FINAL REPORT
ON A HYDROGEOLOGIC STUDY
IN THE VICINITY OF
MUNICIPAL WELL PW 6
VILLAGE OF WINCHESTER

Prepared for
Village of Winchester

M O R R I S O N B E A T T Y L I M I T E D
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APRIL, 1987
PROJECT NO. 325-841

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April 28, 1987

Mr. J.R. Bray, P.Eng.
Director
Project Engineering Branch
Ontario Ministry of the Environment
135 St. Clair Avenue West
Suite 100
Toronto, Ontario
M4V 1P5

re: Final Report
on a Hydrogeologic Study
in the Vicinity of Municipal Well PW 6
Village of Winchester
Our File No. 325-841

Dear Mr. Bray:

We are pleased to submit herein a final report on the above project. We apologize for the delay.

The report concludes the safe sustainable yield of the well is 8.3 L/s (110 igpm). It is recommended, however, that the well be operated at 10.26 L/s (135 igpm) throughout the year except during August and September when the yield should be reduced to 7.6 L/s (100 igpm).

If you have any questions please contact me personally.

Yours very truly,
MORRISON BEATTY LIMITED

William D. Morrison, P.Eng.

WDM/lf

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1.0 EXECUTIVE SUMMARY

Morrison Beatty Limited conducted a hydrogeologic investigation in the vicinity of municipal well PW 6 for the Village of Winchester in the Township of Mountain. The work was performed at the request of the Ministry of the Environment.

The Village had been suppied by five municipal wells (four now in service). PW 6 was constructed during a drilling and testing program conducted in 1982. The pumphouse and connecting watermains were constructed. Long-term testing was undertaken to allay fears of widespread groundwater lowering expressed by a local resident.

The well is equipped and capable of pumping 10.26 L/s (135 igpm) on a daily basis. Due to hydraulic boundaries in the aquifer and significant natural water level lowering that occurs during droughty periods the yield of the well should be restricted to about 7.6 L/s (100 igpm) during the months of August and September. The "safe sustainable yield" of the well is 8.3 L/s (110 igpm).

Water quality monitoring in the municipal well and in private wells throughout the area indicate there is no change in water quality at PW 6 as a result of the pumping. Similarly, there is no change in quality in any of the observation wells. This trend is consistent with observations made during the 1982 test drilling program and is also consistent with the long-term operating trends of the Winchester municipal well system. There is no reason for any long-term quality change.

2.0 INTRODUCTION

At the request of the Ministry of the Environment and on behalf of the Village of Winchester we have conducted a hydrogeologic investigation in the vicinity of municipal well PW 6 (formerly TW 2/82) located in the Township of Mountain. In the report we present background information, analyze technical data then draw conclusions and make recommendations.

The report describes briefly background information on the Winchester water supply system, previous test drilling programs, and the concerns of local residents. The report outlines the study program that has been carried out. This includes a review of the geology and hydrogeology of the area from available information and field observations. A private well survey was conducted using information compiled from published sources and verified with interviews, well inspections and hydraulic and water quality monitoring.

To obtain interference measurements, confirm aquifer coefficients, and verify water quality trends, a 72-hour aquifer performance test and a one month aquifer performance test have been conducted. The report and accompanying documentation detail the water level lowering that has occurred as a result of the municipal well pumping. The report also documents comprehensive water quality testing performed on samples collected from municipal and private wells in the area. Following an analysis of all the data, conclusions and recommendations are presented. The attached Figure 1 shows the study area.

Data is sparse for production well no. 2. Pumping and water level data is unavailable; however, water quality trends indicate alkalinity and hardness remain relatively constant. There is an increase in the chloride concentration in water from this well.

Production well no. 3 is out of service and no data is available.

Production well no. 4 was placed in service in 1973 and the average daily production has decreased from about 350 m^3/day (54 igpm) to to about 200 m^3/day (31 igpm). Pumping levels have declined from about 40 ft below ground surface down to about 16.8m (55 ft) below ground surface during that period. The major change in pumping level and yield appeared to occur in about 1977 which appears to correspond to the initiation of pumping from production well no. 5. The alkalinity, hardness and chloride concentrations of water from production well no. 4 has remained virtually unchanged.

Production well no. 5 came into operation in 1977 and has produced a steady average day yield of about 500 m^3/day (77 igpm). Water levels have declined from initial pumping levels of about 12.3m (40 ft) to recent pumping levels of about 18.3m (60 ft). With steady water takings in the last three years pumping levels have been more constant. Since production well no. 5 went into operation there has been a slight increase in alkalinity, hardness and chlorides; however, the trends are stable at the present time.

Ault Foods are one of the large water users within the community. Their plans for expansions and need for additional water spawned the more recent drilling and testing program. We understand the Winchester municipal water supply system is owned by the Municipality and operated by the Ministry of the Environment's Operations staff.

3.2 The 1978 Test Drilling Program

During the summer of 1978 a test drilling program was performed by Olympic Drilling Co. Ltd., of Ottawa, Ontario for the Ministry of the Environment (MoE). The purpose of that program was to locate and develop one or more municipal wells capable of yielding 12 L/s (150 igpm). Nine test wells were drilled during that program at locations selected by the MoE and shown on the enclosed Figure 3. Seven of the test wells were located to the north and west of the community while two test wells were located to the south. Morrison Beatty Limited provided hydrogeologic consulting services to Olympic Drilling Co. Ltd. for that program. The conclusions and recommendations of that report are presented below.

Conclusions and Recommendations from a Report on
A Test Drilling Project at the Village of Winchester
Ministry of the Environment Project No. 6-0285, Contract No. W4
by Morrison Beatty Limited, October 1978

Conclusions

The test drilling program carried out at the Village of Winchester did not locate a source capable of producing 12 L/s (150 igpm). The testing program did demonstrate that modest quantities of water are available and can be developed from fractured weathered bedrock that subcrops beneath the overburden over an apparently extensive area.

Minimal testing of this modest groundwater source has indicated the transmissivity of the aquifer is in the order of 100 $m^3/m.d$ (7 x 10^3 igpd/ft). Yields in the order of 25 to 30 gpm are indicated. Some interference with existing and proposed wells will be experienced.

Water quality samples collected and analyzed by the Ministry of the Environment are being carefully reviewed by the Ministry. Our review indicates that water is generally acceptable for municipal and domestic consumption.

Recommendations

Based on the above discussions and conclusions it is recommended that:

i) Consideration be given to exploring the shallow bedrock aquifer with the aim of developing wells capable of yielding 25 to 30 igpm.

ii) That wells have a total depth no greater than 45 ft.

iii) Screens and casings be 6 inches in diameter and centred in 12-inch diameter test wells. The annulus between the 6-inch and 12-inch hole should be filled with carefully selected silica gravel.

iv) If individual wells yielding 12 L/s (150 igpm) or more are required, then the concept of groundwater development in the Winchester area should be abandoned.

Respectfully submitted,
MORRISON BEATTY LIMITED

The concept of low capacity municipal wells was not pursued at that time and the community continued to function using the same four municipal wells. In 1982 another test drilling program was undertaken.

3.3 The 1982 Test Drilling Program

During the fall of 1982 the Groundwater Development Group of the Water Resources Branch of the Ministry of the Environment acting as agents of the Corporation of the Village of Winchester awarded a contract to Instant Water Wells Limited of Williamsburg, Ontario to conduct a test drilling program at the Village of Winchester. The purpose of the program was to evaluate the suitability of bedrock aquifers for the development of a municipal water supply of at least 12 L/s (150 igpm). Morrison Beatty Limited were retained by Instant Water Wells Limited to provide consulting services for that program.

The program was partially completed. Site access for further testing was a problem and our report was completed in August of 1983 on the partially completed test drilling program. The conclusions and recommendations of our report are presented below.

Summary of Conclusions and Recommendations from a Report on A Test Drilling Program at the Village of Winchester Contract No. 2 Prepared for the Ministry of the Environment On behalf of Instant Water Wells Limited

Conclusions

The test drilling program carried out in an area northwest of the Village of Winchester in Mountain Township has to date tested three potential well sites. A supply of 11.4 L/s (150 igpm) has been demonstrated at the site of TW-2/82. Additional quantities appear to be available at the site of TW-3/82 if the bottom portions of the well are grouted.

Testing of the groundwater aquifers has indicated the transmissivity is in the range of 208.6 - 312.9 m^2/day (1.4×10^4 - 2.1×10^4 igpd/ft). The storage coefficient is in the order of 5×10^{-5}, which is indicative of artesian conditions.

Water quality samples were collected and analyzed by the Ministry of the Environment and indicate that the water quality from TW-2/82 is acceptable both chemically and bacteriologically for municipal consumption. Although an abundant supply of water was located at the site of TW-3/82, the water quality is unacceptable at this time. Some good quality water should be available to the system at this location.

Recommendations

Based on the above discussions and conclusions, it is recommended that:

i) TW-2/82 which produces up to 11.4 L/s (150 igpm) of acceptable quality groundwater, be converted to a municipal supply well for the Village of Winchester.

ii) TW-3/82 be grouted back to 41.1 m (135 feet) below ground surface. The well should then be re-tested hydraulically and chemically to determine the quantity and quality of the water produced.

iii) TW-3/82 be connected to a distribution system if the quantity and projected water quality are acceptable.

iv) Additional testing be carried out to explore water supply potential, in as yet untested areas in the Winchester area with remaining program funds.

v) Consideration be given to drilling shallow, lower capacity wells along the alignment of the pipeline from TW-2/82 back to the distribution system. Wells with yields ranging from 1.9 to 2.7 L/s (25 to 35 igpm) could be considered.

Respectfully submitted,
MORRISON BEATTY LIMITED

Subsequent to that report TW 3/82 was grouted back and retested briefly. The water quality was significantly improved; however, the yield was dramatically reduced and the well is no longer considered a potential supply source.

The wells drilled during the 1982 test drilling program are shown on the enclosed Figure 3.

3.4 Concerns of Residents

Residents in the immediate vicinity of TW 2/82 expressed concerns regarding the connection of this well to the municipal system.

3.4.1 MoE Response

In an effort to resolve these concerns the MoE conducted a house-to-house survey of a number of water supplies in the immediate vicinity of the proposed municipal well. This investigation was carried on in January of 1985. Exhibit 2 in the section on Background Exhibits is a copy of that Ministry of the Environment study.

Meetings were held with concerned residents and additional testing was promised. Morrison Beatty Limited was retained by the Village of Winchester to co-ordinate a testing program in the vicinity of the new municipal well. The program was designed to investigate groundwater conditions within a 3 km radius of the well.

Initially water well records on file with the Ministry of the Environment were reviewed. A summary of this water well information has been compiled and is included as Exhibit 3 in the section on Background Exhibits.

The Terms of Reference for the comprehensive hydrogeologic investigation is also included in the section on Background Exhibits as Exhibit 4.

Just prior to conducting a 72-hour pumping test on the new municipal well a meeting was held with Mr. C. Howse to describe the proposed testing program. A memorandum describing that meeting and the proposed testing program is included in the Background Exhibits section as Exhibit 5.

4.0 THE STUDY PROGRAM

The study program was outlined in Appendix A - Terms of Reference contained in the Engineering Agreement. The program involved conducting extensive house-to-house surveys within about a 3 km radius of PW 6 (TW 2/82). The study also involved the collection of water samples from private domestic wells in the area prior to any testing. Water samples were also collected after 72 hours of pumping from the selected private wells in the area and the pumped well. In addition to the 3-day test, the Terms of Reference indicated that a 30-day pumping test was to be conducted during the summer months with periodic readings taken in selected observation wells (private wells) throughout the area.

Between July 29th, 1985 and September 12th, 1985 (45 days) the Ministry of the Environment supervised a long-term controlled rate pumping test on PW 6. The rate was controlled at about 10.5 L/s (138.6 igpm). During that time water level readings were recorded in the pumped well and a number of private wells throughout the study area. Water quality samples were also collected.

Details of the various phases of the study program around PW 6 are explained more completely in subsequent sections.

5.0 GEOLOGY AND HYDROGEOLOGY

The regional geology and hydrogeology of the area have been presented in previous reports and are essentially reproduced here.

5.1 Overburden Geology

The overburden in the Winchester area is interpreted from the logs of existing domestic wells, existing municipal wells and test wells and appears to vary in thickness from about 0.6 m to 7.6 m (2 to 25 ft). The overburden consists of a thin surface layer or veneer of lacustrine sands overlying a hard clay silt till which in places overlies a thin layer of sand and gravel which in turn overlays the bedrock. The overburden displays no potential for the development of overburden wells.

5.2 Bedrock Geology

The bedrock geology of the Ottawa-St. Lawrence lowlands of Ontario and Quebec was carefully mapped by Alice E. Wilson, of the Geological Survey of Canada (GSC). This information was published in GSC Memoir No. 241. All bedrock formations subcropping in the Winchester area are from the Ordovician period of the Paleozoic era. The attached Figure 4 depicts the bedrock geology in the Winchester area as adapted from Memoir 241.

In the area west of the village in the vicinity of the new production well, the Oxford Formation was the target of greatest interest. The Oxford Formation overlies the March Formation and underlies the Rockcliffe Formation. The Oxford Formation is a thick-bedded, rusty weathering dolostone which contains impurities such as mud and sand in the Winchester area.

In this area the Oxford beds dip to the east-south east at about 8 degrees and the formation thickness reportedly varies from 73.1 to 106.7 m (240 to 350 ft). The March Formation which is reported to be about 7.6 m (25 ft) thick, subcrops beneath the Oxford Formation and is known to outcrop to the west of the study area. The March Formation also dips to the east-southeast and is underlain by the Nepean sandstone.

5.3 Hydrogeology

Surface water in the Winchester area discharges through the Annable and Henderson Drains to the East Castor River. South of Winchester surface water discharges through the east branch of the Gannon Drain to the South Nation River. Regional groundwater data suggests that groundwater flow from the vicinity of PW 6 (TW 2/82) is to the north-northwest however farther to the east and closer to the community groundwater flow appears to be to the east. These details will be discussed in subsequent sections.

Following concerns raised by local residents, the MoE conducted a study of groundwater near PW 6 in January of 1985. That information is enclosed as Exhibit 2 in the section entitled Background Exhibits. A summary of the water well records on file with the Ministry of the Environment has been prepared. The data is summarized in Exhibit 3 in the section Background Exhibits.

6.0 HOUSE-TO-HOUSE SURVEY

As outlined in the Terms of Reference we conducted a survey of domestic wells within about a 3 km radius of PW 6 (TW 2/82). The survey was conducted by our staff who met with the owners or tenants of most homes with wells within the study area shown on Figure 1 (Page 3). During the interview a questionnaire was completed and the well if possible was inspected. The attached Figure A1 in Appendix A is a copy of the water well survey questionnaire. The questionnaire included a release from all liability for damages to water wells which occurred as a result of our investigation if the work was carried out with reasonable care.

The attached Figure A2 in a pocket in Appendix A shows the location of PW 6 (TW 2/82) and the wells identified in the house-to-house survey. The wells monitored during a subsequent 72-hour pumping test on PW 6 (TW 2/82) are indicated. The information derived from the interviews with local residents has been summarized into tabular form and is included as Table A3.

During the house-to-house surveys, wherever possible, water levels were measured and notes were made on the accessibility of these wells for use during subsequent proposed tests.

During the period of the house-to-house survey, measuring point elevations on all wells selected for monitoring during testing were determined using an aneroid barometer. This method of determining surface elevation, although not as accurate as surveying, was selected because of the large study area. The following is a table of relative measuring point elevations referred to an assumed bench mark of 100 m at the pumphouse.

Summary of Measuring Point Elevations
Determined by Aneroid Barometer
Referred to as an Assumed Bench Mark of 100 m at PW 6

Well No.	Relative Measuring Point Elevation (m)	Relative Ground Elevation (m)
PW 6	100.0	99.3
1	100.3	100.3
2	101.7	101.6
3	102.0	102.0
3a	102.1	102.1
5	99.8	99.2
6b	101.5	100.9
10	103.5	103.4
18	98.1	98.0
39	101.4	101.3
42	103.5	103.3
43	101.8	101.8
44	97.3	97.2
51	102.4	102.3
TW 1/82	102.8	103.0
TW 3/82	103.4	101.5
48	101.5	101.5

Our field staff made observations while recording the water levels in the monitoring wells prior to, during, and subsequent to the 72-hour pumping test. The attached Table A4 in Appendix A presents a summary of those observations.

7.0 AQUIFER TEST - 3-DAYS

As indicated in the Terms of Reference, 3-day and 30-day aquifer performance tests were planned. This report evaluates the 3-day test conducted by Morrison Beatty Limited and discusses the long-term test conducted by the Ministry of the Environment. In this section we will evaluate the 3-day test.

7.1 Methodology

The test was initially scheduled to start on March 5th, 1985. The house-to-house study had been conducted prior to that date and static levels had been obtained from all accessible monitoring wells. Mechanical problems within the pumphouse caused a delay in that test and it was subsequently rescheduled and started on March 19th, 1985. Water was pumped from the well through the installed equipment including the water meter and pumped into the previously chlorinated and tested transmission main. Initially water was discharged at a hydrant near the intersection of Hwy 31 and the 7th Line. Later water was discharged at a hydrant near PW 5. Still later into the test, a hydrant in town was opened and PW 6 pumped directly to the distribution system. An attempt was made to control the rate at 11.4 l/s (150 igpm) however, the maximum pumping rate into the distribution system was about 10.2 l/s (135 igpm).

Water levels were recorded in the pumped well and 16 observation wells prior to, during and following the 3-day test. OW 1/82 and OW 3/82 were equipped with automatic water level recorders.

Water quality samples were collected from the pumped well and a number of the monitoring wells prior to the test and at the end of the 72 hours of pumping and will be discussed in Section 9.

7.2 Weather Conditions

Spring breakup had occurred at the time of the test. Water level rose during the time between the proposed initial test and the actual date of the test. We installed a recording barometer in the pumphouse at PW 6 and recorded barometric changes during the test. The barometer was falling at the start of the test and dropped from 30.2 inches to 29.9 inches of Mercury in the early morning hours of March 20th, 1985. Barometric readings then increased steadily and reached a high of about 30.6 inches of Mercury mid-morning on March 21st, 1985 and maintained approximately that level until shutdown on the morning of March 22nd, 1985. Barometric readings began to fall during the recovery.

Temperatures were generally above freezing throughout the period of testing.

7.3 The Aquifer Test

Following a round of static level readings the aquifer performance test was started on the morning of Tuesday March 19th, 1985. Initial pumping was at a rate of about 13.3 l/s (175 igpm) but that rate dropped quickly to about 11.4 l/s (150 igpm). However, as water was pumped farther into the municipality it was determined that the maximum pumping rate of the system while pumping into the distribution system was about 10.2 l/s (135 igpm). Calculations of aquifer coefficients will be based on a pumping test rate of 10.2 l/s (135 igpm).

The attached Figure B1 in Appendix B, is a plan showing wells monitored during the 72-hour pumping test. Before evaluating the water level changes as depicted on hydrographs, several factors affecting the data should be considered. These include:

- seasonal fluctuations in water levels,
- fluctuations due to atmospheric pressure changes, and
- drawdown effects of pumping in the monitored private wells.

7.3.1 Seasonal Fluctuations

The Ministry of the Environment and Morrison Beatty Limited monitored water levels in several private wells in the area in October and December, 1984 and February and March, 1985. The water level data is summarized in Table 1 below.

TABLE 1

Summary of Natural Water Level Fluctuations

Well No.	Well Owner	Well	Water Level, m bmp			
			Oct 9/84	Dec 11/84	Feb 12-19/85	Mar 18/85
1	H. Holmes	barn	4.44	4.59	3.48	1.79
2	L. Holmes	house	6.61	7.13	5.14	3.0
3	C. House	house	7.84	-	-	3.54
3a	C. House	abandoned	6.99	7.08	5.49	1.39
6b	J. Spruit	barn & house	5.82	7.17	5.2	3.5
TW 1	V. of Winchester	test well	-	-	2.04	0.68
TW 3	V. of Winchester	test well	-	-	3.96	2.70

The table shows that 5.69 m of natural groundwater level recovery (C. House abandoned well) between December 1984 and March 1985. During Feb the month prior to starting the aquifer test, water levels were rising at rates ranging from 5 to 13 cm/day.

Examination of the wells that were not affected by the pumping suggests the peak spring levels may have been reached during the 7 days of monitoring associated with the 3-day test. Many of the wells show minor fluctuations but not definite recovery or decay trends.

7.3.2 Atmospheric Pressure Effects

Changes in atmospheric pressure cause fluctuations in the potentiometric heads (water levels) in confined aquifers. As noted previously, a significant change in atmospheric pressure occurred during the pumping test. The pressure increased by about 0.6 inches of mercury over a 24-hour period, mid-way through the test. At the end of the test, the pressure began to drop.

An increase in atmospheric pressure will cause a decline in water levels in wells that tap the bedrock aquifer. Similarly a decrease in atmospheric pressure will cause a rise in water levels.

7.3.3 Operating Wells

All private wells that were monitored were either pumped or adjacent to wells that were pumped periodically during the pumping test. This adds a margin of error to all observation well data.

7.3.4 Drawdown vs Time

When the pumping test was started on the morning of March 19th, 1985 water level drawdown was recorded in the pumped well and the monitoring wells (selected private wells). The attached Figures B2 to B18 in Appendix B are arithmetic plots of drawdown vs time. These plots were drawn to show changes in water level trends on an arithmetic scale. The water level trends are compared to the changes in pumping rate that occurred and also the barometric changes. When interpreting the degree of interference each well is reviewed individually in its response.

Reviewing the hydrographs and considering seasonal fluctuations, barometric effects, and operation of the wells, the following Table 2 indicates the interpretted amount of water level change due to pumping PW 6.

TABLE 2

Water Level Change Over 72 Hours
Interpretted as Caused by the Pumping of PW 6

Well No.	Water Level Change (m)
TW 1	0.02
TW 3	0.18
PW 6	4.3
1	2.8
2	0
3	0.03
3a	0.07
5	0.07
6b	0.70
10	0
18	0.04
39	0.03
42a	1.0
43	0
44	0.06
48	0.07
51	0

The attached Figures B19 through B22 are semi-logarithmic plots of drawdown/recovery vs time for the pumped well and observation wells 1, 3 and 3a. The interpreted transmissivity of the aquifer is in the range of 208 m^2/d (1.4×10^4 igpd/ft). The storage coefficient is calculated to be 1.9×10^{-4}. This is indicative of artesian conditions.

7.3.5 Drawdown vs Distance

The attached Figure B23 is a semi-logarithmic plot of drawdown vs distance for the test data. The interference affect measured in a number of the wells in the area are shown on this graph. The Holmes well (1) experienced almost 3m of interference while the Spruit well (6b) experienced about 0.5m of interference. All other wells experienced between 0 and 20 cm of interference during the 3 day test. This amount of interference will not detrimentally affect the yield of existing wells other than the Holmes well. Replacement of that well may be required.

7.3.6 Recharge

Although various recharge estimates have been generated by investigators in the Winchester area we estimate recharge to be in the order of 878 to 1755 L/d/ha (50,000 to 100,000 igpd/mi^2). The lower range of the estimate is due to the presence of clay consistently throughout the geologic section while the high range is due to the rapid response in water levels to infiltration from spring breakup. Recharge within the cone of influence is more than adequate to satisfy the desired yield of 150 igpm.

7.3.7 Interference

Some water level lowering was observed in area wells in response to the pumping of PW 6. Based on the 3-day test the amount of interference should not detrimentally affect the yield of private wells in the area. The Holmes well (no. 1) appears to be well connected to PW 6 and may require replacement.

The 44 day test which extended the period of pumping on the semi-logarithmic drawdown vs time plot by more than one log cycle is more useful in establishing interference trends. In addition a long test was run during the dry summer months while the 3-day test was conducted during the spring breakup.

8.0 AQUIFER TEST - 44 DAYS

During the summer of 1985 as promised by the Ministry of the Environment a long-term aquifer performance test was conducted on PW 6. The test was started at 12:30 pm on July 29th, 1985 at a rate of 10.5 L/s (138.6 igpm). As the test proceeded the pumping rate decreased and the pump maintained a rate of 9.5 to 10.1 L/s (125 to 133 igpm) at the end of the test on September 11th, 1985. During the test the Ministry of the Environment observed many of the wells which had been observed during the 72-hour test.

A detailed report outlining the findings of the test prepared by the Ministry of the Environment is presented as Appendix D to this report.

Please note that the numbering system used by the Ministry of the Environment for area wells is different than the system used in our reporting. An airphoto location map showing wells observed during the long-term test is included in the pocket at the end of Appendix C.

Morrison Beatty Limited did not supervise this pumping test and therefore will only comment on significant factors.

8.1 Interference

During the long-term pumping test on PW 6 significant groundwater lowering was experienced at three wells in the area. New wells were drilled to replace the H. Holmes barn well MoE 1a (MBL #1). The J. Spruit "rented" house well MoE 2a (MBL #6b) was also replaced by a new drilled well. In addition the H. Holmes house well MoE 1b (MBL #1a) was equipped with a new submersible pump. No other significant water level lowering was experienced or is anticipated with the continued operation of PW 6.

8.2 Well Yield

The test drilling program and the aquifer performance test conducted in March of 1985 indicated the transmissivity of the aquifer in the vicinity of PW 6 as in the order of 208 m^2/d (1.4×10^4 igpd/ft). The storativity has been calculated from different tests to be in the order of 5×10^{-5} to 1.9×10^{-4}. Both are indicative of artesian conditions.

The attached Figure E1 in Appendix E is a semi-logarithmic plot of drawdown vs time for drawdown readings from the pumped well. The plot again indicates that the transmissivity of the aquifer in the vicinity of PW 6 is in the order of 208 m^2/d (1.4×10^4 igpd/ft). The test also indicates that after about 10,000 minutes of pumping (7 days) a boundary was encountered and drawdown trends steepened. Based on this information we revised the yield of the well down to about 100 igpm during the months of August and September. The well is capable of producing its equipped capacity of 135 igpm in all other months. We therefore recommend that the Permit to Take Water for PW 6 be revised to indicate a maximum daily taking of 884 m^3/d (194,000 igpd). The "safe sustainable yield" of the well is estimated to be 8.3 L/s (110 igpm).

9.0 WATER QUALITY

Prior to the start of the 72-hour pumping test on PW 6 water quality samples were collected from 14 private wells in the area. Samples were also collected at the end of the 72-hour test from 13 of these 14 wells. The following water quality parameters were evaluated:

Conductivity	Chlorides
pH	Sulphate
Hardness	Iron
Calcium	Ammonia
Magnesium	Nitrate
Sodium	Nitrite
Potassium	COD
Alkalinity	BOD_5

The analyses of the samples collected from the 14 wells before and after testing are tabulated in Figure E1 in Appendix E.

Generally the conductivity decreased slightly between the two sets of readings and the pH increased slightly. Hardness, calcium, magnesium, sodium and potassium remained more or less unchanged. Alkalinity decreased in some wells while it increased slightly in others. Chlorides, sulphates, ammonia, nitrate, nitrite and COD remained about the same with some minor anomalies. The iron concentration was steady in some wells but quite variable in others. The BOD_5 was generally lower at the end of the test, although well 6b was an exception.

In summary, minor water quality changes were observed between the samples collected before and after the test, however none of the changes appear to be significant and there is no trend that can be linked to the pumping of PW 6.

The attached Figure E2 in Appendix E documents water quality changes in PW 6 between the start of the test and 72 hours. Samples were collected at the beginning of the test and at 1 hour, 8 hours, 56 hours and 72 hours into the test. Calcium, sodium and potassium concentrations increased slightly during the test. The variations are considered insignificant.

Bacteriologically the water from the bedrock aquifer was also safe for municipal consumption, although protective chlorination will be required.

Following the 44-day pumping test conducted by the Ministry of the Environment they summarize their findings by stating "a review of the sample results indicated that the quality of groundwater in the area was not degraded by the extended pumping test carried out on the PW 6 well". We agree that the quality analyses substantiate this statement.

10.0 CONCLUSIONS

A 72-hour pumping test has been conducted on PW 6 at a rate of about 10.26 L/s (135 igpm). In conjunction with the test, a house-to-house survey was conducted in a 3 km radius around the well and a number of wells were selected for monitoring during the test. The wells were monitored both hydraulically and chemically. The hydraulic monitoring indicated only minor lowering of water levels in area wells.

The interpretation of the long-term pumping test conducted by the Ministry of the Environment led us to conclude that the maximum yield of the wells should be 10.26 L/s (135 igpm) and that the yield of the well should be reduced to 7.6 L/s (100 igpm) during the months of August and September. The "safe sustainable yield" of the well is 8.3 L/s (100 igpm).

During the long-term pumping test significant water level lowering led to the replacement of two wells and the installation of a submersible pump and a third well near PW 6. No other complaints due to water level lowering are anticipated.

Water quality monitoring has indicated that only minor changes in quality have occurred as a result of the pumping tests. There has been no significant change in the water quality of PW 6 during all of these tests. This is consistent with the 1982 test and is also consistent with the long-term trends in other municipal wells in the Winchester area.

11.0 RECOMMENDATIONS

Based on the above discussions and conclusions it is recommended that

i) PW 6 (TW 2/82) be operated at a rate of 10.26 L/s (135 igpm). The well should be restricted to a pumping rate of 7.6 L/s (100 igpm) during the months of August and September because of the significant natural water level lowering. Alternatively the well could be operated at the safe sustainable yield of 8.3 L/s (110 igpm).

ii) Water levels and meter readings should be recorded at the pumphouse daily. Plots of consumption versus groundwater level should be kept by the operators.

iii) Water levels should be recorded in TW 1 on a monthly basis.

iv) The Permit to Take Water should be adjusted on the basis of the conclusions and recommendations presented in this report.

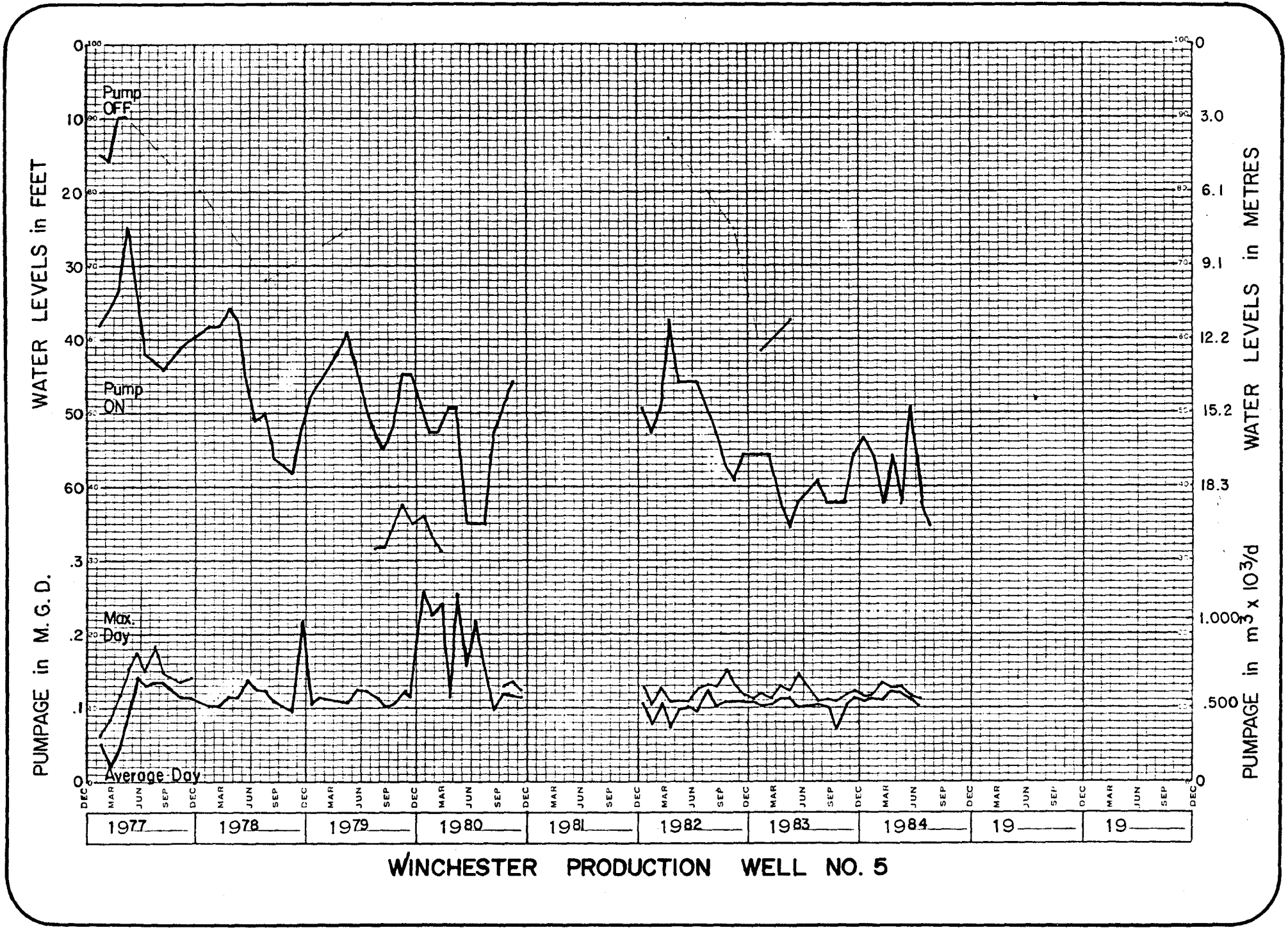
Respectfully submitted,
MORRISON BEATTY LIMITED

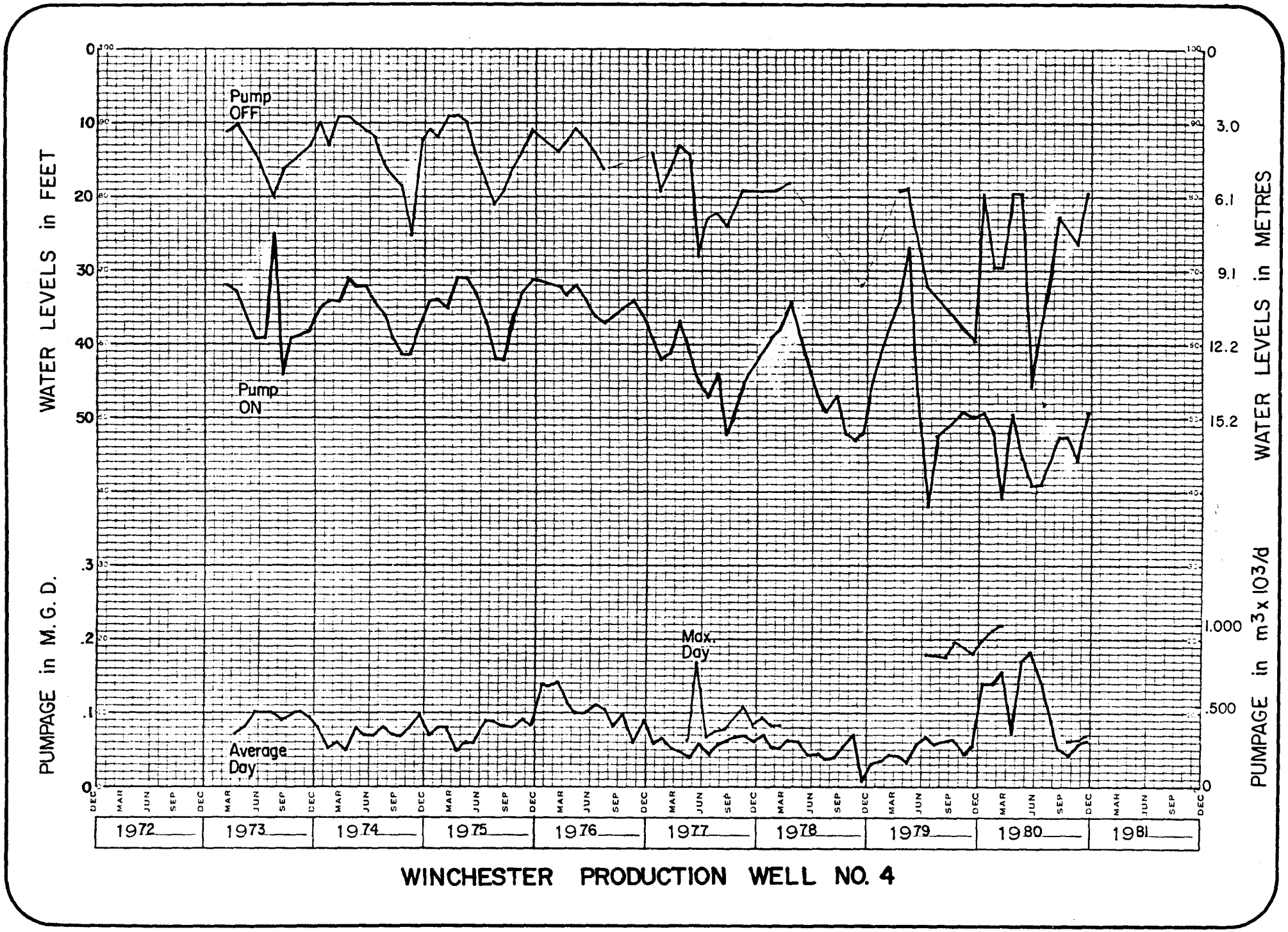
William D. Morrison, P.Eng.

BACKGROUND EXHIBITS

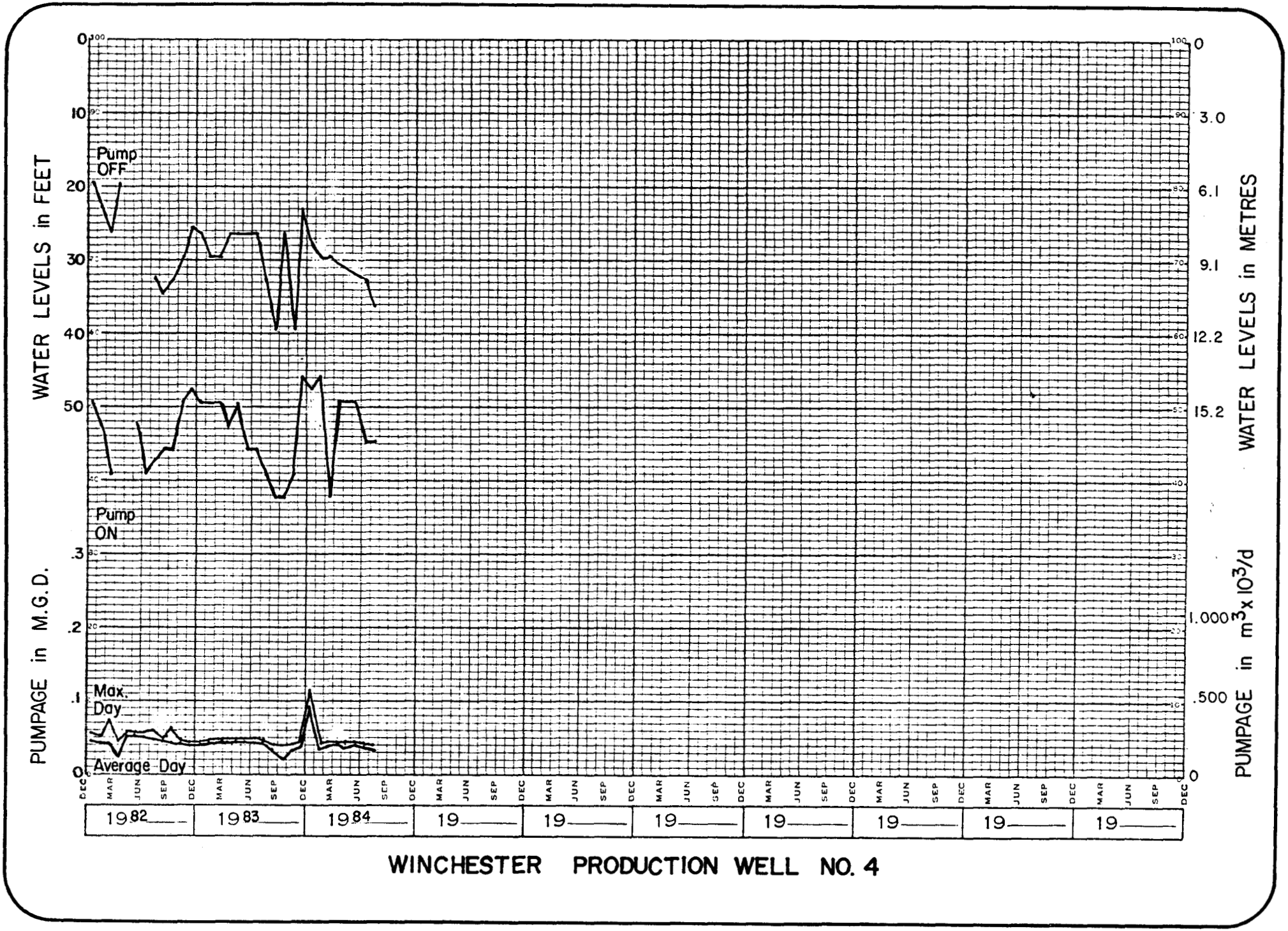
Ex#1	Historical Municipal Well Performance and Quality
Ex#2	MoE Study of Groundwater near PW6 - Jan. 1985
Ex#3	Summary of Water Well Records on file with MoE
Ex#4	Morrison Beatty Limited - Terms of Reference - 1985
Ex#5	Memorandum of Testing Program and Proceedure

Exhibit No. 1
Historical Municipal Well Performance
and Quality

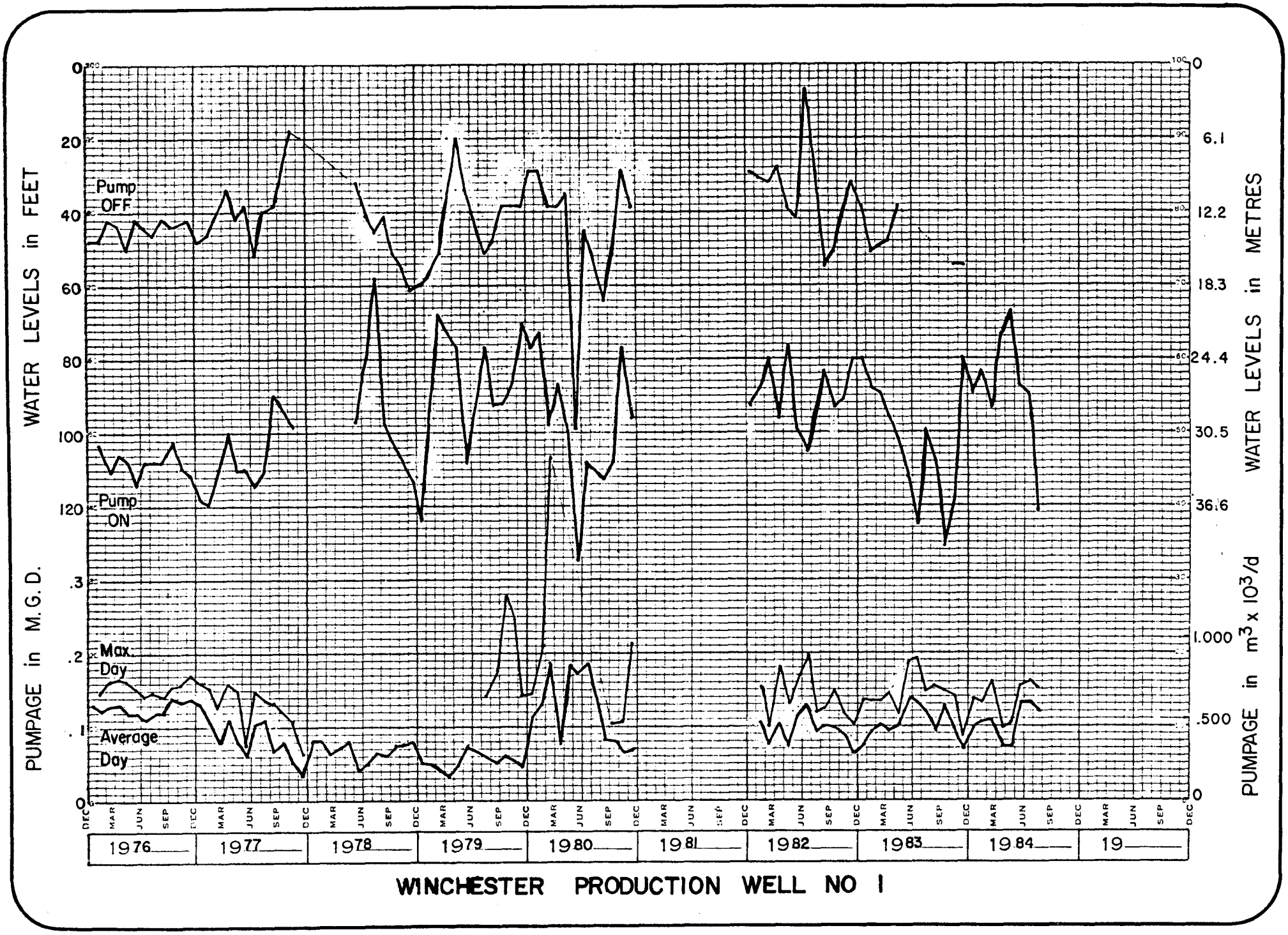

WATER LEVELS in FEET
PUMPAGE in M.G.D.
WATER LEVELS in METRES
PUMPAGE in m³ x 10³/d
Pump OFF
Pump ON
Max. Day
Average Day
0
10
20
30
40
50
60
.3
.2
.1
0
3.0
6.1
9.1
12.2
15.2
18.3
1.000
.500
DEC
MAR
JUN
SEP
1977
1978
1979
1980
1981
1982
1983
1984
19
19
WINCHESTER PRODUCTION WELL NO. 5

