IDAHO Department of Water Resources

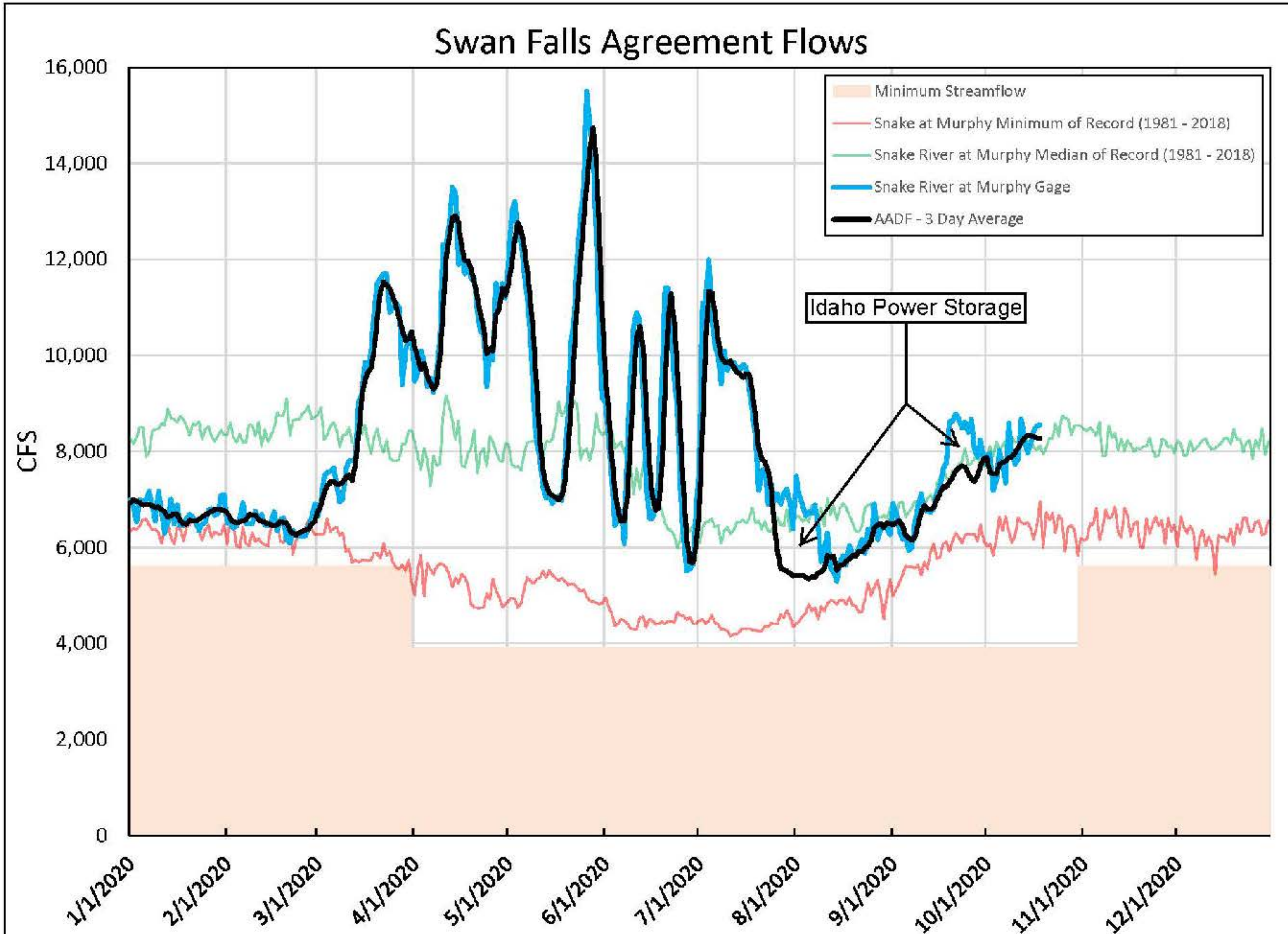
October 21, 2020 Agenda

Item	Time	Topic
1	9:00 – 9:15	Introductions
2	9:15 – 9:30	2020 AADF current conditions update
3	9:30 – 9:45	AADF calculation comparison [15 minute vs hourly time-step]
4	9:45 – 10:15	Headwater data review and discussion (Idaho Power)
5	10:15 – 10:30	Break
6	10:30 – 11:45	Address comments and edits to Forecast Tool Final Report
7	11:45 – 12:00	Schedule next meeting and identify topics for discussion

2020 Swan Falls Technical Working Group

Presented by Ethan Geisler

October 21, 2020



Swan Falls Agreement Flows
Minimum Streamflow
Snake at Murphy Minimum of Record (1981 - 2018)
Snake River at Murphy Median of Record (1981 - 2018)
Snake River at Murphy Gage
AADF - 3 Day Average
Idaho Power Storage
CFS
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
1/1/2020
2/1/2020
3/1/2020
4/1/2020
5/1/2020
6/1/2020
7/1/2020
8/1/2020
9/1/2020
10/1/2020
11/1/2020
12/1/2020

Home / Legal Actions / Settlements / Swan Falls / AADF Calculations   External link

Swan Falls Settlement

Settlement Archive | Technical Working Group | Policy Group | AADF Calculations | Technical Archive | Media

ADJUSTED AVERAGE DAILY FLOW (AADF) CALCULATIONS

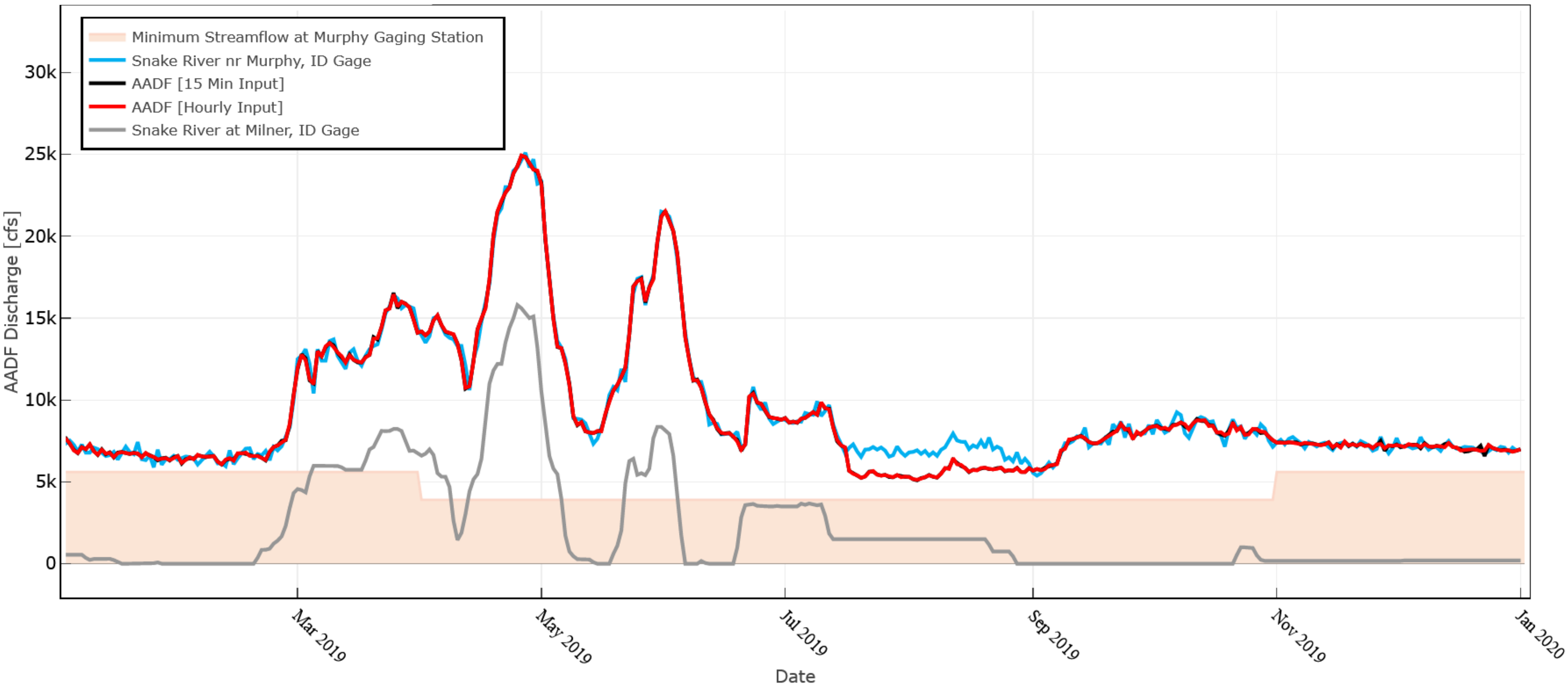
- Swan Falls Adjusted Average Daily Flow Calculation
- 3-Day Average AADF
- AADF Graphs — Weekly Update

