

North Marina Groundwater Model Update

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September 1, 2016

North Marina Groundwater Model

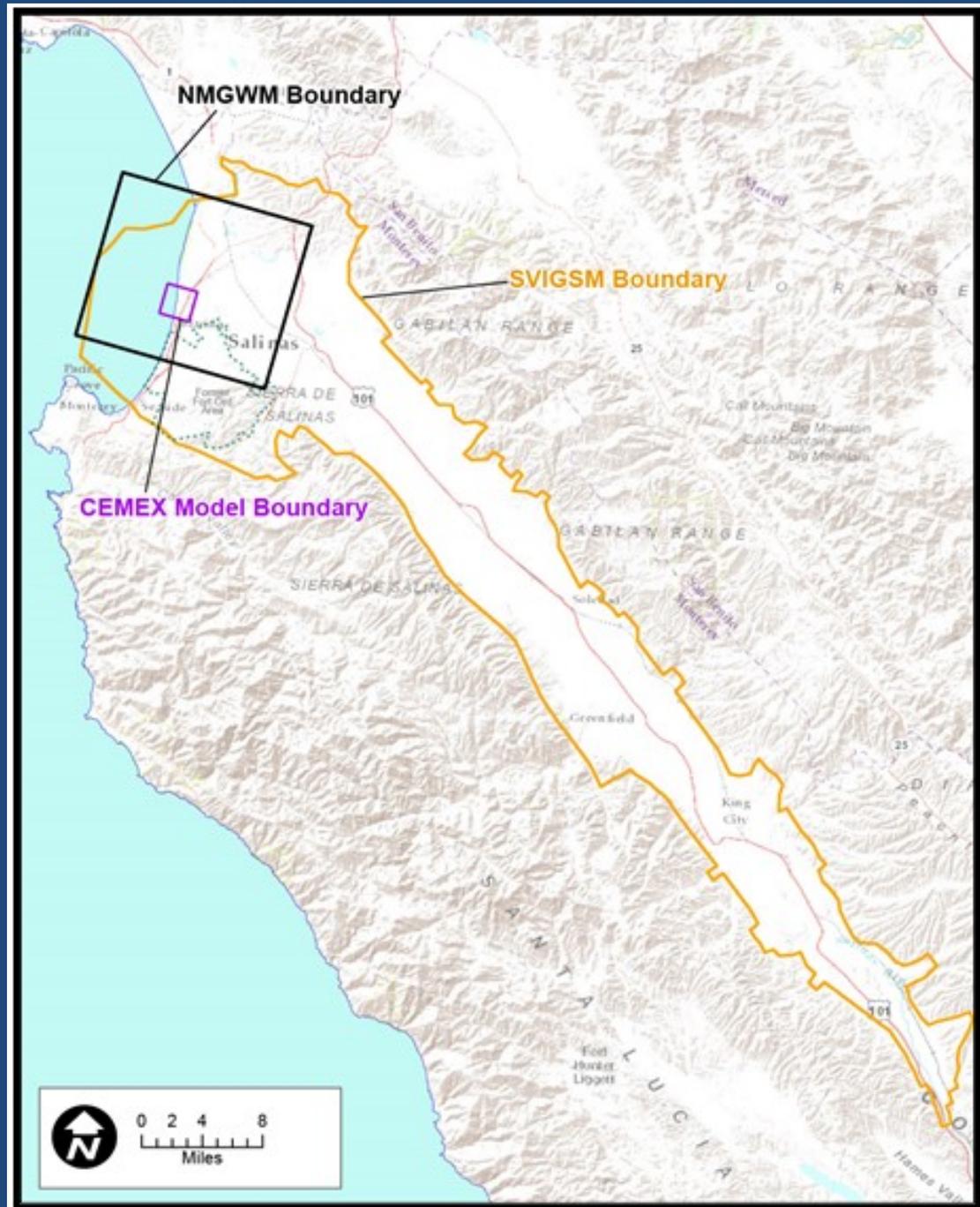
- Review NMGWM²⁰¹⁵
- **Update NMGWM²⁰¹⁵ → NMGWM²⁰¹⁶**
- **Evaluate NMGWM²⁰¹⁶ by assessing history matching results and slant well pumping test results**
- Employ NMGWM²⁰¹⁶ to calculate drawdown from proposed slant well pumping
 - at two sites (CEMEX and Potrero Road) and
 - two pumping rates (24.1 and 15.5 MGD)
- **Characterize sensitivity of NMGWM²⁰¹⁶ results to model assumptions and parameter values.**

Overview of Presentation

- **Modifications/Updates (NMGWM²⁰¹⁶).**
- **Performance assessment – identify deficiencies.**
- **Address deficiencies during model application (*superposition approach*).**

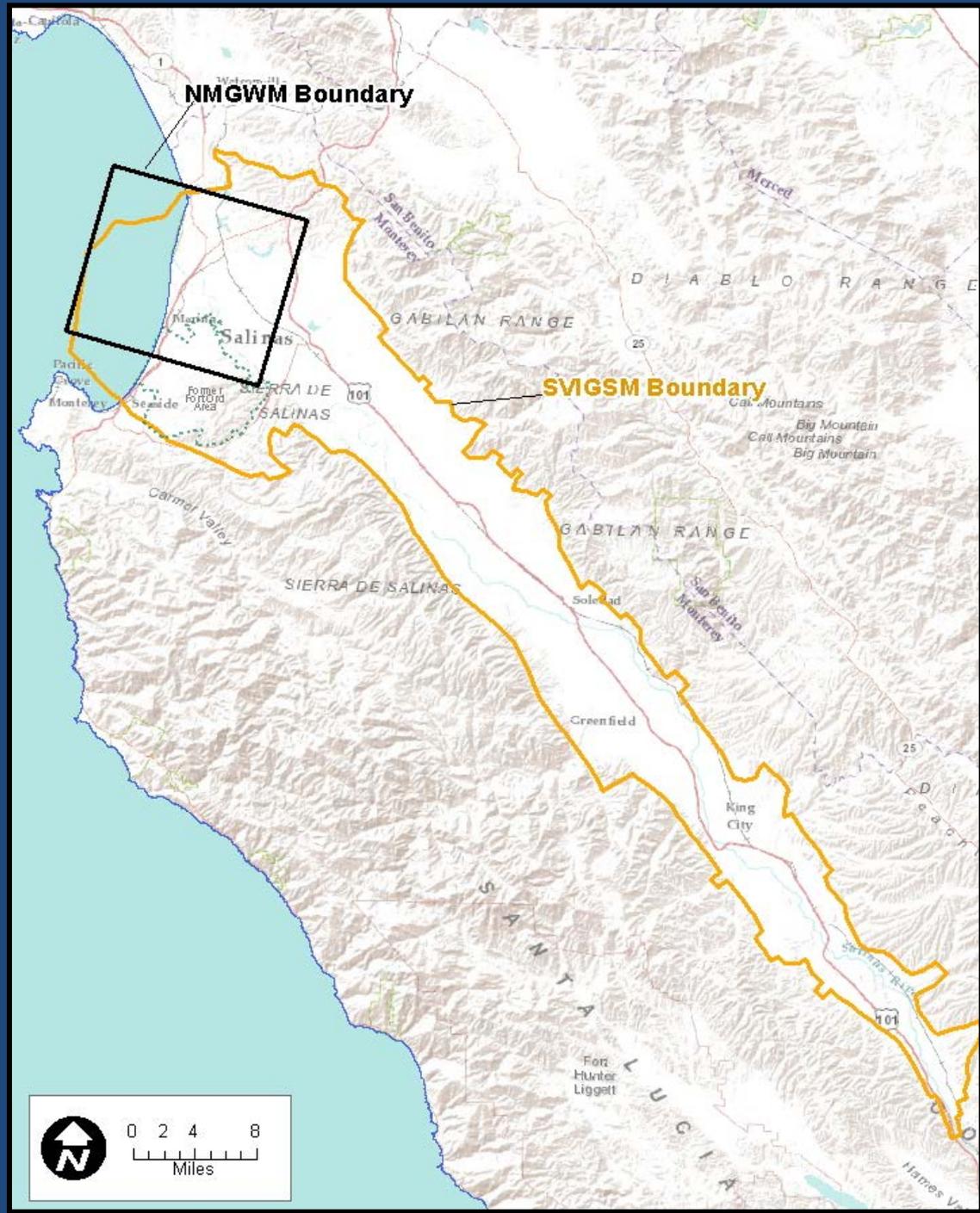
ASSIGNMENT:

Calculate
maximum
extent of
drawdown due
to slant well
pumping using
NMGWM²⁰¹⁶



NMGWM

Boundary
Conditions,
Specified
Recharge,
and Specified
Pumping
from
SVIGSM



EXPLANATION

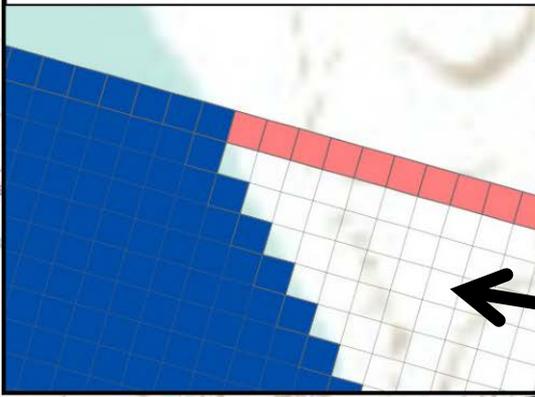
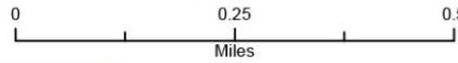
 Constant Head Boundary

Head-Dependent Flow Boundary

 General Head

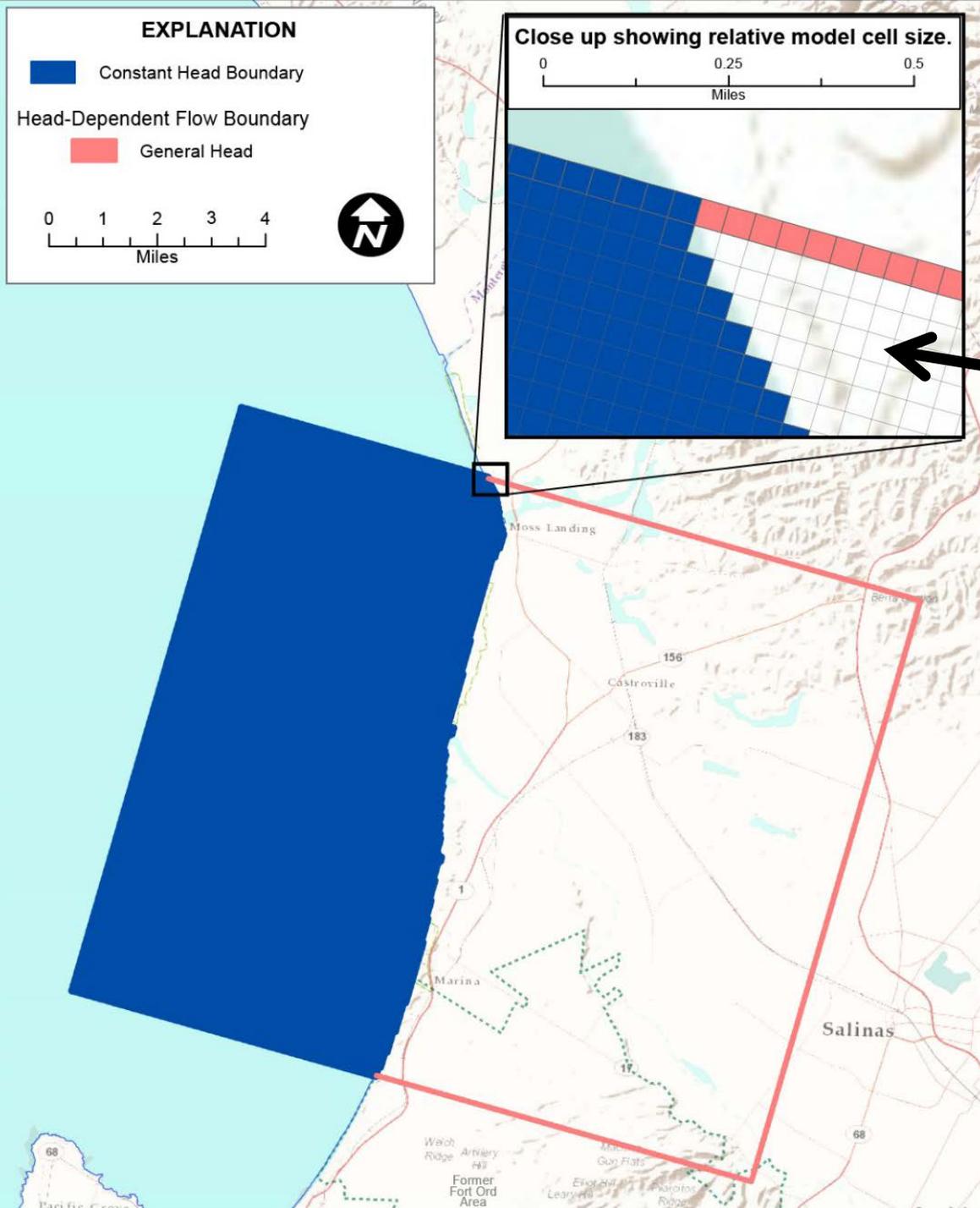


Close up showing relative model cell size.



