



INLAND WATERS BRANCH

DEPARTMENT OF THE ENVIRONMENT

*Observed Changes in Groundwater Regime Caused by  
the Creation of Lake Diefenbaker, Saskatchewan*

R.O. VAN EVERDINGEN

TECHNICAL BULLETIN NO. 59



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OTTAWA, CANADA, 1972

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## *Acknowledgments*

Members of the Test Installations Section, P.F.R.A. Construction Headquarters at Cutbank, Saskatchewan, made piezometer readings during the winter seasons. Their valuable assistance is gratefully acknowledged. W.M. Gillis, formerly of Outlook, and Frank Kuzma and Lance Macfymyc, both of Saskatoon, braved the muddy depths of Lake Diefenbaker to install, service and retrieve pressure transducers used on submerged piezometers. They made it possible to collect further data during 1965, 1966 and 1967 from piezometer group 6, which would otherwise have been abandoned when flooded in April 1965.

Thanks are due also to Mr. George Bishop of Lucky Lake, and Mr. Norris Rudd of Riverhurst, for their permission to install piezometer groups 3 and 8 on their lands. In September 1965 piezometer groups 4 and 5 were found to be partly in the way of the realignment of Highway 42. They were saved, and protected during highway construction, through the cooperative efforts of Mr. M.P. Kocur, District Engineer, and Mr. Keith Glennie, Construction Engineer, both of the Swift Current District, Saskatchewan Department of Highways.

## *Abstract*

Measurements between 1964 and 1971 of piezometric levels in 35 piezometers installed in 9 groups in a multiple aquifer system and in unconsolidated sediments in a section across the valley of the South Saskatchewan River near Riverhurst, Saskatchewan, have revealed increased piezometric pressures as a result of the creation of Lake Diefenbaker. The increases in pressure, which vary with the water level in the reservoir, reflect a hydraulic connection between the aquifers and the reservoir, and not a classical loading effect. The stability of the area immediately downstream from the dam may have been adversely affected by these pressure increases. Groundwater discharge rates have been reduced significantly, and some loss of water from the reservoir appears to take place.

## *Résumé*

Changements observés dans le régime des eaux souterraines par suite de la création du Lac Diefenbaker, Saskatchewan

Entre 1964 et 1971, des mesures de niveau d'eau ont été effectuées dans 35 piézomètres installés en 9 groupes, dans un système d'aquifères multiples ainsi que dans des aquifères de sédiments non consolidés. Ces piézomètres ont été installés selon une section transversale à la vallée de la Rivière Saskatchewan Sud, près de Riverhurst. Les mesures ont révélé un accroissement des pressions piézométriques par suite de la création du Lac Diefenbaker. Les accroissements de pression variant avec la variation du niveau de l'eau dans le réservoir, reflètent bien l'existence d'une relation hydraulique entre les aquifères et le réservoir et non pas l'effet classique de pression, dû au poids. La stabilité de la région située juste en aval du barrage peut de ce fait avoir été malencontreusement affectée. Les taux de décharge des eaux souterraines ont été réduits d'une manière significative et quelques pertes des eaux du réservoir semblent aussi avoir pris place.

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## INTRODUCTION

The Gardiner Dam on the South Saskatchewan River between Elbow and Outlook (Fig. 1) has impounded a multipurpose reservoir with a maximum water depth of 187 ft (57 m), and a total length of about 140 miles (225 km). This reservoir is called Lake Diefenbaker. A second, smaller dam controls flow from the reservoir into the Qu'Appelle River system. Construction of the main dam was started in the fall of 1958; diversion tunnels were completed early in 1964, and closure of the river channel was effected on February 14, 1964. Impoundment started immediately after closure, raising the water level behind the dam from 1640 ft (499.9 m) asl (above sea level) to about 1667 ft (508.1 m) asl by the fall of 1964. The full supply level of 1827 ft (556.9 m) asl was first approached in 1969, when a maximum level of 1825.9 ft (556.5 m) asl was reached.

To investigate the influence of this growing body of surface water on groundwater conditions in bedrock underlying the unconsolidated glacial deposits in the reservoir area, a number of piezometers were installed between November 1962 and July 1966 in a series of groups on either side of the reservoir near Riverhurst, Saskatchewan (Figs. 1 and 2). The locations were selected mainly on the basis of ease of access (Highway 42, with a ferry at Riverhurst), the fact that they were far enough from both damsites to avoid loading effects resulting from dam construction, and the anticipated rise in water level (135 ft or 41.15 m) which was deemed high enough to produce measurable effects on piezometric levels, whether by loading or hydraulic connection.

The purpose of the present report is to present the results of piezometric observations for the period between January 1965 and January 1971. A brief outline of the local stratigraphy is followed by a description of the piezometer installations, and of the characteristics of the bedrock aquifers. The original, pre-impoundment groundwater flow is presented for comparison with the flow system during a near-full supply situation. Observed changes in piezometric levels are further compared with earlier predictions based on an analog-model study, and on observations made during 1965 and 1966.

## STRATIGRAPHY AND STRUCTURE

The stratigraphy of both glacial deposits and bedrock, as encountered during drilling in the Riverhurst area, is summarized in Table I, and illustrated by the cross-sections of Figure 3. Detailed descriptions of the

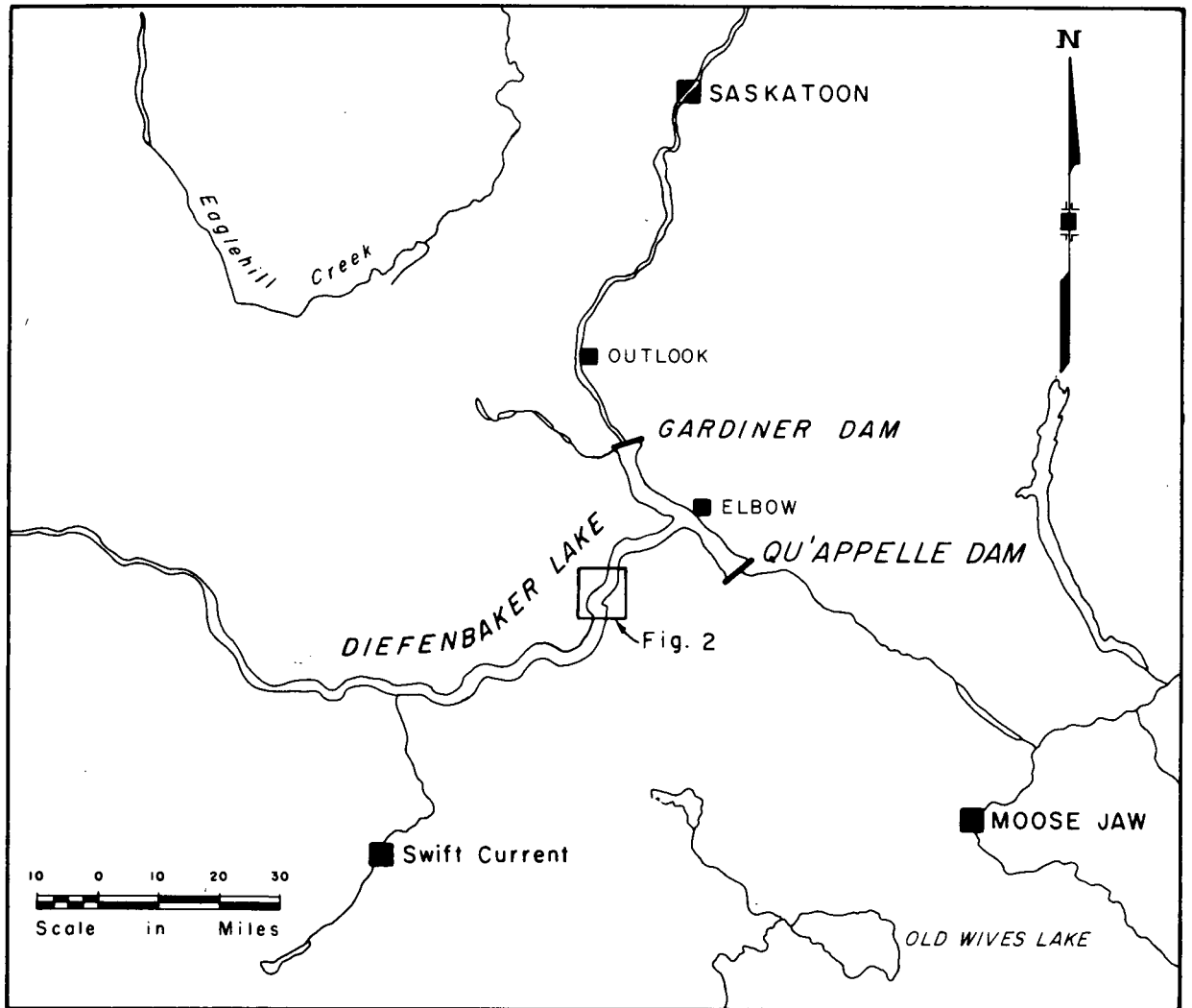


Figure 1. Location map of Lake Diefenbaker and the Riverhurst area, Saskatchewan.



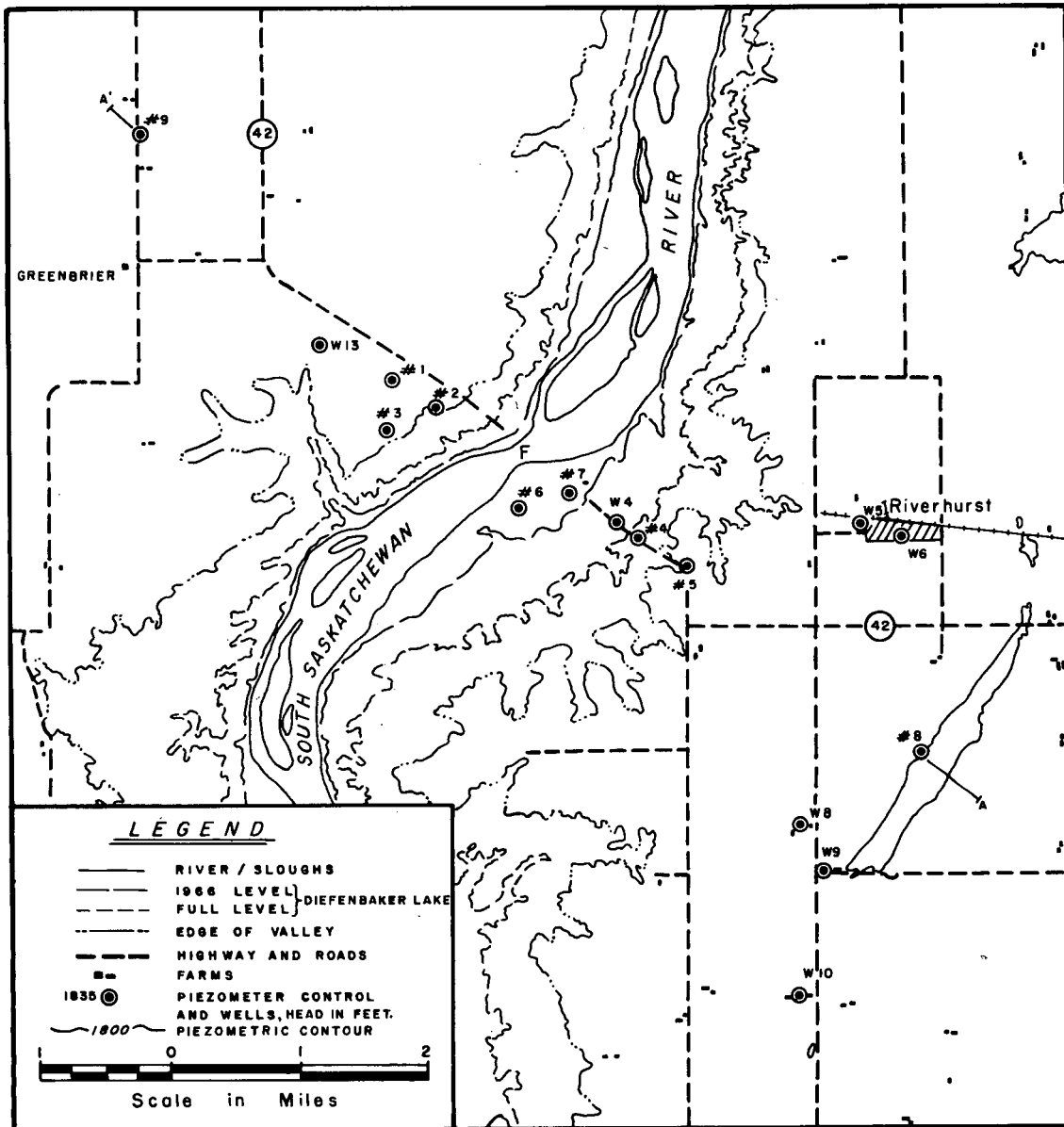


Figure 2. Location of piezometers, wells and springs in the Riverhurst area.

TABLE I

## General Stratigraphy and Lithology of the Riverhurst Area

Formation and Material	Thickness, in Feet
<u>Drift</u>	
Sand	up to 12
Till, brown and blue, sandy in places	up to 330
Inter-till gravels	up to 78
<u>Bedrock</u>	
<u>Upper Cretaceous Bearpaw Formation</u>	
Aquadell member, shale	at least 37
Cruikshank member <sup>1</sup> , sand	7
sandy shale	17
sand	17
Snakebite member, shale	up to 269
Ardkenneth member, sand and sandy shale	99 - 110
Beechy member, shale	55 - 71
Demaine member, sand and sandy shale	18 - 46
Sherrard member, shale	72 - 86
Matador member, sand and silty sand	14 - 21
Broderick member, shale	104 - 117
Outlook member, sandstone with shale layers	at least 82

(after van Everdingen, 1967 and Caldwell, 1968)

<sup>1</sup> Aquadell and Cruikshank members encountered only in location 9.

stratigraphy of the reservoir area were given earlier by Caldwell (1968) and van Everdingen (1968). The aquifers designated as the Demaine and Outlook Members were called Beechy (sand unit 4) and Belly River in earlier publications by van Everdingen (1966, 1967, 1968).

The members of the Bearpaw Formation occupy the core of the plunging Moose Jaw syncline (related to the Williston Basin), the axis of which crosses the river valley in the vicinity of Riverhurst (Caldwell, 1968). Upstream from Riverhurst, the beds dip in a downstream direction, while between Riverhurst and Elbow they dip upstream. A local syncline, the axis of which traverses the river valley near the Gardiner Dam, complicates the picture downstream from Elbow.

As a result of these structural features, the main sand members of the Bearpaw Formation (Cruikshank, Ardkenneth, Demaine and Outlook) are below river level over much of the lower half of the reservoir's reach (Caldwell, 1968). The Cruikshank Member is above the full supply level of the reservoir, its lowest points being near the synclinal axes near Riverhurst and at the Gardiner Dam. The Ardkenneth Member crops out (or subcrops below the glacial and alluvial deposits, about 55 miles (88 km) above the dam, as well as a short distance below the damsite. The Demaine Member rises above the river level about 70 miles (112 km) upstream from the dam (near Swift Current Creek), and also between Gardiner Dam and Outlook. The Outlook Member crops out near Outlook; upstream from the dam it grades into sands of the Oldman Formation, which rise above river level near Saskatchewan Landing, about 90 miles (145 km) above the dam.