HISTORICAL AADF

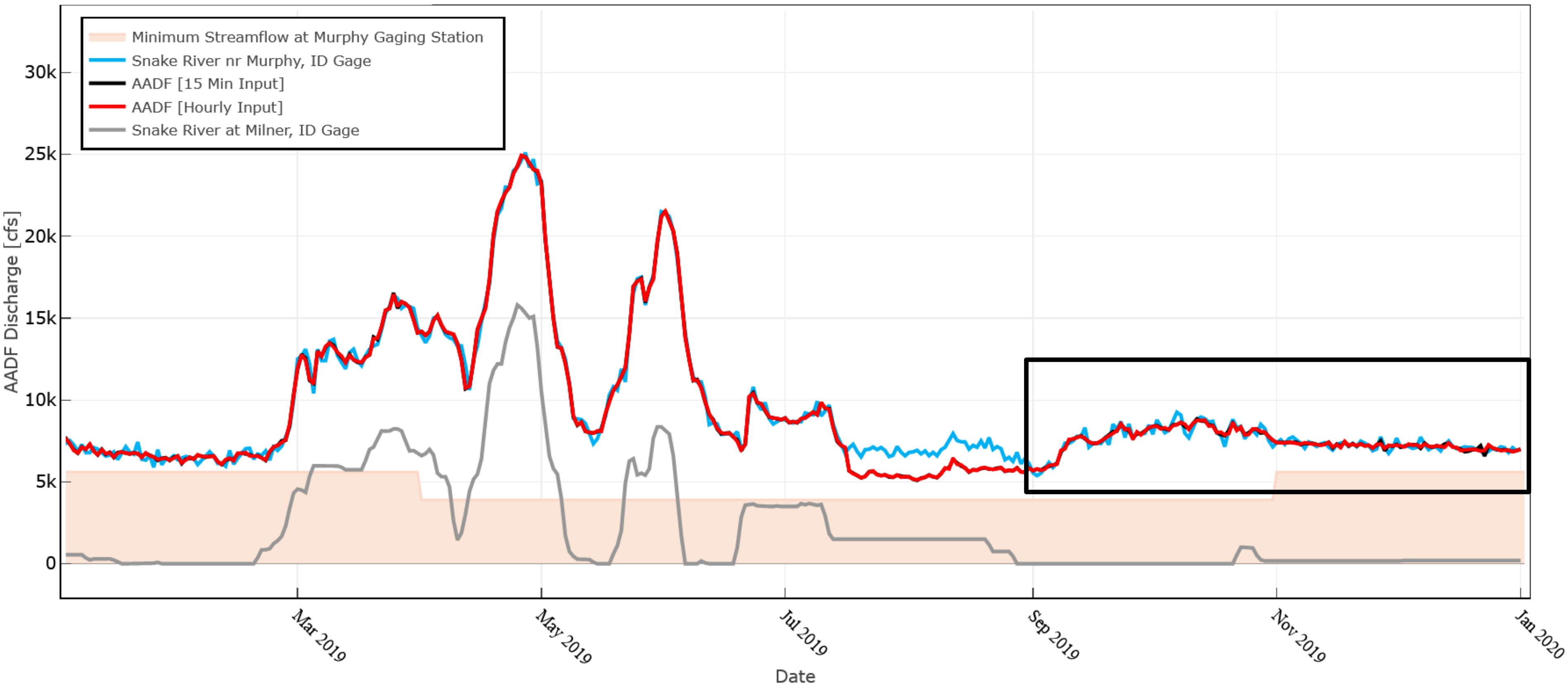
- AADF Graph for 2019
- AADF Graph for 2018
- AADF Graph for 2017
- AADF Graph for 2016
- AADF Graph for 2015
- AADF Graph for 2014

https://idwr.idaho.gov/legal-actions/settlements/swan-falls/AADF-calculations.html

15 Min Inputs vs Hourly Inputs



15 Min Inputs vs Hourly Inputs



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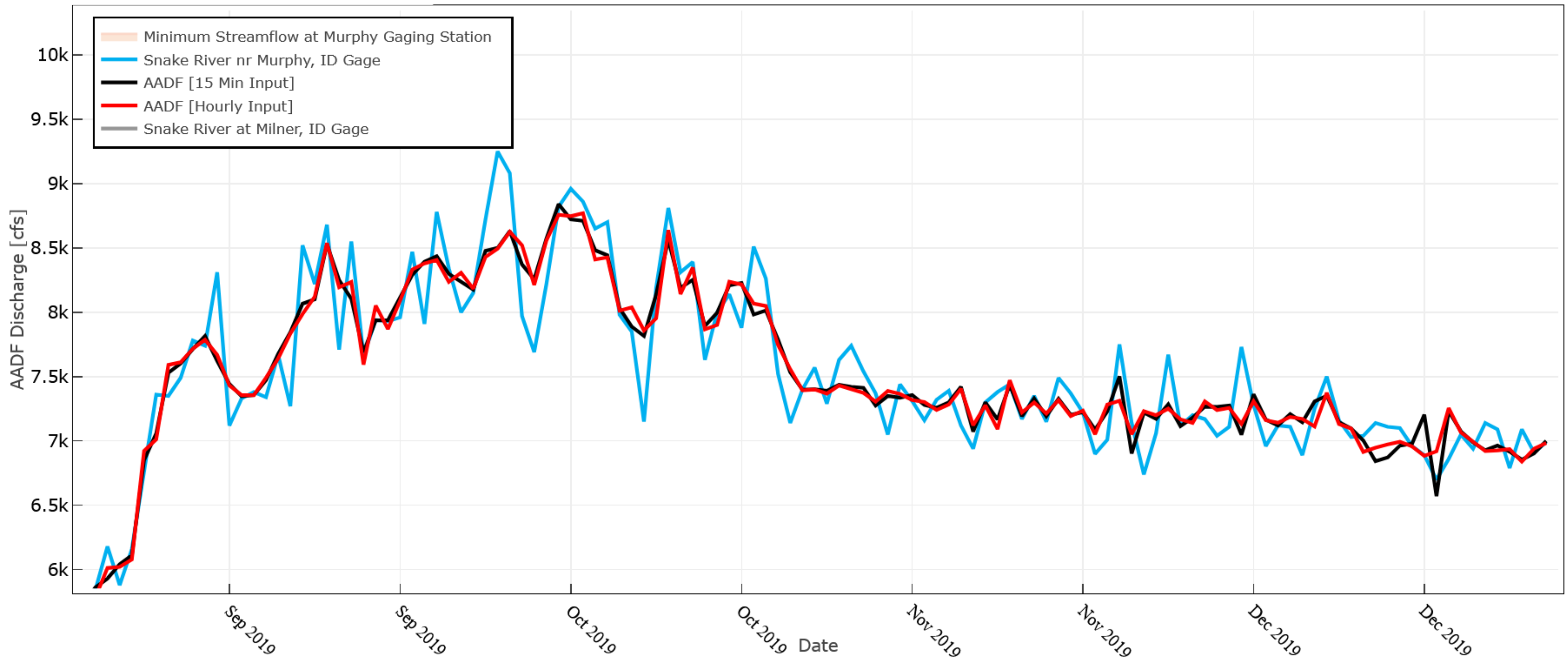
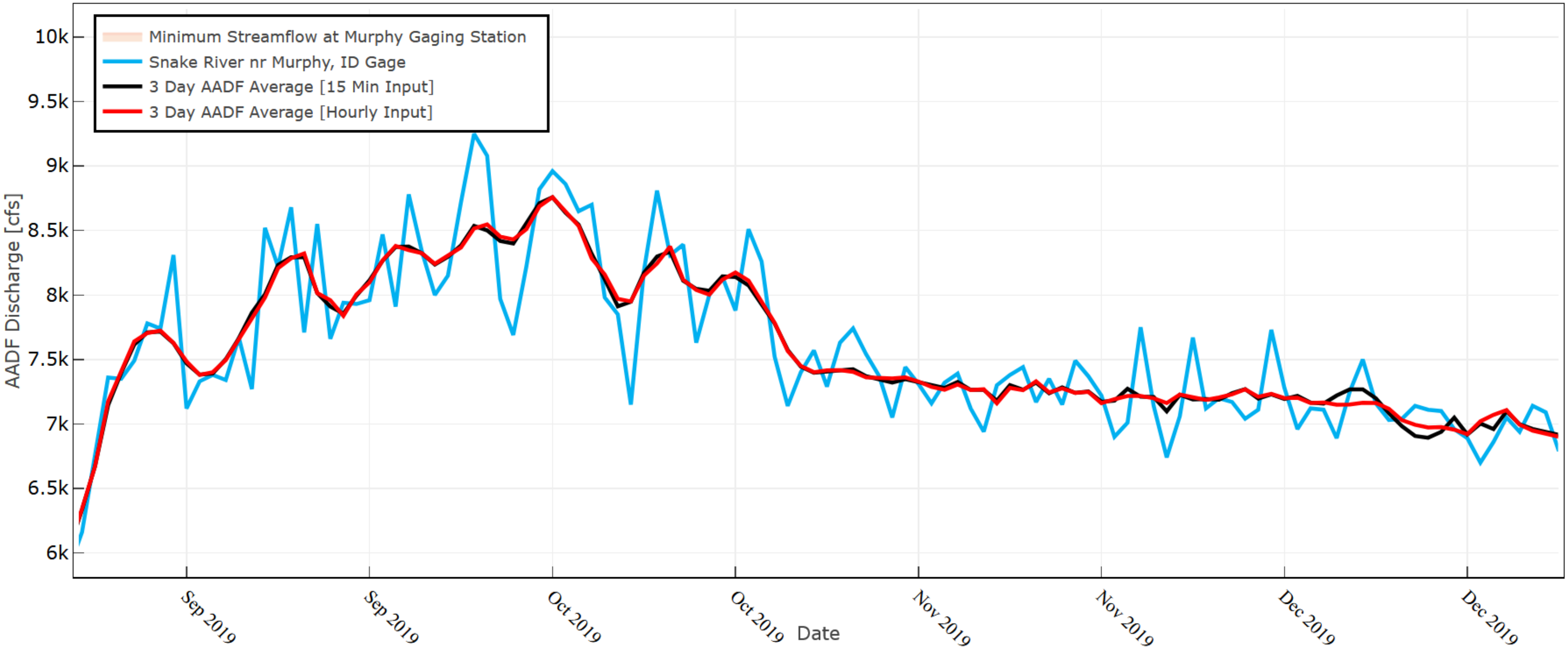
15 Min Inputs vs Hourly Inputs



3 Day Average – AADF Comparison



Current Time-steps

Swan Falls	CJ Strike	Bliss Dam	Lower Salmon Falls
15 min stage	60 min stage	15 min stage	15 min stage

ΔStorage

Discharge

Hourly to Daily Mean

Daily Value | Daily Mean | | Daily Mean

AADF = Snake River nr Murphy + Reservoir Adjustment − Snake River at Milner

* If flow is IPCo Storage

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Swan Falls	CJ Strike	Bliss Dam	Lower Salmon Falls
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Discharge

Hourly to Daily Mean

Daily Value		Daily Mean				Daily Mean
AADF	=	Snake River nr Murphy	+	Reservoir Adjustment	−	Snake River at Milner

