

# **Design Document: Tributary underflow volumetric flux estimates and seasonal distribution of flux; *DRAFT***

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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 MODFLOW 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 Technical Advisory Committee 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.

## Background

One of the most difficult water-budget components to estimate is subsurface inflow or outflow from an aquifer because direct measurement is not possible and the data required for indirect estimates are often lacking. The groundwater-flow model of the Wood River Valley aquifer system requires estimates of the volumetric flux of subsurface outflow from the tributary canyons into the main aquifer system.

Smith (1960) inferred geologic sections at 27 streamgages in the Malad River basin to qualitatively estimate what amount of the basin yield (estimated as “the sum of surface runoff and ground-water underflow from a basin.”) is represented by streamflow measurements. Ten of the streamgages evaluated were in the Wood River Valley, four of which are applicable to the estimate of tributary underflow: Big Wood River near Ketchum, Warm Springs Creek at Guyer Hot Springs near Ketchum, Warm Springs Creek near Ketchum, and Trail Creek at Ketchum. Smith’s estimates are:

- Big Wood River near Ketchum: “The ground-water component probably is more than 10 percent of the water yield.”
- Warm Springs Creek at Guyer Hot Springs near Ketchum: “Underflow probably is less than 1 percent of the water yield.”
- Warm Springs Creek near Ketchum: “The ... alluvium probably transmits a moderate amount of ground water past the gage site. The amount cannot be estimated.”
- Trail Creek at Ketchum: “Underflow...is believed to be an appreciable percentage of the water yield of the...drainage area.”

The groundwater budget described in Bartolino (2009) identifies recharge from 28 tributary canyons as the largest component of recharge to the Wood River Valley aquifer system. This estimate was based on the USGS StreamStats tool (Ries and others, 2004) which uses regression equations from gaged streams to estimate flow in ungaged streams. For 23 of the tributaries Bartolino (2009) assumed that all of this estimated flow was recharged; the remaining five major tributaries were assumed to recharge 50 percent of the measured or estimated flow. Previous estimates of tributary recharge, such as Smith (1959) and Wetzstein and others (1989), were made with basin-yield calculations or model results: they are roughly comparable to those in Bartolino (2009).

Because Bartolino (2009) constructed a water budget for the entire aquifer system no effort was made to differentiate subsurface flux from recharged streamflow. However, the ground-water flow model currently under development requires separate estimates of these components.

## Design decision

### Mean tributary flux determination

Several approaches for determining the volumetric flux of tributary underflow were investigated. First, specification of a constant head boundary using groundwater levels measured in 2006 or 2012 was judged unrealistic and not defensible. Second, water-table gradients taken from water-level contours representing 2006 conditions (Skinner and others, 2007) incorporated interpolation errors inherent in the contouring process and scarce data in many tributary canyons. While water levels from drillers' logs are more plentiful, the wide variability of measurement dates are not directly comparable. The cross-sectional area of model cells in the tributaries are not representative because of errors inherent in discretization. It was therefore decided to estimate a cross-sectional area of the saturated thickness in tributary canyons from well and geophysical data and apply a Darcian analysis for flux.

ArcMap GIS was used to manually draw a straight line across a given tributary canyon roughly perpendicular to the canyon axis ending at the aquifer boundary on each end (the cross-sectional line). These lines were drawn in areas with existing data on depth to bedrock either from drillers' logs or geophysical data. This cross-sectional line was then copied and rotated 90° about the center of both lines so that a second line of equal length was perpendicular to the first line and parallel to the canyon axis (the axial line). The ArcMap "Add surface information" tool and the "Field Calculator" and "Calculate Geometry" attribute table options were used to determine the:

- Length of the cross-sectional line,
- Lowest elevation along the cross-sectional line, and
- Average gradient of the axial line.

By making several explicit assumptions a flux can be estimated:

- That the tributary contains a perennial stream the surface of which is represented by the lowest altitude of the cross-sectional line and that this altitude represents a flat, level water table across the cross-sectional line;
- That the water table parallels the land surface along the canyon axis, that the water-table gradient is represented by the average gradient of the axial line, and that this represents the hydraulic gradient;
- That the altitude of the aquifer base at the center of the cross-sectional line is taken as the altitude of bedrock in the nearest well or geophysical measurement; and
- That the cross-sectional area of the saturated thickness is taken as half of an ellipse with:
  - \* a width of the cross-sectional line length and
  - \* a height of the distance between the estimated water table and bedrock altitudes.

