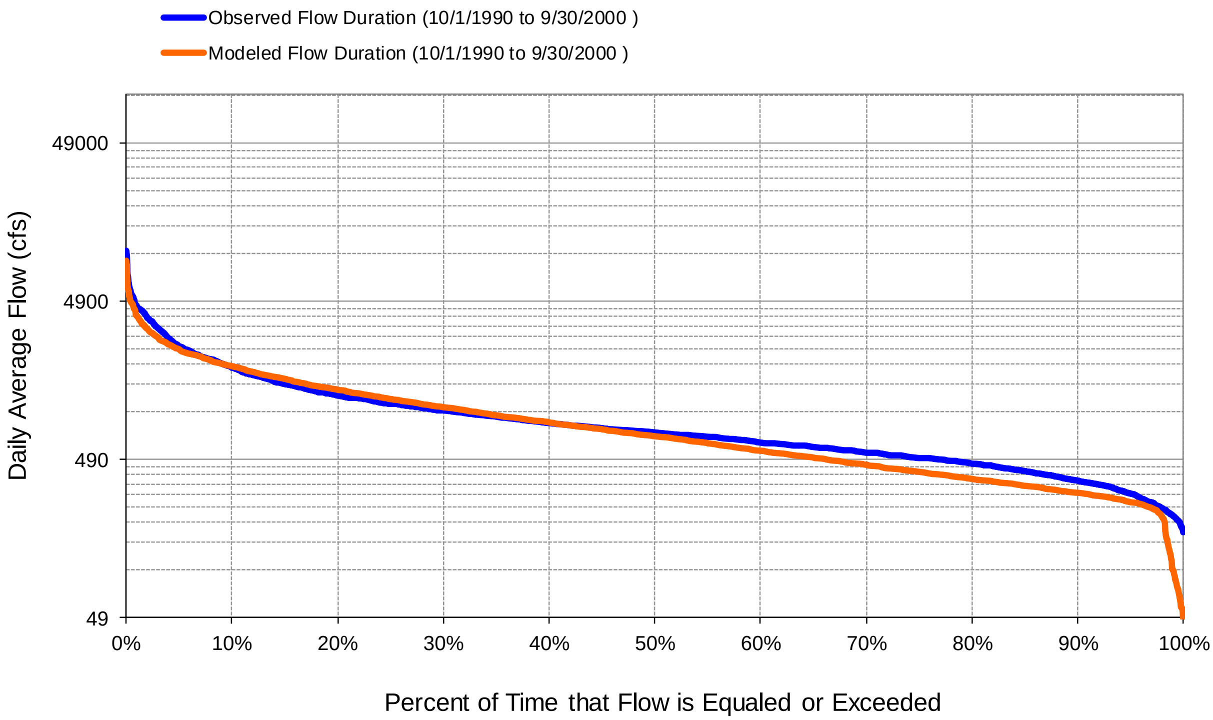


Figure J-6. Flow exceedence at USGS 04273500 Saranac River at Plattsburgh, NY

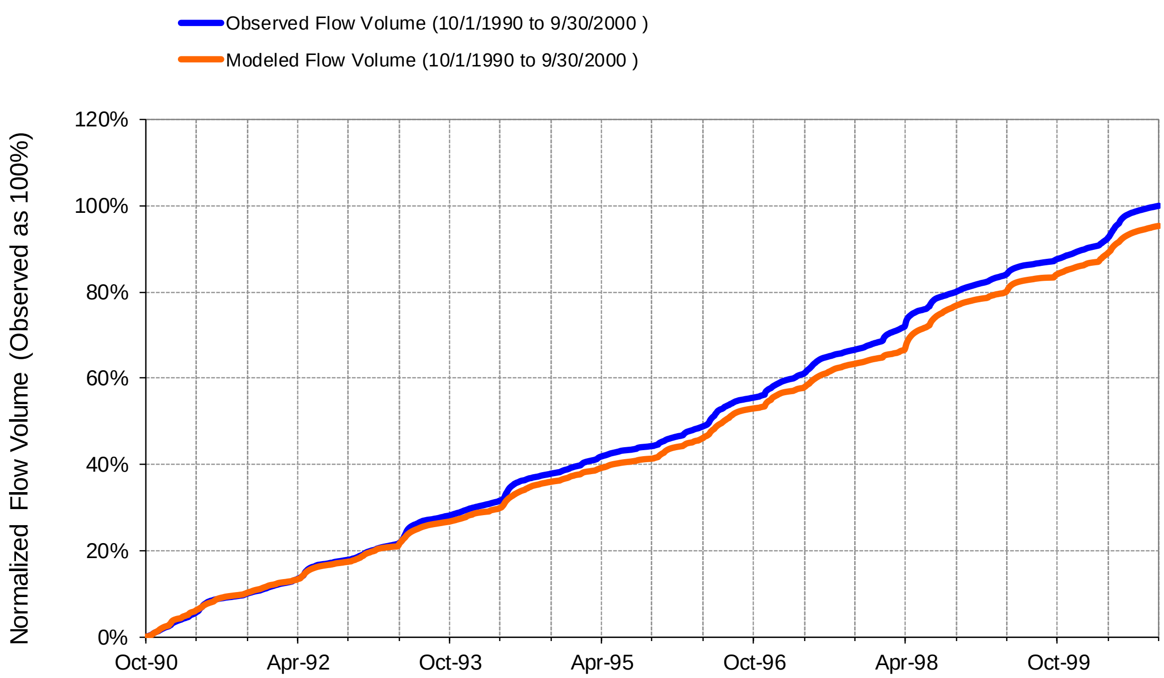


Figure J-7. Flow accumulation at USGS 04273500 Saranac River at Plattsburgh, NY

Table J-2. Summary statistics at USGS 04273500 Saranac River at Plattsburgh, NY

SWAT Simulated Flow		Observed Flow Gage	
REACH OUTFLOW FROM OUTLET 5 10-Year Analysis Period: 10/1/1990 - 9/30/2000 Flow volumes are (inches/year) for upstream drainage area		USGS 04273500 SARANAC RIVER AT PLATTSBURGH NY Hydrologic Unit Code: 2010006 Latitude: 44.68166667 Longitude: -73.4711111 Drainage Area (sq-mi): 608	
Total Simulated In-stream Flow:	**20.91**	Total Observed In-stream Flow:	**21.93**
Total of simulated highest 10% flows:	**6.21**	Total of Observed highest 10% flows:	**6.81**
Total of Simulated lowest 50% flows:	**4.71**	Total of Observed Lowest 50% flows:	**5.53**
Simulated Summer Flow Volume (months 7-9):	**3.60**	Observed Summer Flow Volume (7-9):	**3.19**
Simulated Fall Flow Volume (months 10-12):	**4.90**	Observed Fall Flow Volume (10-12):	**4.88**
Simulated Winter Flow Volume (months 1-3):	**4.25**	Observed Winter Flow Volume (1-3):	**5.18**
Simulated Spring Flow Volume (months 4-6):	**8.16**	Observed Spring Flow Volume (4-6):	**8.68**
Total Simulated Storm Volume:	**4.28**	Total Observed Storm Volume:	**4.67**
Simulated Summer Storm Volume (7-9):	**0.64**	Observed Summer Storm Volume (7-9):	**0.71**

Errors (Simulated-Observed)	*Error Statistics*		*Recommended Criteria*		
Error in total volume:	-4.67		10		
Error in 50% lowest flows:	-14.81		10		
Error in 10% highest flows:	-8.83		15		
Seasonal volume error - Summer:	12.71		30		
Seasonal volume error - Fall:	0.41	>>	30	Clear	
Seasonal volume error - Winter:	-17.99		30		
Seasonal volume error - Spring:	-5.98		30		
Error in storm volumes:	-8.48		20		
Error in summer storm volumes:	-9.81		50		
Nash-Sutcliffe Coefficient of Efficiency, E:	0.677		Model accuracy increases		
Baseline adjusted coefficient (Garrick), E':	0.442		as E or E' approaches 1.0		
Monthly NSE	0.798				

USGS 04273500 Saranac River at Plattsburgh, NY - Validation

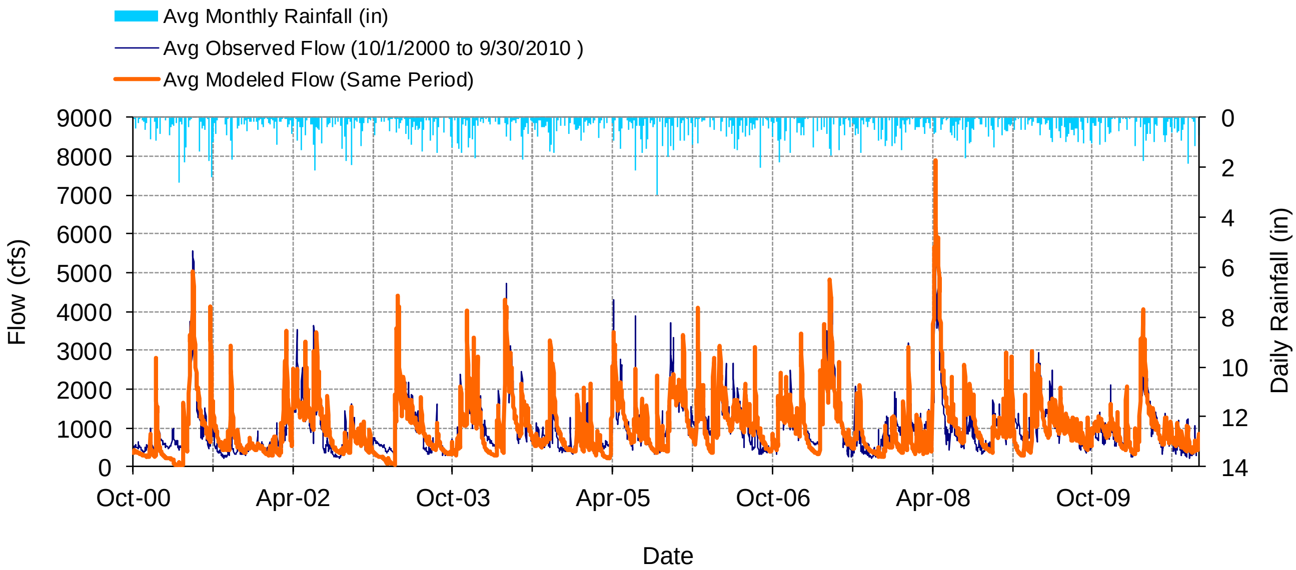


Figure J-8. Mean daily flow at USGS 04273500 Saranac River at Plattsburgh, NY

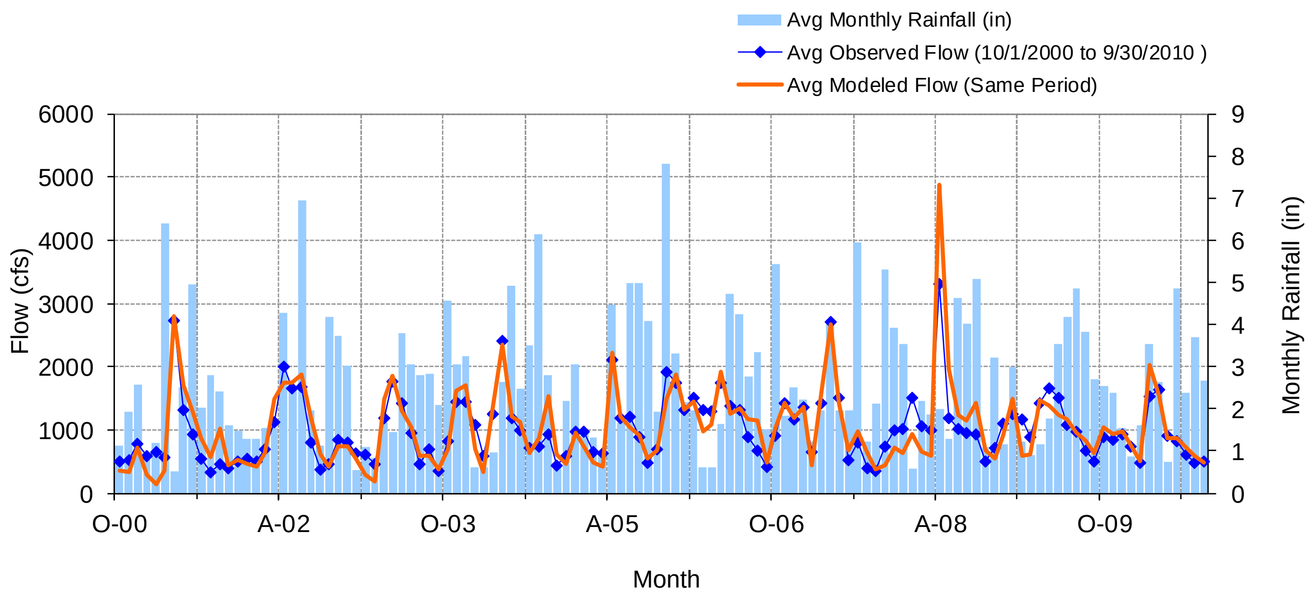


Figure J-9. Mean monthly flow at USGS 04273500 Saranac River at Plattsburgh, NY

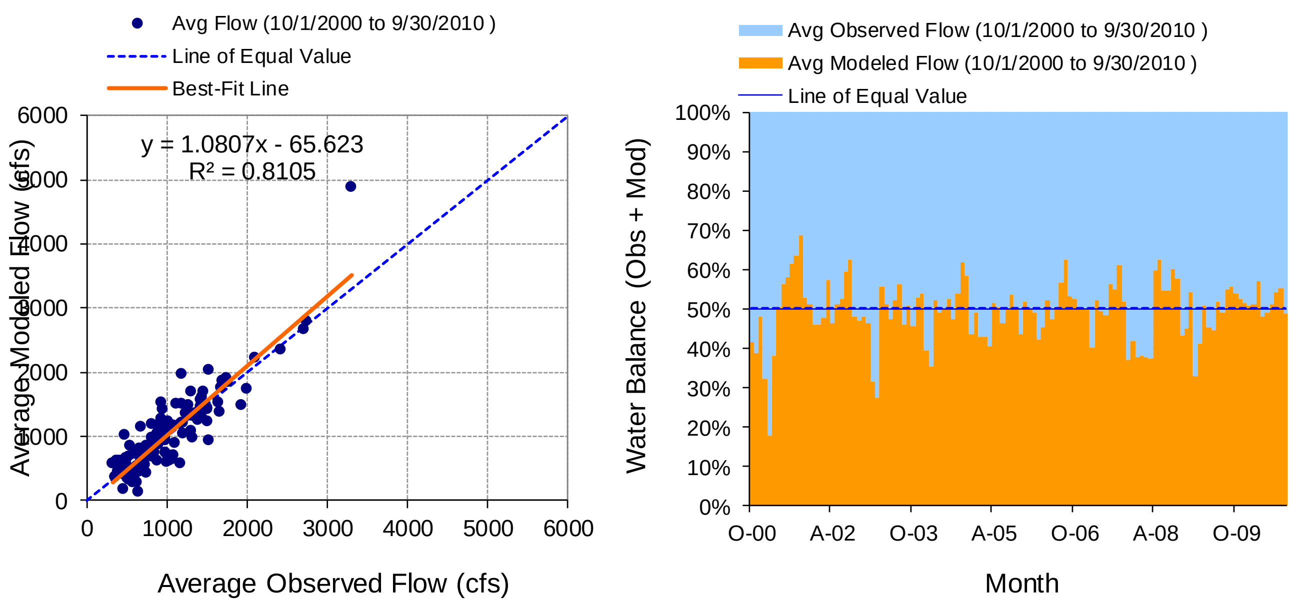


Figure J-10. Monthly flow regression and temporal variation at USGS 04273500 Saranac River at Plattsburgh, NY

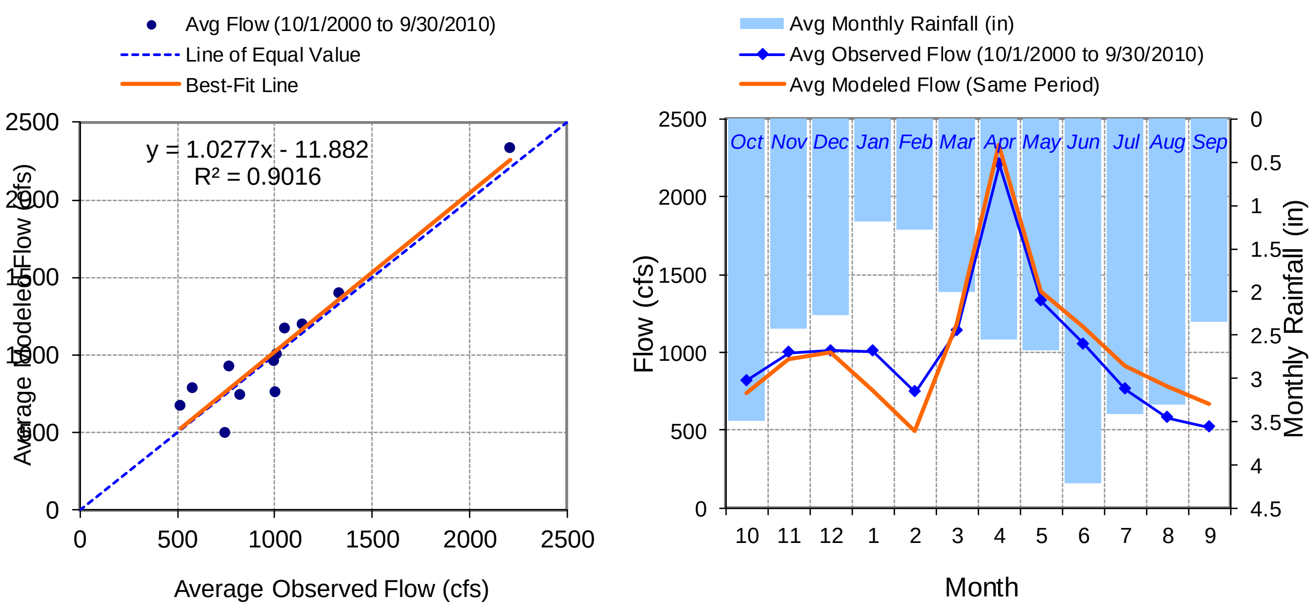


Figure J-11. Seasonal regression and temporal aggregate at USGS 04273500 Saranac River at Plattsburgh, NY

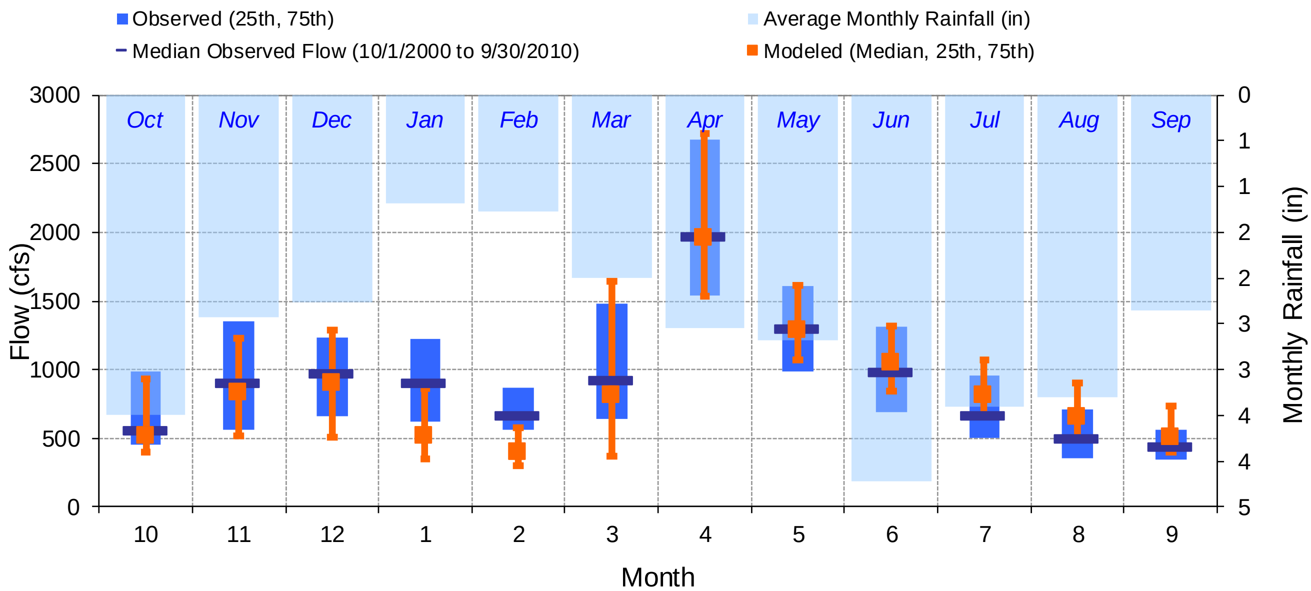


Figure J-12. Seasonal medians and ranges at USGS 04273500 Saranac River at Plattsburgh, NY

Table J-3. Seasonal summary at USGS 04273500 Saranac River at Plattsburgh, NY

MONTH	OBSERVED FLOW (CFS)				MODELED FLOW (CFS)			
	MEAN	MEDIAN	25TH	75TH	MEAN	MEDIAN	25TH	75TH
Oct	819.34	558.00	452.50	988.75	738.43	514.18	394.91	931.07
Nov	997.59	907.00	566.25	1352.50	955.62	837.13	520.45	1228.33
Dec	1011.89	977.00	661.75	1237.50	997.98	907.41	503.06	1285.98
Jan	1006.37	903.50	620.00	1220.00	754.20	520.36	346.64	865.74
Feb	746.73	668.00	560.00	872.50	494.69	396.05	301.08	574.83
Mar	1143.47	926.50	640.00	1477.50	1187.36	817.36	367.36	1644.87
Apr	2210.86	1965.00	1537.50	2680.00	2330.83	1962.61	1538.04	2724.00
May	1329.62	1300.00	988.75	1610.00	1391.21	1284.75	1072.42	1611.67
Jun	1054.59	985.00	690.50	1312.50	1163.82	1046.37	848.17	1320.59
Jul	764.98	665.50	502.00	961.25	915.97	809.24	655.09	1067.30
Aug	579.00	500.50	356.00	707.25	781.23	658.62	492.99	900.08
Sep	519.61	437.50	349.50	557.75	667.89	512.42	401.53	730.75

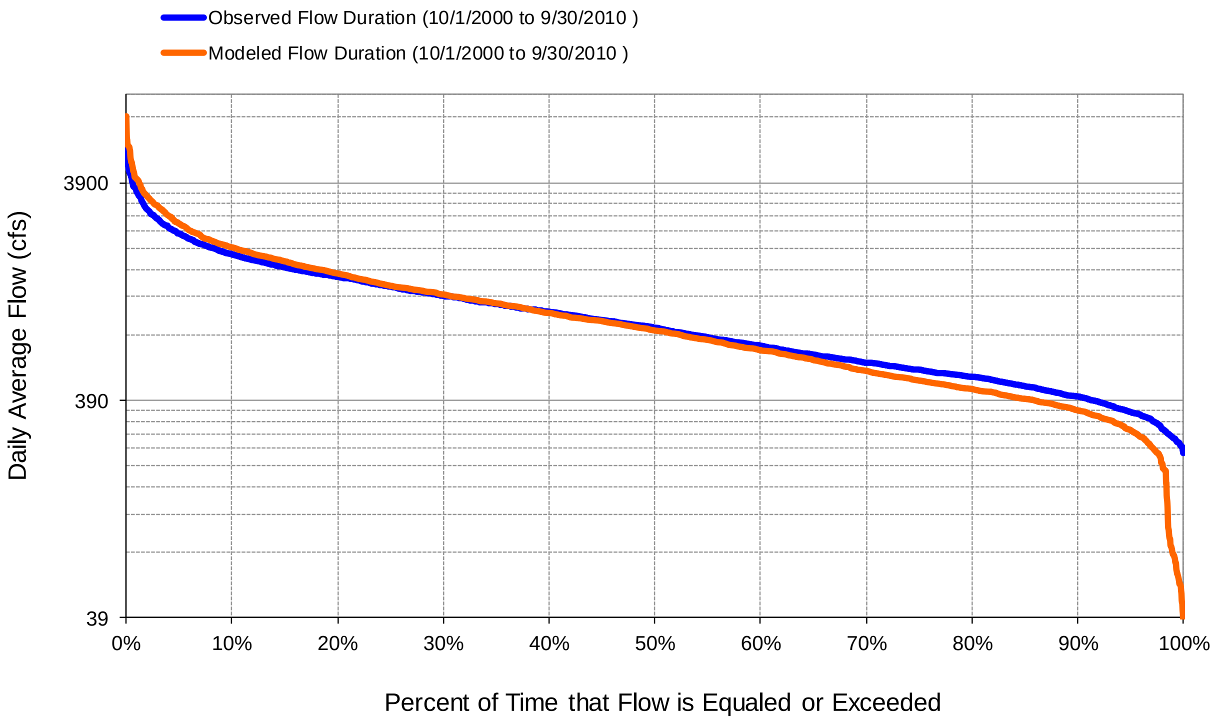


Figure J-13. Flow exceedence at USGS 04273500 Saranac River at Plattsburgh, NY

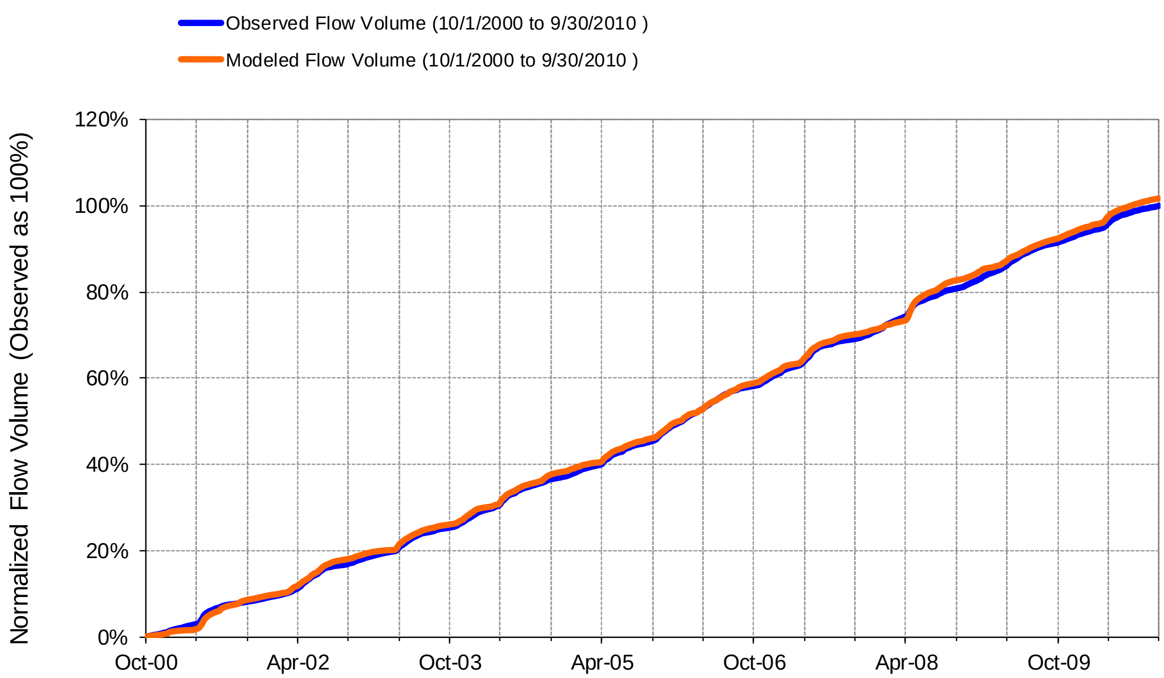


Figure J-14. Flow accumulation at USGS 04273500 Saranac River at Plattsburgh, NY

Table J-4. Summary statistics at USGS 04273500 Saranac River at Plattsburgh, NY

SWAT Simulated Flow		Observed Flow Gage	
REACH OUTFLOW FROM OUTLET 5 10-Year Analysis Period: 10/1/2000 - 9/30/2010 Flow volumes are (inches/year) for upstream drainage area		USGS 04273500 SARANAC RIVER AT PLATTSBURGH NY Hydrologic Unit Code: 2010006 Latitude: 44.68166667 Longitude: -73.4711111 Drainage Area (sq-mi): 608	
Total Simulated In-stream Flow:	**23.08**	Total Observed In-stream Flow:	**22.69**
Total of simulated highest 10% flows:	**6.37**	Total of Observed highest 10% flows:	**5.64**
Total of Simulated lowest 50% flows:	**5.52**	Total of Observed Lowest 50% flows:	**6.09**
Simulated Summer Flow Volume (months 7-9):	**4.44**	Observed Summer Flow Volume (7-9):	**3.50**
Simulated Fall Flow Volume (months 10-12):	**5.05**	Observed Fall Flow Volume (10-12):	**5.30**
Simulated Winter Flow Volume (months 1-3):	**4.54**	Observed Winter Flow Volume (1-3):	**5.37**
Simulated Spring Flow Volume (months 4-6):	**9.05**	Observed Spring Flow Volume (4-6):	**8.51**
Total Simulated Storm Volume:	**4.32**	Total Observed Storm Volume:	**4.35**
Simulated Summer Storm Volume (7-9):	**0.76**	Observed Summer Storm Volume (7-9):	**0.80**

Errors (Simulated-Observed)	*Error Statistics*	*Recommended Criteria*		
Error in total volume:	1.73	10		
Error in 50% lowest flows:	-9.43	10		
Error in 10% highest flows:	12.85	15		
Seasonal volume error - Summer:	26.90	30		
Seasonal volume error - Fall:	-4.84	>> 30		Clear
Seasonal volume error - Winter:	-15.47	30		
Seasonal volume error - Spring:	6.31	30		
Error in storm volumes:	-0.59	20		
Error in summer storm volumes:	-5.04	50		
Nash-Sutcliffe Coefficient of Efficiency, E:	0.596	Model accuracy increases		
Baseline adjusted coefficient (Garrick), E':	0.404	as E or E' approaches 1.0		
Monthly NSE	0.719			

TSS and TP distribution by channel and upland sources

Table J-5. TSS and TP distribution by source categories

Source	TSS		TP	
	Load(mt/year)	Percentage (%)	Load (kg/year)	Percentage (%)
Upland	8,876	38.6	29,187	94.7
Stream	14,104	61.4	1,643	5.3
Total	**22,980**	**100.0**	**30,830**	**100.0**

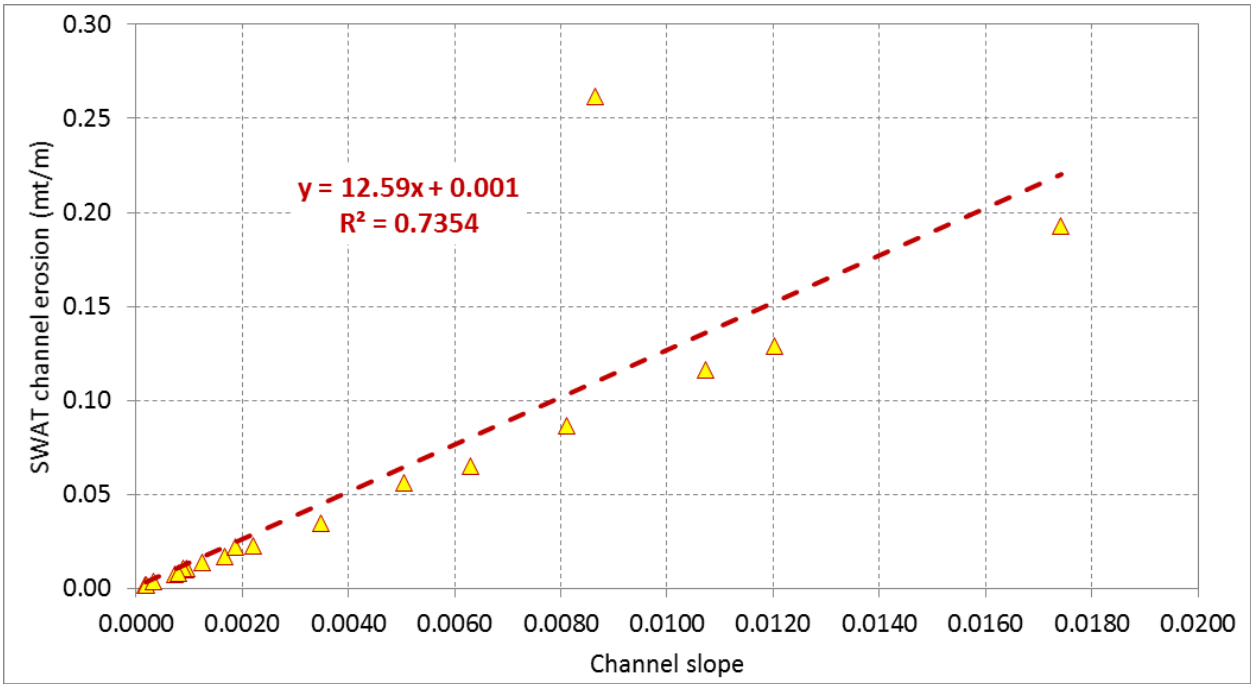


Figure J-15. SWAT simulated channel erosion relative to channel slope

TP distribution by landuse from upland sources

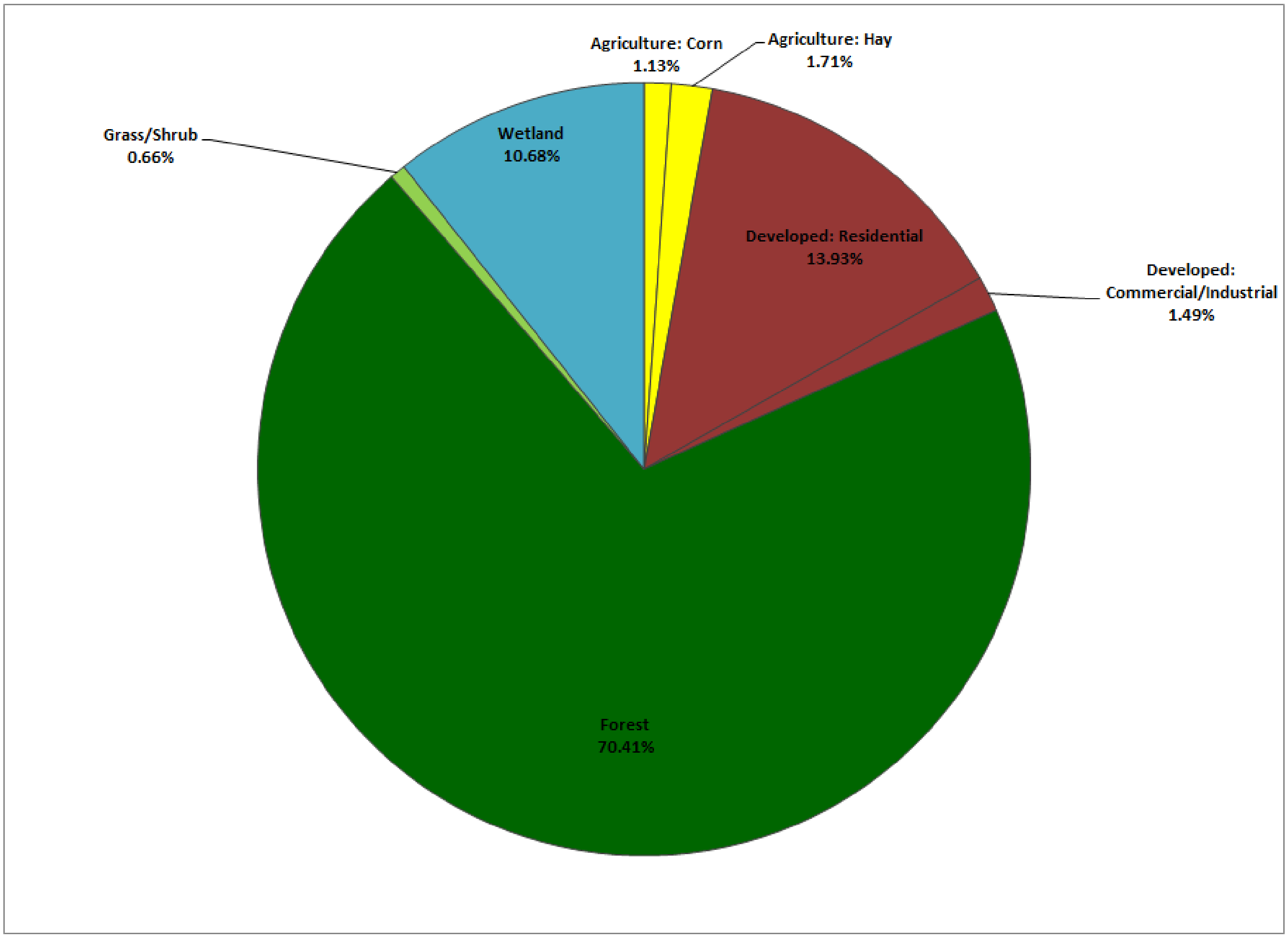


Figure J-16. Distribution of simulated total upland TP loads by landuse categories

Table J-6. TP export rates (kg/ha/yr) by landuse categories for the 30 year simulation period

Landuse	Classification	Area (ha)	Area (%)	Mean	Min	Q_{25}	Q_{50}	Q_{75}	Max
Agriculture	Corn	163	0.11	**2.00**	0.96	1.35	1.72	2.59	4.01
	Hay	538	0.36	**0.92**	0.18	0.57	0.75	1.28	1.98
Urban	Residential	6,190	4.14	**0.65**	0.43	0.58	0.62	0.70	0.98
	Commercial/Industrial	234	0.16	**1.84**	1.45	1.70	1.85	1.96	2.20
Forest	Forest	124,758	83.52	**0.16**	0.11	0.14	0.16	0.18	0.24
Grass/Shrub	Grass/Shrub	1,377	0.92	**0.14**	0.06	0.10	0.15	0.18	0.20
Wetland	Wetland	16,106	10.78	**0.19**	0.12	0.17	0.19	0.20	0.28

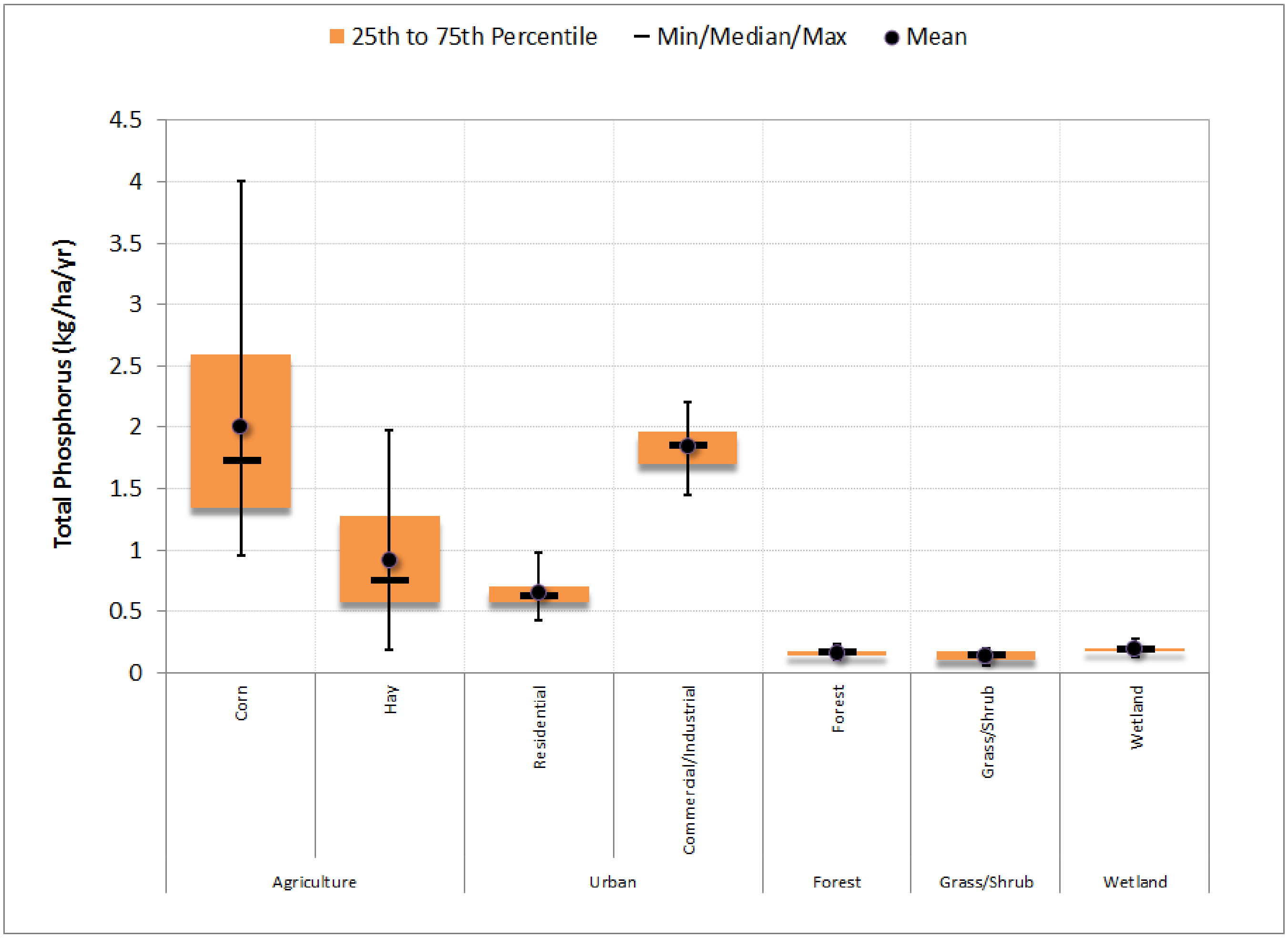


Figure J-17. TP export rates (kg/ha/yr) by landuse categories for the 30 year simulation period

Table J-7. TP export rates (kg/ha/yr) for the residential landuse categories for the 30 year simulation period

Residential Category	Area (ha)	Area (%)	Mean	Min	Q_{25}	Q_{50}	Q_{75}	Max
Low Density	4,444	71.79	**0.42**	0.25	0.34	0.41	0.45	0.76
Medium Density	1,201	19.41	**1.08**	0.73	0.95	1.11	1.18	1.46
High Density	545	8.80	**1.61**	1.19	1.44	1.65	1.74	1.98
Total	6,190	100.00	**0.65**	0.43	0.58	0.62	0.70	0.98

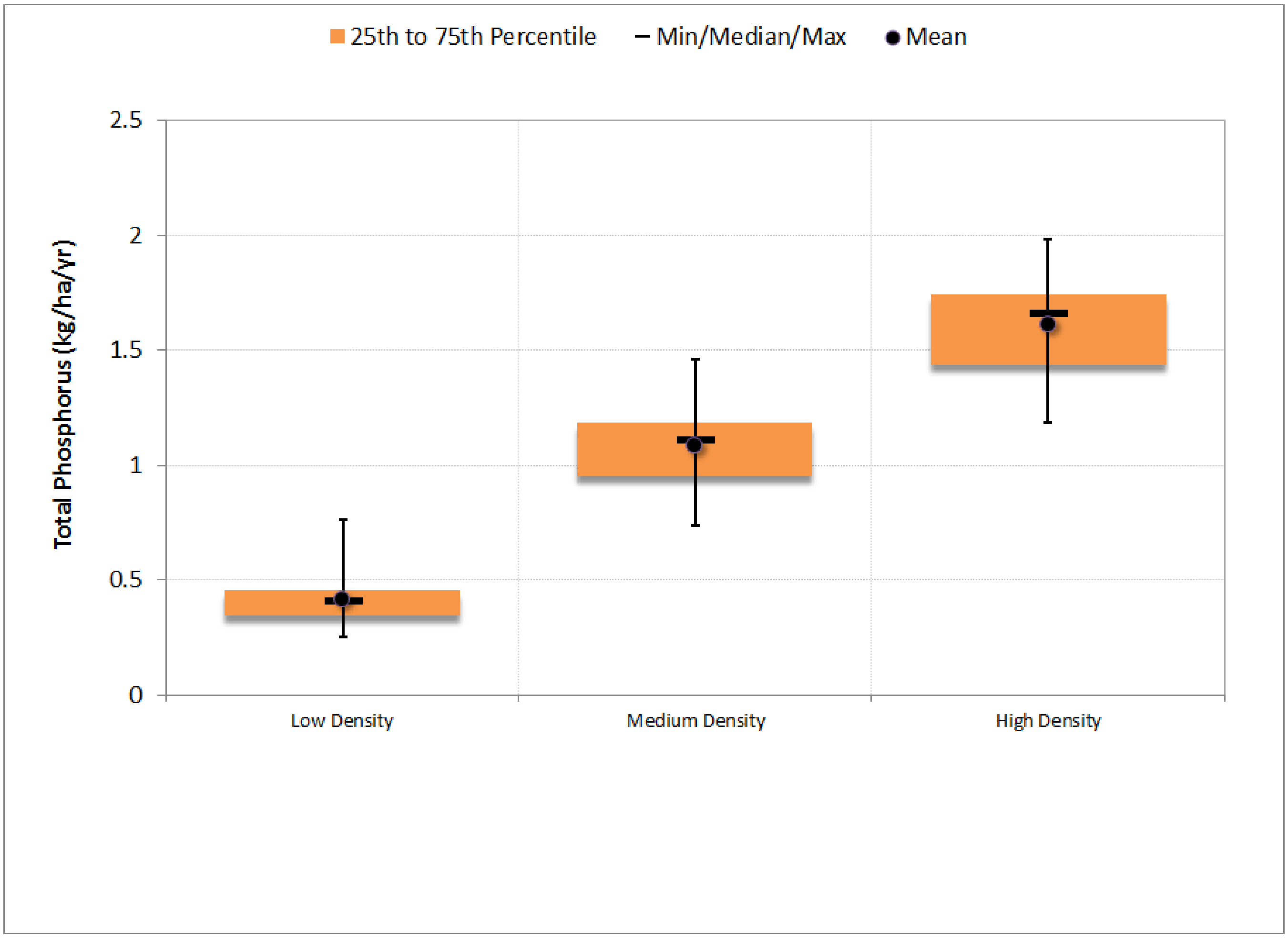


Figure J-18. TP export rates (kg/ha/yr) for the residential landuse categories for the 30 year simulation period

Segmented Regression

Table J-8. Summary statistics

Statistic	Calibration		Validation	
	TSS	TP	TSS	TP
Average absolute error (%)	36.2	38.8	43.6	44.6
Median absolute error (%)	20.8	23.9	13.7	28.2
Regression error (%)	-17.2	-17.4	16.4	-17.9
NSE	0.724	0.303	0.678	0.617
NSE'	0.473	0.232	0.553	0.336

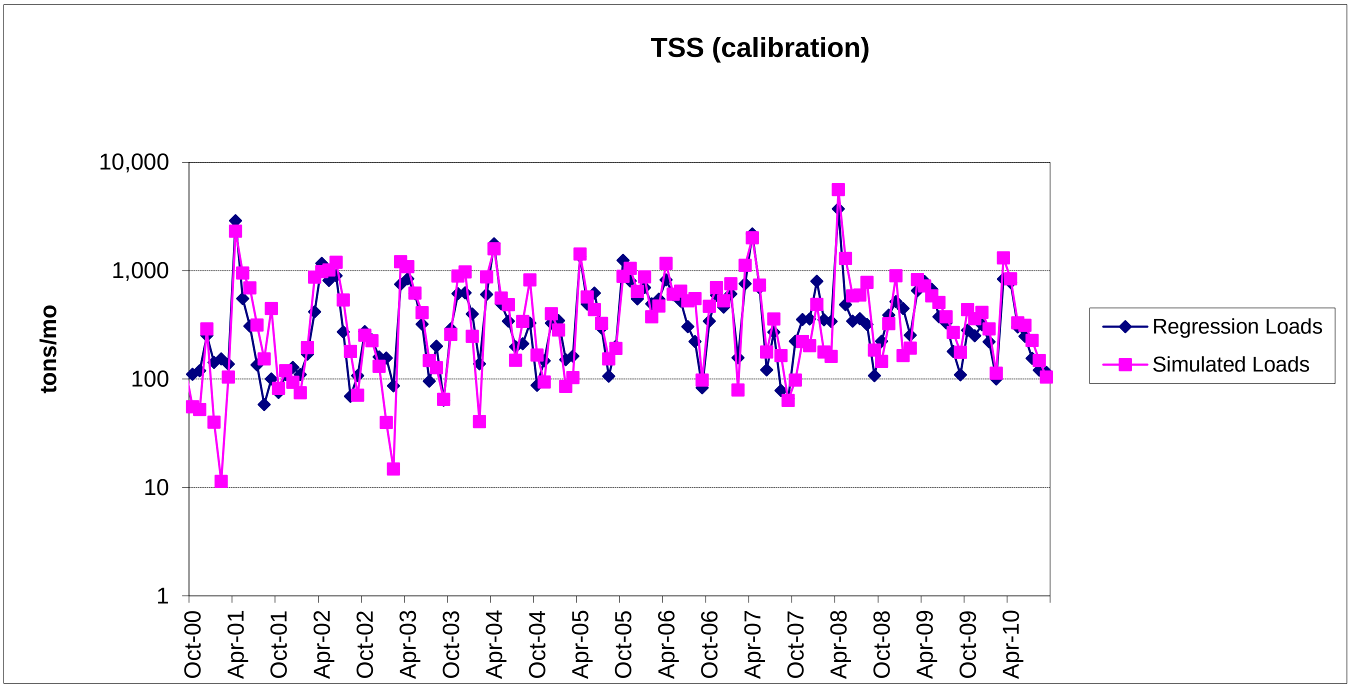


Figure J-19. Monthly simulated and estimated TSS load at Saranac River at Plattsburgh, NY (calibration period)

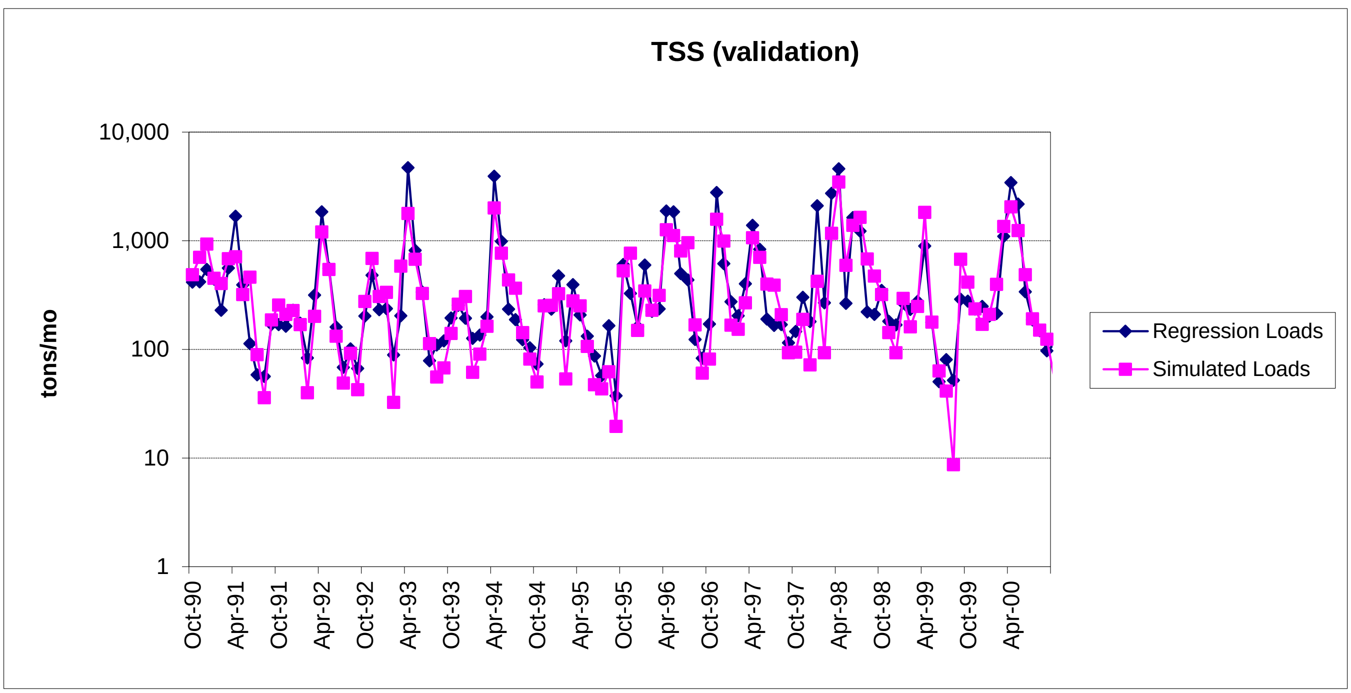


Figure J-20. Monthly simulated and estimated TSS load at Saranac River at Plattsburgh, NY (validation period)

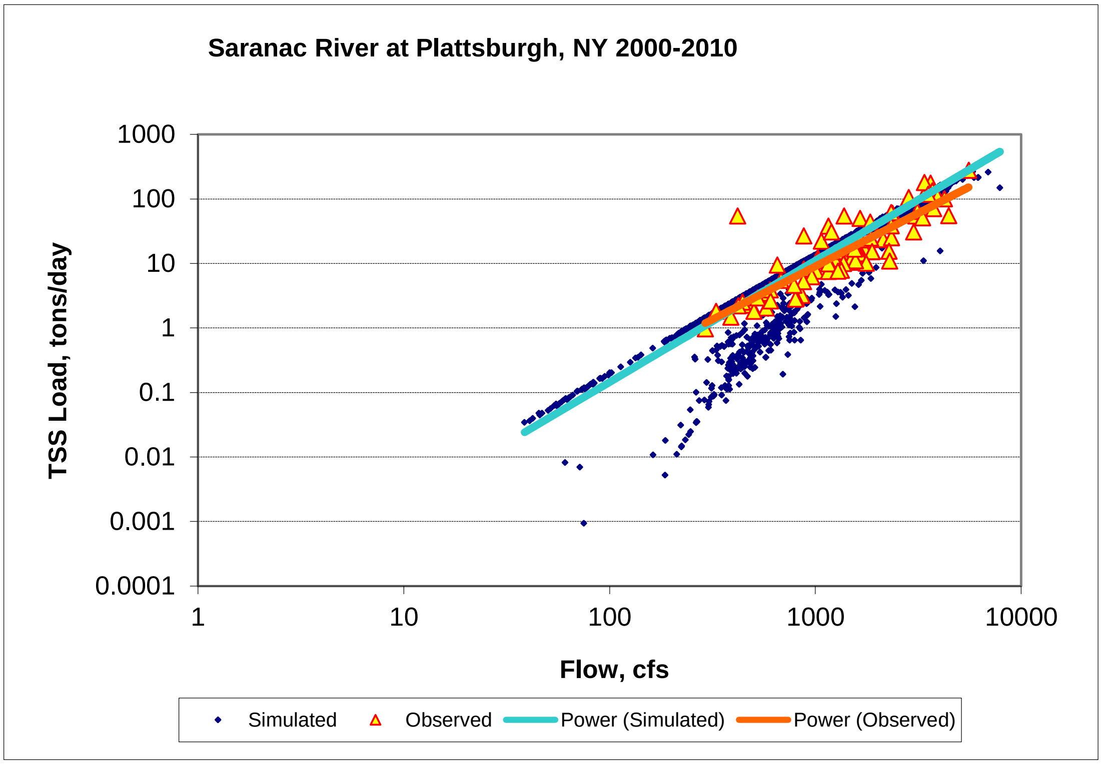


Figure J-21. Power plot of simulated and observed TSS load vs flow at Saranac River at Plattsburgh, NY (calibration period)

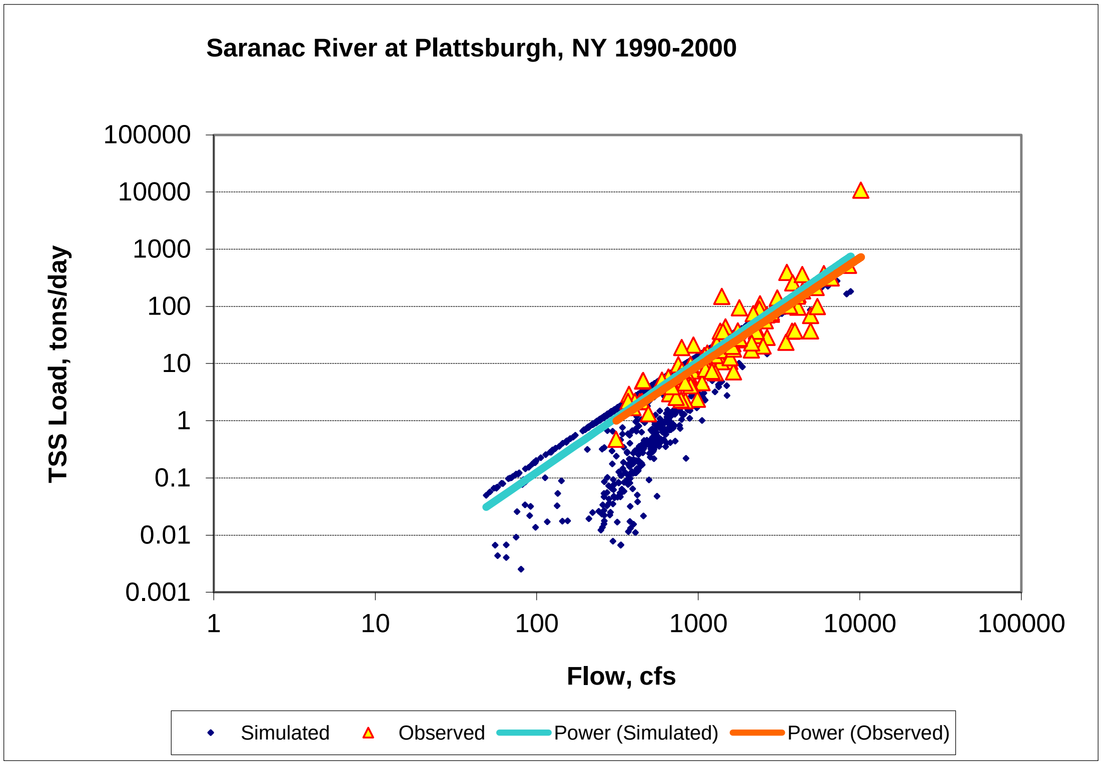


Figure J-22. Power plot of simulated and observed TSS load vs flow at Saranac River at Plattsburgh, NY (validation period)

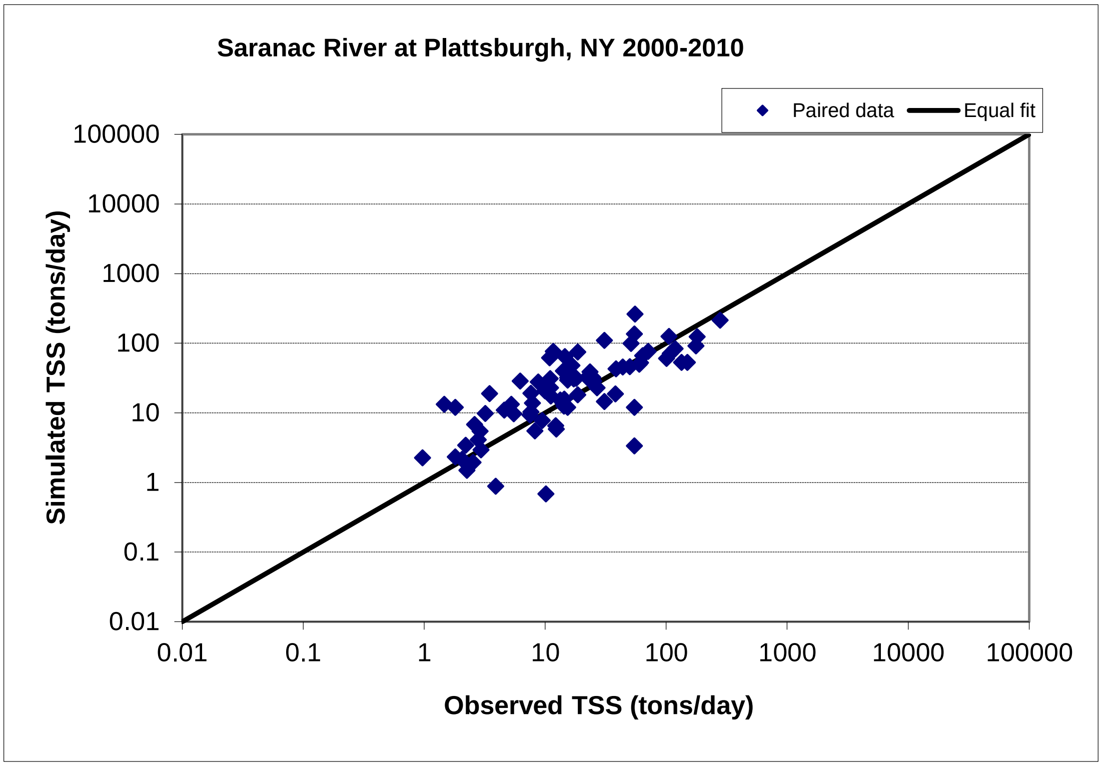


Figure J-23. Paired simulated vs observed TSS load at Saranac River at Plattsburgh, NY (calibration period)

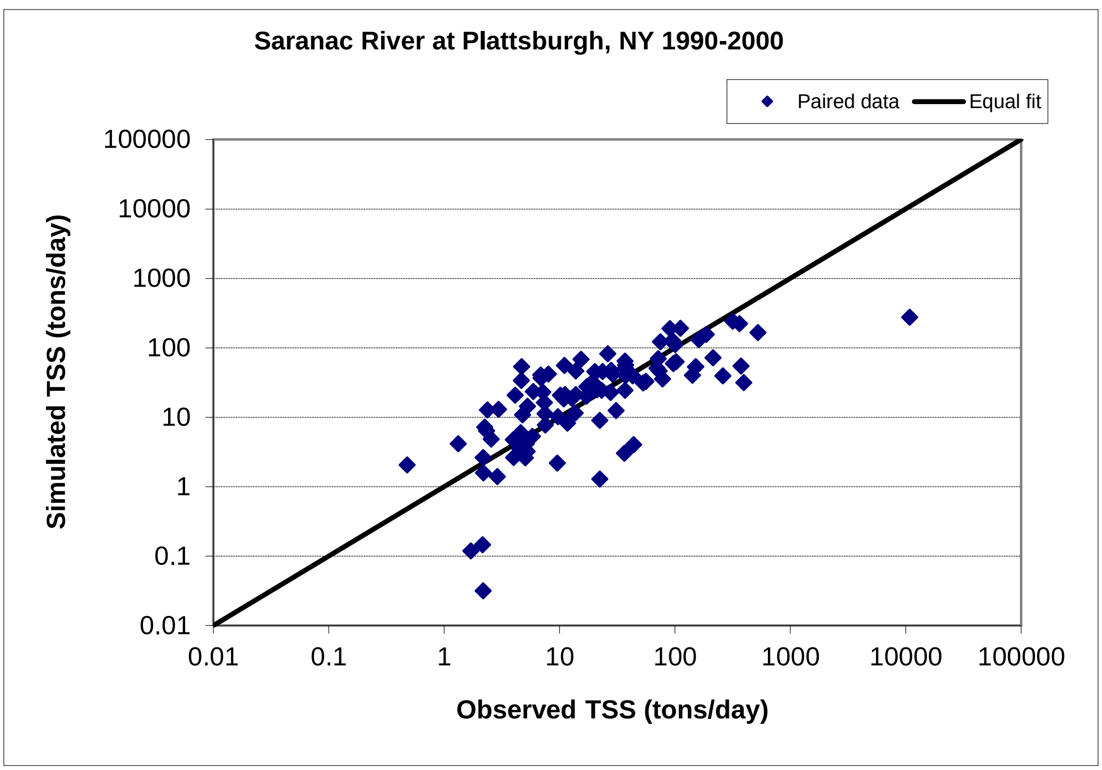


Figure J-24. Paired simulated vs observed TSS load at Saranac River at Plattsburgh, NY (validation period)

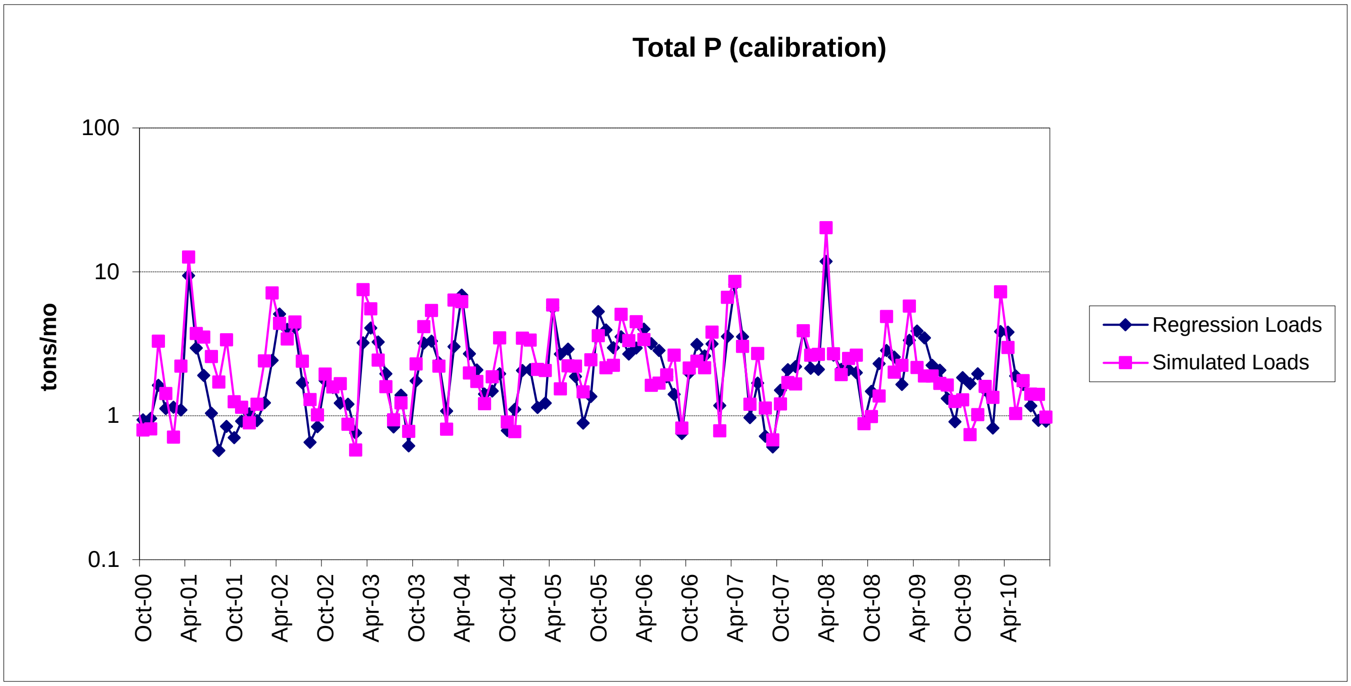


Figure J-25. Monthly simulated and estimated TP load at Saranac River at Plattsburgh, NY (calibration period)

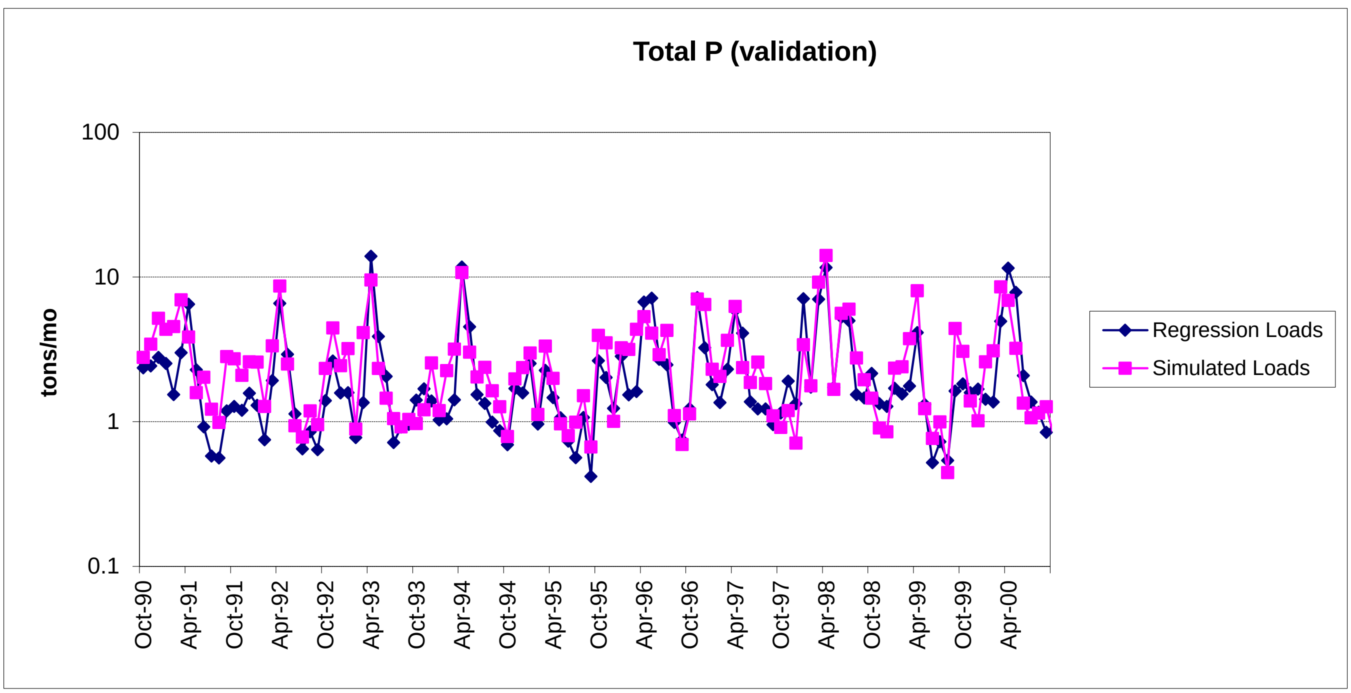


Figure J-26. Monthly simulated and estimated TP load at Saranac River at Plattsburgh, NY (validation period)

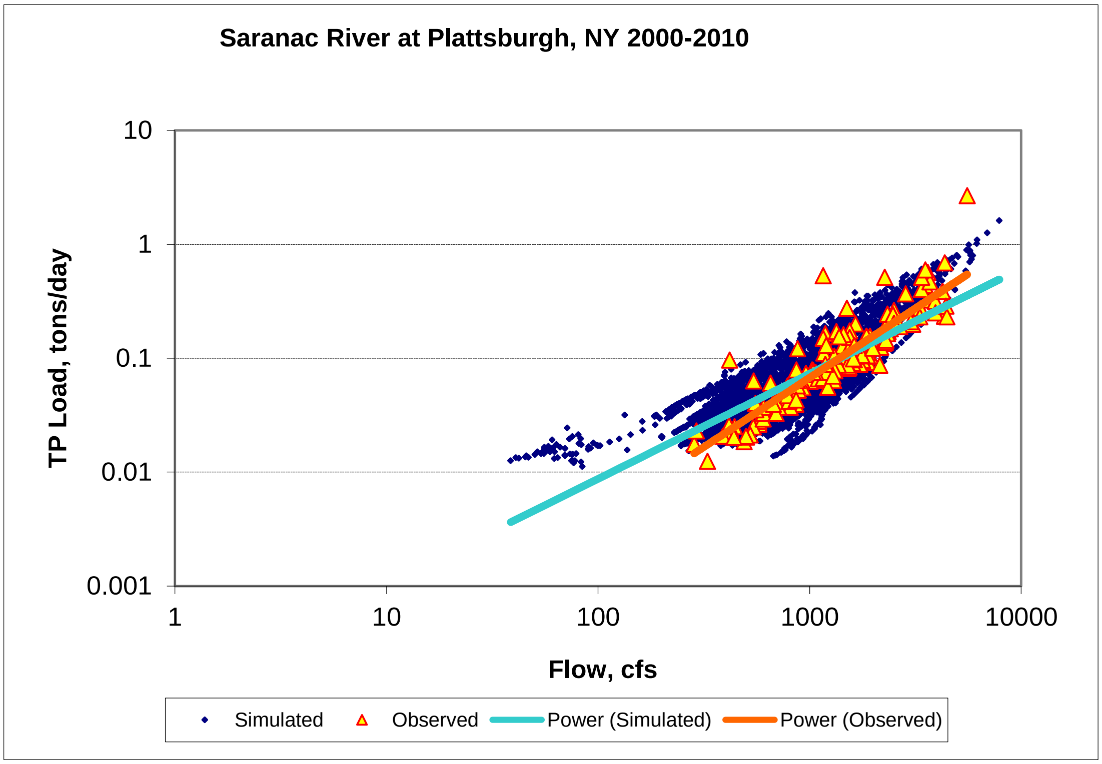


Figure J-27. Power plot of simulated and observed TP load vs flow at Saranac River at Plattsburgh, NY (calibration period)

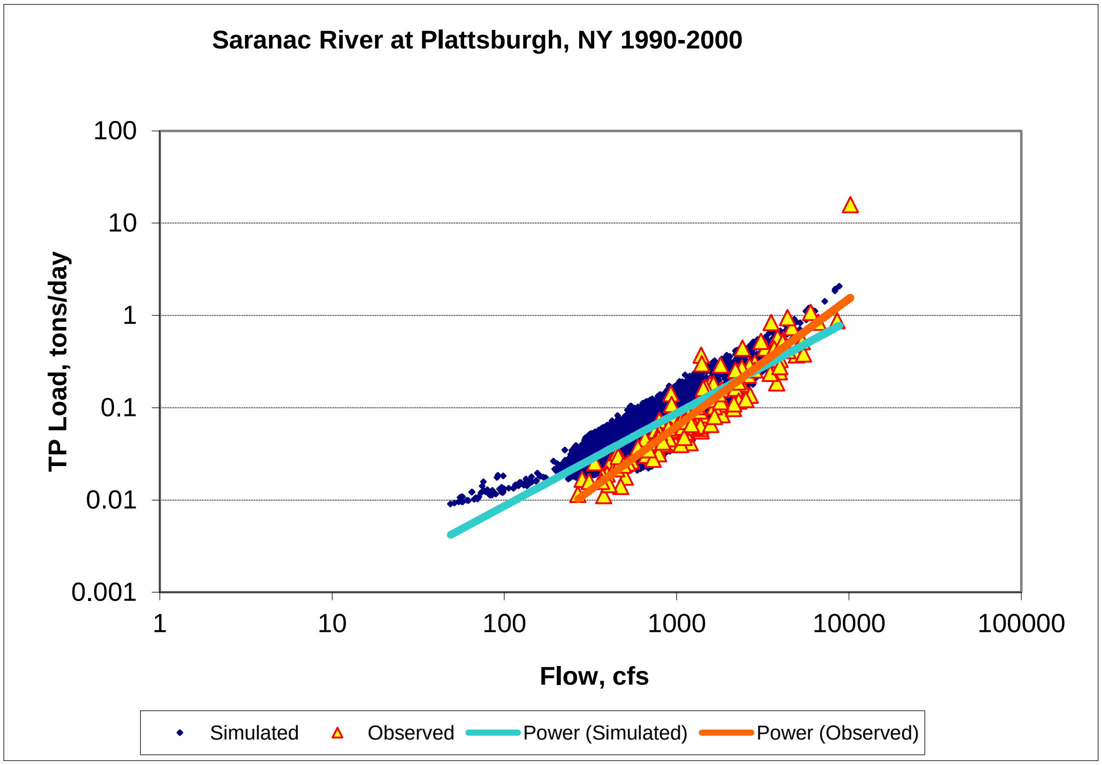


Figure J-28. Power plot of simulated and observed TP load vs flow at Saranac River at Plattsburgh, NY (validation period)

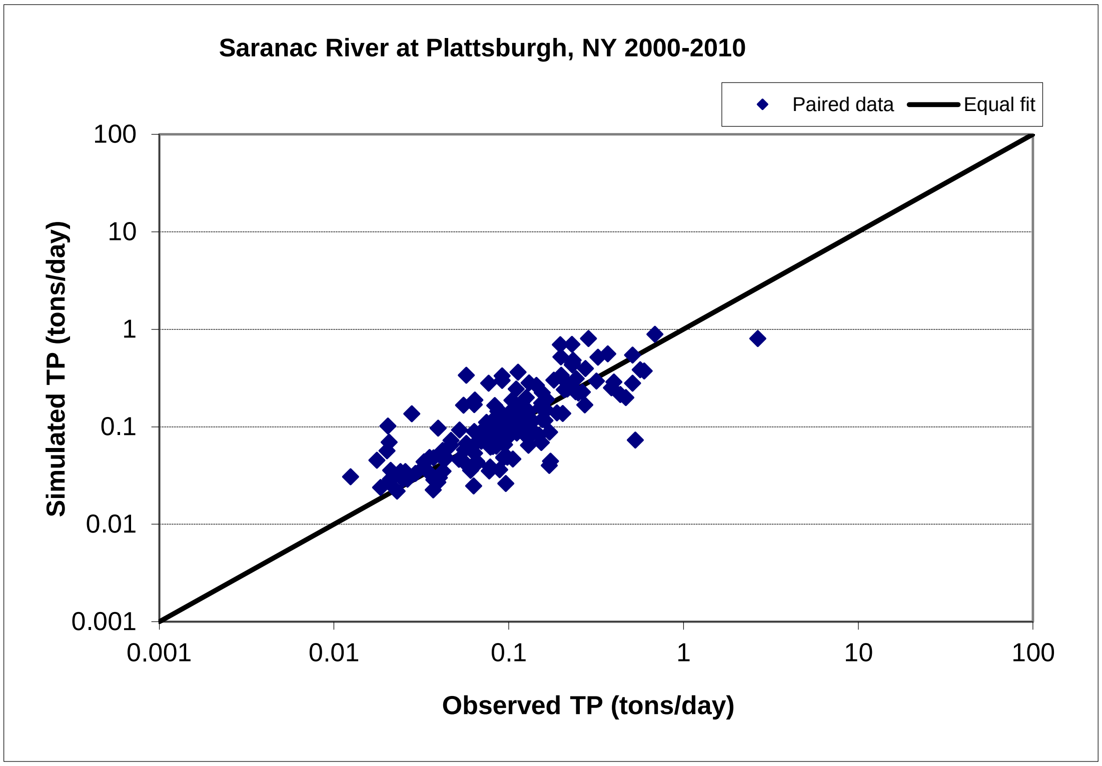


Figure J-29. Paired simulated vs observed TP load at Saranac River at Plattsburgh, NY (calibration period)

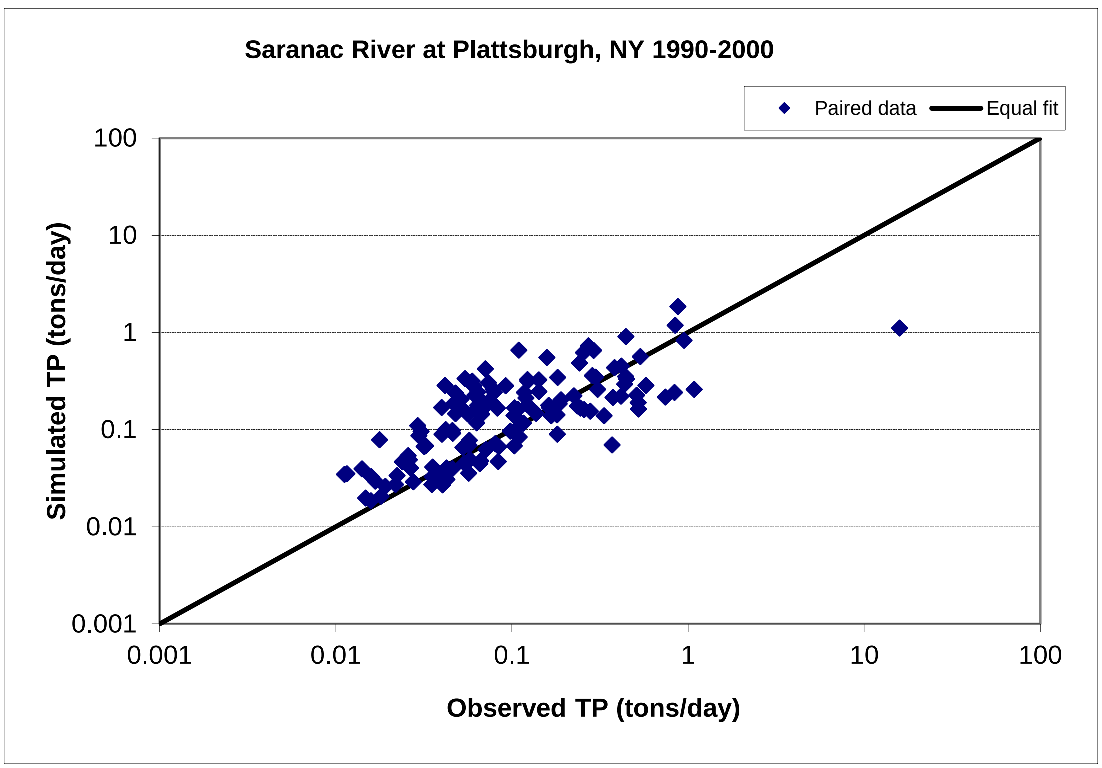


Figure J-30. Paired simulated vs observed TP load at Saranac River at Plattsburgh, NY (validation period)

Comparison of simulated SWAT TP loads with FLUX estimates

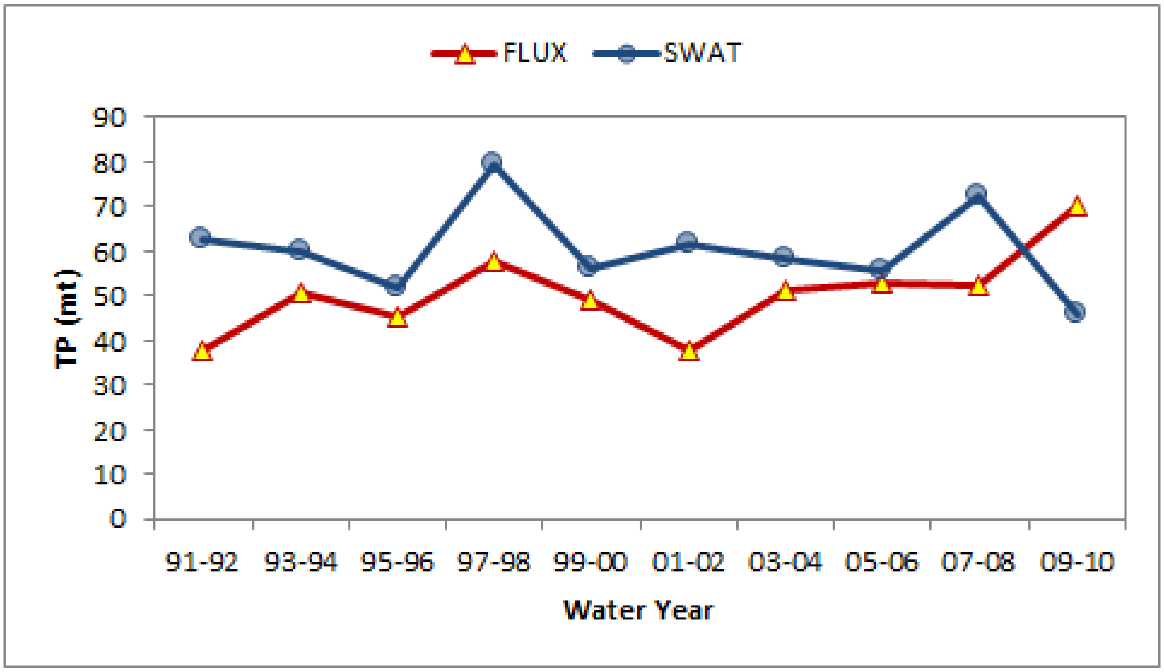


Figure J-31. Bi-annual TP loads on a water year basis as simulated by SWAT and estimated by FLUX (FLUX estimates from Smeltzer et al., 2009)

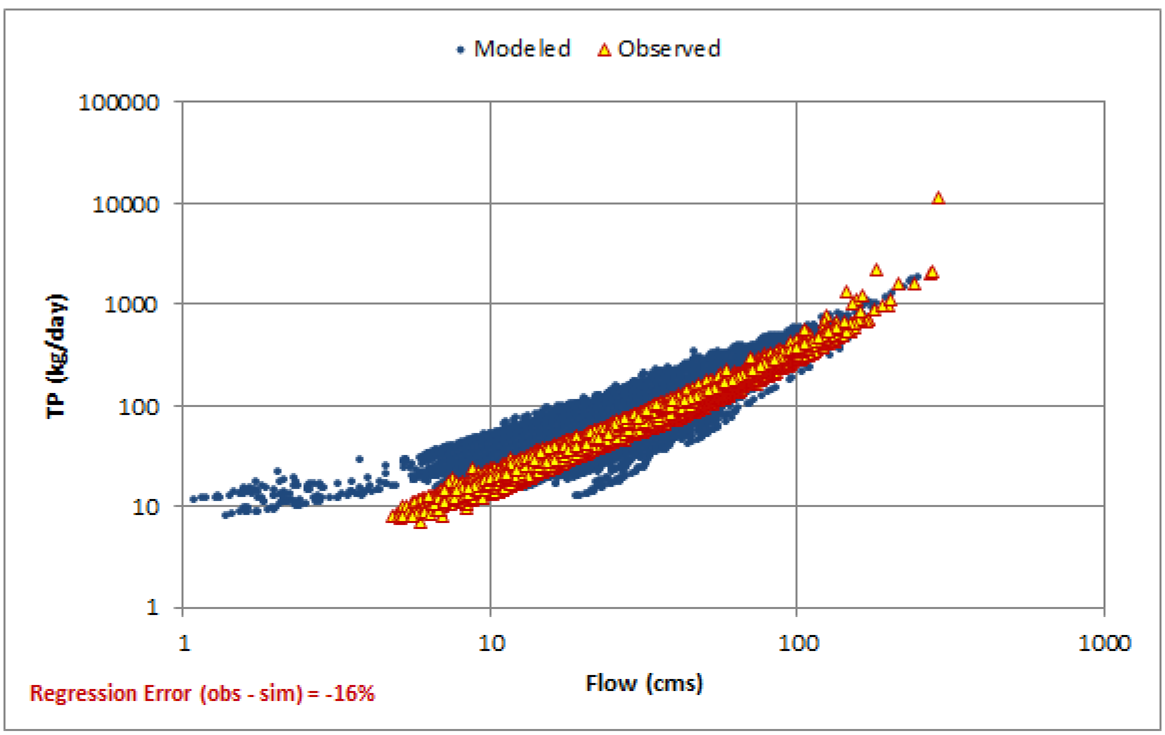
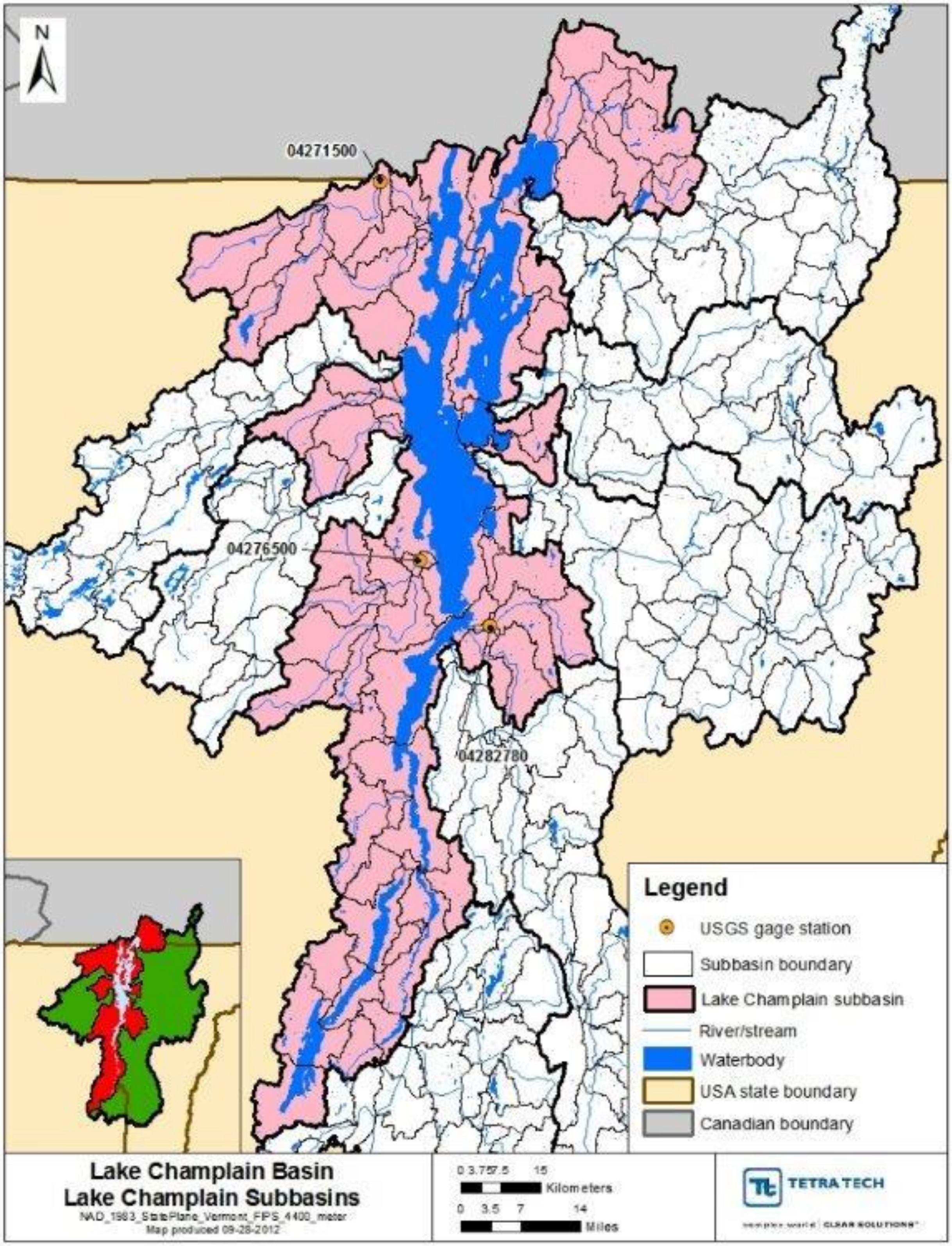


Figure J-32. Daily TP load versus flow as simulated by SWAT and estimated by FLUX (FLUX estimates from Medalie, 2013)

Appendix K - Direct Drainage



USGS 04282795 LaPlatte River at Shelburne Falls, VT - Calibration

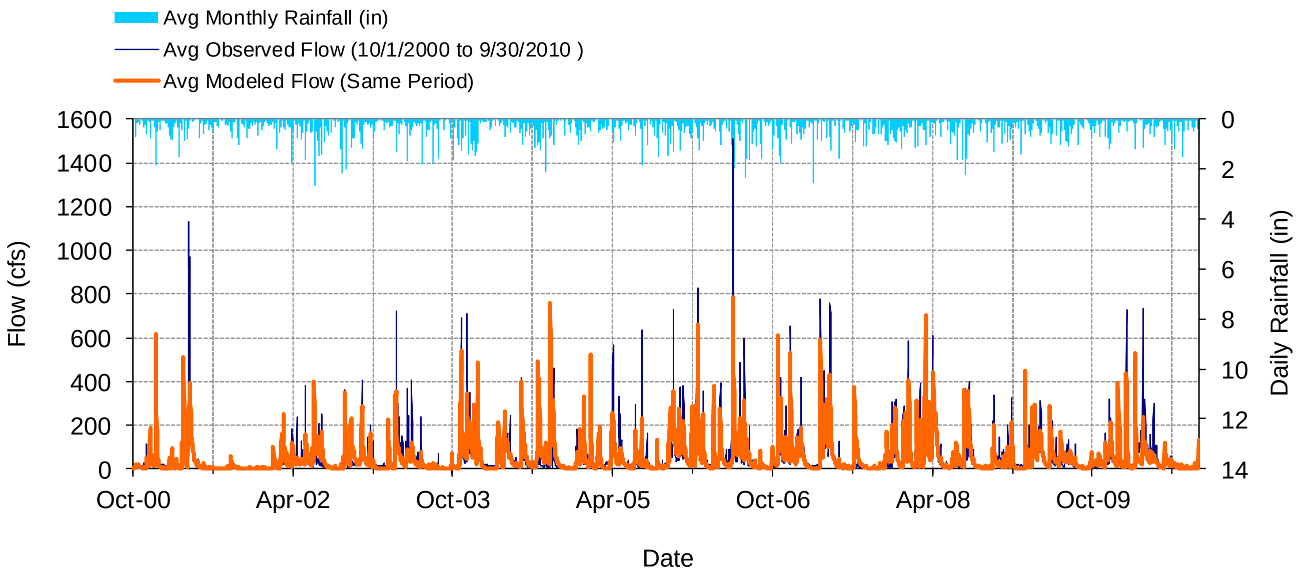


Figure K-1. Mean daily flow at USGS 04282795 LaPlatte River at Shelburne Falls, VT

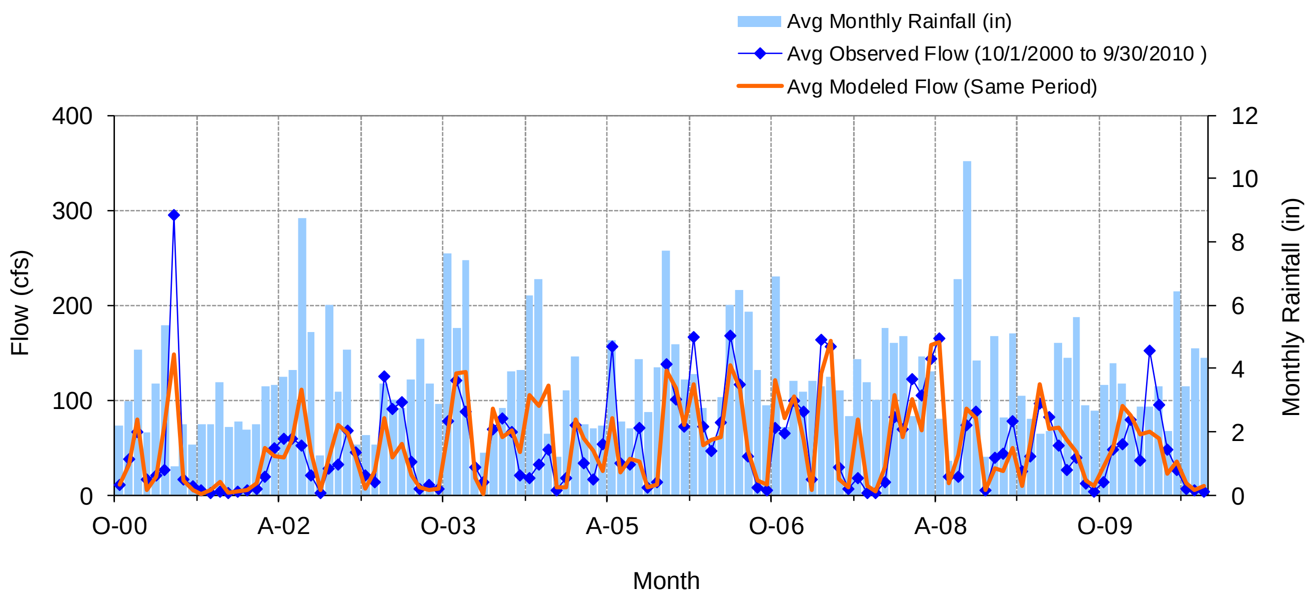


Figure K-2. Mean monthly flow at USGS 04282795 LaPlatte River at Shelburne Falls, VT

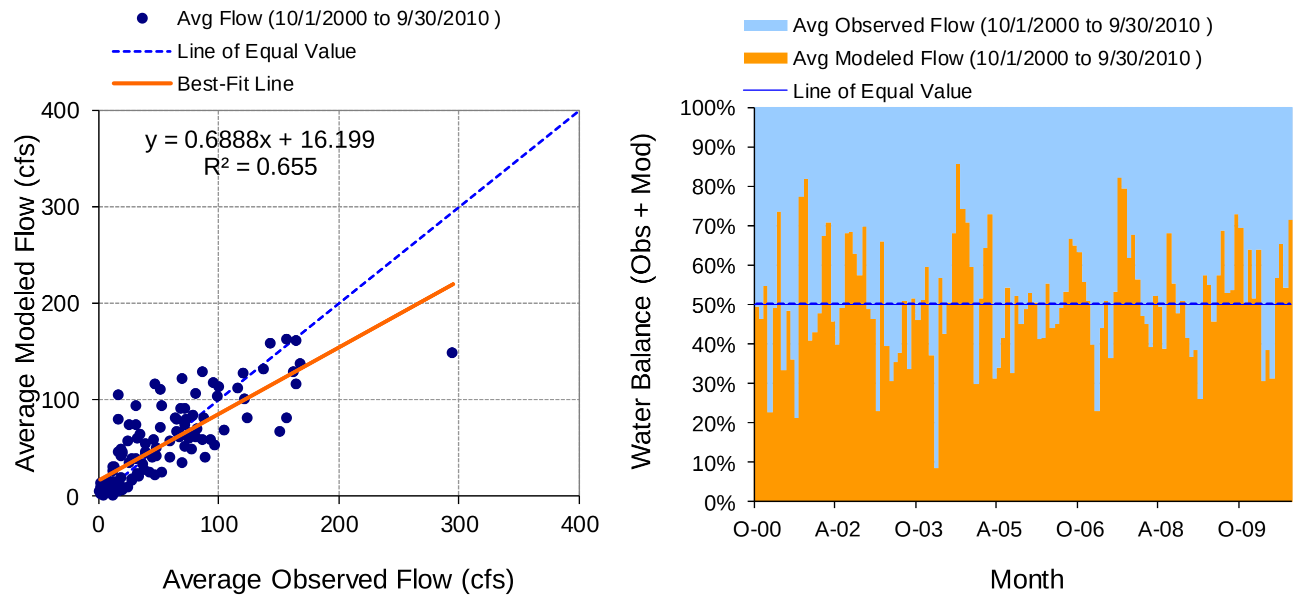


Figure K-3. Monthly flow regression and temporal variation at USGS 04282795 LaPlatte River at Shelburne Falls, VT

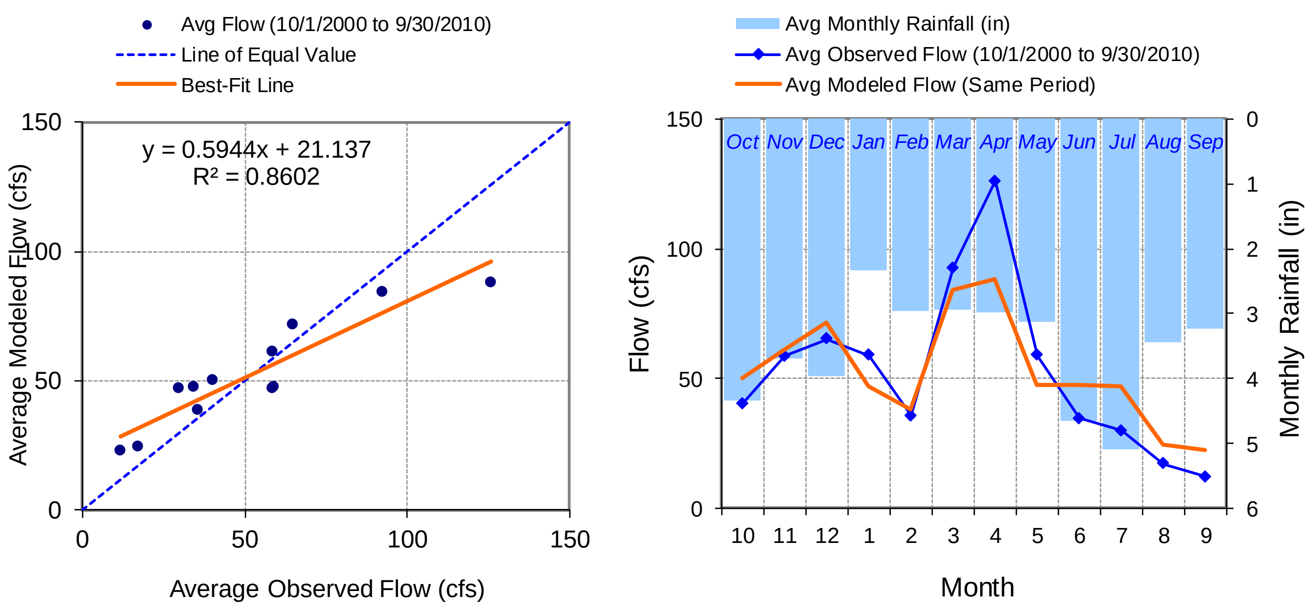


Figure K-4. Seasonal regression and temporal aggregate at USGS 04282795 LaPlatte River at Shelburne Falls, VT

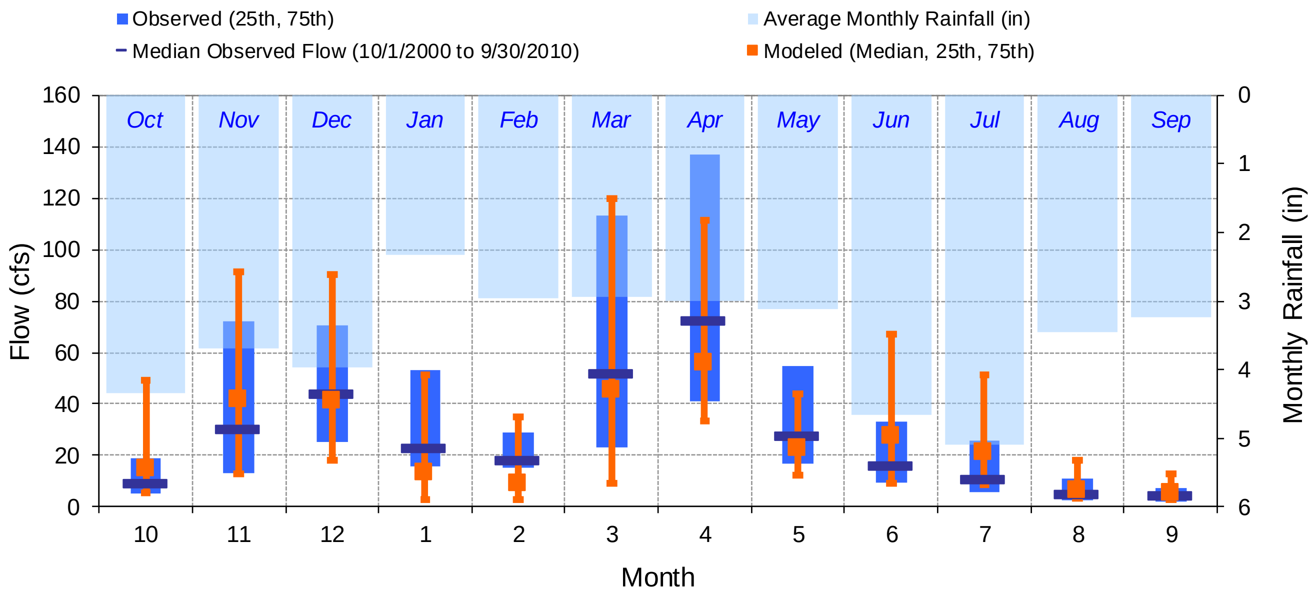


Figure K-5. Seasonal medians and ranges at USGS 04282795 LaPlatte River at Shelburne Falls, VT

Table K-1. Seasonal summary at USGS 04282795 LaPlatte River at Shelburne Falls, VT

MONTH	OBSERVED FLOW (CFS)				MODELED FLOW (CFS)			
	MEAN	MEDIAN	25TH	75TH	MEAN	MEDIAN	25TH	75TH
Oct	40.27	9.15	5.00	19.00	49.89	15.16	5.44	48.99
Nov	58.68	30.00	13.00	72.25	61.00	42.06	12.68	91.32
Dec	65.02	44.00	25.00	70.75	71.32	41.30	18.38	90.25
Jan	58.73	23.00	16.00	53.00	46.90	13.41	2.91	51.45
Feb	35.56	18.00	15.00	29.00	38.24	9.00	2.89	34.91
Mar	92.59	52.00	23.25	113.00	83.97	45.52	9.43	119.71
Apr	126.00	72.50	41.00	137.00	88.02	56.20	33.54	111.20
May	58.96	27.50	17.00	54.75	47.53	22.85	12.42	43.97
Jun	34.52	16.00	9.35	33.00	47.39	27.77	9.39	67.26
Jul	29.91	11.00	5.63	26.00	46.72	21.41	8.78	51.37
Aug	17.12	4.70	2.60	11.00	24.32	6.58	3.39	18.25
Sep	11.95	4.20	2.00	7.40	22.42	5.50	2.82	12.89

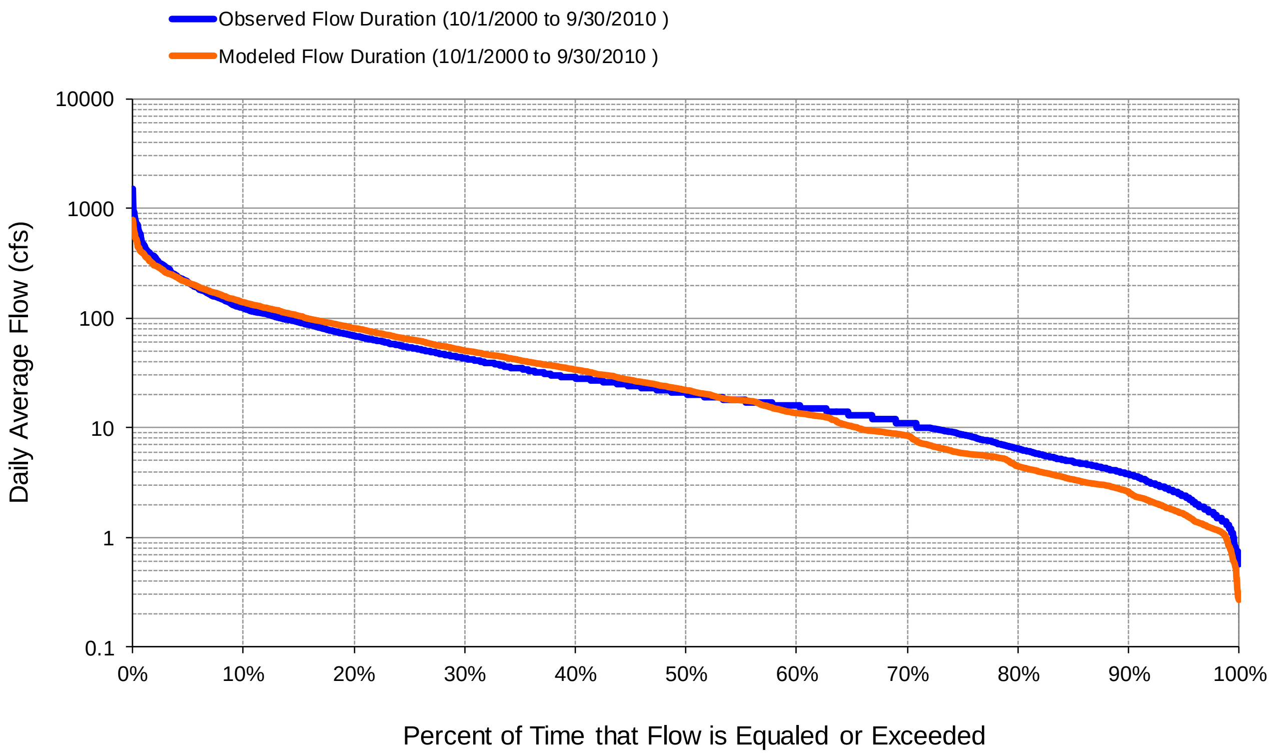


Figure K-6. Flow exceedence at USGS 04282795 LaPlatte River at Shelburne Falls, VT

