Wisconsin Geological
and Natural History Survey
DIVISION OF EXTENSION
UNIVERSITY OF WISCONSIN–MADISON

Collection of Hydraulic and Geologic Data to Improve the Quality of the Wisconsin Observation-Well Network

Final report to the Wisconsin Department of Natural Resources
DNR Project No. 118
July 1, 1994 to June 30, 1996

Charles P. Dunning[a], Bernard R. Ellefson[a], Alexander Zaporozec[b]

[a] U.S. Geological Survey

[b] Wisconsin Geological and Natural History Survey

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Introduction

The Wisconsin Geological and Natural History Survey (WGNHS) in cooperation with the U.S. Geological Survey (USGS) has maintained a ground-water observation-well network since 1946 (Zaporozec, 1982). The purpose of the network is to determine short-term changes and long-term trends in ground-water levels, and to relate these determinations to changes in storage in the ground-water reservoirs .

Currently, water levels are measured in approximately 170 Wisconsin observation wells (Zaporozec, 1996). Water-level measurements and associated geologic and well construction data are stored in a computer data base, and these data are available to the public upon request. For more information call Bernie Ellefson, USGS, 608/276-3849; or Alex Zaporozec, WGNHS, 608/262-3385. Selected water-level measurements representing the water table are available and updated monthly on the World Wide Web (http://wwwdwimdn.er.usgs.gov/gw/).

Interpretation of water-level measurements from about 30% of network wells is difficult because descriptions of geologic units and estimates of hydraulic conductivity are not available. Identification of the geologic units tapped and estimates of their hydraulic conductivity will increase the value of these measurements. In July 1994, WGNHS in cooperation with the USGS initiated a two-year study to obtain these data. The study was funded cooperatively by the Wisconsin Department of Natural Resources (WDNR), WGNHS and USGS. Funding from WDNR came from the Groundwater Account of the Environmental Fund (DNR Project No. 118).

Network Well Selection

Review of the ground-water observation-well network identified accessible wells (wells that can be tested or logged), thereby enabling geologic descriptions and estimates of hydraulic conductivity to be obtained. Most of these wells are less than 150 feet deep, and have a well diameter of 5 inches or less. Although most of these wells are open to sand and gravel geologic units, a number are open to sandstone or dolomite. Project funds were limited, and so 34 of the accessible wells were selected for evaluation based on their regional representation of the state. Three wells which have been evaluated as a part of other studies but are important to the regional distribution of data in the network are also included. These 37 wells are listed in Table 1.

Table 1. Geologic and hydraulic information collected or compiled for 37 observation wells. Wells are listed by county and well ID. [Ca - caliper log; Ga - natural gamma log; Ra - spontaneous potential and single point resistivity logs]

County	Well ID	Geophysical logs	Hydrograph	Displacement/ recovery test	Comments
Adams	AD-17/06E/08-0076		yes	yes	No logs - 1.25" casing
Barron	BR-33/13W/21-0046	Ca, Ga, Ra	yes	yes	
Buffalo	BF-20/12W/16-0120		yes	yes	No logs - 1.25" casing
Burnett	BT-39/16W/17-0002	Ca, Ga, Ra	yes	yes	
Chippewa	CH-28/07W/17-0142	Ca, Ga, Ra	yes	yes	
Columbia	CO-12/09E/27-0620		yes	yes	No logs, slug test data not usable
Dane	DN-09/10E/33-0441	Ca, Ga, Ra	yes	yes	
Dane	DN-09/11E/34-1355	Ca, Ga, Ra	yes	no	
Dane	DN-08/08E/09-1371	Ga, Ra	no	pump test	
Dodge	DG-11/13E/23-0081	Ca, Ga, Ra	yes	yes	
Door	DR-27/26E/05-0265	Ca, Ga, Ra	yes	no	
Florence	FC-39/15E/31-0004	Ca, Ga, Ra	yes	yes	
Forest	FR-41/14E/18-0002		yes	yes	No logs - 1.25" casing
Forest	FR-40/12E/21-0087	Ca, Ga, Ra	yes	yes	
Grant	GR-08/01W/10-0072		yes	yes	No logs - 1.25" casing
Jackson	JA-20/03W/30-0005	Ca, Ga, Ra	yes	yes	
Lafayette	LF-01/02E/33-0057	Ca, Ga, Ra	yes	yes	
Langlade	LA-31/11E/20-0064		yes	yes	No logs - 1.25" casing
Lincoln	LN-34/06E/36-0060		yes	yes	No logs - 1.25" casing
Marathon	MR-27/09E/31-0028		yes	yes	No logs - 1.25" casing
Marinette	MT-37/20E/34-0007	Ca, Ga, Ra	yes	yes	
Marquette	MQ-16/08E/12-0009	Ga, Ra	yes	yes	Open interval unknown
Marquette	MQ-14/09E/30-0026	Ca, Ga, Ra	yes	yes	
Monroe	MO-15/04W/34-0002	Ca, Ga, Ra	yes	yes	
Monroe	MO-18/02W/29-0017	Ga, Ra	yes	yes	
Outagamie	OU-24/18E/08-0416	Ca, Ga, Ra	yes	pump test	
Portage	PT-23/03E/25-0376		yes	yes	No logs - 1.25" casing
Sawyer	SW-41/09W/28-0007	Ca, Ga, Ra	yes	yes	
Shawano	SH-26/18E/30-0001	Ca, Ga, Ra	yes	yes	
Taylor	TA-31/04W/13-0001	Ca, Ga, Ra	yes	yes	slug test data not usable
Vernon	VE-14/07W/26-0008	Ga, Ra	yes	yes	
Vilas	VI-41/10E/09-0003		yes	yes	No logs - 1.25" casing
Vilas	VI-40/10E/28-0033	Ca, Ga, Ra	yes	yes	
Walworth	WW-01/16E/10-0083		yes	yes	No logs
Waukesha	WK-05/19E/02-0031	Ca, Ga	yes	yes	
Waupaca	WP-22/14E/12-0013	Ca, Ga, Ra	yes	yes	
Waushara	WS-19/08E/15-0008	Ca, Ga, Ra	yes	yes	

Site-Identification System

Each network site (well) is identified by a local number based on the cadastral-survey system of the U.S. Government. The number consists of an abbreviation of the county name; the township, range, and section; and a unique four-digit number assigned to the well. For example, the well with the local number AD-17/06E/08-0076 is in Adams County (AD), township 17 north, range 6 east, section 8, and has sequence number 0076. The location of the 37 wells which are a part of this study are identified on Figure 1 using an abbreviated local well number, which includes only the county abbreviation and the well sequence number.

Methods

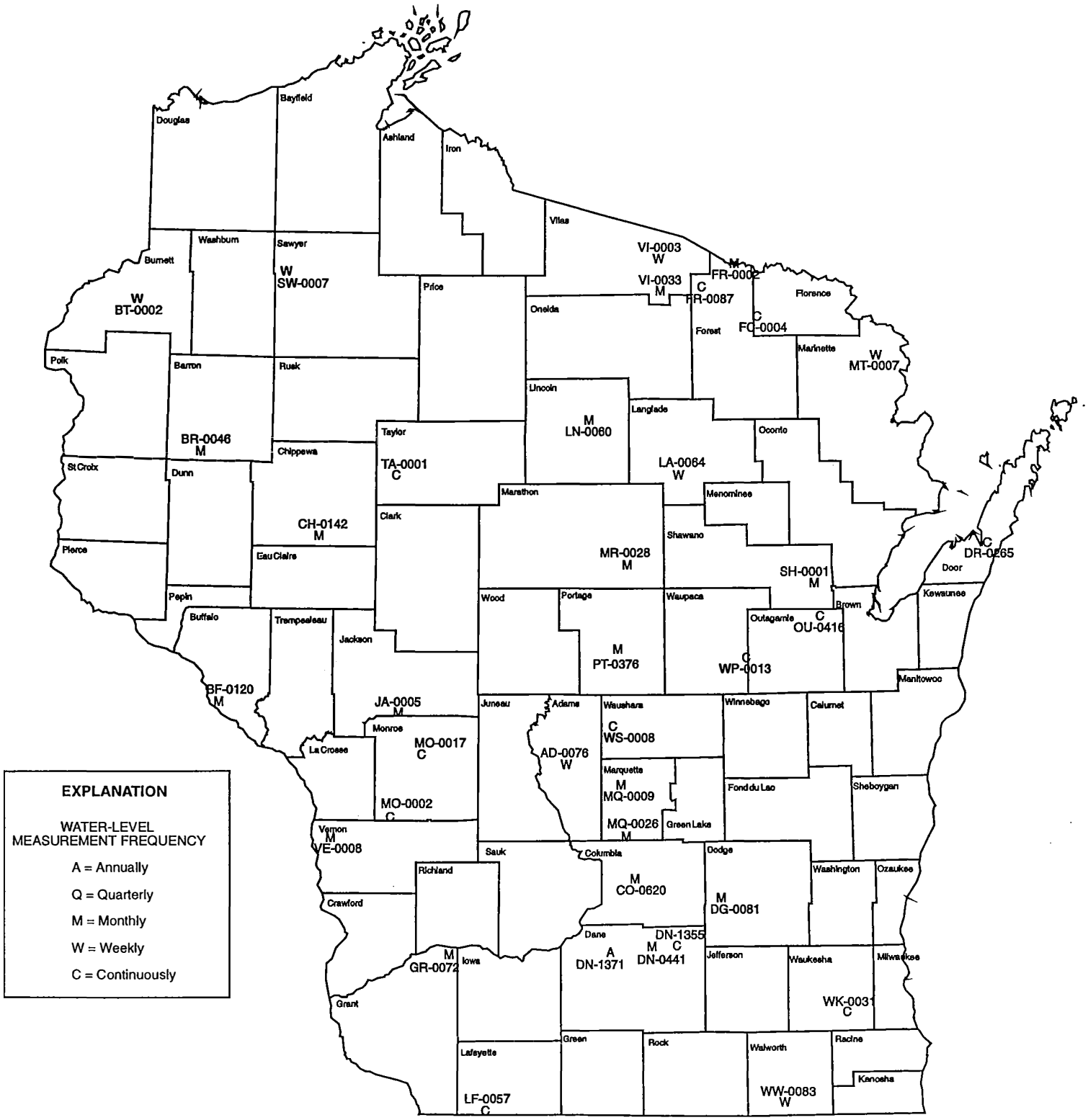
Geophysical logs - caliper, natural gamma, spontaneous potential, and single-point resistivity - were obtained to help interpret geologic units in a wellbore. A Mount Sopris MGX Digital Logger was used for geophysical logging. Methods of logging and interpretation are described in Keyes and MacCary (1971).

Displacement/recovery tests (slug tests) or selective formation pump tests were used to estimate the hydraulic conductivity of geologic units tapped by the wells. Slug tests were conducted in most of the wells. A slug test is conducted by displacing the static water level in a wellbore by quickly adding to, or removing from, the water a solid volume (the slug). The rate with which the water level returns to static is controlled by formation characteristics. Hydraulic conductivity was estimated from slug tests using the Hvorslev method (Hvorslev, 1951). Data from selective formation pump tests were used in two wells which were too deep for slug tests. Selective formation pump tests are conducted by pumping from a selected geologic formation isolated with a down-hole packer assembly in a wellbore (Shuter and Pemberton, 1978). The response of the water level in the well to pumping is controlled by formation characteristics. Hydraulic conductivity was calculated from pump tests using the Cooper-Jacob method (Cooper and Jacob, 1946).

Results and Discussion

The data which has been collected or compiled during the course of this study are listed in Table 1. Geophysical logs were obtained from 26 of the 37 selected network wells, and are presented on single-page well reports in the appendix. Selective formation pump tests were conducted in 2 of these 37 wells and displacement/recovery tests were conducted in 33 others. Well construction information and the results of these tests are listed in Table 2, and presented on single-page well reports in the appendix. Both pump tests provided reliable data for calculation of hydraulic conductivity. Displacement/recovery tests provided reliable data for estimation of hydraulic conductivity for 21 wells, 10 wells exhibited very slow recovery during the test and are listed as "probably plugged", and tests on two wells did not provide usable data.

The 10 wells which exhibited very slow recovery during the displacement/recovery tests (indicated by an asterisk in Table 2) are open to sand and gravel units. Wells open to sand and gravel units would be expected to exhibit quick recovery during the tests, so these 10 are probably plugged due to encrustation of the well screen, plugging of the well screen by fines, or collapse of the well casing. These problems frequently occur with the aging of wells. Most of these 10 wells were constructed between 1934 and 1959, and include some of the oldest wells in the network. However, there are at least 10 similarly aged wells for which reliable estimates of hydraulic conductivity were made, so well age is not necessarily the primary factor. Regardless, the usefulness of the 10 slow-recovering wells for showing short-term changes in water level are doubtful, and their usefulness for reflecting long-term trends may be questionable.



EXPLANATION

WATER-LEVEL MEASUREMENT FREQUENCY

A = Annually

Q = Quarterly

M = Monthly

W = Weekly

C = Continuously

Figure 1. Location and measurement frequency of 37 selected observation wells. Location is at center of the letter representing measurement frequency.

Table 2. Aquifer type, well construction information, and results of displacement/recovery tests for 37 observation wells.

Well ID	Aquifer type	Total depth ft	Effective radius of riser ft	Radius of screen/ perfed/open interval ft	Length of screen/ perfed/open interval ft	Hvorslev time lag To sec	Calculated Hvorslev K ft/day	Calculated Cooper-Jacob K ft/day
AD-17/06E/08-0076	Sand & Gravel	21	.052	.052	2	5000	0.043 *	
BR-33/13W/21-0046	Sandstone	68	.1667	.1667	21	12.75	21.7	
BF-20/12W/16-0120	Sand & Gravel	15.5	.052	.052	2	2.5	85.3	
BT-39/16W/17-0002	Sand & Gravel	46	.333	.333	1.5	*	*	
CH-28/07W/17-0142	Sandstone	67.4	.25	.25	21	43.25	13.2	
CO-12/09E/27-0620	Sandstone	80	.052	.052	2	data not usable		
DN-09/10E/33-0441	Sandstone	105	.25	.25	62	7.5	32.0	
DN-09/11E/34-1355	Sandstone	70	.25	.25	50	no test		
DN-08/08E/09-1371	Sandstone	465						12.3
DG-11/13E/23-0081	Sandstone	125	.25	.25	68	116.25	1.9	
DR-27/26E/05-0265	Silurian	442				no test		
FC-39/15E/31-0004	Sand & Gravel	53	.333	.333	10	253.75	6.4	
FR-41/14E/18-0002	Sand & Gravel	18	.052	.052	3	301.5	0.5	
FR-40/12E/21-0087	Sand & Gravel	102	.25	.25	6	143.25	10.0	
GR-08/01W/10-0072	Sand & Gravel	18	.052	.052	2	83.5	2.6	
JA-20/03W/30-0005	Sandstone	190	.417	.417	136	540	0.6	
LF-01/02E/33-0057	Galena-Platteville	265	.333	.333	249	6	21.2	
LA-31/11E/20-0064	Sand & Gravel	19.7	.083	.083	2.2	47.25	9.4	
LN-34/06E/36-0060	Sand & Gravel	21.8	.052	.052	1.8	10000	0.023 *	
MR-27/09E/31-0028	Sand & Gravel	27	.052	.052	2	*	*	
MT-37/20E/34-0007	Sand & Gravel	33	.333	.333	cased to bottom	*	*	
MQ-16/08E/12-0009	Sandstone	274	.25	.25	?	9.25	> 8.1	
MQ-14/09E/30-0026	Sandstone	170	.25	.25	25	10.75	46.3	
MO-15/04W/34-0002	Sandstone	44	.125	.125	27	4	33.6	
MO-18/02W/29-0017	Sandstone	192	.417	.417	83	111.75	4.3	
OU-24/18E/08-0416	Sandstone	740						8.8
PT-23/03E/25-0376	Sand & Gravel	36.4	.052	.052	2.4	3118	0.060 *	
SH-26/18E/30-0001	Sandstone	132	.25	.25	78	21	9.5	
SW-41/09W/28-0007	Sand & Gravel	25	.333	.333	3	*	*	
TA-31/04W/13-0001	Sand & Gravel	28	.75	.75	8	data not usable		
VE-14/07W/26-0008	Sand & Gravel	53	.167	.167	cased to bottom	*	*	
VI-41/10E/09-0003	Sand & Gravel	19.5	.083	.083	1.5	15.75	36.5	
VI-40/10E/28-0033	Sand & Gravel	37	.25	.25	cased to bottom	*	*	
WW-01/16E/10-0083	Sand & Gravel	149	.25	.25	10	303.75	3.3	
WK-05/19E/02-0031	Silurian	508	.25	.25	74	105	2.0	
WP-22/14E/12-0013	Sand & Gravel	203	.417	.417	15	64	28.0	
WS-19/08E/15-0008	Sand & Gravel	26.4	.167	.167	8.4	*	*	

* probably plugged

Recommendations

Based on the findings of this project, the following recommendations are made.

Most importantly, because such a high percentage (~ 27 %) of the tested wells appear to be plugged, assessment of the remaining accessible network wells is justified and desirable. Those wells which prove to be plugged should be repaired or replaced. This will improve the efficiency and quality of the network, and optimize the use of project funds.

The 10 wells which appear to be plugged should be repaired so that a good hydraulic connection is established between the well and the geologic unit it taps. If the wells cannot be repaired than replacement wells should be identified or installed.

Detailed interpretation of the geophysical logs should be made to provide additional useful information such as depths and thicknesses of geologic formations.

And finally, all accessible network wells should be tested every five years to ensure that they are in good hydraulic connection with the geologic unit.

Cited References

Cooper, H. H., Jr., and Jacob, C. E., 1946, A generalized graphical method for evaluating formation constants and summarizing well field theory: Trans. Amer. Geophys. Union 27, p. 526-534.

Hvorslev, M. J., 1951, Time lag and soil permeability in ground-water observations: U.S. Army Corps of Engineers, Waterways Experimental Station, Bulletin 36, 50 p.

Keyes, W. S., and MacCary, L. M., 1971, Application of borehole geophysics to water-resources investigations: Techniques of Water-Resources Investigations of the Unites States Geological Survey, Book 2, Chapter E1, 126 p.

Shuter, E., and Pemberton, R. R., 1978, Inflatable straddle packers and associated equipment for hydraulic fracturing and hydraulic testing: U.S. Geological Survey Water-Resources Investigations 78-55, 16 p.

Zaporozec, A., 1982, Ground-water level monitoring program in Wisconsin: Wisconsin Geological and Natural History Survey Educational Series 24, 9 p.

Zaporozec, A., 1996, Wisconsin ground-water observation network: Wisconsin Geological and Natural History Survey Educational Series (in print).

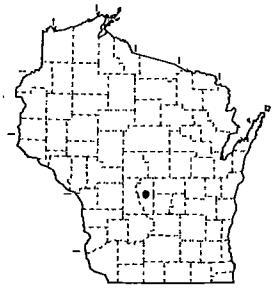
Appendix

WELL REPORTS FOR 38 TESTED WELLS

AD 76
BR 46
BF 120
BT 2
CH 142
CO 620
DN 441
DN 1355
DN 1371
DG 81
DR 265
FC 4
FR 2
FR 87
GR 72
JA 5
LF 57
LA 64
LN 60
MR 28
MT 7
MQ 9
MQ 26
MO 2
MO 17
ON 23
OU 461
PT 376
SW 7
SH 1
TA 1
VE 8
VI 3
VI 33
WW 83
WK 31
WP 13
WS 8

Appendix

Single-page Well Reports for Selected Wells in the
Wisconsin Ground-water Observation Well Network



Adams County

AD-17/06E/08-0076

SAND AND GRAVEL AQUIFER

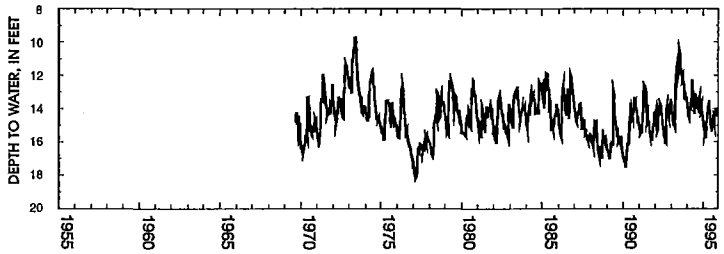
Geophysical Logs

No Logs Available

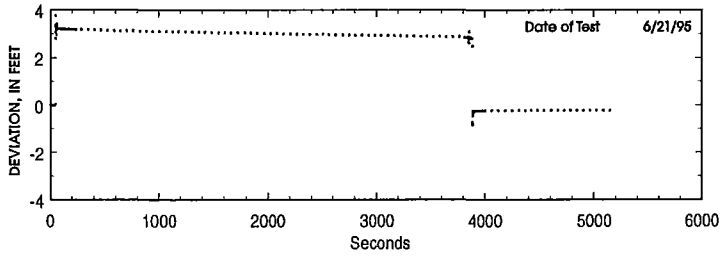
Well Information

Total Depth	21	feet
Cased Depth	19	feet
Casing Diameter	1.25	inches
Use of Well	Non-pumping	

