

Appendix W. National Weather Service

Libby Dam and Bonners Ferry Forecast Analysis and Findings June 2006

Summary

The following report is a compilation of information provided from NWRFC including reports filed by the USACE RCC and Service Hydrologists from Missoula and Spokane. This product is an assessment of NWRFC products and services related to flooding on the Kootenai River at Bonners Ferry Idaho (BFEI1). This report examines the events beginning in May 15th and focuses on the June 8th to June 17th time frame. Findings and recommendations have identified areas to improve forecasts and modeling products and services.

Meteorological Summary

Record daily temperatures occurred during the second and third week of May of 2006 in the Columbia River Basin. Climate stations operated by Environment Canada and NOAA's National Weather Service illustrates the duration and magnitude of the temperature event. Specific station data is documented in figures and text products located in the appendix.

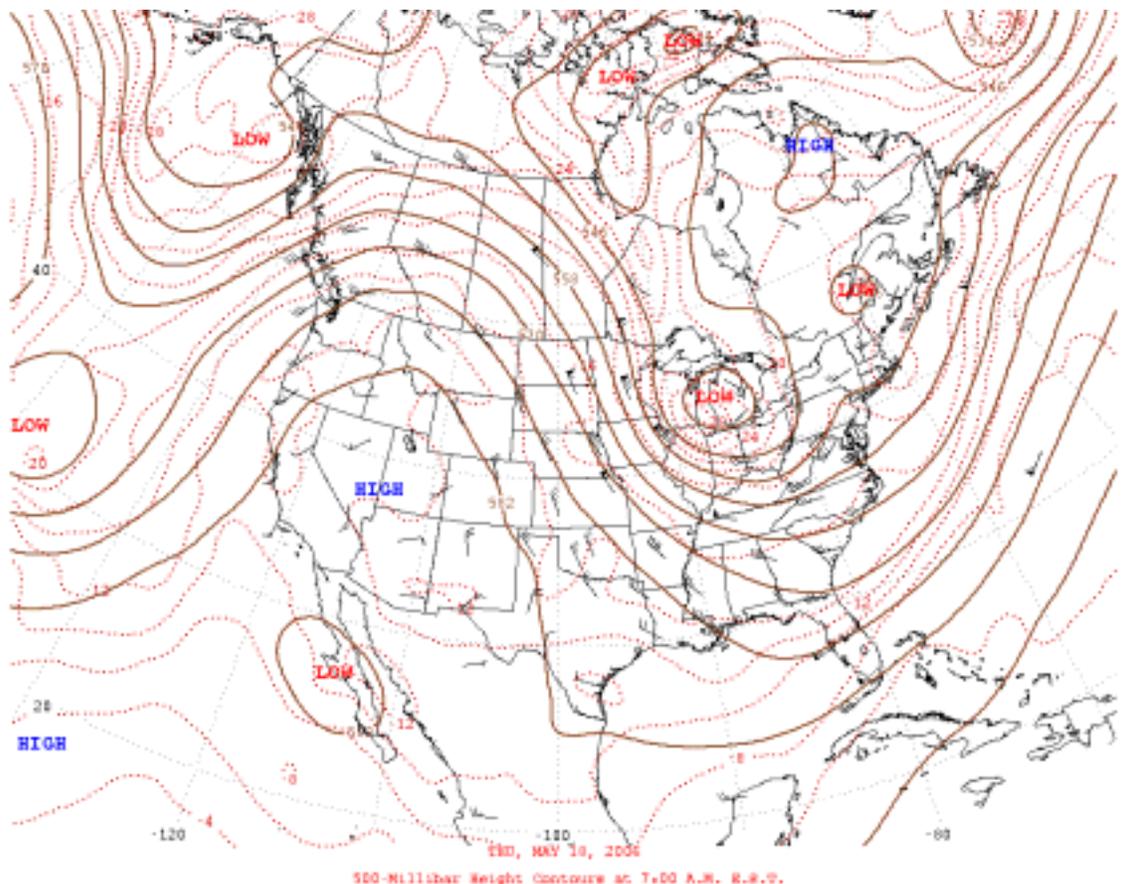


Figure 1: 500mb heights May 18th showing a high pressure ridge over the Western United States

In south east British Columbia the high temperatures were followed by heavy convective rains. Rainfall during the second half of May was above normal for the Kootenay basin. The NWRFC water supply precipitation index describes the precipitation recovery in the Kootenay basin for the month of May. Water supply precipitation analysis was 46 percent of normal on May 15th and by the end of May the Kootenay basin was 96 percent of normal. Dry conditions dominated the region during a period from May 30th to June 2nd. Early in June an upper level Gulf of Alaska low pressure system located off the west coast of the United States began impacting areas west of the cascade crest.

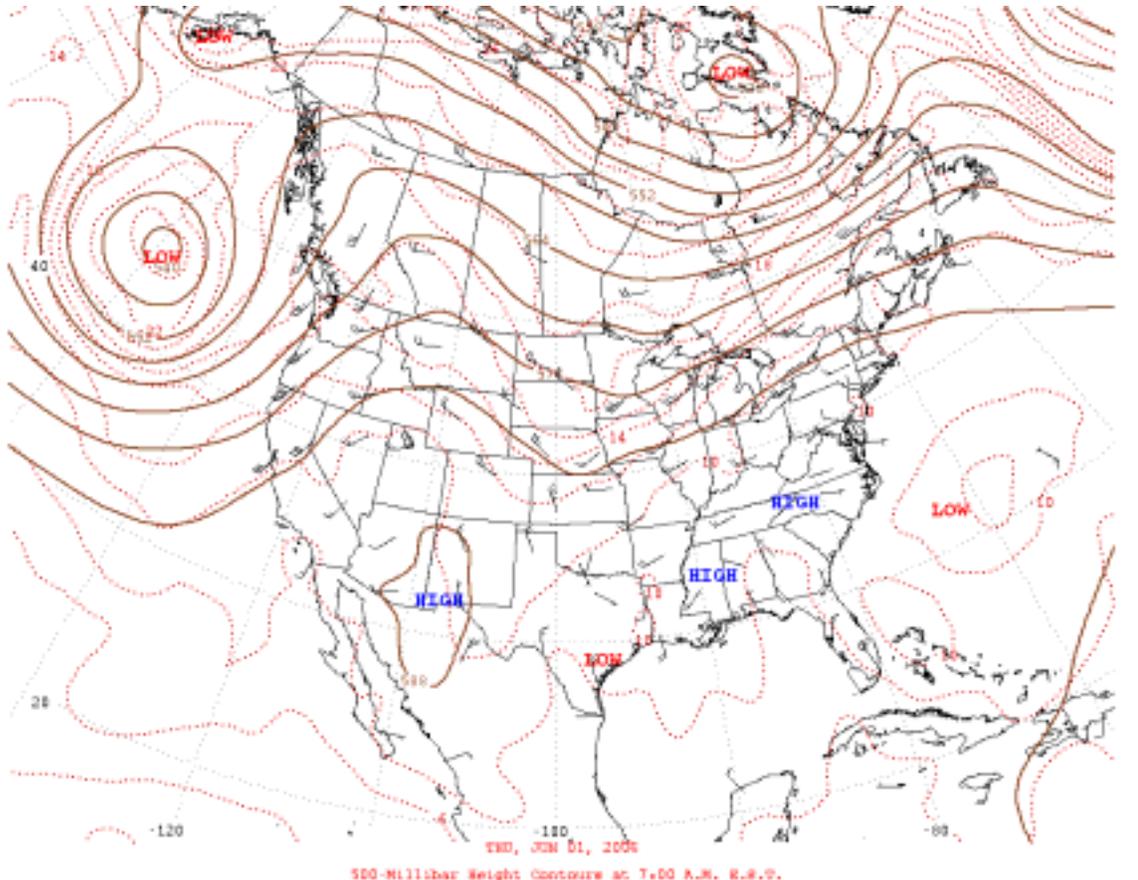


Figure 2: 500mb Heights June 1 shows low pressure off the West coast of the U.S.

Three precipitation events impacted the Kootenay basin June 5th, June 8th and June 15th. The rain events were caused by a trough positioned off the West coast of the U.S.

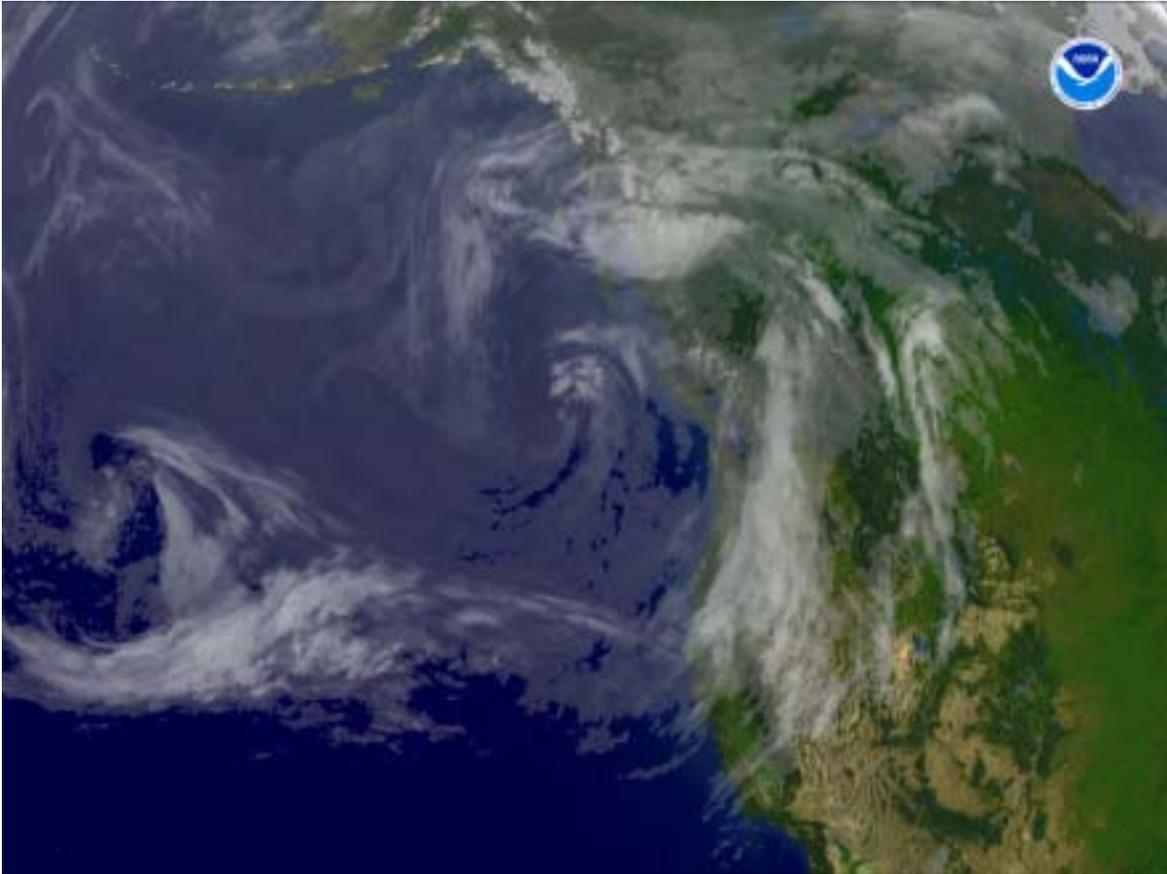


Figure 3: An area of low pressure beginning to move inland over parts of British Columbia and other parts of the Pacific Northwest. Observation Device: GOES-10 4 km infrared imagery. Visualization Date June 2, 2006 12:41:09.

Weather models indicated significant precipitation forecast for the second week of June. The atmosphere was very unstable due to a mix of merging Gulf of Mexico monsoonal moisture and a cold core low over Washington. The contrast of warm southeastern air and a push of cool air created thunderstorms with brief heavy rains June 7th and 8th. Heavy rain was reported at Bonners Ferry, Leonia, the headwaters of Libby Dam near Fernie. Cranbrook(YXC) reported 0.32 inches on the 7th and 0.75 inches on the 8th. Elk River at Fernie reported 1.48 inches in the first 12 hours of June 8th. This heavy rain in the Kootenai headwaters was the first of three rain driven rises. Analyzing the month of June 1.48 inches at Elk River at Fernie(ERFQ2) was exceeded only 10% of the period of record 1913-2004. The persistent weather pushed another event into the Libby headwaters. ERFQ2 reported 1.10 inches on the 15th of June which is exceeded by 20% of the June events in the 91 year period of record.

The center of the cold core low moved east pushing warm moist and unstable north into the eastern British Columbia. An occluding low hit headwater basins in the Upper Columbia basin and the Northern Idaho Panhandle with 0.75 inch to 1.50 inch rain accumulations for the 24 hour period ending 4am PDT June 14th.

