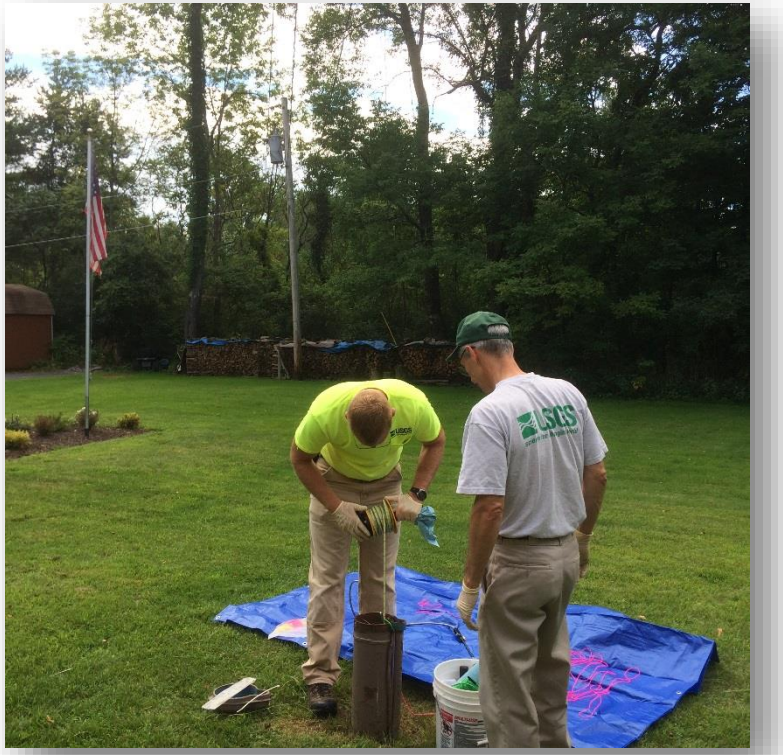
Groundwater-Level Analysis of Selected Water-Supply Wells for Aquifer Framework and Properties, Hoosick Falls, New York

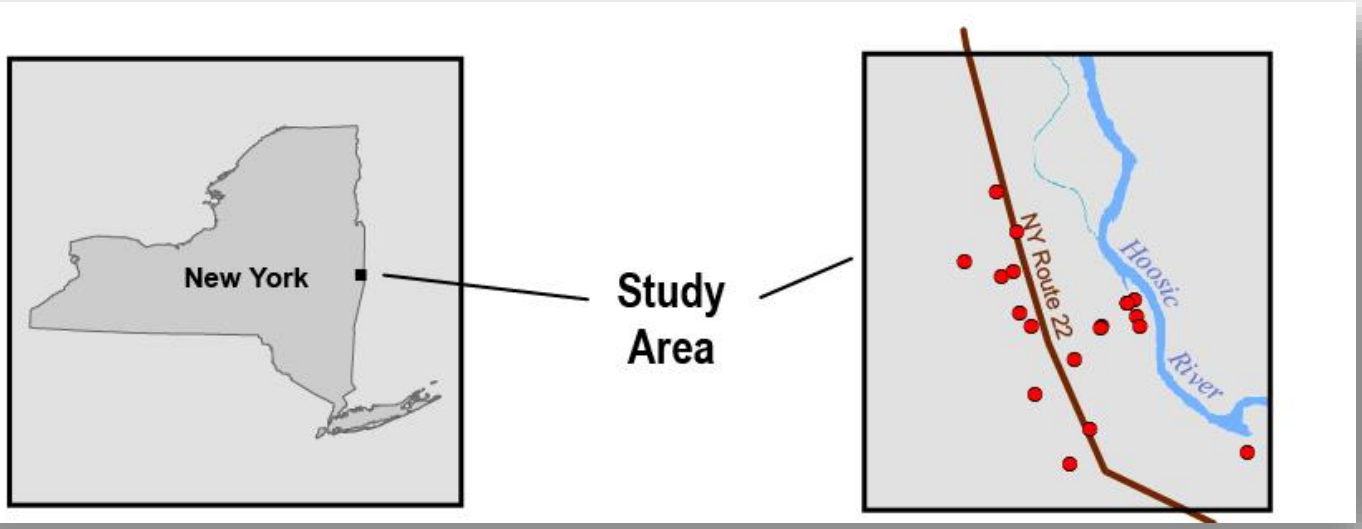
John Williams and Paul Heisig

USGS
science for a changing world

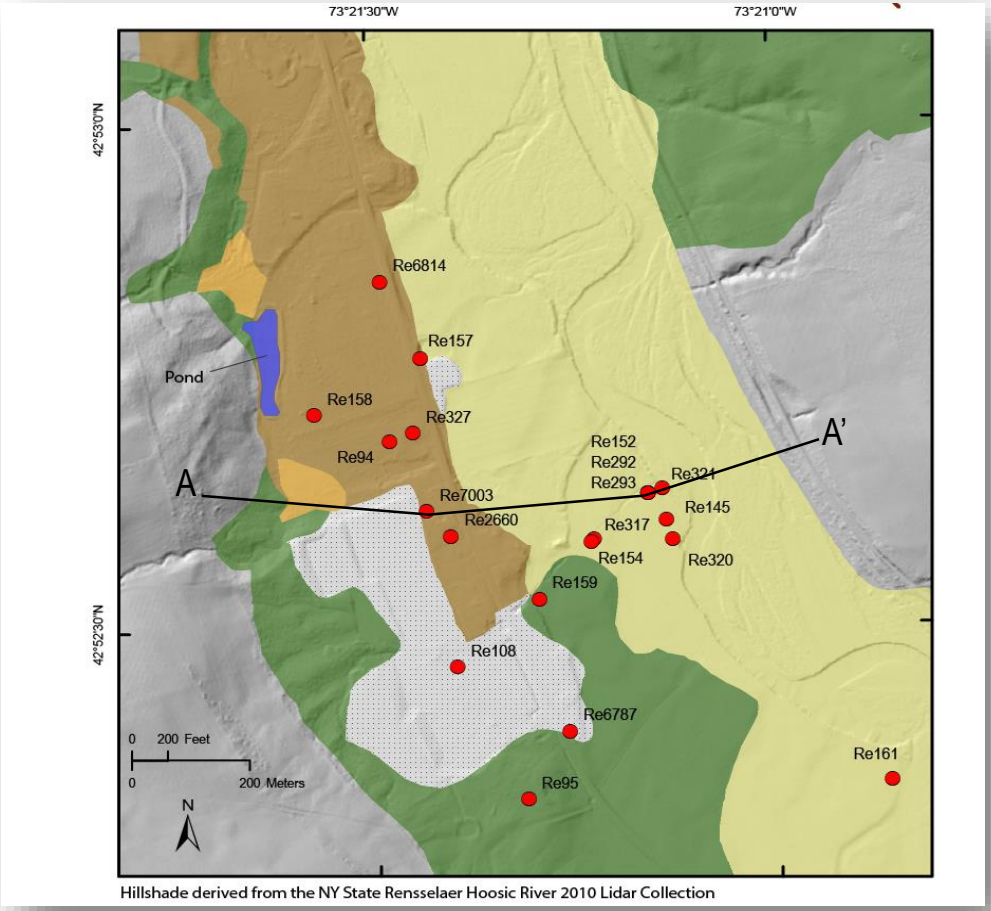
NEW YORK STATE

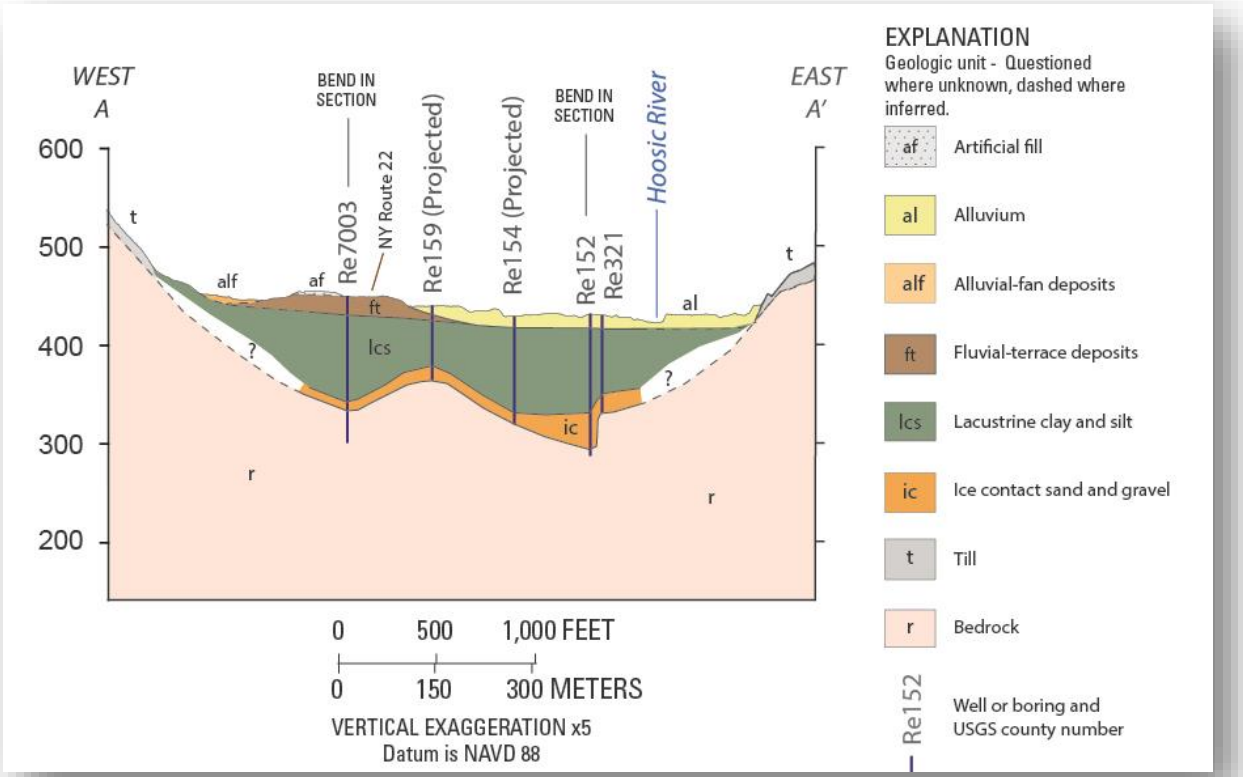


- In cooperation with NYSDEC, USGS collected and analyzed groundwater levels, drilling-record logs, and field water-quality data from selected water-supply wells in association with a pumping test of a confined aquifer 2 miles south of Hoosick Falls



