

Analysis of the Litchfield, Minnesota Well 2 (607420) Aquifer Test

CONDUCTED ON JUNE 29, 2017

CONFINED QUATERNARY GLACIAL-FLUVIAL SAND AQUIFER

**Analysis of the Litchfield, Minnesota Well 2 (607420) Aquifer Test
Conducted on June 29, 2017**

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Data Collection and Analysis

The constant-rate pumping test of Litchfield 2 (607420) was conducted as described below. The representative aquifer properties are summarized in Table 1. The specifics of test location, scope, and timing are presented in Table 2 and Table 3. The associated data files and a comparison of manual and transducer measurements are presented in Table 4. The results of analyses are presented in Appendix 1 and are summarized in Table 5. The analyses used standard methods, cited in references. The figures include maps, field notes, other documentation, and records of well construction.

Description

Purpose of Test

The test of Litchfield 2 was conducted by the Minnesota Department of Health (MDH) Source Water Protection Unit as a small part of a long-term project that was led by the United States Geological Survey (USGS). The overall purpose of the study was to assess the rates of groundwater recharge through low-conductivity glacial sediments (till) at various sites in Minnesota.

Specific to Litchfield, nine observation wells were installed by the USGS in 2015. Water elevations were recorded on a one-hour interval in seven of these wells for approximately one-year. The USGS had completed its data collection and was preparing to seal the observation wells. Prior to sealing the wells, notification was provided to the partner agencies relative to the completion of the work. At that time, staff in the Source Water Protection Unit recognized that this configuration of observation wells is nearly ideal for conducting short-term constant-rate aquifer tests on Public Water Supply (PWS) wells so as to estimate vertical groundwater flow. Therefore prior to sealing the wells, MDH proposed to conduct tests that would complement the USGS data collection efforts.

Well Inventory

The well records are presented in Figures 46-62 and the well construction is summarized in Table 22. The site plan is shown in Figure 16.

Hydrogeologic Setting

A schematic section (geologic cross-section) through the test site is shown on Figure 17 to illustrate the three layers that comprise the flow system; water table, aquitard, aquifer, and the construction of wells within these layers.

Other Interfering Wells

Other high capacity wells exist in the area that may cause interference. These wells are associated with the First District dairy processing in the center of Litchfield (to the south of the wellfield), and the Desens crop irrigation well (to the east of the wellfield). Several smaller domestic and non-community supply wells exist in the area. However, based on previous testing these smaller wells are not judged to present significant interference. Mr. Desens was contacted prior to the test to gain access to the observation well on his property. This well contains a transducer and water level data over the test period was obtained with the assistance of Minnesota Department of Natural Resources (MDNR).

Test Setup

The USGS provided the pressure transducers and data loggers used for long-term monitoring, re-programmed to a one-minute interval. MDH hydrologists, Justin Blum and Luke Pickman, traveled to Litchfield on June 13, 2017 to assess site conditions and re-install the transducers to collect background water level and barometric data. Transducers were placed in all existing observation wells, with the exception of USGS 2-E.

Access to Litchfield 2 is provided by a 0.75-inch polyethylene tube. The restricted diameter of this tube did not allow a transducer to be placed in the well to monitor water levels even though manual measurements were easily made. The three additional PWS wells in the wellfield; 3, 4 and 5, are similarly constructed and equipped. A prior test of Litchfield 2 was conducted by a geotechnical consultant (ECAD, 1998) and the observation well from that testing still exists a short distance from Well 2. Because of these factors; access to the wells, prior tests, and the relative distance of the observation wells, Litchfield 2 was selected to be the pumping well for this test.

The water operator, Mr. Herb Watry, was not comfortable with a standard test schedule; 24-hours of rest, 24-hours of pumping and 24-hours of recovery, because of system water demand and the limitations of the city water treatment plant. Extensive discussions with the operator indicated that an abbreviated pumping and recovery period of 4 to 6 hours each was possible and would still provide sufficient capacity. On that basis, the test was tentatively scheduled to begin on June 23, 2017. However, a major storm event on June 22, 2017 and various other public works projects caused the start of testing to be put off for a week. Other preparations for the test continued; on June 22, 2017 an acoustic water level sensor was installed in Litchfield 2, and the transducer in the Desens observation well was set up on a five-minute interval with the assistance of MDNR staff.

Weather Conditions

Conditions were warm and mostly dry during background data collection. Rain events greater 0.2-inches were recorded on June 22th and 27th at the Litchfield Waste Water Treatment Plant. No appreciable precipitation occurred during the pumping and recovery periods of June 29th to June 30th, 2017.

Discharge Monitoring

The pumping rates of the wells were reported by the Litchfield water treatment plant SCADA system. This was supplemented by manual readings of the totalizing flow meter on the Well 2 discharge line.

Data Collection

MDH personnel mobilized for the test on 6/29/2017, arriving on-site at 11:00. Upon arrival, the system was not in a 'rest' state; Litchfield Wells 3 and 5 were pumping, and Wells 2 and 4 were off. [Well 4 remained out of service for repairs until 7/6.] Wells 3 and 5 were turned off at 12:16:30 to place the wellfield into a limited recovery. The Litchfield 2 pump was started at 6/29/2017 14:03:30 by hand control through the SCADA system. Water levels were collected manually from Litchfield Wells 3, 4, and 5 from 12:00 until 15:00. The operator turned off the Litchfield 2 pump at 20:00 and all city wells remained off until 6/30/2017 06:00. At that time the system was critically short of water and Wells 2, 3, and 5 were pumped intensively over the next day to restore reserve capacity.

The USGS transducers remained in the wells until 7/10/2017 when static levels were measured and all equipment was removed. Data were attempted to be downloaded from the transducers at Nest 2 prior to equipment removal but difficulties connecting to the data loggers caused the equipment to be pulled before downloading. Data from the Desens obwell was downloaded on 7/13/2017 by MDNR staff. (personal communication, Ari Berland, MDNR)

The comparisons of manual and transducer measurements are presented in Figures 15 through 33. Only one well saw a decline in water level below the transducer setting, USGS 1-E, Figure 26, affecting data collection after 7/6/2017. The batteries of the acoustic transducer in Litchfield 2 failed during the extended recovery period and data after 7/7/2017 were not recorded. However, the MDH transducer in the Litchfield monitoring well continued to function over the monitoring period to provide a continuous record at that location.

Time signatures of the data files were checked against the computer clock after the equipment was removed from the wells. It was found that the USGS data logger clocks lost between 40 and 58 seconds, an average of 50 seconds, over the 28-day data collection period. This small and nearly uniform time shift was judged to not strongly affect data over the short, 14-hour, test period. Otherwise, the USGS loggers performed as expected and the equipment was returned to the USGS Mounds View office on 7/11/2017.

After the test was complete, precipitation records from the WWTP were obtained and the operator generated reports from the SCADA system for daily pumping from the wells. The daily pumping totals were compared to readings from the totalizing flowmeter on Well 2. There is a significant difference in flow volume between these two sources. The SCADA average cumulative volume reported for Well 2 was 710 gpm. The reading from totalizer, 46 minutes after the start of pumping, was 787 gpm. The appropriate value to use for the analysis was evaluated by comparison to results from the 1998 test of Litchfield 2, ECAD - test 2209. The larger rate produced comparable transmissivity values to the earlier test and is considered to be more accurate.

Qualitative Aquifer Hydraulic Response

A general site plan is shown in Figure 16, identifying the wells monitored for this test. Distances between the pumping and observation wells are presented in Table 3. A schematic cross section is provided for visual context of the test conditions, Figure 17. Comparison of manual and transducer data are shown in, Figures 18 through 33, documenting the proper functioning of the equipment.

The differences between pre and post-test manual and transducer water levels from wells completed in the pumped aquifer were consistent, indicating little effect of cable stretch, transducer 'drift,' or other common problems. This was not the case for observation wells constructed in till, particularly in Nest 2, where static water levels were disturbed by

installation of the transducers. The instrumentation displaced water in the well casings similar to a 'slug' injection. This disturbance dissipated over a time interval that varied according to the hydraulic conductivity of the materials in which the wells are constructed; from seconds to greater than 20 days. The USGS had analyzed these 'slug' tests during earlier parts of this study; therefore, additional slug analyses were not performed on this dataset.

The groundwater elevations in both nests showed a downward gradient, as expected, Figure 34 and Figure 35. There was a clear signal in all wells completed in the aquifer caused by the pumping of Litchfield 2, Figure 36 and Figure 37. As for the response in the till observation wells, the effects of pumping of Litchfield 2 was seen only at Nest 1, Figure 34. No response was seen in any of the till observation wells at Nest 2, Figure 35.

The possible influence on groundwater elevation from barometric pressure changes was evaluated, Figure 40. Barometric pressure varied little over the pumping test period. The range around the mean pressure was +/- 0.03 psi with a small upward trend of 0.05 psi. This variation is considered to have a negligible effect on water elevation and the data were not corrected for barometric efficiency.

Long-term trends in groundwater elevation were evaluated. The groundwater elevation in the shallow water-table observation well, USGS 1-B declined about 0.5 foot over the monitoring period, Figure 23. At Nest-2, the decline in well USGS 2-A was about 2 feet, Figure 28. The declines differed between the well nests; at Nest 1 the decline was linear, whereas Nest 2 saw a curvilinear decline – similar to a stream recession curve. The overall decrease in groundwater elevation at the water table appears to be an area-wide trend.

The vertical groundwater gradient is uniformly downward over the test area. At Nest 1, to the south of the wellfield, the ambient groundwater elevation difference is approximately 25 feet. During the test this difference increased by about 1 foot. Therefore, the incremental difference in the volume of leakage through the till as the result of this test is small relative to the ambient leakage.

Precipitation events are associated with small increases in groundwater elevation at both Nests 1 and 2, Figure 41. At Nest 2, the changes in elevation are seen to propagate downward, decreasing in magnitude with depth, in wells 2-B, 2-C, and 2-D, Figure 29, Figure 30, and Figure 31. This relationship holds true for Nest 1 also but is less pronounced, Figure 24 and Figure 25. The trend in the pumped aquifer is less clear because of the cycling of many pumping wells; but, groundwater elevation was relatively stable until 7/5/2017.

During the extended monitoring period, between 7/5 and 7/8/2017, groundwater elevation in the aquifer declined up to 10 feet, starting to recover on 7/9/2017, Figure 36. This event affected all wells constructed in the aquifer nearly equally. It was not associated with a marked increase in pumping from the Litchfield wellfield, Figure 42. The SCADA system reported an increase in total pumping volume over that period of about ten percent above average. Nor was it associated with any changes in flow from the First District dairy processing; as the waste water flow from that facility to the Litchfield WWTP was within the normal range over that time and no additional pumping was reported from First District wells. (personal communication, M. Geers, city of Litchfield and R. Albrecht, First District, Inc.) It was clearly not associated with pumping of the Desens irrigation well as that well remained off until about 7/12, after the time that water elevations had started to recover, Figure 33. The small differences in the response of the Desens obwell relative to other wells in the aquifer are probably associated with the return to service of Well 4, Figure 43 and Figure 44. Because of the magnitude and uniform effect of this change in water elevation, it can only be caused by a large discharge located at a large distance; greater than 2000 gpm, and at one mile or greater distance. During this analysis, the mystery of the source of this disturbance was referred to MDNR as it clearly has area-wide significance.

Subsequent discussions with the USGS verified that similar declines had occurred the previous year, Figure 45. In 2016, three episodes of water elevation decline similar in magnitude to that observed during this test occurred during the summer months, June, July and August. Comparison of these declines in water elevation to records of precipitation showed that they only occurred during dry times and on two occasions the recovery coincided with rain events. The declines are not strongly related to local pumping because the magnitude of the cycling of local wells is consistent throughout the year. Because these declines 1) regularly occur only in the summer months, 2) start during dry periods, and 3) recover after significant rainfall events, leads to the conclusion that they are the result of cumulative effects of area-wide irrigation pumping.

Quantitative Analysis

Traditional aquifer test analysis utilizes two main types of simple inverse models, transient and steady-state, see: selected references. When both types of models are used for the analysis (data permitting) - the aquifer hydraulic response may be proved consistent from the two perspectives and uncertainty in hydraulic properties is reduced.

Conceptual Model

The conceptual model for this test is of a layered leaky aquifer system with the majority of wells completed in two of three layers, as per the schematic section, Figure 17. The layers have distinctly different hydraulic characteristics. The first layer is composed of glacial drift and alluvium, which contains the water table. The second layer is the till which provides hydraulic confinement and recharge by leakage to the third layer. The third layer is the hydraulically-confined glacial outwash aquifer in which the production wells are constructed.

For the analysis of the confining layer data, it is preferred initially to use the simplest approach so as to introduce as few degrees of freedom as possible. The conceptual model of flow through the till is each well nest is analogous to a column of permeable material in the laboratory and flow is steady-state. For analysis of aquifer properties, the steady-state conceptual model leakage of a two-layer system is used [de Glee (1930) and Hantush-Jacob (1955)]. There is assumed to be no change in storage in these steady-state models. Transient analysis by the Neuman-Witherspoon (1969) method was also done for comparison, as data permitted.

Pumped Aquifer

Analyses are presented in Figures 1 through 10. Adjustments to the data were made prior to analysis to account for the effects of the short rest period before the start of pumping and the abbreviated duration of the test. The first adjustment is made to estimate the impact of previous pumping/recovery cycles by superposition, Figure 16. This correction was applied to the drawdown of each well for the composite transient analyses, Figures 17 through 21.

The recovery period was 10-hours in length and therefore is a bit higher quality. The transient distance drawdown analysis (t/r^2), Figure 7, used recovery data. However, the duration of the 10-hour recovery was not long enough for steady-state conditions to develop. Therefore, recovery data were projected to 10,000 minutes, Figure A1-8, for the steady-state analyses, Figure 9 and Figure 10.

Aquifer transmissivity is best represented by the distance-drawdown analyses between 8,800 to 11,000 ft²/day. The storativity (dimensionless) is in the range of 5.5e-5 at the Nest 2 site to as large as 2.0e-4 at nest 1, to the south of the wellfield. This variation in storativity corresponds to the relative conductivity of the till at the well nests. No wells showed a leaky response, as expected, and the corresponding leakage factor from the steady-state analyses is quite large, approximately 22,000 feet. Comparison of these results to those of the earlier aquifer test shows that the transmissivity and storativity are within the same range but the characteristic leakage factor from the earlier test was significantly smaller. [This may be due in part to a bias in the earlier analysis which used drawdown values after only 1440 minutes of pumping. It also was the result of choices to weight proximal wells more heavily to the fit rather than more distant wells. The uncertainty of the leakage factor from that analysis was quite large.]

There are differences between the response to pumping and recovery for USGS 1-F and Desens Obwell, Figure 5 and Figure 6, that are not seen in the response of wells located within the wellfield. It is believed that these differences are the result of interference from other, more distant, pumping wells. The effect of the differences causes an increase in uncertainty of hydraulic properties at these wells, +/- 30% of the nominal values which are presented on the figures and Table 5.

Aquitard (Confining) Layer

Analyses are presented in Figures 11 – 15. The assessment of the vertical hydraulic conductivity of the till at Nests 1 and 2 depends on the observed response to pumping. There was no observed response to pumping at Nest 2 and the analysis is therefore limited. The observed response to pumping at Nest 1 is shown on Figure 11 as four series:

- 1) pumping,
- 2) recovery,
- 3) recovery projected to 1000 minutes, and
- 4) that caused by the 'unknown pumping.'

The short-term differences in water level caused by pumping are best fit by a log function. As the well nest is expected to react linearly, as a hydraulic column in the laboratory; this indicates that the duration of pumping was insufficient for the system to reach equilibrium. The recovery data projected to 10,000 minutes may be used, as that response was linear, but limited to only two wells. The strongest linear signal was caused by the 'unknown pumping' 7/5 through 7/8/2017. These data indicate that only the deeper observation wells; USGS 1-E, 1-D, and possibly 1-C, may provide a reasonably linear relationship of clay thickness vs. water level change. As water levels drew down below the transducer in USGS 1-E, an estimate of the water level was made from the consistent difference between USGS 1-E and 1-F of 0.6 feet, Figure 26.

Note that on Figure 11, the intersection of all regressions at ~0 feet of drawdown is much less than the full thickness of the till. Therefore, the true thickness of competent till as a confining layer is not its full lithological thickness at the Nest 1 site. It appears that the effective thickness is approximately 48 to 50 feet.

The composite leaky analysis, Figure 12, used the parameter estimation tool in Aqtesolv for the data from the wellfield area. The data from wells 1-F and Desens Obwell plot significantly below the other wells. This indicates that the transmissivity and/or leakage is different for the wells not matched. This is additional confirmation that the aquitard is more permeable in the area near Nest 1.

The Neuman-Witherspoon analysis of recovery data from Nest 1, Figure 13, produces a kV of the aquitard of 1.8e-2 ft/day. However, the match is poor because the test was not conducted long enough to generate a strong signal. Also, this initial analysis assumed that

the thickness of the aquitard is 63 feet rather than that from the well records (114 feet). The smaller effective aquitard thickness from Figure 11 can be verified with this model. On Figure 14, the match to data from well 1-E is much improved if an aquitard thickness of 50 feet is used, with no other change in parameters.

The analysis of the data associated with this abbreviated constant-rate test is limited because of the relatively small signal that only affected wells 1-E and 1-D. However, a very strong signal was generated by the disturbance after 7/5/2017 19:00, Figure 43. Unfortunately, no facts are available to verify the well location(s) or pumping rate(s) that may have caused the disturbance. Modeling the impact of the observed response has inherent uncertainties but is a worthwhile check on the aquitard properties, if only because of the strength of the signal.

If aquifer properties are reasonably consistent in this area, the effects of the 'unknown pumping' well at Nest 1 may be modeled in Aqtesolv. Assuming a well located approximately 8000 feet from Nest 1 and discharging at a rate of 2300 gpm for 5000 minutes, a steady-state model provides similar aquifer properties: $T = 9,000 \text{ ft}^2/\text{day}$, $S = 5e-5$, and $L = 20,000$ feet. These assumptions were then used as the basis for a Neuman-Witherspoon analysis of the data after 7/5/2017 19:00, Figure 15. The match was quite good to data from all observation wells in the till: 1-E (estimated), 1-D, and 1-C. The k_v of the aquitard was smaller, $1.0e-3 \text{ ft/day}$, than that calculated from the test of Litchfield 2, Figure 14, but not out of the reasonable range. For comparison, this value is essentially the same as that from the steady-state analyses, Figure 9 and Figure 10.

Because no response was observed at the Nest 2 site, the k_v of the aquitard is at least one order of magnitude smaller than that at Nest 1, at most $1.0e-4 \text{ ft/day}$ or smaller.

Conclusion

The hydraulic properties of the two-layer aquifer and aquitard system are shown in Table 1. These values are a summary of the analyses listed on Table 5. The large range of estimated aquifer properties shown are the result of both the sub-set of the data to which an analysis method was applied and natural lithological variation - particularly within the till.

The bulk aquifer properties were within the expected range given the prior test of Litchfield 2 in 1998. The leakage factor from this test was larger (a lower rate of leakage) than that from the earlier test, with better documentation and a much more robust analysis.

The interesting aspect of these data is that the more conductive portion of the aquitard (Nest 1) appears to dominate the bulk hydraulic response, as represented by the steady-state analyses.

Acknowledgements

There have been few opportunities to collect this level of detailed hydraulic information for the analysis of rates of leakage through till. The test conducted at the Litchfield municipal wellfield described here was successful not simply because of the efforts of MDH but also for the work of many, over decades. This analysis drew heavily on previous testing of Litchfield Well 2 in 1998, data collected by the USGS in 2015 and 2016, the work of MDNR with irrigators in the area, as well as other sources. It is an example of how success may

sometimes result from being there to gather information, taking advantage of coincidental and uncontrolled field conditions, rather than the 'proper conduct' of an aquifer test.

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Tables and Figures

Table 1. Summary of Results for Leaky Confined - Radial Porous Media Flow

Parameter	Value	Unit	Range Minimum	Range Maximum	+/- % variation
Top Stratigraphic Elev.	1015	feet (MSL)	1008	1022	
Bottom Stratigraphic Elev.	986	feet (MSL)	978	986	
Transmissivity (T)	9,000	ft ² /day	7,000	14,500	
Aquifer Thickness (b)	29	feet	30	44	
Hydraulic Conductivity (k)	310	ft/day	155	310	
Ratio Vertical/Horizontal k (k_v/k_R)	1	0.00 %			
Primary Porosity (ep)	0.25	0.00 %			
Storativity (S)	7.5e-5	dimensionless	5.5e-5	3.3e-4	
Characteristic Leakage (L)	21,000	feet	5,000	24,100	
Hydraulic Resistance (c)	44,400	days	2,800	63,500	
Thickness of till (b')	50	feet	48	130	
Hydraulic Conductivity of till (k_v)	1.0e-3	ft/day	< 1.0e-4	2.0e-2	

Table 2. Aquifer Test Information

Information Type	Information Recorded
Aquifer Test Number	2617
Test Location	Litchfield 2 (607420)
Well Owner	City of Litchfield
Test Conducted By	MDH - J. Blum and J. Woodside
Aquifer	QBAA
Confined / Unconfined	Confined
Date/Time Monitoring Start	06/13/2017 12:10
Date/Time Pump off Before Test	06/29/2017 12:16:30
Date/Time Pumping Start	06/29/2017 14:03:30
Date/Time Recovery Start	06/29/2017 20:00:00
Date/Time Test Finish	7/13/2017 14:35
Pumping time (minutes)	1454.93
Totalizer – end reading	not recorded
Totalizer – start reading	122,434,800
Total volume (gallons)	280,060 gallons
Nominal Flow Rate	787 (gallon per minute)
Number of Observation Wells	8 (see Table 3)

Table 3. Well Information

Well Name (Unique Number)	Easting Location, X ¹ (meter)	Northing Location, Y ¹ (meter)	Radial Distance (feet)	Ground Surface Elevation, GSE ² (feet, MSL)	Measuring Point Description GSE+(stick-up) (feet, MSL)	Open Interval Top (feet, MSL)	Open Interval Bottom (feet, MSL)	Aquifer
Wellfield								
Litchfield 2 (607420)	613	481.6	1	1120	1124.35 e	1013	988	QBAA
L-MW (607417)	607.8	496.1	51	1120	1123.7	1001.2	996.2	QBAA
Litchfield 3 (632077)	674.4	711.6	781	1123.2	1127.2	1018	990	QBAA
Litchfield 4 (632078)	538.4	1129.6	2140	1126	1130	1026	1002	QBAA
Litchfield 5 (764258)	466.1	1014.9	1815	1149	1153	1015.5	990.5	QBAA
Desens, D. (800011)	1384.7	947.7	2958	1128.4	1129.4 e	980.4	970.4	QBAA
Nest 1								
USGS 1-B (773062)	1021.8	265.5	1517	1114.5	1118.23	1092.1	1089.2	QWTA
USGS 1-C (773060)	1019.2	267.5	1506	1114.8	1118.35	1064.6	1061.7	Till
USGS 1-D (773059)	1020.4	267.5	1510	1114.7	1118.25	1042.3	1039.4	Till
USGS 1-E (773058)	1021.8	267.5	1514	1114.5	1118.07	1022.1	1019.2	Till
USGS 1-F (773057)	1020.4	265.6	1513	1114.7	1118.1	996.7	987.2	QBAA
Nest 2								
USGS 2-A (773056)	559.8	844	1202	1139.6	1142.82	1122.5	1119.6	QWTA
USGS 2-B (773055)	559.8	842.9	1198	1139.2	1142.24	1106.9	1104.1	Till
USGS 2-C (773054)	561.3	844	1201	1139.4	1142.41	1082.4	1079.6	Till
USGS 2-D (773053)	559.7	841.6	1194	1139.2	1142.15	1058.1	1058.1	Till
USGS 2-E (773052)	561.4	842.9	1197	1139.3	1142.46	1028.3	1025.5	QBAA
USGS 2-F (773051)	561.4	841.6	1193	1139.3	1142.37	986.8	976.9	QBAA

¹ Local Datum² Vertical Datum: NAV88

Table 4. Data Collection

Data File Name: Well Name_Unique Number	Data Logger Type, SN:	Probe Id., Range (psi)	Install 1. Static WL ³	Install 2. XD ⁴ Setting	Remove 3. Static WL	Remove 4. XD Setting	Diff. Static WL (1-3)	Diff. XD Setting (4-2)
L-2_(607420)	Acoustic transducer		50.29	49.64	71.04 ⁵			
Baro_data	Hermit 3000 45333	6, 15 psia						
L-Ob(607417)	Troll 500 145815	17, 30 psi	46.50	61.59	59.70	48.54	-13.2	-13.04
USGS-1-B(773062)	OTT 382929		13.55	12.96	14.17	12.33	-0.62	-0.63
USGS-1-C(773060)	OTT 382931		14.61	13.97	15.46	14.83	0.78	0.79
USGS-1-D(773059)	OTT 382935		28.77	28.30	32.75	32.34	-3.98	4.04
USGS-1-E(773058)	OTT 382934		38.04	37.52	45.29	39.60 ⁶	-0.21	--
USGS-1-F(773057)	OTT 382937		38.20	37.11	45.45	44.88	7.25	7.77
USGS-2-A(773056)	OTT 382927		13.99	14.19	16.09	16.23	-2.1	2.04
USGS-2-B(773055)	OTT 382932		14.99	16.09	16.39	18.72	1.4	0.35
USGS-2-C(773054)	OTT 382930		17.87	16.06	19.02	18.59	-2.15	2.52
USGS-2-D(773053)	OTT 382933		35.19	34.07	35.90	35.38	-0.71	1.31
USGS-2-E(773052)	None installed		64.36		71.33			
USGS-2-F(773051)	OTT 382938		65.43	64.88	70.88	70.01	-5.45	5.13

³ WL = water level below measuring point, feet.⁴ XD = pressure transducer depth below water surface, feet.⁵ Pump running⁶ Transducer set above water surface in well at removal

Table 5. Transient Analysis Results

Well Name (Unique Well No.)	Transmissivity, T (ft ² /day)	Storativity, S (dimensionless)	Leakage Factor, L (feet)	Hydraulic Conductivity of Aquitard, k _v (ft/day)	Analysis Method	Figure No. Remarks
L-2 (607420)	3,440	NA ⁷	NA	NA	Theis	2. poor match, T not credible
L-MW (607417)	8,600	2.5e-4	NA	NA	Theis	3. good match
USGS 2-F (773051)	14,700	5.5e-5	NA	NA	Theis	4. good match to pumping data
USGS 1-F (773057)	14,700	3.3e-4	NA	NA	Theis	5. divergence between pumping and recovery data – uncertainty in T & S values +/- 30%
Desens (800011)	14,300	1.5e-4	NA	NA	Theis	6. divergence between pumping and recovery data – uncertainty in T & S values +/- 30%
Aquifer, composite	10,000	1.1e-4	NA	NA	Theis - t/r ²	7. good match, inefficiency of pumped well causes divergence from Theis-curve
Aquifer, composite	9,170	2.0e-4			Cooper – Jacob	9. representative bulk aquifer properties
Aquifer, composite	11,000	9.5e-4	20,000	1.4e-3	Hantush-Jacob - t/r ²	12. Aqtesolv solution - match to L-MW and USGS 2-F
Nest 1, composite	14,000	1.0e-4	6,700	2.0e-2	Neuman-Witherspoon	13. aquitard thickness of 63 feet - poor match
Nest 1, composite	10,800	1.2e-4	5,500	1.8e-3	Neuman-Witherspoon	14. aquitard thickness of 50 feet - better match to USGS 1-E
Nest 1, composite	8,000	7.4e-5	10,800	1.0e-3	Neuman-Witherspoon	15. aquitard thickness of 50 feet - good match to all till wells

Table 6. Steady-state Analysis Results

Transmissivity, T (ft ² /day)	Leakage Factor, L (feet)	Hydraulic Resistance, c (days)	Hydraulic Conductivity of Aquitard, k _v (ft/day)	Analysis Method	Plot No. Remarks
9,170	24,100	63,500	7.9e-4	Hantush-Jacob	9. representative bulk aquifer properties
8,830	22,000	54,800	9.0e-4	De Glee	10. representative bulk aquifer properties

⁷ Not Applicable

Figure 1. Adjustments for pumping-phase data

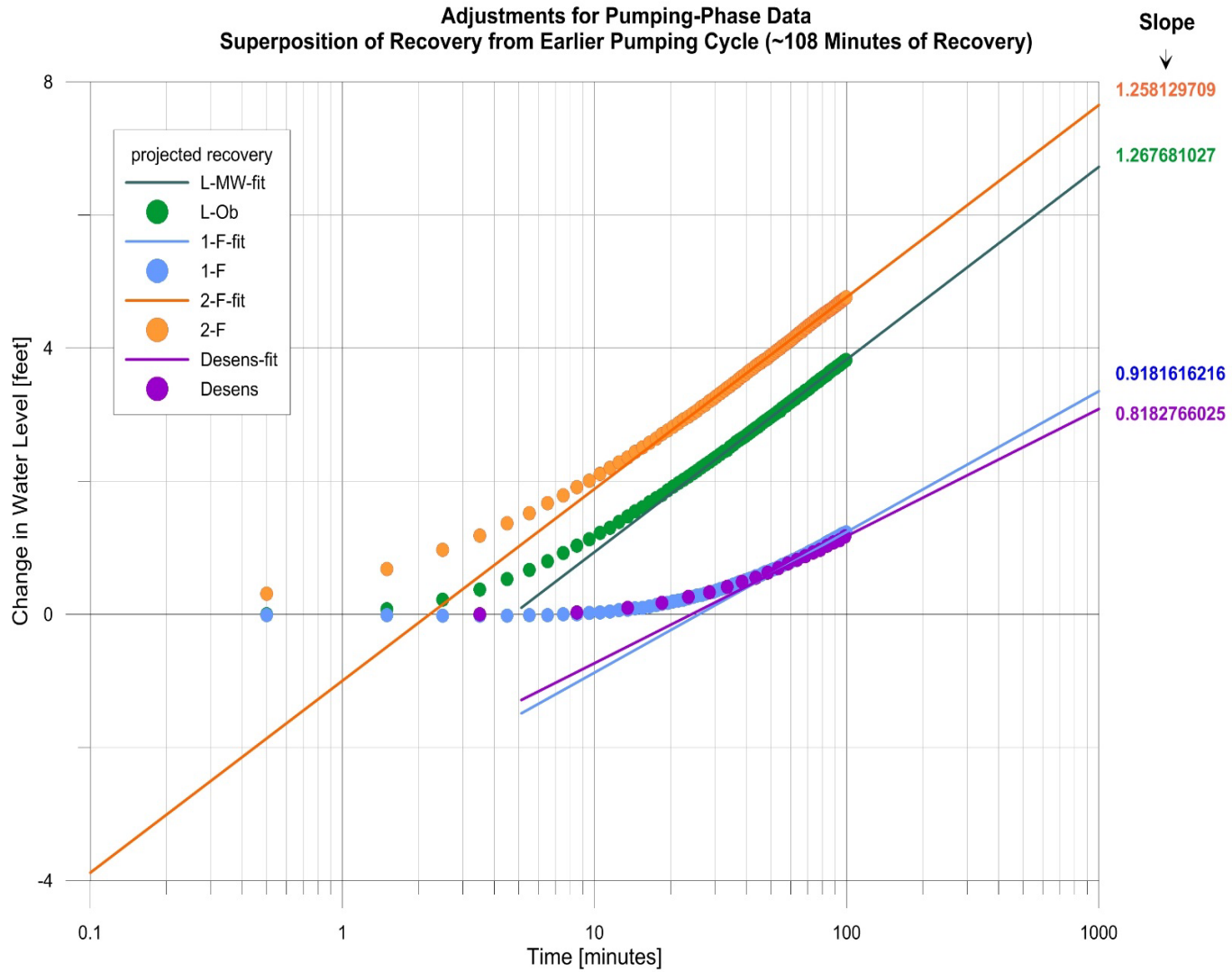


Figure 2. Theis (1935) analysis of pumping and recovery data from Litchfield 2 (607420)