The Moose Jaw syncline is regarded as being probably of tectonic origin, but smaller structural depressions, like the syncline in the damsite area, might well be related to collapse of post-Devonian sediments which resulted from solution of salt from the Devonian Prairie Evaporite Formation (Holter, 1969). Christiansen (1967a, 1967b) indicated the possible existence of faults, related to salt solution and collapse of overlying strata, which might extend into the Upper Cretaceous sediments in the affected areas.

## OBSERVATION POINTS

### Piezometer Installations

Between November 1962 and July 1966, 35 piezometers and two observation wells were installed in 9 groups along a line crossing the South Saskatchewan River Valley in a northwesterly direction west of the town of Riverhurst (Fig. 2). Groups 1 and 2 were installed in 1962, groups 4 and 5 in 1963, groups 3, 6 and 7 in 1964, and groups 8 and 9 in 1966.

In each group piezometers were placed in the Ardkenneth, Demaine and Outlook Members, except in group 3, where the piezometer in the Demaine Member was omitted, and group 9, where an extra piezometer was installed in the Cruikshank Member. In addition to these piezometers in bedrock, groups 1, 2 and 7 each contain a piezometer in glacial till; groups 4 and 5 have a piezometer in inter-till gravel, and group 6 in a sand/gravel bed; groups 8 and 9 have a small water-table observation well each, installed in surficial material.

Collar elevations, total depths drilled, screen elevations, and original piezometric levels are given in Table IIa. Table IIa also indicates the types of screen and pipe used for the piezometers. Further technical details concerning drilling and installation of the piezometers were given in an earlier report (van Everdingen, 1968).

#### Wells, Springs and Ponds

Data on water levels and piezometric pressures in surficial deposits and bedrock aquifers have been augmented by information obtained from a spring issuing from inter-till gravel (W4 on Fig. 2); a town well in the same gravel (W5), a town well and 3 farm wells producing from the Ardkeneth Member (W6, W8, W9, and W10), and a pond in a gravel pit (W13). Details of these are listed in Table IIb. Wells W9 and W10 were flowing for some time after their completion. The water levels listed for these observation points in Table IIb are those for the summer of 1964.

#### AQUIFER CHARACTERISTICS

Physical characteristics of the three main bedrock aquifers are listed in Table III. The thicknesses listed are based on E-logs made in the deepest drill-hole in each location. Both E-logs and drill cuttings indicated a gradual decrease in the sand fraction with depth from the top of each sand member. The piezometer screens were all installed in the upper few feet of the various sands. Porosity figures were derived from tests on core samples obtained from a test hole at the location of group 9. Grain size analyses, made on samples from the upper portion of the sand members, place the aquifers in the fine to very-fine sand to silt groups defined by the U.S. Bureau of Soils Classification (van Everdingen, 1968). Permeabilities were determined from the results of bailing tests and input tests on the piezometers. Barometric and loading efficiencies; storage coefficients, and the bulk moduli of compressibility ( $\alpha$ ) were derived from analysis of piezometer hydrographs and barograph records.

The Cruikshank Member is not listed in Table III; its characteristics, apart from thickness, are similar to those of the Ardkeneth Member.

The gravel bed in which piezometers 4-1 and 5-1 were placed is 41 to 72 ft thick (12.5 - 21.9 m). The gravel is clean and subrounded to rounded, with at least 75 per cent of the pebbles between 4 and 8 mm, and the remainder between 1 and 4 mm. The barometric efficiency for the gravel aquifer is 75 to 80 per cent. No porosity or permeability determinations were made; bail tests were not feasible (4-1 was dry, and the water level in 5-1 too low for an adequate bail test); the input attainable by slug tests was not great enough to raise the water level perceptibly; undisturbed samples for laboratory tests could not be obtained.

Table III further presents a summary of the chemical character of the water in the three main bedrock aquifers. Both total dissolved solids (TDS) and the  $\text{Cl}^-/\text{HCO}_3^-$  ratio increase with increasing depth; the  $(\text{Na}^+ + \text{K}^+)/\text{Cl}^-$  ratio decreases with increasing depth. Total solids also increase with decreasing distance to the river valley. The complete analyses have been published earlier (van Everdingen, 1968, Appendix III).

TABLE IIa

## Piezometer Data, Riverhurst Area

Piezometer	Elevation of Collar (feet asl)	Total Depth Drilled	Aquifer	Elevation of Top of Screen (feet asl)	Original Water Level (feet asl)
9-1	1953.11	16.6	Sandy Till	1941.03	1940.90
9-2	1953.52	125	Cruikshank	1837.52	1938.98
9A	1954.71	425	Ardkenneth	1546.21	1710.89
9B	1954.10	580	Demaine	1386.60	1766.83
9C	1954.11	820	Outlook	1160.61	1880.70
1-1	1931.57	105	Till	1860.07	1909.85
1A	1931.44	365	Ardkenneth	1585.14	1697.89
1B	1931.88	570	Demaine	1403.08	1746.16
1C	1930.95	808	Outlook	1150.50	1865.84
3A	1883.23	330	Ardkenneth	1563.73	1697.87
3C	1883.01	740	Outlook	1173.71	1866.51
2-1	1869.89	105	Till	1785.49	1851.56
2A	1870.39	315	Ardkenneth	1571.59	1696.77
2A1	1870.15	400	Ardkenneth	1485.65	1706.15
2B	1870.25	524	Demaine	1407.70	1744.29
2C	1871.36	748	Outlook	1167.86	1841.88
6-1	1699.94	120	Sand/Gravel	1592.49	1693.19
6A	1701.47	195	Ardkenneth	1525.56	1703.47
6B	1701.05	285	Demaine	1436.67	1734.05
6C	1701.88	560	Outlook	1196.85	1785.27
7-1	1705.70	105	Till	1609.30	1693.81
7A	1706.39	195	Ardkenneth	1528.98	1706.42
7B	1706.42	285	Demaine	1437.83	1729.11
7C	1706.68	530	Outlook	1210.97	1779.44
4-1	1852.71	75	Gravel	1794.41	Dry
4A	1853.30	300	Ardkenneth	1577.00	1834.96
4A1	1852.91	370	Ardkenneth	1503.55	1826.50
4B	1852.80	485	Demaine	1425.88	1746.67
4C	1852.36	740	Outlook	1172.70	1823.57
5-1	1958.09	225	Gravel	1751.62	1790.85
5A	1969.04	410	Ardkenneth	1577.04	1915.36
5B	1968.65	560	Demaine	1414.15	1757.70
5C	1968.46	860	Outlook	1176.96	1835.83
8-1	1946.32	9.5	Sandy Till	1939.32	1938.26
8A	1948.73	360	Ardkenneth	1605.23	1944.44
8B	1948.66	530	Demaine	1432.16	1791.30
8C	1947.81	815	Outlook	1175.81	1865.07

All piezometers have a 3-foot, #10 slots, sandpoint, except 4A (5-foot, #10 slots) and 4B (3-foot, #12 slots). No screens were installed in 8-1 and 9-1. 2-inch black or galvanized steel pipe was used throughout. Piezometer locations 6 and 7 were submerged by the reservoir in April 1965.

TABLE IIb

## Well Data and Data on Springs, Riverhurst Area

Well or Spring	Elevation of Collar (feet asl)	Total Depth (feet)	Elevation of Top of Screen (feet asl)	Aquifer	Original Water Level (feet asl) Summer, 1964
W 13	-	-	Pond	Gravel	1925.66
W 4	-	-	Spring	Gravel	1788.70
W 5	1958	141	1830	Gravel	1902.00
W 6	1953	386	1567	Ardkenneth	1926.00
W 8	1969	405	1601	Ardkenneth	1955.00
W 9	1958	348	1610	Ardkenneth	1958.00
W 10	1963	352	1611	Ardkenneth	1961.00

TABLE III

## Average Aquifer Characteristics for Bedrock Aquifers in the Riverhurst Area

Characteristic	Aquifers		
	Ardkenneth	Demaine	Outlook
Thickness, ft	60	30	40
Porosity, %	20 - 25	20 - 25	20 - 25
Permeability, inch/hour	0.4	0.4	0.4
Storage coefficient S	$1 \times 10^{-4}$	$3.7 \times 10^{-5}$	$3.3 \times 10^{-5}$
Barometric efficiency, %	19	26	39
Loading efficiency, %	81	74	61
Bulk modulus of compressibility, $\alpha$ , sq inch/lb	$3.2 \times 10^{-6}$	$2.1 \times 10^{-6}$	$1.2 \times 10^{-6}$
<u>Chemistry of water</u>			
Total dissolved solids, Max. in ppm	1635	2300	4542
Ratio $Cl^-/HCO_3^-$	0.3 - 2.2	2.3 - 2.7	5.9 - 23.8
Ratio $(Na^++K^+)/Cl^-$	6.10 - 1.64	1.42 - 1.34	1.14 - 1.001

(after van Everdingen, 1968).

## ORIGINAL FLOW SYSTEM

The original system of groundwater movement in the Riverhurst area is illustrated by two sections that show the elevation of the piezometric surfaces for the three main aquifers (Fig. 3a), and the distribution of total head (equal to pressure head plus elevation head) and approximate flow directions between observation points (Fig. 3b). The three small maps of Figure 4 show piezometric contours for the Ardkenneth, Demaine and Outlook Members. Both sections and maps are based on the pre-impoundment water levels listed in the last column of Table II (a and b) and the first column of Table V. Calculated values for both lateral and vertical gradients prevailing in the area during 1964 are listed in Table IV.

Figure 3 indicates that groundwater movement in the sand members of the Bearpaw Formation was originally directed towards the valley from both sides. The existence of longitudinal flow components under the valley is indicated by the configuration of the piezometric contours in Figure 4.

In addition to the horizontal movement of groundwater in the sand members and in the inter-till gravels on the east side of the valley, some vertical movement of groundwater would result from the appreciable vertical gradients indicated in the glacial till on both sides of the valley. This restricted the actual discharge area to the valley bottom, below 1710 ft (521.2 m) asl on the west side, and below 1775 ft (541 m) asl on the east side.

On the west side of the valley, the downward gradients persisted from the till through the Snakebite Member into the Ardkenneth Member. Upward gradients of varying magnitude prevailed between the Outlook and Demaine sands, and between the Demaine and Ardkenneth sands. The Ardkenneth aquifer may thus have received water both from above and from below, in addition to its supply from the upstream portion of the aquifer itself.

Under the central portion of the valley, there was a continuous upward gradient from the Outlook sand to the water table.

The pattern on the east side of the valley was more complicated. The upper inter-till gravel received water from both overlying and underlying beds; the same holds true for the Demaine sand on this side of the valley.

The lowest potentials measured in the Demaine and Outlook Members were found under the central part of the valley (groups 6 and 7), as expected. In the Ardkenneth Member, the lowest potential was found under the west flank of the valley (piezometer 2A). Still lower values might, of course, have been encountered directly below the river channel, if measurements had been possible there.

The strong local gradient in the Ardkenneth Member on the east side of the valley (piezometers 5A and 4A) could be caused by a relatively small offset along a fault related to salt solution. This is unlikely, however, because such a fault would also affect the movement of groundwater in the underlying Demaine and Outlook Members. No evidence of such effects exists. A second possibility is that the bedrock surface between piezometer groups 4 and 5 has been lowered by erosion to an elevation lower than that indicated on the sections. Appreciable headloss would accompany the movement of groundwater through this part of the section if the upper, more permeable, part of the Ardkenneth Member were removed.

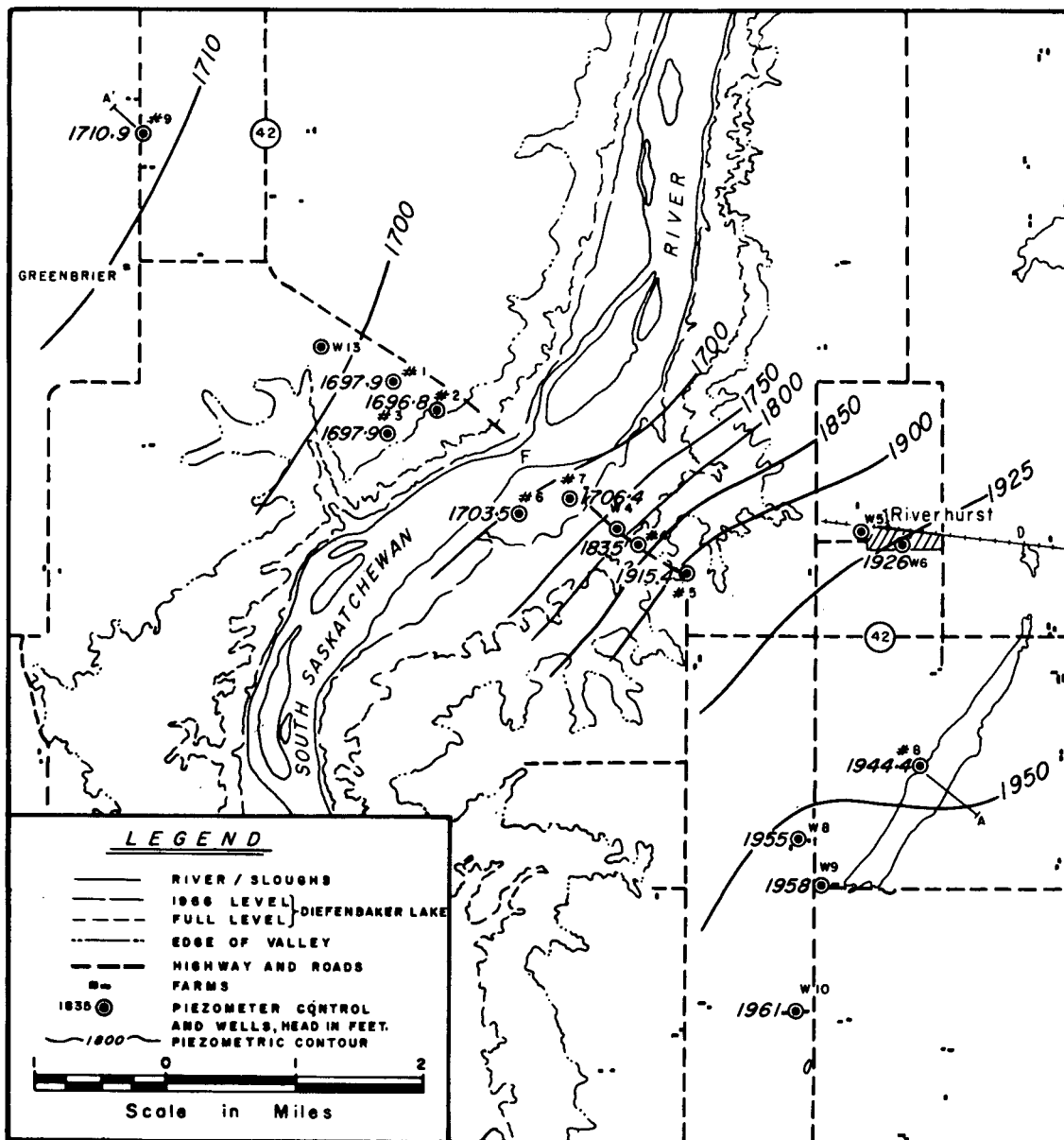


Figure 4a. Map of the Riverhurst area, showing piezometric contours for 1964, Ardkenneth Member.