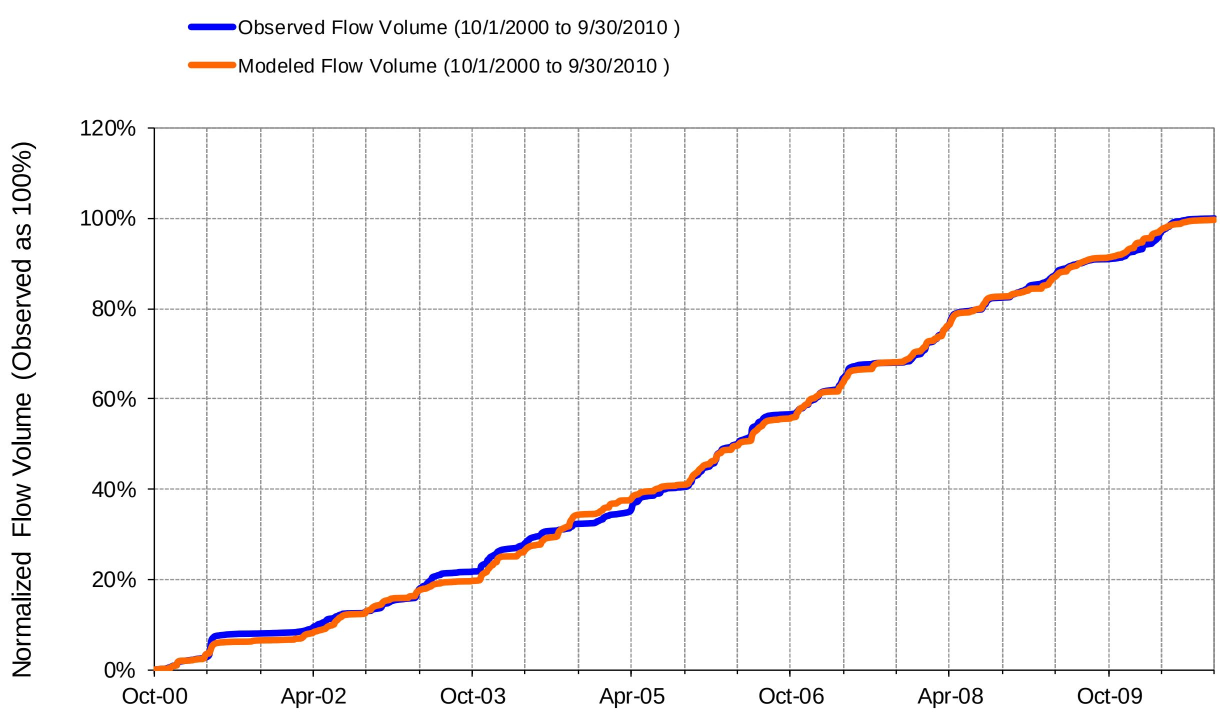


Figure K-7. Flow accumulation at USGS 04282795 LaPlatte River at Shelburne Falls, VT

Table K-2. Summary statistics at USGS 04282795 LaPlatte River at Shelburne Falls, VT

SWAT Simulated Flow		Observed Flow Gage	
REACH OUTFLOW FROM OUTLET 3 10-Year Analysis Period: 10/1/2000 - 9/30/2010 Flow volumes are (inches/year) for upstream drainage area		USGS 04282795 LAPLATTE RIVER AT SHELBURNE FALLS, VT. Hydrologic Unit Code: 4150403 Latitude: 44.3700512 Longitude: -73.2162367 Drainage Area (sq-mi): 44.6	
Total Simulated In-stream Flow:	**15.96**	Total Observed In-stream Flow:	**15.99**
Total of simulated highest 10% flows:	**7.43**	Total of Observed highest 10% flows:	**8.27**
Total of Simulated lowest 50% flows:	**1.21**	Total of Observed Lowest 50% flows:	**1.44**
Simulated Summer Flow Volume (months 7-9):	**2.40**	Observed Summer Flow Volume (7-9):	**1.51**
Simulated Fall Flow Volume (months 10-12):	**4.66**	Observed Fall Flow Volume (10-12):	**4.19**
Simulated Winter Flow Volume (months 1-3):	**4.28**	Observed Winter Flow Volume (1-3):	**4.75**
Simulated Spring Flow Volume (months 4-6):	**4.62**	Observed Spring Flow Volume (4-6):	**5.54**
Total Simulated Storm Volume:	**5.92**	Total Observed Storm Volume:	**6.82**
Simulated Summer Storm Volume (7-9):	**0.86**	Observed Summer Storm Volume (7-9):	**0.79**

Errors (Simulated-Observed)	*Error Statistics*	*Recommended Criteria*
Error in total volume:	-0.24	10
Error in 50% lowest flows:	-16.09	10
Error in 10% highest flows:	-10.04	15
Seasonal volume error - Summer:	58.24	30
Seasonal volume error - Fall:	11.21	30
Seasonal volume error - Winter:	-9.81	30
Seasonal volume error - Spring:	-16.67	30
Error in storm volumes:	-13.25	20
Error in summer storm volumes:	8.54	50
Nash-Sutcliffe Coefficient of Efficiency, E:	0.496	Model accuracy increases
Baseline adjusted coefficient (Garrick), E':	0.409	as E or E' approaches 1.0
Monthly NSE	0.653	

>> Clear

USGS 04282795 LaPlatte River at Shelburne Falls, VT - Validation

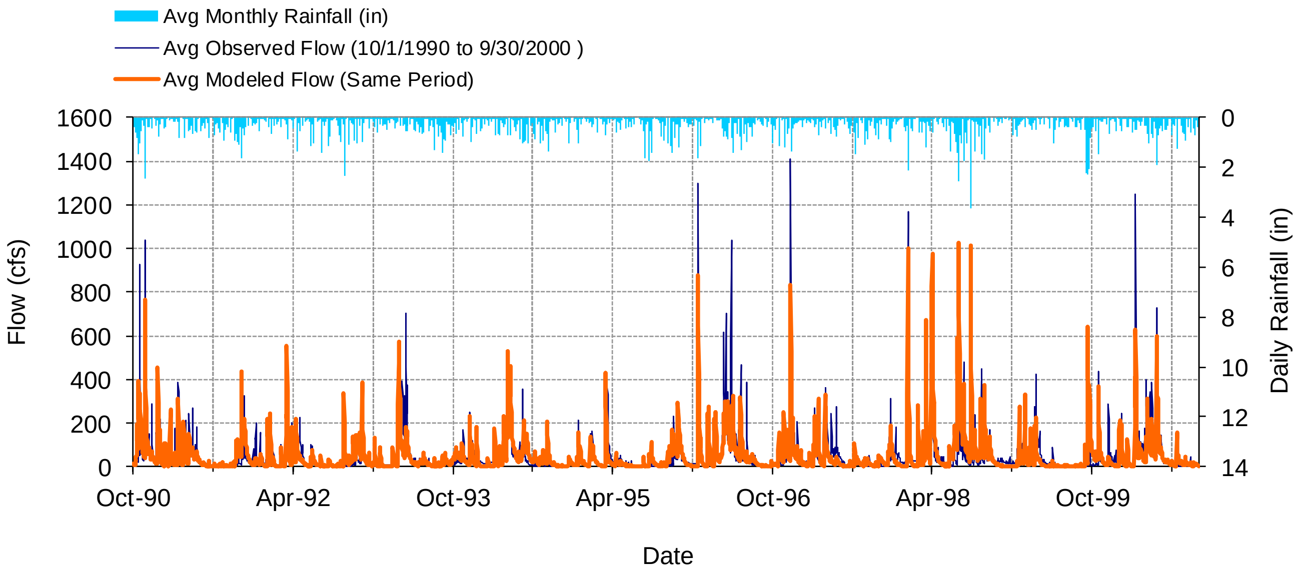


Figure K-8. Mean daily flow at USGS 04282795 LaPlatte River at Shelburne Falls, VT

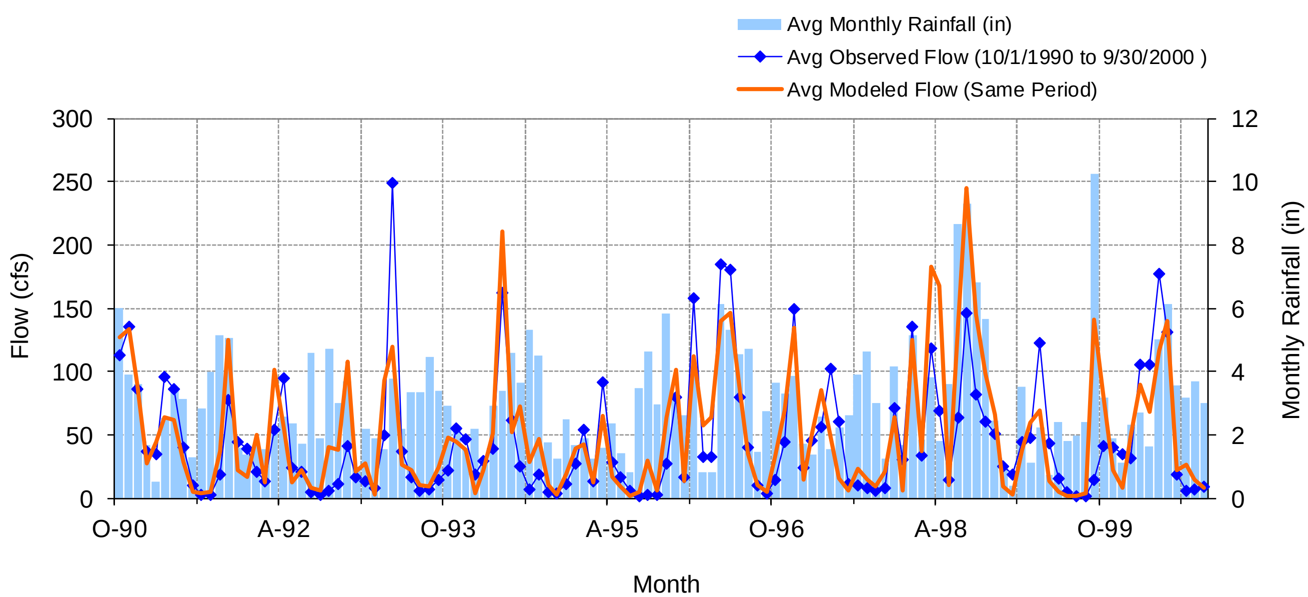


Figure K-9. Mean monthly flow at USGS 04282795 LaPlatte River at Shelburne Falls, VT

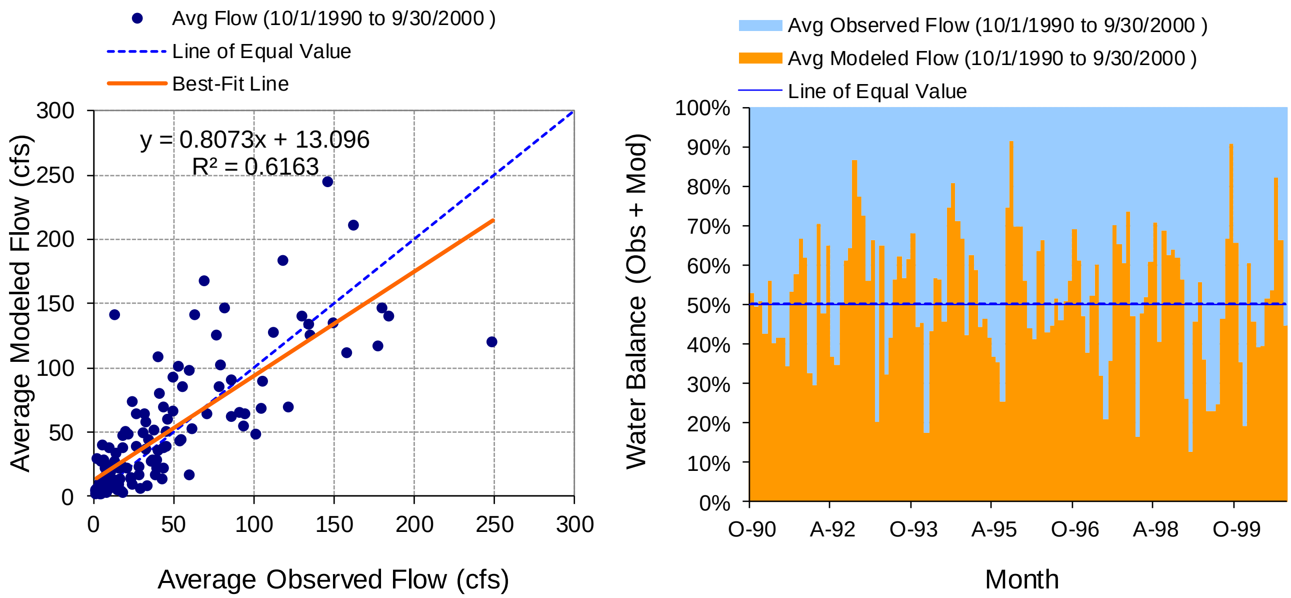


Figure K-10. Monthly flow regression and temporal variation at USGS 04282795 LaPlatte River at Shelburne Falls, VT

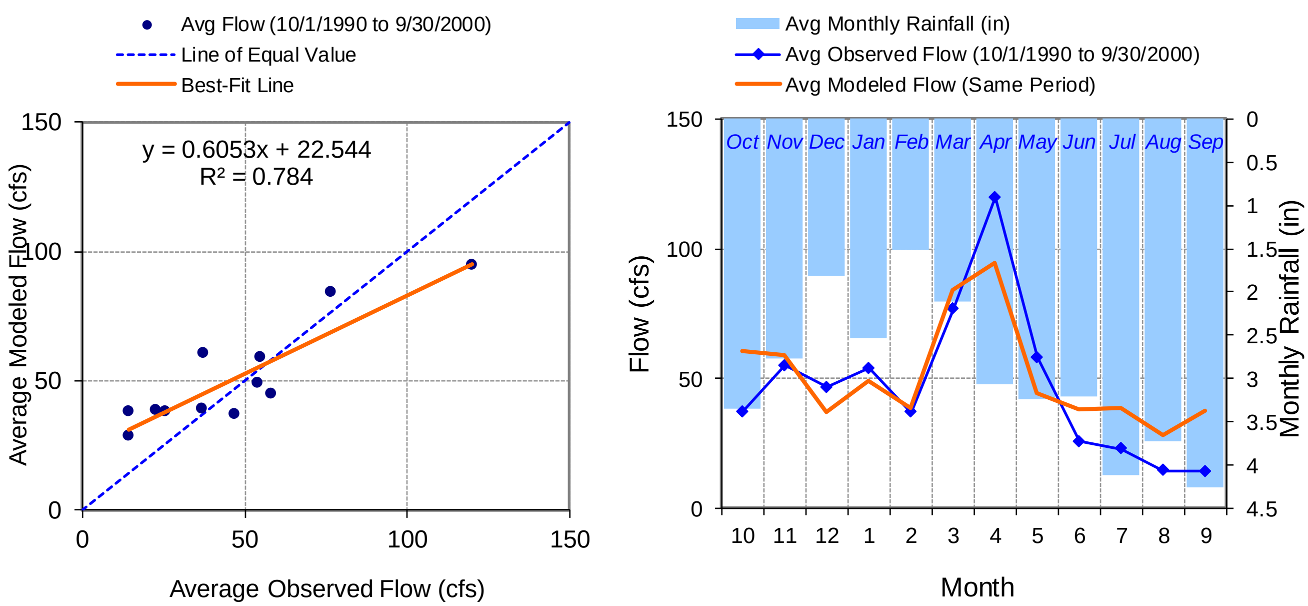


Figure K-11. Seasonal regression and temporal aggregate at USGS 04282795 LaPlatte River at Shelburne Falls, VT

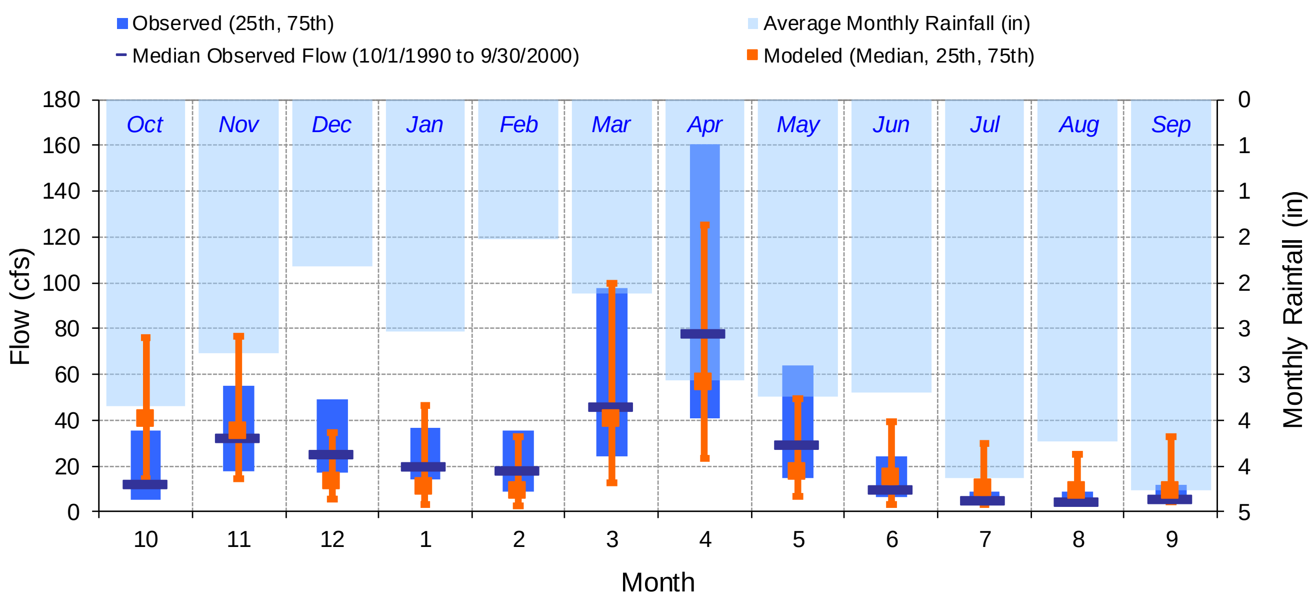


Figure K-12. Seasonal medians and ranges at USGS 04282795 LaPlatte River at Shelburne Falls, VT

Table K-3. Seasonal summary at USGS 04282795 LaPlatte River at Shelburne Falls, VT

MONTH	OBSERVED FLOW (CFS)				MODELED FLOW (CFS)			
	MEAN	MEDIAN	25TH	75TH	MEAN	MEDIAN	25TH	75TH
Oct	37.05	12.00	5.10	35.50	60.42	40.82	14.28	76.26
Nov	54.86	32.00	18.00	55.00	59.09	35.11	14.46	76.84
Dec	46.69	25.00	17.00	49.00	36.91	13.39	5.57	34.59
Jan	53.99	20.00	14.00	36.75	48.92	11.20	3.23	46.76
Feb	36.79	18.00	8.80	35.50	38.78	9.05	2.89	32.69
Mar	76.52	46.00	24.00	97.50	84.22	40.51	12.72	99.63
Apr	119.88	78.00	40.75	160.50	94.73	56.45	23.59	125.04
May	58.15	29.00	15.00	63.75	44.46	17.57	6.97	49.23
Jun	25.72	10.00	6.28	24.00	37.86	14.91	3.37	39.42
Jul	22.81	5.20	2.90	8.88	38.64	10.56	3.18	30.09
Aug	14.42	4.55	2.33	8.90	28.37	9.34	4.29	25.03
Sep	14.17	5.35	3.50	12.00	37.73	8.98	4.29	32.89

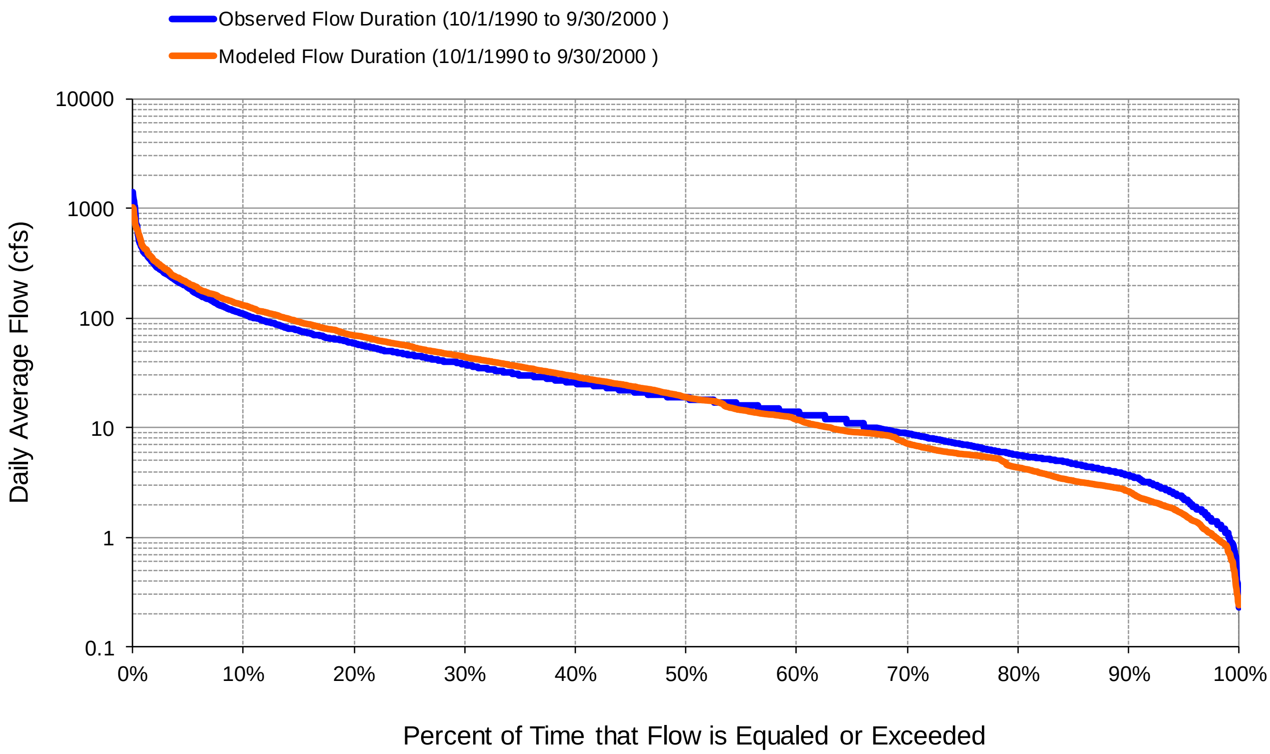


Figure K-13. Flow exceedence at USGS 04282795 LaPlatte River at Shelburne Falls, VT

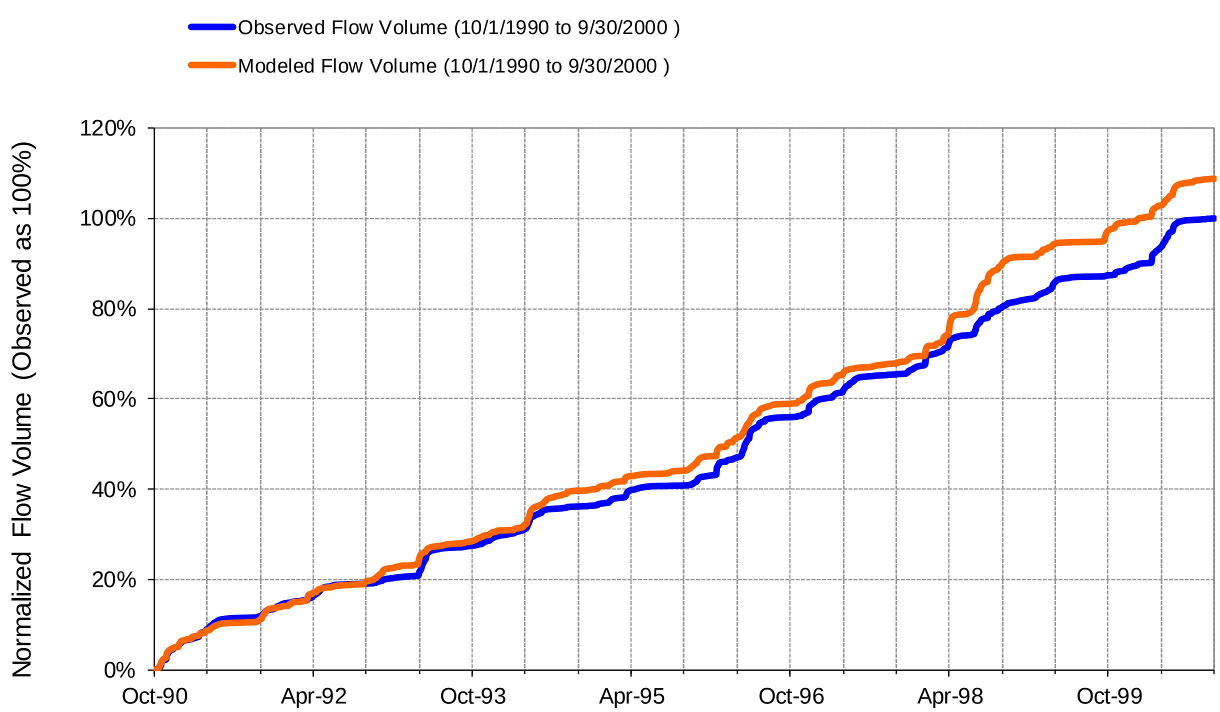


Figure K-14. Flow accumulation at USGS 04282795 LaPlatte River at Shelburne Falls, VT

Table K-4. Summary statistics at USGS 04282795 LaPlatte River at Shelburne Falls, VT

SWAT Simulated Flow		Observed Flow Gage	
REACH OUTFLOW FROM OUTLET 3 10-Year Analysis Period: 10/1/1990 - 9/30/2000 Flow volumes are (inches/year) for upstream drainage area		USGS 04282795 LAPLATTE RIVER AT SHELBURNE FALLS, VT. Hydrologic Unit Code: 4150403 Latitude: 44.3700512 Longitude: -73.2162367 Drainage Area (sq-mi): 44.6	
Total Simulated In-stream Flow:	**15.49**	Total Observed In-stream Flow:	**14.24**
Total of simulated highest 10% flows:	**7.98**	Total of Observed highest 10% flows:	**7.53**
Total of Simulated lowest 50% flows:	**1.08**	Total of Observed Lowest 50% flows:	**1.26**
Simulated Summer Flow Volume (months 7-9):	**2.68**	Observed Summer Flow Volume (7-9):	**1.32**
Simulated Fall Flow Volume (months 10-12):	**3.99**	Observed Fall Flow Volume (10-12):	**3.54**
Simulated Winter Flow Volume (months 1-3):	**4.36**	Observed Winter Flow Volume (1-3):	**4.24**
Simulated Spring Flow Volume (months 4-6):	**4.47**	Observed Spring Flow Volume (4-6):	**5.14**
Total Simulated Storm Volume:	**5.88**	Total Observed Storm Volume:	**6.01**
Simulated Summer Storm Volume (7-9):	**1.05**	Observed Summer Storm Volume (7-9):	**0.76**

Errors (Simulated-Observed)	*Error Statistics*	*Recommended Criteria*
Error in total volume:	8.79	10
Error in 50% lowest flows:	-14.82	10
Error in 10% highest flows:	6.06	15
Seasonal volume error - Summer:	103.22	30
Seasonal volume error - Fall:	12.92	30
Seasonal volume error - Winter:	2.71	30
Seasonal volume error - Spring:	-13.20	30
Error in storm volumes:	-2.19	20
Error in summer storm volumes:	39.26	50
Nash-Sutcliffe Coefficient of Efficiency, E:	0.430	Model accuracy increases
Baseline adjusted coefficient (Garrick), E':	0.299	as E or E' approaches 1.0
Monthly NSE	0.550	

>> Clear

USGS 04282780 Lewis Creek at North Ferrisburg, VT - Calibration

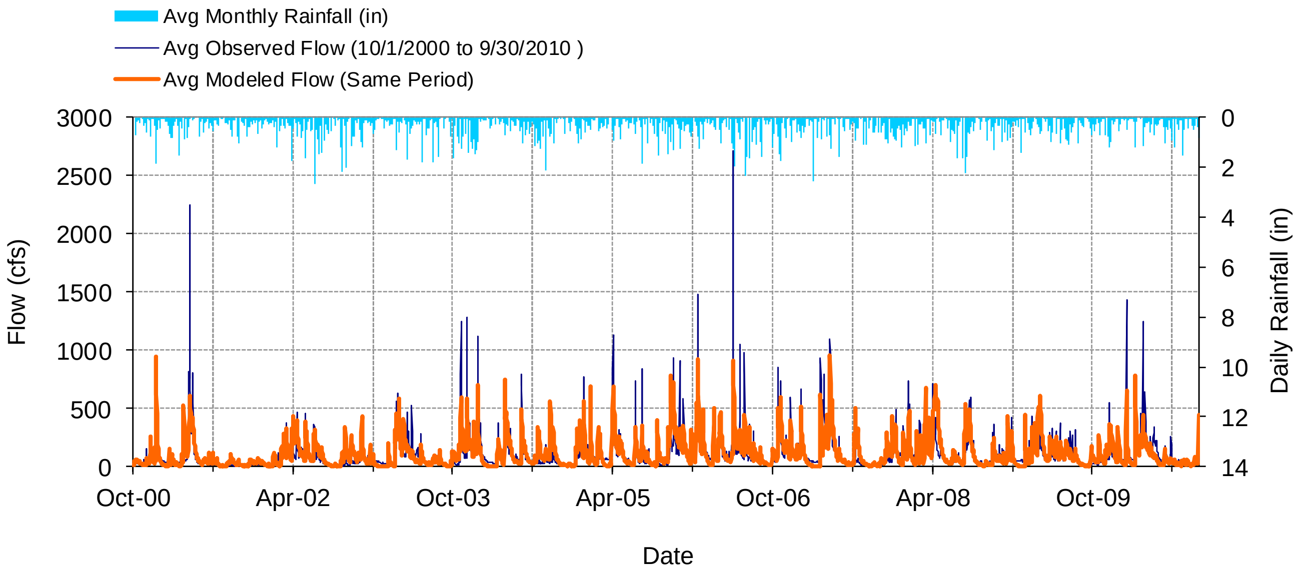


Figure K-15. Mean daily flow at USGS 04282780 Lewis Creek at North Ferrisburg, VT

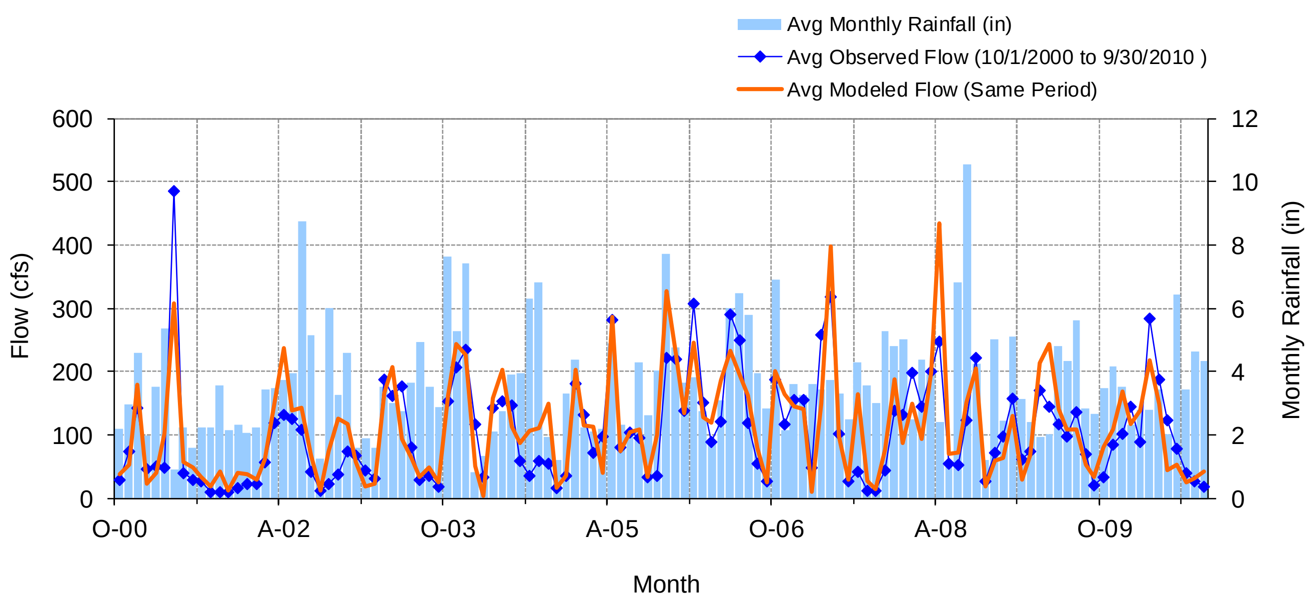


Figure K-16. Mean monthly flow at USGS 04282780 Lewis Creek at North Ferrisburg, VT

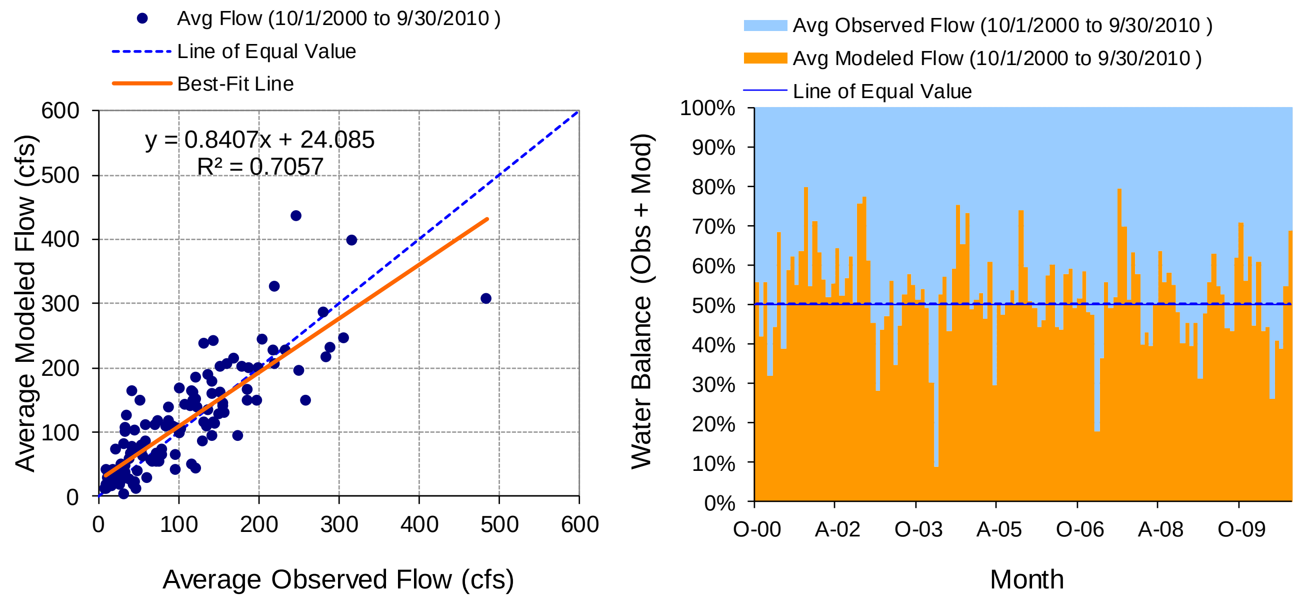


Figure K-17. Monthly flow regression and temporal variation at USGS 04282780 Lewis Creek at North Ferrisburg, VT

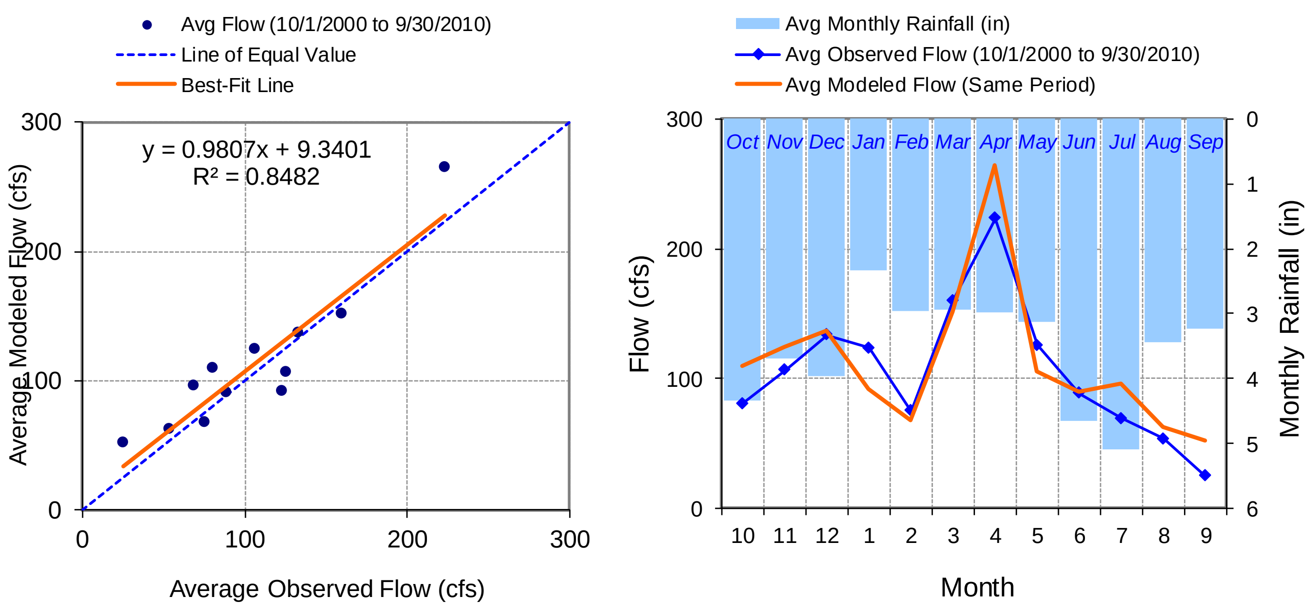


Figure K-18. Seasonal regression and temporal aggregate at USGS 04282780 Lewis Creek at North Ferrisburg, VT

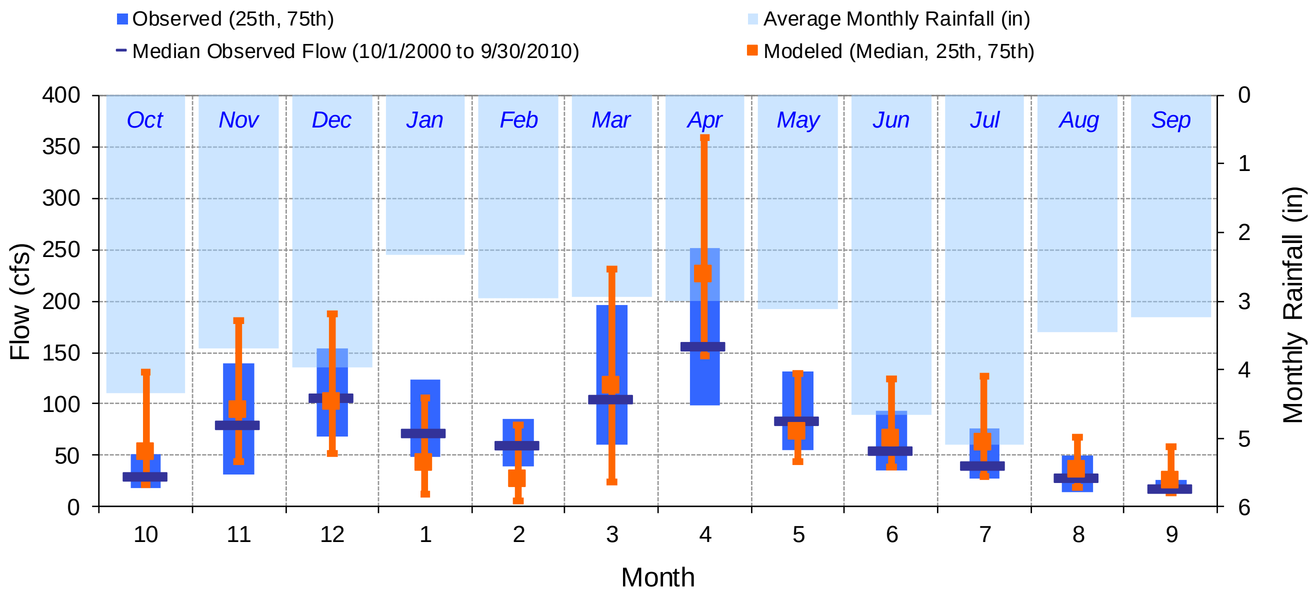


Figure K-19. Seasonal medians and ranges at USGS 04282780 Lewis Creek at North Ferrisburg, VT

Table K-5. Seasonal summary at USGS 04282780 Lewis Creek at North Ferrisburg, VT

MONTH	OBSERVED FLOW (CFS)				MODELED FLOW (CFS)			
	MEAN	MEDIAN	25TH	75TH	MEAN	MEDIAN	25TH	75TH
Oct	80.45	30.00	18.00	50.75	109.36	53.36	21.81	131.36
Nov	106.36	79.50	31.75	140.00	124.10	94.33	44.33	181.34
Dec	133.14	106.00	68.00	154.00	136.40	102.08	51.37	187.68
Jan	123.23	72.00	48.00	123.75	91.41	42.50	12.37	106.23
Feb	75.07	60.00	40.00	85.00	67.65	27.52	6.19	79.66
Mar	159.90	104.50	61.00	195.75	151.11	117.14	24.60	231.36
Apr	223.38	155.50	98.75	252.00	264.67	225.80	146.34	358.80
May	125.57	83.00	55.00	131.50	105.70	72.55	43.56	129.95
Jun	88.50	55.00	35.00	94.00	90.17	66.46	38.18	124.11
Jul	68.90	40.00	27.00	76.75	95.88	62.28	30.01	126.98
Aug	53.42	28.50	14.00	50.00	62.05	35.60	18.42	67.79
Sep	24.79	18.00	13.00	26.00	51.87	24.94	13.20	57.94

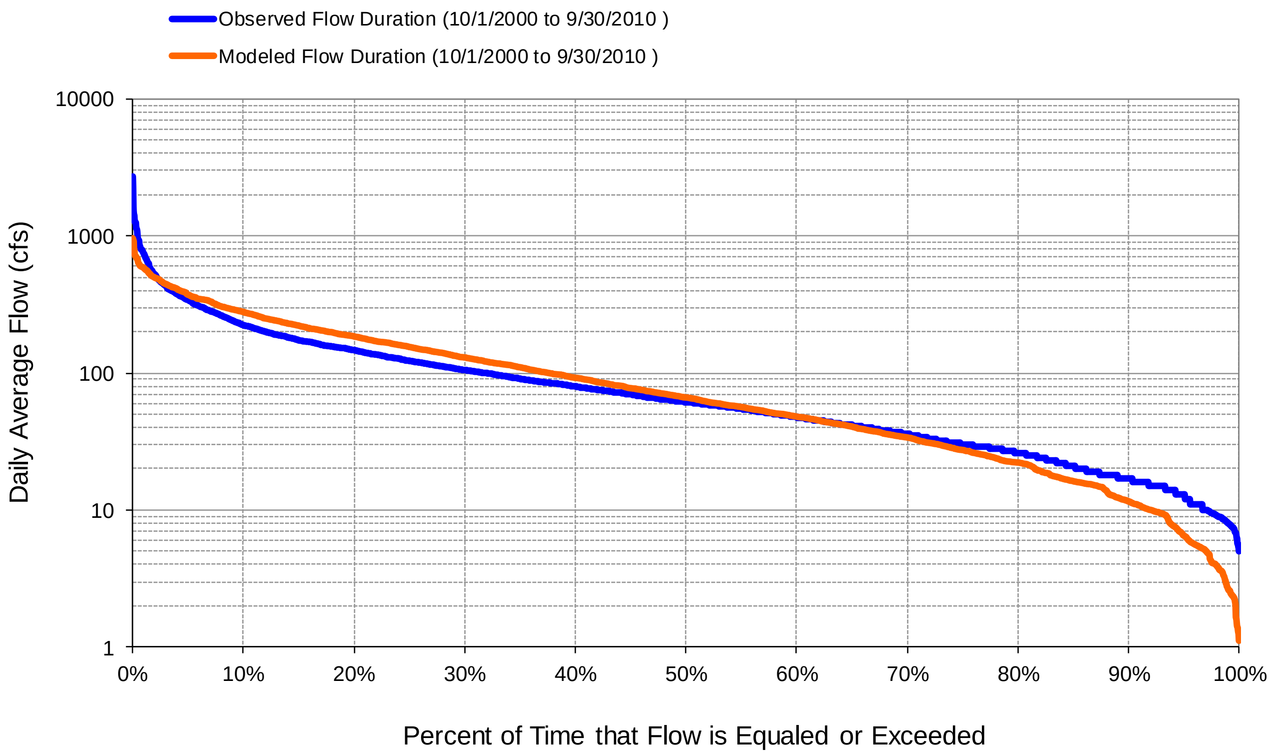


Figure K-20. Flow exceedence at USGS 04282780 Lewis Creek at North Ferrisburg, VT

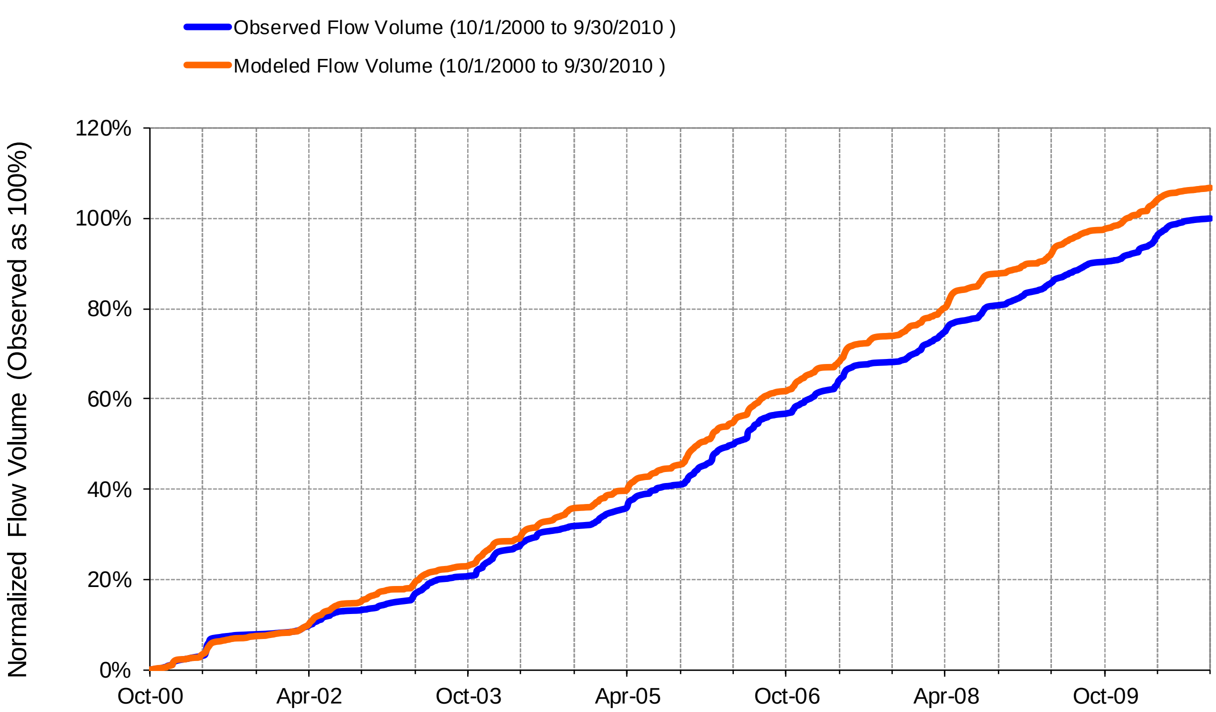


Figure K-21. Flow accumulation at USGS 04282780 Lewis Creek at North Ferrisburg, VT

Table K-6. Summary statistics at USGS 04282780 Lewis Creek at North Ferrisburg, VT

SWAT Simulated Flow		Observed Flow Gage	
REACH OUTFLOW FROM OUTLET 5 10-Year Analysis Period: 10/1/2000 - 9/30/2010 Flow volumes are (inches/year) for upstream drainage area		USGS 04282780 LEWIS CREEK AT NORTH FERRISBURG, VT. Hydrologic Unit Code: 2010002 Latitude: 44.24922015 Longitude: -73.22845688 Drainage Area (sq-mi): 77.2	
Total Simulated In-stream Flow:	**19.82**	Total Observed In-stream Flow:	**18.55**
Total of simulated highest 10% flows:	**7.24**	Total of Observed highest 10% flows:	**7.59**
Total of Simulated lowest 50% flows:	**2.61**	Total of Observed Lowest 50% flows:	**2.82**
Simulated Summer Flow Volume (months 7-9):	**3.11**	Observed Summer Flow Volume (7-9):	**2.19**
Simulated Fall Flow Volume (months 10-12):	**5.46**	Observed Fall Flow Volume (10-12):	**4.73**
Simulated Winter Flow Volume (months 1-3):	**4.54**	Observed Winter Flow Volume (1-3):	**5.25**
Simulated Spring Flow Volume (months 4-6):	**6.71**	Observed Spring Flow Volume (4-6):	**6.38**
Total Simulated Storm Volume:	**5.15**	Total Observed Storm Volume:	**5.62**
Simulated Summer Storm Volume (7-9):	**0.81**	Observed Summer Storm Volume (7-9):	**0.68**

Errors (Simulated-Observed)	*Error Statistics*	*Recommended Criteria*		
Error in total volume:	6.89	10		
Error in 50% lowest flows:	-7.52	10		
Error in 10% highest flows:	-4.63	15		
Seasonal volume error - Summer:	42.25	30		
Seasonal volume error - Fall:	15.59	>> 30		Clear
Seasonal volume error - Winter:	-13.48	30		
Seasonal volume error - Spring:	5.08	30		
Error in storm volumes:	-8.48	20		
Error in summer storm volumes:	19.41	50		
Nash-Sutcliffe Coefficient of Efficiency, E:	0.547	Model accuracy increases		
Baseline adjusted coefficient (Garrick), E':	0.376	as E or E' approaches 1.0		
Monthly NSE	0.672			

USGS 04282780 Lewis Creek at North Ferrisburg, VT - Validation

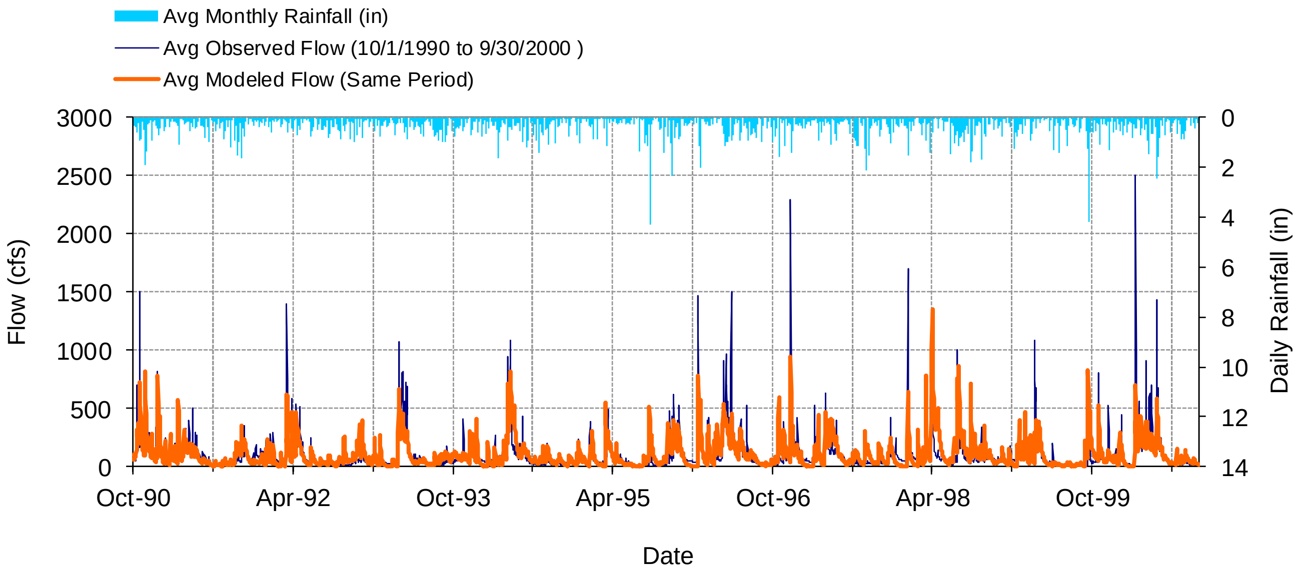


Figure K-22. Mean daily flow at USGS 04282780 Lewis Creek at North Ferrisburg, VT

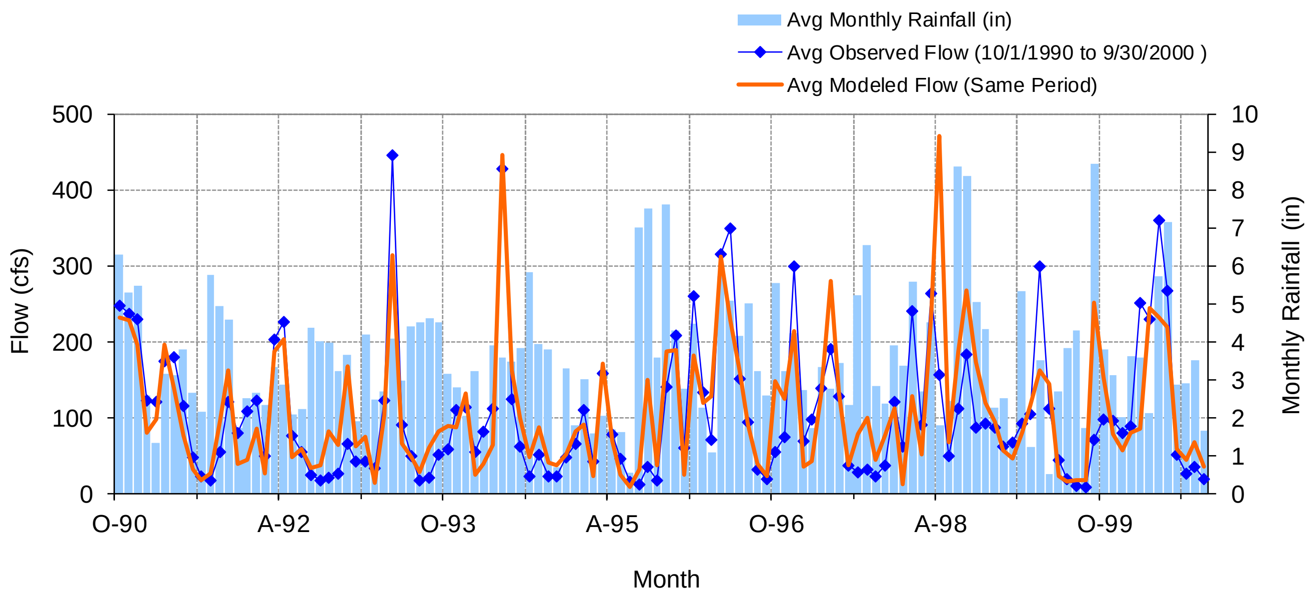


Figure K-23. Mean monthly flow at USGS 04282780 Lewis Creek at North Ferrisburg, VT

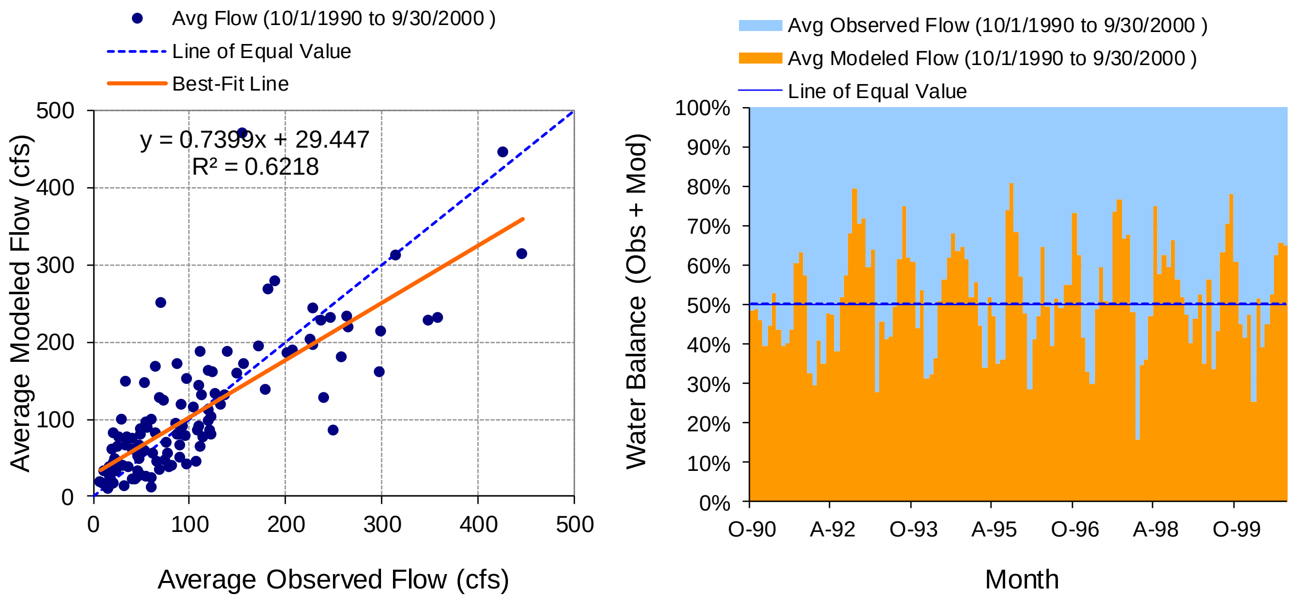


Figure K-24. Monthly flow regression and temporal variation at USGS 04282780 Lewis Creek at North Ferrisburg, VT

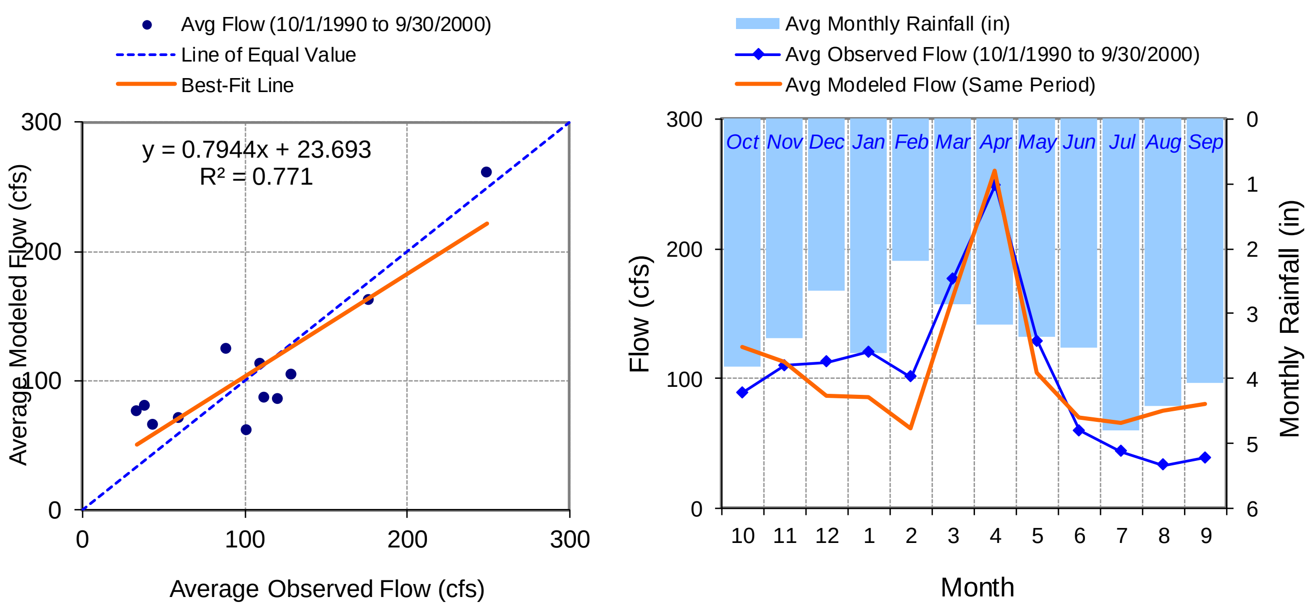


Figure K-25. Seasonal regression and temporal aggregate at USGS 04282780 Lewis Creek at North Ferrisburg, VT

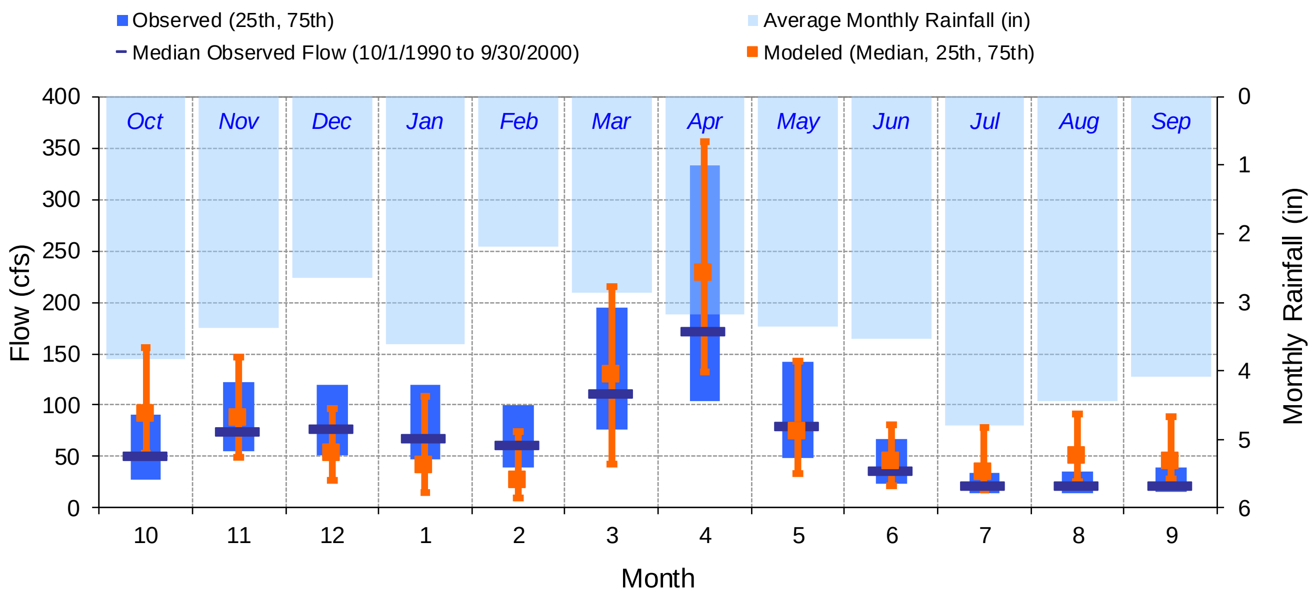


Figure K-26. Seasonal medians and ranges at USGS 04282780 Lewis Creek at North Ferrisburg, VT

Table K-7. Seasonal summary at USGS 04282780 Lewis Creek at North Ferrisburg, VT

MONTH	OBSERVED FLOW (CFS)				MODELED FLOW (CFS)			
	MEAN	MEDIAN	25TH	75TH	MEAN	MEDIAN	25TH	75TH
Oct	88.97	51.00	27.00	91.00	124.02	91.06	53.48	156.60
Nov	109.98	74.00	55.00	122.25	112.90	86.91	48.63	146.53
Dec	112.44	76.50	51.00	119.25	86.27	53.68	26.58	97.27
Jan	120.32	67.50	47.00	120.00	85.69	41.87	15.34	108.24
Feb	100.93	61.00	40.00	100.00	61.11	26.32	9.21	74.51
Mar	176.81	111.50	76.00	195.00	161.50	129.22	43.03	215.51
Apr	248.90	171.50	103.75	333.50	260.55	228.04	132.54	356.32
May	128.73	80.00	49.00	142.25	104.05	74.87	33.26	142.85
Jun	59.83	36.00	24.00	67.25	70.14	45.50	22.09	80.32
Jul	43.69	21.00	15.00	34.75	65.24	35.01	17.81	78.37
Aug	33.22	21.00	15.00	35.00	75.47	50.15	25.70	91.57
Sep	38.74	21.00	16.00	39.00	80.41	44.94	28.12	88.57

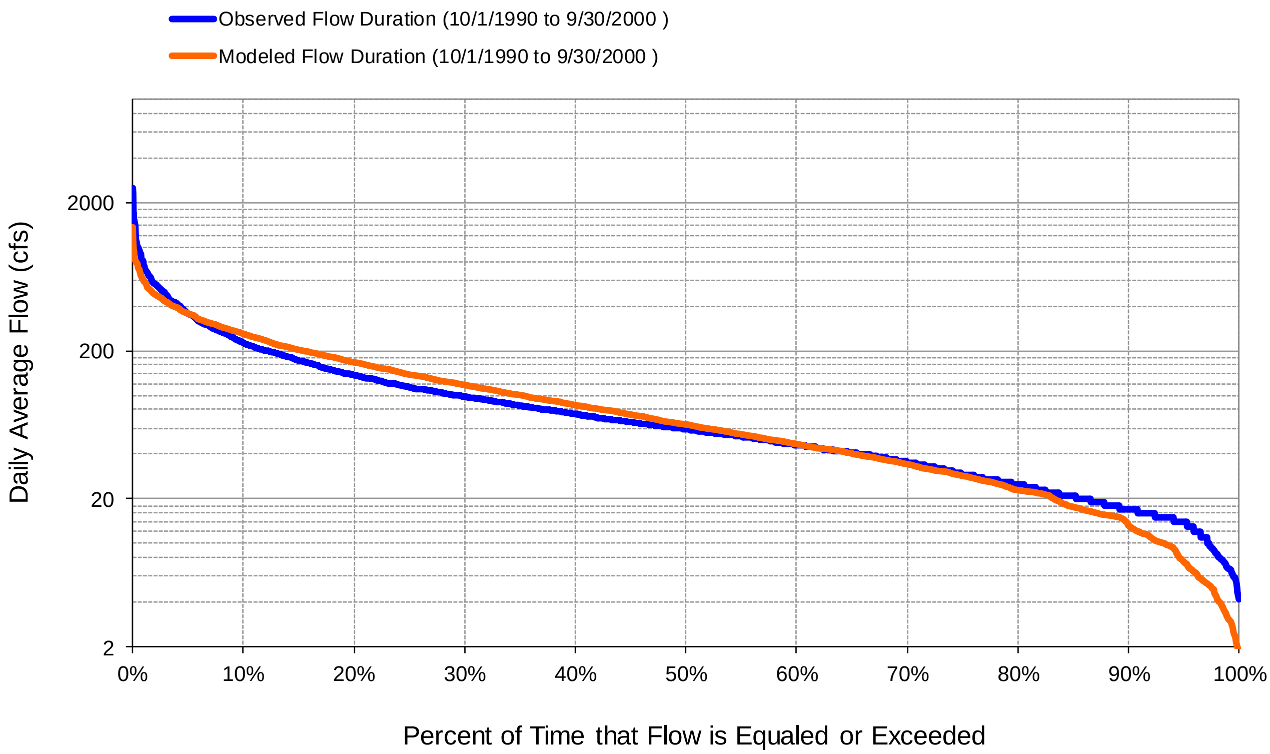


Figure K-27. Flow exceedence at USGS 04282780 Lewis Creek at North Ferrisburg, VT

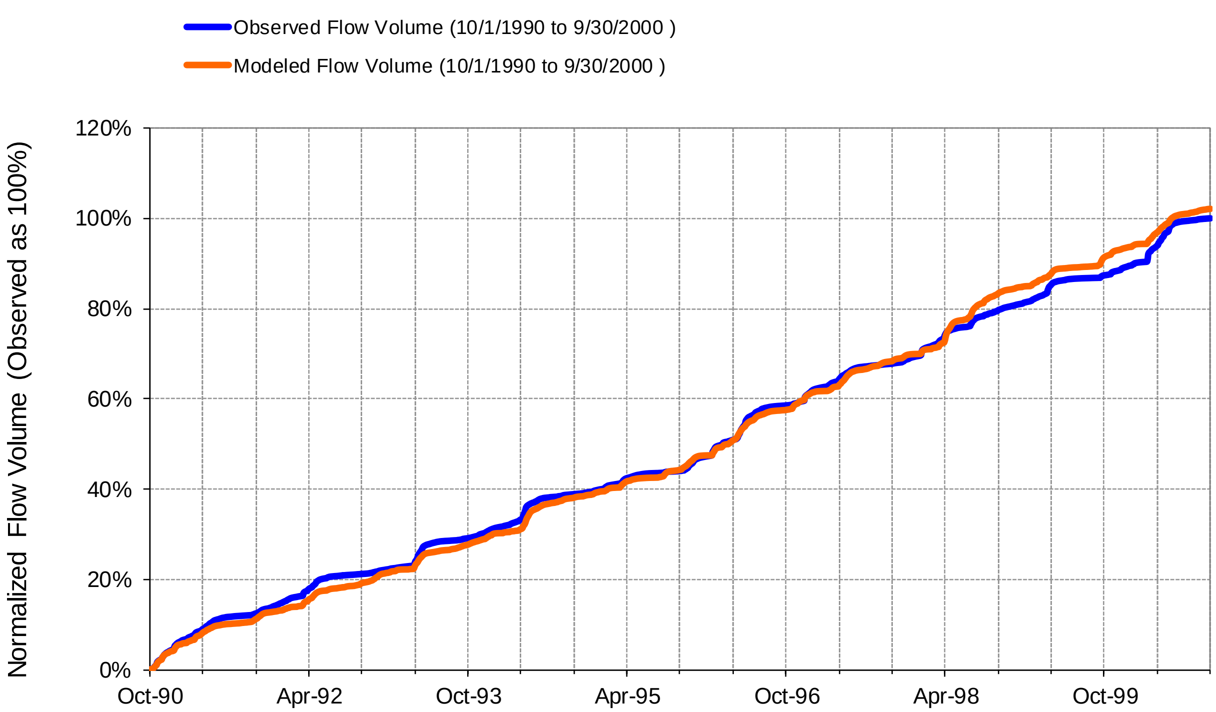


Figure K-28. Flow accumulation at USGS 04282780 Lewis Creek at North Ferrisburg, VT

Table K-8. Summary statistics at USGS 04282780 Lewis Creek at North Ferrisburg, VT

SWAT Simulated Flow		Observed Flow Gage	
REACH OUTFLOW FROM OUTLET 5 10-Year Analysis Period: 10/1/1990 - 9/30/2000 Flow volumes are (inches/year) for upstream drainage area		USGS 04282780 LEWIS CREEK AT NORTH FERRISBURG, VT. Hydrologic Unit Code: 2010002 Latitude: 44.24922015 Longitude: -73.22845688 Drainage Area (sq-mi): 77.2	
Total Simulated In-stream Flow:	**18.89**	Total Observed In-stream Flow:	**18.50**
Total of simulated highest 10% flows:	**7.09**	Total of Observed highest 10% flows:	**7.98**
Total of Simulated lowest 50% flows:	**2.64**	Total of Observed Lowest 50% flows:	**2.76**
Simulated Summer Flow Volume (months 7-9):	**3.26**	Observed Summer Flow Volume (7-9):	**1.71**
Simulated Fall Flow Volume (months 10-12):	**4.77**	Observed Fall Flow Volume (10-12):	**4.60**
Simulated Winter Flow Volume (months 1-3):	**4.52**	Observed Winter Flow Volume (1-3):	**5.81**
Simulated Spring Flow Volume (months 4-6):	**6.33**	Observed Spring Flow Volume (4-6):	**6.38**
Total Simulated Storm Volume:	**4.84**	Total Observed Storm Volume:	**5.54**
Simulated Summer Storm Volume (7-9):	**0.80**	Observed Summer Storm Volume (7-9):	**0.58**

Errors (Simulated-Observed)	*Error Statistics*	*Recommended Criteria*
Error in total volume:	2.11	10
Error in 50% lowest flows:	-4.30	10
Error in 10% highest flows:	-11.15	15
Seasonal volume error - Summer:	91.03	30
Seasonal volume error - Fall:	3.80	30
Seasonal volume error - Winter:	-22.17	30
Seasonal volume error - Spring:	-0.80	30
Error in storm volumes:	-12.66	20
Error in summer storm volumes:	38.02	50
Nash-Sutcliffe Coefficient of Efficiency, E:	0.522	Model accuracy increases
Baseline adjusted coefficient (Garrick), E':	0.369	as E or E' approaches 1.0
Monthly NSE	0.599	

>> Clear

USGS 04282650 Little Otter Creek at Ferrisburg, VT - Calibration

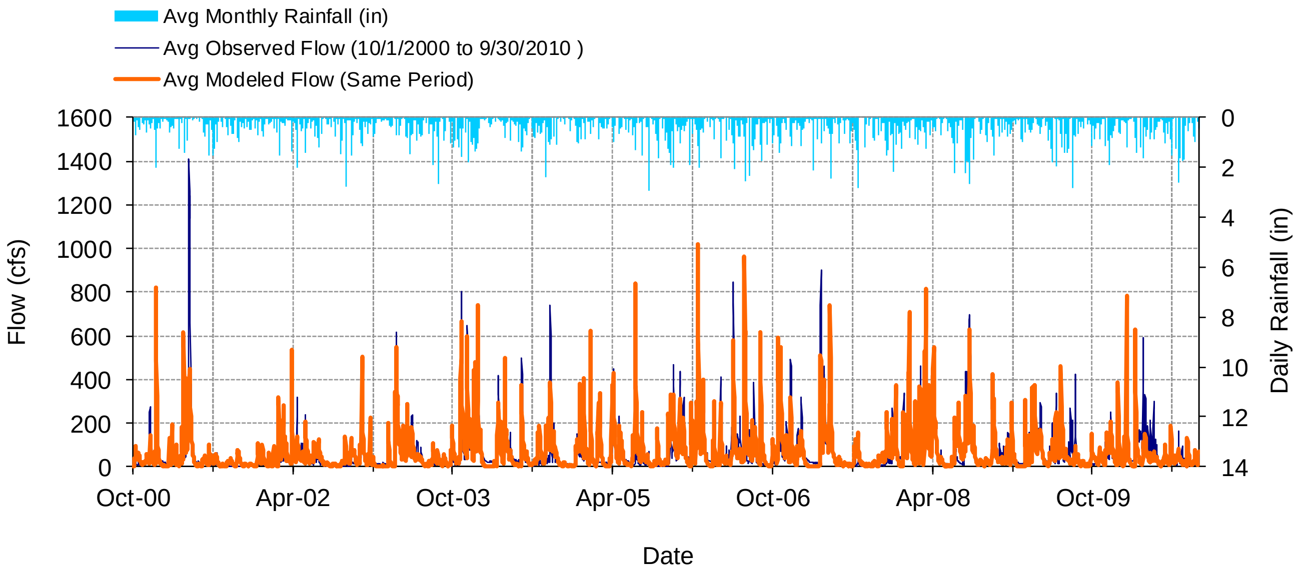


Figure K-29. Mean daily flow at USGS 04282650 Little Otter Creek at Ferrisburg, VT

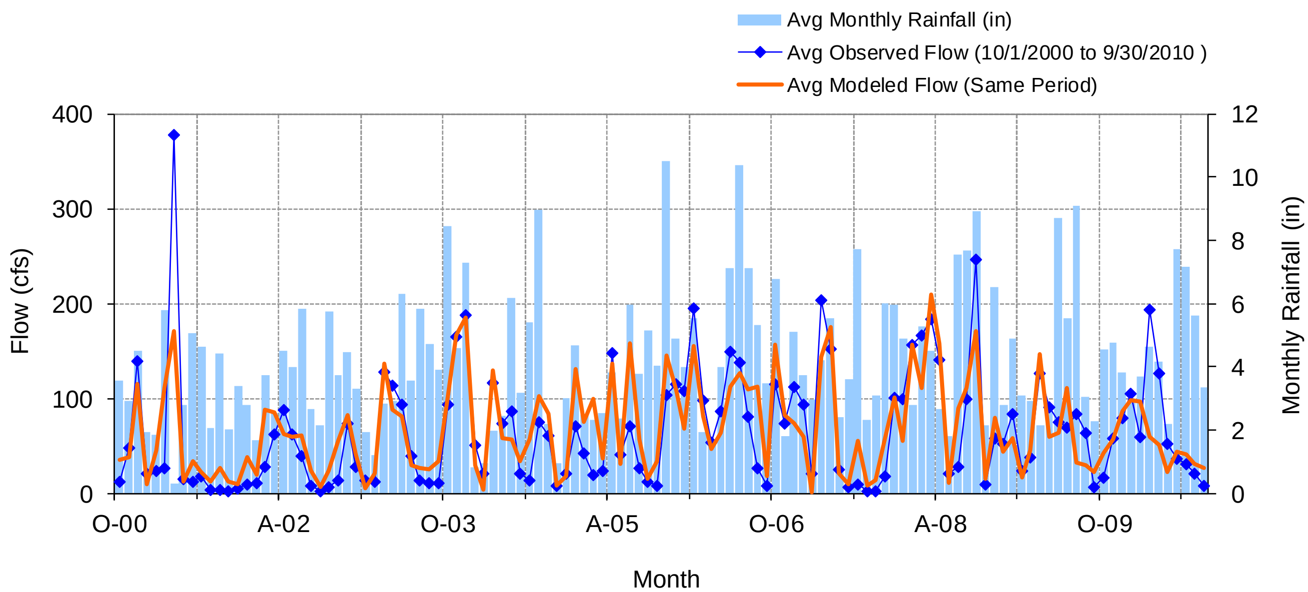


Figure K-30. Mean monthly flow at USGS 04282650 Little Otter Creek at Ferrisburg, VT

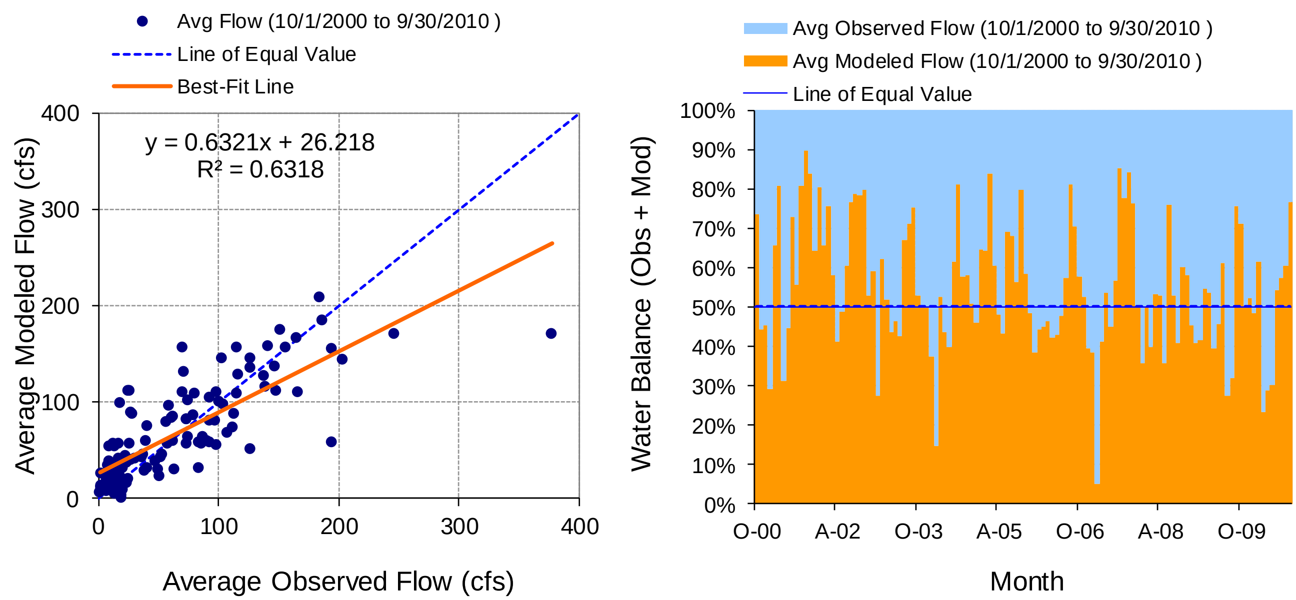


Figure K-31. Monthly flow regression and temporal variation at USGS 04282650 Little Otter Creek at Ferrisburg, VT

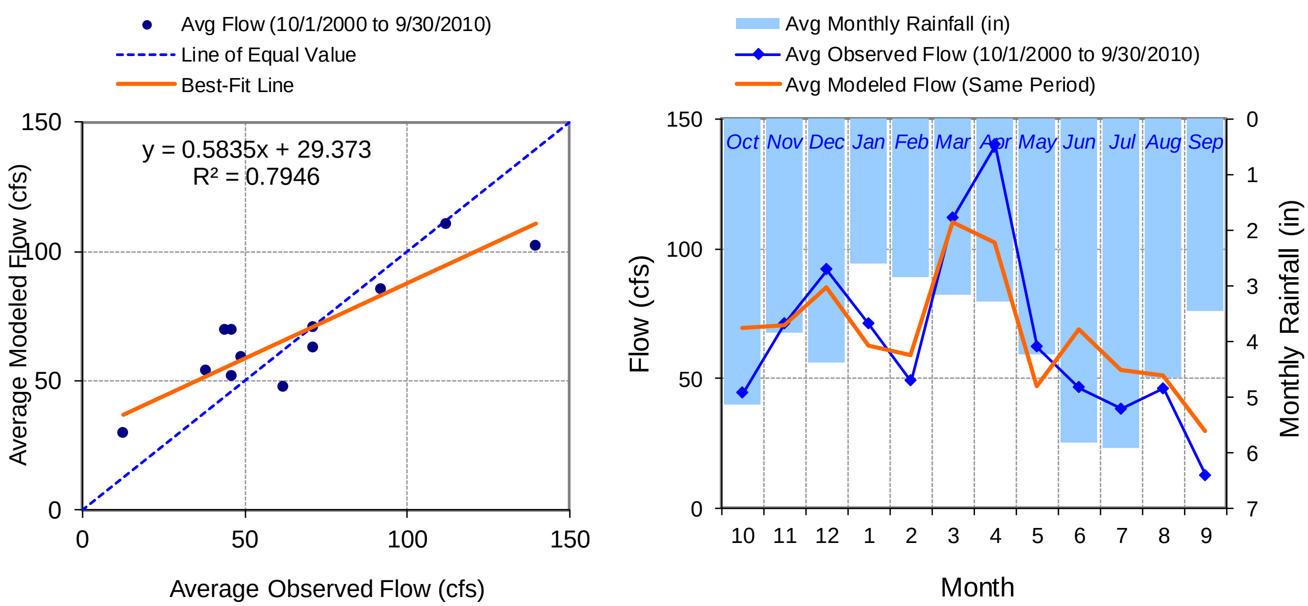


Figure K-32. Seasonal regression and temporal aggregate at USGS 04282650 Little Otter Creek at Ferrisburg, VT

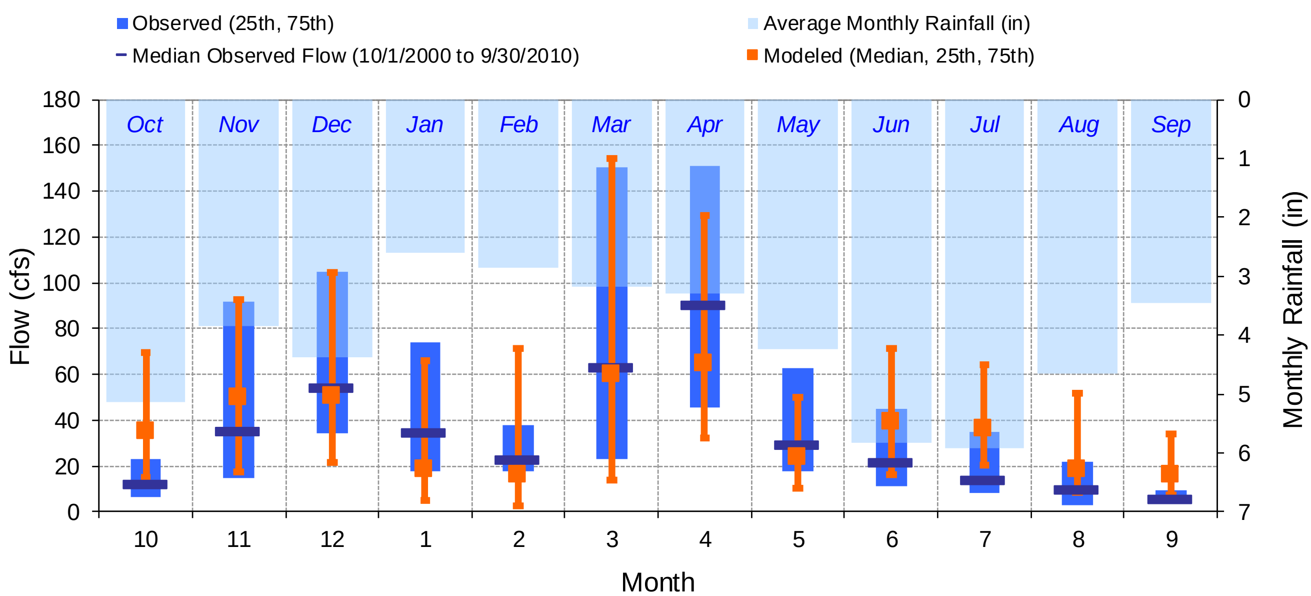


Figure K-33. Seasonal medians and ranges at USGS 04282650 Little Otter Creek at Ferrisburg, VT

Table K-9. Seasonal summary at USGS 04282650 Little Otter Creek at Ferrisburg, VT

MONTH	OBSERVED FLOW (CFS)				MODELED FLOW (CFS)			
	MEAN	MEDIAN	25TH	75TH	MEAN	MEDIAN	25TH	75TH
Oct	44.14	12.00	6.53	23.00	69.59	35.32	15.29	69.77
Nov	71.22	35.50	15.00	92.00	70.69	50.31	17.44	92.46
Dec	91.84	54.00	34.25	104.75	85.20	50.64	21.85	104.63
Jan	70.97	34.50	18.00	73.75	62.47	18.89	4.87	66.17
Feb	48.88	23.00	18.00	38.00	58.86	16.15	2.44	71.66
Mar	111.89	63.00	23.25	150.75	110.24	60.26	13.73	154.43
Apr	139.75	90.50	45.75	151.00	102.15	64.86	32.35	129.73
May	61.95	29.50	18.00	63.00	47.06	24.22	10.57	50.28
Jun	46.23	21.50	11.00	45.00	69.17	39.62	16.45	71.19
Jul	38.28	14.00	8.08	35.00	53.40	36.25	20.46	64.46
Aug	46.02	10.00	3.20	21.75	51.31	18.52	8.75	51.93
Sep	12.50	5.40	3.70	9.15	29.62	16.20	7.60	33.83

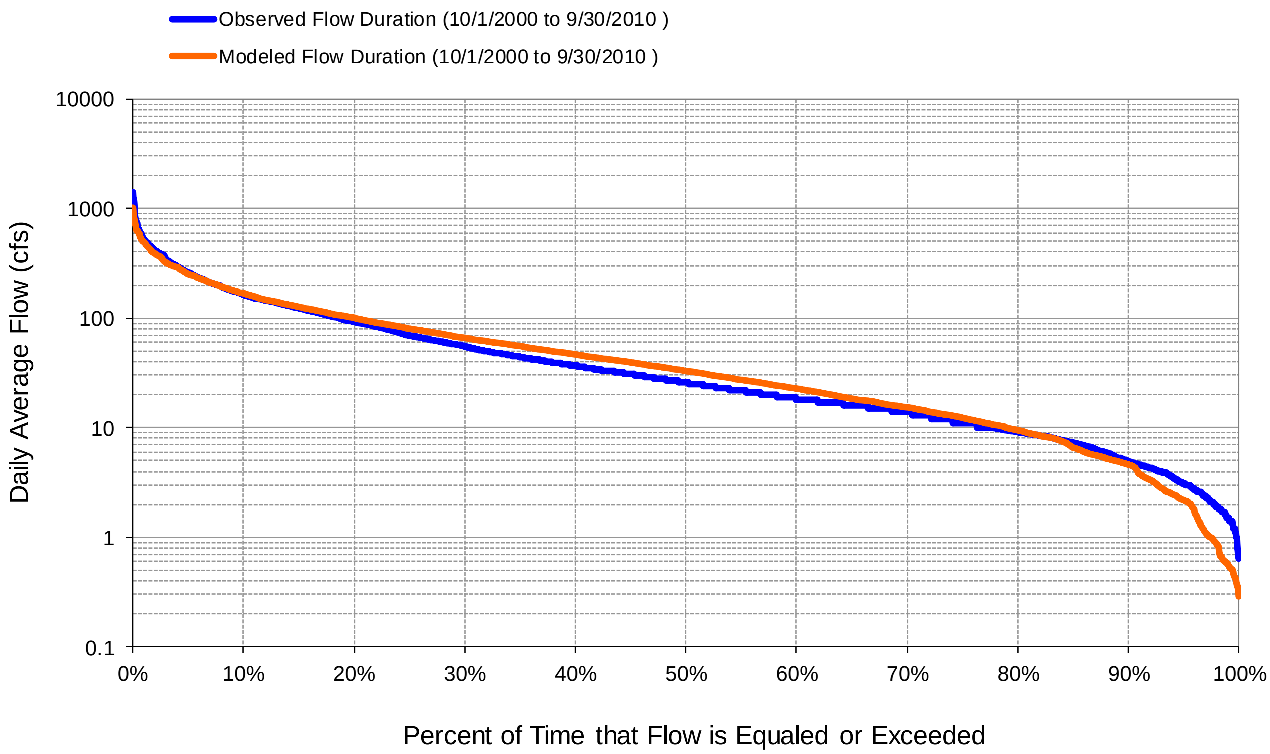


Figure K-34. Flow exceedence at USGS 04282650 Little Otter Creek at Ferrisburg, VT

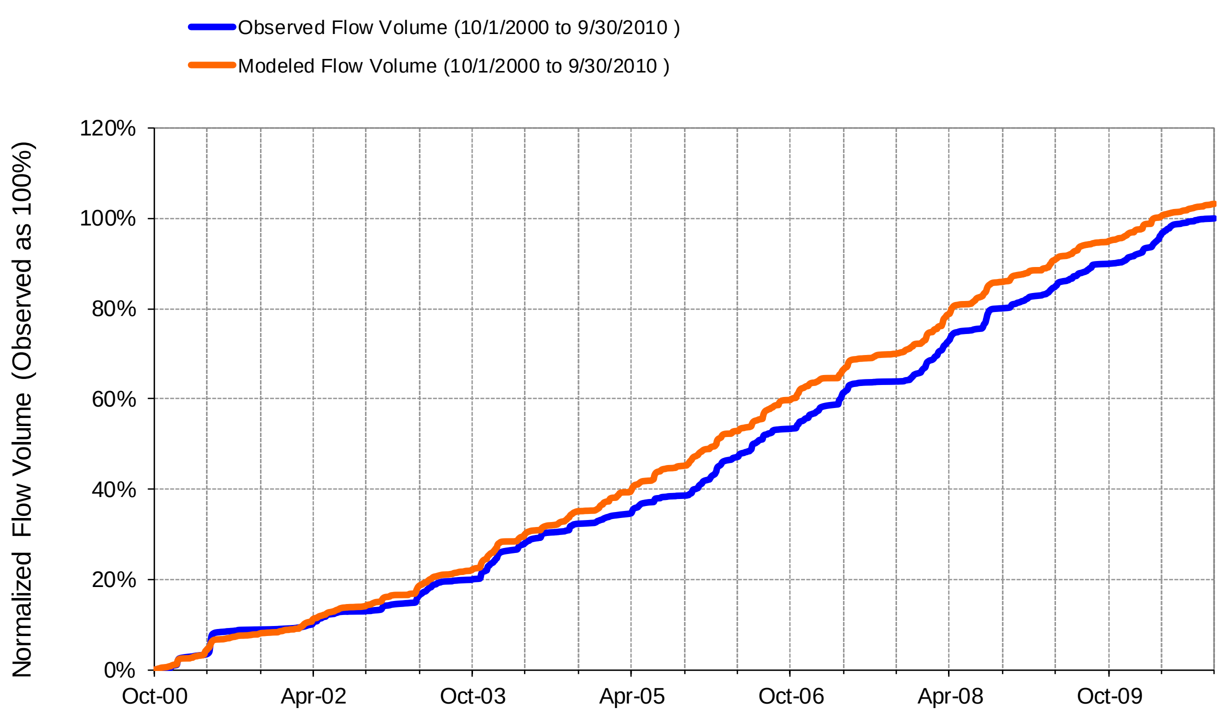


Figure K-35. Flow accumulation at USGS 04282650 Little Otter Creek at Ferrisburg, VT

Table K-10. Summary statistics at USGS 04282650 Little Otter Creek at Ferrisburg, VT

SWAT Simulated Flow		Observed Flow Gage		
REACH OUTFLOW FROM OUTLET 8 10-Year Analysis Period: 10/1/2000 - 9/30/2010 Flow volumes are (inches/year) for upstream drainage area		USGS 04282650 LITTLE OTTER CREEK AT FERRISBURG, VT. Hydrologic Unit Code: 2010002 Latitude: 44.19810987 Longitude: -73.2490117 Drainage Area (sq-mi): 57.1		
Total Simulated In-stream Flow:	**16.07**	Total Observed In-stream Flow:		**15.56**
Total of simulated highest 10% flows:	**7.21**	Total of Observed highest 10% flows:		**7.69**
Total of Simulated lowest 50% flows:	**1.61**	Total of Observed Lowest 50% flows:		**1.42**
Simulated Summer Flow Volume (months 7-9):	**2.69**	Observed Summer Flow Volume (7-9):		**1.95**
Simulated Fall Flow Volume (months 10-12):	**4.51**	Observed Fall Flow Volume (10-12):		**4.14**
Simulated Winter Flow Volume (months 1-3):	**4.57**	Observed Winter Flow Volume (1-3):		**4.59**
Simulated Spring Flow Volume (months 4-6):	**4.30**	Observed Spring Flow Volume (4-6):		**4.89**
Total Simulated Storm Volume:	**6.07**	Total Observed Storm Volume:		**5.61**
Simulated Summer Storm Volume (7-9):	**0.89**	Observed Summer Storm Volume (7-9):		**0.80**
Errors (Simulated-Observed)	*Error Statistics*	*Recommended Criteria*		
Error in total volume:	3.26	10		
Error in 50% lowest flows:	13.64	10		
Error in 10% highest flows:	-6.19	15		
Seasonal volume error - Summer:	38.37	30		
Seasonal volume error - Fall:	8.93	>> 30		Clear
Seasonal volume error - Winter:	-0.47	30		
Seasonal volume error - Spring:	-12.02	30		
Error in storm volumes:	8.21	20		
Error in summer storm volumes:	11.48	50		
Nash-Sutcliffe Coefficient of Efficiency, E:	0.521	Model accuracy increases		
Baseline adjusted coefficient (Garrick), E':	0.409	as E or E' approaches 1.0		
Monthly NSE	0.631			

USGS 04282650 Little Otter Creek at Ferrisburg, VT - Validation

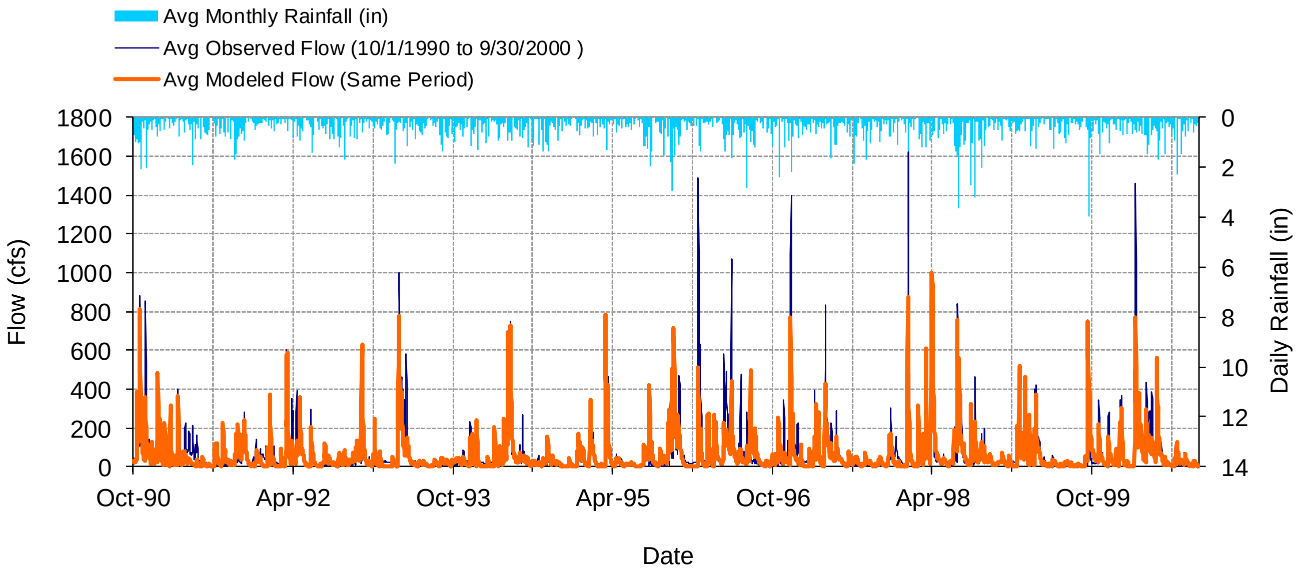


Figure K-36. Mean daily flow at USGS 04282650 Little Otter Creek at Ferrisburg, VT

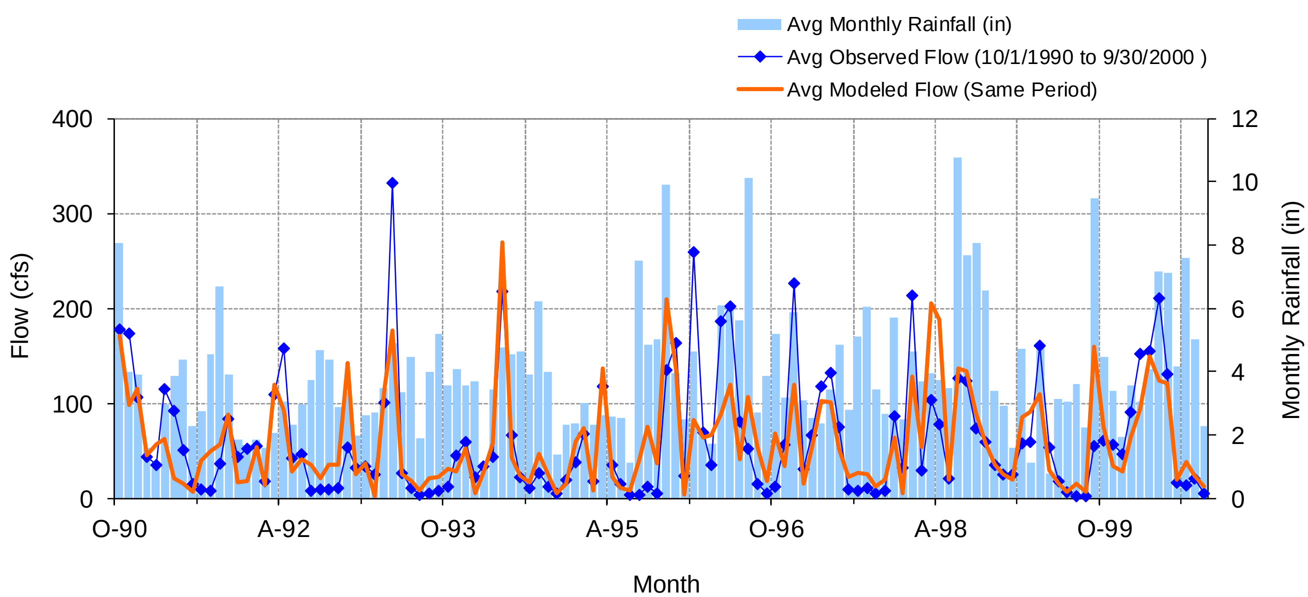


Figure K-37. Mean monthly flow at USGS 04282650 Little Otter Creek at Ferrisburg, VT

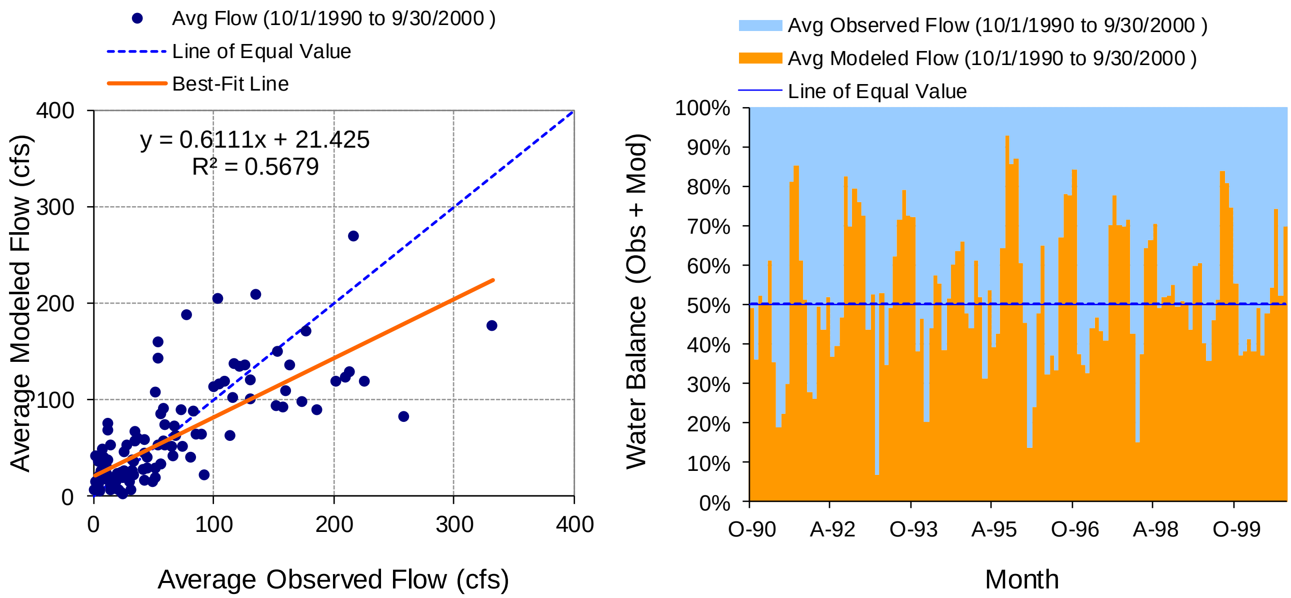


Figure K-38. Monthly flow regression and temporal variation at USGS 04282650 Little Otter Creek at Ferrisburg, VT

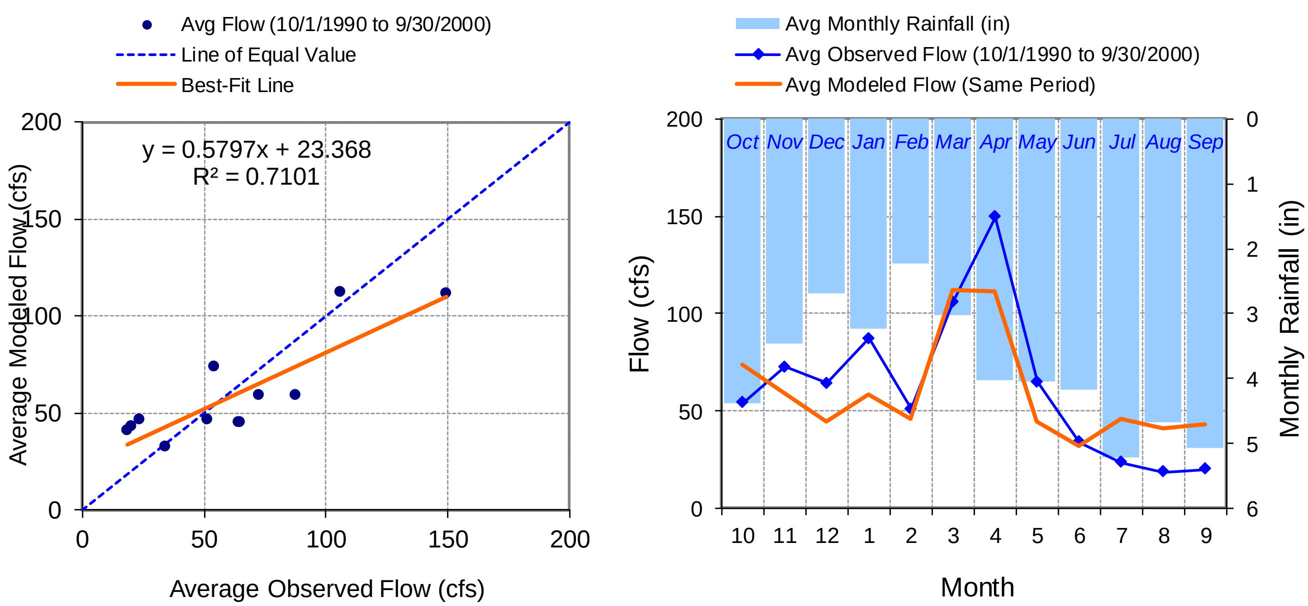


Figure K-39. Seasonal regression and temporal aggregate at USGS 04282650 Little Otter Creek at Ferrisburg, VT

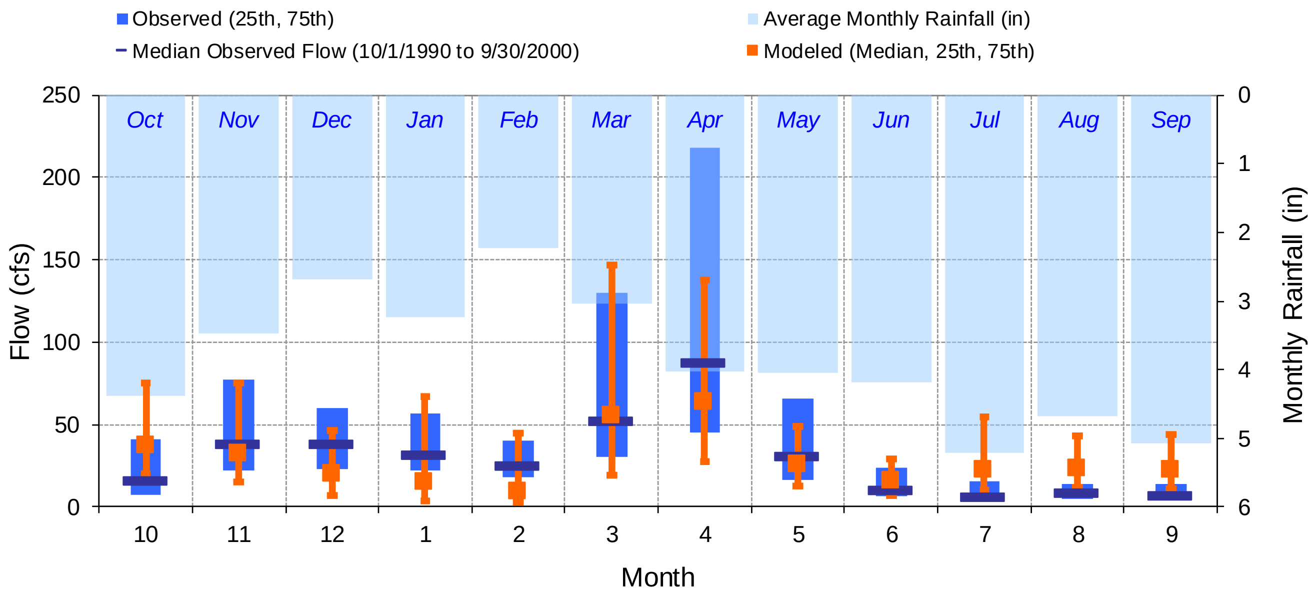


Figure K-40. Seasonal medians and ranges at USGS 04282650 Little Otter Creek at Ferrisburg, VT

Table K-11. Seasonal summary at USGS 04282650 Little Otter Creek at Ferrisburg, VT

MONTH	OBSERVED FLOW (CFS)				MODELED FLOW (CFS)			
	MEAN	MEDIAN	25TH	75TH	MEAN	MEDIAN	25TH	75TH
Oct	54.08	16.00	7.00	40.75	73.57	37.47	20.51	75.59
Nov	72.49	38.50	22.00	77.00	59.17	32.10	15.41	75.23
Dec	64.20	38.00	23.00	60.00	44.71	20.01	6.98	46.60
Jan	87.29	32.00	22.00	57.00	58.69	15.50	3.89	67.31
Feb	51.10	25.00	18.00	40.00	46.07	9.55	2.50	44.44
Mar	105.85	52.00	30.25	130.00	112.17	55.78	19.08	146.81
Apr	149.60	88.00	45.00	218.25	111.12	63.74	27.55	137.99
May	64.76	31.00	16.25	65.75	44.68	26.03	12.88	48.54
Jun	33.80	9.95	6.40	24.00	31.95	15.72	6.78	28.81
Jul	23.35	6.40	3.60	15.75	46.03	22.57	9.98	54.81
Aug	18.41	8.95	4.90	14.00	40.95	23.60	11.72	43.00
Sep	19.92	6.60	4.40	14.00	43.10	22.75	10.71	43.99

