December Calibration Run

Presented by Allan Wylie, IDWR

December 3, 2015
Important Changes

• Set maximum tributary underflow to 20% of average annual precipitation within the basin
• Set kriging limit for Sy to between 0.10 to 0.30
• Adjustments to river stage in Wood River Ranch to Stanton Crossing reach
• Discovered river cells in Silver Cr set in layer 2 and layer 3.
  – Results in three river cells at one X,Y location
  – Jason made adjustments to remove layer 2 and 3 cells
Observation Wells

- Wells with GPS or surveyed location
- Measured by a trained technician
- Total head change from north to south is about 1,500 ft
  - 30 ft mismatch = 2%
Observation Wells

- Wells with GPS or surveyed location
- Measured by a trained technician
- If fit was perfect
  - Intercept = 0
  - Slope = 1
  - $R^2 = 1$
  - All points on the red line
Geo-located Wells

- Wells located by address
- Measured by driller
Geo-located Wells

- Wells located by address
- Measured by driller
- If fit was perfect
  - Intercept = 0
  - Slope = 1
  - \( R^2 = 1 \)
  - All points on the red line

\[ y = 0.9945x + 32.972 \]
\[ R^2 = 0.9946 \]
Driller Wells

- Wells located by PLS
- Measured by driller
Driller Wells

- Wells located by PLSS
- Measured by driller
- If fit was perfect
  - Intercept = 0
  - Slope = 1
  - \( R^2 = 1 \)
  - All points on the red line
Sun Valley Wells

- Municipal production wells
- 2 well fields
- Measured by municipal employee
- One well from each field
The Nature Conservancy Wells

- Graduate student installed transducers
- 12 wells
- 2 are wells we already use
- Not all wells useful for us
- Measurements every 15 min
- Mid 2010 to mid 2011
- Reduced 15 min frequency to one per day
- 5 domestic wells
  - Filtered out pumping events
River Gains and Losses

- Transient Gains
  - Nr Ketchum
  - Hailey
  - Hailey
  - Stanton Crossing
  - Willow Creek
  - Silver Cr Abv
  - Sportsman Access
  - Silver Cr Blw
  - Sportsman Access

[Graph showing river flow data from January 1995 to January 2010 with observed, modeled, and warmup data for nr Ketchum-Hailey.]
River Gains and Losses

- Transient Gains
  - Nr Ketchum
  - Hailey
  - Hailey
  - Stanton Crossing
  - Willow Creek
  - Silver Cr

- Sportsman Access
  - Silver Cr Blw
  - Sportsman Access

0 - 300 - 200 - 100 - 0 - 100 - 200 - 300 - 400 - 500 - 600 - 700

Jan-95 Jan-96 Jan-97 Jan-98 Jan-99 Jan-00 Jan-01 Jan-02 Jan-03 Jan-04 Jan-05 Jan-06 Jan-07 Jan-08 Jan-09 Jan-10
cfs

Hailey-Stanton Crossing

- Observed
- Modeled Warmup
- Modeled
River Gains and Losses

- Transient Gains
  - Nr Ketchum
  - Hailey
  - Hailey
  - Stanton Crossing
  - Willow Creek
  - Silver Cr Abv
  - Sportsman Access
  - Silver Cr Blw
  - Sportsman Access

Graph: Willow Creek

- Observed
- Modeled Warmup
- Modeled
River Gains and Losses

- Transient Gains
  - Ketchum
  - Hailey
  - Stanton Crossing
  - Willow Creek
  - Silver Cr Abv Sportsman Access
  - Silver Cr Blw Sportsman Access

![Graph showing River Gains and Losses]

- **Silver Abv Sportsman's Access**
  - Observed
  - Modeled Warmup
  - Modeled

<table>
<thead>
<tr>
<th>Jan-95</th>
<th>Jan-96</th>
<th>Jan-97</th>
<th>Jan-98</th>
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Silver Blw Sportsman's Access

- Observed
- Warm-up
- Modeled
Subsurface Discharge From Model

• Weight on these observations is low

• Stanton Crossing
  – Estimated ~ Negligible
  – 300 ac-f/yr
  • 0 - 0.41 cfs
  • Modeled = 0.33 cfs
    – 240 ac-ft
Subsurface Discharge From Model