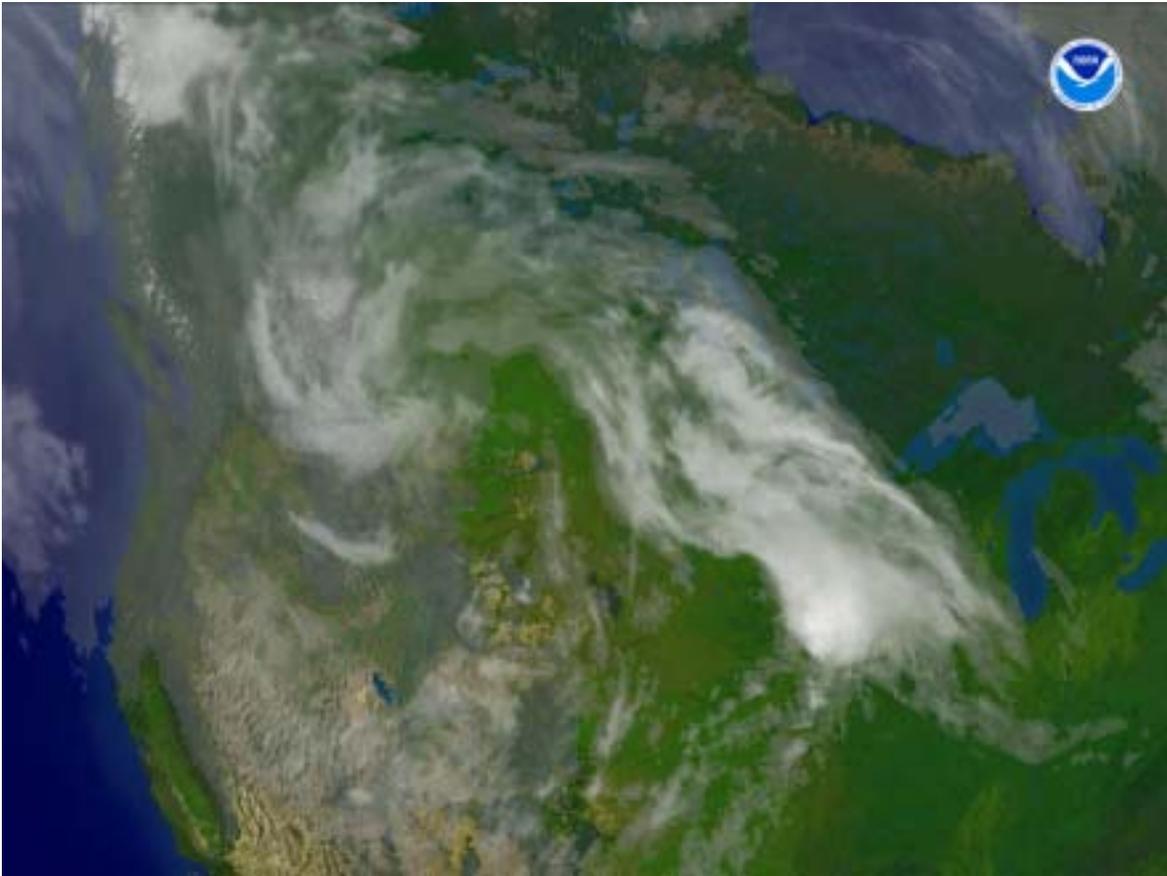


Figure 4: Data Elements: A frontal system bringing showers and thunderstorms to the Pacific Northwest, eastward to parts of the northern Rocky Mountains June 15th 09:35:56 UTC.

The atmosphere contained high precipitable water and that moist air moved from east to west over the continental divide. Rains fell in the eastern sections of the Kootenay, Pend Oreille and Flathead River basins with observed amounts of 1.00 inches common. Imbedded convection resulted in a few sites reporting 1.50 inches to 2.25 inches. Glacier International airport (GPI) received 1.15 inches which is .17 inches less than the 2-year 24-hour precipitation event (NOAA Atlas 2). Glacier Park International airport experienced a three day total of 1.87 inches. The GPI three day precipitation amount for the month of June was exceeded 18 years of the 60 years of record 1943-2003. Libby Dam precipitation for June 2006 was 4.98 inches which was 266% of normal June Libby Dam (1.87 inches). June 14th and 17th were the 8th and 6th wettest days of June since 1986 at Libby Dam. On June 8th, Elk River at Fernie(ERFQ2) received 1.48 inches. 10th wettest June day since 1913. Porthill reported 0.95 inches on June 15th that is the 8th wettest June day since 1892.

Kootenai Basin Description

The Kootenai River is 448 miles in length and drains an area of 17,600 mi² from 50 miles north east of Canal Flats (near Columbia Lake) to Kootenay Lake (QBYQ2). The Elevation distribution ranges from 1739.2 feet minimum forebay elevation of Kootenay Lake to 10,830 feet along the crest of the continental divide.

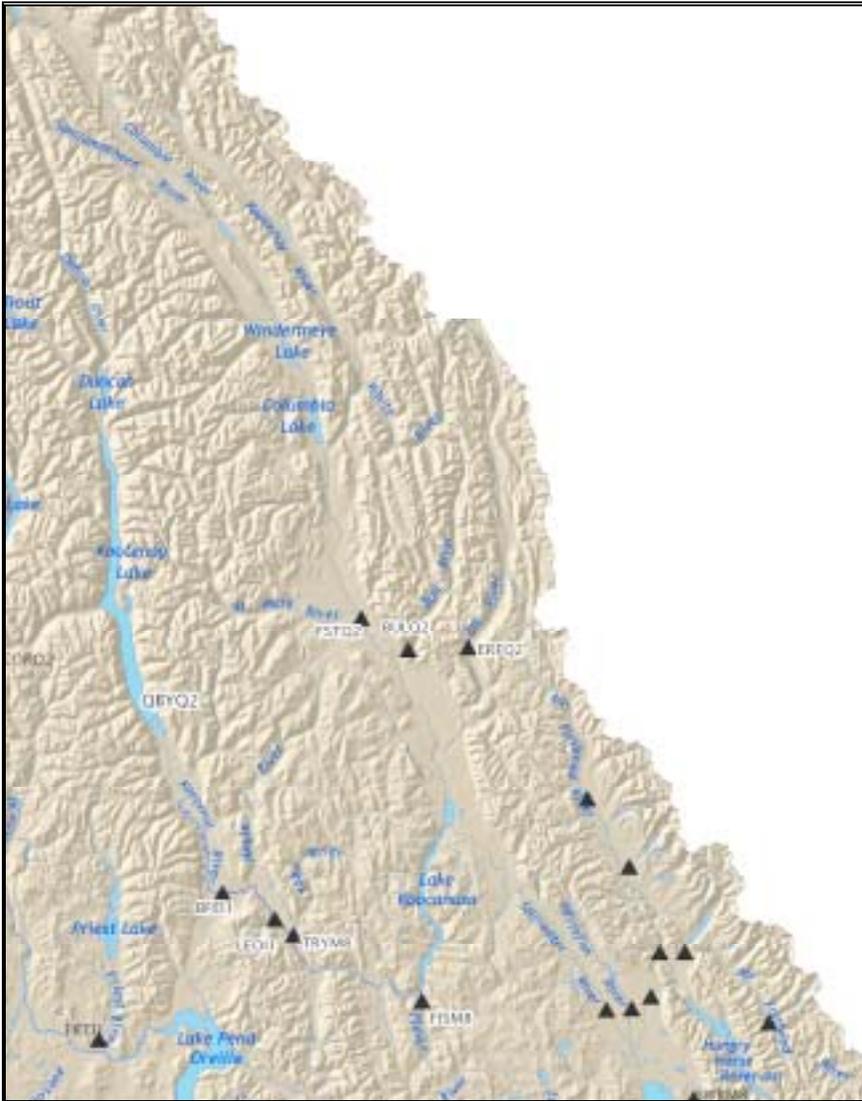


Figure 5

Kootenai Basin Hydrology

Above Libby Dam (LYDM8) nearly 90 percent of the inflow to the reservoirs (Lake Koocanusa) is provided from headwater drainages Elk River (ERFQ2), Bull River (BULQ2) and the major contributor Kootenay River (FSTQ2). Below Libby Dam the main tributaries to the Kootenai River include the Fisher River (FISM8), Yaak River (TRYM8) and Moyie River (EAS11). The Kootenai river tributaries are generally high gradient. The upper-section of the main stem Kootenay is confined within narrow valleys. The lower reaches from Bonners Ferry to Kootenay Lake meander with very low gradients and are affected by backwater from Kootenay Lake during high flows.

Kootenai River Conditions WY 2006

During the snow accumulation season 2006 measurements of snow water equivalent (SWE) made during May 1st at Kootenay basin snow sites indicated between 75% - 105% of normal SWE with a Kootenay snow water index of 99% as reported by the River Forecast Center Environmental Canada. The spring 2006 snow melt was accelerated by several days of record high temperatures during the last two weeks of May causing above normal melt rates. The runoff for May at FSTQ2 was 142% of normal. During a period from May 18th to June 8th Libby Dam was operated at full power capacity releasing 24,000cfs. The LYDM8 pool elevation increased approximately 25 feet leaving 5 feet of usable storage. At Bonners Ferry the rapid melt in May is evident in figure 6 below. The river remained within 4.5 feet of flood stage (64 feet) through early June when several moderate rain events between June 8th and June 16th nearly filled Lake Koocanusa and increased outflow from LYDM8 pushed BFEI1 above flood stage.

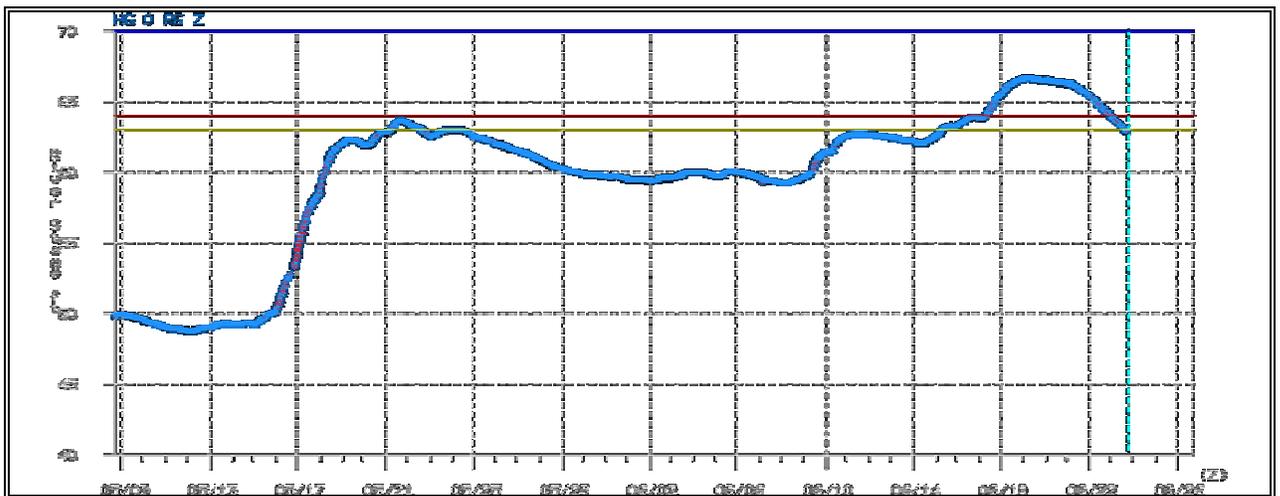


Figure 6: BFEI1 River Stage May 6th - June 23rd

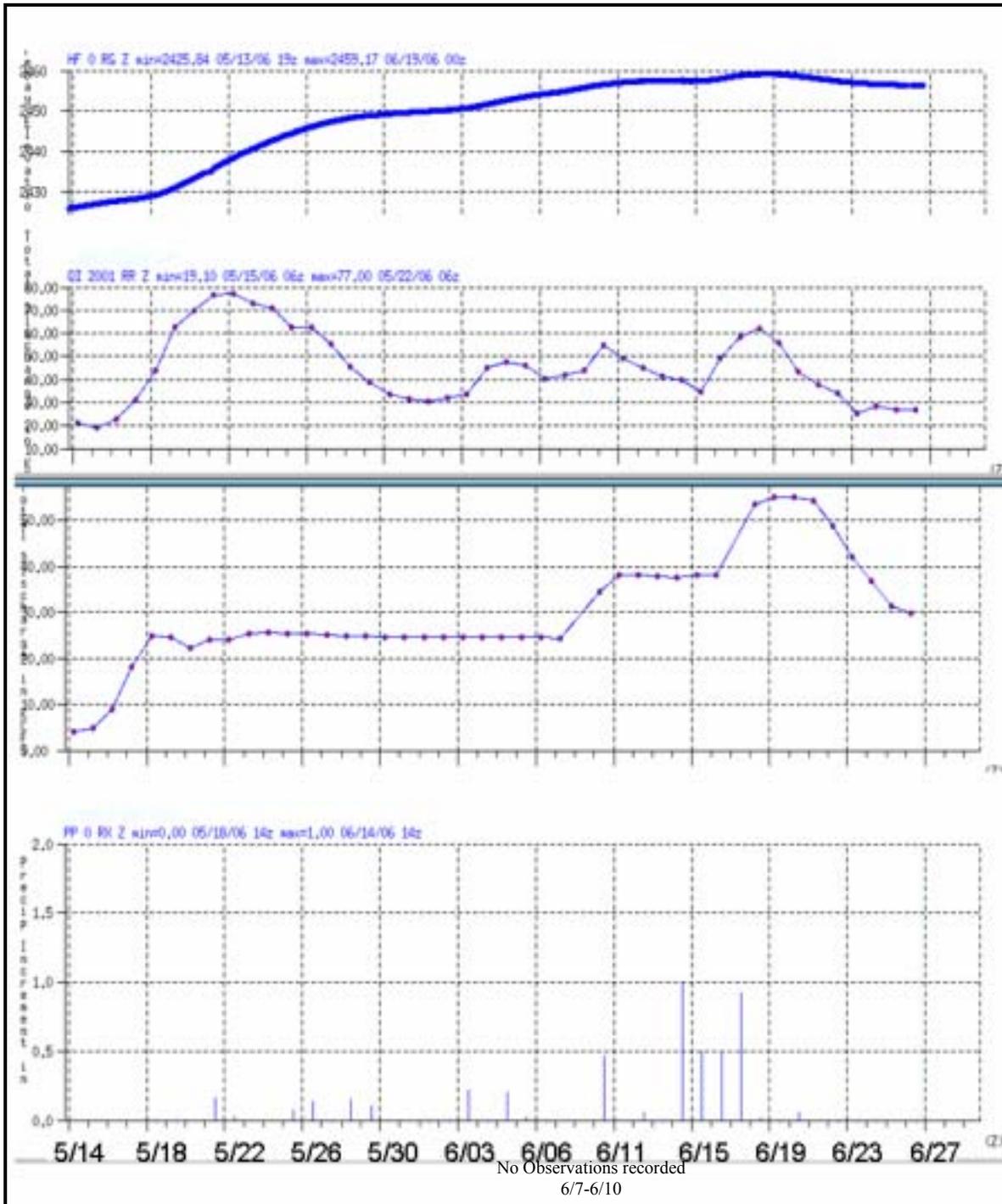


Figure 7: Libby Dam observed data 5/14 to 6/27 listed top to bottom: Pool elevation, Daily Inflow, Daily Outflow and Precipitation. The precipitation amount was not reported June 7-10.

