URANERZ ENERGY CORPORATION
(An Energy Fuels Company)
NICHOLS RANCH URANIUM ISR PROJECT
NICHOLS RANCH UNIT

PRODUCTION AREA #2 PUMP TEST DOCUMENT

FOR:

July 2016

WDEQ-LQD PERMIT NO. 778
NRC License No. SUA- 1597

BY:

Uranerz Energy Corporation
(An Energy Fuels Company)

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Geologist

Brandon Weaver

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EXECUTIVE SUMMARY

The Production Area #2 (PA #2) Hydrologic Test Plan was submitted in December of 2015 by Uranerz Energy Corporation (an Energy Fuels Company) to the Wyoming Department of Environmental Quality – Land Quality Division (WDEQ-LQD). In January 2016 the WDEQ-LQD found the test plan in order. The multi-well pump tests were conducted in March and April in 2016. The wells were pumped at average rate of 34 to 35 gallons per minute (gpm) for 3 days creating greater than 200 feet of drawdown. This stress on the A Sand aquifer resulted in drawdowns in the A Sand monitoring wells including the monitoring ring wells of 3.8 to 37.6 feet. Communication with each of the monitoring ring wells was defined.

The PA #2 pump test data shows adequate confinement between the A Sand and the Overlying and Underlying aquifers. No drawdown was observed in the Overlying and Underlying wells during the two primary multi-well pump tests. A third minor multi-well pump test was performed and added further confirmation of communication within the PA #2 area.

The PA #2 pump test produced an average transmissivity of 44 to 43 ft^2/day for the northern and southern halves of PA #2 respectfully, and an average hydraulic conductivity of 0.46 ft/day for both the northern and southern areas of PA #2. The average storage coefficient for the northern pump test was 7.1E-5 and 9.1E-5 for the southern pump test.

The PA #2 hydrologic test demonstrated the following:

1) All A Sand monitoring ring wells are in communication with the A Sand production zone.

2) Adequate confinement exists between the A Sand aquifer and the Underlying aquifer. Adequate confinement exists between the A Sand aquifer and the Overlying aquifer.

3) The A Sand aquifer characteristics have been adequately defined.

1.0 INTRODUCTION

The Nichols Ranch Uranium ISR Project is located in the southern Powder River Basin of east central Wyoming, along the Campbell and Johnson County lines. Uranerz is presently mining Production Area 1 (PA #1) in the A sand directly adjacent to Production Area 2 (PA #2).

Uranerz is developing PA #2 as its second in-situ recovery (ISR) uranium wellfield within the Nichols Ranch Unit permit. This Pump Test Document provides a summary of the hydrogeologic testing results for PA #2. The report presents the information necessary to initiate operation of PA #2.

PA #2 is located in Sections 7, 17 and 18 of T43N, R76W. Figure 1-1 shows the location of PA #2 and its relationship to the Nichols Ranch Unit of the Nichols Ranch ISR Project permit. Figure 1-2 presents a preliminary wellfield outline, monitoring well locations, and the pumping well locations. Mining operations in PA #2 are regulated under Uranerz's Source Material License #SUA-1597 and the Wyoming Department of Environmental Quality, Land Quality Division (WDEQ-LQD) Permit to Mine #778. PA #2 production is anticipated to begin in 2016.

The objectives of the pump test described in this Plan, as stated in the WDEQ-LQD Permit to Mine and NRC License Application, are to:

1. Determine the hydrologic characteristics of the Production Zone (A Sand) Aquifer;
2. Demonstrate hydrologic communication between the Production Zone and the surrounding Production Zone monitor well ring;
3. Assess the presence of hydrologic boundaries, if any, within the Production Zone Aquifer;
4. Evaluate the degree of hydrologic communication, if any, between the Production Zone and the Overlying and Underlying aquifers; and,
5. Evaluate, if applicable, the vertical hydraulic conductivity of the Overlying and Underlying confining units.

As described in the Pump Test Plan approved by WDEQ-LQD, two wells, MRN-37 and MRN-44 were the pumping wells for the aquifer test. The pumping phase of the pump tests were conducted as follows:

MRN-37:	START	3/15/2016	9:35	MRN-44:	START	4/4/2016	10:30
	STOP	3/18/2016	9:35		STOP	4/7/2016	10:30

The site-specific hydrogeologic conditions are presented in Section 2 while monitor well information and pump test details for the MRN-37 and MRN-44 tests are given in Section 3. Section 4 presents the pump test design for the MRN-37 test. Section 5 presents the results from the production zone (A Sand) while Section 6 gives the confining unit results for the MRN-37 test (northern half of PA #2). Sections 7, 8 and 9 present the corresponding sections for the MRN-44 test (southern half of PA #2). Aquifer test theory is presented in Section 10. An additional pump test was conducted in a portion of PA #2 to further define aquifer continuity and the results of that test are presented in Section 11. Summary and conclusions are presented in Section 12. Section 13 presents the baseline data and calculation results for the upper control limits used for potential excursion monitoring. Section 14 contains the references.

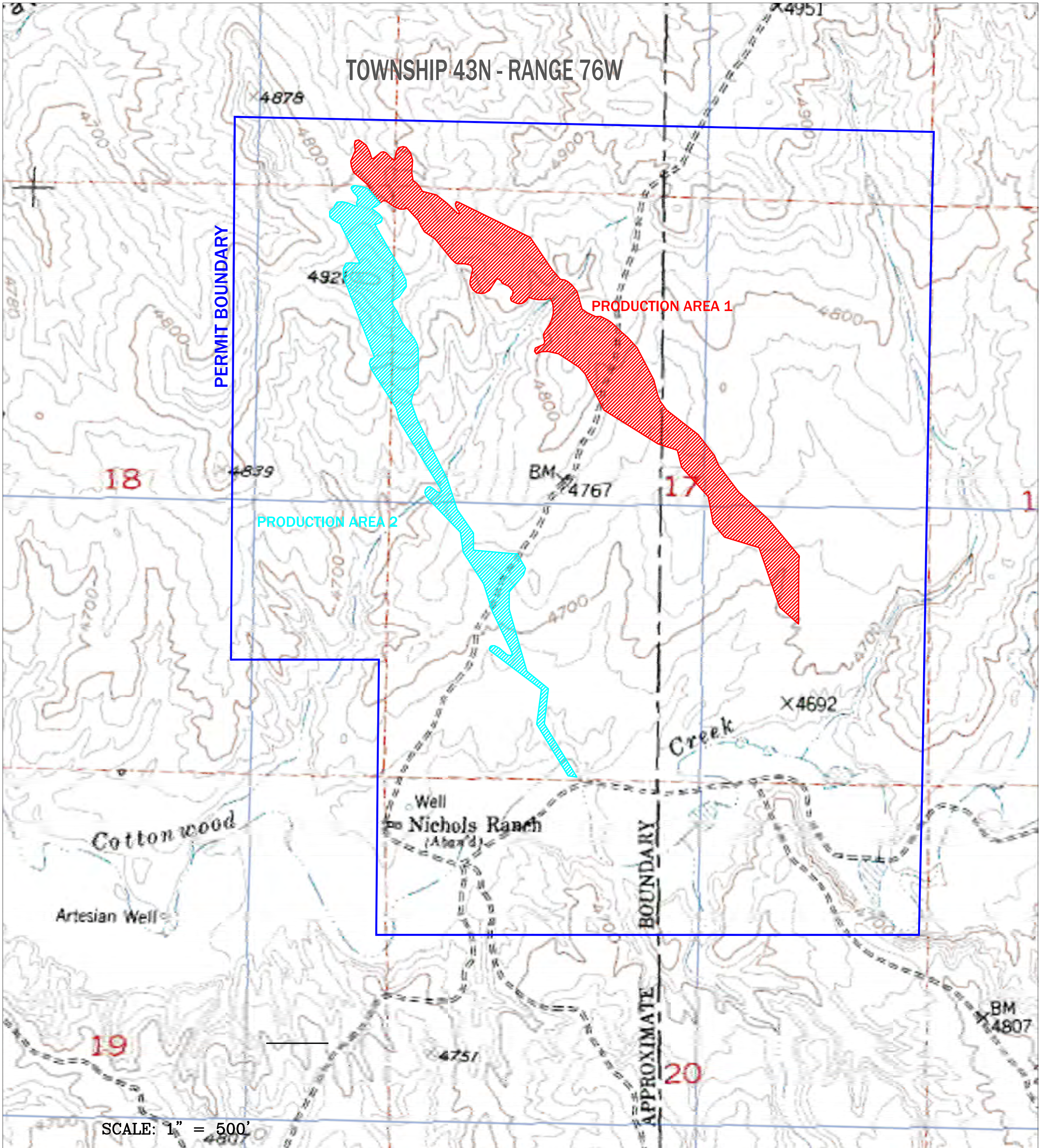

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FIGURE 1–1
NICHOLS RANCH PRODUCTION AREA #2
LOCATION MAP

PAGE: 1–3

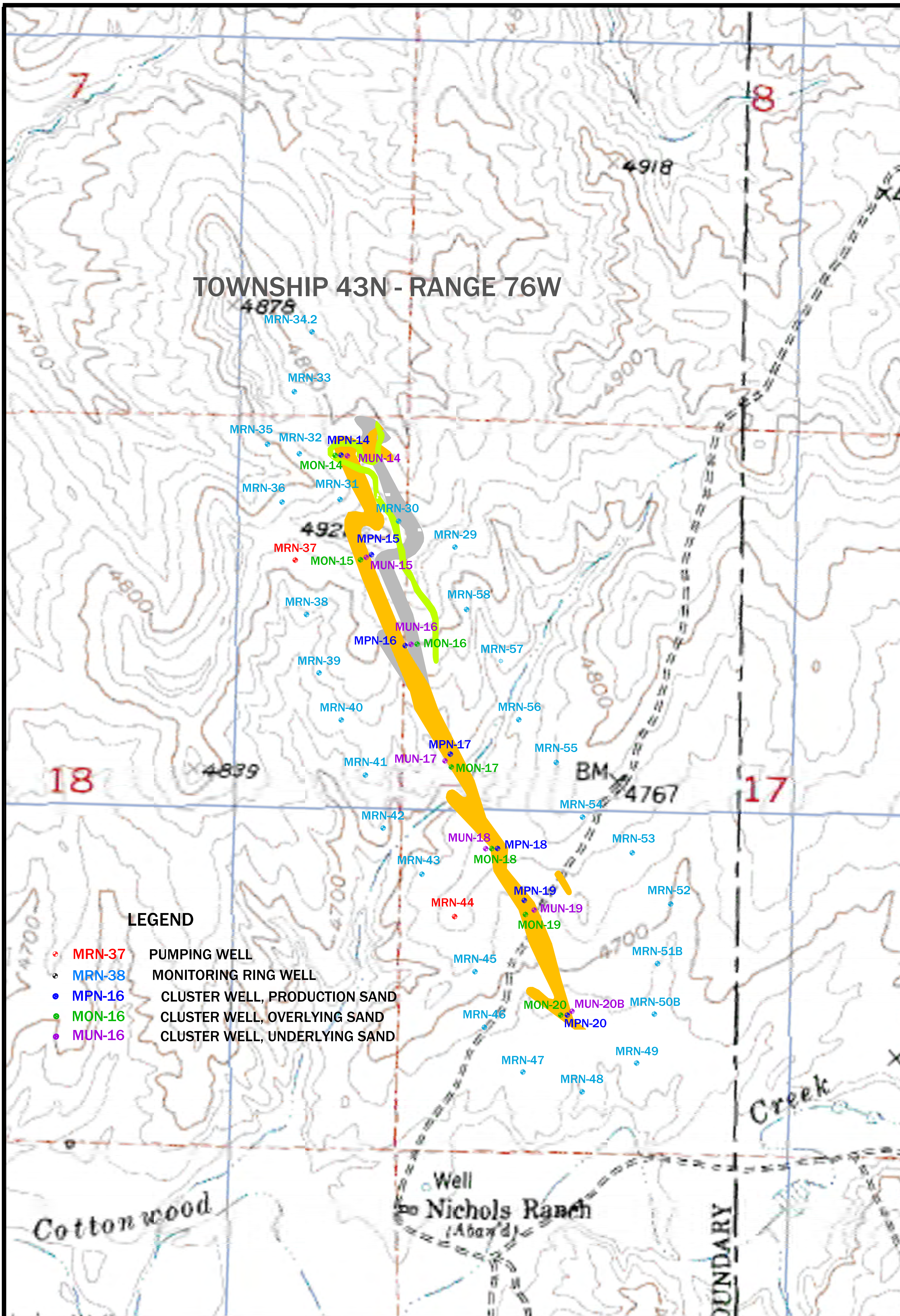

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Figure 1-2

Nichols Ranch Unit Production Area #2
Plan Map

2.0 SITE-SPECIFIC HYDROGEOLOGIC CONDITIONS

Ore-grade uranium deposits underlying Nichols Ranch are predominantly located at the base of the Eocene Age Wasatch Formation. The Wasatch Formation is composed of interbedded, uranium-enriched, fluvial sandstones and mudstones. The sandstones vary in thickness depending on the coalescing nature of the fluvial deposited sandstone. The confining layers of the sandstones consist of the mudstones deposited from the distal overbank facies that thin away from the channels of major deposition. Based on site data, these confining layers are continuous across the PA #2 area. The general stratigraphy underlying the site is summarized in Table 2-1.

TABLE 2-1
GENERALIZED STRATIGRAPHIC SECTION WITHIN PRODUCTION AREA #2 IN THE NICHOLS RANCH UNIT PERMIT AREA

Depth (feet)	Description
0-40	G Sand
40-110	F-G Mudstone
110-180	F Sand
180-220	C-F Mudstone
180-200	C Sand
200-240	B-C Mudstone
220-460	B Sand
390-500	A-B Mudstone
440-550	A Sand
580-590	1-A Mudstone
590-760	1 Sand

Figures 2-2 through 2-5 are the geologic cross-sections for PA #2 (see Figure 2-1 for cross-section location). The A Sand is shown with a green pattern on these cross sections.

The confining layers are composed of mudstones that form ubiquitous facies within the Nichols Ranch Unit Permit area. These confining layers were most likely deposited laterally away from the major braided channel systems as distal overbank facies.

2.1 OVERLYING UNITS: B SAND AND A-B MUDSTONE CONFINING UNIT

The B Sand is overlain by the B-C Mudstone and underlain by the A-B Mudstone. This sand varies from 11 to 180 feet in thickness and averages approximately 110 feet (see Figure 2-6). It is present across the entire PA #2 area. This is the aquifer that is located above the A Sand (production) and is isolated from A Sand by the A-B Mudstone. The A-B Mudstone is the overlying confining unit that separates the production sand (A Sand) from the Overlying aquifer (B Sand). The A-B Mudstone confining unit is continuous across the mine unit and the thickness varies from 15 to 150 feet and averages about 50 feet (see Figure 2-7).

2.2 PRODUCTION ZONE: A SAND

Commercial uranium deposits in PA #2 are found in the A Sand. As described in Appendix D of the LQD Permit to Mine and NRC Source Materials License, the A sand consists of stacked, braided, fluvial sandstone units. Figure 2-8 illustrates the A Sand (ore sand) isopach map which shows a geologic thickness of approximately 40 feet to roughly 110 feet with an average of 90 feet. The A Sand has variable net sand thicknesses, grain size, and shale content, which is characteristic of many production host sand units in the Powder River Basin.

Seven previous multi-well hydrologic tests have been conducted on the Nichols Ranch Unit A Sand near PA #2. These tests produced hydraulic conductivities from 0.23 to 0.56 ft/day. A transmissivity of 350 gal/day/ft (47 ft^2/day) and a storage coefficient of 1.8E-4 are thought to best represent the A Sand in the Nichols Ranch Unit. The results from these tests are summarized below in Table 2-2.

TABLE 2-2
SUMMARY OF RESULTS FROM THE A SAND
MN-1, MN-6, MN-2, URZNA-7, URZNA-9, MRN-23 & MRN-29 PUMP TESTS

Test	MN-1	MN-6	MN-2	URZNA-7	URZNA-9	MRN-23	MRN-29
Transmissivity (T; ft^2/d)	40	47	24	37	39	35	50
Hyd. Cond. (k; ft/day)	0.54	0.44	0.23	0.4	0.39	0.35	0.56
Net Sand Thickness (h; ft)	73	108	102	93	100	100	90
Storativity (S)	1.4×10^{-4}	2.6×10^{-4}	1.0×10^{-4}	1.1×10^{-4}	1.2×10^{-4}	1.2×10^{-4}	1.4×10^{-4}

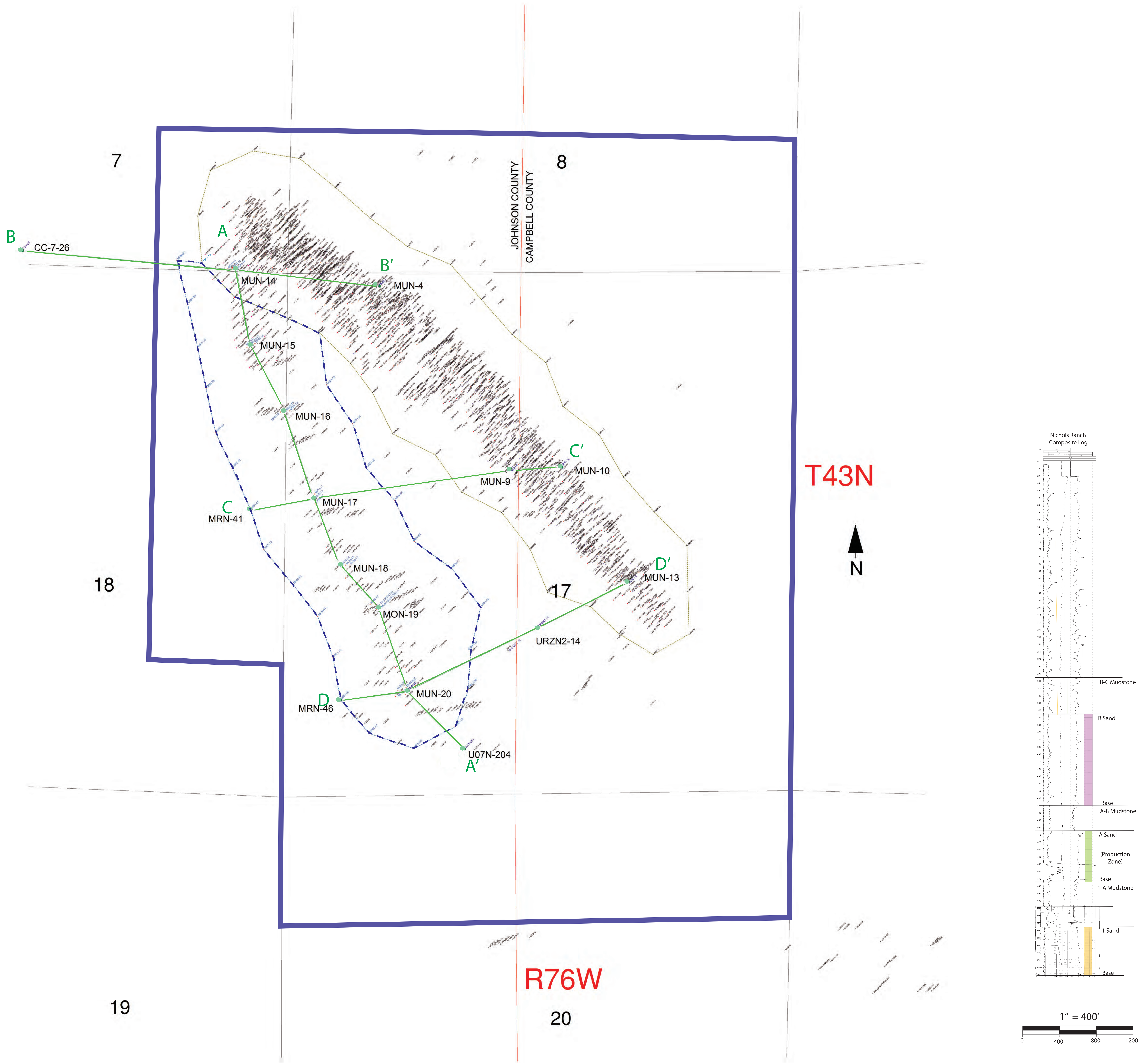
2.3 UNDERLYING UNITS: 1-A MUDSTONE CONFINING UNIT AND 1 SAND UNIT

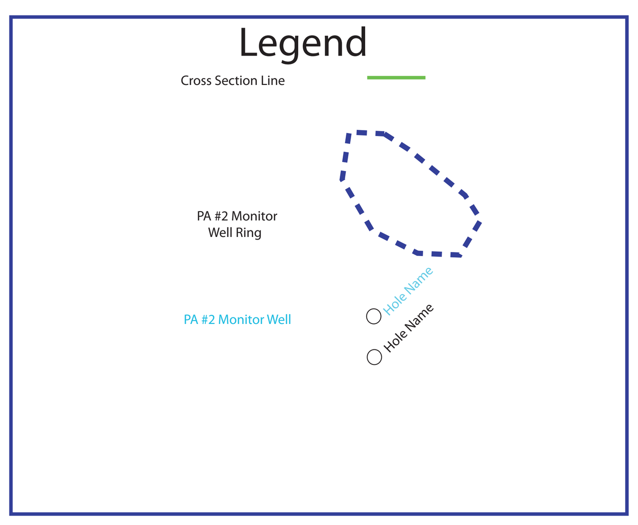
The 1A Mudstone is the Underlying confining unit that separates the A Production Sand from the Underlying lower 1 Sand Unit aquifer. Figure 2-9 presents the contours of the 1-A Mudstone which vary from slightly greater than 30 to over 100 feet thick. The average thickness is around 50 feet.

Figure 2-10 is an isopach map of the 1 Sand. It varies in thickness from zero to over 60 feet for the Nichols Ranch region. This sand is confined to a channel incised into the mudstone (see cross-sections, Figures 2-2, 2-3, 2-4, and 2-5). It appears to be present under the entire PA #2 area.

2.4 POTENTIOMETRIC SURFACE OF THE A SAND

Figure 2-11 is a potentiometric surface map of the A Sand Production Zone within the PA #2 area based on water level just prior to the start of the pump tests. The water-level elevation was variable prior to the start of the pump tests due to production in PA#1. The gradient in PA #2 is mainly to the northeast toward PA #1 at 0.1 to 0.01 ft/ft. This peizometric map for the A Sand is significantly affected by the operation of PA #1 and the present piezometric surface differs from that presented in the Nichols Ranch ISR Project Permit to Mine and Source Material License. As expected, the operation of the PA #1 wellfield has created significant drawdown in the PA #1 area and this has significantly changed the piezometric surface from the pre-mining condition. However, the operation of PA #1 was reasonably consistent over the duration of the pump testing and did not adversely affect the testing.





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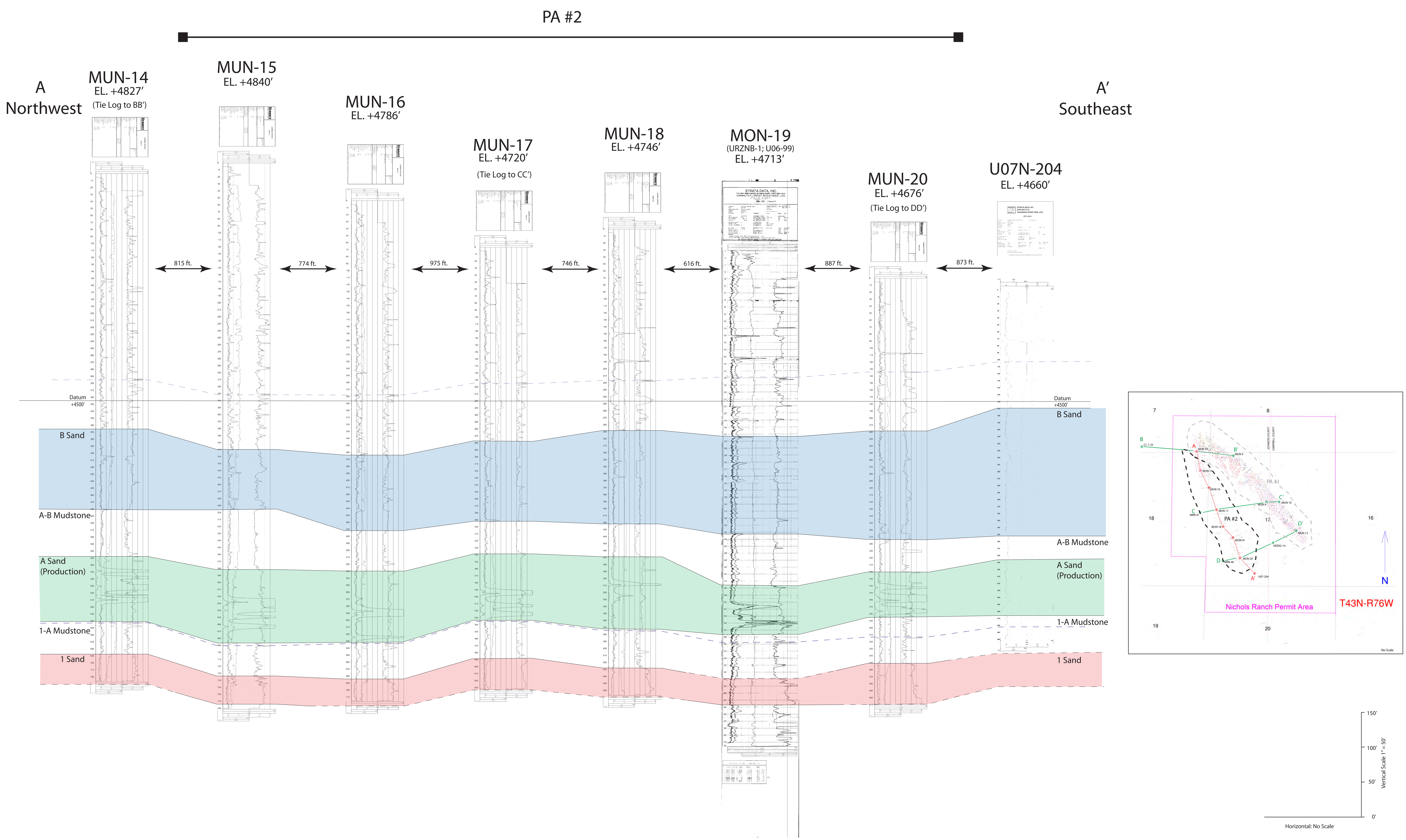
NICHOLS RANCH PA - #2
FIGURE 2-1
CROSS SECTION INDEX AND MONITOR WELL LOCATION MAP

By: SWG/BLL	Date: 7/19/2016
Contour Interval: NA	Revision Date:
Scale: SEE ABOVE	Dwg:
	Exhibit Number:



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NICHOLS RANCH PA - #2

FIGURE 2-2

GEOLOGICAL CROSS-SECTION A-A'

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Contour Interval: NA	Revision Date:
Scale: SEE ABOVE	Dwg:
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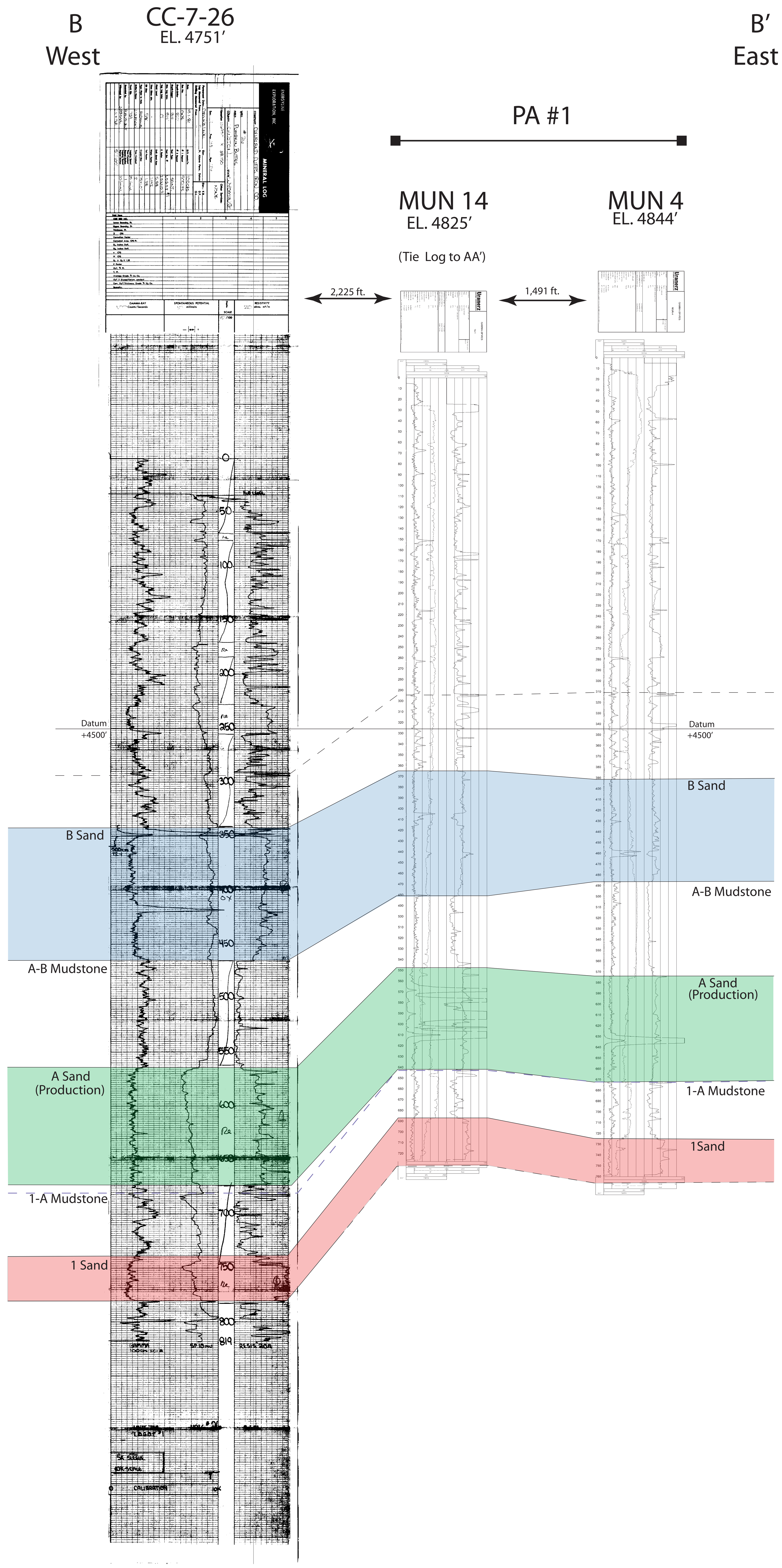

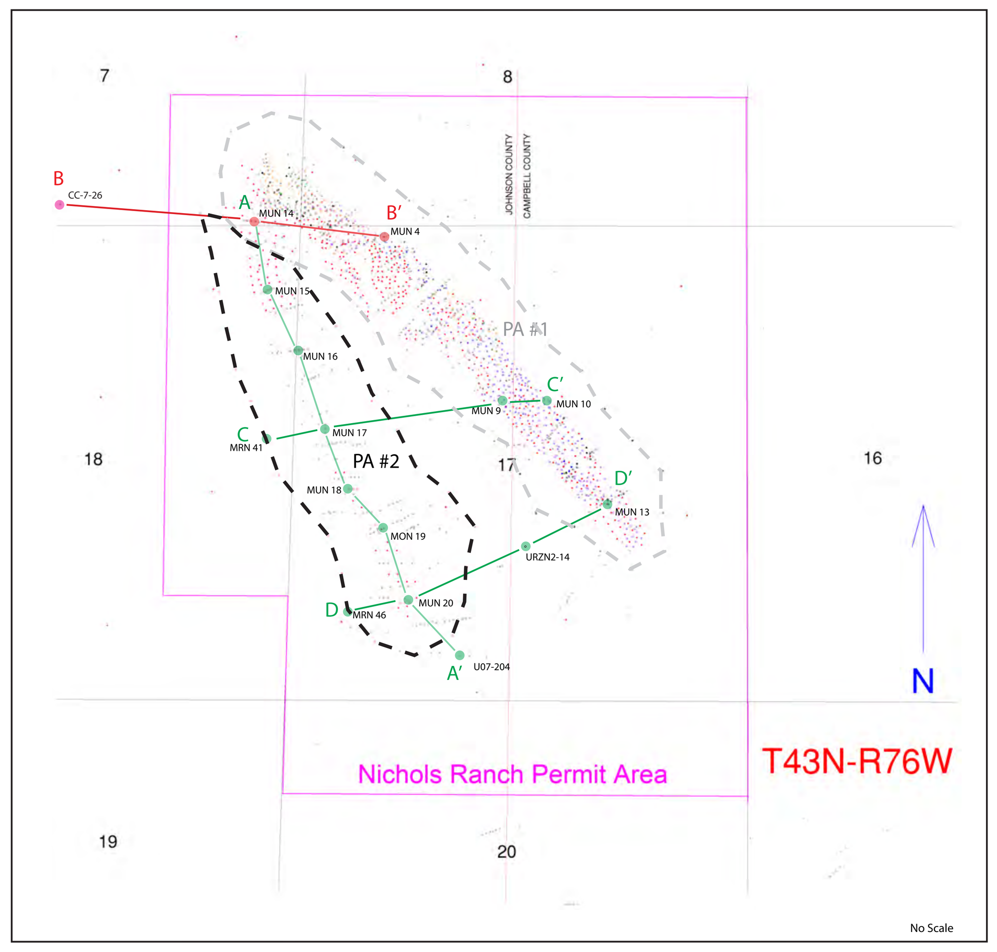

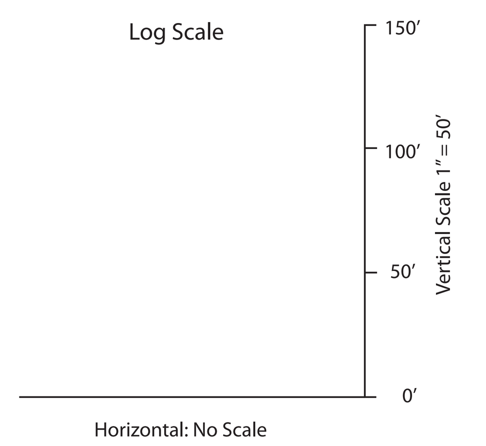

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NICHOLS RANCH PA - #2

FIGURE 2-3

GEOLOGICAL CROSS-SECTION B-B′

By: BLL	Date: 6/27/2016
Contour Interval: NA	Revision Date:
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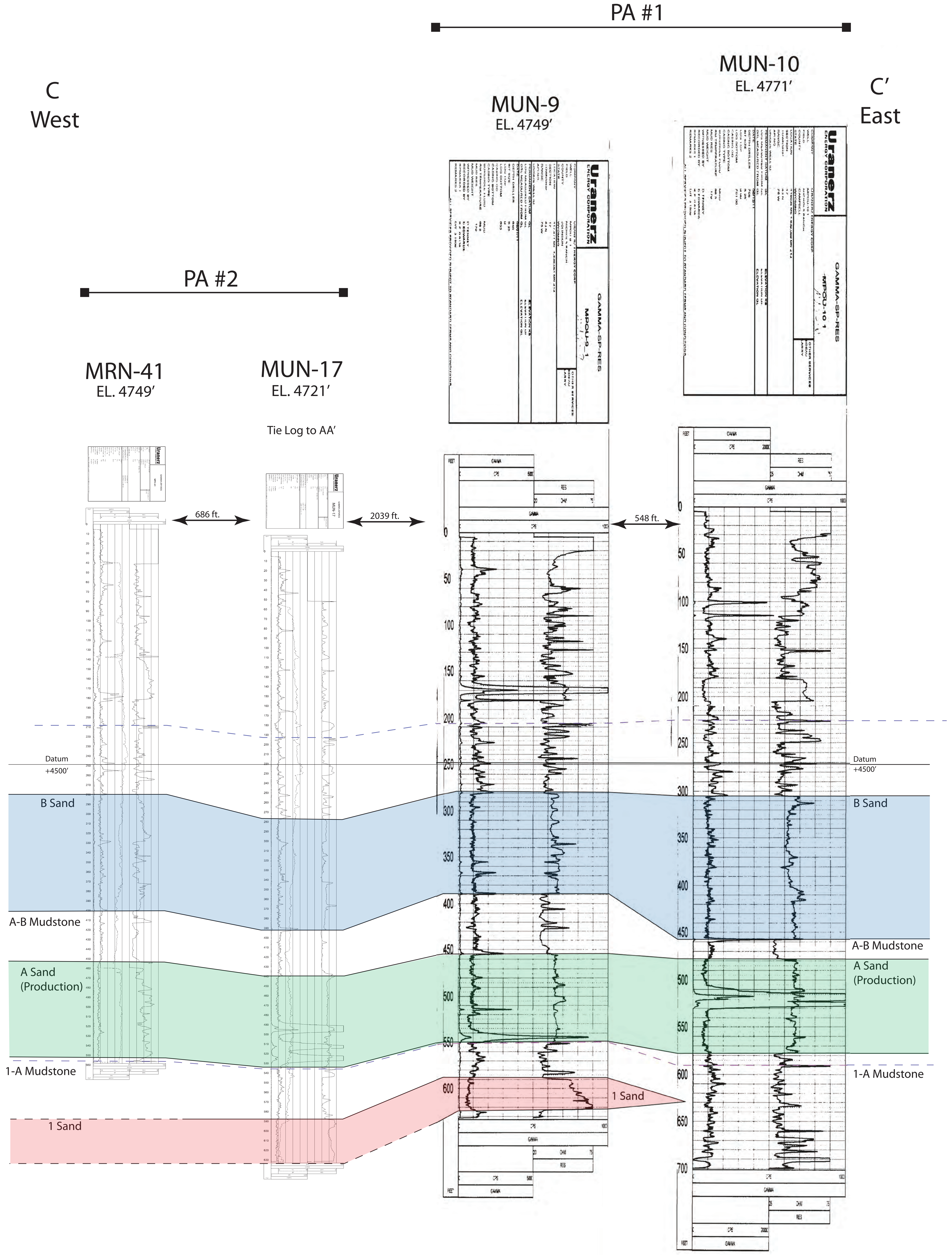
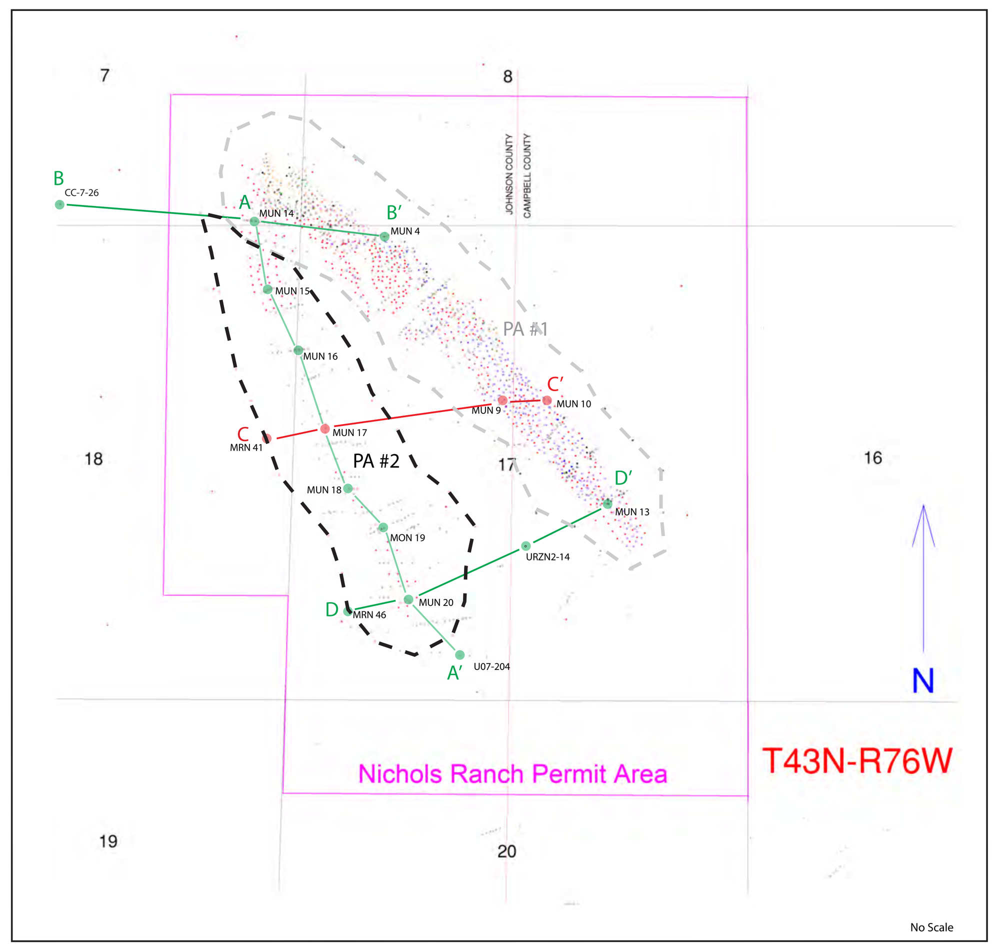
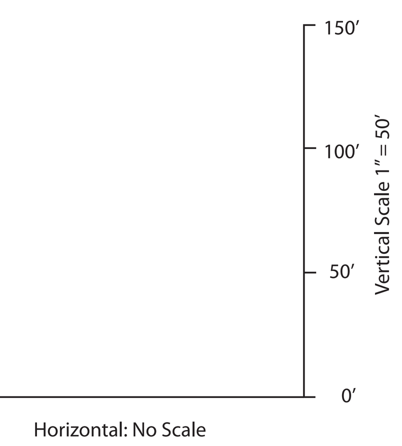
	Exhibit Number:







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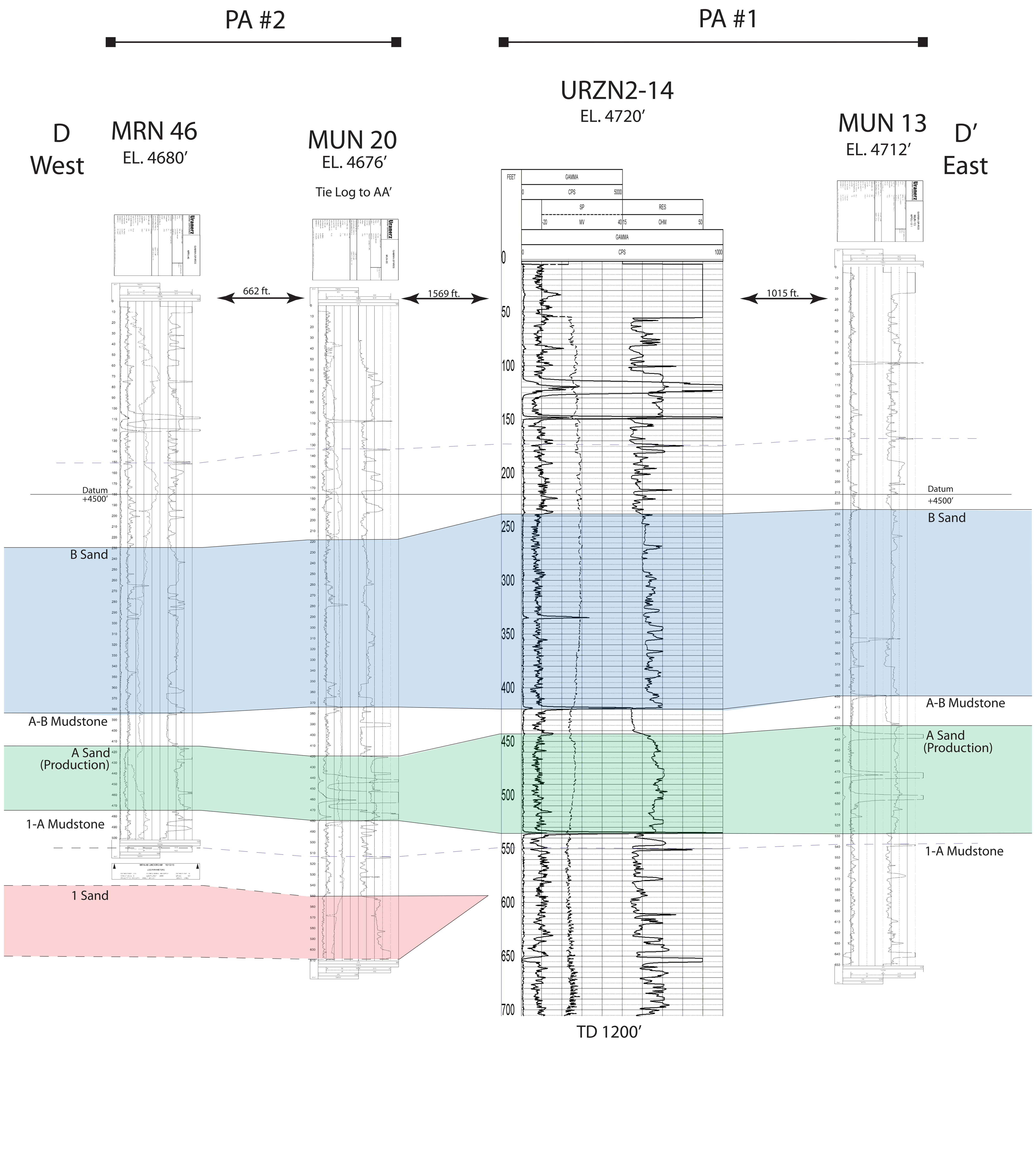
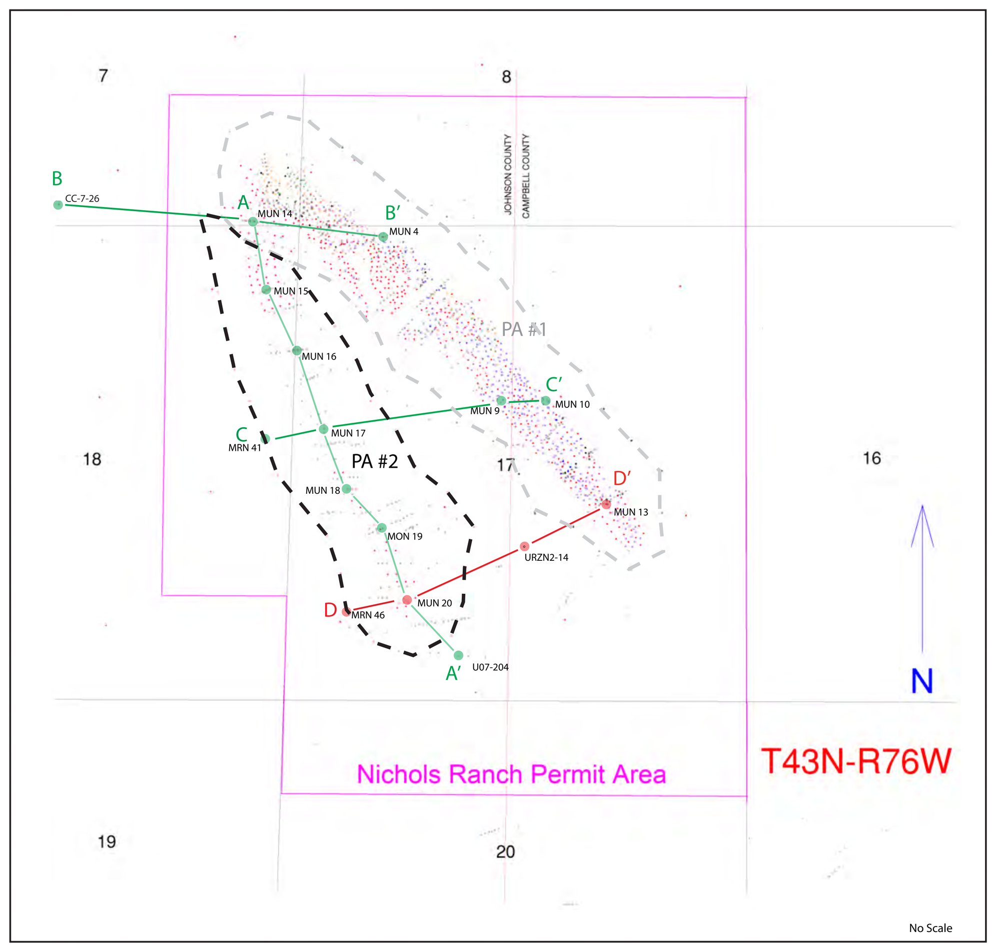
NICHOLS RANCH PA - #2

FIGURE 2-4

GEOLOGICAL CROSS-SECTION C-C'

By: BLL	Date: 6/27/2016
Contour Interval: NA	Revision Date:
Scale: SEE ABOVE	Dwg:
	Exhibit Number:





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NICHOLS RANCH PA - #2
FIGURE 2-5
GEOLOGICAL CROSS-SECTION D-D'

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Contour Interval: NA	Revision Date:
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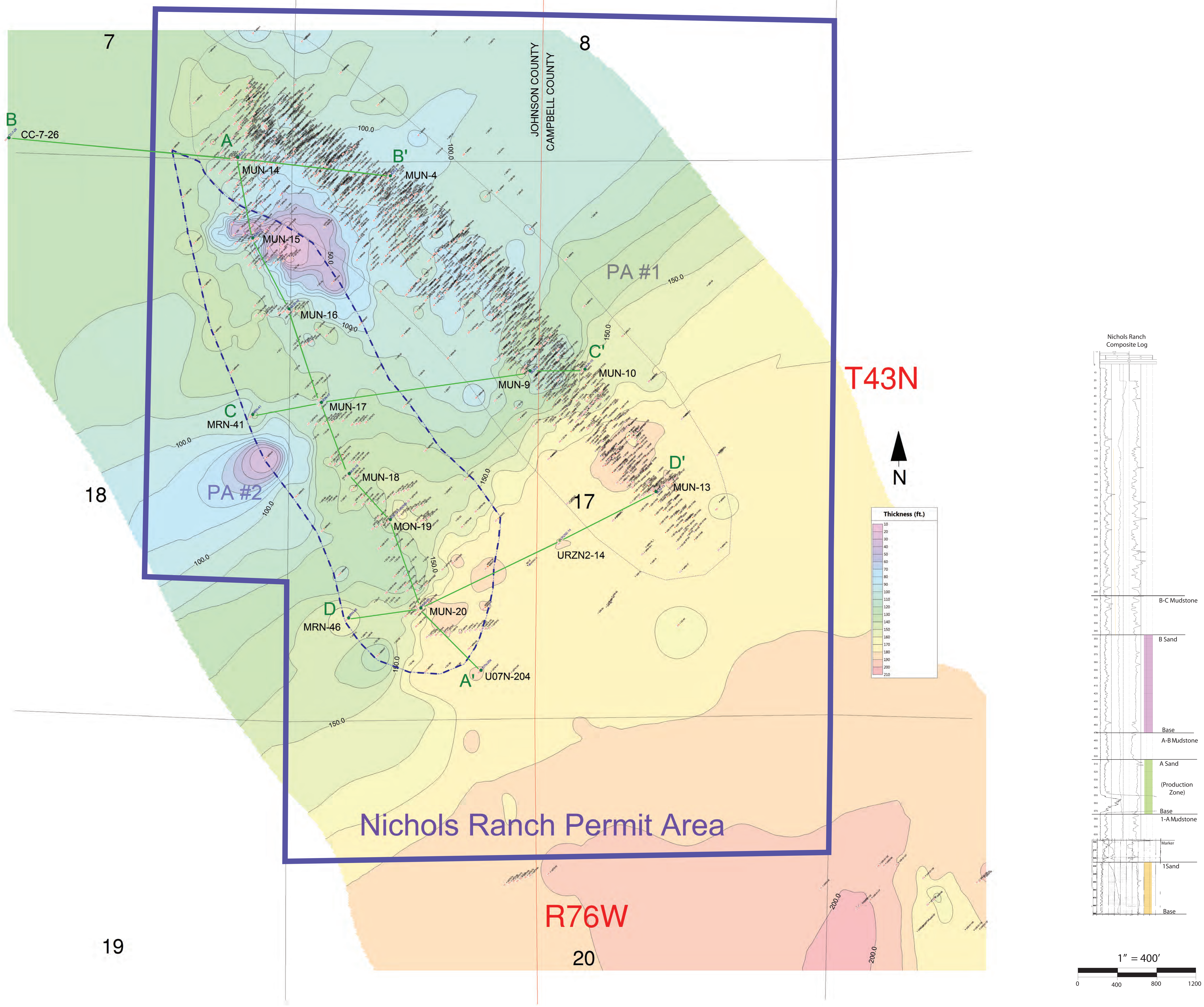

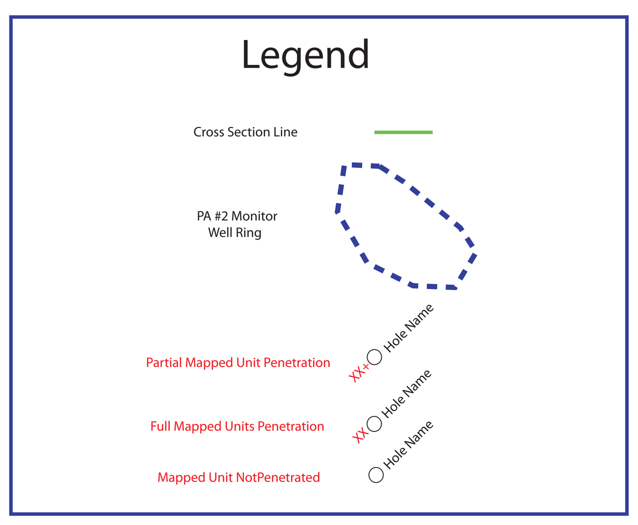

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NICHOLS RANCH PA - #2

FIGURE 2-6

B SAND ISOPACH MAP

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Contour Interval: 10 FEET	Revision Date:
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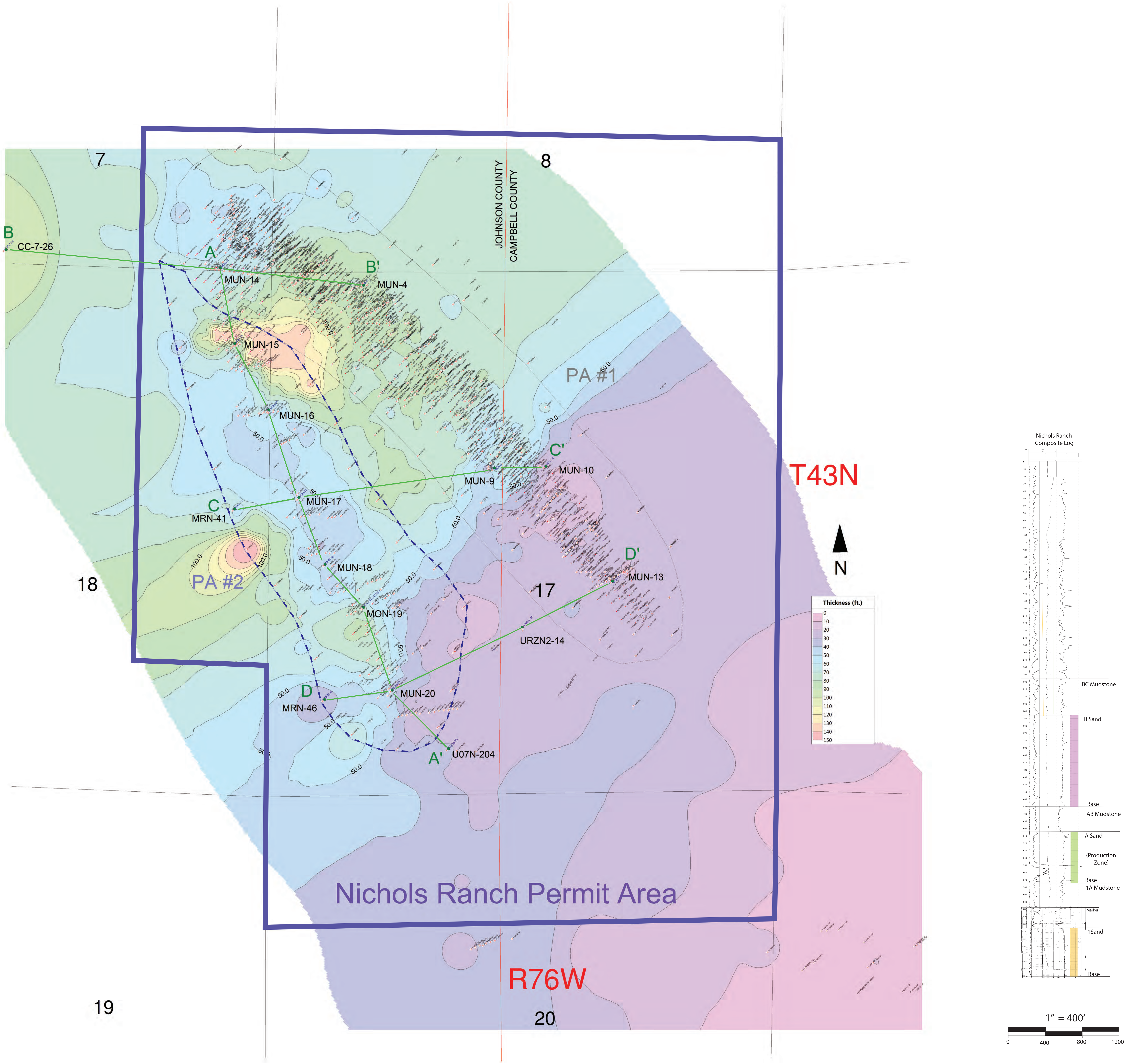

Legend

Cross Section Line

PA #2 Monitor Well Ring

Partial Mapped Unit Penetration

Full Mapped Units Penetration

Mapped Unit NotPenetrated

Hole Name

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FIGURE 2-7

A-B MUDSTONE ISOPACH MAP

By: SWG/BLL	Date: 7/13/2016
Contour Interval: 10 Feet	Revision Date:
Scale: SEE ABOVE	Dwg:
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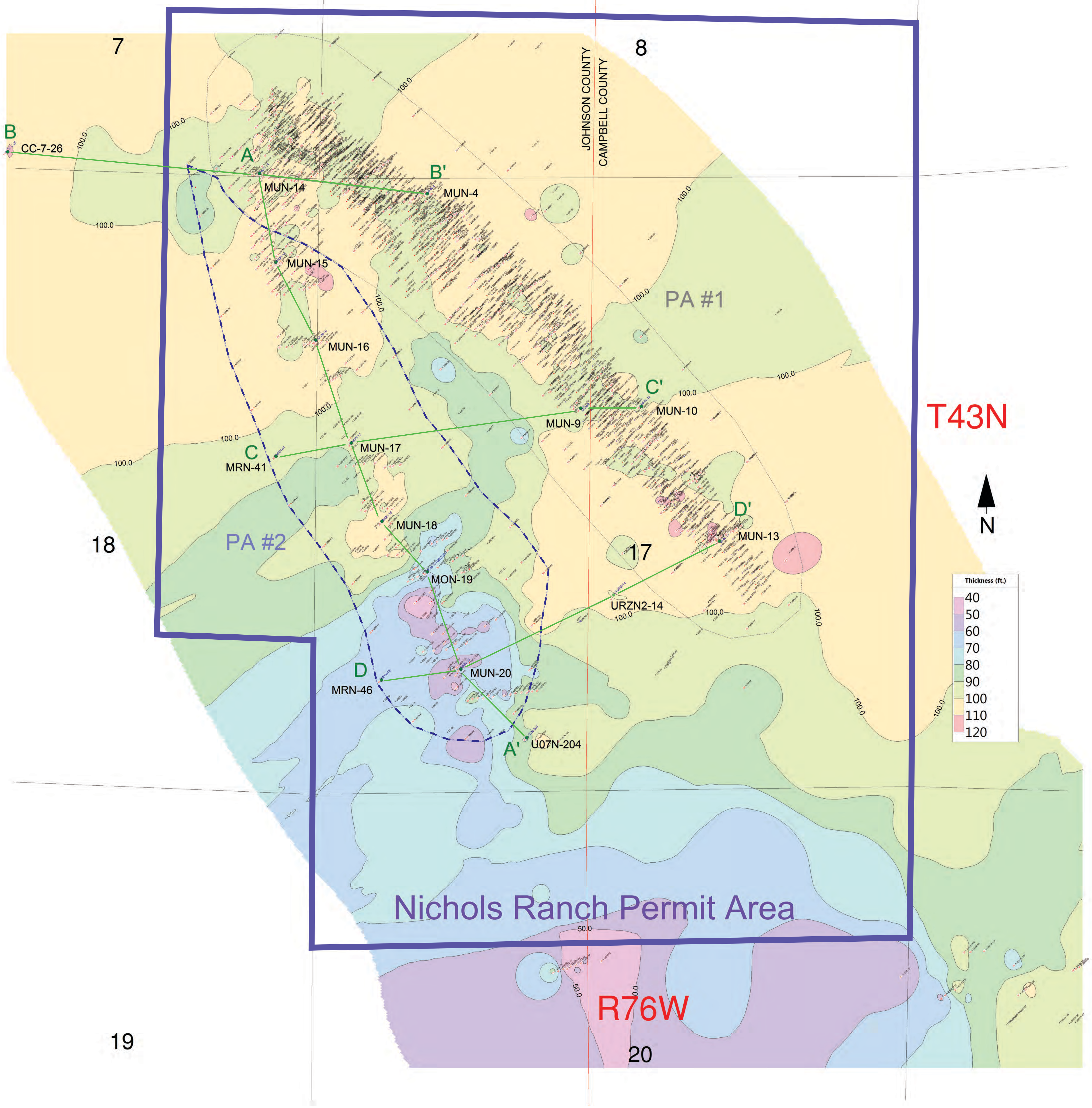

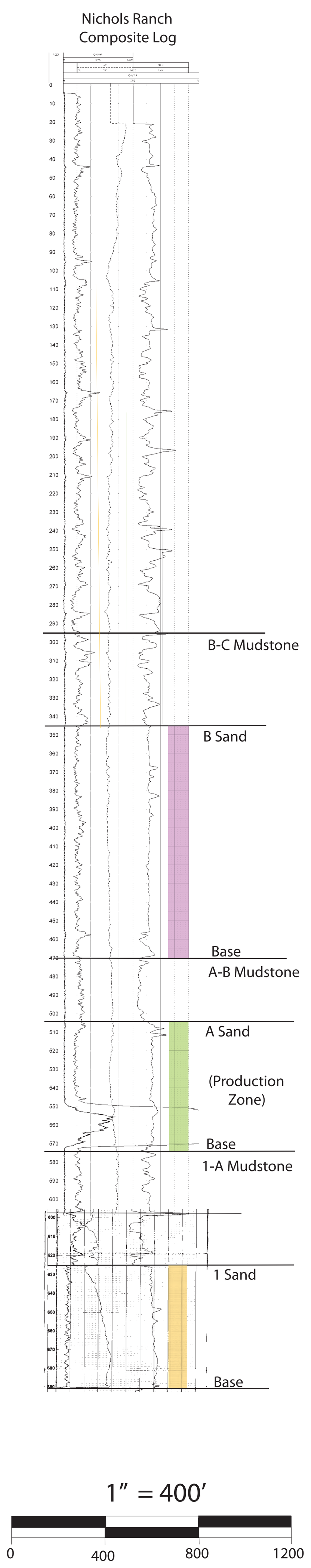

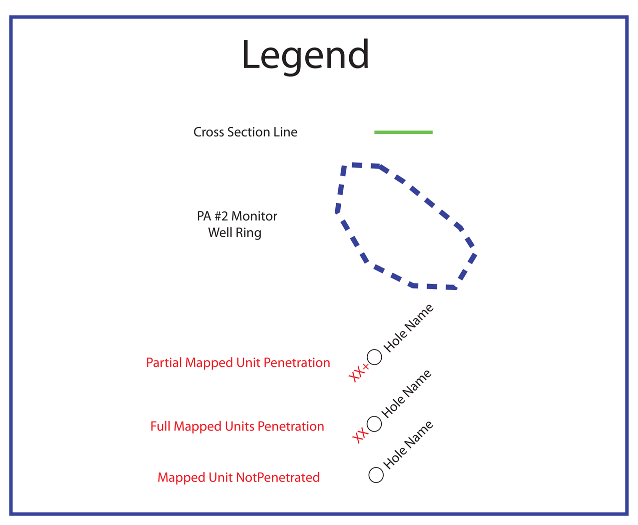

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NICHOLS RANCH PA - #2
FIGURE 2-8
A SAND ISOPACH MAP

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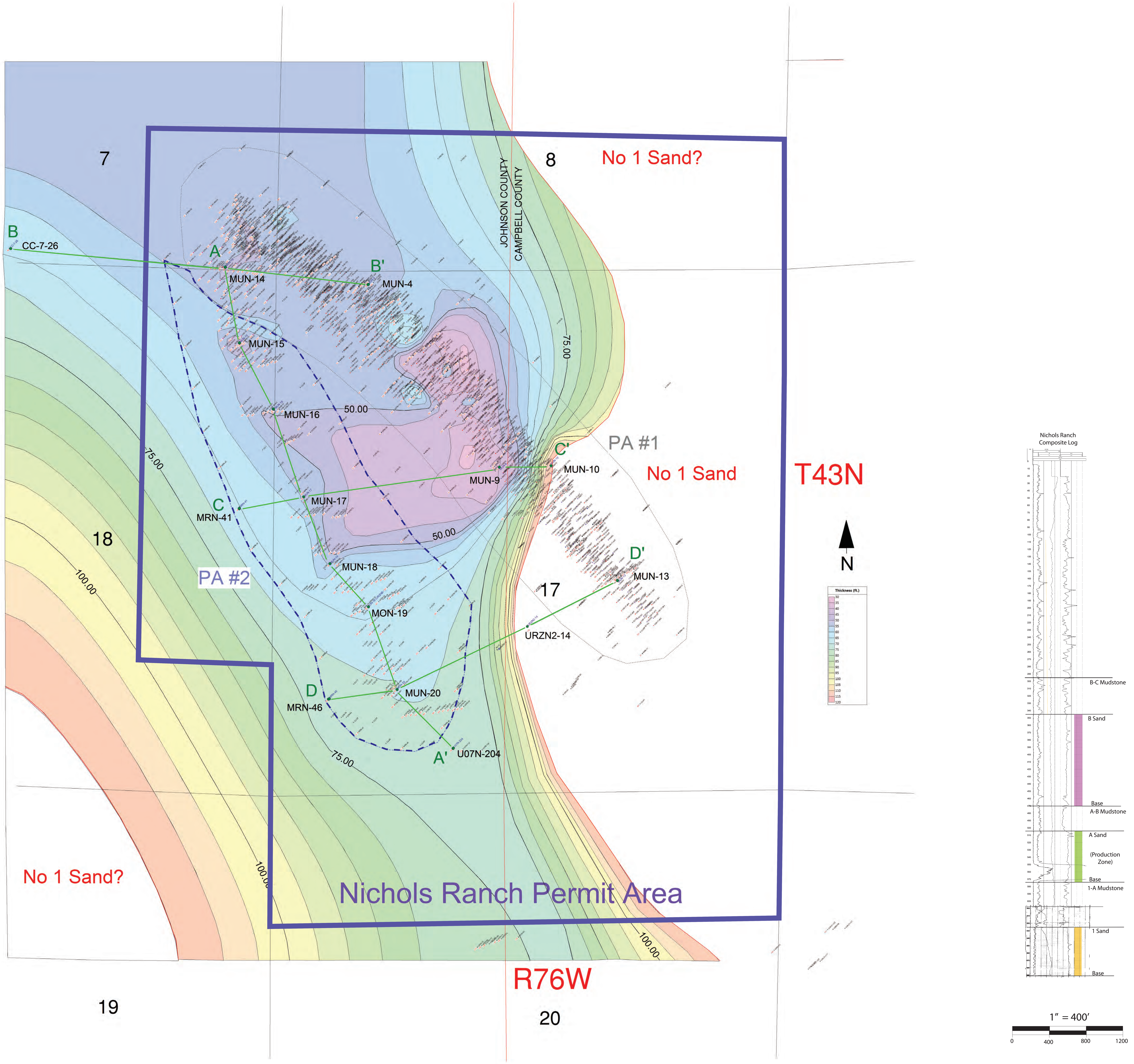

