Ernst Kerkhoven, July 2014

Wapiti River and Tributary Flows 1968-2010

Introduction

The Wapiti River Environmental Flow Needs study requires naturalized and regulated stream flow data sets for the Wapiti River and its major tributaries. In this case, the naturalized flow data set only considers the impacts of historical licensed withdrawals and returns to the watershed.

The area of interest is the Wapiti River from upstream of the mouth of Pinto Creek to the confluence of the Wapiti and Smoky Rivers. Key identified tributaries are: Pinto Creek, Redwillow River, Bear River (also known as Bear Creek), and Big Mountain Creek. The Beaverlodge River, which is a tributary of the Redwillow River, is also of key interest. Historical Water Survey of Canada stream flow data is available for Pinto Creek, Redwilow River, Bear River, and Beaverlodge River. Although the period of record for Bear River is short, there is a much longer record for water levels in Bear Lake that can be used to estimate Bear River flows. The only mainstem WSC station used in this study is the Wapiti River near Grande Prairie, which has been in continuous operation since 1960. Because flows are needed at several locations along the mainstem of the Wapiti River as well as from tributaries, the time period of this study is limited to March 1968 (the first date for which tributary flows are available) and December 2010 (the last date for which flow data is available for Wapiti River near Grande Prairie).

Methodology

The flow data sets were derived by the following Methodology:

1) Estimate missing data at gauged sites by prorating flows from the Wapiti River near Grande Prairie station, which is gap free
2) Linearly adjust the gap-filled data to maintain smooth transitions with observed tributary flow data
3) Estimate ungauged contributions by prorating flows based on drainage area with nearby tributary flow data from step (2)
4) Backwards route flows from Grande Prairie to above the Pinto Creek confluence
5) Smooth the resulting upstream hydrograph from step (4) to reduce noise during periods of low flow
6) Route the hydrograph from step (5) to Grande Prairie to derive the hydrographs from Pinto Creek to Grande Prairie
7) Route the Observed hydrograph at Grande Prairie to the Wapiti River mouth
8) Naturalize the hydrographs from Steps (6) and (7) adding in reported and estimated non-reported licensed water withdrawals and returns

Results

Licensed Water Use

Monthly historical water use data was collected for the 18 largest water licences in the Wapiti River Basin for which reported water use data was available (Table 1). Together these licences represent 89% of the gross allocated volume in the basin (64 million out of a total of 72 million cubic metres per year).

Figure 2 summarizes net water allocation (allocated withdrawal volumes minus allocated return volumes) since 1968. The large increase in 2011 is the new licence for the City of Grande Prairie (Aquatera) to accommodate future growth in the region. Nearly half of the net allocation is for wetlands and lake stabilization licences. These licences represent the annual evaporation from wetlands and lakes that have been altered by wetland restoration/construction projects or weirs on lakes. These licence volumes are typically quite high since they represent the evaporation over a large surface area. However, most of this evaporation would occur with or without the man-made alterations so they do not reflect the actual impact of these projects on the local hydrology. The actual impact is best represented by the net evaporation (annual evaporation minus annual precipitation) over the increased wetted area produced by, typically, a weir. These licences do not report any water use because they do not involve the direct removal of water from a water body, so their impacts on river flows have to be estimated.

For the purpose of estimating the impact of licences on the river flows in the Wapiti River basin, wetland projects were treated as having zero net impact because these projects typically are attempts to restore or compensate for natural wetlands that have been lost. For lake stabilization projects, the effective water use, i.e. net evaporation over the change in lake area, was estimated at 6% of annual allocations. This volume was then distributed over the year based on average monthly runoff data in the Beaverlodge River since the primary impact of a weir is to reduce outflow during periods of higher runoff, which is primarily from April to June. The 6% values is taken by estimating long term reduction in outflow from a lake stabilization project that increases the average surface area of a lake by 20% where the average annual evaporation is 650 mm and the average annual precipitation is 450 mm, which are typical values for the Wapiti River Basin.