Depth to Water Below Land Surface For Period of Record



Deviation From Static Water Level During Displacement\Recovery Test

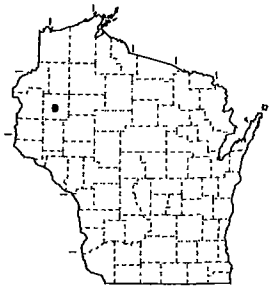


Horizontal Hydraulic Conductivity

Hvorslev K

4.3×10^{-2} ft/day

Probably plugged

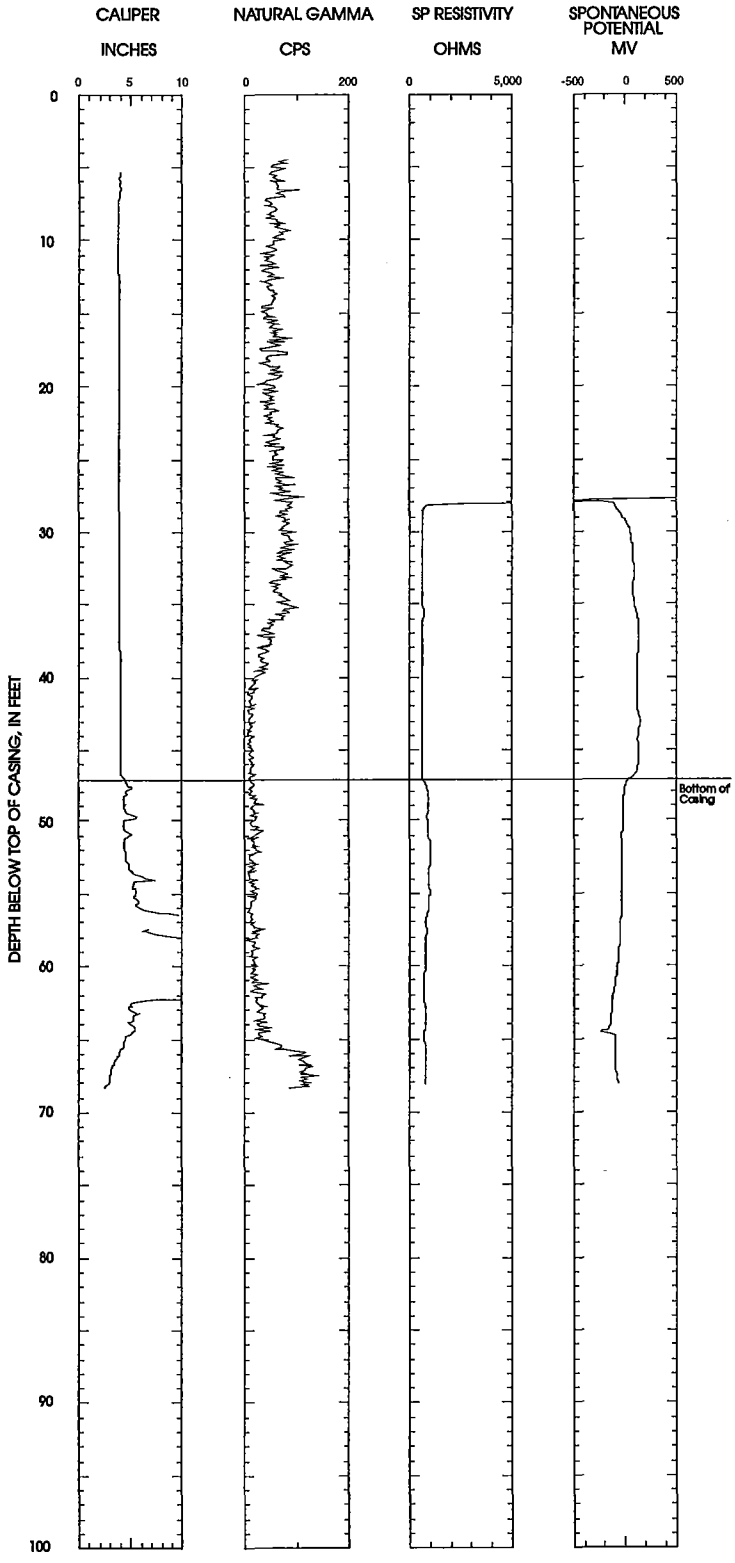


Barron County

BR-33/13W/21-0046

SANDSTONE AQUIFER

Geophysical Logs

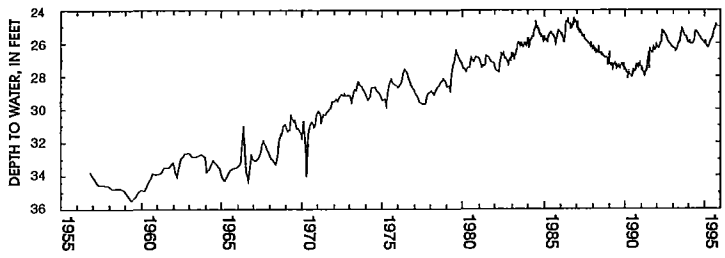


Well Information

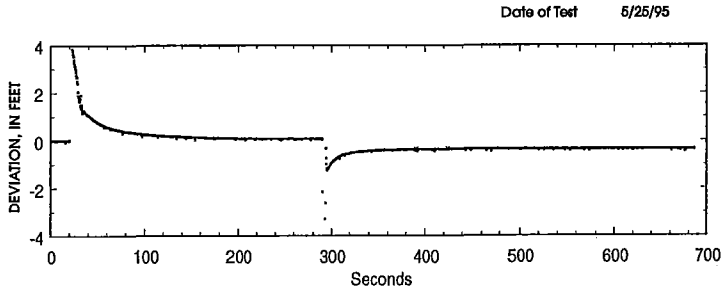
Total Depth	68	feet
Cased Depth	47	feet *
Casing Diameter	4	inches
Use of Well	Non-pumping	

* Picked from geophysical logs

Depth to Water Below Land Surface For Period of Record



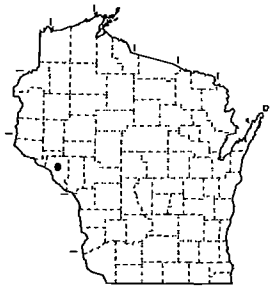
Deviation From Static Water Level During Displacement\Recovery Test



Horizontal Hydraulic Conductivity

Hvorslev K

21.7 ft/day



Buffalo County

BF-20/12W/16-0120

SAND AND GRAVEL AQUIFER

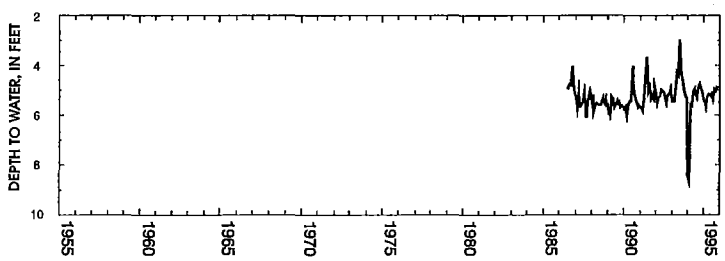
Geophysical Logs

No Logs Available

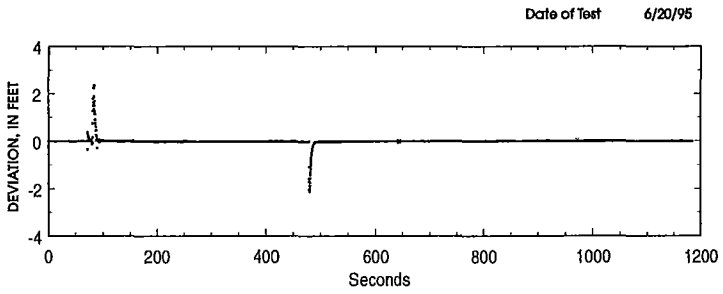
Well Information

Total Depth	15.5	feet
Cased Depth	13.5	feet
Casing Diameter	1.25	inches
Use of Well	Non-pumping	

Depth to Water Below Land Surface For Period of Record



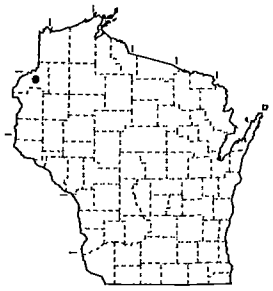
Deviation From Static Water Level During Displacement\Recovery Test



Horizontal Hydraulic Conductivity

Hvorslev K

85.3 ft/day

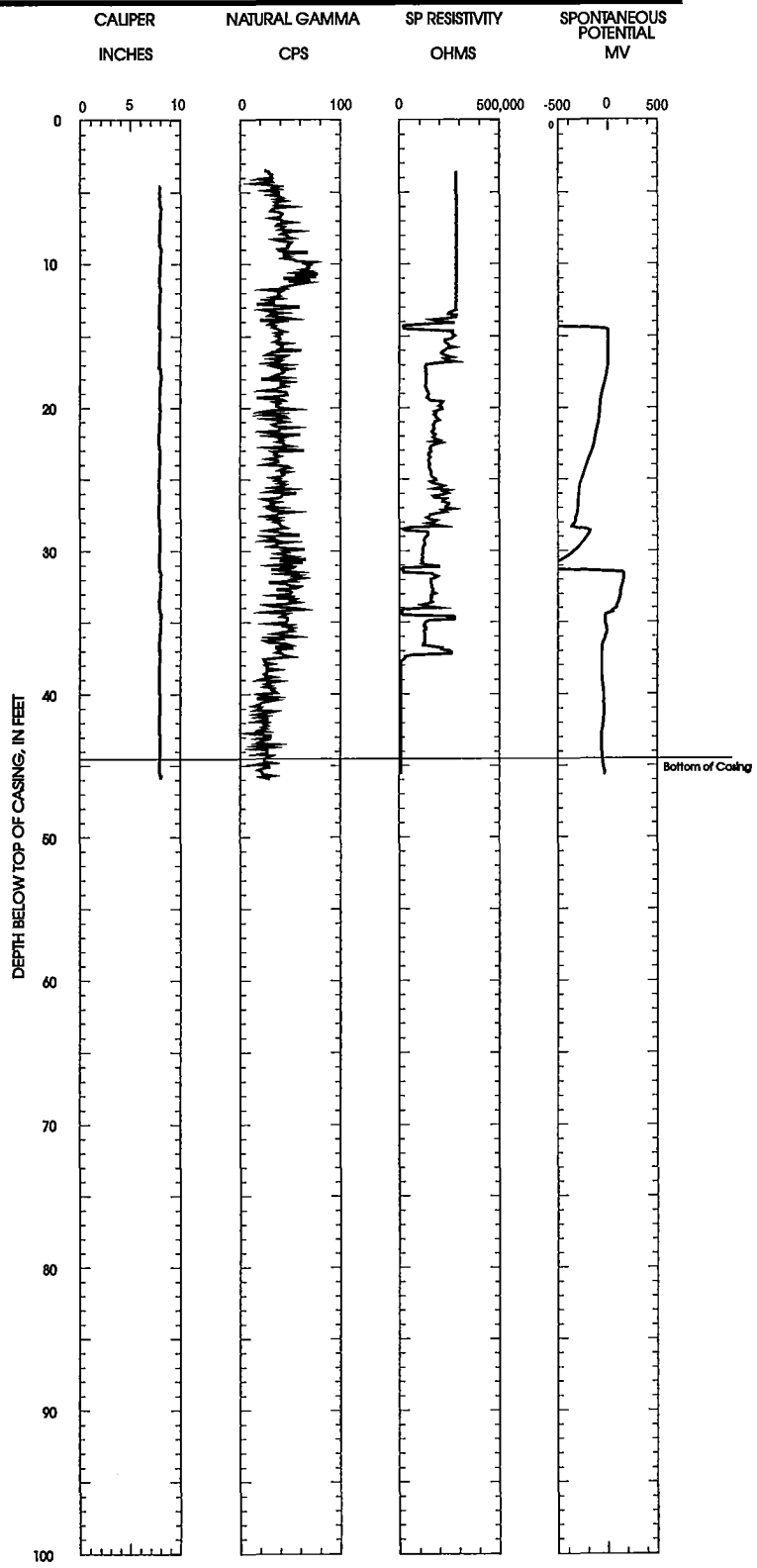


Burnett County

BT-39/16W/17-0002

SAND AND GRAVEL AQUIFER

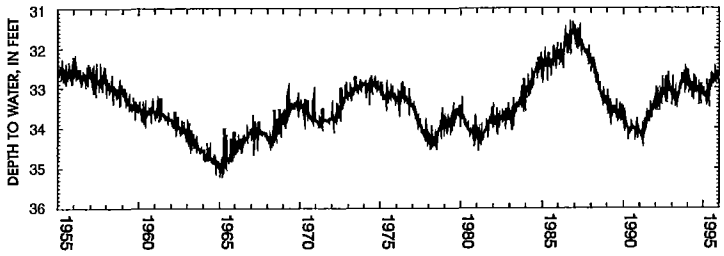
Geophysical Logs



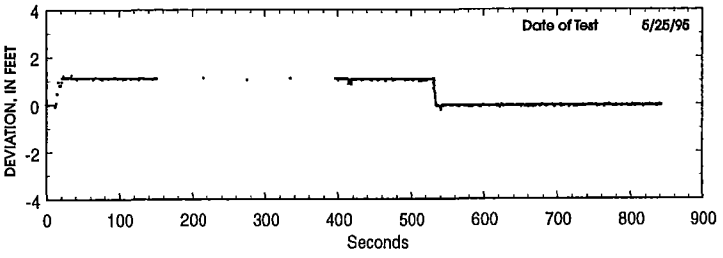
Well Information

Total Depth	46	feet
Cased Depth	44.5	feet
Casing Diameter	8	inches
Use of Well	Non-pumping	

Depth to Water Below Land Surface For Period of Record



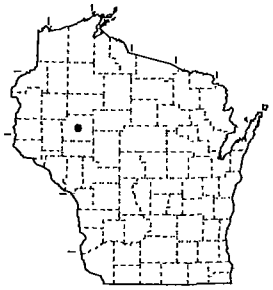
Deviation From Static Water Level During Displacement\Recovery Test



Horizontal Hydraulic Conductivity

Hvorslev K

Probably plugged

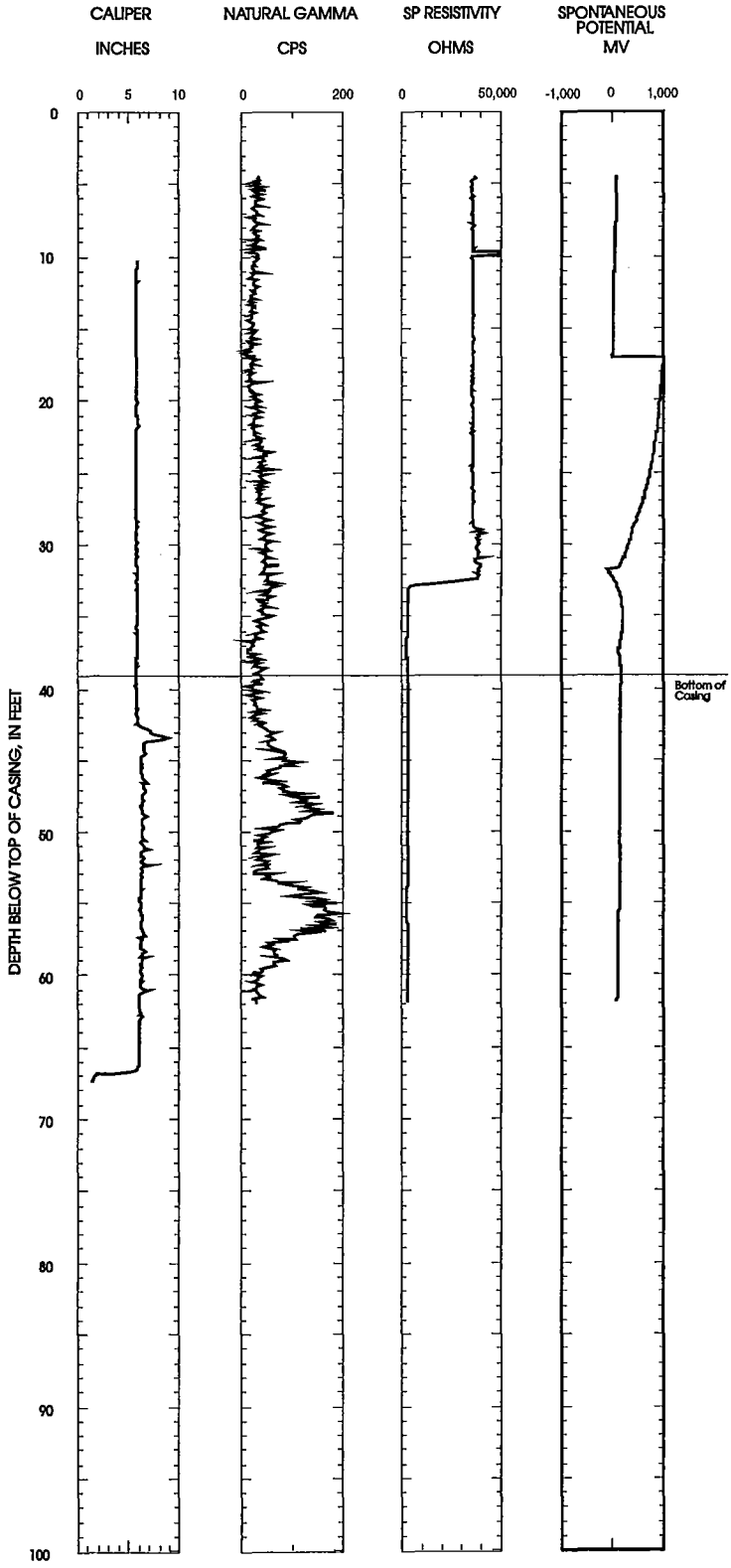


Chippewa County

CH-28/07W/17-0142

SANDSTONE AQUIFER

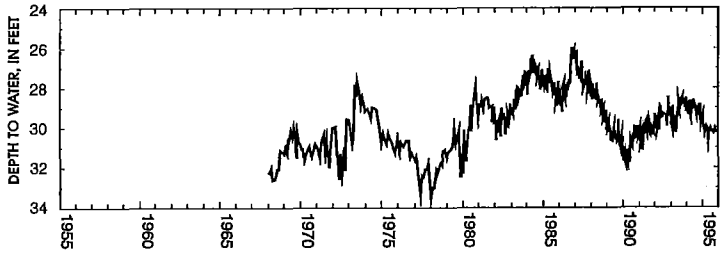
Geophysical Logs



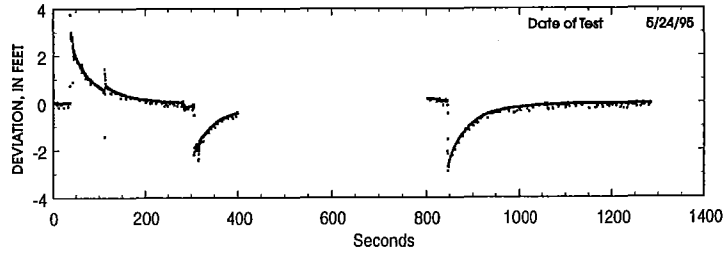
Well Information

Total Depth	67.4	feet
Cased Depth	39	feet
Casing Diameter	6	inches
Use of Well	Non-pumping	

Depth to Water Below Land Surface For Period of Record



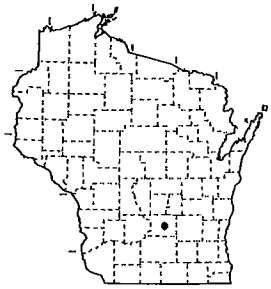
Deviation From Static Water Level During Displacement\Recovery Test



Horizontal Hydraulic Conductivity

Hvorslev K

13.2 ft/day



Columbia County

CO-12/09E/27-0620

SANDSTONE AQUIFER

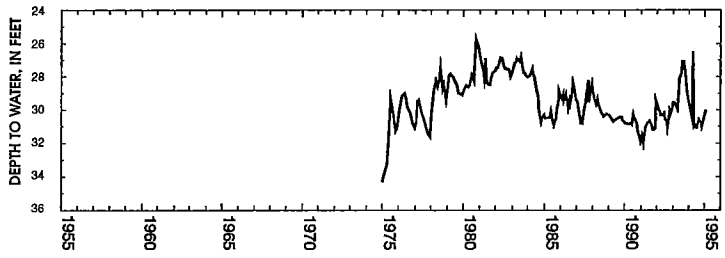
Geophysical Logs

No Logs Available

Well Information

Total Depth	80	feet
Cased Depth	78	feet
Casing Diameter	1.25	inches
Use of Well	Non-pumping	

Depth to Water Below Land Surface For Period of Record

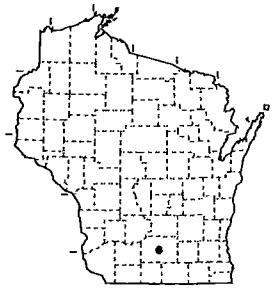


Deviation From Static Water Level During Displacement\Recovery Test

Horizontal Hydraulic Conductivity

Hvorslev K

Data not usable

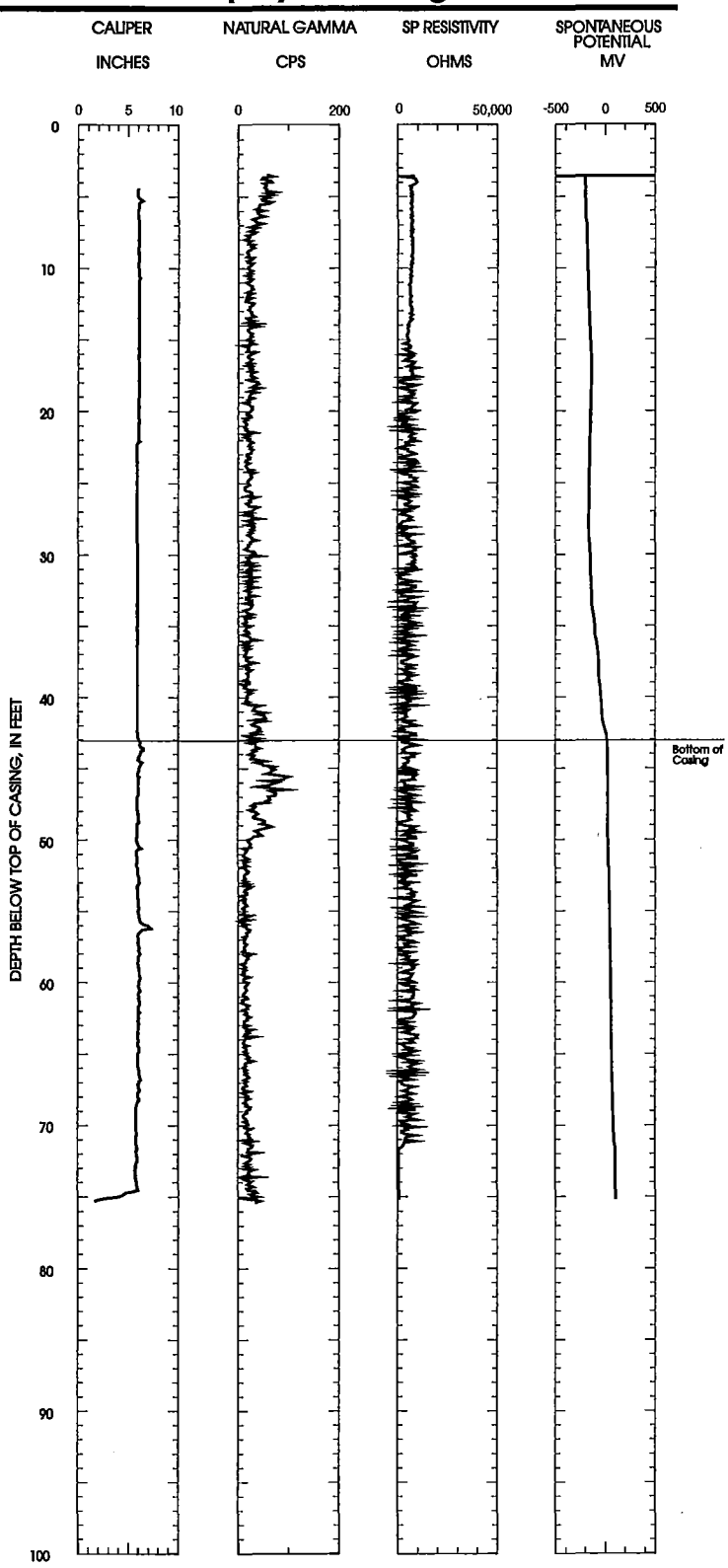


Dane County

DN-09/10E/33-0441

SANDSTONE AQUIFER

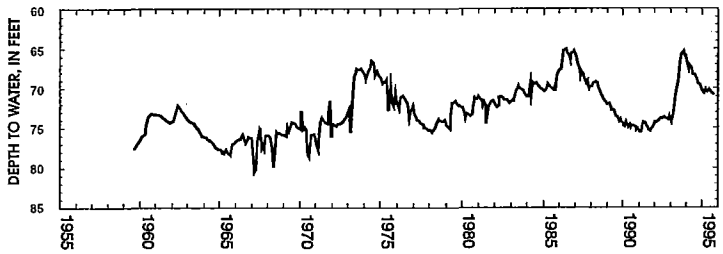
Geophysical Logs



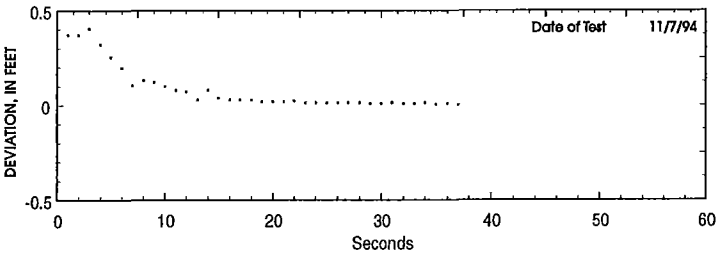
Well Information

Total Depth	105	feet
Cased Depth	43	feet
Casing Diameter	6	inches
Use of Well	Non-pumping	