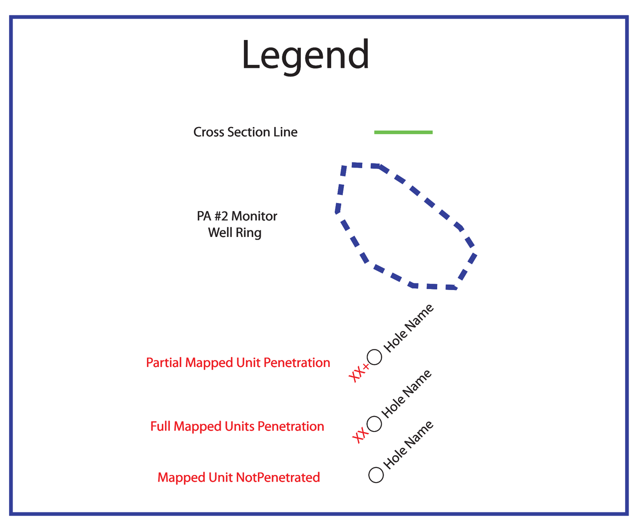

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NICHOLS RANCH PA - #2

FIGURE 2-9

1-A MUDSTONE ISOPACH MAP

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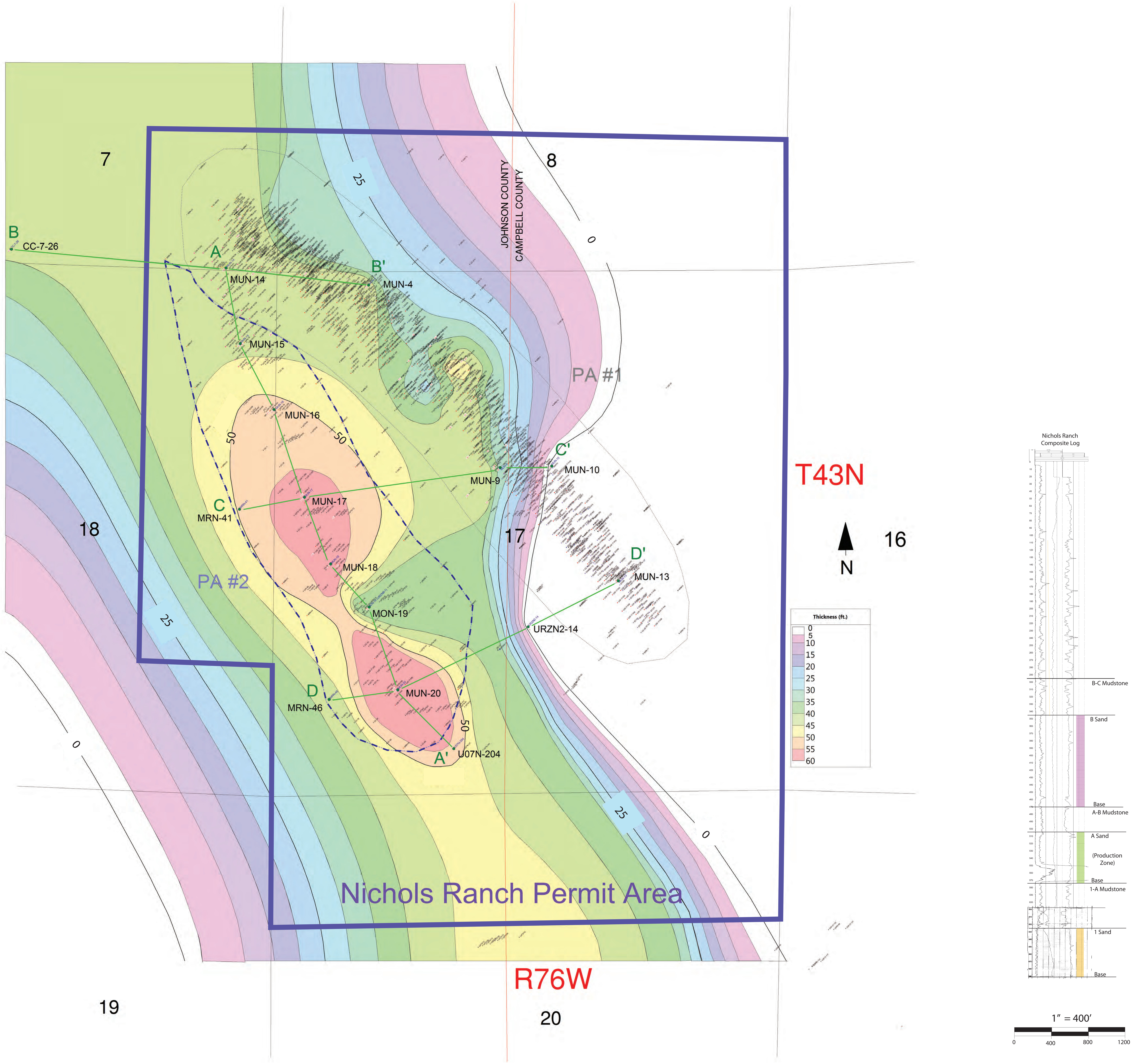

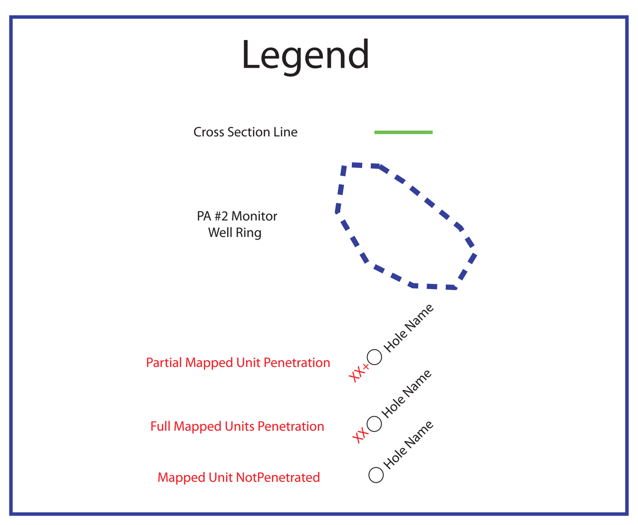

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NICHOLS RANCH PA - #2
FIGURE 2-10
1 SAND ISOPACH MAP

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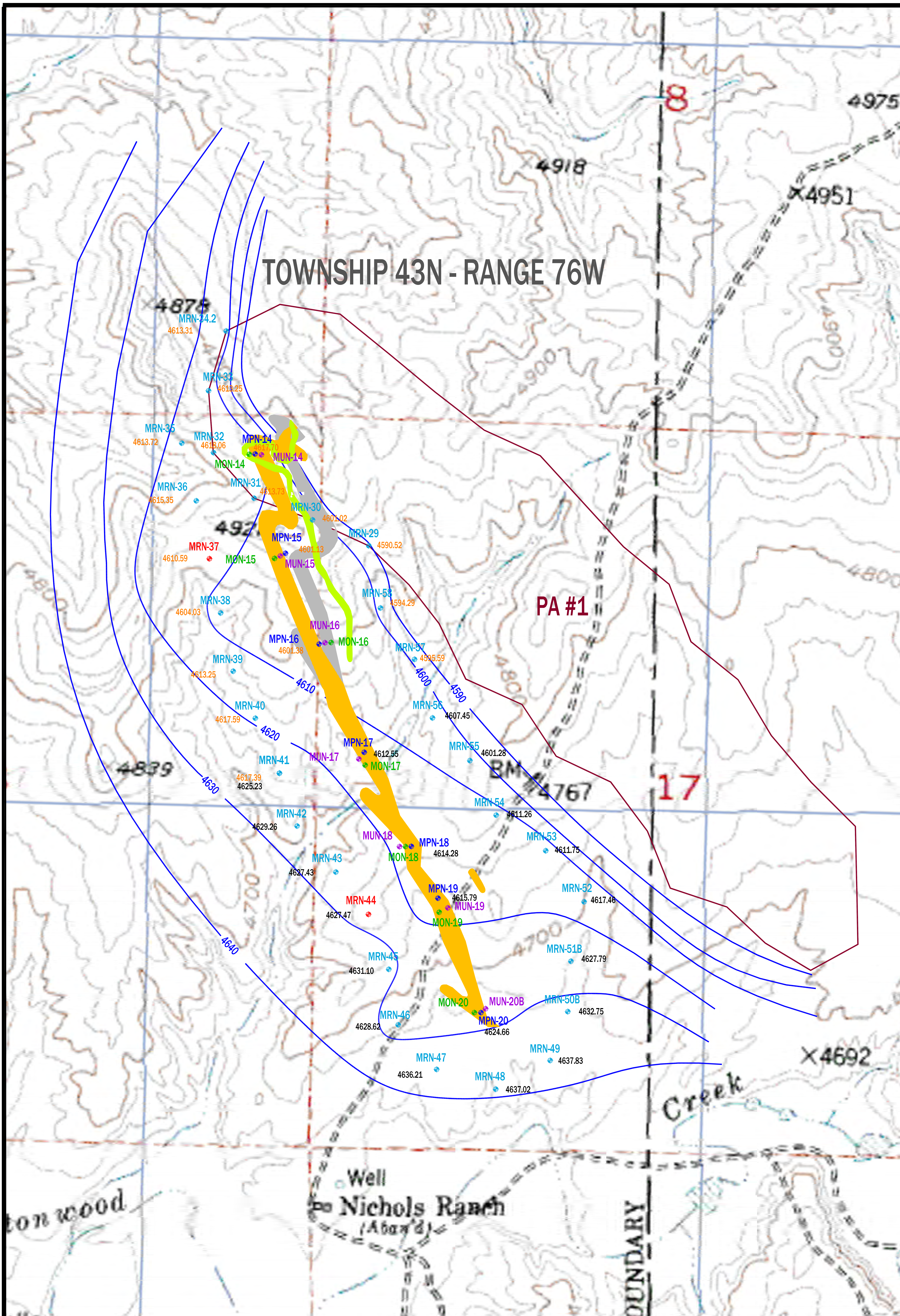

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Figure 2–11
Initial Potentiometric Surface Map:
A Sand; FT–MSL

3.0 MONITORING WELL SPACING AND COMPLETION

3.1 WELL SPACING

To conduct the pump tests in PA #2, Uranerz installed pumps into two existing monitor wells (MRN-37 and MRN-44) in the A Sand to produce the necessary aquifer stress for the pump test(s) (Figure 1-2). The wells are located in Section 17 and 18, Township 43 North, Range 76 West within the existing permit boundary. The hydraulic properties of the subsurface formations encountered during the installation of the monitor wells were consistent with the Nichols Ranch Unit permit area, and the stratigraphic section presented in Table 2-1.

The PA #2 monitoring wells are located in accordance with the Uranerz WDEQ-LQD Permit and the NRC License Application. The perimeter ore zone monitor wells (referred to as MRN wells) are located in a uniform pattern around the wellfield. The distance between the monitor wells typically is 500 feet. The distance between the monitor wells and the production patterns typically is 500 feet. The monitor well spacing for PA #2 is based on the Nichols Ranch permit standard of approximately 500 feet from the outer limits of the wellfield pattern area and 500 feet between the wells.

Well MRN-41 was monitored in both of the pump tests to demonstrate continuity between the two PA #2 multi-well tests. Well MRN-40 was also monitored during both PA #2 multi-well tests but did not respond in the second test. However, an additional multi-well pump test was conducted at well MRN-58 (discussed in Section 11.0) to further demonstrate the connection between the pump testing for the north and south areas of PA #2. The discharge from the 8.5 hour MRN-58 test was pumped to a containment pit. The MRN-58 multi-well pump test included monitoring of wells MRN-16, MRN-29, MRN-55, MRN-56 and MRN-57 to verify continuity in the two previous multi-well tests (MRN-37 and MRN-44).

Monitor wells were installed within the Overlying and Underlying aquifers at a density of one of each well type per every four acres of pattern area. However, spacing between Overlying (MONs) and Underlying (MUNs) monitor wells in the same zone do not exceed 1,000 feet. Seven MUN and seven MON wells were installed in PA #2. Seven of the production zone monitor wells (MPNs) adjacent to the Overlying and Underlying monitor wells were also monitored during the PA #2 Pump Tests.

3.2 WELL INSTALLATION AND COMPLETION

To conduct the pump tests in PA #2, Uranerz used two MRN wells (MRN-37 and MRN-44) that are fully penetrating in the A Production Sand. The pumping wells are 5-inch PVC casing with a 4 ¾” open-hole completion across the A Production Sand.

The monitoring wells were drilled and completed in a manner consistent with Uranerz WDEQ-LQD permits. Drilling and completion information is in included in Appendix B.

The monitoring wells were constructed with a 5-inch PVC casing. The MRN wells fully penetrate the A Sand and the MPN wells were completed across the portion of the A Sand that will be mined in a particular area of PA #2 (Table 3-1). The wells were developed using standard water well construction techniques, such as swabbing, pumping, surging and/or air lifting. Completion reports for each well are provided in Appendix B.

3.3 ABANDONMENT OF EXISTING WELLS

No historic wells that require abandonment were identified in PA #2. Should such wells be identified in the future, abandonment would be performed in accordance with WS-35-11-404 and Chapter VIII of the LQD Rules and Regulations.

TABLE 3.1 PRODUCTION AREA #2 WELL INFORMATION

WELL	COORDINATES UTM13, NAD 27 METERS NORTHING	EASTING	SECTION	TOWNSHIP & RANGE	SURFACE ELEVATION (ft)	CASING STICKUP (ft)	STATIC DEPTH TO WATER	STATIC WATER ELEVATION (ft)	DRILLED DEPTH (ft:bgs)	CASING DEPTH (ft:bgs)	COMPLETION INTERVAL TOP (ft:bgs)	BOTTOM (ft:bgs)	COMPLETION LENGTH (ft)
MPN-14	1368056	15878257	7	43, 76	4825.43	1.88	209.61	4617.70	720	667	601	616	15
MPN-15	1368297	15877470	18	43, 76	4849.71	2.90	251.48	4601.13	790	725	640	661	21
MPN-16	1368564	15876751	18	43, 76	4786.36	2.96	187.94	4601.38	715	657	577	597	20
MPN-17	1368921	15875893	17	43, 76	4725.01	2.90	115.36	4612.55	630	570	510	534	24
MPN-18	1369293	15875148	17	43, 76	4741.01	1.80	128.53	4614.28	660	597	524	547	23
MPN-19	1369507	15874735	17	43, 76	4712.77	1.88	98.86	4615.79	580	570	531	546	15
MPN-20	1369882	15873863	17	43, 76	4675.21	3.20	53.75	4624.66	610	537	458	485	27
MON-14	1368010	15878255	7	43, 76	4823.36	1.80	186.88	4638.28	477	437	438	471	33
MON-15	1368210	15877429	18	43, 76	4830.36	1.80	192.42	4639.74	505	485	420	438	18
								Second Completion Interval			485	497	12
MON-16	1368658	15876764	17	43, 76	4786.57	1.50	145.65	4642.42	497	452	375	394	19
								Second Completion Interval			452	582	130
MON-17	1368929	15875791	17	43, 76	4718.09	2.60	68.22	4652.47	390	350	351	393	42
MON-18	1369247	15875146	17	43, 76	4744.33	1.70	96.98	4649.05	425	377	377	426	49
MON-19 (URZNB-	1369513	15874627	17	43, 76	4716.36	1.60	63.31	4654.65	610	330	330	375	45
MON-20	1369792	15873830	17	43, 76	4676.03	1.70	26.35	4651.38	384	327	327	383	56
MUN-14	1368106	15878250	7	43, 76	4827.52	1.80	207.00	4622.32	725	694	694	725	31
MUN-15	1368255	15877449	18	43, 76	4840.12	3.30	220.00	4623.42	780	750	749	783	34
MUN-16	1368610	15876761	18	43, 76	4786.03	1.75	168.55	4619.23	715	692	692	718	26
MUN-17	1368926	15875839	17	43, 76	4720.67	3.00	103.28	4620.39	630	590	589	636	47
MUN-18	1369200	15875145	17	43, 76	4746.21	1.75	127.52	4620.44	665	637	637	669	32
MUN-19	1369582	15874661	17	43, 76	4714.32	1.50	90.42	4625.40	599	599	599	645	46
MUN-20B	1369844	15873831	17	43, 76	4676.32	3.00	58.97	4620.35	610	565	564	612	48
MRN-29	4839487	417263	17	43, 76	4820.48	1.08	231.05	4590.52	667	565	557	667	110
MRN-30	4839549	417127	18	43, 76	4882.86	2.17	284.00	4601.02	725	620	612	725	113
MRN-31	4839601	416986	18	43, 76	4838.73	2.00	227.00	4613.73	660	560	554	660	106
MRN-32	4839710	416887	7	43, 76	4810.14	1.63	193.70	4618.06	633	536	527	633	106
MRN-33	4839860	416874	7	43, 76	4834.42	1.83	223.00	4613.25	656	555	549	656	107
MRN-34.2	4840002	416904	7	43, 76	4789.95	2.17	178.80	4613.31	595	505	493	595	102
MRN-35	1367475	15878342	7	43, 76	4792.82	1.90	181.00	4613.72	616	537	536	617	81
MRN-36	1367590	15877886	18	43, 76	4815.35	2.00	202.00	4615.35	640	557	557	638	81
MRN-37	1367695	15877427	18	43, 76	4802.69	1.70	193.80	4610.59	640	545	544	640	96
MRN-38	1367783	15876996	18	43, 76	4768.15	1.88	166.00	4604.03	625	530	530	626	96
MRN-39	1367883	15876536	18	43, 76	4764.35	1.80	152.90	4613.25	609	513	513	610	97
MRN-40	1368058	15876163	18	43, 76	4750.63	2.96	136.00	4617.59	580	477	477	581	104
MRN-41	1368249	15875728	18	43, 76	4744.49	2.90	122.16	4625.23	557	457	457	558	101
MRN-42	1368389	15875309	18	43, 76	4715.18	3.13	89.05	4629.26	525	447	447	527	80
MRN-43	1368696	15874944	17	43, 76	4734.05	1.75	108.37	4627.43	557	477	477	559	82
MRN-44	1368954	15874609	17	43, 76	4754.14	1.98	128.65	4627.47	588	507	506	589	83
MRN-45	1369114	15874174	17	43, 76	4714.17	1.63	84.70	4631.10	525	457	456	523	67
MRN-46	1369189	15873734	17	43, 76	4680.58	2.06	54.02	4628.62	500	427	427	502	75
MRN-47	1369494	15873382	17	43, 76	4671.51	2.10	37.40	4636.21	480	407	407	482	75
MRN-48	1369962	15873224	17	43, 76	4666.32	3.04	32.34	4637.02	480	410	410	482	72
MRN-49	1370393	15873452	17	43, 76	4676.28	1.83	40.28	4637.83	500	410	410	500	90
MRN-50B	1370532	15873839	17	43, 76	4684.09	2.19	53.53	4632.75	500	410	410	503	93
MRN-51B	1370557	15874238	17	43, 76	4687.12	3.27	62.60	4627.79	507	407	407	508	101
MRN-52	1370662	15874708	17	43, 76	4699.23	3.40	85.17	4617.46	515	417	417	515	98
MRN-53	1370358	15875113	17	43, 76	4725.41	1.58	115.24	4611.75	540	457	458	540	82
MRN-54	1369966	15875395	17	43, 76	4764.51	1.54	154.79	4611.26	580	497	497	583	86
MRN-55	1369758	15875827	17	43, 76	4787.15	1.50	187.37	4601.28	603	512	512	606	94
MRN-56	1369461	15876165	17	43, 76	4755.78	1.38	149.71	4607.45	575	505	487	575	88
MRN-57	1369319	15876629	17	43, 76	4755.28	2.88	162.57	4595.59	580	487	486	580	94
MRN-58	1369044	15877037	17	43, 76	4784.14	3.70	193.55	4594.29	622	527	527	624	97

Note: All Wells have a DIA of 5"

4.0 PUMP TEST DESIGN AND WATER-LEVEL DATA FOR MRN-37 TEST

4.1 TEST DESIGN

The MRN-37 pump test was conducted with the following objectives for the northern half of PA #2:

- Demonstrate hydraulic communication between the Production Zone and the surrounding monitor well ring (MRN wells);
- Determine the hydrologic characteristics of the Production Zone aquifer;
- Evaluate the presence or absence of hydrologic boundaries within the Production Zone; and,
- Demonstrate sufficient hydrologic isolation between the Production Zone and the Overlying and Underlying sands for the purposes of ISR mining.

The pump test was designed to cause a minimum of 1 to 2 feet of water level drawdown in the A Sand at a radius of 2,500 feet from the pumping well.

Figure 4-1 presents the wellfield outline and the locations of the pumping and observation (monitoring) wells used during the MRN-37 hydrologic test. The pumping well (MRN-37) was completed across 96 feet of the A Production Sand (Table 3-1). The pump was installed to a depth of 535 feet without a check valve.

The general testing procedures were as follows:

- ♦ Install automated monitoring equipment in the wells selected for use in the test. Verify setting depths and head reading with manual water level measurements.
- ♦ Measure and record background water levels every 12 hours for a minimum of 48 hours prior to the start of the test.
- ♦ Pump Well MRN-37 at a constant rate (or as close as possible). Record water levels and barometric pressure throughout the background, pumping and recovery periods.

4.2 EQUIPMENT LAYOUT

Prior to the background monitoring period for the test, Uranerz installed a 35 gpm electric submersible pump in the pumping well. A totalizer meter was used to measure instantaneous flowrate and record total gallons pumped.

The monitoring equipment layout for the test is shown on Figure 4-1. All the monitor wells for the test were equipped with automated water level recorders consisting of 24 Heron Instruments data logger/transducers. A logger/transducer was installed in the pumping well discharge tube. Water levels were also measured manually during the test to verify that the automated equipment was functioning properly. The pumping equipment was off for eight minutes on 3/17/2016 due to a generator problem. For consistency, occasional erroneous data (e.g. inaccurate readings that resulted when the equipment tried to log data while data was being downloaded) were edited out of the database.

Prior to the test, HYDRO personnel selected the transducer layout. HYDRO personnel installed the monitoring equipment prior to testing and provided day-to-day downloads.

The monitor wells used for the test, distance from each monitor well to the pumping well and the drawdown observed are presented in Table 4-1. The equipment layout and measurement range for each transducer is shown on Table 4-2. Figure 4-1 shows the location of the data loggers/transducers. Appendix C presents the tabulation of water levels for all of the MRN-37 pump test wells.

4.3 BACKGROUND MONITORING, TEST PROCEDURES AND DATA COLLECTION

A potentiometric map for the A Sand, based on water level prior to the start of the MRN-37 and MRN-44 tests, is shown in Figure 2-11. Water-level data measured prior to the MRN-37 test along with the pumping and recovery period data for the A Sand monitoring wells are shown on Figures 4-2 through 4-8. These plots present the depth to water versus time on a linear scale and show that each of the A Sand wells responded to the pumping of well MRN-37 with the minimum drawdown of 2.1 feet in well MRN-57. Water levels in the A Sand were variable prior to the start of the MRN-37 pump test due to proximity of the test wells with operating wells in PA #1. Due to the variability of water levels from mining in PA #1, HYDRO conducted a supplemental pump test of MRN-58 which is presented in Section 11. A trend correction was not made because the correction would have been small compared to the amount of drawdown observed. The barometric pressure changed approximately 0.3 inches of mercury during the pumping phase of the MRN-37 test. Barometric correction to the water levels was not made because the correction would have been very small compared to the amount of drawdown observed in the A Sand monitoring wells. A tabulation of the water-level data is presented in Appendix C.

The pump test was performed by pumping MRN-37 at an average rate of 33.9 gpm from 9:35 on March 15, 2016 until 9:35 on March 18, 2016. The total pumping duration was 71.9 hours (4,312 minutes). The drawdown achieved in the pumping well was 203 feet; drawdown in the A Sand monitoring wells ranged from 2.1 to 35.9 feet (Table 4-1). Water levels were automatically measured and recorded at an interval of 5 minutes during the pumping and recovery periods in all the wells. Pumping rate data for well MRN-37 are shown on Table 4-3. Water level recovery was monitored for 3 days. A list of A Sand monitoring wells, the distance of those wells from the pumping well, and the drawdown measured during the pumping period for all the wells is included in Table 4-1.

The water levels in several of the observation (monitor) wells exhibited a significant influence by fluctuations in the operation of PA #1 throughout the MRN-37 pump test. This influence was most pronounced in observation wells MRN-29, MRN-58, and MRN-30 (see Figures 4-4, 4-5, and 4-6, respectively). These three observation wells are located near PA #1. Although the fluctuations in the operation of PA #1 did affect water levels in wells MRN-29, MRN-58, and MRN-30, the drawdown in these three observation wells was sufficient to confirm the connection of the monitoring ring wells to the mining production area.

Table 4-1.
MONITORING WELL DISTANCE AND MAXIMUM DRAWDOWN DURING THE MRN-37 TEST

1st Start Date & Time	3/15/2016 9:35				
1st End Date & Time	3/18/2016 9:35				
Duration	4312 Minutes				
Avg. Pumping Rate	33.9 G.P.M.				
Pumping Well	MRN-37	Distance from	Depth to Water	Water Elevation	Maximum Drawdown
		Pumping Well	Before Test	Before Test	During Test
Monitoring Wells		(ft)	(ft)	(ft)	(ft)
Pumping Well	MRN-37	0	193.80	4610.59	203.1
Ore Zone Completions	MPN-14	905	209.60	4617.70	18.8
	MPN-15	604	251.00	4601.13	20.0
	MPN-16	1101	187.90	4601.38	10.7
	MRN-29	1266	231.05	4590.52	6.5
	MRN-30	891	284.00	4601.02	14.0
	MRN-31	617	227.00	4613.73	27.3
	MRN-32	876	193.70	4618.06	19.7
	MRN-33	1362	223.00	4613.25	11.6
	MRN-34.2	1844	178.80	4613.31	6.3
	MRN-35	941	181.00	4613.72	16.4
	MRN-36	470	202.00	4615.35	35.9
	MRN-38	440	166.00	4604.03	30.9
	MRN-39	911	152.90	4613.25	17.3
	MRN-40	1315	136.00	4617.59	11.4
	MRN-41	1788	130.00	4617.39	7.1
	MRN-57	1810	162.57	4595.59	2.1
	MRN-58	1404	193.55	4594.29	3.8
Overlying Completions	MON-14	885	186.80	4638.28	*
	MON-15	516	196.40	4639.74	*
	MON-16	1169	145.65	4642.42	*
Underlying Completions	MUN-14	920	207.00	4622.32	*
	MUN-15	561	220.60	4623.42	*
	MUN-16	1132	168.55	4619.23	*

Note: * = No Drawdown Observed
e = estimated maximum drawdown because water level was below transducer

TABLE 4-2.
DATA LOGGER AND TRANSDUCER EQUIPMENT FOR MONITORING WELLS FOR THE MRN-37 TEST

	Well Name	Transducer Number
Monitoring Wells		
Pumping Well	MRN-37	D09491
Ore Zone Completions		
	MPN-14	B04084
	MPN-15	C04167
	MPN-16	B05582
	MRN-29	B05586
	MRN-30	B03573
	MRN-31	B04105
	MRN-32	B05606
	MRN-33	B04164
	MRN-34.2	B04128
	MRN-35	B05601
	MRN-36	D04668
	MRN-38	C09480
	MRN-39	B04093
	MRN-40	B05599
	MRN-41	B04091
	MRN-57	B05588
	MRN-58	B05583
Overlying Completions		
	MON-14	B04168
	MON-15	B04104
	MON-16	B05587
Underlying Completions		
	MUN-14	B05592
	MUN-15	B04183
	MUN-16	B05595

Note: Transducers have the following max setting depth below the water level in the well

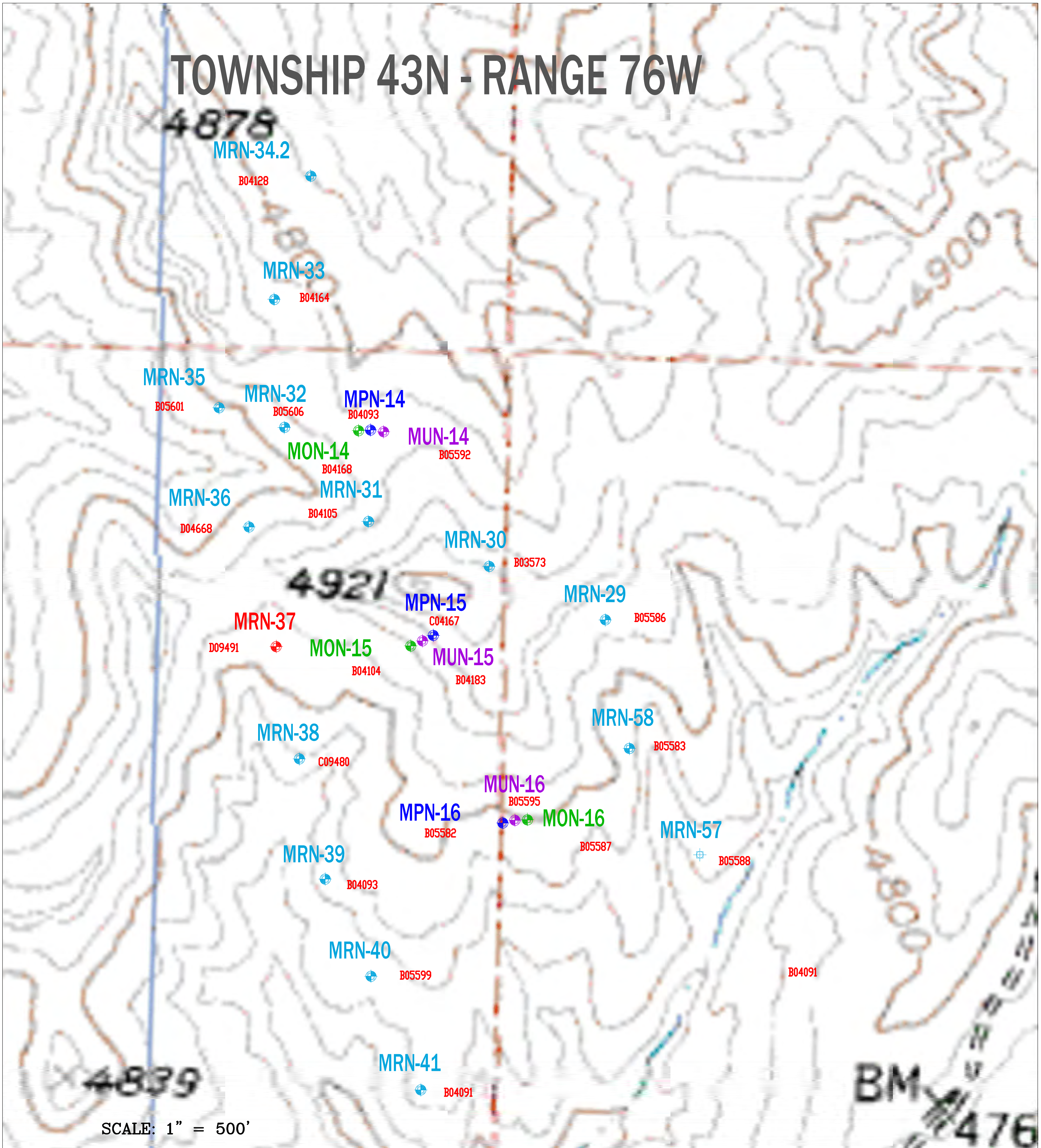
B series = max of 35ft

C series = max of 100ft

D series = max of 200ft

Table 4-3.
PUMPING RATE AND FIELD SAMPLING VERSUS TIME FOR PUMPING WELL MRN-37

DATE/TIME	TOTALIZER (GAL)	METER (GPM)	FIELD SAMPLING		
			pH	CONDUCTIVITY (µS)	Temp (Cº)
3/15/16 9:35 AM	PUMP ON				
3/15/16 9:35 AM	15601				
3/15/16 10:54 AM		37			
3/15/16 11:00 AM	18437	33.4			
3/15/16 12:54 PM	22334	33.8	8.61		
3/16/16 8:15 AM	61716				
3/16/16 10:05 AM	65438	33.8			
3/16/16 12:35 PM			8.67		
3/16/16 12:43 PM	70873				
3/17/16 8:20 AM	110484				
3/17/16 10:20 AM	114415	32.8			
3/17/16 10:32 AM	PUMP OFF				
3/17/16 10:35 AM	114803				
3/17/16 10:40 AM	PUMP ON				
3/17/16 1:16 PM	120025				
3/17/16 1:25 PM			8.47		
3/18/16 8:47 AM	159555				
3/18/16 8:55 AM			8.71		
3/18/16 9:35 AM	PUMP OFF				
3/18/16 9:39 AM	161580				



REVISIONS No.	DATE	MADE BY	DESCRIPTION
1			
2			
3			
4			

DATE	DRAWN BY	CHECKED	APPROVED
6–2016	BMW		

HYDRO–ENGINEERING L.L.C.

HYDRO–ENGINEERING L.L.C.
4685 EAST MAGNOLIA
CASPER, WYOMING, 82604

FILE: C:\PROJECTS\2016–14\nrwellfield

ENERGY FUELS

Uranerz Energy Corporation
(an Energy Fuels Company)
1701 East "E" Street
P.O. Box 50850
Casper, Wyoming
USA 82605-0850

Figure 4–1
Monitoring Well Locations and Transducer Layout For the MRN–37 Pump Test

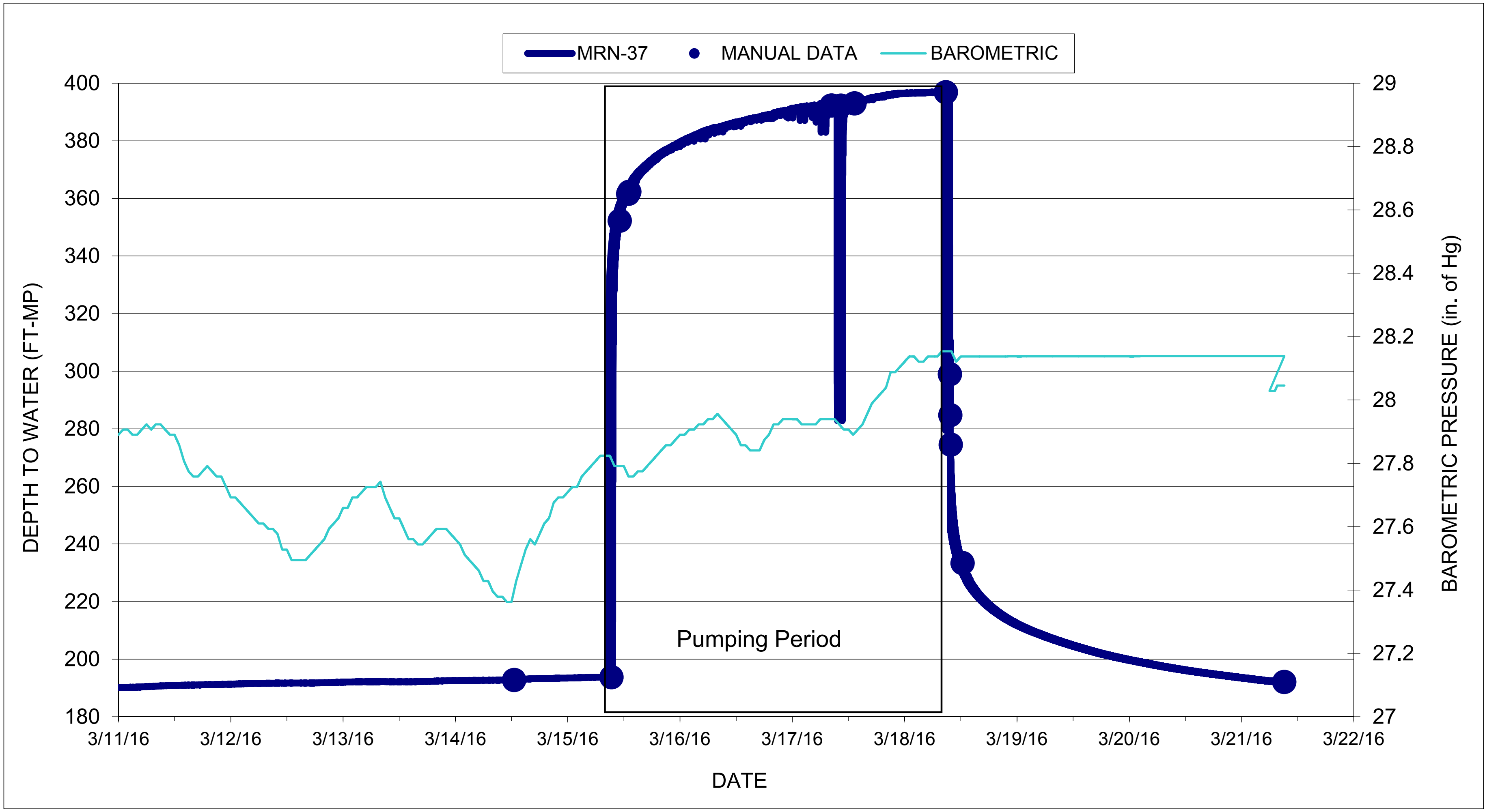


FIGURE 4-2. DEPTH TO WATER VERSUS TIME FOR PUMPING WELL MRN-37

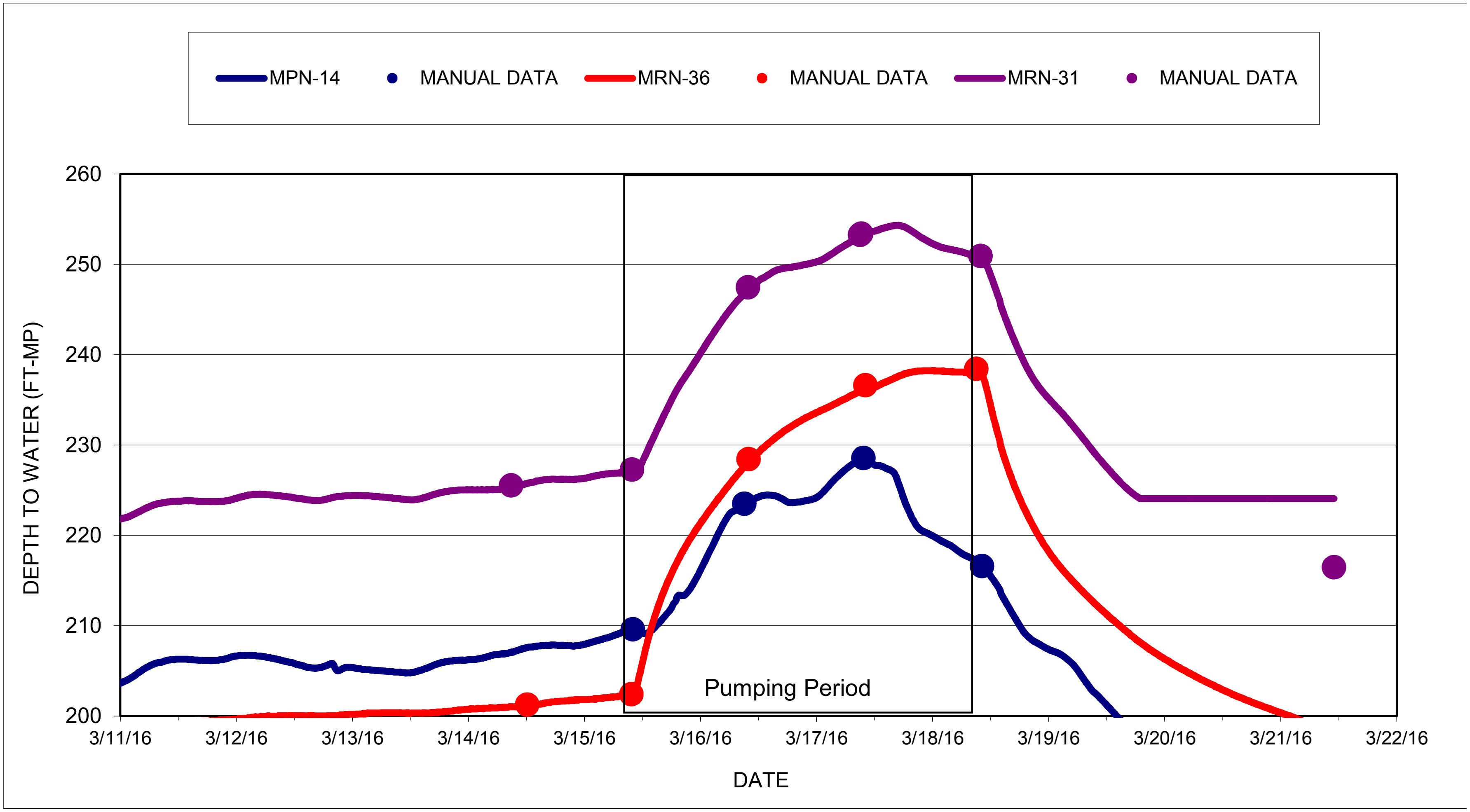


FIGURE 4-3. DEPTH TO WATER VERSUS TIME FOR OBSERVATION WELLS MPN-14, MRN-36 AND MRN-31

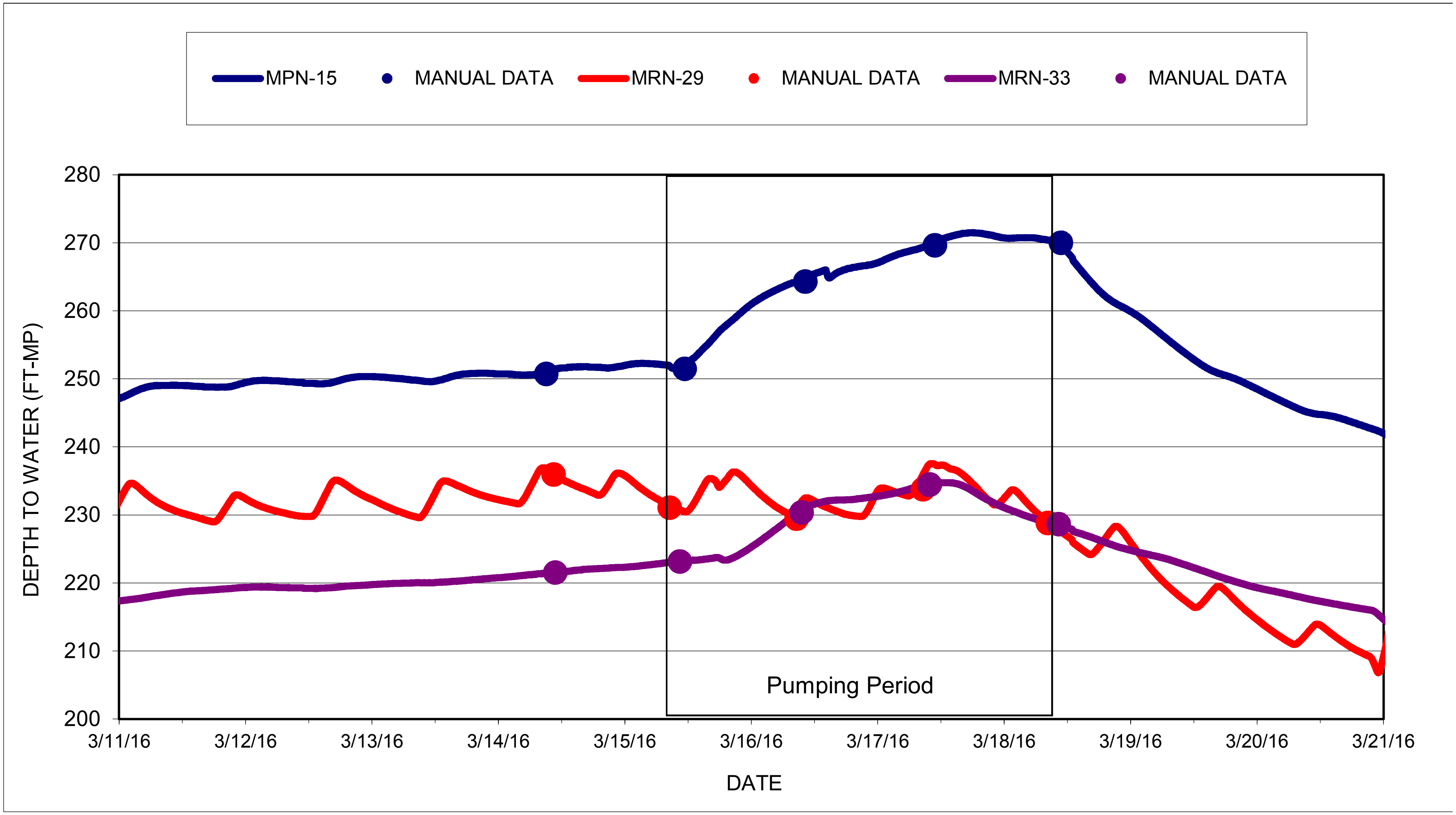


FIGURE 4-4. DEPTH TO WATER VERSUS TIME FOR OBSERVATION WELLS MPN-15, MRN-29 AND MRN-33

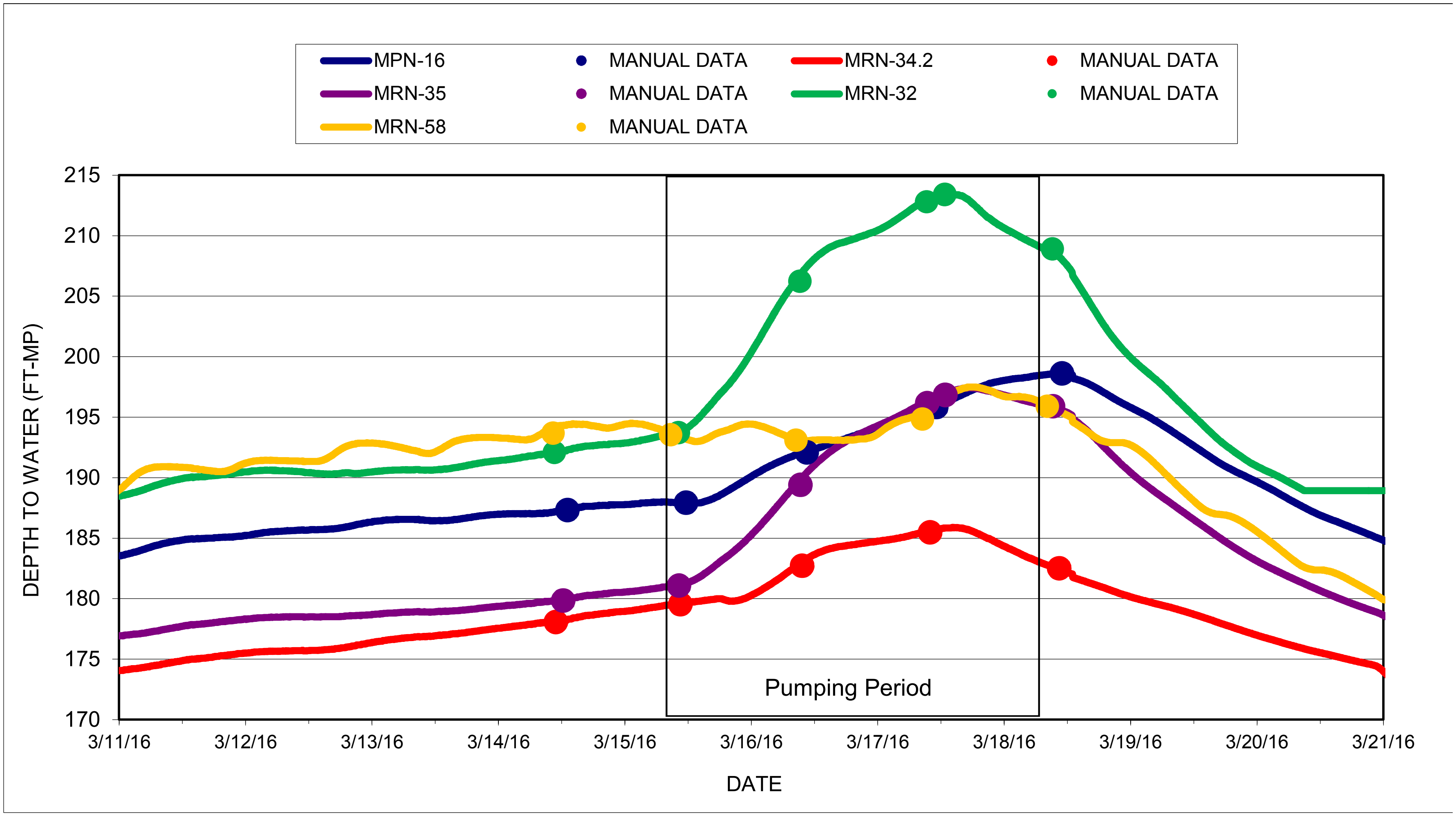


FIGURE 4-5. DEPTH TO WATER VERSUS TIME FOR OBSERVATION WELLS MPN-16, MRN-34, MRN-35, MRN-32 AND MRN-58

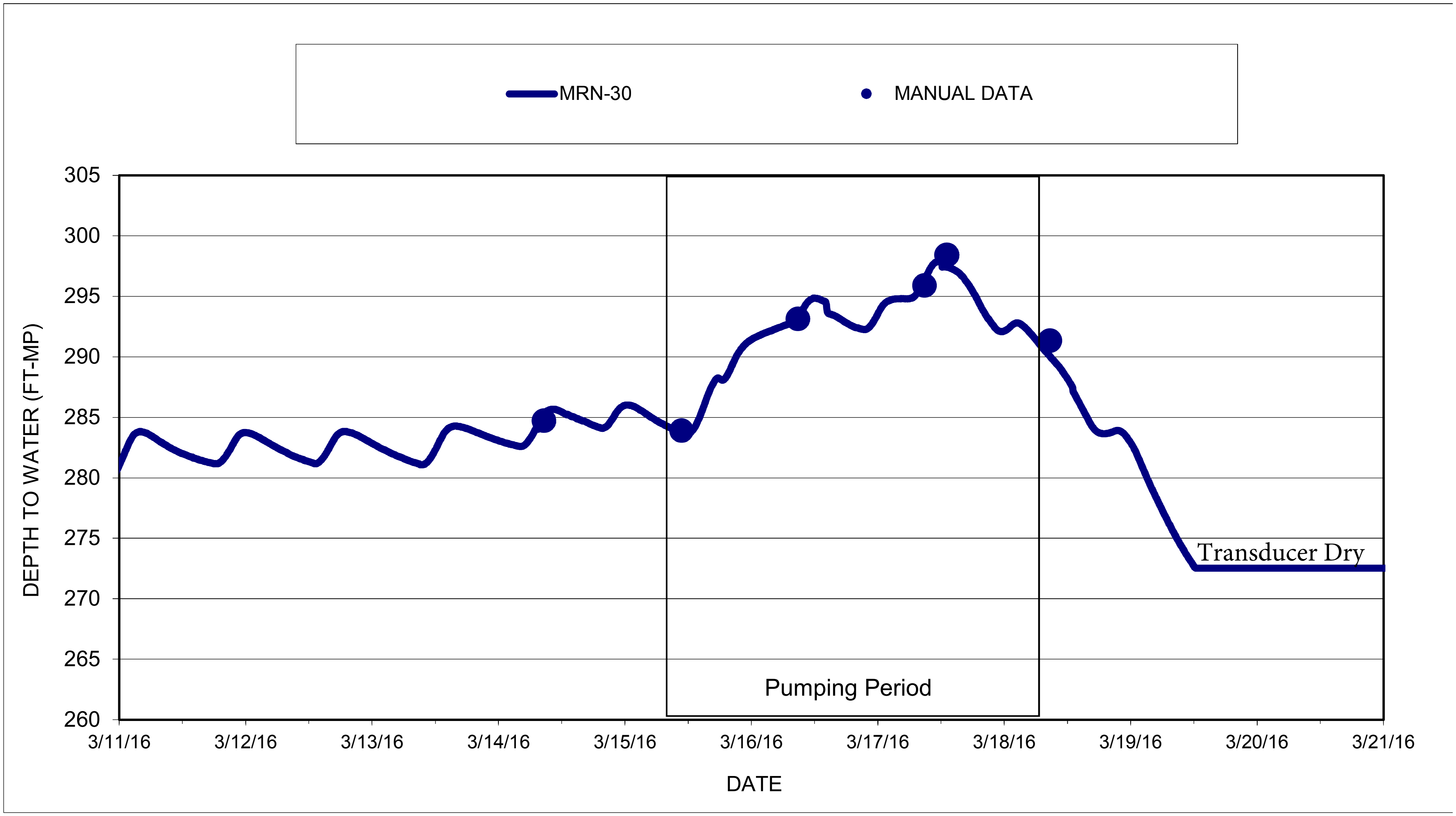


FIGURE 4-6. DEPTH TO WATER VERSUS TIME FOR OBSERVATION WELL MRN-30

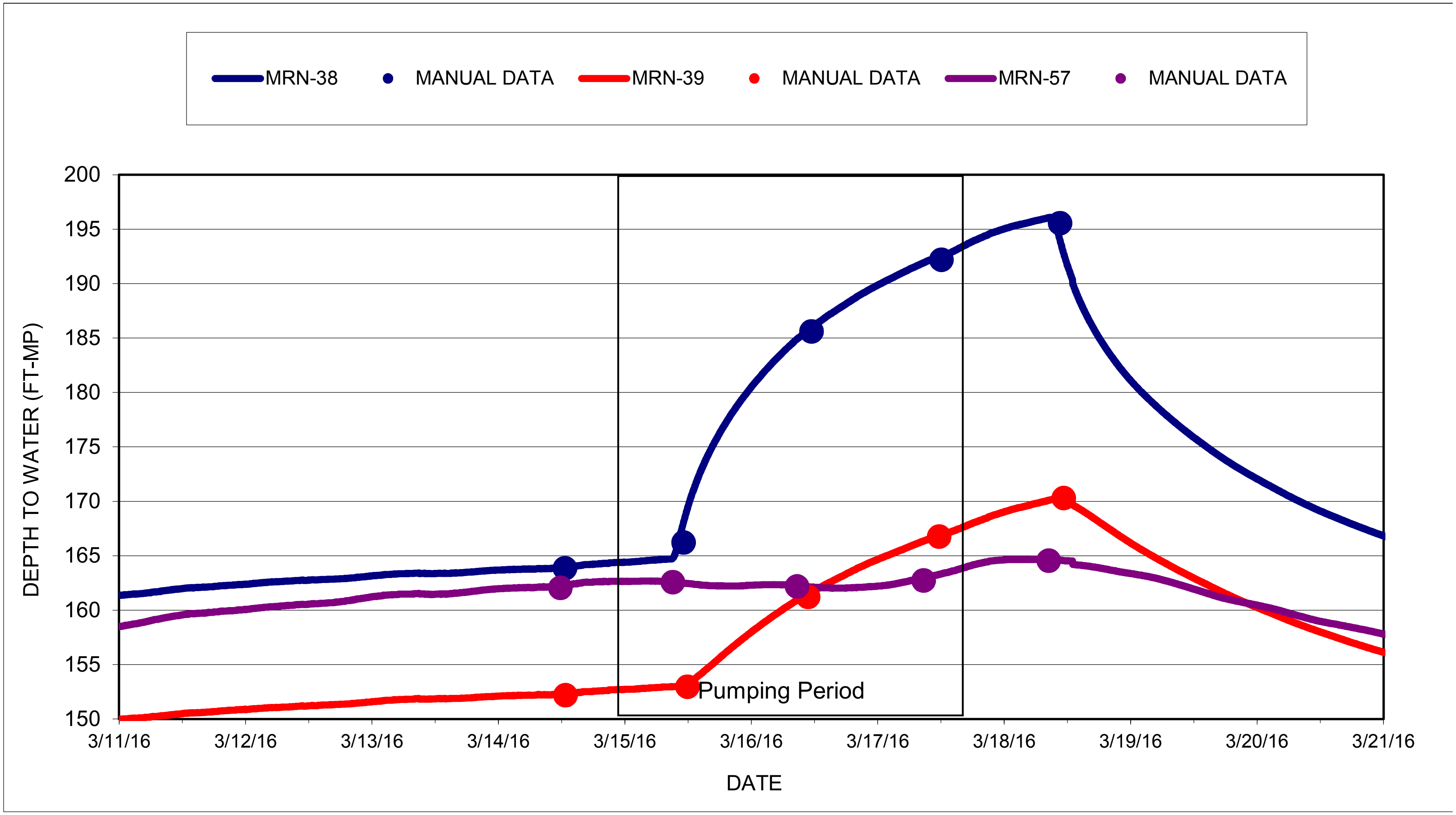


FIGURE 4-7. DEPTH TO WATER VERSUS TIME FOR OBSERVATION WELLS MRN-39, MRN-39 AND MRN-57

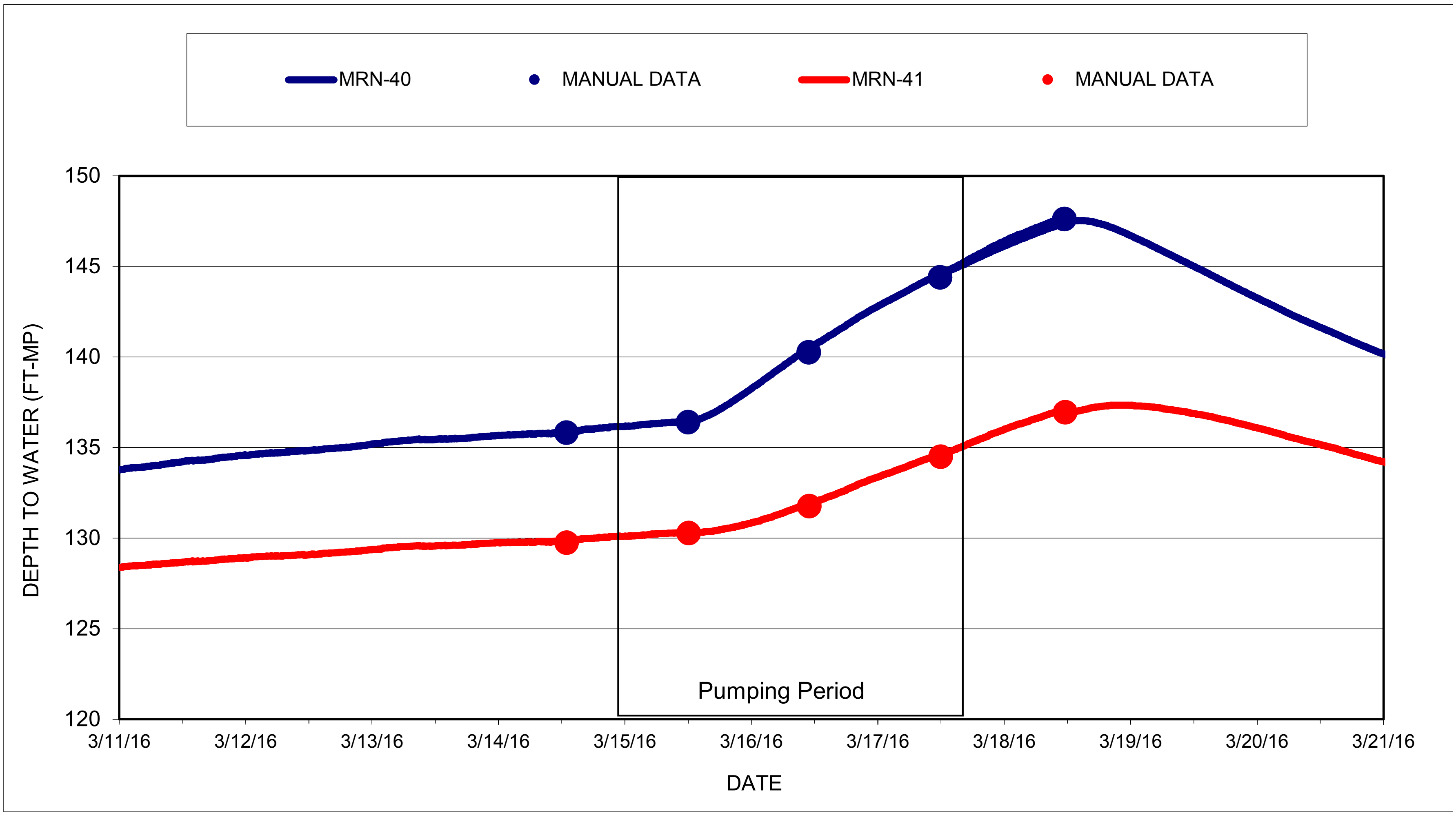


FIGURE 4-8. DEPTH TO WATER VERSUS TIME FOR OBSERVATION WELLS MRN-40 AND MRN-41

5.0 ANAYTICAL METHODS AND TEST RESULTS – PRODUCTION ZONE FOR MRN-37 TEST

5.1 ANALYTICAL METHODS

Drawdown data collected from the monitor wells were graphically analyzed to determine transmissivity and storativity. The primary analysis method used was the Theis (1935) log-log method. The Cooper & Jacob (1946) straight-line method was used in only five monitoring wells for this pump test due to the limitation of not meeting the 'u' criterion. Cooper & Jacob recommended the 'u' value to be <0.01 for usage of the straight line fit. Kruseman and de Rider (1991) suggest that a 'u' value of less than 0.1 is appropriate which can be seen from a plot of the Theis well function versus u on semi-log plot. With the use of the less than 0.1 criterion, the straight line method is appropriate for only five of the A Sand wells.

The test data were analyzed primarily using the Theis method (see Section 10 for a discussion of the aquifer test theories). Ferris and others (1962) present the Theis and Jacob equations with calculation of transmissivity in units of gallon per foot per day units as presented in this section. The significant assumptions inherent in these two methods include:

- ► The aquifer is confined and has apparent infinite extent
- ► The aquifer is homogenous and isotropic, and of uniform thickness over the area influenced by pumping
- ► The piezometric surface is horizontal prior to pumping
- ► The well is pumped at a constant rate
- ► The pumping well is fully penetrating
- ► Well diameter is small, so well storage is negligible

These assumptions are reasonably satisfied. Obviously, the A Sand is not homogenous and isotropic; however, over the scale of the pump tests, it can be treated as meeting this criterion. Observation wells respond to the average conditions in the area and are reflective of hydraulic properties over a large area for a long pumping period.

Leaky aquifer solutions such as Hantush (1960) were not applicable to the data from the A Sand. Likewise, because none of the monitor wells were completed within the confining units, a Neuman-Witherspoon (1972) analysis was not performed.

5.2 BACKGROUND TRENDS

Water level stability data were collected prior to the start of the test. Plots of the background data for the pumping, MRN and MPN wells are shown in Figures 4-2 through 4-8. Water-level stability data collected during the pre-test and post-test periods along with barometric pressure were used to assess the prior trends. No consistent trend was observed for the monitoring wells in the MRN-37 test; however, the water levels were variable due to mining operations in PA #1. A correction for this variability was not practical because the fluctuations in the operation of PA #1 resulted in monitoring wells exhibiting both rising and falling water levels prior to and during the test. Therefore, no correction was made to the water-level data for the MRN-37 test. The barometric change during the pumping phase of the test was approximately 0.3 inches of Hg (see Section 6 plots for barometric pressure data). This small change did not require any adjustments in the A Sand water levels for barometric pressure changes.

5.3 TEST RESULTS

5.3.1 DRAWDOWN

The drawdown achieved during the test is shown on Figure 5-1. A drawdown of 203 feet was developed in pumping well MRN-37 while maximum drawdowns in the A Sand monitoring wells from this pumping were 2.1 to 35.9 feet. The five foot drawdown contour extended to roughly 1500 feet from the pumping well. Drawdown contours were fairly circular.

Theis type curves and Jacob matches are presented in Figures 5-2 through 5-23 for the A Sand wells. Semi-log plots are presented for each of the A Sand wells while fits are presented for only the five wells where the Jacob straight line fit is appropriate. Theis type curve fits are presented for each of the A Sand observation wells and drawdown data shows good fits to the Theis type curve. The type curve fits do not indicate leaky aquifer or boundary conditions in this area of the A Sand.

The tabulation of the water-level data for the test is included in Appendix C.

The A Sand monitoring wells all showed adequate drawdown to prove communication between the Production Zone and the monitoring wells except for the southeastern monitoring wells which showed communication in the supplemental pump test presented in section 11. Therefore adequate communication exists between the monitoring wells and the Production zone.

5.3.2 ANALYTICAL RESULTS

Transmissivity (T) results range from 15 to 61 ft^2/d (111 to 457 gpd/ft) from the Theis type curve matches. An average T value of 44 ft^2/d (327 gpd/ft) was obtained from the MRN-37 test. The Jacob method results from wells were not used in calculating the average because the length of the test was not adequate to meet the requirement for the Jacob method except for the nearest five wells. The Theis method results from 17 A Sand observation wells were used in the calculation of the average. Based on the average thickness of the A Sand at pumping well MRN-37 of 96 feet, the average hydraulic conductivity (K) is 0.46 ft/d (1.6E-4 cm/s). Assuming a water temperature of 50 degrees F, this equates to a permeability of approximately 219 millidarcies (md). Storativity (S) values ranged from 3.3E-5 to 1.2E-4. The average S value for the test was 7.1E-5.

