2022 Klamath Project Hydrologic Forecast

December 14, 2021
Assumptions

UKL Net Inflow (UKLNI) Projections

- Ensemble traces based on **period-of-record (POR) water year (WY)** analogs
  - Selected WYs based on:
    - Distribution pattern & volume
    - La Niña/El Niño index forecasts (Oregon Department of Agriculture)
    - Streamflow forecasts (**California-Nevada River Forecast Center (CNRFC)**)
    - Antecedent/current hydrologic conditions
    - In-house observations & analyses
  - Best fit WY analogs are colorized

- Traces categorized into 25%, 50%, 75%, 90%, 10% **probability of exceedance (POE)** levels
- Current hydrologic conditions inform short-range (<2 week) UKLNI projection
- Current meteorological forecasts inform short-range UKLNI projection

Accretions

- **Lost River**: set to 0% contribution to Klamath River → Iron Gate Dam flows
- **Lake Ewauna**: volume & pattern set to historical percentile -or- WY analog; downscaled to account for Lost River
- **F/FF Pumping Plant**: volume & pattern set to historical percentile -or- analog WY
- **Keno-Iron Gate**: volume & pattern set to multi-model forecast through March 2022, then set to historical percentile -or- WY analog through September 2022
Assumptions cont.

2022 Spring/Summer (March 2022 – September 2022)

- Project Supply
  - Allocation calculation in accordance with current BiOp policy
  - CNRFC KLAO3 UKLNI Mar-Sep 2022 volumetric forecast informs analysis

<table>
<thead>
<tr>
<th>CNRFC – KLAO3 UKL Net Inflow Accumulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forecast Issuance Date</td>
</tr>
<tr>
<td>Forecast Period</td>
</tr>
<tr>
<td>Exceedance</td>
</tr>
<tr>
<td>90%</td>
</tr>
<tr>
<td>75%</td>
</tr>
<tr>
<td>50%</td>
</tr>
<tr>
<td>25%</td>
</tr>
<tr>
<td>10%</td>
</tr>
</tbody>
</table>

- Simulated Project Supply and EWA allocations computed on *March 1 only*
- Simulated end-of-season minimum elevation reflects full utilization of computed Project Supply and EWA (including augmentation when set by allocation logic)
- Surface flushing flows are set and triggered in accordance with current BiOp policy
  - If set, trigger date = April 15
  - Flow rate = 6030 CFS, 3 days continuous, followed by BiOp ramp down rates -OR- maximum Link release capacity, 3 days continuous, followed by BiOp ramp down rates
Assumptions cont.

2021-2022 Fall/Winter (Nov 2021 – Feb 2022) Deliveries & Demand

- **KDD**
  - KDD diversion rates in compliance with/do not exceed Central Tendency (CT)-controlled reductions
  - Daily distribution proportions reflect historical diversion patterns

- **LKNWR**
  - LKNWR diversion rates in compliance with/do not exceed CT-controlled reductions
  - Daily distribution proportion forced to CT-controlled maxima
Current Conditions
NWS Klamath Falls Airport Met Station
WY 2022

Accumulated Precipitation - Klamath Falls Area, OR (ThreadEx)

Black diamonds indicate missing data

<table>
<thead>
<tr>
<th>Water Year</th>
<th>Month</th>
<th>Monthly Total</th>
<th>Monthly Departure</th>
<th>Monthly Normal</th>
<th>% Monthly Normal</th>
<th>WY Total</th>
<th>WY Departure</th>
<th>WY Normal</th>
<th>% WY Normal</th>
</tr>
</thead>
<tbody>
<tr>
<td>2022</td>
<td>Oct</td>
<td>2.31</td>
<td>1.57</td>
<td>0.74</td>
<td>312%</td>
<td>2.31</td>
<td>1.57</td>
<td>0.74</td>
<td>312%</td>
</tr>
<tr>
<td></td>
<td>Nov</td>
<td>0.64</td>
<td>-0.74</td>
<td>1.36</td>
<td>46%</td>
<td>2.95</td>
<td>0.83</td>
<td>2.12</td>
<td>138%</td>
</tr>
<tr>
<td>as of Dec 14</td>
<td></td>
<td>0.07</td>
<td>-0.75</td>
<td>0.82</td>
<td>9%</td>
<td>3.02</td>
<td>0.08</td>
<td>2.94</td>
<td>103%</td>
</tr>
</tbody>
</table>
NRCS Klamath River Basin SNOTEL

WY 2022 Snow Water Equivalent (SWE)

WY2022-to-date SWE = 2.0 inches
Median = 3.2 inches
WY2022-to-date % of median = 62%

Statistical shading breaks at 10th, 30th, 50th, 70th, and 90th Percentiles
Williamson River Flows
WY 2022