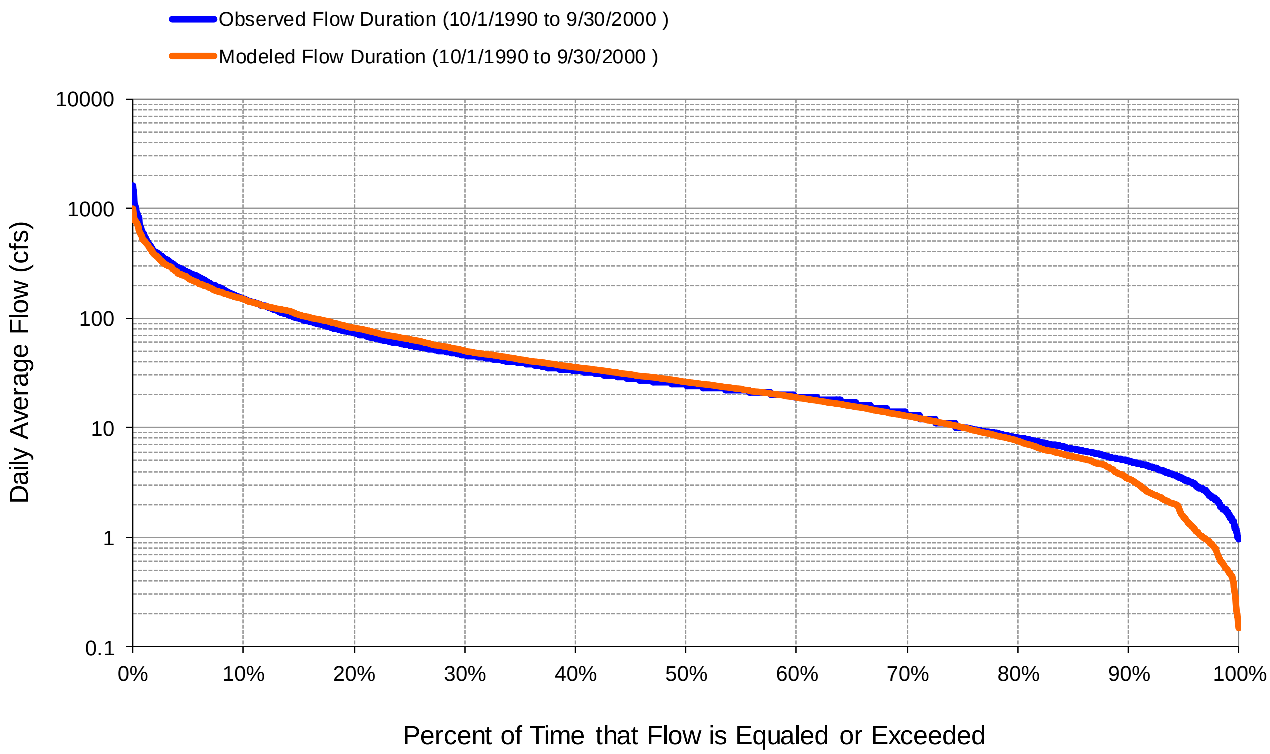


Figure K-41. Flow exceedence at USGS 04282650 Little Otter Creek at Ferrisburg, VT

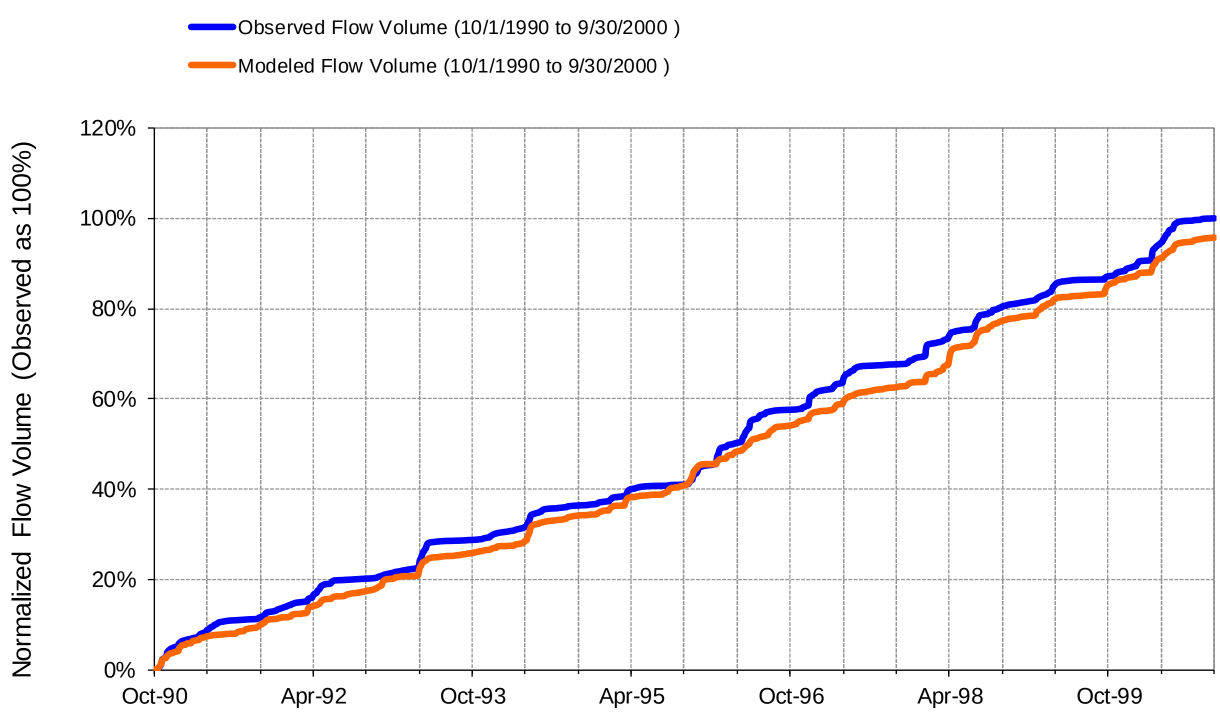


Figure K-42. Flow accumulation at USGS 04282650 Little Otter Creek at Ferrisburg, VT

Table K-12. Summary statistics at USGS 04282650 Little Otter Creek at Ferrisburg, VT

SWAT Simulated Flow		Observed Flow Gage			
REACH OUTFLOW FROM OUTLET 8 10-Year Analysis Period: 10/1/1990 - 9/30/2000 Flow volumes are (inches/year) for upstream drainage area		USGS 04282650 LITTLE OTTER CREEK AT FERRISBURG, VT. Hydrologic Unit Code: 2010002 Latitude: 44.19810987 Longitude: -73.2490117 Drainage Area (sq-mi): 57.1			
Total Simulated In-stream Flow:	**14.14**	Total Observed In-stream Flow:			**14.77**
Total of simulated highest 10% flows:	**6.93**	Total of Observed highest 10% flows:			**7.92**
Total of Simulated lowest 50% flows:	**1.32**	Total of Observed Lowest 50% flows:			**1.39**
Simulated Summer Flow Volume (months 7-9):	**2.60**	Observed Summer Flow Volume (7-9):			**1.23**
Simulated Fall Flow Volume (months 10-12):	**3.54**	Observed Fall Flow Volume (10-12):			**3.80**
Simulated Winter Flow Volume (months 1-3):	**4.30**	Observed Winter Flow Volume (1-3):			**4.84**
Simulated Spring Flow Volume (months 4-6):	**3.70**	Observed Spring Flow Volume (4-6):			**4.89**
Total Simulated Storm Volume:	**5.16**	Total Observed Storm Volume:			**5.61**
Simulated Summer Storm Volume (7-9):	**0.85**	Observed Summer Storm Volume (7-9):			**0.53**
Errors (Simulated-Observed)	*Error Statistics*	*Recommended Criteria*			
Error in total volume:	-4.27	10			
Error in 50% lowest flows:	-5.24	10			
Error in 10% highest flows:	-12.58	15			
Seasonal volume error - Summer:	110.85	30			
Seasonal volume error - Fall:	-6.84	>>	30	Clear	
Seasonal volume error - Winter:	-11.21	30			
Seasonal volume error - Spring:	-24.40	30			
Error in storm volumes:	-7.91	20			
Error in summer storm volumes:	61.77	50			
Nash-Sutcliffe Coefficient of Efficiency, E:	0.468	Model accuracy increases			
Baseline adjusted coefficient (Garrick), E':	0.356	as E or E' approaches 1.0			
Monthly NSE	0.563				

TSS and TP distribution by channel and upland sources

Table K-13. TSS and TP distribution by source categories (LaPlatte River)

Source	TSS		TP	
	Load(mt/year)	Percentage (%)	Load (kg/year)	Percentage (%)
Upland	7,526	90.4	10,519	95.7
Stream	796	9.6	478	4.3
Total	**8,321**	**100.00**	**10,997**	**100.00**

Table K-14. TSS and TP distribution by source categories (Lewis Creek)

Source	TSS		TP	
	Load(mt/year)	Percentage (%)	Load (kg/year)	Percentage (%)
Upland	7,751	82.1	7,261	86.0
Stream	1,688	17.9	1,182	14.0
Total	**9,439**	**100.00**	**8,443**	**100.00**

Table K-15. TSS and TP distribution by source categories (Little Otter Creek)

Source	TSS		TP	
	Load(mt/year)	Percentage (%)	Load (kg/year)	Percentage (%)
Upland	23,735	97.0	12,816	96.9
Stream	727	3.0	406	3.1
Total	**24,462**	**100.00**	**13,222**	**100.00**

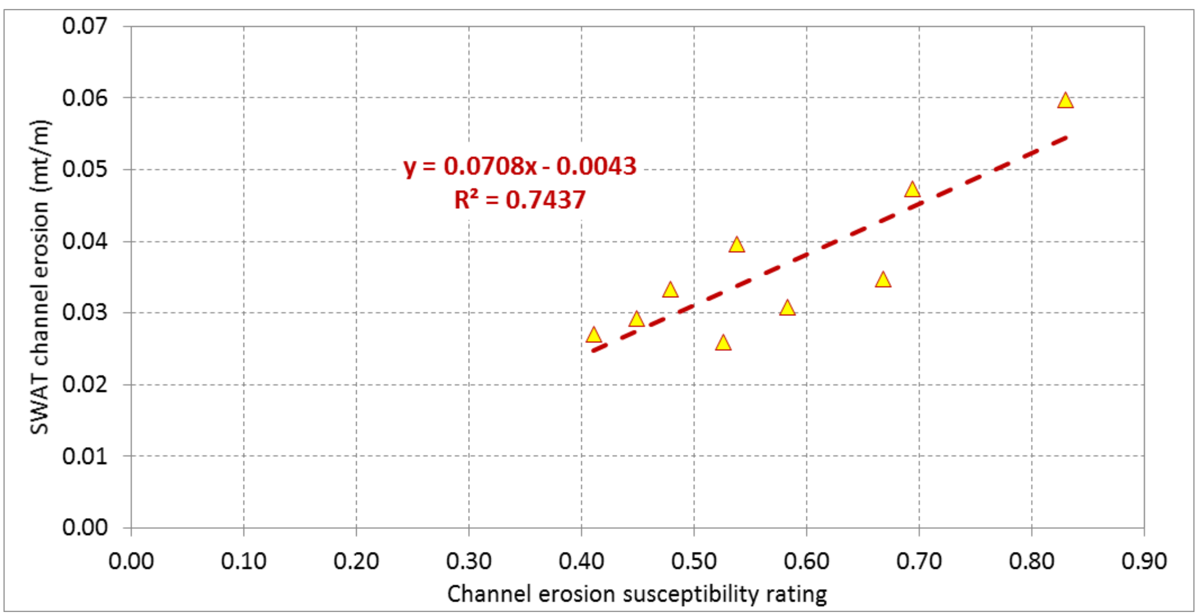


Figure K-43. SWAT simulated channel erosion relative to channel erosion susceptibility rating

TP distribution by landuse from upland sources (LaPlatte River, Lewis Creek, Little Otter Creek)

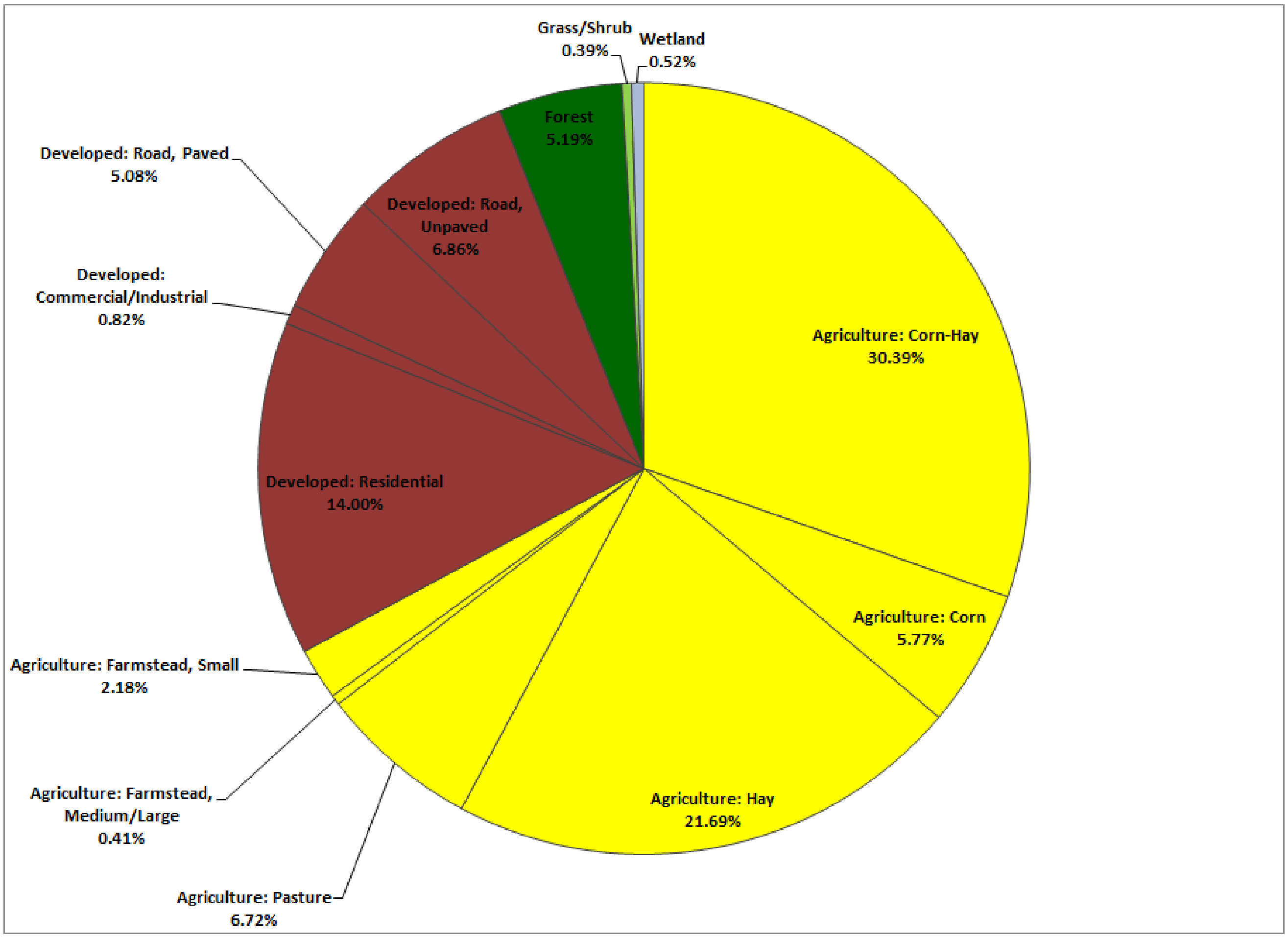


Figure K-44. Distribution of simulated total upland TP loads by landuse categories

Table K-16. TP export rates (kg/ha/yr) by landuse categories for the 30 year simulation period

Landuse	Classification	Area (ha)	Area (%)	Mean	Min	Q_{25}	Q_{50}	Q_{75}	Max
Agriculture	Corn-Hay	6,564	11.50	1.42	0.06	0.75	1.43	1.96	3.83
	Corn	952	1.67	1.85	0.64	1.22	1.72	2.41	3.67
	Hay	10,177	17.83	0.65	0.20	0.40	0.56	0.82	1.40
	Pasture	1,568	2.75	1.31	0.61	0.88	1.21	1.59	2.63
	Farmstead, Medium/Large	40	0.07	3.08	1.51	2.23	2.85	3.99	5.56
	Farmstead, Small	222	0.39	3.00	1.46	2.25	2.77	3.68	5.16
Urban	Residential	4,340	7.60	0.99	0.61	0.82	0.99	1.09	1.60
	Commercial/Industrial	170	0.30	1.47	1.00	1.37	1.50	1.61	1.76
	Road, Paved	765	1.34	2.03	1.54	1.90	2.05	2.13	2.48
	Road, Unpaved	388	0.68	5.40	4.47	5.10	5.43	5.66	6.51
Forest	Forest	28,584	50.08	0.06	0.03	0.04	0.05	0.07	0.10
Grass/Shrub	Grass/Shrub	898	1.57	0.13	0.06	0.09	0.13	0.17	0.32
Wetland	Wetland	2,411	4.22	0.07	0.02	0.05	0.06	0.08	0.20

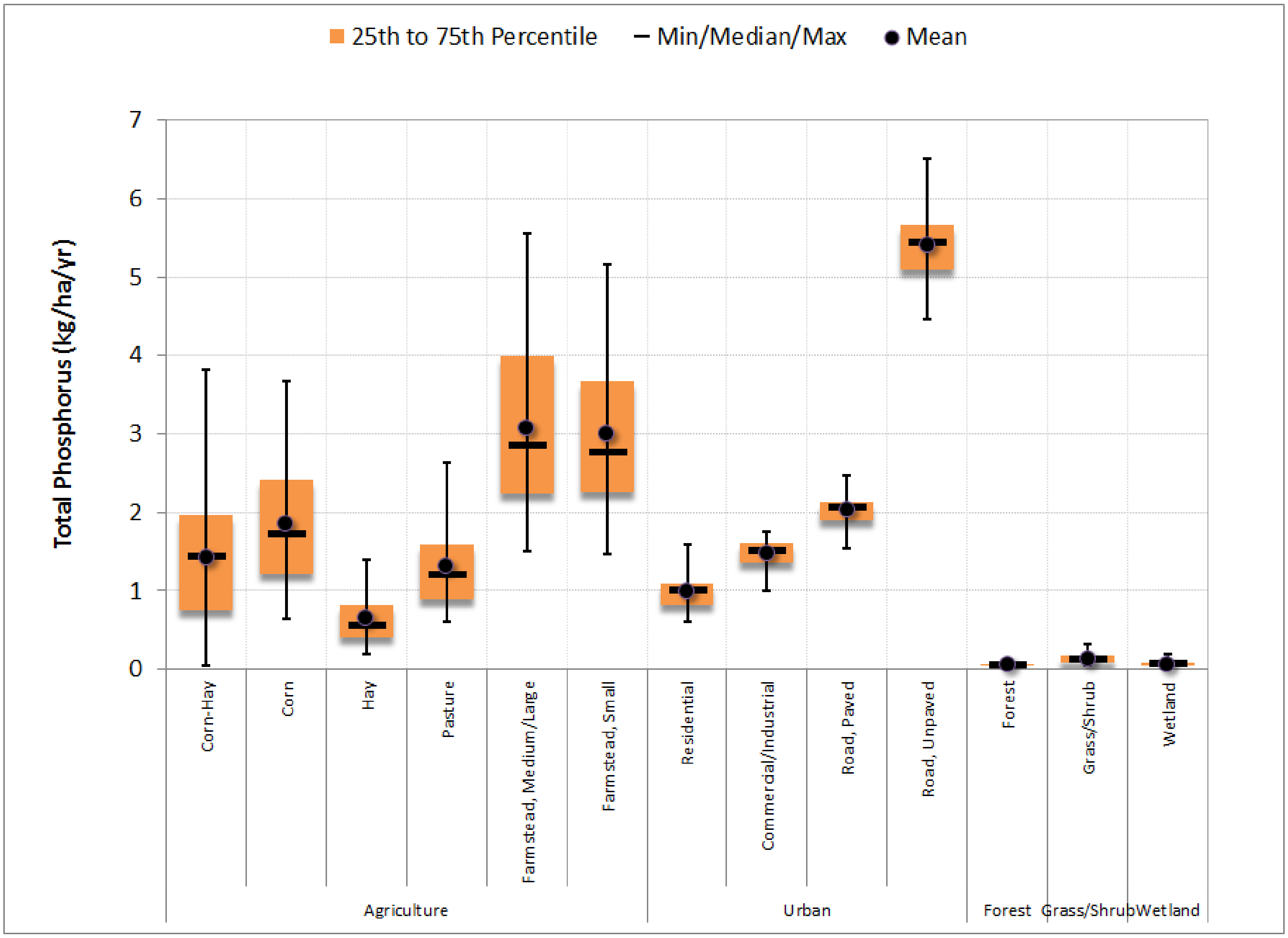


Figure K-45. TP export rates (kg/ha/yr) by landuse categories for the 30 year simulation period

Table K-17. TP export rates (kg/ha/yr) for the residential landuse categories for the 30 year simulation period

Residential Category	Area (ha)	Area (%)	Mean	Min	Q25	Q50	Q75	Max
Low Density	1,966	53.90	**0.60**	0.31	0.45	0.62	0.68	1.19
Medium Density	1,104	30.26	**0.94**	0.51	0.72	0.94	1.09	1.78
High Density	577	15.83	**1.19**	0.72	1.02	1.20	1.34	1.72
Total	3,647	100.00	**0.80**	0.44	0.61	0.81	0.91	1.45

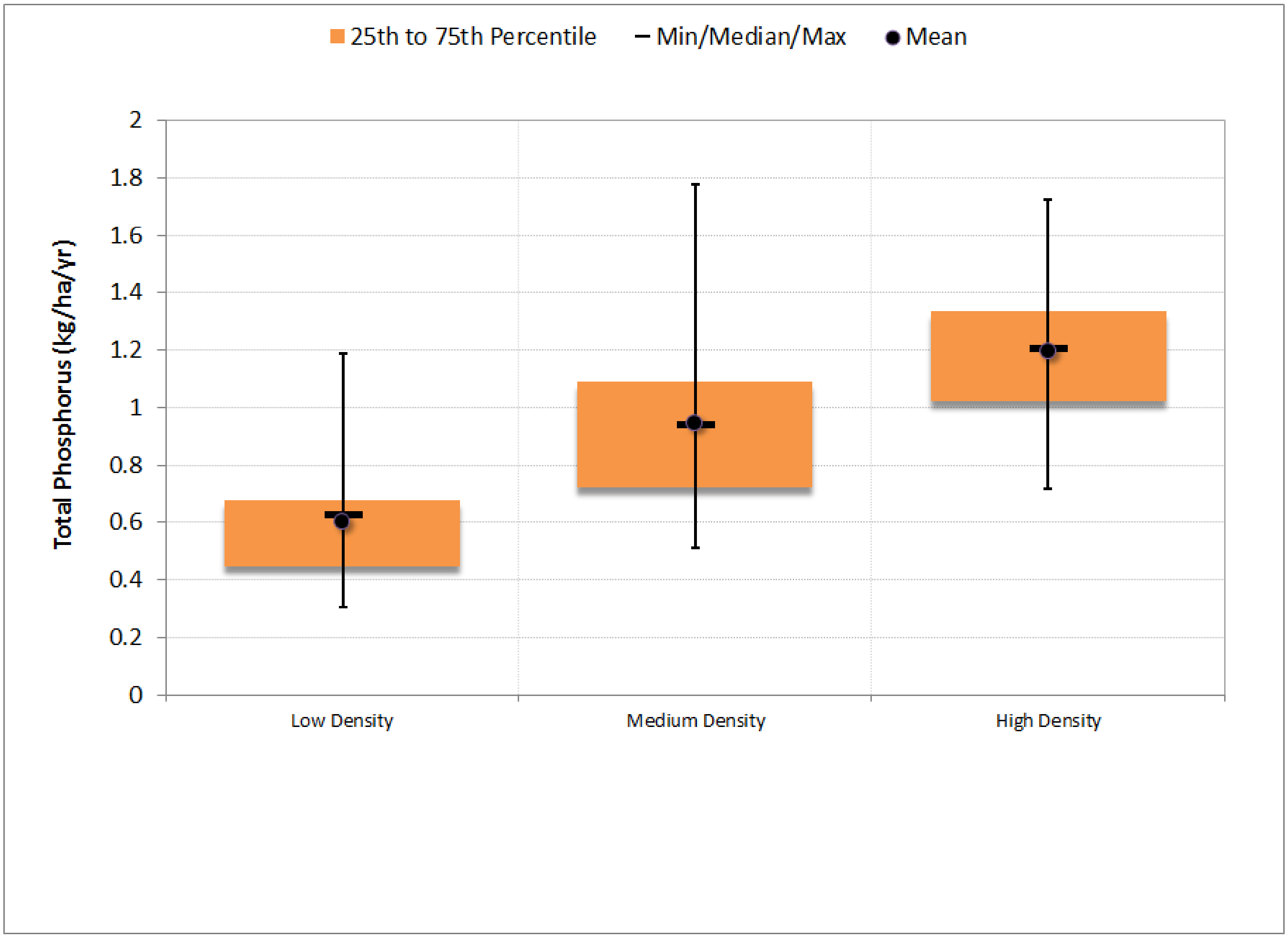


Figure K-46. TP export rates (kg/ha/yr) for the residential landuse categories for the 30 year simulation period

Segmented Regression (LaPlatte River)

Table K-18. Summary statistics

Statistic	Calibration		Validation	
	TSS	TP	TSS	TP
Average absolute error (%)	66.7	56.6	73.7	65.3
Median absolute error (%)	16.6	27.5	16.9	29.7
Regression error (%)	12.2	-3.8	-15.6	-24.8
NSE	0.427	0.384	0.338	0.327
NSE'	0.383	0.336	0.398	0.303

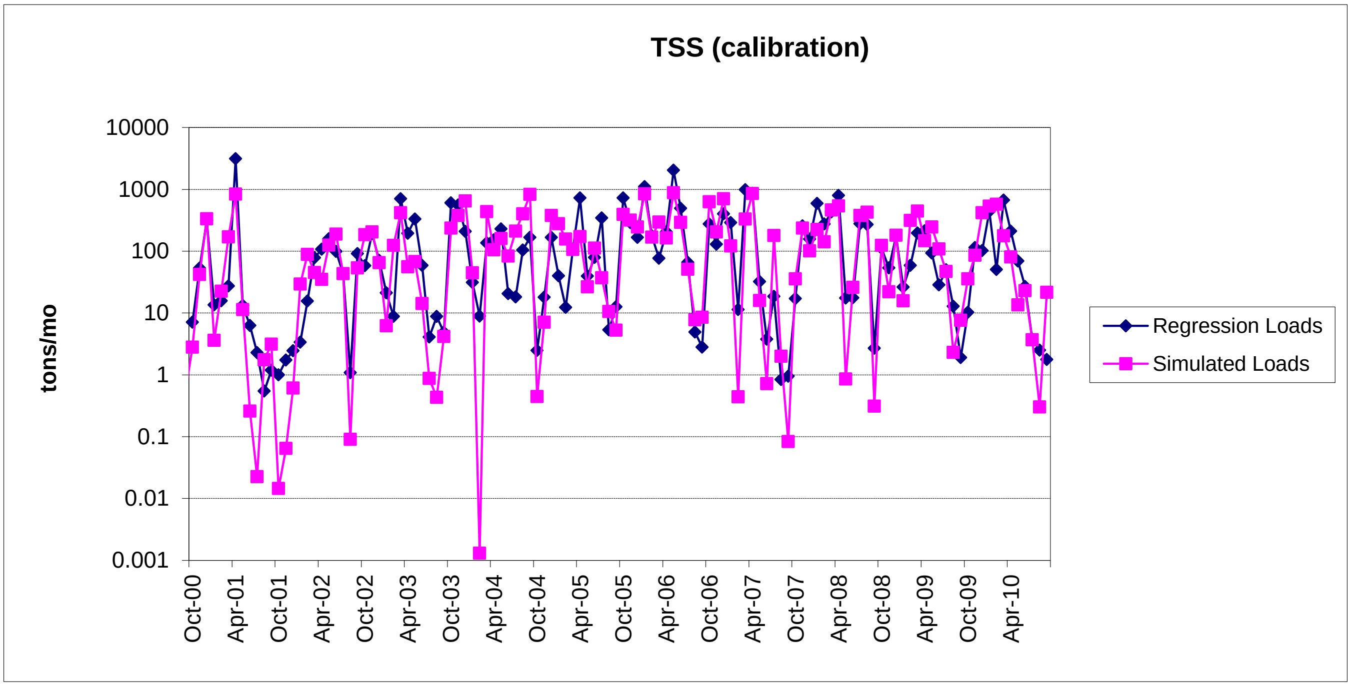


Figure K-47. Monthly simulated and estimated TSS load at LaPlatte River at Shelburne Falls, VT (calibration period)

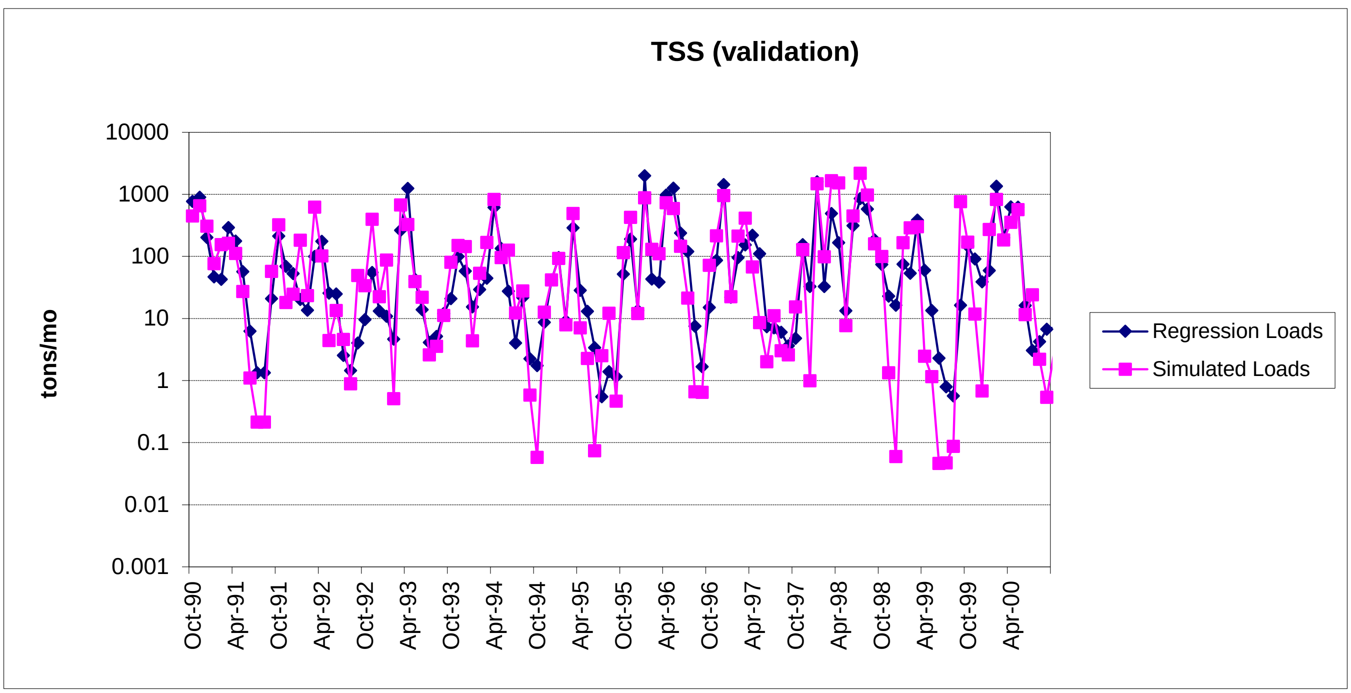


Figure K-48. Monthly simulated and estimated TSS load at LaPlatte River at Shelburne Falls, VT (validation period)

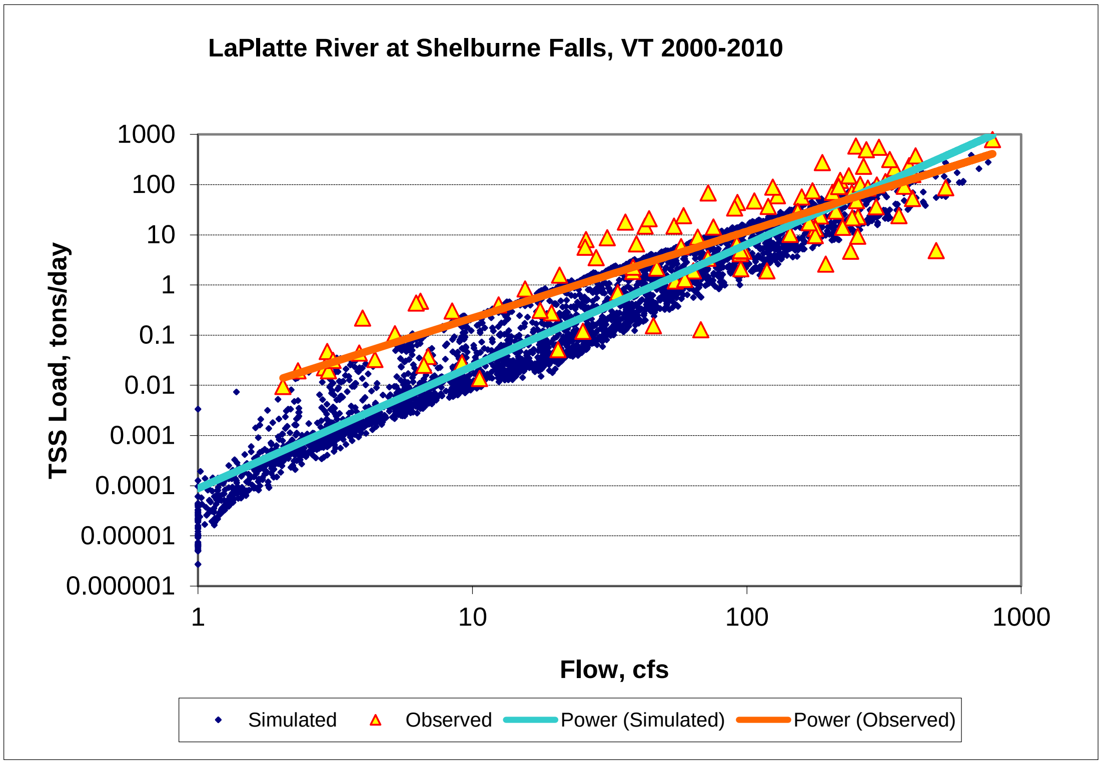


Figure K-49. Power plot of simulated and observed TSS load vs flow at LaPlatte River at Shelburne Falls, VT (calibration period)

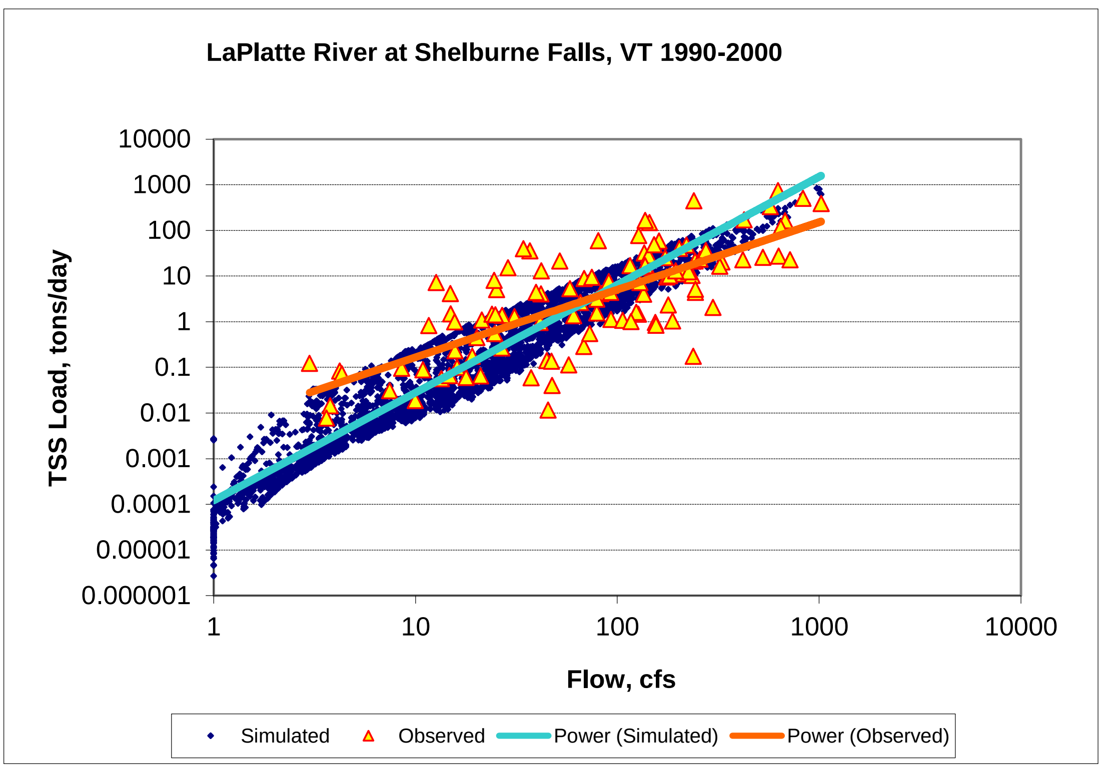


Figure K-50. Power plot of simulated and observed TSS load vs flow at LaPlatte River at Shelburne Falls, VT (validation period)

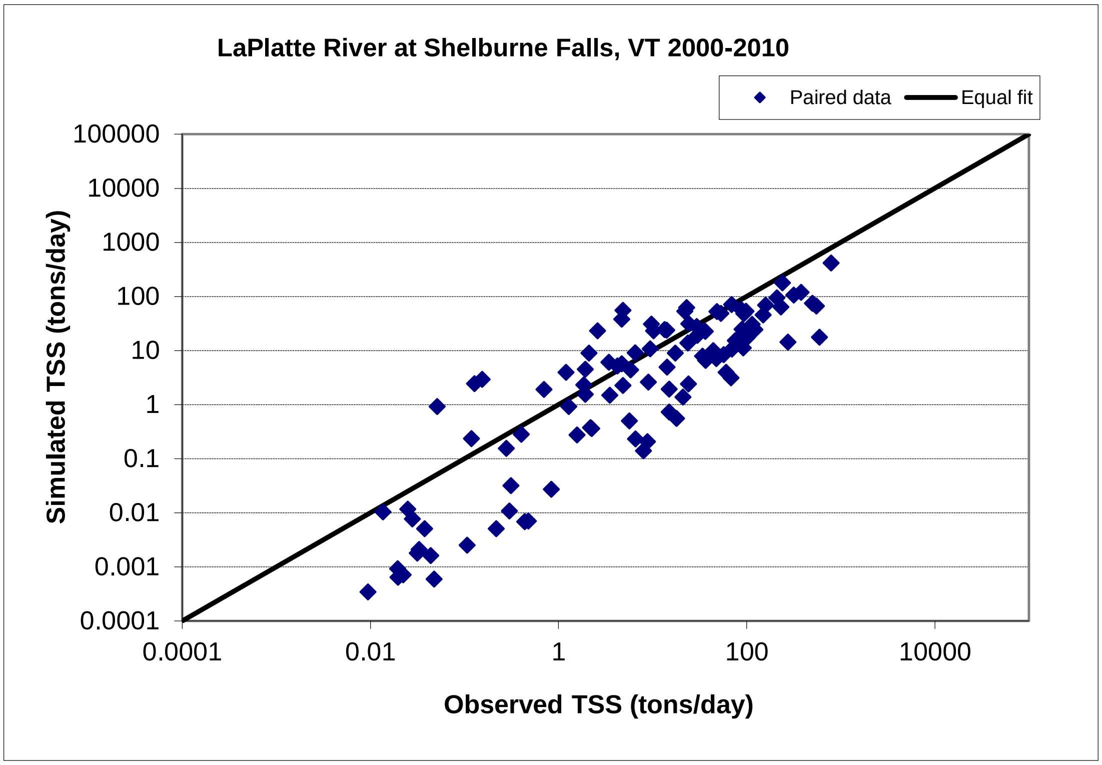


Figure K-51. Paired simulated vs observed TSS load at LaPlatte River at Shelburne Falls, VT (calibration period)

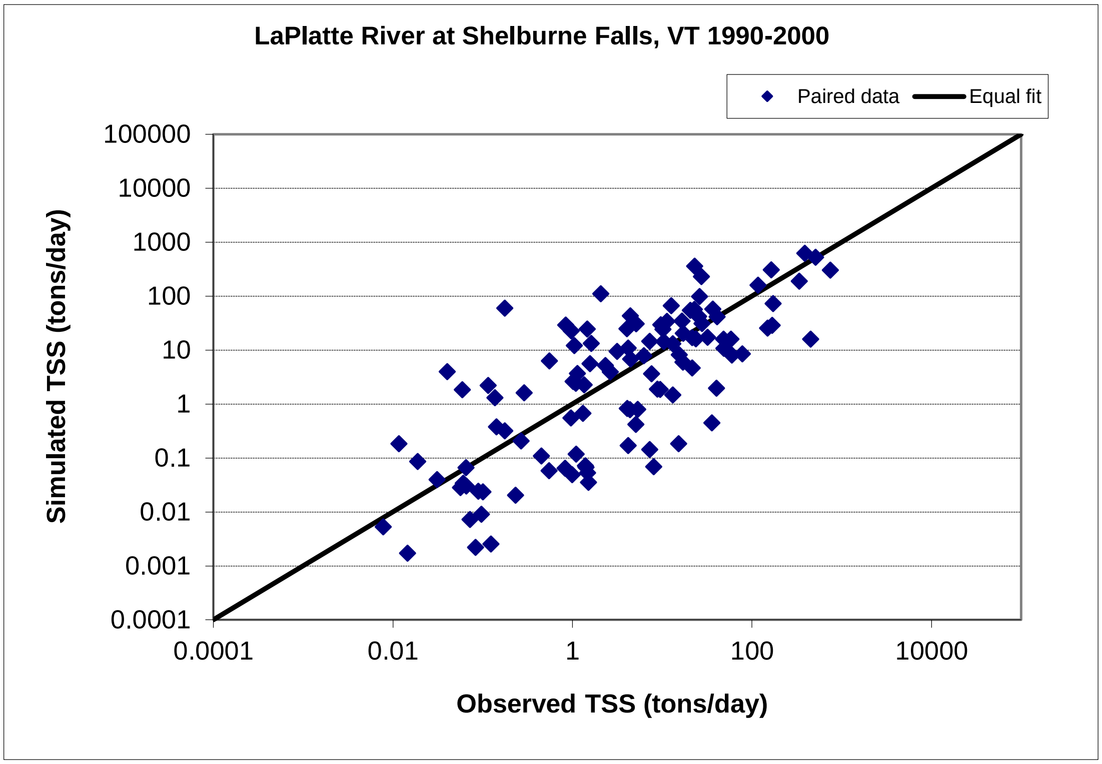


Figure K-52. Paired simulated vs observed TSS load at LaPlatte River at Shelburne Falls, VT (validation period)

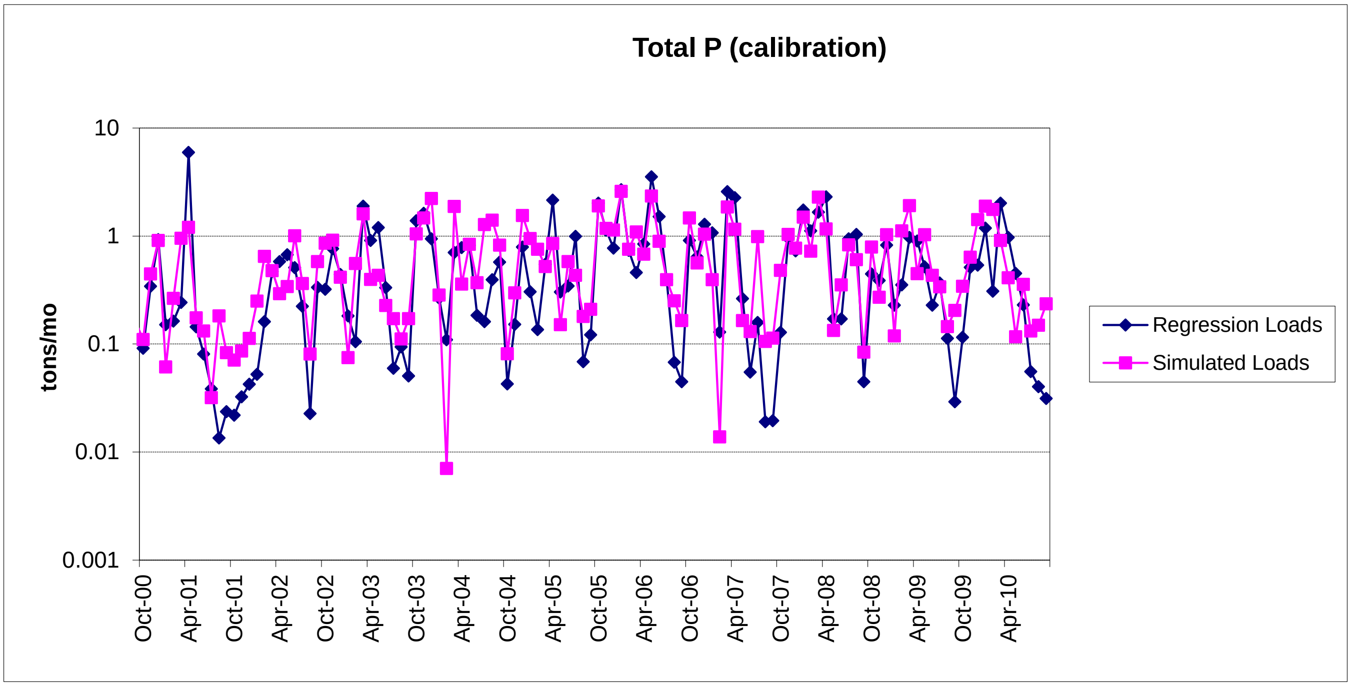


Figure K-53. Monthly simulated and estimated TP load at LaPlatte River at Shelburne Falls, VT (calibration period)

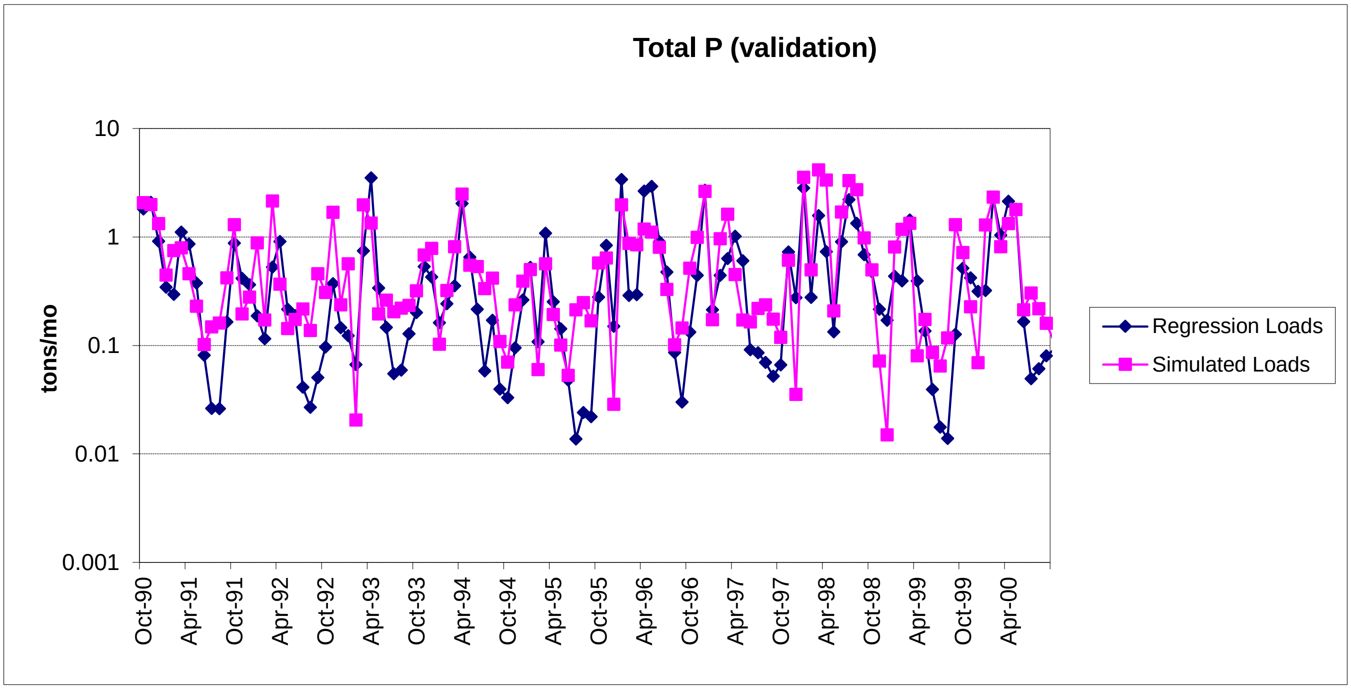


Figure K-54. Monthly simulated and estimated TP load at LaPlatte River at Shelburne Falls, VT (validation period)

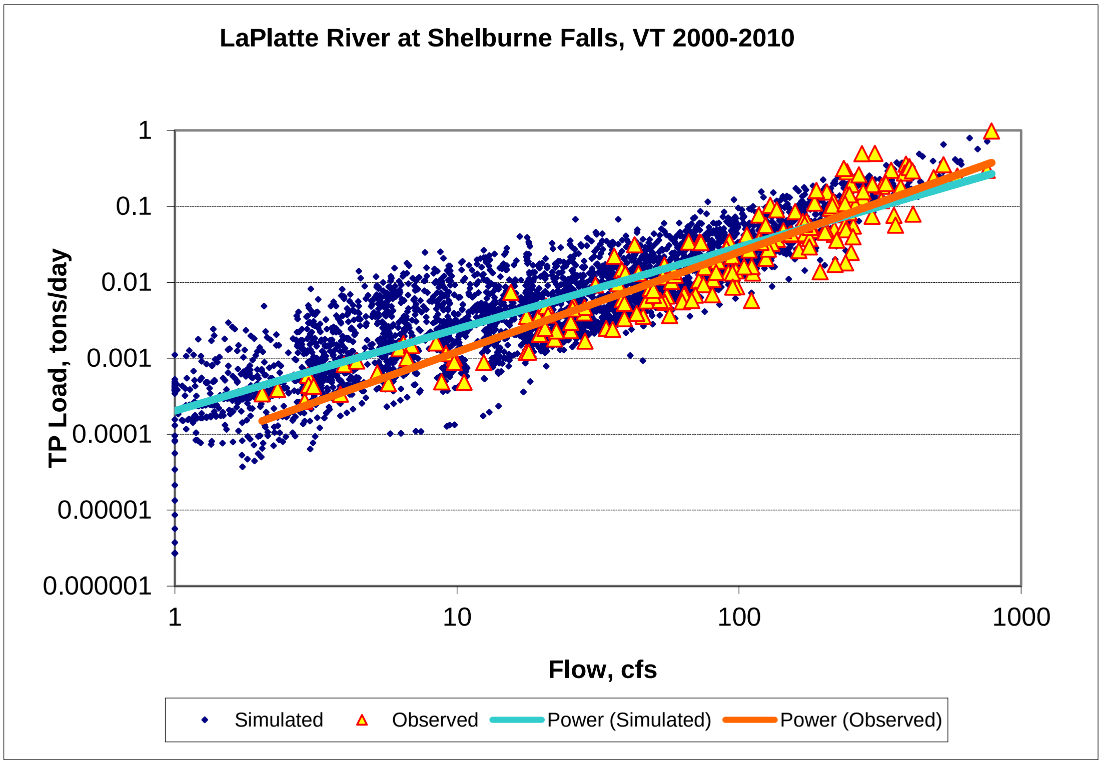


Figure K-55. Power plot of simulated and observed TP load vs flow at LaPlatte River at Shelburne Falls, VT (calibration period)

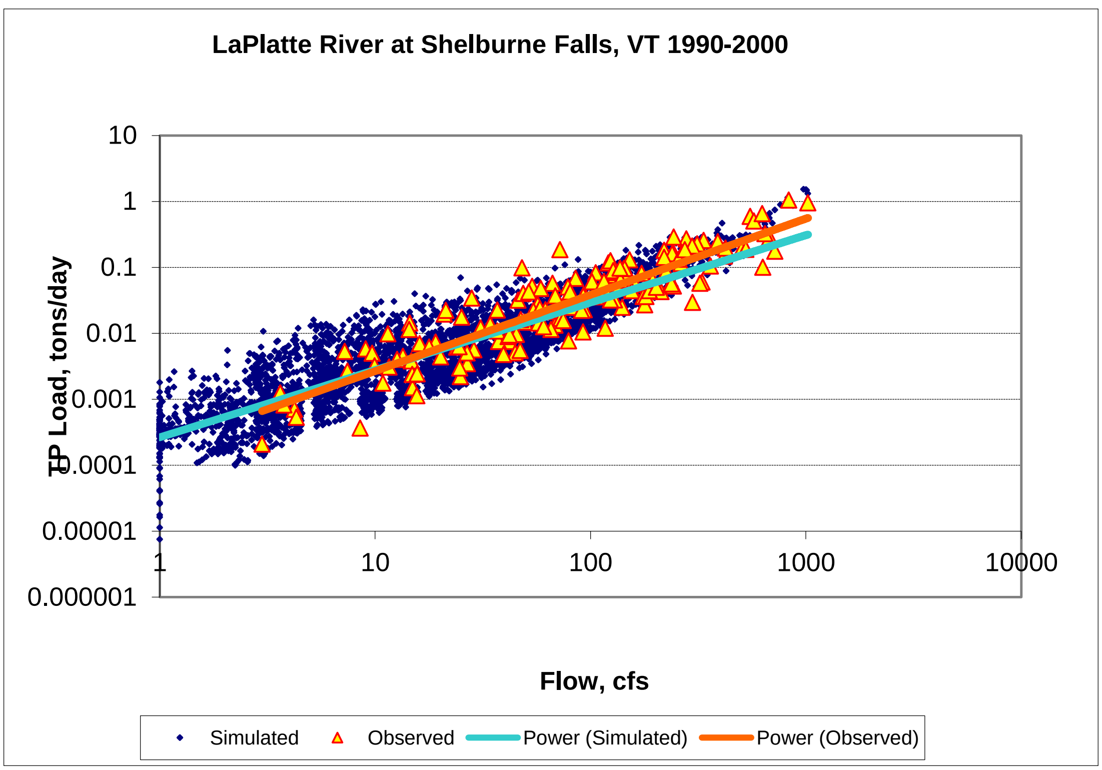


Figure K-56. Power plot of simulated and observed TP load vs flow at LaPlatte River at Shelburne Falls, VT (validation period)

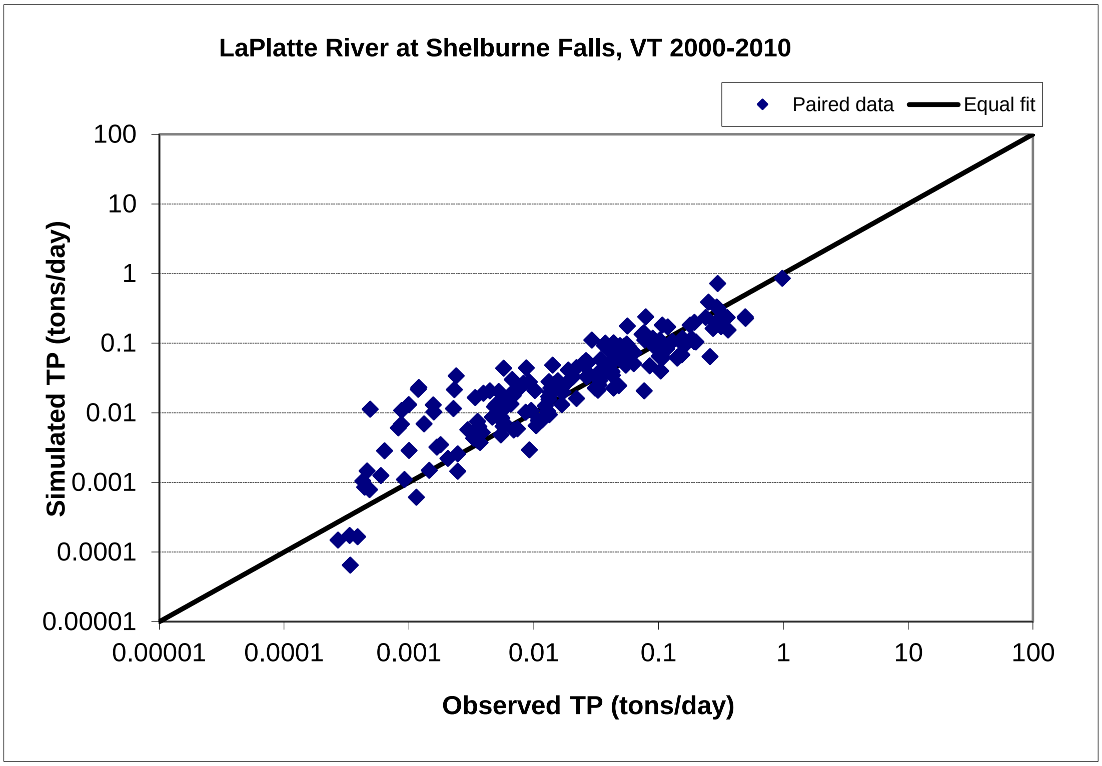


Figure K-57. Paired simulated vs observed TP load at LaPlatte River at Shelburne Falls, VT (calibration period)

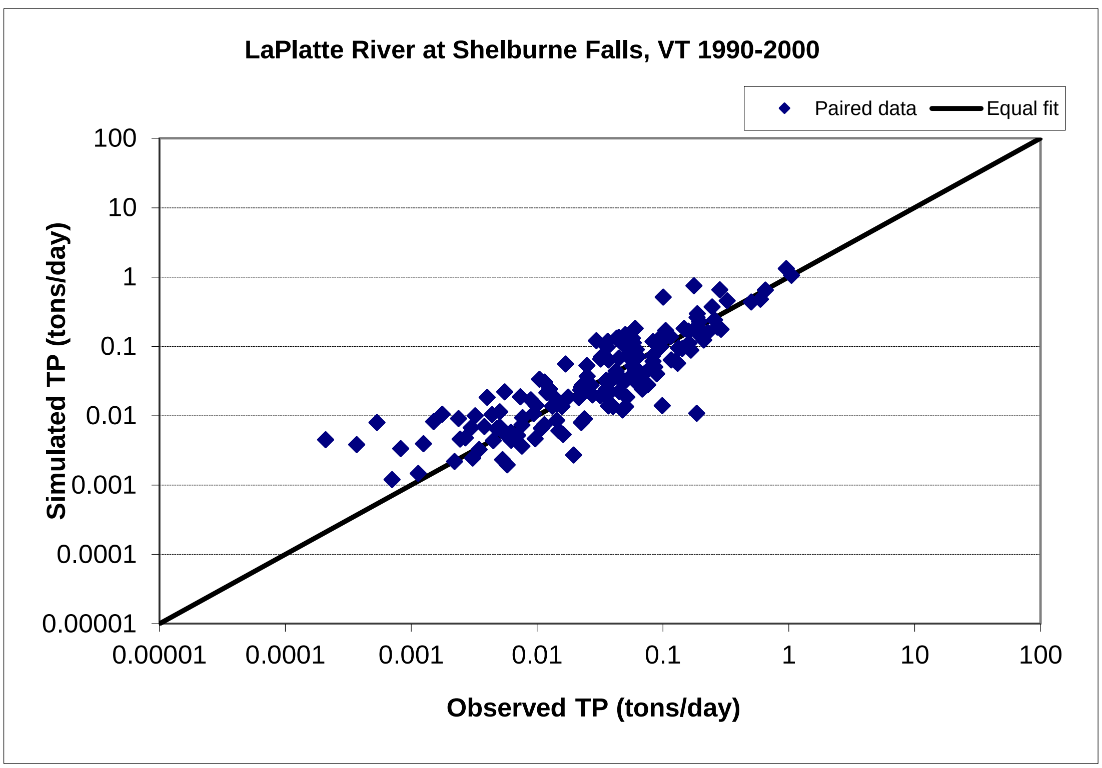


Figure K-58. Paired simulated vs observed TP load at LaPlatte River at Shelburne Falls, VT (validation period)

Segmented Regression (Lewis Creek)

Table K-19. Summary statistics

Statistic	Calibration		Validation	
	TSS	TP	TSS	TP
Average absolute error (%)	70.9	62.1	72.0	66.0
Median absolute error (%)	20.4	25.9	13.4	23.9
Regression error (%)	14.7	4.4	27.8	8.1
NSE	0.354	0.343	0.168	0.350
NSE'	0.362	0.357	0.409	0.385

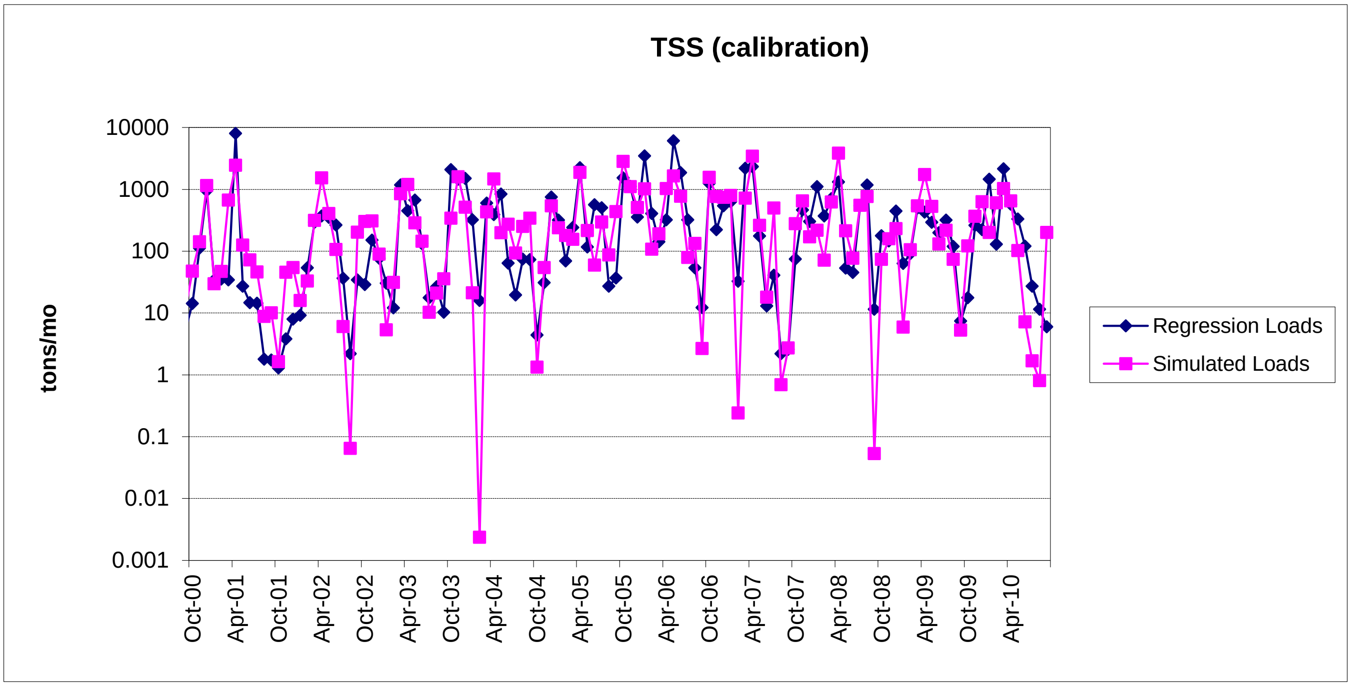


Figure K-59. Monthly simulated and estimated TSS load at Lewis Creek at North Ferrisburg, VT (calibration period)

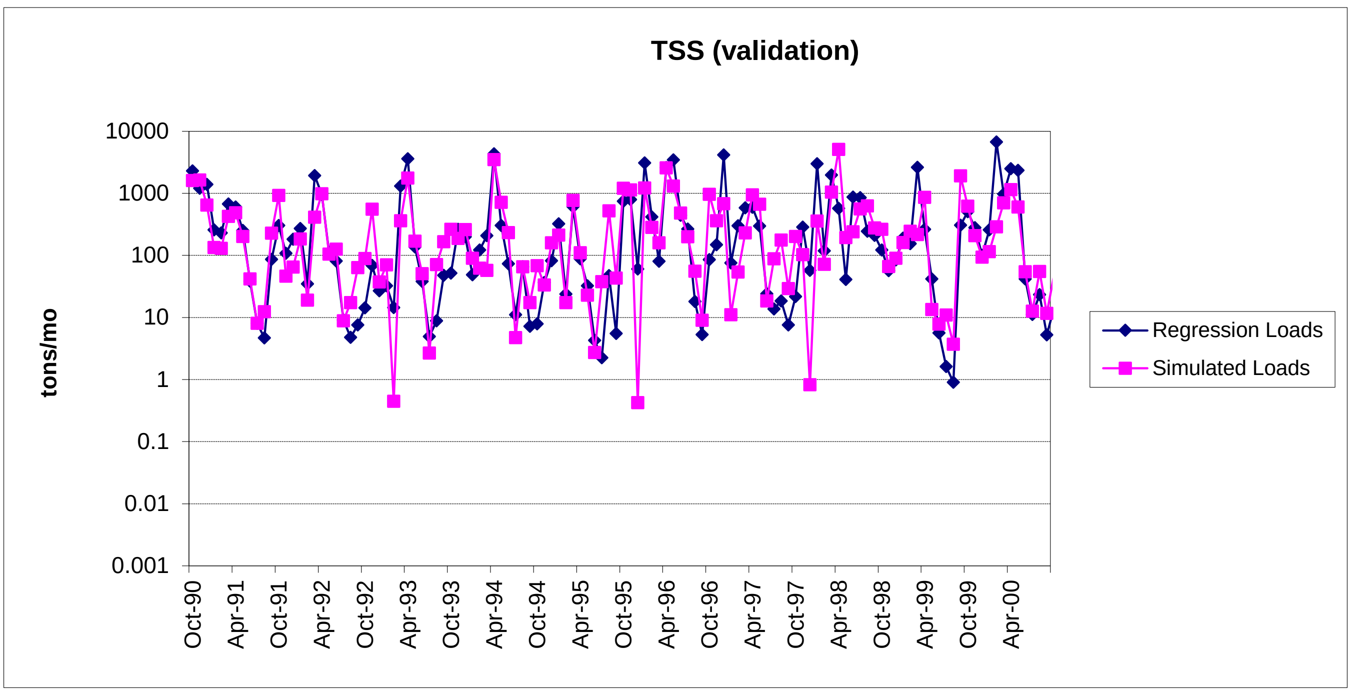


Figure K-60. Monthly simulated and estimated TSS load at Lewis Creek at North Ferrisburg, VT (validation period)

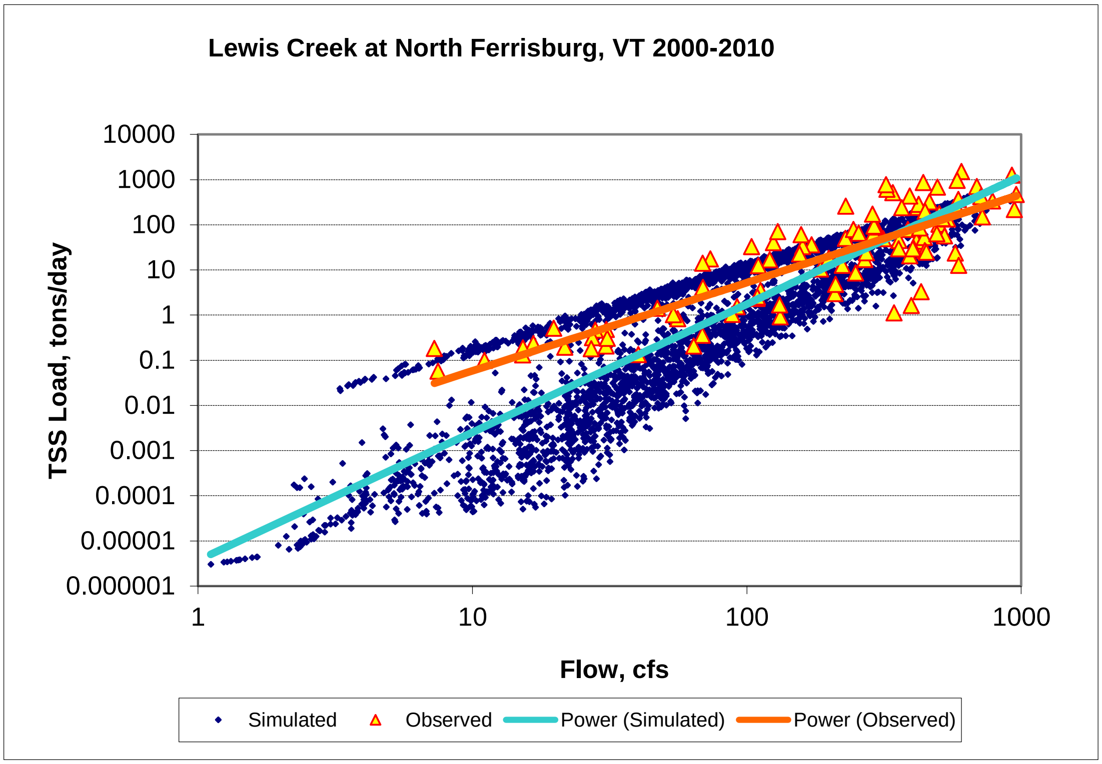


Figure K-61. Power plot of simulated and observed TSS load vs flow at Lewis Creek at North Ferrisburg, VT (calibration period)

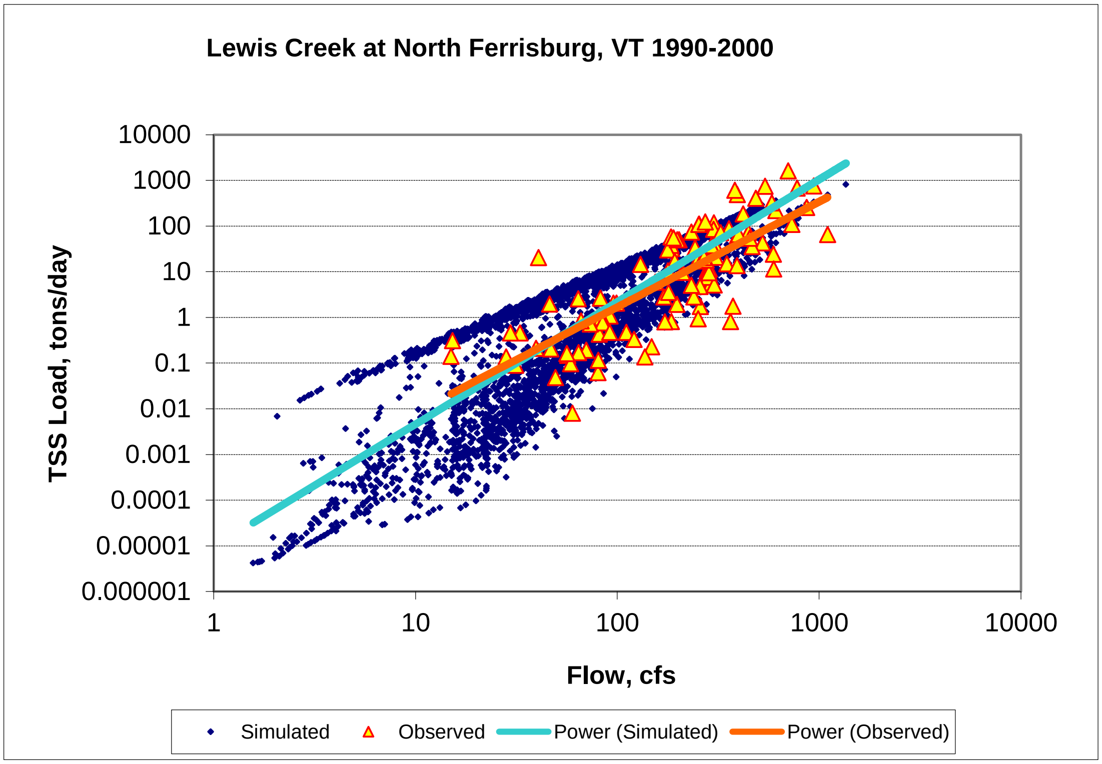


Figure K-62. Power plot of simulated and observed TSS load vs flow at Lewis Creek at North Ferrisburg, VT (validation period)

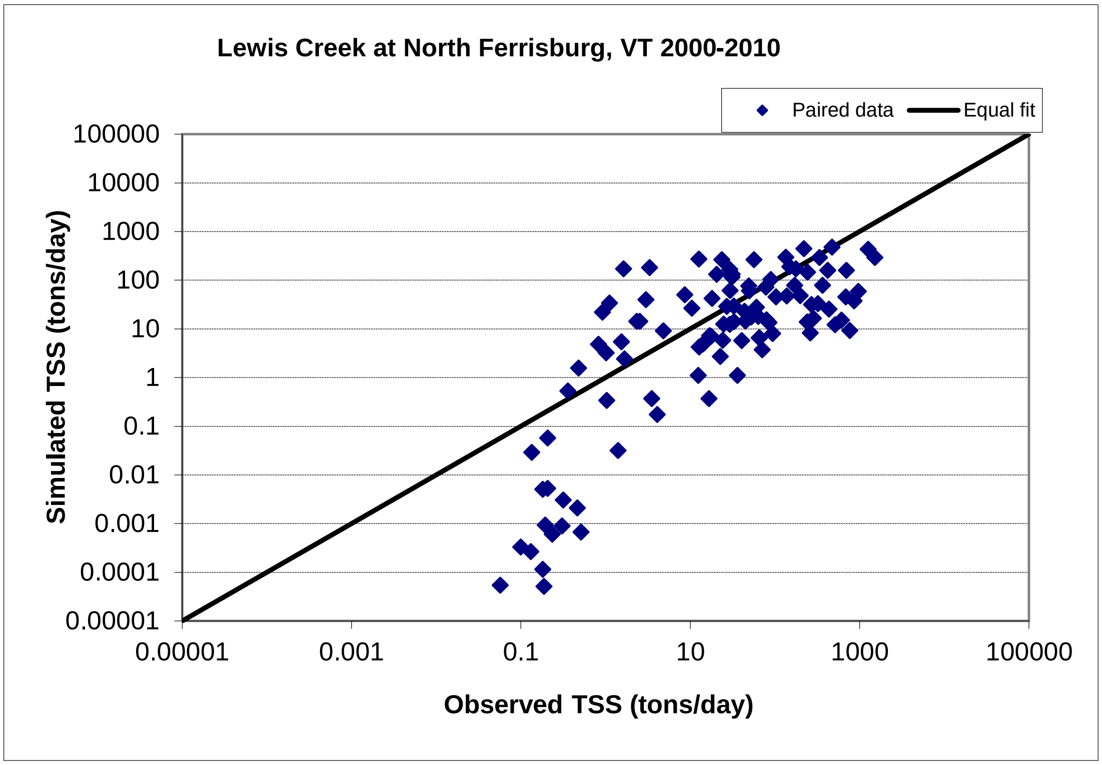


Figure K-63. Paired simulated vs observed TSS load at Lewis Creek at North Ferrisburg, VT (calibration period)

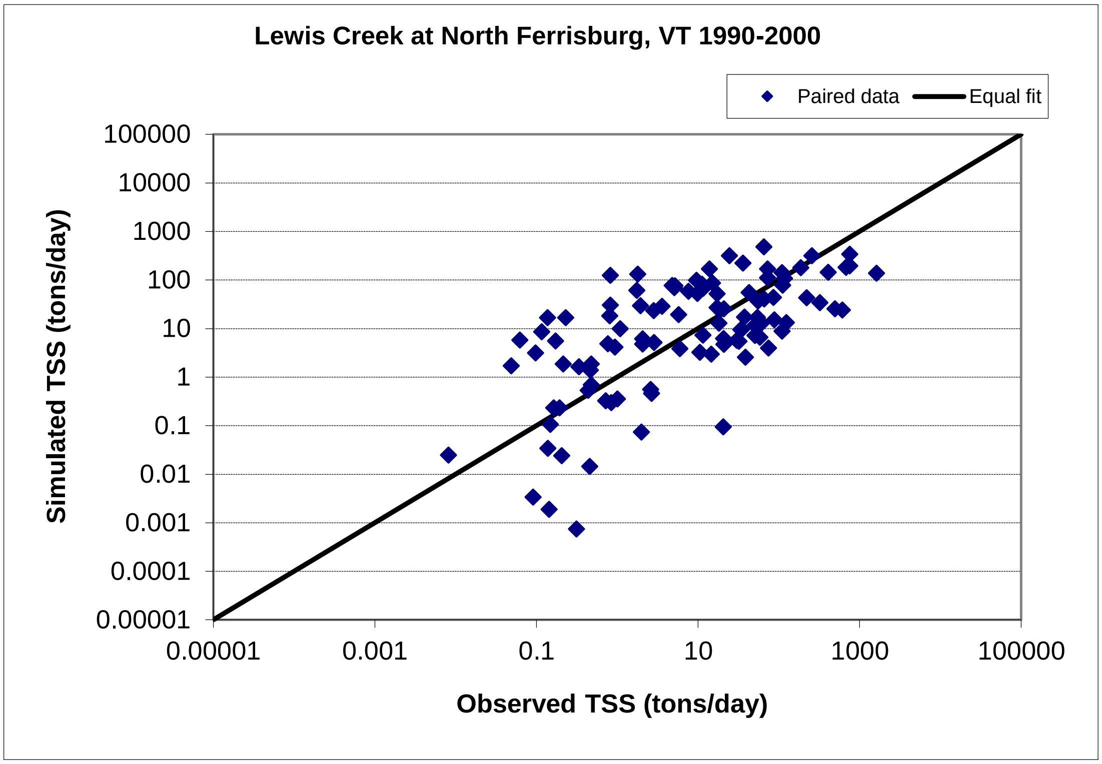


Figure K-64. Paired simulated vs observed TSS load at Lewis Creek at North Ferrisburg, VT (validation period)

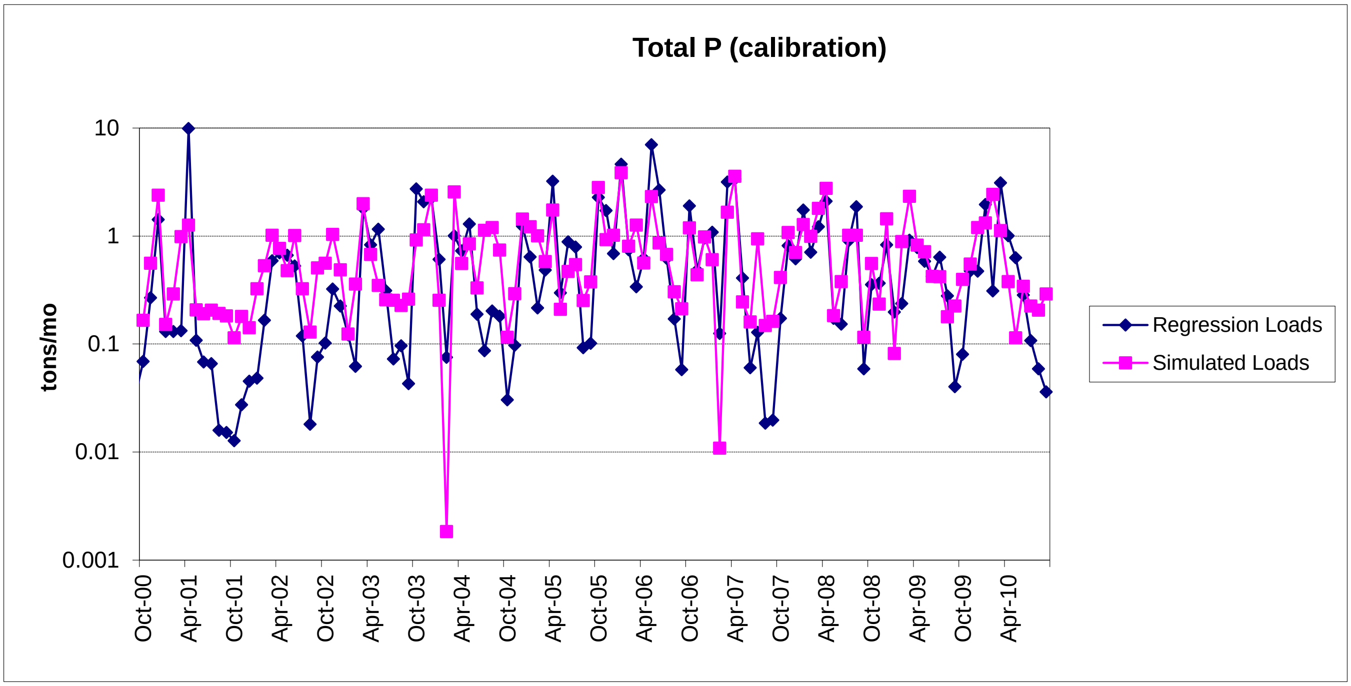


Figure K-65. Monthly simulated and estimated TP load at Lewis Creek at North Ferrisburg, VT (calibration period)

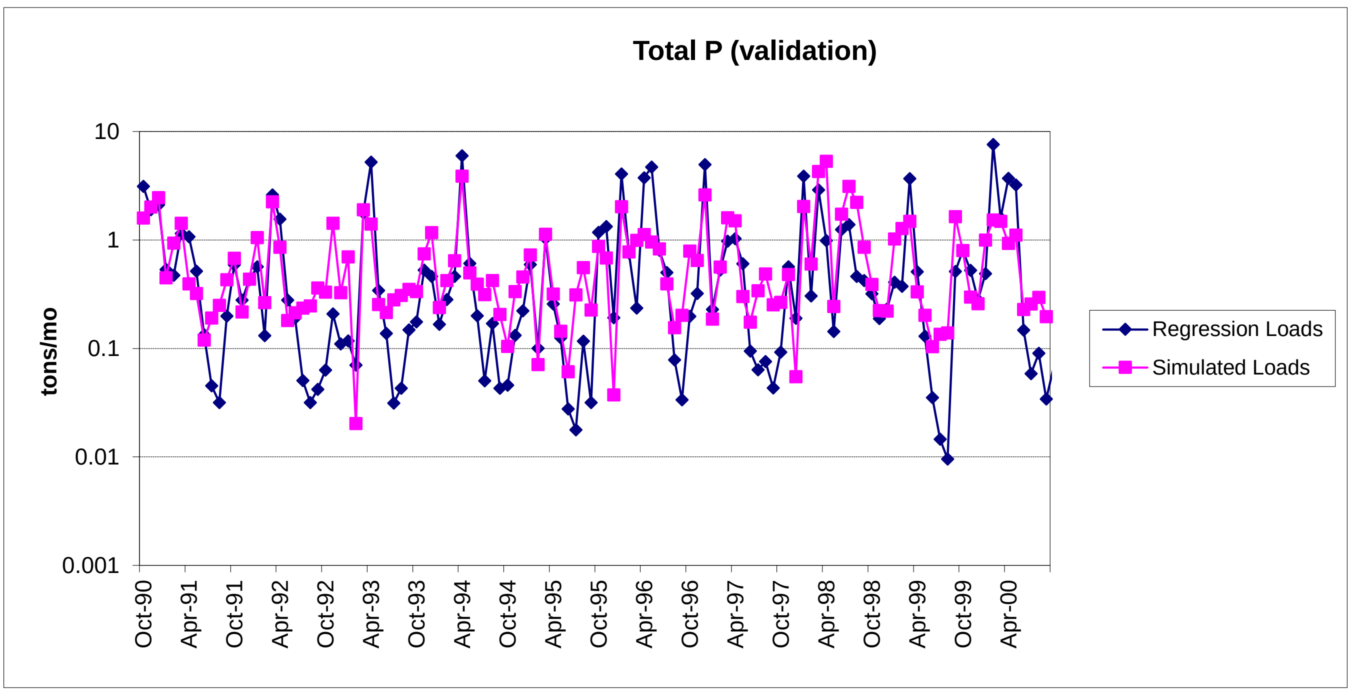


Figure K-66. Monthly simulated and estimated TP load at Lewis Creek at North Ferrisburg, VT (validation period)

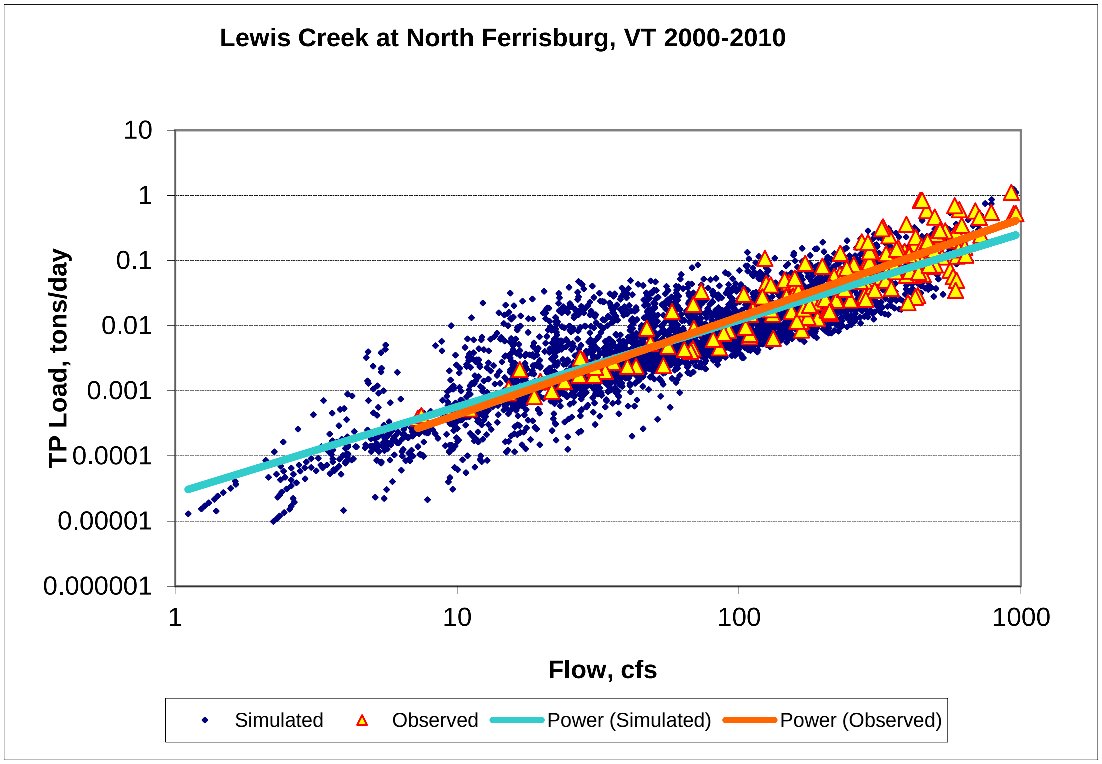


Figure K-67. Power plot of simulated and observed TP load vs flow at Lewis Creek at North Ferrisburg, VT (calibration period)

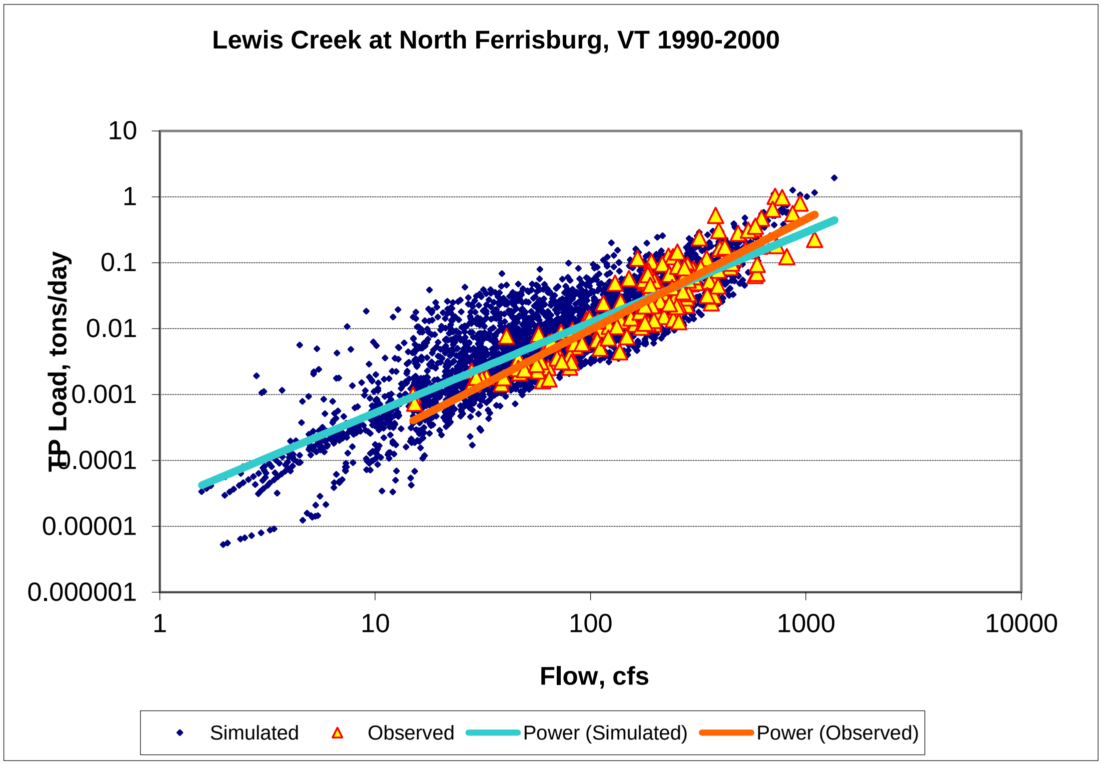


Figure K-68. Power plot of simulated and observed TP load vs flow at Lewis Creek at North Ferrisburg, VT (validation period)

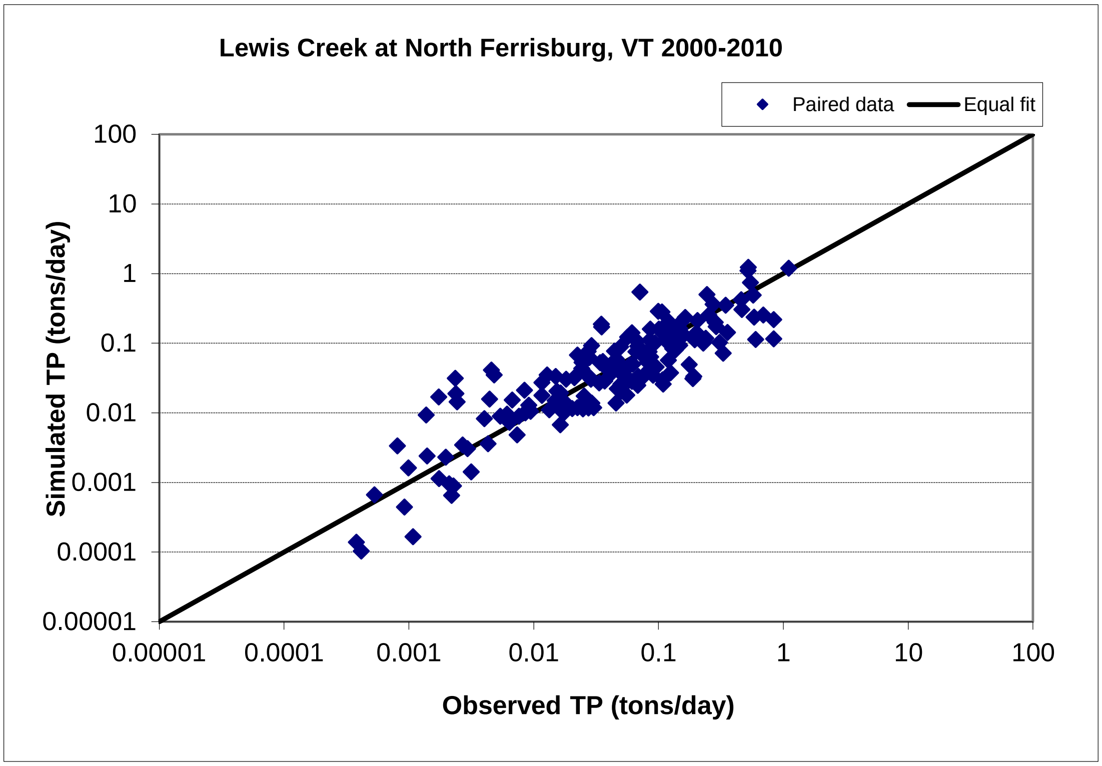


Figure K-69. Paired simulated vs observed TP load at Lewis Creek at North Ferrisburg, VT (calibration period)

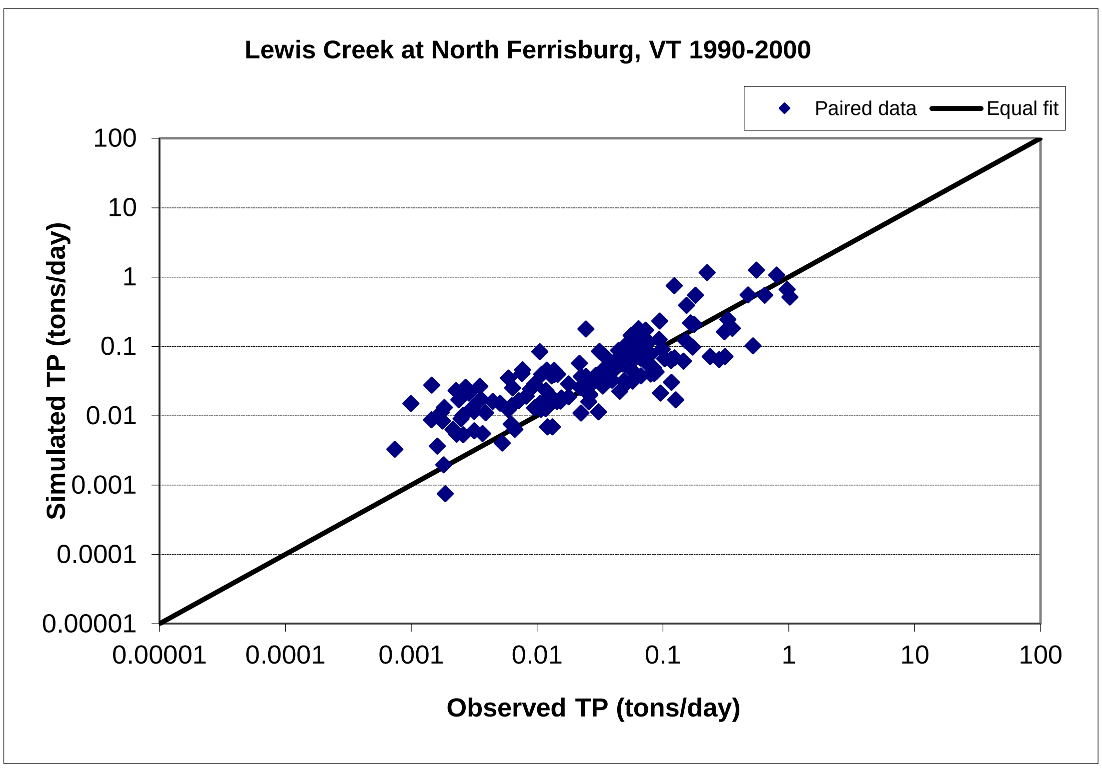


Figure K-70. Paired simulated vs observed TP load at Lewis Creek at North Ferrisburg, VT (validation period)

Segmented Regression (Little Otter Creek)

Table K-20. Summary statistics

Statistic	Calibration		Validation	
	TSS	TP	TSS	TP
Average absolute error (%)	52.8	67.1	62.0	65.2
Median absolute error (%)	28.0	34.4	21.0	23.9
Regression error (%)	9.4	-21.5	15.3	-10.9
NSE	0.449	0.154	0.399	0.303
NSE'	0.429	0.231	0.407	0.334

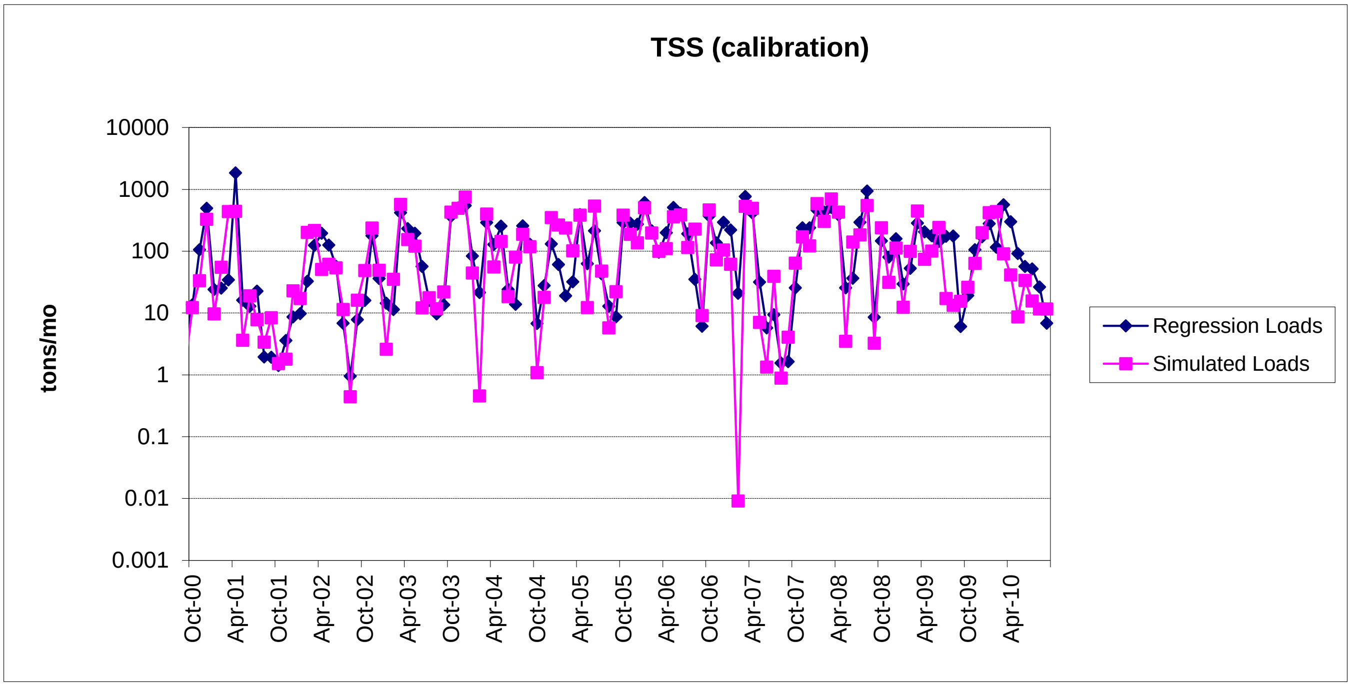


Figure K-71. Monthly simulated and estimated TSS load at Little Otter Creek at Ferrisburg, VT (calibration period)

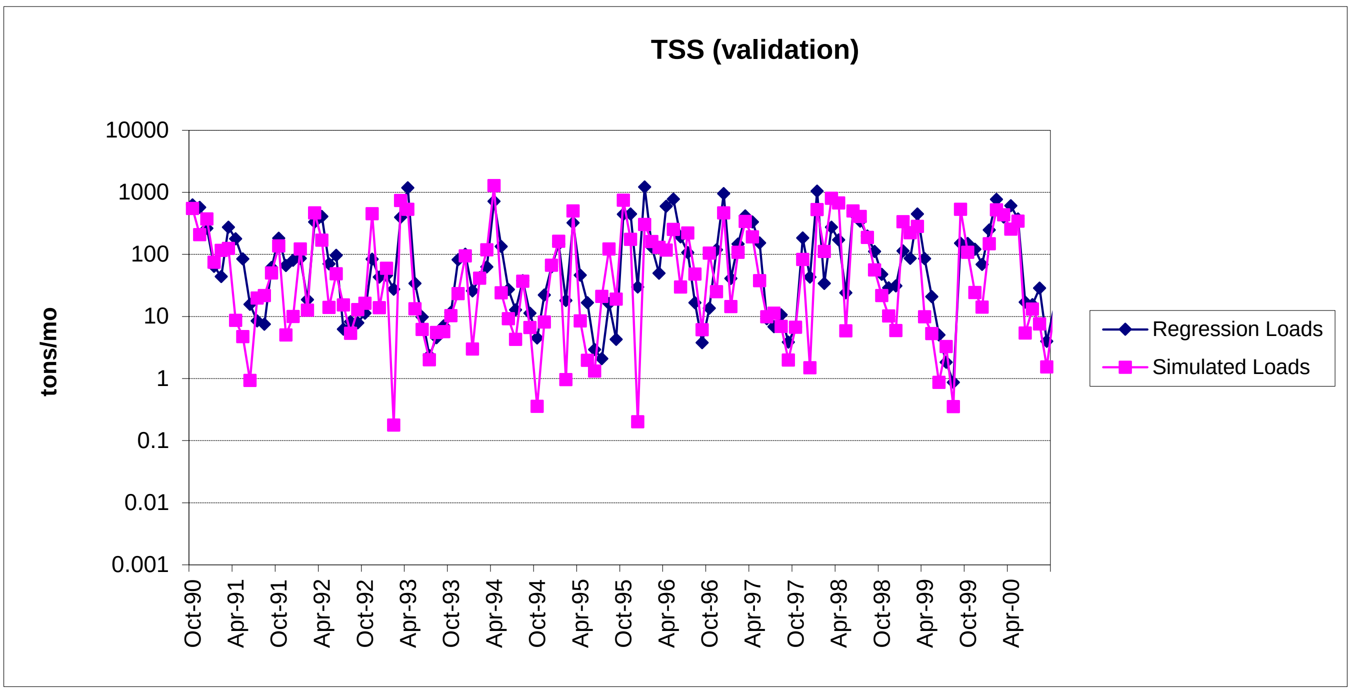


Figure K-72. Monthly simulated and estimated TSS load at Little Otter Creek at Ferrisburg, VT (validation period)

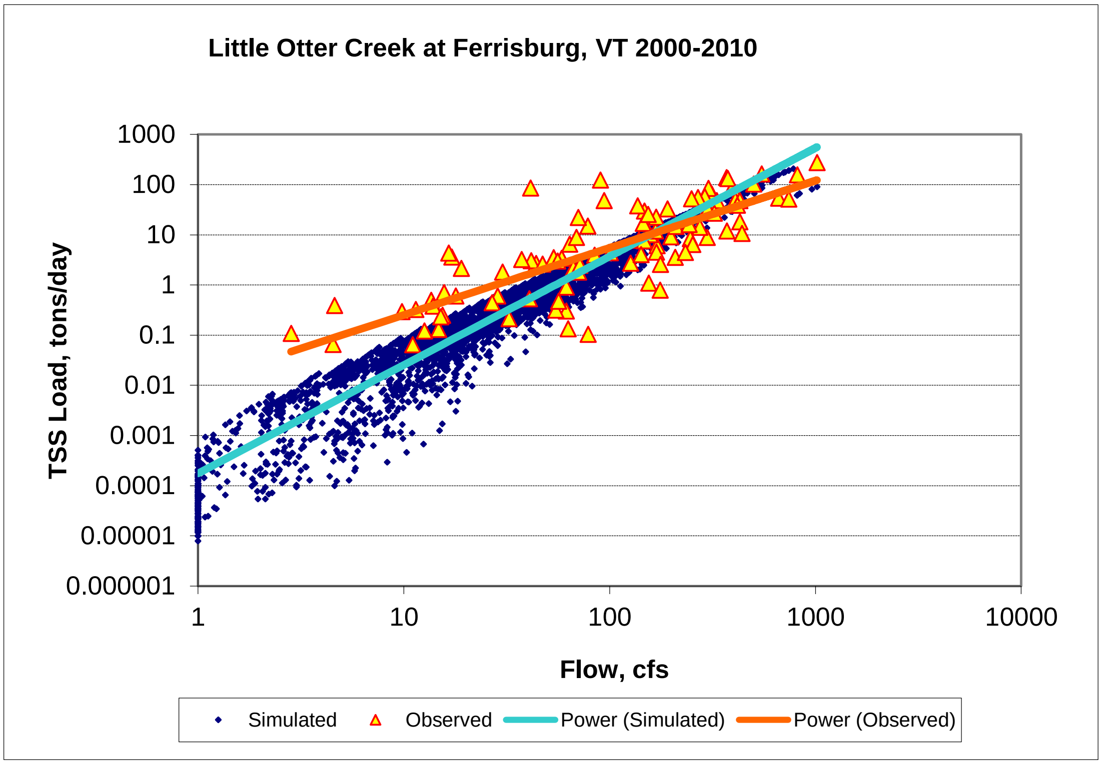


Figure K-73. Power plot of simulated and observed TSS load vs flow at Little Otter Creek at Ferrisburg, VT (calibration period)

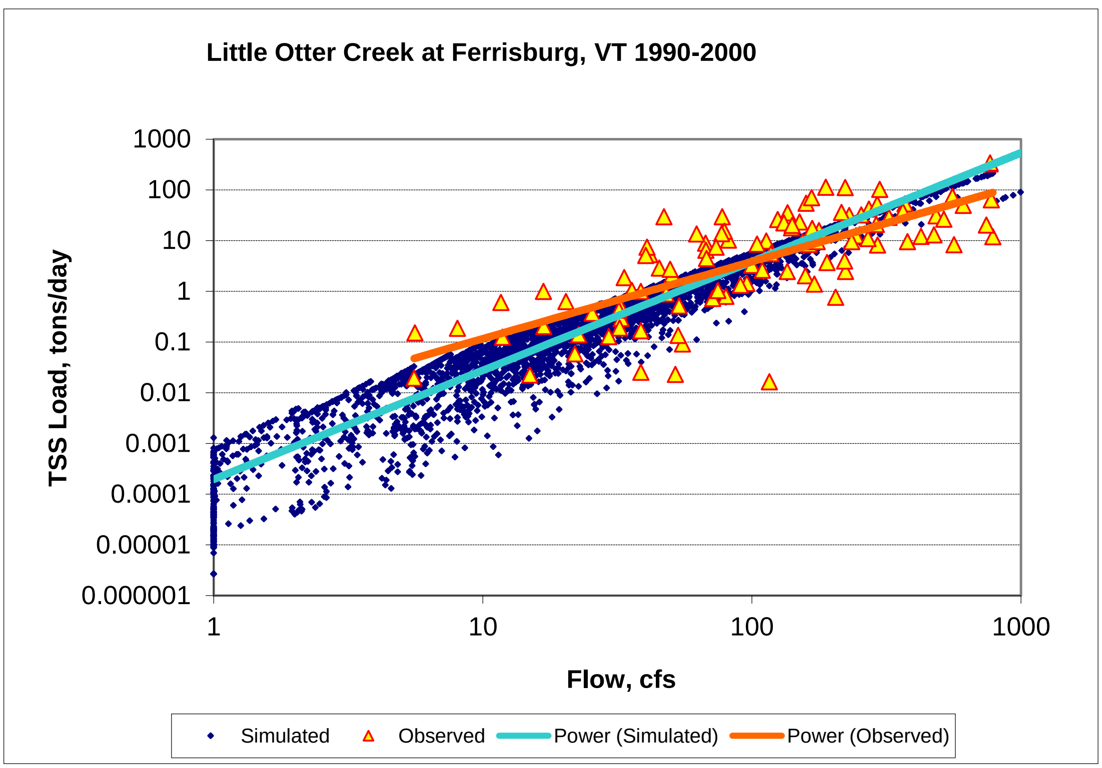


Figure K-74. Power plot of simulated and observed TSS load vs flow at Little Otter Creek at Ferrisburg, VT (validation period)