Volumetric flux is then estimated by calculating the cross-sectional area of the saturated thickness in a given tributary canyon and using this area in the Darcy equation. The cross-sectional area for a segment of an ellipse is represented by equation 1:

$$Area = \left(\frac{aB}{4}\right) \left[ \cos^{-1} \left(1 - \frac{2H}{a}\right) - \left(1 - \frac{2H}{a}\right) \sqrt{\frac{4H}{a} - \frac{4H^2}{a^2}} \right] \quad (1)$$

where

- $a$  is height of the ellipse in length units,
- $B$  is the width of the ellipse in length units,
- $H$  is the height of the segment in length units, and
- $\text{Cos}^{-1}$  is in radians.

Volumetric flux can then estimated using the Darcy equation (equation 2):

$$Q = KA h \quad (2)$$

where

- $Q$  is discharge (volumetric flux) in length<sup>3</sup>/time units,
- $K$  is hydraulic conductivity in length/time units,
- $A$  is the cross sectional area in length<sup>2</sup> units, and
- $h$  is the hydraulic gradient, dimensionless.

Values of hydraulic conductivity were taken as 85 ft/d (26 m/d) which is the average of the two geometric means of hydraulic conductivity in the unconfined aquifer taken from table 2 in Bartolino and Adkins (2012).

An implicit assumption in the volumetric flux estimated by the Darcy equation is that the saturated thickness and hydraulic gradient remain constant, implying an unlimited supply of water. While this assumption may be valid for larger tributary canyons with perennial streamflow, estimates of volumetric flow in smaller tributary canyons with ephemeral streamflow may quickly exceed the total amount of precipitation that falls within the drainage (henceforth referred to as basin yield, it is the maximum possible value because it does not represent evapotranspiration or sublimation). This assumption, in combination with uncertainty due the lack of well or geophysical data typical of the

smaller tributaries, causes overestimation of volumetric fluxes in smaller tributary canyons (Chocolate, Cold Springs, Ohio, Lees, and Townsend Gulches and Clear Creek Canyon) (table 1).

**Table 1.** Initial estimates of tributary underflow volumetric flux and selected tributary basin information.

Tributary	Saturated thickness (ft)	Tributary width (ft)	Area (ft <sup>2</sup> )	Land surface gradient	Estimated underflow (Acre-ft/yr)	Basin Area (mi <sup>2</sup> )	Average precipitation (in)	Basin yield (Acre-ft/yr)	Estimated underflow/Basin yield
Adams Gulch	48	650	24,694	0.0482	851	11	30	17,600	0.048
Chocolate Gulch	59	709	32,778	0.0727	1703	0.75	21.6	864	1.972
Clear Crk	35	623	17,074	0.0795	971	2.2	19.5	2,288	0.424
Cold Springs Gulch	63	344	17,112	0.0576	705	2.9	21.6	3,341	0.211
Cove Canyon	7	3058	15,909	0.0127	145	14	15	11,200	0.013
Croy Creek	40	1391	43,660	0.0226	704	28	15.8	23,595	0.030
Deer Crk	74	2277	131,783	0.0155	1462	55	25.3	74,213	0.020
Eagle Crk	75	1066	62,946	0.0226	1015	11	29.4	17,248	0.059
East Frk	43	1414	48,259	0.0137	471	86	26.3	120,629	0.004
Elkhorn Gulch	8	387	2,483	0.0289	51	13	18.4	12,757	0.004
Greenhorn Gulch	78	860	52,395	0.0182	682	21	27.2	30,464	0.022
Indian Sprgs Crk	83	1070	69,452	0.0485	2407	11	17.3	10,149	0.237
Lake Crk	68	1335	71,257	0.0472	2406	12	27	17,280	0.139
Lees Gulch	57	827	37,328	0.0556	1484	2.8	15	2,240	0.662
Ohio Gulch	85	1243	83,032	0.0664	3940	5.1	15.7	4,270	0.923
Quigley Crk	60	1325	62,378	0.0126	560	17	17.1	15,504	0.036
Seamans Creek	156	1391	170,357	0.0160	1949	23	15.3	18,768	0.104
Slaughterhouse Gulch	60	745	35,380	0.0200	506	13	16.6	11,509	0.044
Townsend Gulch	63	728	35,835	0.0476	1218	1.2	15	960	1.269
Trail Crk	125	2152	212,020	0.0191	2898	64	32.6	111,274	0.026
Warm Sprgs Crk	46	1617	58,006	0.0117	487	96	35.3	180,735	0.003
TOTAL:					26,600				

The USGS StreamStats tool (Ries and others, 2004) was used to delineate a basin area above the cross-sectional line described above. This basin area was then multiplied by the average precipitation in the basin as provided by StreamStats to estimate precipitation volume (table 1). The areas of the tributary basins were then plotted on an exponential scale and a natural break was found between 5.1 and 11 mi<sup>2</sup>. For all tributary basins of 11 mi<sup>2</sup> or greater, the ratio of basin yield to estimated underflow was calculated, the mean value of which was 0.06. This mean ratio is then applied to the StreamStats derived precipitation volume to determine the volumetric flux of tributary basins less than 11 mi<sup>2</sup> (table 2).