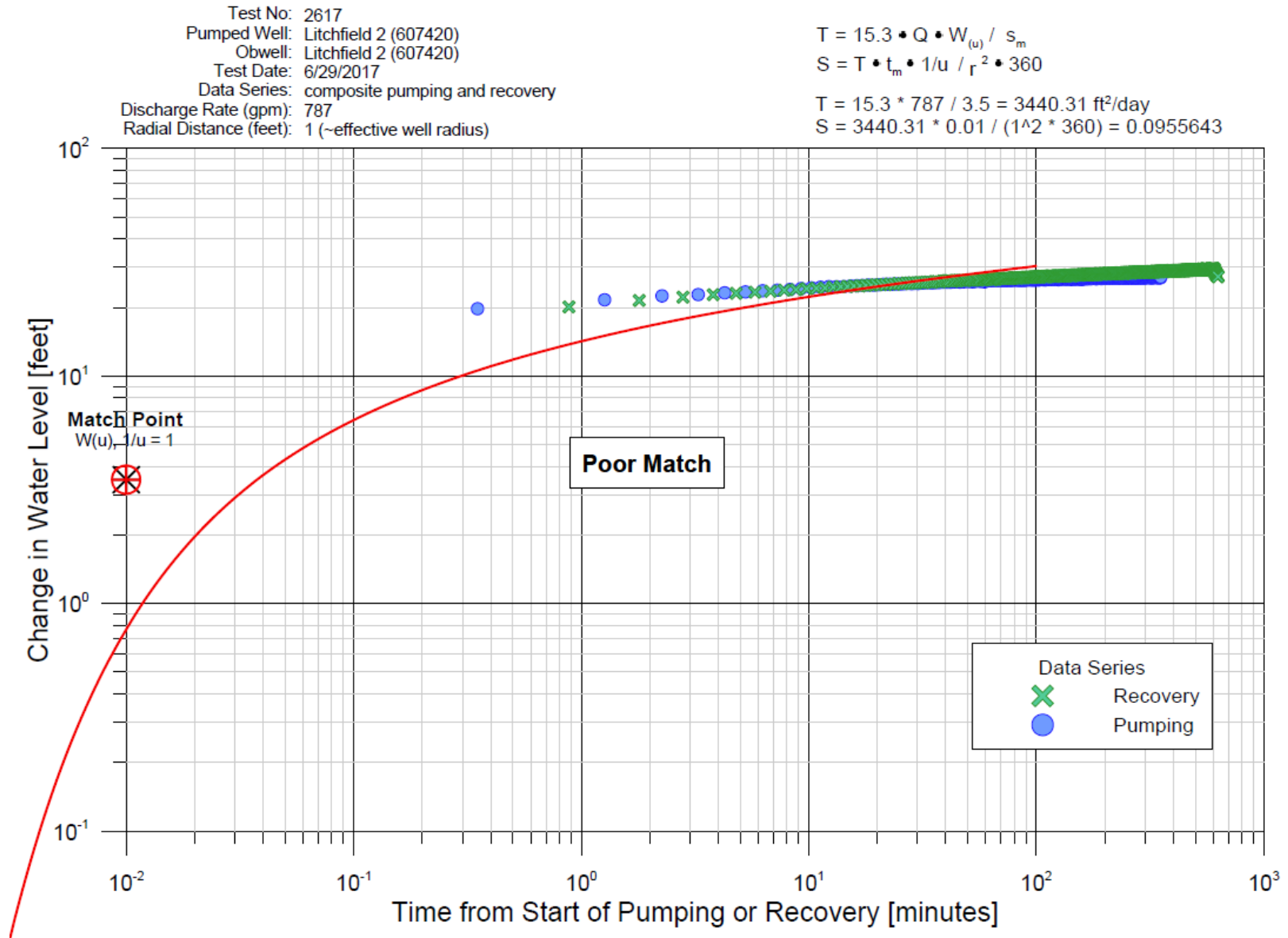


Figure 3. Theis (1935) analysis of pumping and recovery data from Litchfield MW (607417)

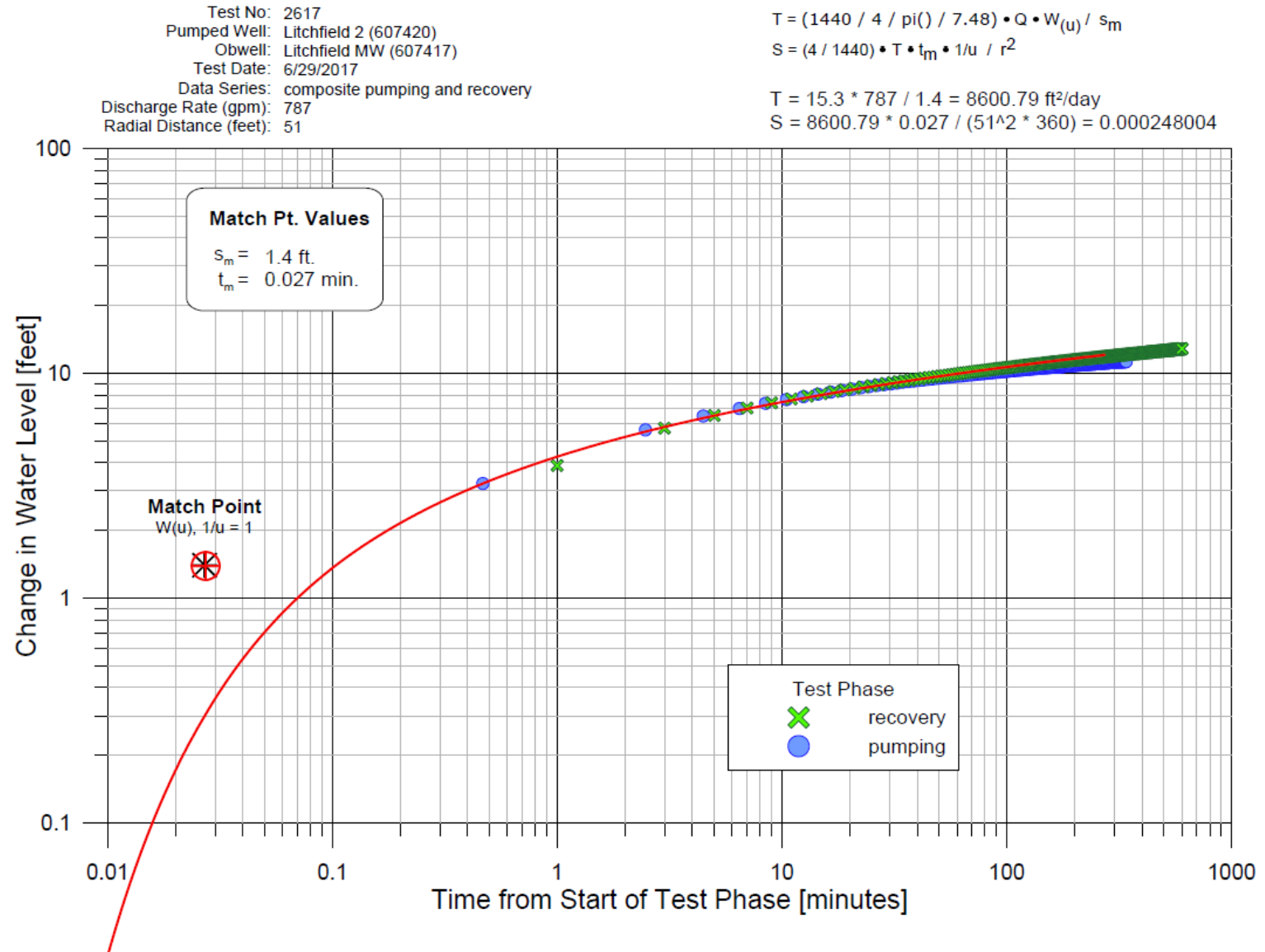


Figure 4. Theis (1935) analysis of pumping and recovery data from USGS 2-F (773051)

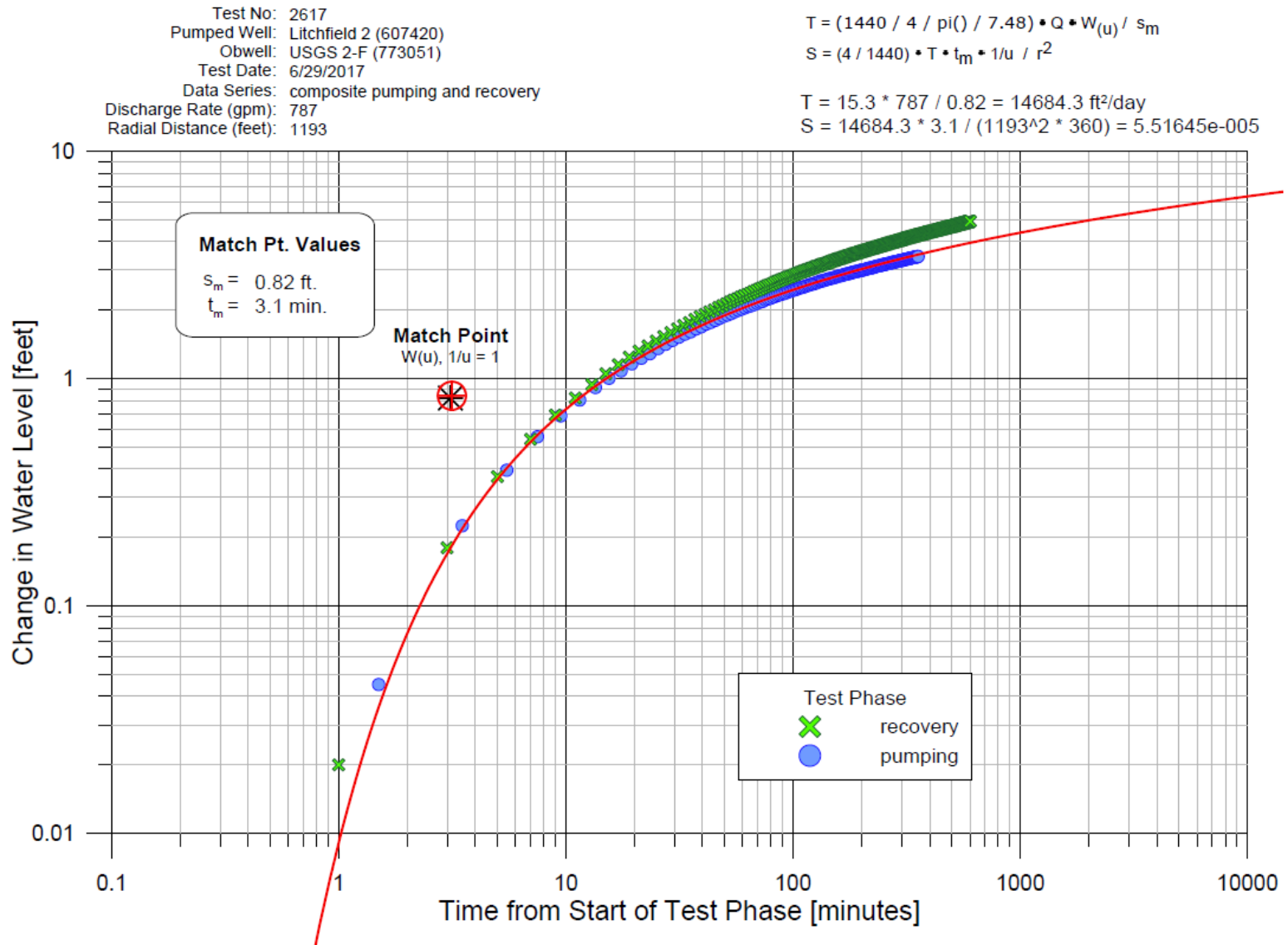


Figure 5. Theis (1935) analysis of pumping and recovery data from USGS 1-F (773057)

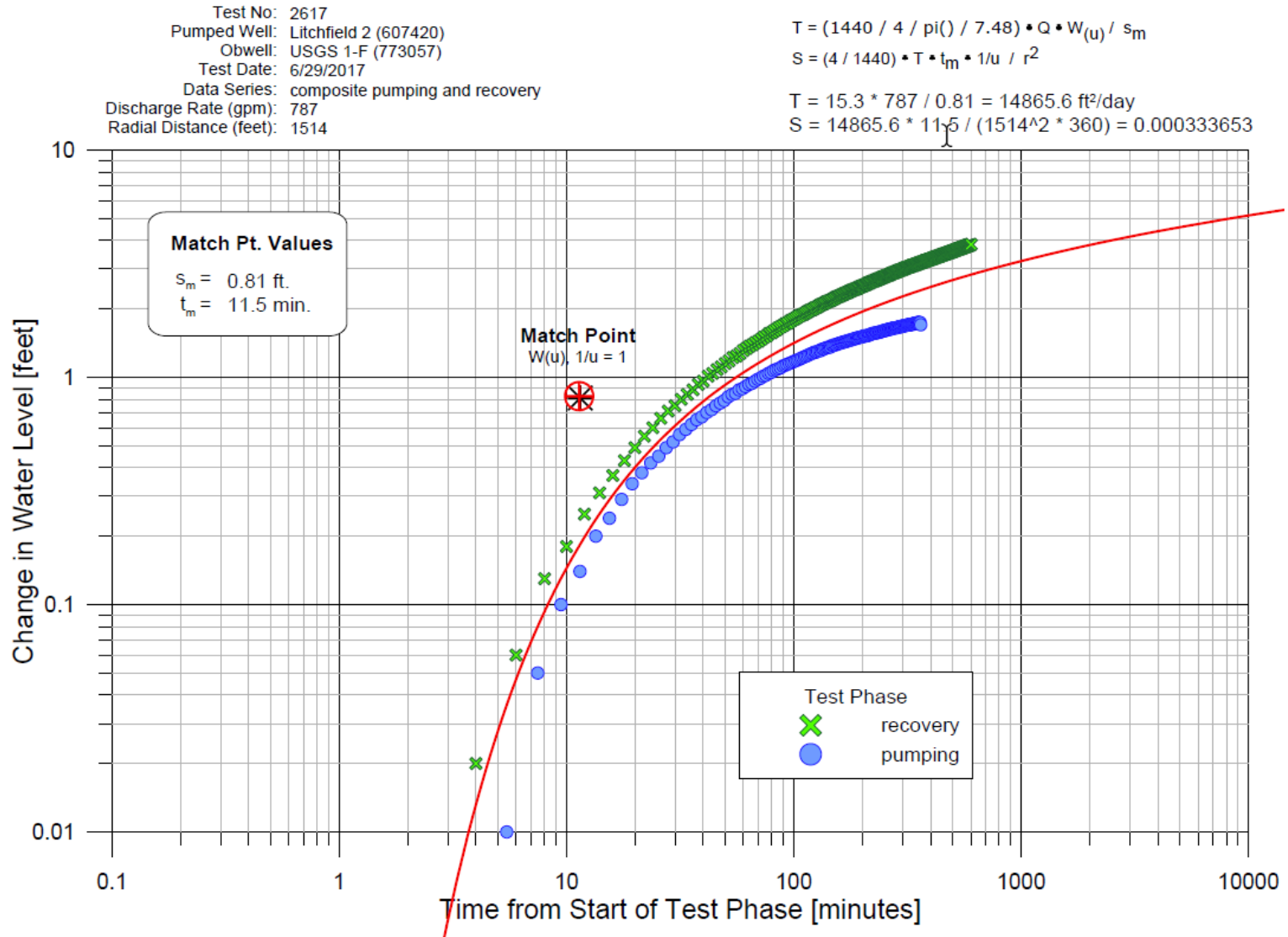


Figure 6. Theis (1935) analysis of pumping and recovery data from Desens (800011)

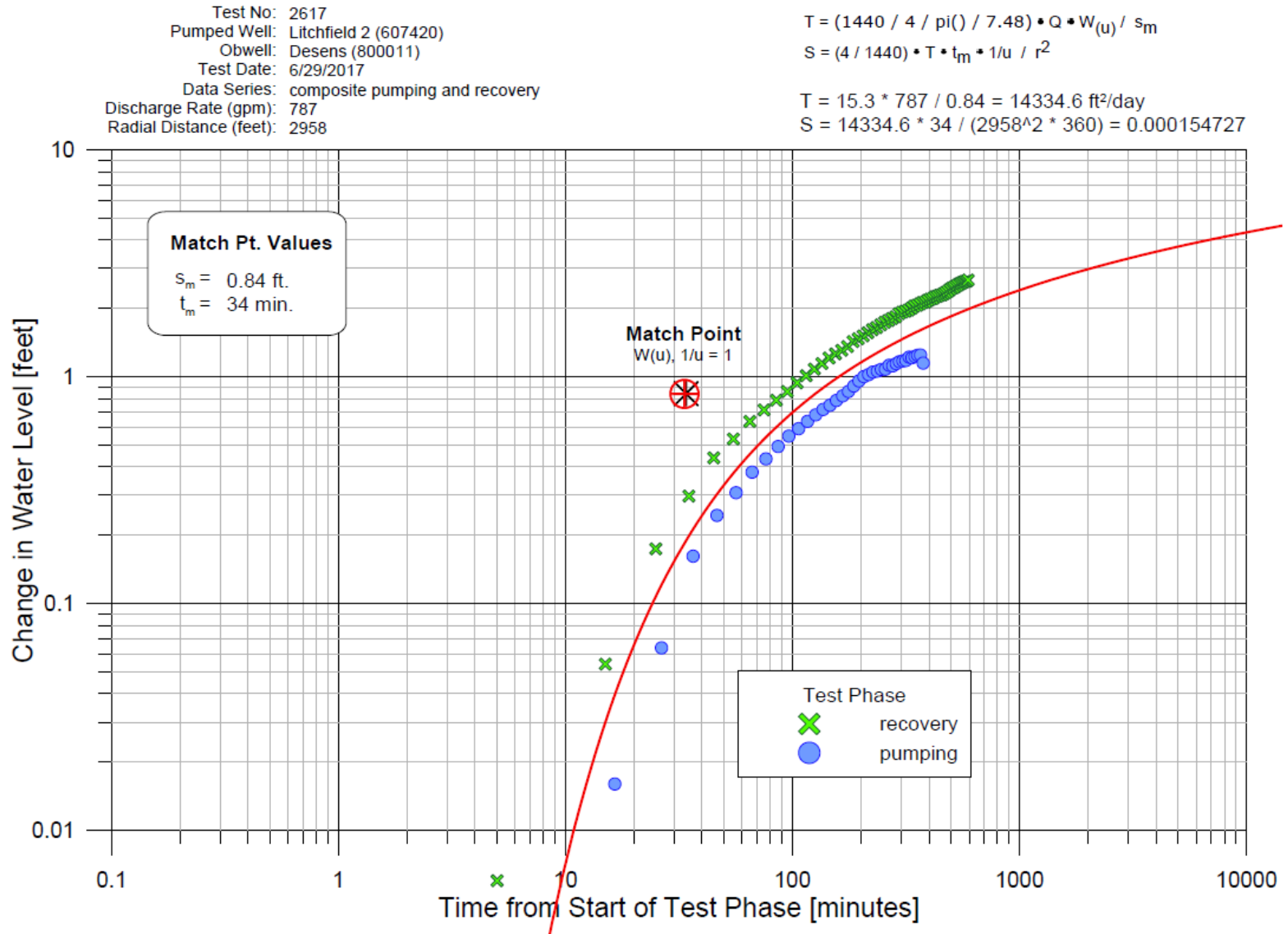


Figure 7. Theis (1935) composite (t/r²) analysis of recovery data

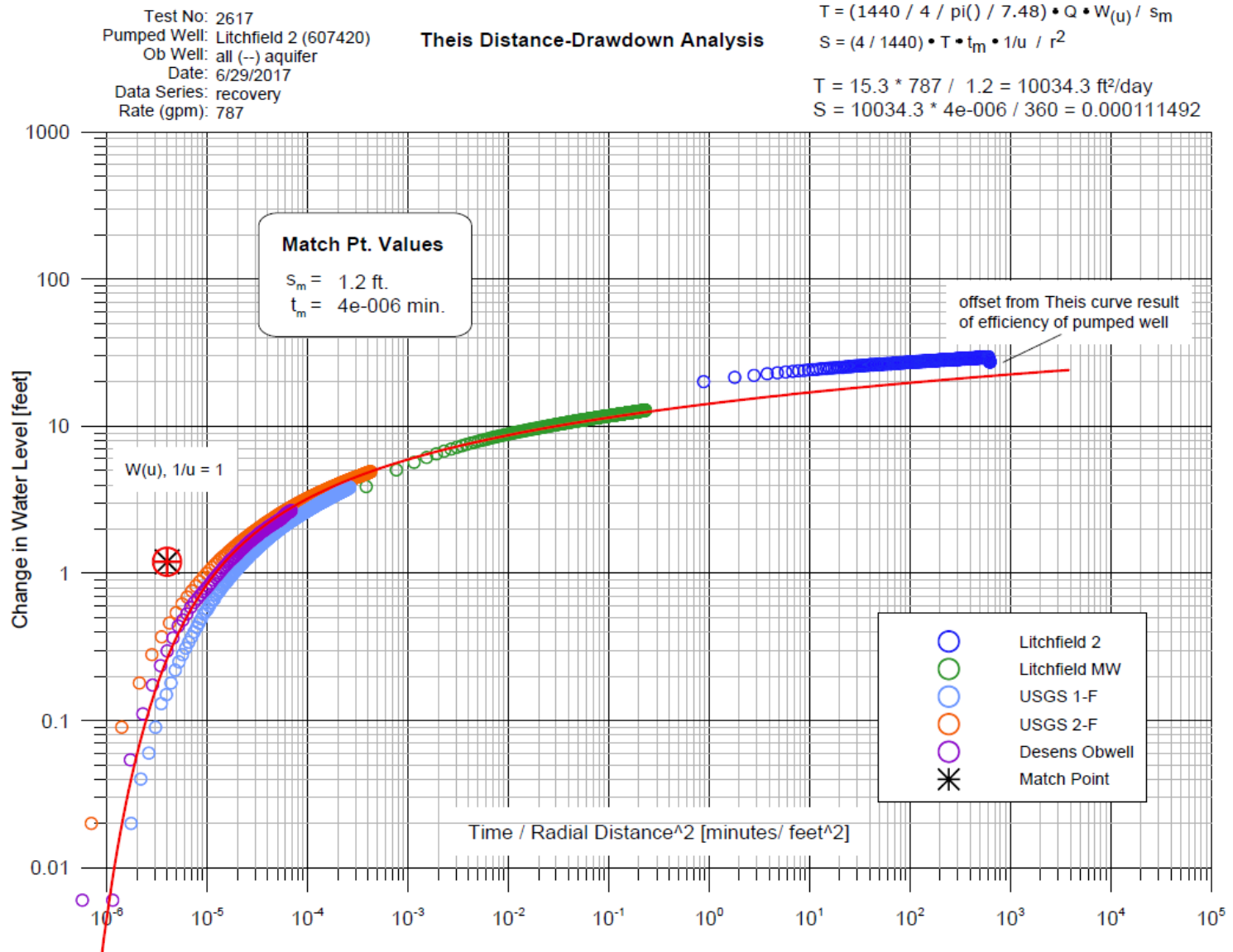


Figure 8. Projected recovery to 10,000 minutes for steady-state analysis

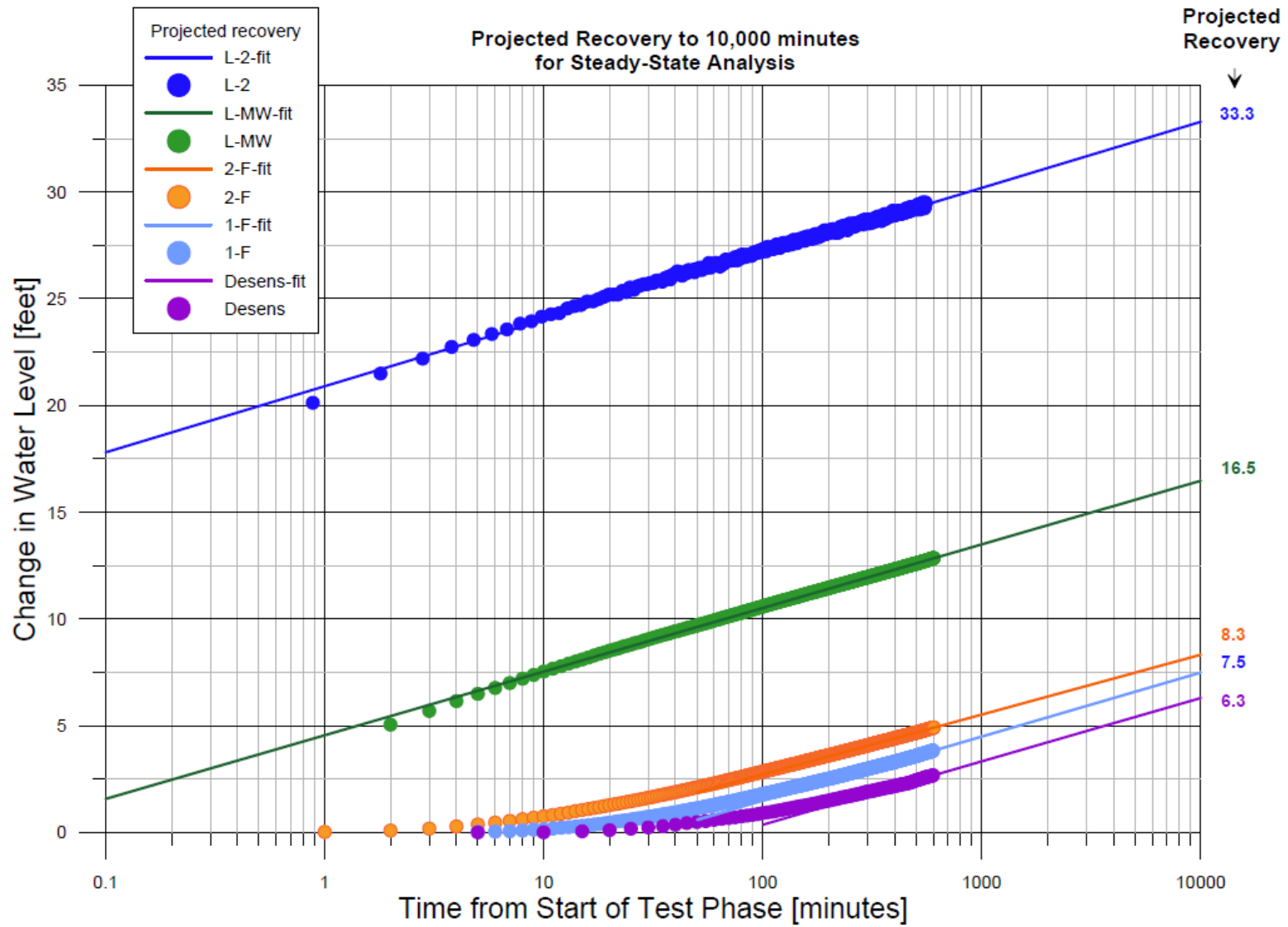


Figure 9. Cooper-Jacob (1946) transient and Hantush-Jacob (1955) steady-state analyses

