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

- Minimum Streamflow
- Snake at Murphy Minimum of Record (1981 - 2018)
- Snake at Murphy Median of Record (1981 - 2018)
- Snake River at Murphy Gage
- AADF - 3 Day Average

Idaho Power Storage
Swan Falls Settlement

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
15 Min Inputs vs Hourly Inputs

Minimum Streamflow at Murphy Gaging Station
Snake River nr Murphy, ID Gage
AADF [15 Min Input]
AADF [Hourly Input]
Snake River at Milner, ID Gage
15 Min Inputs vs Hourly Inputs
15 Min Inputs vs Hourly Inputs

- Minimum Streamflow at Murphy Gaging Station
- Snake River nr Murphy, ID Gage
- AADF [15 Min Input]
- AADF [Hourly Input]
- Snake River at Milner, ID Gage
3 Day Average – AADF Comparison

Minimum Streamflow at Murphy Gaging Station
- Snake River nr Murphy, ID Gage
- 3 Day AADF Average [15 Min Input]
- 3 Day AADF Average [Hourly Input]
Current Time-steps

<table>
<thead>
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<th>Location</th>
<th>Time-steps</th>
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<tr>
<td>Swan Falls</td>
<td>15 min stage</td>
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<tr>
<td>CJ Strike</td>
<td>60 min stage</td>
</tr>
<tr>
<td>Bliss Dam</td>
<td>15 min stage</td>
</tr>
<tr>
<td>Lower Salmon Falls</td>
<td>15 min stage</td>
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\[ \Delta \text{Storage} \]

\[ \text{Discharge} \]

\[ \text{Hourly to Daily Mean} \]

\[ \text{Reservoir Adjustment} \]

\[ \text{Daily Mean} \]

\[ \text{AADF} \]

\[ \text{Snake River nr Murphy} \]

\[ \text{Daily Value} \]

\[ \text{Snake River at Milner} \]

* If flow is IPCo Storage
Current Time-steps

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

AADF

Daily Value

=

Snake River nr Murphy

Daily Mean

Reservoir Adjustment

Hourly to Daily Mean

ΔStorage

Discharge

Snake River at Milner

Daily Mean

* If flow is IPCo Storage
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)
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 Response 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 an 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.
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 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.

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 1975).

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 (ESPM) 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.”
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.
Section 4.2.1

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.”
4.3. Kimberly Gains Estimation Procedure

The Kimberly gains are a component in the $Q_{\text{non-ESPA}}$ 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. 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 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. 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...
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

**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 5-3.** QDivET 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.
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).
Figure 6-2. Hindcast residual analysis plot for Milner to Murphy reach gain for January and May hindcasts.
Section 6.3

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

where,

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

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

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

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

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.

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

Return Flow

Tributary Flow

Q_{non-ESPA}

Consumptive Demand

Q_{DivET}

R_{G, Milner2Murphy} = Q_{ESPA} + Q_{non-ESPA} - Q_{DivET}
# Appendix B.

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<th>Input</th>
<th>Date Range</th>
<th>Statistic</th>
<th>Notes</th>
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<td>Response Functions Groundwater Water Level Data</td>
<td>Preceding Fall or Spring synoptic</td>
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<td>ESPAM 2.1</td>
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<td>Managed Recharge</td>
<td>Current year recharge operations</td>
<td>Actual/ Forecasted values</td>
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<td>Incidental Recharge</td>
<td>SWSI: (Big Wood &amp; Snake nr Heise) &amp; Reservoir Storage</td>
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<td>Correlation to SWSI value</td>
<td>Correlation built with ESPAM 2.1</td>
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<td>1993 to Present</td>
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<td>Southside Returns</td>
<td>2002 - Present</td>
<td>Median</td>
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<td>Kimberley Reach Gains</td>
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<td>1993 to 2016</td>
<td>Median</td>
<td>Smoothed with a 5 day moving average (centered)</td>
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<td>Q&lt;sub&gt;DivET&lt;/sub&gt;</td>
<td>WSU Irrigation Scheduler Mobile Results</td>
<td>2010 - 2014</td>
<td>Median</td>
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Appendix C. Hindcast Validation

- Minimum Streamflow
- Observed Hydrograph
- May Hindcast Hydrograph
- January Hindcast Hydrograph
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?