**Table 2.** Revised estimates tributary underflow volumetric flux and selected tributary basin information.

[\* , denotes a basin for which tributary underflow was calculated by multiplying basin yield by 0.06]

<b>Tributary</b>	<b>Basin Area (mi<sup>2</sup>)</b>	<b>Revised estimated underflow (Acre-ft/yr)</b>
Adams Gulch	11	851
Chocolate Gulch *	0.75	52
Clear Crk *	2.2	137
Cold Springs Gulch *	2.9	200
Cove Canyon	14	145
Croy Creek	28	704
Deer Crk	55	1,462
Eagle Crk	11	1,015
East Frk	86	471
Elkhorn Gulch	13	51
Greenhorn Gulch	21	682
Indian Sprgs Crk	11	2,407
Lake Crk	12	2,406
Lees Gulch *	2.8	134
Ohio Gulch *	5.1	256
Quigley Crk	17	560
Seamans Creek	23	1,949
Slaughterhouse Gulch	13	506
Townsend Gulch *	1.2	58
Trail Crk	64	2,898
Warm Sprgs Crk	96	487
<b>TOTAL:</b>		<b>17,400</b>

### Temporal variation of tributary underflow volumetric flux

Tributary underflow volumetric flux into the unconfined aquifer is dependent on precipitation and snowmelt within a given tributary canyon. Thus, actual flux varies over time and estimated flux should reflect this natural variation.

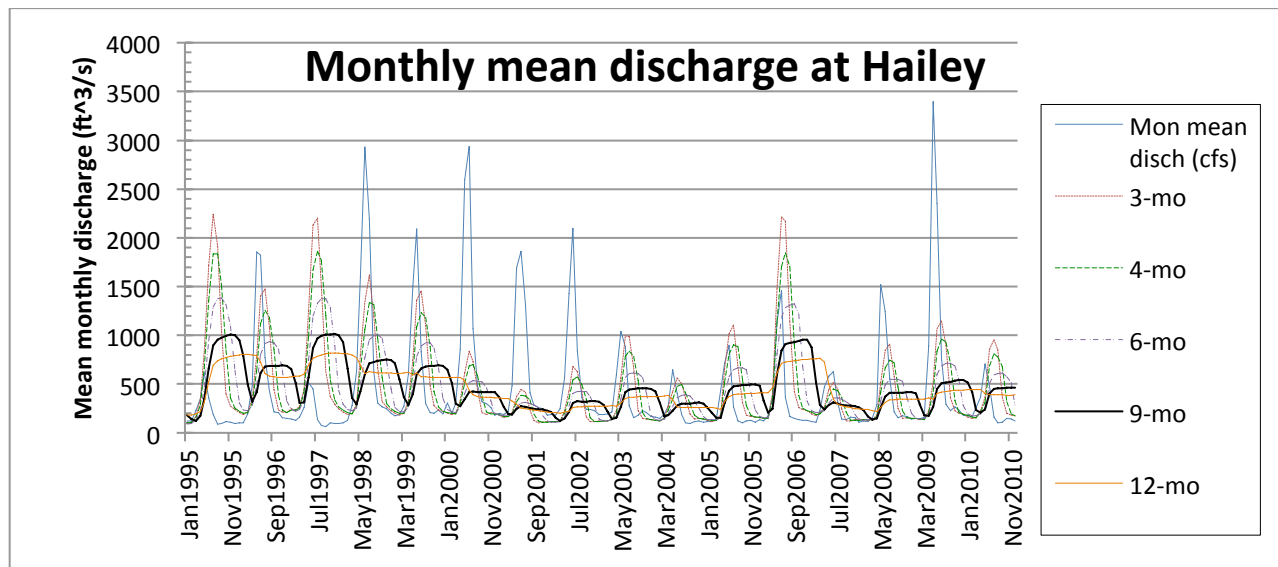
The most direct approach would be to use precipitation to vary flux but this was rejected for several reasons: (1) Only two weather stations in the Wood River Valley have sufficient data to make such an estimate, and (2) snowmelt and infiltration may occurs several months after the precipitation falls as snow. Alternatively, stream discharge recorded at the Big Wood River at Hailey (13139510) streamgage provides a long-term continuous record and aggregates precipitation and snowmelt response in the entire drainage basin above Hailey.