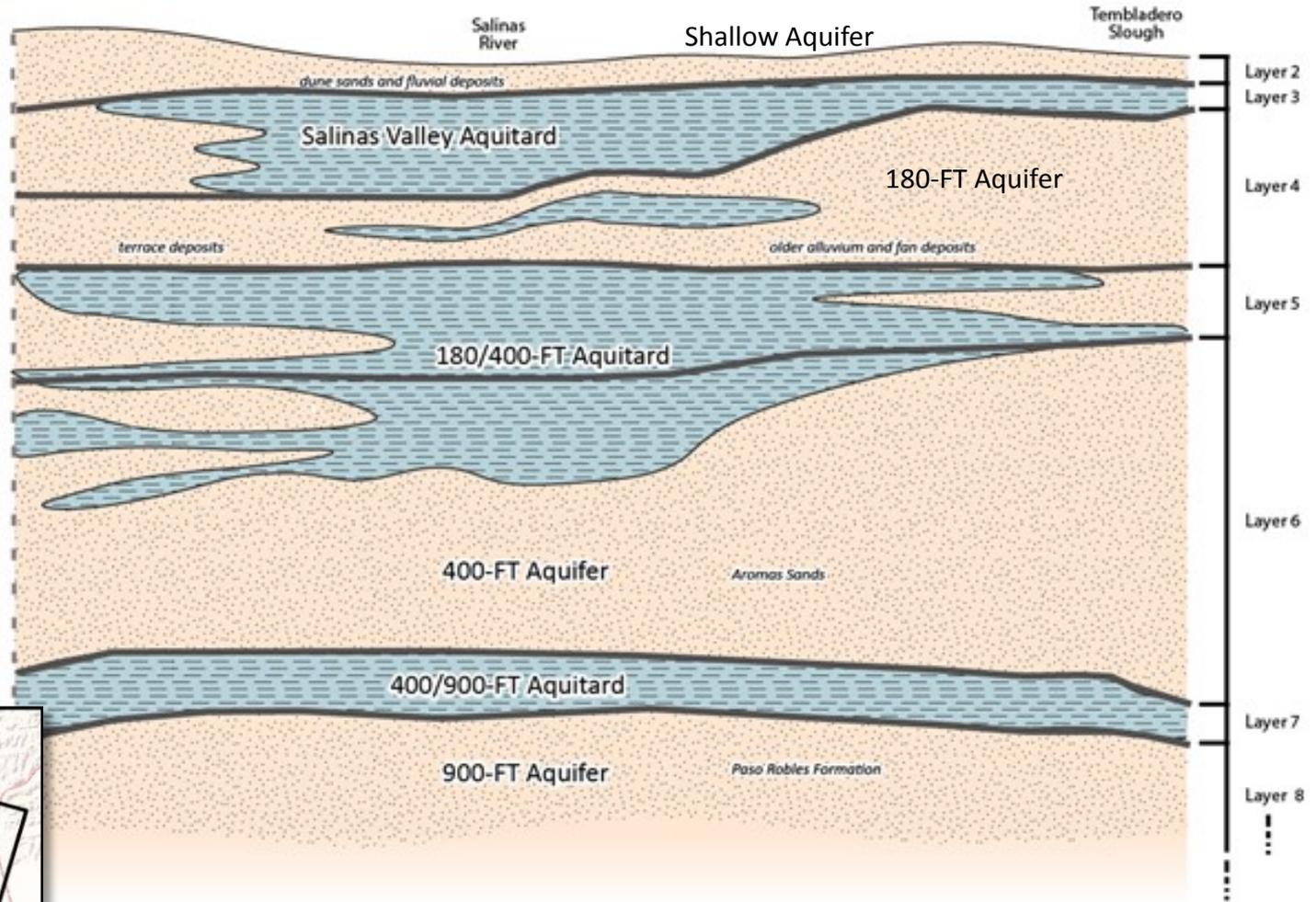
*200 ft x 200 ft
model cells*

Model Structure



South

North

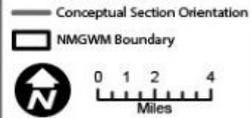


to scale.

Hall P, 1992, "Selected Geological Cross Sections in the Salinas Valley Using GEOBASE," Earthware of California. Prepared for Monterey County Water Resources Agency Basin Management Plan, May 1992. & Geoscience Support Services Inc., 2016, "DRAFT Monterey Peninsula Water Supply Project Monitoring Well Completion Report and CEMEX Model Update," prepared for California American Water, July 15, 2016.



EXPLANATION



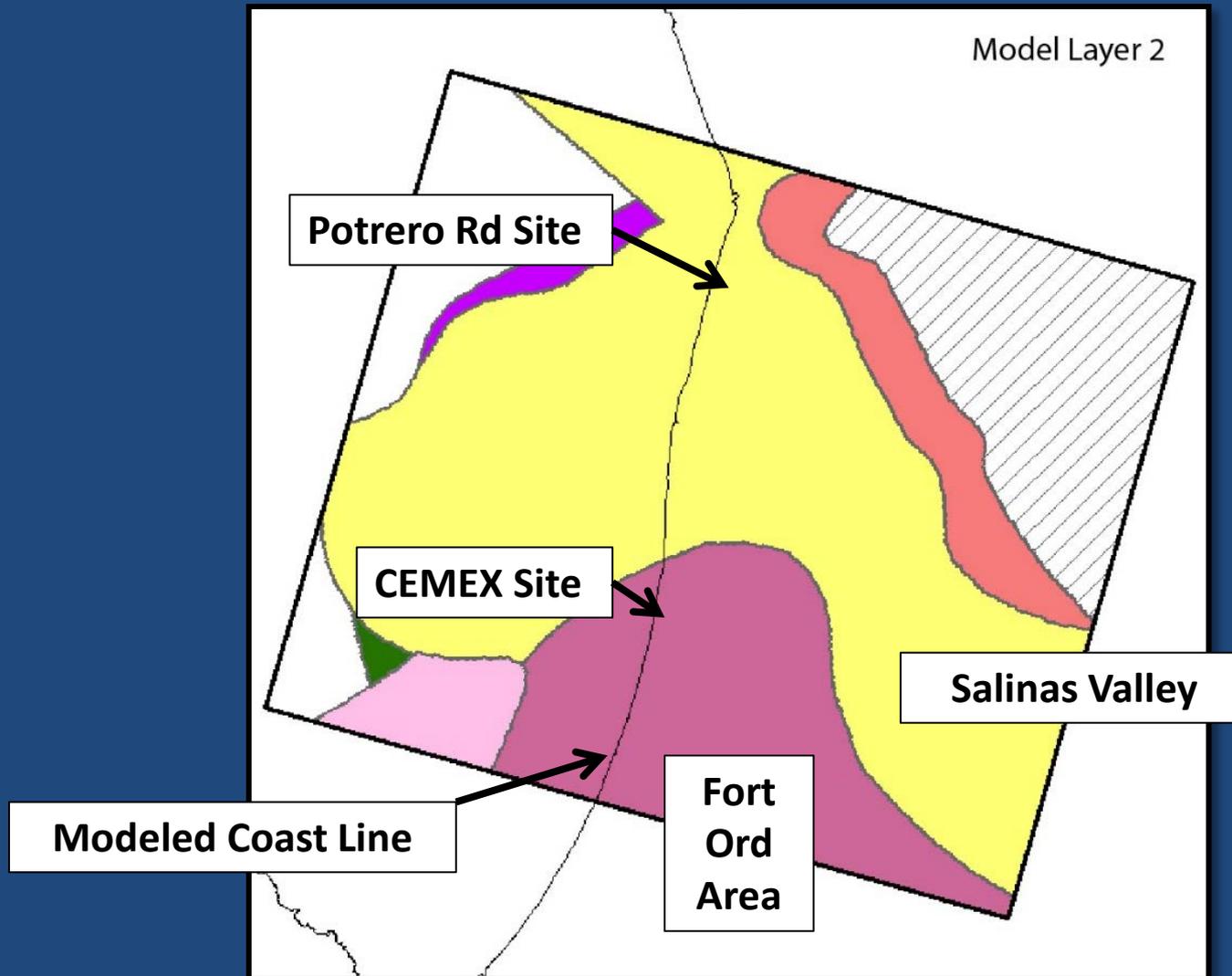
NMGWM layering and associated hydrogeologic descriptors

NMGWM Layer	Water-Bearing Zone	Hydro-geologic Descriptors
1	--	Ocean
2	First (Shallow)	Dune Sand Aquifer A-Aquifer 35-foot Aquifer -2-foot Aquifer Perched Aquifer, Perched "A" Aquifer
3		Salinas Valley Aquitard (SVA) Fort Ord Salinas Valley Aquitard (FO-SVA)
4	Second	180-FT Aquifer 180-FT Equivalent Aquifer Upper & Lower 180-FT Aquifer
5		180/400-FT Aquitard
6	Third	400-FT Aquifer
7		400/900-FT Aquitard
8	Fourth	900-FT Aquifer Deep Aquifer

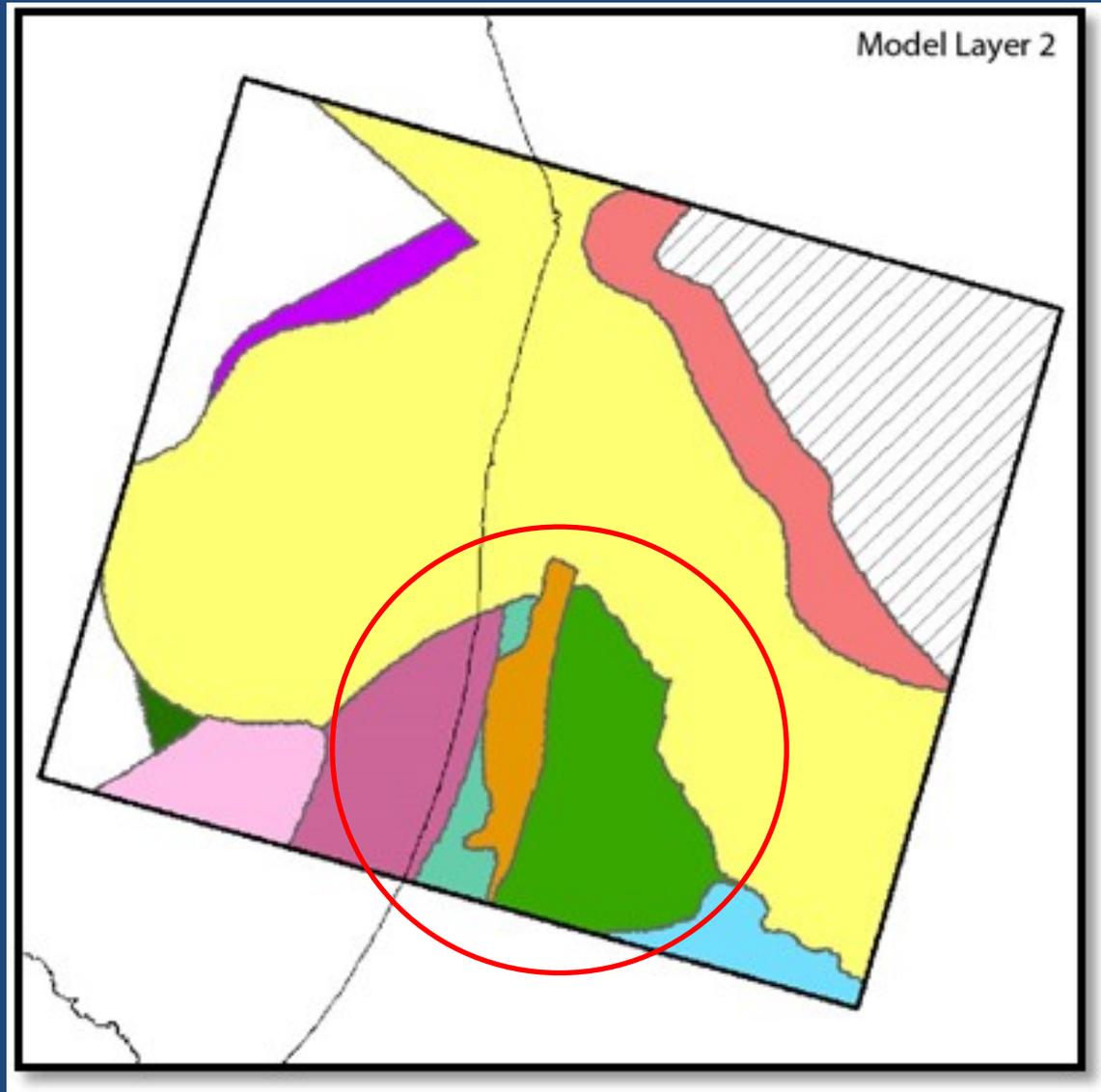
NMGWM²⁰¹⁶ has modified aquifer parameter distribution

- **Updated layering based on new borehole information.**
- **Modified hydraulic conductivity distribution.**
 - **Test slant well data**
 - **Former Fort Ord Area data**
- **Modified hydraulic conductivity values.**
- **Added monitoring well data.**

NMGWM²⁰¹⁵ aquifer parameter zones (Model Layer 2)



