

# Compilation of Results of Aquifer Tests in Texas

by Brent Christian, P.G. • David Wuerch, P.G.

Report 381  
April 2012

Texas Water Development Board  
[www.twdb.texas.gov](http://www.twdb.texas.gov)





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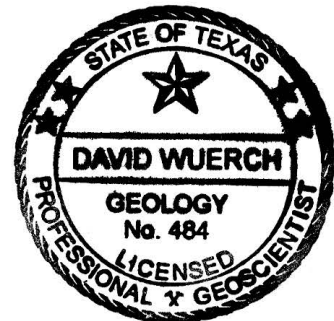
### Geoscientist Seal

The contents of this report (including figures and tables) document the work of the following licensed Texas geoscientists:

David Wuerch, P.G. No. 484

Mr. Wuerch was responsible for reviewing the raw data, preparing the final versions of the aquifer test graphs, and writing the front section of the report.

The seal appearing on this document was authorized on April 10, 2012.



A handwritten signature in black ink, appearing to read "David Wuerch", written over a horizontal line.

*David Wuerch*

This report is dedicated to the memory of Brent Christian. Brent was a professional geologist who worked in the Groundwater Resources Division of the Texas Water Development Board (TWDB). He was instrumental in compiling and analyzing the bulk of the aquifer tests contained in this report. Brent passed away unexpectedly in 2007, prior to the completion of this report. His dedicated work on groundwater issues while at the TWDB was greatly appreciated.

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# 1.0 Introduction

The mission of the Texas Water Development Board's (TWDB) Groundwater Resources Division is to collect, interpret, and provide accurate, objective information on the groundwater resources of Texas. In support of this mission, the TWDB has undertaken a long-term process of mapping and characterizing the aquifers of Texas.

In order to better understand and predict water levels and quantity, TWDB staff are evaluating the results from over 2,200 aquifer tests contained in the TWDB groundwater database. The first installment of results was published in the TWDB Report 98 (R-98) "Compilation of Results of Aquifer Tests in Texas" published in July 1969. This report is intended to be the second installment. Results from 198 additional aquifer tests have been compiled from wells located in 71 counties throughout the state (Figure 1).

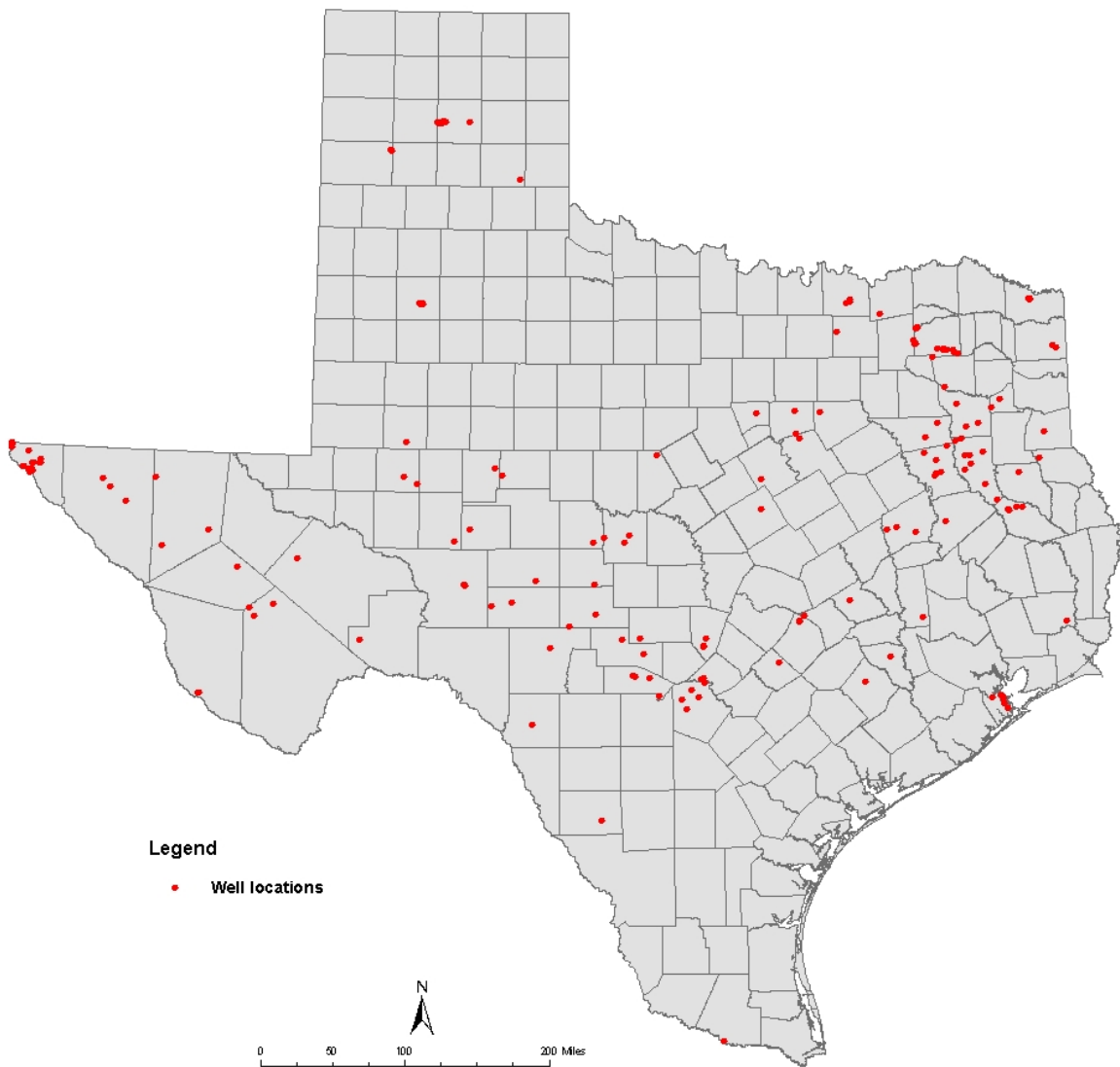


Figure 1. Well location map.



All test results, and in most circumstances, the raw data are available online individually by state well number through the TWDB's Water Information, Integration, and Dissemination Web page under the "Groundwater Database" application.

Aquifer test data are important in determining the performance characteristics of the well along with the hydraulic properties of the aquifer. Hydraulic properties determined by aquifer tests are subsequently used in the development of Groundwater Availability Models (GAMs) and in other regional aquifer studies.

Aquifer test data contained in this report were gathered by the TWDB, the U.S. Geological Survey, individuals, and companies. Submittal of these data to the TWDB is greatly appreciated. The authors have reviewed the data and evaluated the tests using the computer program Aquifer Win32® available from Environmental Simulations, Inc. The program offers multiple solutions for the tests depending on aquifer and well characteristics. As with all evaluations, the authors have the leniency of some interpretation such as negating points when a check valve fails or when storage is the primary recipient of recovery.

## 2.0 Hydraulic Properties of an Aquifer

The flow of groundwater to a well is based on the ability of the aquifer to transmit and store water. Also, well construction can influence well production and can introduce a human factor to an aquifer test and its results. Transmissivity and storativity are two important aquifer properties determined from aquifer tests. Transmissivity (T) is defined as the rate at which water is transmitted under a unit width of an aquifer under a unit hydraulic gradient. Storativity (S) is defined as the volume of water an aquifer releases from or takes into storage per unit surface area of the aquifer per unit change in head.

Hydraulic conductivity is another important aquifer property determined from aquifer tests. Hydraulic conductivity (K) is a coefficient of proportionality describing the rate at which water can move through a permeable medium. It is dependent on a variety of physical properties, including porosity, particle size and distribution, and other factors. Hydraulic conductivity values are calculated using the following equation:

$$K=T/b$$

where      K=hydraulic conductivity (volume/time/length squared)  
              T=transmissivity (volume/time/length)  
              b=saturated thickness of the aquifer (length)

### **3.0 Description of Aquifer Tests**

The types of aquifer tests used for this report included both single-well and multiple-well aquifer tests. The single-well aquifer tests consist of pumping a well at a constant rate and measuring at specific times the drop in water level (drawdown) in the pumping well. The multiple-well aquifer tests incorporate the use of one or more observation wells located near the pumping well. These tests enable time and drawdown measurements to be recorded for both the pumping and observation wells. Additionally, measurements of the rise in water levels (recovery) at specific times, after the pump is turned off, provide important information. These measurements can be used to verify the aquifer properties determined from the pumping phase of the aquifer test.

### **4.0 Methods of Analyzing Aquifer Tests**

The formulas used to analyze the data presented in this report are the Theis non-equilibrium formula, the Cooper-Jacob modified non-equilibrium formula, the Theis recovery formula, the Hantush method, and the Neuman non-equilibrium formula. It is beyond the scope of this report to show the derivations of these formulas; the reader is referred to the following publications for their development and application: Cooper and Jacob (1946), Ferris and others (1962), Hantush (1960), Neuman (1972), Jacob (1950), Theis (1935), Thiem (1906), and Wenzel (1942).

Staff used the software program Aquifer Win32® for analysis of test data by a number of different methods. The time, drawdown, pumping rate, and well configuration are input into the program, which allows for the analysis of the test with various solutions utilizing the same data sets for the individual wells. The primary parameters include screen length, depth to screen top, aquifer thickness, and vertical to horizontal anisotropy ratios. In the case of observation well solutions, data inputs include depth to screen top and screen length.

The above-referenced solutions (methods) use one of the two basic types of operations: type curve matching or straight line solutions. The program allows well response curves plotted on log-log paper to be matched either manually or through automation. The program differs from most test software by displaying multiple type curves for manual or automated comparisons to the tested well's response.

Staff used the Aquifer Win32® software program to calculate transmissivity values for all of the aquifer tests compiled. Storativity values could only be calculated for aquifer tests which incorporated data from one or more observation wells.

## **5.0 Explanation of Data on Graphs**

Graphs of the results from 198 aquifer tests have been compiled for this report (see Appendix). Graph titles include the county name, state well number, and analysis method. The graphs are sorted alphabetically by county followed by the state well number. Contained within each graph is a legend which presents additional information about the well and aquifer test.

The legend contains the latitude and longitude of the well in degrees, minutes, and seconds. The latitude and longitude of the tested wells are usually determined from placement on U.S. Geological Survey 7.5 and 15-minute topographic maps or more recently by using a global positioning device.

The graphs provide details on the data that were used to plot the graph (data used) and data collected during the test but ignored for the plot (data ignored). This information may include the following:

Recovery tests use the residual drawdown or the measurements of water levels after pumping is stopped. After a well is pumped for a known period of time and then shut down, the recovery of the drawdown should be identical to the discharge test. For this test residual drawdown is plotted versus the logarithm of time pumping ( $t$ ) over recovery time ( $t'$ ).

## **6.0 Acknowledgments**

We appreciate the efforts of David Thorkildsen, who did quality analysis/quality control of the various drafts of the report. We also thank Dr. Robert Mace for his support in ensuring the successful completion of this report.

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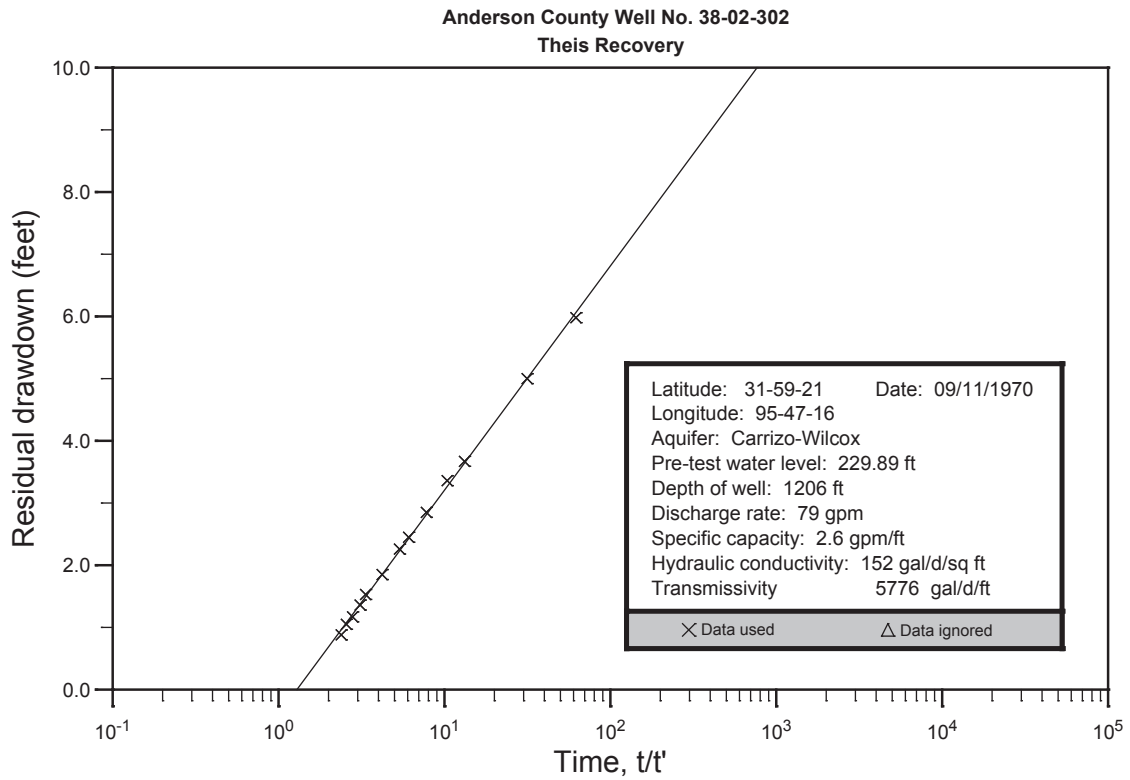
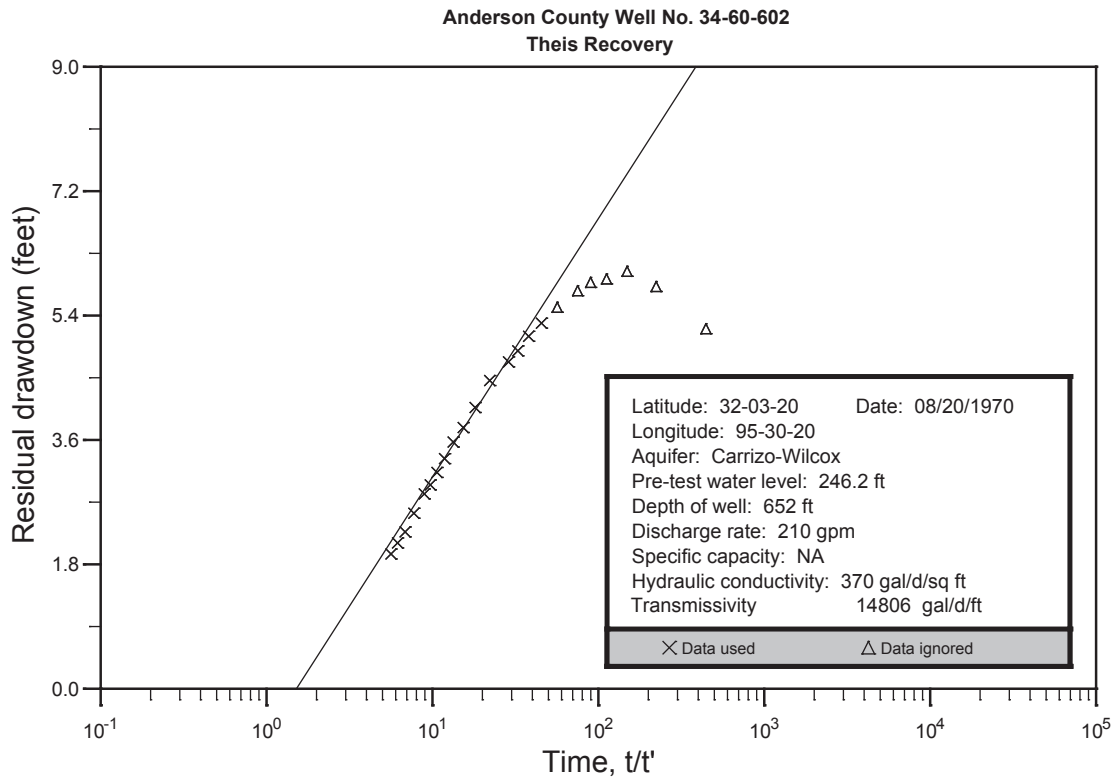
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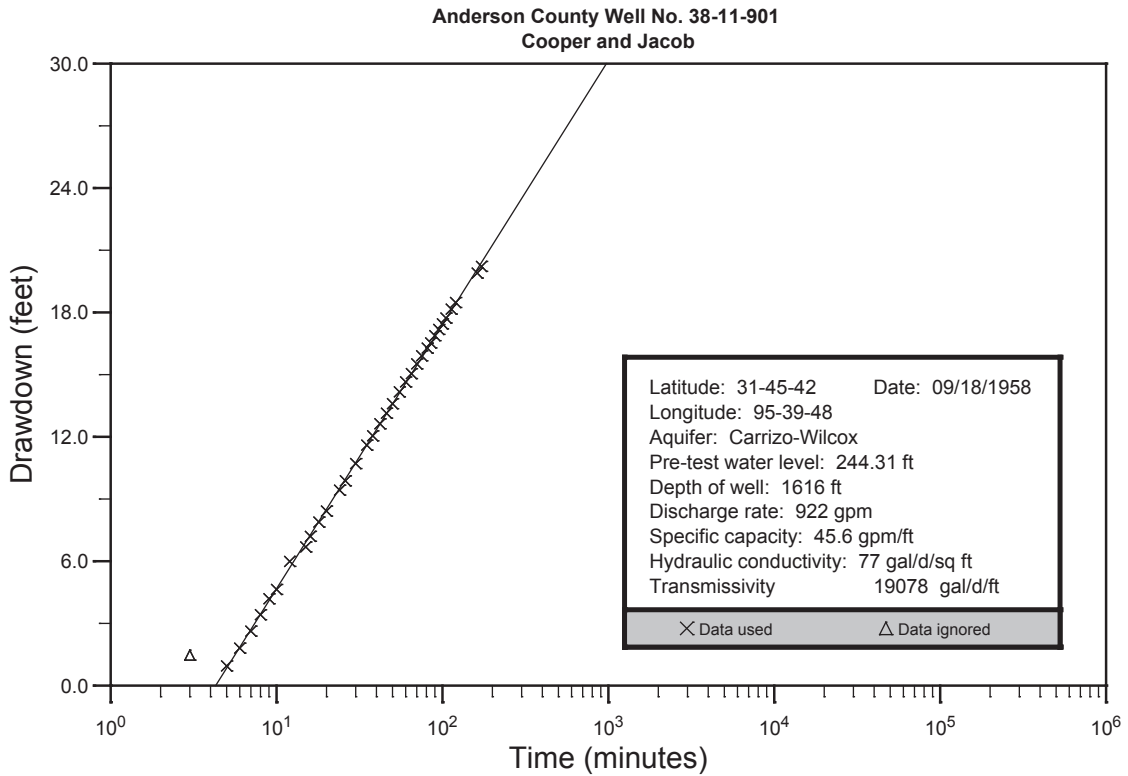
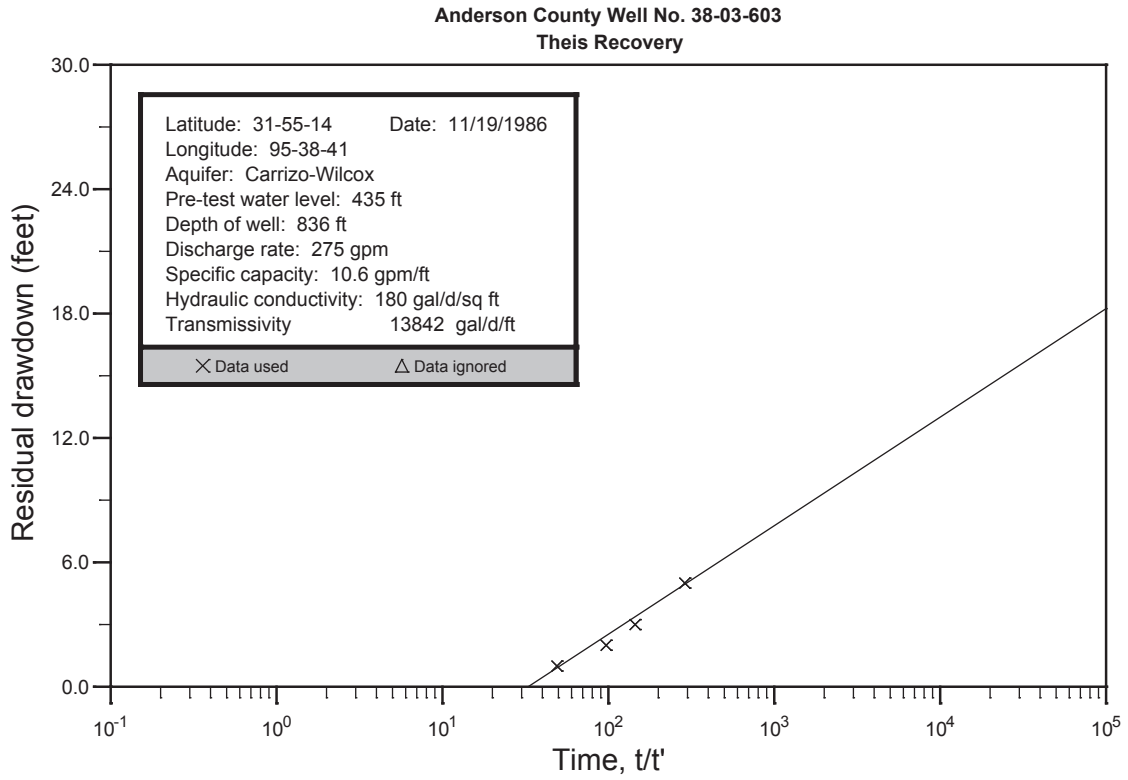
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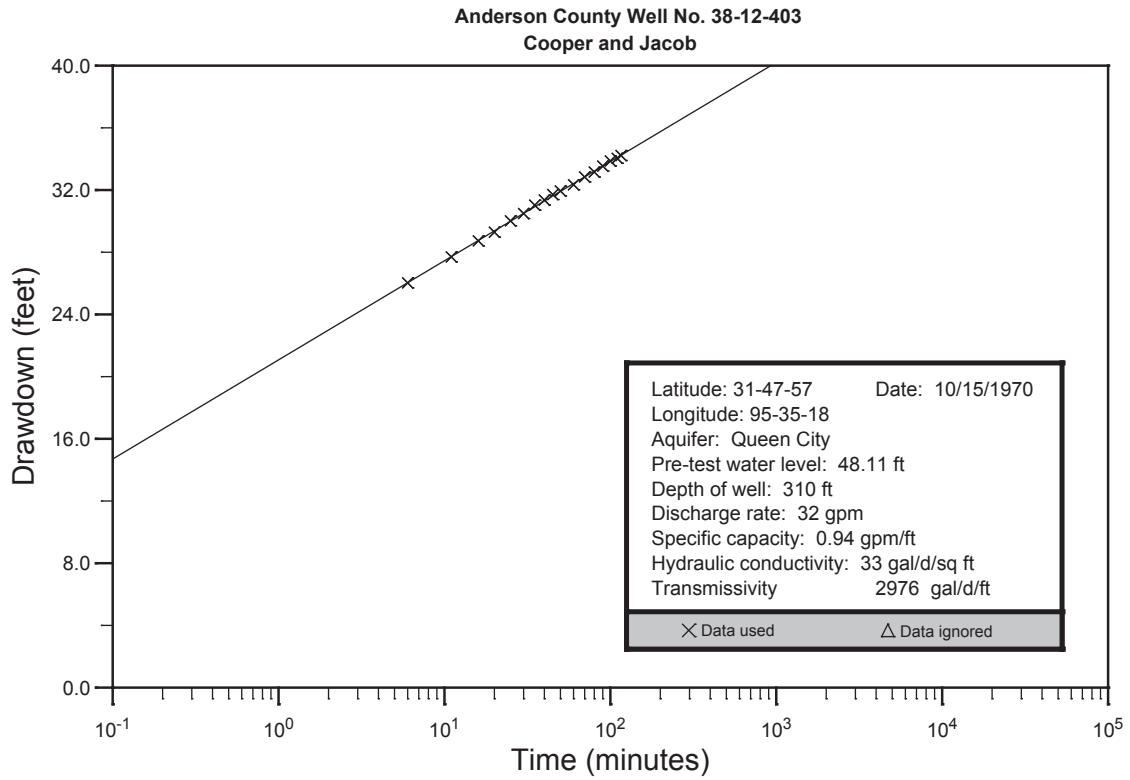
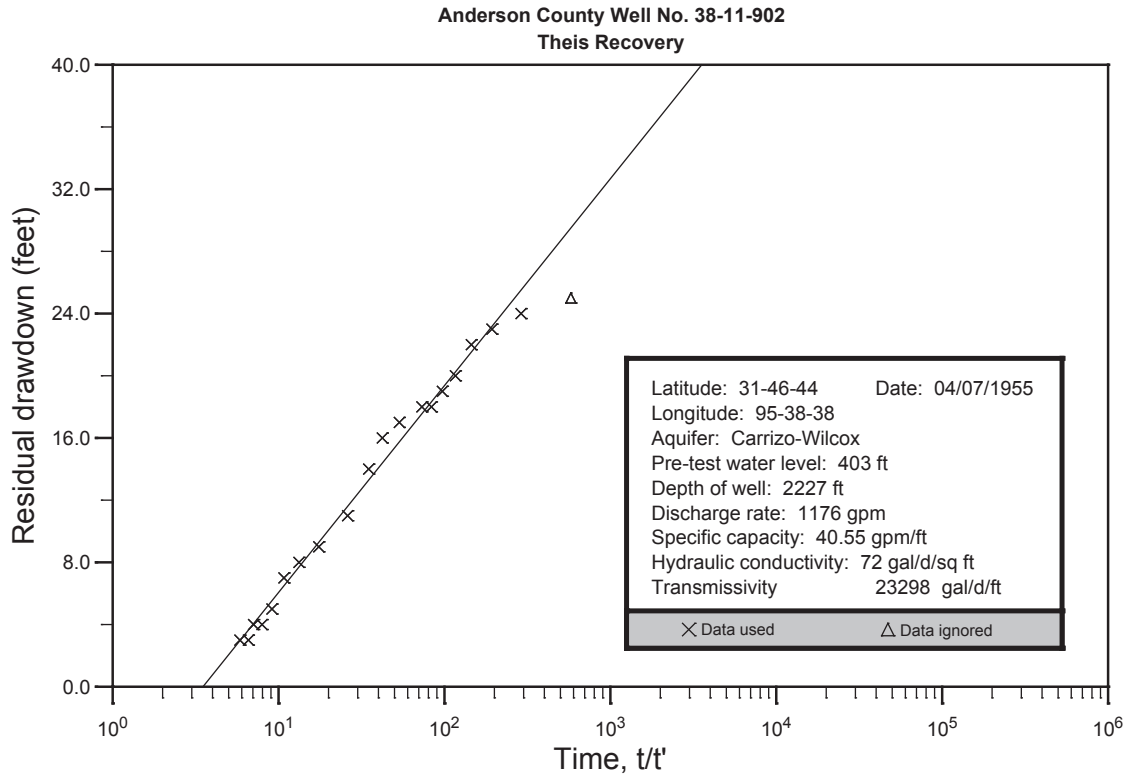
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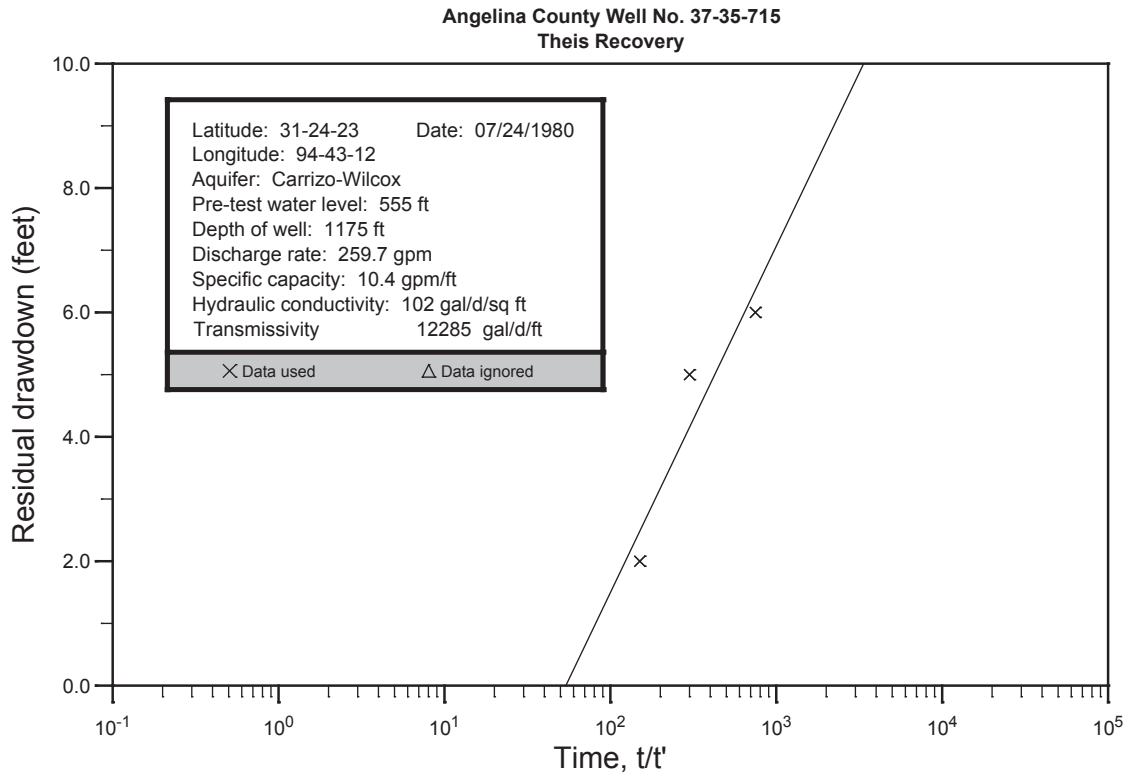
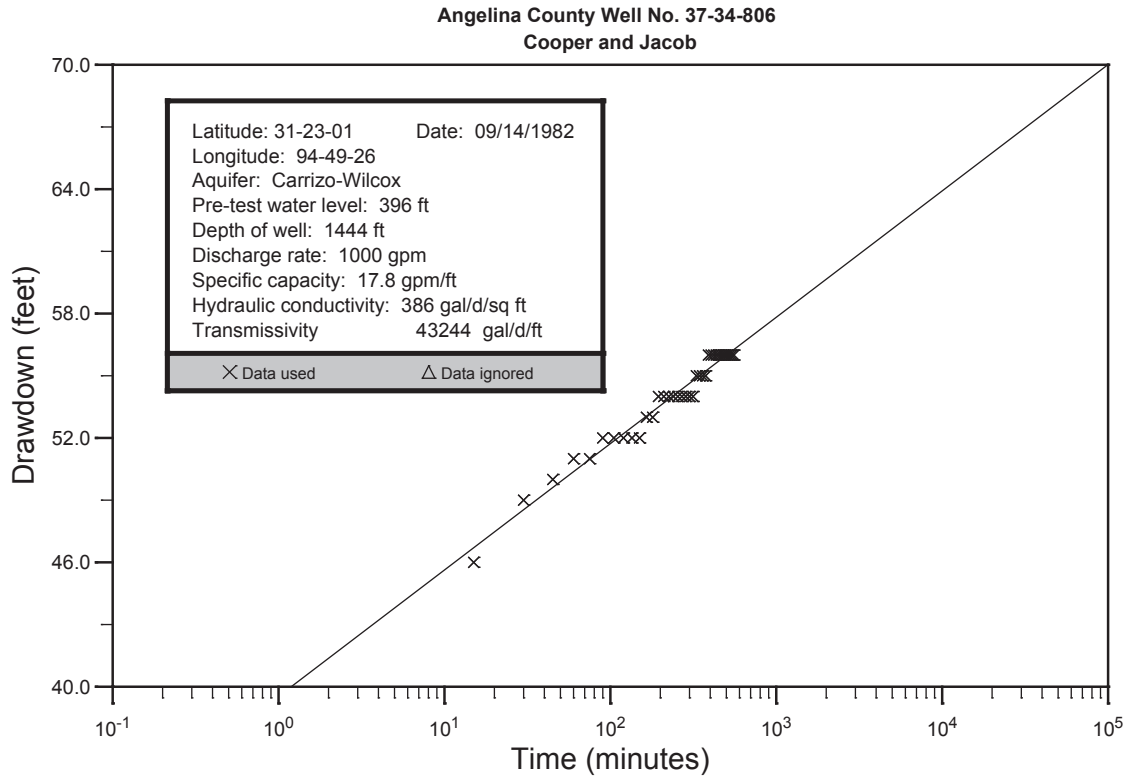
# Appendices

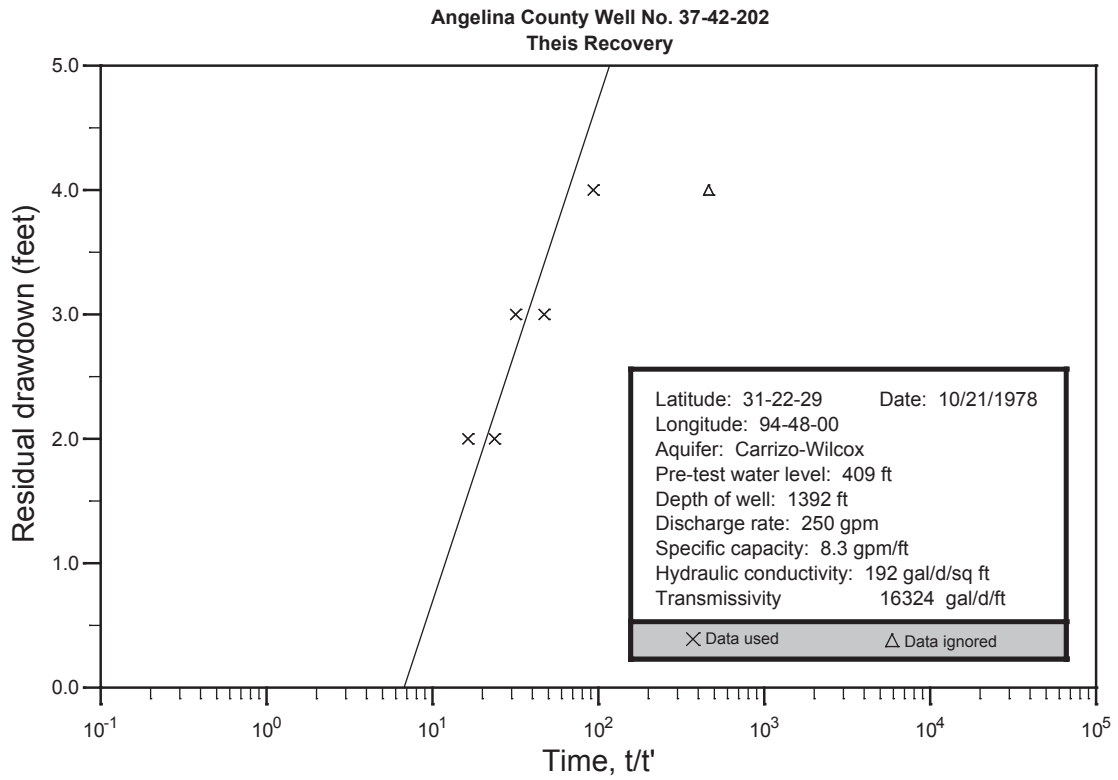
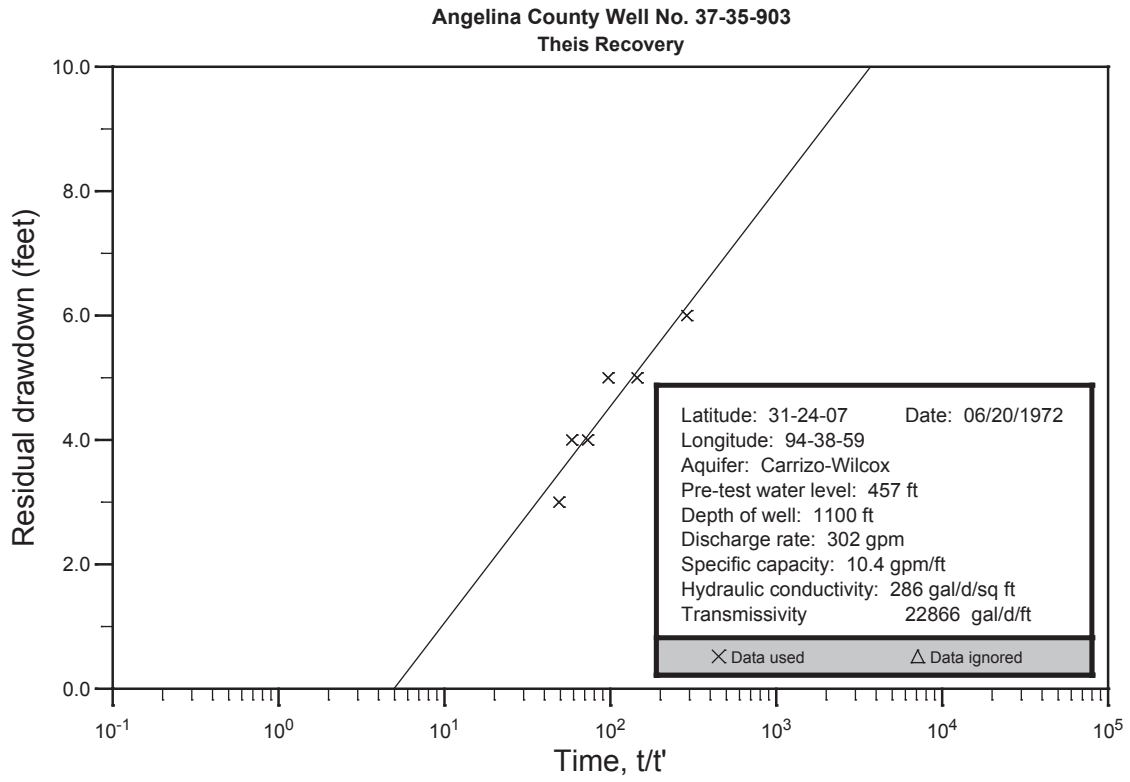


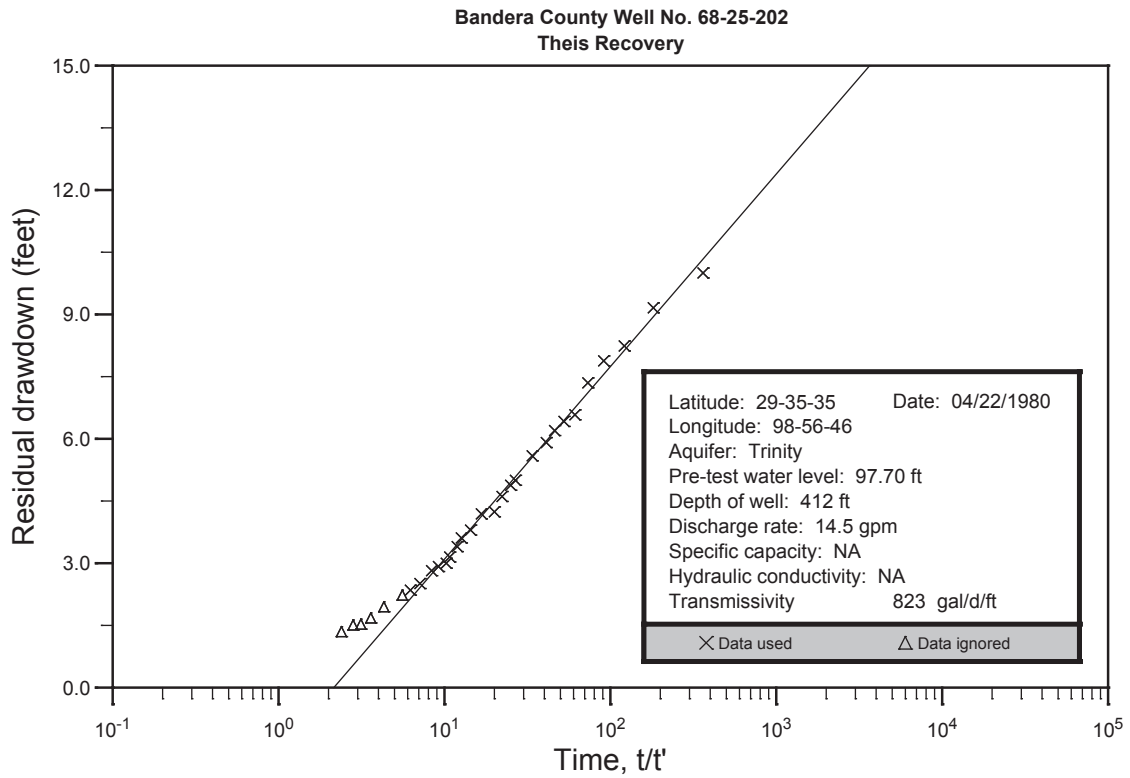
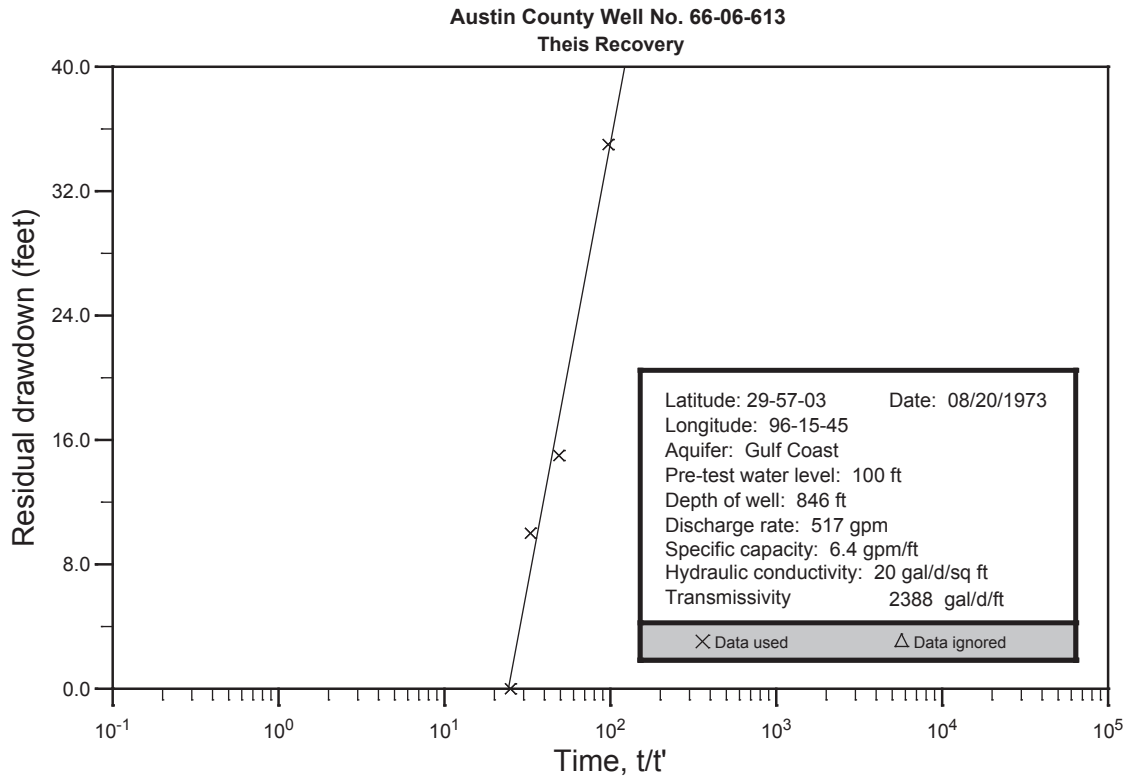


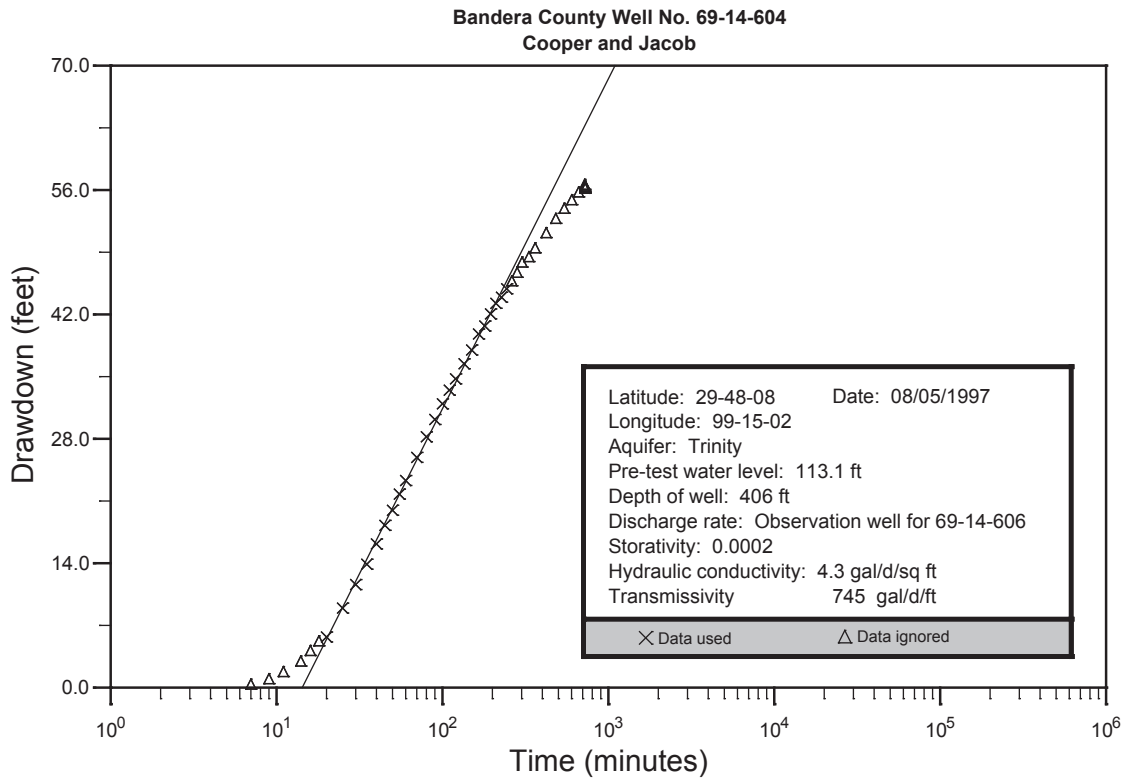
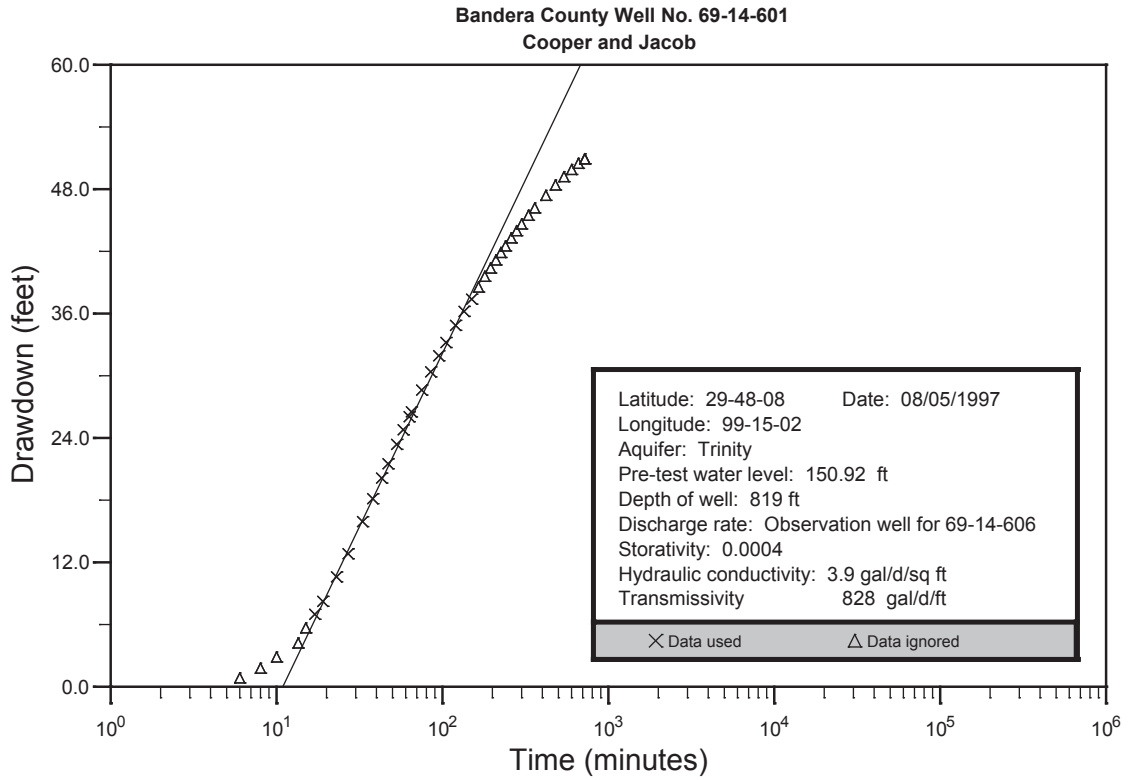


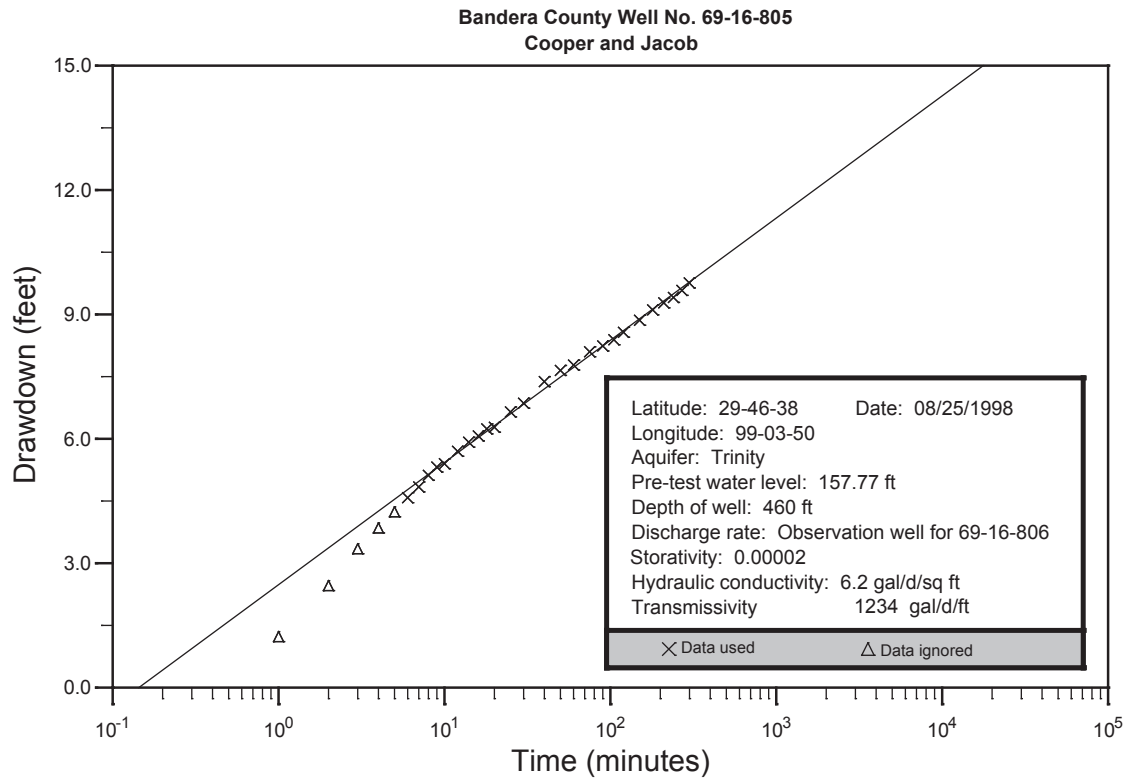
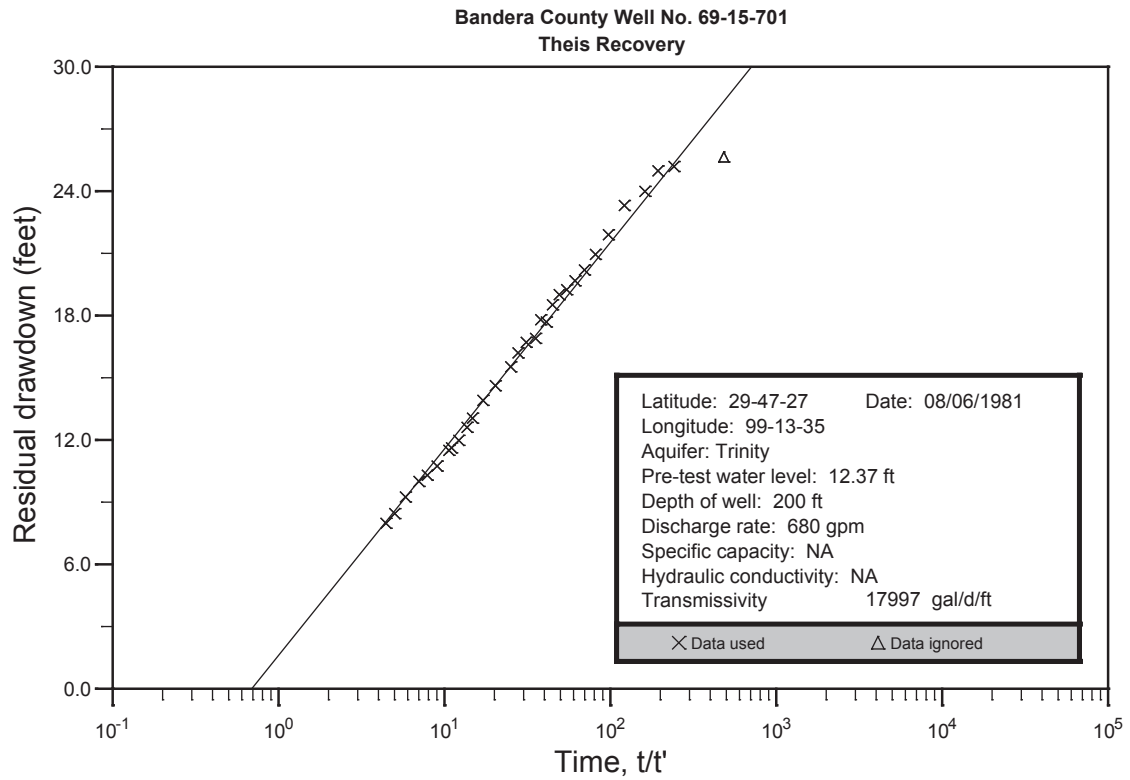