Water use from registrations was also distributed according to the mean Beaverlodge River annual hydrograph because most of this water comes from dugouts that tend to fill during periods of higher runoff. Registrations were assumed to use 100% of their registered annual volume. The current total registration volume in the Wapiti River Basin is 371,895 m^3/year for 1747 registrations. The remaining 140 licences, other than the top 18 reporting licences, were assumed to use 100% of their allocation dating back to the licence priority date.

Temporary Diversion Licences (TDLs) are granted by the province Alberta for water use over a period of less than one year. Digital allocation data for TDLs has been available since 2000. For this report, TDL allocation volumes before 2000 were estimated based on population records. TDL allocations were assumed to have grown proportionately with the total population in the City of Grande Prairie, Wembley, Beaverlodge, and the County of Grande Prairie, which has increased from 21,722 in 1968 to

54,802 in 2000 and 79,154 in 2012. All TDLs were assumed to use 100% of their allocation. Estimated TDL volumes were then distributed among the sub-watersheds based on the TDL allocations in 2000. The total volume allocated to TDLs in 2012 for the Wapiti River Basin was 551,041 m^3 and a total of 102 TDLs were issued that year.

For most of the top 18 licences, water use data is available from 2005 to present. Water use from Weyerhaeuser and the City of Grande Prairie is available from 1994 and 1997, respectively. Earlier water use for the City of Grande Prairie was assumed to grow in proportion to the city's population from 1968 to 1997. For the other licences, water use was assumed to be equal to the first year with reporting data going back to the licences reporting date. The exception was the Weyerhaeuser licence. For this licence, water use from 1977 to 1993 was assumed to be equal to use from 1994. Because Weyerhaeuser's licence volume was 22.7% lower before 1977, its estimated use from 1973 to 1976 was assumed to be 77.3% of 1994 reported water use. Finally, because the Weyerhaeuser plant started operating in September 1973, water use was assumed to be zero before this date.

The estimated historical actual water use is summarized in Figure 3, which shows annual gross withdrawal and return volumes for Weyerhaeuser and the City of Grande Prairie as well as the net water use for all other licences and registrations. Weyerhaeuser and Grande Prairie are by far the largest water users in the basin; however they return most of their water back to the river. Total net water use in the basin has fluctuated around 5 million m^3/year since 1998. In an average year, Weyerhaeuser and Grande Prairie each represent about one-third of net water use in the Wapiti River Basin. The remaining third is accounted for by all other licences and registrations combined.

Regulated and Natural Flows

Figure 4 shows the average monthly flows along the main stem of the Wapiti River from 1968 to 2010. 80% of the annual flow originates upstream of Pinto Creek. Major gauged tributaries are the Redwillow River (9.4%), Bear River (3.7%), and Pinto Creek (2.3%). Annual contributions from the ungauged Big Mountain Creek are estimated to be 4%. All other tributaries combined account for only 1% of Wapiti River flow at the mouth. The Beaverlodge River accounts for 25% of flow in the Redwillow River and 2.4% of flow in the Wapiti River.

Figure 5 compares the natural and regulated flows of the Wapiti River at the river's confluence with the Smoky River over the period 2000 to 2010, which represents the period of current water use. The difference between the regulated and natural flows is also shown. The average natural flow, regulated flow, and net use are 91.04, 90.88, and 0.16, respectively. Therefore, since 2000, net water use has been less than 0.2% of average natural flow. The highest level of relative net withdrawals at the mouth was 3.6% on 3 April 2008 when the regulated and natural flows were 9.20 and 9.54 m^3/s, respectively. The Highest level of net withdrawal at any location along the river was 15.7% in 21 December 2007, when regulated and natural flows were 8.19 and 9.71 m^3/s, respectively. This occurred immediately below the Weyerhaeuser intake.