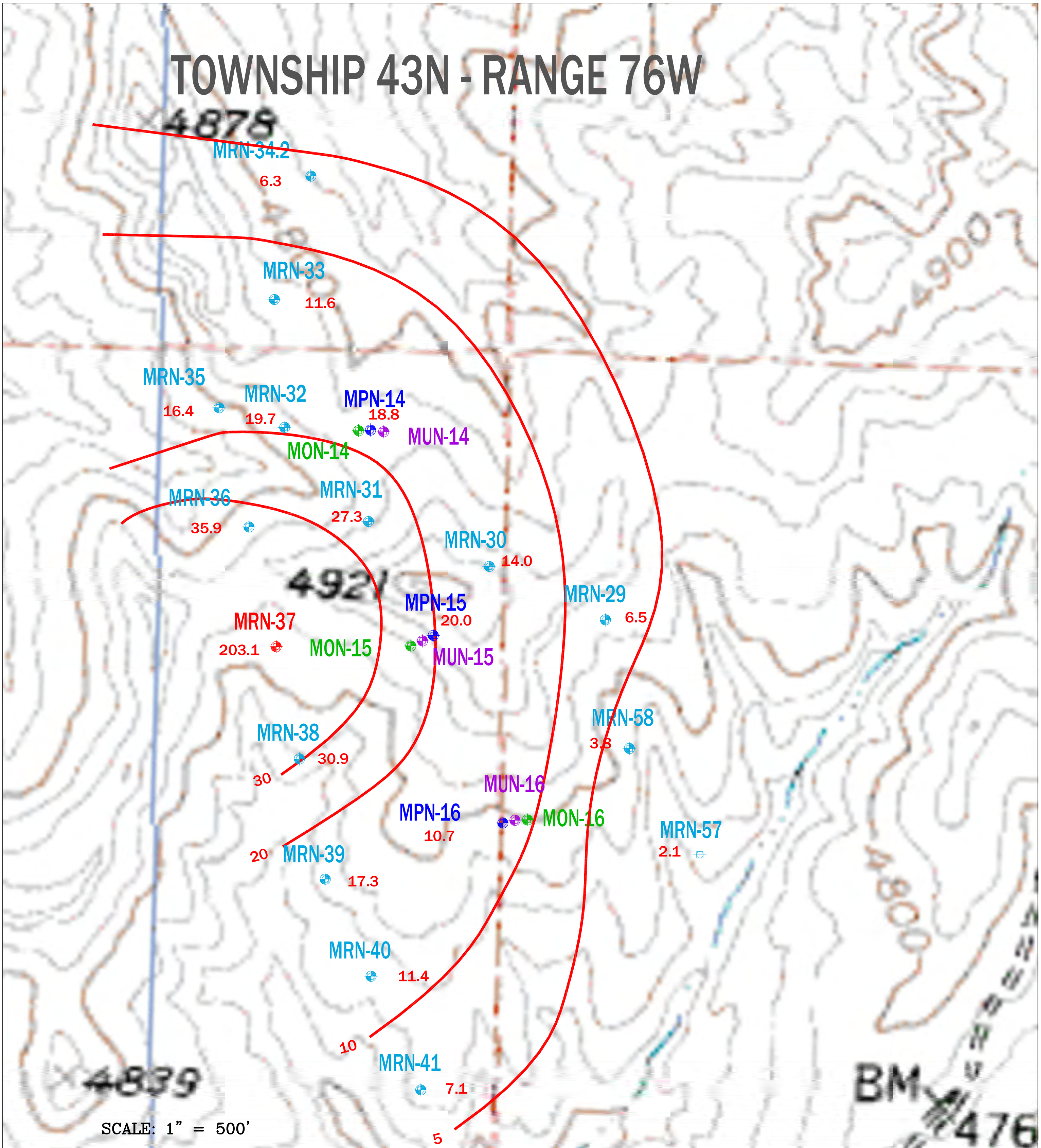
Recovery analysis of the pumping well data (MRN-37) results in a T value of 37 ft^2/d (277 gpd/ft).

5.4 DIRECTIONAL TRANSMISSIVITY

Maximum drawdowns of the MRN-37 pump test are presented in Figure 5-1 and show a fairly uniform circular pattern. The variation in drawdowns does not indicate a consistent directional transmissivity. These variations in drawdowns would greatly affect the calculation of the directional transmissivities by the Papadopulos (1965) method. However, the directional transmissivities in the fluvial sands in the Powder River Basin vary greatly with the combination of wells used in the calculation. These fluvial channels were not formed in a consistent direction over an area such as PA #2 and therefore no calculations of the directional transmissivities were made from MRN-37 pump test.

Table 5-1.
SUMMARY OF AQUIFER PROPERTIES FOR THE MRN-37 TEST

Well	Distance from Pumping Well (ft)	THEIS			COOPER & JACOB		
		Transmissivity		Storage Coefficient	Transmissivity		Storage Coefficient
		(gpd/ft)	(ft^2/day)		(gpd/ft)	(ft^2/day)	
MRN-37	-	-	-	-	333	45	-
MRN-37 (REC)	-	-	-	-	277	37	-
MPN-14	905	129	17	4.6E-05			
MPN-15	604	432	58	9.9E-05	507	68	7.3E-05
MPN-16	1101	444	59	1.2E-04	-	-	-
MRN-29	1266	-	-	-	-	-	-
MRN-30	891	457	61	6.4E-05	-	-	-
MRN-31	617	277	37	6.5E-05	314	42	5.0E-05
MRN-32	876	259	35	5.6E-05	-	-	-
MRN-33	1362	111	15	3.3E-05	-	-	-
MRN-34.2	1844	155	21	5.7E-05	-	-	-
MRN-35	941	259	35	7.6E-05	439	59	5.4E-05
MRN-36	470	299	40	6.3E-05	331	44	5.1E-05
MRN-38	440	409	55	7.8E-05	395	53	8.0E-05
MRN-39	911	444	59	7.4E-05	-	-	-
MRN-40	1315	444	59	8.1E-05	-	-	-
MRN-41	1788	457	61	8.1E-05	-	-	-
MRN-57	1810	-	-	-	-	-	-
MRN-58	1404	-	-	-	-	-	-
	AVERAGE:	**327**	**44**	**7.1E-05**			



REVISIONS No.	DATE	MADE BY	DESCRIPTION
1			
2			
3			
4			

DATE	DRAWN BY	CHECKED	APPROVED
6–2016	BMW		

HYDRO–ENGINEERING L.L.C.

HYDRO–ENGINEERING L.L.C.
4685 EAST MAGNOLIA
CASPER, WYOMING, 82604

FILE: C:\PROJECTS\2016–14\nrwellfield

ENERGY FUELS

Uranerz Energy Corporation
(an Energy Fuels Company)
1701 East "E" Street
P.O. Box 50850
Casper, Wyoming
USA 82605-0850

Figure 5–1
Maximum Drawdown in the A Sand
For the MRN–37 Pump Test

PAGE: 5–5

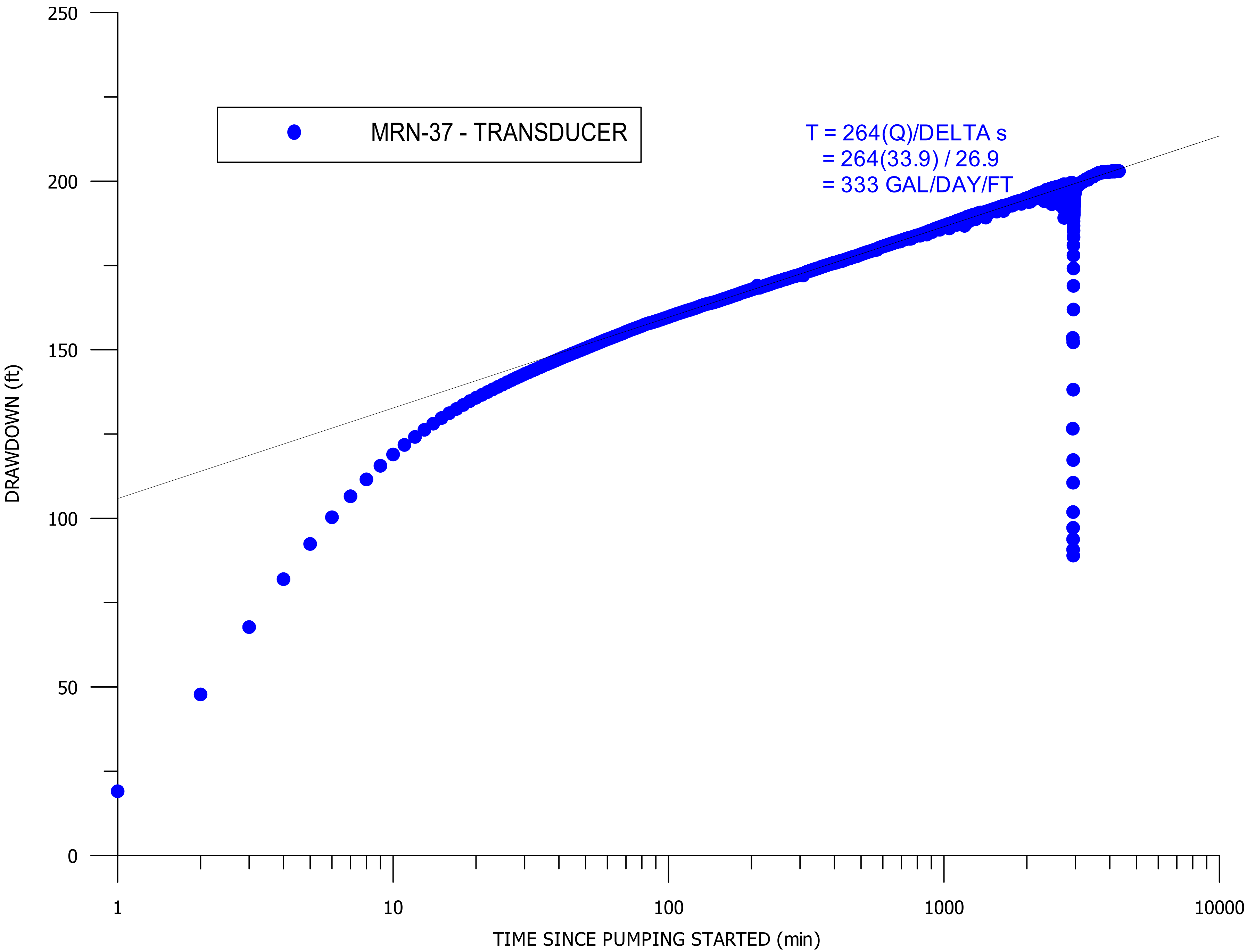


FIGURE 5-2. DRAWDOWN IN PUMPING WELL MRN-37

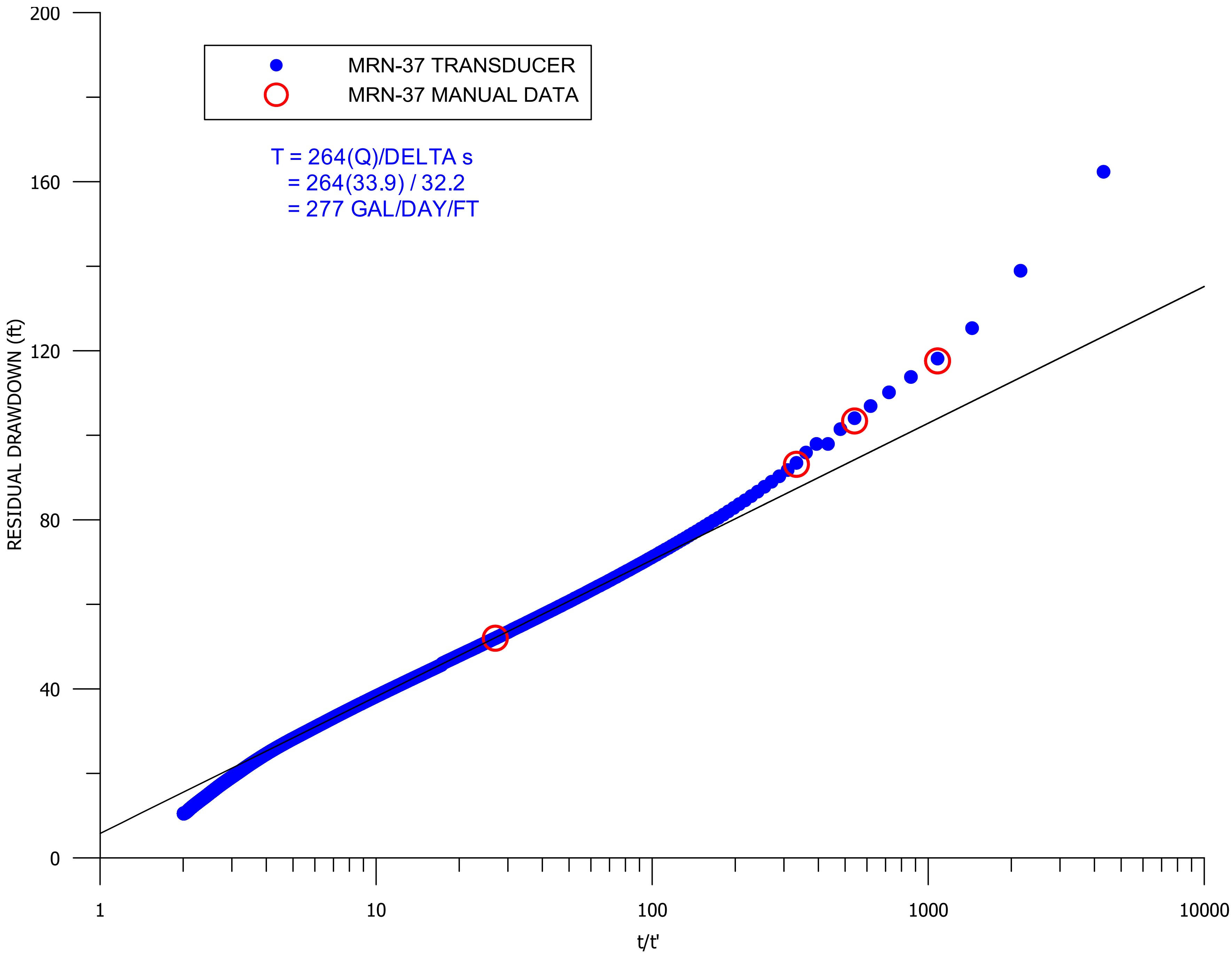


FIGURE 5-3. RECOVERY IN PUMPING WELL MRN-37

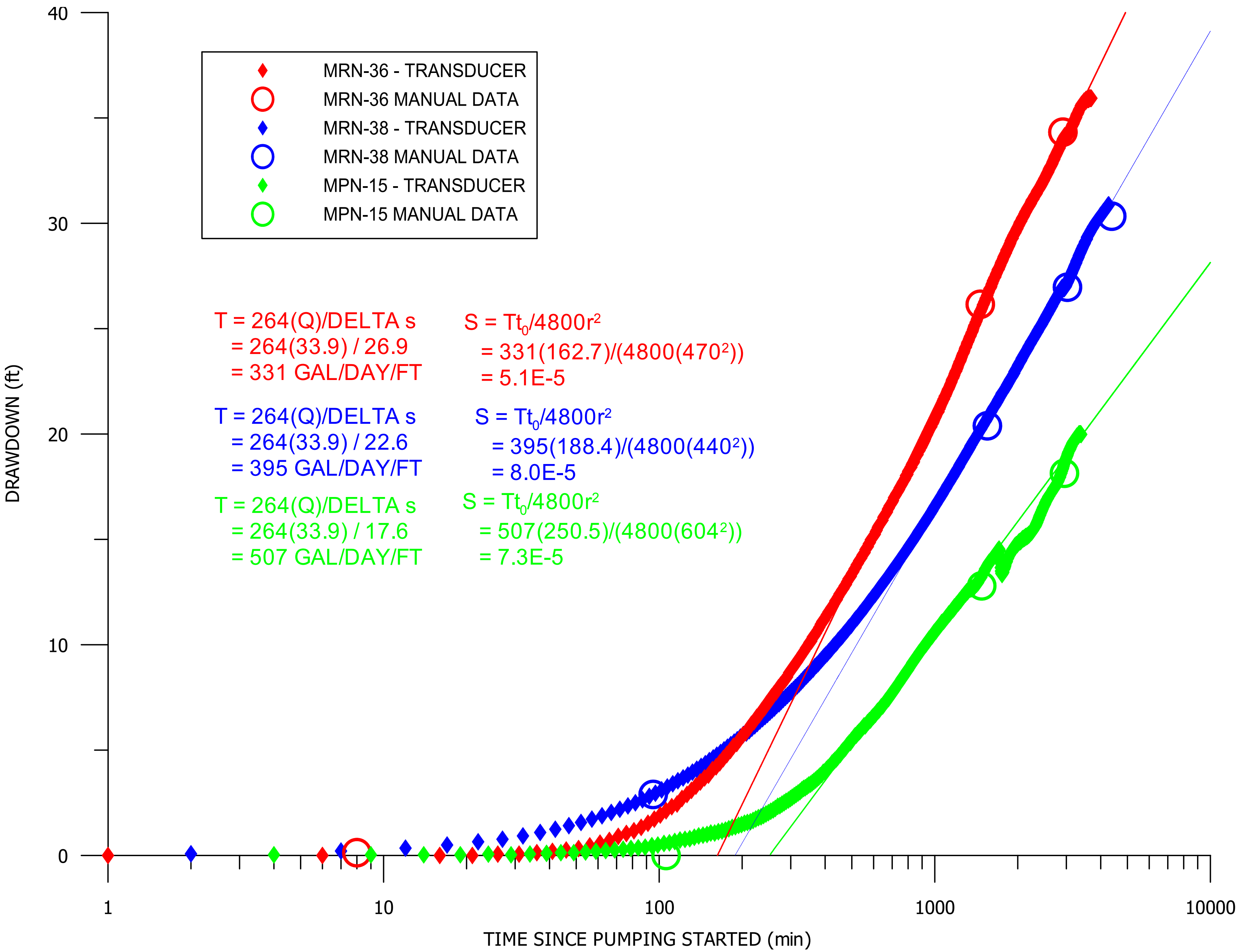
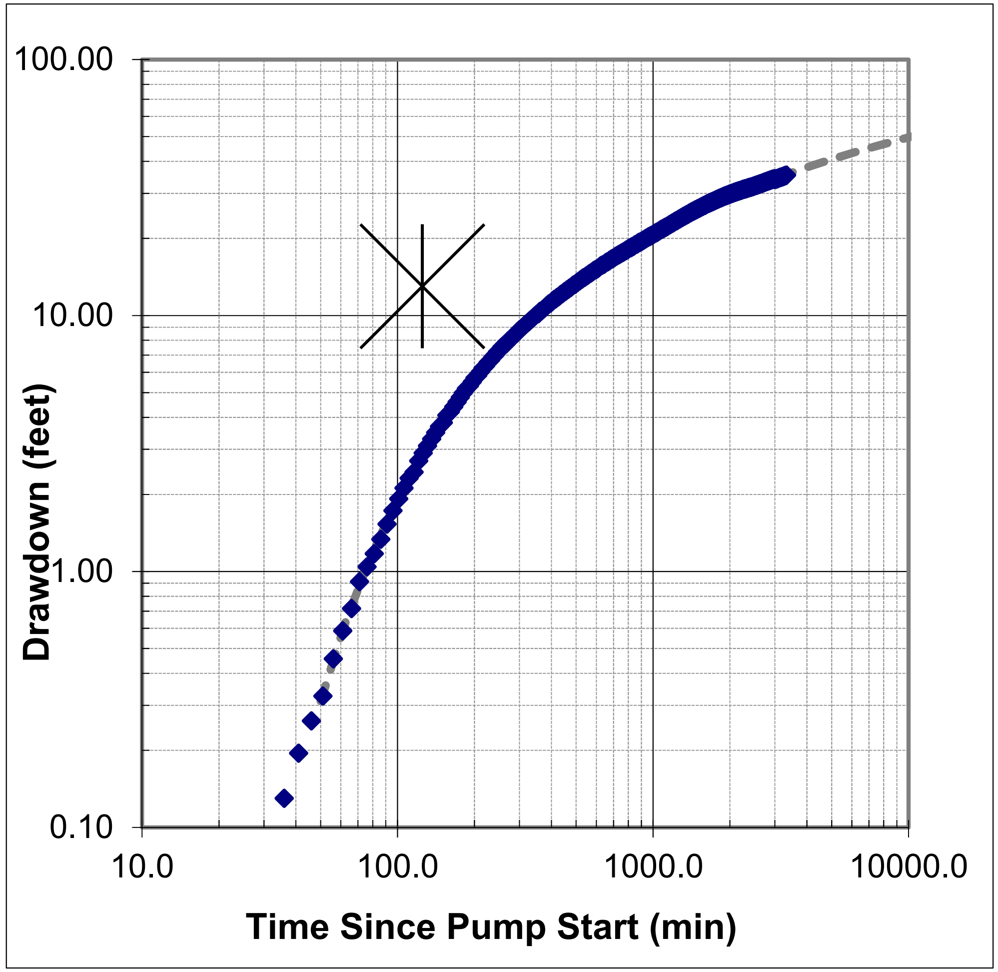


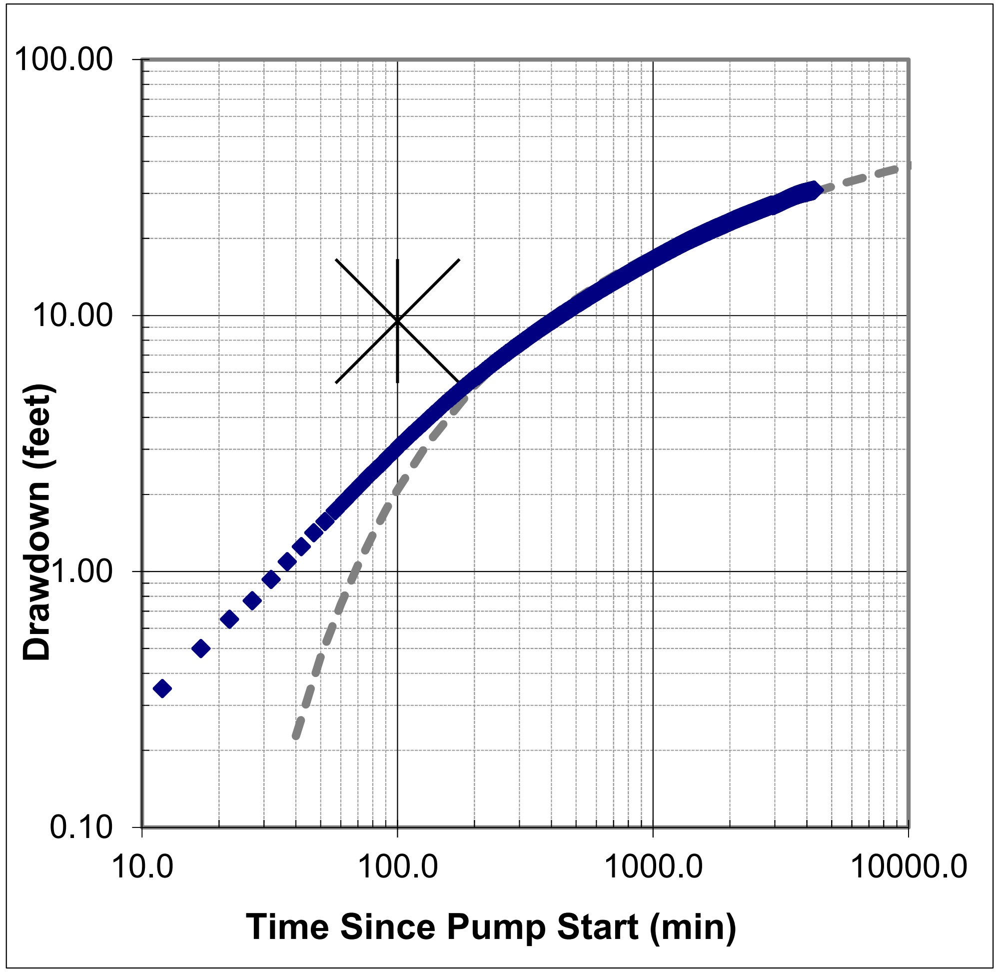
FIGURE 5-4. DRAWDOWN IN OBSERVATION WELLS MRN-36, MRN-38 AND MPN-15



Theis Match Point

Discharge (gpm)	33.9
Radius to Pumping Well (ft) (<1 indicates pumping well)	470
Drawdown Match Point (ft)	13.00
Time Match Point (min)	125.0000
Calculated Transmissivity (gal/day/ft)	299
Calculated Storage Coefficient (ft/ft)	6.3E-05

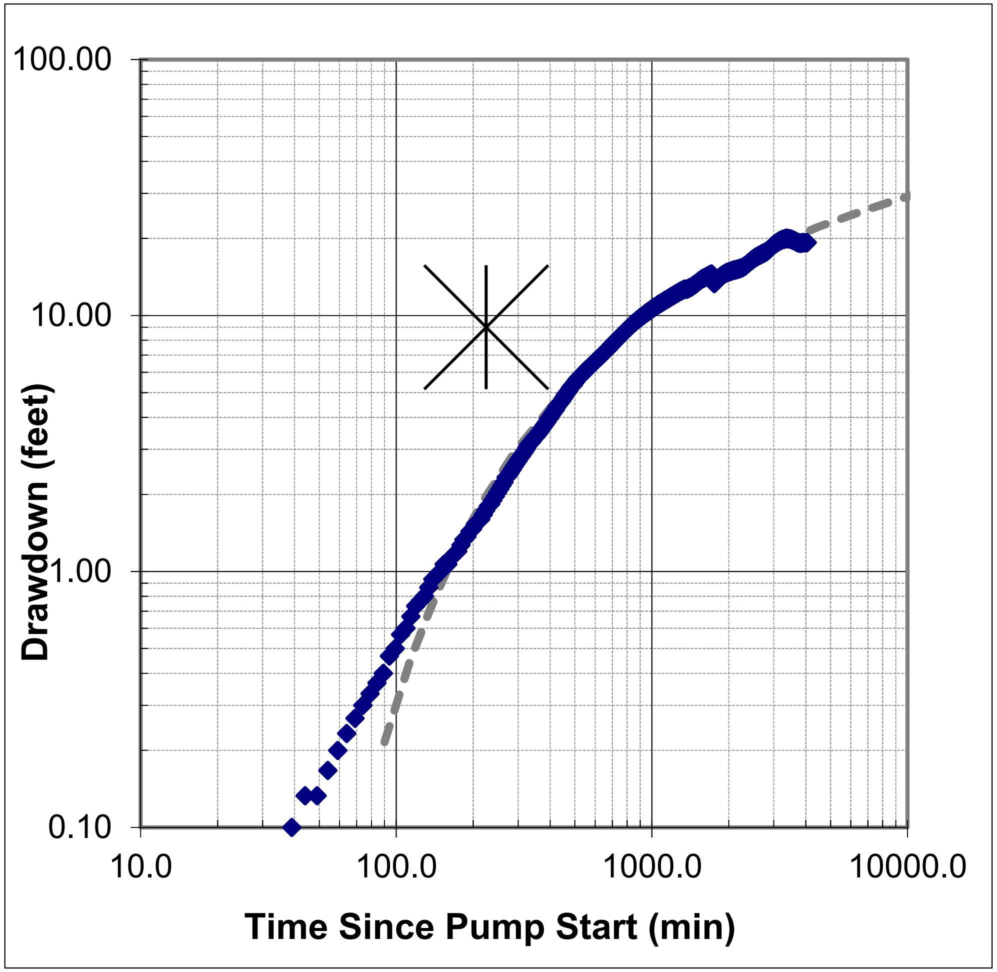
Figure 5-5 Theis Analysis for Observation Well MRN-36



Theis Match Point

Discharge (gpm)	33.9
Radius to Pumping Well (ft) (<1 indicates pumping well)	440
Drawdown Match Point (ft)	9.50
Time Match Point (min)	100.0000
Calculated Transmissivity (gal/day/ft)	409
Calculated Storage Coefficient (ft/ft)	7.8E-05

Figure 5-6 Theis Analysis for Observation Well MRN-38



Theis Match Point

Discharge (gpm)	33.9
Radius to Pumping Well (ft) (<1 indicates pumping well)	604
Drawdown Match Point (ft)	9.00
Time Match Point (min)	225.0000
Calculated Transmissivity (gal/day/ft)	432
Calculated Storage Coefficient (ft/ft)	9.9E-05

Figure 5-7 Theis Analysis for Observation Well MPN-15

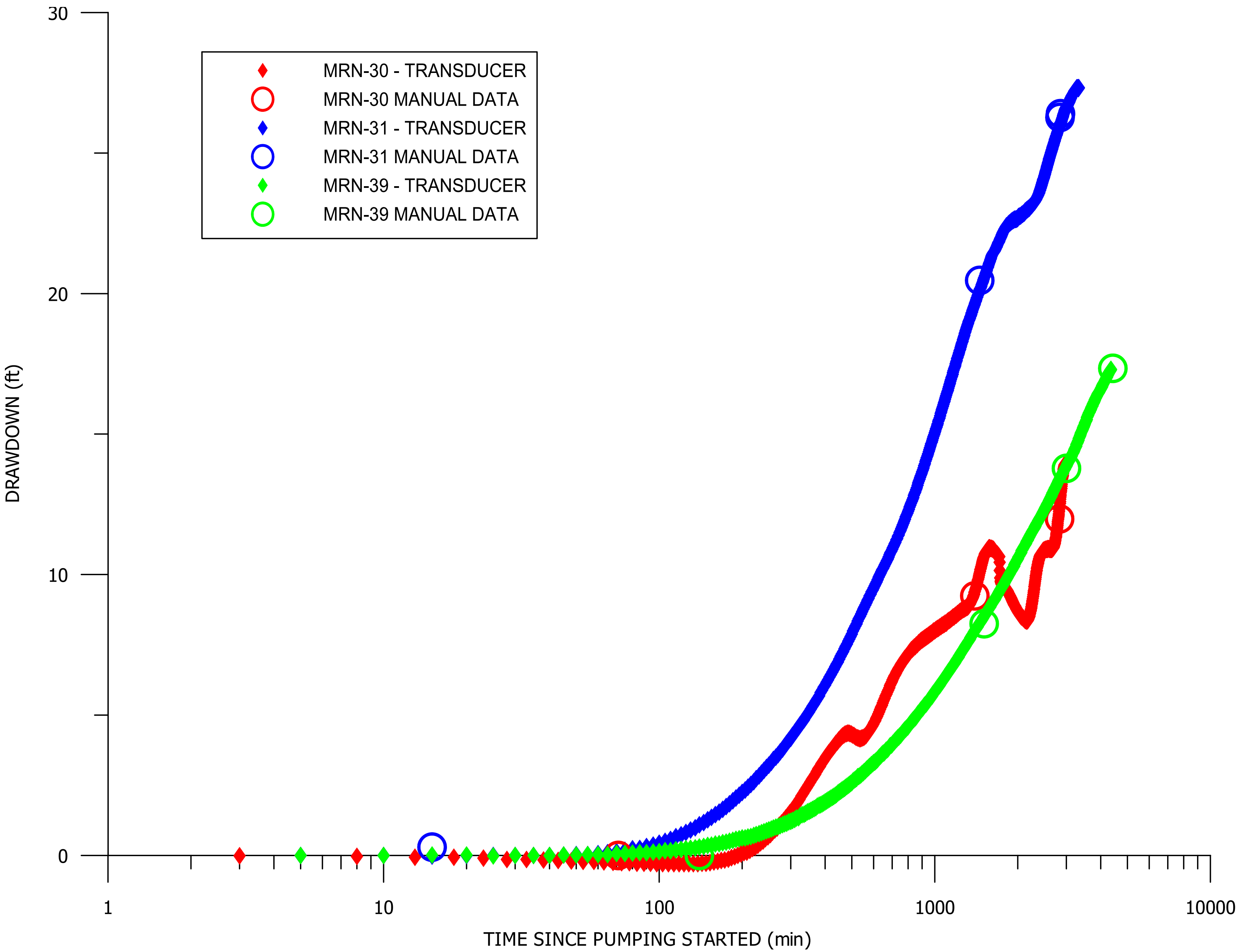
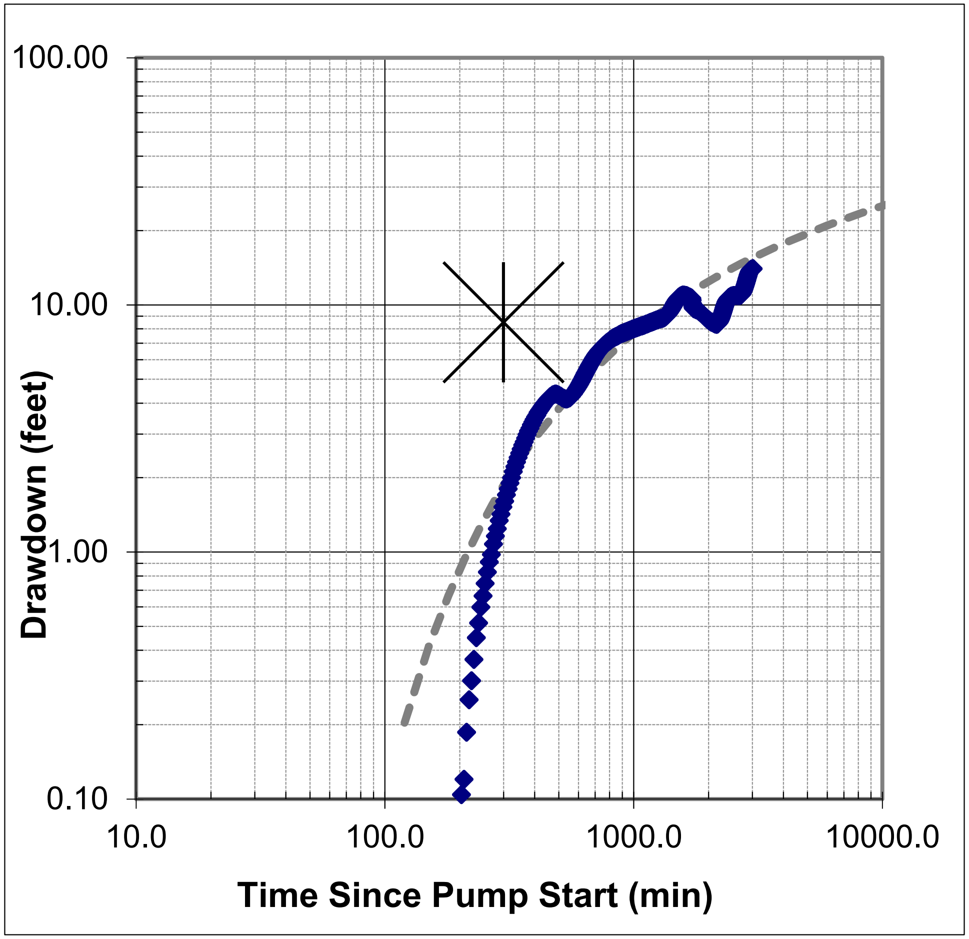


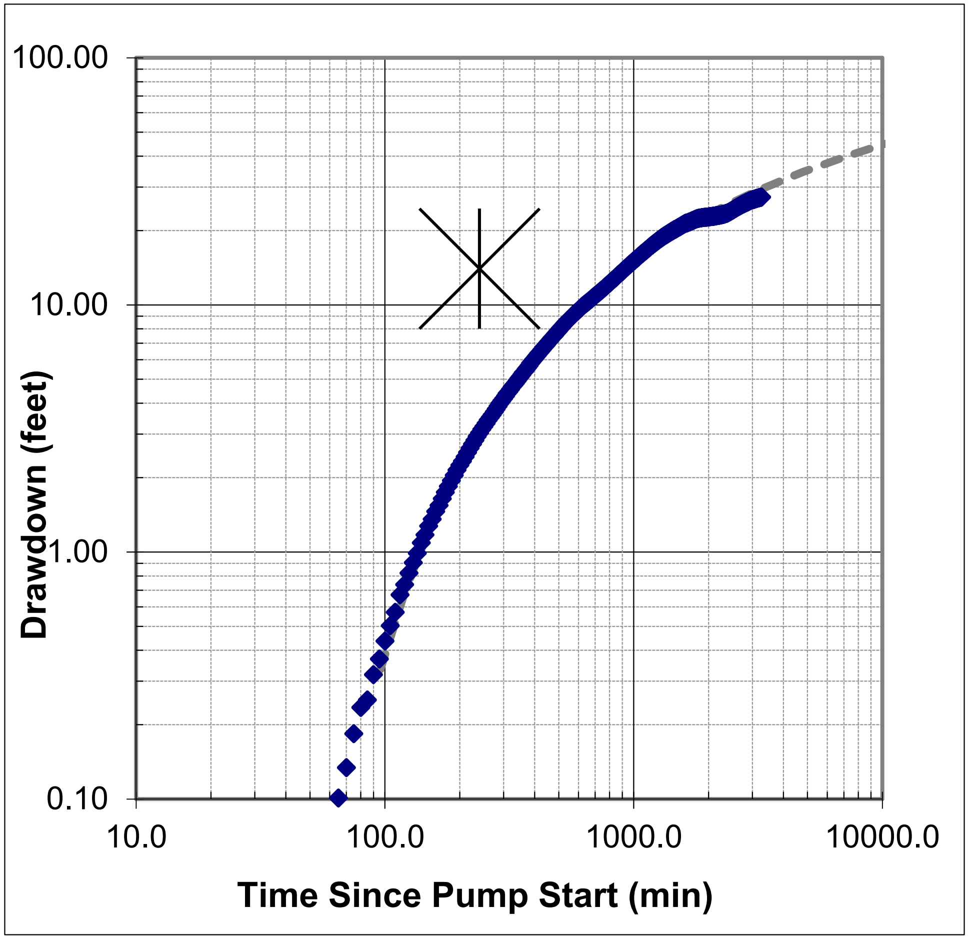
FIGURE 5-8. DRAWDOWN IN OBSERVATION WELLS MRN-30, MRN-31 AND MRN-39



Theis Match Point

Discharge (gpm)	33.9
Radius to Pumping Well (ft) (<1 indicates pumping well)	891
Drawdown Match Point (ft)	8.50
Time Match Point (min)	300.0000
Calculated Transmissivity (gal/day/ft)	457
Calculated Storage Coefficient (ft/ft)	6.4E-05

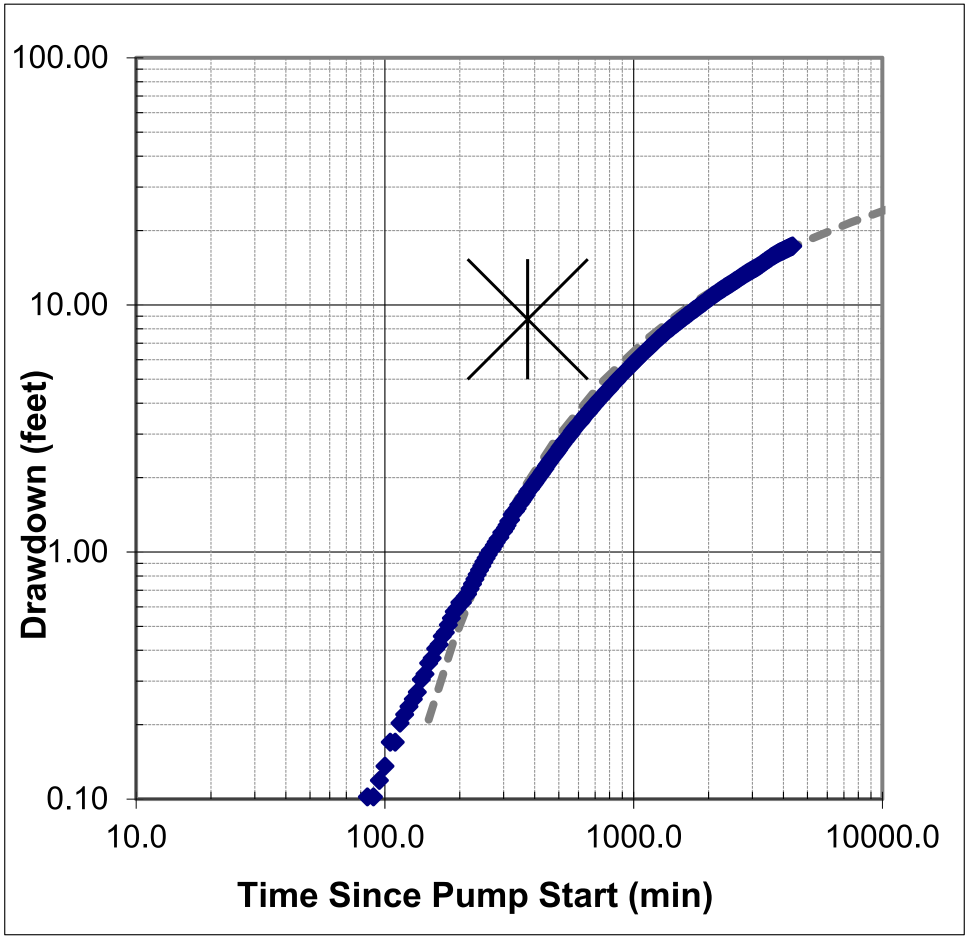
Figure 5-9 Theis Analysis for Observation Well MRN-30



Theis Match Point

Discharge (gpm)	33.9
Radius to Pumping Well (ft) (<1 indicates pumping well)	617
Drawdown Match Point (ft)	14.00
Time Match Point (min)	240.0000
Calculated Transmissivity (gal/day/ft)	277
Calculated Storage Coefficient (ft/ft)	6.5E-05

Figure 5-10 Theis Analysis for Observation Well MRN-31



Theis Match Point

Discharge (gpm)	33.9
Radius to Pumping Well (ft) (<1 indicates pumping well)	911
Drawdown Match Point (ft)	8.75
Time Match Point (min)	375.0000
Calculated Transmissivity (gal/day/ft)	444
Calculated Storage Coefficient (ft/ft)	7.4E-05

Figure 5-11 Theis Analysis for Observation Well MRN-39

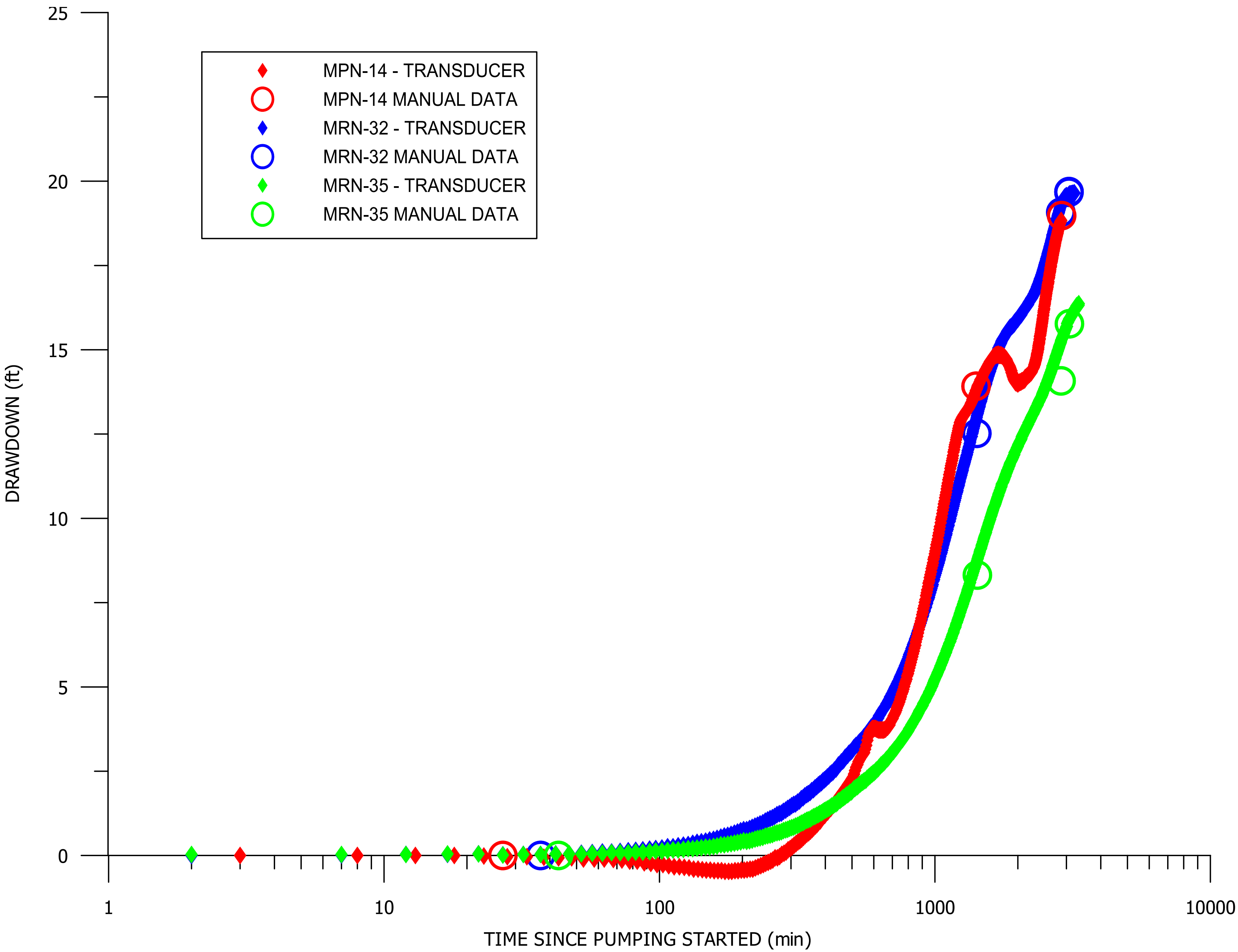
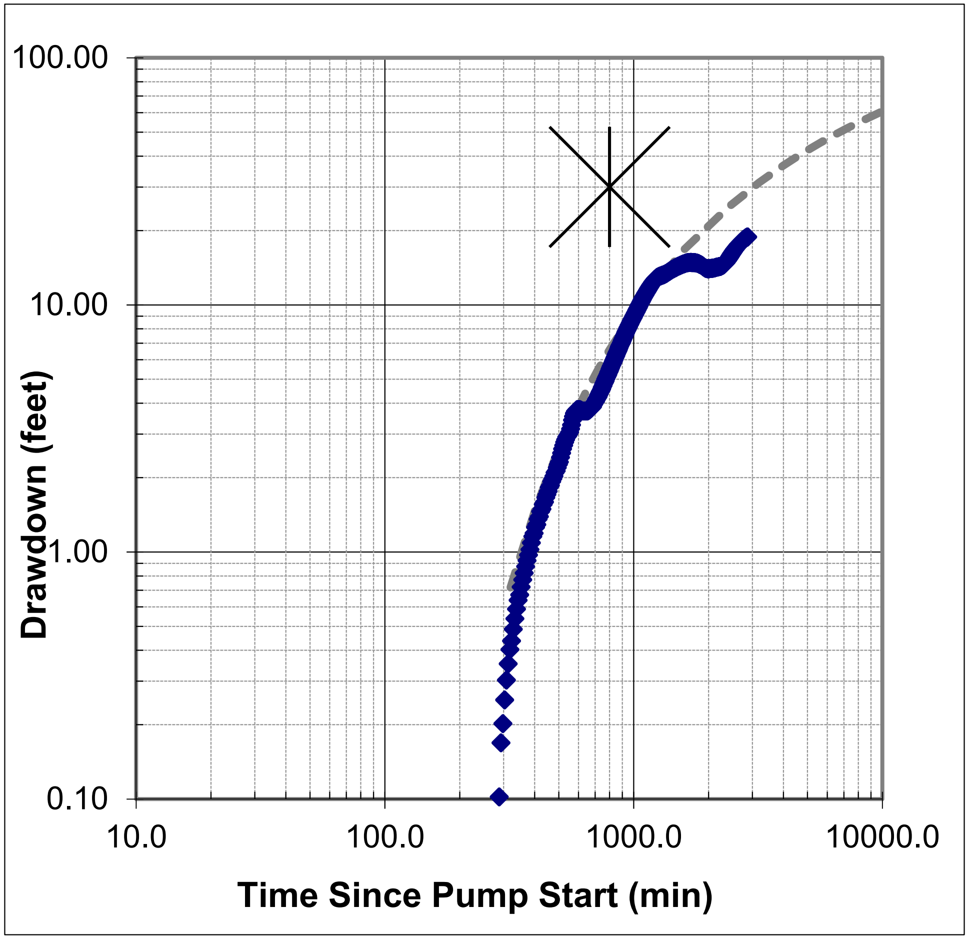


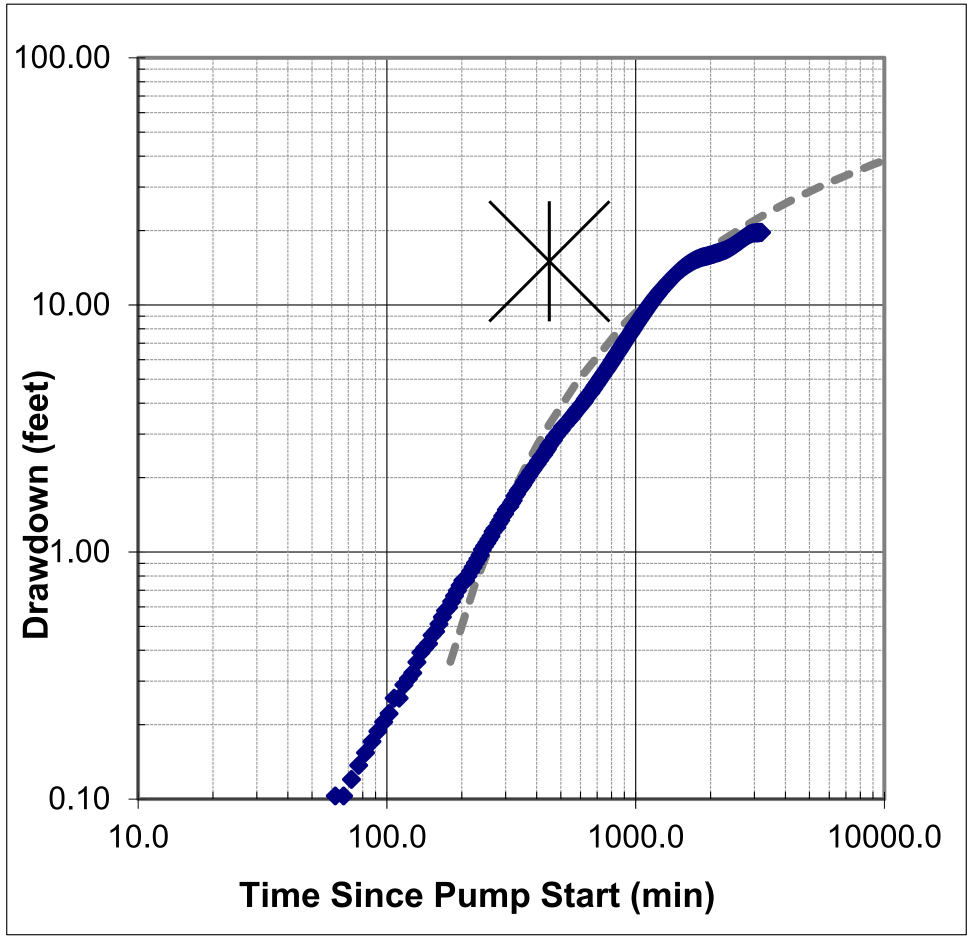
FIGURE 5-12. DRAWDOWN IN OBSERVATION WELLS MPN-14, MRN-32 AND MRN-35



Theis Match Point

Discharge (gpm)	33.9
Radius to Pumping Well (ft) (<1 indicates pumping well)	911
Drawdown Match Point (ft)	30.00
Time Match Point (min)	800.0000
Calculated Transmissivity (gal/day/ft)	129
Calculated Storage Coefficient (ft/ft)	4.6E-05

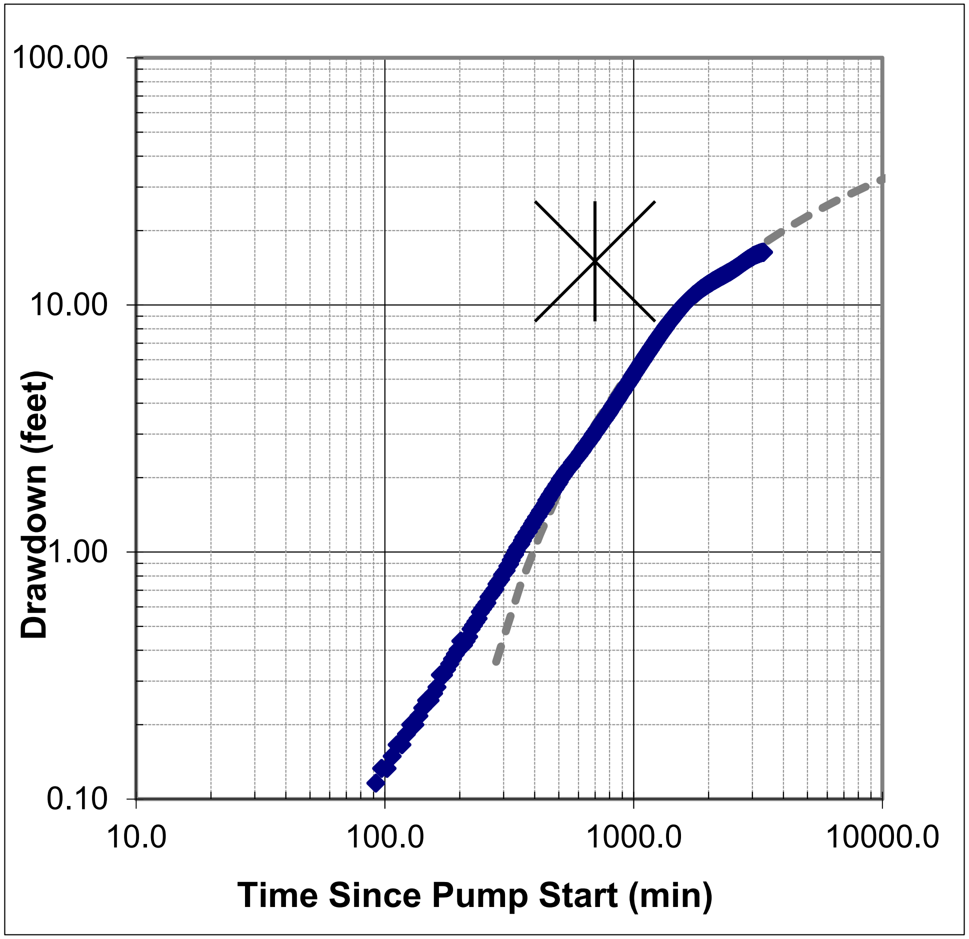
Figure 5-13 Theis Analysis for Observation Well MPN-14



Theis Match Point

Discharge (gpm)	33.9
Radius to Pumping Well (ft) (<1 indicates pumping well)	876
Drawdown Match Point (ft)	15.00
Time Match Point (min)	450.0000
Calculated Transmissivity (gal/day/ft)	259
Calculated Storage Coefficient (ft/ft)	5.6E-05

Figure 5-14 Theis Analysis for Observation Well MRN-32



<u>Theis Match Point</u>

Discharge (gpm)	33.9
Radius to Pumping Well (ft) (<1 indicates pumping well)	941
Drawdown Match Point (ft)	15.00
Time Match Point (min)	700.0000
Calculated Transmissivity (gal/day/ft)	259
Calculated Storage Coefficient (ft/ft)	7.6E-05

Figure 5-15 Theis Analysis for Observation Well MRN-35

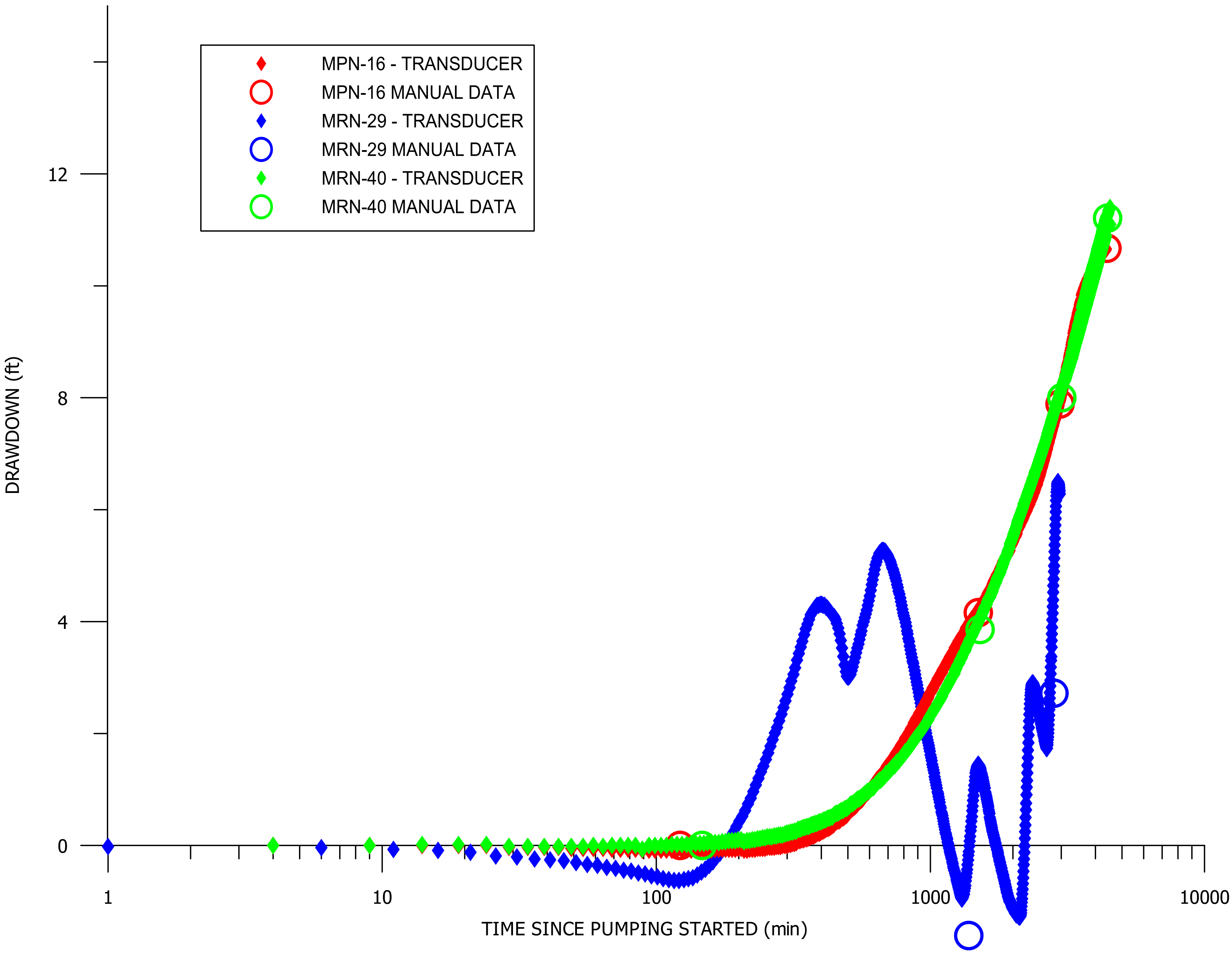
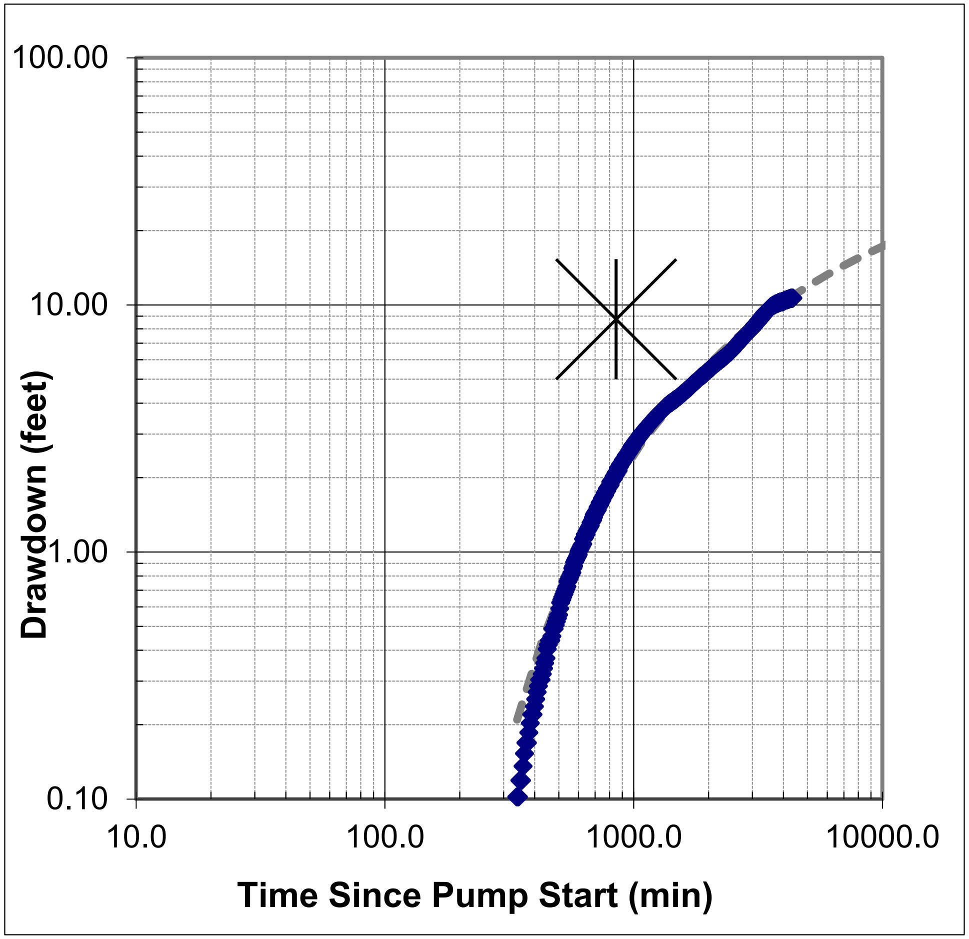
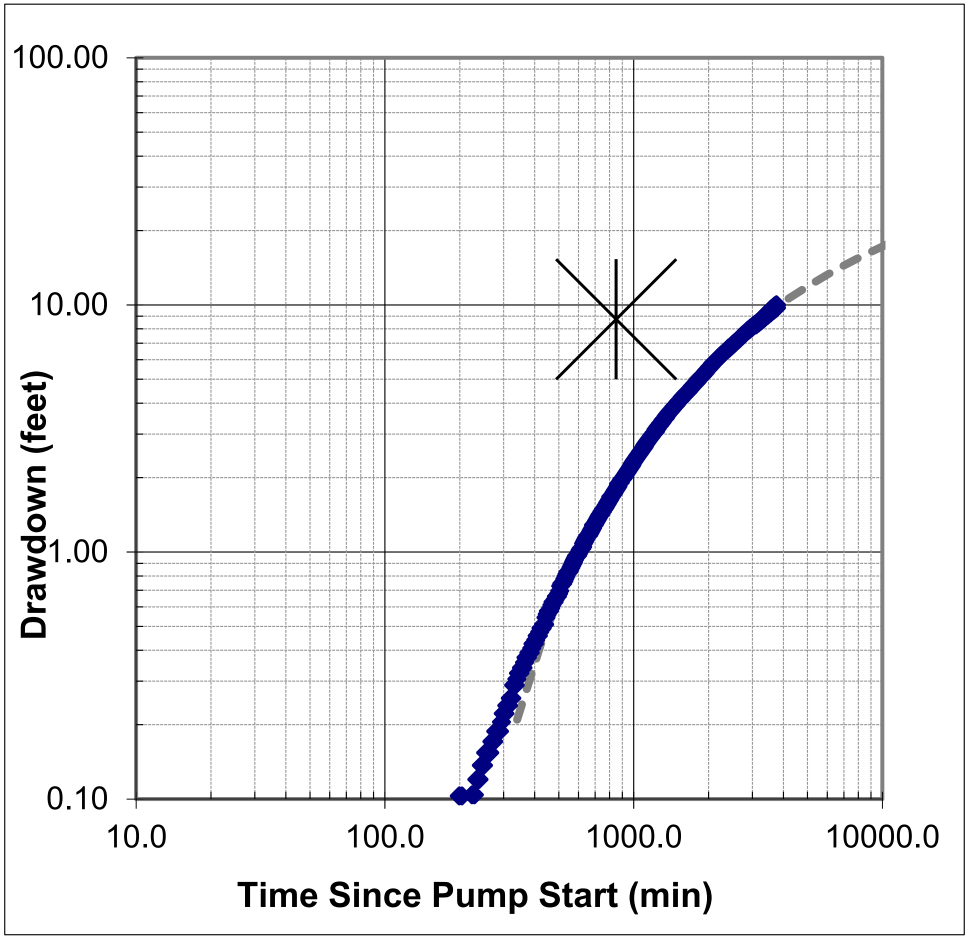


FIGURE 5-16. DRAWDOWN IN OBSERVATION WELLS MPN-16, MRN-29 AND MRN-40



Theis Match Point	
Discharge (gpm)	33.9
Radius to Pumping Well (ft) (<1 indicates pumping well)	1101
Drawdown Match Point (ft)	8.75
Time Match Point (min)	850.0000
Calculated Transmissivity (gal/day/ft)	444
Calculated Storage Coefficient (ft/ft)	1.2E-04

Figure 5-17 Theis Analysis for Observation Well MPN-16



Theis Match Point

Discharge (gpm)	33.9
Radius to Pumping Well (ft) (<1 indicates pumping well)	1315
Drawdown Match Point (ft)	8.75
Time Match Point (min)	850.0000
Calculated Transmissivity (gal/day/ft)	444
Calculated Storage Coefficient (ft/ft)	8.1E-05