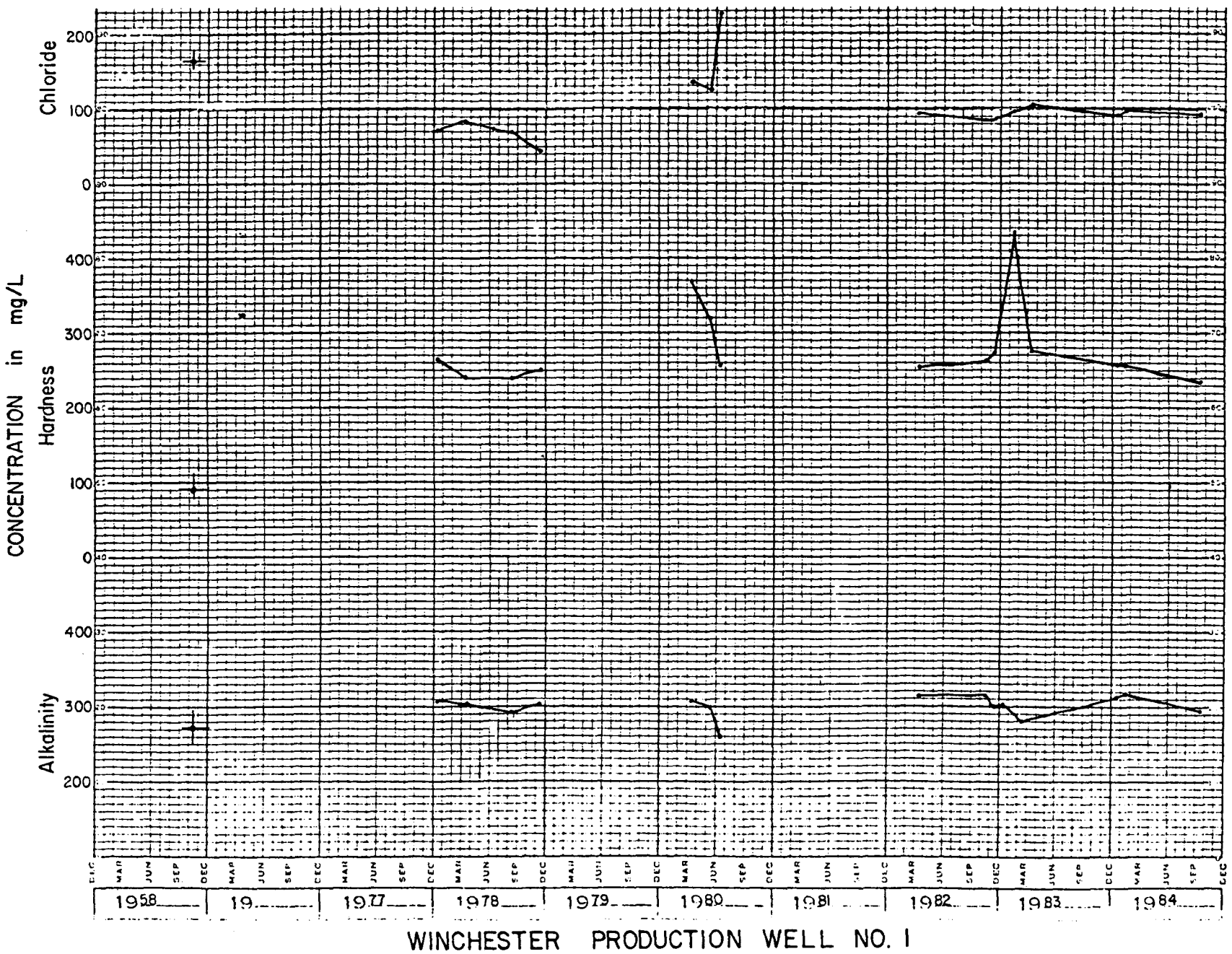


WINCHESTER PRODUCTION WELL NO. 4

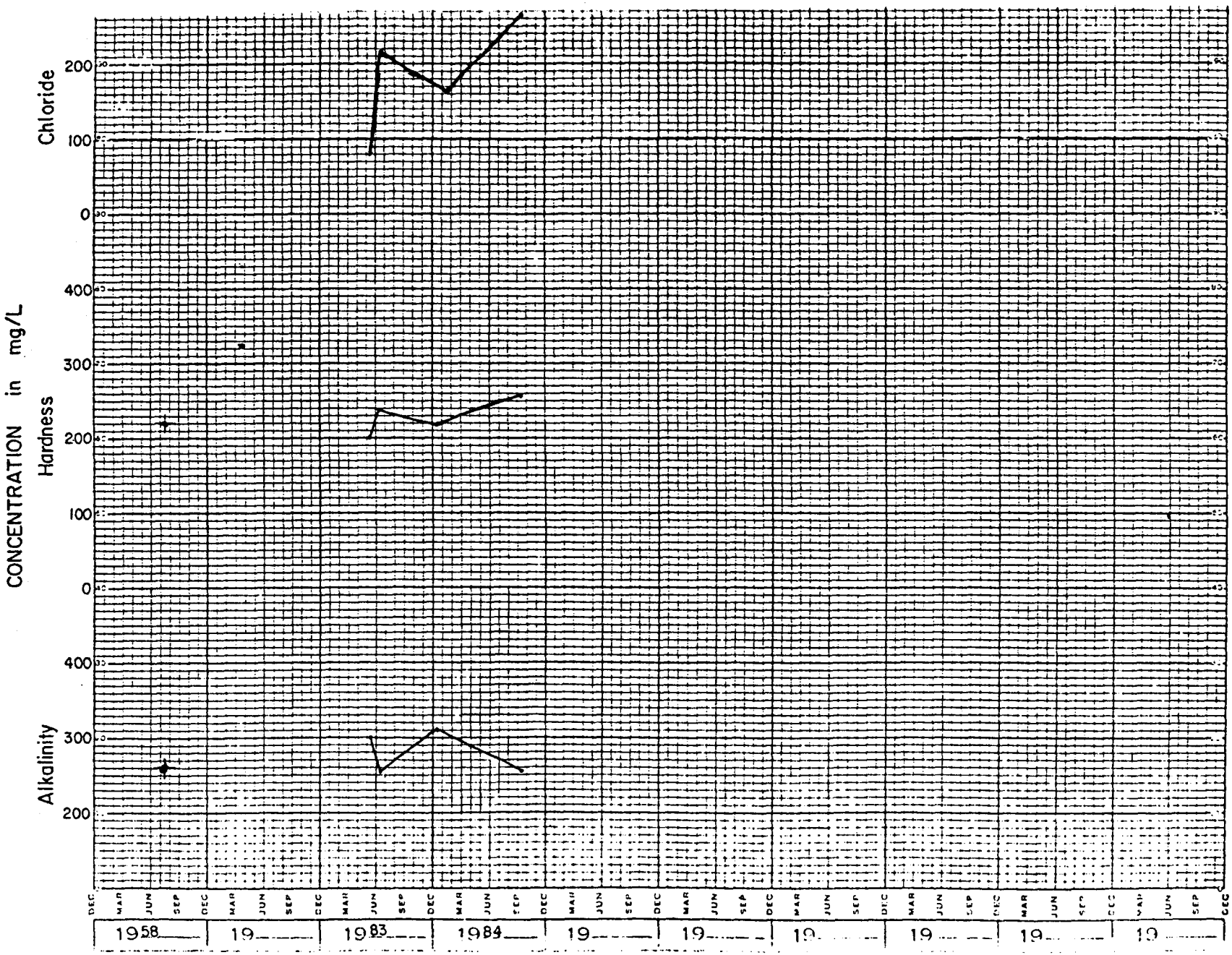


WINCHESTER PRODUCTION WELL NO. 4

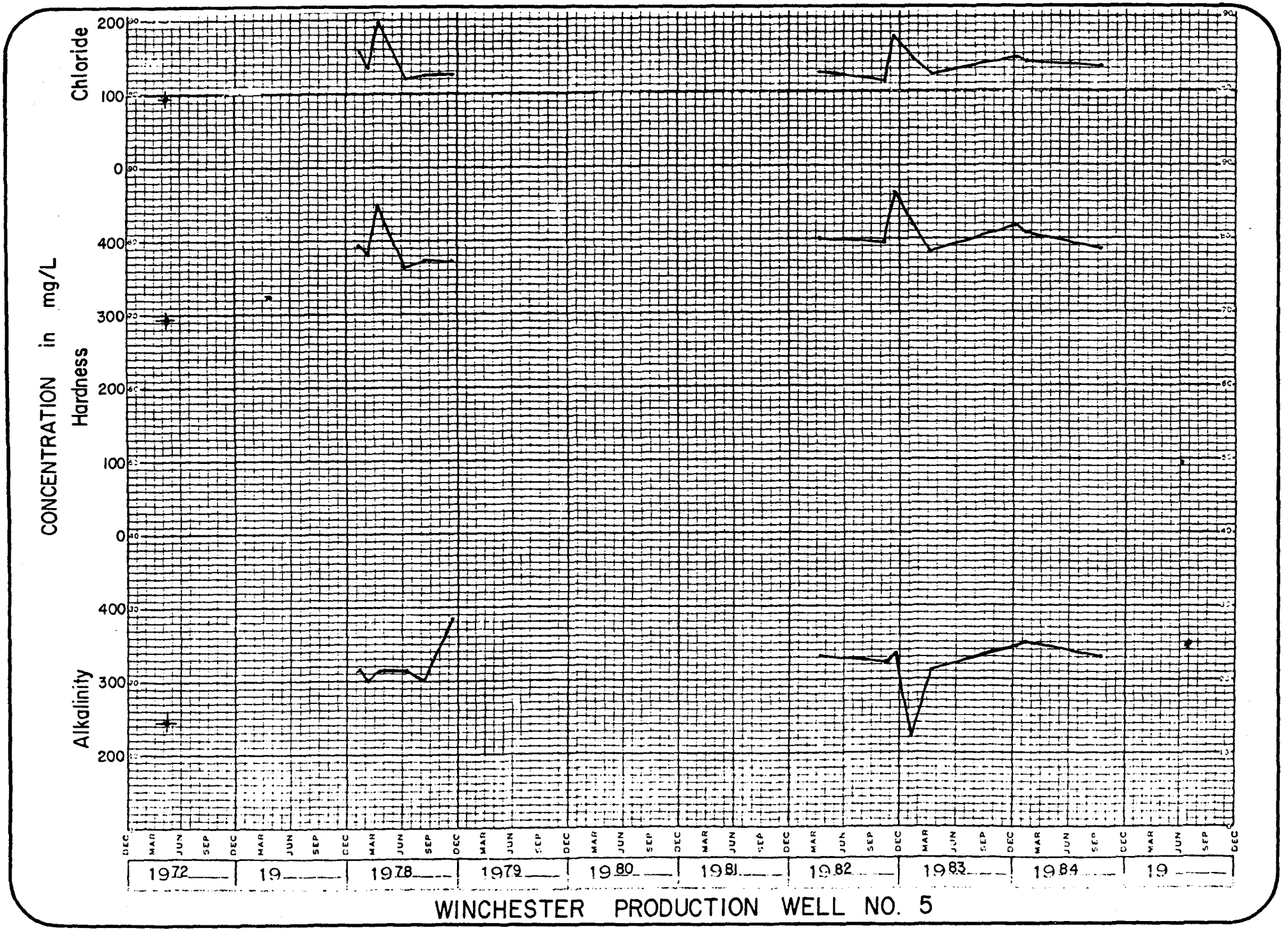

WATER LEVELS in FEET
PUMPAGE in M.G.D.
WATER LEVELS in METRES
PUMPAGE in $m^3 \times 10^3/d$
Pump OFF
Pump ON
Max. Day
Average Day
0
20
40
60
80
100
120
.3
.2
.1
0
6.1
12.2
18.3
24.4
30.5
36.6
1.000
.500
0
DEC MAR JUN SEP DEC MAR JUN SEP DEC MAR JUN SEP DEC MAR JUN SEP DEC MAR JUN SEP DEC MAR JUN SEP DEC MAR JUN SEP DEC MAR JUN SEP DEC MAR JUN SEP DEC MAR JUN SEP DEC
1976
1977
1978
1979
1980
1981
1982
1983
1984
19
WINCHESTER PRODUCTION WELL NO 1

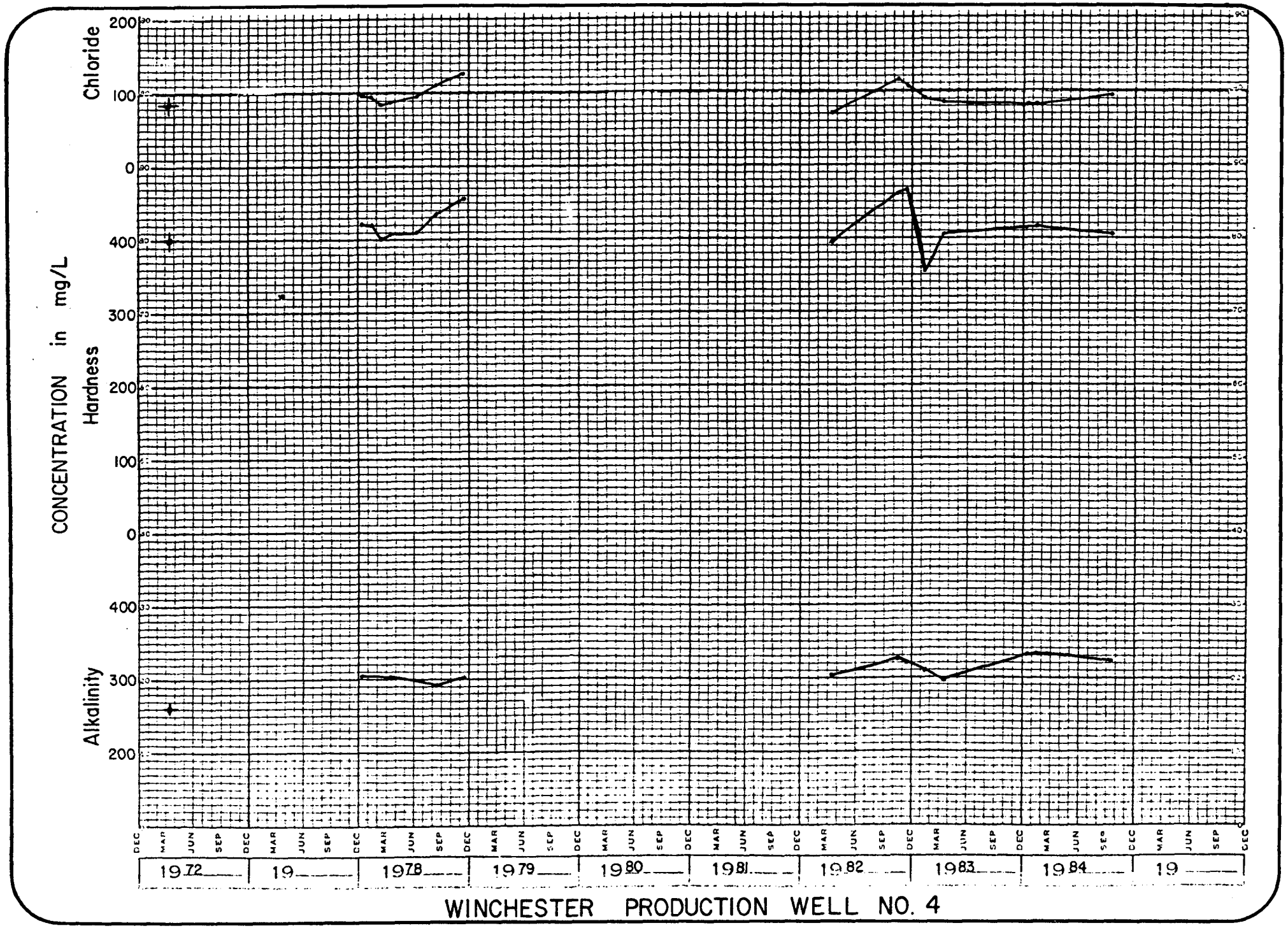


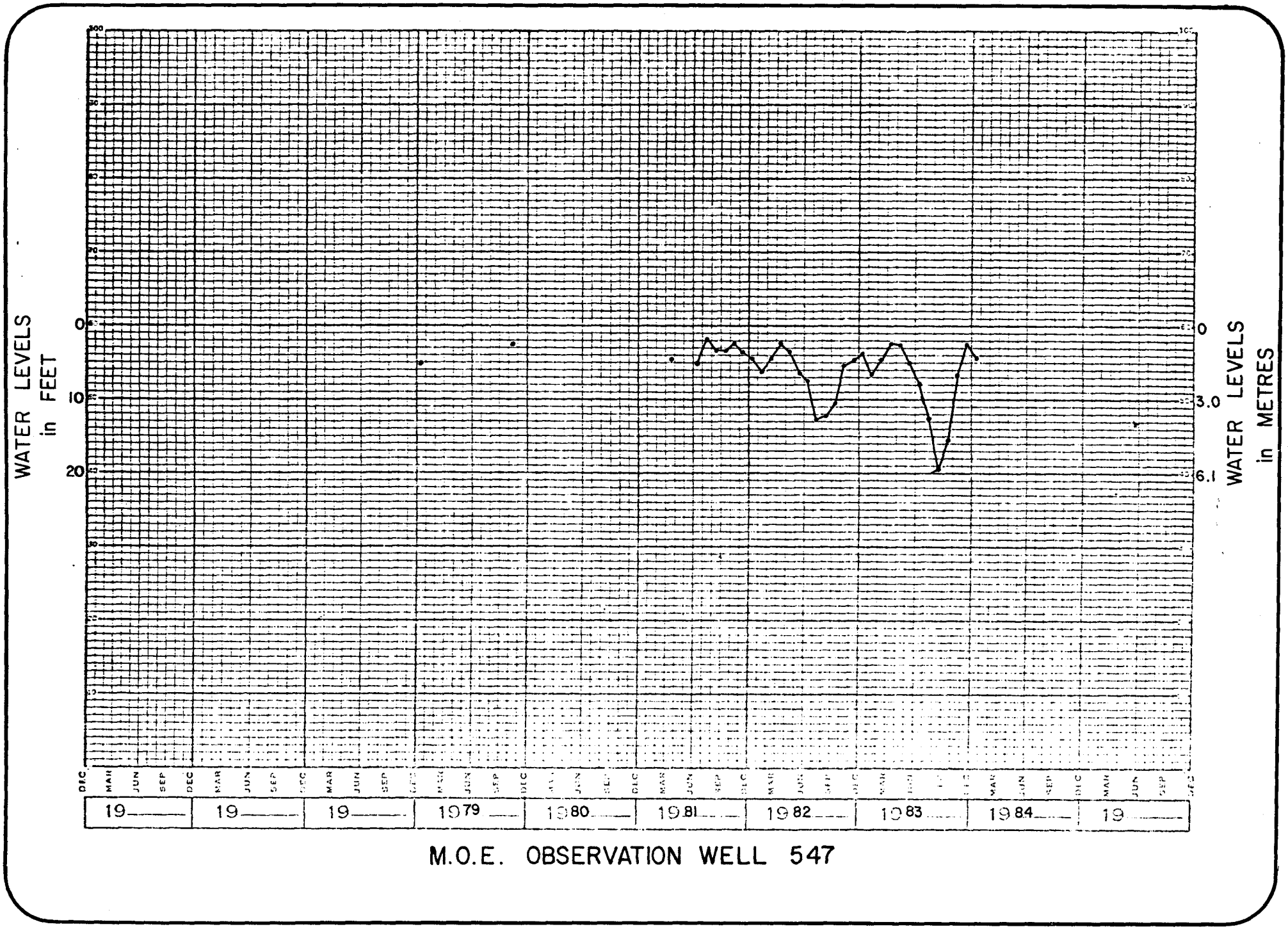
WINCHESTER PRODUCTION WELL NO. 1



WINCHESTER PRODUCTION WELL NO. 2


CONCENTRATION in mg/L
Chloride
Hardness
Alkalinity
200
100
0
400
300
200
100
0
400
300
200
DEC
MAR
JUN
SEP
1972
19
1978
1979
1980
1981
1982
1983
1984
19
WINCHESTER PRODUCTION WELL NO. 5


CONCENTRATION in mg/L
Chloride
Hardness
Alkalinity
200
100
0
400
300
200
100
0
400
300
200
DEC
MAR
JUN
SEP
DEC
1972
19
1978
1979
1980
1981
1982
1983
1984
19
WINCHESTER PRODUCTION WELL NO. 4



M.O.E. OBSERVATION WELL 547

Exhibit No. 2
MoE Study of Groundwater near PW6-
January 1985

Ontario

Ministry of the Environment | Ministère de l'Environnement

Southeastern Region | Région du Sud-Est

Mailing Address
PO Box 820
Kingston Ontario
K7L 4X6

Adresse postale
C.P. 820
Kingston (Ontario)
K7L 4X6

133 Dalton Avenue
Kingston Ontario
K7L 4X6
613 / 549-4000

133, avenue Dalton
Kingston (Ontario)
K7L 4X6
613 / 549-4000

January 11, 1985

R.W. Annable, Clerk
Village of Winchester
P.O. Box 489
546 St. Lawrence Street
Winchester, Ontario
K0C 2K0

Dear Sir:

The new Village of Winchester well (Test Well 2-82), located in Lot 20, Concession VII, Township of Mountain, is to be test pumped in the near future.

A groundwater study was carried out by Ministry of the Environment staff to establish existing groundwater conditions prior to the start of the pumping test. Please consider this as the Ministry of the Environment report on the findings of the pre-pump test study.

The study involved obtaining water well samples and static water level measurements on wells located near the municipal well. The quality of the well water in the current study was determined by routine chemical and analytical procedures. The static water level measurement in a well is the distance measured from the land surface to the top of the water in the well.

Just before the pumping test is carried out at the municipal well, static water level measurements and water samples will be obtained from the same wells by staff of the consultant firm in charge of conducting the pumping test. In addition, static water level measurements from these wells will be obtained several times during the pumping test.

Tables are attached listing static water level measurements and chemical analyses of water samples taken from wells located near the municipal well. A location map and information pamphlet to aid in the interpretation of the analytical analyses are also attached for your information.

The static level measurement in both the drilled and dug wells show only minor changes in the measurements taken on October 9, and December 11, 1984.

The chemical analyses show that the water in the wells is of good quality and that the concentration of components relating to health are not above the maximum acceptable concentrations for Ontario Drinking Water Objectives. However, in a few cases the concentration of the iron does exceed the maximum desireable concentration of 0.3 mg/l. Iron is often naturally present in well water at concentrations above the aesthetic criteria of 0.3 mg/l.

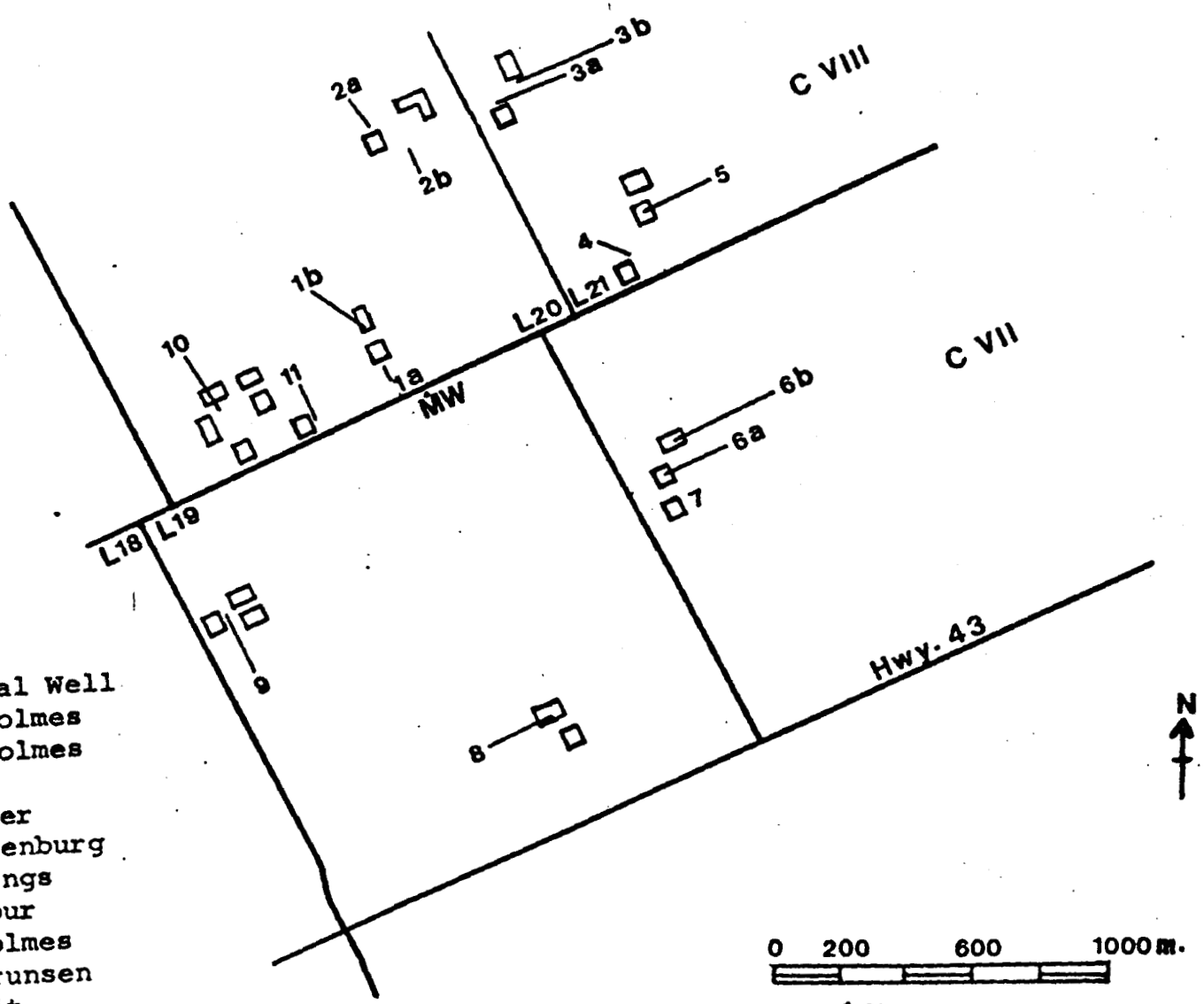
In a number of wells, potassium and ammonia are elevated above the concentrations normally found in groundwater. The concentration of potassium in groundwater normally is in the range of 2 to 3 mg/l and the concentration of ammonia is usually below 0.3 mg/l. It is felt that these parameters are elevated in the well water as a result of farming operations in the area.

A copy of the results of the study will be sent to the Township of Mountain municipal office.

Yours very truly,

M.J. German
Chief, Water Resources Assessment
Technical Support
Southeastern Region
CJH/sh
Attachments

GROUNDWATER STUDY — TOWNSHIP OF MOUNTAIN



Legend

MW - Municipal Well
1. Harold Holmes
2. Lester Holmes
3. C. Howse
4. G. Carkner
5. J. Spierenburg
6. E. Jennings
7. A. Larmour
8. Lyall Holmes
9. J. VanGrunsen
10. J. Spruit
11. J. Spruit

STATIC WATER LEVEL MEASUREMENTS

Well Owner	Reference Numbers	Type of Well	October 9 1984	December 11 1984
Mr. Harold Holmes	1a	house, drilled	NA	NA
	1b	barn, drilled	4.44 m (14.56')	4.59 m (15.06')
Mr. Lester Holmes	2a	house, drilled	6.61 m (21.68')	7.13 m (23.39')
	2b	not in use, dug	6.09 m (19.97')	dry
Mr. C. Howse	3a	house, drilled	7.84 m (25.72')	NA
	3b	not in use, drilled	6.99 m (22.94')	7.08 m (23.23')
Mr. G. Carkner	4	house, drilled	6.49 m (21.28')	6.31 m (20.70')
Mr. J. Spierenburg	5	dug portion	NA	dry
		drilled portion	NA	10.45 m (34.28')
Mrs. E. Jennings	6a	house, drilled	NA	NA
	6b	barn, dug	6.49 m (21.31')	6.14 m (20.14')
Mr. Lyall Holmes	8	dug portion	4.56 m (14.95')	4.98 m (16.34')
		drilled portion	5.72 m (18.78')	NA
Mr. J. VanGrunsven	9	dug portion	3.84 m (12.95')	3.52 m (11.55')
		drilled portion	7.42 m (24.34')	6.20 m (20.34')
Mr. J. Spruit	10	house & barn, drilled	5.82 m (19.12')	7.17 m (23.52')
	11	rented house, drilled	NA	NA

NA - Not accessible

CHEMICAL ANALYSES

Owner	#	Ca	Mg	Hard	Alk	Fe	Cl	pH	Cond	Na	K	SO_4	COD	BOD_5	NH_3	NO_2	NO_3
H. Holmes	1a	63	41	326	281	0.60	17	7.8	660	7.1	3.6	68	L10	L0.1	.09	L.002	L.02
	1b	60	43	327	257	1.55	19	7.8	690	12	6.6	92	L10	0.8	.45	.004	L.02
Lester Holmes	2a	80	39	359	298	L.05	38	7.5	760	10	7.9	48	L10	L0.1	L.01	.004	3.4
C. Howse	3a	72	33	314	286	.20	22	7.4	720	11	NA	NA	NA	NA	.02	L.002	.22
G. Carkner	4	70	28	292	251	.10	8	7.7	550	2.8	1.4	46	L10	L0.1	L.01	L.002	.28
J. Spierenburg	5	67	28	284	263	L.05	20	7.5	660	14	28	60	L10	L0.1	L.01	L.002	2.9
E. Jennings	6a	69	52	386	311	L.05	16	7.6	760	6.4	2.1	84	L10	L0.1	L.01	L.002	.42
Lyall Holmes	8	94	63	491	370	.10	44	7.4	980	18	13	105	L10	L0.1	.02	.004	.16
J. VanGrunsven	9	134	92	710	515	2.0	115	7.3	1500	25	59	120	18	0.2	5.9	.004	L.02
J. Spruit	10	125	72	606	528	.60	90	7.3	1330	25	74	88	18	L0.1	4.1	.006	.71
	11	95	52	448	337	L.05	25	7.7	860	11	17	92	L10	0.9	.01	.002	.08

- Reference Number
Ca - Calcium
Mg - Magnesium
Hard - Hardness
Alk - Alkalinity
Fe - Iron
L - Less Than

Cl - Chloride
pH - pH
Cond - Conductivity
Na - Sodium
K - Potassium
SO_4 - Sulphates

COD - Chemical Oxygen Demand
BOD_5 - Biochemical Oxygen Demand
NH_3 - Ammonia
NO_2 - Nitrite
NO_3 - Nitrate
NA - Not Analysed

Reported in mg/l except conductivity (umhos/cm) and pH (pH units).

Exhibit No.3
Summary of Water Well Records on file
with MoE

SUMMARY OF WATER WELL RECORDS ON FILE WITH MOE

444 Elev: 260 ft Lot 17, Conc. 6 Orig. Owner: K. Edwardson	0 - 35 35 - 39	Sandy gravel Gravel	Q = 8 gpm SL = 20 ft PL = 38 ft (1 hr) 6.25" diameter casing Fresh water at 38 ft Date: 07/01/65
475 Elev: 275 ft Lot 17, Conc. 6 Orig. Owner: J. Palmer	0 - 28 28 - 103	Hardpan & boulders Limestone	Q = 15 gpm SL = 20 ft PL = 67 ft (3 hrs) 5" diameter casing Fresh water at 103 ft Date: 20/06/60
476 Elev: 275 ft Lot 20, Conc. 6 Orig. Owner: Mulloy School S.S.#11	0 - 10 10 - 84	Hardpan Grey limestone	Q = 15 gpm SL = 37 ft PL = 40 ft (2 hrs) 5" diameter casing Fresh water at 84 ft Date: 12/11/60
477 Elev: 256 ft Lot 22, Conc. 6 Orig. Owner: F. Pyper	0 - 30 30 - 71	Clay & boulders Limestone	Q = 33 gpm SL = 12 ft PL = 16 ft (3 hrs) 5" diameter casing Fresh water at 71 ft Date: 25/09/57
478 Elev: 249 ft Lot 23, Conc. 6 Orig. Owner: Docksteader Bros. Ltd.	0 - 3 3 - 38 38 - 44 44 - 94.5	Loam Gravel clay sand boulders Rock layers Limestone	Q = 17 gpm SL = 16 ft PL = 30 ft (1 hr) 5" diameter casing Fresh water at 84 ft Date: 10/09/66
479 Elev: 270 ft Lot 24, Conc. 6 Orig. Owner: B. Dawley	0 - 10 10 - 17 17 - 80	Clay Hardpan Limestone	Q = 17 gpm SL = 12 ft PL = 15 ft (2 hrs) 5" diameter casing Fresh water at 80 ft Date: 08/08/58

486 Elev: 255 ft Lot 17, Conc. 7 Orig. Owner: M. Rose	0 - 30 30 - 112	Hardpan & boulders Limestone	Q = 7 gpm SL = 36 ft PL = 100 ft (2 hrs) 5" diameter casing Fresh water at 112 ft Date: 02/04/58
487 Elev: 275 ft Lot 19, Conc. 7 Orig. Owner: T. Holmes	0 - 33 33 - 163	Hardpan & boulders Limestone	Q = 8 gpm SL = 20 ft PL = 35 ft (3 hrs) 5" diameter casing Fresh water at 163 ft Date: 31/08/57
488 Elev: 275 ft Lot 21, Conc. 7 Orig. Owner: G. Jennings	0 - 38 38 - 96	Hardpan & boulders Grey limestone	Q = 15 gpm SL = 15 ft PL = 17 ft (3 hrs) 5" diameter casing Fresh water at 96 ft Date: 09/02/67
489 Elev: 255 ft Lot 24, Conc. 7 Orig. Owner: S. Garlough	0 - 2 2 - 20 20 - 53	Clay Hardpan & boulders Limestone	Q = 5 gpm SL = ground level PL = 8 ft (1 hr) 5" diameter casing Fresh water at 53 ft Date: 11/05/56
490 Elev: 253 ft Lot 24, Conc. 7 Orig. Owner: B. Larocque	0 - 13 13 - 66	Dug well Limestone	Q = 10 gpm SL = 10 ft PL = 30 ft (1 hr) 5" diameter casing Fresh water at 60 ft Date: 04/02/65
491 Elev: 253 ft Lot 24, Conc. 7 Orig. Owner: G. Garlough	0 - 7 7 - 64	Hardpan & boulders Grey limestone	Q = 20 gpm SL = 8 ft PL = 12 ft (5 hrs) 5" diameter casing Fresh water at 63 ft Date: 11/10/66

508 Elev: 260 ft Lot 18, Conc. 8 Orig. Owner: D. Burleigh	0 - 30 30 - 40	Hardpan & boulders Gravel	Q = 8 gpm SL = 14 ft PL = 25 ft (4 hrs) 5" diameter casing Fresh water at 40 ft Date: 04/10/57
509 Elev: 240 ft Lot 19, Conc. 8 Orig. Owner: J. Spruit	0 - 19 19 - 33 33 - 41 41 - 92	Clay Clay gravel Clay gravel sand Limestone	Q = 17 gpm SL = 5 ft PL = 51 ft (1 hr) 6" diameter casing Fresh water at 85 ft Date: 10/07/65
510 Elev: 250 ft Lot 24, Conc. 8 Orig. Owner: E. Skuce	0 - 8 8 - 38 38 - 200	Sand clay & gravel Hardpan & boulders Grey limestone	Q = 12.5 gpm SL = 18 ft PL = 60 ft (1 hr) 6" diameter casing Salty water at 185 ft Date: 31/10/60
524 Elev: 240 ft Lot 18, Conc. 7 Orig. Owner: E. Dillabough	0 - 50	Sandy boulders	Q = 12 gpm SL = 9 ft PL = 25 ft (2 hrs) 4" diameter casing Fresh water at 50 ft Date: 02/10/60
525 Elev: 245 ft Lot 22, Conc. 9 Orig. Owner: P. Dignard	0 - 18 18 - 31 31 - 34 34 - 102	Hardpan Clay Gravel Rock	Q = 3 gpm SL = 15 ft PL = 20 ft (24 hrs) 5" diameter casing Mineral water at 100 ft Date: 13/11/50
526 Elev: 250 ft Lot 24, Conc. 9 Orig. Owner: I. Docksteader	0 - 14 14 - 26 26 - 40	Broken limestone Grey limestone Brown limestone	Q = 20 gpm SL = 6 ft PL = 7 ft (1 hr) 5" diameter casing Fresh water at 35 ft Date: 28/07/61

527 Elev: 250 ft Lot 24, Conc. 9 Orig. Owner: N. Docksteader	0 - 28 28 - 55	Old drilled well Limestone	Q = 25 gpm SL = 9 ft PL = 22 ft (1 hr) 6" diameter casing Fresh water at 45 ft Date: 01/06/65
1044 Elev: 255 ft Lot 24, Conc. 7 Orig. Owner: D. Watts	0 - 2 2 - 6 6 - 12 12 - 51.5	Topsoil Clay Boulder hardpan Grey limestone	Q = 21 gpm SL = 12 ft PL = 26 ft (1 hr) 5" diameter casing Fresh water at 45 ft Date: 12/07/60
1149 Elev: 270 ft Lot 18, Conc. 6 Orig. Owner: R. Fawcett	0 - 10 10 - 57	Hardpan Grey limestone	Q = 15 gpm SL = 1 ft PL = 13 ft (3 hrs) 5" diameter casing Fresh water at 57 ft Date: 29/01/68
1150 Elev: 275 ft Lot 17, Conc. 7 Orig. Owner: C. Hill	0 - 35 35 - 109	Hardpan & boulders Grey limestone	Q = 18 gpm SL = 30 ft PL = 42 ft (4 hrs) 5" diameter casing Fresh water at 108 ft Date: 04/03/68
1258 Elev: 260 ft Lot 21, Conc. 8 Orig. Owner: W. Thomas	0 - 7 7 - 15 15 - 77	Hardpan Shell rock Limestone	Q = 10 gpm SL = 12 ft PL = 25 ft (2 hrs) 5" diameter casing Fresh water at 75 ft Date: 25/03/70
1310 Elev: 250 ft Lot 23, Conc. 6 Orig. Owner: Docksteader Bros. Ltd.	0 - 2 2 - 35 35 - 113	Brown loam Gravel, clay, sand Limestone	Q = 17 gpm SL = 5 ft PL = 21 ft (2 hrs) 6" diameter casing Fresh water at 95 ft Date: 21/10/70

1389 Elev: 275 ft Lot 20, Conc. 6 Orig. Owner: J. Palmer	0 - 23 23 - 96	Hardpan & boulders Limestone	Q = 14 gpm SL = 10 ft PL = 21 ft (4 hrs) 5" diameter casing Fresh water at 96 ft Date: 17/10/71
1398 Elev: 265 ft Lot 18, Conc. 6 Orig. Owner: A. Montroy	0 - 24 24 - 94	Hardpan Limestone	Q = 11 gpm SL = 22 ft PL = 32 ft (4 hrs) 5" diameter casing Fresh water at 94 ft Date: 04/01/72
1415 Elev: 265 ft Lot 17, Conc. 6 Orig. Owner: R.M. Markham	0 - 13 13 - 96	Clay, gravel Limestone	Q = 18 gpm SL = 2 ft PL = 7 ft (3 hrs) 5" diameter casing Fresh water at 96 ft Date: 18/05/72
1442 Elev: 280 ft Lot 20, Conc. 7 Orig. Owner: R. Brown	0 - 5 5 - 55 55 - 70	Hardpan Limestone Sandstone	Q = 10 gpm SL = 28 ft PL = 35 ft (2 hrs) 5" diameter casing Fresh water at 55 & 65 ft Date: 31/08/72
1450 Elev: 250 ft Lot 22, Conc. 7 Orig. Owner: R.A. Irven	0 - 6 6 - 41 41 - 160	Sand & gravel Boulder till Limestone	Q = 12 gpm SL = 17 ft PL = 80 ft (24 hrs) 6" diameter casing Fresh water at 150 ft Date: 24/06/72
1587 Elev: 275 ft Lot 19, Conc. 7 Orig. Owner: P. Johansen	0 - 2 2 - 9 9 - 65	Topsoil Clay, boulders Limestone	Q = 50 gpm SL = 18 ft PL = 30 ft (1 hr) 6" diameter casing Fresh water at 57 ft Date: 08/09/73

1640 Elev: 252 ft Lot 22, Conc. 6 Orig. Owner: M. Holmes	0 - 2 2 - 15 15 - 65	Fill Clay boulders Limestone	Q = 10 gpm SL = 24 ft PL = 30 ft (1 hr) 6" diameter casing Fresh water at 56 ft Date: 06/05/74
1662 Elev: 250 ft Lot 24, Conc. 7 Orig. Owner: E. Garlough	0 - 14 14 - 65	Hardpan Limestone	Q = 15 gpm SL = 5 ft PL = 20 ft (4 hrs) 5" diameter casing Fresh water at 65 ft Date: 02/07/74
1663 Elev: 245 ft Lot 24, Conc. 8 Orig. Owner: D. Sloane	0 - 40 40 - 77	Grey clay Grey limestone	Q = 15 gpm SL = 3 ft PL = 15 ft (4 hrs) 5" diameter casing Fresh water at 77 ft Date: 05/07/74
1782 Elev: 265 ft Lot 21, Conc. 7 Orig. Owner: A. Larmour	0 - 49 49 - 89	Hardpan & boulders Grey limestone	Q = 6 gpm SL = 14 ft PL = 50 ft (12 hrs) 5" diameter casing Fresh water at 89 ft Date: 18/06/75
1789 Elev: 275 ft Lot 20, Conc. 6 Orig. Owner: W. Kavanagh	0 - 25 25 - 32 32 - 48	Hardpan & boulders Gravel boulders Limestone	Q = 20 gpm SL = 10 ft PL = 25 ft (1 hr) 6" diameter casing Fresh water at 44 ft Date: 29/07/75
2104 Elev: 265 ft Lot 18, Conc. 6 Orig. Owner: J.F. Brown	0 - 16 16 - 63	Gravel muck Limestone	Q = 10 gpm SL = 4 ft PL = 5 ft (1 hr) 6" diameter casing Fresh water at 50 & 63 ft Date: 20/07/77

2171 Elev: 255 ft Lot 24, Conc. 6 Orig. Owner: D. Holmes	0 - 2 2 - 33 33 - 85	Topsoil Clay boulders Grey limestone	Q = 5 gpm SL = 14 ft PL = 40 ft (1 hr) 6" diameter casing Fresh water at 75 ft Date: 01/06/77
2242 Elev: 265 ft Lot 18, Conc. 6 Orig. Owner: R. Brown Construction	0 - 2 2 - 22 22 - 225	Loose fill Clay Grey limestone	Q = 3 gpm SL = 8 ft PL = 200 ft (1 hr) 6" diameter casing Fresh water at 215 ft Date: 02/06/77
2243 Elev: 270 ft Lot 20, Conc. 6 Orig. Owner: Z. Jennings	0 - 12 12 - 65 65 - 80	Hardpan Grey-brown slate Grey rock	Q = 25 gpm SL = 10 ft PL = 20 ft (1 hr) 6" diameter casing Fresh water at 80 ft Date: 31/03/75
2244 Elev: 270 ft Lot 20, Conc. 6 Orig. Owner: V. Flowers	0 - 4 4 - 65 65 - 80	Hardpan Grey rock Brown slate	Q = 60 gpm SL = 30 ft PL = 32 ft (2 hrs) 6" diameter casing Fresh water at 80 ft) Date: 22/07/75
2297 Elev: 260 ft Lot 20, Conc. 8 Orig. Owner: W. Riddell	0 - 31 31 - 35 35 - 75	Sand, clay, gravel, boulders Gravel boulders Limestone	Q = 10 gpm SL = 15 ft PL = 25 ft (1 hr) 6" diameter casing Fresh water at 70 ft Date: 22/08/78
2321 Elev: 280 ft Lot 21, Conc. 7 Orig. Owner: M. Holmes	0 - 5 5 - 15 15 - 135	Sand Grey limestone Soft grey limestone	Q = 3 gpm SL = 30 ft PL = 75 ft (N.A.) 6" diameter casing Fresh water at 131 ft Date: 13/09/78

2322 Elev: 275 ft Lot 21, Conc. 7 Orig. Owner: M. Holmes	0 - 5 5 - 13 13 - 75	Sand & stones Grey limestone Soft grey limestone	Q = 6 gpm SL = 20 ft PL = 45 ft (1 hr) 6" diameter casing Fresh water at 70 ft Date: 13/09/78
2388 Elev: 250 ft Lot 17, Conc. 9 Orig. Owner: P. Eyamie	0 - 6 6 - 46 46 - 48 48 - 75	Clay Blue clay Sand gravel Grey limestone	Q = 100 gpm SL = 10 ft PL = 25 ft (1 hr) 6" diameter casing Sulphur water at 70 ft Date: 04/11/78
2422 Elev: 250 ft Lot 18, Conc. 8 Orig. Owner: L. Levere	0 - 23 23 - 25 25 - 63	Sand & clay Gravel Grey limestone	Q = 10 gpm SL = 8 ft PL = 35 ft (1 hr) 6" diameter casing Fresh water at 53 ft Date: 03/08/78
2479 Elev: 260 ft Lot 19, Conc. 6 Orig. Owner: R. Suffel	0 - 7 7 - 15 15 - 123	Fill Layers of rock Grey limestone	Q = 5 gpm SL = 11 ft PL = 80 ft (1 hr) 6" diameter casing Fresh water at 113 ft Date: 27/12/78
2584 Elev: 250 ft Lot 22, Conc. 7 Orig. Owner: W. Sharpley	0 - 10 10 - 16 16 - 20 20 - 100	Clay, boulders Hardpan & boulders Broken limestone Grey limestone	Q = 8 gpm SL = 2 ft PL = 20 ft (1 hr) 6" diameter casing Fresh water at 75 & 95 ft Date: 01/10/79
2587 Elev: N.A. Lot 18, Conc. 6 Orig. Owner: R. Suffel	0 - 10 10 - 63	Hardpan, sand Limestone	Q = 7 gpm SL = 12 ft PL = 35 ft (1 hr) 6" diameter casing fresh water at 53 ft Date: 16/10/79

2601 Elev: 250 ft Lot 19, Conc. 8 Orig. Owner: J.L. Spruit	0 - 25 25 - 26 26 - 105	Hardpan Gravel Limestone	Q = 15 gpm SL = 12 ft PL = 40 ft (2 hrs) 6" diameter casing Fresh water at 40 & 101 ft Date: 21/05/80
2689 Elev: 265 ft Lot 19, Conc. 6 Orig. Owner: H. St. Pierre	0 - 26 26 - 110	Hardpan Limestone	Q = 10 gpm SL = 5 ft PL = 10 ft (1 hr) 6" diameter casing Fresh water at 90 & 105 ft Date: 20/03/81
2768 Elev: N.A. Lot 22, Conc. 7 Orig. Owner: R. Sharpley	0 - 5 5 - 31 31 - 75	Clay Hardpan, boulders Grey limestone	Q = 30 gpm SL = 5 ft PL = 25 ft (1 hr) 6.25" diameter casing Fresh water at 70 ft Date: 27/08/82
2798 Elev: N.A. Lot 22, Conc. 8 Orig. Owner: Village of Winchester	0 - 1.5 1.5 - 12 12 - 23 23 - 24.5 24.5 - 185	Topsoil Clay, sand & cobbles Clay, cobbles & boulders Sand & gravel Limestone	Q = 200 gpm SL = 12.75 ft PL = 55.93 ft (N.A.) 10" diameter casing Fresh water at 24, 40, 60 ft Date: 10/11/82
2800 Elev: N.A. Lot 20, Conc. 7 Orig. Owner: Village of Winchester	0 - 2 2 - 18.5 18.5 - 22.5 22.5 - 52	Topsoil Clay, cobbles Sand, gravel Limestone	Q = 200 gpm SL = 7.5 ft PL = 25 ft (48 hrs) 10" diameter casing Fresh water at 50 ft Date: 23/10/82
2801 Elev: N.A. Lot 20, Conc. 6 Orig. Owner: Village of Winchester	0 - 1 1 - 10.5 10.5 - 11 11 - 305	Topsoil Clay Sand with gravel Hard limestone	Q = N.A. SL = 25.75 ft PL = N.A. 10" diameter casing Sulphur water Date: 22/10/82

2890 Elev: N.A. Lot 18, Conc. 7 Orig. Owner: Village of Winchester	0 - 1 1 - 7 7 - 16 16 - 22 22 - 24 24 - 32 32 - 63	Topsoil Clay, cobbles, silt Sand, gravel, silt Clay till Boulders Gravel, sand Limestone	Q = N.A. SL = N.A. PL = N.A. N.A. Abandoned Date: 19/08/83
2919 Elev: N.A. Lot 24, Conc. 6 Orig. Owner: Rideau Auctions Inc.	0 - 22 22 - 28 28 - 80	Hardpan Broken rock Limestone, shaley	Q = 50 gpm SL = 10 ft PL = 25 ft (1 hr) 6.25" diameter casing Salty water at 75 ft Date: 19/10/84
2920 Elev: N.A. Lot 24, Conc. 6 Orig. Owner: Rideau Auctions Inc.	0 - 21 21 - 28 28 - 62	Hardpan Broken rock Limestone, shaley	Q = 10 gpm SL = 12 ft PL = 40 ft (1 hr) 6.25" diameter casing Fresh water at 46 & 59 ft Date: 19/10/84

Exhibit No. 4
Morrison Beatty Limited-
Terms of Reference-1985

THIS AGREEMENT, made in triplicate this day of

19

B E T W E E N: The Corporation of the

Village of Winchester
(hereinafter called the "Employer")

OF THE FIRST PART

- and -

Morrison Beatty Limited
(hereinafter called the "Consulting Engineer")

OF THE SECOND PART

WHEREAS the Employer requires the Consulting Engineer to provide the following engineering services:

Preparation of reports for 3 & 30 day pump tests on well T W 2, Township of Mountain.

and agrees to pay to the Consulting Engineer in respect thereof fees in accordance with the provisions hereof,

THIS AGREEMENT WITNESSETH that the Employer and the Consulting Engineer hereby covenant and agree with each other that:

1.0 The Consulting Engineer shall supply to the satisfaction of the Employer the following:

1.1 based on the Terms of Reference set out in Appendix 'A' hereto and such further directions as may be given by the Employer which submissions shall be comprehensive and complete to enable the Consulting Engineer to compile accurate cost estimates, both for capital and operating costs;

Duties of Consulting Engineer

1.2 Progress reports, attendances at meetings and the incorporation of such changes and revisions in the submissions as the Employer may require prior to the completion thereof;

1.3 All information which, in the opinion of the Employer, is relevant to the preparation of the submissions and estimates of cost referred to in sub-section 1.1 above which is in the possession of the Consulting Engineer, upon request by the Employer;

1.4 All equipment, apparel, accommodation, staff and assistance required to enable the Consulting Engineer to perform the services provided for by this Agreement at his expense as otherwise provided herein.