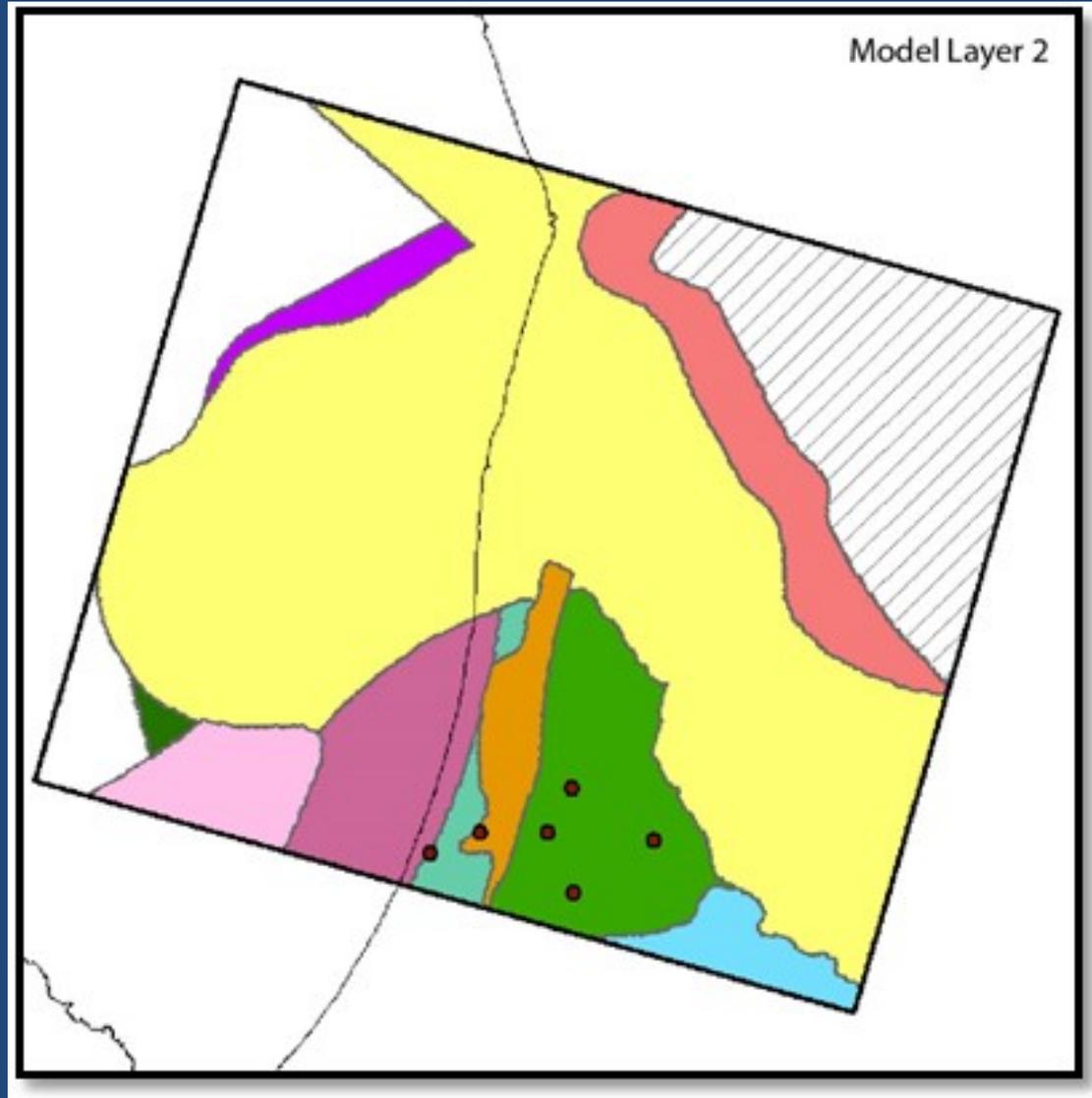
NMGWM²⁰¹⁶ modified aquifer parameter zones (Model Layer 2)



Changes to parameter zones

- **Modified aquifer parameter values (for example)**
 - Horizontal hydraulic conductivity decreased by factor of about 50 to represent shallowest water-bearing zone in FOA.
 - Vertical hydraulic conductivity decreased by factor of over 10,000 to represent FO-SVA.
 - Specific storage decreased by factor of 100 to 1,000 (confined conditions).
- **Assessed sensitivity of model results to hydraulic conductivity**

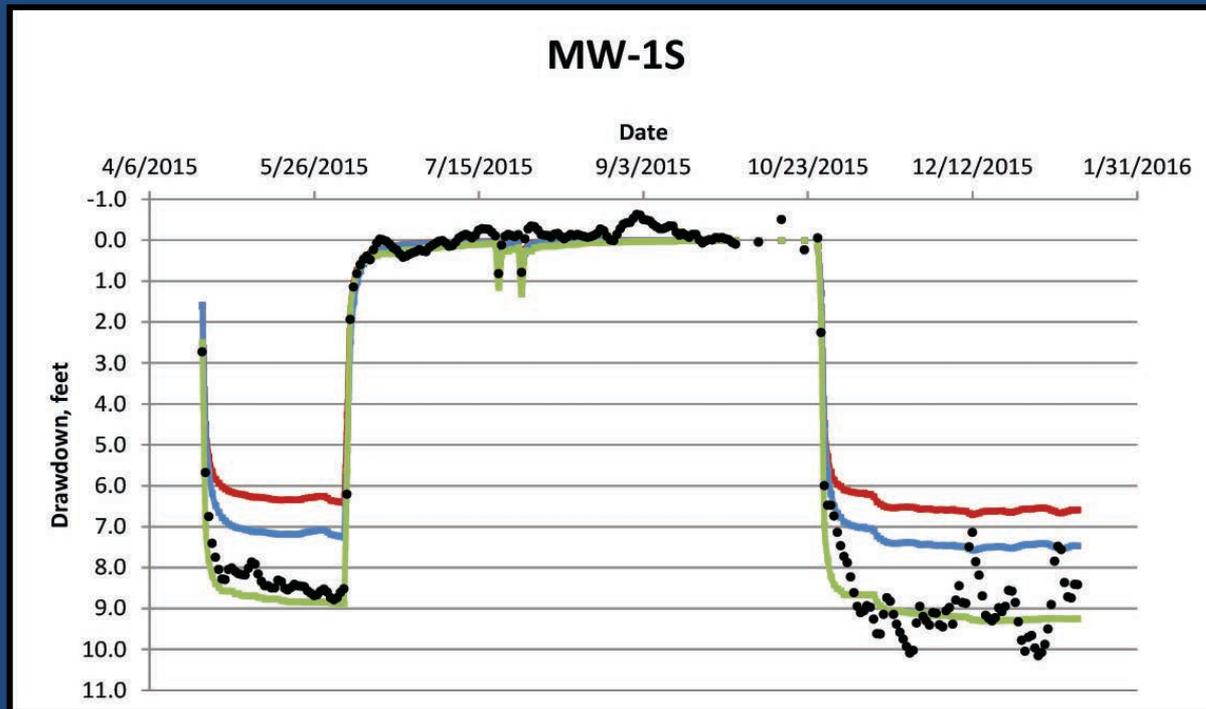
Added well clusters with water level data in Fort Ord Area of NMGWM²⁰¹⁶ (Model Layers 2, 4, and 6)



Evaluate NMGWM²⁰¹⁶ performance

- Test slant well pumping response.
- History matching (1979-2011).

Measured and model-calculated drawdown in CEMEX monitoring well MW-1S during test slant well pumping (Layer 2)



EXPLANATION

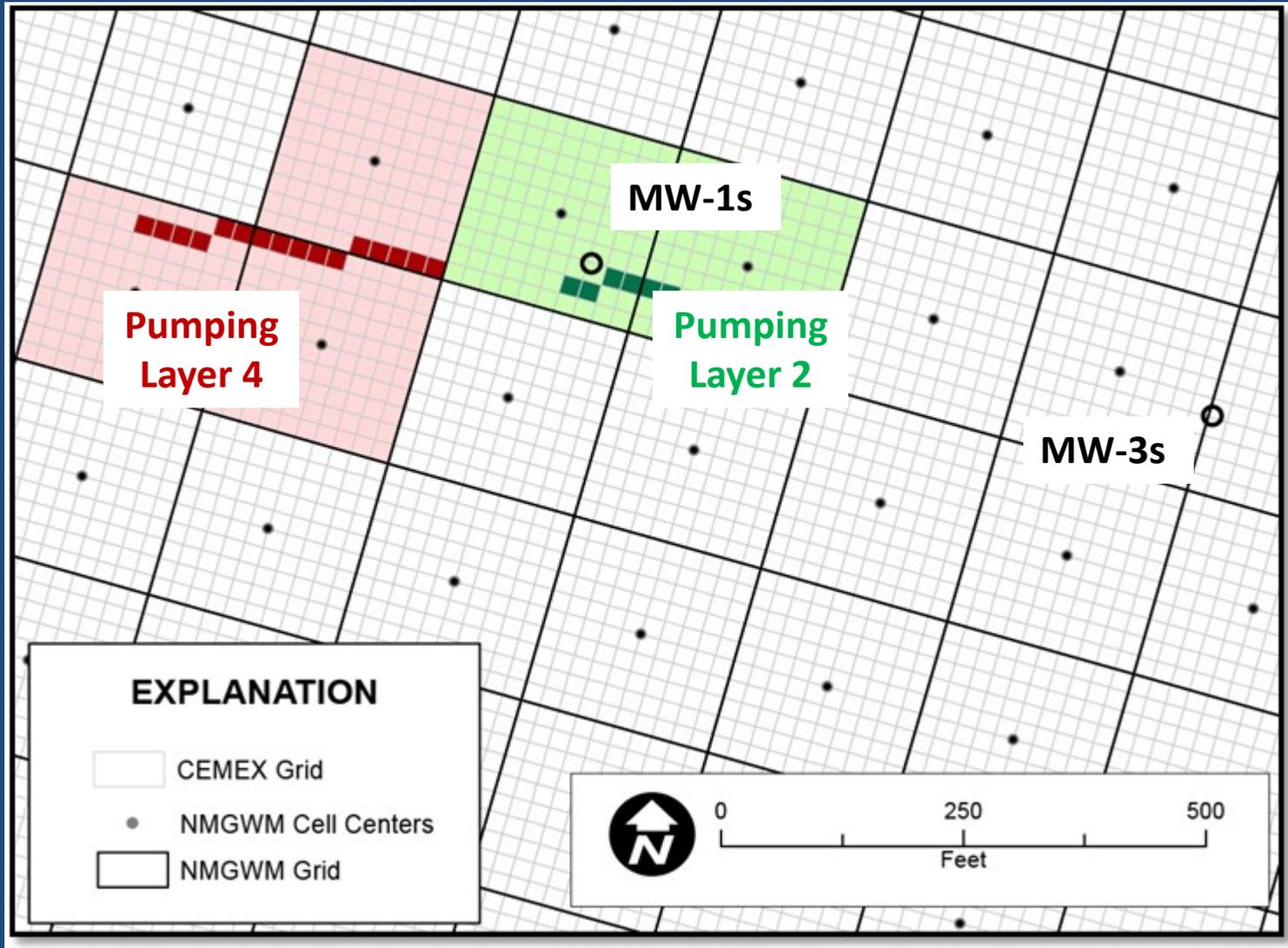
Hydrograph:

- NMGWM²⁰¹⁵
 - NMGWM²⁰¹⁶
 - CEMEX
 - Measured
- > Geoscience (2016)

Test Slant Well

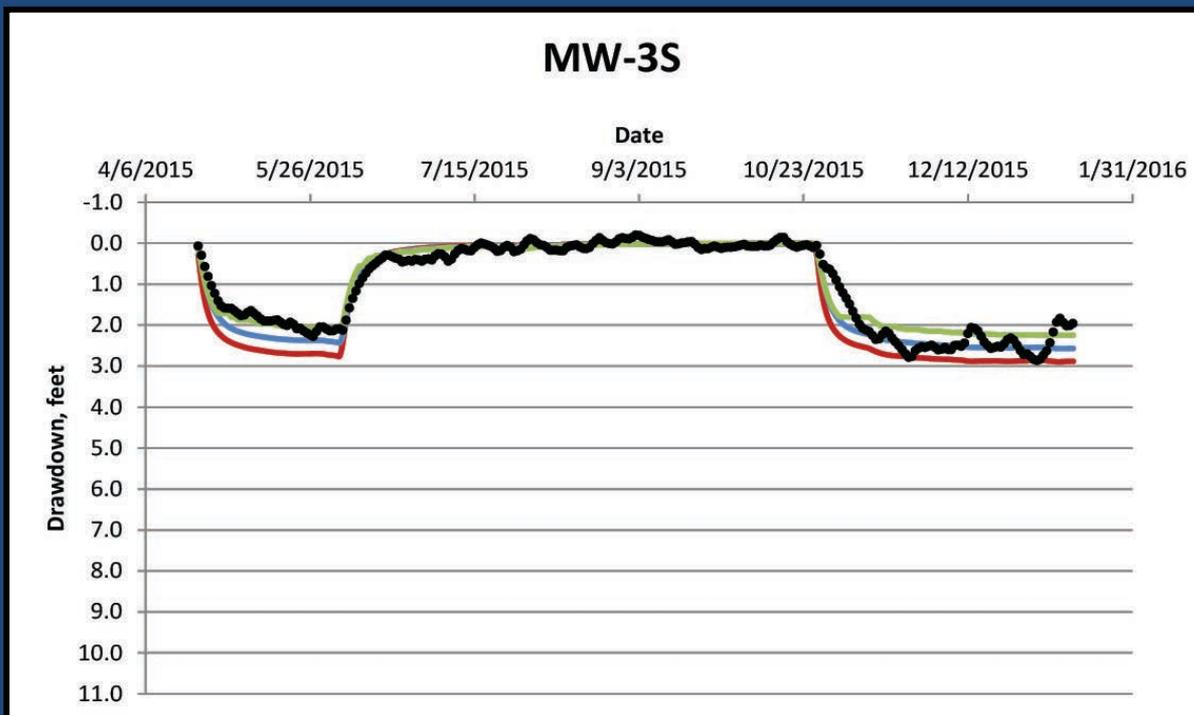
Model scaling effects

NMGWM and CEMEX Model



Measured and model-calculated drawdown in monitoring well MW-3S (Model Layer 2).

Model performance improves with increasing distance from pumping well.