Table 2 summarizes the difference between regulated and natural flows at various locations along the Wapiti River. The reach between the Weyerhaeuser intake and outfall is the location of the largest

reductions in flow because Weyerhaeuser withdraws far more water than any other user in the watershed. However, because Weyerhaeuser returns almost all the water it withdrawals changes in flow below the outfall are much smaller. For example, the regulated and natural flows in the Wapiti River below the Weyerhaeuser outfall on 21 December 2007 were 10.00 and 10.14 m^3/s, respectively; a difference of only 1.4%. Negative values in Table 2 indicate occurrences when the town of Beaverlodge releases water from its sewage lagoons.

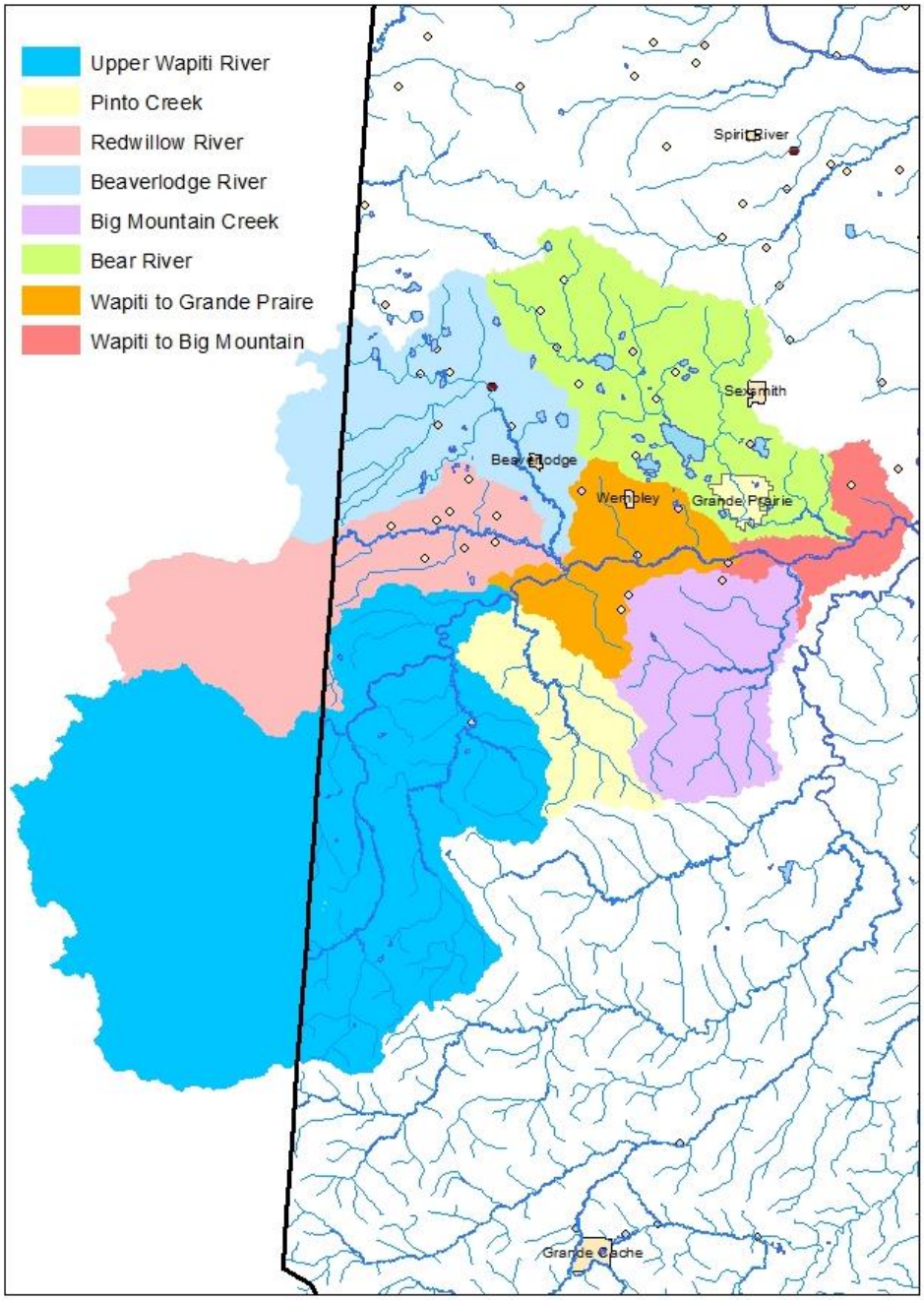

Figure 1 – Wapiti River Watershed and the sub-watersheds used in this report.