Depth to Water Below Land Surface For Period of Record



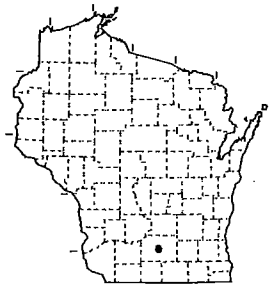
Deviation From Static Water Level During Displacement\Recovery Test



Horizontal Hydraulic Conductivity

Hvorslev K

32.0 ft/day

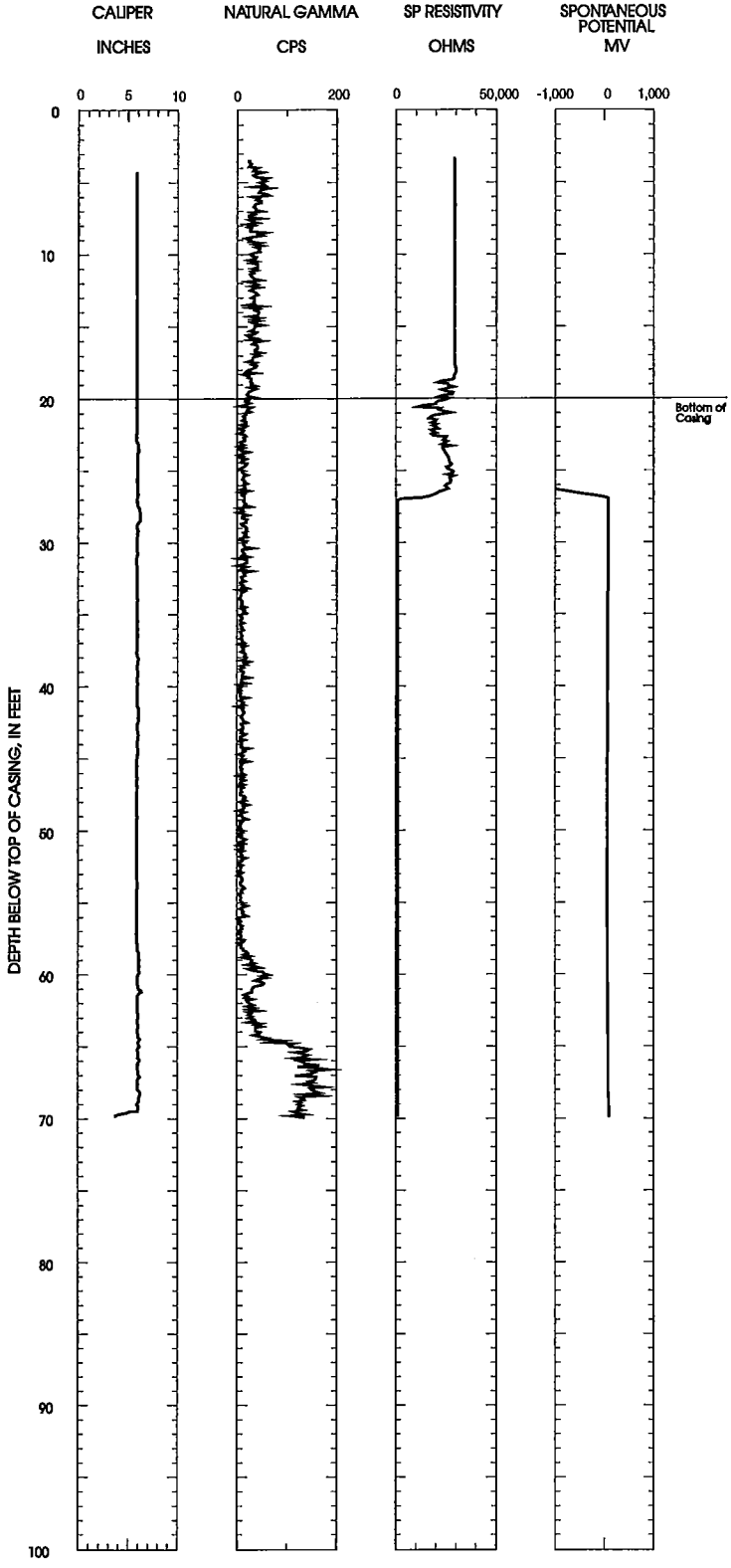


Dane County

DN-09/11E/34-1355

SANDSTONE AQUIFER

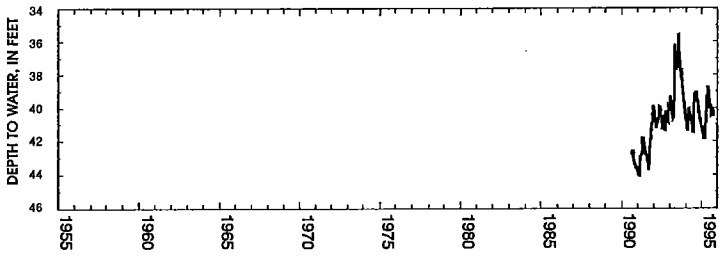
Geophysical Logs



Well Information

Total Depth	70	feet
Cased Depth	20	feet
Casing Diameter	6	inches
Use of Well	Non-pumping	

Depth to Water Below Land Surface For Period of Record

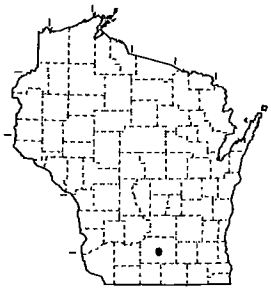


Deviation From Static Water Level During Displacement\Recovery Test

Horizontal Hydraulic Conductivity

Hvorslev K

No test

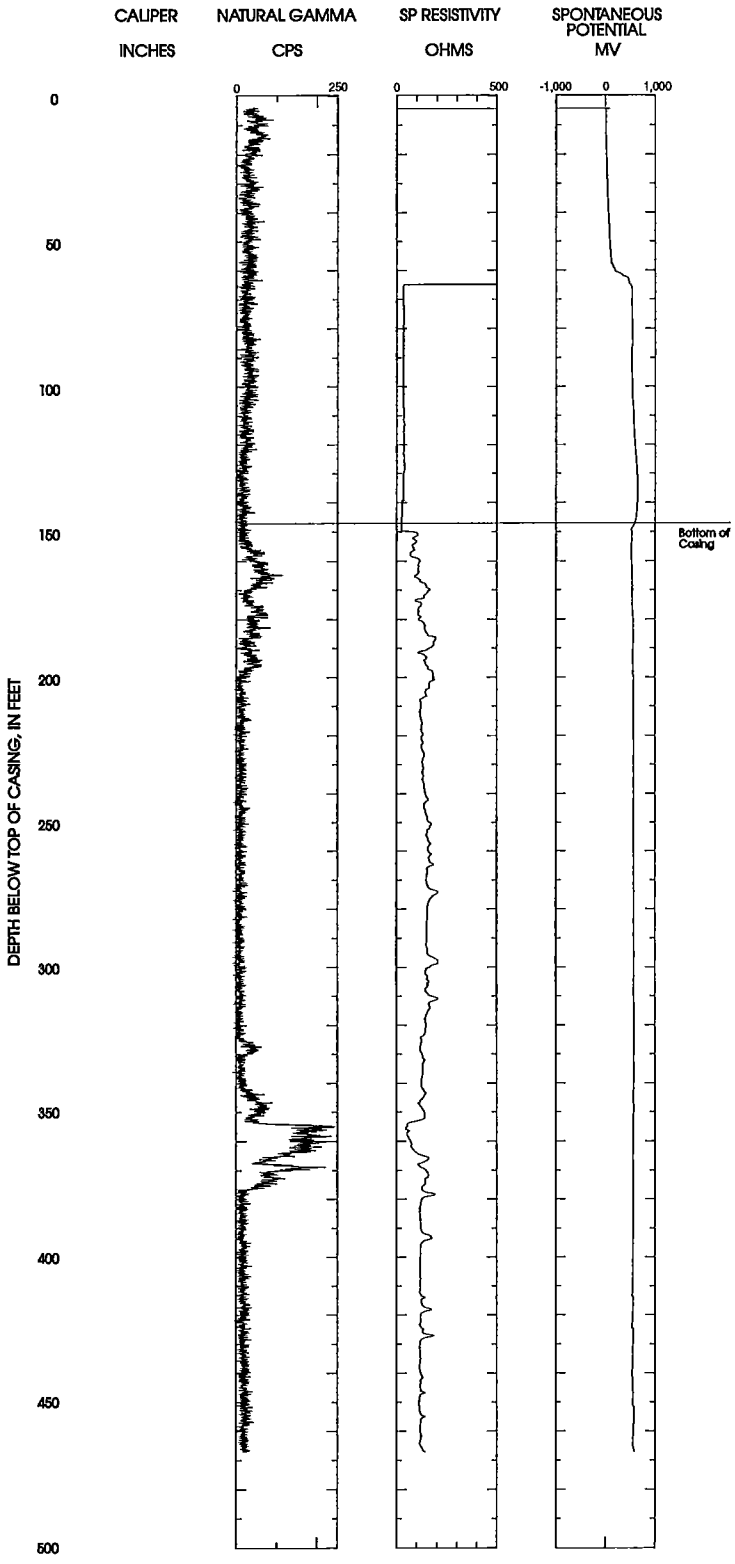


Dane County

DN-08/08E/09-1371

SANDSTONE AQUIFER

Geophysical Logs



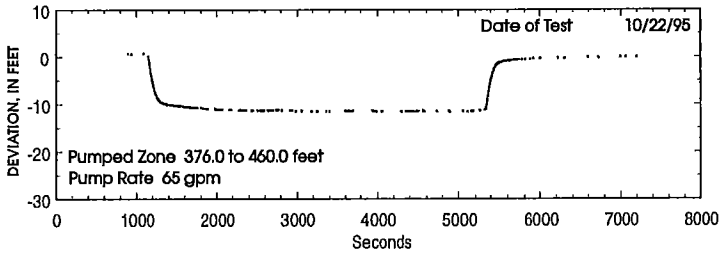
Well Information

Total Depth	465	feet
Cased Depth	147	feet
Casing Diameter	6	inches
Use of Well	Non-pumping	

Depth to Water Below Land Surface For Period of Record

New well - no record available

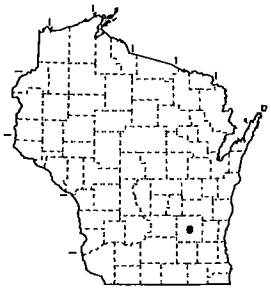
Deviation From Static Water Level During Pump Test



Horizontal Hydraulic Conductivity

Cooper - Jacob K

12.3 ft/day

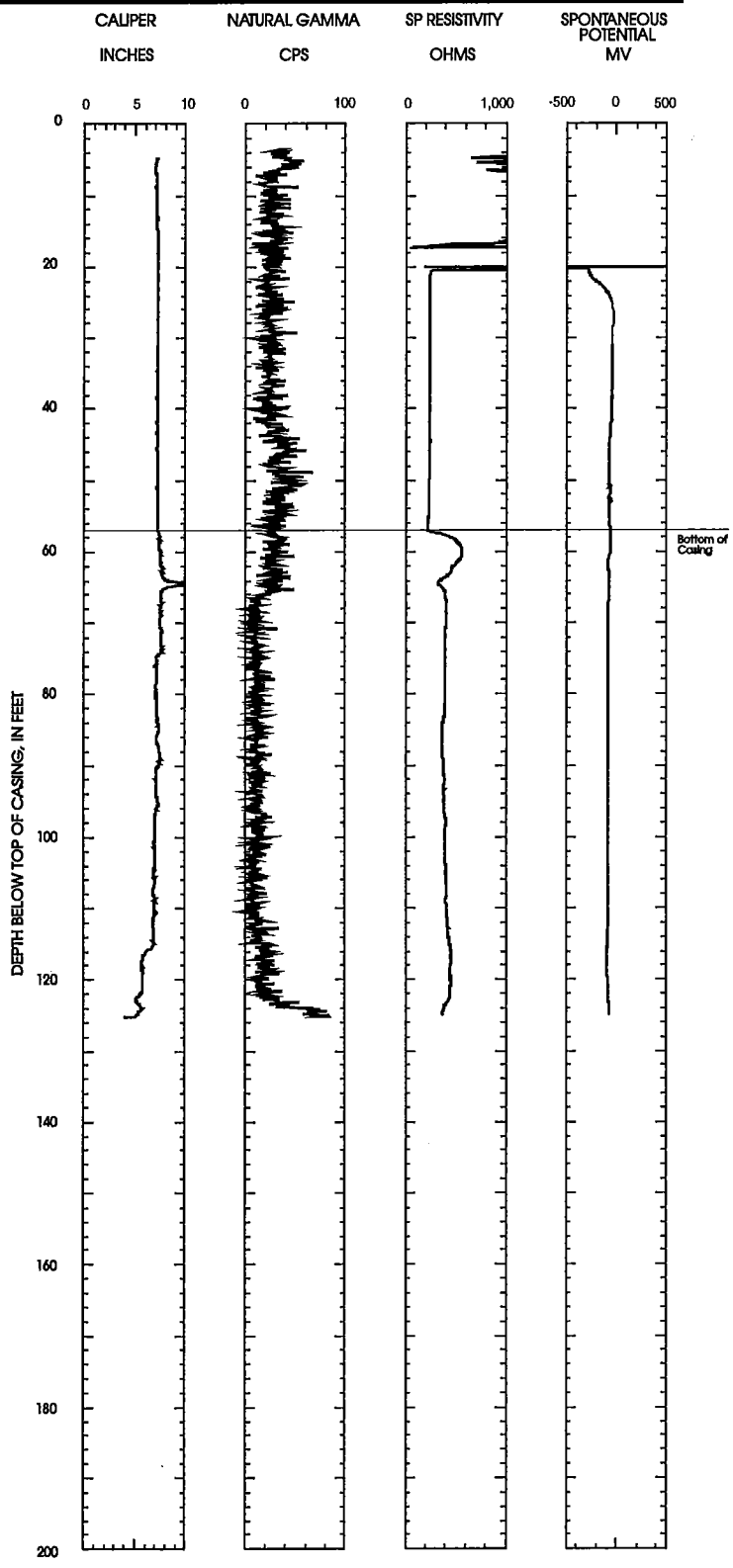


Dodge County

DG-11/13E/23-0081

SANDSTONE AQUIFER

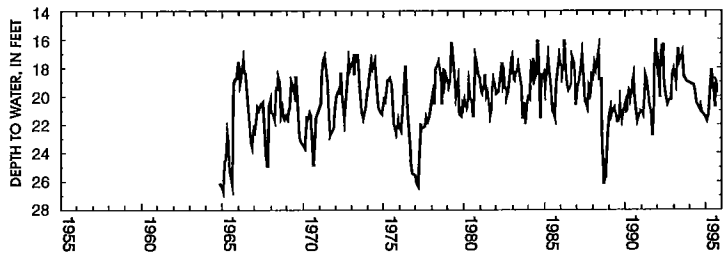
Geophysical Logs



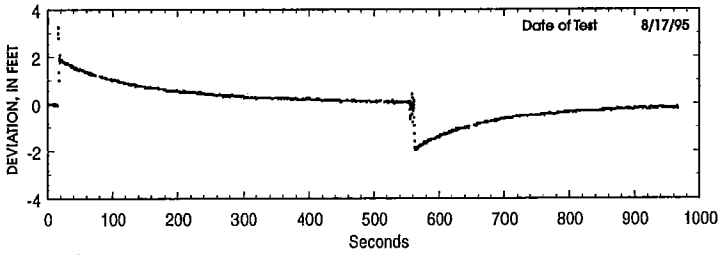
Well Information

Total Depth	125	feet
Cased Depth	57	feet
Casing Diameter	6	inches
Use of Well	Non-pumping	

Depth to Water Below Land Surface For Period of Record



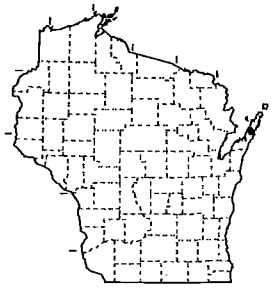
Deviation From Static Water Level During Displacement\Recovery Test



Horizontal Hydraulic Conductivity

Hvorslev K

1.9 ft/day

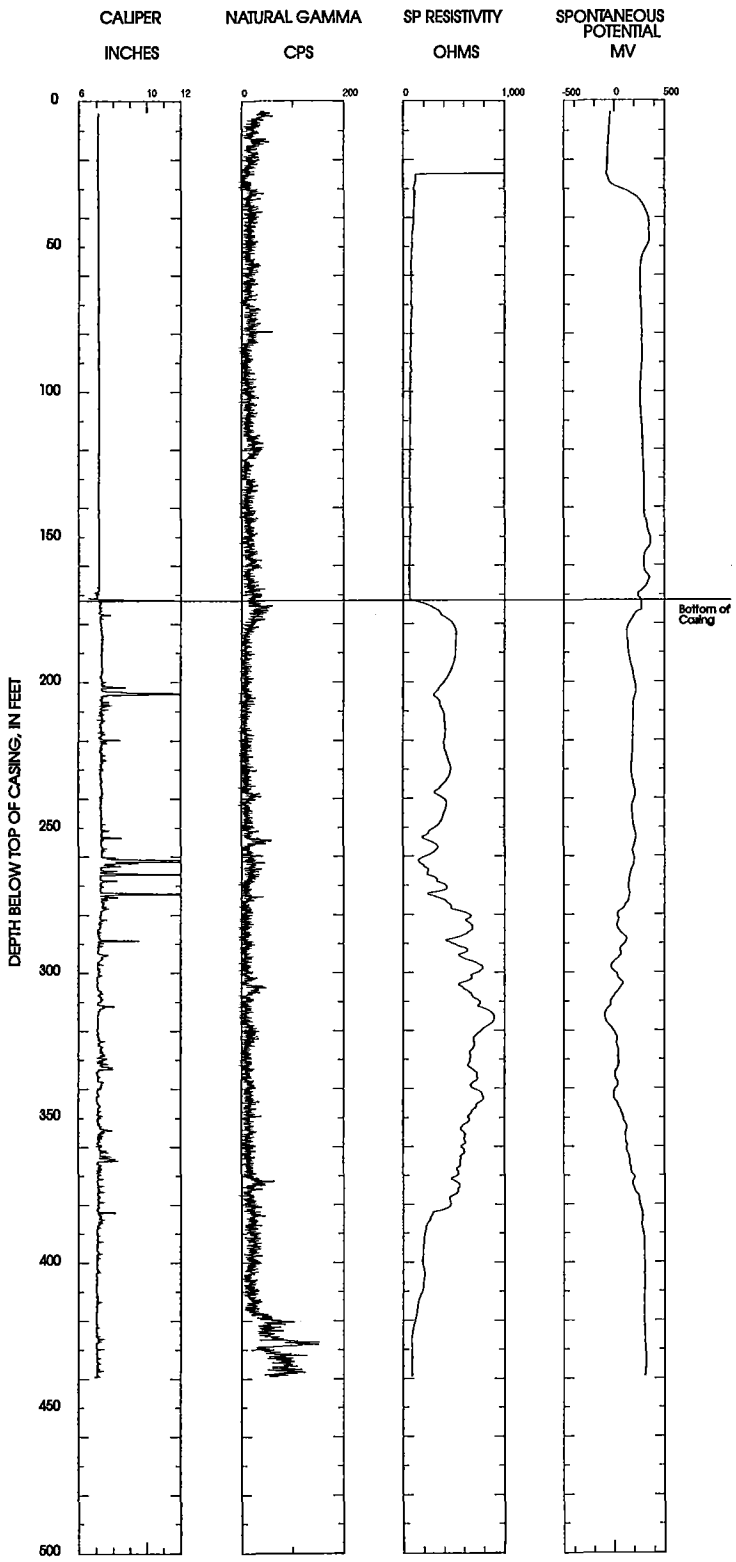


Door County

DR-27/26E/05-0265

SILURIAN AQUIFER

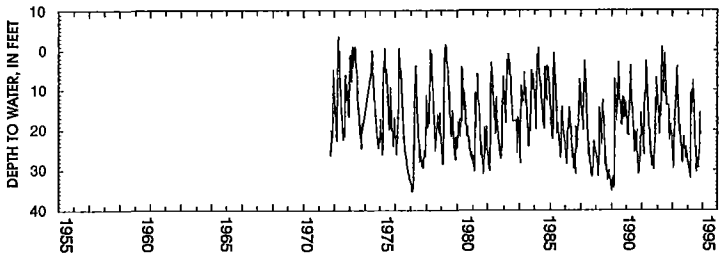
Geophysical Logs



Well Information

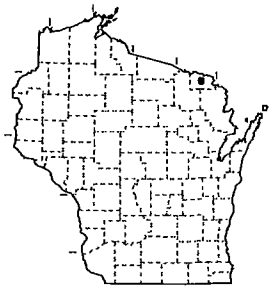
Total Depth	442	feet
Cased Depth	172	feet
Casing Diameter	6	inches
Use of Well	Non-pumping	