- Weight on these observations is very low
- Silver Cr underflow
  - Estimated ~ 4,000 – 53,000 ac-f/yr
  - 5.5 – 73 cfs
  - Modeled = 8.6 cfs
  - 6,242 ac-ft
End
Outline

• 3\textsuperscript{rd} Final Calibration
  – Specific yield in layer 1 was too low in places
  – Adjustments to dry bed assumptions

• Transient Calibration Run

• Are we there yet?
  – We expect to submit this version for review
Review

- Recharge program
  - Tributary underflow
    - Adjusted by multiplying starting values by a scalar
    - Adjust seasonal amplitude
    - Adjust averaging period
  - Surface water irrigation efficiency
  - Canal seepage fixed percentage of diversion
    - Currently held fixed

- Physical properties adjusted by changing values in MODFLOW input files
  - Aquifer hydraulic conductivity and storage
  - Riverbed conductance
  - Drain conductance
Observation Wells

01N 18E 01DAA1

ft abv mean sea level

Observed  Warm-up  Modeled
Observation Wells

01S 18E 14AAB1

ft abv mean sea level

Jan-95 Jan-96 Dec-96 Dec-97 Jan-99 Jan-00 Dec-00 Dec-01 Jan-03 Jan-04 Dec-04 Dec-05 Jan-07 Jan-08 Dec-08 Dec-09 Jan-11

Observed Warm-up Modeled
Observation Wells

01S 19E 03CCB2

- Observed
- Warm-up
- Modeled
Observation Wells

04N 17E 14BBC1

ft abv mean sea level

Jan-95 Jan-96 Dec-96 Dec-97 Jan-99 Jan-00 Dec-00 Dec-01 Jan-03 Jan-04 Dec-04 Dec-05 Jan-07 Jan-08 Dec-08 Dec-09 Jan-11

- Observed
- Warm-up
- Modeled
All Wells Measured Once

Legend
- Wells Measured Once

Wells Measured Once

- Average: 2.83 ft
- Median: 1.26 ft
- 1st Q: -5.97 ft
- 3rd Q: 10.76 ft
- StDev: 21.60 ft
- Max: 91.06 ft
- Min: -170.16 ft
- Count: 582

68-95-99.7 rule
All Wells Measured Once

Wells Measured Once

Legend
- PLSS Wells
- Geolocated Wells
- Observation Wells

Frequency
Residual (ft)
Wells Measured Once

- ObsWells
- GeoWells
- DriWells
Sun Valley Wells

Sun Valley-Well 11

ft abv mean sea level

- Observed
- Warm-up
- Modeled
The Nature Conservancy Wells

Graduate student installed transducers on 12 wells. Not all wells were useful for the purpose. Measurements were taken every 15 minutes from mid-2010 to mid-2011.

5 domestic wells (4922, 4924, 4926, 4928, 4930, 4932, 4934, 4936, 4938, 4940, 4942) were monitored over the period.

The graph shows the water levels over time, with observations and modeled data plotted against time.
The Nature Conservancy Wells

Graduate student installed transducers – 12 wells – Not all wells useful for us – Measurements every 15 min – Mid 2010 to mid 2011

4800
4805
4810
4815
4820
4825
4830
4835

Jan-95 Jan-96 Dec-96 Dec-97 Jan-99 Jan-00 Dec-00 Dec-01 Jan-03 Jan-04 Dec-04 Dec-05 Jan-07 Jan-08 Dec-08 Dec-09 Jan-11

ft abv mean sea level

7002

Observed Warm-up Modeled
The Nature Conservancy Wells

Graduate student installed transducers

- 12 wells
- Not all wells useful for us
- Measurements every 15 min
- Mid 2010 to mid 2011
- 5 domestic wells

