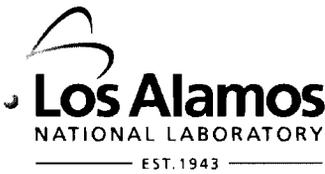


TA03



Environmental Programs
P.O. Box 1663, MS M991
Los Alamos, New Mexico 87545
(505) 606-2337/FAX (505) 665-1812



National Nuclear Security Administration
Los Alamos Site Office, MS A316
Environmental Restoration Program
Los Alamos, New Mexico 87544
(505) 667-4255/FAX (505) 606-2132

Date:
Refer To: EP2009-0556

James Bearzi, Bureau Chief
Hazardous Waste Bureau
New Mexico Environment Department
2905 Rodeo Park Drive East, Building 1
Santa Fe, NM 87505-6303

Subject: Submittal of the Summary Report for Aquifer Test Activities at Monitoring Well 03-B-10

Dear Mr. Bearzi:

Enclosed please find two hard copies with electronic files of the Summary Report for Aquifer Test Activities at Monitoring Well 03-B-10. This report is due to the New Mexico Environment Department by November 30, 2009, per the Approval with Modifications for the Work Plan to Plug and Abandon Wells 03-B-09 and 03-B-10, dated August 10, 2009.

If you have any questions, please contact Becky Coel-Roback at (505) 665-5501 (becky_cr@lanl.gov) or Suzy Schulman at (505) 606-1962 (sschulman@doeal.gov).

Sincerely,

Michael J. Graham, Associate Director
Environmental Programs
Los Alamos National Laboratory

Sincerely,

David R. Gregory, Project Director
Environmental Operations
Los Alamos Site Office

MG/DG/TG:sm

Enclosures: Two hard copies with electronic files – Summary Report for Aquifer Test Activities at Monitoring Well 03-B-10 (LA-UR-09-7270)

Cy: (w/enc.)
Neil Weber, San Ildefonso Pueblo
Robert George, NMED-GWQB, Santa Fe, NM
Suzy Schulman, DOE-LASO, MS A316
Tim Goering, EP-LWSP, MS M992
RPF, MS M707 (w/two CDs)
Public Reading Room, MS M992

Cy: (Letter and CD and/or DVD only)
Laurie King, EPA Region 6, Dallas, TX
Steve Yanicak, NMED-DOE-OB, MS M894
Mark Haagenstad, ENV-RCRA, MS K490
Velimir V. Vesselinov, EES-16, MS T003
Richard Koch, EP-LWSP, MS M992
Danny Katzman, EP-LWSP, MS M992
Kristine Smeltz, EP-WES, MS M992
Jose O. Romero, IRM-DCS, MS C349

Cy: (w/o enc.)
Tom Skibitski, NMED-OB, Santa Fe, NM
Annette Russell, DOE-LASO (date-stamped letter emailed)
Michael J. Graham, ADEP, MS M991
Dave McInroy, EP-CAP, MS M992
IRM-RMMSO, MS A150 (date-stamped letter emailed)

LA-UR-09-7270
November 2009
EP2009-0556

Report for Aquifer Test Activities at Monitoring Well 03-B-10

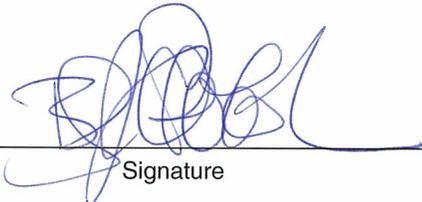
Prepared by the Environmental Programs Directorate

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Report for Aquifer Test Activities at Monitoring Well 03-B-10

November 2009

Responsible project leader:

Becky Coel-Roback		Project Leader	Environmental Programs	11/24/09
Printed Name	Signature	Title	Organization	Date

Responsible LANS representative:

Michael J. Graham		Associate Director	Environmental Programs	11/24/09
Printed Name	Signature	Title	Organization	Date

Responsible DOE representative:

David R. Gregory		Project Director	DOE-LASO	11/25/09
Printed Name	Signature	Title	Organization	Date

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1.0 INTRODUCTION

This report describes the hydraulic analysis of an aquifer test conducted at monitoring well 03-B-10 on September 14, 2009. The well is located at Los Alamos National Laboratory Technical Area 03 (TA-03), west of building SM-30. Well 03-B-10 is located on Sigma Mesa, adjacent to the upper reaches of the north fork of Twomile Canyon. The objective of the pumping test was to evaluate the hydraulic properties of the intermediate perched groundwater in the vicinity of building SM-30.

Figure 1 shows the location of building SM-30 within TA-03 at Los Alamos National Laboratory (LANL). Figure 2 shows the location of pumping well 03-B-10 and the observation wells 03-B-9 and 03-B-13 west of building SM-30, along with 10-ft radius circles centered on the pumped well. Observation well 03-B-13 is located 13.8 ft northeast of well 03-B-10 and observation well 03-B-9 is located 26 ft north-northwest of well 03-B-10.

Testing consisted of a brief, background-data collection period at each well prior to pumping, pumping of well 03-B-10 at a rate of 0.69 gal. per minute (gpm) for 102 minutes (1.7 h), and monitoring recovery in all three wells for several hours.

1.1 Conceptual Hydrogeology and Historical Evaluation

The "B" wells are completed to depths of 31 to 32 ft below ground surface (bgs) in Unit 4 of the Bandelier Tuff (Qbt 4). Well completion diagrams for 03-B-09, 03-B-10, and 03-B-13 are presented in Attachment A. The fill/tuff interface is located 10.6 to 12.8 ft bgs (DOE 2006, 092669). At the time of completion, water levels in the "B" wells ranged from 23 to 29 ft bgs, while water levels in September 2009 ranged from 20 to 21 ft bgs, slightly above the top of the screen in each well. Prior to the test, water levels were slightly above the top of the screen in each well. Assuming that the wells fully penetrate the zone of saturation, the thickness of the perched intermediate groundwater on September 14, 2009, was approximately 11 ft.

All three B-series wells are flush-mounted with the road immediately west of SM-30, and have been vulnerable to surface runoff from the road. Well 03-B-9 is located in a surface depression where surrounding runoff flows to the well and enters the protective casing cover despite efforts to maintain the well cover gasket and bolt washers. Prior to measuring the groundwater levels in well 03-B-9 on September 14, 2009, the well contained water in the annulus to the top of the well casing. The water level within the annulus was pumped down several inches prior to the test to prevent the water from entering the well during testing. However, while recovery was being monitored after the pumping test, a nearby roof drain drip line, apparently from an air conditioner discharge, was observed flowing to the well. In addition, a thunderstorm during the pumping test recovery period generated runoff that flowed down the well. The hydraulic response to this event is evident in the well hydrograph discussed later in this report.

Groundwater levels measured in each well prior to the test on September 14, 2009, are shown in Figure 3. The groundwater elevation at 03-B-9 was highest at 7437.9 ft; the level at 03-B-10 was 7437.7 ft, and the level at 03-B-13 was 7437.1 ft. The groundwater level data measured on September 14, 2009, indicated a gradient to the east-northeast of 0.054 ft/ft. The highest water levels were measured in well 03-B-9. However, when the B-series wells were first installed, the perched groundwater was interpreted to be mounded with the highest levels at 03-B-10 and 03-B-13 (DOE 2006, 092669, Figure 7.2-1).

Additionally, Figure 3 presents historical water levels in the B-series wells, along with the total daily precipitation recorded at the LANL TA-06 meteorological station. Due to their close proximity, groundwater levels are usually very similar in each well, and responsive to precipitation events.

In 2007 it was discovered that runoff in the vicinity of the B wells was entering the wells through the flush-mounted surface completions. Apparently, a snowplow may have damaged the surface well completions of 03-B-10 and 10-B-13 in December 2006. The high water levels in well 03-B-10 in January and February 2007 (Figure 3) represent runoff entering the well. The wells were repaired, and new seals and bolt gaskets were installed, but well 03-B-9 continued to be vulnerable to runoff. Well 03-B-9 is located in a service roadway with heavy truck traffic. Due to apparent subsidence, the well is now located in a topographic low in the roadway, allowing runoff to continue to the well cover and annulus, following precipitation and snowmelt events.

In 2008, a roof drain from the adjacent building, SM-30, was found to be corroded and discharging into the ground adjacent to the building in the vicinity of the B-series wells. The roof drain was subsequently repaired in 2008.

Groundwater levels in the B-series wells are closely correlated to precipitation events. Figure 4 presents hydrographs of groundwater levels at wells 03-B-10 and 03-B-13 from March to May 2009 along with total daily precipitation at the TA-06 meteorological station. The correlation between groundwater level responses and precipitation events is evident, with responses of more than 2 ft following larger precipitation events. It is apparent that runoff is recharging the perched groundwater.

A water supply line north of building SM-30 burst on or about May 10, 2009, and leaked an estimated 100,000 to 1,000,000 gal. of potable water into the ground. Water levels in the B-series wells responded to this leak, with groundwater levels rising approximately 1 ft in well 03-B-10 and approximately 0.6 ft in well 03-B-13 (Figure 4).

The extent of the perched intermediate groundwater beneath and adjacent to building SM-30 was evaluated during the investigation drilling of Solid Waste Management Units 03-010(a) and 03-001(e), and was determined to be of limited extent (DOE 2006, 092669). A fine-grained layer, or clay lens, within unit Qbt 4 (see Appendix A, Figure A-1) apparently provides the perching layer for the groundwater, which was estimated to extend over an area about 100 ft long by 60 ft wide beneath and west of building SM-30 (DOE 2006, 092669, p. 85). If consistent with bedding in the Bandelier Tuff, the perching layer probably dips slightly to the east beneath building SM-30. West of building SM-30 and the asphalt roadway, the ground surface slopes steeply to the west into a tributary canyon of Two-mile Canyon that is incised about 15 ft within about 50 ft west of well 03-B-10.

1.2 Well 03-B-10 Pumping Test

Prior to the pumping test, the transducers in each well were programmed to record at 5-second intervals for the duration of the test and the recovery period. The pumping test was performed on September 14, 2009, using a Geotech Geosquirt 12 VDC pump (60-ft model). The pump at well 03-B-10 was turned on at 10:15 a.m. (MDT) and the immediate drawdown at 03-B-10 was 0.17 ft. The initial near-instantaneous decline of the water levels is a function of borehole storage effects and an imperfect hydraulic connection between the well and the pumped saturated zone. Because the groundwater level fell within the screen during the test, storage effects on the drawdown and recovery data were unavoidable. Drawdown continued through the duration of pumping test, with an additional 0.15 ft recorded over the remainder of the test. The well was pumped at a steady rate of 0.69 gpm for a total of 102 minutes, with 71 gal. pumped during the test. At 11:57 a.m. (MDT), the pump was shut off, initiating the recovery phase of the test.

Recovery was monitored at 5-second intervals for approximately 2 h, and then at 15-minute intervals for approximately one week. Each well recovered to a near static level within about 15 minutes, but neither the pumping well nor the two observation wells recovered to the pre-pumping level. The unrecovered drawdown of wells 03-B-10 and 03-B-13 was about 0.13 ft, and for well 03-B-9, about 0.11 ft. This

suggests that the pumped zone of hydraulic saturation has limited spatial extent. It is also plausible that the initial water levels may not have been representative of steady-state condition; however, this is unlikely, given the length of time that the pump and transducers were in the wells prior to the test, and given the rapid recovery of water levels following the test. During the recovery period, natural runoff from a thunderstorm flowed across the road into well 03-B-9 and caused an immediate rapid rise in groundwater levels within the well casing (Figure 12).