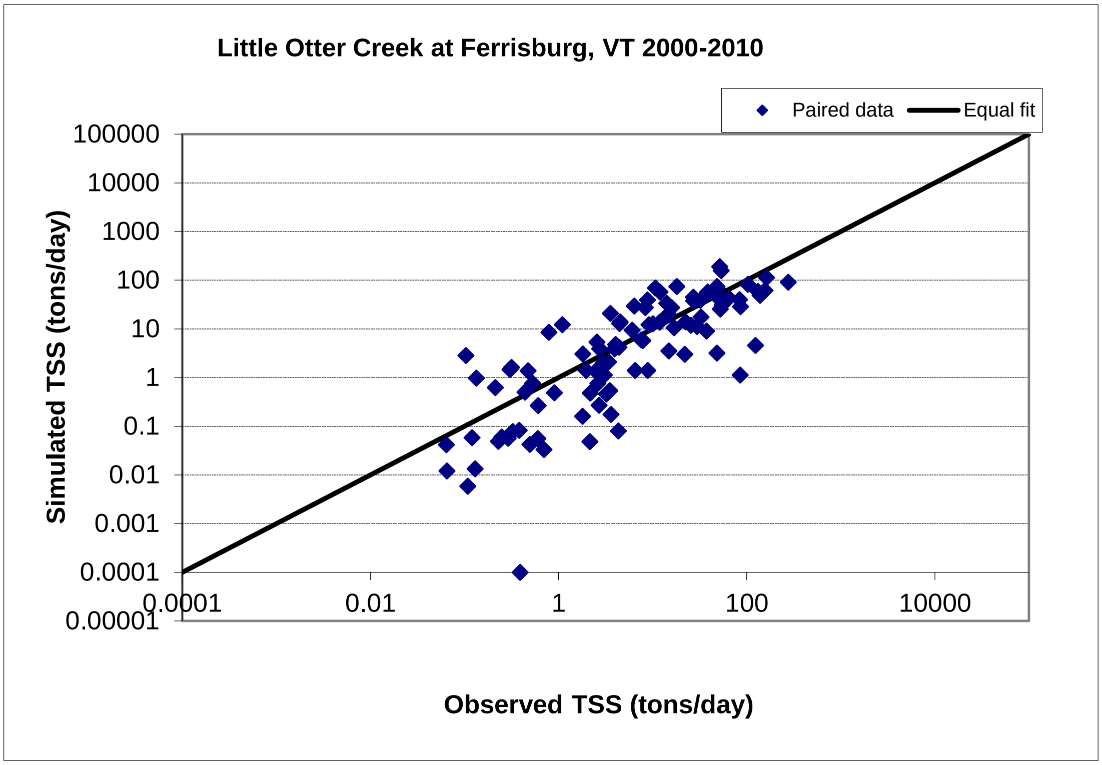


Figure K-75. Paired simulated vs observed TSS load at Little Otter Creek at Ferrisburg, VT (calibration period)

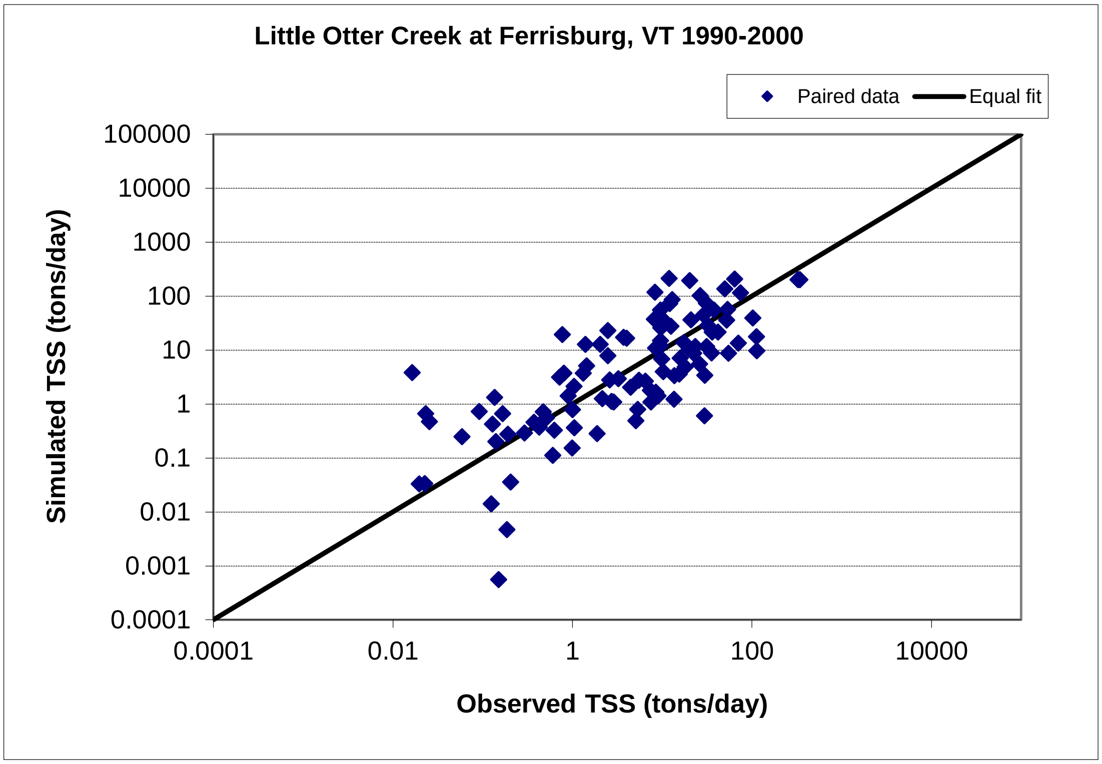


Figure K-76. Paired simulated vs observed TSS load at Little Otter Creek at Ferrisburg, VT (validation period)

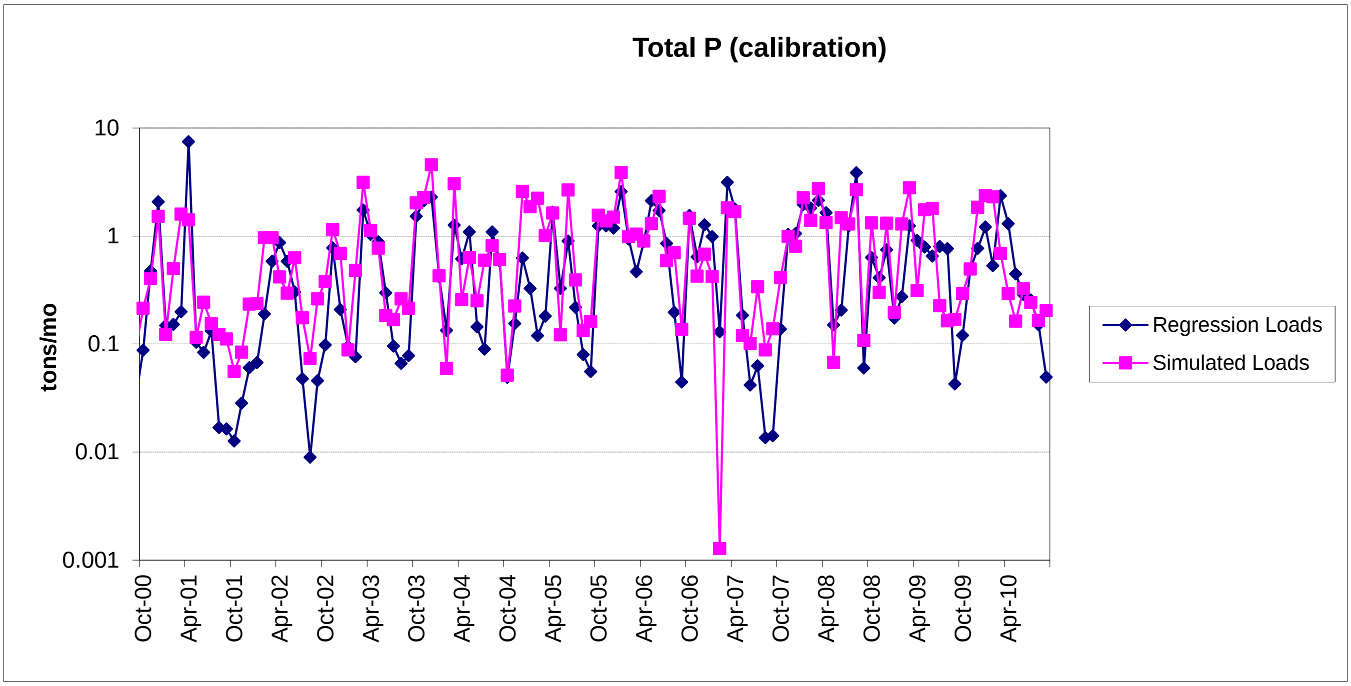


Figure K-77. Monthly simulated and estimated TP load at Little Otter Creek at Ferrisburg, VT (calibration period)

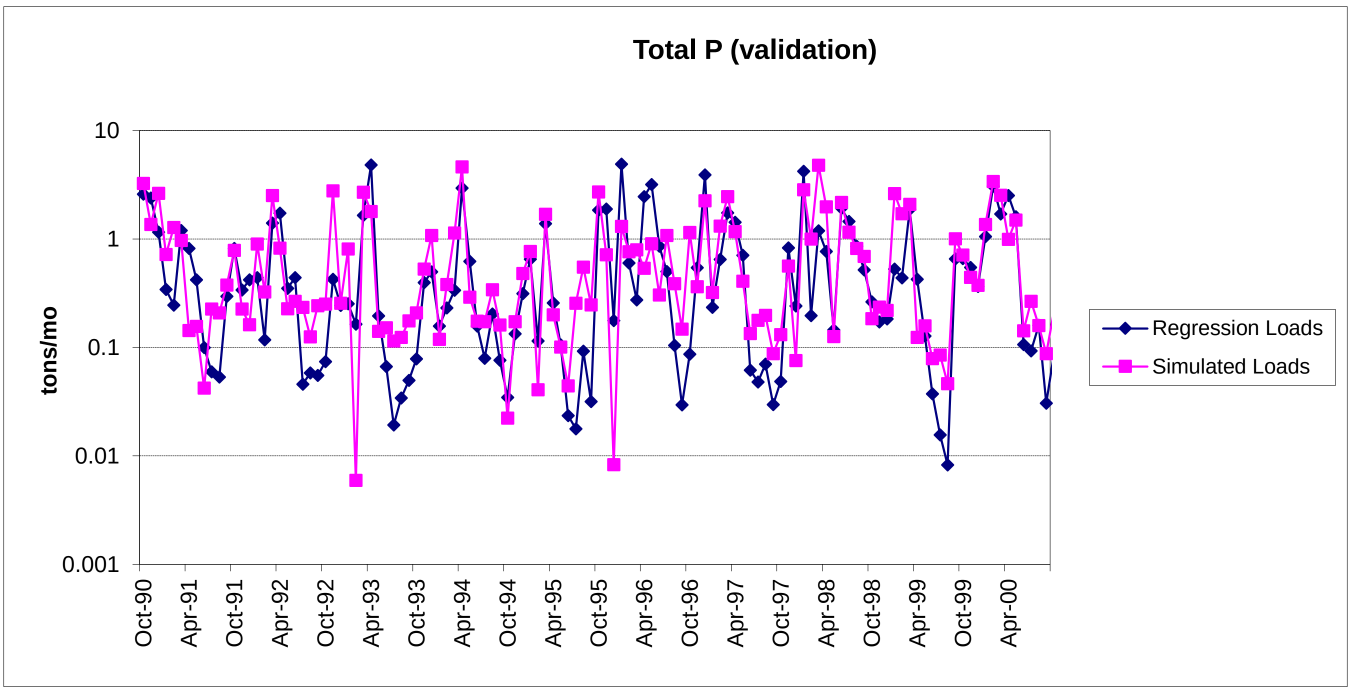


Figure K-78. Monthly simulated and estimated TP load at Little Otter Creek at Ferrisburg, VT (validation period)

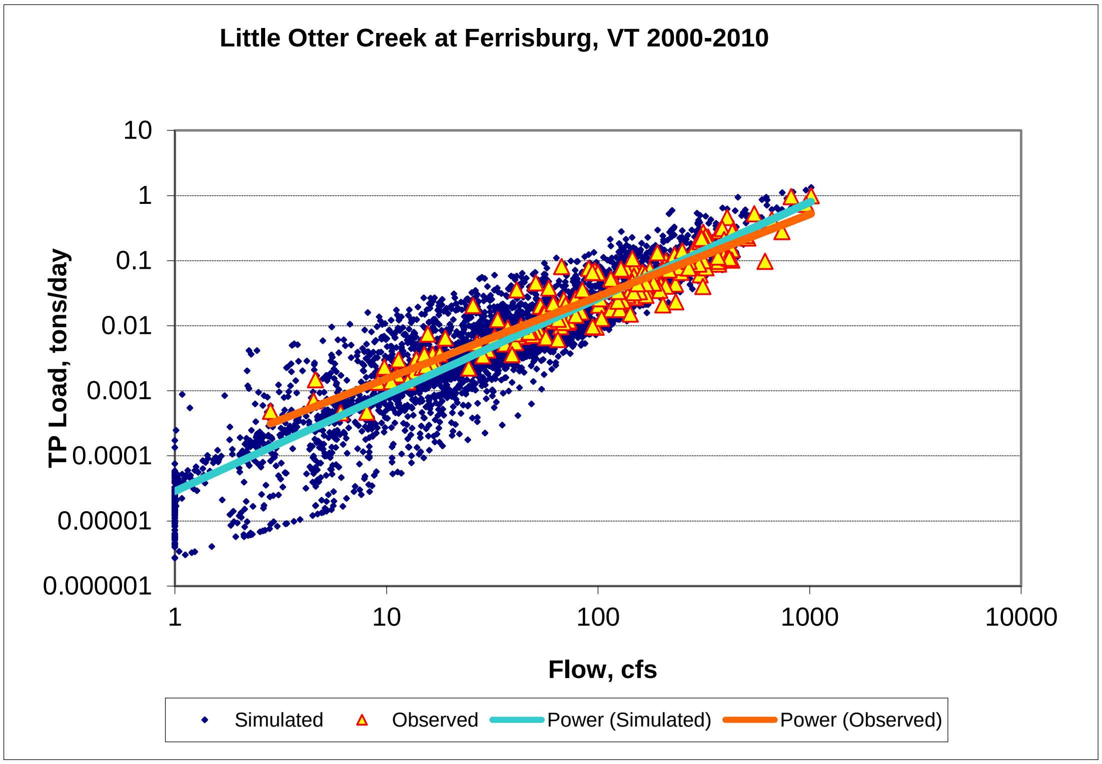


Figure K-79. Power plot of simulated and observed TP load vs flow at Little Otter Creek at Ferrisburg, VT (calibration period)

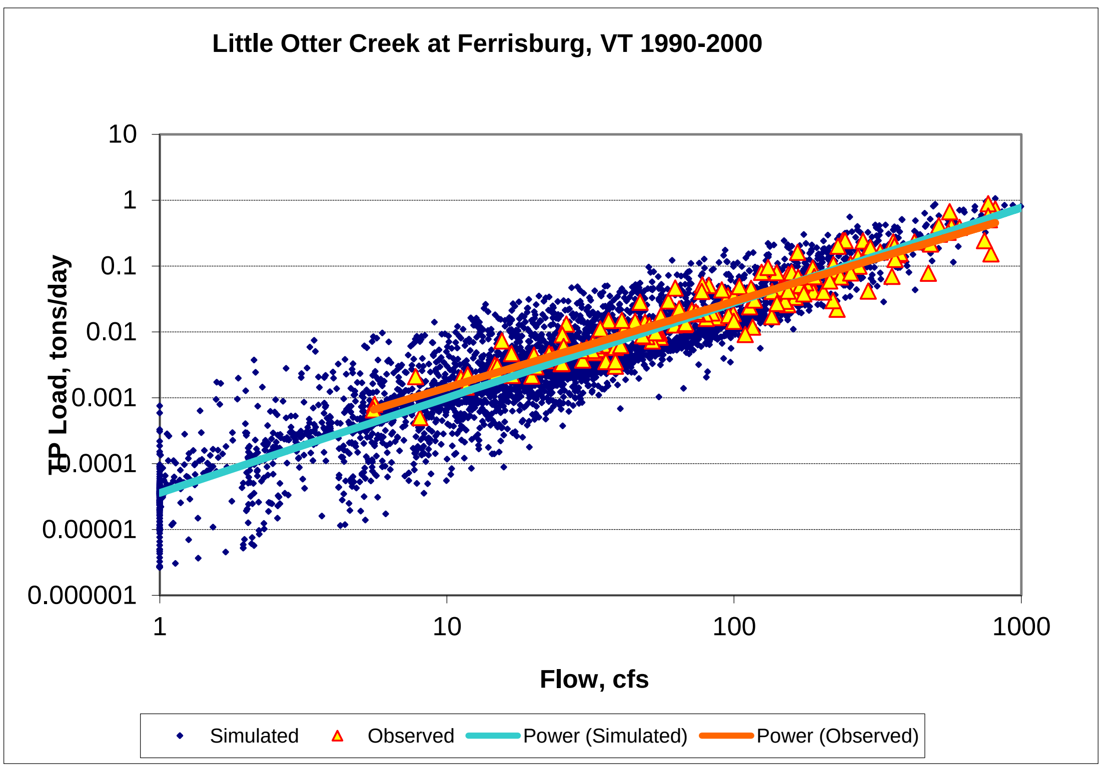


Figure K-80. Power plot of simulated and observed TP load vs flow at Little Otter Creek at Ferrisburg, VT (validation period)

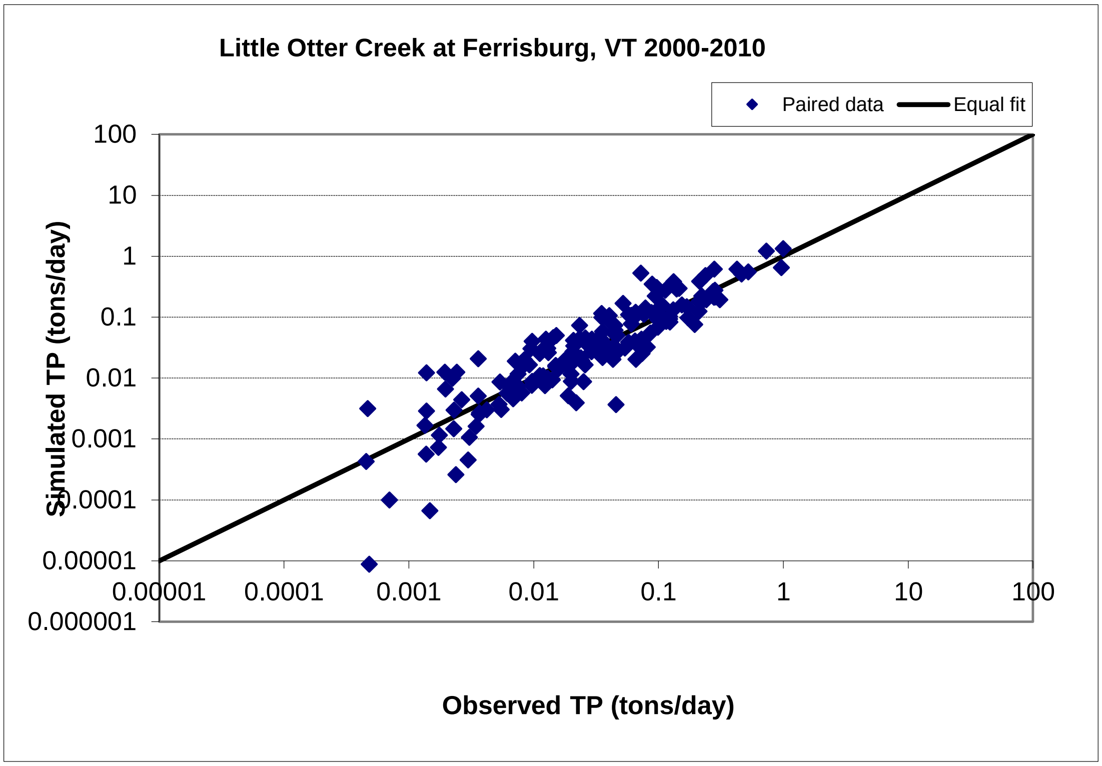


Figure K-81. Paired simulated vs observed TP load at Little Otter Creek at Ferrisburg, VT (calibration period)

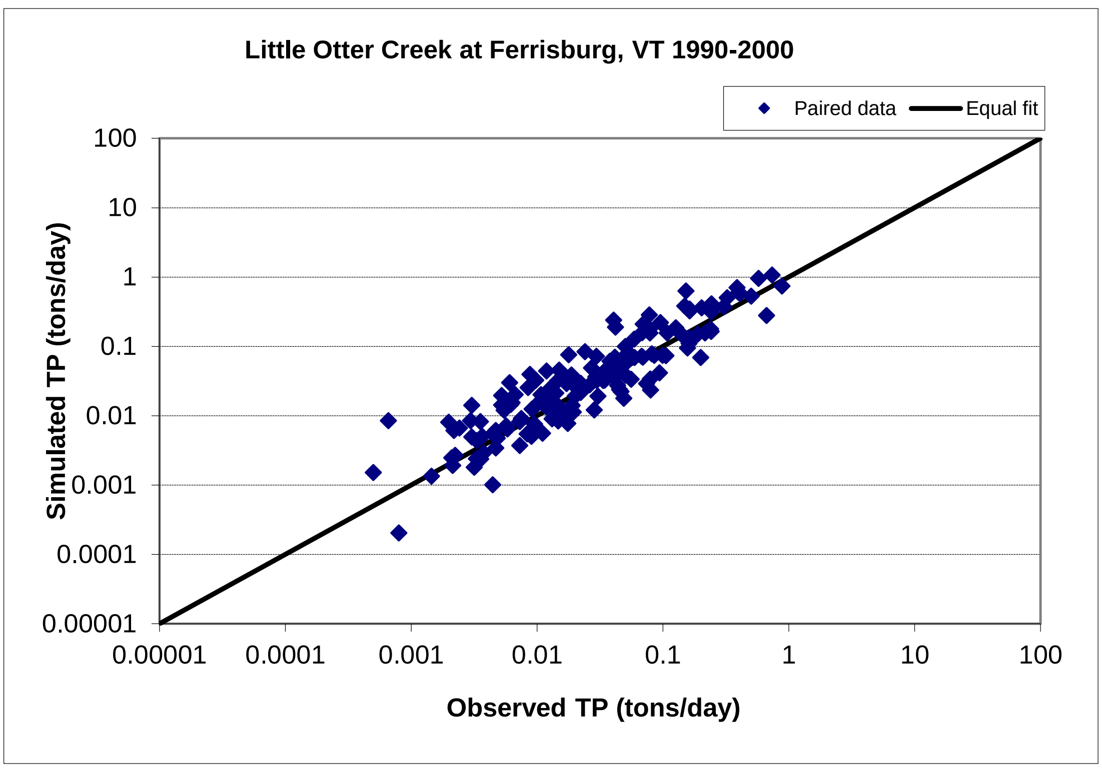


Figure K-82. Paired simulated vs observed TP load at Little Otter Creek at Ferrisburg, VT (validation period)

Comparison of simulated SWAT TP loads with FLUX estimates (LaPlatte River)

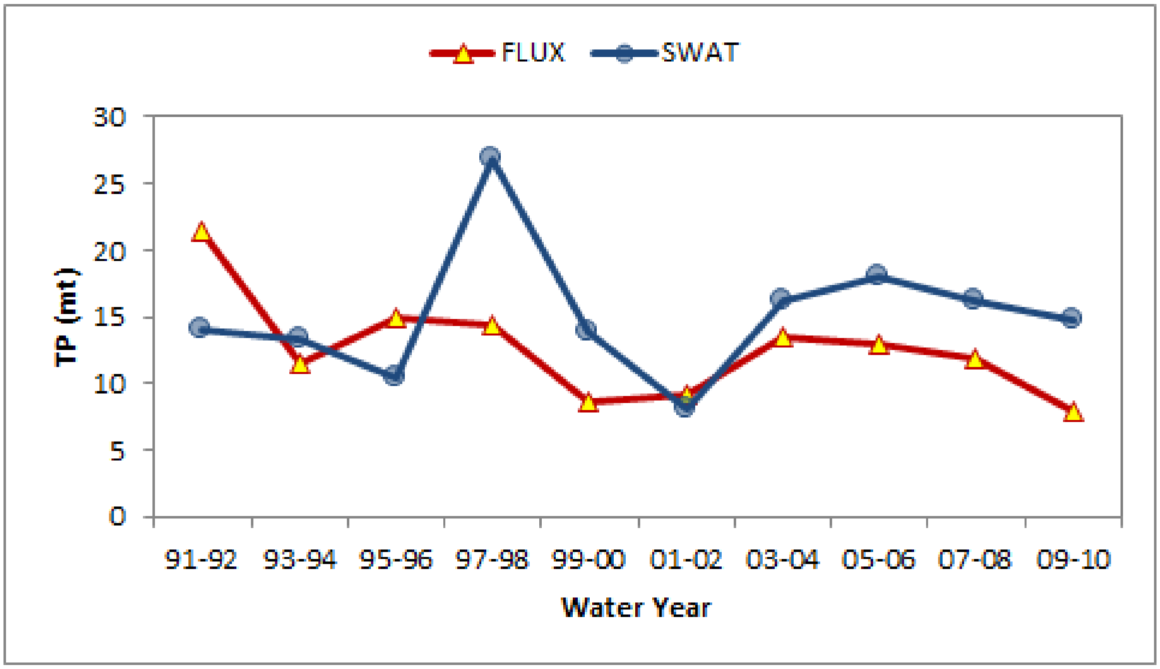


Figure K-83. Bi-annual TP loads on a water year basis as simulated by SWAT and estimated by FLUX (FLUX estimates from Smeltzer et al., 2009)

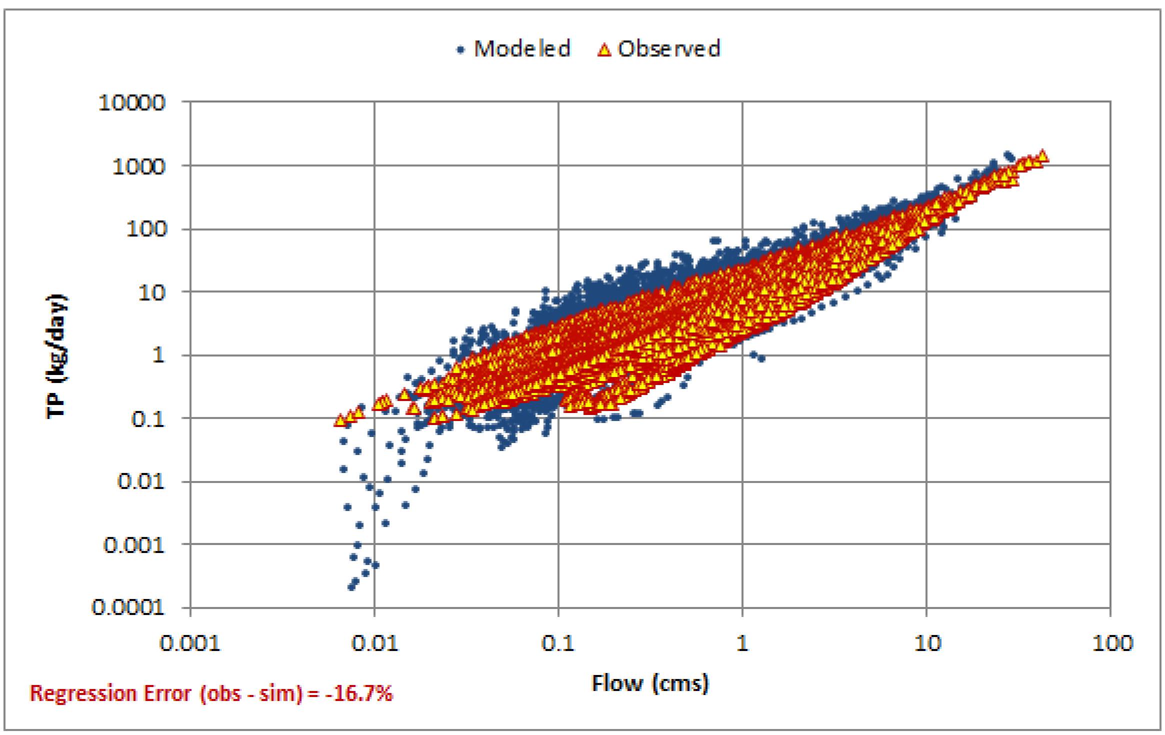


Figure K-84. Daily TP load versus flow as simulated by SWAT and estimated by FLUX (FLUX estimates from Medalie, 2013)

Comparison of simulated SWAT TP loads with FLUX estimates (Lewis Creek)

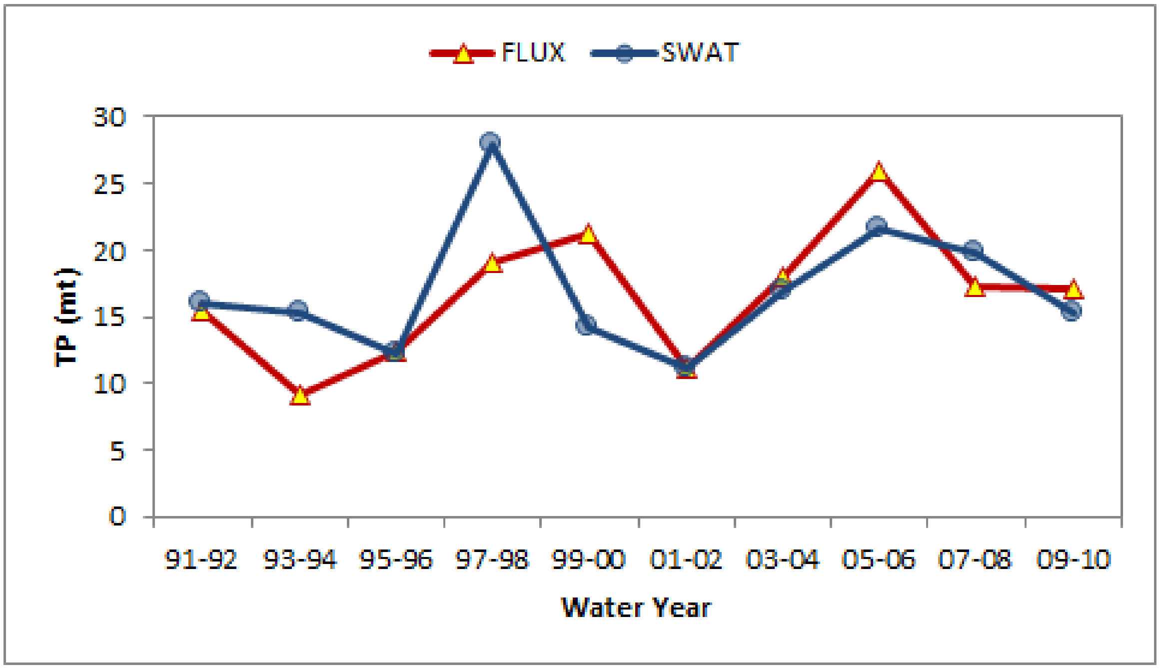


Figure K-85. Bi-annual TP loads on a water year basis as simulated by SWAT and estimated by FLUX (FLUX estimates from Smeltzer et al., 2009)

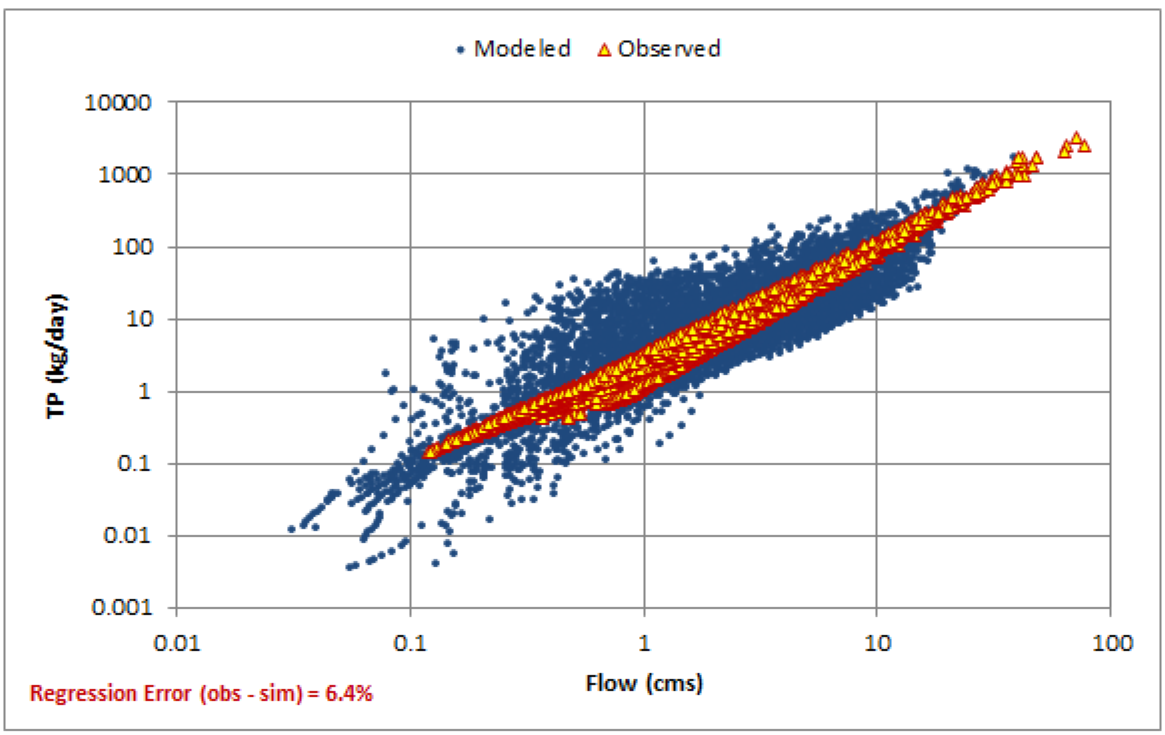


Figure K-86. Daily TP load versus flow as simulated by SWAT and estimated by FLUX (FLUX estimates from Medalie, 2013)

Comparison of simulated SWAT TP loads with FLUX estimates (Little Otter Creek)

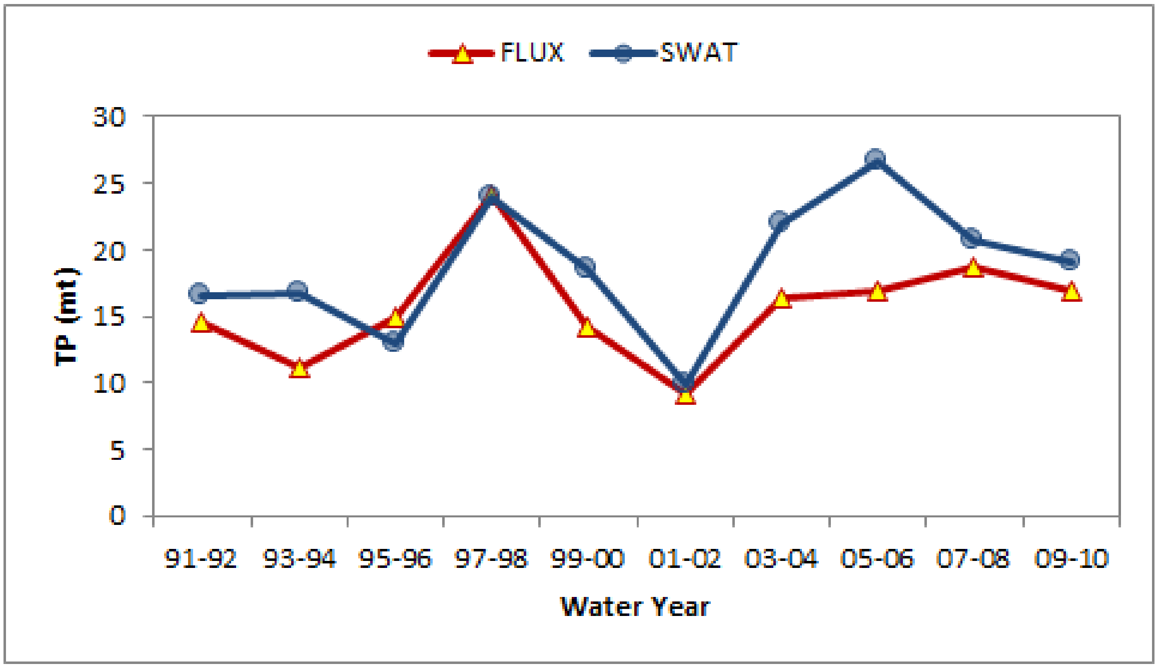


Figure K-87. Bi-annual TP loads on a water year basis as simulated by SWAT and estimated by FLUX (FLUX estimates from Smeltzer et al., 2009)

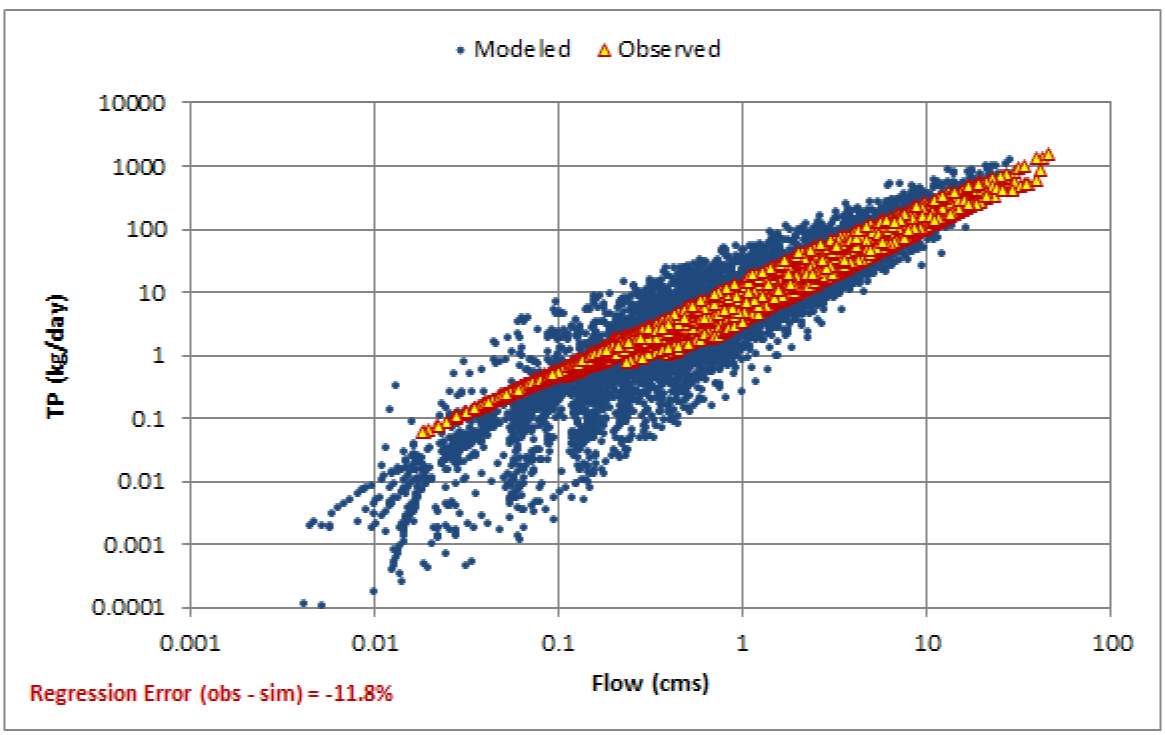


Figure K-88. Daily TP load versus flow as simulated by SWAT and estimated by FLUX (FLUX estimates from Medalie, 2013)

TP distribution by landuse from upland sources

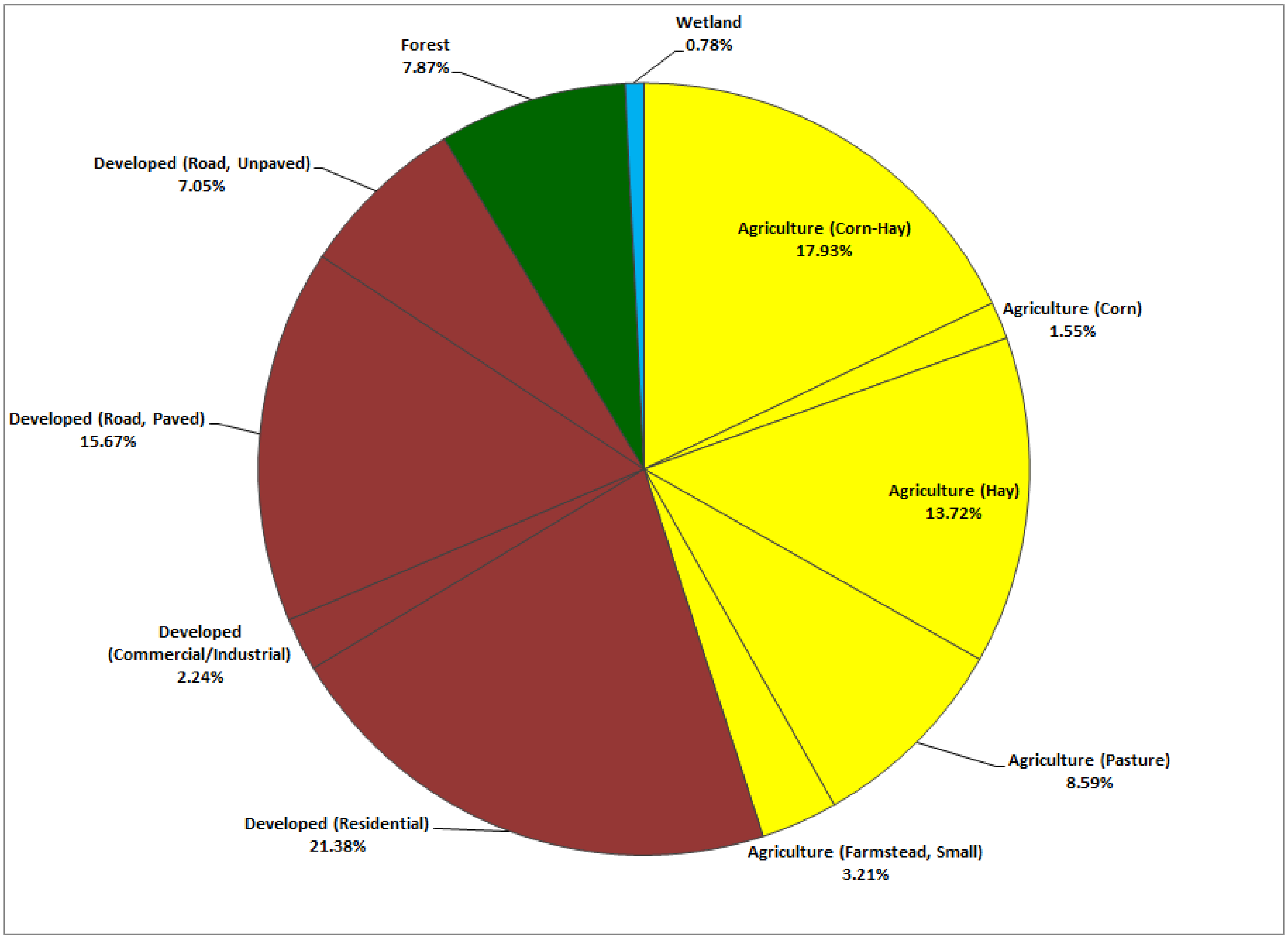


Figure K-89. Distribution of simulated total upland TP loads by landuse categories

Table K-21. TP export rates (kg/ha/yr) by landuse categories for the 30 year simulation period

Landuse	Classification	Area (ha)	Area (%)	Mean	Min	Q_{25}	Q_{50}	Q_{75}	Max
Agriculture	Corn-Hay	573	4.23	**1.15**	0.02	0.70	1.21	1.60	2.82
	Corn	73	0.54	**0.78**	0.31	0.50	0.75	0.94	1.65
	Hay	781	5.75	**0.65**	0.21	0.41	0.57	0.84	1.37
	Pasture	227	1.67	**1.39**	0.53	0.98	1.21	1.78	3.22
	Farmstead, Small	46	0.34	**2.58**	1.30	1.91	2.28	3.28	4.65
Urban	Residential	2,126	15.67	**0.37**	0.25	0.31	0.37	0.41	0.51
	Commercial/Industrial	52	0.38	**1.59**	1.12	1.49	1.60	1.70	1.91
	Road, Paved	346	2.55	**1.67**	1.24	1.57	1.68	1.74	2.01
	Road, Unpaved	53	0.39	**4.95**	3.86	4.71	4.97	5.13	5.94
Forest	Forest	8,771	64.64	**0.03**	0.01	0.02	0.03	0.04	0.07
Wetland	Wetland	522	3.84	**0.06**	0.02	0.04	0.05	0.07	0.13

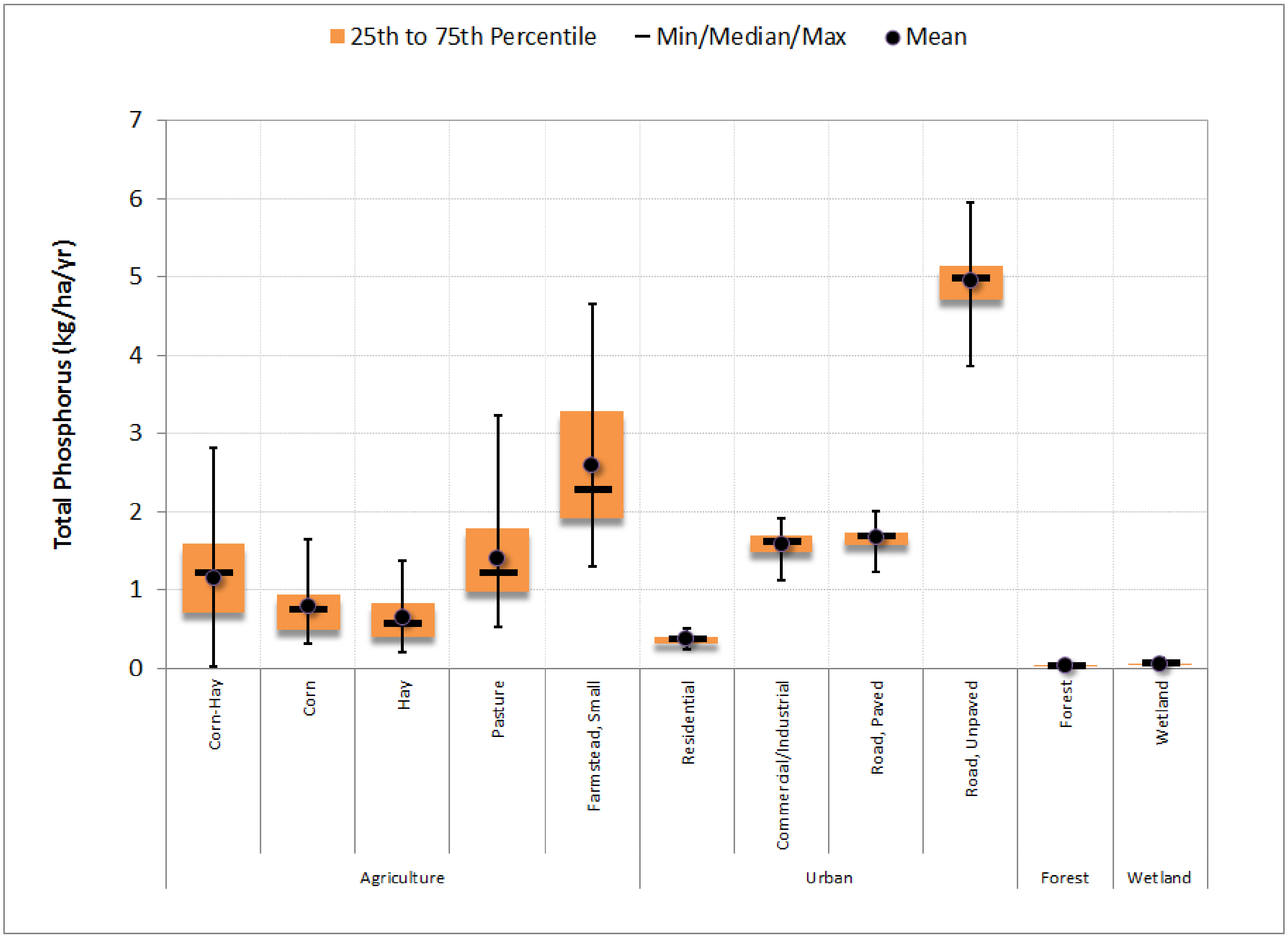


Figure K-90. TP export rates (kg/ha/yr) by landuse categories for the 30 year simulation period

Table K-22. TP export rates (kg/ha/yr) for the residential landuse categories for the 30 year simulation period

Residential Category	Area (ha)	Area (%)	Mean	Min	Q25	Q50	Q75	Max
Low Density	1,056	55.08	**0.06**	0.02	0.03	0.06	0.07	0.15
Medium Density	653	34.08	**0.24**	0.14	0.17	0.24	0.28	0.41
High Density	208	10.84	**0.91**	0.55	0.78	0.91	1.02	1.25
Total	1,917	100.00	**0.21**	0.13	0.16	0.21	0.24	0.35

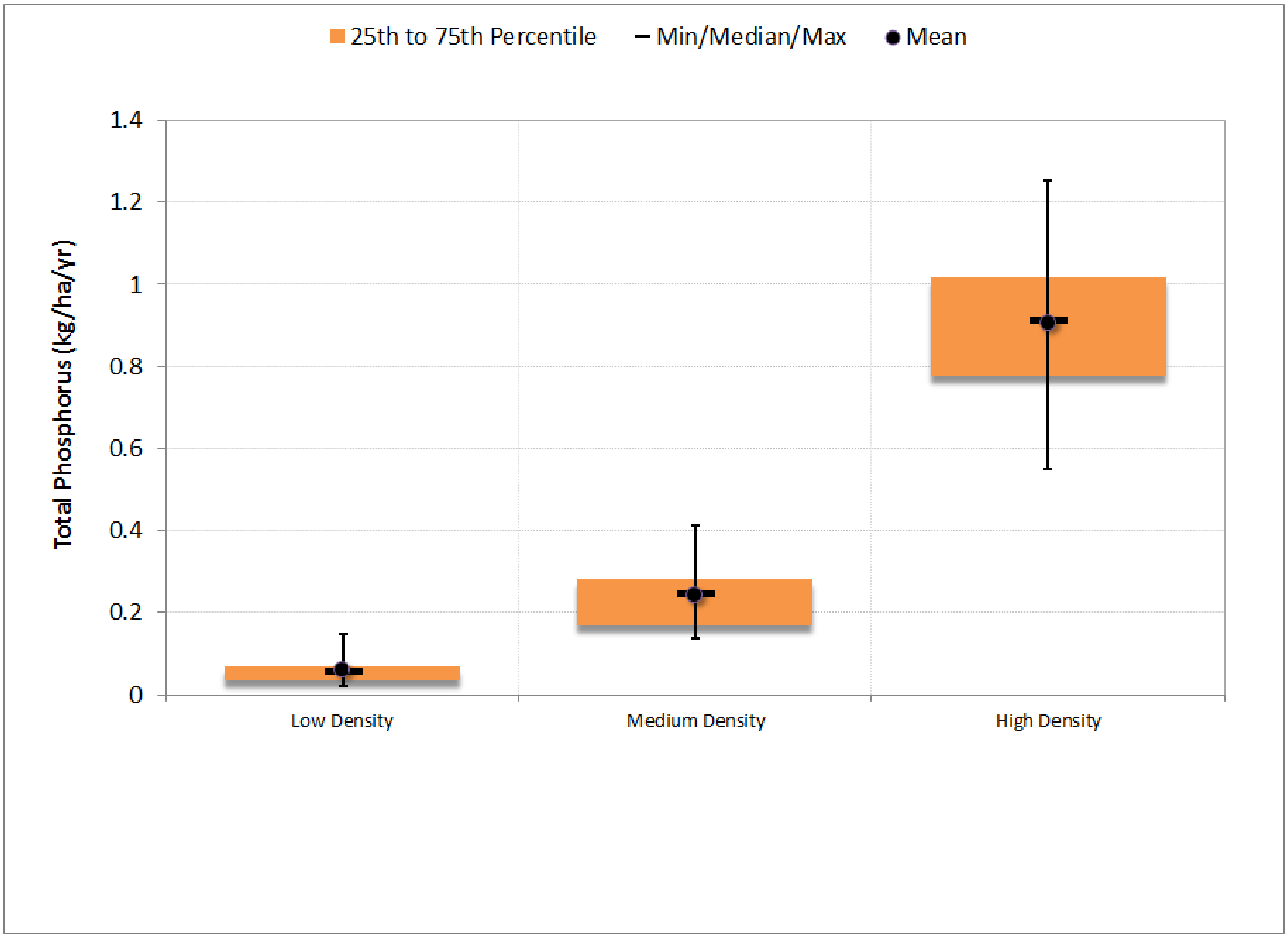


Figure K-91. TP export rates (kg/ha/yr) for the residential landuse categories for the 30 year simulation period

WATER QUALITY – Mill River, Jewett and Stevens Brook

TP distribution by landuse from upland sources

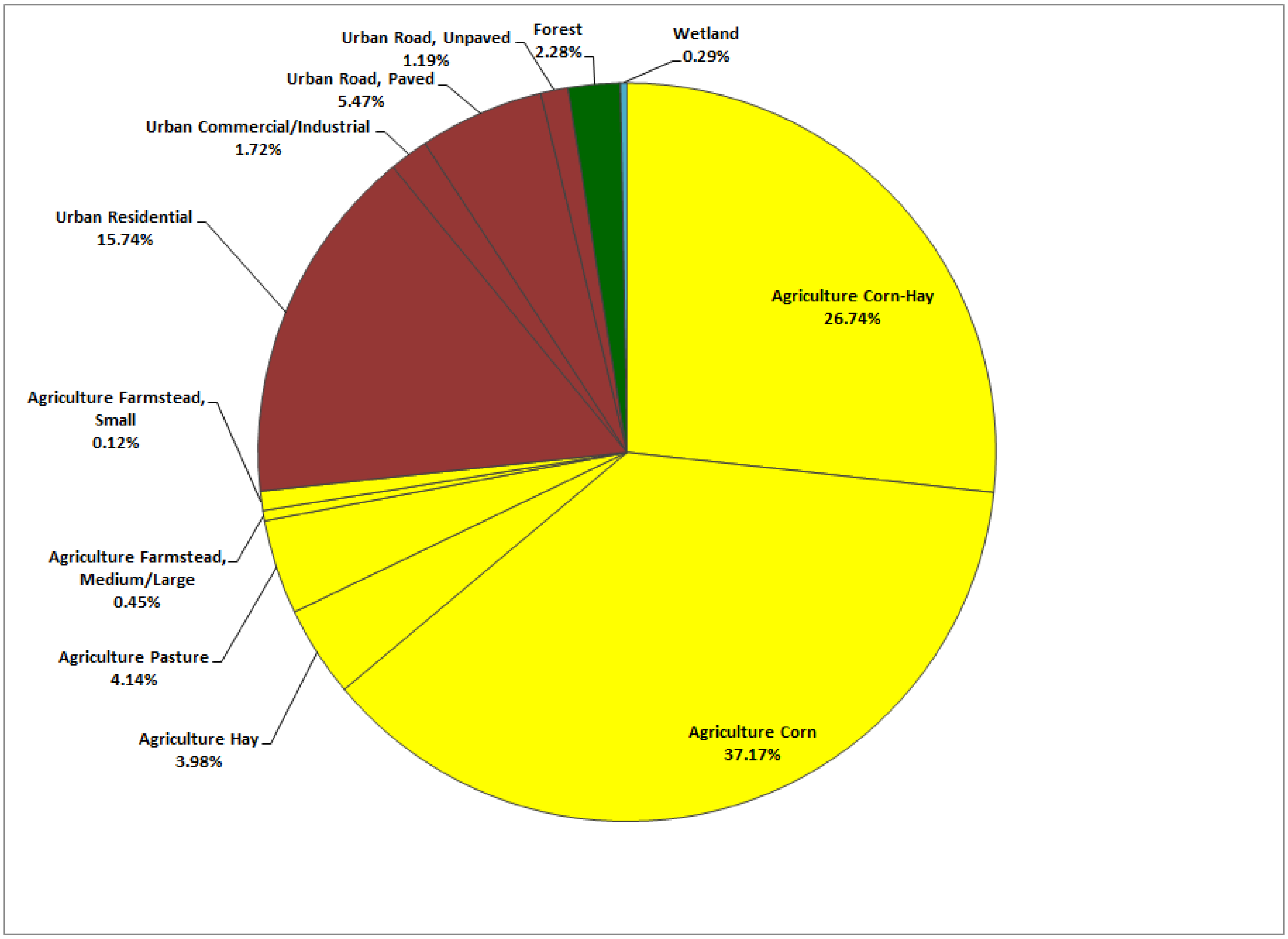


Figure K-92. Distribution of simulated total upland TP loads by landuse categories

Table K-23. TP export rates (kg/ha/yr) by landuse categories for the 30 year simulation period

Landuse	Classification	Area (ha)	Area (%)	Mean	Min	Q_{25}	Q_{50}	Q_{75}	Max
Agriculture	Corn-Hay	2,697	22.49	**0.96**	0.05	0.65	0.98	1.26	2.35
	Corn	932	7.77	**3.84**	1.16	2.54	3.45	4.89	7.68
	Hay	1,096	9.13	**0.35**	0.08	0.19	0.35	0.47	0.89
	Pasture	528	4.40	**0.76**	0.31	0.52	0.76	0.95	1.22
	Farmstead, Medium/Large	22	0.19	**1.94**	0.87	1.39	1.83	2.47	3.38
	Farmstead, Small	39	0.33	**2.06**	0.85	1.41	1.89	2.78	3.70
Urban	Residential	1,803	15.03	**0.84**	0.51	0.66	0.83	1.02	1.15
	Commercial/Industrial	94	0.79	**1.75**	1.37	1.57	1.72	1.92	2.15
	Road, Paved	272	2.27	**1.94**	1.48	1.79	1.91	2.05	2.36
	Road, Unpaved	25	0.20	**4.68**	3.67	4.43	4.69	4.93	5.54
Forest	Forest	3,929	32.75	**0.06**	0.03	0.04	0.05	0.06	0.11
Wetland	Wetland	558	4.65	**0.05**	0.01	0.03	0.04	0.07	0.10

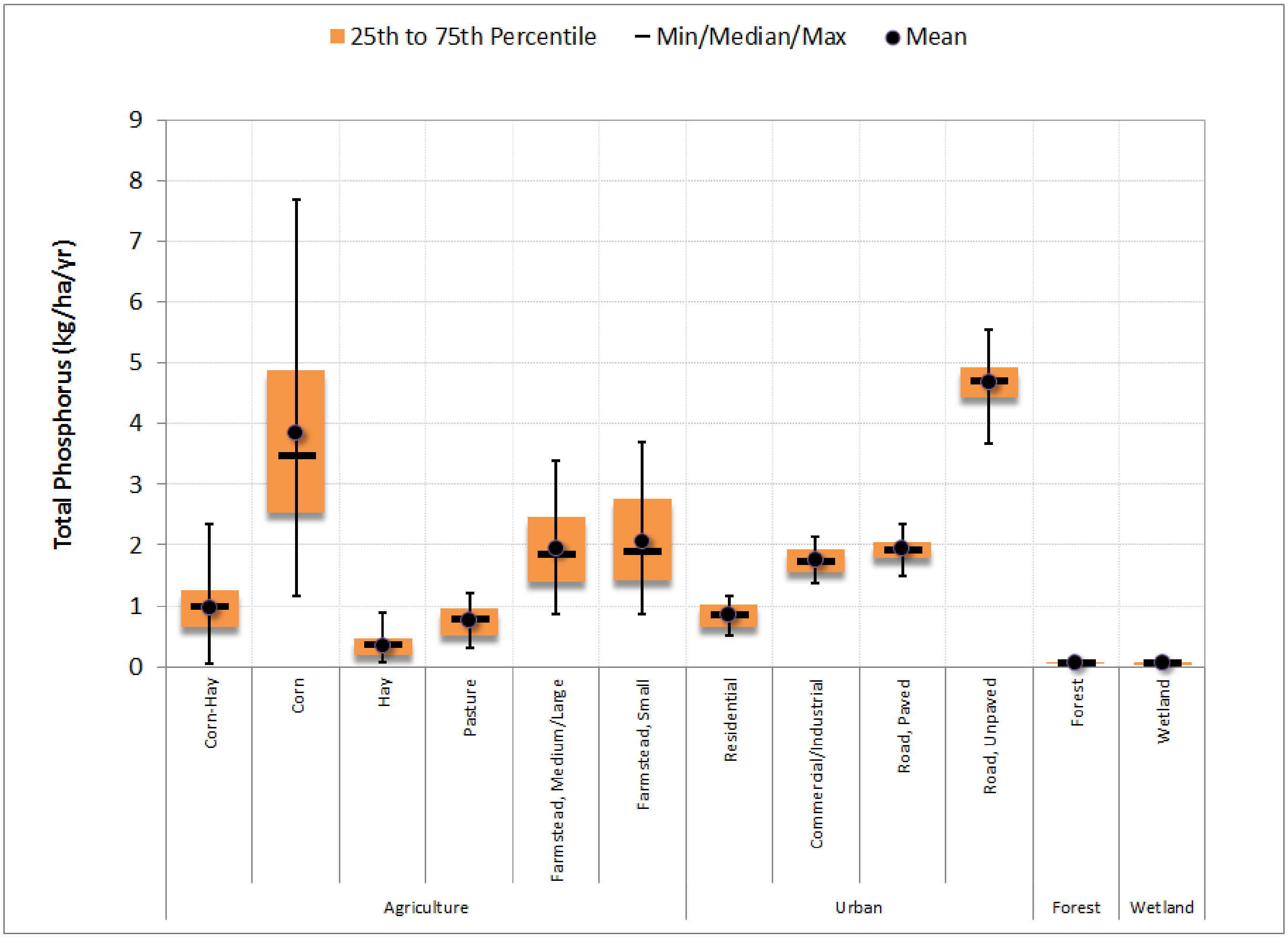


Figure K-93. TP export rates (kg/ha/yr) by landuse categories for the 30 year simulation period

Table K-24. TP export rates (kg/ha/yr) for the residential landuse categories for the 30 year simulation period

Residential Category	Area (ha)	Area (%)	Mean	Min	Q_{25}	Q_{50}	Q_{75}	Max
Low Density	791	46.75	**0.39**	0.17	0.26	0.39	0.50	0.59
Medium Density	650	38.43	**1.01**	0.57	0.77	1.00	1.23	1.40
High Density	251	14.82	**1.37**	0.89	1.12	1.34	1.61	1.81
Total	1,693	100.00	**0.77**	0.43	0.58	0.76	0.94	1.08

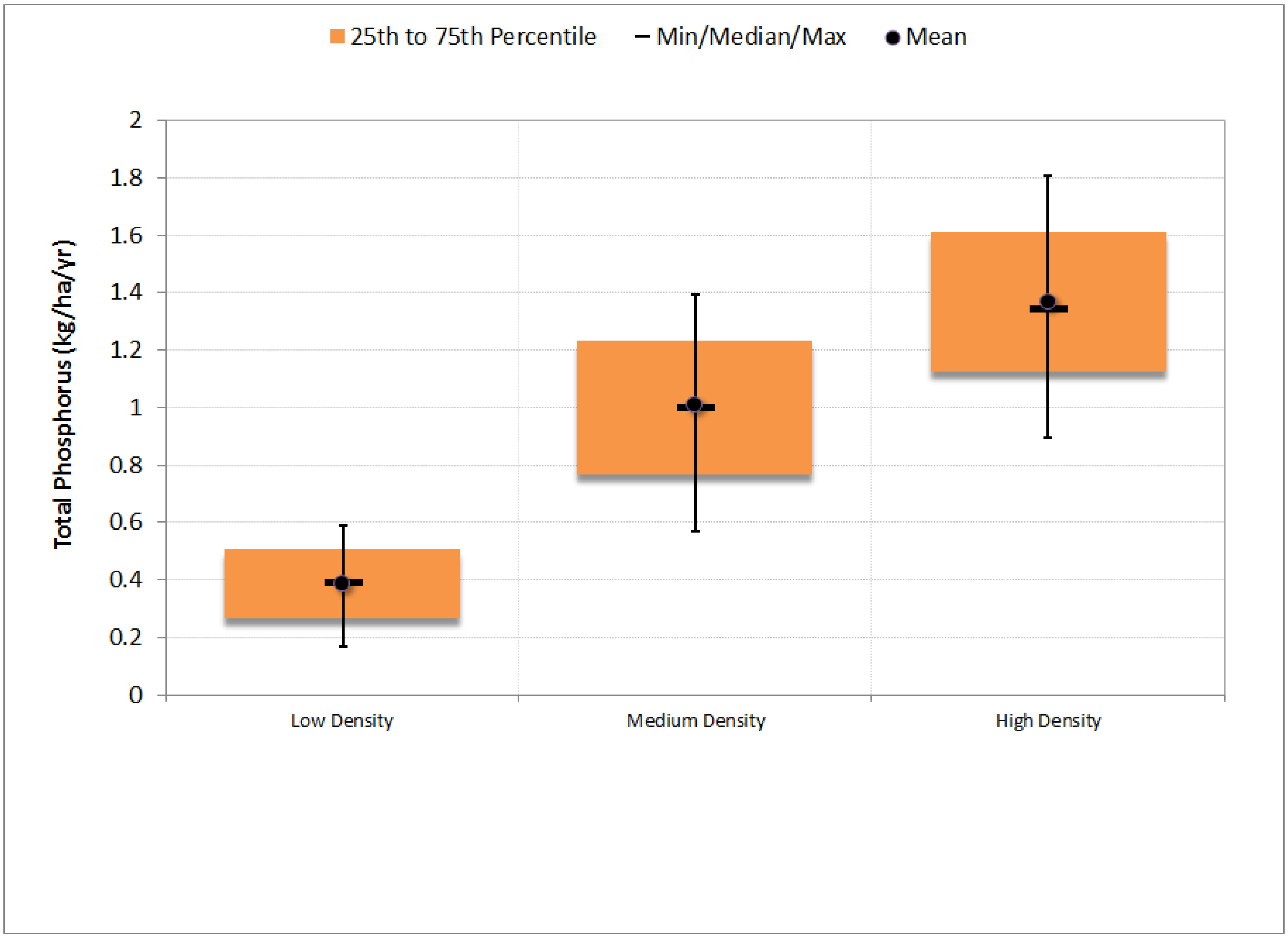


Figure K-94. TP export rates (kg/ha/yr) for the residential landuse categories for the 30 year simulation period

TSS and TP distribution by channel and upland sources

Table K-25. TSS and TP distribution by source categories

Source	TSS		TP	
	Load(mt/year)	Percentage (%)	Load (kg/year)	Percentage (%)
Upland	27,515	76.9	54,355	89.8
Stream	8,255	23.1	6,191	10.2
Total	**35,770**	**100.0**	**60,546**	**100.0**

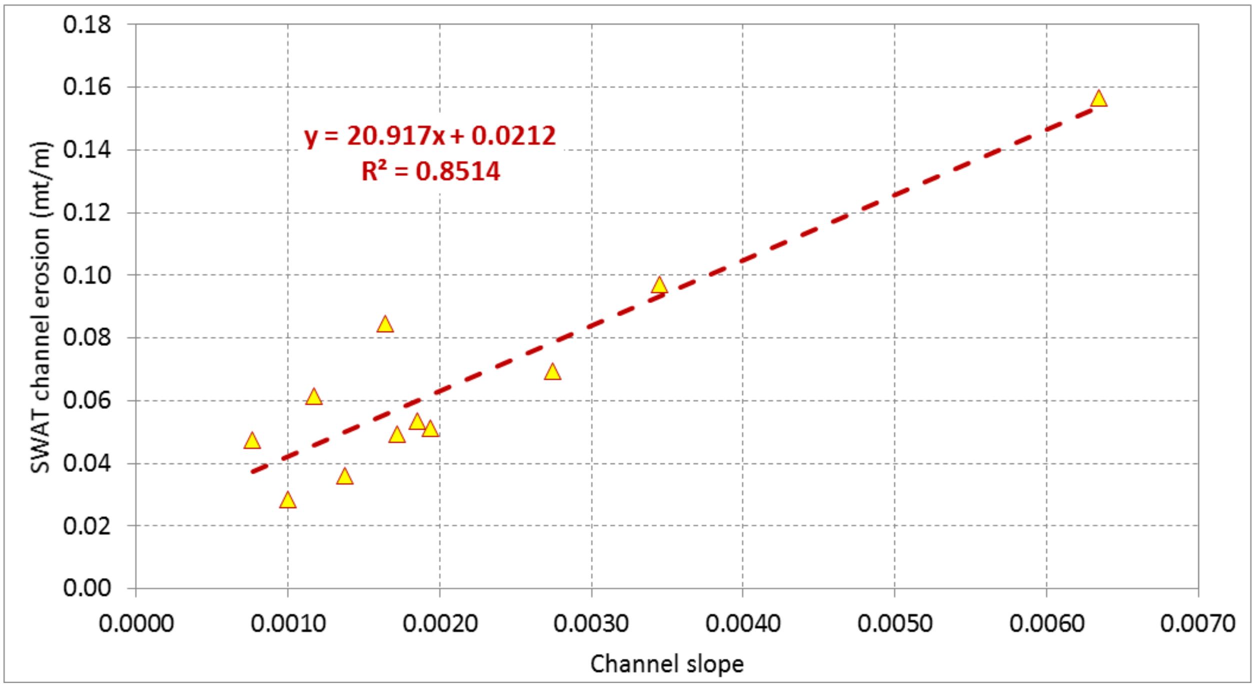


Figure K-95. SWAT simulated channel erosion relative to channel erosion susceptibility rating

TP distribution by landuse from upland sources

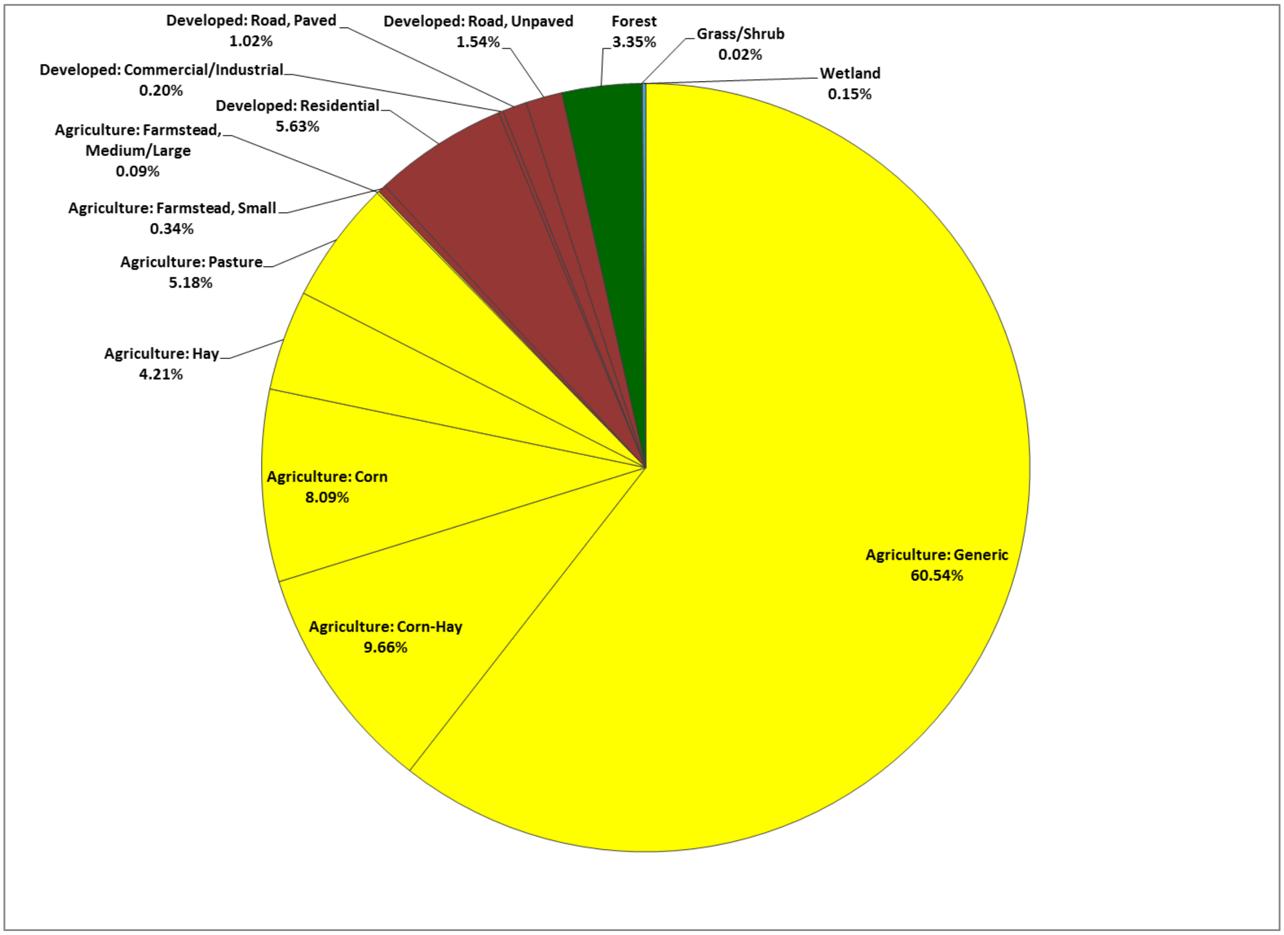


Figure K-96. Distribution of simulated total upland TP loads by landuse categories

Table K-26. TP export rates (kg/ha/yr) by landuse categories for the 30 year simulation period

Landuse	Classification	Area (ha)	Area (%)	Mean	Min	Q_{25}	Q_{50}	Q_{75}	Max
Agriculture	Generic	18,126	22.60	**1.82**	1.11	1.39	1.77	2.04	2.87
	Corn-Hay	2,601	3.24	**2.02**	0.09	1.46	2.10	2.77	3.97
	Corn	2,155	2.69	**2.04**	0.73	1.31	1.82	2.79	4.59
	Hay	3,277	4.09	**0.70**	0.35	0.48	0.68	0.83	1.40
	Pasture	13,592	16.95	**0.21**	0.11	0.16	0.20	0.24	0.35
	Farmstead, Medium/Large	16	0.02	**3.03**	1.57	2.38	2.81	3.77	4.95
	Farmstead, Small	62	0.08	**3.01**	1.54	2.28	2.72	3.74	4.99
Urban	Residential	3,221	4.02	**0.95**	0.66	0.84	0.92	1.06	1.27
	Commercial/Industrial	69	0.09	**1.58**	1.23	1.47	1.56	1.67	1.93
	Road, Paved	268	0.33	**2.06**	1.63	1.94	2.03	2.16	2.49
	Road, Unpaved	171	0.21	**4.87**	3.86	4.63	4.87	5.10	5.82
Forest	Forest	35,033	43.68	**0.05**	0.03	0.04	0.05	0.06	0.08
Grass/Shrub	Grass/Shrub	123	0.15	**0.07**	0.03	0.06	0.07	0.09	0.12
Wetland	Wetland	1,497	1.87	**0.05**	0.01	0.03	0.04	0.07	0.10

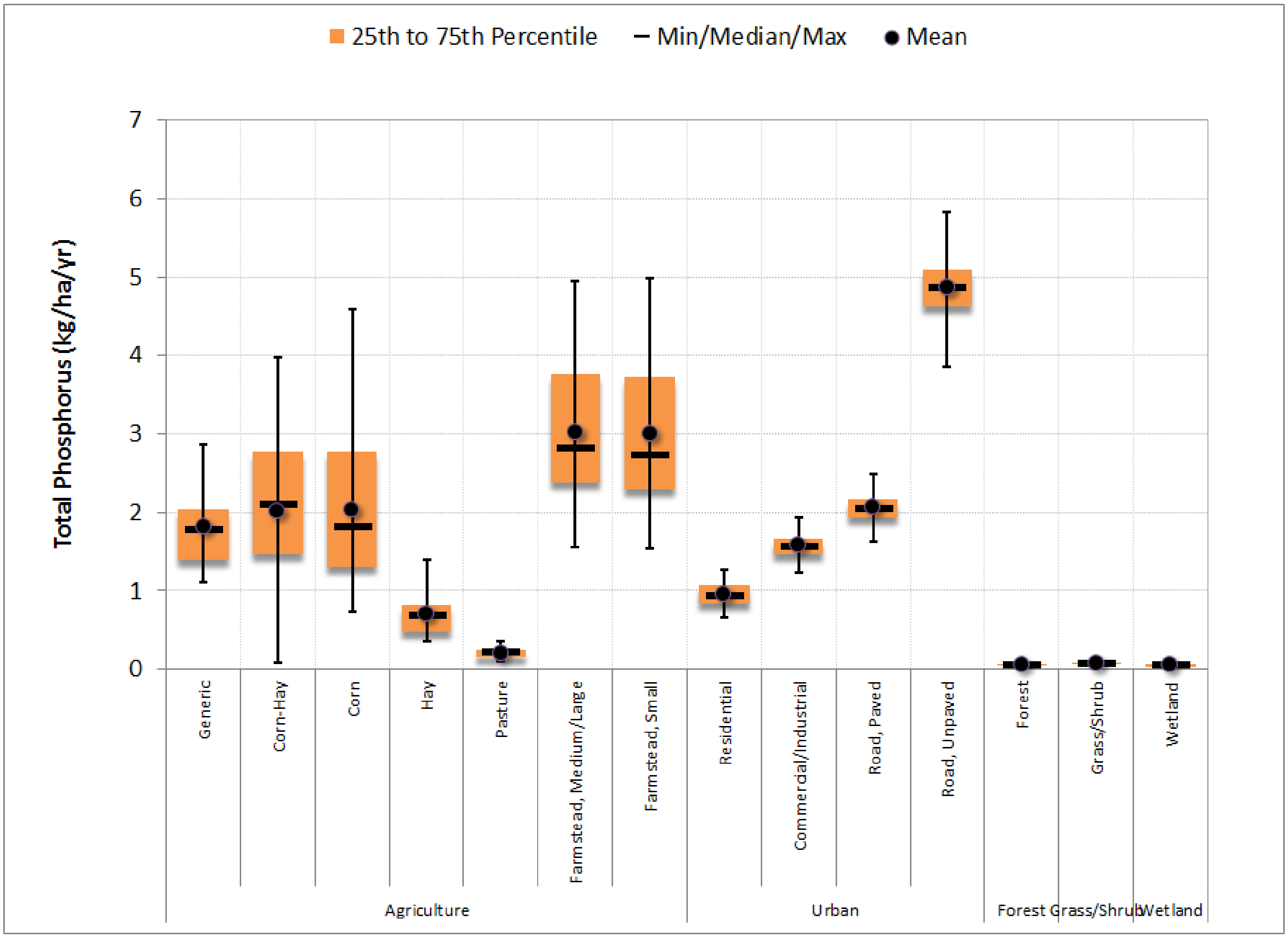


Figure K-97. TP export rates (kg/ha/yr) by landuse categories for the 30 year simulation period

Table K-27. TP export rates (kg/ha/yr) for the residential landuse categories for the 30 year simulation period

Residential Category	Area (ha)	Area (%)	Mean	Min	Q_{25}	Q_{50}	Q_{75}	Max
Low Density	479	15.38	**0.73**	0.44	0.55	0.66	0.92	1.15
Medium Density	2,516	80.83	**0.91**	0.63	0.81	0.88	1.01	1.21
High Density	118	3.78	**1.79**	1.38	1.59	1.78	1.97	2.28
Total	3,112	100.00	**0.92**	0.63	0.80	0.89	1.03	1.24

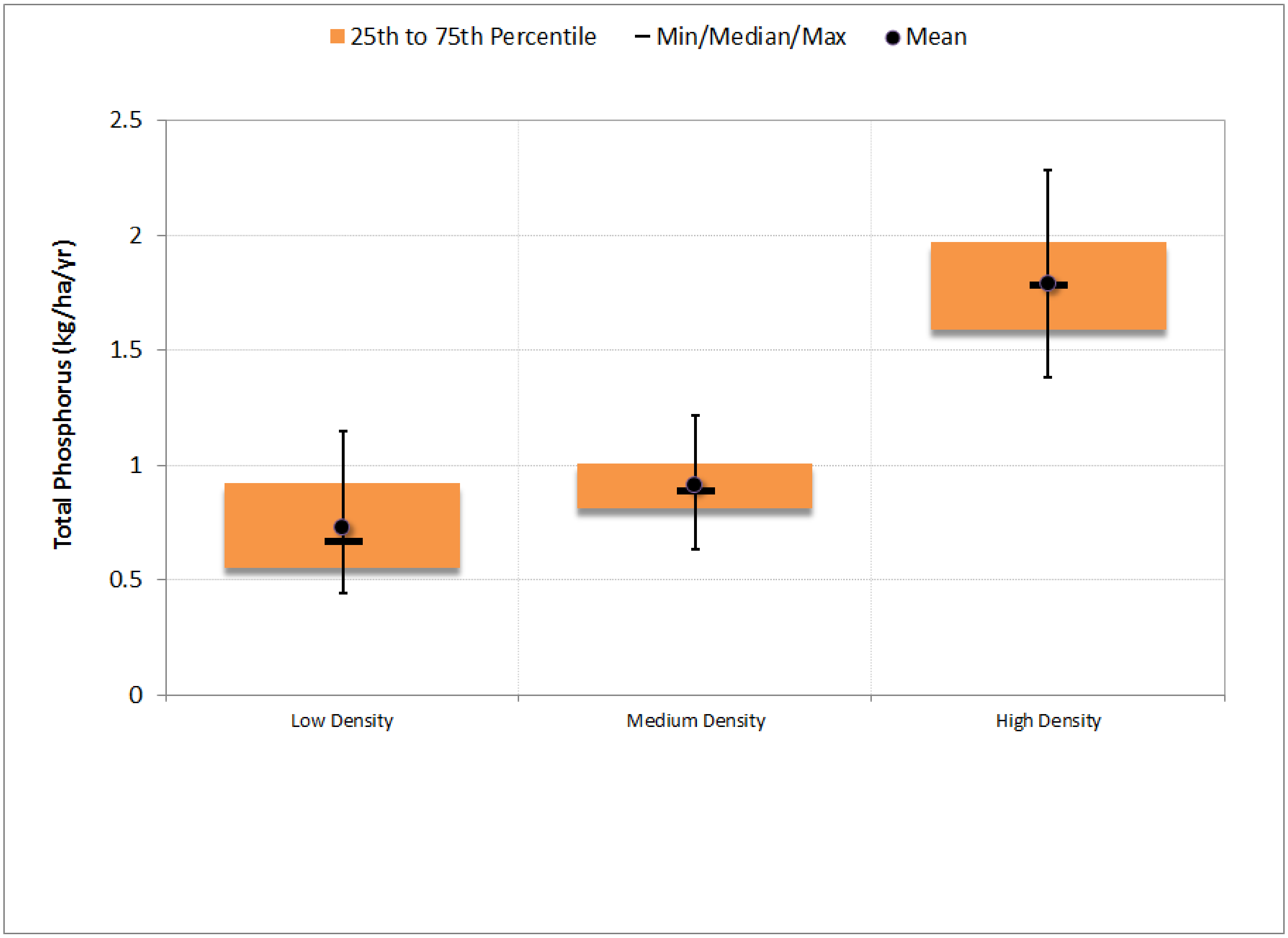


Figure K-98. TP export rates (kg/ha/yr) for the residential landuse categories for the 30 year simulation period

Comparison of simulated SWAT TP loads with FLUX estimates (Rock River)

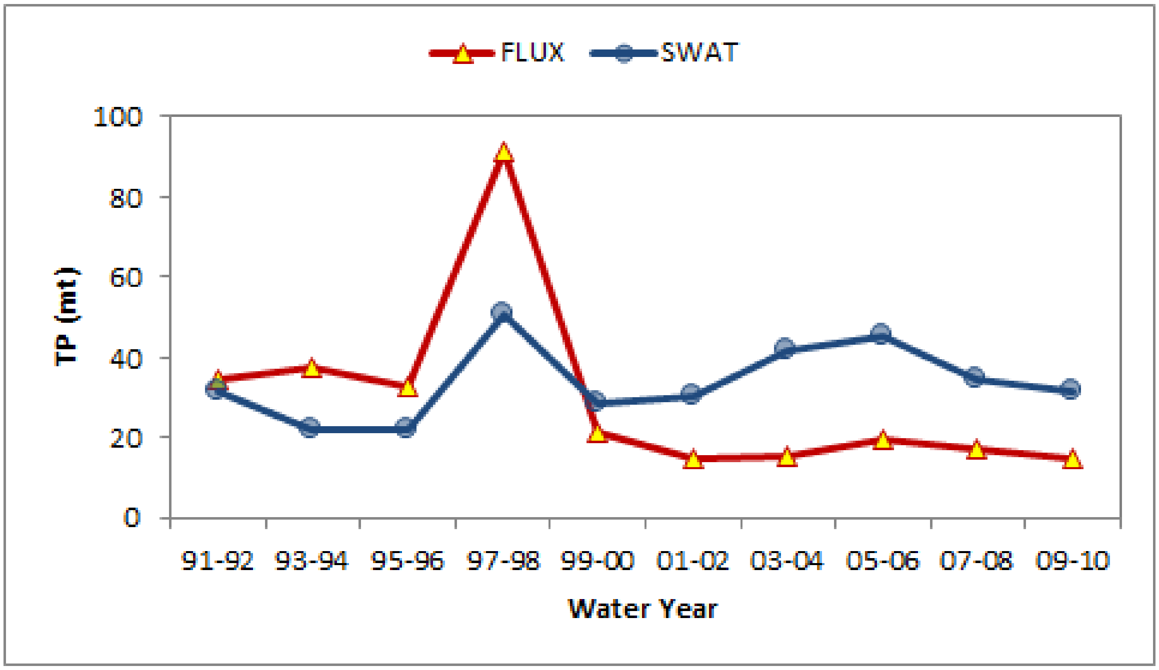


Figure K-99. Bi-annual TP loads on a water year basis as simulated by SWAT and estimated by FLUX (FLUX estimates from Smeltzer et al., 2009)

Comparison of simulated SWAT TP loads with FLUX estimates (Pike River)

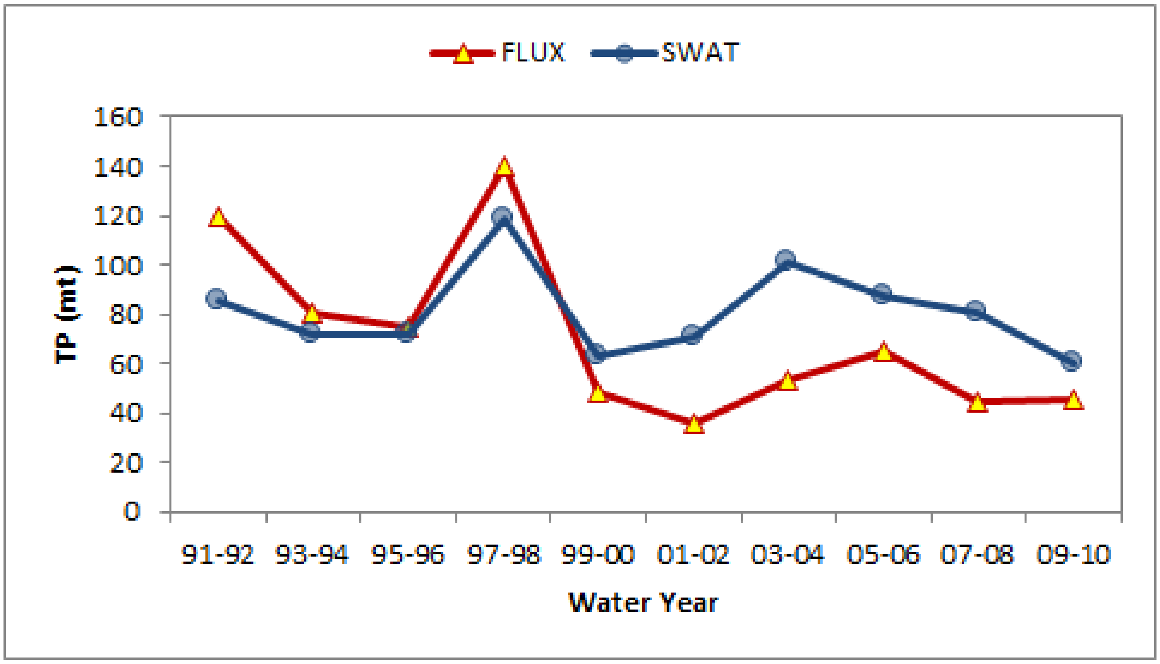


Figure K-100. Bi-annual TP loads on a water year basis as simulated by SWAT and estimated by FLUX (FLUX estimates from Smeltzer et al., 2009)

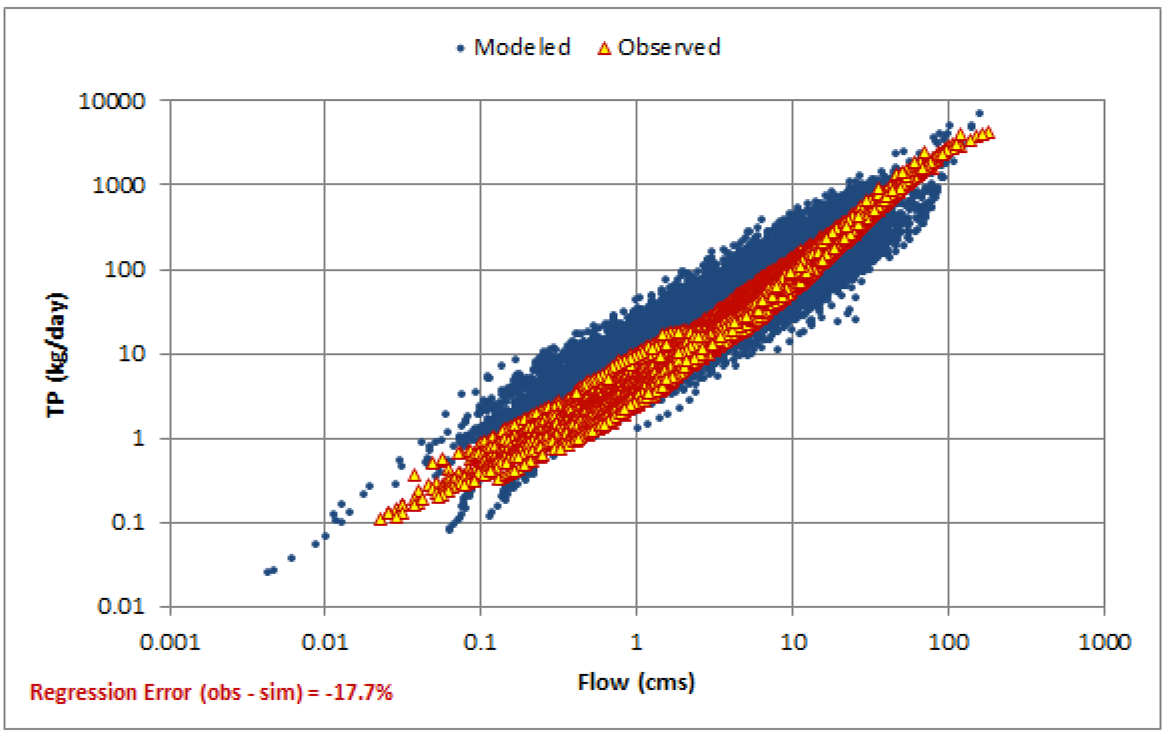


Figure K-101. Daily TP load versus flow as simulated by SWAT and estimated by FLUX (FLUX estimates from Medalie, 2013)

HYDROLOGY - Boquet River

USGS 04276500 Boquet River at Willsboro, NY - Calibration

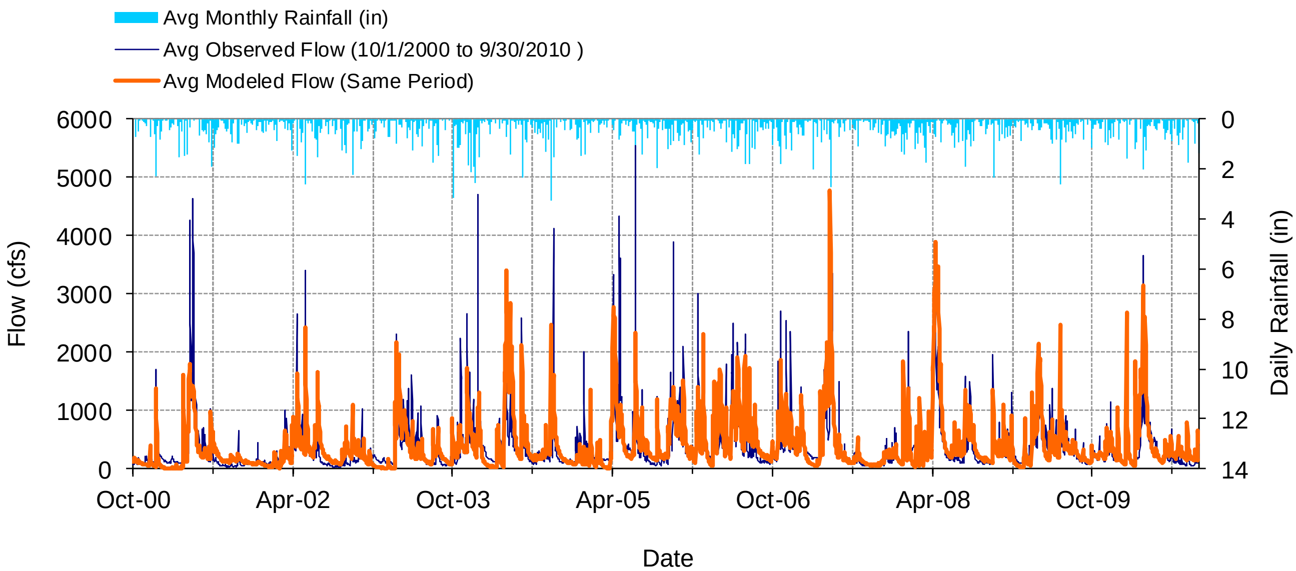


Figure K-102. Mean daily flow at USGS 04276500 Boquet River at Willsboro, NY

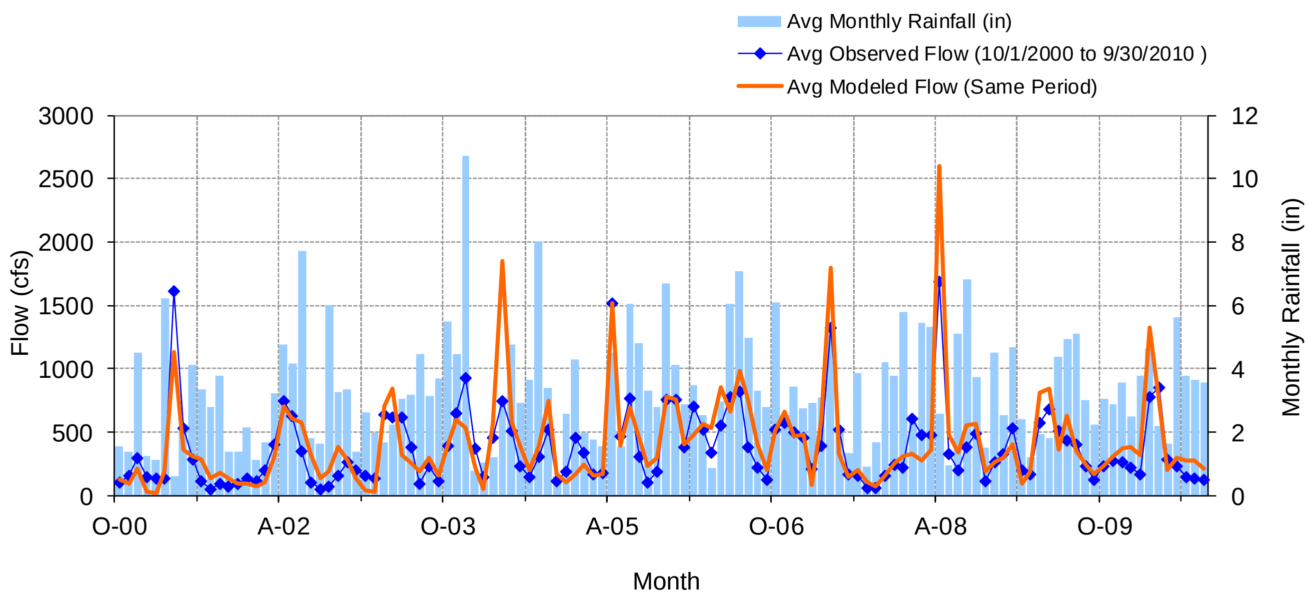


Figure K-103. Mean monthly flow at USGS 04276500 Boquet River at Willsboro, NY

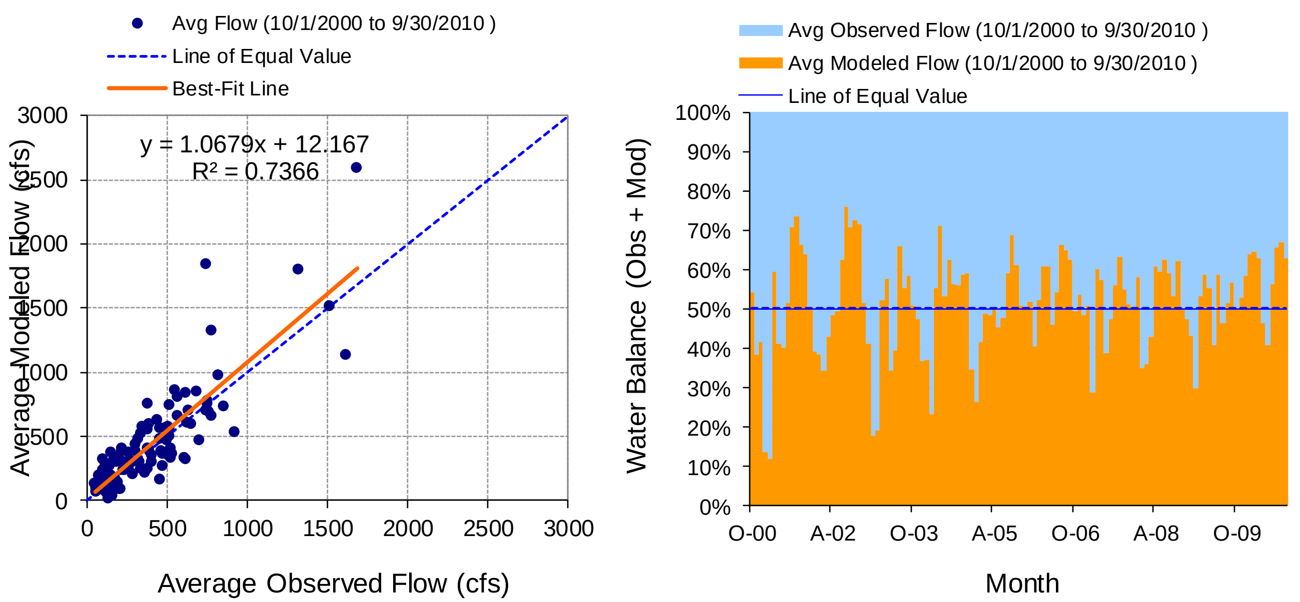


Figure K-104. Monthly flow regression and temporal variation at USGS 04276500 Boquet River at Willsboro, NY

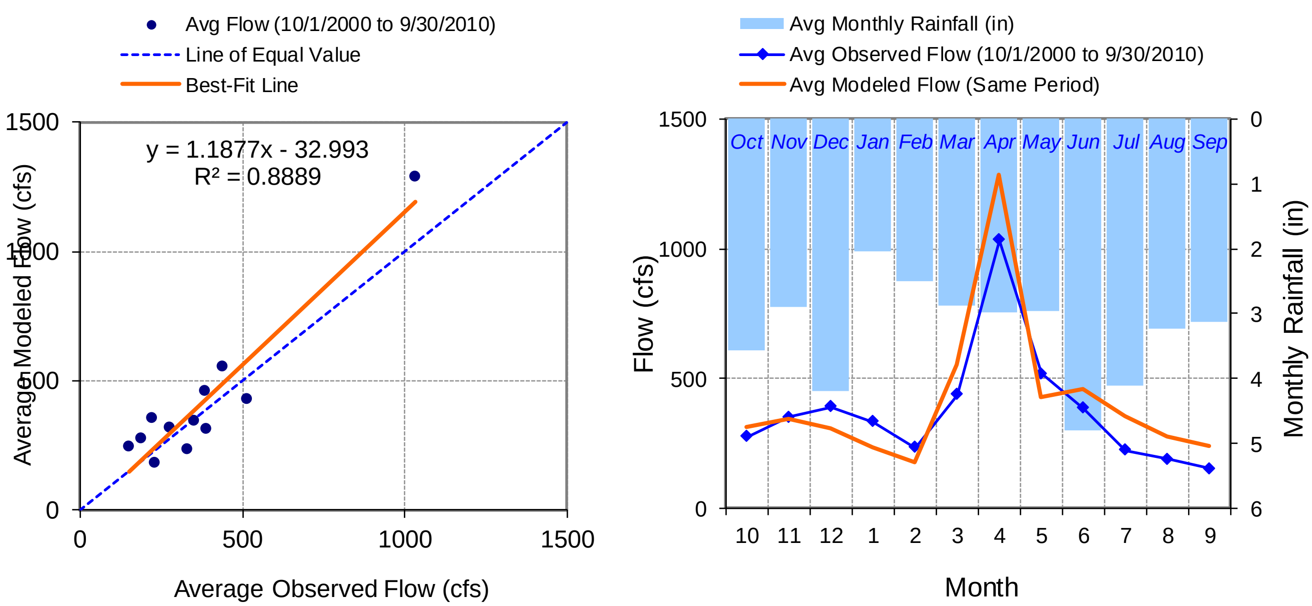


Figure K-105. Seasonal regression and temporal aggregate at USGS 04276500 Boquet River at Willsboro, NY

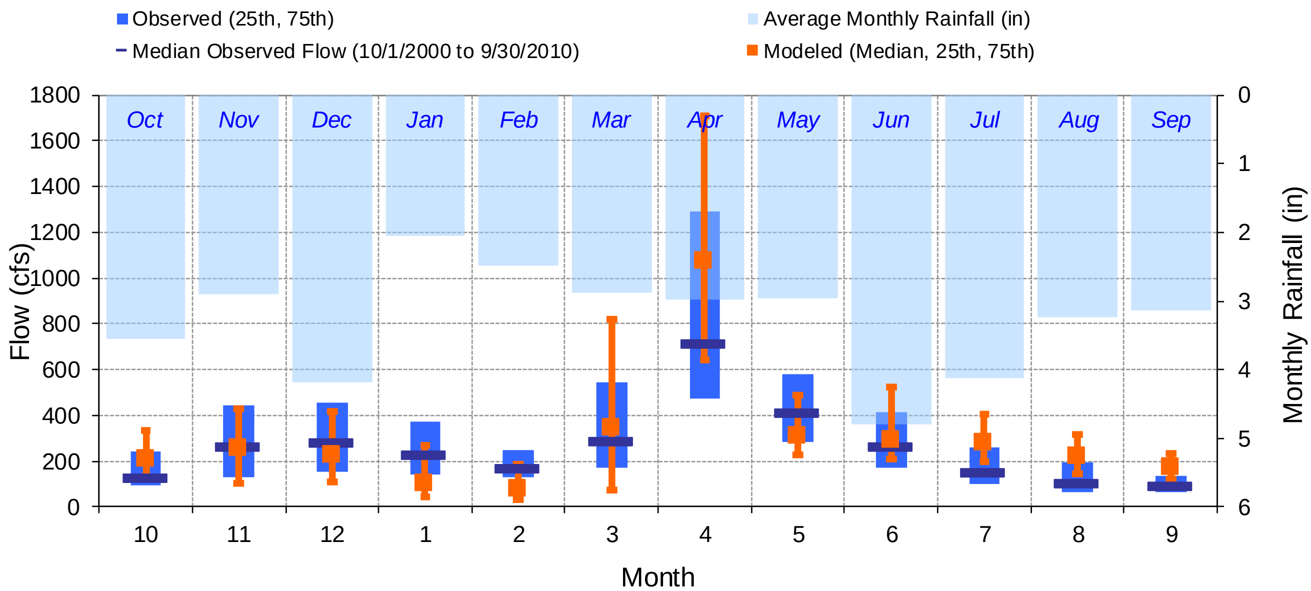


Figure K-106. Seasonal medians and ranges at USGS 04276500 Boquet River at Willsboro, NY

Table K-28. Seasonal summary at USGS 04276500 Boquet River at Willsboro, NY

MONTH	OBSERVED FLOW (CFS)				MODELED FLOW (CFS)			
	MEAN	MEDIAN	25TH	75TH	MEAN	MEDIAN	25TH	75TH
Oct	275.58	126.50	94.00	240.75	314.28	207.61	131.48	333.05
Nov	351.91	262.50	129.75	445.25	341.81	260.02	106.17	429.78
Dec	389.22	279.50	153.75	457.25	307.84	227.64	108.21	414.51
Jan	331.85	230.00	140.00	370.00	233.81	105.52	46.80	270.75
Feb	231.90	170.00	130.00	250.00	177.31	80.23	33.64	185.45
Mar	437.48	287.50	174.00	545.75	554.08	346.37	75.11	819.21
Apr	1033.63	712.00	472.00	1290.00	1285.48	1075.16	639.90	1706.93
May	516.63	408.50	284.00	577.50	427.21	308.26	226.49	489.02
Jun	385.87	265.00	168.75	411.50	458.78	293.75	207.46	526.01
Jul	223.07	151.00	101.00	258.25	353.87	282.34	195.93	407.62
Aug	188.34	105.50	64.00	197.75	275.86	220.22	142.77	316.36
Sep	152.67	94.00	67.00	137.25	239.93	176.34	121.82	232.51