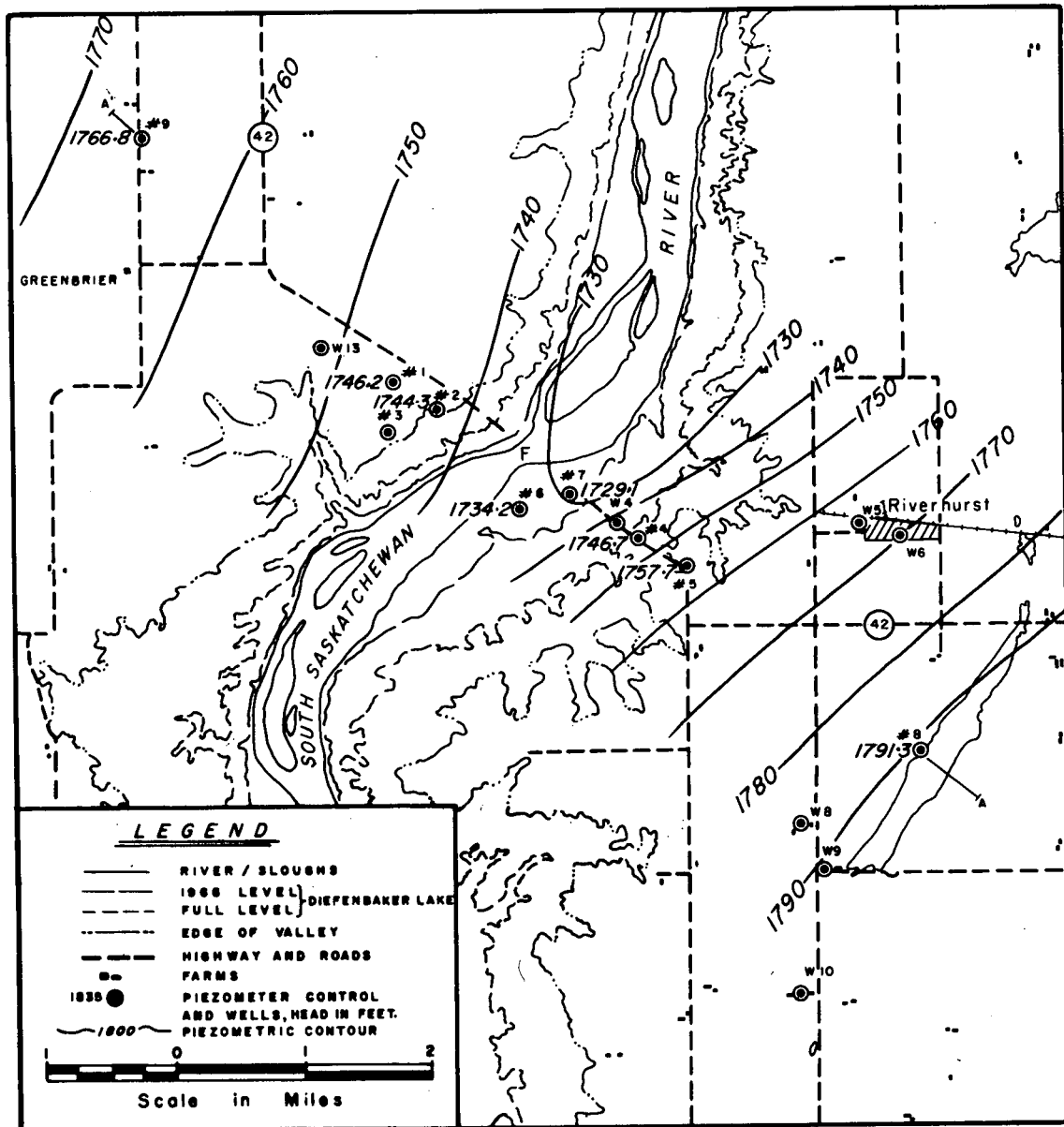


Figure 4b. Map of the Riverhurst area, showing piezometric contours for 1964, Demaine Member.

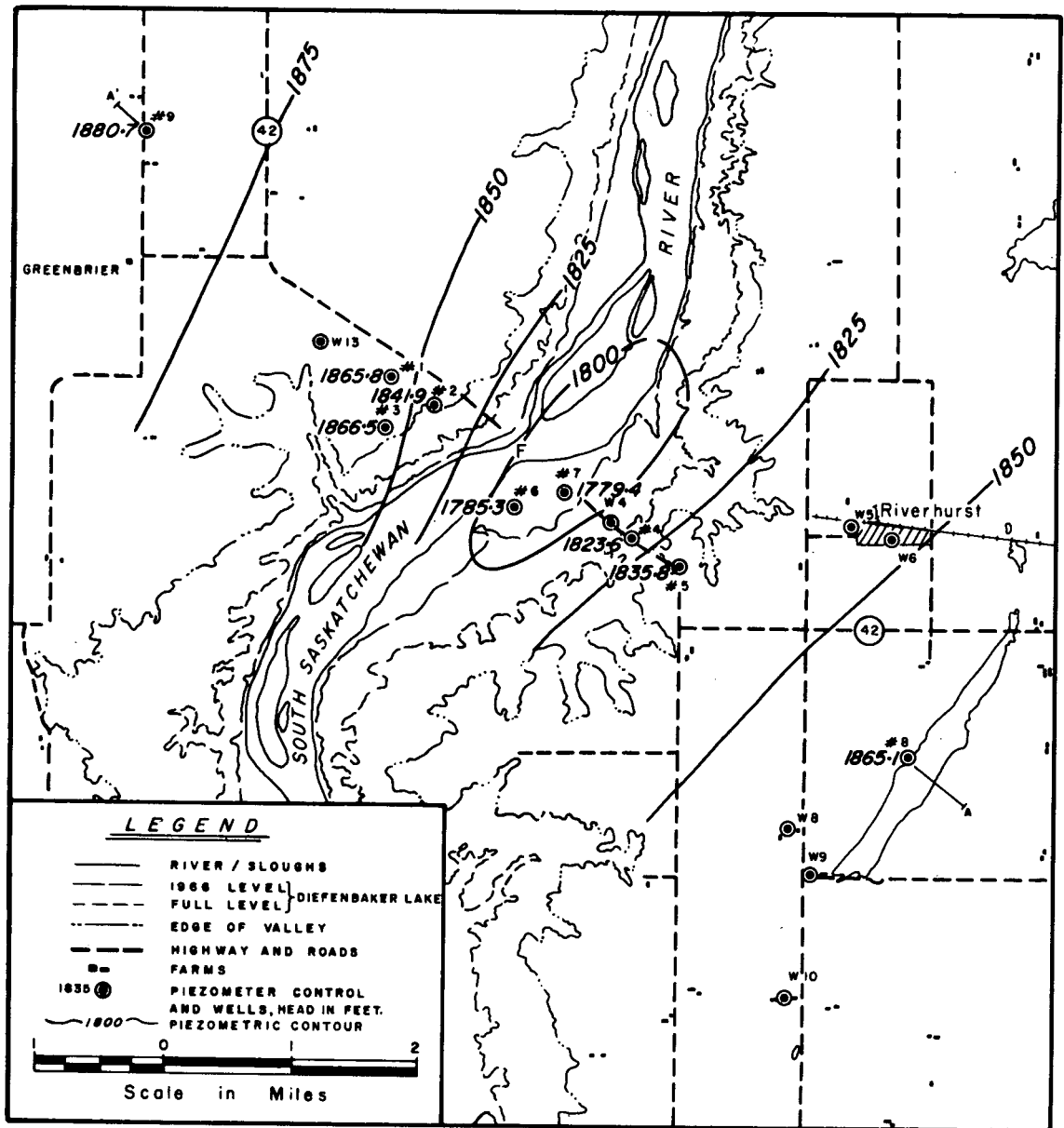


Figure 4c. Map of the Riverhurst area, showing piezometric contours for 1964, Outlook Member.

TABLE IV

## Lateral and Vertical Gradients in Bedrock, in 1964 and 1970

## A. Lateral Gradients (in ft/ft or m/m)

Aquifer	On W side (#1 → #2)		On E side (#5 → #4)	
	1964	1970	1964	1970
Ardkenneth	$+4.7 \times 10^{-4}$	$-4.5 \times 10^{-3}$	$+3.0 \times 10^{-2}$	$+2.7 \times 10^{-2}$
Demaine	$+7.8 \times 10^{-4}$	$-3.6 \times 10^{-3}$	$+4.1 \times 10^{-3}$	$-4.0 \times 10^{-3}$
Outlook	$+1.0 \times 10^{-2}$	$+1.96 \times 10^{-3}$	$+4.5 \times 10^{-3}$	$+1.7 \times 10^{-3}$

## B. Vertical Gradients (in ft/ft or m/m)

Members	Between Sand Members		Between Piezometer Screens		
	1964	1970	Numbers	1964	1970
Demaine to Ardkenneth					
Location 1	+ 0.74	+ 1.23	1B → 1A	+ 0.26	+ 0.44
Location 2	+ 0.73	+ 1.20	2B → 2A	+ 0.26	+ 0.42
Location 4	- 1.36	- 0.15	4B → 4A	- 0.59	- 0.065
Location 5	- 2.36	- 0.44	5B → 5A	- 0.94	- 0.58
Outlook to Demaine					
Location 1	+ 0.89	+ 0.74	1C → 1B	+ 0.47	+ 0.39
Location 2	+ 0.72	+ 0.64	2C → 2B	+ 0.31	+ 0.27
Location 4	+ 0.57	+ 0.33	4C → 4B	+ 0.30	+ 0.18
Location 5	+ 0.55	+ 0.45	5C → 5B	+ .71	+ 0.25

Note: Upward gradients, and lateral gradients directed towards the valley are indicated by a plus (+) sign.

TABLE V

Predicted and Observed Changes in Piezometric Levels  
in Bedrock Aquifers and Gravels, Riverhurst Area

Piezometer	Original Water Level (feet asl)	Maximum Level, (feet asl)		Max. Increase, (feet)	
		Predicted	Observed	Predicted	Observed
9-2	1938.98	1940.54	1940.55	1.56	1.57
9A	1710.89	1716.36	1719.55*	5.47	8.66
9B	1766.83	1779.73	1779.93	12.90	13.10
9C	1880.70	1887.35	1898.52*	6.65	17.82
1A	1697.89	1705.24	1719.04*	7.35	21.15
1B	1746.16	1775.17	1799.13*	29.01	52.97
1C	1865.84	1884.10	1898.83	18.26	32.99
2A	1696.77	1714.64	1729.97	17.87	33.20
2B	1744.29	1782.26	1807.85	37.97	63.56
2C	1841.88	1876.41	1894.13**	34.53	52.25
3A	1697.87	1708.15	1721.18	10.28	23.31
3C	1866.51	1884.93	1897.54**	18.42	31.03
4-1	<1791.41	1827.0	1813.25	>35.6	>21.84
4A	1834.96	1837.89	1851.48	2.93	16.52
4B	1746.67	1806.84	1841.72	60.17	95.05
4C	1823.57	1869.67	1886.53**	46.10	62.96
5-1	1790.85	1830.0	1798.62	39.15	7.77
5A	1915.36	1917.00	1924.93*	1.64	9.57
5B	1757.70	1793.01	1830.82	35.31	73.12
5C	1835.83	1873.01	1891.21	37.18	55.38
8A	1944.44	1946.00	1948.46**	1.56	4.02
8B	1791.30	1794.42	1809.93*	3.12	18.63
8C	1865.07	1879.15	1896.94	14.08	31.87
Lake Diefenbaker	1690.0	1827.0	1826.48	137.0	136.48

\* Still rising on Dec. 7, 1970

\*\* Piezometric level above ground

No appreciable seasonal variations in total head were recorded in any of the piezometers in bedrock. Fluctuations of nearly 6 feet (1.8 m) were recorded in piezometer 6 in the valley fill, as a result of the passing of the crest of the 1964 spring flood. Observation wells 8-1 and 9-1 revealed water-table fluctuations of 7.1 and 1.4 ft (2.16 and 0.43 m), respectively.

#### PREDICTED CHANGES IN THE FLOW SYSTEM

Changes in the groundwater flow pattern, expected to result from the creation of Lake Diefenbaker, were predicted in 1965 on the basis of electric-analog models (van Everdingen, 1968), and later on the basis of initial changes observed during 1965 and 1966 (van Everdingen, 1967). The thesis of both papers was that the main effect would result from transmission to the aquifers of the increased hydraulic heads generated in the valley by the reservoir, that the effect would be permanent, and that it would vary with the water level in the reservoir. Any increases in pressure caused by loading of the aquifers by the weight of the water in the reservoir would be dissipated as quickly as they were generated.

The magnitude of the changes in piezometric level would decrease along the reservoir with distance upstream from the damsite, approaching zero where the aquifers rise above reservoir level. The changes would also be smaller in magnitude the greater the lateral distance from the reservoir. The possibility of the occurrence of a temporary piezometric high below the reservoir, with reverse lateral gradients persisting for some time over some distance from the reservoir, was also recognized.

In the 1965 predictions, it was stated that the original artesian wells W9 and W10, which had stopped flowing prior to 1950, might again become flowing wells. In addition, it was predicted (van Everdingen, 1967) that piezometers 2C, 3C and 4C in Outlook sand, and 8A in Ardkenneth sand would start flowing before full supply level was reached in the reservoir.

On the basis of the 1965 model study, the piezometric minima below the reservoir were expected to increase to 1828 ft, 1775.4 ft, and 1801.6 ft asl in the Ardkenneth, Demaine and Outlook Member, respectively. This would virtually eliminate the upward gradient between the Ardkenneth Member and the reservoir, reverse the upward gradient between the Ardkenneth and Demaine sands, and strongly reduce the upward gradient from the Outlook to the Demaine sand. In addition, the decrease in available head difference in the aquifers between their respective recharge and discharge areas would reduce the magnitude of the overall lateral gradients and, consequently, the groundwater flow rates.

In the 1967 paper, the predictions were revised on the basis of observations during 1965 and 1966. The new predicted piezometric minima were 1812.4 ft, 1808.1 ft, and 1881.7 ft asl, respectively, for the three sands. This would effectively eliminate all contribution from the bedrock aquifers to the surface water in the valley, decrease somewhat the magnitude of the expected downward gradient between the Ardkenneth and Demaine sands, and increase the upward gradient between the Outlook and Demaine sands to a value exceeding the original gradient. Piezometric levels predicted in 1967 for the other observation points are listed in Table V.

Potential continuing loss of water from the reservoir was indicated in 1966 by the existence of a piezometric low in the Ardkenneth Member on the west side of the reservoir.

The movement of groundwater to the reservoir through the inter-till gravels on the east side of the valley was expected to decrease as a result of the increase in head in the discharge area. Saturation of the basal gravels was also anticipated.

The increase in head in the discharge area was further expected to lead to a decrease in groundwater discharge from water-table aquifers along the reservoir. The increase in saturated thickness which would accompany flooding in the valley was presumed to offset to some extent the above effect.

