Draft Design Document: Reach Gain Calibration Targets for the Big Wood River and Silver Creek

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Design document description and purpose

The U.S. Geological Survey (USGS), in collaboration with the Idaho Department of Water Resources (IDWR), is constructing a numerical groundwater-flow model of the Wood River Valley aquifer system in order to simulate potential anthropogenic and climatic effects on groundwater and surface-water resources. This model will serve as a tool for water-rights administration and water-resource management and planning. The study will be conducted over a 3-year period from late 2012 until model and report completion in 2015. One of the goals of the modeling study is to develop the model in an open and transparent manner. To this end, a Modeling Technical Advisory Committee (MTAC) was formed to provide for transparency in model development and to serve as a vehicle for stakeholder input. Technical representation was solicited by the IDWR and includes such interested parties as water-user groups and current USGS cooperating organizations in the Wood River Valley.

The design, construction, and calibration of a groundwater-flow model requires a number of decisions such as the number of layers, model cell size, or methodologies used to represent processes such as evapotranspiration or pumpage. While these decisions will be documented in a final USGS report, intermediate decision documents will be prepared in order to facilitate technical discussion and ease preparation of the report. These decision documents should be considered preliminary status reports and not final products.

Problem statement

Reach gain calibration targets are needed to calibrate the interaction between the aquifer and surface water within the model boundary. Interaction between the aquifer and surface streams will be modeled along the Big Wood River, Willow Creek, Silver Creek, and spring-fed tributary streams shown in Figure 1. Groundwater may discharge to gaining river reaches and springs, or be recharged from losing river reaches. For the purposes of the groundwater-flow model, reach gain is defined as an increase in streamflow resulting from aquifer discharge to the river. Reach loss is defined as a decrease in streamflow resulting from seepage of surface water into the aquifer, and is represented by a negative reach gain value. Surface inflow and outflows, including tributary streamflow, irrigation return flow, inflow from exchange wells, wastewater treatment plant discharge, and surface water diversions need to be accounted for in the calculation of reach gain calibration targets.

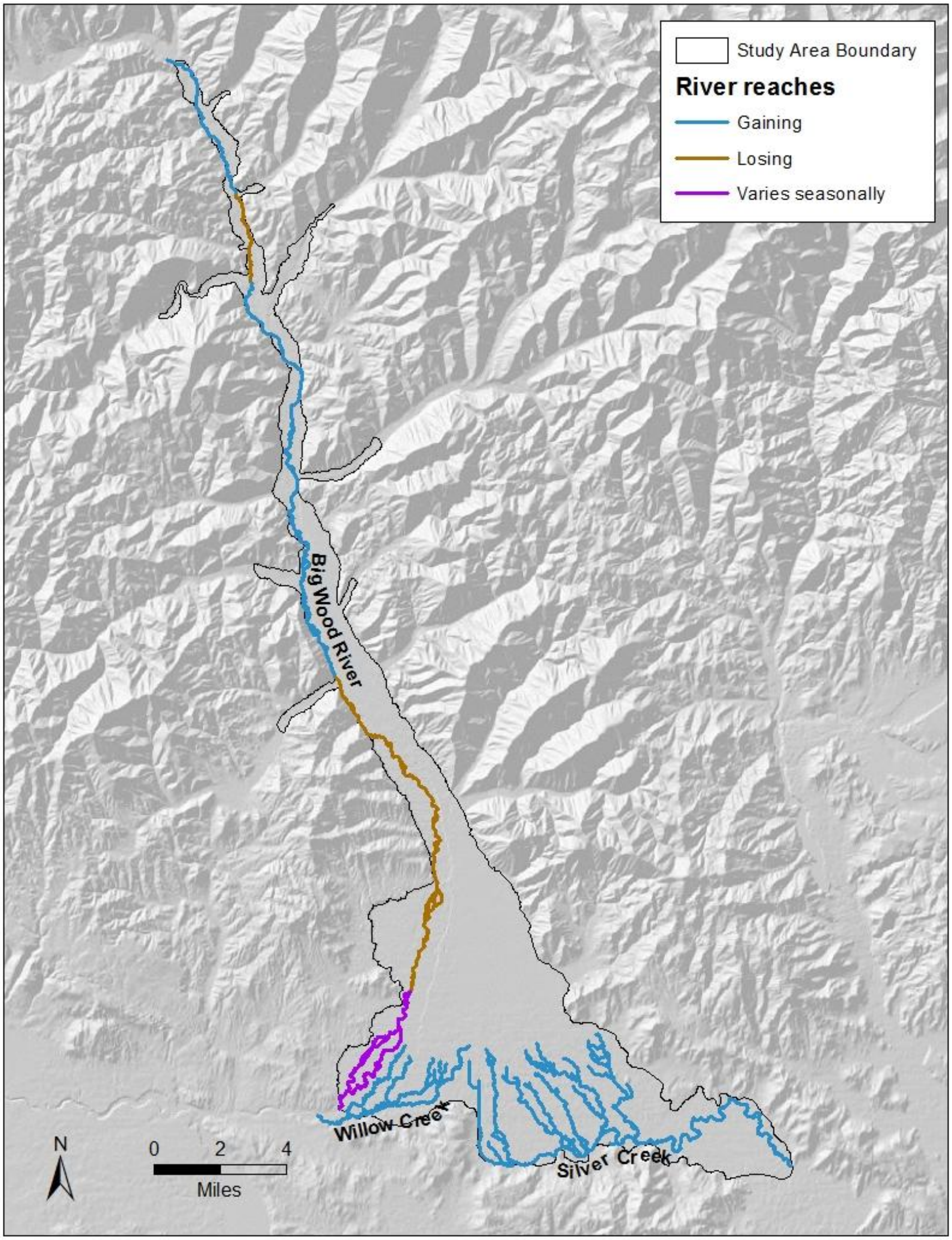

Figure 1. Location of Big Wood River, Willow Creek, Silver Creek, and spring-fed tributaries.

Data availability

The following data sources are available for use in calculating reach gain calibration targets for the groundwater-flow model.

Continuous recording streamflow gages

Streamflow measurements are available from nine continuous recording gage stations operated by the USGS or Idaho Power Company. Locations of streamflow gages are shown in Figure 2. The Big Wood River near Ketchum gage and the North Fork Big Wood River gage measure inflow at the northern boundary of the model. The Big Wood River is also measured with continuous recording gages at Hailey and at Stanton Crossing, which is the southwest boundary of the model. There are also gaging stations on three other tributaries to the Big Wood River with significant perennial flow (Warm Springs Creek, Trail Creek, and East Fork). Willow Creek, a spring-fed stream tributary to the Big Wood River downstream of the model boundary is gaged near the southwest boundary of the model. The Silver Creek at Sportsman Access gage measures spring-fed Silver Creek approximately 7 river miles upstream of the southeast model boundary. The period of record for each gage is shown in Table 1.

Station Number	Station Name	Period of Record
13135500	Big Wood River near Ketchum	May 1948 to September 1971; April 2011 to present
13135520	North Fork Big Wood River near Sawtooth NRA HQ	April 2011 to present
13137000	Warm Springs Creek near Ketchum	January 2011 to present
13137500	Trail Creek at Ketchum	November 2010 to present
13138000	East Fork Big Wood River at Gimlet	October 2010 to present
13139510	Big Wood River at Hailey, total flow	July 1915 to present
13140800	Big Wood River at Stanton Crossing	September 1996 to present
13140900	Willow Creek near Spring Creek Ranch	June 2000 to present
13150430	Silver Creek at Sportsman Access	October 1974 to September 2006; October 2007 to present

Table 1. Period of record for continuous recording gaging stations.

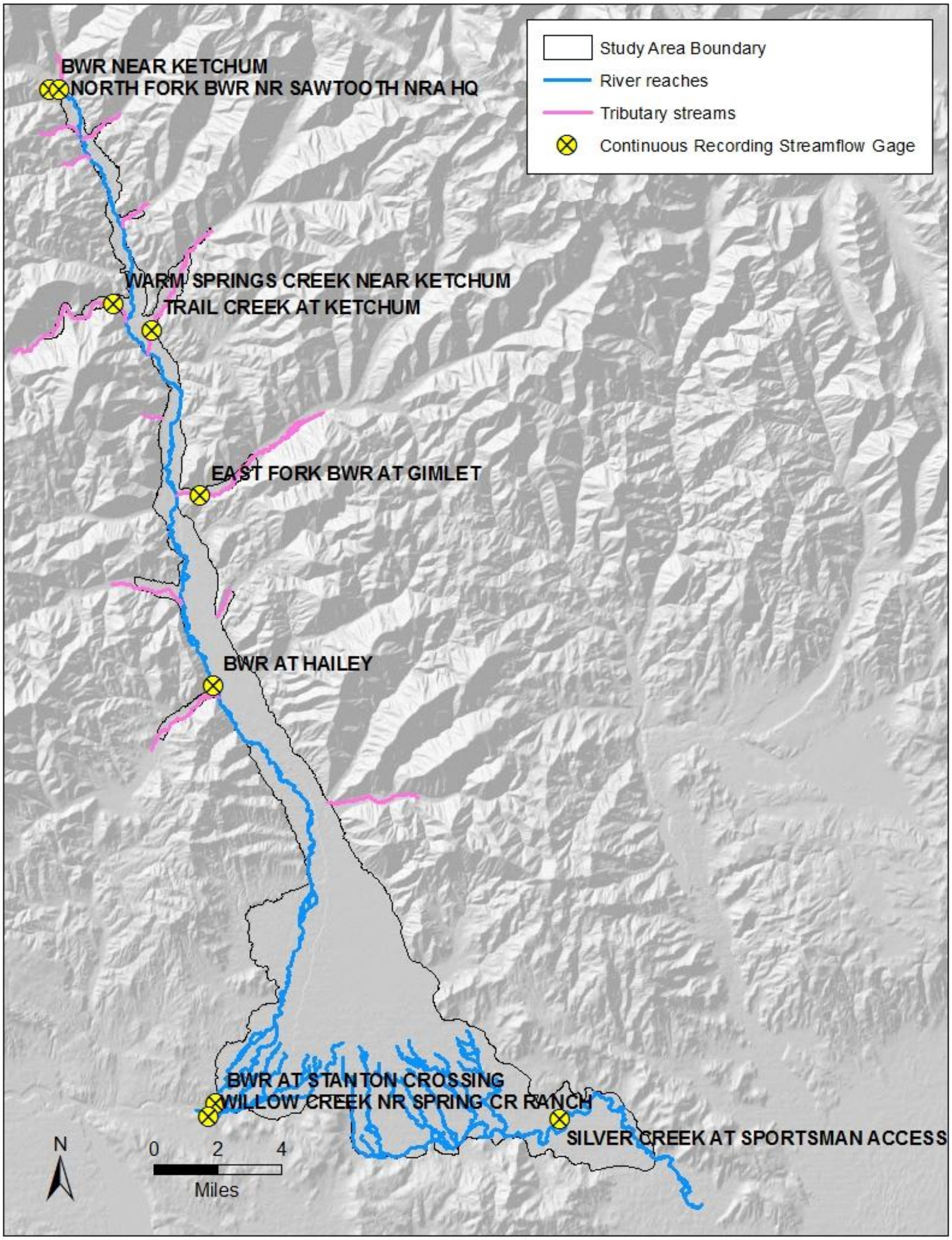

Figure 2. Continuous recording streamflow gaging stations currently in operation.

Diversions

Surface water diversions from the Big Wood River, Silver Creek, and spring-fed tributary streams have been recorded by Water District 37 and Water District 37M since 1920. IDWR compiled monthly diversion data for the model calibration period (1995 – 2010). Data are available for April through September. Although the irrigation season extends through October 31, the Water Districts do not record diversions that occur between September 30 and April 1.

Return flows

Effluent from three municipal wastewater treatment plants is discharged into the Big Wood River. The City of Ketchum /Sun Valley Water and Sewer District wastewater plant and The Meadows wastewater plant discharge into the river between the near Ketchum gage and the Hailey gage. The City of Hailey wastewater treatment plant discharges into the river between the Hailey gage and the Stanton Crossing gage. Records of wastewater treatment plant discharge are available for various years (1995-2012 for Ketchum and Sun Valley, 1996-2012 for Hailey, and 2000-2012 for The Meadows). Effluent discharge during periods of missing data (1995 for Hailey and 1995-1999 for The Meadows) was assumed to be similar to the first year for which data were available.

There are few measured surface returns from canals in the model area. Water District 37 has recorded surface discharge from the District canal system to the Loving Creek area. In recent years, Water District 37 began recording returns to the Big Wood River from canals that primarily deliver water for aesthetic, non-consumptive uses, such as the Gimlet and Rinker systems. Based on personal communication with Watermaster Kevin Lakey (August 27, 2013), unmeasured surface returns from irrigation canals are believed to be negligible in the model area.

Exchange wells

Water diverted from exchange wells is discharged into a stream in exchange for the right to redivert water from the stream at another location. Water District 37M records of exchange well diversions are available for nine exchange wells. Eight of these wells discharge into Silver Creek or its tributaries above the gaging station at Sportsman Access. The other well discharges into Silver Creek downstream of Sportsman Access.