Monthly mean discharge at the Hailey streamgage was retrieved from NWIS; this record shows extreme variability, sometimes with large month-to-month fluctuations that cannot be represented in the

groundwater-flow model. Because the processes of infiltration and groundwater movement both lag and smooth specific recharge events, additional smoothing or dampening of the monthly mean stream discharge is needed to better represent this variation.

Initially the monthly mean discharges were used to calculate a quarterly (or seasonal) mean. While this smoothed the data slightly it was insufficient.

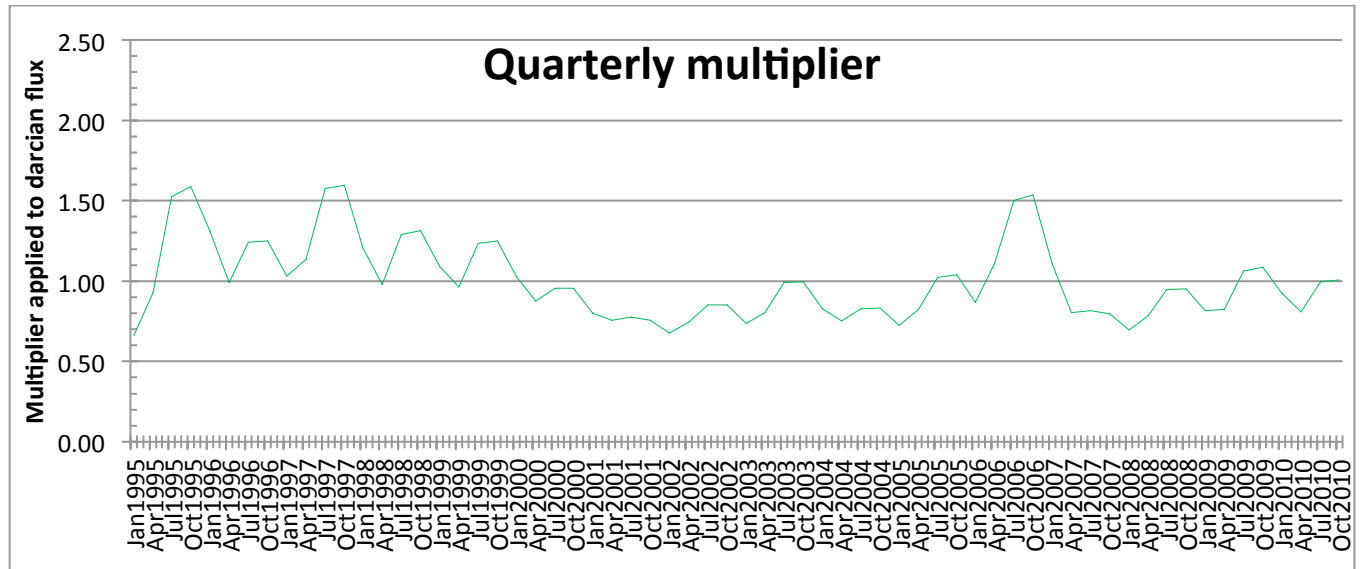
Further smoothing was made using a simple moving (or running) average of the monthly discharge for the months preceding and including a specific month. Smoothing windows of 3, 4, 6, 9, and 12 months were investigated; results are shown in figure 1. A nine-month window was chosen as the best compromise between representing the timing and magnitude of monthly mean discharge. These smoothed monthly values were then used to calculate the quarterly mean discharge for each of the 64 quarters encompassing the 1995-2010 model period.



**Figure 1.** Monthly mean discharge at the Big Wood River at Hailey (13139510) streamgauge and smoothing based on different interval of moving averages, 1995-2010.

The quarterly mean discharge was then used to calculate a quarterly multiplier to vary the estimated volumetric flux for each tributary. These quarterly multipliers were determined by dividing the quarterly mean discharge by the mean discharge of all 64 quarters. This yielded the percentage each quarterly mean discharge the a The mean of each of these quarters was then divided by the mean of all 64 quarters to get a percentage of the mean discharge for each quarter a percentage of mean flow for each quarter (fig. 2). The estimated volumetric flux for each tributary was then multiplied by this

percentage to get an estimated volumetric flux for each tributary for 64 quarters (table 3, at end of document).