2.0 BACKGROUND DATA ANALYSES

The background water-level data collected in conjunction with running the pumping tests provide an understanding of natural groundwater water-level fluctuations, and help distinguish between fluctuations in water levels due to the pumping test and fluctuations associated with other causes. Background water-level fluctuations have several causes, among them barometric pressure changes, pumping of other wells, Earth tides, and long-term trends related to weather patterns. The background data hydrographs from the monitored wells were compared with barometric pressure data from the area to determine if a correlation existed.

Figure 5 shows the background hydrographs for wells 03-B10 and 03-B-13 and the atmospheric pressure (shown in ft-of-water equivalent) recorded at the TA-06 meteorological tower for the week before the pumping test. The groundwater levels fluctuated approximately 0.7 ft in both wells during this period, but were not affected by atmospheric pressure fluctuations, indicating these wells have 0% barometric efficiency (typical of unconfined aquifer).

On September 11, 2009, monitoring well 03-B-13 was purged and sampled. The transducer was removed from the well during sampling, indicated by the gap in water-level data for well 03-B-13 on that date. There appears to be a minor response at well 03-B-10 during the pumping of well 03-B-13 on September 11, 2009 (Figure 5).

3.0 ANALYTICAL METHODS

3.1 Time-Drawdown Analysis

Time-drawdown data can be analyzed using a variety of methods. Among them is the Theis method (Theis 1934-1935, 098241). The Theis equation describes drawdown around a well as follows:

$$s = \frac{114.6Q}{T} W(u) \tag{Equation 1}$$

Where,

$$W(u) = \int_u^\infty \frac{e^{-x}}{x} dx \tag{Equation 2}$$

and

$$u = \frac{1.87r^2S}{Tt} \tag{Equation 3}$$

and where, s = drawdown, in ft

Q = discharge rate, in gal. per min

T = transmissivity, in gal. per day per ft

S = storage coefficient (dimensionless)

t = pumping time, in days

r = distance from center of pumpage, in ft

To use the Theis method of analysis, the time-drawdown data are plotted on log-log graph paper. Then, Theis curve matching is performed using the Theis type curve—a plot of the Theis well function $W(u)$ versus $1/u$. Curve matching is accomplished by overlaying the type curve on the data plot and, while keeping the coordinate axes of the two plots parallel, shifting the data plot to align with the type curve, effecting a match position. An arbitrary point, referred to as the match point, is selected from the overlapping parts of the plots. Match-point coordinates are recorded from the two graphs, yielding four values: $W(u)$, $1/u$, s , and t . Using these match-point values, transmissivity and storage coefficient are computed as follows:

$$T = \frac{114.6Q}{s} W(u) \quad \text{Equation 4}$$

$$S = \frac{Tut}{2693r^2} \quad \text{Equation 5}$$

Where, T = transmissivity, in gal. per day per ft

S = storage coefficient

Q = discharge rate, in gal. per min

$W(u)$ = match-point value

s = match-point value, in ft

u = match-point value

t = match-point value, in min

An alternative solution method applicable to time-drawdown data is the Cooper–Jacob method (Cooper and Jacob 1946, 098236), a simplification of the Theis equation that is mathematically equivalent to the Theis equation for most pumped well data. The Cooper–Jacob equation describes drawdown around a pumping well as follows:

$$s = \frac{264Q}{T} \log \frac{0.3Tt}{r^2 S} \quad \text{Equation 6}$$

The Cooper–Jacob equation is a simplified approximation of the Theis equation and is valid whenever the u value is less than about 0.05. For small radius values (e.g., corresponding to borehole radii), u is less than 0.05 at very early pumping times and therefore is less than 0.05 for most or all measured drawdown

values. Thus, for the pumped well, the Cooper–Jacob equation usually can be considered a valid approximation of the Theis equation.

According to the Cooper–Jacob method, the time-drawdown data are plotted on a semilog graph, with time plotted on the logarithmic scale. Then a straight line of best fit is constructed through the data points and transmissivity is calculated using:

$$T = \frac{264Q}{\Delta s} \tag{Equation 7}$$

Where, T = transmissivity, in gal. per day per ft

Q = discharge rate, in gal. per min

Δs = change in head over one log cycle of the graph, in ft

3.2 Recovery Methods

Recovery data were analyzed using the Theis recovery method, a semilog analysis method similar to the Cooper–Jacob procedure. Residual drawdown is plotted on a semilog graph as a function of the ratio t/t' , where t is the time since pumping began and t' is the time since pumping stopped. A straight line of best fit is constructed through the data points and T is calculated from the slope of the line as follows:

$$T = \frac{264Q}{\Delta s} \tag{Equation 8}$$

The recovery data are particularly useful compared with time-drawdown data. Because the pump is not running, spurious data responses associated with dynamic discharge rate fluctuations are eliminated. The result is that the data set is generally “smoother” and easier to analyze.

3.3 Unconfined Aquifer Drawdown Correction

For unconfined groundwater, the saturated thickness is reduced below the original thickness during testing. This results in drawdown values that deviate from theoretical predictions, because well hydraulics formulas are based on 100% saturation. Prior to analysis, the actual drawdown values must be corrected for dewatering effects using the following formula (Kruseman et al. 1991, 106681):

$$s_c = s_a - \frac{s_a^2}{2b} \tag{Equation 9}$$

Where, s_c = corrected drawdown, in ft

s_a = observed drawdown, in ft

b = saturated aquifer thickness, in ft

Assumptions required for validity of Equation 9 are (1) homogeneous hydraulic conductivity, (2) full penetration of the producing zone by the well screen, and (3) no head loss associated with vertical flow. This last assumption is satisfied by one of two extremes—either zero permeability in the vertical direction so that there is no flow (and therefore no head loss) vertically, or infinite vertical permeability. Failure to meet any of these three assumptions leads to modest errors in application of the drawdown correction equation.

The hydrogeological parameters of the perched intermediate zone were estimated using the water-level data observed at wells 03-B-10, 03-B-9, and 03-B-13 during pumping of well 03-B-10. The data from the pumping and recovery tests were evaluated using the code AQTESOLV (Version 4.5). The code allows pumping-test analysis using a wide range of analytical solutions. The code also allows curve matching to be performed using manual and numerical approaches. The input data for the analyses are in Attachment B.

4.0 PUMPING WELL 03-B-10 DATA ANALYSIS

The drawdown and recovery data of the pumping test from well 03-B-10, and the results of the data analysis, are presented in this section.

Figure 6 shows the hydrograph for the pumping well 03-B-10 during testing on September 14, 2009. After the pump was turned on, there was an immediate drawdown in the well of 0.17 ft associated with casing storage. This rapid initial response reflects borehole-storage effects and an imperfect hydraulic connection between the well and the pumped saturated zone. After the initial decline, the groundwater continued to decline throughout the pumping period, and the decline is characterized by an almost linear trend; this may suggest limited spatial extent of the stressed perched zone.

The maximum drawdown before the pump was turned off was 0.33 ft. The groundwater showed very little recovery (about 0.06 ft) after the casing storage recovered, with about 0.13 ft of unrecovered (residual) drawdown. The residual drawdown suggests that the perched intermediate aquifer in which the B-series wells are completed has limited spatial extent. This is also supported by the almost linear decline of the water levels during the pumping test.

It is also plausible that the initial water levels may not have been representative of steady-state condition; however, this is unlikely, given the length of time that the pump and transducers were in the wells prior to the test, and given the rapid recovery of water levels following the test. During the recovery period, a thunderstorm generated surface runoff that entered well 03-B-9, causing an immediate, rapid rise in groundwater levels at this well (Figure 12).

Figure 7 shows a semilog plot of the drawdown data collected at well 03-B-10 during the pumping test conducted at a discharge rate of 0.69 gpm. As shown on the graph, approximately half of the water-level change was affected by casing storage. The groundwater level continued to decline throughout the duration of pumping, so the static pumping water level was not achieved during the test. The maximum drawdown during pumping was 0.33 ft, the estimated maximum specific capacity of well 03-B-10 would be 2.12 gpm/ft.

The recovery data recorded from well 03-B-10 following the pumping test is shown in Figure 8. Again, most of the water-level change was related to casing-storage effects. Recharge in well 03-B-10 occurred relatively rapidly, with water levels equilibrating within 30 min to a static level of 7437.56 ft, 0.13 ft lower than the groundwater level at the start of the pumping test. An expanded-scale plot of the recovery data is shown in Figure 9.

Figure 10 shows the hydrograph recorded at well 03-B-13 during the pumping test. Water levels in well 03-B-13 clearly show a response to the pumping from well 03-B-10, with a maximum drawdown during pumping of 0.17 ft, and a recovery of 0.04 ft. Well 03-B-13 never fully recovered, and water levels showed a residual drawdown of 0.13 ft after recovery. Figure 11 shows the drawdown data on a log-log scale from well 03-B-13.

The hydrograph recorded at well 03-B-9 during the pumping test is shown in Figure 12. The data clearly shows a response to pumping well 03-B-10. The maximum drawdown during pumping was 0.10 ft, with no apparent recovery before the well was impacted by surface runoff entering the well. Thus, water levels

in well 03-B-9 showed a residual drawdown of 0.10 ft. Figure 13 shows the drawdown data on a log-log scale for well 03-B-9.

The water-level data from the 03-B-10 pumping test and the obtained matching curve are presented in Figure 14 and Figure 15 in semi-log and log-log scales, respectively. The curves represent the Theis solution with a correction for unconfined conditions. The model assumes that the hydrogeological properties are uniform within the perched zone. Boundary effects are accounted for by using the principle of superposition, and are incorporated by assuming the perched zone forms a square centered at the pumping well 03-B-10. This assumption is required by the analytical method used to analyze the data.

The applied solution also takes into account for the dewatering of the perched zone during the pumping test. As a result, the water levels do not completely recover after the pumping is terminated (Figure 14 and Figure 15). The analytical solution was found to accurately represent the late-time data during the pumping and recovery periods (Figure 14 and Figure 15), but did not simulate the early time transients observed during the test. These early data are significantly influenced by storage and wellbore effects.

In addition, the model did not accurately represent the water levels at well 03-B-9, the well farthest from the pumping well. The water levels observed in well 03-B-9 are most influenced by boundary effects, perhaps explaining the deviation between the model predictions and the observed data at well 03-B-9.

The estimated parameters resulting from the data analysis are: hydraulic conductivity $k \sim 60$ ft/d, storativity $S \sim 0.003$, and side of the square representing the lateral extent of the perched zone $L \sim 160$ ft.

The applied method also allows evaluating the sensitivity of the estimated parameters. The analysis indicated that the solution is sensitive to all three estimated parameters. The hydraulic conductivity predominantly controls the vertical location the solution curves, the storativity predominantly controls the curve slopes and the magnitude of the unrecovered water levels, and the lateral dimension of the perched zone predominantly controls the magnitude of unrecovered water levels.

The obtained estimate for permeability is reasonable for the tested hydrogeological unit (welded and non-welded tuffs). The estimated storativity is about an order of magnitude lower than expected; the estimate may be biased due to other transient influences impacting the observed water-level responses that are not accounted by the applied analytical model (e.g. infiltration recharge or discharge of groundwater from the perched zone). The estimated lateral dimensions of the perched zone are consistent with previous estimates (DOE 2006, 092669, Figure 7.2-1).