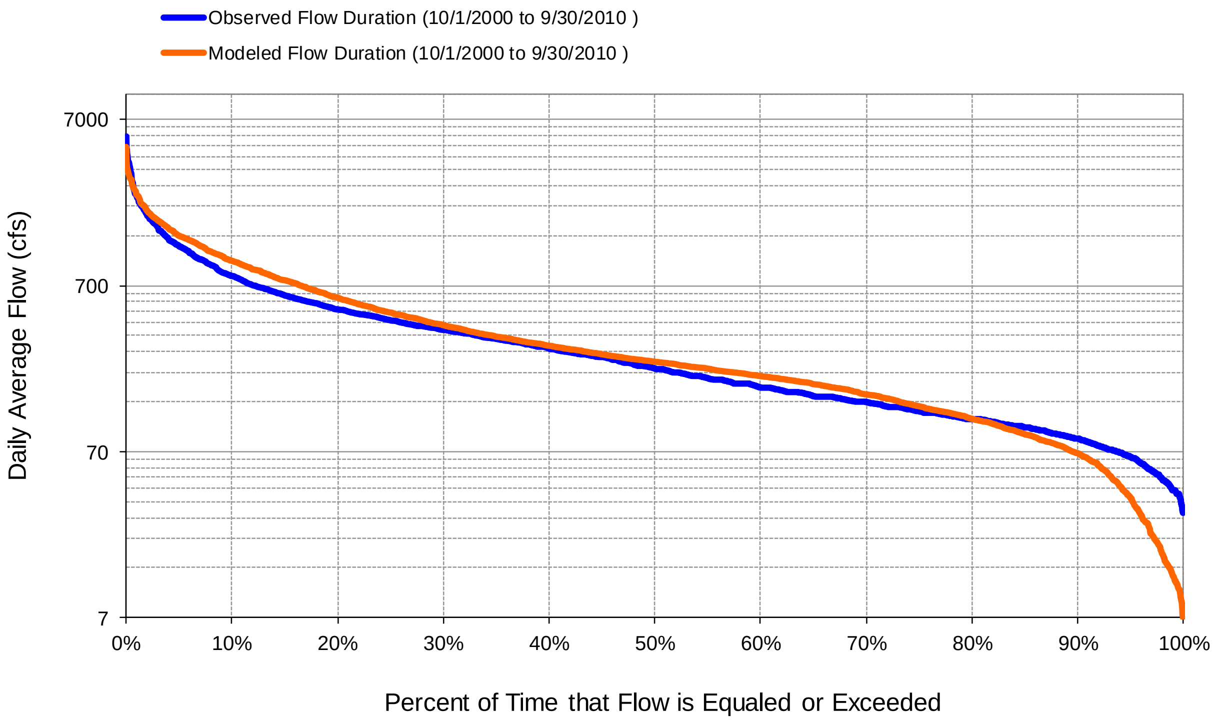


Figure K-107. Flow exceedence at USGS 04276500 Boquet River at Willsboro, NY

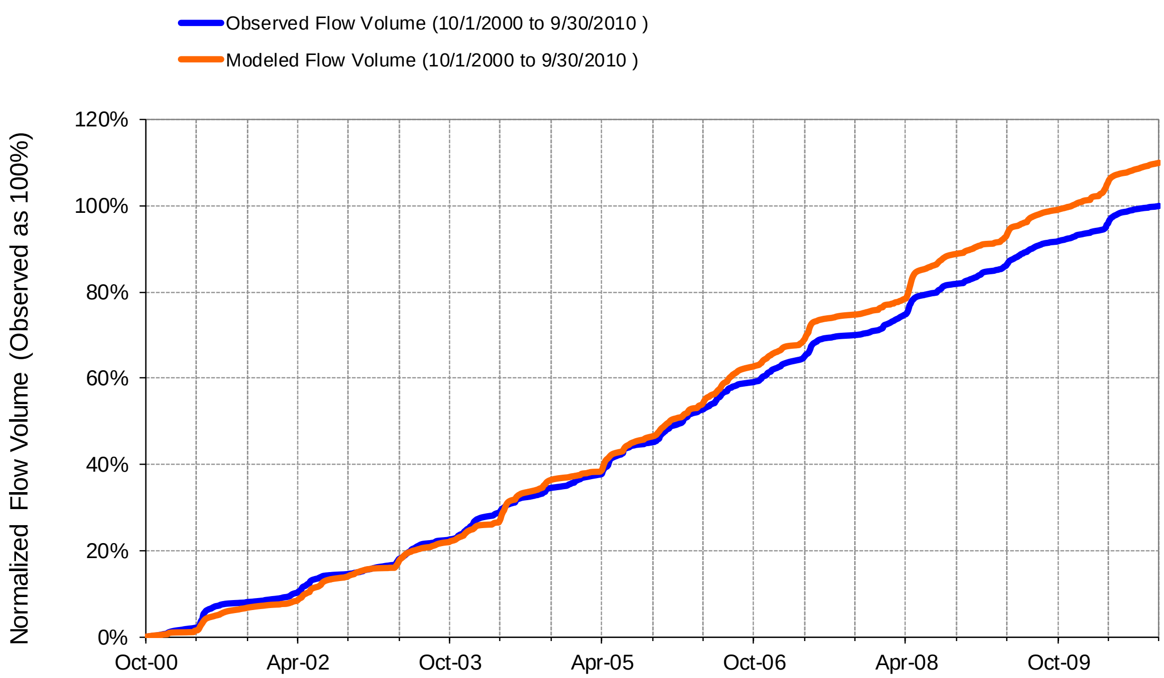


Figure K-108. Flow accumulation at USGS 04276500 Boquet River at Willsboro, NY

Table K-29. Summary statistics at USGS 04276500 Boquet River at Willsboro, NY

SWAT Simulated Flow		Observed Flow Gage	
REACH OUTFLOW FROM OUTLET 2 10-Year Analysis Period: 10/1/2000 - 9/30/2010 Flow volumes are (inches/year) for upstream drainage area		USGS 04276500 BOUQUET RIVER AT WILLSBORO NY Hydrologic Unit Code: 2010004 Latitude: 44.3583333 Longitude: -73.3944444 Drainage Area (sq-mi): 270	
Total Simulated In-stream Flow:	**20.84**	Total Observed In-stream Flow:	**18.94**
Total of simulated highest 10% flows:	**8.11**	Total of Observed highest 10% flows:	**7.44**
Total of Simulated lowest 50% flows:	**3.32**	Total of Observed Lowest 50% flows:	**3.19**
Simulated Summer Flow Volume (months 7-9):	**3.68**	Observed Summer Flow Volume (7-9):	**2.39**
Simulated Fall Flow Volume (months 10-12):	**4.07**	Observed Fall Flow Volume (10-12):	**4.29**
Simulated Winter Flow Volume (months 1-3):	**4.05**	Observed Winter Flow Volume (1-3):	**4.19**
Simulated Spring Flow Volume (months 4-6):	**9.03**	Observed Spring Flow Volume (4-6):	**8.07**
Total Simulated Storm Volume:	**6.02**	Total Observed Storm Volume:	**6.63**
Simulated Summer Storm Volume (7-9):	**0.87**	Observed Summer Storm Volume (7-9):	**0.89**

Errors (Simulated-Observed)	*Error Statistics*		*Recommended Criteria*		
Error in total volume:	10.01		10		
Error in 50% lowest flows:	4.09		10		
Error in 10% highest flows:	9.03		15		
Seasonal volume error - Summer:	54.15		30		
Seasonal volume error - Fall:	-5.22	>>	30		Clear
Seasonal volume error - Winter:	-3.17		30		
Seasonal volume error - Spring:	11.90		30		
Error in storm volumes:	-9.12		20		
Error in summer storm volumes:	-1.93		50		
Nash-Sutcliffe Coefficient of Efficiency, E:	0.435		Model accuracy increases		
Baseline adjusted coefficient (Garrick), E':	0.301		as E or E' approaches 1.0		
Monthly NSE	0.572				

USGS 04276500 Boquet River at Willsboro, NY - Validation

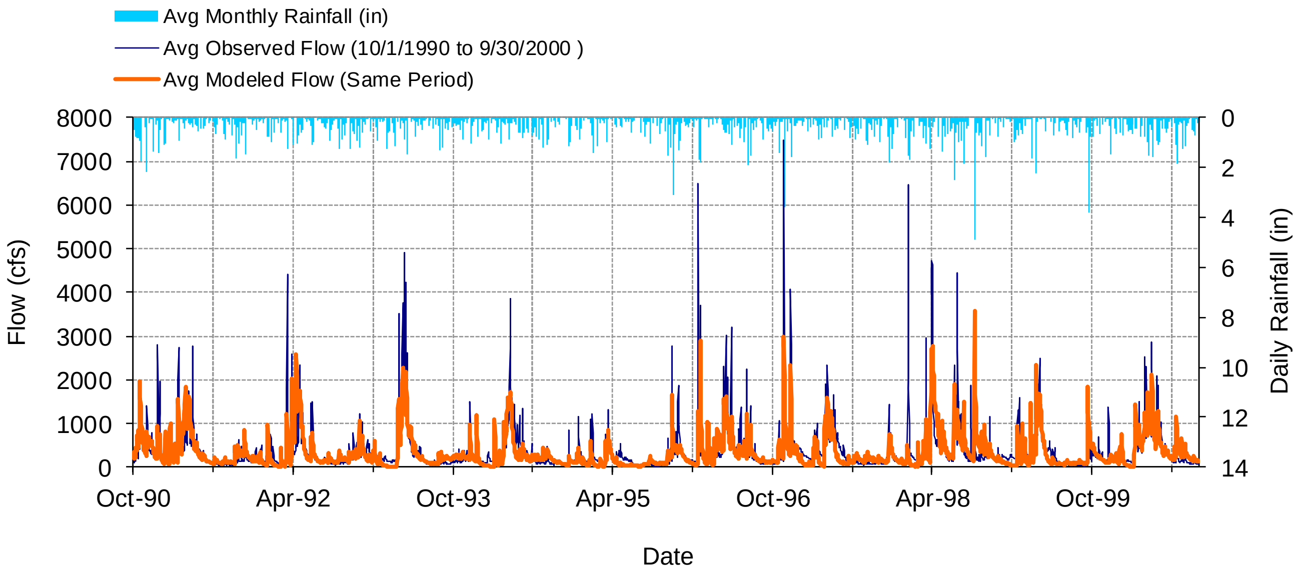


Figure K-109. Mean daily flow at USGS 04276500 Boquet River at Willsboro, NY

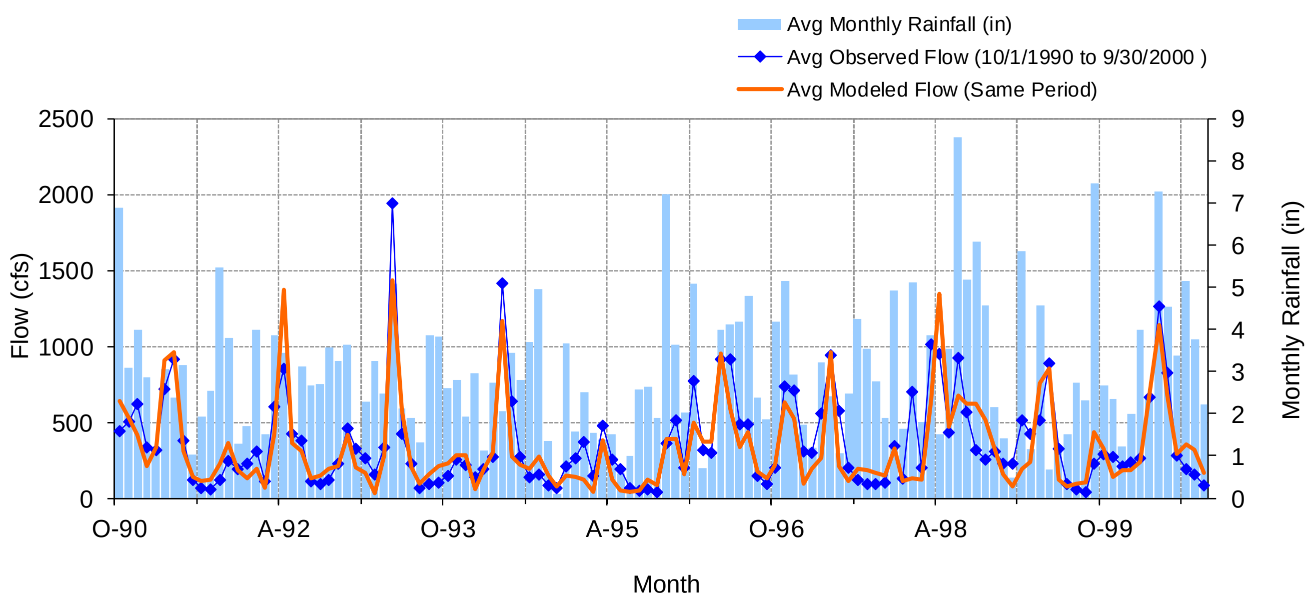


Figure K-110. Mean monthly flow at USGS 04276500 Boquet River at Willsboro, NY

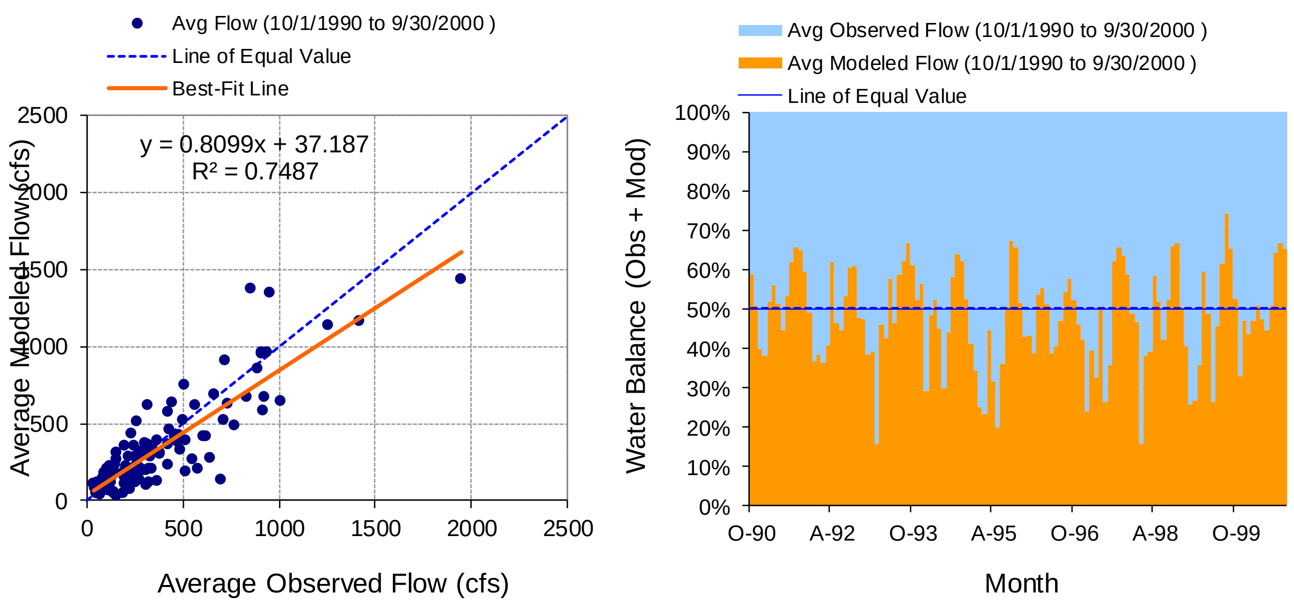


Figure K-111. Monthly flow regression and temporal variation at USGS 04276500 Boquet River at Willsboro, NY

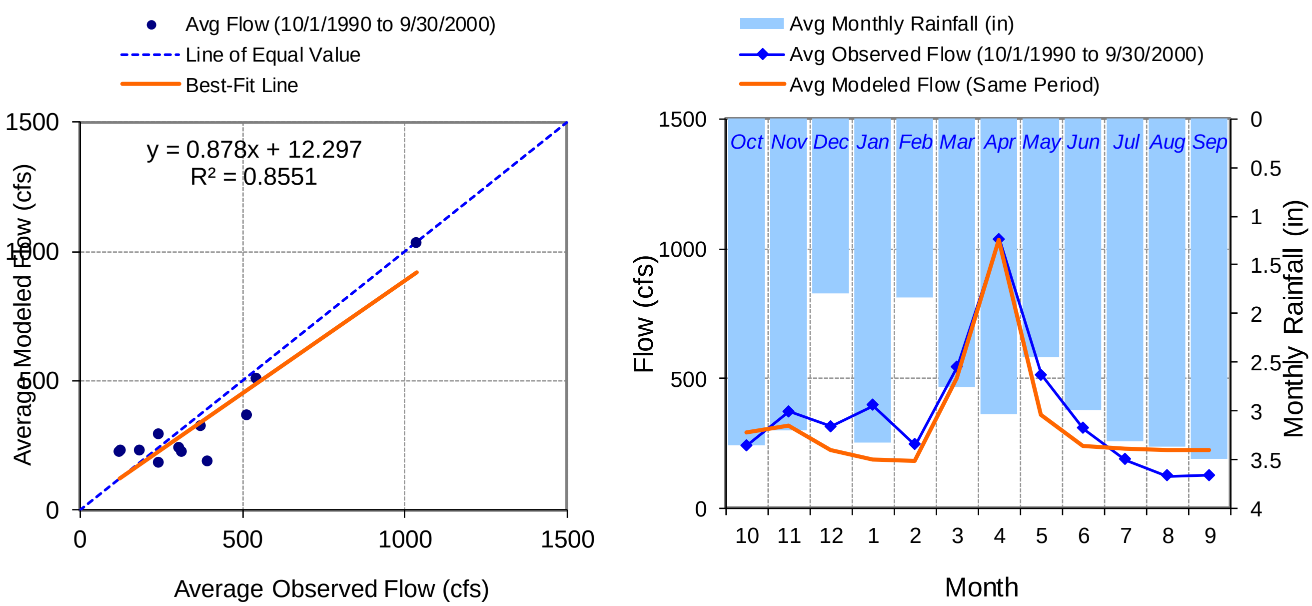


Figure K-112. Seasonal regression and temporal aggregate at USGS 04276500 Boquet River at Willsboro, NY

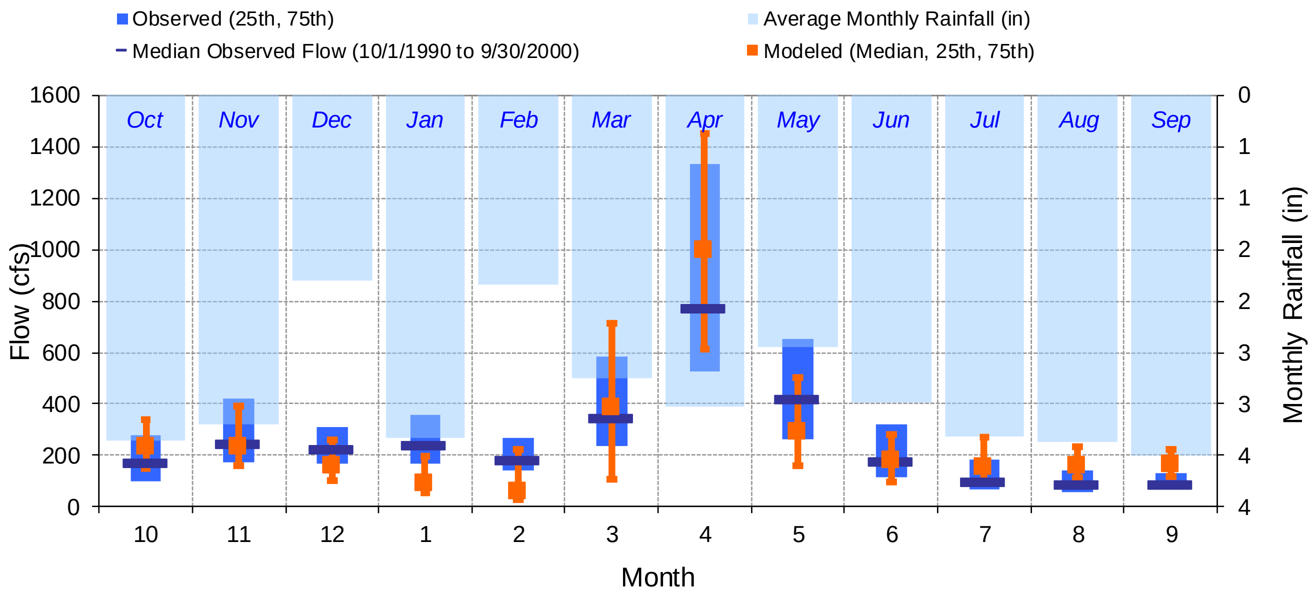


Figure K-113. Seasonal medians and ranges at USGS 04276500 Boquet River at Willsboro, NY

Table K-30. Seasonal summary at USGS 04276500 Boquet River at Willsboro, NY

MONTH	OBSERVED FLOW (CFS)				MODELED FLOW (CFS)			
	MEAN	MEDIAN	25TH	75TH	MEAN	MEDIAN	25TH	75TH
Oct	240.99	170.50	98.25	277.75	291.31	235.05	148.64	336.97
Nov	372.27	245.00	171.00	418.50	318.81	235.02	160.28	390.23
Dec	313.90	221.00	170.00	310.75	222.84	159.73	104.36	258.37
Jan	395.02	240.00	170.00	357.50	184.80	90.48	53.40	194.57
Feb	242.91	180.00	140.00	270.00	181.77	58.45	27.02	222.71
Mar	545.23	345.00	239.25	585.00	503.21	386.17	110.05	713.09
Apr	1034.82	772.50	524.50	1332.50	1031.80	999.93	615.71	1451.26
May	513.77	420.00	263.00	653.00	361.75	293.34	160.91	503.15
Jun	306.43	178.50	116.00	320.00	238.33	182.84	98.98	281.32
Jul	186.50	99.00	67.00	185.00	227.82	155.19	94.38	269.41
Aug	122.84	88.50	57.00	141.50	221.46	158.12	115.05	234.90
Sep	124.74	88.00	66.00	133.25	226.19	163.74	115.81	222.28

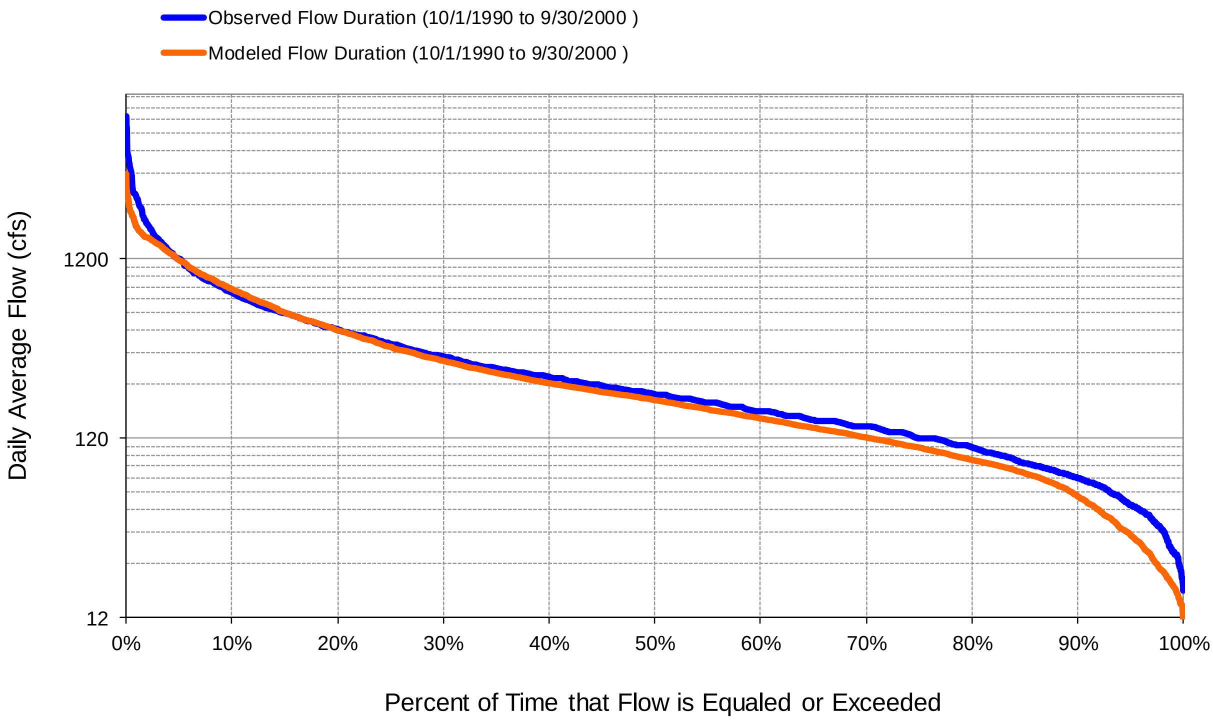


Figure K-114. Flow exceedence at USGS 04276500 Boquet River at Willsboro, NY

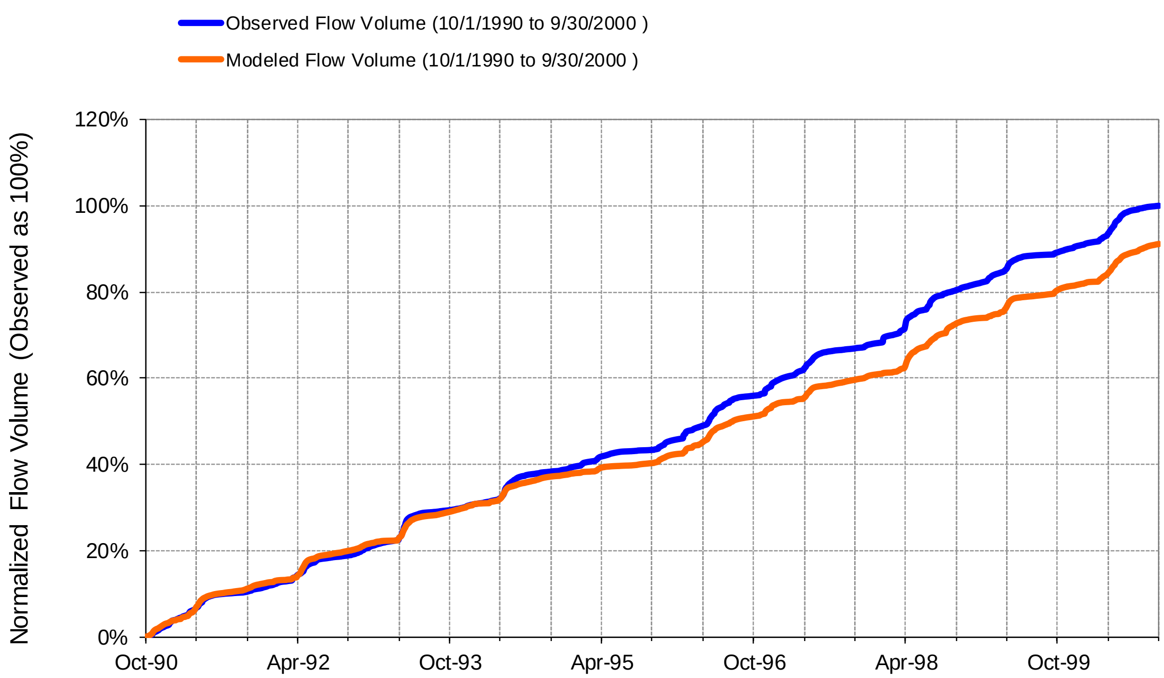


Figure K-115. Flow accumulation at USGS 04276500 Boquet River at Willsboro, NY

Table K-31. Summary statistics at USGS 04276500 Boquet River at Willsboro, NY

SWAT Simulated Flow		Observed Flow Gage	
REACH OUTFLOW FROM OUTLET 2 10-Year Analysis Period: 10/1/1990 - 9/30/2000 Flow volumes are (inches/year) for upstream drainage area		USGS 04276500 BOUQUET RIVER AT WILLSBORO NY Hydrologic Unit Code: 2010004 Latitude: 44.3583333 Longitude: -73.3944444 Drainage Area (sq-mi): 270	
Total Simulated In-stream Flow:	**16.80**	Total Observed In-stream Flow:	**18.44**
Total of simulated highest 10% flows:	**6.53**	Total of Observed highest 10% flows:	**7.61**
Total of Simulated lowest 50% flows:	**2.67**	Total of Observed Lowest 50% flows:	**3.05**
Simulated Summer Flow Volume (months 7-9):	**2.85**	Observed Summer Flow Volume (7-9):	**1.84**
Simulated Fall Flow Volume (months 10-12):	**3.51**	Observed Fall Flow Volume (10-12):	**3.91**
Simulated Winter Flow Volume (months 1-3):	**3.65**	Observed Winter Flow Volume (1-3):	**4.96**
Simulated Spring Flow Volume (months 4-6):	**6.79**	Observed Spring Flow Volume (4-6):	**7.74**
Total Simulated Storm Volume:	**4.75**	Total Observed Storm Volume:	**6.52**
Simulated Summer Storm Volume (7-9):	**0.69**	Observed Summer Storm Volume (7-9):	**0.64**

Errors (Simulated-Observed)	*Error Statistics*	*Recommended Criteria*		
Error in total volume:	-8.87	10		
Error in 50% lowest flows:	-12.70	10		
Error in 10% highest flows:	-14.20	15		
Seasonal volume error - Summer:	55.37	30		
Seasonal volume error - Fall:	-10.11	>> 30		Clear
Seasonal volume error - Winter:	-26.51	30		
Seasonal volume error - Spring:	-12.19	30		
Error in storm volumes:	-27.11	20		
Error in summer storm volumes:	8.53	50		
Nash-Sutcliffe Coefficient of Efficiency, E:	0.510	Model accuracy increases		
Baseline adjusted coefficient (Garrick), E':	0.398	as E or E' approaches 1.0		
Monthly NSE	0.733			

TSS and TP distribution by channel and upland sources

Table K-32. TSS and TP distribution by source categories

Source	TSS		TP	
	Load(mt/year)	Percentage (%)	Load (kg/year)	Percentage (%)
Upland	13,134	86.1	17,579	94.3
Stream	2,126	13.9	1,063	5.7
Total	**15,260**	**100.0**	**18,643**	**100.0**

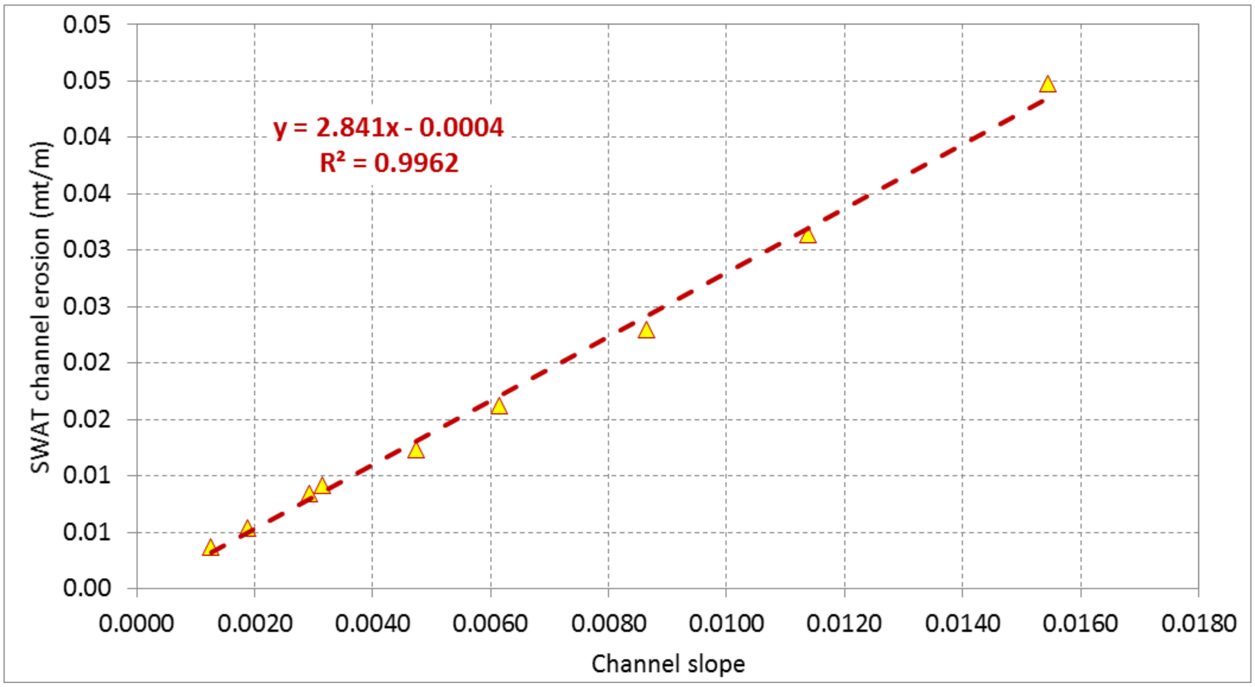


Figure K-116. SWAT simulated channel erosion relative to channel slope

TP distribution by landuse from upland sources (Boquet River)

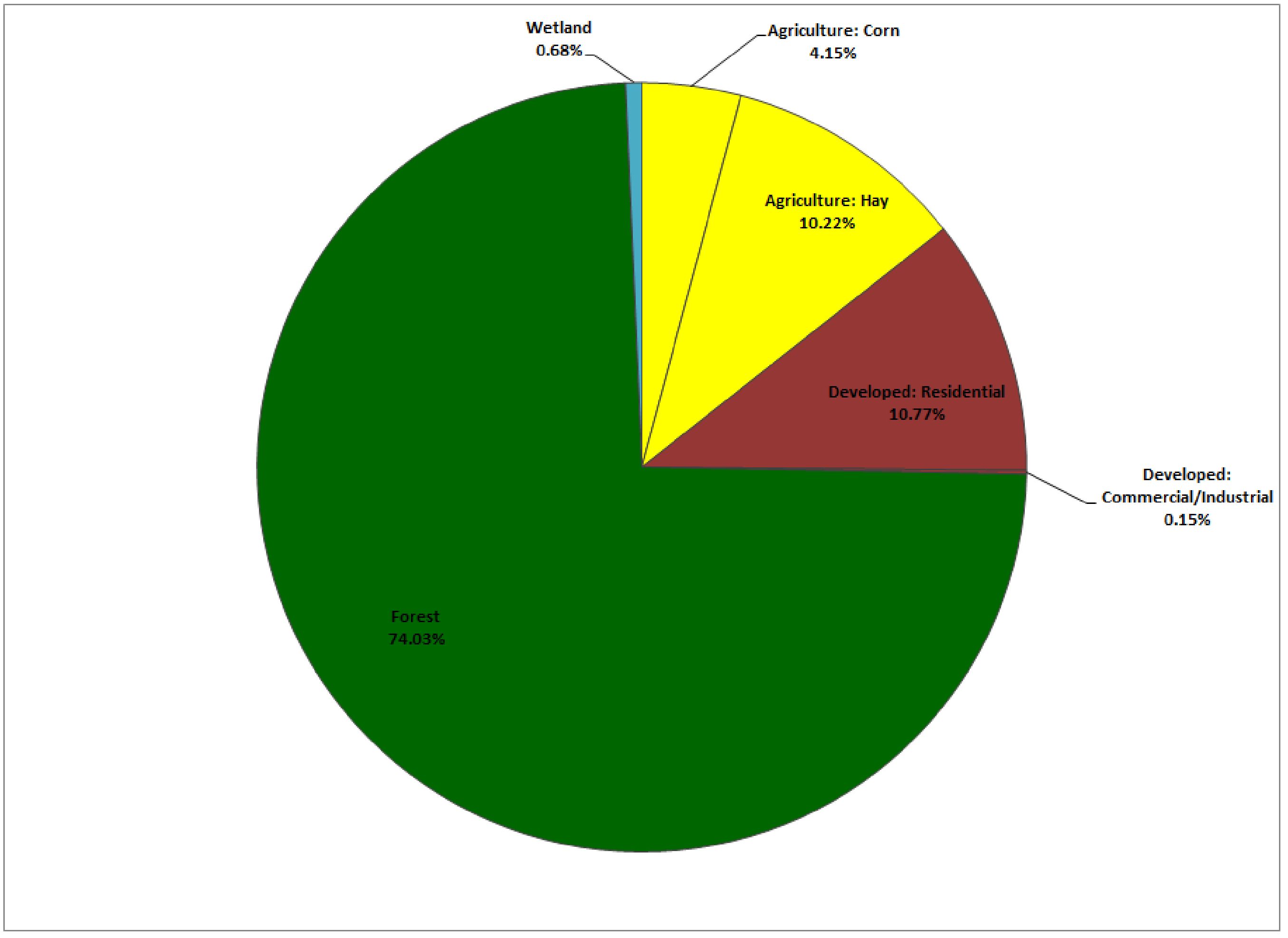


Figure K-117. Distribution of simulated total upland TP loads by landuse categories

Table K-33. TP export rates (kg/ha/yr) by landuse categories for the 30 year simulation period

Landuse	Classification	Area (ha)	Area (%)	Mean	Min	Q_{25}	Q_{50}	Q_{75}	Max
Agriculture	Corn	376	0.53	**1.94**	0.59	1.02	1.75	2.55	4.74
	Hay	1,925	2.73	**0.93**	0.29	0.49	0.80	1.42	2.05
Urban	Residential	2,852	4.05	**0.66**	0.40	0.50	0.64	0.79	1.09
	Commercial/Industrial	14	0.02	**1.86**	1.54	1.68	1.82	2.01	2.23
Forest	Forest	60,974	86.53	**0.21**	0.08	0.18	0.20	0.26	0.35
Wetland	Wetland	4,322	6.13	**0.03**	0.01	0.02	0.03	0.03	0.06

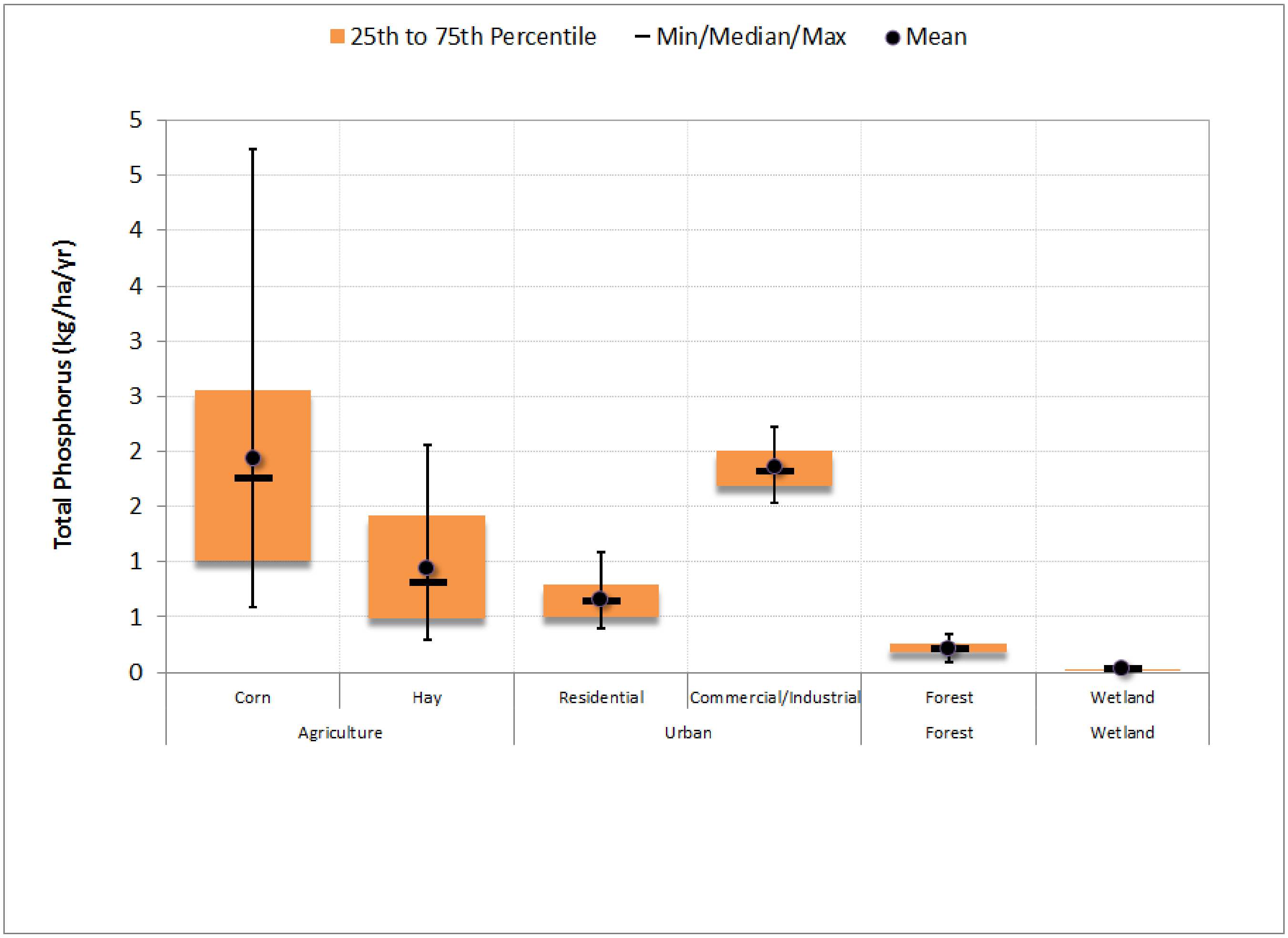


Figure K-118. TP export rates (kg/ha/yr) by landuse categories for the 30 year simulation period

Table K-34. TP export rates (kg/ha/yr) for the residential landuse categories for the 30 year simulation period

Residential Category	Area (ha)	Area (%)	Mean	Min	Q_{25}	Q_{50}	Q_{75}	Max
Low Density	2,160	75.74	**0.51**	0.26	0.37	0.49	0.64	0.85
Medium Density	625	21.92	**1.10**	0.77	0.89	1.06	1.21	1.83
High Density	67	2.34	**1.59**	1.23	1.38	1.56	1.68	2.09
Total	2,852	100.00	**0.66**	0.40	0.50	0.64	0.79	1.09

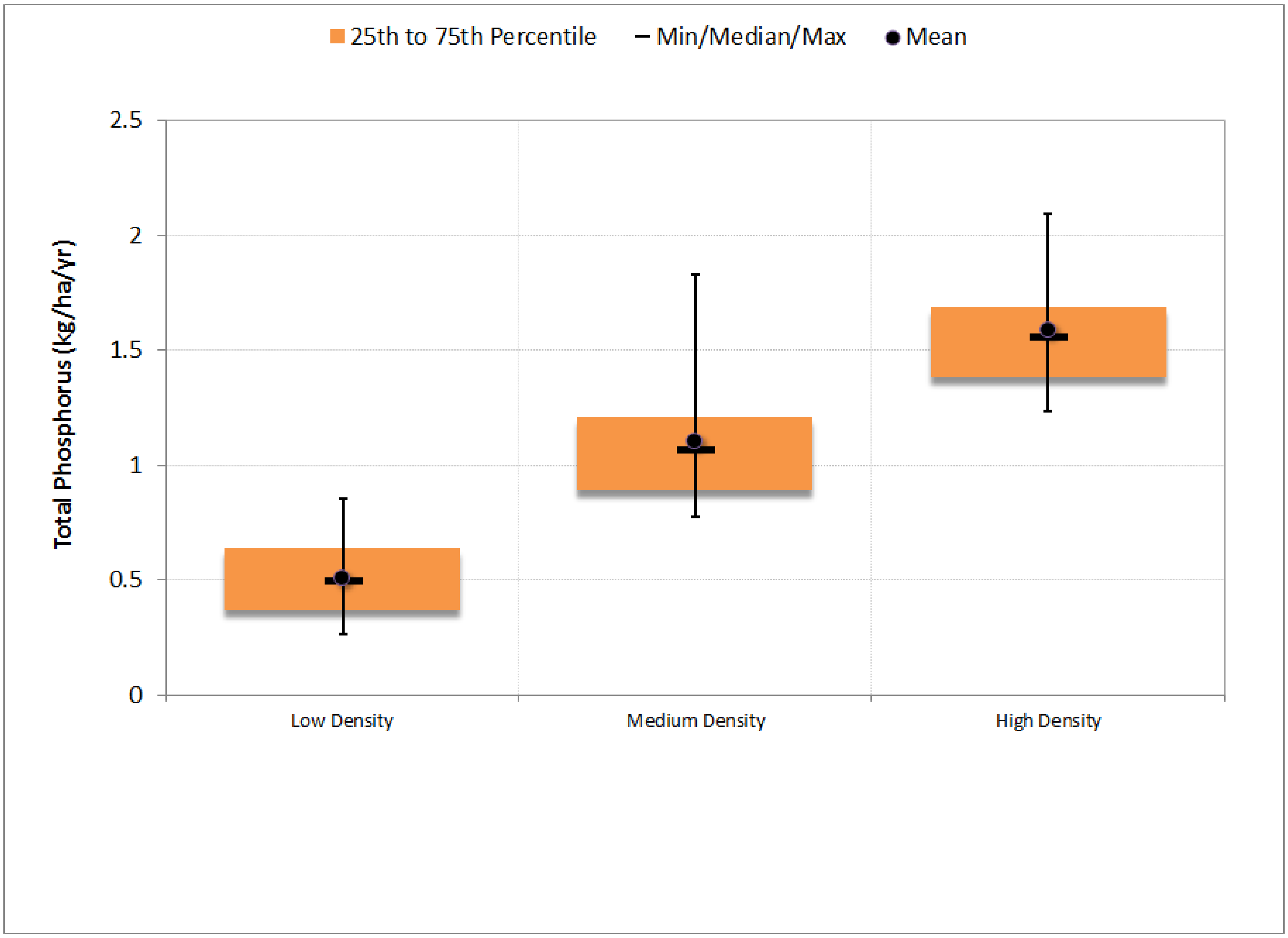


Figure K-119. TP export rates (kg/ha/yr) for the residential landuse categories for the 30 year simulation period

Segmented Regression

Table K-35. Summary statistics

Statistic	Calibration		Validation	
	TSS	TP	TSS	TP
Average absolute error (%)	65.6	58.2	61.4	63.6
Median absolute error (%)	18.6	25.8	10.4	13.3
Regression error (%)	-3.8	6.1	39.8	30.7
NSE	0.387	0.519	0.462	0.377
NSE'	0.426	0.433	0.506	0.435

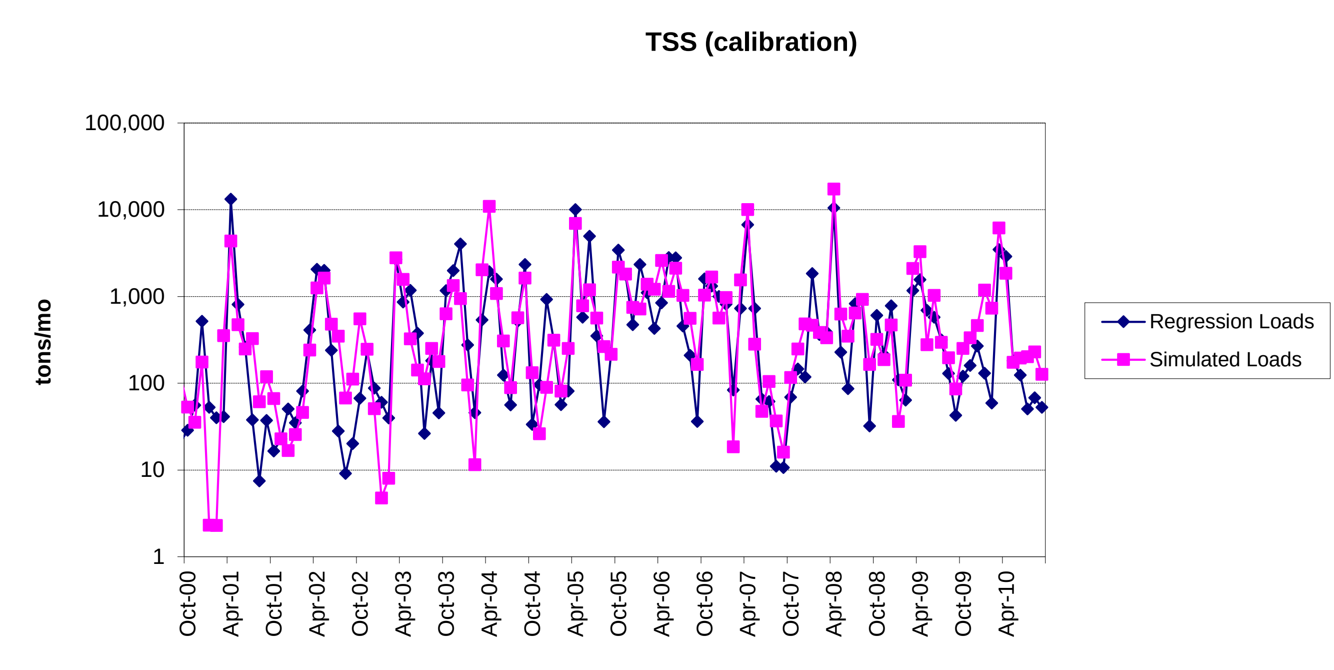


Figure K-120. Monthly simulated and estimated TSS load at Boquet River at Willsboro, NY (calibration period)

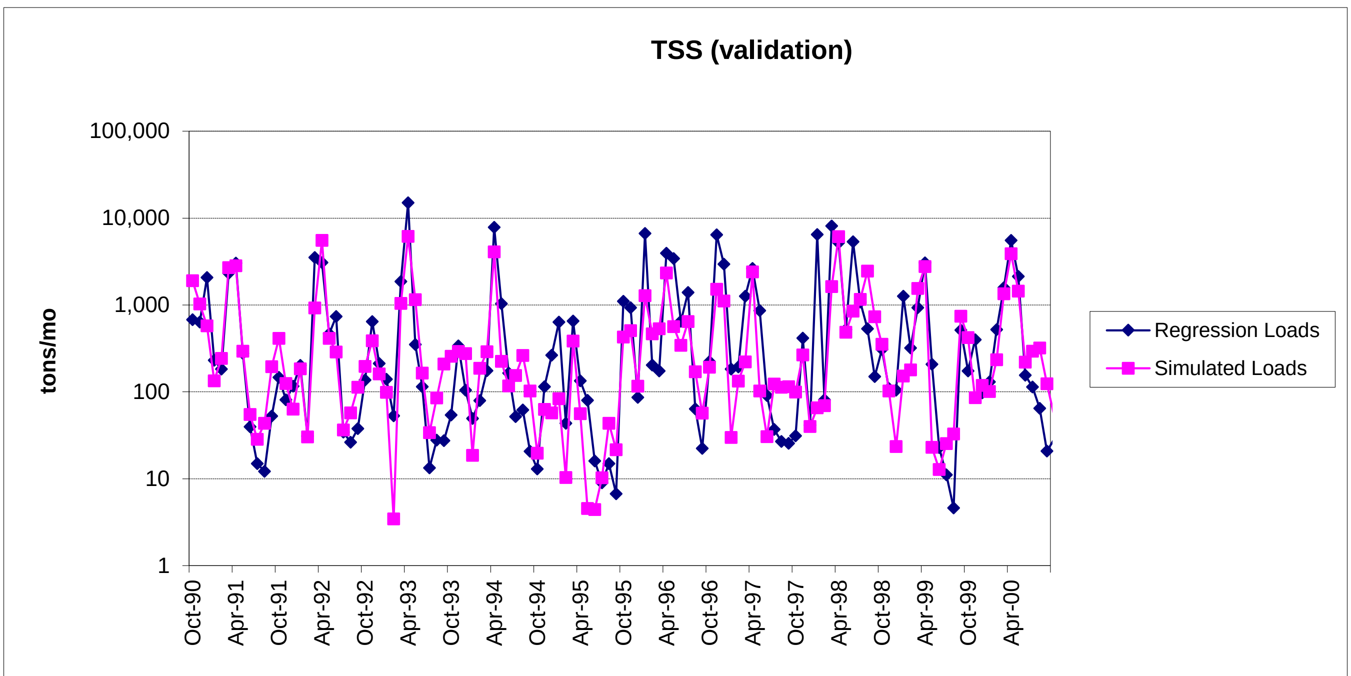


Figure K-121. Monthly simulated and estimated TSS load at Boquet River at Willsboro, NY (validation period)

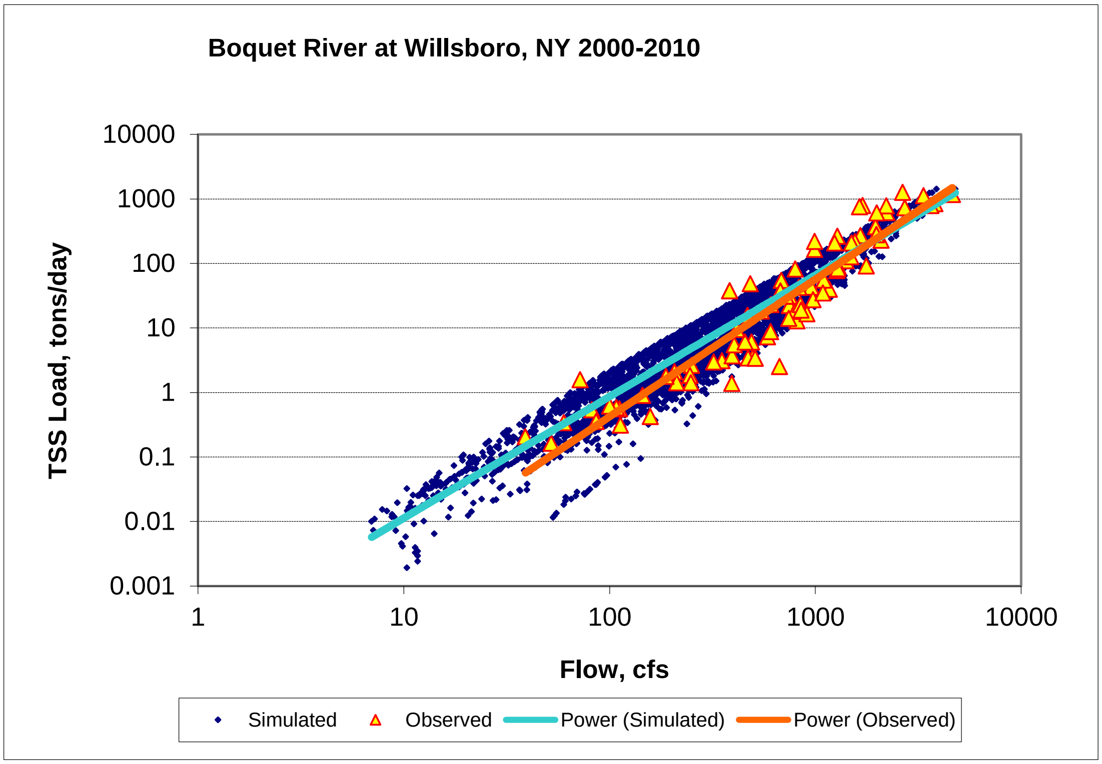


Figure K-122. Power plot of simulated and observed TSS load vs flow at Boquet River at Willsboro, NY (calibration period)

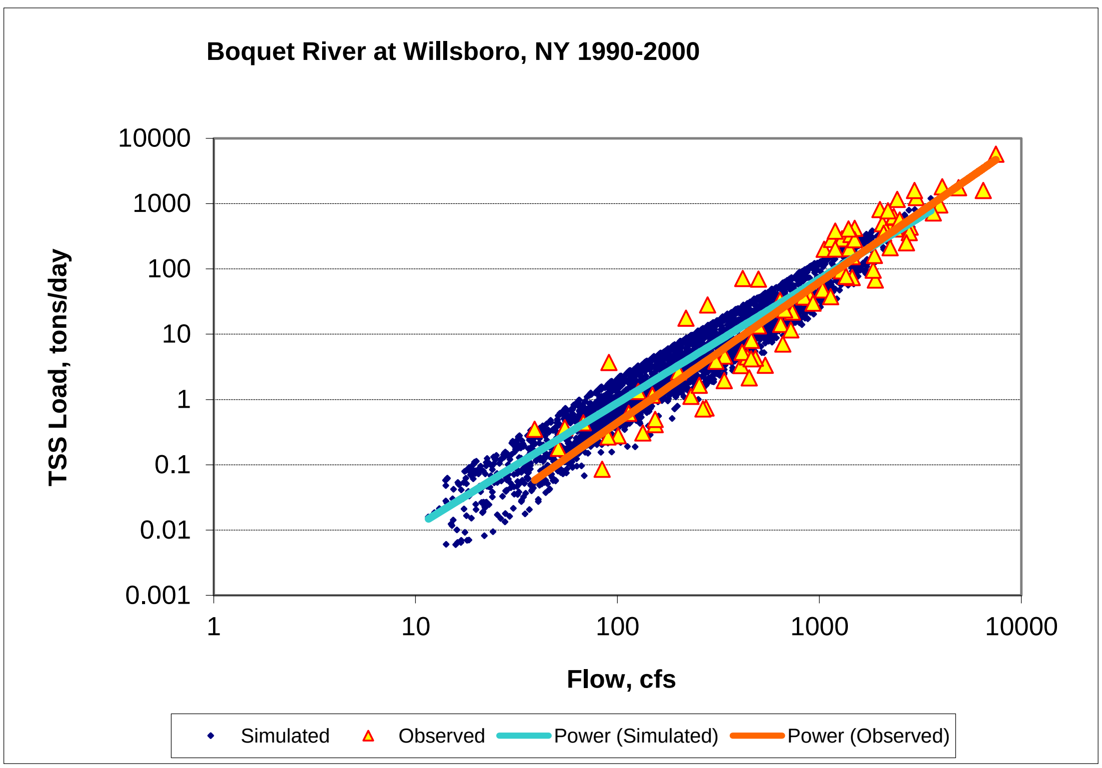


Figure K-123. Power plot of simulated and observed TSS load vs flow at Boquet River at Willsboro, NY (validation period)

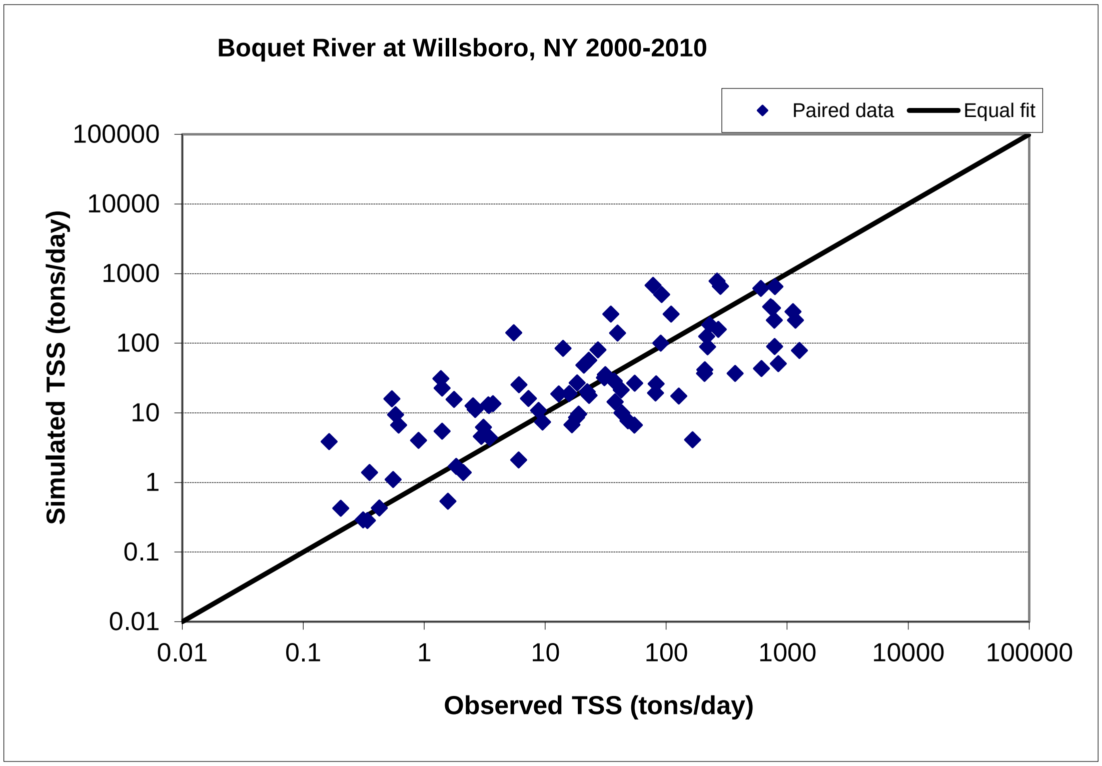


Figure K-124. Paired simulated vs observed TSS load at Boquet River at Willsboro, NY (calibration period)

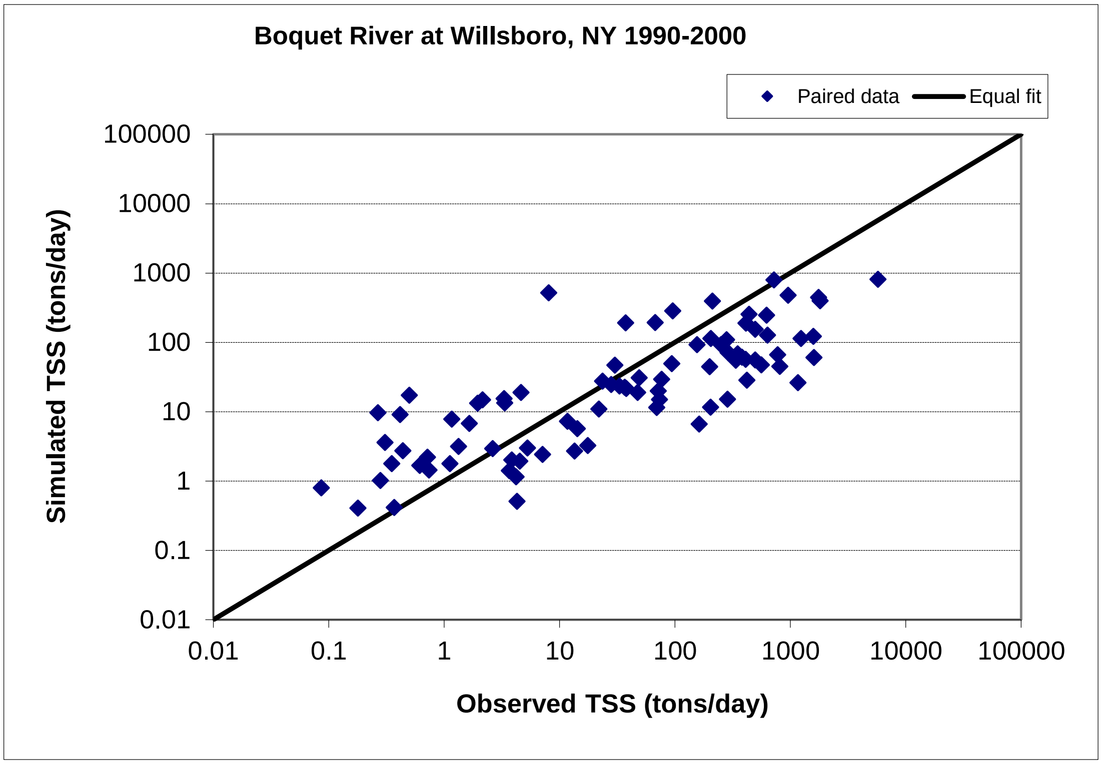


Figure K-125. Paired simulated vs observed TSS load at Boquet River at Willsboro, NY (validation period)

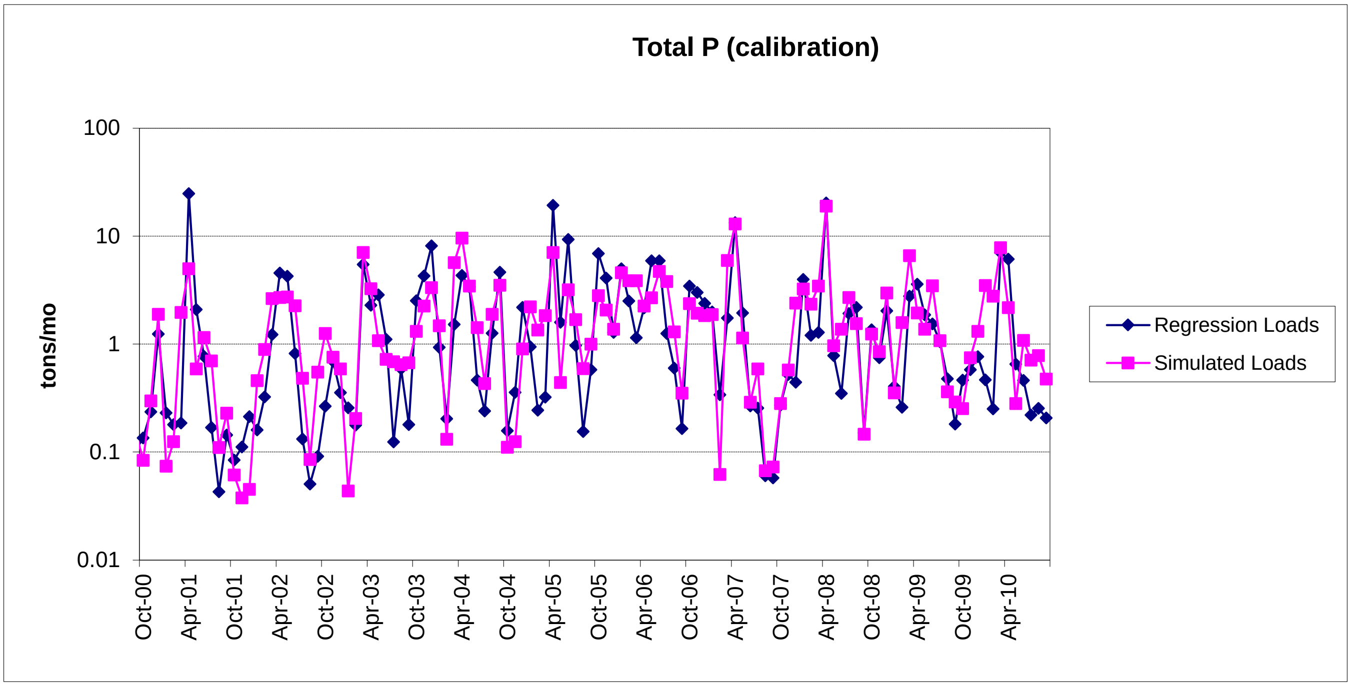


Figure K-126. Monthly simulated and estimated TP load at Boquet River at Willsboro, NY (calibration period)

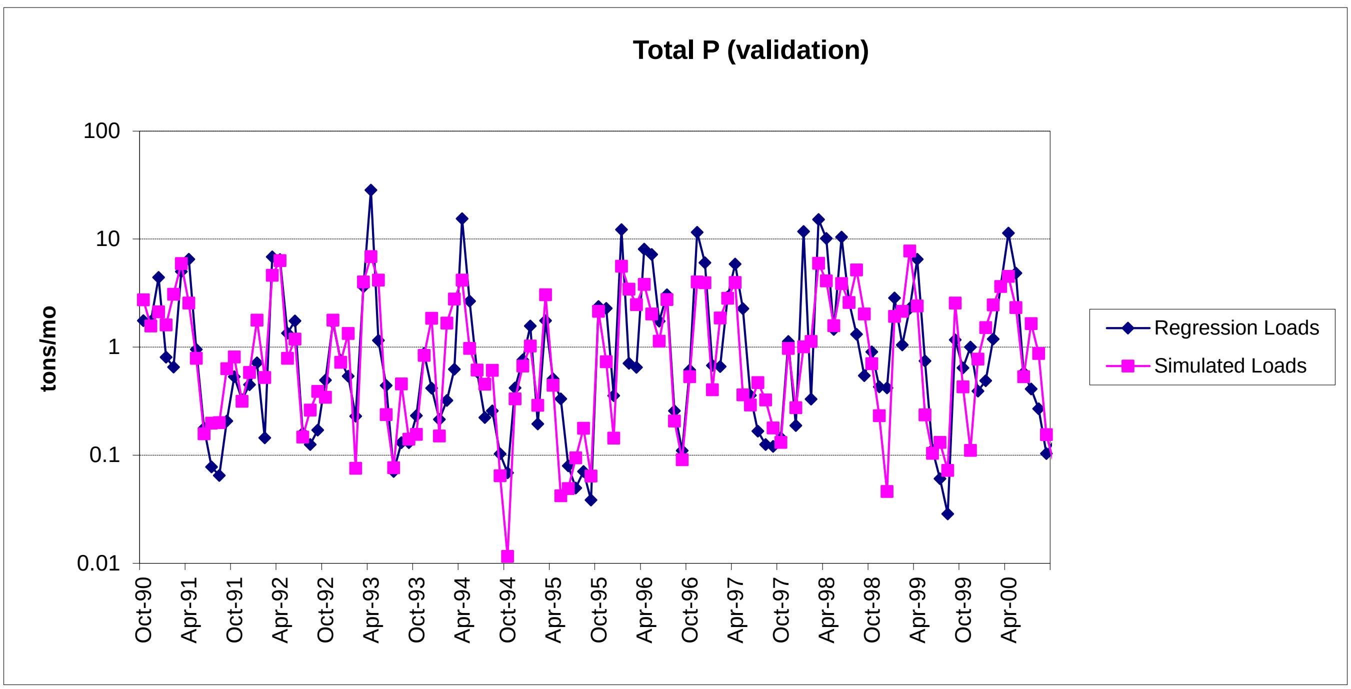


Figure K-127. Monthly simulated and estimated TP load at Boquet River at Willsboro, NY (validation period)

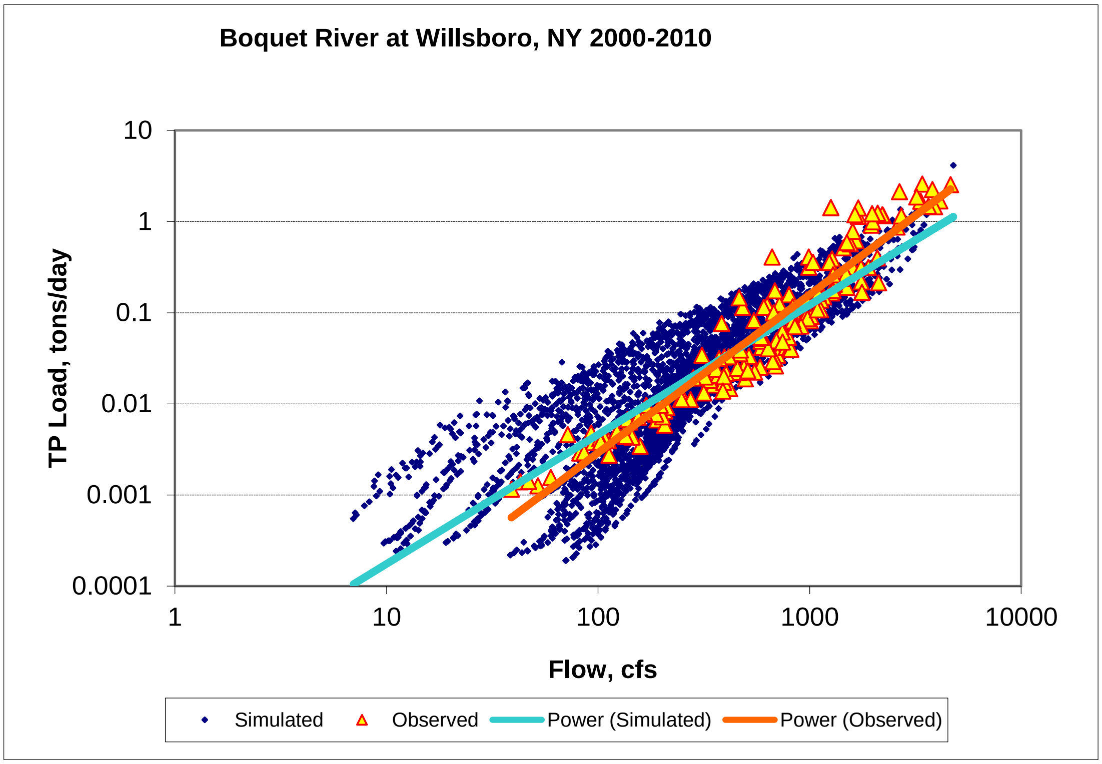


Figure K-128. Power plot of simulated and observed TP load vs flow at Boquet River at Willsboro, NY (calibration period)

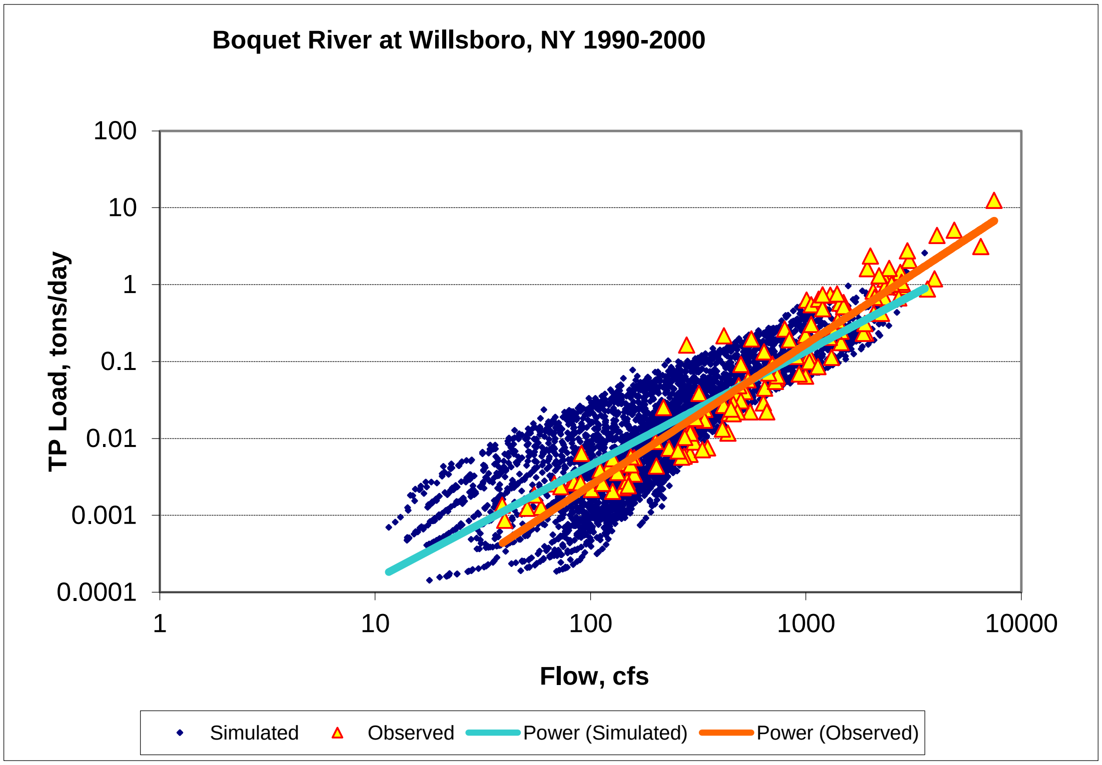


Figure K-129. Power plot of simulated and observed TP load vs flow at Boquet River at Willsboro, NY (validation period)

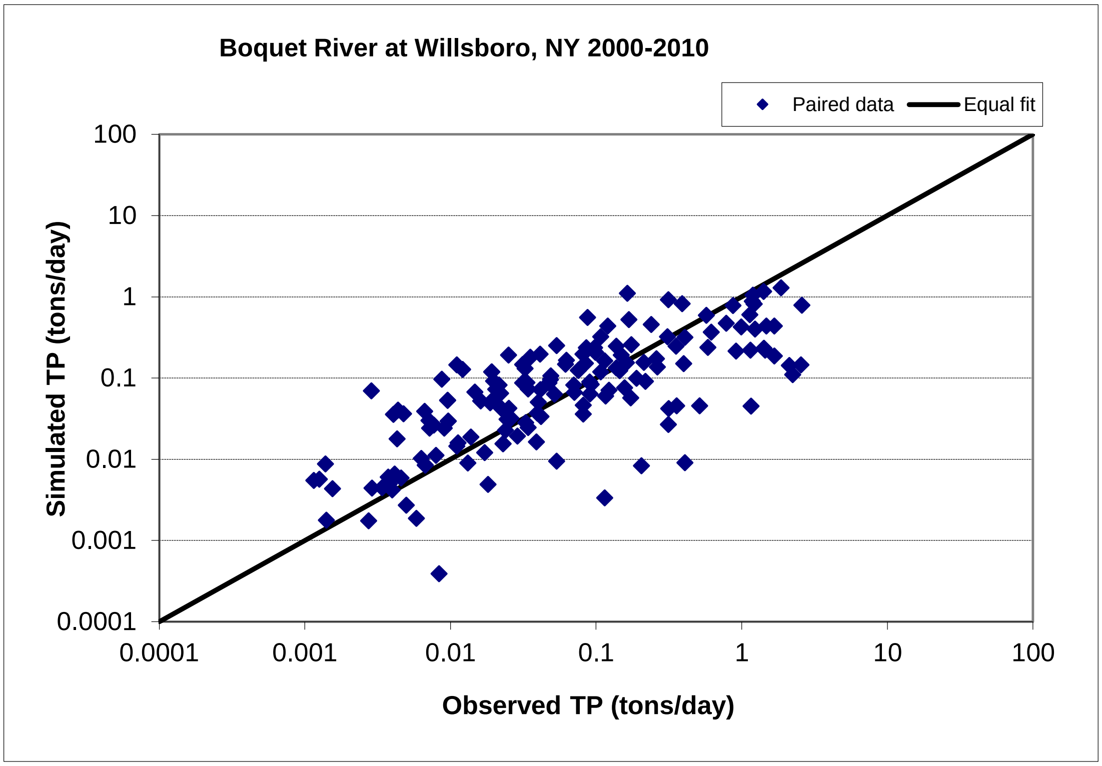


Figure K-130. Paired simulated vs observed TP load at Boquet River at Willsboro, NY (calibration period)

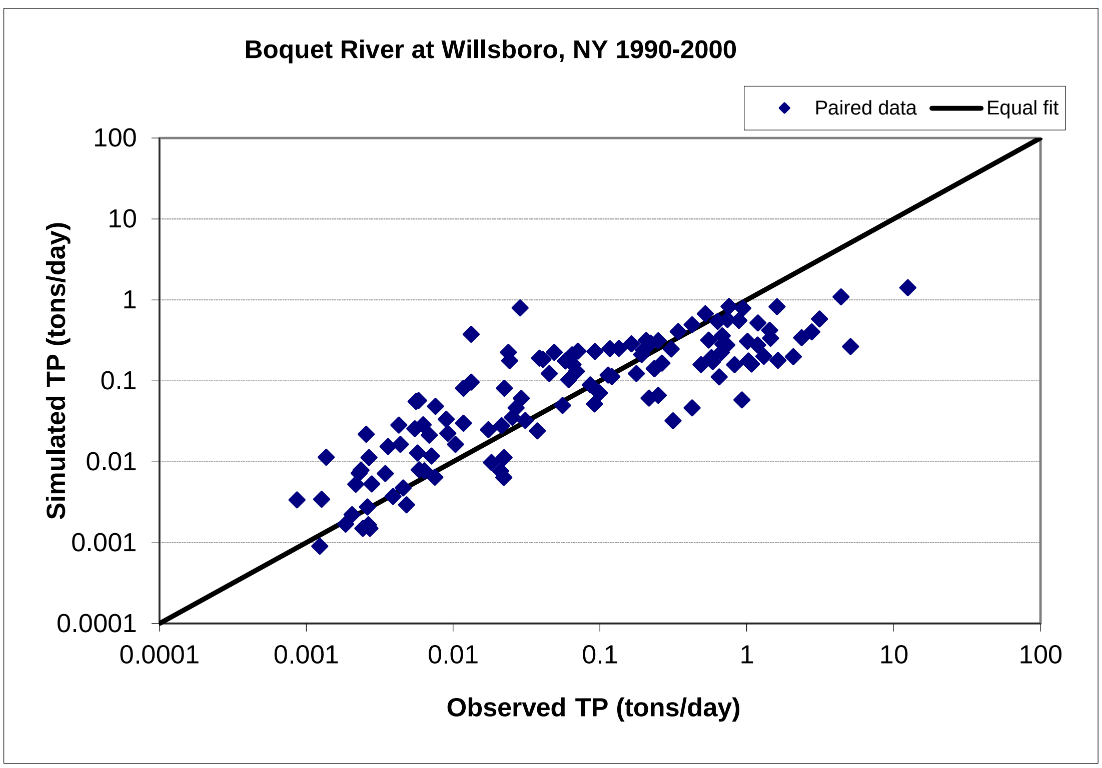


Figure K-131. Paired simulated vs observed TP load at Boquet River at Willsboro, NY (validation period)

Comparison of simulated SWAT TP loads with FLUX estimates

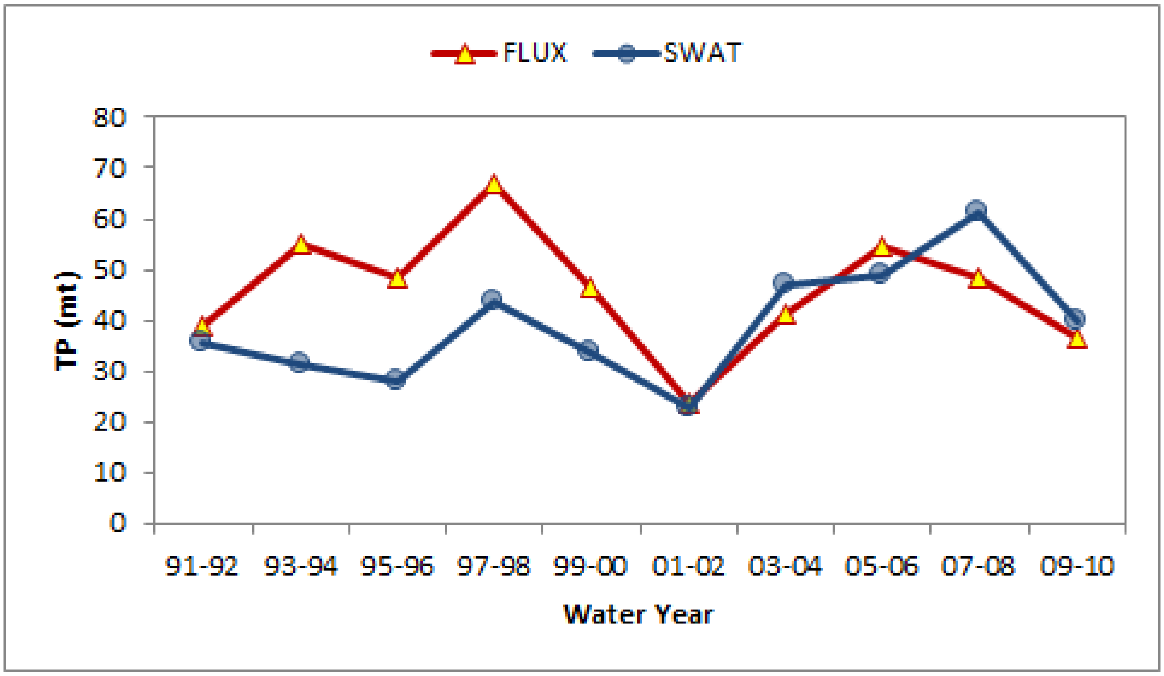


Figure K-132. Bi-annual TP loads on a water year basis as simulated by SWAT and estimated by FLUX (FLUX estimates from Smeltzer et al., 2009)

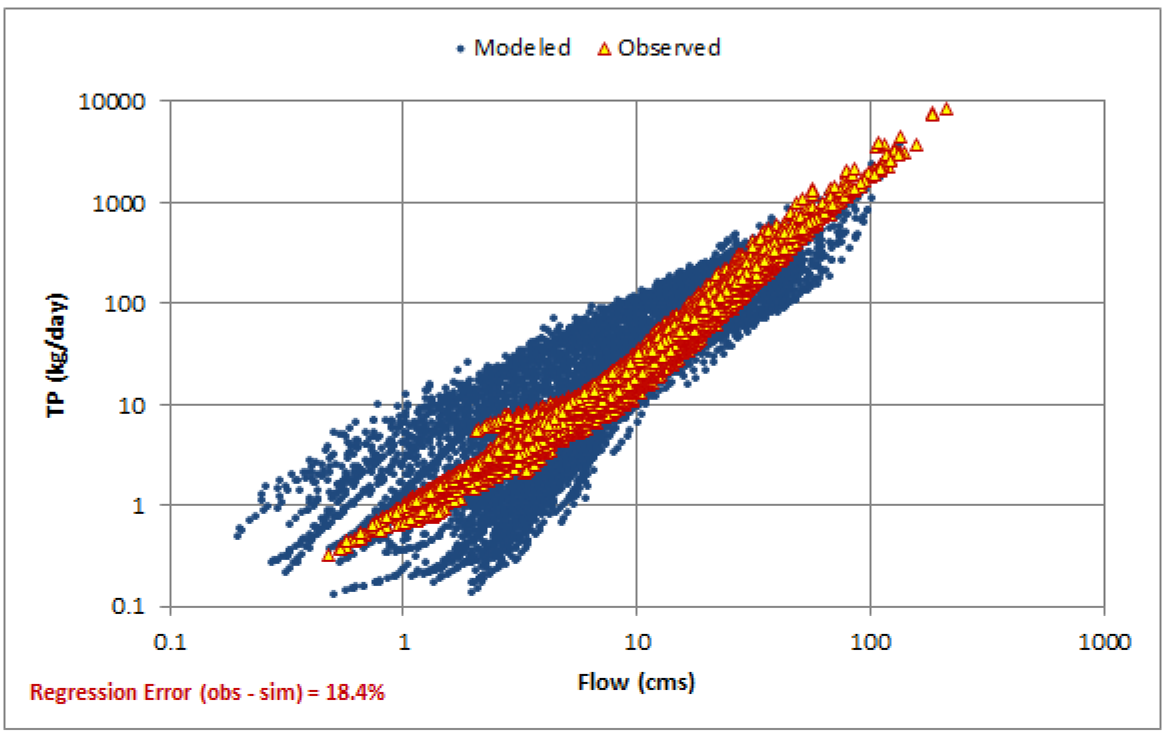


Figure K-133. Daily TP load versus flow as simulated by SWAT and estimated by FLUX (FLUX estimates from Medalie, 2013)

TP distribution by landuse from upland sources

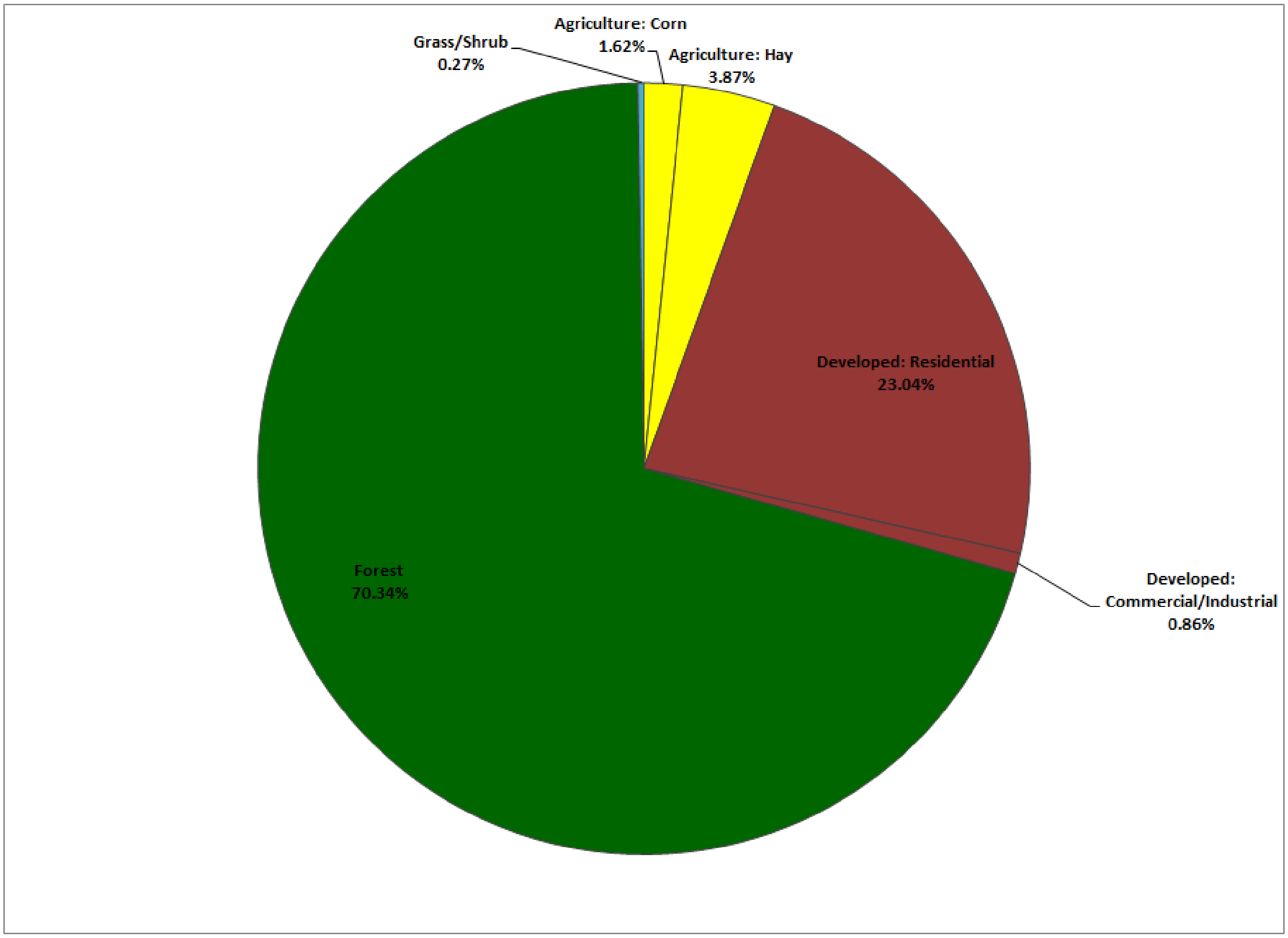


Figure K-134. Distribution of simulated total upland TP loads by landuse categories

Table K-36. TP export rates (kg/ha/yr) by landuse categories for the 30 year simulation period

Landuse	Classification	Area (ha)	Area (%)	Mean	Min	Q_{25}	Q_{50}	Q_{75}	Max
Agriculture	Corn	156	0.18	**2.00**	0.63	1.12	1.77	2.40	5.69
	Hay	818	0.92	**0.91**	0.31	0.65	0.80	1.13	1.77
Urban	Residential	4,787	5.38	**0.93**	0.47	0.75	0.83	1.02	1.87
	Commercial/Industrial	70	0.08	**2.38**	1.90	2.13	2.34	2.51	4.20
Forest	Forest	82,936	93.20	**0.16**	0.08	0.13	0.15	0.19	0.28
Grass/Shrub	Grass/Shrub	219	0.25	**0.24**	0.10	0.20	0.22	0.27	0.43
Wetland	Wetland	3,780	4.25	**0.15**	0.06	0.12	0.13	0.17	0.31

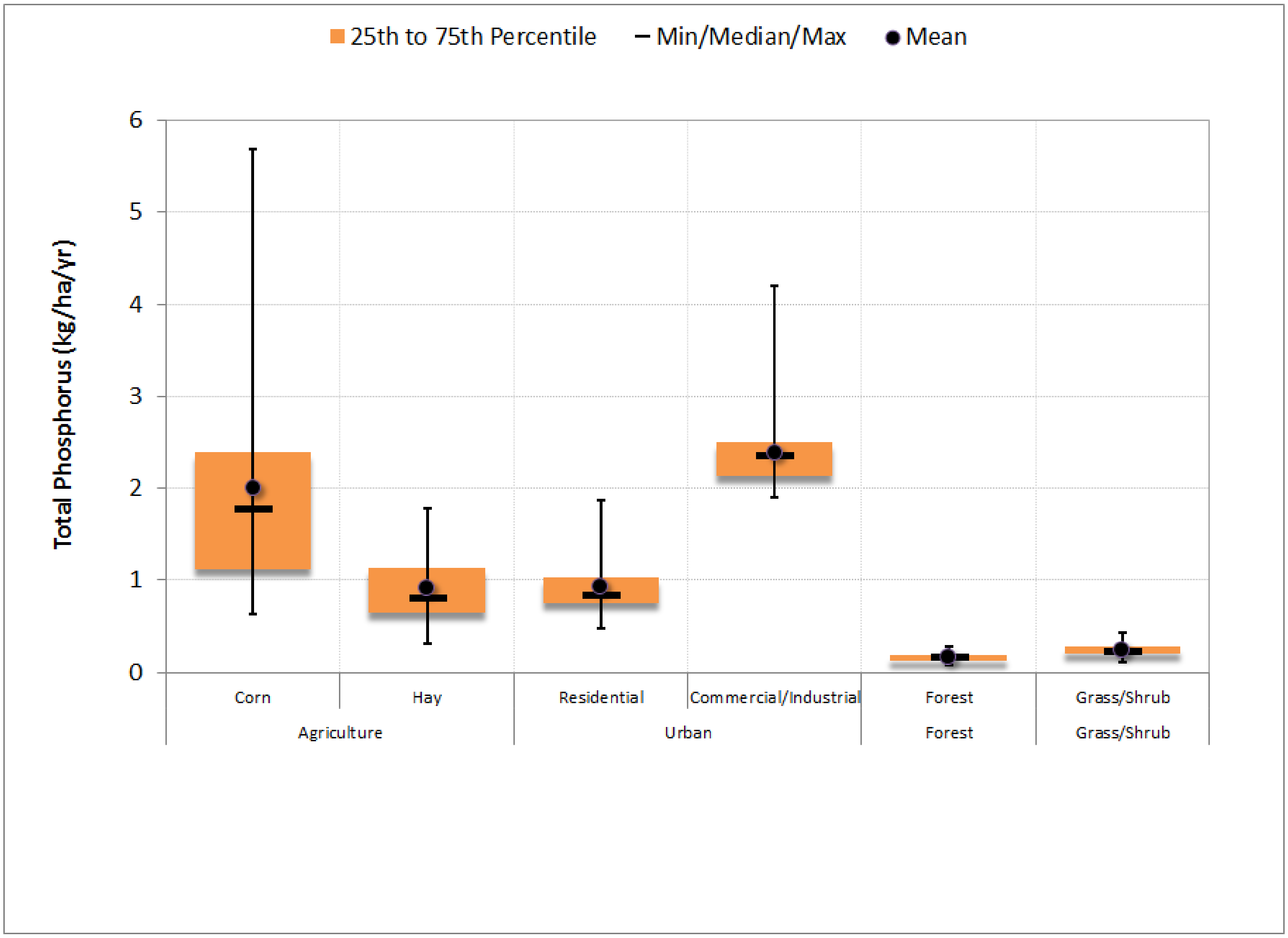


Figure K-135. TP export rates (kg/ha/yr) by landuse categories for the 30 year simulation period

Table K-37. TP export rates (kg/ha/yr) for the residential landuse categories for the 30 year simulation period

Residential Category	Area (ha)	Area (%)	Mean	Min	Q_{25}	Q_{50}	Q_{75}	Max
Low Density	3,630	75.83	**0.72**	0.30	0.54	0.64	0.82	1.60
Medium Density	904	18.89	**1.48**	0.90	1.20	1.37	1.56	3.10
High Density	253	5.28	**1.97**	1.44	1.70	1.87	2.01	3.27
Total	4,787	100.00	**0.93**	0.47	0.75	0.83	1.02	1.87

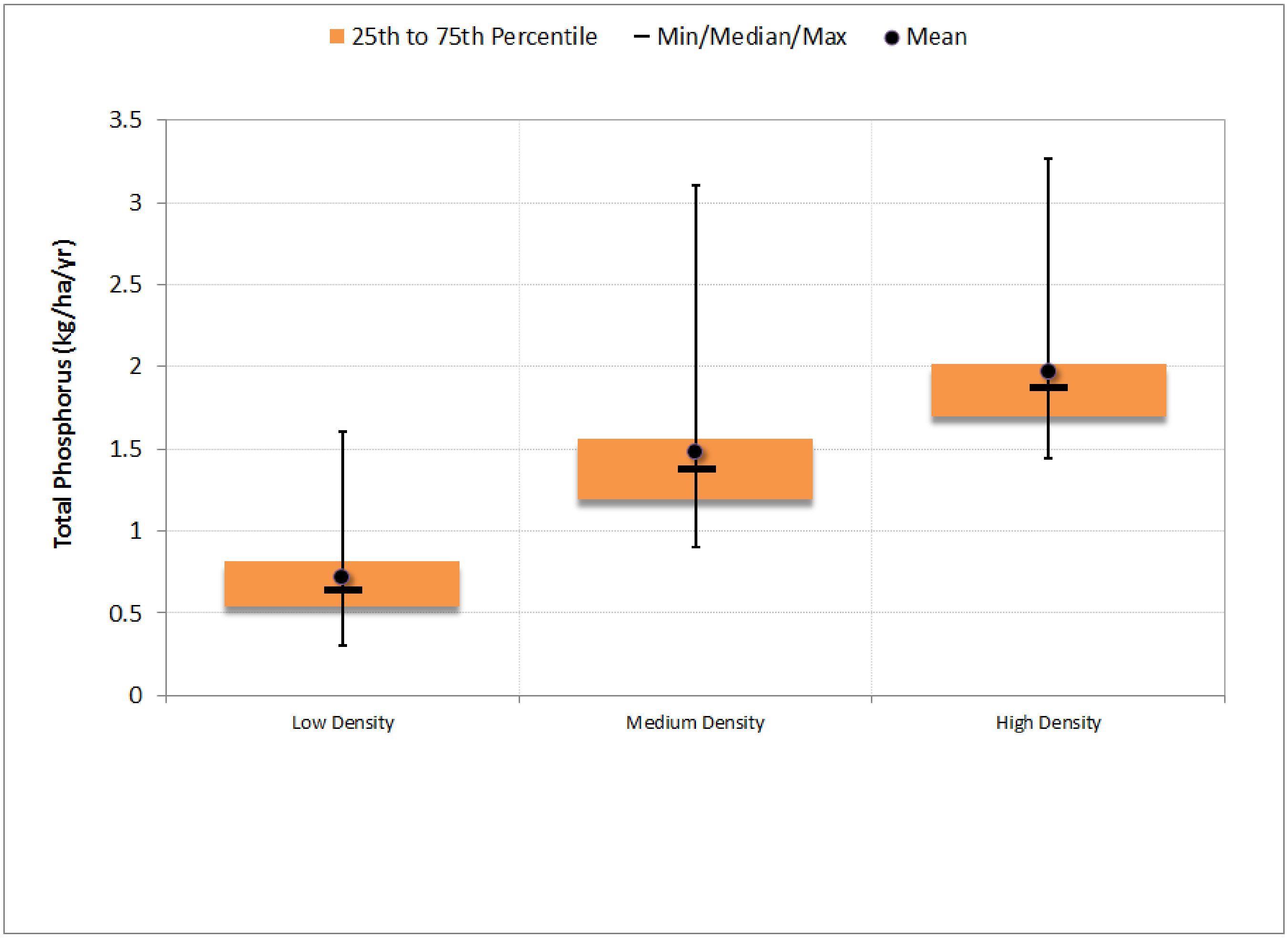


Figure K-136. TP export rates (kg/ha/yr) for the residential landuse categories for the 30 year simulation period

USGS 04275500 Little Ausable River near Valcour, NY - Calibration

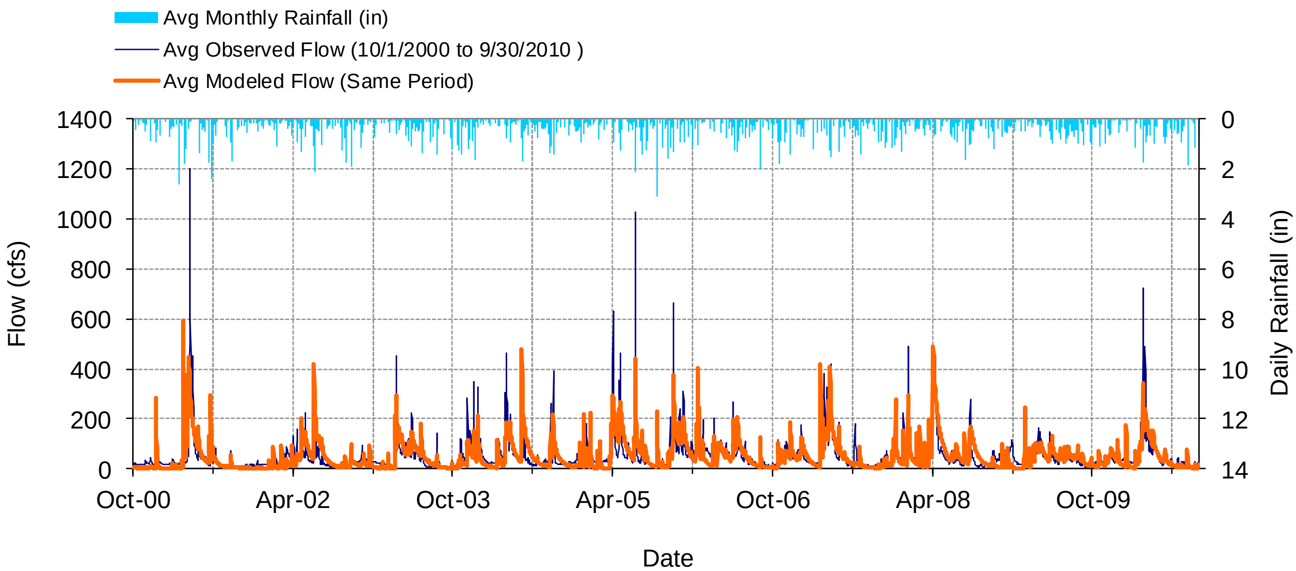


Figure K-137. Mean daily flow at USGS 04275500 Little Ausable River near Valcour, NY

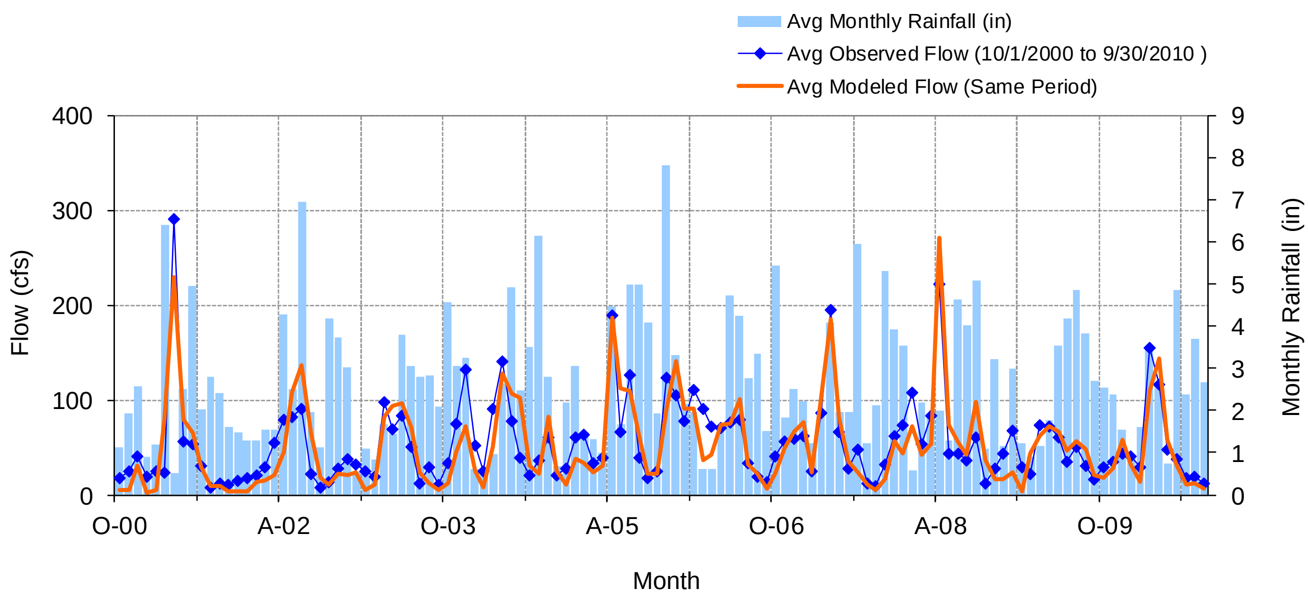


Figure K-138. Mean monthly flow at USGS 04275500 Little Ausable River near Valcour, NY

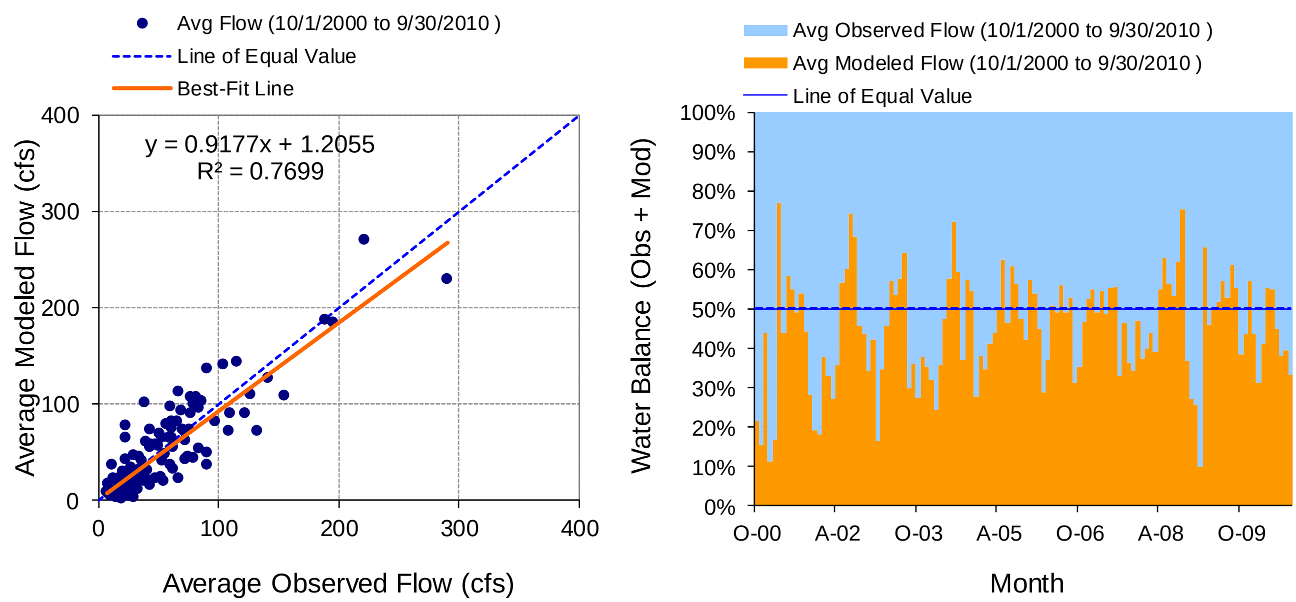


Figure K-139. Monthly flow regression and temporal variation at USGS 04275500 Little Ausable River near Valcour, NY

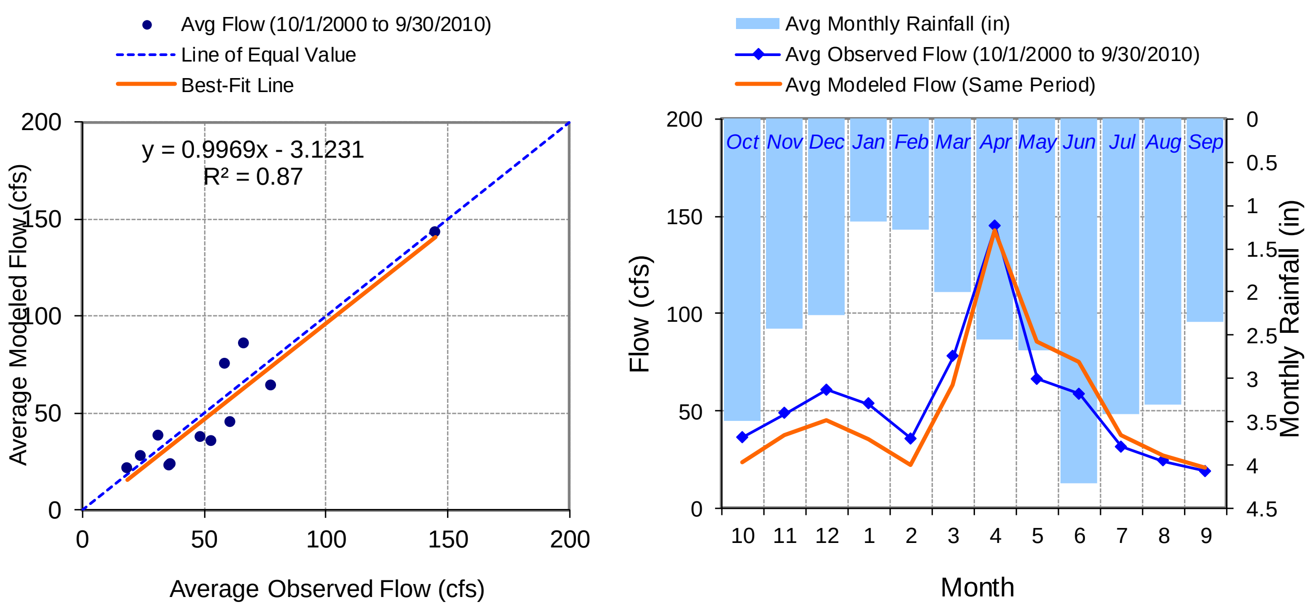


Figure K-140. Seasonal regression and temporal aggregate at USGS 04275500 Little Ausable River near Valcour, NY