**Figure 2.** Quarterly multiplier applied to estimated tributary underflow, 1995-2010.

This shaping process appears to give quarterly volumetric flux estimates that represent the conceptual understanding of the tributary underflow process.

## Summary

The volumetric fluxes of tributary underflow into the Wood River Valley aquifer system were made using the estimated saturated cross-sectional area in tributary canyons and estimated water-table gradients in a form of the Darcy equation. Volumetric flux from the smallest tributary canyons were estimated as a fraction of basin yield determined from an analysis of the ratio of estimated flux to basin yield in larger tributaries. These estimates of tributary underflow volumetric flux were then adjusted to represent seasonal variation using monthly mean discharge at the Big Wood River at Hailey streamgage and a smoothing technique.

## References Cited

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**Table 1. Tributary underflow volumetric flux estimates by season.**

Adm, Adams Gulch; ChG, Chocolate Gulch; Clr, Clear Creek; Cld, Cold Springs Gulch; Cov, Cove Canyon; Cry, Croy Canyon; DrC, Dry Creek; Eag, Eagle Creek; EFk, East Fork; Elk, Elkhorn; Grn, Greenhorn Gulch; InC, Indian Creek; Lak, Lake Creek; Lee, Lees Gulch; OhG, Ohio Gulch; QgC, Quigley Creek; Sea, Seamans Creek; Slh, Slaughterhouse Creek; Twn, Townsend Gulch; Trl, Trail Creek; WmS, Warm Springs Creek.