Seepage surveys

The USGS performed three seepage surveys of the Big Wood River, Silver Creek, and selected tributaries. Each survey consisted of a single measurement of streamflow and diversions at 28 sites on the Big Wood River and tributaries, and ten sites along Silver Creek and tributaries, made within a two or three day period. Seepage surveys were performed in August 2012, October 2012, and March 2013. Records of diversions and exchange wells not measured by the USGS are available from Water Districts 37 and 37M for the August 2012 survey. The seepage survey data can be used to calculate reach gains and losses for shorter subreaches of the river between continuous gaging stations. The surveys were performed after the model calibration period and do not provide continuous data, but do provide valuable insight into reach gains and losses within the larger reaches defined by the continuous gaging stations. The results of the USGS seepage survey will be published by the USGS in a Scientific Investigations Report.

Moreland (1977) performed three seepage surveys of Silver Creek and tributaries in May 1975, June 1975, and September 1975. The surveys were performed before the model calibration period and do not provide continuous data, but do provide additional insight into reach gains and losses in Silver Creek and spring-fed tributary streams.

Calculation of transient calibration targets for gaged reaches

Transient calibration targets were calculated for four gaged reaches (Figure 3). The near Ketchum to Hailey reach and the Hailey to Stanton Crossing reach of the Big Wood River are each approximately 30 river miles in length. The Willow Creek reach includes Willow Creek and several spring-fed tributary streams with a total stream length of approximately 19 miles. The Silver Creek above Sportsman Access reach includes a portion of Silver Creek and several spring-fed tributary streams with a total stream length of approximately 56 miles. There are not sufficient data to calculate a transient calibration target for the approximately 7-mile reach of Silver Creek below Sportsman Access.

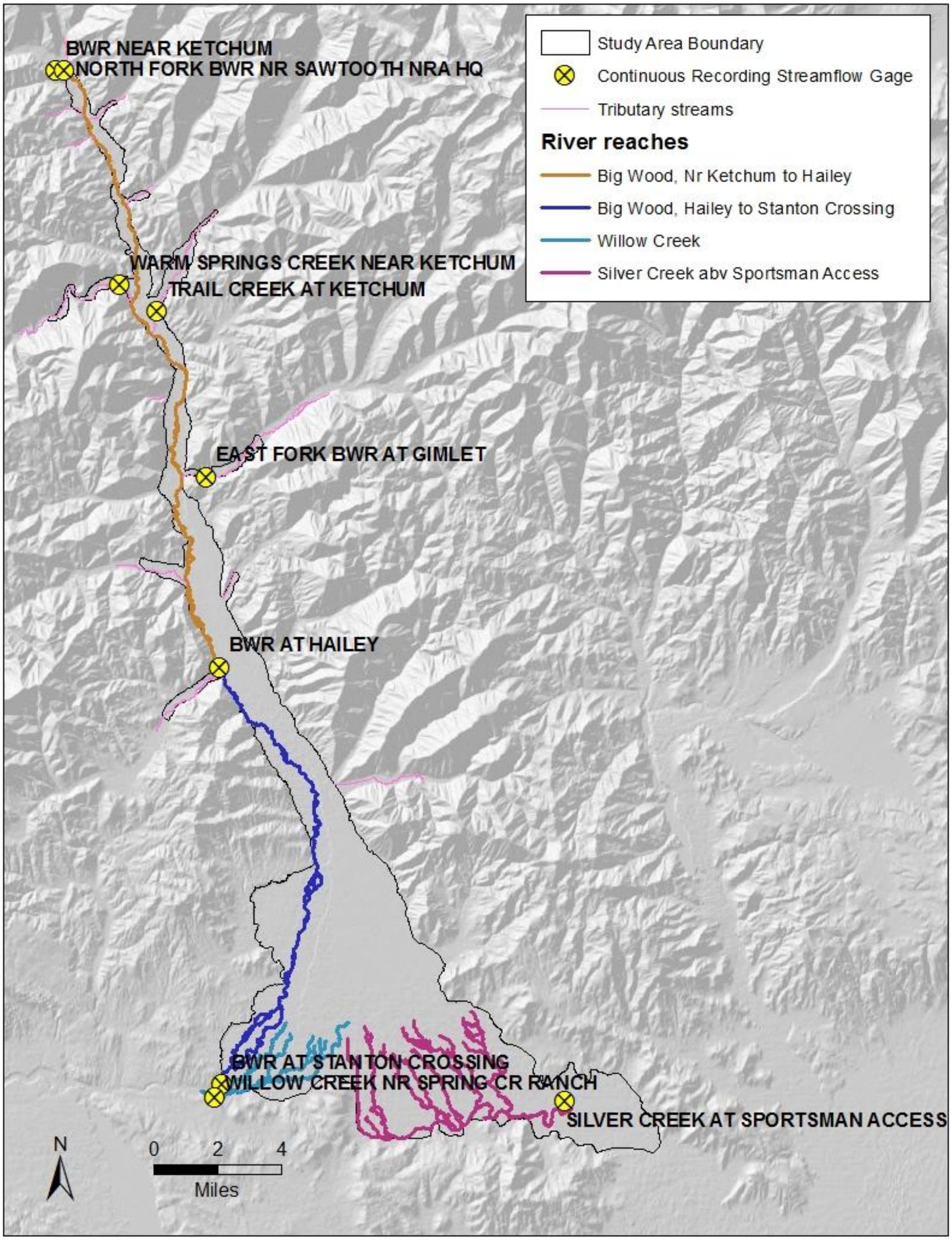

Figure 3. River reaches with transient calibration targets.

Reach gain calculations

Reach gains are calculated using Equation 1.

[ReachGain] = [Out] – [In] – [Trib] + [Div] – [Ret] – [Exch] – [WTTP]   Equation 1.

Where [Out] = streamflow at downstream end of reach

[In] = streamflow at upstream end of reach

[Trib] = inflow from tributary streams

[Div] = diversions

[Ret] = return flow from irrigation canals or ponds

[Exch] = inflow from exchange wells

[WWTP] = inflow from wastewater treatment plant

Correlation between gages

Gaging stations at the Big Wood River near Ketchum, the North Fork Big Wood River, Warm Springs Creek, Trail Creek, and East Fork were not in operation during the model calibration period (1995-2010). These gaging stations are all located within the near Ketchum to Hailey reach. Daily streamflow data collected at these stations between October 2010 and July 2013 were correlated with daily streamflow measured in the Big Wood River at Hailey (Figure 4 through Figure 8). These correlations were used to predict historic streamflow during the model calibration period.

The Big Wood River near Ketchum gaging station was also operated prior to the model calibration period between 1948 and 1971. The MTAC requested the correlation between streamflow in the Big Wood River near Ketchum and at Hailey be evaluated using the older historic data. Figure 9 compares the correlation of the 1948 through 1971 data with the correlation of the 2011 through 2013 data. The correlation is very similar for both time periods.

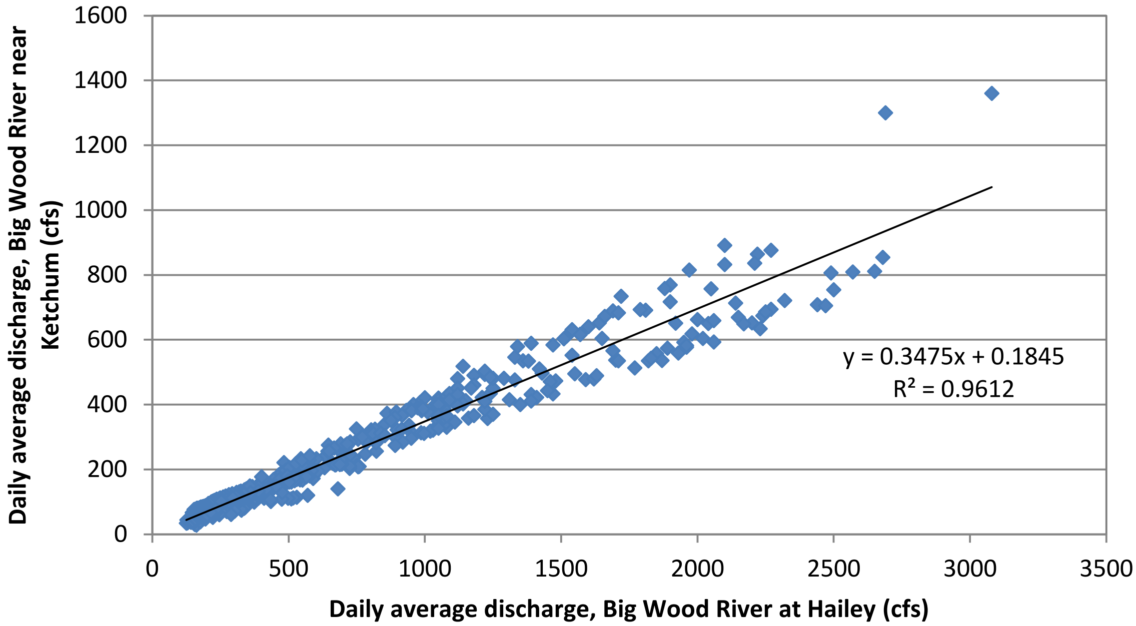

Figure 4. Correlation between streamflow in Big Wood River near Ketchum and Big Wood River at Hailey, 4/21/2011 to 7/17/2013.

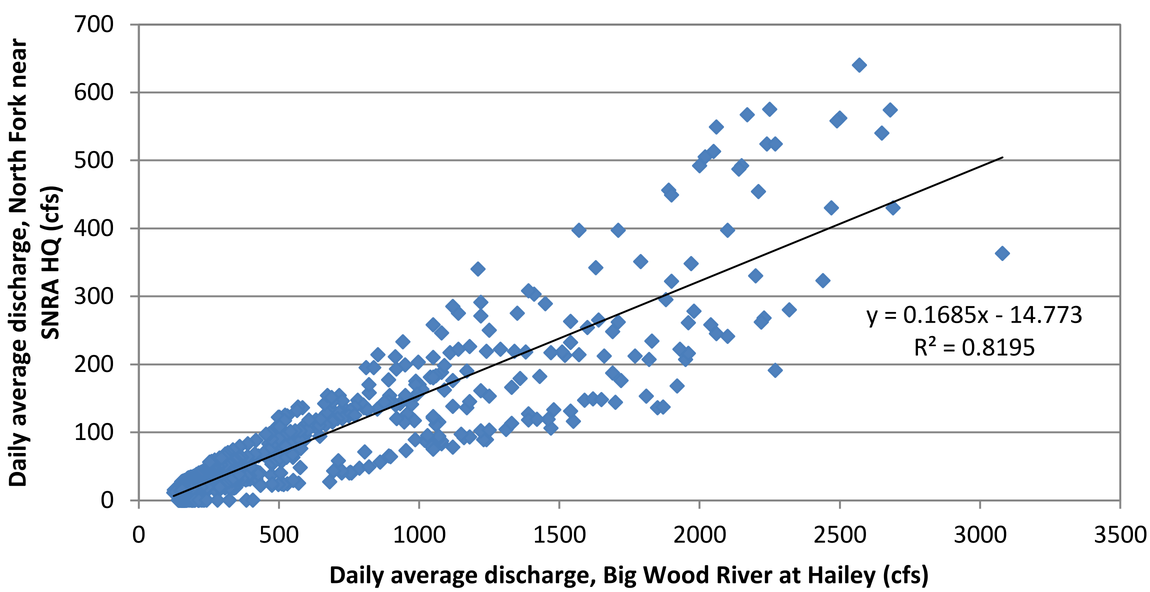

Figure 5. Correlation between streamflow in North Fork Big Wood River near SNRA HQ and Big Wood River at Hailey, 4/8/2011 to 7/17/2013.