Insurance

2.0 The Consulting Engineer agrees to carry, in respect of all motor vehicles used by his staff in connection with the technical and professional services provided pursuant to this Agreement, public liability and property damage insurance in an amount satisfactory to the Employer and agrees to furnish the Employer with evidence of such insurance upon request.

3.0 Where, in the opinion of the Employer, any of the following services are to be provided, the Employer will authorize the provision of and pay for:

Other Services

3.1 Site investigations to ascertain sub-surface ground or underwater conditions at the site of any proposed works;

3.2 Special testing services at the site or in a laboratory;

3.3 Aerial mapping required in relation to any of the items referred to in Section 1.0 hereof.

The Consulting Engineer shall advise the Employer of the necessity for or desirability of such services and shall, if required by the Employer, obtain and submit to the Employer for approval, alternative proposals and estimates of cost from firms specializing in providing such services.

Payment

4.0 The Consulting Engineer having complied with the terms of this Agreement, shall be paid by the Employer in the manner and at times hereinafter set out.

4.1 Briefs or Reports

A fee for the preparation of the material referred to in Section 1.0 hereof in accordance with Schedule 'A' of Appendix 'B' hereto.

The Employer may, on request, make interim payments prior to the completion of this engineering assignment. A progress report will normally be required to accompany each request for an interim payment.

4.2 Cost of Revisions

If, after the submission of the material, or any part thereof, referred to in Section 1.0 hereof, revisions are ordered by the Employer the Consulting Engineer shall be paid a fee for the revisions per Schedule 'A' of Appendix 'B' hereto unless otherwise agreed to.

4.3 Expenses

The Employer shall reimburse the Consulting Engineer for all approved incidental expenses necessarily incurred by the Consulting Engineer in carrying out the work referred to in Section 1.0 hereof. When claiming reimbursement of expenses incurred, the Consulting Engineer shall submit to the Employer detailed expense sheets, receipts and car travel records. Receipts and invoices submitted shall be the originals save that if the original is not available for submission, a photocopy will be accepted provided that it is endorsed "Certified that this invoice/receipt has not previously been submitted" and is signed by a responsible officer of the Consulting Engineer.

Reimbursement for car travel shall be at the rate paid by the Consulting Engineer to the staff involved subject to a maximum of cents/km or subject to such other maxima as may be approved by the Employer.

4.4 Design for Construction

If the Consulting Engineer is authorized by the Employer to proceed with the design for construction and the preparation of contract plans and specifications for works based upon the submissions referred to in Section 1.0 hereof, the fee paid by the Employer for such portion of the said submissions which, in the opinion of the Employer, is applicable shall be deducted from the fee to be paid for the design for construction and the preparation of contract plans and specifications of the works. (Such deduction shall only be applied with respect to works or to such part of the works for which the payment for design shall be on a percentage fee basis).

Subletting

5.0 If the Consulting Engineer proposed to engage the services of any person (other than in the full-time employment of the Consulting Engineer), firm or company to carry out any part of the services which the Consulting Engineer is required by this Agreement to provide, he shall give particulars below (otherwise the Consulting Engineer shall enter "NONE PROPOSED").

NAME	SCOPE OF WORK

The employment of each person, firm or company shall be subject to the prior written approval of the Employer and the granting of such approval shall not relieve the Consulting Engineer of any of his responsibilities or obligations to the Employer under this Agreement.

Audit

6.0 The Consulting Engineer shall maintain in his office accurate records of the names and classifications of, the hours and dates worked by, the salaries paid to (or the per diem rates claimed for) and the nature of the work carried out by all members of his staff engaged on work pursuant to this Agreement. These reocrds shall be retained by the Consulting Engineer for not less than two years after the completion of the work carried out pursuant to this Agreement and shall be made available upon request at any reasonable time for inspection for audit purposes by any authorized officer or audit agent of the Employer.

In addition, an authorized officer or audit agent of the Employer shall have the right to inspect for audit purposes at any reasonable time such records of the Consulting Engineer as the said officer or agent considers pertinent to verifying or establishing the payroll burden (or fringe benefit) percentage applicable during any particular fiscal year to invoices submitted by the Consulting Engineer based upon salaries paid and hours worked.

The Consulting Engineer shall co-operate with and shall provide every reasonable assistance to such aforesaid officer or audit agent who wishes to carry out an inspection or audit of the Consulting Engineer's records as outlined above.

7.0

Estimates of Fees and Expenses

7.1 The Consulting Engineer shall enter below his estimated fees and related reimbursable expenses for carrying out the services to be provided under this Agreement:

see letter attached as "Appendix C"

7.2 The Consulting Engineer shall inform the Employer in writing if it becomes apparent that the above mentioned estimated cost will be exceeded and shall provide reasons for the increase in cost.

8.0

Professional and Technical Staff

8.1 The Consulting Engineer shall enter below the names and classifications or positions of the professional and senior technical staff to be assigned to carry out the work covered by this Agreement:

see letter attached as"Appendix C"

8.2 The Consulting Engineer shall inform the Employer in writing of any proposed additions to or changes in the foregoing list.

8.3 Before commencing work pursuant to this Agreement the Consulting Engineer shall notify the Employer in writing of the per diem rates and/or salaries proposed to be charged in respect of the above named staff.

Work Discontinued

9.0 The Employer may, at any time and for any reason, discontinue the performance of engineering services under this Agreement and upon such discontinuance, the Employer shall determine the total fee payable to the Consulting Engineer for engineering services under this Agreement at the date of such discontinuance and shall not be liable to the Consulting Engineer for services under this Agreement for any amount in excess of such total fee.

Special Provisions

10.0 If any of the provisions of this section should conflict with anything hereinbefore contained, then the following provisions, if any, of this section shall govern.

10.1 The Consulting Engineer may claim a mark-up of 5% to cover office administration costs when claiming reimbursement of eligible expenses. This mark-up is not applicable to fees paid to a sub-consultant whose work is normal to the services required under this Agreement or to overtime premium costs but will be applicable to items such as invoices from soil engineering consultants and Ontario Land Surveyors engaged by the Consulting Engineer in relation to this Agreement.

10.2 The Crown shall act as agent of the Employer for carrying out the Agreement until the Consulting Engineer is notified in writing to the contrary.

10.3 So long as the Crown is the agent of the Employer, the Director of the Ministry of the Environment's Project Co-ordination Branch or such other person or persons as he or the Minister of the Environment, from time to time, designates in writing for particular purposes of the Agreement, shall act for the Employer.

10.4 So long as the Crown is the agent of the Employer, "The Director of Construction" means the Director of the Project Co-ordination Branch of the Ministry of the Environment or any other person designated by him or the Minister of the Environment in writing, as the Director.

10.5 If the Crown ceases to be the agent of the Employer, the Employer may, from time to time, by resolution, designate a person or persons to act for the Employer for particular purposes under this contract.

11.0 This Agreement shall apply to and be binding on the parties hereto and their successors, administrators, executors and assigns and each of them.

IN WITNESS WHEREOF the parties hereto have hereunto set their hands and seals on the day and year first above written or caused their corporate seals to be affixed, attested by the signature of their proper officers, as the case may be.

IF APPLICABLE

Approved by the Minister of Intergovernmental Affairs and executed by Him on behalf of The Corporation of _____

_____

_____

_____
The Ministry of Intergovernmental Affairs

Per: _____

The Corporation of the Village of Winchester

Per: _____
(Chairman, Mayor, Reeve)

Per: _____
(Secretary, Clerk, Treasurer)

For the Consulting Engineer

Witness _____

Address _____

_____

Occupation _____

Witness _____

Address _____

_____

Occupation _____

* Morrison Beatty Limited

** _____

*** _____

** _____

*** _____

Company Seal

* Insert name of Consulting Engineer.
** Signature of partner or authorized signing officer.
*** Insert title of signing officer, e.g., president, secretary, partner.

NOTE:

1. In the case of a partnership, a red seal shall be affixed beside the signature of each partner and the signatures shall be witnessed.

2. In the case of a corporation, the corporation seal shall be affixed but the signatures need not be witnessed.

PROJECT NO. 7-0379

APPENDIX A
TERMS OF REFERENCE

Reports on Monitoring Wells in
Winchester and Mountain Townships

1. Prepare reports on conditions of wells in the area of well No. T.W. 2, a well detailed in Morrison & Beatty Ltd. Report for Instant Water Wells Ltd. dated August 1983, prior to well No. T.W. 2 going into production and during the period of 3 and 30 day pump tests to be conducted at a mutually convenient date in 1985.

2. Prior to the 3 and 30 day pump tests, and in conjunction with MOE Kingston office, the farm wells to be monitored will be established within a 3 Km radius from well No. T.W. 2.

3. Obtain approval in writing from well owners to monitor and/or uncover farm and/or domestic wells.

4. Assume all liability that may arise due to monitoring the wells. (see Appendix C)

5. It is anticipated that well No. T.W. 2 will go into production in February/March 1985. Carry out a three day pump test on T.W. 2 in conjunction with MOE Kingston office. Details to be monitored during this test shall include, but not be limited to:

   - sustainable yield, quality and quantities of water from well No. T.W. 2

   - Any adverse interference to quality and/or quantity of wells identified in (2) above.

6. During the dry season of 1985, carry out a 30 day pump test on well T.W. 2 and monitor details as in (5) above.

7. In order to reduce costs, MOE personnel and equipment and materials are to be used where possible.

Exhibit No. 5
Memorandum of Testing Program
and Proceedure

M E M O R A N D U M

March 5, 1985

TO: File UO-02-01
Winchester Municipal Water

FROM: S.I. Grey
Operations Officer
Utility Operations

RE: Village of Winchester - Well No. 6

On March 4 last the writer, Les Fitz, Cy Holland, Harold Sharkey, and Doug Black all of the MOE, and Bill Morrison of Morrison and Beatty Limited, met with Mr. Howse to discuss the three day pumping test that is to be conducted by Morrison and Beatty.

The following points were conveyed to Mr. Howse.

1. The well is to be pumped at 150 gallons per minute for 72 hours.

2. A map was given to Mr. Howse indicating the farm wells to be monitored.

3. 18 wells are to be monitored.

4. Farm wells will be monitored twice per day for static levels, and at the beginning and end of the 72 hour test samples will be collected for chemical analysis.

5. Production well to be sampled five times for chemical analysis and static levels to be periodically taken during the 72 hour test.

6. Two wells are equipped with continuous water level recorders.

7. A copy of the report for the 72 hour test will be made available to Mr. Howse.

8. An interim Permit To Take Water will be issued after the 72 hour test report has been studied. This permit will be valid until December 1985. A further permit will be issued at that time based on the interpretation of the ongoing monitoring data.

9. Mr. Howse indicated that no other farmers wished to talk to us with regard to the pumping of the production well.

10. Mr. Howse indicated that he was in agreement with all of the above procedures.

11. Mr. Howse will be updated as to ongoing test results (static level, quality, and pumping rate) as information becomes available.

12. The 72 hour test is scheduled to commence on March 5, 1985.

S.I. Grey
/km
cc: D.N. Jeffs
- D.G. Currie
- L.W. Fitz
- C.J. Holland
- Gordon Rose
- Mr. C.W. Howse, R.R. #2, Mountain, Ontario K0E 1S0
- Mr. Bill Morrison, Morrison and Beatty Limited

APPENDIX A

PRIVATE WATER WELL SURVEY

morrison beatty limited
consulting engineers and hydrogeologists
4500 dixie road, unit 12a, mississauga, ontario L4W 1V7 (416-624-9308)

A1
WATER WELL SURVEY

LOCATION:_____ DATE:_____
(Lot, Conc., Twp., Street & No., etc.)

OWNER:_____ PROJECT NO.:_____

TELEPHONE NUMBER:_____ WELL NO.:_____

WELL INFORMATION

Drilled_____ Dug or bored____ Combination__

Date completed_____ Depth*_____

Casing diameter*_____ Seal_____

Aquifer: Overburden_____ Bedrock_____

Static level: Original____ Present*_____

Pumping level: Original___ Present*_____

Has well ever been dry? _____

Owner when well drilled _____

PUMP INFORMATION

Make _____ Age____ HP____

Type: Jet__ Sumbersible__ Shallow well___

Deep well__ Other_____

Depth to intake*_____

Centre of pump (shallow well) measured from ground level*_____

Pump capacity*_____

Condition: good____ fair____ poor____

WATER QUALITY (if tested)

Bacterial_____ Iron_____

Clear: Yes____ No____ Sand free:Yes__ No_

Sulfurous: Yes__ No__ Odour: Yes__ No___

Any water treatment?_____

WATER CONSUMPTION

Domestic: No. of persons_____

Livestock: (specify)_____

Other uses_____

PUMPING TEST (if performed)

Pumping rate_____ Static level_____

Pumping level_____ Test duration_____

Accessible for measurement: Yes___ No____

REMARKS

SKETCH
(location & construction)

I hereby release Morrison Beatty Ltd. from all liability for any damages to my water well, which occurs as a result of investigations carried out with reasonable care.

SIGNATURE:_____ DATE:_____
(Owner/tenant)

SIGNATURE:_____
(Interviewer)

* All dimensions: indicate estimated or measured.

TABLE A3

PRIVATE WATER WELL SURVEY Village of Winchester 325 841

Feb. 12-19, 1985

Map #	Owner	Lot	Conc.	Twp.	Diam.	Total Depth bmp	Static Level	Quality	Water Use People	Water Use Livestock
1	H. Holmes	W 20,	8,	Mountain	6" est.	11.16 m mea.	3.48 m mea.	-	-	7-8 horses
1a	H. Holmes	W 20,	8,	Mountain	-	well buried	-	-	1	-
2	H. & L. Holmes	E 20,	8,	Mountain	6" est.	12 m mea.	5.14 m mea.	-	abandoned	
2a	H. & L. Holmes	E 20,	8,	Mountain	6" est.	15.92 m mea.	5.49 m mea.	-	8	200 cattle
3	C. Howse	21,	8,	Mountain	-	sealed	-	some iron	5	250 pigs
3a	C. Howse	21,	8,	Mountain	-	18.15 m mea.	5.49 m mea.	-	abandoned	
4	B. Smith	23,	8,	Mountain	36"	4.30 m mea.	2.20 m mea.	-	3	-
5	L. Levere	17,	8,	Mountain	6"	8.30 m mea.	2.83 m mea.	-	5	-
6	J. Spruit	19,	8,	Mountain	-	17 m est.	buried	some iron	abandoned	
6a	J. Spruit	19,	8,	Mountain	6"	27 m est.	buried	-	4	70 cattle
6b	J. Spruit	19,	8,	Mountain	6"	30 m+ mea.	5.20 m mea.		7	300 cattle
7	W. Baker	17,	9,	Mountain	6" est.	presently snow covered - sulferous odour			5	2 pigs
8	A. Larmour	21,	7,	Mountain		well buried under drive		high iron	4	cattle
9	A. Larmour	21,	7,	Mountain	-	well buried				
10	P. Holmes	20,	7,	Mountain	6" est.	11.7 m	5.3 m	high iron	5	50 cattle
11	J. Baldwin	20,	7,	Mountain	-	Buried location not known		high iron	5	
12	McKinley	20,	7,	Mountain	-	Owner not home more information needed			6	-
13	Flowers	20,	6,	Mountain	-	24 m est.	need narrow probe ie vent	some iron	6	-
14	T. Holmes	19,	7,	Mountain	6" est.	Buried under drive		-	2	-
14a	T. Holmes	19,	7,	Mountain	6" est.	52 m est.	-	-		90 cattle
15	Hart	S/W 19,	7,	Mountain	-	Well sealed at surface			2	-
16	H. Clapp	17,	9,	Mountain	6" est.	Well head flooded in pit		-	2	-
17	D. Don	23,	6,	Mountain		9 m est.	locked in shed	-	8	-
17a	D. Don	23,	6,	Mountain	-	22.9 m est.		min. iron	8	7 calves
18	LaFrance	23,	7,	Mountain	-	9 m est.	2.29 m mea.	sand	4	

PRIVATE WATER WELL SURVEY Village of Winchester 325 841

Feb. 12-19, 1985

Map #	Owner	Lot	Conc.	Twp.	Diam.	Total Depth	Static Level bmp	Quality	Water Use People	Water Use Livestock
19	Auto Stand									
20	E. Garlough	24,	7,	Mountain	-	27.4 m est.	buried		2	140 cattle
21	Garlough	?								
22	Larocque	24,	7,	Mountain	6" est.	16 m est.	buried		2-5	
23	Steck	24,	6,	Mountain	-	23 m est.	-	sand sulferous odour	2	in summer
24	D. Johnston	22,	6,	Mountain	-	26 m est.	-	iron & sand	6	125 cattle
25	Dawley									
26	W. Lynch	29,	6,	Mountain		24.4 m est.	buried well		9	
27	Jennings									
28	C. Holmes	21,	7,	Mountain		40.2 m est.	-		6	30 cattle 80 chickens
28a	C. Holmes	21,	7,	Mountain		27.4 m est.	-	sulfurous	4	
29	L. Kay	E 17,	7,	Mountain		48.8 m est.	-	odour	8	40 rabbits
30	R. Fawcett		6,	Mountain		Buried well			3	
31	J. Adams	18,	6,	Mountain	6" est.	19.2 m est.	well buried	sulfurous odour,sand	4	
32	R. Hedge	19,	6,	Mountain		-	need work for access	sulfurous	8	
32a	R. Hedge	19,	6,	Mountain		-	buried	iron & sand		40 cattle
33	R. Suffel	18,	6,	Mountain		18.3 m est.	buried	iron	5	
34	W. McSheffrey	18,	5,	Mountain		30.0 m est.	buried	iron	5	chickens
35	H. Thompson	18,	5,	Mountain		buried			2	
36	A. Montroi	18,	6,	Mountain		28 m est.	buried	iron, sulfurous & sand	4	4 pigs

PRIVATE WATER WELL SURVEY Village of Winchester 325 841

Feb. 12-19, 1985

Map #	Owner	Lot	Conc.	Twp.	Diam.	Total Depth bmp	Static Level	Quality	Water Use People	Water Use Livestock
37	A. St. Pierre	19,	6,	Mountain		30.8 m est.	-	iron, sulfurous	2	
38	J. Lewis	16,	6,	Mountain		5.2 m est.	-		6	65 cattle
39	K. Last	15/16,	6,	Mountain	4" est.	12.3 m est.	4.77 m mea.	sand	3	40 cattle
40	P. Kerkhof	16,	7,	Mountain		buried				100 cattle
40a	P. Kerkhof	16,	7,	Mountain		buried		iron, sulfurous	7	
41	D. Dunant	17,	7,	Mountain		3.6 m sealed	2.99 m mea.		4	70 cattle
42	D. Rose	18,	7,	Mountain	6" est.	35 m est.	-	abandoned		
42a	D. Rose	18,	7,	Mountain	6" est.	35 m est.	12.5 m mea.		6	125 cattle
43	D. Williams	24,	8,	Mountain		76.2 est.	-	little iron	3	350 cattle
44	Big "O"	24,	8,	Mountain	6" est.	26 m est	2.35 m mea	some iron, sulf. odour	15 max.	cooling
45	N. Williams	24,	8,	Mountain	-	Owner not home		sulfurous	5	
46	W. Lamoureux	22/23,	9,	Mountain	-	-	buried		7	
46a	W. Lamoureux	22/23,	9,	Mountain	-	6.1 m est.				85 cattle
47										
48	J. VanGrunsvan	9,	7,	Mountain	-	21.3 m est.	-		5	170 cattle
49	R. Suffel	18,	6,	Mountain	-	51.8 m est.	-	iron	4	71 cattle
50	M. Carkner	21/22,	8,	Mountain	6" est.	-	-		5	
51										
52										
53	H. Irven	22,	7,	Mountain	-	48.7 m est.	-	iron	1	
53a	H. Irven	22,	7,	Mountain	-	24.3 m est.	-	buried under		

TABLE A4

WINCHESTER

Summary Notes - Private Water Well Survey

PW #6

- reading taken using MoE meter
- all readings are below top of well tile - from metal jam on steel lid
- samples taken from raw water tap at the following times: 3 min, 60 min, 480 min., 4320 min
- at elapsed time 1440 min. flow was to town system and not to wate, the backpressure reduced flow by 10 ipgm - with valve open full only 141 igpm could be pumped
- the village water became dirty, some residents complained - it was assumed this was due to increased flow pulling scale off the pipe
- a hydrant was opened in village at 1730 min to flush the dirty water - the hydrant was closed at 2110 min
- the test was shut down after 4320 min of pumping, recovery was taken for 4435 min (from 390 min on the MOE took the readings)
- the mp is .72 m agl

#1 Harold Holmes

- well is located in the barn 250 m from PW #6
- there is no well seal - an empty grain bag is stuffed in the casing
- the well only serves livestock
- water quality is poor due to assumed surface contamination
- we were not allowed to sample
- measurements were made below top of casing which is at barn floor level
- a definite drawdown trend was recorded with a maximum drawdown of 2.99m resulting
- barometric pressure reading taken from the barn floor showed elevated difference between PW #6 and well #1 of +1.1 ft

#2 Lester Holmes

- first attempted to read Holmes #2A well which is abandoned however it is a combination well and the dug portion was flooded therefore any readings would not be accurate or respresentative
- well #2 is a drilled well serving the house and barn
- it contained a submersible pump and has a sanitary well seal
- the casing stickup is 4 " above ground level and barometric readings were taken at ground level
- the elevation difference between PW #6 and m.p. of #2 is 5.5 ft
- samples were taken from the house tap it was later learned a charcoal filter is on the system
- no drawdown or recovery trend was noted during the test
- at the time of the readings the water level was monitored for a few minutes to get an accurate level (due to water demand at house and barn)

#3 C. Howse

- this well services both the house and barn
- it is a drilled well with a well pit and a sanitary seal
- readings were taken through the vent hole and measured below top of well tile which is at general ground level - an arrow on the well tile lip marks the exact m.p.
- the vent line was returned to its original state and the concrete lid was replaced each evening
- on March 21 the lid was frozen in place - this prevented us from getting a W/L
- a very subtle drawdown trend was noted. At the end of the test a drawdown of 5cm was reached
- during a number of the readings the well was observed to be slowly recovering when the pump would come on
- this well is 6.5 ft higher than the m.p. at PW #6
- samples taken first from barn, second from house bypassing any treatment - no treatment in barn
- located 900 m from PW #6

#3A C. Howse

- this well is abandoned reportedly due to lack of quantity
- it is sealed by a plastic bag stretched over the top
- located 925 m from PW #6
- a drawdown trend occurred throughout the test with a maximum drawdown at the end of the test of 15 cm
- no samples could be collected owing to the lack of a pump
- the m.p. is the top of casing which is 3.5 in a.g.l.
- the relative elevation difference between PW #6 and #3A is +7.0 ft

#5 Levere

- located 1470 m from PW #6
- this well is complete with a 0.6 m stickup, and a well cap which has been broken due to being hit by a car (assumed) - the well is now covered by an old oil drum which has caused the well cap and ground around the well to be covered in oil - note there is a hole in the well cap
- the well services a home and a truck repair garage
- a subtle drawdown trend occurred with maximum drawdown of 14 cm at the end of the test - household laundry was being done over this period
- readings were taken below the top of casing
- relative elevation difference is 7" below the PW#6 m.p.

#6b J. Spruit

- well services both the house and barn
- 530 m from PW #6
- samples taken from barn pres. tank
- a drawdown trend was noted
- W/L was monitored for approx. 5 min during each visit - this was necessary because of large barn water demand
- well is equipped with a submersible pump and sanitary seal
- measurements are from top of casing which is 0.6 m above ground level
- relative elevation difference between #6b m.p. and PW #6 m.p. is +5.0 ft (#6b is higher)

#7 Baker

- no readings taken
- made a number of attempts however nobody home - large dog was home however

#10 Pat Holmes

- located 1120 m from PW #6
- this well is located in the garage - covered by wooden planks
- it is a combination well and the dug portion was flooded and this flooded the open casing of the drilled well
- measurements were taken from the garage floor which is .14 m above casing
- well actually recovered during pumping test
- the well serves both house and barn
- samples were taken from a household tap
- relative elevation difference between #10 m.p. and PW #6 m.p. is +11.5 ft (#10 is higher)

#13 Flowers

- no W/L was taken as there was no access to the well - a vent line sticking a.s.l. was plugged or restricted at the well head
- samples were collected at the beginning and end of the test

#18 Lafrance

- located 2485 m from PW #6
- dug well located in garage
- W/L's taken below concrete lip of lid jam
- m.p. is 0.1 m above ground level
- a subtle drawdown trend occurred with 6 cm maximum drawdown at the end of the test
- the well services a house
- samples were taken from househole tap - water had been softened (no bypass available)
- relative elevation difference between #18 m.p. and PW #6 m.p. is that #18 is 6.30 ft lower

#39 K. Last

- located 2900 m from PW #6
- well services both the house and barn
- m.p. is the top of casing which is .08 m above ground level
- well is capped with a homemade metal cap
- no drawdown trend during test
- samples collected from household tap
- relative elevation difference between PW #6 m.p. and #39 m.p. is 4.25 ft (#39 is higher)

#42 D. Rose

- located 1315 m from PW #6
- well located in barn
- heavy barn demand
- W/L's measured below top of casing which is .16 m above ground level
- top of well casing is open
- no drawdown trend during test however due to constant barn use it is hard to tell
- #42 m.p. is 11.5 ft higher than PW #6 m.p.

#43 D. Williams

- located 1840 m from PW #6
- well completed at ground level with a sanitary seal
- top of well grouted in place
- serves barn and house (automatic water bowls in barn)
- no drawdown trend occurred
- during the majority of the readings the well would be recovering when the pump came on
- water samples collected from barn tap
- relative elevation difference between m.p.'s of 6 ft (#43 higher)

#44 Big "O"

- located 2900 m from PW #6
- well used in office plus used for cooling
- located in pumphouse by office
- sanitary seal casing .05 m above ground level
- samples taken from pressure tank - poor quality
- no drawdown trends during test
- relative elevation difference between PW #6 m.p. and #44 m.p. is -9 ft (#44 is 9 ft lower)

#48 J. Vangranson

- well is located 830 m from PW #6
- this is a combination well the dug portion was flooded and flowing into the drilled well however the drilled well casing was not submerged and the drilled static was lower than the dug therefore readings were possible
- drilled casing open - dug opening covered with a metal sheet
- measurements taken from ground level
- no drawdown trend - well actually recovered during pumping test
- samples collected #1 from kitchen tap; #2 from barn tap
- well services both house and barn
- relative elevation difference between PW #6 m.p. and #48 m.p. is +5 ft (#48 is higher)

#49 Suffel

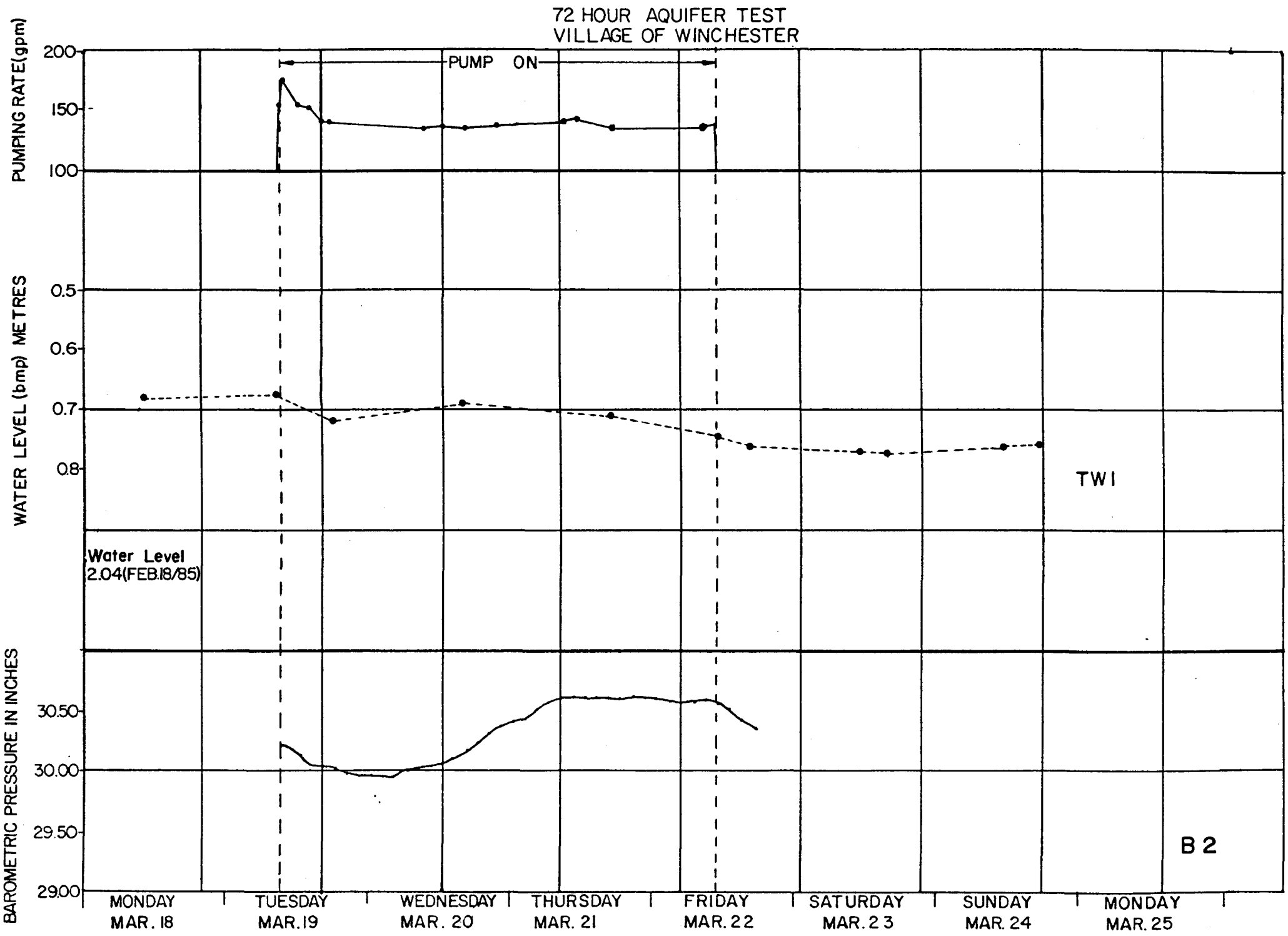
- no access well pit flooded
- sample collected before test

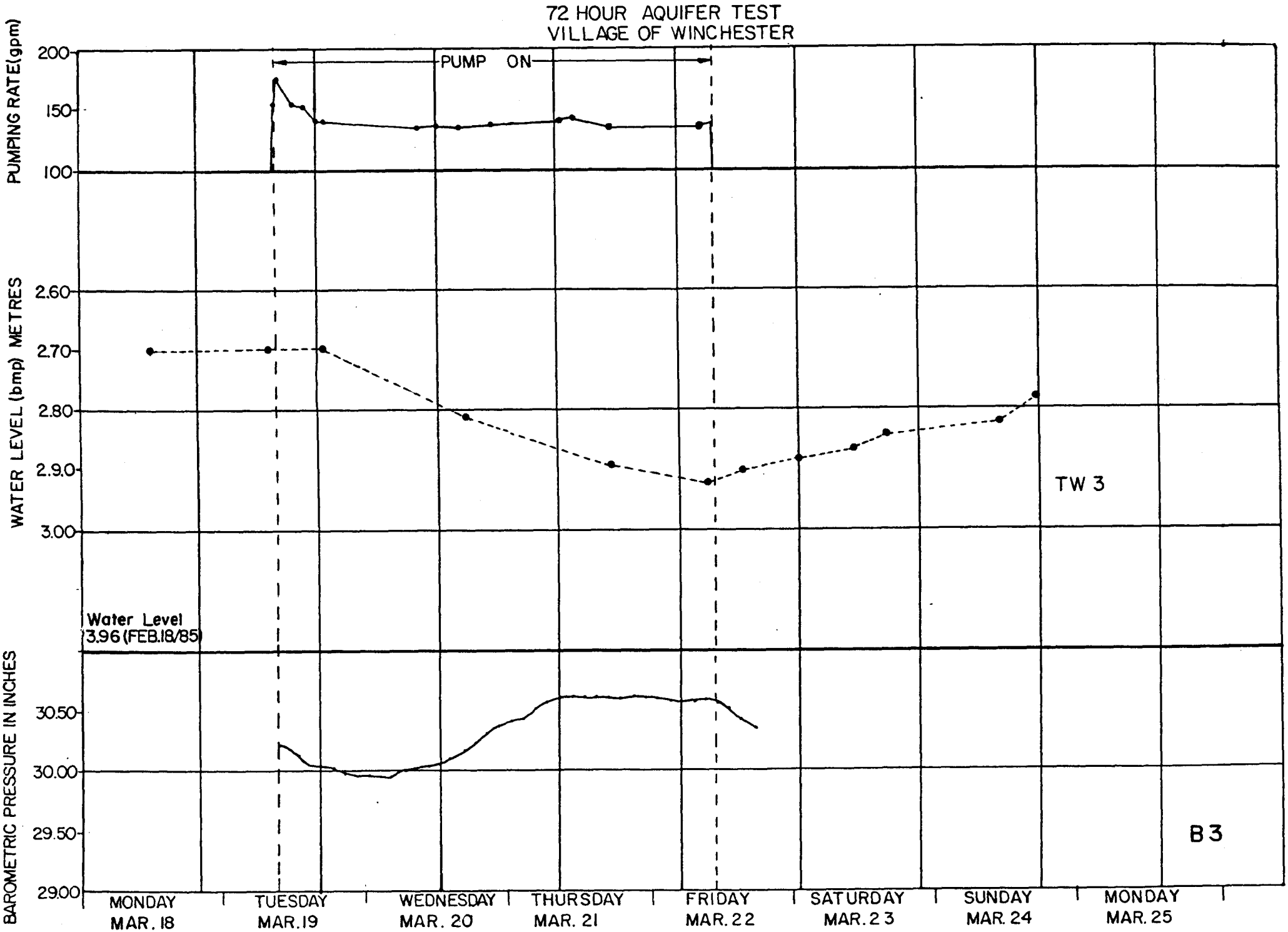
#51 Vanderbrook

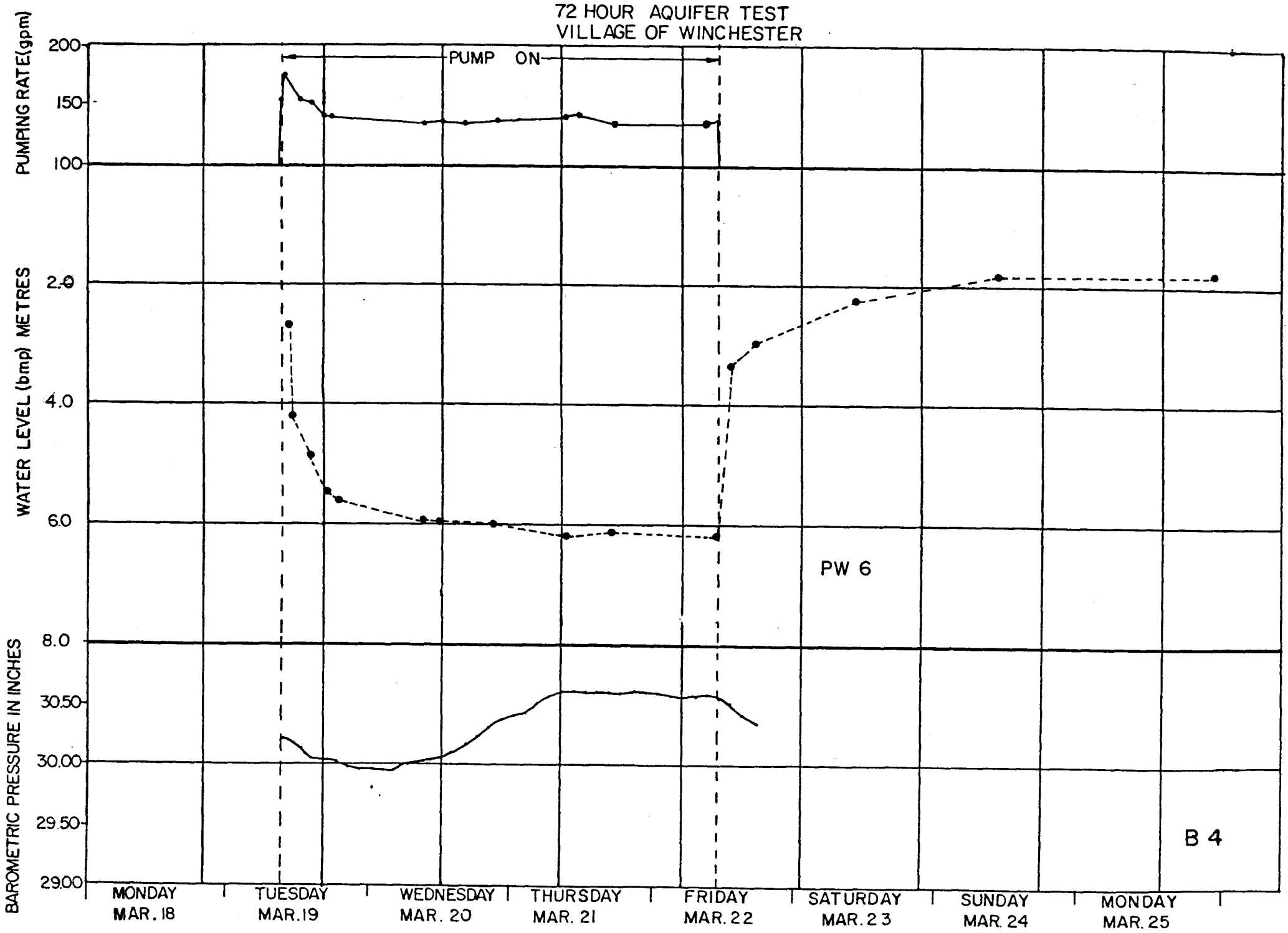
- dug well services barn and house
- monitored due to owners concern
- m.p. southwest corner of well head (concrete) .185 m above ground level
- no drawdown trend occurred during pumping test
- samples collected from kitchen tap before and after
- 8 inches above PW #6

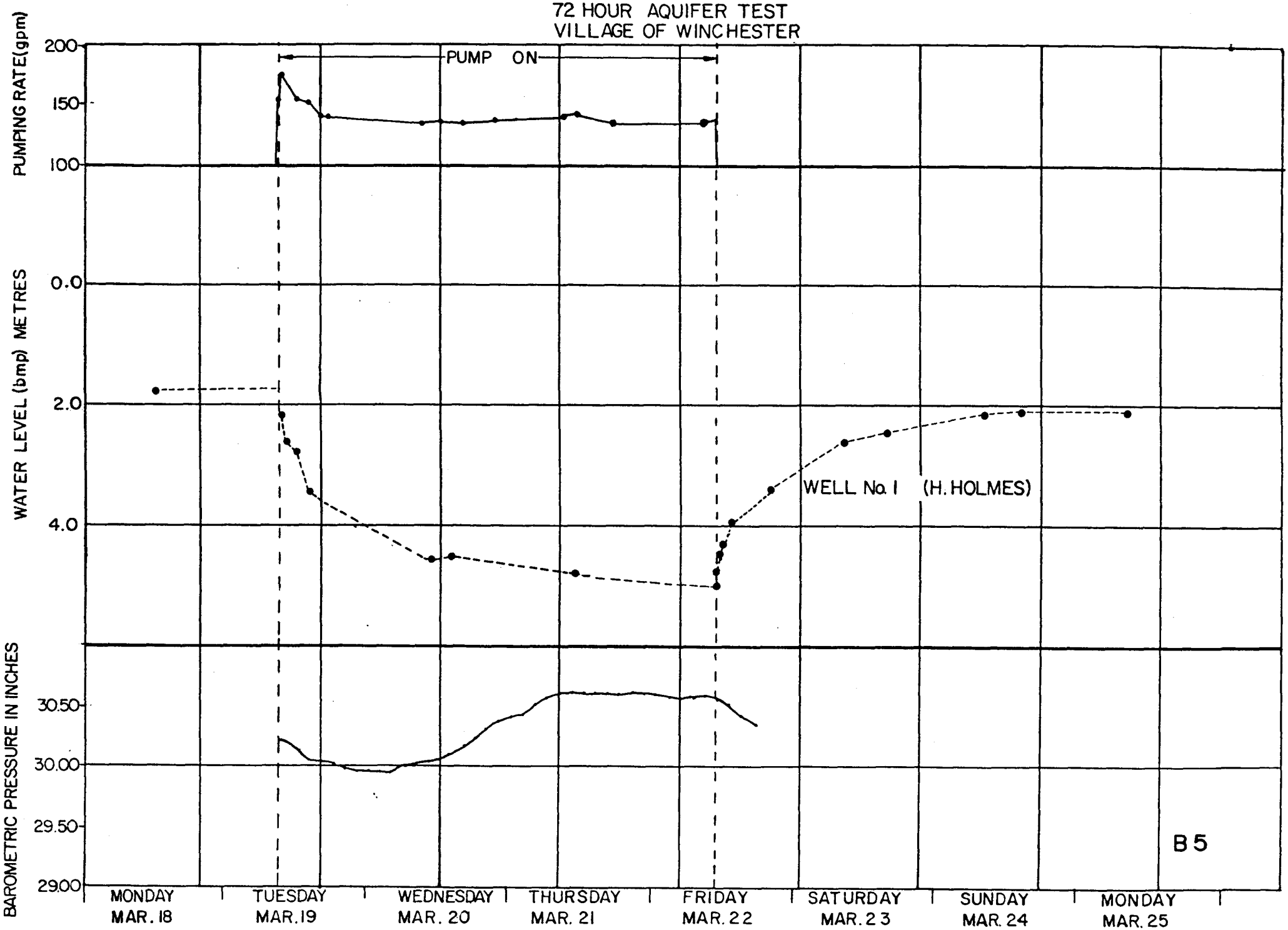
APPENDIX B

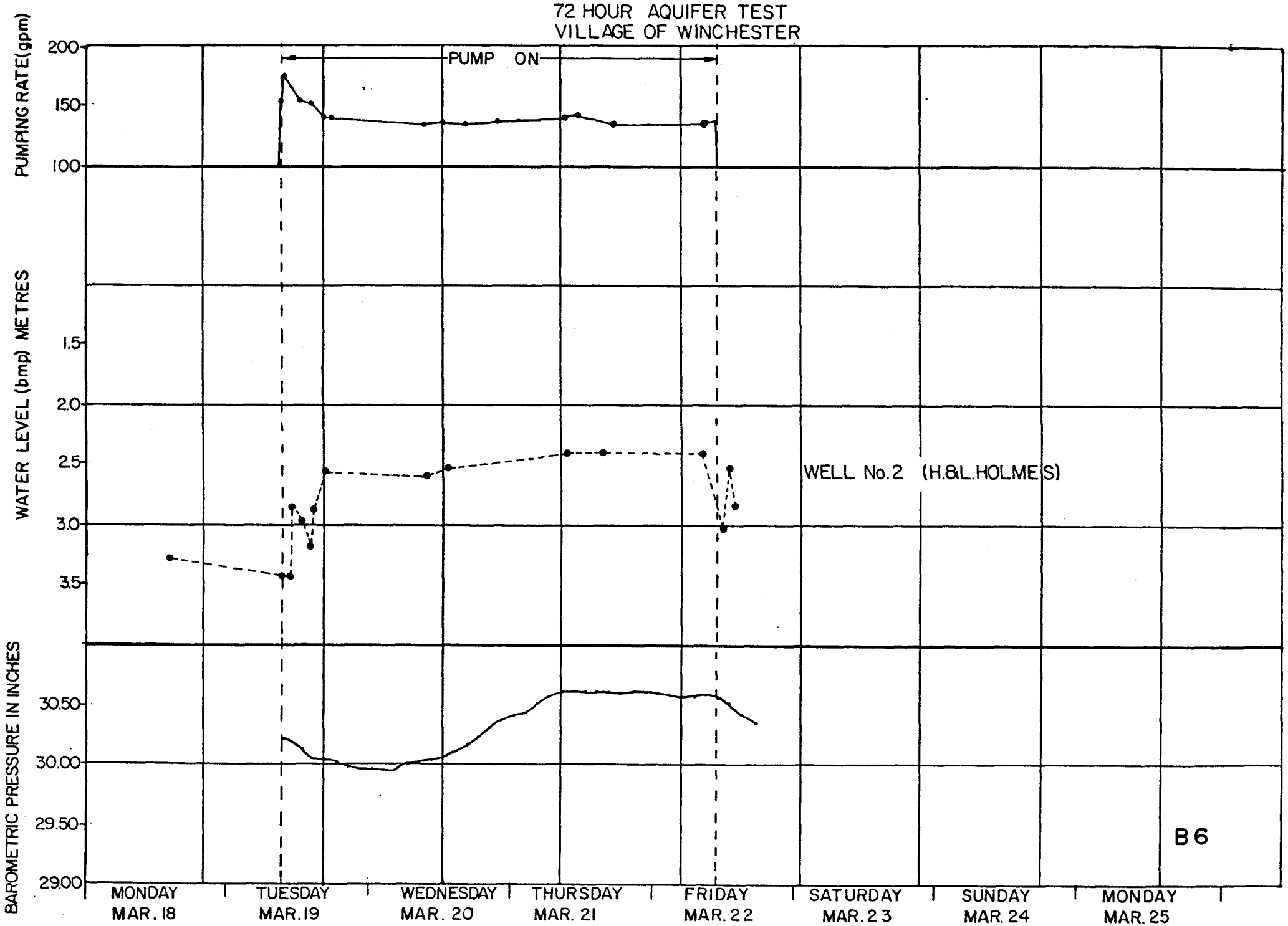
72 HOUR AQUIFER PERFORMANCE TEST

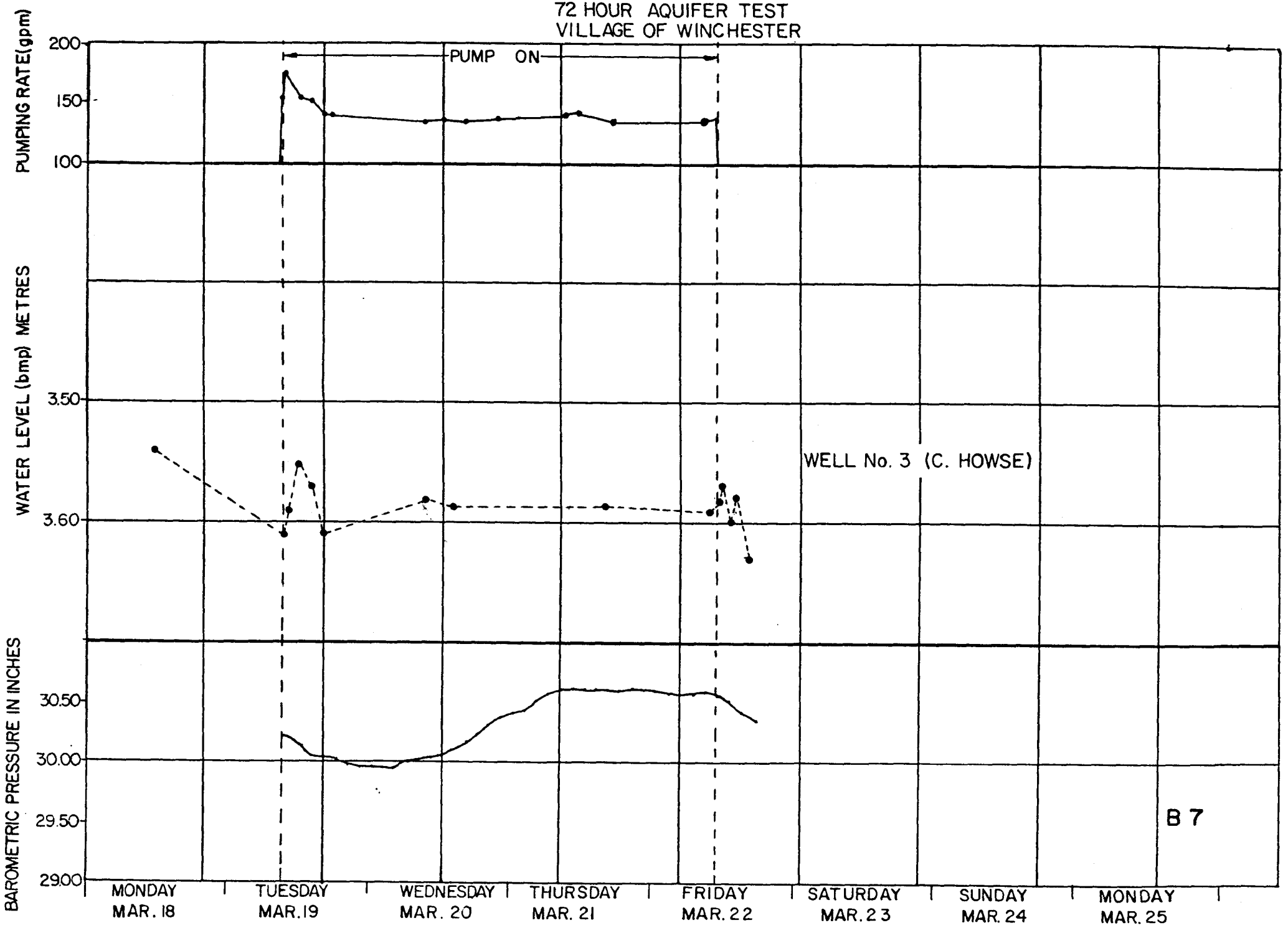

72 HOUR AQUIFER TEST
VILLAGE OF WINCHESTER
PUMPING RATE(gpm)
200
150
100
PUMP ON
WATER LEVEL (bmp) METRES
0.5
0.6
0.7
0.8
TW1
Water Level
2.04(FEB.18/85)
BAROMETRIC PRESSURE IN INCHES
30.50
30.00
29.50
29.00
B 2
MONDAY MAR. 18
TUESDAY MAR. 19
WEDNESDAY MAR. 20
THURSDAY MAR. 21
FRIDAY MAR. 22
SATURDAY MAR. 23
SUNDAY MAR. 24
MONDAY MAR. 25