5.0 SUMMARY

A constant-rate pumping test was conducted on well 03-B-10 on September 14, 2009. The test was conducted to evaluate the hydraulic characteristics of the perched intermediate groundwater in the vicinity of building SM-30 at TA-03, prior to plugging and abandoning monitoring wells 03-B-9 and 03-B-10. Monitoring well 03-B-10 is installed to a depth of 30.6 ft, and extends to the base of perched groundwater in Unit 4 of the Bandelier Tuff (Qbt 4). The well is fully-penetrating and contains 11 ft of saturated formation. Groundwater levels in the three B-series wells are not responsive to changes in barometric pressure, indicating 0% barometric efficiency, and indicative of unconfined conditions.

The pumping test was conducted at a rate of 0.69 gpm over 102 min, with a total of 71 gal. pumped. Initial drawdown in the pumping well was significantly affected by casing-storage and wellbore effects. After the initial drawdown response, drawdown continued to increase linearly throughout the remainder of the test. Because drawdown never equilibrated to a steady-state value, the well-specific capacity could not be determined.

Based on the pumping test results, the estimated hydraulic conductivity of the perched intermediate aquifer in the vicinity of well 03-B-10 is approximately 60 ft/d. Assuming an saturated thickness of 11 ft, the perched intermediate aquifer has an estimated transmissivity (T) value of 660 ft²/d. The AQTESOLV code used matched observed and predicted drawdowns fairly closely (see Figure and 15). The model predicted an S of 0.003, a value more indicative of confined, rather than unconfined conditions, suggesting other factors which have not been accounted for in the analysis. A residual drawdown of 0.13 ft was observed at wells 03-B-10 and 03-B-13 following recovery, indicating that the perched aquifer was of limited areal extent.

The approximate lateral dimensions of the aquifer were simulated using AQTESOLV, and were estimated to be approximately 160 ft by 160 ft. Assuming an area of 160 ft by 160 ft and an S of 0.003, the calculated residual drawdown would represent approximately 75 gal., which compares well with the 71 gal. produced during the pumping test.

6.0 REFERENCES AND MAP DATA SOURCES

6.1 References

The following list includes all documents cited in this report. Parenthetical information following each reference provides the author(s), publication date, and ER ID. This information is also included in text citations. ER IDs are assigned by the Environmental Programs Directorate's Records Processing Facility (RPF) and are used to locate the document at the RPF and, where applicable, in the master reference set.

Copies of the master reference set are maintained at the NMED Hazardous Waste Bureau and the Directorate. The set was developed to ensure that the administrative authority has all material needed to review this document, and it is updated with every document submitted to the administrative authority. Documents previously submitted to the administrative authority are not included.

Cooper, H.H., Jr., and C.E. Jacob, August 1946. "A Generalized Graphical Method for Evaluating Formation Constants and Summarizing Well-Field History," American Geophysical Union Transactions, Vol. 27, No. 4, pp. 526-534. (Cooper and Jacob 1946, 098236)

DOE (U.S. Department of Energy), April 20, 2006. "Investigation Report for Solid Waste Management Units 03-010(a) and 03-001(e) at Technical Area 3 [NMED NOD Replacement]," DOE Los Alamos Area Office document, Los Alamos, New Mexico. (DOE 2006, 092669)

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Theis, C.V., 1934-1935. "The Relation Between the Lowering of the Piezometric Surface and the Rate and Duration of Discharge of a Well Using Ground-Water Storage," American Geophysical Union Transactions, Vol. 15-16, pp. 519-524. (Theis 1934-1935, 098241)

6.2 Map Data Sources

MONITOR AND PLUGGED WELLS; Point Feature Locations of the Environmental Restoration Project Database; Los Alamos National Laboratory, Waste and Environmental Services Division, EP2009-0283; 04 June 2009.

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PAVED ROAD; Paved Road Arcs; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 06 January 2004; as published 28 May 2009.

LANDSCAPE; Primary Landscape Features; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 06 January 2004; as published 28 May 2009.

STRUCTURES; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 06 January 2004; as published 28 May 2009.

CONTOUR; Hypsography, 2, 10, 20, and 100 Foot Contour Interval; Los Alamos National Laboratory, ENV Environmental Remediation and Surveillance Program; 1991.

LANL BOUNDARY; LANL Areas Used and Occupied; Los Alamos National Laboratory, Site Planning & Project Initiation Group, Infrastructure Planning Office; 19 September 2007; as published 04 December 2008.

TECHNICAL AREA; Technical Area Boundaries; Los Alamos National Laboratory, Site Planning & Project Initiation Group, Infrastructure Planning Office; September 2007; as published 04 December 2008.

SWMU; Potential Release Sites; Los Alamos National Laboratory, Waste and Environmental Services Division, Environmental Data and Analysis Group, EP2009-0137; 1:2,500 Scale Data; 13 March 2009.

PRIMARY AND SECONDARY ROAD; Road Centerlines for the County of Los Alamos; County of Los Alamos, Information Services; as published 04 March 2009.

OWNERSHIP BOUNDARIES AROUND LANL AREA; Los Alamos National Laboratory, Site Planning & Project Initiation Group, Infrastructure Planning Office; 19 September 2007; as published 04 December 2008.

Road Centerlines; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 15 December 2005; as published 28 May 2009.

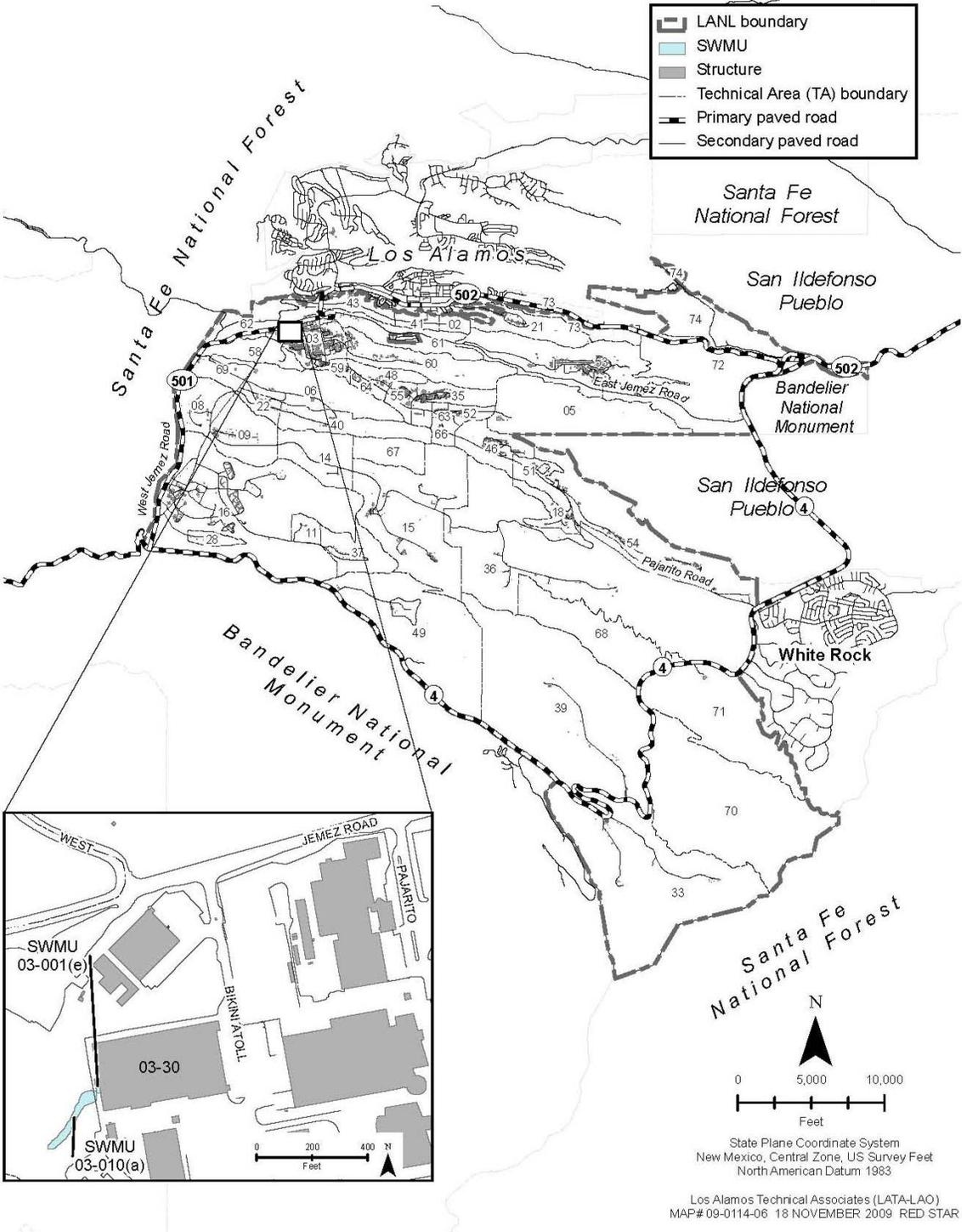


Figure 1 Locations of building SM-30 at TA-3 with respect to Los Alamos National Laboratory

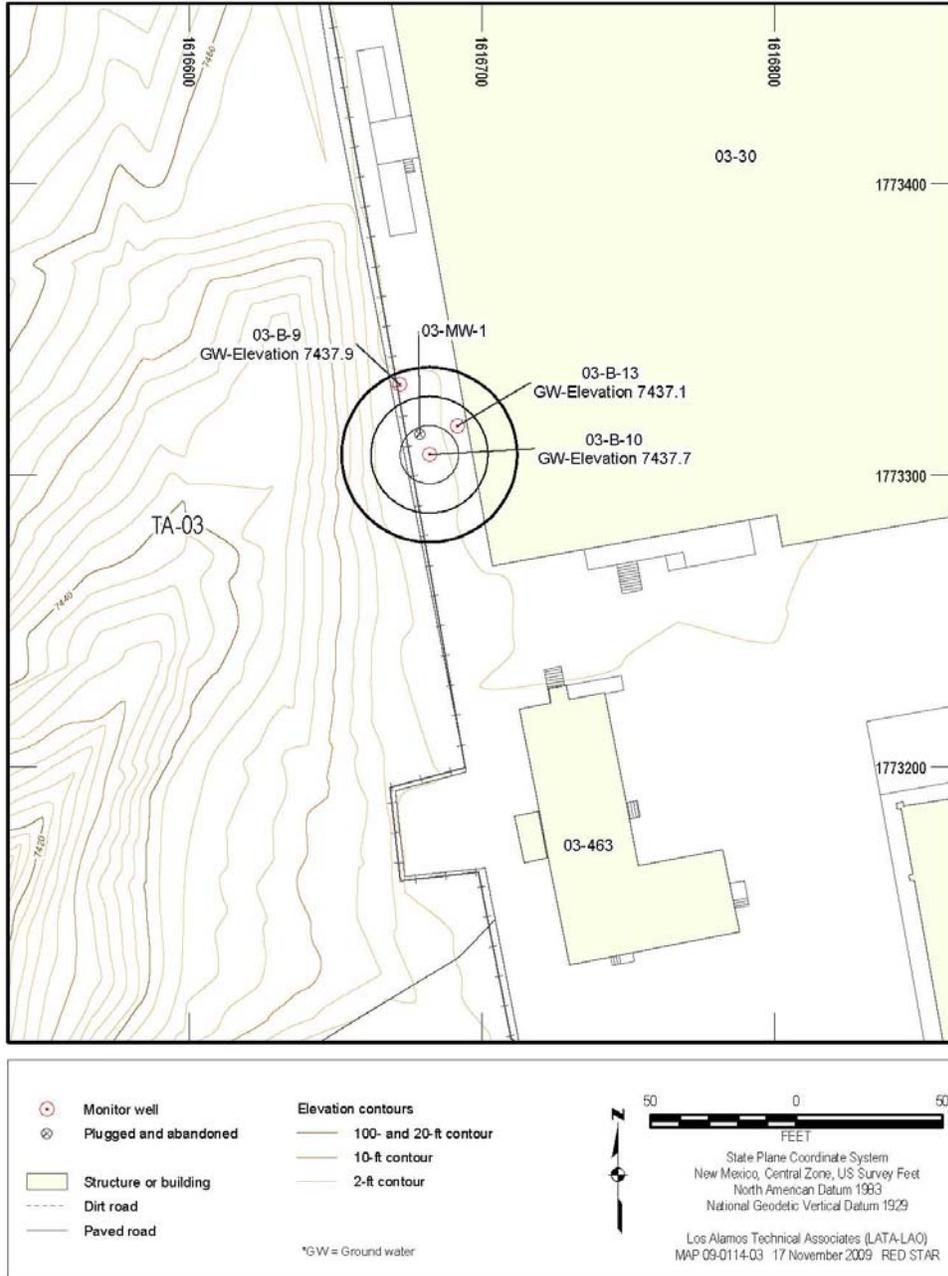


Figure 2 Location of pumping well 03-B-10 with 10-ft-radius circles, and observation wells 03-B-9 and 03-B-13

