Study No. 20

Ramping Rates in West Rosebud Creek

Mystic Lake Hydroelectric Project FERC No. 2301

Mystic Lake, Montana

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October 3, 2005

Geotechnical
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To: Jon Jourdonnais, PPL Montana

From: Ginger Gillin, GEI Consultants, Inc.

Date: 9/7/2005

Re: Ramping rate issue identified in scoping document 1 for Mystic Hydroelectric Project

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The Federal Energy Regulatory Commission (FERC) identified ramping rates as an issue in scoping document 1 (SD-1) for the Mystic Lake Hydroelectric Project. Specifically, FERC prepared a preliminary list of issues to be addressed in the environmental assessment. The list included this issue:

"Effects of ramping rates on fish habitat and fish populations in West Rosebud Creek from Mystic Lake to Emerald Lake."

In a conference call with FERC staff on March 29, 2005, FERC staff expressed concern that no studies were proposed to address this issue. They requested that the ramping rate issue be addressed at the time that PPL Montana submits study plan reports in October 2005.

PPL Montana has committed to the Mystic Lake stakeholders that they will not modify operations of the Mystic Lake Project under the new license. In addition, the stakeholders have not identified ramping rates as a particular area of concern (see the Pre-Application Document, preliminary issues and study list, Section 5). For this reason, no studies were proposed by either PPL Montana or any of the stakeholders to specifically address ramping rates, per se.

Bypass Reach

West Rosebud Creek between Mystic Lake and Emerald Lake contains three distinct reaches. The portion of the stream between Mystic Lake Dam and the powerhouse is known as the bypass reach. The flow regime in the bypass reach is significantly different from the flow regime in the portion of the stream between the powerhouse and Emerald Lake.

Under the current license, PPL Montana is required to maintain a minimum instream flow of 10 cfs in the bypass reach from June 1 through August 31 and 3 cfs the remainder of the year. Studies of fish populations and fish habitat in the bypass reach indicate that flows are currently adequate to support a healthy fishery. However, stakeholders have discussed a ramping rate to gradually increase flows from 3 cfs to 10 cfs at the end of May and to gradually step flows down from 10 cfs to 3 cfs in early September. PPL Montana has indicated a willingness to accommodate this request.

Powerhouse to Re-regulation Dam

Downstream of the bypass reach, flow is composed of a combination of the flow from the bypass reach plus the discharge from the powerhouse. There is a short reach of West Rosebud Creek (approximately 0.75 mi) between the powerhouse and West Rosebud Lake. Flows in this reach of

stream fluctuate with powerhouse discharge. Peaking operations may occur whenever economically beneficial or when generation changes are required. PPL Montana employs peaking when water and market conditions support it, and then generally from 8:00 AM to 4:00 PM daily, with lower flows for the remaining hours of the day. The reregulation dam is used to minimize any fluctuations farther downstream.

The elevation of West Rosebud Lake fluctuates on average less than 2 feet during peaking operations (Source: Pre-Application Document).

In order to get a sense of the amount of peaking that actually occurs at the Mystic Lake Powerplant, flow data for the last ten years was requested from the U.S.G.S. for the station immediately below the Mystic Project powerhouse. These data (flows at 15-minute intervals) were plotted for each month. The resulting plots were assessed, and judgments made of whether or the not the plant was peaking during the month. Peaking was defined as significant flow fluctuations that occurred regularly over a 24-hour cycle. Results are displayed in Table 1.

Table 1. Months when peaking operations occurred evaluating ten years (October 1, 1994 - September 30, 2004) of flow data from USGS gage station #6204050 (below the Powerhouse). The letter 'P' in the orange highlighted boxes depicts months when peaking operations occurred. Only half of the month is highlighted in orange when peaking operations occurred approximately half of the month or less. The entire month is highlighted in orange when peaking operations occurred for more than half or the whole month. Other boxes are highlighted in green representing all other times. White spaces indicate months that were not evaluated or data was not available.

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	Total months peaking
January				P								0.5
February				P	P	P	P					3.5
March				P	P	P						2.5
April					P							1
May							P					.5
June							P					.5
July												0
August								P				1
September							P	P				1.5
October								P	P	P		2.5
November		P		P				P		P		3
December								P		P		1.5
Total Months	0*	0.5	0	3	2.5	1.5	2	4	0.5	3	0*	

* Incomplete data for the year

As can be seen in Table 1, over the last ten years, peaking has occurred most often in February, November, October, and March. It has never occurred in July, and rarely in April, May or June. The greatest amount of peaking occurred in 2001, when peaking occurred most of the time from August through December. There have been other years with no peaking.

Table 2 has a description of the size of the flow fluctuations that occurs during peaking. During most months with peaking operations, flow fluctuations were relatively constant. However, during some months (e.g. August or December 2001), fluctuations would change, as presented in the table.

Table 2. Approximate flow fluctuations during months where peaking operations occurred are presented using data (October 1, 1994 – September 30, 2004) from USGS gage station #6204050 (downstream of the Powerhouse).