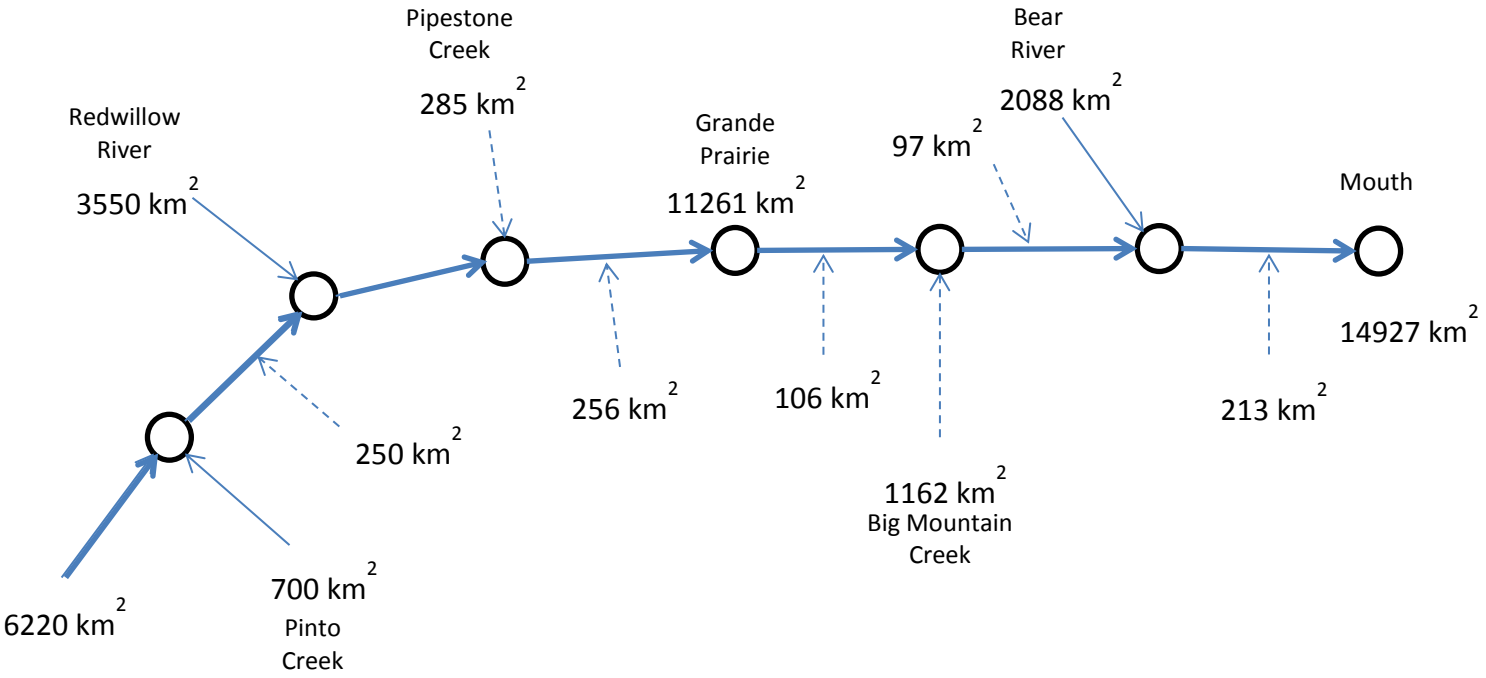

Figure 2 – Drainage Area Contributions to the Wapiti River Watershed from above Pinto Creek to Smoky River Confluence. Dashed lines indicate contributions from ungauged watersheds.

