Water – The New Oil for Midwestern Agriculture

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¡AGUA ES VIDA!
Northern New Mexico Adage
Dry Farming at 11,500 ft
TOPICS

- Ground Water Irrigation in the Arid Southwest
- Design of Efficient, High Capacity Wells
- Water Rights
- Water Conservation
- Why Irrigate in the Midwest?
Ground Water Irrigation in SW United States

High Plains/Ogallala Aquifer
Ogallala Aquifer Water Level Changes, 1950-2013
Ground Water Irrigation in SW United States

Amargosa Valley, NV
TOPICS

- Ground Water Irrigation in the Arid Southwest
- **Design of Efficient, High Capacity Wells**
- Water Rights
- Water Conservation
- Why Irrigate in the Midwest?
Types of Wells

- Domestic
- Municipal
- Commercial
- Irrigation
Types of screen

- Torch cut
- Plasma cut
- Saw cut (PVC)
- Mill slot
- Wire wrapped
- Louvered

Photo from johnsonscreens.com
Well Design

Design from inside – out

- Calculate pump size
- Casing/screen preferably 4 in diameter larger than pump diameter (2 inches all around)
- Borehole drilled 4 inches larger than casing diameter
- Analyze formation cuttings to design screen size and placement
Well Drilling

- 1500 ft deep municipal exploratory well
- Aquifers with naturally occurring As, F, U
- GGI selected and isolated 5 water bearing units for zone testing
- After zone testing, well was plugged back to 380 ft as treatment costs for deeper portions of the aquifer were too expensive for the municipality
Well Screen Design

- Slot size
- Slot geometry
- Filter pack

Total open area
- Sized in conjunction with sieve analysis of formation material and screen slot size
- Increases hydraulic conductivity, reduces (eliminates) sand production
Well Efficiency

**Inefficient well:**
- Limited open area
- Incorrect/no filter pack
- Screens get dewatered
- Pumps sand and/or air
- Oversized pump motor
- Artificially high total dynamic head

**Efficient well:**
- Maximize open area
- Proper filter pack
- Screens are not dewatered
- Does not pump sand and/or air
- Properly sized pump motor
- Minimizes total dynamic head
Specific Capacity

• Defined as production rate per unit of drawdown (Q/s)
  – Typically expressed as gpm/ft
  – The bigger the number the better the well

• Allows well to be designed in a manner that will avoid dewatering screens
  – Often must estimate Q/s in design phase based on nearby wells or lithologic analogues
  – Confirm actual Q/s with test pump prior to selecting permanent pump

• A well pumping 500 gpm with 50 feet of drawdown has a specific capacity of 10 gpm/ft
Why is Well Efficiency Important?

- Energy cost savings
- An efficient, sand-free well will save a farmer significant money on energy costs to produce the water and the well and pump lifetime will be extended significantly.
Specific Capacity
Directly impacts pumping costs

Well specific capacity vs. estimated annual energy charge to irrigate one 122 acre pivot, assuming rate of $0.09064/kWh

- South WJ, $34,528.85
- Barn 2, $33,002.84
- Champion, $30,227.26
- Barn 1 Comm, $26,644.44
- Barn 1 Scalehouse, $26,451.99
- Shop (Fat Man, Barn 3), $26,616.80
- S Gilligan (Monster), $22,436.84
Well Development

• Removes drilling fluid from filter pack and formation (increases production)
• Removes fines from filter pack, properly grades filter pack and formation for long term sand-free production

Photo from Driscoll, 1986
When Does a Pump Fail?

• When you need it the most.....

• During the hottest time of the irrigation season.....

• When the pump contractor is servicing a municipal well for a bigger client.....
What Causes Sand Production?

- Improper screen/filter pack sand sizes
- Casing failure (bad welds, corrosion)
Well Development
Well Completion

<table>
<thead>
<tr>
<th>Total Depth</th>
<th>756 ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>Screened Interval/Slot Size</td>
<td>242-756 ft; 0.050 in slots</td>
</tr>
<tr>
<td>Well Production</td>
<td>3500 gpm</td>
</tr>
<tr>
<td>Purpose</td>
<td>2-100 acre pivots</td>
</tr>
<tr>
<td>Pump Size</td>
<td>125 hp</td>
</tr>
<tr>
<td>Total Cost</td>
<td>$300,000.00</td>
</tr>
</tbody>
</table>
# Well Completion – How We Designed the Well

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total Depth</strong></td>
<td>756 ft</td>
</tr>
<tr>
<td><strong>Static Water Level</strong></td>
<td>135 ft</td>
</tr>
<tr>
<td><strong>Casing Diameter</strong></td>
<td>16 in – allows for 12-14 in pump bowls</td>
</tr>
<tr>
<td><strong>Top of Screen</strong></td>
<td>242 ft – allows for 1 ft/yr regional decline plus operating drawdown (Specific Capacity)</td>
</tr>
<tr>
<td><strong>Pump Size</strong></td>
<td>125 hp – 3500 gpm</td>
</tr>
<tr>
<td><strong>Pump Setting</strong></td>
<td>220 ft</td>
</tr>
</tbody>
</table>
Well Efficiency