Figure 5-18 Theis Analysis for Observation Well MRN-40

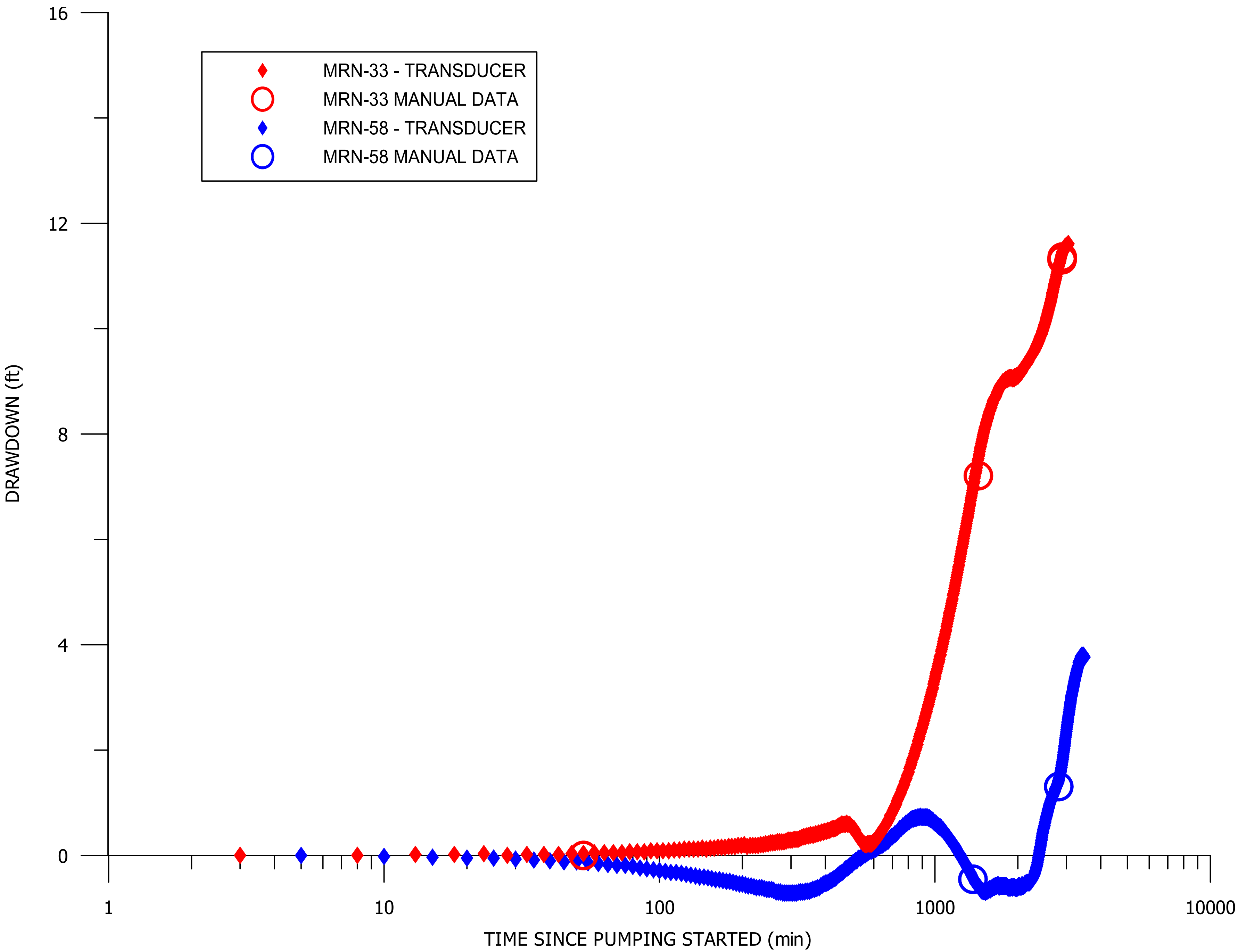
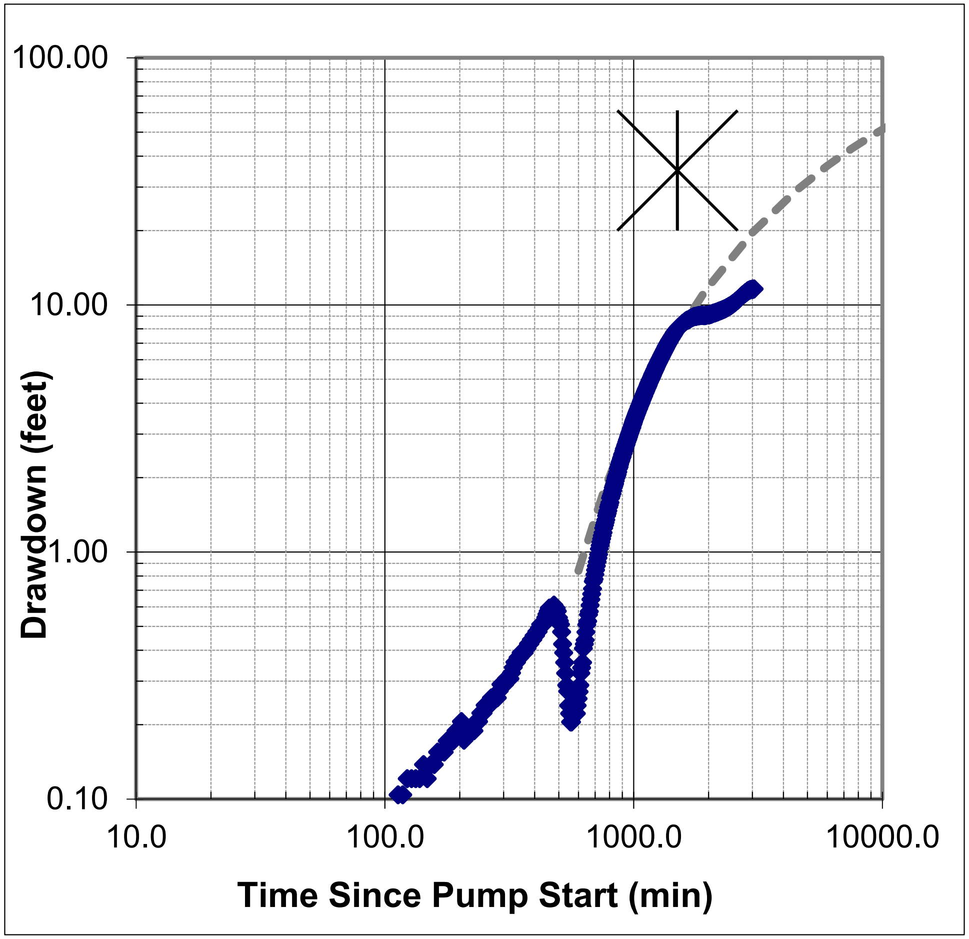


FIGURE 5-19. DRAWDOWN IN OBSERVATION WELLS MRN-33 AND MRN-58



Theis Match Point

Discharge (gpm)	33.9
Radius to Pumping Well (ft) (<1 indicates pumping well)	1362
Drawdown Match Point (ft)	35.00
Time Match Point (min)	1500.0000
Calculated Transmissivity (gal/day/ft)	111
Calculated Storage Coefficient (ft/ft)	3.3E-05

Figure 5-20 Theis Analysis for Observation Well MRN-33

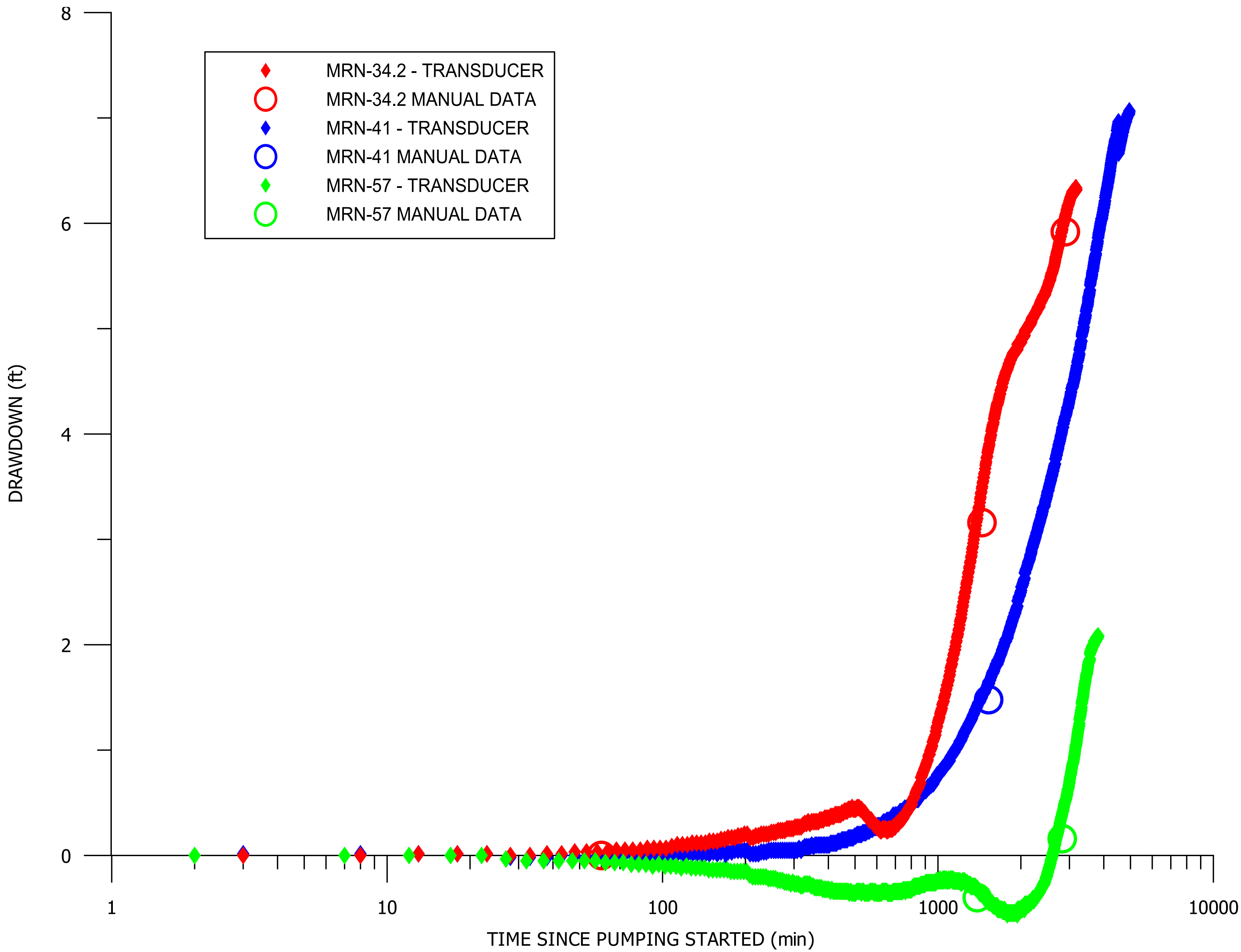
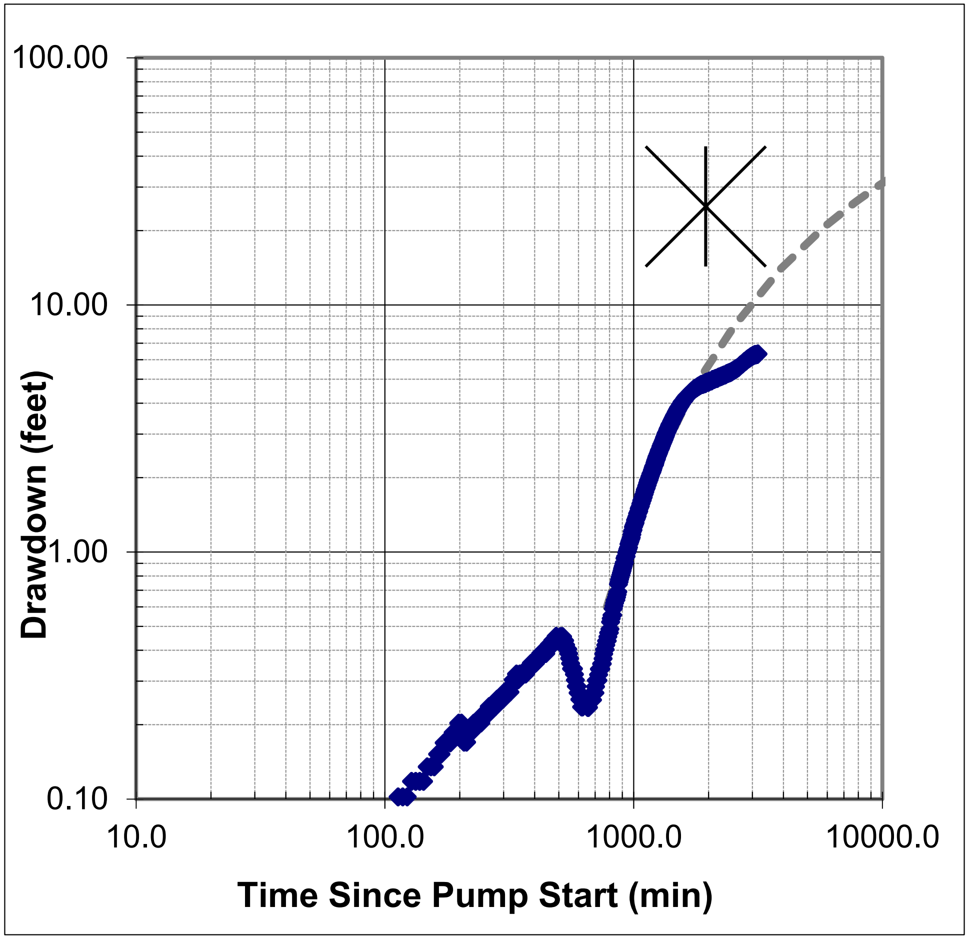


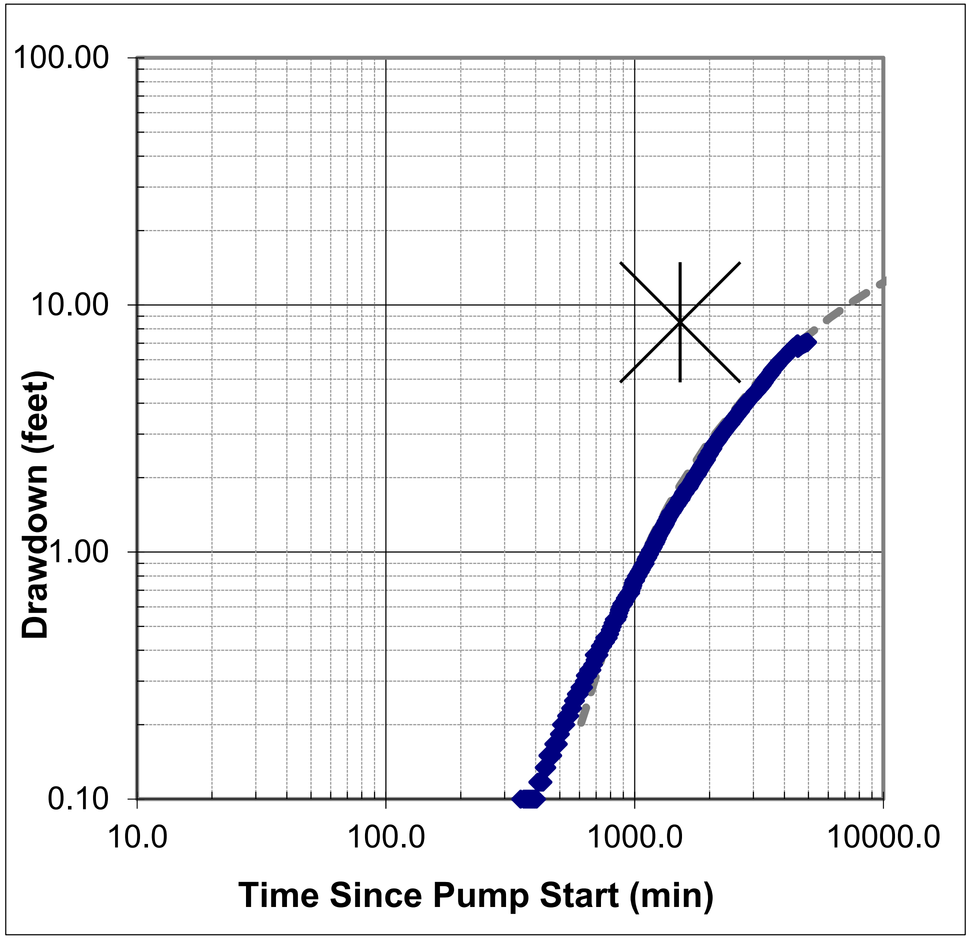
FIGURE 5-21. DRAWDOWN IN OBSERVATION WELLS MRN-34.2, MRN-41 AND MRN-57



<u>Theis Match Point</u>

Discharge (gpm)	33.9
Radius to Pumping Well (ft) (<1 indicates pumping well)	1404
Drawdown Match Point (ft)	25.00
Time Match Point (min)	1950.0000
Calculated Transmissivity (gal/day/ft)	155
Calculated Storage Coefficient (ft/ft)	5.7E-05

Figure 5-22 Theis Analysis for Observation Well MRN-34.2



Theis Match Point

Discharge (gpm)	33.9
Radius to Pumping Well (ft) (<1 indicates pumping well)	1788
Drawdown Match Point (ft)	8.50
Time Match Point (min)	1525.0000
Calculated Transmissivity (gal/day/ft)	457
Calculated Storage Coefficient (ft/ft)	8.1E-05

Figure 5-23 Theis Analysis for Observation Well MRN-41

6.0 TEST RESULTS – CONFINING UNITS FOR MRN-37 TEST

6.1 HYDRAULIC CONDUCTIVITY OF CONFINING UNITS

Confining unit vertical hydraulic conductivities have been defined on some of the sites near Nichols Ranch in the Powder River Basin. Table D6-5a in the Nichols Ranch ISR Project Permit to Mine summarizes the testing conducted on the confining units in this area.

The data indicate the vertical conductivities from core and pumping test results range from 1.5 x 10^{-9} cm/sec (4.3 x 10^{-6} ft/d) to 1.0 x 10^{-7} cm/sec (2.84 x 10^{-4} ft/d). Therefore, the vertical conductivity of these confining units is sufficiently small to limit hydraulic communication between the Overlying or Underlying aquifers and the production sand.

This test was conducted to define the continuity and adequacy of the aquitards to isolate the A Sand from the adjacent aquifers.

6.2 OVERLYING AQUIFERS

Plots of depths of water levels in the Overlying (MON) aquifers for the pre-test, pumping and recovery periods are presented in Figures 6-1 through 6-3 for wells MON-14, MON-15 and MON-16. The water levels are compared to barometric pressure for the entire period. The barometric pressure changes were small during this test, with a change of less than 0.3 inches of mercury during the pumping phase of the test. Corrections for barometric pressure changes were not made due to the small change during this test. Typical barometric pressure coefficients of 0.3 to 0.4 feet of water per inch of mercury would only make small adjustments in the depths to water.

Figure 6-1 presents the depth to water versus time for Overlying well MON-14. No significant water level change occurred during the pumping phase of the test. The overall steady response indicates no connection with the Overlying aquifer near well MON-14. Figure 6-2 shows that the water-level in well MON-15 was steady prior to the test. A brief rise in water level was observed on 3/16/2016 due to adjacent delineation drilling in the area and was not associated with pumping MRN-37. This brief change in water-level elevation is not significant.

Depth to water versus time for Overlying well MON-16 is presented on Figure 6-3. No significance change in depth to water was observed in MON-16 during any phase of the pump test.

The water level plots for the Overlying wells do not indicate any connection between the A Sand production zone and the Overlying B Sand aquifer.

6.3 UNDERLYING AQUIFERS

Plots of the water level versus time for the Underlying aquifer wells are presented in Figures 6-4, 6-5 and 6-6 for wells MUN-14, MUN-15 and MUN-16 respectively. The water levels in the Underlying aquifer wells were very gradually recovering prior to the start of the MRN-37 pump test at well MUN-14. During the pump test and subsequent recovery, water level in well MUN-14 showed a slight decline likely due to a small change in the water level trend. A similar trend can be found on Figure 6-5 for well MUN-15. Water levels in well MUN-16 showed no trend prior to or during the pumping of MRN-37. Depth to water slightly increased after the pumping phase. This is likely due to a small change in the trend in the Underlying aquifer. The water-level data presented for well MUN-16 does not indicate connection between the 1 and A Sands.

The water-level data collected on the Underlying aquifer wells indicates no connection between the A Sand and the Underlying aquifer in the southern half of PA #2 mine area.

6.4 INTEGRITY OF CONFINING UNITS

The MRN-37 test indicates that the northern half of PA #2 has adequate confinement above and below the A Sand such that mining in northern half of PA #2 can proceed in accordance with Permit To Mine No. 778 and License No. SUA-1597.

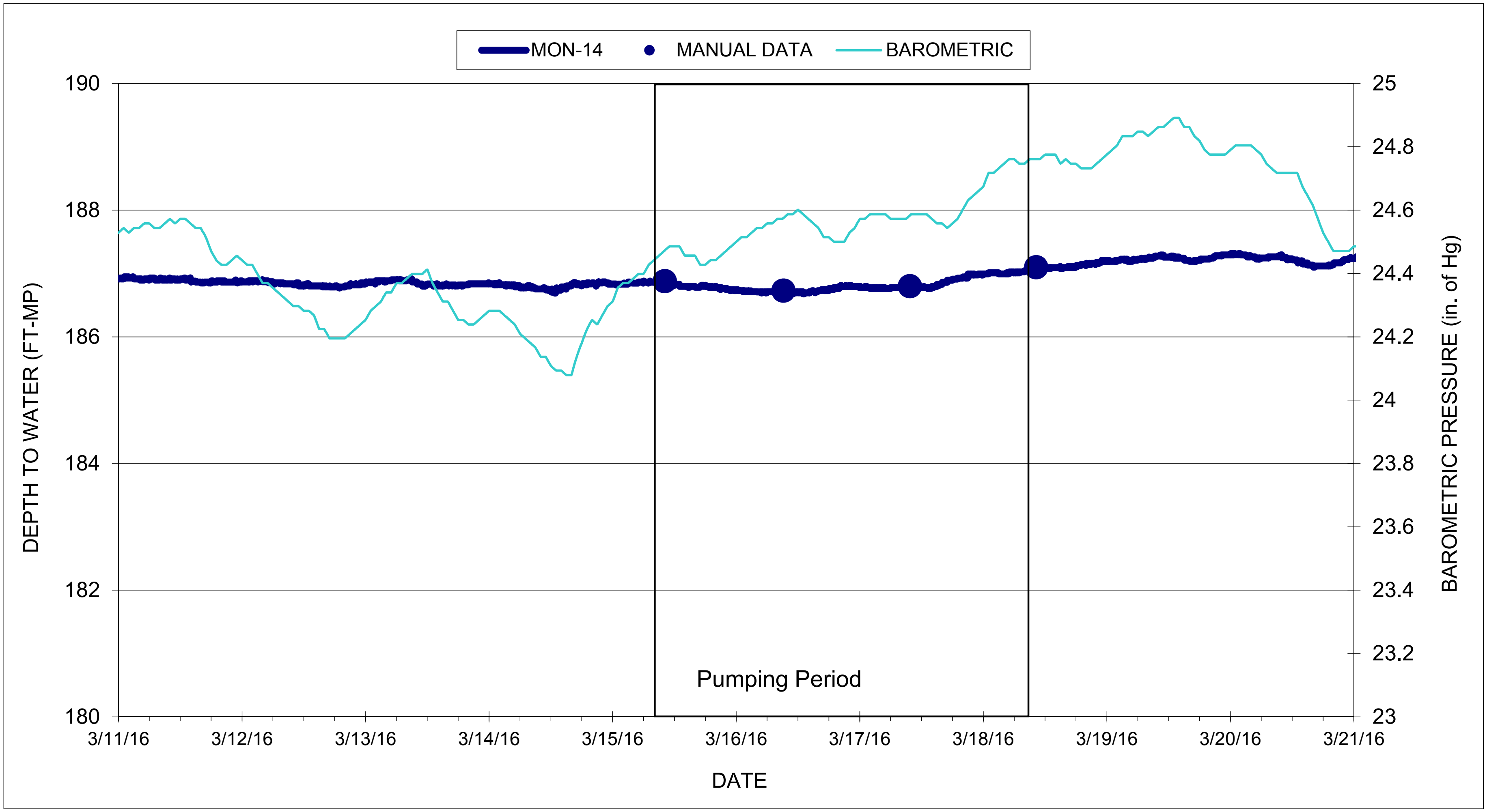


FIGURE 6-1. DEPTH TO WATER VERSUS TIME FOR OVERLYING AQUIFER WELL MON-14

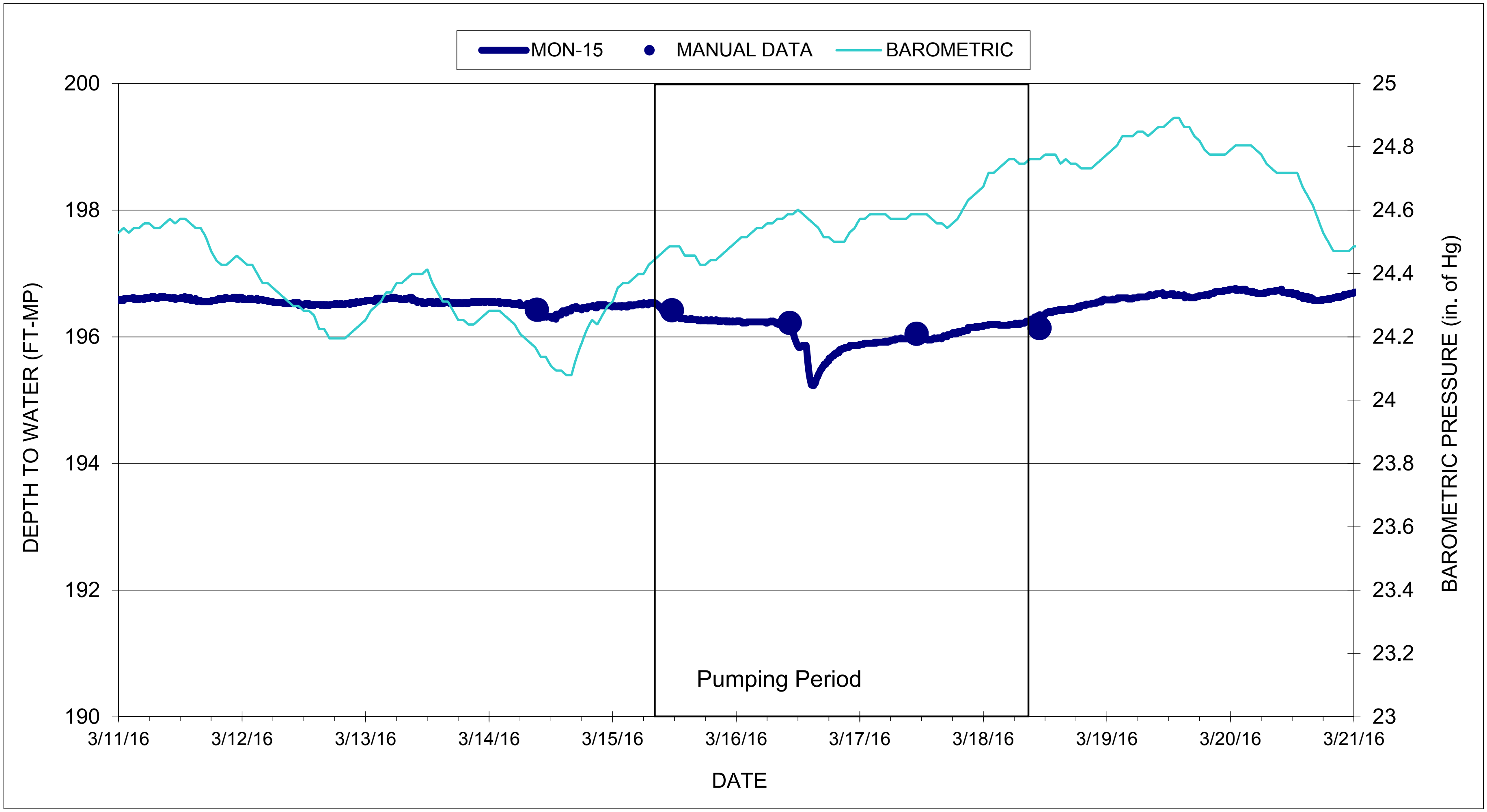


FIGURE 6-2. DEPTH TO WATER VERSUS TIME FOR OVERLYING AQUIFER WELL MON-15

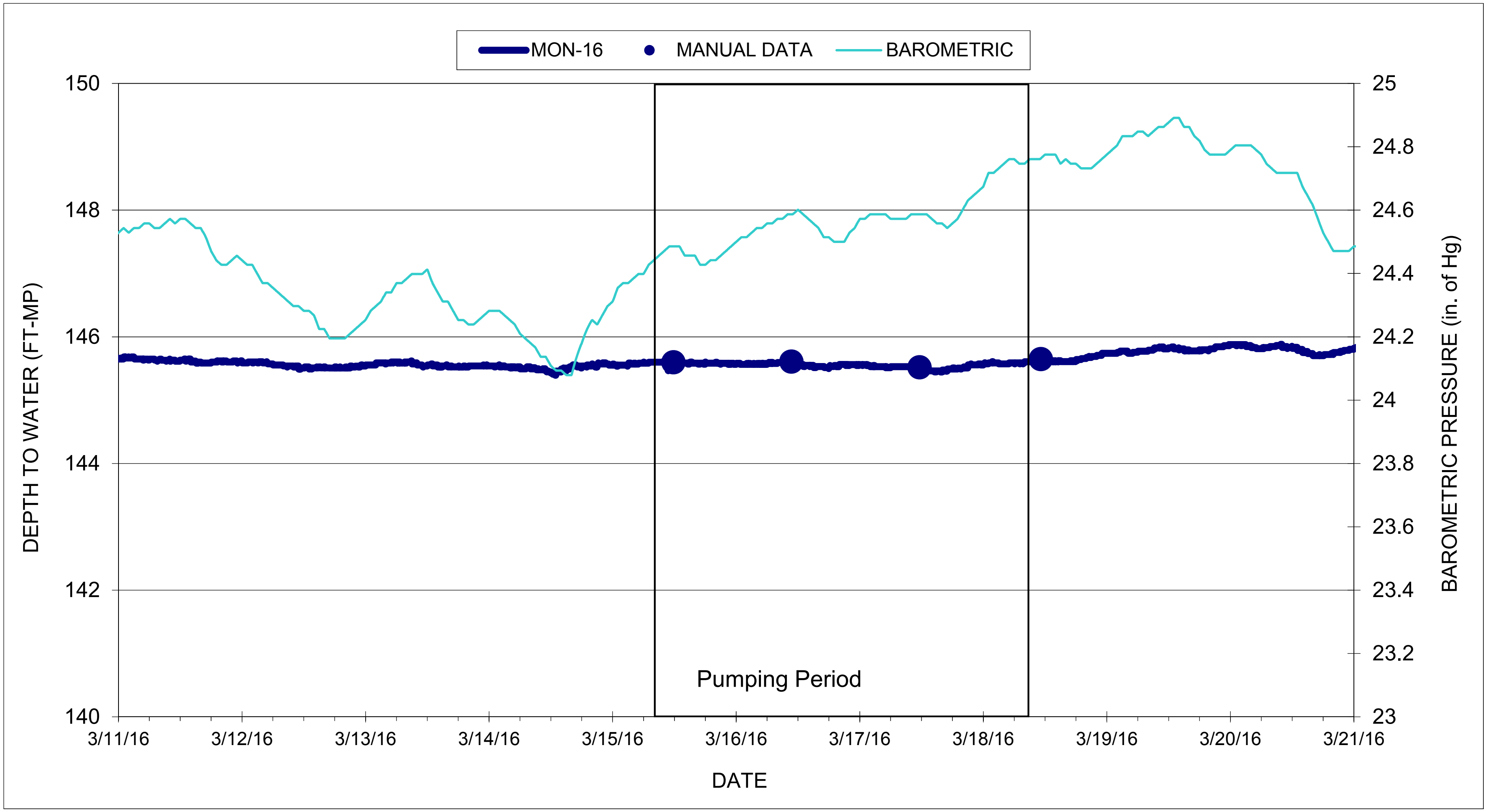


FIGURE 6-3. DEPTH TO WATER VERSUS TIME FOR OVERLYING AQUIFER WELL MON-16

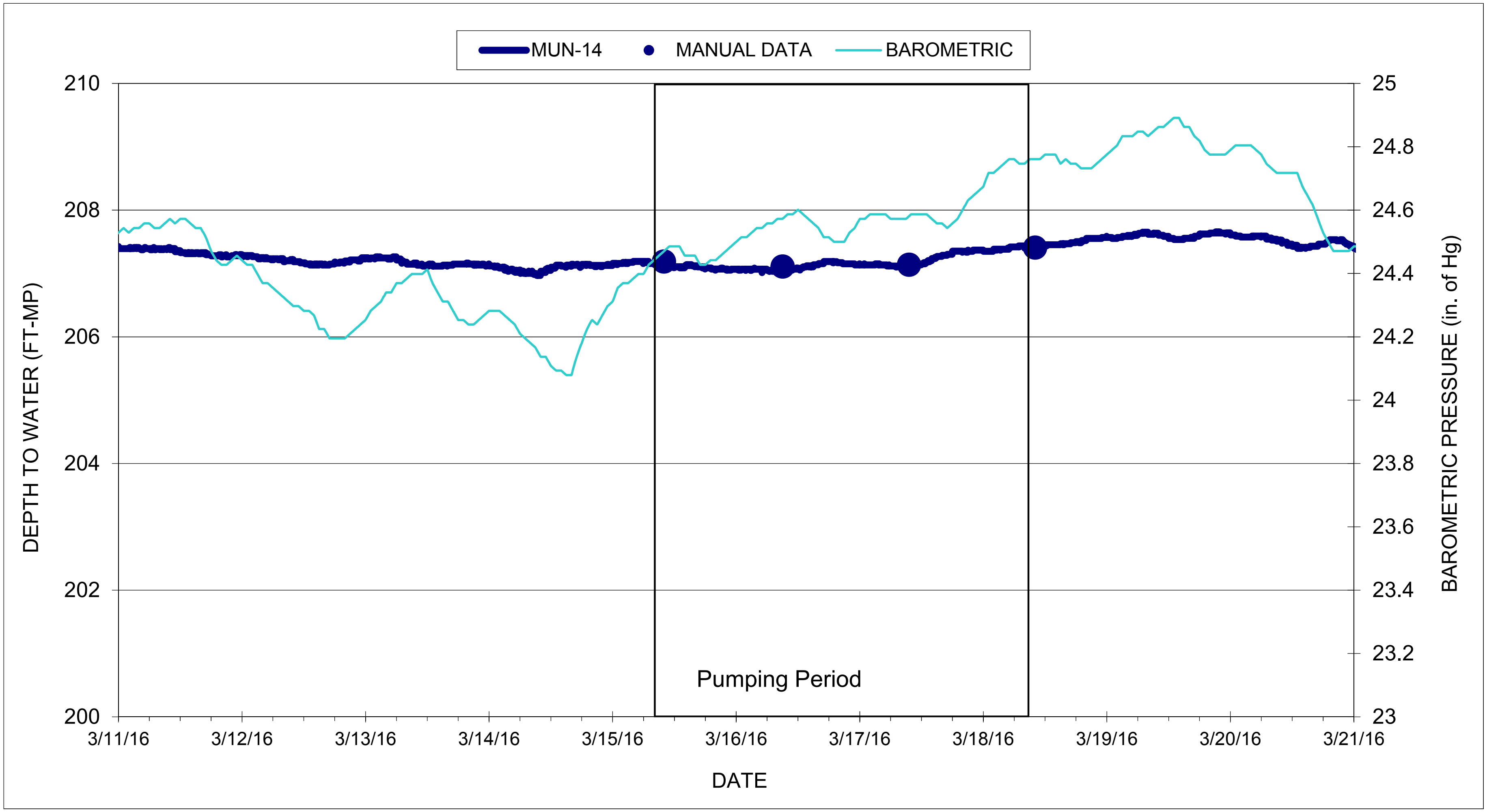


FIGURE 6-4. DEPTH TO WATER VERSUS TIME FOR UNDERLYING AQUIFER WELL MUN-14

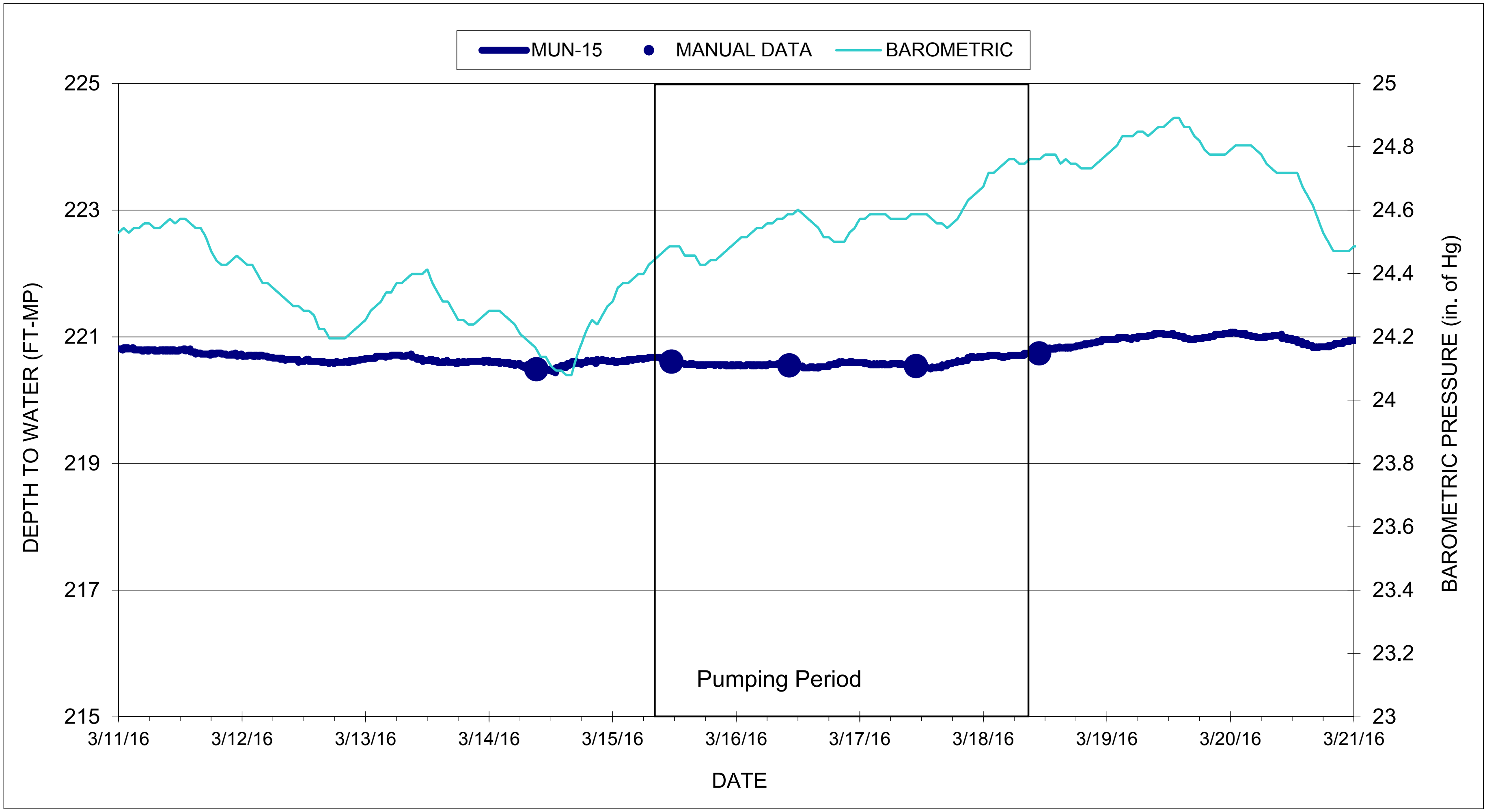


FIGURE 6-5. DEPTH TO WATER VERSUS TIME FOR UNDERLYING AQUIFER WELL MUN-15

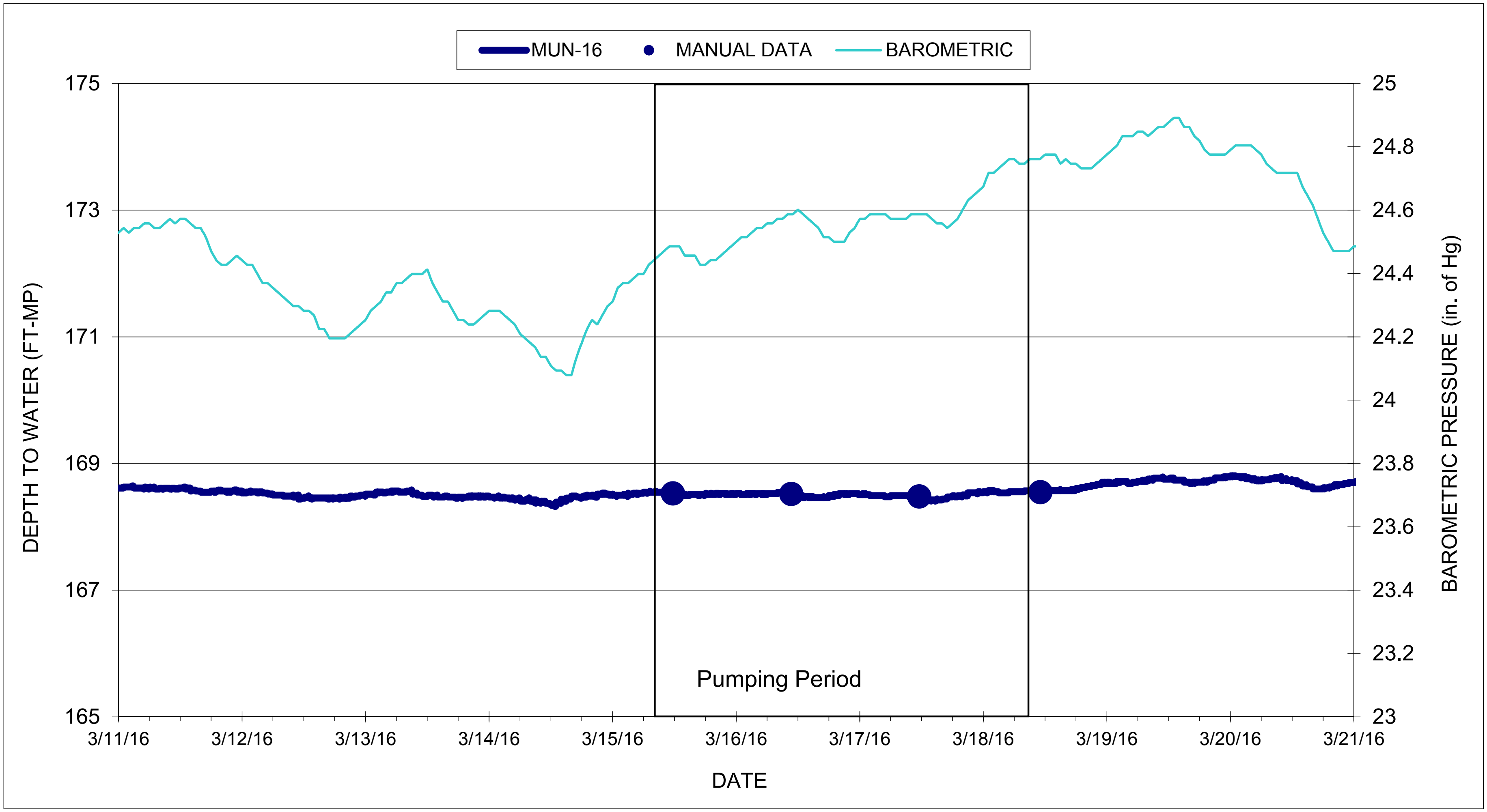


FIGURE 6-6. DEPTH TO WATER VERSUS TIME FOR UNDERLYING AQUIFER WELL MUN-16

7.0 PUMP TEST DESIGN AND WATER-LEVEL DATA FOR MRN-44 TEST

7.1 TEST DESIGN

The MRN-44 pump test was conducted with the following objectives for the southern half of PA #2:

- Demonstrate hydraulic communication between the Production Zone and the surrounding monitor well ring (MRN wells) for the southern half of PA #2;

- Determine the hydrologic characteristics of the Production Zone aquifer;

- Evaluate the presence or absence of hydrologic boundaries within the Production Zone; and,

- Demonstrate sufficient hydrologic isolation between the Production Zone and the Overlying and Underlying sands for the purposes of ISR mining.

The pump tests were designed to cause a minimum of one to two feet of water level drawdown in the A Sand at a radius of 2,500 feet from the pumping well.

Figure 7-1 presents the southern half of the PA #2 wellfield outline and the locations of the pumping and observation (monitoring) wells used during the MRN-44 hydrologic test. The pumping well (MRN-44) was completed across 83 feet of the A Production Sand (Table 3-1). However, the effective thickness of the A Sand at well MRN-44 is estimated at 93 feet. The pump was installed to a depth of 497 feet without a check valve.

The general testing procedures were as follows:

♦ Install automated monitoring equipment in the wells selected to be used in the test. Verify setting depths and head reading with manual water level measurements.

♦ Measure and record background water levels every 12 hours for a minimum of 48 hours prior to the start of the test.

♦ Pump the Well MRN-44 at a constant rate (or as close as possible). Record water levels and barometric pressure throughout the background, pumping and recovery periods.

7.2 EQUIPMENT LAYOUT

Prior to the background monitoring period for the test, Uranerz installed a 35 gpm electric submersible pump. A totalizer meter was used to measure instantaneous flowrate and record total gallons pumped.

The monitoring equipment layout for the test is shown on Figure 7-1. All the monitor wells for the test were equipped with automated water level recorders consisting of Heron Instruments data logger/transducers (see Table 7-2). Water levels were also measured manually throughout the test to verify that the automated equipment was functioning properly. The pumping equipment performed as designed. For consistency, occasional erroneous data (e.g., inaccurate readings that resulted when the equipment tried to log data during a data download) were edited out of the database.

Prior to the test, HYDRO personnel selected the data logger/transducer layout. HYDRO personnel installed the monitoring equipment prior to testing and provided day-to-day downloads.

The monitor wells used for the test, distance from each monitor well to the pumping well, and the drawdown observed are presented in Table 7-1. The equipment layout and head ratings for each transducer, is given on Table 7-2. Figure 7-1 shows the location of the data loggers/transducers. Appendix D presents the tabulation of water levels for all of the MRN-44 pump test wells.

7.3 BACKGROUND MONITORING, TEST PROCEDURES AND DATA COLLECTION

A potentiometric map for the A Sand, based on water levels prior to the start of each of the two tests, is shown in Figure 2-11. The water levels measured prior to the MRN-37 test are presented in orange while the water levels prior to the MRN-44 test are presented in black. Pre-test water level monitoring data along with the pumping and recovery period data for the A Sand monitoring wells are shown on Figures 7-2 through 7-9. These plots present the depth to water versus time on a linear scale. A tabulation of the water-level data is presented in Appendix D.

The pump test was performed by pumping MRN-44 at an average rate of 35.0 gpm from 10:30 on April 4, 2016 until 10:30 on April 7, 2016. The total pumping duration was 72 hours (4,320 minutes). The drawdown achieved in the pumping well was 196.6 feet; drawdown in the A Sand monitoring wells ranged from 7.2 to 37.6 feet (Table 7-1). Water levels were automatically measured and recorded at a maximum interval of 5 minutes during the pumping and recovery periods. The pumping well transducer readings were recorded every 5 minutes. Pumping rate data for the test are shown on Table 7-3. Water level recovery was monitored for 72 hours. A list of A Sand monitoring wells, the distance of those wells from the pumping well, and the drawdown measured during the pumping period for all the wells are summarized in Table 7-1.

Table 7-1.
MONITORING WELL DISTANCE AND MAXIMUM DRAWDOWN DURING THE MRN-44 TEST

1st Start Date & Time	4/4/2016 10:30				
1st End Date & Time	4/7/2016 10:30				
Duration	4320 Minutes				
Avg. Pumping Rate	35.0 G.P.M.				
Pumping Well	MRN-44	Distance from	Depth to Water	Water Elevation	Maximum Drawdown
		Pumping Well	Before Test	Before Test	During Test
Monitoring Wells		(ft)	(ft)	(ft)	(ft)
	MRN-44	0	128.65	4627.47	196.6
Ore Zone Completions	MPN-17	1284	115.36	4612.55	7.2
	MPN-18	636	128.53	4614.28	37.5
	MPN-19	567	98.86	4615.79	36.6
	MPN-20	1191	53.75	4624.66	13.2
	MRN-41	1322	122.16	4625.23	4.8
	MRN-42	899	89.05	4629.26	14.3
	MRN-43	423	108.37	4627.43	37.6
	MRN-45	464	84.70	4631.10	35.5
	MRN-46	906	54.02	4628.62	18.1
	MRN-47	1341	37.40	4636.21	11.5
	MRN-48	1713	32.34	4637.02	8.3
	MRN-49	1847	40.28	4637.83	7.9
	MRN-50B	1757	53.53	4632.75	9.6
	MRN-51B	1645	62.60	4627.79	11.5
	MRN-52	1710	85.17	4617.46	13.8
	MRN-53	1896	115.24	4611.75	15.8
	MRN-54	1281	154.79	4611.26	15.7
	MRN-55	1459	187.37	4601.28	12.8
	MRN-56	1637	149.71	4607.45	7.7
Overlying Completions	MON-17	1182	68.22	4652.47	*
	MON-18	612	96.98	4649.05	*
	MON-19	559	63.31	4654.65	*
	MON-20	1145	26.35	4651.38	*
Underlying Completions	MUN-17	1230	103.28	4620.39	*
	MUN-18	590	127.52	4620.44	*
	MUN-19	630	90.42	4625.40	*
	MUN-20B	1183	58.97	4620.35	*

Note: * = No Drawdown Observed
e = estimated maximum drawdown because water level was below transducer

TABLE 7-2.
DATA LOGGER AND TRANSDUCER EQUIPMENT FOR MONITORING WELLS FOR THE MRN-44 TEST

	Well Name	Transducer Number
Monitoring Wells		
Pumping Well	MRN-44	D09491
Ore Zone Completions		
	MPN-17	B04183
	MPN-18	C04167
	MPN-19	D01388
	MPN-20	B04473
	MRN-41	B04091
	MRN-42	B04104
	MRN-43	D04668
	MRN-45	C09480
	MRN-46	B05606
	MRN-47	B03573
	MRN-48	B04085
	MRN-49	B05595
	MRN-50B	B04192
	MRN-51B	B05587
	MRN-52	B05583
	MRN-53	B04164
	MRN-54	B04128
	MRN-55	B05592
	MRN-56	B04084
Overlying Completions		
	MON-17	B04093
	MON-18	B04168
	MON-19	B04086
	MON-20	B04101
Underlying Completions		
	MUN-17	B04105
	MUN-18	B05601
	MUN-19	B04166
	MUN-20B	B04094

Note: Transducers have the following max setting depth below the water level in the well

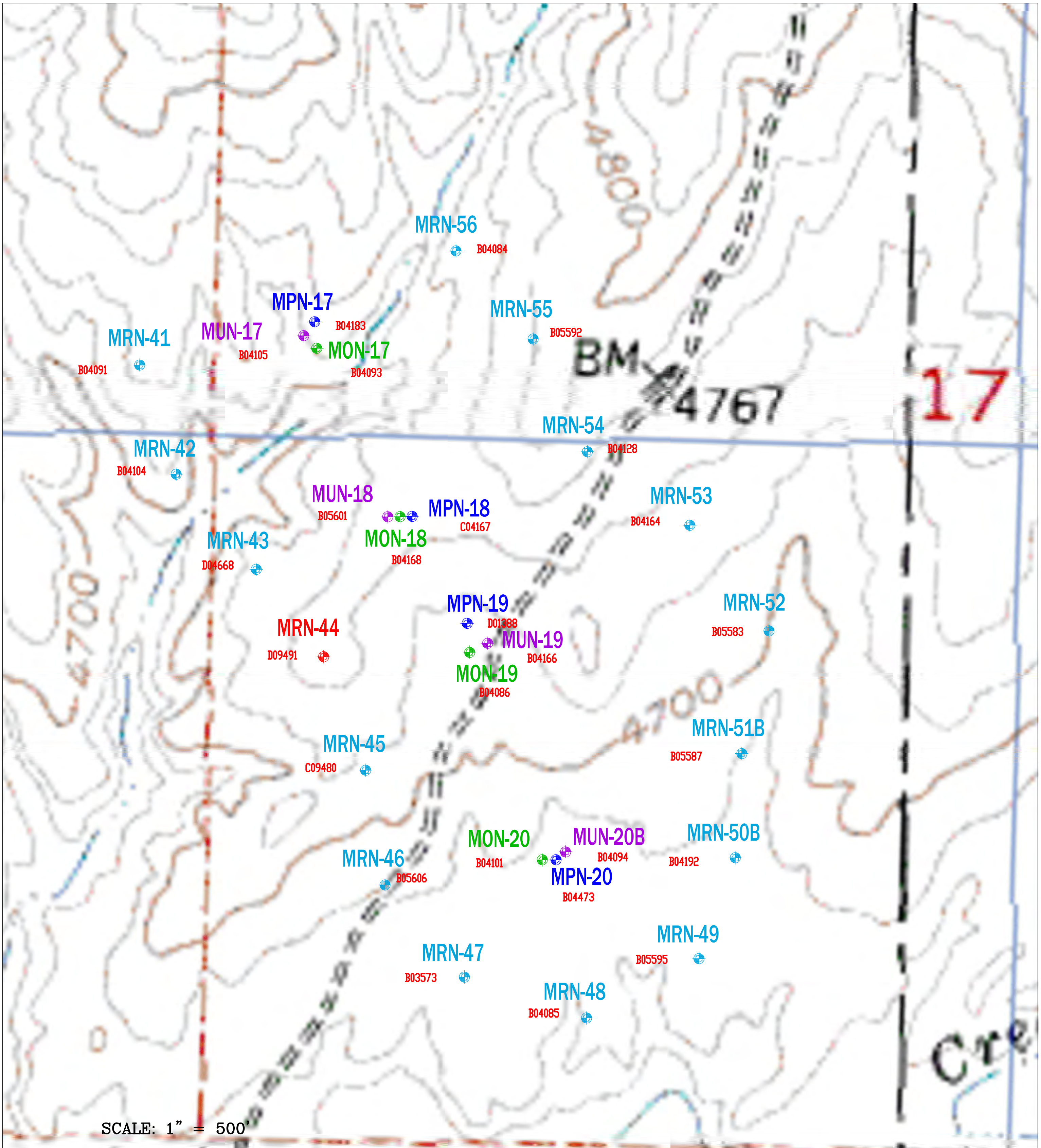
B series = max of 35ft

C series = max of 100ft

D series = max of 200ft

Table 7-3.
PUMPING RATE AND FIELD SAMPLING VERSUS TIME FOR PUMPING WELL MRN-44

DATE/TIME	TOTALIZER (GAL)	METER (GPM)	FIELD SAMPLING		
			pH	CONDUCTIVITY (µS)	Temp (Cº)
4/4/16 10:30 AM	PUMP ON				
4/4/16 10:40 AM	179070				
4/4/16 11:57 AM	181751				
4/4/16 2:00 PM	186150	35.8	8.62		
4/5/16 11:44 AM	231980	34.9	8.42		
4/5/16 2:45 PM	238290				
4/6/16 8:15 AM	274955	34.9			
4/6/16 11:30 AM	281755		8.39		
4/7/16 10:11 AM	329100	34.5			
4/7/16 10:30 AM	329718				
4/7/16 10:30 AM	PUMP OFF				



REVISIONS No.	DATE	MADE BY	DESCRIPTION
1			
2			
3			
4			

DATE	DRAWN BY	CHECKED	APPROVED
6-2016	BMW		

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4685 EAST MAGNOLIA
CASPER, WYOMING, 82604

FILE: C:\PROJECTS\2016-14\nrwellfield

ENERGY FUELS

Uranerz Energy Corporation
(an Energy Fuels Company)
1701 East "E" Street
P.O. Box 50850
Casper, Wyoming
USA 82605-0850

Figure 7-1
Monitoring Well Locations and Transducer Layout For the MRN-44 Pump Test

