Washington Hydrogeology Symposium
Tacoma, Washington
10-11 May 2022

Hydraulic property control on observed groundwater response to development and the implication for future groundwater management in the Harney Basin, Oregon

Gerald H. Grondin
Hydrogeologist
Oregon Water Resources Department
725 Summer Street NE, Suite A
Salem, OR 97301
Gerald.H.Grondin@water.oregon.gov
503-437-5348

Darrick E. Boschmann, Oregon Water Resources Department
Halley J. Schibel, Oregon Water Resources Department
Benjamin P. Scandella, Oregon Water Resources Department

Slide 1: Cover slide

- USGS-OWRD cooperative investigation
- Part of the OWRD contribution to the Investigation
- Darrick Boschmann:
  - geologic interpretations
  - well drilling and well network
- Halley Schibel:
  - Spring & stream discharge and sampling
  - Python scripts to mine, organize, analyze, & calculate data
  - ArcMap products
- Ben Scandella:
  - Statistics
  - Python scripts to mine, organize, analyze, & calculate data
  - ArcMap products

Slide 2: Harney Basin: location

- 5,240 mi^2
- North portion of Malheur Lake Administrative Basin
- Mostly within Harney County
- Greater Harney Valley Area = HUC based lowlands, most GW use

Slide 3: Crane vicinity: well complaint

- Well to well interference affecting GW level
- Instability of well site: repeated loads of gravel to refill caving

Slide 4: Crane vicinity: GW level trend

- USGS Leonard noted possible decline and warned risk of decline
- OWRD post-2000: added wells, definite GW level decline

Slide 5: Weaver Springs vicinity: GW development & GW level trend

- Significant GW development after 1990
- OWRD post 2010: added wells, definite area-wide decline

Slide 6: GW level maps: water table & deeper potentiometric surface

- Map data sources:
  - 230 study located and utilized wells
  - 200 permit wells measured annually in March and reported
  - Temporary shallow borings
  - More than 4,200 driller water well reports
  - NHD location for more than 2,500 springs
  - Harney watershed council GW level measurements
- Cones of depression:
  - Weaver Springs-Dog Mountain: depression shallow & deep
  - Crane: depression shallow & deep GW
  - Hwy 20 (east Burns): depression deep GW, not shallow GW
  - Isolated small depressions
- Flat gradient areas:
  - Virginia Valley: gradual area-wide decline
  - Silver Creek: gradual area-wide decline

Slide 7: GW level trend

- Weaver Springs:
  - Decline ~8 ft/yr
  - Shallow & deep GW levels similar & within 5 ft
  - Shallow GW level above deep level
- Dog Mountain:
  - Decline ~1 ft/yr
  - Deep GW level muted expression of shallow
  - Shallow & deep GW levels ~15 ft apart
  - Deep GW level above shallow level

Slide 8: GW level trend (continued)

- Lawen to Warm Springs Butte:
  - Shallow GW level muted expression of deep
  - Shallow GW level decline rate less than deep
  - Shallow & deep had common level & then separated
- Virginia Valley:
  - Decline ~1 ft/yr
  - Shallow & deep GW levels overlap tightly

Why:

- Cone of depression:
  - Why cones some areas, flat gradient other areas?
  - Why cones shallow & deep some areas, just deep other?
- GW level trend (seasonal & annual) shallow & deep:
  - Why same & close some areas?
  - Why some areas have different amplitude & same decline rate?
  - Why some areas have different amplitude & decline rate (both)?
  - Why shallow vs deep having larger amplitude & decline varies?