NWRFC Flood Operations

On Monday June 12th the NWRFC issued a Libby Dam forecast indicating a nearly full Pool by the end of the week. The forecast precipitation for June 12th was extreme with day 3 forecast precipitation amounts at Duncan Dam of 2.35 inches (June monthly average a Duncan Dam is 2.40). The precipitation forecast points that contribute to Libby Dam inflow and Bonners Ferry predicted a general 1.50 inches for Wednesday June 14th with amounts of: 1.50 inches Elk River Fernie, BC. 1.63 inches Cranbrook, BC., 1.67 inches Bonners Ferry, ID and 1.02 inches Glacier International Airport.

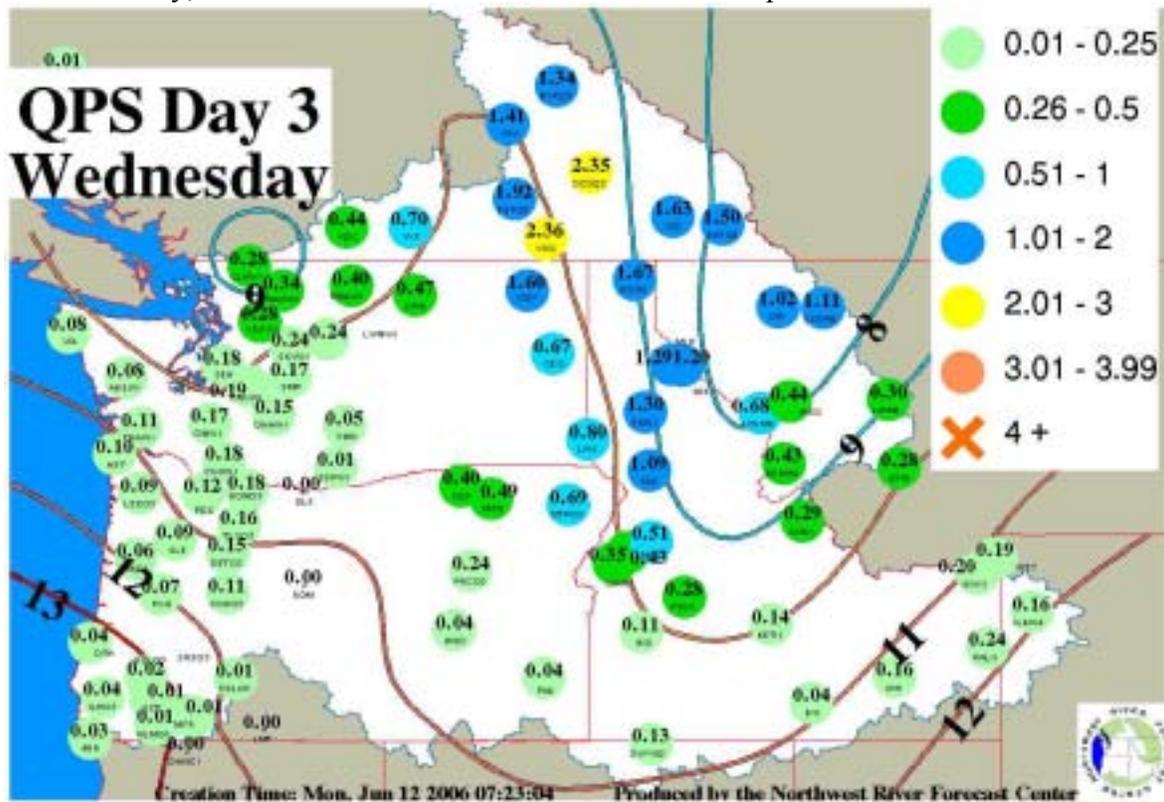


Figure 8 Precipitation Forecast for June 14th created June 12th.

Subsequent precipitation forecasts indicated less precipitation and were under forecast. Further illustration of river model input precipitation is discussed in the findings and recommendations section of this document.

River Forecast Description

Short term river forecasts provided by the NWRFC for Libby dam inflow varied based on precipitation forecasts input to the river model. The inflow forecast issued on June 12th incorporated the precipitation amounts in figure 8. The forecast created on June 15th incorporated a reduced precipitation forecast (figure 10).

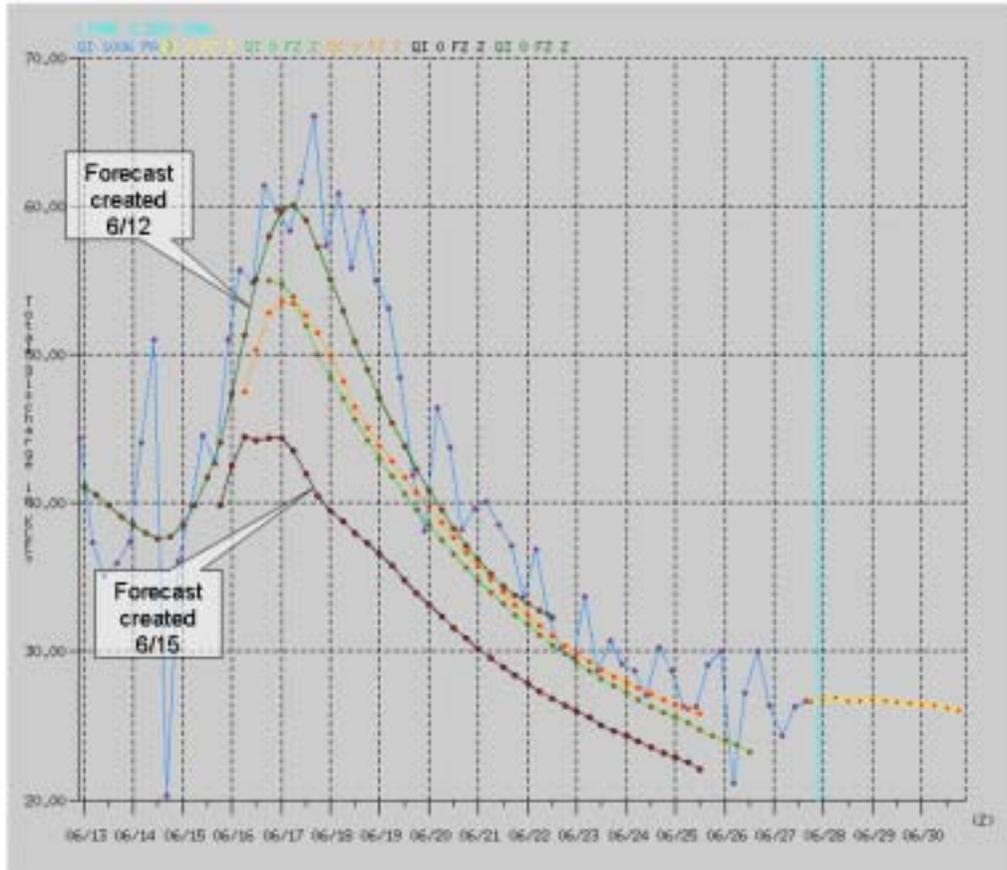


Figure 9: Libby Inflow Forecasts and Observed

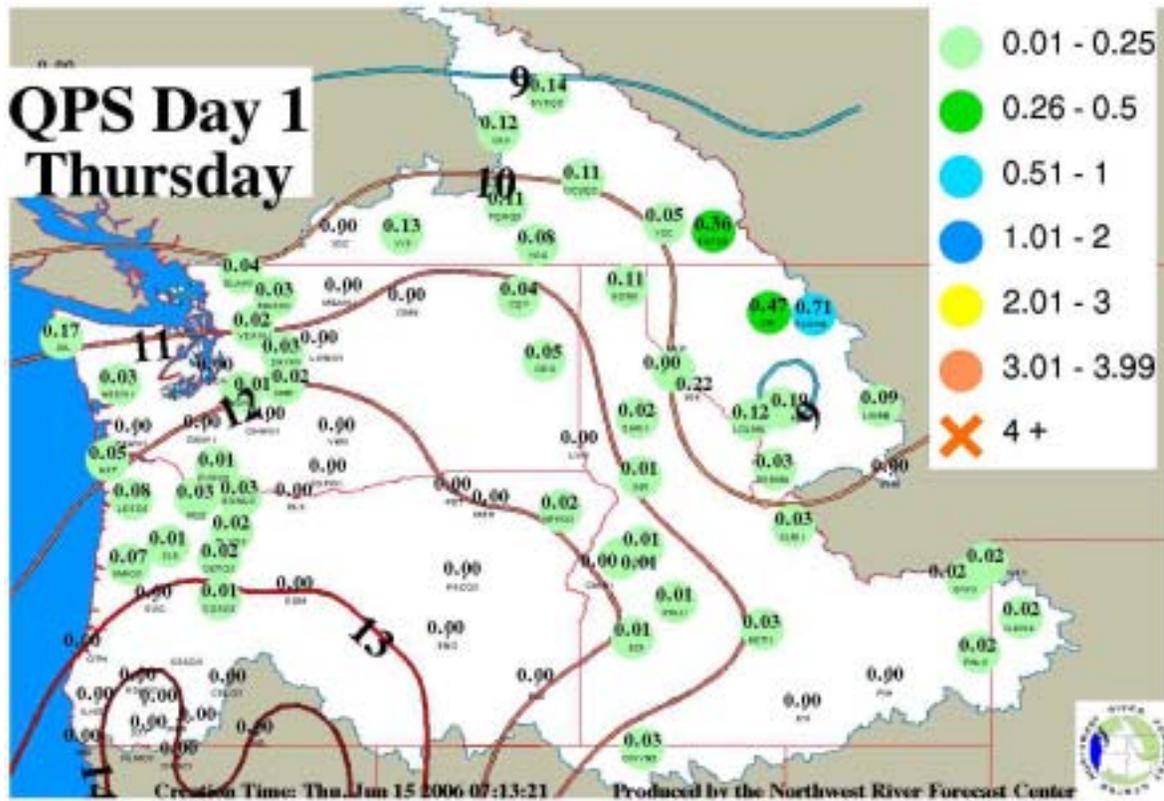


Figure 10 Precipitation forecast June 15th for June 15th

Bonnors Ferry

The River forecasts at Bonnors Ferry (BFEI1) were controlled by three key factors. The routed water from Libby Dam regulation, local area contribution between Libby Dam and Bonnors Ferry and a balance factor used to adjust the river stage at BFEI1.

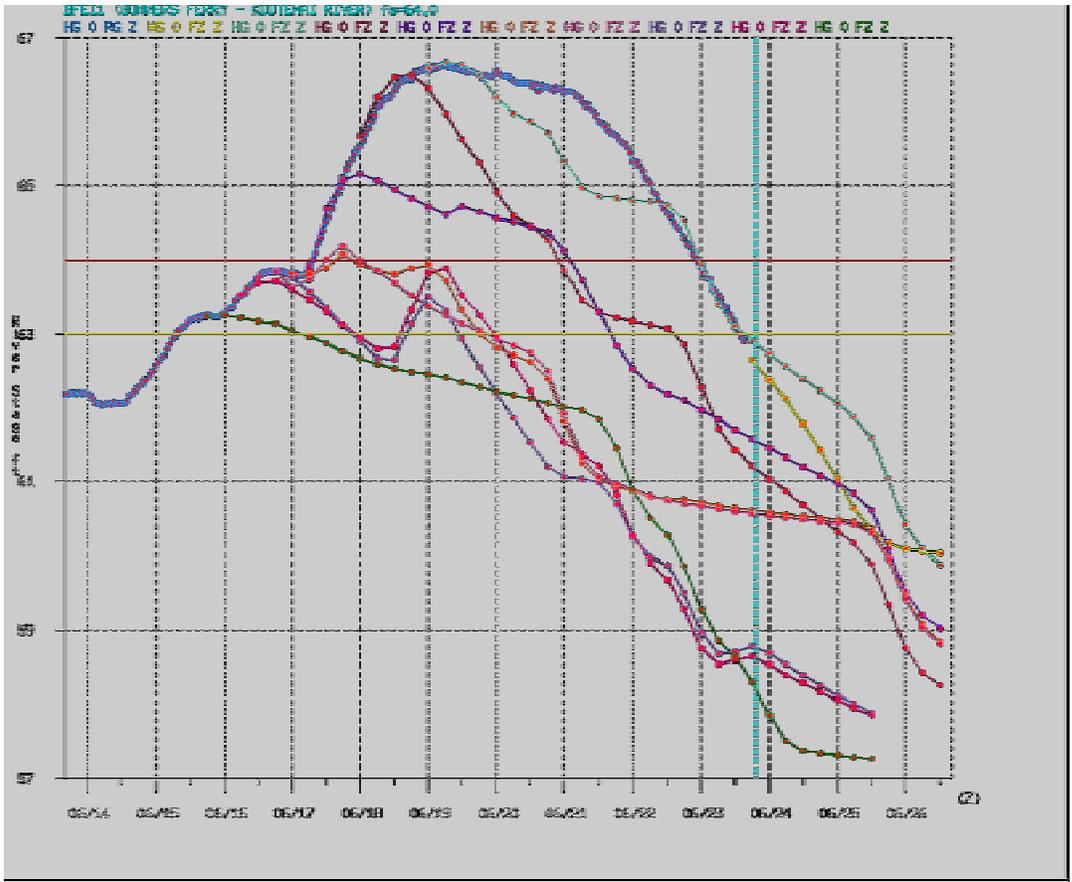


Figure 11 Bonners Ferry Forecast and Observed

Forecast regulations were made for Libby Dam in coordination with the COE. Several iterations of the river model forecast were created during June 16th and 17th to account for the change in regulation plans. On June 17th Libby Dam increased outflow (figure 7) and forecasts were updated to account for regulation changes.