Finally it was pointed out that the stability of the damsite area might be adversely affected by the increased pressures in the bedrock aquifers. The increase in reservoir level, and consequently the increases in groundwater pressure, would be at a maximum just upstream from the dam. Downstream from the dam, only the weight of the saturated material overlying the bedrock aquifers would be available to counteract the increased pressures transmitted through the aquifers. Relief wells have been installed in the upper aquifer at the damsite to keep the pressures in this aquifer within acceptable limits on the downstream side.

#### OBSERVED CHANGES IN THE FLOW SYSTEM

Water levels in Lake Diefenbaker for the period from January 1, 1965, to January 1, 1971, are listed in Appendix I, and plotted on Figure 7. The major fluctuations in the level (feet above sea level) of the reservoir can be summarized as follows: in 1965 a mid-July peak of 1730.3 was followed by a 6-month period of small fluctuations between 1717 and 1722, and a further 6-month period of fluctuations between 1723 and 1726; between August 1, 1966, and January 7, 1967, the level rose to 1756; it dropped to 1737.8 by mid-March, and rose again to about 1805 by mid-July 1967, followed by a 5-month period of fluctuations between 1804.3 and 1805.7; between early December 1967 and mid-January 1968, it dropped to 1791, then rose to 1822.9 between mid-March and mid-October of 1968. The level dropped to just below 1800 by the end of March 1969, rose to 1825.9 by mid-August 1969, dropped to 1798.8 by mid-March 1970 and rose to 1826.5 by the end of July 1970; at the end of 1970 the level was again below 1813.

The piezometric levels in the Riverhurst area, observed between 1964 and the end of 1970, are listed in Appendix II, and plotted on Figure 7. It is apparent from a comparison of these piezometer hydrographs with the reservoir hydrograph, that the reaction to major fluctuations in reservoir level is delayed in a number of piezometers. In some cases this is caused by a delay in aquifer response due to distance from the reservoir (compare, e.g., 1B with 2B, 1C with 2C, 5B with 4B, and 5C with 4C, for 1967 and 1968). As a result, the piezometric levels in both the Demaine and the Outlook Members in locations 8 and 9 have been increasing slowly, but without interruption, through 1970.

In some other piezometers, the delayed response is probably caused by inefficiency in the piezometer (e.g., 4A, in 1968 and 1969). In these piezometers a full response to any change in reservoir level will not have been registered before the reservoir level started changing in the opposite direction.

The main conclusion that can be drawn from Figure 7, supporting the thesis of the two earlier papers (1967, 1968), is that increases in piezometric pressures in the aquifer system are permanent as long as the reservoir level is kept constant (see periods of 5 - 6 months during 1965, 1966 and 1967). The increased piezometric pressures are a direct consequence of the *hydraulic connection* between the surface water and the groundwater in the bedrock aquifers. The existence of such a hydraulic connection was evidenced by the continuous upward gradient that was found below the valley before impoundment started. The aquifers are not truly confined in the vicinity of the reservoir. The fluctuating water level in the reservoir determines the outlet pressure at the discharge end of the flow system in the aquifers; pressures in the aquifers at some distance from the discharge area are adjusted to the changing outlet pressures with a certain amount of time lag.

No evidence has been found for any dissipation of the increased pressures with time, which could have been expected if these pressure increases represented the reaction of a confined aquifer to the imposition of a static load.

Table V lists the predicted and observed maximum piezometric levels as well as the predicted and observed increases. A comparison between the last two columns of Table V reveals that all of the observed pressure increases in the bedrock aquifers are larger than predicted. Observed increases for the inter-till gravel on the east side of the reservoir, on the other hand, are smaller than predicted.

The discrepancy between the 1967 predictions for the bedrock aquifers and the piezometric levels observed after full supply level was reached in the reservoir in 1970, generally increases with distance from the reservoir. This indicates that (1) equilibrium had not been attained in the aquifers by the end of 1966, (2) the time lag increased with distance from the reservoir, and (3) in at least some cases the piezometric pressures did not reach final equilibrium by the end of 1970. Further increases can be expected, especially in the locations farthest from the reservoir.

The largest increase, 95 ft (20 m), or nearly 71 per cent of the increase in surface-water level, was observed in the Demaine Member at location 4, about 400 ft (122 m) from the reservoir bank, and almost 3600 ft (1100 m) from the original river channel.

Piezometric pressures in the Ardkenneth Member on the east side of the reservoir, as well as those in the Outlook Member, have increased sufficiently to bring water levels above ground elevation in piezometers 8A (+ 1.9 ft or 0.58 m), 2C (+ 22 ft or 6.7 m), 3C (+ 15 ft or 4.57 m) and 4C (+ 34 ft or 10.4 m), as predicted in 1967. The static water level in farm well W9 has also risen about 1 foot above ground level.

The piezometric elevations for 1970 listed in Table V have been used as the basis for two sections and three maps to illustrate the modified system that existed in the Riverhurst area during the latter half of 1970. Figure 5a shows the elevation of the piezometric surface for the three aquifers studied, and Figure 5b the total-head distribution; Figure 6 presents maps of piezometric contours for these aquifers. Lateral and vertical gradients in the section, calculated from the observed levels listed in Table V, have been added to Table IV for comparison with the pre-impoundment gradients.

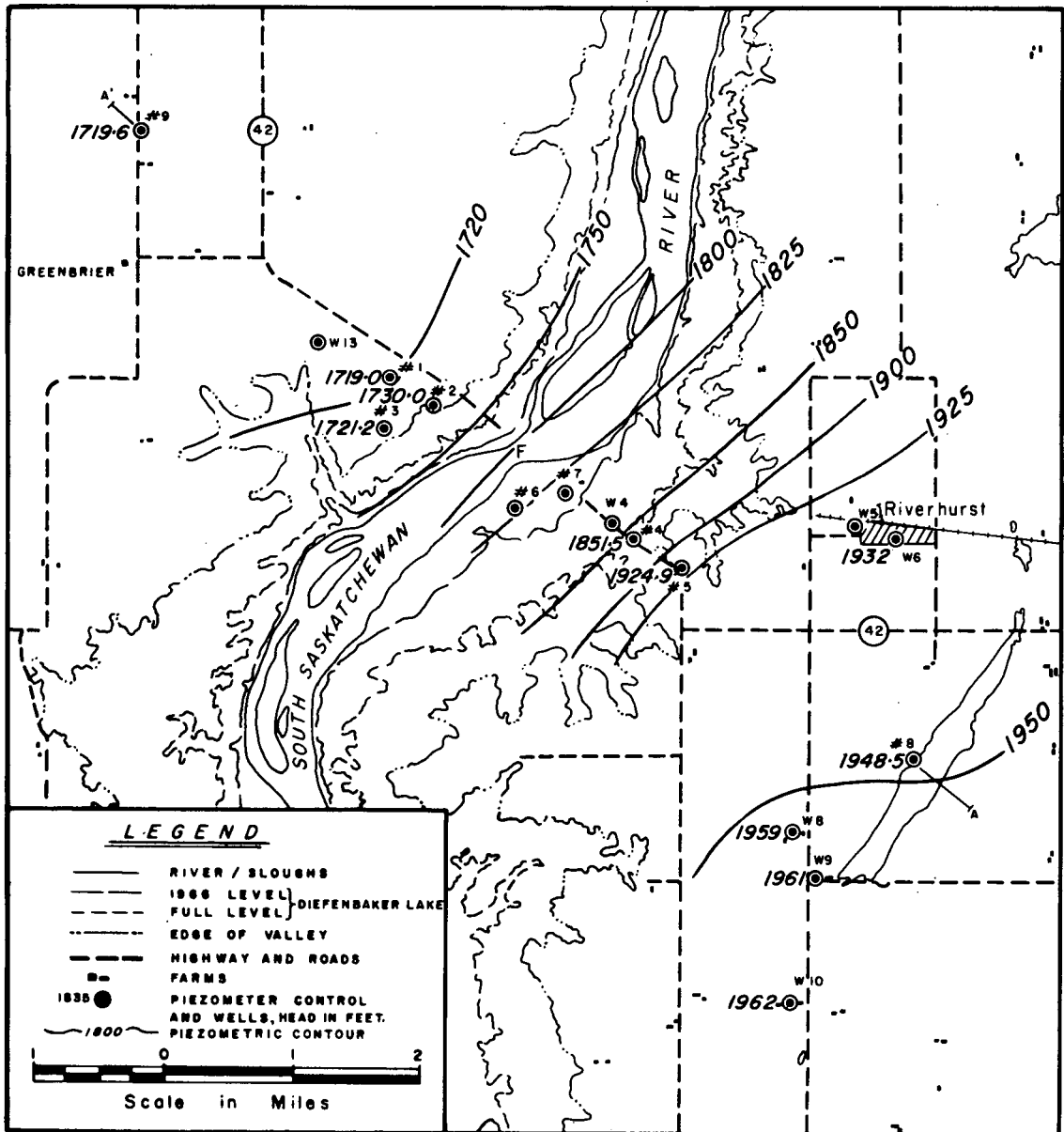


Figure 6a. Map of the Riverhurst area, showing piezometric contours for 1970, Ardkenneth Member.



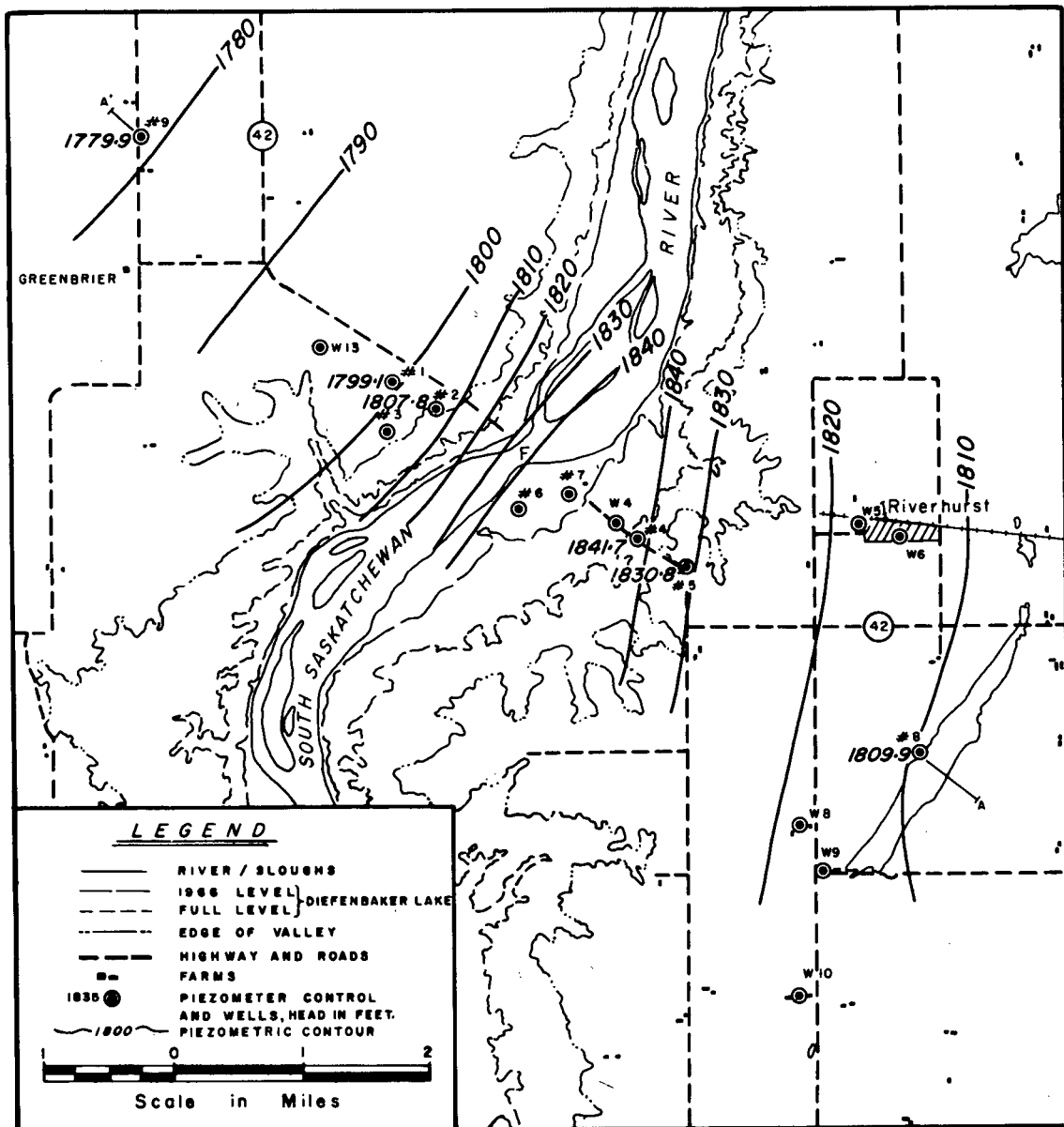


Figure 6b. Map of the Riverhurst area, showing piezometric contours for 1970, Demaine Member.

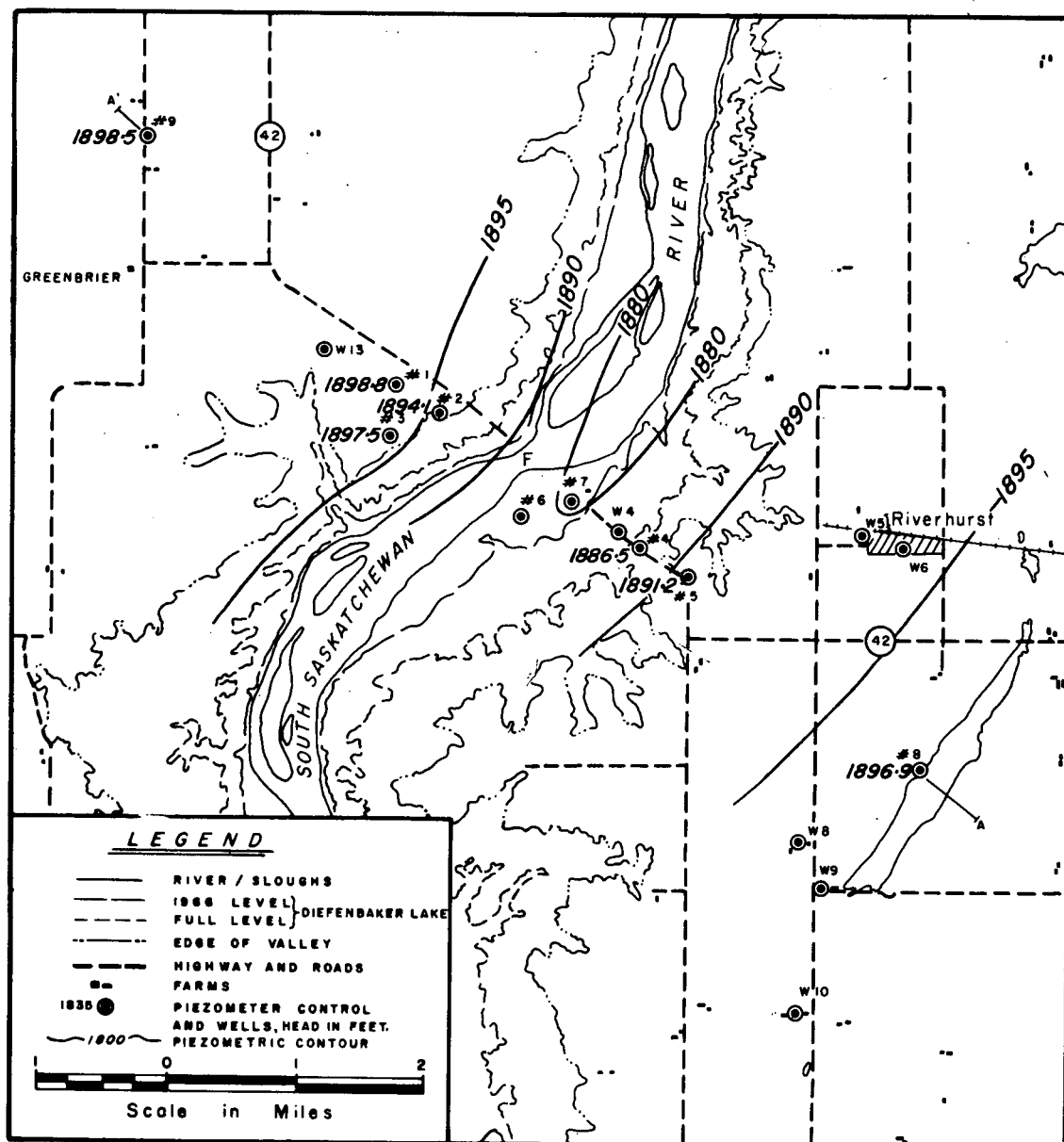


Figure 6c. Map of the Riverhurst area, showing piezometric contours for 1970, Outlook Member.