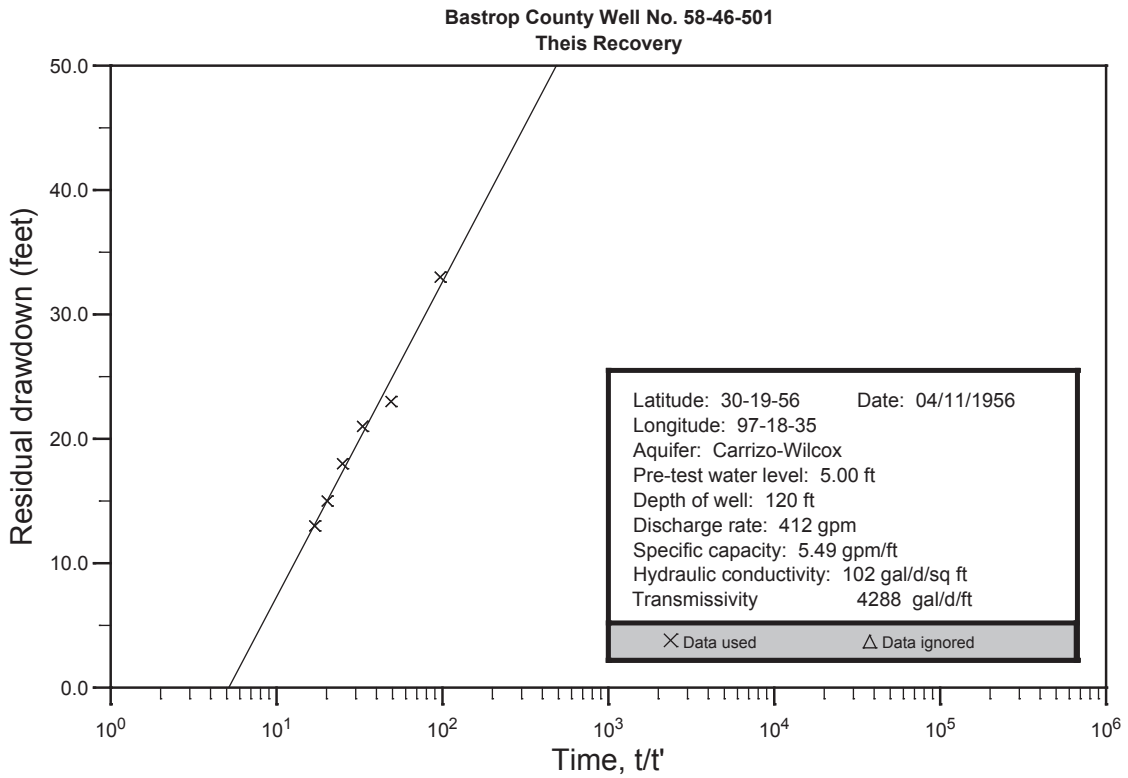
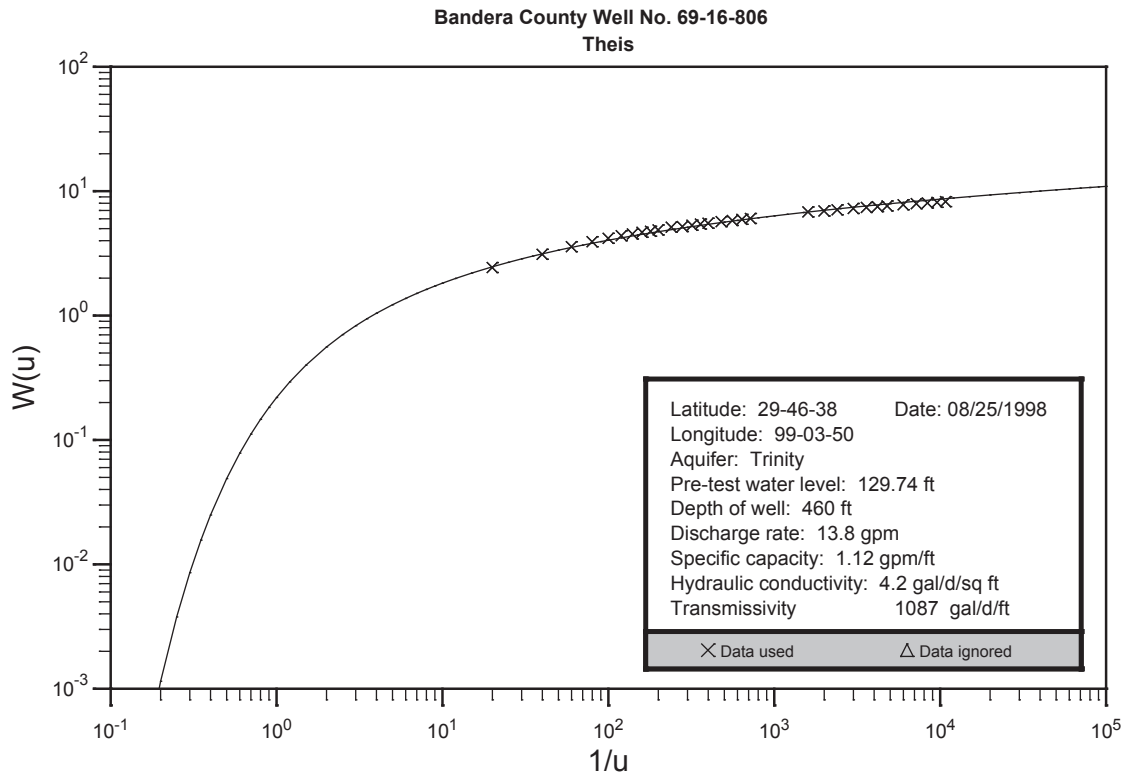


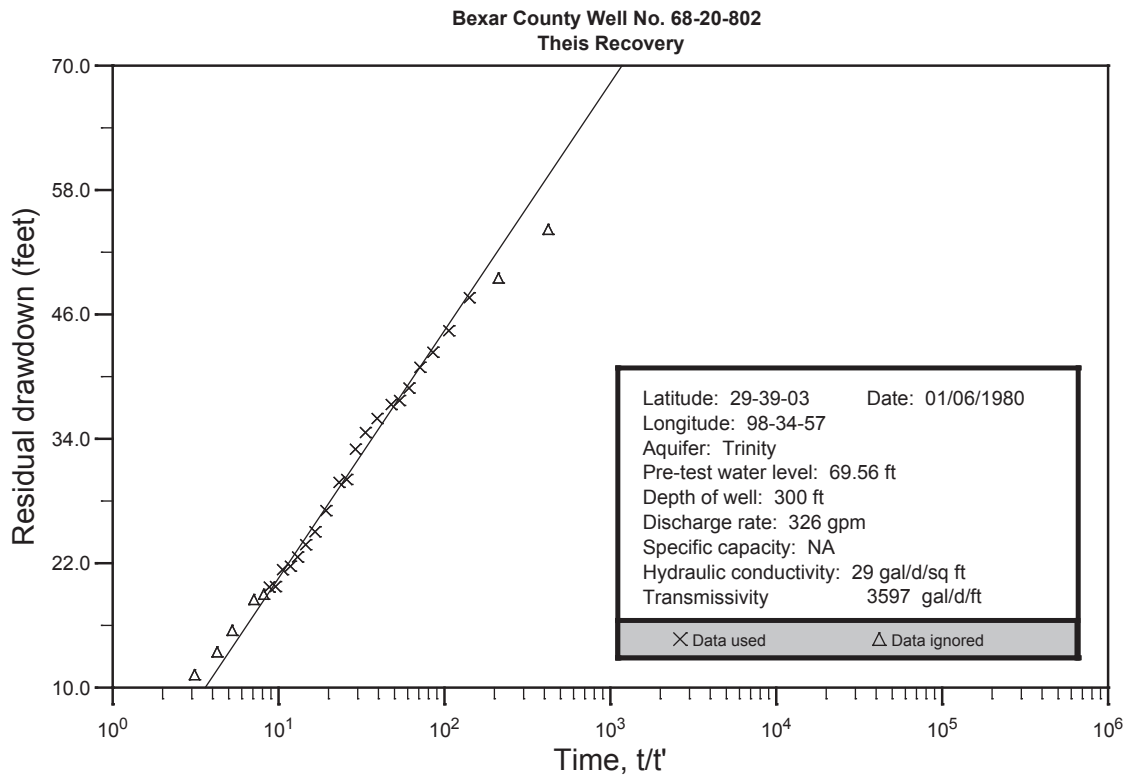
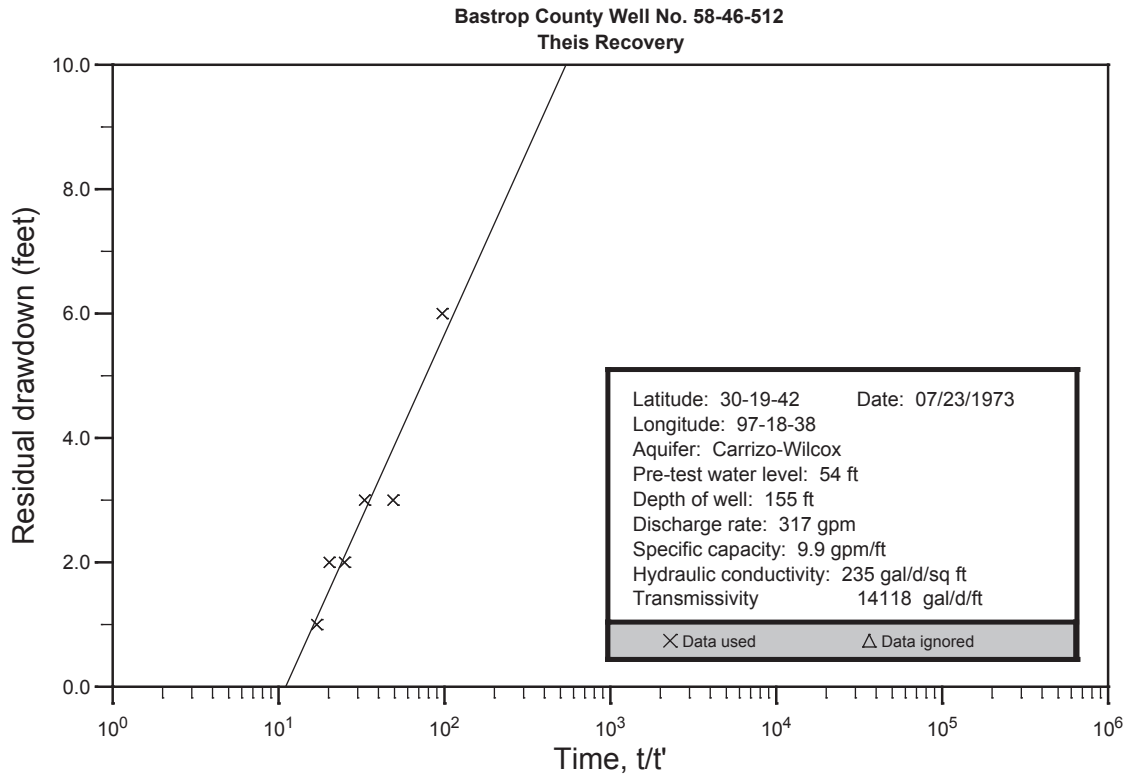




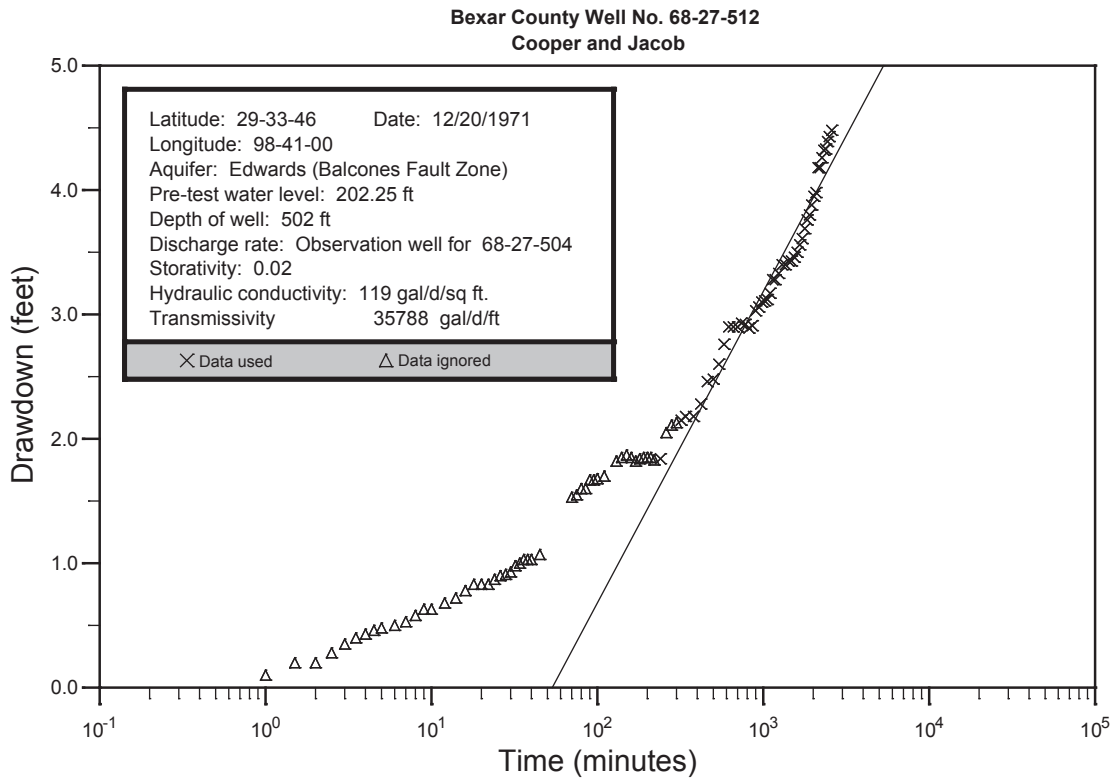
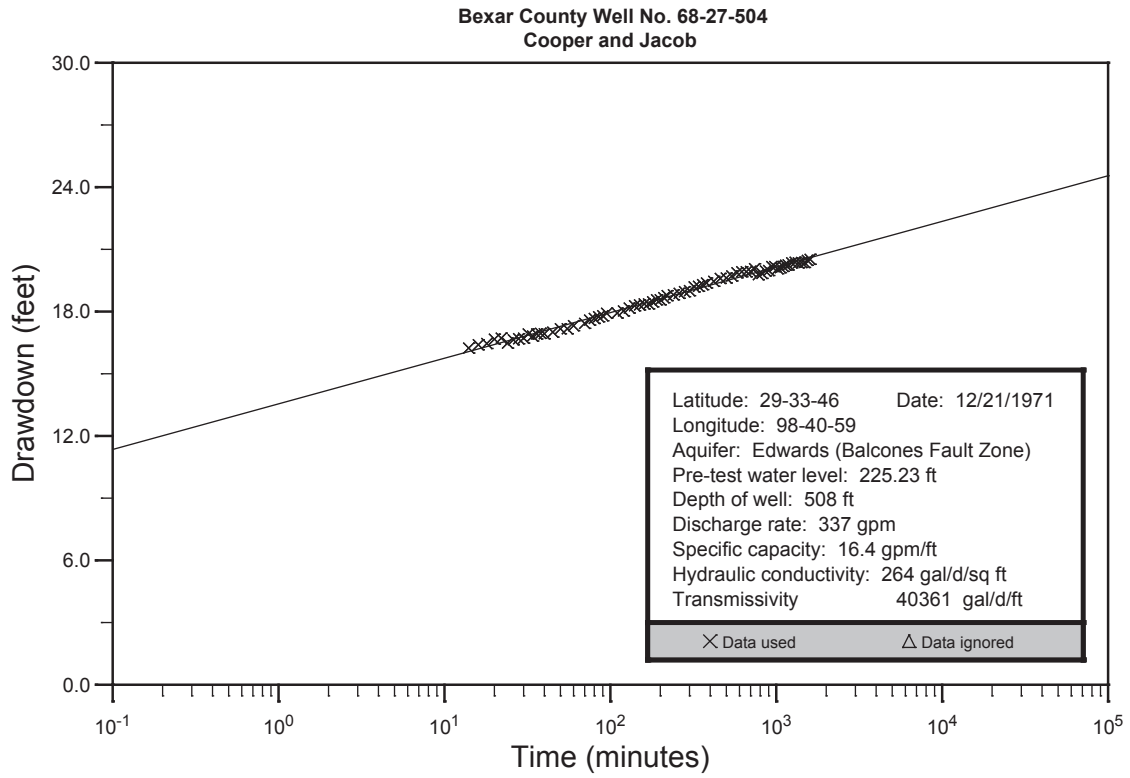


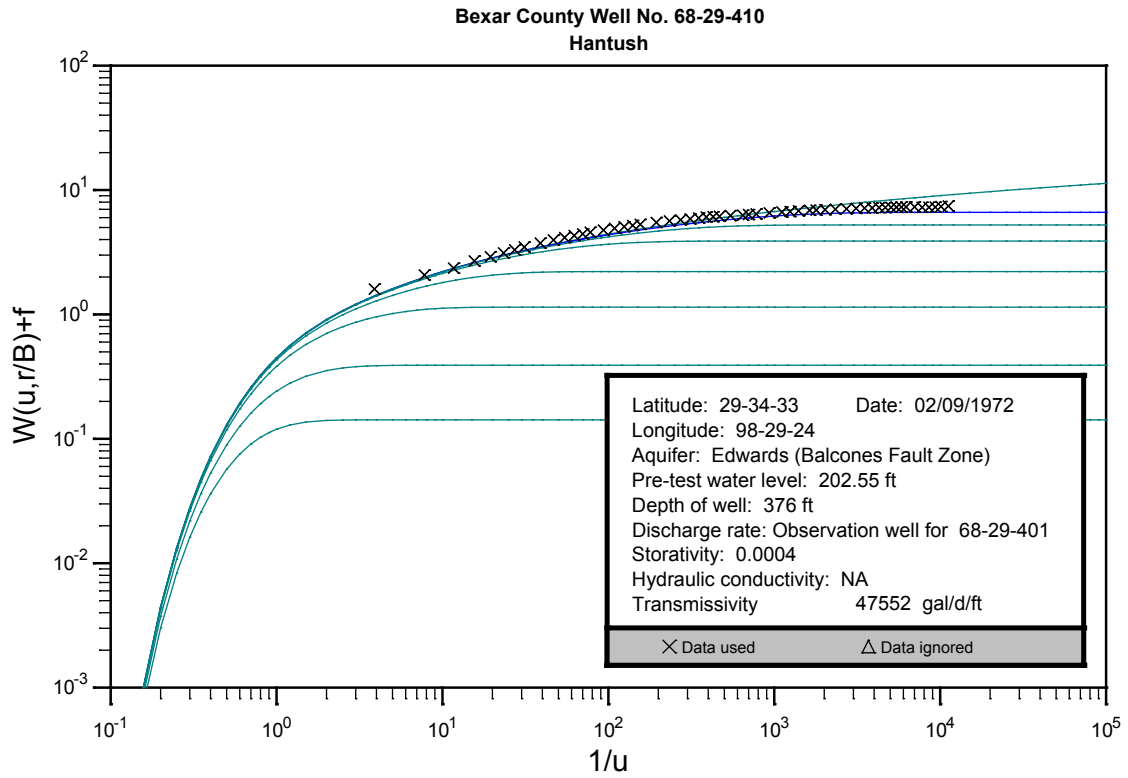
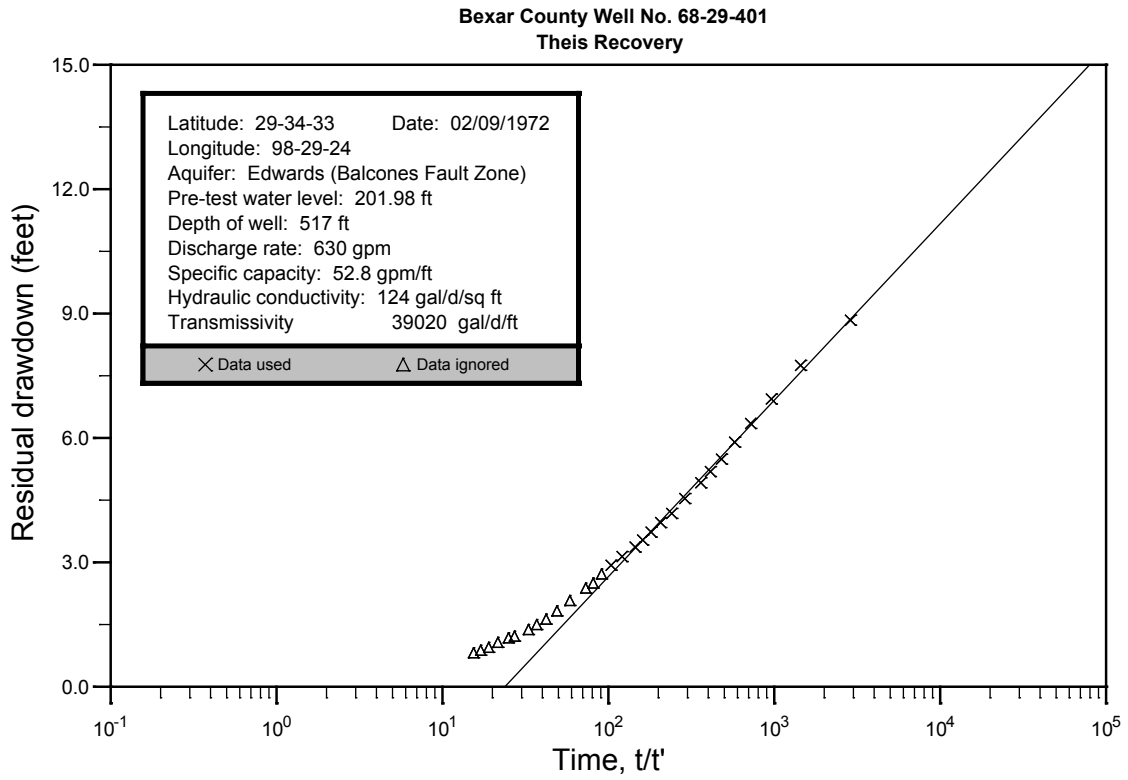


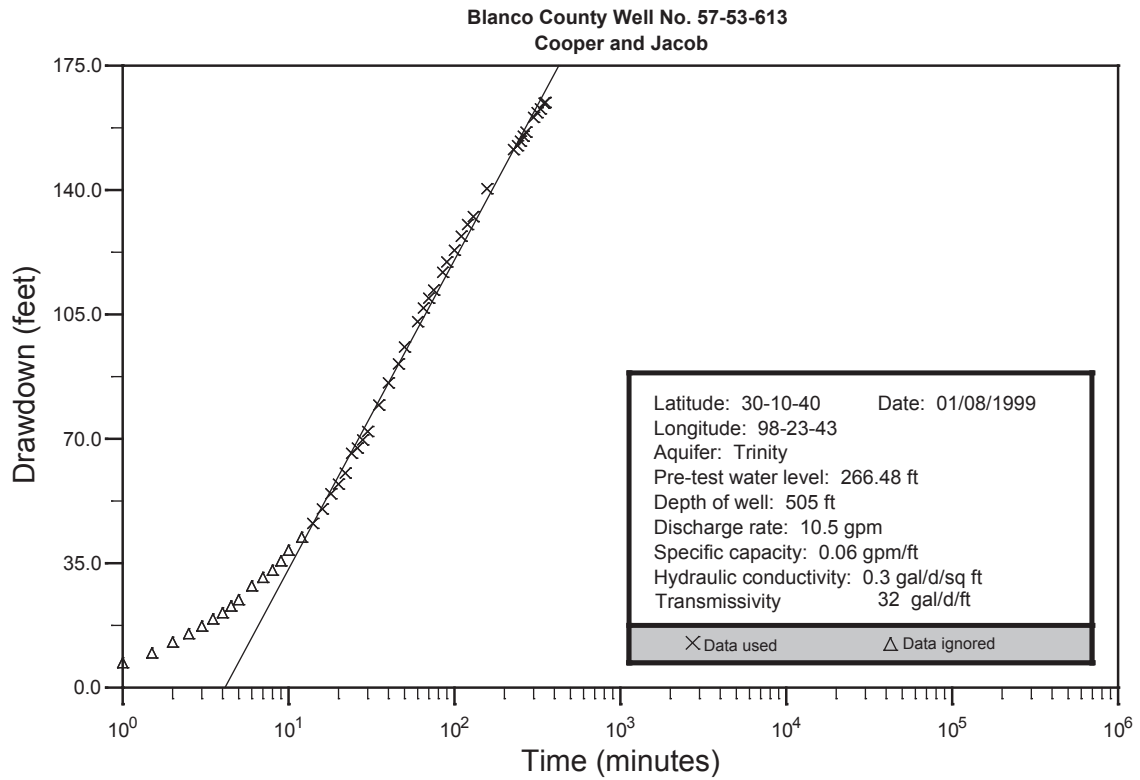
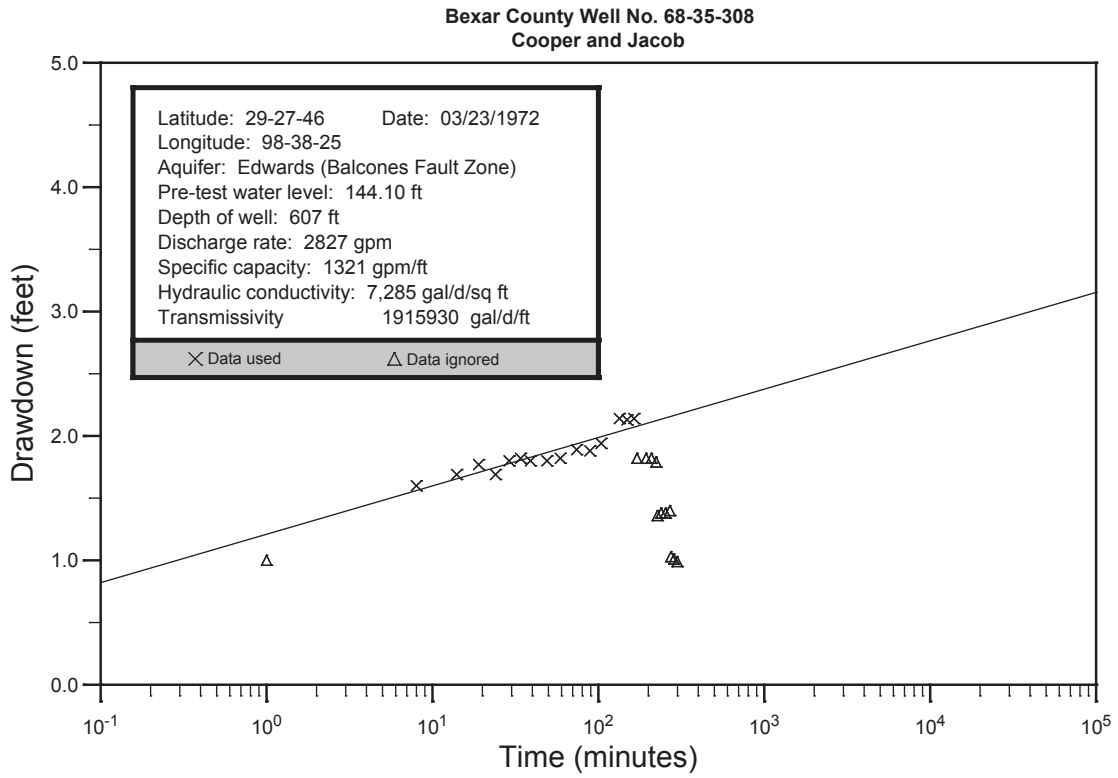


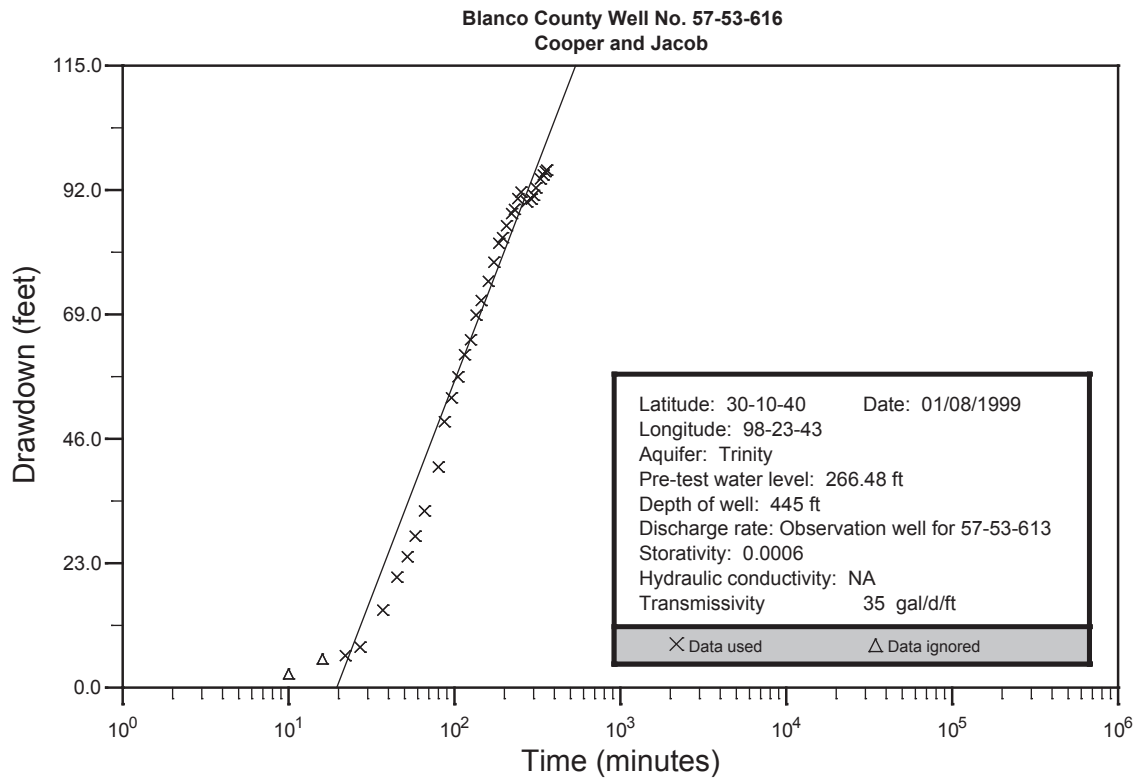
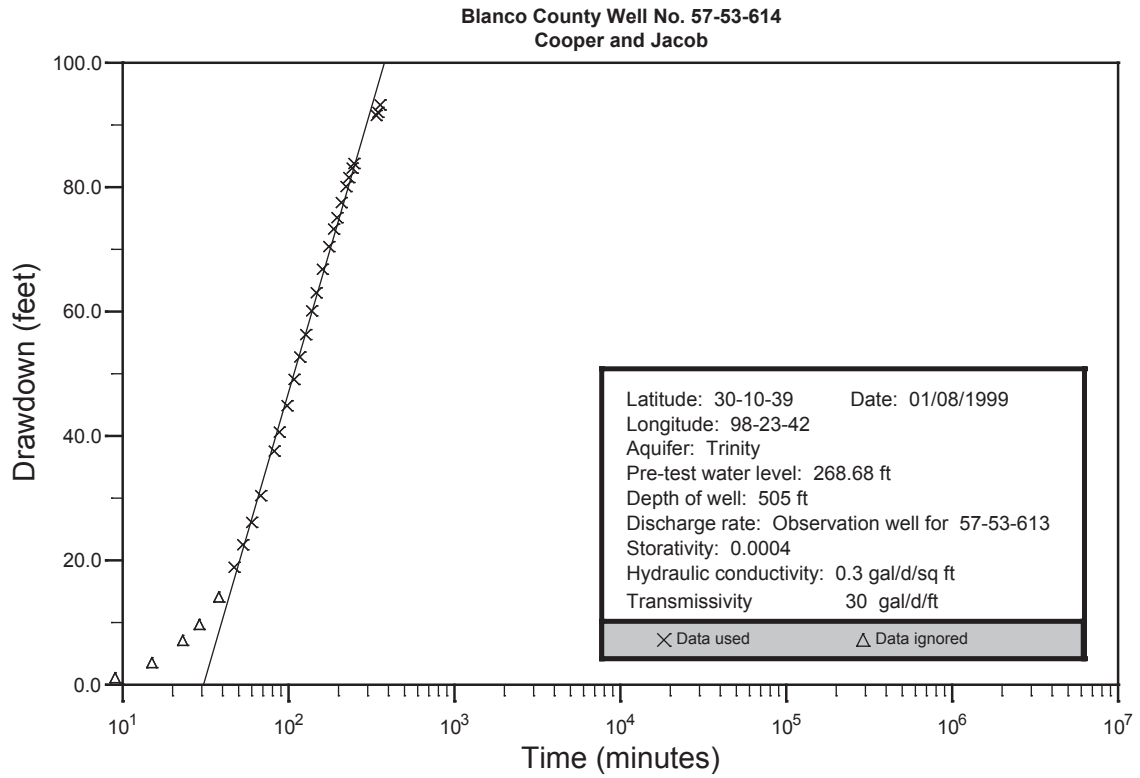


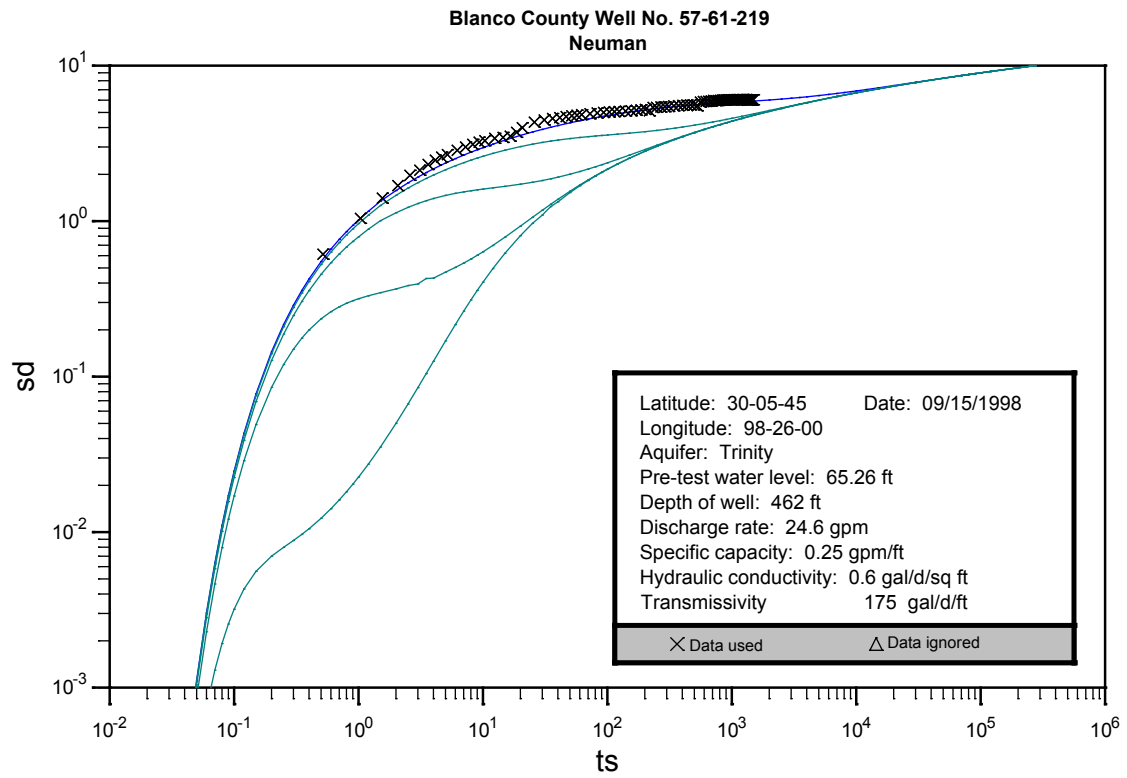
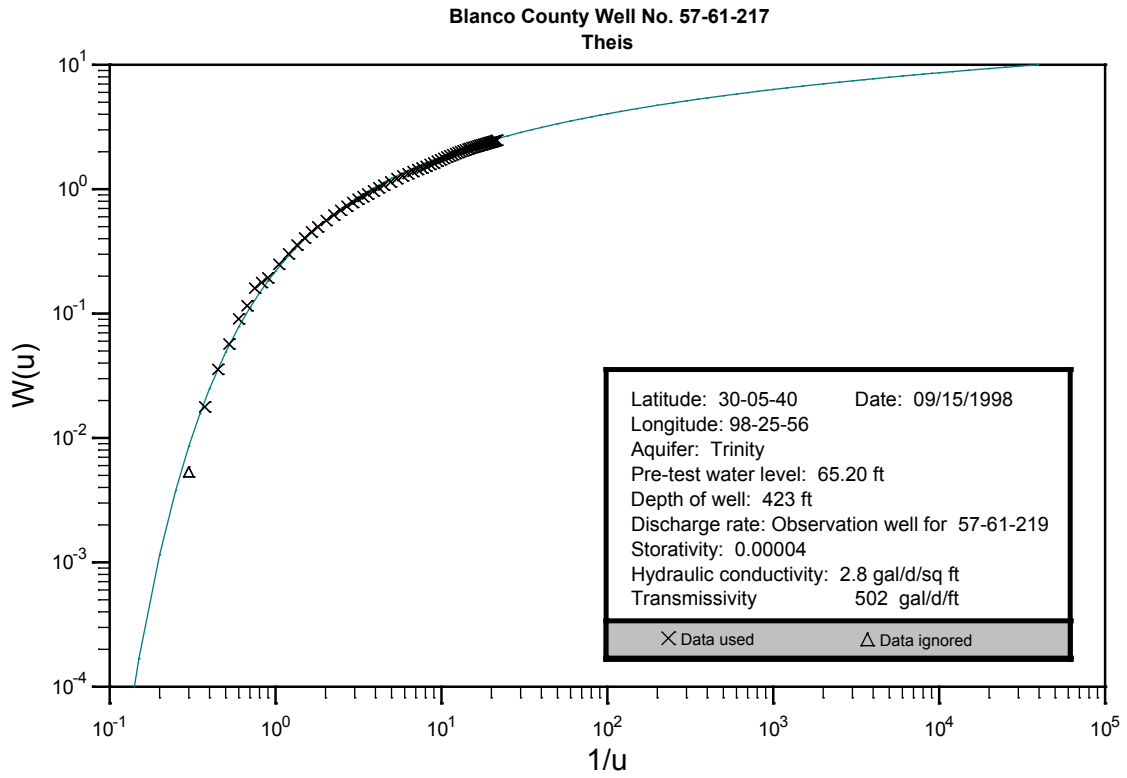


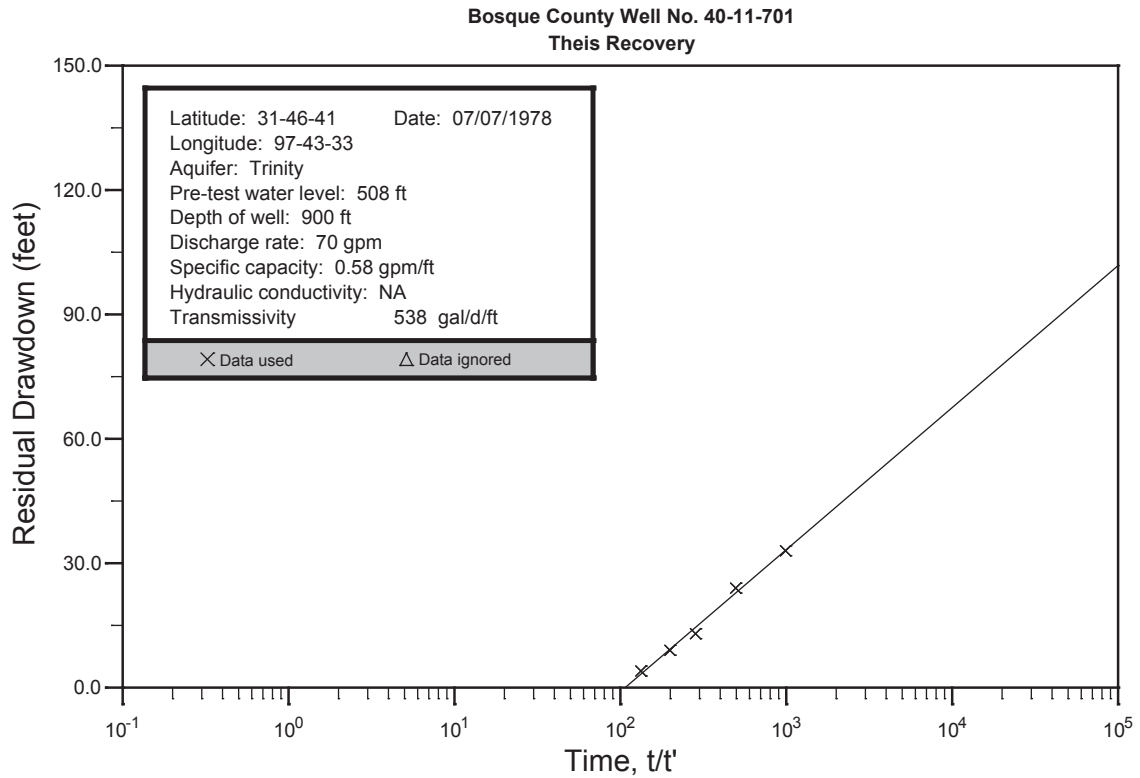
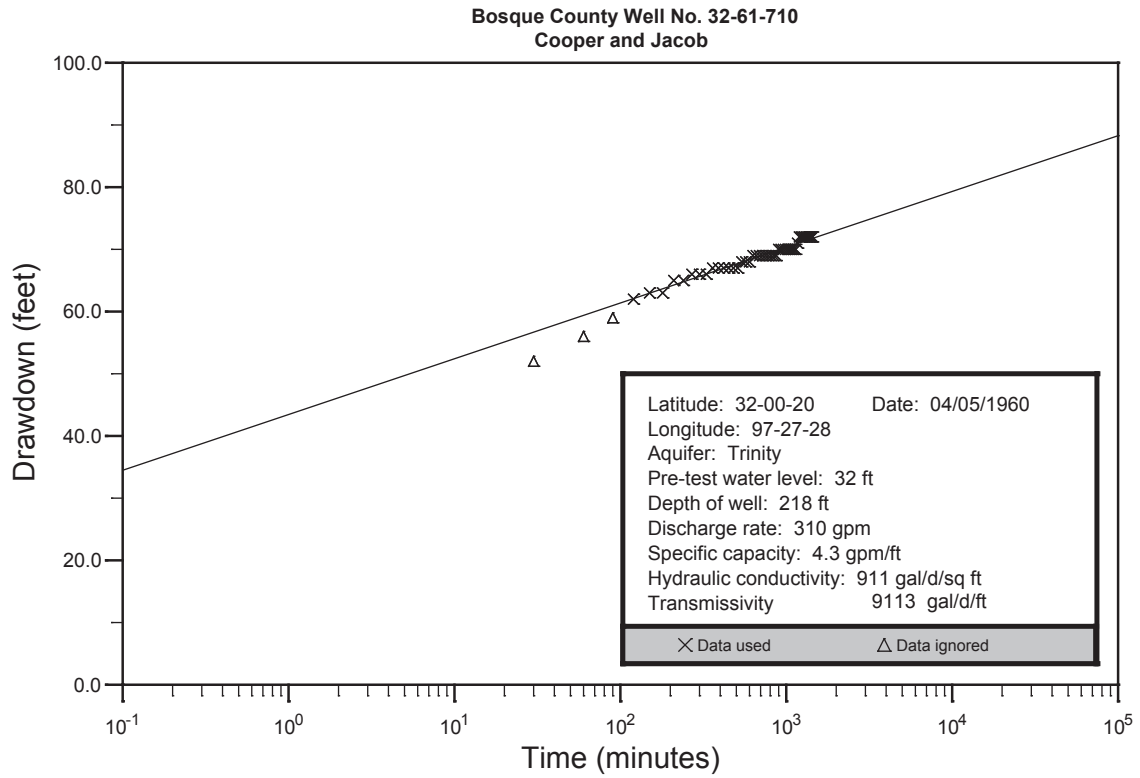


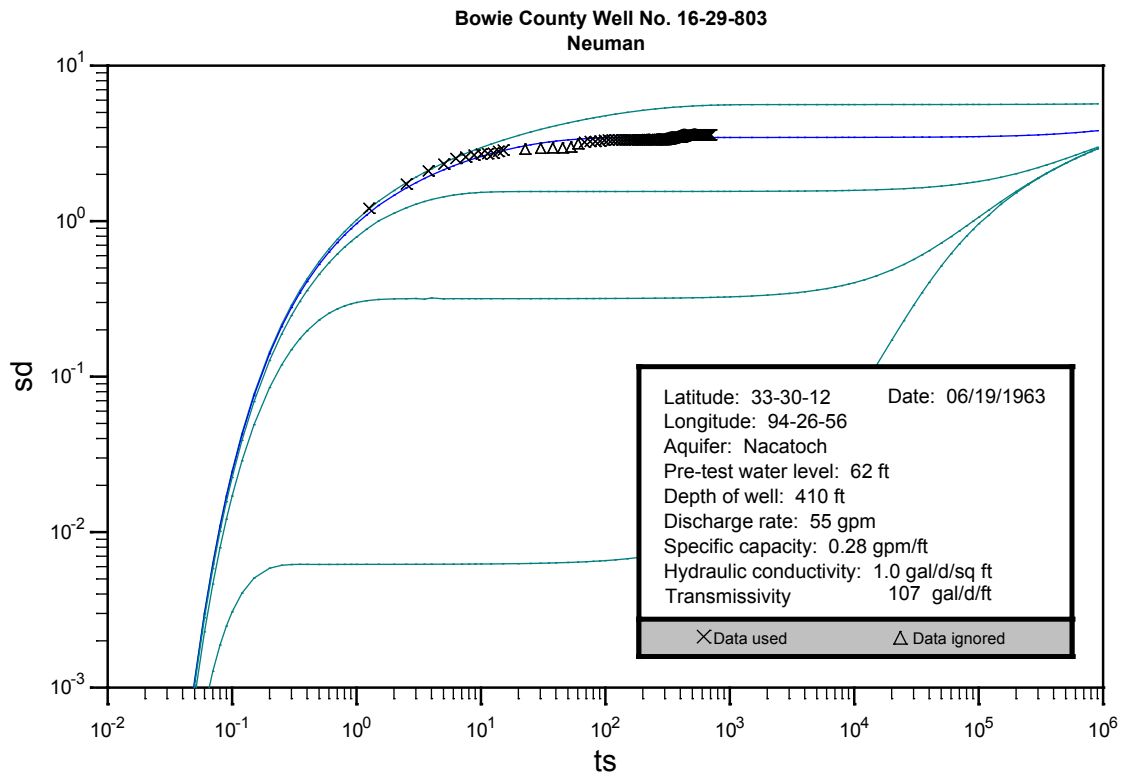
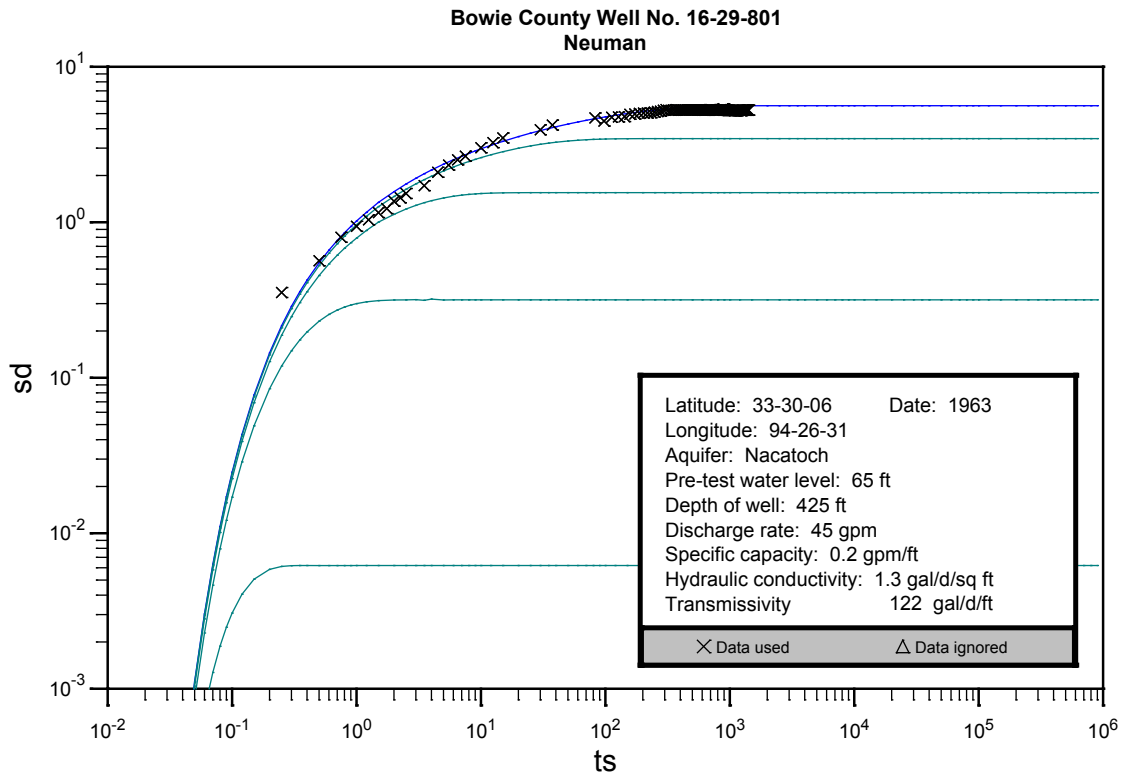


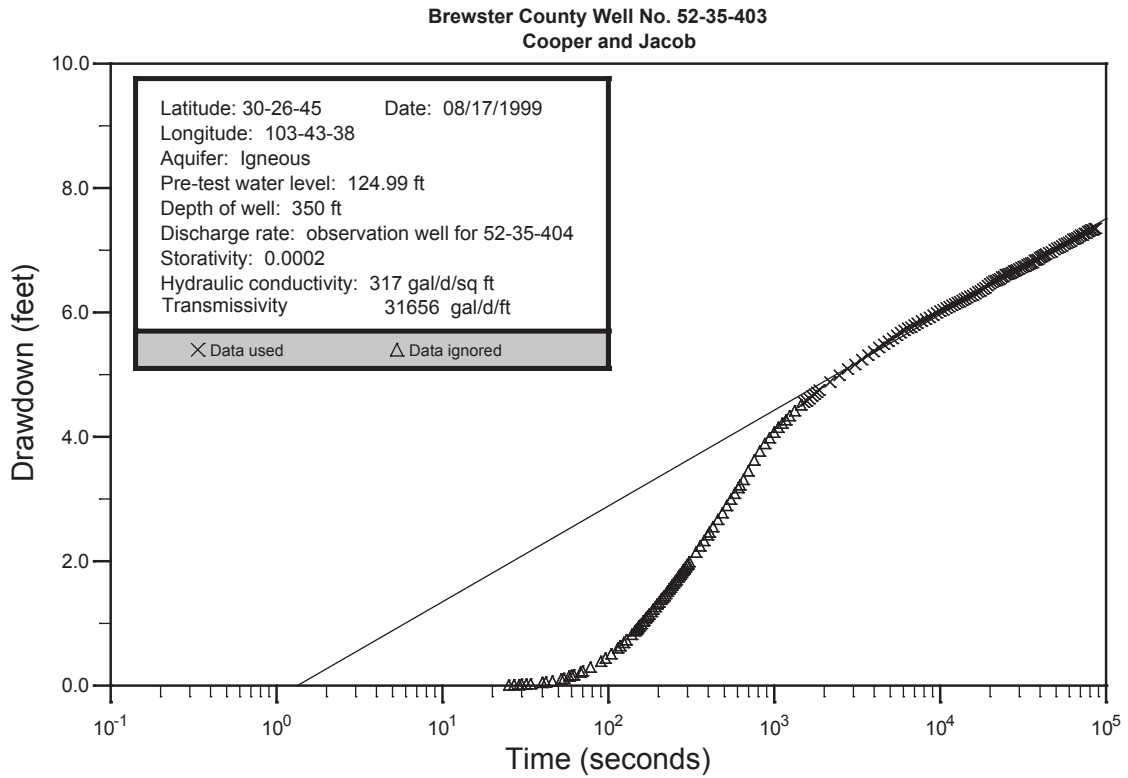
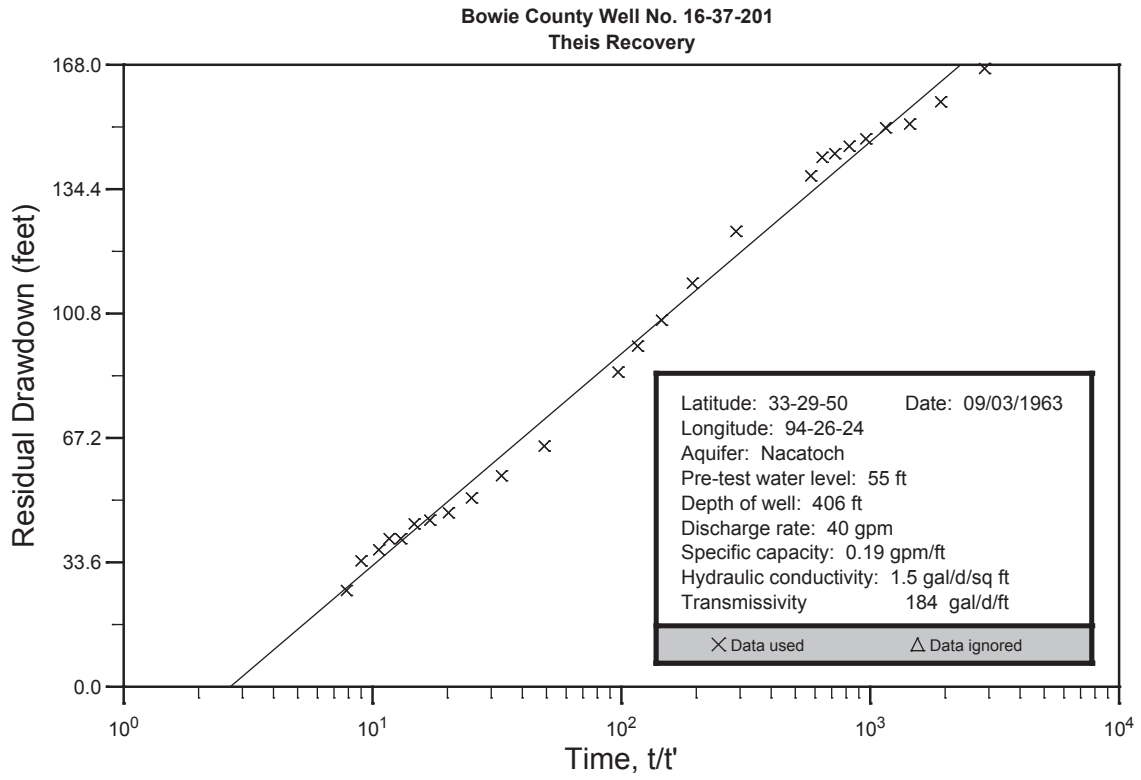