Explore: hydraulic property relationship to geology & GW development

Slide 9: Hydraulic property data sources

- 33 aquifer tests:
  - 1 interference test conducted by OWRD (pump & 2 obs wells)
  - 2 observation wells near irrigation wells with OWRD recorders
  - 41 single well pump tests submitted to OWRD
- 1,451 driller reported well yield tests (specific capacity):
  - 1,161 within the Harney Basin
  - 290 in area surrounding the Harney Basin

Slide 10: Hydraulic property calculations

- Aquifer tests: graphical analyses:
  - All tests: Jacob-Cooper semi-log plot method
  - Tests with obs wells: Theis log-log curve match method
  - Tested results from recorder data by matching hydrograph
- Well yield tests:
  - Vorhis iterative numerical method using Theis equation

Slide 11: Range of transmissivity values calculated

- Median is about 1,000 ft^2/day
- 90% is less than 13,000 ft^2/day
- Aquifer test result curve (irrigation wells) generally show slightly larger transmissivity than well yield test result curve
- For wells with both aquifer test and well yield test, well yield test result for a given well is generally larger than aquifer test result

Slide 12: Spatial distribution of transmissivity values

- Smaller values across entire basin, even among larger values
- Larger value locations more limited
- Largest values:
  - Periphery of Harney Valley
  - Upper Silver Creek floodplain
  - Even more segregated for wells >150 ft vs. <150 ft

Slide 13: Transmissivity correlated to stratigraphic units

- Geologic map:
  - Seamless & stratigraphically consistent
  - Based on 14 original publications
  - More than 100 unique stratigraphic unit names grouped into 18 map units sharing similar geologic origins, physical properties, stratigraphic position
- Identify stratigraphic units for each well:
  - Driller description to lithology code (2,242 wells)
  - Lithology code to stratigraphic unit (1,495 wells)
- Assign well transmissivity to a single stratigraphic unit
  - Only if a single unit occupies 90% of well open interval
  - Used total open interval

Slide 14: Stratigraphic Transmissivity to Hydrostratigraphic Transmissivity

- Calculated & plotted transmissivity statistics for each unit
- Grouped 8 stratigraphic units into 9 hydrostratigraphic units:
  - Similar geologic properties
  - Similar hydraulic properties
- Largest median values:
  - Younger volcanic deposits
  - Deposits with secondary permeability
- Intermediate median values:
  - Silicic lava flows and domes
  - High Lava Plains basalt
  - Basin-fill sediments
- Smallest median values:
  - Upland volcanic rocks
  - Marine sedimentary rocks
- Only 2 storage coefficient values:
  - From recorder well data analyses
  - Unconfined to intermediate

Slide 15: Hydrostratigraphy, transmissivity, GW response to development

- Weaver Springs:
  - Vent deposits (large transmissivity) shallow and deep
  - Enclosed by low permeability deposits
  - Pumping response efficient lateral & vertically in vent deposits
  - Low permeability deposits yield water slowly to vent deposits
  - Significant cone depression (shallow & deep) in vent deposits that spreads more slowly into the low permeability deposits
- Crane: GW response similar to response at Weaver Springs
  - However, large transmissivity deposits are different
  - Shallow & deep cone of depression
- Dog Mountain:
  - Shallower GW developed,
  - Shallow GW levels drop below deeper GW levels
  - Deeper GW response muted but decline rate similar
  - Cone of depression shallow & deep
- Hwy 20 (east Burns):
  - Deeper GW developed
  - Shallow GW response muted
  - Deep cone of depression only
- Lawen to Warm Springs Butte:
  - Deeper GW developed
  - Shallow GW response muted
  - Shallow & deeper GW levels progressively separating
  - Deep cone of depression only
- Virginia Valley:
  - Extensive large transmissivity deposits shallow & deep
  - Primarily Voltage basalt
  - Other deposits also (secondary permeability?)
  - Pumping response efficient vertically & large lateral area
  - Similar, broad decline area-wide (shallow & deep)
- Upper Silver Creek floodplain:
  - Extensive large transmissivity zone (deep only)
  - Secondary permeability of multiple consolidated deposits?
  - Deeper GW developed, Shallow GW response muted
  - Similar decline over broad area (deep only)
- Above variability has implications for how to manage GW

Slide 16: Noordbergum Effect

- Reverse water level response to pumping start & shut-off:
  - Observed at shallow wells of interference test
  - Indicates deformability, plasticity, and/or elasticity of subsurface
- Note rising levels during the pumping phase after initial decline:
  - Immediate vicinity channels dry
  - Nearby Silvies River flow increasing
  - May or may not be loading response to increased river flow
- Beyond scope of current study, worth future look

Slide 17: Thank You