The graph shows the mean daily flow of the Williamson River from October to February, with shaded areas indicating historical percentiles. The period of record is from WY1918 to WY2021. The data includes daily flow measurements in cubic feet per second (CFS). The statistical shading breaks at the historical percentiles indicated by the legend.
<table>
<thead>
<tr>
<th>WY</th>
<th>Cumulative UKL Net Inflow (TAF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2021</td>
<td>156.511</td>
</tr>
<tr>
<td>2014</td>
<td>159.446</td>
</tr>
<tr>
<td>1991</td>
<td>163.723</td>
</tr>
<tr>
<td>2003</td>
<td>164.890</td>
</tr>
<tr>
<td>1995</td>
<td>165.101</td>
</tr>
<tr>
<td>1992</td>
<td>168.146</td>
</tr>
<tr>
<td>2019</td>
<td>170.962</td>
</tr>
<tr>
<td>2022</td>
<td>171.925</td>
</tr>
<tr>
<td>2020</td>
<td>179.456</td>
</tr>
<tr>
<td>2004</td>
<td>180.225</td>
</tr>
<tr>
<td>2016</td>
<td>180.805</td>
</tr>
<tr>
<td>2010</td>
<td>185.337</td>
</tr>
<tr>
<td>2015</td>
<td>186.877</td>
</tr>
<tr>
<td>1993</td>
<td>189.796</td>
</tr>
<tr>
<td>1994</td>
<td>190.181</td>
</tr>
<tr>
<td>2012</td>
<td>192.789</td>
</tr>
<tr>
<td>1990</td>
<td>200.576</td>
</tr>
<tr>
<td>2009</td>
<td>201.258</td>
</tr>
<tr>
<td>2005</td>
<td>204.824</td>
</tr>
<tr>
<td>2018</td>
<td>206.869</td>
</tr>
<tr>
<td>2008</td>
<td>211.188</td>
</tr>
</tbody>
</table>

**WY2022 % of POR average ≈ 78%**

Data are provisional and subject to revision.
Forecasts
<table>
<thead>
<tr>
<th>Probability of Exceedance (POE)</th>
<th>Water Year Analogs</th>
</tr>
</thead>
<tbody>
<tr>
<td>25%</td>
<td>1997</td>
</tr>
<tr>
<td>50%</td>
<td><strong>1999</strong></td>
</tr>
<tr>
<td>75%</td>
<td>2008</td>
</tr>
<tr>
<td>10%</td>
<td>2000</td>
</tr>
<tr>
<td>90%</td>
<td>2021</td>
</tr>
</tbody>
</table>

Highlighted years 1999, 2021 and 2020 are considered best fit for their respective exceedance level forecast.
CNRFC UKL Net Inflow Forecast
March-September 2022

CNRFC KLA03 March-September 2022 UKLNI Forecast
Issuance Date: 14 December 2022

Acre-feet (AF)

POR average = 620,000 AF

Percentages indicate probability of exceedance (POE)
Upper Klamath Lake Water Surface Elevation WY2022

UKL Surface Elevation
Water Year 2022

Percentages indicate probability of exceedance (POE)
Central Tendency set on 50% POE trace

WSE (USBRKB Datum) (FT)

1-Oct 1-Nov 1-Dec 1-Jan 1-Feb 1-Mar 1-Apr 1-May 1-Jun

Past Elevation
BiOp 2000 (10%)
Yesterday's Elevation 2021 (90%)
Central Tendency 2020
Flood Curve 2001

4,138.0 4,139.0 4,140.0 4,141.0 4,142.0 4,143.0 4,144.0
## 50% Probability Of Exceedance

<table>
<thead>
<tr>
<th></th>
<th>OPS 50% - WY1999</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2022 proj EOF elev (FT)</td>
<td>4140.98</td>
<td>2022 proj EOF elev (FT)</td>
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<tr>
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<td>2022 proj Prj Supp (TAF)</td>
<td>197</td>
<td>2022 proj Prj Supp (TAF)</td>
<td>207</td>
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<tr>
<td></td>
<td>2022 proj EWA (TAF)</td>
<td>407</td>
<td>2022 proj EWA (TAF)</td>
<td>407</td>
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<tr>
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<td>2022 proj min elev (FT)</td>
<td>4138.45</td>
<td>2022 proj min elev (FT)</td>
<td>4138.47</td>
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<tr>
<td></td>
<td>KDD F/W proj total supp (TAF)</td>
<td>19.310</td>
<td>KDD F/W proj total supp (TAF)</td>
<td>19.310</td>
</tr>
<tr>
<td></td>
<td>LKNWR F/W proj total supp (TAF)</td>
<td>1.833</td>
<td>LKNWR F/W proj total supp (TAF)</td>
<td>1.833</td>
</tr>
</tbody>
</table>