All lateral gradients within the bedrock aquifers in the section have either been reduced or reversed (Figs. 5b, 6 and 7). Reverse lateral gradients were established in the Ardkenneth Member on the west side of the reservoir between 6A and 2A and between 2A and 1A in April 1965; between 2A and 3A in October 1965; and between 3C and 9C, temporarily, in November and December 1968, from July to December 1969, and from June to December 1970. Reversals took place in the Demaine Member on the west side, between 6B and 2B during the summer peaks since 1965; between 2B and 1B in May 1965; and between 1B and 9B in February 1968; in the Demaine Member on the east side between 4B and 5B from October 1966 to January 1967, and from May 1967 onwards; and between 5B and 8B in September 1967.

In the Outlook Member, the level in 6C exceeded that in 4C, temporarily, in June 1965, September 1966, and August 1967; levels in 1C and/or 3C exceeded levels in 9C temporarily in June and July 1967, from June to October 1968, in July and August 1969, and from July to September 1970. In the inter-till gravel on the east bank a reverse gradient was established between the reservoir and 4-1, and between 4-1 and 5-1 in July 1967. The normal gradient between 4-1 and the reservoir was re-established for short periods during the lowest reservoir stages in 1968 (January to early April) and 1970 (late February to early April).

The reverse lateral gradients, some of which will no doubt be eliminated if enough time is available for adjustment, resulted wherever the combination of large storage capacity and low permeability made it impossible for the aquifer to adjust rapidly enough to the changed conditions in the discharge area.

Reversals in the vertical gradients between the aquifers have not taken place. The upward gradients prevailing between the Demaine and Ardkenneth aquifers on the west side of the reservoir have increased in magnitude, and the downward gradients between these aquifers on the east side have decreased, mainly as a result of the large increase in pressure in the Demaine Member. The same increase is responsible for the reduction of the upward gradients between the Outlook and Demaine Members on both sides of the reservoir.

Predictions made in 1965 and 1967 about pressure increases to be expected in the bedrock aquifers immediately below the reservoir were also too conservative. A reversal of the upward gradient was expected between the reservoir and the Ardkenneth Member, and between the Ardkenneth and Demaine Members. However, the South Saskatchewan River valley will still represent the locus of piezometric lows for bedrock aquifers in the area, and groundwater discharge from the bedrock aquifers to the valley will continue. This conclusion is supported by results obtained with electronic pressure transducers installed on piezometers of group 6 in 1965, 1966 and 1967. New piezometric levels for both valley fill and bedrock aquifers indicated that upward movement of groundwater to the reservoir would continue, although at a reduced rate. Reaction to fluctuations in reservoir level was virtually instantaneous in these piezometers, and no evidence was found to indicate dissipation of the effect (see measurements for 1966 and 1967).

As a result of the decreased lateral and upward gradients in the bedrock, the valley will ultimately receive some 60 to 70 per cent less water from groundwater discharge than it did before the creation of the reservoir. Discharge from water-table aquifers, as stated earlier, will

by now have decreased by about 30 per cent, as a result of the higher head in the discharge area, which is only partly compensated by an increase in saturated section available for groundwater movement. The reverse gradient in the inter-till gravel (max. levels 1813.2 ft in 4-1, and 1798.6 ft in 5-1) reflects active loss of water from the reservoir. The new town well of Riverhurst (W5), which appears to obtain water from this same gravel, may ultimately benefit from this in the form of improved water quality. The reverse gradients in the Demaine and Ardkenneth Members probably do not reflect active loss of water from the reservoir, but only diversion of discharge. These reverse gradients may be only temporary.

#### CONCLUSIONS

1. Increases in piezometric pressures in Upper Cretaceous bedrock aquifers in the area of Lake Diefenbaker are the result of the creation of this man-made lake.
2. The increased pressures will persist as long as the reservoir is maintained; small fluctuations in pressure will accompany seasonal fluctuations in reservoir level.
3. The piezometric reactions are a direct consequence of the hydraulic connection existing between the multiple aquifer system and the surface water in the valley of the South Saskatchewan River which constitutes a natural discharge area for these aquifers, as evidenced by the continuous upward gradient below the valley. The creation of the reservoir has increased the outlet pressure for these aquifers.
4. The increased piezometric pressures in the bedrock aquifers have reduced pumping lifts in a number of wells in the area, and caused some piezometers and at least one farm well to start flowing.
5. No evidence has been found for the existence of a classical loading effect on the aquifers.
6. Lateral gradients in the bedrock aquifers have in general been reduced, leading to a decrease in the rate of groundwater movement towards the valley.
7. In a number of instances lateral gradients in the aquifers have been reversed, indicating that the aquifers could not adjust rapidly enough to the changing conditions in their discharge area; continued adjustment will probably lead to the re-establishment of normal gradients.
8. Overall vertical gradients below the reservoir have been reduced, with a resulting decrease in the rate of discharge from the aquifers.
9. Just downstream from Gardiner Dam, the increased piezometric pressures must have led to increased discharge rates and possibly to instability in places where the thickness of saturated overburden overlying the upper aquifer is small.

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**APPENDIX I**

**WATER LEVELS, LAKE DiefENBAKER, 1965-1970**

WATER LEVELS, IN FEET ABOVE SEA LEVEL, FOR 1965

	January	February	March	April	May	June	July	August	September	October	November	December
1		1675.23	1683.78	1689.31	1723.42	1720.60	1722.63	1721.00	1720.72	1720.95	1720.45	1718.99
2	1667.56	.56	1684.24	.11	.15	.57	.90	1720.25	.60	.80	.35	1719.23
3		.90	.61	.12	1722.97	.56	1723.35	1719.50	.70	.70	.35	.44
4	.40	1676.08	1685.04		.89	.61	.50	.10	.70	.70	.30	.62
5	.35	.41	.40	.27	.96	.94	.80	1718.80	1721.00	.60	.30	
6	.87	.74	.76	.33	1723.58	1721.20	1724.24	.40	.20	.60	.30	1720.12
7	.87			.46	1724.23	.79	.42	.10	.40	.50	.35	.32
8	.90	1677.41	1686.46	.65	1723.79	1722.01	.18	1717.70	.45	.70	.35	.50
9	.76	.88	.85	.97	.08	.00	.02	.35	.35	.75	.35	.78
10		1678.21	1687.28	1690.17	1722.82	.16	1723.73	.60	.25	.85	.40	1721.07
11	.45	.60	.68		.57	.19	.20	1718.00	.20	.90	.40	.39
12	1668.01	.93	1688.08	1691.71	.68	.31	1722.68	.50	.10	.85	.35	
13	.54	1679.22		1693.02	.59	.55	1723.49	1719.60	.10	.80	.20	.71
14	.97			1695.53	.52	.26	1724.78	1720.40	.00	.85	1719.90	.83
15	.90	.73	1689.32	1704.00	.28	.01	1726.50	.60	.00	.90	.60	.91
16	1669.66	1680.03	.75	1709.50	.00	1721.84	1728.00	.40	1720.85	.88		.75
17		.27	.94	1713.00	1721.94	.65	1729.30		.75	.85		.44
18	.79	.54	.84	1715.60	.28	.78	1730.30		.65	.35		.23
19	.99	.78	.74	1717.70	.18	.68	1729.90		.60	.35	.00	
20	1670.27	1681.04	.64	1718.50	1720.94	.85	.40		.45	.60	1718.95	1720.56
21	.50			1719.87	.80	.91	1728.40	.40	.45	.65	.80	.47
22	.85	.47	.68	1721.00	.71	.74	1727.90	.60	.25	.70	.80	.30
23	1671.34	.68	.81	.94	.70	1722.79	.60		.60	.70	.80	.36
24		.94	1690.01	1722.74	.75	1724.22	.00	.90	.65	.70	.70	.25
25	1672.36	1682.37	.15	1723.30	.57	1725.52	1726.40		.70	.40	.70	.10
26	.80	.61	.17	.70	.54	.68	1725.85		.92	.35	.70	.10
27	1673.07	1682.98	.14	.90	.73	.20	.08		.98	.30	.70	.10
28	.54			1724.13	.88	1724.78	1724.83		1721.10	.45	.70	.10
29	1674.01		1689.87	.18	.90	1723.95	1723.40		.10	.45	.70	.31
30	1674.36		.68	<u>1724.02</u>	.75	<u>1722.95</u>	1722.00	1720.90	<u>1721.00</u>	.45	<u>1718.83</u>	.31
31			<u>1689.47</u>		<u>1720.60</u>		<u>1721.00</u>			<u>1720.45</u>		<u>1720.23</u>

WATER LEVELS, IN FEET ABOVE SEA LEVEL, FOR 1966

	January	February	March	April	May	June	July	August	September	October	November	December
1		1722.75	1724.06	1725.85		1724.70	1725.10	1724.85	1738.28		1749.80	1751.88
2		.98	.01	.70	1724.95	.72	.00	1725.40	.52		.92	1752.03
3	1720.22	.91	.07	.80	.95	1725.00	1724.95	1726.00	.95	1745.30	1750.13	
4	.05	1723.08	.16	.88	1725.00	.15	.75	.70	1739.10	.53	.26	
5	.11	.26	.19	.91	1724.97	.15	.80	1727.35	.25	.72	.40	.62
6	.03			.50	.88	.35	.80		.65	.90	.50	.73
7	.00	.50	.30	.05	.80	.60	.80		1740.00	1746.05	.63	.81
8	1719.92	.52	.36	1724.60	.80	.45	1725.00	1728.86	.35	.10	.78	.91
9		.84	.26	.45	.60	.20	.55	1729.35	.77	.30	.85	1753.00
10	.65	.94	.36	.40	.50	.30	.75	.75	1741.35	.60	.89	
11	.65	1724.06	.37	.40	.40		.75	1730.15	.45	.68	.85	
12	.70	.18	.41	.40	.55	.30	.40	.54	.50	.79	.95	.18
13	.75			.68	.70	1724.80	.25		.75	.85	1751.00	.21
14	.86	.39	.63	.70	.80	.70	.15	1731.68	1742.00	1747.05	1750.95	.23
15	.95	.28	.76	.80	.95	.60	.00	1732.00	.17		.96	.32
16		.23	.96	.80	1725.20	.75	1724.95	.62	.35	.30	.95	.45
17	1720.25	.14	1725.02		.40	.65	.80	1733.15	.65	.62	.97	
18	.40	.28	.20	.60	.42	.47	1725.00	.62	.80	.79	1751.05	.65
19	.50	.27	.30	.50	.50	.50	.30	1734.05	1743.00	.85	.01	.76
20	.73			.50	.35	.35	.30	.60	.23	.93	.05	.82
21	.80	.16	.40	.36	.15	.35	.25	.95	.43	1748.06	.12	.97
22	.93	1723.96	.30	.42	1724.80	.50	1724.85	1735.25	.55	.20	.13	1754.12
23		1724.12	.20	.40	.50	.68	.85	.62	.70	.30	.31	.29
24	1721.60	.03	.10	.40	.45	.80		.97		.47	.37	
25	.80	1723.99	.10	.35	.60	.90	.90	1736.32	1744.00	.69	.42	
26	1722.00	.91	.00	.30	.70	1725.10	.75	.55	.17	.90	.45	
27	.17			.32	.75	1724.75	.98	.85	.35	1749.03	.55	
28	.35	<u>1724.05</u>	1724.77	.56	.80	.90	1725.05	1737.10	.50	.25	.67	1755.14
29	.15		.80	1724.70	.80	1725.10	.15	.40	.63	.32	.74	.22
30			.81		1725.00	<u>1725.15</u>	.10	.75	<u>1744.80</u>		<u>1751.82</u>	1755.33
31	<u>1722.34</u>		<u>1725.01</u>		<u>1725.00</u>		<u>1725.00</u>	<u>1738.07</u>		<u>1749.53</u>		



WATER LEVELS, IN FEET ABOVE SEA LEVEL, FOR 1967

	January	February	March	April	May	June	July	August	September	October	November	December
1		1746.31	1740.16		1753.87	1771.90	1802.02	1804.67	1804.92	1804.40	1805.15	1805.00
2		.19	.03		.73	1772.64	.30	.58	.90	.44	.12	1804.86
3	1755.75	1745.93	1739.81	1740.89	1754.00	.86	.60	.53	.94	.50	.08	.72
4	.96			1741.51	.13	1773.72	.93	.55	.80	.48	.12	.67
5	1756.00			.84	.21	1775.50	1803.13	.52	.78	.50	.12	.48
6	.07	.21	.01	1742.25	.27	1777.36	.58	.56	.77	.45	.07	.30
7	.28	.01	.10	.55	.30	1779.03	.96	.51	.68	.60	.10	.14
8	.23	1744.81	1738.79		.20	1780.43	1804.28	.71	.64	.62	.07	1803.94
9	.15	.68	.66		.33	1781.84	.54	.78	.62	.68	.11	.92
10	.09	.53	.49	1743.67	.42	1783.20	.67	.83	.50	.74	.11	.85
11	.05			1744.20	.63	1784.64	.73	.88	.48	.81	.17	.46
12	1755.87			.89	.77	1785.31	.82	.94	.48	.88	.32	.27
13	.58	1743.86	.12	1745.64	1755.44	1786.33	.96	.96	.36	.87	.48	1802.93
14		.71	1737.97	1746.65	1756.22	1787.34	1805.03	1805.00	.63		.47	.75
15		.55	.91		.90	1788.45	.00	.06	.57	.94	.53	.46
16	1754.50	.30	.89		1757.65	1789.58	.04	.08	.63	.90	.57	.08
17	.12	.04	.84	1750.59	1758.26	1790.84	.06	.05	.68	1805.00	.64	1801.54
18	1753.77			1751.04	.82	1791.62	.00	.19	.70	1804.96	.54	.10
19	.14			1752.55	1759.45	1792.42	1804.94	.20	.72	.85	.52	1800.80
20	1752.53	1742.33	1738.11	1753.26	1760.08	1793.15	.86	.18	.72	.92	.60	.45
21		.18	.10	.72	.72	.85		.20	.75	.92	.64	.20
22		1741.82	.14		1761.40	1794.75	.70	.16	.75	1805.16	.65	1799.90
23	1750.89	.72	.14		1762.29	1795.75	.66	.10	.66	1804.97	.50	.74
24	.35	.33		1754.32	1763.18	1796.79	.60	.09	.66	1805.01	.72	.56
25	1749.84				1764.19	1797.76	.66	.08	.57	.05	.54	.34
26	.18			.34	1765.24	1798.55	.67		.46	.00	.52	.28
27	1748.60	1740.67			1766.44	1799.41	.67		.49	.10	.48	1798.96
28		<u>1740.67</u>	.11	1754.08	1767.70	1800.21	.69	1804.88	.41	.04	.38	.82
29			.63		1768.99	.85	.68	.98	.35	.10	.31	.66
30	1746.95		1738.96		1770.09	<u>1801.43</u>	.68	.97	<u>1804.46</u>	.10	<u>1805.16</u>	.18
31	<u>1746.50</u>				<u>1771.04</u>		<u>1804.68</u>	<u>1804.94</u>		<u>1805.07</u>		<u>1797.72</u>