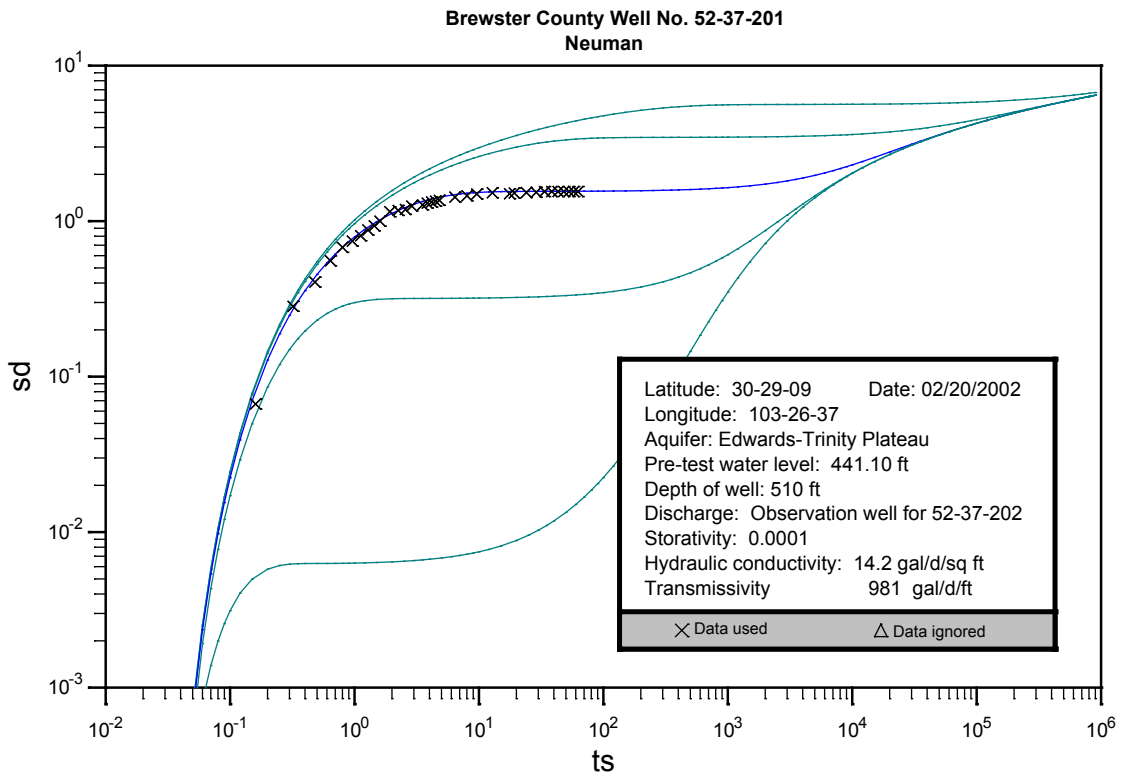
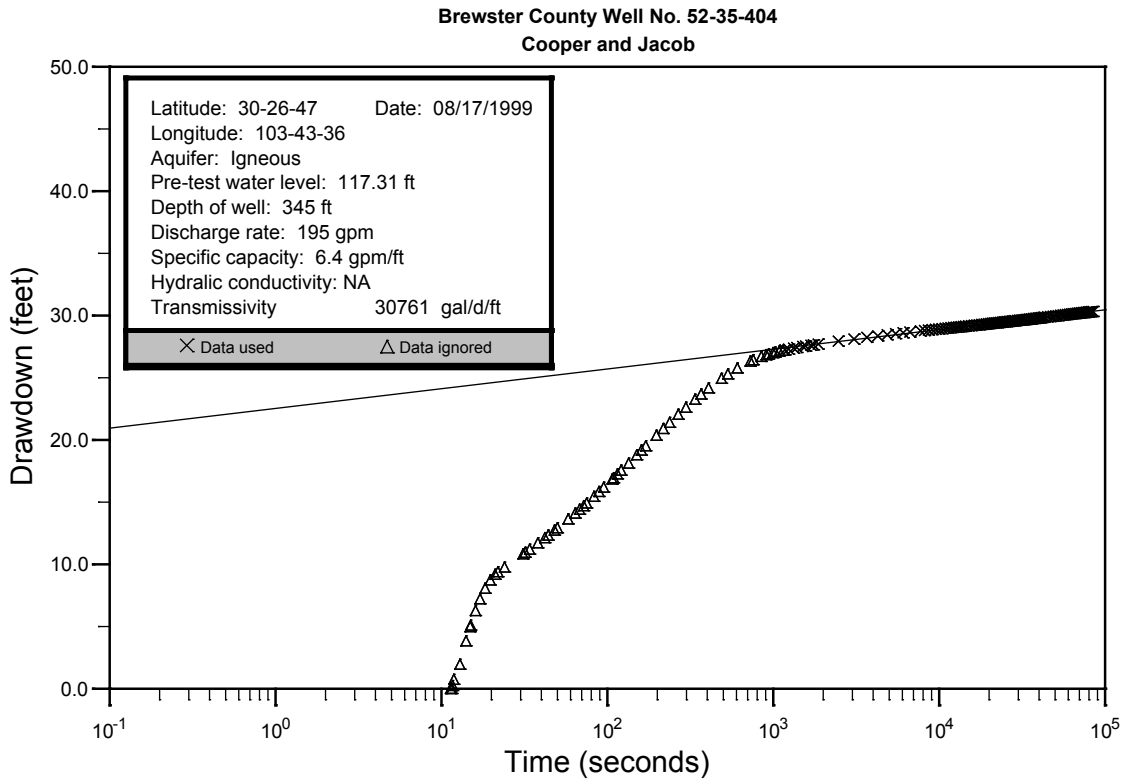


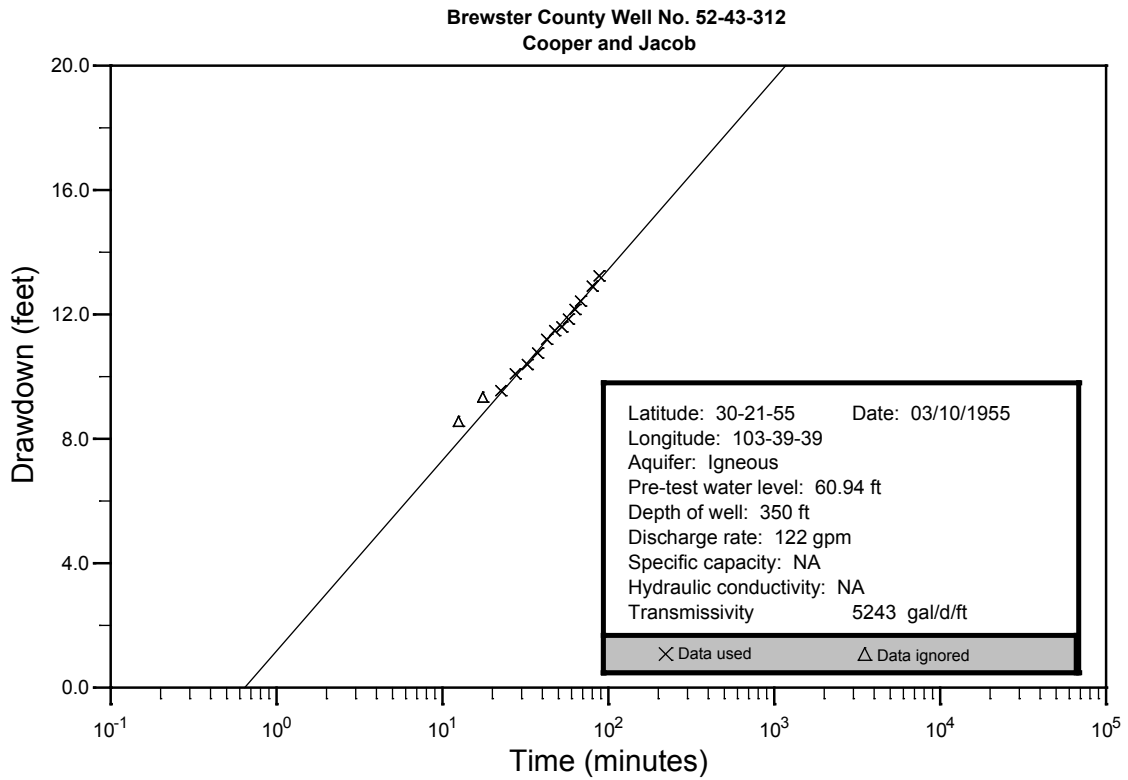
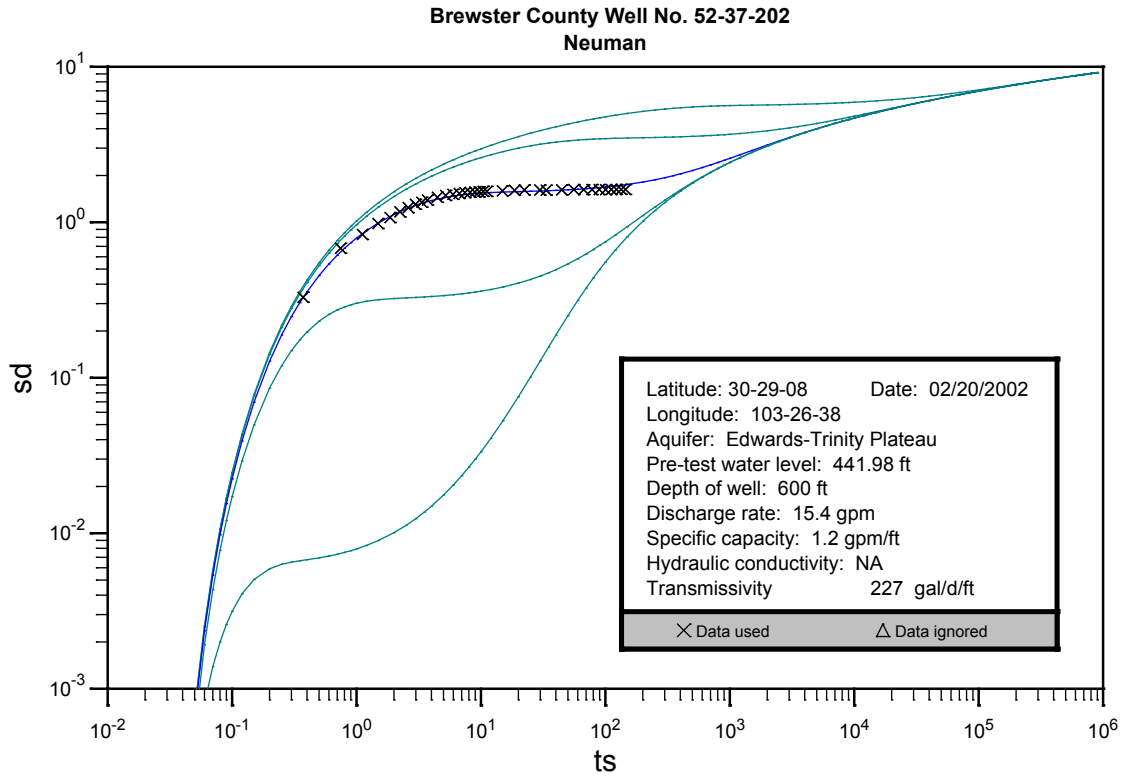


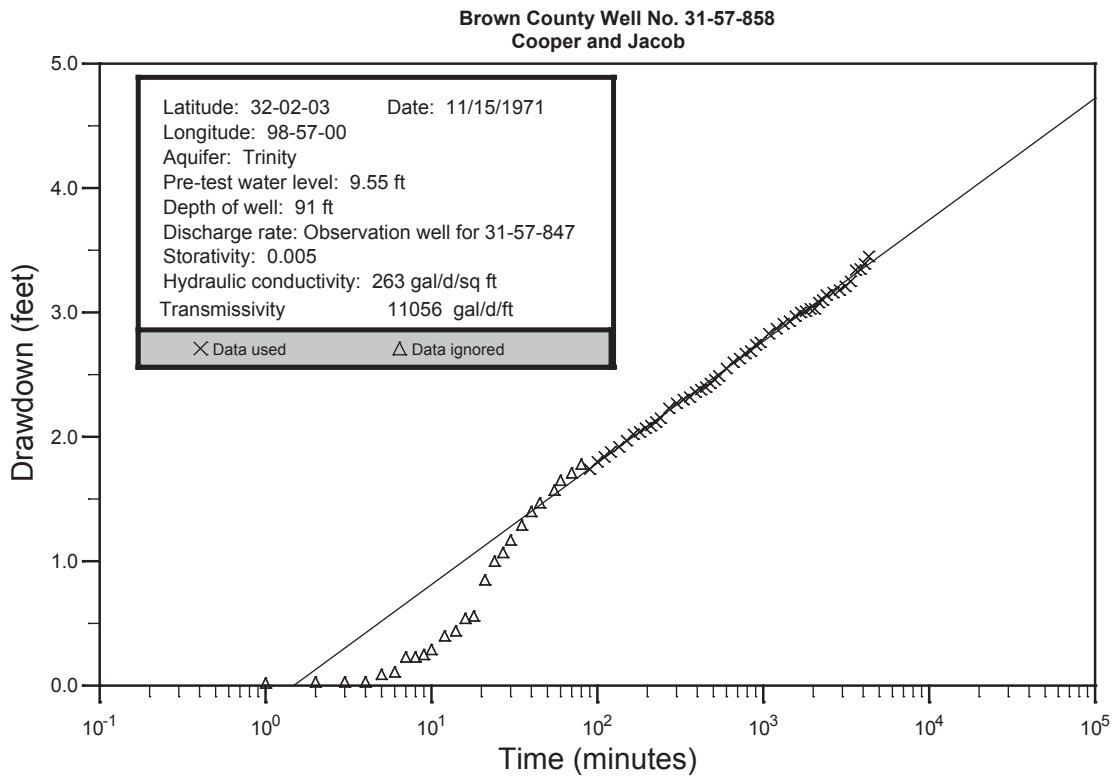
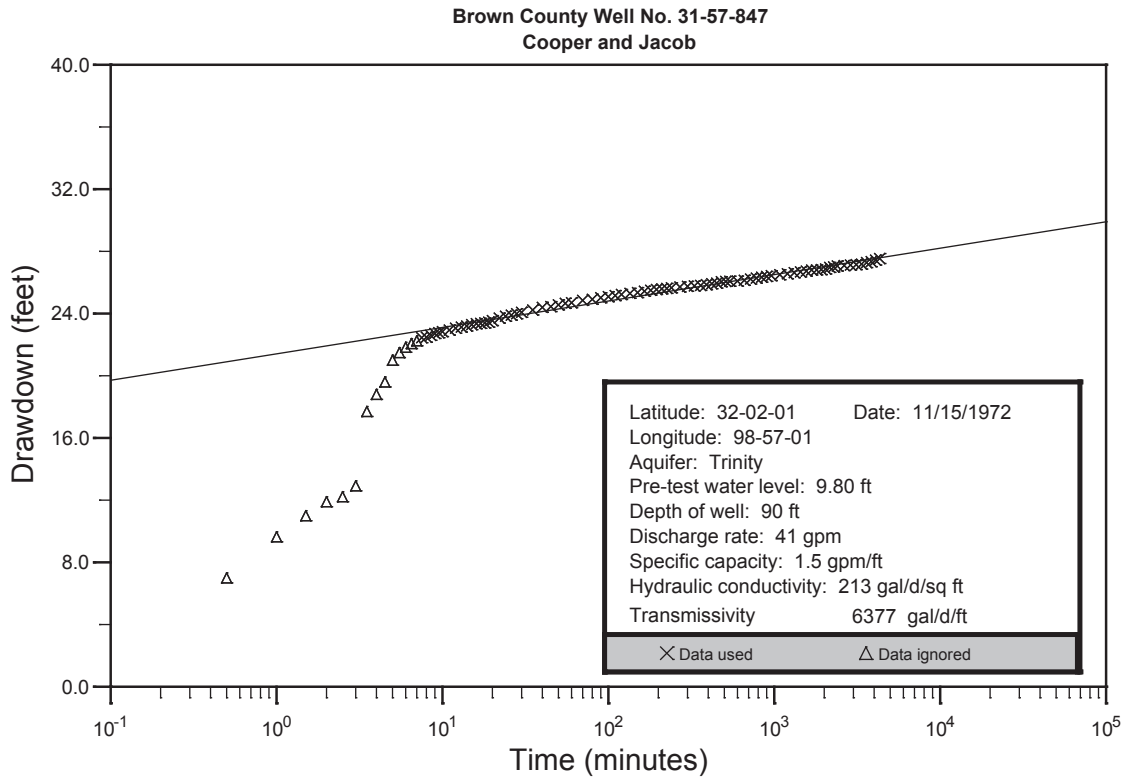


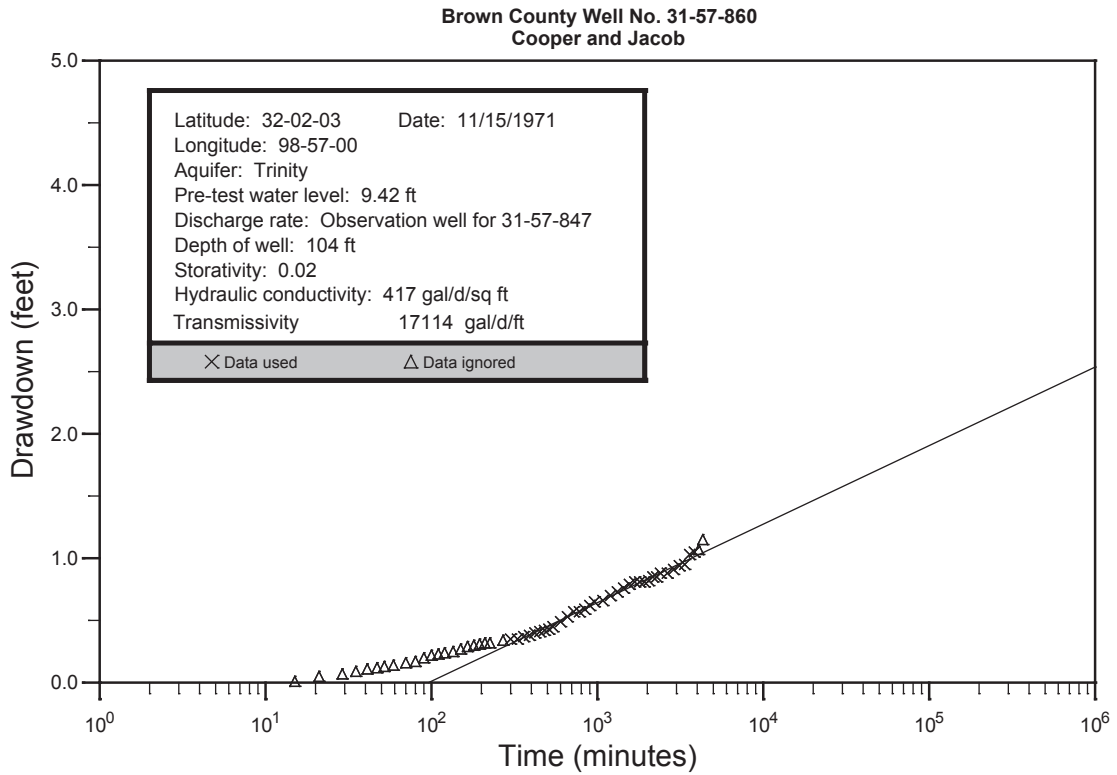
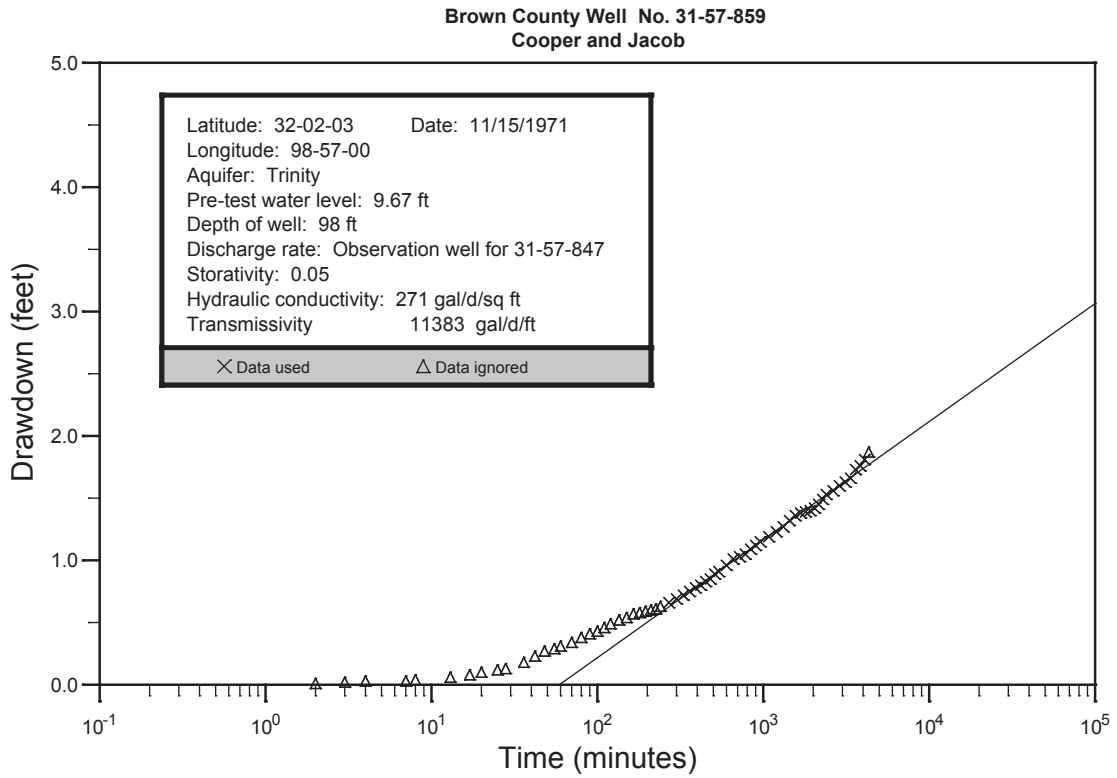


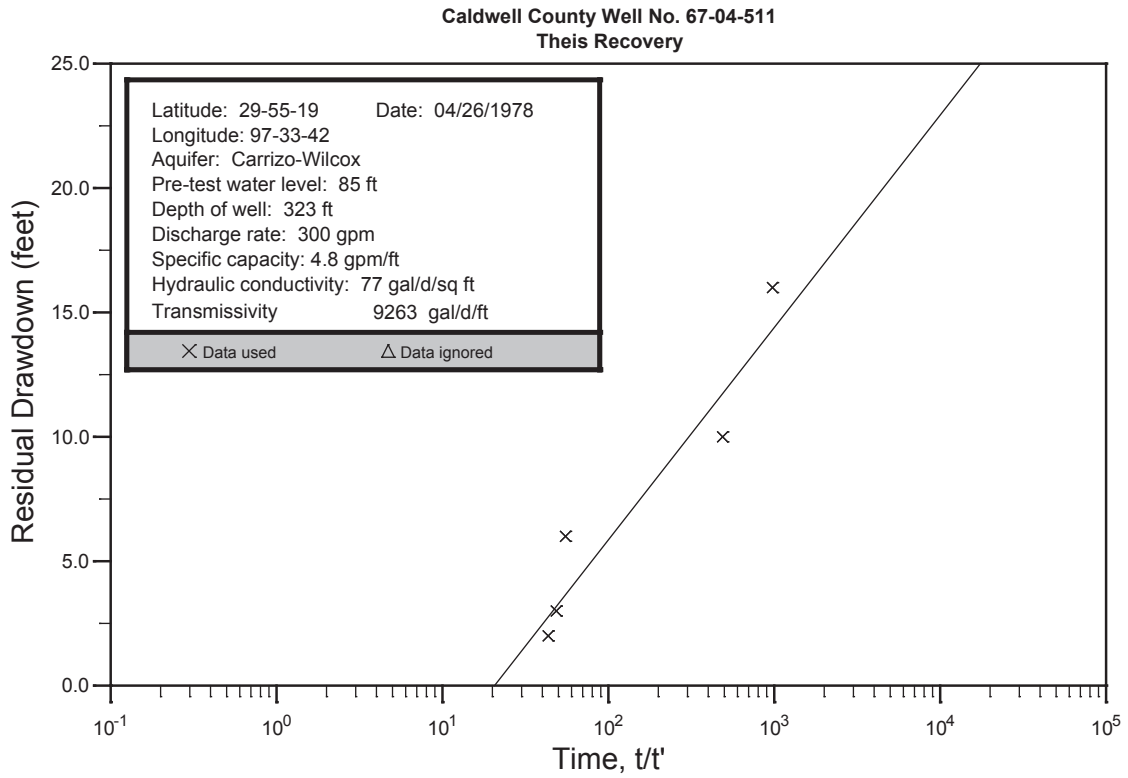
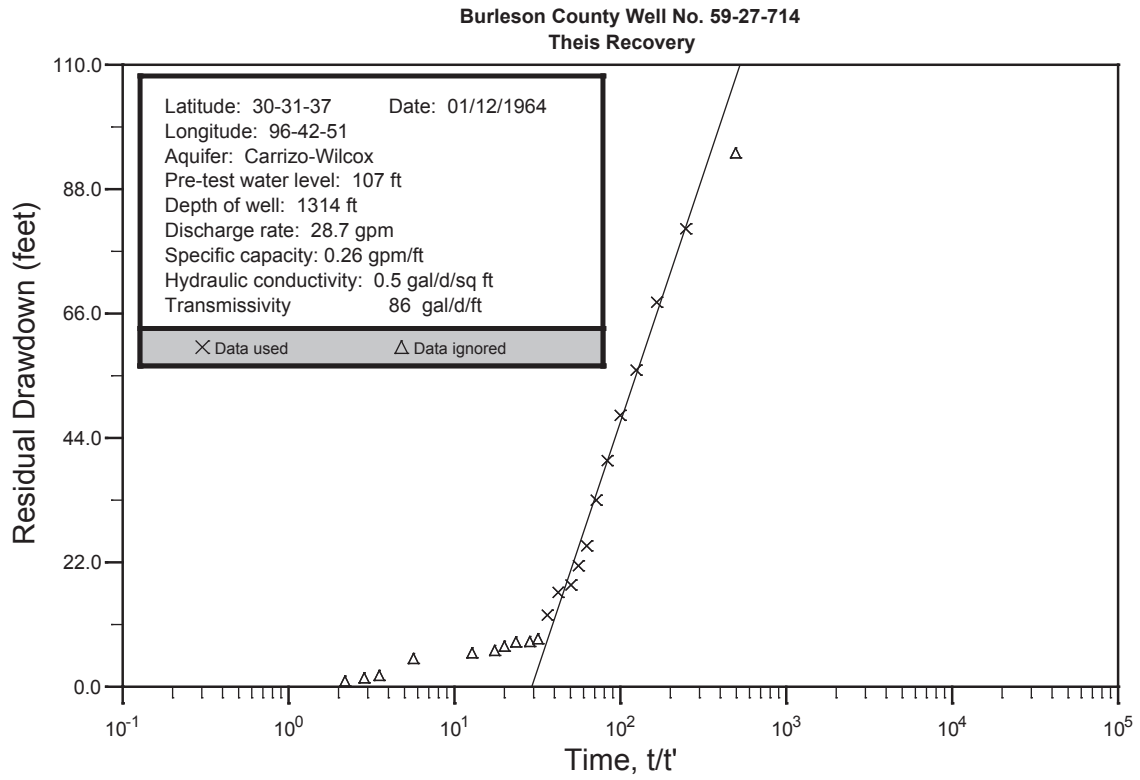


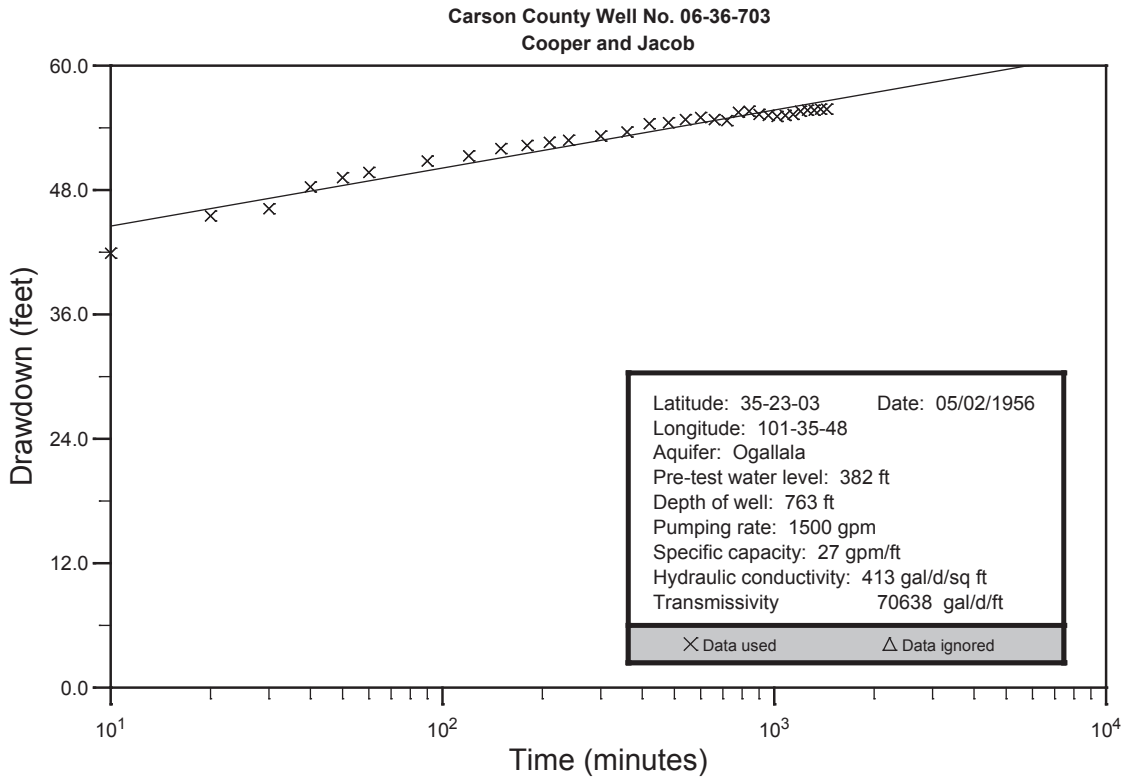
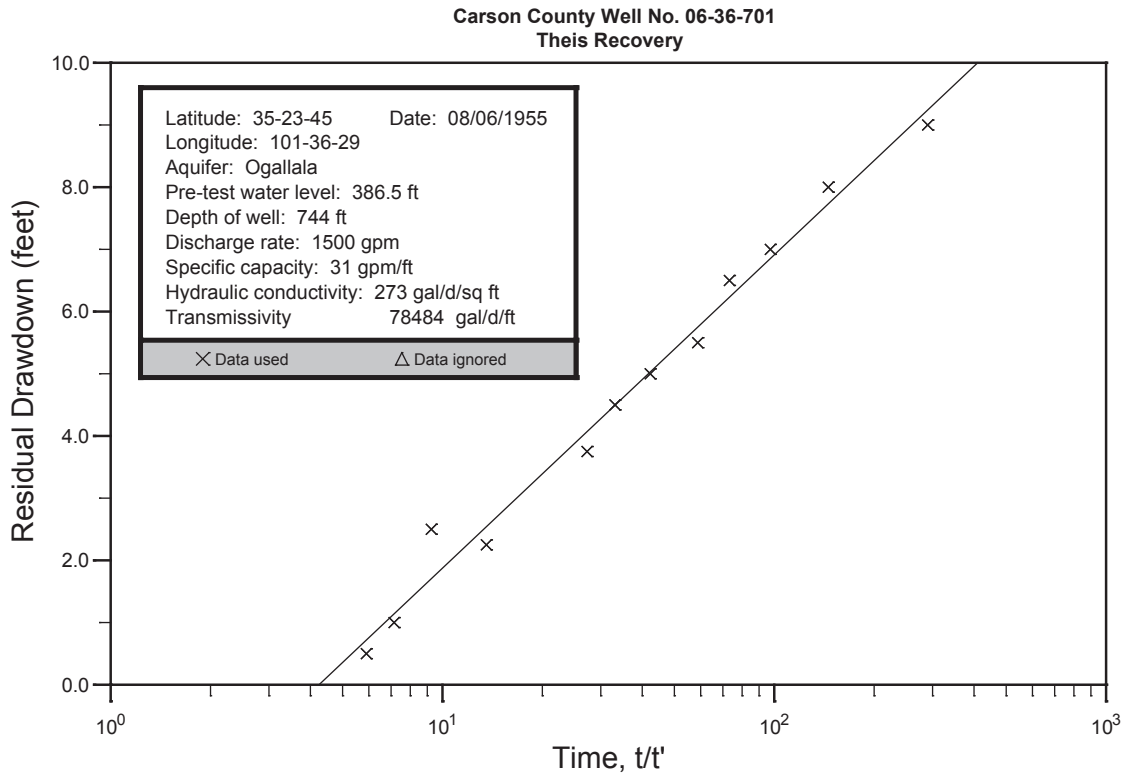


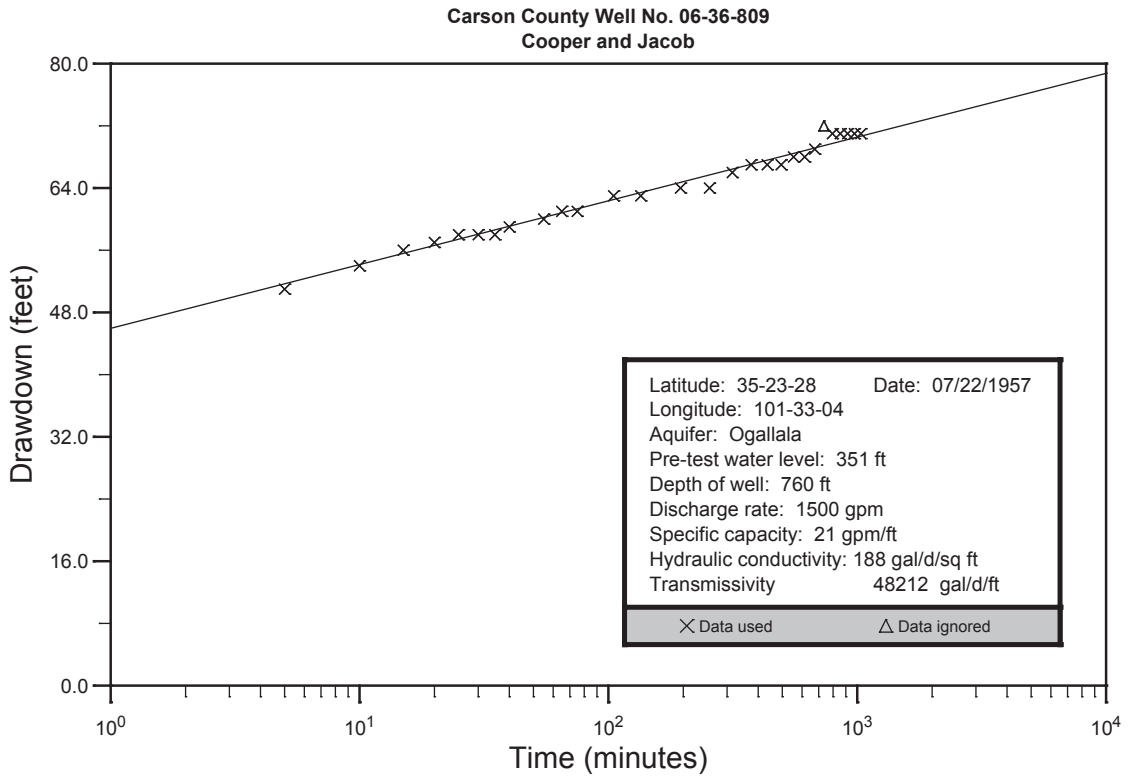
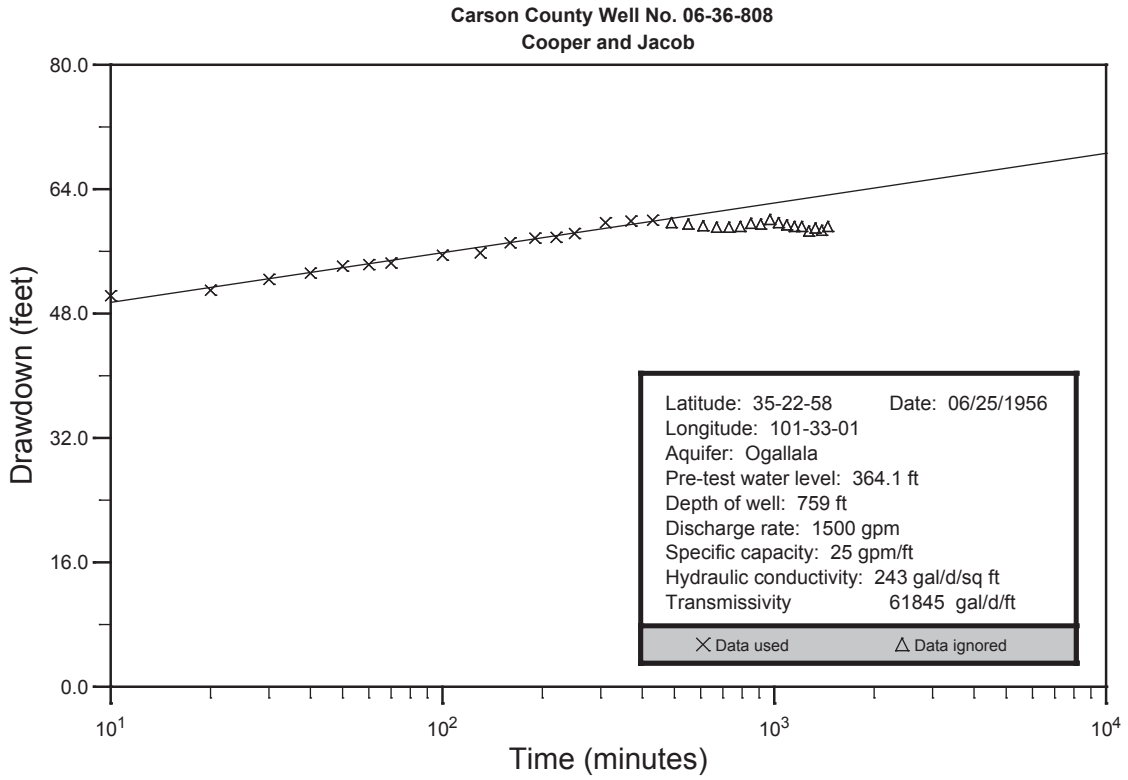


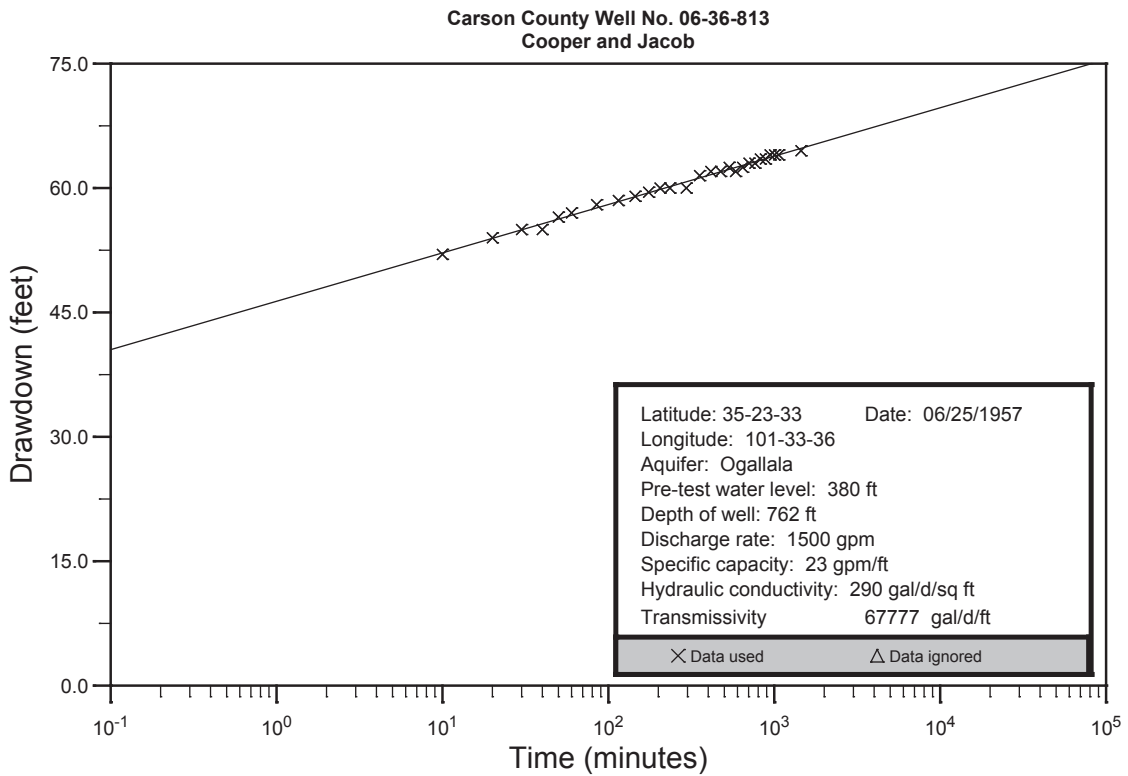
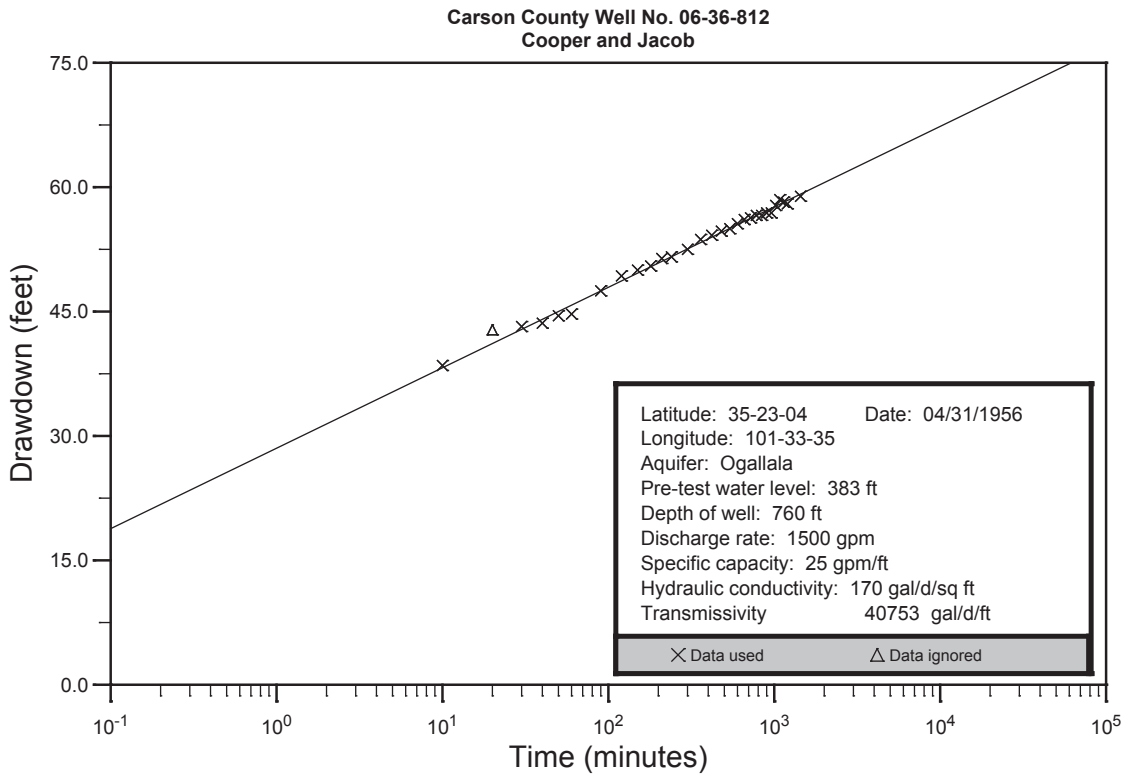




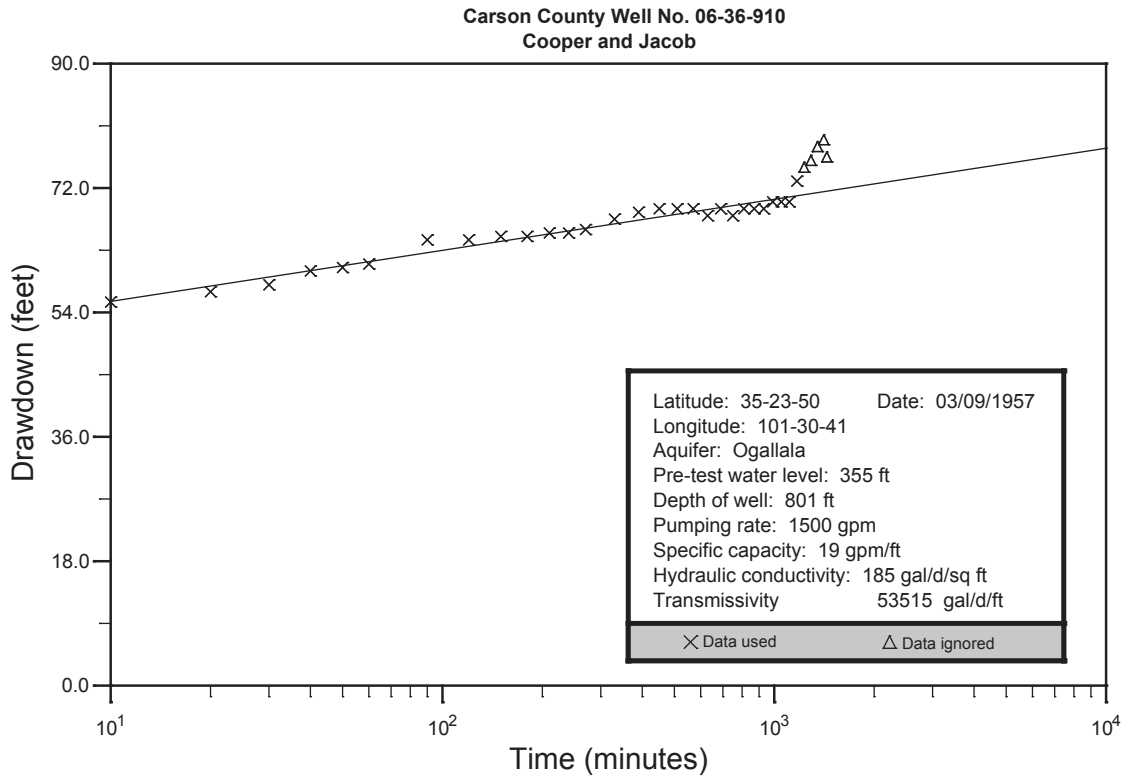
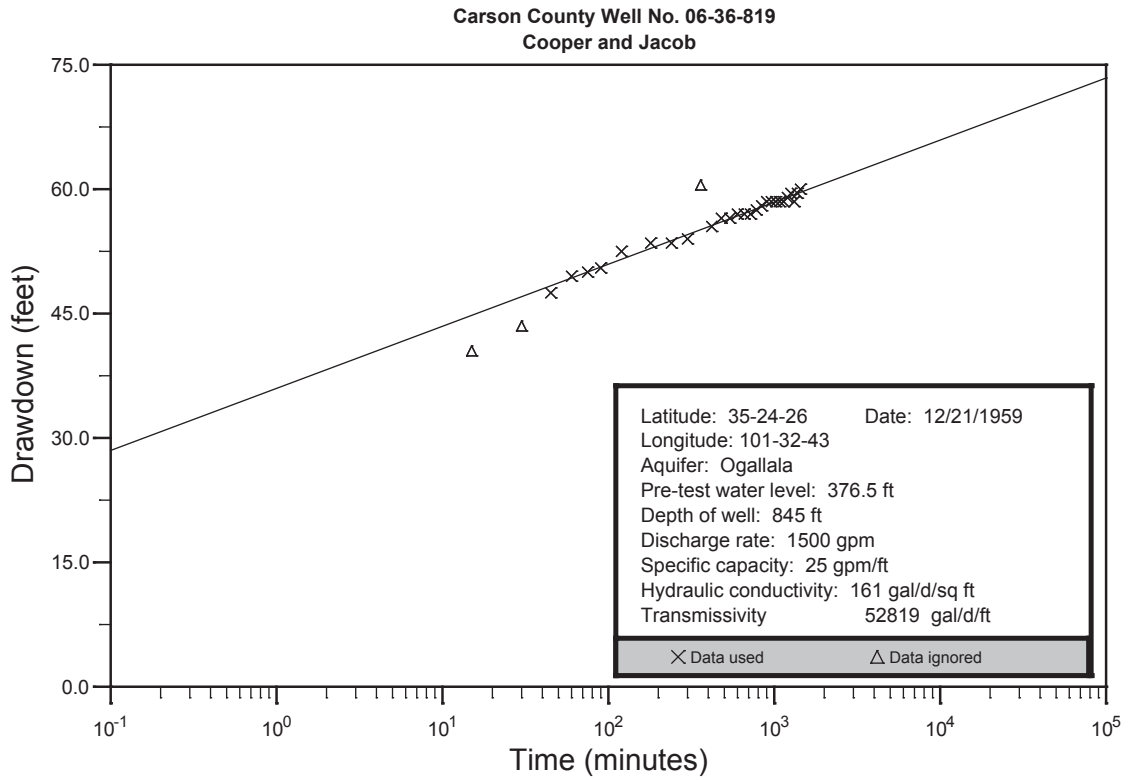


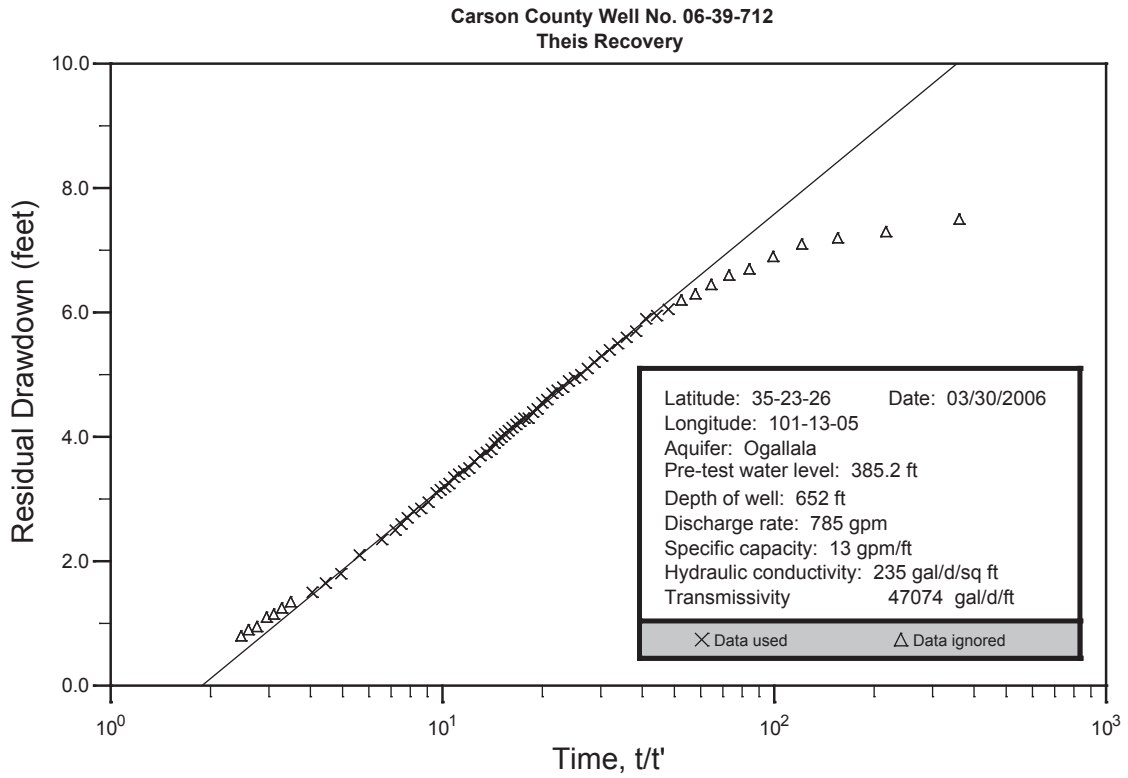
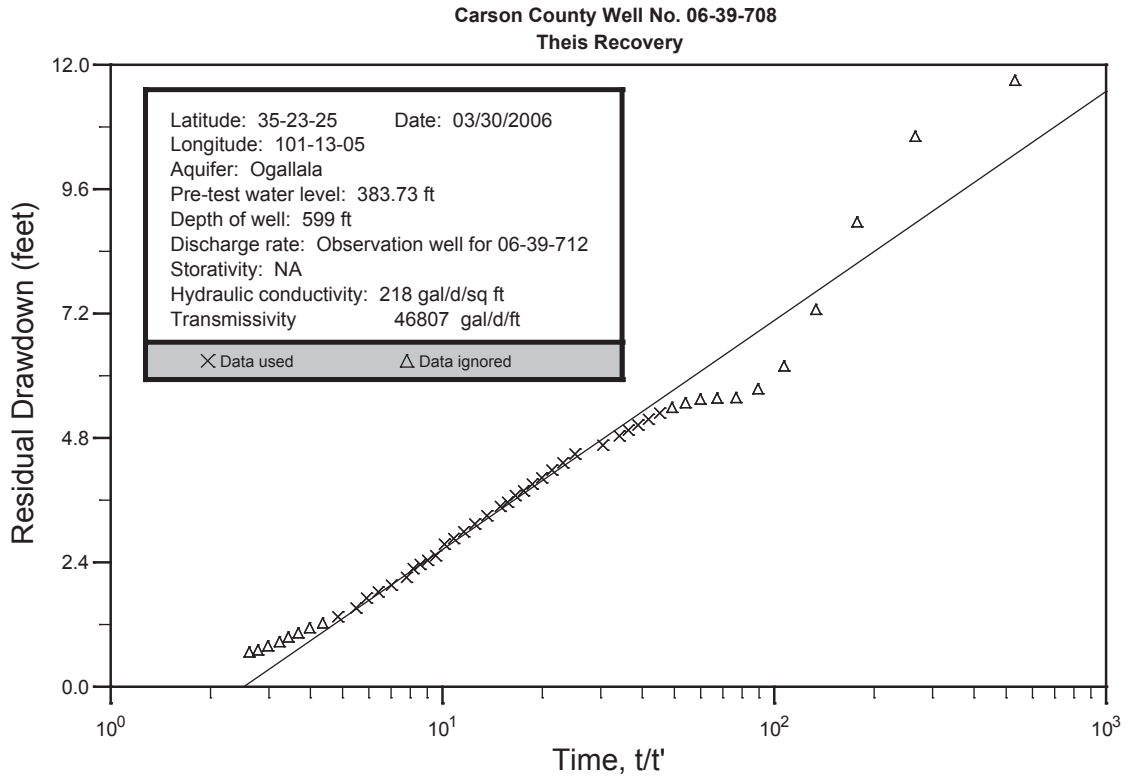