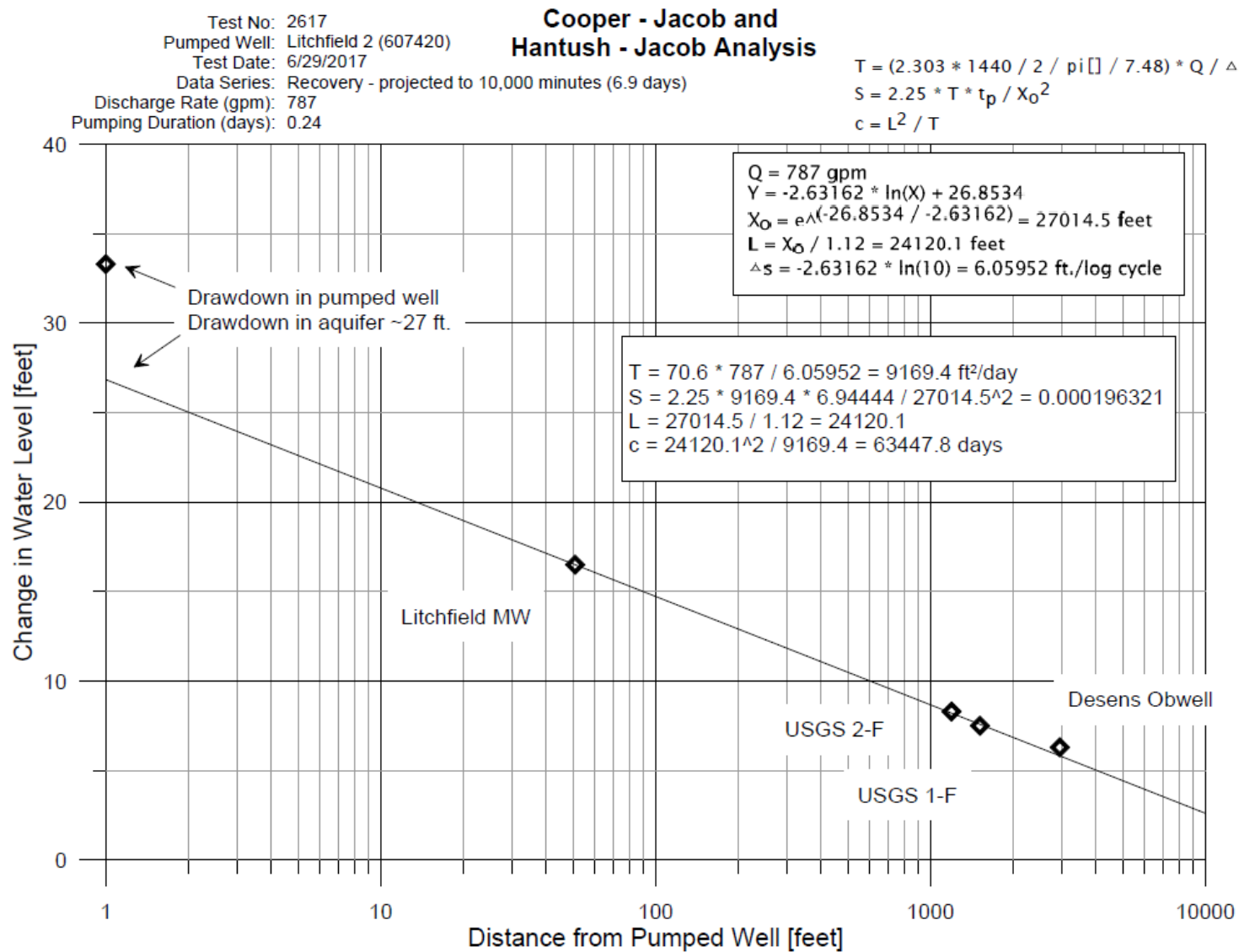


Figure 10. de Glee (1930) steady-state analysis

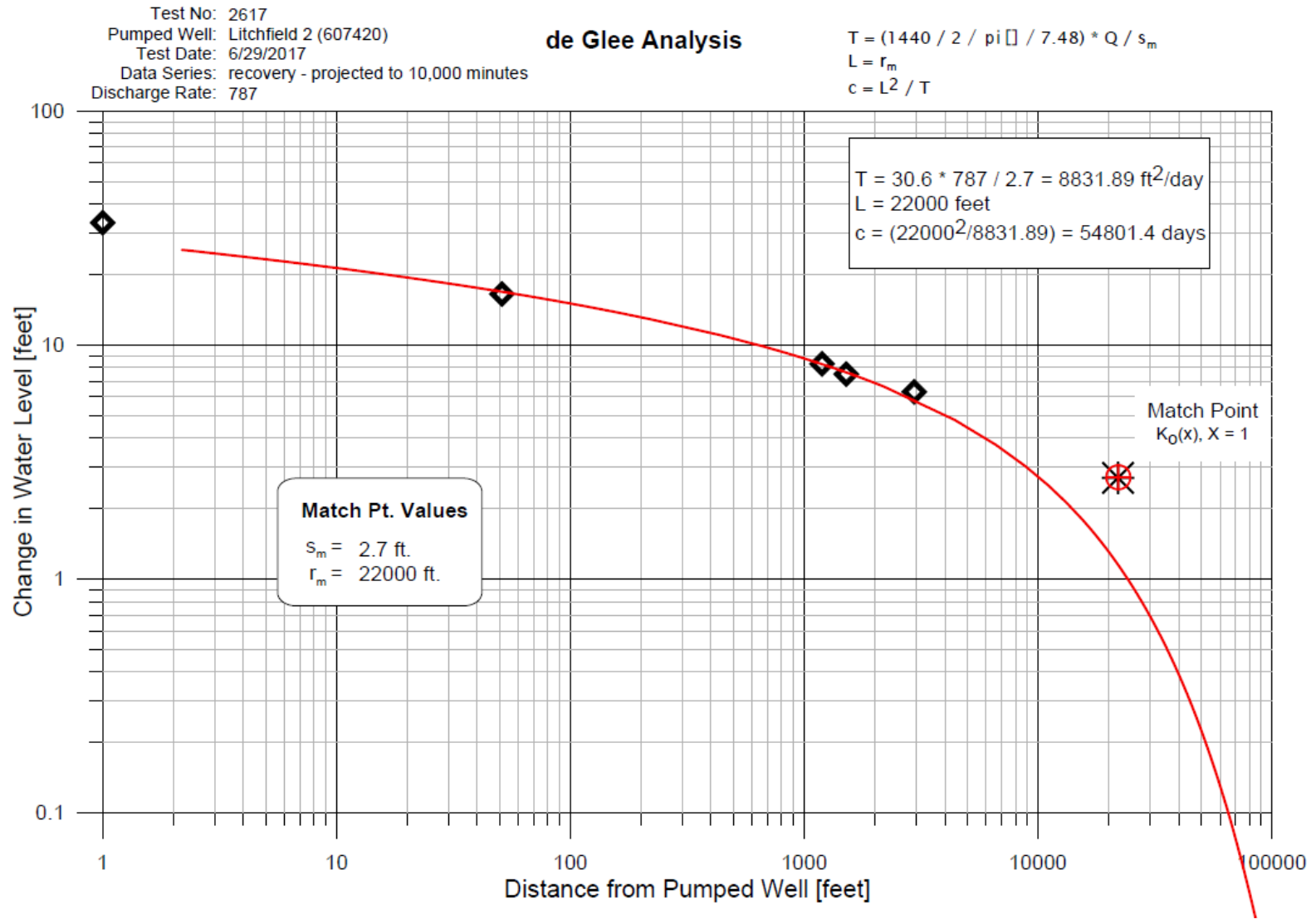


Figure 11. Difference in water level at USGS Nest-1 during pumping and recovery

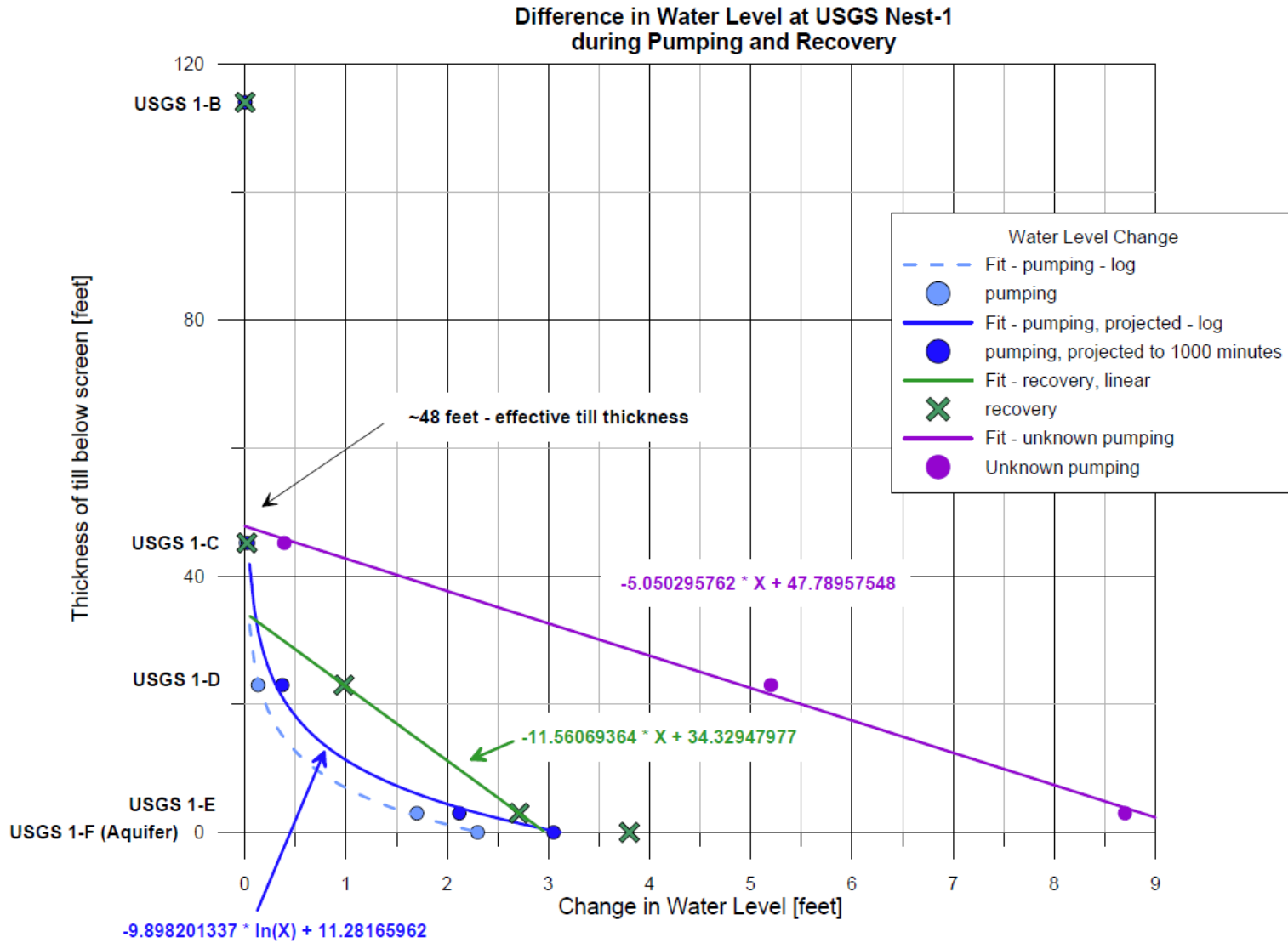
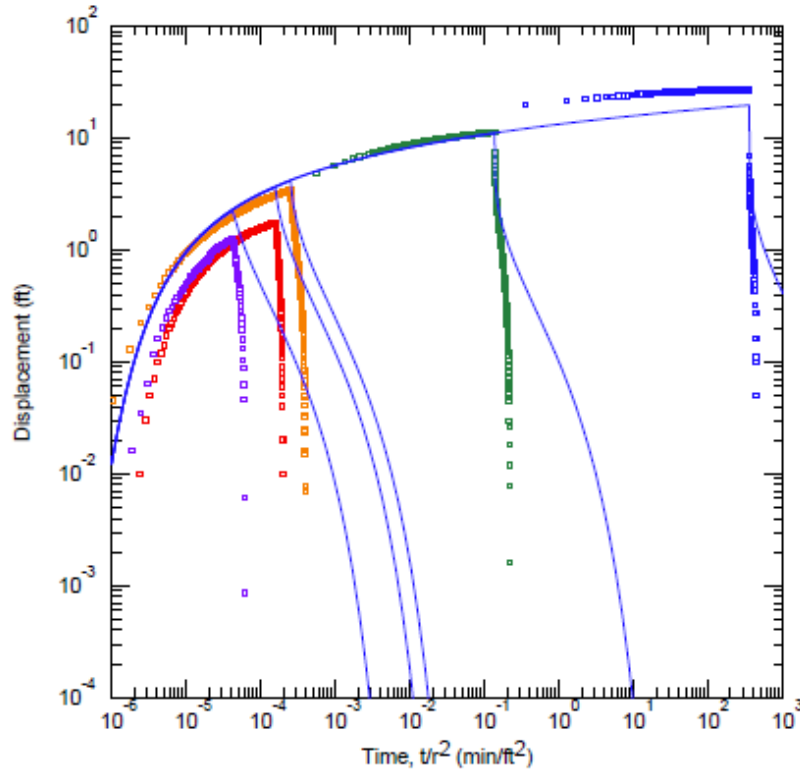


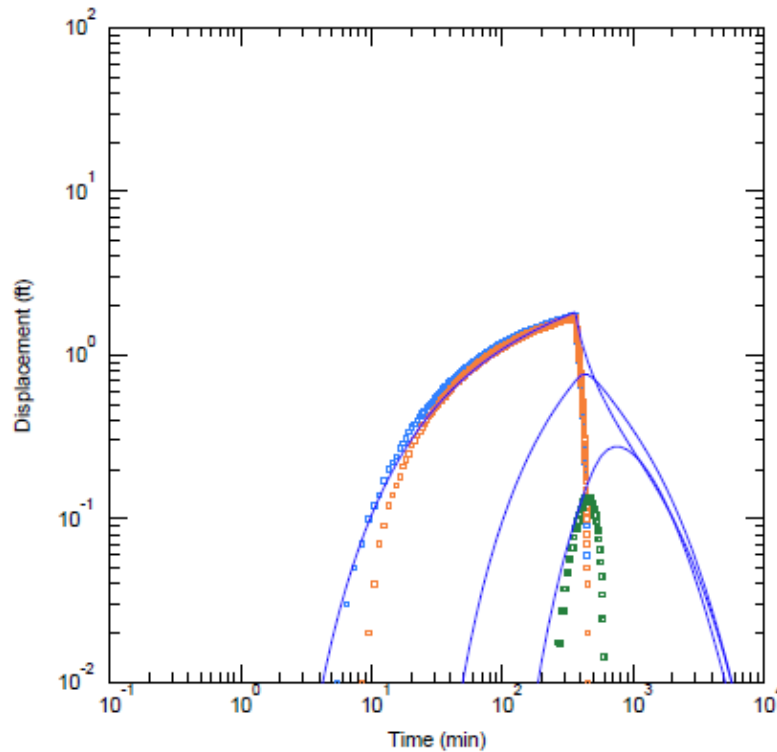
Figure 12. Aqtesolv composite (t/r²). Hantush-Jacob (1955) model



<u>WELL TEST ANALYSIS</u>					
Data Set: O:\...Litchfield_aquifer_composite.aqt			Time: 15:35:03		
Date: 08/28/17					
<u>PROJECT INFORMATION</u>					
Company: MDH					
Client: City of Litchfield					
Location: Litchfield 2					
Test Well: L-2 (607420)					
Test Date: 6/29/2017					
<u>WELL DATA</u>					
Pumping Wells			Observation Wells		
Well Name	X (ft)	Y (ft)	Well Name	X (ft)	Y (ft)
2	0	0	2	0	0
			MW	0	51
			USGS 1-F	0	-1513
			USGS 2-F	0	1193
			Desens	2958	0
<u>SOLUTION</u>					
Aquifer Model: Leaky			Solution Method: Hantush-Jacob		
T = 1.1E+4 ft ² /day			S = 9.5E-5		
1/B = 5.0E-5 ft ⁻¹			Kz/Kr = 1		
b = 6.944 ft					

L = 20,000 feet
 kV = 0.00005 * 11,000 * 50 = 0.0014 ft/day

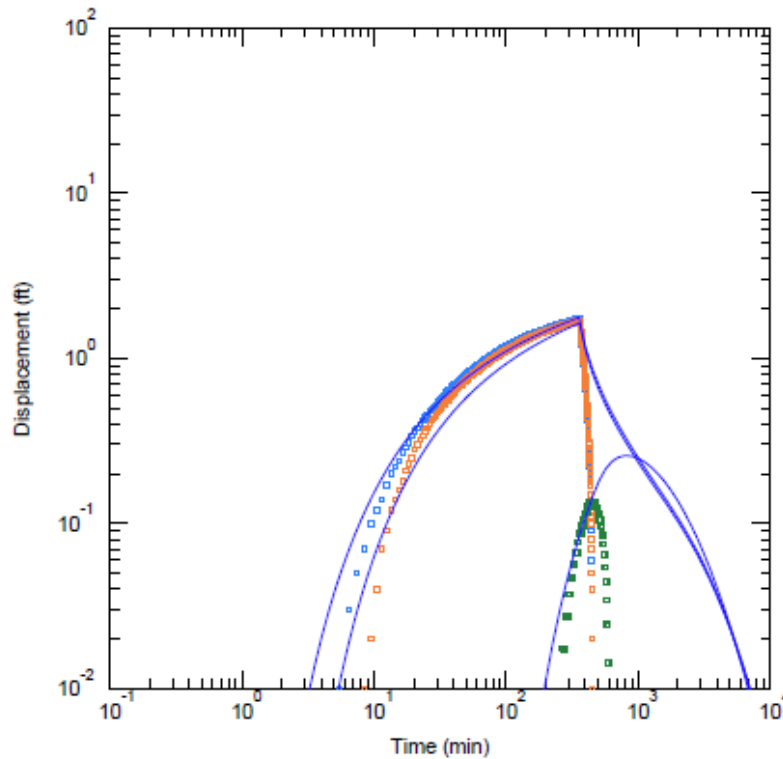
Figure 13. Aqtesolv analysis of data from Nest 1 wells, Neuman-Witherspoon (1969) model. Till thickness 63 feet.



<u>WELL TEST ANALYSIS</u>					
Data Set: O:\...113_litchfield_nest-1_neuman.aqt			Time: 12:24:43		
Date: 08/29/17					
<u>PROJECT INFORMATION</u>					
Company: MDH					
Client: City of Litchfield					
Location: Litchfield 2					
Test Well: L-2 (607420)					
Test Date: 6/29/2017					
<u>AQUIFER DATA</u>					
Saturated Thickness: 30. ft			Anisotropy Ratio (Kz/Kr): 1.		
Aquitard Thickness (b'): 63. ft			Aquitard Thickness (b''): 1. ft		
<u>WELL DATA</u>					
Pumping Wells			Observation Wells		
Well Name	X (ft)	Y (ft)	Well Name	X (ft)	Y (ft)
2	0	0	USGS 1-F	0	-1513
			USGS 1-E	0	-1514
			USGS 1-D	0	-1510
<u>SOLUTION</u>					
Aquifer Model: Leaky			Solution Method: Neuman-Witherspoon		
T = 10000. ft ² /day			S = 0.00015		
1/B = 0.0002092 ft ⁻¹			B/r = 0.0001731 ft ⁻¹		
T2 = 1000. ft ² /day			S2 = 1.		

L = 5,000 feet
 $kV = 0.0002 * 10,000 * 50 = 0.02 \text{ ft/day}$

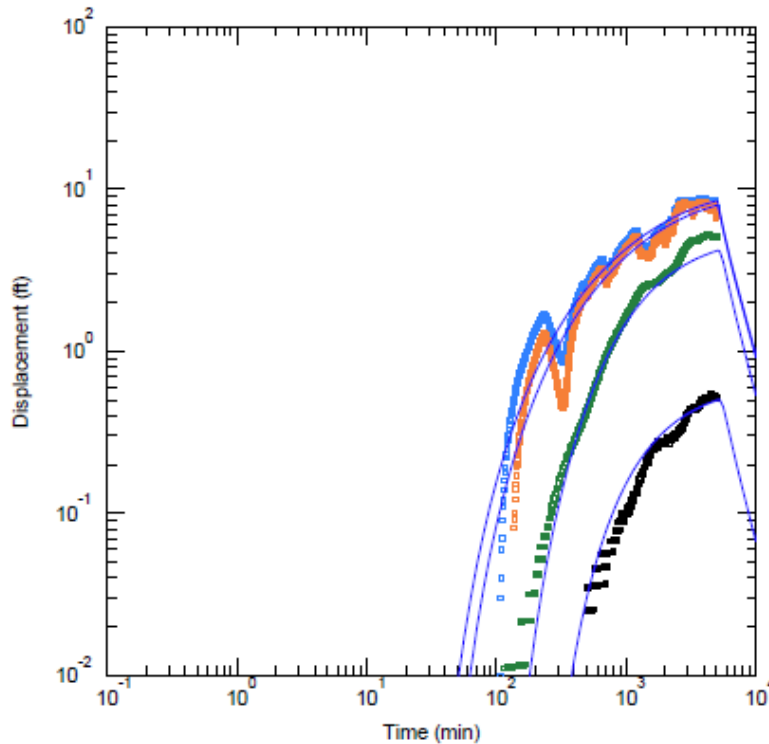
Figure 14. Aqtesolv analysis of data from Nest 1 wells, Neuman-Witherspoon (1969) model. Till thickness 50 feet



<u>WELL TEST ANALYSIS</u>					
Data Set: O:\...14_litchfield_nest-1_neuman_thickness.aqt					
Date: 08/29/17			Time: 12:19:34		
<u>PROJECT INFORMATION</u>					
Company: MDH					
Client: City of Litchfield					
Location: Litchfield 2					
Test Well: L-2 (607420)					
Test Date: 6/29/2017					
<u>AQUIFER DATA</u>					
Saturated Thickness: 30. ft			Anisotropy Ratio (Kz/Kr): 1.		
Aquitard Thickness (b'): 50. ft			Aquitard Thickness (b''): 1. ft		
<u>WELL DATA</u>					
Pumping Wells			Observation Wells		
Well Name	X (ft)	Y (ft)	Well Name	X (ft)	Y (ft)
2	0	0	USGS 1-F	0	-1513
			USGS 1-E	0	-1514
			USGS 1-D	0	-1510
<u>SOLUTION</u>					
Aquifer Model: Leaky			Solution Method: Neuman-Witherspoon		
T = 1.08E+4 ft ² /day			S = 0.00012		
1/B = 0.0001825 ft ⁻¹			B/r = 0.0001939 ft ⁻¹		
T2 = 1000. ft ² /day			S2 = 1.		

L = 5,500 feet
 $k_v = 0.0001825 * 10,800 * 50 = 0.018 \text{ ft/day}$

Figure 15. Aqtesolv analysis of data from Nest 1 wells, Neuman-Witherspoon (1969) model. Drawdown from unknown pumping wells.



WELL TEST ANALYSIS					
Data Set: O:\...115_litchfield_unkpump_nest-1_neuman.aqt					
Date: 08/29/17			Time: 12:16:07		
PROJECT INFORMATION					
Company: MDH					
Client: City of Litchfield					
Location: Litchfield 2					
Test Well: L-2 (607420)					
Test Date: 6/29/2017					
AQUIFER DATA					
Saturated Thickness: 30. ft			Anisotropy Ratio (Kz/Kr): 1.		
Aquitard Thickness (b'): 50. ft			Aquitard Thickness (b''): 1. ft		
WELL DATA					
Pumping Wells			Observation Wells		
Well Name	X (ft)	Y (ft)	Well Name	X (ft)	Y (ft)
UnkPump	0	0	USGS 1-F	8000	0
			USGS 1-E	8000	0
			USGS 1-D	8000	0
			USGS 1-C	8000	0
SOLUTION					
Aquifer Model: Leaky			Solution Method: Neuman-Witherspoon		
T = 8000. ft ² /day			S = 7.38E-5		
1/B = 5.0E-5 ft ⁻¹			B/r = 9.198E-6 ft ⁻¹		
T2 = 10000. ft ² /day			S2 = 1.		

$L = 20,000 \text{ feet}$
 $k_v = 0.00005 * 8000 * 50 = 0.001 \text{ ft/day}$

Figure 16. Well Location Map: well name and Minnesota unique well number

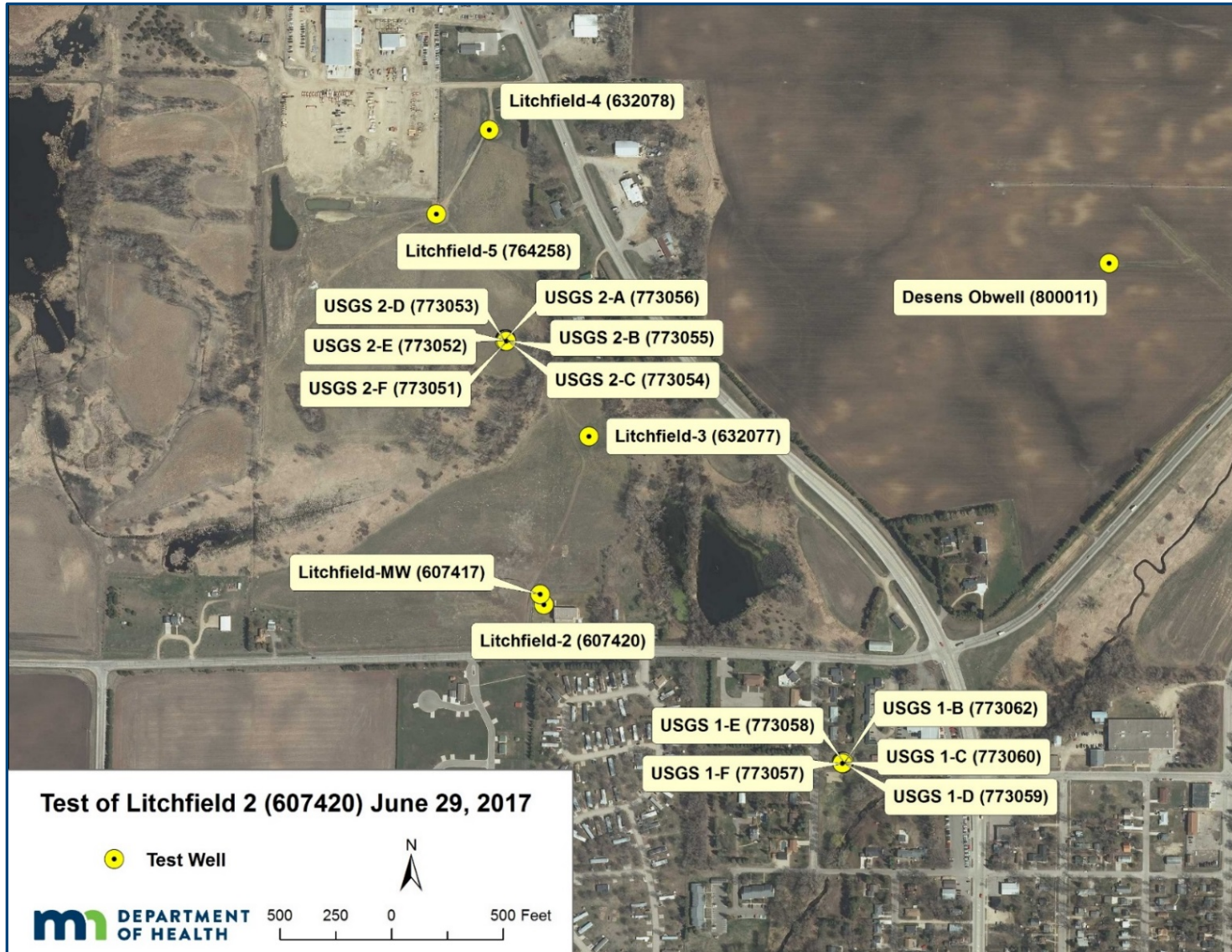


Figure 17. Schematic Section

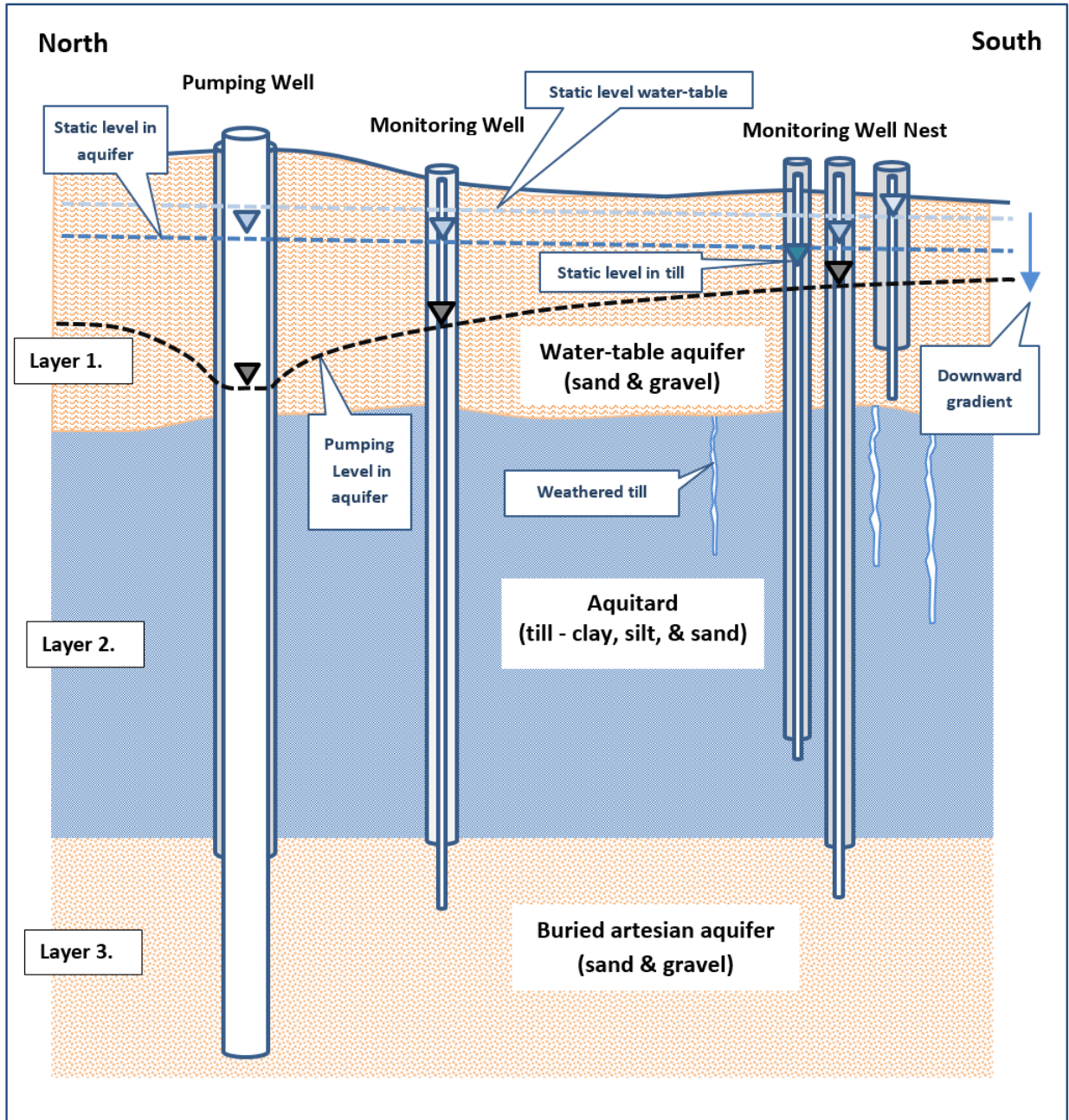
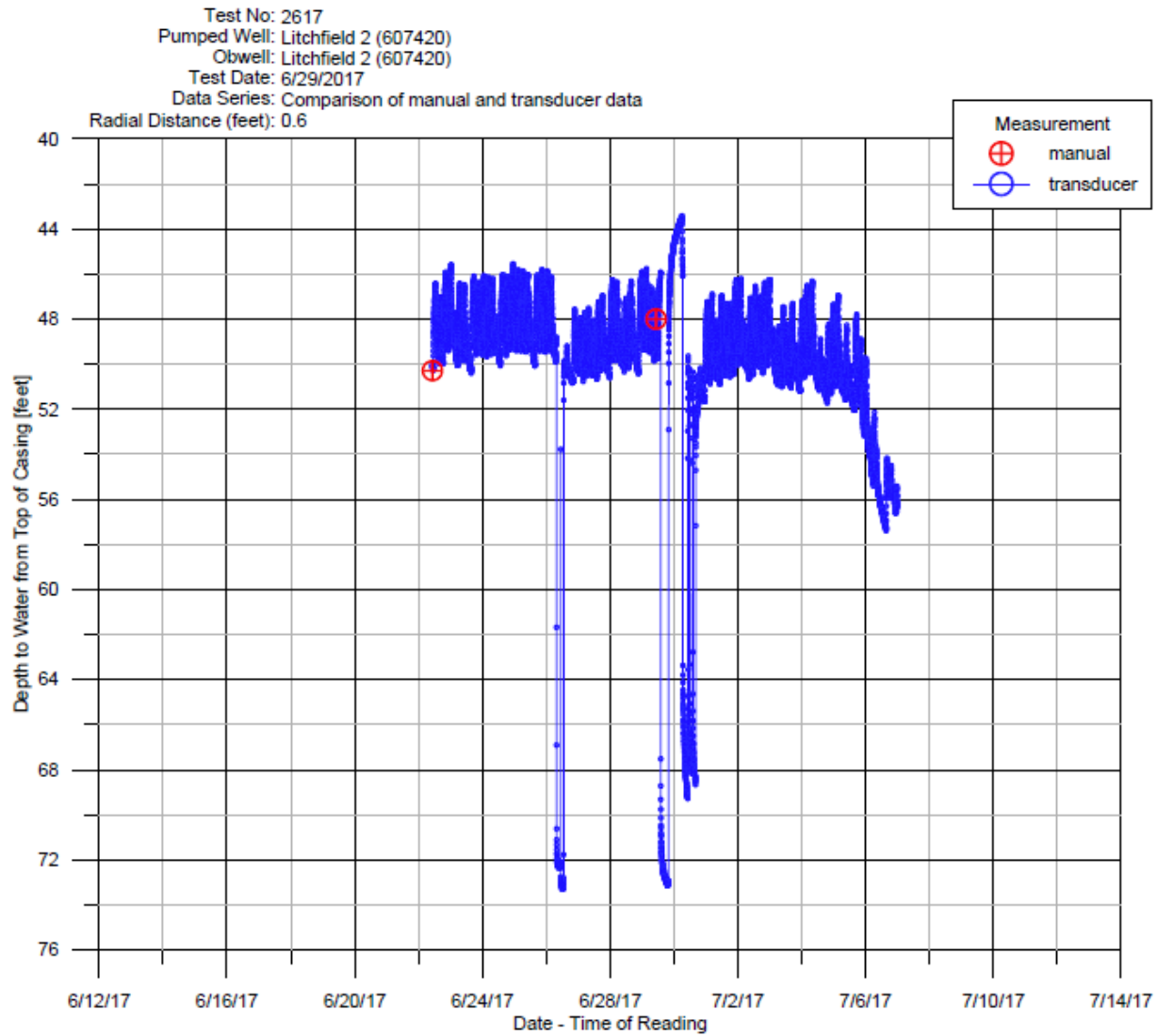


Figure 18. Depth to Water from Top of Casing at Litchfield 2 (607417), Both Manual and Electronic Measurements



TEST 2617, LITCHFIELD 2 (607420) JUNE 29, 2017

Figure 19. Depth to Water from Top of Casing at Litchfield MW (607420), Both Manual and Electronic Measurements

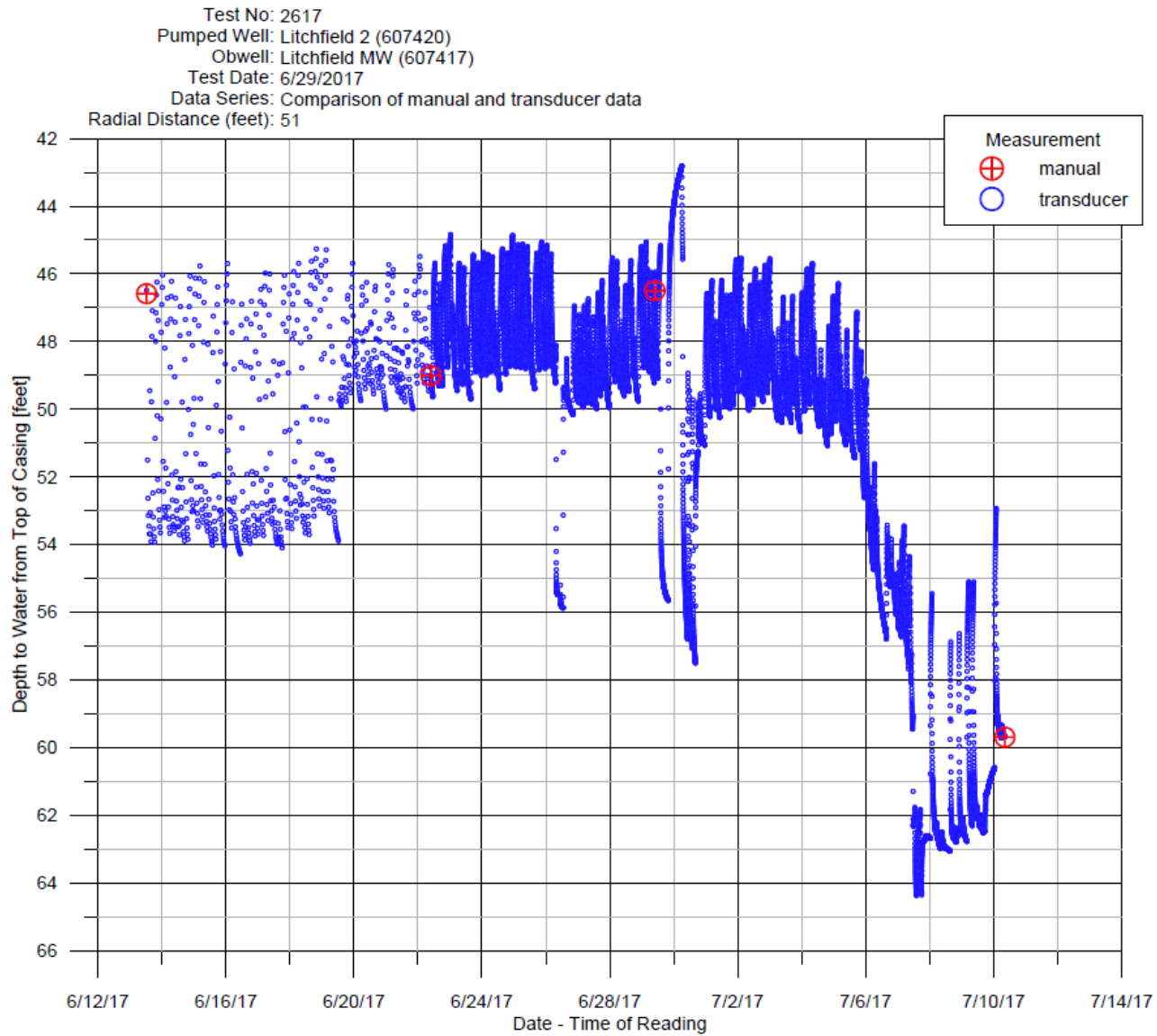


Figure 20. Depth to Water from Top of Casing at Litchfield 3 (632077), Manual Measurements