<table>
<thead>
<tr>
<th>Year</th>
<th>Jan 95</th>
<th>Jan 96</th>
<th>Dec 96</th>
<th>Jan 97</th>
<th>Dec 97</th>
<th>Jan 99</th>
<th>Jan 00</th>
<th>Dec 00</th>
<th>Jan 01</th>
<th>Dec 01</th>
<th>Jan 03</th>
<th>Jan 04</th>
<th>Dec 04</th>
<th>Dec 05</th>
<th>Jan 07</th>
<th>Jan 08</th>
<th>Dec 08</th>
<th>Dec 09</th>
<th>Jan 11</th>
</tr>
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<tbody>
<tr>
<td>ft abv mean sea level</td>
<td>4865</td>
<td>4870</td>
<td>4875</td>
<td>4880</td>
<td>4885</td>
<td>7003</td>
<td>4875</td>
<td>4880</td>
<td>4885</td>
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- Observed
- Warm-up
- Modeled
The Nature Conservancy Wells

Graduate student installed transducers – 12 wells – Not all wells useful for us – Measurements every 15 min – Mid 2010 to mid 2011 – 5 domestic wells

ft abv mean sea level

Observed

Warm-up

Modeled

7004

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The Nature Conservancy Wells

Graduate student installed transducers – 12 wells – Not all wells useful for us – Measurements every 15 min – Mid 2010 to mid 2011 – 5 domestic wells

Observed Warm-up Modeled

7005

ft abv mean sea level

Jan-95 Jan-96 Dec-96 Dec-97 Jan-98 Jan-99 Dec-99 Jan-00 Dec-00 Jan-01 Dec-01 Jan-02 Dec-02 Jan-03 Dec-03 Jan-04 Dec-04 Jan-05 Dec-05 Jan-06 Dec-06 Jan-07 Dec-07 Jan-08 Dec-08 Jan-09 Dec-09 Jan-10 Dec-10 Jan-11

Observed Warm-up Modeled
The Nature Conservancy Wells

Graduate student installed transducers
- 12 wells
- Not all wells useful for us
- Measurements every 15 min
- Mid 2010 to mid 2011

5 domestic

Observed Warm-up Modeled
The Nature Conservancy Wells

Graduate student installed transducers on 12 wells. Not all wells were useful for the analysis. Measurements were taken every 15 minutes from mid 2010 to mid 2011. The graph shows data from 5 domestic wells, with observations plotted for January 1995 to January 2011, showing changes in ft above mean sea level (ft abv mean sea level). The graph includes observed data, warm-up data, and modeled data.
The Nature Conservancy Wells

Graduate student installed transducers – 12 wells – Not all wells useful for us – Measurements every 15 min – Mid 2010 to mid 2011 – Since added 5 domestic wells by filtering out pumping events

5086
5088
5090
5092
5094
5096
5098
5100
Jan-95 Jan-96 Dec-96 Dec-97 Jan-99 Jan-00 Dec-00 Dec-01 Jan-03 Jan-04 Dec-04 Dec-05 Jan-07 Jan-08 Dec-08 Dec-09 Jan-11
ft abv mean sea level
7008
Observed Warm-up Modeled
The Nature Conservancy Wells

- Graduate student installed transducers
- 12 wells
- Not all wells useful for us
- Measurements every 15 min
- Mid 2010 to mid 2011
- Since added 5 domestic wells by filtering out pumping events

Graph showing data from Jan 1995 to Jan 2011 with measurements in feet above mean sea level.

- Observed
- Warm-up
- Modeled
The Nature Conservancy Wells

Graduate student installed transducers – 12 wells – Not all wells useful for us – Measurements every 15 min – Mid 2010 to mid 2011 – Since added 5 domestic wells by filtering out pumping events

Observed

Warm-up

Modeled

5135

5140

5145

5150

5155

5160

7010

Jan-95 Jan-96 Dec-96 Dec-97 Jan-99 Jan-00 Dec-00 Dec-01 Jan-03 Jan-04 Dec-04 Dec-05 Jan-07 Jan-08 Dec-08 Dec-09 Jan-11

ft abv mean sea level
Sub-reach Targets

- March 2013 seepage run
- Match ratios to larger reach
Sub-reach Targets

- August 2012 seepage run
- Match ratios to larger reach
- Flows for nr Ketchum to Hailey are unusual
- Seepage run results removed for nr Ketchum to Hailey
Sub-reach Targets

- October 2012 seepage run
- Match ratios to larger reach

![Graph showing modeled and observed Ro values for Wood River and Silver Creek in October](image_url)
Layer 1 Aquifer head (famsl)
Riverbed Conductance