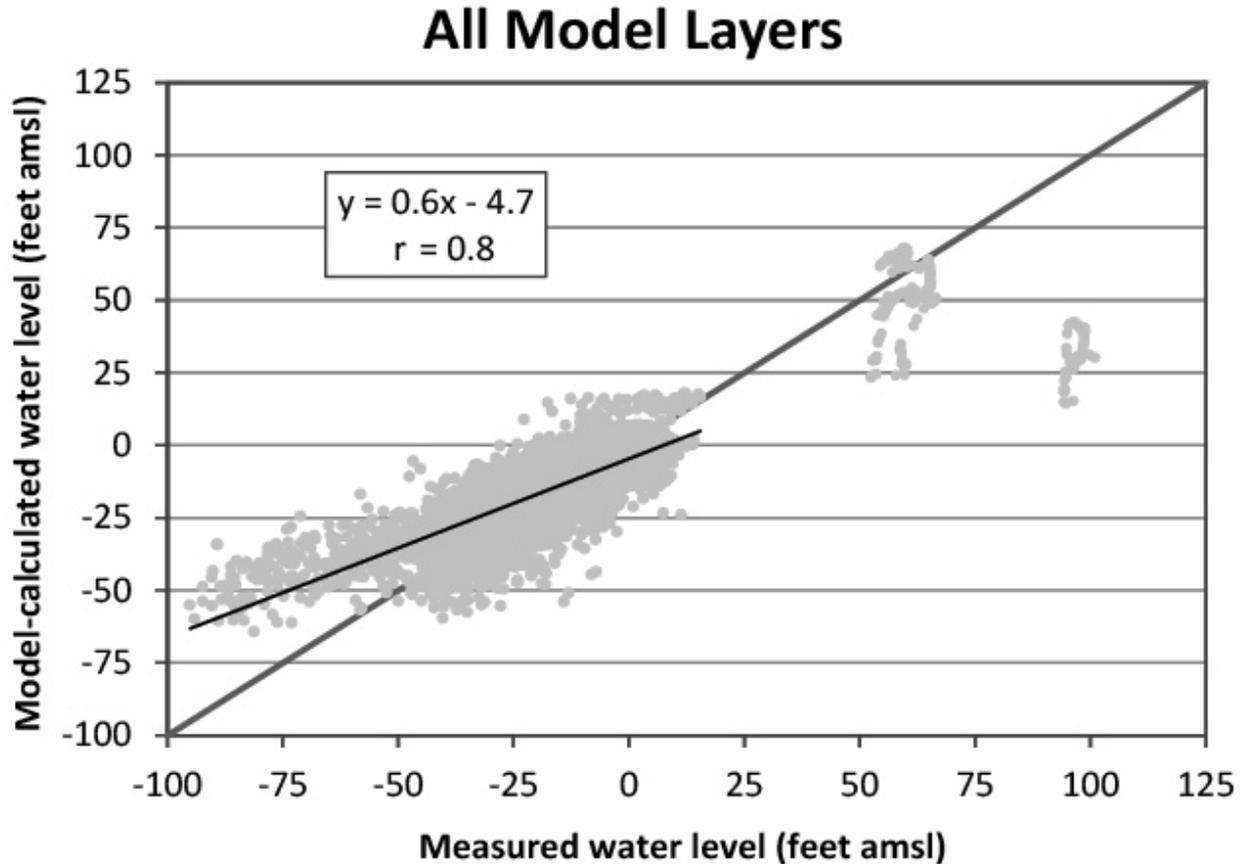


EXPLANATION

Hydrograph:

- NMGWM²⁰¹⁵
 - NMGWM²⁰¹⁶
 - CEMEX
 - Measured
- > Geoscience (2016)

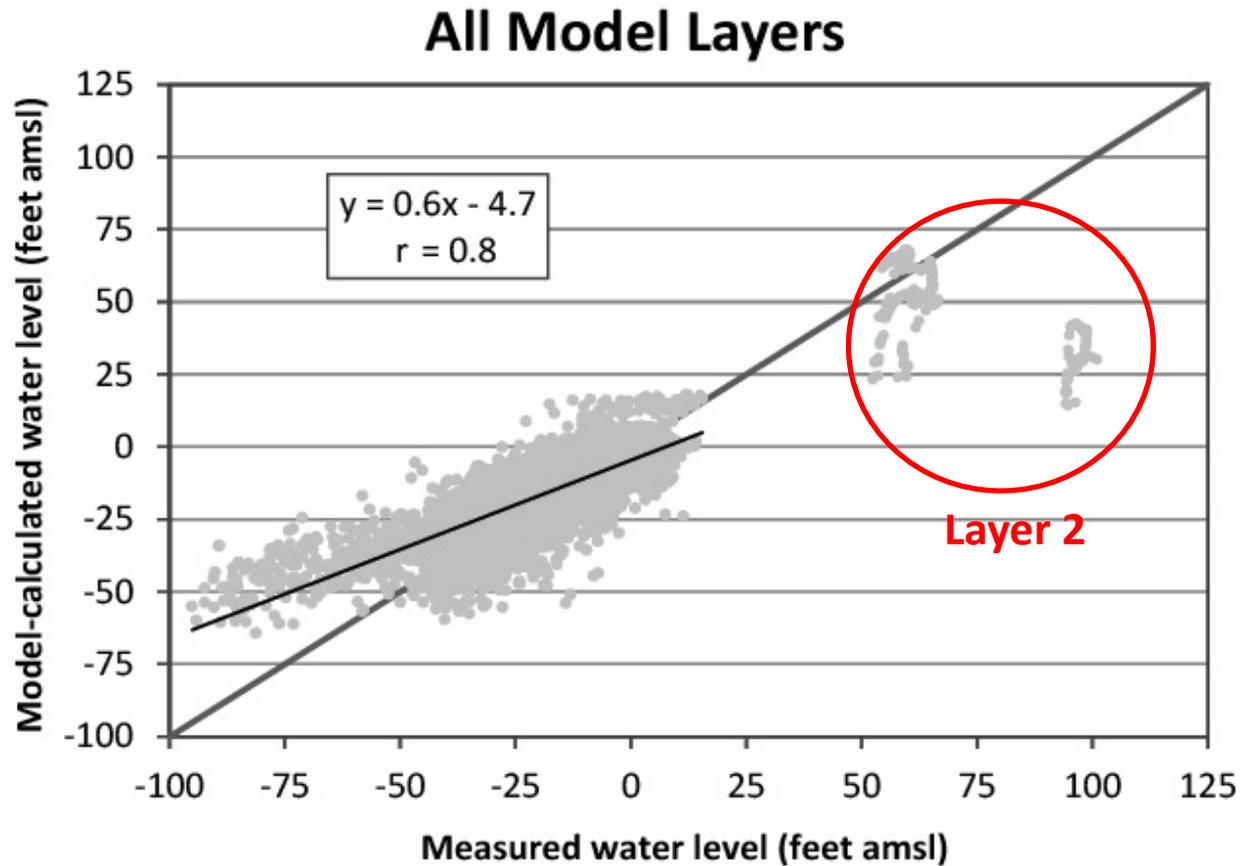
Reasonable match between measured and model-calculated water levels



EXPLANATION

- Observation Well
- Linear (Wells)
- 1 to 1

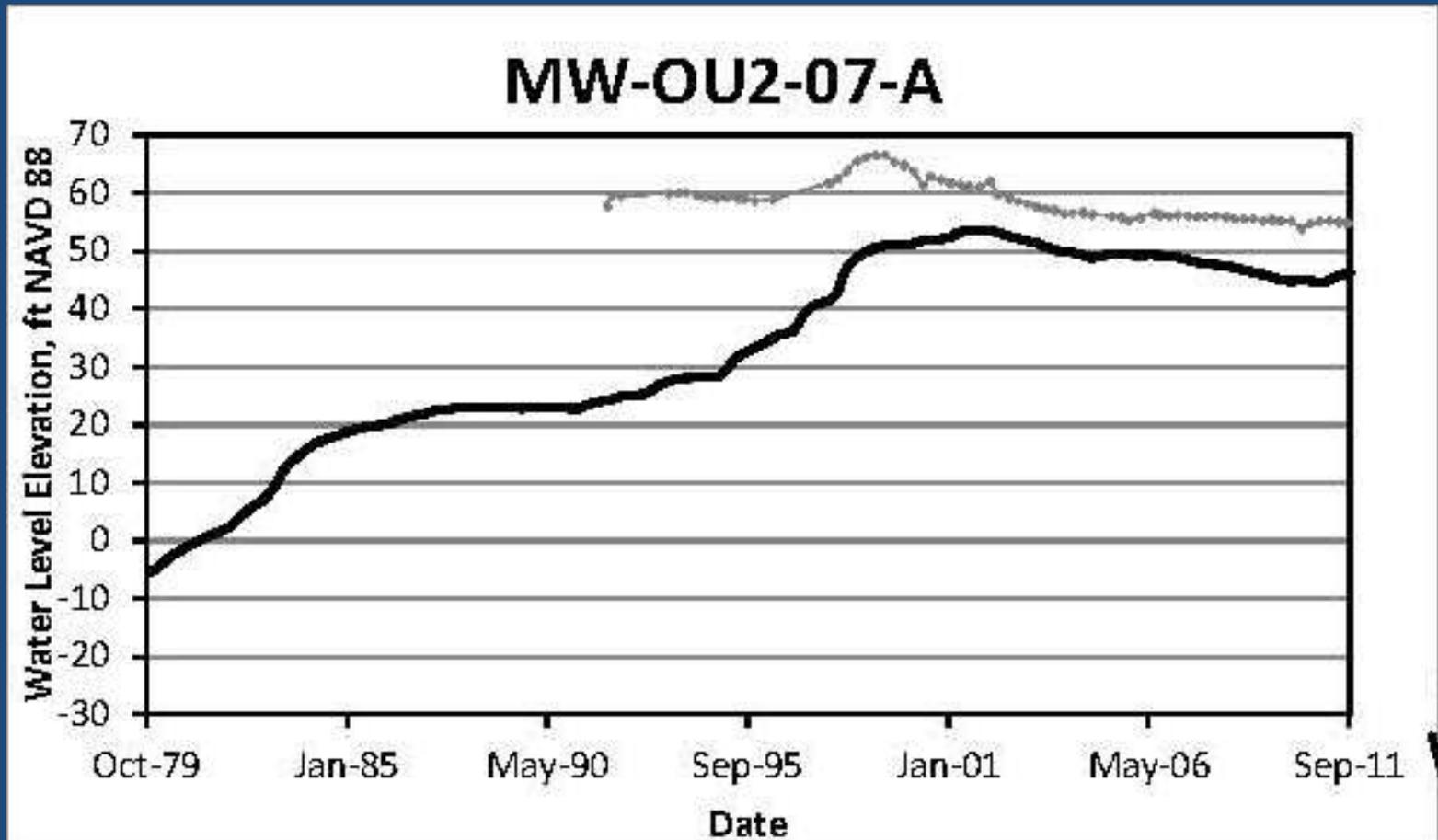
Measured vs. modeled water levels



EXPLANATION

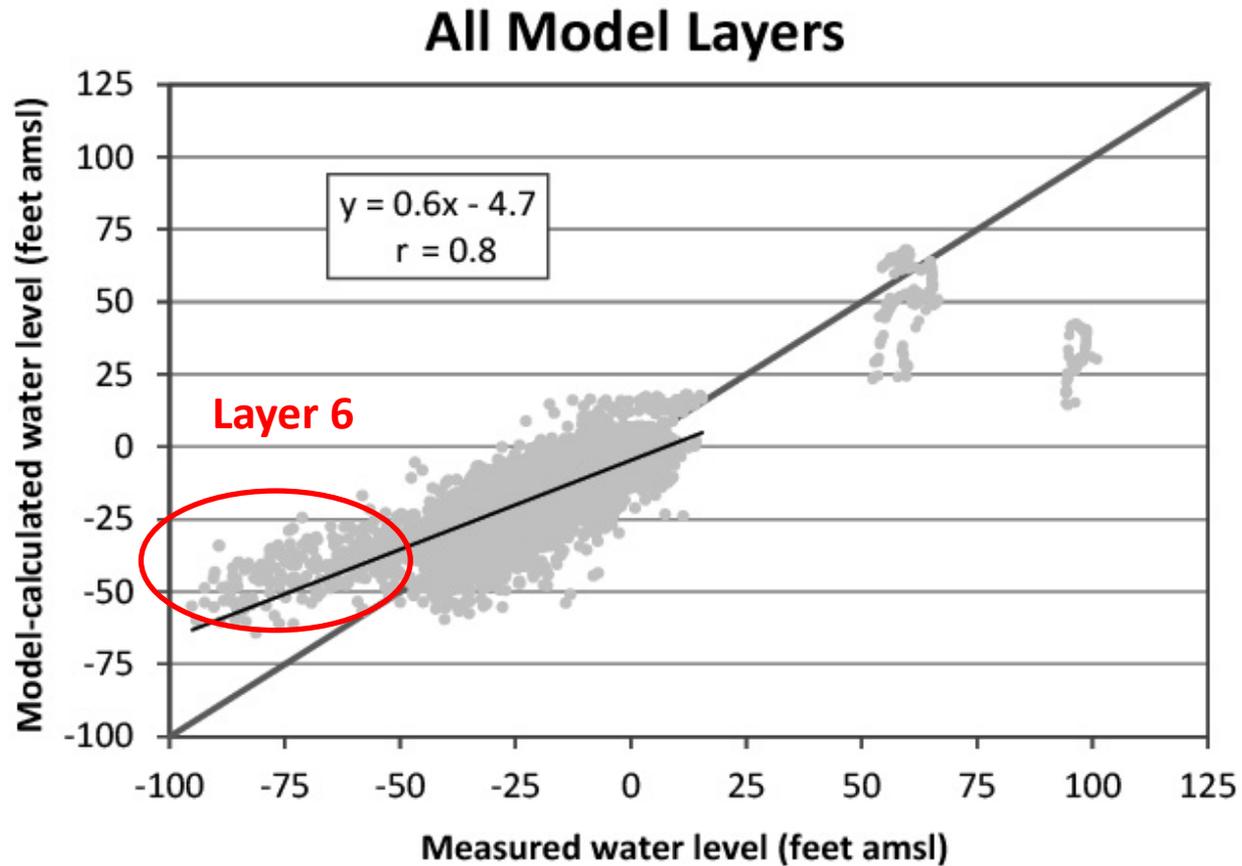
- Observation Well
- Linear (Wells)
- 1 to 1