* If flow is IPCo Storage

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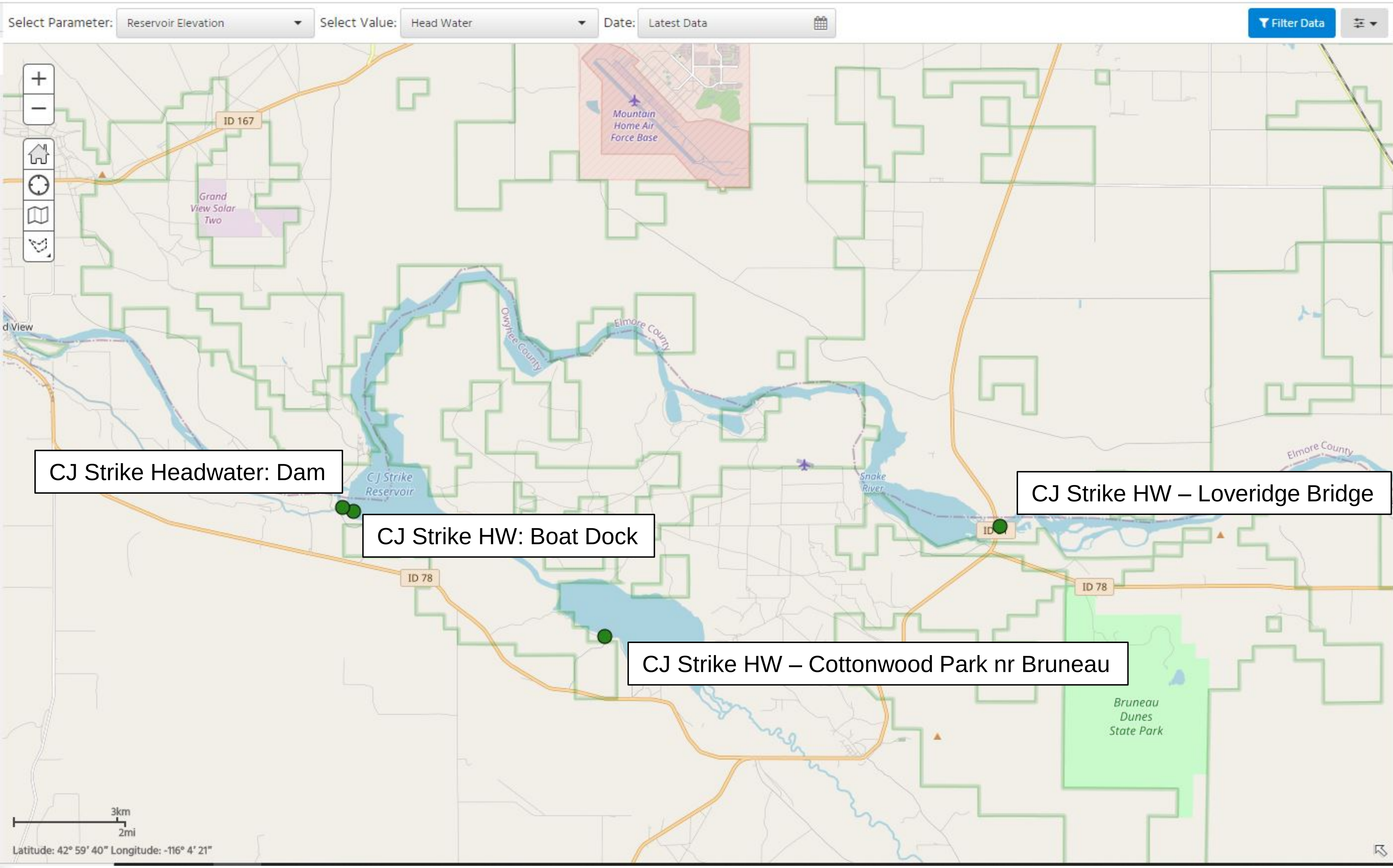


Swan Falls Forecast Tool

October 21, 2020

Manual for the Milner to Murphy Reach Gain Forecast Tool Version 1.0

Final Report

May 2020

Idaho Department of Water Resources
Adapted from CH2M Hill's Final Signed Document (May 31, 2017)

Comment and Discussion

Executive Summary

As described in Section 5, diversion measurements below Milner Dam on the Snake River are not readily available. Therefore, calculations in the forecast tool assume that any excess diversions below Milner Dam will return to the Snake River. The tool utilized the median consumptive diversion estimate from 2003 through 2016 to determine the consumptive diversion amount for the forecast. ~~By using historic estimates of the consumptive diversion, the tool allows the user to estimate Snake River withdrawals for agricultural use between Milner Dam and Murphy using a categorical approach. The user can select the five years with the highest consumptive diversions or select analog years. A user seeking to make a more conservative forecast of the Milner to Murphy reach gain would want to select years with higher consumptive diversions.~~

Forecast Tool Input. The State of Idaho must update the tool with new well water level data and surface water supply index (SWSI) data each year, then other users can use the forecast tool with the following inputs:

– **Forecast year –** the year the user wants to forecast.

– **Number of wells in the head surface interpolation scheme –** the number of points used to interpolate a head surface across the model grid ESPA Model version 2.1.

– **Anticipated Managed Recharge Volumes** – anticipated monthly managed recharge volumes at seven managed recharge locations.

Commented [GE2]: In Reponse to Sophia Sigstedt's comment: " The documentation describes how the consumptive diversions can be estimated based on the highest five years in the historical record or by selecting a analog year (Executive summary pg.5). Will the investigators provide a recommendation for the most accurate forecast method or will various scenarios always be presented for consideration?"

David Hoekema stated this was a relic of an old method that was not used in the final forecast tool. We have changed to text to represent the current approach to calculating QDivET.

2. Forecast Tool Target

The forecast target is the baseflow in the Milner to Murphy reach of the Snake River defined as the natural flow of the Snake River past Murphy gaging station minus Snake River flows past Milner Dam, which is equivalent to the Adjusted Average Daily Flow (AADF) at the Murphy Gaging Station when no flow is passing Milner Dam (Figure 2-1 to 2-3). The AADF calculated flow past Murphy minus flows past Milner would have been the ideal target for this analysis, but the AADF has only been calculated since 2014. Since there was not enough data to validate the forecasts to the AADF, a simplified version of the AADF minus Milner flows was developed and used as the validation target for this analysis. The simplified AADF was calculated as the which was estimated as 7-day moving average of the daily discharge past the Murphy gaging station minus the daily discharge of the Snake River past Milner Dam two days prior. The 2-day lag on the flow past Milner is applied to account for travel time from Milner to Murphy. The 7-day average was assumed to remove most of the Idaho Power Company's reservoir adjustments from the baseflow. The 7-day average is very similar to the AADF calculation when flow passing over Milner is removed. In this analysis the Murphy minus Milner flow is referred to as the Milner to Murphy reach gain. Figures 2-1, 2-2, and 2-3 compare the AADF (grey line) to the forecast target (black line). Where the grey line departs from the blackline, flow is passing Milner Dam.

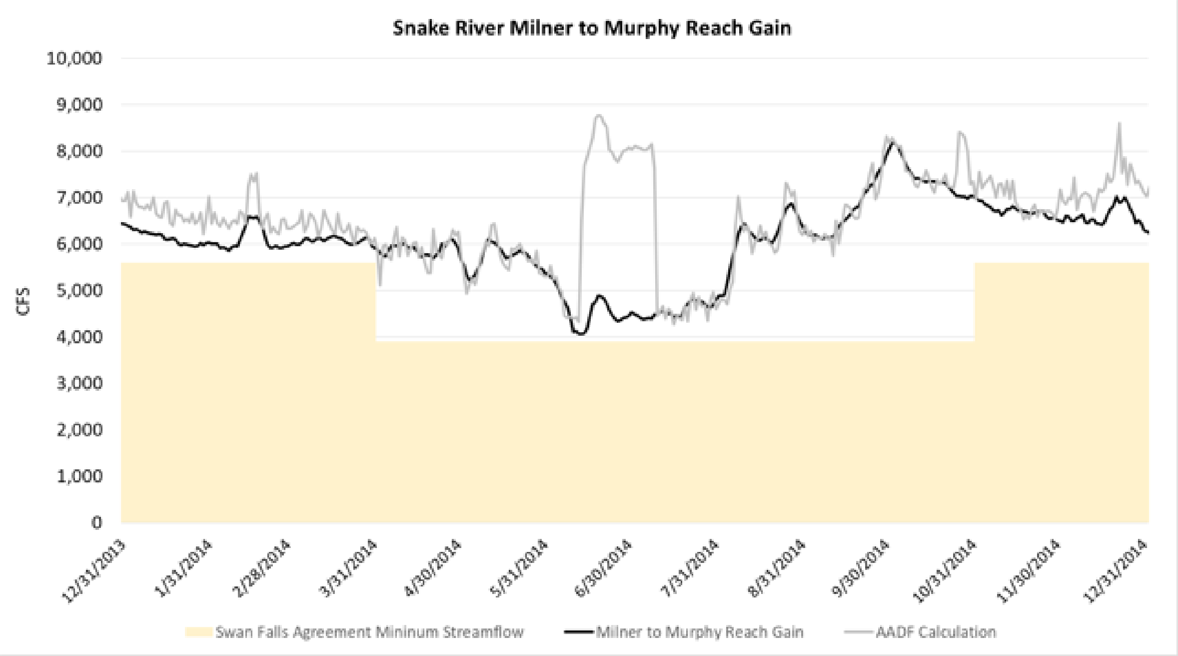


Figure 2-1. 2014 Snake River Milner Dam to the Snake River at Murphy Gaging Station Reach Gain compared to the 2014 AADF Calculation.

Geisler, Ethan
Idaho Power comment: Section 2
Page 3 - The first sentence states that, "The forecast target is the daily gain in the Milner to Murphy reach of the Snake River, which is equivalent to the Adjusted Average Daily Flow (AADF) at the Murphy Gaging Station when no flow is passing Milner Dam (Figure 1-1)." Is this technically correct? The AADF includes adjustments for IPC operations so technically speaking it is not equivalent to the daily gain.
Page 3 – Why was a 7-day moving average for the forecast target calculation selected? It seems like the best way would have been to use an averaging period that produced a target series most similar to the AADF (which could be determined for the period in which the AADF has been calculated). I would imagine that a 3-day moving average might produce a forecast target that is closer to the AADF. It would be good to use the most appropriate forecast target time series, since the intent is to mimic the AADF as closely as possible so that the tool can be assessed based on it's ability to forecast the AADF.