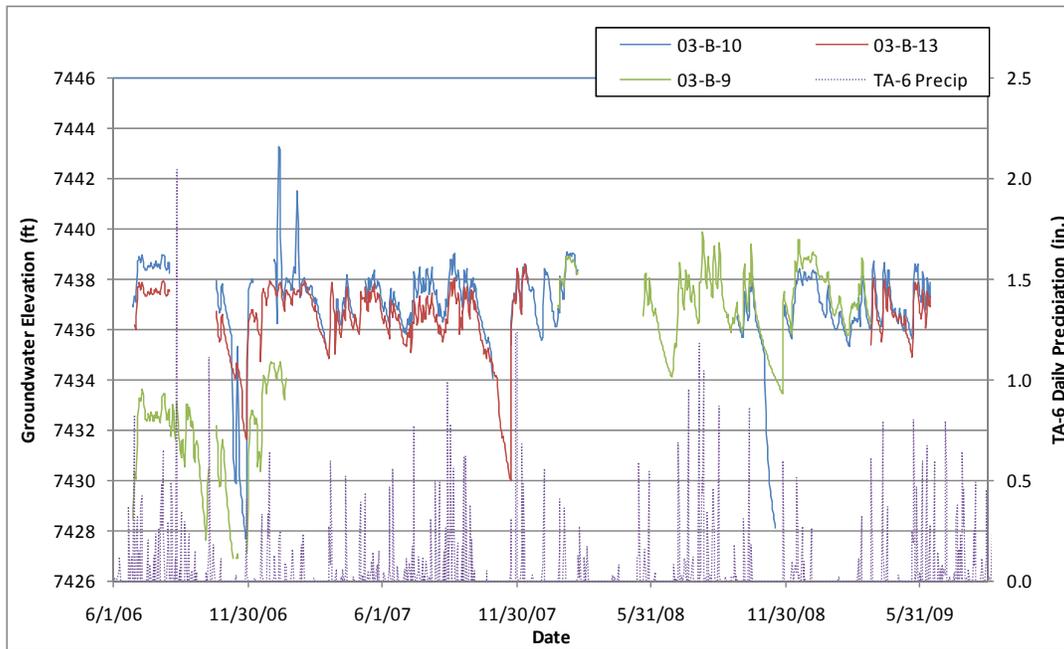


Figure 3 Historic groundwater levels in the B-series wells and total daily precipitation at TA-06

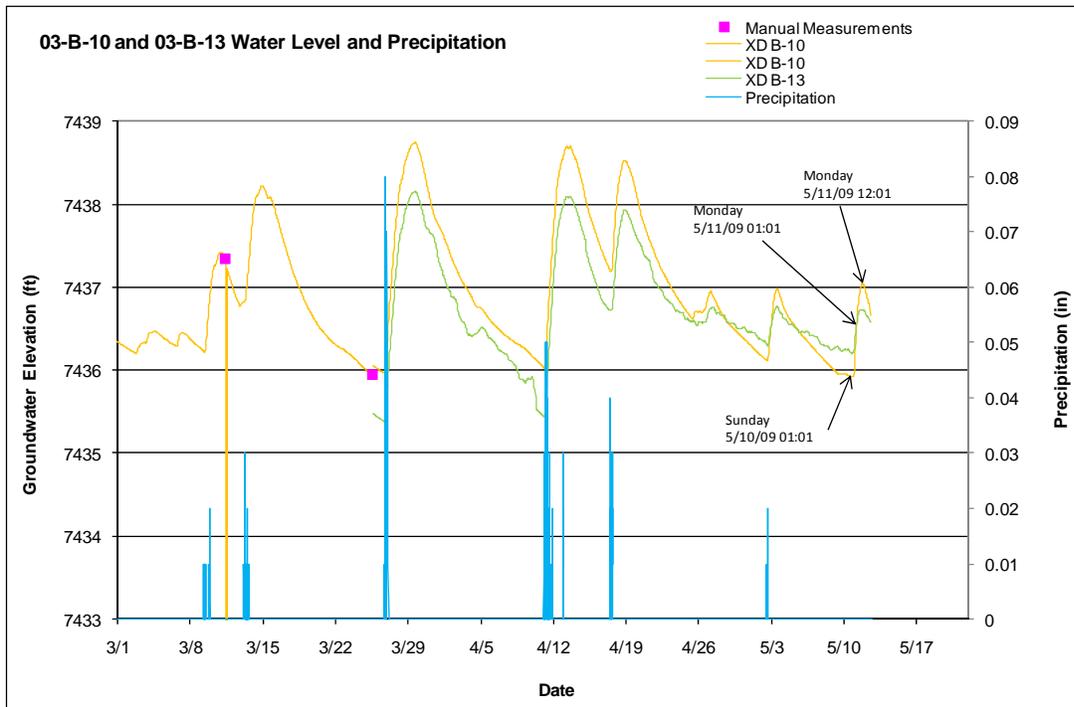
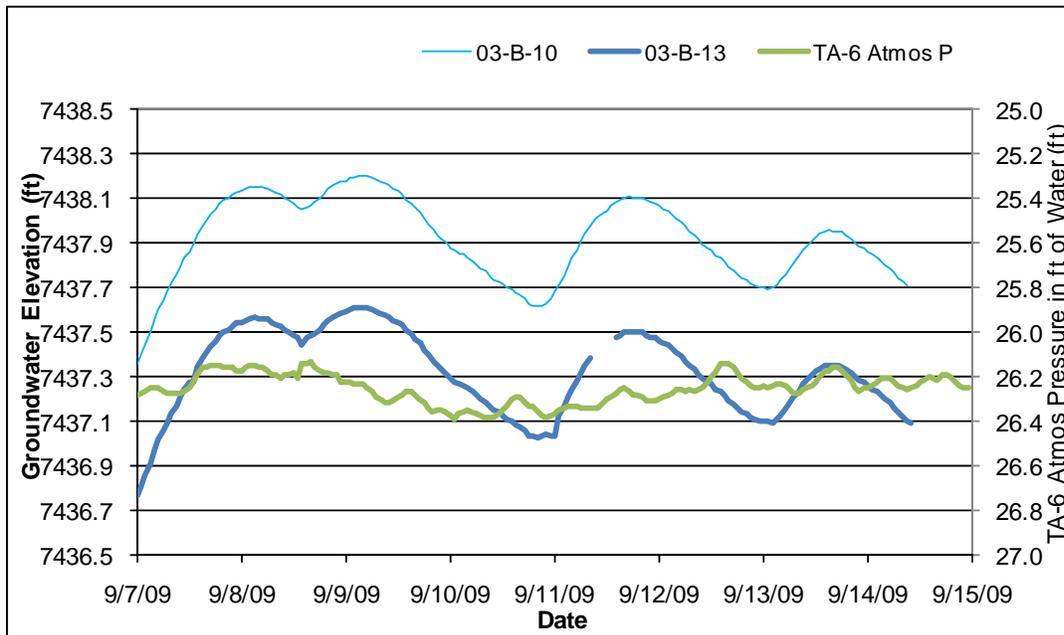


Figure 4 Groundwater levels in monitoring wells 03-B-10 and 03-B-13, showing responses to precipitation events and to the water line break on May 10, 2009



Note that well 03-B-13 was pumped and sampled on September 11, 2009.

Figure 5 Background hydrographs of 03-B-10 and 03-B-13, and atmospheric pressure at TA-06