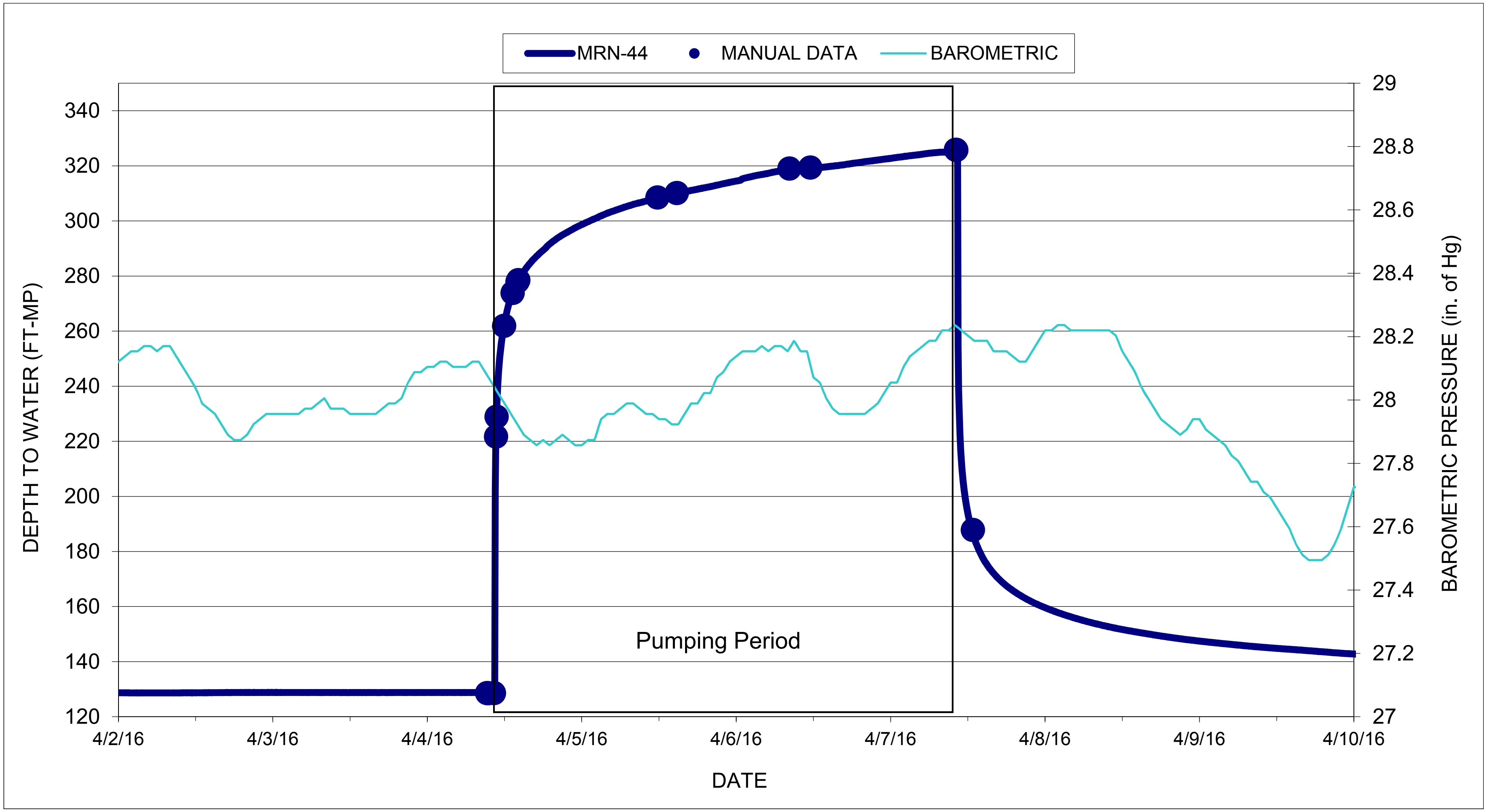


FIGURE 7-2. DEPTH TO WATER VERSUS TIME FOR PUMPING WELL MRN-44

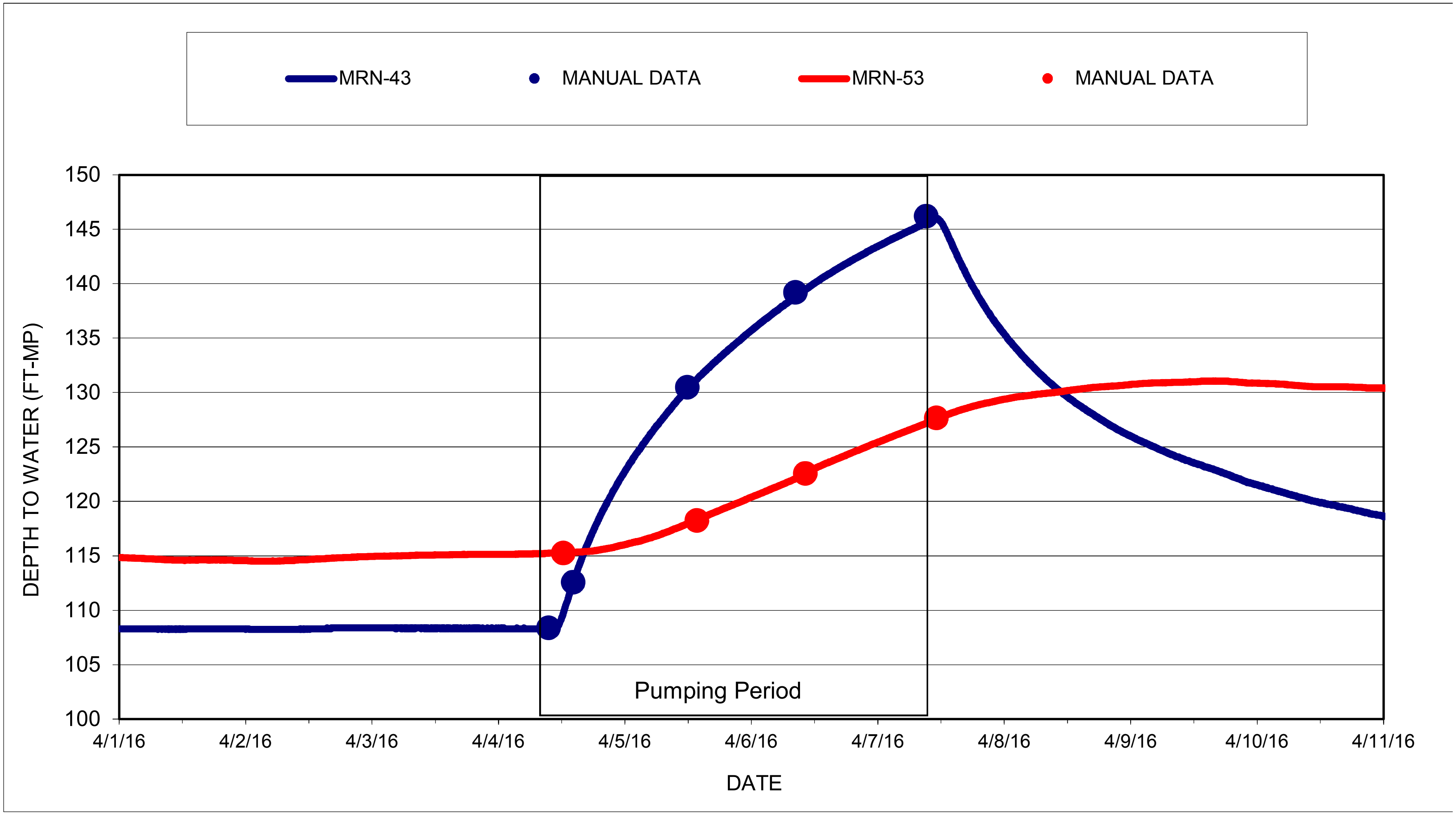


FIGURE 7-3. DEPTH TO WATER VERSUS TIME FOR OBSERVATION WELLS MRN-43 AND MRN-53

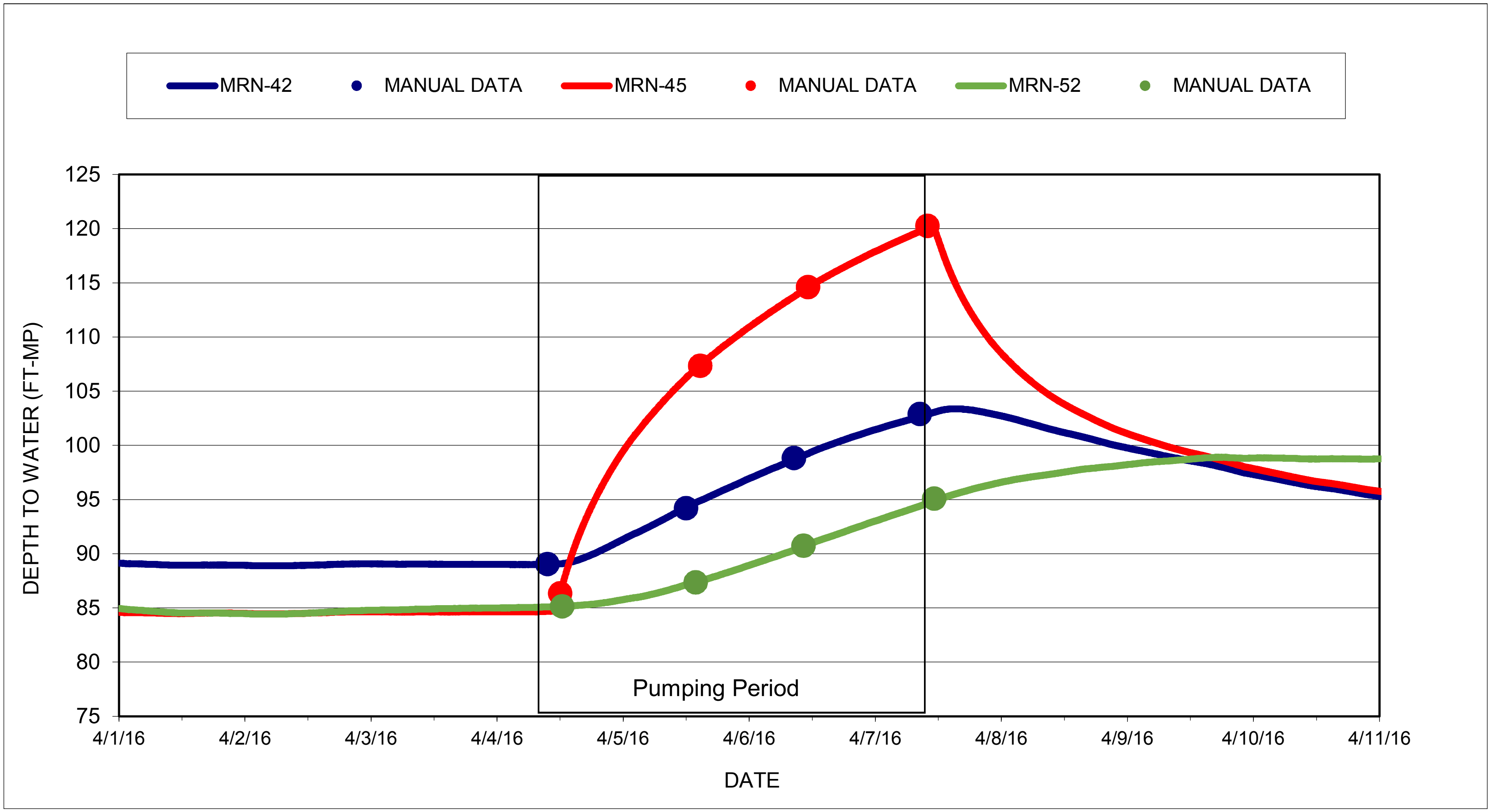


FIGURE 7-4. DEPTH TO WATER VERSUS TIME FOR OBSERVATION WELLS MRN-42, MRN-45 AND MRN-52

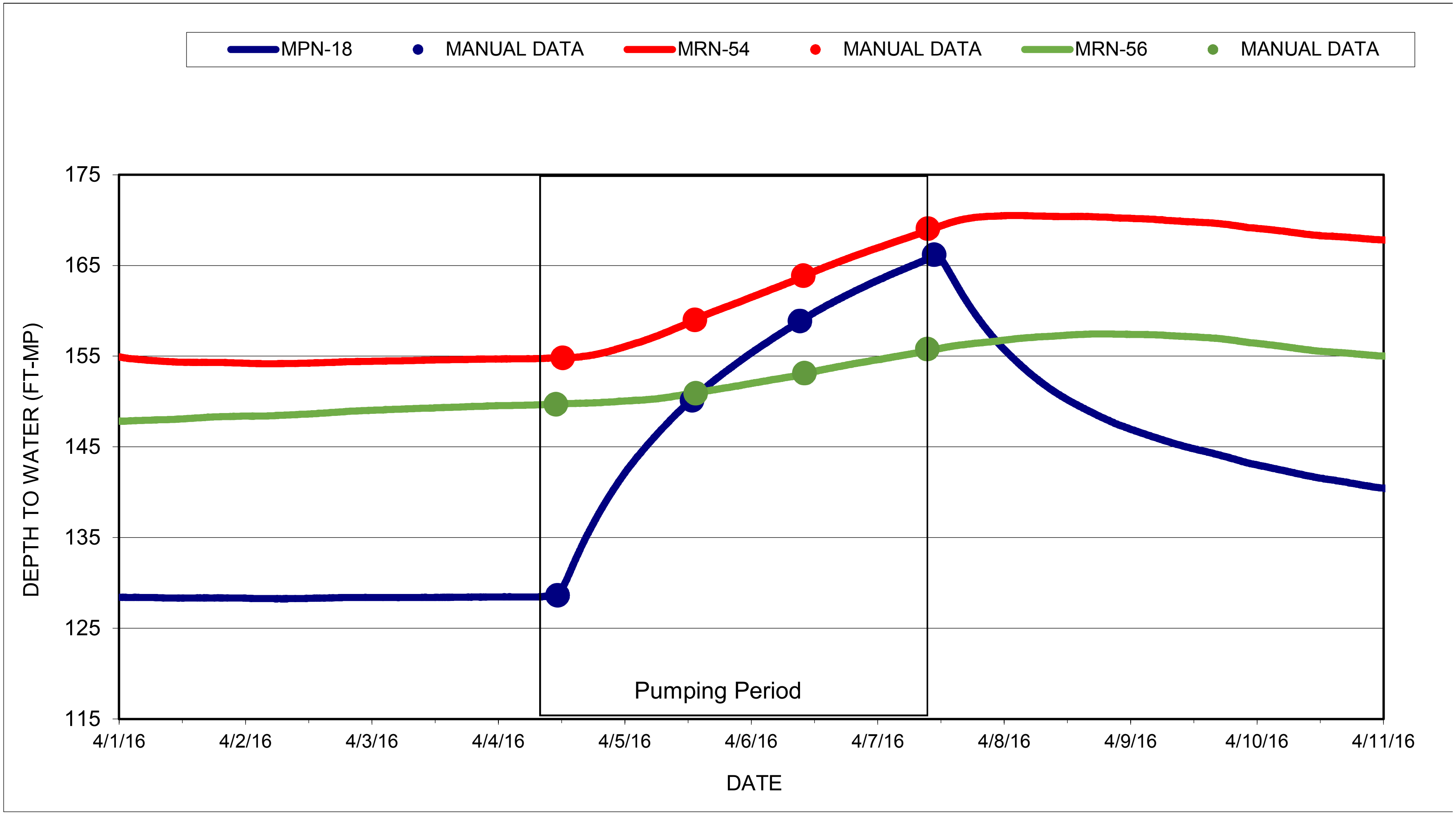


FIGURE 7-5. DEPTH TO WATER VERSUS TIME FOR OBSERVATION WELLS MPN-18, MRN-54 AND MRN-56

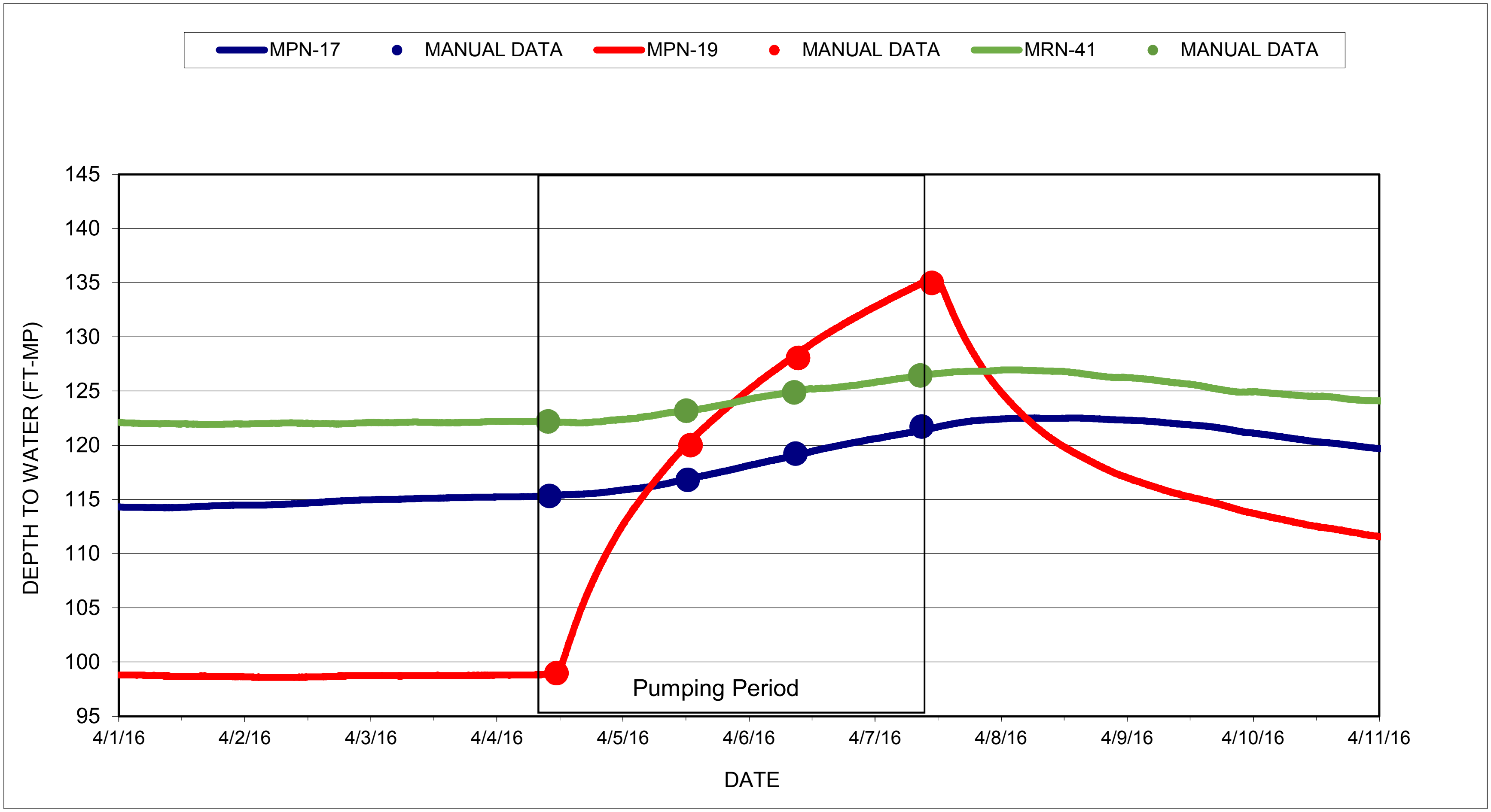


FIGURE 7-6. DEPTH TO WATER VERSUS TIME FOR OBSERVATION WELLS MPN-17, MPN-19 AND MRN-41

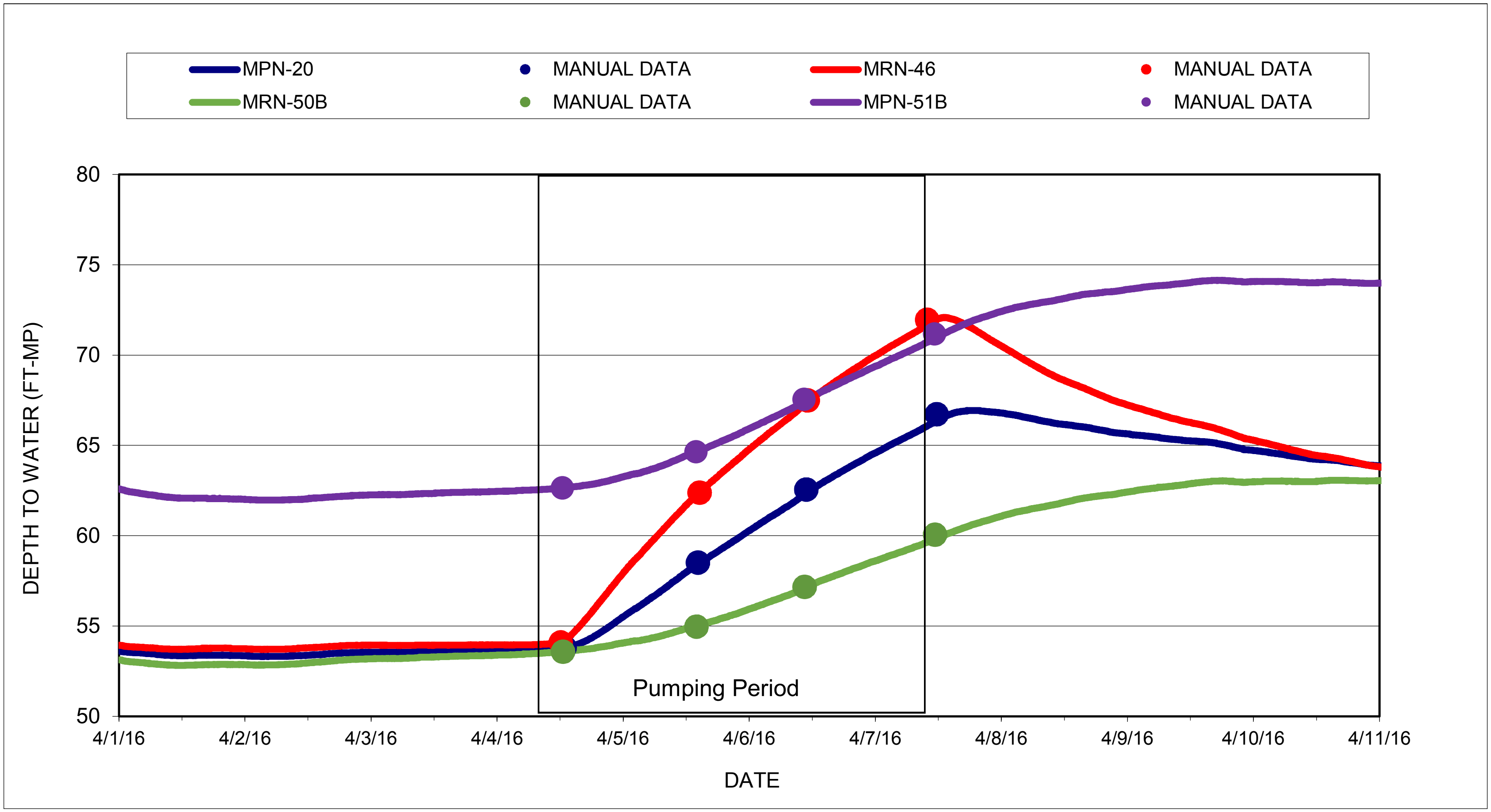


FIGURE 7-7. DEPTH TO WATER VERSUS TIME FOR OBSERVATION WELLS MPN-20, MRN-46, MRN-50B AND MRN-51B

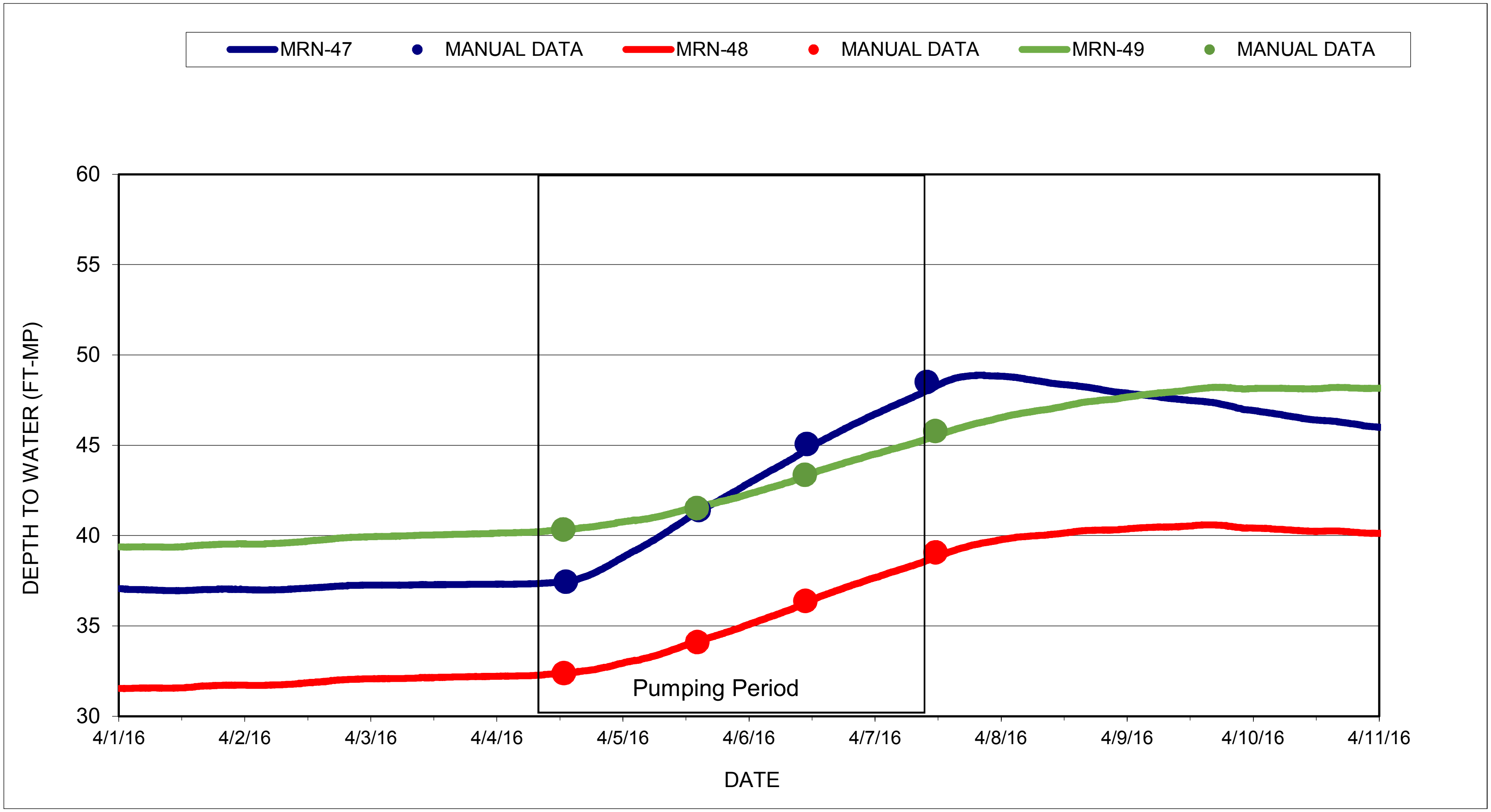


FIGURE 7-8. DEPTH TO WATER VERSUS TIME FOR OBSERVATION WELLS MRN-47, MRN-48 AND MRN-49

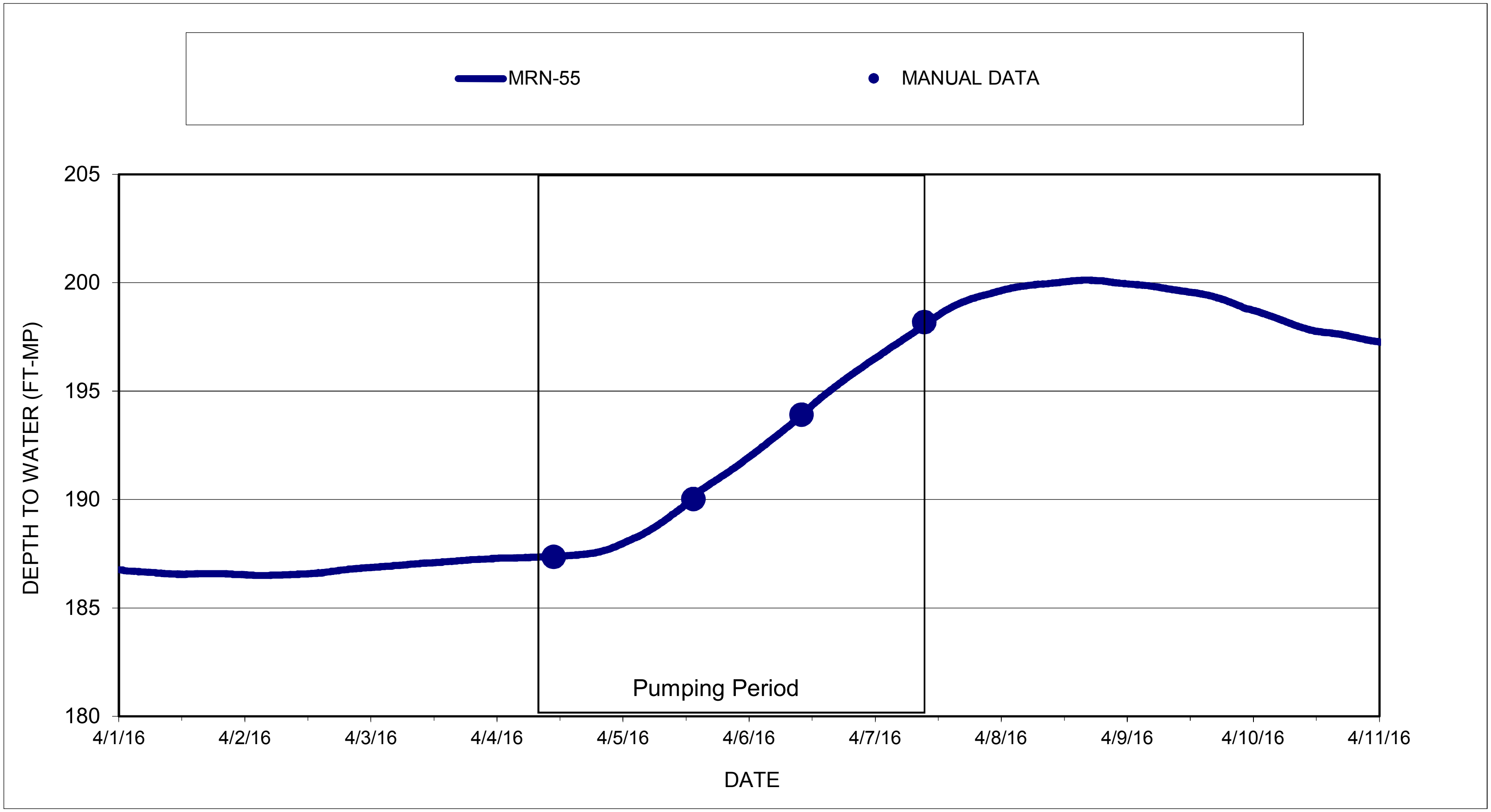


FIGURE 7-9. DEPTH TO WATER VERSUS TIME FOR OBSERVATION WELL MRN-55

8.0 ANAYTICAL METHODS AND TEST RESULTS – PRODUCTION ZONE FOR MRN-44 TEST

8.1 ANALYTICAL METHODS

Drawdown data collected from the monitor wells were graphically analyzed to determine transmissivity and storativity. The primary analysis method used was the Theis (1935) log-log method. The Cooper & Jacob (1946) straight-line method was used only for analysis of data from the pumping well MRN-44 and monitoring wells MPN-18, MPN-19, MRN-43 and MRN-45 due to the limitation on this method. Cooper & Jacob recommended the 'u' value to be <0.01 for usage of the straight line fit. Kruseman and de Rider (1991) suggest that a 'u' value of less than 0.1 is appropriate which can be seen from a plot of the Theis well function versus u on semi-log plot. With the use of the 'u' value less than 0.1 criterion, the straight line method is appropriate for four of the A Sand monitoring wells.

The test data were analyzed using the Theis method for all of the observation wells because the Jacob method is not appropriate for the majority of this test results. Ferris and others (1962) present the Theis and Jacob equations with calculation of transmissivity in units of gallon per foot per day as presented in this section. Theis type curves, which use the well function summation to account for the drawdown period, were used in matching the log-log plot of the drawdown data (see Section 10 for the theory used to adjust the type curves). The significant assumptions inherent in these two methods include:

- ► The aquifer is confined and has apparent infinite extent
- ► The aquifer is homogenous and isotropic, and of uniform thickness over the area influenced by pumping
- ► The piezometric surface is horizontal prior to pumping
- ► The well is pumped at a constant rate
- ► The pumping well is fully penetrating
- ► Well diameter is small, so well storage is negligible

These assumptions are reasonably satisfied. Obviously, the A Sand is not homogenous and isotropic; however, over the scale of the pump tests, it can be treated in this manner. Observation wells respond to the average conditions in the area and are reflective of large area for a long pumping period.

Leaky aquifer solutions such as Hantush (1960) were not applicable to the data from the A Sand. Likewise, because none of the monitor wells were completed within the confining units, a Neuman-Witherspoon (1972) analysis was not performed.

Water level stability data collected during the pre-test and post-test periods along with barometric pressure were used to assess the background trends. No significant recharge or trend corrections were warranted for any of the MRN-44 wells.

8.2 BACKGROUND TRENDS

Water-level stability data were collected prior to the start of the test. Plots of the background data for the pumping, MRN and MPN wells are shown in Figures 7-2 through 7-9. Water-level stability data collected during the pre-test and post-test periods along with barometric pressure were used to assess the background trends. No significant recharge or trend corrections were warranted for any of the MRN-44 pump test wells. The barometric change during the pumping phase of the test was approximately 0.3 inches of Hg (see Section 9 plots for barometric pressure data) which did not warrant any adjustments in the A Sand water levels for barometric changes.

8.3 TEST RESULTS

8.3.1 DRAWDOWN

The drawdown achieved during the test is shown on Figure 8-1. A drawdown of 196.6 feet was developed in pumping wells MRN-44 while maximum drawdowns in the A Sand monitoring wells from this pumping were 7.2 to 37.6 feet. The five foot drawdown contour extended to roughly 1800 feet from the pumping well. Drawdown contours extended further to the northeast of the pumping well and this was likely due to variation in PA #1 operation. Drawdown in A Sand well MRN-41 from both tests (MRN-37 and MRN-44), in addition to the supplemental pump test of MRN-58 (presented in section 11), demonstrates continuity between the multi-well tests.

Figure 8-2 presents the semi-log plot of the drawdown data for pumping well MRN-44. The straight line fit of this data produced a transmissivity of 257 gal/day/ft (34 ft^2/d). The pumping well recovery plot is presented in Figure 8-3 and the straight line fit yields a transmissivity of 255 gal/day/ft (34 ft^2/d).

Theis type curve matches and semi-log plots are presented in Figures 8-4 through 8-28 for the A Sand monitoring wells. Semi-log plots are presented for each of the A Sand wells while fits are presented for only the four wells where the Jacob straight line fit is appropriate. Theis type curve fits are presented for each of the A Sand observation wells and drawdown data shows good fits to the Theis type curve. The type curve fits do not indicate leaky aquifer or boundary conditions in this area of the A Sand.

The A Sand monitoring wells all showed adequate drawdown to prove communication between the Production Zone and the monitoring. Therefore adequate communication exists between the monitoring wells and the Production zone.

The tabulation of the water-level data for the test is included in Appendix D.

8.3.2 ANALYTICAL RESULTS

Transmissivity (T) results range from 27 to 67 ft^2/d (201 to 501 gpd/ft) from the Theis type curve matches. An average T value of 43 ft^2/d (325 gpd/ft) was obtained from the MRN-44 test. The Jacob results from wells were not used in calculating the average because the length of the test was not adequate to meet the requirement for the Jacob method except for the nearest four wells. The Theis method results from 18 A Sand observation wells were used in the calculation of the average. MRN-41 Theis method results were not used in the calculation of the average due to the results being outliers. Based on the effective thickness of the A Sand at pumping well MRN-44 of 93 feet, the average hydraulic conductivity (K) is 0.46 ft/d (1.6E-4 cm/s). Assuming a water temperature of 50 degrees F, this equates to a permeability of approximately 219 millidarcies (md). Storativity (S) values ranged from 4.1E-5 to 1.8E-4. The average S value for the test was 9.1E-5.

Recovery analysis of the pumping well data (MRN-44) results in a T value of 34 ft^2/d (255 gpd/ft).

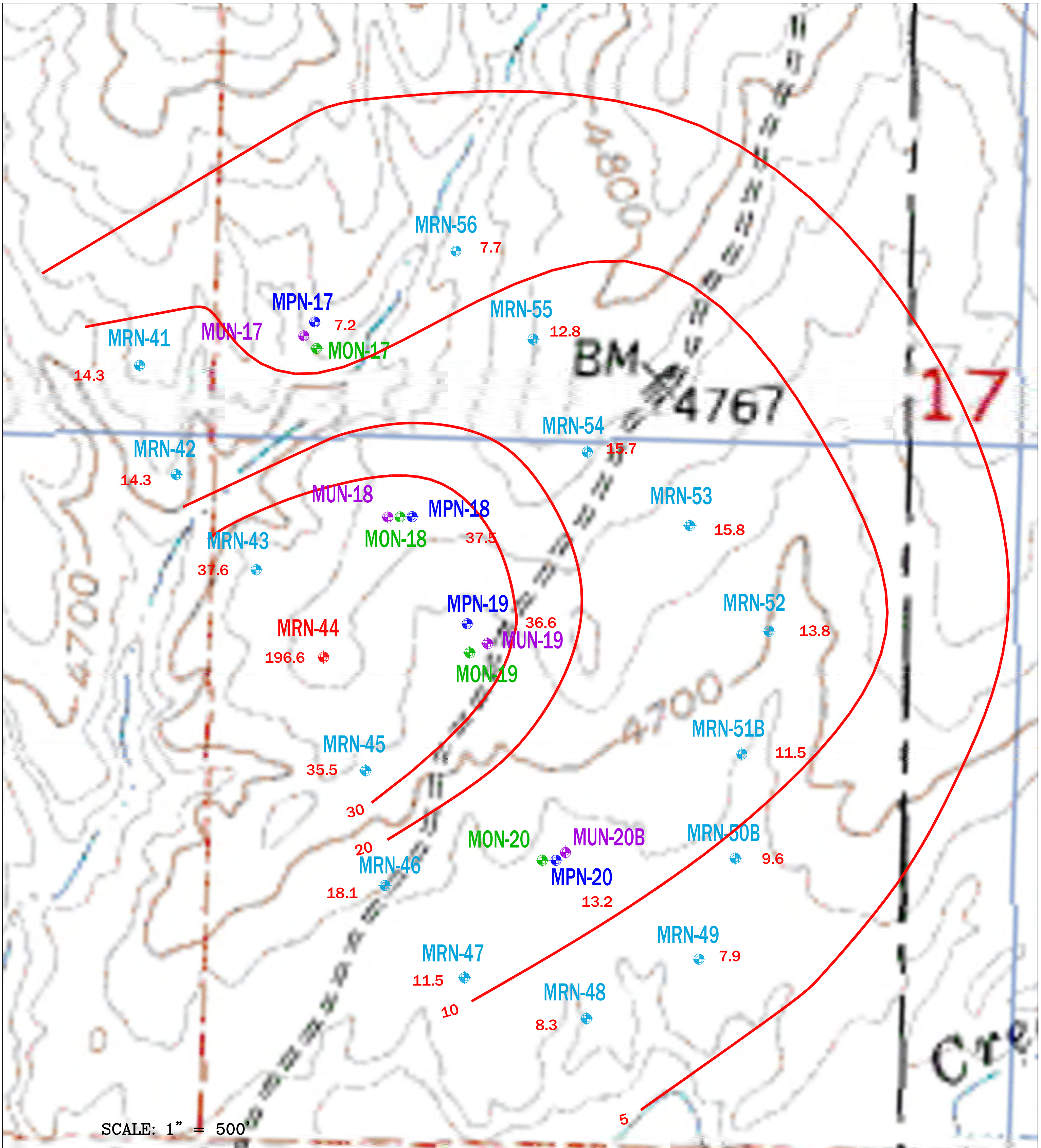
8.4 DIRECTIONAL TRANSMISSIVITY

Drawdowns at the end of the MRN-44 pump test are presented in Figure 8-1 and show a pattern that extends slightly farther to the northeast which is likely caused by PA #1 operation variation. The small variations in drawdowns do not indicate a consistent directional transmissivity. These variations in drawdowns would greatly affect the result of the directional transmissivities calculated from the Papadopulos (1965) method. The directional transmissivities in the fluvial sands in the Powder River Basin vary greatly due to the combination of wells used in calculating the directional transmissivities. These fluvial channels were not formed in a consistent direction over any area such as PA #2; therefore no calculations of the directional transmissivities were made from MRN-44 pump test.

Table 8-1.
SUMMARY OF AQUIFER PROPERTIES FOR THE MRN-44 TEST

Well	Distance from Pumping Well	THEIS			COOPER & JACOB		
		Transmissivity		Storage Coefficient	Transmissivity		Storage Coefficient
	(ft)	*(gpd/ft)*	*(ft^2/day)*		*(gpd/ft)*	*(ft^2/day)*	
MRN-44	-	-	-	-	257	34	-
MRN-44 (REC)	-	-	-	-	255	34	-
MPN-17	1284	401	54	1.8E-04	-	-	-
MPN-18	636	267	36	5.3E-05	266	36	5.1E-05
MPN-19	567	281	38	6.7E-05	282	38	6.3E-05
MPN-20	1191	357	48	9.3E-05	-	-	-
MRN-41	1322	729	97	2.3E-04	-	-	-
MRN-42	899	349	47	1.4E-04	-	-	-
MRN-43	423	267	36	1.1E-04	314	42	1.1E-04
MRN-45	464	321	43	8.9E-05	287	38	9.6E-05
MRN-46	906	349	47	9.5E-05	-	-	-
MRN-47	1341	349	47	9.0E-05	-	-	-
MRN-48	1713	401	54	9.6E-05	-	-	-
MRN-49	1847	501	67	1.0E-04	-	-	-
MRN-50B	1757	334	45	9.6E-05	-	-	-
MRN-51B	1645	287	38	7.9E-05	-	-	-
MRN-52	1710	251	34	6.4E-05	-	-	-
MRN-53	1896	201	27	4.1E-05	-	-	-
MRN-54	1281	229	31	6.0E-05	-	-	-
MRN-55	1459	309	41	7.8E-05			
MRN-56	1637	401	54	1.1E-04	-	-	-
	AVERAGE:	**325**	**43**	**9.1E-05**			

Note: MRN-41 values not used in average calculation



REVISIONS No.	DATE	MADE BY	DESCRIPTION
1			
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4685 EAST MAGNOLIA
CASPER, WYOMING, 82604

FILE: C:\PROJECTS\2016-14\nrwellfield

ENERGY FUELS

Uranerz Energy Corporation
(an Energy Fuels Company)
1701 East "E" Street
P.O. Box 50850
Casper, Wyoming
USA 82605-0850

Figure 8-1
Maximum Drawdown in the A Sand
For the MRN-44 Pump Test

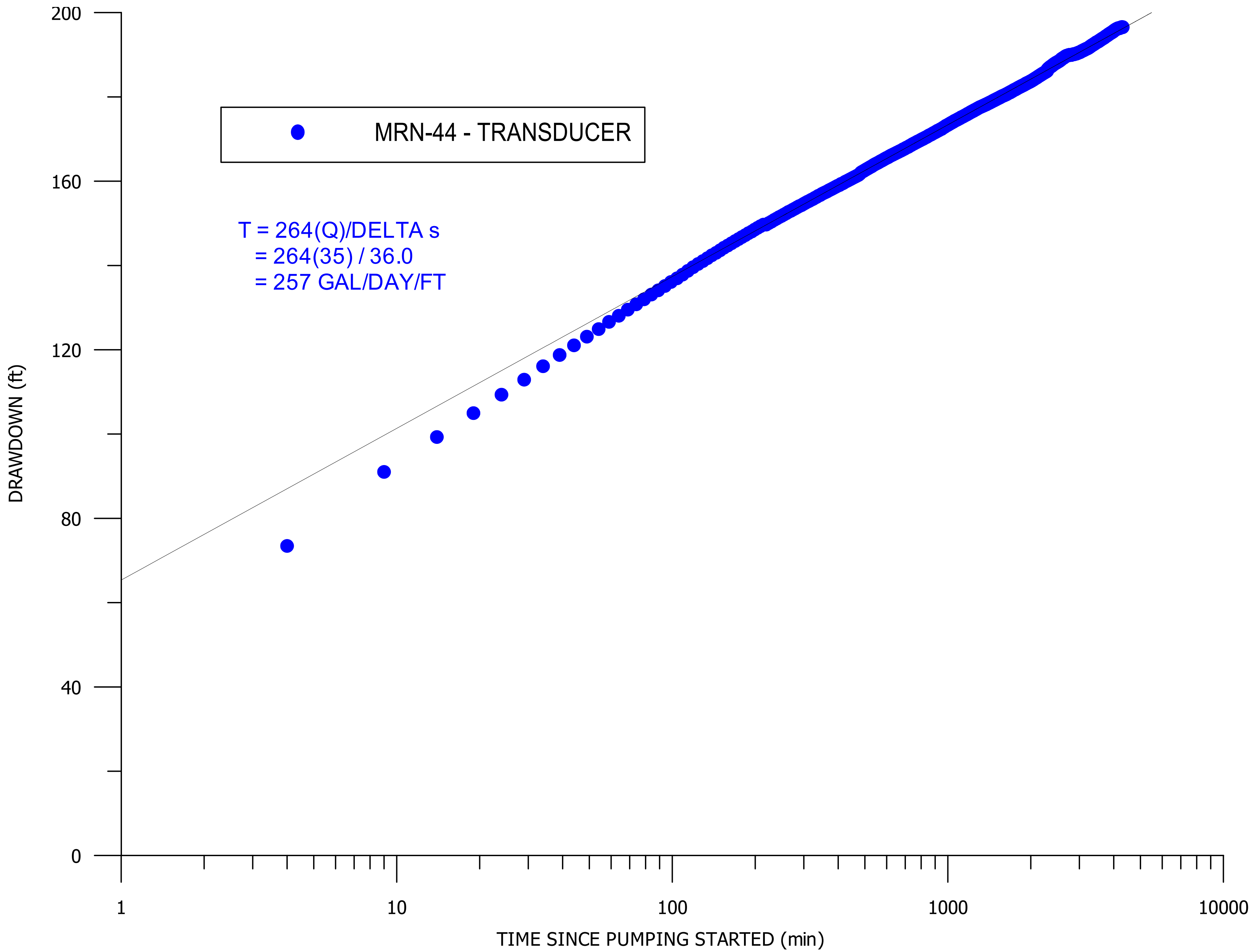


FIGURE 8-2. DRAWDOWN IN PUMPING WELL MRN-44

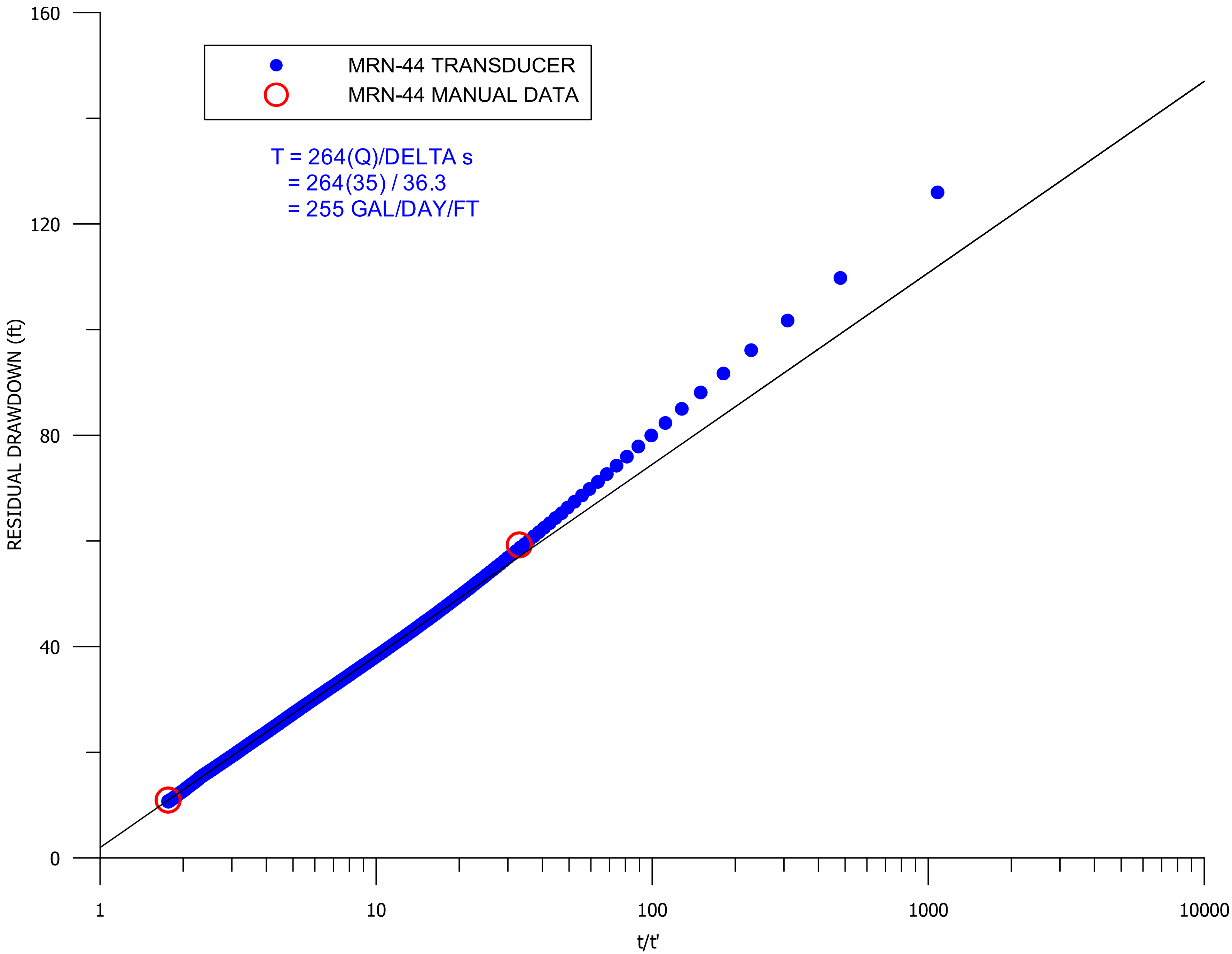


FIGURE 8-3. RECOVERY IN PUMPING WELL MRN-44

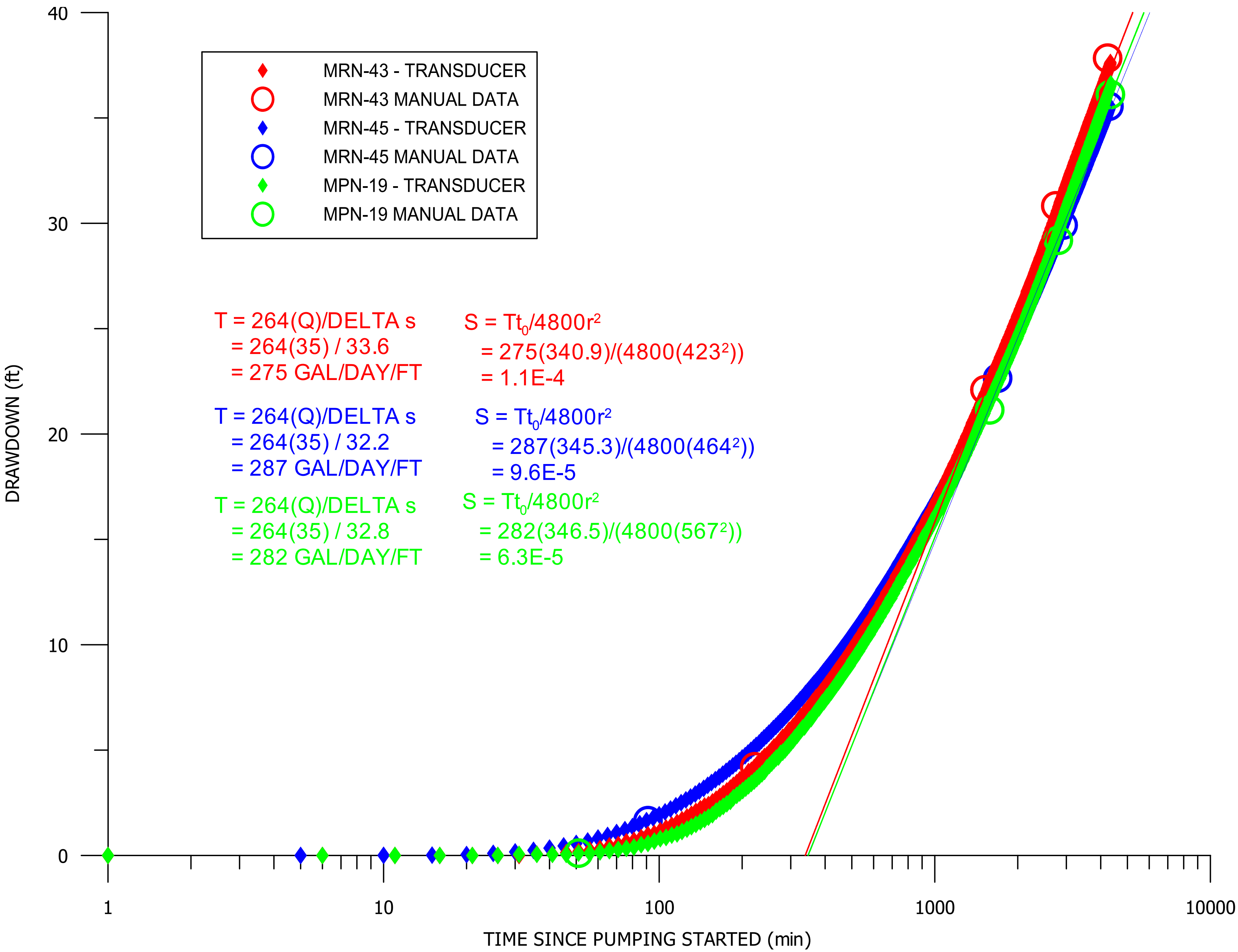
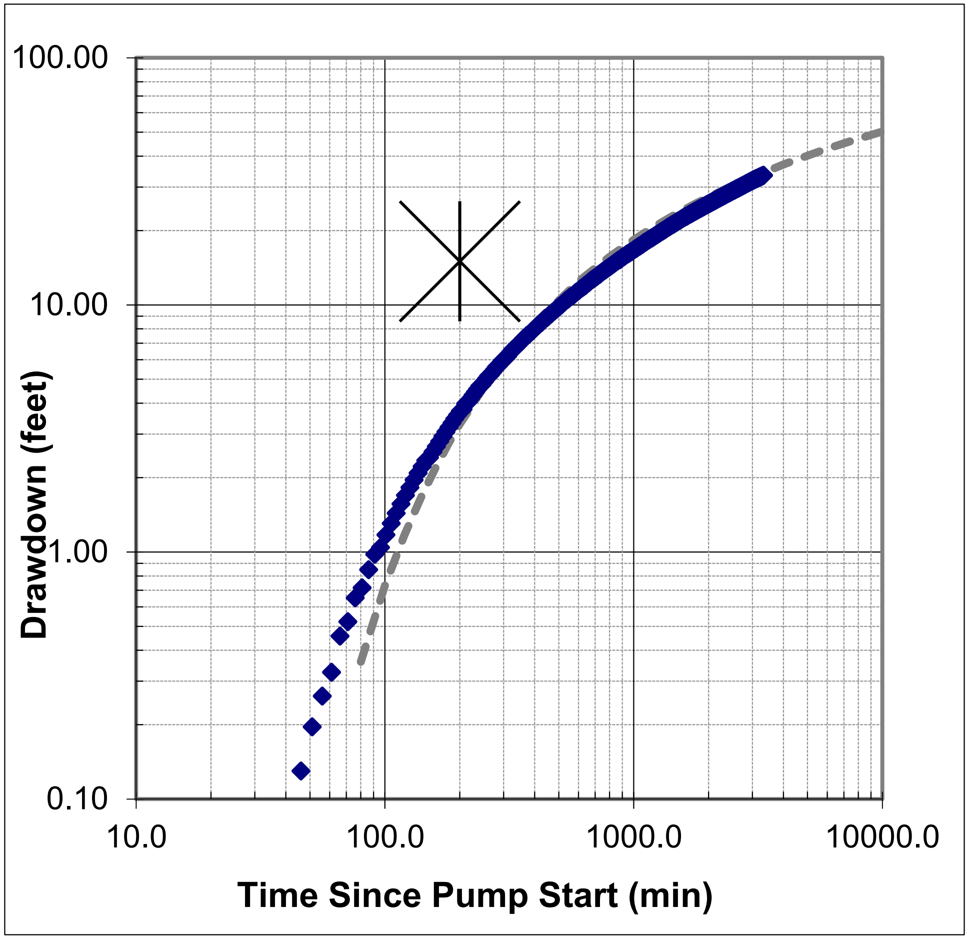


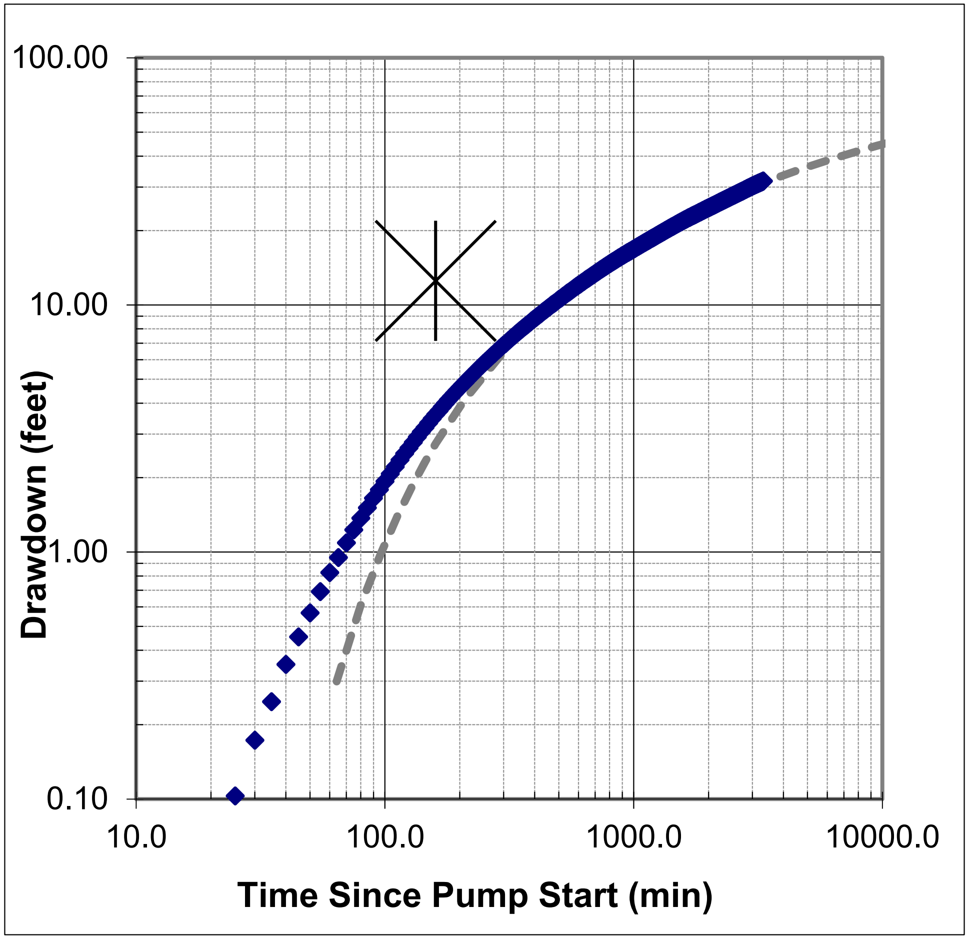
FIGURE 8-4. DRAWDOWN IN OBSERVATION WELLS MRN-43, MRN-45 AND MPN-19



<u>Theis Match Point</u>

Discharge (gpm)	35
Radius to Pumping Well (ft) (<1 indicates pumping well)	423
Drawdown Match Point (ft)	15.00
Time Match Point (min)	200.0000
Calculated Transmissivity (gal/day/ft)	267
Calculated Storage Coefficient (ft/ft)	1.1E-04

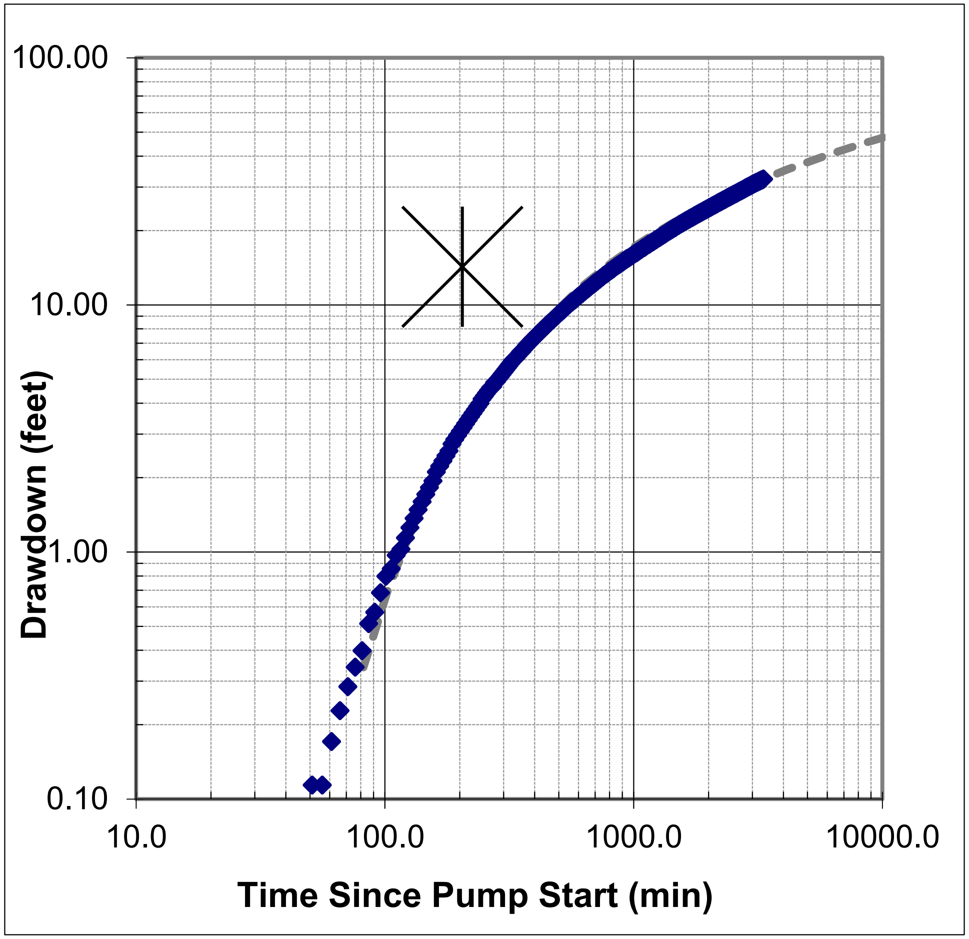
Figure 8-5 Theis Analysis for Observation Well MRN-43



Theis Match Point

Discharge (gpm)	35
Radius to Pumping Well (ft) (<1 indicates pumping well)	464
Drawdown Match Point (ft)	12.50
Time Match Point (min)	160.0000
Calculated Transmissivity (gal/day/ft)	321
Calculated Storage Coefficient (ft/ft)	8.9E-05

Figure 8-6 Theis Analysis for Observation Well MRN-45



Theis Match Point

Intitial Discharge (gpm)	35
Radius to Pumping Well (ft) (<1 indicates pumping well)	567
Drawdown Match Point (ft)	14.25
Time Match Point (min)	205.0000
Calculated Transmissivity (gal/day/ft)	281
Calculated Storage Coefficient (ft/ft)	6.7E-05

Figure 8-7 Theis Analysis for Observation Well MPN-19

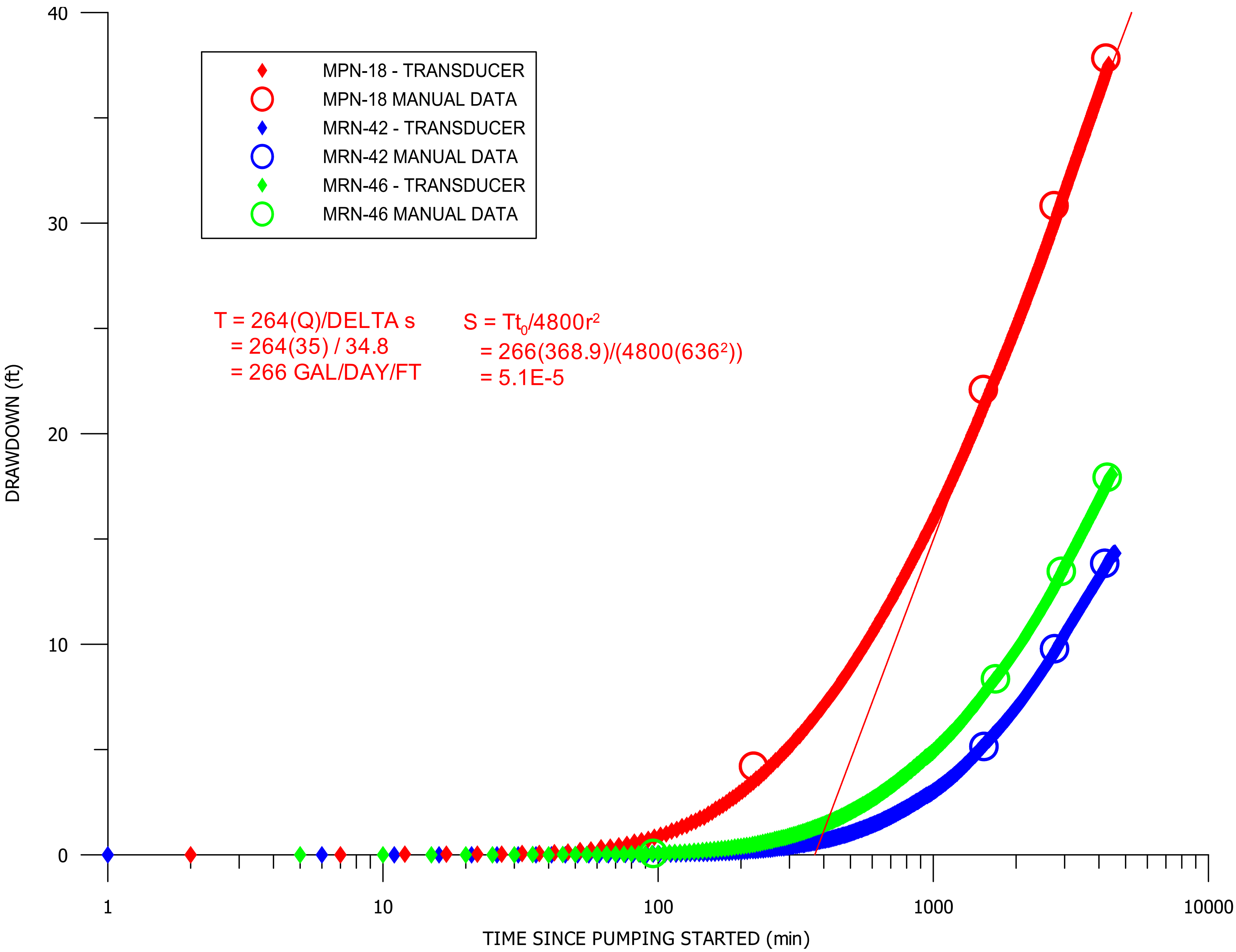
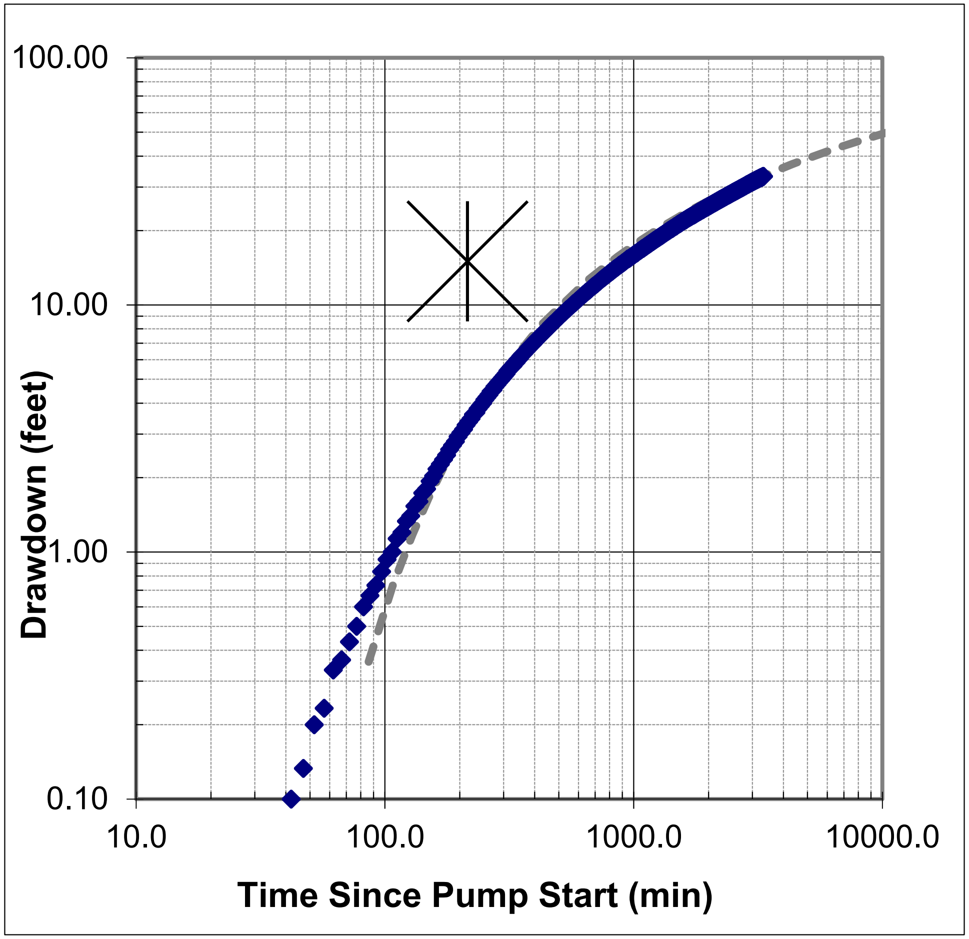


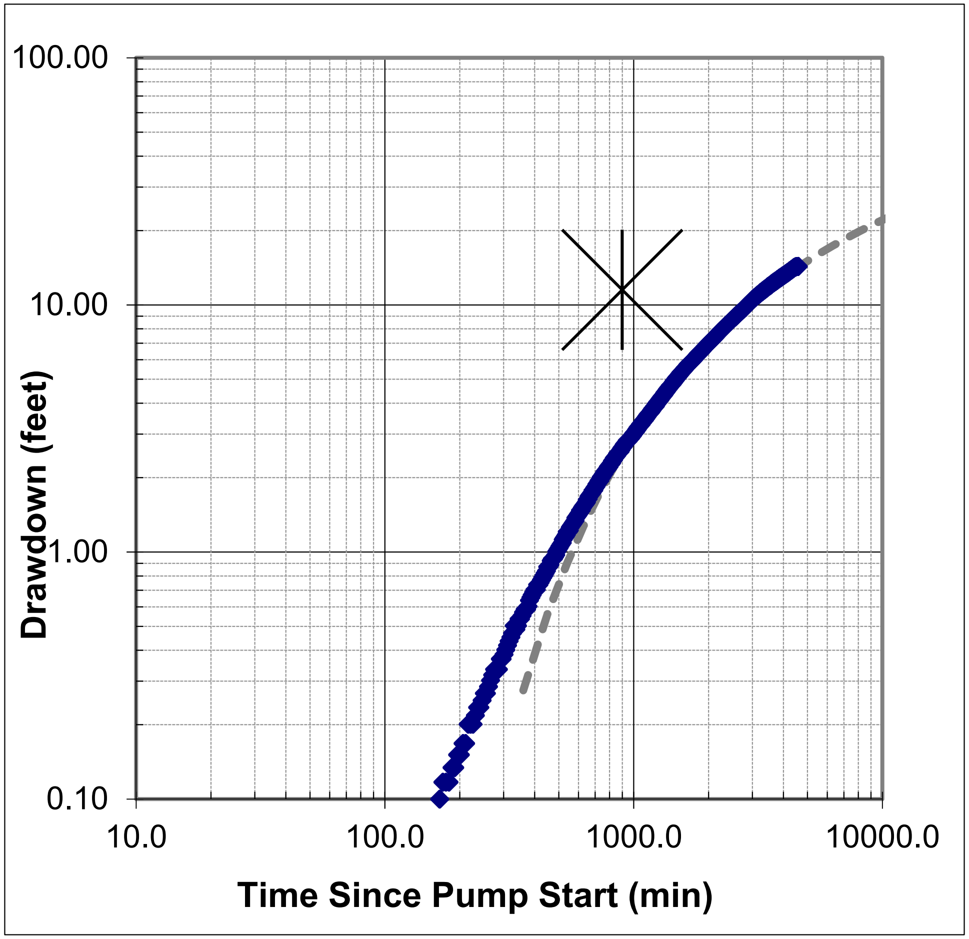
FIGURE 8-8. DRAWDOWN IN OBSERVATION WELLS MPN-18, MRN-42 AND MRN-46



<u>Theis Match Point</u>

Discharge (gpm)	35
Radius to Pumping Well (ft) (<1 indicates pumping well)	636
Drawdown Match Point (ft)	15.00
Time Match Point (min)	215.0000
Calculated Transmissivity (gal/day/ft)	267
Calculated Storage Coefficient (ft/ft)	5.3E-05

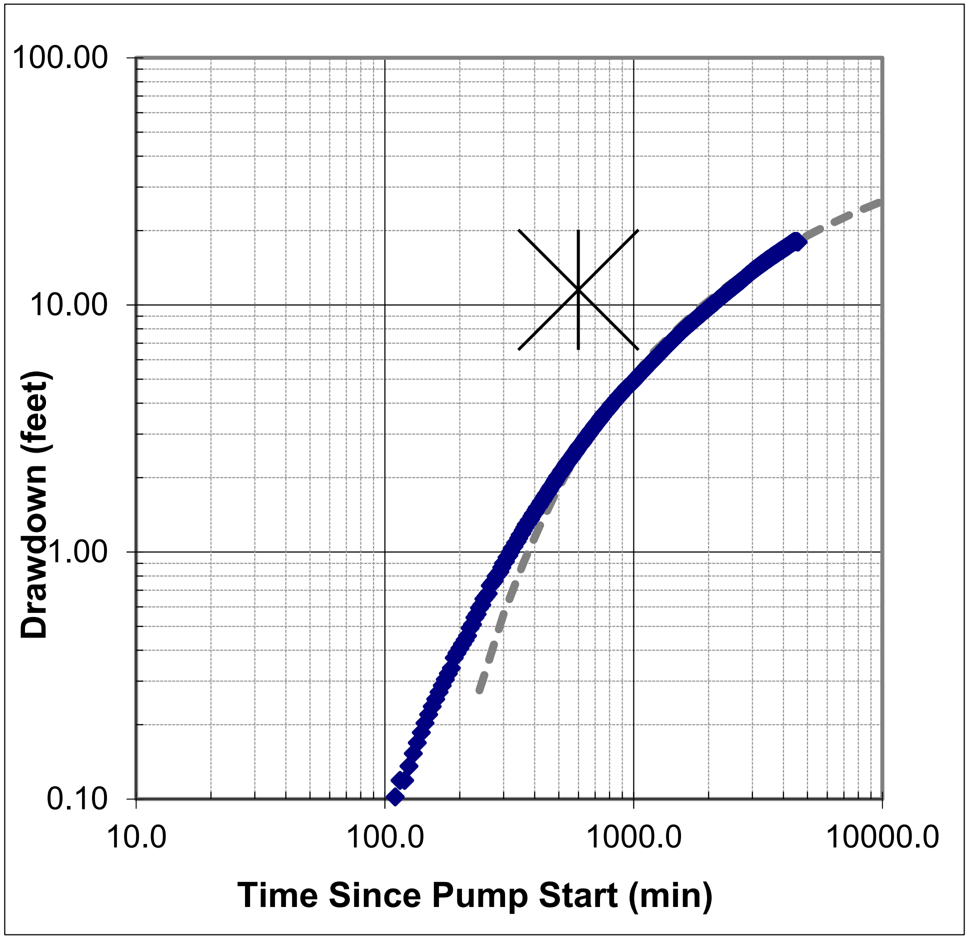
Figure 8-9 Theis Analysis for Observation Well MPN-18



Theis Match Point

Discharge (gpm)	35
Radius to Pumping Well (ft) (<1 indicates pumping well)	899
Drawdown Match Point (ft)	11.50
Time Match Point (min)	900.0000
Calculated Transmissivity (gal/day/ft)	349
Calculated Storage Coefficient (ft/ft)	1.4E-04