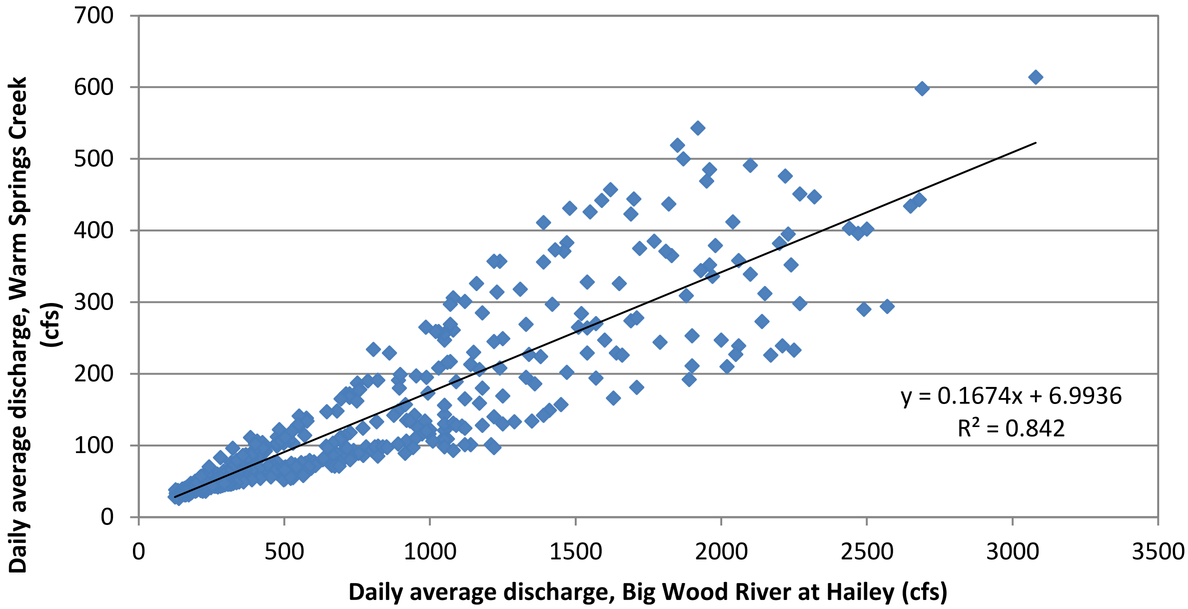

Figure 6. Correlation between streamflow in Warm Springs Creek near Ketchum and Big Wood River at Hailey, 1/27/2011 to 7/17/2013.

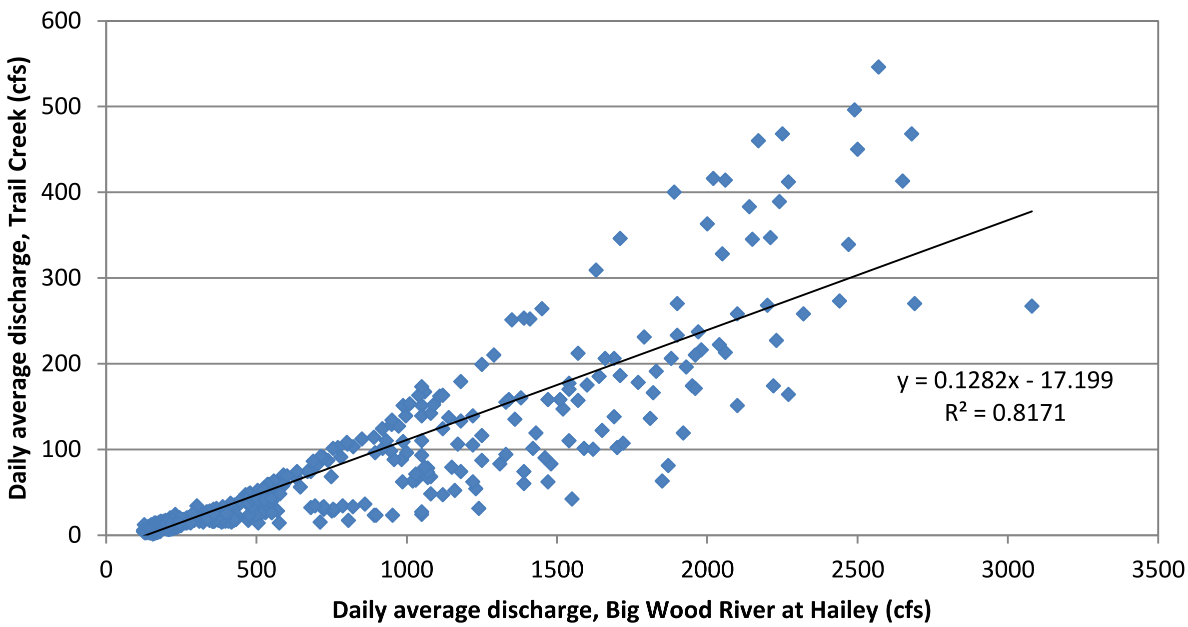

Figure 7. Correlation between streamflow in Trail Creek at Ketchum and Big Wood River at Hailey, 11/17/2010 to 7/17/2013.

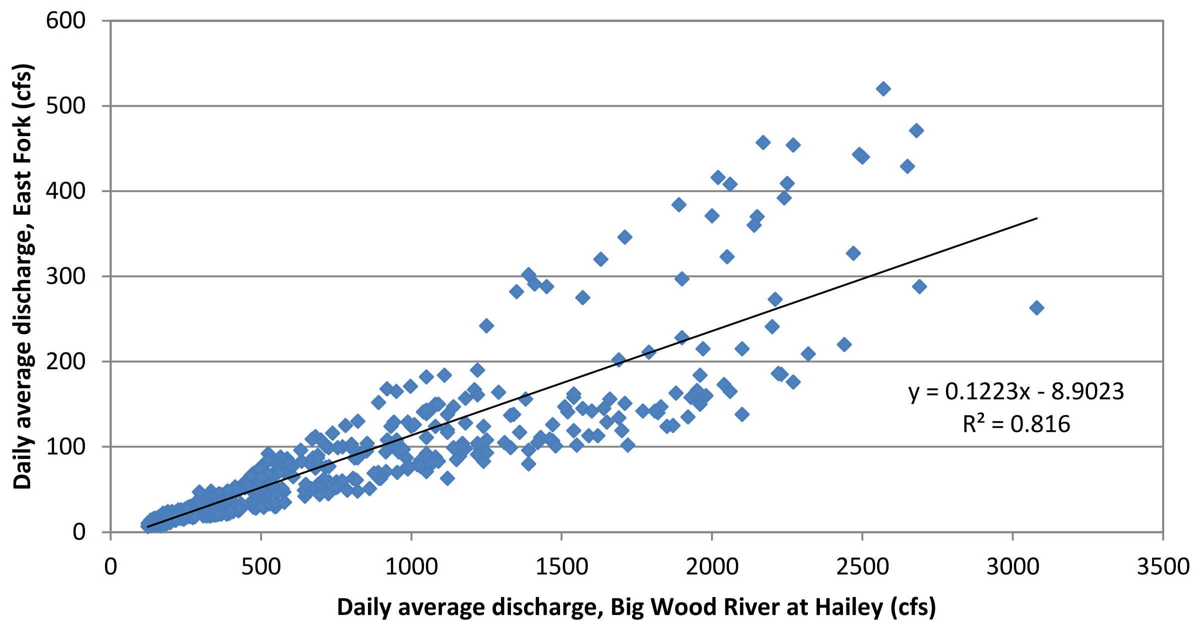

Figure 8. Correlation between streamflow in East Fork Big Wood River at Gimlet and Big Wood River at Hailey, 10/20/2010 to 7/17/2013.

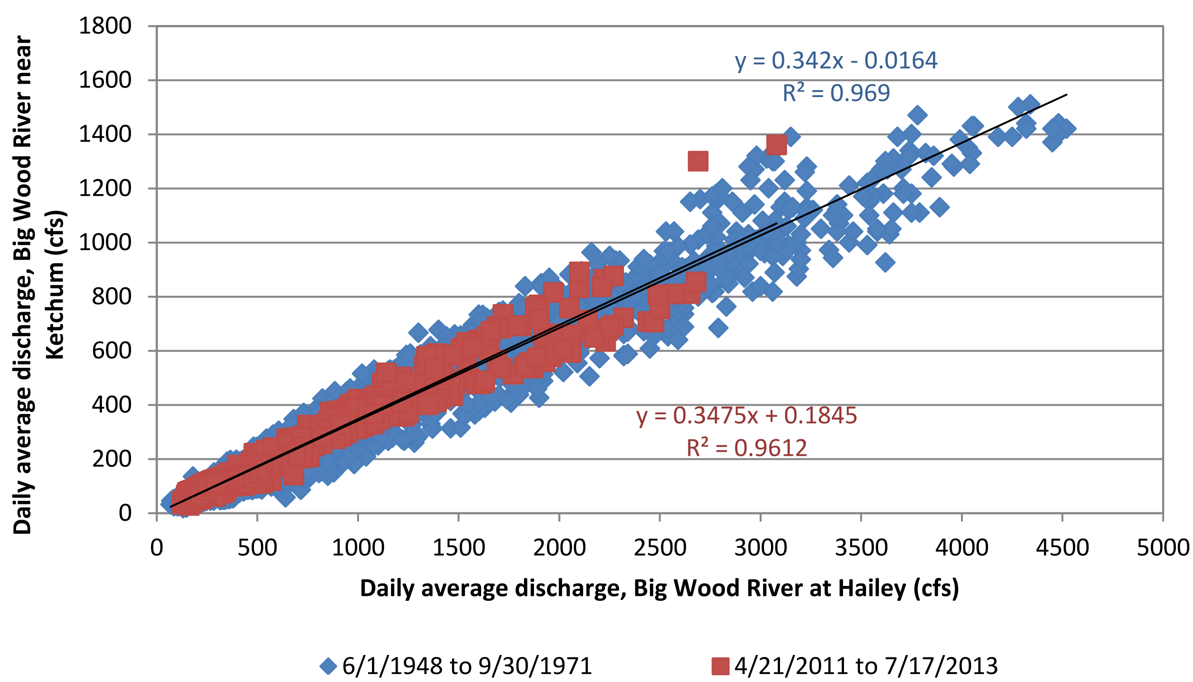

Figure 9. Correlation between streamflow in Big Wood River near Ketchum and Big Wood River at Hailey, 6/1/1948 to 9/30/1971 and 4/21/2011 to 7/17/2013.

Estimating contributions from ungaged tributaries

There are several ungaged tributaries to the Big Wood River. Inflow from these tributaries is negligible from late summer to early spring, but can be significant during snowmelt runoff in late spring and early summer. USGS StreamSTATS was used to evaluate the potential contribution of these tributaries to Big Wood River streamflow during late spring and early summer. StreamSTATS data indicate that these ungaged tributaries may contribute significant inflow during peak runoff, typically between April and July. While StreamSTATS is useful for determining average monthly contributions, a method to correlate predicted inflow from these streams with the transient climatic variation reflected in the measured streamflow at Hailey and Stanton Crossing is needed to estimate the transient contribution of the ungaged tributaries.

The baseflow separation filter in TSPROC (Watermark Numerical Computing and University of Idaho, 2011) was used to estimate the transient contribution of the ungaged tributaries. The baseflow separation filter extracts the "quick response" flow from a time series of streamflow data. The quick response flow is the portion of the streamflow that results from surface runoff, and is the difference between the total flow and the baseflow, which is the portion of the streamflow that results from groundwater inflow. The TSPROC baseflow separation filter uses the baseflow and recession analysis method described by Nathan and McMahon (1990). TSPROC input settings used in this analysis are provided in Appendix A. Prior to running the baseflow separation filter, diversions upstream of Hailey were added to the Hailey gage data and diversions between Hailey and Stanton Crossing were added to the Stanton Crossing gage data. Correlated data were included in the input data for the near Ketchum, North Fork, Warm Springs Creek, Trail Creek, and East Fork gages. Results of the baseflow separation filter are shown in Figure 10 through Figure 16.

The transient contribution of ungaged tributaries in the near Ketchum to Hailey reach was predicted by subtracting the TSPROC quick response flow at the Big Wood River near Ketchum, the North Fork Big Wood River, Warm Springs Creek, Trail Creek, and East Fork from the TSPROC quick response flow at Hailey (Figure 17). The transient contribution of ungaged tributaries in the Hailey to Stanton Crossing reach was predicted by subtracting the TSPROC quick response flow at Hailey from the TSPROC quick response flow at Stanton Crossing (Figure 18).

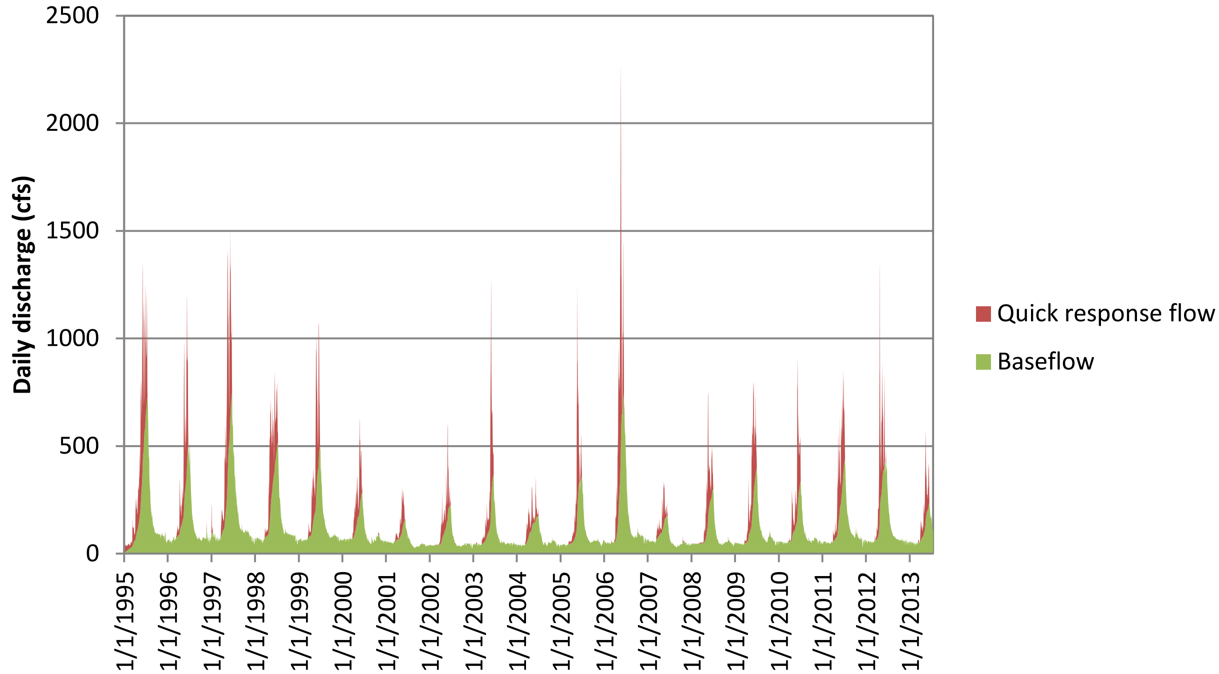

Figure 10. TSPROC baseflow separation filter results for near Ketchum gage.