Depth to Water Below Land Surface For Period of Record



Deviation From Static Water Level During Pump Test

No selective formation pump test

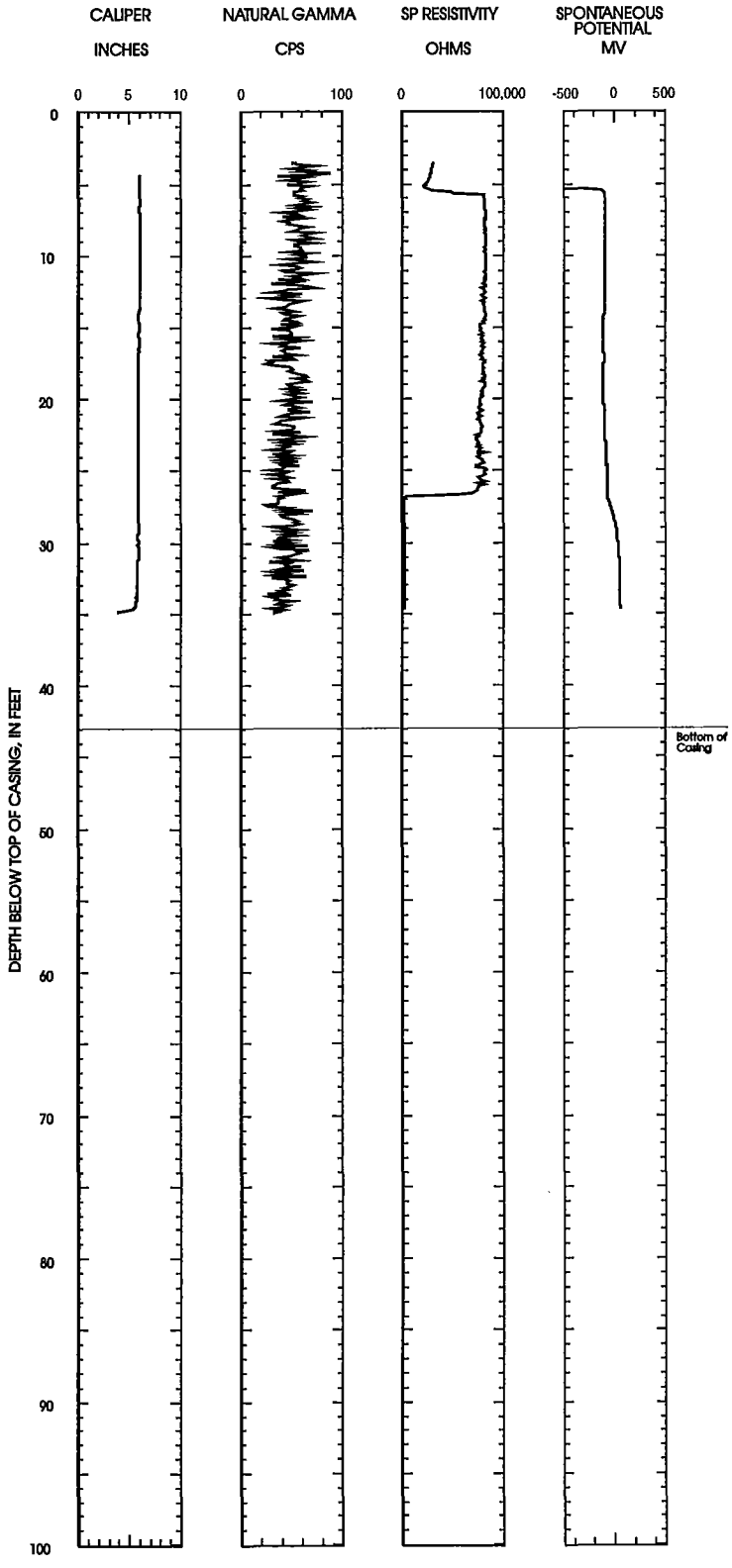


Florence County

FC-39/15E/31-0004

SAND AND GRAVEL AQUIFER

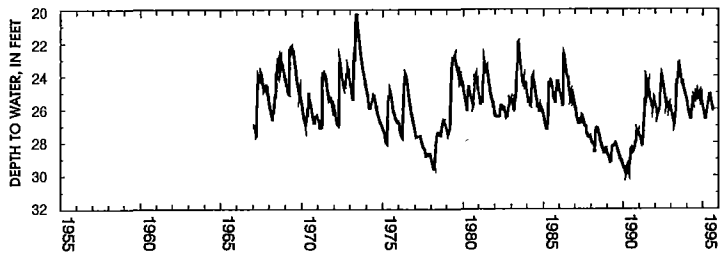
Geophysical Logs



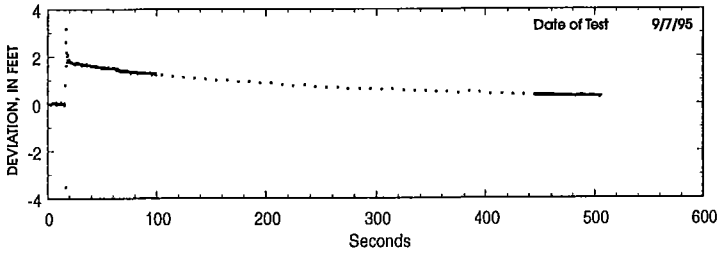
Well Information

Total Depth	53	feet
Cased Depth	43	feet
Casing Diameter	6	inches
Use of Well	Non-pumping	

Depth to Water Below Land Surface For Period of Record



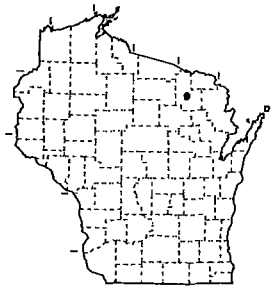
Deviation From Static Water Level During Displacement\Recovery Test



Horizontal Hydraulic Conductivity

Hvorslev K

6.4 ft/day



Forest County

FR-41/14E/18-0002

SAND AND GRAVEL AQUIFER

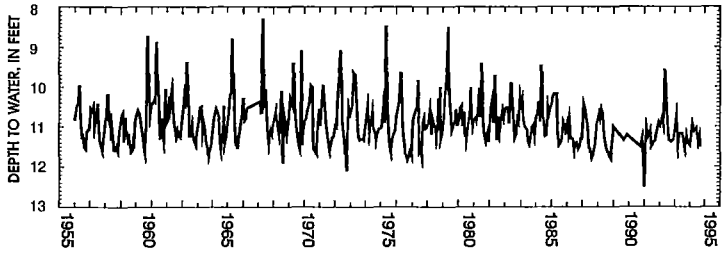
Geophysical Logs

No Logs Available

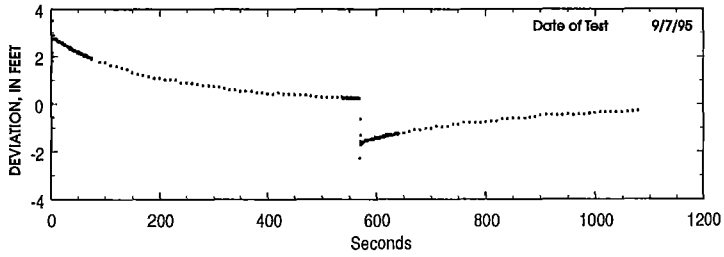
Well Information

Total Depth	18	feet
Cased Depth	15	feet
Casing Diameter	1.25	inches
Use of Well	Non-pumping	

Depth to Water Below Land Surface For Period of Record



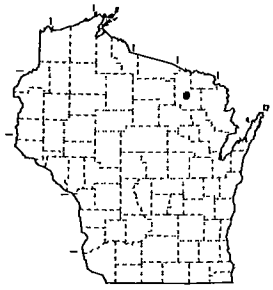
Deviation From Static Water Level During Displacement\Recovery Test



Horizontal Hydraulic Conductivity

Hvorslev K

0.5 ft/day

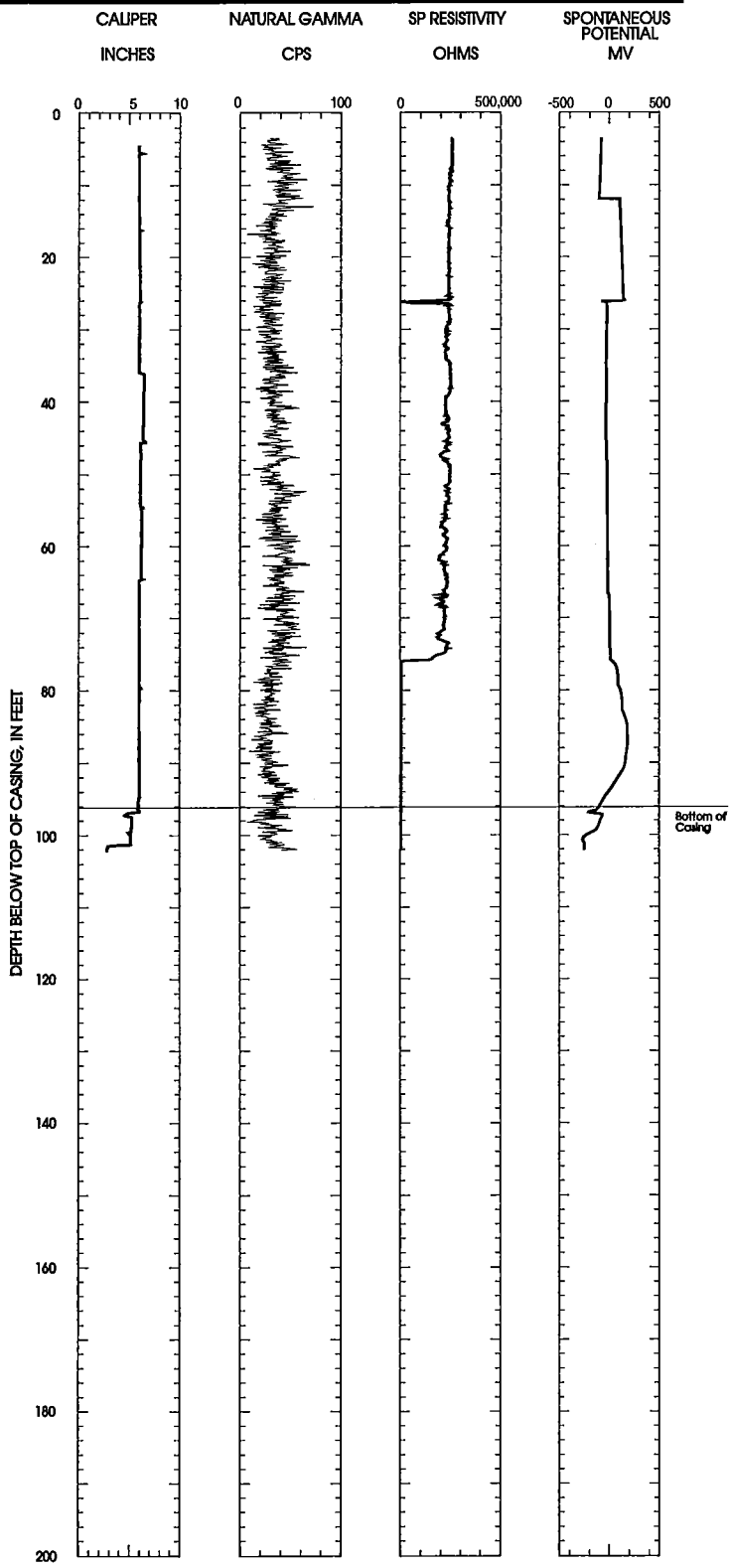


Forest County

FR-40/12E/21-0087

SAND AND GRAVEL AQUIFER

Geophysical Logs

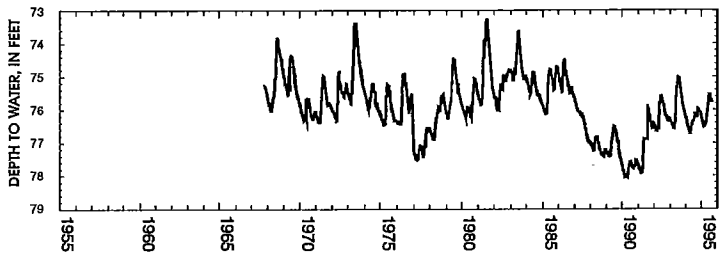


Well Information

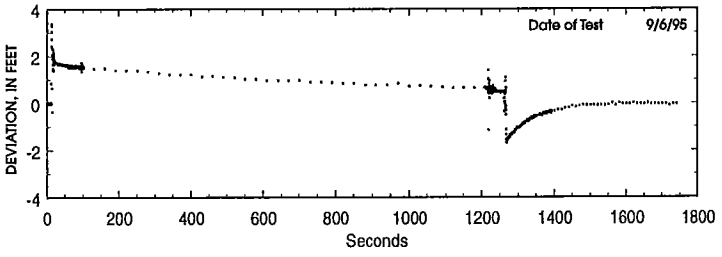
Total Depth	102	feet
Cased Depth	96	feet *
Casing Diameter	6	inches
Use of Well	Non-pumping	

* Picked from geophysical logs

Depth to Water Below Land Surface For Period of Record



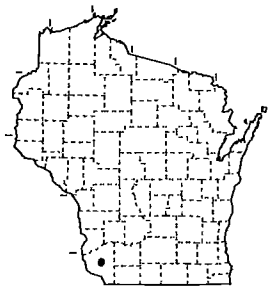
Deviation From Static Water Level During Displacement\Recovery Test



Horizontal Hydraulic Conductivity

Hvorslev K

10.0 ft/day



Grant County

GR-08/01W/10-0072

SAND AND GRAVEL AQUIFER

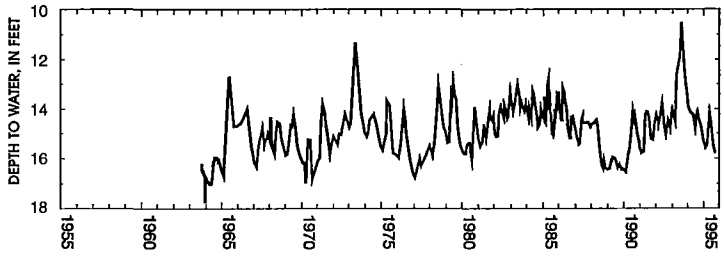
Geophysical Logs

No Logs Available

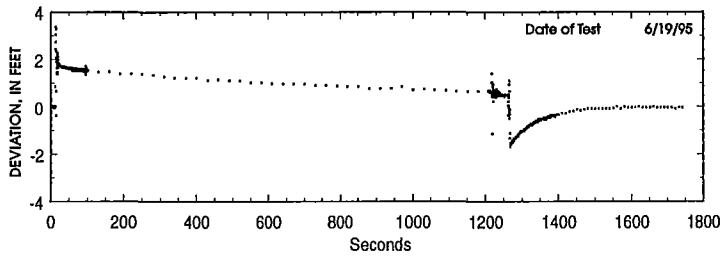
Well Information

Total Depth	18	feet
Cased Depth	16	feet
Casing Diameter	1.25	inches
Use of Well	Non-pumping	

Depth to Water Below Land Surface For Period of Record



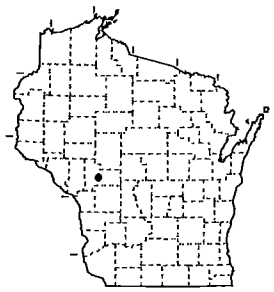
Deviation From Static Water Level During Displacement\Recovery Test



Horizontal Hydraulic Conductivity

Hvorslev K

2.6 ft/day

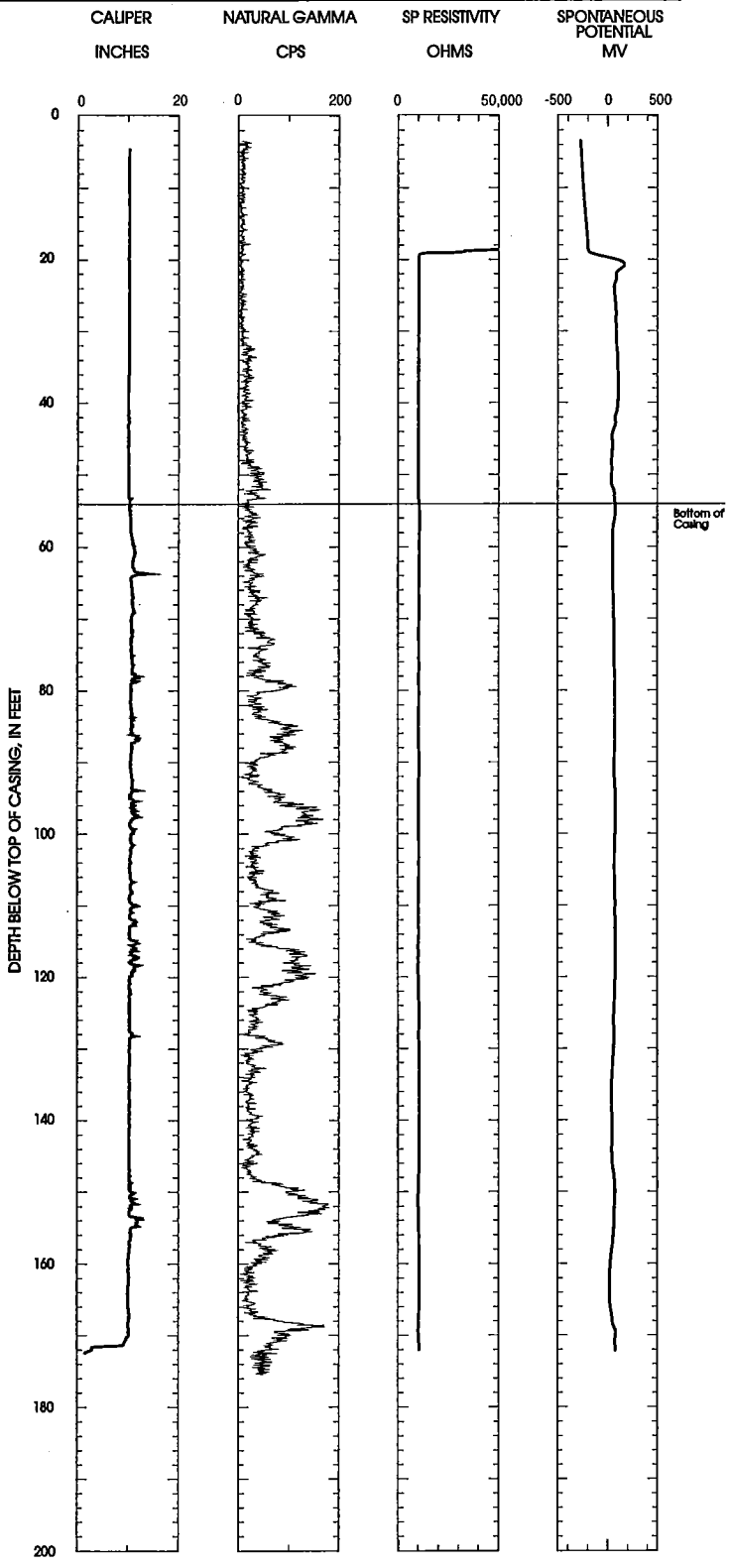


Jackson County

JA-20/03W/30-0005

SANDSTONE AQUIFER

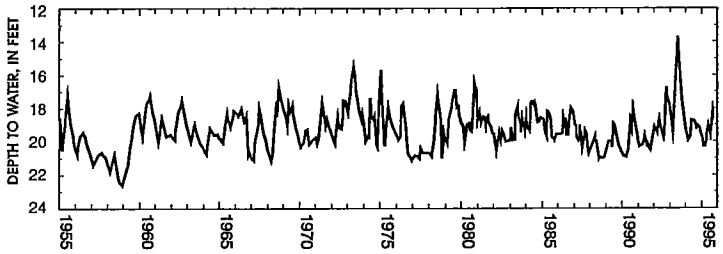
Geophysical Logs



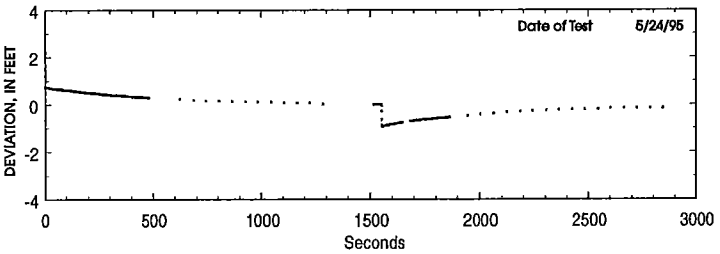
Well Information

Total Depth	190	feet
Cased Depth	54	feet
Casing Diameter	10	inches
Use of Well	Non-pumping	

Depth to Water Below Land Surface For Period of Record



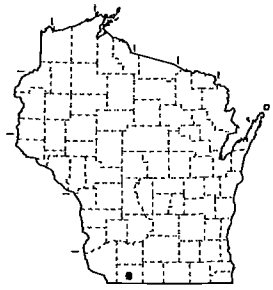
Deviation From Static Water Level During Displacement\Recovery Test



Horizontal Hydraulic Conductivity

Hvorslev K

0.6 ft/day

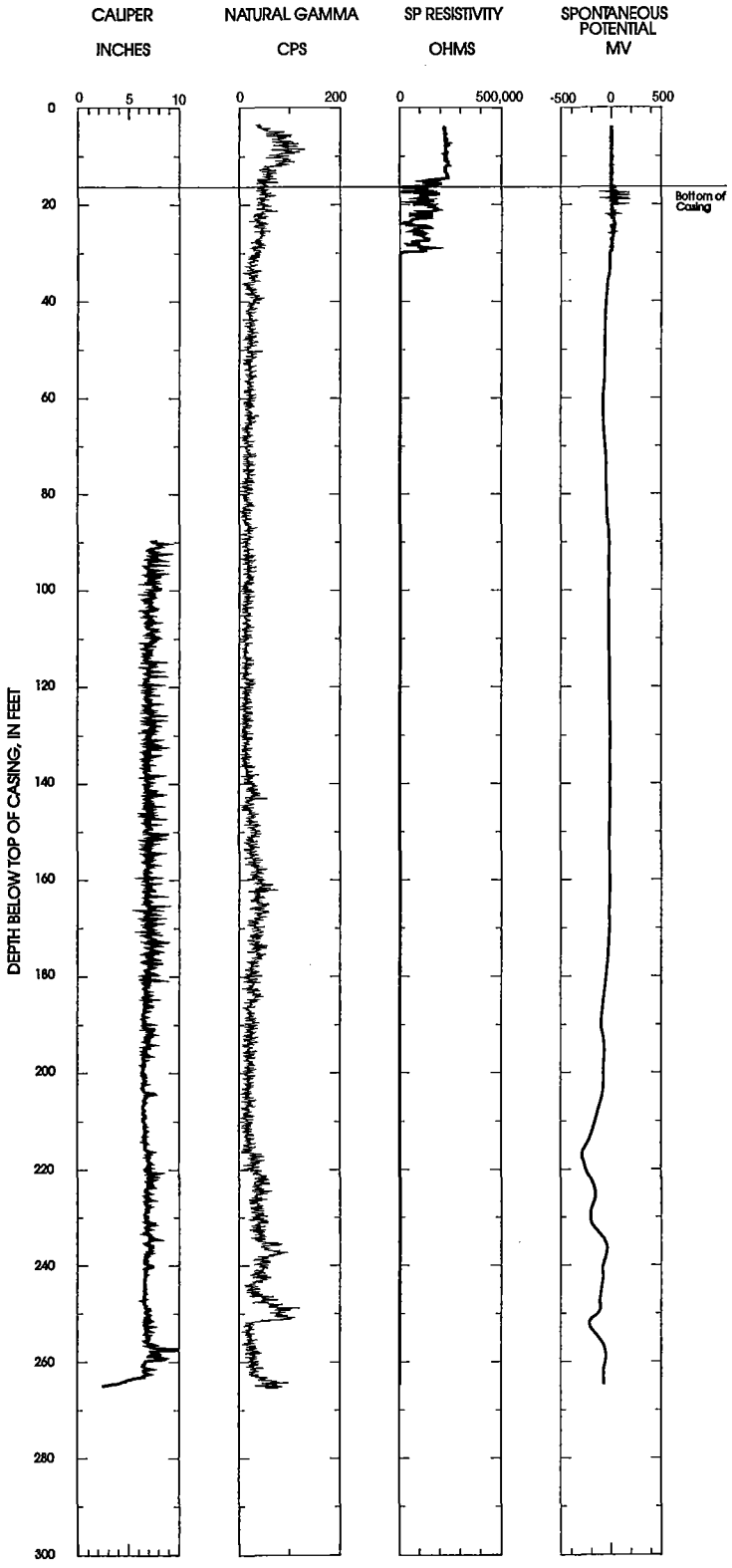


Lafayette County

LF-01/02E/33-0057

GALENA-PLATTEVILLE AQUIFER

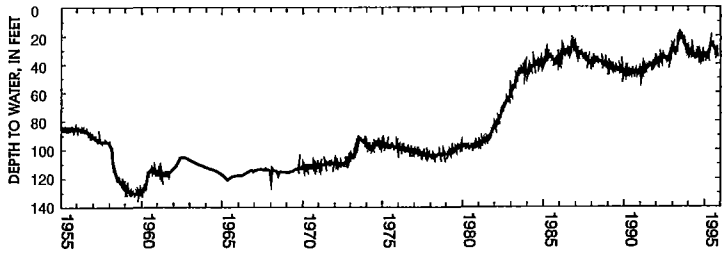
Geophysical Logs



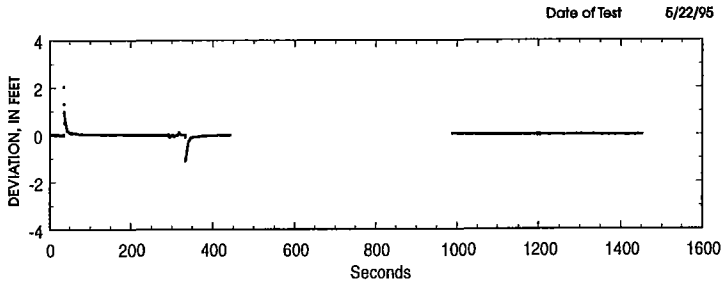
Well Information

Total Depth	265	feet
Cased Depth	16	feet
Casing Diameter	8	inches
Use of Well	Non-pumping	