Table 1 – Top 18 water allocations in the Wapiti River Basin

Name	Start Date	Specific Use	Water Body	Allocation (m^3/year)	Return (m^3/year)	Net (m^3/year)
AQUATERA UTILITIES INC.	3-Feb-1965	Urban	Wapiti River	21,470,767	12,919,267	8,551,500
WEYERHAEUSER COMPANY LIMITED	30-Jun-1971	Other	Wapiti River	40,504,910	36,434,420	4,070,490
ERIC & CARMEN DE SCHIPPER	22-Dec-1975	Crop	Redwillow River	23,440	0	23,440
WAPITI GRAVEL SUPPLIERS (N.P.A. LTD.)	25-Jul-1978	Aggregate	Bear River	19,730	0	19,730
DUCKS UNLIMITED CANADA, EDMONTON	21-Jun-1979	Wetlands	Beavertail Creek	407,050	0	407,050
TISSINGTON FARMS	25-Feb-1980	Crop	Wapiti River	27,140	0	27,140
TOWN OF BEAVERLODGE	6-Jul-1981	Urban	Beaverlodge River	690,760	536,570	154,190
ANDREWS, ROBERT	27-Feb-1984	Garden	Dimsdale Lake	76,480	0	76,480
GOOD-TO-FARE RANCH LTD., THE	25-Jun-1986	Crop	Barr Creek	18,500	0	18,500
ERCO WORLDWIDE	9-Aug-1990	Other	Wapiti River	271,360	57,970	213,390
RICHMOND HILL GOLF CLUB LIMITED	23-Oct-1991	Golf Course	Bear River	98,670	0	98,670
BEAR CREEK GOLF CLUB LTD.	22-Oct-1992	Golf Course	Bear River	83,000	0	83,000
NEWALTA CORPORATION	5-Jul-1994	Other	Wapiti River	14,800	0	14,800
AINSWORTH ENGINEERED CANADA LIMITED PARTNERSHIP	23-Sep-1994	Other	Surface Runoff	117,180	0	117,180
AINSWORTH ENGINEERED CANADA LIMITED PARTNERSHIP	4-Feb-1999	Other	Unnamed Lake - Noncontributing	25,000	0	25,000
1031266 ALBERTA LTD.	13-Sep-1999	Golf Course	Beaverlodge River	60,000	0	60,000
PIPESTONE GOLF COURSE	14-Oct-2004	Golf Course	Surface Runoff	55,300	0	55,300
HUTTERIAN BRETHREN CHURCH OF GRANDVIEW	29-Dec-2008	Co-op	Bear Lake	33,000	0	33,000
			Total - Top 18	63,997,087	49,948,227	14,048,860
			Total Other	8,092,962	313,300	7,779,662
			Total	72,090,049	50,261,527	21,828,522

