Hydrologic Investigation of the Ogallala – Roger Mills Aquifer in West-Central Oklahoma

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Oklahoma Water Resources Board

December 6, 2018
Major groundwater basin (aquifer) is defined as a distinct underground body of water overlain by contiguous land and having substantially the same geological and hydrological characteristics and from which groundwater wells yield at least fifty (50) gallons per minute on the average throughout the basin if from a bedrock aquifer and at least one hundred fifty (150) gallons per minute on the average throughout the basin if from an alluvial aquifer, or as otherwise designated by the Board.

For more information visit the OWRB website: http://www.owrb.ok.gov. Updated: 8/24/2016
Purpose and Scope

- Investigation of the hydrogeology of the aquifer to supply the OWRB information needed to determine the maximum annual yield and equal proportionate share (EPS) based on various proposed management scenarios

- Update 2002 technical report

- Characterization of the aquifer:
  - Aquifer boundary & geology
  - Aquifer base and water table
  - Water levels
  - Hydraulic properties
  - Streamflow measurements
  - Climate & recharge
  - Water use
  - Water quality
Geology

- Study Area: 385 mi²

<table>
<thead>
<tr>
<th>Era</th>
<th>Period</th>
<th>Geologic Unit</th>
<th>Description</th>
<th>Thickness, in feet</th>
<th>Hydrogeologic Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cenozoic</td>
<td>Neogene</td>
<td>Ogallala Formation</td>
<td>Miocene-age fine to medium grained semi-consolidated layers of sand interbedded with silt, clay, gravel, volcanic ash and carbonates. Sediments are tan, brown, and light gray to white in color.</td>
<td>0 - 335</td>
<td>Ogallala - Roger Mills Co. Aquifer</td>
</tr>
<tr>
<td></td>
<td>elk City Sandstone</td>
<td>Elk City Sandstone</td>
<td>Late Permian-age reddish, fine grained sandstone with minor amounts of silt and clay, weakly cemented by iron oxides, calcium carbonates, and gypsum.</td>
<td>0 - 260</td>
<td>Elk City Sandstone Aquifer</td>
</tr>
<tr>
<td></td>
<td>Doggy Shale</td>
<td>Doggy Shale</td>
<td>Bloody, red and maroon silty shale and siltstone.</td>
<td>0 - 160</td>
<td>Confining</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Coos Bay Formation</td>
<td>Red-brown to orange-brown shale, with interbedded fine to medium grained cross-bedded sandstone and siltstone. In the middle section, the base of the formation is marked by a gypsum bed called the Moccasin Creek.</td>
<td>0 - 175 - 400</td>
<td>Rush Springs Aquifer</td>
</tr>
<tr>
<td></td>
<td>Rush Springs Formation</td>
<td>Rush Springs Formation</td>
<td>Red to orange-brown cross-bedded, fine-grained, quartz sandstone interbedded with dolomite and gypsum, with minor silt.</td>
<td>0 - 300 - 400</td>
<td>Rush Springs Aquifer</td>
</tr>
</tbody>
</table>

*Kell, 1960
*OWRB, 2017
*Kent and others, 1952
*Cam and Bergman, 1977
*Heale and others, 2018
Determining Base of Aquifer
Determining Base of Aquifer
## Determining Base of Aquifer

### Well Driller’s Logs

<table>
<thead>
<tr>
<th>MATERIAL</th>
<th>ENCLOSED FROM (ft.)</th>
<th>ENCLOSED TO (ft.)</th>
<th>SATURATED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface soil</td>
<td>0</td>
<td>3</td>
<td>N</td>
</tr>
<tr>
<td>Tan sand &amp; white clay</td>
<td>3</td>
<td>15</td>
<td>N</td>
</tr>
<tr>
<td>White sand (fine)</td>
<td>15</td>
<td>27</td>
<td>N</td>
</tr>
<tr>
<td>Tan clay</td>
<td>27</td>
<td>38</td>
<td>N</td>
</tr>
<tr>
<td>Fine-med white sand &amp; clay layers</td>
<td>38</td>
<td>46</td>
<td>N</td>
</tr>
<tr>
<td>Tan clay</td>
<td>46</td>
<td>55</td>
<td>N</td>
</tr>
<tr>
<td>Med white sand</td>
<td>55</td>
<td>70</td>
<td>N</td>
</tr>
<tr>
<td>Med white sand &amp; clay</td>
<td>70</td>
<td>75</td>
<td>N</td>
</tr>
<tr>
<td>Med white sand</td>
<td>75</td>
<td>100</td>
<td>N</td>
</tr>
<tr>
<td>Med-coarse white sand</td>
<td>100</td>
<td>128</td>
<td>N</td>
</tr>
<tr>
<td>Red bed</td>
<td>128</td>
<td>132</td>
<td>N</td>
</tr>
</tbody>
</table>
Locating and Measuring Wells