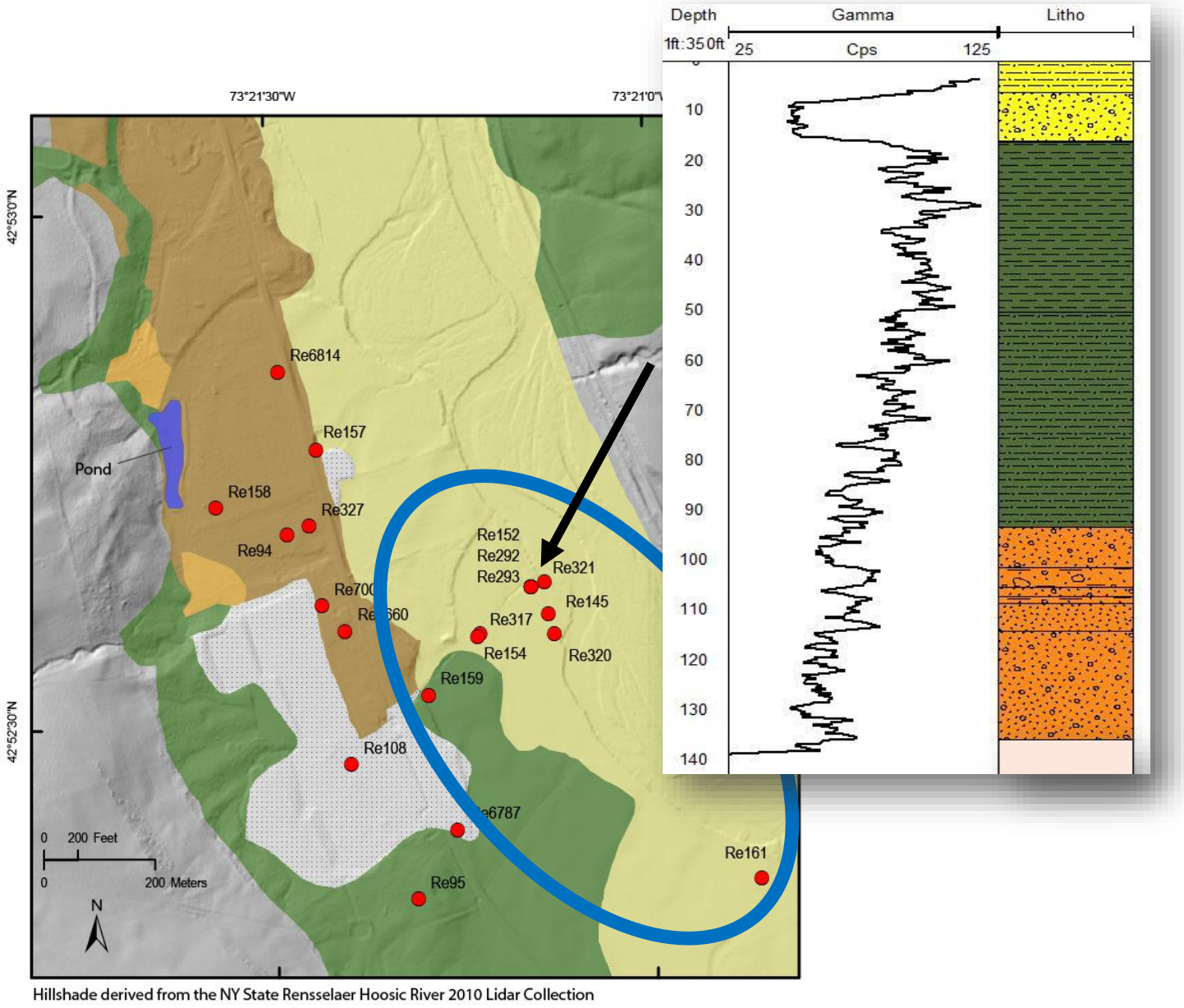
- Aquifer evaluated by the NYSDEC and their consultant Arcadis as part of alternate water supply study for the Hoosick Falls wellfield has been affected by PFOA





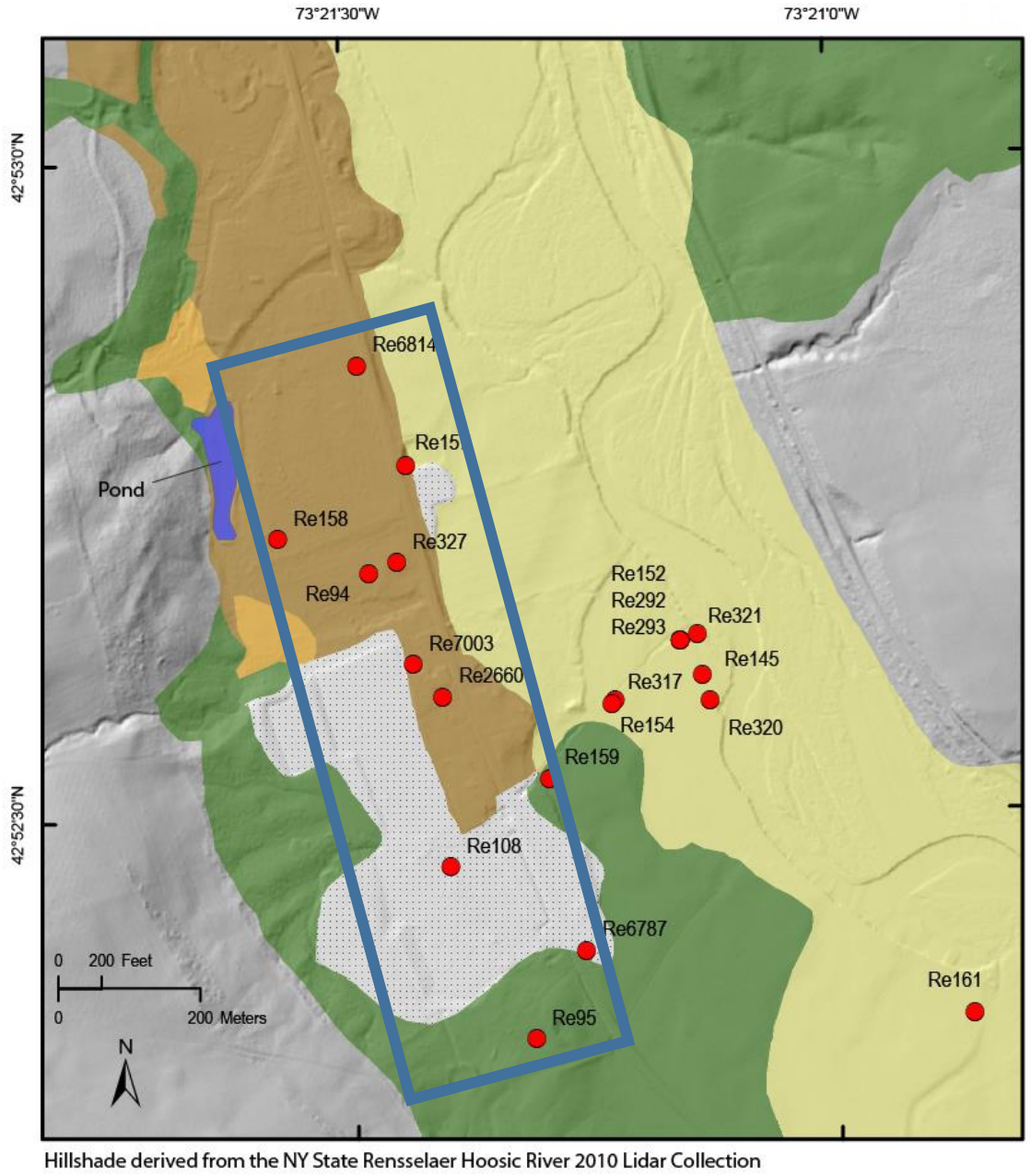
- **Water-table aquifer** - Saturated alluvium on the valley bottom and fluvial-terrace and alluvial-fan deposits near the valley wall; in hydraulic contact with the till-bedrock uplands and surface water

- **Confined aquifer** - Ice-contact sand and gravel aquifer confined by lacustrine clay and silt; upper fractured bedrock forms the lower part of the confined aquifer; recharge is focused where the lacustrine clay and silt are thin or absent as a result of fluvial erosion



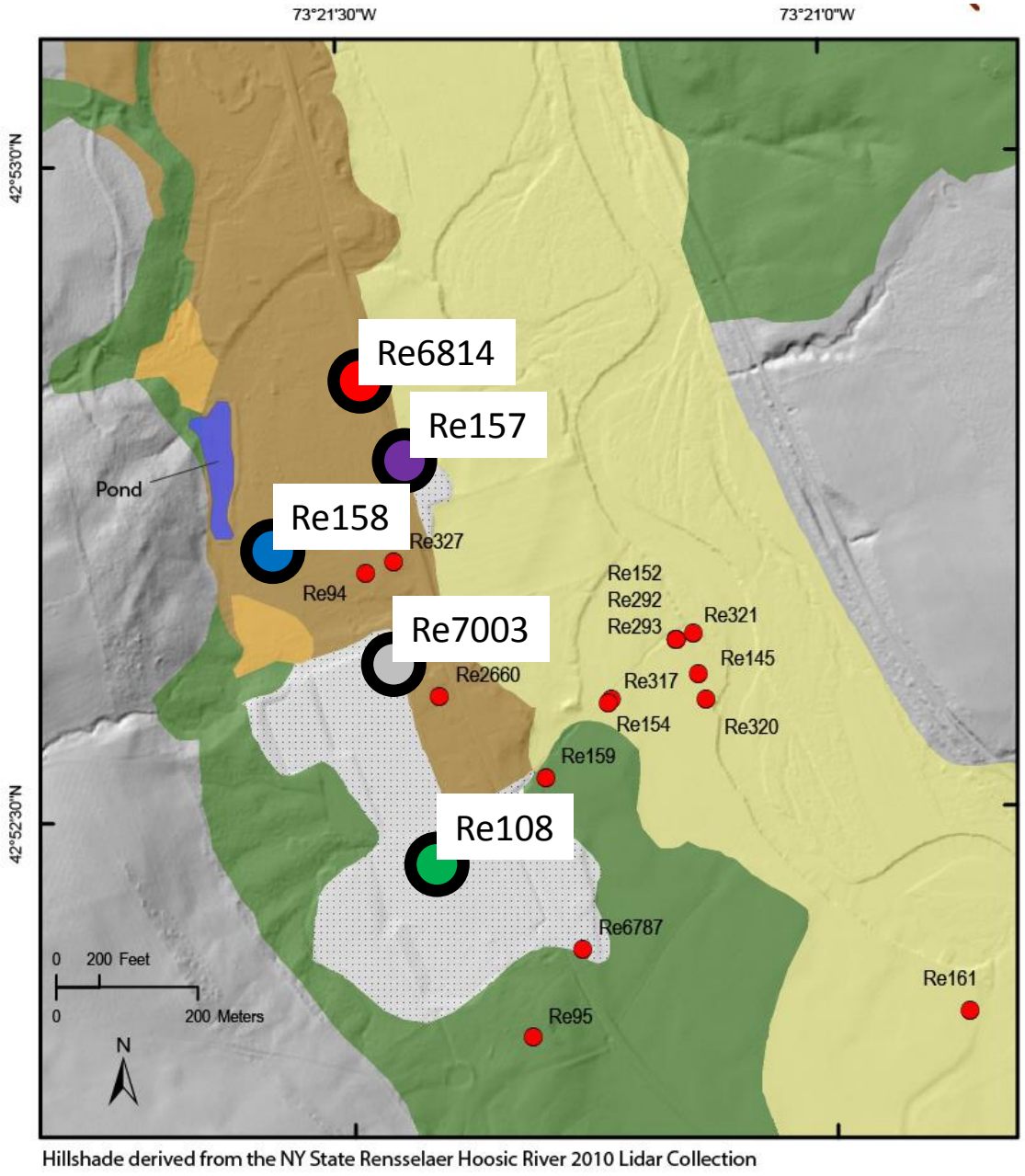
Hillshade derived from the NY State Rensselaer Hoosic River 2010 Lidar Collection