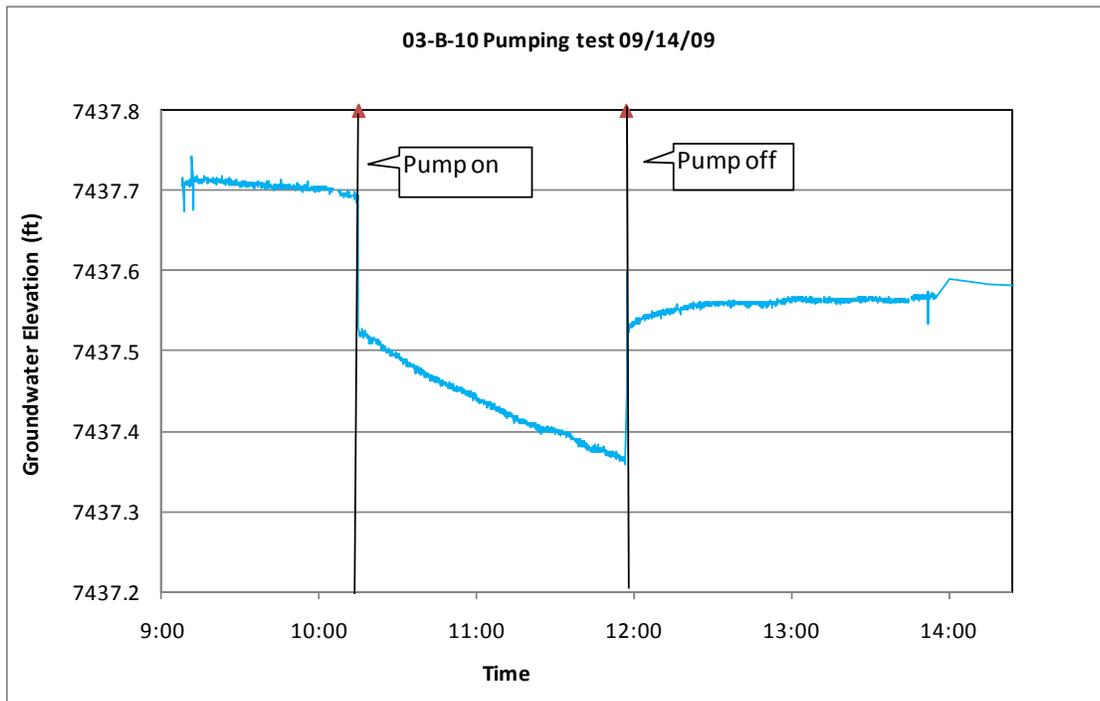


Figure 6 Hydrograph of pumping well 03-B-10 during testing on September 14, 2009

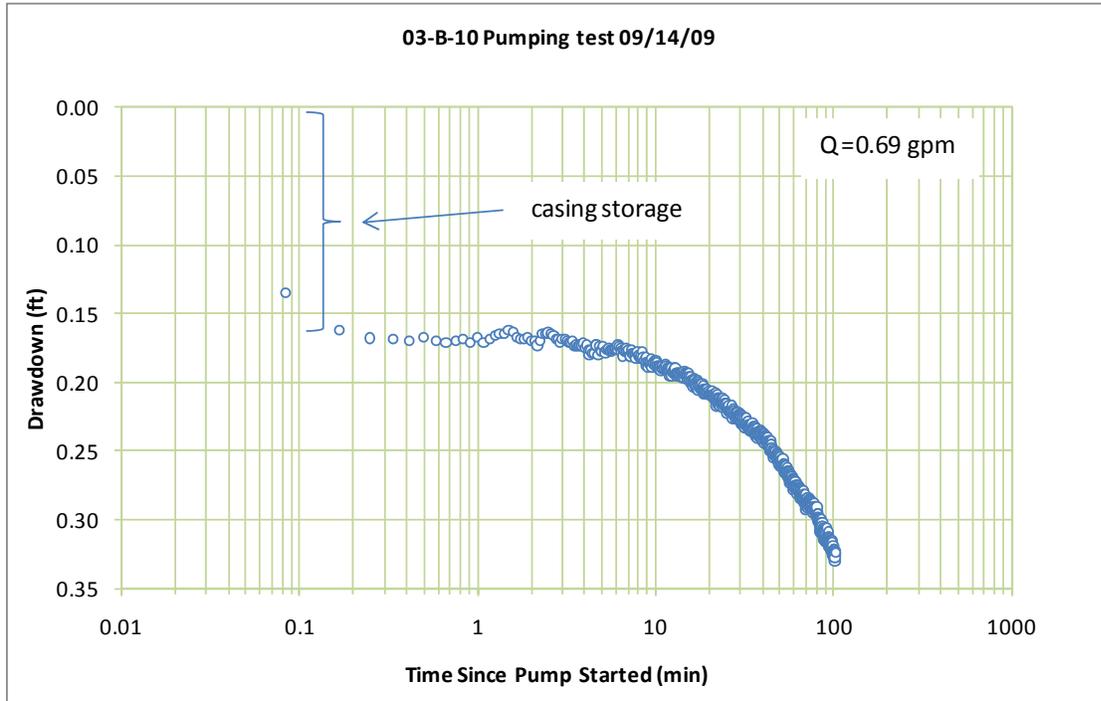


Figure 7 Pumping well 03-B-10 drawdown

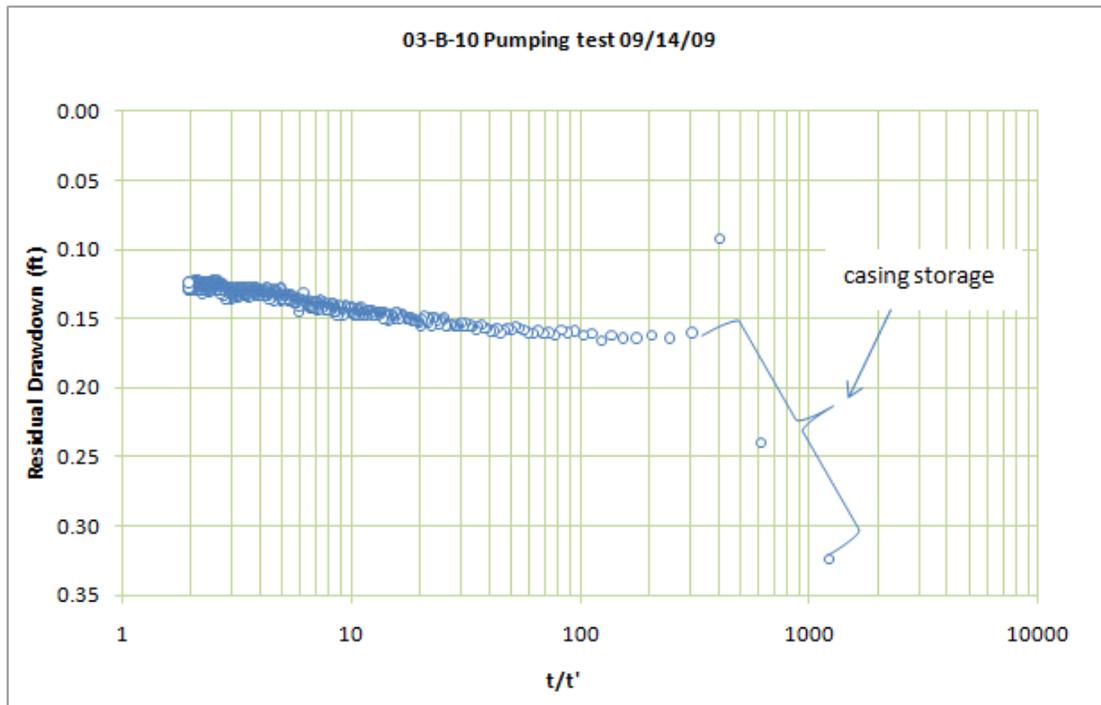


Figure 8 Pumping well 03-B-10 recovery

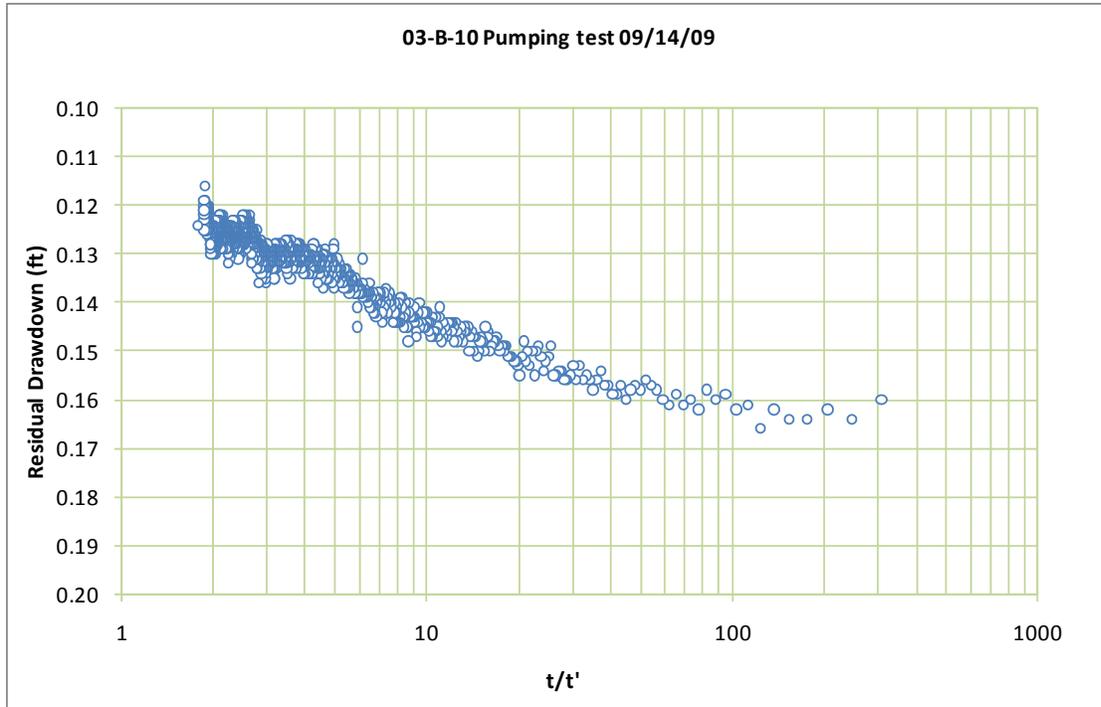


Figure 9 Pumping well 03-B-10 recovery—expanded scale

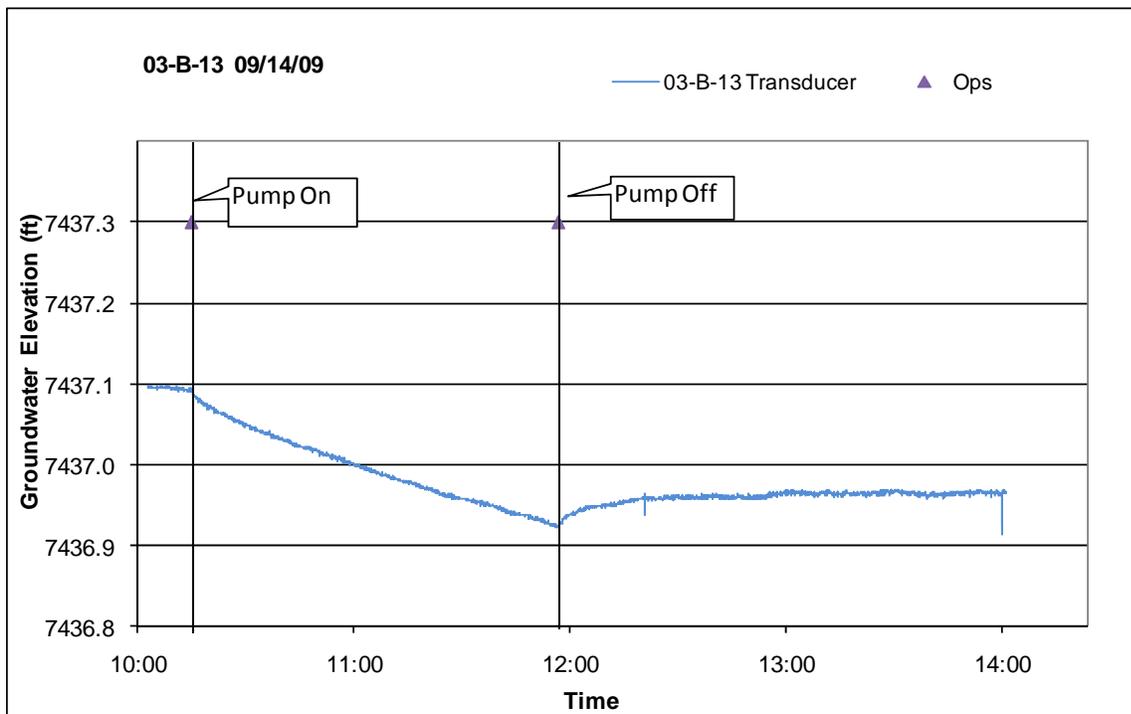


Figure 10 Hydrograph of observation well 03-B-13