Deficiency in Layer 2 initial water levels from SVIGSM



— Simulated
••• Measured

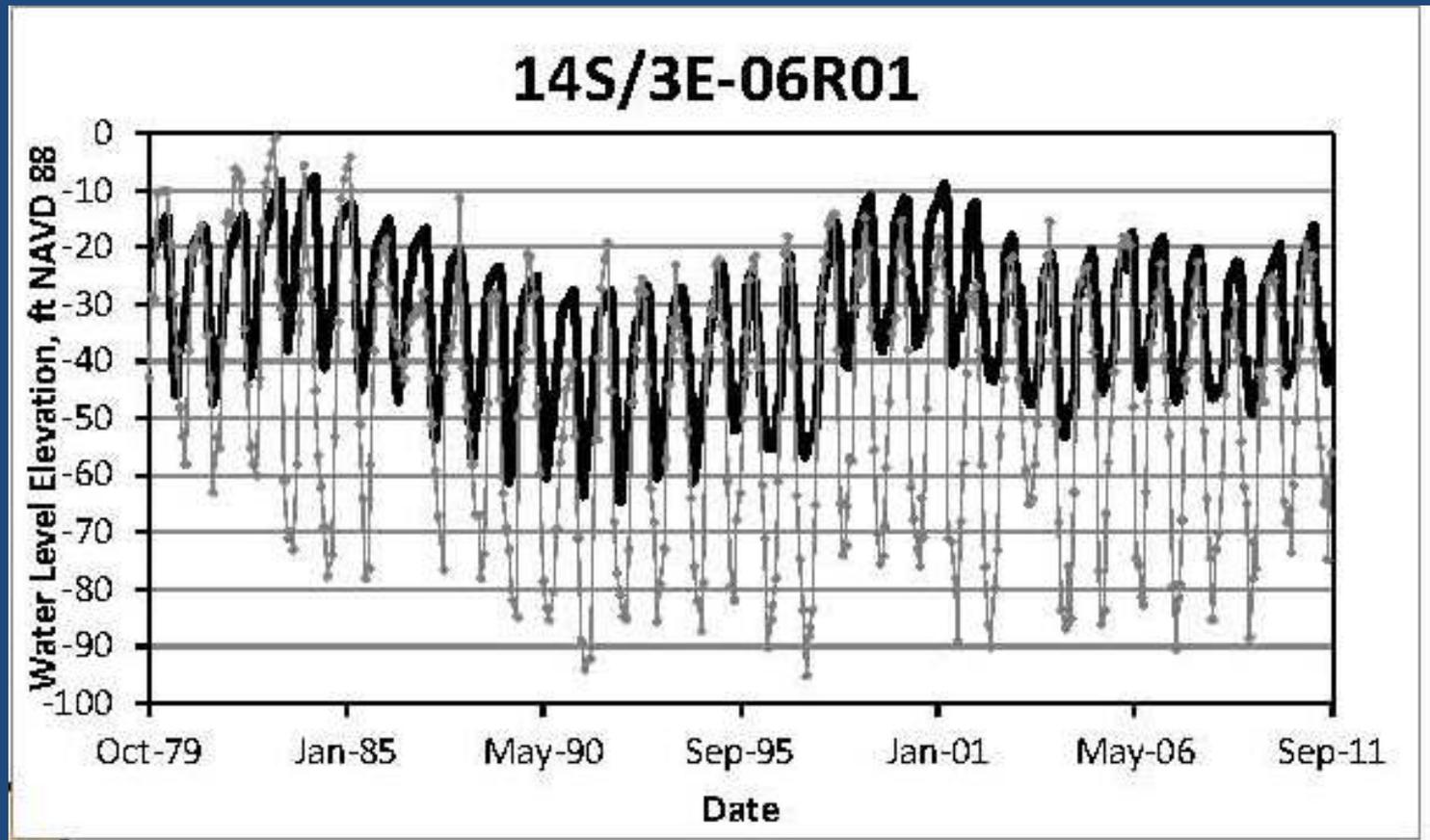
Measured vs. modeled water levels



EXPLANATION

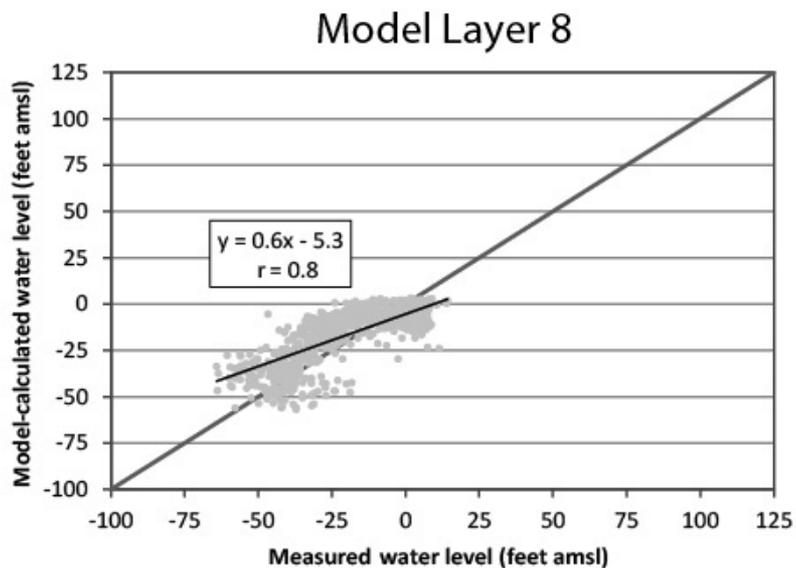
- Observation Well
- Linear (Wells)
- 1 to 1

Deficiency in specified pumping from SVIGSM (Layer 6)



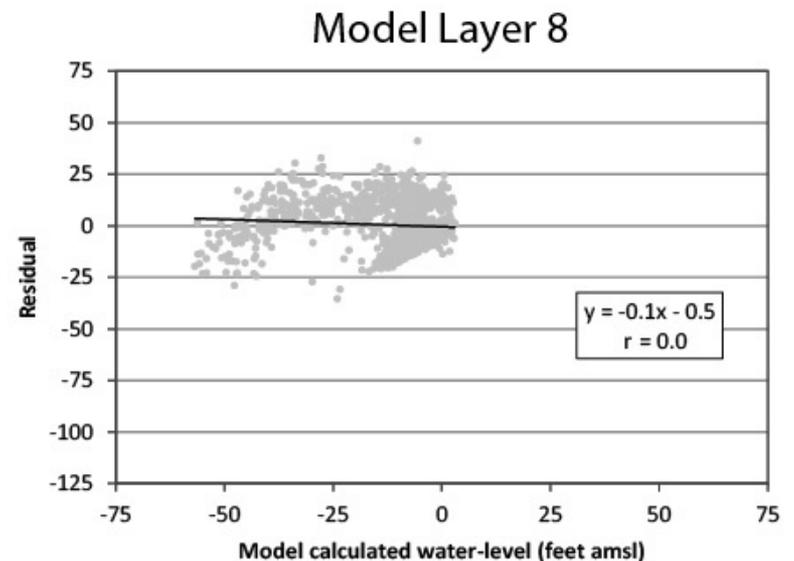
— Simulated
••• Measured

Measured vs. modeled water levels and errors (residuals), Model Layer 8



EXPLANATION

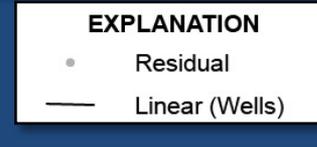
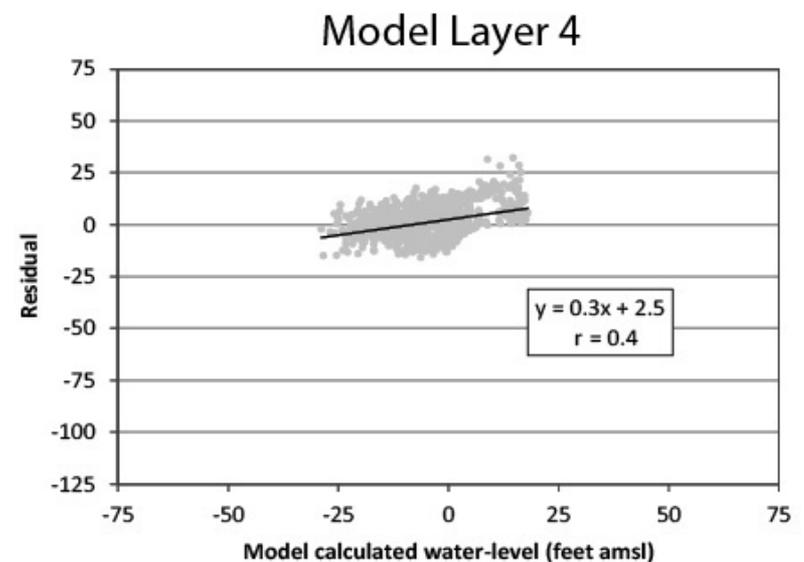
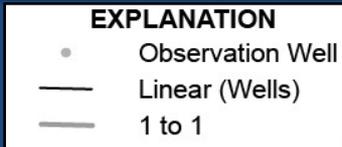
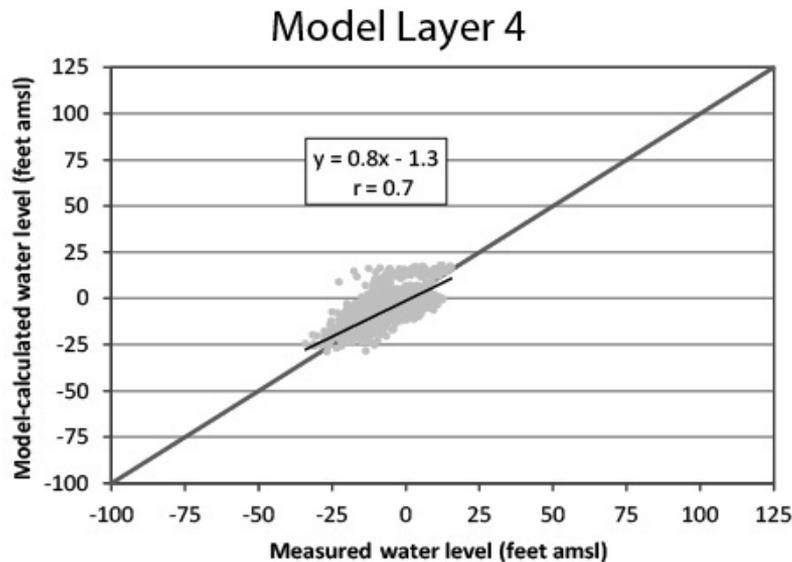
- Observation Well
- Linear (Wells)
- 1 to 1



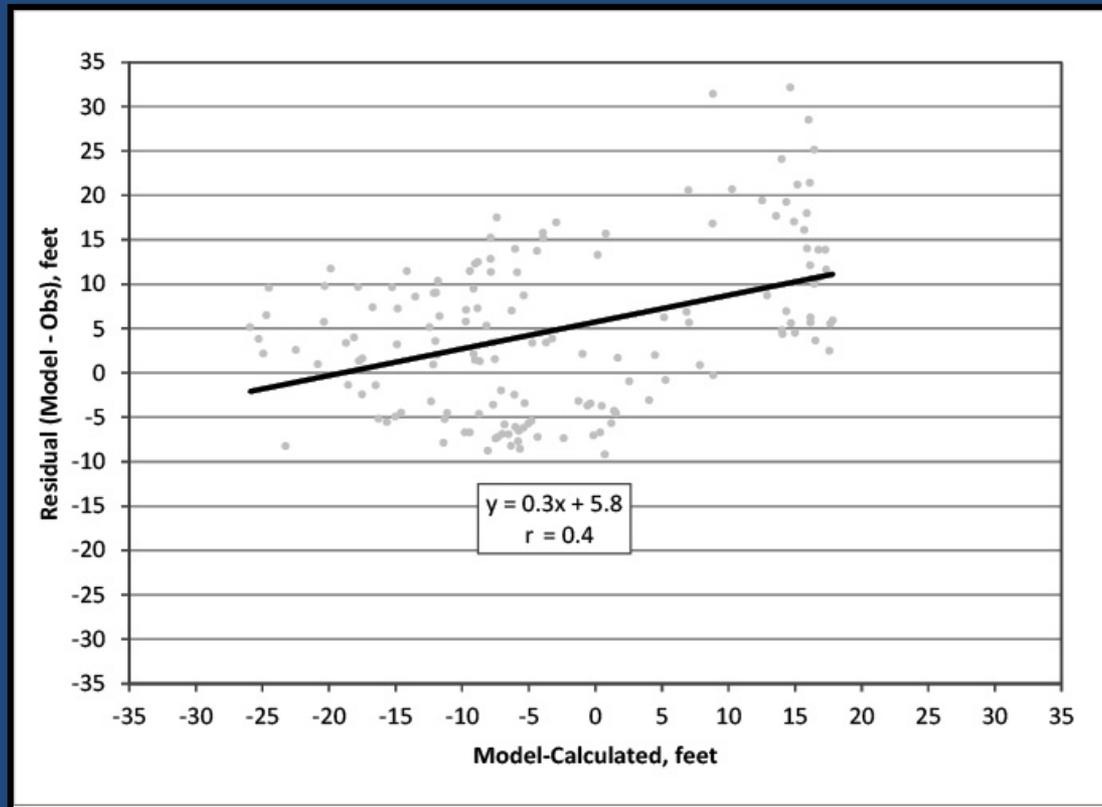
EXPLANATION

- Residual
- Linear (Wells)