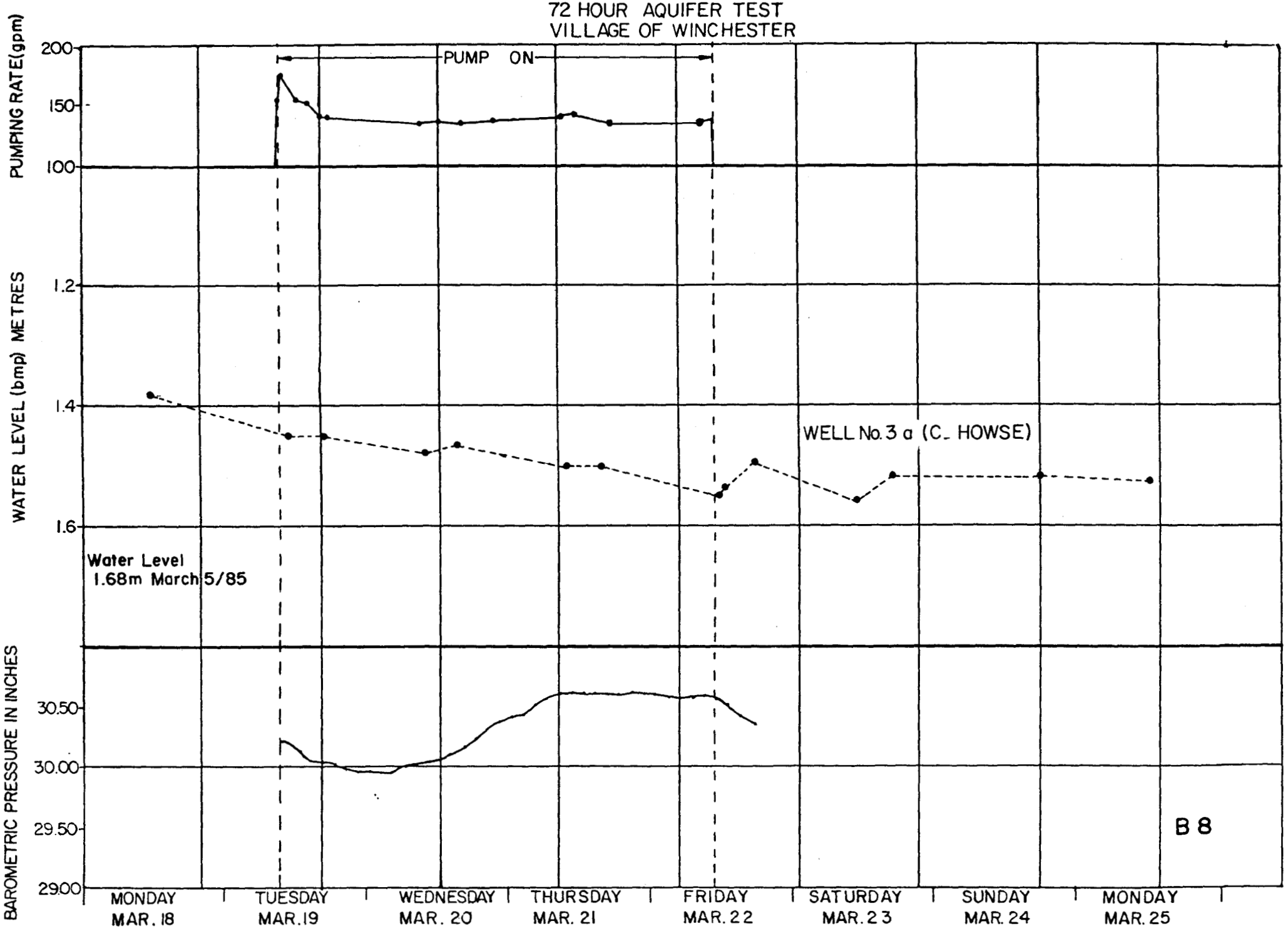

72 HOUR AQUIFER TEST
VILLAGE OF WINCHESTER
PUMPING RATE(gpm)
200
150
100
PUMP ON
WATER LEVEL (bmp) METRES
2.60
2.70
2.80
2.90
3.00
TW 3
Water Level
3.96 (FEB.18/85)
BAROMETRIC PRESSURE IN INCHES
30.50
30.00
29.50
29.00
B3
MONDAY MAR. 18
TUESDAY MAR. 19
WEDNESDAY MAR. 20
THURSDAY MAR. 21
FRIDAY MAR. 22
SATURDAY MAR. 23
SUNDAY MAR. 24
MONDAY MAR. 25

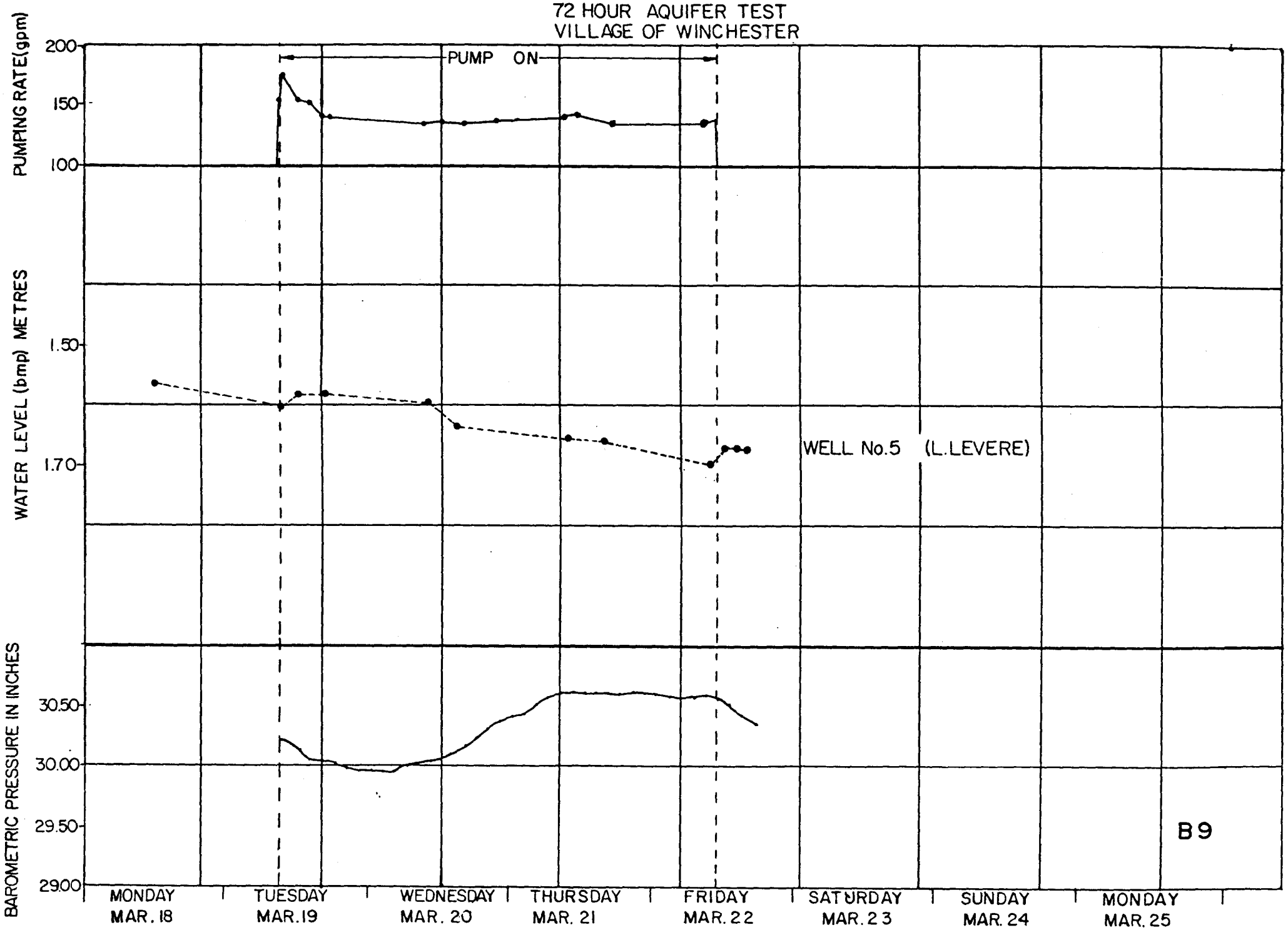

72 HOUR AQUIFER TEST
VILLAGE OF WINCHESTER
PUMP ON
PUMPING RATE(gpm)
200
150
100
WATER LEVEL (bmp) METRES
2.0
4.0
6.0
8.0
PW 6
BAROMETRIC PRESSURE IN INCHES
30.50
30.00
29.50
29.00
B 4
MONDAY MAR. 18
TUESDAY MAR. 19
WEDNESDAY MAR. 20
THURSDAY MAR. 21
FRIDAY MAR. 22
SATURDAY MAR. 23
SUNDAY MAR. 24
MONDAY MAR. 25

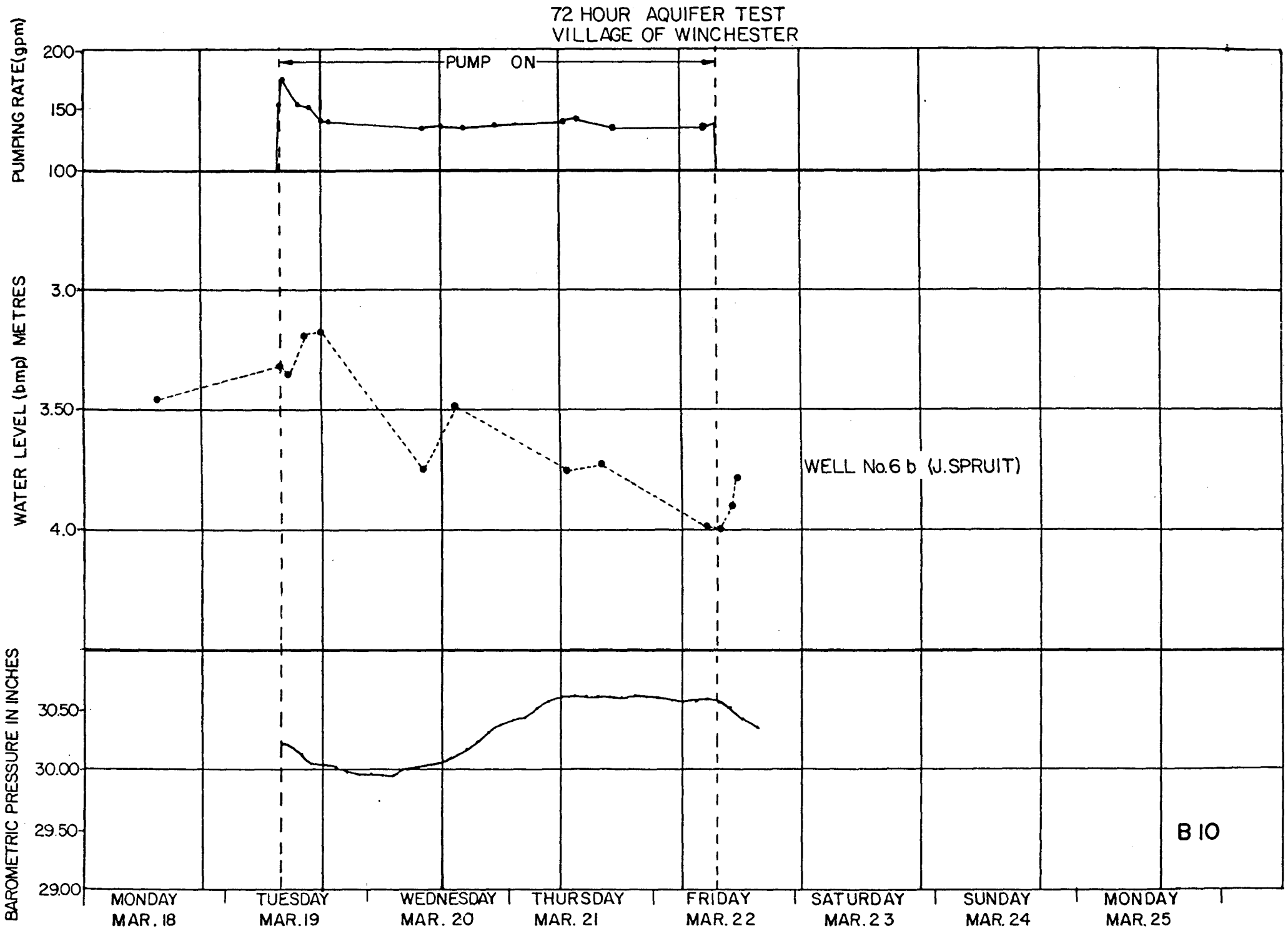

72 HOUR AQUIFER TEST
VILLAGE OF WINCHESTER
PUMPING RATE(gpm)
200
150
100
PUMP ON
WATER LEVEL (bmp) METRES
0.0
2.0
4.0
WELL No. 1 (H. HOLMES)
BAROMETRIC PRESSURE IN INCHES
30.50
30.00
29.50
29.00
MONDAY MAR. 18
TUESDAY MAR. 19
WEDNESDAY MAR. 20
THURSDAY MAR. 21
FRIDAY MAR. 22
SATURDAY MAR. 23
SUNDAY MAR. 24
MONDAY MAR. 25
B5

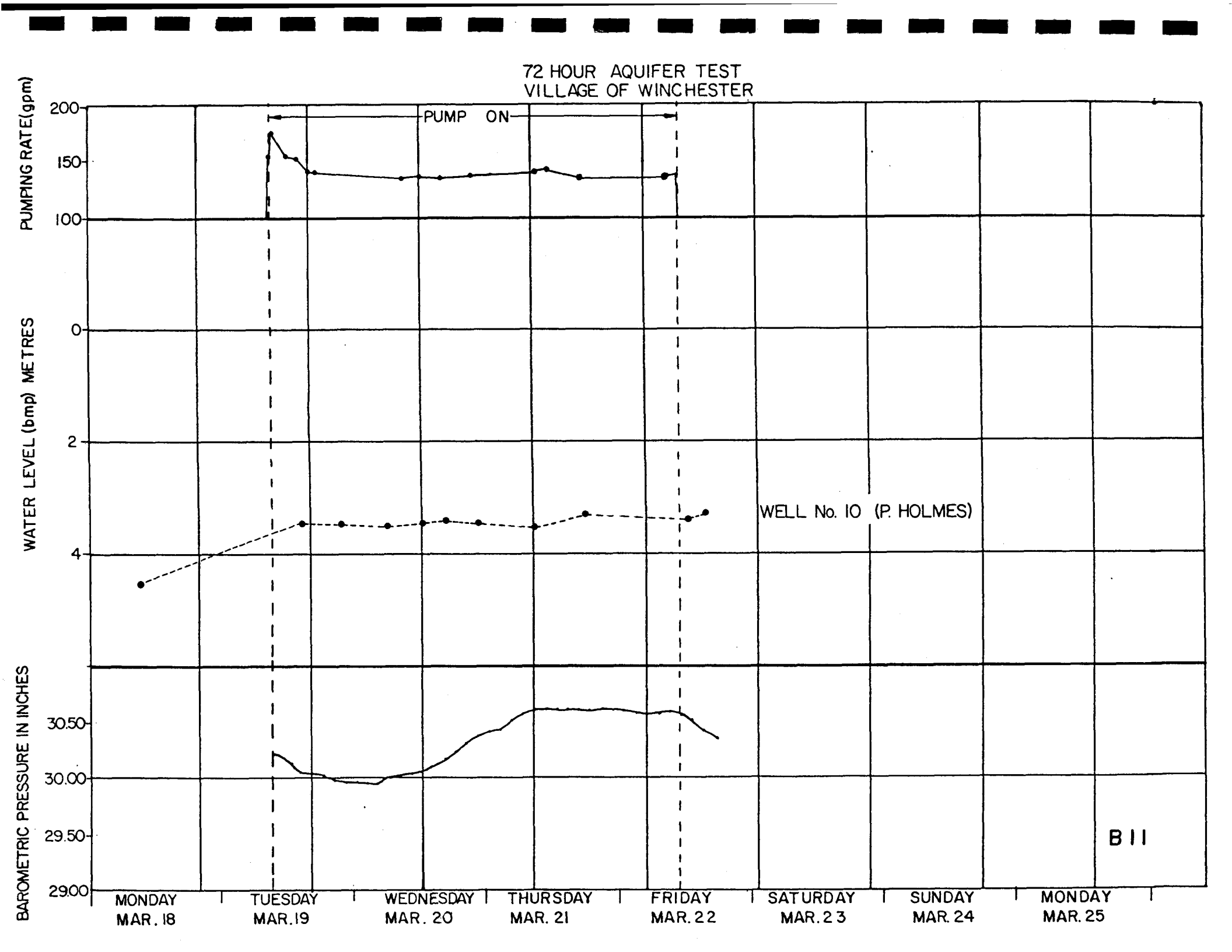

72 HOUR AQUIFER TEST
VILLAGE OF WINCHESTER
PUMPING RATE(gpm)
200
150
100
PUMP ON
WATER LEVEL (bmp) METRES
1.5
2.0
2.5
3.0
3.5
WELL No.2 (H.&L.HOLMES)
BAROMETRIC PRESSURE IN INCHES
30.50
30.00
29.50
29.00
B6
MONDAY MAR. 18
TUESDAY MAR. 19
WEDNESDAY MAR. 20
THURSDAY MAR. 21
FRIDAY MAR. 22
SATURDAY MAR. 23
SUNDAY MAR. 24
MONDAY MAR. 25

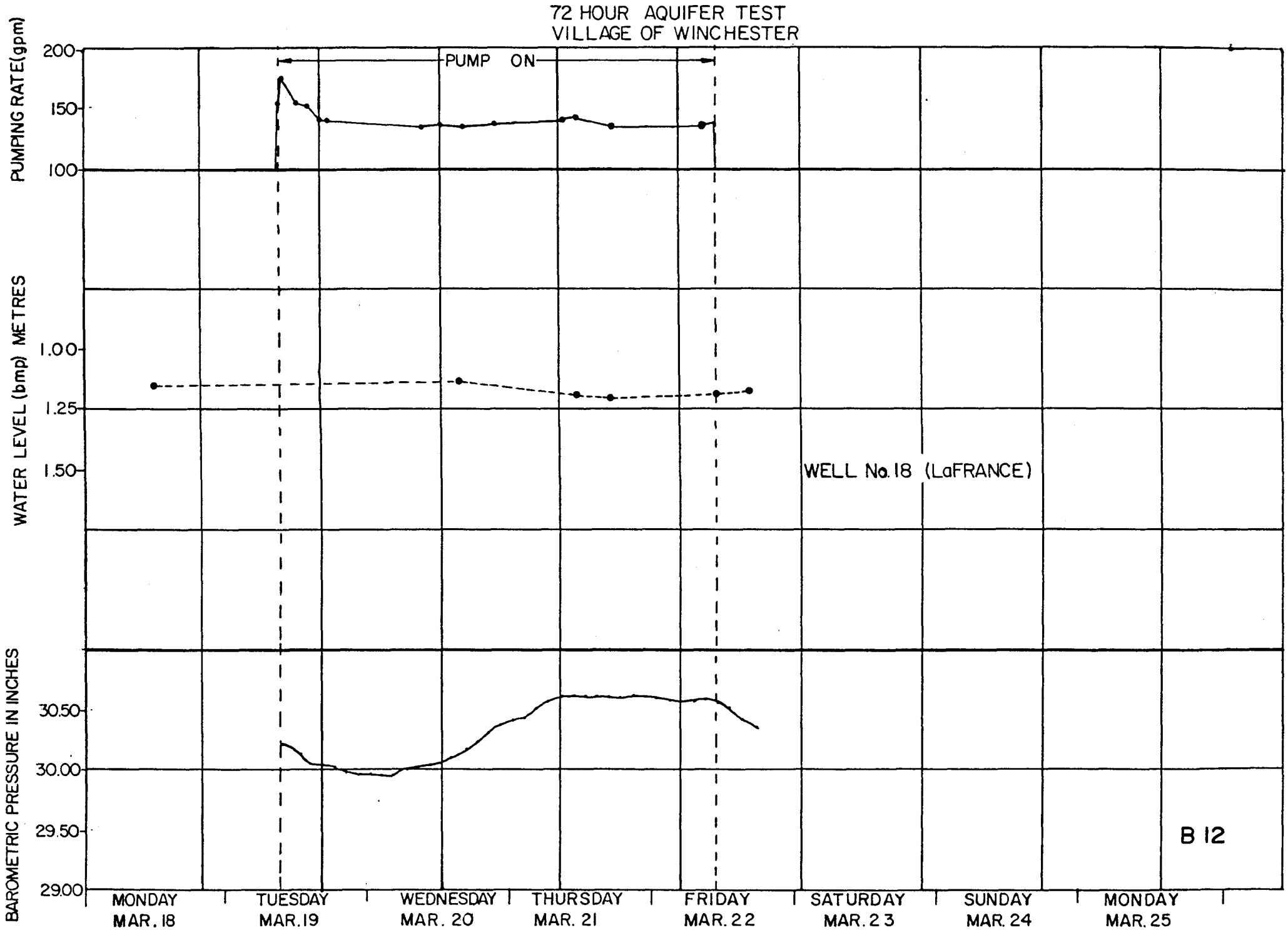

72 HOUR AQUIFER TEST
VILLAGE OF WINCHESTER
PUMPING RATE(gpm)
200
150
100
PUMP ON
WATER LEVEL (bmp) METRES
3.50
3.60
WELL No. 3 (C. HOWSE)
BAROMETRIC PRESSURE IN INCHES
30.50
30.00
29.50
29.00
MONDAY MAR. 18
TUESDAY MAR. 19
WEDNESDAY MAR. 20
THURSDAY MAR. 21
FRIDAY MAR. 22
SATURDAY MAR. 23
SUNDAY MAR. 24
MONDAY MAR. 25
B 7

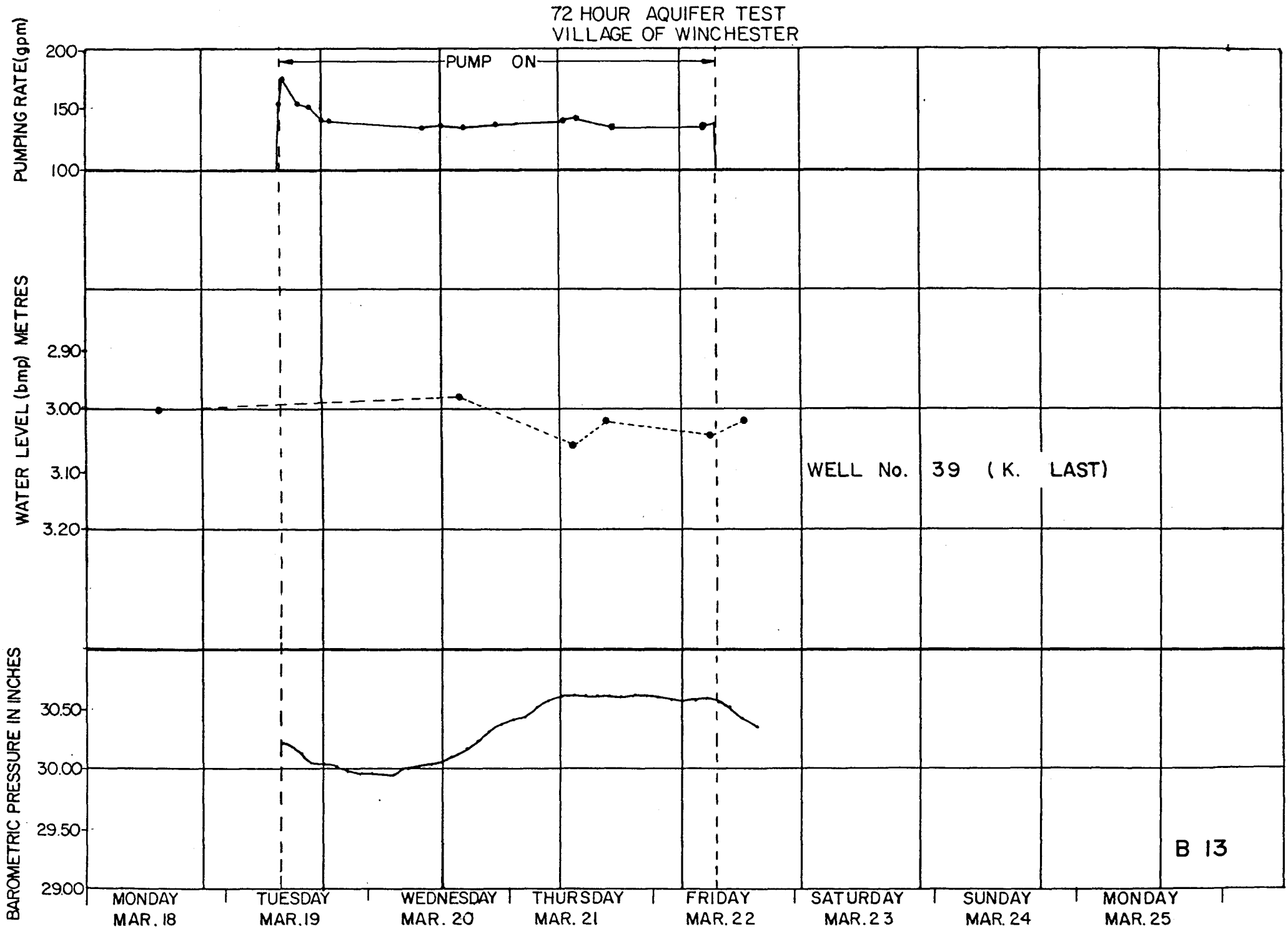

72 HOUR AQUIFER TEST
VILLAGE OF WINCHESTER
PUMPING RATE(gpm)
200
150
100
PUMP ON
WATER LEVEL (bmp) METRES
1.2
1.4
1.6
WELL No. 3 a (C. HOWSE)
Water Level
1.68m March 5/85
BAROMETRIC PRESSURE IN INCHES
30.50
30.00
29.50
29.00
MONDAY MAR. 18
TUESDAY MAR. 19
WEDNESDAY MAR. 20
THURSDAY MAR. 21
FRIDAY MAR. 22
SATURDAY MAR. 23
SUNDAY MAR. 24
MONDAY MAR. 25
B 8

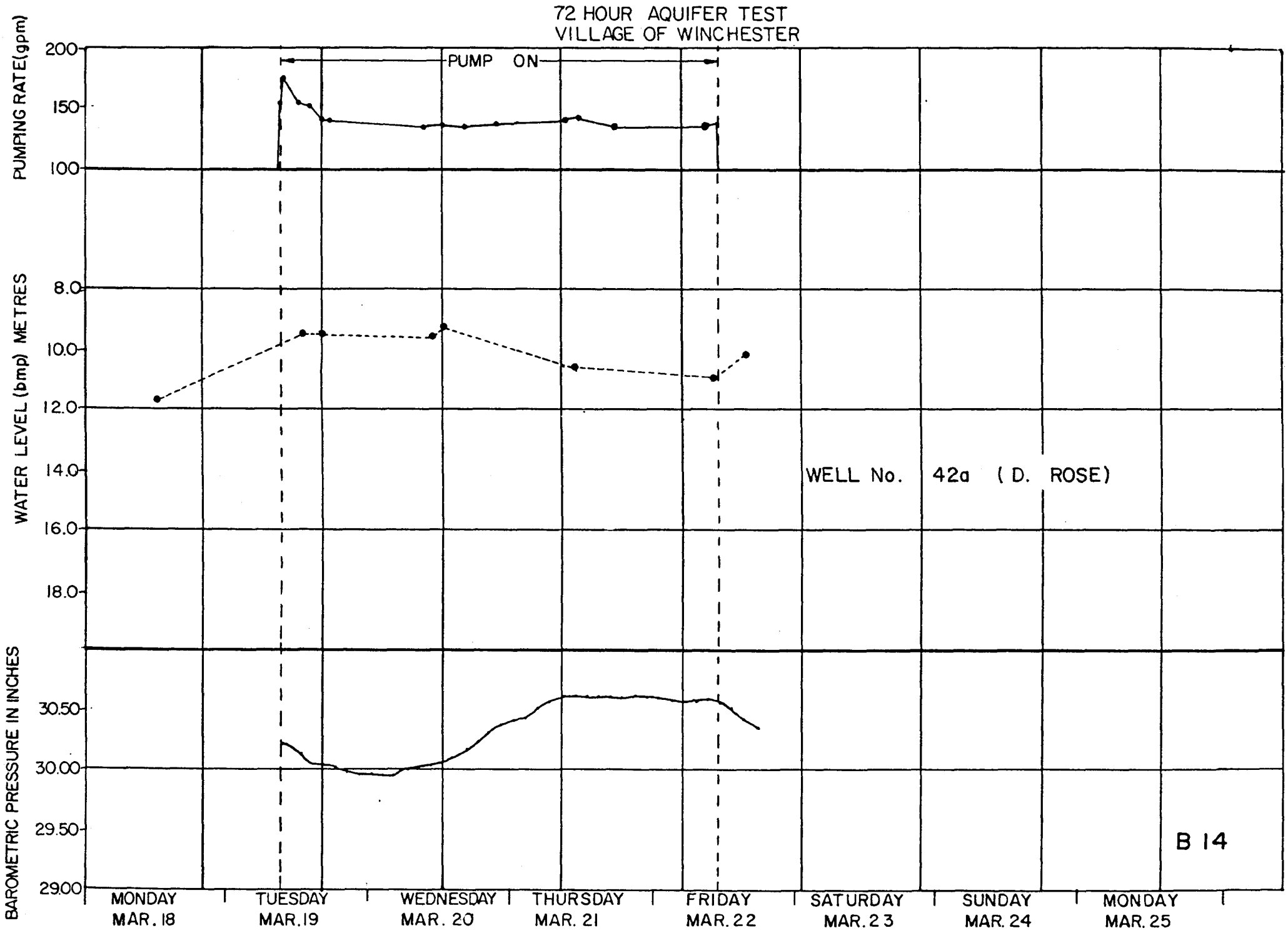

72 HOUR AQUIFER TEST
VILLAGE OF WINCHESTER
PUMPING RATE(gpm)
200
150
100
PUMP ON
WATER LEVEL (bmp) METRES
1.50
1.70
WELL No.5 (L.LEVERE)
BAROMETRIC PRESSURE IN INCHES
30.50
30.00
29.50
29.00
MONDAY MAR. 18
TUESDAY MAR.19
WEDNESDAY MAR. 20
THURSDAY MAR. 21
FRIDAY MAR. 22
SATURDAY MAR. 23
SUNDAY MAR. 24
MONDAY MAR. 25
B9

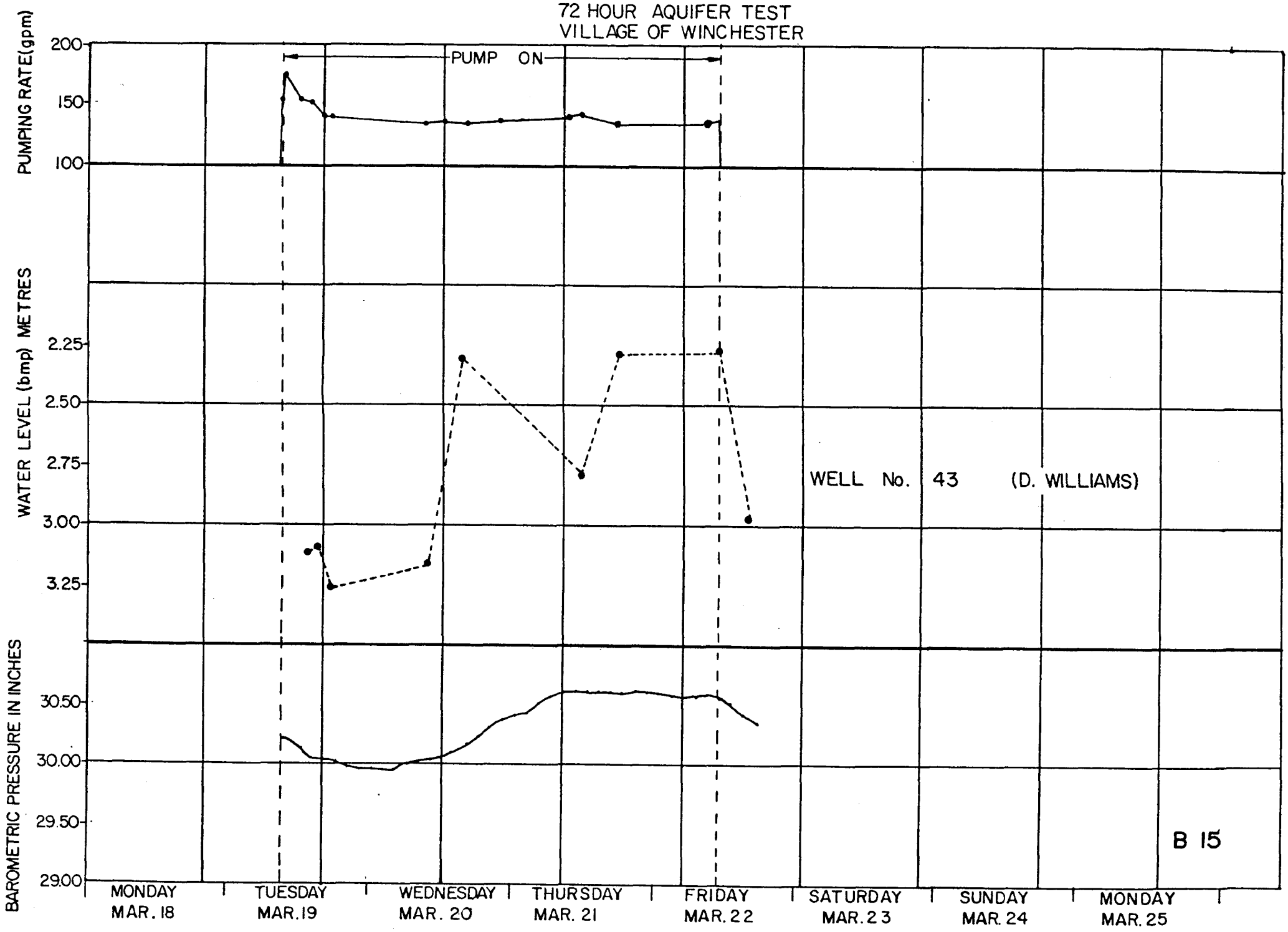

72 HOUR AQUIFER TEST
VILLAGE OF WINCHESTER
PUMPING RATE(gpm)
200
150
100
PUMP ON
WATER LEVEL (bmp) METRES
3.0
3.50
4.0
WELL No.6 b (J.SPRUIT)
BAROMETRIC PRESSURE IN INCHES
30.50
30.00
29.50
29.00
B 10
MONDAY MAR. 18
TUESDAY MAR.19
WEDNESDAY MAR. 20
THURSDAY MAR. 21
FRIDAY MAR. 22
SATURDAY MAR. 23
SUNDAY MAR. 24
MONDAY MAR. 25

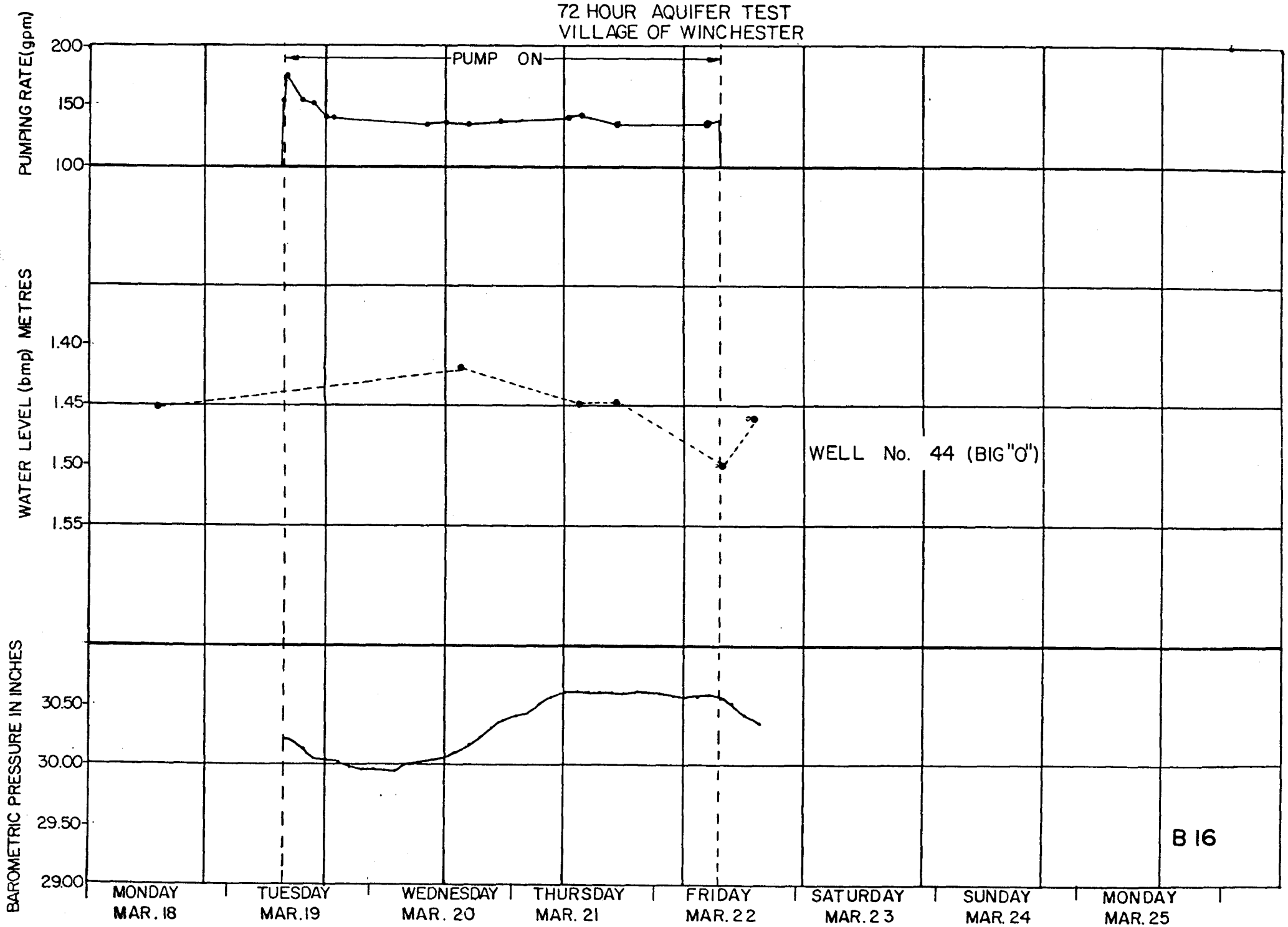

72 HOUR AQUIFER TEST
VILLAGE OF WINCHESTER
PUMPING RATE(gpm)
200
150
100
PUMP ON
WATER LEVEL (bmp) METRES
0
2
4
WELL No. 10 (P. HOLMES)
BAROMETRIC PRESSURE IN INCHES
30.50
30.00
29.50
29.00
B 11
MONDAY MAR. 18
TUESDAY MAR. 19
WEDNESDAY MAR. 20
THURSDAY MAR. 21
FRIDAY MAR. 22
SATURDAY MAR. 23
SUNDAY MAR. 24
MONDAY MAR. 25

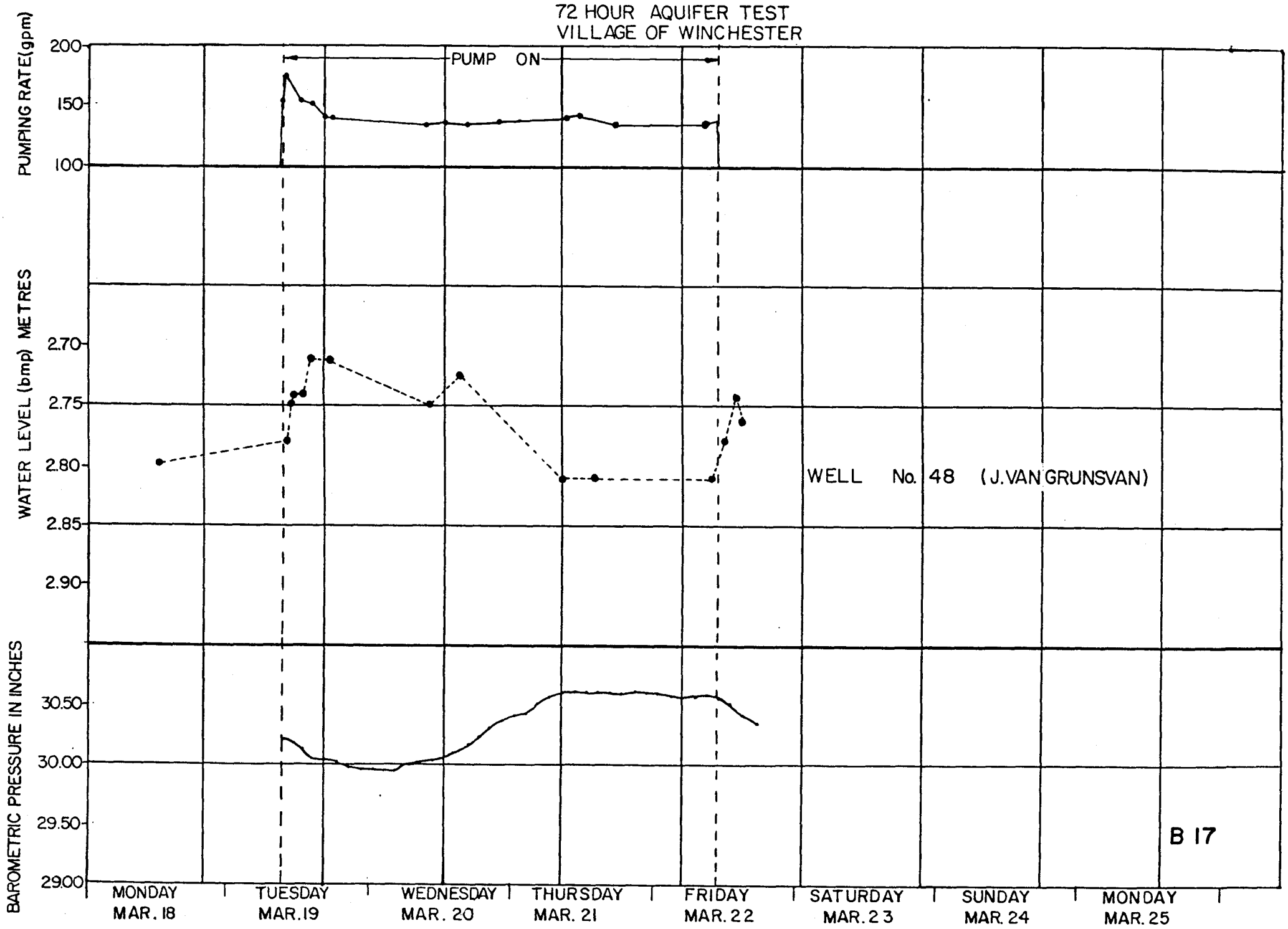

72 HOUR AQUIFER TEST
VILLAGE OF WINCHESTER
PUMPING RATE(gpm)
200
150
100
PUMP ON
WATER LEVEL (bmp) METRES
1.00
1.25
1.50
WELL No. 18 (LaFRANCE)
BAROMETRIC PRESSURE IN INCHES
30.50
30.00
29.50
29.00
MONDAY MAR. 18
TUESDAY MAR. 19
WEDNESDAY MAR. 20
THURSDAY MAR. 21
FRIDAY MAR. 22
SATURDAY MAR. 23
SUNDAY MAR. 24
MONDAY MAR. 25
B 12