- **Production test well -** site selected by NYSDEC and Arcadis based on test borings and surface geophysical surveys
- 35 feet of ice-contact sand and gravel, confined by 80 ft of lacustrine clay and silt
- Completed with a natural gravel-pack screen
- Five observation wells installed at distances of 190 to 2,165 feet



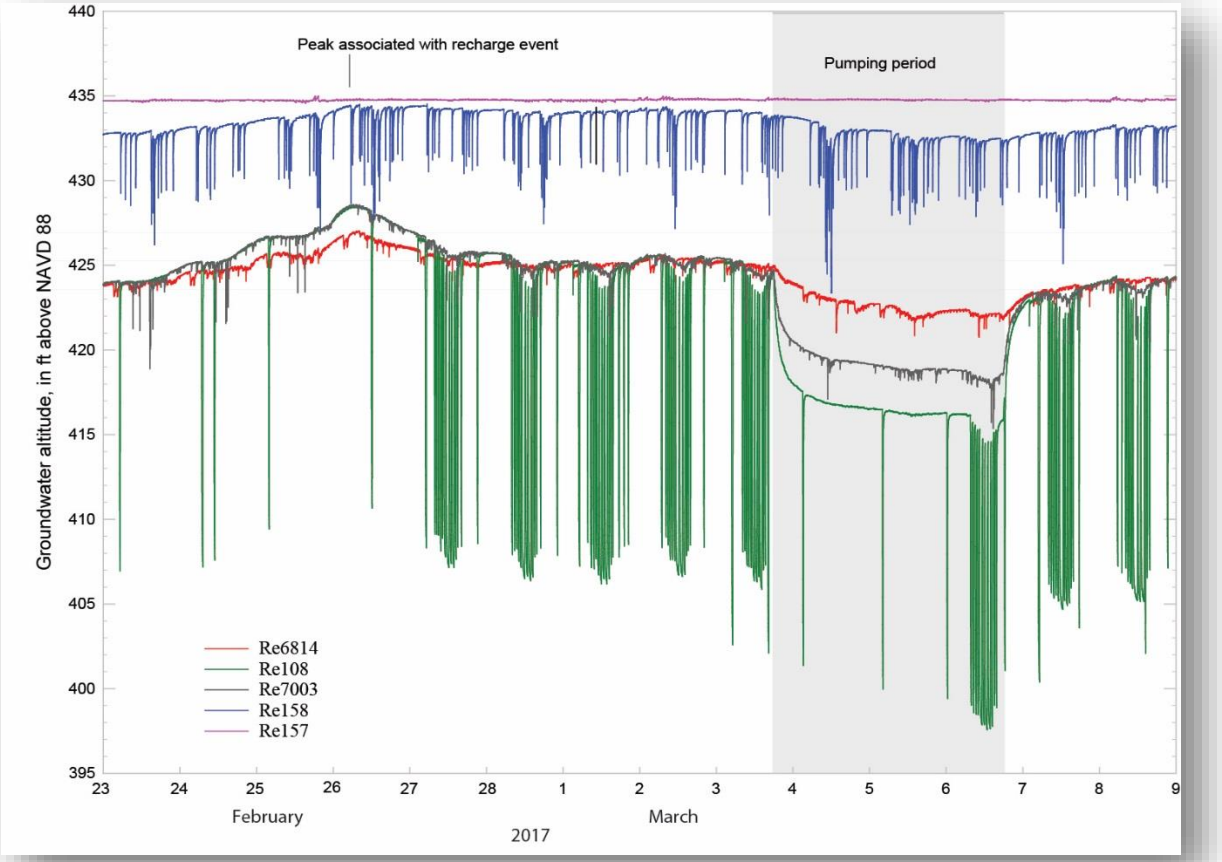
Hillshade derived from the NY State Rensselaer Hoosic River 2010 Lidar Collection

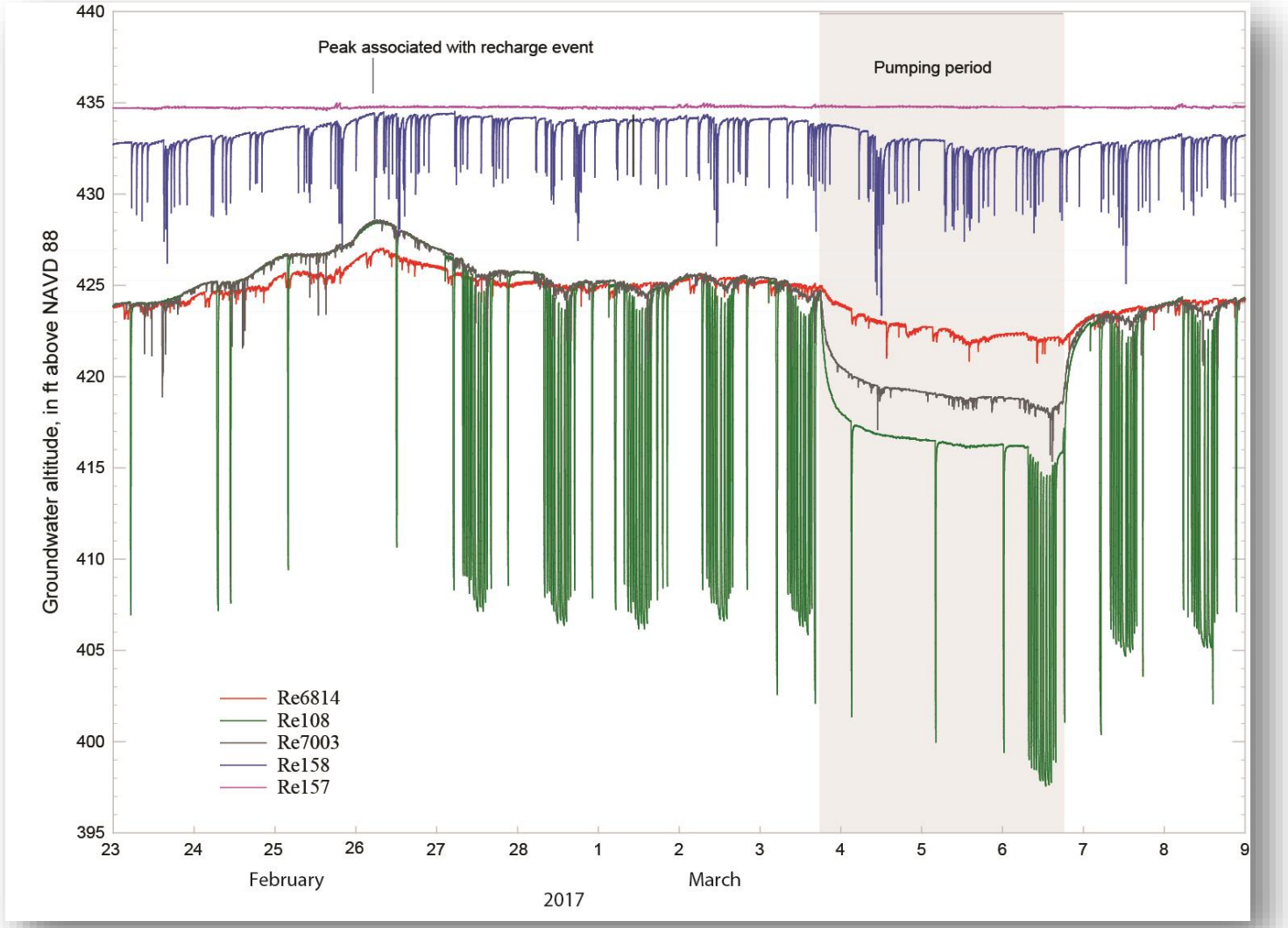
- **Water-supply wells** – additional water-level monitoring sites and further characterize the hydrogeologic framework
- Most drilled wells penetrated 60 to 80 feet of lacustrine clay/silt and completed in confined aquifer
- Well points/dug wells completed in water-table aquifer above confining unit
- Specific conductance and pH increased from water table to confined conditions
- Based on drilling logs and field water quality classified as water table, confined, or transitional



Hillshade derived from the NY State Rensselaer Hoosic River 2010 Lidar Collection

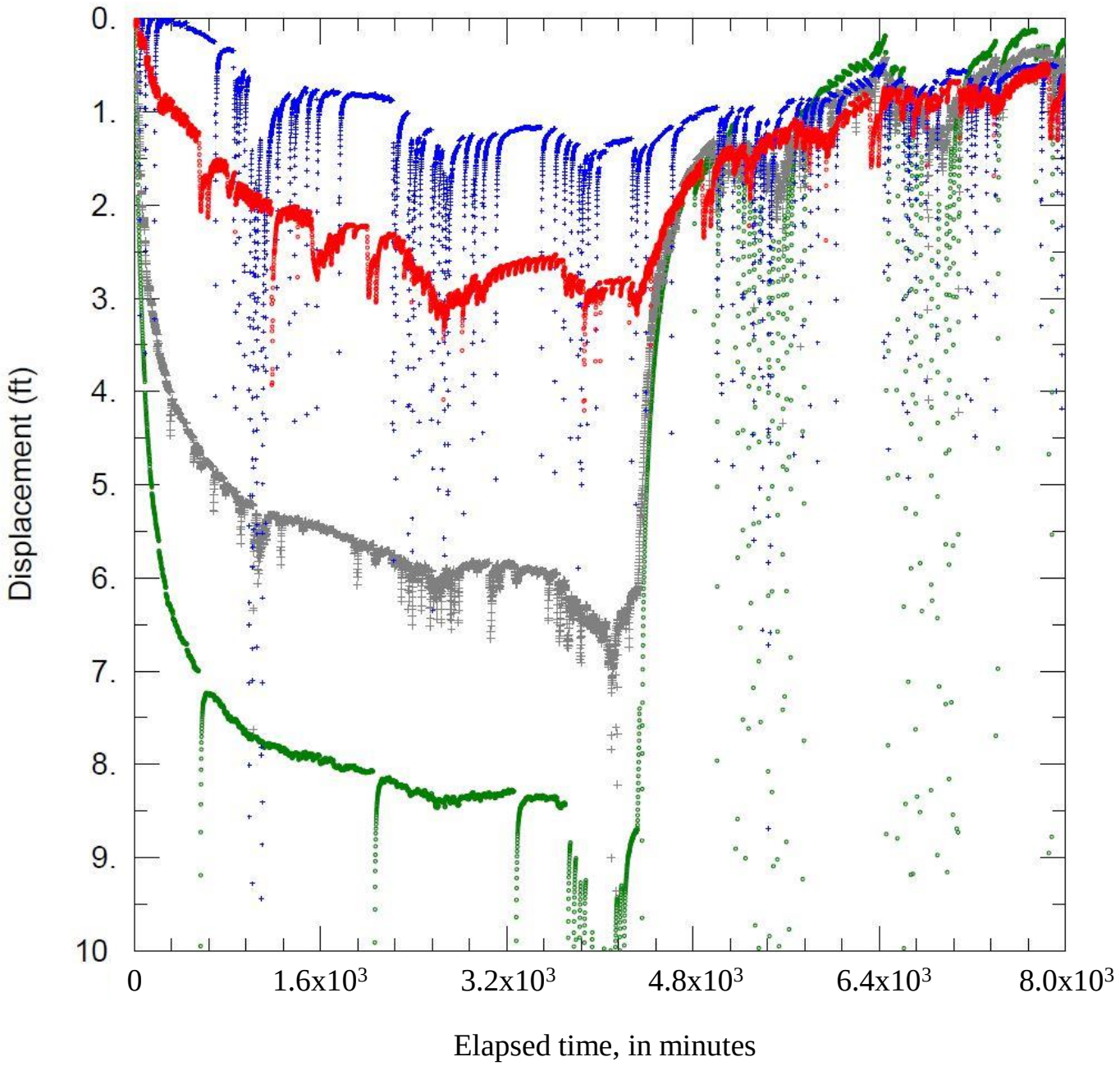
Continuous water levels – collected in five of the water-supply wells; in-well pumping and recovery cycles evident; ambient water levels lowest in confined and highest water-table well and between in transitional well