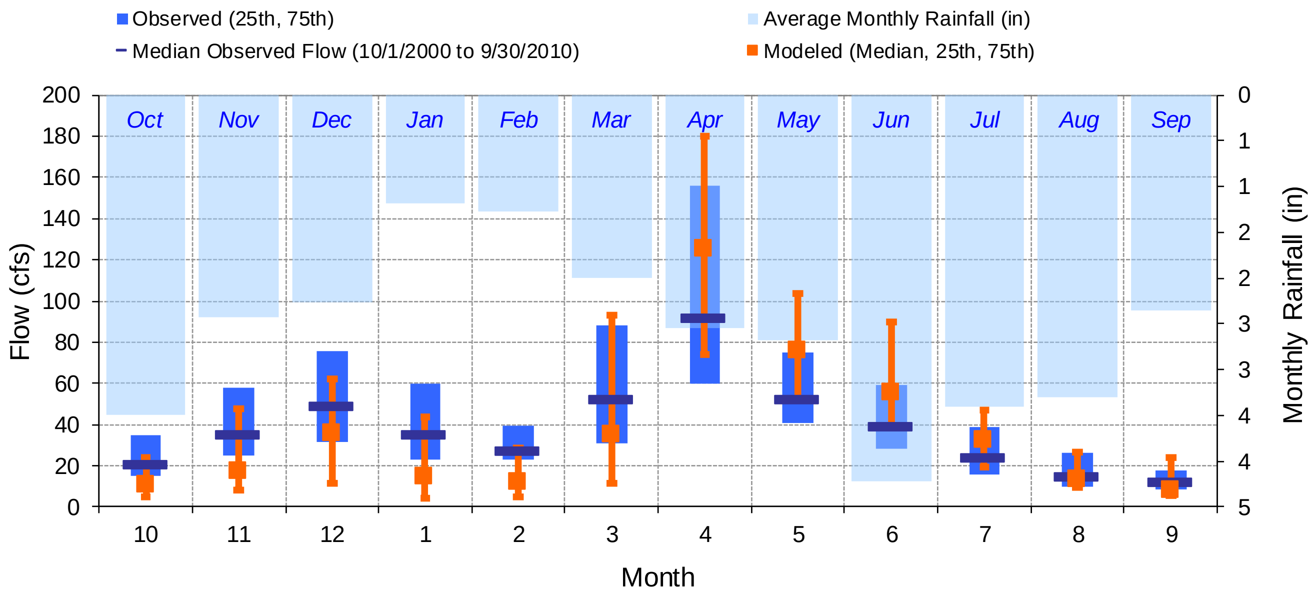


Figure K-141. Seasonal medians and ranges at USGS 04275500 Little Ausable River near Valcour, NY

Table K-38. Seasonal summary at USGS 04275500 Little Ausable River near Valcour, NY

MONTH	OBSERVED FLOW (CFS)				MODELED FLOW (CFS)			
	MEAN	MEDIAN	25TH	75TH	MEAN	MEDIAN	25TH	75TH
Oct	36.36	21.00	15.00	35.00	23.25	11.13	4.99	24.14
Nov	48.39	35.00	25.00	58.00	37.45	17.46	8.44	47.62
Dec	60.76	49.00	31.25	75.50	45.15	35.92	11.64	61.92
Jan	53.27	35.00	23.00	60.00	35.25	14.61	4.02	43.54
Feb	35.56	27.00	23.00	39.75	22.18	12.12	4.77	28.64
Mar	77.79	52.00	31.00	88.00	63.46	34.94	11.38	92.91
Apr	144.68	92.00	60.00	156.25	142.78	125.47	73.79	180.05
May	66.29	52.50	41.00	74.75	85.81	75.84	52.48	103.86
Jun	58.51	39.00	28.00	59.00	75.19	55.60	38.25	89.88
Jul	31.33	24.00	16.00	39.00	37.54	32.35	19.43	47.09
Aug	24.05	15.00	9.50	26.00	27.40	13.37	9.55	26.64
Sep	18.73	12.00	8.38	18.00	20.74	8.04	5.23	23.81

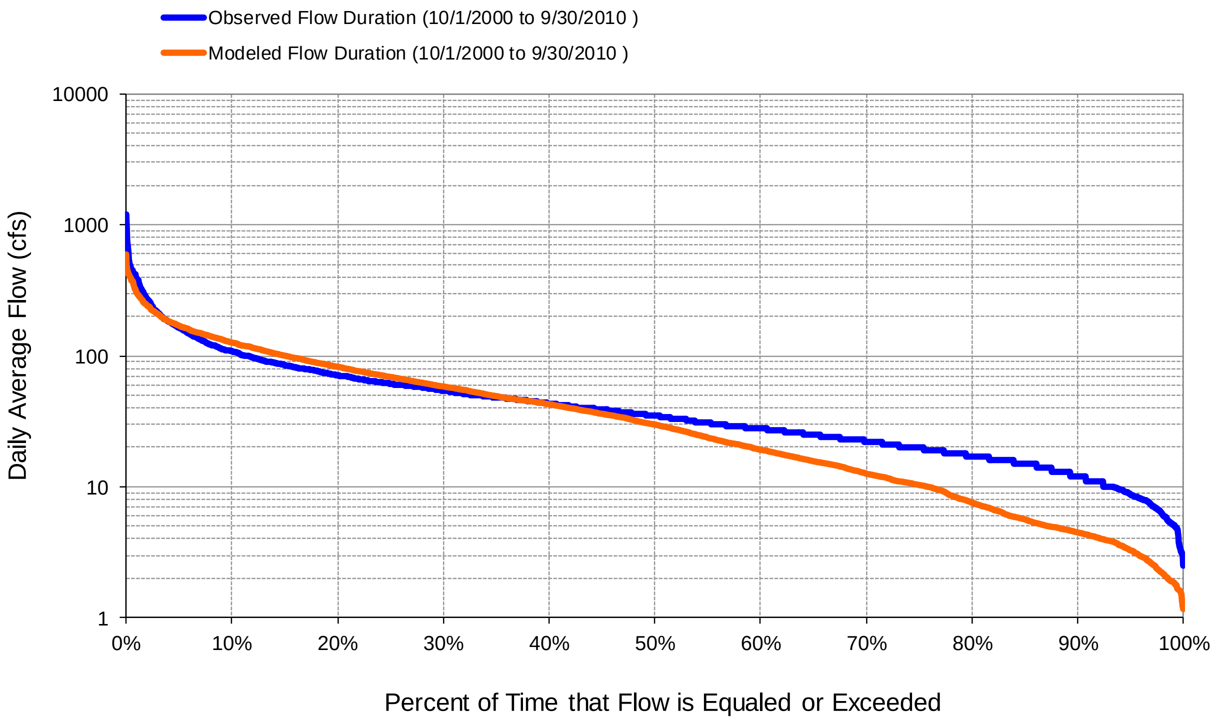


Figure K-142. Flow exceedence at USGS 04275500 Little Ausable River near Valcour, NY

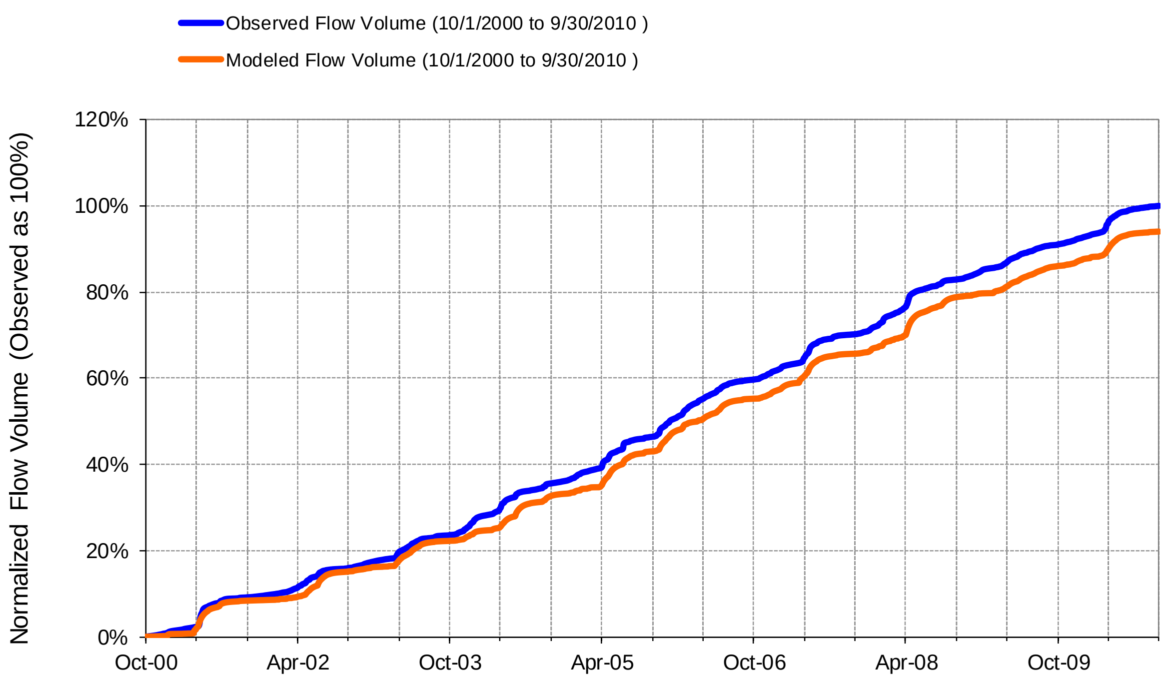


Figure K-143. Flow accumulation at USGS 04275500 Little Ausable River near Valcour, NY

Table K-39. Summary statistics at USGS 04275500 Little Ausable River near Valcour, NY

SWAT Simulated Flow		Observed Flow Gage	
REACH OUTFLOW FROM OUTLET 22 10-Year Analysis Period: 10/1/2000 - 9/30/2010 Flow volumes are (inches/year) for upstream drainage area		USGS 04273800 LITTLE AUSABLE RIVER NEAR VALCOUR NY Hydrologic Unit Code: 2010004 Latitude: 44.59416667 Longitude: -73.4961111 Drainage Area (sq-mi): 67.8	
Total Simulated In-stream Flow:	**10.29**	Total Observed In-stream Flow:	**10.95**
Total of simulated highest 10% flows:	**3.97**	Total of Observed highest 10% flows:	**4.25**
Total of Simulated lowest 50% flows:	**1.18**	Total of Observed Lowest 50% flows:	**1.98**
Simulated Summer Flow Volume (months 7-9):	**1.45**	Observed Summer Flow Volume (7-9):	**1.25**
Simulated Fall Flow Volume (months 10-12):	**1.78**	Observed Fall Flow Volume (10-12):	**2.45**
Simulated Winter Flow Volume (months 1-3):	**2.02**	Observed Winter Flow Volume (1-3):	**2.78**
Simulated Spring Flow Volume (months 4-6):	**5.05**	Observed Spring Flow Volume (4-6):	**4.47**
Total Simulated Storm Volume:	**2.19**	Total Observed Storm Volume:	**2.77**
Simulated Summer Storm Volume (7-9):	**0.27**	Observed Summer Storm Volume (7-9):	**0.37**

Errors (Simulated-Observed)	*Error Statistics*	*Recommended Criteria*		
Error in total volume:	-5.98	10		
Error in 50% lowest flows:	-40.31	10		
Error in 10% highest flows:	-6.61	15		
Seasonal volume error - Summer:	15.67	30		
Seasonal volume error - Fall:	-27.31	>> 30	Clear	
Seasonal volume error - Winter:	-27.25	30		
Seasonal volume error - Spring:	12.87	30		
Error in storm volumes:	-20.91	20		
Error in summer storm volumes:	-26.75	50		
Nash-Sutcliffe Coefficient of Efficiency, E:	0.506	Model accuracy increases		
Baseline adjusted coefficient (Garrick), E':	0.286	as E or E' approaches 1.0		
Monthly NSE	0.736			

USGS 04275500 Little Ausable River near Valcour, NY - Validation

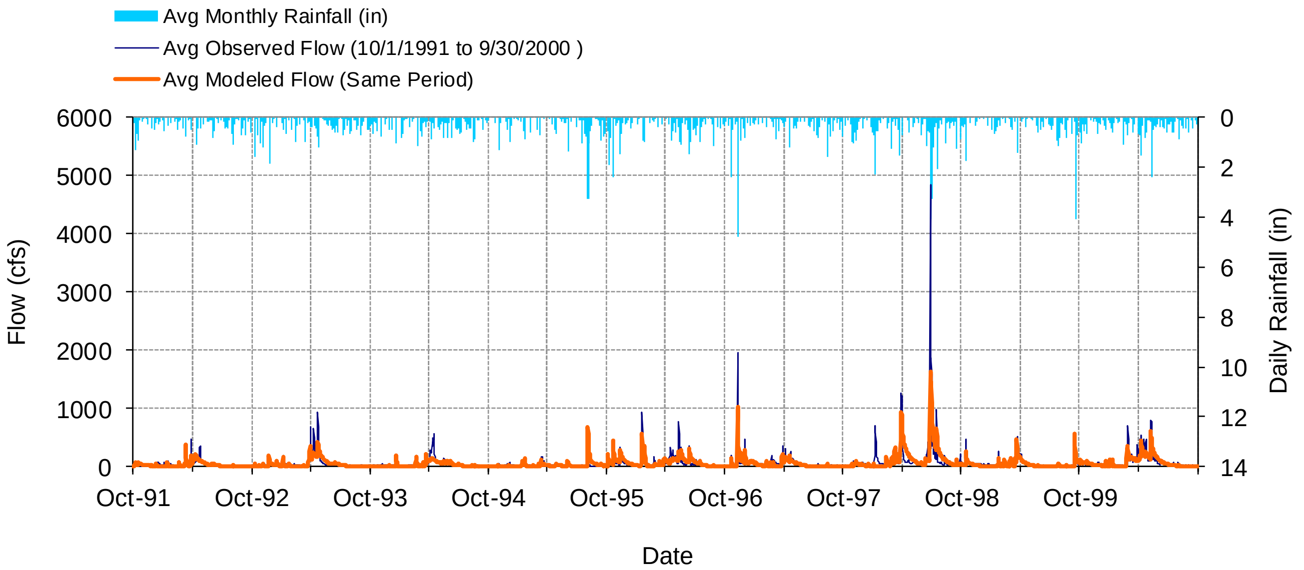


Figure K-144. Mean daily flow at USGS 04275500 Little Ausable River near Valcour, NY

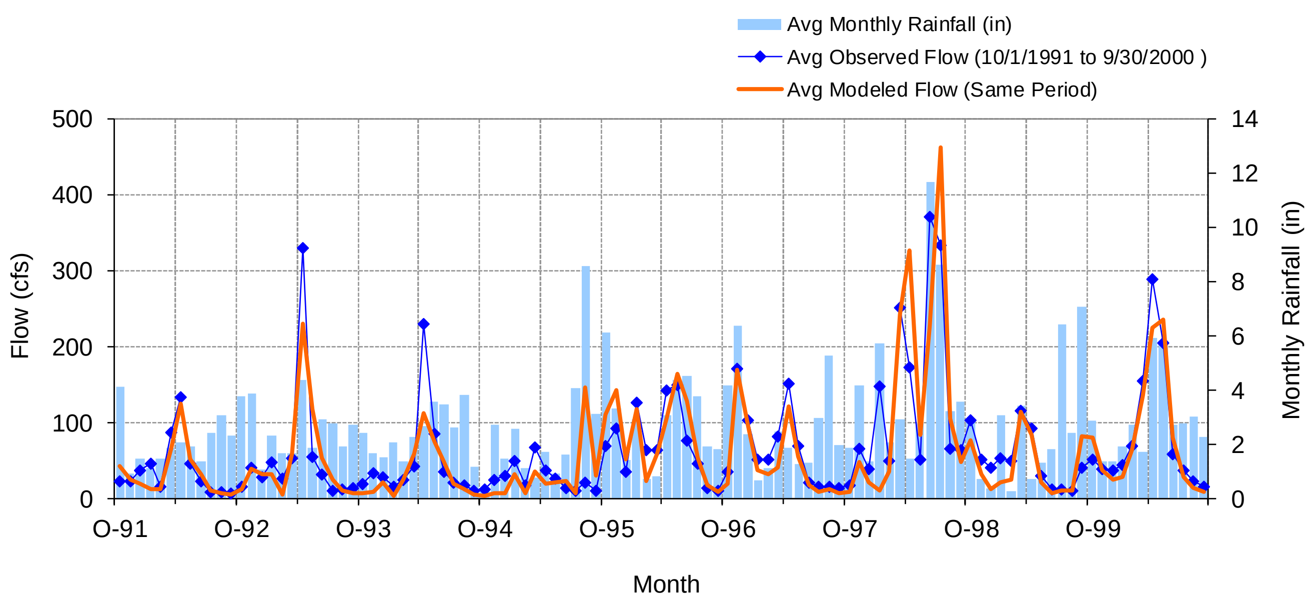


Figure K-145. Mean monthly flow at USGS 04275500 Little Ausable River near Valcour, NY

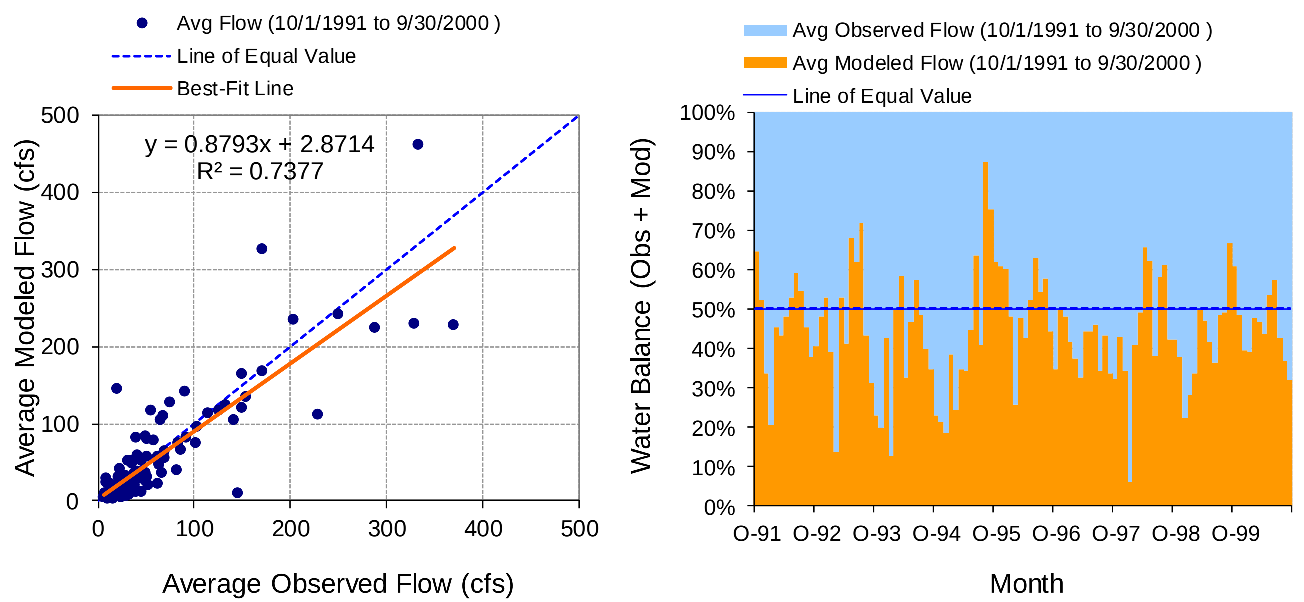


Figure K-146. Monthly flow regression and temporal variation at USGS 04275500 Little Ausable River near Valcour, NY

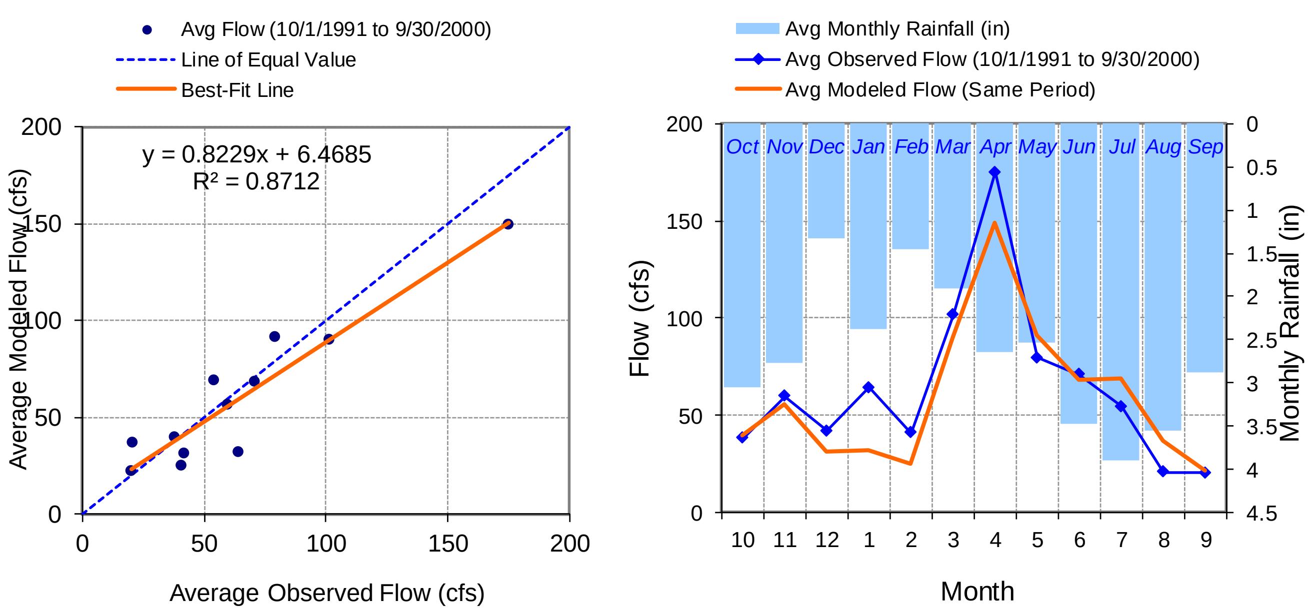


Figure K-147. Seasonal regression and temporal aggregate at USGS 04275500 Little Ausable River near Valcour, NY

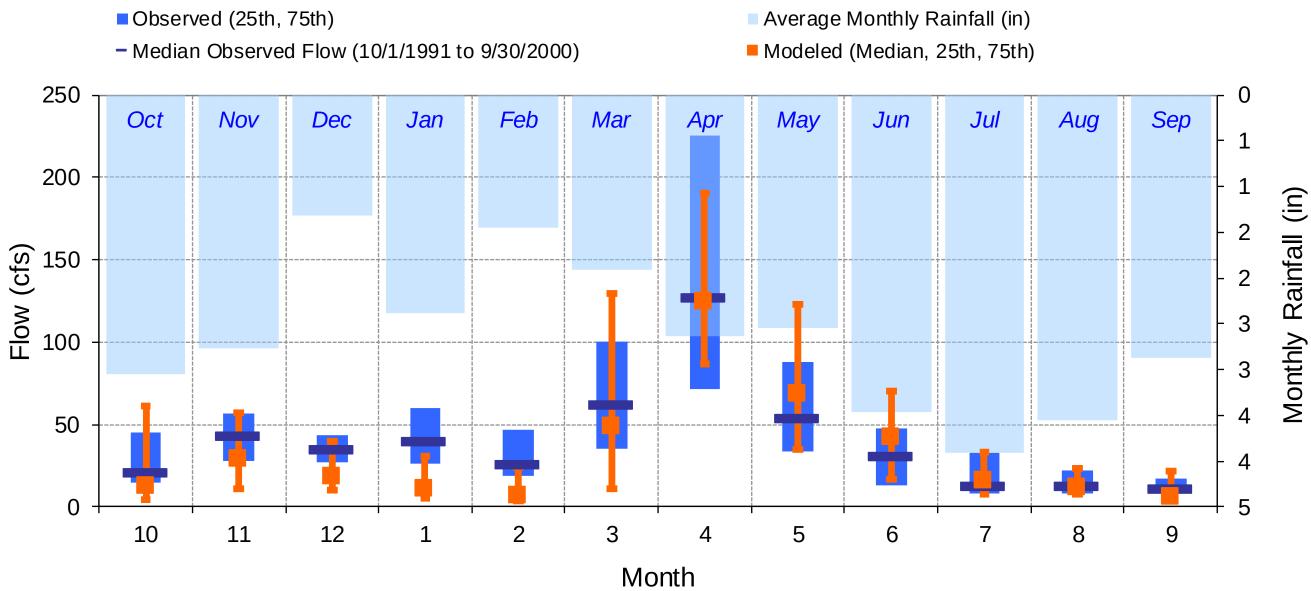


Figure K-148. Seasonal medians and ranges at USGS 04275500 Little Ausable River near Valcour, NY

Table K-40. Seasonal summary at USGS 04275500 Little Ausable River near Valcour, NY

MONTH	OBSERVED FLOW (CFS)				MODELED FLOW (CFS)			
	MEAN	MEDIAN	25TH	75TH	MEAN	MEDIAN	25TH	75TH
Oct	38.10	21.00	14.50	45.50	39.30	12.97	4.66	60.85
Nov	59.76	43.00	28.00	57.00	55.89	28.77	10.95	57.36
Dec	41.72	35.00	27.00	43.50	31.22	18.10	10.36	39.64
Jan	64.10	40.00	26.00	60.00	31.82	10.94	5.21	30.68
Feb	40.73	26.00	19.00	47.00	24.70	6.93	3.34	24.18
Mar	101.35	62.00	35.00	100.00	89.63	48.77	11.15	129.25
Apr	174.92	127.50	71.25	225.50	148.99	124.84	87.12	190.20
May	79.37	54.00	34.00	88.00	91.32	68.69	34.81	122.95
Jun	70.89	30.50	13.00	48.00	67.93	42.43	16.95	70.40
Jul	54.37	13.00	8.15	33.00	69.01	16.24	7.52	32.93
Aug	20.55	13.00	8.30	22.00	36.53	11.70	7.62	23.79
Sep	20.19	11.00	7.93	17.00	21.68	6.49	5.04	22.08

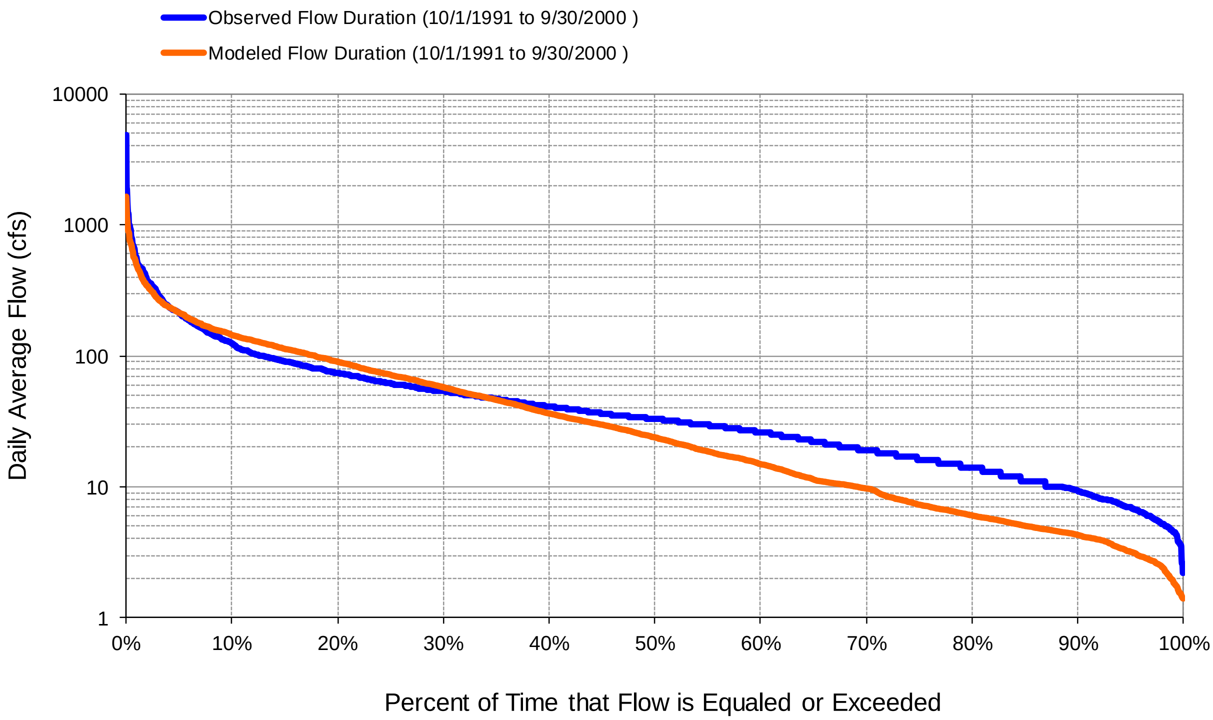


Figure K-149. Flow exceedence at USGS 04275500 Little Ausable River near Valcour, NY

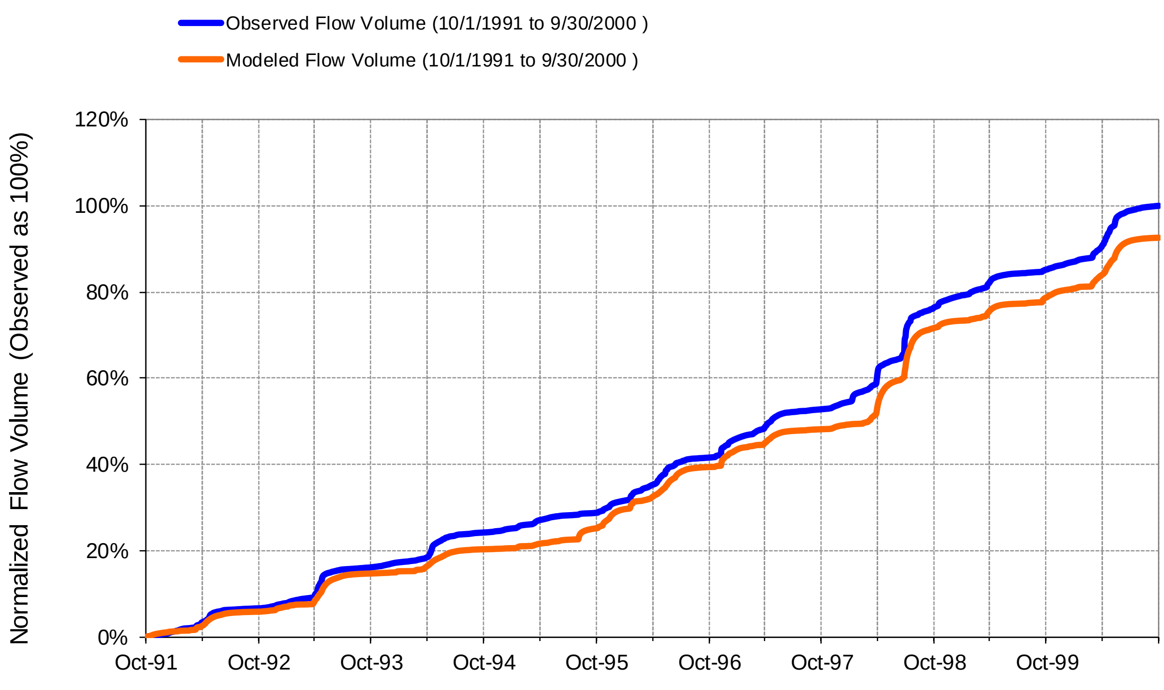


Figure K-150. Flow accumulation at USGS 04275500 Little Ausable River near Valcour, NY

Table K-41. Summary statistics at USGS 04275500 Little Ausable River near Valcour, NY

SWAT Simulated Flow		Observed Flow Gage	
REACH OUTFLOW FROM OUTLET 22		USGS 04273800 LITTLE AUSABLE RIVER NEAR VALCOUR NY	
9-Year Analysis Period: 10/1/1991 - 9/30/2000 Flow volumes are (inches/year) for upstream drainage area		Hydrologic Unit Code: 2010004 Latitude: 44.59416667 Longitude: -73.4961111 Drainage Area (sq-mi): 67.8	
Total Simulated In-stream Flow:	**11.84**	Total Observed In-stream Flow:	**12.78**
Total of simulated highest 10% flows:	**5.65**	Total of Observed highest 10% flows:	**6.28**
Total of Simulated lowest 50% flows:	**0.93**	Total of Observed Lowest 50% flows:	**1.74**
Simulated Summer Flow Volume (months 7-9):	**2.15**	Observed Summer Flow Volume (7-9):	**1.61**
Simulated Fall Flow Volume (months 10-12):	**2.12**	Observed Fall Flow Volume (10-12):	**2.34**
Simulated Winter Flow Volume (months 1-3):	**2.45**	Observed Winter Flow Volume (1-3):	**3.45**
Simulated Spring Flow Volume (months 4-6):	**5.12**	Observed Spring Flow Volume (4-6):	**5.39**
Total Simulated Storm Volume:	**2.66**	Total Observed Storm Volume:	**3.99**
Simulated Summer Storm Volume (7-9):	**0.48**	Observed Summer Storm Volume (7-9):	**0.62**

Errors (Simulated-Observed)	*Error Statistics*	*Recommended Criteria*		
Error in total volume:	-7.40	10		
Error in 50% lowest flows:	-46.31	10		
Error in 10% highest flows:	-10.06	15		
Seasonal volume error - Summer:	33.95	30		
Seasonal volume error - Fall:	-9.48	>> 30		Clear
Seasonal volume error - Winter:	-28.94	30		
Seasonal volume error - Spring:	-5.04	30		
Error in storm volumes:	-33.28	20		
Error in summer storm volumes:	-22.81	50		
Nash-Sutcliffe Coefficient of Efficiency, E:	0.607	Model accuracy increases		
Baseline adjusted coefficient (Garrick), E':	0.381	as E or E' approaches 1.0		
Monthly NSE	0.733			

WATER QUALITY - Little Ausable River

TSS and TP distribution by channel and upland sources

Table K-42. TSS and TP distribution by source categories

Source	TSS		TP	
	Load(mt/year)	Percentage (%)	Load (kg/year)	Percentage (%)
Upland	1,003	59.7	3,106	94.6
Stream	677	40.3	178	5.4
Total	**1,679**	**100.0**	**3,284**	**100.0**

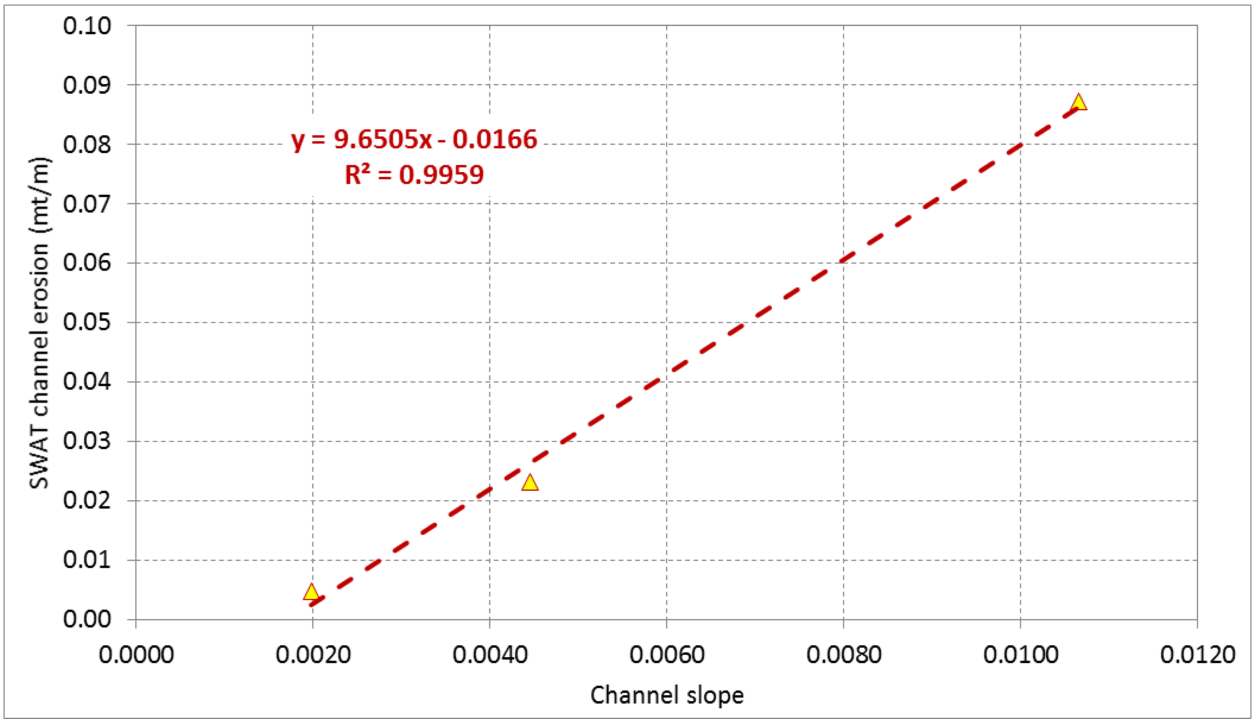


Figure K-151. SWAT simulated channel erosion relative to channel slope

TP distribution by landuse from upland sources

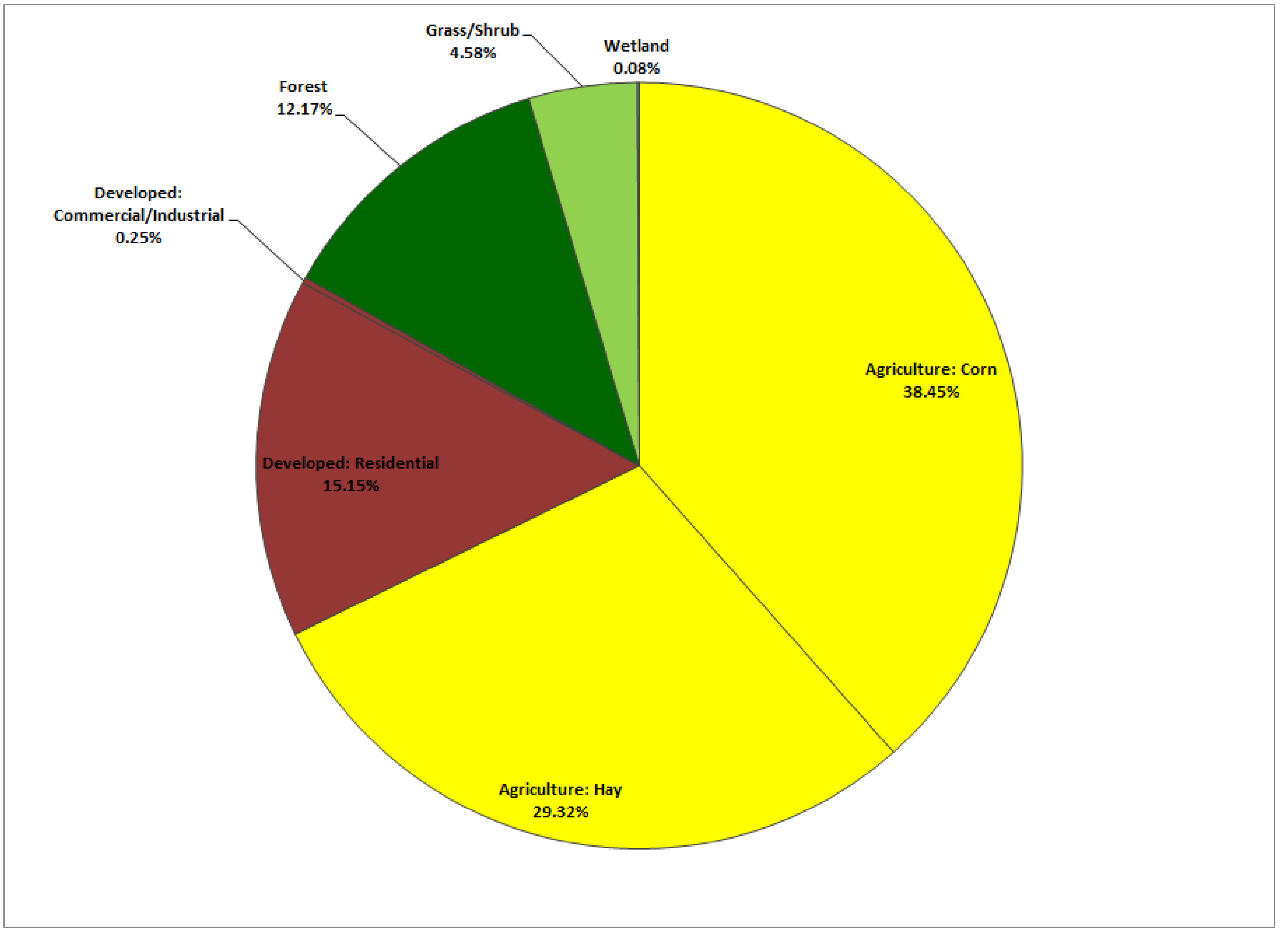


Figure K-152. Distribution of simulated total upland TP loads by landuse categories

Table K-43. TP export rates (kg/ha/yr) by landuse categories for the 30 year simulation period

Landuse	Classification	Area (ha)	Area (%)	Mean	Min	Q_{25}	Q_{50}	Q_{75}	Max
Agriculture	Corn	598	3.10	**2.16**	0.49	1.09	1.43	2.07	15.67
	Hay	1,299	6.74	**0.76**	0.10	0.28	0.56	1.11	3.80
Urban	Residential	1,087	5.64	**0.47**	0.29	0.37	0.47	0.53	0.92
	Commercial/Industrial	5	0.03	**1.59**	1.37	1.49	1.60	1.68	1.87
Forest	Forest	15,304	79.45	**0.03**	0.01	0.02	0.02	0.03	0.09
Grass/Shrub	Grass/Shrub	822	4.27	**0.19**	0.09	0.13	0.16	0.20	0.57
Wetland	Wetland	148	0.77	**0.02**	0.01	0.01	0.01	0.02	0.08

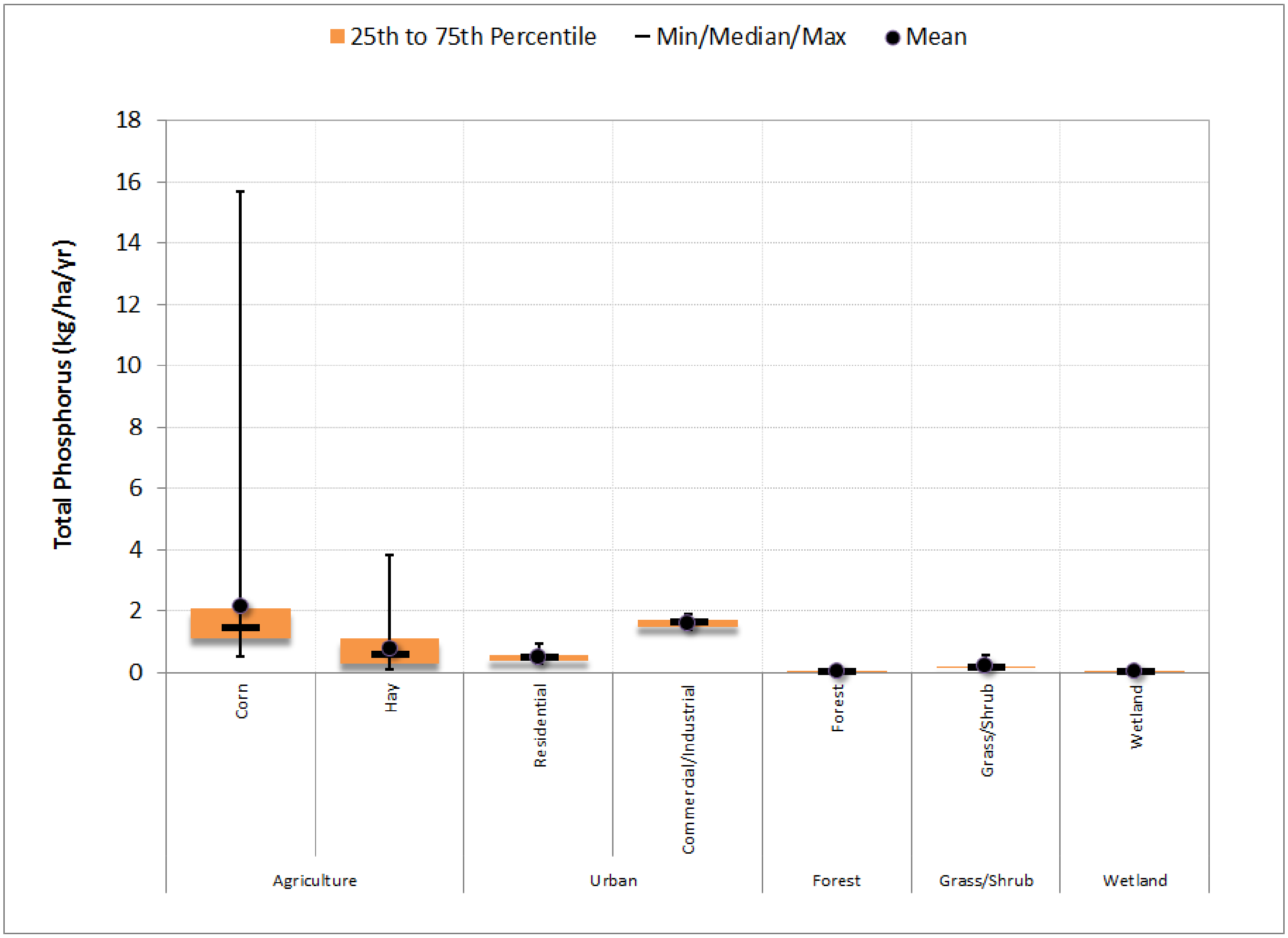


Figure K-153. TP export rates (kg/ha/yr) by landuse categories for the 30 year simulation period

Table K-44. TP export rates (kg/ha/yr) for the residential landuse categories for the 30 year simulation period

Residential Category	Area (ha)	Area (%)	Mean	Min	Q_{25}	Q_{50}	Q_{75}	Max
Low Density	828	76.12	**0.28**	0.13	0.19	0.26	0.32	0.70
Medium Density	227	20.84	**1.00**	0.70	0.85	0.99	1.09	1.57
High Density	33	3.04	**1.59**	1.31	1.44	1.55	1.70	1.99
Total	1,087	100.00	**0.47**	0.29	0.37	0.47	0.53	0.92

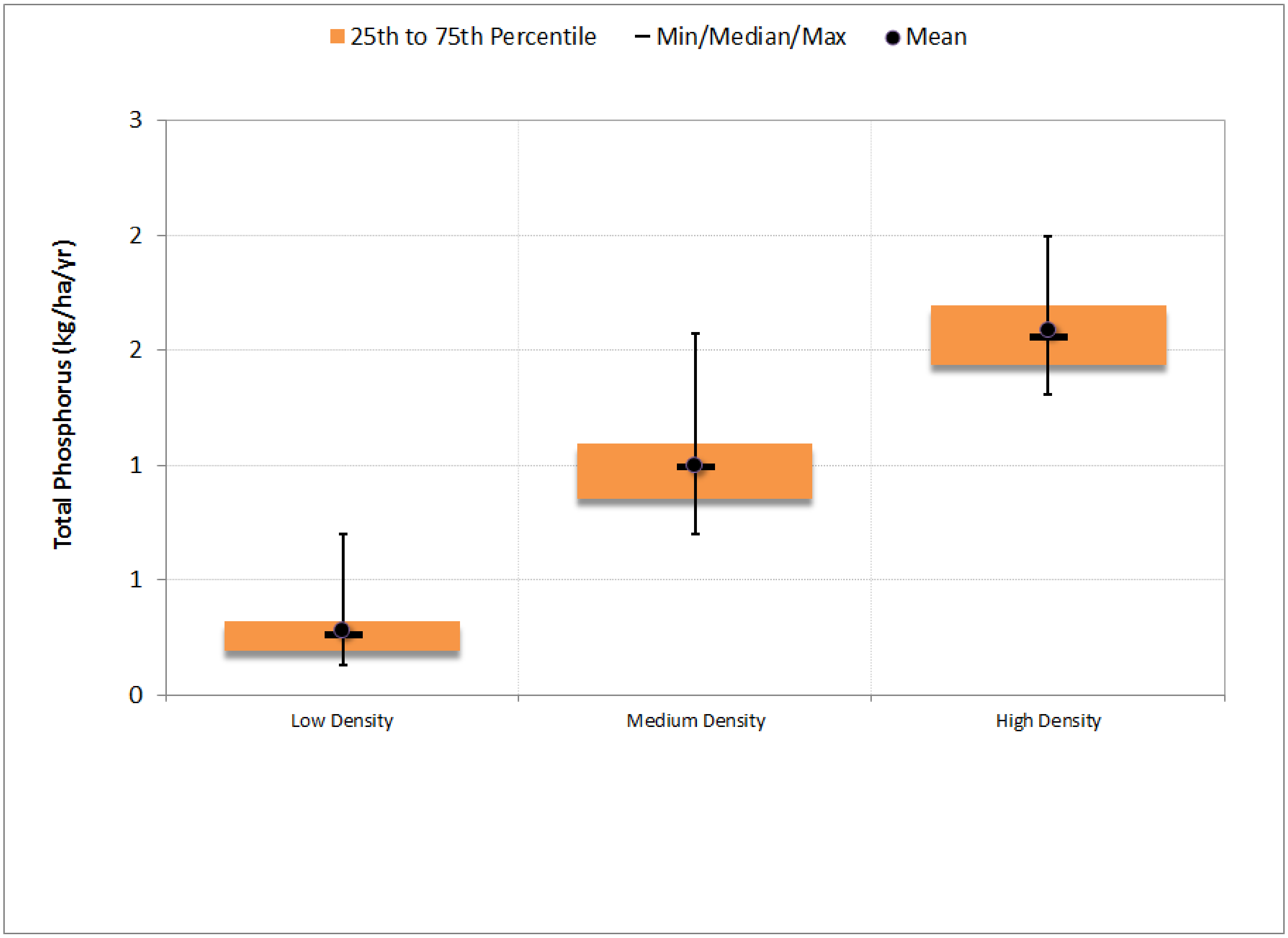


Figure K-154. TP export rates (kg/ha/yr) for the residential landuse categories for the 30 year simulation period

Segmented Regression

Table K-45. Summary statistics

Statistic	Calibration		Validation	
	TSS	TP	TSS	TP
Average absolute error (%)	51.6	50.3	53.2	64.4
Median absolute error (%)	24.0	22.3	17.2	16.8
Regression error (%)	25.2	0.9	13.8	-15.5
NSE	0.702	0.257	0.678	0.239
NSE'	0.425	0.246	0.551	0.313

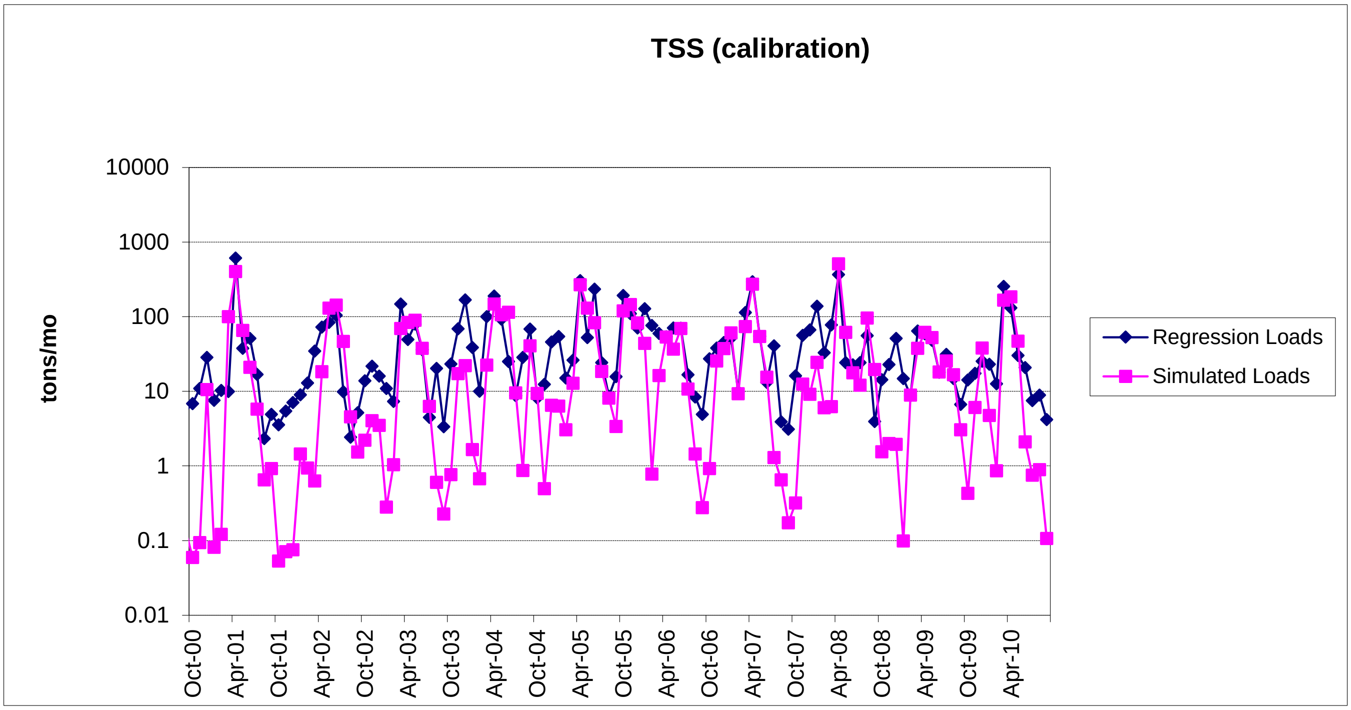


Figure K-155. Monthly simulated and estimated TSS load at Little Ausable river near Valcour, NY (calibration period)

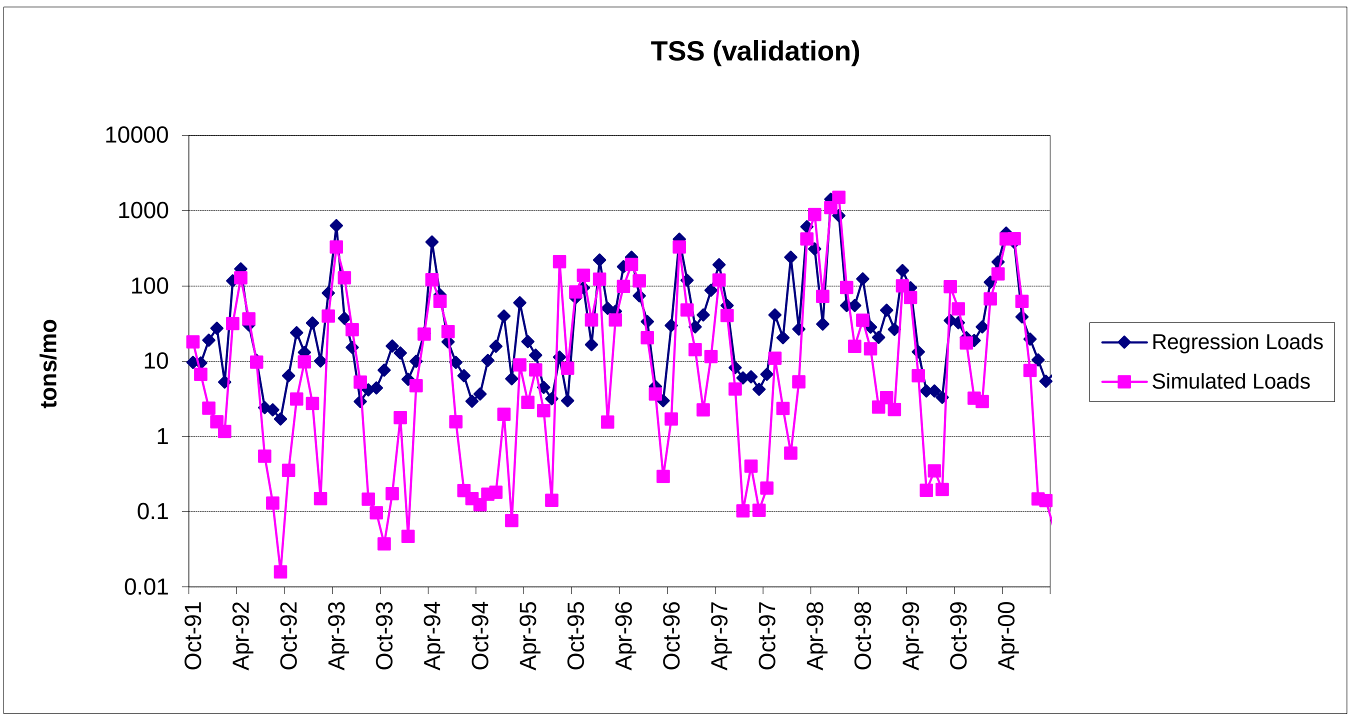


Figure K-156. Monthly simulated and estimated TSS load at Little Ausable river near Valcour, NY (validation period)

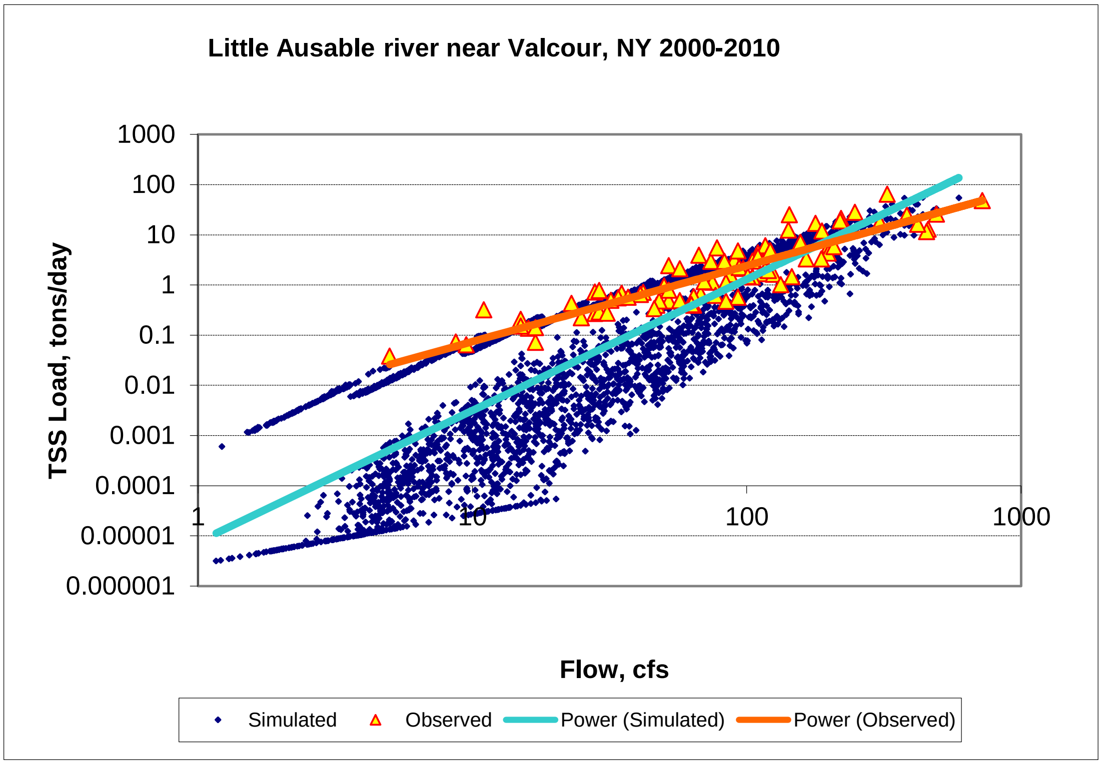


Figure K-157. Power plot of simulated and observed TSS load vs flow at Little Ausable river near Valcour, NY (calibration period)

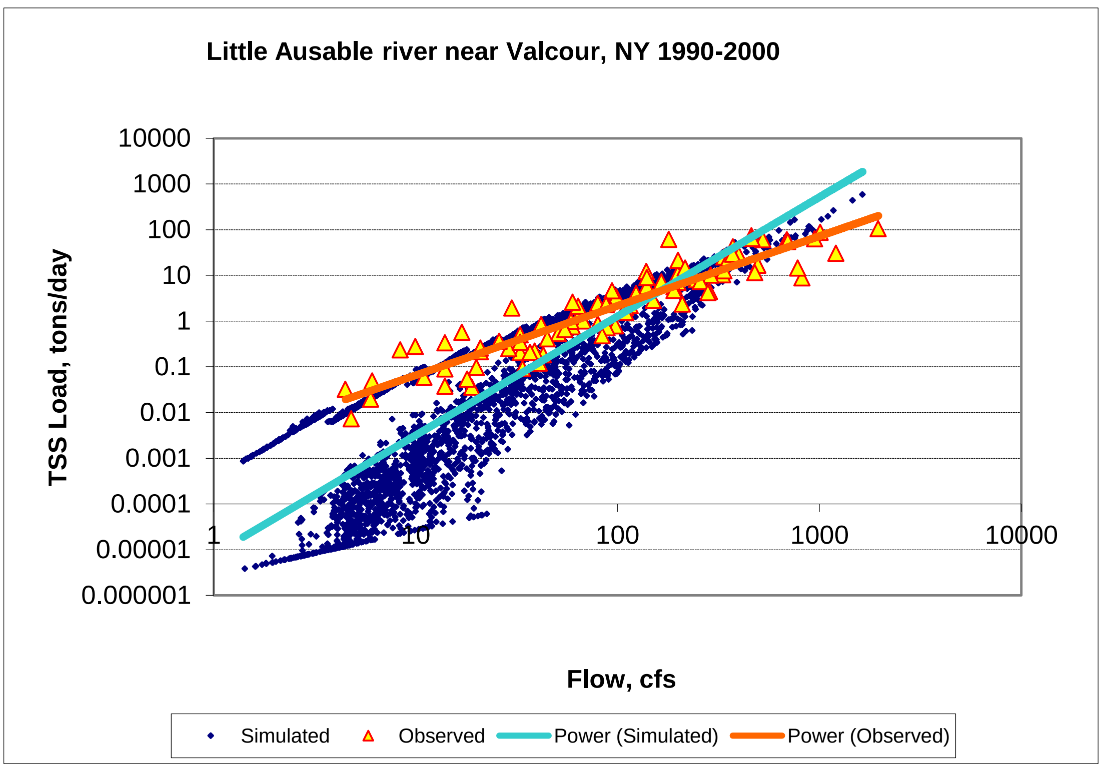


Figure K-158. Power plot of simulated and observed TSS load vs flow at Little Ausable river near Valcour, NY (validation period)

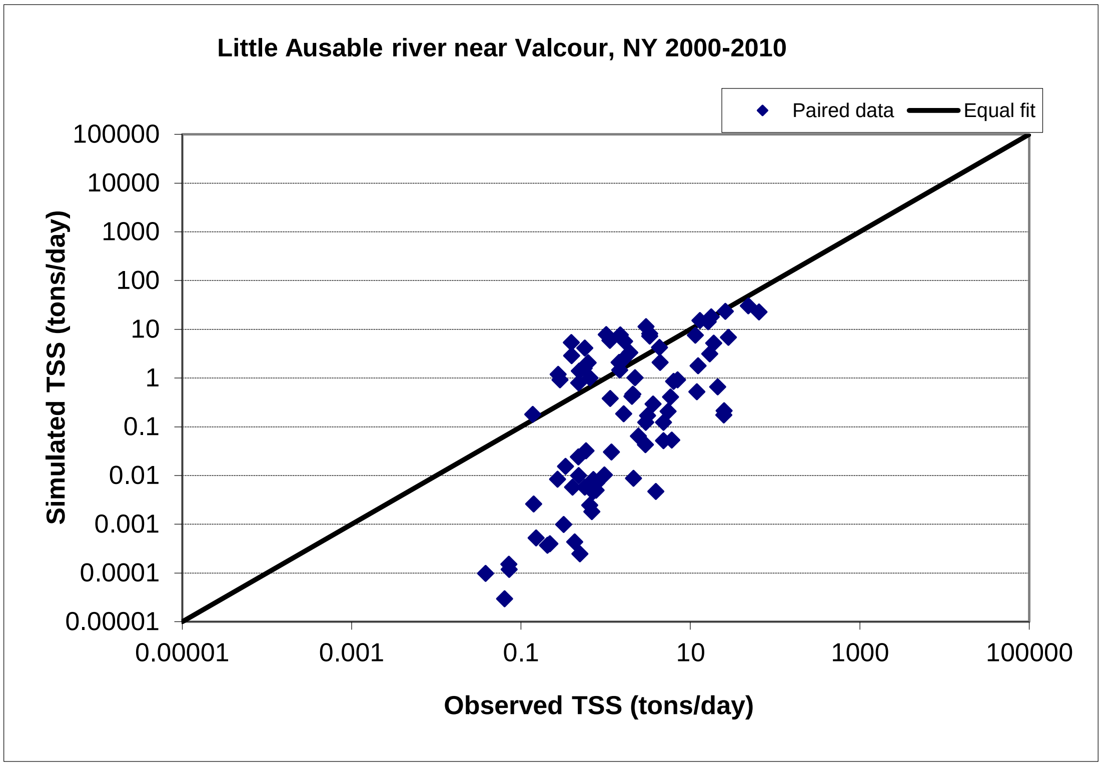


Figure K-159. Paired simulated vs observed TSS load at Little Ausable river near Valcour, NY (calibration period)

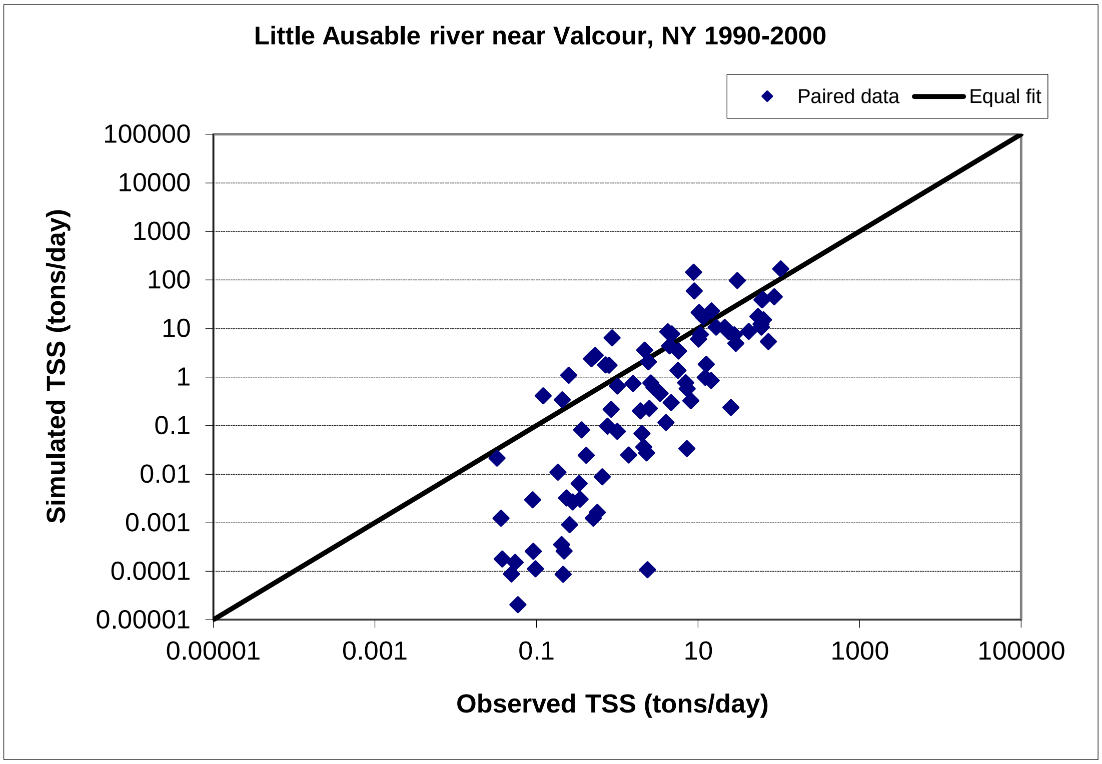


Figure K-160. Paired simulated vs observed TSS load at Little Ausable river near Valcour, NY (validation period)

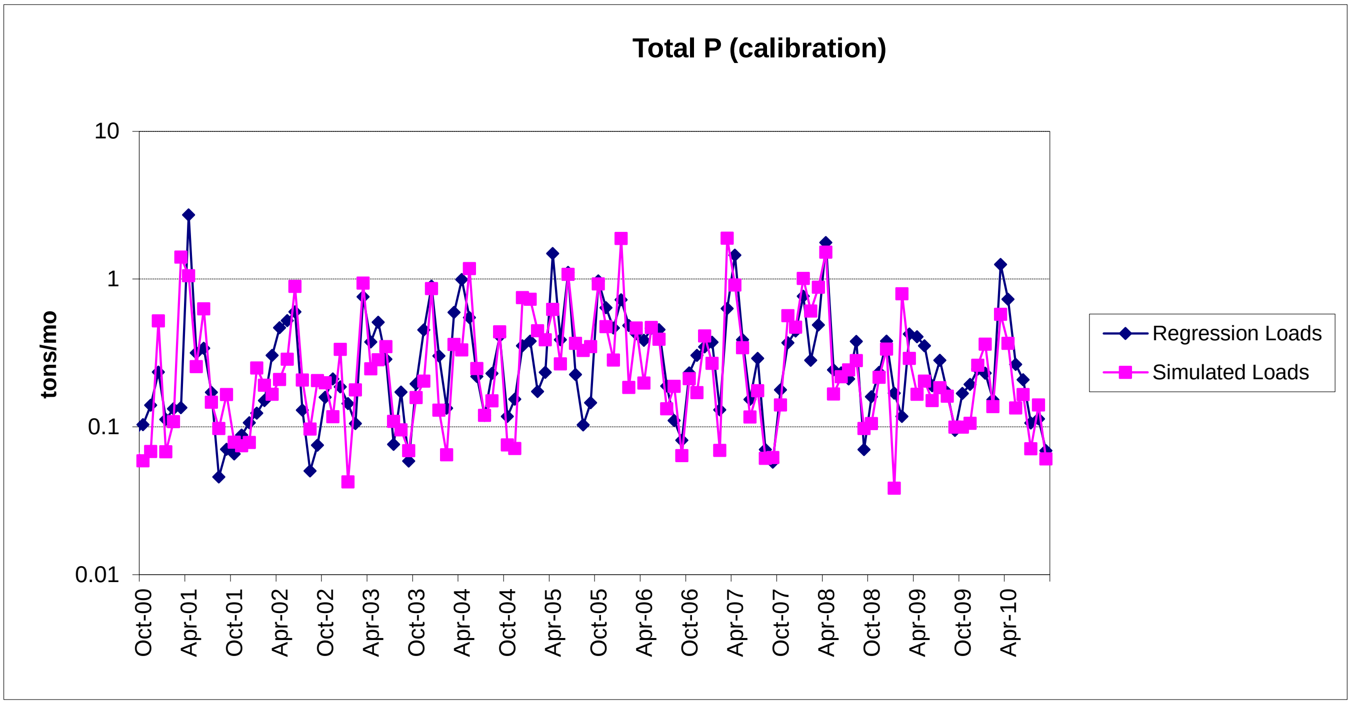


Figure K-161. Monthly simulated and estimated TP load at Little Ausable river near Valcour, NY (calibration period)

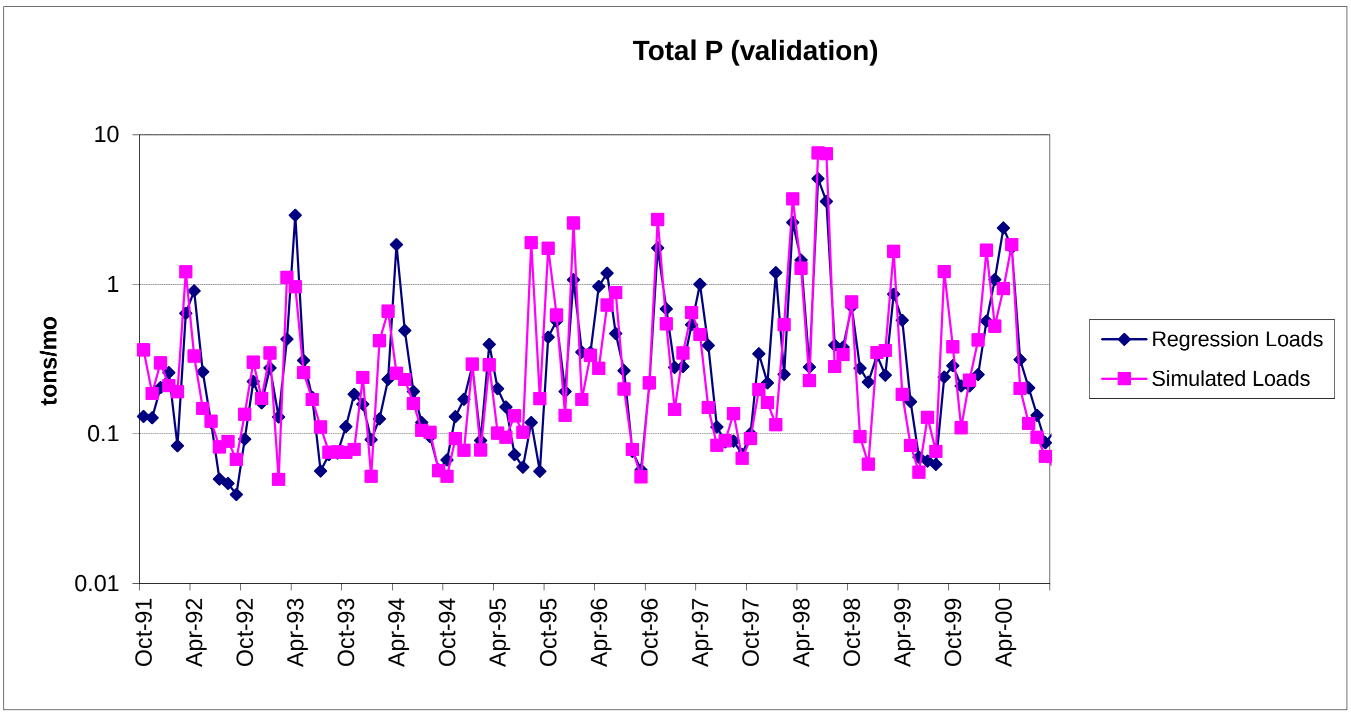


Figure K-162. Monthly simulated and estimated TP load at Little Ausable river near Valcour, NY (validation period)

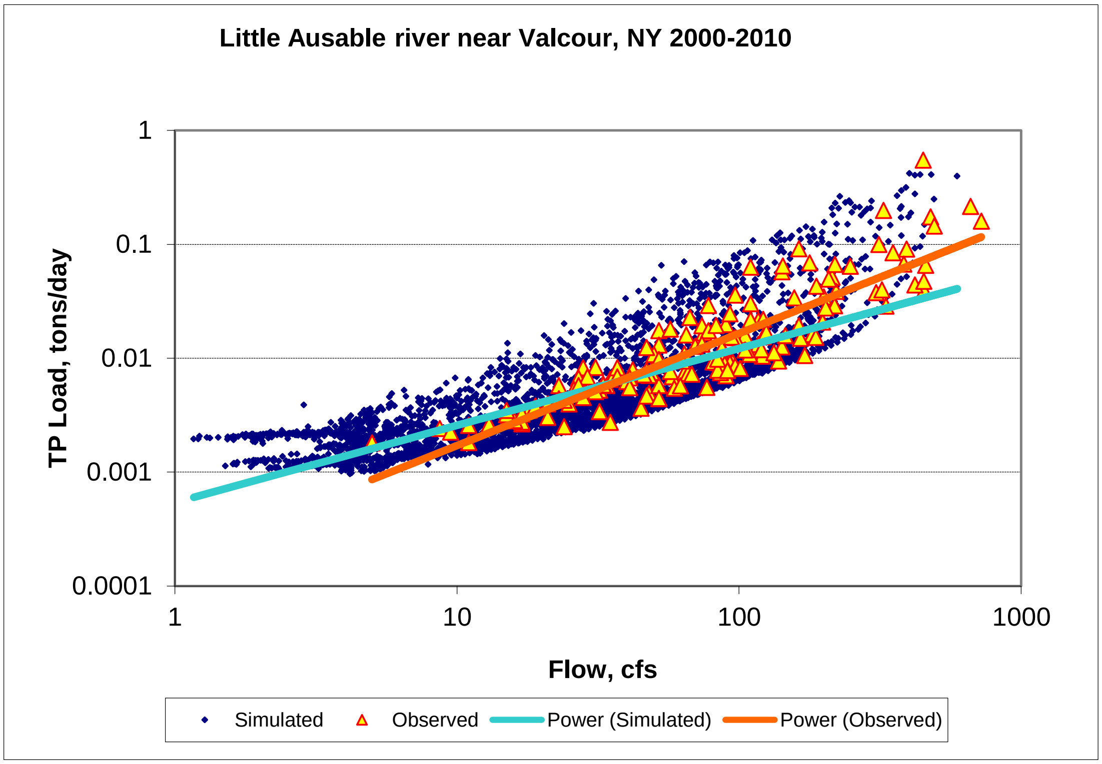


Figure K-163. Power plot of simulated and observed TP load vs flow at Little Ausable river near Valcour, NY (calibration period)

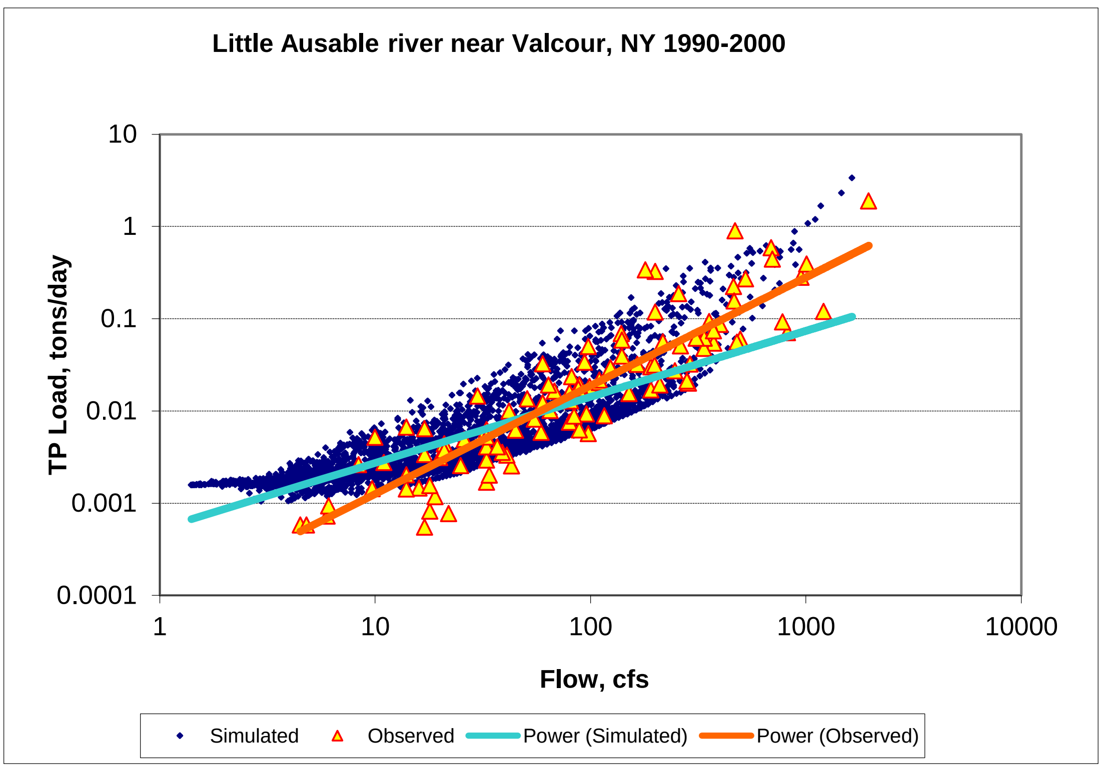


Figure K-164. Power plot of simulated and observed TP load vs flow at Little Ausable river near Valcour, NY (validation period)

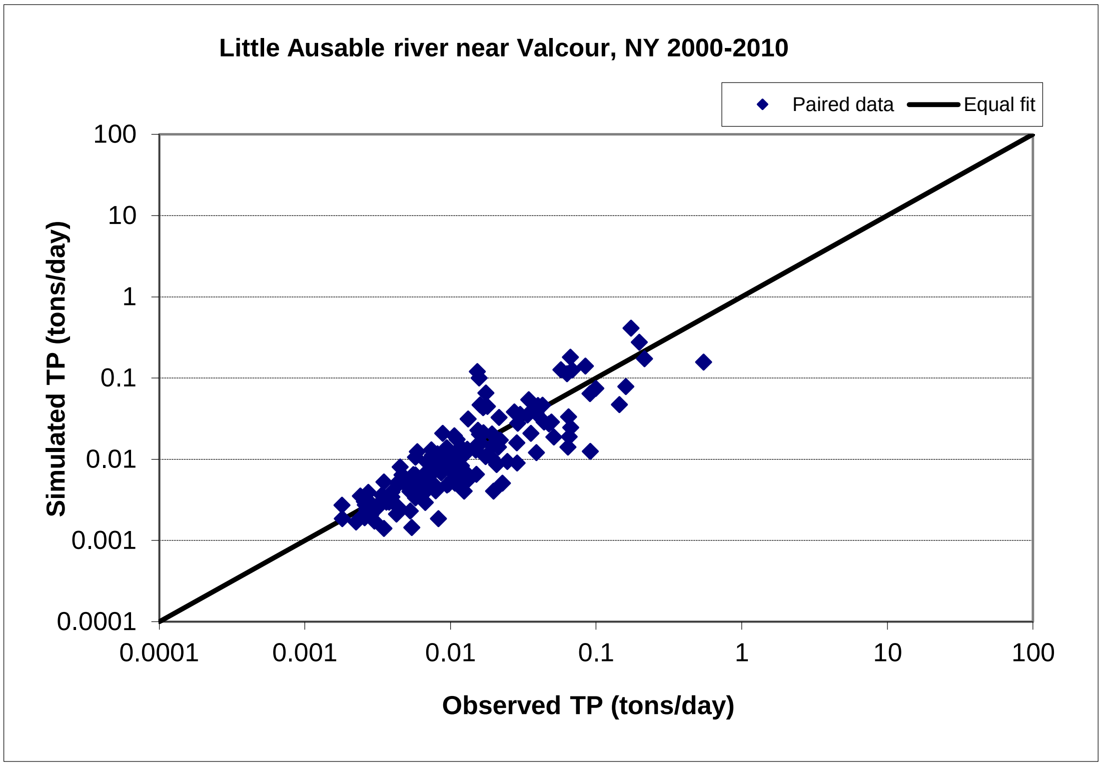


Figure K-165. Paired simulated vs observed TP load at Little Ausable river near Valcour, NY (calibration period)

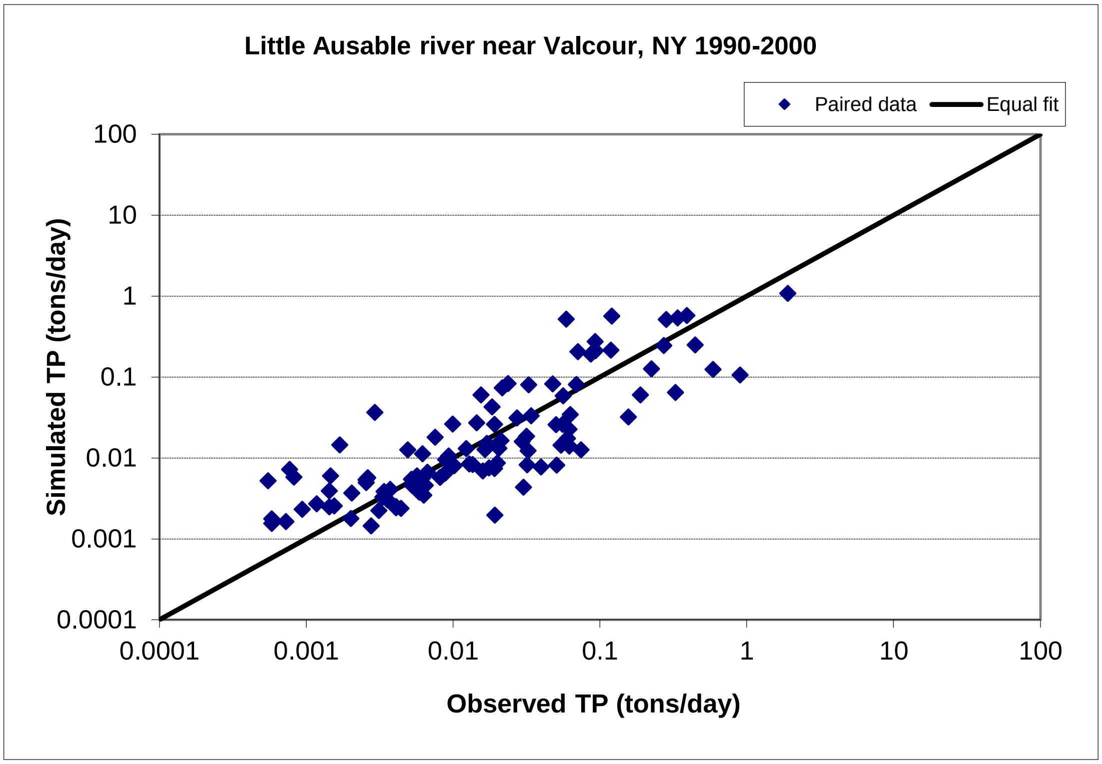


Figure K-166. Paired simulated vs observed TP load at Little Ausable river near Valcour, NY (validation period)

Comparison of simulated SWAT TP loads with FLUX estimates

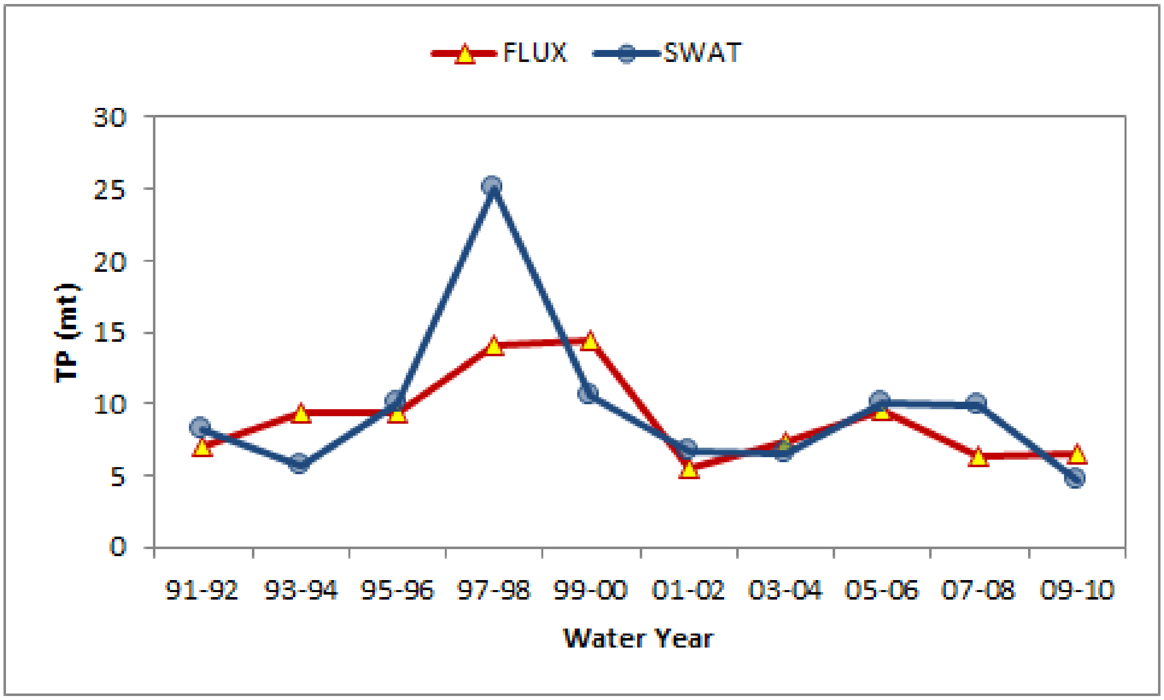


Figure K-167. Bi-annual TP loads on a water year basis as simulated by SWAT and estimated by FLUX (FLUX estimates from Smeltzer et al., 2009)

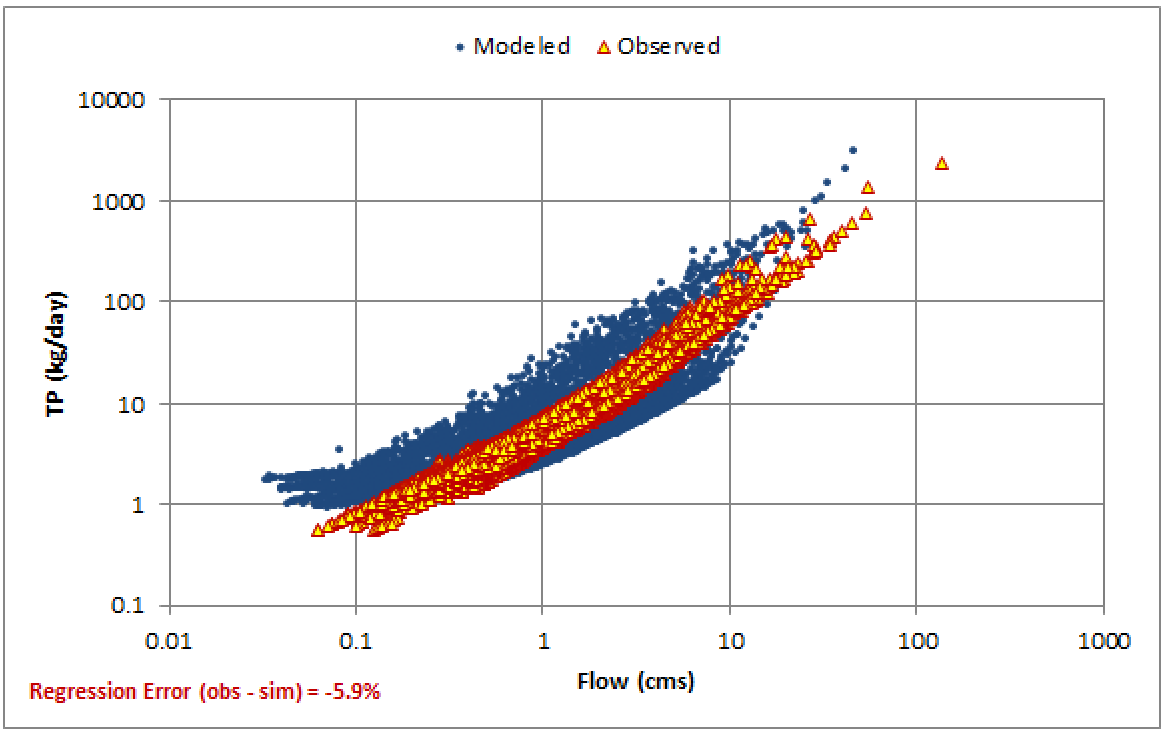


Figure K-168. Daily TP load versus flow as simulated by SWAT and estimated by FLUX (FLUX estimates from Medalie, 2013)

HYDROLOGY - Salmon River

USGS 04273700 Salmon River at South Plattsburgh, NY - Calibration

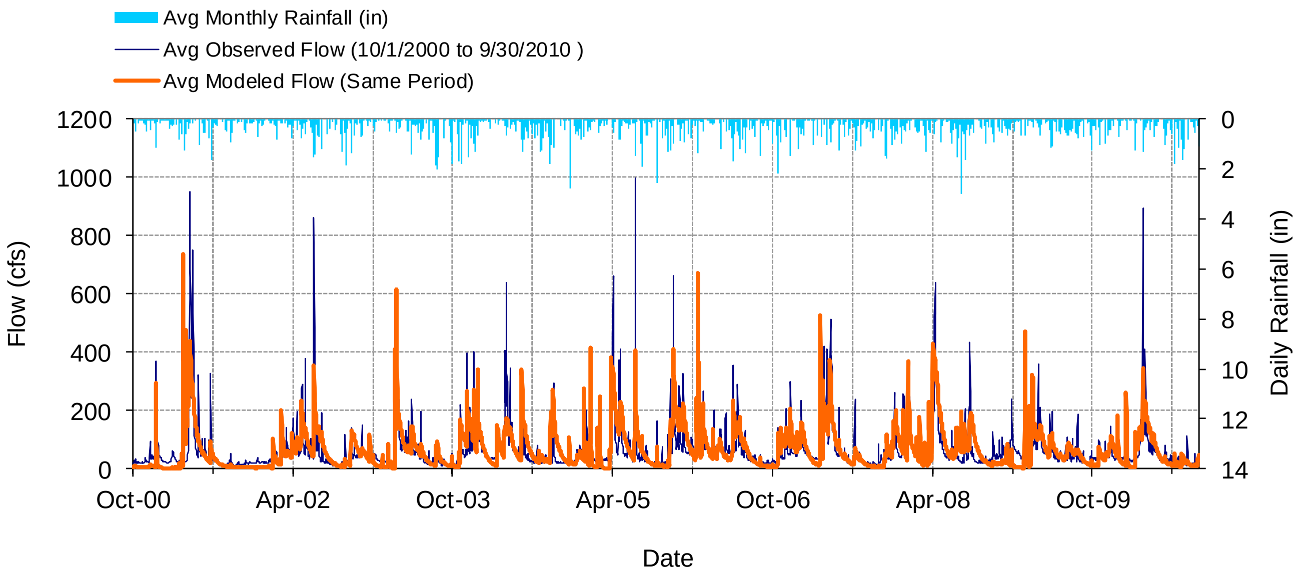


Figure K-169. Mean daily flow at USGS 04273700 Salmon River at South Plattsburgh, NY

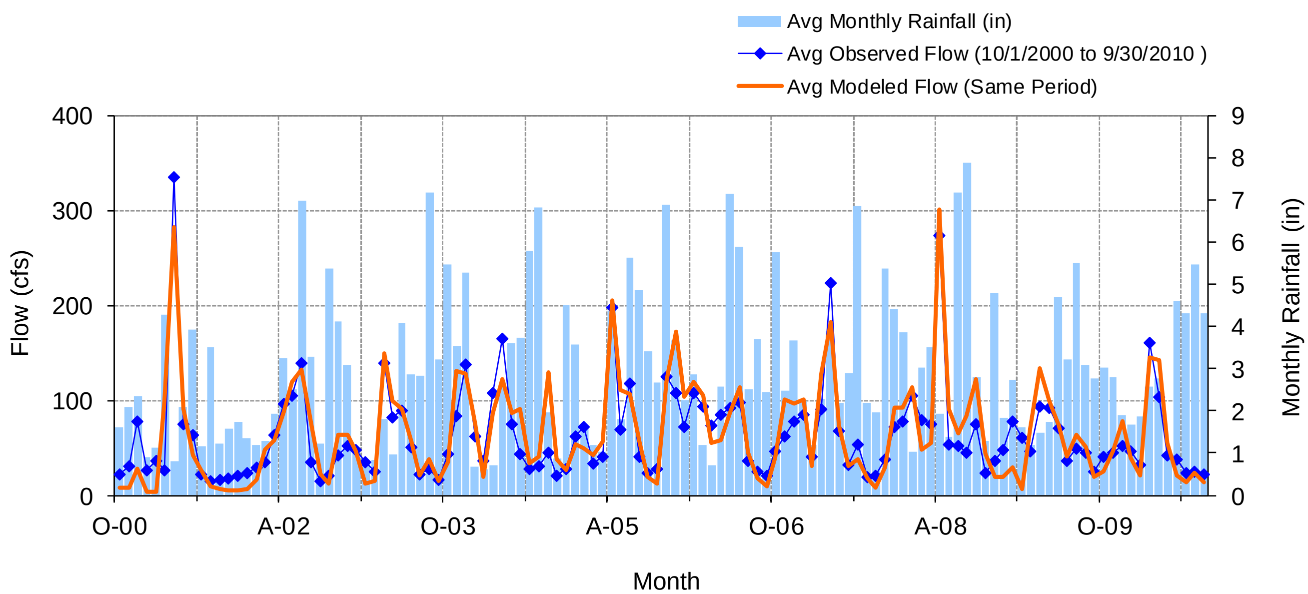


Figure K-170. Mean monthly flow at USGS 04273700 Salmon River at South Plattsburgh, NY

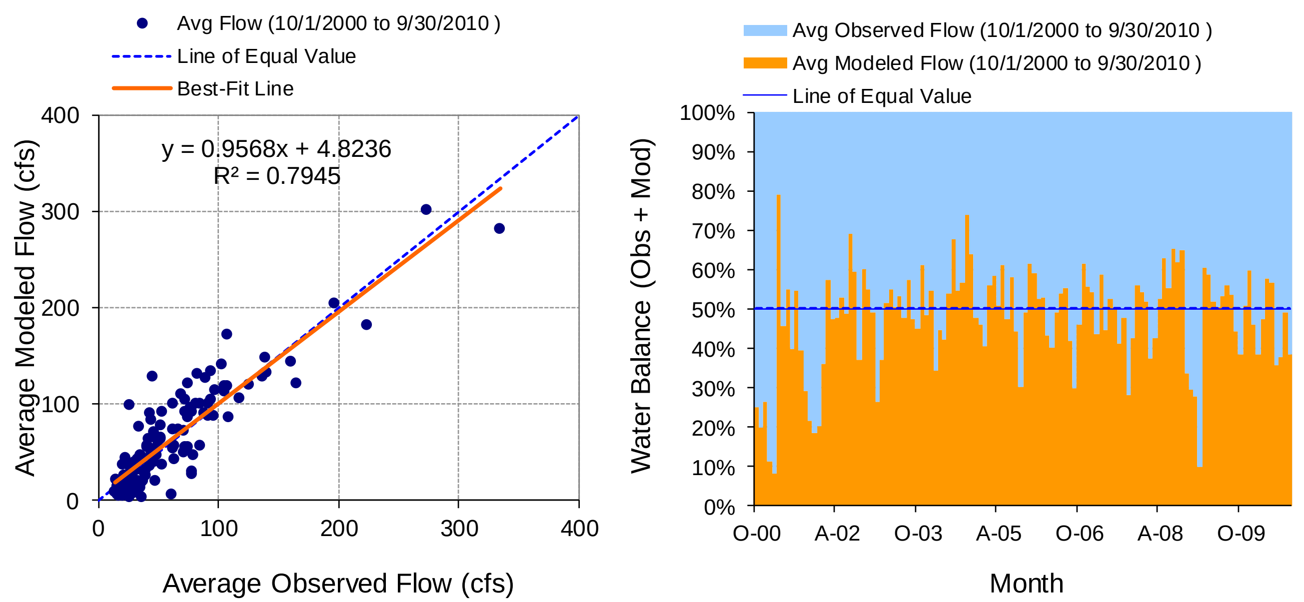


Figure K-171. Monthly flow regression and temporal variation at USGS 04273700 Salmon River at South Plattsburgh, NY

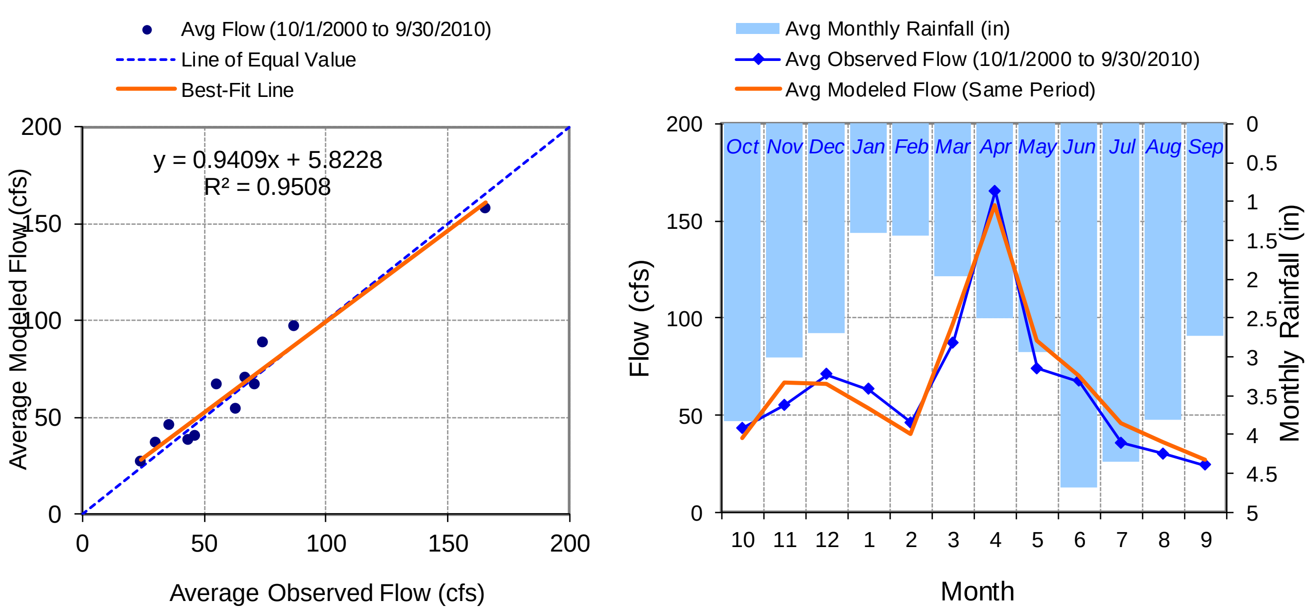


Figure K-172. Seasonal regression and temporal aggregate at USGS 04273700 Salmon River at South Plattsburgh, NY

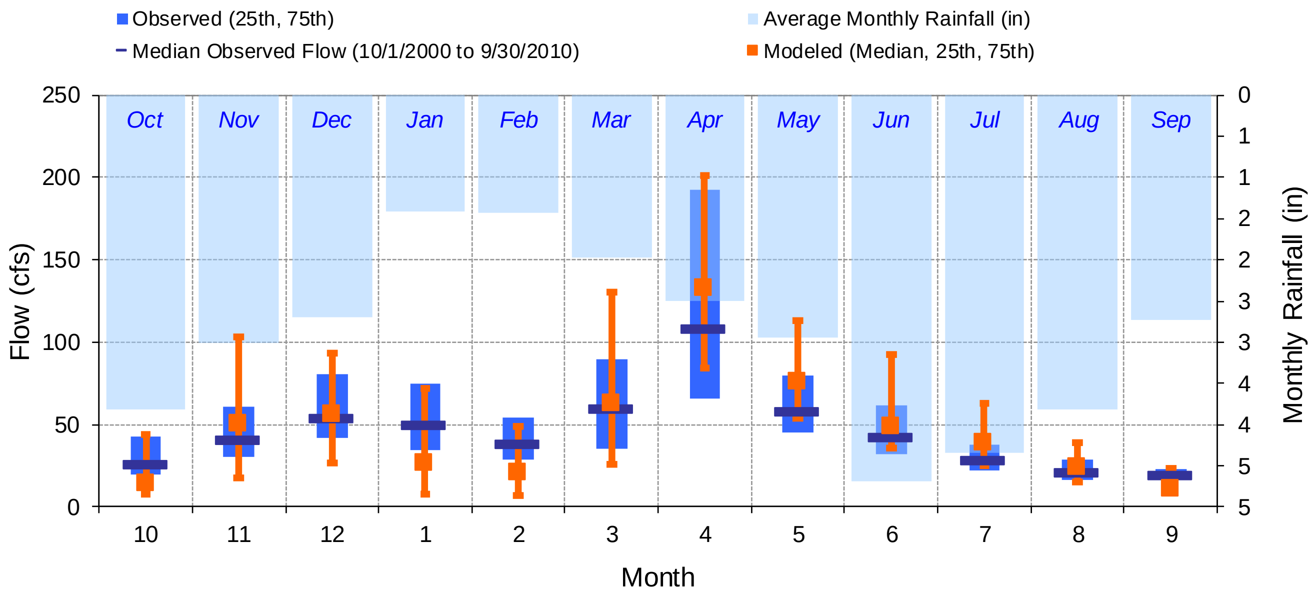


Figure K-173. Seasonal medians and ranges at USGS 04273700 Salmon River at South Plattsburgh, NY

Table K-46. Seasonal summary at USGS 04273700 Salmon River at South Plattsburgh, NY

MONTH	OBSERVED FLOW (CFS)				MODELED FLOW (CFS)			
	MEAN	MEDIAN	25TH	75TH	MEAN	MEDIAN	25TH	75TH
Oct	43.38	26.00	20.00	43.00	38.12	14.29	7.71	43.75
Nov	55.11	40.50	30.00	61.00	66.53	50.22	17.36	103.15
Dec	70.88	54.00	42.00	80.75	66.44	56.24	26.41	93.18
Jan	63.18	50.00	34.25	75.00	53.69	26.65	7.38	71.60
Feb	46.06	38.00	29.00	54.00	40.18	20.53	7.11	49.22
Mar	87.21	60.00	35.00	90.00	96.73	63.00	26.18	130.36
Apr	165.39	108.50	66.00	192.25	157.88	133.10	84.28	200.88
May	74.07	58.00	45.25	80.00	88.16	76.47	54.21	112.94
Jun	67.16	42.00	32.00	62.00	70.17	48.54	35.62	92.55
Jul	35.56	28.00	22.00	38.00	45.79	39.27	24.66	62.86
Aug	30.18	21.00	16.00	29.00	36.30	23.90	14.78	38.71
Sep	23.93	19.00	16.00	23.00	27.00	11.35	8.77	23.11

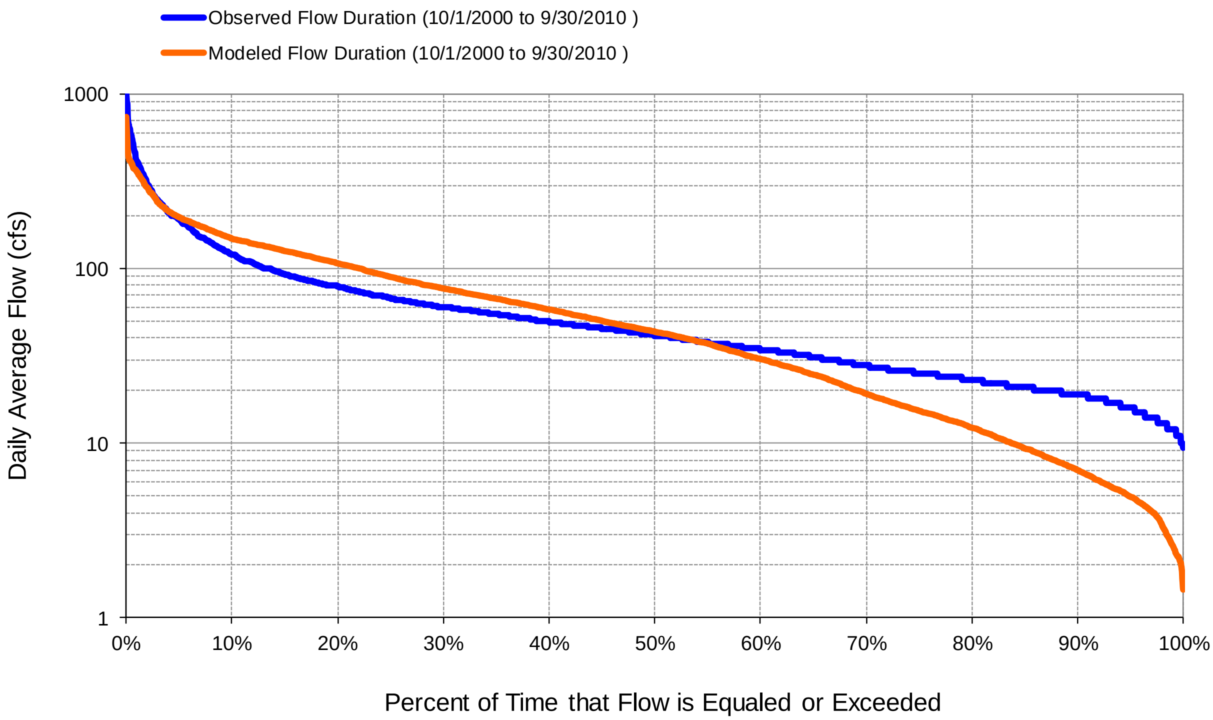


Figure K-174. Flow exceedence at USGS 04273700 Salmon River at South Plattsburgh, NY