- Riverbed conductance in $M^2/d$
- Wood River
Streambed Conductance

- Riverbed conductance in $M^2/d$
- Willow Cr, and Silver Cr
Drain Conductance

- Drain conductance in $M^2/d$
- Layer 1
  - Silver Creek
  - Stanton Crossing
Drain Conductance

- Drain conductance in $M^2/d$
- Layer 2
  - Silver Creek
Drain Conductance

- Drain conductance in $\text{M}^2/\text{d}$
- Layer 3
  - Silver Creek
Layer 1 Hydraulic Conductivity

- Layer 1 modeled as non-time varying transmissivity
- Pilot points can be moved
- Number of pilot points not fixed
- Tributary valleys are in their own zones
- In valley and triangle
  - Min = 1.67 ft/day
  - Max = 4,412 ft/day
  - Mean = 715 ft/day
Layer 1 Hydraulic Conductivity

- Tributary valleys are in their own zones
  - Contain maximum and minimum values
- In valley and triangle
  - Min = 1.67 ft/day
  - Max = 4,412 ft/day
  - Mean = 715 ft/day
- 437 wells in Wood River alluvial sediments.

Groundwater, Freeze & Cherry, 1979
Layer 2 Hydraulic Conductivity

- Layer 2 modeled as confined
- Includes basalt in east
- Includes confining layer
- Sand and gravel aquifer in valley and triangle
  - Min = 27 ft/day
  - Max = 52 ft/day
  - Mean = 33 ft/day
Layer 2 Hydraulic Conductivity

- Low hydraulic conductivity in confining layer
  - Min = 0.000236 ft/day
  - Max = 0.000469 ft/day

- Basalt
  - Min = 49.7 ft/day
  - Max = 59.4 ft/day

- Sand and gravel in valley and triangle
  - Min = 27 ft/day
  - Max = 52 ft/day
  - Mean = 33 ft/day

- 14 wells in Wood River alluvial sediments.

Groundwater, Freeze & Cherry, 1979
Layer 3 Hydraulic Conductivity

- Layer 3 modeled as confined
- Basalt
  - Min = 53.1 ft/day
  - Max = 68.2 ft/day
- Sand and gravel aquifer in valley and triangle
  - Min = 724 ft/day
  - Max = 7,365 ft/day
  - Mean = 2,595 ft/day
Layer 3 Hydraulic Conductivity

- **Basalt**
  - Min = 53.1 ft/day
  - Max = 68.2 ft/day

- **Sand and gravel aquifer in valley and triangle**
  - Min = 724 ft/day
  - Max = 7,365 ft/day
  - Mean = 2,595 ft/day

Groundwater, Freeze & Cherry, 1979
Layer 1 Storage

- Layer 1 temporarily modeled as non-time varying thickness
- Pilot points can be moved
- Number of pilot points not fixed
Layer 2 Storage

- Layer 2 modeled as storage
- Includes basalt in east
- Includes confining layer
- Pilot points can be moved
- Number of pilot points can be changed
Layer 3 Storage

- Layer 3 modeled as storage
- Includes basalt in east
- Pilot points can be moved
- Number of pilot points can be changed
Surface Water Irrigation Efficiency

- CIR/Diversion
  - Efficiency of canal system and field irrigation system
- Inefficient fraction infiltrates into layer 1 aquifer
  - Note to the engineers
    - Low efficiency is not necessarily bad
Tributary Underflow

- Trib underflow adjusted using
  - Adjustment factors
    - Adjust average flux
  - Reduction factor
    - Adjust seasonal amplitude
  - Averaging period
    - 200 day, 300 day, 400 day, etc
## Tributary Underflow