Depth to Water Below Land Surface For Period of Record



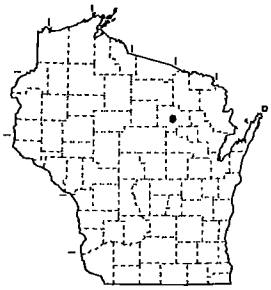
Deviation From Static Water Level During Displacement\Recovery Test



Horizontal Hydraulic Conductivity

Hvorslev K

21.2 ft/day



Langlade County

LA-31/11E/20-0064

SAND AND GRAVEL AQUIFER

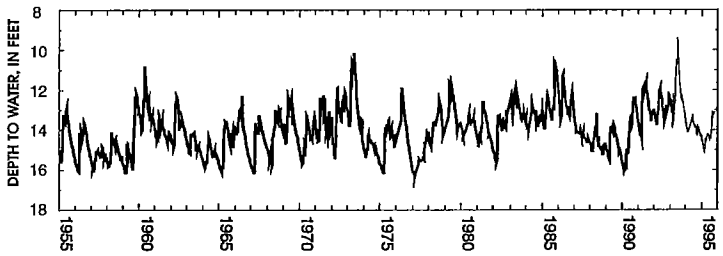
Geophysical Logs

No Logs Available

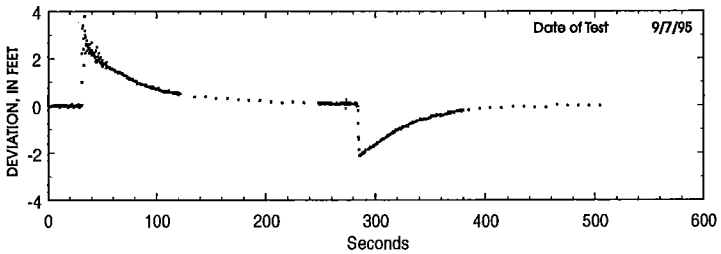
Well Information

Total Depth	19.7	feet
Cased Depth	17.5	feet
Casing Diameter	2	inches
Use of Well	Non-pumping	

Depth to Water Below Land Surface For Period of Record



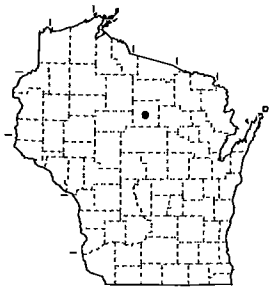
Deviation From Static Water Level During Displacement\Recovery Test



Horizontal Hydraulic Conductivity

Hvorslev K

9.4 ft/day



Lincoln County

LN-34/06E/36-0060

SAND AND GRAVEL AQUIFER

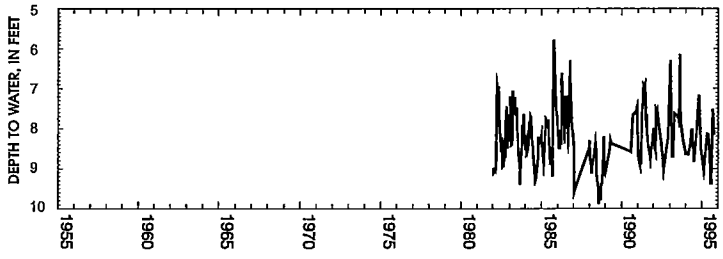
Geophysical Logs

No Logs Available

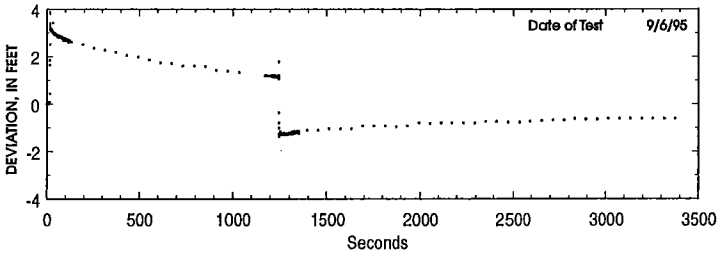
Well Information

Total Depth	21.8	feet
Cased Depth	20	feet
Casing Diameter	1.25	inches
Use of Well	Non-pumping	

Depth to Water Below Land Surface For Period of Record



Deviation From Static Water Level During Displacement\Recovery Test

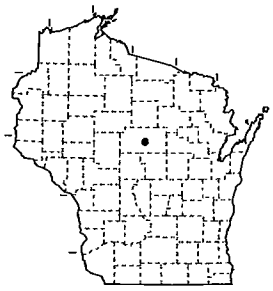


Horizontal Hydraulic Conductivity

Hvorslev K

2.3×10^{-2} ft/day

Probably plugged



Marathon County

MR-27/09E/31-0028

SAND AND GRAVEL AQUIFER

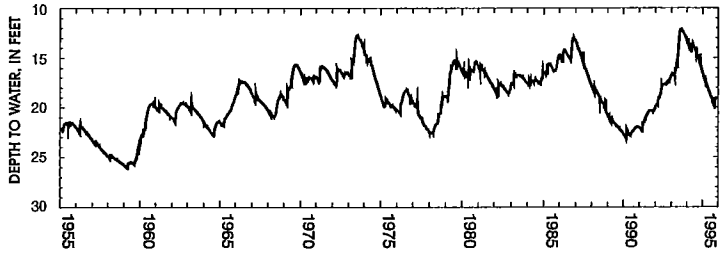
Geophysical Logs

No Logs Available

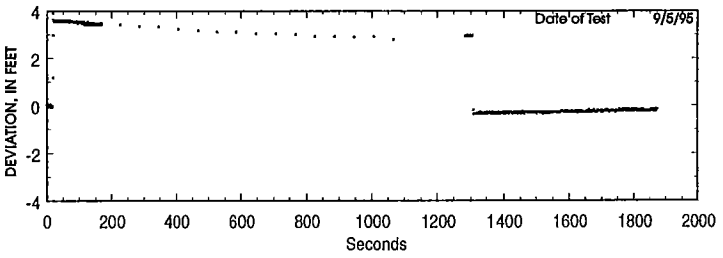
Well Information

Total Depth	27	feet
Cased Depth	25	feet
Casing Diameter	1.25	inches
Use of Well	Non-pumping	

Depth to Water Below Land Surface For Period of Record



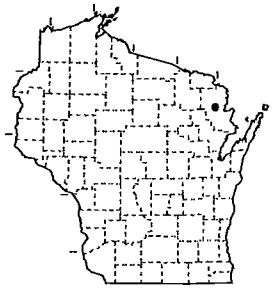
Deviation From Static Water Level During Displacement\Recovery Test



Horizontal Hydraulic Conductivity

Hvorslev K

Probably plugged

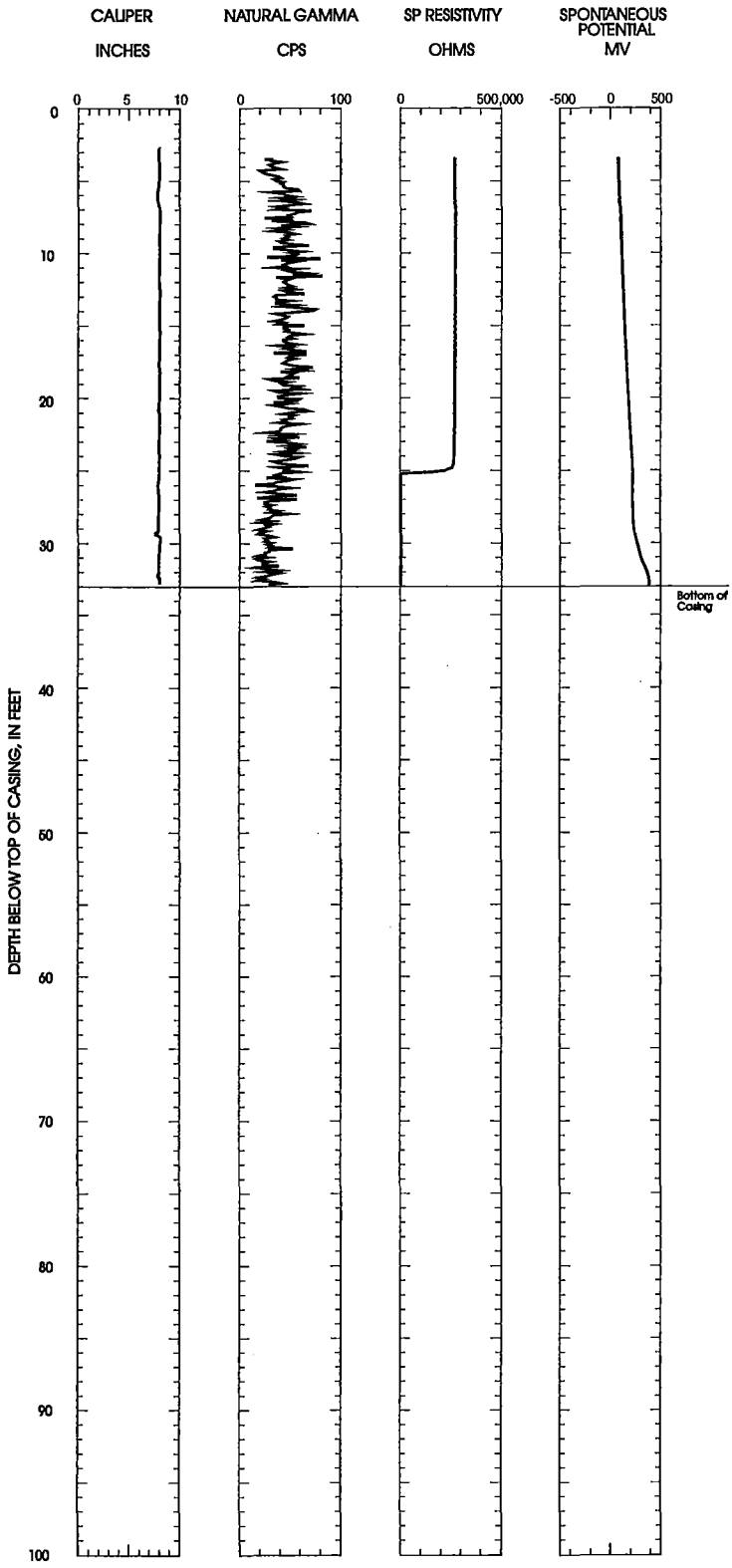


Marinette County

MT-37/20E/34-0007

SAND AND GRAVEL AQUIFER

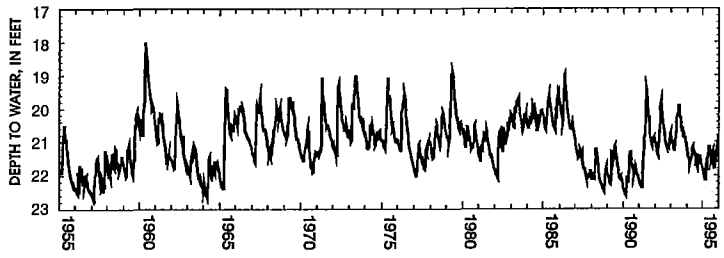
Geophysical Logs



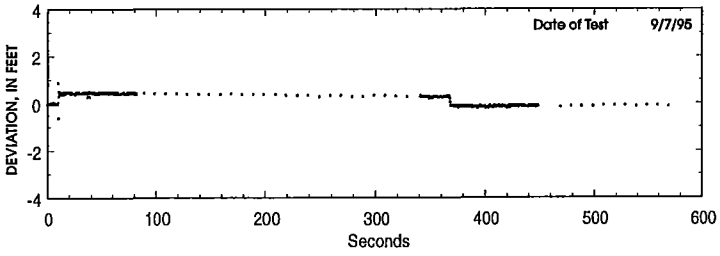
Well Information

Total Depth	33	feet
Cased Depth	33	feet
Casing Diameter	8	inches
Use of Well	Non-pumping	

Depth to Water Below Land Surface For Period of Record



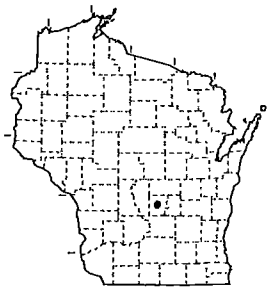
Deviation From Static Water Level During Displacement\Recovery Test



Horizontal Hydraulic Conductivity

Hvorslev K

Probably plugged

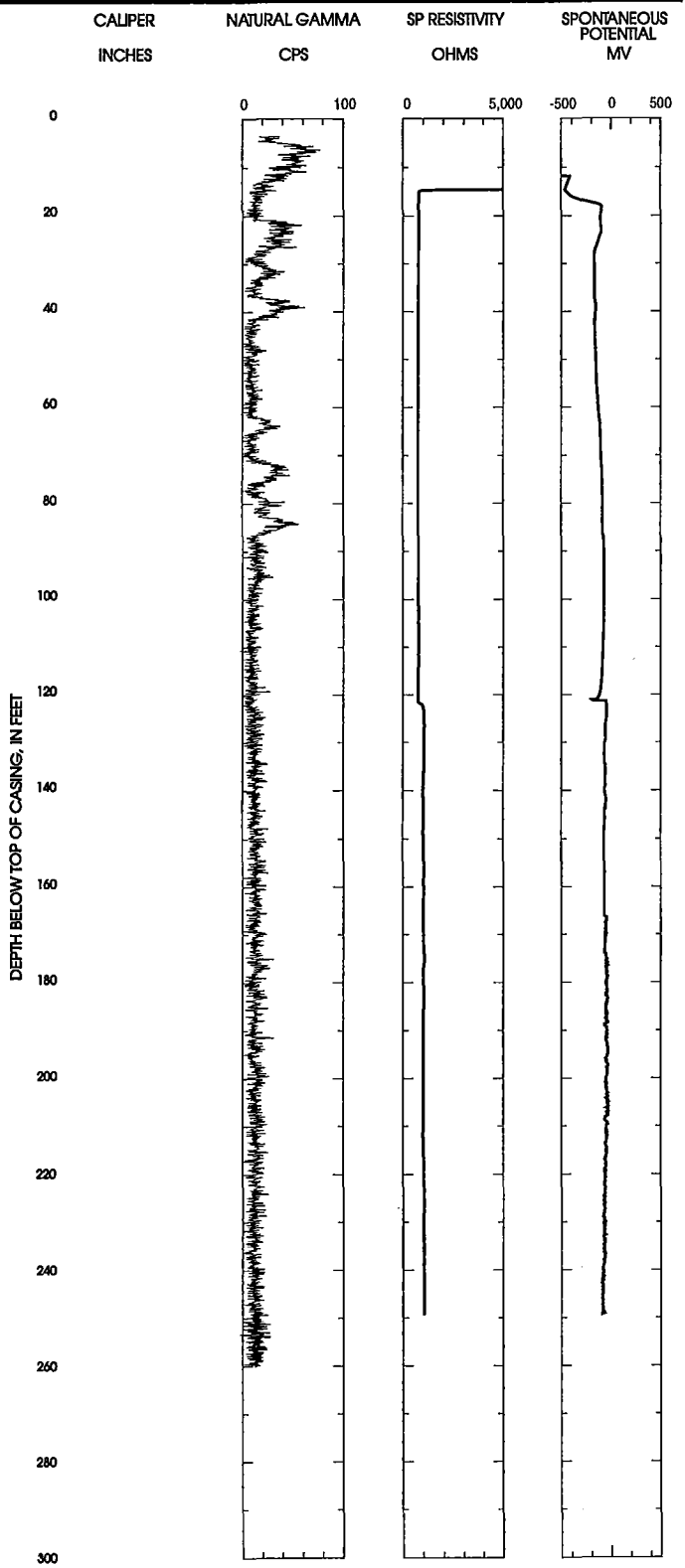


Marquette County

MQ-16/08E/12-0009

SANDSTONE AQUIFER

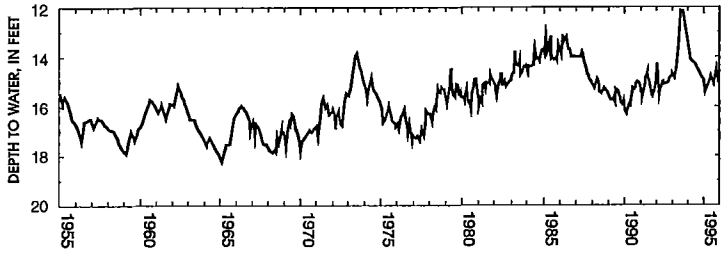
Geophysical Logs



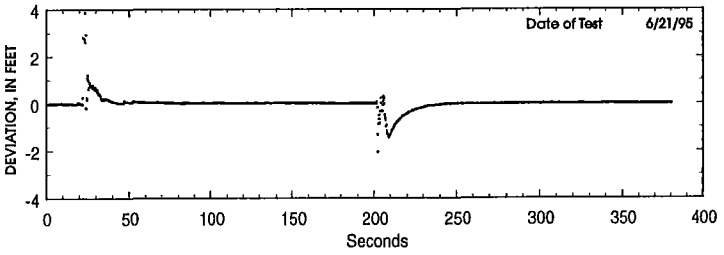
Well Information

Total Depth	274	feet
Cased Depth	Unknown	feet
Casing Diameter	6	inches
Use of Well	Non-pumping	

Depth to Water Below Land Surface For Period of Record



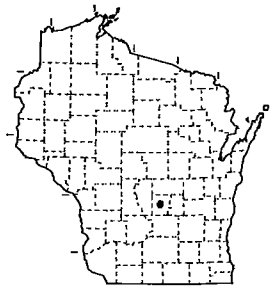
Deviation From Static Water Level During Displacement\Recovery Test



Horizontal Hydraulic Conductivity

Hvorslev K

> 8.1 feet/day

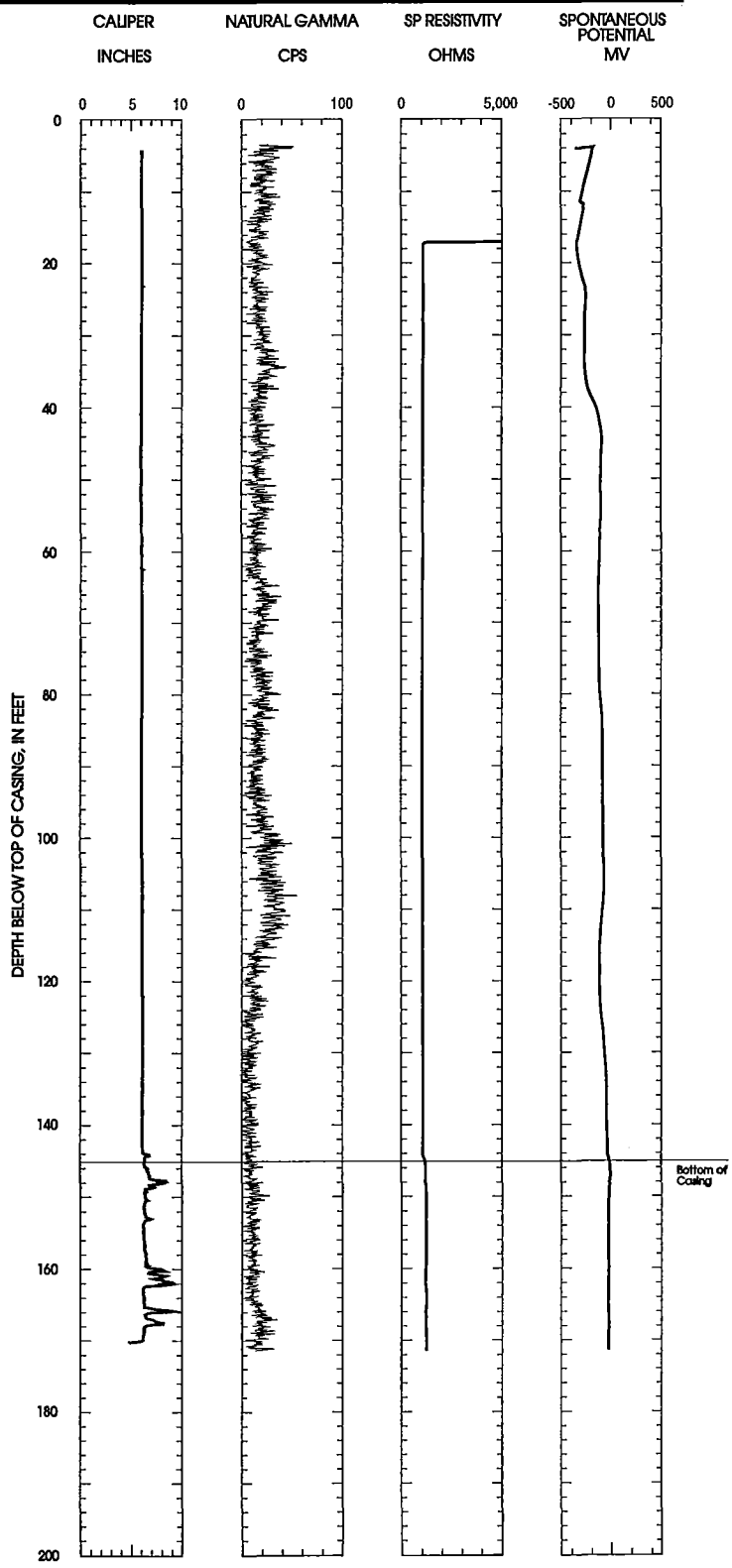


Marquette County

MQ-14/09E/30-0026

SANDSTONE AQUIFER

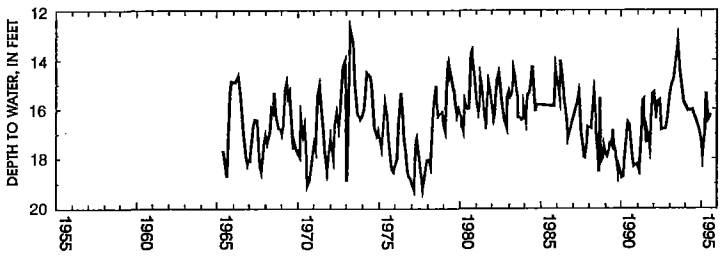
Geophysical Logs



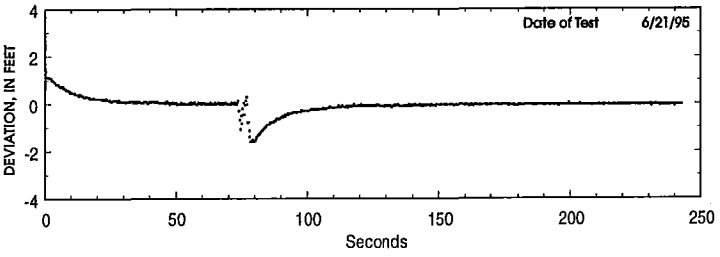
Well Information

Total Depth	170	feet
Cased Depth	145	feet
Casing Diameter	6	inches
Use of Well	Non-pumping	