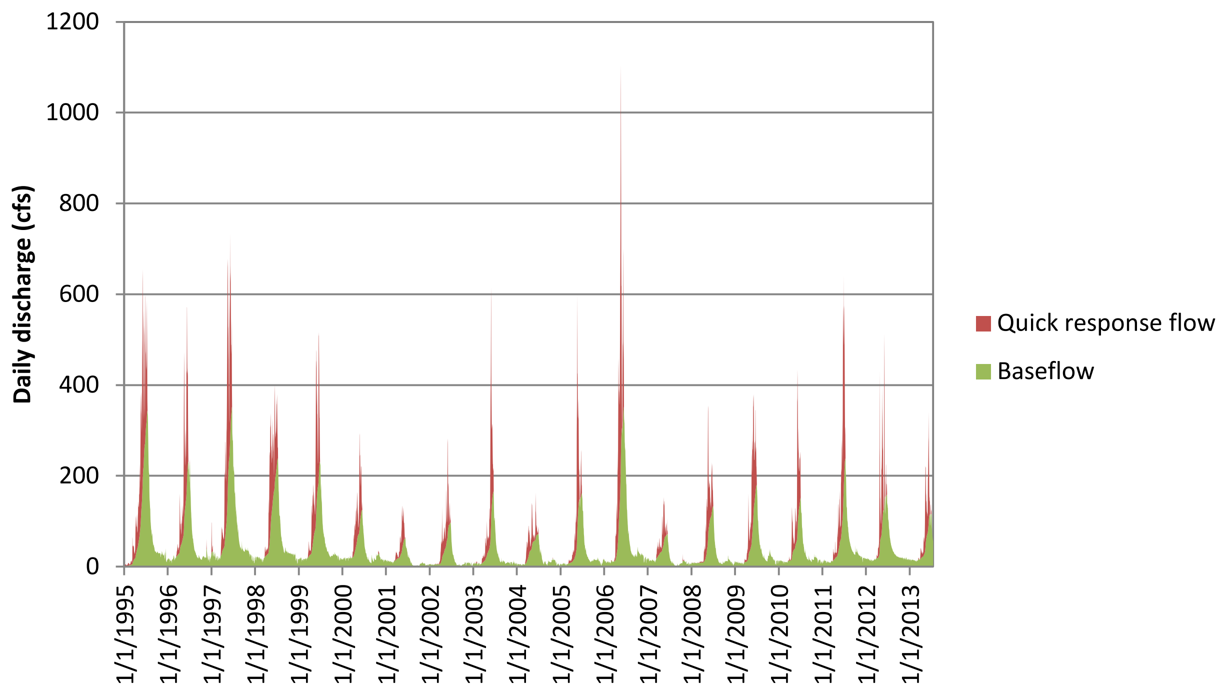

Figure 11. TSPROC baseflow separation filter results for North Fork Big Wood River.

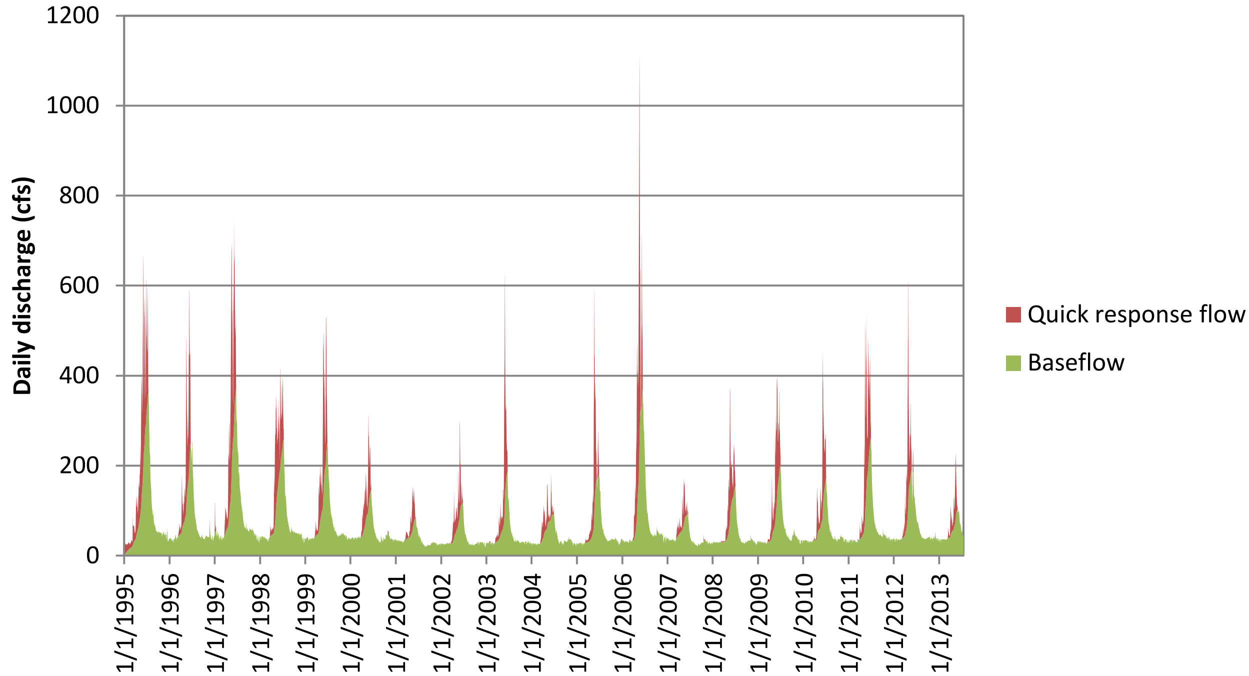

Figure 12. TSPROC baseflow separation filter results for Warm Springs Creek.

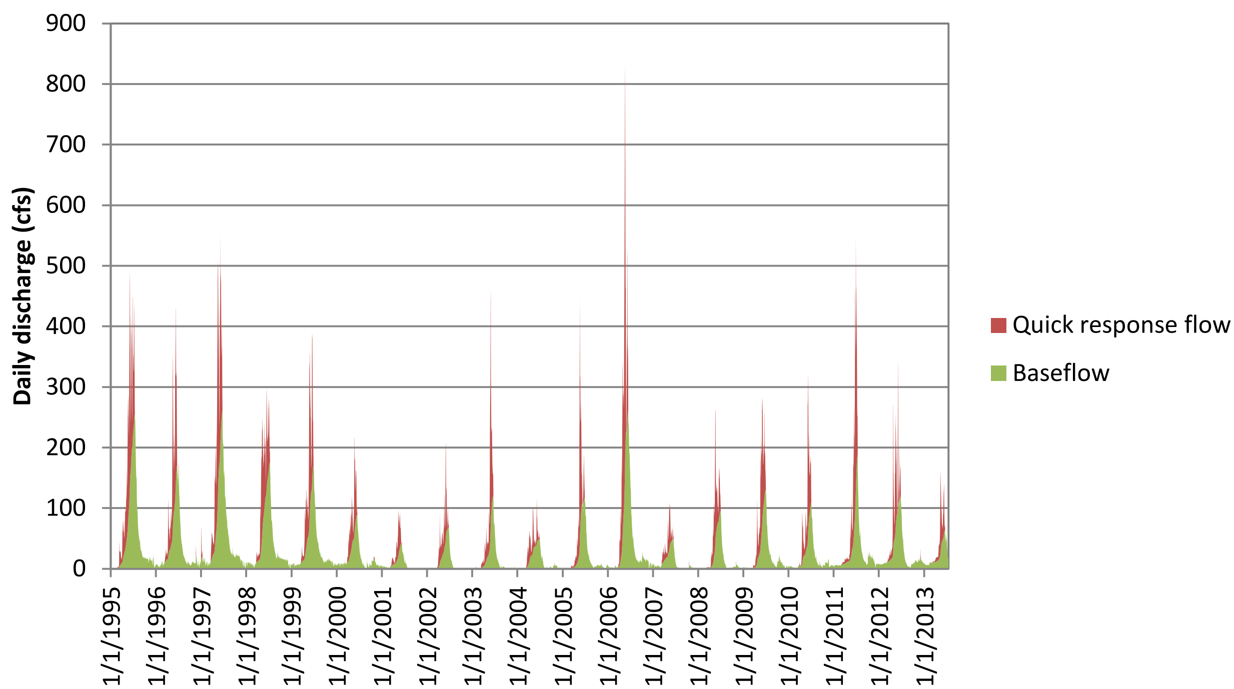

Figure 13. TSPROC baseflow separation filter results for Trail Creek.

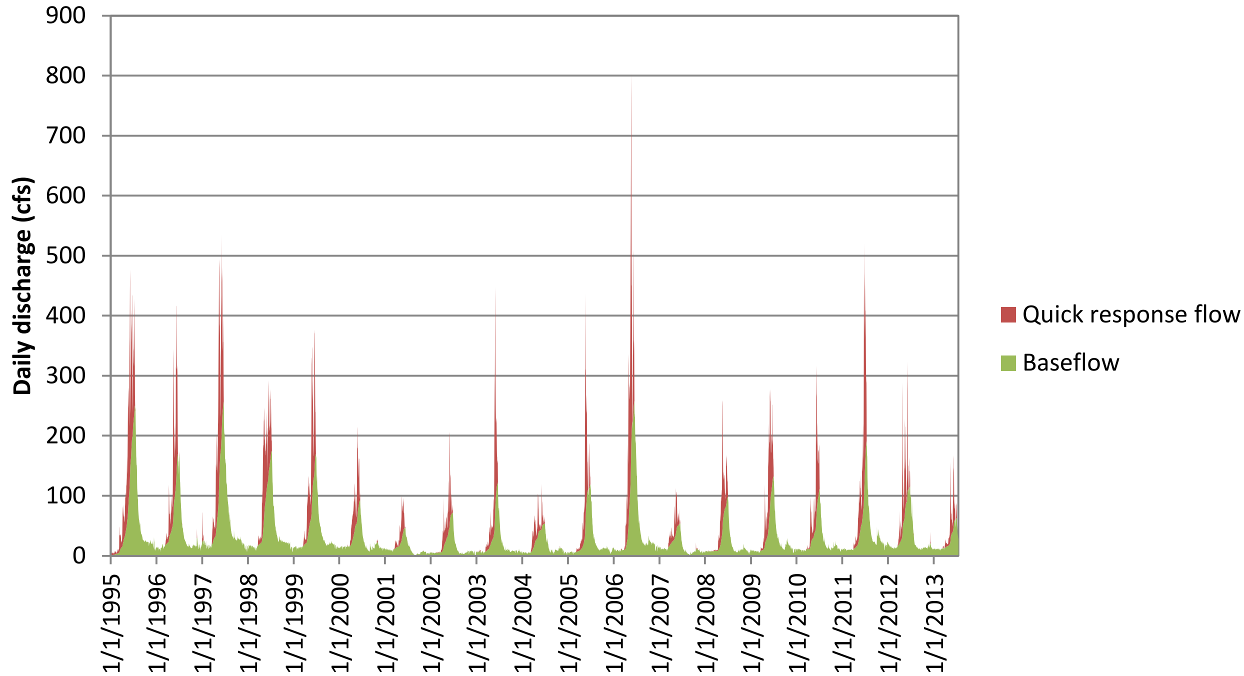

Figure 14. TSPROC baseflow separation filter results for East Fork Big Wood River.