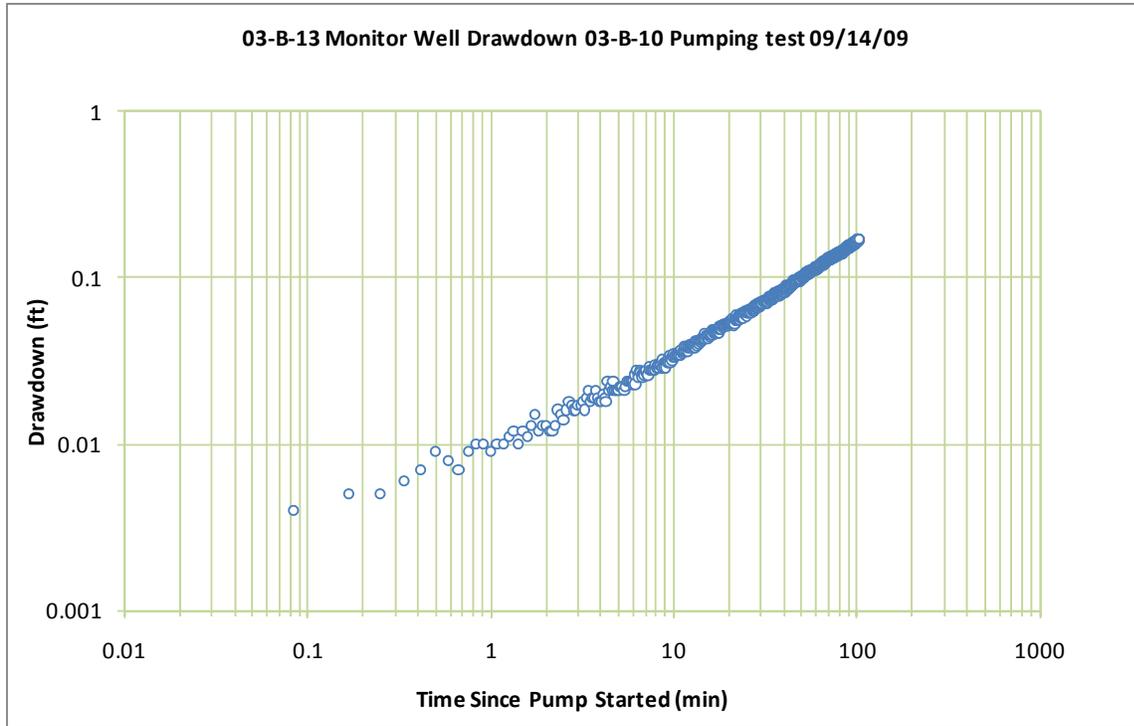


Figure 11 Observation well 03-B-13 drawdown

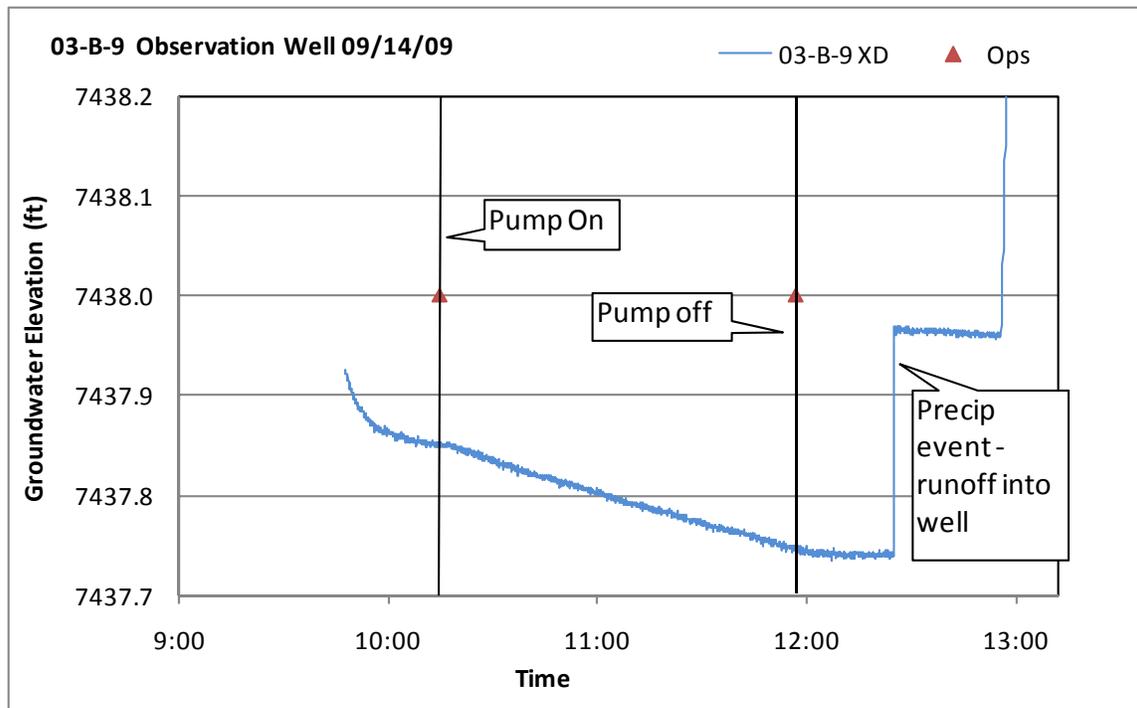


Figure 12 Hydrograph of observation well 03-B-9

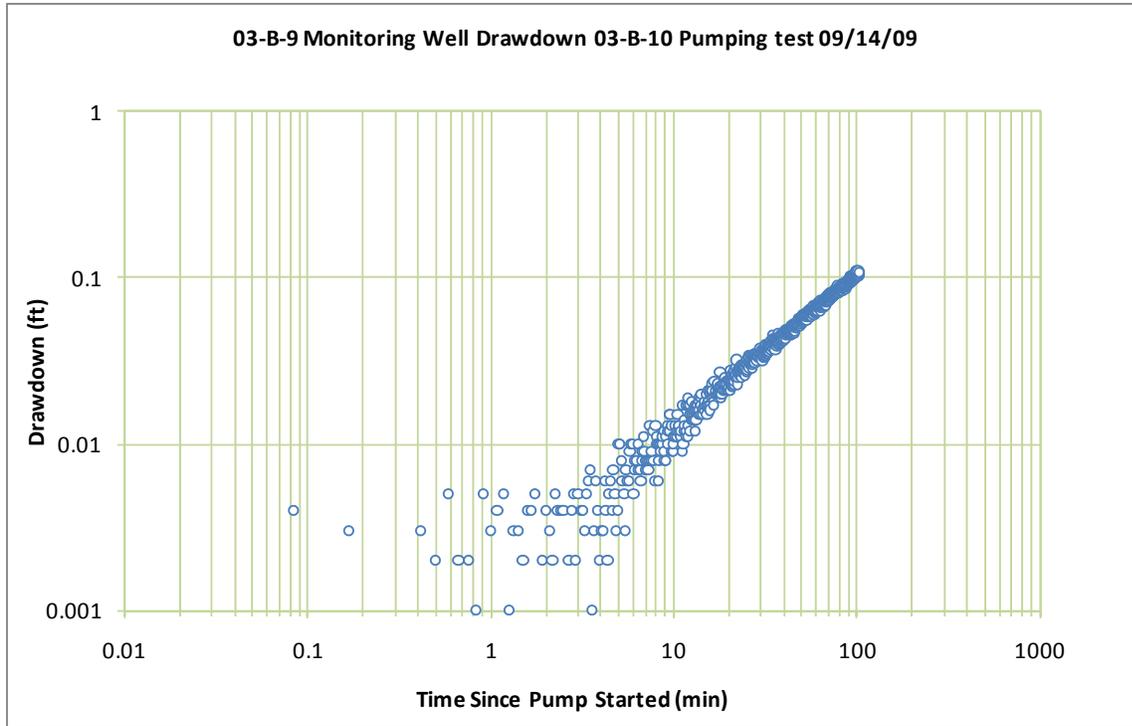
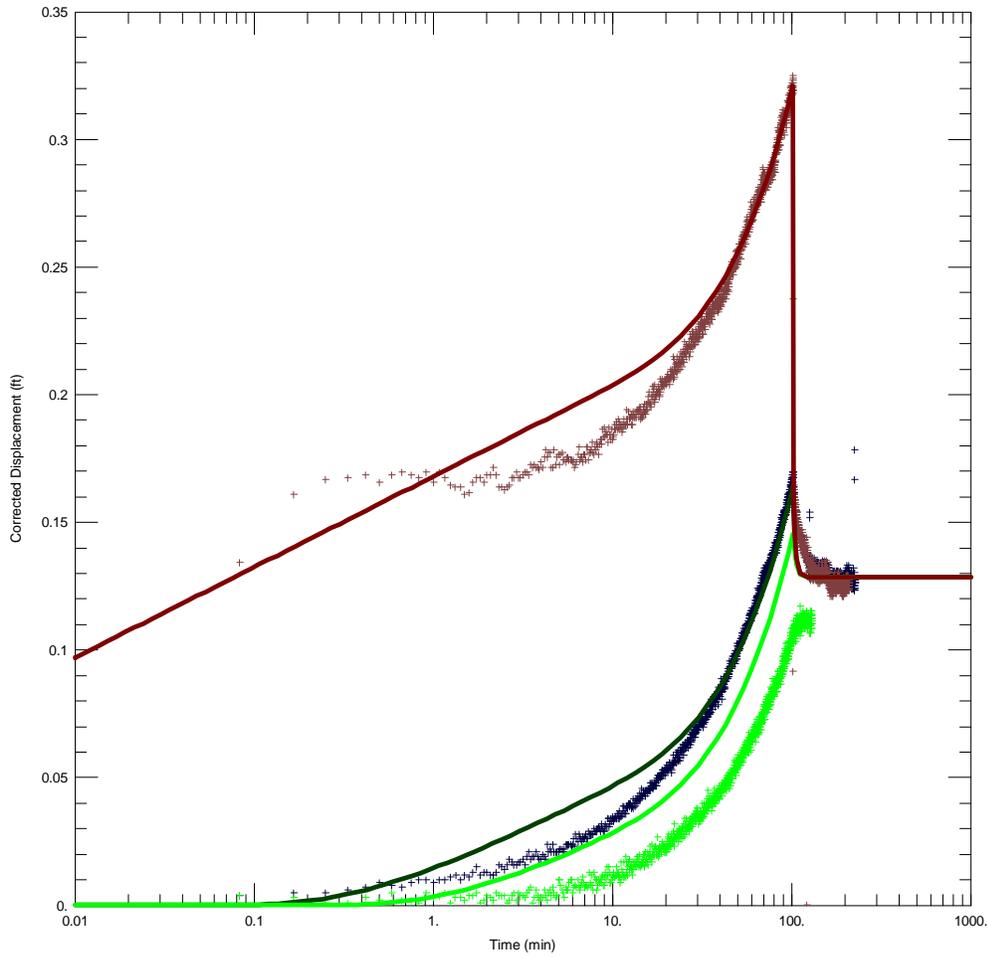
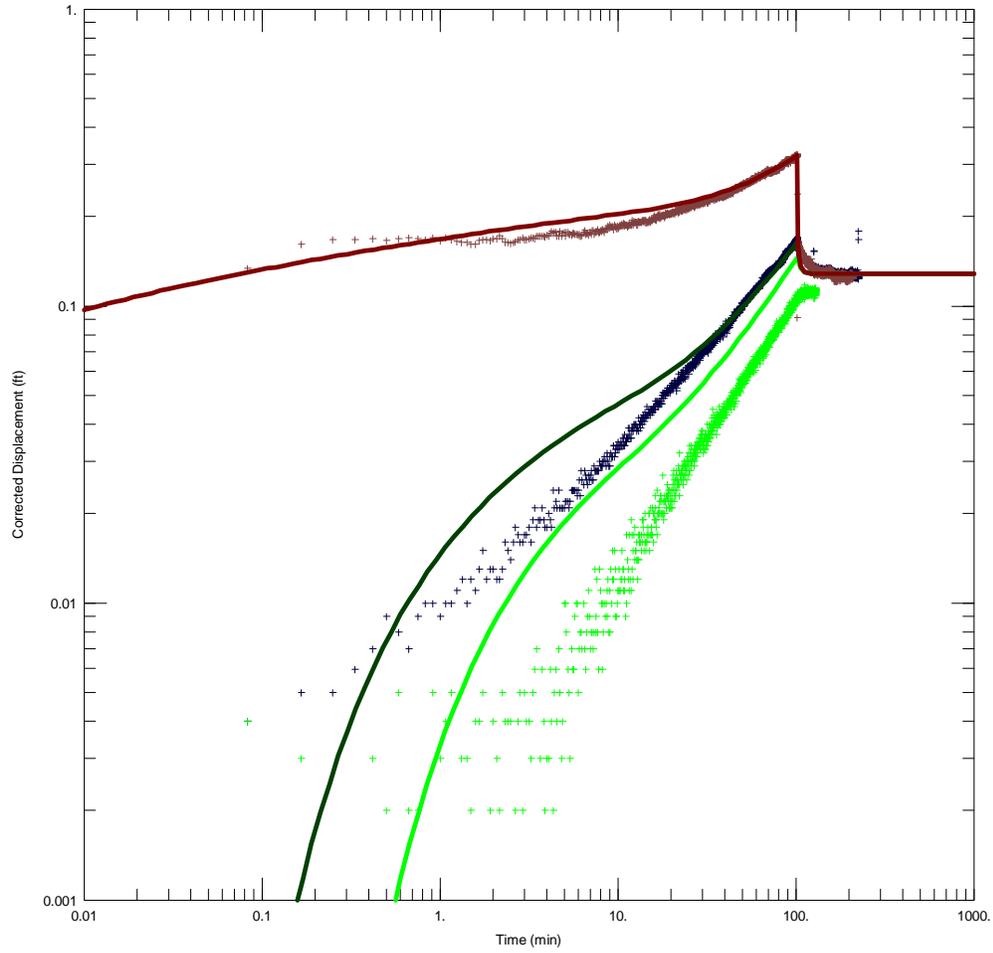


Figure 13 Observation well 03-B-9 drawdown



Note: Brown represents 03-B-10; green represents 03-B-9; blue represents 03-B-13; crosses represent observations; solid lines represent matching curves.