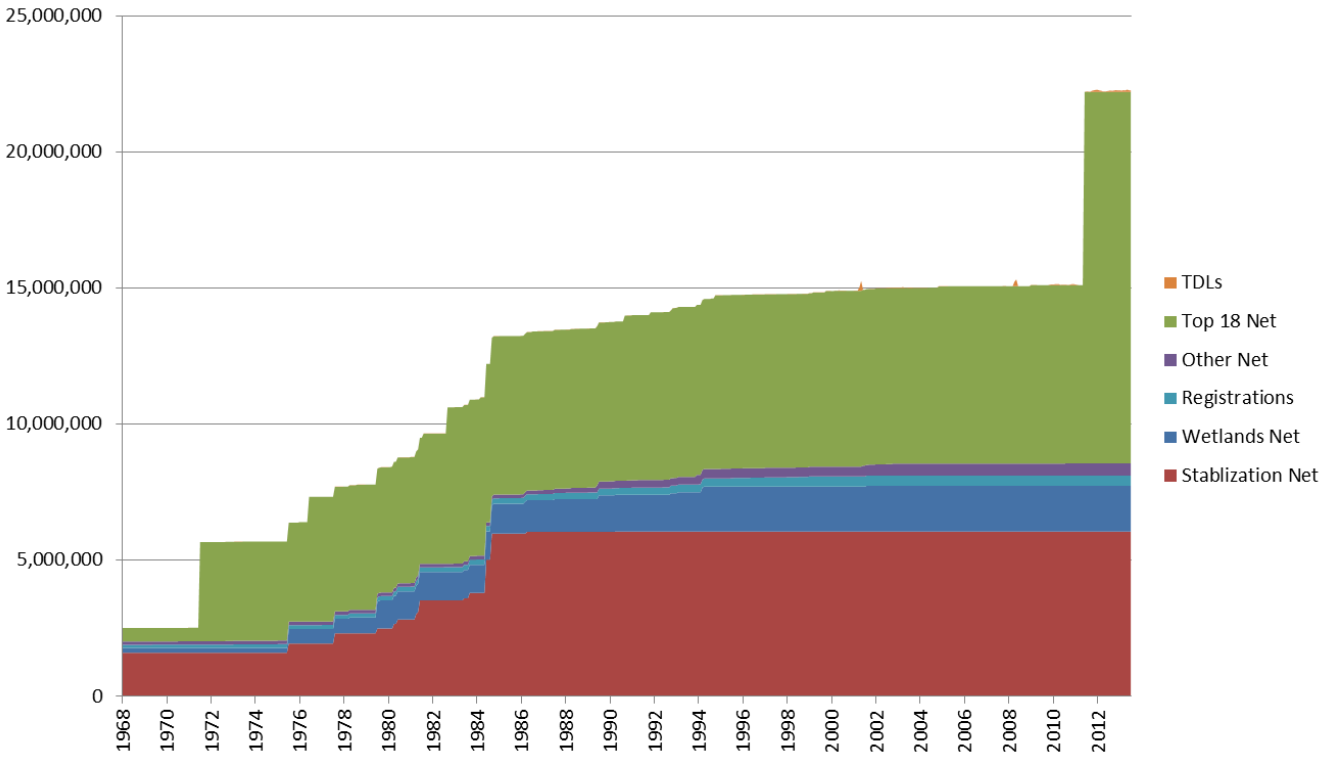

Figure 2 – Historic annual net water allocation in the Wapiti River Basin.