Measured vs. modeled water levels and residuals, Model Layer 4



Modeled water levels versus residuals Well 02J01 (Model Layer 4)

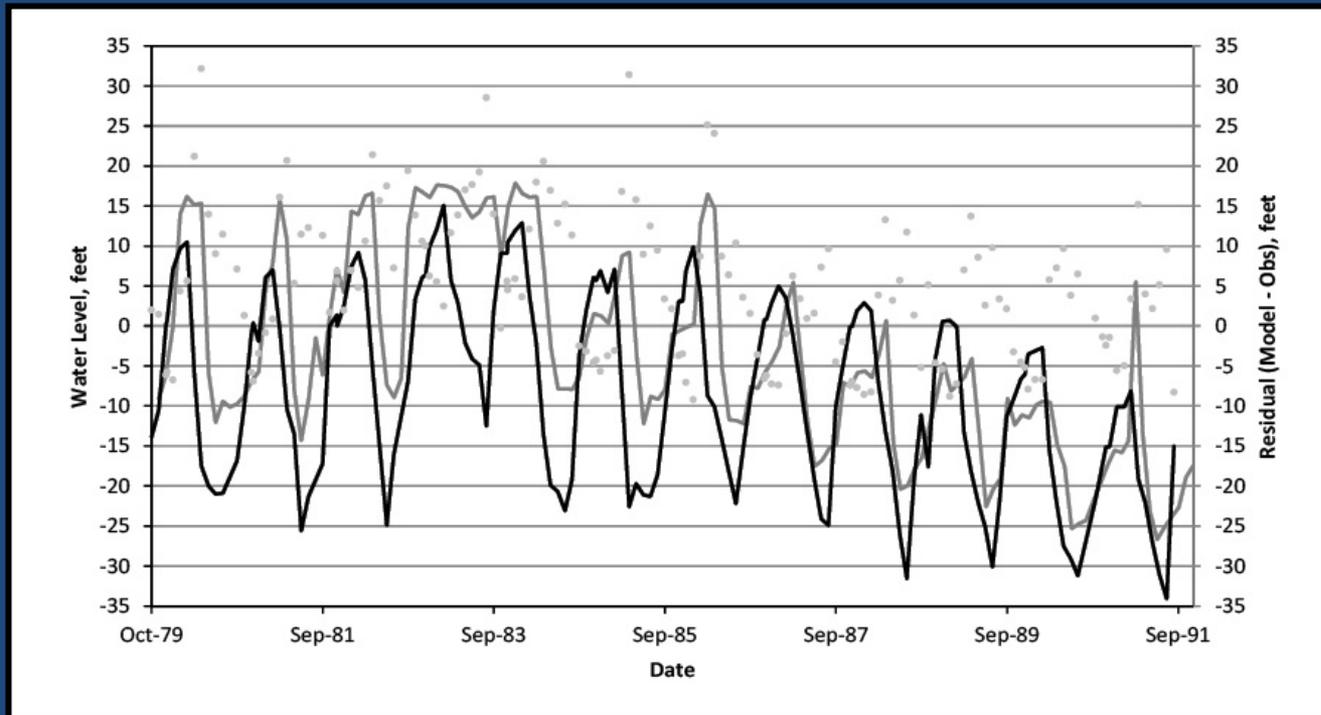


EXPLANATION

- Residual
- Linear (Wells)

Deficiency in SVIGSM pumping causes residuals to decrease with time

Well 02J01 (Model Layer 4)



EXPLANATION

- Residual
- Model Calculated
- Measured

Performance Conclusions

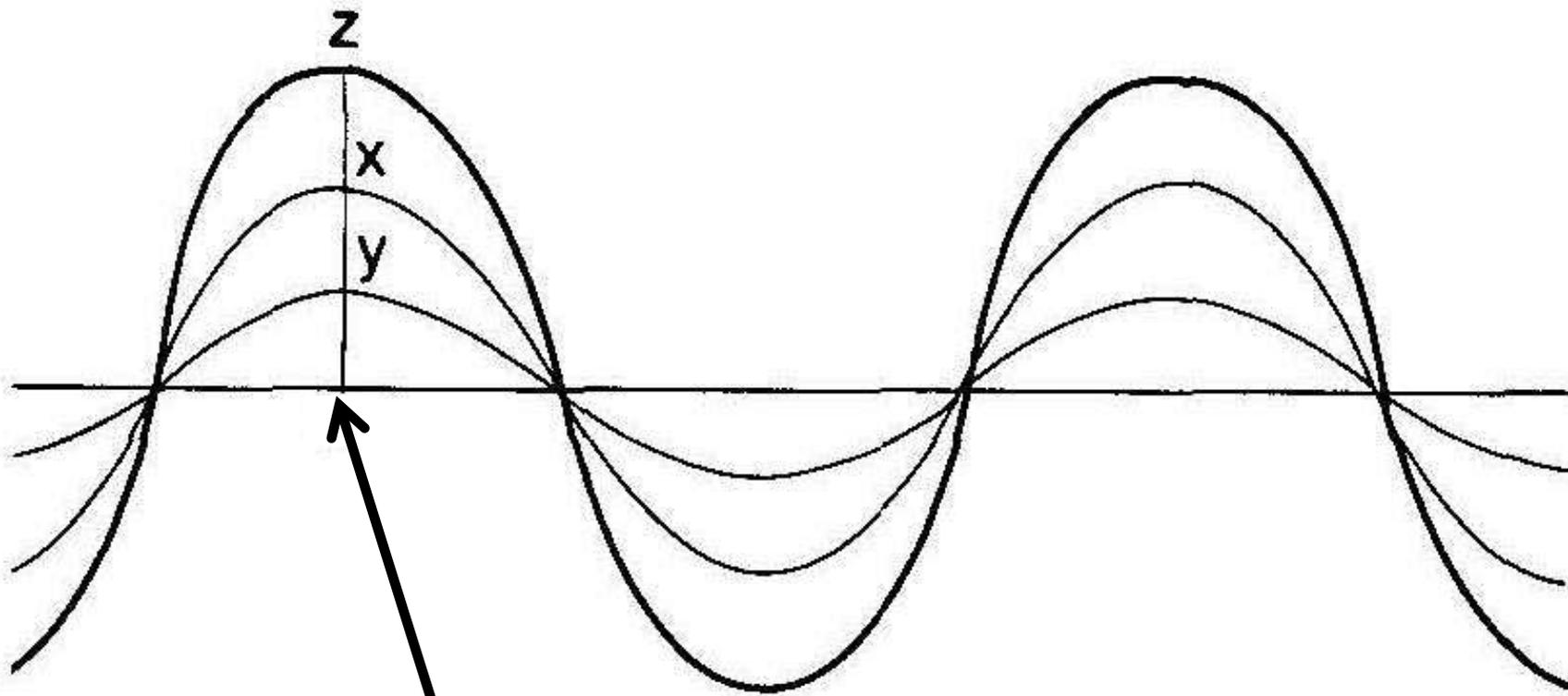
- **NMGWM²⁰¹⁶ reasonably calculates water level changes (seasonal, trends, and drawdown).**
- **NMGWM²⁰¹⁶ calculated drawdown improves with increasing distance from pumping well.**
- **Deficiencies in historical input from SVIGSM**
 - **Specified water levels (i.e., initial water levels)**
 - **Specified stresses (i.e., pumping)**

Method of Superposition removes SVIGSM related deficiencies

- **Calculates the change in water levels (drawdown) to a change in stress (pumping).**
- **Eliminates uncertainty.**
 - Specified water levels
 - Specified background stresses (pumping)
- **Solves for pumping drawdown directly.**

Theory of Superposition

- The solutions to parts of a complex problem can be added to solve the composite problem.
- Projected water level change (drawdown) is the sum of proposed slant well pumping drawdown and combined water level changes from other processes (for example, other pumping wells, recharge, etc.).