Bonnors Ferry Balance:

Backwater conditions affect the lower reaches of the Kootenai River to Bonners Ferry Idaho (BFEI1) during high water. Backwater is caused by Kootenay Lake(QBYQ2) levels, combined with tributary and flow on the main stem Kootenai below Libby Dam. The QBYQ2 backwater condition is accounted for in the BFEI1 stage forecast using a three variable lookup table. The river model forecast flow from LEOI1 is added to a BFEI1 local area contribution and considering the QBYQ2 lake elevation a computed gage height is derived for BFEI1. The computed BFEI1 is compared to the observed value and the difference is computed resulting in an observed balance. The NWRFC adjusts the forecast balance at BFEI1 using information in figure 7. The NWS river model variances from the lookup table are effected in operations by a BFEI1 balance.

The plot below (figure 12.) was produced prior to the June 17th Bonners Ferry Flood, shows historical BFEI1 balances or differences between the three variable lookup table and observed BFEI1 stage heights. The graphic and summation guidance below was used on the operational floor for the June 17th event.

BFEI1 Balances adjusted to the observed value.

BFEI1 (computed) 60 - 65 -2' > -5' (mostly between -2' and -3')
 55 - 59 +1' > -2'
 45 - 54 +1.5 > -1.5'

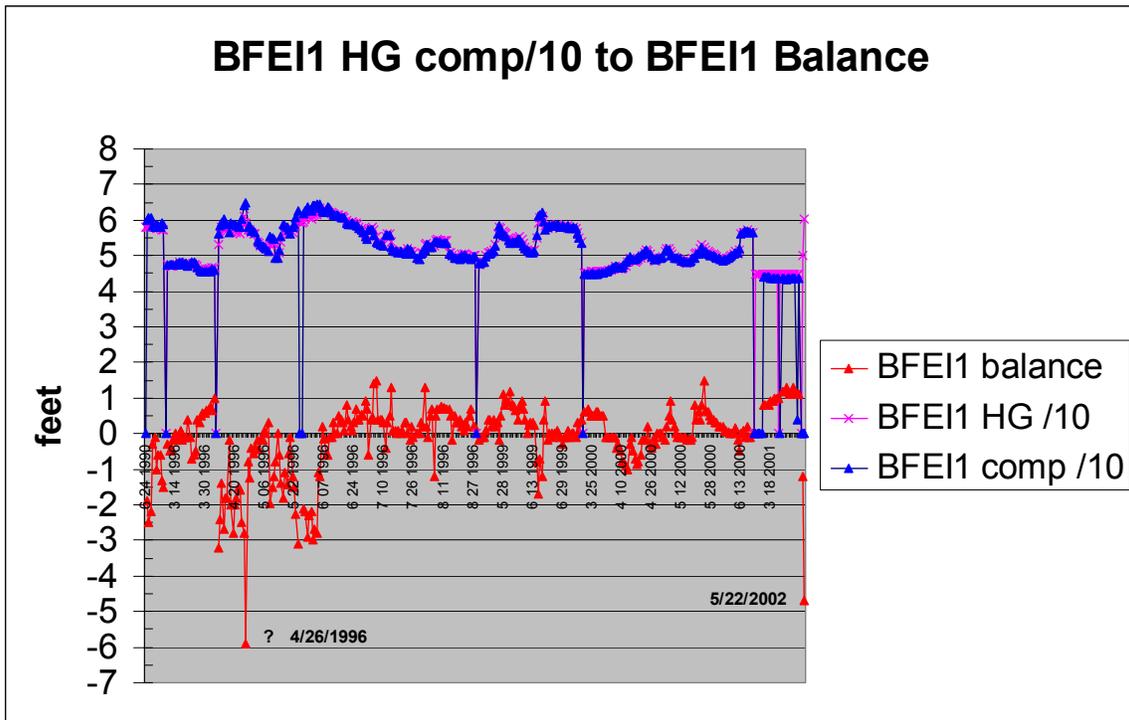


Figure 12 Bonners Ferry Historical Balance

Below is a graphic of BFEI1 balances for the mid June Bonners Ferry Flood.

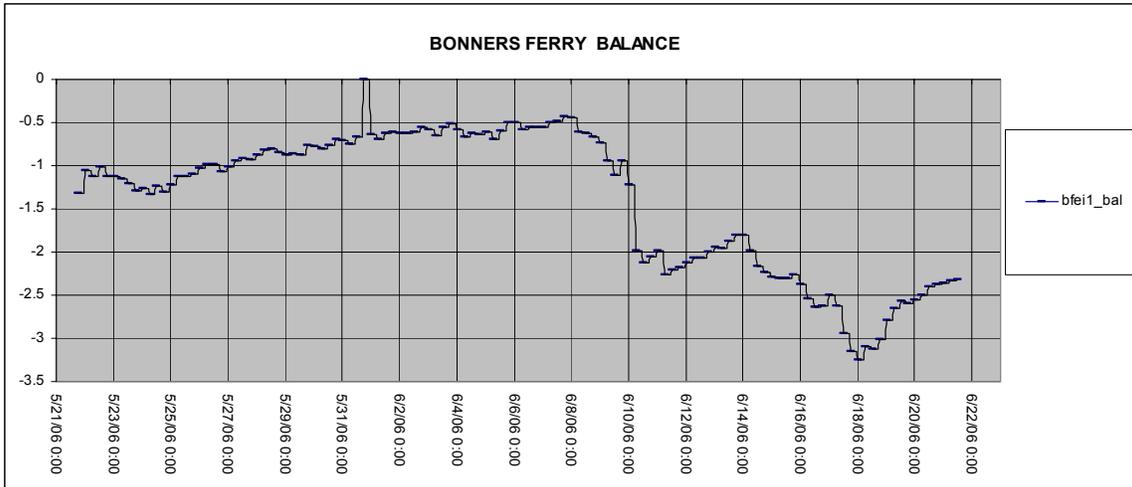


Figure 13 Computed stage - Observed stage

In general, the observed BFEI1 balances fell within the Balance Guidance for the June 17th event.

Water Supply

The following plot depicts the NWRFC water supply forecasts for April – July. The forecasts were generated from three different methods. The LYDM8W and LYDM8TW are generated through ESP. The WSF line with a dot is the official coordinated regression based water supply forecast. The larger dot with no line connecting is the forecast from the COE. Observed Normal and the observed are also plotted.

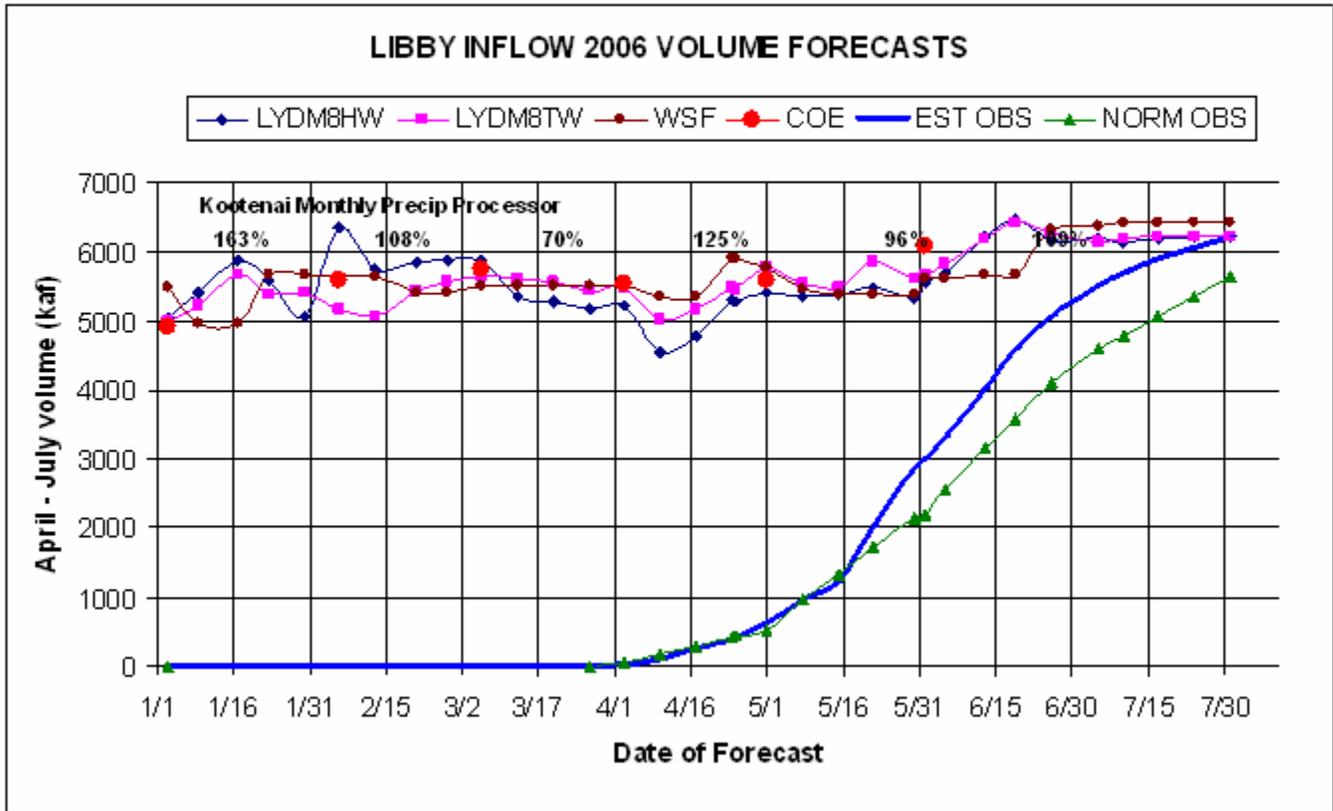


Figure 14: Libby Dam Inflow Forecast from Water Supply, ESP and the COE Plotted with Observed Runoff

Notice the departure from normal runoff starting 5/16 caused by above normal snow melt rates.

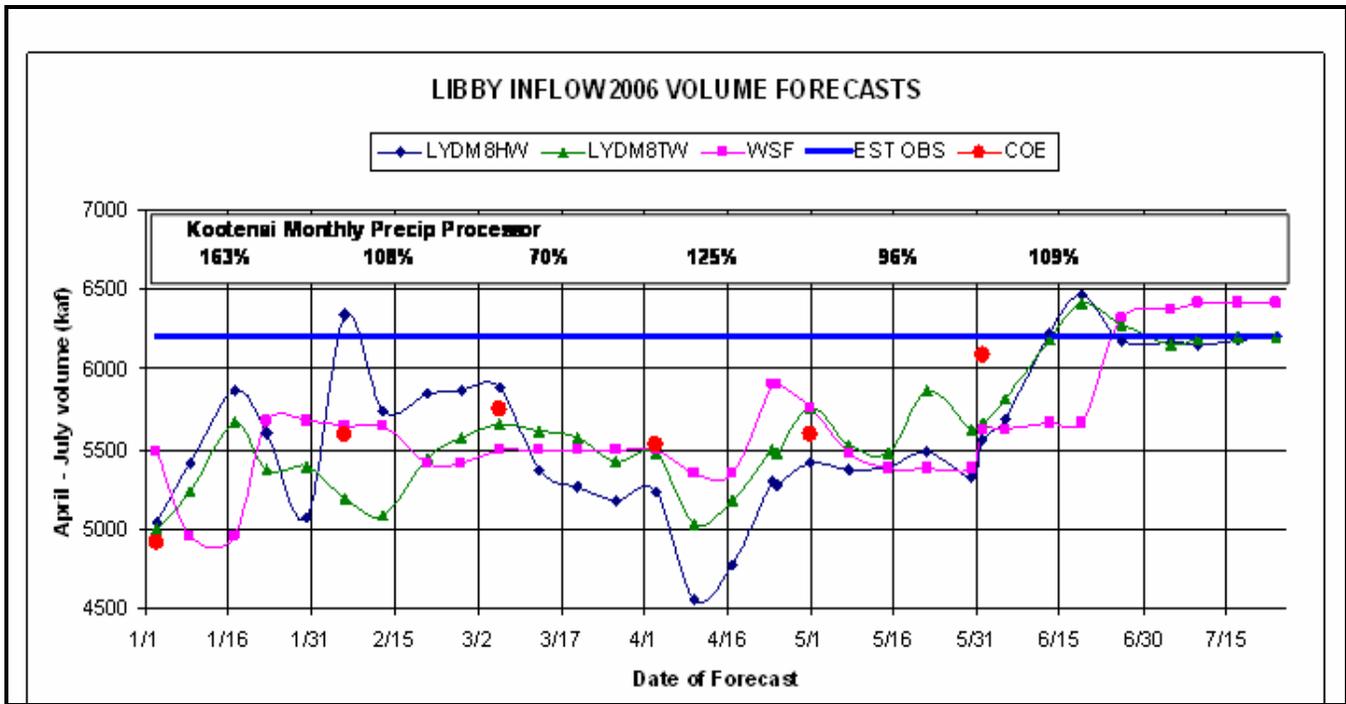


Figure 15 Libby Dam Inflow Forecast from Water Supply, ESP and the COE.