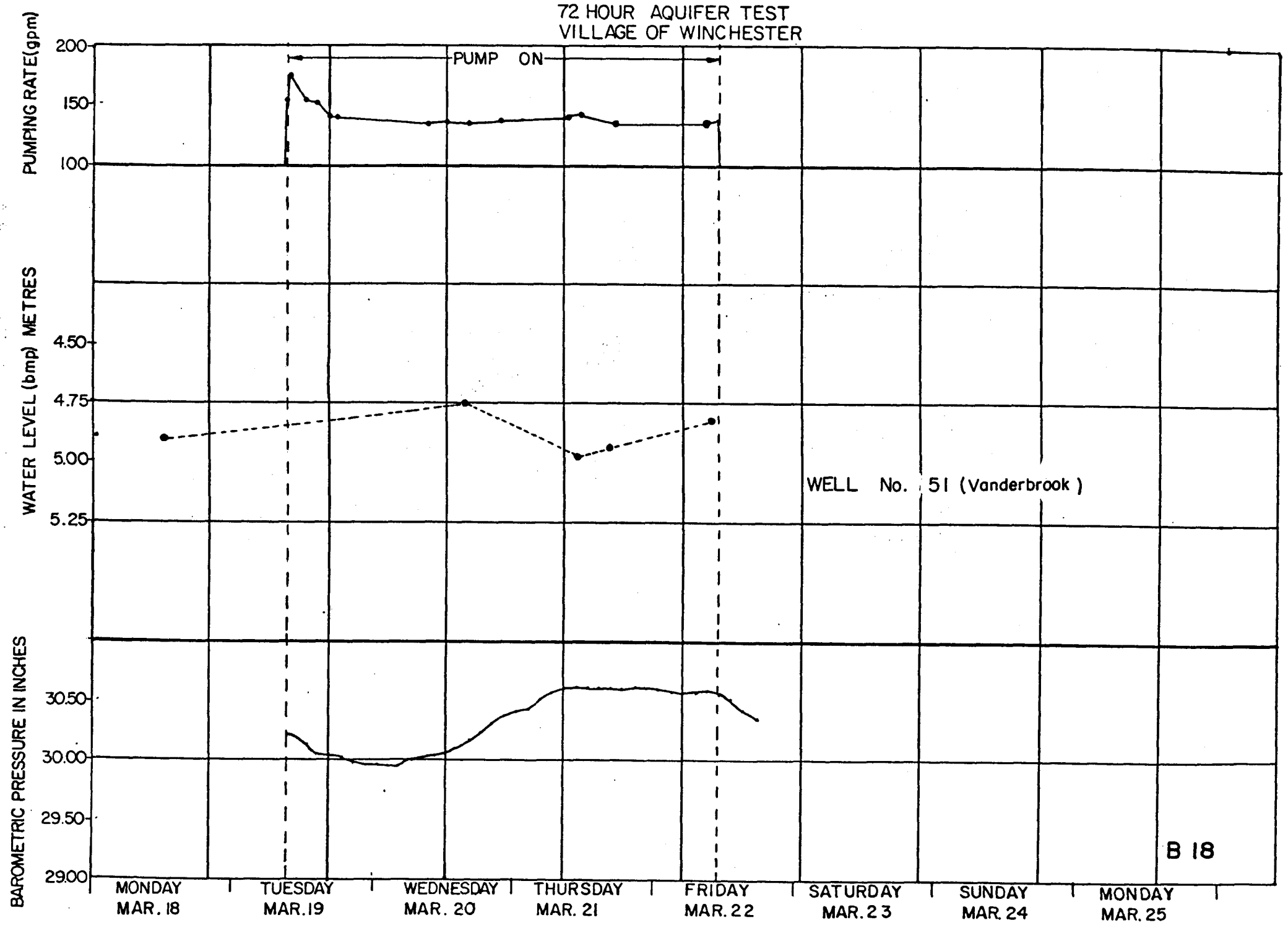

72 HOUR AQUIFER TEST
VILLAGE OF WINCHESTER
PUMPING RATE(gpm)
200
150
100
PUMP ON
WATER LEVEL (bmp) METRES
2.90
3.00
3.10
3.20
WELL No. 39 (K. LAST)
BAROMETRIC PRESSURE IN INCHES
30.50
30.00
29.50
29.00
B 13
MONDAY MAR. 18
TUESDAY MAR. 19
WEDNESDAY MAR. 20
THURSDAY MAR. 21
FRIDAY MAR. 22
SATURDAY MAR. 23
SUNDAY MAR. 24
MONDAY MAR. 25


72 HOUR AQUIFER TEST
VILLAGE OF WINCHESTER
PUMP ON
PUMPING RATE(gpm)
200
150
100
WATER LEVEL (bmp) METRES
8.0
10.0
12.0
14.0
16.0
18.0
BAROMETRIC PRESSURE IN INCHES
30.50
30.00
29.50
29.00
WELL No. 42a (D. ROSE)
B 14
MONDAY MAR. 18
TUESDAY MAR. 19
WEDNESDAY MAR. 20
THURSDAY MAR. 21
FRIDAY MAR. 22
SATURDAY MAR. 23
SUNDAY MAR. 24
MONDAY MAR. 25

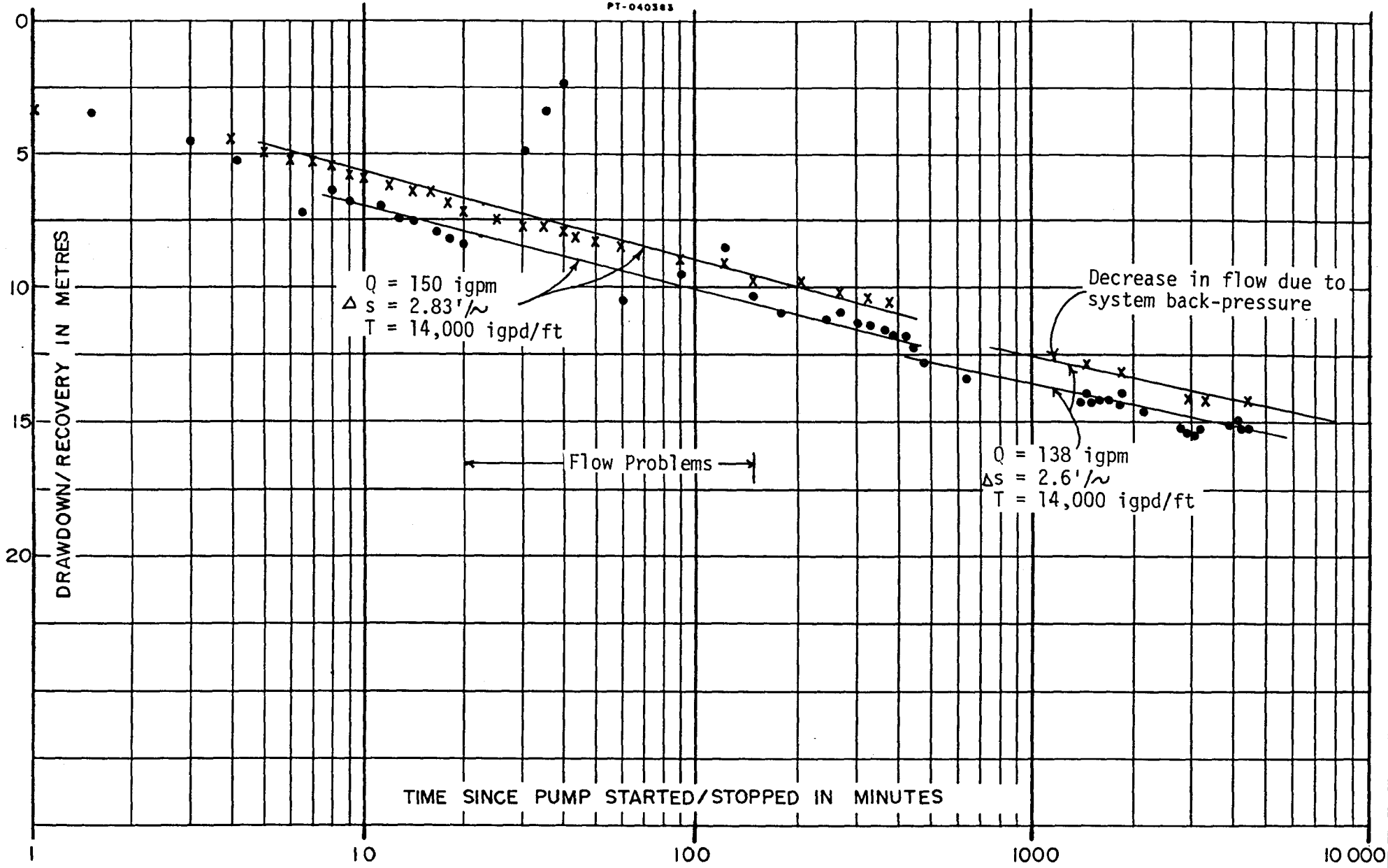

72 HOUR AQUIFER TEST
VILLAGE OF WINCHESTER
PUMP ON
PUMPING RATE(gpm)
200
150
100
WATER LEVEL (bmp) METRES
2.25
2.50
2.75
3.00
3.25
BAROMETRIC PRESSURE IN INCHES
30.50
30.00
29.50
29.00
WELL No. 43 (D. WILLIAMS)
B 15
MONDAY MAR. 18
TUESDAY MAR. 19
WEDNESDAY MAR. 20
THURSDAY MAR. 21
FRIDAY MAR. 22
SATURDAY MAR. 23
SUNDAY MAR. 24
MONDAY MAR. 25


72 HOUR AQUIFER TEST
VILLAGE OF WINCHESTER
PUMPING RATE(gpm)
200
150
100
PUMP ON
WATER LEVEL (bmp) METRES
1.40
1.45
1.50
1.55
WELL No. 44 (BIG "O")
BAROMETRIC PRESSURE IN INCHES
30.50
30.00
29.50
29.00
B 16
MONDAY MAR. 18
TUESDAY MAR. 19
WEDNESDAY MAR. 20
THURSDAY MAR. 21
FRIDAY MAR. 22
SATURDAY MAR. 23
SUNDAY MAR. 24
MONDAY MAR. 25


72 HOUR AQUIFER TEST
VILLAGE OF WINCHESTER
PUMP ON
PUMPING RATE(gpm)
200
150
100
WATER LEVEL (bmp) METRES
2.70
2.75
2.80
2.85
2.90
BAROMETRIC PRESSURE IN INCHES
30.50
30.00
29.50
29.00
WELL No. 48 (J.VAN GRUNSVAN)
B 17
MONDAY MAR. 18
TUESDAY MAR. 19
WEDNESDAY MAR. 20
THURSDAY MAR. 21
FRIDAY MAR. 22
SATURDAY MAR. 23
SUNDAY MAR. 24
MONDAY MAR. 25


72 HOUR AQUIFER TEST
VILLAGE OF WINCHESTER
PUMPING RATE(gpm)
200
150
100
PUMP ON
WATER LEVEL (bmp) METRES
4.50
4.75
5.00
5.25
WELL No. 51 (Vanderbrook)
BAROMETRIC PRESSURE IN INCHES
30.50
30.00
29.50
29.00
B 18
MONDAY MAR. 18
TUESDAY MAR. 19
WEDNESDAY MAR. 20
THURSDAY MAR. 21
FRIDAY MAR. 22
SATURDAY MAR. 23
SUNDAY MAR. 24
MONDAY MAR. 25

PT-040383



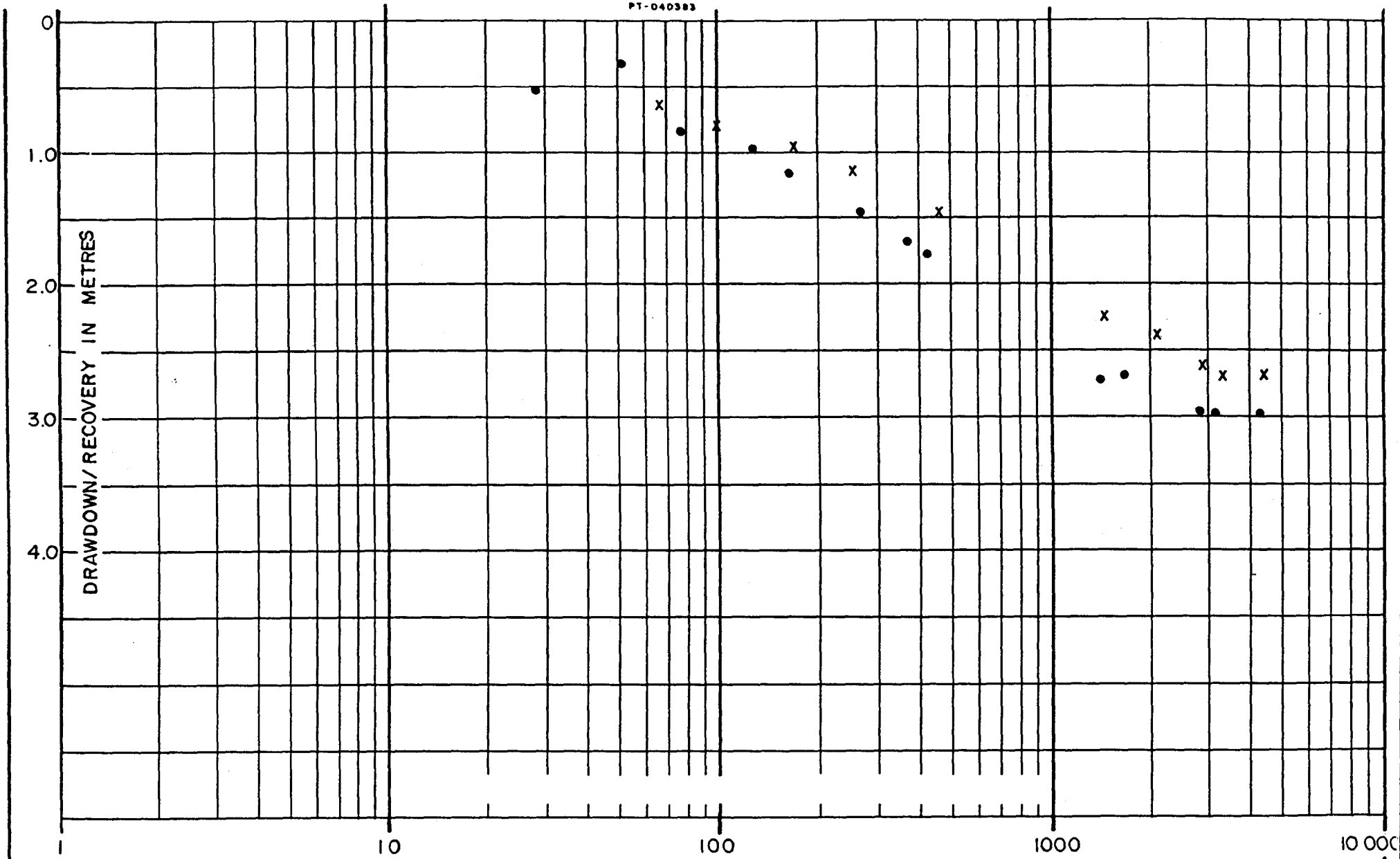
WELL NO. PW6 Q=150igpm (138igpm range for last 48 hrs.)
STATIC LEVEL 0.87m bgl
TEST DATE 18-25, MARCH, 1985

x DRAWDOWN
● RECOVERY

PROJECT No. 325-841

morrison beatty limited
consulting engineers and hydrogeologists

B19



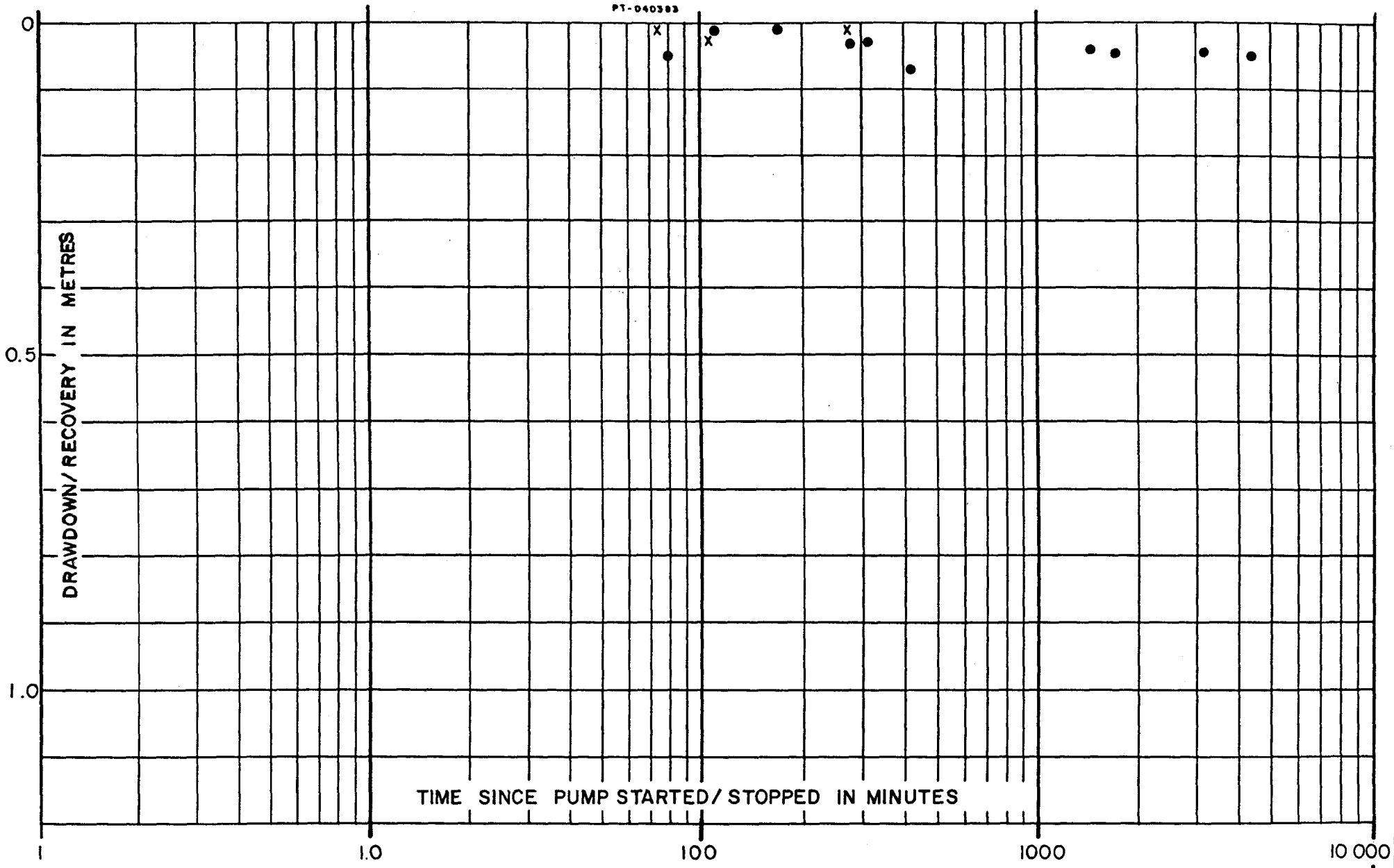
WELL NO. HOLMES No. 1 250m from PW 6
STATIC LEVEL 1.79m bgl
TEST DATE MARCH, 1985

x DRAWDOWN
● RECOVERY

PROJECT No. 325-841

morrison beatty limited
consulting engineers and hydrogeologists

B20



WELL NO. C. HOWSE No.3
STATIC LEVEL 3.54m bgl
TEST DATE MARCH, 1985

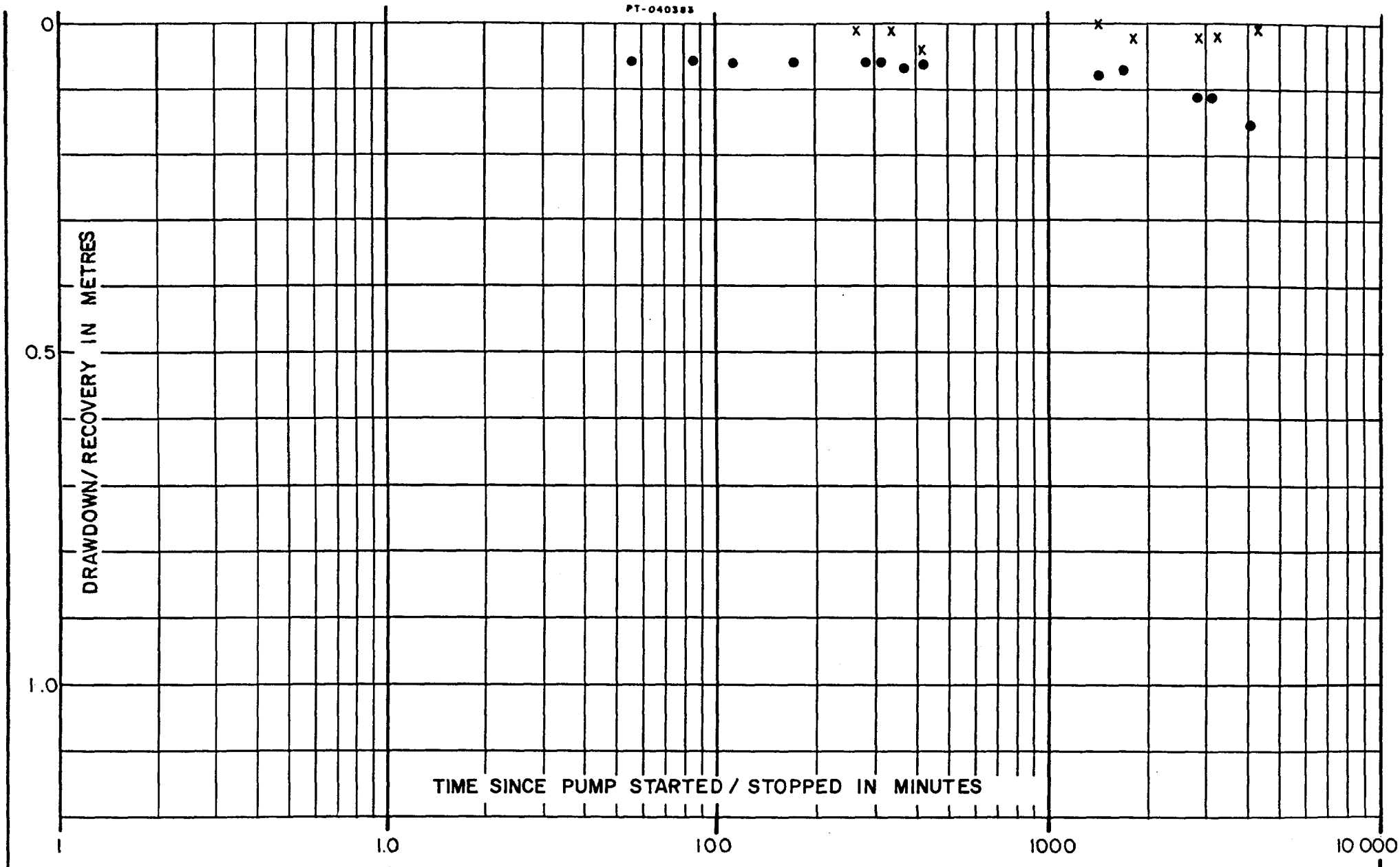
900m FROM PUMPED WELL

• DRAWDOWN
x RECOVERY

PROJECT No. 325-841

morrison beatty limited
consulting engineers and hydrogeologists

B21



WELL NO. C.HOWSE No. 3a
STATIC LEVEL 1.39 m bgl
TEST DATE MARCH, 1985

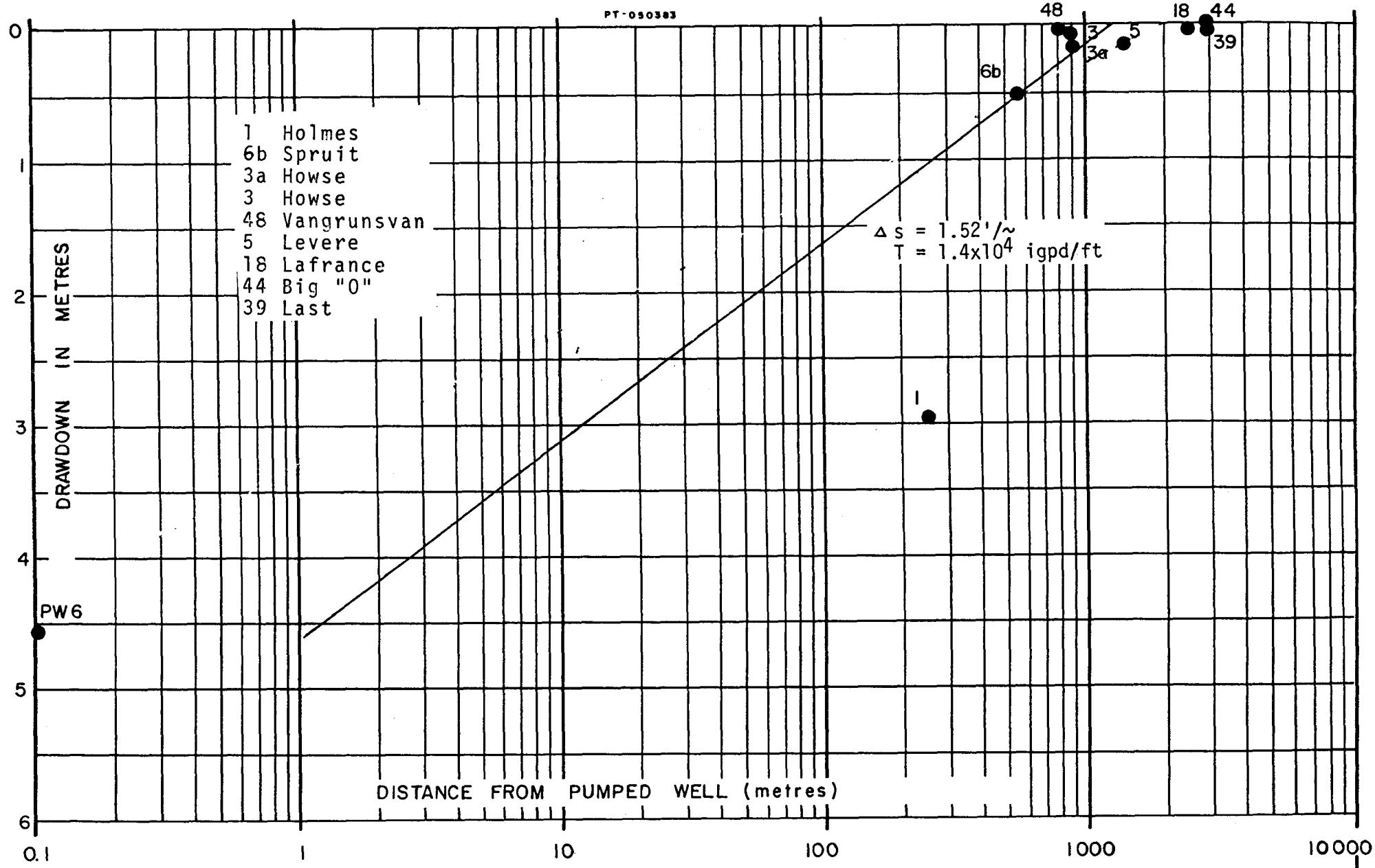
925m FROM PW No. 6

• DRAWDOWN
x RECOVERY

PROJECT No. 325-841

morrison beatty limited
consulting engineers and hydrogeologists

B22



WELL NO. PW 6
STATIC LEVEL
TEST DATE MAR. 18-25, 1985

PROJECT No. 325-841

morrison beatty limited
consulting engineers and hydrogeologists

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APPENDIX C

WATER WELL INTERFERENCE
INVESTIGATION & LONG TERM
PUMPING TEST ON PW6 BY MoE

Water Well Interference Investigation

Winchester PW-6 Municipal Well

Township of Mountain

MINISTRY OF THE ENVIRONMENT

Municipality: Township of Mountain, Lot 20, Concession VII

Re: Water Well Interference Caused by a Long Term Pumping Test of the Winchester PW-6 Municipal Well

Date: March 6, 1986 Report by: C.J. Holland

Background

The Village of Winchester had a test drilling program carried out during October and November 1982 to develop additional water well supplies for the Village.

Three test wells were drilled in the Township of Mountain. Test well No. 2 located in Lot 20, Concession VII of the Township of Mountain intercepted a water bearing formation that provided large quantities of potable water. The water found in Test Well No. 1 located in Lot 19, Concession VI, of the Township of Mountain and Test Well No. 3 located in Lot 22, Concession VIII, of the Township of Mountain, contained salty water.

A two-day pumping test was carried out on Test Well No. 2 on November 3 and 4, 1982 at a rate of 15.2 L/s. The consultant concluded that the well could supply potable water at a sustained pumping rate of 11.4 L/s. Test Well No. 2 was subsequently named PW-6.

A pipeline from the Winchester PW-5 well was constructed in the fall of 1984 so that water from the PW-6 well could be pumped into the Winchester water system.

Because of concerns put forth by Mr. C. Howse and Ms K.B. Switzer-Howse that the Winchester PW-6 well would reduce the quantity of water available to their well and would cause a deterioration of the quality of water in their well, it was decided to carry out a three-day pumping test before the PW-6 well went into production in the spring of 1985. The pumping test was to be carried out by Morrison Beatty Ltd.

It was also decided that a 30-day pumping test would be carried out by staff members of the Ministry of the Environment on the PW-6 well during the "dry period" of the summer of 1985.

Primarily, the purpose of the long term pumping test was to determine the extent of water well quantity interference and water well quality interference that might be caused to domestic and farm wells located near the PW-6 well.

The three-day pumping test began on March 19, 1985 and ended on March 22, 1985 and the well was pumped at approximately 10.2 L/s.

Water well measurements were taken from a total of 14 domestic and farm wells during the three-day pumping test of the PW-6 well. Water samples were collected from the 14 wells before the pumping test began and at the end of the pumping test.

A draft report on the three-day pumping test carried out by Morrison and Beatty was produced in July 1985. To date, the final report of this pumping test has not been received from the consultant by the Ministry of the Environment. The consultant stated in the draft report that "well interference was demonstrated during the pumping test on PW-6. The amount of interference should not detrimentally affect the yields of private wells in the area".

The analyses of the water samples taken from the domestic and farm wells indicated to the consultant that "minor quality changes were observed between the samples collected before and after the test, however none of the changes appear to be significant and there is no trend that can be linked to the pumping of PW-6".

Investigation

Ministry of the Environment staff decided to begin the long term pumping test near the end of July 1985. The water was to be pumped into the newly constructed pipeline so that it could be used by the Village of Winchester.

Just before the long term pumping test was to begin, it was learned by Groundwater Unit staff that water was being pumped into the Winchester water supply system at approximately 5.7 L/s.

Mr. H. Sharkey, Superintendent of the Winchester Water Works was asked to shut off the PW-6 pump for five days prior to the beginning of the long term pumping test so that the well would be fully recovered before the test began. Because of an urgent demand for water in Winchester, the pump was shut off for only 42.5 hours before the test began at 12:30 p.m., July 29, 1985.

The pumping test was to be carried out at a rate of 11.4 L/s. However, the pump could only supply about 10.5 L/s to the water supply system at the beginning of the test. By the end of the test the well pump could only supply about 9.5 - 10.1 L/s to the water supply system. The pumping level in the PW-6 well lowered from 4.44 metres on July 29, 1985 to 11.08 metres on September 11, 1985 for a total lowering of 6.64 metres.

It was arranged that H. Sharkey or a member of his staff would take water level measurements daily (excluding weekends) at 23 domestic and farm wells in the area as well as at the PW-6 well.

The first complete set of measurements of the wells to be monitored was taken by Groundwater Unit staff on July 29, 1985. On August 13, 1985 a second complete set of water level measurements was taken by Groundwater Unit staff. When measurements on individual wells were compared to those measurements taken by H. Sharkey and his staff on August 13, 1985 large differences in the measurements were noted.

It was later determined that the water level indicator being used by Mr. H. Sharkey and his staff was defective. The Groundwater Unit loaned Mr. Sharkey one of its water level indicators on August 27, 1985. Mr. Sharkey began using the water level indicator on that date.

Since the measurements taken between July 30 to August 12, 1985, and between August 14 to August 26, 1985 by Mr. Sharkey were not reliable, it was decided to use data collected on the wells by Groundwater Unit staff on July 29, August 13, August 27, September 3, September 6, September 11, and September 16, 1985 to produce a report on the effects of pumping of PW-6 on nearby wells.

Although the pumping test officially lasted from July 29 until September 3, 1985 (36 days), the well was pumped constantly at its maximum rate until the morning of September 12, 1985 (45 days).

The Groundwater Unit took water samples from the PW-6 well, and 17 domestic and farm wells in the area on July 29, August 13 and August 27, 1985.

Mr. Crossley carried out a pumping test on the H. Holmes barn well on August 27, 1985 and on the J. Spruit "rented" house well on September 6, 1985, to determine the seriousness of the effects of interference caused by the pumping of the PW-6 well.

On September 11, Mr. F. Crossley of the Groundwater Unit carried out a pumping test on the Howse barn and house well after the PW-6 well had been pumped at its maximum rate for 44 days.

Water level recorders had been installed on Test Well No. 1 and Test Well No. 3 in the winter of 1985, and the readings from the recorders are tabulated for the same dates as the water level measurements that were taken from the domestic and farm wells.

The effect of pumping of the PW-6 on nearby domestic and farm wells and Test Wells No. 1 and No. 3 is presented below. Graphs are attached that show the water levels in the wells that were monitored during the long term pumping test. Table 1 shows the measurements taken in the PW-6 well and farm and domestic wells in the area. Table 2 shows the analyses of water samples taken from wells in the area. Tables 3 and 3A show precipitation data from the Russell Meteorological

Station that indicate that dry weather conditions existed in the area during the long term pumping test. A map showing the locations of the monitored wells is also attached.

Harold Holmes Well - 1A - Lot 20, Concession VIII, Township of Mountain

The H. Holmes water well was used to water a number of horses. It is located approximately 250 metres from the PW-6 well. The depth of the well was found to be 11.06 metres. The well was equipped with a jet pump.

On July 29, 1985 the water level in the barn well was 4.73 metres below land surface. On August 13, 1985, the water level in the barn well was 7.39 metres below land surface.

In the middle of August, Mr. H. Sharkey received a complaint from H. Holmes that he could no longer obtain sufficient water from his barn well to water his horses.

Mr. Sharkey was instructed by Groundwater staff to have a plumber inspect the condition of the pump and if necessary to lower the pump intake as far as possible into the well.

Mr. Sharkey contacted a plumber but had a difficult time to get him to inspect the water well pumping system. On August 21, 1985, the plumber lowered the pump intake as far as possible into the well. The distance that the intake was lowered was reported to be approximately 1.5 metres.

Within a few days, Mr. Holmes reported that the well again was not supplying sufficient water for his needs. Mr. H. Sharkey reported the event to Groundwater staff and he was instructed to have water supplied to Mr. Holmes for barn use. Subsequently, it was reported that sufficient water for barn needs was delivered to Mr. Holmes.

On August 27, 1985 Mr. F. Crossley of the Groundwater Unit carried out a pumping test on the barn well. It was only capable of producing 136 litres of water before the pumping level reached the pump intake set at a depth of about 9.75 metres. Recovery level measurements showed the well only recovered 0.08 metres after the pump had been shut off for five minutes.

On September 11, 1985, the water level in the well had lowered to 8.74 metres. The total lowering of the water level in the barn well during the extended pumping test on the PW-6 well was 4.01 metres.

On September 12, 1985 the pumping rate of the PW-6 well was reduced to 6.1 L/s. The water level in the barn well was measured on September 16, 1985 and was found to have recovered to a depth of 7.77 metres.

It was obvious that the pumping of the PW-6 well at its maximum rate had seriously interfered with the capacity of the Holmes barn well.

On September 19, 1985, a memo was sent to Mr. H. Sharkey instructing him to contact the Reeve of the Village of Winchester and inform him that the Village was to arrange to have a new barn well drilled for Mr. H. Holmes. Additional instructions to the Village indicated a new submersible pump was to be installed in the well and that the well was to be fitted with a pitless adaptor. The well was to be cased through the entire thickness of the overburden and for at least the upper 0.3 metres of bedrock. The casing was to be grouted into place.

The location of the well was to be outside of the barnyard and upgradient of the Holmes septic tank system.

Specific instructions were given that the well was to be drilled to a maximum depth of 17 metres. At a depth of 17 metres, the bottom of the well would be at about the same elevation as the bottom of the PW-6 well. The well driller was to stop drilling at this depth. If the driller thought that there was insufficient water to supply water for barn use for Mr. Holmes, he was to contact Ministry personnel for instructions.

The well was drilled by Instant Water Wells Limited on October 5, 1985. It was subsequently fitted with a submersible pump.

The well was drilled to a depth of 25.30 metres and it was indicated that the well could supply 1.1 L/s.

Harold Holmes Well - 1B - Lot 20, Concession VIII, Township of Mountain

The H. Holmes house well is located approximately 190 metres from the PW-6 well.

Before the beginning of the extended pumping test on the PW-6 well it was noted that the top of the Holmes well was buried. Mr. Holmes informed a Groundwater Unit staff member that there was a jet pump installed in the well. The depth of the well was unknown to Mr. Holmes.

A few days after the pumping test began, Mr. H. Holmes complained that his well had gone dry. Mr. H. Sharkey reported the event to Groundwater staff and he was instructed to have the well uncovered and to have the pumping equipment examined.

The top of the well was uncovered, and it was reported that the pump in the well was a shallow well pump. It was also found that the water level in the well was approximately 6.4 metres or 6.7 metres below land surface. This depth is near

the limit of lift for a shallow well pump. It was also reported that the well was approximately 18 metres deep. It was felt that the static level of the well on July 29, 1985 had probably been at about the same depth as the water level in the barn well, i.e. about 4.5 metres.

Since the well is relatively close to the PW-6 well and it was known that Mr. H. Holmes had not experienced any problems with his water well supply previously, it was felt that the pumping of PW-6 well had seriously interfered with the Holmes house water well supply.

Mr. Sharkey was instructed by Groundwater staff to have a plumber install a submersible pump in the well. It was installed near the bottom of the well on August 6, 1985. The Village of Winchester was to pay for the pump and the cost of installing it.

The well was left uncovered so that water level measurements could be taken in the well during the remainder of the PW-6 pumping test.

On August 13, 1985, the water level measurement in the well was at a depth of 7.62 metres. Between August 13 and September 11, 1985 the water level lowered to a depth of 9.16 metres. The total lowering of the house well was estimated to be about 4.5 metres.

The pumping rate of the PW-6 well was reduced to 6.1 L/s on September 12, 1985. On September 16, 1985, the water level in the Holmes house well had recovered to a depth of 7.95 metres.

It was obvious that the pumping of the PW-6 well at approximately 10.5 L/s had seriously interfered with the H. Holmes house water well supply.

J. Spruit Well - 2A - Lot 19, Concession VIII, Township of Mountain

The J. Spruit "rented" house well is located approximately 410 metres from the PW-6 well. At the beginning of the pumping test there was no-one living in the house and it was thought that the July 29, 1985 water level measurement was a static water level measurement.

The well consists of a dug well with a drilled well constructed through the bottom of the dug well. The depth of the drilled well was 17.9 metres. The dry dug well portion of the well was 9.05 metres deep.

On July 29, the water level in the well was at a depth of 12.72 metres. On August 13, the water level in the well was at a depth of 12.83 metres.

Around the middle of August 1985, Mr. J. Spruit complained to H. Sharkey that his "rented" house well wasn't supplying sufficient water for his cattle. (Up to this time the Groundwater staff was unaware that the well water was being used to supply 70 to 80 head of cattle on the Spruit farm.) Mr. H. Sharkey reported this event to Groundwater staff and he was instructed to have a plumber lower the pump intake as close to the bottom of well as possible. On August 21, 1985, the plumber reported that he could not lower the pump any deeper into the well.

On August 27, 1985, the water level in the well was found to be at a depth of 11.54 metres.

On September 3, 1985, the water level in the well was found to be at a depth of 12.73 metres.

On September 4, 1985 it was reported by H. Sharkey that Mr. J. Spruit again complained that the well had gone dry again and that he had to haul water for his cattle.

On September 6, 1985, the Groundwater Unit staff carried out a pumping test on the Spruit "rented" house well. Renovations were being carried out to the house and the basement window located near the well had been removed. The pump was running when staff first arrived on site and pumped continuously for at least ten minutes.

The water level in the well was measured and found to be at a depth of 13.72 metres. The pump was then shut off. After 25 minutes, the water had recovered to a depth of 11.77 metres. This is a recovery of 1.94 metres.

A pumping test was attempted on the well. After about 3.5 minutes of pumping, the water well level in the well was drawn down to the pump intake which was reported to be located at about 18 metres below ground level. It was not possible to determine the pumping rate before water stopped flowing into an orifice bucket. It was obvious to groundwater staff that the pump was working almost constantly trying to supply enough water for the 70 to 80 head of cattle belonging to Mr. Spruit.

Groundwater staff were afraid that the pump would burn out if matters were left as they were. The son of Mr. J. Spruit was told that arrangements would be made to have water delivered for his cattle if the water could be stored in a 4550 litre tank that the Spruits had available on the farm. Mr. J. Spruit agreed to this proposal and Groundwater staff instructed Mr. H. Sharkey (Doug Black) to have 4550 litres of water delivered to the Spruit farm daily. The water delivery began on September 7, 1985.

The well pump had been shut off on September 6, 1985 and because water was being supplied for the Spruit's cattle it was felt that the measurements taken on September 6 and

September 11, 1985 were the first reliable water level measurements obtained from the well. The water level had lowered from a depth of 11.77 metres on September 6, 1985 to 12.00 metres on September 11, 1985.

The PW-6 pumping rate was reduced to 6.1 L/s on September 12, 1985. The water level in the Spruit well on September 16, 1985 had recovered to a depth of 11.41 metres. This recovery definitely indicates that the pumping of PW-6 had affected the Spruit well.

The earlier water level measurements taken on the Spruit well were not static water levels. If it is assumed that the water level in the area was lowered outwards from the PW-6 well in a conical manner, an estimate of the total drawdown in the Spruit well by the pumping of PW-6 can be made graphically.

A graphical representation of the Spruit well, the Holmes barn well and the PW-6 well as well as the total drawdown experienced in the Holmes barn well, and the PW-6 well were plotted to scale on a cross section. The relative elevations of the tops of the three wells had been determined by a levelling survey. The horizontal distances between the PW-6 well, the Spruit "rented" house well and the Holmes barn well were also noted. A line was drawn from the water level marked on the PW-6 to the water level marked on the Holmes barn well. The line was continued until it intercepted the Spruit well. It was then determined with a scale that the PW-6 well had lowered the water in the Spruit well approximately 2.4 metres.

The trace of the water level was continued on the graph beyond the Spruit "rented" house well until it reached the elevation of land surface. It was estimated that the PW-6 well would lower water levels in wells in the area for a distance of approximately 610 metres in all directions from the pumped well.

The estimated lowering of the water level in the Spruit well, the recovery of the well on September 16, 1985 and the fact that the well could supply only a minimal quantity of water on September 6, 1985 led Groundwater staff to feel that the pumping of PW-6 well had seriously interfered with the quantity of water available to the Spruit well.

On September 19, 1985, Mr. H. Sharkey was informed that the pumping of PW-6 well had seriously interfered with the water well supply of the Spruit "rented" house well. He was instructed to inform the Village of Winchester to arrange to have a new well drilled for Mr. Spruit to a depth of 21 metres. At a depth of 21 metres, the bottom of the well would be at approximately the same elevation as the bottom of the PW-6 well.

A memo containing specific instructions pertaining to the construction of the new well was sent to Mr. H. Sharkey to relay to the Reeve of Winchester. Besides indicating the depth of the well, instructions were given regarding the location of the well. The well was to be fitted with a submersible pump and the casing was to be grouted into place from land surface to a depth of at least 0.3 metres into the bedrock.

The well was drilled by Instant Water Wells on October 11, 1985. The well was drilled to a depth of 27.74 metres and the driller indicated the well could supply 0.75 L/s.

J. Spruit Well - 2B - Lot 19, Concession VIII, Township of Mountain

The well that services the J. Spruit house and barn is located approximately 520 metres from PW-6.

Water level measurements were taken in the well on July 29, August 13, August 27, and September 3, 1985. The depth to the water level in the well on these dates was 5.81 metres, 7.69 metres, 7.90 metres, and 9.00 metres.

Although the water level in the well was deeper on each successive measurement, the differences between pairs of measurements fluctuated greatly. For example, there was a lowering of the water level of 1.88 metres between July 29 and August 13, 1985 but only a lowering of the water level 0.21 metres between August 13 and August 27, 1985.

The well was probably being pumped when the measurements were being taken or it was in a recovery phase. It can't be determined definitely from the measurements if the pumping of the PW-6 well had influenced the house and barn well. However, the well is only 107 metres farther away from PW-6 than the Spruit "rented" house well. It is felt that the pumping of the PW-6 well may have lowered the water level in the well slightly, but that most of the lowering was caused by dry weather conditions in the area.

Mr. Spruit did not complain of water shortages in the well during the PW-6 pumping test. It is the opinion of the groundwater staff that serious well interference was not caused to this well by the pumping of the PW-6 well.

J. Spruit Well - 2C - Lot 19, Concession VIII, Township of Mountain

Mr. J. Spruit has an unused drilled well located approximately 18 metres from his barn well. It is approximately 520 metres from the PW-6 well.

The water level in the well on July 29, August 13, August 27, and September 3, 1985 on these dates was at a depth of 5.36 metres, 5.23 metres, 6.61 metres and 6.83 metres respectively.

Although there was a general lowering of the water level in the well between July 29 and September 3, 1985 the water level measurements taken during the extended pumping test of PW-6 probably show the influence of the pumping of the barn well on the unused drilled well.

The relatively minor lowering of the water level of 1.48 metres in the well between July 29 and September 3, 1985 was probably caused by a combination of dry weather conditions, the pumping of the PW-6 well, and the pumping of the barn well.

C. Howse - Well 3A - Lot 21, Concession VIII, Township of Mountain

The C. Howse drilled well that supplies their barn and house is heavily pumped. No complaints of water well interference were received from Mr. or Mrs. Howse during or after the pumping of the PW-6 well. The well is located approximately 885 metres from the PW-6 well.

Water level measurements were taken in the well on July 29, August 13, August 27, September 3, and September 11, 1985. The depth to the water level in the well on these dates was found to be 8.85 metres, 10.19 metres, 8.36 metres, 8.37 metres and 8.47 metres respectively.

A comparison of the measurements taken on July 29 and August 13, 1985, and the later measurements on August 27, September 3 and September 11, 1985 show that the well at times was being pumped when it was measured or it was in a recovery cycle. The measurement taken on September 11, 1985 by Groundwater staff is the only measurement that can be considered a true static water level measurement.

On September 11, 1985, a pumping test was carried out by Groundwater staff on the Howse barn and house well. The test was carried out after the PW-6 well had been pumped at its maximum pumping rate for 44 days. The pump on the Howse well was turned off and the water was allowed to recover for 75 minutes. The water level in the well was then found to be at a depth of 8.47 metres.

The well was then pumped for one hour at approximately 0.38 L/s. The water level lowered 1.92 metres to a depth of 10.39 metres during the pumping test. It is the opinion of the Groundwater unit that pumping of the PW-6 well had not affected the quantity of water available in the well of Mr. and Mrs. Howse. It is also the opinion of the Groundwater staff that Mr. and Mrs. Howse have a well that can supply water at rates greater than 0.38 L/s.

C. Howse - Well 3B - Lot 21, Concession VIII, Township of Mountain

There is an unused drilled well on the Howse farm and it is also located about 885 metres from the PW-6 well.

The water level in the well was measured on July 29, August 13, August 27, September 3, and September 11, 1985 and the water level on these dates was found to be at a depth of 5.48 metres, 6.26 metres, 5.45 metres, 5.71 metres and 5.99 metres respectively. The measurements taken in the well reflect the measurements taken on the same day from the barn and house well. That is, if the water level measurement in the barn and house well was at a low elevation on a particular day because of heavy pumping, then the water level in the unused well was also at a low elevation.

For example, the lowest elevation of the water level in the Howse barn and house well was measured on August 13, 1985. The lowest elevation of the water level in the unused well was also measured on August 13, 1985.