Why is Well Efficiency Important in the Midwest?
Minnesota Ground Water Sustainability

Sustainability Criteria

• One allowable drawdown for the entire Aquifer (i.e., 200 feet from 1977)
• Percent of original “Pressure Head”
• MN DNR uses Pressure (Available) Head approach
• At 50% loss, submit a plan to assure Available Head will not fall below 25% of original
• MN DNR applies this at the well, not in a mapped zone around it.
Iowa Ground Water Sustainability

Sustainability Criteria: IAC 567 Chapter 52.4(3)c.

• *Two hundred (200) foot limit on the decline of groundwater piezometric levels.*
• The maximum collective long-term decline in groundwater piezometric levels in the Cambrian Jordan Sandstone Aquifer in any high use area will not be permitted to exceed 200 feet from the 1977 baseline as determined from available records of the department’s Iowa Geological Survey (IGS).
Iowa Ground Water Sustainability
(not much different than the Ogallala drawdowns)
TOPICS

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• Water Rights
• Water Conservation
• Why Irrigate in the Midwest?
Water Rights Similarities between NM, Arid West and Upper Midwest

Stream connected aquifers
Dakota Sandstone aquifer
## Surface Water Resource Comparison

<table>
<thead>
<tr>
<th>State</th>
<th>% Surface Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>New Mexico</td>
<td>0.24</td>
</tr>
<tr>
<td>Iowa</td>
<td>0.74</td>
</tr>
<tr>
<td>Minnesota</td>
<td>8.41</td>
</tr>
<tr>
<td>Wisconsin</td>
<td>17.31</td>
</tr>
</tbody>
</table>
Middle Rio Grande Basin

Stream Connected Aquifer
- Critical Management Areas (CMAs)
- Endangered Silvery Minnow
- Imported water
- Interstate compacts
- **New groundwater appropriations must offset 100% of their depletions on the Rio Grande**
- Competition for water with Indians and municipalities
- Surface water shortages
- Not adjudicated
Lower Rio Grande Basin

Complicating Factors

• Stream connected ground water
• Texas is suing NM over pumping effects on Rio Grande
• Texas claiming NM is in violation of Interstate Stream
Roswell Artesian Basin

Complicating Factors

• Endangered Pecos Bluntnosed shiner
• State must provide Pecos River flows sufficient for shiner habitat
• Compact deliveries to Texas
Complicating Factors – Water Rights

- Is additional groundwater available for **new appropriations**?
- Is sufficient **wet water** available (new appropriation or transfer of existing rights)?
- Cost of purchasing existing rights to transfer.
- Government agencies protesting ag to ag water transfers.
- Surface water impacts
Complication - Competition for Groundwater

• Food production and municipalities compete for groundwater
• This municipal drought-relief well is completed into a fractured bedrock aquifer (similar to Jordan Aquifer) that is connected to a river with downstream senior irrigation rights
Complication - Competition for Groundwater

Can Upper Midwest ground water users “retire” surface water rights if there is a recognized river depletion caused by ground water pumping?
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Water Conservation

• Example
  – Dairy hose running 20 gpm, 24 hours per day
  – 28,800 gal/day
  • 32 ac-ft/yr wasted
  • Lagoon capacity for 60 days storage increased by 5.3 ac-ft
Water Use at Dairies is Up a Little
Water Conservation

Water conservation in milking parlors, A Tale of 2 Dairy Barns
Water Conservation

• How did we reduce barn water usage?
  – Eliminate sprinklers
  – Install spray nozzles/automatic shutoff valves on hoses
  – Extra valves are available to replace leaky valves
  – Train milkers in conservation practices

• Barn runs more efficiently with automatic shut-offs because milkers have to go back to work and not stand around with hoses
Consequences of Water Waste

- Decreased aquifer life
- Decreased pump life
- Decreased well life
- Increased cost of well replacement (deeper wells, deeper pump setting, more HP required)
- Increased energy costs
- Increased water rights acquisition cost
- Green water lagoons must be larger
- More green water to manage
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• **Why Irrigate in the Midwest?**
Why Irrigate in the Midwest?

I am CORN – Am I Food, Feed, Sugar, Fuel, Plastic, Pharmaceutical, Sheet rock, Cosmetic, Toothpaste, Whiskey or Beer and Chips?
Why Irrigate in the Midwest?

SOME YEARS IT DOESN’T RAIN.................
Why Irrigate in the Midwest?
Why Irrigate in the Midwest?

• If 1 of every 4 years is a severe drought how soon can you pay back $300,000-$500,000 for a completed well and pivot?
• How much can you increase yields in average years with a well and pivot?
Remember,
Always check
the Snow Pack!
QUESTIONS?