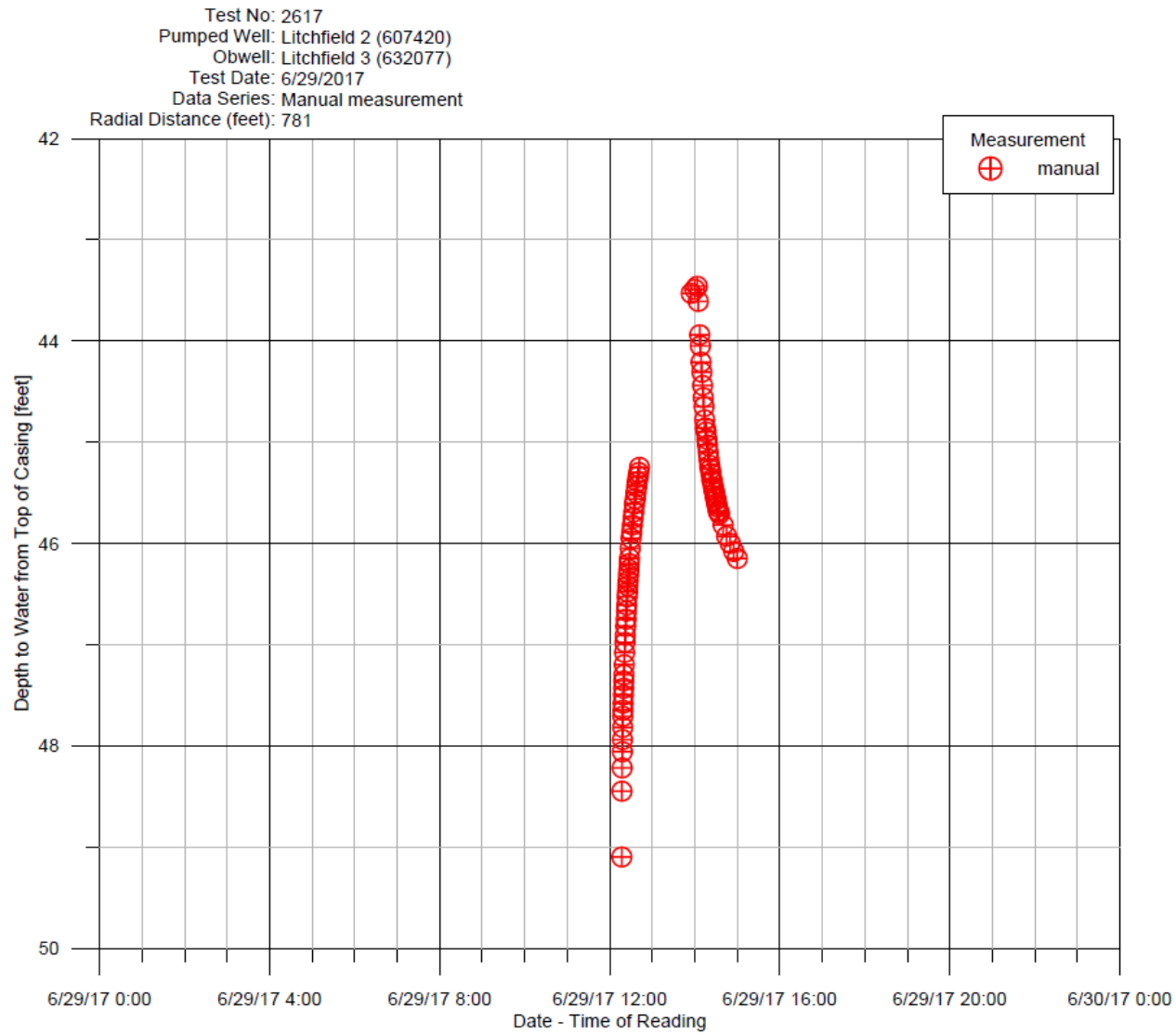


Figure 21. Depth to Water from Top of Casing at Litchfield 4 (632078), Manual Measurements

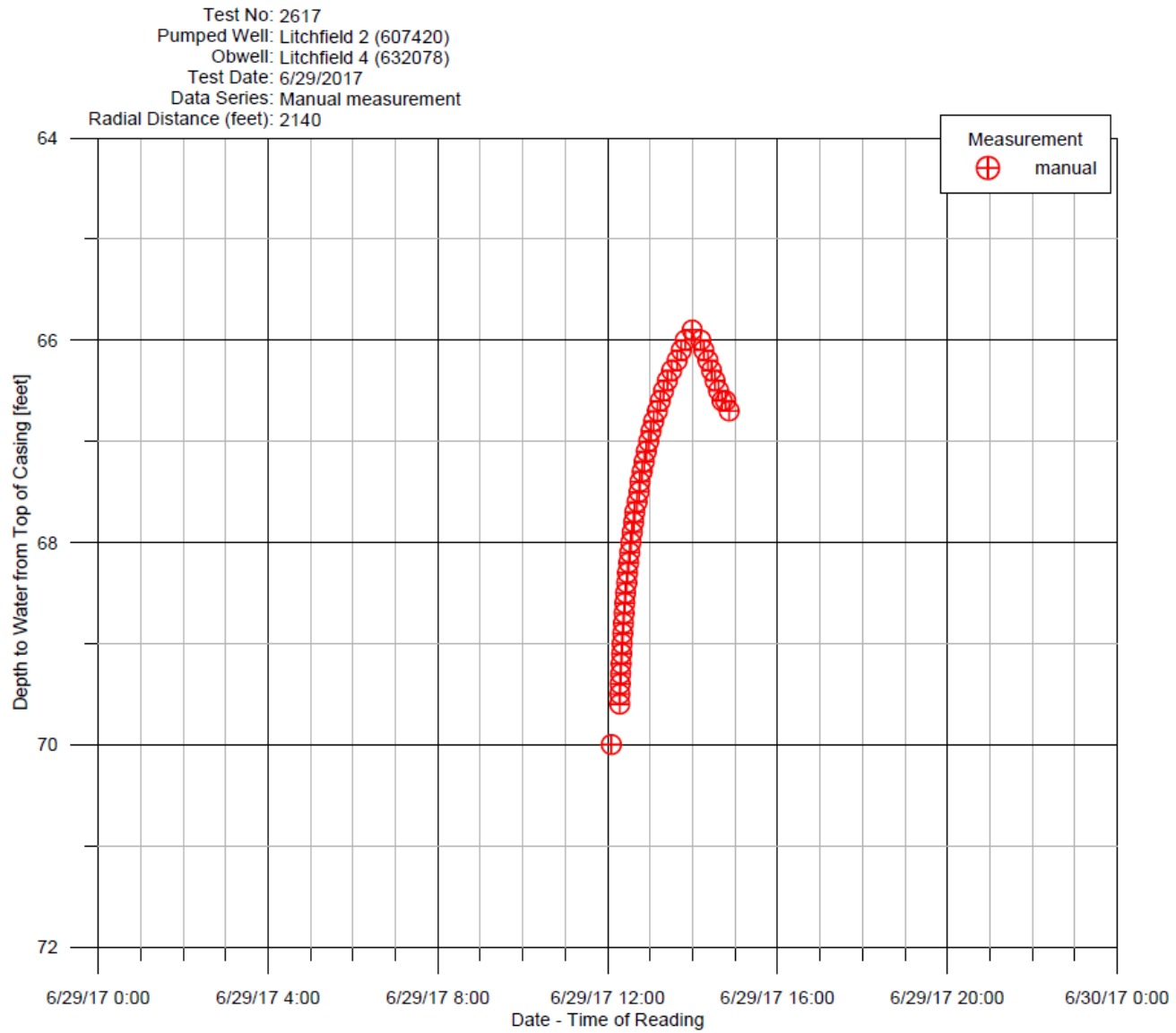


Figure 22. Depth to Water from Top of Casing at Litchfield 5 (764258), Manual Measurements

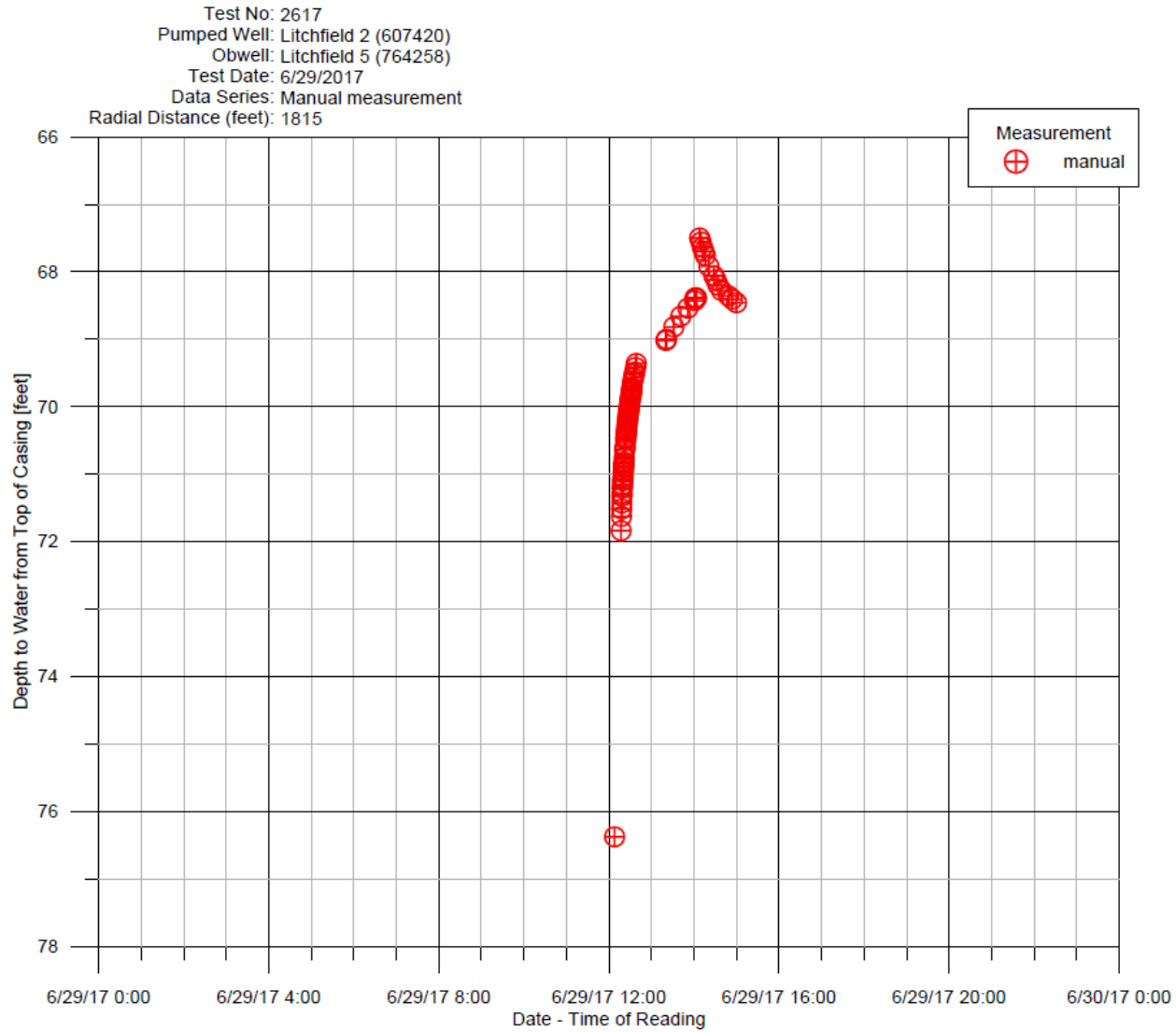


Figure 23. Depth to Water from Top of Casing at USGS 1-B (773062), Both Manual and Electronic Measurements

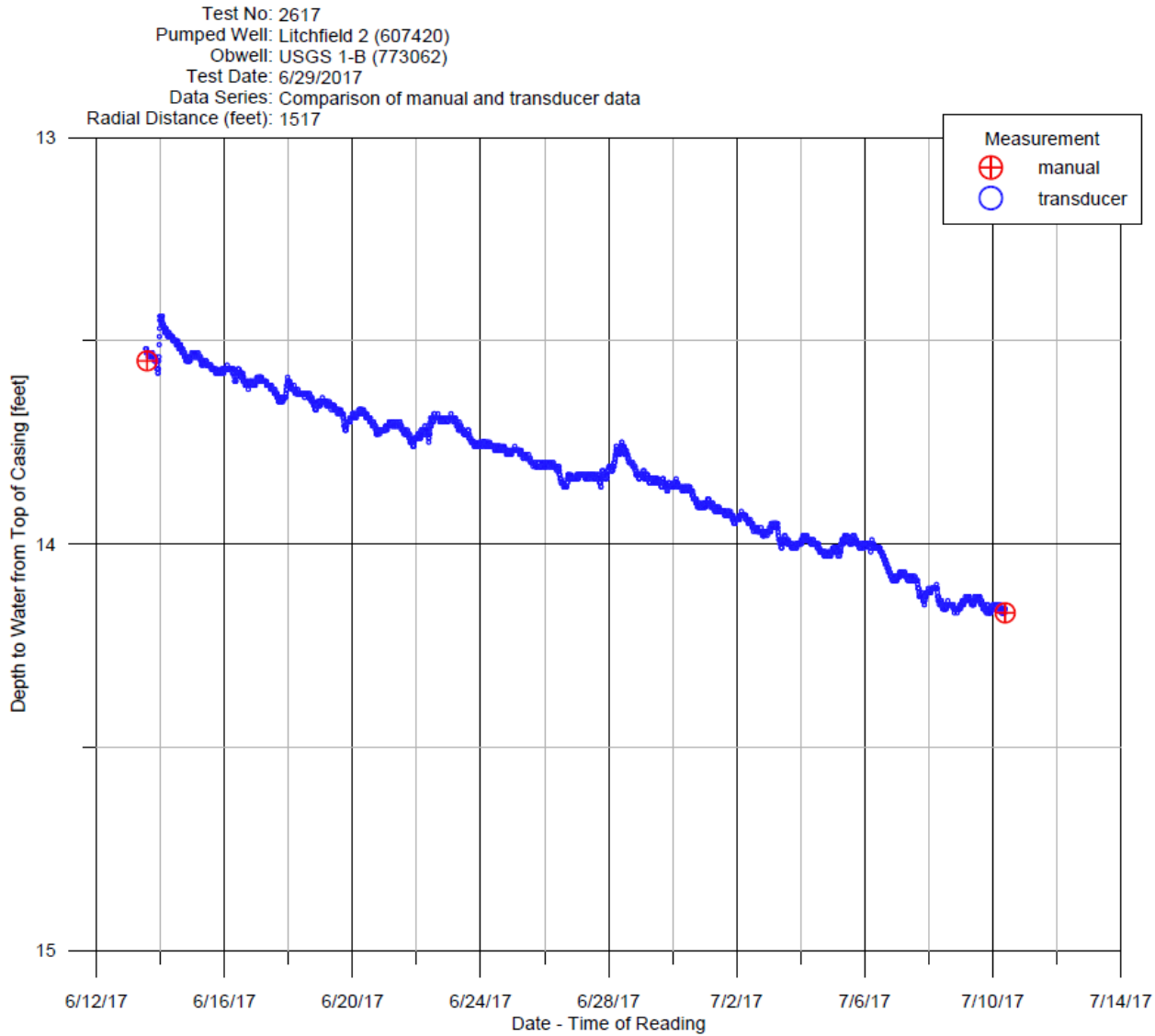
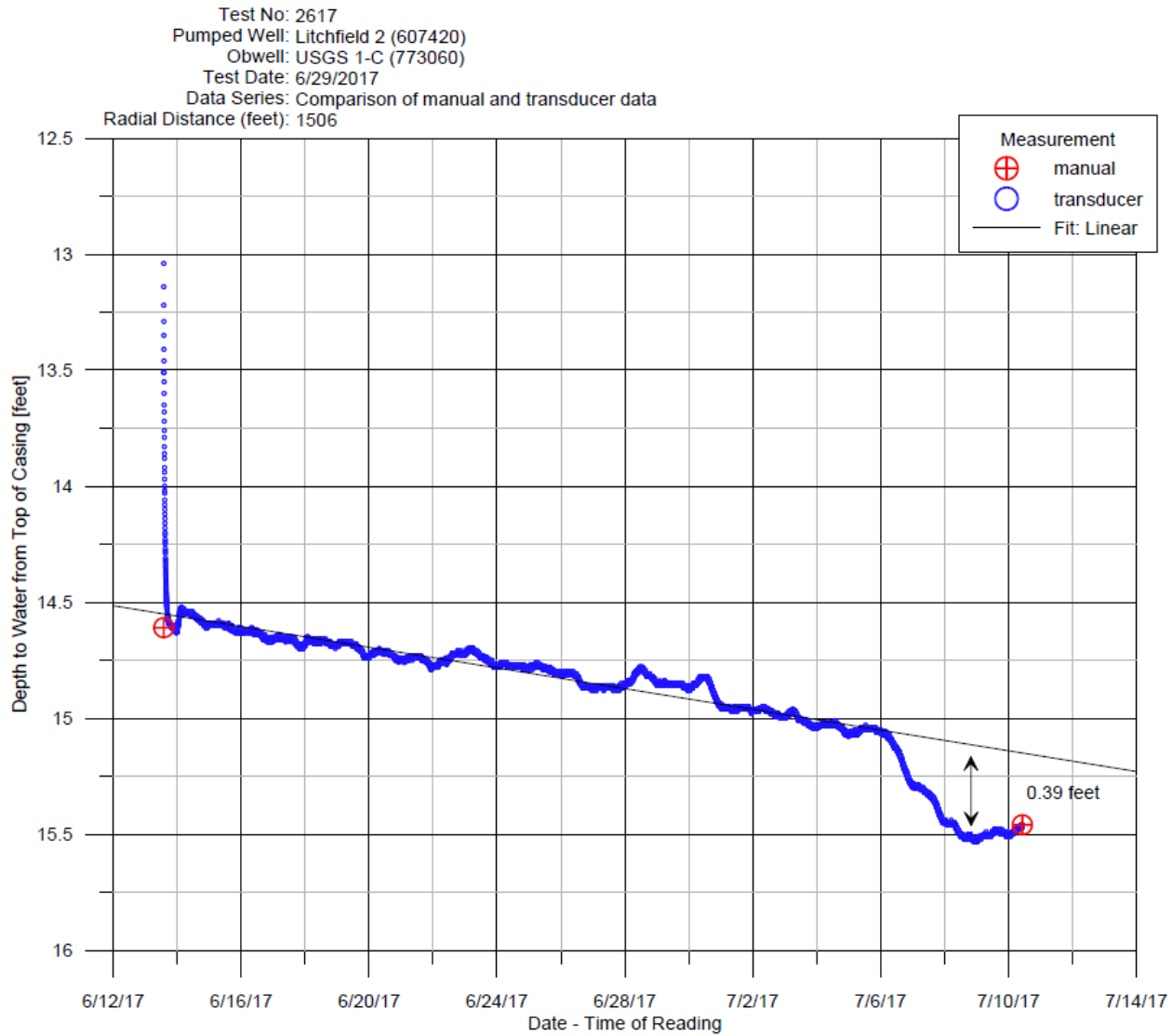
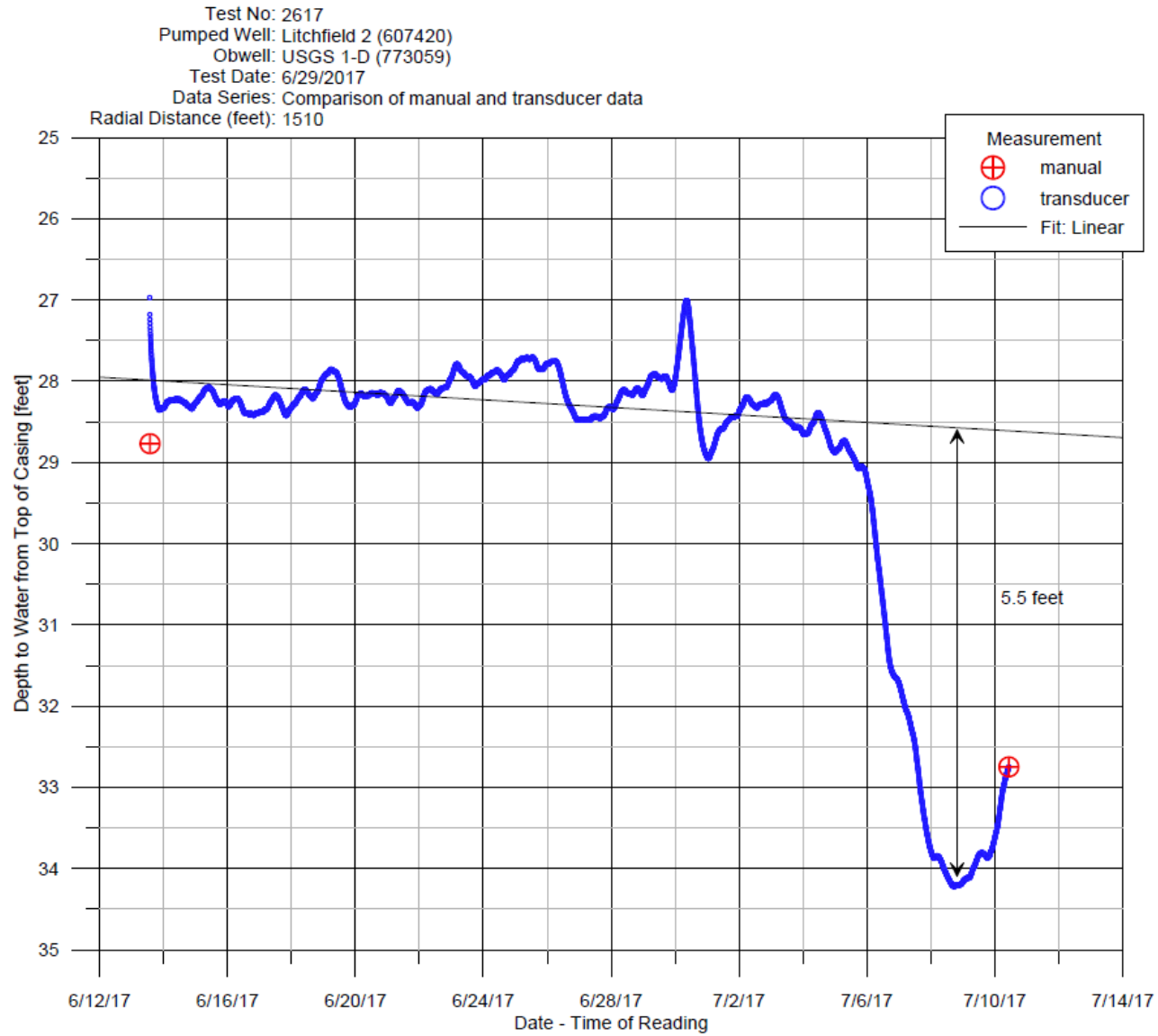


Figure 24. Depth to Water from Top of Casing at USGS 1-C (773060), Both Manual and Electronic Measurements



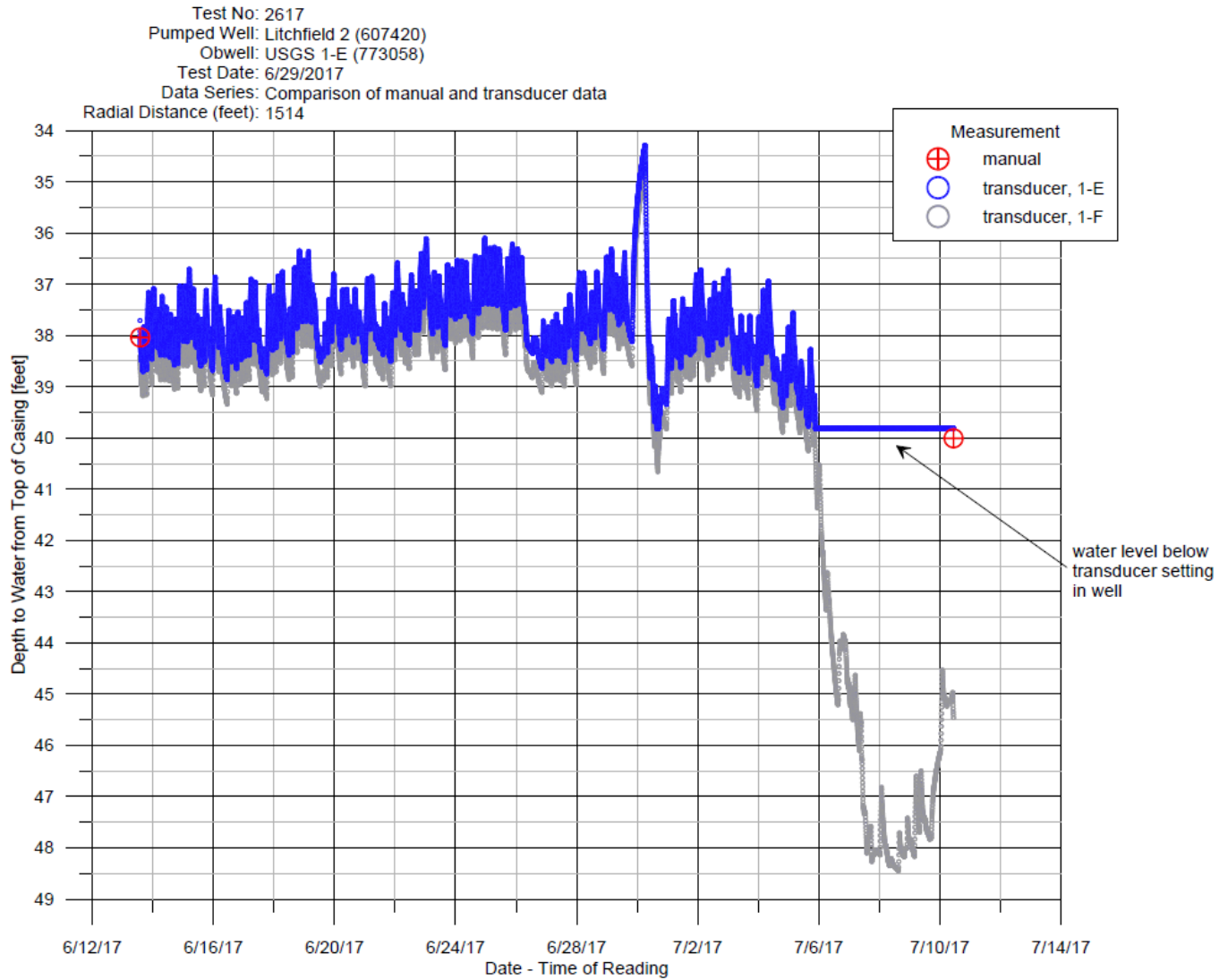
TEST 2617, LITCHFIELD 2 (607420) JUNE 29, 2017

Figure 25. Depth to Water from Top of Casing at USGS 1-D (773059), Both Manual and Electronic Measurements



TEST 2617, LITCHFIELD 2 (607420) JUNE 29, 2017

Figure 26. Depth to Water from Top of Casing at USGS 1-E (773058), Both Manual and Electronic Measurements



TEST 2617, LITCHFIELD 2 (607420) JUNE 29, 2017

Figure 27. Depth to Water from Top of Casing at USGS 1-F (773057), Both Manual and Electronic Measurements

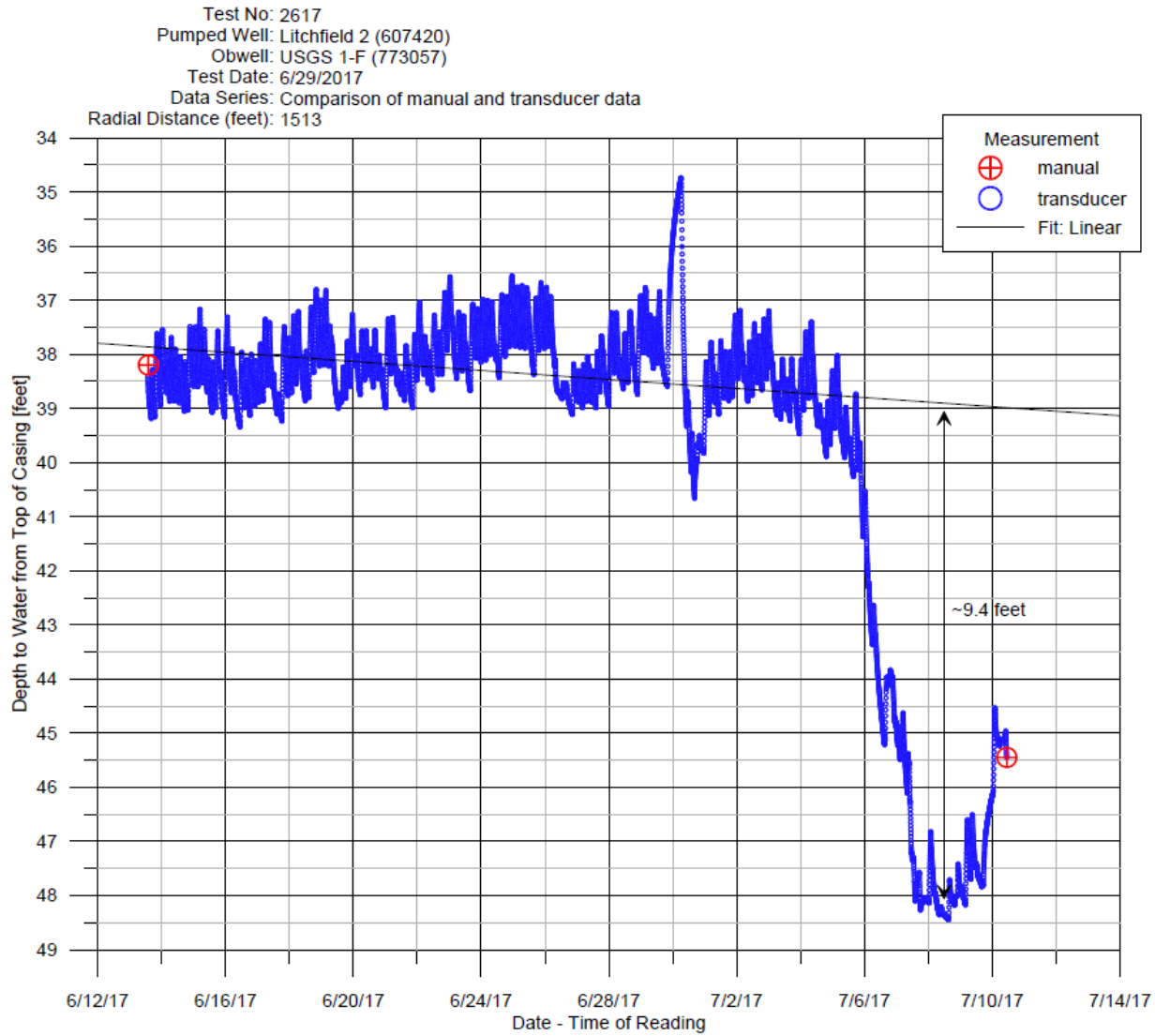


Figure 28. Depth to Water from Top of Casing at USGS 2-A (773056), Both Manual and Electronic Measurements