WATER LEVELS, IN FEET ABOVE SEA LEVEL, FOR 1968

	January	February	March	April	May	June	July	August	September	October	November	December
1	1797.30	1790.83	1790.21	1792.02	1794.84	1798.03	1810.30	1815.29	1818.46	1821.38	1822.59	1821.36
2	1796.94	.86	.24	.13	.80	.42	.52	.36	.52	.66	.48	.34
3	.52	.90	.27	.25	.80	.78	.72	.43	.63	.81	.42	.30
4	.08	.86	.30	.30	.83	1799.12	.92	.57	.68	.92	.37	.26
5	1795.69	.76	.32	.44	.88	.45	1811.20	.66	.68	1822.10	.36	.04
6	.28	.66	.40	.54	.90	.85	.52	.72	.78	.36	.39	1820.86
7	1794.82	.62	.41	.68	.92	1800.18	.84	.82	.84	.52	.40	.76
8	.35	.57	.45	.83	1795.03	.54	.97	.93	1819.02	.70	.42	.66
9	.02	.53	.47	.93	.14	.92	1812.15	1816.05	.07	.86	.42	.43
10	1793.53	.50	.47	1793.04	.15	1801.40	.25	.11	.12	.88	.42	.38
11	.19	.48	.55	.15	.25	.97	.40	.18	.19	.91	.40	.10
12	1792.73	.46	.54	.27	.30	1802.48	.64	.25	.27	.90	.35	.04
13	.30	.45	.58	.30	.39	1803.02	.82	.36	.30	.94	.41	1819.98
14	1791.82	.47	.67	.41	.44	.60	1813.06	.36	.42	.88	.50	.96
15	.44	.45	.75	.46	.50	1804.22	.20	.40	.60	.82	.44	.78
16	.29	.45	.80	.61	.56	.80	.33	.55	.72	.86	.28	.64
17	.05	.44	.86	.64	.59	1805.31	.50	.68	.72	.70	.34	.57
18	.01	.41	.91	.72	.67	.99	.65	.76	.78	.70	.25	.41
19	.00	.39	.99	.78	.76	1806.49	.82	.96	.90	.60	.12	.16
20	1790.96	.36	1791.02	.87	.84	1807.06	.84	1817.05	.92	.52	.04	.05
21	.94	.36	.06	.96	.91	.39	1814.22	.08	1820.16	.50	1821.90	1818.86
22	.89	.33	.16	1794.10	.94	.72	.24	.33	.36	.49	1822.09	.65
23	.86	.33	.23	.18	1796.06	1808.14	.39	.49	.44	.48	1821.85	.41
24	.88	.30	.31	.29	.14	.35	.50	.62	.50	.46	.72	.21
25	.87	.28	.34	.36	.28	.68	.60	.71	.51	.43	.69	.02
26	.82	.24	.40	.41	.36	.96	.60	.80	.62	.45	.71	1817.88
27	.80	.24	.55	.51	.51	1809.23	.80	.86	.70	.52	.62	.72
28	.82	.20	.72	.60	.71	.58	.94	1818.07	.92	.56	.51	.58
29	.84	<u>1790.23</u>	.88	.64	.93	.84	1815.04	.22	1821.12	.60	.61	.44
30	.79		.94	<u>1794.72</u>	1797.27	<u>1809.96</u>	.23	.25	<u>1821.26</u>	.69	<u>1821.36</u>	.26
31	<u>1790.76</u>		<u>1792.02</u>		<u>1797.78</u>		<u>1815.23</u>	<u>1818.40</u>		<u>1822.65</u>		<u>1817.07</u>

WATER LEVELS, IN FEET ABOVE SEA LEVEL, FOR 1969

	January	February	March	April	May	June	July	August	September	October	November	December
1	1816.84	1810.76	1804.55	1799.78	1811.20	1815.26	1821.56	1825.39	1825.43	1824.10	1822.70	1819.39
2	.66	.58	.39	.78	.34	.57	1822.06	.47	.36	.14	.66	.21
3	.50	.38	.20	.64	.46	.79	.45	.62	.35	.00	.67	.10
4	.28	.17	1803.99	.67	.60	.91	.74	.60	.26	.18	.57	1818.94
5	.04	1809.98	.80	.66	.74	1816.03	.78	.52	.27	.17	.49	.78
6	1815.79	.72	.67	.64	.74	.12	.65	.82	.20	.20	.44	.60
7	.51	.47	.55	.88	.80	.22	.67	.83	.18	.13	.30	.46
8	.35	.24	.46	1800.27	.87	.32	1823.13	.81	.06	.05	.28	.23
9	.24	.00	.28	1801.70	.96	.45	.40	.80	.04	.05	.26	.02
10	.09	1808.79	.07	1803.16	1812.06	.52	.52	.86	.14	1823.77	.15	1817.86
11	1814.91	.50	1802.83	1804.53	.18	.67	.64	.82	.19	.85	.06	.62
12	.76	.28	.63	1805.91	.31	.99	.79	.89	.08	.80	.08	.46
13	.50	.08	.46	1807.00	.36	1817.32	.90	.94	.05	.78	1821.80	.25
14	.33	1807.77	.26	.88	.47	.63	1824.08	.81	.06	.69	.69	.12
15	.14	.50	.02	1808.34	.37	.84	.20	.75	1824.93	.56	.43	.00
16	1813.95	.26	1801.78	.72	.60	1818.05	.42	.82	.83	.55	.33	1816.74
17	.75	.02	.54	1809.12	.77	.03	.55	.94	.77	.52	.20	.42
18	.52	1806.81	.25	.43	.96	.23	.63	.71	.73	.44	1820.99	.10
19	.35	.66	.10	.73	1813.26	.32	.67	.71	.60	.36	.84	1815.99
20	.20	.46	1800.91	1810.02	.55	.53	.63	.71	.59	.30	.71	.74
21	1812.99	.27	.71	.17	.80	.65	.87	.70	.48	.22	.60	.52
22	.82	1805.94	.62	.31	1814.06	.85	.93	.67	.52	.13	.43	.30
23	.62	.74	.31	.41	.21	.97	.82	.59	.53	.18	.35	.19
24	.40	.52	.20	.52	.36	1819.05	.85	.69	.52	1822.91	.25	1814.90
25	.21	.32	.01	.77	.54	.10	.87	.72	.51	.97	.16	.70
26	1811.98	.14	.00	.76	.62	.18	.96	.67	.41	1823.06	1819.96	.48
27	.82	1804.95	1799.95	.89	.63	.53	1825.08	.73	.37	1822.97	.85	.28
28	.60	<u>1804.78</u>	1800.03	.96	.83	.75	.15	.55	.26	.93	.72	.12
29	.38		.03	.96	.92	1820.03	.21	.46	.21	.89	.64	1813.92
30	.21		.00	<u>1811.06</u>	.94	<u>1820.76</u>	.25	.54	<u>1824.19</u>	.79	<u>1819.48</u>	.72
31	<u>1811.00</u>		<u>1799.92</u>		<u>1814.98</u>		<u>1825.35</u>	<u>1825.45</u>		<u>1822.73</u>		<u>1813.44</u>

WATER LEVELS, IN FEET ABOVE SEA LEVEL, FOR 1970

	January	February	March	April	May	June	July	August	September	October	November	December
1	1813.22	1805.84	1800.26	1798.97	1804.70	1809.98	1822.86	1826.38	1825.38	1824.04	1821.38	1818.28
2	.02	.64	.15	1799.04	.84	1810.30	.72	.35	.50	1823.94	.35	.04
3	1812.82	.42	.10	.05	.94	.61	.87	.33	.48	.80	.34	1817.86
4	.64	.19	1799.89	.14	1805.00	.84	1823.07	.32	.37		.43	.65
5	.50	1804.96	.78	.26	.08	1811.03	.38	.26	.53	.55	.33	.42
6	.24	.67	.64	.43	.06	.24	.74	.27	.48	.41	.33	.23
7	1811.93	.43	.60	.76	.09	.43	1824.17	.27	.46	.40	.32	.07
8	.69	.20	.47	.95	.12	.66	.50	.23	.42	.25	.33	1816.87
9	.47	1803.93	.43	1800.20	.08	.73	.69	.33	.44	.11	.28	.71
10	.28	.70	.36	.53	.12	1812.10	1825.00	.19	.38	.06		.68
11	1810.99	.49	.30	1801.03	.00	.65	.28	.09	.38	.01	.05	.42
12	.66	.24	.21	.48	.26	.80	.48	.10	.44	1822.85	.04	.20
13	.38	.10	.08	.85	.40	1813.10	.58	.01	.37	.84	.05	.00
14	.14	1802.89	1798.84	1802.25	.62	.54	.63	.26	.29	.75	1820.89	1815.94
15	1809.95	.71	.81	.54	.84	1814.06	.74	1825.90	.23	.62	.82	.66
16	.75	.67	.80	.82	1806.05	.43	.78	.78	.14	.52	.75	.64
17	.49	.42	.82	1803.03	.30	.76	.78	.77	.10	.22	.61	.45
18	.21	.30	.83	.21	.48	1815.22	1826.02	.75	.06	.21	.61	.33
19	1808.97	.10	.81	.36	.60	1816.07	1825.93	.77	.00	.10	.44	.16
20	.75	1801.94	.80	.53	.80	.94	1826.01	.65	1824.85	.01	.26	1814.90
21	.49	.79	.80	.70	1807.04	1817.82	.01	.64	.81	1821.95	.10	.80
22	.26	.55	.79	.83	.17	1818.80	.10	.64	.76	.92	1819.92	.65
23	.04	.38	.80	.95	.33	1819.55	.20	.55	.85	.85	.84	.47
24	1807.76	.21	.81	1804.04	.78	.97	.23	.52	.68	.70	.72	.27
25	.48	.06	.84	.11	.92	1820.36	.20	.45	.53	.77	.02	.02
26	.27	1800.89	.86	.24	1808.31	.68	.29	.53	.42	.82	.02	1813.77
27	1806.96	.71	.88	.33	.48	1821.06	.26	.53	.35	.71	1818.85	.55
28	.78	<u>1800.48</u>	.90	.37	.76	.59	.35	1825.45	.26	.54	.68	.27
29	.59		.92	.50	1809.10	.82	.47		.15	.49	1818.36	1813.14
30	.36		.92	<u>1804.61</u>	.35	<u>1822.14</u>	.48		<u>1824.10</u>	.40		
31	<u>1806.10</u>		<u>1798.95</u>		<u>1809.67</u>		<u>1826.41</u>			<u>1821.34</u>		

**APPENDIX II**

**PIEZOMETRIC OBSERVATIONS, RIVERHURST AREA, 1964-1970**

PIEZOMETER 1-1

Elevations: Collar - 1931.57; Ground - 1930.24; Screen - 1860.07

Installed: July 1964

Date	Level	Date	Level	Date	Level
24-09-64	1906.92	27-05-66	1910.20	08-08-68	1910.40
22-10	1907.81	02-06	.17	03-09	.29
28-11	1908.49	05	.18	03-10	.33
22-12	.77	12	.17	18	.27
20-01-65	.99	21	.12	07-11	.22
25-02	1909.26	28	.10	21	.30
25-03	.37	06-07	.14	05-12	.26
15-04	.61	09	.17	15-01-69	.24
23	.56	11	.16	17-04	1909.97
29	.54	18	.11	02-05	1910.12
06-05	.42	05-08	.20	23	.12
13	.65	08	.22	30	.09
27	.75	14	.26	12-06	1909.97
11-06	.79	16	.23	27	1910.29
25	.74	22	.28	11-07	.29
28	.84	03-09	.26	25	.30
29	.84	08	.24	15-08	.30
01-07	.85	13	.22	28	.27
03	.84	17	.21	11-09	.32
05	.85	03-11	.27	25	.24
07	.84	20-12	.25	10-10	.21
09	.84	01-03-67	.30	23	.30
13	.85	25-04	.39	05-11	.07
15	.85	03-05	.36	20	.47
17	.85	08-06	.45	18-12	.42
19	.87	16	.50	21-01-70	.32
21	.86	19	.45	20-02-70	.19
23	.86	21	.46	24-03	.24
25	.87	05-07	.47	14-04	.27
27	.86	18	.50	13-05	.18
29	.88	01-08	.53	18-06	.27
31	.88	09	.55	15-07	.26
02-08	.88	15	.53	10-08	.24
05	.89	19	.53	27	.26
07	.88	22	.55	18-09	.26
09	.89	19-09	.27	16-10	.24
11	.89	10-10	.45	18-11	.16
26	.89	24	.57	07-12-70	1910.25
07-10	.99	15-11	.48		
02-11-65	1910.01	06-12	.56		
09-12	1909.71	24-01-68	.55		
17-01-66	1910.06	14-03	.53		
09-03	1909.92	09-04	.54		
04-05	1910.01	09-05	.48		
21	.20	13	.49		
24	.18	07-06	.47		
25-05-66	1910.20	15-07-68	1910.39		