Greg Sullivan: Page 3: Summarize here or in an appendix analyses that support the use of a 7-day average.

Sophia Sigstedt: In section 2 "Forecast Tool Target" please provide a comparison of the 7-day moving average and the 2-day lag of the raw Milner to Murphy reach gain daily time series and the AADF where there are overlapping years.

Section 2

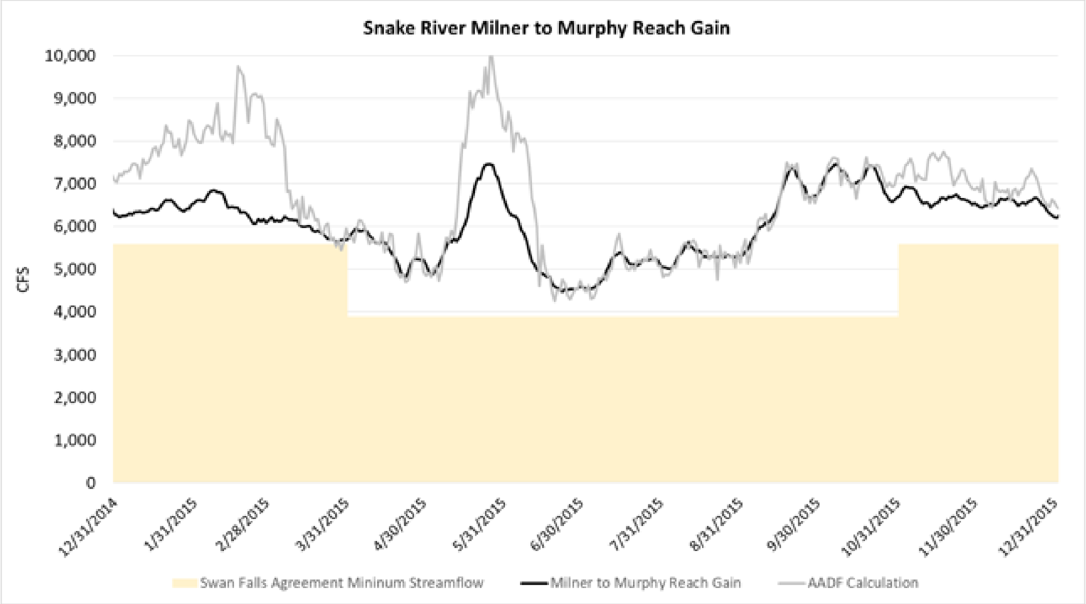


Figure 2-2. 2015 Snake River Milner Dam to the Snake River at Murphy Gaging Station Reach Gain compared to the 2015 AADF Calculation.

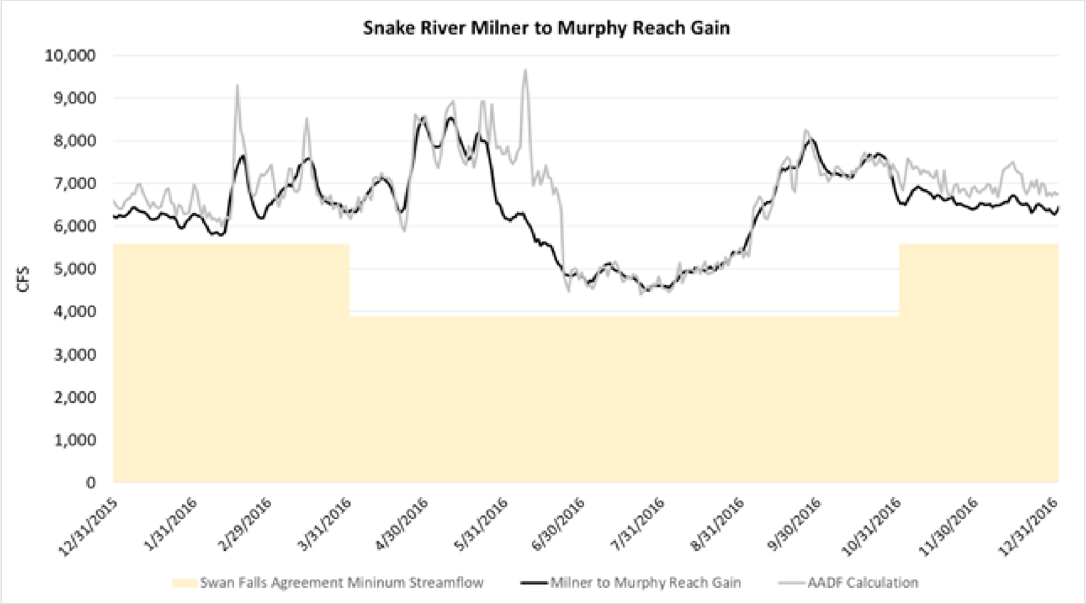


Figure 2-3. 2016 Snake River Milner Dam to the Snake River at Murphy Gaging Station Reach Gain compared to the 2016 AADF calculation.

Section 2

Section 3

3. Aquifer Discharge Forecast Methods and Procedures

This section details each component used to generate a forecast of ESPA discharge (Snake River reach gains between Kimberly and King Hill), including starting heads, recharge incidental to irrigation, managed recharge, and pumping. Each component of the discharge forecast is based on response functions from ESPAM 2.1. Moving forward, if a new ESPA model is approved, the response functions within the forecast tool will be updated appropriately and as soon as practical.

Commented [GE4]: In response to Idaho Power comment: "What will happen if a new ESPAM model is adopted?"
&
Sophia Sigstedt's comment:
"Please consider that in this forecasting tool each component of discharge is based on Eastern Snake Plain Aquifer Model (ESPAM) version 2.1 unit response functions (timing of stream accretions/depletions). I expect that the new ESPAM2.2 calibration will have an impact on the prediction tool when it is implemented. I suggest the investigators evaluate potential changes in implementing the new ESPAM2.2 calibration."

3.1. General Response Function Concepts

Cause and effect relationships in groundwater hydrology can be described by response functions, also termed response ratios, impulse responses, algebraic technologic functions (Maddock 1972), and transfer functions. Response functions can be thought of as the system response to an external stress. There is extensive information on response ratios in the literature, including a detailed mathematical derivation (Maddock 1972, Morel-Seytoux and Daly 1975); a description of MODSRP, which is a modified version of MODFLOW that was developed to generate response functions (Maddock and Lacher 1991); a report on the integration of surface-water and ground-water flow models (Fredericks and Labadie

Section 4.1

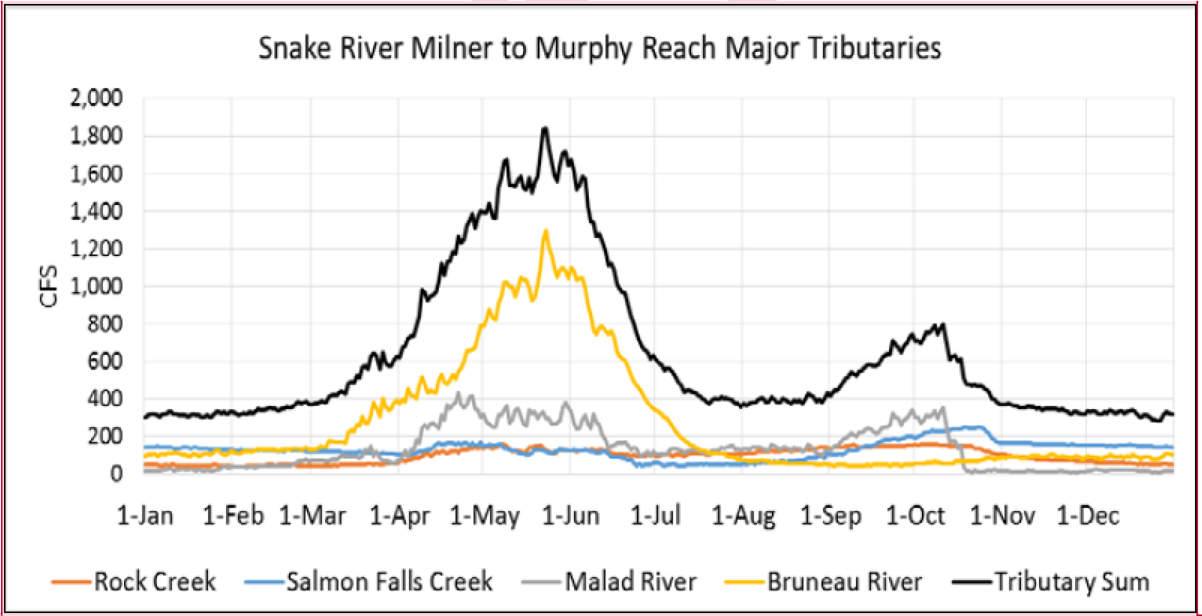


Figure 4-2. Median annual hydrographs for the major tributaries for the period 1993-2016.

Commented [GE8]: Changed the colors of some line to address Greg Sullivan's comment: "Many of the report graphs that compare different results (median, 90th percentile, 10th percentile, etc) use black and blue lines that are difficult to discern. Consider using different colors that can be more easily distinguished."