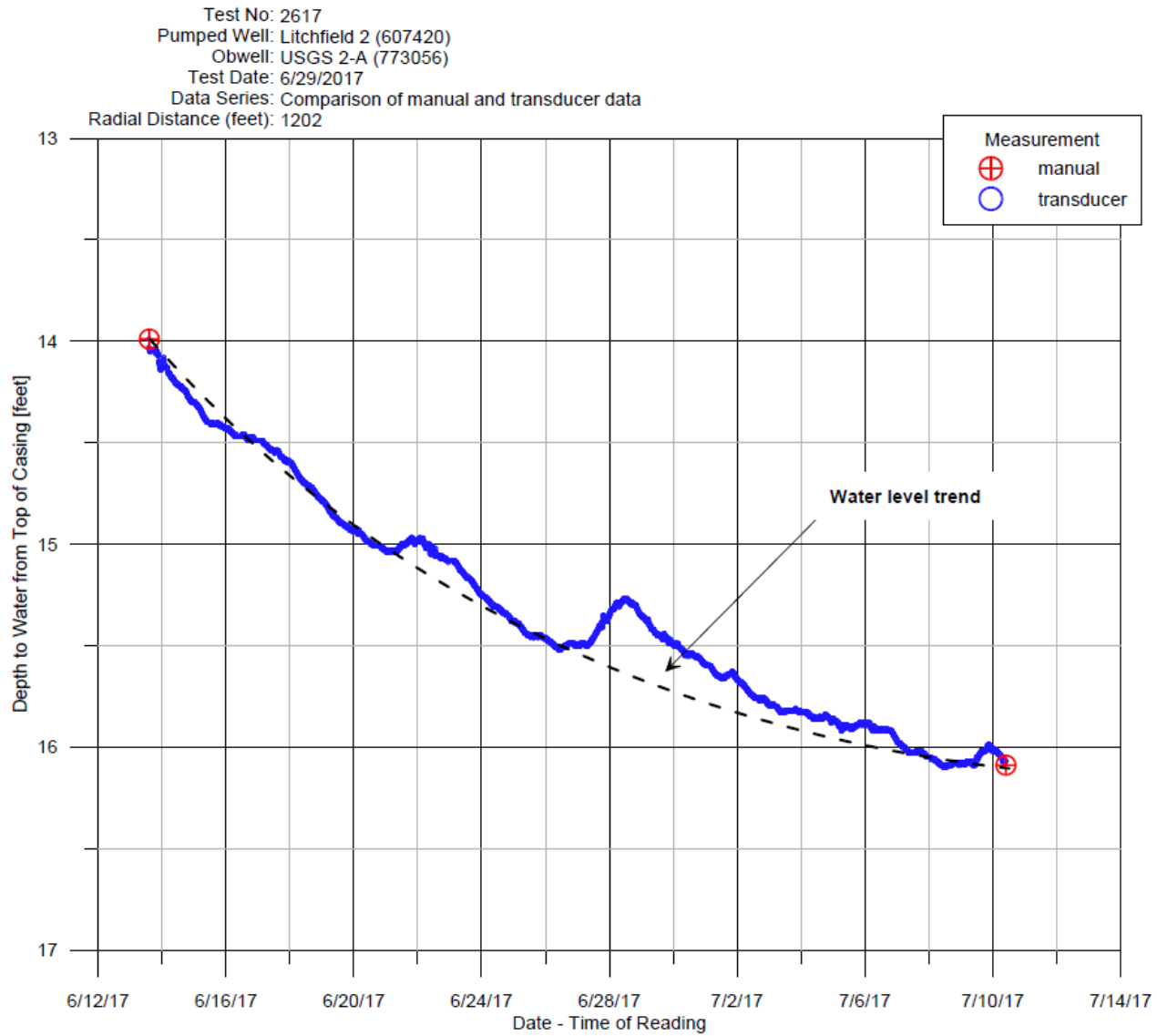


Figure 29. Depth to Water from Top of Casing at USGS 2-B (773055), Both Manual and Electronic Measurements

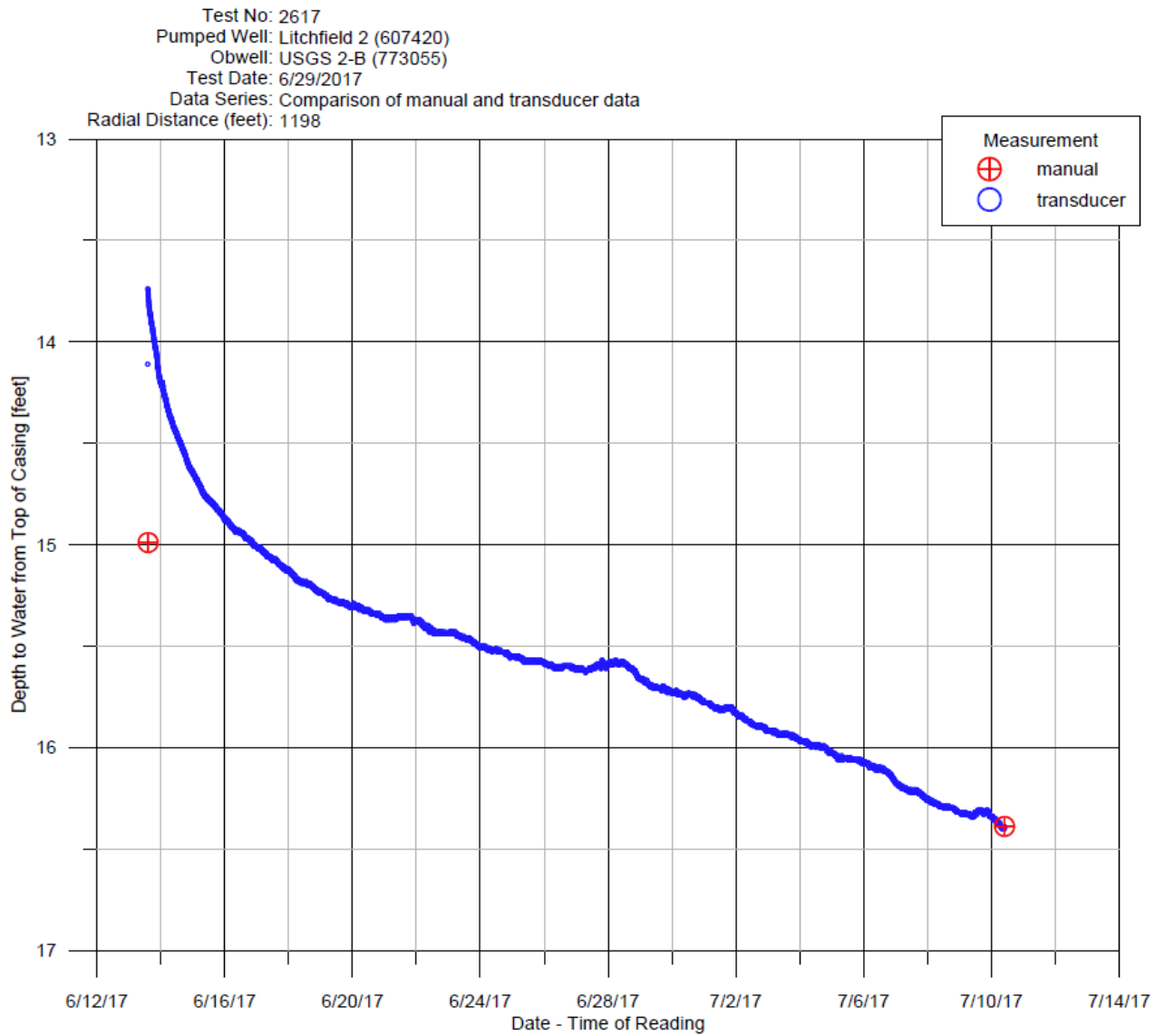


Figure 30. Depth to Water from Top of Casing at USGS 2-C (773054), Both Manual and Electronic Measurements

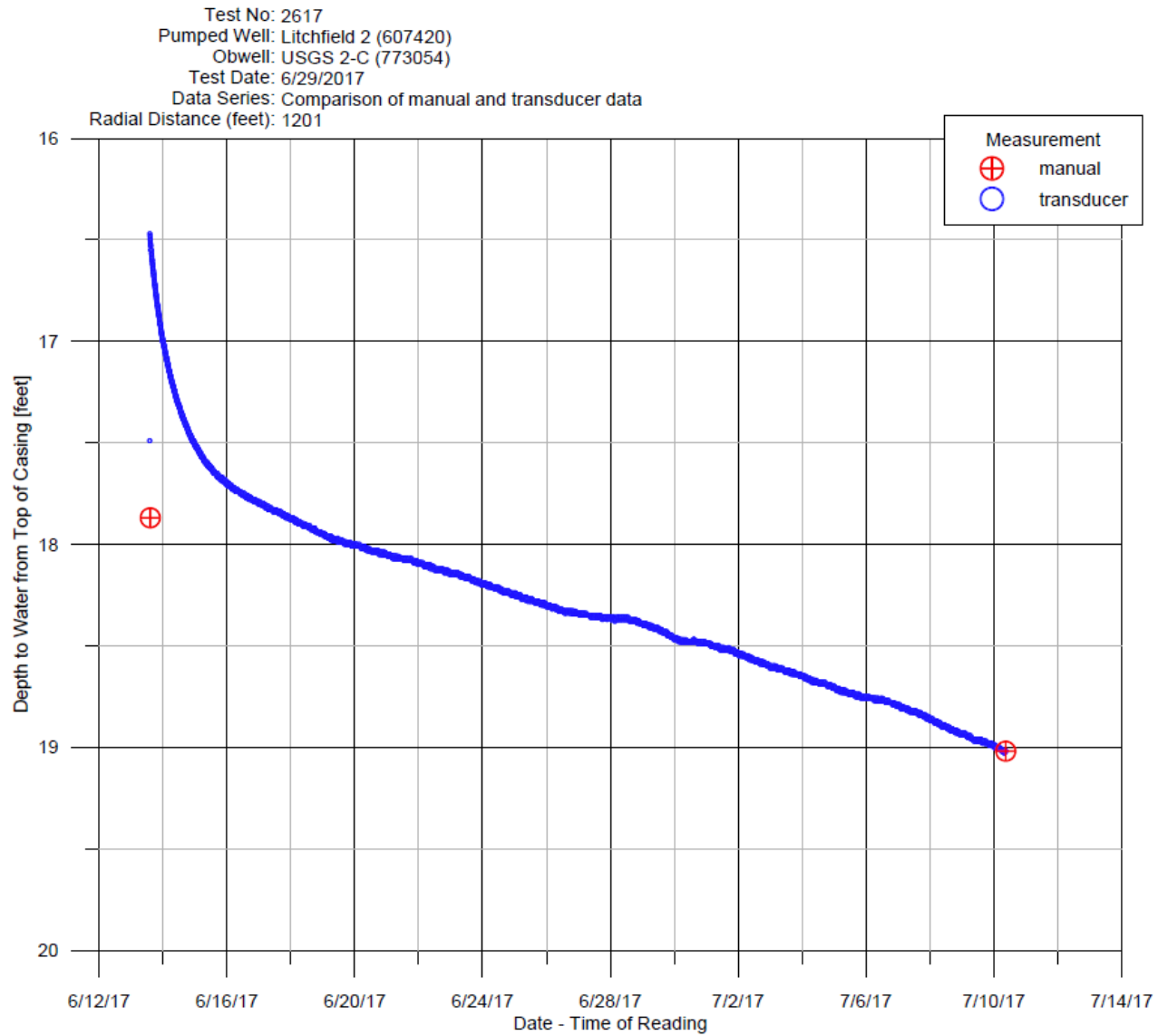
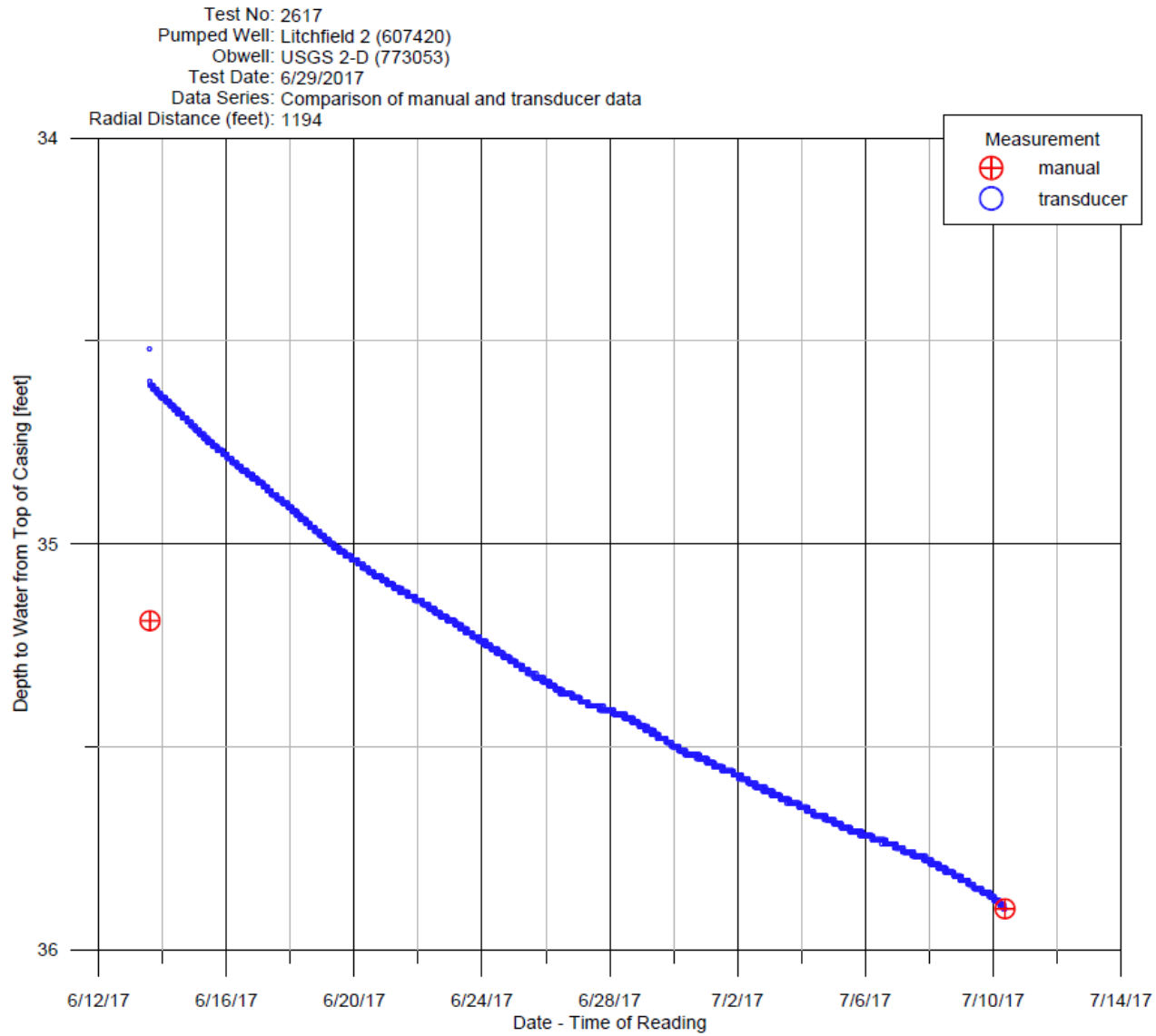


Figure 31. Depth to Water from Top of Casing at USGS 2-D (773053), Both Manual and Electronic Measurements



TEST 2617, LITCHFIELD 2 (607420) JUNE 29, 2017

Figure 32. Depth to Water from Top of Casing at USGS 2-F (773051), Both Manual and Electronic Measurements

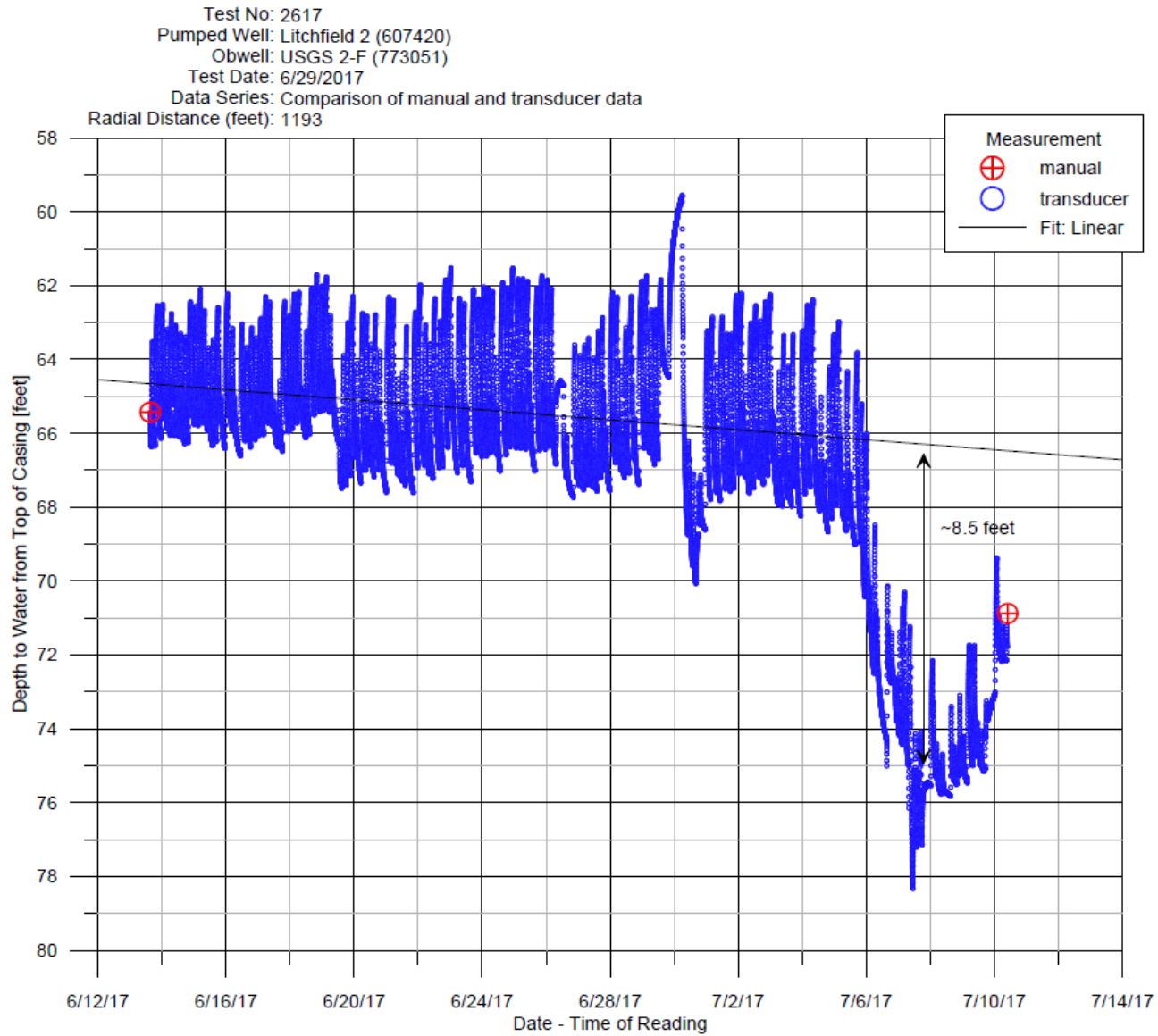


Figure 33. Depth to Water from Top of Casing at Desens Observation (800011), Both Manual and Electronic Measurements

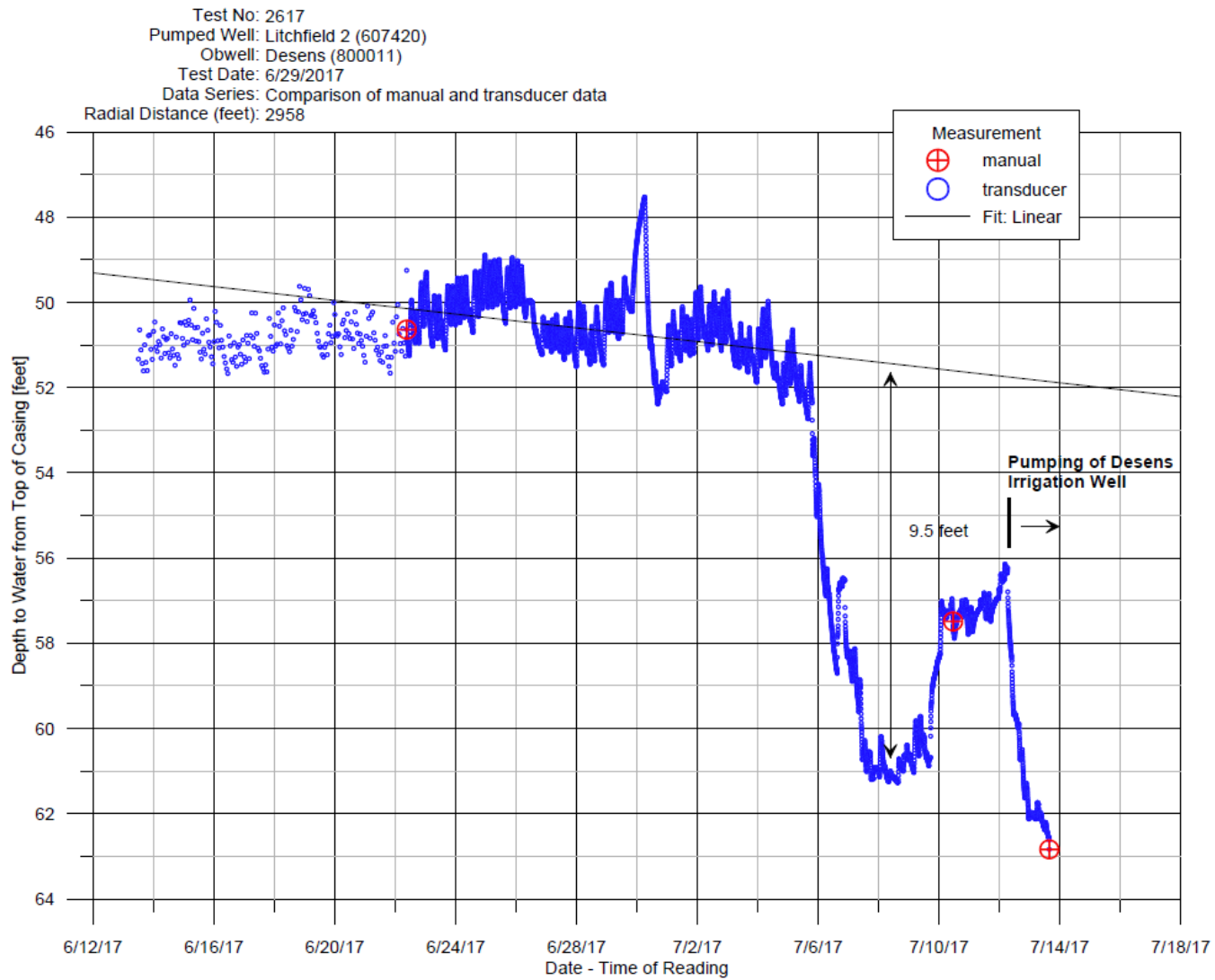


Figure 34. Groundwater elevation at Litchfield-2 and Nest 1

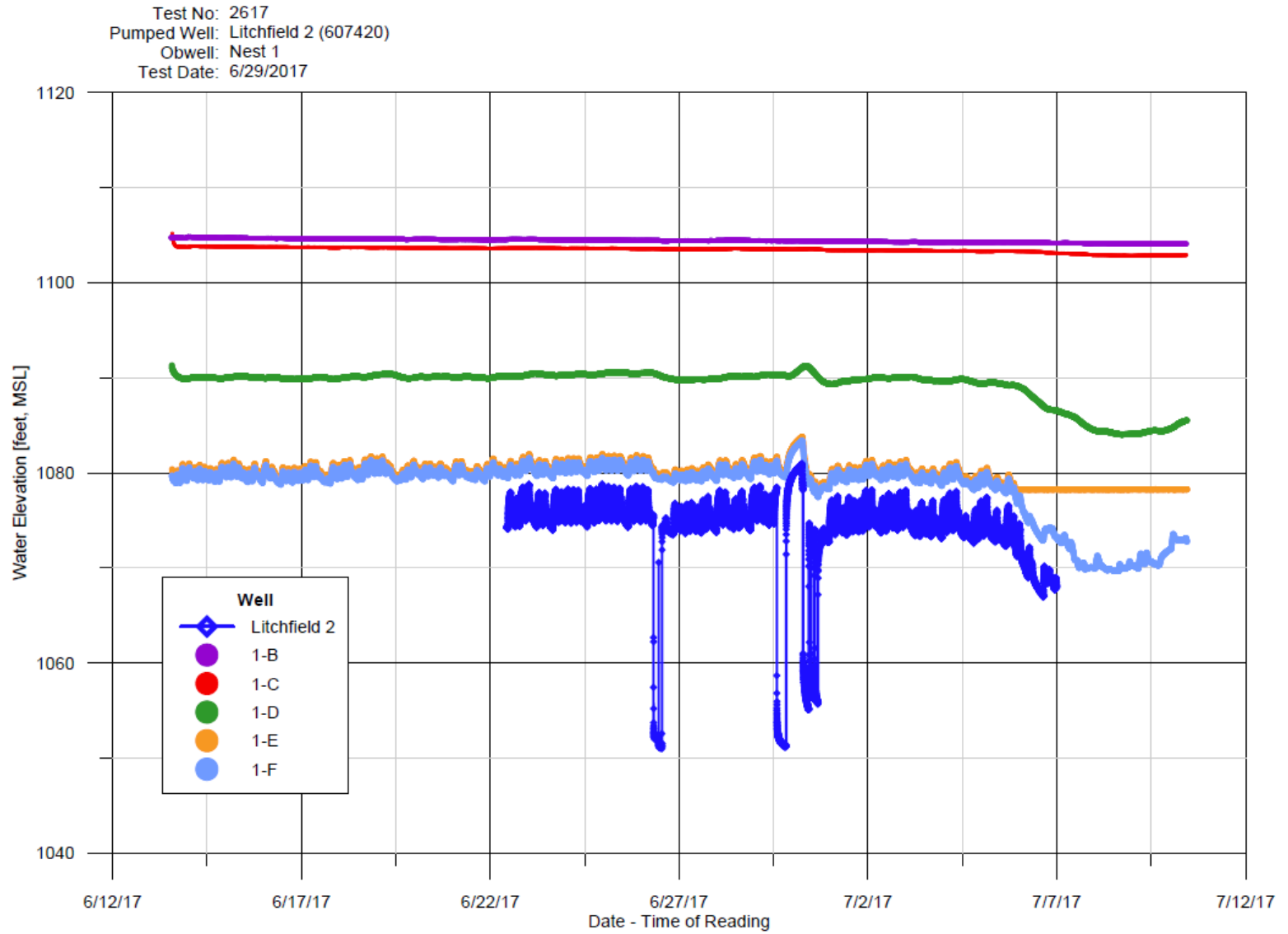
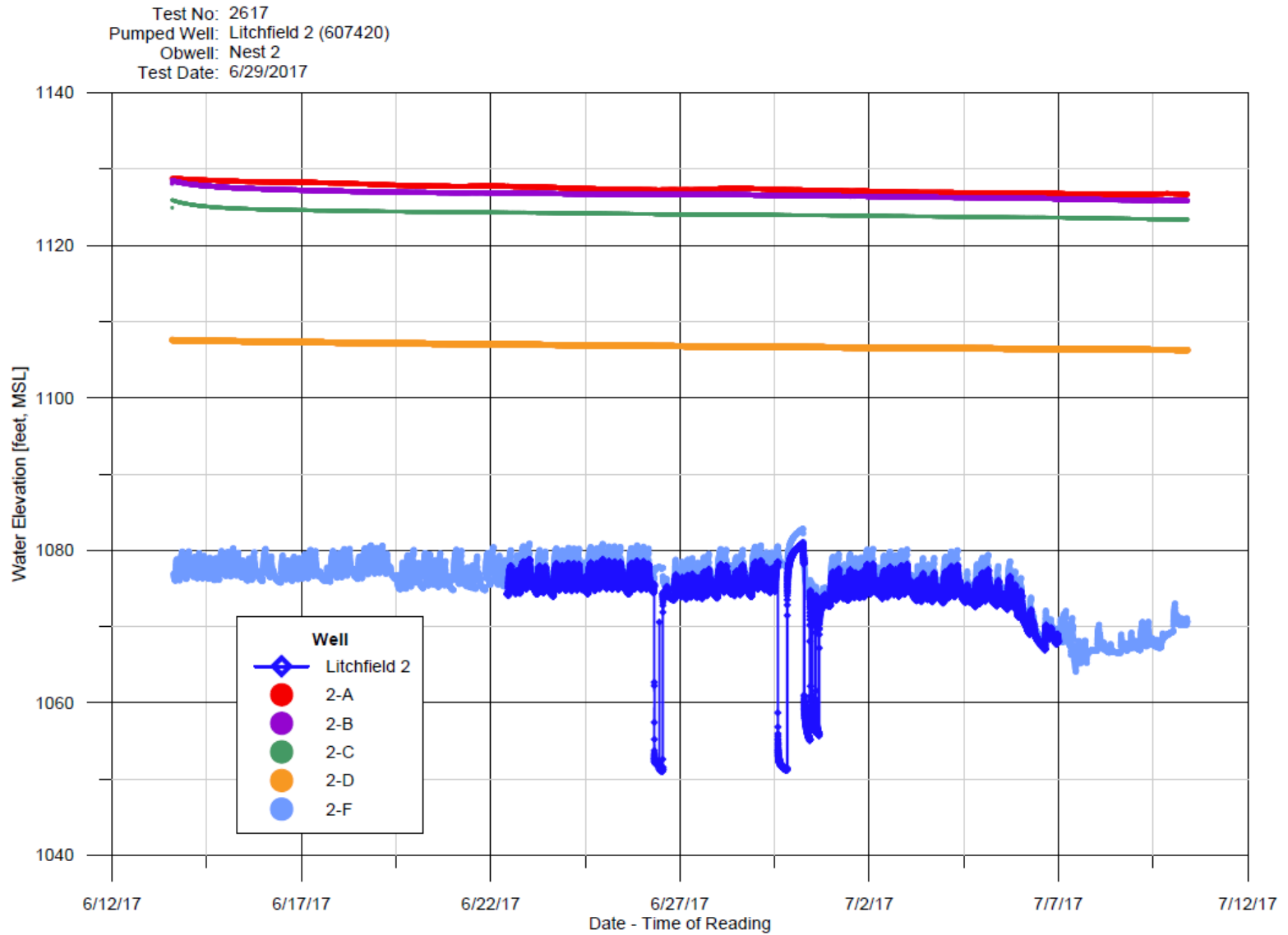


Figure 35. Groundwater elevation at Litchfield-2 and Nest 2



TEST 2617, LITCHFIELD 2 (607420) JUNE 29, 2017

Figure 36. Groundwater elevation at Litchfield-2 and Observation Wells Constructed in Aquifer, All Data

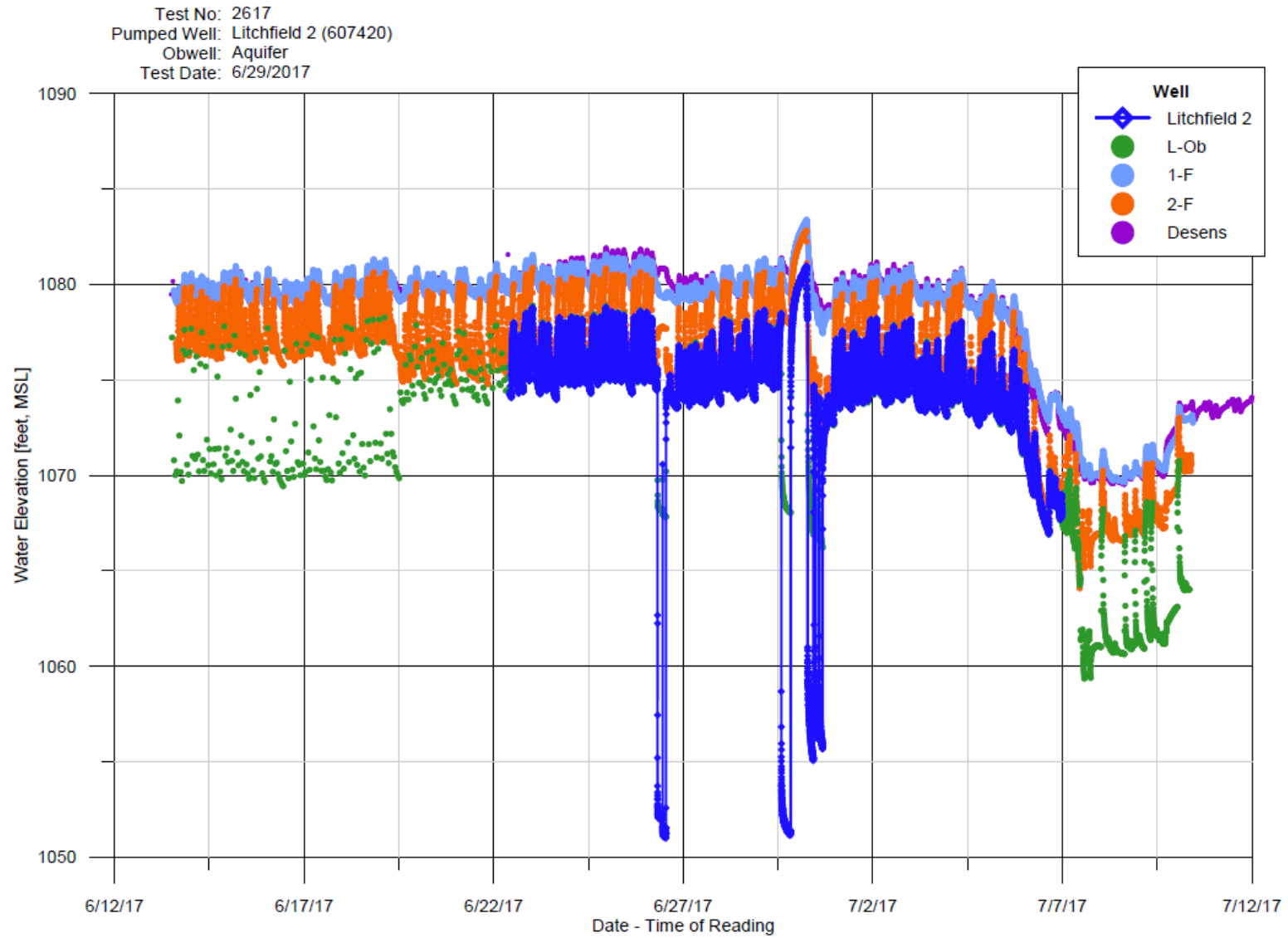


Figure 37. Groundwater elevation at Litchfield-2 and Observation Wells, Test Period