Figure 14 Semilog plot of the pumping test data and matching solution curves



Note: Brown represents 03-B-10; green represents 03-B-9; blue represents 03-B-13; crosses represent observations; and solid lines represent matching curves .

Figure 15 Log-log plot of the pumping test data and matching solution curves

Attachment A

Well Completion Diagrams

BOREHOLE/WELL CONSTRUCTION AND COMPLETION LOG SWMU 03-010(a) and SWMU 03-001(e) RFI Investigation		
BOREHOLE ID: 03-24529 (B-9)	Technical Area (TA): 03-010(a)	Field Team Leader: G. Stoopes
DRILLING COMPANY: Spectrum Exploration START DATE/TIME: 06/02/2005:1500 FINISH DATE/TIME: 06/03/2005:0950		

DRAWING NOT TO SCALE
ALL DEPTHS IN FEET BELOW GROUND SURFACE (bgs)

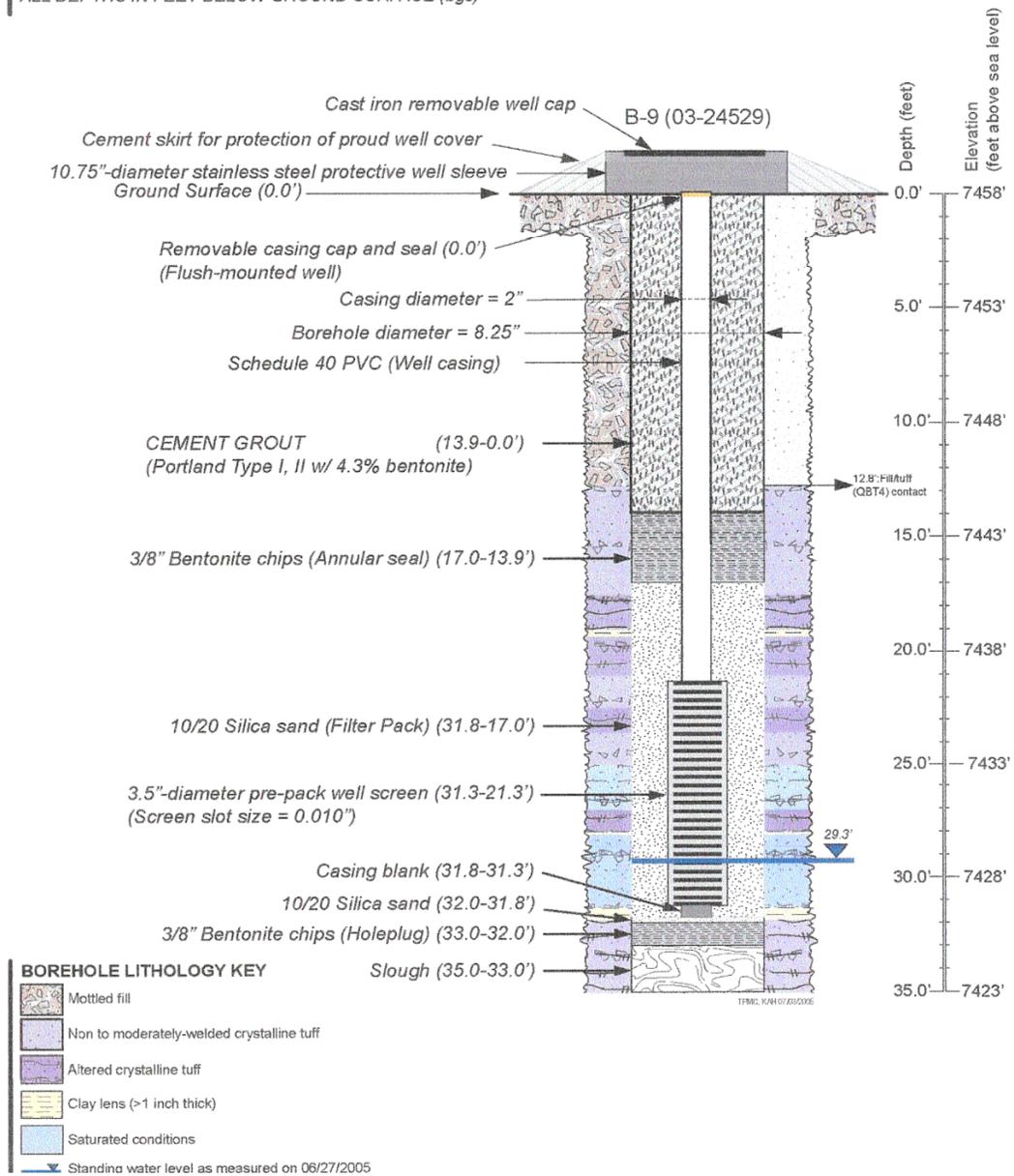


Figure A-1 03-B-9 Well Completion Diagram

BOREHOLE/WELL CONSTRUCTION AND COMPLETION LOG SWMU 03-010(a) and SWMU 03-001(e) RFI Investigation		
BOREHOLE ID: 03-24530 (B-10)	Technical Area (TA): 03-010(a)	Field Team Leader: G. Stoopes
DRILLING COMPANY: Spectrum Exploration START DATE/TIME: 06/03/2005:1502 FINISH DATE/TIME: 06/04/2005:1200		

DRAWING NOT TO SCALE
ALL DEPTHS IN FEET BELOW GROUND SURFACE (bgs)