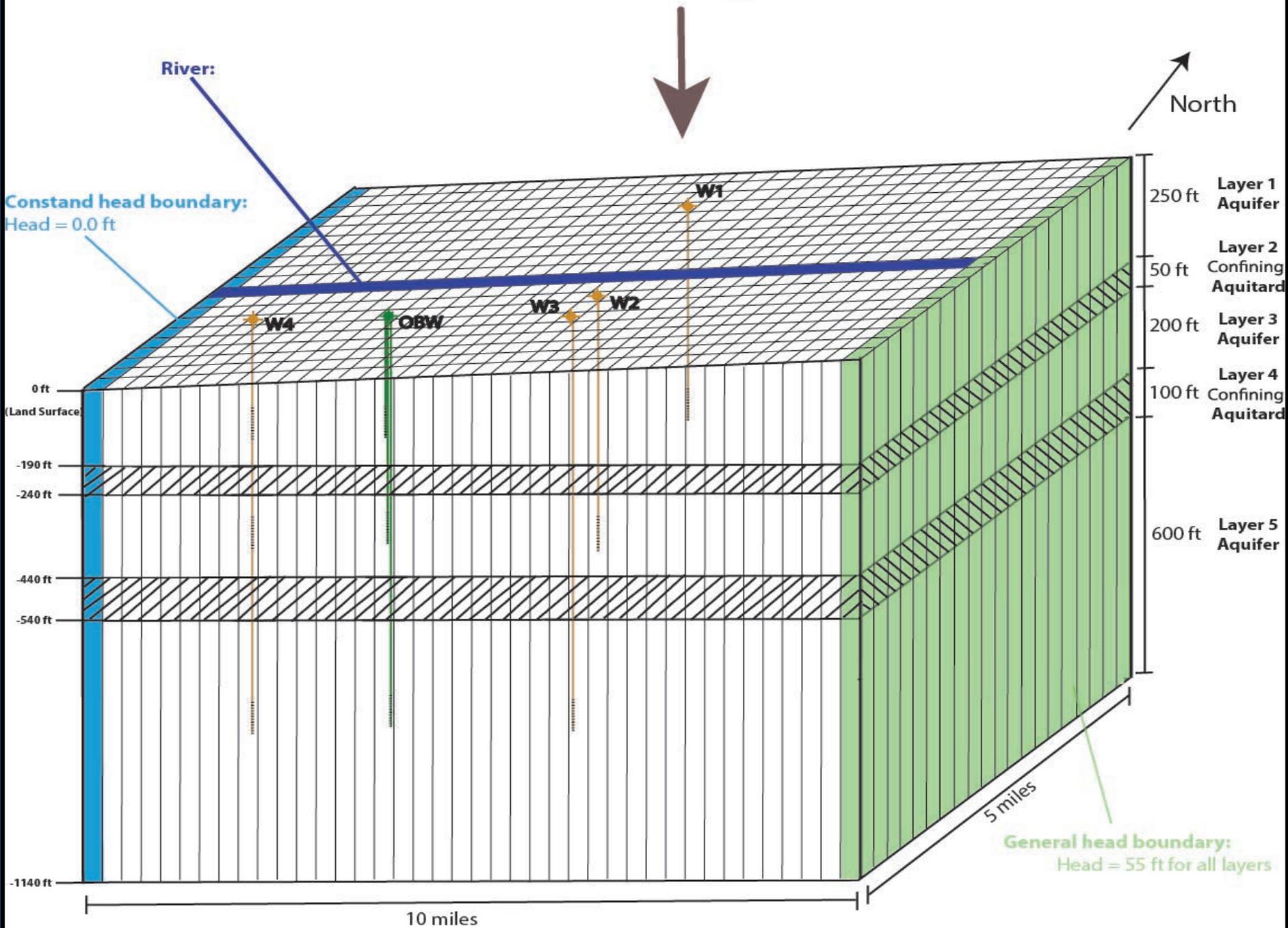
$$Z = x + y$$

Example application using model of hypothetical groundwater basin

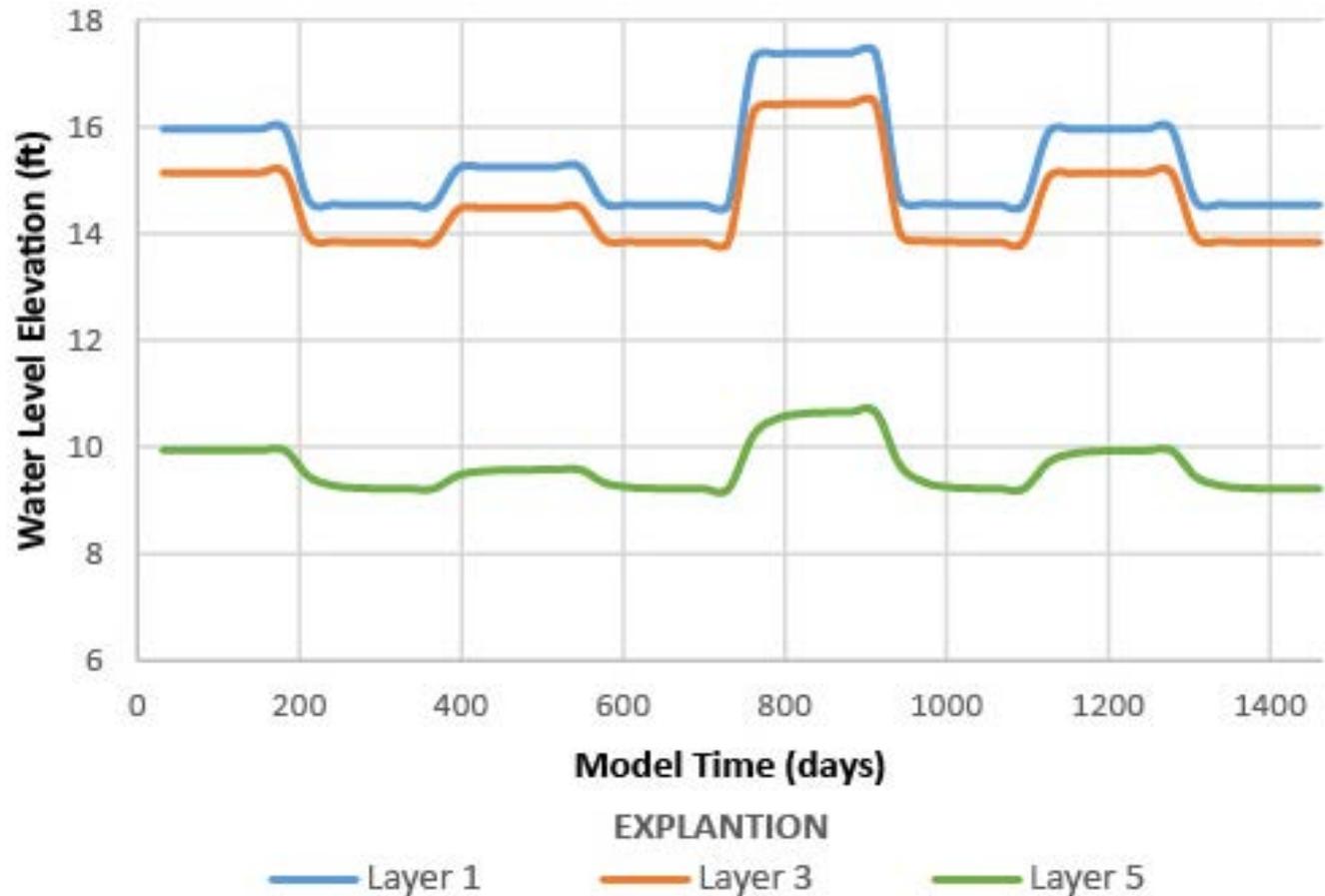
- 1) Employ model to calculate background groundwater conditions.
- 2) Employ model to calculate effect of new pumping well on groundwater conditions.
- 3) [New Conditions] – [Background Conditions] = drawdown due solely to new well.

Employ superposition to calculate drawdown directly.

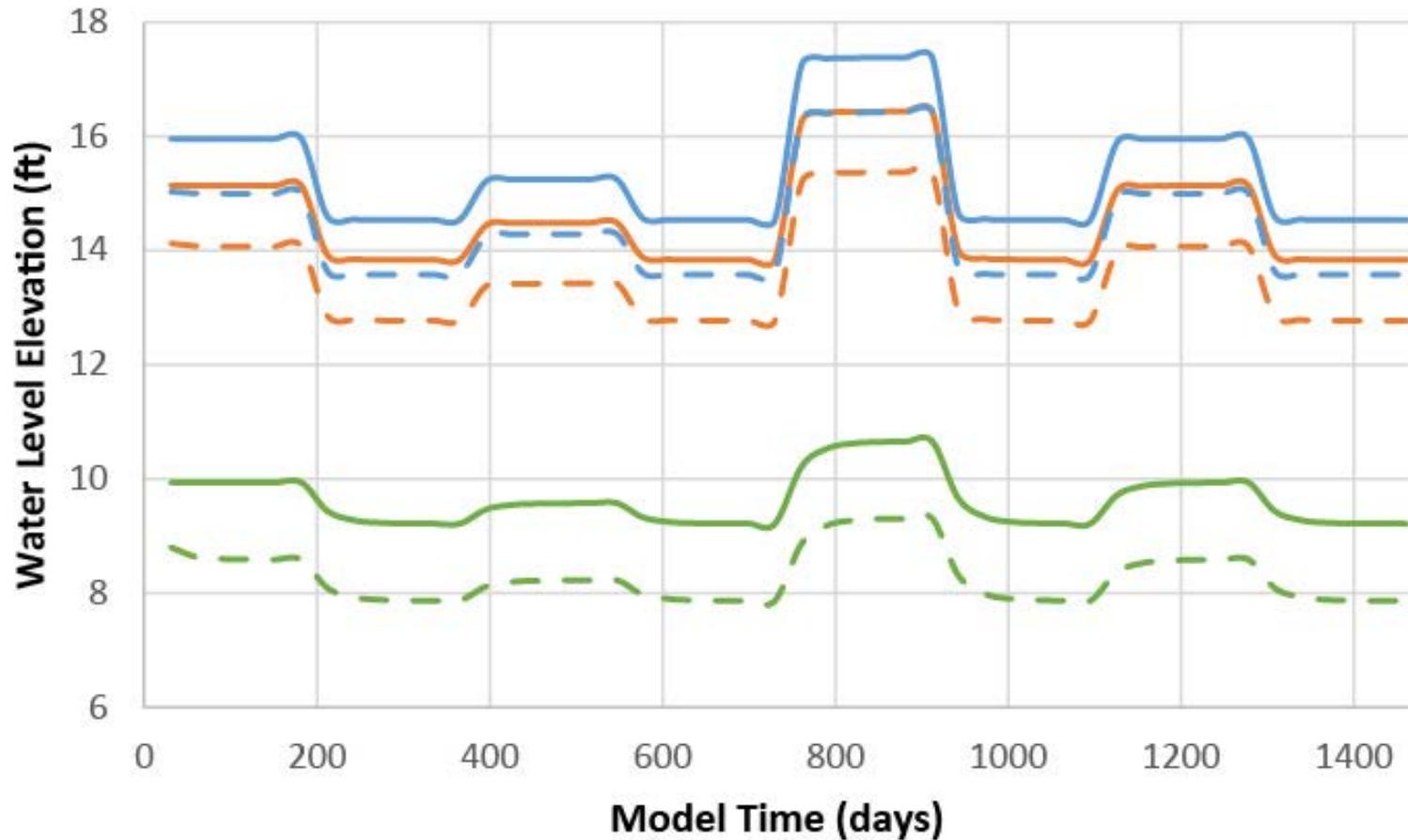
Recharge to Layer 1



MODFLOW calculated background water levels



MODFLOW calculated changed background water levels due to new pumping



EXPLANATION

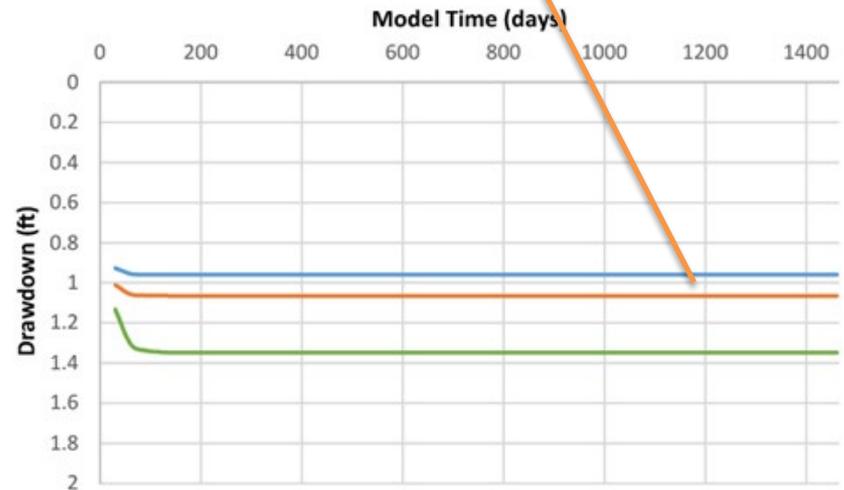
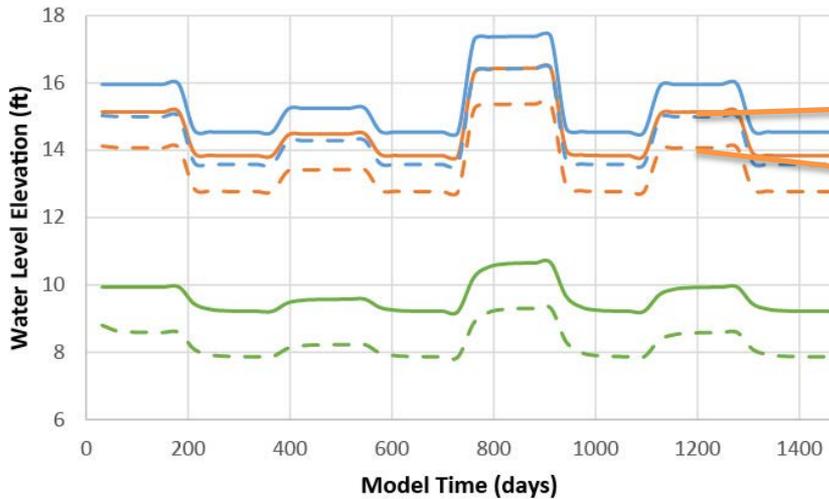
- Layer 1 Background
- Layer 3 Background
- Layer 5 Background
- - - Layer 1 New Well
- - - Layer 3 New Well
- - - Layer 5 New Well

Background water level minus New well water level equals Drawdown

$$15.13 - 14.07 = 1.06$$

EXPLANATION

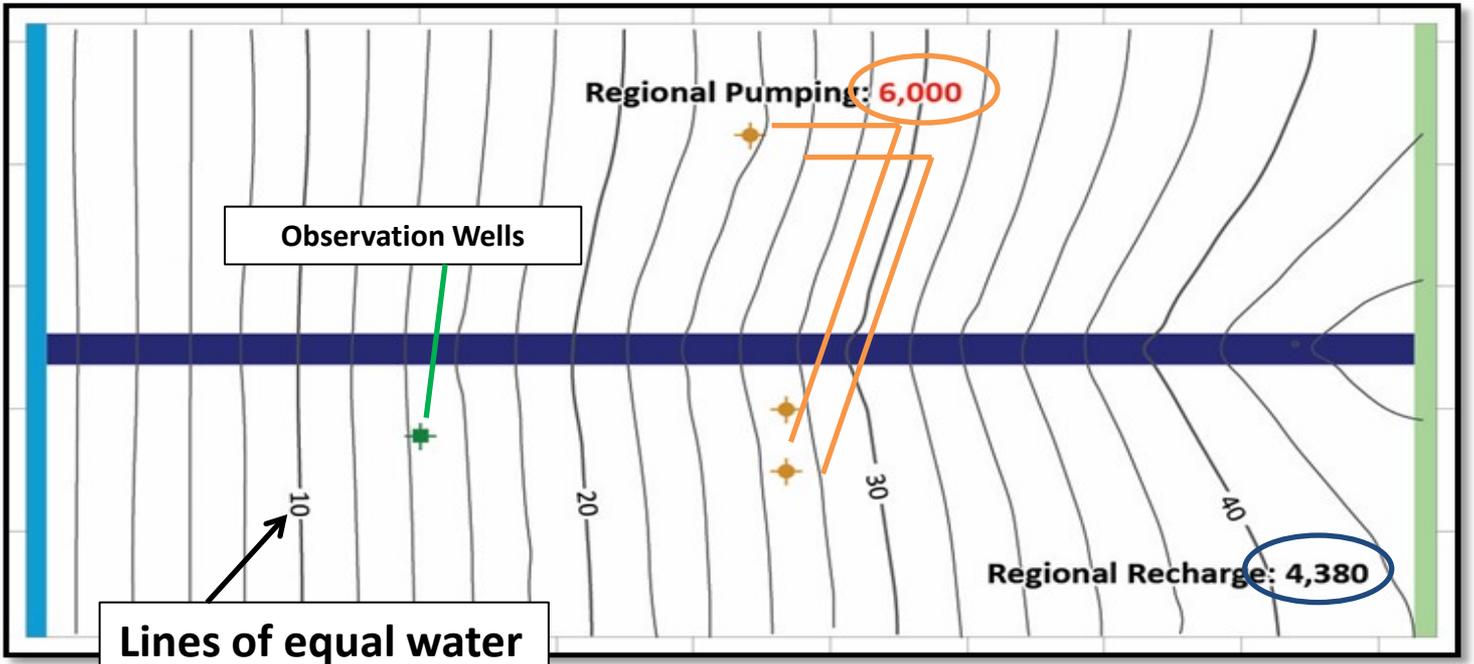
- Layer 1 Background
- Layer 3 Background
- Layer 5 Background
- - Layer 1 New Well
- - Layer 3 New Well
- - Layer 5 New Well