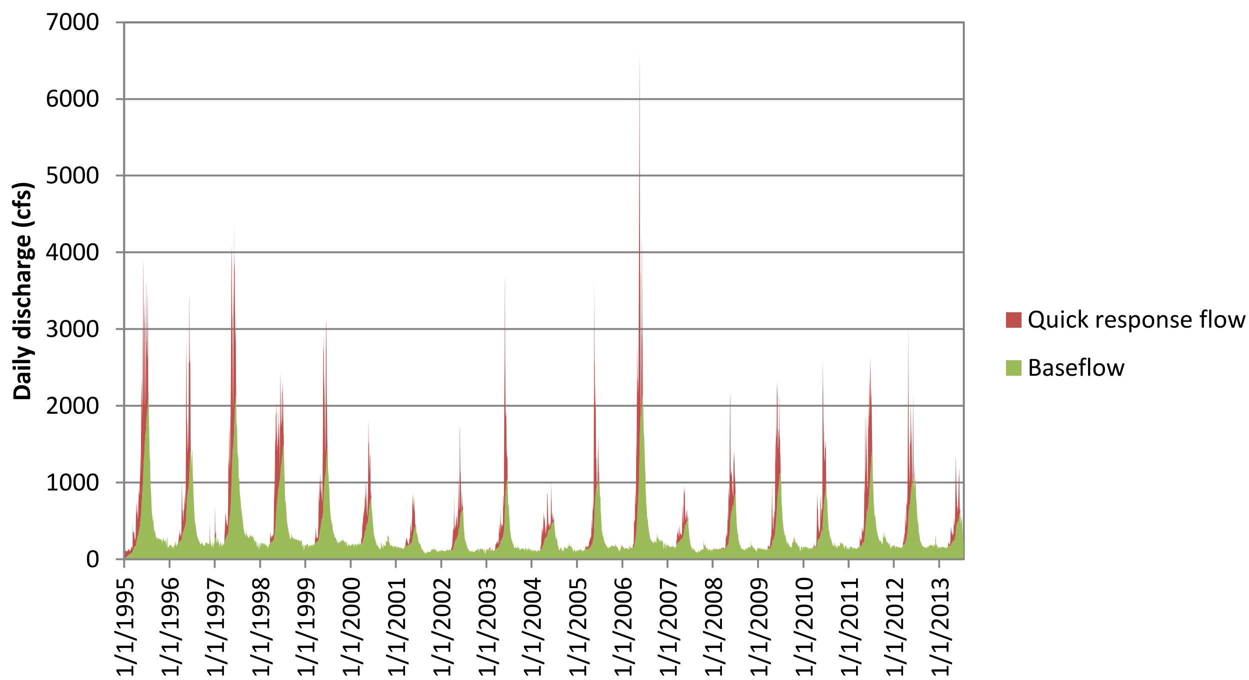

Figure 15. TSPROC baseflow separation filter results for Hailey gage plus diversions.

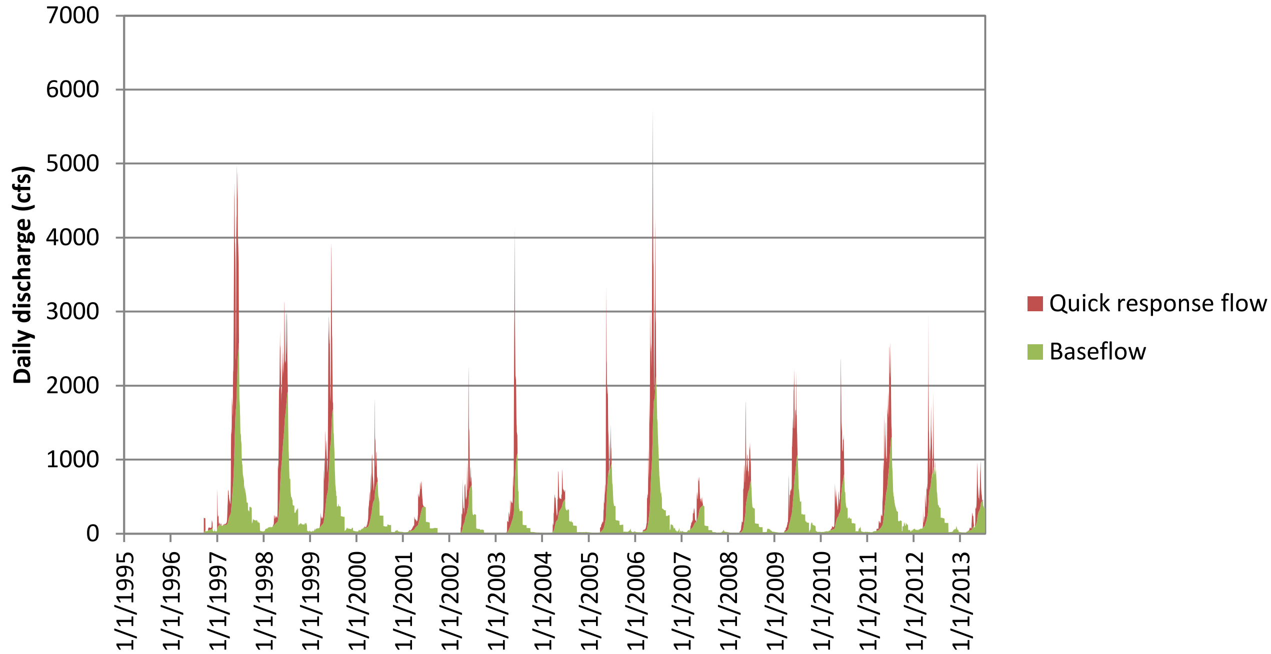

Figure 16. TSPROC baseflow separation filter results for Stanton Crossing gage plus diversions

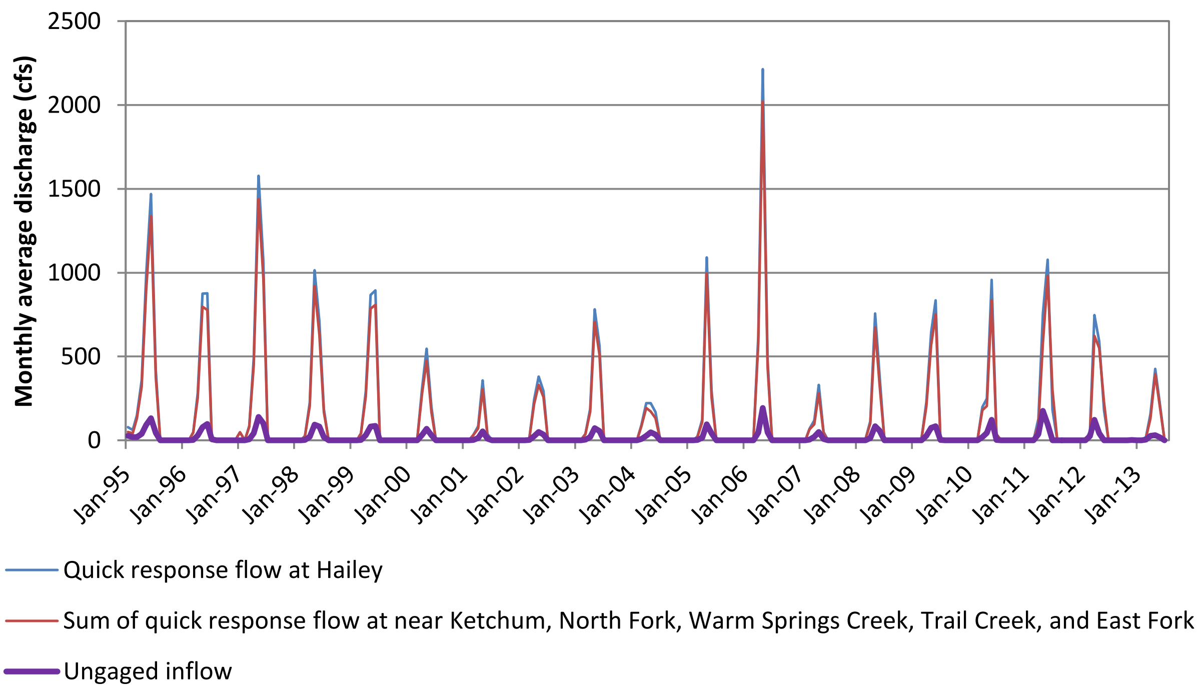

Figure 17. Estimated ungaged inflow in near Ketchum to Hailey reach.

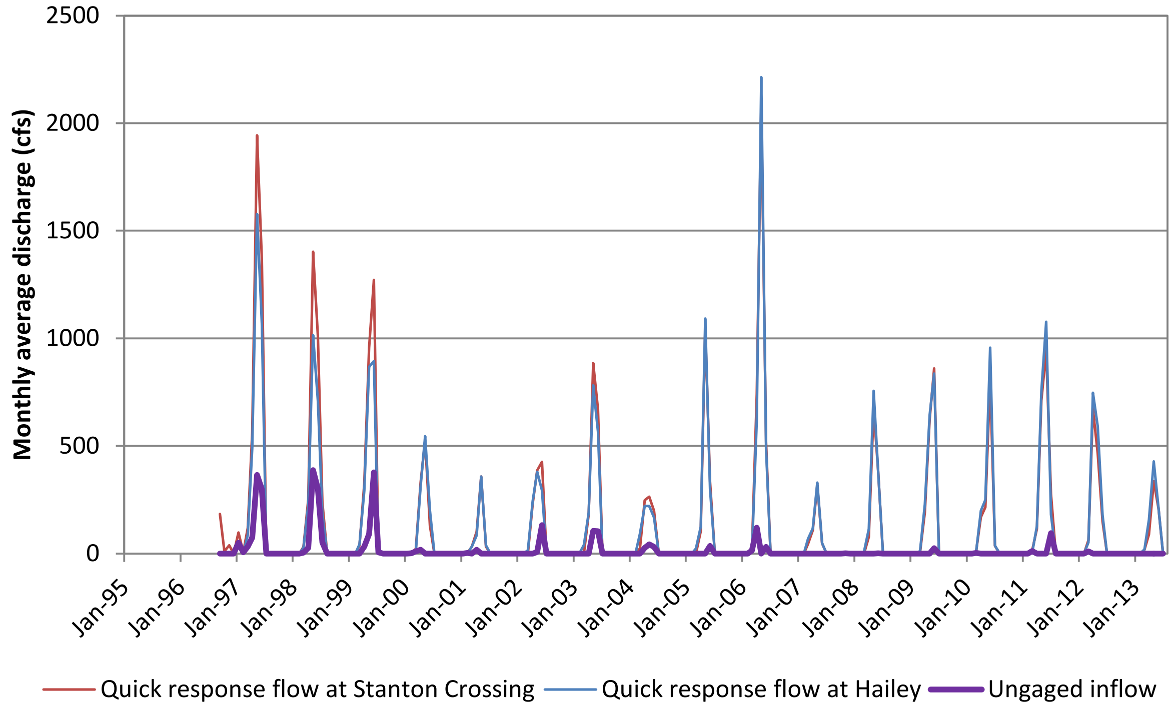

Figure 18. Estimated ungaged inflow in Hailey to Stanton Crossing reach.

Proposed transient reach gain targets

Big Wood River, near Ketchum to Hailey reach

The reach gain between the near Ketchum gage and the Hailey gage was calculated using Equation 1. Outflows from the reach are the measured streamflow at the Hailey gage and recorded diversions. Inflows to the reach are correlated streamflow at the near Ketchum gage, North Fork, Warm Spring Creek, Trail Creek, and East Fork, estimated flow from ungaged tributaries, and recorded wastewater treatment plant discharge. The reach gain target is shown in Figure 19. The reach is gaining throughout the calibration period. On average, the reach gain is lowest in February and peaks in June (Figure 20). Between 2000 and 2010, the average annual reach gain was 45,200 AF (62 cfs).

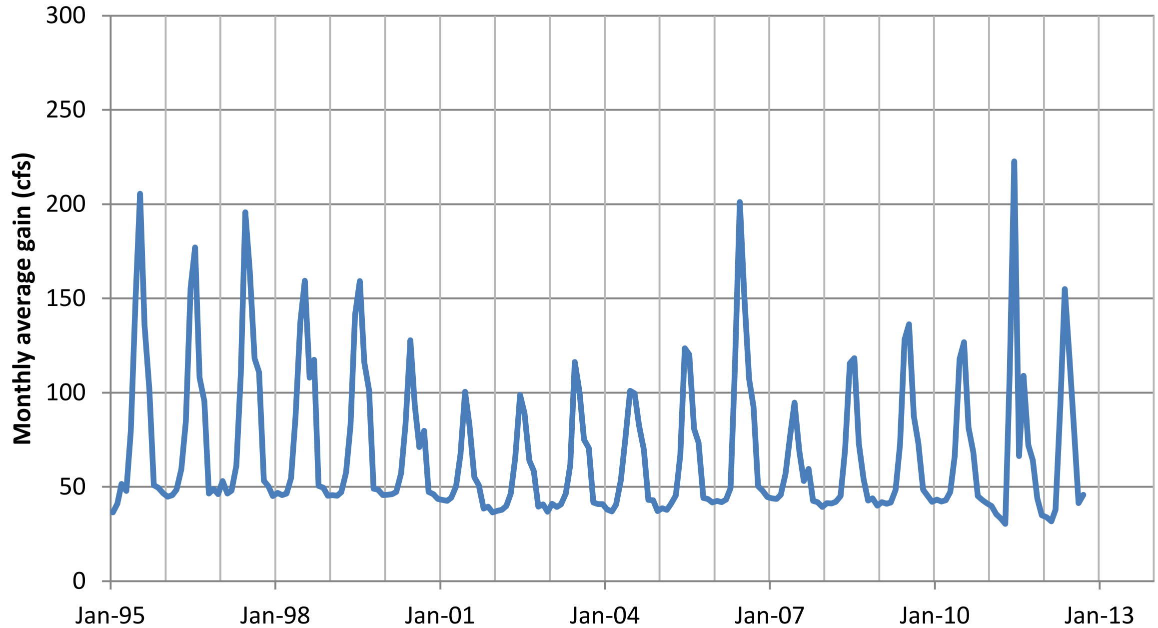

Figure 19. Transient reach gain target for Big Wood River, near Ketchum to Hailey.