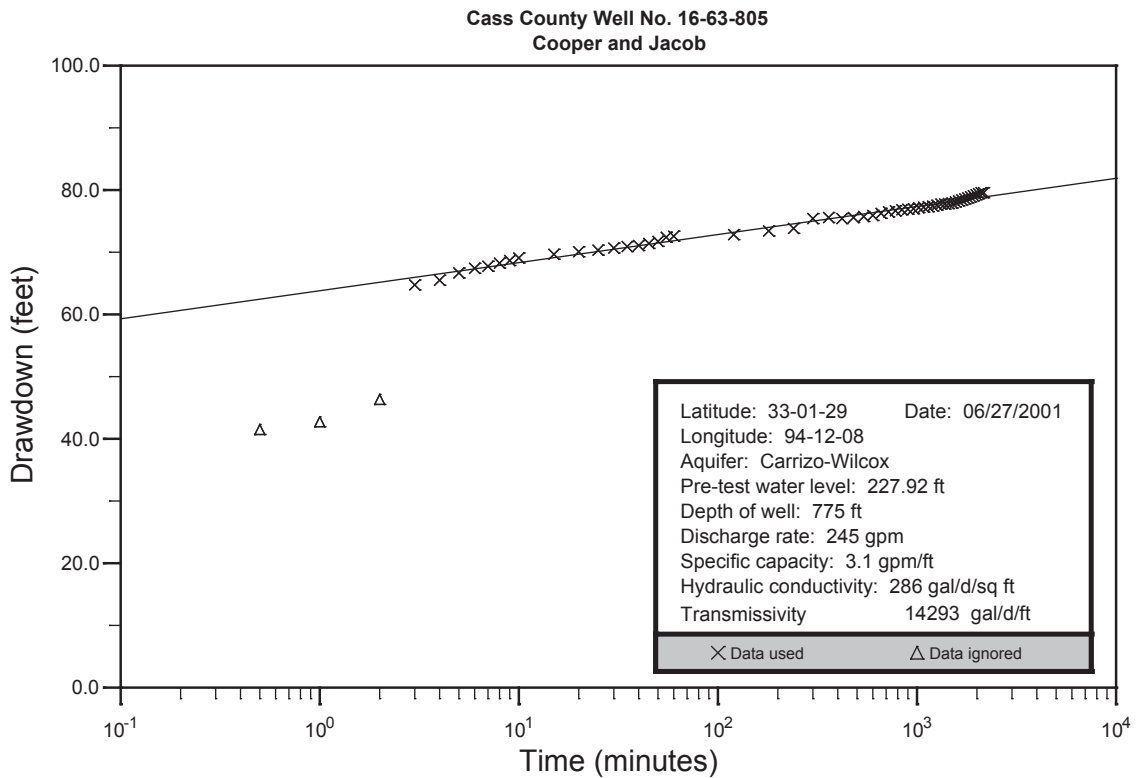
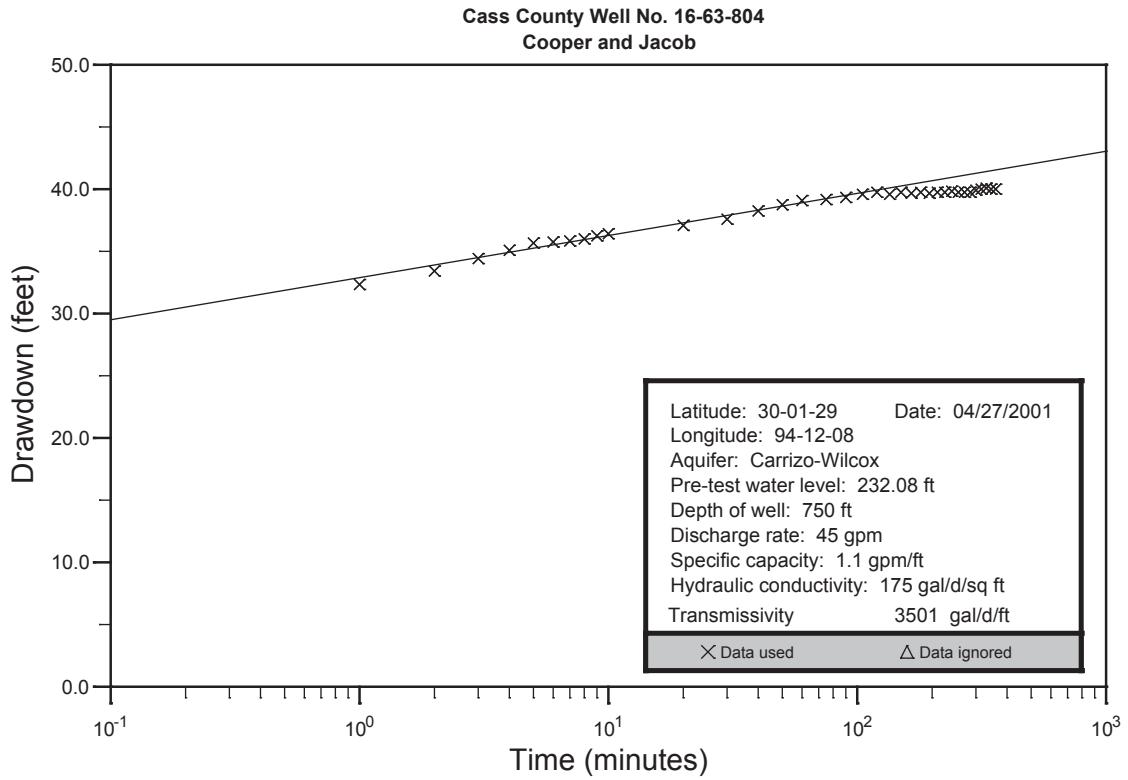


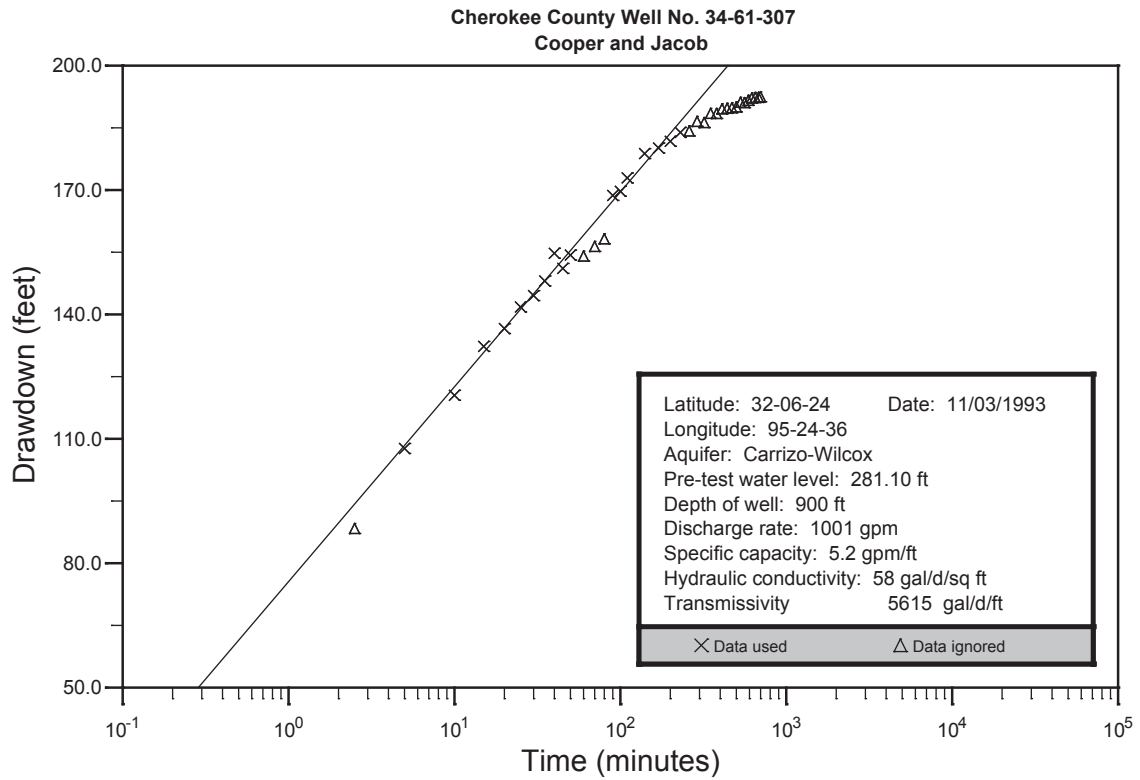
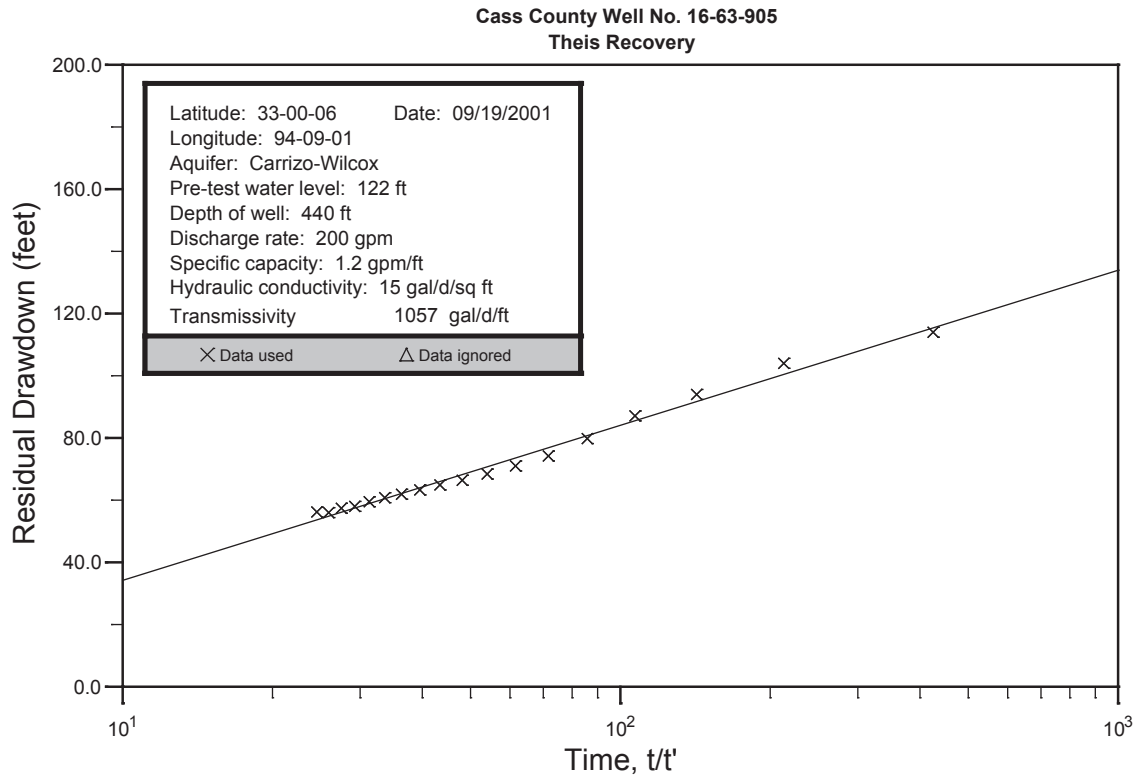


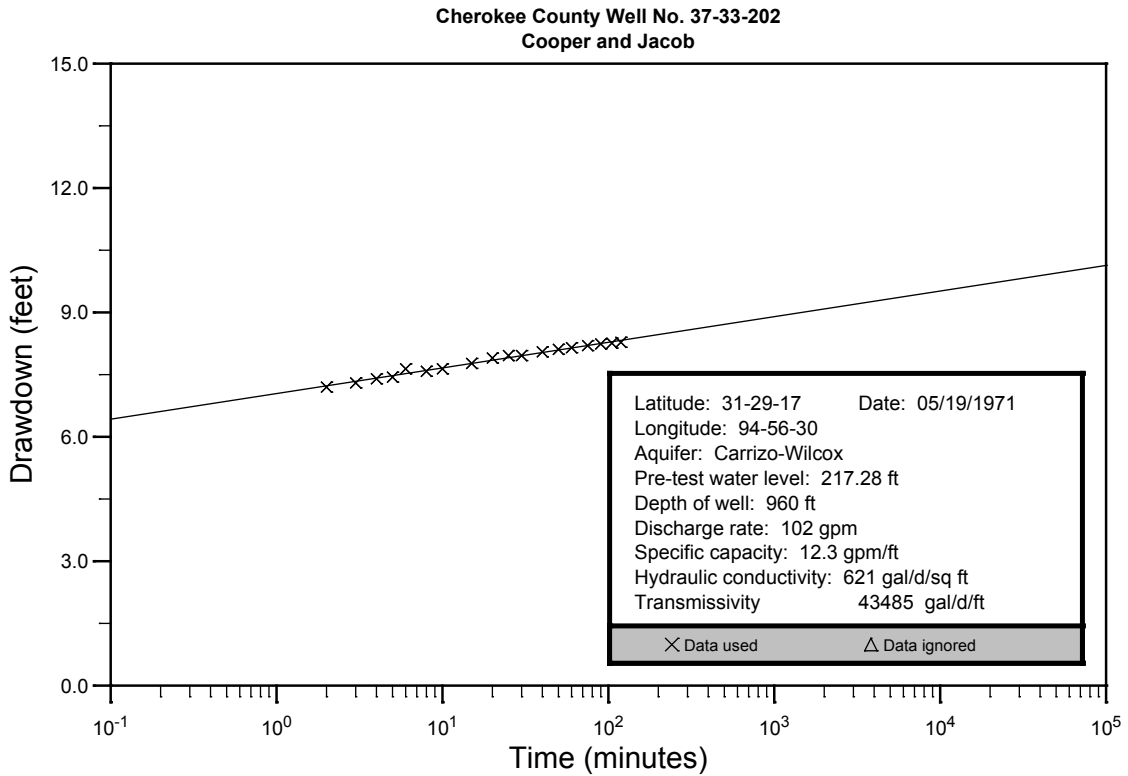
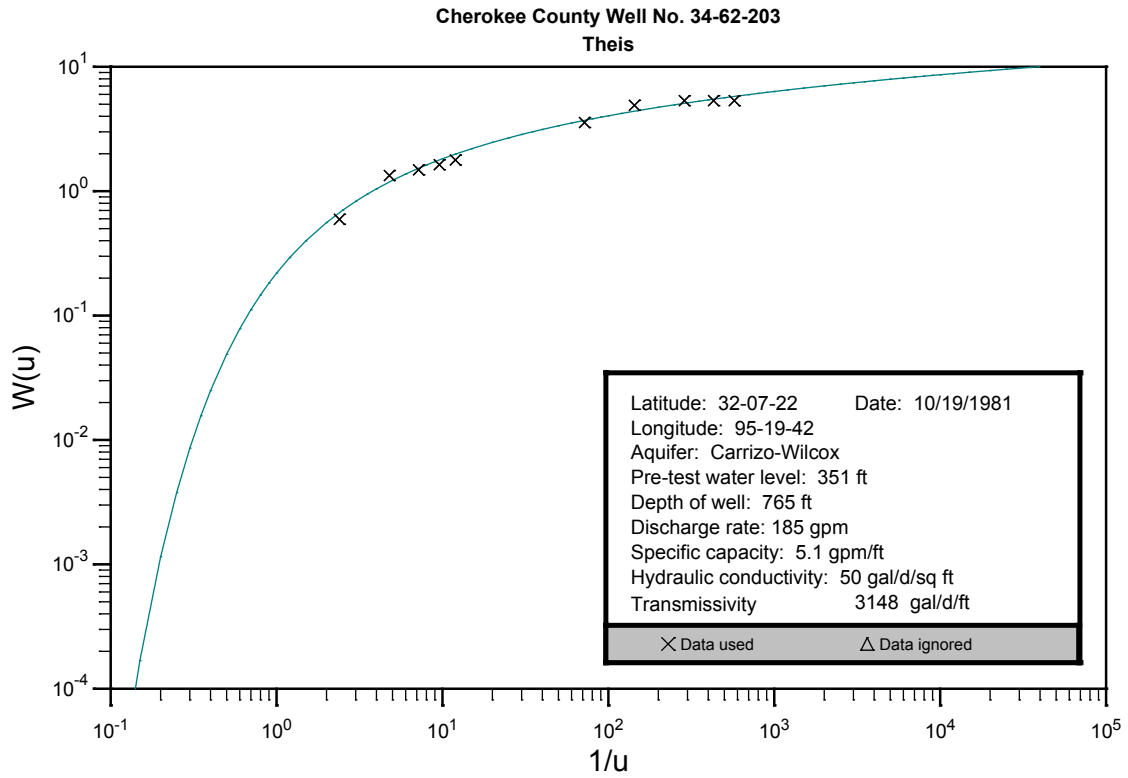


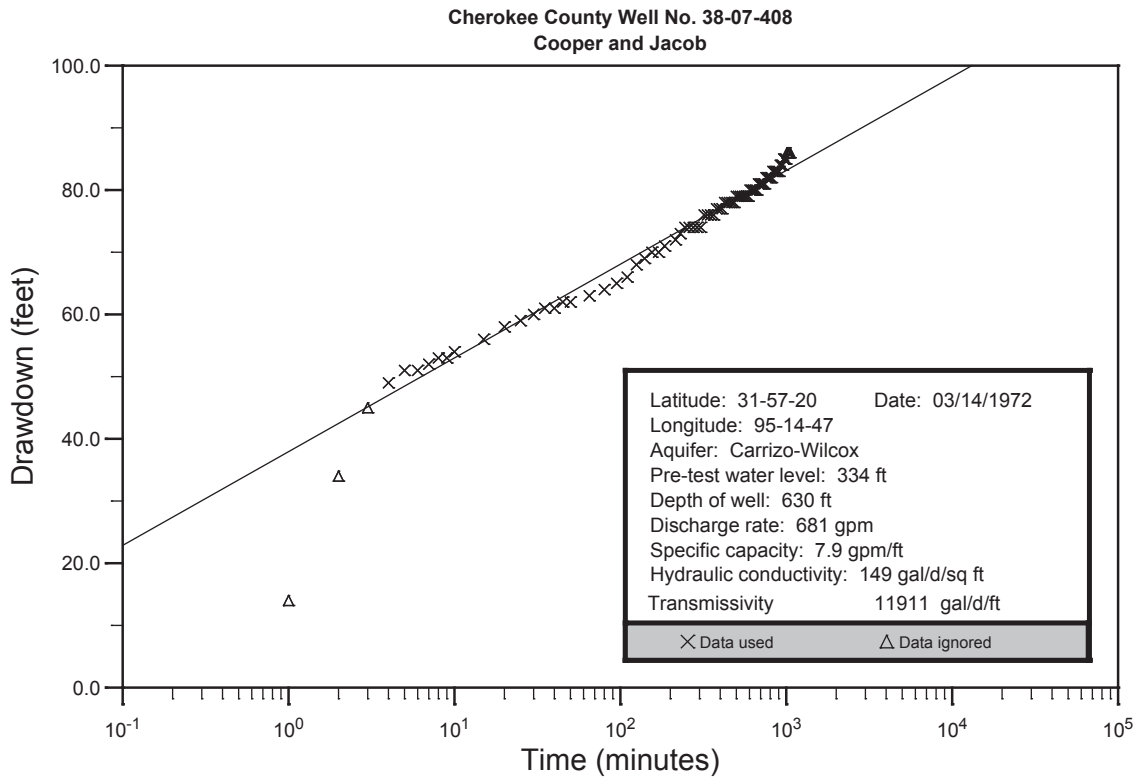
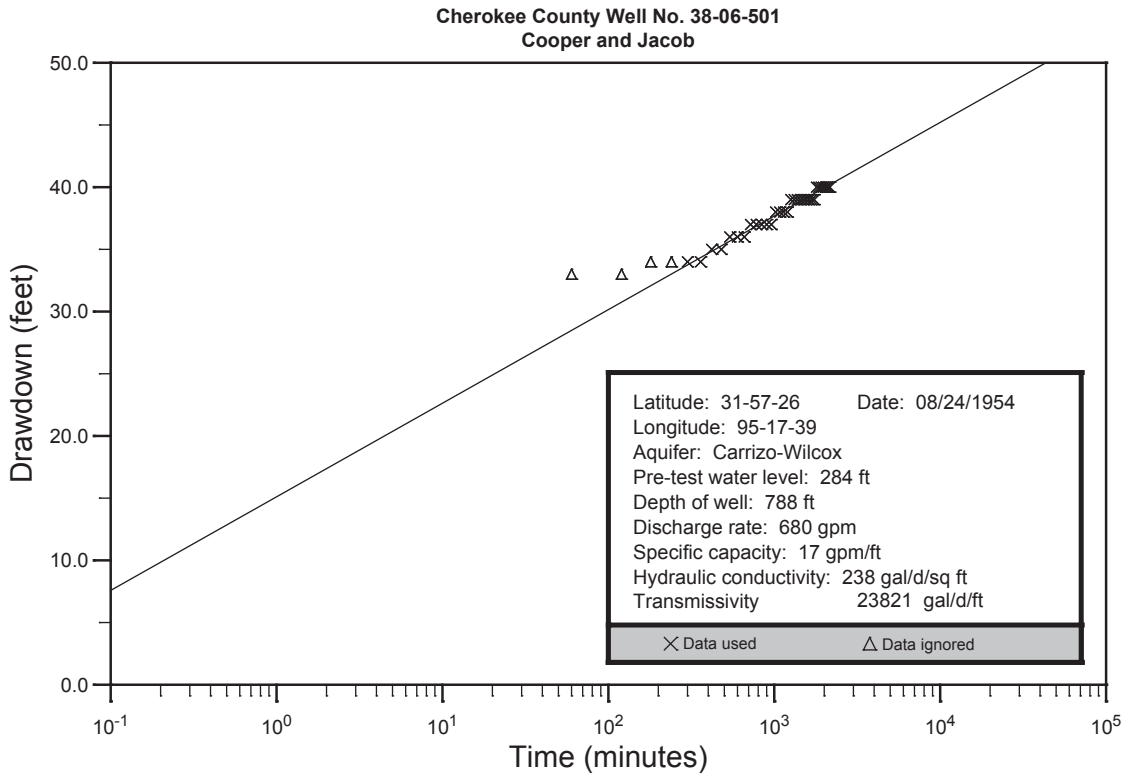


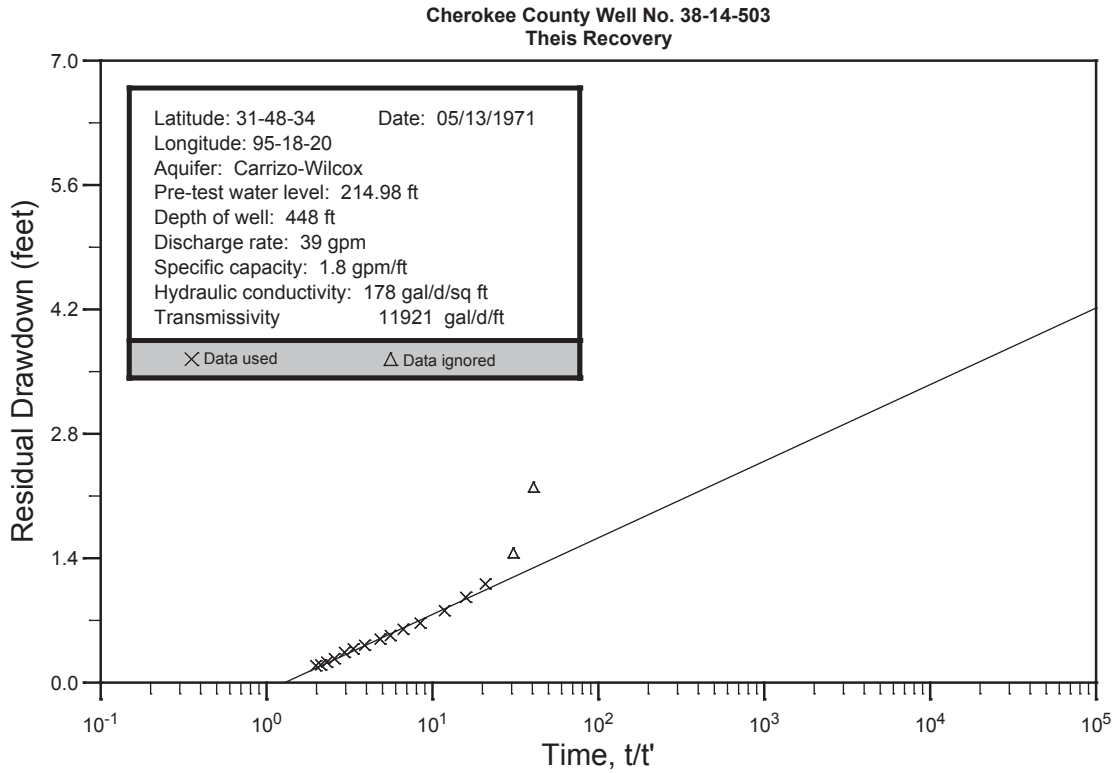
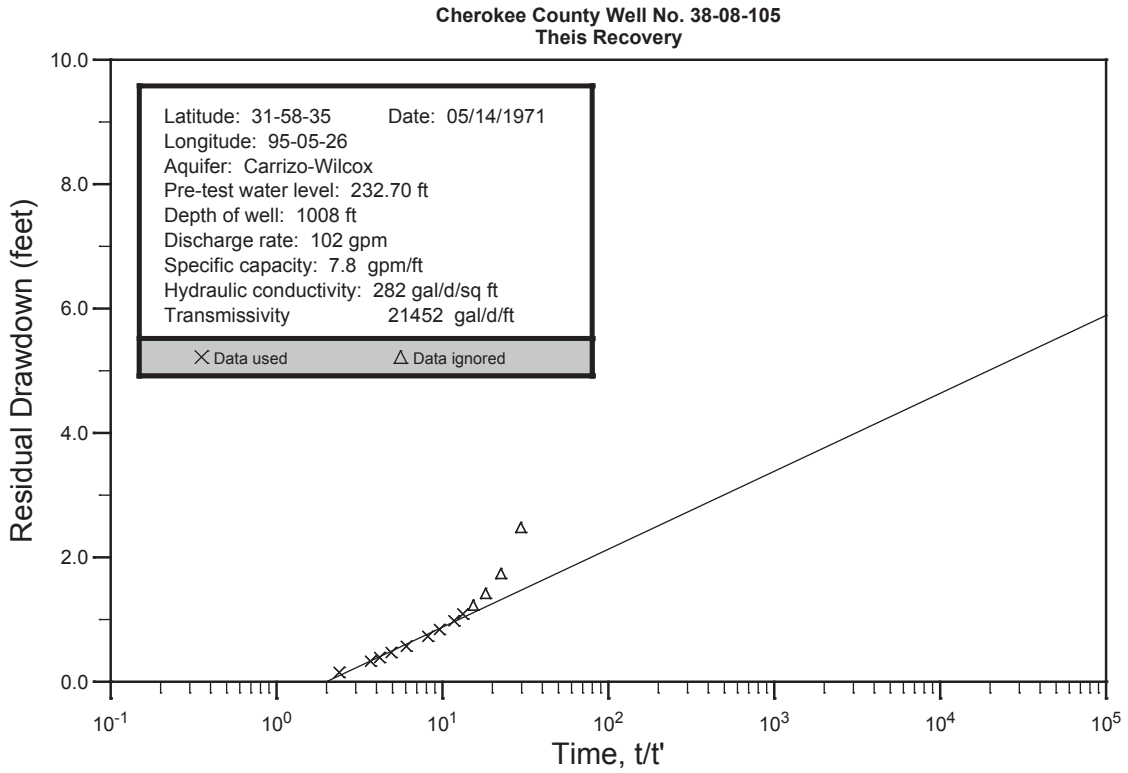


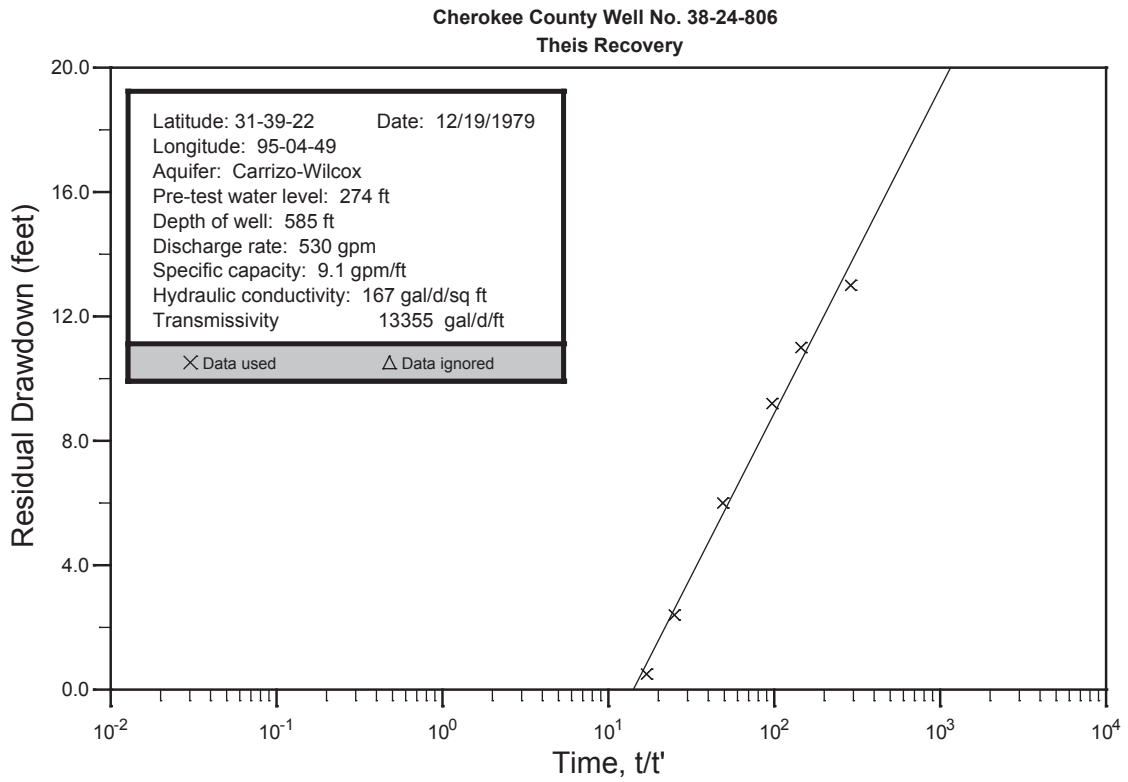
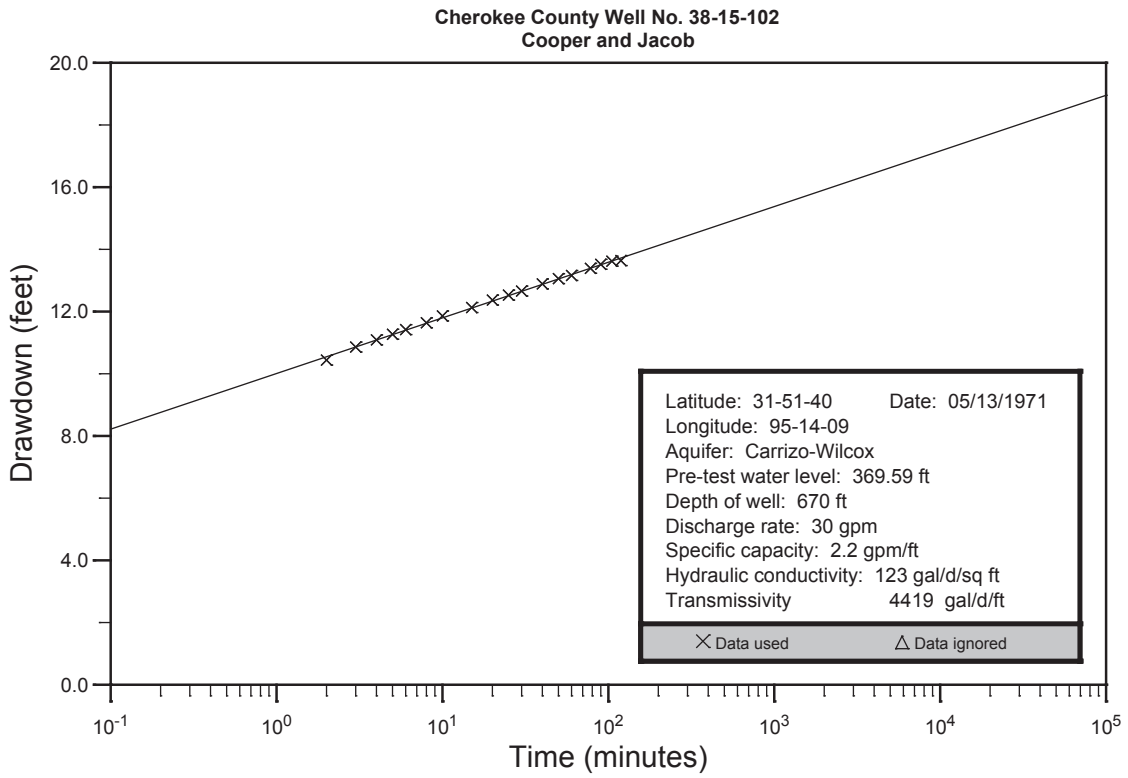




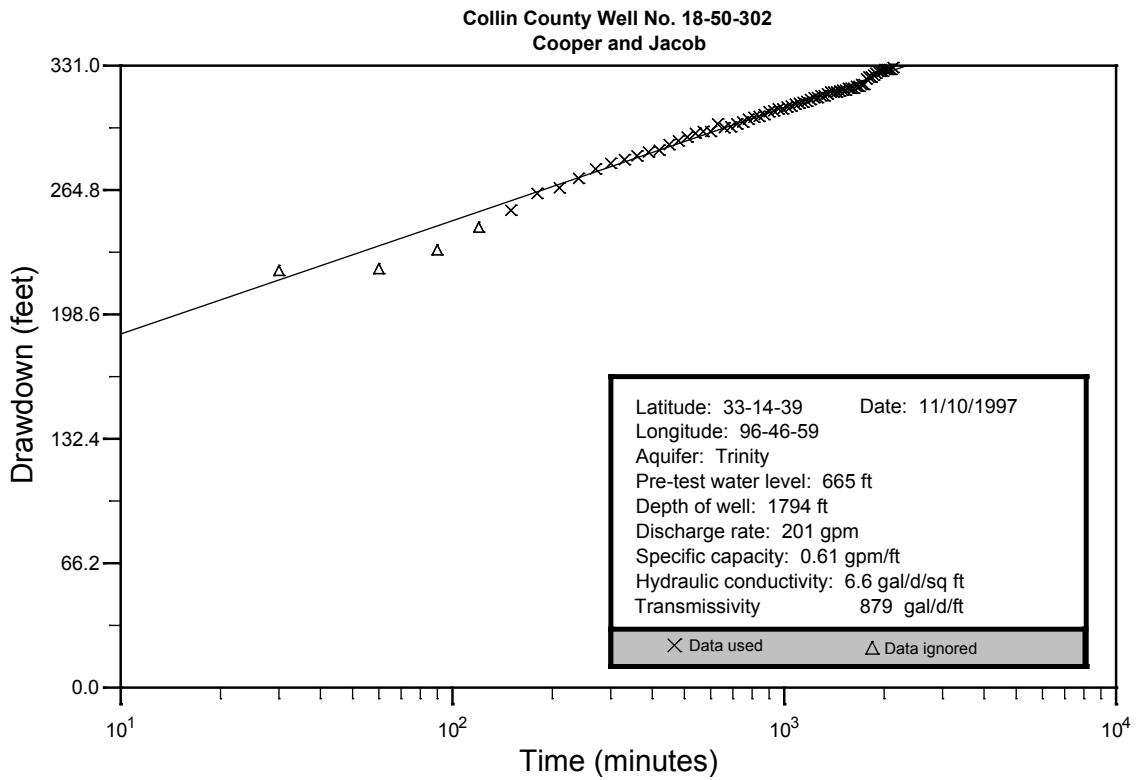
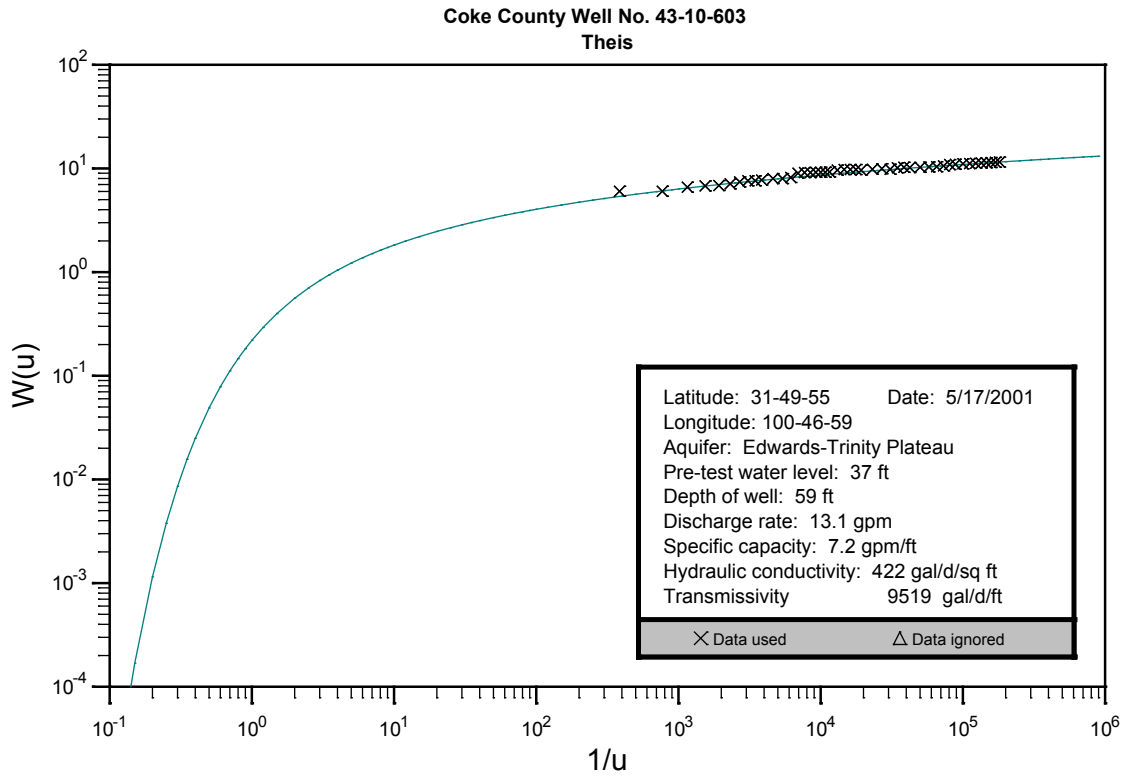


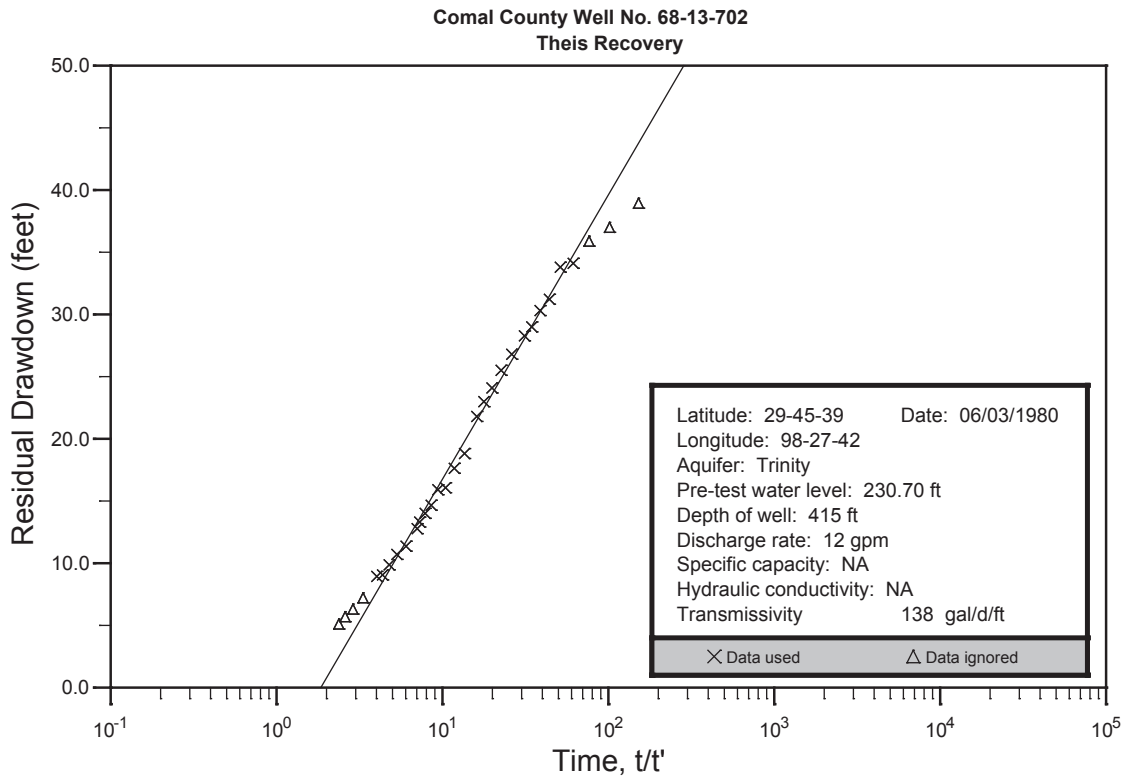
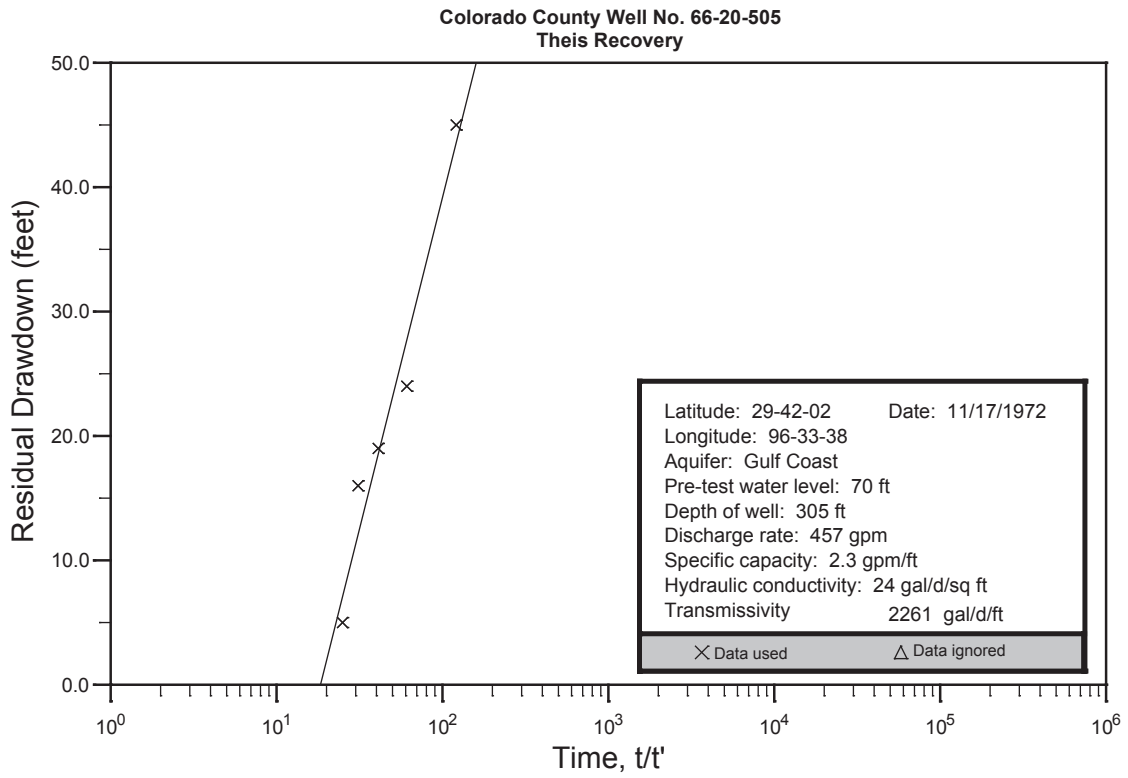


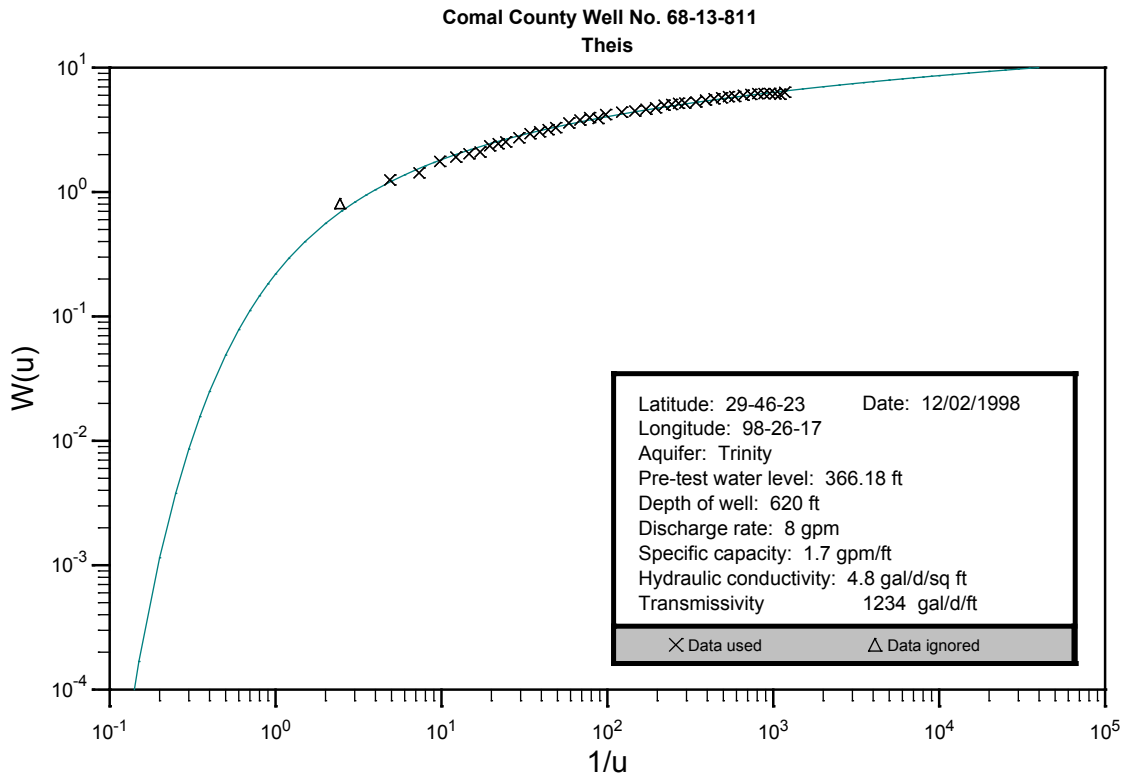
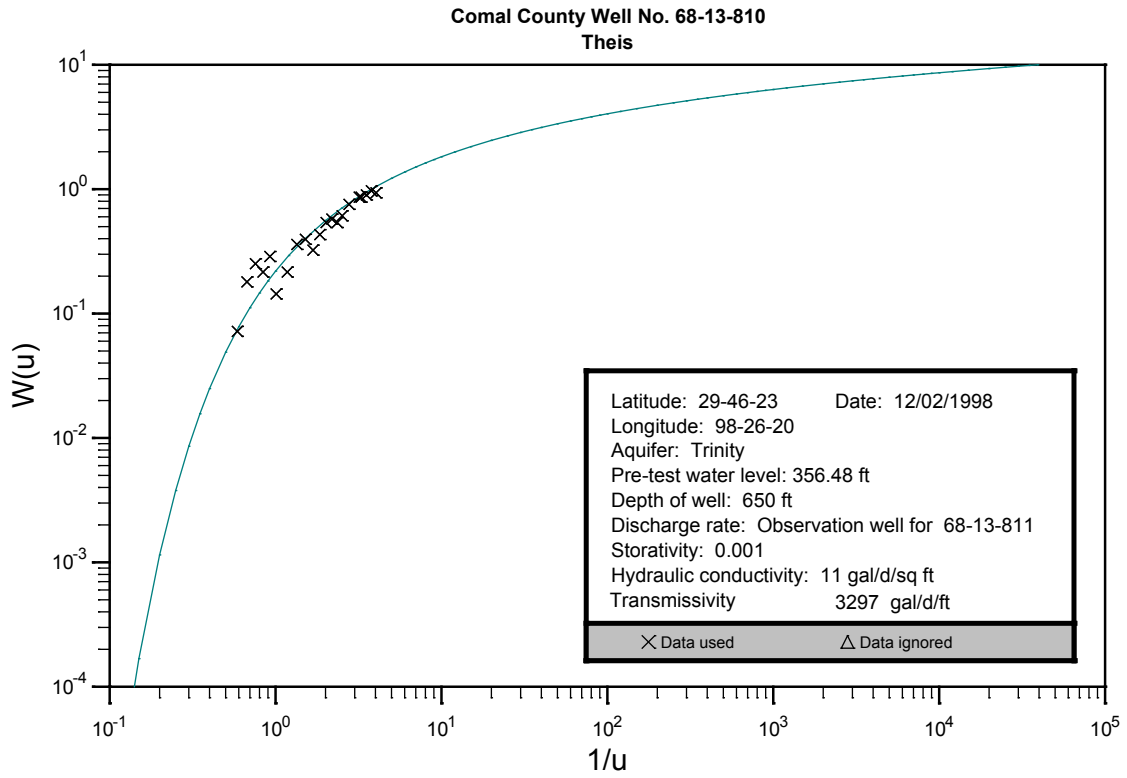


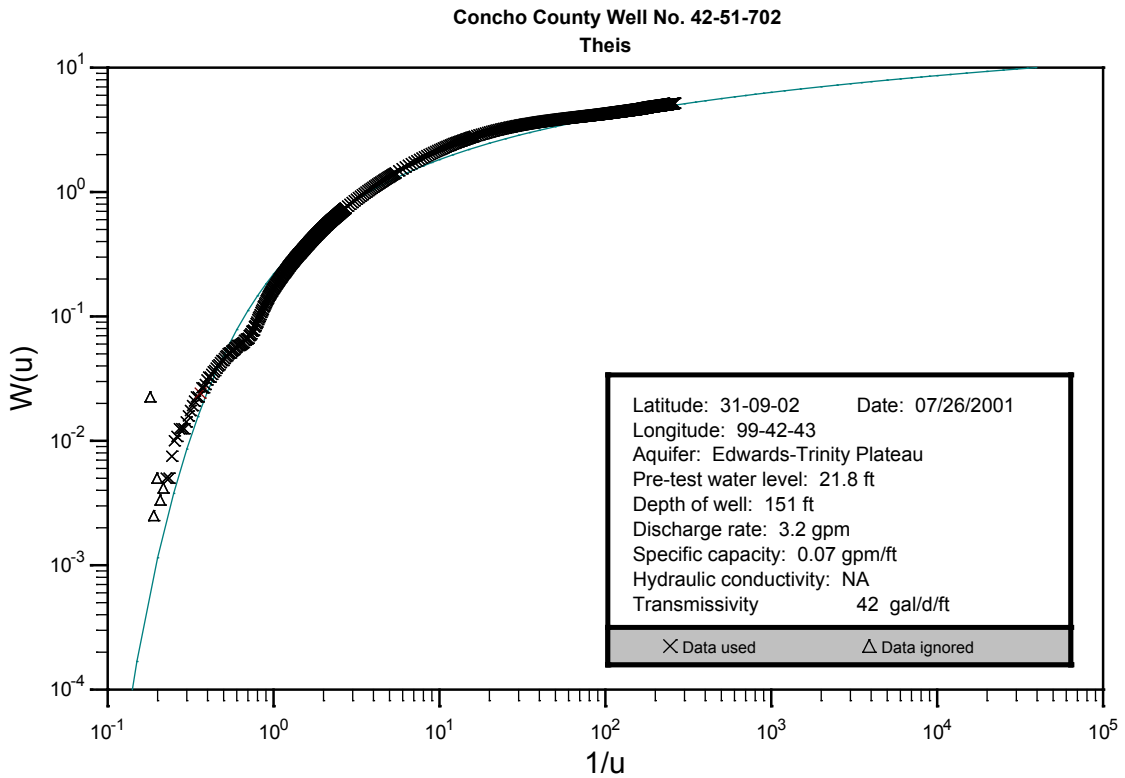
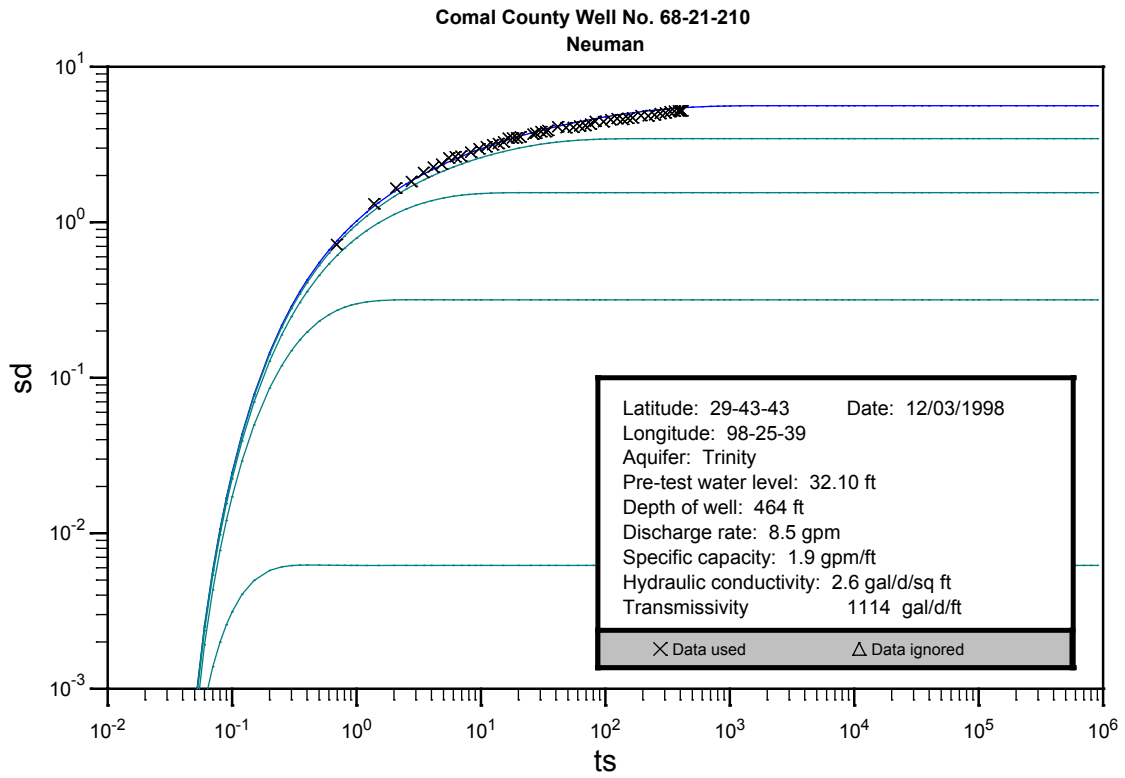