Season	Trib Est Uflw:	Estimated tributary underflow by season (ft <sup>3</sup> /s)																					
	% of mean	Adm	ChG	Clr	Cld	Cov	Cry	DrC	Eag	EFk	Elk	Grn	InC	Lak	Lee	OhG	QgC	Sea	Slh	Twn	Trl	WmS	
		1.175	0.072	0.190	0.277	0.200	0.973	2.020	1.402	0.651	0.071	0.942	3.325	3.324	0.186	0.354	0.774	2.692	0.699	0.080	4.002	0.673	
Jan1995	0.66	0.776	0.047	0.125	0.183	0.132	0.642	1.334	0.926	0.430	0.047	0.622	2.196	2.195	0.123	0.234	0.511	1.778	0.462	0.053	2.643	0.444	
Apr1995	0.93	1.091	0.066	0.176	0.257	0.185	0.903	1.875	1.301	0.604	0.066	0.874	3.086	3.085	0.172	0.329	0.718	2.499	0.649	0.074	3.715	0.624	
Jul1995	1.52	1.791	0.109	0.289	0.422	0.304	1.483	3.079	2.137	0.993	0.108	1.436	5.068	5.067	0.283	0.540	1.179	4.105	1.066	0.121	6.102	1.025	
Oct1995	1.59	1.867	0.114	0.301	0.440	0.317	1.545	3.209	2.227	1.034	0.112	1.496	5.281	5.280	0.295	0.562	1.229	4.277	1.111	0.126	6.358	1.069	
Jan1996	1.31	1.542	0.094	0.249	0.363	0.262	1.276	2.650	1.839	0.854	0.093	1.236	4.361	4.360	0.244	0.464	1.015	3.532	0.917	0.104	5.250	0.882	
Apr1996	0.99	1.165	0.071	0.188	0.274	0.198	0.964	2.002	1.390	0.645	0.070	0.934	3.295	3.294	0.184	0.351	0.767	2.669	0.693	0.079	3.967	0.667	
Jul1996	1.24	1.461	0.089	0.236	0.344	0.248	1.209	2.511	1.743	0.809	0.088	1.171	4.133	4.132	0.231	0.440	0.962	3.347	0.869	0.099	4.975	0.836	
Oct1996	1.25	1.468	0.089	0.237	0.346	0.249	1.215	2.523	1.751	0.813	0.088	1.177	4.153	4.152	0.232	0.442	0.966	3.363	0.873	0.099	5.000	0.840	
Jan1997	1.03	1.213	0.074	0.196	0.286	0.206	1.004	2.085	1.447	0.672	0.073	0.972	3.431	3.430	0.192	0.365	0.798	2.779	0.722	0.082	4.131	0.694	
Apr1997	1.13	1.332	0.081	0.215	0.314	0.226	1.103	2.290	1.589	0.738	0.080	1.068	3.769	3.768	0.210	0.401	0.877	3.052	0.793	0.090	4.538	0.763	
Jul1997	1.58	1.853	0.113	0.299	0.437	0.315	1.534	3.185	2.211	1.027	0.112	1.486	5.243	5.242	0.293	0.558	1.220	4.246	1.103	0.125	6.312	1.061	
Oct1997	1.60	1.875	0.114	0.303	0.442	0.319	1.553	3.224	2.237	1.039	0.113	1.503	5.306	5.305	0.296	0.565	1.235	4.297	1.116	0.127	6.388	1.074	
Jan1998	1.21	1.417	0.086	0.229	0.334	0.241	1.173	2.436	1.690	0.785	0.085	1.136	4.009	4.008	0.224	0.427	0.933	3.247	0.843	0.096	4.826	0.811	
Apr1998	0.98	1.149	0.070	0.185	0.271	0.195	0.951	1.975	1.371	0.637	0.069	0.921	3.250	3.250	0.181	0.346	0.756	2.632	0.684	0.078	3.913	0.658	
Jul1998	1.29	1.515	0.092	0.244	0.357	0.258	1.254	2.604	1.808	0.840	0.091	1.215	4.287	4.286	0.239	0.456	0.998	3.472	0.901	0.103	5.161	0.867	
Oct1998	1.31	1.545	0.094	0.249	0.364	0.263	1.279	2.655	1.843	0.856	0.093	1.238	4.370	4.369	0.244	0.465	1.017	3.539	0.919	0.105	5.261	0.884	
Jan1999	1.09	1.282	0.078	0.207	0.302	0.218	1.062	2.204	1.530	0.711	0.077	1.028	3.628	3.627	0.203	0.386	0.844	2.938	0.763	0.087	4.367	0.734	
Apr1999	0.96	1.134	0.069	0.183	0.267	0.193	0.939	1.949	1.352	0.628	0.068	0.909	3.207	3.207	0.179	0.341	0.746	2.597	0.675	0.077	3.861	0.649	
Jul1999	1.23	1.450	0.088	0.234	0.342	0.246	1.200	2.492	1.730	0.803	0.087	1.162	4.102	4.101	0.229	0.437	0.955	3.322	0.863	0.098	4.939	0.830	
Oct1999	1.25	1.471	0.090	0.237	0.347	0.250	1.218	2.528	1.754	0.815	0.089	1.179	4.161	4.160	0.232	0.443	0.968	3.369	0.875	0.100	5.009	0.842	
Jan2000	1.03	1.208	0.074	0.195	0.285	0.205	1.000	2.076	1.441	0.669	0.073	0.968	3.416	3.416	0.191	0.364	0.795	2.767	0.718	0.082	4.113	0.691	
Apr2000	0.88	1.030	0.063	0.166	0.243	0.175	0.853	1.770	1.229	0.571	0.062	0.826	2.914	2.913	0.163	0.310	0.678	2.360	0.613	0.070	3.508	0.590	
Jul2000	0.95	1.122	0.068	0.181	0.264	0.191	0.929	1.929	1.339	0.622	0.068	0.899	3.174	3.174	0.177	0.338	0.739	2.571	0.668	0.076	3.821	0.642	
Oct2000	0.96	1.123	0.068	0.181	0.264	0.191	0.929	1.929	1.339	0.622	0.068	0.900	3.176	3.175	0.177	0.338	0.739	2.572	0.668	0.076	3.823	0.643	
Jan2001	0.80	0.940	0.057	0.152	0.221	0.160	0.778	1.615	1.121	0.521	0.057	0.753	2.659	2.658	0.148	0.283	0.619	2.153	0.559	0.064	3.201	0.538	
Apr2001	0.76	0.889	0.054	0.143	0.209	0.151	0.736	1.527	1.060	0.492	0.054	0.712	2.514	2.513	0.140	0.268	0.585	2.036	0.529	0.060	3.026	0.509	
Jul2001	0.78	0.914	0.056	0.148	0.215	0.155	0.757	1.571	1.091	0.507	0.055	0.733	2.586	2.586	0.144	0.275	0.602	2.095	0.544	0.062	3.114	0.523	
Oct2001	0.76	0.890	0.054	0.144	0.210	0.151	0.737	1.529	1.062	0.493	0.054	0.713	2.517	2.517	0.141	0.268	0.586	2.039	0.529	0.060	3.031	0.509	
Jan2002	0.68	0.794	0.048	0.128	0.187	0.135	0.657	1.365	0.947	0.440	0.048	0.636	2.246	2.246	0.125	0.239	0.523	1.819	0.472	0.054	2.704	0.454	
Apr2002	0.74	0.874	0.053	0.141	0.206	0.149	0.724	1.502	1.043	0.484	0.053	0.701	2.473	2.472	0.138	0.263	0.575	2.003	0.520	0.059	2.977	0.500	