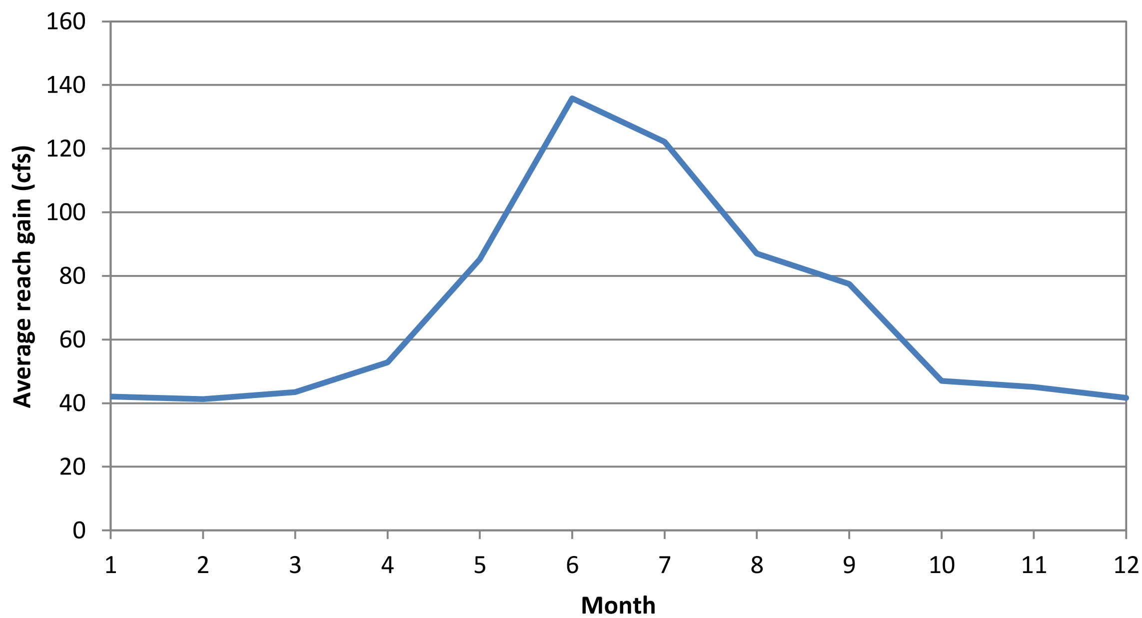

Figure 20. Average monthly reach gain for Big Wood River, near Ketchum to Hailey.

Big Wood River, Hailey to Stanton Crossing reach

The reach gain between the Hailey gage and the Stanton Crossing gage was calculated using Equation 1. Outflows from the reach are the measured streamflow at the Stanton Crossing gage and recorded diversions. Inflows to the reach are measured streamflow at the Hailey gage and estimated flow from ungaged tributaries. The reach gain target is shown in **Figure 21**. The reach is losing during most of the calibration period. On average, the reach loss is greatest in October and lowest in August (Figure 22). Between 2000 and 2010, the average annual reach gain was -71,100 AF (-98 cfs).

Seepage losses in this reach are affected by the use of the Bypass Canal, which was constructed in 1920 to bypass the section of the river below Glendale Bridge known as the "Dry Bed" (Chapman, 1922). Chapman (1922) reported that use of the Bypass Canal during the 1921 irrigation season reduced seepage losses by an average of 18 cfs.

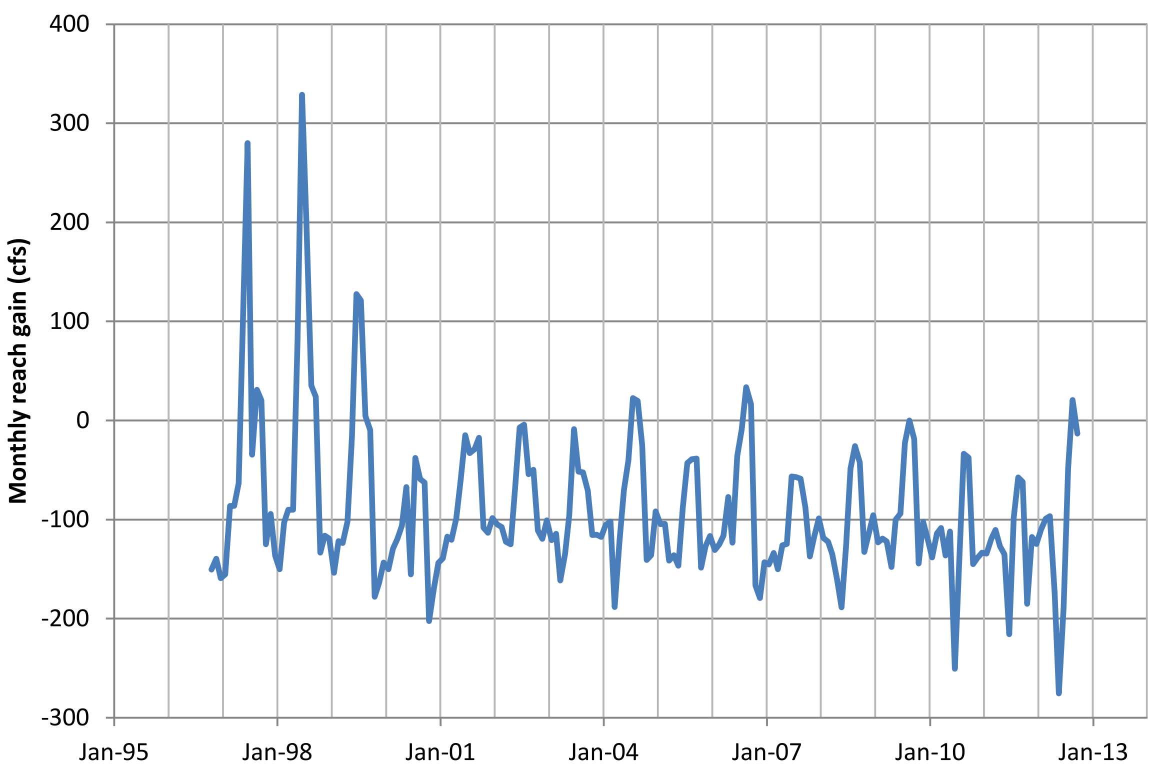

Figure 21. Transient reach gain target for Big Wood River, Hailey to Stanton Crossing.

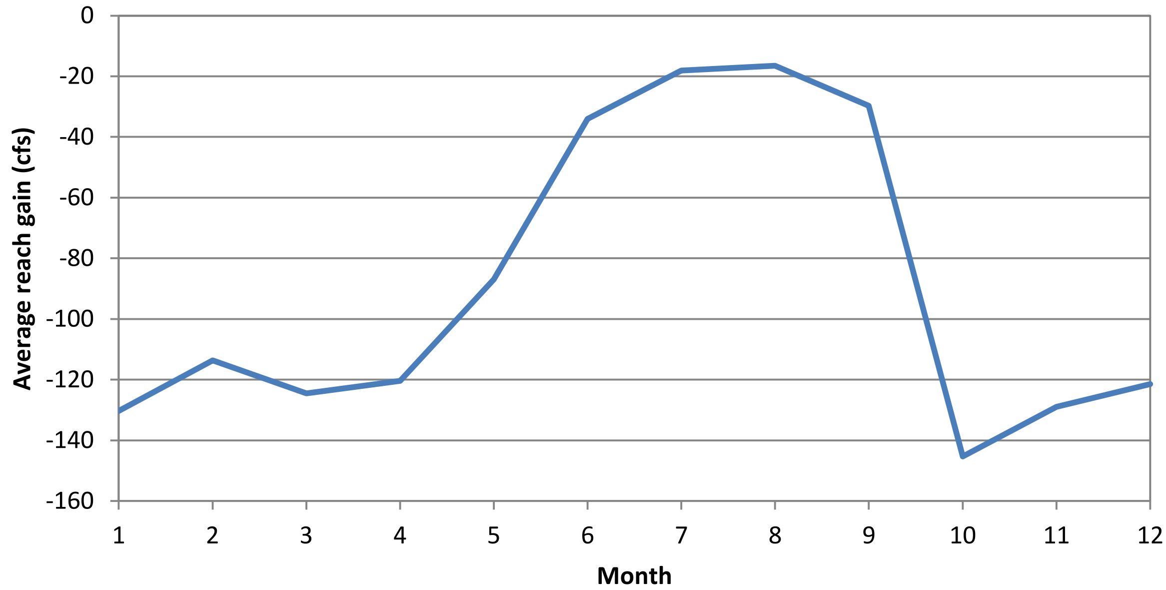

Figure 22. Average monthly reach gain for Big Wood River, Hailey to Stanton Crossing.

Willow Creek

Reach gain in the Willow Creek reach, which includes Crystal Creek and Spring Creek, was calculated using Equation 1. Outflows from the reach are the measured streamflow at the Willow Creek gage and recorded diversions. There are no surface water inflows to the reach, which is fed by aquifer discharge to springs. Discharge from uncontrolled flowing wells may also be included in the reach gain. The reach gain target is shown in Figure 23. The reach is gaining throughout the calibration period. On average, the reach gain is lowest in January and peaks in July (Figure 24). Between 2001 and 2010, the average annual reach gain was 19,600 AF (27 cfs).

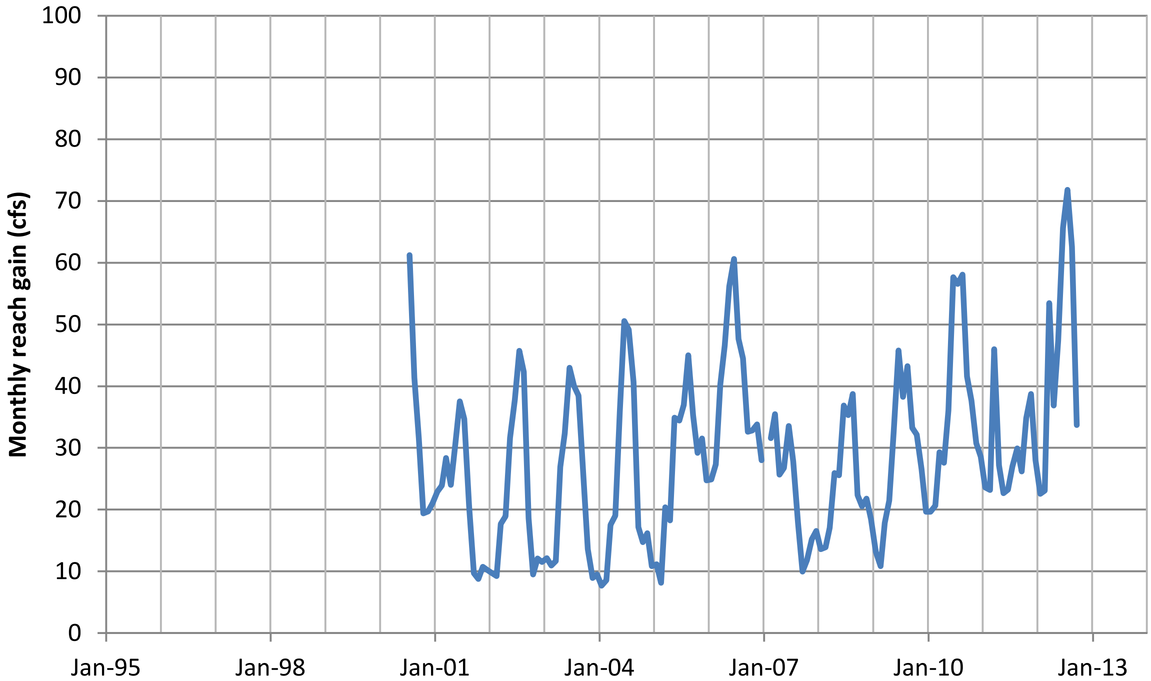

Figure 23. Transient reach gain target for Willow Creek reach.