- **Pumping test** - production test well pumped at 300 gallons per minute for 72 hours on March 3-6, 2017
- Acardis measured and analyzed drawdown and recovery data in the observation wells
- USGS measured and analyzed drawdown and recovery data in the water-supply wells
- Pumping of production test well impacted water levels in the three confined wells and the transitional well but not the water-table well

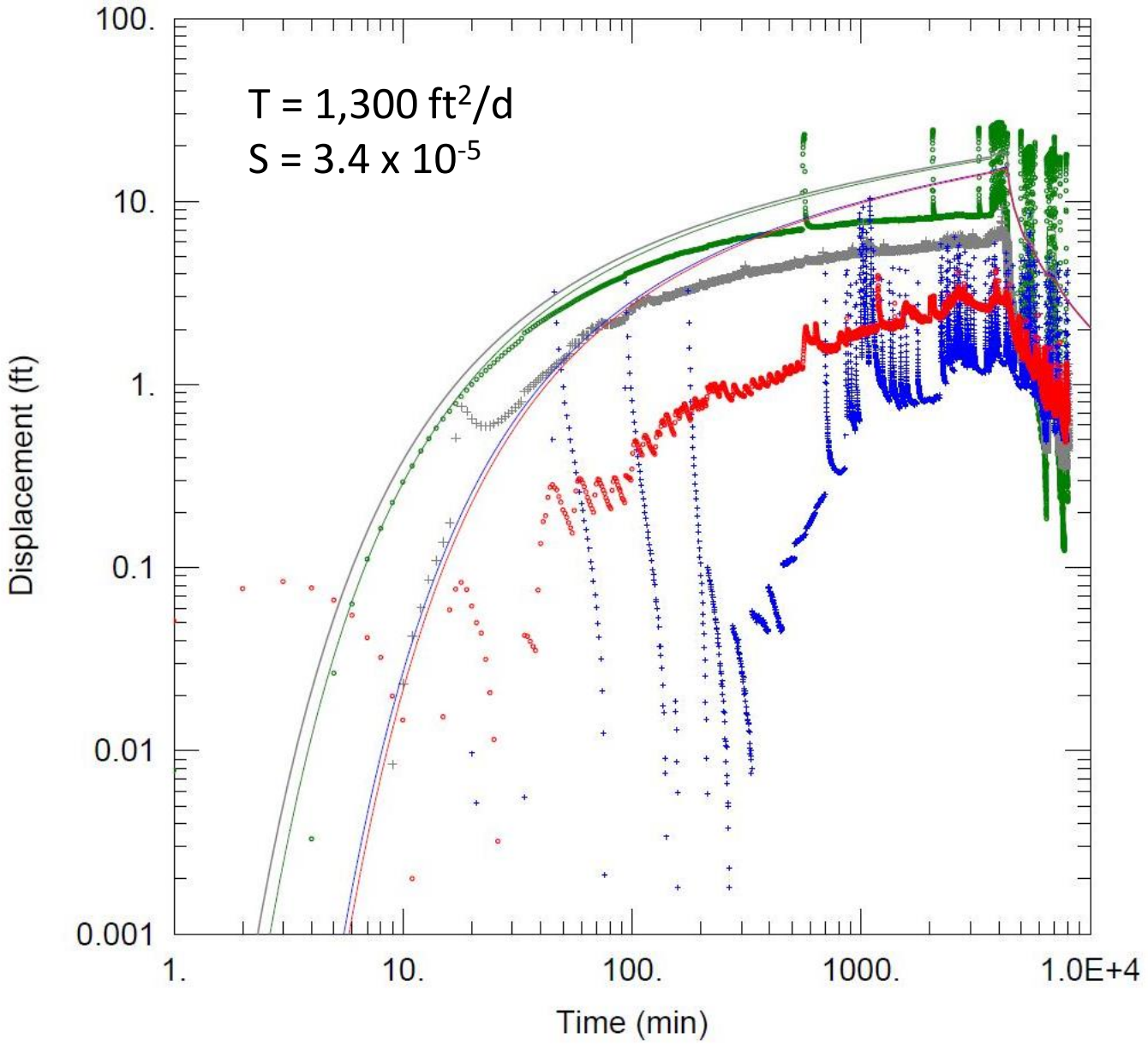
Drawdown and Recovery



- Confined well Re108 had most rapid and largest response indicating greatest degree of confinement and hydraulic connection with production test well
- Transitional well Re158 had subdued and smallest response indicating less confinement and potentially greater degree of hydraulic connection with the water-table aquifer
- Confined well Re7003 response more similar to confined well Re108
- Confined well Re6814 response more similar to transitional well Re158

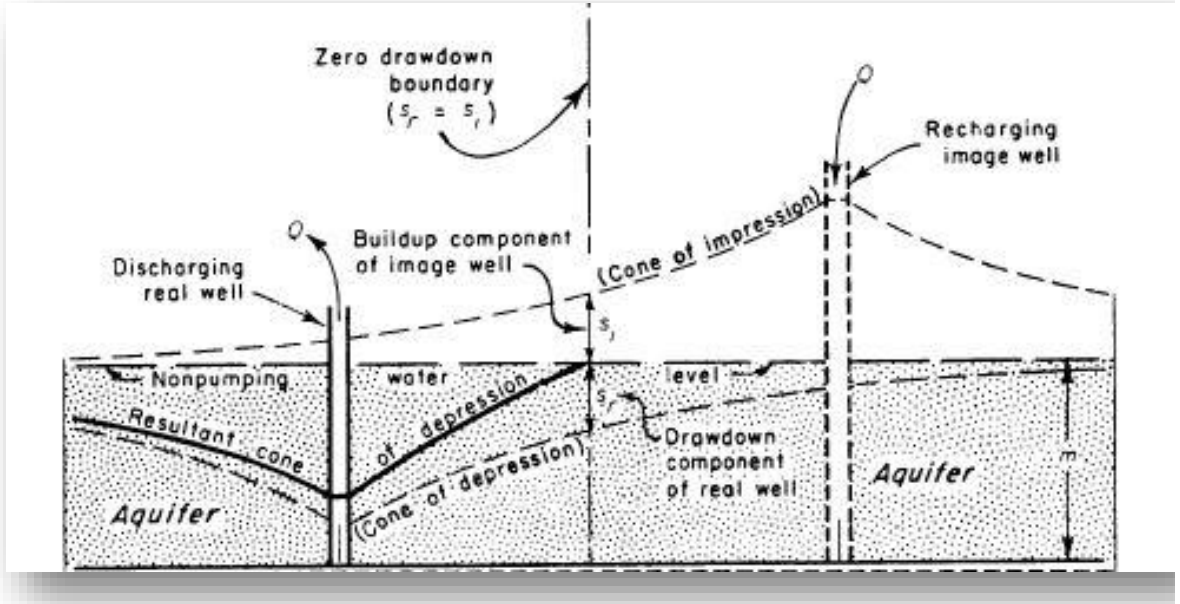
Well no.	Type	Distance (feet)
Re108	Confined	1,490
Re7003	Confined	1,240
Re6814	Confined	1,955
Re158	Transitional	1,920