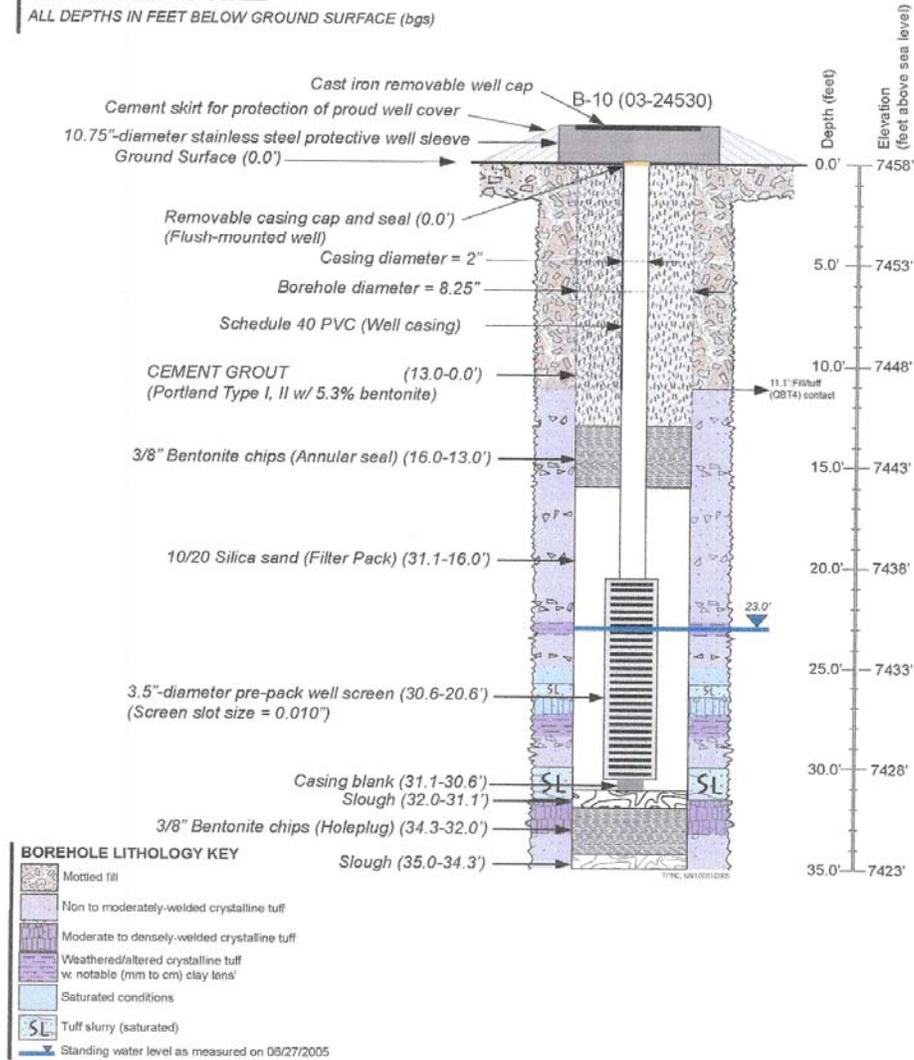


Figure A-2 03-B-10 Well Completion Diagram

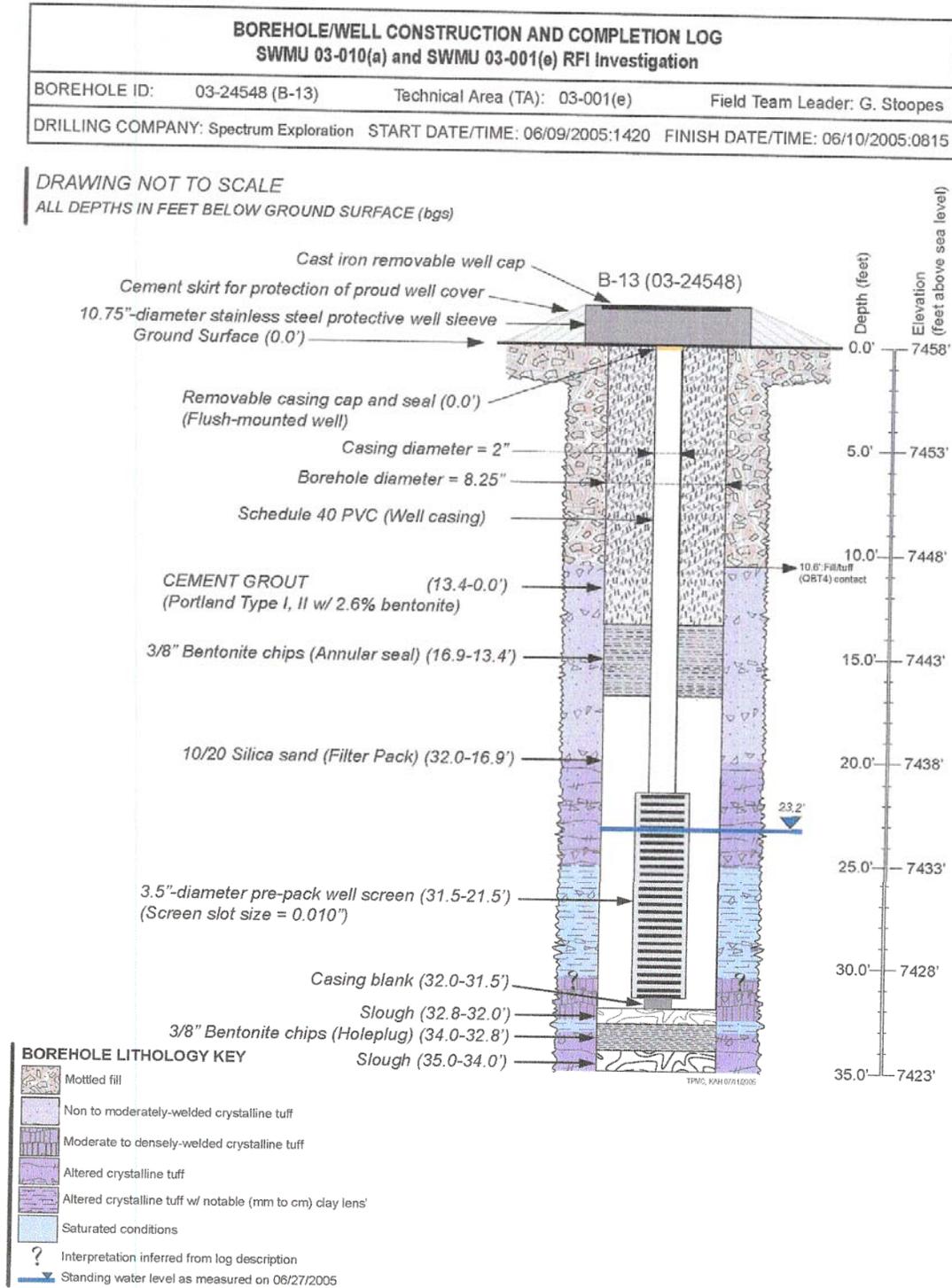
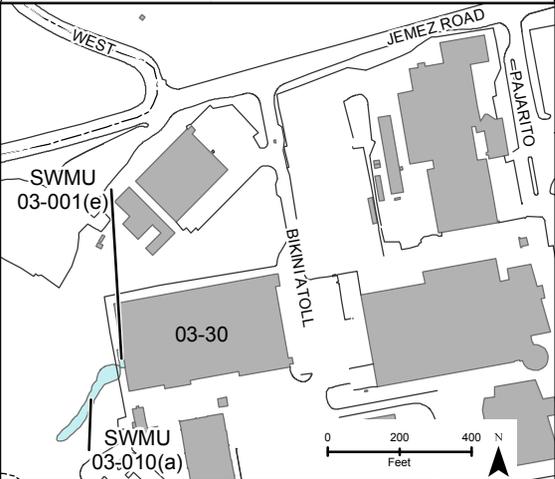
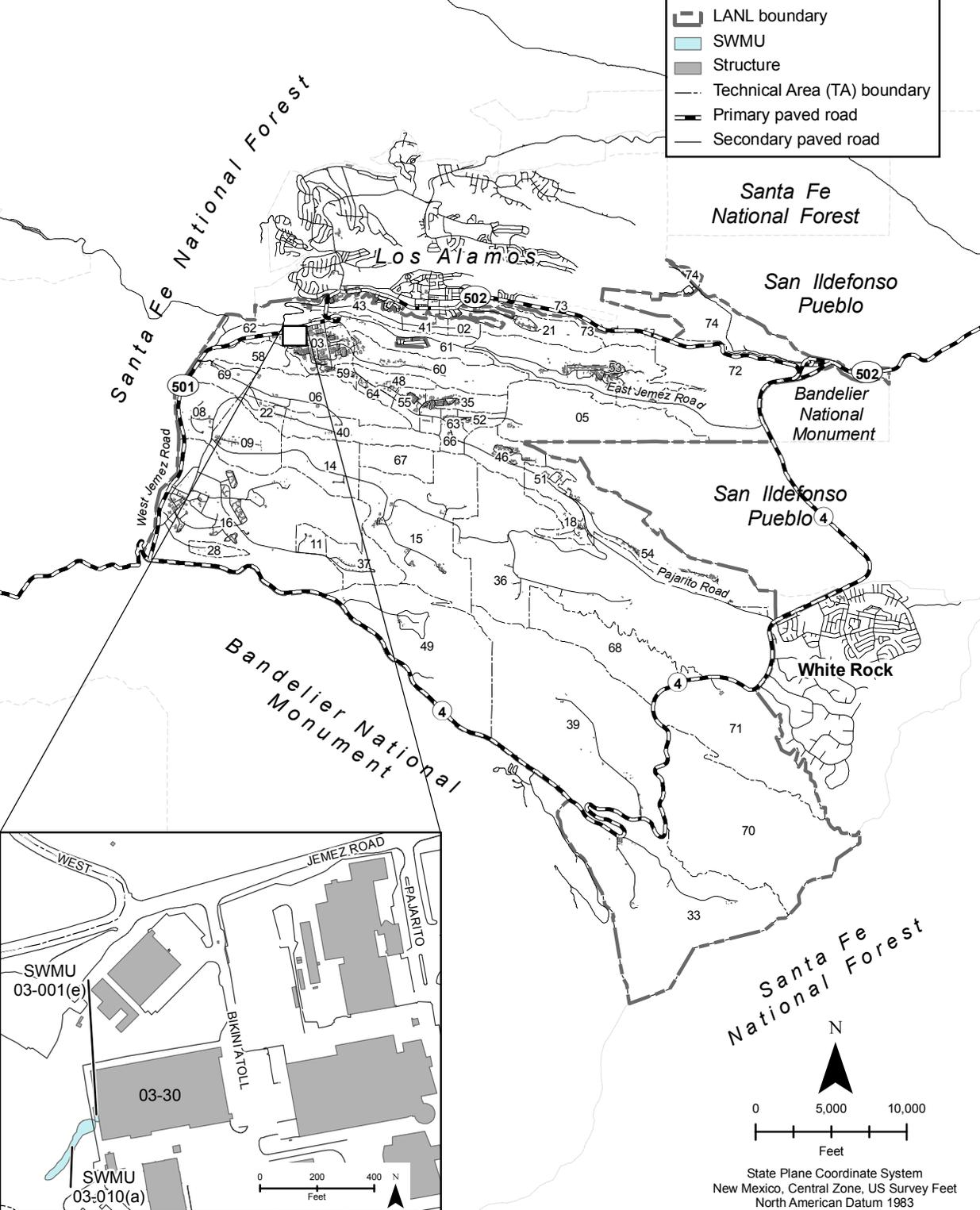
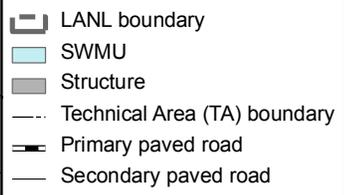
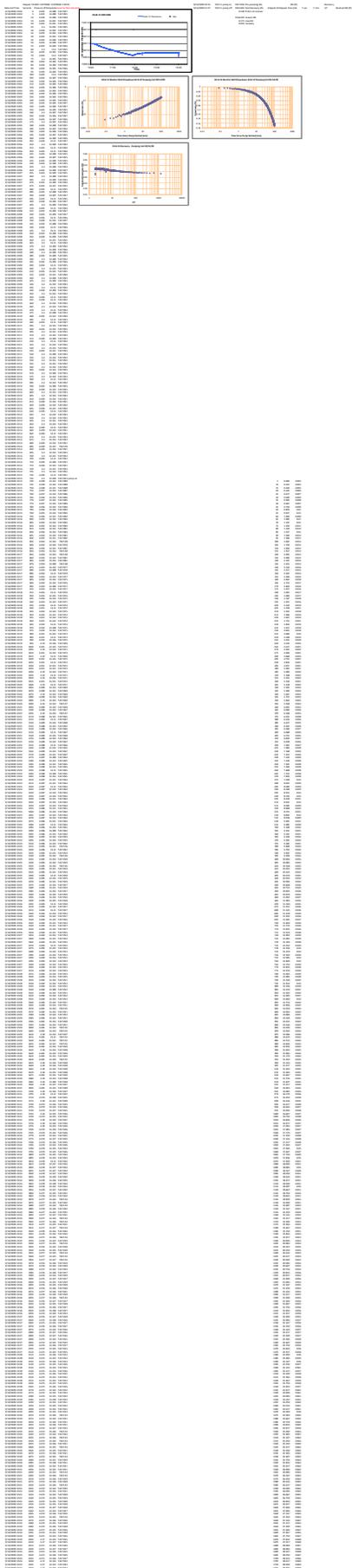


Figure A-3 03-B-13 Well Completion Diagram

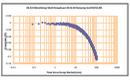
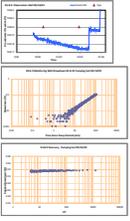
Attachment B

*Data Input for Software Analysis
(on CD included with this document)*





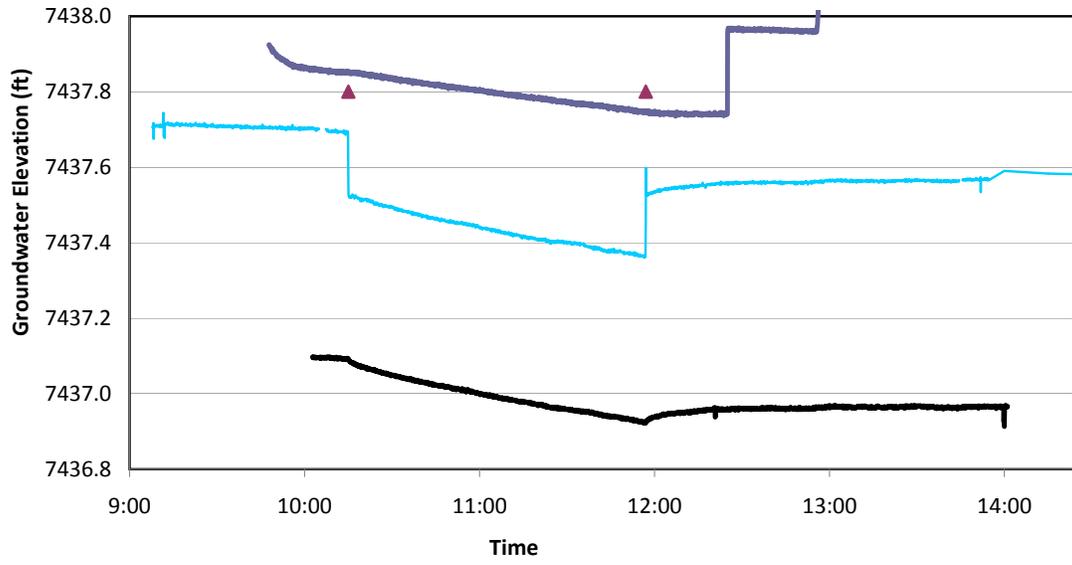
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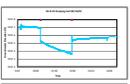
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03-B-10 Pumping test 09/14/09

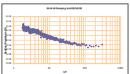
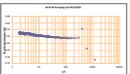
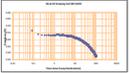
▲ OPs 03-B-10 03-B-13 03-B-9



Small text block containing a list of names or identifiers, possibly a roster or index, arranged in a vertical column.



Category	Value
Category 1	100
Category 2	50
Category 3	75
Category 4	60
Category 5	80

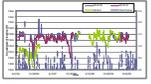


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 Value

1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000
 0 10 20 30 40 50 60 70 80 90 100
 Value