The other blue and black line plots that are referenced in this comment are not a concern to change due to the fact they are showing the overall comparison and are not utilized for a detailed comparison analysis

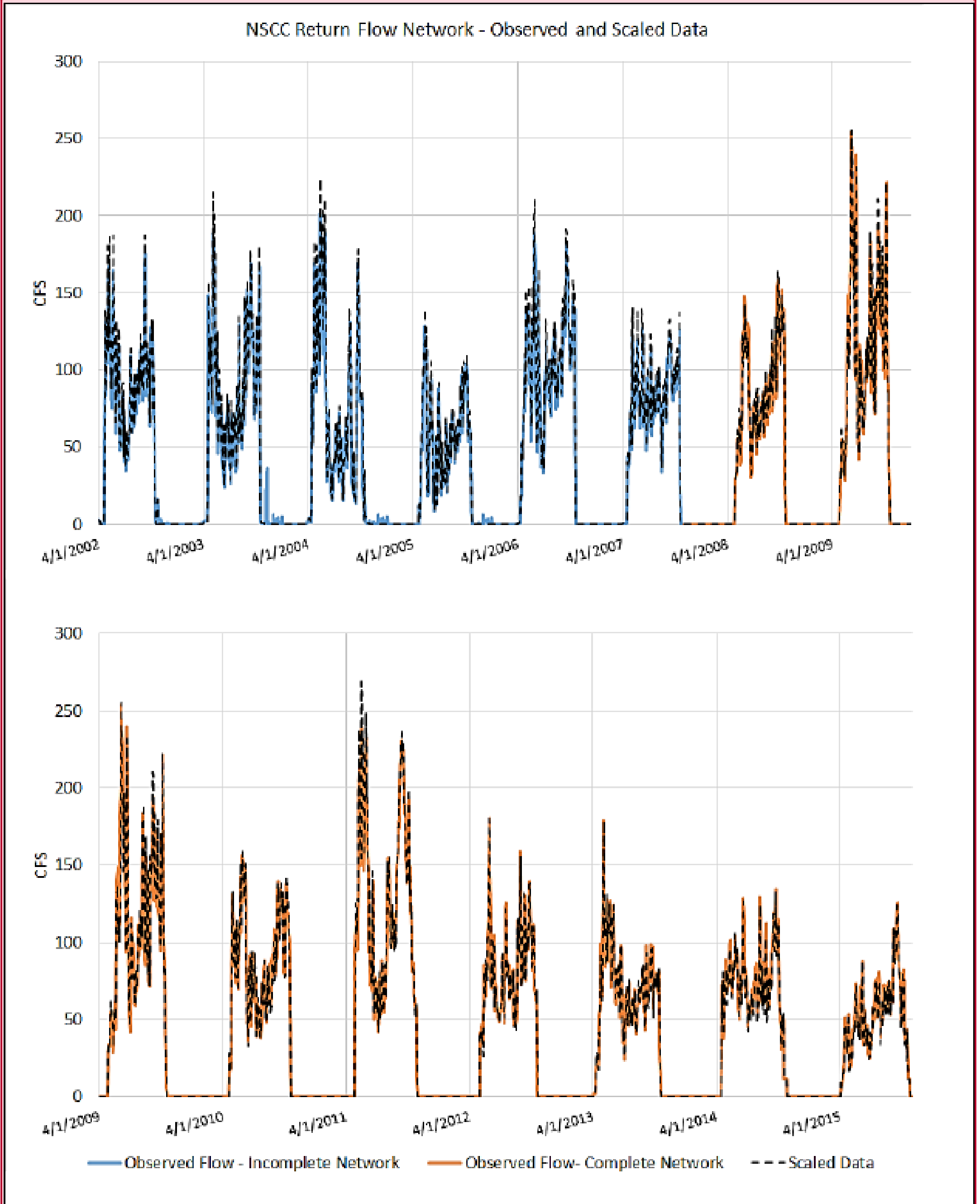


Figure 4-4. Measured and estimated discharge from the North Side Canal Company (NSCC) return flow network (2002-2016).

Commented [GE10]: Split the graph into two per Greg Sullivan comment: "• . Page 44 and 45 Figure 4-4 and 4-5: Split this chart into two or three separate ones to expand the axis to more clearly distinguish the measured and estimated discharges."

Section 4.2.1

Section 4.3

4.3. Kimberly Gains Estimation Procedure

The Kimberly gains are a component in the $Q_{non\text{-}ESPA}$ equation and is non-ESPA spring discharge and minor irrigation return flows that enter the system between Milner Dam and the Snake River at Kimberly gaging station. Daily gains are calculated by subtracting the Snake River at Kimberly gage from the Snake River at Milner gage for WY 1993 – 2016. This period of record is consistent with the tributary forecast. The Kimberly gains estimation is the median statistical hydrograph of the daily gage calculation.

The Kimberly gains are calculated as the gage difference between Snake River at Kimberly and Snake River at Milner. Milner data is lagged by one day to account for travel time[2]. Daily gains are then filtered to include only days when the gain is greater than 10% of Kimberly flow. The 10% of Kimberly flow filter criteria is based on the "good" rating of the gage by Idaho Power[3] and is used to identify gains that are greater than gage uncertainty. A "good" rating indicates that 95% of the daily discharge values are within 10% of the true value[4]. After filtering for gage uncertainty, outlying values were identified and removed. Outliers are identified as a daily gain value outside of 2 standard deviations of the mean and

Geisler, Ethan A few seconds ago
Greg Sullivan's comment: →Page 47 in reference to Kimberley Gains estimation: It seems that removing the gains that are less than 10% would have the effect of biasing the predicted gains as too high

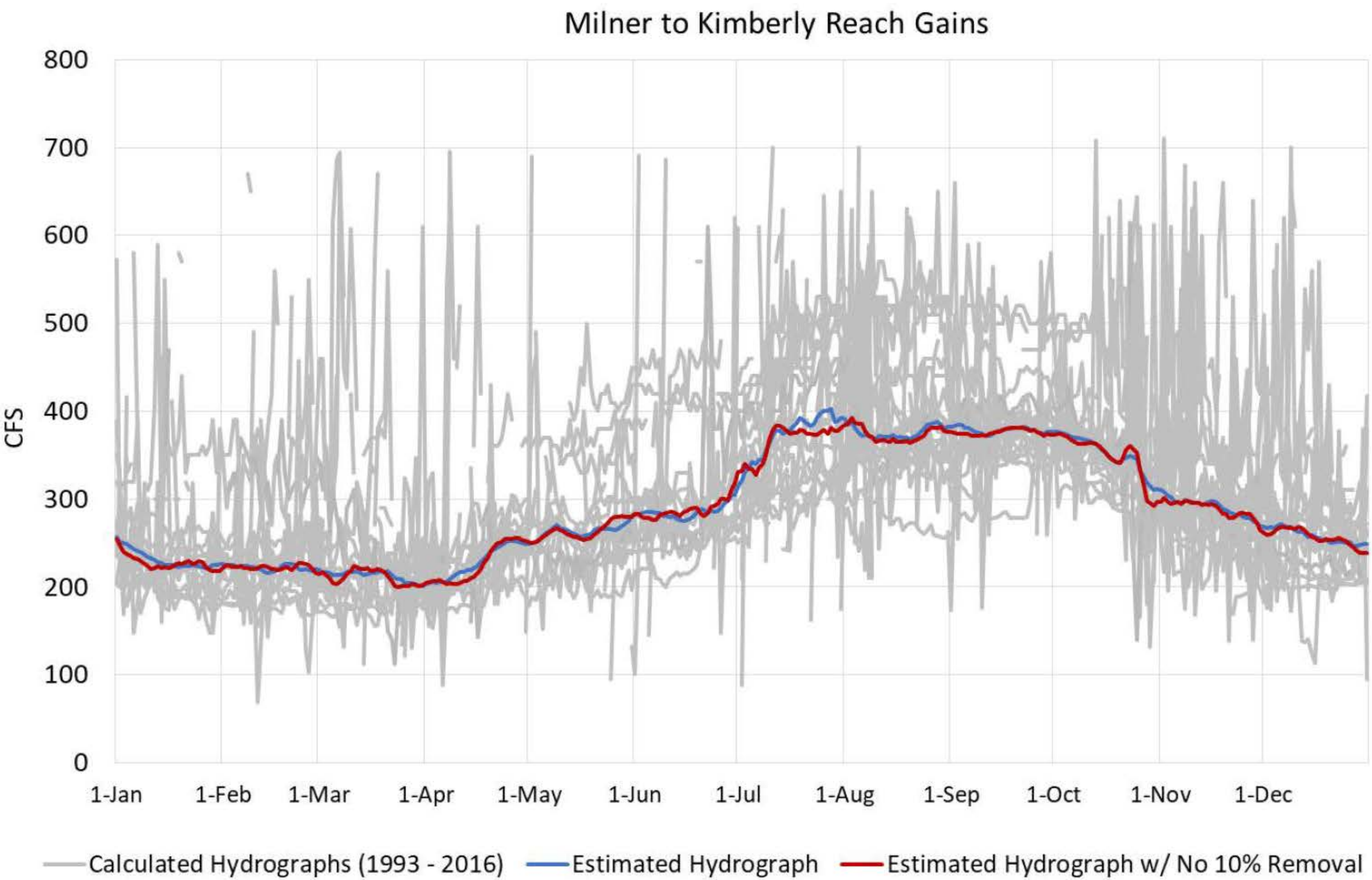

Milner to Kimberly Reach Gains
800
700
600
500
400
300
200
100
0
CFS
1-Jan
1-Feb
1-Mar
1-Apr
1-May
1-Jun
1-Jul
1-Aug
1-Sep
1-Oct
1-Nov
1-Dec
Calculated Hydrographs (1993 - 2016)
Estimated Hydrograph
Estimated Hydrograph w/ No 10% Removal