Depth to Water Below Land Surface For Period of Record



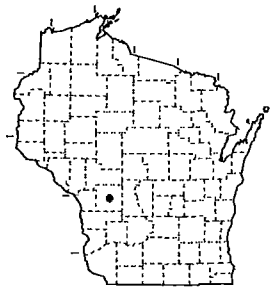
Deviation From Static Water Level During Displacement\Recovery Test



Horizontal Hydraulic Conductivity

Hvorslev K

46.3 ft/day

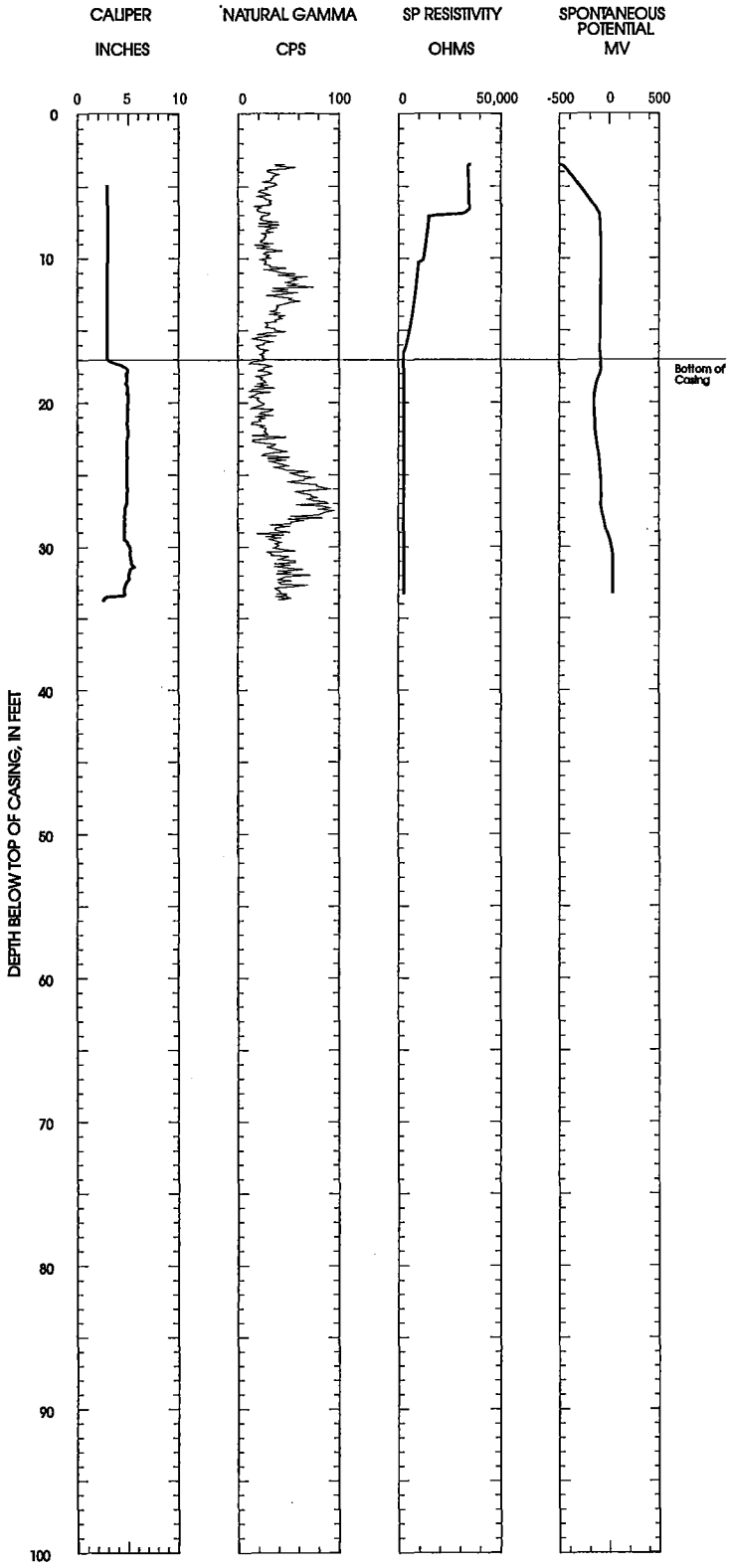


Monroe County

MO-15/04W/34-0002

SANDSTONE AQUIFER

Geophysical Logs

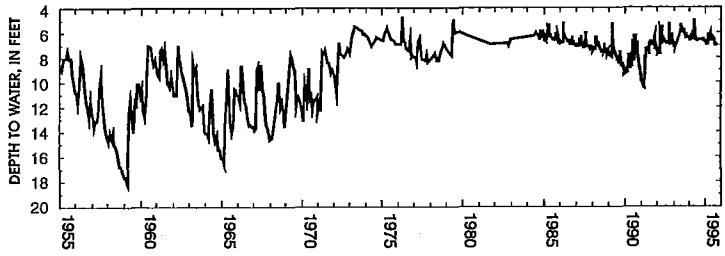


Well Information

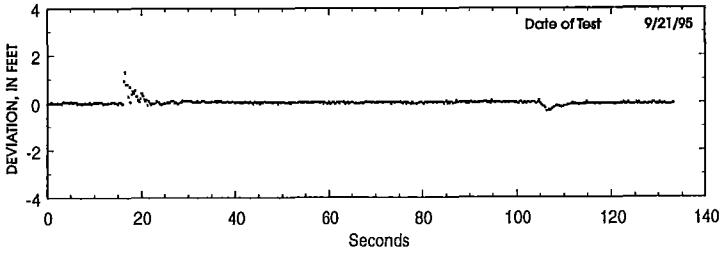
Total Depth	44	feet
Cased Depth	17	feet *
Casing Diameter	3	inches
Use of Well	Non-pumping	

*Picked from geophysical logs

Depth to Water Below Land Surface For Period of Record



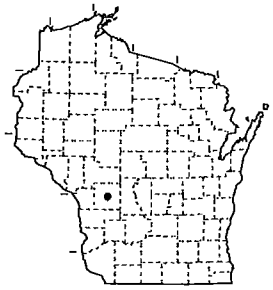
Deviation From Static Water Level During Displacement\Recovery Test



Horizontal Hydraulic Conductivity

Hvorslev K

33.6 ft/day

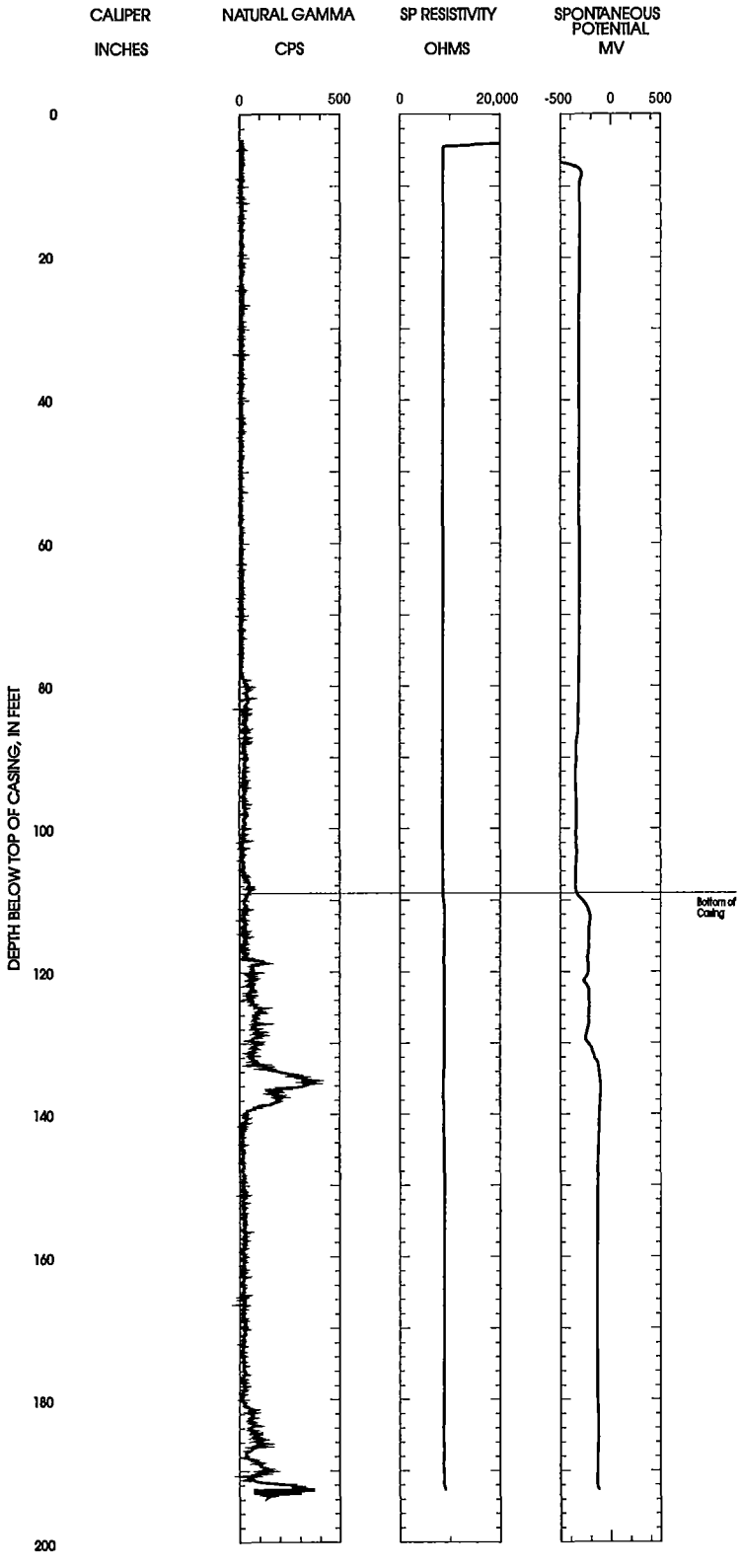


MO-18/02W/29-0017

Monroe County

SANDSTONE AQUIFER

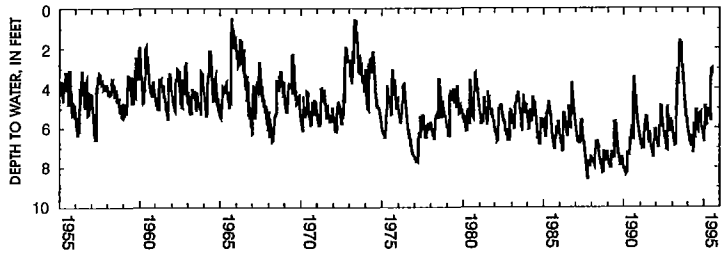
Geophysical Logs



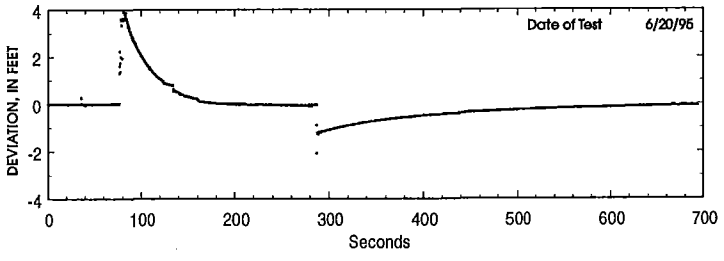
Well Information

Total Depth	192	feet
Cased Depth	109	feet
Casing Diameter	9	inches
Use of Well	Non-pumping	

Depth to Water Below Land Surface For Period of Record



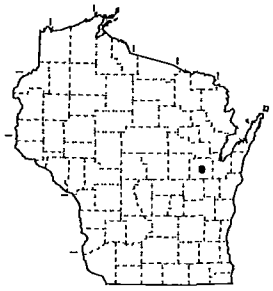
Deviation From Static Water Level During Displacement\Recovery Test



Horizontal Hydraulic Conductivity

Hvorslev K

4.3 ft/day

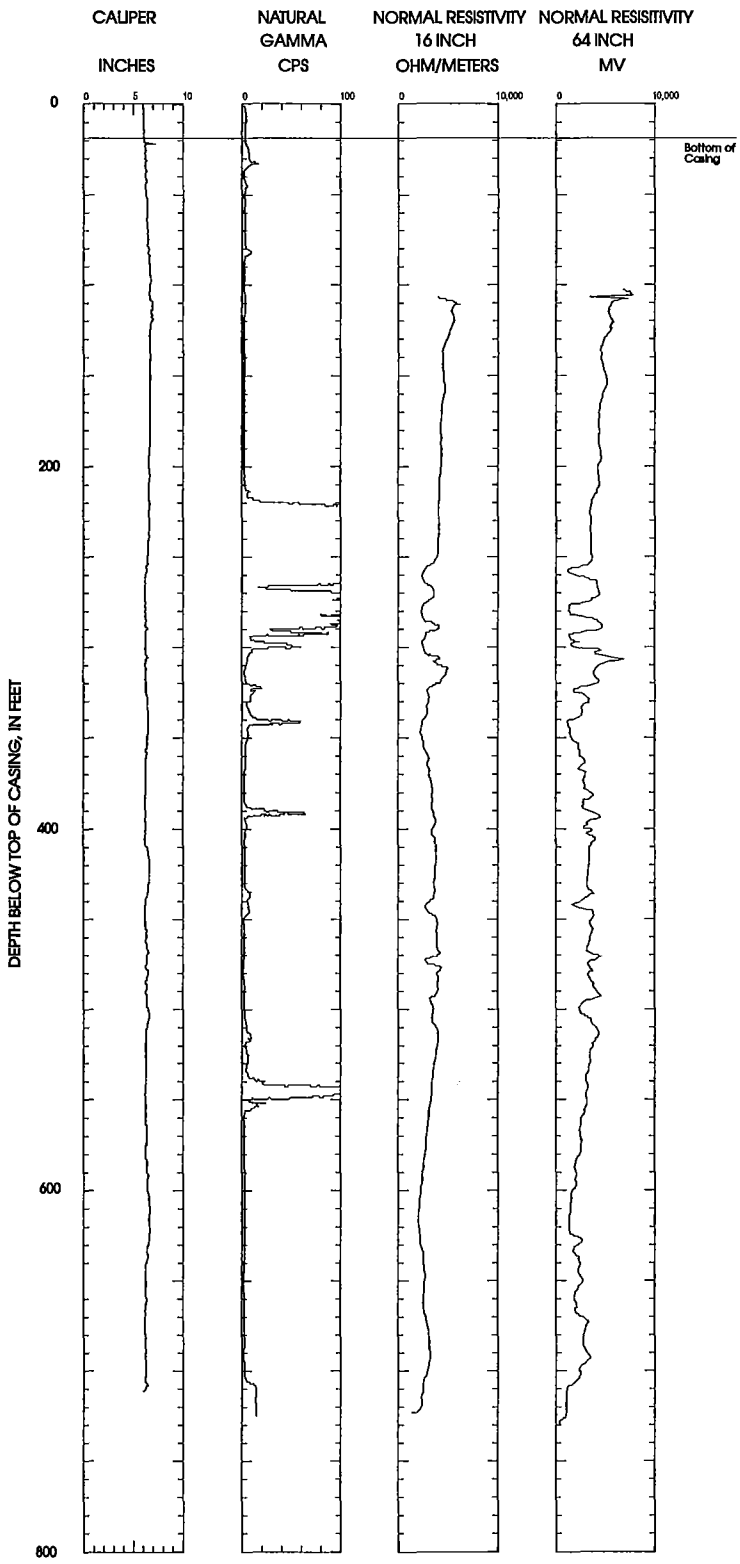


Outagamie County

OU-24/18E/08-0416

SAND AND GRAVEL AQUIFER

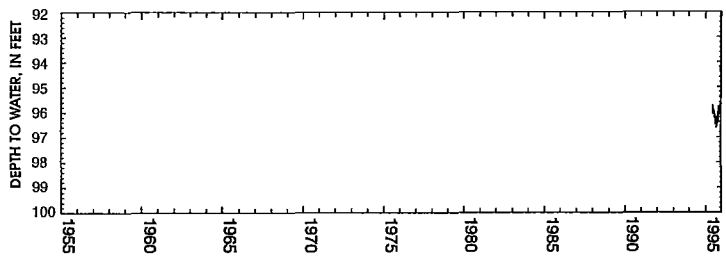
Geophysical Logs



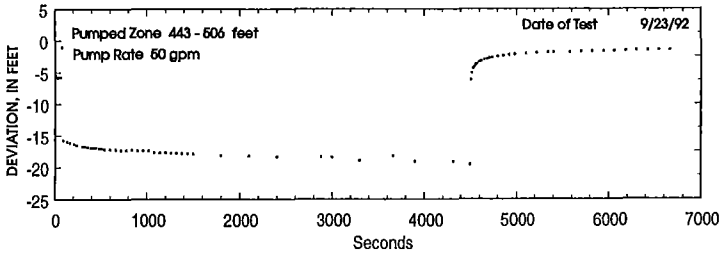
Well Information

Total Depth	740	feet
Cased Depth	18	feet
Casing Diameter	6.0	inches
Use of Well	Non-pumping	

Depth to Water Below Land Surface For Period of Record



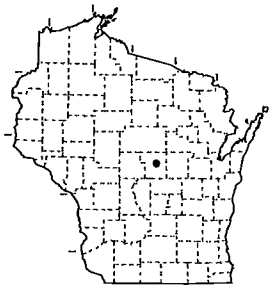
Deviation From Static Water Level During Pump Test



Horizontal Hydraulic Conductivity

Cooper - Jacob K

8.8 ft/day



Portage County

PT-23/03E/25-0376

SAND AND GRAVEL AQUIFER

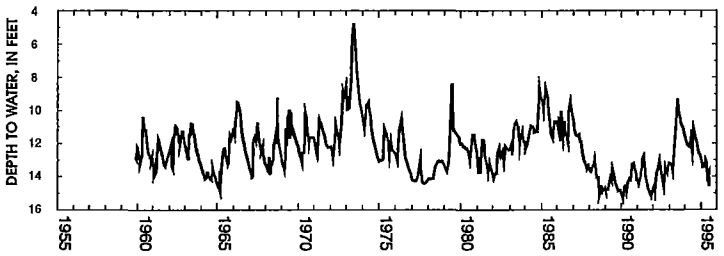
Geophysical Logs

No Logs Available

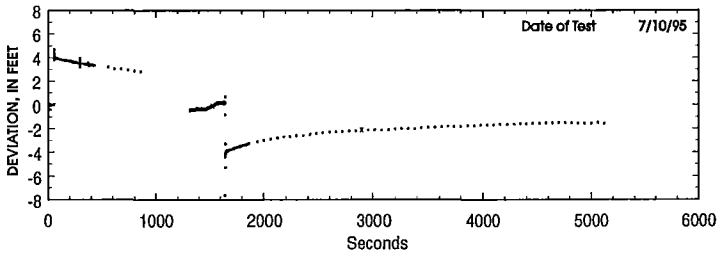
Well Information

Total Depth	36.4	feet
Cased Depth	34.0	feet
Casing Diameter	1.25	inches
Use of Well	Non-pumping	

Depth to Water Below Land Surface For Period of Record



Deviation From Static Water Level During Displacement\Recovery Test

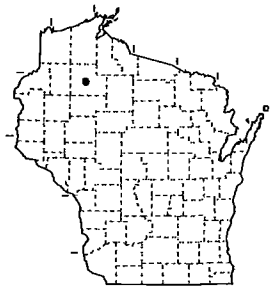


Horizontal Hydraulic Conductivity

Hvorslev K

6.0×10^{-2} ft/day

Probably plugged

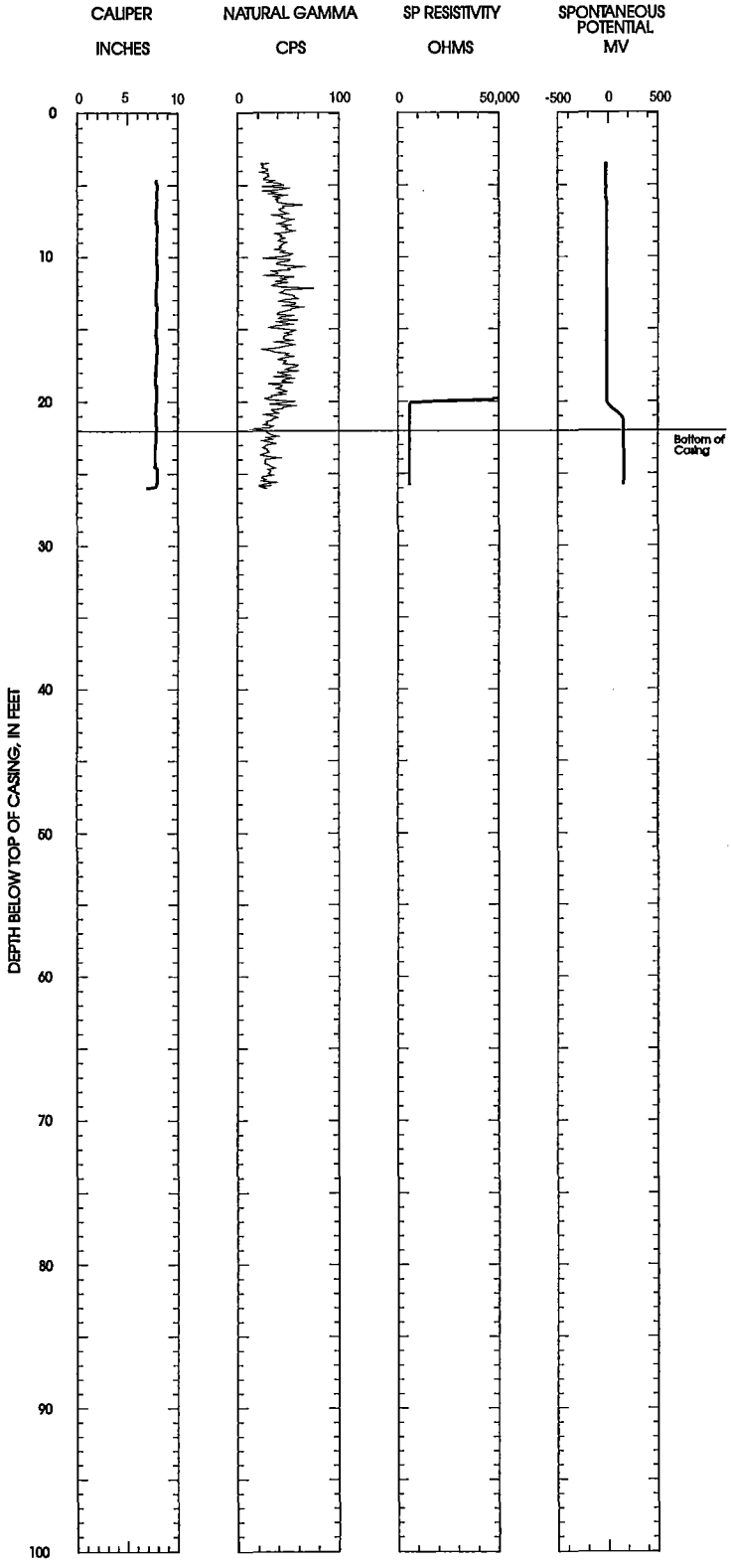


Sawyer County

SW-41/09W/28-0007

SAND AND GRAVEL AQUIFER

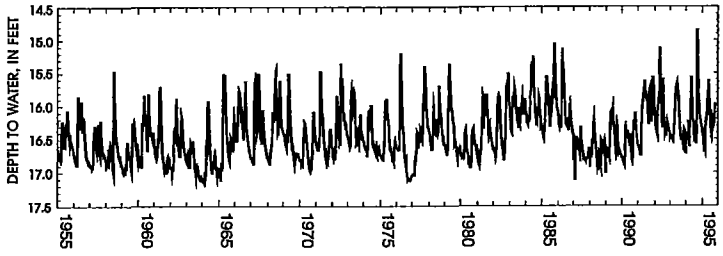
Geophysical Logs



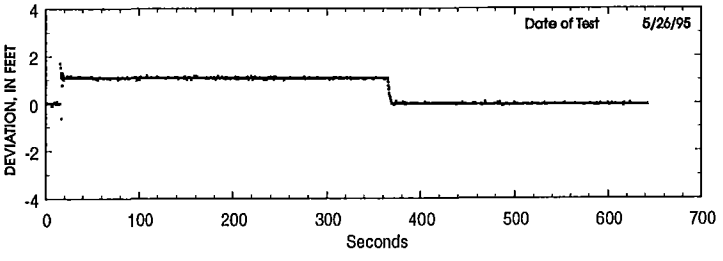
Well Information

Total Depth	25	feet
Cased Depth	22	feet
Casing Diameter	8	inches
Use of Well	Non-pumping	