All forecasts increased after the rain events around the 6/15 time frame. All forecasts were underestimated for the April-July volume with the COE projection plotted on 5/31 being the best estimate. Water supply forecasts increased after accounting for the above normal precipitation in June.

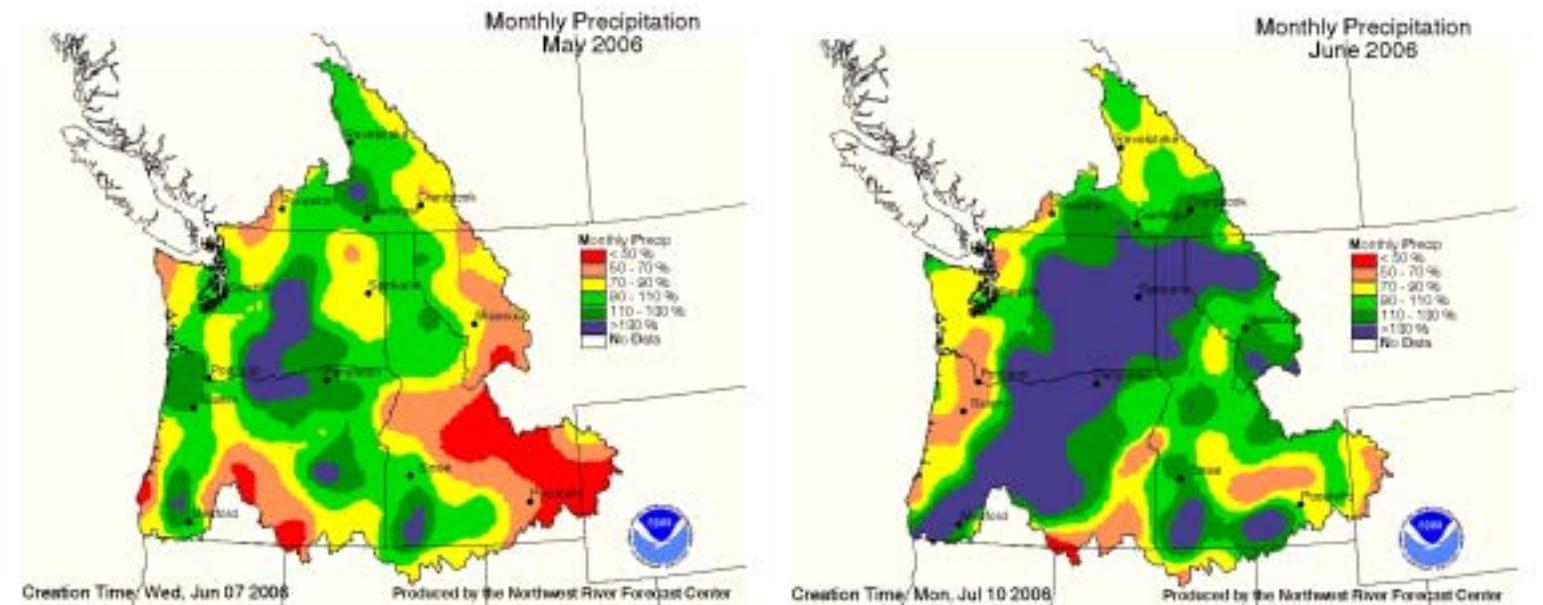


Figure 16: May and June Monthly Precipitation. Notice the increase from May to June. Also note the general pattern of precipitation from Southwest to Northeast.

Customer Feedback

The NWRFC began issuing forecasts that indicated rapid snow melt would impact the Kootenai River. Rapid rises to Libby Dam inflows were forecast as well as significant Rises to Kootenai River at Bonners Ferry.

The Service Hydrologist from Spokane wrote:

“In early May the Kootenai River reported water levels in the 49.0 foot range. It had remained at low levels for several months. Around May 10th (date not verified) forecasts from the NWRFC indicated that the Kootenai River was going to see a rapid increase in water levels, something on the order of 10+ feet by the middle of May. This put the river well over the 57 foot action stage in addition to the very large rise in elevation in a short period of time. A call was made to Person of Contact (POC) Bonners Ferry around May 10th alerting him to the likelihood of a large rise on the Kootenai River. This call placed to POC was the first that he and the emergency manager of Boundary County had heard of the impending rise. About this time the inland northwest reported an unusual May heat wave in which records were broken across much of the region for up to 5 days. This intense heat brought rapid snow melt and flooding to many rivers. During this period the Kootenai River rose from just over 49.0 feet on May 15th to over 62.0 feet just 4 days later on May 19th. During this initial rise the river crested just below flood stage at 63.65 feet on May 21st. The river then slowly receded, but remained at levels over 59 feet until June 10th.”

Products:

While assessing forecast hydrographs for Bonners Ferry the NWRFC received several comments from customers.

- The RCC indicated that at Bonners Ferry there was a large disconnect between observed and forecasted data, especially during the early high water.
- The forecasts seemed to fluctuate wildly from one day to the next. There was little consistency, which made operating Libby difficult. Both of the big events (June 8 and June 16) were significantly under forecasted at Libby.

Services:

Corps of Engineers Reservoirs Control Center (RCC) provided the following comments:

“Model runs were created in a timely manner, which allowed the Corps to modify operations and coordinate with the region effectively. There was a lot of dialog between RCC and RFC which helped us understand what the forecaster was thinking. I think these conversations helped improve the forecasts. Occasionally RCC was able to provide RFC information, which sometimes helped them prepare the forecasts. RFC worked with RCC fine-tuning initial conditions and getting best inflow estimates for the early forecast periods. There was great cooperation in this respect. RFC generally called when conditions changed in the basin, which gave RCC a heads up to look at the new forecast.”

The Service Hydrologist Spokane wrote the following:

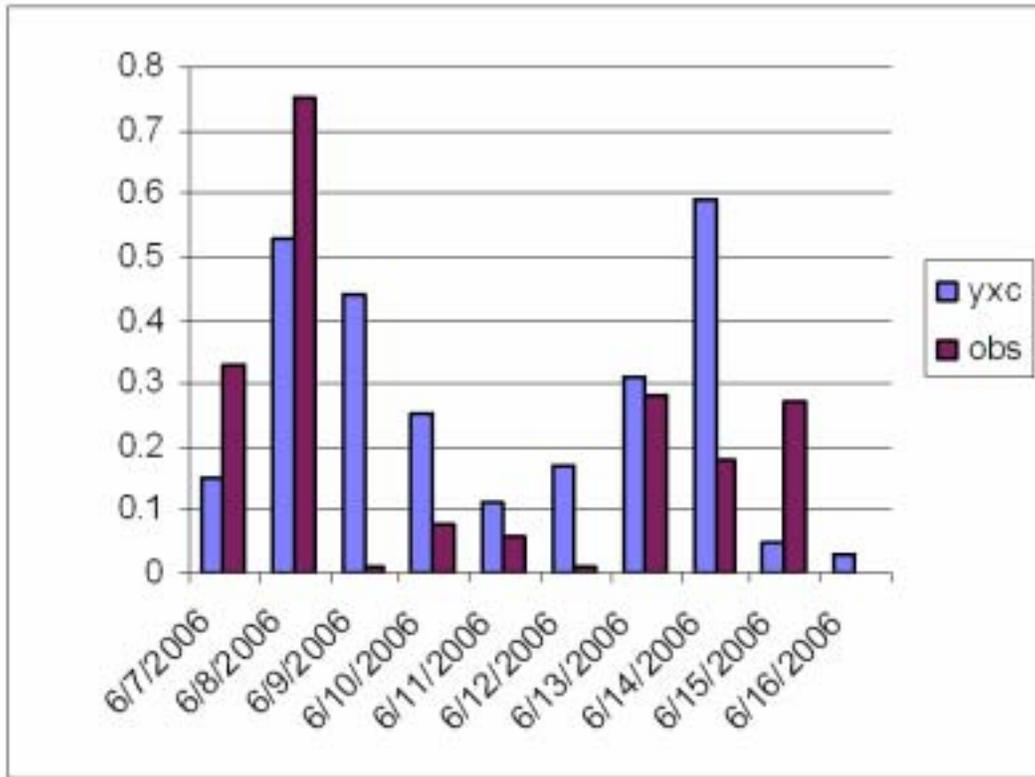
“I spoke briefly with the POC from Boundary County on Friday June 23. I asked him a few questions. First I asked him what he thought of our performance during this event. I asked him to give me a candid view of the good and the bad. He had mostly good things to say. He thought the communications could not have been any better. He made a point to express his sincere thanks to everyone at our office who took whatever time was needed to brief him on the weather and water situation. He thought the customer service he received from our staff was top notch. He rated the quality of our forecasts we issued slightly above average.

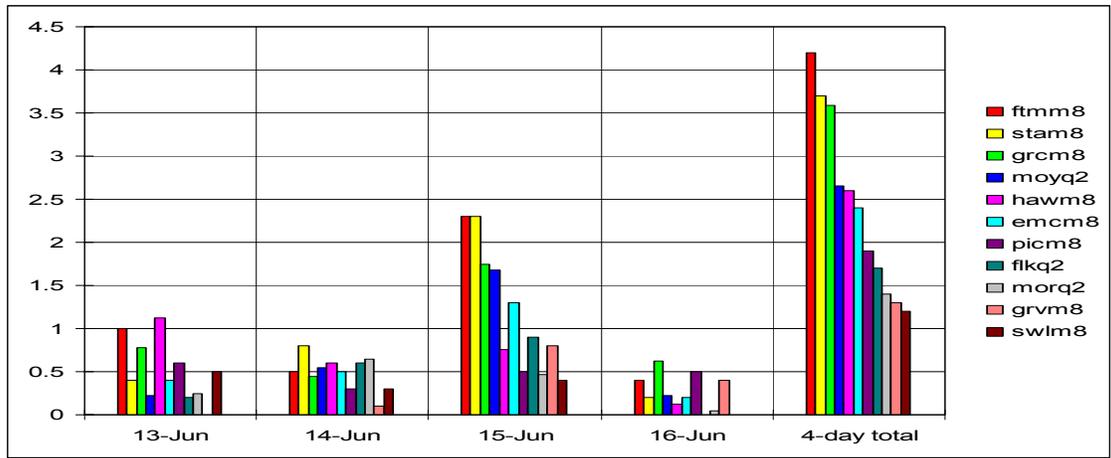
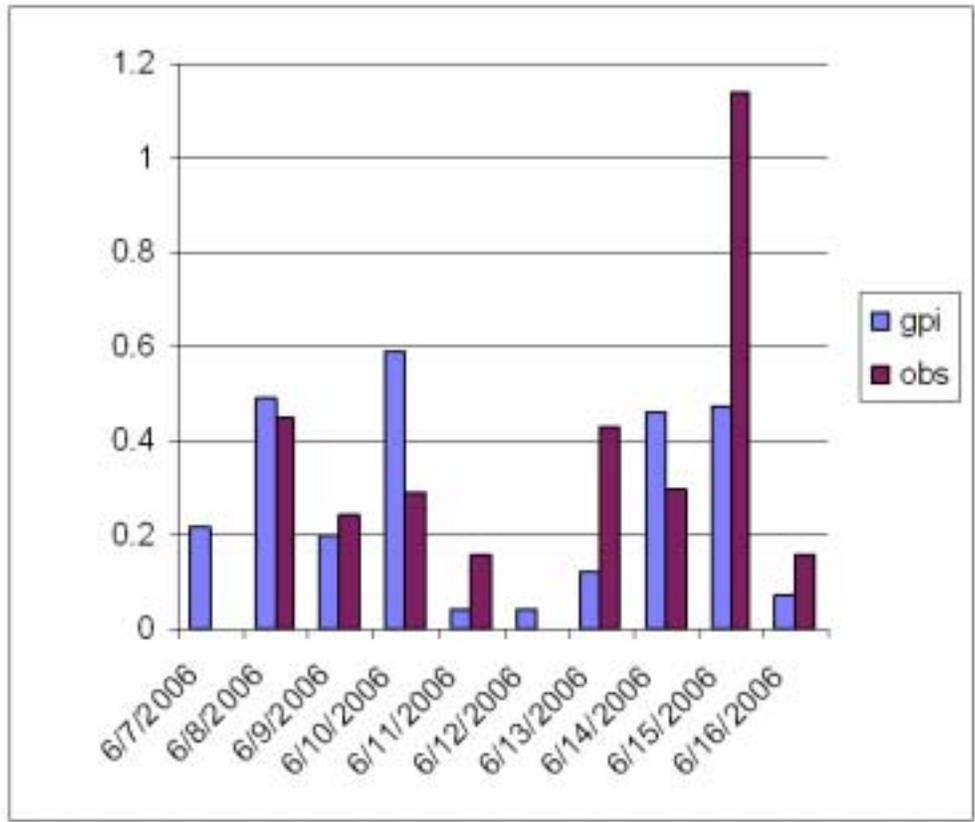
I also asked the emergency manager Boundary county from whom and what agency did he receive his forecasts. He told me that he used exclusively the forecasts from Spokane. The emergency manager also pointed out that it was the notification from NWS Spokane in early May that the river was going to rise over 10 feet that got the ball rolling in their preparation in this flood event. He was very appreciative of the job that the NWS did.”