Figure 8-10 Theis Analysis for Observation Well MRN-42



Theis Match Point

Discharge (gpm)	35
Radius to Pumping Well (ft) (<1 indicates pumping well)	906
Drawdown Match Point (ft)	11.50
Time Match Point (min)	600.0000
Calculated Transmissivity (gal/day/ft)	349
Calculated Storage Coefficient (ft/ft)	9.5E-05

Figure 8-11 Theis Analysis for Observation Well MRN-46

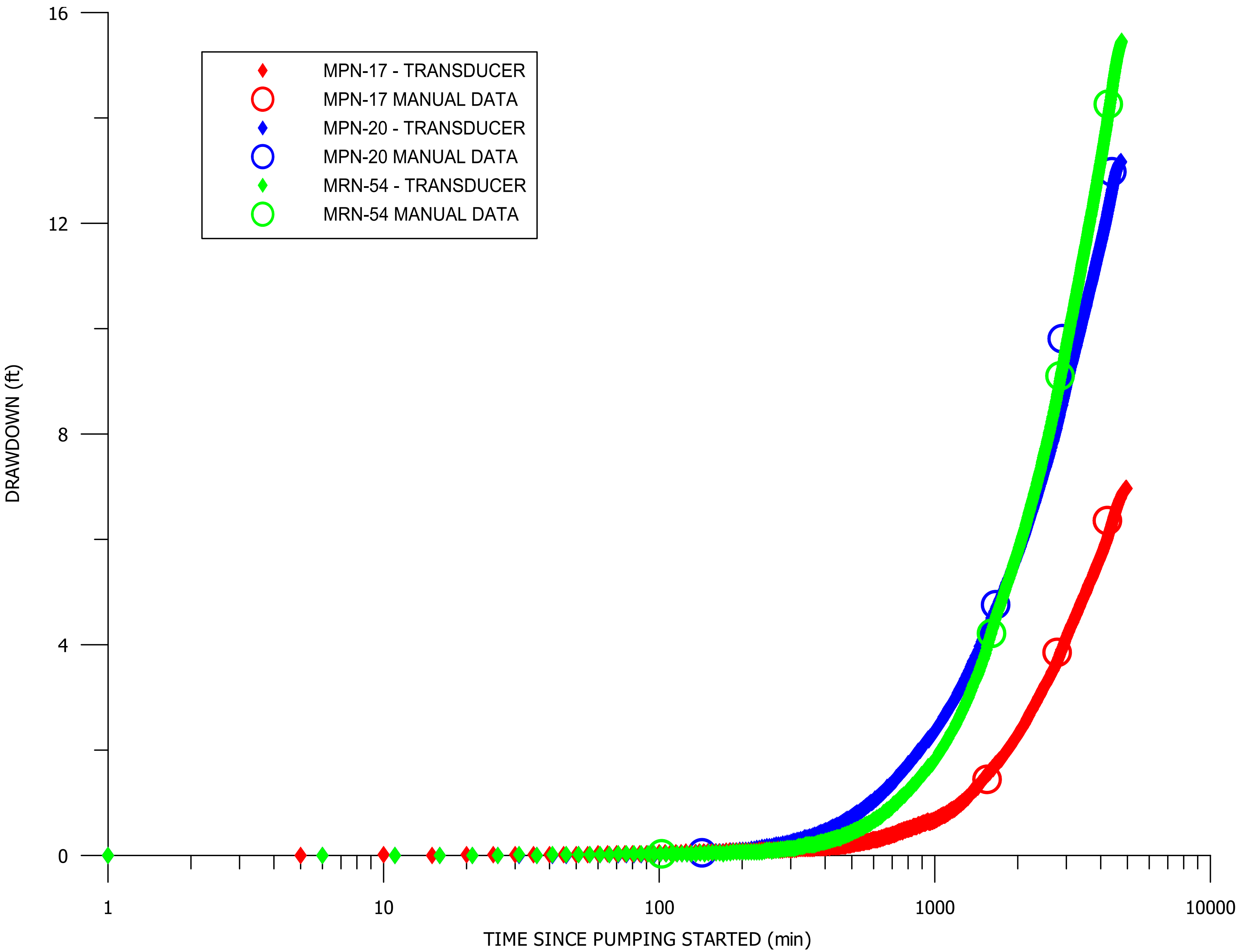
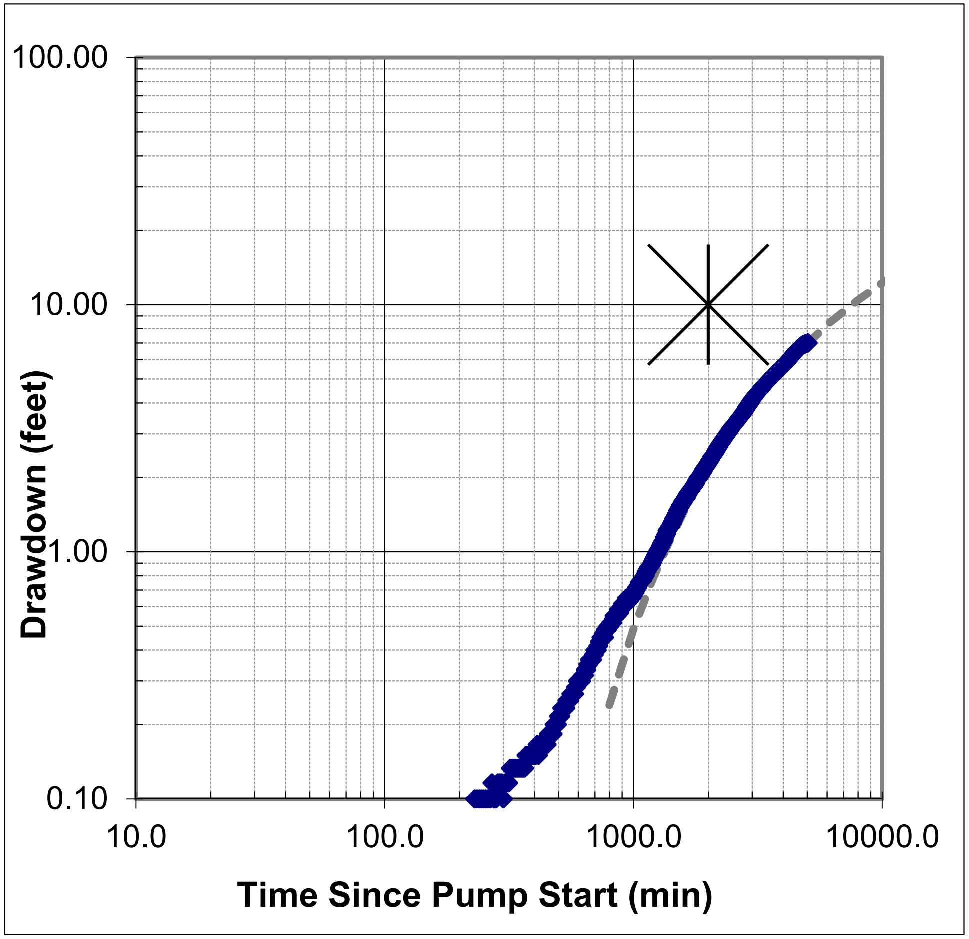


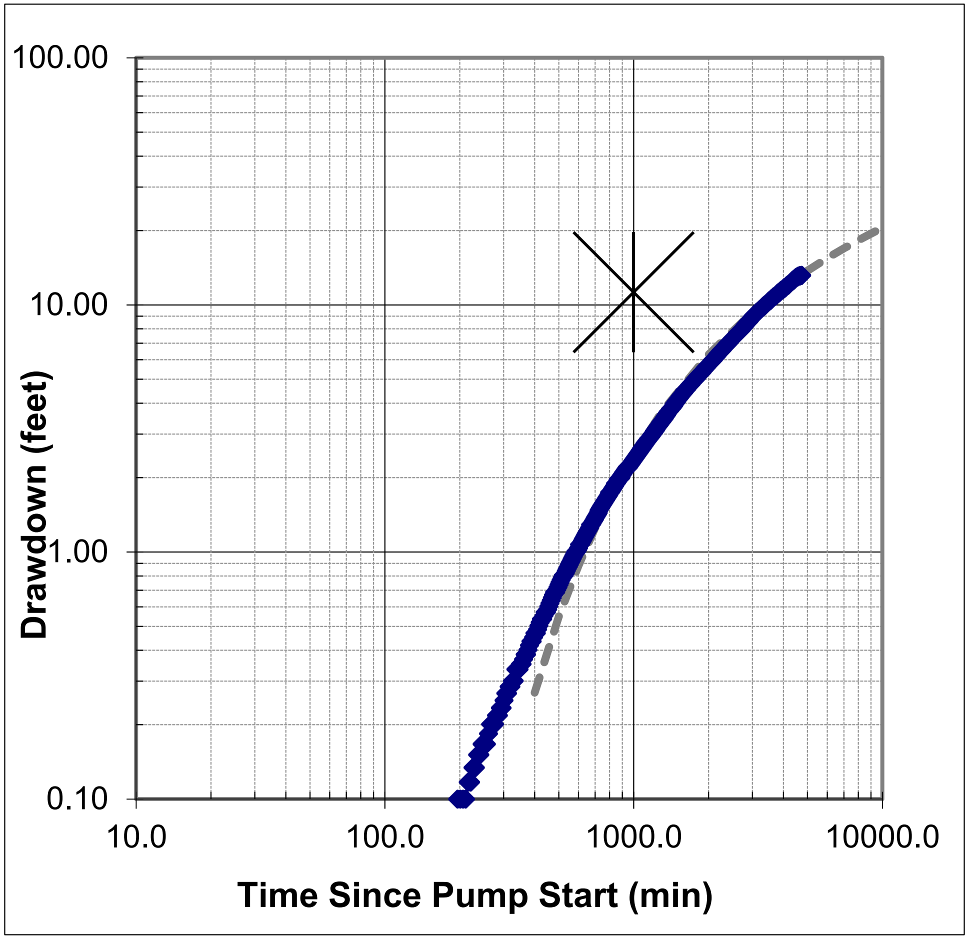
FIGURE 8-12. DRAWDOWN IN OBSERVATION WELLS MPN-17, MPN-20 AND MRN-54



<u>Theis Match Point</u>

Discharge (gpm)	35
Radius to Pumping Well (ft) (<1 indicates pumping well)	1284
Drawdown Match Point (ft)	10.00
Time Match Point (min)	2000.0000
Calculated Transmissivity (gal/day/ft)	401
Calculated Storage Coefficient (ft/ft)	1.8E-04

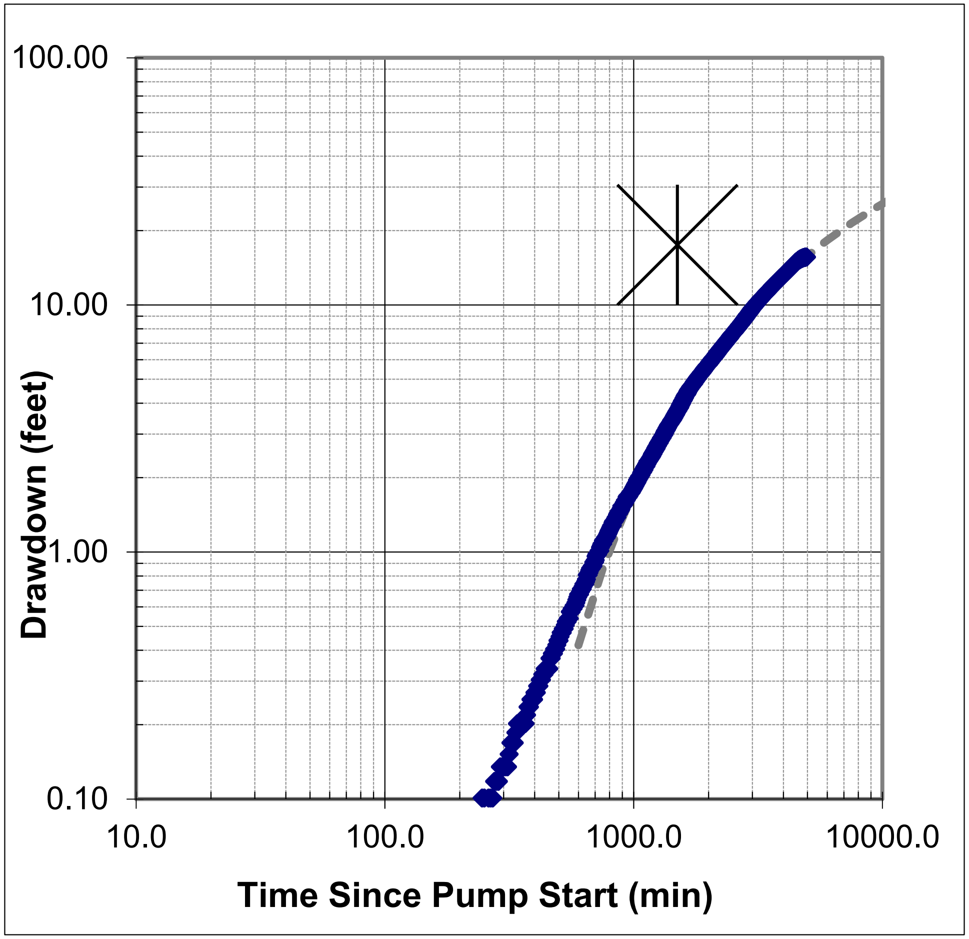
Figure 8-13 Theis Analysis for Observation Well MPN-17



<u>Theis Match Point</u>

Discharge (gpm)	35
Radius to Pumping Well (ft) (<1 indicates pumping well)	1191
Drawdown Match Point (ft)	11.25
Time Match Point (min)	1000.0000
Calculated Transmissivity (gal/day/ft)	357
Calculated Storage Coefficient (ft/ft)	9.3E-05

Figure 8-14 Theis Analysis for Observation Well MPN-20



Theis Match Point

Discharge (gpm)	35
Radius to Pumping Well (ft) (<1 indicates pumping well)	1459
Drawdown Match Point (ft)	17.50
Time Match Point (min)	1500.0000
Calculated Transmissivity (gal/day/ft)	229
Calculated Storage Coefficient (ft/ft)	6.0E-05

Figure 8-15 Theis Analysis for Observation Well MRN-54

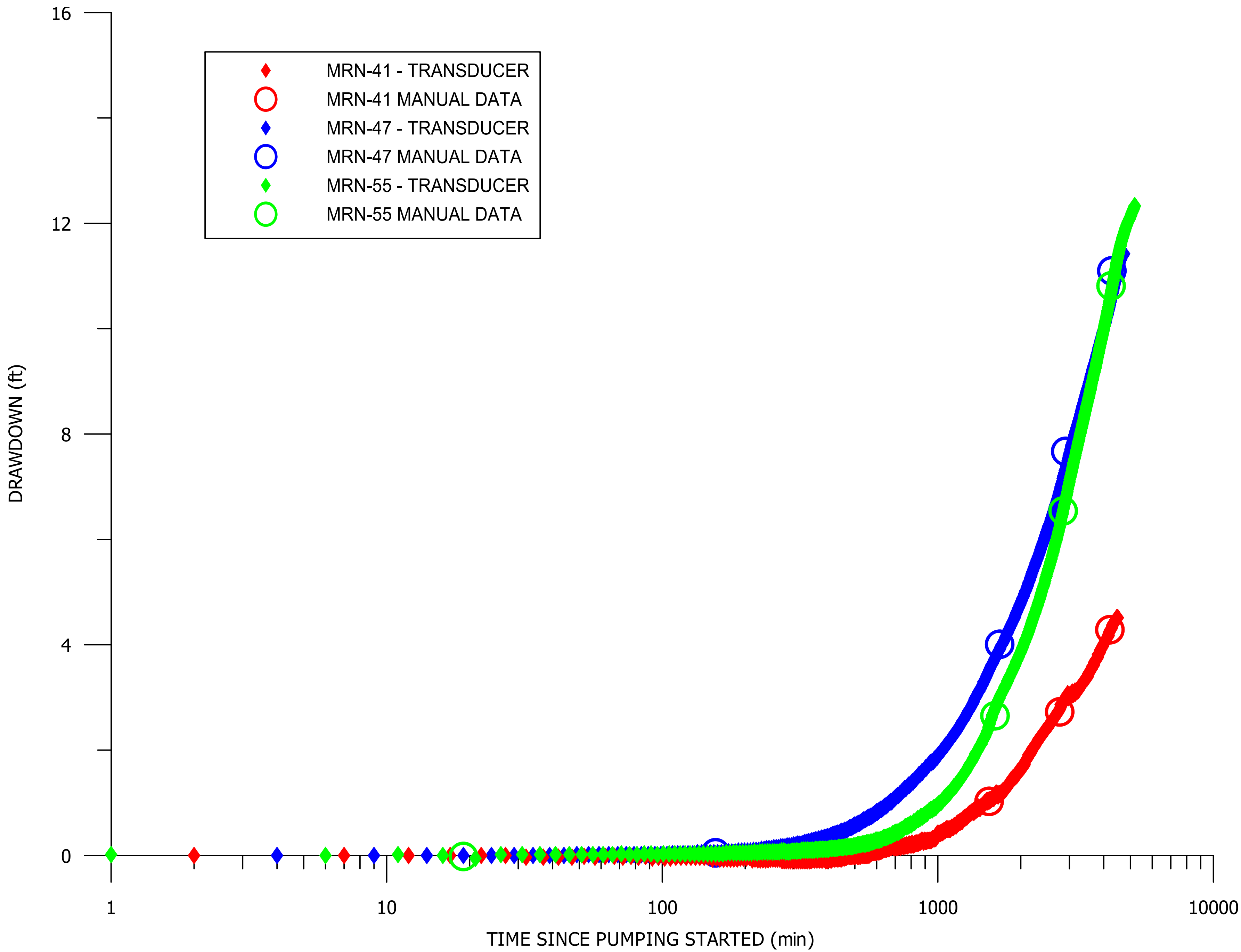
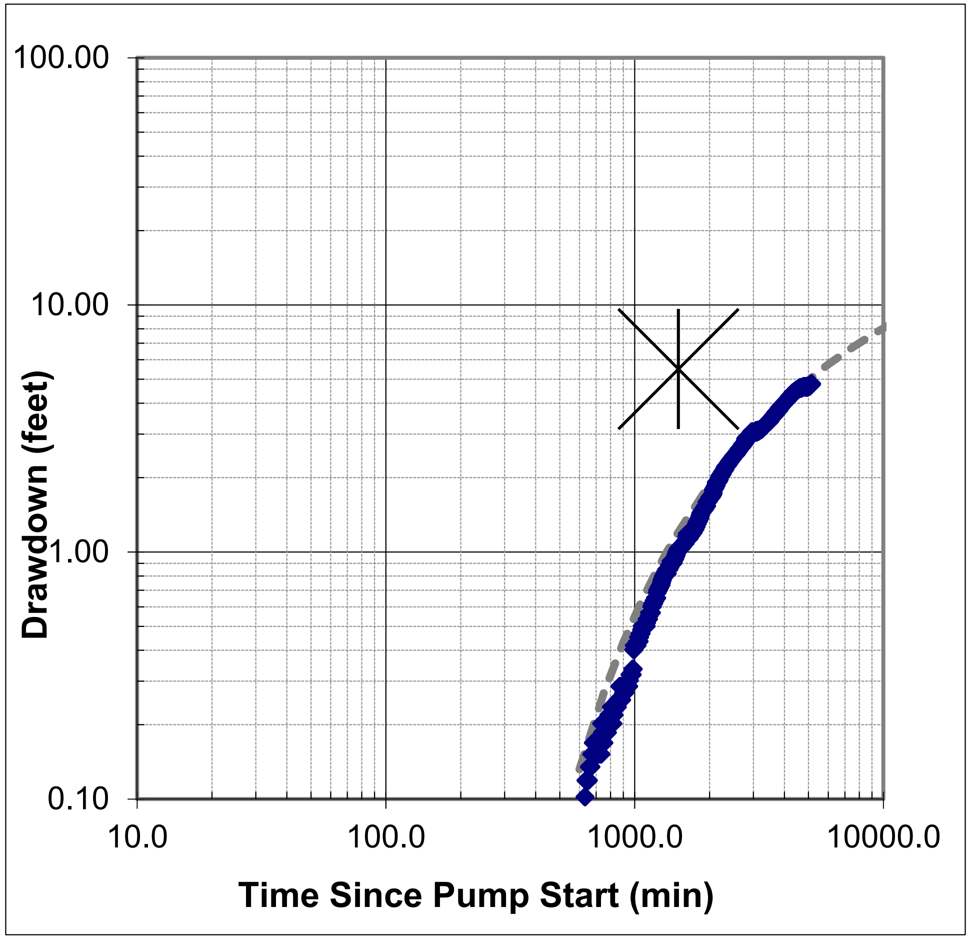


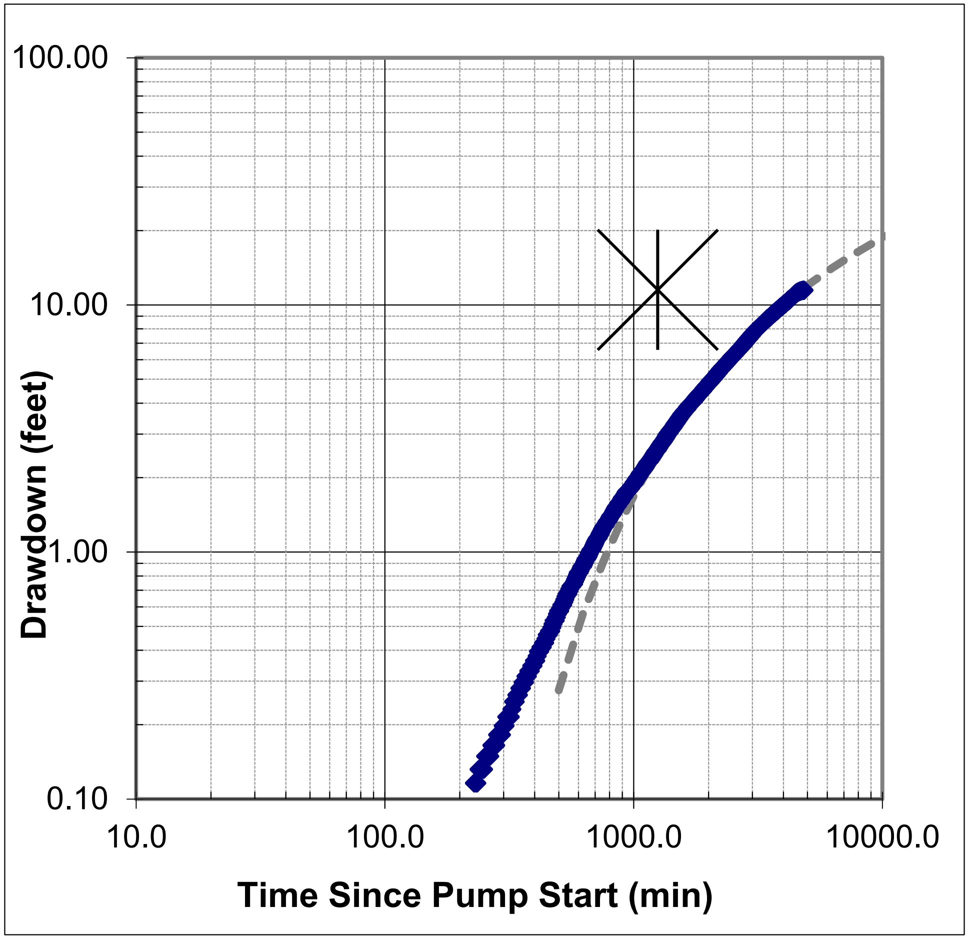
FIGURE 8-16. DRAWDOWN IN OBSERVATION WELLS MRN-41, MRN-47 AND MRN-55



Theis Match Point

Discharge (gpm)	35
Radius to Pumping Well (ft) (<1 indicates pumping well)	1322
Drawdown Match Point (ft)	5.50
Time Match Point (min)	1500.0000
Calculated Transmissivity (gal/day/ft)	729
Calculated Storage Coefficient (ft/ft)	2.3E-04

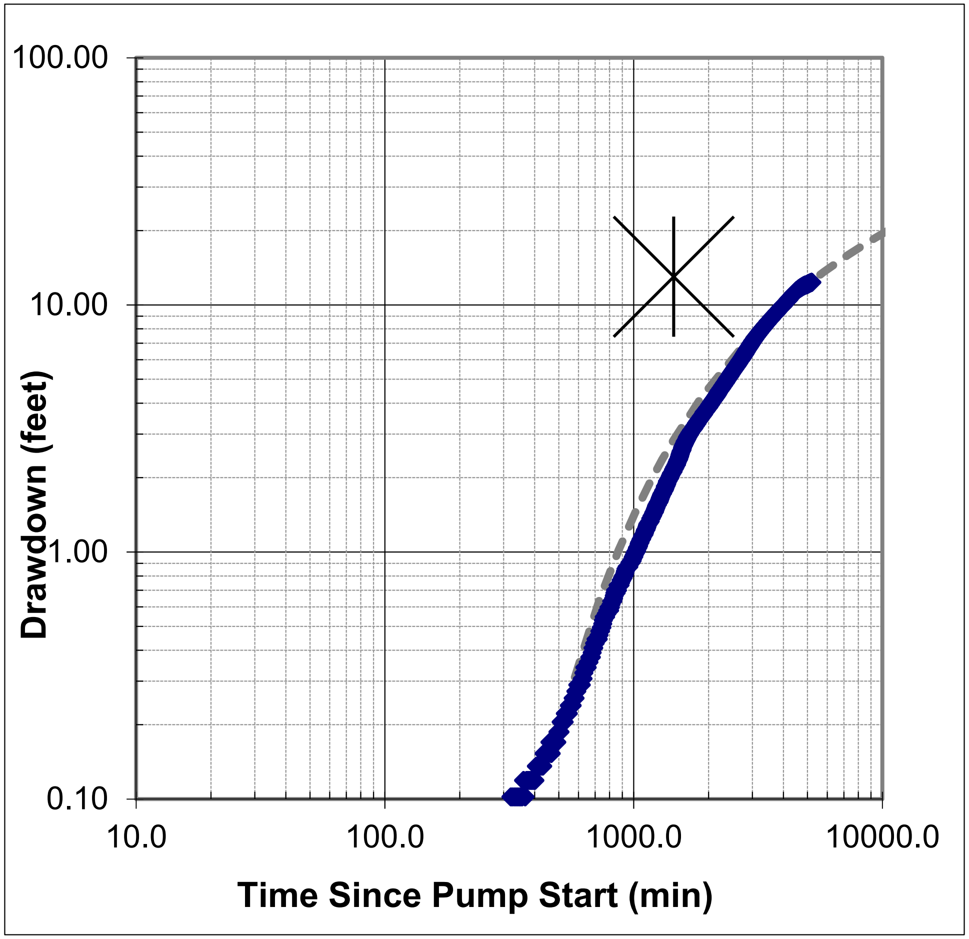
Figure 8-17 Theis Analysis for Observation Well MRN-41



<u>Theis Match Point</u>

Discharge (gpm)	35
Radius to Pumping Well (ft) (<1 indicates pumping well)	1341
Drawdown Match Point (ft)	11.50
Time Match Point (min)	1250.0000
Calculated Transmissivity (gal/day/ft)	349
Calculated Storage Coefficient (ft/ft)	9.0E-05

Figure 8-18 Theis Analysis for Observation Well MRN-47



<u>Theis Match Point</u>

Discharge (gpm)	35
Radius to Pumping Well (ft) (<1 indicates pumping well)	1459
Drawdown Match Point (ft)	13.00
Time Match Point (min)	1450.0000
Calculated Transmissivity (gal/day/ft)	309
Calculated Storage Coefficient (ft/ft)	7.8E-05

Figure 8-19 Theis Analysis for Observation Well MRN-55

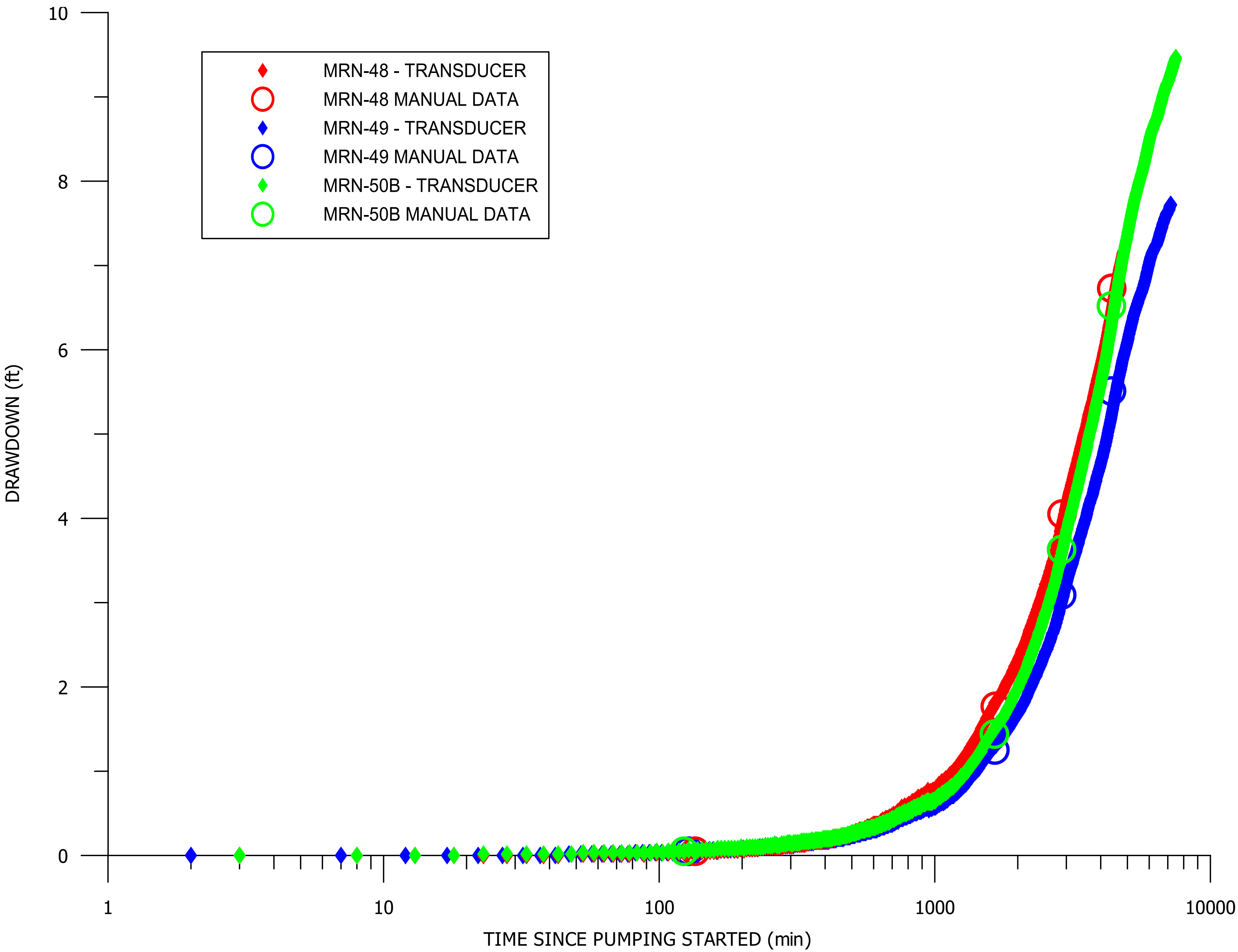
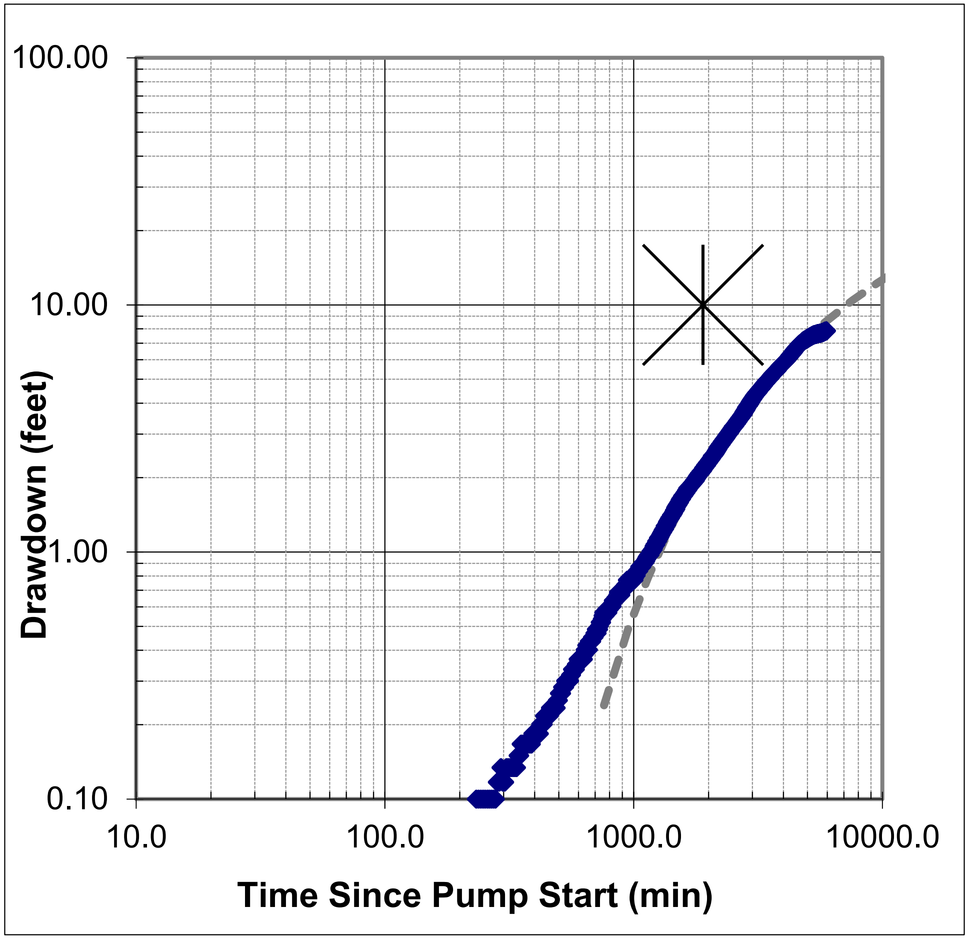


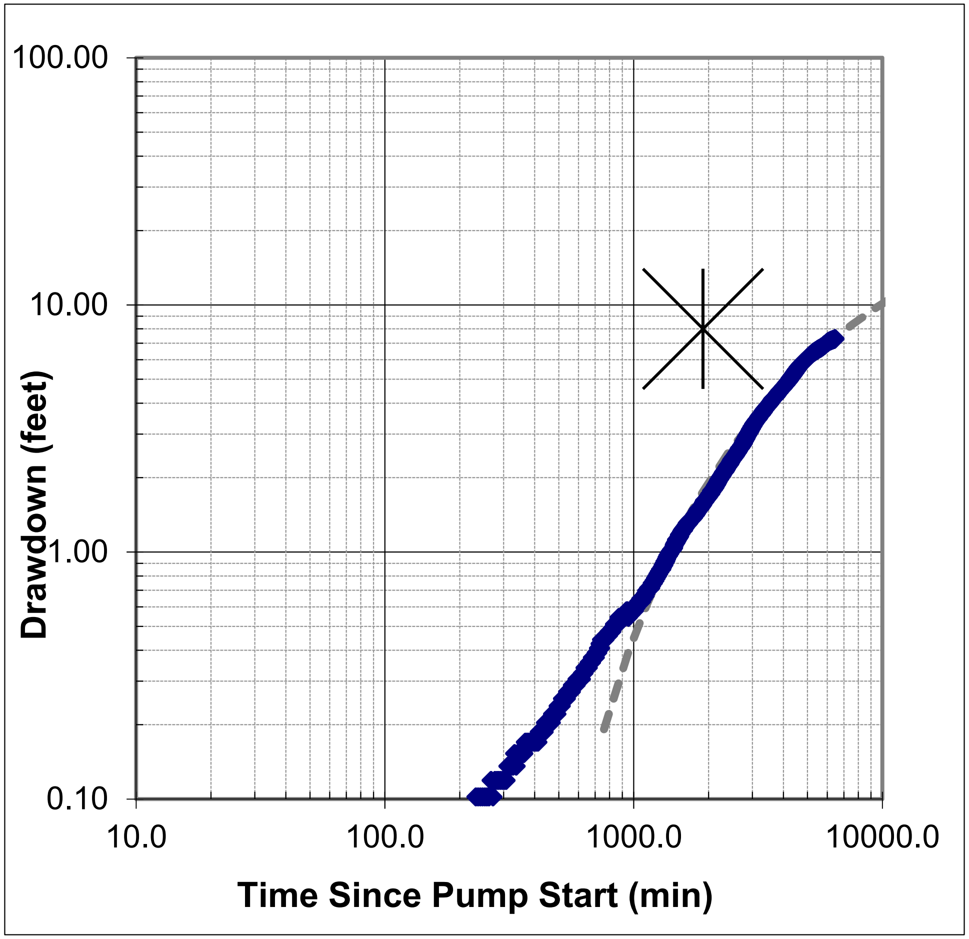
FIGURE 8-20. DRAWDOWN IN OBSERVATION WELLS MRN-48, MRN-49 AND MRN-50B



<u>Theis Match Point</u>

Discharge (gpm)	35
Radius to Pumping Well (ft) (<1 indicates pumping well)	1713
Drawdown Match Point (ft)	10.00
Time Match Point (min)	1900.0000
Calculated Transmissivity (gal/day/ft)	401
Calculated Storage Coefficient (ft/ft)	9.6E-05

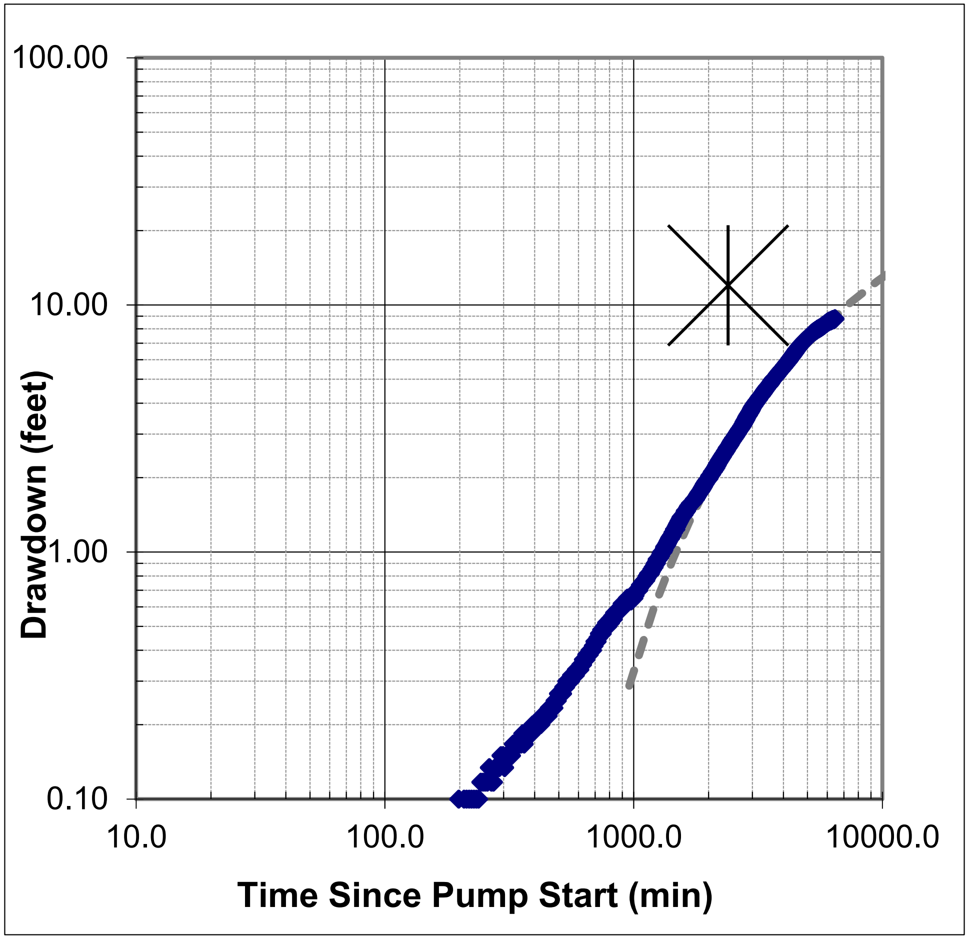
Figure 8-21 Theis Analysis for Observation Well MRN-48



Theis Match Point

Discharge (gpm)	35
Radius to Pumping Well (ft) (<1 indicates pumping well)	1847
Drawdown Match Point (ft)	8.00
Time Match Point (min)	1900.0000
Calculated Transmissivity (gal/day/ft)	501
Calculated Storage Coefficient (ft/ft)	1.0E-04

Figure 8-22 Theis Analysis for Observation Well MRN-49



Theis Match Point

Discharge (gpm)	35
Radius to Pumping Well (ft) (<1 indicates pumping well)	1757
Drawdown Match Point (ft)	12.00
Time Match Point (min)	2400.0000
Calculated Transmissivity (gal/day/ft)	334
Calculated Storage Coefficient (ft/ft)	9.6E-05

Figure 8-23 Theis Analysis for Observation Well MRN-50B

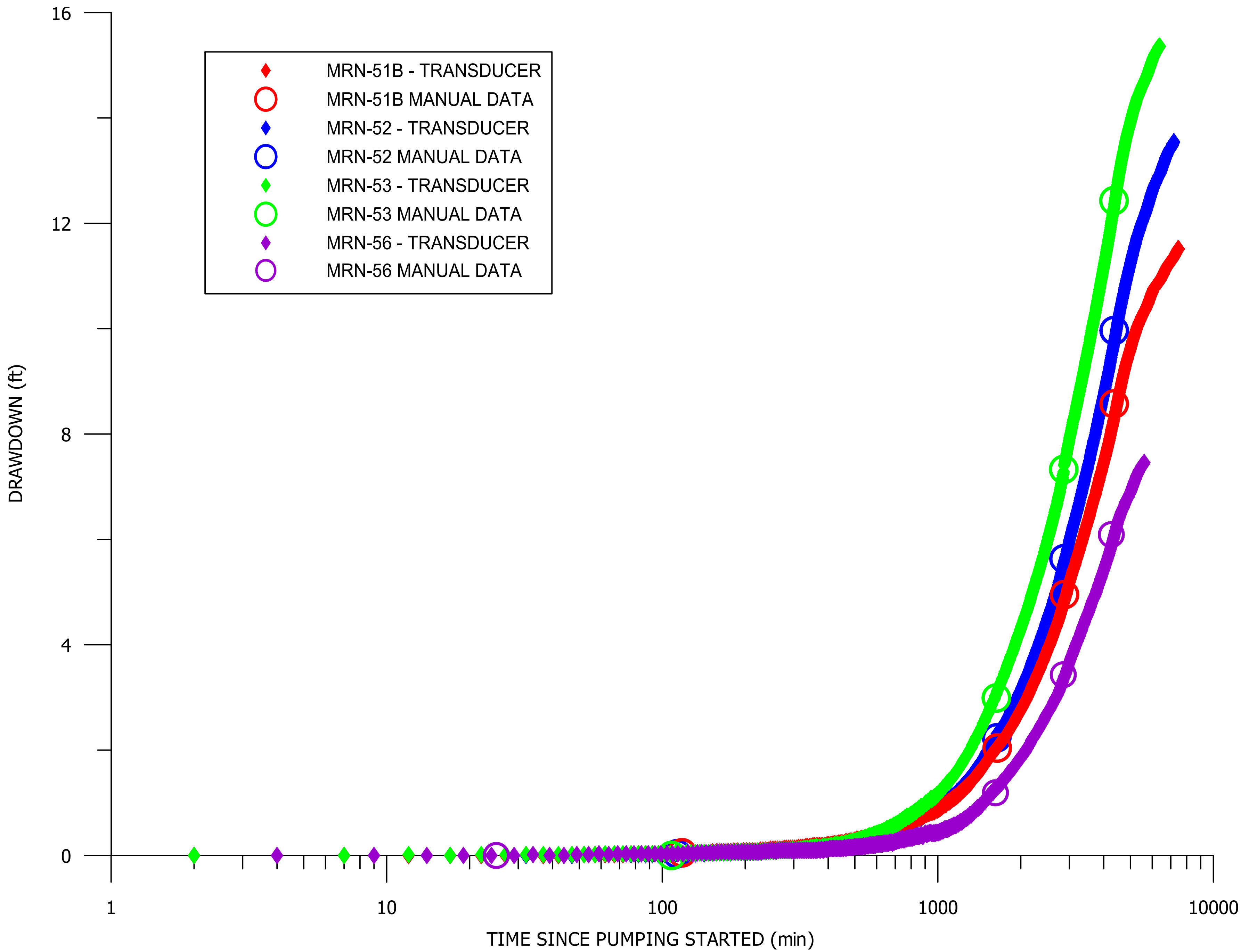
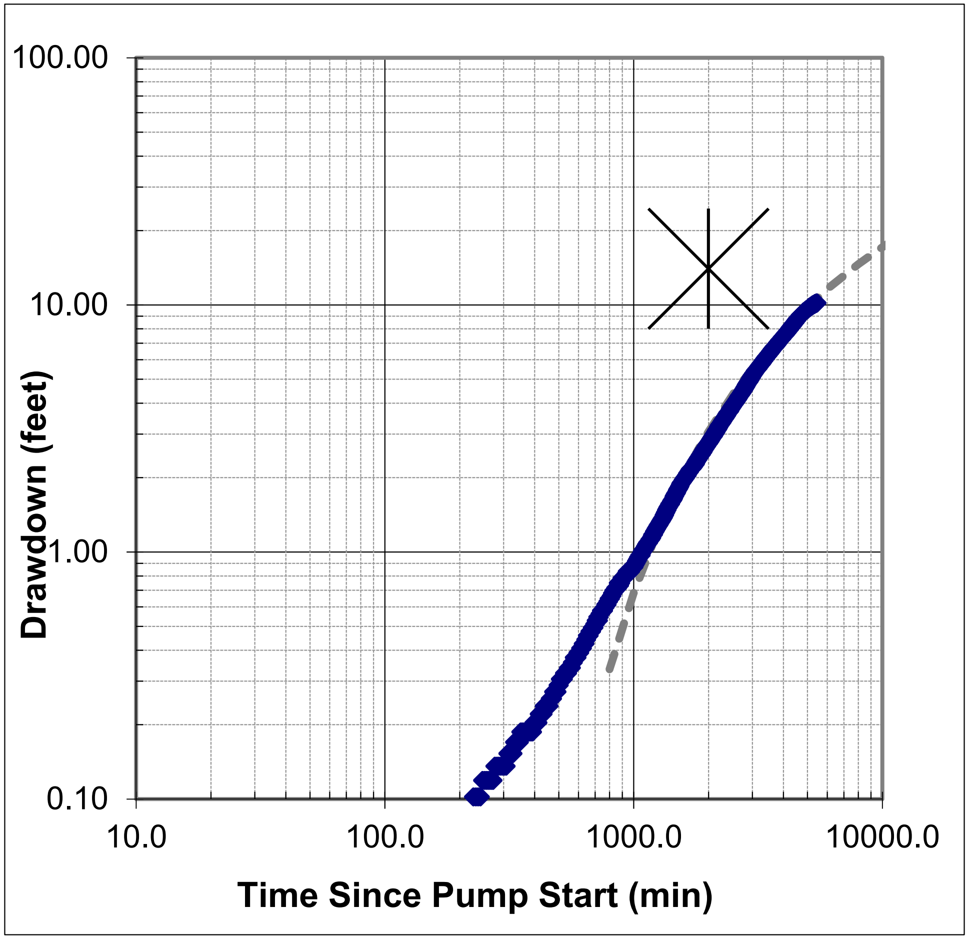


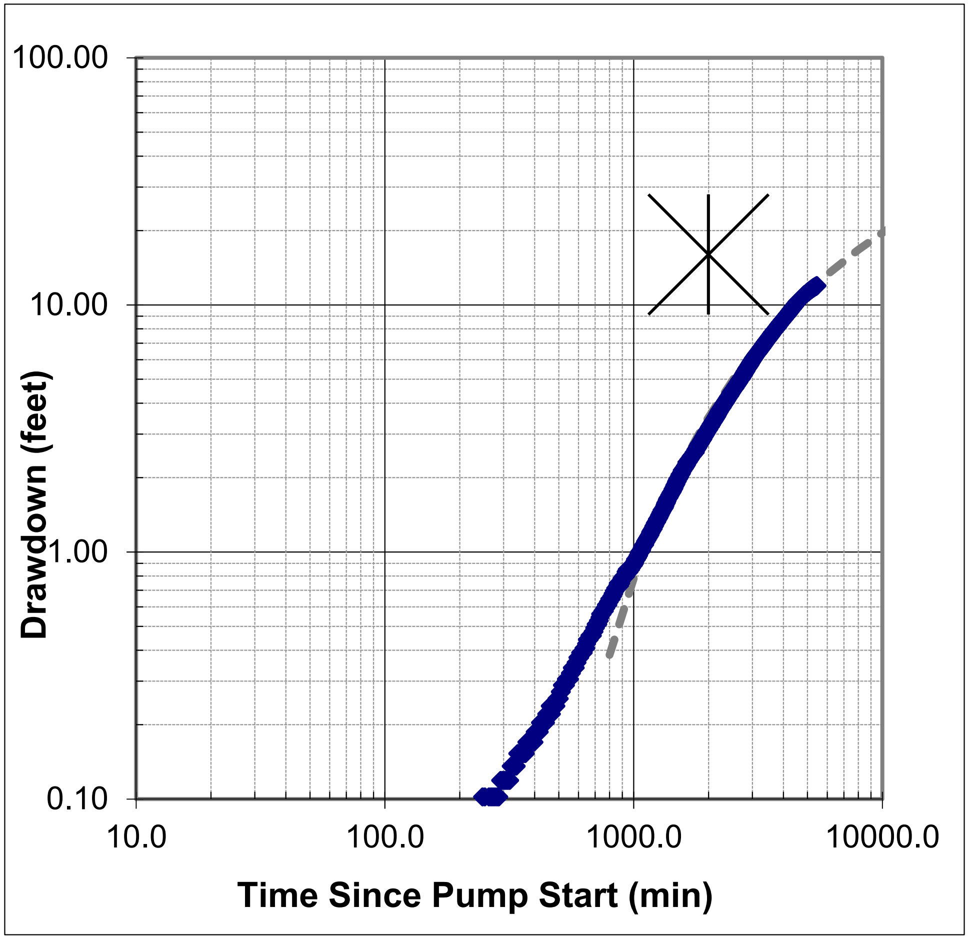
FIGURE 8-24. DRAWDOWN IN OBSERVATION WELLS MRN-51B, MRN-52, MRN-53 AND MRN-56



Theis Match Point

Discharge (gpm)	35
Radius to Pumping Well (ft) (<1 indicates pumping well)	1645
Drawdown Match Point (ft)	14.00
Time Match Point (min)	2000.0000
Calculated Transmissivity (gal/day/ft)	287
Calculated Storage Coefficient (ft/ft)	7.9E-05

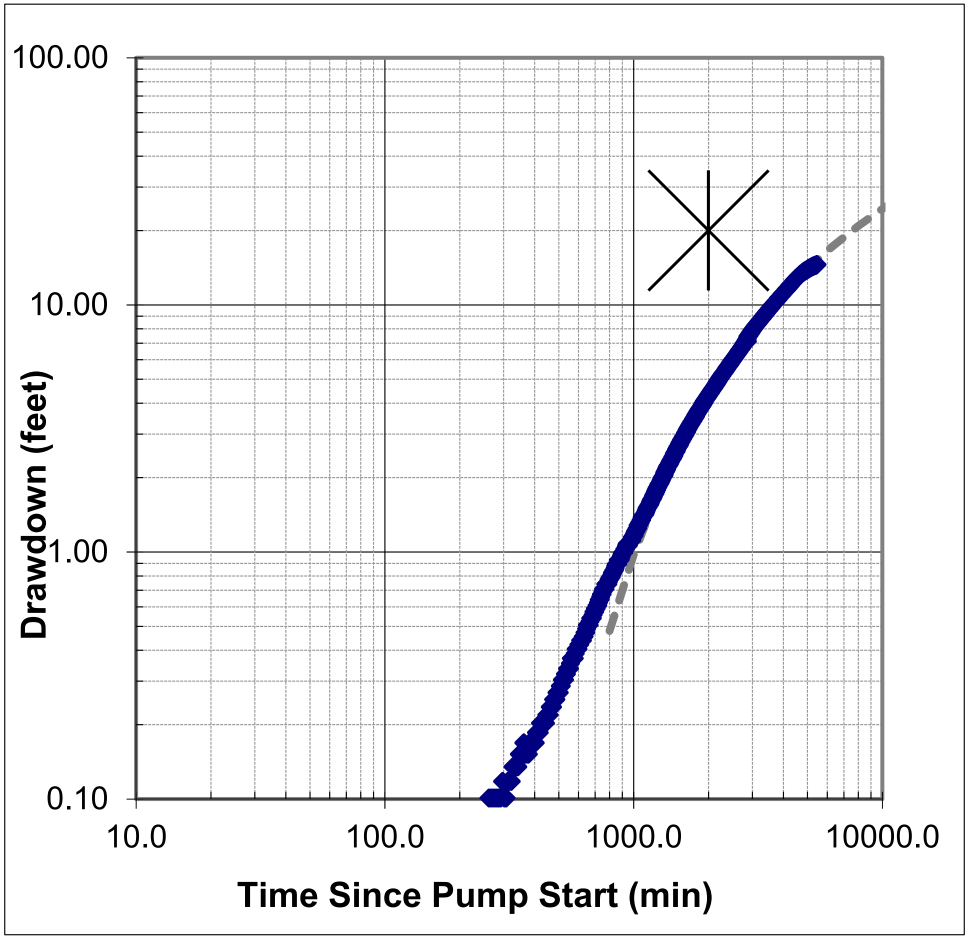
Figure 8-25 Theis Analysis for Observation Well MRN-51B



Theis Match Point

Discharge (gpm)	35
Radius to Pumping Well (ft) (<1 indicates pumping well)	1710
Drawdown Match Point (ft)	16.00
Time Match Point (min)	2000.0000
Calculated Transmissivity (gal/day/ft)	251
Calculated Storage Coefficient (ft/ft)	6.4E-05

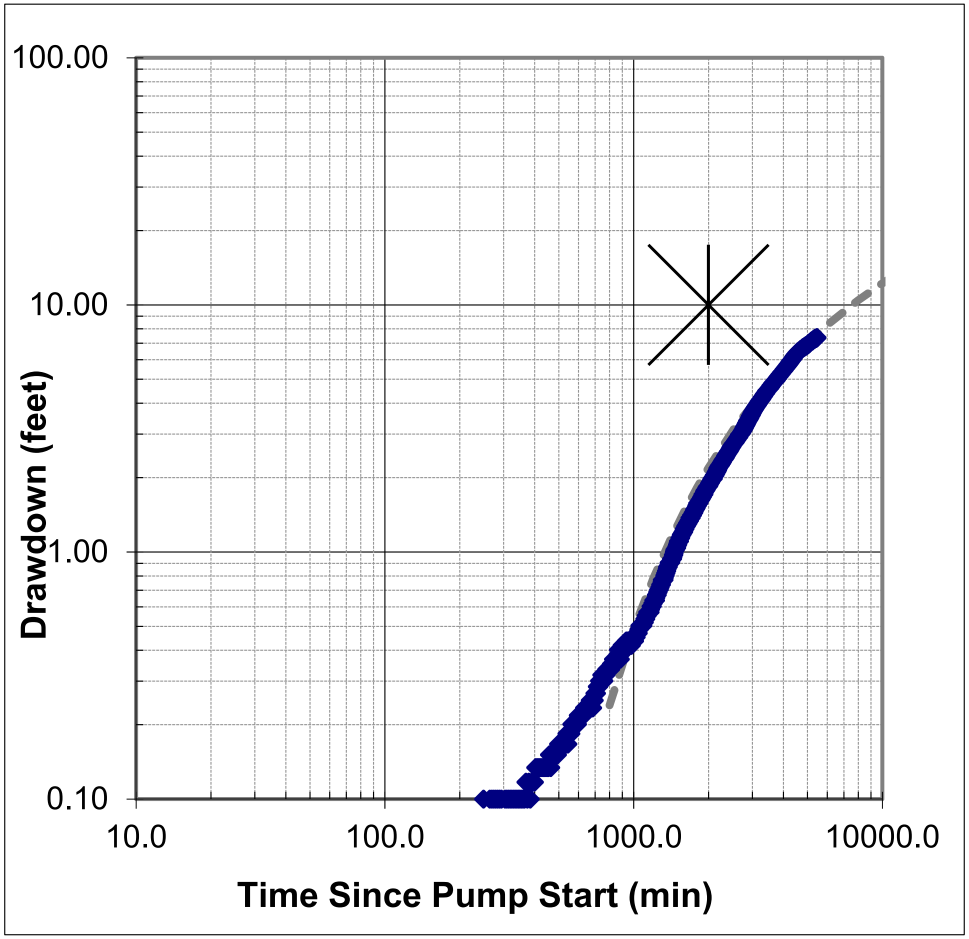
Figure 8-26 Theis Analysis for Observation Well MRN-52



Theis Match Point

Discharge (gpm)	35
Radius to Pumping Well (ft) (<1 indicates pumping well)	1896
Drawdown Match Point (ft)	20.00
Time Match Point (min)	2000.0000
Calculated Transmissivity (gal/day/ft)	201
Calculated Storage Coefficient (ft/ft)	4.1E-05

Figure 8-27 Theis Analysis for Observation Well MRN-53



Theis Match Point

Discharge (gpm)	35
Radius to Pumping Well (ft) (<1 indicates pumping well)	1637
Drawdown Match Point (ft)	10.00
Time Match Point (min)	2000.0000
Calculated Transmissivity (gal/day/ft)	401
Calculated Storage Coefficient (ft/ft)	1.1E-04

Figure 8-28 Theis Analysis for Observation Well MRN-56

9.0 TEST RESULTS – CONFINING UNITS FOR MRN-44 TEST

9.1 HYDRAULIC CONDUCTIVITY OF CONFINING UNITS

Confining unit vertical hydraulic conductivities have been defined at some of the sites near Nichols Ranch in the Powder River Basin. Table D6-5a in the Nichols Ranch permit summarizes the tests conducted on the confining units in this area.

The data indicate the vertical conductivities from core and pumping test results range from 1.5×10^{-9} cm/sec (4.3×10^{-6} ft/d) to 1.0×10^{-7} cm/sec (2.84×10^{-4} ft/d).
Therefore, the vertical conductivity of these confining units is sufficiently small to limit hydraulic communication between the Overlying or Underlying aquifers and the production sand.

This test was conducted to define the continuity and adequacy of the aquitard to isolate the A Sand from the adjacent aquifers in the southern half of PA #2.

9.2 OVERLYING AQUIFERS

Plots of depths of water levels in the Overlying (MON) aquifers for the pre-test, pumping and recovery periods are presented in Figures 9-1 through 9-4 for wells MON-17, MON-18, MON-19 and MON-20. The water levels are compared to barometric pressure for the entire period. The barometric pressure changes were small during this test, with a change of less than 0.3 inches of mercury during the pumping phase of the test. Corrections for barometric pressure changes were not made due to the small change during this test. Typical barometric pressure coefficients of 0.3 to 0.4 feet of water per inch of mercury would only make small adjustments in the depths to water.

Figure 9-1 presents the depth to water versus time for Overlying well MON-17. Steady water levels occurred during this pre-pumping phase for well MON-17. A small water-level rise was seen during the pumping period. This very small water level change is thought to be due to a change in water level trends in the Overlying aquifer. Figures 9-2, 9-3 and 9-4 show that the water-levels in wells MON-18, MON-19 and MON-20, respectively, were generally steady prior to, during and after the test. A very small water-level rise in the pumping phase and shortly after the pump was turned off in well MRN-44 was observed in monitoring wells MON-18 and MON-19. This does not indicate any connection between the Overlying and A Production aquifers.

The water-level plots for the Overlying wells do not indicate any connection between the A Sand production zone and the Overlying B Sand aquifer.

9.3 UNDERLYING AQUIFERS

Plots of the water level versus time for the Underlying aquifer wells are presented in Figures 9-5 through 9-8.

The water levels in the Underlying aquifer wells are generally steady and show very little indication of a trend. Barometric pressure changes influence the water levels only slightly during this test and therefore the water levels were not corrected for barometric pressure changes.

The water-level data collected from the Underlying wells indicates no connection between the A-Sand and the Underlying 1 Sand aquifer in the southern half of PA #2 mine area.

9.4 INTEGRITY OF CONFINING UNITS

The MRN-44 pump test indicates that adequate confinement is present between the A Sand and the Underlying 1 Sand. Drawdown was not observed in the Overlying aquifer wells in the southern portion of PA #2 indicating adequate confinement is present between the A Sand and the Overlying B Sand aquifer. This shows that adequate confinement exists in the southern portion of PA #2.