Year	Month	Approx. Fluctuation over a 24 hour cycle (cfs)	Difference in Flow (cfs)
1995	November	40 - 160	120
1997	January	36 - 124	88
	February	40 - 125	85
	March	40 - 124	84
		32 - 84	52
	November	44 - 122	78
1998	February	42 - 124	82
		38 - 77	39
	March	36 - 77	41
	April	36 - 80	44
		36 - 66	30
		36 - 50	16
	June	55 - 85	30
1999	February	35 - 72	37
	March	33 - 71	38
2000	February	24 - 60	36
	May	86 - 133	47
	June	86 - 133	47
		90 - 154	64
	September	61 - 152	91
2001	August	116 - 187	71
		74 - 187	113
	September	69 - 164	95
	October	85 - 174	89
	November	103 - 194	91
	December	100 - 187	87
		100 - 166	66
2002	October	23 - 116	93
2003	October	28 - 180	152
	November	28 - 194	166

Year	Month	Approx. Fluctuation over a 24 hour cycle (cfs)	Difference in Flow (cfs)
		44 - 150	106
	December	46 - 146	100
Average			**74**

There has been considerable variation in the amount of fluctuation that occurs during peaking. In late April 1998, flows only fluctuated by 16 cfs. However, in November 2003, flows fluctuated by 166 cfs over a 24-hour cycle. The average flow fluctuation during the 10-year period of record during months with peaking was 74 cfs.

Monthly graphs of the 15-minute increment flow measurements for 2001 illustrate the distinct difference between months with no peaking from months with peaking (see Appendix). When reviewing the graphs, note that the Y-axis changes in scale from month to month.

For example, the graph for April 2001 shows flow fluctuations, but these fluctuations did not occur on a regular 24-hour cycle and only were 2-3 cfs. In contrast, August 2001 shows regular daily flow fluctuations of 71 – 113 cfs. Consequently, April was designated as a non-peaking month in the analysis, but August was identified as having peaking.

What are the biological impacts of peaking operations on West Rosebud Creek? No biological sampling has been conducted of the aquatic resources in the stream between the powerhouse and West Rosebud Lake. However, fisheries samples of West Rosebud Lake have been collected by Montana Fish, Wildlife, and Parks, most recently in May of 2001 and 2003 and September 2004. According to the Montana Fish, Wildlife and Parks 2005 report (*in draft):*

> "West Rosebud Lake is a popular destination for anglers because of its proximity to Forest Service campgrounds and other recreation areas and because of its diverse fishery. The lake supports wild populations of brown and brook trout, mountain whitefish, and longnose suckers. Six thousand Arlee rainbow trout are also stocked into the lake annually. The lake was modified in early 1980's when the reregulation dam was constructed to moderate the flows from the Mystic Lake hydroelectric facility into West Rosebud Creek. This dam raised the water elevation of the lake, making it deeper and it effectively eliminated the daily spikes and drops in stream level below the lake. The dam also precluded fish passage from downstream in West Rosebud Creek. Thus, the populations of fish in West Rosebud Lake are isolated from downstream and can only migrate upstream to near the powerhouse where they encounter natural barriers. Despite a barriers being present in the system, there appears to be adequate spawning and rearing habitat upstream of the reservoir to provide ample angling opportunities while sustaining the lake's populations of fish…"
>
> "Because it contains adequate spawning and rearing habitat, West Rosebud Creek upstream of the lake likely serves as the primary recruitment source of small fish into the lake system. It is also likely that juvenile fish rear in the inlet stream before migration to the lake."
>
> "The brook trout population in the lake appears to be expanding considerably [since 1995]. It is unclear why there has been an increase in the brook trout numbers, but all fish in the lake appear to be in excellent condition, with no evidence of food limitation."