Season	Trib Est Uflw:	Estimated tributary underflow by season (ft <sup>3</sup> /s)																				
	% of mean	Adm	ChG	Clr	Cld	Cov	Cry	DrC	Eag	EFk	Elk	Grn	InC	Lak	Lee	OhG	QgC	Sea	Slh	Twn	Trl	WmS
		1.175	0.072	0.190	0.277	0.200	0.973	2.020	1.402	0.651	0.071	0.942	3.325	3.324	0.186	0.354	0.774	2.692	0.699	0.080	4.002	0.673
Jul2002	0.85	0.999	0.061	0.161	0.235	0.170	0.827	1.718	1.192	0.554	0.060	0.801	2.828	2.827	0.158	0.301	0.658	2.290	0.595	0.068	3.404	0.572
Oct2002	0.85	1.000	0.061	0.161	0.236	0.170	0.828	1.720	1.194	0.554	0.060	0.802	2.830	2.830	0.158	0.301	0.659	2.292	0.595	0.068	3.407	0.573
Jan2003	0.74	0.866	0.053	0.140	0.204	0.147	0.717	1.488	1.033	0.480	0.052	0.694	2.450	2.449	0.137	0.261	0.570	1.984	0.515	0.059	2.949	0.496
Apr2003	0.81	0.946	0.058	0.153	0.223	0.161	0.783	1.626	1.129	0.524	0.057	0.759	2.677	2.676	0.149	0.285	0.623	2.168	0.563	0.064	3.223	0.542
Jul2003	0.99	1.163	0.071	0.188	0.274	0.198	0.963	1.999	1.387	0.644	0.070	0.932	3.290	3.289	0.184	0.350	0.766	2.664	0.692	0.079	3.960	0.666
Oct2003	0.99	1.168	0.071	0.188	0.275	0.198	0.967	2.007	1.393	0.647	0.070	0.936	3.303	3.302	0.184	0.352	0.769	2.675	0.695	0.079	3.977	0.668
Jan2004	0.83	0.971	0.059	0.157	0.229	0.165	0.804	1.669	1.159	0.538	0.059	0.779	2.748	2.747	0.153	0.293	0.639	2.225	0.578	0.066	3.308	0.556
Apr2004	0.75	0.882	0.054	0.142	0.208	0.150	0.731	1.517	1.053	0.489	0.053	0.707	2.496	2.496	0.139	0.266	0.581	2.022	0.525	0.060	3.005	0.505
Jul2004	0.83	0.972	0.059	0.157	0.229	0.165	0.805	1.671	1.160	0.539	0.059	0.779	2.750	2.749	0.154	0.293	0.640	2.227	0.578	0.066	3.311	0.556
Oct2004	0.83	0.978	0.060	0.158	0.230	0.166	0.809	1.680	1.166	0.542	0.059	0.784	2.766	2.765	0.154	0.294	0.644	2.240	0.582	0.066	3.330	0.560
Jan2005	0.73	0.853	0.052	0.138	0.201	0.145	0.706	1.466	1.017	0.472	0.051	0.684	2.412	2.412	0.135	0.257	0.561	1.954	0.507	0.058	2.904	0.488
Apr2005	0.82	0.966	0.059	0.156	0.228	0.164	0.800	1.661	1.153	0.536	0.058	0.775	2.734	2.734	0.153	0.291	0.636	2.214	0.575	0.065	3.292	0.553
Jul2005	1.02	1.202	0.073	0.194	0.283	0.204	0.995	2.067	1.434	0.666	0.072	0.964	3.401	3.401	0.190	0.362	0.792	2.755	0.715	0.081	4.095	0.688
Oct2005	1.04	1.221	0.074	0.197	0.288	0.208	1.011	2.099	1.457	0.677	0.074	0.979	3.456	3.455	0.193	0.368	0.804	2.798	0.727	0.083	4.160	0.699
Jan2006	0.87	1.022	0.062	0.165	0.241	0.174	0.846	1.757	1.219	0.566	0.062	0.819	2.891	2.890	0.161	0.308	0.673	2.341	0.608	0.069	3.481	0.585
Apr2006	1.11	1.306	0.080	0.211	0.308	0.222	1.081	2.245	1.558	0.724	0.079	1.047	3.695	3.694	0.206	0.393	0.860	2.992	0.777	0.088	4.448	0.748