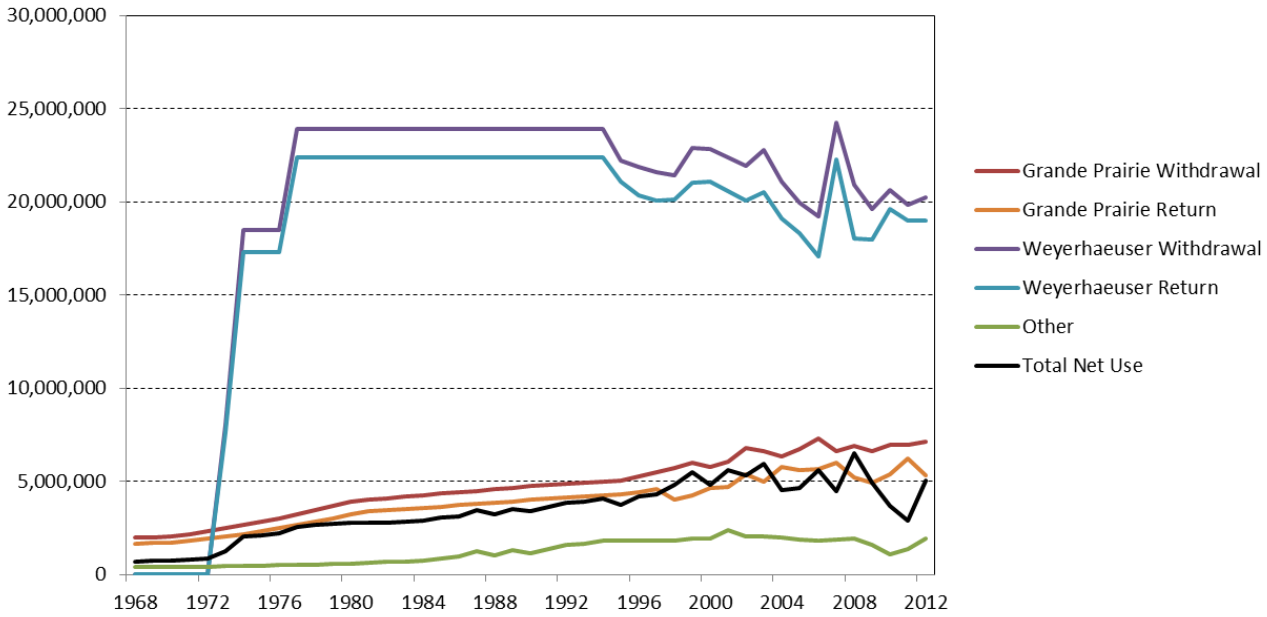

Figure 3 – Historic annual water use in the Wapiti River Basin. Weyerhaeuser water use before 1994 is estimated based on use in 1994. Grande Prairie water use before 1997 is estimated based on population before 1997.

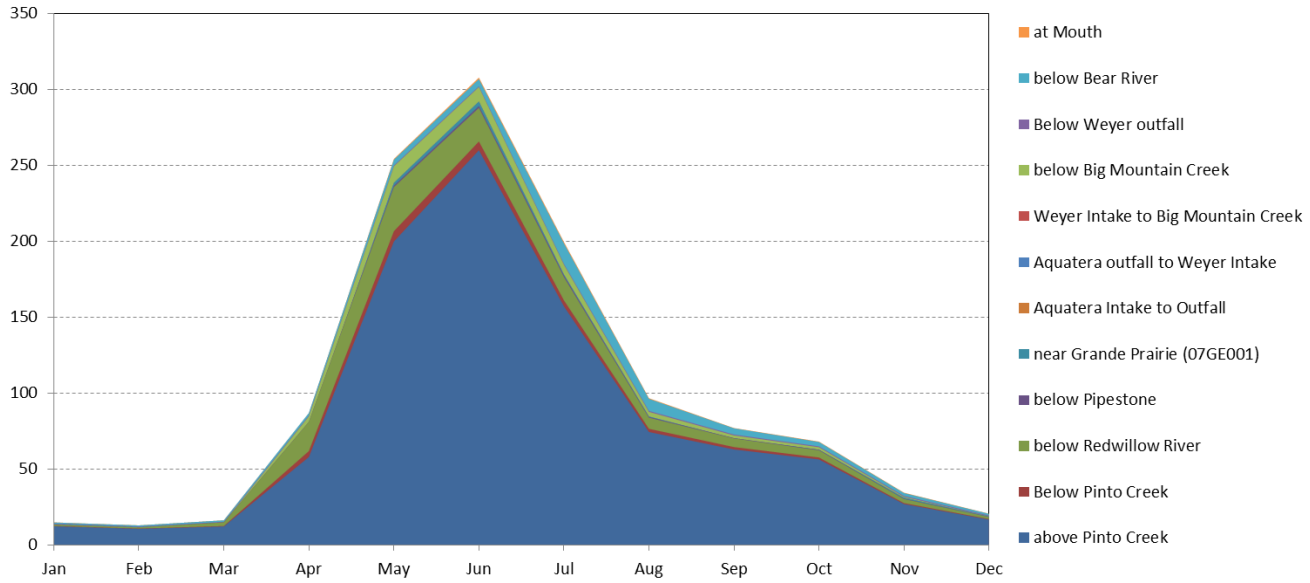

Figure 4 – Average monthly flows along the Wapiti River, 1968-2010. 80% of Wapiti River flow at the mouth originates upstream of Pinto Creek.