Lester Holmes - Well 4B - Lot 20, Concession VIII, Township of Mountain

The Lester Holmes house well is a drilled well and is approximately 875 metres from the PW-6 well. Mr. L. Holmes did not complain of water shortages during the extended pumping test of the PW-6 well.

Water level measurements were taken in the well on July 29, August 13, August 27 and September 3, 1985 and the water level on these dates was found to be at a depth of 5.65 metres, 6.90 metres, 6.83 metres and 7.00 metres respectively. The water level decreased gradually and the total lowering of the water level was 1.35 metres. This lowering was probably due to dry weather conditions. It is felt that the pumping of the PW-6 well, 875 metres away, had no effect on the water well supply of Lester Holmes.

Lester Holmes - Well 4B - Lot 20, Concession VIII, Township of Mountain

Lester Holmes has an unused drilled well on his property at about 875 metres from the PW-6 well. Water level measurements were taken in the well on July 29, August 13, August 27, and September 3, 1985. The water level on these dates was found to be at a depth of 5.15 metres, 6.20 metres, 6.24 metres, and 6.36 metres respectively. The total lowering of the water level in the well during the pumping test of PW-6 was 1.21 metres. The lowering was probably caused by dry weather conditions.

J. Spierenburg - Well 5 - Lot 21, Concession VII, Township of Mountain

The J. Spierenburg well is a new drilled well and is located approximately 945 metres away from PW-6. Mr. Spierenburg did not complain about any water quantity problems during the pumping of PW-6.

The Spierenburg well was measured on July 29, August 13, August 27, September 3, September 11 and September 16, 1985.

The water level on these dates was found to be at a depth of 5.60 metres, 6.75 metres, 7.26 metres, 7.47 metres, 7.68 metres and 7.80 metres respectively.

The water level in the Spierenburg well lowered a total of 2.08 metres during the pumping test of PW-6. The water level in the well on September 6, 1985, four days after the pumping rate of PW-6 had been reduced to 6.1 L/s lowered an additional 0.12 metres.

If pumping of the PW-6 well had affected the Spierenburg well, the water level should have stabilized or risen after the pumping rate of PW-6 had been reduced to 6.1 L/s. Since the water level continued to lower, it then appears that no water well interference was caused to the Spierenburg well during the pumping test of the PW-6 well. It would appear that the water level in the well gradually lowered as a result of dry weather conditions.

J. VanGrunsen - Well 6A - Lot 19, Concession VII, Township of Mountain

The J. VanGrunsen house and barn drilled well was constructed through the bottom of a dug well and is located approximately 810 metres from the PW-6 well. Mr. VanGrunsen did not report any water quantity problems during the 45 days that the PW-6 was being pumped at its greatest possible capacity.

The water level in the drilled well was measured on July 29, August 13, August 27, and September 3, 1985. The water level on these dates was found to be at a depth of 5.17 metres, 7.29 metres, 5.95 metres and 6.00 metres respectively.

The water level in the well did not lower steadily. The measurement taken on August 13, 1985 was probably taken during a pumping cycle or a recovery cycle. The measurements taken on July 29 and September 3, 1985 showed that the water level lowered approximately 0.82 metres. The lowering of the water level was probably caused by dry weather conditions in the area.

It is the opinion of Groundwater staff that the pumping of the PW-6 well did not interfere with the water well supply of Mr. VanGrunsen.

J. VanGrunsen - Well 6B - Lot 19, Concession VII, Township of Mountain

Mr. J. VanGrunsen has an unused dug well on his property through which his drilled well was constructed. The dug well is located approximately 810 metres from the PW-6 well. The drilled well and dug well are not connected hydraulically. The water level in the well was measured on July 29, August

13, August 27, and September 3, 1985. The water level in the well on these dates was found to be at a depth of 3.00 metres, 3.61 metres, 4.12 metres and 4.23 metres respectively.

The total lowering of the water level in the dug well totalled 1.23 metres and it appeared to be due to dry weather conditions.

G. Carkner - Well 7 - Lot 21, Concession VIII, Township of Mountain

Mr. G. Carkner has a drilled well that supplies water for his domestic needs. It is located approximately 795 metres from the PW-6 well. Mr. Carkner did not report any water quantity problems during the pumping test of PW-6.

The Carkner well was measured on July 29, August 13, August 27, and September 3, 1985. The water level in the well on these dates was found to be at a depth of 6.27 metres, 6.22 metres, 6.88 metres, and 6.36 metres respectively. The measurements did not lower with time indicating that some of the measurements were probably taken during a pumping cycle or a recovery cycle. Three of these measurements were approximately the same but the measurement taken on August 27, 1985, was approximately 0.6 metres lower than the other three measurements. Comparing the measurements taken on July 29, 1985 and that of September 3, 1985, it is felt by the Groundwater staff that the pumping of PW-6 well did not cause interference in the Carkner well.

E. Jennings - Well 8 - Lot 21, Concession VII, Township of Mountain

The E. Jennings well is a dug well and it supplies water for a house and a nursing home. It is located approximately 760 metres from the PW-6 well. The water level measurements were taken on July 29, August 13, August 27 and September 3, 1985. The water level taken on these dates was found to be at a depth of 6.57 metres, 6.08 metres, 5.19 metres, and 5.43 metres, respectively. The measurements probably were taken during a pumping cycle or recovery cycle. Mrs. Jennings did not complain of water shortages during the pumping of PW-6. The water level measurements give no indication that the pumping of the PW-6 well caused interference to the Jennings well.

Lyall Holmes - Well 9A - Lot 20, Concession VII, Township of Mountain

The Lyall Holmes house and barn well is a drilled well. Mr. Holmes did not report any water supply problems during the pumping of PW-6. The well is located approximately 1080 metres the PW-6 well.

Water level measurements were taken in the well on July 29, August 13, August 27, and September 3, 1985. The water level on these dates was found to be at a depth of 4.17 metres, 5.32 metres, 5.58 metres, and 5.75 metres respectively.

The water level in the well lowered gradually during the pumping of the PW-6 well for a total of 1.58 metres. At a separation distance of 1080 metres, it is felt by the Groundwater staff that the pumping of the PW-6 well did not cause interference to the well. The lowering of the water level was probably caused by dry weather conditions.

Lyall Holmes - Well 9B - Lot 20, Concession VII, Township of Mountain

Mr. Lyall Holmes has an unused dug well on his property. It is located approximately 1080 metres from the PW-6 well. The drilled house and barn well was constructed through the bottom of the dug well. There does not appear to be a hydraulic connection between the two wells. The water level in the well lowered very slightly during the pumping of the PW-6 well.

Water level measurements were taken in the well on July 29, August 13, August 27, and September 3, 1985. The water level on these dates was found to be at a depth of 4.17 metres, 4.28 metres, 4.32 metres, and 4.38 metres respectively. The slight lowering of the water level in the well was probably caused by dry weather conditions in the area.

L. Levere - Well 10 - Lot 17, Concession VIII, Township of Mountain

The Levere drilled well supplies a house and an auto repair shop. It is located approximately 1475 metres from the PW-6 well. Mr. Levere did not complain of water quantity problems during the pumping of the PW-6 well.

Water level measurements were taken on July 29, August 13, August 27, and September 3, 1985. The water level on these dates was found to be at a depth of 3.30 metres, 4.33 metres, 4.75 metres, and 4.89 metres respectively. The total lowering of the water level in the Levere well was 1.59 metres. The lowering of the water level in this well located almost one and one-half kilometres away from PW-6 was probably caused by dry weather conditions. It is felt by Groundwater staff that pumping of the PW-6 well did not interfere with the Levere well.

J. LaFrance - Well 11 - Lot 23, Concession VII, Township of Mountain

The J. LaFrance well is a dug domestic well. It is located about 2485 metres from the PW-6 well. Mr. LaFrance did not complain about water quantity problems during the extended pumping of the PW-6 well. The water level in the well was

measured on July 29, August 13, August 27, and September 3, 1985. The water level on these dates was found to be at a depth of 2.57 metres, 3.13 metres, 3.36 metres, and 5.47 metres respectively.

The water level lowered by 2.90 metres during the extended pumping test carried out on PW-6. The lowering of the water level in the well was probably caused by dry weather conditions. The pumping of the PW-6 well did not interfere with the LaFrance well.

K. Last - Well 12 - Lot 16, Concession VI, Township of Mountain

The K. Last drilled well supplies water for a house and barn. The well is located about 2925 metres from PW-6 well. Mr. Last did not report any water quantity problems during the pumping of the PW-6 well.

The water level in the well was measured on July 29, August 13, August 27 and September 3, 1985. The water level on these dates was found to be at a depth of 4.87 metres, 5.32 metres, 5.56 metres and 5.71 metres respectively.

The water level lowered gradually over the pumping period for a total lowering of 0.84 metres. The lowering of the water level was probably caused by dry weather conditions in the area. The pumping of the PW-6 well has not affected the water level in the Last well.

D. Rose - Well 13 - Lot 18, Concession VII, Township of Mountain

The D. Rose drilled well supplies his barn and house and is heavily used. Groundwater staff noted that the pump ran almost constantly.

The well is located approximately 1310 metres from the PW-6 well. Mr. Rose did not complain about water quantity problems during the extended pumping test of the PW-6 well.

The water level in the well was measured on July 29, August 13, August 27, and September 3, 1985. The water level on these dates was found to be at a depth of 26.35 metres, 20.35 metres, 16.34 metres, and 11.82 metres respectively. It is obvious that the measurements were taken during a pumping cycle or during a recovery cycle. The measurements do not indicate that the pumping of the PW-6 well interfered with the Rose well.

D. Williams - Well 14 - Lot 23, Concession VIII, Township of Mountain

The Williams well is used to supply water for a farm. The well is located about 1905 metres from the PW-6 well. Mr. Williams did not complain of water well quantity problems during the extended PW-6 pumping test.

Water levels in the well were measured on July 29, August 13, August 27, and September 3, 1985. The water level on these dates was found to be at a depth of 4.27 metres, 4.84 metres, 4.89 metres, and 4.97 metres respectively.

The water level lowered gradually during the test. The total lowering of the water level was 0.70 metres. It is felt the lowering of the water level was probably caused by dry weather conditions. The pumping of the PW-6 well has not interfered with Mr. Williams' well.

The Big "O" - Well 15 - Lot 24, Concession VIII, Township of Mountain

The Big "O" well supplies the needs of a commercial enterprise. Not much water is used in the operation. The well is located about 2865 metres from the PW-6 well. The Big "O" staff did not complain about water quantity problems during the pumping of PW-6.

Water level measurements were taken in the well on July 29, August 13, August 27, and September 3, 1985. The water level on these dates was found to be at a depth of 2.42 metres, 2.60 metres, 2.45 metres, and 2.56 metres respectively. The water level in the well lowered gradually during the pumping test. The total lowering of the water level was 0.14 metres during the pumping test. The pumping of the PW-6 well did not interfere with the Big "O" well.

H. Vandenbroek - Well 16 - Lot 17, Concession VI, Township of Mountain

The Vandenbroek drilled well is used to supply water for a farm. It is located about 2410 metres from the PW-6 well. Mr. Vandenbroek did not complain about water quantity problems during the extended pumping test of the PW-6 well. The water level in the well was measured on July 29, August 13, August 27 and September 3, 1985. The water level on these dates was found to be at a depth of 6.96 metres, 7.43 metres, 7.51 metres, and 7.54 metres respectively.

The total lowering of the water level in the well during the pumping test was 0.58 metres. The lowering of the water level in the well is felt to have been caused by dry weather conditions. The pumping of PW-6 well has not interfered with the water level in the Vandenbroek well.

A. McKinley - Well 17 - Lot 20, Concession VII, Township of Mountain

Originally the McKinley well was not included as one of the wells to be monitoring during the PW-6 pumping test. On August 13, 1985 Mr. A. McKinley indicated that he had experienced well problems. The pump intake was lowered by Mr. McKinley and no additional water well complaints were reported to Ministry personnel. The well is located approximately 1065 metres from the PW-6 well.

The water level in the well was measured on August 13, August 27 and September 3, 1985. The water level in the well on these dates was found to be at a depth of 13.65 metres, 16.30 metres, and 16.43 metres respectively.

The water level appears to have lowered a great deal over the period that the well was measured. The total lowering of the water level was 2.78 metres. It is believed that these measurements were taken while the well was being pumped or the well was in a recovery cycle. It is the opinion of the Groundwater Unit that the lowering of the water level in this well was not caused by the pumping of the PW-6 well.

Test Well No. 1 - Lot 19, Concession VI, Township of Mountain

Test well No. 1 is located about 1570 metres from PW-6. A water level recorder was installed in the well during the winter of 1985.

Measurements were taken from the recorder charts for July 29, August 13, August 27, September 3, September 6, September 11 and September 16, 1985. The water level in the well on these dates was at a depth of 3.10 metres, 3.41 metres, 3.79 metres, 3.92 metres, 3.95 metres. 4.00 metres and 4.03 metres respectively.

The total lowering of the water level in the well between July 29 and September 3, 1985 was 0.82 metres. The lowering of the water level in the well between July 29, 1985 and September 6, 1985 was 0.85 metres.

The September 11, 1985 measurement at 4.00 metres was 0.05 metres lower than the September 6, 1985 measurement. The September 16, 1985 measurement at 4.03 metres - four days after the pumping rate of the PW-6 well was reduced from 10.1 L/s to 6.1 L/s - was 0.03 metres lower than the September 11, 1985 measurements.

No rise in the water level in Test Well No. 1 was noted as a result of the decreasing of the pumping rate of the PW-6 well. There was no indication on the charts that the water level in the well rose after the pumping rates in the PW-6 well was reduced to 6.1 L/s on September 12, 1985. It is considered that the pumping of PW-6 did not affect the water levels in Test Well No. 1.

Test Well No. 3 - Lot 22, Concession VIII, Township of Mountain

Test well No. 3 is located approximately 1205 metres from the PW-6 well. A water level recorder had been installed in the well during the winter of 1985. Water level measurements were taken from the water level recorder chart for July 29, August 13, August 27, September 3, September 6, September 11 and September 16, 1985. The water levels were found to be at depth of 3.85 metres, 4.36 metres, 4.70 metres, 4.79 metres, 4.84 metres, 4.91 metres, and 4.94 metres respectively.

The total lowering of the water level in the well between July 29 and September 3, 1985 was 0.94 metres. The lowering of the water level in the well between July 29 and September 6, 1985 was 0.99 metres.

The water level lowered from 4.84 metres to 4.91 metres (0.07 metres) between September 6 and September 11, 1985. The water level lowered from 4.91 metres to 4.94 metres (0.03 metres) between September 11 to September 16, 1985. There was no indication on the charts that the water level rose in the well after the pumping rate of PW-6 was reduced to 6.1 L/s on September 12, 1985. It is felt the pumping of the PW-6 well did not affect the water level in Test Well No. 3.

Water Well Quality

Water samples were taken from the PW-6 well and 17 nearby domestic and farm wells and analysed for 18 chemical parameters. The wells were sampled before the beginning of the test on July 29, 1985, during the test on August 13, 1985, and near the end of the test on August 27, 1985.

One domestic well was sampled on July 29 and August 13, 1985. One well was sampled on July 29 and August 27, 1985. Two wells were sampled on August 27, 1985.

Most of the wells sampled contained potable groundwater. A few contained chemical parameters that were above Ontario Drinking Water Criteria. The quality of none of the domestic and farm wells deteriorated as a result of pumping of the PW-6 well.

A short discussion on the water quality of each well follows. A table is attached that lists the chemical analyses carried out on each well.

PW-6 Winchester Well

The well water from PW-6 was sampled on July 29, August 13, and August 27, 1985. The overall chemical water quality of the well water is excellent.

The conductivity of the water increased from 600 umhos/cm to 700 umhos over the 45-day extended pumping test while the well was running at the maximum pumping rate of 9.5 L/s to 10.5 L/s. The chloride concentrations increased from 15 mg/l to 23 mg/l. The sulphate concentration increased from 85 mg/l to 90 mg/l. The concentration of the other chemical parameters remained fairly stable during the pumping test.

H. Holmes Well - 1A

The H. Holmes barn well water was sampled on July 29, August 13, and August 27, 1985. It contained elevated concentrations of a number of chemical parameters in the

sample taken on July 29, 1985. The BOD_5 concentration was fairly high at 3.4 mg/l. The iron concentration was also high at 1.45 mg/l. The turbidity and colour were at 9.3 Formazin Turbidity Units and 48 True Colour Units. The water contained elevated ammonia concentrations at 0.20 mg/l. The potassium concentration was elevated at 12 mg/l.

On August 27, the BOD_5 concentration again was 3.4 mg/l. The iron had increased significantly to 7.0 mg/l. The turbidity increased to 28 FTU. The ammonia concentration increased to 0.5 mg/l. The nitrate increased to 1.7 mg/l. The potassium concentration decreased to 8.5 mg/l.

The well is located in the Holmes barn. Outside the barn is a loafing area for horses. It is not surprising that the well water contained high concentrations of BOD_5, iron, turbidity, colour, and ammonia. The quality of the well water was poor prior to July 29, 1985. It continued to be poor during the PW-6 long term pumping test.

The well was replaced with a new well on October 5, 1985 because water well quantity interference was caused by the pumping of the PW-6 well. The new well was sampled on November 27, 1985. The iron concentration was found to be 0.55 mg/l and the chloride concentration was found to be 265 mg/l. The potassium concentration was elevated at 20 mg/l.

Lester Holmes Well - 4A

The Lester Holmes house well water was sampled on July 29, August 13 and August 27, 1985. On July 29, 1985 the nitrates and potassium were elevated at 15.8 mg/L and 14 mg/l. When the water was sampled on August 27, 1985, the nitrate and potassium concentrations had decreased to 4.4 mg/l and 6.5 mg/l respectively. It is interesting to note that the chloride concentration decreased from 63 mg/l in the July 29, 1985 sample to 34 mg/l on the August 27, 1985 sample.

It is evident that pumping of PW-6 well did not affect the quality of water in the Lester Holmes well.

C. Howse Well - 3A

The C. Howse house and barn well water was sampled on July 29, August 13 and August 27, 1985. The chemical quality of the well water on July 29, 1985 was excellent. The only elevated parameter was potassium at 16 mg/l. The concentration of the chemical parameters remained fairly stable during the entire pumping of the PW-6 well. In all three samples the chloride concentration was found to be 28 mg/l. It is evident that the pumping of the PW-6 well did not affect the quality of the Howse house and barn well water.

L. Levere Well - 10

The L. Levere well was sampled on July 29, August 13, and August 27, 1985. The water on July 29, 1985 was found to contain elevated concentrations of iron at 3.6 mg/l, turbidity at 34 FTU, colour at 13 TCU, chlorides at 323 mg/l, ammonia at 0.40 mg/l, sodium at 128 mg/l and potassium at 16 mg/l. The conductivity was 1750 umhos/cm. When the well was sampled on August 27, 1985 the iron concentration decreased to 0.25 mg/l, the turbidity increased to 37 FTU and the colour had increased to 76 TCU. The chloride concentration had lowered slightly to 303 mg/l. The ammonia concentration had remained virtually the same. The sodium concentration had increased to 180 mg/l. The potassium concentration had decreased to 14 mg/l.

The water in the well had a number of parameters with elevated concentrations before the pumping of the TW-6 well began on July 29, 1985. In subsequent samplings, the concentrations of some parameters increased and some decreased. It is evident that the pumping of the TW-6 well did not affect the quality of the Levere well water.

J. Spruit Well - 2B

The J. Spruit house and barn well was sampled on July 29, August 13, and August 27, 1985. The samples taken on July 29 and August 13, 1985 were treated water samples. The August 27, 1985 sample was untreated. There is a water softener installed in the system.

The chemical quality of the water on July 29, 1985 was good with the exception that the conductivity was high at 1310 umhos/cm and the iron concentration was elevated at 0.95 mg/l. The potassium concentration was also elevated at 12 mg/l.

The August 13, 1985 sample contained an iron concentration of 0.25 mg/l and a potassium concentration of 10 mg/l.

Because of the presence of a softener on the system, sodium was found to be at concentrations of 217 and 313 mg/l in the July 29, and August 13, 1985 samples. The hardness concentration was reduced to 3 mg/l and less than 1 mg/l on the July 29 and August 13, 1985 samples.

On August 27, 1985, raw water well samples were taken from the Spruit well. The hardness was found to be 515 mg/l. The iron concentration had decreased to 0.20 mg/l. The ammonia concentration had increased to 1.4 mg/l and the sodium concentration was 22 mg/l. The potassium concentration had increased to 50 mg/l indicating that the softener had been taking potassium out of the well water. The analytical results of the samples taken from the Spruit well water show that the pumping of the PW-6 well did not affect the quality of the Spruit well water.

Lyall Holmes Well - 9A

Water from the Lyall Holmes house and barn well was sampled on July 29, August 13, and August 27, 1985.

The analysis of the well sample taken on July 29, 1985 indicated that the water had elevated concentrations of nitrate at 14 mg/l and potassium at 23 mg/l.

The analysis of the sample taken from the well on August 13, 1985 indicated that the water was almost identical to the quality of the water sampled on July 29, 1985.

The August 27, 1985 sample results indicated that the nitrate concentration had decreased to 0.71 mg/l and the potassium concentration had decreased to 14 mg/l. It is apparent that the pumping of the PW-6 well did not affect the quality of water in the Spruit well.

K. Last Well - 12

The K. Last well was sampled on July 29, August 13, and August 27, 1985.

The sample taken on July 29, 1985 indicated that the quality of the water in the Last well was good. None of the chemical parameters exceeded the Ontario Drinking Water Criteria. The water had a slightly elevated concentration of 2.8 mg/l of nitrate and it contained an elevated concentration of potassium at 12 mg/L.

The water sample taken from the well on August 13, 1985 indicated that the concentration of many of the parameters in the Last well had decreased. However, nitrate concentrations increased to 4.8 mg/l and the potassium concentration increased to 17 mg/l.

The water sample taken from the Last well on August 27, 1985 indicated that the concentrations of many of the chemical parameters in the well water had decreased. The nitrate concentration decreased to 1.2 mg/l and the potassium concentration had decreased to 8.8 mg/l. It is apparent that the pumping of the PW-6 well did not affect the quality of the water in the Last well.

D. Rose Well - 13

The D. Rose well was sampled on July 29, August 13, and August 27, 1985.

The quality of the well water remained virtually unchanged during the entire sampling period. The only chemical parameter that was elevated was potassium at 17 mg/l. It is obvious that the quality of the water in the Rose well was not affected by the pumping of the PW-6 well.

D. Williams Well - 14

The D. Williams well was sampled on July 29, August 13 and August 27, 1985.

The water sample taken on July 29, 1985 had very slightly elevated concentrations of iron at 0.25 mg/L, turbidity at 1.2 FTU, colour at 9 TCU and ammonia at 0.34 mg/1. The potassium concentration was elevated at 11 mg/1.

In the August 13, 1985 sample, the concentrations of many of the chemical parameters decreased including that of iron at 0.05 mg/1, turbidity at 0.6 FTU, colour at 7 TCU, and ammonia at 0.31 mg/1. The potassium concentration decreased to 10 mg/1.

In the August 27, 1985 sample the concentration of many of the chemical parameters decreased. However the iron concentration increased slightly to 0.10 mg/1 the turbidity increased to 0.65 FTU, the colour decreased to 3 TCU and ammonia decreased to 0.27 mg/1. The potassium concentration remained the same at 10 mg/1.

The pumping of the PW-6 well did not affect the quality of the water in the D. Williams well.

The Big "O" Well - 15

The well water at the Big "O" industrial site was sampled on July 29, August 13, and August 27, 1985.

In the July 29, 1985 sample, the COD, turbidity, and ammonia concentrations were elevated at 58 mg/1, 210 FTU, 1.0 mg/L respectively.

In conversation with Ministry Laboratory staff, the reported concentration of iron at less than 0.01 mg/L must have been incorrect. It was indicated that the concentration of iron in the sample must have been very high. The analysis for colour at 210 FTU indicates that there was interference caused to the testing equipment.

In the August 13, 1985 samples, the concentration of COD was 82 mg/L, the turbidity was at 210 FTU, and ammonia was at 0.7 mg/1. These analyses showed that the concentration of the chemical parameters had remained about the same as those found in the July 29, 1985 sample. The iron concentration was reported at 20 mg/1 and colour was reported to be greater than 100 TCU.

In the August 27, 1985 sample, the concentration of COD at 82 mg/1, turbidity at 240 FTU, ammonia at 0.7 mg/1, iron at 0.24 mg/1 and colour at greater than 100 TCU again showed the quality of water in the well had remained essentially the same as that noted in the previous samples. The pumping of the PW-6 well did not affect the water quality in the Big "O" well.

G. Carkner Well - 7

The G. Carkner well water was sampled on July 29, August 13 and August 27, 1985. The water analyses of the well samples taken on July 29, 1985 showed that the concentration of iron was elevated at 1.92 mg/l. Subsequent sampling of the Carkner well water on August 13 and August 27, 1985 indicated the quality of the well water was essentially the same as it was on July 29, 1985 with the exception that the concentration of iron decreased markedly to 0.10 mg/l in the August 13, 1985 sample and to less than 0.05 mg/l in the August 27, 1985 sample. The pumping of the PW-6 well did not affect the quality of water in the Carkner well.

E. Jennings Well - 8

The water from the Jennings well was sampled on July 29, August 13, and August 27, 1985. The concentration of chemical parameters tested in the well water remained essentially the same for each sampling date. Therefore it is evident that the pumping of the PW-6 well did not affect the quality of water in the Jennings well.

H. Vandenbroek Well - 16

The H. Vandenbroek farm well was sampled on July 29, August 13, and on August 27, 1985. The nitrate and potassium concentrations were elevated at 6.5 and 15 mg/l respectively in the July 29, 1985 sample. The concentration of chemical parameters was virtually the same in the August 13 and August 27, 1985 samples. It is evident that the pumping of the PW-6 well did not affect the quality of the Vandenbroek well water.

J. LaFrance Well - 11

The J. LaFrance well water was sampled on July 29 and August 13, 1985. The concentration of the various chemical parameters was virtually the same on both sampling dates. It is evident that the LaFrance has a softener installed in the water pressure system since the concentration of parameters that cause hardness in water was very low and the concentration of sodium found in the water was very high. The pumping of the PW-6 well did not affect the quality of water in the LaFrance well.

J. VanGrunsen Well - 6A

The VanGrunsen well was sampled on July 29 and August 27, 1985. The sample taken on July 29, 1985 showed that the well water had an elevated conductivity reading at 1490 umhos/cm, iron at 1.02 mg/l, turbidity at 22 FTU, colour at 54 TCU, chloride at 118 mg/l, sulphate at 130 mg/l, ammonia at 4.3 mg/l, and potassium at 45 mg/l.

On August 27, the conductivity although still high, had decreased to 1330 umhos/cm. The iron concentration had increased to 4 mg/l. The turbidity had increased to 60 FTU, and the chlorides and sulphate concentrations remained virtually the same as found in the July 29, 1985 sample. The ammonia concentration decreased to 2.2 mg/l. The potassium concentration had decreased to 24 mg/l.

The July 29, 1985 sample showed that the well water was of poor quality. The August 27, 1985 sample showed that the quality of the water was still poor. Therefore, the pumping of the PW-6 well had not changed the quality of the VanGrunsen well water.

J. Spierenburg Well - 5

The Spierenburg well was sampled only on August 27, 1982. The water quality was excellent. The pumping of the PW-6 well did not affect the quality of water in the Spierenburg well.

A. McKinley Well - 17

The McKinley well water was sampled on August 27, 1985. The quality of the water in the well was excellent. The pumping of the PW-6 well did not affect the quality of the water in the McKinley well.

Discussion and Summary

The Winchester PW-6 well was pumped at a rate ranging from 9.5 L/s to 10.5 L/s for a period of 45 days. The pumping level in the PW-6 well lowered from 4.44 metres on July 29, 1985 to 11.08 metres on September 11, 1985 for a total lowering of the water level of 6.64 metres.

At the beginning of the pumping test, the H. Holmes house well was buried. Mr. Holmes reported water supply problems a few days after the pumping test began. The top of the well was uncovered and it was found that the house was serviced with a shallow well pump.

The water level in the well was reported to be at about 6.4 or 6.7 metres from land surface which is about the maximum depth that a shallow well pump can lift water. It was evident that the water in the well had been lowered to some extent since it was known that Mr. Holmes had had an adequate water supply prior to the beginning of the pumping test. It is felt that the water level in the well prior to the beginning of the PW-6 pumping test would have been at about the same elevation as the water level in the Holmes barn well, i.e. about 4.5 metres.

Since it was obvious that the water level in the well had been lowered to the intake of the shallow well pump by the pumping of the PW-6 well, a new submersible pump was installed in the well on August 6, 1985 by a plumber hired by the Village of Winchester.

The first reliable water well measurement taken from the well was on August 13, 1985 and the water level was found to be at a depth of 7.62 metres. The water level had lowered to a depth of 9.16 metres on September 11, 1985. The total lowering of the water level in the Holmes well is estimated to be about 4.5 metres.

The H. Holmes barn well water level lowered from 4.73 metres on July 29, 1985 to 8.74 metres on September 11, 1985 for a total lowering of 4.01 metres. A pumping test on the barn well showed that it was not capable of supplying sufficient water for Mr. Holmes' horses.

Because of the considerable lowering of the water level in the Holmes barn well by the pumping of the PW-6 well, and the results of a pumping test carried out on the well by Groundwater Unit staff that indicated the well could supply only marginal quantities of water, a new well equipped with a submersible pump was drilled on the Holmes property on October 5, 1985.

The water level in the J. Spruit "rented" house well was measured on July 29, 1985. The house was empty at the time and the measurement was thought to be a static level measurement. However successive measurements showed the water level fluctuated greatly. Only when Mr. Spruit complained to Ministry personnel that the "rented" house well was not capable of supplying water for his cattle, was it learned the well was hooked up to a cattle pen and that it was used to supply 70 to 80 head of cattle.

It became apparent that water level measurements had been taken when the pump was running or when the pump was in a recovery cycle.

A pumping test was carried out on the well on September 6, 1985 and it was determined that the well was not capable of supplying sufficient quantity of water for the Spruit needs. It was estimated that the total drawdown in the Spruit well caused by the pumping of PW-6 well was approximately 2.4 metres.

Because of the extensive lowering of the water level in the well caused by the pumping of the PW-6 well and the results of the pumping test carried out on September 6, 1985 that indicated the well could only supply marginal quantities of water, a new well was drilled for J. Spruit on October 11, 1985 and it was equipped with a submersible pump.

From the measured drawdown on the PW-6 well, the Holmes barn well and the Spruit well, it was estimated that the cone of influence caused by the pumping of the PW-6 well during the long term pumping test was extended approximately 610 metres from the pumping well. It must be remembered that the PW-6 well was pumped at its highest capacity during the driest part of the year. It is expected that the cone of influence of the well will not extend as far as 610 metres under normal operating conditions.

The water level in the Howse house and barn well was not affected by the pumping of the PW-6 well. A pumping test was carried out on the well and it showed that the quantity of water available to the well was greater than the capacity of the pump installed in the well.

From the data collected during the 45-day extended pumping test, none of the water levels in other wells in the area were seriously affected by the pumping of PW-6 well. In addition, there were no valid complaints of water well interference received during the pumping test other than that of Mr. H. Holmes and Mr. J. Spruit.

The water level in a large number of the wells monitored during the long term pumping test lowered. In many cases, the lowering varied from just less than one metre to approximately 1.5 metres. The lowering of the water levels was attributed to dry weather conditions in the area and not water well interference caused by the pumping of the PW-6 well. Tables 3 and 3A indicate that the rainfall in the area from April to August 1985 was 33 percent lower than the average rainfall recorded for the same months from 1981 to 1984.

The water in the PW-6 well and a number of other wells in the area were sampled on July 29, 1985 before the pumping test began on the PW-6 well, on August 13, 1985 during the pumping test, and on August 27, 1985 near the end of the pumping test.

A review of the sample results indicated that the quality of groundwater in the area was not degraded by the extended pumping test carried out on the PW-6 well.

Conclusions

It is concluded that the pumping of the PW-6 Winchester well had seriously interfered with the quantities of water available to the house well and the barn well of Mr. H. Holmes and the "rented" house well of Mr. J. Spruit.

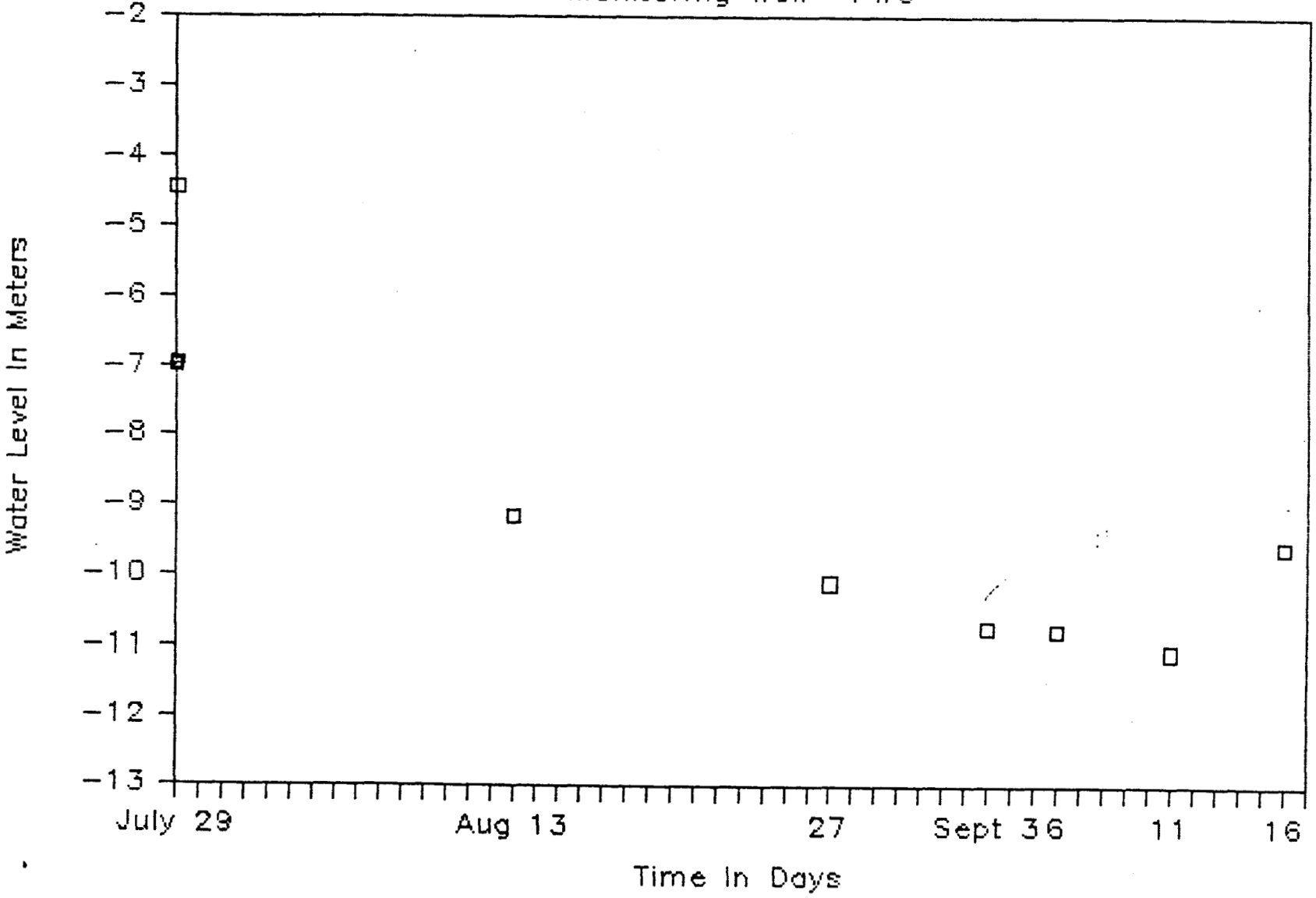
It is concluded that serious water well quantity interference occurred to no other wells in the area during the pumping test.

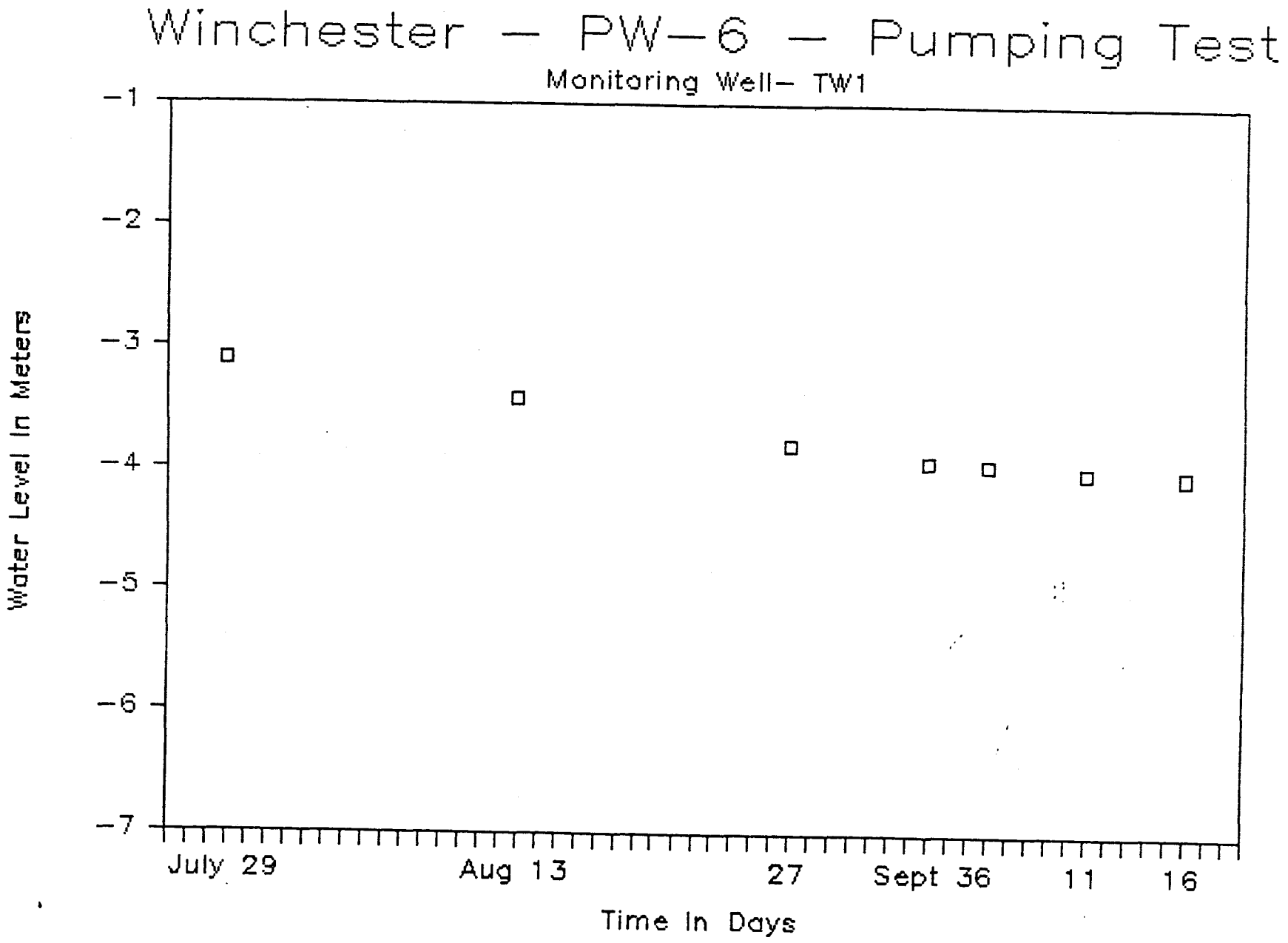
It is concluded that the pumping of the PW-6 Winchester well did not degrade the quality of groundwater in the area.

C.J. Holland
/km
Attachments

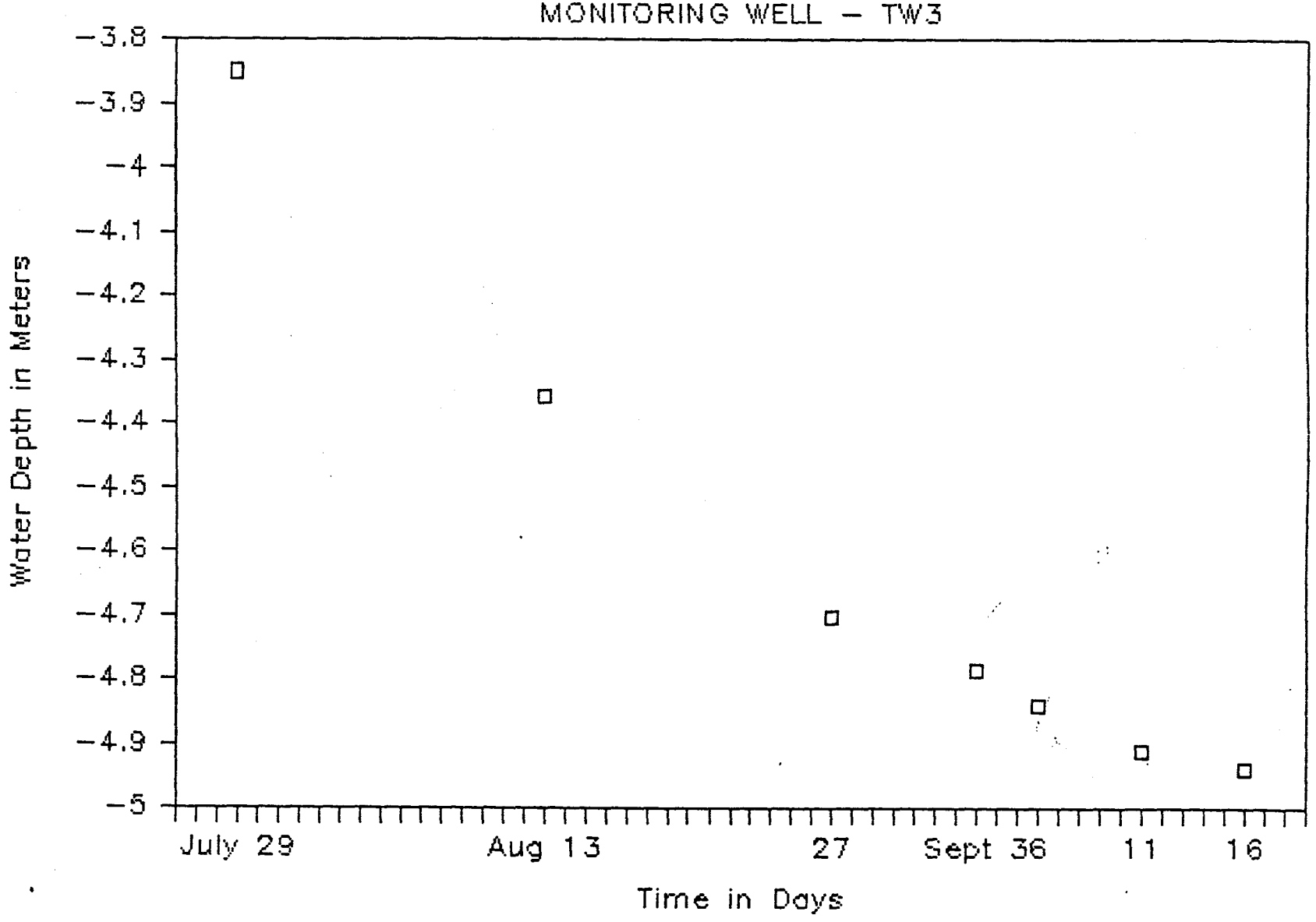
Winchester PW—6 Pumping Test

Monitoring Well— PW6



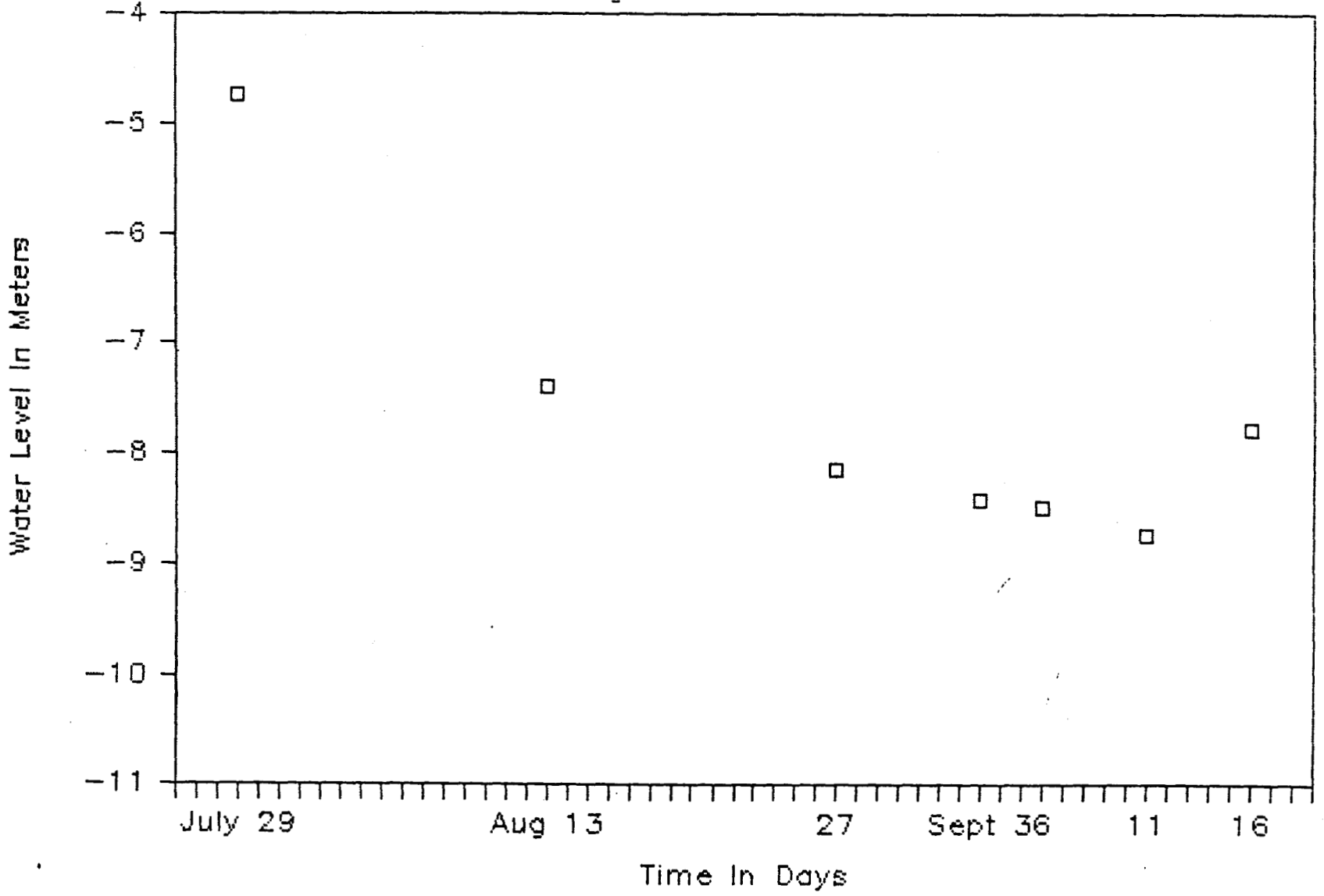

Winchester — PW—6 — Pumping Test
Monitoring Well— TW1
Water Level In Meters
-1
-2
-3
-4
-5
-6
-7
July 29
Aug 13
27
Sept 36
11
16
Time In Days