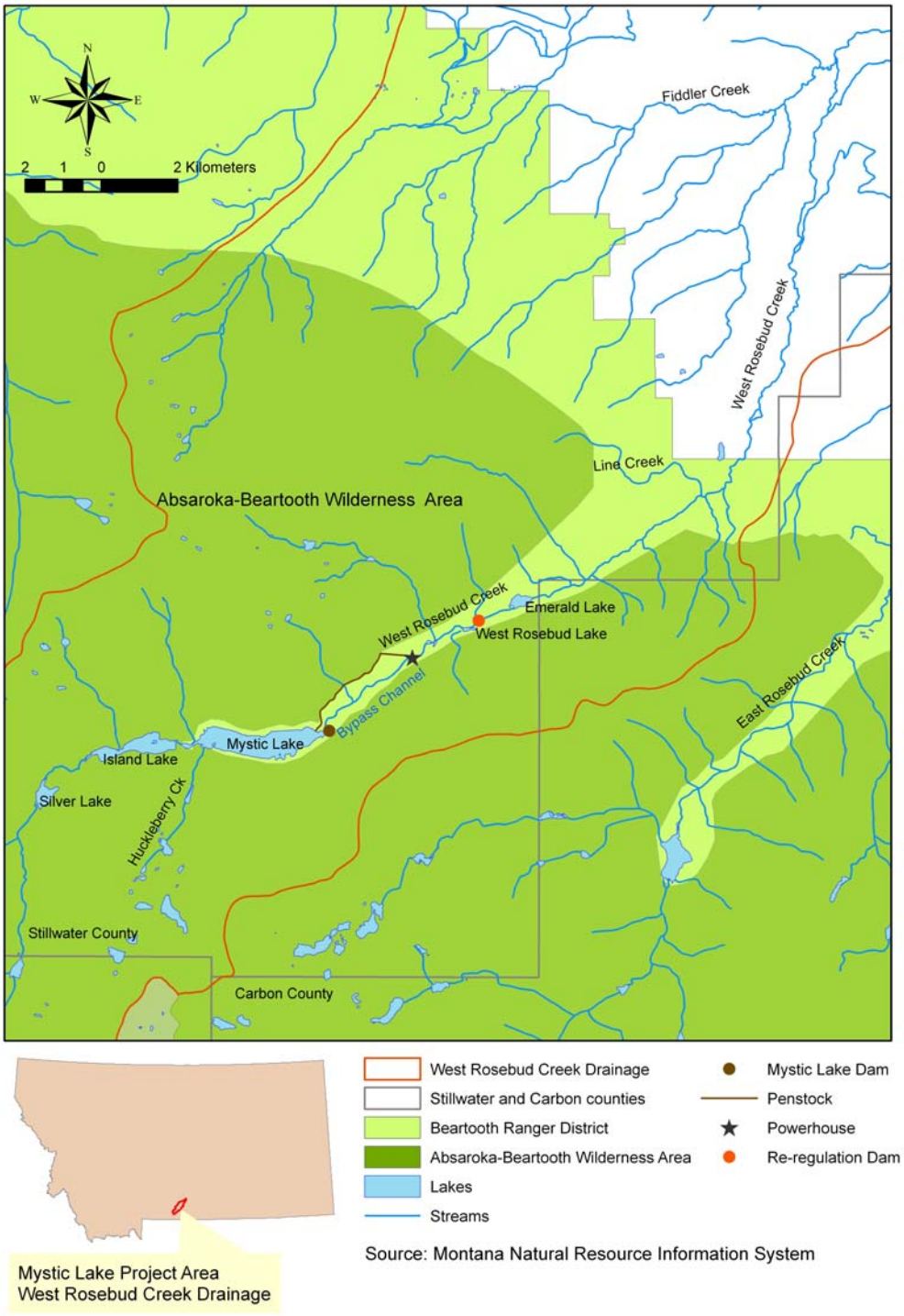
Therefore, based on the available fisheries information, it appears that current project operations are compatible with maintenance of a sport fishery in the West Rosebud Creek and

Lake system. Flow fluctuations in the reach between the powerhouse and West Rosebud Lake have not been identified as an issue by any of the stakeholders. No further studies of ramping rates are proposed for this reach.

Re-regulation Dam to Emerald Lake

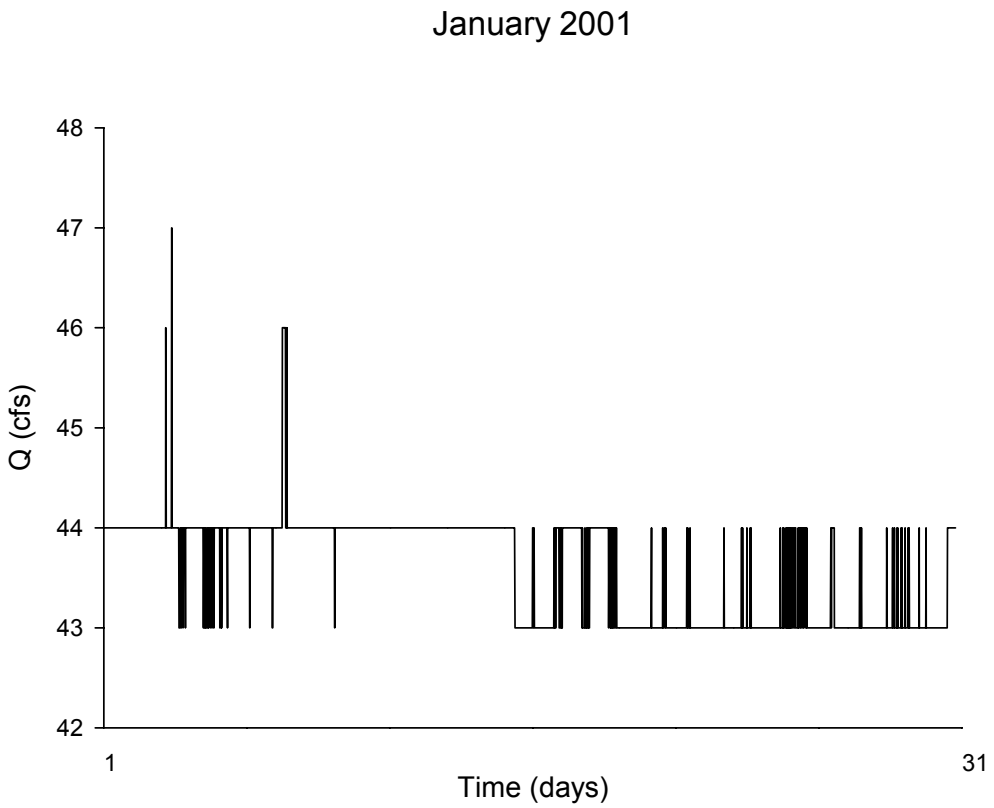
There is another short reach of stream between West Rosebud Lake and Emerald Lake (approximately 0.5 mi). Flow fluctuations in this reach of stream are moderated by West Rosebud Lake. PPL Montana operates a re-regulating dam on West Rosebud Lake that was built to reduce flow fluctuations in lower West Rosebud Creek. According to an environmental impact statement prepared by the Federal Power Commission in 1975, the re-regulating dam modifies fluctuating flows from the powerhouse to a minimum continuous flow. This promotes stabilization of stream bank erosion and prevents ice gouging in the winter. FERC issued an order issuing the new license on October 5, 1976, including provisions for the construction of the re-regulating dam. This license order acknowledged both beneficial and adverse impacts of the re-regulating dam. Among the beneficial effects noted was a uniform minimum stream flow of 20 cfs downstream of the re-regulating dam. This minimum stream flow was included as a license requirement. Therefore, the need for ramping rates below West Rosebud Lake is eliminated by the re-regulating dam.