Figure 4-11

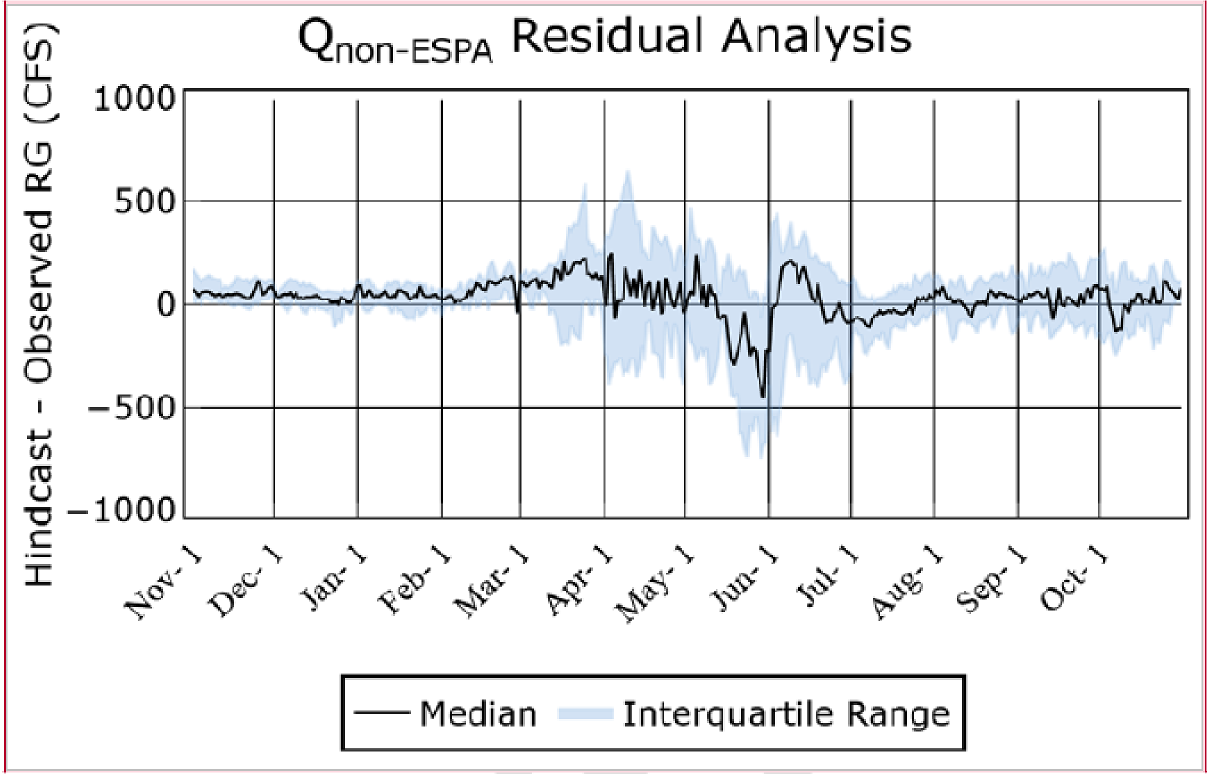


Figure 4-11. Residual analysis hydrograph showing the interquartile range of the daily difference between observed and hindcasted values for years 2002 – 2017.

Commented [GE13]: Changed to Predicted-Observed per Greg Sullivan's Comment on the Hindcast residual plot: "Switch difference calculation to Predicted minus Observed which is more intuitive (e.g., positive value means model overpredicts"

Figure 5-3 and 5-4

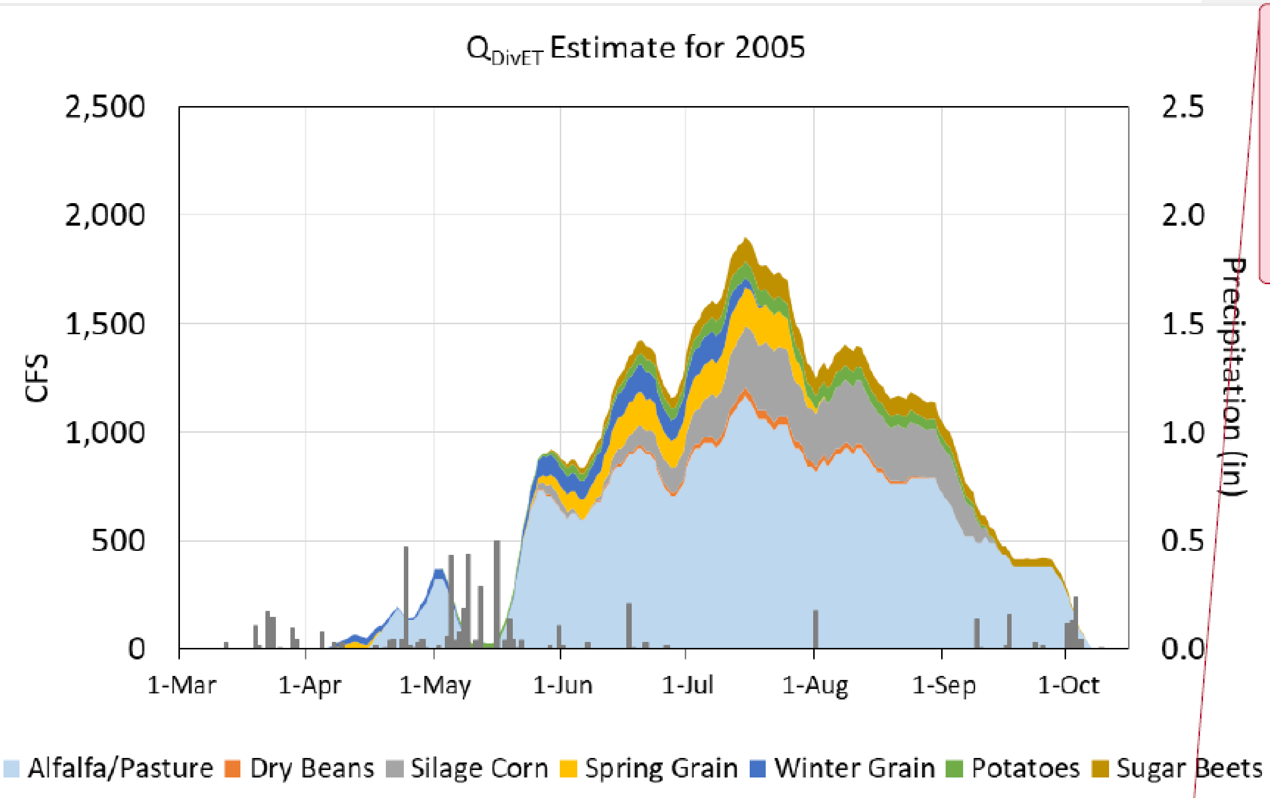


Figure 5-3. Q_{DivET} for the Milner to Murphy reach of the Snake River in 2013 by crop type and daily precipitation amounts on the secondary axis from the Grand View Agrimet Station.

Commented [GE14]: In Response to Sophia Sigstedt Comment: "10. On the historical plots of monthly QDivET, it would be helpful to somehow show the precipitation events on a secondary axis."
&
Greg Sullivan comment: • Figure 5-4: Explain the reasons for the multi-weekly fluctuations in Qdivet. Are these temperature swings, precipitation swings, simulated irrigation applications, simulated alfalfa cuttings, etc.?

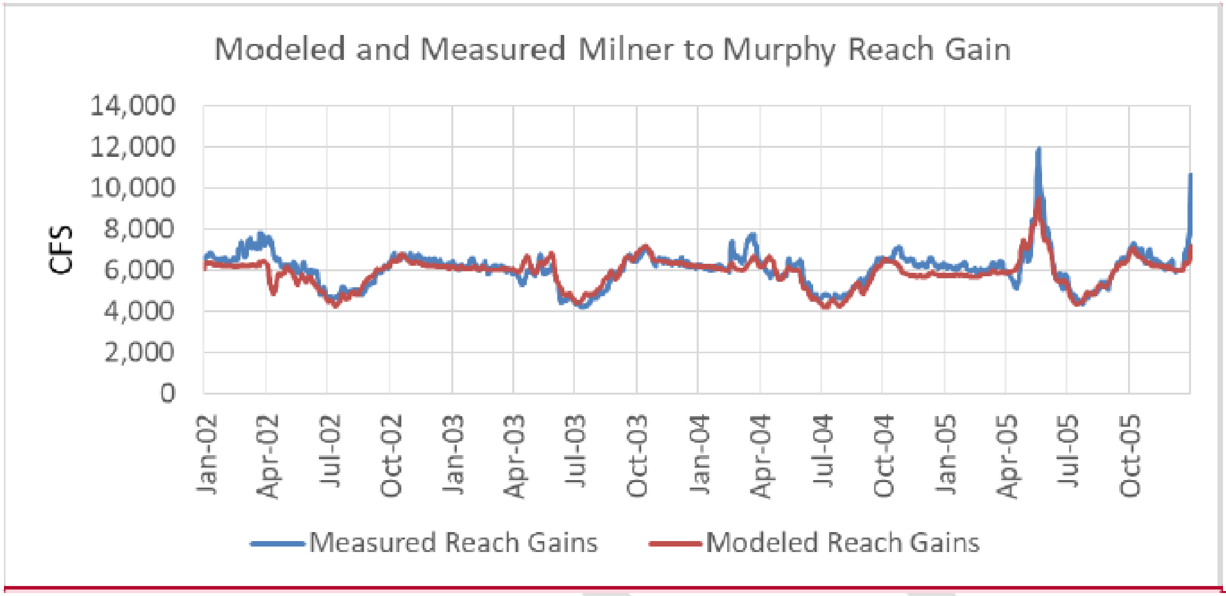


Figure 5-10. A comparison of the modeled versus measured Milner to Murphy reach gains from 2002 through 2005. The correlation coefficient, r, is 0.91 (for the entire comparison 2002-2012).

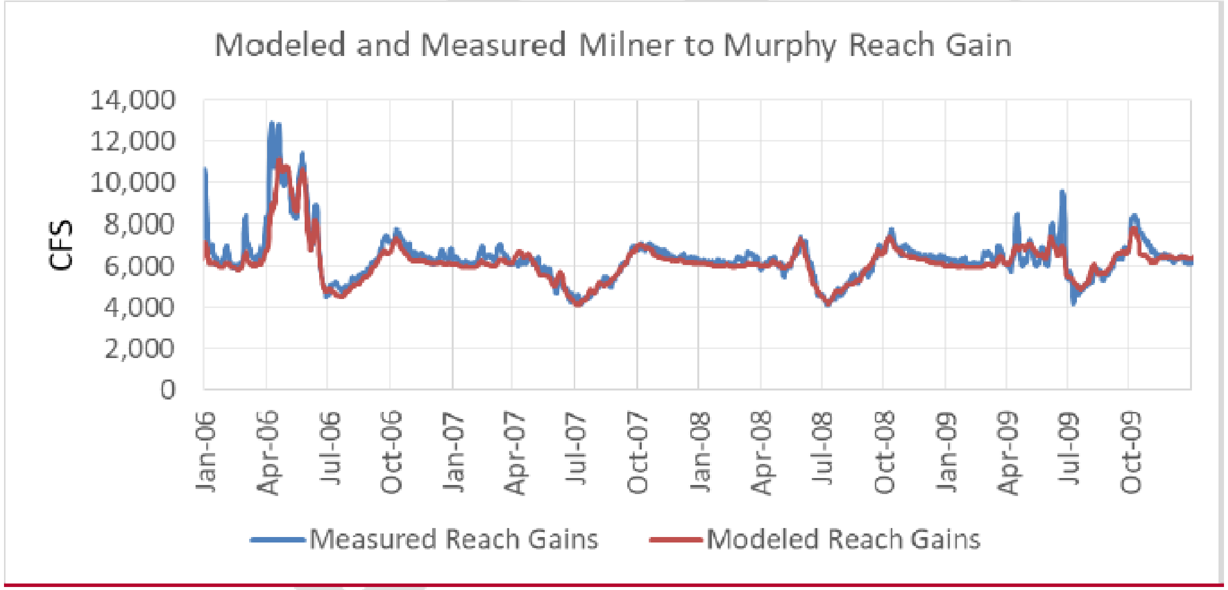


Figure 5-11. A comparison of the modeled versus measured Milner to Murphy reach gains from 2006 through 2009. The correlation coefficient, r, is 0.91 (for the entire comparison 2002-2012).