Jul2006	1.50	1.764	0.107	0.285	0.416	0.300	1.461	3.032	2.105	0.978	0.106	1.414	4.991	4.990	0.279	0.531	1.161	4.042	1.050	0.119	6.008	1.010
Oct2006	1.54	1.804	0.110	0.291	0.425	0.307	1.493	3.101	2.152	1.000	0.109	1.446	5.104	5.102	0.285	0.543	1.188	4.133	1.073	0.122	6.144	1.033
Jan2007	1.11	1.303	0.079	0.210	0.307	0.221	1.078	2.239	1.554	0.722	0.078	1.044	3.685	3.684	0.206	0.392	0.858	2.984	0.775	0.088	4.436	0.746
Apr2007	0.81	0.946	0.058	0.153	0.223	0.161	0.783	1.626	1.129	0.524	0.057	0.758	2.677	2.676	0.149	0.285	0.623	2.168	0.563	0.064	3.222	0.542
Jul2007	0.82	0.959	0.058	0.155	0.226	0.163	0.794	1.648	1.144	0.531	0.058	0.769	2.713	2.712	0.151	0.289	0.631	2.197	0.571	0.065	3.266	0.549
Oct2007	0.80	0.934	0.057	0.151	0.220	0.159	0.774	1.606	1.115	0.518	0.056	0.749	2.644	2.643	0.148	0.281	0.615	2.141	0.556	0.063	3.182	0.535
Jan2008	0.70	0.817	0.050	0.132	0.193	0.139	0.677	1.405	0.975	0.453	0.049	0.655	2.313	2.312	0.129	0.246	0.538	1.873	0.486	0.055	2.784	0.468
Apr2008	0.78	0.919	0.056	0.148	0.217	0.156	0.761	1.580	1.097	0.509	0.055	0.737	2.601	2.600	0.145	0.277	0.605	2.106	0.547	0.062	3.131	0.526
Jul2008	0.95	1.112	0.068	0.179	0.262	0.189	0.920	1.911	1.326	0.616	0.067	0.891	3.145	3.144	0.176	0.335	0.732	2.547	0.661	0.075	3.786	0.636
Oct2008	0.95	1.119	0.068	0.181	0.264	0.190	0.926	1.923	1.334	0.620	0.067	0.897	3.165	3.164	0.177	0.337	0.736	2.563	0.666	0.076	3.810	0.640
Jan2009	0.82	0.960	0.058	0.155	0.226	0.163	0.795	1.650	1.145	0.532	0.058	0.769	2.715	2.715	0.152	0.289	0.632	2.199	0.571	0.065	3.269	0.549
Apr2009	0.83	0.970	0.059	0.156	0.228	0.165	0.803	1.667	1.157	0.537	0.058	0.777	2.744	2.743	0.153	0.292	0.638	2.222	0.577	0.066	3.303	0.555
Jul2009	1.06	1.247	0.076	0.201	0.294	0.212	1.033	2.144	1.488	0.691	0.075	1.000	3.529	3.528	0.197	0.376	0.821	2.858	0.742	0.084	4.249	0.714
Oct2009	1.09	1.275	0.078	0.206	0.301	0.217	1.056	2.192	1.522	0.707	0.077	1.023	3.609	3.608	0.201	0.384	0.840	2.922	0.759	0.086	4.344	0.730
Jan2010	0.92	1.084	0.066	0.175	0.255	0.184	0.897	1.863	1.293	0.601	0.065	0.869	3.066	3.065	0.171	0.326	0.714	2.483	0.645	0.073	3.691	0.620
Apr2010	0.81	0.949	0.058	0.153	0.224	0.161	0.786	1.631	1.132	0.526	0.057	0.761	2.685	2.684	0.150	0.286	0.625	2.174	0.565	0.064	3.232	0.543
Jul2010	0.99	1.169	0.071	0.189	0.275	0.199	0.968	2.009	1.394	0.648	0.070	0.937	3.307	3.306	0.185	0.352	0.770	2.678	0.695	0.079	3.981	0.669
Oct2010	1.01	1.182	0.072	0.191	0.278	0.201	0.978	2.031	1.410	0.655	0.071	0.947	3.344	3.343	0.187	0.356	0.778	2.708	0.703	0.080	4.025	0.677