<table>
<thead>
<tr>
<th>Tributary</th>
<th>Scalar</th>
<th>Av Basin Precip AcFt</th>
<th>Modeled AcFt</th>
<th>% Basin Av PPT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adams Gulch</td>
<td>0.01</td>
<td>17600</td>
<td>8.51</td>
<td>0.05%</td>
</tr>
<tr>
<td>Chocolate Gulch</td>
<td>0.01</td>
<td>864</td>
<td>0.70</td>
<td>0.08%</td>
</tr>
<tr>
<td>Cold Springs Gulch</td>
<td>0.91</td>
<td>3341</td>
<td>159.26</td>
<td>4.77%</td>
</tr>
<tr>
<td>Clear Creek</td>
<td>0.01</td>
<td>2288</td>
<td>1.06</td>
<td>0.05%</td>
</tr>
<tr>
<td>Cove Canyon</td>
<td>3.59</td>
<td>11200</td>
<td>512.88</td>
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</tr>
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<td>Croy Creek</td>
<td>2.06</td>
<td>23595</td>
<td>1447.38</td>
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<tr>
<td>Deer Creek</td>
<td>3.02</td>
<td>74213</td>
<td>4405.48</td>
<td>5.94%</td>
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<tr>
<td>Eagle Creek</td>
<td>3.40</td>
<td>17248</td>
<td>3442.80</td>
<td>19.96%</td>
</tr>
<tr>
<td>Elkhorn Gulch</td>
<td>0.02</td>
<td>12757</td>
<td>0.87</td>
<td>0.01%</td>
</tr>
<tr>
<td>East Fork</td>
<td>1.00</td>
<td>120629</td>
<td>467.69</td>
<td>0.39%</td>
</tr>
<tr>
<td>Greenhorn Gulch</td>
<td>0.08</td>
<td>30464</td>
<td>52.12</td>
<td>0.17%</td>
</tr>
<tr>
<td>Indian Creek</td>
<td>0.10</td>
<td>10149</td>
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</tr>
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<td>1.44</td>
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<td>Lees Gulch</td>
<td>3.79</td>
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<td>450.58</td>
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</tr>
<tr>
<td>Ohio Gulch</td>
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<td>15504</td>
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<td>Seamans Creek</td>
<td>1.93</td>
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<td>3740.12</td>
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<tr>
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<td>0.08</td>
<td>11509</td>
<td>39.73</td>
<td>0.35%</td>
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<td>Trail Creek</td>
<td>3.36</td>
<td>111274</td>
<td>9677.70</td>
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</tr>
<tr>
<td>Townsend Gulch</td>
<td>0.01</td>
<td>960</td>
<td>0.40</td>
<td>0.04%</td>
</tr>
<tr>
<td>Upper Big Wood River</td>
<td>22.74</td>
<td>313278</td>
<td>13892.63</td>
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<tr>
<td>Warm Springs Creek</td>
<td>4.99</td>
<td>180735</td>
<td>2408.15</td>
<td>1.33%</td>
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<td>960</td>
<td>0.40</td>
<td>0.04%</td>
</tr>
<tr>
<td>Upper Big Wood River</td>
<td>22.74</td>
<td>313278</td>
<td>13892.63</td>
<td>4.43%</td>
</tr>
<tr>
<td>Warm Springs Creek</td>
<td>4.99</td>
<td>180735</td>
<td>2408.15</td>
<td>1.33%</td>
</tr>
</tbody>
</table>
OLD Wood River Stage

- Nr Ketchum to Hailey
  - Interpolate change between Nr Ketchum and At Hailey

- Hailey to Glendale Rd
  - Use change from At Hailey

- Glendale Rd to Wood River Ranch
  - Use steady state stage when dry bed is not dry
  - Stage = river bottom when dry bed is dry

- Wood River Ranch to At Stanton Crossing
  - Use At Stanton Crossing change
MODFLOW River Package

- River stage = river bottom
  - River dry perched above aquifer
  - No aquifer river interaction

- River stage = river bottom
  - River intersects aquifer
  - River gains

- River stage above aquifer head
  - River loses water to aquifer
NEW Wood River Stage

- Nr Ketchum to Hailey
  - Interpolate change between Nr Ketchum and At Hailey
- Hailey to Glendale Rd
  - Use change from At Hailey
- Glendale Rd to Wood River Ranch
  - Use steady state stage when dry bed is not dry
  - Stage = river bottom when dry bed is dry
- Wood River Ranch to At Stanton Crossing
  - Stage = river bottom
    - when first goes dry until October
  - Use change from At Stanton Crossing rest of the year