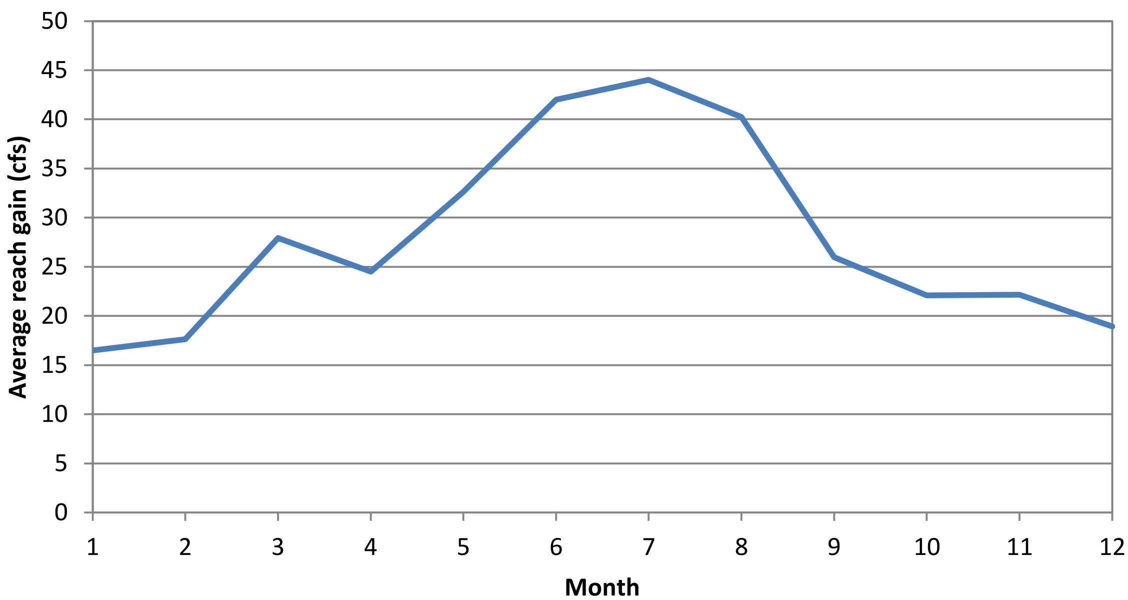

Figure 24. Average monthly reach gain for Willow Creek reach.

Silver Creek above Sportsman Access

Reach gain in the Silver Creek above Sportsman Access reach, which includes Buhler Drain and Stalker, Patton, Cain, Chaney, Mud, Wilson, Grove, and Loving Creeks, was calculated using Equation 1. Outflows from the reach are the measured streamflow at the Sportsman Access gage on Silver Creek and recorded diversions. Recorded inflows to the reach include inflows from exchange wells and return flows from the District 45 Legacy Project. The reach is fed primarily by aquifer discharge to springs. Discharge from uncontrolled flowing wells may also be included in the reach gain. The reach gain target is shown in Figure 25. The reach is gaining throughout the calibration period. On average, reach gain is lowest in October and peaks in March (Figure 26). Between 2000 and 2010, the average annual reach gain was 97,600 AF (135 cfs).

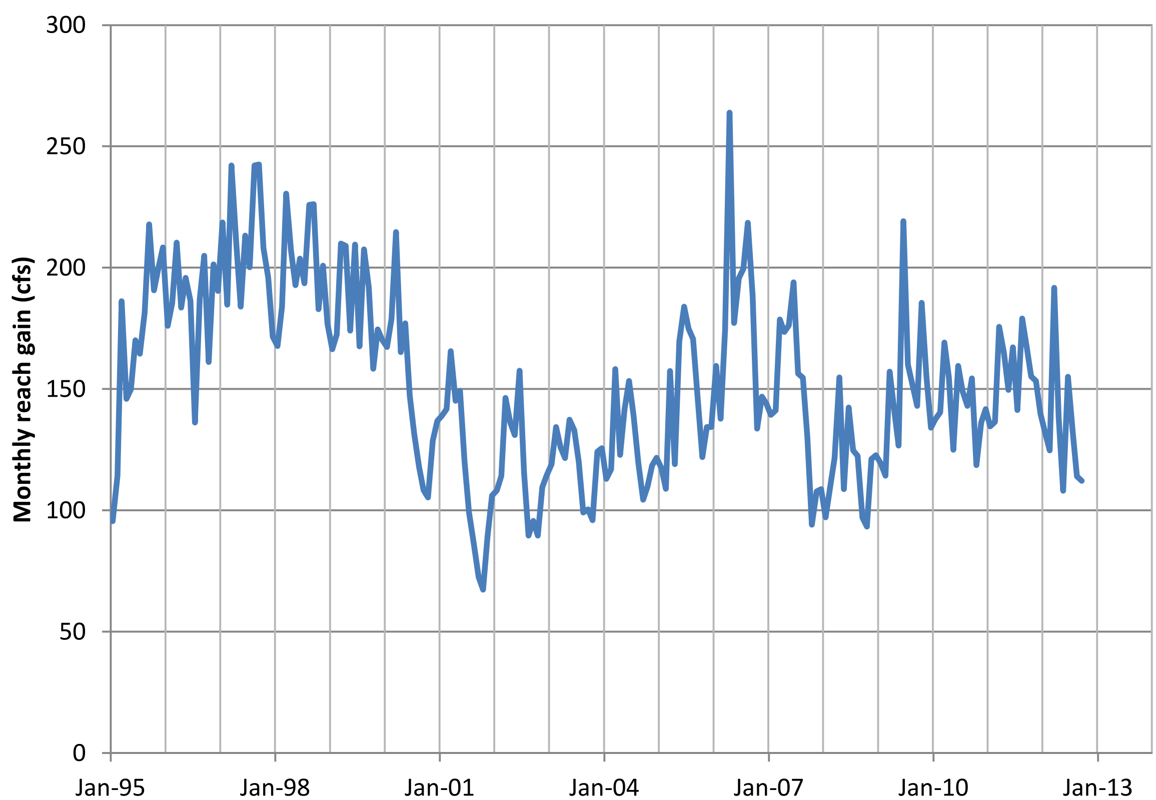

Figure 25. Transient reach gain target for Silver Creek above Sportsman Access reach.

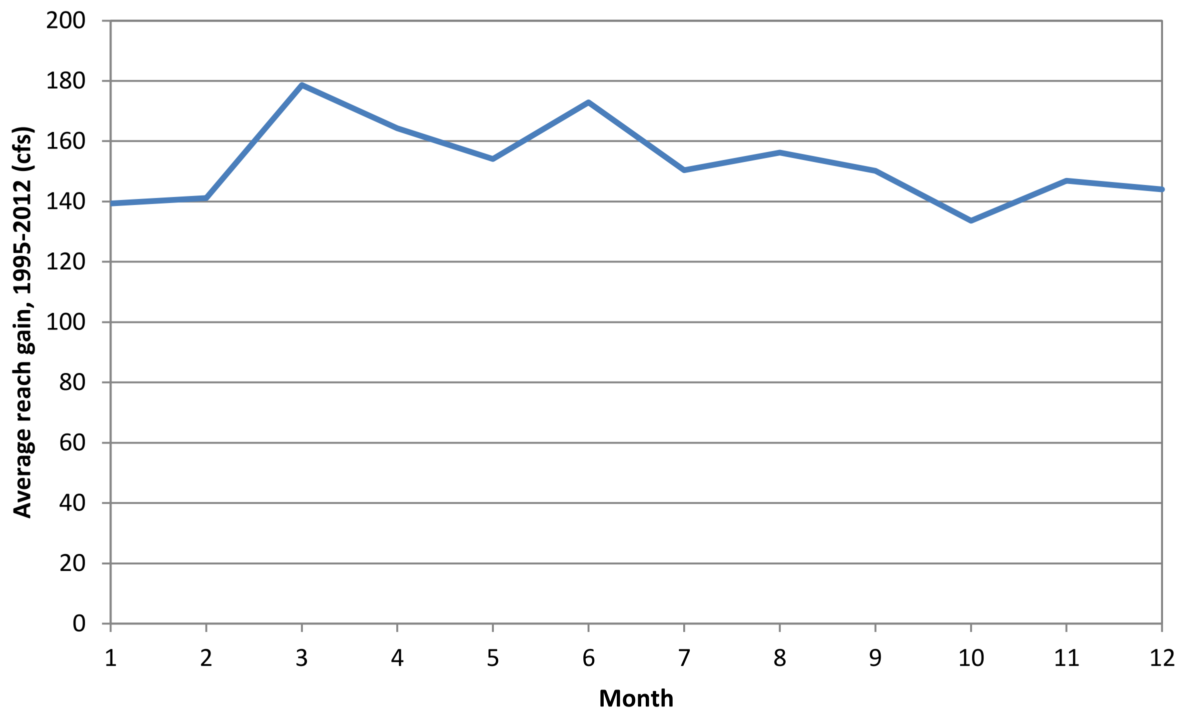

Figure 26. Average monthly reach gain for Silver Creek above Sportsman Access reach.

Calculation of average calibration targets for subreaches

Because the gaged reaches on the Big Wood River and Silver Creek are long, seepage surveys were performed to provide additional information to discretize reach gains within the model boundary. Subreaches delineated based on seepage survey sites are shown in Figure 27. The seepage survey data were not collected during the model calibration period, thus the results cannot be used directly as model targets. The seepage survey results can be used to determine if subreaches are generally gaining, losing, or neutral, and to calculate ratios of subreach gains to the larger gaged reach gain.

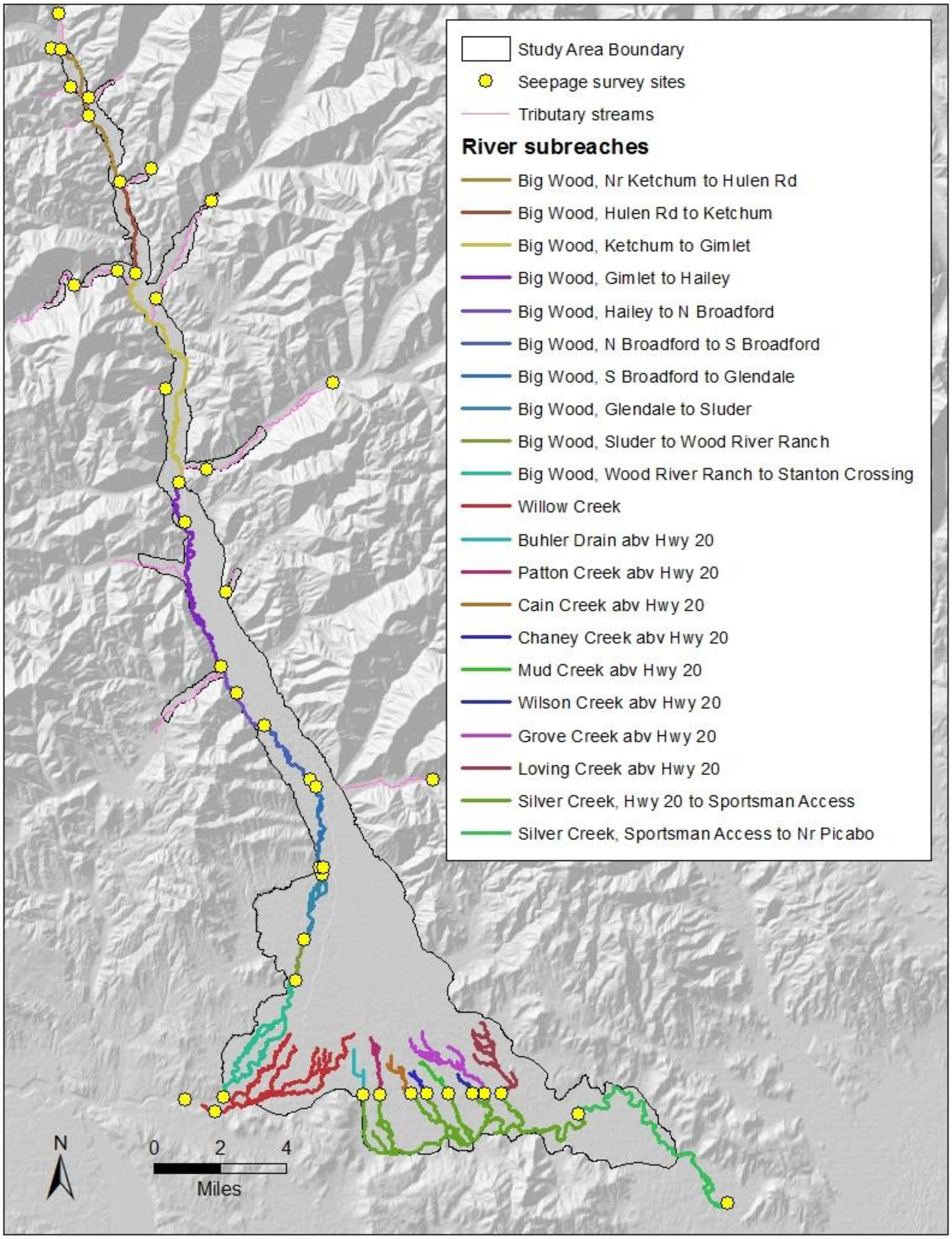

Figure 27. Subreaches and seepage survey measurement sites.

Subreach seepage survey results

Measurements used to calculate subreach gains for August 2012, October 2012, and March 2013 are provided in Appendix B. Sites shown in Figure 27 were measured by the USGS. For August 2012, data for diversions and exchange well inflows that were not measured by the USGS were obtained from Water District 37 and 37M records. Measurement methods for diversions and exchange well inflows reported by the Water District vary. These measurements may be less accurate than the measurements performed by the USGS. Calculated gains for reaches and subreaches are shown in Table 2. For each seepage survey event, the ratio of subreach gain to reach gain is shown in Table 3.