Theis Type-Curve Analysis

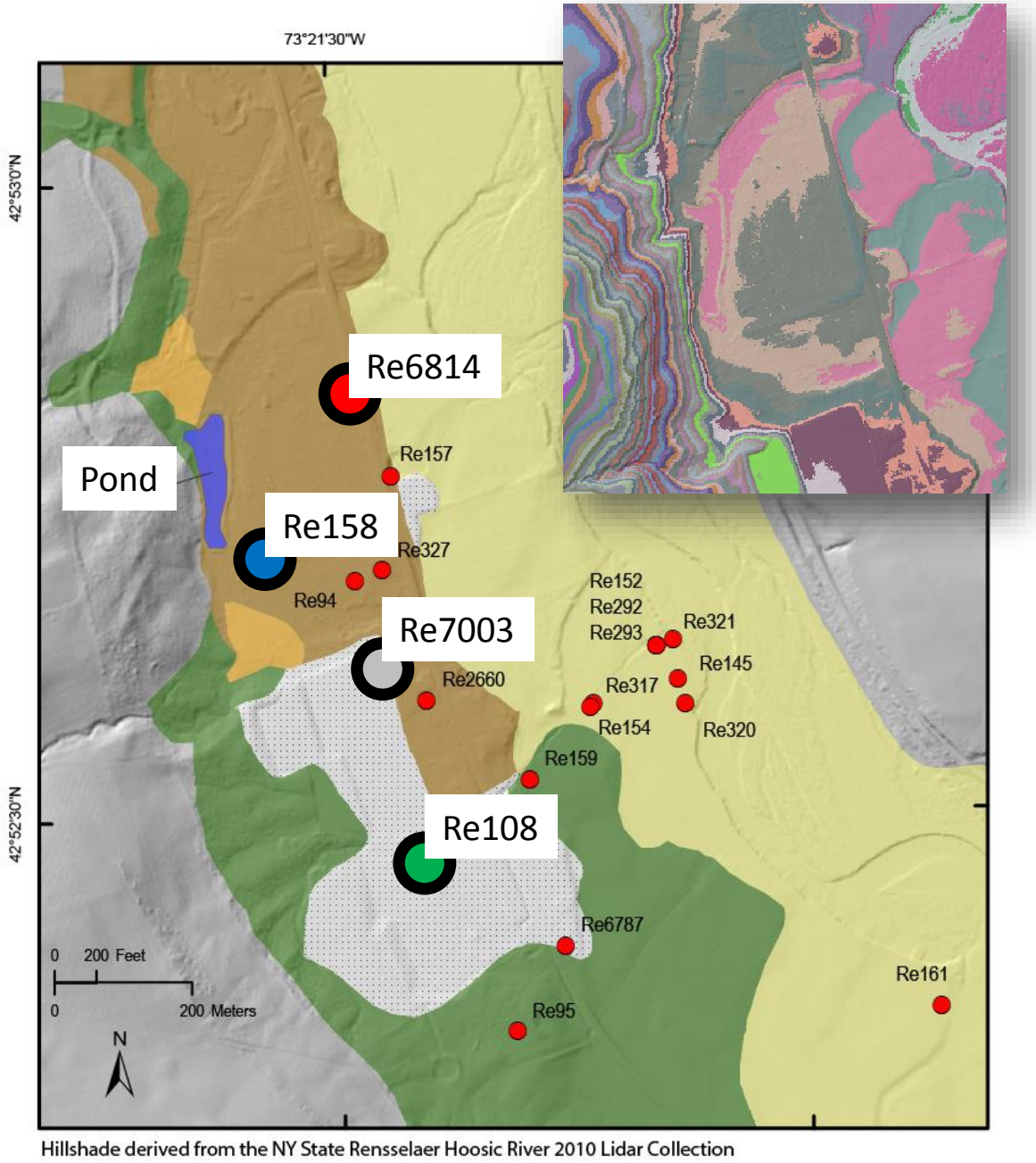


- Early time drawdown in confined well Re108 matches Theis type curve but diverges at later time indicated a leaky confined aquifer and(or) recharge boundary
- Progressively greater divergence from Theis type curve between confined wells Re108, Re7003 and Re6814
- Delayed response in transitional well Re158 diverted most substantially from Theis type curve
- Drawdown response suggests a focused recharge area rather than uniform leakage across the confining unit, most likely nearest to transitional well Re158 and furthest away from confined well Re108

- **Recharge boundary** – area of an unnamed pond where the fluvial-terrace deposits abut the valley wall along a meander scarp
- Represented focused recharge area as a constant-head boundary in the Theis analysis using image-well theory

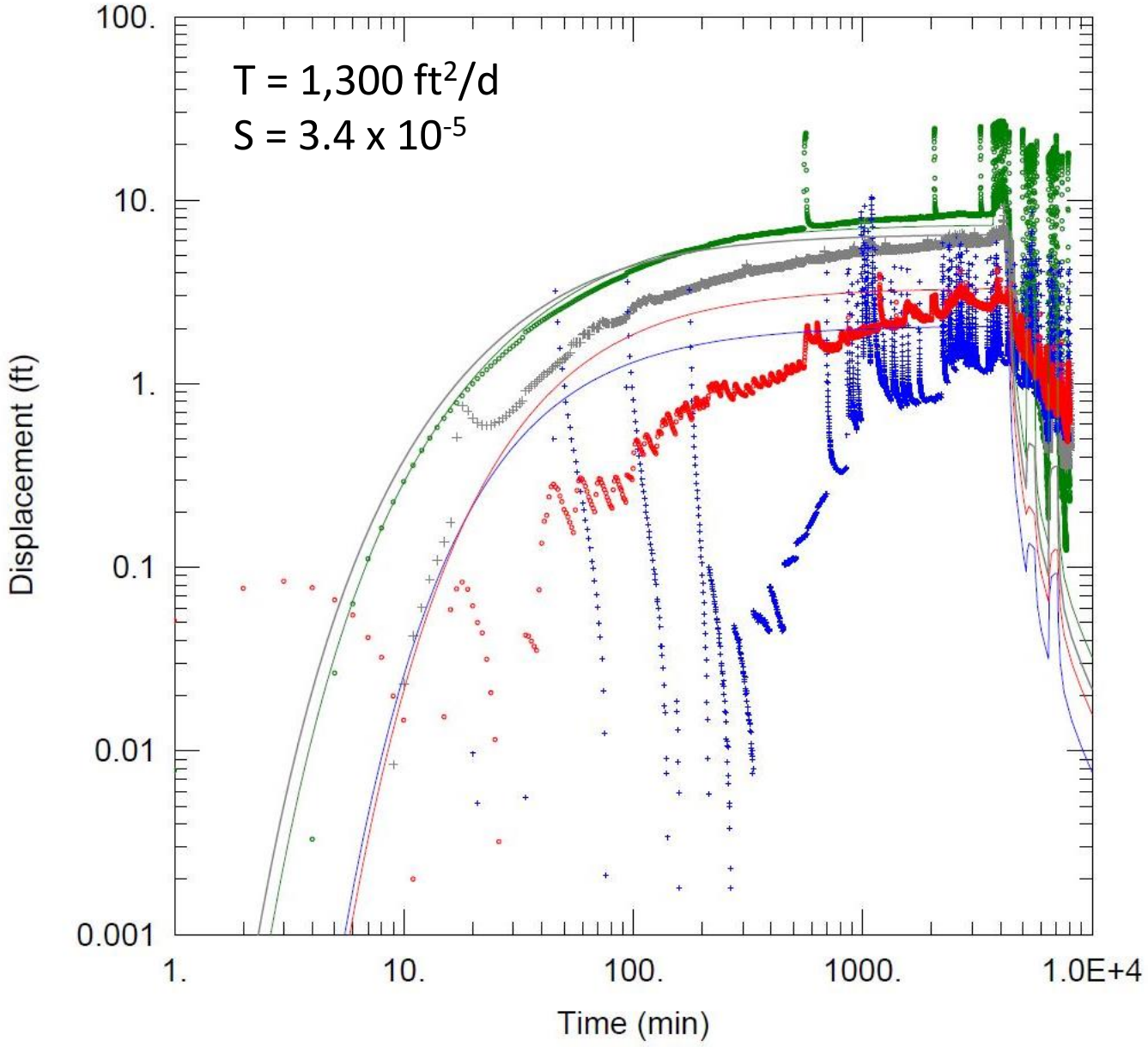


Ferris and others (1962)