EOF = End-of-February  
Prj Supp = Project Supply  
EWA = Environmental Water Account  
Min elev = Seasonal minimum elevation  
F/W = Fall/Winter
75% Probability Of Exceedance

UKL Surface Elevation
Water Year 2022

- Past Elevation
- Flood Curve 2018
- Central Tendency 2008
- BiOp 2020
### 75% Probability Of Exceedance

<table>
<thead>
<tr>
<th>OPS 75% - WY2008</th>
<th>OPS 75% - WY2018</th>
<th>OPS 75% - WY2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>2022 proj EOF elev (FT)</td>
<td>4140.69</td>
<td>2022 proj EOF elev (FT)</td>
</tr>
<tr>
<td>2022 proj Prj Supp (TAF)</td>
<td>74</td>
<td>2022 proj Prj Supp (TAF)</td>
</tr>
<tr>
<td>2022 proj EWA (TAF)</td>
<td>407</td>
<td>2022 proj EWA (TAF)</td>
</tr>
<tr>
<td>2022 proj min elev (FT)</td>
<td>4138.97</td>
<td>2022 proj min elev (FT)</td>
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EOF = End-of-February  
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25% Probability Of Exceedance
### 25% Probability Of Exceedance

<table>
<thead>
<tr>
<th>OPS 25% - WY1997</th>
<th>OPS 25% - WY2018</th>
<th>OPS 25% - WY2012</th>
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<tbody>
<tr>
<td>2022 proj EOF elev (FT)</td>
<td>2022 proj EOF elev (FT)</td>
<td>2022 proj EOF elev (FT)</td>
</tr>
<tr>
<td>263</td>
<td>4141.43</td>
<td>4141.60</td>
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<tr>
<td>2022 proj Prj Supp (TAF)</td>
<td>2022 proj Prj Supp (TAF)</td>
<td>2022 proj Prj Supp (TAF)</td>
</tr>
<tr>
<td>512</td>
<td>267</td>
<td>265</td>
</tr>
<tr>
<td>2022 proj EWA (TAF)</td>
<td>2022 proj EWA (TAF)</td>
<td>2022 proj EWA (TAF)</td>
</tr>
<tr>
<td>19.310</td>
<td>523</td>
<td>516</td>
</tr>
<tr>
<td>2022 proj min elev (FT)</td>
<td>2022 proj min elev (FT)</td>
<td>2022 proj min elev (FT)</td>
</tr>
<tr>
<td>4139.29</td>
<td>4139.39</td>
<td>4139.41</td>
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<tr>
<td>KDD F/W proj total supp (TAF)</td>
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<td>1.833</td>
<td>19.310</td>
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<td>1.833</td>
<td>1.833</td>
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EOF = End-of-February  
Prj Supp = Project Supply  
EWA = Environmental Water Account  
Min elev = Seasonal minimum elevation  
F/W = Fall/Winter
## 90% & 10% Probability Of Exceedance

### 90%

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td><strong>OPS 90% - WY2021</strong></td>
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<tr>
<td>2022 proj EOF elev (FT)</td>
<td>4140.37</td>
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<tr>
<td>2022 proj Prj Supp (TAF)</td>
<td>17</td>
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<tr>
<td>2022 proj EWA (TAF)</td>
<td>407</td>
</tr>
<tr>
<td>2022 proj min elev (FT)</td>
<td>4139.29</td>
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<td>LKNWR F/W proj total supp (TAF)</td>
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### 10%

<table>
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<tr>
<th>Description</th>
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<tbody>
<tr>
<td><strong>OPS 10% - WY2000</strong></td>
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<tr>
<td>2022 proj EOF elev (FT)</td>
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<tr>
<td>2022 proj Prj Supp (TAF)</td>
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<tr>
<td>2022 proj EWA (TAF)</td>
<td>707</td>
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<tr>
<td>2022 proj min elev (FT)</td>
<td>4139.46</td>
</tr>
<tr>
<td>KDD F/W proj total supp (TAF)</td>
<td>22.682</td>
</tr>
<tr>
<td>LKNWR F/W proj total supp (TAF)</td>
<td>2.894</td>
</tr>
</tbody>
</table>

EOF = End-of-February
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EWA = Environmental Water Account
Min elev = Seasonal minimum elevation
F/W = Fall/Winter
Upper Klamath Lake Water Surface Elevation
WY2022

UKL Surface Elevation
Water Year 2022

Percentages indicate probability of exceedance (POE)
Central Tendency set on 50% POE trace

WSE (USBRKB Datum) (FT)

Past Elevation
BiOp
2000 (10%)

Yesterday's Elevation
2021 (90%)

Central Tendency
2020

Flood Curve
2001
Thank you