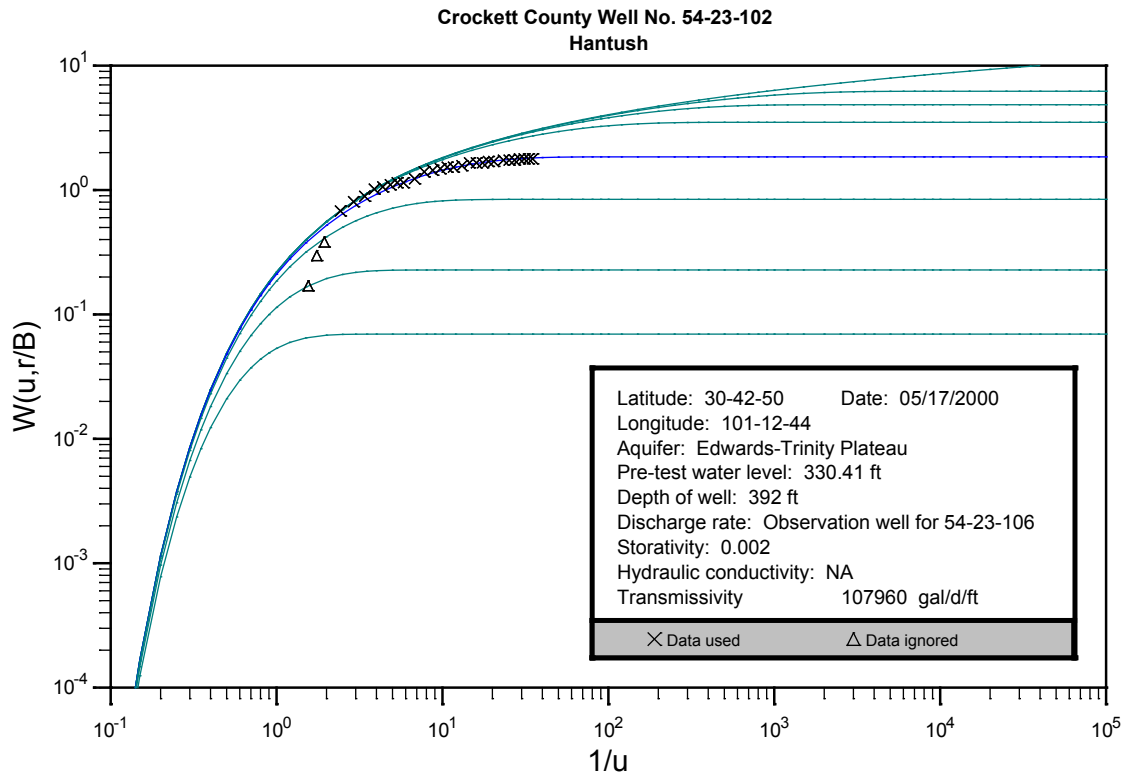
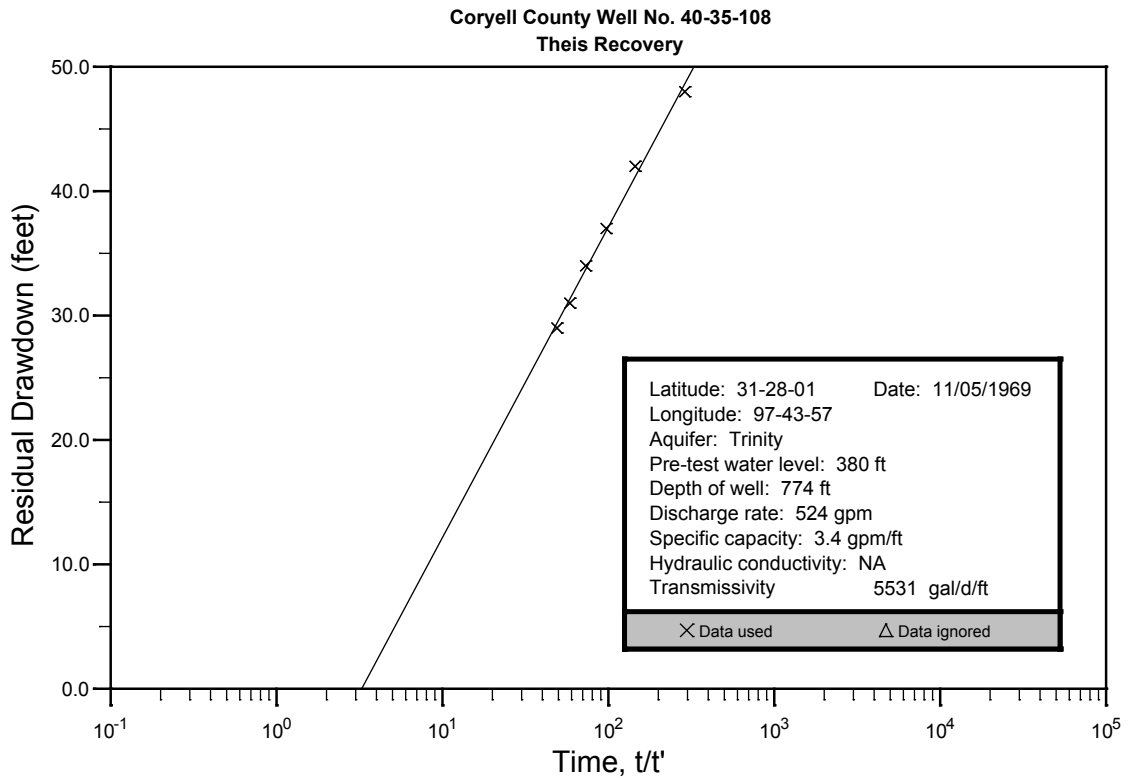


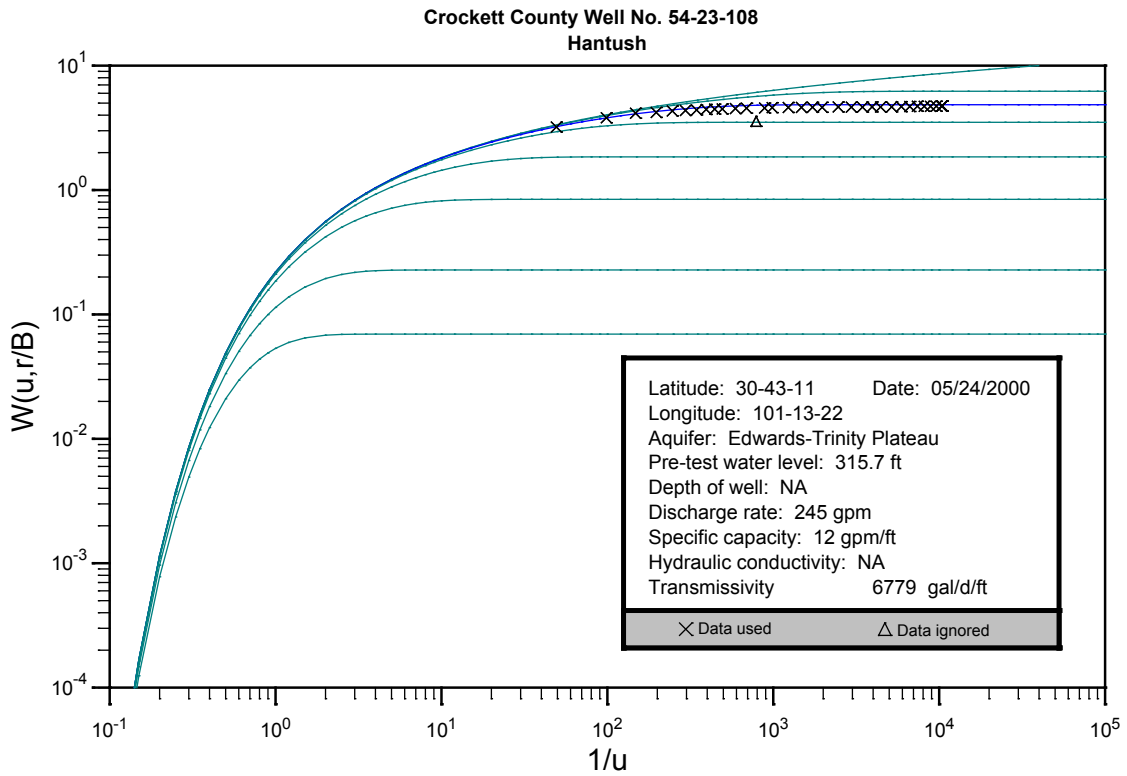
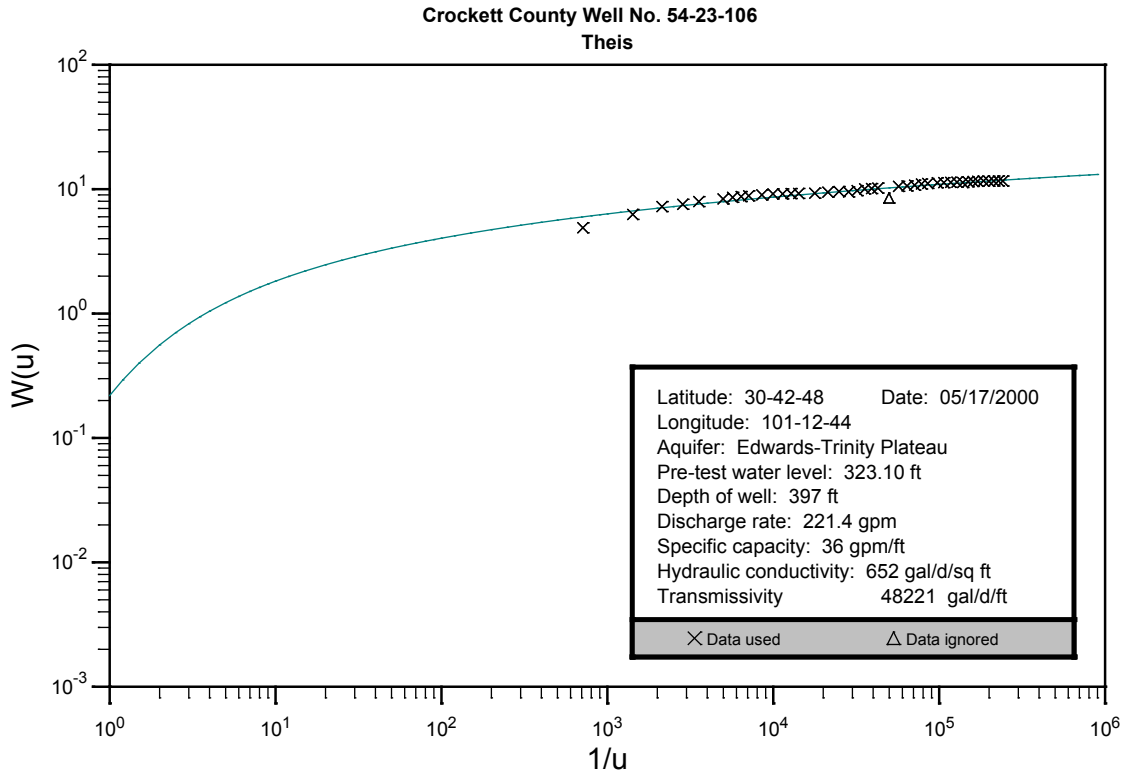


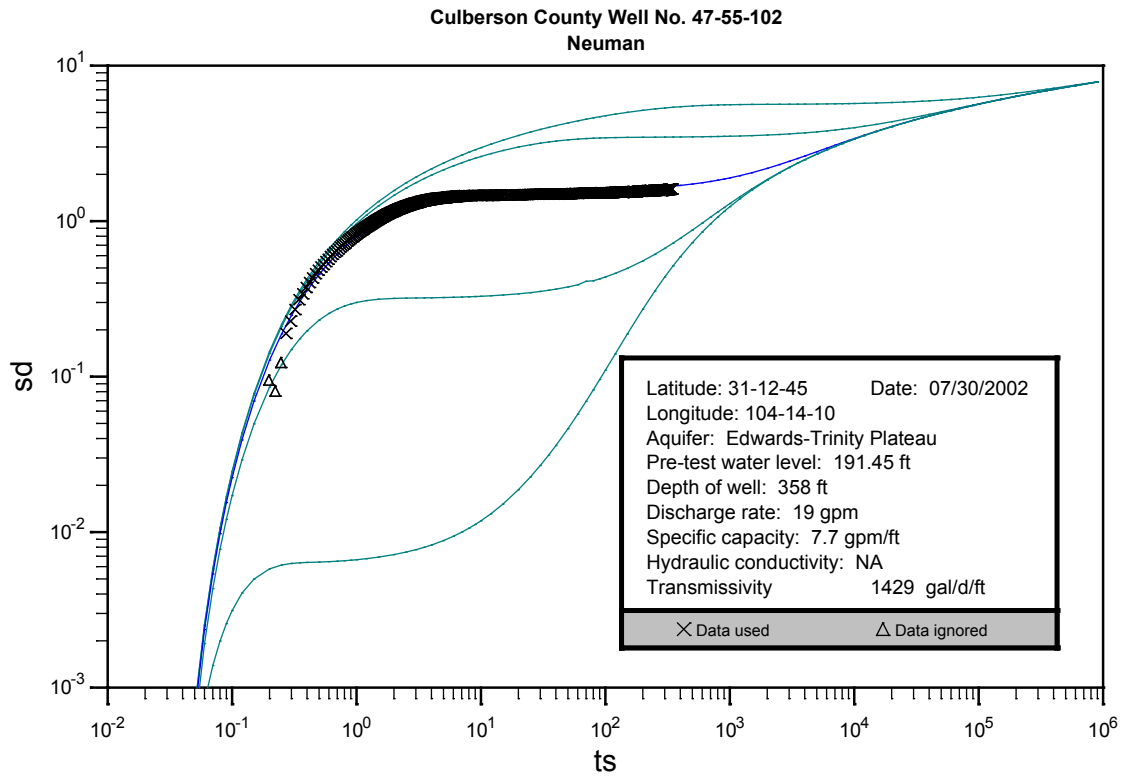
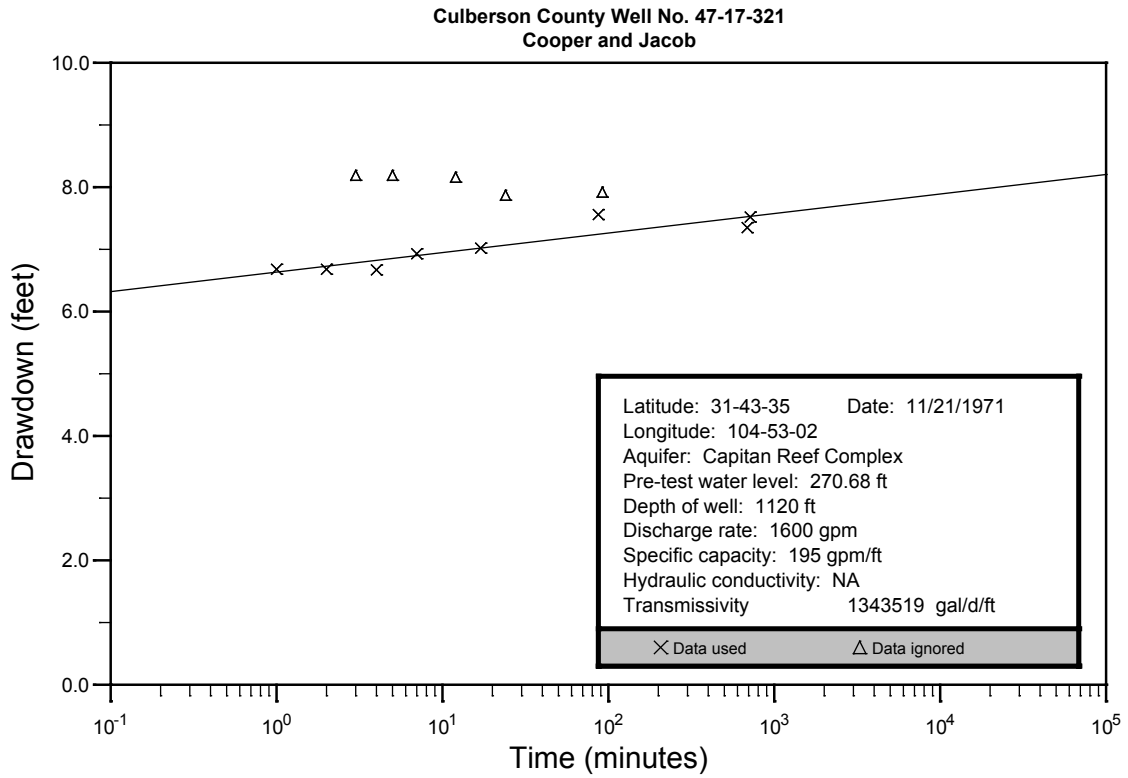


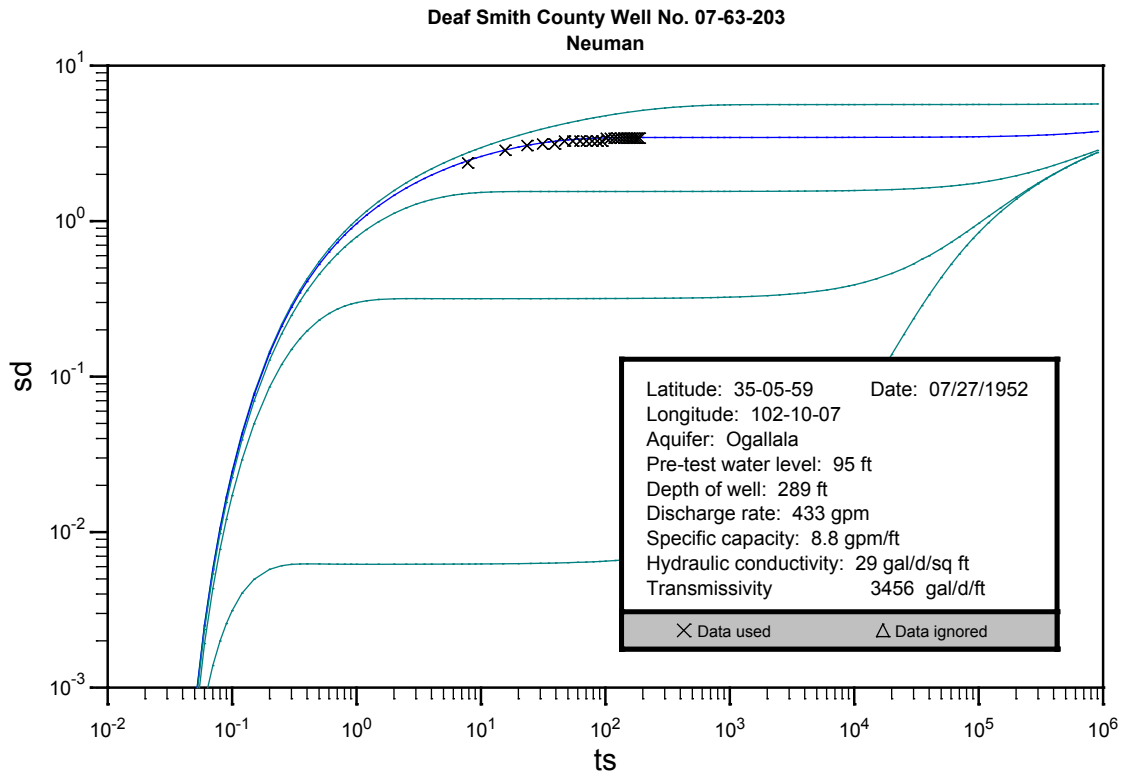
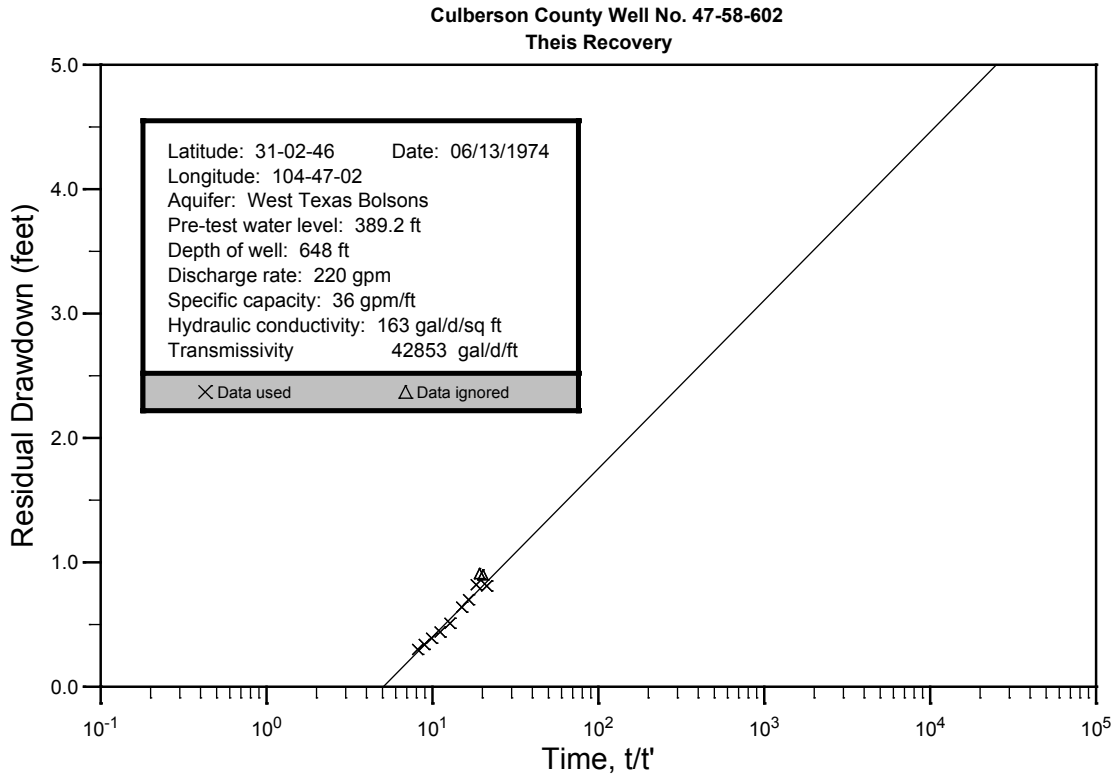




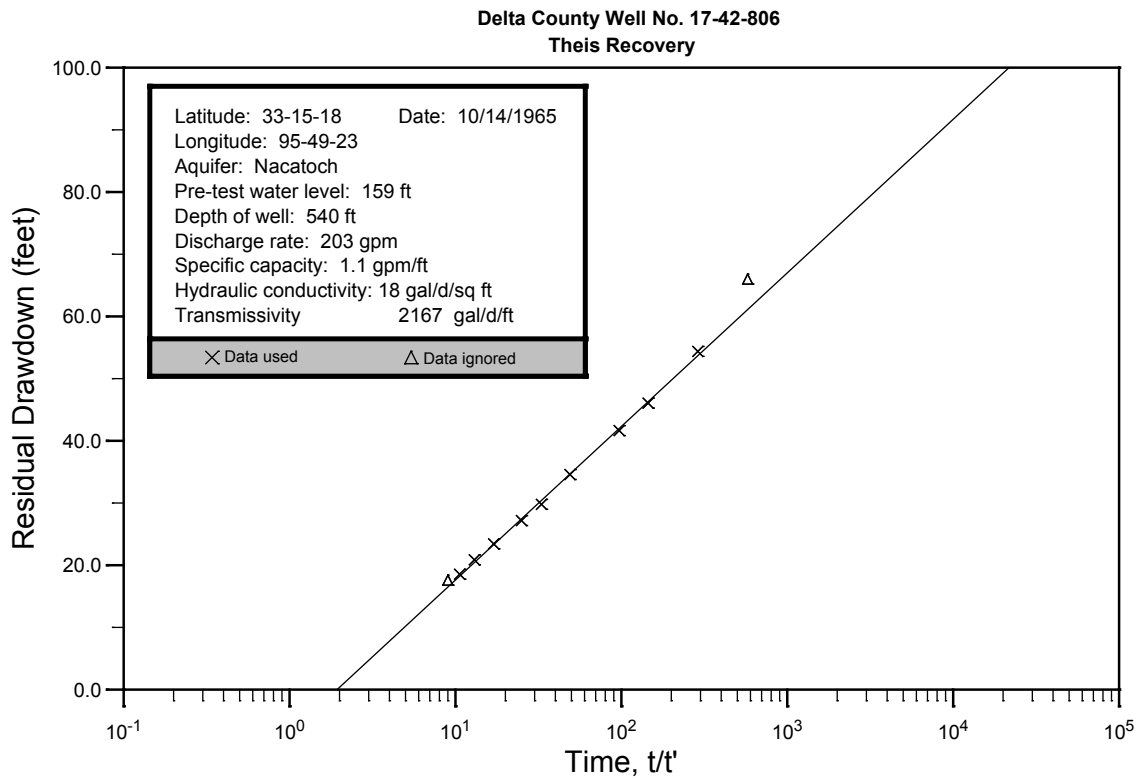
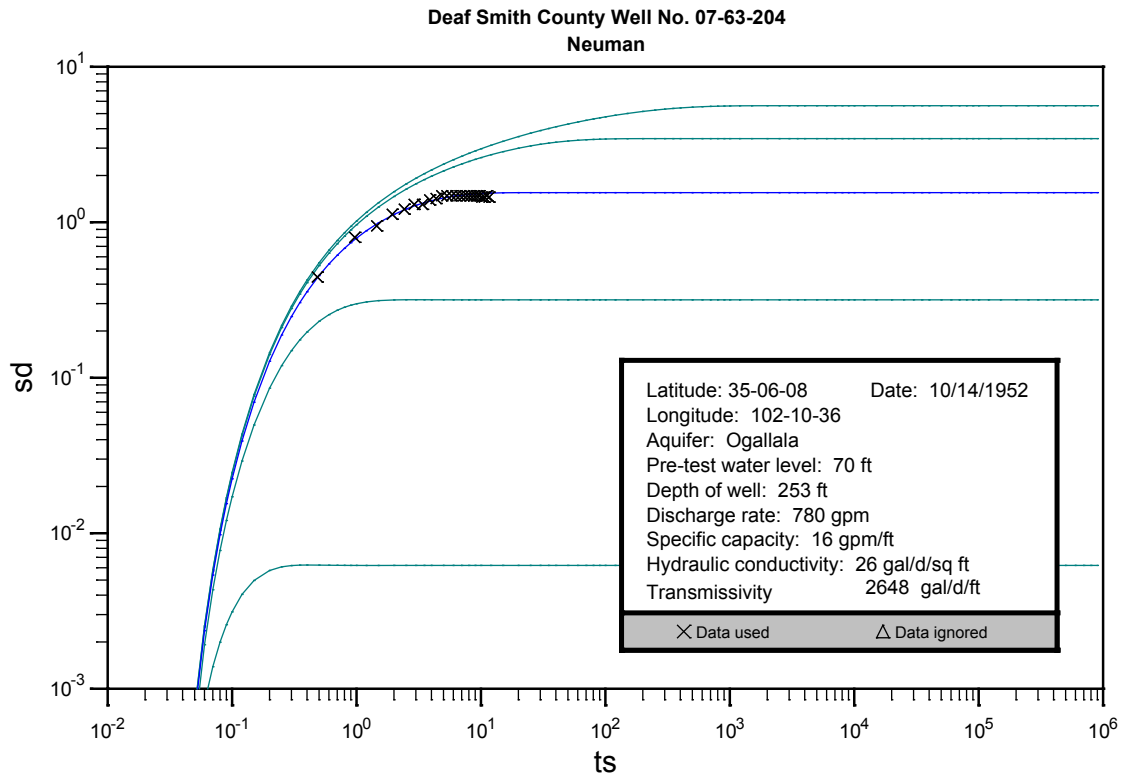


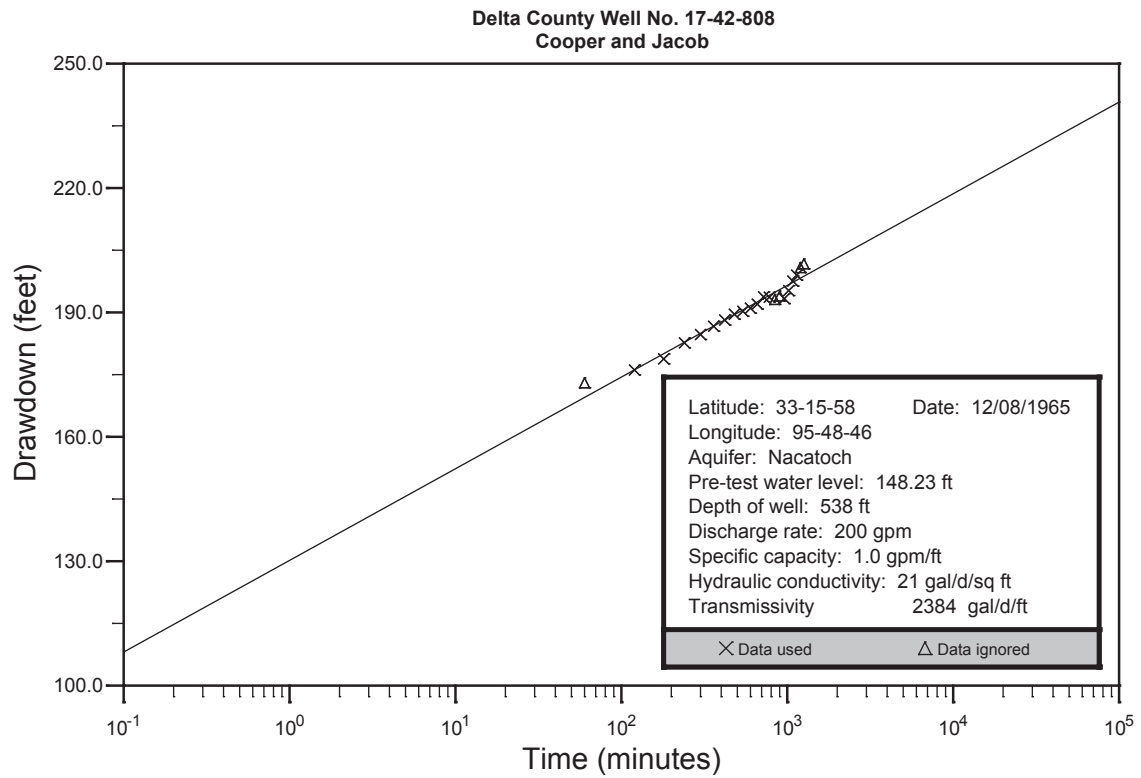
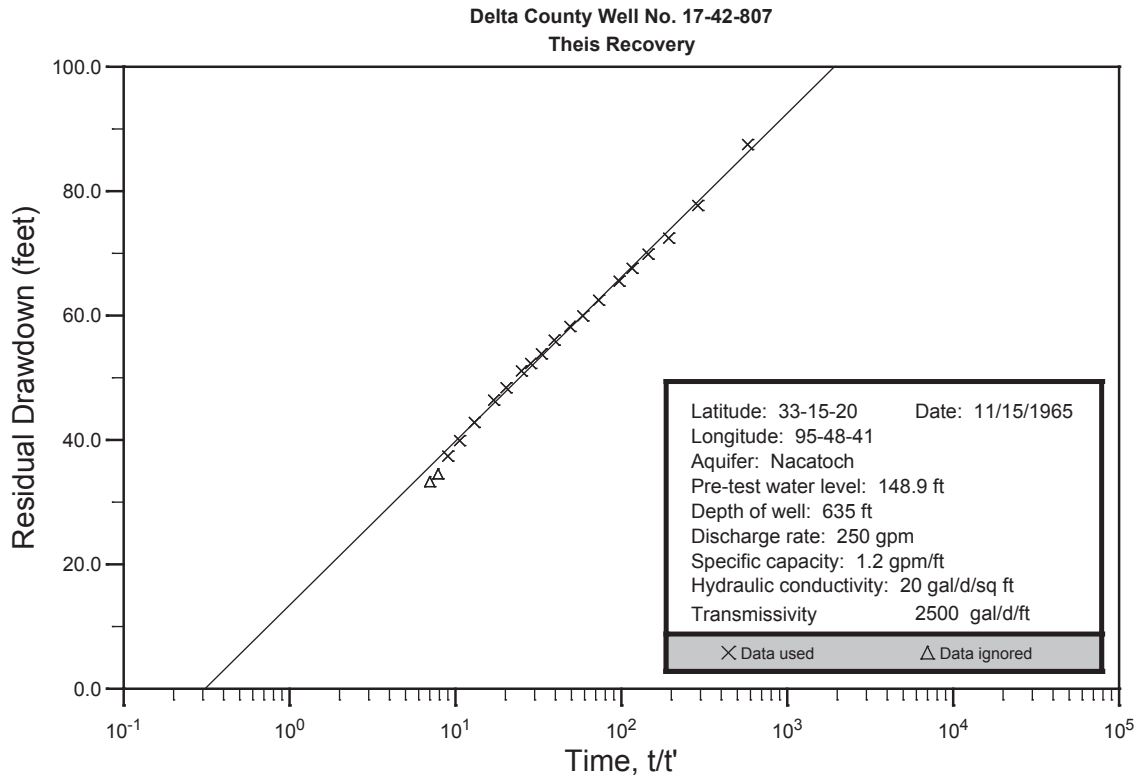


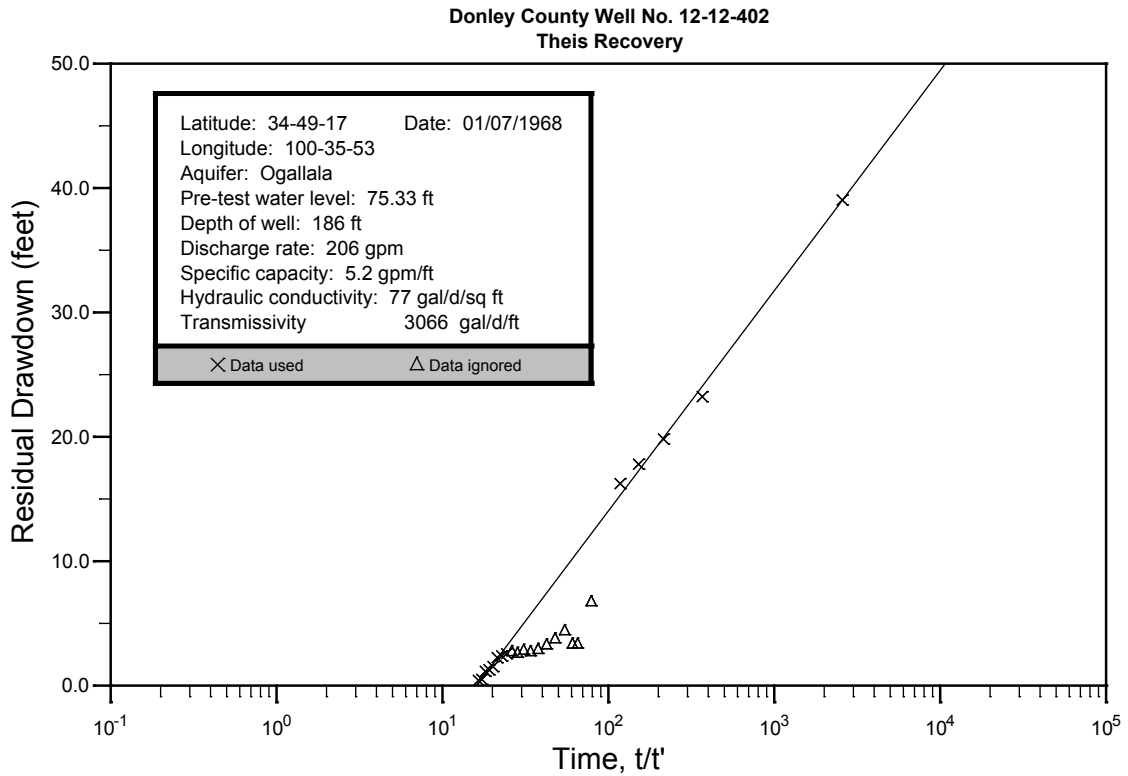
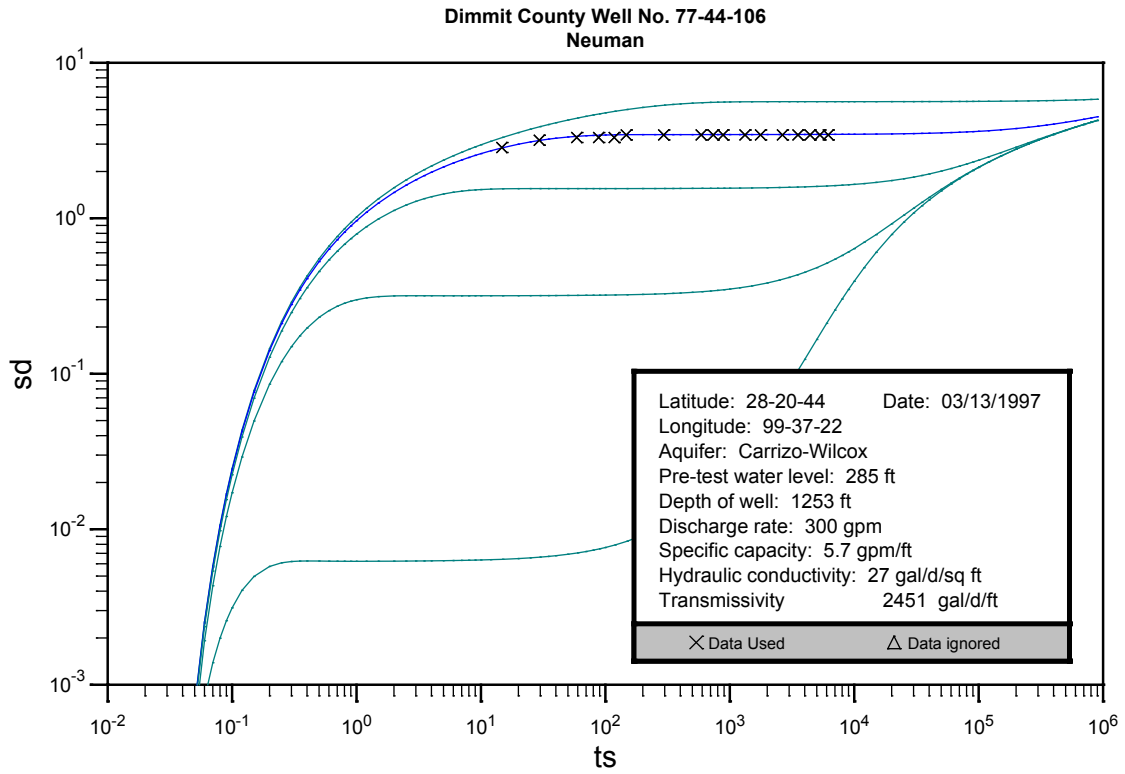


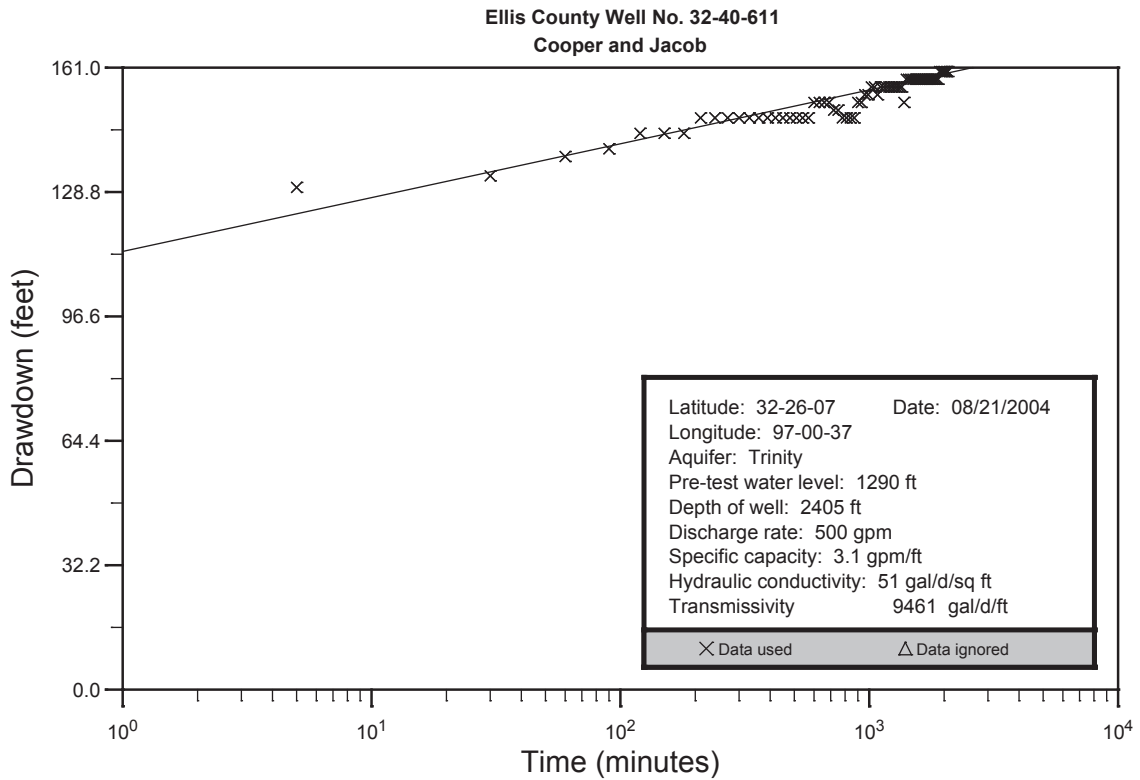
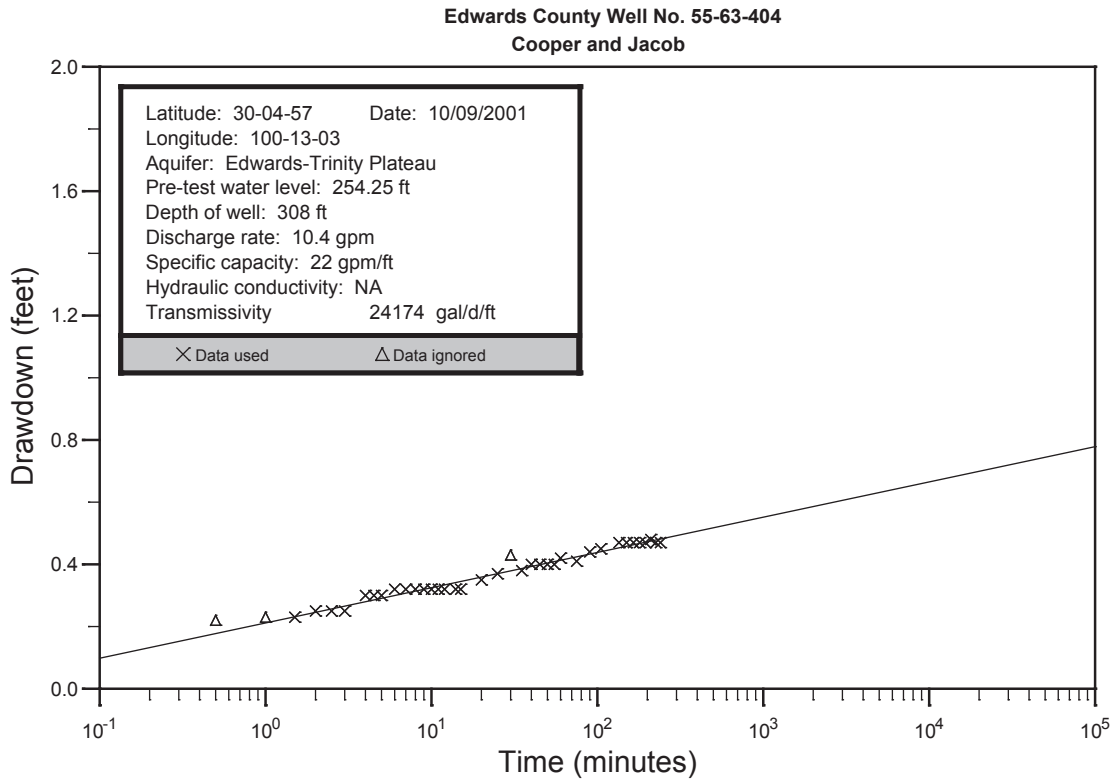


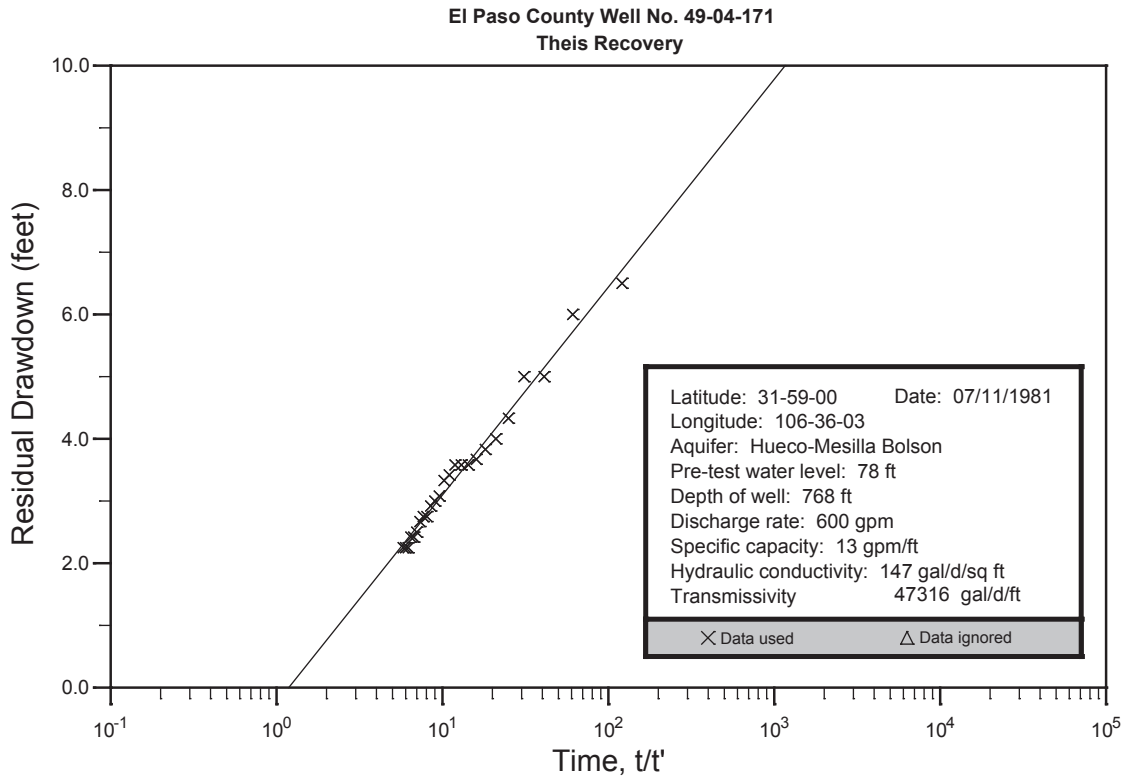
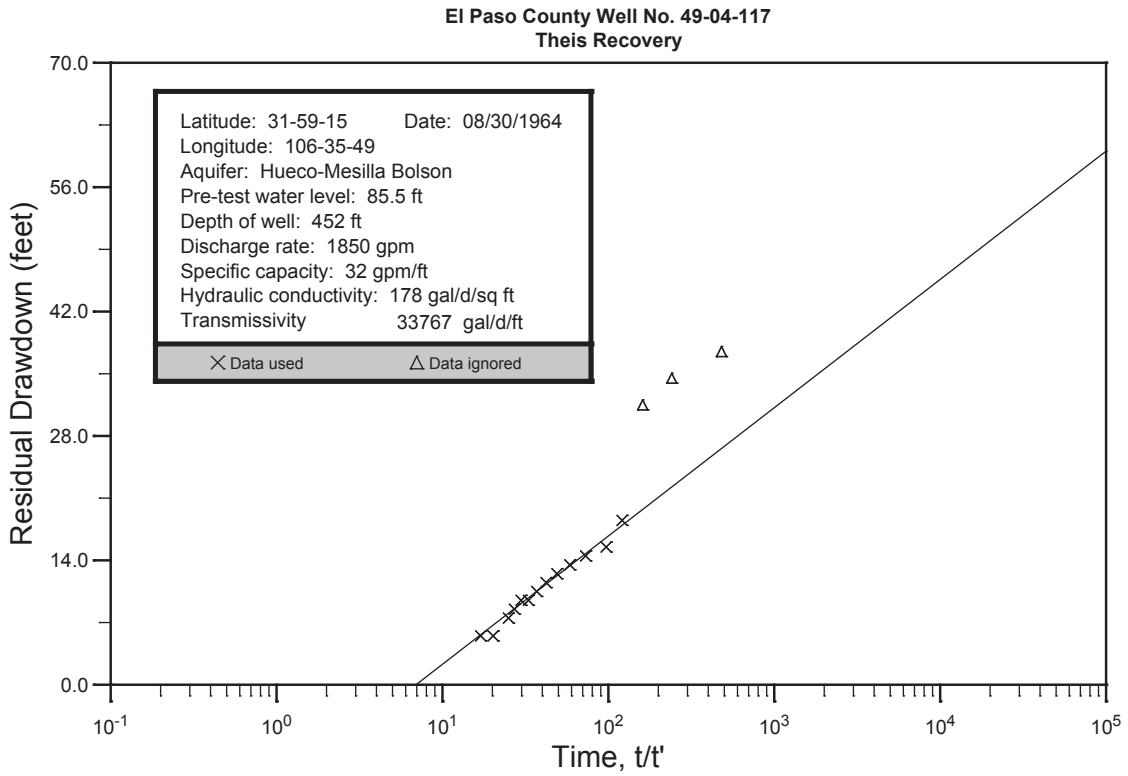


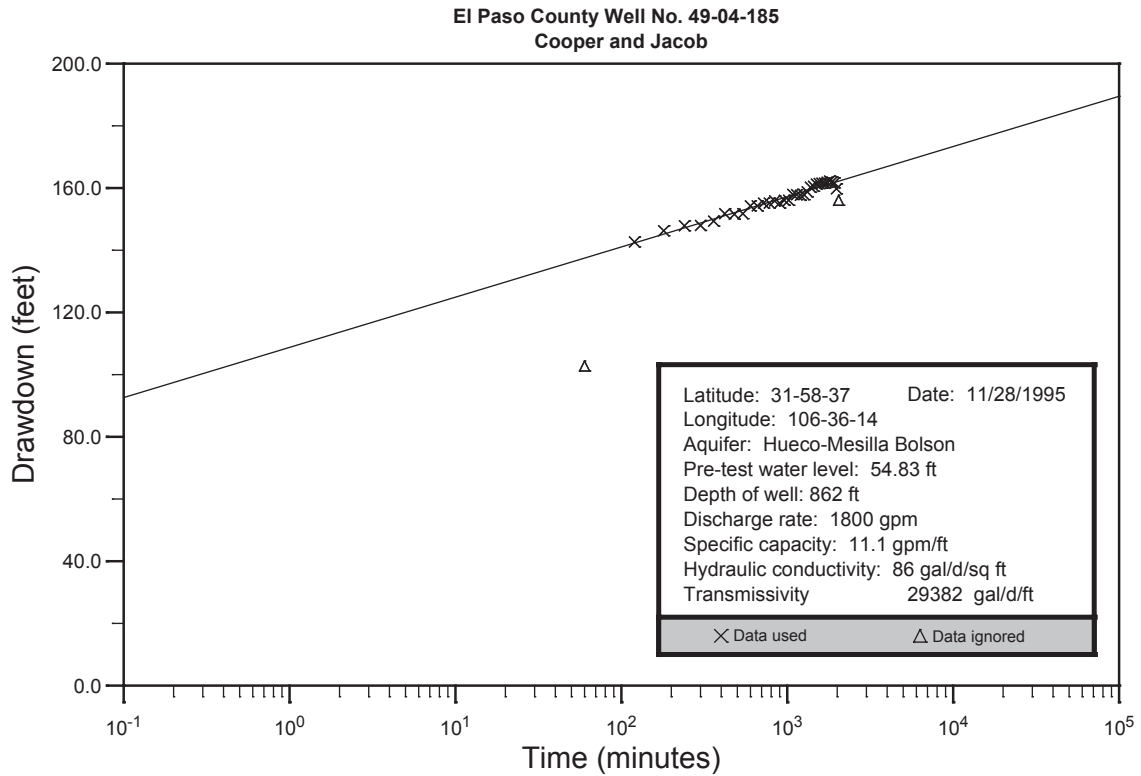
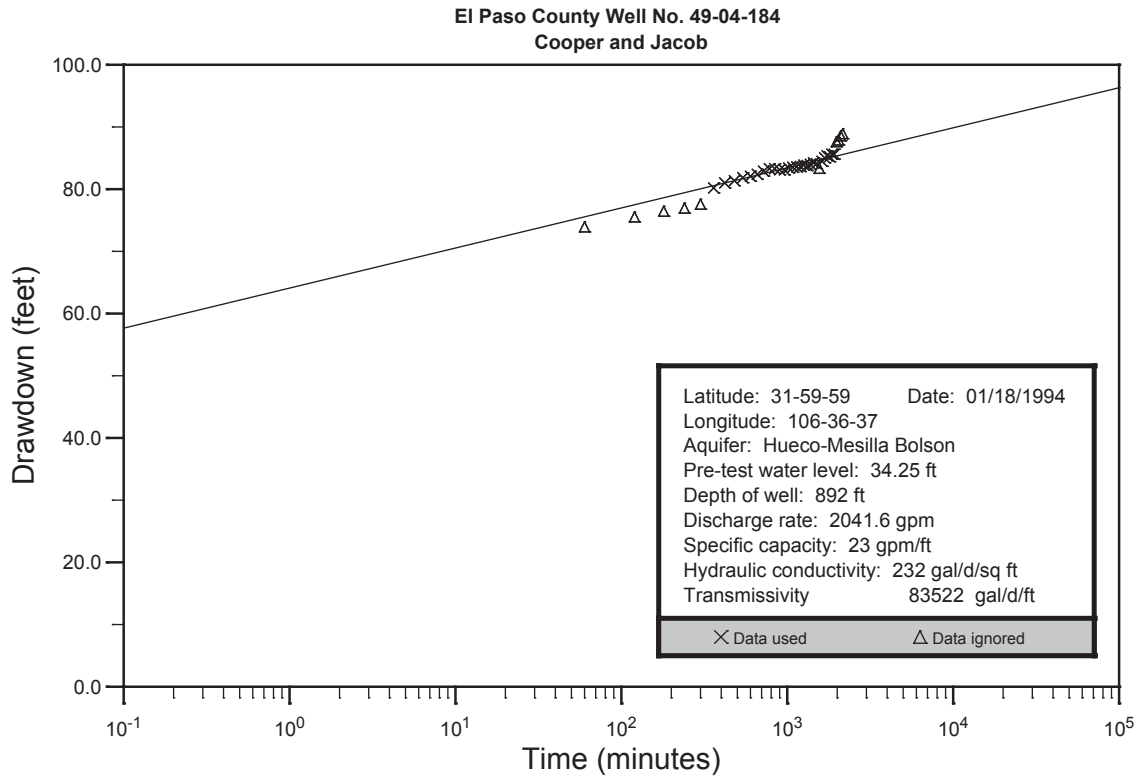