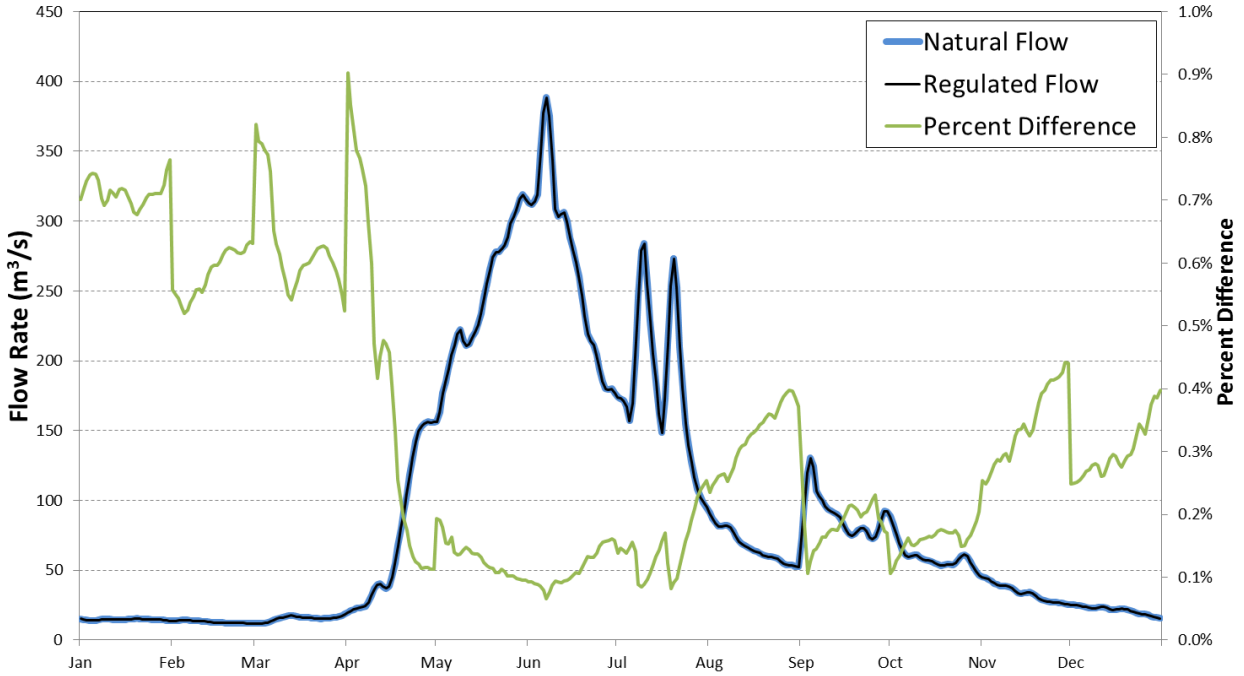

Figure 5 – Average daily flow of the Wapiti River at the mouth with the Smoky River flow under regulated and natural conditions for the period 2000-2010. The percent difference is shown in green.

Location	Maximum	Upper Quartile	Mean	Lower Quartile	Minimum
above Pinto Creek	0.9%	0.0%	0.0%	0.0%	0.0%
Below Pinto Creek	0.8%	0.0%	0.0%	0.0%	0.0%
below Redwillow River	1.9%	0.1%	0.0%	0.0%	-2.1%
below Pipestone	1.9%	0.1%	0.0%	0.0%	-2.0%
near Grande Prairie (07GE001)	2.0%	0.1%	0.1%	0.0%	-2.0%
Aquatera Intake to Outfall	4.8%	1.5%	0.9%	0.3%	-0.4%
Aquatera outfall to Weyer Intake	2.8%	0.3%	0.2%	0.0%	-2.0%
Weyer Intake to Big Mountain Creek	15.7%	4.8%	3.1%	0.8%	0.0%
below Big Mountain Creek	15.0%	4.6%	3.0%	0.8%	0.0%
Below Weyer outfall	2.5%	0.6%	0.4%	0.1%	-2.1%
below Bear River	3.0%	0.6%	0.4%	0.2%	-1.8%
at Mouth	3.6%	0.6%	0.4%	0.2%	-1.7%

Table 2 – Summary statistics for the difference between natural and regulated flows along the Wapiti River for the period 2000-2010. Positive values indicate reductions in flows due to withdrawals exceeding returns.