In summary, ramping rates may be proposed during settlement negations to smooth the transition between 3 cfs and 10 cfs in the bypass reach. The re-regulating dam moderates flow fluctuations in West Rosebud Creek below West Rosebud Lake. Emerald Lake also has a moderating influence on flow fluctuations. Only the reach of West Rosebud Creek between the powerhouse and West Rosebud Lake is subject to flow fluctuations during power peaking or load following. No resource concerns have been identified in this reach. Currently, several species of non-native salmonids are naturally reproducing in the West Rosebud Creek and Lake system, in adequate numbers to support a popular fishery.

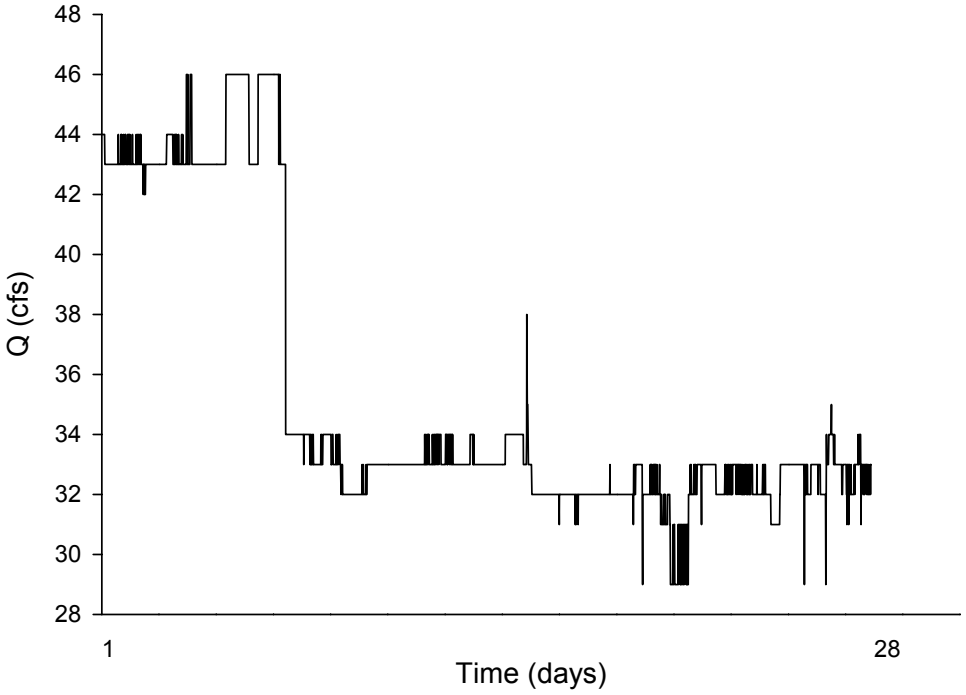

N
W
E
S
2 1 0 2 Kilometers
Fiddler Creek
West Rosebud Creek
Line Creek
Absaroka-Beartooth Wilderness Area
West Rosebud Creek
Emerald Lake
West Rosebud Lake
Bypass Channel
East Rosebud Creek
Mystic Lake
Island Lake
Silver Lake
Huckleberry Ck
Stillwater County
Carbon County
West Rosebud Creek Drainage
Stillwater and Carbon counties
Beartooth Ranger District
Absaroka-Beartooth Wilderness Area
Lakes
Streams
Mystic Lake Dam
Penstock
Powerhouse
Re-regulation Dam
Source: Montana Natural Resource Information System
Mystic Lake Project Area
West Rosebud Creek Drainage

Appendix A.