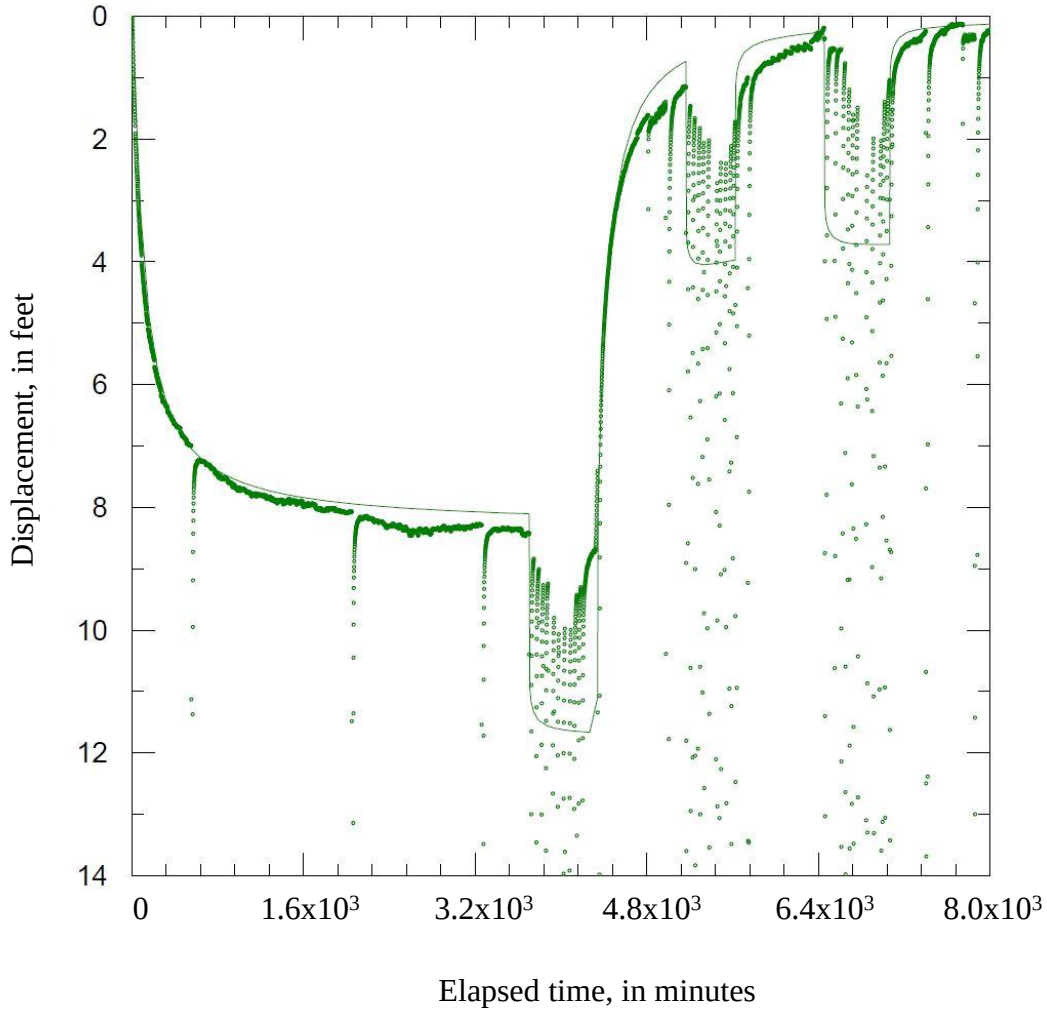
USGS science for a changing world

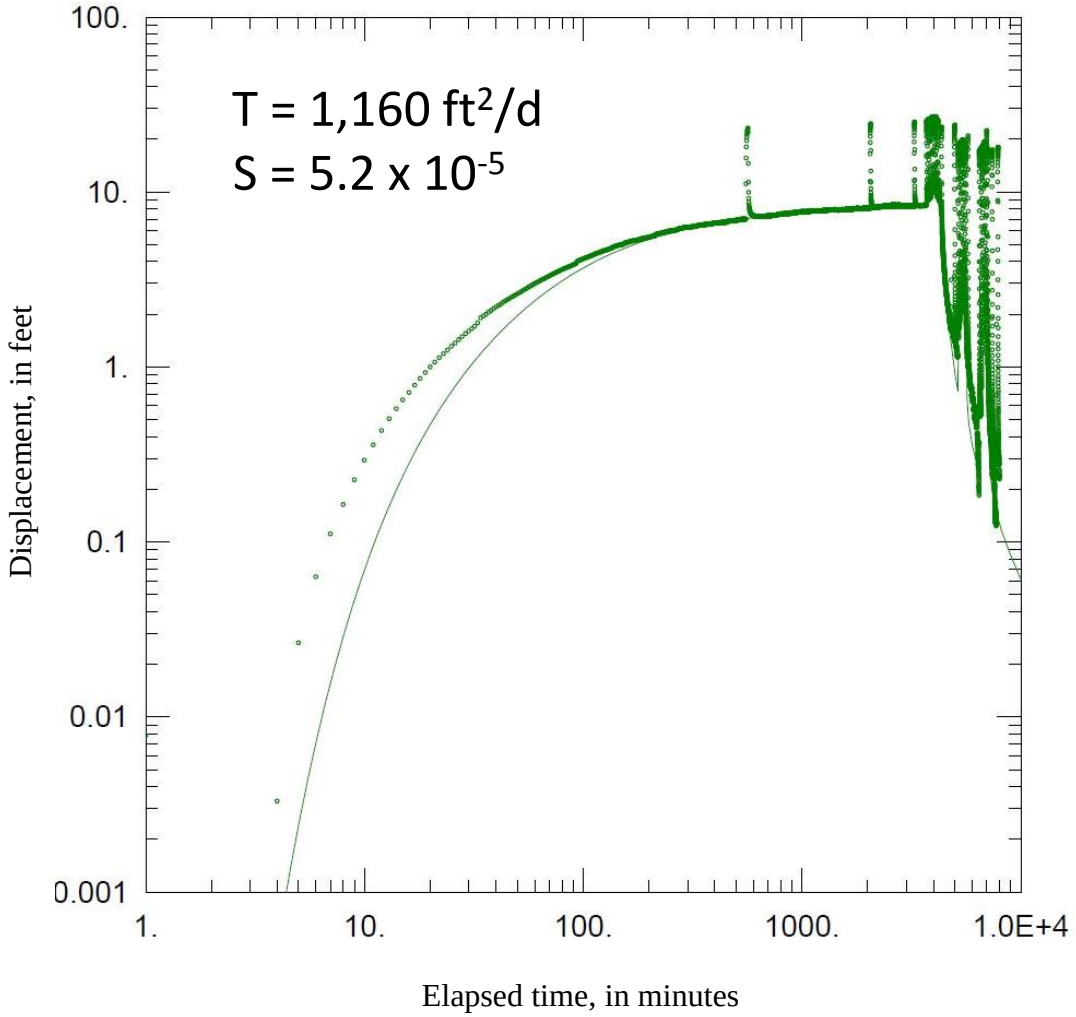
Theis Type-Curve Analysis with Recharge Boundary



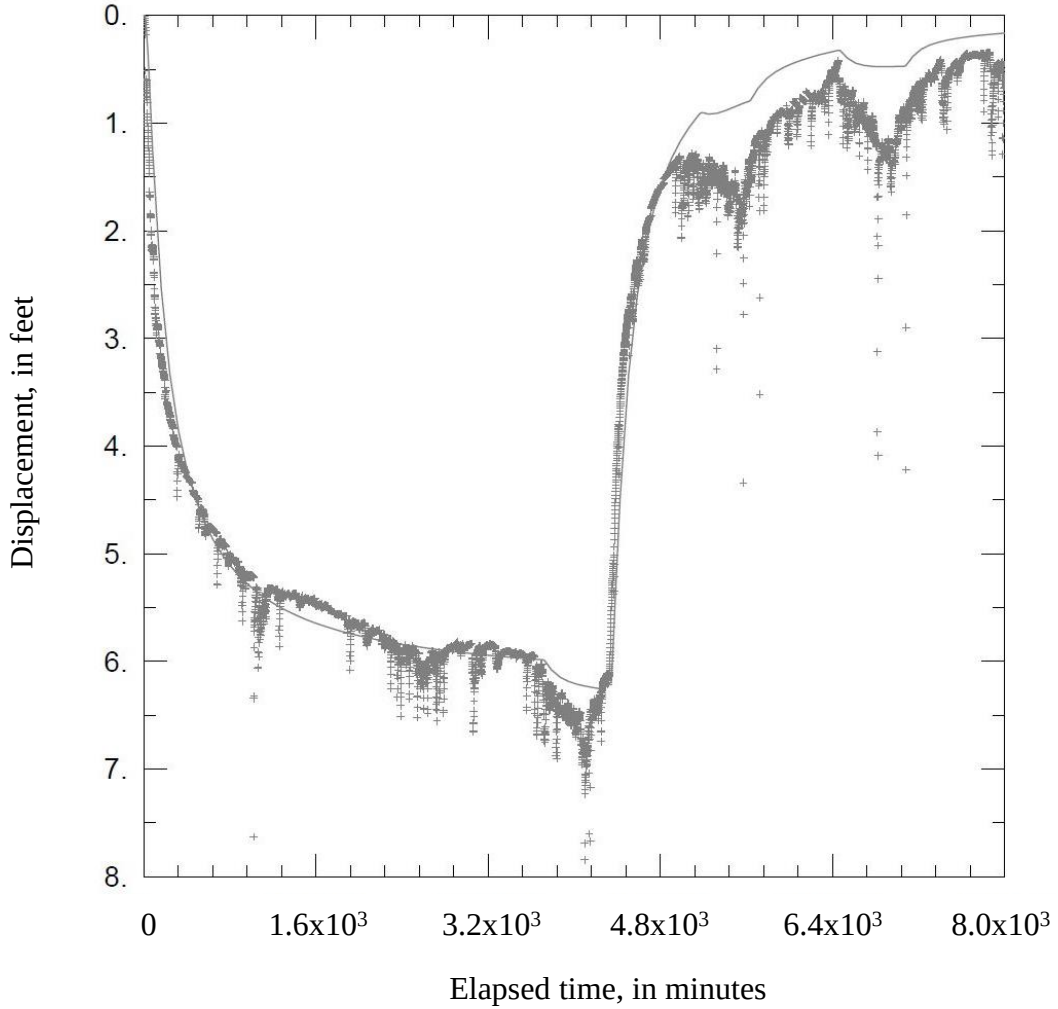
- Drawdown and recovery in confined well Re108 satisfactorily matches Theis type curve analysis with represented recharge boundary
- Represented recharge boundary improves Theis type curve match for other confined wells and the transitional well
- Automated least-squares regression used to improve Theis type-curve matches of drawdown and recovery and estimates of T and S in each well with the represented recharge boundary