WINCHESTER — PW—6 — PUMPING TEST



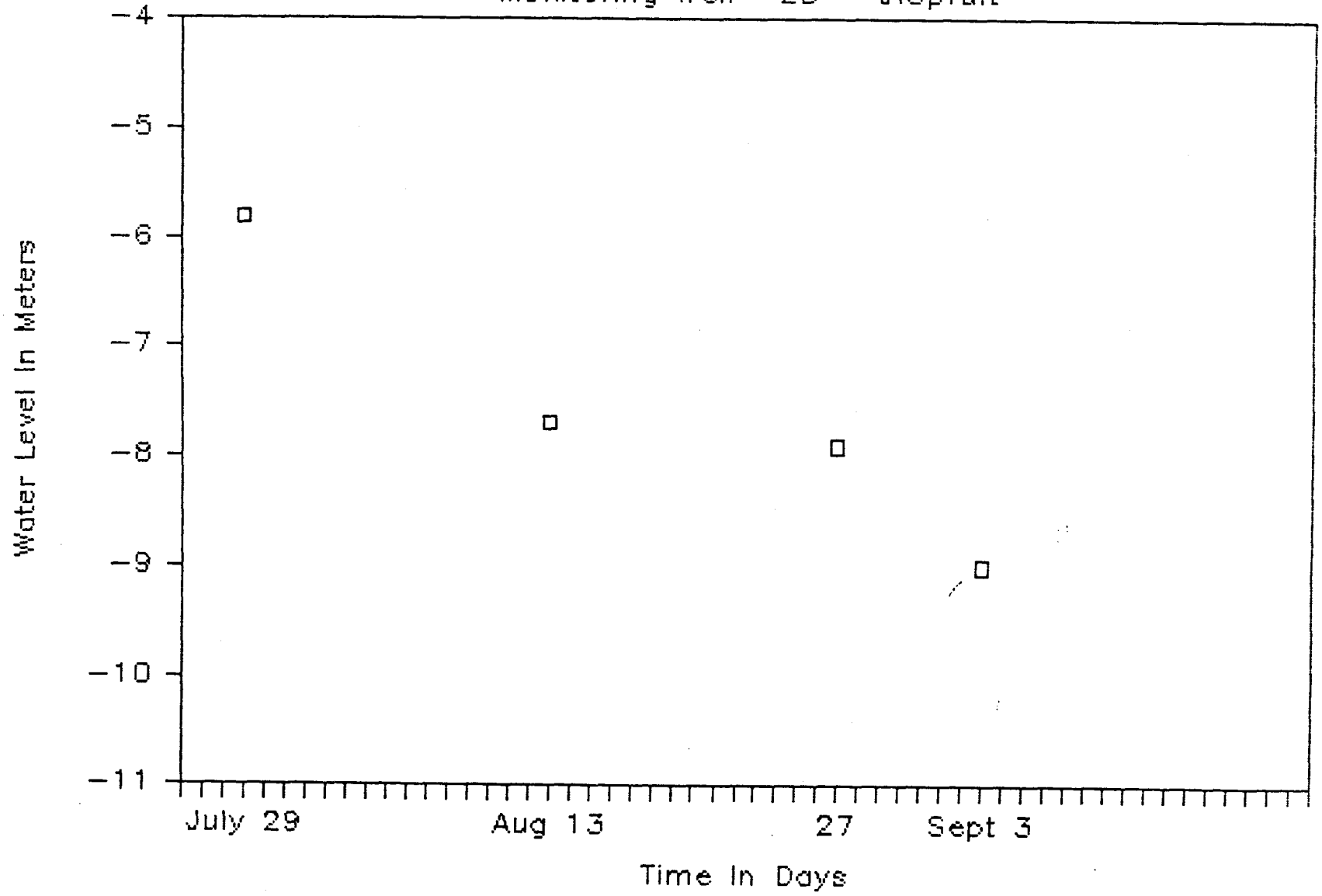
Winchester — PW—6 — Pumping Test

Monitoring Well — 1A — H. Holmes

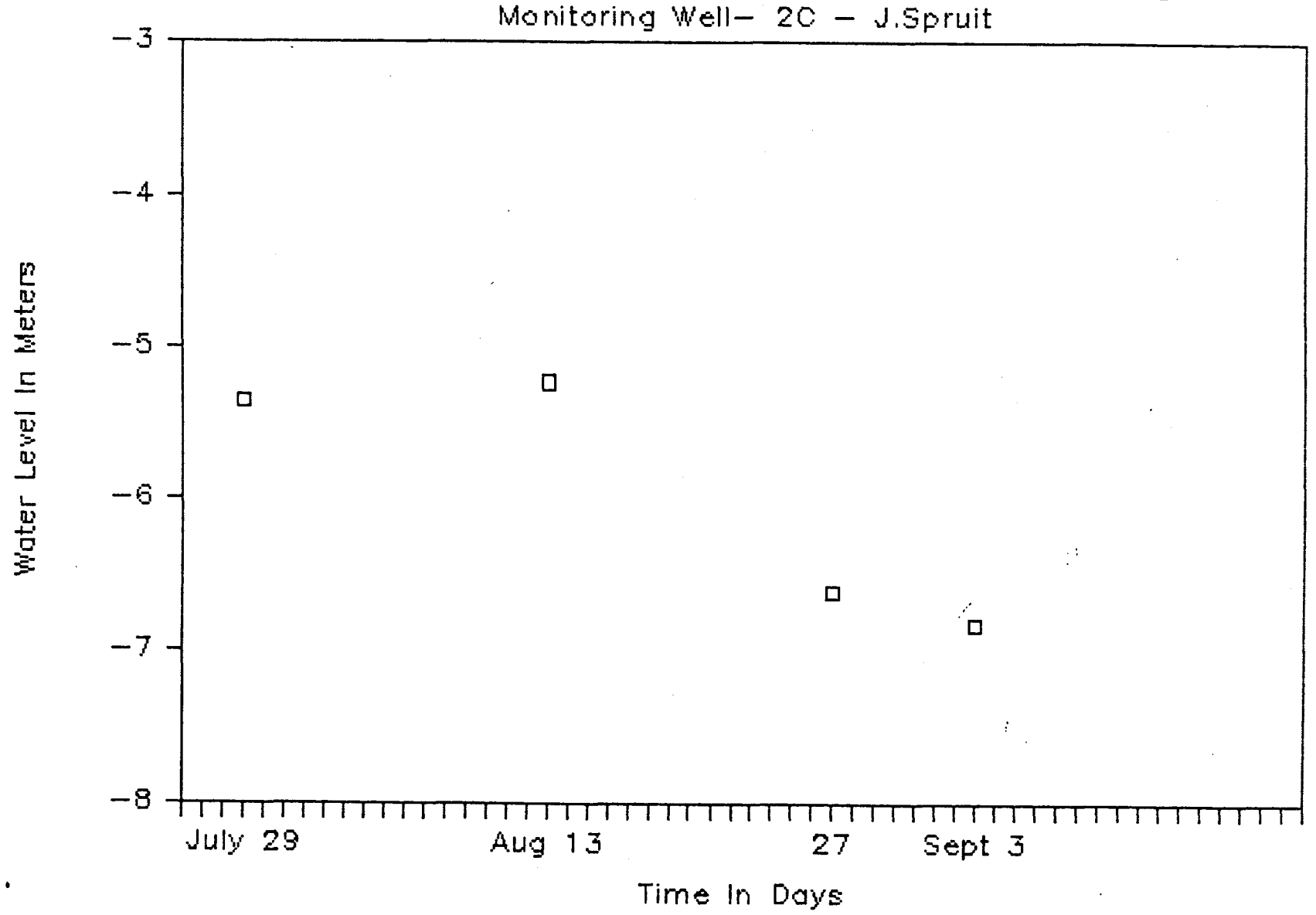


Winchester — PW—6 — Pumping Test

Monitoring Well— 2B — J.Spruit

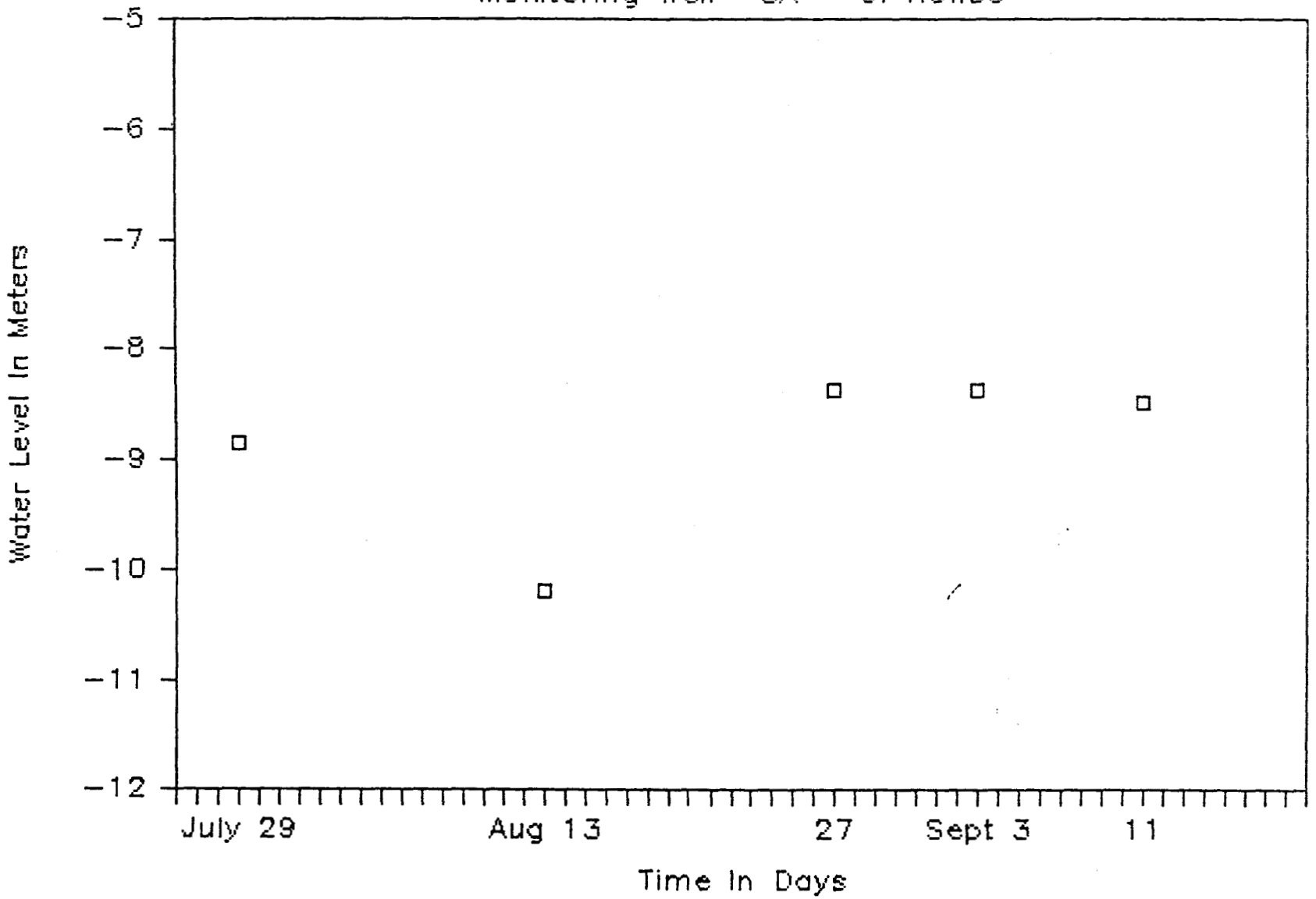


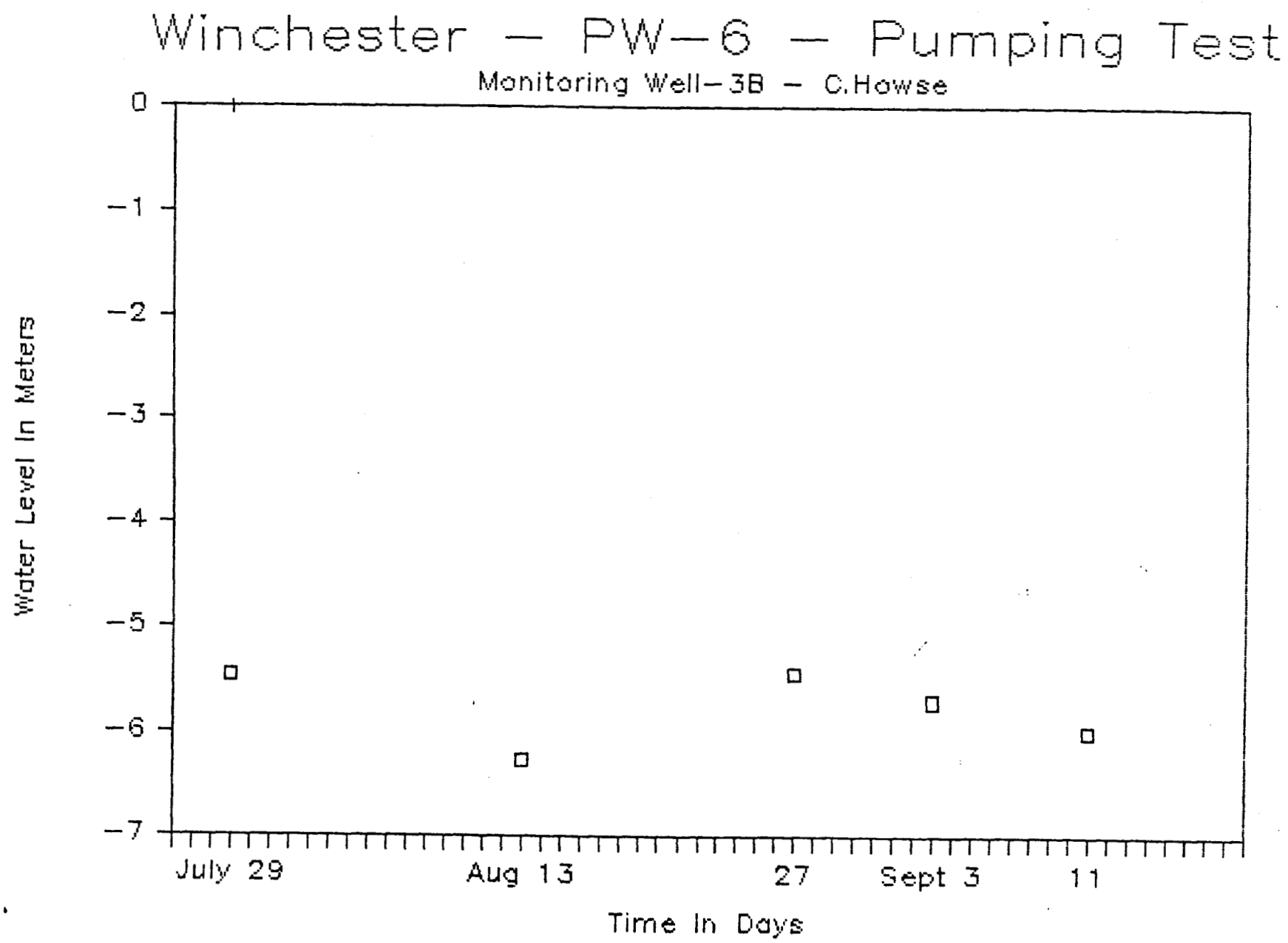
Winchester — PW—6 — Pumping Test

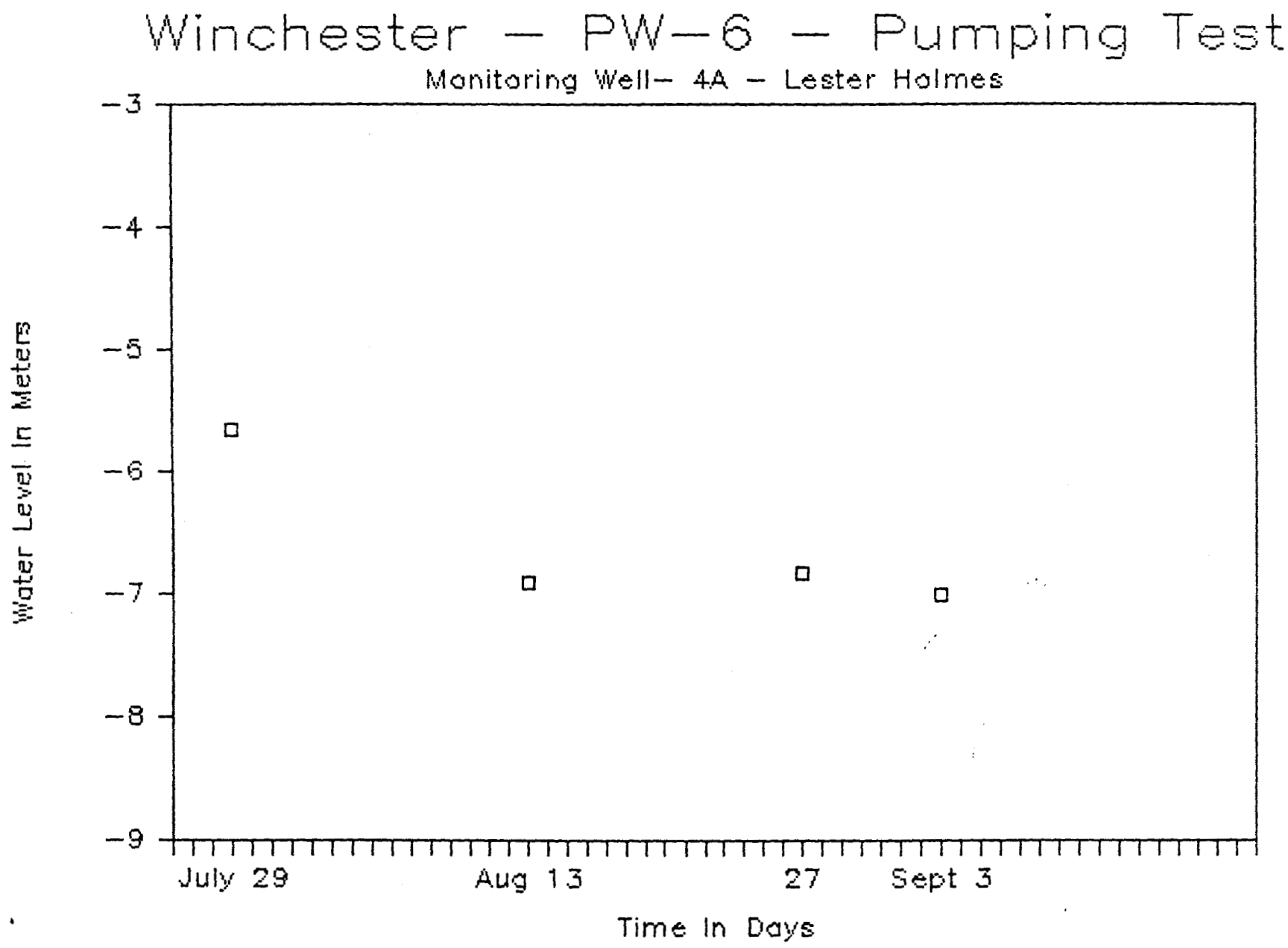


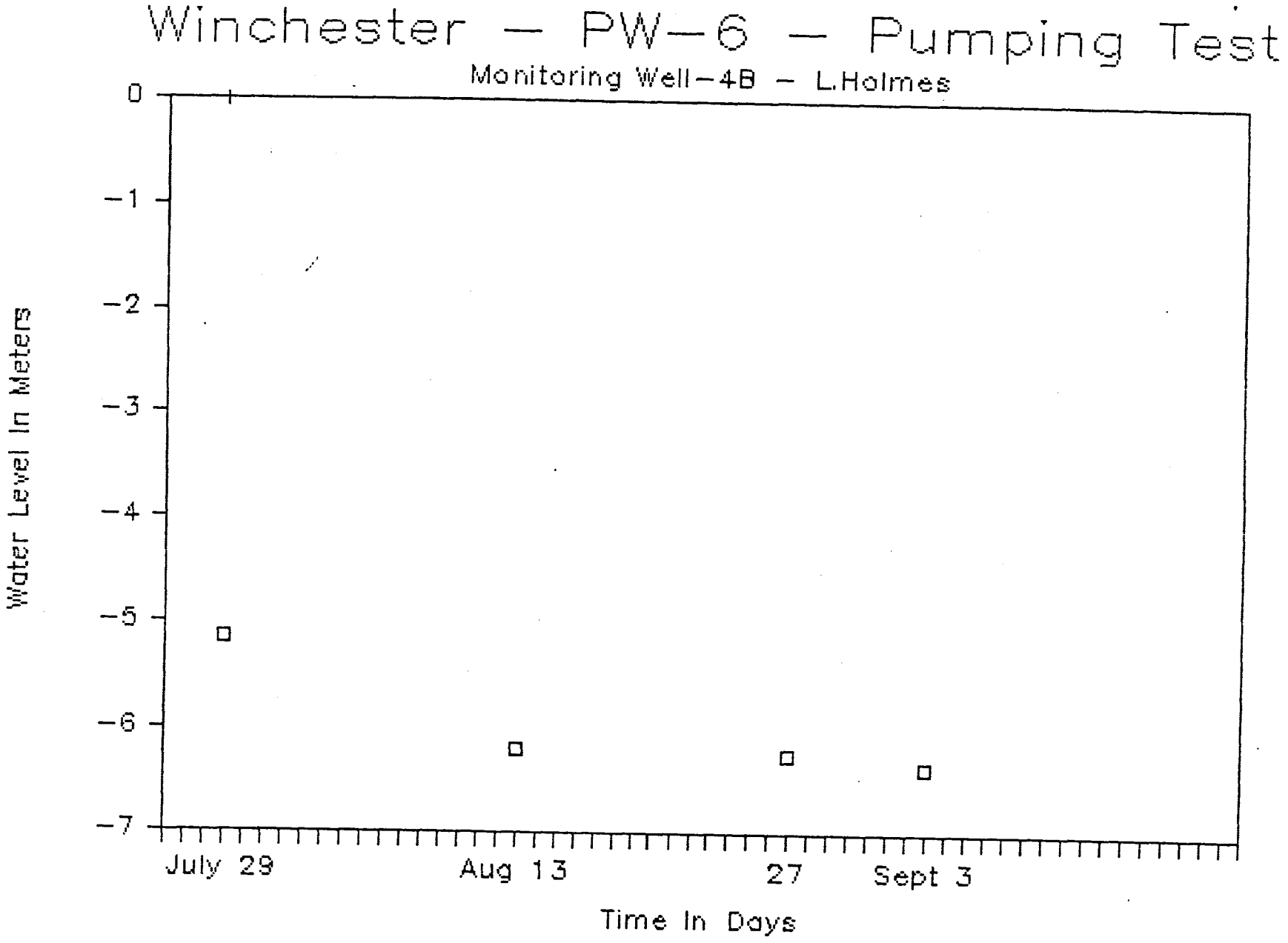
Winchester — PW—6 — Pumping Test

Monitoring Well— 3A — C. Howse



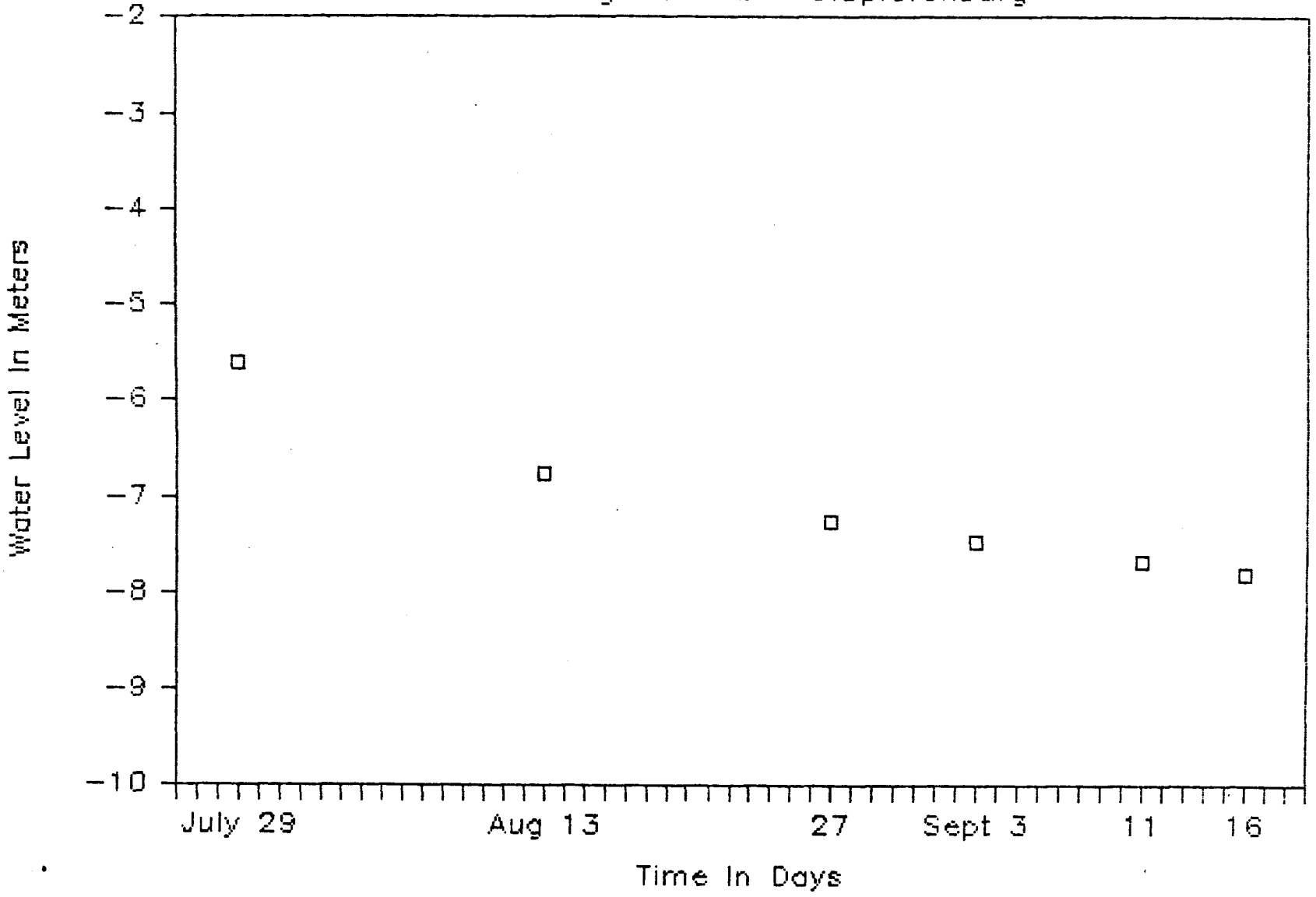

Winchester — PW—6 — Pumping Test
Monitoring Well—3B — C.Howse
Water Level In Meters
0
−1
−2
−3
−4
−5
−6
−7
July 29
Aug 13
27
Sept 3
11
Time In Days

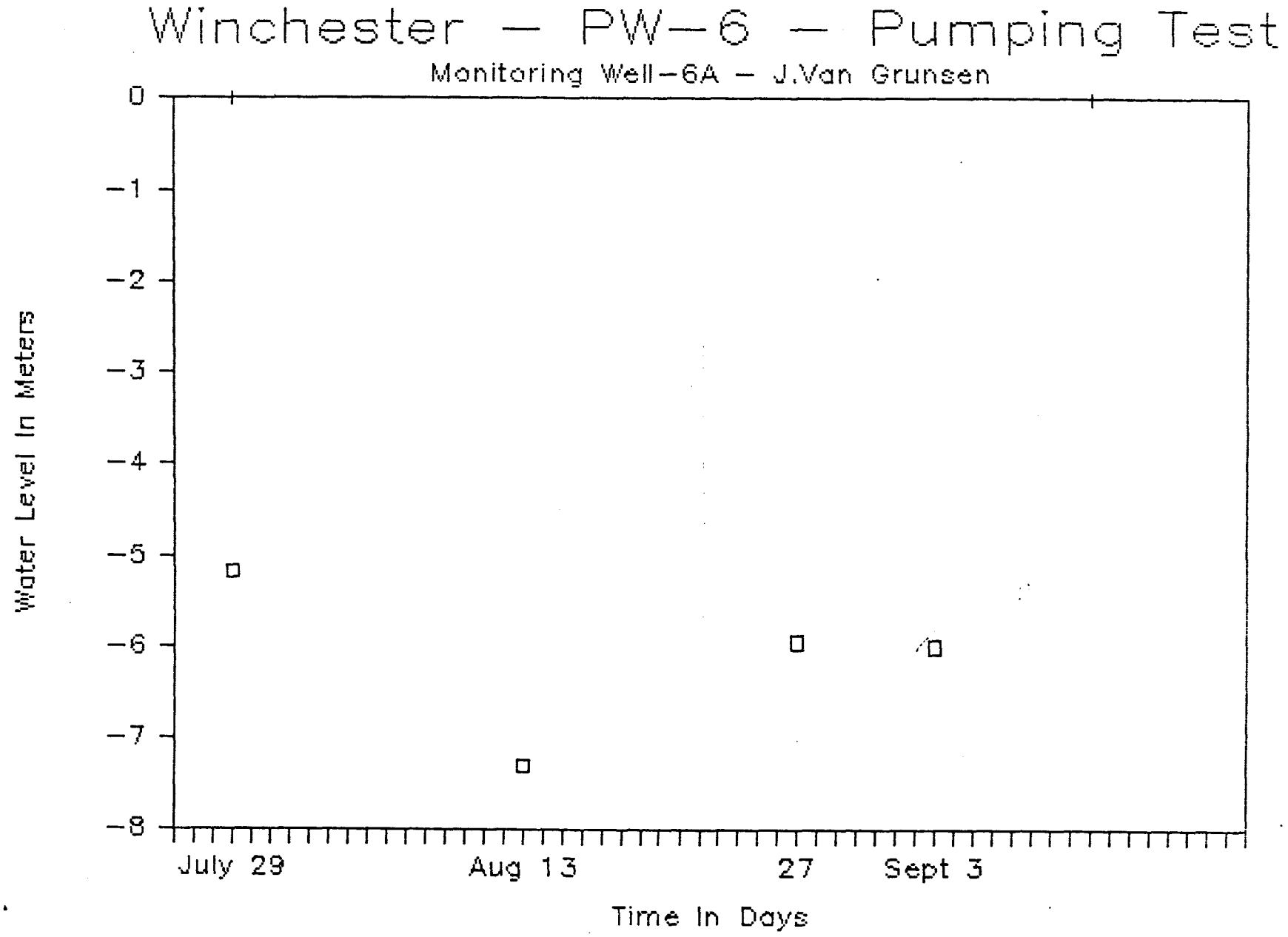

Winchester — PW—6 — Pumping Test
Monitoring Well— 4A — Lester Holmes
Water Level In Meters
-3
-4
-5
-6
-7
-8
-9
July 29
Aug 13
27
Sept 3
Time In Days

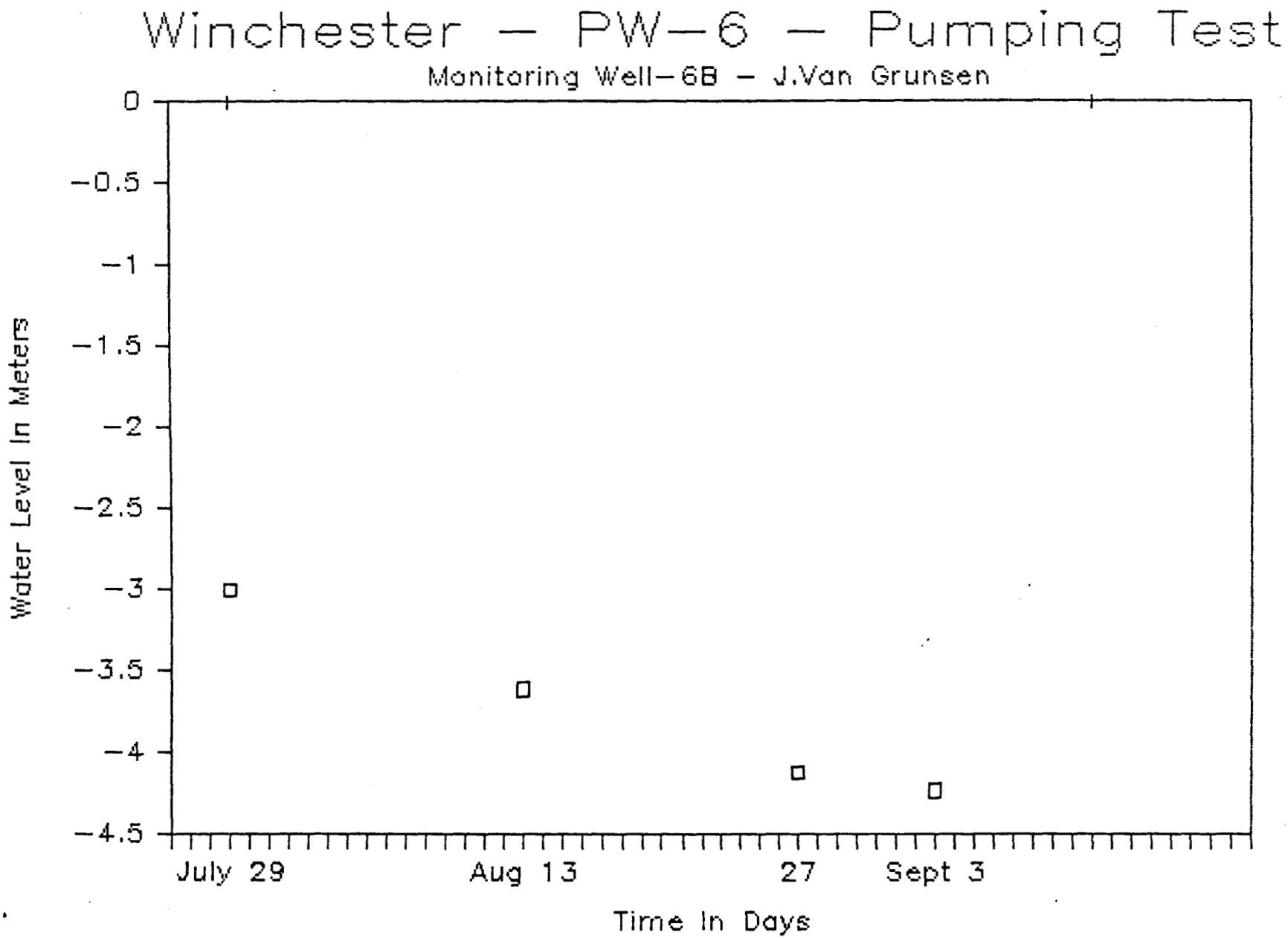

Winchester — PW—6 — Pumping Test
Monitoring Well—4B — L.Holmes
0
−1
−2
−3
−4
−5
−6
−7
Water Level In Meters
July 29
Aug 13
27
Sept 3
Time In Days

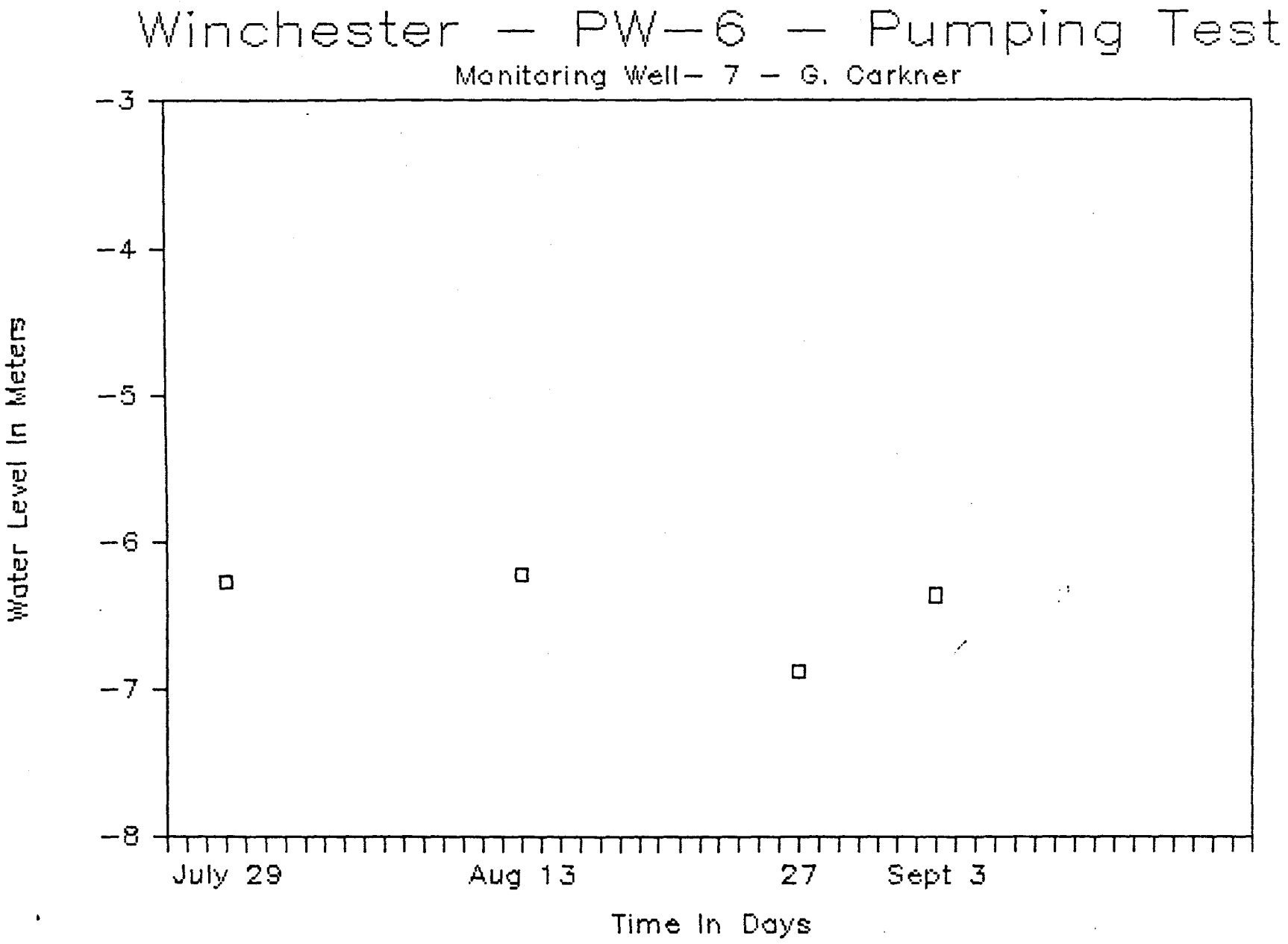
Winchester — PW—6 — Pumping Test

Monitoring Well— 5 — J.Spierenburg

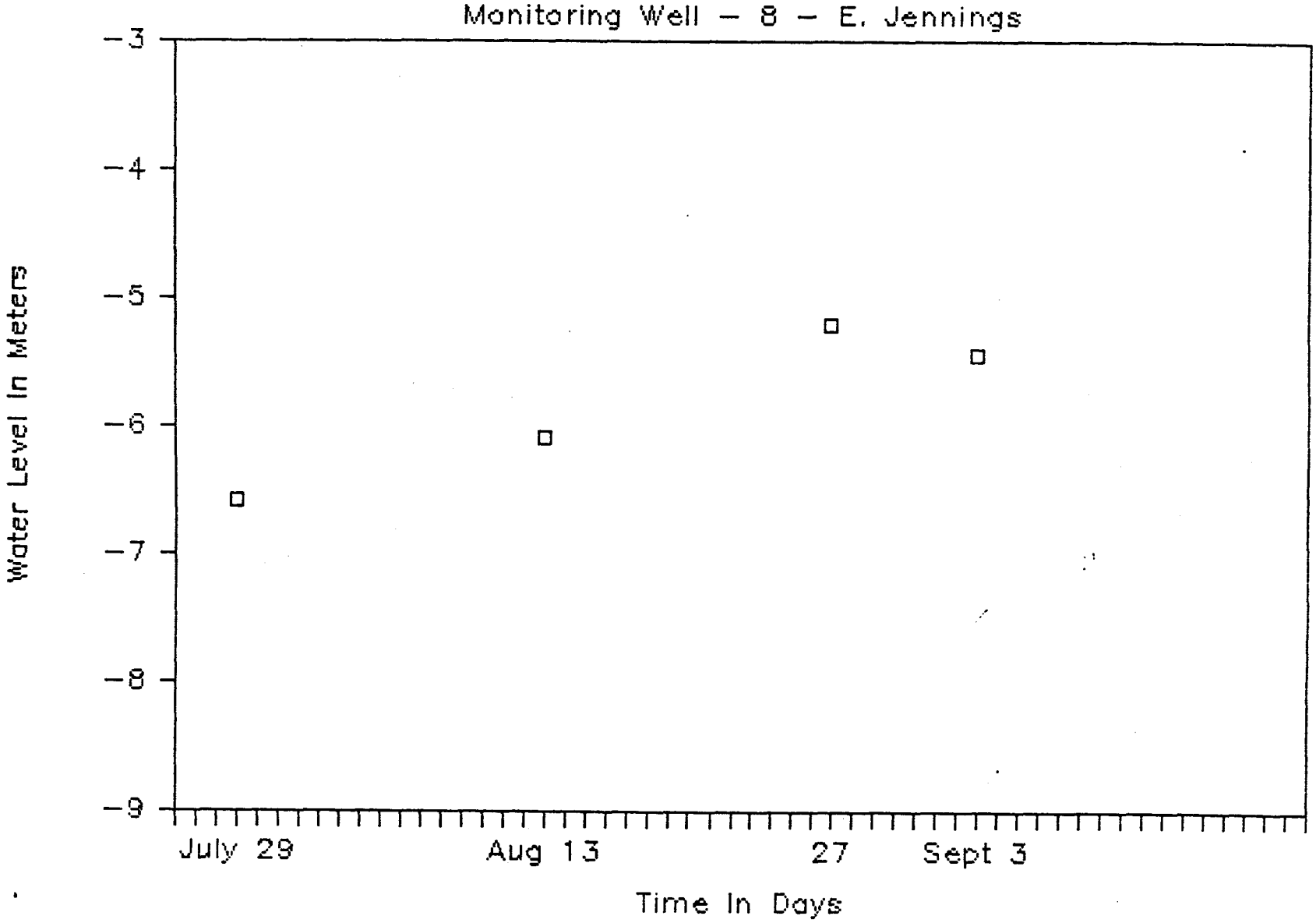



Winchester — PW—6 — Pumping Test
Monitoring Well—6A — J.Van Grunsen
Water Level In Meters
0
-1
-2
-3
-4
-5
-6
-7
-8
July 29
Aug 13
27
Sept 3
Time In Days


Winchester — PW—6 — Pumping Test
Monitoring Well—6B — J.Van Grunsen
0
-0.5
-1
-1.5
-2
-2.5
-3
-3.5
-4
-4.5
Water Level In Meters
July 29
Aug 13
27
Sept 3
Time In Days

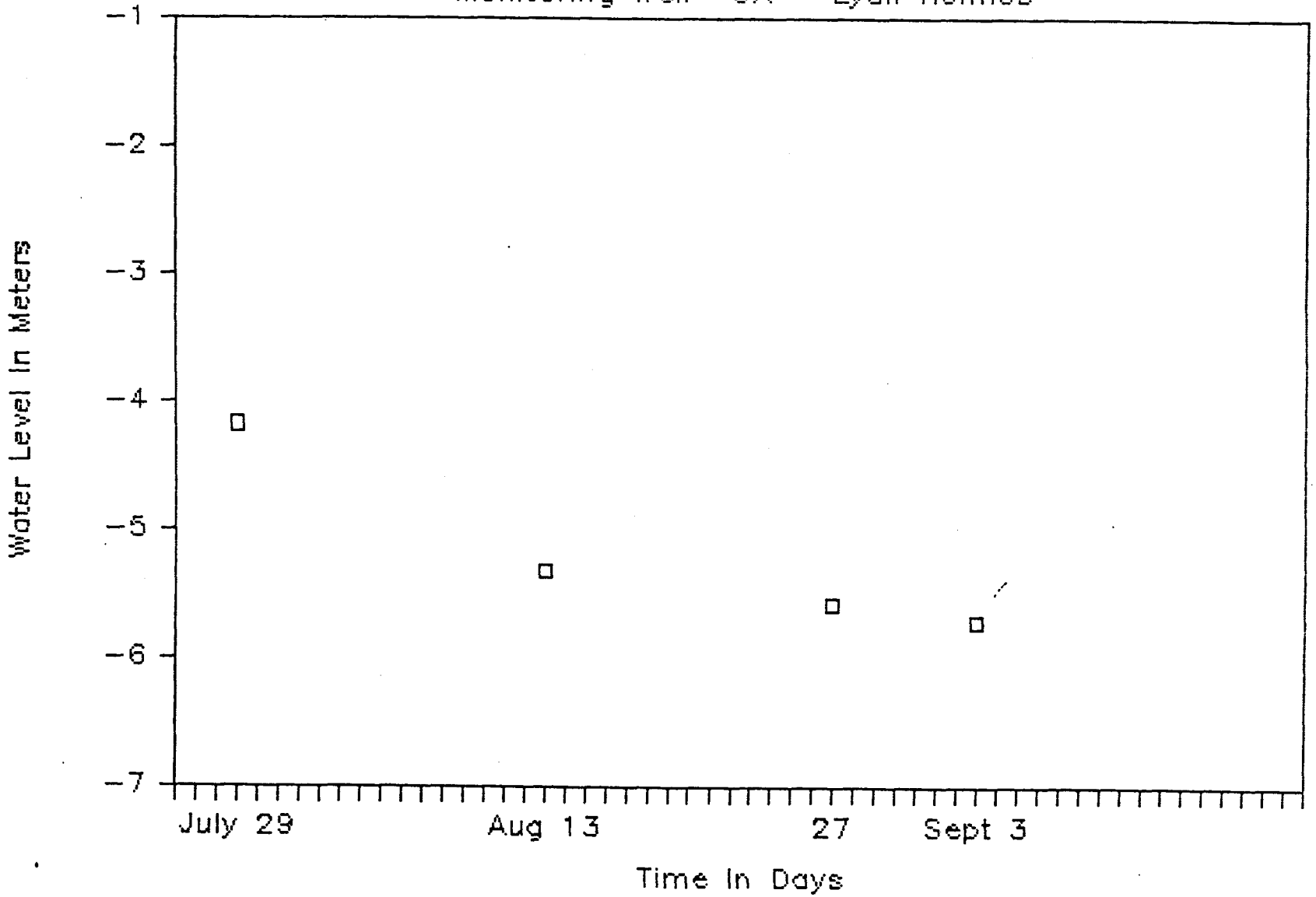

Winchester — PW—6 — Pumping Test
Monitoring Well— 7 — G. Carkner
Water Level In Meters
-3
-4
-5
-6
-7
-8
July 29
Aug 13
27
Sept 3
Time In Days