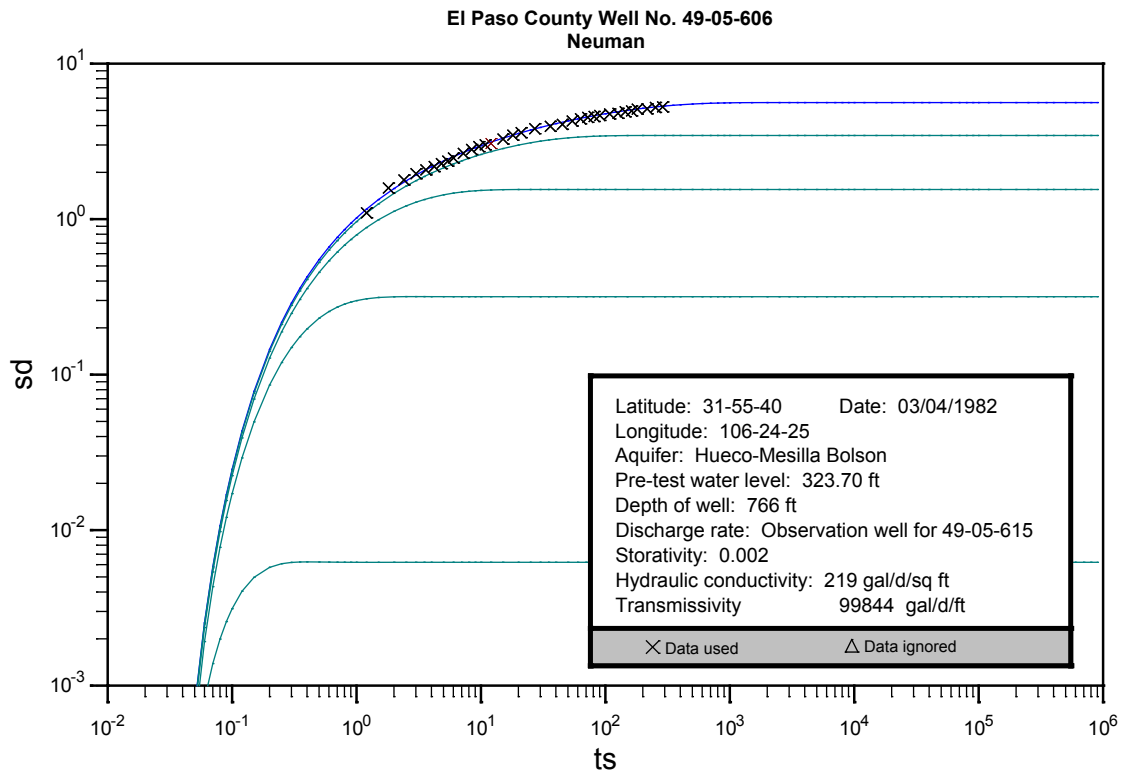
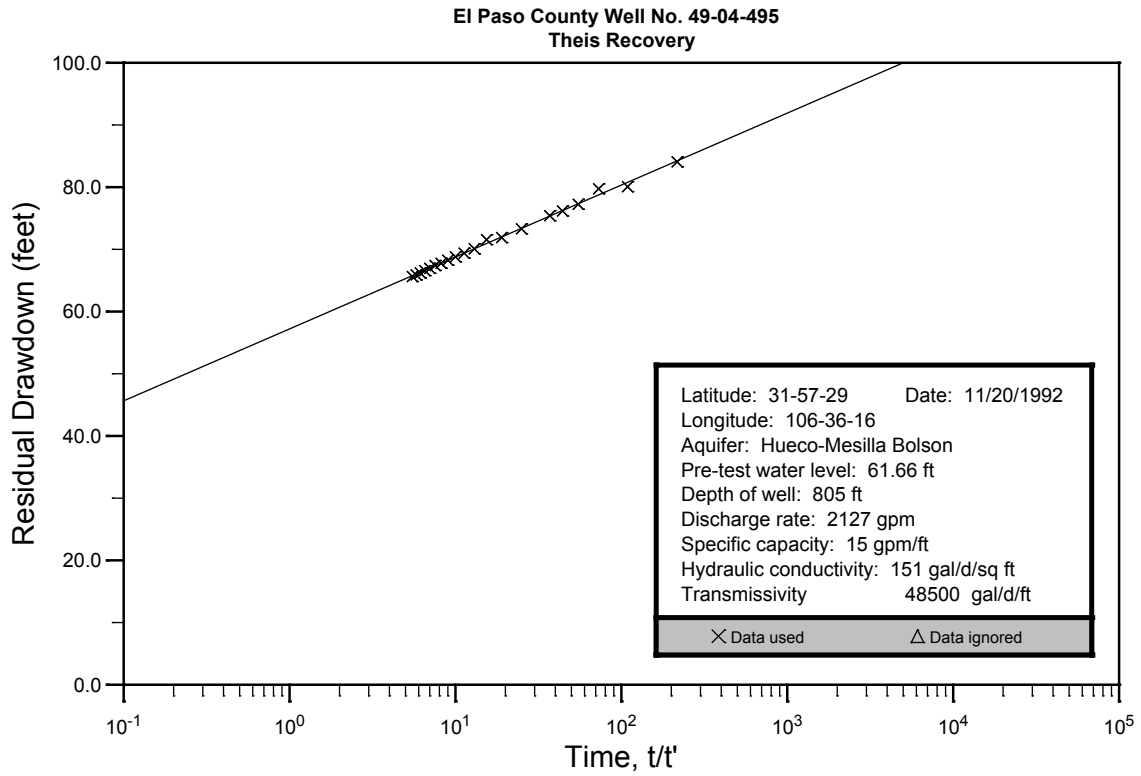


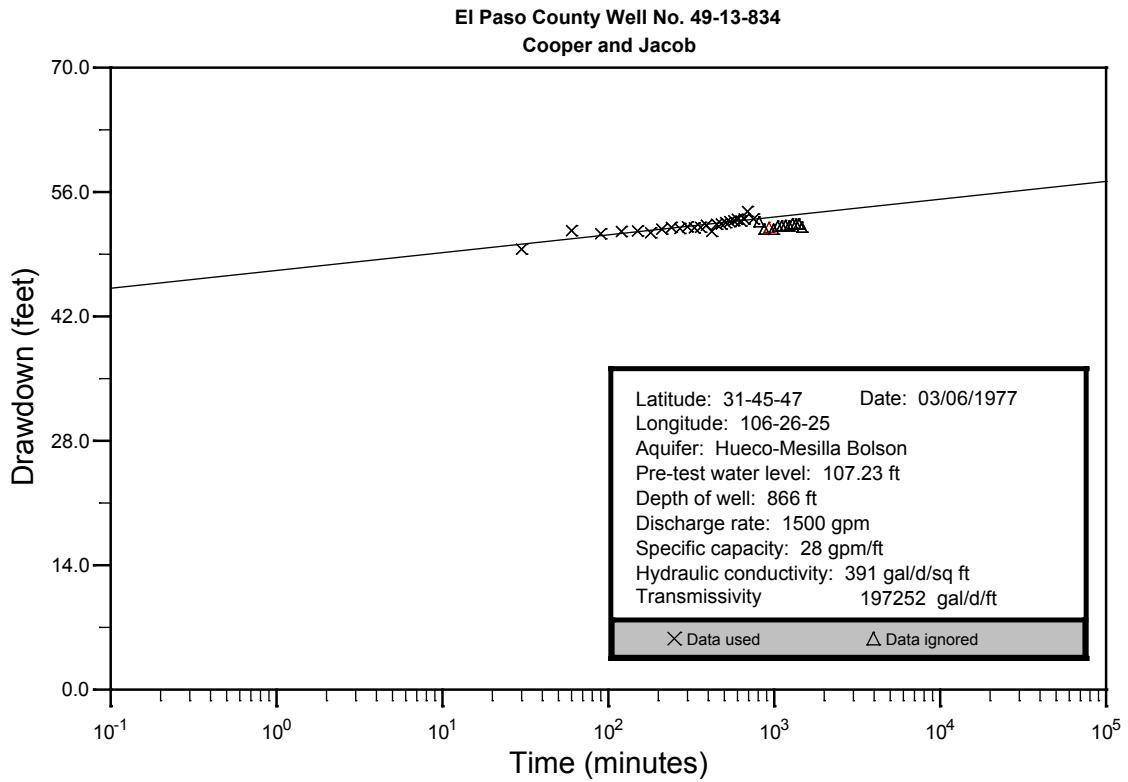
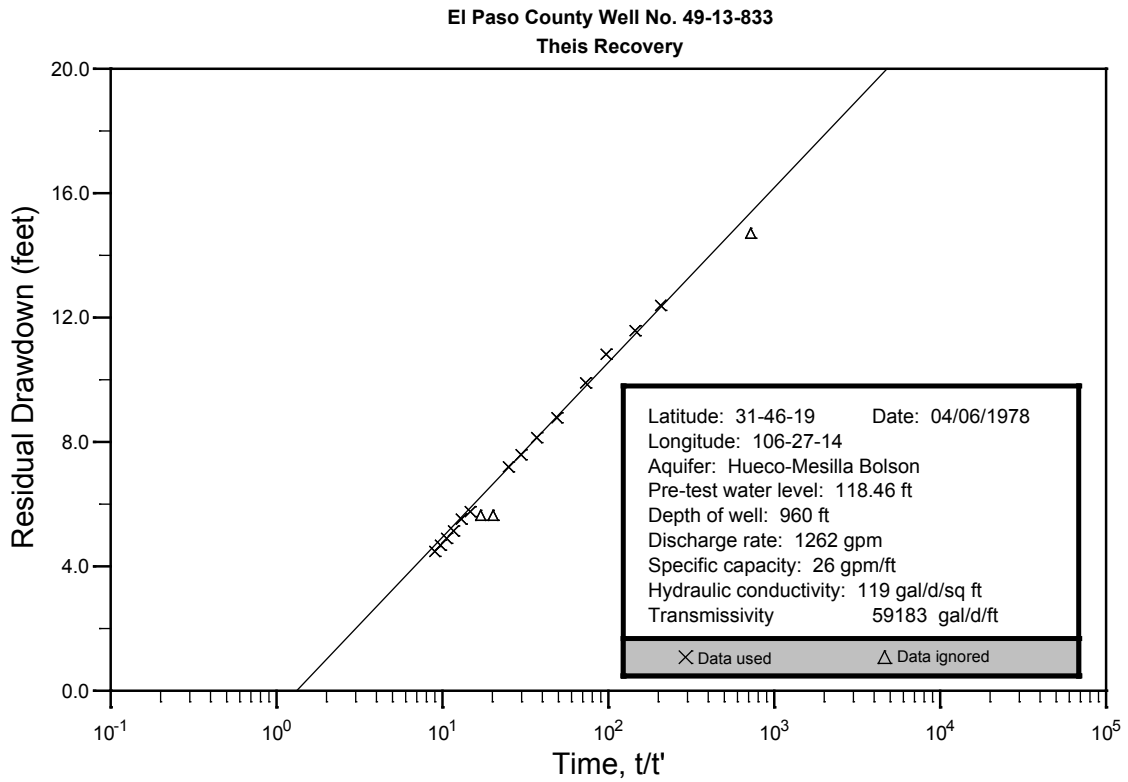




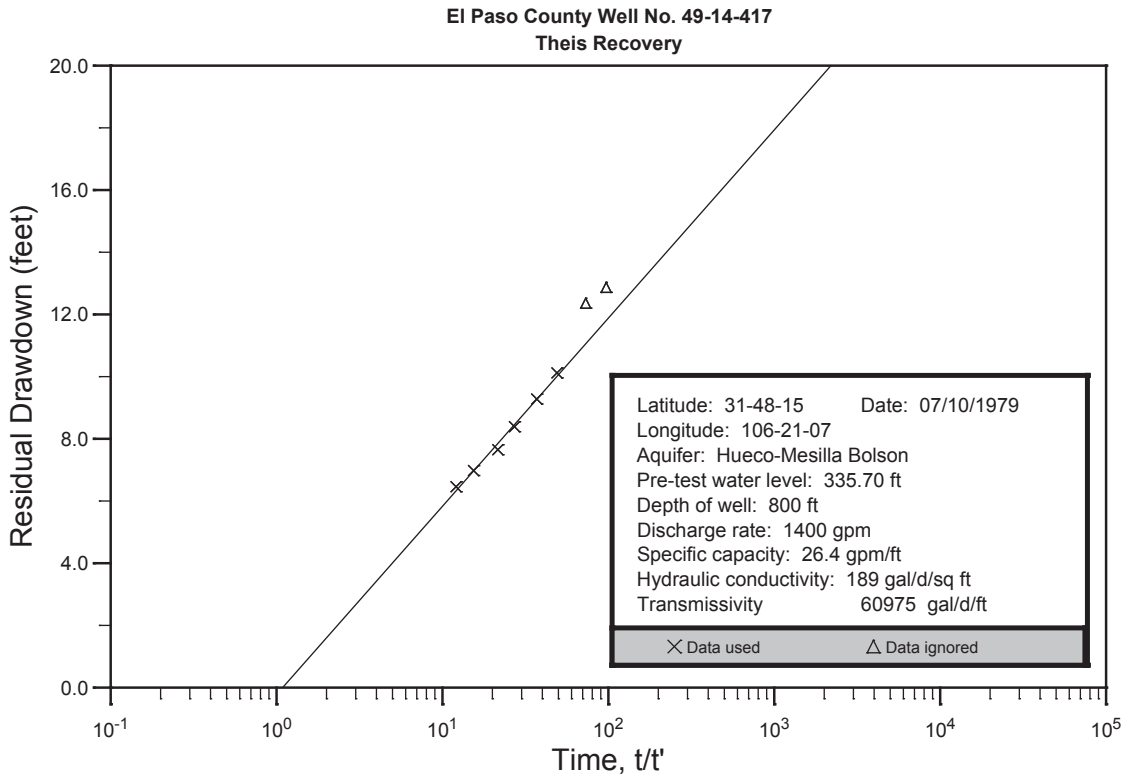
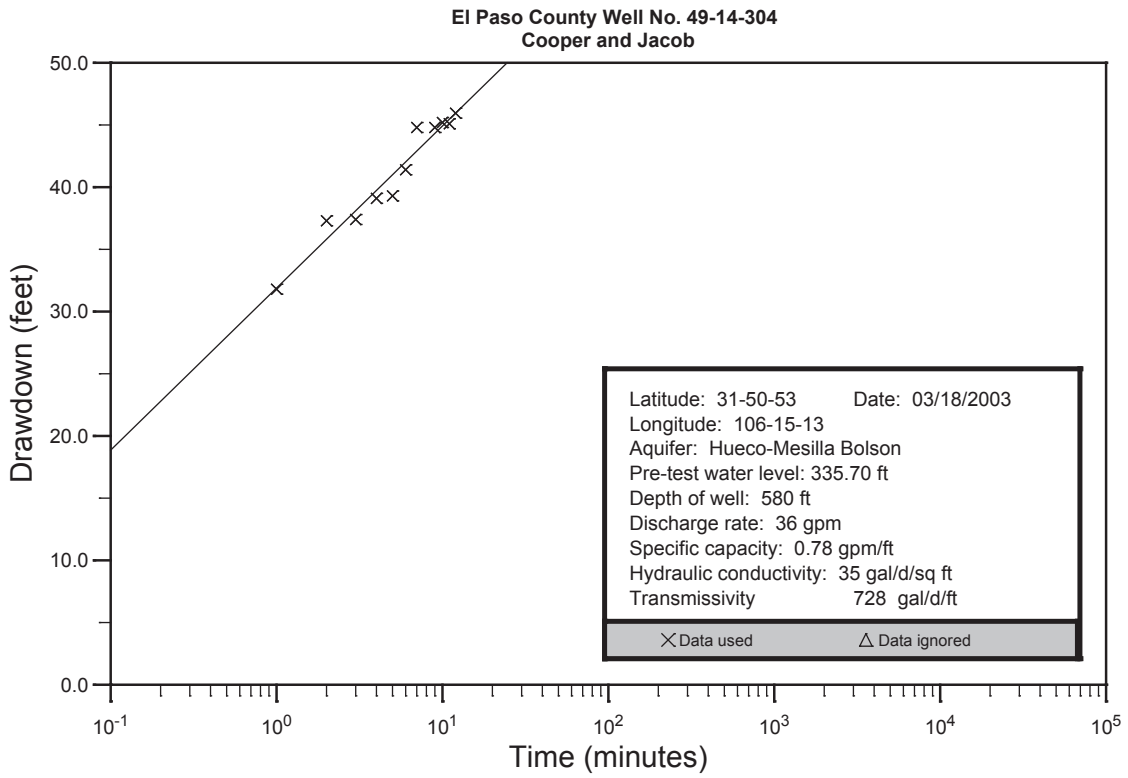


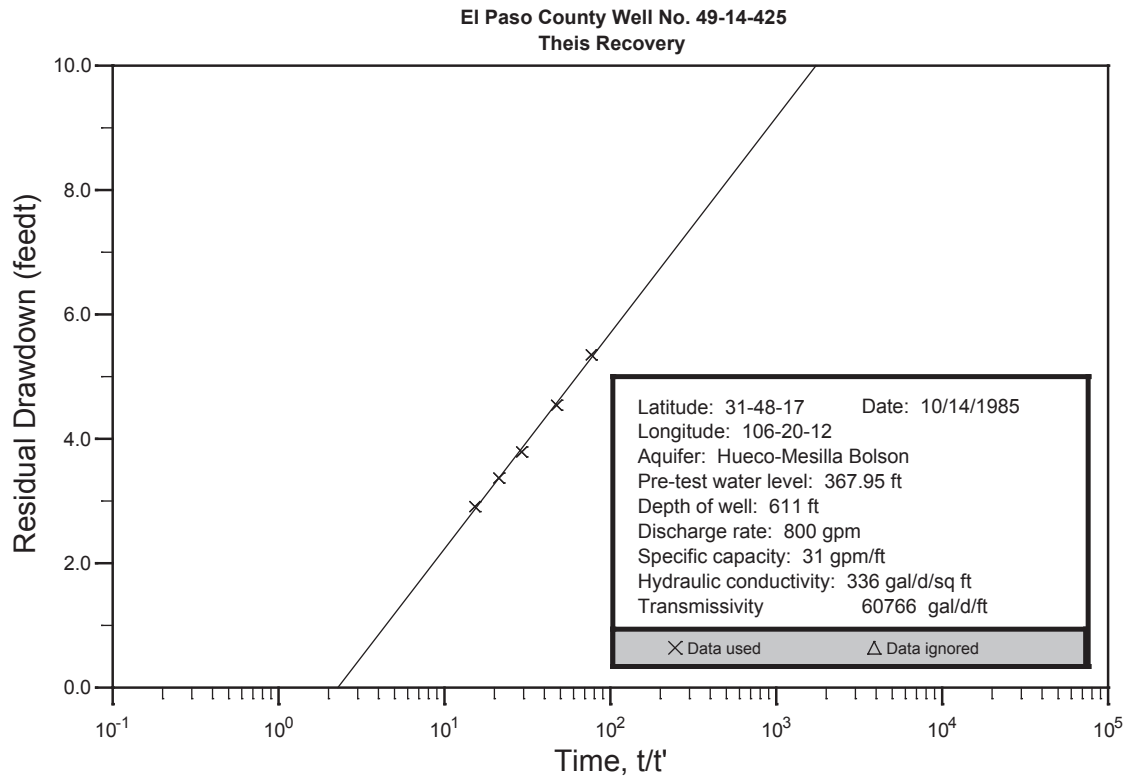
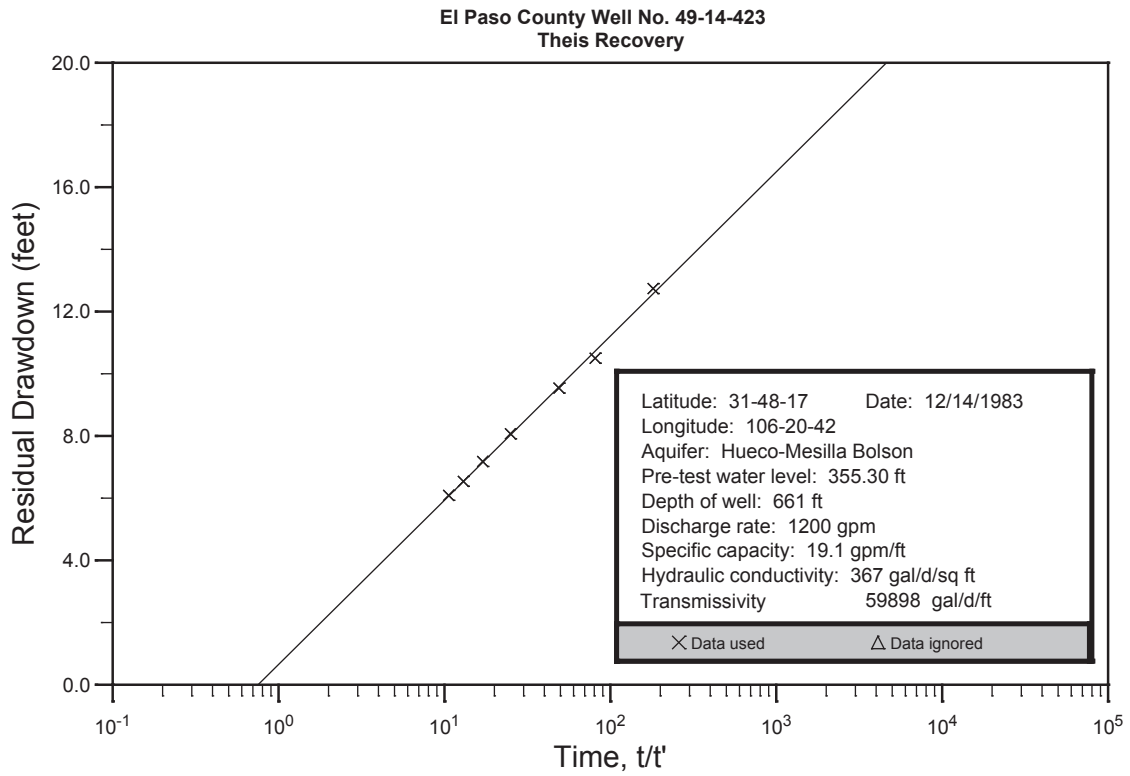


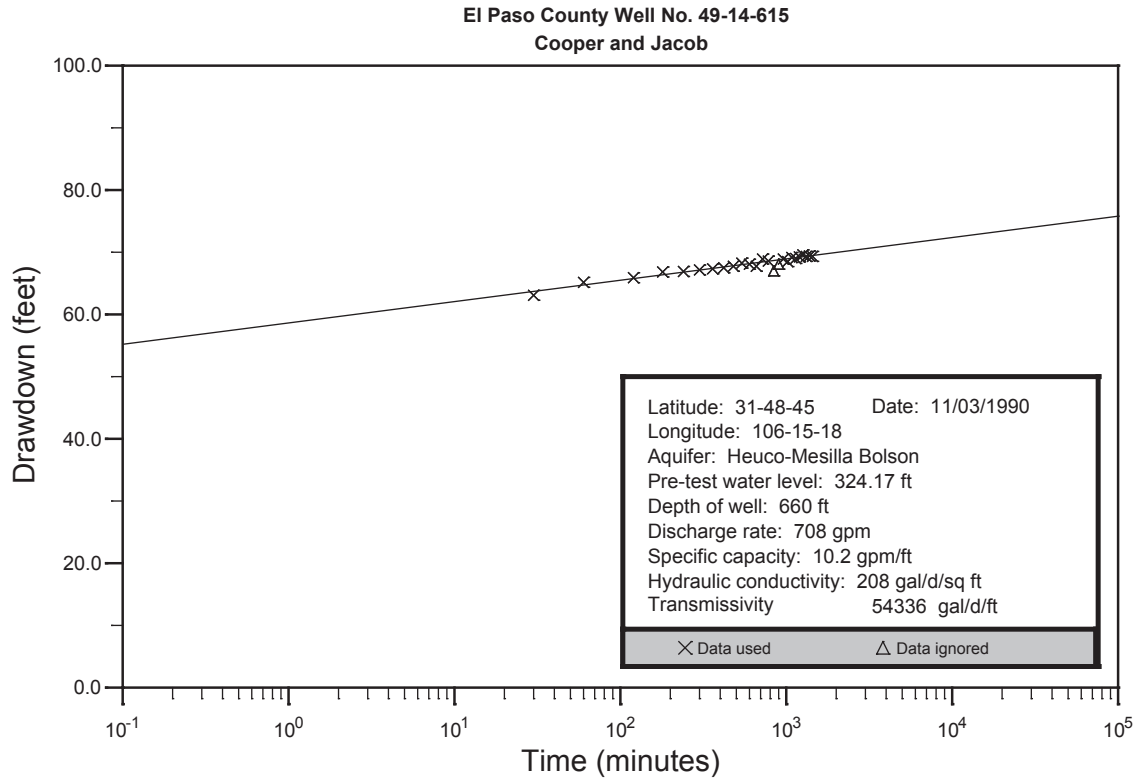
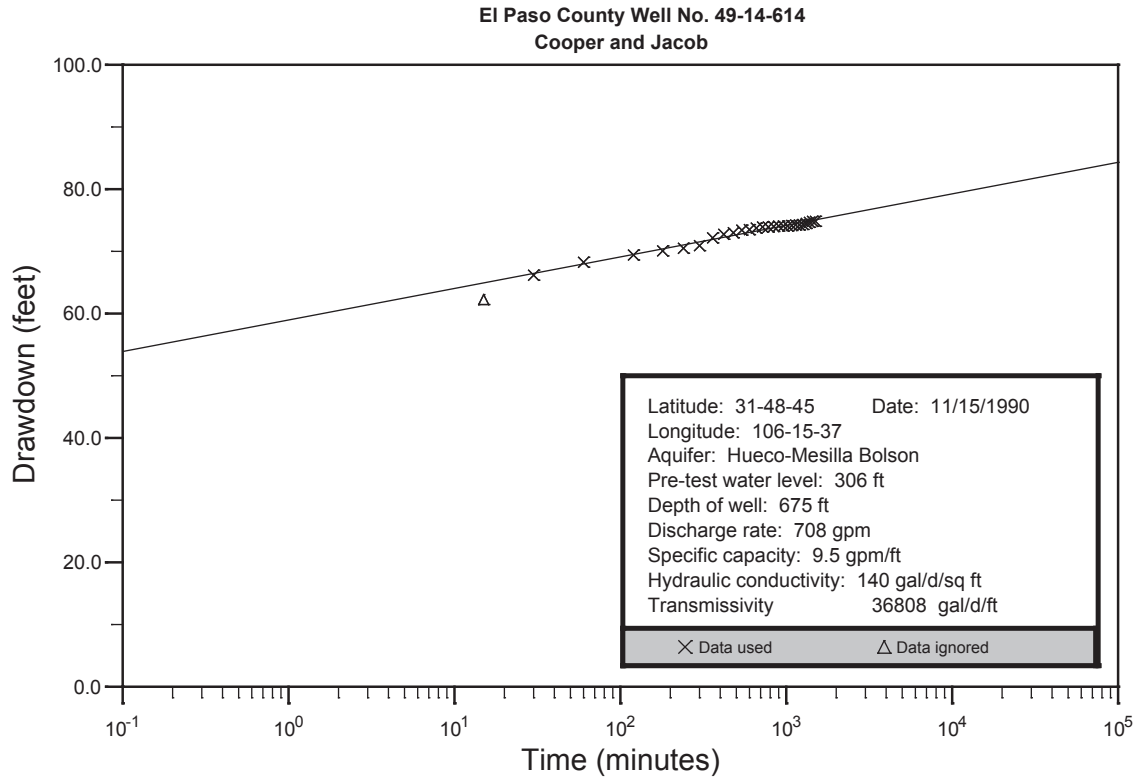


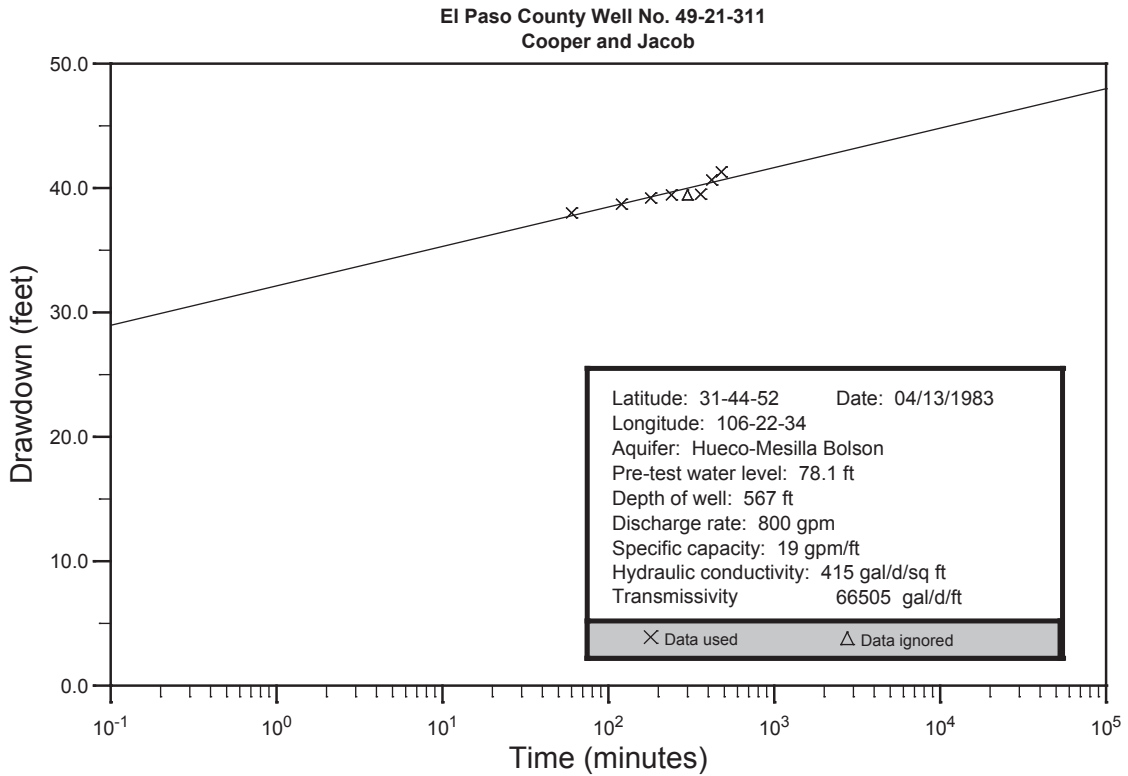
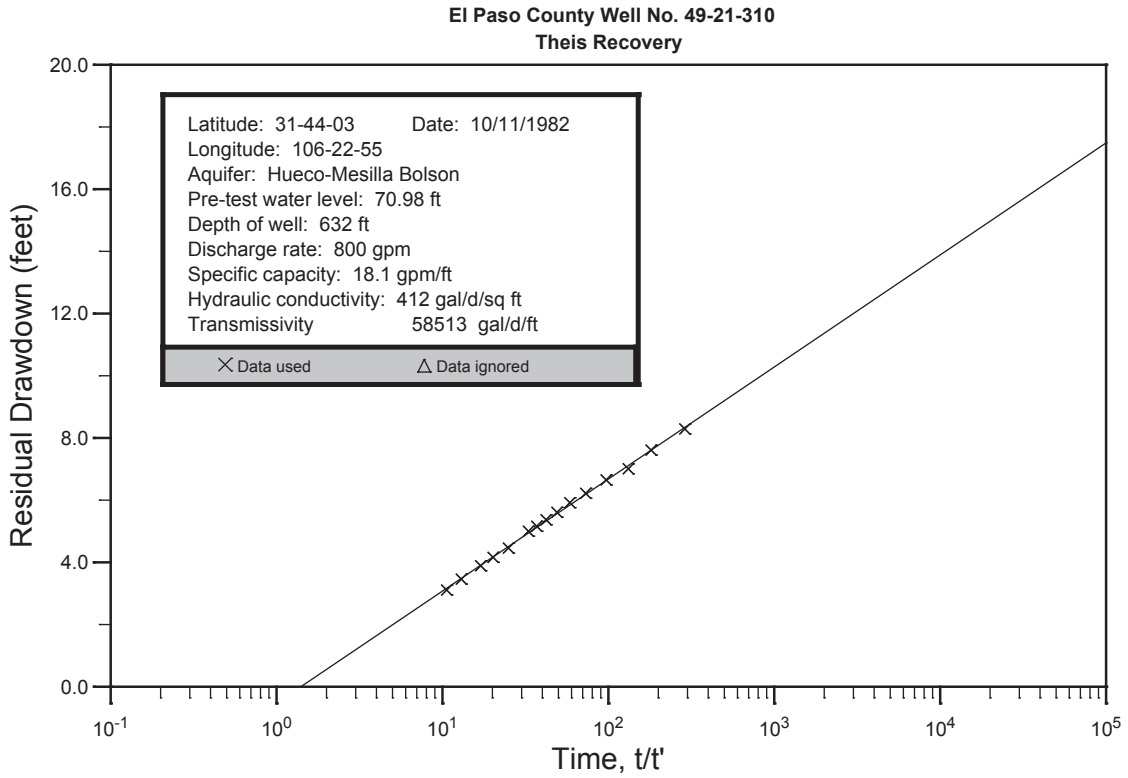


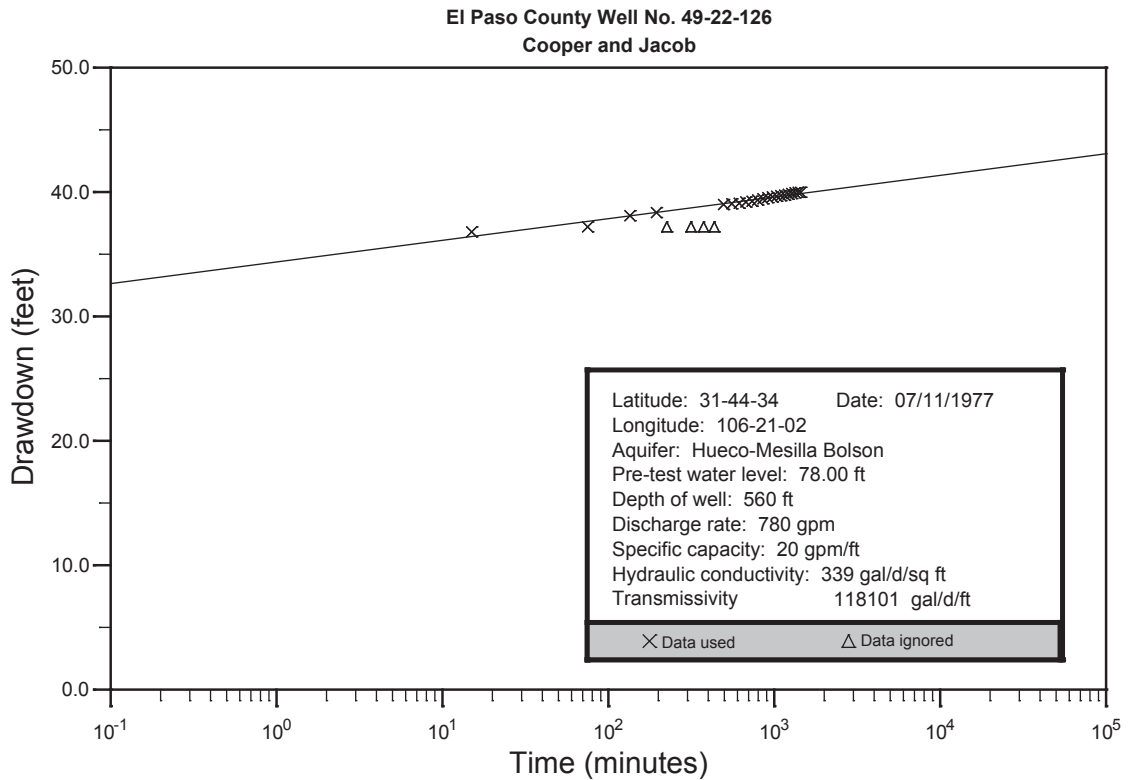
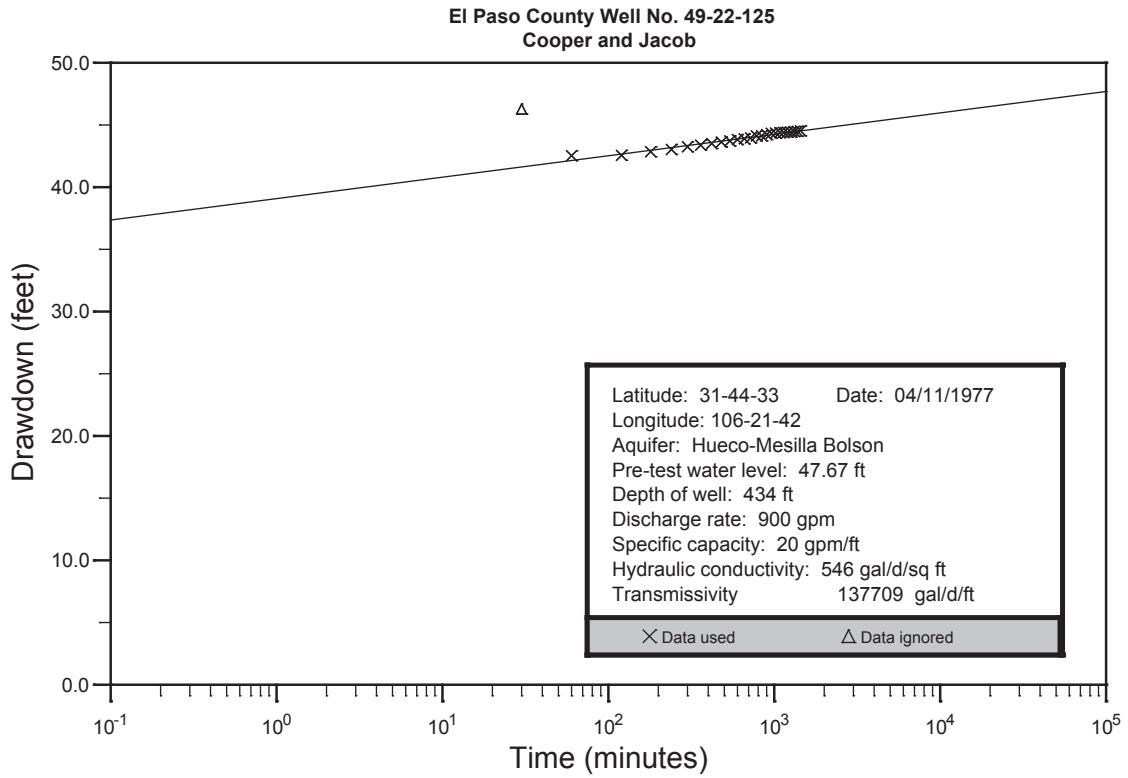


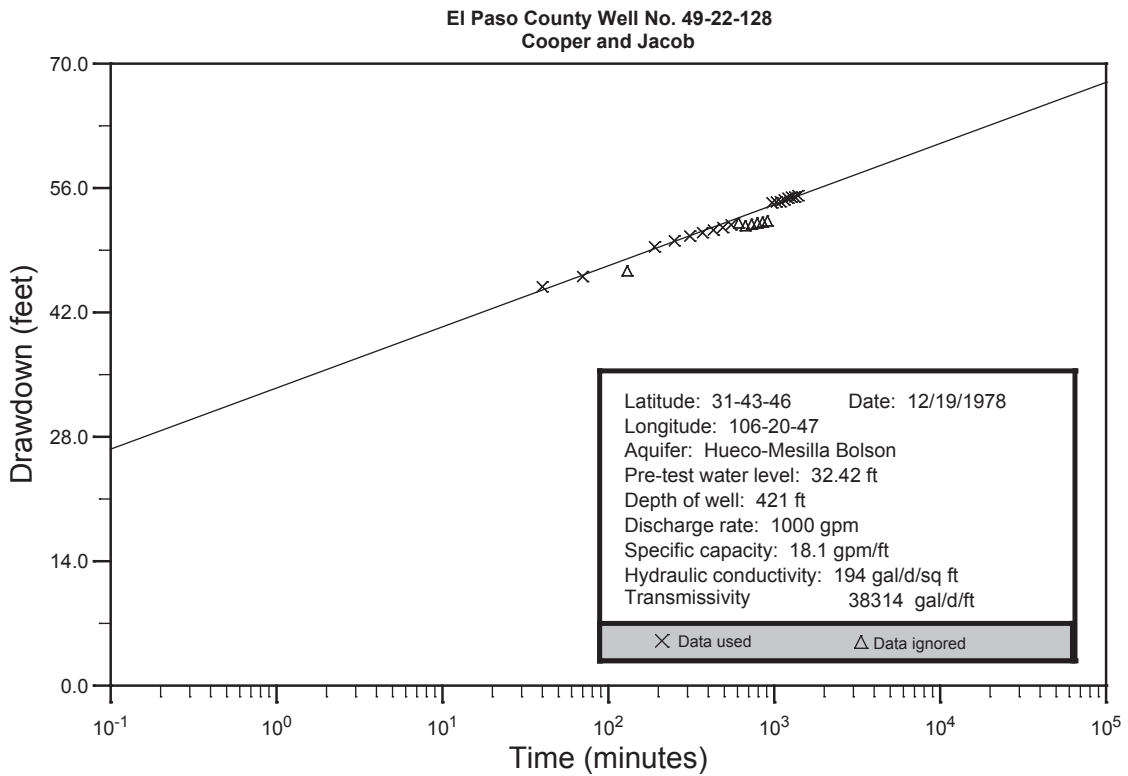
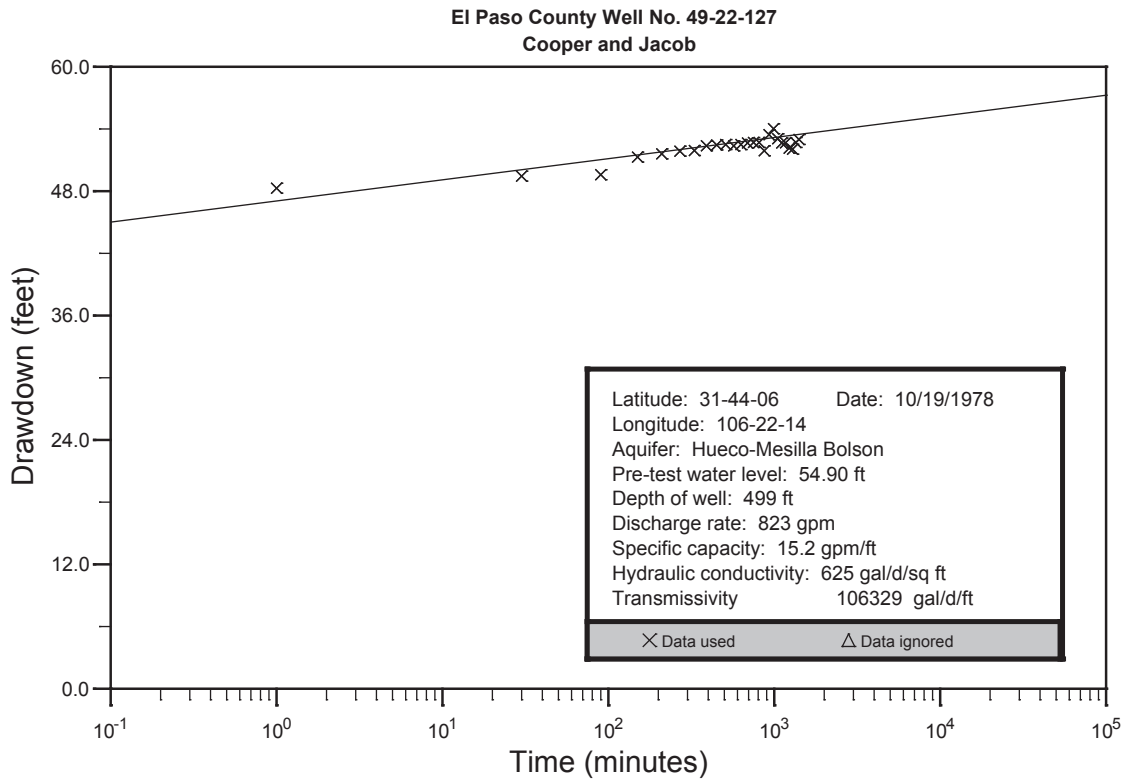


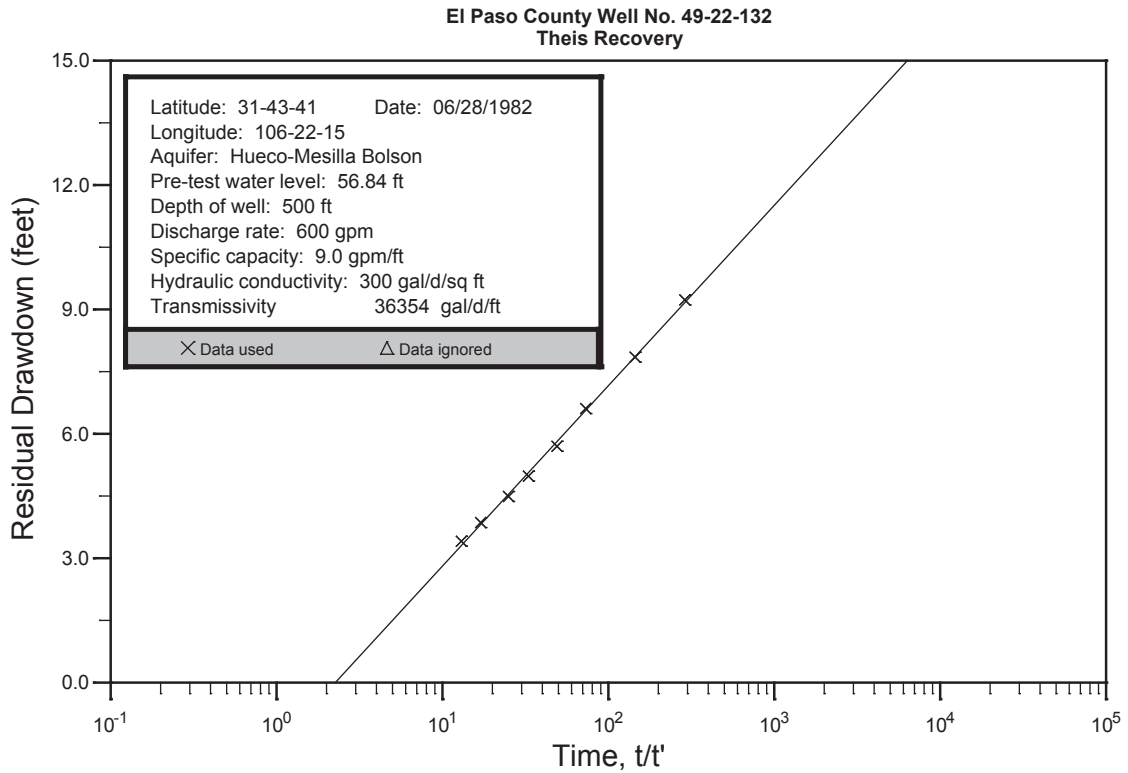
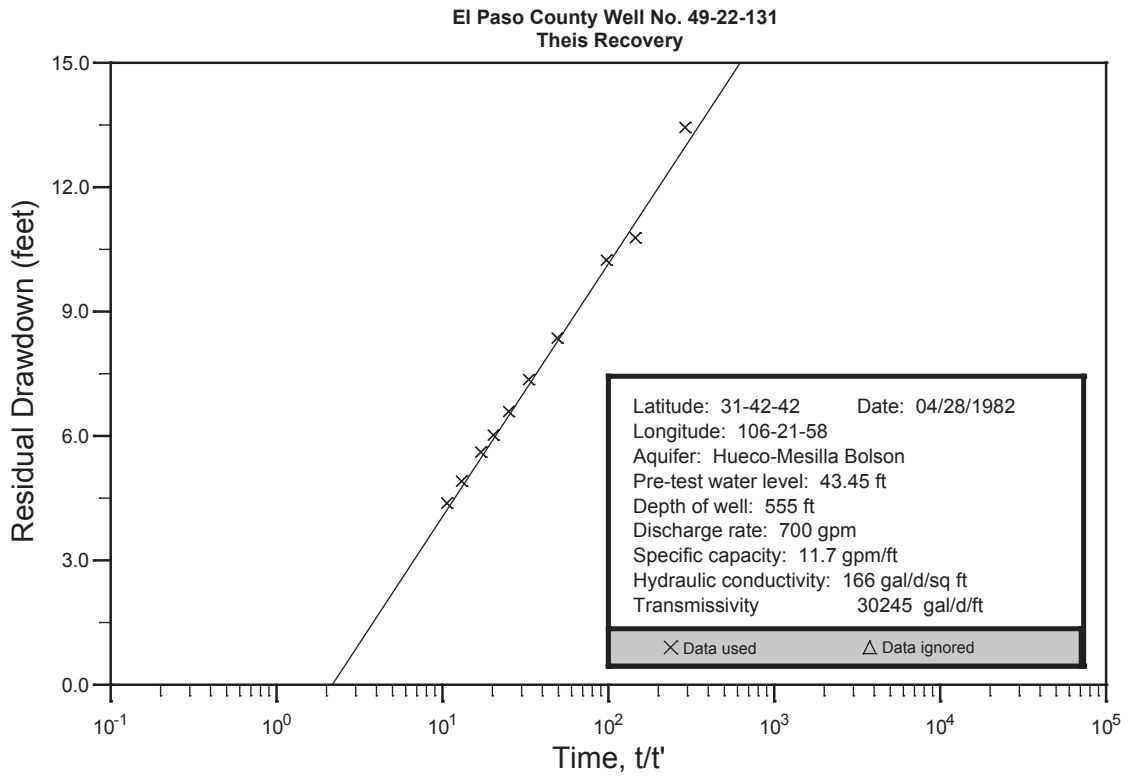


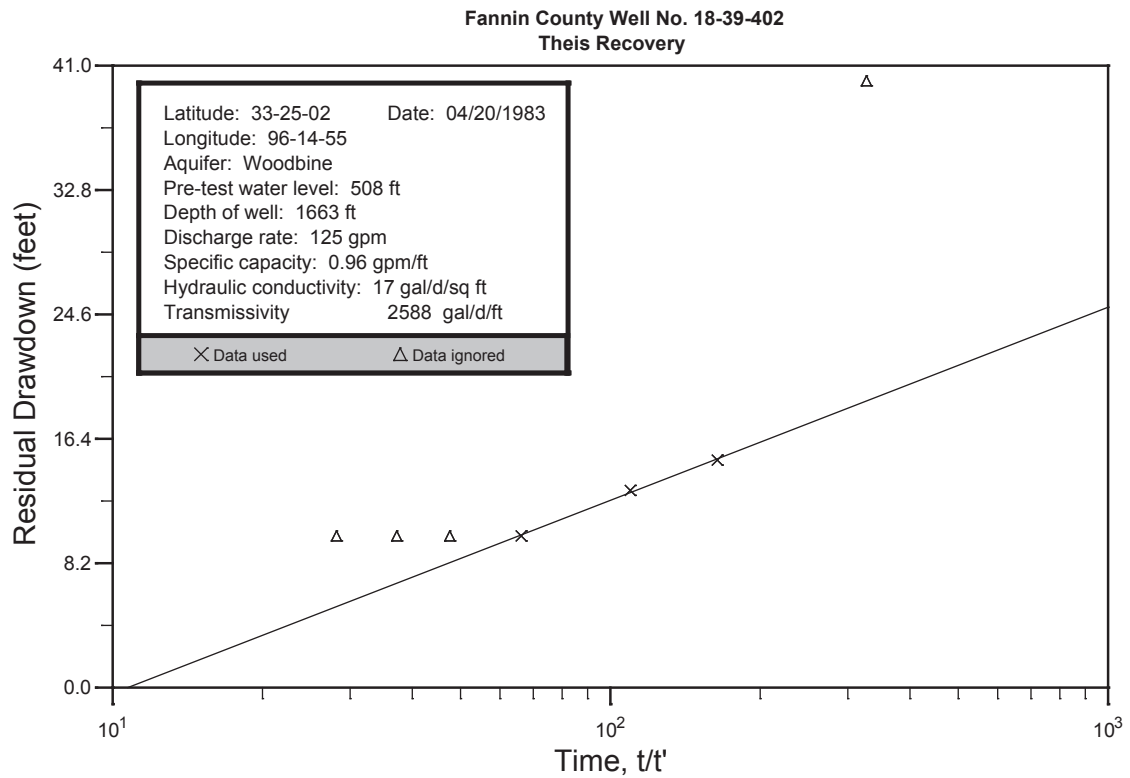
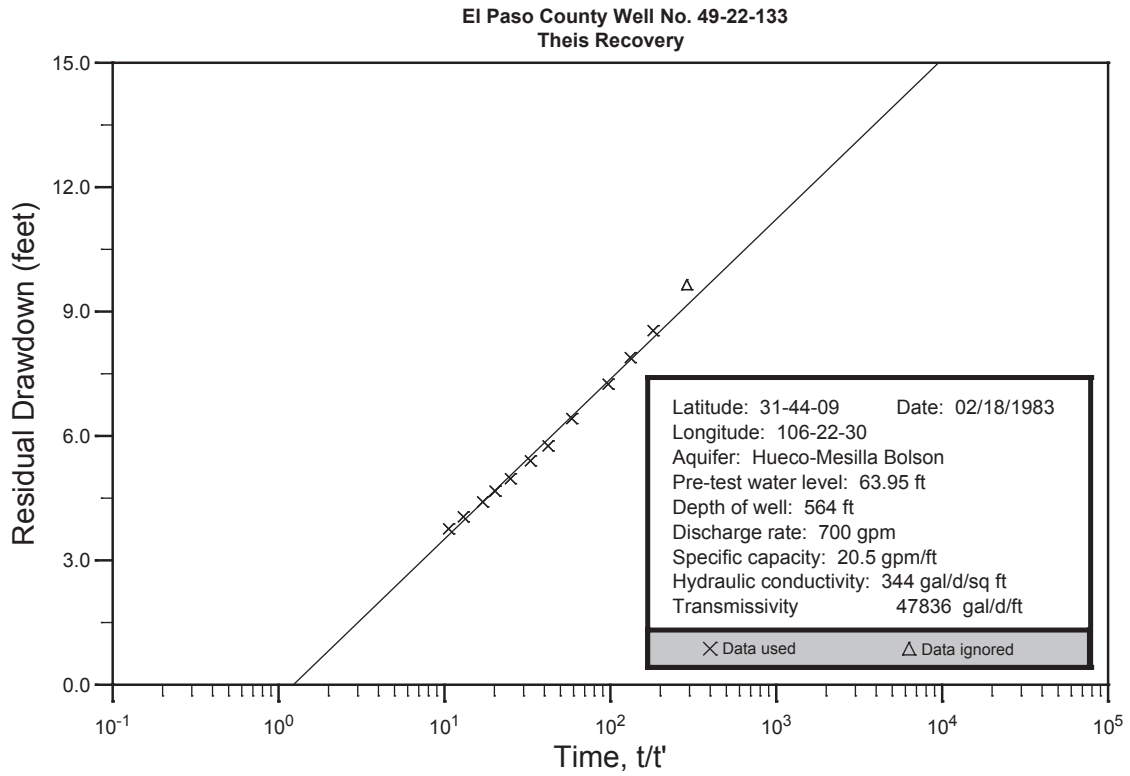