Findings and Recommendations:

Finding: Precipitation forecasts under estimated precipitation amounts and were reduced with successive runs. On June 15th and June 16th heavy rainfall was occurring along the spine of the Rocky Mountains in western Montana and southeastern British Columbia.

Precipitation at points that contribute to the modeling of Libby Dam inflow were under forecast. Specifically, the sites ERFQ2, GPI and YXC were under forecast by 0.61, 0.83 and 0.22 inches respectively.





The plot above contains observed precipitation data gathered at SNOTEL sites in the proximity of the Kootenay River Basin.

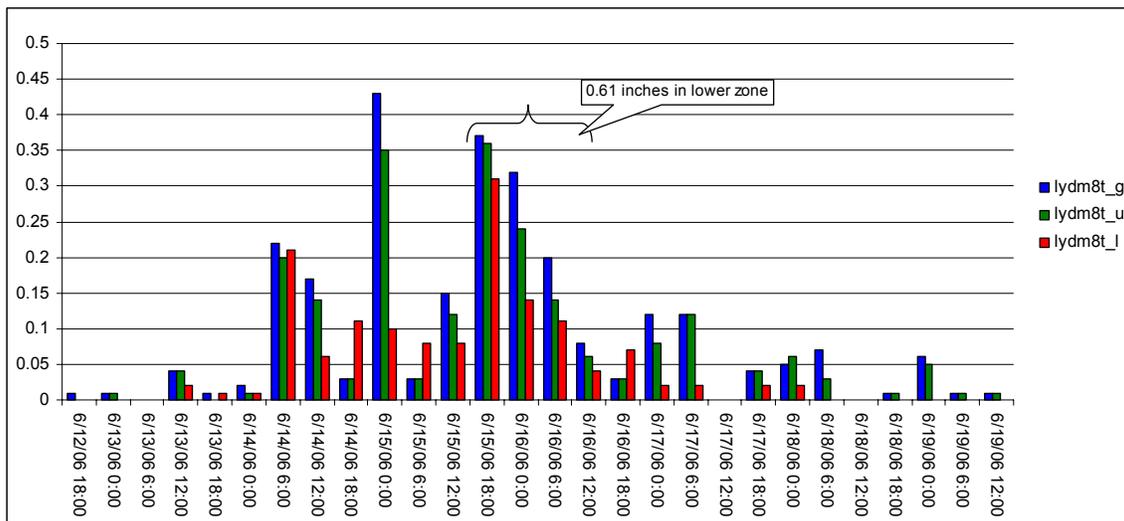
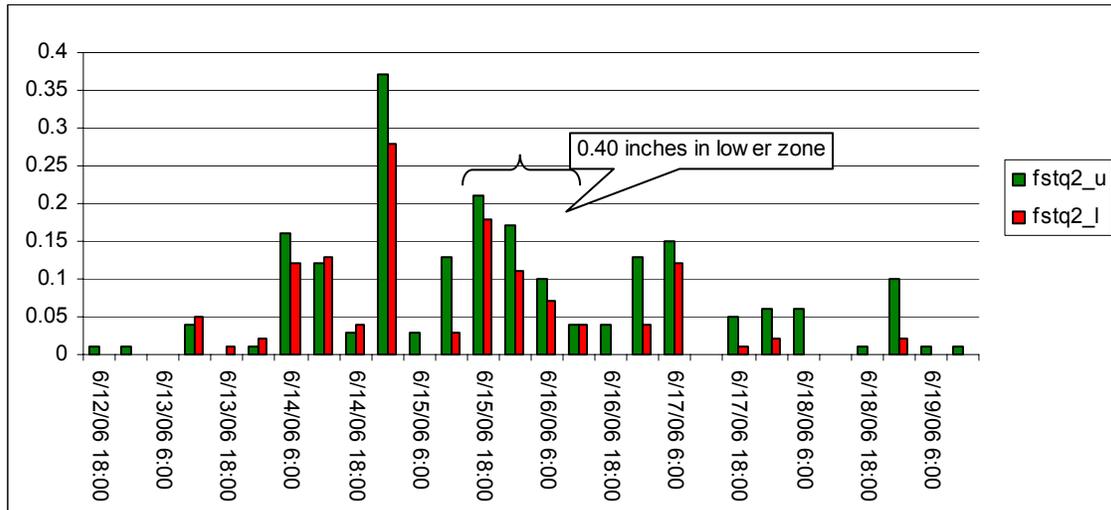
Finding: The QPS was not updated when Heavy rains prompted MSO to issue a Small Stream Flood Warning for East Central Flathead County.

Finding: FMAP Factors were applied during the event.

Recommendation: NWRFC staff will coordinate during AM briefing about application of factors and distinguish between widespread precipitation and convective events.

Finding: NWRFC provided excellent coordination and timely forecasts for our customers both internal and external.

Finding: The MAP did not adequately represent precipitation amounts in the Kootenay river headwaters.



Recommendation: Explore better relationships for deriving MAP in this data sparse area.

Finding: Bonners Ferry Balance guidance was inadequate during the early stages of this event.

Recommendation: Provide guidance within IFP in the form of ts-plot.

Recommendation: Provide proof-of-concept for the implementation of FloodWav for BFE11

Recommendation: Incorporate Floodwav model for Bonners Ferry backwater condition.

Bonners Ferry Improvement:

The Lower Kootenai River's braided stream characteristics, its low bed slope, and the occurrence of periodic backwater conditions make the Lower Kootenai River a candidate for FLDWAV dynamic routing.

A FLDWAV model from Leonia, Idaho to Kootenai Lake was created to explore BFEI1 stage forecast improvement.

FLDWAV Model Topology/Description:

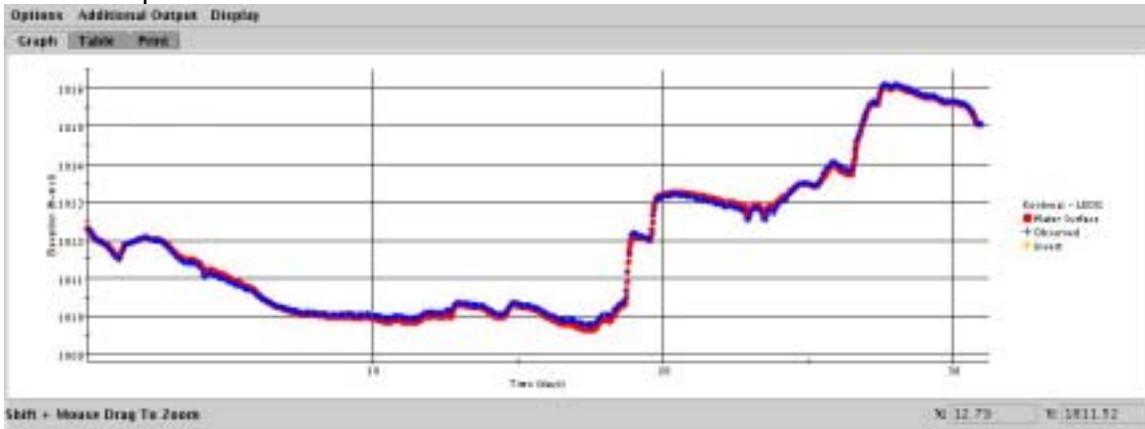
94.3 River Miles

- Study Period - May 21, 2006 - June 21, 2006
- Upstream Boundary - LEOI1 flow (RFS input)
- Downstream Boundary - QBYQ2 elevation (RFS input)
- Lateral Inflow - EASI1 flow (RFS input - Moyie River)
- Forecast Points - BFEI1 stage, PORI1 stage

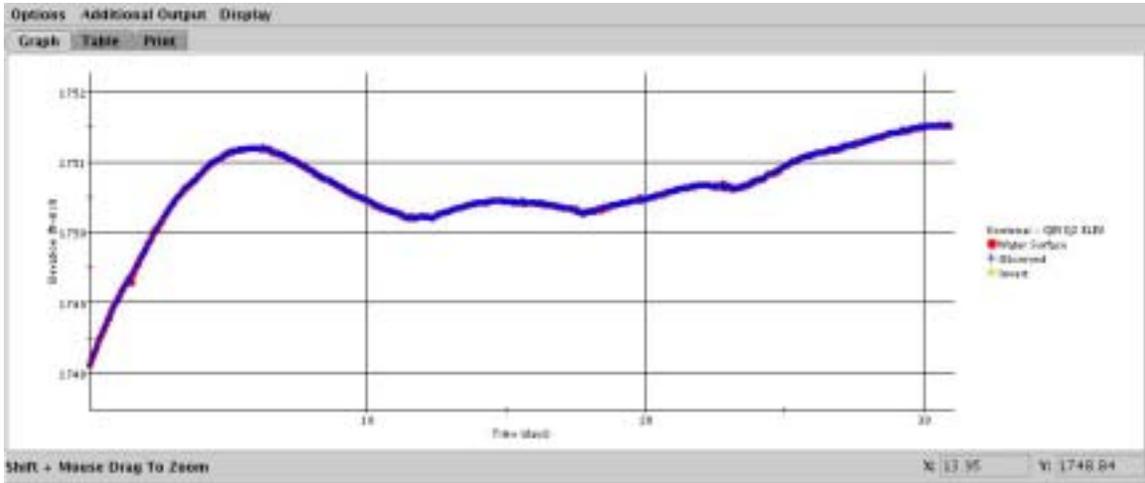
8 cross sections (5 from LEOI1 to BFEI1). Cross sections from a 2002-2003 USGS study.

Preliminary Results/ Graphics:

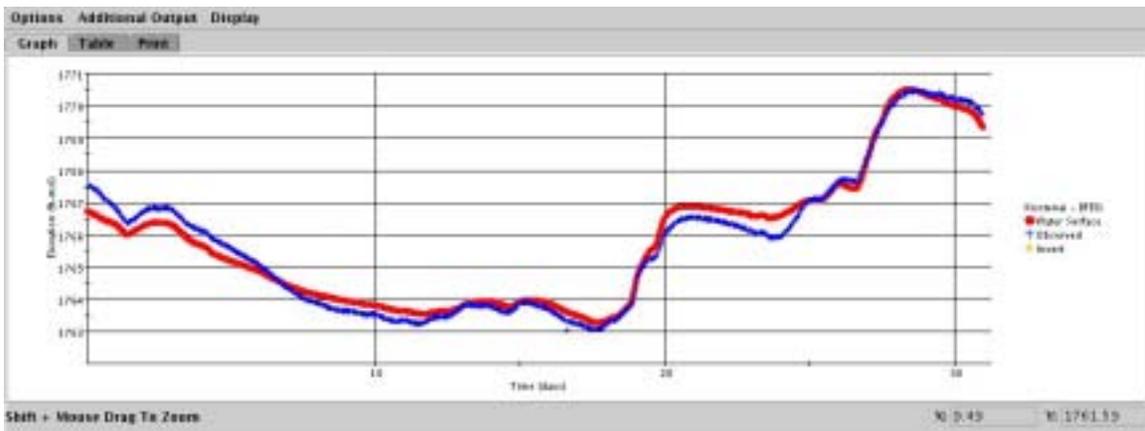
Preliminary results indicate FLDWAV can produce BFEI1 stage forecasts for the May-June 2006 period within half a foot of observed.



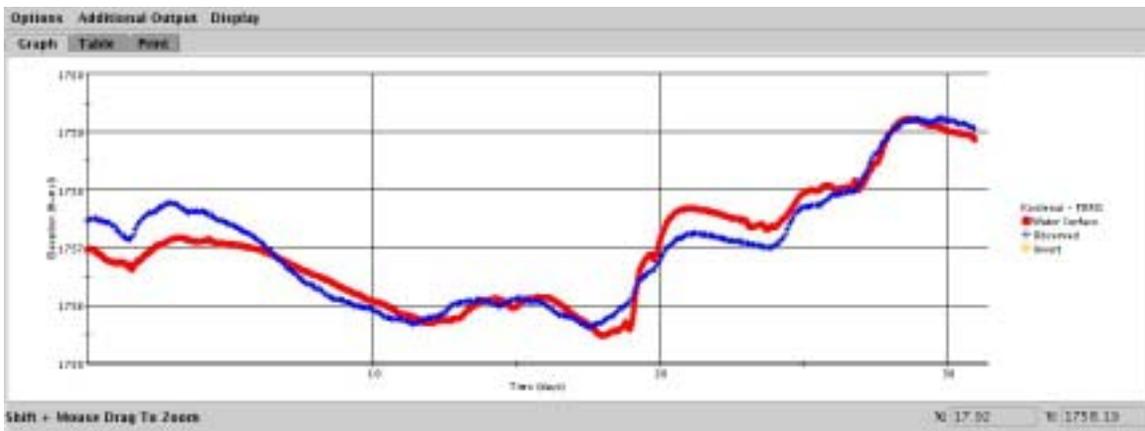
Leonia Flow (LEOI1) - Upstream Boundary



Kootenai Lake Elevation (QBYQ2) - Downstream Boundary



Bonners Ferry Stage (BFEI1) - Observed vs. Simulated



Porthill Stage (PORI1) - Observed vs. Simulated

With model refinements outlined below, the preliminary FLDWAV model can be ready for operational use.