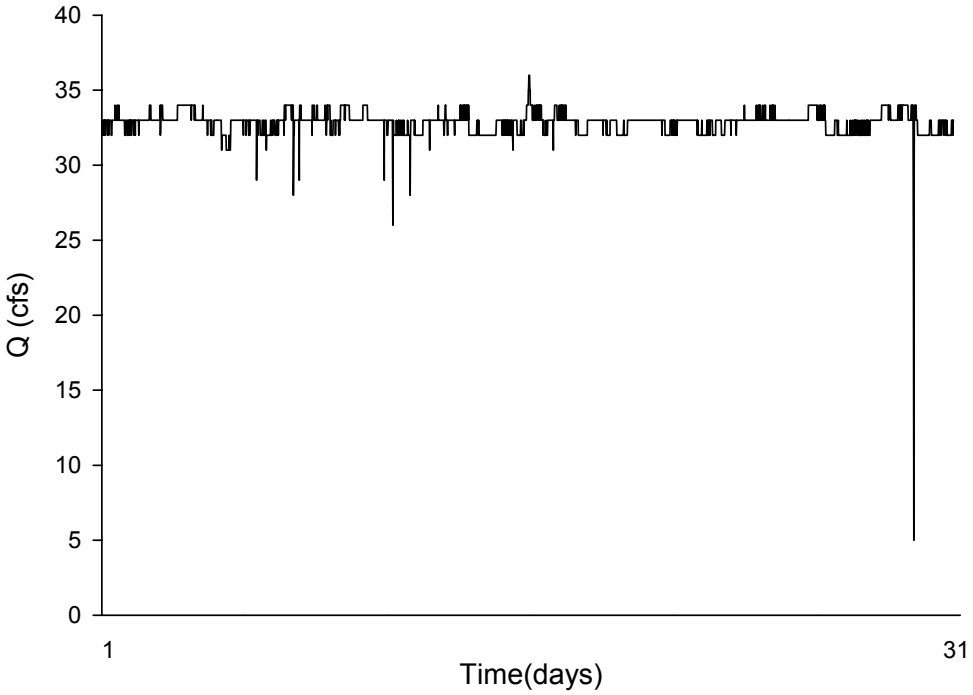
Peaking was defined by a significant and repetitive fluctuation of flow over time. Refer to graphs from January through December 2001 for an example of peaking and non-peaking operations. There were five months in 2001 where peaking operations were observed. These months included August, September, October, November, and December. However, peaking operations only occurred during some portions of September and December.