Commented [GE16]: Split the graph up into more plots per Greg Sullivan's comment: "• Figure 5-10: Expand this chart to full page with three or four charts each containing a subset of the full study period results (e.g., 2002-2005, 2006-2009, 2010-2013, 2014-2017)"

Figure 5-10

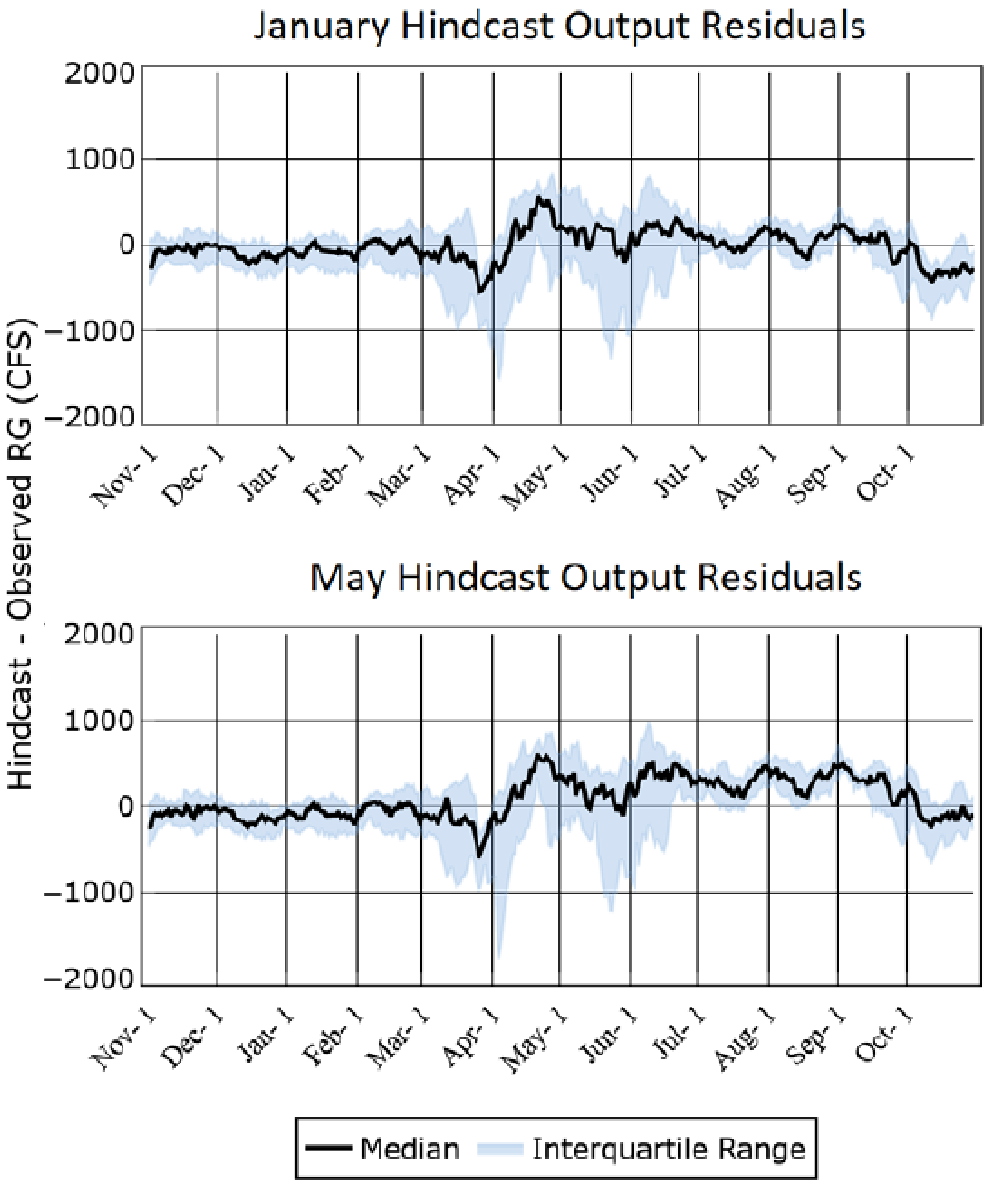


Figure 6-2. Hindcast residual analysis plot for Milner to Murphy reach gain for January and May hindcasts.

Commented [GE18]: Changed to Predicted-Observed per Greg Sullivan's Comment: "Switch difference calculation to Predicted minus Observed which is more intuitive (e.g., positive value means model overpredicts"

Added in the May forecast to addres Idaho Power's Comment: "3. . It is difficult to follow whether the hindcasts are all referenced to a single SFFT forecast (January or May) or if the forecast switches through the year. If this could be clarified it would be helpful in better understanding how the tool might be used in a given runoff year."

Figure 6-2

Section 6.3

$$SFFT_{Forecast} = Q_{ESPA} + Q_{non\text{-}ESPA} - Q_{DivET} + R_{percentile}$$

where,

Q_{ESPA} = discharge from the ESPA between Milner Dam and King Hill

$Q_{non\text{-}ESPA}$ = Milner to Murphy reach gains from non-ESPA sources

Q_{DivET} = Milner to Murphy consumptive use of diverted flow

$R_{percentile}$ = Percentile of the residuals from the Hindcast analysis

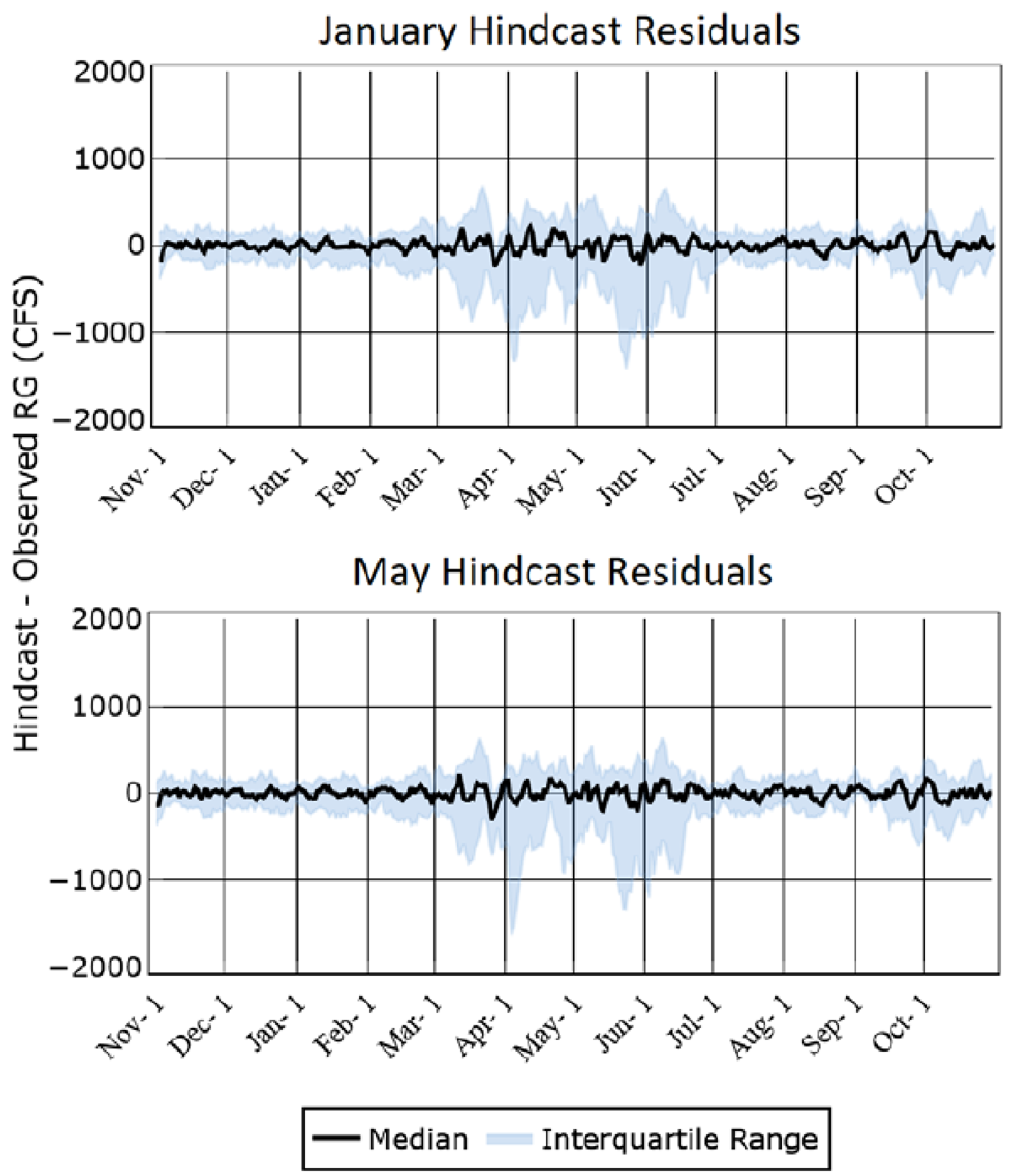
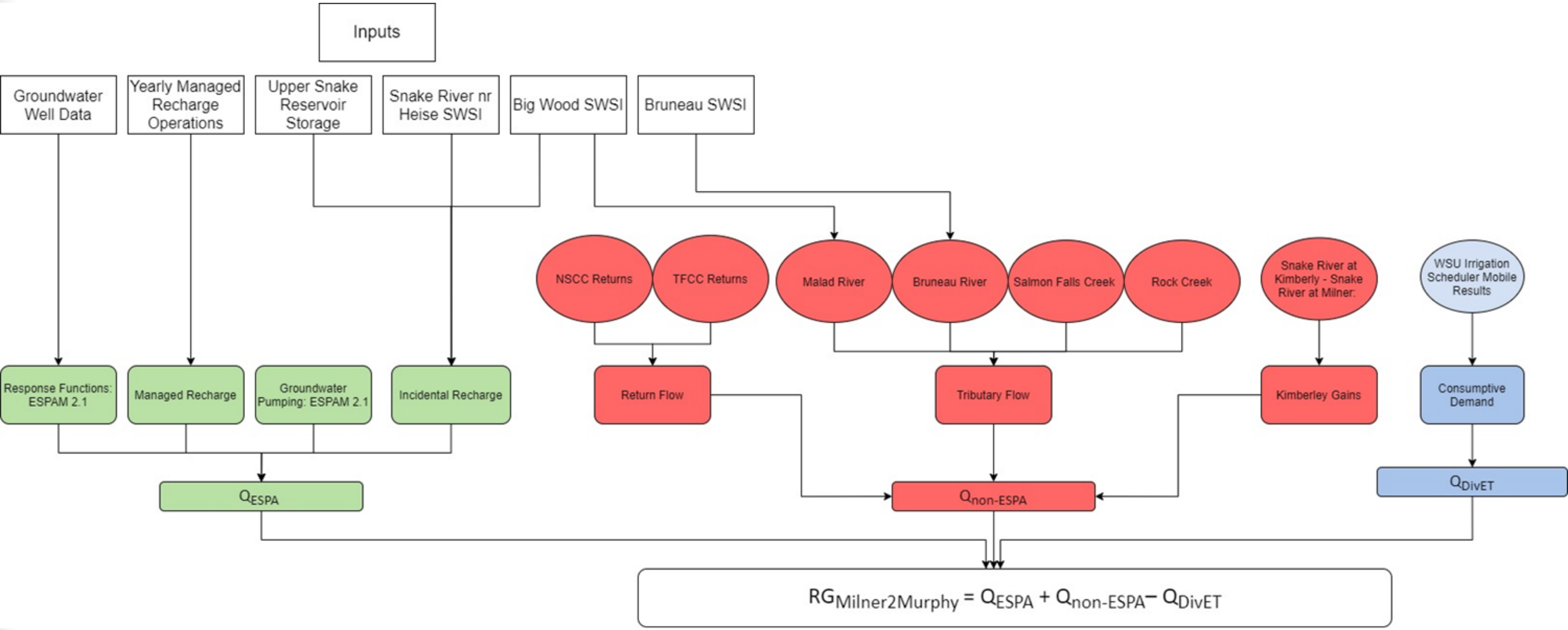