	TIME
- One year data set	(3 day)
- Additional cross sections and inclusion of NPS HEC-RAS cross sections that contain greater levee definition	(1 week)
- Recalb	(4 days)
- FLDWAV operation creation and test	(1 days)
- RFS segment creation and test	(2 days)

Finding: NWRFC updated LYDM8 segment to account for Libby pool over 2459.00 the pool elevation was raised to 2459.50.

Recommendation: Consult the RCC on actual full pool elevation at LYDM8.

Finding: The ESP forecast created June 1st with 10-days of QPS did not adequately reflect the hydrologic risk for filling Libby Dam. Assuming that Libby was to continue with the June 1 outflow of 25 kcfs, how many of the ESP years would Libby fill on June 30 and of these years what inflow would Libby have to pass? Volume needed to fill in 30 days = 409 kaf to fill + 1488 kaf (25kcfs for 30days) = 1897 kaf.

	# years fill*	June 30 inflow range
Libby Headwater with 10 day QPF	4 years	26-52.5 kcfs
Libby Headwater without 10 day QPF	21 years	17-62.2 kcfs
Libby Total without 10 day QPF	25 years	18-66 kcfs
Libby Total with 10 day QPF	6 years	20-61 kcfs

* based on 45 years of record

Recommendation: Discuss the effects of 10day QPS in ESP specifically related to this event.

Finding: NWRFC does not create a Peak Flow prediction for Libby Dam inflow in ESP.

Recommendation: Incorporate LYDM8T into Peak Flow ESPADP batch file.

Finding: Multiple outputs were delivered to Bonners Ferry POC via RCC

Recommendation: Contact the RCC and determine why this happened and see that, in the future, the forecasts delivered are consistent with NWRFC forecast guidance.

Finding: The NWRFC web page does not have a bank full stage for BFEI1

Recommendation: Determine a bank full stage for indication on the web-page.

Flood Event Impacts:

The following was collected from the Kootenai Valley press:

- Residents reported groundwater seeping into yards and daylight basements.
- Docks also were torn from their riverbank moorings.
- Landscaping was washed away from banks in peoples yards and some lawn furniture and ornaments were swept downstream.
- Minor flooding occurred at the Kootenai River Inn
- \$2.6 million in crop damage was reported.
- Several roads were closed and widespread lowland flooding occurred along the river.



APPENDIX

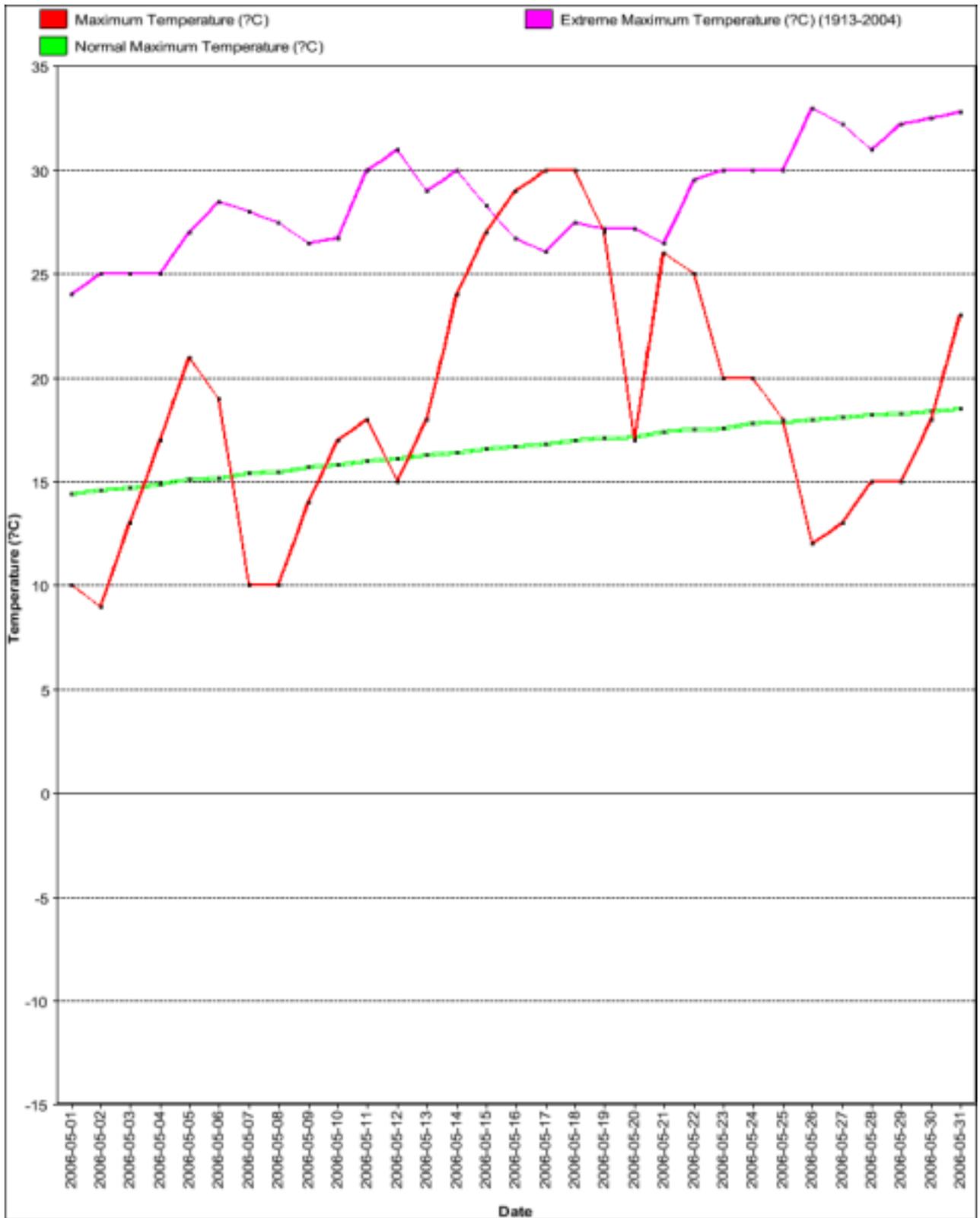


Figure 17 Month Temperature Graph for May 2006 Fernie British Columbia

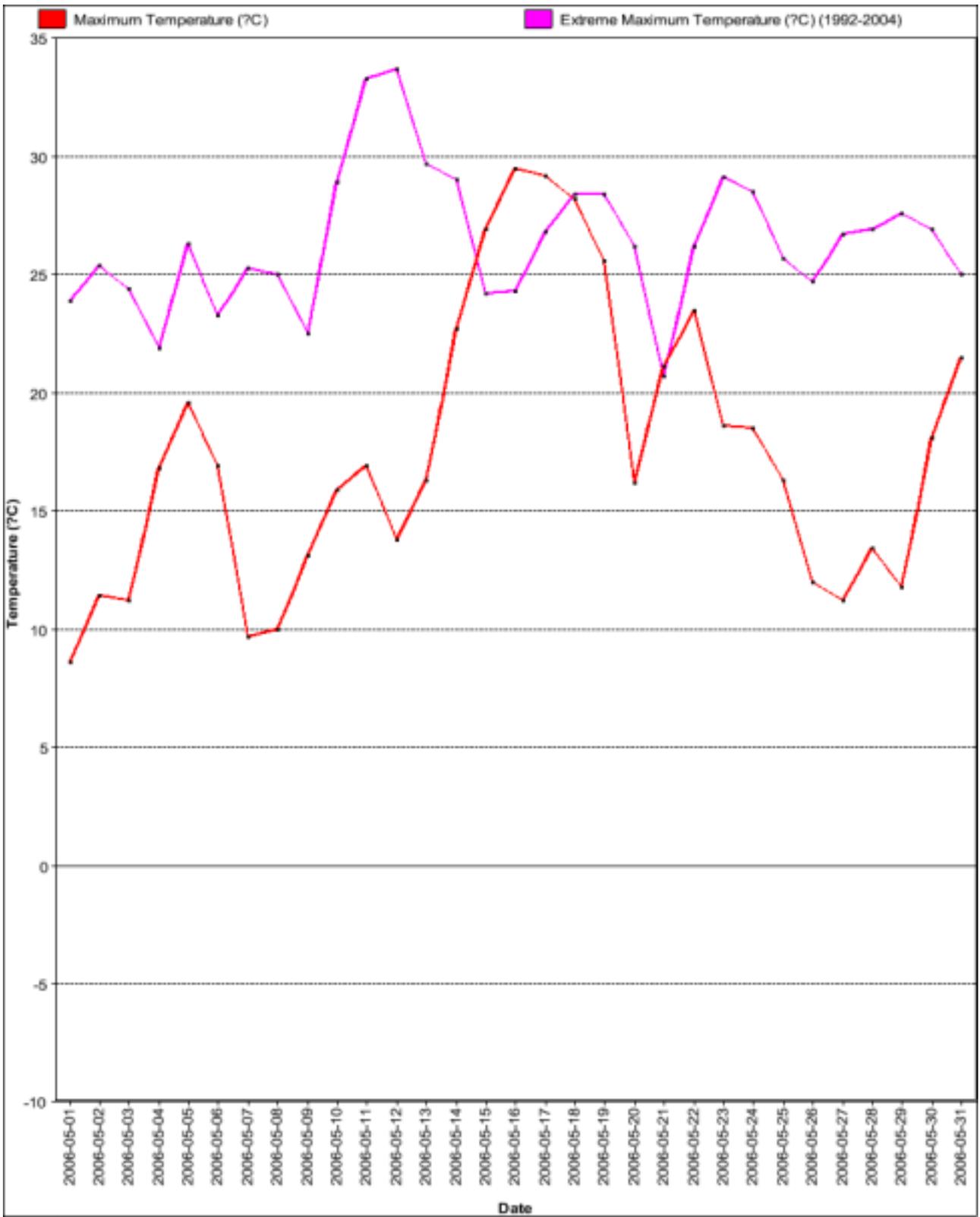


Figure 18 Month Temperature Graph for May 2006 Cranbrook (YXC) British Columbia

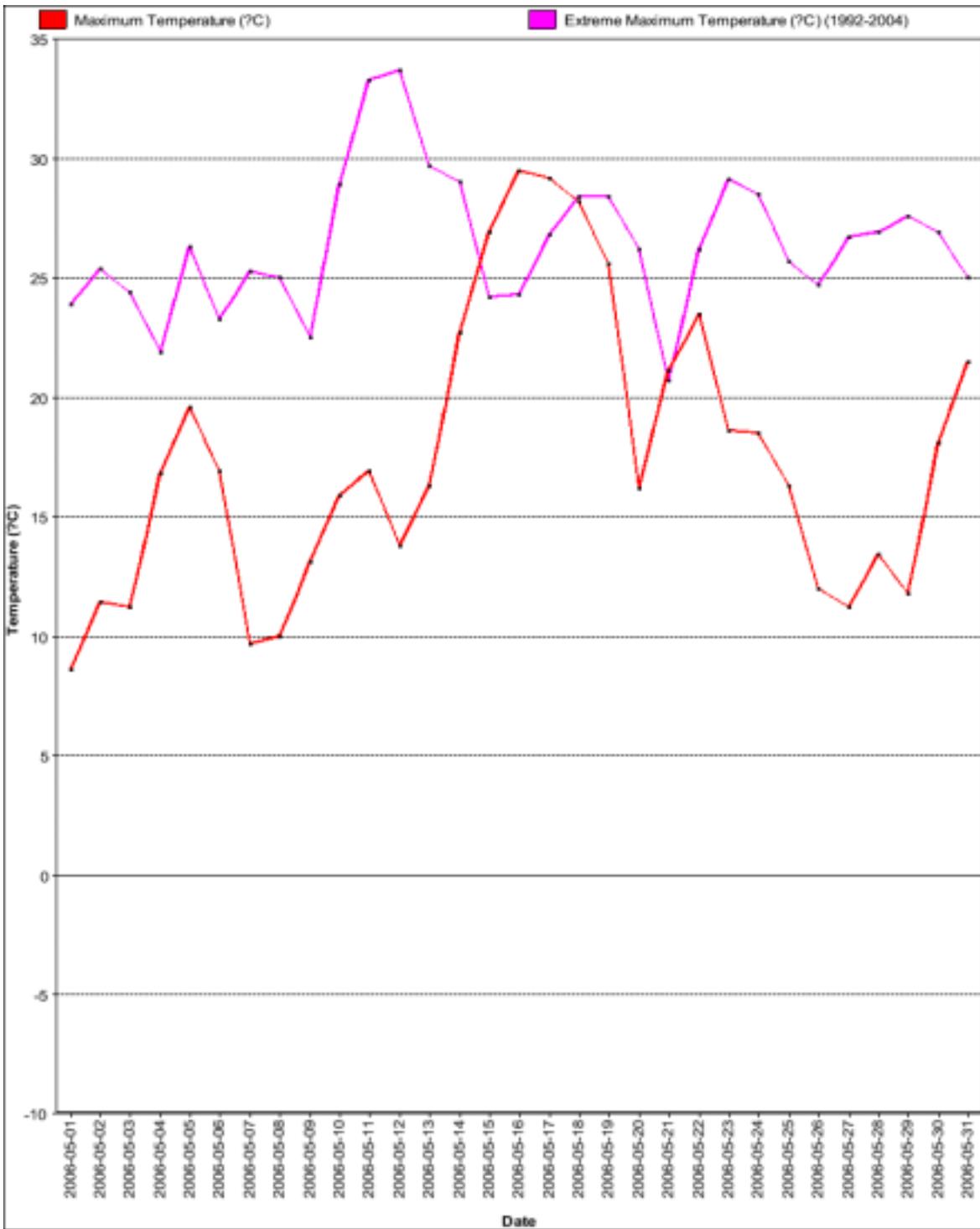


Figure 19 Month Temperature Graph for May 2006 Sparwood British Columbia

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SXUS76 KOTX 170845
REROTX

RECORD EVENT REPORT
NATIONAL WEATHER SERVICE SPOKANE, WA
146 AM PDT TUE MAY 16 2006

... RECORD HEAT REPORTED ACROSS MUCH OF EASTERN WASHINGTON AND NORTH IDAHO YESTERDAY...