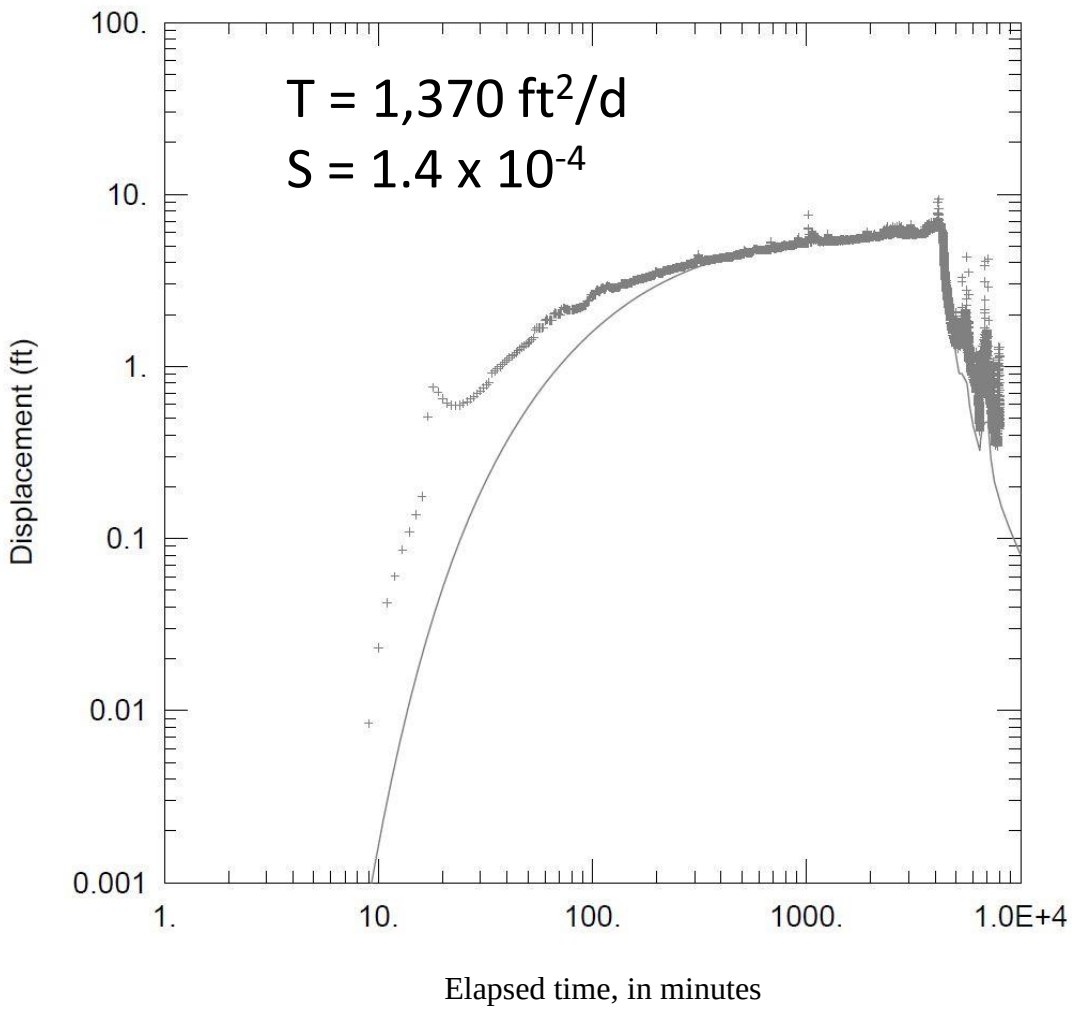
Confined well Re108



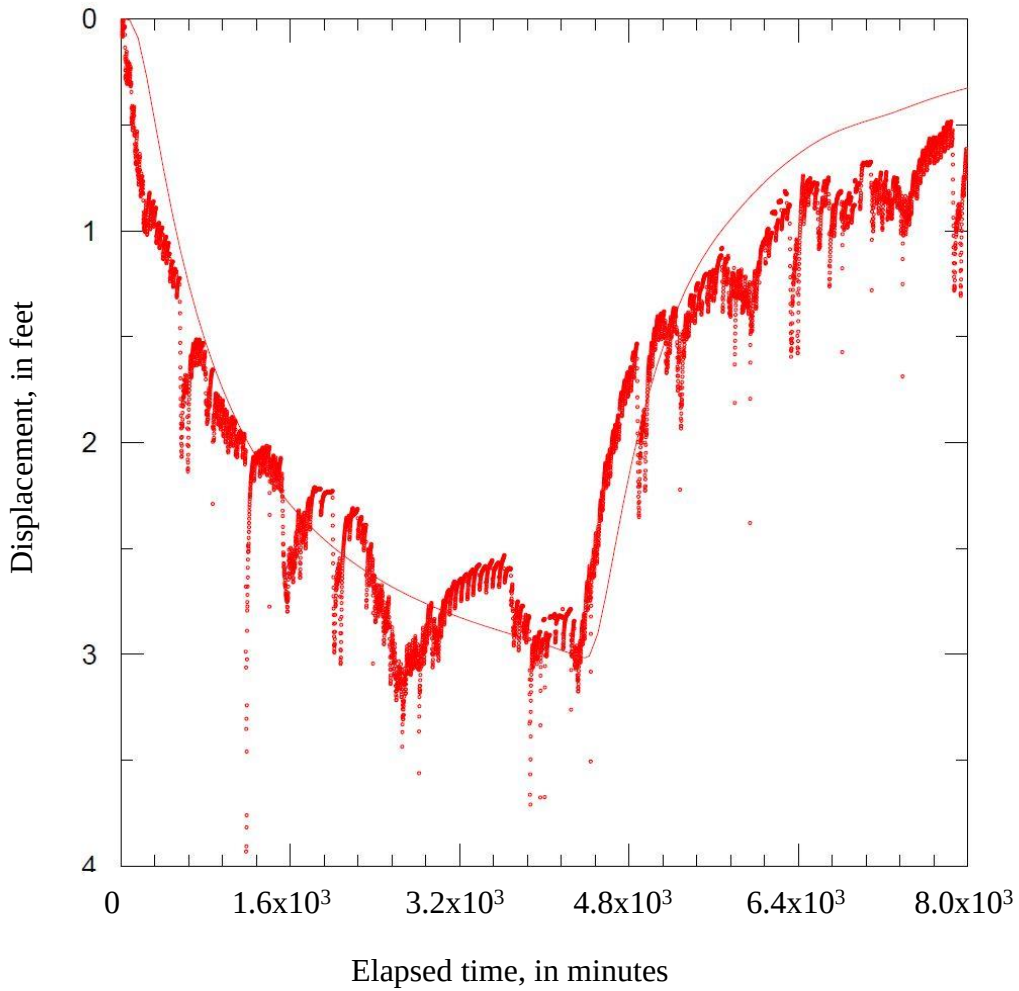


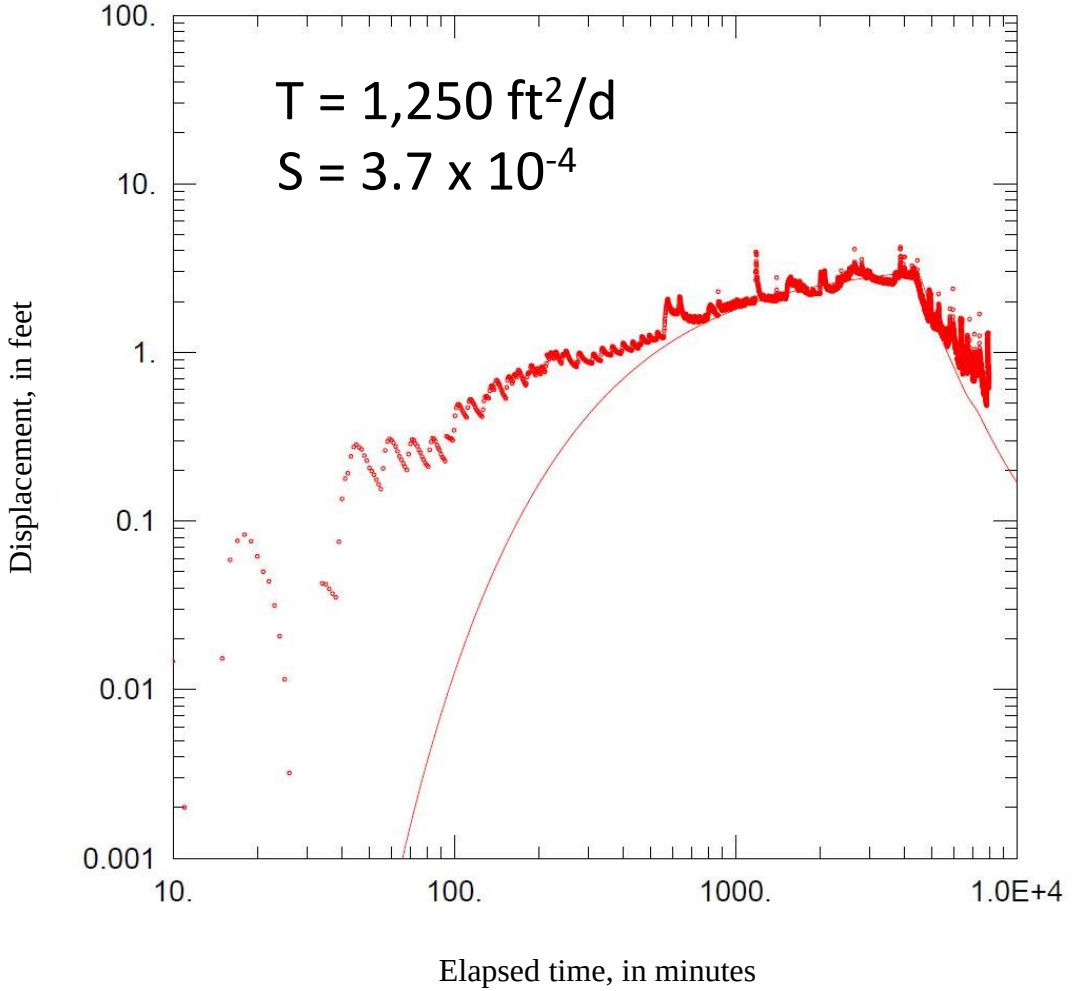
Confined well Re7003



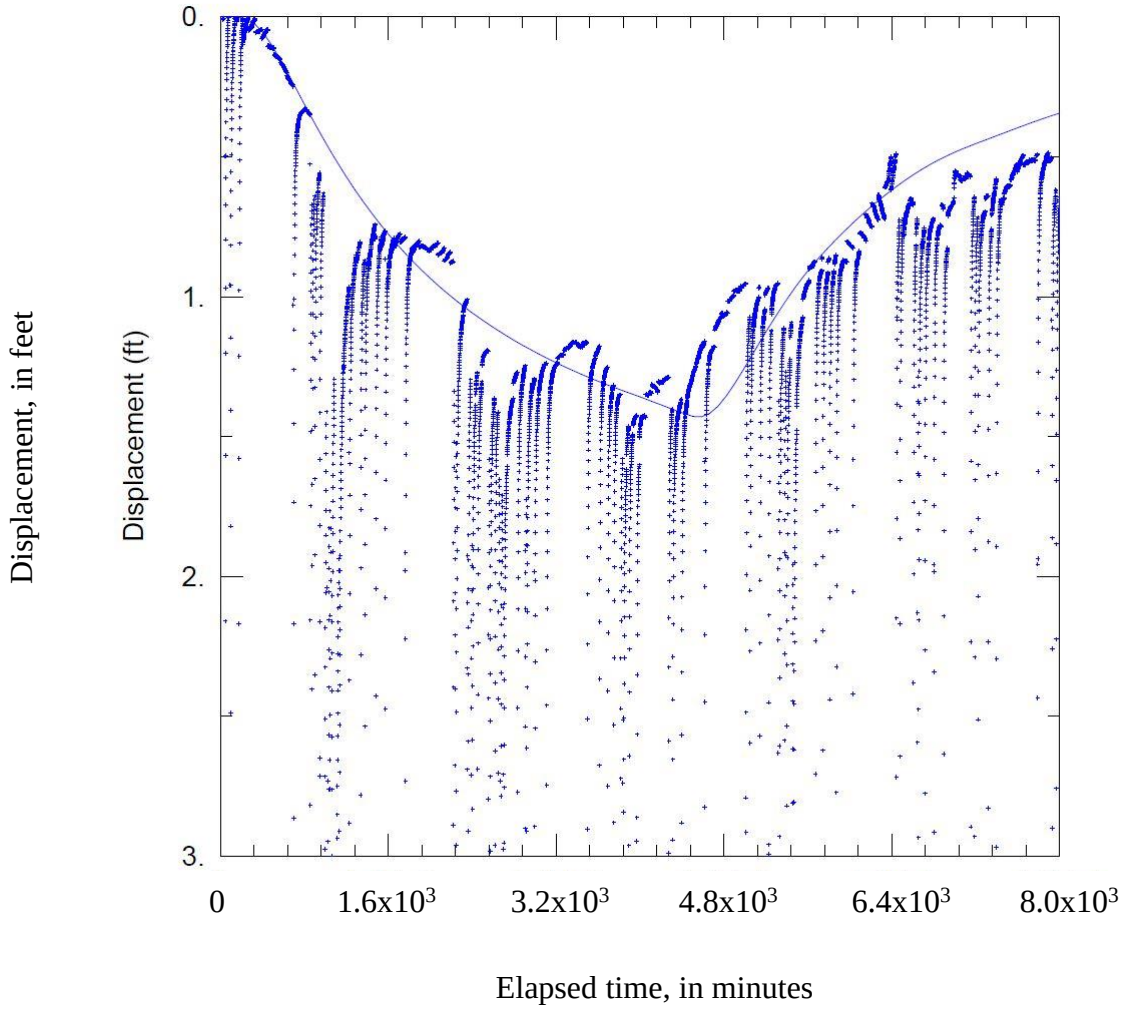


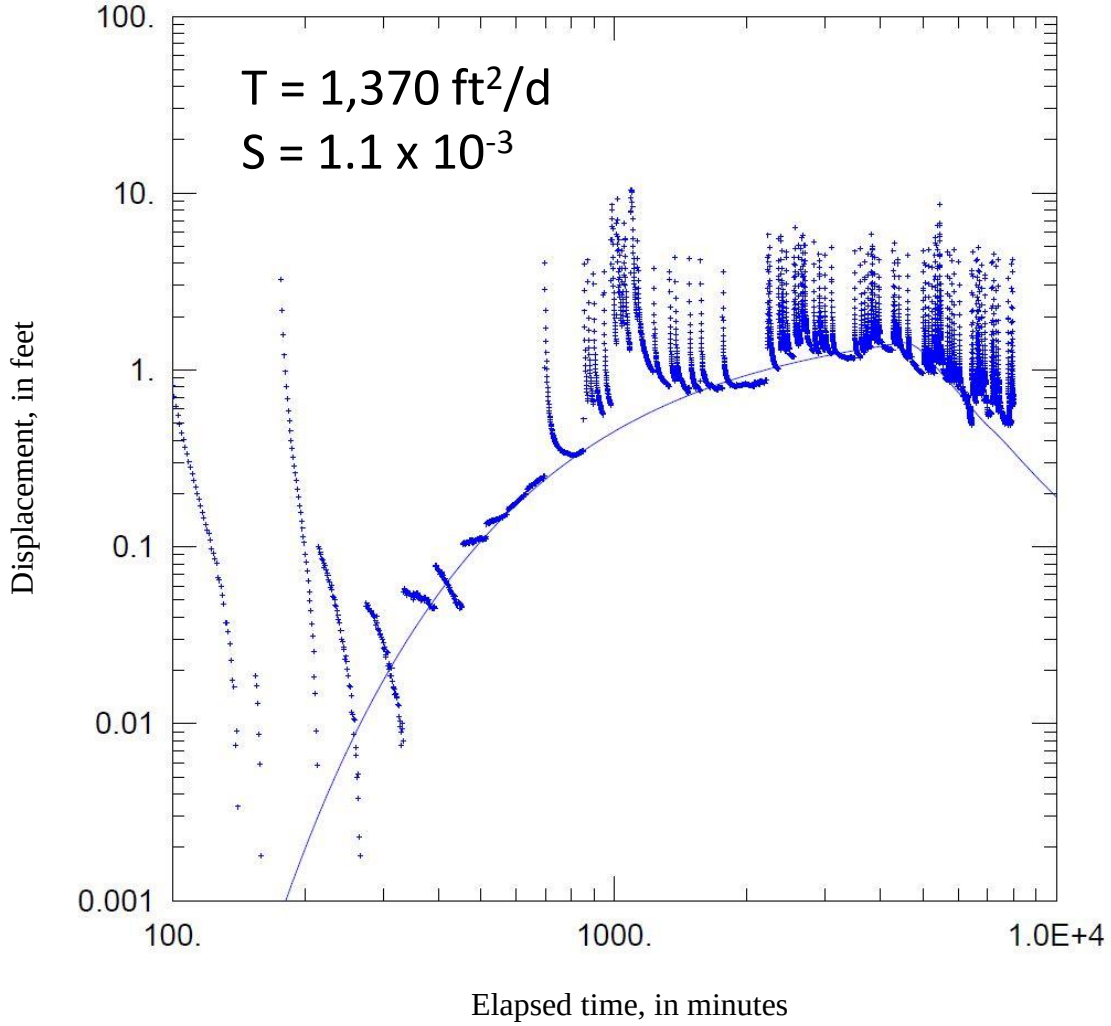
Confined well Re6814

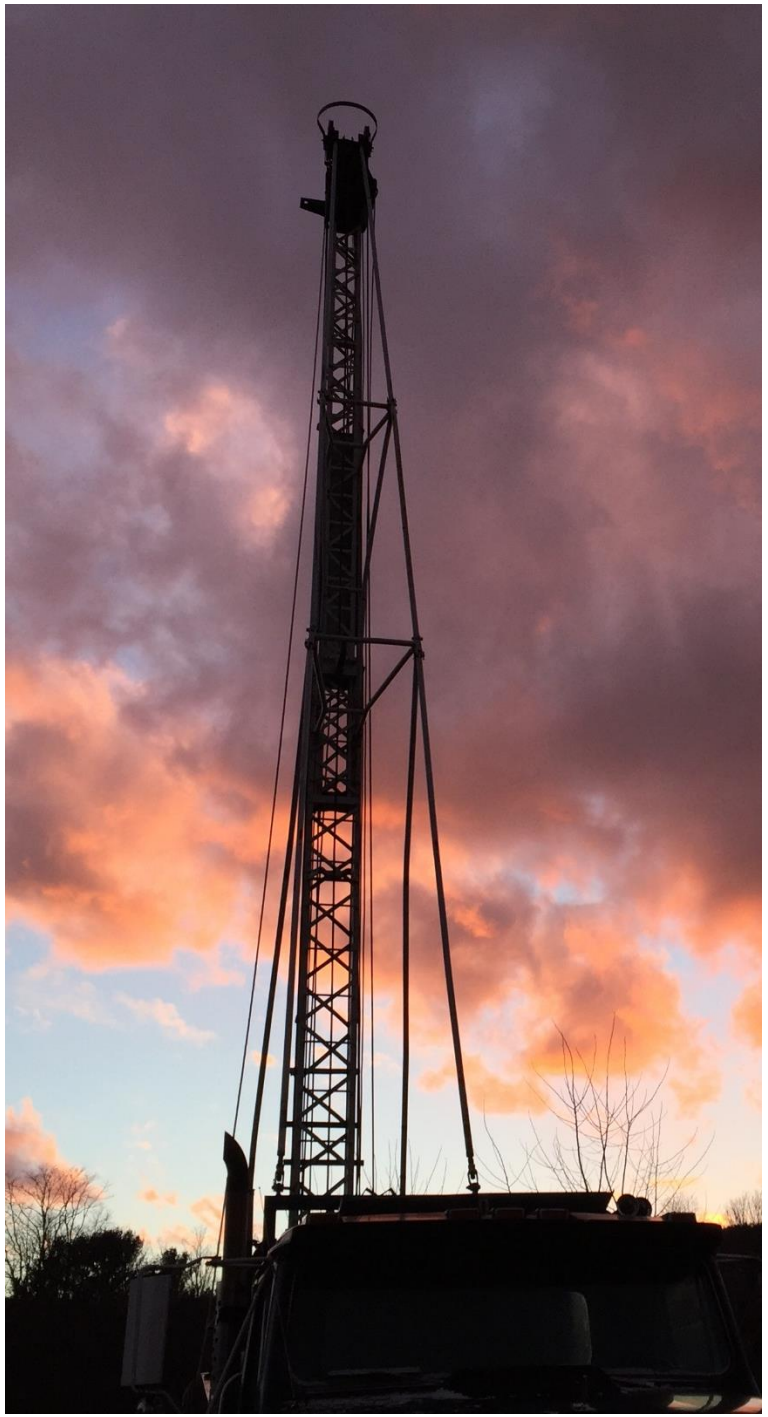




Transitional well Re158







Summary

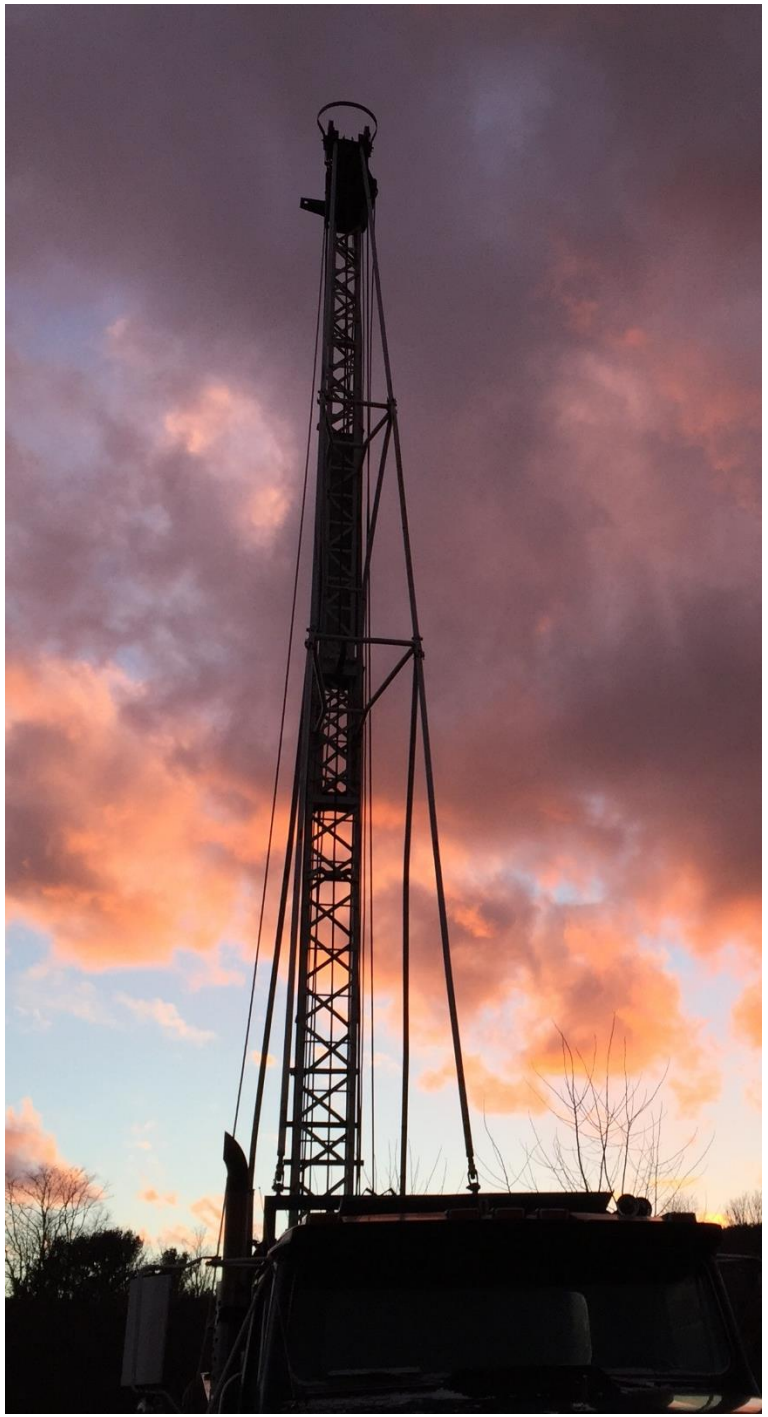
- Integrated analysis of well logs, groundwater levels, and field water quality along with the surficial geology defined hydrogeologic framework and classified wells as confined, water table, or transitional between the two aquifer conditions

- Theis type-curve analysis of a multi-well pumping test provided estimates of aquifer properties and insights into the presence of an area of focused recharge

- Representation of the recharge boundary where an unnamed pond and the fluvial-terrace deposits abut the valley wall yielded satisfactory Theis type curve matches with the observed water-level responses and reasonable estimates of aquifer properties.

- Aquifer transmissivity estimates for the wells were very similar, about 1,250 feet squared per day