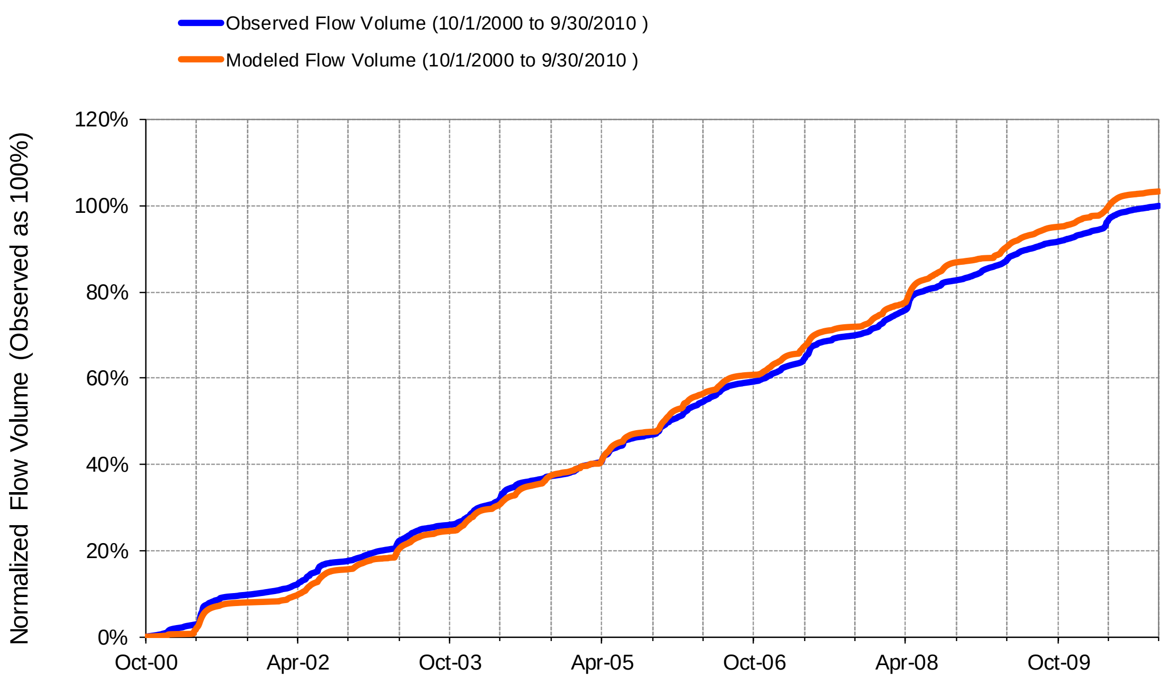


Figure K-175. Flow accumulation at USGS 04273700 Salmon River at South Plattsburgh, NY

Table K-47. Summary statistics at USGS 04273700 Salmon River at South Plattsburgh, NY

SWAT Simulated Flow		Observed Flow Gage	
REACH OUTFLOW FROM OUTLET 2		USGS 04273700 SALMON RIVER AT SOUTH PLATTSBURGH NY	
10-Year Analysis Period: 10/1/2000 - 9/30/2010 Flow volumes are (inches/year) for upstream drainage area		Hydrologic Unit Code: 2010004 Latitude: 44.64 Longitude: -73.4947222 Drainage Area (sq-mi): 63.3	
Total Simulated In-stream Flow:	**14.08**	Total Observed In-stream Flow:	**13.62**
Total of simulated highest 10% flows:	**4.94**	Total of Observed highest 10% flows:	**5.18**
Total of Simulated lowest 50% flows:	**1.96**	Total of Observed Lowest 50% flows:	**2.80**
Simulated Summer Flow Volume (months 7-9):	**1.97**	Observed Summer Flow Volume (7-9):	**1.62**
Simulated Fall Flow Volume (months 10-12):	**3.08**	Observed Fall Flow Volume (10-12):	**3.05**
Simulated Winter Flow Volume (months 1-3):	**3.41**	Observed Winter Flow Volume (1-3):	**3.50**
Simulated Spring Flow Volume (months 4-6):	**5.63**	Observed Spring Flow Volume (4-6):	**5.45**
Total Simulated Storm Volume:	**2.53**	Total Observed Storm Volume:	**3.50**
Simulated Summer Storm Volume (7-9):	**0.26**	Observed Summer Storm Volume (7-9):	**0.44**

Errors (Simulated-Observed)	*Error Statistics*	*Recommended Criteria*		
Error in total volume:	3.35	10		
Error in 50% lowest flows:	-30.03	10		
Error in 10% highest flows:	-4.51	15		
Seasonal volume error - Summer:	21.72	30		
Seasonal volume error - Fall:	0.80	>> 30	Clear	
Seasonal volume error - Winter:	-2.77	30		
Seasonal volume error - Spring:	3.26	30		
Error in storm volumes:	-27.60	20		
Error in summer storm volumes:	-42.29	50		
Nash-Sutcliffe Coefficient of Efficiency, E:	0.424	Model accuracy increases		
Baseline adjusted coefficient (Garrick), E':	0.215	as E or E' approaches 1.0		
Monthly NSE	0.760			

USGS 04273700 Salmon River at South Plattsburgh, NY - Validation

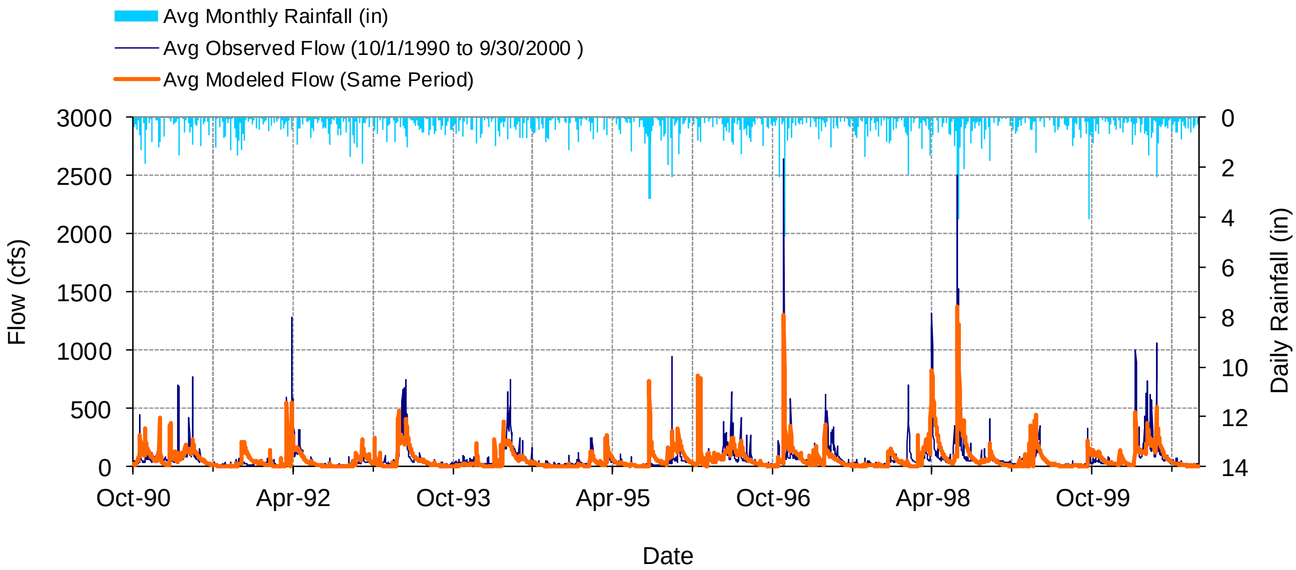


Figure K-176. Mean daily flow at USGS 04273700 Salmon River at South Plattsburgh, NY

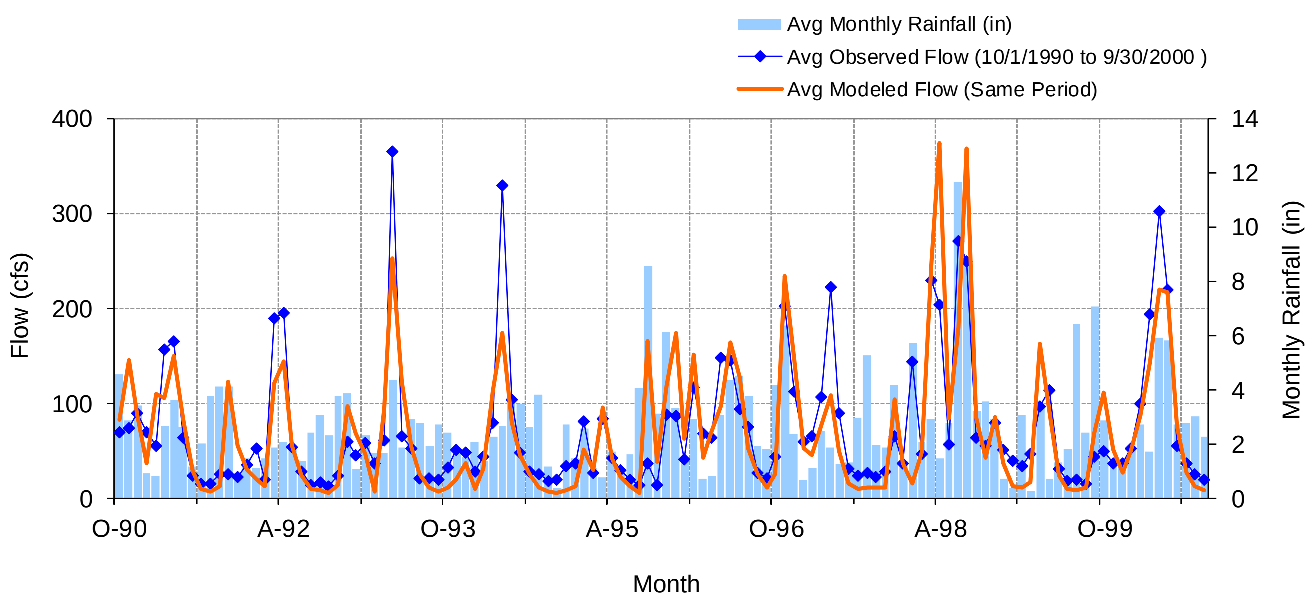


Figure K-177. Mean monthly flow at USGS 04273700 Salmon River at South Plattsburgh, NY

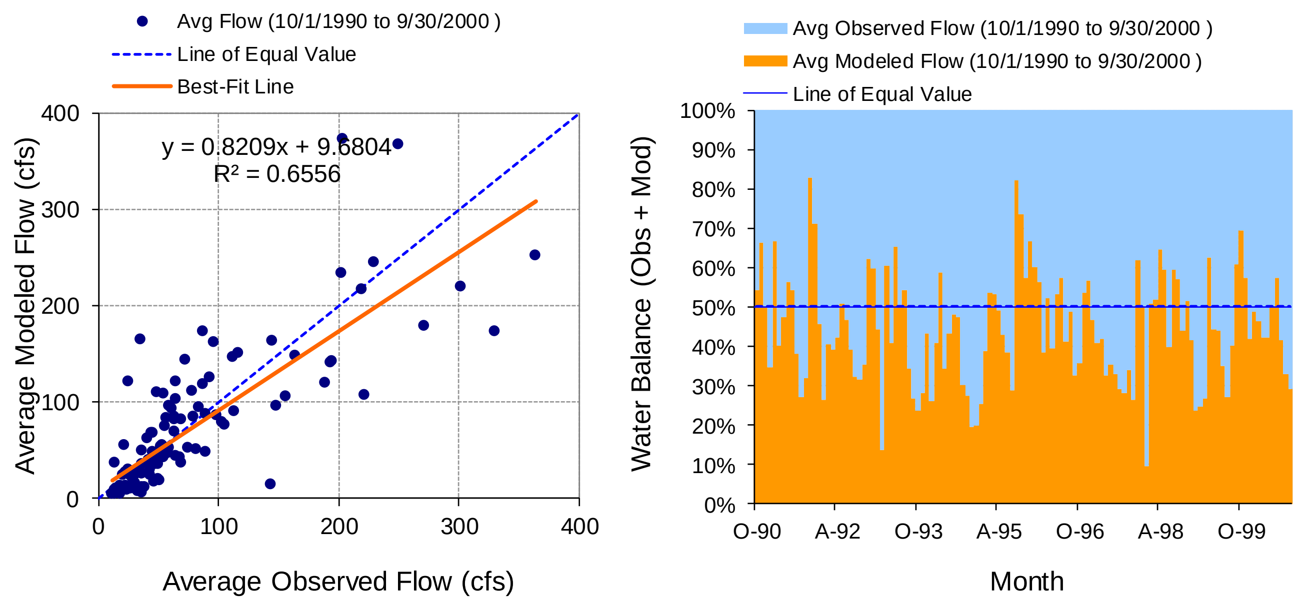


Figure K-178. Monthly flow regression and temporal variation at USGS 04273700 Salmon River at South Plattsburgh, NY

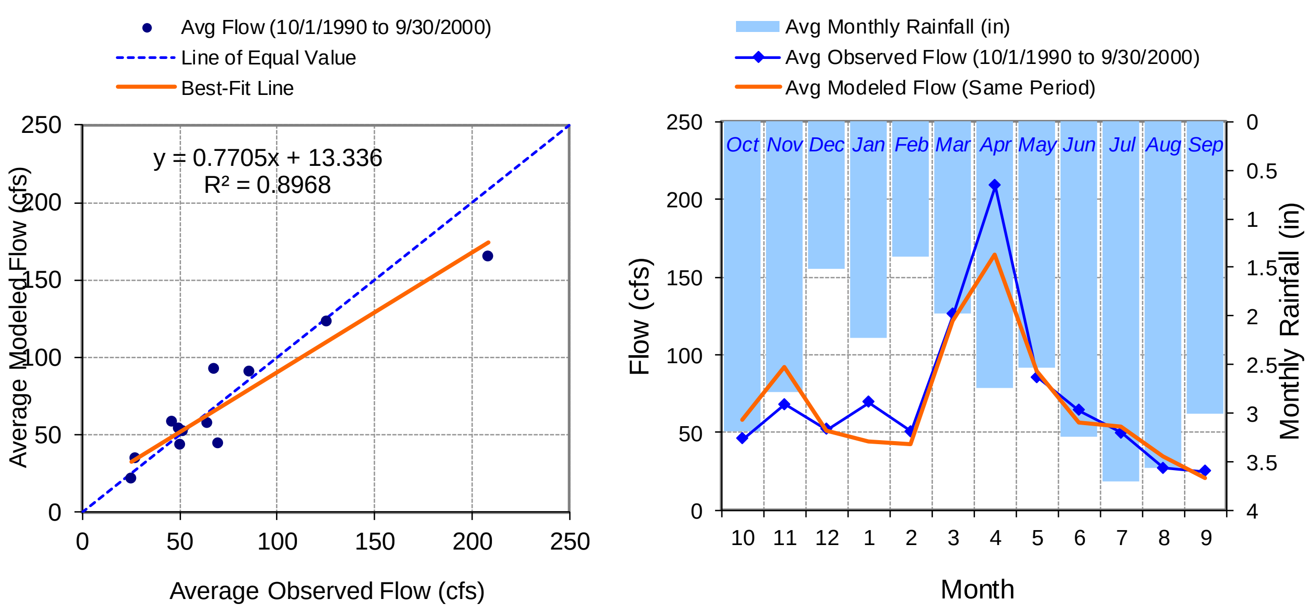


Figure K-179. Seasonal regression and temporal aggregate at USGS 04273700 Salmon River at South Plattsburgh, NY

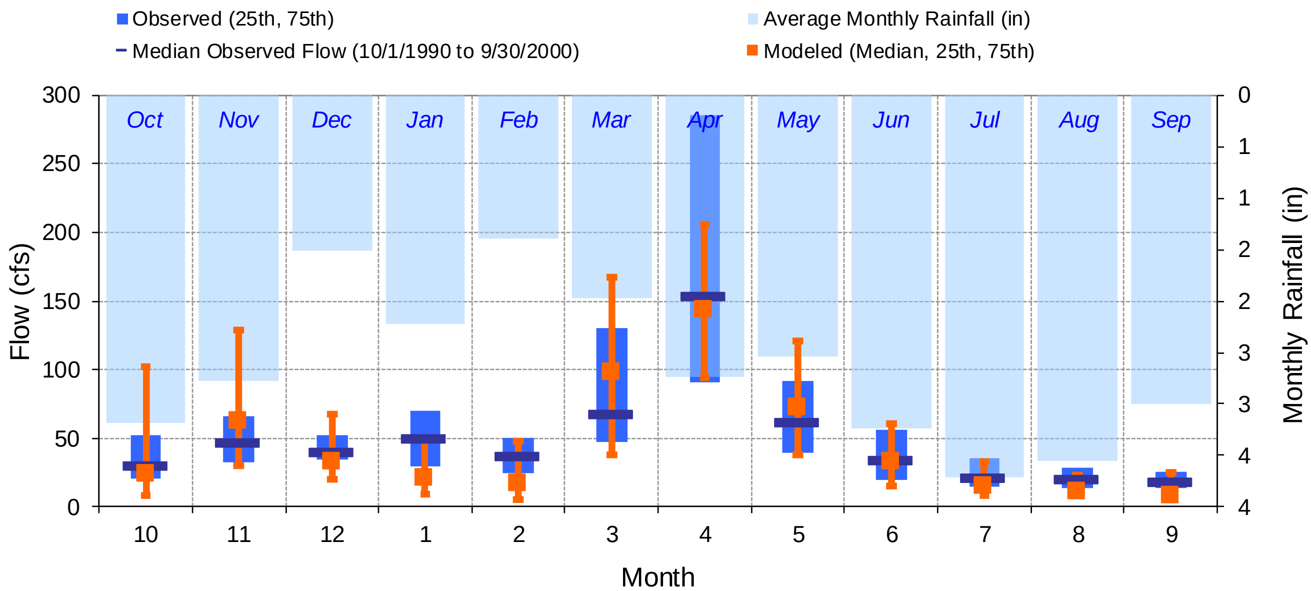


Figure K-180. Seasonal medians and ranges at USGS 04273700 Salmon River at South Plattsburgh, NY

Table K-48. Seasonal summary at USGS 04273700 Salmon River at South Plattsburgh, NY

MONTH	OBSERVED FLOW (CFS)				MODELED FLOW (CFS)			
	MEAN	MEDIAN	25TH	75TH	MEAN	MEDIAN	25TH	75TH
Oct	45.80	30.00	21.00	52.00	58.07	23.75	8.76	101.79
Nov	67.90	47.00	33.00	66.00	92.18	62.82	29.78	129.03
Dec	51.72	40.00	34.00	52.00	51.60	32.86	19.84	67.92
Jan	69.49	50.00	30.00	70.00	44.18	21.35	9.74	48.64
Feb	50.50	37.00	25.00	50.00	42.71	17.56	5.75	47.53
Mar	125.75	68.00	47.25	130.00	122.21	98.19	38.25	167.58
Apr	208.55	154.00	90.50	285.25	164.71	143.91	94.09	206.22
May	85.59	61.50	39.00	91.75	89.83	72.22	38.22	120.94
Jun	63.94	34.00	19.75	56.25	56.72	32.76	14.97	60.82
Jul	49.59	21.00	15.00	35.75	53.69	14.89	7.88	33.24
Aug	27.22	20.00	14.00	29.00	34.34	11.60	7.95	23.15
Sep	24.93	18.00	14.00	25.25	20.89	8.39	6.69	24.66

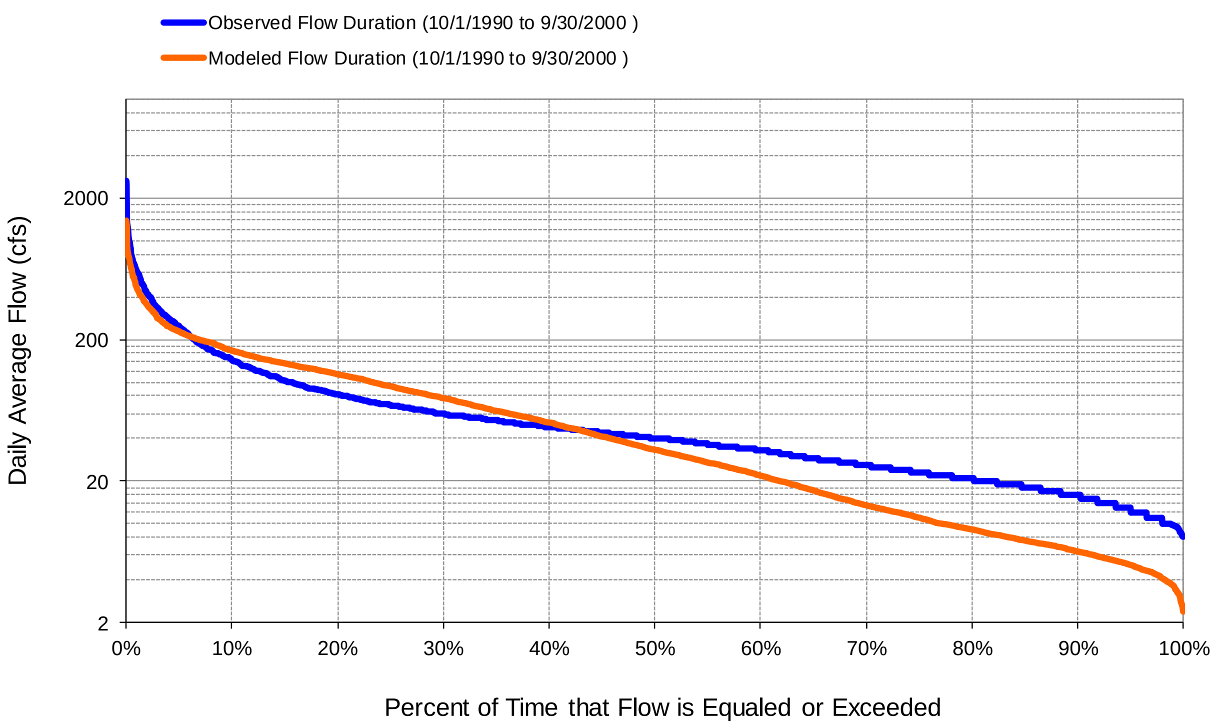


Figure K-181. Flow exceedence at USGS 04273700 Salmon River at South Plattsburgh, NY

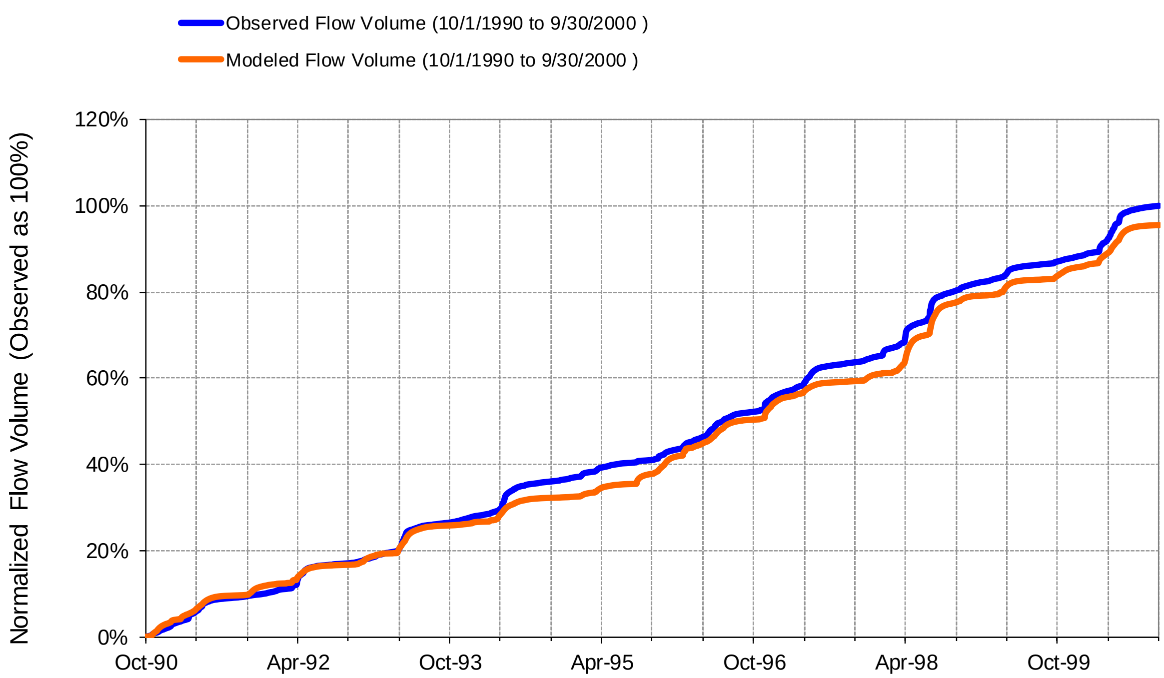


Figure K-182. Flow accumulation at USGS 04273700 Salmon River at South Plattsburgh, NY

Table K-49. Summary statistics at USGS 04273700 Salmon River at South Plattsburgh, NY

SWAT Simulated Flow		Observed Flow Gage	
REACH OUTFLOW FROM OUTLET 2 10-Year Analysis Period: 10/1/1990 - 9/30/2000 Flow volumes are (inches/year) for upstream drainage area		USGS 04273700 SALMON RIVER AT SOUTH PLATTSBURGH NY Hydrologic Unit Code: 2010004 Latitude: 44.64 Longitude: -73.4947222 Drainage Area (sq-mi): 63.3	
Total Simulated In-stream Flow:	**14.87**	Total Observed In-stream Flow:	**15.57**
Total of simulated highest 10% flows:	**6.19**	Total of Observed highest 10% flows:	**7.14**
Total of Simulated lowest 50% flows:	**1.47**	Total of Observed Lowest 50% flows:	**2.57**
Simulated Summer Flow Volume (months 7-9):	**1.97**	Observed Summer Flow Volume (7-9):	**1.84**
Simulated Fall Flow Volume (months 10-12):	**3.62**	Observed Fall Flow Volume (10-12):	**2.97**
Simulated Winter Flow Volume (months 1-3):	**3.74**	Observed Winter Flow Volume (1-3):	**4.39**
Simulated Spring Flow Volume (months 4-6):	**5.54**	Observed Spring Flow Volume (4-6):	**6.36**
Total Simulated Storm Volume:	**2.82**	Total Observed Storm Volume:	**4.65**
Simulated Summer Storm Volume (7-9):	**0.35**	Observed Summer Storm Volume (7-9):	**0.59**

Errors (Simulated-Observed)	*Error Statistics*	*Recommended Criteria*		
Error in total volume:	-4.47	10		
Error in 50% lowest flows:	-42.71	10		
Error in 10% highest flows:	-13.40	15		
Seasonal volume error - Summer:	7.25	30		
Seasonal volume error - Fall:	21.84	>> 30		Clear
Seasonal volume error - Winter:	-14.90	30		
Seasonal volume error - Spring:	-12.93	30		
Error in storm volumes:	-39.31	20		
Error in summer storm volumes:	-40.19	50		
Nash-Sutcliffe Coefficient of Efficiency, E:	0.546	Model accuracy increases		
Baseline adjusted coefficient (Garrick), E':	0.302	as E or E' approaches 1.0		
Monthly NSE	0.612			

WATER QUALITY - Salmon River

TSS and TP distribution by channel and upland sources

Table K-50. TSS and TP distribution by source categories

Source	TSS		TP	
	Load(mt/year)	Percentage (%)	Load (kg/year)	Percentage (%)
Upland	1,250	45.0	1,722	84.9
Stream	1,529	55.0	306	15.1
Total	**2,779**	**100.0**	**2,027**	**100.0**

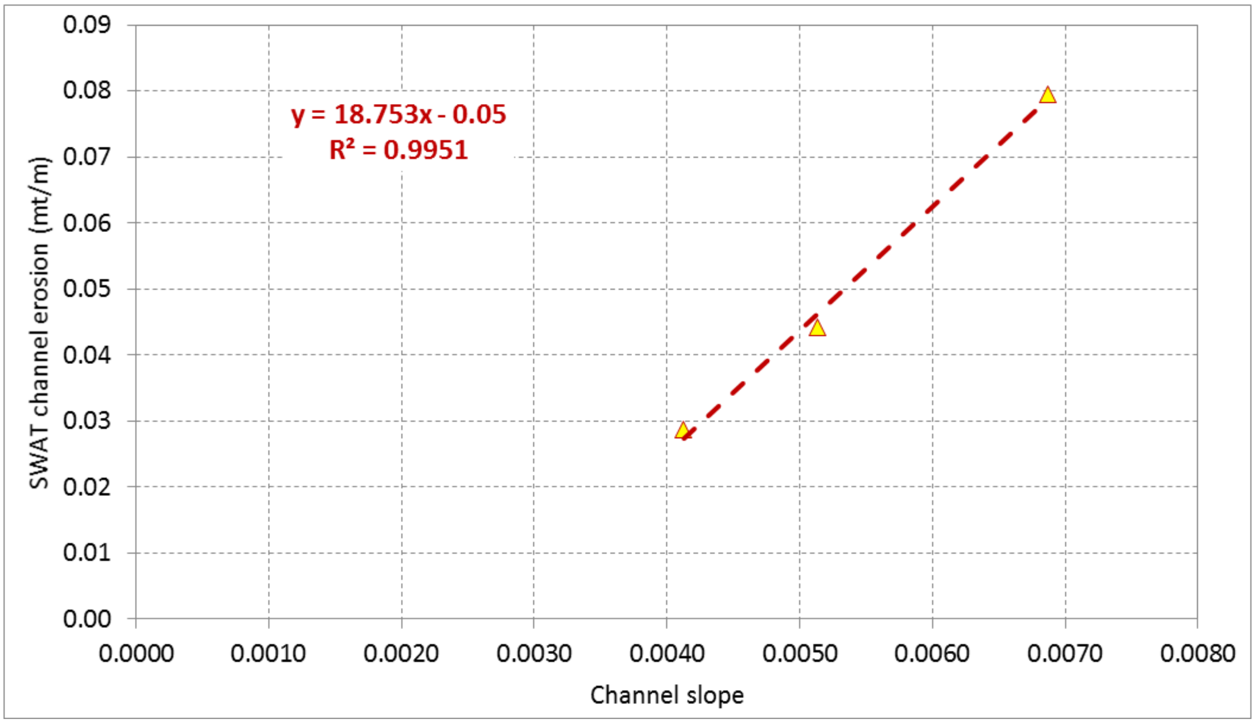


Figure K-183. SWAT simulated channel erosion relative to channel slope

TP distribution by landuse from upland sources

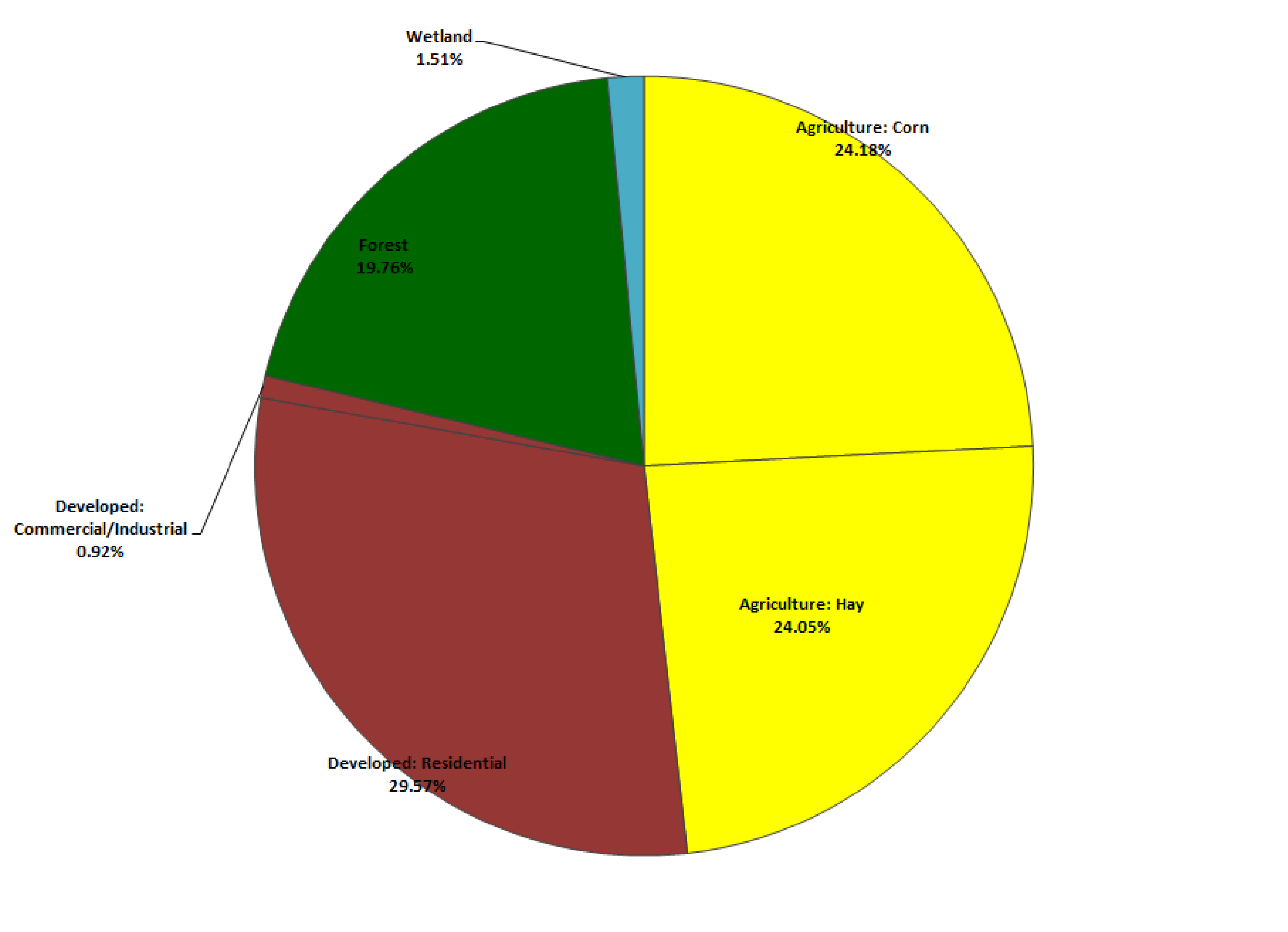


Figure K-184. Distribution of simulated total upland TP loads by landuse categories

Table K-51. TP export rates (kg/ha/yr) by landuse categories for the 30 year simulation period

Landuse	Classification	Area (ha)	Area (%)	Mean	Min	Q_{25}	Q_{50}	Q_{75}	Max
Agriculture	Corn	199	1.19	**2.10**	1.03	1.58	1.93	2.76	4.08
	Hay	430	2.57	**0.97**	0.30	0.54	0.82	1.25	2.47
Urban	Residential	1,145	6.84	**0.45**	0.34	0.39	0.44	0.50	0.63
	Commercial/Industrial	10	0.06	**1.66**	1.36	1.57	1.65	1.73	2.02
Forest	Forest	14,638	87.44	**0.02**	0.01	0.02	0.02	0.03	0.05
Wetland	Wetland	320	1.91	**0.08**	0.04	0.06	0.07	0.10	0.17

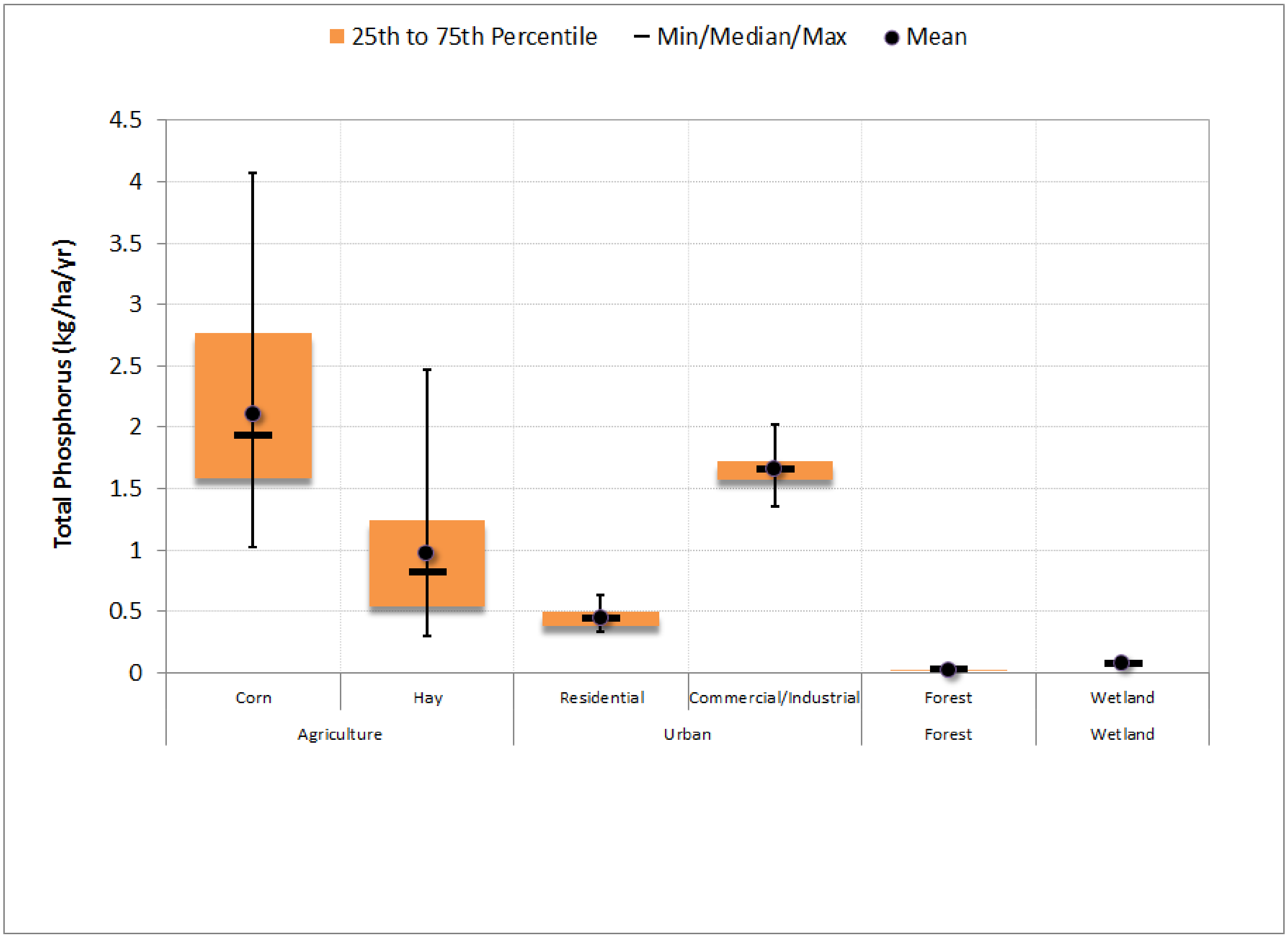


Figure K-185. TP export rates (kg/ha/yr) by landuse categories for the 30 year simulation period

Table K-52. TP export rates (kg/ha/yr) for the residential landuse categories for the 30 year simulation period

Residential Category	Area (ha)	Area (%)	Mean	Min	Q_{25}	Q_{50}	Q_{75}	Max
Low Density	724	63.20	**0.23**	0.15	0.18	0.23	0.26	0.44
Medium Density	334	29.13	**0.72**	0.55	0.63	0.72	0.81	0.95
High Density	88	7.67	**1.19**	0.91	1.11	1.18	1.26	1.47
Total	1,145	100.00	**0.45**	0.34	0.39	0.44	0.50	0.63

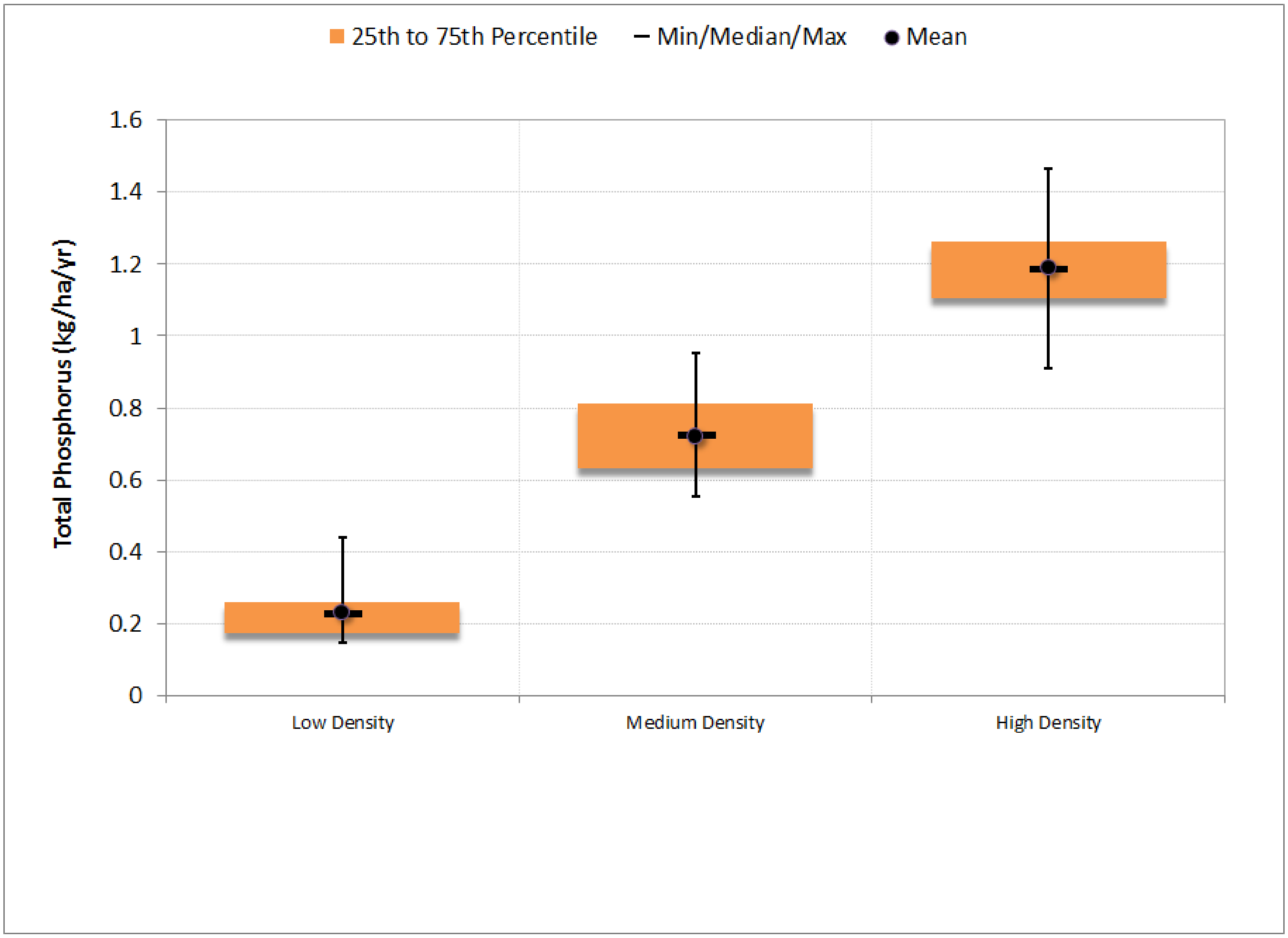


Figure K-186. TP export rates (kg/ha/yr) for the residential landuse categories for the 30 year simulation period

Segmented Regression

Table K-53. Summary statistics

Statistic	Calibration		Validation	
	TSS	TP	TSS	TP
Average absolute error (%)	57.3	57.1	63.5	53.5
Median absolute error (%)	23.4	20.9	10.8	12.1
Regression error (%)	-17.0	-6.9	-3.5	17.1
NSE	0.679	0.419	0.521	0.497
NSE'	0.459	0.312	0.512	0.499

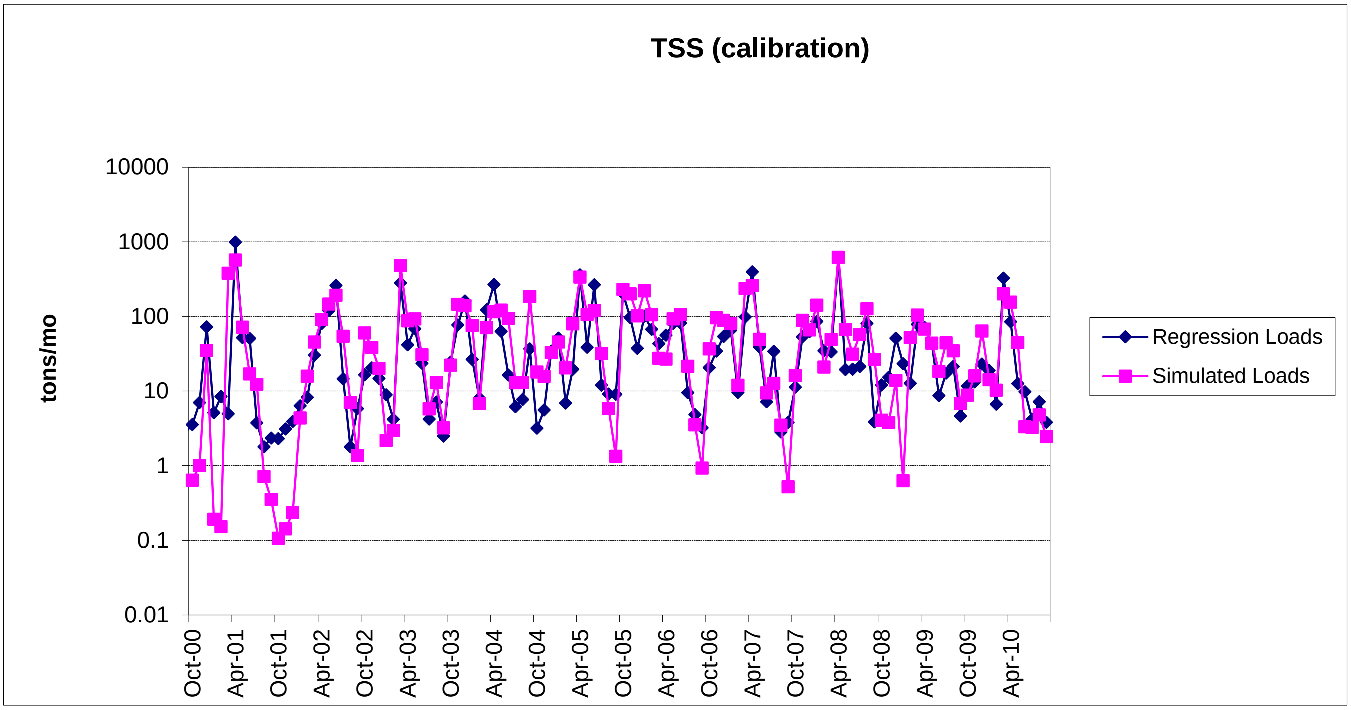


Figure K-187. Monthly simulated and estimated TSS load at Salmon River at Plattsburgh, NY (calibration period)

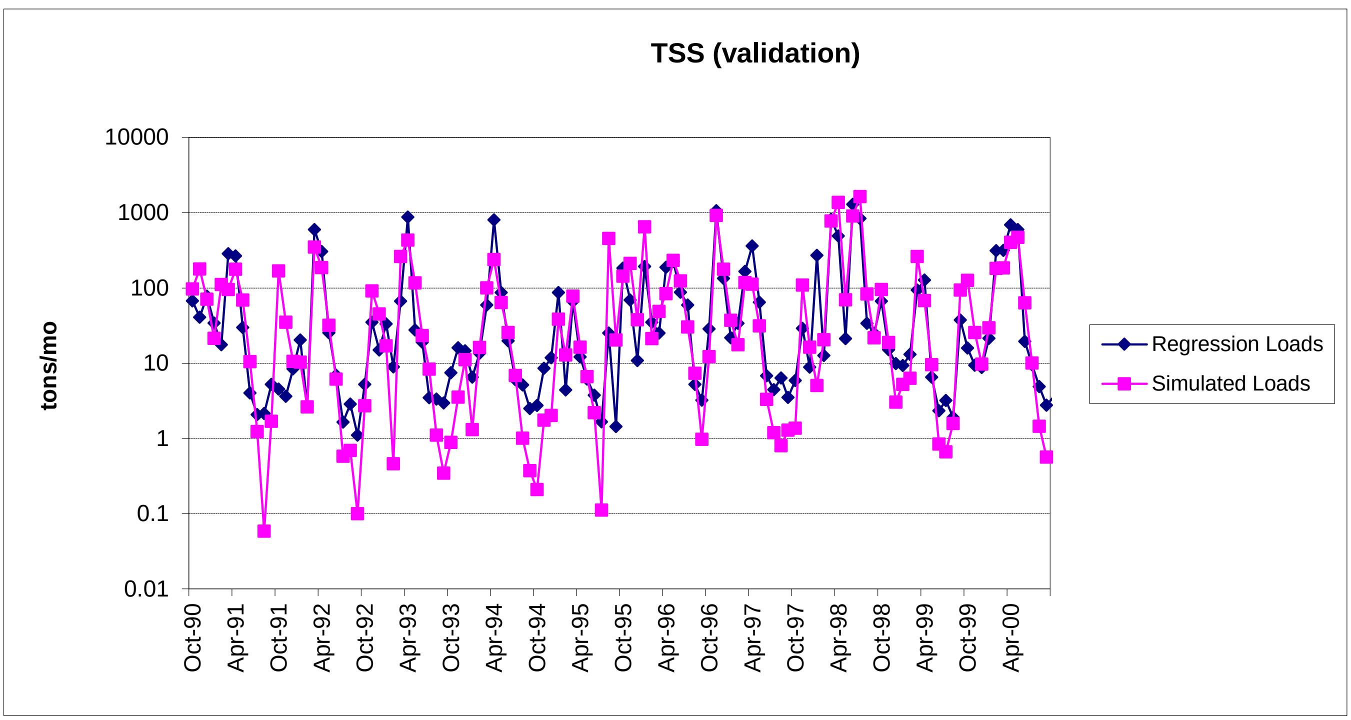


Figure K-188. Monthly simulated and estimated TSS load at Salmon River at Plattsburgh, NY (validation period)

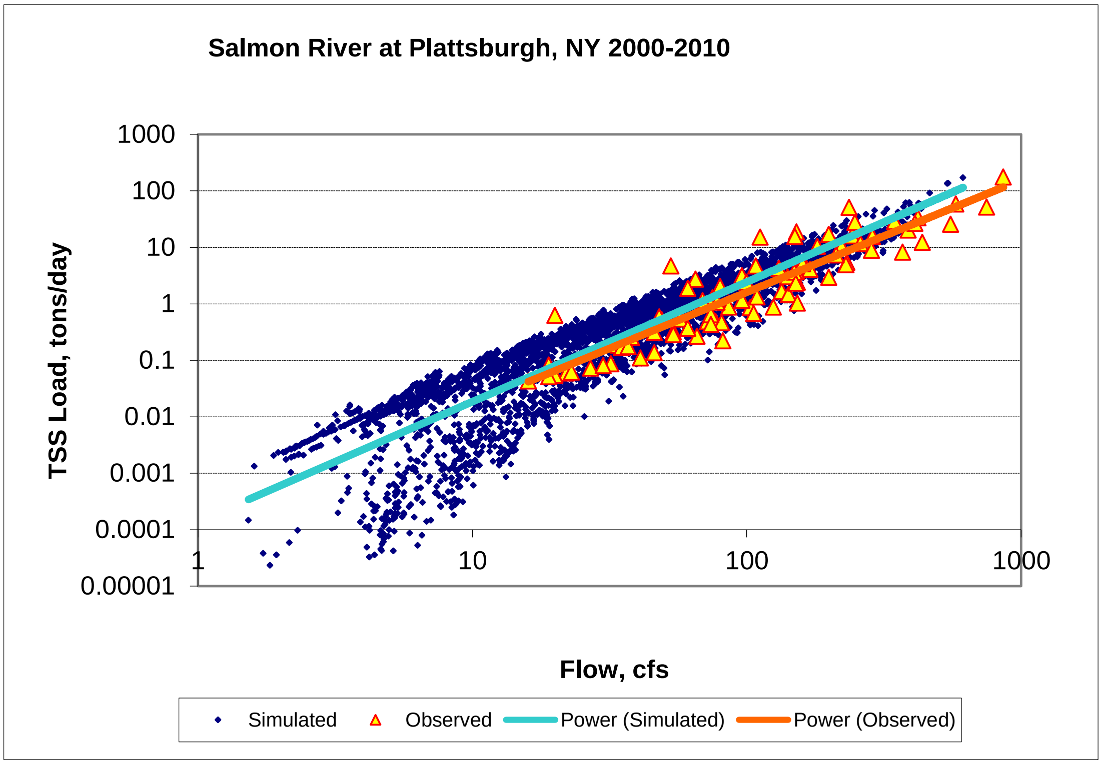


Figure K-189. Power plot of simulated and observed TSS load vs flow at Salmon River at Plattsburgh, NY (calibration period)

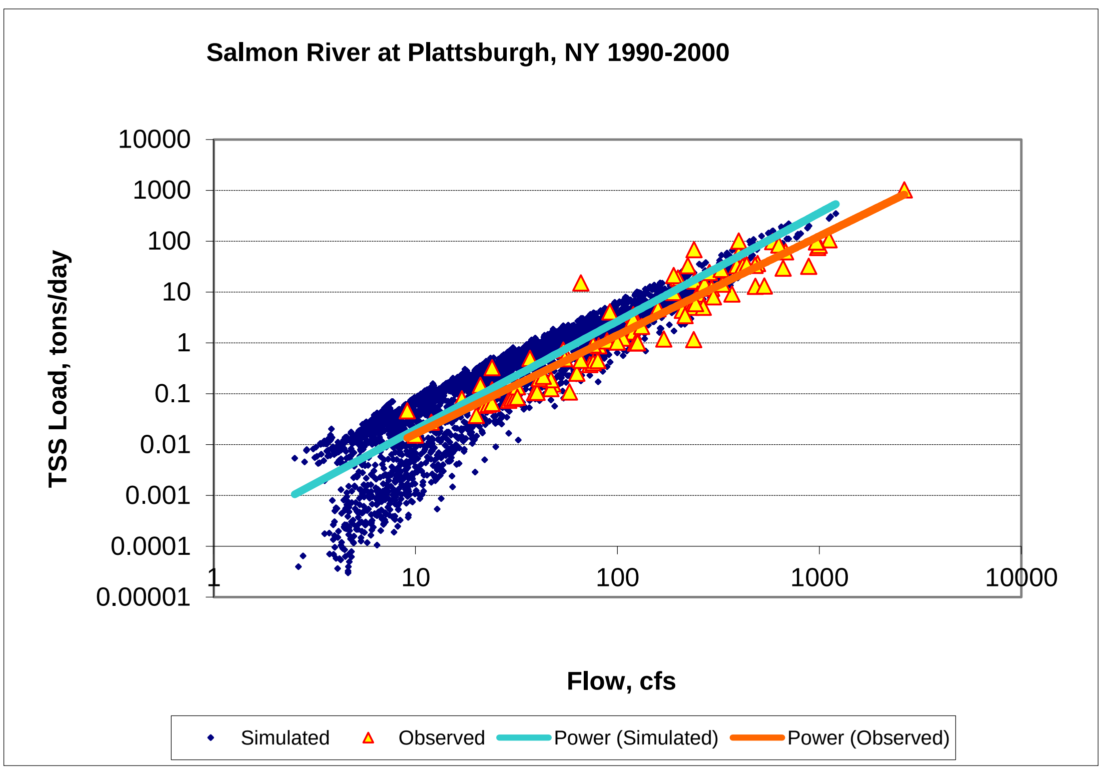


Figure K-190. Power plot of simulated and observed TSS load vs flow at Salmon River at Plattsburgh, NY (validation period)

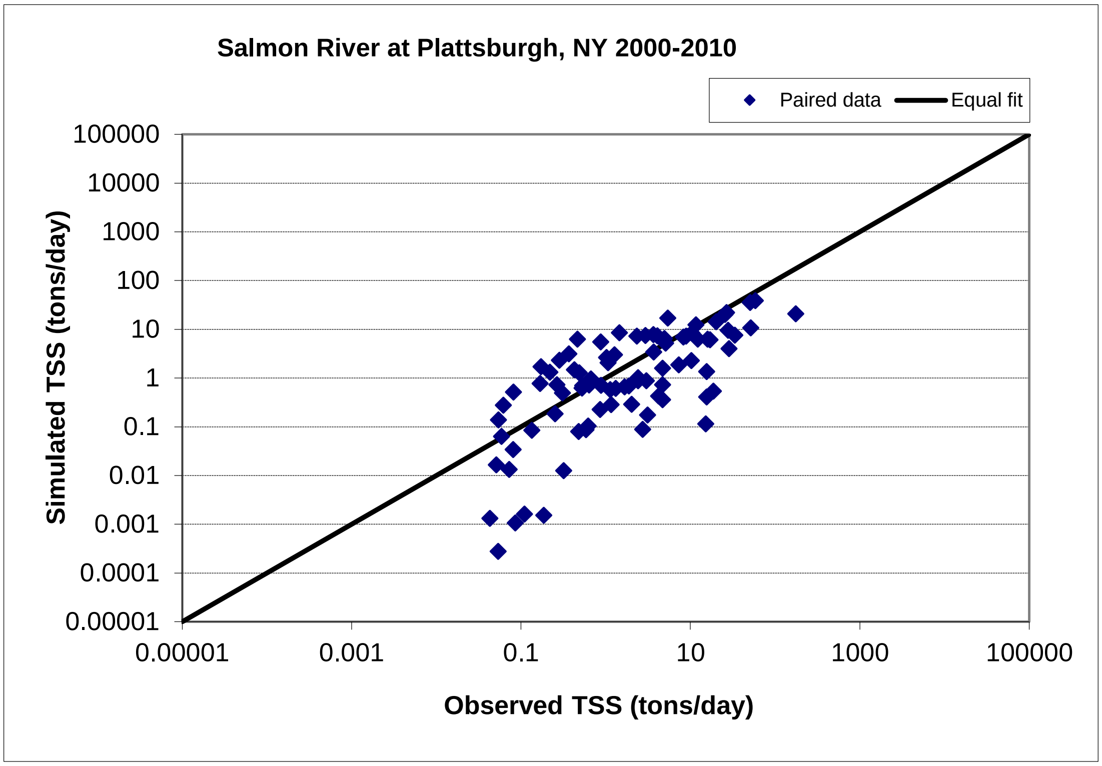


Figure K-191. Paired simulated vs observed TSS load at Salmon River at Plattsburgh, NY (calibration period)

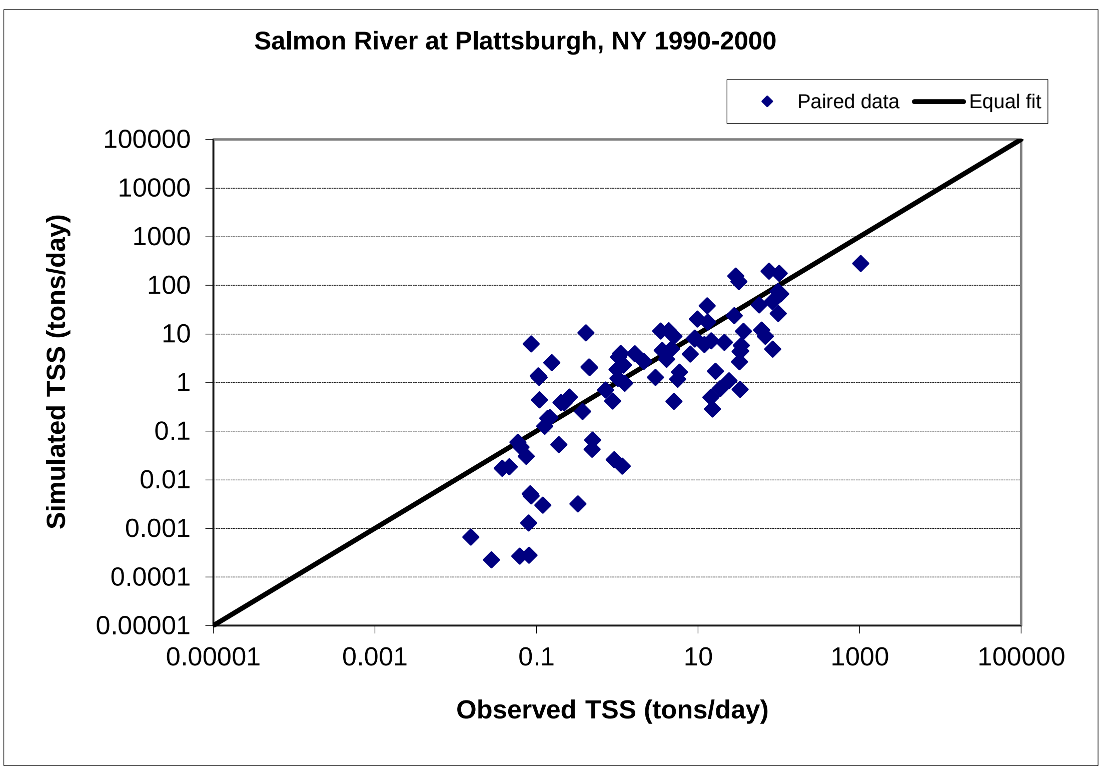


Figure K-192. Paired simulated vs observed TSS load at Salmon River at Plattsburgh, NY (validation period)

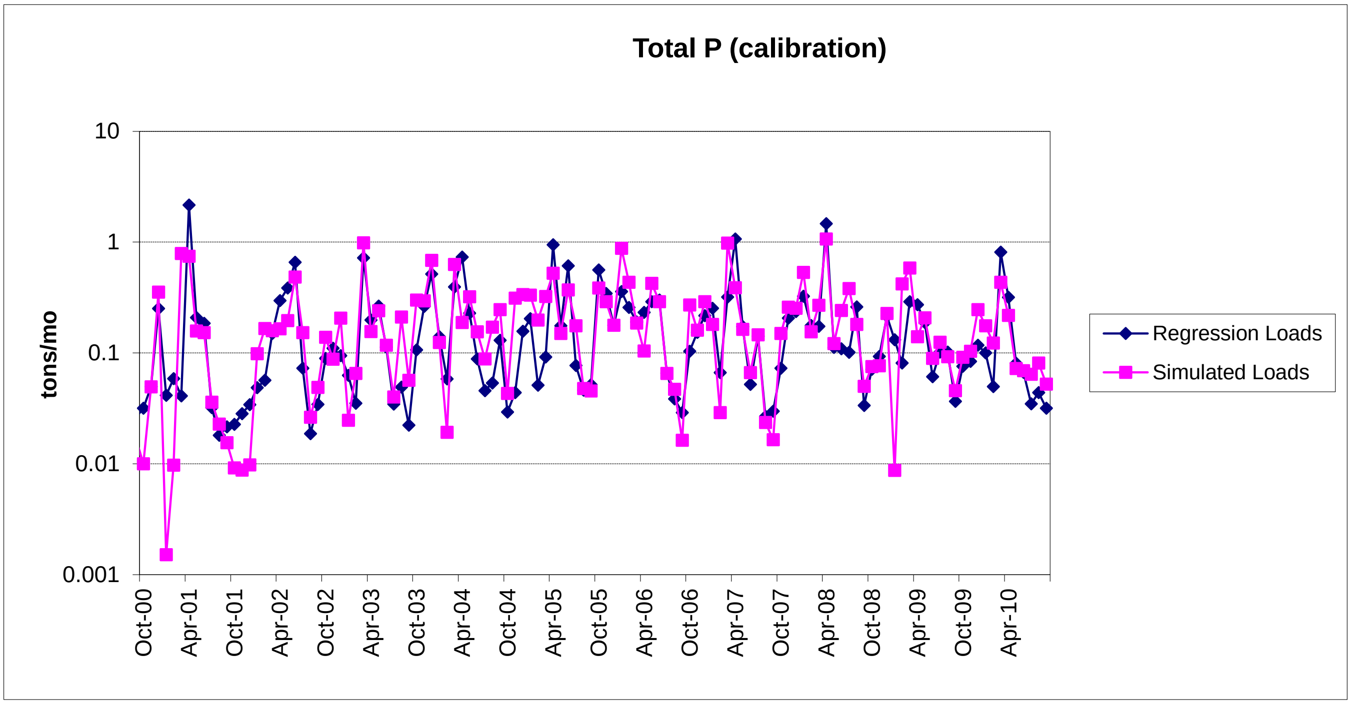


Figure K-193. Monthly simulated and estimated TP load at Salmon River at Plattsburgh, NY (calibration period)

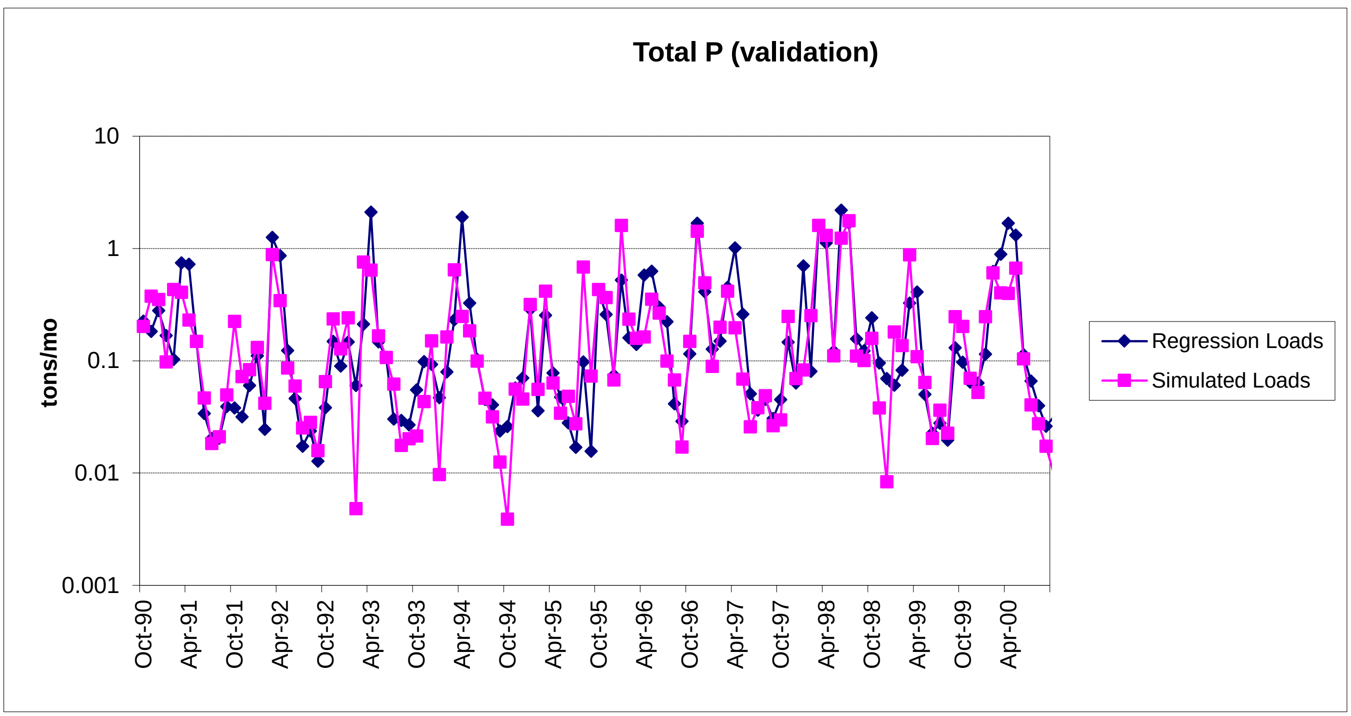


Figure K-194. Monthly simulated and estimated TP load at Salmon River at Plattsburgh, NY (validation period)

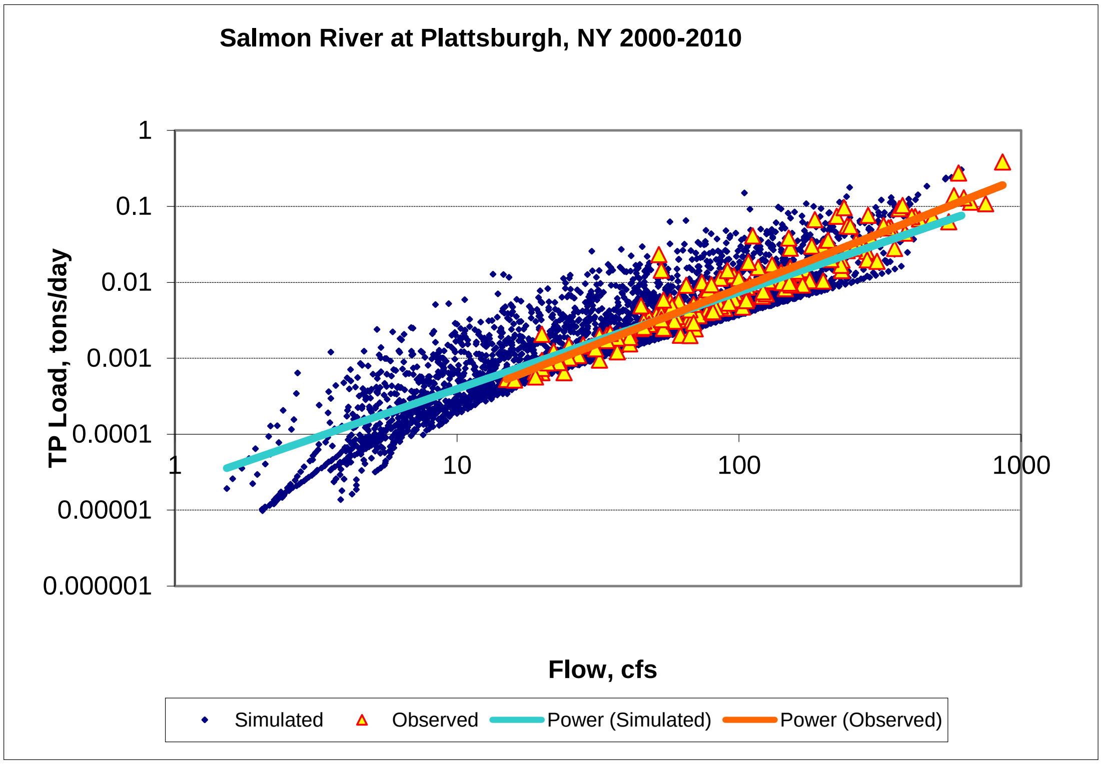


Figure K-195. Power plot of simulated and observed TP load vs flow at Salmon River at Plattsburgh, NY (calibration period)

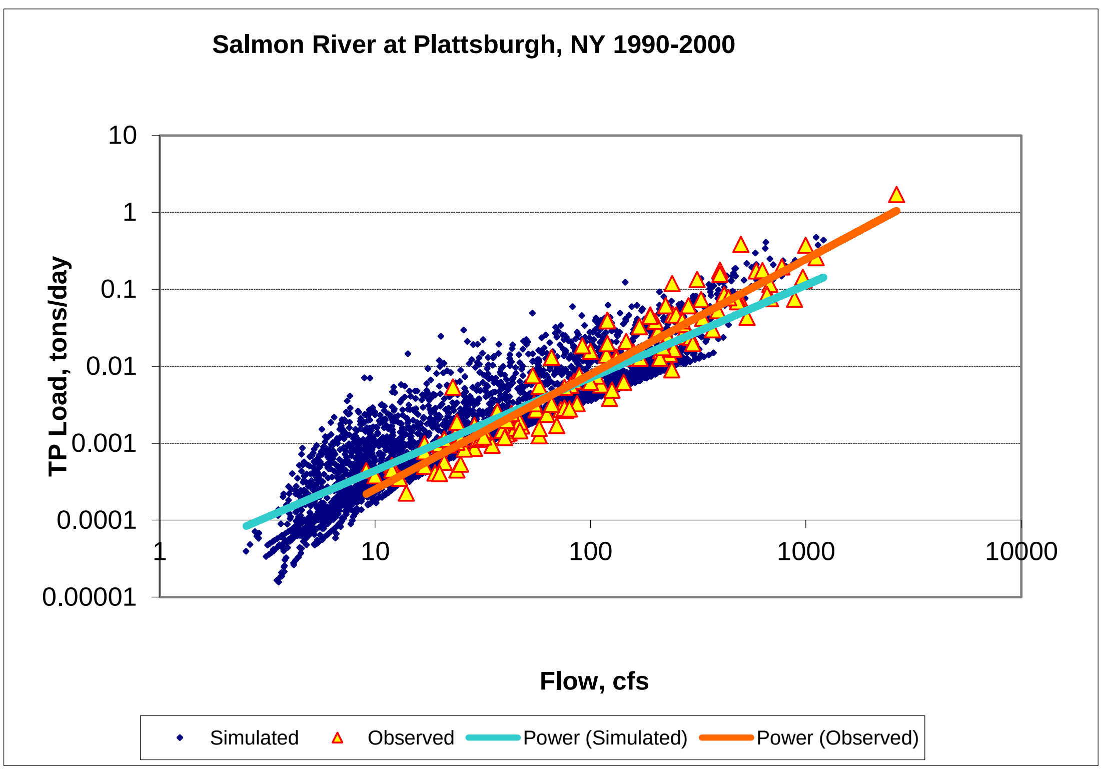


Figure K-196. Power plot of simulated and observed TP load vs flow at Salmon River at Plattsburgh, NY (validation period)

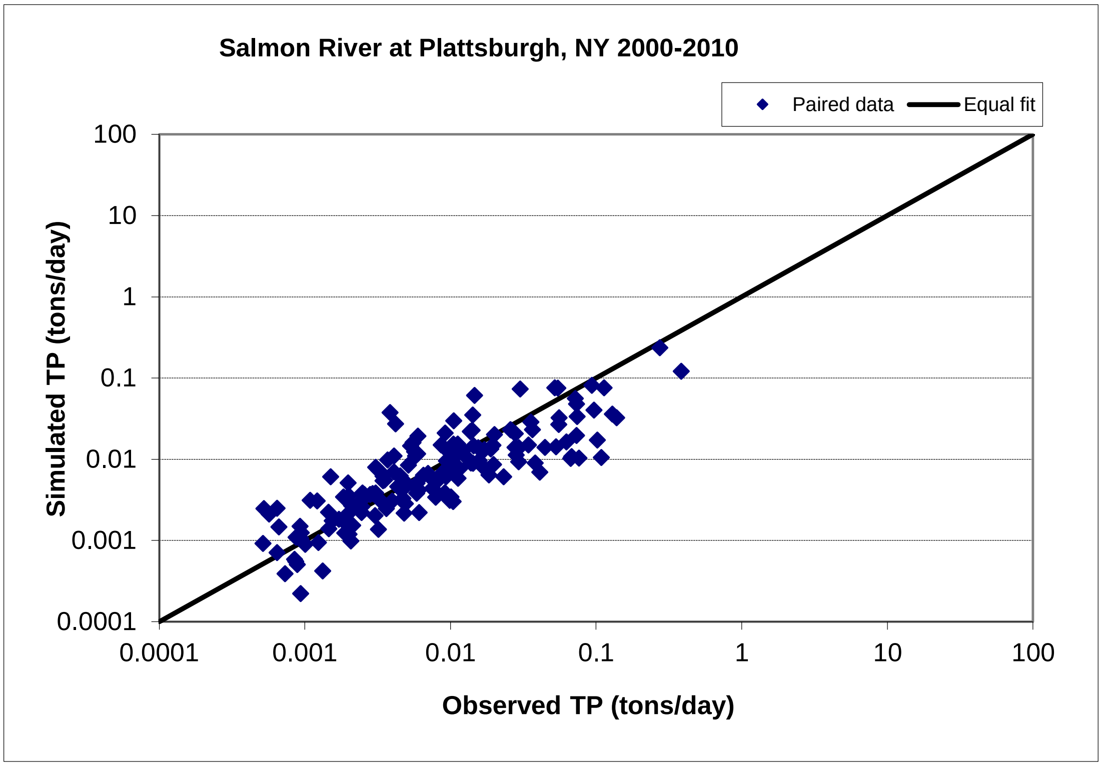


Figure K-197. Paired simulated vs observed TP load at Salmon River at Plattsburgh, NY (calibration period)

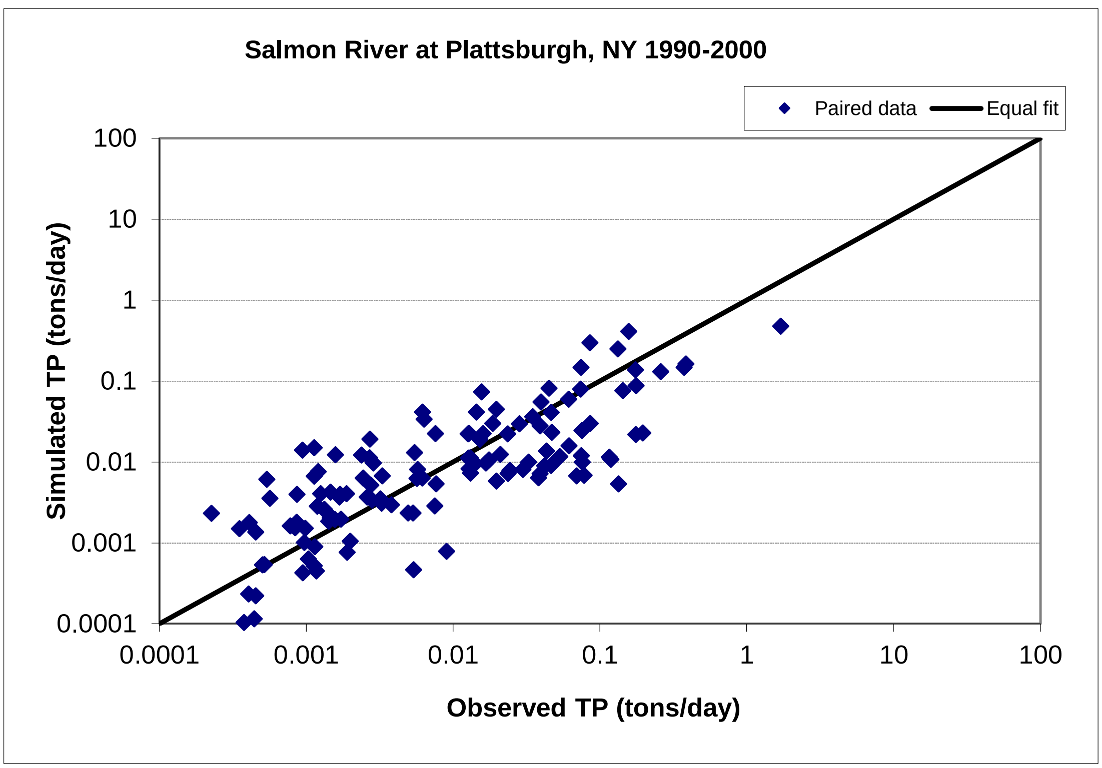


Figure K-198. Paired simulated vs observed TP load at Salmon River at Plattsburgh, NY (validation period)

Comparison of simulated SWAT TP loads with FLUX estimates

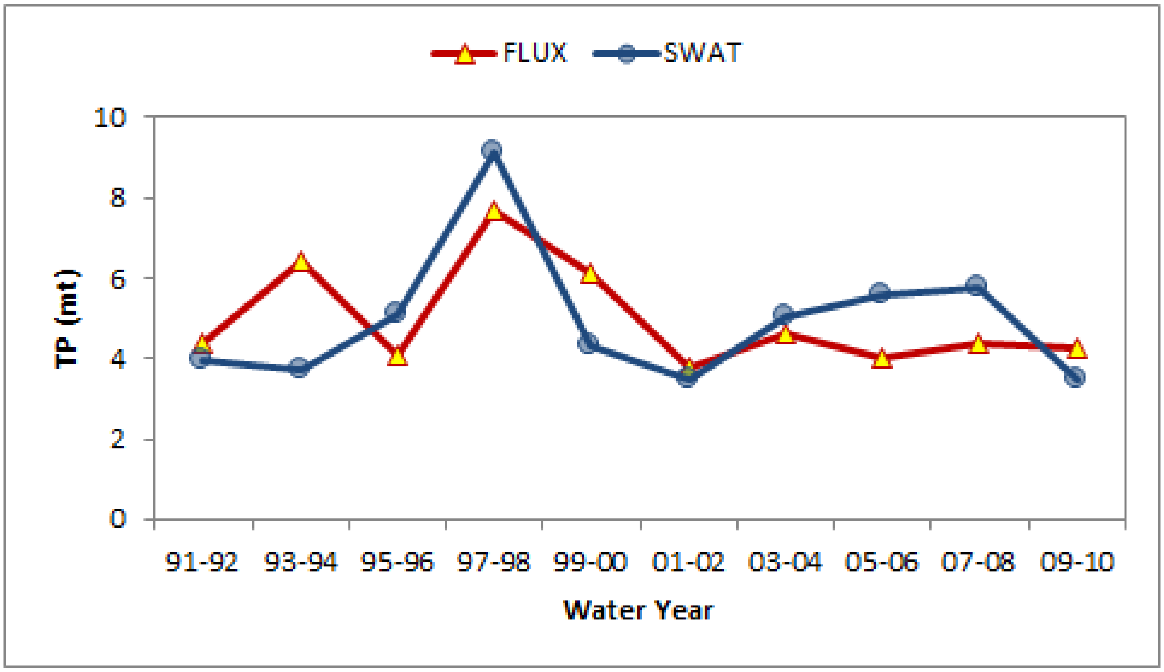


Figure K-199. Bi-annual TP loads on a water year basis as simulated by SWAT and estimated by FLUX (FLUX estimates from Smeltzer et al., 2009)

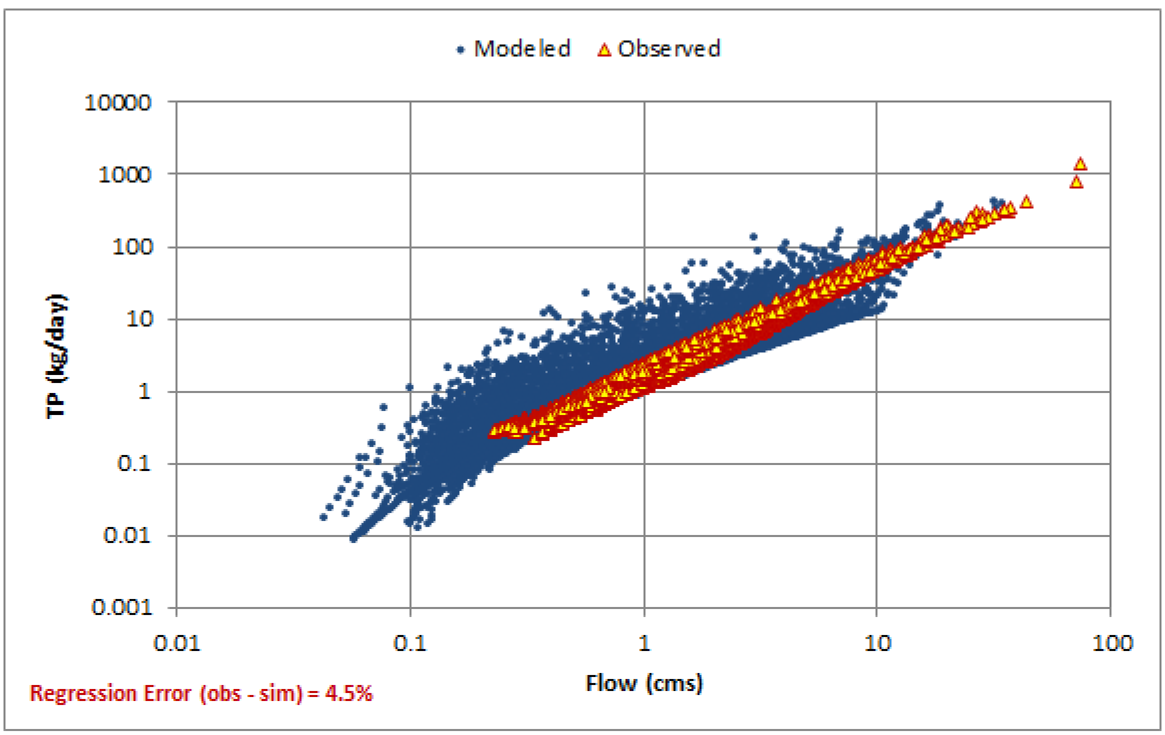


Figure K-200. Daily TP load versus flow as simulated by SWAT and estimated by FLUX (FLUX estimates from Medalie, 2013)

TP distribution by landuse from upland sources

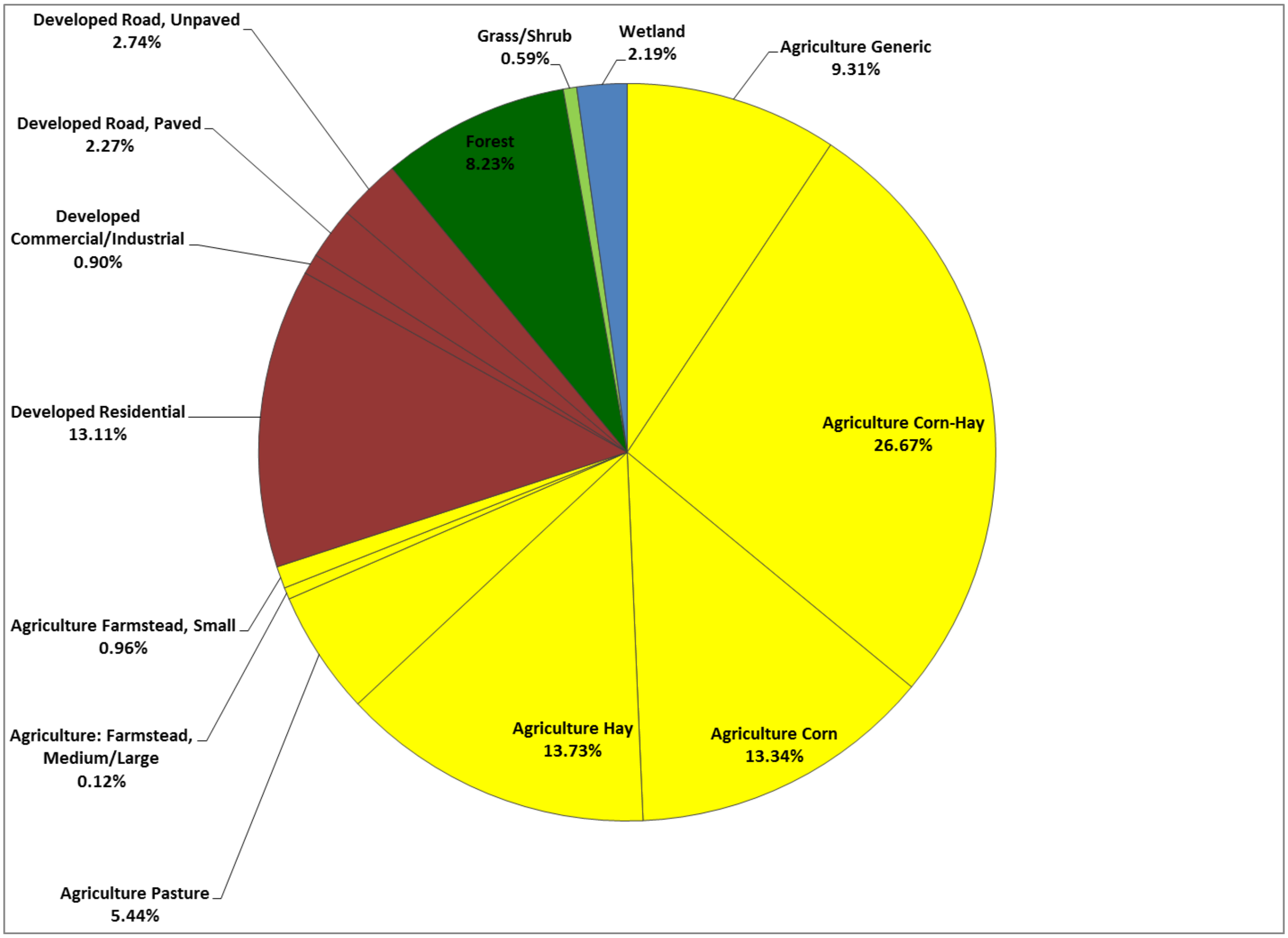


Figure K-201. Distribution of simulated total upland TP loads by landuse categories

Table K-54. TP export rates (kg/ha/yr) by landuse categories for the 30 year simulation period

Landuse	Classification	Area (ha)	Area (%)	Mean	Min	Q_{25}	Q_{50}	Q_{75}	Max
Agriculture	Generic	4,659	3.69	**1.90**	0.66	1.39	1.77	2.38	3.83
	Corn-Hay	12,836	10.17	**1.98**	0.11	1.41	1.87	2.83	3.51
	Corn-Hay	6,118	4.85	**2.07**	0.80	1.45	2.10	2.69	3.81
	Hay	14,149	11.22	**0.92**	0.32	0.60	0.85	1.21	1.88
	Pasture	4,207	3.33	**1.23**	0.47	0.91	1.10	1.36	2.91
	Farmstead, Medium/Large	159	0.13	**3.08**	1.46	2.29	2.78	3.97	5.56
	Farmstead, Small	300	0.24	**3.05**	1.36	2.29	2.75	4.03	5.51
Urban	Residential	13,181	10.45	**0.95**	0.60	0.77	0.88	1.05	1.88
	Commercial/Industrial	325	0.26	**2.62**	2.02	2.49	2.64	2.76	3.12
	Road, Paved	1,092	0.87	**1.98**	1.58	1.85	1.94	2.08	2.38
	Road, Unpaved	485	0.38	**5.38**	4.44	5.09	5.36	5.59	6.42

Forest	Forest	52,148	41.34	**0.15**	0.07	0.11	0.15	0.17	0.27
Grass/Shrub	Grass/Shrub	3,012	2.39	**0.19**	0.10	0.15	0.17	0.23	0.34
Wetland	Wetland	13,486	10.69	**0.15**	0.07	0.12	0.15	0.20	0.25

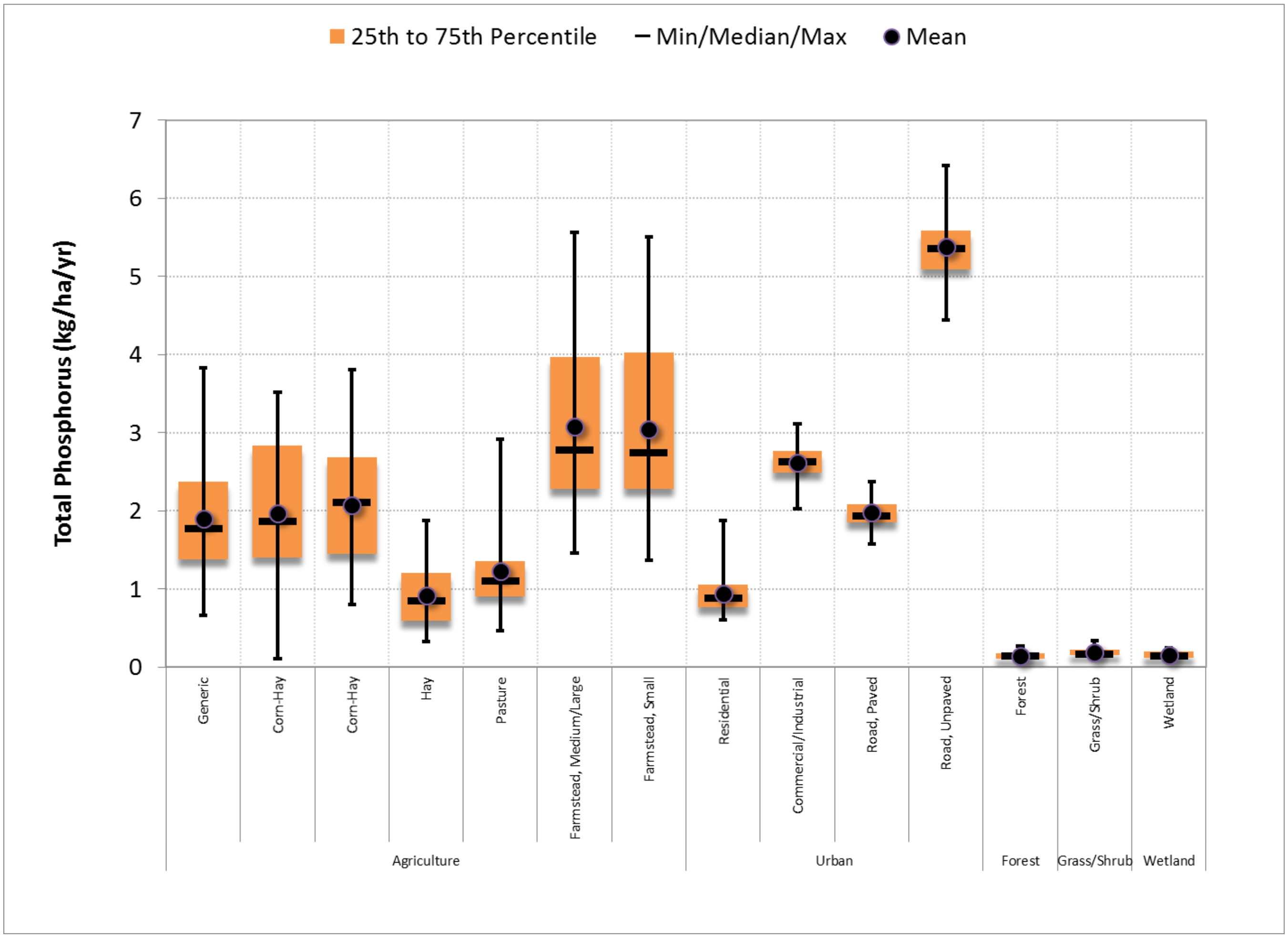


Figure K-202. TP export rates (kg/ha/yr) by landuse categories for the 30 year simulation period

Table K-55. TP export rates (kg/ha/yr) for the residential landuse categories for the 30 year simulation period

Residential Category	Area (ha)	Area (%)	Mean	Min	Q_{25}	Q_{50}	Q_{75}	Max
Low Density	7,109	57.02	**0.61**	0.30	0.43	0.55	0.68	1.52
Medium Density	4,174	33.48	**1.09**	0.69	0.88	1.03	1.23	2.18
High Density	1,184	9.50	**1.82**	1.30	1.60	1.79	1.99	2.65
Total	12,467	100.00	**0.88**	0.54	0.70	0.82	0.99	1.85

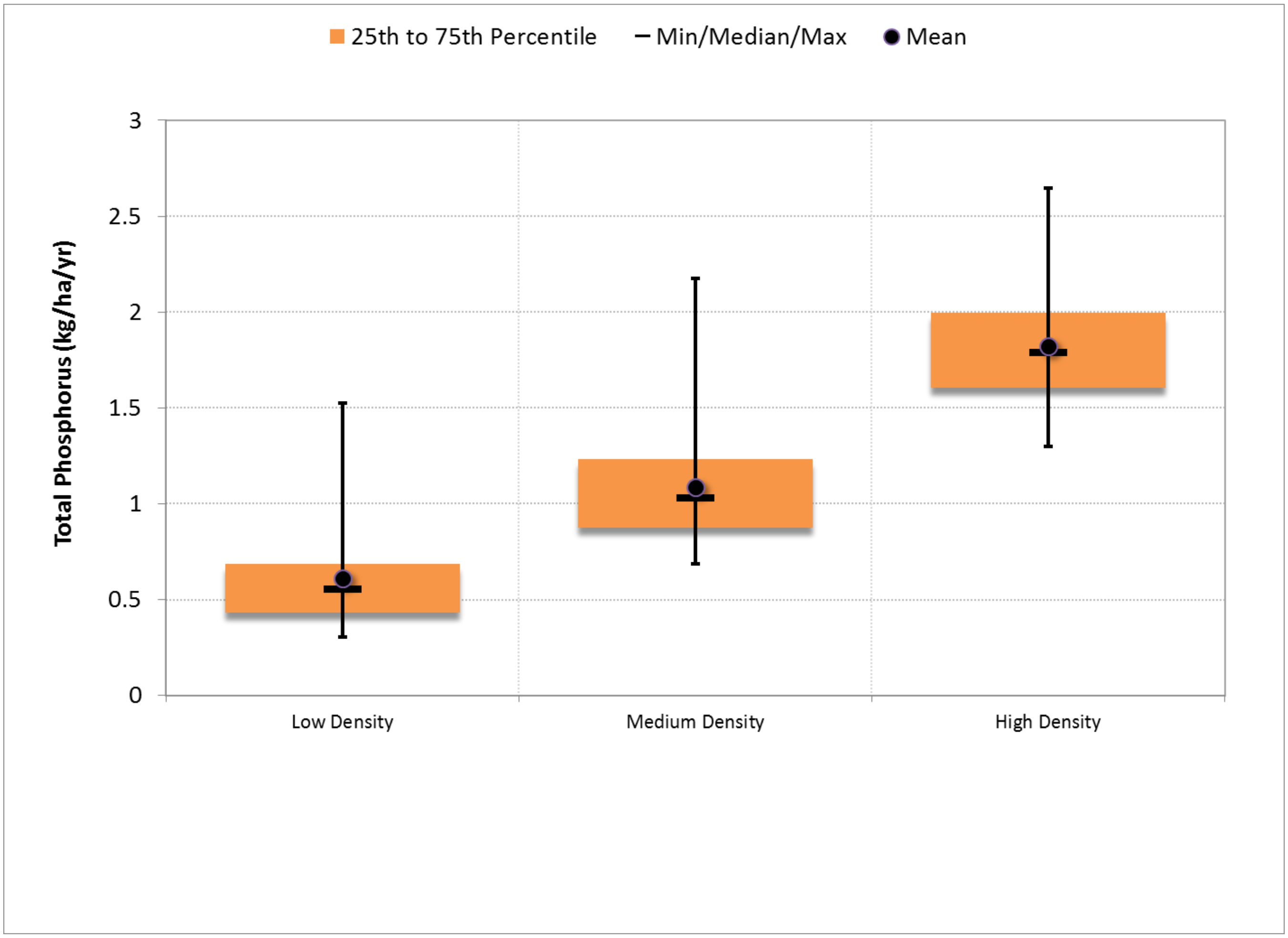


Figure K-203. TP export rates (kg/ha/yr) for the residential landuse categories for the 30 year simulation period

HYDROLOGY - Chazy River

USGS 04271500 Great Chazy River at Perry Mills, NY - Calibration

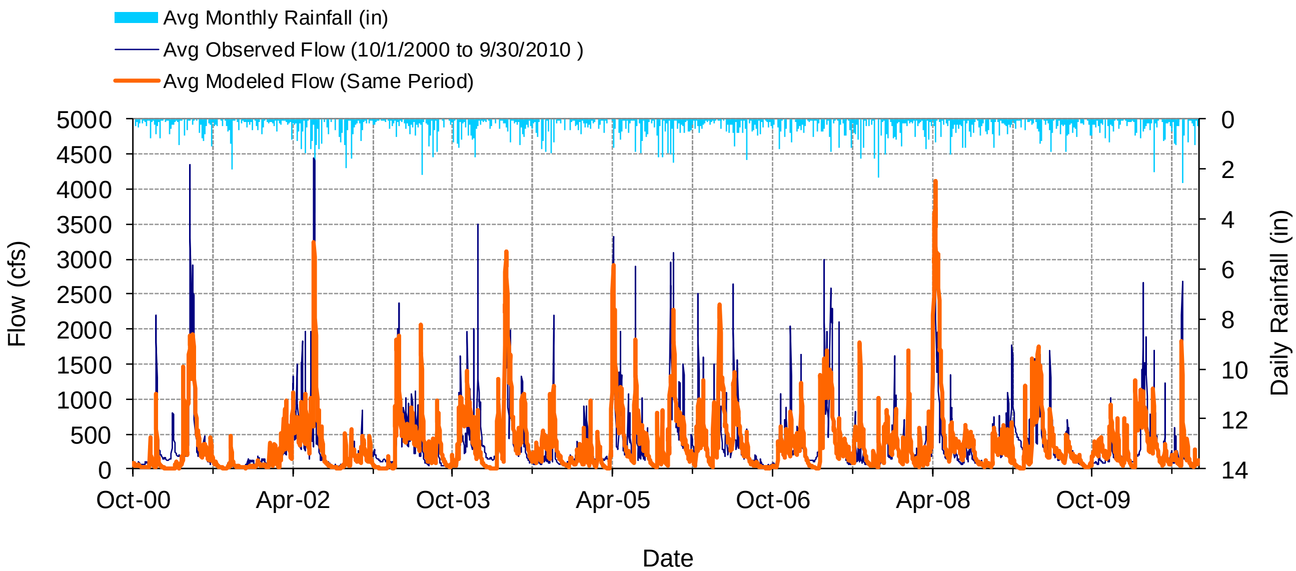


Figure K-204. Mean daily flow at USGS 04271500 Great Chazy River at Perry Mills, NY

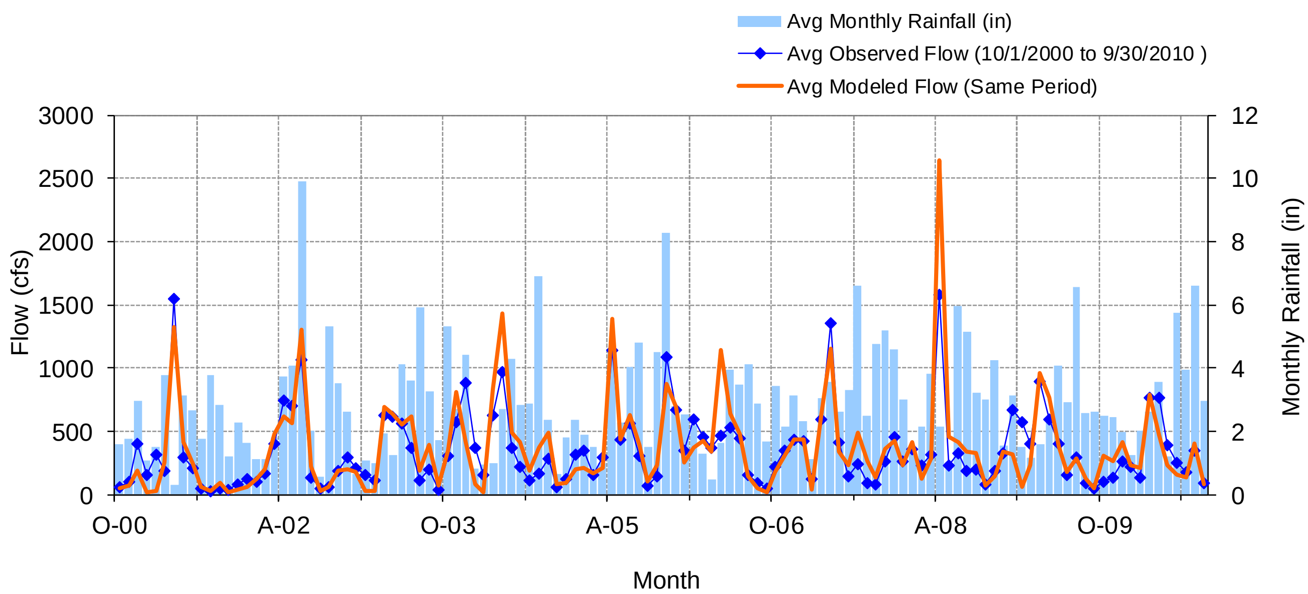
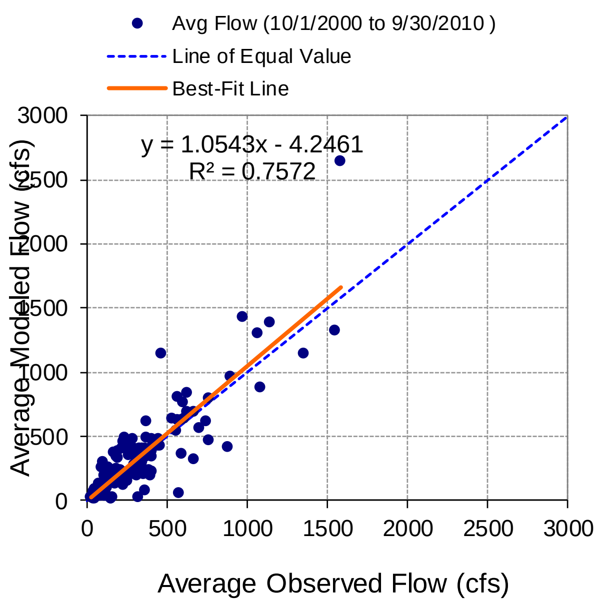


Figure K-205. Mean monthly flow at USGS 04271500 Great Chazy River at Perry Mills, NY



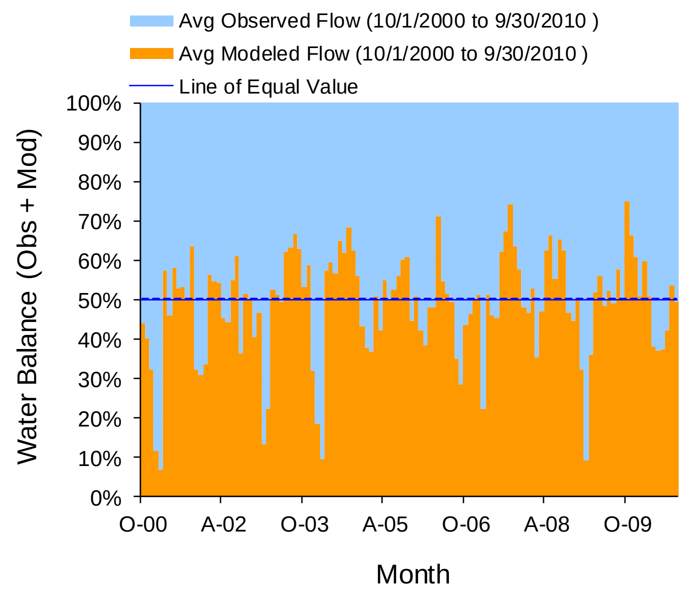
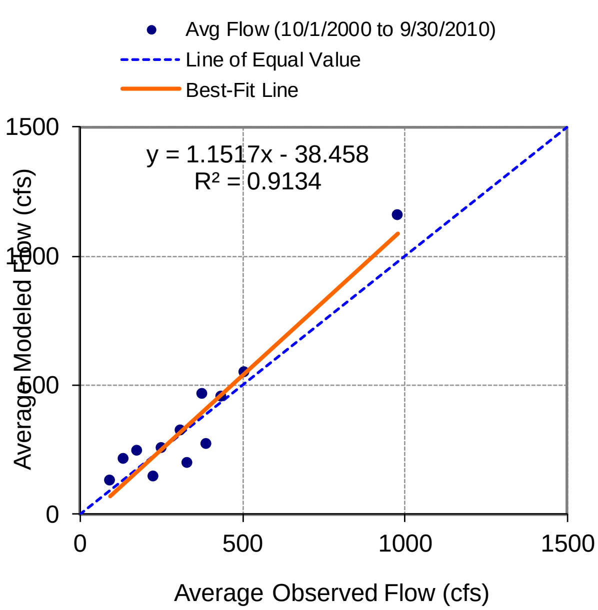


Figure K-206. Monthly flow regression and temporal variation at USGS 04271500 Great Chazy River at Perry Mills, NY



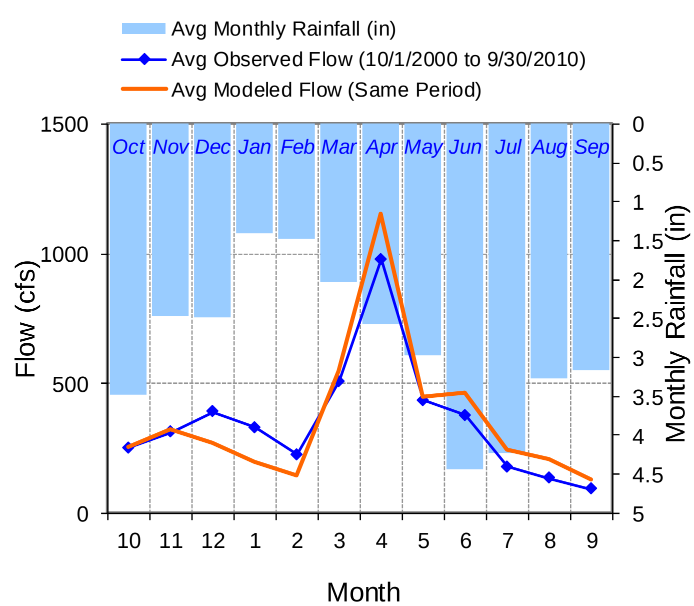


Figure K-207. Seasonal regression and temporal aggregate at USGS 04271500 Great Chazy River at Perry Mills, NY