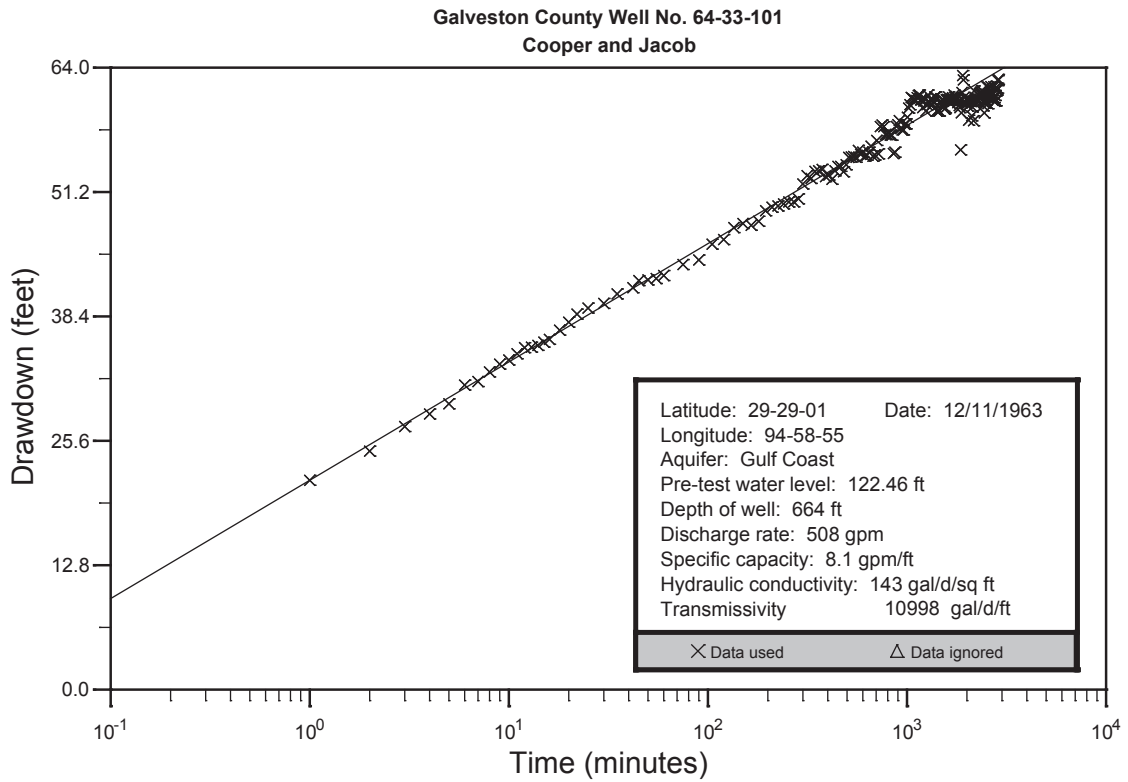
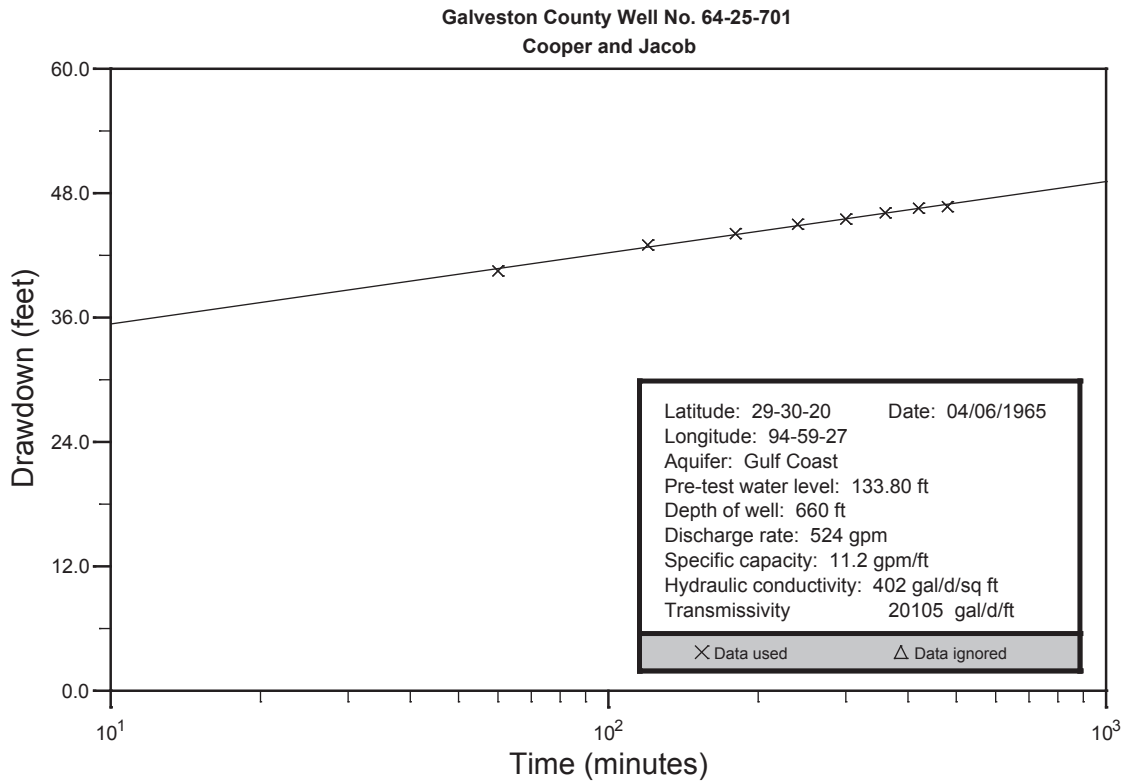


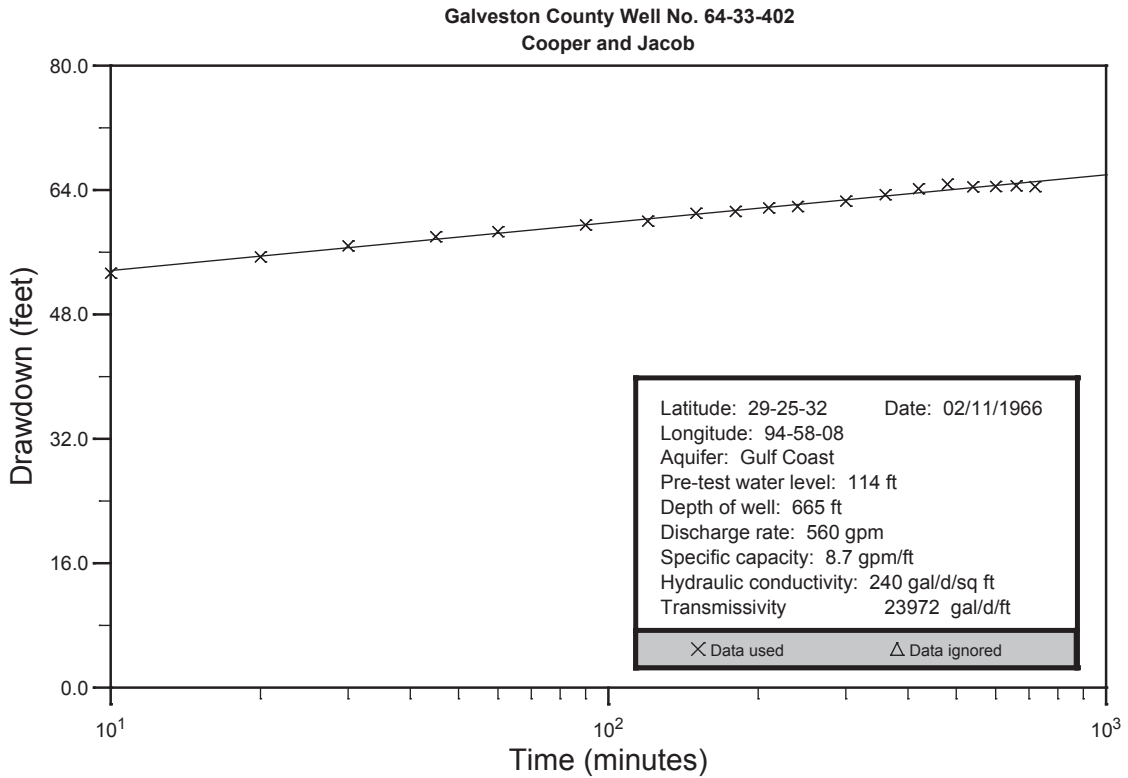
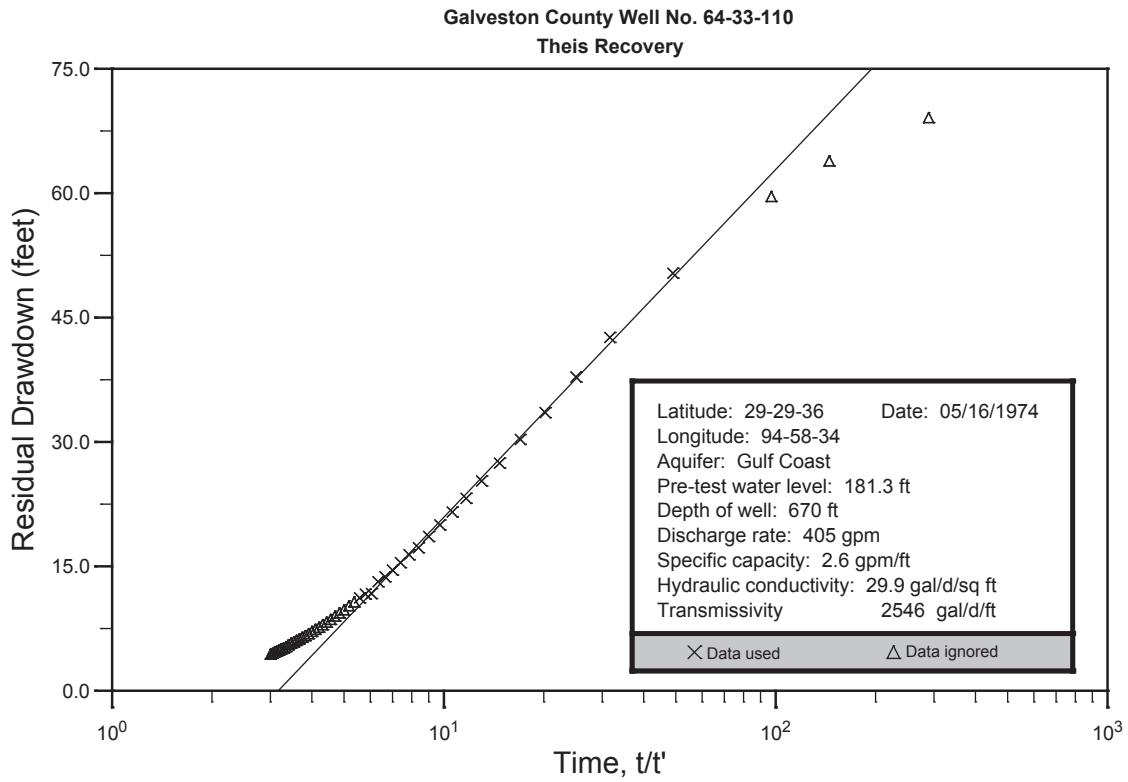


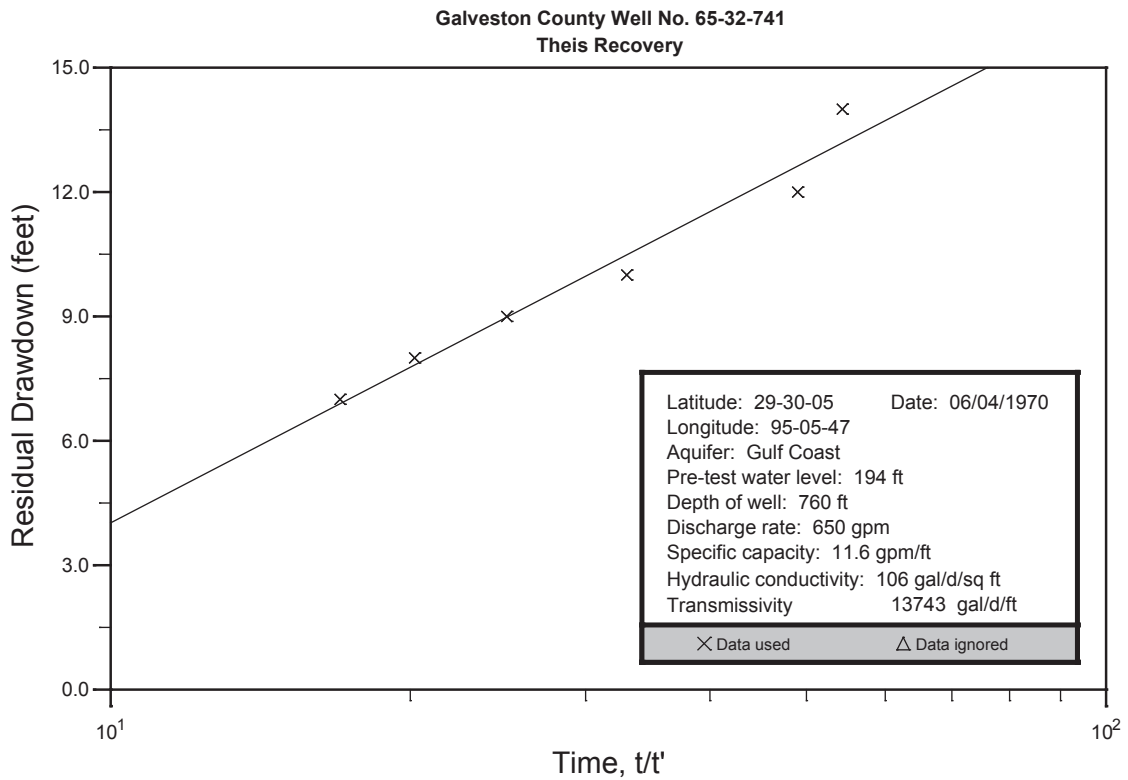
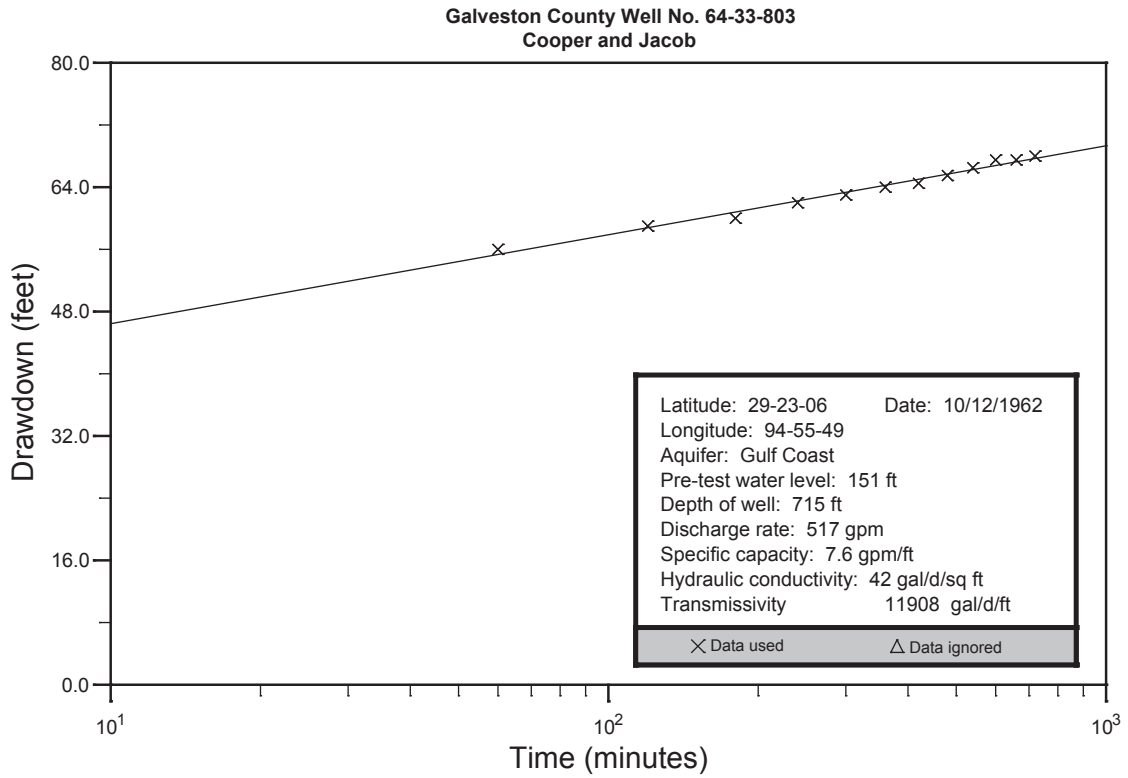


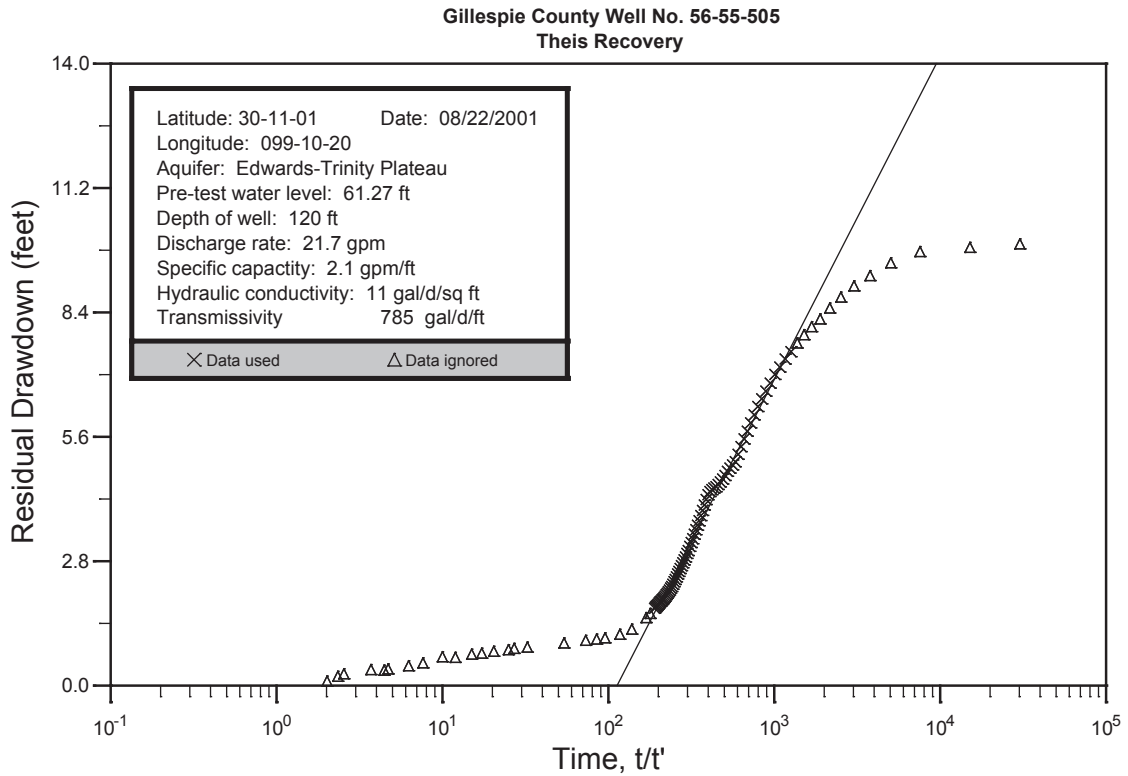
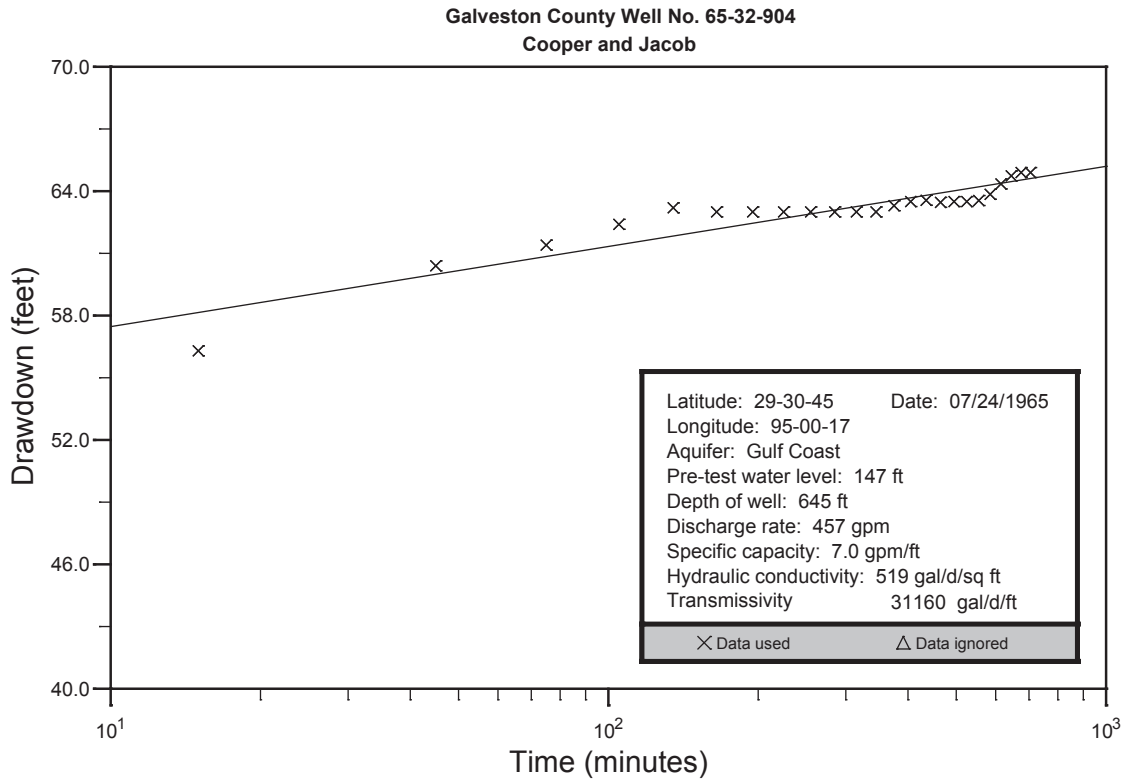


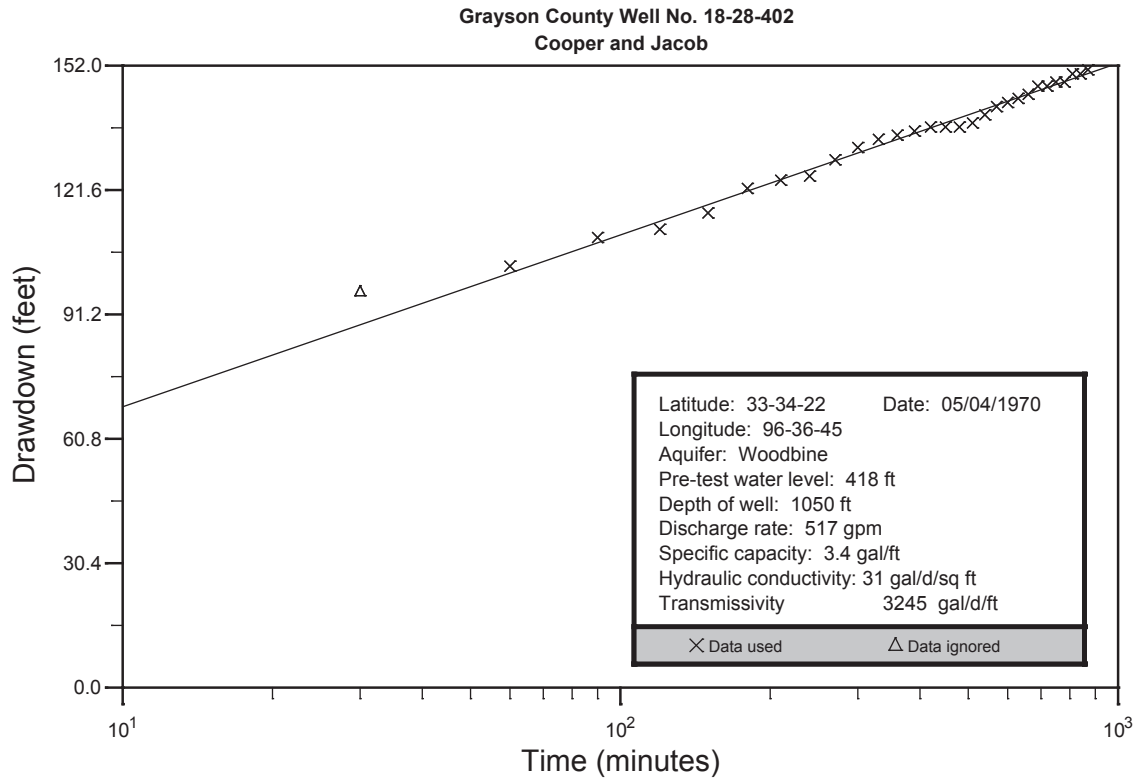
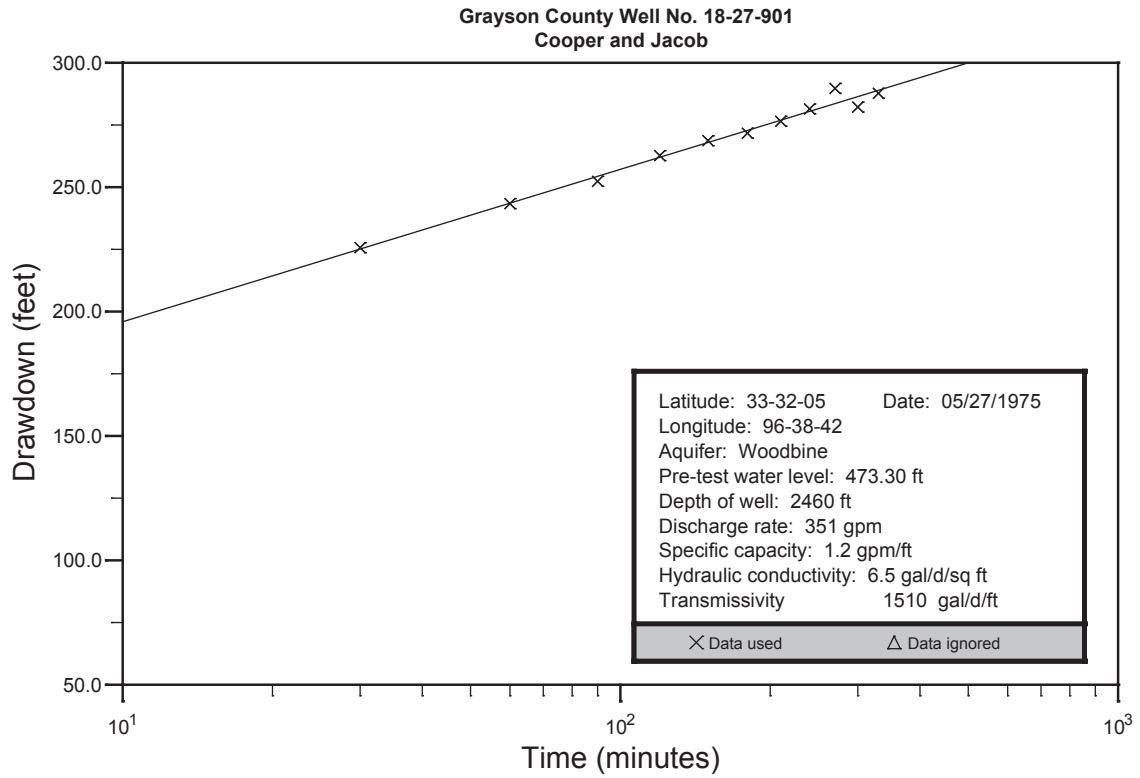


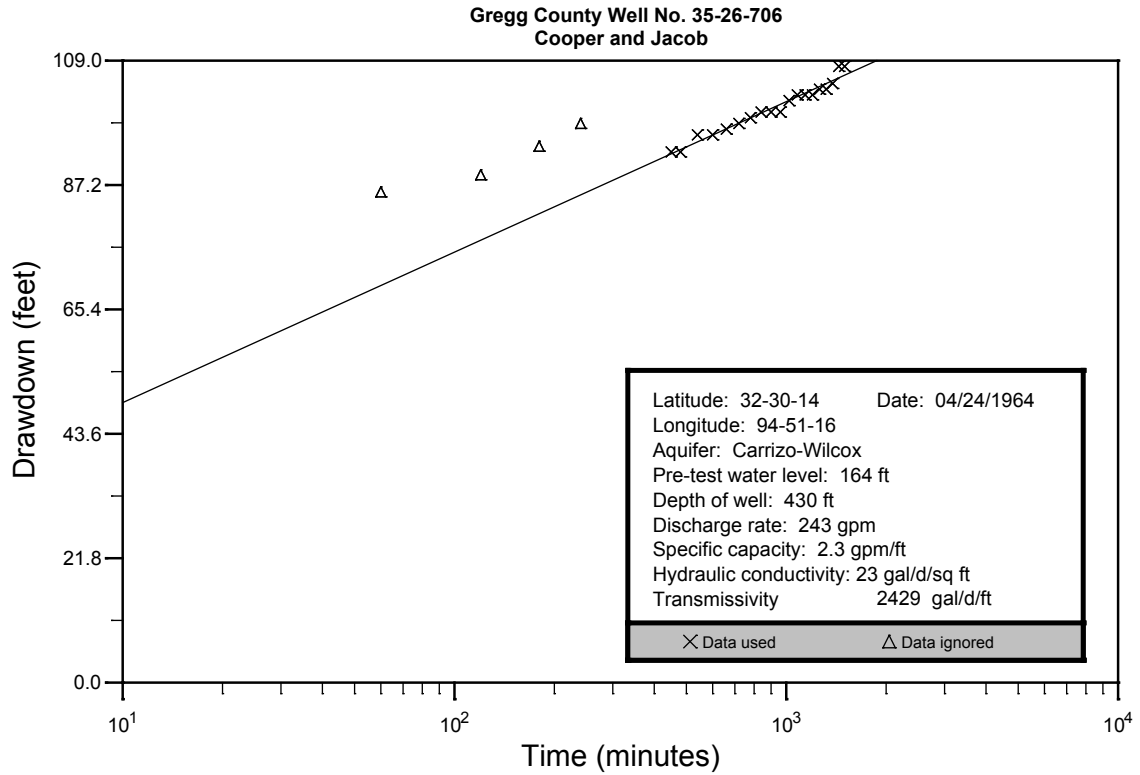
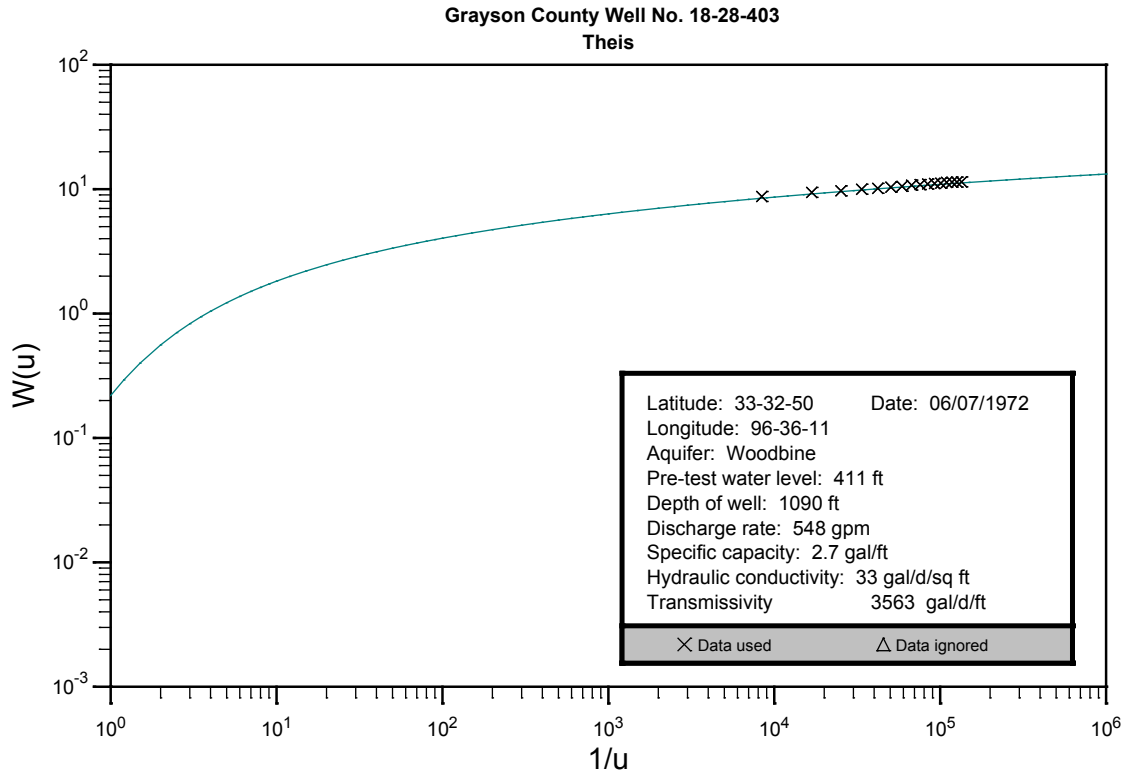


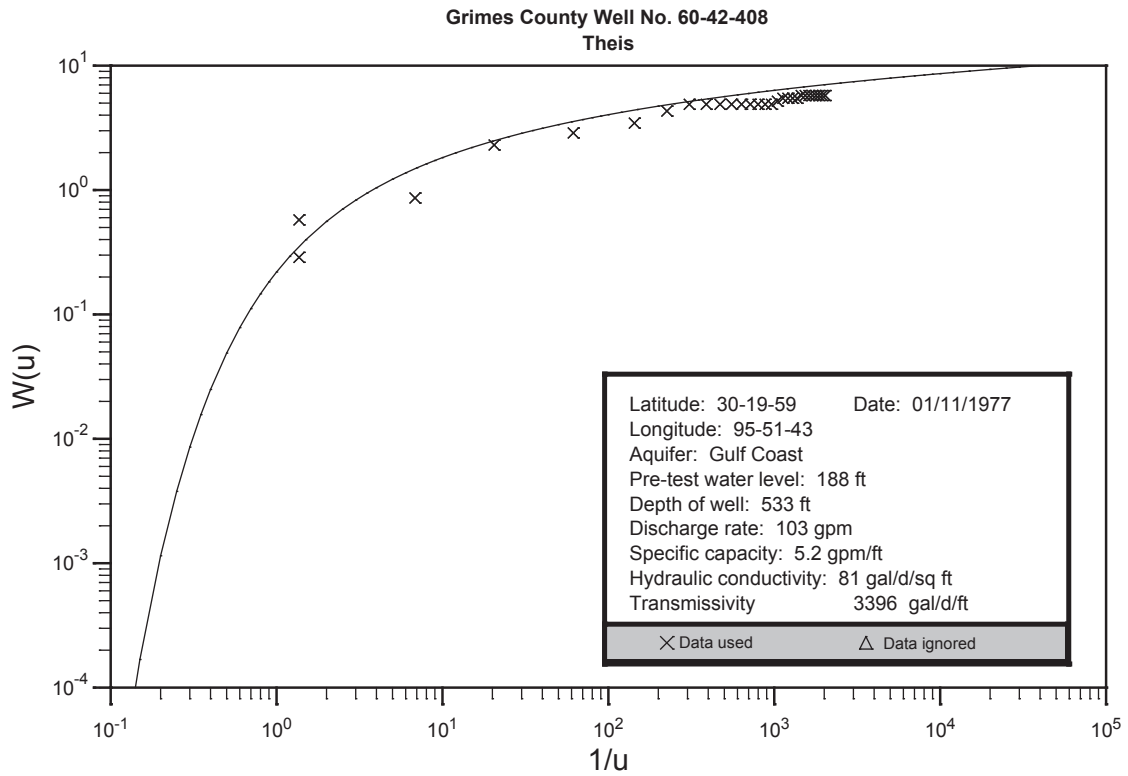
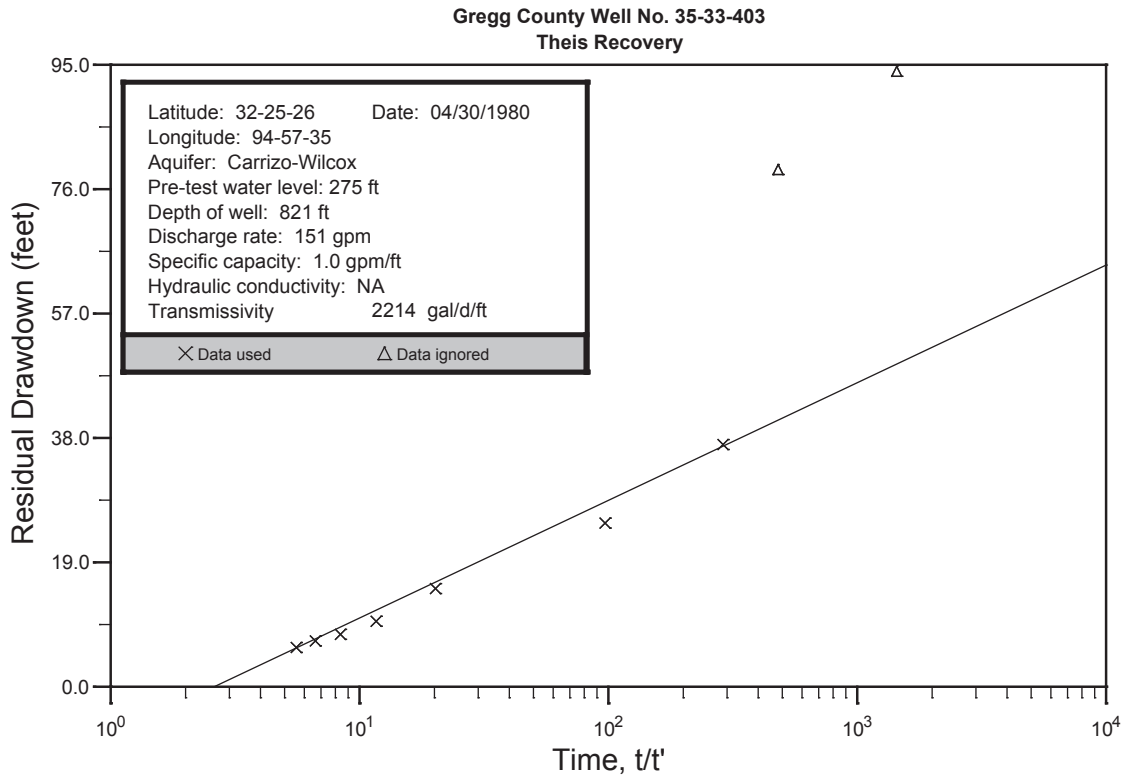


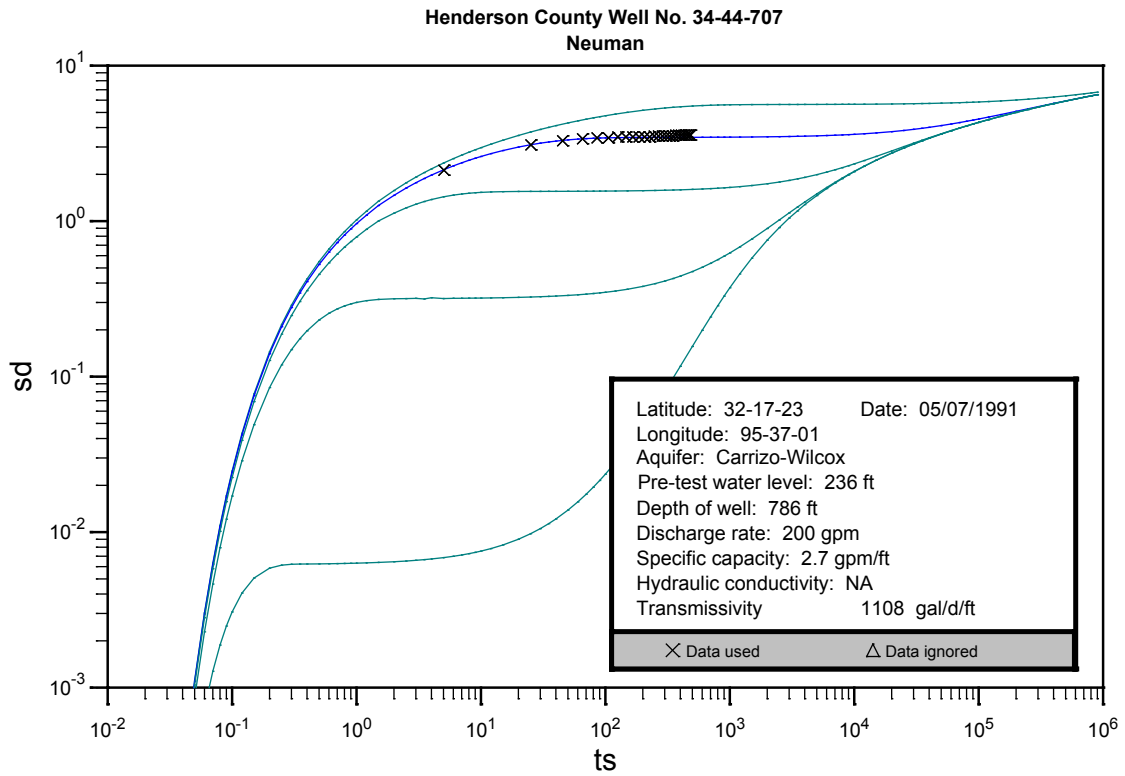
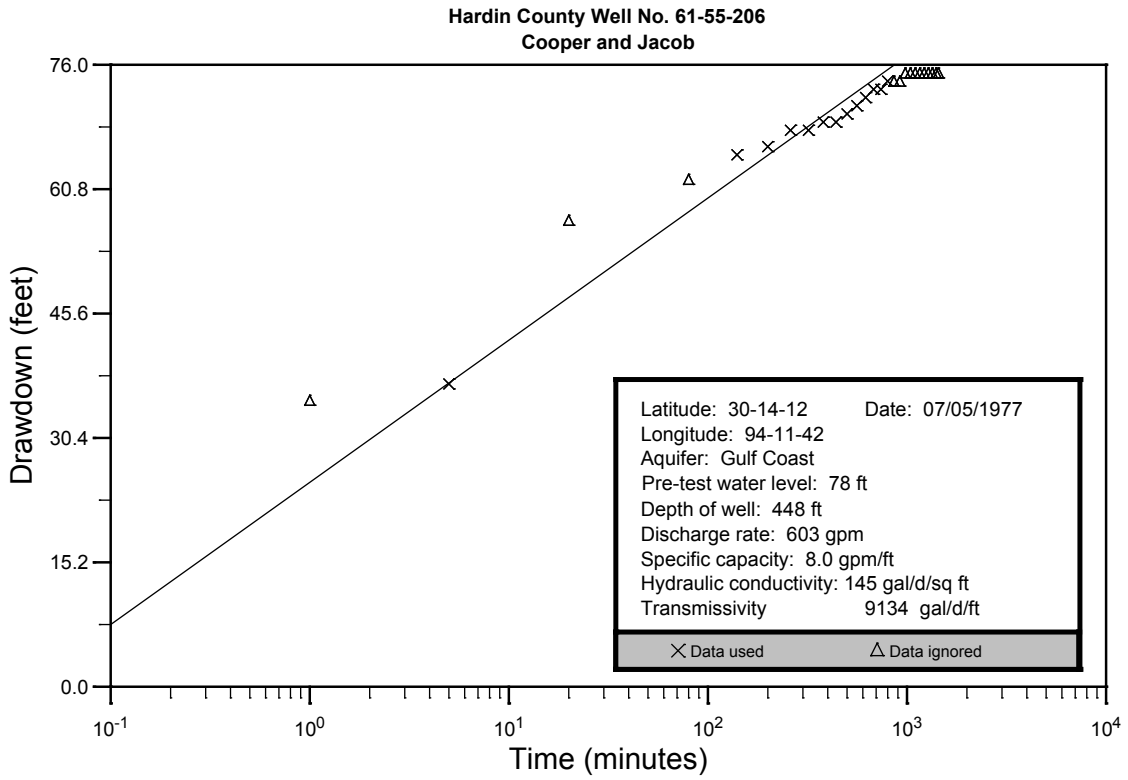




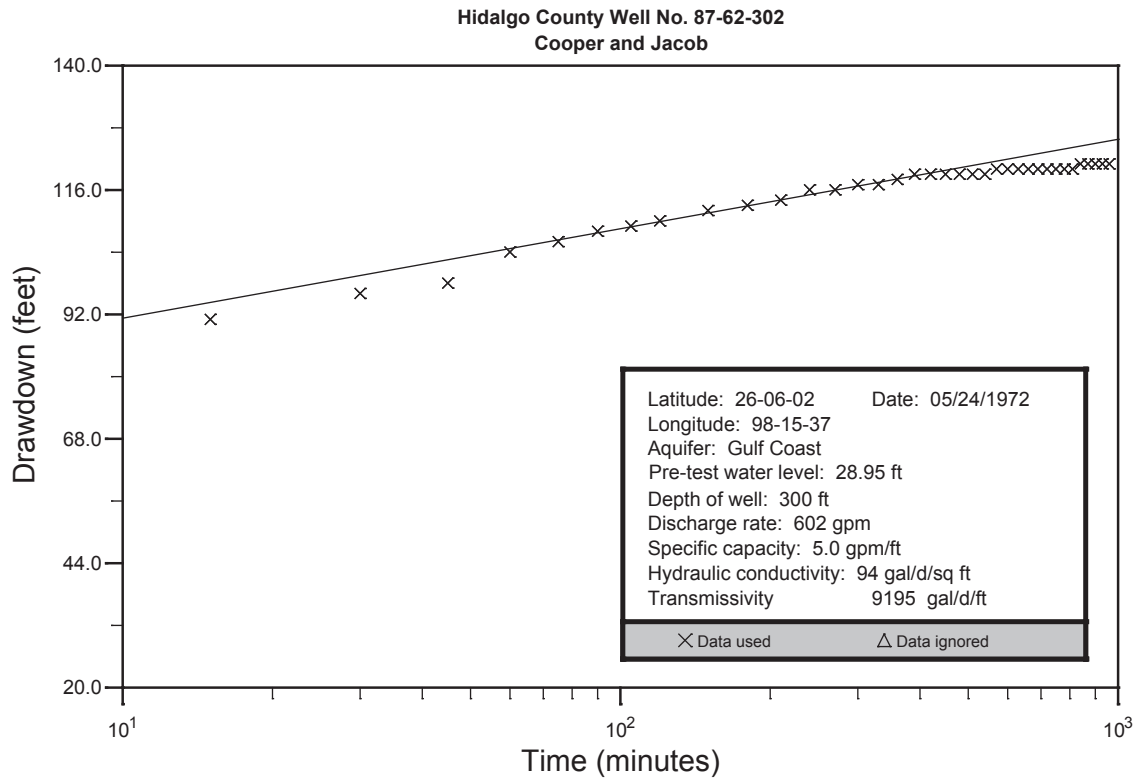
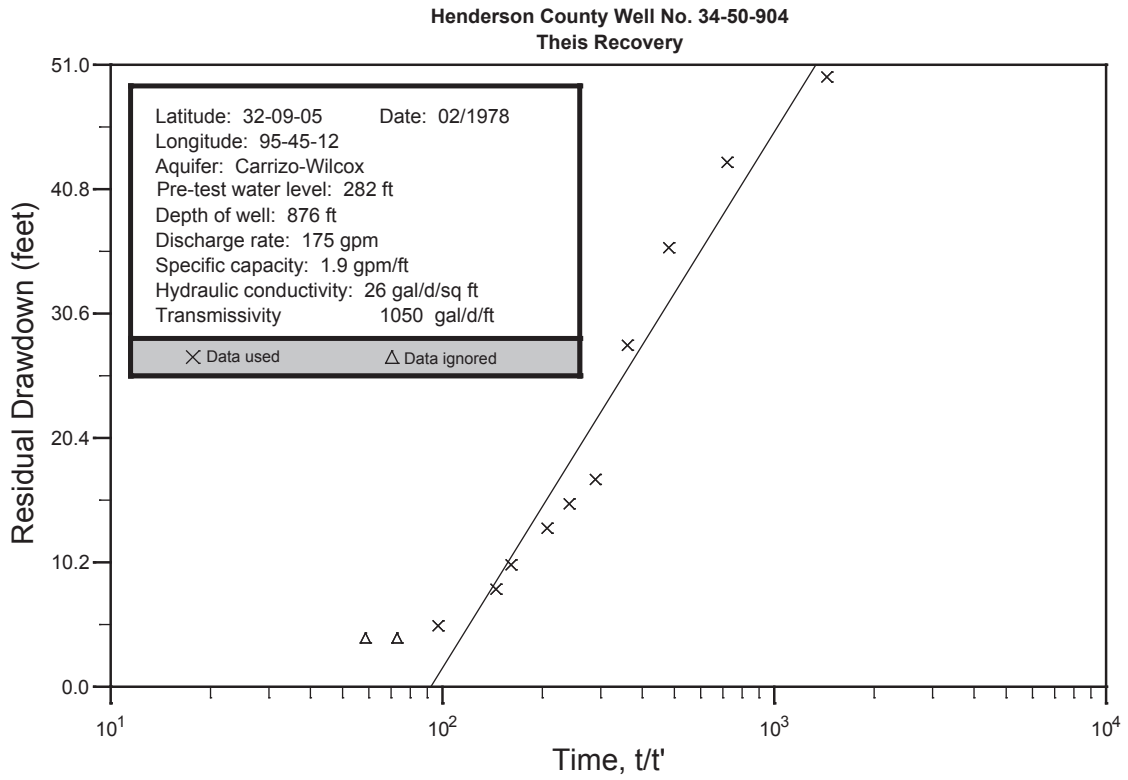


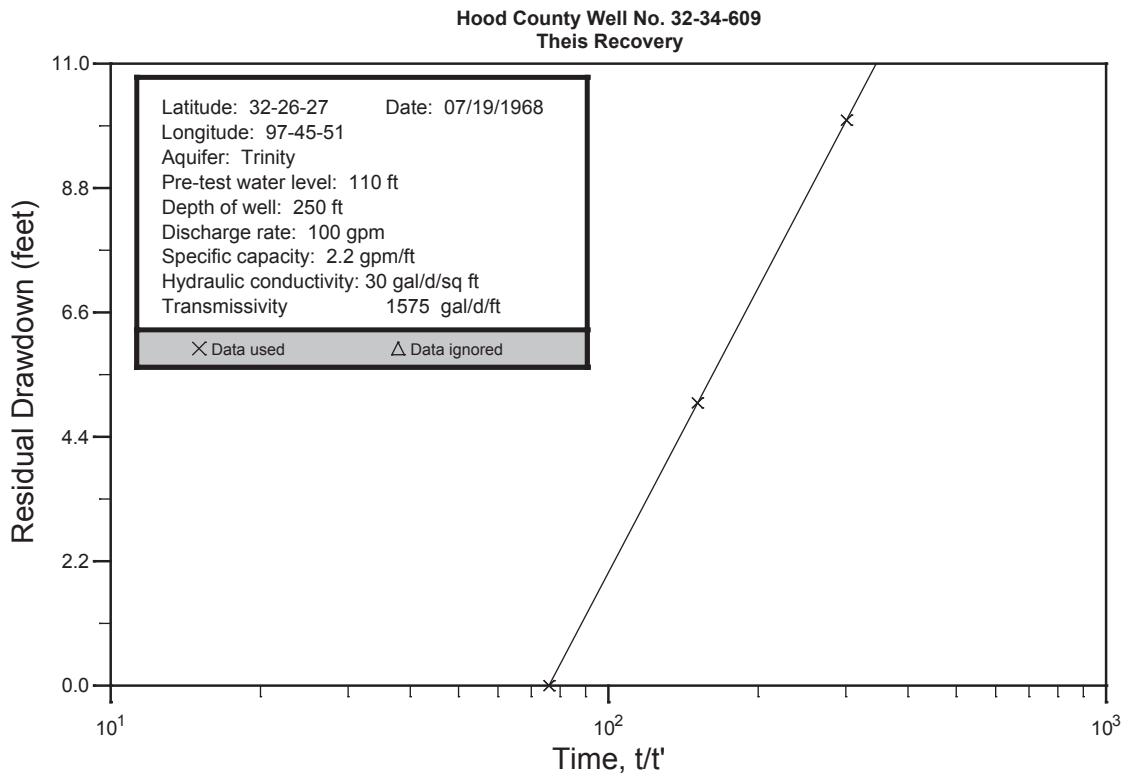
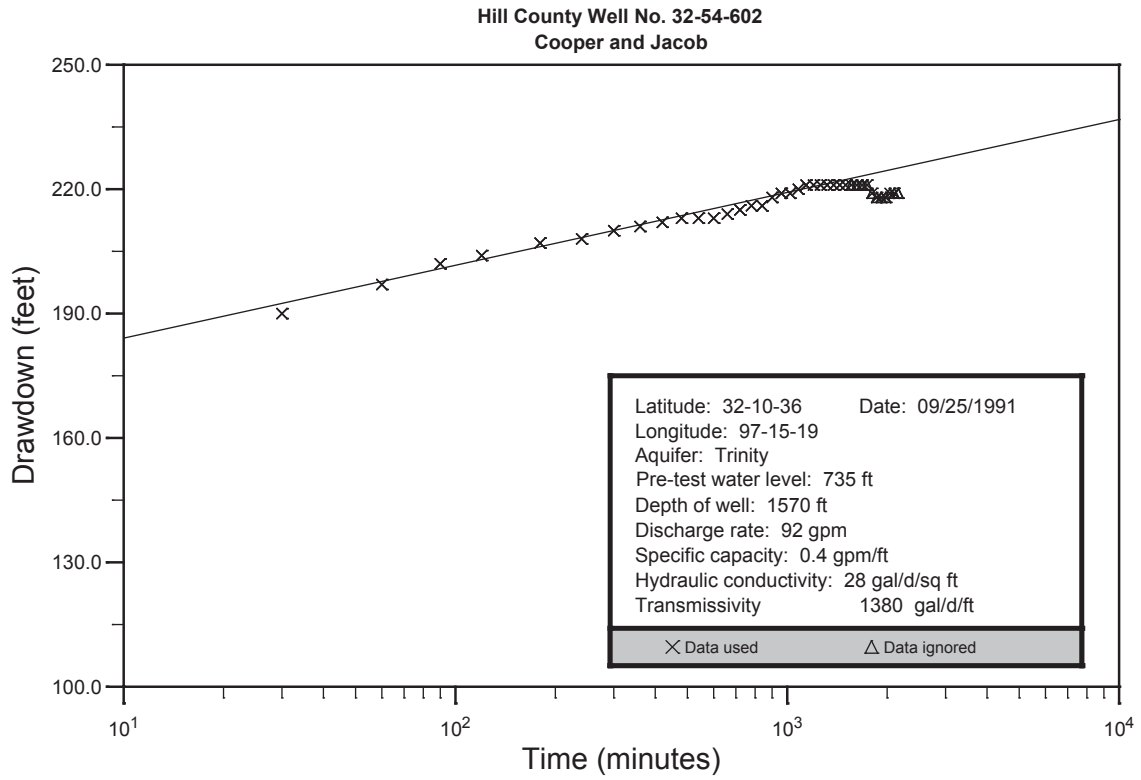