THE HIGH TEMPERATURE AT SPOKANE AIRPORT IN THE PAST 24 HOURS WAS 90 DEGREES. THIS SETS THE RECORD FOR THE HIGHEST TEMPERATURE FOR THIS DATE. THE PREVIOUS RECORD OF 85 DEGREES WAS SET IN 1973. RECORDS HAVE BEEN KEPT AT THIS SITE SINCE 1881.

THE HIGH TEMPERATURE AT WENATCHEE AIRPORT IN THE PAST 24 HOURS WAS 95 DEGREES. THIS SETS THE RECORD FOR THE HIGHEST TEMPERATURE FOR THIS DATE. THE PREVIOUS RECORD OF 90 DEGREES WAS SET IN 1973. RECORDS HAVE BEEN KEPT AT THIS SITE SINCE 1959.

THE HIGH TEMPERATURE AT EPHRATA IN THE PAST 24 HOURS WAS 96 DEGREES. THIS SETS THE RECORD FOR THE HIGHEST TEMPERATURE FOR THIS DATE. THE PREVIOUS RECORD OF 92 DEGREES WAS SET IN 1973. RECORDS HAVE BEEN KEPT AT THIS SITE SINCE 1948.

THE HIGH TEMPERATURE AT MOSES LAKE ASOS/COOP IN THE PAST 24 HOURS WAS 96 DEGREES. THIS SETS THE RECORD FOR THE HIGHEST TEMPERATURE FOR THIS DATE. THE PREVIOUS RECORD OF 87 DEGREES WAS SET IN 1970. RECORDS HAVE BEEN KEPT AT THIS SITE SINCE 1947.

THE LOW TEMPERATURE AT MOSES LAKE ASOS/COOP IN THE PAST 24 HOURS WAS 58 DEGREES. THIS SETS THE RECORD FOR THE WARMEST LOW TEMPERATURE FOR THIS DATE. THE PREVIOUS RECORD OF 53 DEGREES WAS SET IN 1979. RECORDS HAVE BEEN KEPT AT THIS SITE SINCE 1947.

THE HIGH TEMPERATURE AT PULLMAN IN THE PAST 24 HOURS WAS 92 DEGREES. THIS SETS THE RECORD FOR THE HIGHEST TEMPERATURE FOR THIS DATE. THE PREVIOUS RECORD OF 85 DEGREES WAS SET IN 1973. RECORDS HAVE BEEN KEPT AT THIS SITE SINCE 1940.

THE HIGH TEMPERATURE AT LEWISTON IN THE PAST 24 HOURS WAS 96 DEGREES. THIS SETS THE RECORD FOR THE HIGHEST TEMPERATURE FOR THIS DATE. THE PREVIOUS RECORD OF 91 DEGREES WAS SET IN 1973. RECORDS HAVE BEEN KEPT AT THIS SITE SINCE 1881.

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SXUS76 KOTX 180319
REROTX

RECORD EVENT REPORT
NATIONAL WEATHER SERVICE SPOKANE, WA
815 PM PDT WED MAY 17 2006

... RECORD HEAT REPORTED ACROSS MUCH OF EASTERN WASHINGTON AND NORTH
IDAHO TODAY MAY 17, 2006.

	17 MAY 2006	PREV RECORD
SPOKANE AIRPORT	92	86 IN 1924
EPHRATA	96	93 IN 1973
PULLMAN	92	83 IN 1970
LEWISTON	97	92 IN *1895*
COEUR D`ALENE	91	86 IN 1964
LA CROSSE	96	89 IN 1956
MAZAMA	94	86 IN 1985
NORTHPORT	94	93 IN 1973
PRIEST RIVER	91	83 IN 1973
QUINCY	94	91 IN 1973
WENATCHEE AIRPORT	96	89 IN 1993
WINTHROP	95	91 IN 1924
WINCHESTER	84	78 IN 1956
COOLEE DAM	92	89 IN 1973
MOSES LAKE	96	89 IN 1956
BONNERS FERRY	90	86 IN 1956
REPUBLIC	92	89 IN 1924
PLAIN	93	89 IN 1956
OMAK	95	88 IN 1932

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SXUS76 KOTX 200844
REROTX

RECORD EVENT REPORT
NATIONAL WEATHER SERVICE SPOKANE, WA
145 AM PDT SAT MAY 20 2006

...RECORD HEAT CONTINUED OVER PARTS OF EASTERN WASHINGTON AND NORTH
IDAHO YESTERDAY...

THE FOLLOWING TABLE LISTS ALL OF THE RECORD HIGH TEMPERATURES BROKEN
YESTERDAY ACROSS EASTERN WASHINGTON AND NORTH IDAHO.

	19 MAY 2006	PREV RECORD
SPOKANE AIRPORT, WA	85 (TIED)	85 IN 1897
EPHRATA, WA	87 (TIED)	87 IN 1985

LIBBY DAM BASE (245011)

Extremes

Highest Daily Maximum Temperature (degrees F)

Days: 5/1 - 5/31

Length of period: 1 day

Years: 1986-2006

Rank	Value	Ending Date
1	97.0	5/13/1993
2	93.0	5/19/2006, 5/24/2001
4	92.0	5/25/2001
5	91.0	5/20/2002, 5/28/2001, 5/12/1993
8	90.0	5/17/2006, 5/23/1988
10	89.0	5/18/2006

Only periods with no missing data were evaluated.

Last value also occurred in one or more previous years.

LIBBY DAM BASE (245011)

Daily Almanac

Date: May 17, 2006

Daily Values	Observed	Normal	Record/Year	Prev Year
Max Temperature	90	68	90 in 2006	63
Min Temperature	46	38	27 in 2003	45
Avg Temperature	68.0	53	68.0 in 2006+	54.0
Precipitation	0.00	0.06	0.32 in 1989	0.00
New Snowfall	0.0	-	0.0 in 2006+	0.0
Snow Depth	0	-	0 in 2006+	0
HDD (base 65)	0	12	24 in 2003	11
CDD (base 65)	3	0	3 in 2006+	0

Month-To-Date	Observed	Normal	Record/Year	Prev Year
Avg Max Temperature	66.8	66.2	75.9 in 1998	66.2
Avg Min Temperature	35.3	36.5	32.3 in 1999	36.9
Avg Temperature	51.0	51.4	58.5 in 1987	51.6
Total Precipitation	0.61	0.81	1.60 in 1996	1.45
Total Snowfall	0.0	-	0.0 in 2006	0.0
Avg Snow Depth	0	-	0 in 2005	0
Total HDD	194	233	332 in 1999	226
Total CDD	3	0	18 in 1993	0

LIBBY DAM BASE (245011)

Daily Almanac

Date: May 18, 2006

Daily Values	Observed	Normal	Record/Year	Prev Year
Max Temperature	89	69	89 in 2006	61
Min Temperature	49	39	29 in 2003	39
Avg Temperature	69.0	54	69.0 in 2006	50.0
Precipitation	0.00	0.06	0.65 in 1998	0.00
New Snowfall	-	-	0.0 in 2005+	0.0
Snow Depth	-	-	0 in 2005+	0
HDD (base 65)	0	11	25 in 2003	15
CDD (base 65)	4	0	4 in 2006	0

Month-To-Date	Observed	Normal	Record/Year	Prev Year
Avg Max Temperature	68.3	66.4	74.7 in 1998	65.9
Avg Min Temperature	36.2	36.6	32.9 in 1999	37.0
Avg Temperature	52.2	51.5	58.6 in 1987	51.5
Total Precipitation	0.61	0.87	1.85 in 1996	1.45
Total Snowfall	0.0	-	0.0 in 2006	0.0
Avg Snow Depth	0	-	0 in 2005	0
Total HDD	194	244	344 in 1999	241
Total CDD	7	0	18 in 1993	0

LIBBY DAM BASE (245011)

Daily Almanac

Date: May 19, 2006

Daily Values	Observed	Normal	Record/Year	Prev Year
Max Temperature	93	69	93 in 2006	64
Min Temperature	50	39	31 in 1997	43
Avg Temperature	71.5	54	71.5 in 2006	53.5
Precipitation	0.00	0.06	0.40 in 2005	0.40
New Snowfall	-	-	0.0 in 2005+	0.0
Snow Depth	-	-	0 in 2005+	0
HDD (base 65)	0	11	22 in 2003	11
CDD (base 65)	7	0	7 in 2006	0

Month-To-Date	Observed	Normal	Record/Year	Prev Year
Avg Max Temperature	69.8	66.5	75.0 in 1993	65.8
Avg Min Temperature	37.1	36.7	32.9 in 2003	37.3
Avg Temperature	53.4	51.6	58.3 in 1987	51.6
Total Precipitation	0.61	0.93	1.96 in 1996	1.85
Total Snowfall	0.0	-	0.0 in 2006	0.0
Avg Snow Depth	0	-	0 in 2005	0
Total HDD	194	255	355 in 1999	252
Total CDD	14	0	19 in 1993	0

BONNERS FERRY (101079)
 Daily Almanac
 Date: May 17, 2006

Daily Values	Observed	Normal	Record/Year	Prev Year
Max Temperature	90	70	90 in 2006	62
Min Temperature	87	42	28 in 1966	49
Avg Temperature	88.5	56	88.5 in 2006	55.5
Precipitation	0.00	0.06	0.75 in 1941	0.05
New Snowfall	0.0	-	0.0 in 2006+	0.0
Snow Depth	0	-	0 in 2006+	0
HDD (base 65)	0	9	21 in 1966+	9
CDD (base 65)	24	0	24 in 2006	0

Month-To-Date	Observed	Normal	Record/Year	Prev Year
Avg Max Temperature	67.2	67.6	76.8 in 1998	69.1
Avg Min Temperature	42.3	40.0	33.7 in 1911	43.7
Avg Temperature	54.8	53.9	60.4 in 1998	56.4
Total Precipitation	0.17	0.92	3.76 in 1996	0.98
Total Snowfall	0.0	-	4.4 in 1956	0.0
Avg Snow Depth	0	-	0 in 2005	0
Total HDD	114	190	322 in 1913	142
Total CDD	24	0	24 in 2006	0

Columbia Basin Seasonal Precipitation Division Averages
 Northwest River Forecast Center

(Weekly Summary: 12Z may 1 - 15, 2006)

DIVISION	..MAY TO DAY 15..		OCT - MAY....		
	OBSD	DEP	PCT AV	OBSD	DEP	PCT AV
COLUMBIA ABOVE COULEE	0.38	-0.69	36.	18.25	1.27	107.
SNAKE RV AB ICE HARBOR	0.20	-0.72	22.	15.95	3.28	126.
COLUMBIA AB THE DALLIES	0.27	-0.68	29.	18.56	1.68	110.
COLUMBIA AB CASTLEGAR	0.58	-0.51	53.	22.66	-0.82	97.
KOOTENAI	0.50	-0.58	46.	19.51	2.09	112.

Columbia Basin Seasonal Precipitation Division Averages
 Northwest River Forecast Center

(Monthly Summary - may 2006)

DIVISION	..MAY TO DAY 31..		OCT - MAY....		
	OBSD	DEP	PCT AV	OBSD	DEP	PCT AV
COLUMBIA ABOVE COULEE	1.92	-0.31	86.	19.79	1.66	109.

SNAKE RV AB ICE HARBOR	1.46	-0.43	77.	17.21	3.57	126.
COLUMBIA AB THE DALLES	1.74	-0.23	88.	20.02	2.12	112.
COLUMBIA AB CASTLEGAR	2.49	0.23	110.	24.56	-0.08	100.
KOOTENAI	2.13	-0.09	96.	21.14	2.58	114.

LIBBY DAM BASE (245011)

Extremes

Highest Daily Precipitation (inches)

Days: 6/1 - 6/30

Length of period: 1 day

Years: 1986-2006

Rank	Value	Ending Date
1	1.83	6/20/1995
2	1.62	6/7/1995
3	1.13	6/19/1987
4	1.12	6/17/1995
5	1.10	6/18/2005
6	1.00	6/14/2006
7	0.94	6/30/1992
8	0.92	6/17/2006, 6/14/1998
10	0.87	6/21/1991