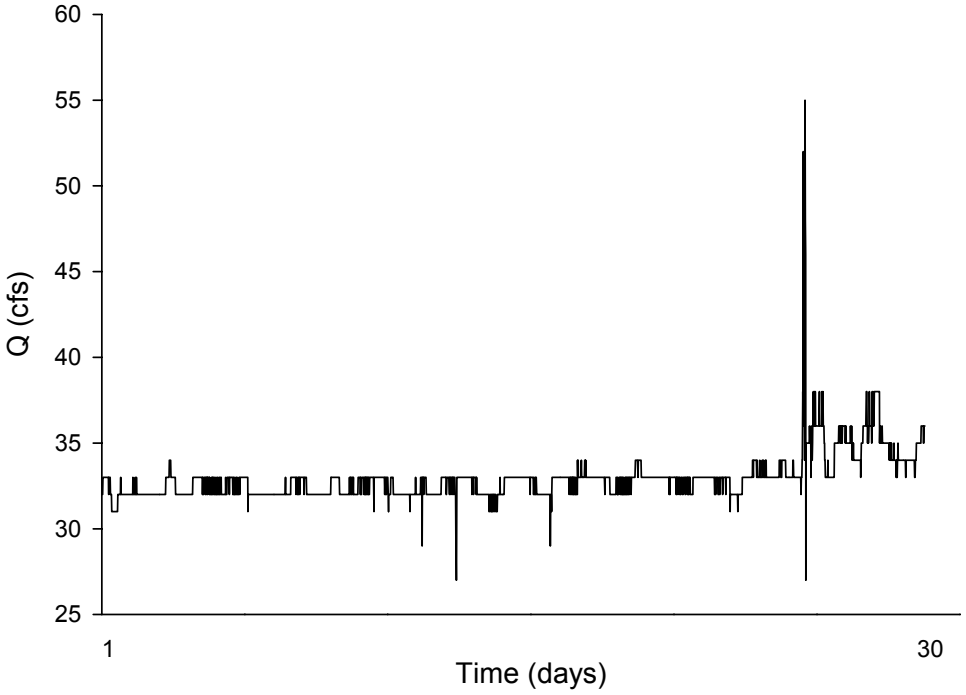
February 2001



March 2001



April 2001



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