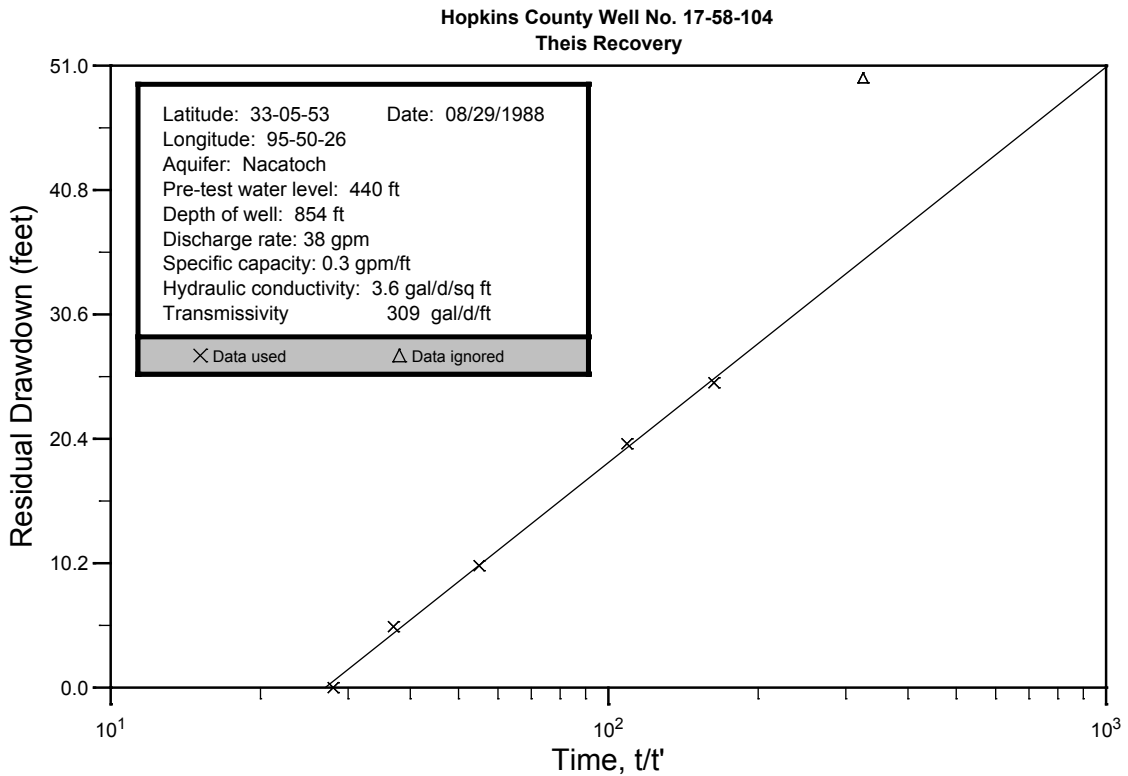
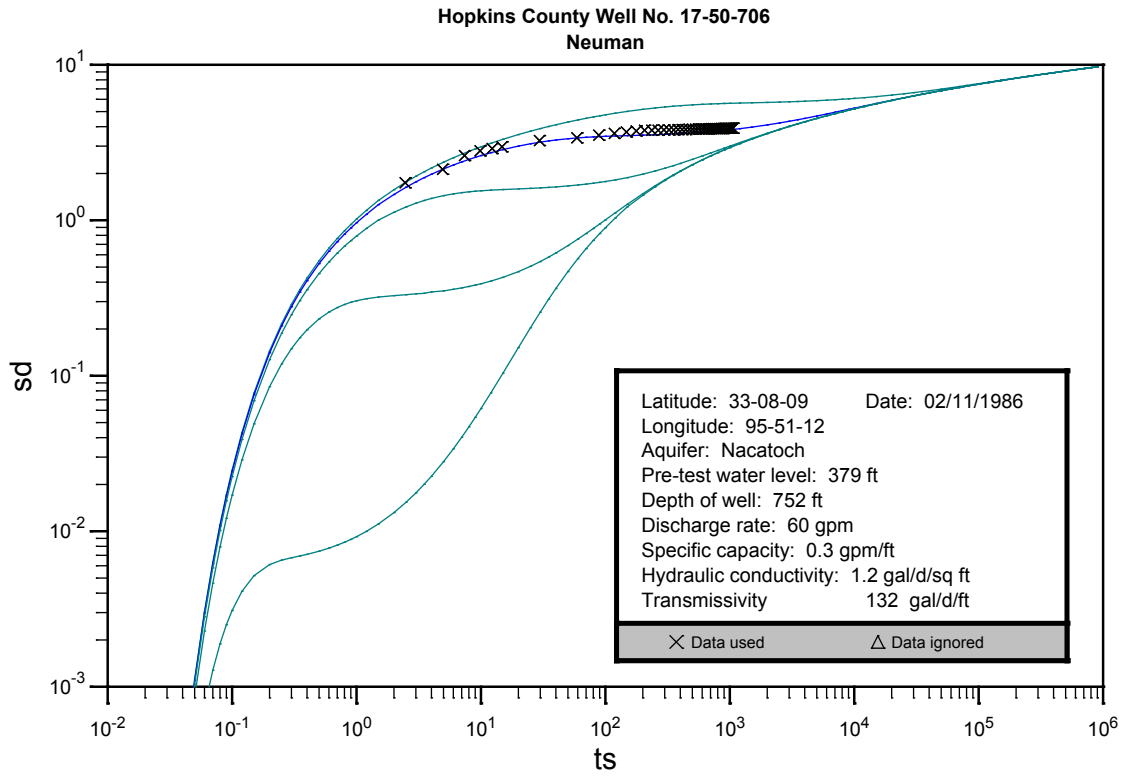


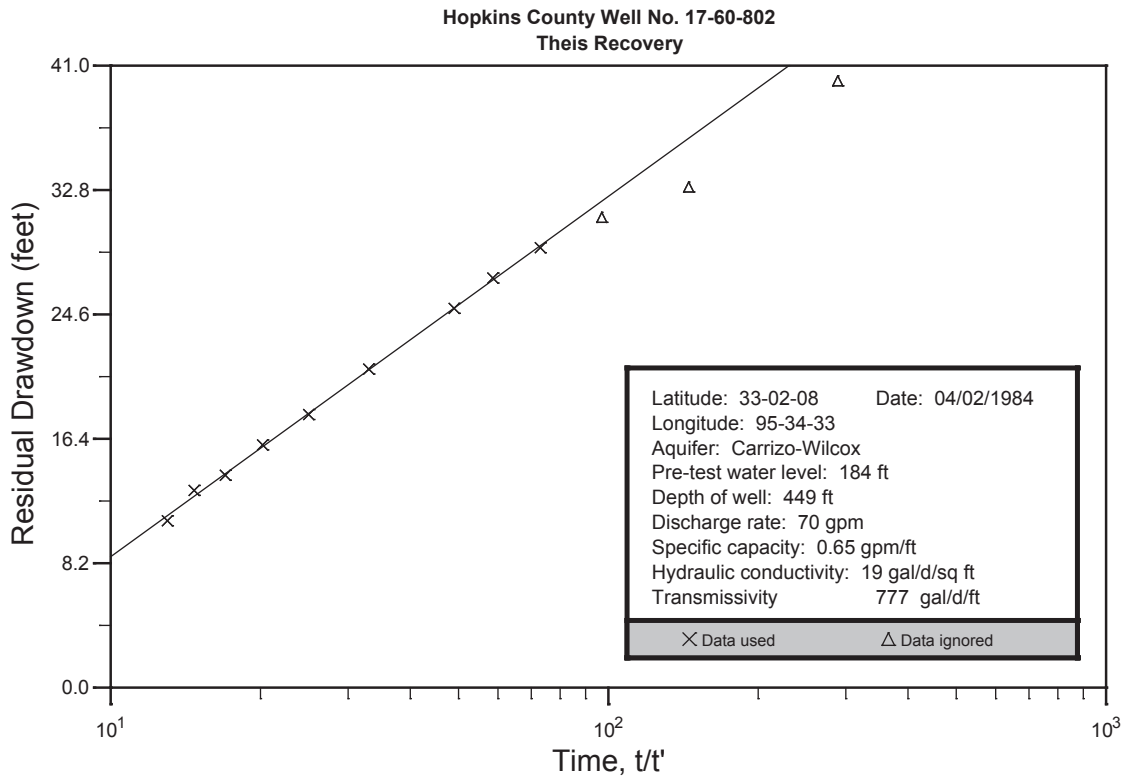
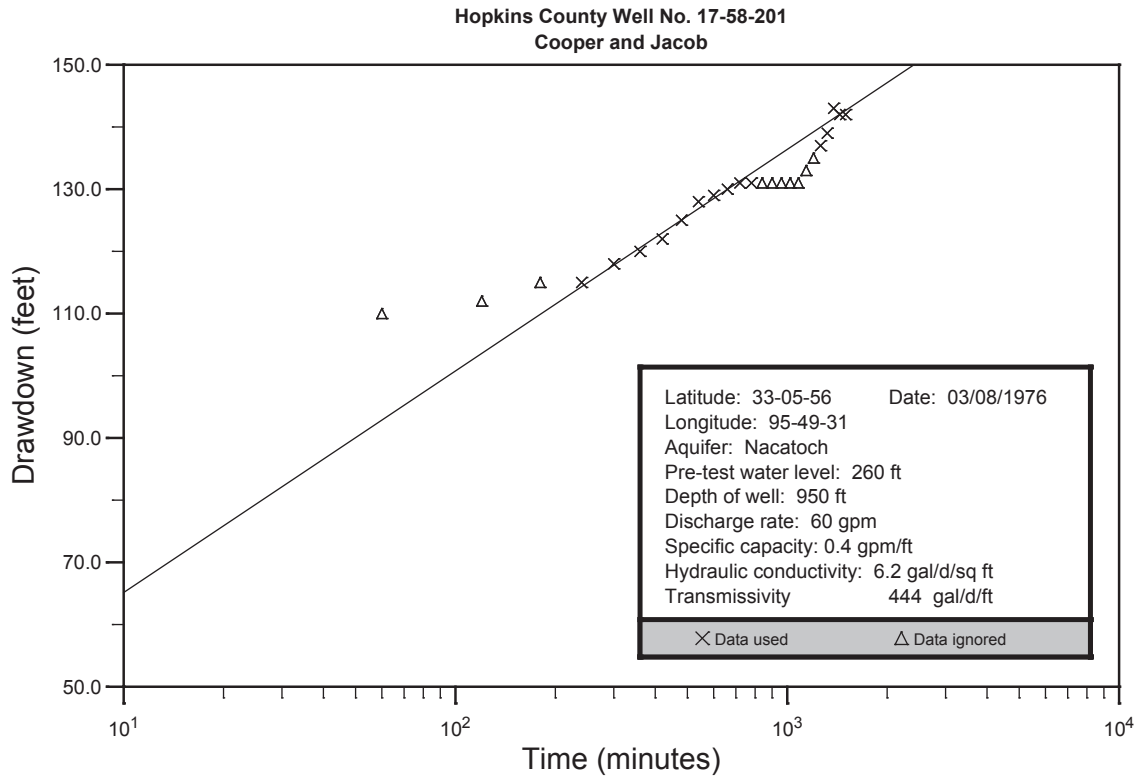


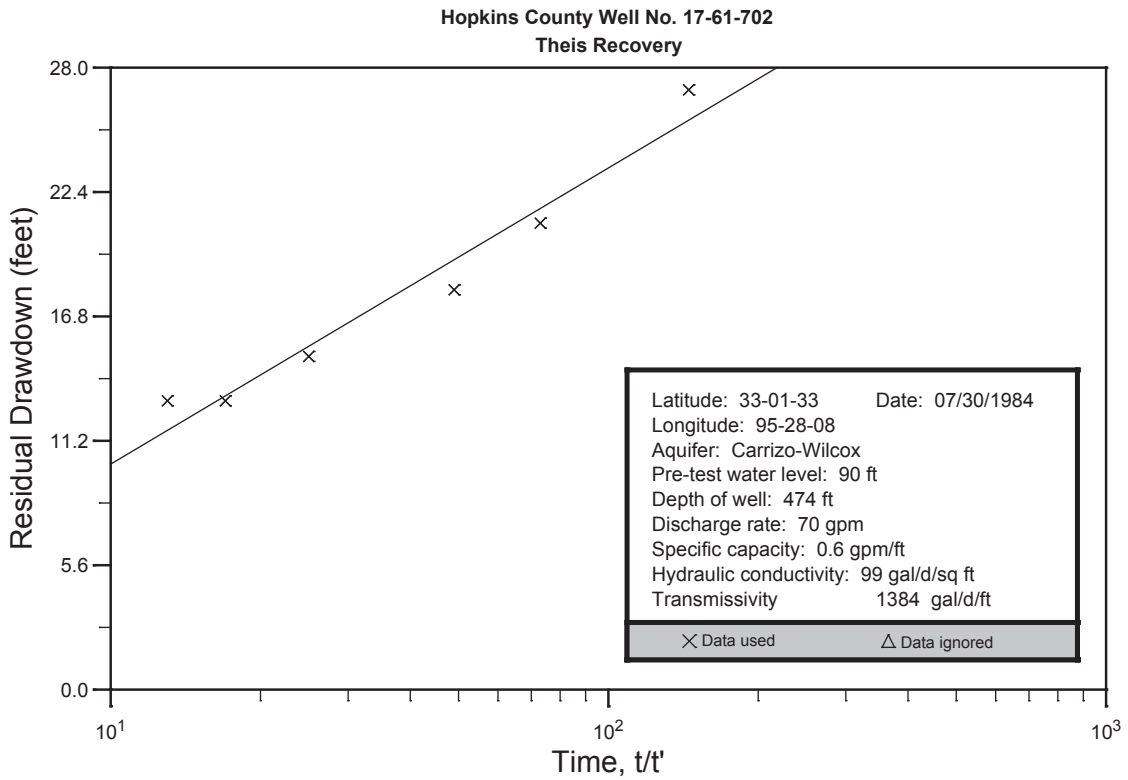
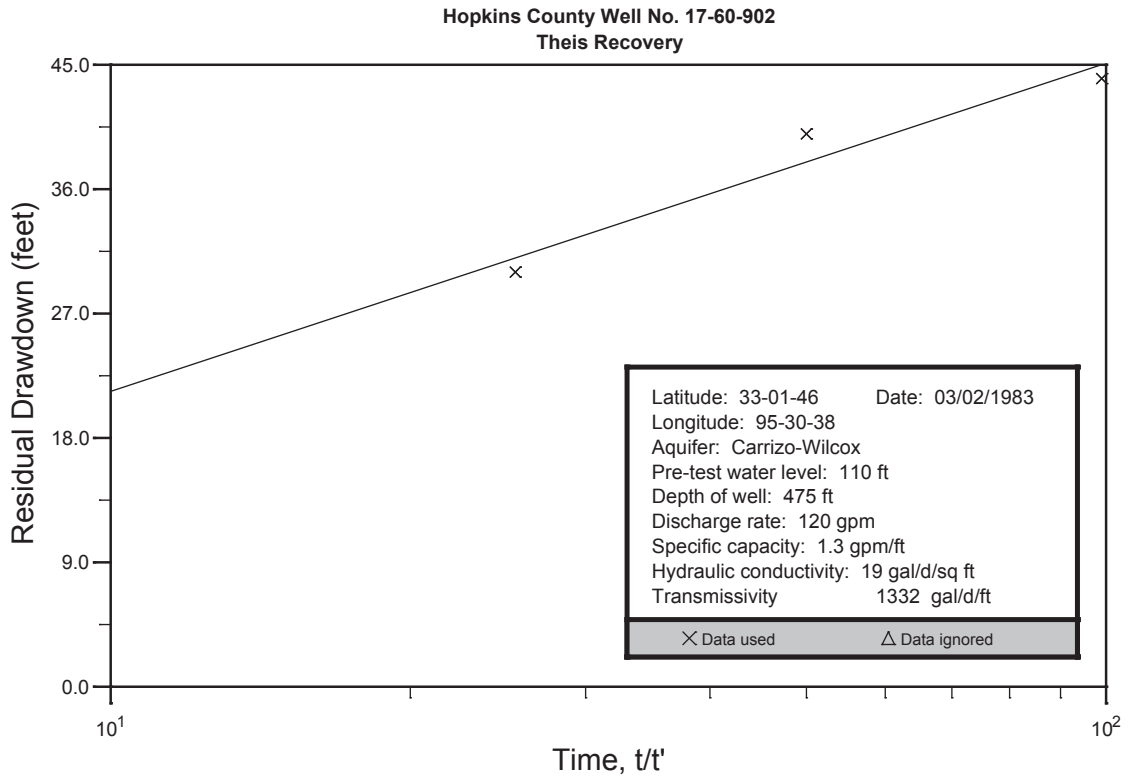


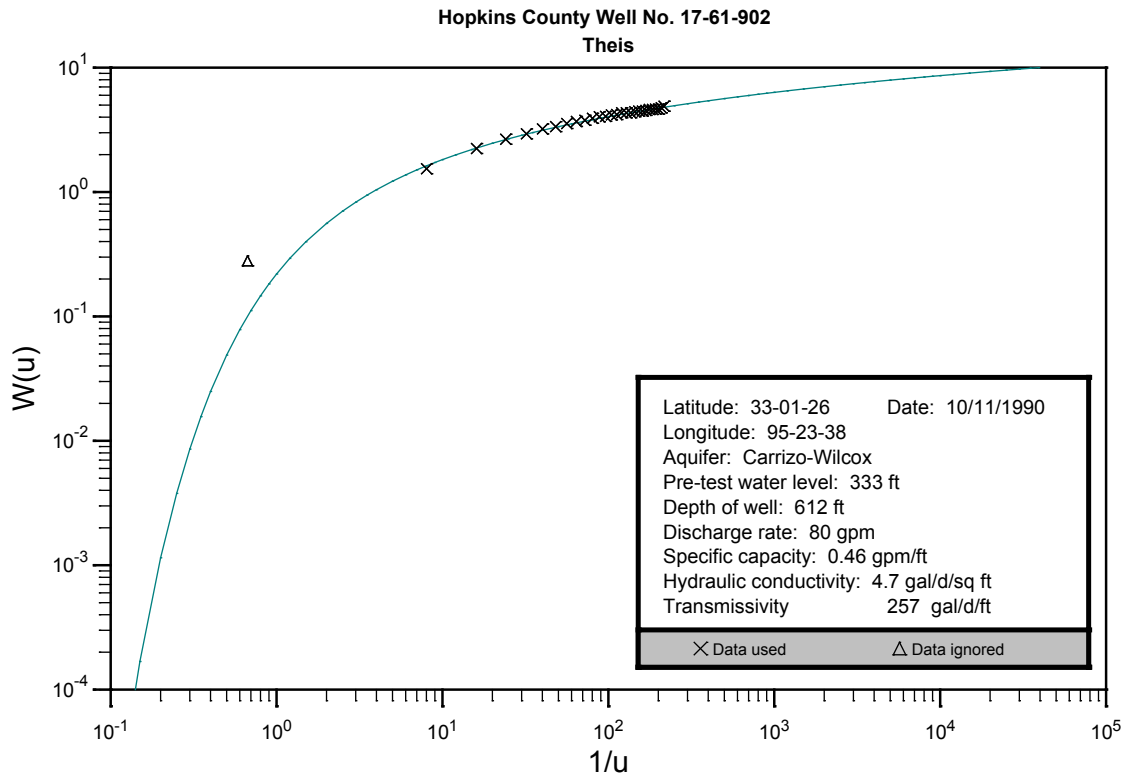
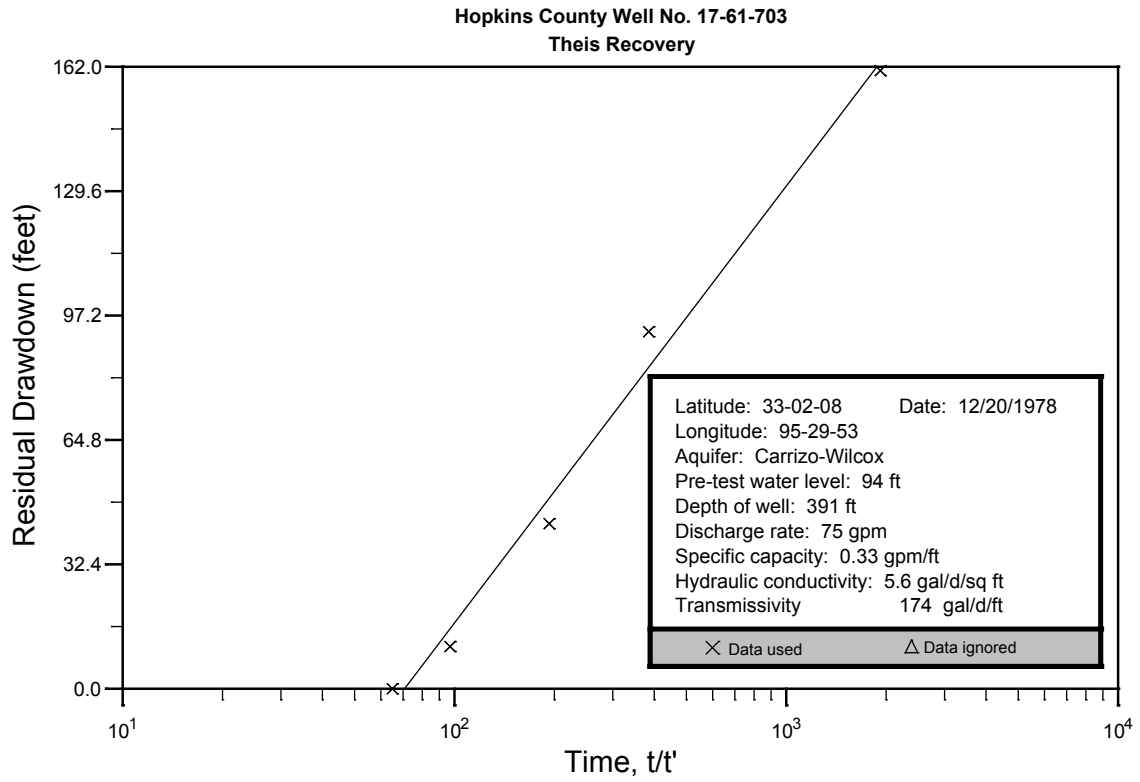


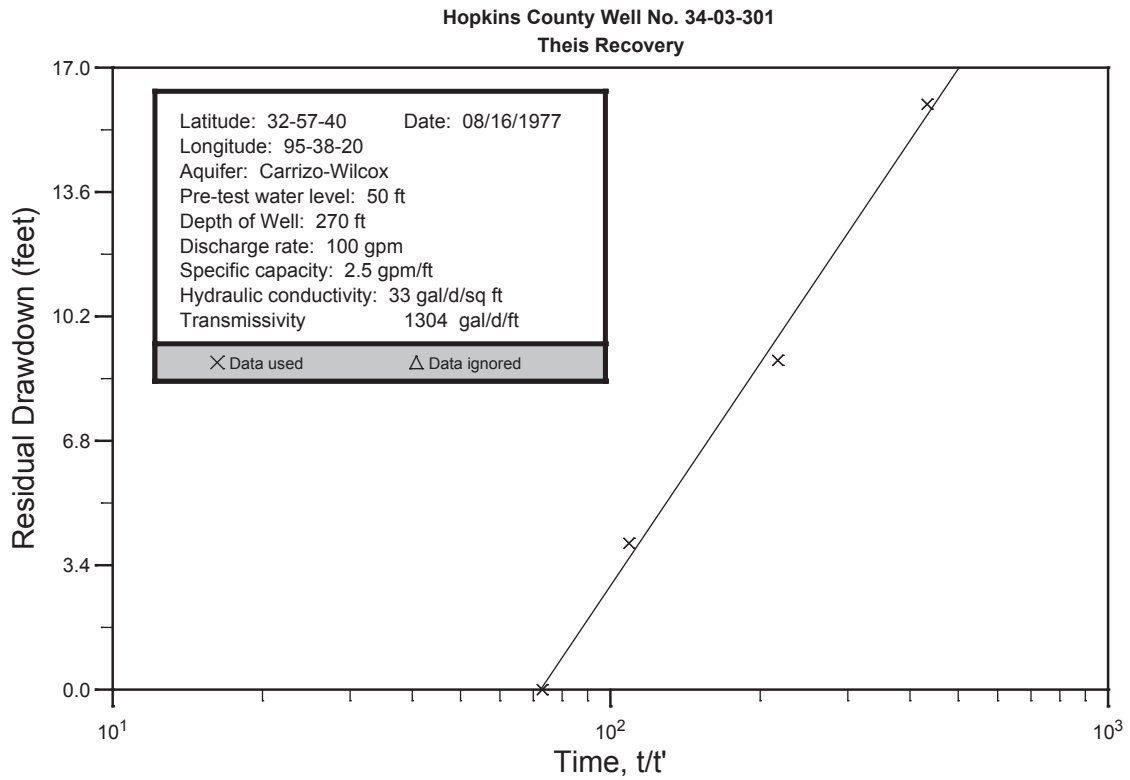
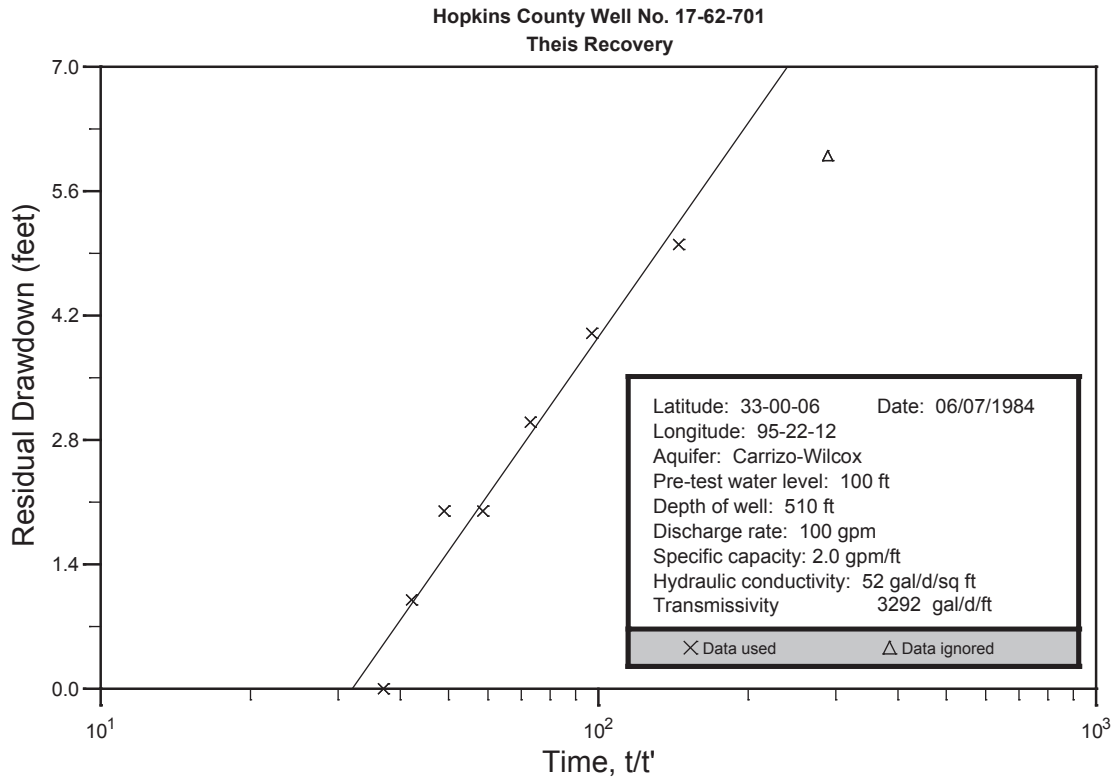


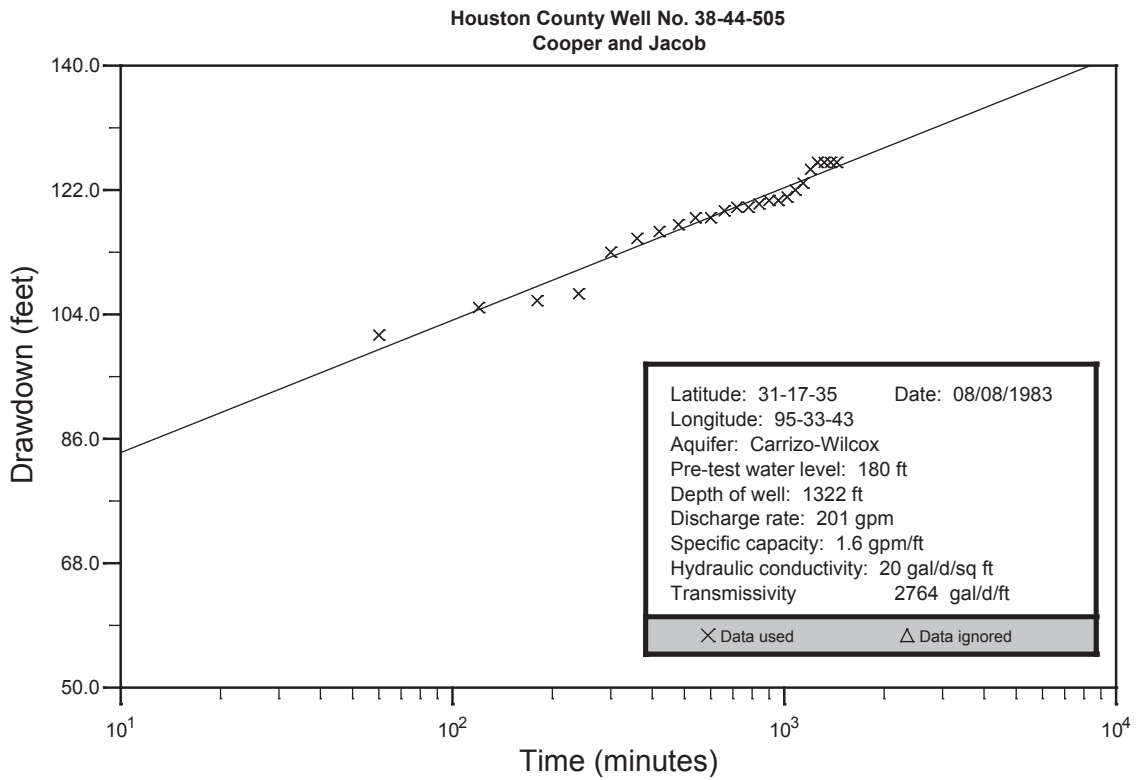
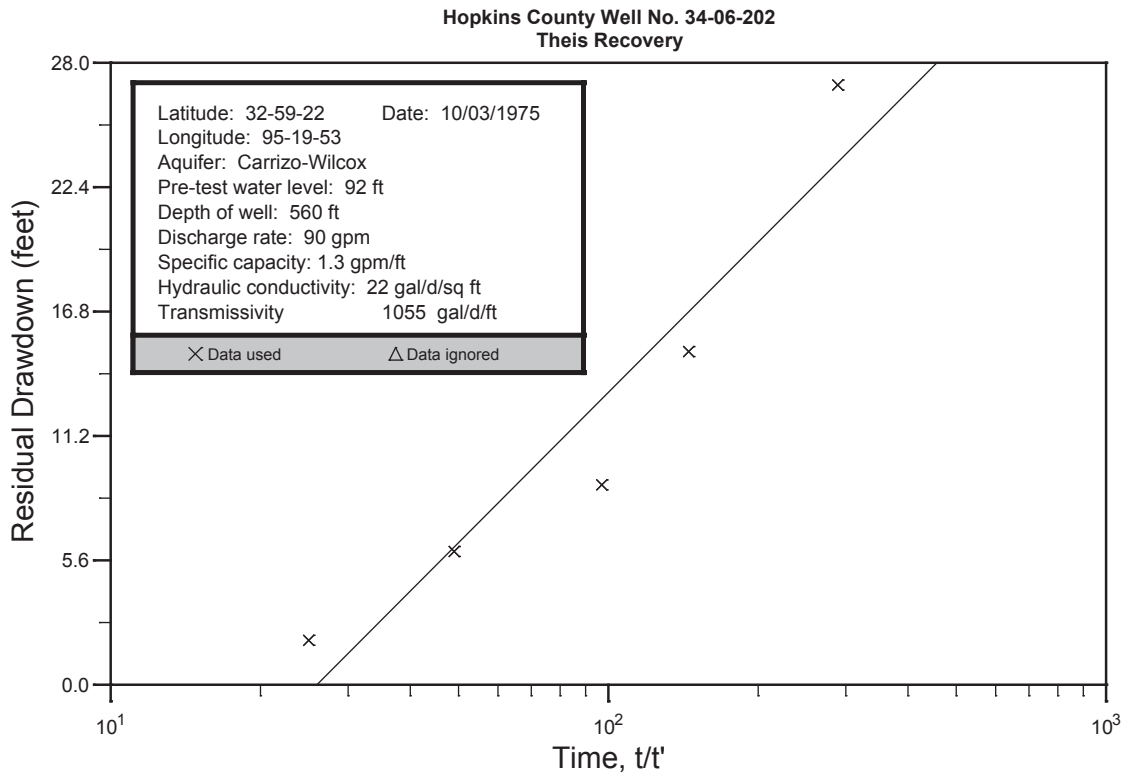




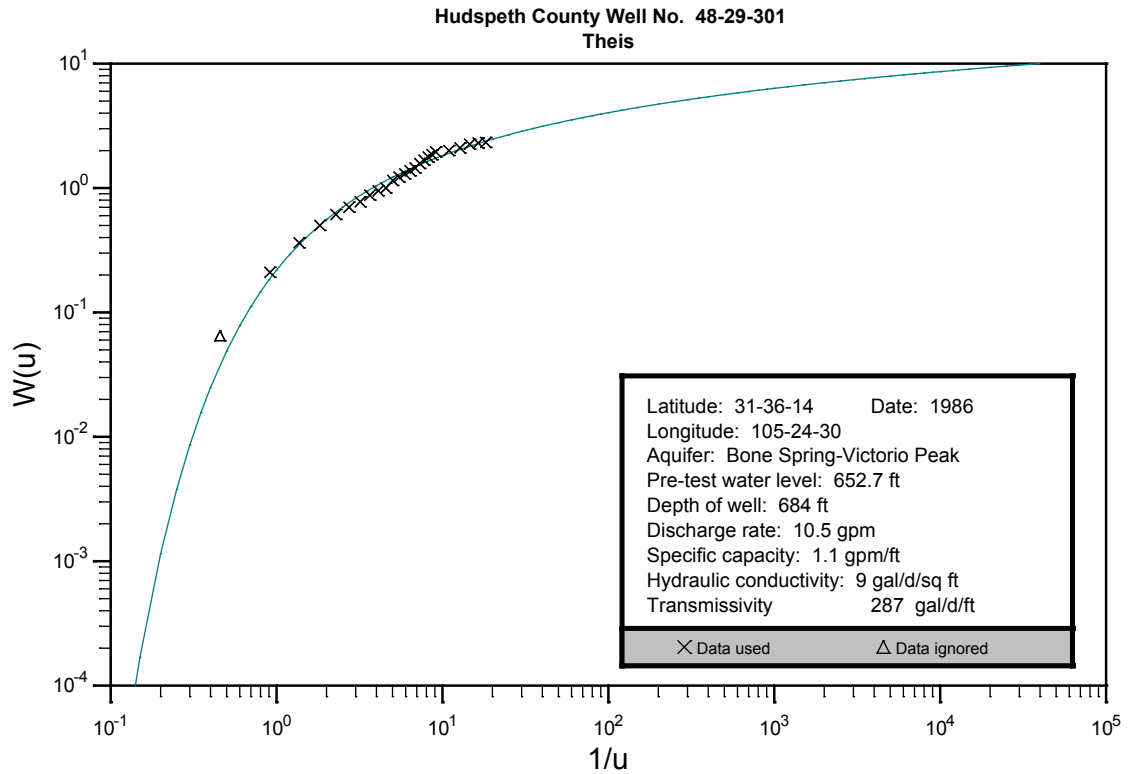
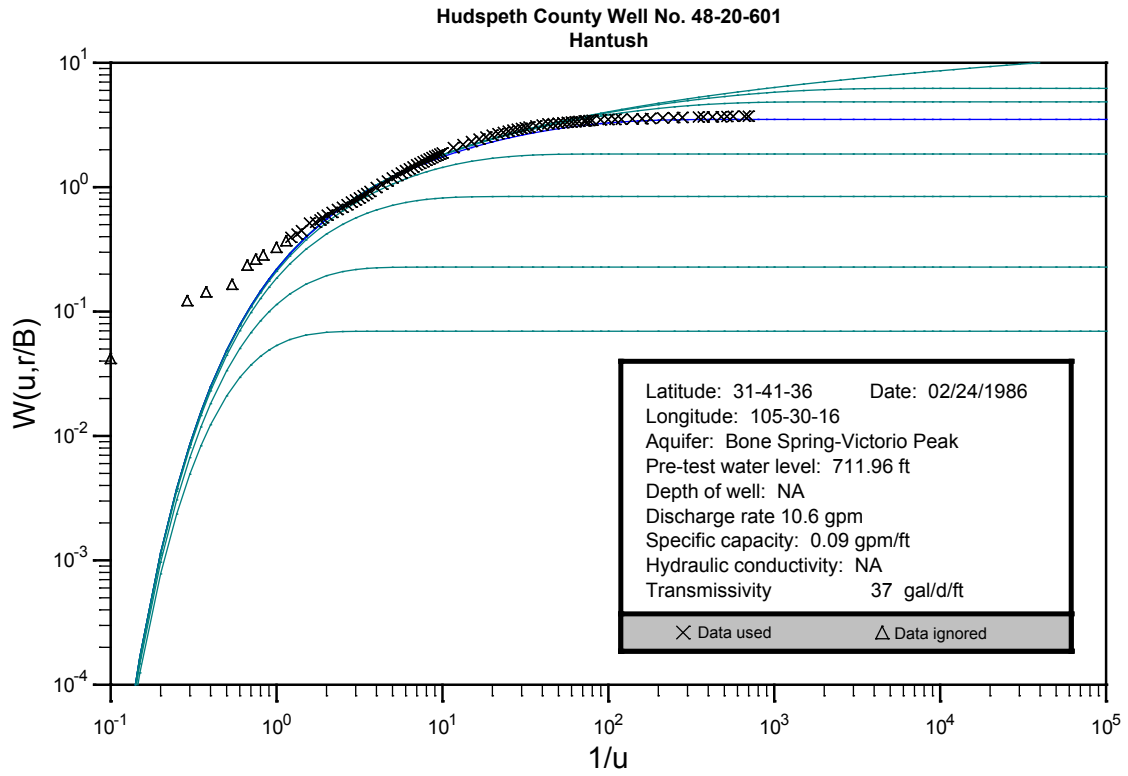


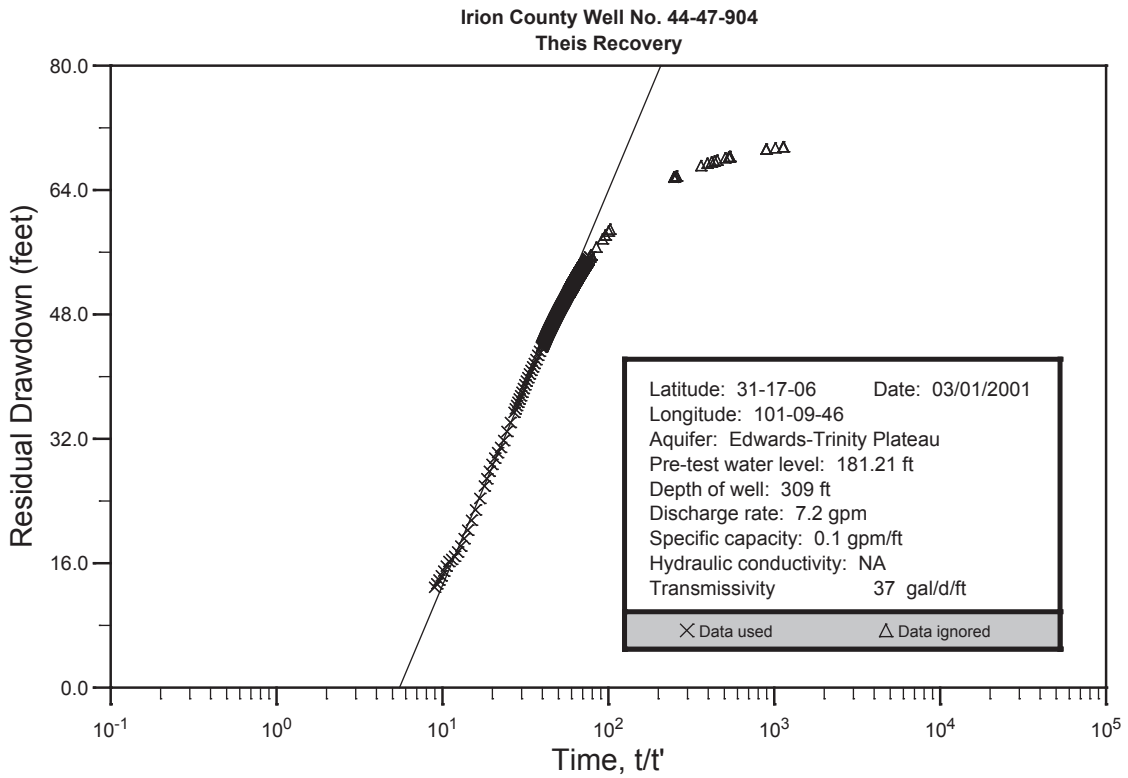
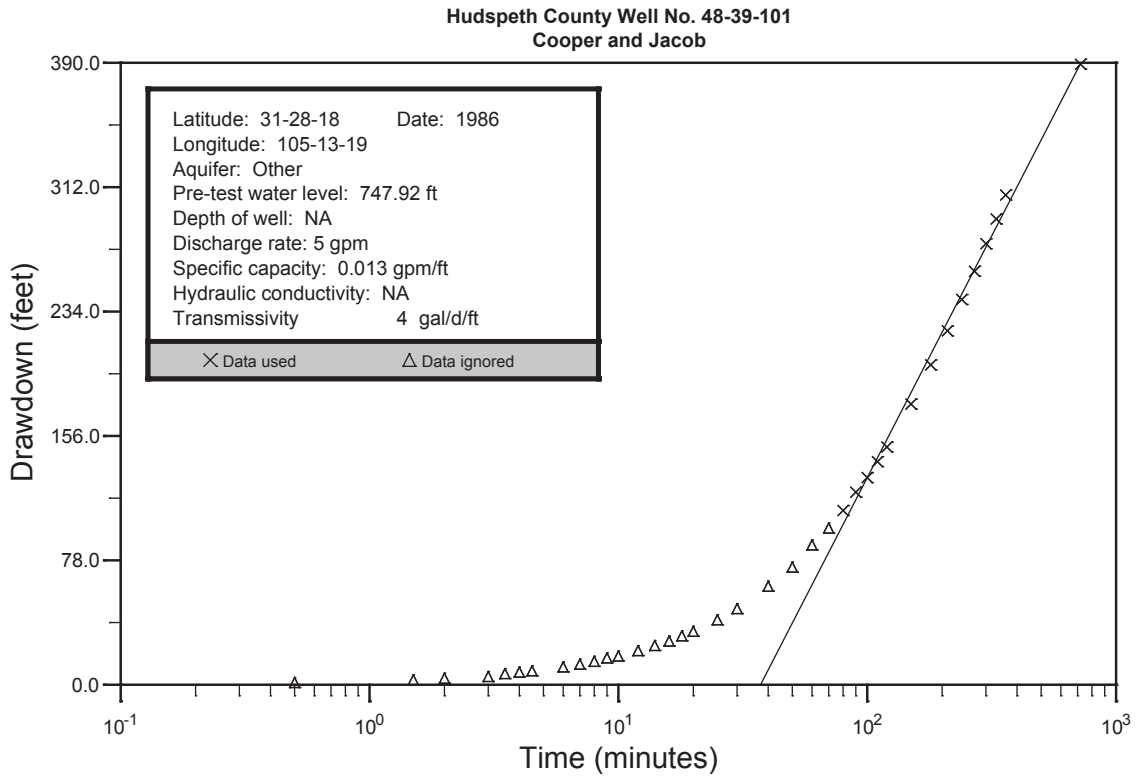


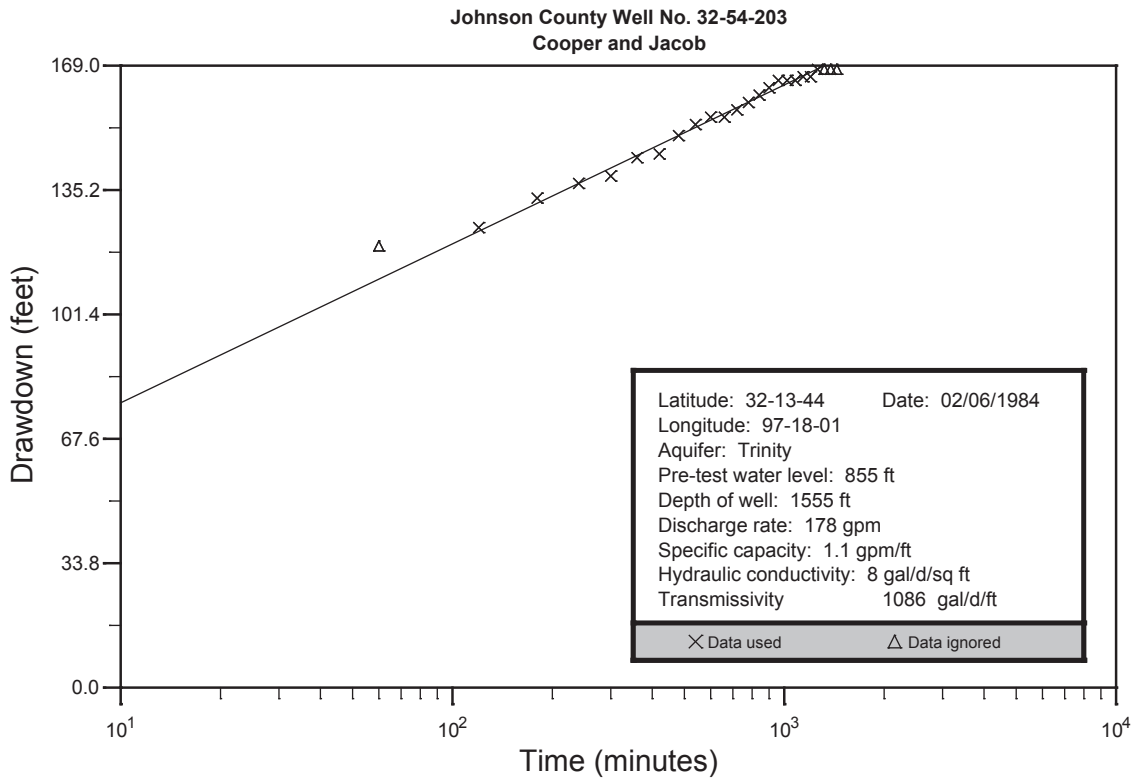
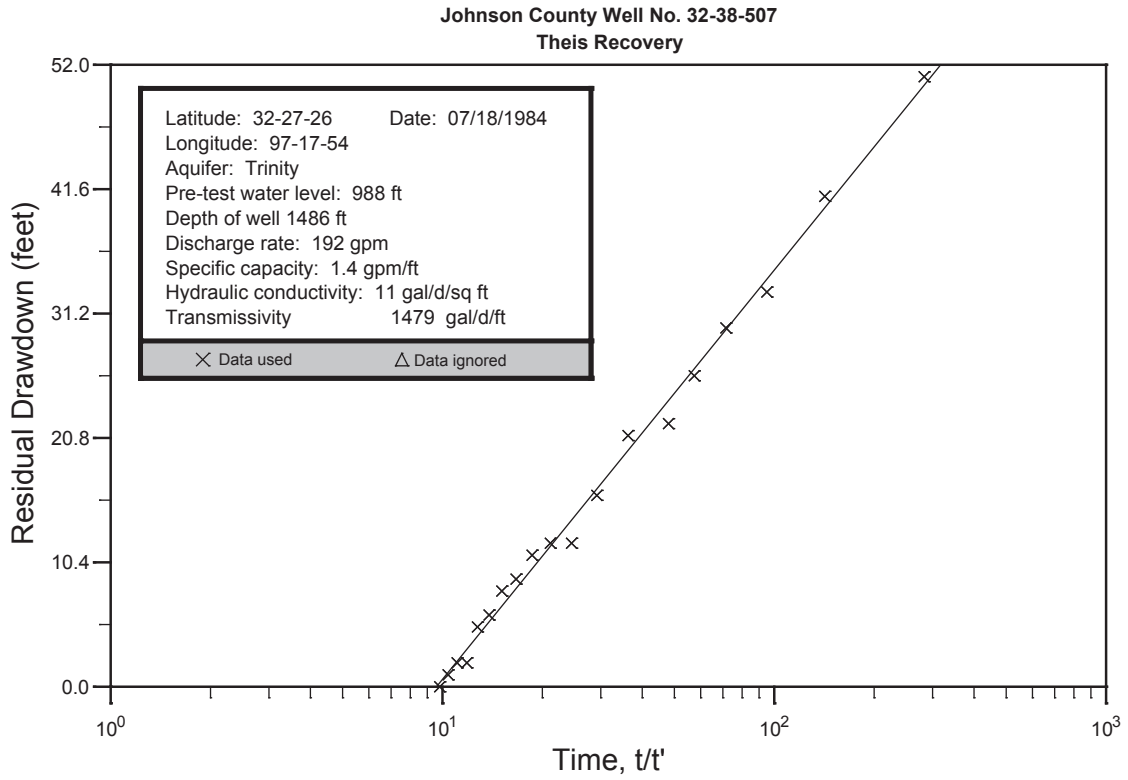




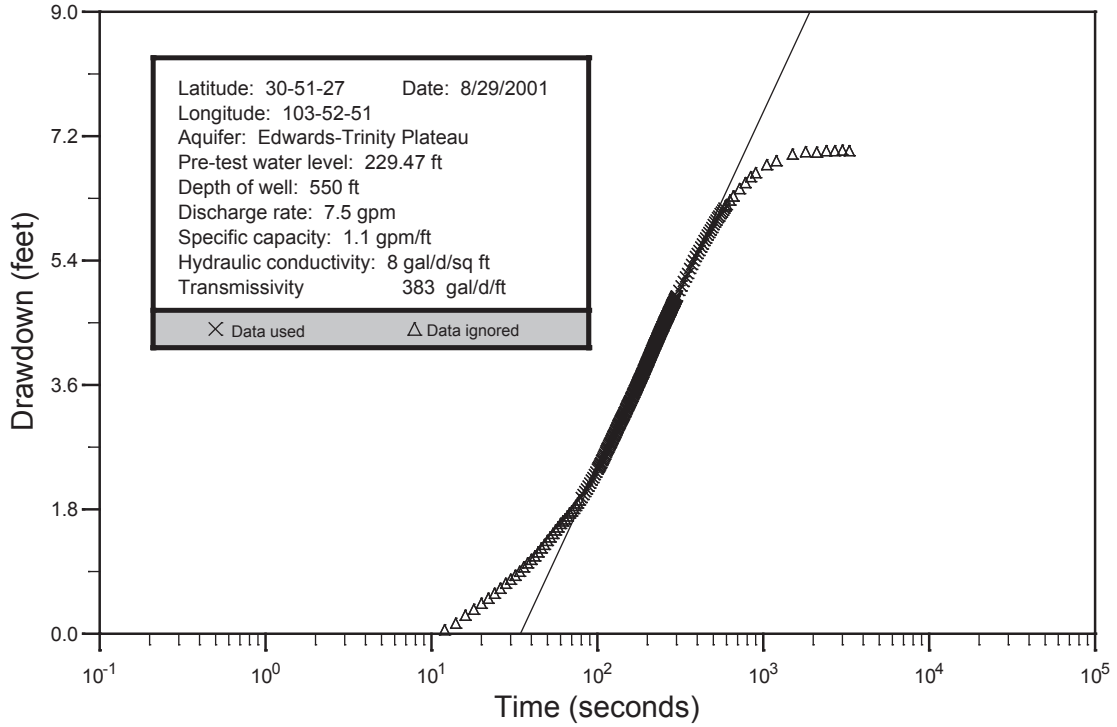








**Jeff Davis Well No. 52-09-303**  
**Cooper and Jacob**



**Kerr County Well No. 56-54-404**  
**Thisis Recovery**