PIEZOMETER 1A

Elevations: Collar - 1931.44; Ground 1930.55; Screen - 1585.14

Installed: July 1964

Date	Level	Date	Level	Date	Level
24-09-64	1697.89	02-06-66	1699.38	08-08-68	1709.12
22-10	.37	05	.50	03-09	1708.86
28-11	.53	12	.67	03-10	1710.31
22-12	.90	21	.60	18	.94
20-01-65	1698.00	28	.14	07-11	.74
25-02	1697.93	06-07	.52	21	1711.14
25-03	.69	09	.76	05-12	.39
15-04	.80	11	.67	15-01-69	.46
23	1698.02	18	.52	17-04	.62
29	.18	05-08	.77	02-05	.96
06-05	.55	08	.65	23	1712.24
13	.47	11	.97	30	.69
27	.31	14	1700.01	12-06	.54
11-06	.55	16	.00	27	1713.44
28	.42	22	1699.71	11-07	1714.40
29	.38	03-09	1700.04	25	.25
01-07	.54	08	.19	15-08	.66
03	.61	13	.02	28	.71
05	.45	17	.34	11-09	.66
07	.52	03-11	.75	25	1715.79
09	.36	20-12	1701.49	10-10	.05
13	.48	01-03-67	.68	23	.00
15	.66	25-04	.82	05-11	.51
17	.62	03-05	.68	20	.26
19	.77	08-06	1703.02	18-12	.09
21	.74	16	.27	21-01-70	.84
23	.59	19	.44	20-02	1714.84
25	.58	21	.44	24-03	1715.25
27	.49	05-07	1704.39	14-04	.16
29	.61	18	.91	13-05	.57
31	.49	01-08	1705.21	18-06	1716.52
02-08	.66	09	.33	15-07	1717.52
05	.59	15	.55	10-08	.98
07	.52	19	.60	27	1718.19
09	.46	22	.72	18-09	.70
11	.70	19-09	1706.06	16-10	.76
26	.62	10-10	.19	18-11	.98
07-10	.88	24	.21	07-12-70	1719.04
02-11	.96	15-11	.73		
09-12	.92	06-12	.86		
17-01-66	1699.00	24-01-68	.75		
09-03	.21	14-03	.91		
04-05	.22	09-04	1707.13		
21	.82	09-05	.28		
24	.48	13	.68		
25	.44	07-06	.77		
27-05-66	1699.54	15-07	1708.86		

PIEZOMETER 1B

Elevations: Collar - 1931.88; Ground - 1930.28; Screen - 1403.08

Installed: December 1962

Date	Level	Date	Level	Date	Level
24-09-64	1746.37	02-06-66	1753.15	03-09-68	1782.98
22-10	.16	05	.23	03-10	1784.86
28-11	.11	12	.35	18	1785.63
22-12	.38	21	.38	07-11	1786.48
20-01-65	.42	28	.51	21	.67
25-02	.36	06-07	.40	05-12	1787.59
25-03	.51	09	.58	15-01-69	1788.56
15-04	.94	11	.52	17-04	.43
23	1747.23	18	.42	02-05	.92
29	.29	05-08	.71	23	1789.75
06-05	.59	08	.64	30	1790.02
13	.54	11	.91	12-06	.28
27	.88	14	.95	27	1791.10
11-06	1748.47	16	.98	11-07	.80
28	.99	22	.79	25	1793.36
29	.92	03-09	1754.28	15-08	.05
01-07	1749.11	08	.43	28	.38
03	.19	13	.44	11-09	.68
05	.19	17	.67	25	1794.14
07	.23	03-11	1756.15	10-10	.54
09	.19	20-12	1758.05	23	.73
13	.36	01-03-67	1759.59	05-11	.98
15	.57	25-04	1760.06	20	1795.56
17	.61	03-05	.17	18-12	.34
19	.78	16-06	1762.69	21-01-70	.90
21	.78	19	.97	20-02	.10
23	.73	21	1763.05	24-03	1794.49
25	.74	05-07	1764.37	14-04	.23
27	.73	08	1765.53	13-05	.28
29	.79	01-08	1766.61	18-06	.99
31	.79	09	1767.35	15-07	1796.03
02-08	.79	15	.89	10-08	.85
05	.89	19	1768.24	27	1797.33
07	.90	22	.47	18-09	1798.09
09	.89	19-09	1770.55	16-10	.53
11	1750.05	10-10	1771.88	18-11	1799.07
26	.29	24	1772.77	07-12-70	1799.13
07-10	1751.05	15-11	1774.04		
02-11	.42	06-12	1775.02		
09-12	.45	24-01-68	1776.33		
17-01-66	.90	14-03	1777.06		
09-03	1752.33	09-04	.61		
04-05	.77	09-05	1778.13		
21	1753.28	13	.38		
24	.13	07-06	.98		
25	.13	15-07	1780.83		
27-05-66	1753.19	08-08-68	1781.88		



PIEZOMETER 1C

Elevations: Collar - 1930.95; Ground - 1929.44; Screen - 1150.50

Installed: December 1962

Date	Level	Date	Level	Date	Level
24-09-64	1865.95	27-05-66	1870.36	15-07-68	1890.74
22-10	.87	02-06	.26	08-08	1891.27
28-11	.84	05	.32	03-09	1892.14
22-12	1866.15	12	.43	03-10	.74
20-01-65	.17	21	.22	18	1893.26
25-02	.53	28	.39	07-11	.23
25-03	.16	06-07	.43	21	.40
15-04	.87	09	.51	05-12	.25
23	1868.17	11	.46	15-01-69	1892.42
29	1869.01	18	.38	17-04	1891.65
07-05	.66	05-08	.60	02-05	1892.65
13	.83	08	.65	23	1893.13
27	.63	11	.93	30	.46
11-06	.61	14	1871.05	12-06	.45
25	.57	16	.18	27	1894.58
28	.68	22	.40	11-07	1895.45
29	.64	03-09	1872.14	25	.88
01-07	.77	08	.45	15-08	1896.14
03	.80	13	.58	28	.08
05	.76	17	.91	11-09	1895.77
07	.75	03-11	1874.37	25	.95
09	.69	20-12	1875.41	10-10	1896.04
13	.73	01-03-67	1874.16	23	.25
15	.89	25-04	1875.57	05-11	1895.72
17	.90	03-05	.66	20	.82
19	1870.11	08-06	1879.07	18-12-69	1894.87
21	.16	16	1880.76	21-01-70	1895.87**
23	.15	19	1881.39	20-02	1893.95
25	.15	21	.69	24-03	.15
27	.12	05-07	1883.97	14-04	.00
29	.10	18	.85	13-05	.95
31	.06	01-08	.95	18-06	1895.62
02-08	1869.93	09	1884.90	15-07	1897.68
05	.72	15	1885.29	10-08	.99
07	.58	19	.37	27	1898.83
09	.41	22	.42	18-09	1897.84
11	.42	19-09	.48	16-10	.37
26	.30	10-10	.49	18-11	.08
07-10	.35	24	.57	07-12-70	1896.75
02-11	.56	15-11	1886.25		
09-12	.35	06-12	.67		
17-01-66	.49	24-01-68	1885.34		
09-03	1870.10	14-03	.95		
04-05	.20	09-04	1886.51		
21	.49	09-05	1887.16		
24	.33	13	.41		
25-05-66	1870.33	07-06-68	1888.03		

\*\* Doubtful measurement.

PIEZOMETER 2-1

Elevations: Collar - 1869.89; Ground - 1868.49; Screen - 1785.49

Installed: July 1964

Date	Level	Date	Level	Date	Level
24-09-64	1851.39	02-06-66	1851.05	03-09-68	1850.99
22-10	.56	05	.04	03-10	.91
28-11	.45	12	1850.97	14	.89
22-12	.29	21	.89	07-11	.84
20-01-65	.30	28	.97	21	.94
25-02	.27	06-07	.97	05-12	.83
25-03	.10	09	.93	15-01-69	.81
15-04	.01	11	.95	17-04	.99
23	.24	18	.89	02-05	.79
29	.35	07-08	.90	23	.95
06-05	.40	08	.95	30	1851.09
13	.40	14	.95	12-06	.00
27	.70	16	.90	27	.26
11-06	.80	22	1851.03	11-07	.27
28	.85	03-09	1850.91	25	.20
29	.87	08	.91	15-08	.33
01-07	.85	13	.89	28	.26
03	.88	17	.85	11-09	.14
05	.89	03-11	.74	25	.37
07	.72	20-12	.59	10-10	.93
09	.85	01-03-67	.54	23	.19
13	.77	25-04	.93	05-11	.04
15	.93	03-05	1851.23	20	.23
17	.90	08-06	.29	18-12	.26
19	.89	16	.55	21-01-70	.23
21	.89	19	.56	20-02	.23
23	.87	21	.55	14-04	.14
25	.88	05-07	.55	13-05	.10
27	.87	08	.61	18-06	.29
29	.86	01-08	.68	15-07	.37
31	.88	09	.69	10-08	.31
02-08	.86	15	.70	27	.34
05	.89	19	.70	18-09	.28
07	.87	22	.71	16-10	.24
09	.88	19-09	.68	18-11	.09
11	.87	10-10	.69	07-12-70	1851.15
26	.82	24	.62		
07-10	.75	15-11	.63		
02-11	.61	06-12	.59		
09-12	.22	24-01-68	.00		
17-01-66	.27	14-03	.39		
09-03	1850.92	09-04	.31		
04-05	.82	09-05	.21		
21	1851.04	13	.21		
24	.06	07-06	.11		
25	.05	15-07	.03		
27-05-66	1851.01	08-08-68	1851.06		

PIEZOMETER 2A

Elevations: Collar - 1870.39; Ground - 1868.84; Screen - 1571.59

Installed: July 1964

Date	Level	Date	Level	Date	Level
24-09-64	1697.07	02-06-66	1700.95	07-11-68	1722.49
22-10	1696.88	05	1701.02	21	1723.23
28-11	.77	12	.11	05-12	1722.66
22-12	.99	21	.34	15-01-69	1721.27
20-01-65	1697.17	28	.19	17-04	.19
25-02	.17	06-07	.10	02-05	1722.11
25-03	.01	09	.27	23	1723.23
15-04	.60	11	.25	30	.10
23	1698.51	18	.18	12-06	1722.94
29	.77	16-08	1702.14	27	1724.63
06-05	.97	22	.24	11-07	1725.92
13	.95	03-09	.75	25	1726.29
27	.84	08	.97	15-08	.58
11-06	1699.00	13	1703.07	28	.46
28	.14	17	.27	11-09	.26
29	.08	03-11	1704.39	25	.25
01-07	.16	20-12	1705.31	10-10	.16
03	.18	01-03-67	1704.48	23	1725.94
05	.15	25-04	1706.17	05-11	.96
07	.17	03-05	.15	20	.63
09.	.13	08-06	1710.97	18-12	.04
13	.17	16	1712.31	21-01-70	1723.63
15	.40	19	.97	20-02	1722.81
17	.52	21	1713.24	14-04	1723.27
19	.65	05-07	1715.75	13-05	.30
21	.61	18	1716.40	18-06	.06
23	.53	01-08	.06	15-07	1729.97
25	.49	09	.02	10-08	.93
27	.42	15	.09	27	.71
29	.36	19	.10	18-09	.68
31	.27	22	.10	16-10	.15
02-08	.22	19-09	1715.95	18-11	1728.94
05	.10	10-10	.83	07-12-70	1728.36
07	.04	24	.92		
09	1698.96	15-11	1716.28		
11	1699.07	06-12	.16		
26	.18	24-01-68	1713.70		
07-10	.52	14-03	1714.30		
02-11	.78	09-04	1715.00		
09-12	.88	09-05	.63		
17-01-66	1700.15	13	.81		
09-03	.58	07-06	1716.77		
04-05	.77	15-07	1720.14		
21	1701.09	08-08	.57		
24	1700.91	03-09	.58		
25	.94	03-10	1722.43		
27-05-66	1700.98	18-10-68	1722.84		

PIEZOMETER 2A<sup>1</sup>

Elevations: Collar - 1870.15; Ground 1868.96; Screen - 1485.65

Installed: July 1964

Date	Level	Date	Level	Date	Level
24-09-64	1705.89	25-04-67	1712.67	05-11-69	1723.15
22-10	1706.15	03-05	.84	20	.32
28-11	1706.75	08-06	1713.57	18-12	.93
22-12	1707.04	16	1714.12	21-01-70	.51
20-01-65	.35	19	.27	20-02	.26
25-02	.69	21	.36	14-04	1722.83
25-03	.94	05-07	1715.32	13-05	.61
15-04	1708.48	18	1716.21	18-06	1723.04
23	1709.30	01-08	.85	15-07	1724.32
29	.68	09	1717.17	10-08	1726.07
06-05	.69	15	.39	27	1725.72
13	1710.15	19	.52	18-09	.99
27	.25	22	.60	16-10	1726.08
11-06	.30	19-09	1718.14	18-11	.02
28	.30	10-10	.40	07-12-70	1725.89
29	.30	24	.35		
01-07	.33	15-11	.60		
03	.35	06-12	1719.21		
05	.38	24-01-68	.61		
07	.41	14-03	1718.81		
09.	.41	09-04	.32		
13	.50	09-05	.03		
15	.52	13	.01		
17	.51	07-06	.02		
19	.61	15-07	.66		
21	.65	08-08	1719.09		
23	.69	03-09	.44		
25	.74	03-10	.70		
27	.78	18	1720.35		
29	.80	07-11	.65		
31	.81	21	.79		
02-08	.84	05-12	.89		
05	.84	15-01-69	1721.75		
07	.85	17-04	1722.15		
09	.86	02-05	1721.88		
11	.89	23	.82		
26	.95	30	.78		
07-10	1711.27	12-06	.97		
02-11	.39	27	1722.15		
09-12	.05	11-07	.33		
03-09-66	1710.44	25	.55		
08	.15	15-08	.98		
13	1709.90	28	1723.06		
17	.75	11-09	.05		
03-11	.70	25	.23		
20-12	1711.21	10-10	.13		
01-03-67	1712.83	23-10-69	1723.15		

PIEZOMETER 2B

Elevations: Collar - 1870.25; Ground - 1869.10; Screen - 1407.07  
 Installed: December 1962

Date	Level	Date	Level	Date	Level
24-09-64	1744.59	26-08-65	1751.13	19-09-67	1779.96
22-10	.29	07-10	.55	10-10	1780.02
28-11	.58	02-11	.78	24	1781.64
22-12	.70	09-12	.72	15-11	1782.76
20-01-65	1745.05	17-01-66	1752.13	06-12	1783.47
25-02	.08	09-03	.80	24-01-68	.08
25-03	.20	04-05	1753.42	14-03	.31
15-04	.85	21	.75	09-04	1784.05
23	1746.46	24	.61	09-05	.97
29	1747.01	25	.56	13	1785.21
06-05	.80	27	.67	07-06	1786.32
13	1748.18	02-06	.66	15-07	1789.83
27	.88	05	.72	08-08	1791.57
11-06	1749.53	12	.82	03-09	1793.42
28	1750.13	21	.79	03-10	1795.35
29	.06	28	.91	18	.75
01-07	.21	06-07	.84	07-11	1797.05
03	.31	09	1754.00	21	.53
05	.32	11	1753.95	05-12	.86
07	.42	18	.91	15-01-69	.81
13	.49	26	1754.10	17-04	1796.35
14	.65	31	.15	02-05	1797.21
15	.76	03-08	.23	23	.33
16	.81	05	.25	30	.53
17	.88	08	.26	12-06	.51
18	.99	11	.50	27	1800.20
19	.96	14	.61	11-07	1801.37
20	1751.00	16	.69	25	1802.19
21	1750.95	22	.80	15-08	1803.13
22	.96	03-09	1755.54	28	.45
23	.92	08	.88	11-09	.73
24	.90	13	1756.04	25	1804.20
25	.92	17	.42	10-10	.23
26	.93	03-11	1759.02	23	.32
27	.91	20-12	1761.40	05-11	.40
28	.93	01-03-67	.90	20	.47
29	.92	25-04	1762.72	18-12	1803.88
30	.89	03-05	.69	21-01-70	1804.14
31	.90	08-06	1767.04	20-02	1801.57
01-08	.92	16	1768.13	14-04	1800.38
02	.94	19	.74	13-05	.71
03	.96	21	1769.03	18-06	1802.78
04	.97	05-07	1772.06	15-07	1805.55
05	.92	18	1774.25	10-08	1806.79
06	.86	01-08	1775.90	27	1807.18
07	.88	09	1776.76	18-09	.80
08	.86	15	1777.39	16-10	.81
09	.97	19	.71	18-11	.85
11-08-65	1751.08	22-08-67	1777.97	07-12-70	1807.50