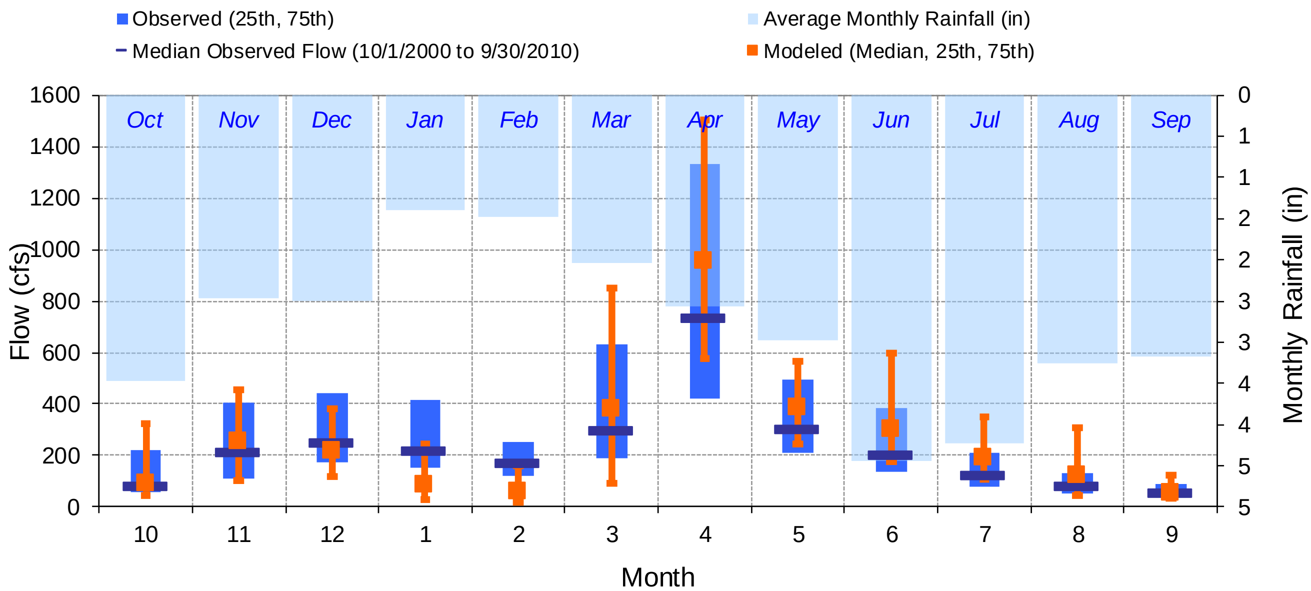


Figure K-208. Seasonal medians and ranges at USGS 04271500 Great Chazy River at Perry Mills, NY

Table K-56. Seasonal summary at USGS 04271500 Great Chazy River at Perry Mills, NY

MONTH	OBSERVED FLOW (CFS)				MODELED FLOW (CFS)			
	MEAN	MEDIAN	25TH	75TH	MEAN	MEDIAN	25TH	75TH
Oct	251.25	82.50	57.25	220.00	254.48	93.05	46.20	321.58
Nov	311.32	210.50	107.75	407.75	322.29	252.55	104.27	454.76
Dec	390.60	252.00	176.00	440.50	269.61	220.82	116.00	384.14
Jan	330.33	220.00	150.00	414.50	196.11	88.89	29.62	244.09
Feb	226.28	169.50	121.00	254.50	144.74	58.07	16.29	160.15
Mar	507.39	297.00	190.00	631.50	548.49	379.28	93.88	847.99
Apr	978.79	732.50	422.00	1330.00	1156.18	956.67	575.28	1504.05
May	435.02	305.00	212.25	497.00	450.35	384.75	245.49	568.12
Jun	377.46	200.00	137.50	384.25	463.97	303.46	174.46	597.70
Jul	177.06	123.50	79.00	208.75	244.07	190.43	107.14	347.64
Aug	132.45	83.00	54.25	133.00	208.65	122.77	44.51	308.27
Sep	92.60	56.50	39.00	87.00	128.99	54.00	33.22	122.43

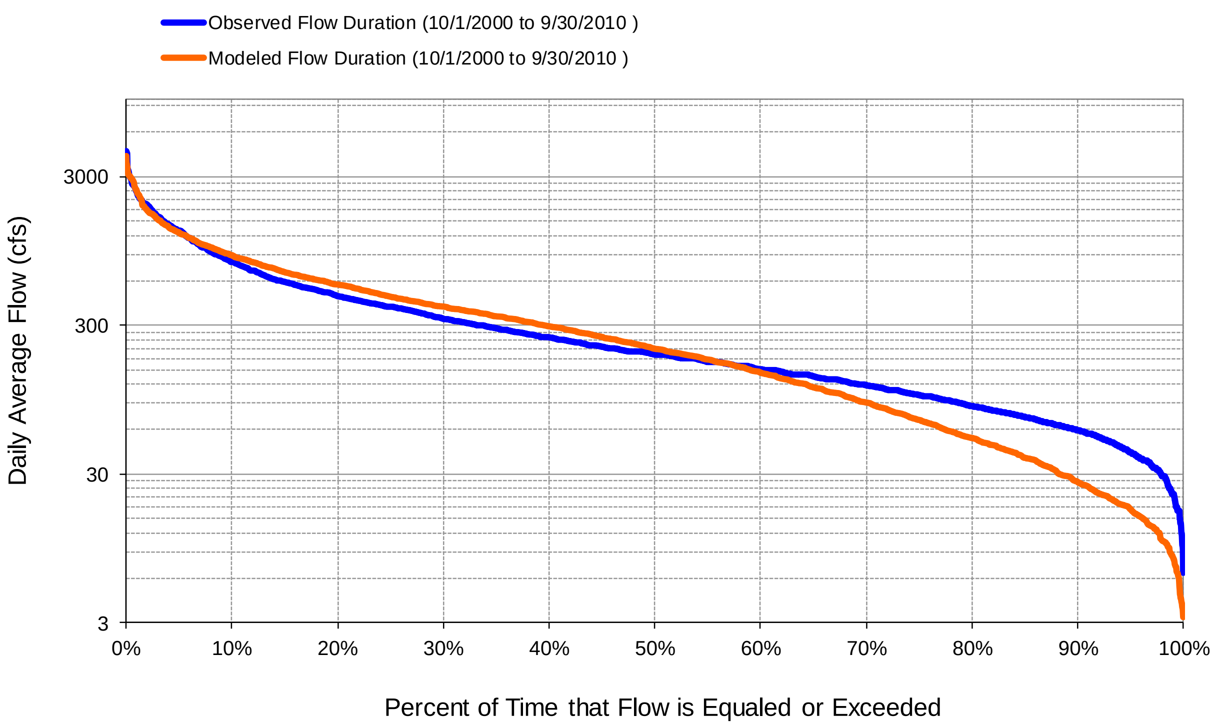


Figure K-209. Flow exceedence at USGS 04271500 Great Chazy River at Perry Mills, NY

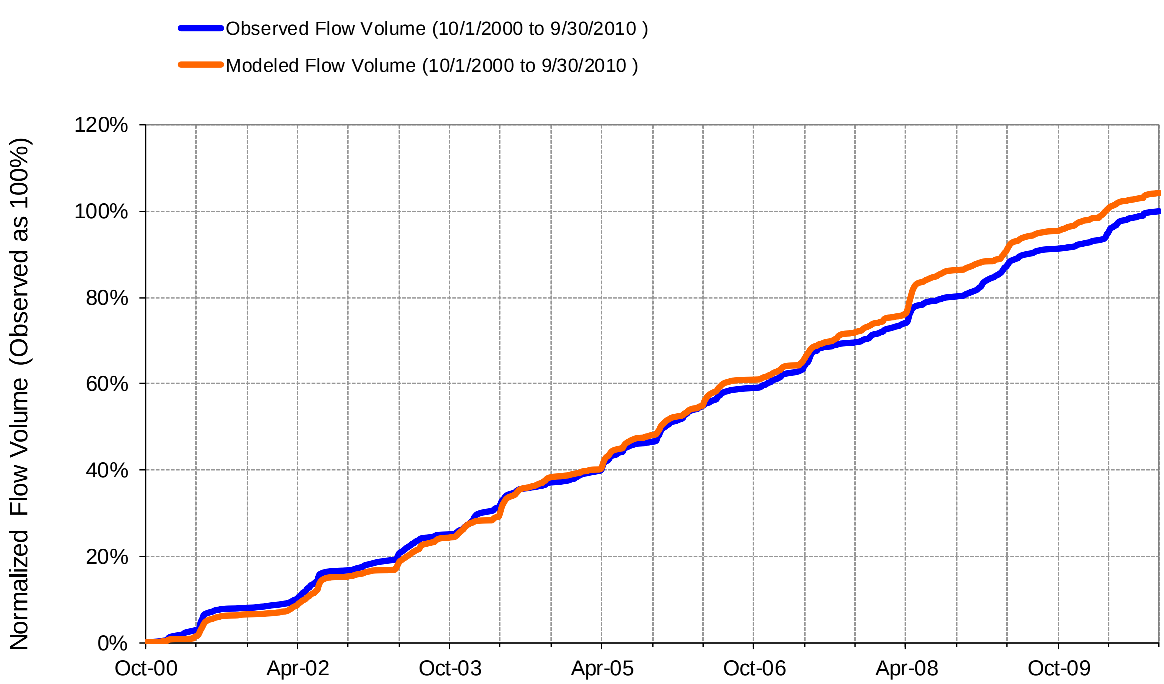


Figure K-210. Flow accumulation at USGS 04271500 Great Chazy River at Perry Mills, NY

Table K-57. Summary statistics at USGS 04271500 Great Chazy River at Perry Mills, NY

SWAT Simulated Flow		Observed Flow Gage	
REACH OUTFLOW FROM OUTLET 7 10-Year Analysis Period: 10/1/2000 - 9/30/2010 Flow volumes are (inches/year) for upstream drainage area		USGS 04271500 GREAT CHAZY RIVER AT PERRY MILLS NY Hydrologic Unit Code: 2010006 Latitude: 45 Longitude: -73.5008333 Drainage Area (sq-mi): 243	
Total Simulated In-stream Flow:	**20.44**	Total Observed In-stream Flow:	**19.61**
Total of simulated highest 10% flows:	**8.21**	Total of Observed highest 10% flows:	**8.25**
Total of Simulated lowest 50% flows:	**2.34**	Total of Observed Lowest 50% flows:	**2.93**
Simulated Summer Flow Volume (months 7-9):	**2.74**	Observed Summer Flow Volume (7-9):	**1.89**
Simulated Fall Flow Volume (months 10-12):	**3.97**	Observed Fall Flow Volume (10-12):	**4.48**
Simulated Winter Flow Volume (months 1-3):	**4.16**	Observed Winter Flow Volume (1-3):	**4.95**
Simulated Spring Flow Volume (months 4-6):	**9.58**	Observed Spring Flow Volume (4-6):	**8.29**
Total Simulated Storm Volume:	**4.21**	Total Observed Storm Volume:	**5.49**
Simulated Summer Storm Volume (7-9):	**0.67**	Observed Summer Storm Volume (7-9):	**0.63**

Errors (Simulated-Observed)	*Error Statistics*	*Recommended Criteria*
Error in total volume:	4.23	10
Error in 50% lowest flows:	-19.98	10
Error in 10% highest flows:	-0.56	15
Seasonal volume error - Summer:	44.71	30
Seasonal volume error - Fall:	-11.36	30
Seasonal volume error - Winter:	-16.03	30
Seasonal volume error - Spring:	15.49	30
Error in storm volumes:	-23.39	20
Error in summer storm volumes:	6.56	50
Nash-Sutcliffe Coefficient of Efficiency, E:	0.546	Model accuracy increases
Baseline adjusted coefficient (Garrick), E':	0.375	as E or E' approaches 1.0
Monthly NSE	0.638	

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USGS 04271500 Great Chazy River at Perry Mills, NY - Validation

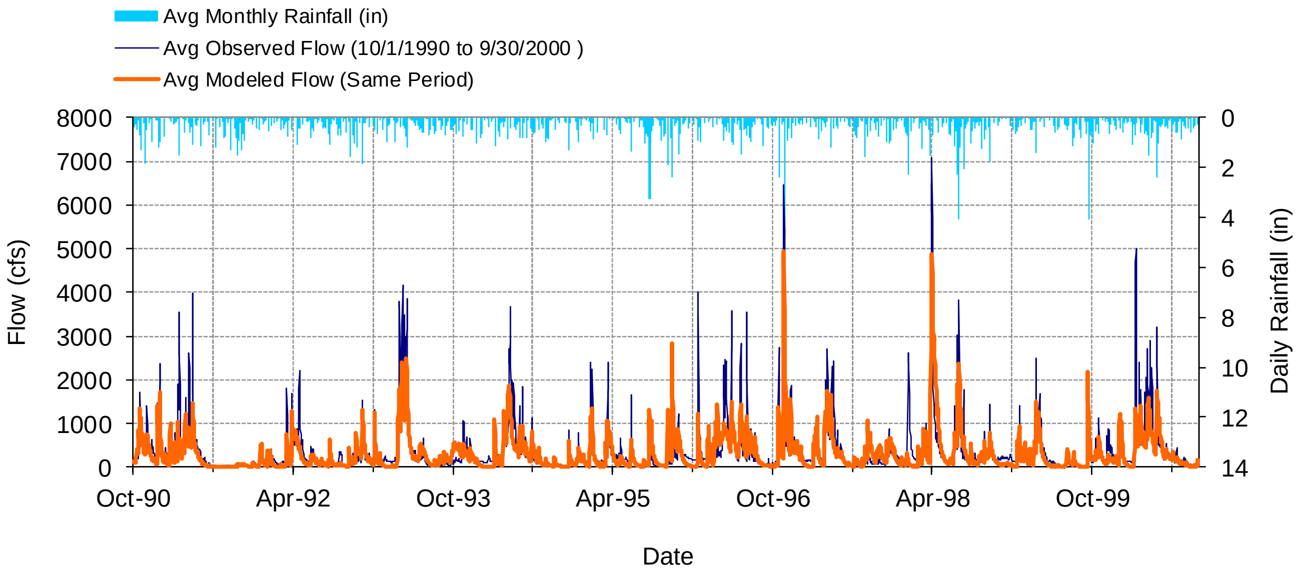

Figure K-211. Mean daily flow at USGS 04271500 Great Chazy River at Perry Mills, NY

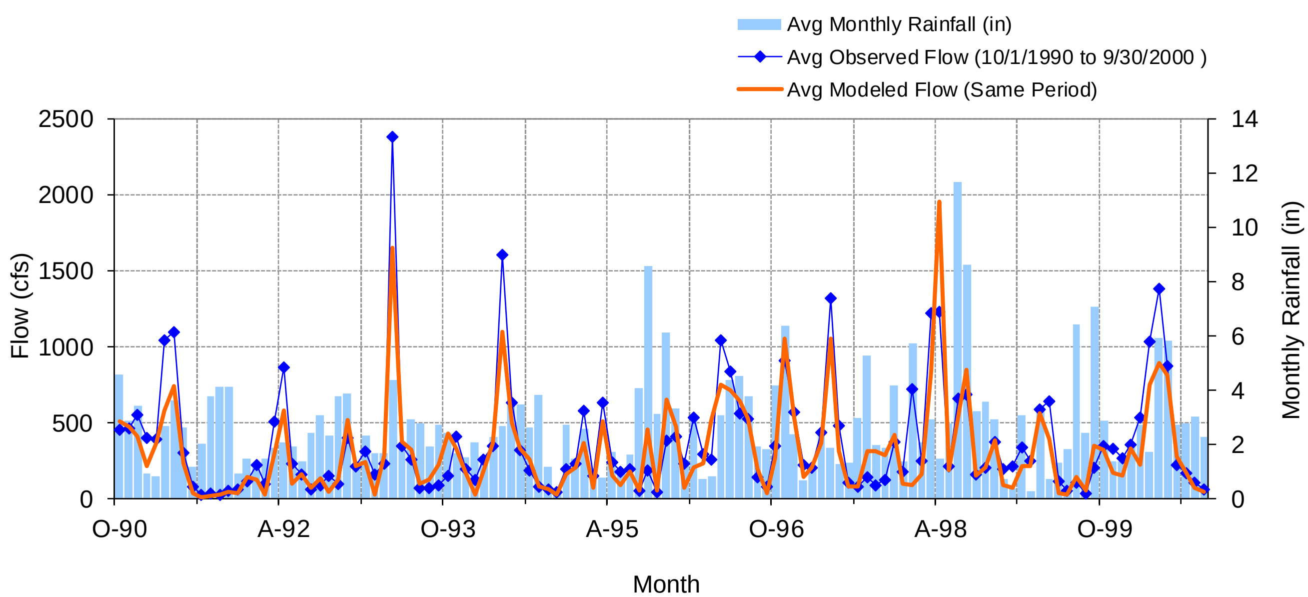

Figure K-212. Mean monthly flow at USGS 04271500 Great Chazy River at Perry Mills, NY

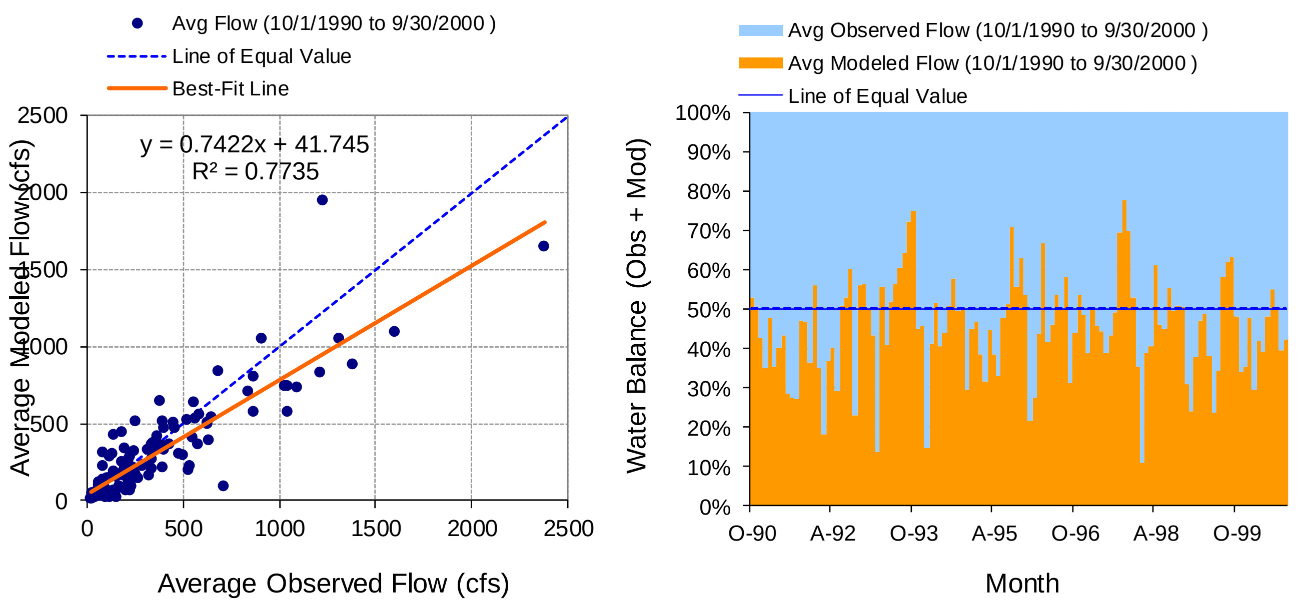

Figure K-213. Monthly flow regression and temporal variation at USGS 04271500 Great Chazy River at Perry Mills, NY

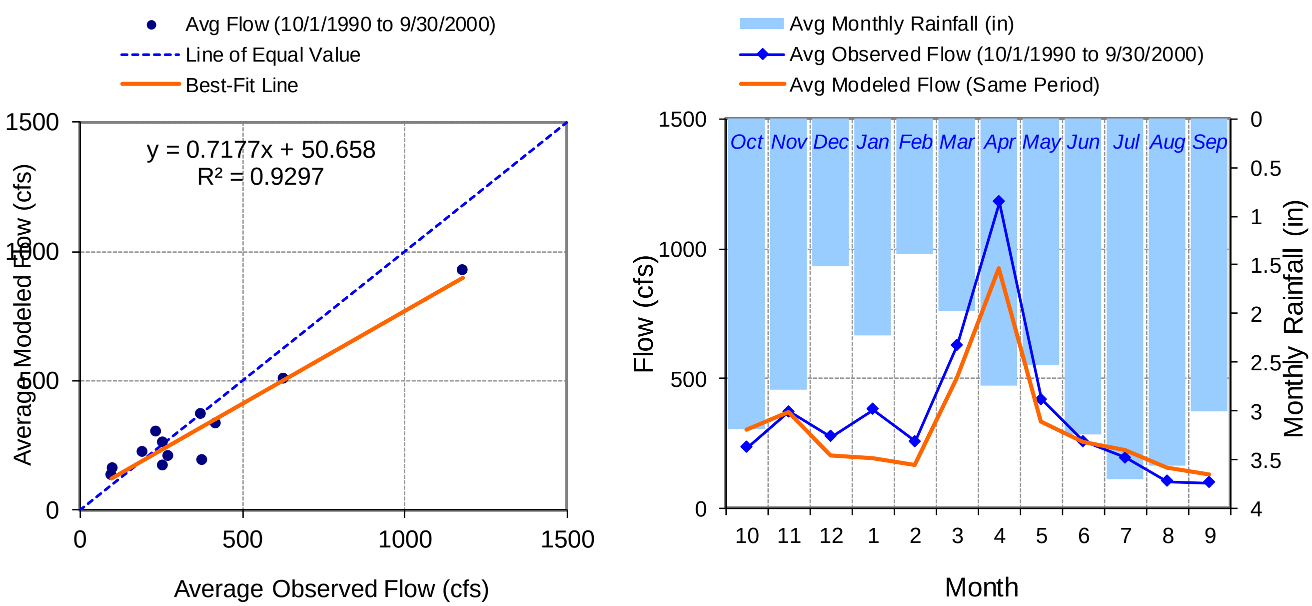

Figure K-214. Seasonal regression and temporal aggregate at USGS 04271500 Great Chazy River at Perry Mills, NY

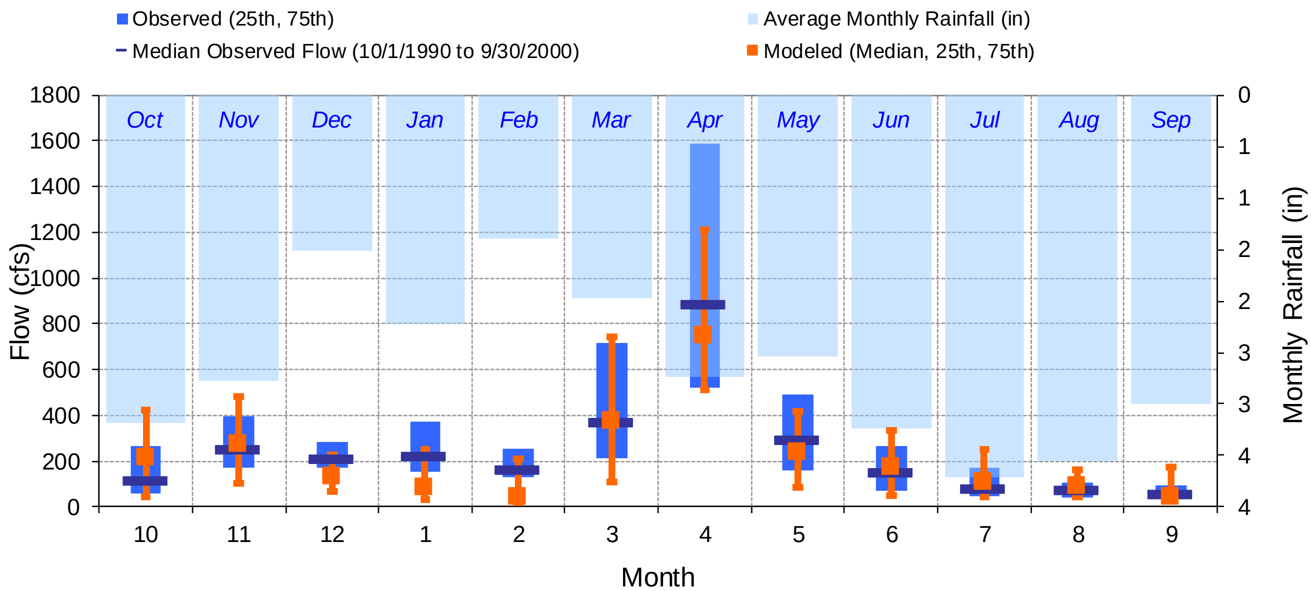

Figure K-215. Seasonal medians and ranges at USGS 04271500 Great Chazy River at Perry Mills, NY

Table K-58. Seasonal summary at USGS 04271500 Great Chazy River at Perry Mills, NY

MONTH	OBSERVED FLOW (CFS)				MODELED FLOW (CFS)			
	MEAN	MEDIAN	25TH	75TH	MEAN	MEDIAN	25TH	75TH
Oct	233.60	117.50	59.25	265.00	300.29	215.51	43.83	421.92
Nov	370.64	252.00	170.75	395.50	369.42	273.42	105.96	480.28
Dec	274.22	211.50	170.00	282.25	203.14	133.98	70.29	230.27
Jan	378.22	220.00	152.50	370.00	190.88	85.97	30.81	253.44
Feb	255.92	160.00	130.00	255.00	166.67	43.30	16.88	207.70
Mar	626.82	370.00	210.00	715.00	503.13	378.22	108.34	742.31
Apr	1178.28	883.50	518.25	1585.00	922.27	747.96	513.74	1212.35
May	419.85	292.00	159.00	491.25	332.34	242.06	87.98	414.77
Jun	256.70	151.00	71.75	267.50	256.30	176.41	52.27	333.78
Jul	193.24	81.50	46.25	170.25	222.89	110.59	41.11	250.18
Aug	101.16	73.00	41.00	106.00	155.88	89.81	45.95	163.70
Sep	96.84	58.00	40.00	92.00	132.16	46.21	27.77	175.82

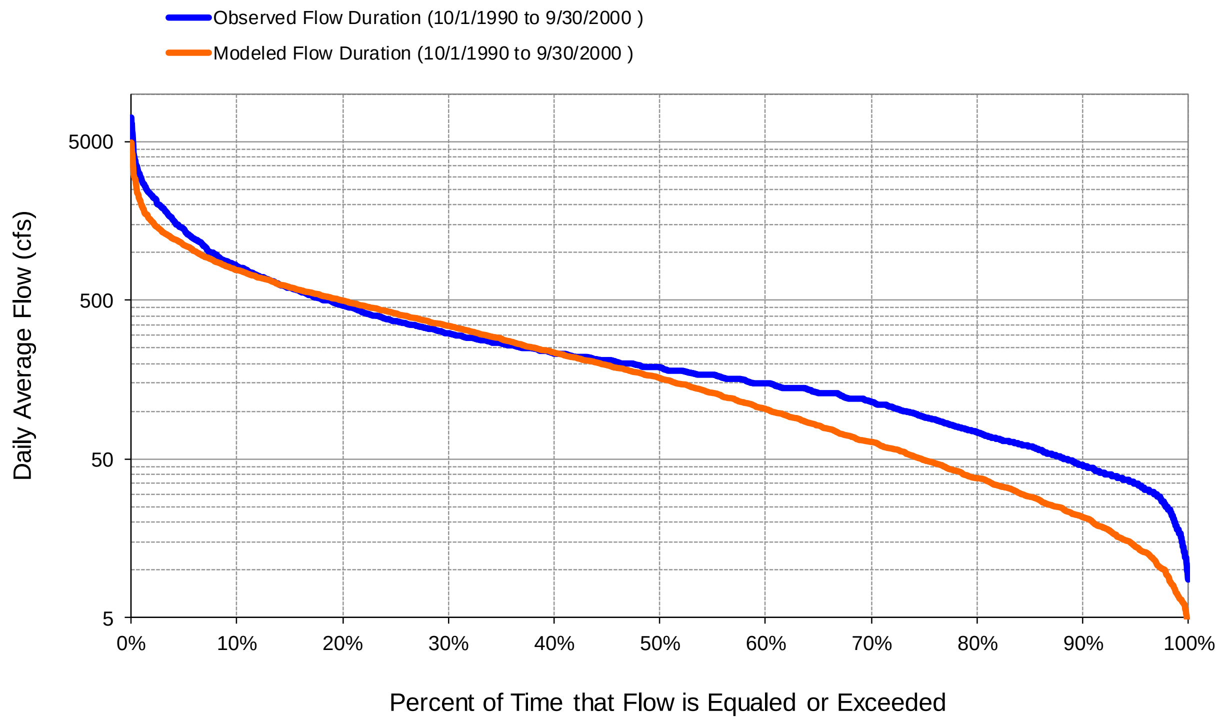

Figure K-216. Flow exceedence at USGS 04271500 Great Chazy River at Perry Mills, NY

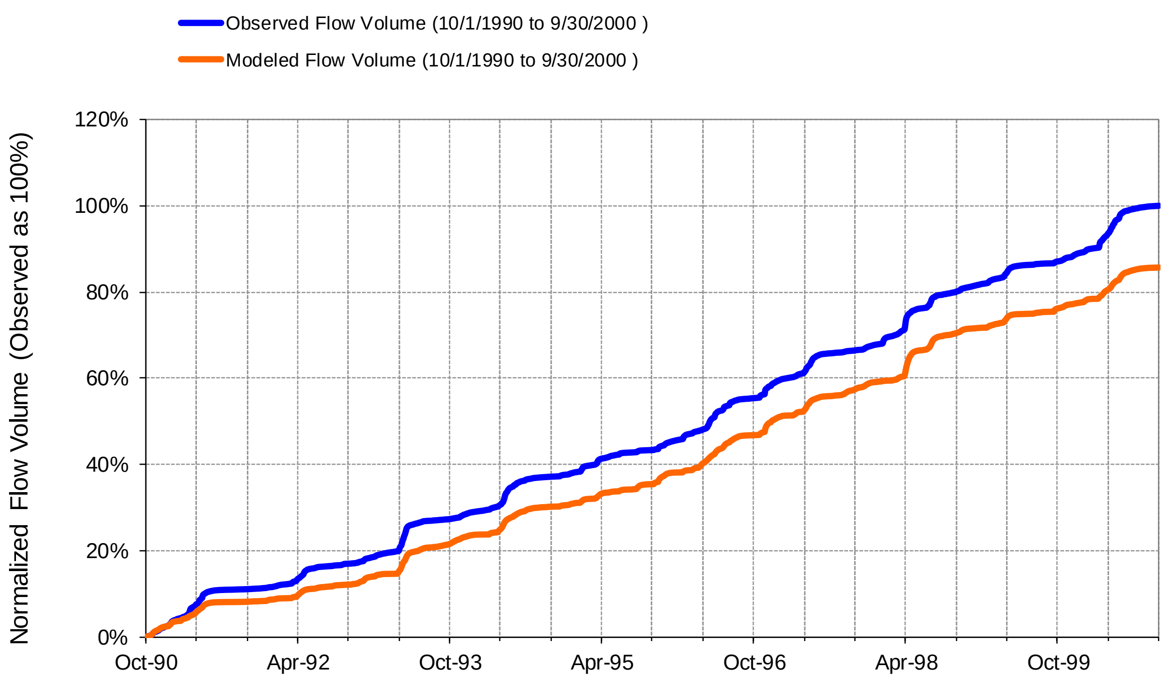

Figure K-217. Flow accumulation at USGS 04271500 Great Chazy River at Perry Mills, NY

Table K-59. Summary statistics at USGS 04271500 Great Chazy River at Perry Mills, NY

SWAT Simulated Flow		Observed Flow Gage	
REACH OUTFLOW FROM OUTLET 7 10-Year Analysis Period: 10/1/1990 - 9/30/2000 Flow volumes are (inches/year) for upstream drainage area		USGS 04273500 SARANAC RIVER AT PLATTSBURGH NY Hydrologic Unit Code: 2010006 Latitude: 44.68166667 Longitude: -73.4711111 Drainage Area (sq-mi): 608	
Total Simulated In-stream Flow:	**6.99**	Total Observed In-stream Flow:	**8.16**
Total of simulated highest 10% flows:	**2.92**	Total of Observed highest 10% flows:	**3.80**
Total of Simulated lowest 50% flows:	**0.68**	Total of Observed Lowest 50% flows:	**1.08**
Simulated Summer Flow Volume (months 7-9):	**0.96**	Observed Summer Flow Volume (7-9):	**0.74**
Simulated Fall Flow Volume (months 10-12):	**1.63**	Observed Fall Flow Volume (10-12):	**1.64**
Simulated Winter Flow Volume (months 1-3):	**1.60**	Observed Winter Flow Volume (1-3):	**2.35**
Simulated Spring Flow Volume (months 4-6):	**2.79**	Observed Spring Flow Volume (4-6):	**3.43**
Total Simulated Storm Volume:	**2.25**	Total Observed Storm Volume:	**3.14**
Simulated Summer Storm Volume (7-9):	**0.33**	Observed Summer Storm Volume (7-9):	**0.32**

Errors (Simulated-Observed)	*Error Statistics*	*Recommended Criteria*		
Error in total volume:	-14.30	10		
Error in 50% lowest flows:	-36.92	10		
Error in 10% highest flows:	-23.03	15		
Seasonal volume error - Summer:	30.55	30		
Seasonal volume error - Fall:	-0.64	>> 30	Clear	
Seasonal volume error - Winter:	-31.69	30		
Seasonal volume error - Spring:	-18.56	30		
Error in storm volumes:	-28.32	20		
Error in summer storm volumes:	3.68	50		
Nash-Sutcliffe Coefficient of Efficiency, E:	0.609	Model accuracy increases		
Baseline adjusted coefficient (Garrick), E':	0.453	as E or E' approaches 1.0		
Monthly NSE	0.752			

TSS and TP distribution by channel and upland sources

Table K-60. TSS and TP distribution by source categories

Source	TSS		TP	
	Load(mt/year)	Percentage (%)	Load (kg/year)	Percentage (%)
Upland	10,039	56.0	26,030	79.7
Stream	7,877	44.0	6,636	20.3
Total	**17,916**	**100.0**	**32,667**	**100.0**

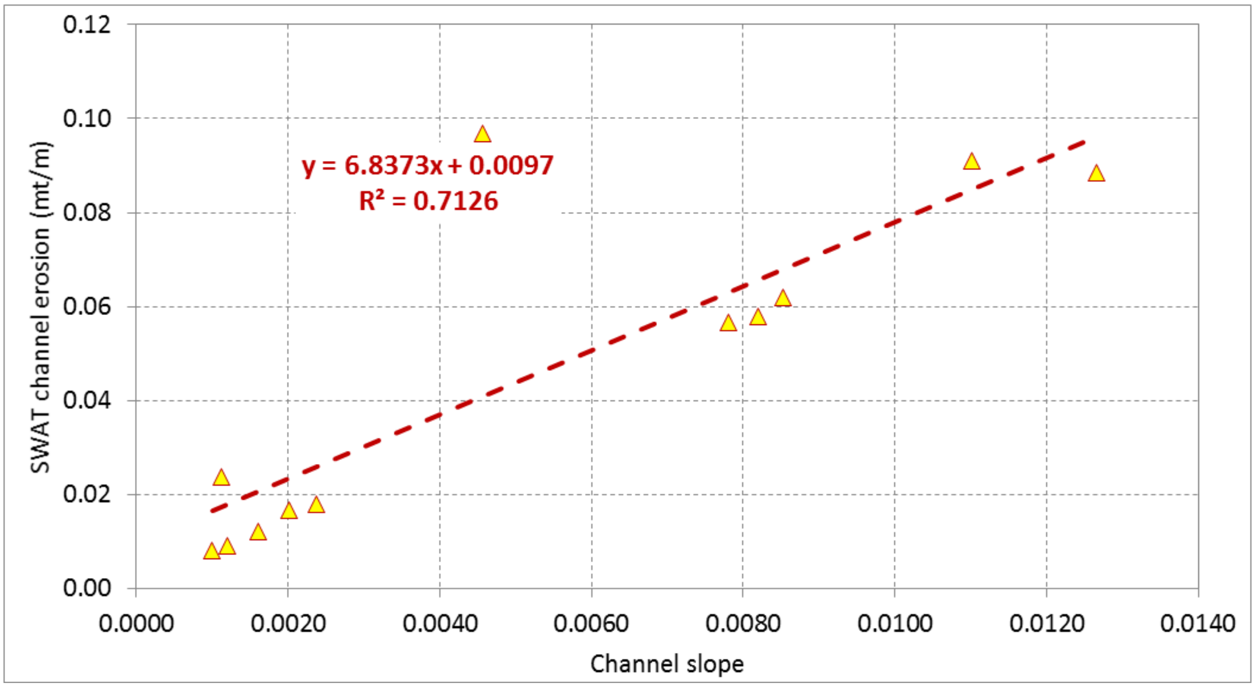

Figure K-218. SWAT simulated channel erosion relative to channel slope

TP distribution by landuse from upland sources (Great Chazy River)

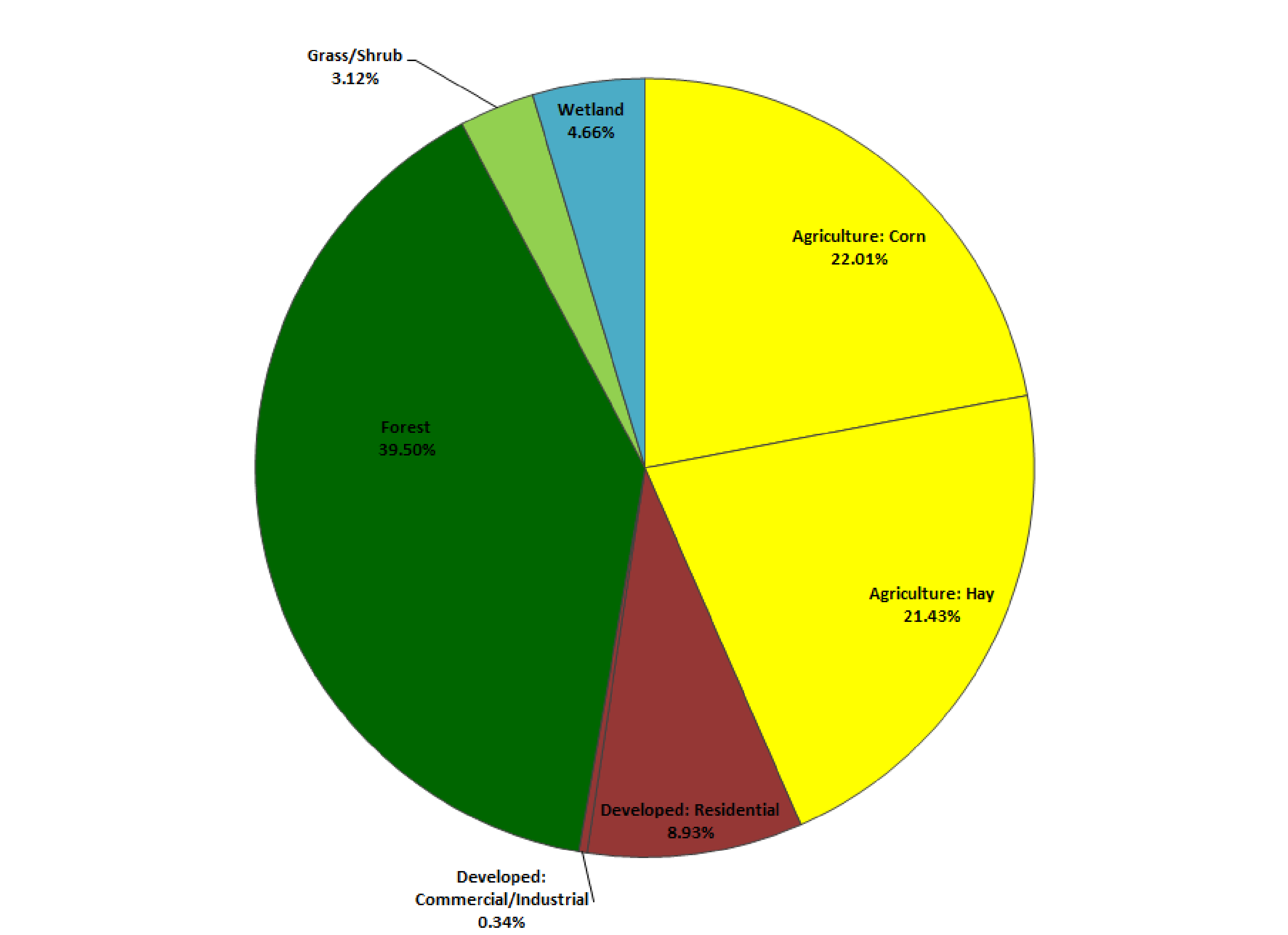

Figure K-219. Distribution of simulated total upland TP loads by landuse categories

Table K-61. TP export rates (kg/ha/yr) by landuse categories for the 30 year simulation period

Landuse	Classification	Area (ha)	Area (%)	Mean	Min	Q_{25}	Q_{50}	Q_{75}	Max
Agriculture	Corn	2,577	3.37	**1.87**	0.61	1.16	1.52	2.42	4.40
	Hay	4,763	6.23	**0.99**	0.26	0.58	0.95	1.25	2.45
Urban	Residential	3,641	4.76	**0.54**	0.35	0.44	0.50	0.67	0.77
	Commercial/Industrial	42	0.06	**1.76**	1.40	1.66	1.79	1.85	2.16
Forest	Forest	53,565	70.02	**0.16**	0.10	0.13	0.15	0.19	0.26
Grass/Shrub	Grass/Shrub	4,278	5.59	**0.16**	0.09	0.13	0.15	0.19	0.27
Wetland	Wetland	7,630	9.97	**0.13**	0.07	0.09	0.12	0.17	0.26

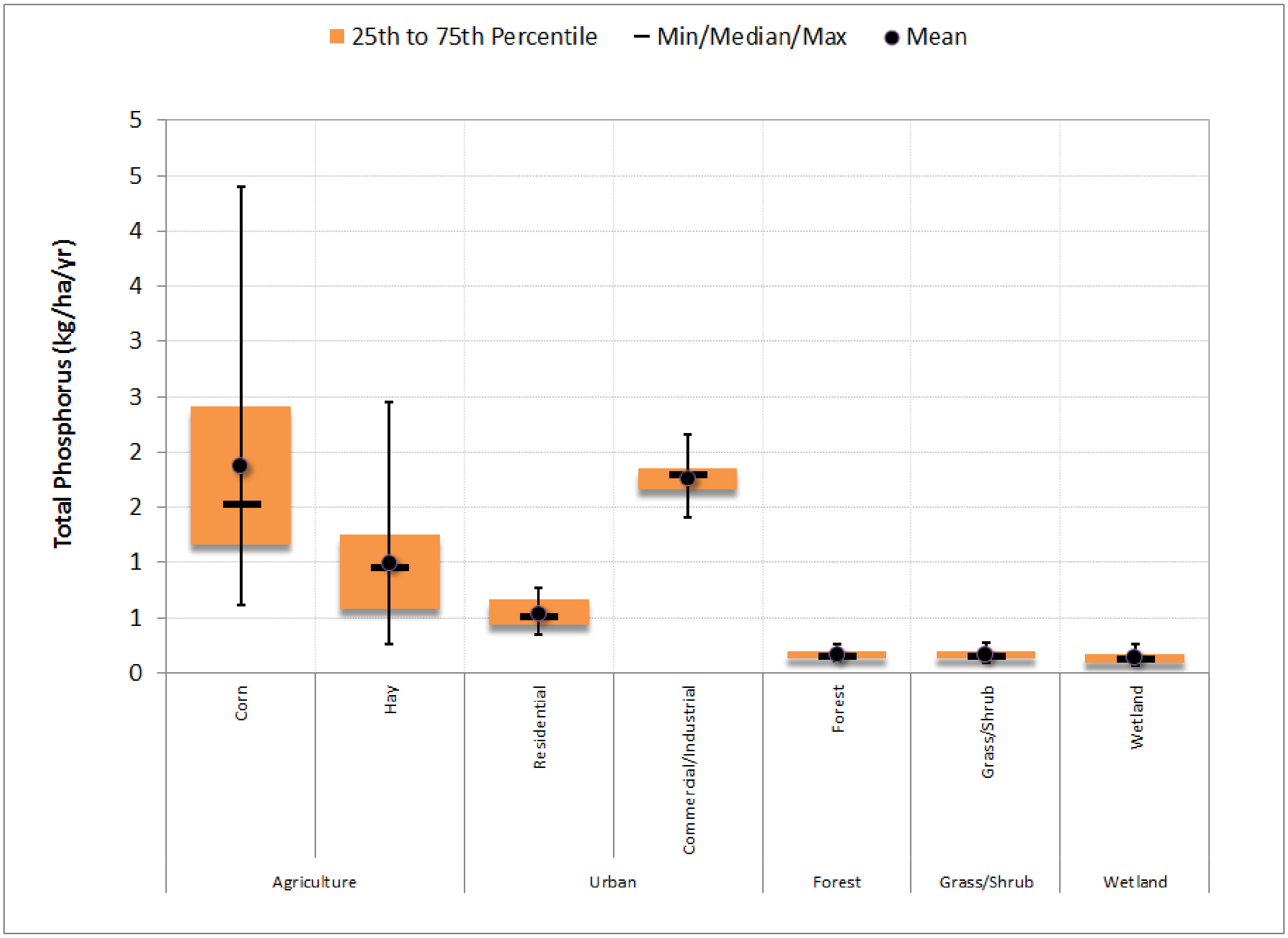

Figure K-220. TP export rates (kg/ha/yr) by landuse categories for the 30 year simulation period

Table K-62. TP export rates (kg/ha/yr) for the residential landuse categories for the 30 year simulation period

Residential Category	Area (ha)	Area (%)	Mean	Min	Q_{25}	Q_{50}	Q_{75}	Max
Low Density	2,620	71.96	**0.36**	0.19	0.28	0.33	0.48	0.58
Medium Density	861	23.65	**0.91**	0.63	0.76	0.86	1.09	1.21
High Density	160	4.39	**1.44**	1.08	1.29	1.43	1.61	1.77
Total	3,641	100.00	**0.54**	0.35	0.44	0.50	0.67	0.77

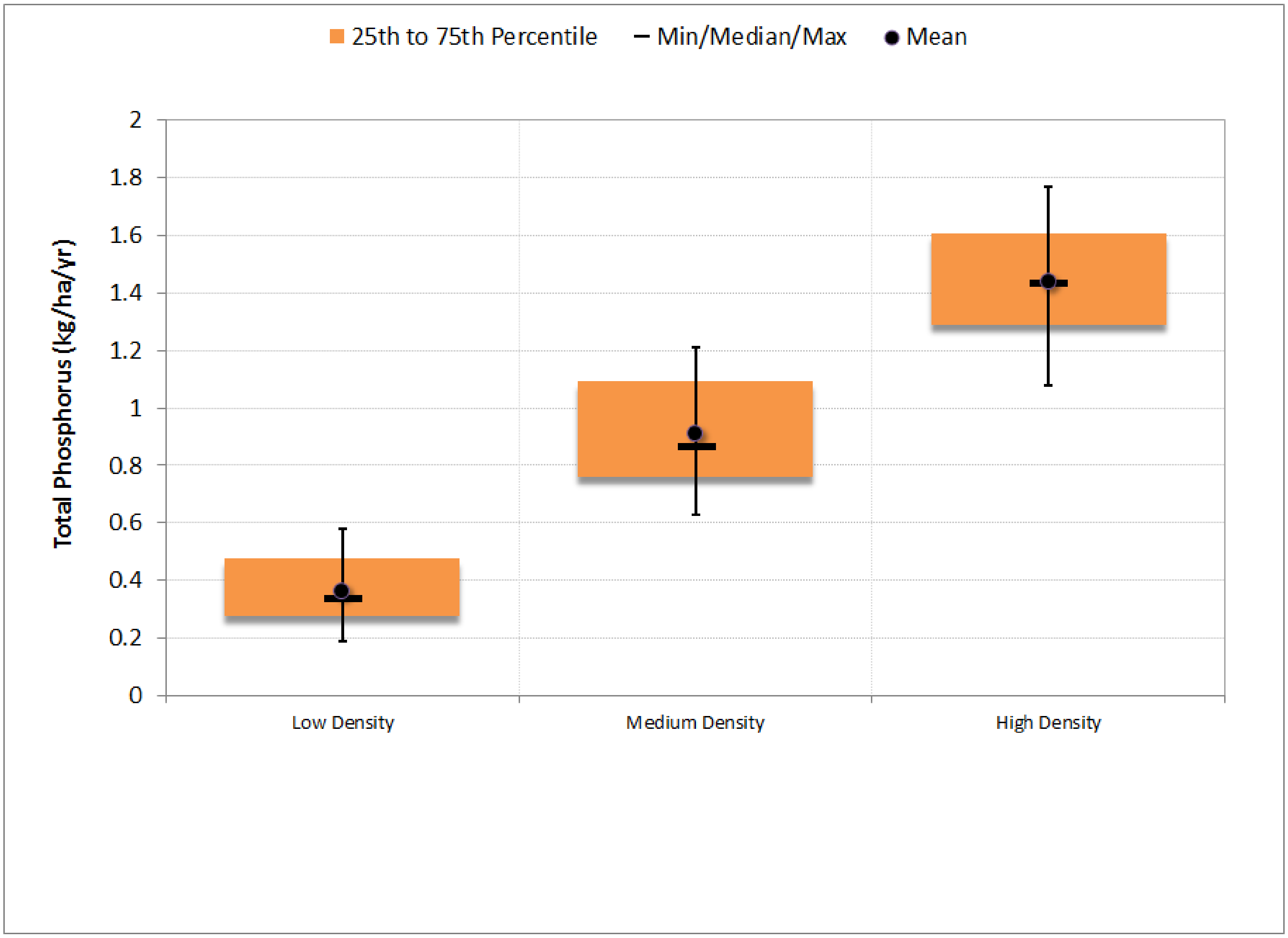

Figure K-221. TP export rates (kg/ha/yr) for the residential landuse categories for the 30 year simulation period

TP distribution by landuse from upland sources (Little Chazy River and Dead Creek)

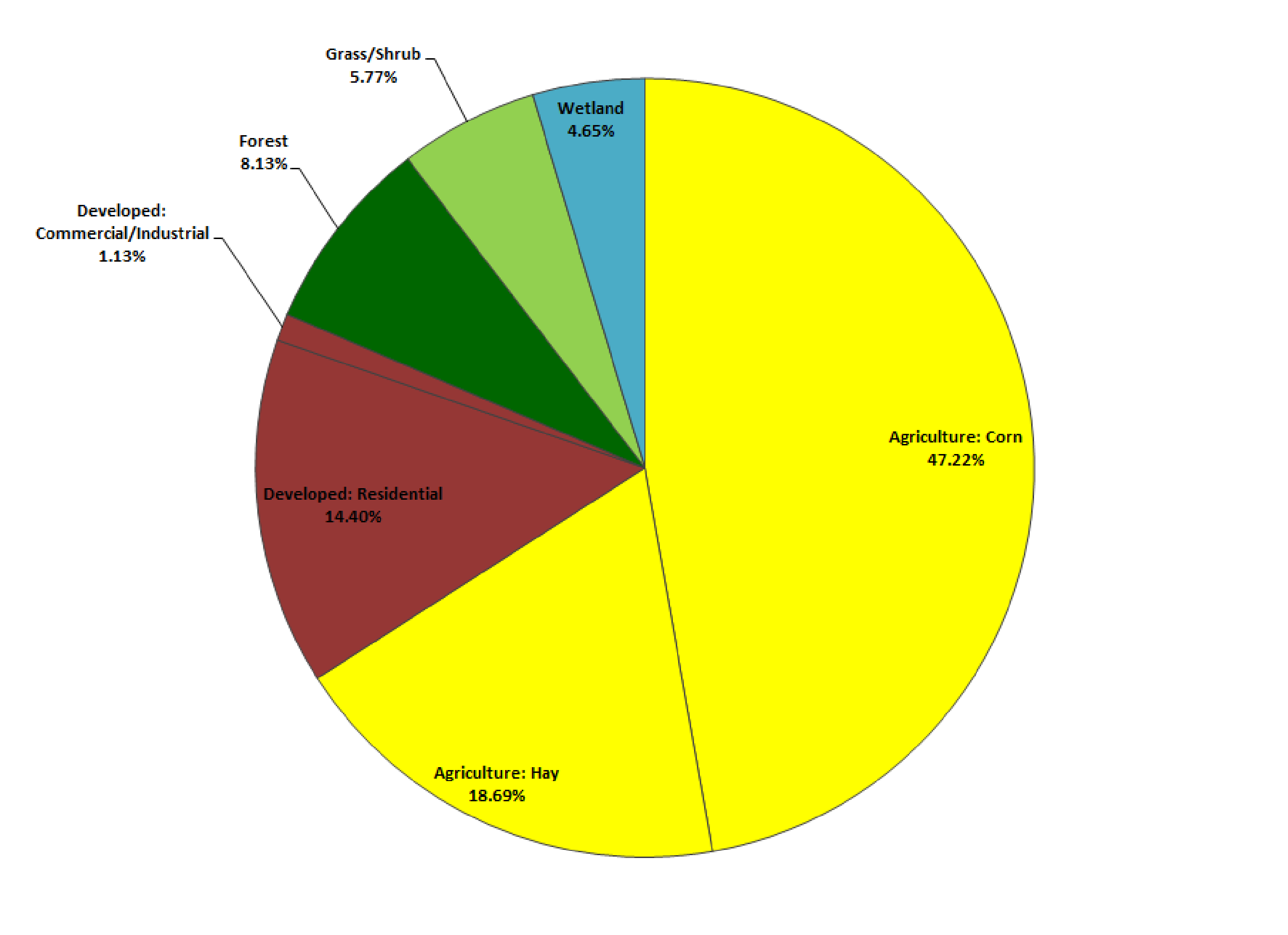

Figure K-222. Distribution of simulated total upland TP loads by landuse categories

Table K-63. TP export rates (kg/ha/yr) by landuse categories for the 30 year simulation period

Landuse	Classification	Area (ha)	Area (%)	Mean	Min	Q_{25}	Q_{50}	Q_{75}	Max
Agriculture	Corn	1,693	8.25	**2.61**	0.53	1.44	2.19	2.96	7.51
	Hay	2,147	10.46	**0.81**	0.02	0.33	0.66	1.19	2.11
Urban	Residential	2,297	11.19	**0.59**	0.38	0.50	0.55	0.70	0.78
	Commercial/Industrial	58	0.28	**1.81**	1.39	1.69	1.83	1.91	2.22
Forest	Forest	11,271	54.90	**0.07**	0.02	0.05	0.06	0.09	0.13
Grass/Shrub	Grass/Shrub	3,063	14.92	**0.18**	0.08	0.14	0.16	0.22	0.28
Wetland	Wetland	0	0.00	**0.10**	0.03	0.07	0.09	0.13	0.17

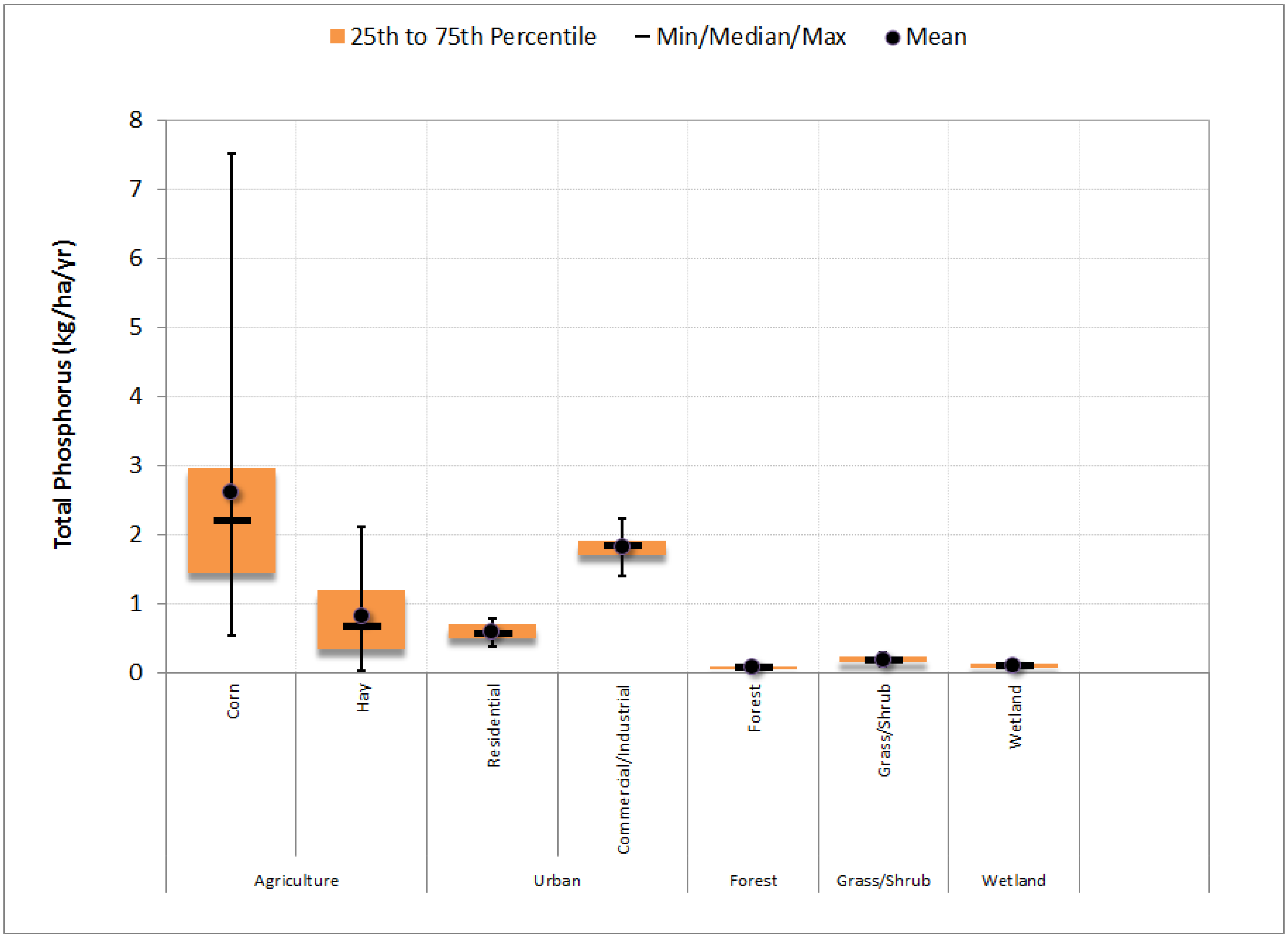

Figure K-223. TP export rates (kg/ha/yr) by landuse categories for the 30 year simulation period

Table K-64. TP export rates (kg/ha/yr) for the residential landuse categories for the 30 year simulation period

Residential Category	Area (ha)	Area (%)	Mean	Min	Q_{25}	Q_{50}	Q_{75}	Max
Low Density	1,182	51.46	**0.27**	0.13	0.21	0.23	0.34	0.45
Medium Density	889	38.72	**0.80**	0.53	0.68	0.77	0.93	1.04
High Density	225	9.82	**1.43**	1.03	1.31	1.43	1.60	1.77
Total	2,297	100.00	**0.59**	0.38	0.50	0.55	0.70	0.78

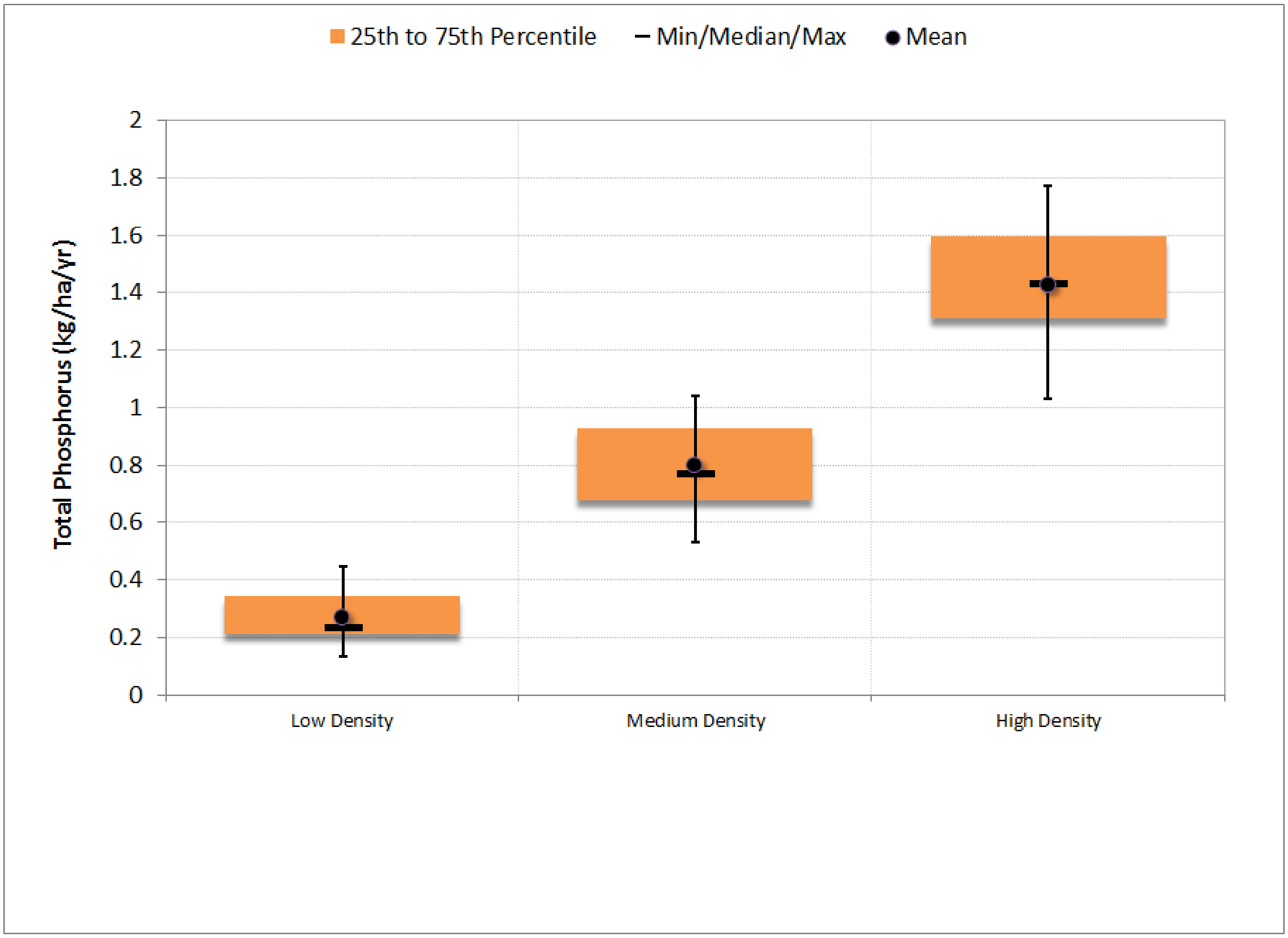

Figure K-224. TP export rates (kg/ha/yr) for the residential landuse categories for the 30 year simulation period

Segmented Regression

Table K-65. Summary statistics

Statistic	Calibration		Validation	
	TSS	TP	TSS	TP
Average absolute error (%)	55.1	53.3	49.4	52.2
Median absolute error (%)	18.3	30.1	13.7	21.9
Regression error (%)	-19.3	7.4	32.5	27.0
NSE	0.577	0.533	0.617	0.531
NSE'	0.459	0.350	0.582	0.457

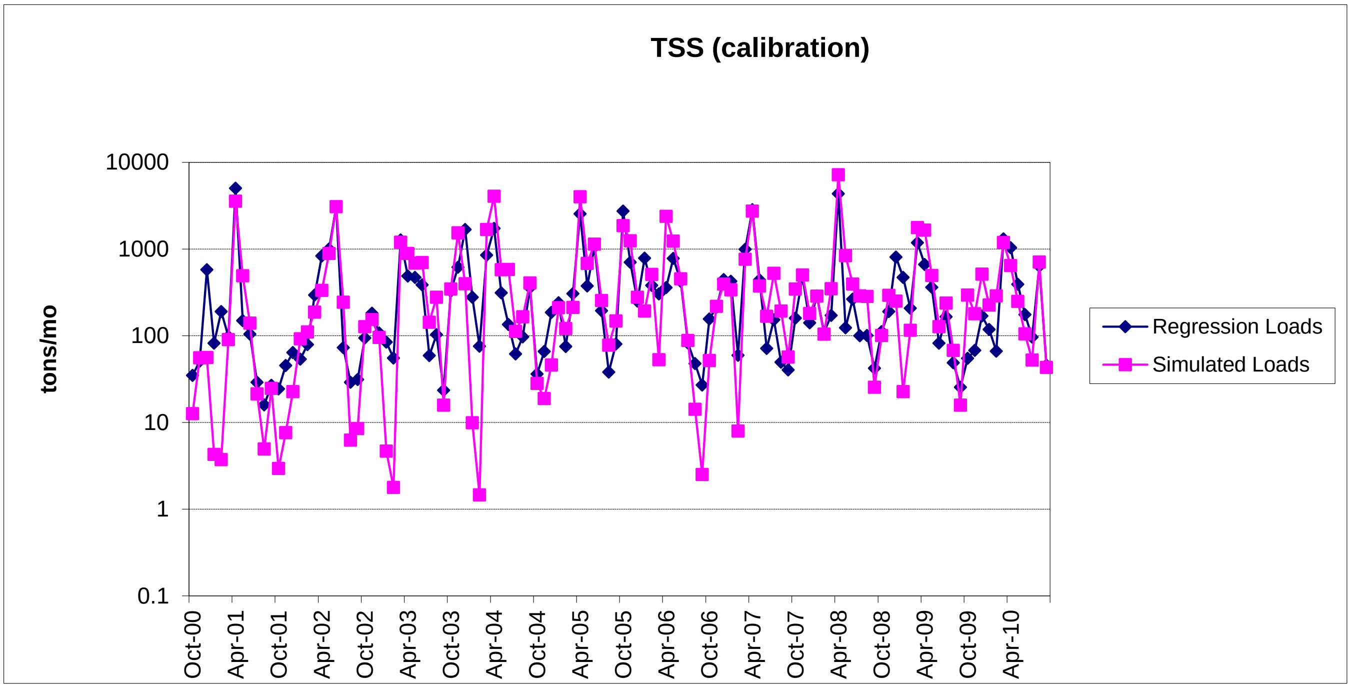

Figure K-225. Monthly simulated and estimated TSS load at Great Chazy River at Perry Mills, NY (calibration period)

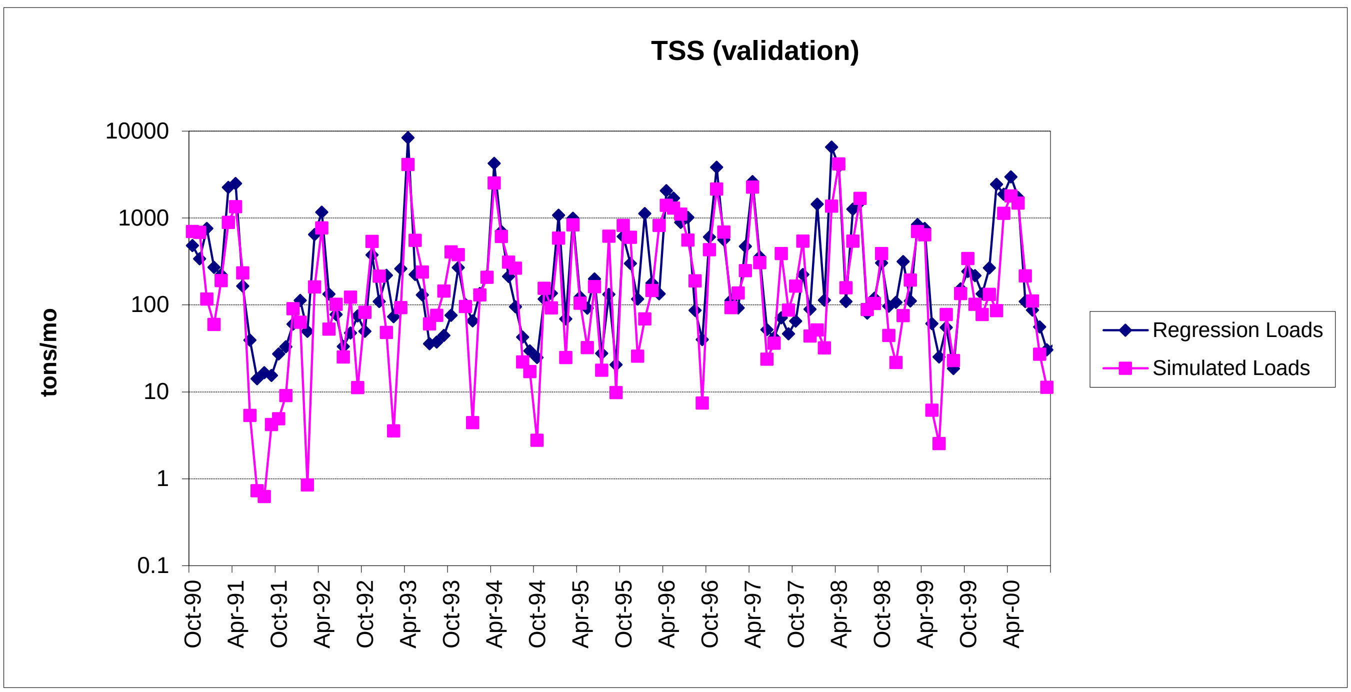

Figure K-226. Monthly simulated and estimated TSS load at Great Chazy River at Perry Mills, NY (validation period)

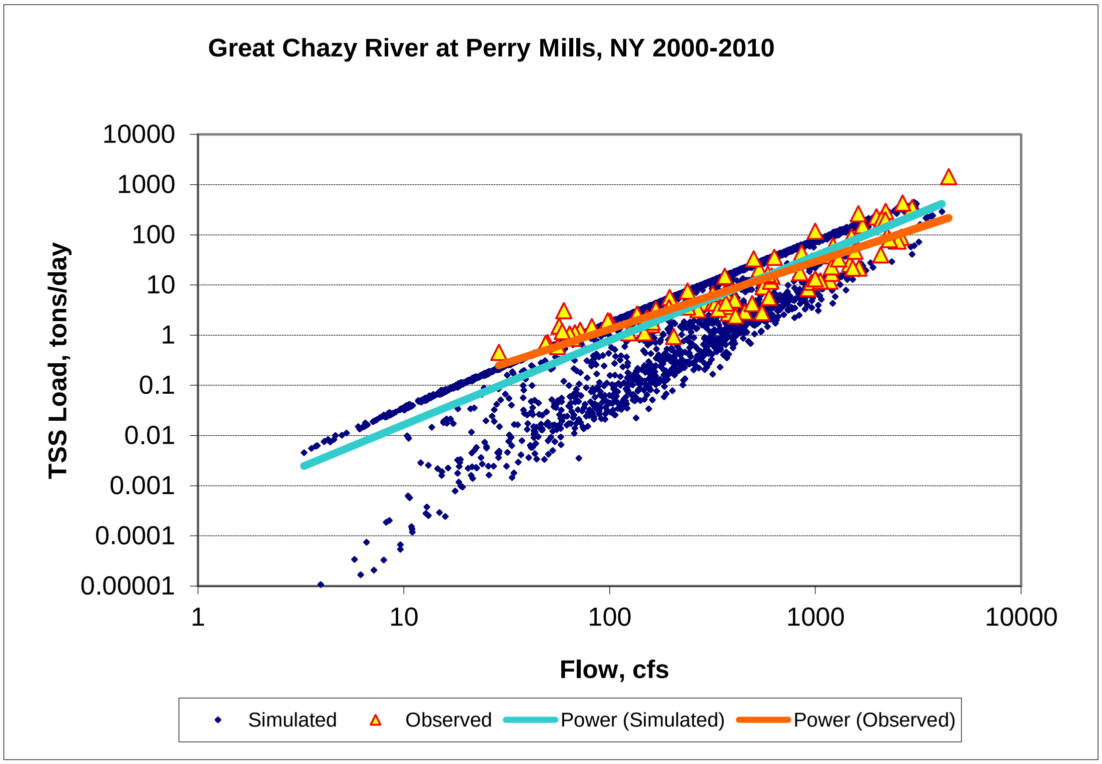

Figure K-227. Power plot of simulated and observed TSS load vs flow at Great Chazy River at Perry Mills, NY (calibration period)

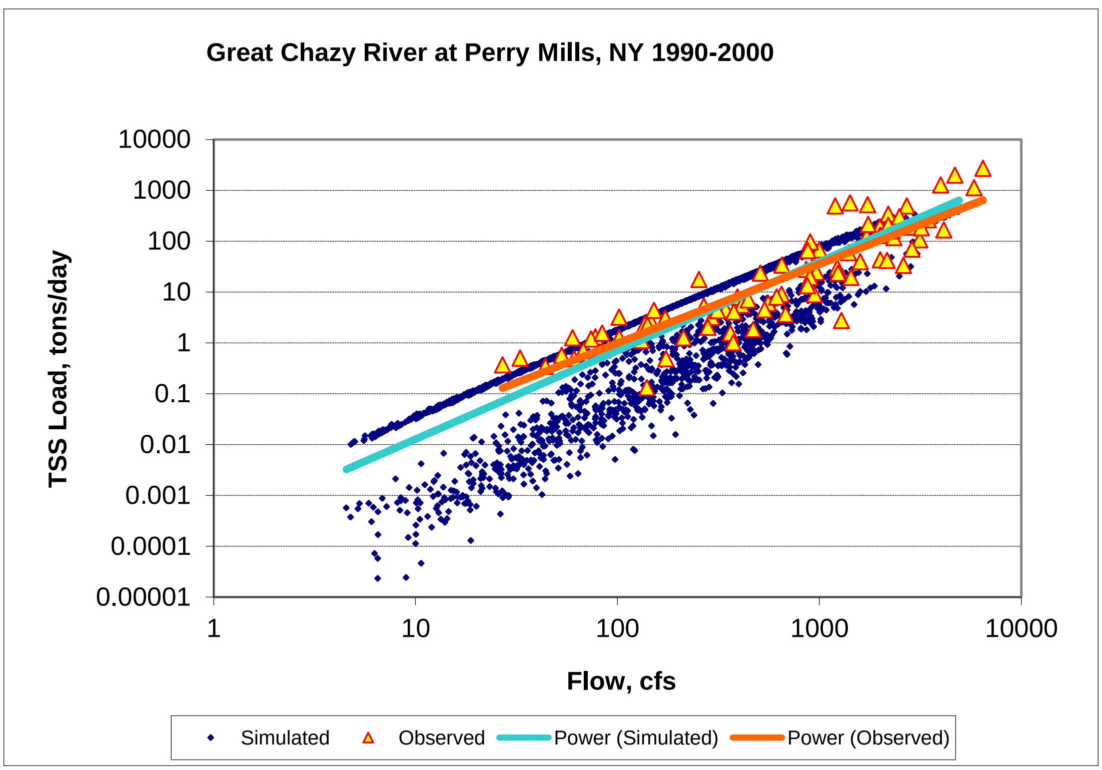

Figure K-228. Power plot of simulated and observed TSS load vs flow at Great Chazy River at Perry Mills, NY (validation period)

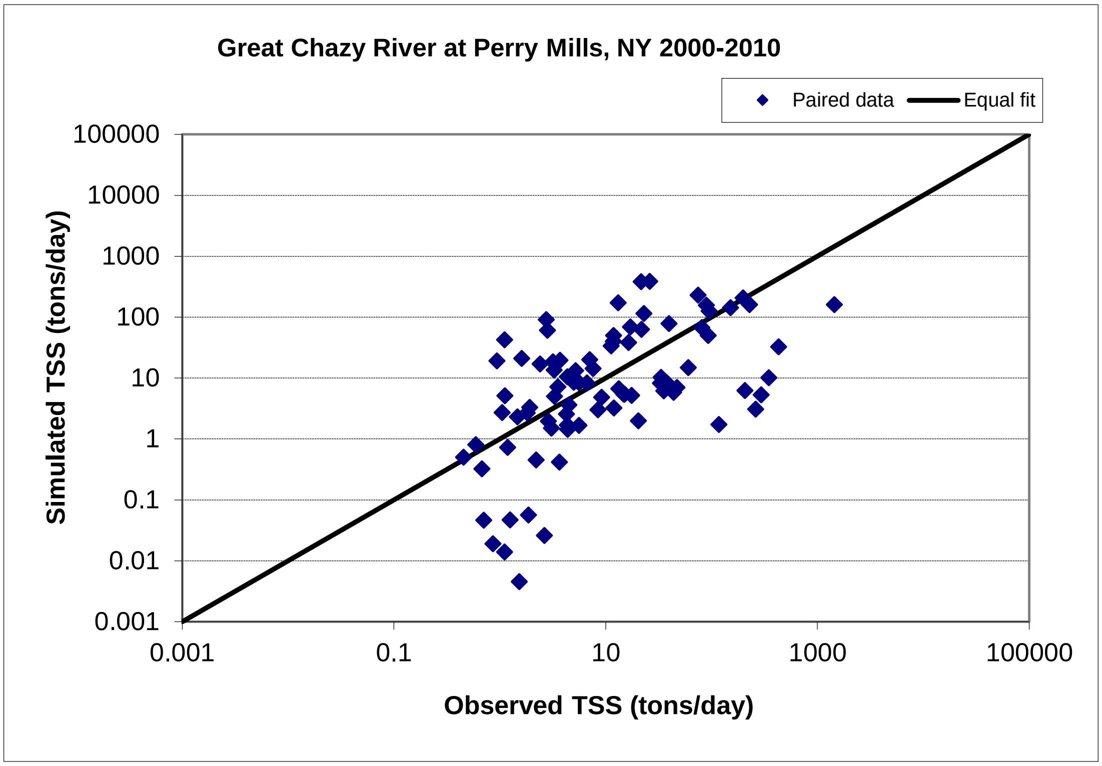

Figure K-229. Paired simulated vs observed TSS load at Great Chazy River at Perry Mills, NY (calibration period)

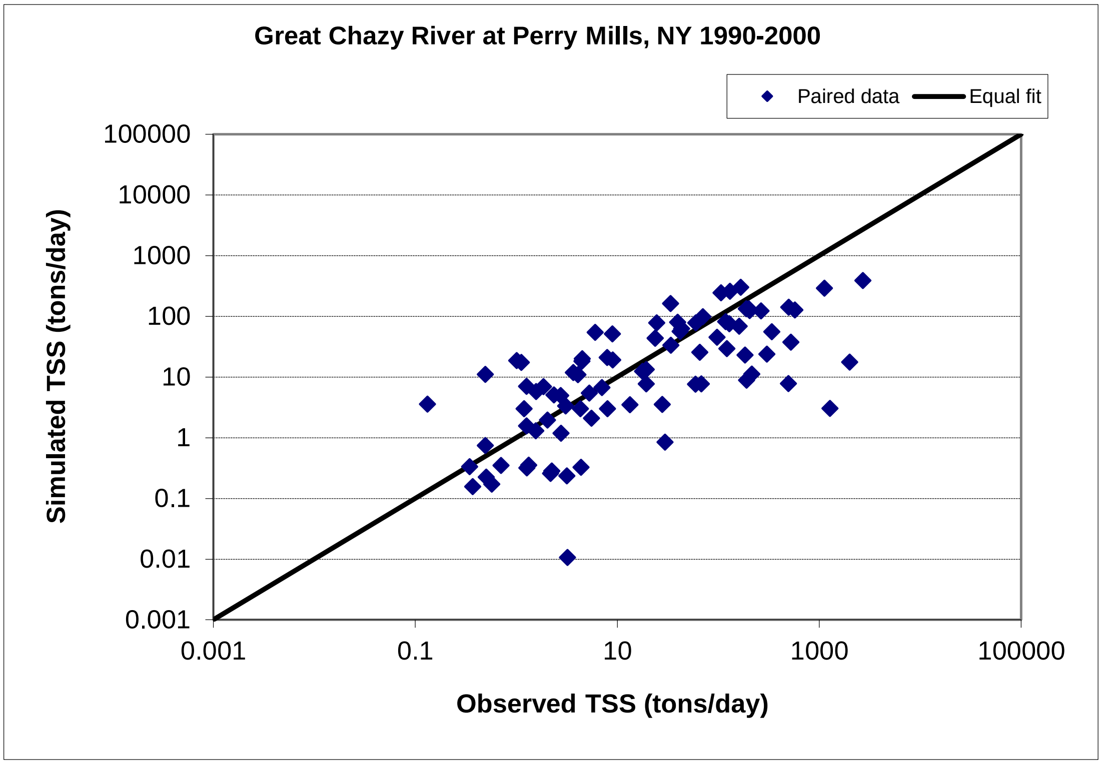

Figure K-230. Paired simulated vs observed TSS load at Great Chazy River at Perry Mills, NY (validation period)

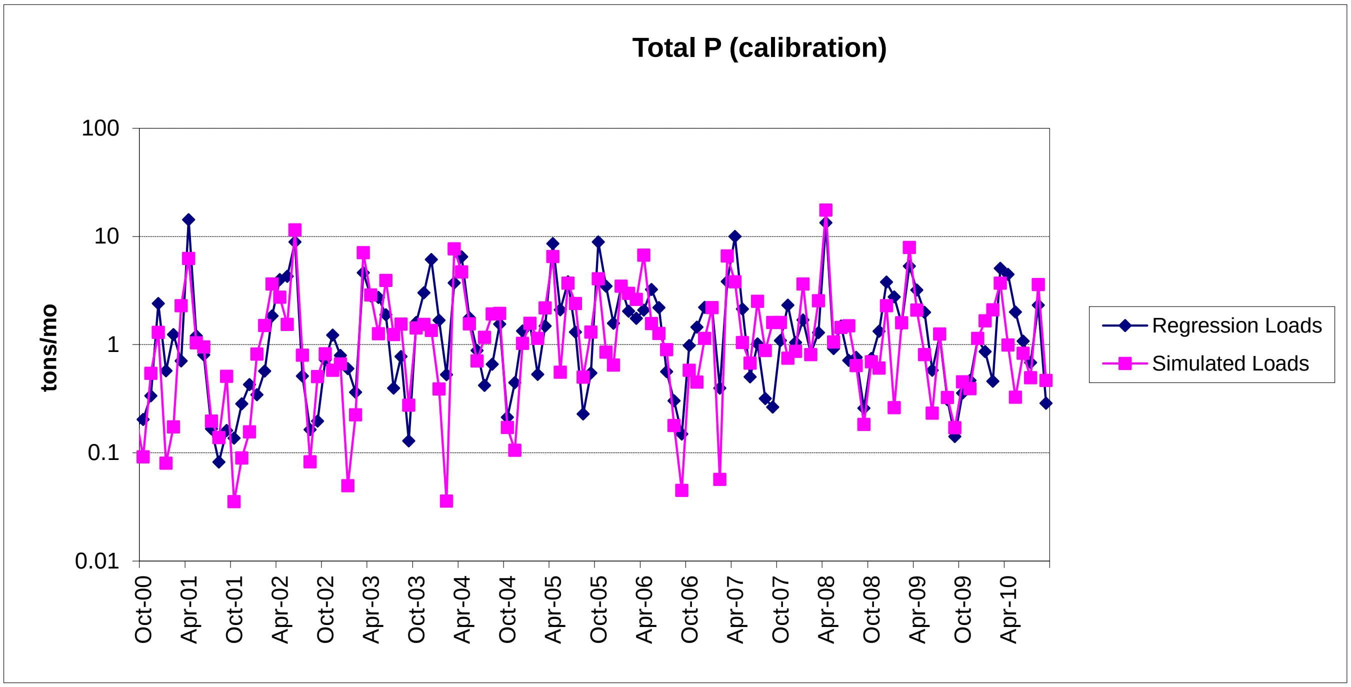

Figure K-231. Monthly simulated and estimated TP load at Great Chazy River at Perry Mills, NY (calibration period)

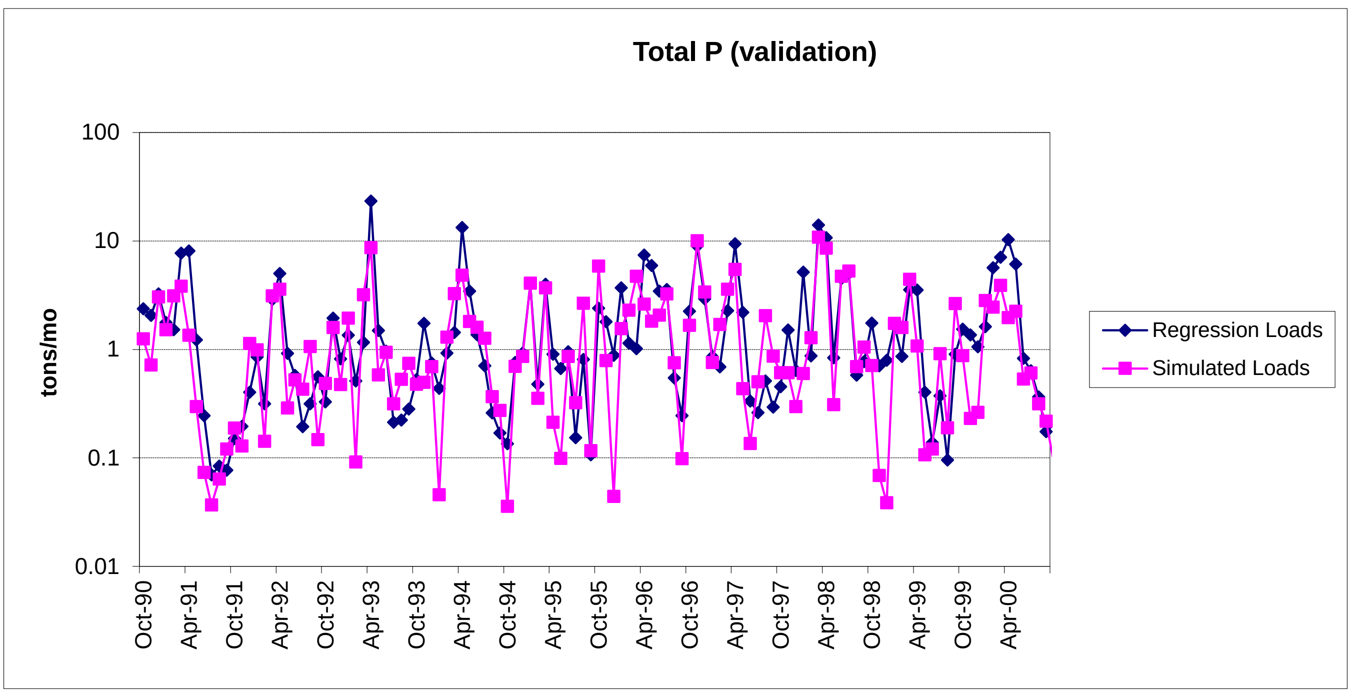

Figure K-232. Monthly simulated and estimated TP load at Great Chazy River at Perry Mills, NY (validation period)

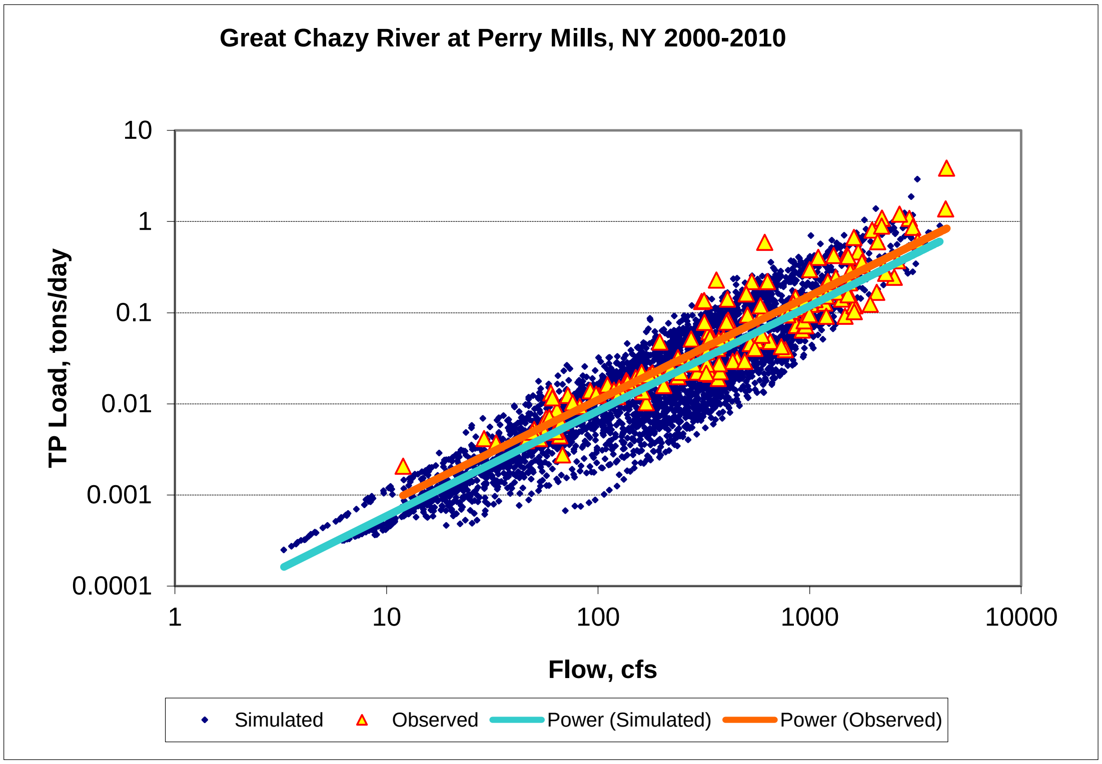

Figure K-233. Power plot of simulated and observed TP load vs flow at Great Chazy River at Perry Mills, NY (calibration period)

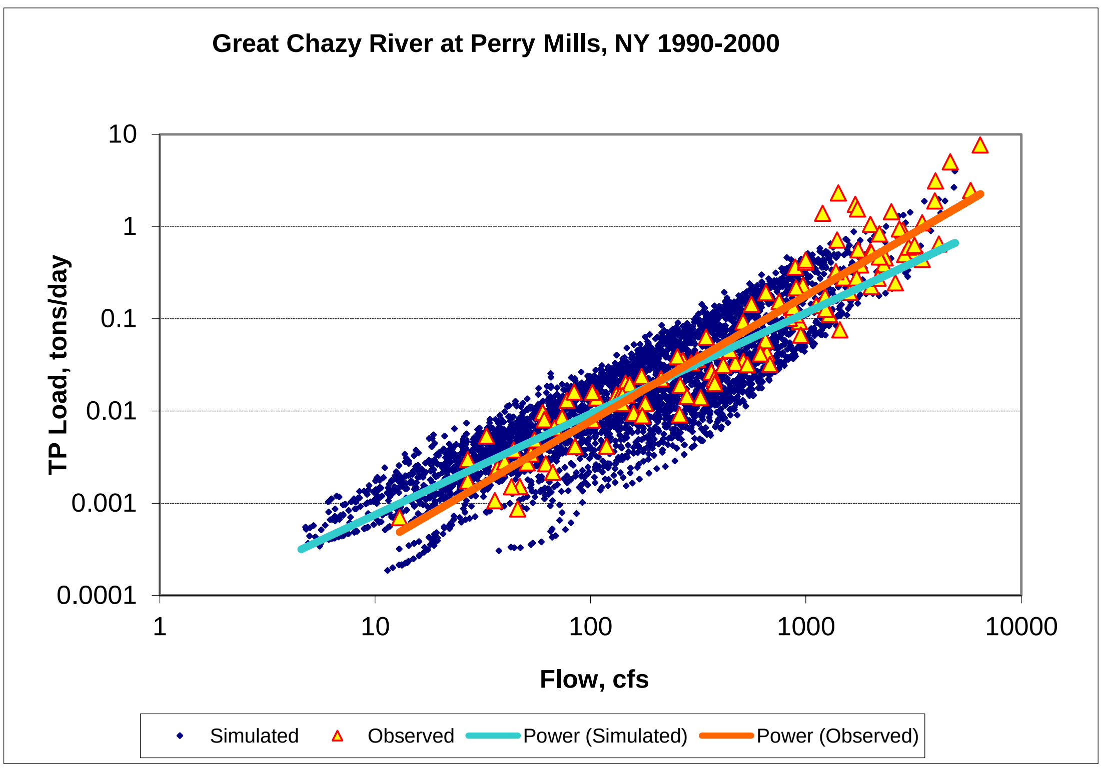

Figure K-234. Power plot of simulated and observed TP load vs flow at Great Chazy River at Perry Mills, NY (validation period)

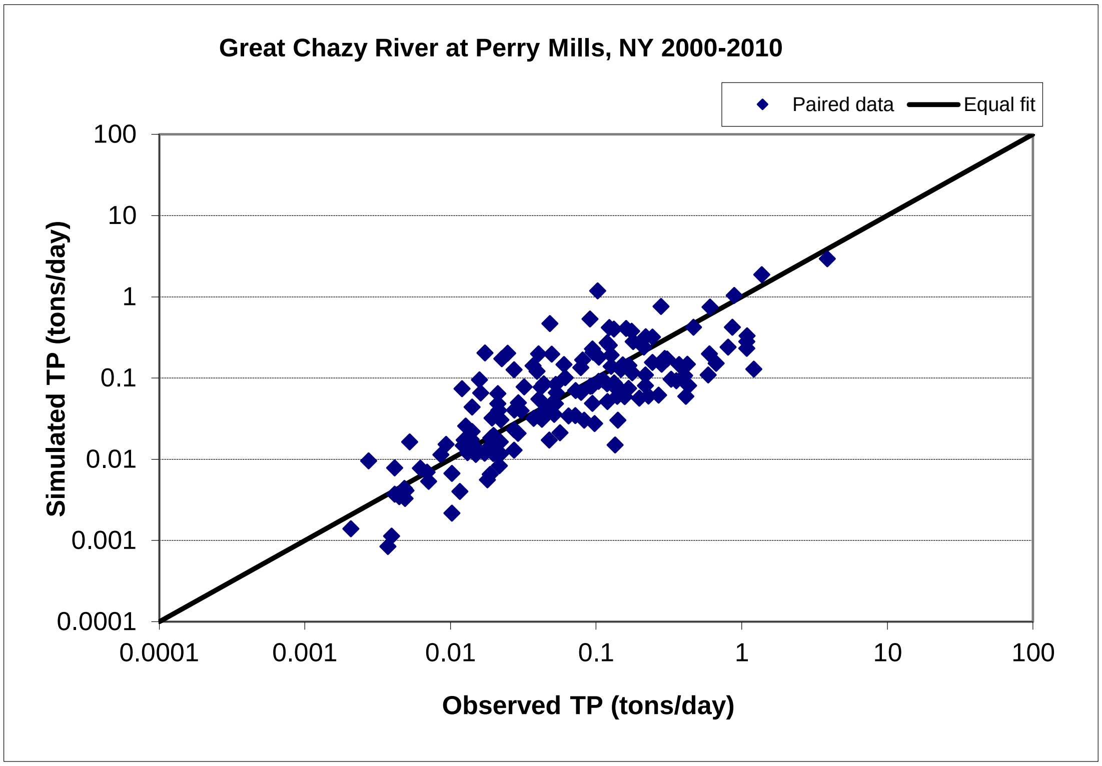

Figure K-235. Paired simulated vs observed TP load at Great Chazy River at Perry Mills, NY (calibration period)

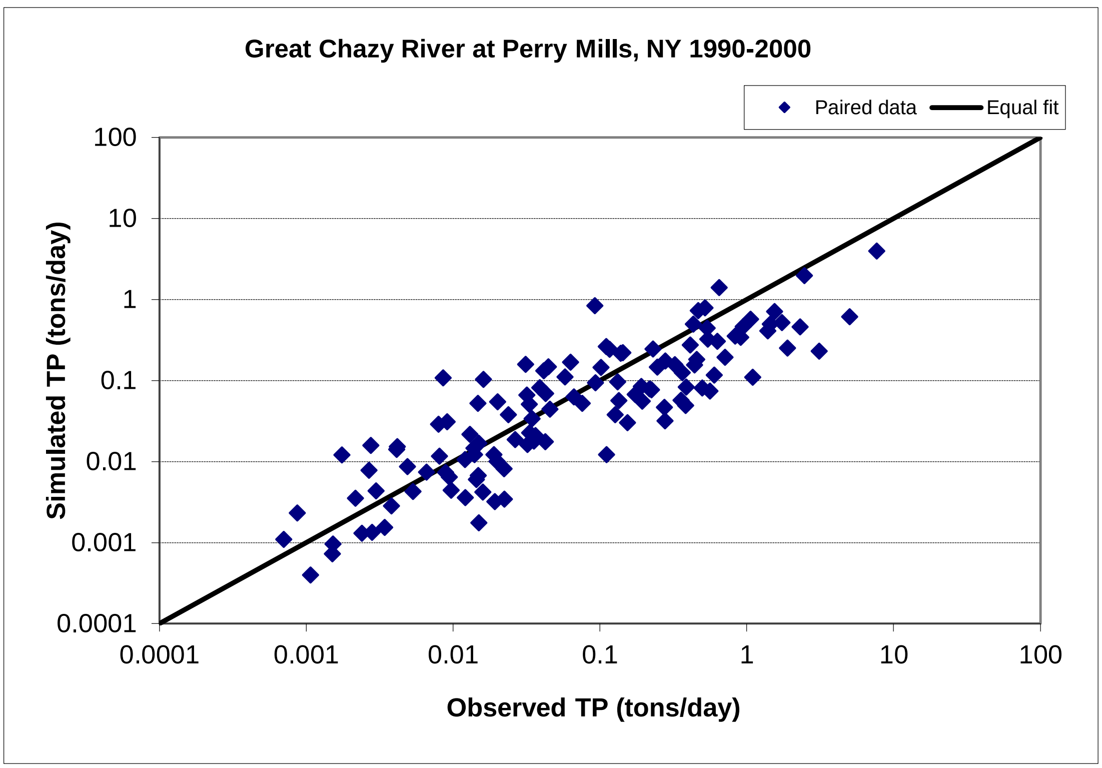

Figure K-236. Paired simulated vs observed TP load at Great Chazy River at Perry Mills, NY (validation period)

Comparison of simulated SWAT TP loads with FLUX estimates (Great Chazy River)

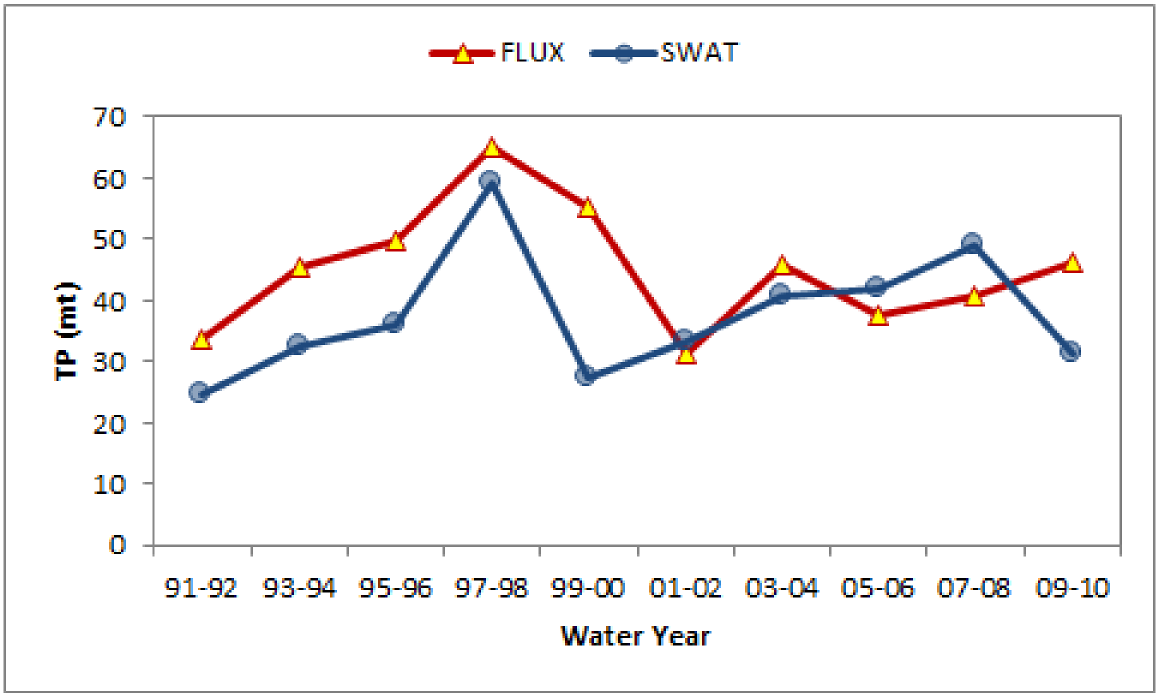

Figure K-237. Bi-annual TP loads on a water year basis as simulated by SWAT and estimated by FLUX (FLUX estimates from Smeltzer et al., 2009)

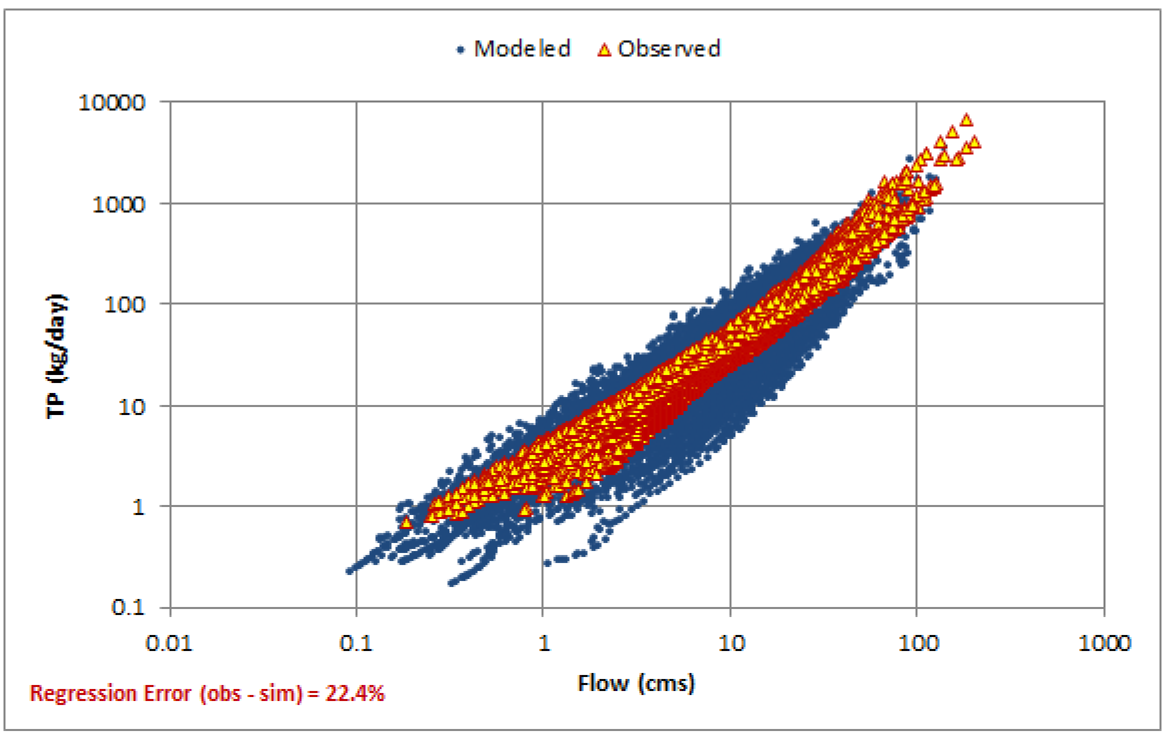

Figure K-238. Daily TP load versus flow as simulated by SWAT and estimated by FLUX (FLUX estimates from Medalie, 2013)

Comparison of simulated SWAT TP loads with FLUX estimates (Little Chazy River)

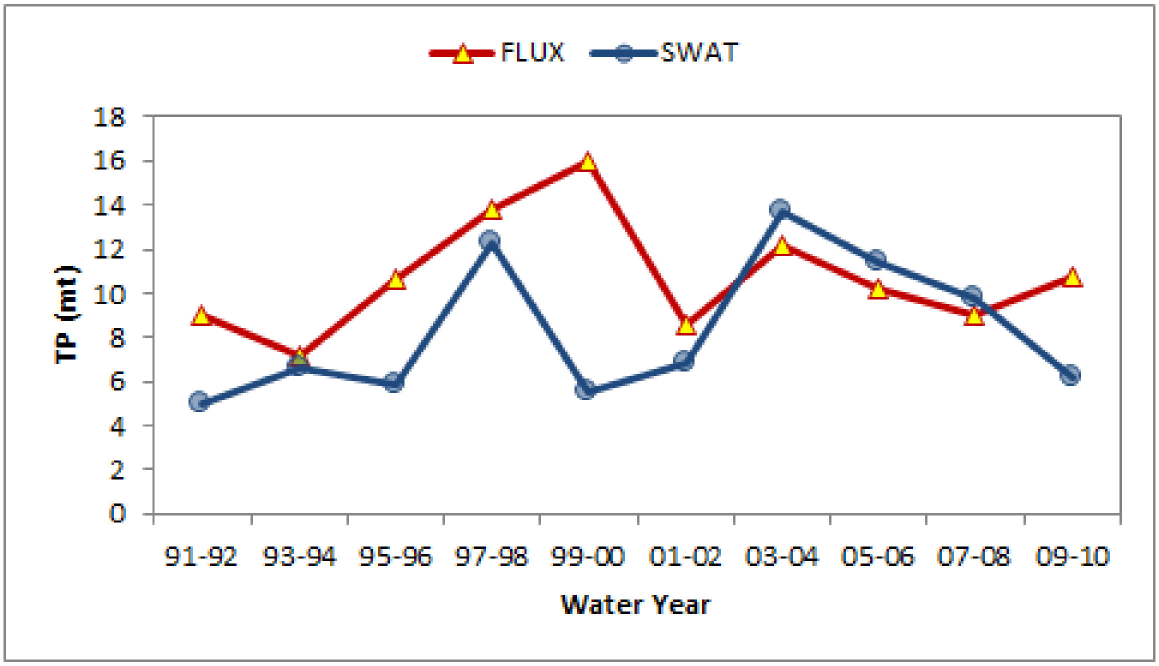

Figure K-239. Bi-annual TP loads on a water year basis as simulated by SWAT and estimated by FLUX (FLUX estimates from Smeltzer et al., 2009)

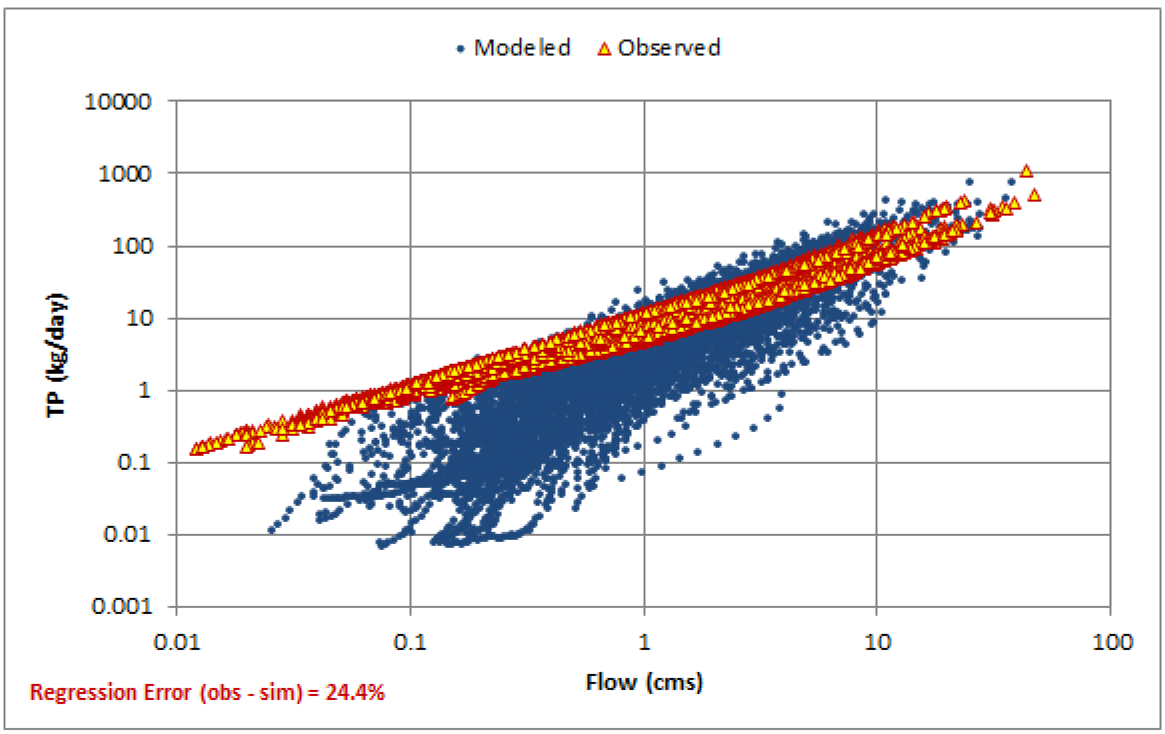

Figure K-240. Daily TP load versus flow as simulated by SWAT and estimated by FLUX (FLUX estimates from Medalie, 2013)