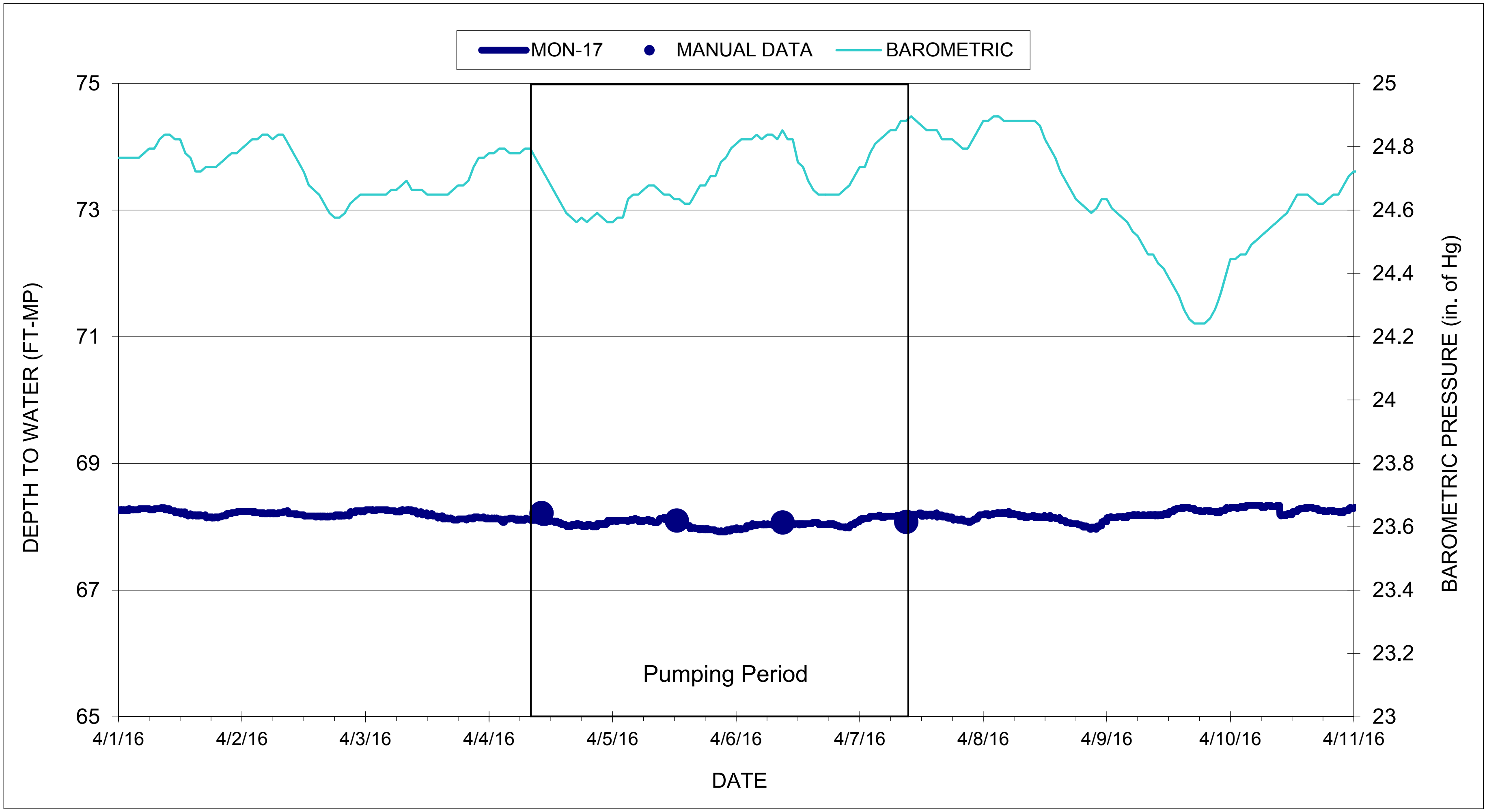


FIGURE 9-1. DEPTH TO WATER VERSUS TIME FOR OVERLYING AQUIFER WELL MON-17

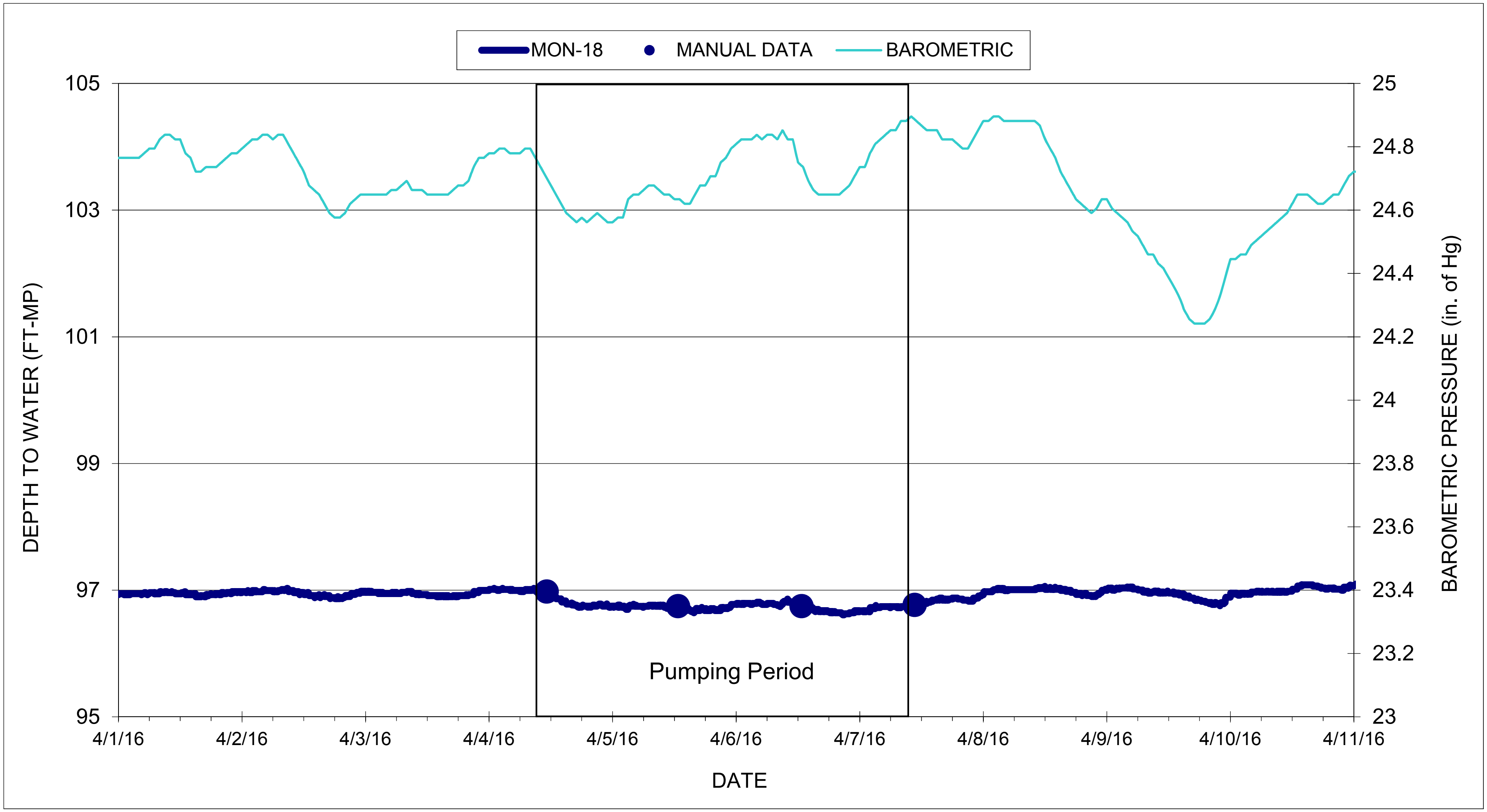


FIGURE 9-2. DEPTH TO WATER VERSUS TIME FOR OVERLYING AQUIFER WELL MON-18

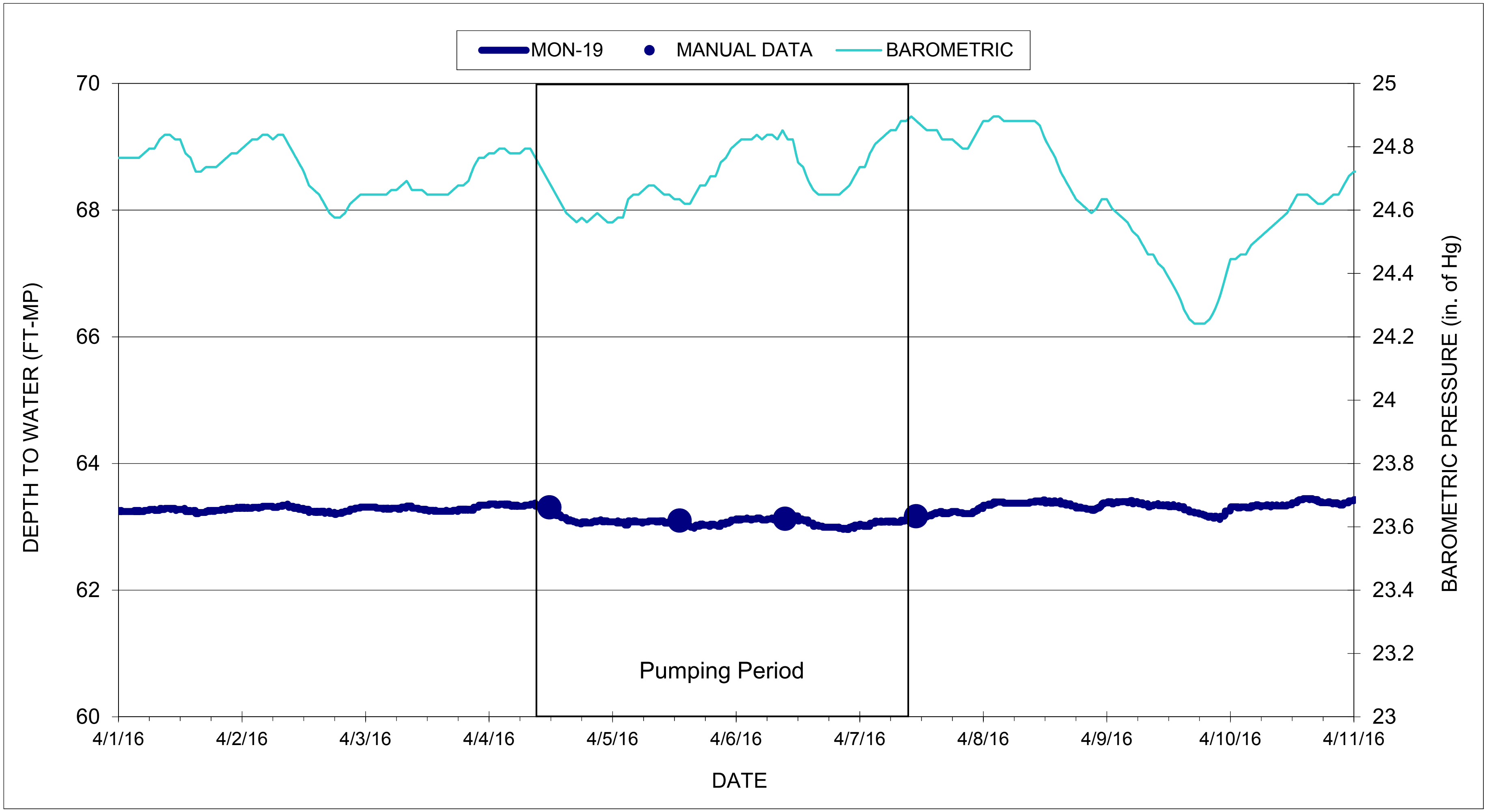


FIGURE 9-3. DEPTH TO WATER VERSUS TIME FOR OVERLYING AQUIFER WELL MON-19

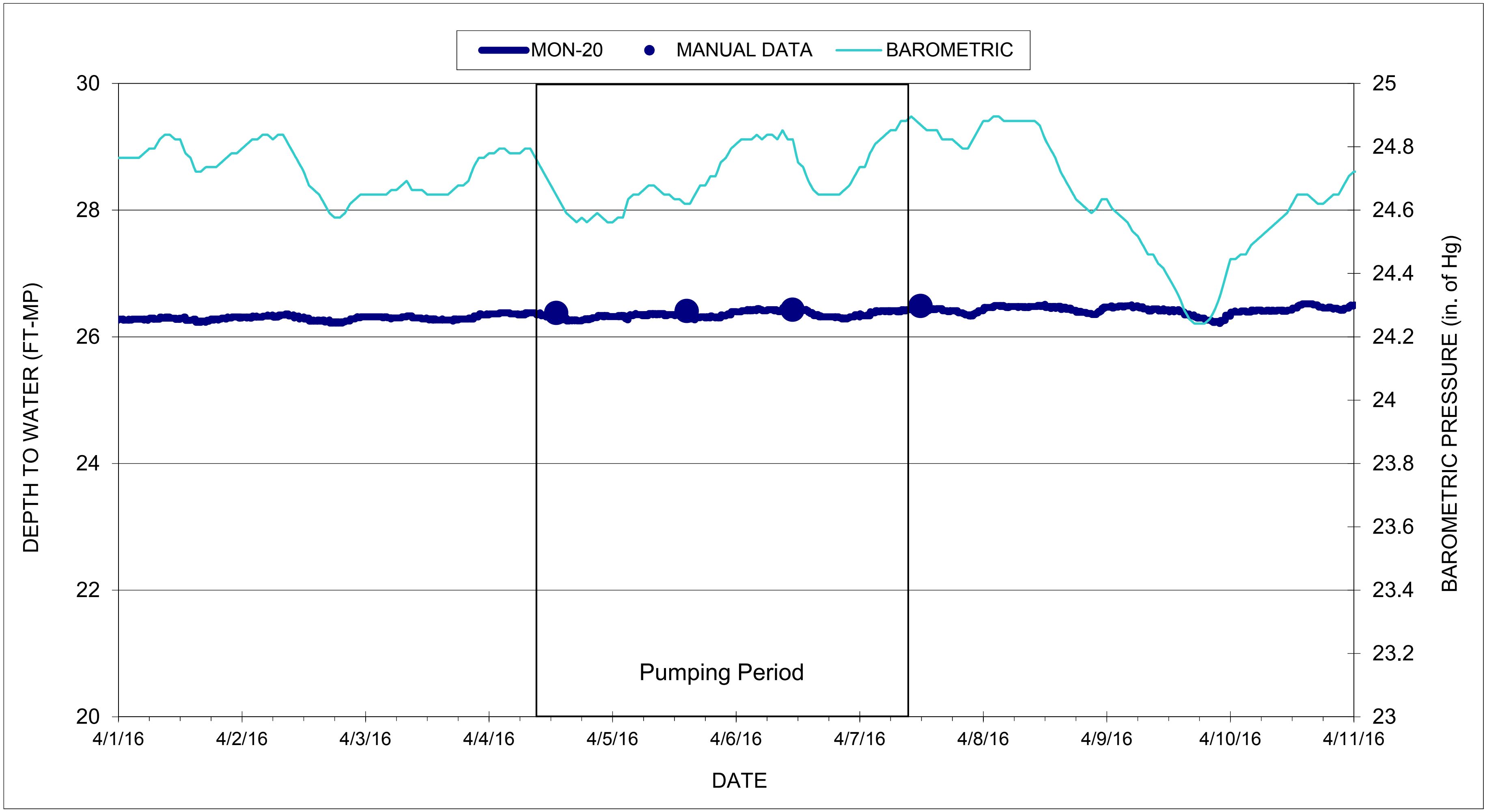


FIGURE 9-4. DEPTH TO WATER VERSUS TIME FOR OVERLYING AQUIFER WELL MON-20

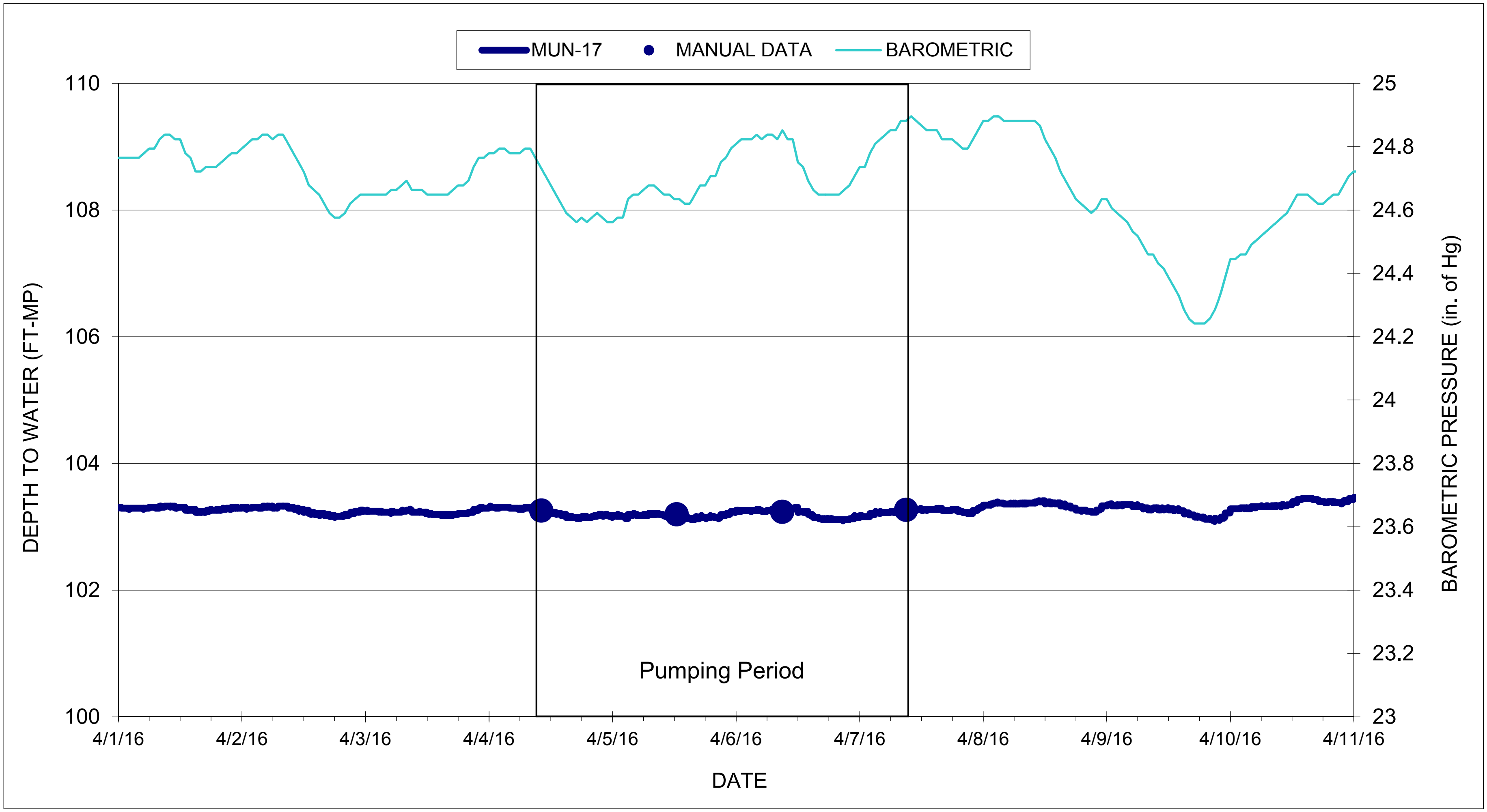


FIGURE 9-5. DEPTH TO WATER VERSUS TIME FOR UNDERLYING AQUIFER WELL MUN-17

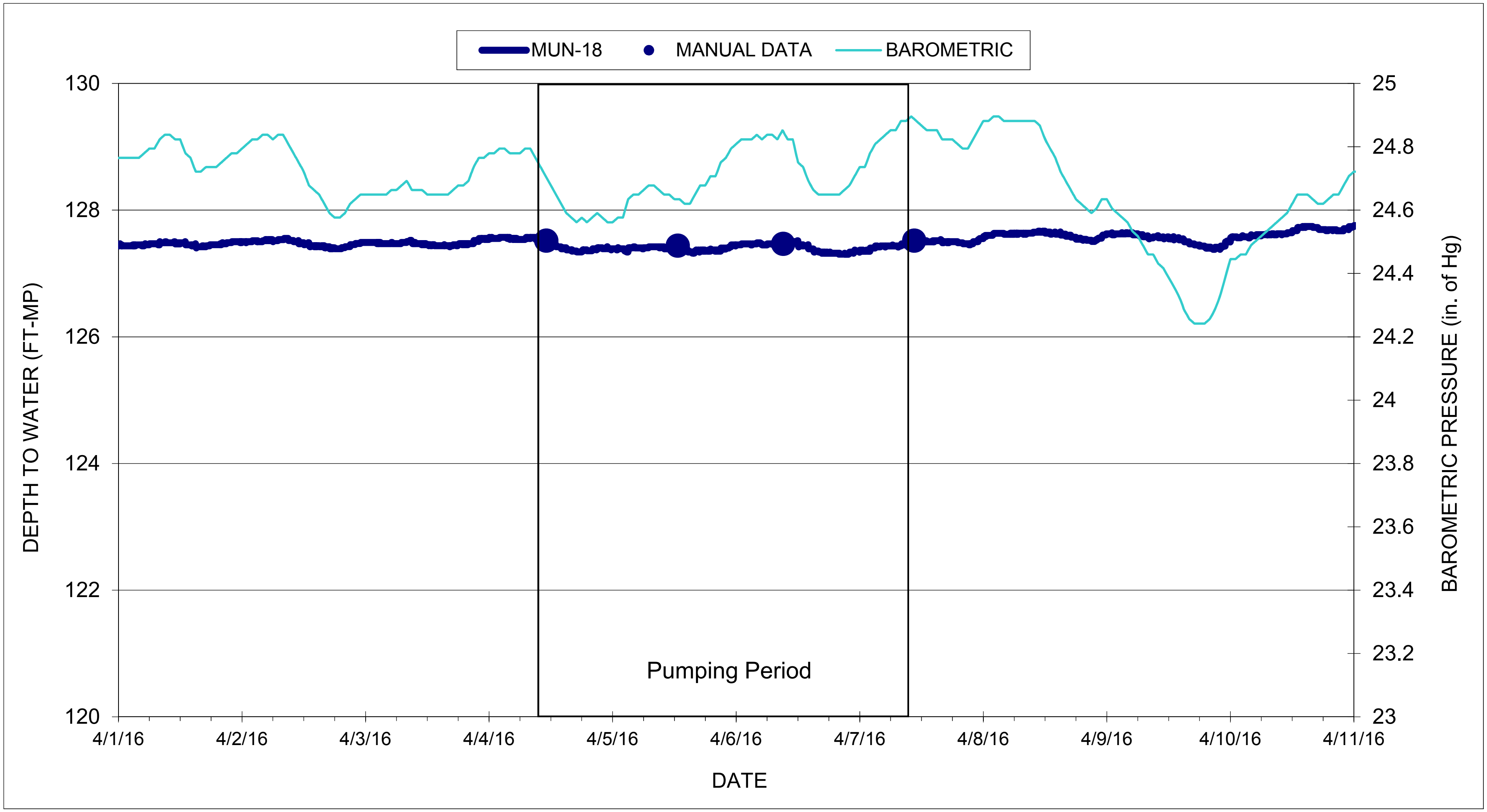


FIGURE 9-6. DEPTH TO WATER VERSUS TIME FOR OVERLYING AQUIFER WELL MUN-18

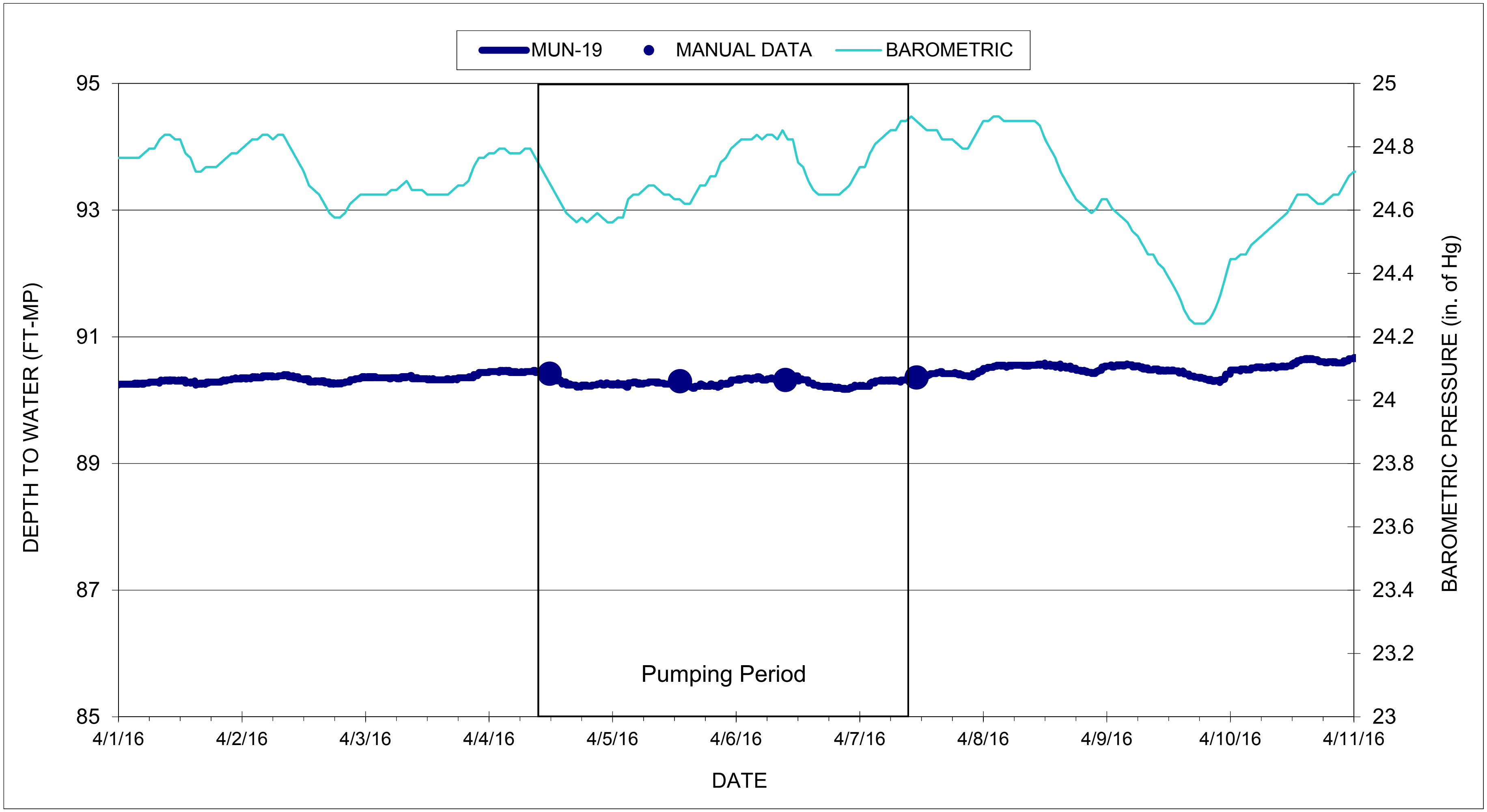


FIGURE 9-7. DEPTH TO WATER VERSUS TIME FOR OVERLYING AQUIFER WELL MUN-19

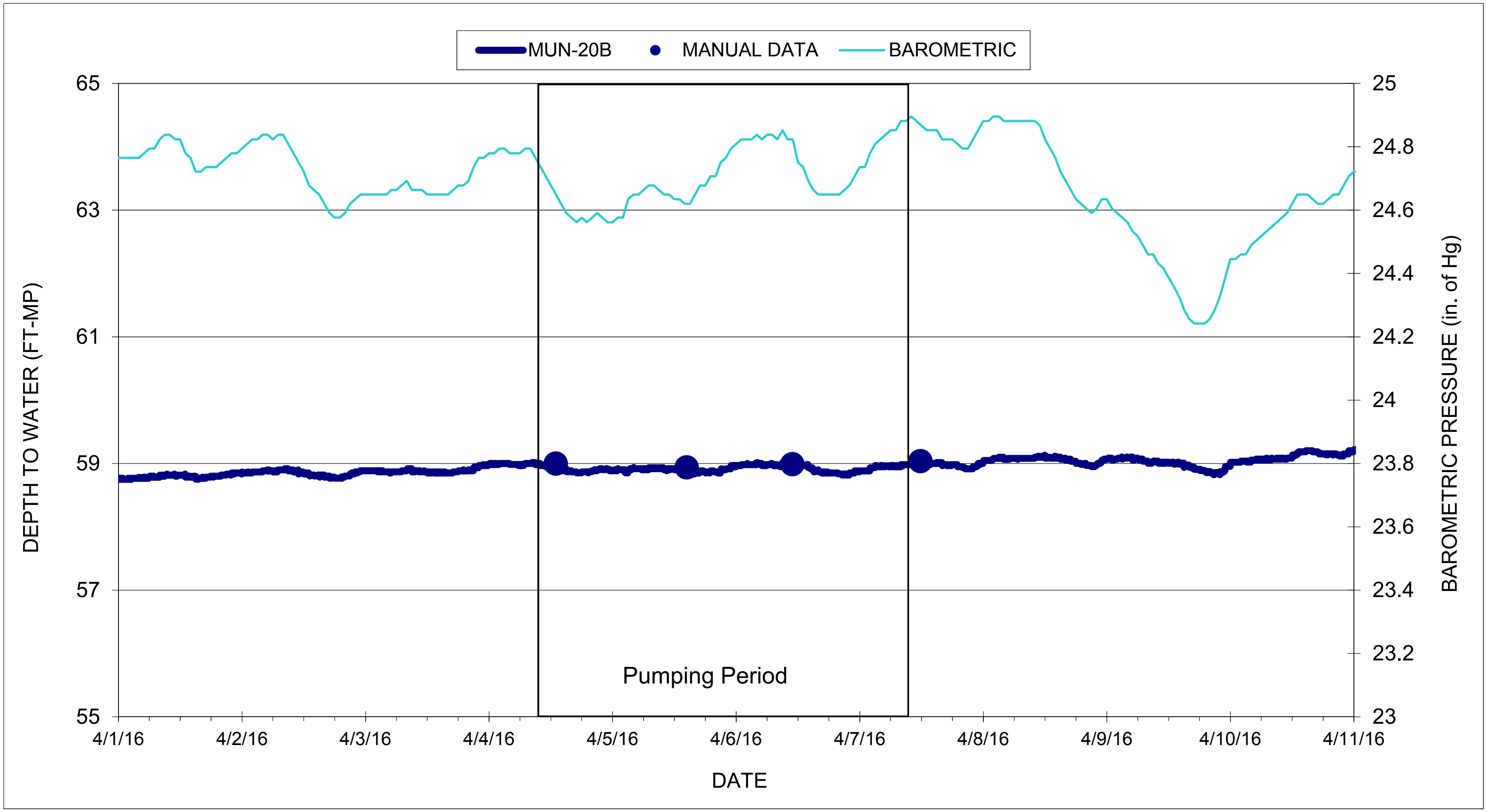


FIGURE 9-8. DEPTH TO WATER VERSUS TIME FOR OVERLYING AQUIFER WELL MUN-20B

10.0 AQUIFER-TEST THEORY

Horizontal hydraulic conductivity, commonly referred to as permeability, of the aquifer is the transmissivity divided by the aquifer thickness. Permeability is the main property that governs the velocity of groundwater movement. Hydraulic gradient and effective porosity are also needed with permeability to determine the velocity.

The storage coefficient, as defined by Theis, is the volume of water an aquifer releases from or takes into storage per unit surface area of the aquifer per unit change in head. The storage coefficient is dimensionless. Storage in a confined aquifer is derived from compression of the aquifer and a slight expansion of the water.

10.1 THEIS EQUATION

Theis, in 1935, introduced his equation to determine drawdowns in a non-leaky, confined aquifer. The following is a general definition of the Theis equation:

$$T = \frac{114.6Q\, W(u)}{s}$$

$$u = \frac{2693 r^2 S}{Tt}$$

where: s = drawdown, in feet
Q = discharge, in gallons per minute (gpm)
W(u) = well function, the integral from u to infinity of (e^{-u})/u du
T = Transmissivity, gal/day/ft
u = well function variable
r = observation well radius from pumping well, in feet
S = storage coefficient
and t = time since pumping started, in minutes

Pump test data are analyzed by matching the log-log plot of drawdown versus time to Theis' type curve [W(u) vs. 1/u] and applying the preceding equations to the match. The value of the integral expression for W(u) is given by the following series:

$$W(u) = -0.577216 - \ln u + u - \frac{u^2}{2.2!} + \frac{u^3}{3.3!} \ldots$$

where all terms are as previously defined.

10.1.1 STRAIGHT LINE EQUATION

Jacob developed a simplified form of Theis' drawdown equation by truncating the well function series after the first two terms. Assuming the truncation, the following equations were developed to analyze drawdown versus time data on semi-log plots and are called the straight-line or Jacob equation:

$$T = 264\ Q[\log (t_2/t_1)]/(s_2-s_1)$$
$$T = 264\ Q/\Delta s$$
$$S = T\ t_0\ /4800r^2$$

s_1 = drawdown, in feet, at time since pumping started, t_1, in minutes
s_2 = drawdown, in feet, at time since pumping started, t_2, in minutes
and $t_2 > t_1$
Δs = change in drawdown over one log cycle of time on a semi-log plot, in feet
S = storage coefficient
t_0 = straight-line intercept of zero drawdown, in minutes
r = radius of well, in feet

A straight line is fit to the semi-log plot of drawdown versus time (log scale) to obtain transmissivity. Jacob suggested the u values less than 0.01 are needed before his straight-line method is useful. However, a plot of W(u) versus 1/u on semi-log paper indicates that this method should be applicable for values of u as large as 0.1. Kruseman and de Rider (1991) suggest the use of a u of less than 0.1 to meet the Jacob condition.

10.1.2 THEIS RECOVERY EQUATION

Theis' equation can be modified to handle recharge of a well or multiple pumping periods by summation of the well functions. The following equation is the solution of Theis' equation for one pumping and recharge cycle (Recovery equation) of a non-leaky confined aquifer using a log-log match format:

$$T = 114.6\ Q\ [W(u) - W(u')]s'$$
$$u' = 2693\ r^2\ S/Tt'$$
$$T = 114.6\ Q\ [W(u) - W(u) + (u')]\ sr$$
$$= 114.6\ Q\ W(u')/sr$$
$$s_r = s - s'$$

where: s_r = recovery, in feet

s' = residual drawdown (static water level – water level @ t'), in feet
W(u') = recovery well function
u' = recovery well function variable
t' = time since pumping stopped, in minutes

The recovery data sets are analyzed by matching the log-log plot of the recovery versus time since pumping stopped to Theis' type curve. The type curve variables are W(u') and 1/u' for the recovery match. The recovery is computed by estimating the drawdown which would have occurred if pumping had continued, and subtracting this predicted drawdown from the residual drawdown. For example, the recovery at 100 minutes after pumping has stopped is computed by estimating the drawdown had the pumping continued uninterrupted, and subtracting the estimated drawdown from the residual drawdown. The straight-line fit of the drawdown is normally extended to obtain these estimates of drawdown.

The well functions of the residual-drawdown form of Theis' equation were approximated by using the first two terms in the well function series. The following equations present the semi-log form of the Theis recovery equation:

$$T = 264\ Q\ [\log (t/t')]/s'$$

or

$$T = 264\ Q/\Delta s'$$

where: t = time since pumping started, in minutes
t' = time since pumping stopped, in minutes
s' = residual drawdown, in feet
and $\Delta s'$ = change in residual drawdown over one log cycle of t/t' on a semi-log plot, in feet

Therefore, when residual drawdown is plotted on an arithmetic scale versus t/t' on a logarithmic scale, the above equation can be used for the straight line fit.

10.1.3 MULTI-WELL THEIS EQUATION

The Theis equation can be modified to predict drawdown from more than one pumping period for one pumping well. Stallman used the well function summation theory to develop type curves for a variable discharge pump test (see Ferris & et al. 1962). HYDRO has used the well summation theory to analyze numerous pump tests with more than one pumping well. The sum of the W(u) times Q values that are plotted versus $1/u_1$, on log-log paper to create the type curves. The following equations are for one pumping well that has three different discharges during the pump test:

$$T = 114.6/s\ [W(u_1)Q_1 + W(u_2)Q_2 + W(u_3)Q_3]$$
$$W(u_1) = -0.577216 - \ln u_1 + u_1 - u_1^2/2.2! + u_1^3/3.3! - u_1^4/4.4!$$
$$u_1 = 1.87r^2S/Tt_1$$

where: parameters are the same as before, plus:

u_1 = well function variable for the 1st pumping period

u_2 = well function variable for the 2nd pumping period
u_3 = well function variable for the 3rd pumping period
Q_1 = discharge for 1st pumping period in gpm
Q_2 = discharge for 2nd pumping period in gpm
Q_3 = discharge for 3rd pumping period in gpm

r = observation well radius from pumping well in ft.
t_1 = time since pumping started 1st pumping period
t_2 = time since pumping started 2nd pumping period
t_3 = time since pumping started 3rd pumping period

The summation of the product of the well functions and their corresponding discharge

$$\left(\sum_{i=1}\left[W(u_i)Q_i\right]\right)$$

have typically been plotted against the inverse of the well function variable for the first pumping period ($1/u_1$). If the discharge for each pumping period is the same, Q can be extracted from the summation term and taken as constant.

$$\frac{114.6Q}{s}\sum_{i=1}^{3}W(u_i)$$

The analysis of the multi-well Theis equation was done by selecting a match point for the first pumping period and computing a transmissivity and storage coefficient. This match point was evaluated as outlined in Section 10.1. The refined transmissivity and storage coefficient for the entire drawdown curve were computed from the above multi-well Theis equation by using the off and on periods for the second and third pumping phases and the aquifer properties from the match of the first phase of the pump test. The aquifer properties were then iteratively varied to refine the match of the predicted drawdown to the measured drawdown which produced refined transmissivity and storage coefficients based on the entire drawdown curve. Thus, the primary enhancement of the refined match is that it reflects fitting of the drawdown data over the entire pumping period. These refined transmissivity and storage coefficient values are the values from the entire log-log analysis of the pump test data fit.

10.1.4 MULTI-WELL STRAIGHT LINE EQUATION

The above Theis equation for three pumping periods can be modified using Jacob's approximation (see pp. 98-100 of Ferris, 1962) to obtain a straight-line (semi-log plot) for the drawdown data from three pumping periods. The u value for each of the pumping periods must meet the straight-line assumptions before the straight-line method is applicable for the combined drawdown. As with the single-well tests, u values should be less than 0.1 for t_3 before the use of the straight-line method. The following is the derivation of the straight-line equation that is equivalent to Jacob's equation for three pumping periods at the same pumping rate. The second pumping period is the first pump off period and therefore is at a negative rate of the first pumping rate:

$$s = \left(\frac{264Q}{T}\right)\left[\log\left(\frac{0.3Tt_1}{r^2S}\right) - \log\left(\frac{0.3Tt_2}{r^2S}\right) + \log\left(\frac{0.3Tt_3}{r^2S}\right)\right]$$

For drawdown at times of t_a and t_b:

$$s_b - s_a = \left(\frac{264Q}{T}\right)\left[\log\left(\frac{0.3Tt_{1b}}{r^2S}\right) - \log\left(\frac{0.3Tt_{2b}}{r^2S}\right) + \log\left(\frac{0.3Tt_{3b}}{r^2S}\right) - \log\left(\frac{0.3Tt_{1a}}{r^2S}\right) + \log\left(\frac{0.3Tt_{2a}}{r^2S}\right) - \log\left(\frac{0.3Tt_{3a}}{r^2S}\right)\right]$$

after multiplication and simplification of the log terms:

$$s_b - s_a = \frac{264Q}{T}\left[\log\left(\frac{t_{1b}t_{3b}t_{2a}}{t_{2b}t_{1a}t_{3a}}\right)\right]$$

$$T = \frac{264Q}{\Delta s} \text{ for } \Delta s = s_b - s_a \text{ for one log cycle over } \frac{t_1 t_3}{t_2}$$

The straight line equation is the same as the Jacob equation except the ratio of the three pumping periods is used in the place of t. The following is our derivation of the storage coefficient equation for the three pumping periods for the same well:

$$s = \left(\frac{Q}{4\pi T}\right)\left[\ln\left(\frac{2.25Tt_1}{r^2S}\right) - \ln\left(\frac{2.25Tt_2}{r^2S}\right) + \ln\left(\frac{2.25Tt_3}{r^2S}\right)\right]$$

$$s = \left(\frac{Q}{4\pi T}\right)\ln\left[\left(\frac{2.25Tt_1t_3}{r^2St_2}\right)\right]$$

$$0 = \ln\left(\frac{2.25Tt_o}{r^2S}\right)$$

$$1 = \left(\frac{2.25Tt_o}{r^2S}\right)$$

$$S = \left(\frac{2.25Tt_o}{r^2}\right)$$

or in the usual USGS units

$$S = \frac{(0.3Tt_o)}{(r^2)}$$

where: parameters are the same as before, and:

s_b = drawdown, in feet, at time since pumping started, t_b, in days
s_a = drawdown, in feet, at time since pumping started, t_a, in days
t_o = time when drawdown equals zero (extension of straight-line fit to s = 0), in days

The drawdown data for an observation well are plotted on semi-log paper against times since the ratio of t_1t_3/t_2. The slope of the straight-line fit is used with the discharge to compute the transmissivity, and the intercept of the straight line is used with the well radii to compute the storage coefficient.

10.2 HANTUSH'S MODIFIED METHOD

Hantush (1960) presents a modification of the theory of leaky confined aquifers which had previously been described by Hantush and Jacob (1955). The modification took into account the storage of water in the semipervious confining bed. Equations developed are as follows:

$$T = \frac{114.6Q}{s} H(u, BETA)$$

where: H(u, BETA) = the integral from u to infinity of $(e^{-y})/y$ [complementary error function of (BETA*Square Root u) / Square Root (y(y-u))]dy

$u = [(2693)r^2(S)]/Tt$

And $$BETA = \frac{r}{4b}\sqrt{\frac{K'Ss'}{KSs}}$$

The main parameters are as follows:

T = transmissivity, gal/day/ft.
Q = discharge, gpm
s = drawdown, ft.
y = variable of integration

r = radius, ft.
S = storage coefficient
t = time, min.
b = aquifer thickness, ft.
K = aquifer permeability, ft/day
K' = confining layer permeability, ft/day
Ss = aquifer specific storage, 1/ft.
and Ss' = confining layer specific storage, 1/ft.

This form of the beta equation assumes all leakage is coming from only one of the two confining layers. Hantush (1961) presented tabulations of H(u, BETA) for varying values of u and BETA, and subsequently, a family of type curves showing H(u, BETA) vs. 1/u has been developed. Main aquifer properties can be determined by matching plots of observed drawdown versus time data to one of Hantush's type curves and using the equations presented above. The specific storage of the confining layer can be determined from laboratory measurements of the coefficient of compressibility and void ratio on a core of the aquitard or the specific storage of the aquifer if the laboratory measurements are not available.

10.3 NEUMAN-WITHERSPOON METHOD

A method for determining aquitard vertical permeability has been described by Neuman and Witherspoon (1971) and Neuman and Witherspoon (1972). In this technique, referred to as the Ratio Method, the ratio of drawdown in the aquitard to the drawdown in the pumped aquifer at the same time and distance is related to a dimensionless time parameter, t'D:

where: t'D = K't / Ss z^2
K' = aquitard vertical permeability
t = time for which drawdown ration was determined
Ss' = specific storage of the aquitard
= K' / ALPHA'
ALPHA = aquitard diffusivity,
and z = vertical distance from the center of the screened section of the well completed in the aquitard to the aquifer.

The variable t'D is determined graphically. Therefore, aquitard diffusivity (ALPHA') can be calculated from ALPHA' = K' / Ss' = T'D Z^2 / t.

In order to determine aquitard specific storage, Ss', must be ascertained.

where: Ss' = avWw / (1 + e)
av = coefficient of compressibility
Ww = weight of water,
and e = void ratio

The values of av and e must be determined for samples of the aquitard using laboratory methods or Ss' may be estimated based on published reports on similar sediments.

10.4 DIRECTIONAL TRANSMISSIVITY

Directional transmissivity of the aquifer was quantified using a method described by Papadopulos (1965). Papadopulos derived an equation for the drawdown distribution around a well discharging at a constant rate from an infinite horizontal anisotropic aquifer. Aquifer-test data from a minimum of three observation wells are analyzed to obtain principal transmissivities and the orientation of the principal axes.

The equations derived by Papadopulos for use in a type-curve matching technique are as follows:

$$s = \frac{114.6Q\ W(Uxy)}{\left[(Txx)(Tyy) - Txy^2\right]^{1/2}}$$

and

$$Uxy = \frac{(1.87S)}{(t)} \frac{\left[(Txx)(y^2) + (Tyy)(x^2) - (2Txy)(x)(y)\right]}{\left[(Txx)(Tyy) - Txy^2\right]}$$

where s = drawdown, in feet
Q = discharge, in gpm
W(Uxy) = well function
Txx, Tyy & Txy = transmissivity components, in gal/day/ft
Uxy = well function variable
S = storage coefficient
t = elapsed time, in days
x = distance from pumping well of observation well along arbitrarily selected x-axis, in feet
and y = distance from pumping well of observation well along arbitrarily selected y-axis (orthogonal to x-axis), in feet

For each of the three wells analyzed, observed drawdown data are matched against type curves to determine values of s, t, W(Uxy) and U(xy). Three equations with three unknowns are then solved simultaneously to determine the transmissivity components Txx, Tyy and Txy. Then principal transmissivities, Tee and Tnn, are calculated from the following equations:

$$\text{Tee} = \tfrac{1}{2}\left[(\text{Txx} + \text{Tyy}) + (\text{Txx} - \text{Tyy})^2 + 4\text{Txy}^2\right]$$

and

$$\text{Tnn} = \tfrac{1}{2}\left[(\text{Txx} + \text{Tyy})^2 + 4\text{Txy}^2\right]$$

where: Tee = maximum transmissivity
and Tnn = minimum transmissivity

The angle between the arbitrarily selected x-axis and the axis of maximum transmissivity (θ) is then determined by the following equation:

$$\theta = \arctan(\text{Tee} - \text{Txx})/\text{Txy}$$

11.0 RESULTS FROM ADDITIONAL PUMP TESTS

An additional pump test was conducted in the eastern section of PA #2 closest to PA #1 to demonstrate connection of A Sand monitor wells in this area. The well MRN-58 (see Figure 2-1 for location) pump test was conducted on March 22, 2016 starting at 8:30 A.M and was concluded at 4:45 P.M. The average pumping rate was 35.3 gallons per minute during the MRN-58 pump test. During this test, wells MPN-16, MRN-29, MRN-55, MRN-56 and MRN-57 exhibited drawdowns of 6.2, 8.4, 1.8, 1.6 and 6.5 feet respectively (see Figure 11-1 and 11-2 for water level plots). Table 11-1 presents the pump test data for this additional pump test.

This additional pump test demonstrates good A Sand continuity between wells MRN-58, MPN-16, MRN-29, MRN-56 and MRN-57. The MRN-44 pump test shows good connection of A Sand wells MRN-55 and MRN-56 with the other A Sand wells in this area.

TABLE 11-1.
MONITORING WELL DISTANCE, STATIC WATER-LEVEL BEFORE TEST AND MAXIMUM DRAWDOWN DURING THE MRN-58 TEST

Start Date & Time	3/22/2016 8:30				
End Date & Time	3/22/2016 16:45				
Duration	495				
Avg. Pumping Rate	35.3				
Pumping Well	MRN-58	Distance from	Depth to Water	Water Elevation	Maximum Drawdown
		Pumping Well	Before Test	Before Test	During Test
Monitoring Wells		(ft)	(ft)	(ft)	(ft)
	MRN-58	0	173.90	4613.94	157.0
Ore Zone Completions	MPN-16	559	180.92	4608.40	6.2
	MRN-29	535	189.60	4631.96	8.4
	MRN-55	1405	184.10	4604.55	1.8
	MRN-56	967	152.53	4604.63	1.6
	MRN-57	492	157.00	4601.16	6.5

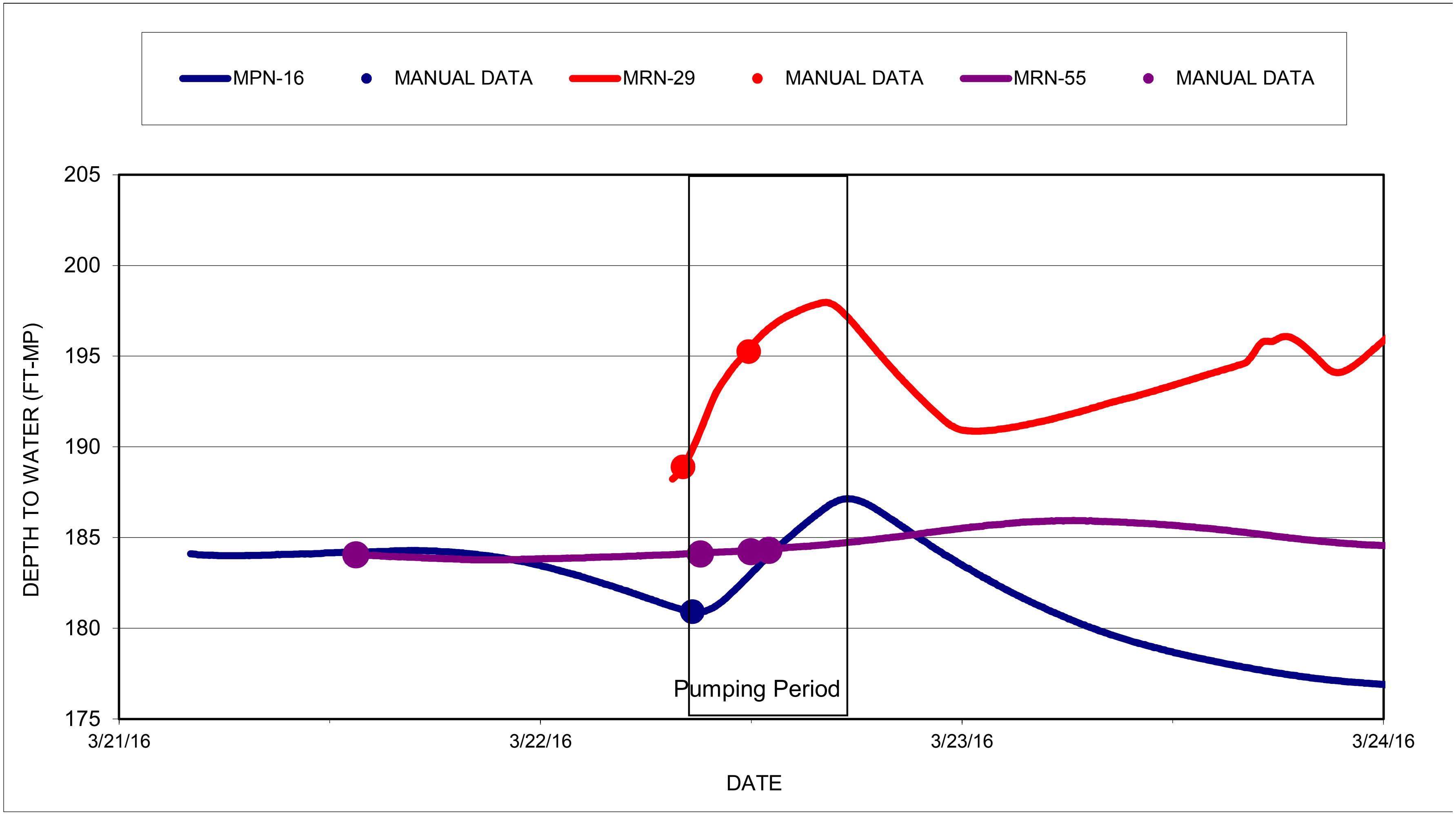


FIGURE 11-1. DEPTH TO WATER VERSUS TIME FOR OBSERVATION WELLS MPN-16, MRN-29 AND MRN-55

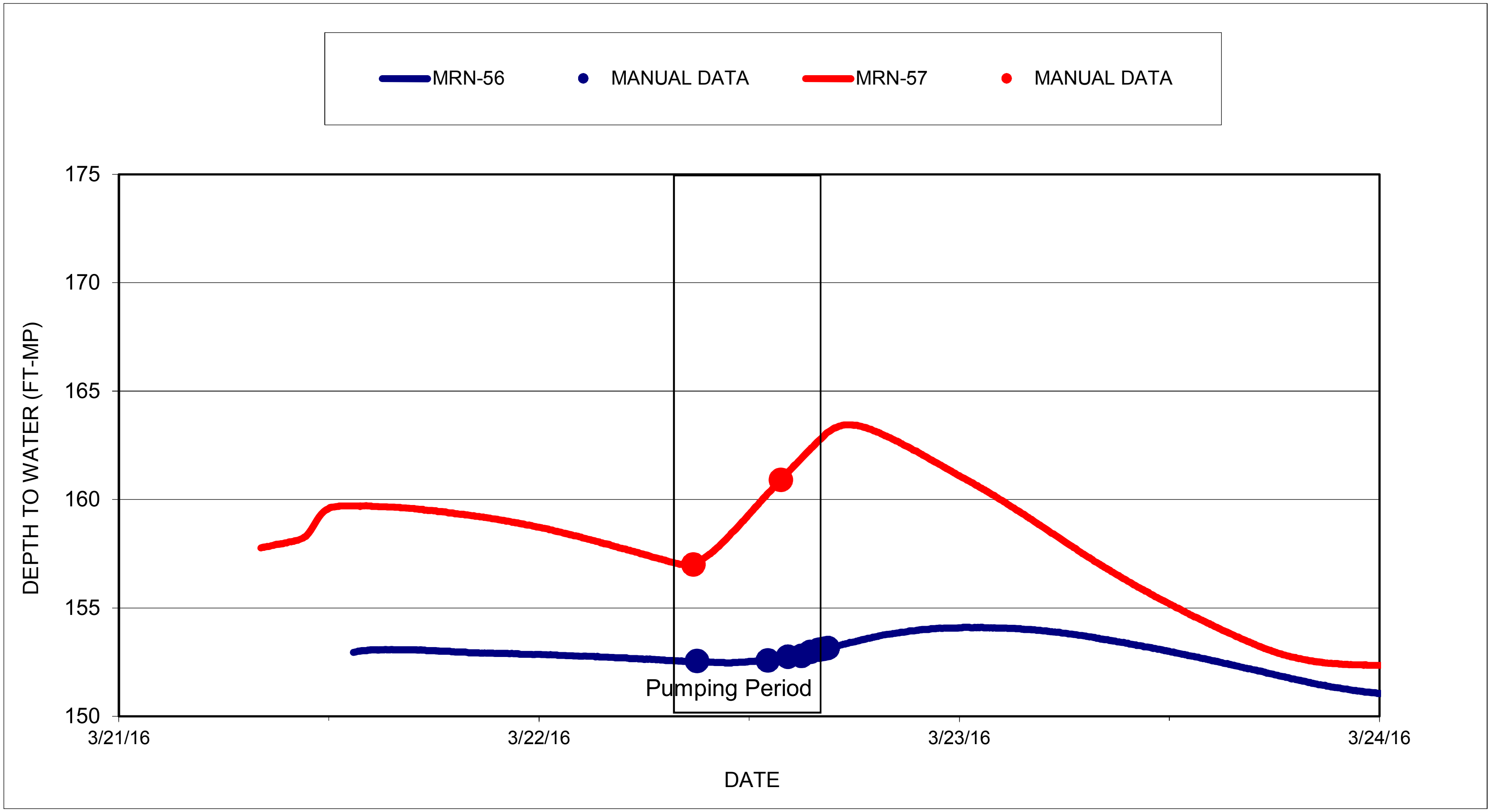


FIGURE 11-2. DEPTH TO WATER VERSUS TIME FOR OBSERVATION WELLS MRN-56 AND MRN-57

12.0 SUMMARY AND CONCLUSIONS

Two pump tests were preformed for the area wellfield analysis for PA #2. The first by pumping well MRN-37 during March 15, 16, 17 and 18, 2016; the second by pumping MRN-44 during April 4, 5, 6 and 7, 2016. Greater than 200 feet of drawdown in the pumping well MRN-37 was observed in the first pump test and just under 200 feet of drawdown in the pumping well MRN-44 for the second test.

The Overlying aquifer monitor wells were fairly steady during the pre-pumping and pumping phases of the pump test. No measurable drawdown was observed in any of the Overlying aquifer wells during both pump tests for the PA #2. Small changes in water level can be attributed to barometric pressure changes, small trends, or influence by localized drilling operations in the area. Therefore, the PA #2 pump tests show that adequate confinement exists between the A Sand and the Overlying aquifer.

The Underlying aquifer monitoring wells were generally very steady during the PA #2 pump tests. Therefore the PA #2 pump tests show that adequate confinement exists between the A Sand and the Underlying aquifer.

Analysis of the water-level data for the A Sand wells resulted in an average transmissivity of 44 ft^2/day for the northern half of PA #2 and 43 ft^2/day for the southern half of PA #2, and average hydraulic conductivity of 0.46 ft/day (1.6E-4 cm/sec) and an average permeability (assuming a water temperature of 50 degrees F) of 219 millidarcies (md) for both the northern and southern portions of PA #2. The average storativity was 7.1E-5 and 9.1E-5. The analysis did not indicate the presence of significant geologic boundaries within the A Sand aquifer over the area evaluated by the testing.

In summary, the pump tests were performed in accordance with the Hydrologic Test Plan submitted by Uranerz in January 2016 to WDEQ-LQD. The testing objectives were met. The test results demonstrate:

- All A Sand monitoring wells are in communication with the A Sand Production Zone;
- Adequate confinement exists between the A Sand Production Zone and the Overlying and Underlying sands;
- The A Sand has been adequately characterized with respect to the hydrogeologic conditions within PA #2; and,
- Mining can proceed in accordance with Permit to Mine No. 778.

13.0 CALCULATED UPPER CONTROL LIMITS AND RESTORATION TARGET VALUES

Baseline sampling was performed on the monitor well network for PA #2 in accordance with the approved WDEQ-LQD permit to mine and NRC license application. The samples collected were submitted to a third party laboratory for analysis and have been tabulated in the following tables by well type (e.g. MON, MRN, MUN and MPN). From the data collected, the Upper Control Limits (UCLs) were calculated for the Overlying (MON), Perimeter (MRN) and Underlying (MUN) monitor wells. Restoration target values (RTVs) were calculated for the production (MPN) monitor wells. The UCLs are presented in Tables 13-1, 13-2 and 13-3 for the Overlying aquifer, monitor ring, and Underlying aquifer wells, respectively. The Production monitor well RTVs are presented in Table 13-4.

RTVs were calculated based on NRC criteria from 10 CFR 40, Appendix A, Criterion 5(B)(5) which lists three standards, one of which must be met at the point of compliance. The standards are:

- The commission approved background concentration of that constituent in the ground water;
- The respective value given in the table in paragraph 5 C if the constituent is listed in the table and if the background level of the constituent is below the value listed; or
- An alternate concentration limit established by the Commission

Monitor wells MRN-30, MRN-31, and MRN-32 are common perimeter monitor wells between PA #1 and PA #2. The three wells were installed, baselined and approved as part of the monitor well ring network for PA #1. Each of the monitor wells has been sampled twice a month with 10 days between sampling events since inception of PA #1. These three wells however will be discontinued as monitor ring wells, as they fall within the pattern area of PA #2, with the approval and production commencement in PA #2. The discontinued use of these wells will not interrupt sampling as the monitor well ring around PA #1 and PA #2 remains continuous with approximately 500 ft between the wells.

Table 13-1
Water Quality Data and Upper Control Limits
Overlying Monitor Wells (MON Wells)
Summary Sheet

Upper Control Limit Parameters	n Sample Events	Minimum Value	Maximum Value	MEAN	Standard Deviation	k Factor α=0.05/P=0.99, n=78	Tolerance Minimum	Tolerance Maximum	Mean without Outliers	Standard Deviation without Outliers	Standard Deviation x 5	UCL
						LQD Guideline 4						
Alkalinity, Total as CaCO3 mg/L	28	118	213	131	16.48	3.35	115	142	128	4.04	20	**148**
Chloride mg/L	28	5	9	6	0.65	NA				NA		**21**
Conductivity @ 25 C umhos/cm	28	342	603	522	58.90	3.35	407	662	535	38.08	190	**725**

Table 13-1
Water Quality Data and Upper Control Limits
Overlying Monitor Wells (MON Wells)

Production Area #2 Overlying Monitoring Wells (MON-14 thru MON-20)			MON-14	MON-14	MON-14	MON-14	MON-15	MON-15	MON-15	MON-15	MON-16	MON-16	MON-16	MON-16	MON-17	MON-17	MON-17	MON-17	MON-18	MON-18	MON-18
Sampling Dates			1/14/2016	2/18/2016	4/21/2016	5/20/2016	1/26/2016	2/25/2016	5/9/2106	5/25/2016	1/19/2016	2/17/2016	5/4/2016	5/20/2016	1/27/2016	2/24/2106	5/5/2016	5/26/2016	1/7/2016	2/11/2016	4/14/2016
Upper Control Limit Parameters	**Units**	Laboratory RL	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS
Alkalinity, Total as CaCO3	mg/L	5	127	128	124	129	133	132	125	125	128	122	118	125	213	132	128	126	138	129	128
Chloride	mg/L	1	6	6	6	6	6	6	6	6	6	6	7	6	9	6	6	5	6	6	6
Conductivity	µmhos/cm	5	542	562	342	574	585	552	572	576	583	576	551	603	378	474	496	490	498	487	500
			RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS
Alkalinity, Bicarbonate as HCO3	mg/L	5	146	145	143	148	134	138	139	137	141	135	131	140	226	149	143	144	156	149	147
Alkalinity, Carbonate as CO3	mg/L	5	ND	5	ND	ND	14	11	7	7	7	7	6	6	16	6	7	5	6	ND	ND
Alkalinity, Total as CaCO3	mg/L	5	127	128	124	129	133	132	125	125	128	122	118	125	213	132	128	126	138	129	128
Aluminum	mg/L	0.1	ND	ND			ND	ND			ND	ND			ND	ND			ND	ND	ND
Arsenic	mg/L	0.001	0.003	0.004	0.005	0.003	0.004	0.004	0.004	0.005	0.004	0.003	0.003	0.004	ND	0.005	0.005	0.006	0.005	0.005	0.005
Barium	mg/L	0.1	ND	ND			ND	ND			ND	ND			ND	ND			ND	ND	ND
Boron	mg/L	0.1	ND	ND			ND	ND			ND	ND			ND	ND			ND	ND	ND
Cadmium	mg/L	0.0	ND	ND			ND	ND			ND	ND			ND	ND			ND	ND	ND
Calcium	mg/L	1	6	6	6	6	5	5	6	6	6	6	6	6	3	5	5	5	6	5	6
Chloride	mg/L	1.0	6	6	6	6	6	6	6	6	6	6	7	6	9	6	6	5	6	6	6
Chromium	mg/L	0.05	ND	ND			ND	ND			ND	ND			ND	ND			ND	ND	ND
Conductivity	µmhos/cm	5	542	562	342	574	585	552	572	576	583	576	551	603	378	474	496	490	498	487	500
Copper	mg/L	0.01	ND	ND			ND	ND			ND	ND			ND	ND			ND	ND	ND
Fluoride	mg/L	0.1	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.3	0.2	0.2	0.2	0.6	0.3	0.3	0.3	0.3	0.3	0.3
Gross Alpha	pCi/L	2.0	23	32.5	23	24.3	28.1	25.1	34	25.5	22.1	35.6	26	24.2	ND	19	15.4	17.1	15.2	14.1	15.5
Gross Beta	pCi/L	3.0	4.3	13.1	7.1	9.4	23.3	14.1	10.1	10.5	7.7	17	12.4	9.4	5.2	19.2	6	7.4	5.5	5.7	5.6
Iron	mg/L	**0.05**	ND	ND			ND	ND			ND	ND			ND	ND		0.13	ND	ND	ND
Lead	mg/L	0.001	ND	ND			ND	ND			ND	ND			ND	ND			ND	ND	ND
Magnesium	mg/L	1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Manganese	mg/L	0.01	ND	ND			ND	ND			ND	ND			ND	ND			ND	ND	ND
Mercury	mg/L	0.001	ND	ND			ND	ND			ND	ND			ND	ND			ND	ND	ND
Molybdenum	mg/L	0.1	ND	ND			ND	ND			ND	ND			ND	ND			ND	ND	ND
Nickel	mg/L	0.05	ND	ND			ND	ND			ND	ND			ND	ND			ND	ND	ND
Nitrogen, Ammonia as N	mg/L	0.05	ND	ND			ND	ND			ND	ND			ND	ND			0.07	ND	ND
Nitrogen, Nitrite as N	mg/L	0.1	ND	ND			ND	ND			ND	ND			ND	ND			ND	ND	ND
pH	s.u.	0.1	8.7	8.7	8.6	8.6	9.1	9.1	8.8	8.9	8.8	8.8	8.9	8.7	9	8.8	8.9	8.7	8.7	8.6	8.6
Potassium	mg/L	1	2	2	2	2	8	8	5	5	4	4	4	4	2	3	3	3	2	2	2
Radium 226	pCi/L	0.2	ND	1.2	ND	ND	ND	ND			ND	0.9	ND	0.3	ND	0.9	ND	ND	ND	0.3	0.2
Radium 228	pCi/L	1	ND	ND			ND	ND			ND	ND			ND	ND			ND	ND	ND
Selenium	mg/L	0.001	ND	ND			ND	ND			ND	ND			ND	ND			ND	ND	ND
Silica as SiO2	mg/L	0.1	8	8.1	7.7	8.2	8	8.1	9	8.2	8.4	8.2	8.4	8.2	8.9	7.9	7.9	7.6	8.2	7.6	8
Sodium	mg/L	1	103	106	100	105	120	116	122	117	106	109	112	111	96	97	96	94	102	96	98
Sulfate	mg/L	2	118	117	118	118	138	132	134	124	124	132	136	133	4	91	94	94	95	97	94
Total Dissolved Solids (180)	mg/L	10	320	290	330	330	390	360	350	360	340	320	340	350	230	290	300	300	300	320	290
Uranium	mg/L	0.0003	0.0276	0.0312	0.031	0.0279	0.0358	0.0366	0.0345	0.0324	0.0338	0.0258	0.0273	0.032	ND	0.0129	0.0128	0.0172	0.0121	0.0118	0.0129
Vanadium	mg/L	0.1	ND	ND			ND	ND			ND	ND			ND	ND			ND	ND	ND
Zinc	mg/L	0.01	ND	ND			ND	ND			ND	ND			ND	ND			ND	ND	ND
Sodium Adsorption Ratio	calculation	0.1	11.6	12.2	11.2	12	15.3	14.7	13.4	12.7	11.7	12.1	12.5	12.4	14.9	12	12	11.9	11.9	11.3	11.4

Table 13-1
Water Quality Data and Upper Control Limits
Overlying Monitor Wells (MON Wells)

Table 13-1

Production Area #2 Overlying Monitoring Wells (MON-14 thru MON-20)			**MON-18**	**MON-19**	**MON-19**	**MON-19**	**MON-19**	**MON-20**	**MON-20**	**MON-20**	**MON-20**									
Sampling Dates			5/12/2016	1/11/2016	2/10/2016	4/13/2016	5/18/2016	1/6/2016	2/9/2016	4/12/2016	5/19/2016									
Upper Control Limit Parameters	**Units**	**Laboratory RL**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**n Sample Events**	**Minimum Value**	**Maximum Value**	**MEAN**	**Standard Deviation**	**k Factor α=0.05/P=0.99, n=28 Guideline 4**	**Tolerance Minimum**	**Tolerance Maximum**	**Mean without Outliers**
Alkalinity, Total as CaCO3	mg/L	5	125	133	133	130	130	129	132	128	128	28	118	213	131	16.48	3.350	115	142	128
Chloride	mg/L	1	6	6	6	7	6	6	6	6	6	28	5	9	6	0.65	NA			
Conductivity	µmhos/cm	5	482	552	531	551	547	503	500	506	513	28	342	603	522	58.90	3.350	407	662	535
			RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS									
Alkalinity, Bicarbonate as HCO3	mg/L	5	145	149	149	148	146	141	149	144	150									
Alkalinity, Carbonate as CO3	mg/L	5	ND	7	6	5	6	8	6	6	ND									
Alkalinity, Total as CaCO3	mg/L	5	125	133	133	130	130	129	132	128	128									
Aluminum	mg/L	0.1		ND	ND			ND	0.1	ND	ND									
Arsenic	mg/L	0.001	0.005	0.005	0.004	0.004	0.004	0.003	0.004	0.003	0.004									
Barium	mg/L	0.1		ND	ND			ND	ND											
Boron	mg/L	0.1		ND	ND			ND	ND											
Cadmium	mg/L	0.0		ND	ND			ND	ND											
Calcium	mg/L	1	5	6	6	6	6	5	6	6	5									
Chloride	mg/L	1.0	6	6	6	7	6	6	6	6	6									
Chromium	mg/L	0.05		ND	ND			ND	ND											
Conductivity	µmhos/cm	5	482	552	531	551	547	503	500	506	513									
Copper	mg/L	0.01		ND	ND			ND	ND											
Fluoride	mg/L	0.1	0.3	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3									
Gross Alpha	pCi/L	2.0	15	22.5	16.5	18.2	17.9	14.6	24.6	15.4	25.1									
Gross Beta	pCi/L	3.0	6.4	5.9	7.7	6.4	9	3.7	13.5	5.7	26.5									
Iron	mg/L	**0.05**		ND	ND			ND	ND											
Lead	mg/L	0.001		ND	ND			ND	ND											
Magnesium	mg/L	1	ND	ND	ND	ND	ND	ND	ND	ND	ND									
Manganese	mg/L	0.01		ND	ND			ND	ND											
Mercury	mg/L	0.001		ND	ND			ND	ND											
Molybdenum	mg/L	0.1		ND	ND			ND	ND											
Nickel	mg/L	0.05		ND	ND			ND	ND											
Nitrogen, Ammonia as N	mg/L	0.05	ND	ND	ND			ND	0.27	ND	ND									
Nitrogen, Nitrite as N	mg/L	0.1		ND	ND			ND	ND											
pH	s.u.	0.1	8.6	8.8	8.7	8.7	8.7	8.8	8.7	8.7	8.6									
Potassium	mg/L	1	2	2	2	2	2	2	2	2	2									
Radium 226	pCi/L	0.2	ND	0.3	0.2	0.4	ND	ND	0.7	0.5	0.3									
Radium 228	pCi/L	1		ND	ND			ND	ND											
Selenium	mg/L	0.001		ND	ND			ND	ND											
Silica as SiO2	mg/L	0.1	7.6	9.2	8.8	8.4	8.6	8.1	8.3	8.8	8.1									
Sodium	mg/L	1	93	109	103	101	101	99	96	101	93									
Sulfate	mg/L	2	101	110	116	111	114	89	100	97	98									
Total Dissolved Solids (180)	mg/L	10	310	340	320	310	330	310	320	300	310									
Uranium	mg/L	0.0003	0.0149	0.0202	0.0159	0.0167	0.0178	0.0102	0.0128	0.0113	0.0119									
Vanadium	mg/L	0.1		ND	ND			ND	ND											
Zinc	mg/L	0.01		ND	ND			ND	ND											
Sodium Adsorption Ratio	calculation	0.1	11.4	12.6	11.6	11.4	11.2	11.9	11.2	11.3	10.9									

Values in red boxes are outliers

Table 13-1
Water Quality Data and Upper Control Limits
Overlying Monitor Wells (MON Wells)