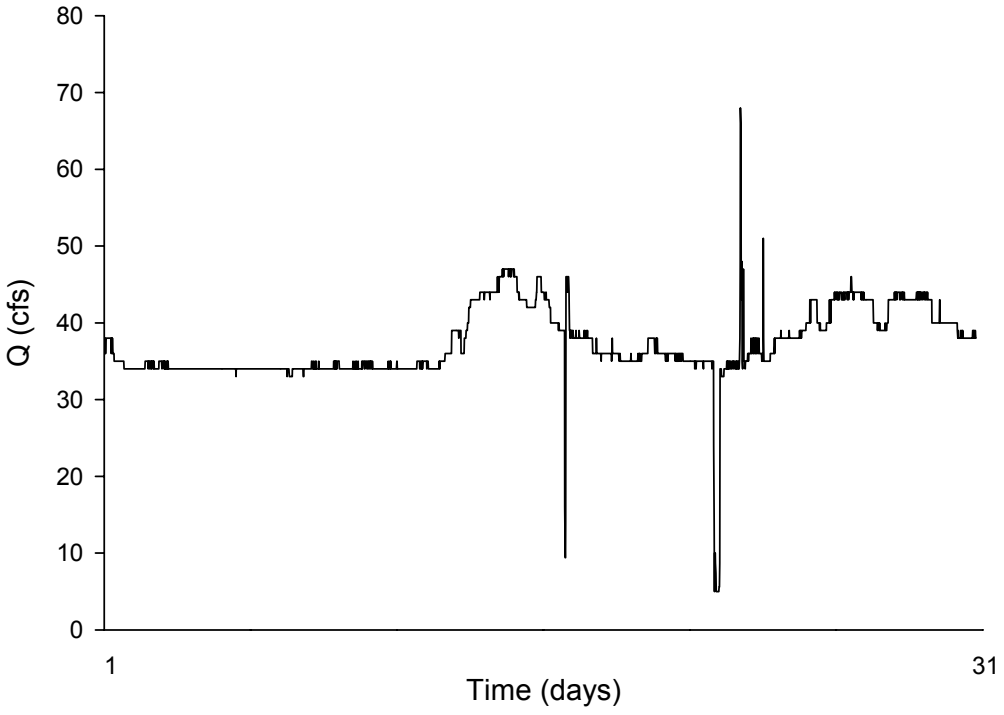
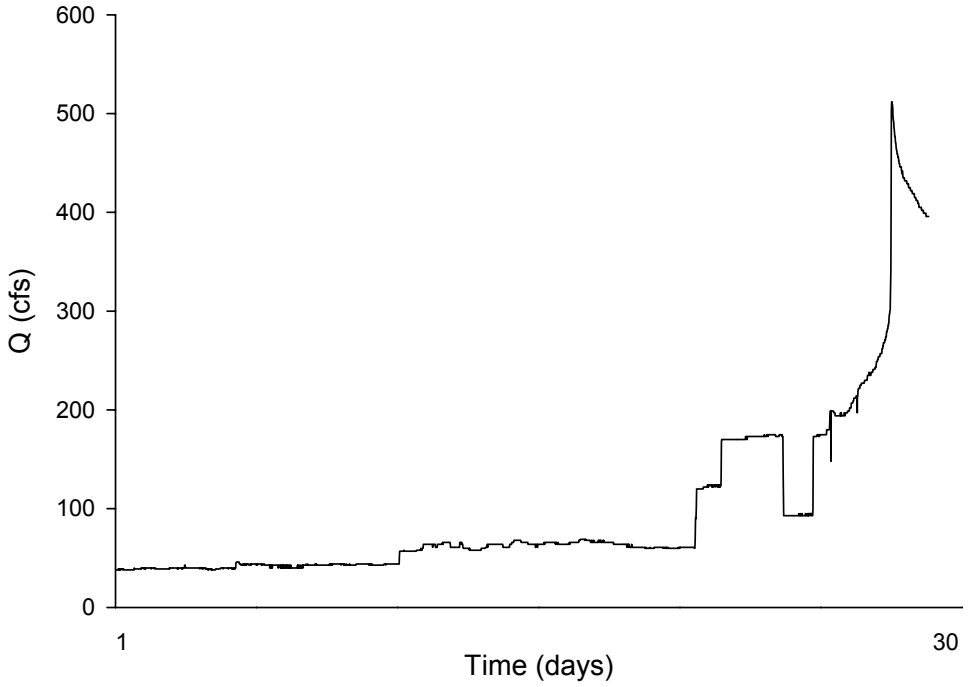
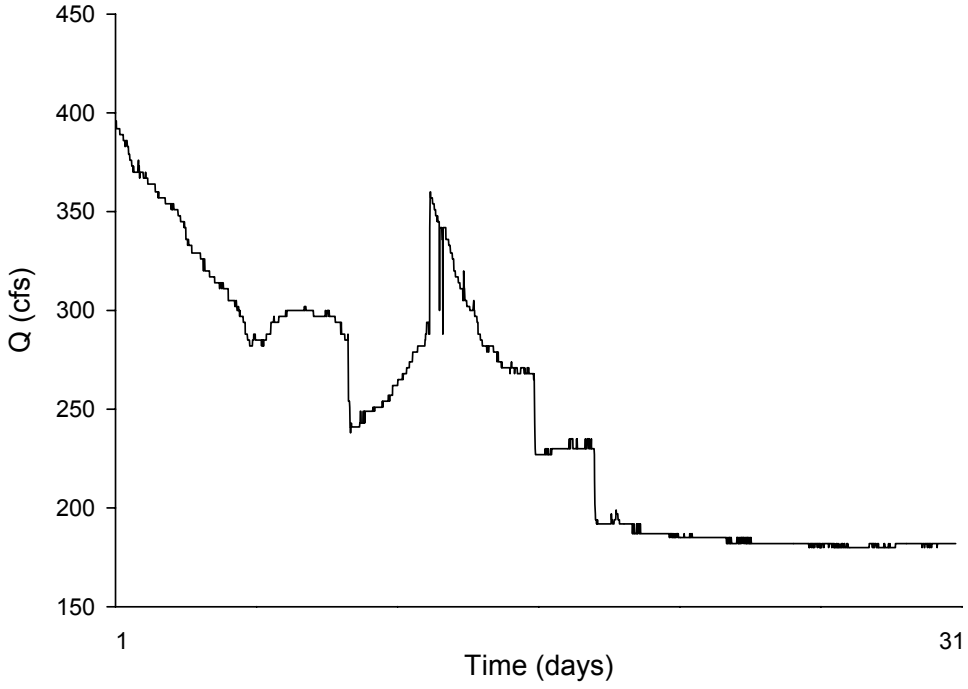