Reach or Subreach	August 2012 gain (cfs)	October 2012 gain (cfs)	March 2013 gain (cfs)
Big Wood River, near Ketchum to Hulen Road	18	13	21
Big Wood River, Hulen Road to Ketchum	-6	-1	-3
Big Wood River, Ketchum to Gimlet	1	20	12
Big Wood River, Gimlet to Hailey	1	8	25
Big Wood River, near Ketchum to Hailey	**15**	**39**	**55**
Big Wood River, Hailey to N Broadford	-20	-22	-22
Big Wood River, N Broadford to S Broadford	-20	-17	-30
Big Wood River, S Broadford to Glendale	-23	-20	-22
Big Wood River, Glendale to Sluder	0	-1	-26
Big Wood River, Sluder to Bypass Return/Wood River Ranch	0	0	-17
Big Wood River, Bypass Return/Wood River Ranch to Stanton Crossing	32	-41	-11
Big Wood River, Hailey to Stanton Crossing	**-32**	**-101**	**-127**
Willow Creek	**52**	**43**	**30**
Buhler Drain above Highway 20	4	1	1
Patton Creek above Highway 20	3	1	1
Cain Creek above Highway 20	4	1	2
Chaney Creek above Highway 20	12	11	14
Mud Creek above Highway 20	5	5	5
Wilson Creek above Highway 20	10	10	12
Grove Creek above Highway 20	43	35	36
Loving Creek above Highway 20	31	30	31
Silver Creek, Highway 20 to Sportsman Access	33	26	29
Silver Creek above Sportsman Access	**145**	**121**	**132**
Silver Creek, Sportsman Access to near Picabo	**15**	**12**	**0**

Table 2. Reach and subreach gains calculated from seepage survey measurements.

Reach or Subreach	August 2012	October 2012	March 2013	Weighted Average
Big Wood River, near Ketchum to Hulen Road	1.23	0.34	0.39	0.48
Big Wood River, Hulen Road to Ketchum	-0.39	-0.04	-0.06	-0.10
Big Wood River, Ketchum to Gimlet	0.09	0.50	0.21	0.30
Big Wood River, Gimlet to Hailey	0.07	0.19	0.46	0.31
Big Wood River, near Ketchum to Hailey	**1.00**	**1.00**	**1.00**	**1.00**
Big Wood River, Hailey to N Broadford	0.63	0.22	0.17	0.25
Big Wood River, N Broadford to S Broadford	0.62	0.17	0.24	0.26
Big Wood River, S Broadford to Glendale	0.72	0.20	0.17	0.25
Big Wood River, Glendale to Sluder	0	0.01	0.20	0.10
Big Wood River, Sluder to Wood River Ranch	0	0	0.13	0.06
Big Wood River, Wood River Ranch to Stanton Crossing	-0.99	0.40	0.09	0.08
Big Wood River, Hailey to Stanton Crossing	**1.00**	**1.00**	**1.00**	**1.00**
Buhler Drain above Highway 20	0.03	0.01	0.01	0.02
Patton Creek above Highway 20	0.02	0.01	0.01	0.01
Cain Creek above Highway 20	0.03	0.01	0.01	0.02
Chaney Creek above Highway 20	0.09	0.09	0.11	0.09
Mud Creek above Highway 20	0.03	0.04	0.04	0.04
Wilson Creek above Highway 20	0.07	0.09	0.09	0.08
Grove Creek above Highway 20	0.32	0.28	0.28	0.29
Loving Creek above Highway 20	0.22	0.25	0.24	0.23
Silver Creek, Highway 20 to Sportsman Access	0.23	0.22	0.22	0.22
Silver Creek above Sportsman Access	**1.00**	**1.00**	**1.00**	**1.00**

Table 3. Ratios of subreach gains to gaged reach gains.

Proposed average calibration targets for subreaches

The average ratios (weighted by discharge rate) of subreach gains to gaged reach gains calculated from seepage survey results can be used as calibration targets for the subreaches within the Big Wood River reaches and the Silver Creek above Sportsman Access reach. The ratios could be implemented as calibration targets by comparing a target ratio to the average model subreach gain from January 2000 through December 2010 divided by the average model reach gain from the same time period. Average reach gains and calculated average subreach gains are provided for comparison in Table 4.

Reach or Subreach	Target Ratio	2000-2010 Average Reach or Subreach Gain
Big Wood River, near Ketchum to Hulen Road	0.48	30.2
Big Wood River, Hulen Road to Ketchum	-0.10	-6.0
Big Wood River, Ketchum to Gimlet	0.30	18.8
Big Wood River, Gimlet to Hailey	0.31	19.4
Big Wood River, near Ketchum to Hailey	**1.00**	**62.5**
Big Wood River, Hailey to N Broadford	0.25	-24.3
Big Wood River, N Broadford to S Broadford	0.26	-25.3
Big Wood River, S Broadford to Glendale	0.25	-24.6
Big Wood River, Glendale to Sluder	0.10	-10.2
Big Wood River, Sluder to Wood River Ranch	0.06	-6.2
Big Wood River, Wood River Ranch to Stanton Crossing	0.08	-7.7
Big Wood River, Hailey to Stanton Crossing	**1.00**	**-98.2**
Buhler Drain above Highway 20	0.02	2.3
Patton Creek above Highway 20	0.01	1.5
Cain Creek above Highway 20	0.02	2.6
Chaney Creek above Highway 20	0.09	12.7
Mud Creek above Highway 20	0.04	4.8
Wilson Creek above Highway 20	0.08	11.3
Grove Creek above Highway 20	0.29	39.5
Loving Creek above Highway 20	0.23	31.9
Silver Creek, Highway 20 to Sportsman Access	0.22	30.5
Silver Creek above Sportsman Access	**1.00**	**137.2**

Table 4. Target ratios and equivalent 2000-2010 average subreach gain.

For Silver Creek below Sportsman Access, the USGS seepage survey measurements indicate that gains between the Sportsman Access and near Picabo sites ranged from zero in March 2013 to 15 cfs in August 2012. Approximately 7 miles of this 11 mile reach are located within the model boundary. Moreland (1977) measured seepage in six subreaches between Sportsman Access and near Picabo. Five of these subreaches are located within the model boundary and one subreach is downstream of the model boundary. Reach gains measured by Moreland (1977) are summarized in Table 5. The reach gain between Sportsman Access and near Picabo was 14 cfs in May 1975 and 9 cfs in September 1975, and is comparable to the results of the USGS seepage surveys in August and October 2012 (15 cfs and 12 cfs, respectively). The June 1975 reach gain (25 cfs) may have been higher because of surface water irrigation influence on groundwater level.

Date	Gain (cfs) from Sportsman Access to model boundary	Gain (cfs) from model boundary to near Picabo	Gain (cfs) from Sportsman Access to near Picabo
May 1975	16	-2	14
June 1975	16	9	25
Sept 1975	24	-15	9

Table 5. Reach gains between Sportsman Access and near Picabo from Moreland (1977).

The average gain from Sportsman Access to the model boundary based on Moreland's measurements was approximately 19 cfs during the irrigation season. This value can be implemented as a calibration target by comparing this target to the average model reach gain during the irrigation season (April through October) from 2000 through 2010.

References

Chapman, S.H., 1922, *Canal Deliveries from Big and Little Wood Rivers Districts 7A, 7B, & 11AB, and Different Features Affecting These Deliveries for the Irrigation Season Ending September 30, 1921*, Watermaster Report to Governor, February 28, 1922, 21 p.

Moreland, J.A., 1977, *Ground Water-Surface Water Relations in the Silver Creek Area, Blaine County, Idaho*, USGS Open-File Report 77-456, 66 p., 5 pl.

Nathan, R.J. and McMahon, T.A., 1990, *Evaluation of Automated Techniques for Base Flow and Recession Analysis*, Water Resources Research, v. 26, no. 7, pp. 1465-1473.

Water District 37 & 37M, 1995-2012, *Water Distribution and Hydrometric Works*.

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APPENDIX A.

TSPROC BASEFLOW SEPARATION FILTER SETTINGS

TSPROC baseflow separation filter settings for gages in near Ketchum to Hailey reach

```
START SETTINGS
  CONTEXT pest_input
  DATE_FORMAT mm/dd/yyyy
END SETTINGS


########################################################################
# River flows are read from a site sample file.
########################################################################

START GET_MUL_SERIES_SSF
  CONTEXT all
  FILE DailyFlows.prn
  SITE 13135500
  NEW_SERIES_NAME BWRnrKet
  SITE 13135520
  NEW_SERIES_NAME NFnrSNRA
  SITE 13137000
  NEW_SERIES_NAME WarmSpCk
  SITE 13137500
  NEW_SERIES_NAME TrailCk
  SITE 13138000
  NEW_SERIES_NAME EastFk
  SITE 13139510
  NEW_SERIES_NAME BWRHail
  DATE_1 01/01/1995
  TIME_1 12:00:00
  DATE_2 07/17/2013
  TIME_1 12:00:00
END GET_MUL_SERIES_SSF


########################################################################
# Baseflow separation filter is implemented on each series.
########################################################################

START DIGITAL_FILTER
  CONTEXT all
  FILTER_TYPE baseflow_separation
  SERIES_NAME BWRnrKet
  NEW_SERIES_NAME qflowBWRnK
  ALPHA 0.98
  PASSES 1
  CLIP_INPUT yes
  CLIP_ZERO yes
```

```
END DIGITAL_FILTER


START DIGITAL_FILTER
  CONTEXT all
  FILTER_TYPE baseflow_separation
  SERIES_NAME NFnrSNRA
  NEW_SERIES_NAME qflowNF
  ALPHA 0.98
  PASSES 1
  CLIP_INPUT yes
  CLIP_ZERO yes
END DIGITAL_FILTER


START DIGITAL_FILTER
  CONTEXT all
  FILTER_TYPE baseflow_separation
  SERIES_NAME WarmSpCk
  NEW_SERIES_NAME qflowWmSp
  ALPHA 0.98
  PASSES 1
  CLIP_INPUT yes
  CLIP_ZERO yes
END DIGITAL_FILTER


START DIGITAL_FILTER
  CONTEXT all
  FILTER_TYPE baseflow_separation
  SERIES_NAME TrailCk
  NEW_SERIES_NAME qflowTrail
  ALPHA 0.98
  PASSES 1
  CLIP_INPUT yes
  CLIP_ZERO yes
END DIGITAL_FILTER


START DIGITAL_FILTER
  CONTEXT all
  FILTER_TYPE baseflow_separation
  SERIES_NAME EastFk
  NEW_SERIES_NAME qflowEast
  ALPHA 0.98
  PASSES 1
  CLIP_INPUT yes
```

```
  CLIP_ZERO yes
END DIGITAL_FILTER


START DIGITAL_FILTER
  CONTEXT all
  FILTER_TYPE baseflow_separation
  SERIES_NAME BWRHail
  NEW_SERIES_NAME qflowBWRHa
  ALPHA 0.98
  PASSES 1
  CLIP_INPUT yes
  CLIP_ZERO yes
END DIGITAL_FILTER

##########################################################################
# Baseflow separation filter output is written to a file.
##########################################################################

START LIST_OUTPUT
  CONTEXT all
  FILE qflow.out
  SERIES_NAME qflowBWRnK
  SERIES_FORMAT short
  SERIES_NAME qflowNF
  SERIES_FORMAT short
  SERIES_NAME qflowWmSp
  SERIES_FORMAT short
  SERIES_NAME qflowTrail
  SERIES_FORMAT short
  SERIES_NAME qflowEast
  SERIES_FORMAT short
  SERIES_NAME qflowBWRHa
  SERIES_FORMAT short
END LIST_OUTPUT_BLOCK
```

TSPROC baseflow separation filter settings for Stanton Crossing gage

```
START SETTINGS
  CONTEXT pest_input
  DATE_FORMAT mm/dd/yyyy
END SETTINGS


########################################################################
# River flows are read from a site sample file.
########################################################################

START GET_SERIES_SSF
  CONTEXT all
  FILE Stanton.prn
  SITE 13140800
  NEW_SERIES_NAME BWRStant
END GET_SERIES_SSF


########################################################################
# Baseflow separation filter is implemented on each series.
########################################################################

START DIGITAL_FILTER
  CONTEXT all
  FILTER_TYPE baseflow_separation
  SERIES_NAME BWRStant
  NEW_SERIES_NAME qflowStant
  ALPHA 0.98
  PASSES 1
  CLIP_INPUT yes
  CLIP_ZERO yes
END DIGITAL_FILTER


########################################################################
# Baseflow separation filter output is written to a file.
########################################################################

START LIST_OUTPUT
  CONTEXT all
  FILE Stant.out
  SERIES_NAME qflowStant
  SERIES_FORMAT short
END LIST_OUTPUT_BLOCK
```

APPENDIX B.

2012-2013 SEEPAGE SURVEY DATA