Production Area #2 Overlying Monitoring Wells (MON-14 thru MON-20)					
Sampling Dates					
Upper Control Limit Parameters	**Units**	**Laboratory RL**	**Standard Deviation without Outliers**	**Standard Deviation x 5**	**UCL Value**
Alkalinity, Total as CaCO3	mg/L	5	4.04	20	148
Chloride	mg/L	1	NA		21
Conductivity	µmhos/cm	5	38.08	190	725
Alkalinity, Bicarbonate as HCO3	mg/L	5			
Alkalinity, Carbonate as CO3	mg/L	5			
Alkalinity, Total as CaCO3	mg/L	5			
Aluminum	mg/L	0.1			
Arsenic	mg/L	0.001			
Barium	mg/L	0.1			
Boron	mg/L	0.1			
Cadmium	mg/L	0.0			
Calcium	mg/L	1			
Chloride	mg/L	1.0			
Chromium	mg/L	0.05			
Conductivity	µmhos/cm	5			
Copper	mg/L	0.01			
Fluoride	mg/L	0.1			
Gross Alpha	pCi/L	2.0			
Gross Beta	pCi/L	3.0			
Iron	mg/L	**0.05**			
Lead	mg/L	0.001			
Magnesium	mg/L	1			
Manganese	mg/L	0.01			
Mercury	mg/L	0.001			
Molybdenum	mg/L	0.1			
Nickel	mg/L	0.05			
Nitrogen, Ammonia as N	mg/L	0.05			
Nitrogen, Nitrite as N	mg/L	0.1			
pH	s.u.	0.1			
Potassium	mg/L	1			
Radium 226	pCi/L	0.2			
Radium 228	pCi/L	1			
Selenium	mg/L	0.001			
Silica as SiO2	mg/L	0.1			
Sodium	mg/L	1			
Sulfate	mg/L	2			
Total Dissolved Solids (180)	mg/L	10			
Uranium	mg/L	0.0003			
Vanadium	mg/L	0.1			
Zinc	mg/L	0.01			
Sodium Adsorption Ratio	calculation	0.1			

Table 13-2
Water Quality and Upper Control Limits
Monitor Ring Wells (MRN Wells)
Summary Sheet

Upper Control Limit Parameters	n Sample Events	Minimum Value	Maximum Value	MEAN	Standard Deviation	k Factor α=0.05/P= 0.99, n=96	Tolerance Minimum	Tolerance Maximum	Mean without Outliers	Standard Deviation without Outliers	Standard Deviation x 5	UCL
						LQD Guideline 4						
Alkalinity, Total as CaCO3 mg/L	96	117	145	133	6	3	117	148	133	5.32	28	**161**
Chloride mg/L	96	4	10	6	0.8	NA					NA	**21**
Conductivity @ 25 C umhos/cm	96	443	591	517	34	3	421	613	517	32.77	164	**681**

Table 13-2
Water Quality and Upper Control Limits
Monitor Ring Wells (MRN Wells)

Production Area #2 MRN Monitoring Wells (MRN-35 thru MRN-58)		**Well ID**	**MRN-35**	**MRN-35**	**MRN-35**	**MRN-35**	**MRN-36**	**MRN-36**	**MRN-36**	**MRN-36**	**MRN-37**	**MRN-37**	**MRN-37**	**MRN-37**	**MRN-38**	**MRN-38**	**MRN-38**	**MRN-38**	**MRN-39**	**MRN-39**
Sampling Dates			12/9/2015	2/18/2016	4/20/2016	5/18/2016	12/9/2015	2/11/2016	4/20/2016	5/18/2016	11/24/2015	1/13//16	2/29/2016	4/21/2016	12/10/2015	2/24/2016	4/20/2016	5/19/2016	12/30/2015	2/25/2016
Upper Control Limit Parameters	**Units**	**Laboratory RL**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**
Alkalinity, Total as CaCO3	mg/L	5	131	129	124	126	137	133	121	134	144	134	132	129	133	134	130	130	136	137
Chloride	mg/L	1	6	6	6	6	6	6	6	6	6	6	6	6	6	5	6	6	5	6
Conductivity	µmhos/cm	5	537	545	511	537	542	518	499	519	542	513	499	498	514	481	503	503	486	452
			RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS
Alkalinity, Bicarbonate as HCO3	mg/L	5	144	144	146	144	128	142	131	145	149	148	146	148	149	155	146	146	144	150
Alkalinity, Carbonate as CO3	mg/L	5	8	7	ND	5	19	10	8	9	13	7	8	ND	6	ND	6	6	11	8
Alkalinity, Total as CaCO3	mg/L	5	131	129	124	126	137	133	121	134	144	134	132	129	133	134	130	130	136	137
Aluminum	mg/L	0.1	0.1	ND	ND	ND	ND	ND			ND	ND			ND	ND			ND	ND
Arsenic	mg/L	0.001	0.003	0.002	0.002	0.002	0.002	0.001	0.002	0.002	0.001	0.002	0.002	0.002	0.003	0.002	0.002	0.002	0.002	0.001
Barium	mg/L	0.1	ND	ND			ND	ND			ND	ND			ND	ND			ND	ND
Boron	mg/L	0.1	ND	ND			ND	ND			ND	ND			ND	ND			ND	ND
Cadmium	mg/L	0.0	ND	ND			ND	ND			ND	ND			ND	ND			ND	ND
Calcium	mg/L	1	4	4	4	5	4	4	2	2	4	3	4	5	5	5	4	4	3	3
Chloride	mg/L	1.0	6	6	6	6	6	6	6	6	6	6	6	6	6	5	6	6	5	6
Chromium	mg/L	0.05	ND	ND			ND	ND			ND	ND			ND	ND			ND	ND
Conductivity	µmhos/cm	5	537	545	511	537	542	518	499	519	542	513	499	498	514	481	503	503	486	452
Copper	mg/L	0.01	ND	ND			ND	ND			ND	ND			ND	ND			ND	ND
Fluoride	mg/L	0.1	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Gross Alpha	pCi/L	2.0	7.3	3.2	ND	6.1	3.5	29.2	ND	2.1	ND	ND			10.3	2.9	ND	ND	ND	2.4
Gross Beta	pCi/L	3.0	9.5	4.4	7.4	6.5	8.1	15.1	3.4	4.2	3.9	3.5	6.3	ND	7.4	3.8	ND	ND	4.2	7.4
Iron	mg/L	**0.05**	ND	ND			ND	ND			ND	ND			ND	ND			ND	ND
Lead	mg/L	0.001	ND	ND			ND	ND			ND	ND			ND	ND			ND	ND
Magnesium	mg/L	1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Manganese	mg/L	0.01	ND	ND	ND		ND	ND			ND	ND			ND	ND			ND	ND
Mercury	mg/L	0.001	ND	ND			ND	ND			ND	ND			ND	ND			ND	ND
Molybdenum	mg/L	0.1	ND	ND			ND	ND			ND	ND			ND	ND			ND	ND
Nickel	mg/L	0.05	ND	ND			ND	ND			ND	ND			ND	ND			ND	ND
Nitrogen, Ammonia as N	mg/L	0.05	ND	ND			ND	0.05	0.05	0.07	0.05	ND	ND	ND	0.05	ND	ND	ND	0.07	ND
Nitrogen, Nitrite as N	mg/L	0.1	ND	ND			ND	ND			ND	ND			ND	ND			ND	ND
pH	s.u.	0.1	8.9	8.8	8.5	8.8	9.4	8.9	8.9	9	9.4	8.9	8.9	8.7	8.8	8.6	8.7	8.7	9	8.8
Potassium	mg/L	1	2	2	2	2	5	4	3	4	3	3	3	2	2	2	2	2	3	2
Radium 226	pCi/L	0.2	0.2	1	ND	0.2	0.3	0.3	ND	ND	ND	ND			0.3	0.4	0.4	0.4	ND	0.3
Radium 228	pCi/L	1	ND	ND			ND	ND			ND	ND			ND	ND			1	ND
Selenium	mg/L	0.001	ND	ND			ND	ND			ND	ND			ND	ND			ND	ND
Silica as SiO2	mg/L	0.1	9.9	9.7	9.5	9.9	8.9	8.8	8.8	9.2	9	9.8	9.8	9.2	9.3	9.7	9.3	9.3	9	8.9
Sodium	mg/L	1	105	102	98	102	104	104	95	99	105	101	97	94	101	101	94	94	98	97
Sulfate	mg/L	2	107	108	109	109	100	104	102	103	99	99	95	96	95	94	96	96	85	92
Total Dissolved Solids (180)	mg/L	10	340	280	330	320	320	350	310	310	320	300	320	300	290	300	310	310	310	290
Uranium	mg/L	0.0003	ND	ND			ND	ND			ND	ND			ND	0.0003	ND	ND	ND	ND
Vanadium	mg/L	0.1	ND	ND			ND	ND			ND	ND			ND	ND			ND	ND
Zinc	mg/L	0.01	ND	ND			ND	ND			ND	ND			ND	ND	ND	ND	ND	ND
Sodium Adsorption Ratio	calculation	0.1	14.4	14	13	13	15	15.1	17	17.8	15.3	15.1	14.2	12	12.7	13	12.4	12.7	14.5	14.9

Table 13-2
Water Quality and Upper Control Limits
Monitor Ring Wells (MRN Wells)

Production Area #2 MRN Monitoring Wells (MRN-35 thru MRN-58)		**Well ID**	**MRN-39**	**MRN-39**	**MRN-40**	**MRN-40**	**MRN-40**	**MRN-40**	**MRN-41**	**MRN-41**	**MRN-41**	**MRN-41**	**MRN-42**	**MRN-42**	**MRN-42**	**MRN-42**	**MRN-43**	**MRN-43**	**MRN-43**	**MRN-43**
Sampling Dates			4/21/2016	5/19/2016	12/31/2015	1/28/2016	3/3/2016	4/20/2016	12/31/2015	1/28/2016	3/3/2016	4/21/2016	12/31/2015	1/27/2016	4/21/2016	5/19/2016	12/30/2015	1/28/2016	3/3/2016	4/13/2016
Upper Control Limit Parameters	**Units**	**Laboratory RL**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**
Alkalinity, Total as CaCO3	mg/L	5	131	133	132	135	137	132	134	136	137	133	138	141	137	135	140	141	142	137
Chloride	mg/L	1	5	5	7	7	5	6	5	5	5	5	5	8	5	5	5	10	5	5
Conductivity	µmhos/cm	5	452	472	491	467	511	488	467	469	507	466	493	471	443	470	482	477	511	491
			RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS
Alkalinity, Bicarbonate as HCO3	mg/L	5	143	151	142	149	151	147	153	150	155	150	155	168	156	155	150	152	159	146
Alkalinity, Carbonate as CO3	mg/L	5	8	6	9	8	8	7	5	8	6	6	6	ND	6	5	11	9	7	10
Alkalinity, Total as CaCO3	mg/L	5	131	133	132	135	137	132	134	136	137	133	138	141	137	135	140	141	142	137
Aluminum	mg/L	0.1			ND	ND			0.1	2.5	ND	ND	ND	ND			ND	0.7	ND	ND
Arsenic	mg/L	0.001	0.002	0.201	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.001	0.001	ND	ND	0.001	0.001	0.001	0.001
Barium	mg/L	0.1			ND	ND			ND	ND			ND	ND			ND	ND		ND
Boron	mg/L	0.1			ND	ND			ND	ND			ND	ND			ND	ND		ND
Cadmium	mg/L	0.0			ND	ND			ND	ND			ND	ND			ND	ND		ND
Calcium	mg/L	1	3	3	3	4	4	4	3	3	3	3	4	5	5	4	5	5	5	4
Chloride	mg/L	1.0	5	5	7	7	5	6	5	5	5	5	5	8	5	5	5	10	5	5
Chromium	mg/L	0.05			ND	ND			ND	ND			ND	ND			ND	ND		ND
Conductivity	µmhos/cm	5	452	472	491	467	511	488	467	469	507	466	493	471	443	470	482	477	511	491
Copper	mg/L	0.01			ND	ND			ND	ND			ND	ND			ND	ND		ND
Fluoride	mg/L	0.1	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Gross Alpha	pCi/L	2.0	ND	ND	ND	ND	2.2		2.8	ND	2	ND	ND	ND			4.1	2.6	ND	ND
Gross Beta	pCi/L	3.0	ND	4	5	4.6	4.9	4.6	5.1	4.2	4.8	3.3	ND	8.4	ND	3.6	6.7	5.2	4.3	5.1
Iron	mg/L	**0.05**			ND	ND			ND	ND			ND	ND			ND	0.3	ND	ND
Lead	mg/L	0.001			ND	ND			ND	ND			ND	ND			ND	ND		ND
Magnesium	mg/L	1	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND		ND	ND	ND	ND	ND
Manganese	mg/L	0.01			ND	ND			ND	ND			ND	ND			ND	ND		ND
Mercury	mg/L	0.001			ND	ND			ND	ND			ND	ND			ND	ND		ND
Molybdenum	mg/L	0.1			ND	ND			ND	ND			ND	ND			ND	ND		ND
Nickel	mg/L	0.05			ND	ND			ND	ND			ND	ND			ND	ND		ND
Nitrogen, Ammonia as N	mg/L	0.05	ND	0.05	ND	ND			0.11	ND	ND	ND	ND	ND			ND	ND		ND
Nitrogen, Nitrite as N	mg/L	0.1			ND	0.1	ND	ND	ND	ND			ND	ND			ND	ND		ND
pH	s.u.	0.1	8.9	8.7	8.9	8.8	8.9	8.8	8.7	8.9	8.8	8.8	8.6	8.4	8.7	8.7	9	8.9	8.8	9
Potassium	mg/L	1	3	3	3	3	3	3	3	4	4	3	2	2	2	2	4	4	4	4
Radium 226	pCi/L	0.2	ND	ND	ND	ND			ND	ND			ND	0.3	0.7	ND	ND	ND		0.4
Radium 228	pCi/L	1	ND	ND	ND	ND			ND	ND			ND	ND			ND	ND		ND
Selenium	mg/L	0.001			ND	ND			ND	ND			ND	ND			ND	ND		ND
Silica as SiO2	mg/L	0.1	9	9.2	8.4	10.2	9.4	9	8.8	24.7	9.9	9.1	8.6	9	9	9.2	9.4	14.1	9.5	9
Sodium	mg/L	1	94	98	103	103	97	95	95	103	97	92	96	103	92	98	100	103	98	93
Sulfate	mg/L	2	86	87	100	90	88	90	82	86	84	85	83	86	82	84	85	87	87	86
Total Dissolved Solids (180)	mg/L	10	290	290	300	300	300	300	310	300	300	290	300	290	290	280	320	300	290	280
Uranium	mg/L	0.0003			ND	ND			ND	ND			0.0004	0.0004	0.0004	0.0005	0.0006	0.0003	0.0004	0.0005
Vanadium	mg/L	0.1			ND	ND			ND	ND			ND	ND			ND	ND		ND
Zinc	mg/L	0.01			ND	ND			ND	ND			ND	ND			ND	ND		ND
Sodium Adsorption Ratio	calculation	0.1	14.5	15	15.2	14.8	13.5	13.4	15.8	16.4	14.8	14.1	13	13.2	11.8	13.1	12.5	12.9	12.3	13.2

Table 13-2
Water Quality and Upper Control Limits
Monitor Ring Wells (MRN Wells)

Production Area #2 MRN Monitoring Wells (MRN-35 thru MRN-58)		Well ID	MRN-44	MRN-44	MRN-44	MRN-44	MRN-45	MRN-45	MRN-45	MRN-45	MRN-46	MRN-46	MRN-46	MRN-46	MRN-47	MRN-47	MRN-47	MRN-47	MRN-48	MRN-48
Sampling Dates			11/24/2015	1/13/2016	3/3/2016	4/7/2016	12/9/2015	1/13/2016	2/25/2016	4/12/2016	12/9/2015	1/13/2016	2/25/2016	3/31/2016	12/10/2015	1/13/2016	2/25/2016	4/12/2016	12/10/2015	1/13/2016
Upper Control Limit Parameters	**Units**	**Laboratory RL**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**
Alkalinity, Total as CaCO3	mg/L	5	133	137	138	138	142	137	137	131	145	144	143	142	137	137	137	135	140	133
Chloride	mg/L	1	5	5	5	5	5	5	5	5	5	5	5	5	5	5	6	6	6	6
Conductivity	µmhos/cm	5	540	498	507	507	527	490	457	495	505	492	455	566	518	500	462	498	524	514
			RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS
Alkalinity, Bicarbonate as HCO3	mg/L	5	132	147	154	154	151	150	153	144	154	156	160	155	148	150	152	150	156	147
Alkalinity, Carbonate as CO3	mg/L	5	15	10	7	7	11	9	7	8	11	9	7	9	9	9	7	7	7	7
Alkalinity, Total as CaCO3	mg/L	5	133	137	138	138	142	137	137	131	145	144	143	142	137	137	137	135	140	133
Aluminum	mg/L	0.1	ND	ND			ND	ND			ND	ND			ND	ND			ND	ND
Arsenic	mg/L	0.001	0.001	0.001	0.001	0.001	ND	0.001	0.001	0.001	0.001	0.001	ND	ND	0.001	0.001	0.001	ND	0.001	0.001
Barium	mg/L	0.1	ND	ND			ND	ND			ND	ND			ND	ND			ND	ND
Boron	mg/L	0.1	ND	ND			ND	ND			ND	ND			ND	ND			ND	ND
Cadmium	mg/L	0.0	ND	ND			ND	ND			ND	ND			ND	ND			ND	ND
Calcium	mg/L	1	4	4	5	5	5	5	5	3	5	5	5	5	5	5	5	5	5	4
Chloride	mg/L	1.0	5	5	5	5	5	5	5	5	5	5	5	5	5	5	6	6	6	6
Chromium	mg/L	0.05	ND	ND			ND	ND			ND	ND			ND	ND			ND	ND
Conductivity	µmhos/cm	5	540	498	507	507	527	490	457	495	505	492	455	566	518	500	462	498	524	514
Copper	mg/L	0.01	ND	ND			ND	ND			ND	ND			ND	ND			ND	ND
Fluoride	mg/L	0.1	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Gross Alpha	pCi/L	2.0	ND	ND			2.7	2.3	2.8	2.2	2.8	ND	4.3	2.5	8.1	ND	3.6	2.4	10.8	ND
Gross Beta	pCi/L	3.0	ND	ND			6	3.8	5.5	3.7	8.1	ND	5	ND	6.2	ND	3.4	3.1	10.5	ND
Iron	mg/L	**0.05**	ND	ND			ND	ND			ND	ND			ND	ND			ND	ND
Lead	mg/L	0.001	ND	ND			ND	ND			ND	ND			ND	ND			ND	ND
Magnesium	mg/L	1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND	ND
Manganese	mg/L	0.01	ND	ND			ND	ND			ND	ND			ND	ND			ND	ND
Mercury	mg/L	0.001	ND	ND			ND	ND			ND	ND			ND	ND			ND	ND
Molybdenum	mg/L	0.1	ND	ND			ND	ND			ND	ND			ND	ND			ND	ND
Nickel	mg/L	0.05	ND	ND			ND	ND			ND	ND			ND	ND			ND	ND
Nitrogen, Ammonia as N	mg/L	0.05	ND	ND			0.05	ND	ND	ND	0.07	ND	ND	ND	ND	ND		ND	ND	ND
Nitrogen, Nitrite as N	mg/L	0.1	ND	ND			ND	ND			ND	ND			ND	ND			ND	ND
pH	s.u.	0.1	9.1	9	8.8	8.8	9	8.9	8.9	8.9	9	8.9	8.8	8.9	8.9	8.9	8.8	8.8	8.8	8.8
Potassium	mg/L	1	3	3	3	3	4	3	3	4	3	3	3	2	2	2	2	2	2	2
Radium 226	pCi/L	0.2	ND	ND			2.4	0.2	0.3	ND	0.2	0.2	0.3	0.4	0.7	ND	ND	0.4	1.1	0.2
Radium 228	pCi/L	1	1.2	ND	ND	ND	1	ND	ND	ND	ND	ND			ND	ND			1.1	ND
Selenium	mg/L	0.001	ND	ND			ND	ND			ND	ND			ND	ND			ND	ND
Silica as SiO2	mg/L	0.1	8.8	9.2	9.4	9.4	9.2	9.2	8.8	9.7	9.2	9.2	8.8	9.7	9.2	9.4	8.8	10	9	9.1
Sodium	mg/L	1	103	99	98	98	98	95	99	100	97	96	98	104	101	94	99	103	104	101
Sulfate	mg/L	2	88	90	88	88	88	88	90	89	82	84	84	84	92	91	96	91	94	96
Total Dissolved Solids (180)	mg/L	10	300	290	300	300	300	300	300	280	290	290	290	310	310	310	300	290	320	300
Uranium	mg/L	0.0003	0.0005	0.0005	0.0008	0.0008	0.0008	0.0008	0.0007	0.0006	0.001	0.001	0.0009	0.0011	0.0008	0.0008	0.0007	0.0007	0.0006	0.0005
Vanadium	mg/L	0.1	ND	ND			ND	ND			ND	ND			ND	ND			ND	ND
Zinc	mg/L	0.01	ND	ND			ND	ND			ND	ND			ND	ND			ND	ND
Sodium Adsorption Ratio	calculation	0.1	13.8	13.4	12.1	13.4	12.3	11.6	12.6	12.3	12.1	11.7	12.2	12.6	12.2	11.6	12.6	12.2	13	13.2

Table 13-2
Water Quality and Upper Control Limits
Monitor Ring Wells (MRN Wells)

Table 13-2

Production Area #2 MRN Monitoring Wells (MRN-35 thru MRN-58)		Well ID	MRN-48	MRN-48	MRN-49	MRN-49	MRN-49	MRN-49	MRN-50	MRN-50	MRN-50	MRN-50	MRN-51	MRN-51	MRN-51	MRN-51	MRN-52	MRN-52	MRN-52	MRN-52
Sampling Dates			2/25/2016	4/12/2016	12/10/2015	1/13/2016	2/25/2016	4/12/2016	12/10/2015	1/14/2016	3/3/2016	3/31/2016	12/17/2015	1/14/2016	3/3/2016	3/31/2016	12/17/2015	1/14/2016	3/31/2016	4/21/2016
Upper Control Limit Parameters	Units	Laboratory RL	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS
Alkalinity, Total as CaCO3	mg/L	5	135	133	135	137	138	131	128	129	129	130	129	127	129	134	124	127	125	126
Chloride	mg/L	1	6	6	6	6	6	7	6	7	6	6	6	7	6	4	6	6	6	6
Conductivity	µmhos/cm	5	473	511	544	532	492	535	547	541	565	589	549	551	564	505	560	564	505	500
			RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS
Alkalinity, Bicarbonate as HCO3	mg/L	5	152	151	149	152	157	148	144	147	157	146	143	144	150	153	137	142	141	145
Alkalinity, Carbonate as CO3	mg/L	5	6	5	8	7	6	5	6	ND	ND	6	7	6	ND	5	7	6	6	ND
Alkalinity, Total as CaCO3	mg/L	5	135	133	135	137	138	131	128	129	129	130	129	127	129	134	124	127	125	126
Aluminum	mg/L	0.1			ND	ND			ND	ND			ND	ND			ND	ND		
Arsenic	mg/L	0.001	0.001	0.001	0.003	0.002	0.002	0.003	0.002	0.002	0.002	0.001	0.003	0.003	0.003	0.002	0.003	0.003	0.003	0.003
Barium	mg/L	0.1			ND	ND			ND	ND			ND	ND			ND	ND		
Boron	mg/L	0.1			ND	ND			ND	ND			ND	ND			ND	ND		
Cadmium	mg/L	0.0			ND	ND			ND	ND			ND	ND			ND	ND		
Calcium	mg/L	1	5	5	6	6	5	7	5	6	6	6	5	5	6	6	5	5	4	6
Chloride	mg/L	1.0	6	6	6	6	6	7	6	7	6	6	6	7	6	4	6	6	6	6
Chromium	mg/L	0.05			ND	ND			ND	ND			ND	ND			ND	ND		
Conductivity	µmhos/cm	5	473	511	544	532	492	535	547	541	565	589	549	551	564	505	560	564	505	500
Copper	mg/L	0.01			ND	ND			ND	ND			ND	ND			ND	ND		
Fluoride	mg/L	0.1	0.3	0.3	0.3	0.2	0.2	0.2	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Gross Alpha	pCi/L	2.0	4	ND	24.2	19.4	17.1	17.5	18.8	12.6	11.5	11.6	19.4	14.4	15.7	14.9	25.4	17.4	27.5	11.9
Gross Beta	pCi/L	3.0	8.6	3.1	15.5	10	8.7	7.3	10.3	5	6.4	6.2	11	6.9	7.1	5	15.6	7.2	10.6	4.4
Iron	mg/L	**0.05**			ND	ND			ND	ND			ND	ND			ND	ND		
Lead	mg/L	0.001			ND	ND			ND	ND			ND	ND			ND	ND		
Magnesium	mg/L	1	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND		ND	ND		
Manganese	mg/L	0.01			ND	ND			ND	ND			ND	ND			ND	ND		
Mercury	mg/L	0.001			ND	ND			ND	ND			ND	ND			ND	ND		
Molybdenum	mg/L	0.1			ND	ND			ND	ND			ND	ND			ND	ND		
Nickel	mg/L	0.05			ND	ND			ND	ND			ND	ND			ND	ND		
Nitrogen, Ammonia as N	mg/L	0.05			ND	ND			ND	0.05	ND	ND	ND	ND			ND	ND		
Nitrogen, Nitrite as N	mg/L	0.1			ND	ND			ND	ND			ND	ND			ND	ND		
pH	s.u.	0.1	8.8	8.7	8.8	8.8	8.7	8.7	8.8	8.7	8.2	8.9	8.8	8.8	8.6	8.7	8.8	8.8	8.8	8.6
Potassium	mg/L	1	2	2	4	3	2	2	4	3	3	3	3	3	3	3	5	4	5	3
Radium 226	pCi/L	0.2	0.2	0.3	0.5	0.5	0.6	0.9	0.4	ND	0.5	1.2	ND	0.3 ± 0.1	ND	0.8	1.1	0.8	1.6	0.3
Radium 228	pCi/L	1	ND	ND	ND	ND			ND	ND			ND	ND			ND	ND		
Selenium	mg/L	0.001			ND	ND			ND	ND			ND	ND			ND	ND		
Silica as SiO2	mg/L	0.1	8.8	9.3	8.8	8.5	8.3	9.4	8.4	8.2	8.5	8.9	8.1	8.2	8.8	8.6	8.1	8.1	8.5	8.1
Sodium	mg/L	1	103	97	105	101	103	108	111	103	105	113	104	103	107	107	107	104	108	101
Sulfate	mg/L	2	96	95	107	104	110	108	116	117	115	117	119	121	120	119	126	123	122	118
Total Dissolved Solids (180)	mg/L	10	300	300	340	320	330	320	310	320	330	340	340	330	330	330	350	330	340	330
Uranium	mg/L	0.0003	0.0006	0.0005	0.0105	0.0103	0.0097	0.0107	0.0072	0.0069	0.0081	0.0076	0.0075	0.0069	0.0097	0.0084	0.0137	0.0133	0.0167	0.0088
Vanadium	mg/L	0.1			ND	ND			ND	ND			ND	ND			ND	ND		
Zinc	mg/L	0.01			ND	ND			ND	ND			ND	ND			ND	ND		
Sodium Adsorption Ratio	calculation	0.1	13	12.4	12.3	11.8	12.2	11.6	13.2	12	11.9	12.9	12.4	12.3	12.1	12.4	12.7	13	14.1	11.5

Table 13-2
Water Quality and Upper Control Limits
Monitor Ring Wells (MRN Wells)

Production Area #2 MRN Monitoring Wells (MRN-35 thru MRN-58)		Well ID	MRN-53	MRN-53	MRN-53	MRN-53	MRN-54	MRN-54	MRN-54	MRN-54	MRN-55	MRN-55	MRN-55	MRN-55	MRN-56	MRN-56	MRN-56	MRN-56	MRN-57	MRN-57
Sampling Dates			12/30/2015	2/11/2016	4/14/2016	5/20/2016	12/29/2015	1/14/2016	3/31/2016	5/19/2016	12/17/2015	2/11/2016	4/12/2016	5/19/2016	12/17/2015	2/15/2016	4/13/2016	5/5/2016	12/10/2015	2/15/2016
Upper Control Limit Parameters	**Units**	**Laboratory RL**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**
Alkalinity, Total as CaCO3	mg/L	5	132	130	130	133	132	130	125	144	130	130	126	128	132	130	129	129	124	127
Chloride	mg/L	1	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
Conductivity	µmhos/cm	5	568	555	557	591	567	552	498	519	545	547	554	549	546	515	551	555	559	516
			RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS
Alkalinity, Bicarbonate as HCO3	mg/L	5	141	145	149	150	137	141	133	162	139	144	142	147	147	154	147	145	131	139
Alkalinity, Carbonate as CO3	mg/L	5	10	7	ND	6	12	9	9	7	10	7	6	ND	7	ND	5	6	10	8
Alkalinity, Total as CaCO3	mg/L	5	132	130	130	133	132	130	125	144	130	130	126	128	132	130	129	129	124	127
Aluminum	mg/L	0.1	ND	ND	ND		ND	ND			ND	ND			0.2	ND	ND	ND	ND	ND
Arsenic	mg/L	0.001	0.003	0.003	0.004	0.004	0.003	0.003	0.003	0.005	0.004	0.004	0.002	0.004	0.002	0.002	0.003	0.003	0.004	0.003
Barium	mg/L	0.1	ND	ND	ND		ND	ND			ND	ND			ND	ND	ND		ND	ND
Boron	mg/L	0.1	ND	ND	ND		ND	ND			ND	ND			ND	ND	ND		ND	ND
Cadmium	mg/L	0.0	ND	ND	ND		ND	ND			ND	ND			ND	ND	ND		ND	ND
Calcium	mg/L	1	4	5	5	5	4	4	3	3	3	4	4	4	6	6	6	6	4	4
Chloride	mg/L	1.0	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
Chromium	mg/L	0.05	ND	ND	ND		ND	ND			ND	ND			ND	ND	ND		ND	ND
Conductivity	µmhos/cm	5	568	555	557	591	567	552	498	519	545	547	554	549	546	515	551	555	559	516
Copper	mg/L	0.01	ND	ND	ND		ND	ND			ND	ND			ND	ND	ND		ND	ND
Fluoride	mg/L	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.2
Gross Alpha	pCi/L	2.0	14.6	13.9	34.9	14.1	19.9	14.7	13.8	14.2	14.4	17.1	16.2	14.7	25.1	41.6	17.7	19.7	20.3	18.4
Gross Beta	pCi/L	3.0	7.4	8.6	42.3	8.2	9.2	7.1	7.2	8.8	7	12.6	7.6	8.2	7.2	19.7	7.4	7.8	10.8	9.3
Iron	mg/L	**0.05**	ND	ND	ND		ND	ND			ND	ND			0.07	ND	ND	ND	ND	ND
Lead	mg/L	0.001	ND	ND	ND		ND	ND			ND	ND			ND	ND	ND		ND	ND
Magnesium	mg/L	1	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Manganese	mg/L	0.01	ND	ND	ND		ND	ND			ND	ND			ND	ND	ND		ND	ND
Mercury	mg/L	0.001	ND	ND	ND		ND	ND			ND	ND			ND	ND	ND		ND	ND
Molybdenum	mg/L	0.1	ND	ND	ND		ND	ND			ND	ND			ND	ND	ND		ND	ND
Nickel	mg/L	0.05	ND	ND	ND		ND	ND			ND	ND			ND	ND	ND		ND	ND
Nitrogen, Ammonia as N	mg/L	0.05	ND	ND	ND		0.14	ND	ND	ND	ND	ND			ND	ND	0.08		ND	ND
Nitrogen, Nitrite as N	mg/L	0.1	ND	ND	ND		ND	ND			ND	ND			ND	ND	ND		ND	ND
pH	s.u.	0.1	8.9	8.7	8.7	8.7	9	8.9	9	8.8	9	8.8	8.8	8.6	8.8	8.5	8.7	8.7	9	8.9
Potassium	mg/L	1	6	6	5	6	3	4	4	5	5	4	5	5	3	2	3	2	5	4
Radium 226	pCi/L	0.2	ND	0.7	0.3	ND	0.2	0.4	0.6	0.5	ND	0.7	0.3	ND	1.6	3.6	0.9	0.9	0.4	4.7
Radium 228	pCi/L	1	ND	ND	ND		ND	ND			ND	ND			ND	ND	ND		ND	ND
Selenium	mg/L	0.001	ND	ND	ND		ND	ND			ND	ND			ND	ND	ND		ND	ND
Silica as SiO2	mg/L	0.1	8.2	8.2	8.3	8.4	8.3	8.3	8.7	8.4	8.4	8.4	9.4	8.6	9.4	8.9	8.8	9.1	8.2	8.5
Sodium	mg/L	1	113	110	110	110	110	106	114	107	108	108	113	102	108	106	108	105	107	106
Sulfate	mg/L	2	117	121	119	120	112	116	115	113	114	117	116	117	118	116	122	119	117	118
Total Dissolved Solids (180)	mg/L	10	370	370	330	340	390	320	320	300	340	360	320	330	340	340	320	340	340	350
Uranium	mg/L	0.0003	0.0111	0.0101	0.0115	0.011	0.0097	0.007	0.009	0.01	0.0087	0.0097	0.0076	0.0106	0.0101	0.0085	0.0109	0.0111	0.0104	0.0091
Vanadium	mg/L	0.1	ND	ND	ND		ND	ND			ND	ND			ND	ND	ND		ND	ND
Zinc	mg/L	0.01	ND	ND	ND		ND	ND			ND	ND			ND	ND	ND		ND	ND
Sodium Adsorption Ratio	calculation	0.1	15.4	14.1	13.7	14.2	15.6	15	17.3	18.2	16.3	14.8	15	14.1	11.8	11.7	11.9	11.7	14.4	14.3

Table 13-2
Water Quality and Upper Control Limits
Monitor Ring Wells (MRN Wells)

Production Area #2 MRN Monitoring Wells (MRN-35 thru MRN-58)		Well ID	MRN-57	MRN-57	MRN-58	MRN-58	MRN-58	MRN-58												
Sampling Dates			4/14/2016	5/5/2016	12/10/2015	2/29/2016	4/14/2016	5/5/2016												
Upper Control Limit Parameters	**Units**	**Laboratory RL**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**n Sample Events**	**Minimum Value**	**Maximum Value**	**MEAN**	**Standard Deviation**	**k Factor α=0.05/P=0.99, n=96 Guideline 4**	**Tolerance Minimum**	**Tolerance Maximum**	**Mean without Outliers**	**Standard Deviation without Outliers**	**Standard Deviation x 5**	**UCL Value**
Alkalinity, Total as CaCO3	mg/L	5	124	123	117	127	127	126	96	117	145	133	5.65	2.934	117	148	133	5.319	28	161
Chloride	mg/L	1	6	6	6	6	6	6	96	4	10	6	0.75	NA					NA	21
Conductivity	µmhos/cm	5	547	549	544	536	548	552	96	443	591	517	34.15	2.934	421	613	517	32.77	164	681
			RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS												
Alkalinity, Bicarbonate as HCO3	mg/L	5	142	136	123	142	147	145												
Alkalinity, Carbonate as CO3	mg/L	5	ND	7	10	6	ND	ND						*Values in red boxes are outliers*						
Alkalinity, Total as CaCO3	mg/L	5	124	123	117	127	127	126												
Aluminum	mg/L	0.1	ND		ND	ND	ND													
Arsenic	mg/L	0.001	0.004	0.003	0.004	0.005	0.005	0.004												
Barium	mg/L	0.1	ND		ND	ND	ND													
Boron	mg/L	0.1	ND		ND	ND	ND													
Cadmium	mg/L	0.0	ND		ND	ND	ND													
Calcium	mg/L	1	4	3	3	4	5	6												
Chloride	mg/L	1.0	6	6	6	6	6	6												
Chromium	mg/L	0.05	ND		ND	ND	ND													
Conductivity	µmhos/cm	5	547	549	544	536	548	552												
Copper	mg/L	0.01	ND		ND	ND	ND													
Fluoride	mg/L	0.1	0.2	0.2	0.3	0.2	0.2	0.2												
Gross Alpha	pCi/L	2.0	14.7	16.3	19.5	14.1	17.2	16.4												
Gross Beta	pCi/L	3.0	6.5	7.4	12.1	7	6.9	6.7												
Iron	mg/L	**0.05**	ND		ND	ND	ND													
Lead	mg/L	0.001	ND		ND	ND	ND													
Magnesium	mg/L	1	ND	ND	ND	ND	ND	ND												
Manganese	mg/L	0.01	ND		ND	ND	ND													
Mercury	mg/L	0.001	ND		ND	ND	ND													
Molybdenum	mg/L	0.1	ND		ND	ND	ND													
Nickel	mg/L	0.05	ND		ND	ND	ND													
Nitrogen, Ammonia as N	mg/L	0.05	ND		ND	0.05	ND	0.06												
Nitrogen, Nitrite as N	mg/L	0.1	ND		ND	ND	ND													
pH	s.u.	0.1	8.7	8.9	9	8.8	8.6	8.7												
Potassium	mg/L	1	4	4	3	3	2	2												
Radium 226	pCi/L	0.2	ND	ND	0.3	ND	0.3	ND												
Radium 228	pCi/L	1	ND	ND	ND	ND	ND													
Selenium	mg/L	0.001	ND		ND	ND	ND													
Silica as SiO2	mg/L	0.1	8.6	8.6	8.4	8.6	8.7	9												
Sodium	mg/L	1	107	105	108	107	107	104												
Sulfate	mg/L	2	117	122	116	114	118	122												
Total Dissolved Solids (180)	mg/L	10	320	340	330	330	320	340												
Uranium	mg/L	0.0003	0.0109	0.009	0.0065	0.0078	0.0109	0.0085												
Vanadium	mg/L	0.1	ND		ND	ND	ND													
Zinc	mg/L	0.01	ND		ND	ND	ND													
Sodium Adsorption Ratio	calculation	0.1	15	15.9	16.4	13.9	12.6	12.1												

Table 13-3
Water Quality Data and Upper Control Limits
Underlying Monitor Wells (MUN Wells)
Summary Sheet

Upper Control Limit Parameters	n Sample Events	Minimum Value	Maximum Value	MEAN	Standard Deviation	k Factor α=0.05/P=0.99, n=78	Tolerance Minimum	Tolerance Maximum	Mean without Outliers	Standard Deviation without Outliers	Standard Deviation x 5	UCL
						LQD Guideline 4						
Alkalinity, Total as CaCO3 mg/L	28	204	229	216	6.56	3.3500	198	234	215.6800	5.3207	32.81	**249**
Chloride mg/L	28	4	6	4	0.55	NA					NA	**19**
Conductivity @ 25 C umhos/cm	28	350	432	399	17.39	3.3500	354	446	400.0769	13.6350	68.18	**468**

Table 13-3
Water Quality Data and Upper Control Limits
Underlying Monitor Wells (MUN Wells)

Production Area #2 Underlying Monitoring Wells (MUN-14 thru MUN-20)		**Well ID**	**MUN-14**	**MUN-14**	**MUN-14**	**MUN-14**	**MUN-15**	**MUN-15**	**MUN-15**	**MUN-15**	**MUN-16**	**MUN-16**	**MUN-16**	**MUN-16**	**MUN-17**	**MUN-17**	**MUN-17**	**MUN-17**	**MUN-18**	**MUN-18**
	Sampling Dates		1/14/2016	2/18/2016	4/21/2016	5/20/2016	1/26/2016	2/25/2016	5/9/2106	5/25/2016	1/19/2016	2/17/2016	5/4/2016	5/20/2016	1/27/2016	2/24/2106	5/5/2016	5/26/2016	1/7/2016	2/11/2016
Upper Control Limit Parameters	**Units**	**Laboratory RL**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**
Alkalinity, Total as CaCO3	mg/L	5	217	218	212	221	221	216	208	210	216	218	213	219	212	211	206	206	229	229
Chloride	mg/L	1	4	4	5	4	4	4	4	4	4	5	5	5	6	5	5	5	4	4
Conductivity	µmhos/cm	5	397	417	397	432	393	350	391	397	392	406	394	426	376	368	407	400	419	402
			RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS
Alkalinity, Bicarbonate as HCO3	mg/L	5	238	238	238	246	207	218	221	223	234	238	229	241	229	235	220	221	247	252
Alkalinity, Carbonate as CO3	mg/L	5	13	14	10	12	31	23	16	16	14	14	15	13	15	11	15	15	16	14
Alkalinity, Total as CaCO3	mg/L	5	217	218	212	221	221	216	208	210	216	218	213	219	212	211	206	206	229	229
Aluminum	mg/L	0.1	ND	ND			ND	ND			0.1	ND	0.1	0.1	ND	ND			ND	ND
Arsenic	mg/L	0.001	ND	ND			ND	ND			ND	ND			ND	ND			ND	ND
Barium	mg/L	0.1	ND	ND			ND	ND			ND	ND			ND	ND			ND	ND
Boron	mg/L	0.1	ND	ND			ND	ND			ND	ND			ND	ND			ND	ND
Cadmium	mg/L	0.0	ND	ND			ND	ND			ND	ND			ND	ND			ND	ND
Calcium	mg/L	1	3	3	3	3	4	3	4	4	4	4	3	3	3	3	3	3	4	4
Chloride	mg/L	1.0	4	4	5	4	4	4	4	4	4	5	5	5	6	5	5	5	4	4
Chromium	mg/L	0.05	ND	ND			ND	ND			ND	ND			ND	ND			ND	ND
Conductivity	µmhos/cm	5	397	417	397	432	393	350	391	397	392	406	394	426	376	368	407	400	419	402
Copper	mg/L	0.01	ND	ND			ND	ND			ND	ND			ND	ND			ND	ND
Fluoride	mg/L	0.1	0.6	0.6	0.6	0.5	0.5	0.5	0.5	0.5	0.6	0.5	0.6	0.5	0.6	0.6	0.6	0.6	0.6	0.6
Gross Alpha	pCi/L	2.0	2.1	ND			ND	ND			ND	ND			2.9	ND	6.6	ND	ND	ND
Gross Beta	pCi/L	3.0	3.5	ND			4.5	4.6	5.3	4.2	ND	ND			4.9	ND	10.7	3	3.5	4
Iron	mg/L	**0.05**	ND	ND			ND	ND			ND	ND			ND	ND			ND	ND
Lead	mg/L	0.001	ND	ND			ND	ND			ND	ND			ND	ND			ND	ND
Magnesium	mg/L	1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Manganese	mg/L	0.01	ND	ND			ND	ND			ND	ND			ND	ND			ND	ND
Mercury	mg/L	0.001	ND	ND			ND	ND			ND	ND			ND	ND			ND	ND
Molybdenum	mg/L	0.1	ND	ND			ND	ND			ND	ND			ND	ND			ND	ND
Nickel	mg/L	0.05	ND	ND			ND	ND			ND	ND			ND	ND			ND	ND
Nitrogen, Ammonia as N	mg/L	0.05	0.09	ND	ND	0.1	0.08	0.17	ND	0.09	0.08	0.27	0.07	0.09	ND	ND			0.06	0.07
Nitrogen, Nitrite as N	mg/L	0.1	ND	ND			ND	ND			ND	ND			ND	ND			ND	ND
pH	s.u.	0.1	8.9	8.9	8.8	8.9	9.3	9.2	9	9.1	8.9	8.9	9	8.9	9	8.9	9	9	8.9	8.8
Potassium	mg/L	1	2	2	2	2	4	3	3	3	2	2	2	2	2	2	2	2	3	2
Radium 226	pCi/L	0.2	ND	0.5	ND	ND	ND	0.2	0.4	0.7	ND	0.6	ND	0.3	ND	1.7	ND	ND	0.2	ND
Radium 228	pCi/L	1	ND	ND			ND	ND			ND	ND			ND	ND			ND	ND
Selenium	mg/L	0.001	ND	ND			ND	ND			ND	ND			ND	ND			ND	ND
Silica as SiO2	mg/L	0.1	9.3	9.4	9.2	9.7	9.2	9.2	10.1	9.4	9.7	9.6	9.8	9.8	8.9	9.3	9.5	8.8	9.2	9
Sodium	mg/L	1	89	91	101	92	93	90	93	91	91	91	89	92	97	95	87	86	100	93
Sulfate	mg/L	2	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	2	2	2	2	ND	ND
Total Dissolved Solids (180)	mg/L	10	240	210	240	240	270	240	240	220	250	230	240	250	230	230	240	240	260	280
Uranium	mg/L	0.0003	ND	ND			ND	ND			ND	ND			ND	ND			ND	ND
Vanadium	mg/L	0.1	ND	ND			ND	ND			ND	ND			ND	ND			ND	ND
Zinc	mg/L	0.01	ND	ND			ND	ND			ND	ND			ND	ND			ND	ND
Sodium Adsorption Ratio	calculation	0.1	13.9	14.3	15.9	14.2	13.1	13.6	13.5	13.3	12.8	13.2	14.1	14.1	15.3	14.3	14.6	14.4	14.3	13.3

Table 13-3
Water Quality Data and Upper Control Limits
Underlying Monitor Wells (MUN Wells)

Production Area #2 Underlying Monitoring Wells (MUN-14 thru MUN-20)		Well ID	MUN-18	MUN-18	MUN-19	MUN-19	MUN-19	MUN-19	MUN-20	MUN-20	MUN-20	MUN-20							
	Sampling Dates		4/14/2016	5/12/2016	1/11/2016	2/10/2016	4/13/2016	5/18/2016	1/6/2016	2/9/2016	4/12/2016	5/19/2016							
Upper Control Limit Parameters	**Units**	**Laboratory RL**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**RESULTS**	**n Sample Events**	**Minimum Value**	**Maximum Value**	**MEAN**	**Standard Deviation**	**k Factor α=0.05/P=0.99, n=28 Guideline 4**	**Tolerance Minimum**
Alkalinity, Total as CaCO3	mg/L	5	224	222	223	223	216	217	219	214	210	204	28	204	229	216	6.56	3.350	198
Chloride	mg/L	1	4	4	4	4	4	4	4	4	4	4	28	4	6	4	0.55	NA	
Conductivity	µmhos/cm	5	400	409	405	393	399	423	413	387	383	408	28	350	432	399	17.39	3.350	354

			RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS
Alkalinity, Bicarbonate as HCO3	mg/L	5	252	246	242	258	240	241	220	239	228	235
Alkalinity, Carbonate as CO3	mg/L	5	11	12	15	7	11	12	23	11	14	7
Alkalinity, Total as CaCO3	mg/L	5	224	222	223	223	216	217	219	214	210	204
Aluminum	mg/L	0.1	ND		ND	ND			0.1	ND	ND	ND
Arsenic	mg/L	0.001	ND		ND	ND			ND	ND		
Barium	mg/L	0.1	ND		ND	ND			ND	ND		
Boron	mg/L	0.1	ND		ND	ND			ND	ND		
Cadmium	mg/L	0.0	ND		ND	ND			ND	ND		
Calcium	mg/L	1	4	3	3	3	3	3	3	3	3	3
Chloride	mg/L	1.0	4	4	4	4	4	4	4	4	4	4
Chromium	mg/L	0.05	ND		ND	ND			ND	ND		
Conductivity	µmhos/cm	5	400	409	405	393	399	423	413	387	383	408
Copper	mg/L	0.01	ND		ND	ND			ND	ND		
Fluoride	mg/L	0.1	0.5	0.5	0.6	0.5	0.5	0.6	0.6	0.6	0.6	0.6
Gross Alpha	pCi/L	2.0	ND		ND	ND			2.2	4.5	ND	12.3
Gross Beta	pCi/L	3.0	4.5	3.2	ND	3.3	ND	ND	ND	5.5	ND	11.9
Iron	mg/L	**0.05**	ND		ND	ND			ND	ND		
Lead	mg/L	0.001	ND		ND	ND			ND	ND		
Magnesium	mg/L	1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Manganese	mg/L	0.01	ND		ND	ND			ND	ND		
Mercury	mg/L	0.001	ND		ND	ND			ND	ND		
Molybdenum	mg/L	0.1	ND		ND	ND			ND	ND		
Nickel	mg/L	0.05	ND		ND	ND			ND	ND		
Nitrogen, Ammonia as N	mg/L	0.05	0.09	ND	ND	0.08	0.07	0.11	0.07	ND	0.07	ND
Nitrogen, Nitrite as N	mg/L	0.1	ND		ND	ND			ND	ND		
pH	s.u.	0.1	8.8	8.8	9	8.6	8.8	8.8	9.1	8.8	8.9	8.6
Potassium	mg/L	1	2	2	2	2	2	2	4	2	2	2
Radium 226	pCi/L	0.2	ND	ND	ND	0.2	0.6	ND	ND	0.8	0.2	0.3
Radium 228	pCi/L	1	ND		ND	ND			ND	ND		
Selenium	mg/L	0.001	ND		ND	ND			ND	ND		
Silica as SiO2	mg/L	0.1	9.2	8.8	10.1	9.7	9.2	9.6	9.2	8.8	9.8	8.7
Sodium	mg/L	1	94	93	95	92	93	93	97	90	95	84
Sulfate	mg/L	2	ND	ND	ND	ND		ND	ND	ND	ND	ND
Total Dissolved Solids (180)	mg/L	10	260	260	250	240	230	250	260	240	240	250
Uranium	mg/L	0.0003	ND		ND	ND			ND	ND		
Vanadium	mg/L	0.1	ND		ND	ND			ND	ND		
Zinc	mg/L	0.01	ND		ND	ND			ND	ND		
Sodium Adsorption Ratio	calculation	0.1	13.6	13.9	15.4	14.6	14.8	14.4	15.7	13.7	14	13.3

Values in red boxes are outliers

Table 13-3
Water Quality Data and Upper Control Limits
Underlying Monitor Wells (MUN Wells)

Production Area #2 Underlying Monitoring Wells (MUN-14 thru MUN-20)		**Well ID**					
	Sampling Dates						
Upper Control Limit Parameters	**Units**	**Laboratory RL**	**Tolerance Maximum**	**Mean without Outliers**	**Standard Deviation without Outliers**	**Standard Deviation x 5**	**UCL Value**
Alkalinity, Total as CaCO3	mg/L	5	234	216	5.32	33	249
Chloride	mg/L	1				NA	19
Conductivity	µmhos/cm	5	446	400	13.64	68	468
Alkalinity, Bicarbonate as HCO3	mg/L	5					
Alkalinity, Carbonate as CO3	mg/L	5					
Alkalinity, Total as CaCO3	mg/L	5					
Aluminum	mg/L	0.1					
Arsenic	mg/L	0.001					
Barium	mg/L	0.1					
Boron	mg/L	0.1					
Cadmium	mg/L	0.0					
Calcium	mg/L	1					
Chloride	mg/L	1.0					
Chromium	mg/L	0.05					
Conductivity	µmhos/cm	5					
Copper	mg/L	0.01					
Fluoride	mg/L	0.1					
Gross Alpha	pCi/L	2.0					
Gross Beta	pCi/L	3.0					
Iron	mg/L	**0.05**					
Lead	mg/L	0.001					
Magnesium	mg/L	1					
Manganese	mg/L	0.01					
Mercury	mg/L	0.001					
Molybdenum	mg/L	0.1					
Nickel	mg/L	0.05					
Nitrogen, Ammonia as N	mg/L	0.05					
Nitrogen, Nitrite as N	mg/L	0.1					
pH	s.u.	0.1					
Potassium	mg/L	1					
Radium 226	pCi/L	0.2					
Radium 228	pCi/L	1					
Selenium	mg/L	0.001					
Silica as SiO2	mg/L	0.1					
Sodium	mg/L	1					
Sulfate	mg/L	2					
Total Dissolved Solids (180)	mg/L	10					
Uranium	mg/L	0.0003					
Vanadium	mg/L	0.1					
Zinc	mg/L	0.01					
Sodium Adsorption Ratio	calculation	0.1					

Table 13-4
Production Monitor Well
Restoration Target Values

Table 13-4

Production Area #2 MPN monitoring Wells (MPN-14 thru MPN-20)		**Well ID Sampling Dates**	**MPN-14**	**MPN-14**	**MPN-14**	**MPN-14**	**MPN-15**	**MPN-15**	**MPN-15**	**MPN-15**	**MPN-16**	**MPN-16**	**MPN-16**	**MPN-16**	**MPN-17**	**MPN-17**	**MPN-17**	**MPN-17**
Upper Control Limit Parameters	**Units**	**Laboratory RL**	1/14/2016	2/18/2016	4/21/2016	5/20/2016	1/26/2016	2/25/2016	5/9/2106	5/25/2016	1/20/2016	2/17/2016	5/4/2016	5/20/2016	1/27/2016	2/24/2106	5/5/2016	5/26/2016
			RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS
Alkalinity, Bicarbonate as HCO3	mg/L	5	148.00	149.00	166.00	182.00	133.00	134.00	140.00	142.00	142.00	143.00	139.00	150.00	135.00	149.00	139.00	145.00
Alkalinity, Carbonate as CO3	mg/L	5	7.00	6.00	7.00	6.00	14.00	12.00	7.00	ND	15.00	13.00	12.00	10.00	18.00	10.00	13.00	9.00
Alkalinity, Total as CaCO3	mg/L	5	133.00	132.00	147.00	159.00	132.00	130.00	127.00	125.00	141.00	139.00	134.00	140.00	141.00	139.00	136.00	134.00
Aluminum	mg/L	0.1	ND	ND			ND	ND			ND	ND			ND	ND		
Arsenic*	mg/L	0.001	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Barium*	mg/L	0.1	ND	ND			ND	ND			ND	ND			ND	ND		
Boron	mg/L	0.1	ND	ND			ND	ND			ND	ND			ND	ND		
Cadmium*	mg/L	0.0	ND	ND			ND	ND			ND	ND			ND	ND		
Calcium	mg/L	1	5.00	5.00	7.00	8.00	5.00	5.00	5.00	5.00	6.00	5.00	4.00	4.00	6.00	5.00	3.00	4.00
Chloride	mg/L	1.0	7.00	6.00	15.00	18.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	11.00	6.00	6.00	6.00
Chromium*	mg/L	0.05	ND	ND			ND	ND			ND	ND			ND	ND		
Conductivity	µmhos/cm	5	549.00	565.00	588.00	714.00	530.00	501.00	518.00	529.00	560.00	559.00	536.00	579.00	530.00	510.00	541.00	531.00
Copper	mg/L	0.01	ND	ND			ND	ND			ND	ND			ND	ND		
Fluoride	mg/L	0.1	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Gross Alpha	pCi/L	2.0	46.10	68.40	72.20	86.20	71.80	53.40	63.50	68.10	115.00	130.00	98.00	95.90	57.00	58.60	44.70	44.10
Gross Beta	pCi/L	3.0	76.20	143.00	82.70	62.20	63.80	67.90	55.70	104.00	189.00	213.00	198.00	177.00	65.40	73.10	62.10	65.10
Iron	mg/L	**0.05**	ND	ND			ND	ND			ND	ND			ND	ND		
Lead*	mg/L	0.001	ND	ND			ND	ND			ND	ND			ND	ND		
Magnesium	mg/L	1	ND	ND	ND	1.00	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Manganese	mg/L	0.01	ND	ND			ND	ND			ND	ND			ND	ND		
Mercury*	mg/L	0.001	ND	ND			ND	ND			ND	ND			ND	ND		
Molybdenum	mg/L	0.1	ND	ND			ND	ND			ND	ND			ND	ND		
Nickel	mg/L	0.05	ND	ND			ND	ND			ND	ND			ND	ND		
Nitrogen, Ammonia as N	mg/L	0.05	ND	ND			ND	ND			ND	ND			ND	ND		
Nitrogen, Nitrite as N	mg/L	0.1	ND	ND			ND	ND			ND	ND			ND	ND		
pH	s.u.	0.1	8.80	8.70	8.70	8.60	9.10	9.10	8.90	8.80	9.10	9.10	9.10	9.00	9.20	8.90	9.10	9.00
Potassium	mg/L	1	2.00	2.00	2.00	3.00	4.00	3.00	3.00	3.00	6.00	6.00	7.00	7.00	5.00	4.00	5.00	4.00
Radium 226	pCi/L	0.2	8.20	11.90	11.00	13.00	11.30	12.20	11.60	12.50	35.80	24.60	18.30	19.00	ND	13.30	10.10	10.90
Radium 228	pCi/L	1	ND	ND			ND	ND			ND	ND			ND	1.00	ND	
Selenium*	mg/L	0.001	ND	ND			ND	ND			ND	ND			ND	ND		
Silica as SiO2	mg/L	0.1	8.70	8.80	8.60	9.10	9.10	9.20	9.90	9.60	10.00	9.30	9.60	9.50	9.40	9.70	9.50	8.80
Sodium	mg/L	1	103.00	110.00	119.00	136.00	112.00	106.00	110.00	110.00	108.00	109.00	110.00	111.00	115.00	108.00	105.00	103.00
Sulfate	mg/L	2	117.00	115.00	120.00	126.00	114.00	112.00	111.00	111.00	108.00	111.00	113.00	111.00	106.00	104.00	105.00	104.00
Total Dissolved Solids (180)	mg/L	10	330.00	290.00	380.00	410.00	350.00	330.00	320.00	330.00	350.00	320.00	320.00	340.00	320.00	320.00	330.00	320.00
Uranium	mg/L	0.0003	0.02	0.02	0.03	0.03	0.02	0.02	0.03	0.02	0.03	0.02	0.03	0.03	0.02	0.02	0.01	0.01
Vanadium	mg/L	0.1	ND	ND			ND	ND			ND	ND			ND	ND		
Zinc	mg/L	0.01	ND	ND			ND	ND			ND	ND			ND	ND		
Sodium Adsorption Ratio	calculation	0.1	12.7	13.9	12.1	12	13.5	13.3	14	13.6	12.4	13.2	15.6	15.3	13.4	13.1	15.6	15

Values in red boxes are outliers

Table 13-4
Production Monitor Well
Restoration Target Values

Production Area #2 MPN monitoring Wells (MPN-14 thru MPN-20)		**Well ID Sampling Dates**	**MPN-18**	**MPN-18**	**MPN-18**	**MPN-18**	**MPN-19**	**MPN-19**	**MPN-19**	**MPN-19**	**MPN-20**	**MPN-20**	**MPN-20**	**MPN-20**					
Upper Control Limit Parameters	**Units**	Laboratory RL	1/7/2016	2/11/2016	4/14/2016	5/12/2016	1/12/2016	2/10/2016	4/13/2016	5/18/2016	1/7/2016	2/9/2016	4/12/2016	5/19/2016	**Total Number Samples**	**Minimum Value**	**Maximum Value**	**k factor α=0.05, p=0.99, n=28**	**Mean**
			RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS	RESULTS					
Alkalinity, Bicarbonate as HCO3	mg/L	5	122.00	142.00	151.00	147.00	148.00	152.00	151.00	149.00	144.00	148.00	148.00	151.00	28	122	182	3.350	146
Alkalinity, Carbonate as CO3	mg/L	5	23.00	11.00	6.00	7.00	9.00	7.00	5.00	6.00	10.00	8.00	6.00	ND	28	5	23	3.350	10
Alkalinity, Total as CaCO3	mg/L	5	138.00	134.00	134.00	132.00	136.00	136.00	133.00	132.00	135.00	134.00	131.00	131.00	28	125	159	3.350	136
Aluminum	mg/L	0.1	ND	ND	ND		ND	ND			ND	ND							
Arsenic*	mg/L	0.001	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00					
Barium*	mg/L	0.1	ND	ND	ND		ND	ND			ND	ND							
Boron	mg/L	0.1	ND	ND	ND		ND	ND			ND	ND							
Cadmium*	mg/L	0.0	ND	ND	ND		ND	ND			ND	ND							
Calcium	mg/L	1	6.00	5.00	4.00	4.00	5.00	6.00	5.00	5.00	5.00	5.00	5.00	5.00	28	3	8	3.350	5
Chloride	mg/L	1.0	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	28	6	18	3.350	7
Chromium*	mg/L	0.05	ND	ND	ND		ND	ND			ND	ND							
Conductivity	µmhos/cm	5	540.00	522.00	524.00	515.00	521.00	515.00	533.00	532.00	531.00	531.00	535.00	536.00	28	501	714	3.350	542
Copper	mg/L	0.01	ND	ND	ND		ND	ND			ND	ND							
Fluoride	mg/L	0.1	0.20	0.30	0.20	0.20	0.20	0.20	0.20	0.30	0.20	0.30	0.20	0.30	28	0.20	0.30	3.350	0.21
Gross Alpha	pCi/L	2.0	19.80	21.30	18.00	19.60	164.00	160.00	155.00	187.00	75.20	58.90	48.60	53.10	28	18	187	3.350	77
Gross Beta	pCi/L	3.0	14.80	21.80	16.50	22.80	120.00	163.00	127.00	187.00	49.80	51.70	49.90	63.50	28	15	213	3.350	92
Iron	mg/L	**0.05**	ND	ND	ND		ND	ND			ND	ND							
Lead*	mg/L	0.001	ND	ND	ND		ND	ND			ND	ND							
Magnesium	mg/L	1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND					
Manganese	mg/L	0.01	ND	ND	ND		ND	ND			ND	ND							
Mercury*	mg/L	0.001	ND	ND	ND		ND	ND			ND	ND							
Molybdenum	mg/L	0.1	ND	ND	ND		ND	ND			ND	ND							
Nickel	mg/L	0.05	ND	ND	ND		ND	ND			ND	ND							
Nitrogen, Ammonia as N	mg/L	0.05	ND	ND	0.06		ND	ND			0.06	ND		ND					
Nitrogen, Nitrite as N	mg/L	0.1	ND	ND	ND		ND	ND			ND	ND							
pH	s.u.	0.1	9.30	9.00	8.80	8.90	8.90	8.70	8.70	8.70	9.00	8.80	8.80	8.70	28	9	9	3.350	9
Potassium	mg/L	1	5.00	3.00	3.00	3.00	3.00	3.00	2.00	2.00	4.00	3.00	3.00	3.00	28	2	7	3.350	4
Radium 226	pCi/L	0.2	1.40	1.80	1.80	1.80	43.90	44.60	49.90	56.30	10.50	13.30	10.20	11.40	28	1	56	3.350	17
Radium 228	pCi/L	1	ND	ND	ND		ND	ND			ND	ND							
Selenium*	mg/L	0.001	ND	ND	ND		ND	ND			ND	ND							
Silica as SiO2	mg/L	0.1	9.10	9.10	9.30	9.00	9.80	9.70	9.20	9.50	8.90	9.00	9.90	9.00	28	9	10	3.350	9
Sodium	mg/L	1	108.00	105.00	105.00	102.00	110.00	102.00	104.00	97.00	108.00	102.00	110.00	99.00	28	97	136	3.350	108
Sulfate	mg/L	2	105.00	104.00	104.00	110.00	102.00	107.00	103.00	104.00	107.00	109.00	106.00	106.00	28	102	126	3.350	109
Total Dissolved Solids (180)	mg/L	10	320.00	350.00	310.00	340.00	310.00	310.00	310.00	320.00	320.00	340.00	320.00	320.00	28	290	410	3.350	330
Uranium	mg/L	0.0003	0.01	0.01	0.01	0.01	0.04	0.02	0.02	0.02	0.03	0.02	0.02	0.02	28	0.01	0.04	3.350	0.02
Vanadium	mg/L	0.1	ND	ND	ND		ND	ND			ND	ND							
Zinc	mg/L	0.01	ND	ND	ND		ND	ND			ND	ND							
Sodium Adsorption Ratio	calculation	0.1	12.4	12.9	13.80	14.2	12.9	11.9	12.70	11.6	12.8	12.4	12.90	12.4					

Grey boxes represent non detectable constituents

Table 13-4
Production Monitor Well
Restoration Target Values

Production Area #2 MPN monitoring Wells (MPN-14 thru MPN-20)		Well ID Sampling Dates						
Upper Control Limit Parameters	**Units**	Laboratory RL	**Standard Deviation**	**Tolerance Miniumum**	**Tolerance Maximum**	**Mean without Outliers**	**Standard Deviation without Outliers**	**Restoration Target Value (Mean + 2σ)**
Alkalinity, Bicarbonate as HCO3	mg/L	5	10.67	122	169	145.58	6.92	159
Alkalinity, Carbonate as CO3	mg/L	5	4.27	-4	24	9.88	4.27	18
Alkalinity, Total as CaCO3	mg/L	5	6.45	121	149.33	135.04	4.27	144
Aluminum	mg/L	0.1						
Arsenic*	mg/L	0.001						*
Barium*	mg/L	0.1						*
Boron	mg/L	0.1						
Cadmium*	mg/L	0.0						*
Calcium	mg/L	1	0.98	3	8	5.04	0.72	7
Chloride	mg/L	1.0	2.89	0.03	13	6.56	1.95	10
Chromium*	mg/L	0.05						*
Conductivity	µmhos/cm	5	39.11	468	603	535.59	20.19	576
Copper	mg/L	0.01						
Fluoride	mg/L	0.1	0.04			NA	NA	0.29
Gross Alpha	pCi/L	2.0	46.11	-62	212	74.94	40.84	169
Gross Beta	pCi/L	3.0	59.41	-92	274	90.70	54.65	211
Iron	mg/L	**0.05**						
Lead*	mg/L	0.001						*
Magnesium	mg/L	1						
Manganese	mg/L	0.01						
Mercury*	mg/L	0.001						*
Molybdenum	mg/L	0.1						
Nickel	mg/L	0.05						
Nitrogen, Ammonia as N	mg/L	0.05						
Nitrogen, Nitrite as N	mg/L	0.1						
pH	s.u.	0.1	0.18			NA	NA	9
Potassium	mg/L	1	1.47			NA	NA	7
Radium 226	pCi/L	0.2	15.13	-27.612	60.64398	16.52	13.17	48
Radium 228	pCi/L	1						
Selenium*	mg/L	0.001						*
Silica as SiO2	mg/L	0.1	0.39			NA	NA	10
Sodium	mg/L	1	7.23	93	122	107	4.47	116
Sulfate	mg/L	2	5.63	94	124	108.73	4.54	118
Total Dissolved Solids (180)	mg/L	10	23.33	286	370	328.08	12.58	353
Uranium	mg/L	0.0003	0.01			NA	NA	0.04
Vanadium	mg/L	0.1						
Zinc	mg/L	0.01						
Sodium Adsorption Ratio	calculation	0.1						

Grey boxes represent non detectable constituents

*10 CFR Part 40, Appendix A, Criterion 5(B)(5) lists three standards, one of which each hazardous constituent in groundwater must meet at the point of compliance. The standards are:

a) The commission approved background concentration of that constiuent in the ground water;

b) The respective value given in the table in paragraph 5 C if the contiuent is listed in the table and if the background level of the constiuent is below the value listed; or

c) An alternate concentration limit established by the Commission

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