EXPLANATION

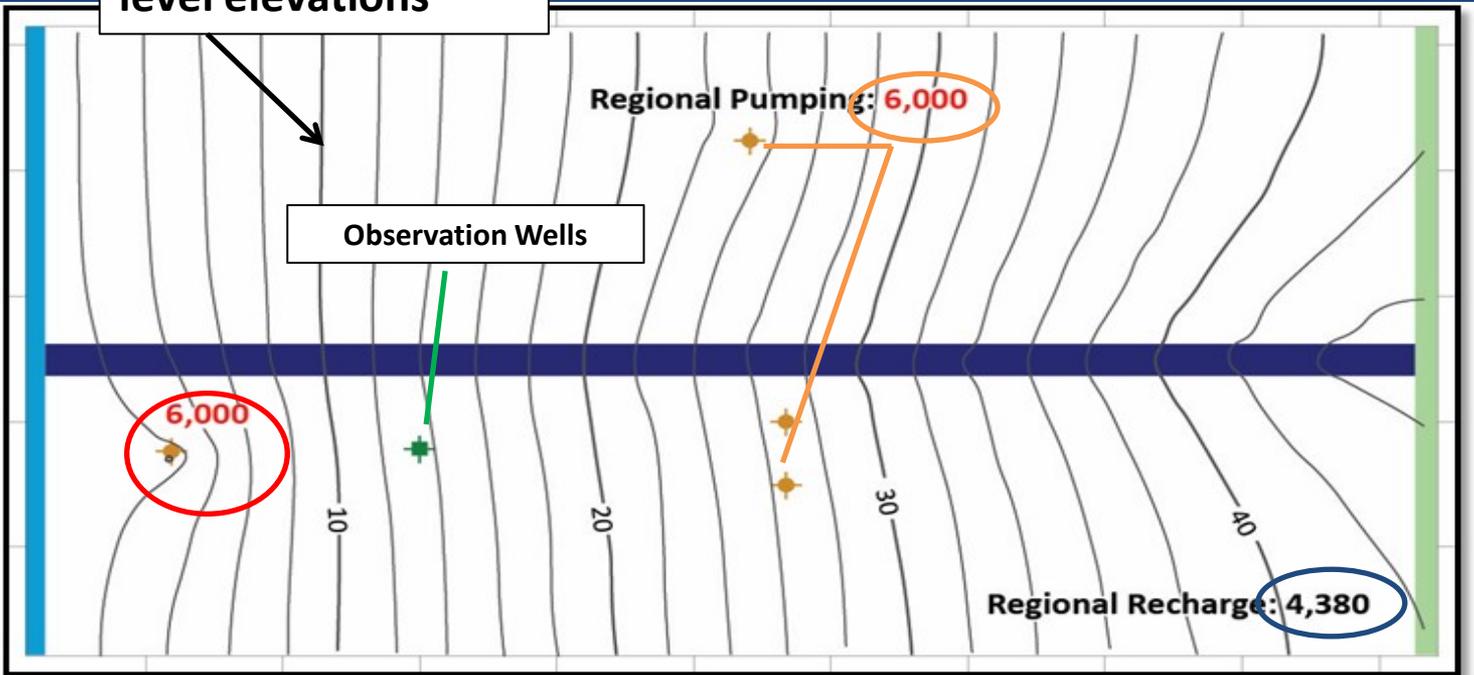
- Layer 1
- Layer 3
- Layer 5

Background

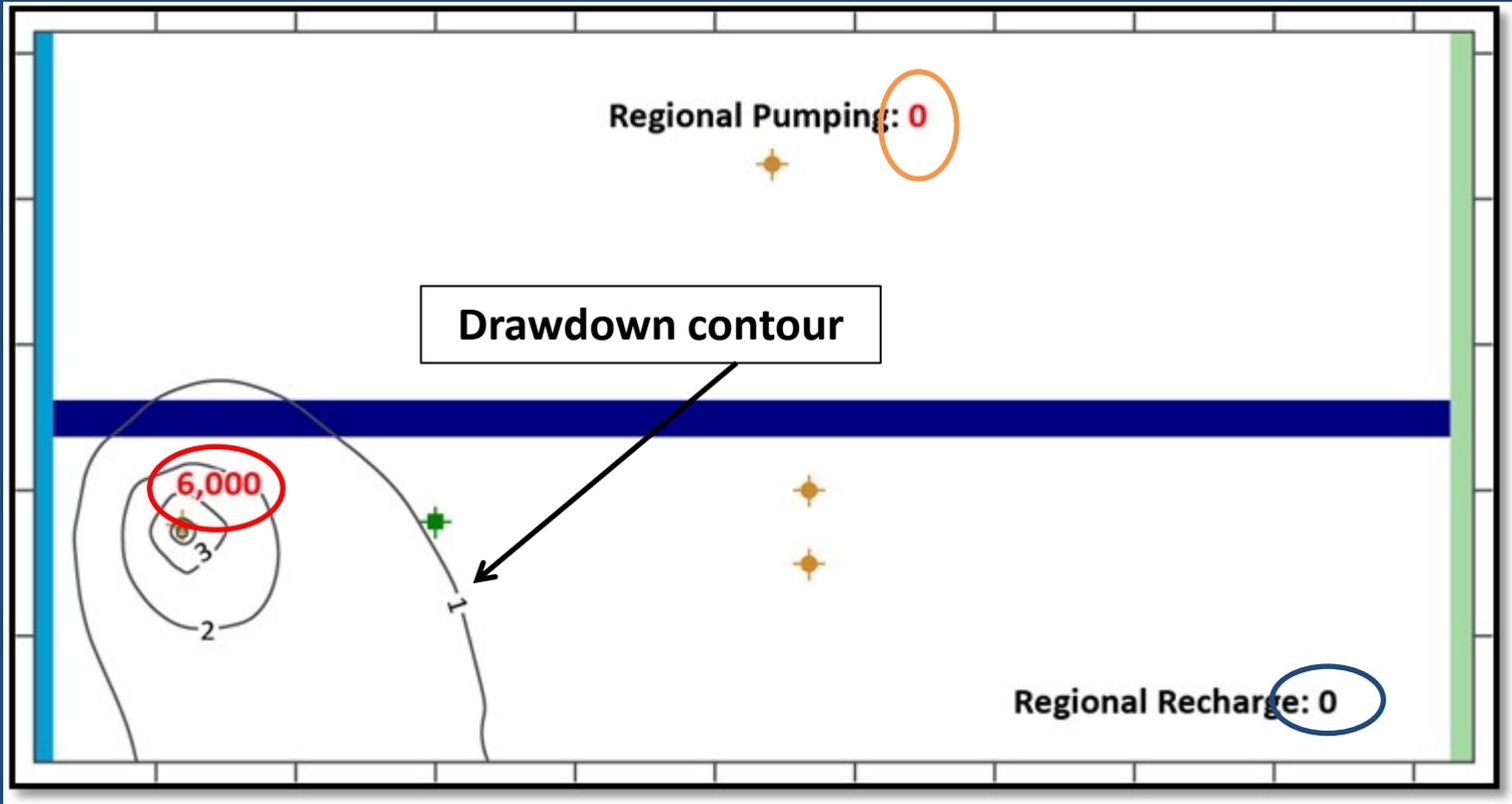


Lines of equal water level elevations

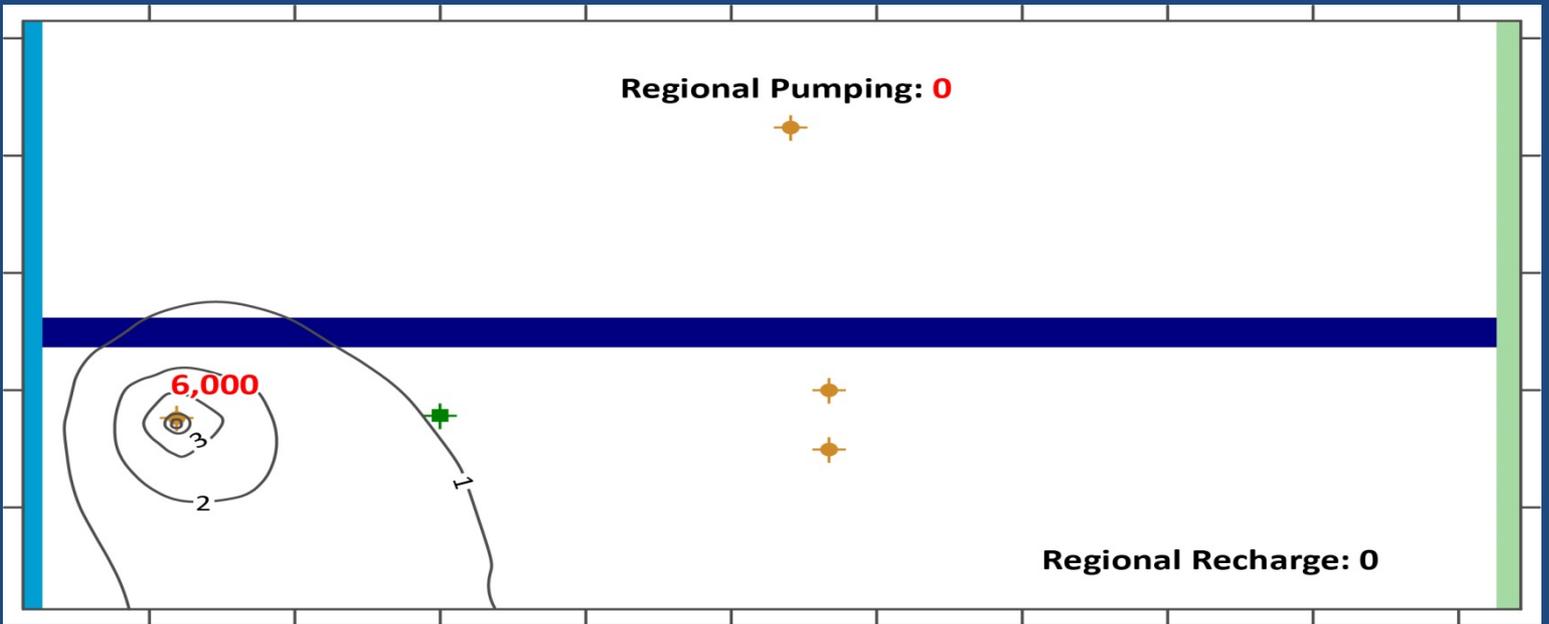
New Well



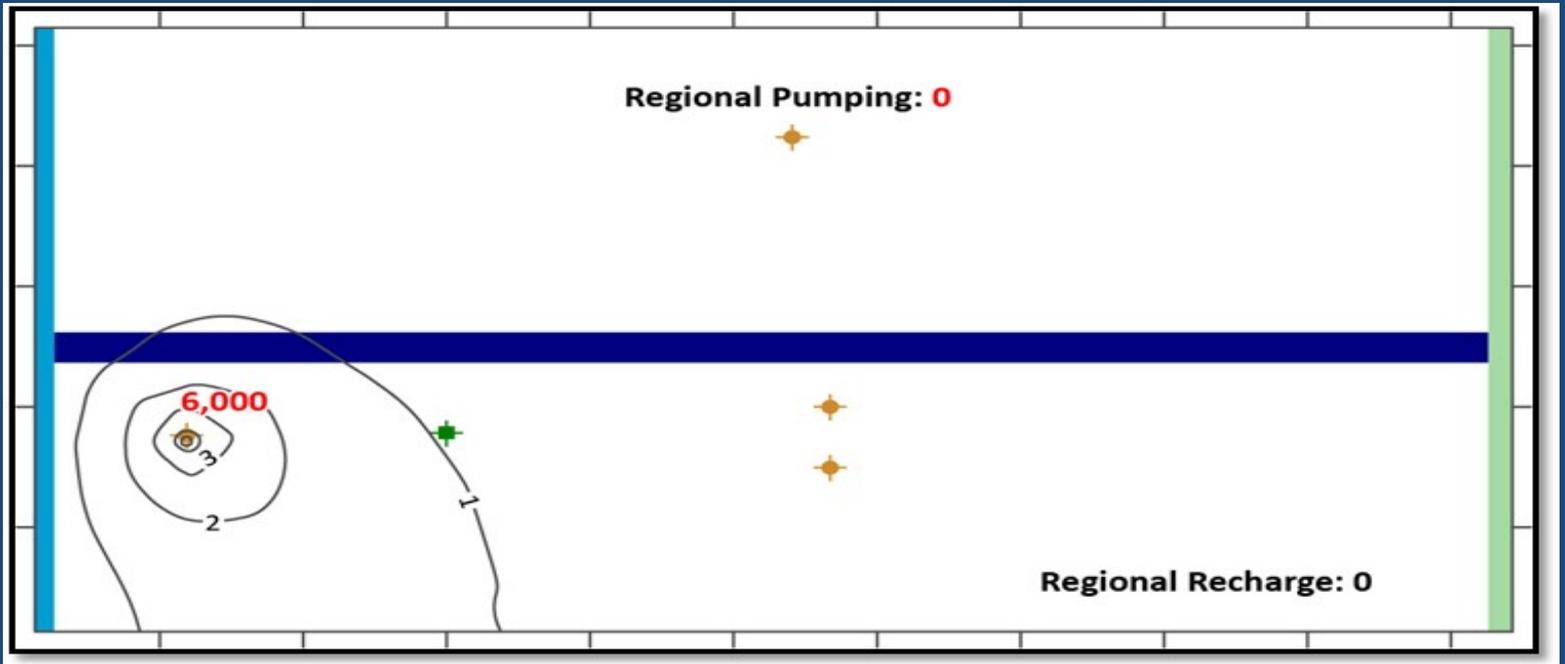
(Background) minus (New well) = change



(Background) -
(New Well)



Superposition



Sensitivity Tests Affecting Model-Calculated Drawdown

- **Sea Levels (2012 and 2073)**
- **Proportional contributions from pumped water-bearing zones**
- **Assumed Project operations**
 - **Extraction rates (24.1 and 15.5 MGD)**
 - **Return water (considered range 0% - 12%)**

Summary

- NMGWM²⁰¹⁶ = modified hydraulic conductivity distribution, values, and added monitoring well data.
- Reasonably calculates water level changes (drawdown), and performance improves increasing distance from pumping well.
- Employed superposition to eliminate model deficiencies introduced by SVIGSM.
- Conducted sensitivity testing to assess uncertainty in drawdown distribution due to uncertainty in hydrogeologic conditions, future hydrologic conditions, and assumed project operations (*“How wrong might the model be?”*)

Questions