Depth to Water Below Land Surface For Period of Record



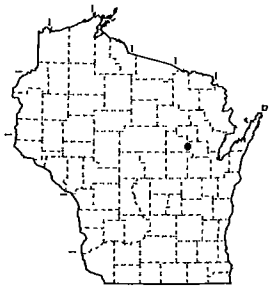
Deviation From Static Water Level During Displacement\Recovery Test



Horizontal Hydraulic Conductivity

Hvorslev K

Probably plugged

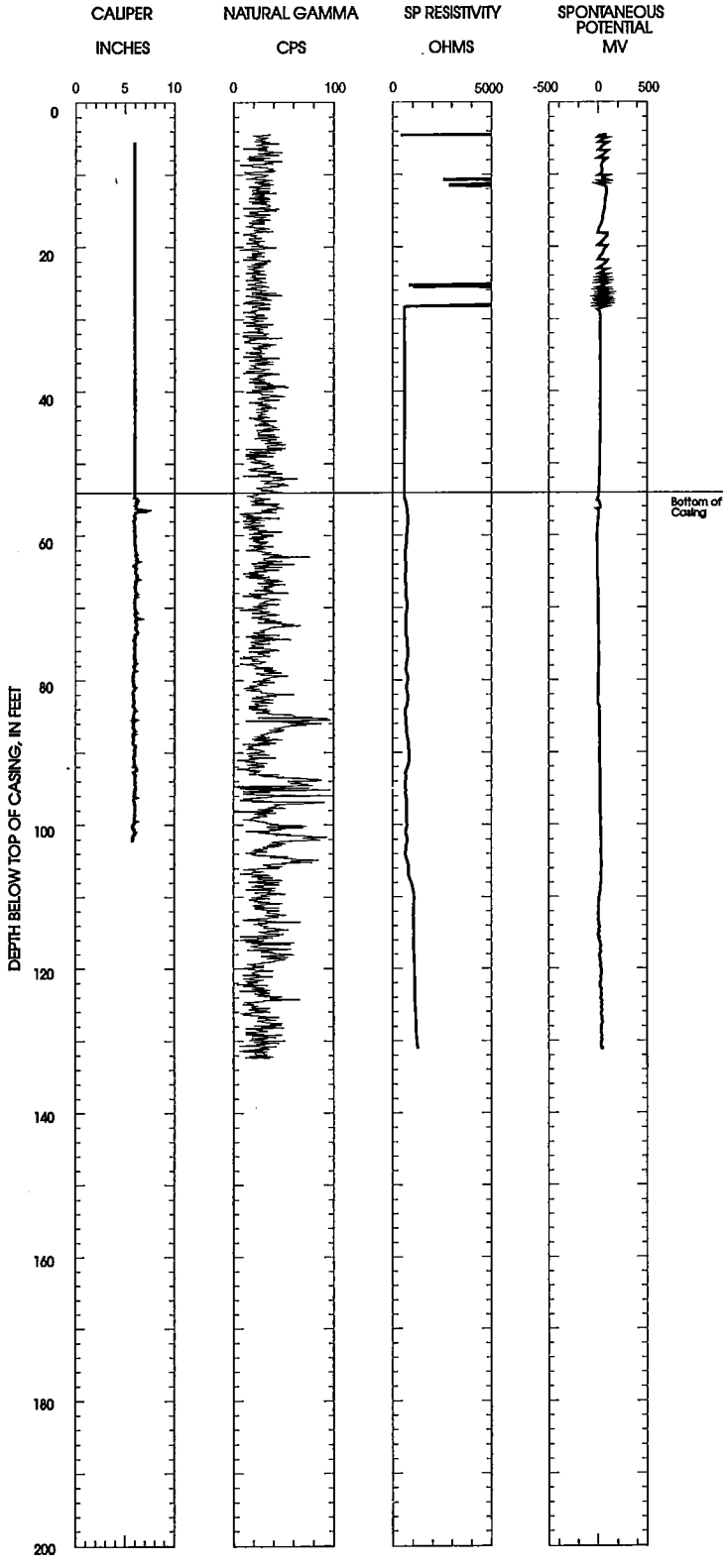


Shawano County

SH-26/18E/30-0001

SANDSTONE AQUIFER

Geophysical Logs

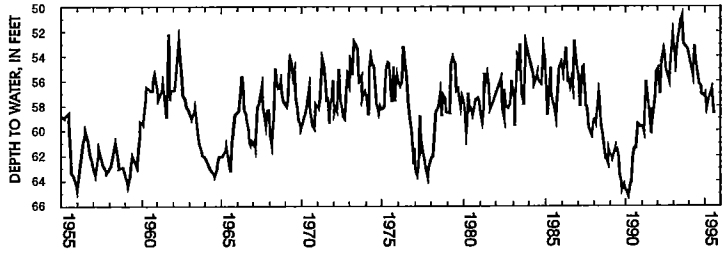


Well Information

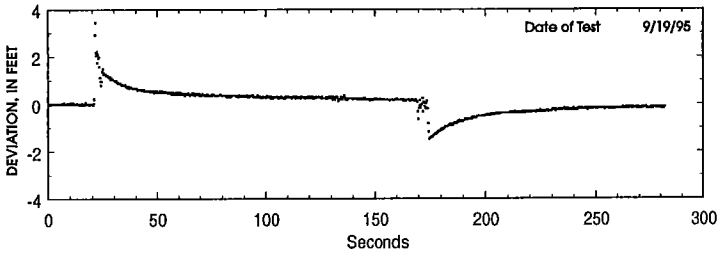
Total Depth	132	feet
Cased Depth	54	feet *
Casing Diameter	6	inches
Use of Well	Non-pumping	

* Picked from geophysical logs

Depth to Water Below Land Surface For Period of Record



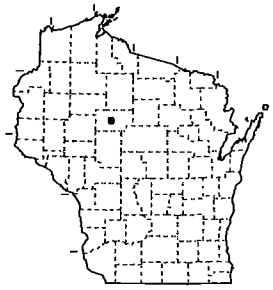
Deviation From Static Water Level During Displacement\Recovery Test



Horizontal Hydraulic Conductivity

Hvorslev K

9.5 ft/day

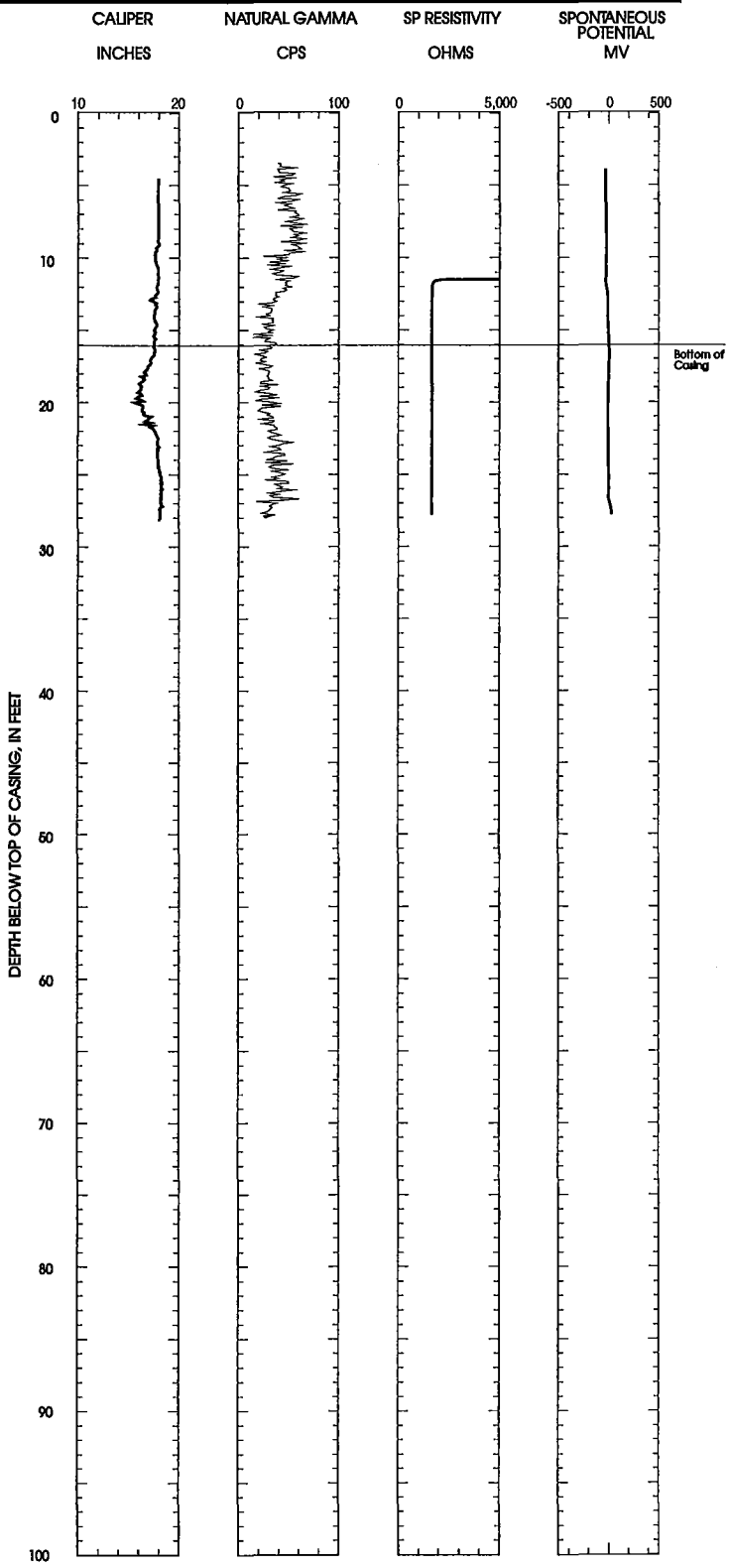


Taylor County

TA-31/04W/13-0001

SAND AND GRAVEL AQUIFER

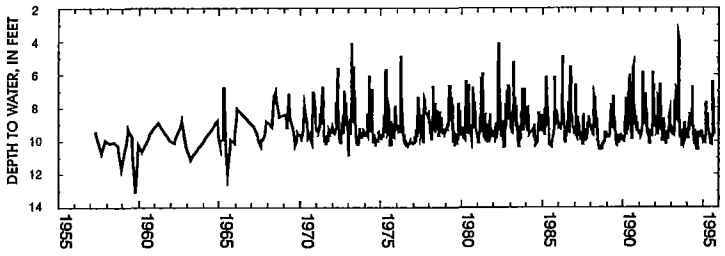
Geophysical Logs



Well Information

Total Depth	28	feet
Cased Depth	16	feet
Casing Diameter	18	inches
Use of Well	Non-pumping	

Depth to Water Below Land Surface For Period of Record

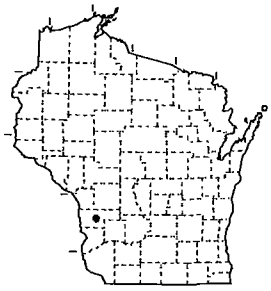


Deviation From Static Water Level During Displacement\Recovery Test

Horizontal Hydraulic Conductivity

Hvorslev K

Data not usable

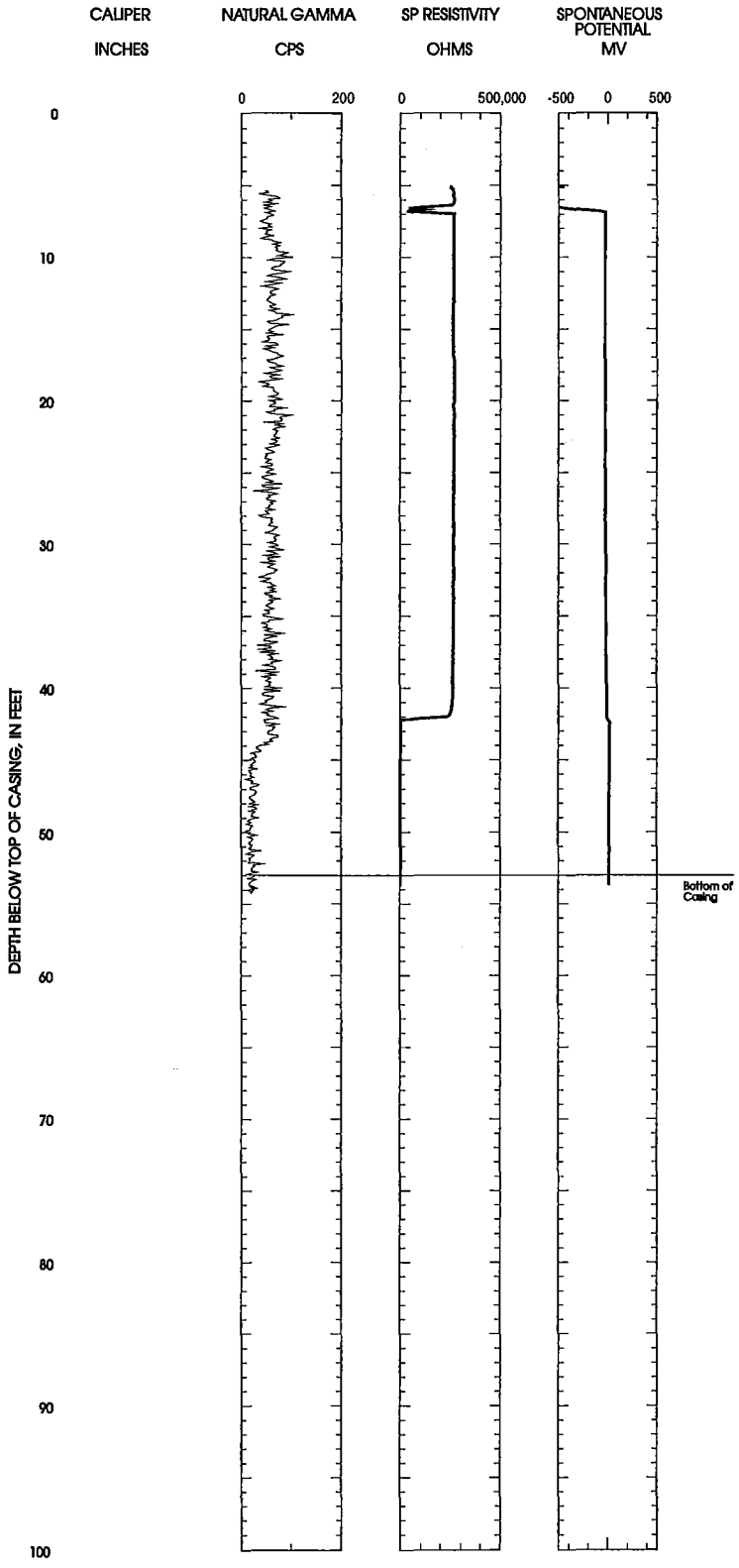


Vernon County

VE-14/07W/26-0008

SAND AND GRAVEL AQUIFER

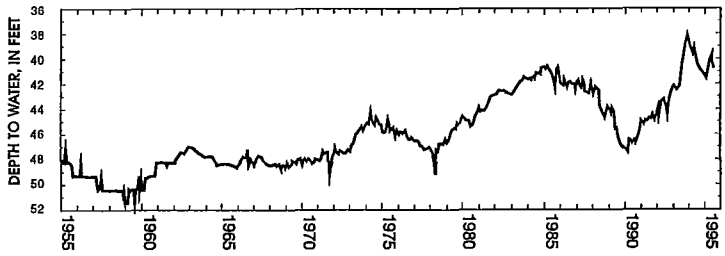
Geophysical Logs



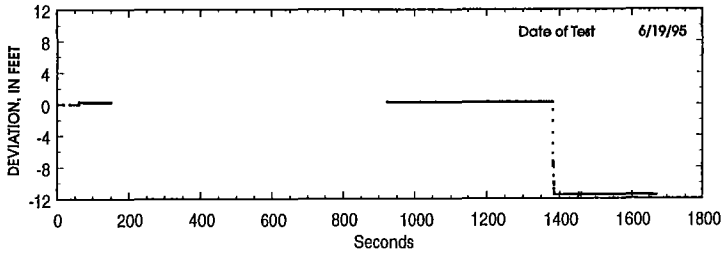
Well Information

Total Depth	53	feet
Cased Depth	53	feet
Casing Diameter	4	inches
Use of Well	Non-pumping	

Depth to Water Below Land Surface For Period of Record



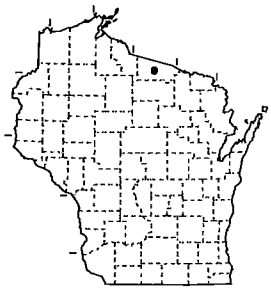
Deviation From Static Water Level During Displacement\Recovery Test



Horizontal Hydraulic Conductivity

Hvorslev K

Probably plugged



Vilas County

VI-41/10E/09-0003

SAND AND GRAVEL AQUIFER

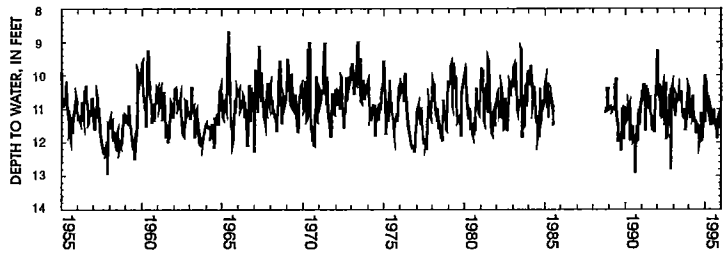
Geophysical Logs

No Logs Available

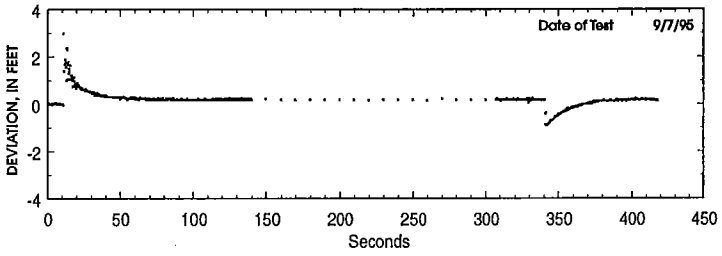
Well Information

Total Depth	19.5 feet
Cased Depth	18 feet
Casing Diameter	1.25 inches
Use of Well	Non-pumping

Depth to Water Below Land Surface For Period of Record



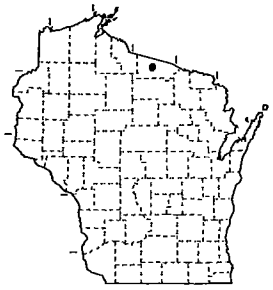
Deviation From Static Water Level During Displacement\Recovery Test



Horizontal Hydraulic Conductivity

Hvorslev K

36.5 ft/day

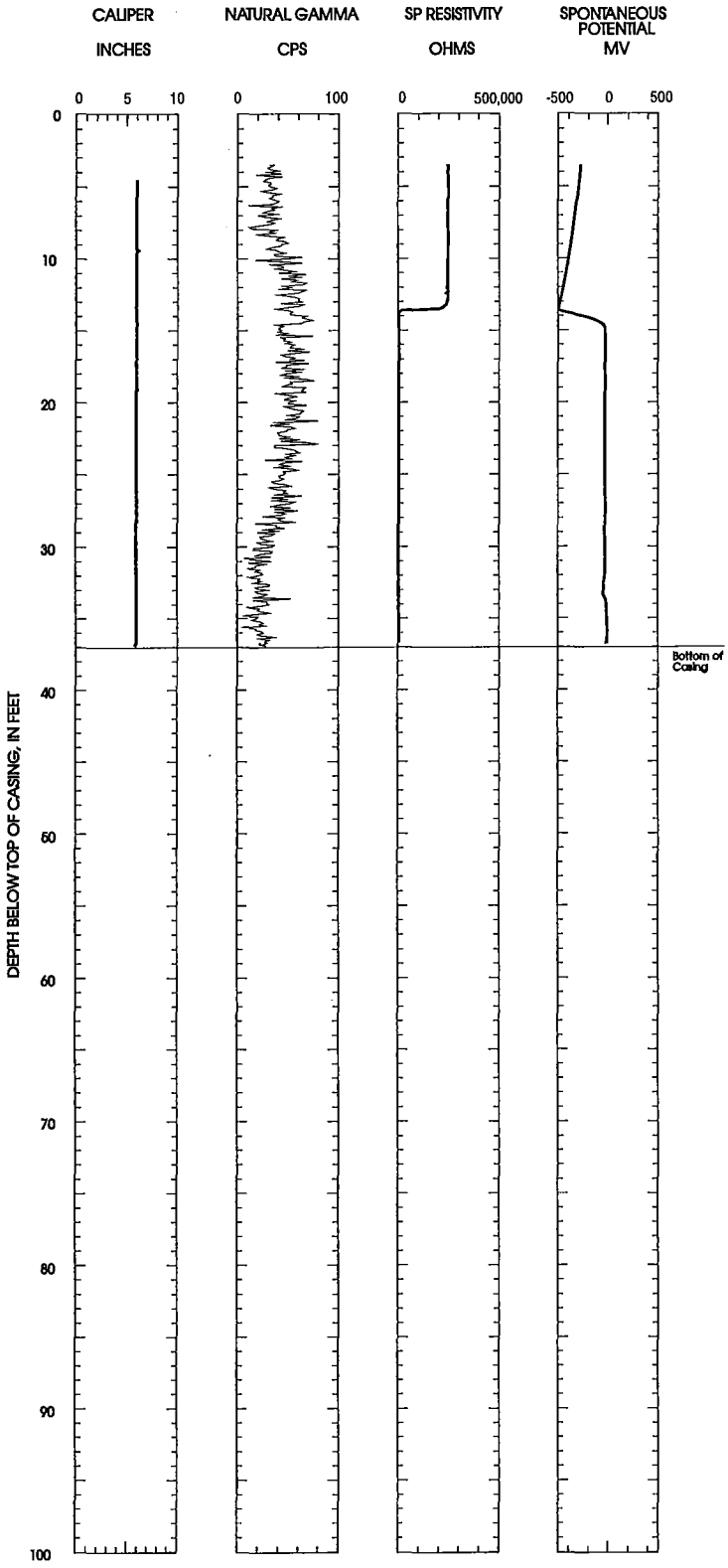


Vilas County

VI-40/10E/28-0033

SAND AND GRAVEL AQUIFER

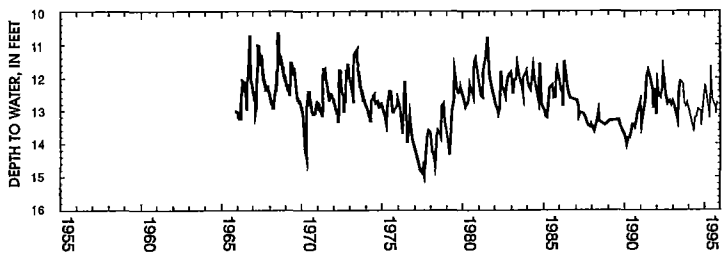
Geophysical Logs



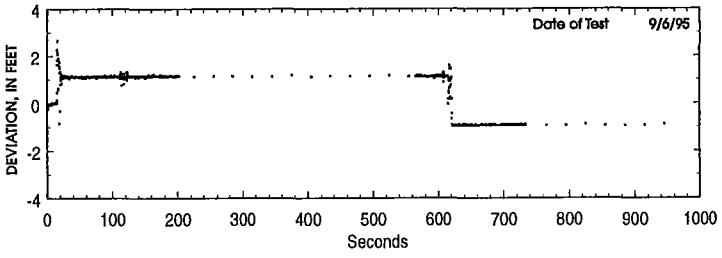
Well Information

Total Depth	37	feet
Cased Depth	37	feet
Casing Diameter	6	inches
Use of Well	Non-pumping	