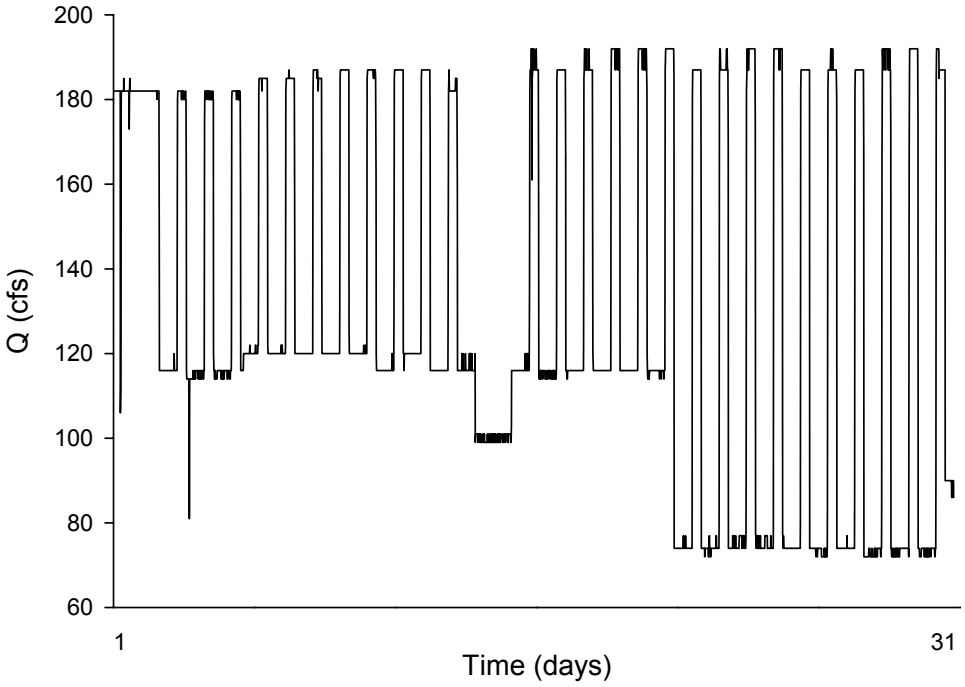
June 2001



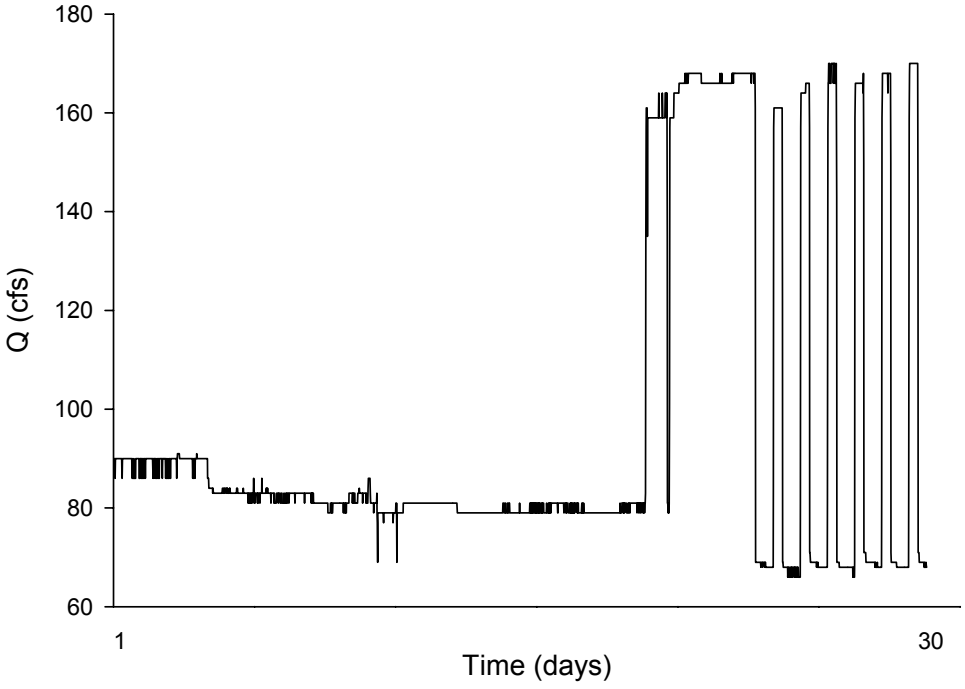
July 2001



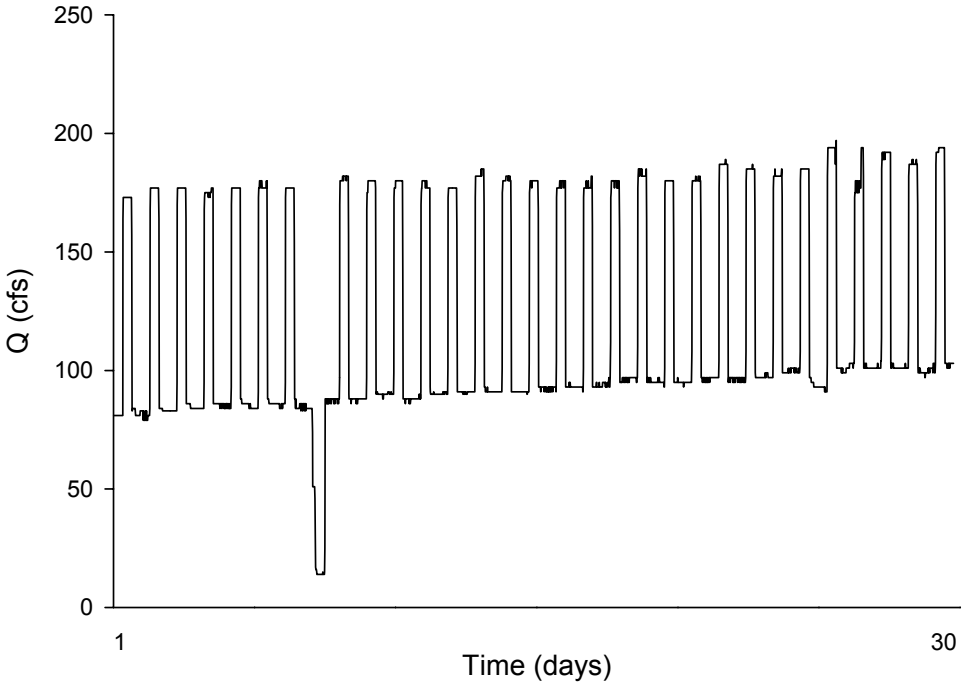
August 2001



September 2001



October 2001



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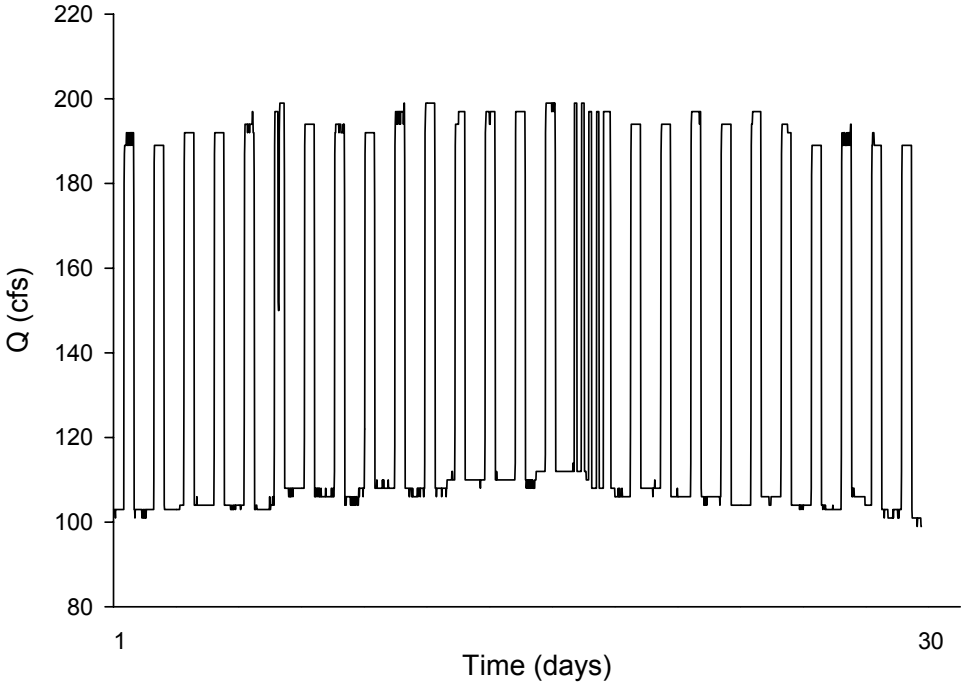

December 2001