Figure 6-3. Hindcast residual analysis plot for Milner to Murphy reach gain for January and May hindcast after including a 15-day centered average of the 50th percentile of residuals for each day to correct for bias

Figure 6-3

Commented [GE19]: David and I elaborated/expanded on this section because it was not clear that residuals are included in the forecast by adding in the 50th percentile to the SFFT output to correct bias that the model may have. The residual plots in this section show the difference between predicted-observe once residual and bias are accounted for.

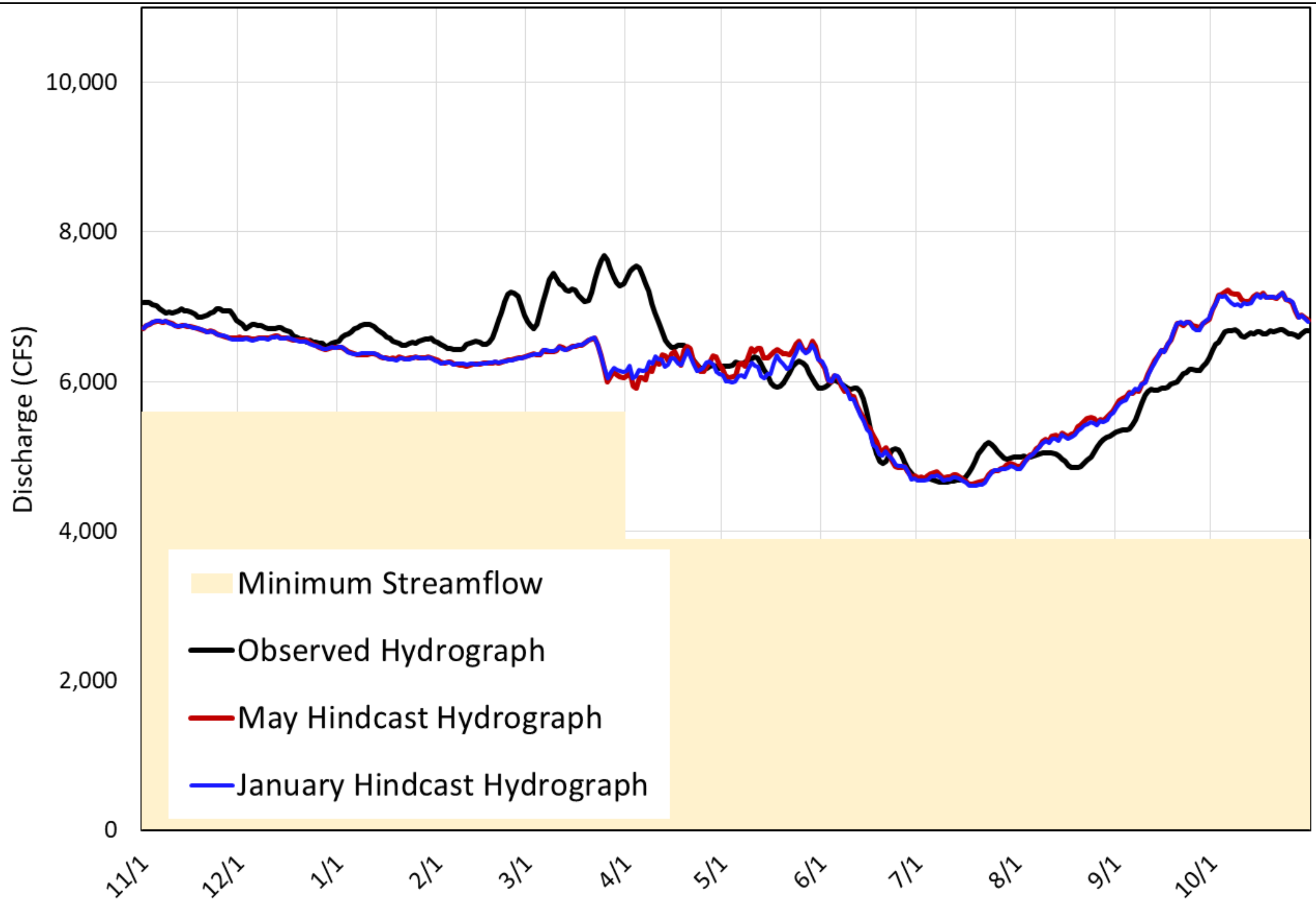
Appendix B.


Inputs
Groundwater Well Data
Yearly Managed Recharge Operations
Upper Snake Reservoir Storage
Snake River nr Heise SWSI
Big Wood SWSI
Bruneau SWSI
NSCC Returns
TFCC Returns
Malad River
Bruneau River
Salmon Falls Creek
Rock Creek
Snake River at Kimberly - Snake River at Milner.
WSU Irrigation Scheduler Mobile Results
Response Functions: ESPAM 2.1
Managed Recharge
Groundwater Pumping: ESPAM 2.1
Incidental Recharge
Return Flow
Tributary Flow
Kimberley Gains
Consumptive Demand
Q_{ESPA}
$Q_{non\text{-}ESPA}$
Q_{DivET}
$RG_{Milner2Murphy} = Q_{ESPA} + Q_{non\text{-}ESPA} - Q_{DivET}$

Appendix B.

	Type of Data	Input	Date Range	Statistic	Notes
Q_{ESPA}	Starting Head Component	Response Functions			ESPAM 2.1
		Groundwater Water Level Data	Preceding Fall or Spring synoptic		
	Managed Recharge		Current year recharge operations	Actual/ Forecasted values	
	Incidental Recharge	SWSI: (Big Wood & Snake nr Heise) & Reservoir Storage	1981 to 2014	Correlation to SWSI value	Correlation built with ESPAM 2.1
	Groundwater Pumping	ESPAM 2.1	2001 to 2010	Average	
$Q_{non\text{-}ESPA}$	Tributary Flow	Salmon Falls Creek	1986 to Present	Median	
		Rock Creek	1993 to Present	Median	
		Bruneau River	1986 to Present	Analog SWSI	
		Malad River	1987 to Present	Analog SWSI	
	Return Flow	Northside Returns	2002 - Present	Median	
		Southside Returns	2002 - Present	Median	
	Kimberley Reach Gains	Snake River at Kimberly	1993 to 2016	Median	Smoothed with a 5 day moving average (centered)
Q_{DivET}	WSU Irrigation Scheduler Mobile Results		2010 - 2014	Median	

Appendix C. Hindcast Validation



My understanding is that this forecasting tool is being presented as a planning tool where predictions can be utilized by the water users such that they can adjust storage needs (i.e. set storage water aside to release if a shortfall occurs) or tweak operations on the ground such as what crops are grown in the upcoming season. It is also my understanding that the Policy Group has not significantly weighed in and that we (TWG) are not at the Administration versus Planning tool conversation yet. Will there be a recommendation for how the tool is distributed, to who, and for what purpose?