Depth to Water Below Land Surface For Period of Record



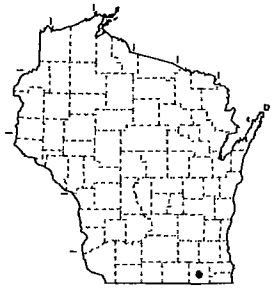
Deviation From Static Water Level During Displacement\Recovery Test



Horizontal Hydraulic Conductivity

Hvorslev K

Probably plugged



Walworth County

WW-01/16E/10-0083

SAND AND GRAVEL AQUIFER

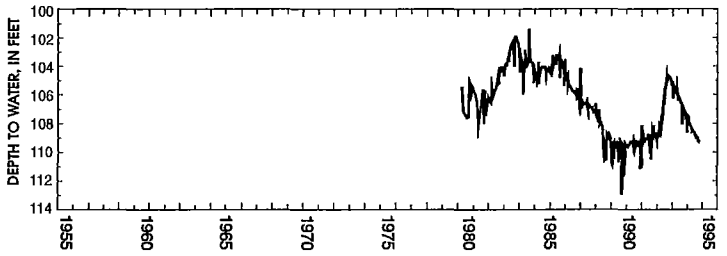
Geophysical Logs

No Logs Available

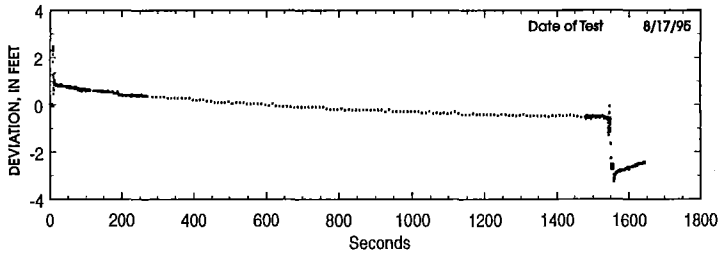
Well Information

Total Depth	149	feet
Cased Depth	134	feet
Casing Diameter	6	inches
Use of Well	Non-pumping	

Depth to Water Below Land Surface For Period of Record



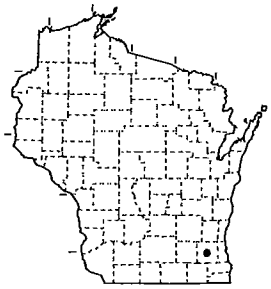
Deviation From Static Water Level During Displacement\Recovery Test



Horizontal Hydraulic Conductivity

Hvorslev K

3.3 ft/day

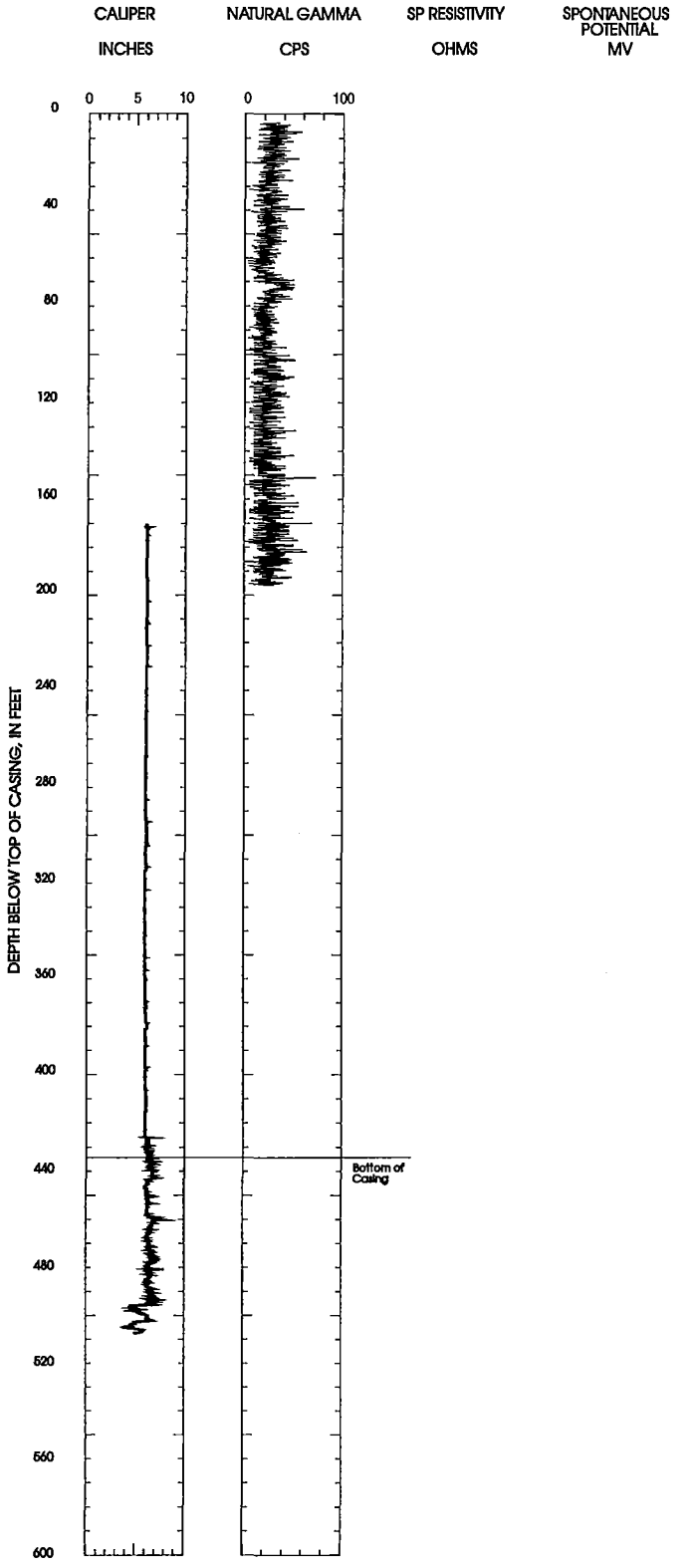


Waukesha County

WK-05/19E/02-0031

SILURIAN AQUIFER

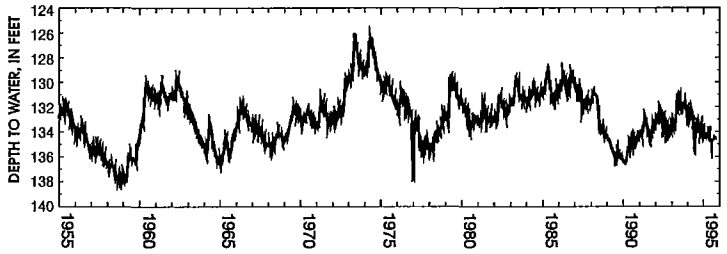
Geophysical Logs



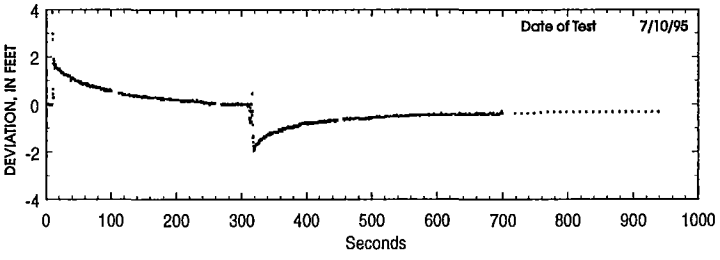
Well Information

Total Depth	508	feet
Cased Depth	434	feet
Casing Diameter	6	inches
Use of Well	Non-pumping	

Depth to Water Below Land Surface For Period of Record



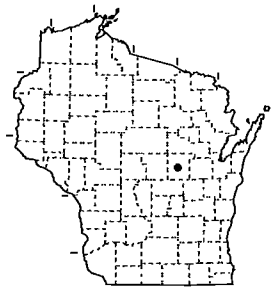
Deviation From Static Water Level During Displacement\Recovery Test



Horizontal Hydraulic Conductivity

Hvorslev K

2.0 ft/day

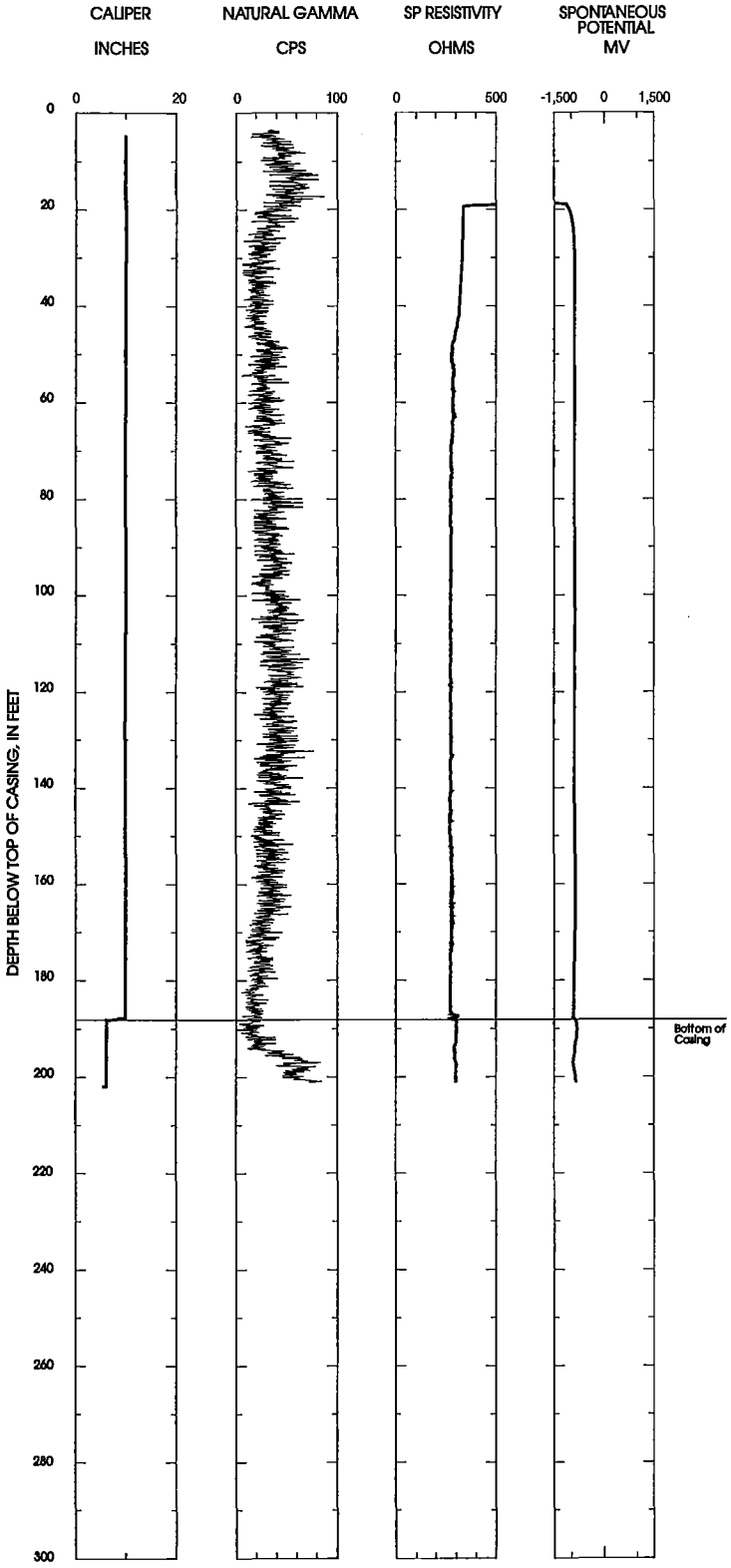


Waupaca County

WP-22/14E/12-0013

SAND AND GRAVEL AQUIFER

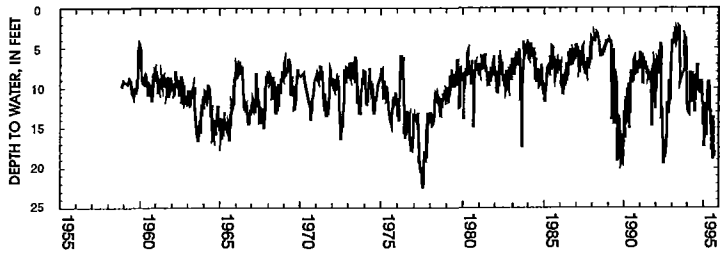
Geophysical Logs



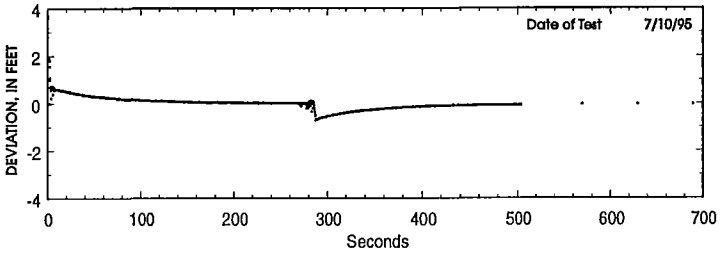
Well Information

Total Depth	203	feet
Cased Depth	188	feet
Casing Diameter	10	inches
Use of Well	Non-pumping	

Depth to Water Below Land Surface For Period of Record



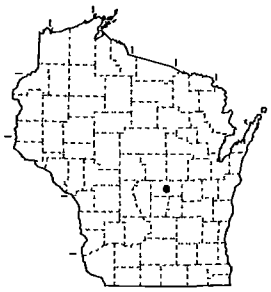
Deviation From Static Water Level During Displacement\Recovery Test



Horizontal Hydraulic Conductivity

Hvorslev K

28.0 ft/day

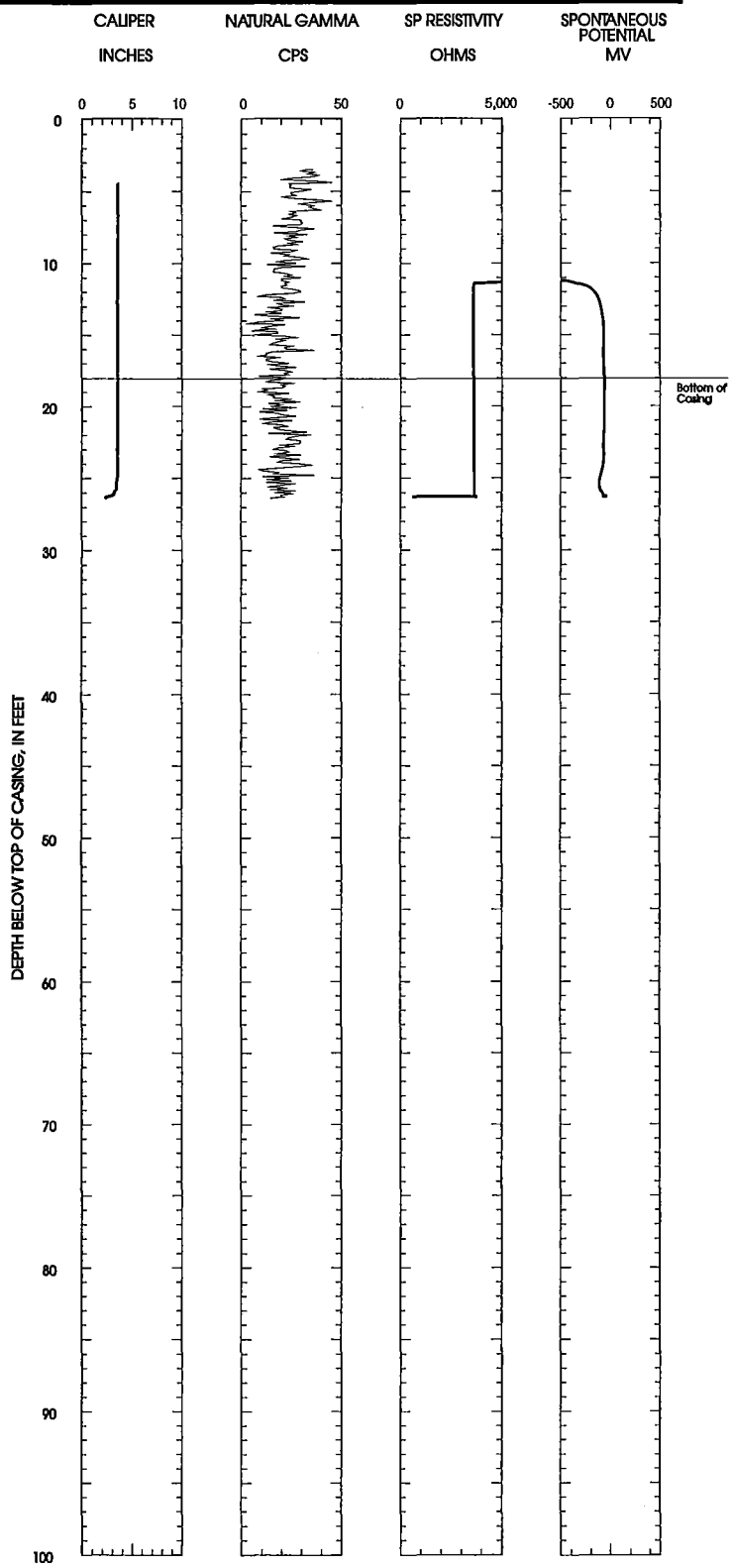


Waushara County

WS-19/08E/15-0008

SAND AND GRAVEL AQUIFER

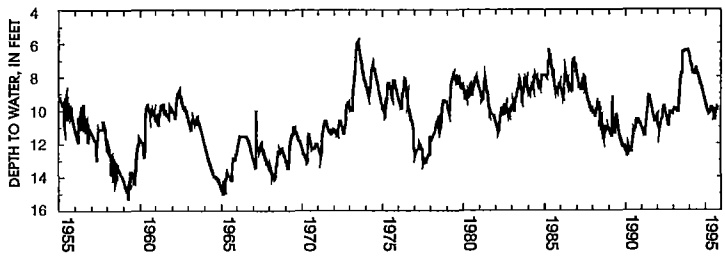
Geophysical Logs



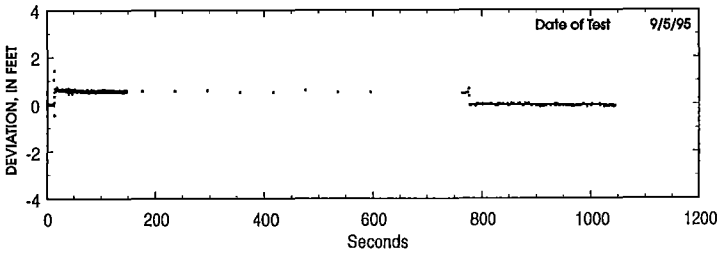
Well Information

Total Depth	26.4	feet
Cased Depth	18	feet
Casing Diameter	4	inches
Use of Well	Non-pumping	

Depth to Water Below Land Surface For Period of Record



Deviation From Static Water Level During Displacement\Recovery Test



Horizontal Hydraulic Conductivity

Hvorslev K

Probably plugged

Title: **Collection of hydraulic and geologic data to improve the quality of the Wisconsin ground-water monitoring network**

Project I.D.: DNR Project No. 118

Investigators: Alexander Zaporozec, Senior Hydrogeologist, WGNHS
Charles Dunning, Hydrologist, U.S. Geological Survey
Bernard Ellefson, Hydrologist, U.S. Geological Survey

Period of Contract: July 1, 1994 - June 30, 1996

Background/Need: Evaluation and use of collected water-level measurements on a significant proportion of Wisconsin observation wells is hampered by lack of geologic description and insufficient knowledge of hydraulic properties of geologic units. Geophysical logging and hydraulic testing will increase the value of water-level measurements.

Objectives: To improve the base of knowledge needed for the proper management of ground-water resources in Wisconsin by obtaining specific data on the hydraulic properties of individual geologic units.

Methods: Geophysical logs were run and slug tests conducted on 37 selected observation wells. Geophysical logs included natural gamma, spontaneous potential, single-point resistivity, and caliper logs. Displacement/recovery (slug) tests were conducted to evaluate the communication of observation wells with individual aquifers.

Results and Discussion: Geophysical logs were run on 26 of the 37 tested wells. The logs were used to identify contributing aquifers for wells and to determine the bottom of casing where well construction information was incomplete. Displacement/recovery tests were conducted on 33 of the 37 tested wells using a slug. The Hvorslev method was used to calculate hydraulic conductivity, which ranged from 0.52 to 85.26 ft/day. Hydraulic conductivities from formation pump tests on two deep wells were calculated by the Cooper-Jacob method, with values of 8.8 and 39.3 ft/day.

Conclusions/ Implications/ Recommendations: The project provided very valuable information on aquifers contributing to observation wells and provided opportunity to test the quality of connection of wells with aquifers. This knowledge will increase the value of collected water-level measurements. Results of pumping and slug tests helped increase the general knowledge of hydraulic properties of Wisconsin aquifers. Only a relatively small number of wells in Wisconsin have been logged and tested in the past.

Additional testing on all accessible observation wells is recommended to evaluate their value for the Wisconsin observation-well network. The ten wells which exhibited poor communication with aquifers should be rehabilitated where feasible or replaced if necessary for keeping an adequate spatial and aquifer type distribution of wells in the network. All accessible network wells should be tested every five years to maintain the efficiency and quality of the network and to optimize the use of limited network funding.

Key Words: Hydraulic properties of aquifers, geophysical logs, Wisconsin observation-well network.

Funding: DNR

Final Report: A final report containing more detailed information on this project is available for loan at the Water Resources Center, University of Wisconsin - Madison, 1975 Willow Drive, Madison, Wisconsin 53706, (608) 262-3069.