- Aquifer storativity estimates ranged more than 2 orders of magnitude and were consistent with the inferred degree of confinement and distance from the represented recharge boundary



References

Arcadis CE, Inc., 2017, Groundwater source aquifer evaluation—Hoosick Falls alternate water supply study: New York State Department of Environmental Conservation, 26 p., 5 appendixes.

DeSimone, D.J., 2017, Surficial geology of Hoosick Falls, New York: Hoosick Falls Central School District, 1:12,000 scale, 31 p., http://www.hoosickfallscsd.org/hoosick-area-hydrogeology-groundwater-research-data/.

Duffield, G.M., 2007, AQTESOLV for Windows; version 4.5; user's guide: Reston, Va., HydroSOLVE, Inc., 529 p.

Ferris, J.G., Knowles, D.B., Brown, R.H., and Stallman, R.W., 1962, Theory of aquifer tests: U.S. Geological Survey Water-Supply Paper 1536–E, 174 p., https://pubs.er.usgs.gov/publication/wsp1536E.

U.S. Geological Survey, 2017, USGS water data for the Nation: U.S. Geological Survey National Water Information System database, https://doi.org/10.5066/F7P55KJN .

Williams, J.H., and Heisig, P.M., 2018, Groundwater-level analysis of selected wells in the Hoosic River Valley near Hoosick Falls, New York, for aquifer framework and properties: U.S. Geological Survey Open-File Report 2018–1015, 14 p., https://doi.org/10.3133/ofr20181015.