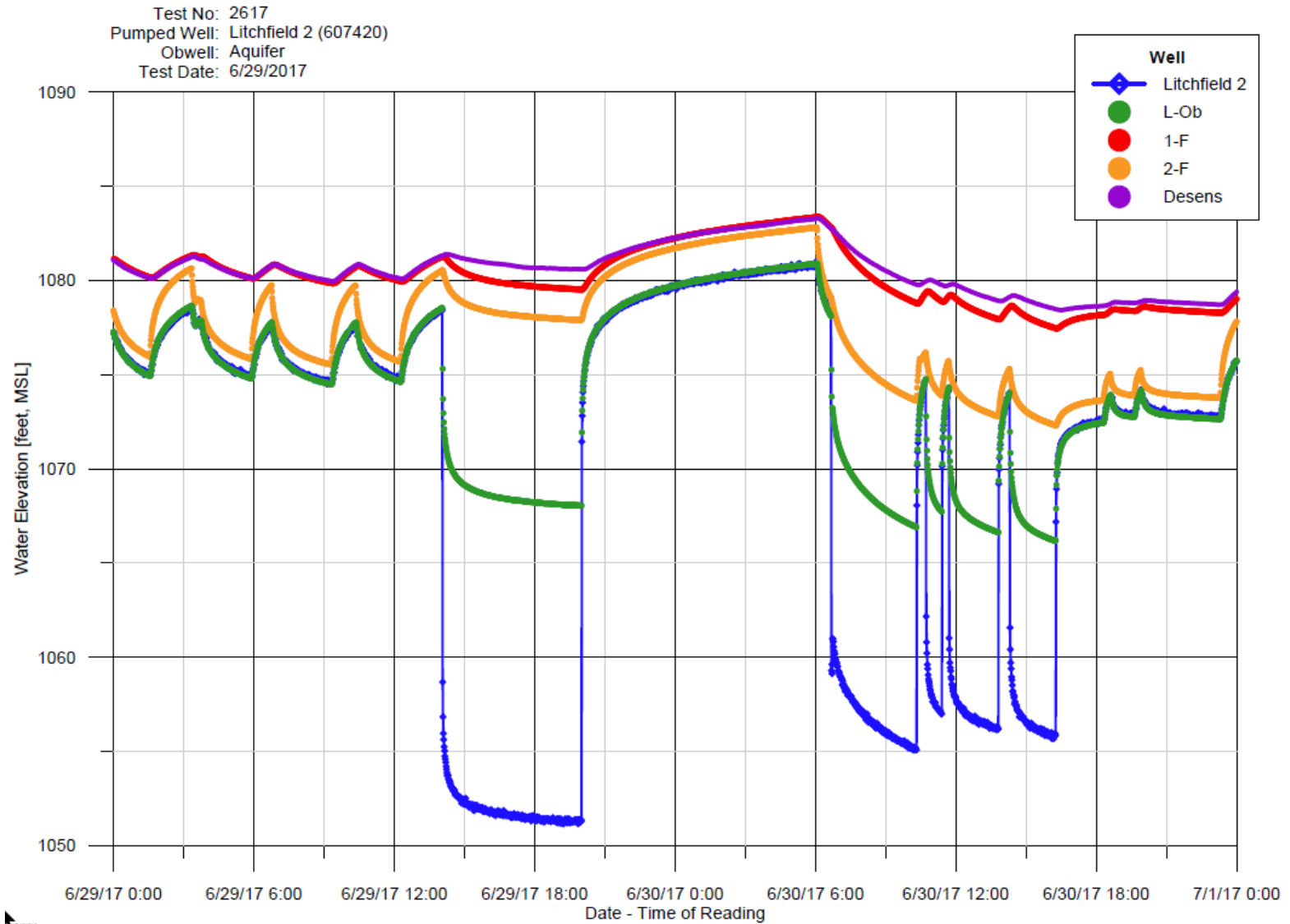
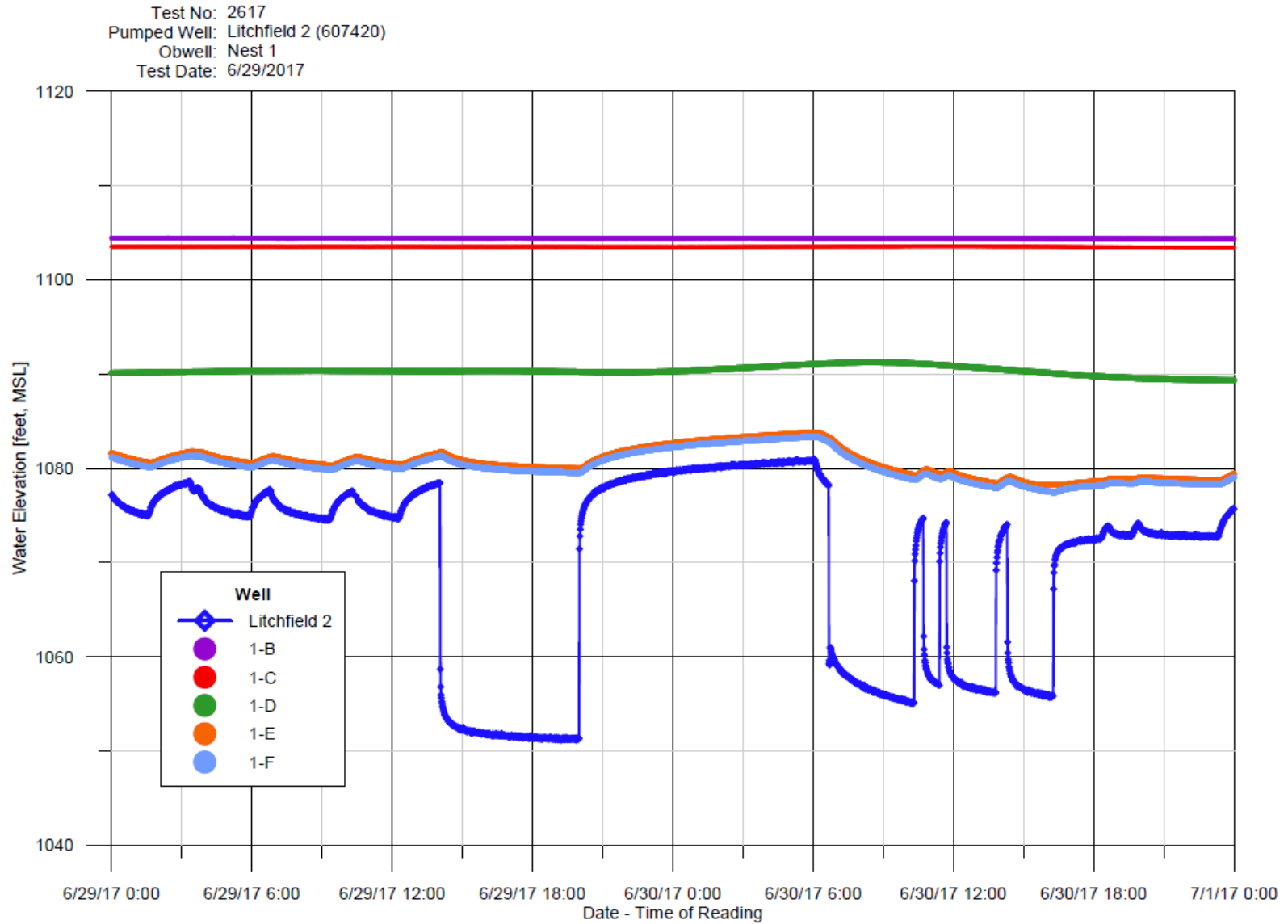
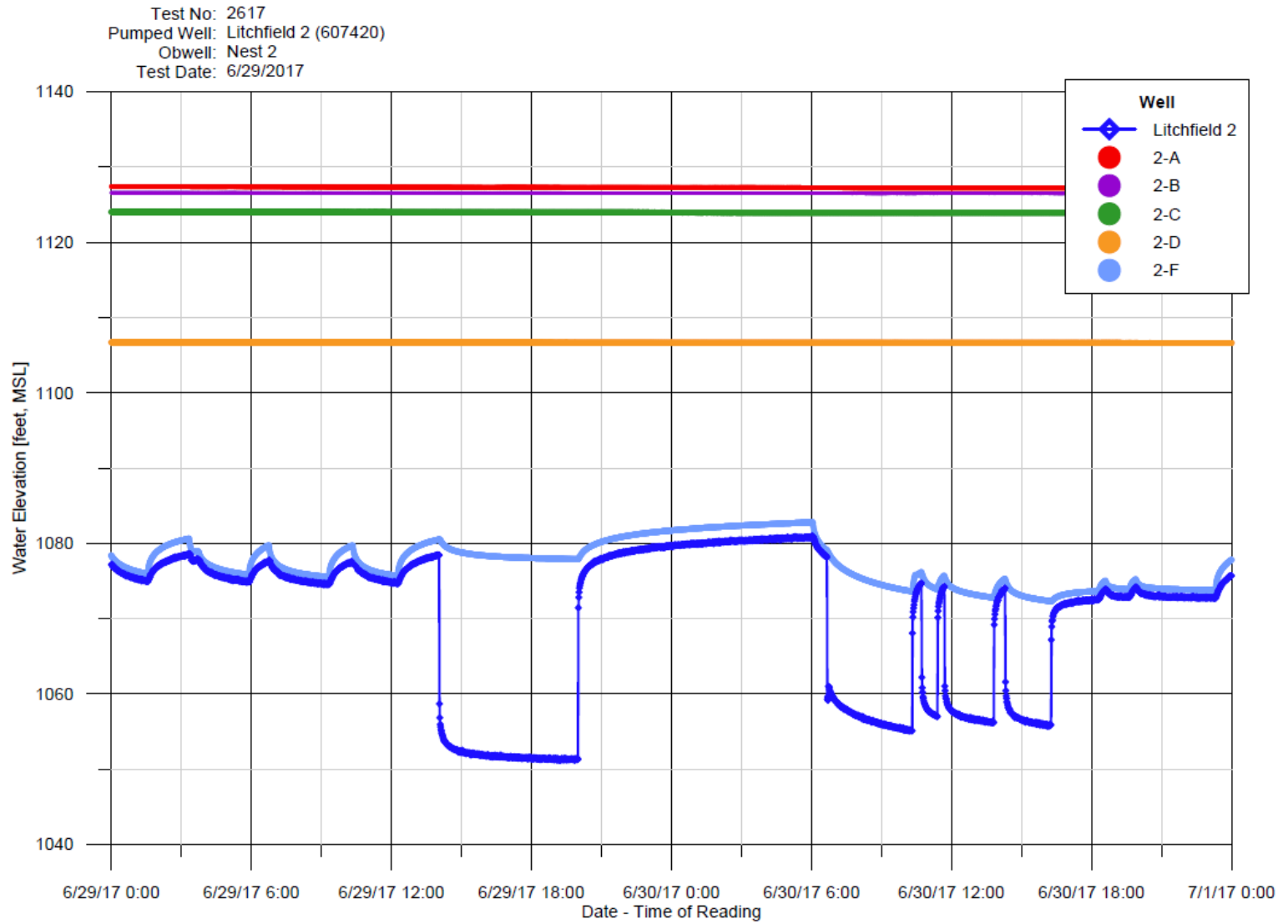


Figure 38. Groundwater elevation at Litchfield-2 and Nest 1, Test Period



TEST 2617, LITCHFIELD 2 (607420) JUNE 29, 2017

Figure 39. Groundwater elevation at Litchfield-2 and Nest 2, Test Period



TEST 2617, LITCHFIELD 2 (607420) JUNE 29, 2017

Figure 40. Groundwater Elevation in Aquifer Compared to Barometric Pressure, Test Period

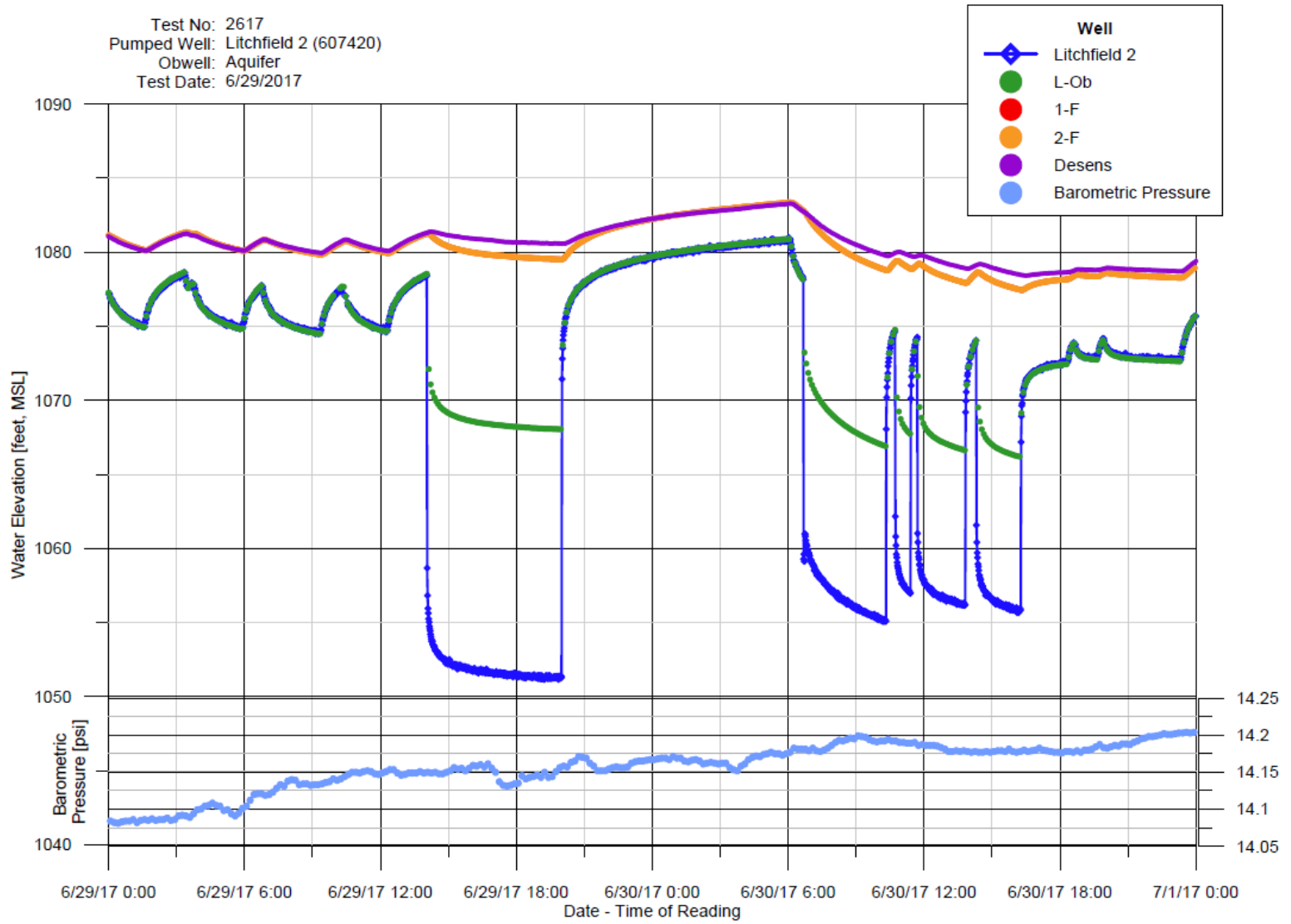


Figure 41. Depth to Water in Water-Table Wells Compared to Rainfall Events

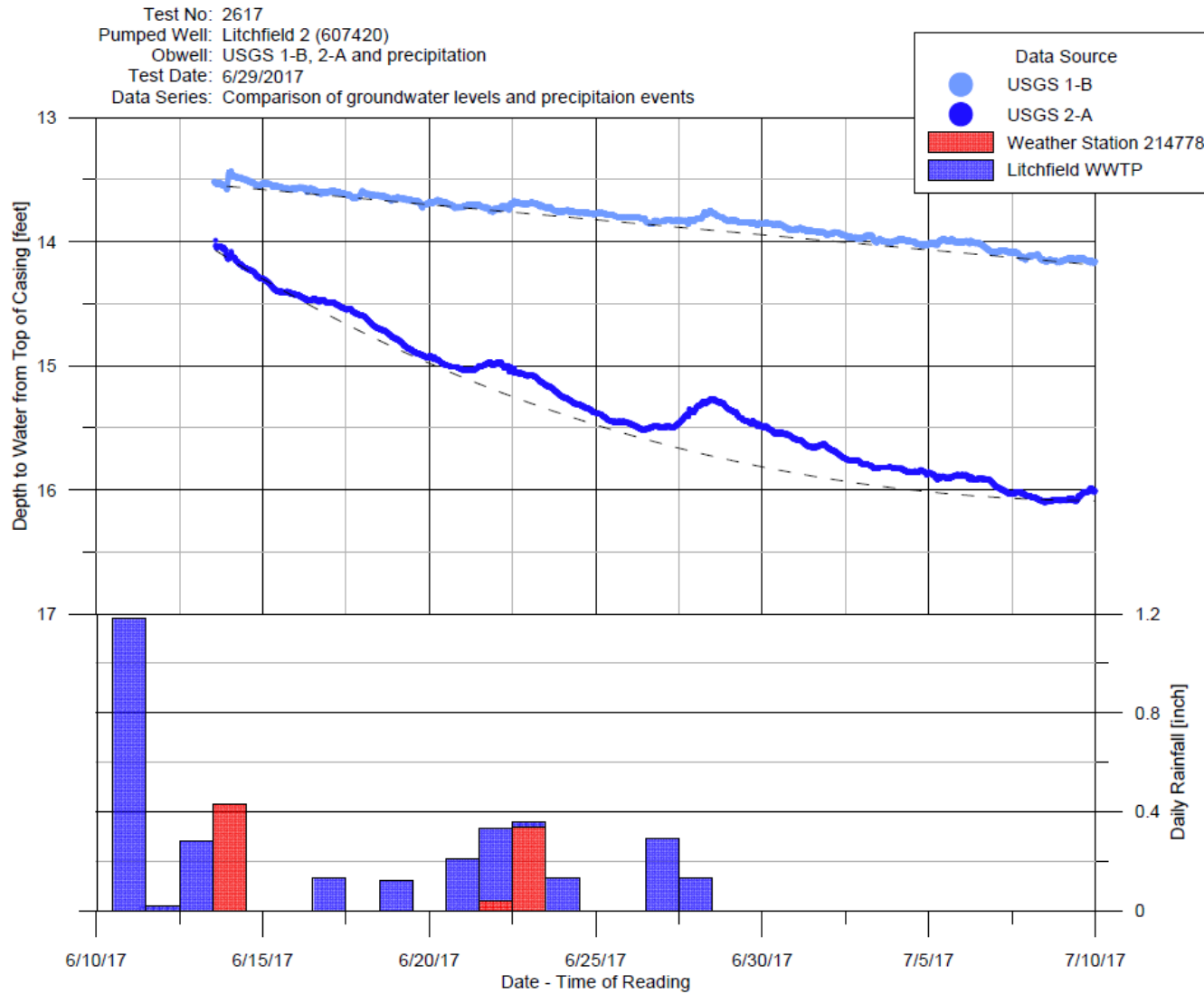


Figure 42. Daily Pumping Volume from Community Supply Wells, June 1, to July 10, 2017

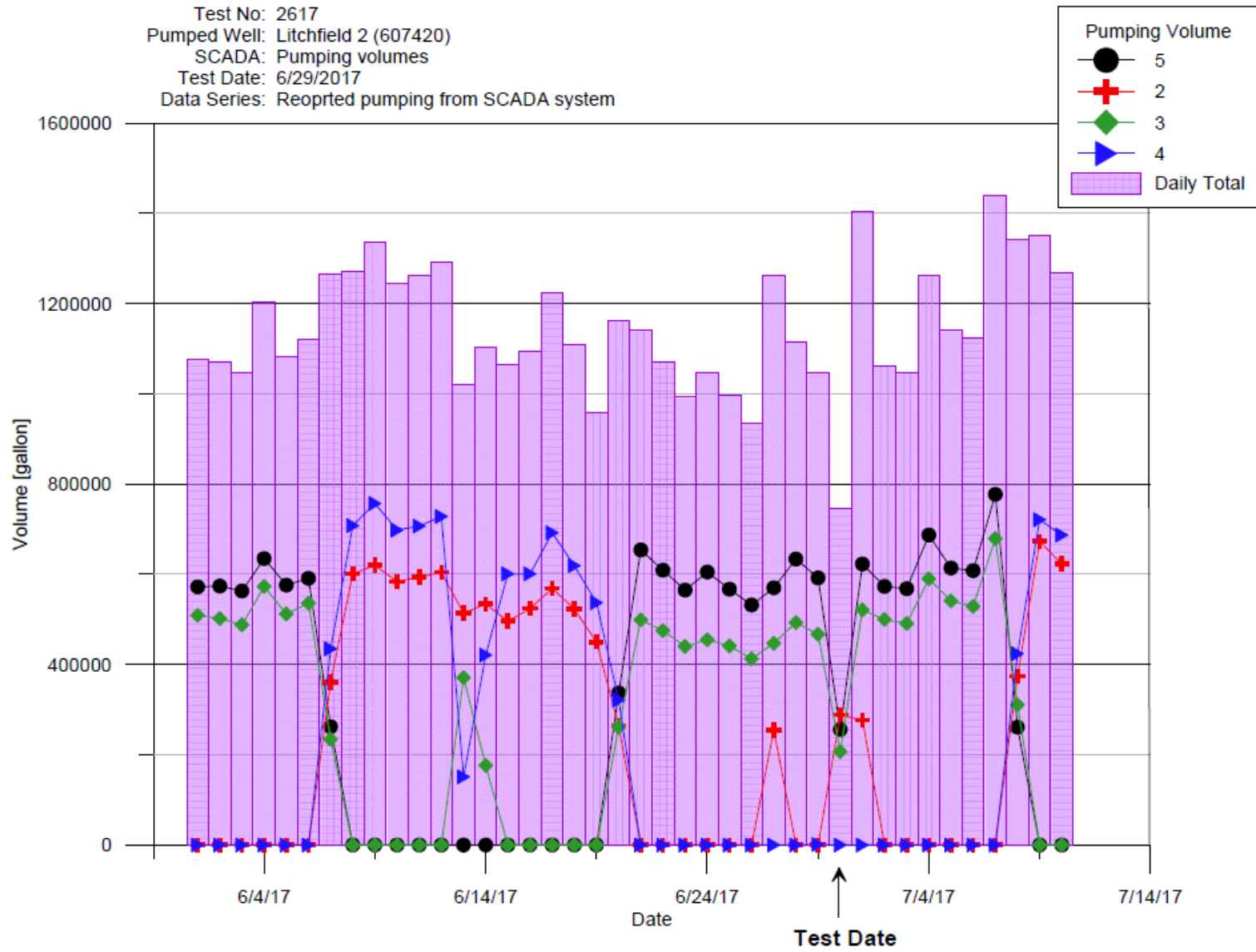


Figure 43. Expanded View of Groundwater Elevation in Aquifer Wells from July 2 to July 11, 2017

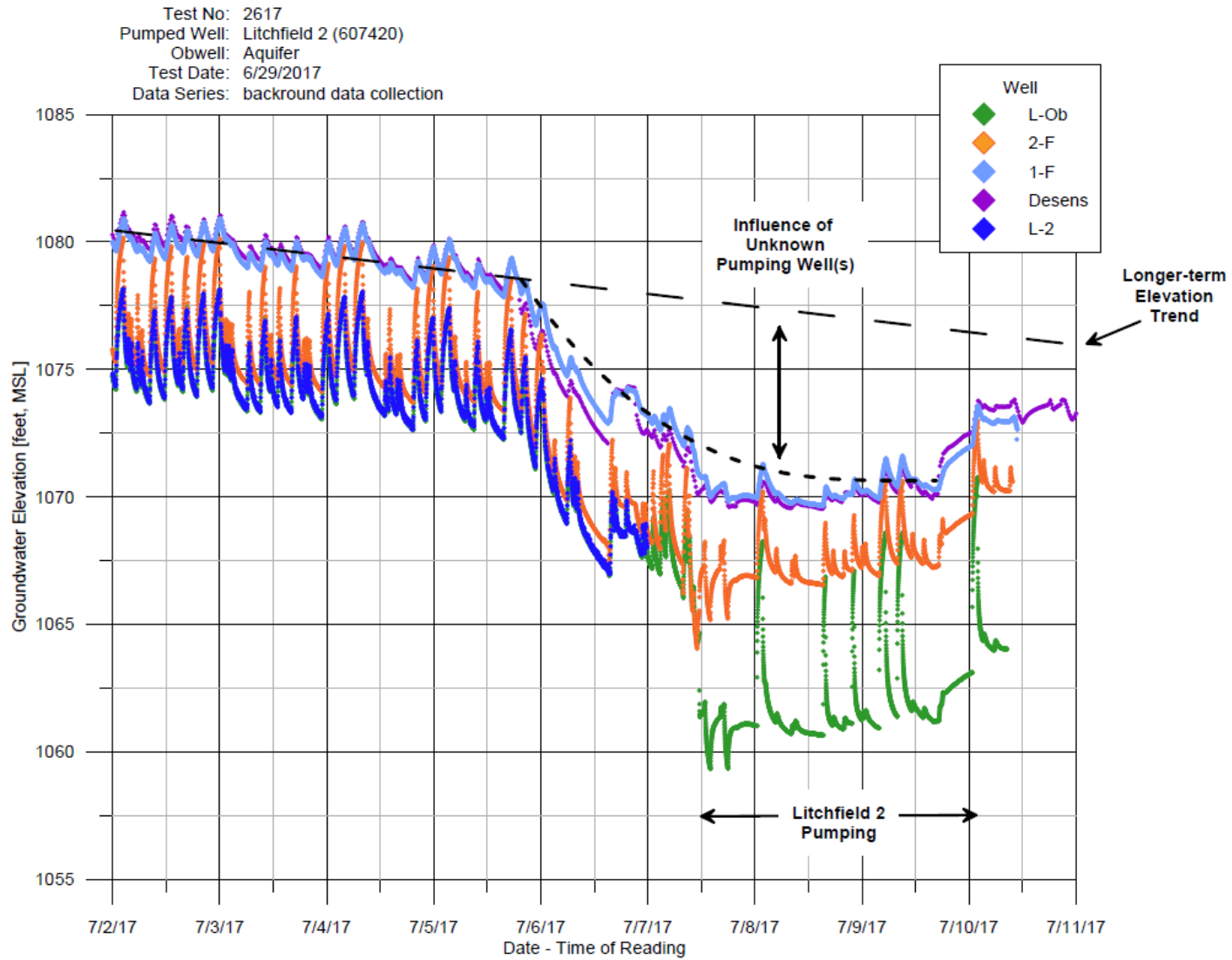


Figure 44. Local Effects of Community Supply Wells from July 5 to July 11, 2017

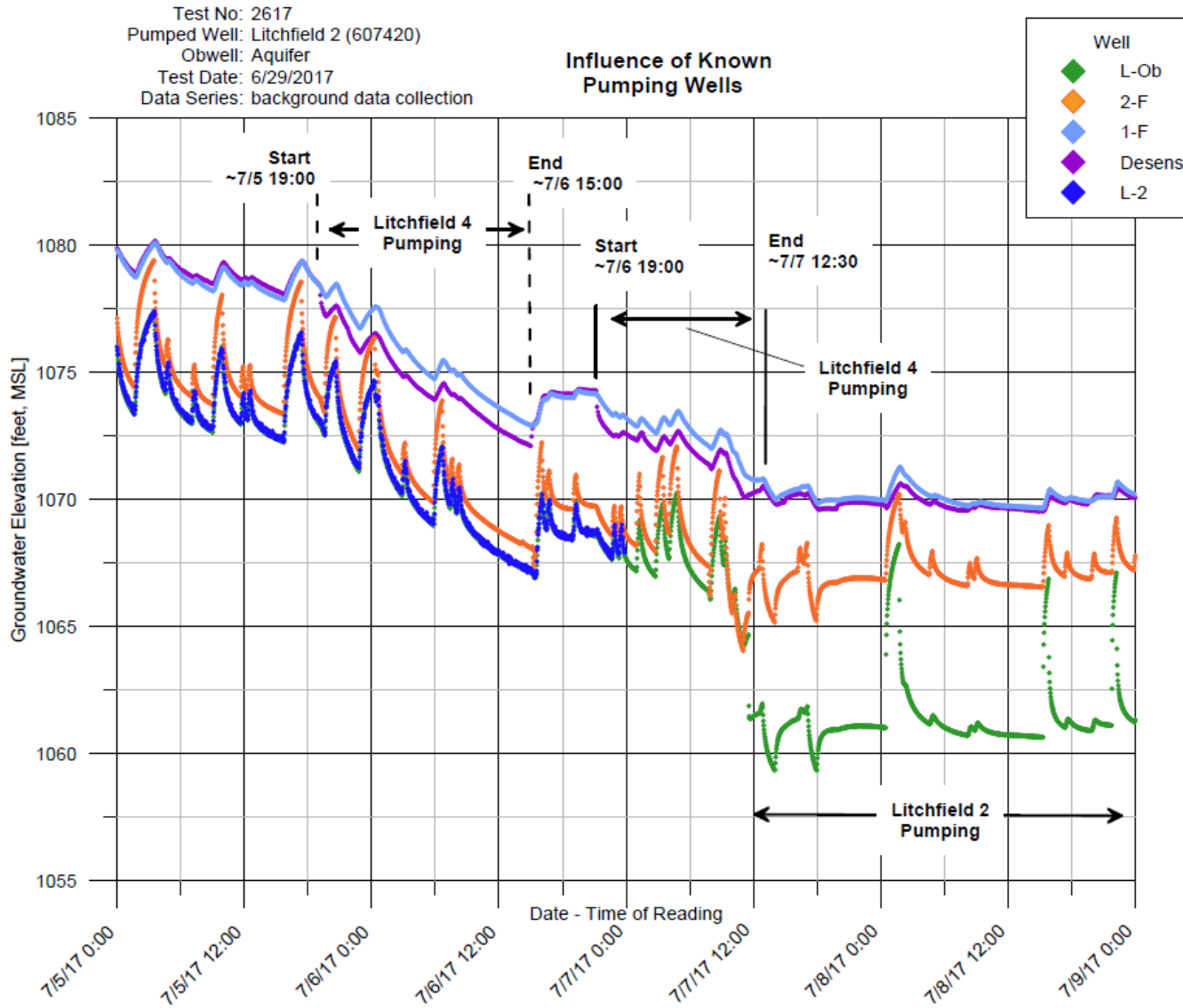


Figure 45. Groundwater Elevation at USGS 2-F (773051) Compared to Rainfall Events, Summer of 2016