- 79 wells measured in January 2017
- 6 continuous water-level recorders
- 7 mass measurement wells
Continuous water-level recorders
Continuous water-level recorders
Mass measurement wells
Locating and Measuring Wells

- Depth to water ranged from 5 to 170 feet below land surface
Saturated Thickness:

- Average: 44 feet
- Maximum: 179 feet
Determining Aquifer Properties - Hydraulic Conductivity (K)

- 28 Slug Test Locations
- 2 - Single-Well Aquifer Tests
- 8 Drawdown Tests
- Percent-Coarse Analysis
## Determining Aquifer Properties - Hydraulic Conductivity ($K$)

<table>
<thead>
<tr>
<th>Horizontal Hydraulic Conductivity, in feet per day</th>
<th>Slug tests</th>
<th>Single-well aquifer tests</th>
<th>Drawdown</th>
<th>Percent-coarse</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum</td>
<td>0.51</td>
<td>8.4</td>
<td>0.9</td>
<td>1.7</td>
</tr>
<tr>
<td>Maximum</td>
<td>207</td>
<td>14.9</td>
<td>50.3</td>
<td>42.9</td>
</tr>
<tr>
<td>Mean</td>
<td>21.3</td>
<td>11.4</td>
<td>11.8</td>
<td>12.4</td>
</tr>
<tr>
<td>Median</td>
<td>11.2</td>
<td>11.1</td>
<td>6.9</td>
<td>10</td>
</tr>
<tr>
<td>Count</td>
<td>21</td>
<td>2</td>
<td>8</td>
<td>637</td>
</tr>
</tbody>
</table>
## Determining Aquifer Properties - Specific Yield

### Regional Method

<table>
<thead>
<tr>
<th>Subsurface watershed</th>
<th>Basin size (square miles)</th>
<th>Dates measured</th>
<th>Total discharge based on weekly measurements (acre-feet)</th>
<th>Volume of aquifer drained in subsurface watershed (acre-feet)</th>
<th>Average water level decline (feet)</th>
<th>Specific yield (dimensionless)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rush Creek</td>
<td>60</td>
<td>February 2018 - April 2018</td>
<td>485</td>
<td>5536</td>
<td>0.14</td>
<td>0.09</td>
</tr>
</tbody>
</table>

### Summary

<table>
<thead>
<tr>
<th>Method</th>
<th>Specific Yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aquifer Tests</td>
<td>0.20</td>
</tr>
<tr>
<td>Percent-Coarse</td>
<td>0.18</td>
</tr>
<tr>
<td>Regional Method</td>
<td>0.09</td>
</tr>
</tbody>
</table>
Surface Water Synoptic
Surface Water Synoptic

- 24 measurements
- 12 streams
Climate Trends

- 3 NOAA Cooperative observer stations
- 1 Mesonet station
Climate Trends

94-year average: 24.41 inches

EXPLANATION

[Precipitation data for the Cheyenne, Cheyenne 11 NW, Redpine 26SE, and Sweetwater cooperative observer stations and the Cheyenne mesonet station]

- Above historic average (5-year moving average)
- Below historic average (5-year moving average)
- Annual Precipitation
Recharge – Soil Water Balance Code (SWB)

- 1948 - 2017
- Mean annual recharge: 1.16 in.
Reported Groundwater Use

- **Irrigation**: 34.32% (232 acre-feet per year)
  - Total: 417 acre-feet per year

- **Mining**: 2.33% (15.5 acre-feet per year)
- **Public Supply**: 0.03% (0.2 acre-feet per year)
- **Other**: 0.03%
Water Quality