Winchester — PW—6 — Pumping Test



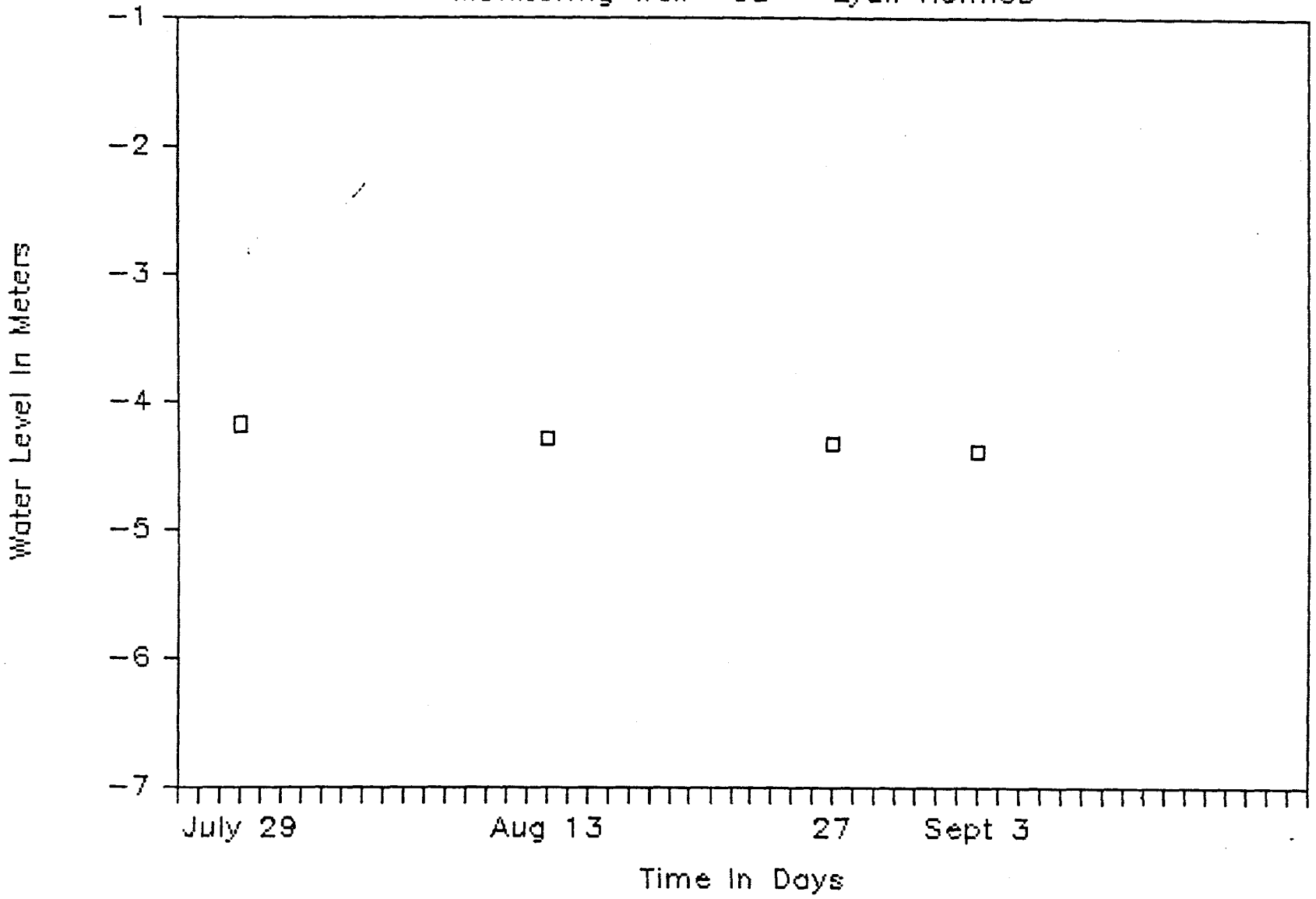
Winchester — PW—6 — Pumping Test

Monitoring Well— 9A — Lyall Holmes



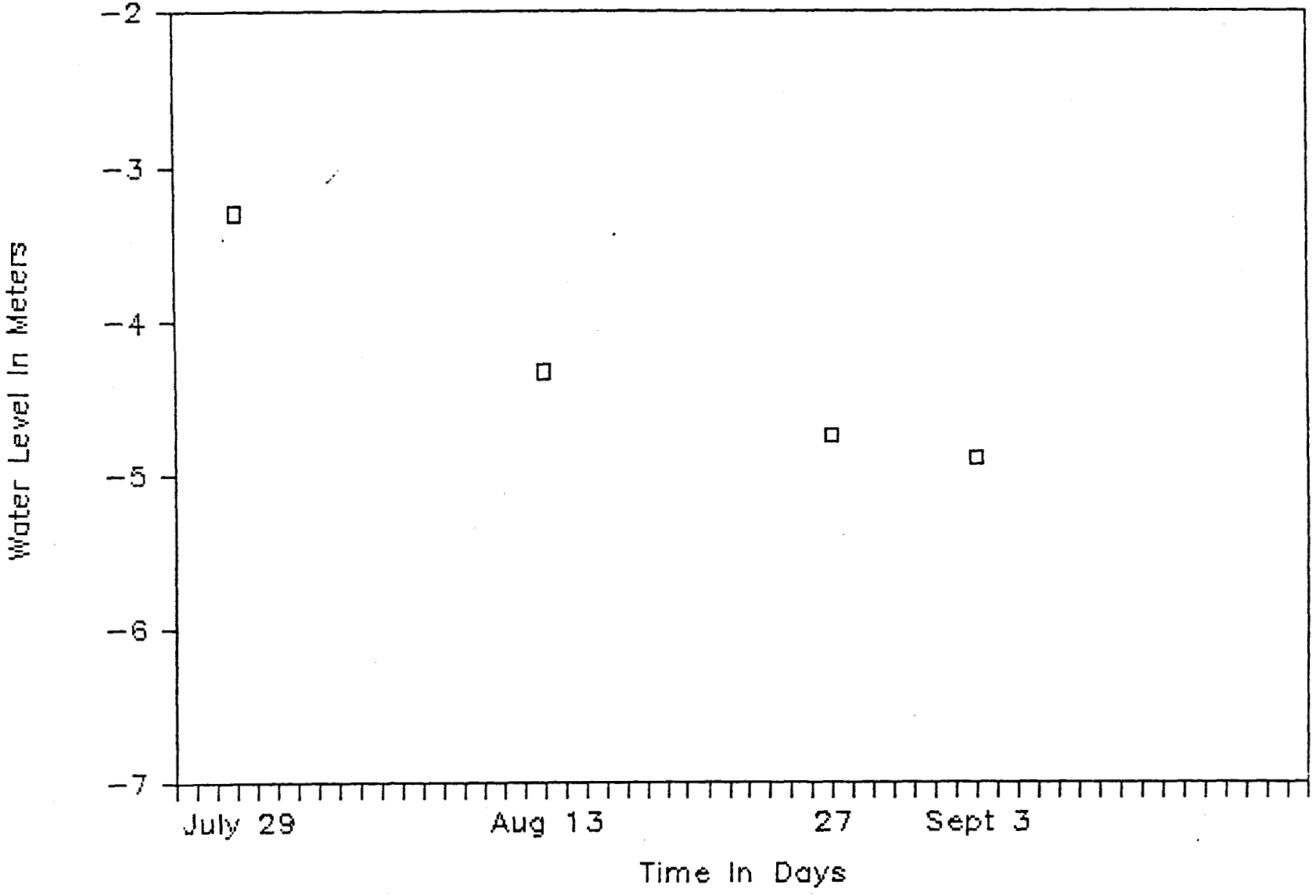
Winchester — PW—6 — Pumping Test

Monitoring Well— 9B — Lyall Holmes



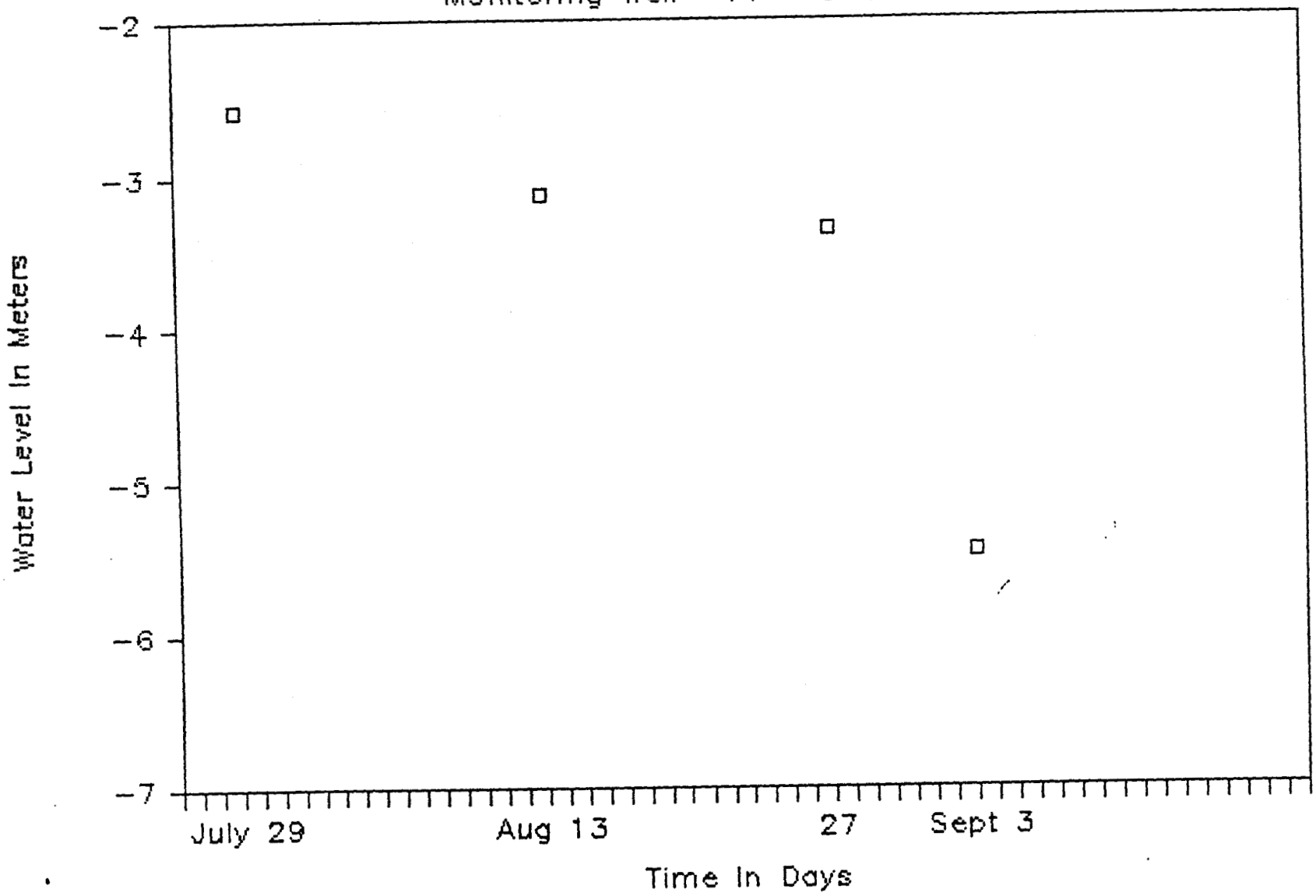
Winchester — PW—6 — Pumping Test

Monitoring Well— 10 — L. Levere



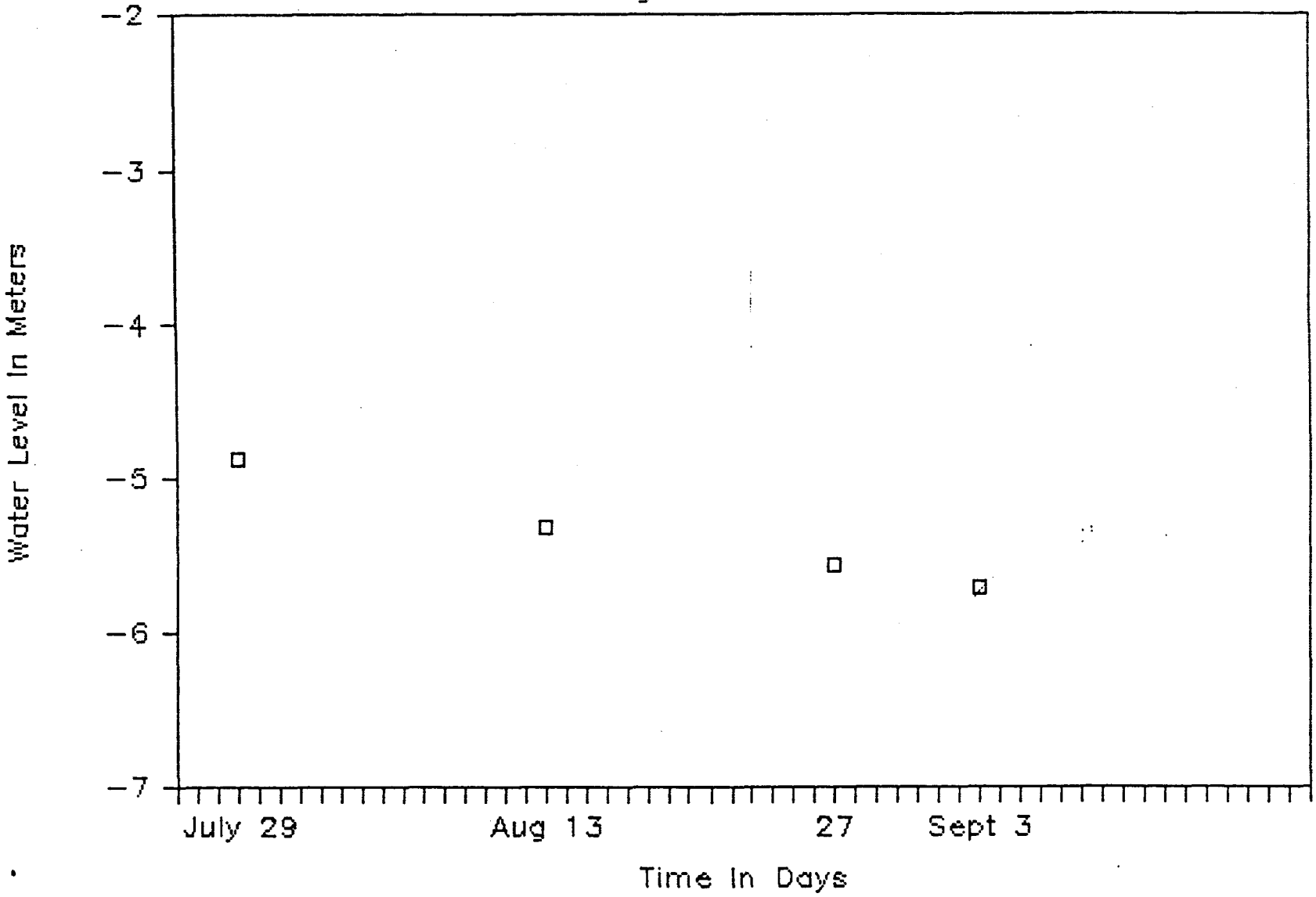
Winchester — PW—6 — Pumping Test

Monitoring Well— 11 — J. La France



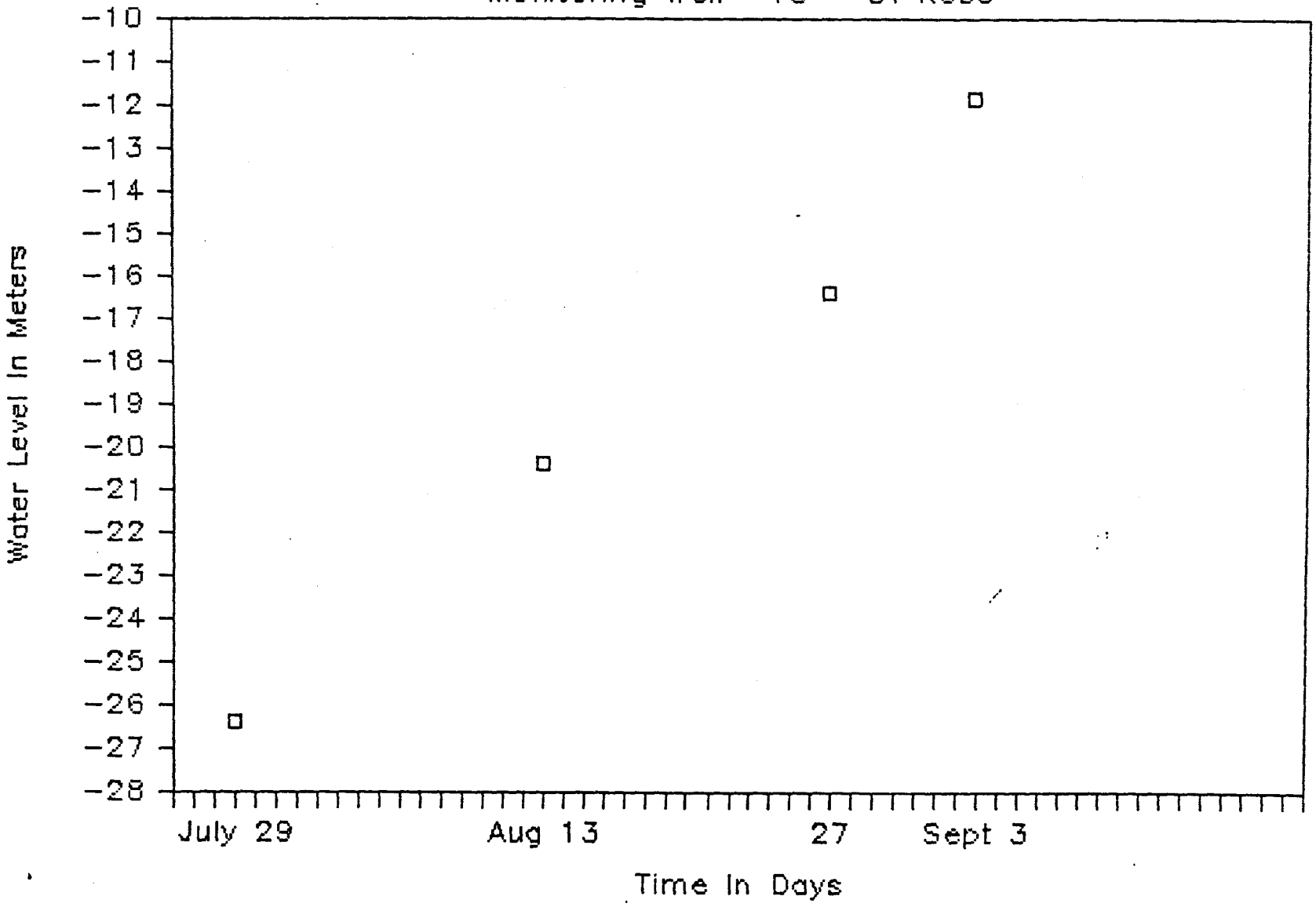
Winchester — PW—6 — Pumping Test

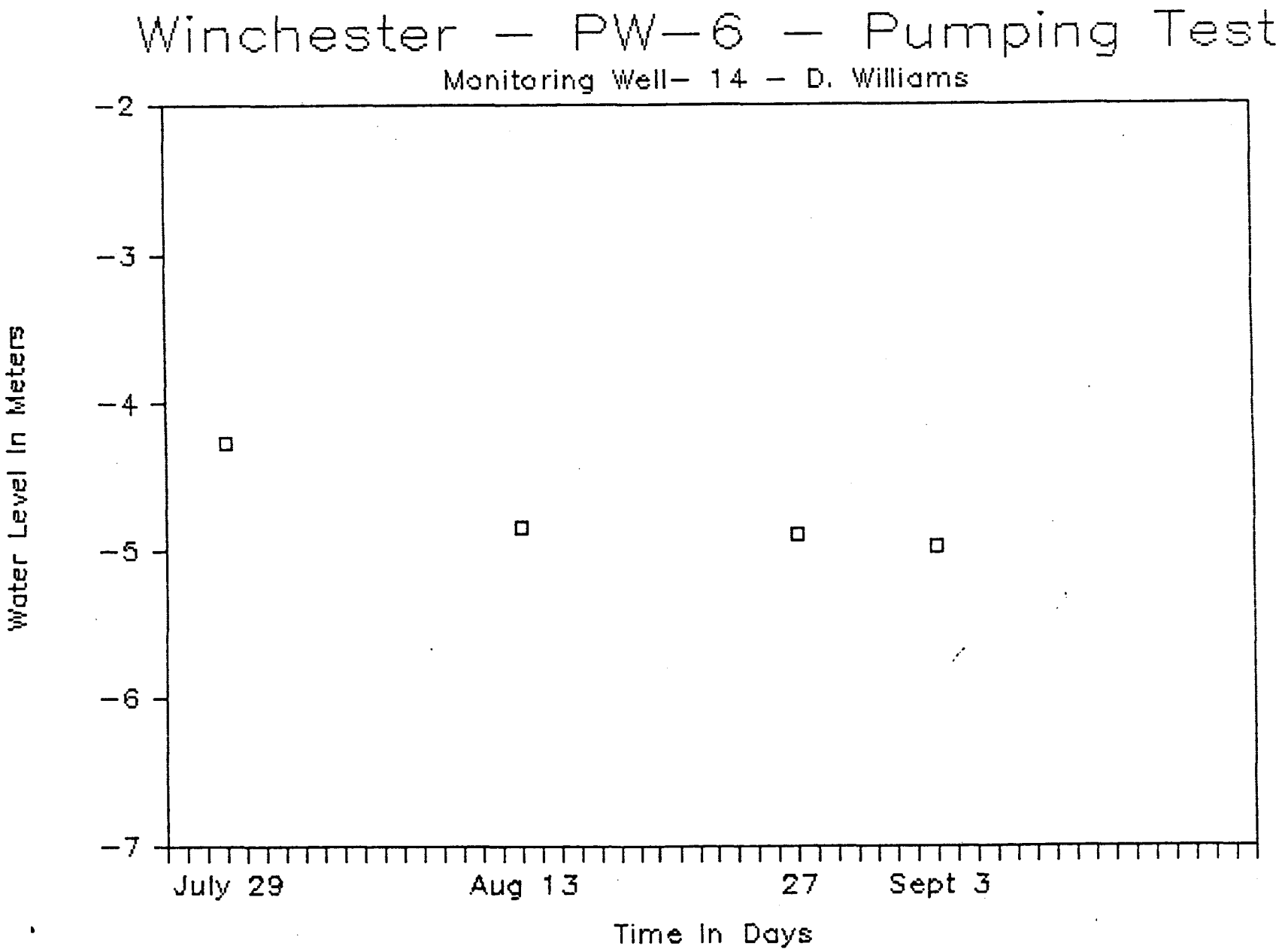
Monitoring Well— 12 — K. Last



Winchester — PW—6 — Pumping Test

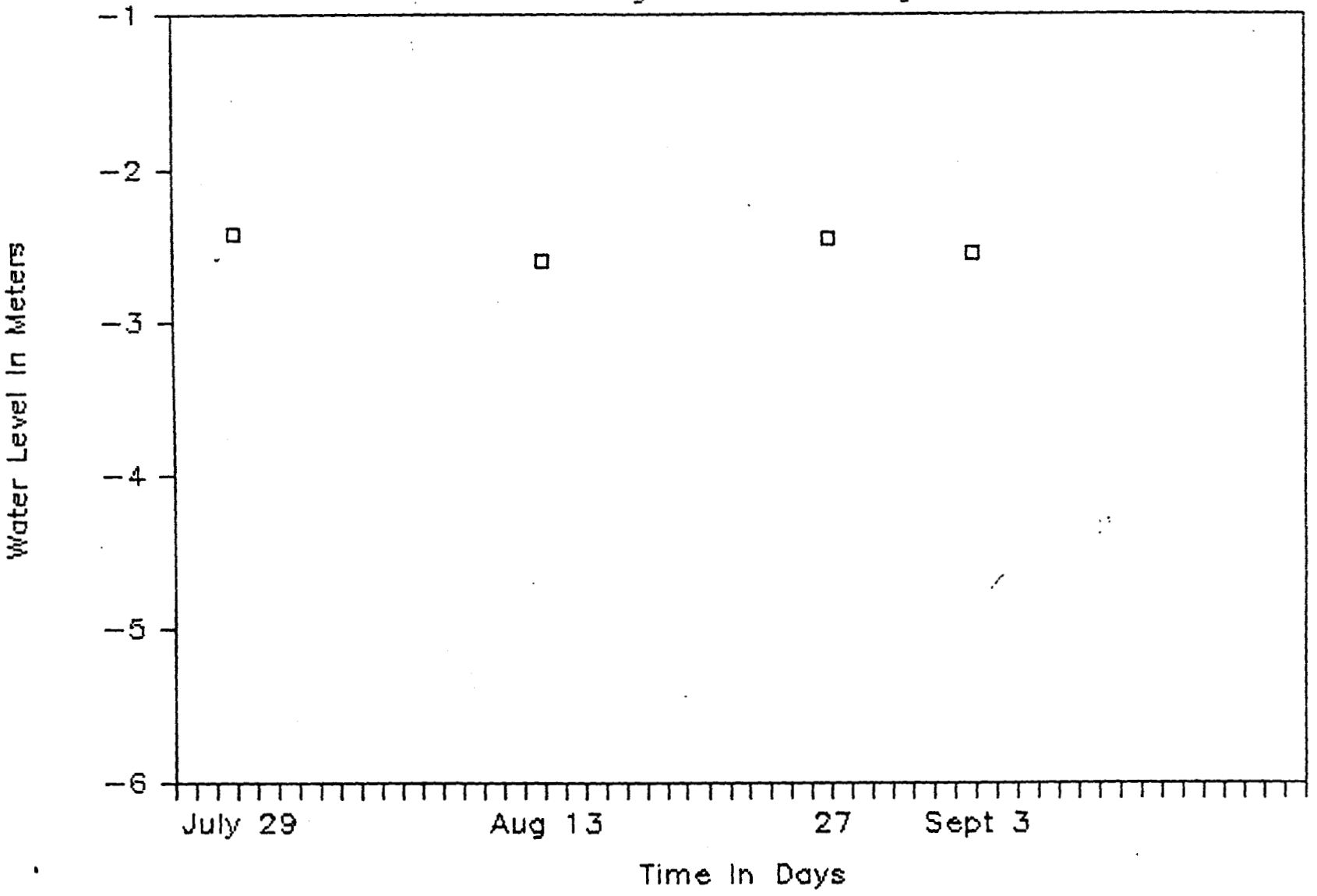
Monitoring Well— 13 — D. Rose



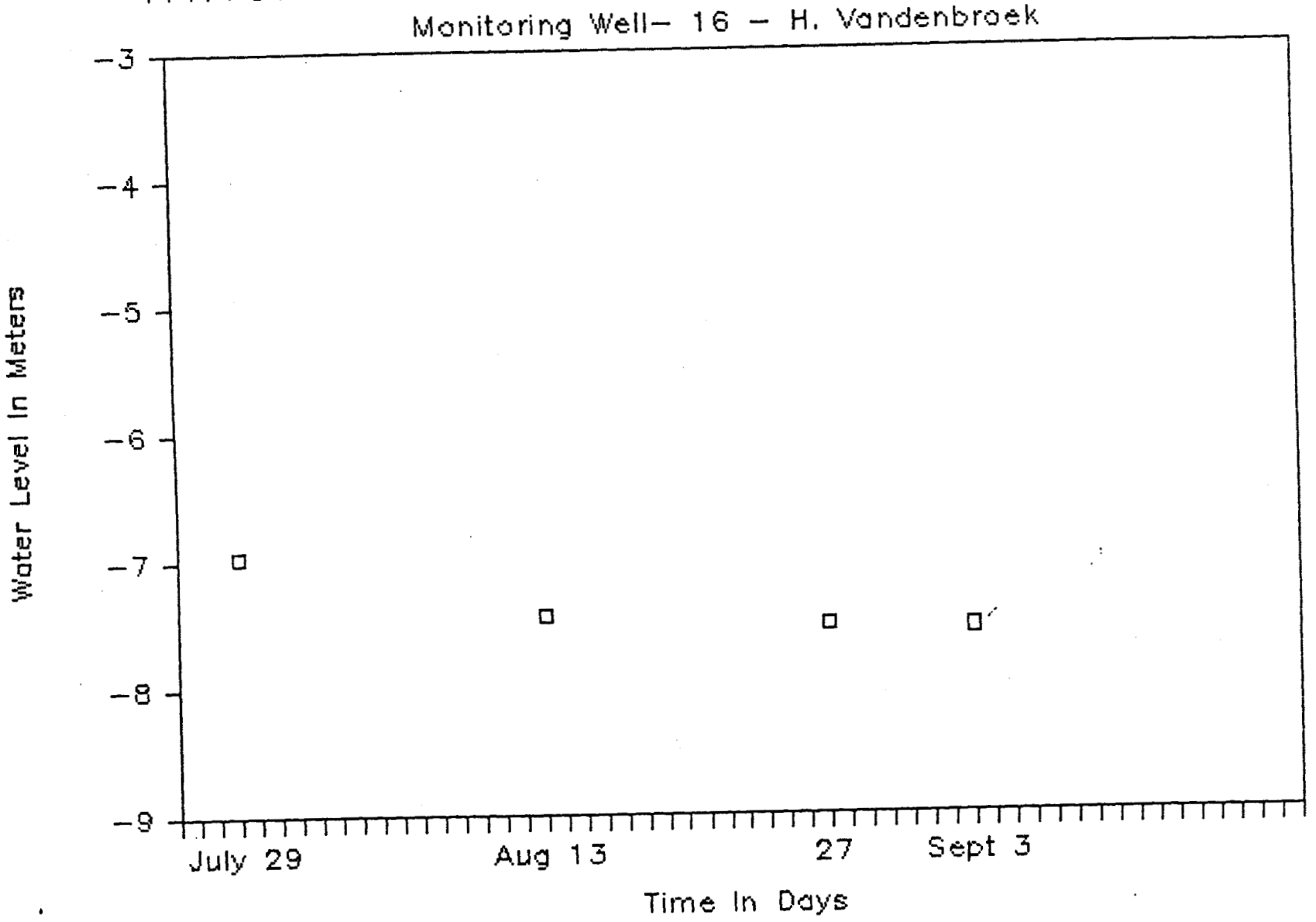

Winchester — PW—6 — Pumping Test
Monitoring Well— 14 — D. Williams
Water Level In Meters
-2
-3
-4
-5
-6
-7
July 29
Aug 13
27
Sept 3
Time In Days

Winchester — PW—6 — Pumping Test

Monitoring Well— 15 — Big "O"



Winchester — PW—6 — Pumping Test



Winchester — PW—6 — Pumping Test

Monitoring Well— 17 — A. McKinley

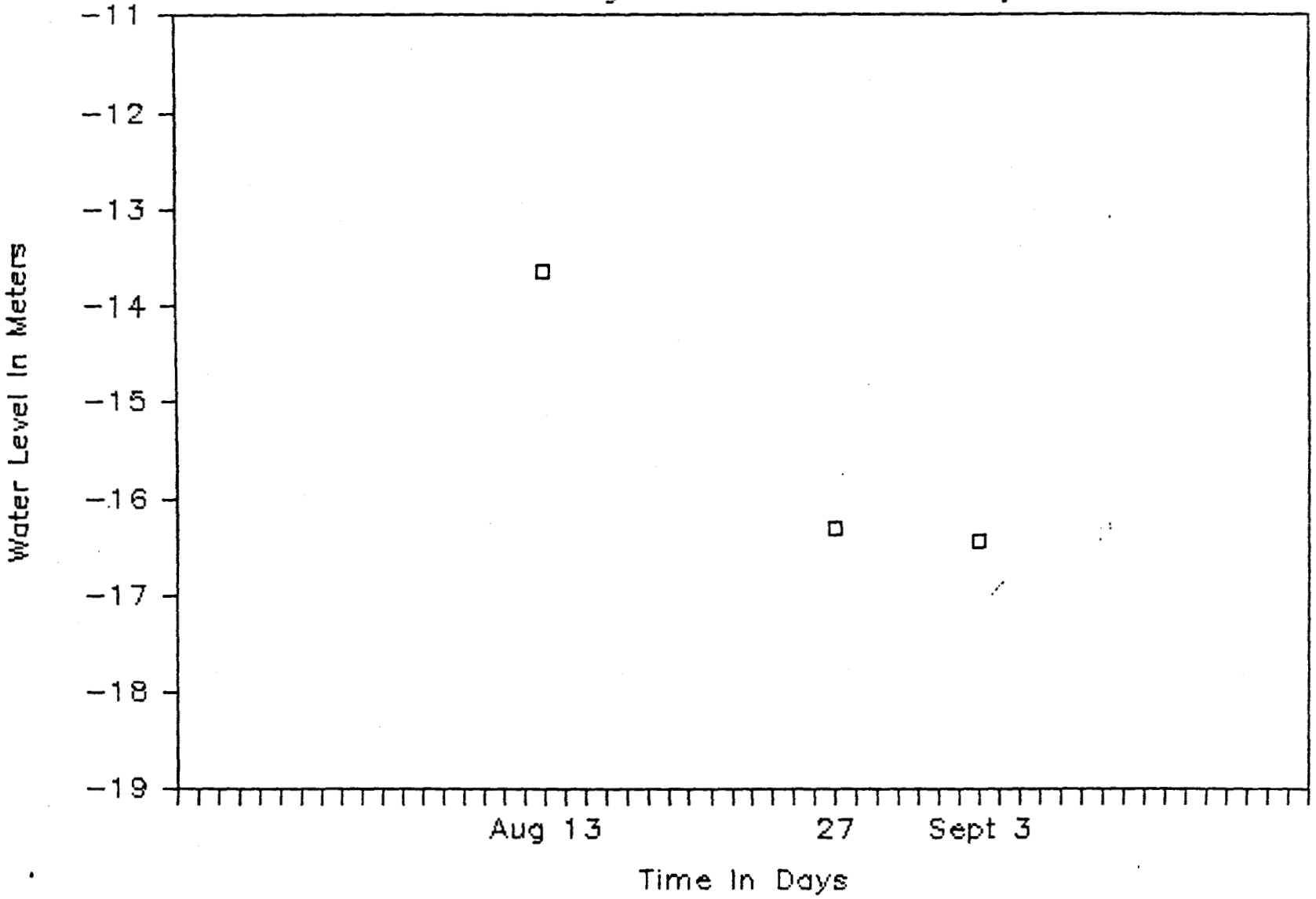


TABLE 1

WATER LEVEL MEASUREMENTS
JULY 29, 1985 - SEPTEMBER 16, 1985
WINCHESTER-PW-6-PUMPING TEST

WELLS	NO.	JULY 29	AUG. 13	AUG. 27	SEPT. 3	SEPT. 6	SEPT. 11	SEPT. 16	DUG	DRILLED	REMARKS
PW6 - Winchester	PW6	4.44 6.96	9.18	10.11	10.75	10.79	11.08	9.59		X	July 29 to Sept. 11/85 - 9.5 to 10.1 lps from Sept. 11 onward pumped at 6.1 lps
Test Well No. 1	TW1	3.10	3.41	3.79	3.92	3.95	4.00	4.03		X	Water level recorder
Test Well No. 3	TW3	3.85	4.36	4.70	4.79	4.84	4.91	4.94		X	Water level recorder
H. Holmes	1A	4.73	7.39	8.15	8.42	8.48	8.74	7.77		X	Barn - very little used during test
H. Holmes	1B	-	7.62	8.43	8.81	-	9.16	7.95		X	House not accessible July 29/85
J. Spruit	2A	12.72	12.83	11.54	12.73	11.77	12.00	11.41		X	Rented house - not used between Sept. 6 and Sept. 16/85
J. Spruit	2B	5.81	7.69	7.90	9.00	-	-	-		X	House and barn used heavily
J. Spruit	2C	5.36	5.23	6.61	6.83	-	-	-		X	Unused
C. Howse	3A	8.85	10.19	8.36	8.37	-	8.47	-		X	House & barn used heavily
C. Howse	3B	5.48	6.26	5.45	5.71	-	5.99	-		X	Unused
Lester Holmes	4A	5.65	6.90	6.83	7.00	-	-	-		X	House
Lester Holmes	4B	5.15	6.20	6.24	6.36	-	-	-		X	Unused
J. Spierenburg	5	5.60	6.75	7.26	7.47	-	7.68	7.80			In use after July 29/85
J. Van Grunsen	6A	5.17	7.29	5.95	6.00	-	-	-		X	Used
J. Van Grunsen	6B	3.00	3.61	4.12	4.23	-	-	-	X		Not in use
G. Carkner	7	6.27	6.22	6.88	6.36	-	-	-		X	In use
E. Jennings	8	6.57	6.08	5.19	5.43	-	-	-	X		Dug - in use
Lyall Holmes	9A	4.17	5.32	5.58	5.75	-	-	-		X	House & barn being used
Lyall Holmes	9B	4.17	4.28	4.32	4.38	-	-	-	X		Not being used
L. Levere	10	3.30	4.33	4.75	4.89	-	-	-		X	House & Auto Shop
J. La France	11	2.57	3.13	3.36	5.47	-	-	-	X		House
K. Last	12	4.87	5.32	5.56	5.71	-	-	-		X	House & farm -average pumping
D. Rose	13	26.35	20.35	16.34	11.82	-	-	-		X	Farm - heavy use
D. Williams	14	4.27	4.84	4.89	4.97	-	-	-		X	Farm
Big "O"	15	2.42	2.60	2.45	2.56	-	-	-		X	Drainage Co. - not much use
H. Vandenbroek	16	6.96	7.43	7.51	7.54	-	-	-		X	Farm
A. McKinley	17	-	13.65	16.30	16.43	-	-	-		X	House

TABLE 2

WATER WELL QUALITY

WINCHESTER PW-6 PUMPING TEST

NAME	COND.	BOD_5	COD	HARD-NESS	ALKA.	IRON	TURB.	COLOR	CHLO-RIDE	SULPHATE	NH_3	NITRITE	NIT-RATE	Ca	Mg	Na	K	pH
PW6																		
Jul. 29/85	680	< 0.2	10	365	276	0.08	0.7	5	15	85	0.03	< 0.002	< 0.02	62	51	7.1	4.1	7.7
Aug. 13/85	690	< 2.0	10	325	278	0.20	0.5	5	23	90	0.06	< 0.002	0.02	65	40	8	4	7.2
Aug. 27/85	700	< 0.2	< 10	360	273	0.20	0.55	7	23	90	< 0.01	< 0.002	< 0.002	77	41	9.5	4.4	7.9
H. Holmes 1A																		
Jul. 29/85	690	3.4	< 10	300	263	1.45	9.3	48	20	90	0.20	0.008	0.01	55	39	11	12	7.9
Aug. 13/85	700	1.2	10	315	259	1.2	0.9	26	20	110	0.40	0.024	0.36	59	41	12	7	7.3
Aug. 27/85	600	3.4	16	290	209	7	28	46	15	95	0.5	0.29	1.7	61	34	9.7	8.5	7.7
Lester Holmes 4A																		
Jul. 29/85	990	< 0.2	10	445	345	0.04	0.3	0.4	63	50	0.01	0.052	15.8	100	47	25	14	7.5
Aug. 13/85	780	< 0.2	< 10	360	299	0.05	0.2	0.4	38	55	< 0.01	< 0.002	8.6	81	39	13	7	7.6
Aug. 27/85	730	< 0.2	< 10	375	283	< 0.05	0.6	4	34	55	< 0.01	< 0.002	4.4	87	38	9.2	6.5	8.0
C. Howse 3A																		
Jul. 29/85	740	< 0.2	14	325	282	< 0.01	0.3	5	28	80	0.01	0.002	0.26	72	35	34	16	7.7
Aug. 13/85	720	< 0.2	14	330	287	0.05	0.4	4	28	75	0.01	< 0.002	0.10	73	37	12	16	7.5
Aug. 27/85	700	< 0.2	12	345	262	< 0.05	0.3	1	28	70	0.01	0.006	0.11	82	34	11	16	7.6
H. Levere 10																		
Jul. 29/85	1750	0.2	24	375	341	3.6	34	13	323	105	0.46	0.002	0.02	43	66	128	16	7.9
Aug. 13/85	1600	0.4	28	325	300	1	8	34	295	110	0.39	< 0.002	< 0.02	31	61	189	14	7.6
Aug. 27/85	1600	0.8	10	360	300	0.25	37	76	303	110	0.39	0.002	< 0.02	49	58	180	14	7.7
J. Spruit 2B																		
Jul. 29/85	1310	< 0.2	< 10	3	473	0.95	1.8	9	80	100	0.30	0.016	0.44	< 0.1	0.7	217	12	7.6
Aug. 13/85	1300	< 0.2	22	< 1	492	0.25	1.5	10	63	110	0.15	0.012	0.49	< 0.1	< 0.1	313	10	7.2
Aug. 27/85	1160	< 0.2	12	515	444	0.20	1.5	5	80	95	1.4	0.008	0.07	104	62	22	50	7.4
Lyall Holmes 9A																		
Jul. 29/85	1120	< 0.2	< 10	555	434	< 0.01	0.4	5	45	90	< 0.01	< 0.002	14	124	60	61	23	7.7
Aug. 13/85	1100	< 0.2	12	540	426	0.10	0.6	5	45	90	< 0.01	< 0.002	13	110	64	21	23	7.3
Aug. 27/85	1000	< 0.2	< 10	525	366	< 0.05	0.6	3	50	115	0.02	0.008	0.71	99	67	19	14	7.5
J. La France 11																		
Jul. 29/85	1260	0.4	28	33	302	< 0.01	0.3	3	155	100	0.01	0.004	0.70	9.6	2.2	277	1.3	7.7
Aug. 13/85	1100	< 0.2	10	4	308	< 0.05	0.2	7	110	100	< 0.01	0.008	0.69	< 0.1	1	246	1.1	7.5
K. Last 12																		
July 29/85	840	0.4	22	395	307	< 0.01	0.2	5	35	90	0.10	0.036	2.8	92	41	13	12	7.7
Aug. 13/85	860	0.2	10	345	323	< 0.05	0.2	7	38	80	0.18	0.042	4.8	70	42	13	17	7.3
Aug. 27/85	770	< 0.02	14	365	285	0.05	0.20	3	31	90	0.03	0.018	1.2	87	36	13	8.8	7.6

NAME	COND.	BOD_5	COD	HARD-NESS	ALKA.	IRON	TURB.	COLOR	CHLO-RIDE	SULPHATE	NH_3	NITRITE	NIT-RATE	Ca	Mg	Na	K	pH
D. Rose 23																		
Jul. 29/85	770	0.2	< 10	280	280	0.14	0.5	7	52	60	0.02	0.002	0.34	49	39	42	17	7.8
Aug. 13/85	760	< 0.2	< 10	245	285	0.15	0.3	7	53	60	0.22	0.004	0.14	34	39	37	17	7.7
Aug. 27/85	760	< 0.2	< 10	285	279	0.15	0.45	3	48	60	0.29	0.004	< 0.02	52	38	45	17	7.7
D. Williams 14																		
Jul. 29/85	580	0.8	< 10	260	266	0.25	1.2	9	10	45	0.34	0.008	0.01	56	30	18	11	7.8
Aug. 13/85	580	0.6	< 10	235	234	0.05	0.6	7.0	10	45	0.31	0.004	0.02	41	32	17	10	7.7
Aug. 27/85	600	< 0.02	12	285	272	0.10	0.65	3.0	12	45	0.27	0.006	< 0.02	59	33	19	10	7.8
Big "O" 15																		
Jul. 29/85	1040	0.4	58	565	502	< 0.01 Must have contained iron	210	- interference	35	55	1.0	< 0.002	< 0.5	145	50	13	5.5	7.2
Aug. 13/85	1040	0.6	82	575	504	20	210	>100	38	55	0.7	< 0.02	< 0.02	143	54	13	6	6.9
Aug. 27/85	1070	0.3	82	580	520	24	240	>100	36	60	0.7	0.01	< 0.01	146	53	14	6.1	7.2
G. Carkner 7																		
Jul. 29/85	550	< 0.2	< 10	285	256	1.92	0.3	4	9	45	0.01	< 0.002	0.38	72	26	3.2	0.7	8.0
Aug. 13/85	540	< 0.2	< 10	290	255	0.10	0.3	7	9	45	< 0.01	< 0.002	0.38	69	28	3	2	7.7
Aug. 27/85	560	< 0.2	< 10	305	255	< 0.05	3.5	4	9	45	< 0.01	< 0.002	0.44	76	28	-	-	8.2
J. Van Grunsen 6A																		
Jul. 29/85	1490	< 0.2	< 10	705	511	1.02	22	54	118	130	4.3	0.004	< 0.02	134	90	24	45	7.5
Aug. 27/85	1330	0.2	16	610	448	4	60	89	120	125	2.2	0.008	< 0.02	117	77	22	24	7.7
H. Vandenbroek 16																		
Jul. 29/85	920	< 0.2	< 10	465	357	< 0.04	0.3	2	35	80	< 0.02	0.04	6.5	89	53	8.8	15	7.6
Aug. 13/85	920	< 0.02	< 10	480	366	< 0.05	0.2	7	38	80	< 0.01	0.044	7.2	105	54	8	17	7.0
Aug. 27/85	920	< 0.2	< 10	480	363	0.05	0.81	4	39	85	< 0.01	0.32	5.57	107	52	8.3	15	7.6
J. Spierenburg 5																		
Aug. 27/85	560	< 0.2	< 10	225	239	0.10	1	4	6	-	0.27	< 0.002	< 0.02	34	33	-	11	8.0
A. McKinley 17																		
Aug. 27/85	770	< 0.2	< 10	415	293	< 0.05	0.25	4	13	115	< 0.01	< 0.002	0.06	77	54	6.4	4.5	7.8
E. Jennings 8																		
July 29/85	760	< 0.2	< 10	395	311	< 0.01	0.3	7	19	100	< 0.01	< 0.002	0.38	71	53	?	2.0	7.9
Aug. 13/85	730	0.2	12	370	316	< 0.05	0.3	7	18	95	< 0.01	< 0.002	0.38	64	51	7.0	2.0	7.4
Aug. 27/85	760	< 0.2	< 10	410	311	< 0.05	0.25	3	21	95	< 0.01	< 0.002	0.34	78	53	6.9	2.3	7.6

CONDUCTIVITY IN UHMOS/CM
TURBIDITY IN FORMAZIN TURBIDITY UNITS
COLOR IN TRUE COLOR UNITS
pH IS NEGATIVE LOGARITHM OF THE HYDROGEN ION ACTIVITY
REMAINDER IN MG/L

TABLE 3

MONTHLY PRECIPITATION DATA FOR

THE RUSSELL STATION (mm)

YEAR	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL
1985	68.0	78.6	76.4	51.8	61.6	77.0	62.8	60.5					
1984	40.4	73.9	41.6	114.2	101.2	30.2	68.7	143.4	22.0	42.4	71.6	85.8	835.4
1983	76.6	59.0	69.6	96.2	117.5	62.2	77.1	60.2	52.8	139.2	116.2	143.0	1069.6
1982	79.4	30.0	105.0	50.2	32.4	98.4	120.6	114.8	84.0	44.6	93.8	96.6	949.8
1981	39.0	112.9	29.6	66.6	103.6	192.3	48.7	181.2	193.4	105.2	68.0	41.2	1181.7

TABLE 3A

MONTHLY PRECIPITATION DATA FOR

RUSSELL STATION (mm)

YEAR	APRIL	MAY	JUNE	JULY	AUGUST
1985	51.8	61.6	77.0	62.8	60.5
AVERAGE 1981-1984	81.8	88.6	95.8	78.8	124.9

APPENDIX D

LONG TERM PUMPING TEST

APPENDIX E

WATER QUALITY

MORRISON BEATTY LIMITED PROJECT NO. 325-841 VILLAGE OF WINCHESTER

WATER QUALITY - MUNICIPAL WELL PW 6

Parameters	Mar. 19/85 t = 0 hours	t = 1 hour	Mar. 22/85 t = 8 hours	t = 56 hours	t = 72 hours
Conductivity (umho/cm)	660	630	650	660	660
pH	8	8.1	8.3	7.8	7.4
Hardness (CaCO3)	345	334	349	346	349
Calcium	67	66	67	72	73
Magnesium	43	41	44	40	41
Sodium	3.7	3.4	3.9	5	5.2
Potassium	3.7	4.1	4.4	4.5	4.6
Alkalinity (CaCO3)	274	269	275	281	278
Chloride	13	11	12	13	13
Sulfate	75	73	73	72	74
Iron	.15	.1	.1	.1	.2
Ammonia (N)	.07	.1	.1	.11	.1
Nitrate (N)	<.02	<.02	<.02	<.02	<.02
Nitrite (N)	<.002	<.002	<.002	.002	<.002
COD	38	.1	<10	<10	<10
BOD5	<0.1	<0.1	<0.1	<0.1	<0.1
Indicator Bacteria					
Total Coliforms	0				
Background	0				