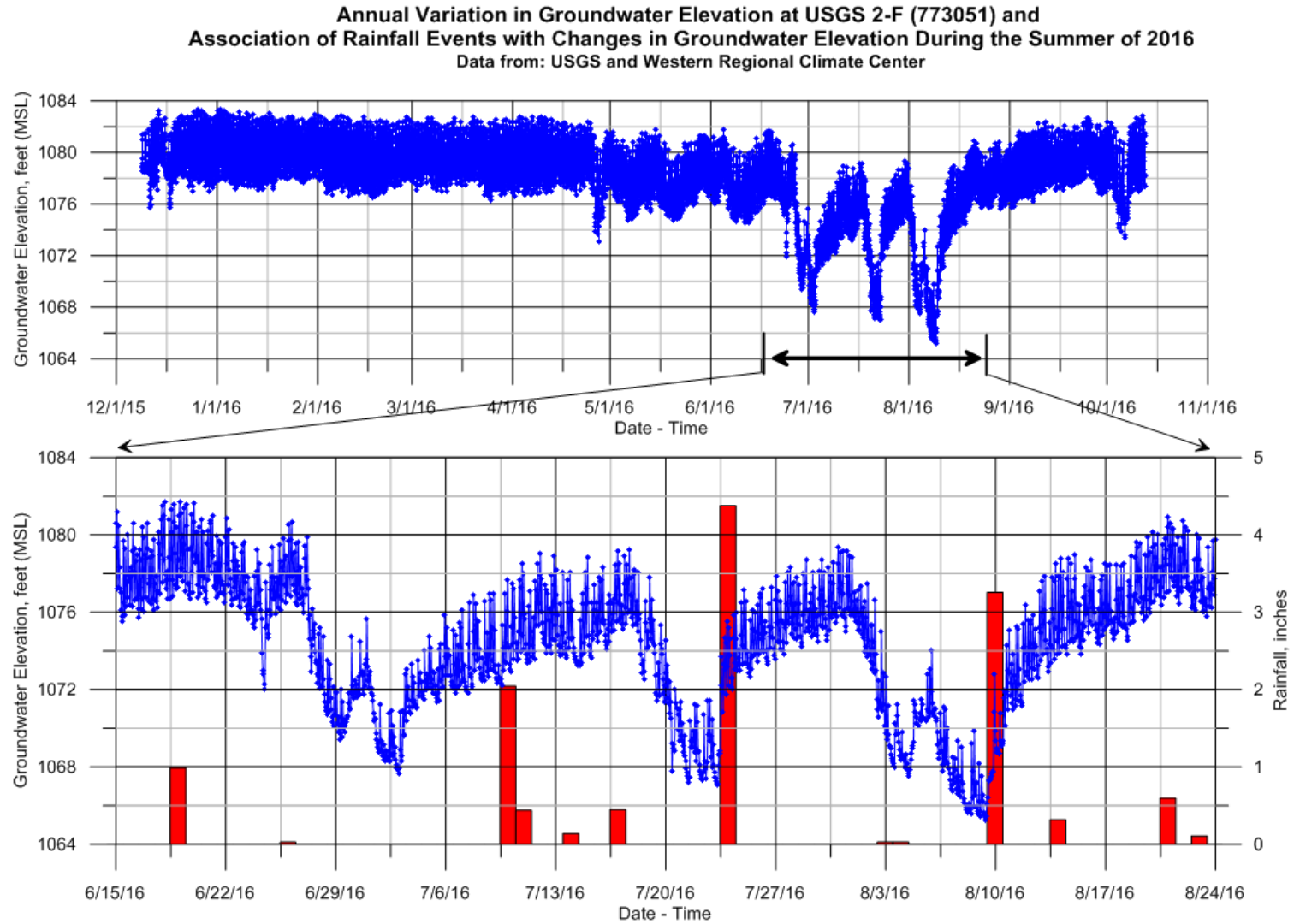


Figure 46. Well and Boring Report - Litchfield 2 (607420)

Minnesota Unique Well Number 607420		County Mooker Quad Litchfield Quad ID 125A	MINNESOTA DEPARTMENT OF HEALTH WELL AND BORING REPORT <i>Minnesota Statutes Chapter 1031</i>		Entry Date 03/23/1999 Update Date 06/16/2017 Received Date				
Well Name	Township	Range	Dir Section	Subsection	Well Depth	Depth Completed	Date Well Completed		
LITCHFIELD 2	119	31	W 2	CDCDAA	134 ft.	132 ft.	02/19/1998		
Elevation	1120	Elev. Method	7.5 minute topographic map (+/- 5 feet)						
Address:						Use	community supply(municipal)	Status	Active
Contact	126 MARSHALL AV N LITCHFIELD MN 55355					Well Hydrofractured?	Yes <input type="checkbox"/> No <input checked="" type="checkbox"/>	From	To
Well	LITCHFIELD MN 55355					Casing Type	Single casing Joint		
Stratigraphy Information						Drive Shoe?	Yes <input type="checkbox"/> No <input checked="" type="checkbox"/>	Above/Below	
Geological Material	From	To (ft.)	Color	Hardness	Casing Diameter	Weight	Hole Diameter		
CLAY	0	24	BROWN		12 in. To	107 ft. lbs./ft.	18 in. To	134 ft.	
CLAY	24	29	GRAY						
SAND & GRAVEL	29	35	BROWN						
CLAY	35	65	GRAY						
SAND & GRAVEL	65	71	BROWN						
CLAY	71	105	GRAY						
SAND & GRAVEL	105	134	BROWN						
CLAY	134	134	GRAY						
Open Hole						From	ft.	To	ft.
Screen? <input checked="" type="checkbox"/>						Type	stainless	Make	JOHNSON
Diameter						Slot/Gauze	Length	Set	
12 in.						115	25 ft.	107 ft.	132 ft.
Static Water Level						42 ft.	land surface	Measure	02/19/1998
Pumping Level (below land surface)						132 ft.	7.5 hrs.	Pumping at	1000 g.p.m.
Wellhead Completion						Well Gouted? <input checked="" type="checkbox"/>	Yes <input type="checkbox"/> No <input type="checkbox"/>	Not Specified	
Fitless adapter manufacturer						Model			
<input type="checkbox"/> Casing Protection						<input checked="" type="checkbox"/> 12 in. above grade			
<input type="checkbox"/> At-grade (Environmental Wells and Borings ONLY)									
Material						Amount	From	To	
most cement						85 Sacks	0	ft. 87	ft.
high solids bentonite						50 Sacks	87	ft. 132	ft.
Nearest Known Source of Contamination						foot	Direction	Type	
Well disinfected upon completion?						<input checked="" type="checkbox"/> Yes	<input type="checkbox"/> No		
Pump <input checked="" type="checkbox"/> Not Installed						Date Installed			
Manufacturer's name						HP	Volt		
Model Number						ft Capacity	g.p.	Typ	
Length of drop pipe									
Abandoned						Does property have any not in use and not sealed well(s)? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No			
Variance						Was a variance granted from the MDH for this well? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No			
Miscellaneous:						First Bedrock	Aquifer	Quat. buried	ft
Last Strat clay-gray						Depth to Bedrock			
Located by						Minnesota Department of Health			
Locate Method						Digitization (Screen) - Map (1:24,000)			
System						UTM - NAD83, Zone 15, Meters	X 379247	Y 4999548	
Unique Number Verification						Information from	Input Date	09/19/2000	
Angled Drill Hole									
Well Contractor						Trant M.J. Well Co.	71536	ROBBIE/DON	
Licenses Business						Lic. or Reg. No.	Name of Driller		
Minnesota Well Index Report					607420	Printed on 06/19/2017 HE-01205-15			

Figure 47. Well and Boring Report - Litchfield 3 (632077)

Minnesota Unique Well Number 632077		County Mooker Quad Litchfield Quad ID 125A	MINNESOTA DEPARTMENT OF HEALTH WELL AND BORING REPORT <i>Minnesota Statutes Chapter 1031</i>		Entry Date 03/22/2000 Update Date 03/10/2014 Received Date		
Well Name	Township	Range	Dir Section	Subsection	Well Depth	Depth Completed	Date Well Completed
LITCHFIELD 3	119	31	W 2	CDABDC	140 ft.	136 ft.	12/09/1999
Elevation	1126	Elev. Method	7.5 minute topographic map (+/- 5 feet)				
Address:					Use	Status	
Contact 126 MARSHALL AV N LITCHFIELD MN 55355					community supply(municipal)	Active	
Well LITCHFIELD MN 55355					Well Hydrofractured?	Yes <input type="checkbox"/>	No <input type="checkbox"/>
Stratigraphy Information					Casing Type	Single casing Joint Welded	
Geological Material	From	To (ft.)	Color	Hardness	Drive Shoe?	Yes <input type="checkbox"/>	No <input type="checkbox"/>
TOP SOIL	0	2	BLACK		Above/Below		
CLAY	2	18	YELLOW		Casing Diameter	Weight	Hole Diameter
CLAY	18	98	GRAY		12 in. To	108 ft. 49.5 lbs./ft.	18 in. To 140 ft.
DIRTY SAND	98	106	GRAY		Open Hole		
SAND	106	117	GRAY		From	ft.	To
SAND COARSER	117	130	GRAY		ft.	ft.	ft.
SAND FINER	130	136	GRAY		Screen? <input checked="" type="checkbox"/>	Type stainless	Make JOHNSON
CLAY	136	140	GRAY		Diameter	Slot/Gauze	Length
					12 in.	70	28 ft.
					Set	108 ft.	136 ft.
					Static Water Level	43.6 ft. null Measure 11/22/1999	
					Pumping Level (below land surface)	65.5 ft. 20 hrs. Pumping at 750 g.p.m.	
					Wellhead Completion	Pileless adapter manufacturer MONITOR Model 7PS1214WBW	
					<input type="checkbox"/> Casing Protection	<input checked="" type="checkbox"/> 12 in. above grade	
					<input type="checkbox"/> At-grade (Environmental Wells and Borings ONLY)		
					Grouting Information	Well Grouted? <input checked="" type="checkbox"/>	Yes <input type="checkbox"/>
					Material	Amount	From
					neat cement	3 Cubic yards	12 ft. 98 ft.
					Nearest Known Source of Contamination	foot Direction Type	
					Well disinfected upon completion? <input checked="" type="checkbox"/>	Yes <input type="checkbox"/>	No <input type="checkbox"/>
					Pump <input checked="" type="checkbox"/>	Not Installed Date Installed	
					Manufacturer's name		
					Model Number	HP	Volt
					Length of drop pipe	ft	Capacity
					g.p.	Typ	
					Abandoned	Does property have any not in use and not sealed well(s)? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	
					Variance	Was a variance granted from the MDH for this well? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	
					Miscellaneous	First Bedrock	
					Last Strat	clay-gray	Aquifer
					Located by	Minnesota Department of Health	Quart. buried
					Locate Method	GPS SA Off (averaged)	ft
					System	UTM - NAD83, Zone 15, Meters	X 379308 Y 4999778
					Unique Number Verification	Input Date	09/19/2000
					Angled Drill Hole		
					Well Contractor	L.t.p. Enterprises, Inc. 91686 VERDECK, D.	
					Licensee Business	Lic. or Reg. No.	Name of Driller
Minnesota Well Index Report				632077	Printed on 06/12/2017 HE-01205-15		

Figure 48. Well and Boring Report - Litchfield 4 (632078)

Minnesota Unique Well Number 632078		County Mooker Quad Litchfield Quad ID 125A	MINNESOTA DEPARTMENT OF HEALTH WELL AND BORING REPORT <i>Minnesota Statutes Chapter 1031</i>		Entry Date 03/22/2000 Update Date 03/10/2014 Received Date
Well Name	Township	Range	Dir	Section	Subsection
LITCHFIELD 4	119	31	W	2	CABACB
Elevation	1149	Elev. Method	7.5 minute topographic map (+/- 5 feet)		
Address					
Contact	126 MARSHALL AV N LITCHFIELD MN 55355				
Well	LITCHFIELD MN 55355				
Stratigraphy Information					
Geological Material	From	To (ft.)	Color	Hardness	
TOP SOIL SILTY	0	1	BLACK		
SANDY CLAY/GRAVEL	1	10	BROWN		
CLAY SANDY/PEBBLES	10	42	GRAY		
SANDY CLAY/SAND	42	48	GRAY		
SANDY CLAY/PEBBLES	48	97	GRAY		
SANDY CLAY	97	113	BROWN	V.SOFT	
SANDY CLAY/PEBBLES	113	121	GRAY		
SAND & GRAVEL	121	128	GRAY		
SAND & GRAVEL	128	136	GRAY		
SAND & GRAVEL	136	146	GRAY		
SANDY CLAY/PEBBLES	146	150	GRAY		
CLAY	150	159	GRAY		
Well Depth	Depth Completed		Date Well Completed		
159 ft.	147 ft.		12/09/1999		
Drill Method	Non-specified Rotary		Drill Fluid Bentonite		
Use	community supply(municipal)				Status Active
Well Hydrofractured?	Yes <input type="checkbox"/>	No <input type="checkbox"/>	From	To	
Casing Type	Single casing		Joint Welded		
Drive Shoe?	Yes <input type="checkbox"/>	No <input type="checkbox"/>	Above/Below		
Casing Diameter	Weight	Hole Diameter			
12 in. To 123 ft.	49.5 lbs./ft.	18 in. To 147 ft. 6.2 in. To 159 ft.			
Open Hole	From	ft.	To	ft.	
Screen? <input checked="" type="checkbox"/>	Type stainless		Make JOHNSON		
Diameter	Slot/Gauze	Length	Set		
12 in.	70	24 ft.	123 ft.	147 ft.	
Static Water Level					
61.2 ft.	land surface		Measure	12/08/1999	
Pumping Level (below land surface)					
77.8 ft.	21 hrs.	Pumping at		750 g.p.m.	
Wellhead Completion					
Pitless adapter manufacturer	MONITOR		Model	7PS1214WBW	
<input type="checkbox"/>	Casing Protection		<input checked="" type="checkbox"/> 12 in. above grade		
<input type="checkbox"/> At-grade (Environmental Wells and Borings ONLY)					
Grouting Information Well Grouted? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Not Specified					
Material	Amount	From	To		
neat cement	4.5 Cubic yards	8 ft.	113 ft.		
Nearest Known Source of Contamination					
foot	Direction	Type			
Well disinfected upon completion? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No					
Pump <input checked="" type="checkbox"/>	Not Installed		Date Installed		
Manufacturer's name					
Model Number	HP	Volt			
Length of drop pipe	ft	Capacity	g.p.	Type	
Abandoned					
Does property have any not in use and not sealed well(s)? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No					
Variance					
Was a variance granted from the MDH for this well? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No					
Miscellaneous:					
First Bedrock	Aquifer		Quat. buried		
Last Strat	clay-brown	Depth to Bedrock		ft	
Located by Minnesota Department of Health					
Locate Method	GPS SA Off (averaged)				
System	UTM - NAD83, Zone 15, Meters		X 379172	Y 5000196	
Unique Number Verification	Input Date				09/19/2000
Angled Drill Hole					
Well Contractor					
L.t.p. Enterprises, Inc.		91686	VERDECK, D.		
Licensee Business		Lic. or Reg. No.	Name of Driller		
Minnesota Well Index Report		632078	Printed on 06/19/2017 HE-01205-15		

Figure 49. Well and Boring Report - Litchfield 5 (764258)

Minnesota Unique Well Number 764258		County Mooker Quad Litchfield Quad ID 125A	MINNESOTA DEPARTMENT OF HEALTH WELL AND BORING REPORT <i>Minnesota Statutes Chapter 1031</i>		Entry Date 01/29/2009 Update Date 04/16/2015 Received Date 01/21/2009		
Well Name LITCHFIELD 5	Township 119	Range 31	Dir Section W 2	Subsection CABCCA	Well Depth 165 ft.	Depth Completed 161.5 ft.	Date Well Completed 10/30/2008
Elevation 1152	Elev. Method 7.5 minute topographic map (+/- 5 feet)	Drill Method Non-specified Rotary		Drill Fluid Bentonite	Use community supply(municipal) Status Active		
Address: Contact 126 MARSHALL AV NE LITCHFIELD MN 55355 Well LITCHFIELD MN 55355					Well Hydrofractured? Yes <input type="checkbox"/> No <input checked="" type="checkbox"/> From To		
Stratigraphy Information					Casing Type Single casing Joint		
Geological Material					Drive Shoe? Yes <input type="checkbox"/> No <input checked="" type="checkbox"/> Above/Below		
TOP SOIL	From 0	To (ft.) 1	Color BLACK	Hardness	Casing Diameter	Weight	Hole Diameter
SANDY CLAY	1	2	BROWN		12 in. To 136. ft.	0 lbs./ft.	18 in. To 165 ft.
SANDY CLAY WITH	2	7	YELLOW		Open Hole		
SANDY CLAY	7	11	TAN		From	ft.	To
SANDY CLAY WITH	11	14	GRAY		ft.	To	ft.
SANDY CLAY-SAND &	14	20	GRAY		Screen? <input checked="" type="checkbox"/>	Type stainless	Make JOHNSON
SANDY CLAY	20	36	GRAY		Diameter	Slot/Gauze	Length
SANDY CLAY WITH	36	47	GRAY		12 in.	60	25 ft.
SANDY CLAY WITH	47	121	GRAY		Set	136.5 ft.	161.5 ft.
SOFT SANDY CLAY	121	123	BROWN	SOFT	Static Water Level		
SANDY CLAY WITH	123	125	GRAY		70.4 ft.	land surface	Measure 08/12/2008
COARSE SAND AND	125	128	VARIED		Pumping Level (below land surface)		
SANDY CLAY	128	131	GRAY		88.5 ft.	24 hrs. Pumping at	900 g.p.m.
SAND WITH CLAY	131	135	GRAY		Wellhead Completion		
SAND SOME PEA ROCK	135	144	GRAY	MEDIUM	Fitness adapter manufacturer	MONITOR	Model 9PS1214
FINER SAND	144	147	GRAY		<input type="checkbox"/> Casing Protection	<input type="checkbox"/> 12 in. above grade	
COARSE SAND-	147	158	VARIED		<input type="checkbox"/> At-grade (Environmental Wells and Borings ONLY)		
GRAVEL	158	162	VARIED		Grouting Information Well Grouted? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Not Specified		
SANDY CLAY	162	165	GRAY		Material	Amount	From To
					neat cement	4.5 Cubic yards	10 ft. 126.5 ft.
					Nearest Known Source of Contamination		
					ft.	Direction	Type
					Well disinfected upon completion? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No		
					Pump <input type="checkbox"/> Not Installed	Date Installed	10/30/2008
					Manufacturer's name	GRUNDFOS	
					Model Number	800S400-	HP 40 Volt 460
					Length of drop pipe	120 ft	Capacity 800 g.p. Typ Submersible
					Abandoned		
					Does property have any not in use and not sealed well(s)? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No		
					Variance		
					Was a variance granted from the MDH for this well? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No		
					Miscellaneous:		
					First Bedrock	Aquifer	Quat. buried
					Last Strat	clay+sand-gray	Depth to Bedrock ft
					Located by Minnesota Department of Health		
					Locate Method GPS S.A. Off (averaged)		
					System	UTM - NAD83, Zone 15, Meters	X 379100 Y 5000084
					Unique Number Verification	Input Date 11/13/2008	
					Angled Drill Hole		
					Well Contractor		
					LTP Enterprises, Inc.	2157	THEISEN, R.
					Licensee Business	Lic. or Reg. No.	Name of Driller
Minnesota Well Index Report					764258		Printed on 06/12/2017 HE-01205-15

Figure 50. Well and Boring Report - Litchfield-MW (607417)

Minnesota Unique Well Number 607417		County Meeker Quad Litchfield Quad ID 125A	MINNESOTA DEPARTMENT OF HEALTH WELL AND BORING REPORT <i>Minnesota Statutes Chapter 1031</i>		Entry Date 04/22/2003 Update Date 08/18/2014 Received Date	
Well Name LITCHFIELD MW 119	Township 31	Range W 2	Dir Section CDCADB	Well Depth 130 ft.	Depth Completed 127 ft.	Date Well Completed 12/18/1997
Elevation 1123.2	Elev. Method Surveyed			Drill Method Augur (non-specified)	Drill Fluid Bentonite	
Address				Use monitor well	Status Active	
Stratigraphy Information				Well Hydrofractured? Yes <input type="checkbox"/> No <input checked="" type="checkbox"/>	From To	
Geological Material	From	To (ft.)	Color	Hardness		
SANDY CLAY	0	22	BROWN			
CLAY	22	29	GRAY			
SAND & GRAVEL	29	37	BROWN			
CLAY	37	40	GRAY			
SAND	40	45	BROWN			
ROCK	45	47	BLK/WHT			
CLAY	47	72	GRAY			
SAND & GRAVEL	72	76	BROWN			
CLAY	76	107	GRAY			
SAND & GRAVEL	107	130	BROWN			
				Casing Type Single casing	Joint	
				Drive Shoe? Yes <input type="checkbox"/> No <input checked="" type="checkbox"/>	Above/Below	
				Casing Diameter 2 in.	Weight 122 lb./ft.	Hole Diameter 6.5 in.
				Open Hole From	ft. To	ft.
				Screen? <input checked="" type="checkbox"/>	Type stainless	Make JOHNSON
				Diameter 2 in.	Slot/Gauze Length 10 ft.	Set 122 ft.
						127 ft.
				Static Water Level		
				40 ft.	land surface	Measure 12/18/1997
				Pumping Level (below land surface)		
				Wellhead Completion		
				Pitless adapter manufacturer	Model	
				<input checked="" type="checkbox"/> Casing Protection	<input checked="" type="checkbox"/> 12 in. above grade	
				<input type="checkbox"/> At-grade (Environmental Wells and Borings ONLY)		
				Grouting Information		
				Well Grouted? <input checked="" type="checkbox"/>	Yes	No <input type="checkbox"/>
				Material		
				Amount 7 Sacks	From 3 ft.	To 120 ft.
				Material high solids bentonite		
				Nearest Known Source of Contamination		
				foot	Direction	Type
				Well disinfectant upon completion? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No		
				Pump <input type="checkbox"/> Not Installed <input checked="" type="checkbox"/> Installed		
				Manufacturer's name		
				Model Number	HP	Volt
				Length of drop pipe ft	Capacity g.p.	Type
				Abandoned		
				Does property have any not in use and not sealed well(s)? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No		
				Variance		
				Was a variance granted from the MDH for this well? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No		
				Miscellaneous:		
				First Bedrock	Aquifer	Quat. buried
				Last Strat sand +larger-brown	Depth to Bedrock	ft
				Located by Minnesota Geological Survey		
				Locate Method Digitization (Screen) - Map (1:24,000)		
				System UTM - NAD83, Zone 15, Meters	X 379227	Y 4999595
				Unique Number Verification	Info/GPS from data	Input Date 10/22/1998
				Angled Drill Hole		
				Well Contractor		
				Trant M.J. Well Co.	71536	ROBBIE & DON
				Licensee Business	Lic. or Reg. No.	Name of Driller
Remarks WELL OBS #1						
Minnesota Well Index Report				607417		Printed on 06/19/2017 HE-01205-15

Figure 51. Well and Boring Report - USGS 1-B (773062)

Minnesota Unique Well Number 773062		County Mooker Quad Litchfield Quad ID 125A	MINNESOTA DEPARTMENT OF HEALTH WELL AND BORING REPORT <i>Minnesota Statutes Chapter 1031</i>		Entry Date 08/14/2015 Update Date 10/20/2015 Received Date		
Well Name LFO1-B	Township 119	Range 31	Dir Section W 11	Subsection ABACBB	Well Depth 25.27 ft.	Depth Completed 25.27 ft.	Date Well Completed 06/12/2015
Elevation 1114.5	Elev. Method LIDAR 1m DEM (MNDNR)					Drill Method Augur (non-specified)	Drill Fluid
Address:					Use monitor well	Status: Active	
Contact 126 MARSHALL AV N LITCHFIELD MN 55355					Well Hydrofractured? Yes <input type="checkbox"/> No <input checked="" type="checkbox"/>	From	To
Well 982 MILLER AV N LITCHFIELD MN 55355					Casing Type Single casing	Joint	Gluid
Stratigraphy Information HOODALE DR MOUNDS VIEW MN 55112					Drive Shoe? Yes <input type="checkbox"/> No <input checked="" type="checkbox"/>	Above/Below	
Geological Material	From	To (ft.)	Color	Hardness	Casing Diameter	Weight	Hole Diameter
SAND, WELL SORTED	0	12	GRAY	SOFT	1.2 in. To	22.4 ft. 0.74 lbs./ft.	8.2 in. To 25.2 ft.
SAND WELLSORTED	12	14	GRAY	SOFT			
SAND, WELL SORTED,	14	19	GRAY	SOFT			
SAND, MED. TO	19	25	GRAY	SOFT			
					Open Hole	From	To
					Screen? <input checked="" type="checkbox"/>	Type slotted pipe	Make ENVIRONMENTAL
					Diameter	Slot/Gauze	Length
					1.2 in.	10	2.7 ft.
							Set
							22.4 ft. 25 ft.
					Static Water Level		
					11 ft.	land surface	Measure 08/17/2015
					Pumping Level (below land surface)		
					ft.	3.7 hrs.	Pumping at 0.21 g.p.m.
					Wellhead Completion		
					Pileless adapter manufacturer	Model	
					<input checked="" type="checkbox"/> Casing Protection	<input checked="" type="checkbox"/> 12 in. above grade	
					<input type="checkbox"/> At-grade (Environmental Wells and Borings ONLY)		
					Grouting Information	Well Grouted? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Not Specified	
					Material	Amount	From To
					bentonite	1.87 Sacks	4.5 ft. 19.2 ft.
					concrete	2 Sacks	ft. 4.5 ft.
					Nearest Known Source of Contamination		
					foot	Direction	Type
					Well disinfected upon completion? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No		
					Pump <input checked="" type="checkbox"/> Not Installed	Date Installed	
					Manufacturer's name		
					Model Number	HP	Volt
					Length of drop pipe	ft	Capacity g.p. Typ
					Abandoned		
					Does property have any not in use and not sealed well(s)? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No		
					Variance		
					Was a variance granted from the MDH for this well? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No		
					Miscellaneous:		
					First Bedrock	Aquifer	Quat. Water
					Last Strat sand+silt-gray	Depth to Bedrock	ft
					Located by Minnesota Geological Survey		
					Locate Method Digitization (Screen) - Map (1:24,000)		
					System UTM - NAD83, Zone 15, Meters	X 379655	Y 4999332
					Unique Number Verification	Information from	Input Date 08/14/2015
					Angled Drill Hole		
					Well Contractor		
					US Geological Survey	1548	HUCKABY, J.
					License Business	Lic. or Reg. No.	Name of Driller
Minnesota Well Index Report					773062		Printed on 06/19/2017 HE-01205-15

Figure 52. Well and Boring Report - USGS 1-C (773060)

Minnesota Unique Well Number		County	MINNESOTA DEPARTMENT OF HEALTH			Entry Date	
773060		Mooser	WELL AND BORING REPORT Minnesota Statutes Chapter 1031			08/14/2015	
		Quad Litchfield				Update Date	10/20/2015
		Quad ID 125A				Received Date	
Well Name	Township	Range	Dir Section	Subsection	Well Depth	Depth Completed	Date Well Completed
LFO1-C	119	31	W 11	ABACBB	53.1 ft.	53.1 ft.	06/12/2015
Elevation	1114.8	Elev. Method	LIDAR 1m DEM (MNDNR)				
Address					Use	Status	
Contact 126 MARSHALL AV N LITCHFIELD MN 55355					monitor well	Active	
Well 982 MILLER AV N LITCHFIELD MN 55355					Well Hydrofractured?	Yes <input type="checkbox"/>	No <input checked="" type="checkbox"/>
Geography Information 982 MILLER AV N LITCHFIELD MN 55355					Casing Type	Single casing	Joint
Geological Material					Drive Shoe?	Yes <input type="checkbox"/>	No <input checked="" type="checkbox"/>
From To (ft) Color Hardness					Above/Below		
SAND, WELL SORTED 0 12 GRAY SOFT					Casing Diameter	Weight	Hole Diameter
SAND WELL SORT 12 14 GRAY SOFT					1.2 in. To	50.2 ft. 0.74 lbs./ft.	8.2 in. To 53 ft.
SAND, WELL SORTED, 14 19 GRAY SOFT					Open Hole		
SAND, MED. TO 19 22 GRAY SOFT					From	ft.	To
SAND, MEDIUM WELL 22 43 GRAY SOFT					ft.		ft.
SILT & CLAY WITH 43 53 GRAY MEDIUM					Screen? <input checked="" type="checkbox"/>	Type	slotted pipe
					Diameter	Slot/Gauze	Length
					1.2 in.	10	2.7 ft.
					Make	ENVIRONMENTAL	
					Set	52.8 ft.	
					Static Water Level		
					12.5 ft.	land surface	Measure 08/17/2015
					Pumping Level (below land surface)		
					ft.	1.9 hrs.	Pumping at 0.21 g.p.m.
					Wellhead Completion		
					Fitless adapter manufacturer	Model	
					<input checked="" type="checkbox"/> Casing Protection	<input checked="" type="checkbox"/> 12 in. above grade	
					<input type="checkbox"/> At-grade (Environmental Wells and Borings ONLY)		
					Grouting Information	Well Grouted?	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Not Specified
					Material	Amount	From To
					bentonite	3.5 Sacks	3.5 ft. 4.7 ft.
					concrete	2.5 Sacks	ft. 3.5 ft.
					Nearest Known Source of Contamination		
					foot	Direction	Type
					Well disinfected upon completion?	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	
					Pump <input checked="" type="checkbox"/> Not Installed	Date Installed	
					Manufacturer's name		
					Model Number	HP	Volt
					Length of drop pipe	ft	Capacity g.p. Typ
					Abandoned		
					Does property have any not in use and not sealed well(s)?	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	
					Variance		
					Was a variance granted from the MDH for this well?	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	
					Miscellaneous		
					First Bedrock	Aquifer	Quat. buried
					Last Strat	pobby sand/silt/clay-gray	Depth to Bedrock ft
					Located by	Minnesota Geological Survey	
					Locate Method	Digitization (Screen) - Map (1:24,000)	
					System	UTM - NAD83, Zone 15, Meters	X 379653 Y 4999334
					Unique Number Verification	Information from	Input Date 08/14/2015
					Angled Drill Hole		
					Well Contractor		
					US Geological Survey	1548	HUCKABY, J.
					Licensee Business	Lic. or Reg. No.	Name of Driller
Minnesota Well Index Report				773060	Printed on 06/19/2017 HE-01205-15		

Figure 53. Well and Boring Report - USGS 1-D (773059)

Minnesota Unique Well Number					County Mooker			MINNESOTA DEPARTMENT OF HEALTH			Entry Date 08/14/2015	
773059					Quad Litchfield			WELL AND BORING REPORT			Update Date 10/20/2015	
					Quad ID 125A			Minnesota Statutes Chapter 1031			Received Date	
Well Name	Township	Range	Dir Section	Subsection	Well Depth	Depth Completed	Date Well Completed					
LFO1-D	119	31	W 11	ABACBB	75.5 ft.	75.27 ft.	06/11/2015					
Elevation	1114.7	Elev. Method	LIDAR 1m DEM (MNDNR)		Drill Method	Angar (non-specified)		Drill Fluid				
Address					Use	monitor well			Status	Active		
Contact	126 MARSHALL AV N LITCHFIELD MN 55355				Well Hydrofractured?	Yes <input type="checkbox"/>	No <input checked="" type="checkbox"/>	From	To			
Well	982 MILLER AV N LITCHFIELD MN 55355				Casing Type	Single casing		Joint	Ghead			
Stratigraphy Information					Drive Shoe?	Yes <input type="checkbox"/>	No <input checked="" type="checkbox"/>	Above/Below				
MOODALE DR MOUNDS VIEW MN 55112					Casing Diameter	Weight	Hole Diameter					
Geological Material	From	To (ft.)	Color	Hardness	1.2 in. To	72.4 ft. 0.74 lbs./ft.	8.2 in. To		75.5 ft.			
SAND, WELL SORTED	0	12	GRAY	SOFT								
SAND, WELL SORT	12	14	GRAY	SOFT								
SAND, MEDIUM WELL	14	19	GRAY	SOFT								
SAND, MED. TO	19	22	GRAY	SOFT								
SAND, MEDIUM WELL	22	43	GRAY	SOFT								
SILT & CLAY WITH	43	76	GRAY	MEDIUM								
Open Hole					From	ft.	To	ft.				
Screen?					<input checked="" type="checkbox"/>	Type	slotted pipe		Make	ENVIRONMENTAL		
Diameter					Slot/Gauge	Length	Set					
1.2 in.					10	2.7 ft.	73.4 ft.	75 ft.				
Static Water Level					25.8 ft.	land surface	Measure	08/17/2015				
Pumping Level (below land surface)					ft.	3.6 hrs.	Pumping at	0.2		g.p.m.		
Wellhead Completion					Fidess adapter manufacturer			Model				
<input checked="" type="checkbox"/> Casing Protection					<input checked="" type="checkbox"/> 12 in. above grade							
<input type="checkbox"/> At-grade (Environmental Wells and Borings ONLY)												
Grouting Information					Well Grouted?	<input checked="" type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Not Specified				
Material					Amount	From	To					
cuttings					5	4	ft. 70.2	ft.				
concrete					2.5	ft. 4	ft.					
Nearest Known Source of Contamination					foot	Direction	Type					
Well disinfected upon completion?					<input type="checkbox"/> Yes	<input checked="" type="checkbox"/> No						
Pump					<input checked="" type="checkbox"/> Not Installed	Date Installed						
Manufacturer's name												
Model Number					HP	Volt						
Length of drop pipe					ft	Capacity	g.p.	Typ				
Abandoned					Does property have any not in use and not sealed well(s)? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No							
Variance					Was a variance granted from the MDH for this well? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No							
Miscellaneous												
First Bedrock					Aquifer			Quat. buried				
Last Strat					pobbly sand/silt/clay-gray			Depth to Bedrock ft				
Located by					Minnesota Geological Survey							
Locate Method					Digitization (Screen) - Map (1:24,000)							
System					UTM - NAD83, Zone 15, Meters		X 379654	Y 4999334				
Unique Number Verification					Information from		Input Date	08/14/2015				
Angled Drill Hole												
Well Contractor					US Geological Survey			1548	HUCEABY, J.			
Licensee Business					Lic. or Reg. No.			Name of Driller				
Minnesota Well Index Report					773059			Printed on 06/19/2017				
								HE-01205-15				

Figure 54. Well and Boring Report - USGS 1-E (773058)

Minnesota Unique Well Number					MINNESOTA DEPARTMENT OF HEALTH			Entry Date		
773058 County Mooker Quad Litchfield Quad ID 125A					WELL AND BORING REPORT Minnesota Statutes Chapter 1031			08/14/2015		
								Update Date		
								10/20/2015		
					Received Date					
Well Name	Township	Range	Dir Section	Subsection	Well Depth	Depth Completed	Date Well Completed			
LFO1-E	119	31	W 11	ABACBB	95.3 ft.	95.28 ft.	06/10/2015			
Elevation	1114.5	Elev. Method	LIDAR 1m DEM (MNDNR)			Drill Method	Angular (non-specified)			
Address					Use	monitor well		Status	Active	
Contact	126 MARSHALL AV N LITCHFIELD MN 55355				Well Hydrofractured?	Yes <input type="checkbox"/>	No <input type="checkbox"/>	From	To	
Well	982 MILLER AV N LITCHFIELD MN 55355				Casing Type	Single casing		Joint		
Geology					Drive Shoe?	Yes <input type="checkbox"/>	No <input checked="" type="checkbox"/>	Above/Below		
Geology					Casing Diameter	Weight	Hole Diameter			
Geology					1.2 in. To	92.4 ft. 0.74 lbs./ft.	8.2 in. To		95 ft.	
Geology					Open Hole	From	ft.	To	ft.	
Geology					Screen?	<input checked="" type="checkbox"/>	Type	slotted pipe		
Geology					Diameter	Slot/Graze	Length	Set	Make	
Geology					1.2 in.	10	2.7 ft.	92.4 ft.	ENVIRONMENTAL	
Geology					Static Water Level	36.3 ft. land surface		Measure	08/17/2015	
Geology					Pumping Level (below land surface)	ft.	11. hrs.	Pumping at	0.28 g.p.m.	
Geology					Wellhead Completion	Pitless adapter manufacturer		Model		
Geology					<input checked="" type="checkbox"/>	Casing Protection		<input checked="" type="checkbox"/> 12 in. above grade		
Geology					<input type="checkbox"/>	At-grade (Environmental Wells and Borings ONLY)				
Geology					Grouting Information	Well Grouted?	<input checked="" type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Not Specified	
Geology					Material	Amount	From	To		
Geology					bentonite	7 Sacks	4	ft. 89.5 ft.		
Geology					concrete	2.5 Sacks	ft. 4	ft.		
Geology					Nearest Known Source of Contamination	foot	Direction	Type		
Geology					Well disinfected upon completion?	<input type="checkbox"/> Yes	<input checked="" type="checkbox"/> No			
Geology					Pump	<input checked="" type="checkbox"/> Not Installed	Date Installed			
Geology					Manufacturer's name					
Geology					Model Number	HP	Volt			
Geology					Length of drop pipe	ft	Capacity	g.p.	Typ	
Geology					Abandoned	Does property have any not in use and not sealed well(s)? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No				
Geology					Variance	Was a variance granted from the MDH for this well? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No				
Geology					Miscellaneous	First Bedrock	Aquifer	Quat. buried		
Geology					Last Strat	pebbly sand/silt/clay-gray		Depth to Bedrock	ft	
Geology					Located by	Minnesota Geological Survey				
Geology					Locate Method	Digitization (Screen) - Map (1:24,000)				
Geology					System	UTM - NAD83, Zone 15, Meters	X 379655	Y 4999334		
Geology					Unique Number Verification	Information from	Input Date	08/14/2015		
Geology					Angled Drill Hole					
Geology					Well Contractor	US Geological Survey		1548	HUCKABY, J.	
Geology					Licenses Business	Lic. or Reg. No.		Name of Driller		
Remarks					SEE DRILLER LOG FOR DETAILED INFORMATION.					
Minnesota Well Index Report					773058		Printed on 06/19/2017 HE-01205-15			

Figure 55. Well and Boring Report - USGS 1-F (773057)

Minnesota Unique Well Number		County	Monitor	MINNESOTA DEPARTMENT OF HEALTH WELL AND BORING REPORT Minnesota Statutes Chapter 1031			Entry Date	08/14/2015	
773057		Litchfield	125A				Update Date	10/22/2015	
					Received Date				
Well Name	LFO1-F	Township	119	Range	31	Dir Section	W 11	Subsection	ABACBB
Elevation	1114.7	Elev. Method	LIDAR 1m DEM (MNDNR)						
Address:		Use monitor well Status Active							
Contact	126 MARSHALL AV N LITCHFIELD MN 55355								
Well	982 MILLER AV N LITCHFIELD MN 55355								
Stratigraphy Information		Well Hydrofractured? Yes <input type="checkbox"/> No <input checked="" type="checkbox"/> From To							
Geological Material		Casing Type Single casing Joint Glued							
WELL SORT, SAND,		Drive Shoe? Yes <input type="checkbox"/> No <input checked="" type="checkbox"/> Above/Below							
SAND WELL SORT		Casing Diameter Weight Hole Diameter							
SAND, MEDIUM WELL		2 in. To 118 ft. 1.02 lbs./ft. 8.2 in. To 130 ft.							
SAND, MED. TO		Open Hole From ft To ft							
SAND, MEDIUM WELL		Screen? <input checked="" type="checkbox"/> Type slotted pipe Make ENVIRONMENTAL							
SILT & CLAY W/ SAND		Diameter Slot/Gauge Length Set							
SAND & GRAVEL,		1.9 in. 20 9.6 ft. 118 ft. 127.4 ft.							
		Static Water Level							
		36.6 ft. land surface Measure 08/17/2015							
		Pumping Level (below land surface)							
		ft. 2.9 hrs. Pumping at 1.11 g.p.m.							
		Wellhead Completion							
		Pileless adapter manufacturer Model							
		<input checked="" type="checkbox"/> Casing Protection <input checked="" type="checkbox"/> 12 in. above grade							
		<input type="checkbox"/> At-grade (Environmental Wells and Borings ONLY)							
		Grouting Information Well Grouted? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Not Specified							
		Material Amount From To							
		bentonite 9 Sacks 3.4 ft. 95 ft.							
		concrete 2.5 Sacks ft. 3.4 ft.							
		Nearest Known Source of Contamination							
		ft Direction Type							
		Well disinfected upon completion? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No							
		Pump <input checked="" type="checkbox"/> Not Installed Date Installed							
		Manufacturer's name							
		Model Number HP Volt							
		Length of drop pipe ft Capacity g.p. Typ							
		Abandoned							
		Does property have any not in use and not sealed well(s)? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No							
		Variance							
		Was a variance granted from the MDH for this well? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No							
		Miscellaneous							
		First Bedrock Aquifer Quat. buried							
		Last Strat sand +larger-gray Depth to Bedrock ft							
		Located by Minnesota Geological Survey							
		Locate Method Digitization (Screen) - Map (1:24,000)							
		System UTM - NAD83, Zone 15, Meters X 379654 Y 4999332							
		Unique Number Verification Information from Input Date 08/14/2015							
		Angled Drill Hole							
		Well Contractor							
		US Geological Survey 1548 HUCKABY, J.							
		Licensee Business Lic. or Reg. No. Name of Driller							
Minnesota Well Index Report		773057			Printed on 06/19/2017 HE-01205-15				

Figure 56. Well and Boring Report - USGS 2-A (773056)

Minnesota Unique Well Number		County	Monitor	MINNESOTA DEPARTMENT OF HEALTH			Entry Date	
773056		Litchfield	125A	WELL AND BORING REPORT			09/09/2015	
				Minnesota Statutes Chapter 1031			Update Date 10/20/2015	
							Received Date	
Well Name	Township	Range	Dir Section	Subsection	Well Depth	Depth Completed	Date Well Completed	
LFO2-A	119	31	W 2	CACDBD	20 ft.	19.99 ft.	06/24/2015	
Elevation	1139.6	Elev. Method	LIDAR 1m DEM (MNDNR)					
Address:				Use	Status			
Well 61656 270TH ST LITCHFIELD MN 55355				monitor well	Active			
Contact 126 MARSHALL AV N LITCHFIELD MN 55355				Well Hydrofractured?	Yes <input type="checkbox"/>	No <input type="checkbox"/>	From To	
Stratigraphy Information: MOODALE DR MOUNDS VIEW MN 55112				Casing Type	Single casing Joint Grout			
Geological Material: SILT&CLAY W/SAND, From 0 To (ft.) 20 Color GRAY Hardness MEDIUM				Drive Shoe?	Yes <input type="checkbox"/>	No <input type="checkbox"/>	Above/Below	
				Casing Diameter	Weight	Hole Diameter		
				1.2 in. To	17.1 ft. 0.74 lbs./ft.	8.2 in. To 20 ft.		
				Open Hole	From	ft.	To	
				Screen? <input checked="" type="checkbox"/>	Type	slot pipe Make ENVIRONMENTAL		
				Diameter	Slot/Gauze	Length	Set	
				1.2 in.	10	2.7 ft.	17.1 ft. 19.7 ft.	
				Static Water Level	17.3 ft. land surface Measure 08/17/2015			
				Pumping Level (below land surface)	ft. 1.2 hrs. Pumping at 0.08 g.p.m.			
				Wellhead Completion	Pitless adapter manufacturer Model			
				<input checked="" type="checkbox"/> Casing Protection	<input checked="" type="checkbox"/> 12 in. above grade			
				<input type="checkbox"/> At-grade (Environmental Wells and Borings ONLY)				
				Grouting Information	Well Grouted?	<input checked="" type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Not Specified
				Material	Amount	From	To	
				bentonite	2 Sacks	3	ft. 15 ft.	
				concrete	1.5 Sacks		ft. 3 ft.	
				Nearst Known Source of Contamination	foot	Direction	Type	
				Well disinfected upon completion?	<input type="checkbox"/> Yes	<input checked="" type="checkbox"/> No		
				Pump	<input checked="" type="checkbox"/> Not Installed	Date Installed		
				Manufacturer's name				
				Model Number	HP	Volt		
				Length of drop pipe	ft	Capacity	g.p. Typ	
				Abandoned	Does property have any not in use and not sealed well(s)? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No			
				Variance	Was a variance granted from the MDH for this well? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No			
				Miscellaneous:	First Bedrock Aquifer Quat. buried			
				Last Strat	pobby sand/silt/clay-gray	Depth to Bedrock	ft	
				Located by	Minnesota Geological Survey			
				Locate Method	Digitization (Screen) - Map (1:24,000)			
				System	UTM - NAD83, Zone 15, Meters	X 379193	Y 4999910	
				Unique Number Verification	Information from	Input Date	09/09/2015	
				Angled Drill Hole				
				Well Contractor	US Geological Survey 1548 HUCKABY, J.			
				Licensee Business	Lic. or Reg. No.	Name of Driller		
Minnesota Well Index Report				773056	Printed on 06/12/2017 HE-01205-15			

Figure 57. Well and Boring Report - USGS 1-F (773057)

Minnesota Unique Well Number		County	County	MINNESOTA DEPARTMENT OF HEALTH			Entry Date		
773055		Mooker	Litchfield	WELL AND BORING REPORT			09/09/2015		
		Quad ID	125A	Minnesota Statutes Chapter 1031			Update Date 10/20/2015		
					Received Date				
Well Name	Township	Range	Dir	Section	Subsection	Well Depth	Depth Completed	Date Well Completed	
LFO2-B	119	31	W	2	CACDBD	35.5 ft.	35.13 ft.	06/24/2015	
Elevation	1139.2	Elev. Method	LIDAR 1m DEM (MNDNR)						
Address						Use	monitor well	Status	
Well 61656 270TH ST LITCHFIELD MN 55355						Active			
Contact 126 MARSHALL AV N LITCHFIELD MN 55355						Well Hydrofractured?	Yes <input type="checkbox"/> No <input checked="" type="checkbox"/>	From	To
Stratigraphy Info						Casing Type	Single casing		
2600 WOODDALE DR MOUNDS VIEW MN 55112						Drive Shoe?	Yes <input type="checkbox"/> No <input type="checkbox"/>	Joint	Glued
Geological Material						Above/Below			
SILT&CLAY W/SAND,						Casing Diameter	Weight	Hole Diameter	
From To (ft.) Color Hardness						1.2 in. To 32.3 ft. 0.74 lbs./ft.	8.2 in. To 35.5 ft.		
						Open Hole	From	To	
						ft. ft.	ft. ft.		
						Screen?	<input checked="" type="checkbox"/>	Type	slot pipe
						Diameter	Slot/Gauge	Length	Set
						1.2 in. 10	2.7 ft.	32.2 ft.	34.9 ft.
						Static Water Level			
						23.8 ft.	land surface	Measure	08/17/2015
						Pumping Level (below land surface)			
						ft.	1.4 hrs.	Pumping at	1.43 g.p.m.
						Wellhead Completion			
						Filter adapter manufacturer	Model		
						<input checked="" type="checkbox"/>	Casing Protection	<input checked="" type="checkbox"/>	12 in. above grade
						At-grade (Environmental Wells and Borings ONLY)			
						Grouting Information			
						Well Grouted?	<input checked="" type="checkbox"/>	Yes	<input type="checkbox"/> No
						Material	Amount	From	To
						bentonite	4 Sacks	3 ft.	30.5 ft.
						concrete	1.5 Sacks	ft. 3	ft.
						Nearest Known Source of Contamination			
						foot	Direction	Type	
						Well disinfected upon completion?			
						<input type="checkbox"/> Yes	<input checked="" type="checkbox"/> No		
						Pump	<input checked="" type="checkbox"/> Not Installed	Date Installed	
						Manufacturer's name			
						Model Number	HP	Volt	
						Length of drop pipe	ft	Capacity	g.p.
						Typ			
						Abandoned			
						Does property have any not in use and not sealed well(s)?			
						<input type="checkbox"/> Yes	<input checked="" type="checkbox"/> No		
						Variance			
						Was a variance granted from the MDH for this well?			
						<input type="checkbox"/> Yes	<input checked="" type="checkbox"/> No		
						Miscellaneous			
						First Bedrock	Aquifer	Quat. buried	ft
						Last Strat	pobbly sand/silt/clay-gray	Depth to Bedrock	
						Located by Minnesota Geological Survey			
						Locate Method Digitization (Screen) - Map (1:24,000)			
						System	UTM - NAD83, Zone 15, Meters	X 379193	Y 4999909
						Unique Number Verification	Information from	Input Date	09/09/2015
						Angled Drill Hole			
						Well Contractor			
						US Geological Survey	1548	HUCKABY, J.	
						License Business	Lic. or Reg. No.	Name of Driller	
Minnesota Well Index Report						773055		Printed on 06/12/2017	
								HE-01205-15	

Figure 58. Well and Boring Report - USGS 2-C (773054)

Minnesota Unique Well Number		County	Monitor	MINNESOTA DEPARTMENT OF HEALTH			Entry Date			
773054		Litchfield	125A	WELL AND BORING REPORT			08/14/2015			
				Minnesota Statutes Chapter 1031			Update Date 10/20/2015			
							Received Date			
Well Name	Township	Range	Dir Section	Subsection	Well Depth	Depth Completed	Date Well Completed			
LFO2-C	119	31	W 2	CACDBD	70 ft.	59.84 ft.	06/22/2015			
Elevation	1139.4	Elev. Method	LIDAR 1m DEM (MNDNR)							
Address										
Wall	61656 270TH ST LITCHFIELD MN 55355									
Contact	126 MARSHALL AV N LITCHFIELD MN 55355									
Stratigraphy Info										
61656 270TH ST LITCHFIELD MN 55355; 126 MARSHALL AV N LITCHFIELD MN 55355; MOODALE DR MOUNDS VIEW MN 55112										
Geological Material	From	To (ft.)	Color	Hardness						
SILT & CLAY W/SAND,	0	70	GRAY	MEDIUM						
Well Hydrofractured?					Yes	<input type="checkbox"/>	No	<input checked="" type="checkbox"/>	From	To
Casing Type					Single casing	Joint	Good			
Drive Shoe?					Yes	<input type="checkbox"/>	No	<input type="checkbox"/>	Above/Below	
Casing Diameter	Weight	Hole Diameter								
1.2 in. To	57 ft. 0.74 lbs./ft.	8.2 in. To 70 ft.								
Open Hole										
		From	ft.	To	ft.					
Screen?	<input checked="" type="checkbox"/>	Type		slotted pipe		Make	ENVIRONMENTAL			
Diameter		Slot/Gauze	Length	Set						
1.2 in.	10	2.7	ft.	36.9	ft.	59.6	ft.			
Static Water Level										
31.8	ft.	land surface	Measure		06/22/2015					
Pumping Level (below land surface)										
	ft.	1.2	hrs.	Pumping at	0.14	g.p.m.				
Wellhead Completion										
Pitless adapter manufacturer										
<input checked="" type="checkbox"/> Casing Protection										
<input checked="" type="checkbox"/> 12 in. above grade										
<input type="checkbox"/> At-grade (Environmental Wells and Borings ONLY)										
Grouting Information										
Well Grouted? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Not Specified										
Material	Amount		From		To					
bentonite	7	Sacks	3	ft.	54.7	ft.				
concrete	2	Sacks	ft.	3	ft.					
Nearest Known Source of Contamination										
foot Direction Type										
Well disinfected upon completion? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No										
Pump										
<input checked="" type="checkbox"/> Not Installed Date Installed										
Manufacturer's name										
Model Number HP Volt										
Length of drop pipe ft Capacity g.p. Typ										
Abandoned										
Does property have any not in use and not sealed well(s)? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No										
Variance										
Was a variance granted from the MDH for this well? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No										
Miscellaneous										
First Bedrock Aquifer Quat. buried										
Last Strat. pobbly sand/silt/clay-gray Depth to Bedrock ft										
Located by Minnesota Geological Survey										
Locate Method Digitization (Screen) - Map (1:24,000)										
System UTM - NAD83, Zone 15, Meters X 379195 Y 4999910										
Unique Number Verification Information from Input Date 08/14/2015										
Angled Drill Hole										
Well Contractor										
US Geological Survey 1548 HUCKABY, J.										
License Business Lic. or Reg. No. Name of Driller										
Minnesota Well Index Report				773054				Printed on 06/12/2017 HE-01205-15		

TEST 2617, LITCHFIELD 2 (607420) JUNE 29, 2017

Figure 59. Well and Boring Report - USGS 2-D (773053)

Minnesota Unique Well Number		County	Meeker	MINNESOTA DEPARTMENT OF HEALTH WELL AND BORING REPORT Minnesota Statutes Chapter 1031			Entry Date	08/14/2015	
773053		Quad	Litchfield				Update Date	10/20/2015	
		Quad ID	125A				Received Date		
Well Name	Township	Range	Dir	Section	Subsection	Well Depth	Depth Completed	Date Well Completed	
LFO2-D	119	31	W	2	CACDBD	85.5 ft.	81.14 ft.	06/23/2015	
Elevation	1139.2	Elev. Method	LIDAR 1m DEM (MNDNR)						
Address:						Use	monitor well	Status	Active
Well						Well Hydrofractured? Yes <input type="checkbox"/> No <input checked="" type="checkbox"/> From To			
Contact						Casing Type Single casing Joint Grouted			
Summitography Information						Drive Shoe? Yes <input type="checkbox"/> No <input type="checkbox"/> Above/Below			
Geological Material						Casing Diameter Weight Hole Diameter			
SILT & CLAY W/SAND, 0 80 GRAY MEDIUM						1.2 in. To 81.1 ft. 0.74 lbs./ft. 8.2 in. To 85.5 ft.			
SAND & CLAY W/SAND, 80 86 GRAY HARD									
						Open Hole From ft. To ft.			
						Screen? <input checked="" type="checkbox"/> Type slotted pipe Make ENVIRONMENTAL			
						Diameter Slot/Gauge Length Set			
						1.2 in. 10 2.7 ft. 81.1 ft. 81.1 ft.			
						Static Water Level			
						78 ft. land surface Measure 08/17/2015			
						Pumping Level (below land surface)			
						ft. 1.4 hrs. Pumping at 0.1 g.p.m.			
						Wellhead Completion			
						Pileless adapter manufacturer Model			
						<input checked="" type="checkbox"/> Casing Protection <input checked="" type="checkbox"/> 12 in. above grade			
						<input type="checkbox"/> At-grade (Environmental Wells and Borings ONLY)			
						Grouting Information Well Grouted? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Not Specified			
						Material Amount From To			
						bantomite 6.5 Sacks 3 ft. 78.5 ft.			
						concrete 1.5 Sacks ft. 3 ft.			
						Nearest Known Source of Contamination			
						feet Direction Type			
						Well disinfected upon completion? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No			
						Pump <input checked="" type="checkbox"/> Not Installed Date Installed			
						Manufacturer's name			
						Model Number HP Volt			
						Length of drop pipe ft Capacity g.p. Typ			
						Abandoned			
						Does property have any not in use and not sealed well(s)? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No			
						Variance			
						Was a variance granted from the MDH for this well? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No			
						Miscellaneous			
						First Bedrock Aquifer Quat. buried			
						Last Strat. pobby sand/silt/clay-gray Depth to Bedrock ft			
						Located by Minnesota Geological Survey			
						Locate Method Digitization (Screen) - Map (1:24,000)			
						System UTM - NAD83, Zone 15, Meters X 379193 Y 4999908			
						Unique Number Verification Information from Input Date 08/14/2015			
						Angled Drill Hole			
						Well Contractor			
						US Geological Survey 1548 HUCKABY, J.			
						Licensee Business Lic. or Reg. No. Name of Driller			
Minnesota Well Index Report				773053		Printed on 06/12/2017 HE-01205-15			

Figure 60. Well and Boring Report - USGS 2-E (773052)

Minnesota Unique Well Number		County	Monitor	MINNESOTA DEPARTMENT OF HEALTH		Entry Date	08/14/2015
773052		Quad	Litchfield	WELL AND BORING REPORT Minnesota Statutes Chapter 1031		Update Date	10/20/2015
		Quad ID	125A			Received Date	
		Well Name Township Range Dir Section Subsection LFO2-E 119 31 W 2 CACDBD				Well Depth	Depth Completed
Elevation 1139.3 Elev. Method LIDAR 1m DEM (MNDNR)		113.9 ft.	113.82 ft.	06/20/2015			
Address Well 61656 270TH ST LITCHFIELD MN 55355 Contact 126 MARSHALL AV N LITCHFIELD MN 55355 Stratiigraphy Information MOODALE DR. MOUNDS VIEW MN 55112		Drill Method Augur (non-specified) Drill Fluid		Use	monitor well Status Active		
Geological Material From To (ft.) Color Hardness SILT&CLAY W/SAND, 0 80 GRAY MEDIUM SILT&CLAY W/SAND, 80 114 GRAY HARD		Well Hydrofractured? Yes <input type="checkbox"/> No <input checked="" type="checkbox"/> From To		Casing Type	Single casing Joint Glued		
		Drive Shoe? Yes <input type="checkbox"/> No <input type="checkbox"/> Above/Below		Casing Diameter	Weight Hole Diameter		
				1.2 in. To	111 ft. 0.74 lbs./ft. 8.2 in. To 113. ft.		
		Open Hole From ft. To ft.		Screen? <input checked="" type="checkbox"/> Type slotted pipe Make ENVIRONMENTAL			
				Diameter	Slot/Gauge Length Set		
				1.2 in.	10 2.7 ft. 110.9 ft. 113.6 ft.		
		Static Water Level 95.6 ft. land surface Measure 08/17/2015		Pumping Level (below land surface) ft. 0.6 hrs. Pumping at 0.47 g.p.m.			
		Wellhead Completion Pileless adapter manufacturer Model <input checked="" type="checkbox"/> Casing Protection <input checked="" type="checkbox"/> 12 in. above grade <input type="checkbox"/> At-grade (Environmental Wells and Borings ONLY)		Grouting Information Well Grouted? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Not Specified Material Amount From To bentonite Sacks 3 ft. 108.6 ft. concrete Sacks ft. 3 ft.			
		Nearest Known Source of Contamination feet Direction Type Wall disinfected upon completion? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No		Pump <input checked="" type="checkbox"/> Not Installed Date Installed Manufacturer's name Model Number HP Volt Length of drop pipe ft Capacity g.p. Typ			
		Abandoned Does property have any not in use and not sealed well(s)? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No		Variance Was a variance granted from the MDH for this well? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No			
		Miscellaneous First Bedrock Aquifer Quant. buried Last Strat pebbly sand/silt/clay-gray Depth to Bedrock ft.		Located by Minnesota Geological Survey Locate Method Digitization (Screen) - Map (1:24,000) System UTM - NAD83, Zone 15, Meters X 379195 Y 4999909 Unique Number Verification Information from Input Date 08/14/2015			
Remarks SEE DRILLERS LOG FOR DETAILED INFORMATION.		Angled Drill Hole		Well Contractor US Geological Survey 1548 HUCEABY, J. Licensee Business Lic. or Reg. No. Name of Driller			
Minnesota Well Index Report		773052		Printed on 06/12/2017 HE-01205-15			

Figure 61. Well and Boring Report - USGS 2-F (773051)

Minnesota Unique Well Number		County	Quad	Range	Dir Section	Subsection	MINNESOTA DEPARTMENT OF HEALTH	Entry Date
773051		Mooker	Litchfield	31	W 2	CACDBD	WELL AND BORING REPORT	08/14/2015
		Quad ID	125A				Minnesota Statutes Chapter 1031	Update Date
								Received Date
Well Name	Township	Range	Dir Section	Subsection	Well Depth	Depth Completed	Date Well Completed	
LFO2-F	119	31	W 2	CACDBD	162.5 ft.	162.42 ft.	06/18/2015	
Elevation	1139.3	Elev. Method	LIDAR 1m DEM (MNDNR)					
Address				Use		Status		
Well 61656 270TH ST LITCHFIELD MN 55355				monitor well		Active		
Contact 126 MARSHALL AV N LITCHFIELD MN 55355				Well Hydrofractured?		Yes <input type="checkbox"/> No <input checked="" type="checkbox"/>		From To
Stratigraphy Information				Casing Type		Joint		Glued
Geological Material				Single casing				
From To (ft) Color Hardness				Drive Shoe?		Yes <input type="checkbox"/> No <input type="checkbox"/>		Above/Below
SILT&CLAY W/SAND, 0 80 GRAY MEDIUM				Casing Diameter		Weight		
SILT&CLAY W/SAND, 80 117 GRAY HARD				2 in. To		152. ft. 1.02 lbs./ft.		
SAND & GRAVEL, 117 161 GRAY HARD				Open Hole		From ft. To ft.		
SILT&CLAY W/SAND, 161 163 GRAY HARD				Screen?		<input checked="" type="checkbox"/>		Type slotted pipe Make ENVIRONMENTAL
				Diameter		Slot/Gauge Length Set		
				1.9 in.		20 9.6 ft. 152.4 ft. 162 ft.		
				Static Water Level				
				61 ft. land surface		Measure 08/17/2015		
				Pumping Level (below land surface)				
				ft. 6.4 hrs. Pumping at		0.86 g.p.m.		
				Wellhead Completion				
				Pitless adapter manufacturer		Model		
				<input checked="" type="checkbox"/> Casing Protection		<input checked="" type="checkbox"/> 12 in. above grade		
				<input type="checkbox"/> At-grade (Environmental Wells and Borings ONLY)				
				Grouting Information		Well Grouted? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Not Specified		
				Material		Amount From To		
				bentonite		10 Sacks 2 ft. 137 ft.		
				concrete		2 Sacks ft. 2 ft.		
				Nearest Known Source of Contamination				
				foot		Direction		Type
				Well disinfected upon completion?		<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No		
				Pump <input checked="" type="checkbox"/> Not Installed		Date Installed		
				Manufacturer's name				
				Model Number		HP Volt		
				Length of drop pipe		ft Capacity g.p. Typ		
				Abandoned				
				Does property have any not in use and not sealed well(s)? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No				
				Variance				
				Was a variance granted from the MDH for this well? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No				
				Miscellaneous				
				First Bedrock		Aquifer Quat. buried		
				Last Strat		Depth to Bedrock ft		
				Located by Minnesota Geological Survey				
				Locate Method Digitization (Screen) - Map (1:24,000)				
				System		UTM - NAD83, Zone 15, Meters X 379195 Y 4999908		
				Unique Number Verification		Information from Input Date 08/14/2015		
				Angled Drill Hole				
				Well Contractor				
				US Geological Survey		1548 HUCKABY, J.		
				Licensee Business		Lic. or Reg. No. Name of Driller		
Minnesota Well Index Report				773051				Printed on 06/19/2017 HE-01205-15

Figure 62. Well and Boring Report - Desens Observation (800011)

Minnesota Unique Well Number 800011		County Mooker Quad Litchfield Quad ID 125A	MINNESOTA DEPARTMENT OF HEALTH WELL AND BORING REPORT <i>Minnesota Statutes Chapter 1031</i>		Entry Date 01/13/2014 Update Date 08/26/2014 Received Date 10/02/2013		
Well Name DESEN, DOUG	Township 119	Range 31	Dir Section W 2	Subsection DACAAC	Well Depth 158 ft.	Depth Completed 158 ft.	Date Well Completed 07/29/2013
Elevation 1128.4	Elev. Method Surveyed				Drill Method Non-specified Rotary	Drill Fluid Bentonite	
Address: Contact 28003 620TH AV LITCHFIELD MN 55355 Well 620TH AV LITCHFIELD MN 55355					Use monitor well Status: Active		
Stratigraphy Information					Well Hydrofractured? Yes <input type="checkbox"/> No <input checked="" type="checkbox"/> From To		
Geological Material	From	To (ft.)	Color	Hardness	Casing Type Single casing	Joint Gload	
TOP SOIL	0	3	BLACK	SOFT	Drive Shoe? Yes <input type="checkbox"/> No <input checked="" type="checkbox"/>	Above/Below	
CLAY	3	5	BROWN	SOFT	Casing Diameter	Weight	Hole Diameter
GRAVEL	5	9	BROWN	SOFT	2 in. To 148 ft.	Ibs./ft.	6.2 in. To 158 ft.
CLAY	9	112	GRAY	MED-HRD	Open Hole		
DIRTY GRAVEL	112	117	GRAY	SOFT	Screen? <input checked="" type="checkbox"/>	From ft.	To ft.
CLAY	117	120	GRAY	SFT-MED	Type plastic	Make JOHNSON	
SAND/GRAVEL	120	158	GRAY	SOFT	Diameter	Slot/Gauze	Length
CLAY/GRAVEL	158	158	GRAY	SOFT	2 in.	10	10 ft.
					Set	148 ft.	158 ft.
					Static Water Level		
					59.8 ft.	land surface	Measure 07/29/2013
					Pumping Level (below land surface)		
					Wellhead Completion		
					Fitness adapter manufacturer	Model	
					<input checked="" type="checkbox"/> Casing Protection	<input type="checkbox"/> 12 in. above grade	
					<input type="checkbox"/> At-grade (Environmental Wells and Borings ONLY)		
					Grouting Information		
					Well Grouted? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Not Specified		
					Material	Amount	From To
					bentonite		4 ft. 142 ft.
					neat cement	2 Sacks	ft. 4 ft.
					Nearest Known Source of Contamination		
					Soil foot	West Direction	Septic tank/drain field Type
					Well disinfected upon completion? <input type="checkbox"/> Yes <input type="checkbox"/> No		
					Pump <input checked="" type="checkbox"/> Not Installed Date Installed		
					Manufacturer's name		
					Model Number HP Volt		
					Length of drop pipe ft Capacity g.p. Typ		
					Abandoned		
					Does property have any not in use and not sealed well(s)? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No		
					Variance		
					Was a variance granted from the MDH for this well? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No		
					Miscellaneous:		
					First Bedrock	Aquifer	Quat. buried
					Last Strat	pobbly sand/silt/clay-gray	Depth to Bedrock ft
					Located by Minnesota Geological Survey		
					Locate Method Digitization (Screen) - Map (1:12,000)		
					System UTM - NAD83, Zone 15, Meters X 380018 Y 5000014		
					Unique Number Verification Info/GPS from data Input Date 08/18/2014		
					Angled Drill Hole		
					Well Contractor		
					Mark J Trout Wells, Inc. 1404 STEVE/DREW		
					Licensee Business Lic. or Reg. No. Name of Driller		
Remarks DRILLERS: STEVE WEISBRICH & DREW BATES.					Minnesota Well Index Report		
					800011		
					Printed on 06/12/2017 HE-01205-15		