PIEZOMETER 2C

Elevations: Collar - 1871.36; Ground - 1870.16; Screen - 1167.86

Installed: December 1962

Date	Level	Date	Level	Date	Level
24-09-64	1841.96	09-08-65	1847.94	10-10-67	1873.36
22-10	.88	11	.90	24	.36
28-11	.91	26	1848.47	15-11	.36
22-12	1842.26	07-10	.61	06-12	1875.36
20-01-65	.23	02-11	.57	24-01-68	*
25-02	.26	09-12	.38	14-03	.36
25-03	.43	17-01-66	.69	09-04	1876.86
15-04	1843.78	09-03	1849.56	09-05	1879.01
23	1847.86	04-05	1850.05	13	.42
29	1849.44	21	.54	07-06	1880.86
06-05	.56	24	.28	15-07	1883.86
13	.41	25	.26	08-08	.36
27	1848.81	27	.27	03-09	1884.36
11-06	.94	02-06	.22	03-10	.36
25	1849.26	05	.30	18	.36
28	.28	12	.52	07-11	1883.36
29	.30	21	.26	21	1883.36
01-07	.28	28	.54	05-12	*
03	.20	06-07	.54	15-01-69	*
05	.19	09	.67	17-04	1880.36
07	.15	11	.71	02-05	1884.36
08	.18	18	.59	23	1880.36
09	.10	26	.73	30	1881.36
10	.20	31	.76	12-06	.36
11	.12	03-08	.86	27	.36
12	.07	05	1851.09	11-07	.36
13	.00	08	.41	25	1885.36
14	.24	11	.88	15-08	1890.50
15	.46	14	1852.27	28	1889.86
16	.66	16	.51	11-09	.36
17	.94	22	1853.20	25	1888.36
18	1850.20	03-09	1854.54	10-10	.36
19	.32	08	1855.00	23	1889.36
20	.39	13	.38	05-11	.36
21	.34	17	.82	20	1888.36
22	.30	03-11	1857.58	18-12	1888.36
23	.20	20-12	1859.48	21-01-70	*
24	.13	01-03-67	1856.33	20-02	*
25	.06	25-04	1859.96	24-03	*
26	1849.92	03-05	1860.11	14-04	*
27	.78	08-06	1869.06	13-05	1885.36
28	.66	16	1871.36	18-06	1889.36
29	.43	19	.55	15-07	1893.36
30	.24	21	.65	10-08	1892.36
31	.08	05-07	1874.86	27	.13
01-08	1848.96	18	1875.36	18-09	1892.36
02	.80	01-08	1874.36	16-10	1891.36
03	.66	08	.59	18-11	1890.36
04	.53	19	1873.84	07-12-70	*
05	.47	22	.99		
07-08-65	1848.22	19-09-67	1873.36		

\* Frozen

PIEZOMETER 3A

Elevations: Collar - 1883.23; Ground - 1882.04; Screen - 1563.73

Installed: July 1964

Date	Level	Date	Level	Date	Level
24-09-64	1698.08	12-06-66	1700.44	03-09-68	1713.78
22-10	1697.89	21	.31	03-10	1714.67
28-11	.87	28	.38	18	.98
22-12	1698.08	06-07	.35	07-11	1715.18
20-01-65	.18	09	.50	21	.47
25-02	.20	11	.48	05-12	.59
25-03	.03	18	.39	15-01-69	1714.91
15-04	.48	31	.54	17-04	.10
23	.92	05-08	.54	02-05	.59
29	.99	08	.54	23	1715.23
06-05	1699.38	11	.67	30	.49
13	.38	14	.77	12-06	.22
27	.33	16	.83	27	1716.52
11-06	.43	22	.77	11-07	1717.18
28	.58	03-09	1701.16	25	.60
01-07	.55	08	.30	15-08	1718.08
03	.58	13	.34	28	.18
05	.53	17	.50	11-09	.10
09	.48	03-11	1702.30	25	.51
13	.49	20-12	.48	10-10	.23
15	.67	01-03-67	.76	23	.19
17	.74	25-04	1703.16	04-11	.23
19	.83	03-05	.23	20	.10
21	.80	08-06	1705.40	18-12	.11
23	.73	16	1706.35	21-01-70	1717.05
25	.67	19	.69	20-02	1716.10
27	.60	21	.81	14-04	.33
29	.58	05-07	1708.36	13-05	.88
31	.52	18	1709.39	18-06	1719.14
02-08	.54	01-08	.84	15-07	1720.11
05	.52	09	.99	10-08	.60
07	.49	15	1710.15	27	.90
09	.51	19	.18	18-09	1721.18
11	.53	22	.26	16-10	.00
26	.56	19-09	.49	18-11	.15
07-10	.66	10-10	.53	07-12-70	1720.80
02-11	.68	24	.61		
09-12	.53	15-11	.82		
17-01-66	.69	06-12	.89		
09-03	1700.05	24-01-68	1709.71		
04-05	.00	14-03	.41		
21	.44	09-04	.75		
24	.35	09-05	1710.07		
25	.35	13	.27		
27	.38	07-06	.69		
02-06	.27	15-07	1712.48		
05-06-66	1700.32	08-08-68	1713.23		

PIEZOMETER 3C

Elevations: Collar - 1883.01; Ground - 1881.60; Screen - 1173.71

Installed: July 1964

Date	Level	Date	Level	Date	Level
24-09-64	1866.31	12-06-66	1870.95	07-06-68	1889.51
22-10	.51	21	.80	15-07	1891.01
28-11	.78	28	.90	08-08	.01
22-12	.89	06-07	.89	03-09	.01
20-01-65	.89	09	.99	03-10	.01
25-02	1867.01	11	1871.02	18	1892.01
25-03	.13	18	1870.95	07-11	1891.01
15-04	.24	26	.91	21	1890.01
23	1869.52	31	.91	05-12	.01
29	1870.42	03-08	.97	15-01-69	*
06-05	.78	05	1871.08	17-04	1888.01
13	.93	08	.23	02-05	1892.01
27	.67	11	.55	23	1888.01
11-06	.41	14	.71	30	1889.01
28	.61	16	.86	12-06	1887.01
01-07	.50	22	1872.43	27	.01
03	.60	03-09	1873.09	11-07	1888.01
05	.56	08	.32	25	1892.01
09	.55	13	.51	15-08	1896.66
13	.58	17	.77	28	.01
15	.72	03-11	1875.15	11-09	.01
17	1871.01	20-12	1876.08	25	1895.01
19	.22	01-03-67	1874.26	10-10	1894.01
21	.30	25-04	1876.27	23	1895.01
23	.19	03-05	.38	05-11	.01
25	.07	08-06	1880.59	20	.01
27	1870.86	16	1882.53	18-12	1894.01
29	.74	17	.93	21-01-70	*
31	.57	18	1883.01	20-02	*
02-08	.42	19	.20	24-03	*
05	.14	21	.91	14-04	1892.01
07	1869.93	05-07	1887.01	13-05	1893.01
09	.80	18	.01	18-06	1896.01
11	.74	01-08	.01	15-07	1898.01
26	.96	09	1886.42	10-08	.01
07-10	1870.06	19	.57	27	1897.54
02-11	1869.99	22	.50	18-09	1898.01
09-12	.76	19-09	.01	16-10	1897.01
17-01-66	.77	10-10	.01	18-11	1896.01
09-03	1870.47	24	.01	07-12-70	*
04-05	.61	15-11	.01		
21	.97	06-12	.01		
24	.89	24-01-68	1885.01		
25	.80	14-03	.01		
27	.76	09-04	1887.01		
02-06	.71	09-05	1888.35		
05-06-66	1870.76	13-05-68	1888.99		

\* Frozen



PIEZOMETER 4-1

Elevations: Collar - 1852.71; Ground - 1852.50; Screen - 1794.41

Installed: July 1963

Date	Level	Date	Level
01-09-64	<1792.21 1)	18-04-69	1798.73
18-07-67	<1792.21	02-05	1799.75
01-08	1793.45	23	1801.51
09	1794.43	30	1802.20
11	.37	12-06	1803.40
15	.66	27	1805.14
19	.91	11-07	1807.07
22	1795.12	25	1809.07
19-09	1796.31	08-08	1810.51
10-10	.87	15	1811.44
24	.85	28	1812.09
15-11	1797.47	11-09	.25
06-12	.63	25	.04
24-01-68	1795.65	10-10	1811.69
14-03	1793.11	23	.35
09-04	1792.61	05-11	1810.41
09-05	.65	20	1809.57
13	.71	18-12	1807.61
07-06	1793.01	21-01-70	.26
15-07	1797.63	20-02	1802.17
08-08	1800.49	24-03	1799.85
03-09	1802.43	13-05	1800.11
03-10	1805.06	18-06	1802.57
18	1806.21	15-07	1808.77
07-11	.91	10-08	1812.71
21	1807.37	27	.95
05-12	.19	18-09	1813.25
20	1806.91	16-10	1811.68
10-01-69	1805.76	18-11	1810.35
07-02-69	1803.69	08-12-70	1810.31

1) Dry

PIEZOMETER 4A

Elevations: Collar - 1853.30; Ground - 1853.10; Screen - 1577.00

Installed: July 1963

Date	Level	Date	Level	Date	Level
24-09-64	1835.06	07-08-65	1835.29	24-10-67	1843.03
22-10	1834.96	08	.27	15-11	.34
24-11	1835.09	09	.27	06-12	.40
22-12	.12	11	.34	24-01-68	1842.10
20-01-65	.16	26	.29	14-03	1841.95
25-02	.36	07-10	.38	09-04	.98
01-04	.27	10-11	.20	09-05	1842.12
13	.34	09-12	.26	13	.24
21	.73	18-01-66	.36	07-06	.56
28	.79	28-02	.40	15-07	1844.55
07-05	.69	13-04	.35	08-08	1845.46
14	.55	21-05	.53	03-09	1846.70
26	.59	23	.44	03-10	1847.97
09-06	.52	25	.43	18	1848.60
23	.46	27	.43	07-11	.90
24	.52	31	.41	21	1849.05
25	.59	02-06	.40	05-12	1848.95
26	.61	05	.41	20	.63
28	.43	08	.40	10-01-69	.07
29	.47	13	.37	07-02	1847.57
01-07	.53	21	.42	18-04	1846.87
03	.44	28	.46	02-05	.90
05	.40	06-07	.41	23	1847.20
07	.40	11	.42	30	.64
08	.40	19	.35	12-06	.82
09	.36	05-08	.45	27	1848.56
10	.49	08	.49	11-07	1849.74
11	.47	11	.54	25	1850.30
12	.45	14	.58	08-08	.65
13	.42	22	.54	15	.90
14	.41	03-09	.63	28	1851.00
15	.53	08	.70	11-09	.10
16	.51	12	.69	25	.05
17	.53	17	1836.02	10-10	.12
18	.57	03-11	.92	23	1850.94
19	.54	20-12	1837.07	05-11	.88
20	.51	01-03-67	1836.83	20	.58
21	.48	25-04	1837.12	18-12	1849.80
22	.47	04-05	.18	21-01-70	1848.84
23	.42	08-06	1838.55	20-02	1847.82
24	.39	16	.95	24-03	.20
25	.40	19	1839.16	16-04	.09
26	.35	21	.31	13-05	.11
27	.34	05-07	1840.50	18-06	1848.25
28	.31	18	.90	15-07	1850.65
30	.36	01-08	1841.53	10-08	1851.24
31	.34	09	.64	27	.28
02-08	.36	15	.82	18-09	.48
03	.37	19	.91	16-10	.10
04	.37	22	.98	18-11	1850.85
05	.34	19-09	1842.54	08-12-70	1850.24
06-08-65	1835.28	10-10-67	1842.89		

PIEZOMETER 4A<sup>1</sup>

Elevations: Collar - 1852.91; Ground - 1852.80; Screen - 1503.55  
 Installed: July 1964 1)

Date	Level	Date	Level	Date	Level
24-09-64	1834.95	06-08-65	1832.72	19-09-67	1801.07
22-10	1835.50	07	.74	10-10	1802.50
24-11	.46	08	.75	24	1807.16
22-12	1832.50	09	.76	15-11	1809.27
20-01-65	1829.16	11	.78	06-12	1810.15
25-02	1827.31	26	.92	24-01-68	.43
01-04	1826.50	07-10	1833.20	14-03	1807.26
13	1827.15	10-11	.14	09-04	1806.12
21	.88	09-12	.13	09-05	1805.31
28	1828.47	18-01-66	1830.88	13	.19
07-05	1829.14	28-02	1828.28	07-06	1804.44
14	.56	13-04	1829.30	15-07	.44
26	1830.29	21-05	1830.22	08-08	.91
09-06	.61	23	.23	03-09	1807.51
23	1831.55	25	.22	03-10	1811.65
24	.57	27	.32	18	1813.11
25	.59	31	.38	07-11	1814.69
26	.64	02-06	.42	21	1816.09
28	.72	05	.46	05-12	.83
29	.75	08	.51	20	1817.37
01-07	.82	13	.55	10-01-69	.77
03	.85	21	.63	07-02	.35
05	.92	28	.72	18-04	1813.47**
07	.97	06-07	.68	02-05	1810.91
08	1832.05	11	.86	23	.32
09	.08	19	.90	30	.41
11	.14	08-08	1831.70	12-06	.39
12	.16	09	.49	27	.82
13	.20	11	.11	11-07	1811.43
14	.23	14	1830.83	25	1812.23
15	.25	16	.53	08-08	1814.01
16	.28	22	.47	15	.71
17	.30	03-09	1829.13	28	1815.74
18	.33	08	1828.83	11-09	1816.52
19	.36	12	.51	25	1817.54
20	.38	17	.20	10-10	1818.22
21	.41	03-11	1812.52	23	.53
22	.43	20-12	1801.30	05-11	.76
23	.45	01-03-67	.29	20	.82
24	.48	04-05	1815.81	18-12	.51
25	.50	08-06	1804.03	21-01-70	1818.08
26	.52	16	1803.47	20-02	1816.24
27	.54	19	.33	24-03	1814.68
28	.56	21	.08	16-04	1813.56
29	.58	05-07	1801.81	14-05	.38
30	.60	18	.51	18-06	1813.71**
31	.62	01-08	.85	15-07	1814.41
01-08	.64	09	.06	10-08	1815.58
02	.66	11	1798.92	27	1816.21
03	.68	15	1793.36	18-09	.91
04	.70	19	1794.36	16-10	1817.50
05-08-65	1832.71	22-07-67	1794.51	18-11	.38
				08-12-70	1817.54

1) Some cement in screen  
 \*\* Doubtful measurement

PIEZOMETER 4B

Elevations: Collar - 1852.80; Ground - 1852.80; Screen - 1425.88

Installed: June 1963

Date	Level	Date	Level	Date	Level
24-09-64	1746.66	09-08-65	1757.31	24-10-67	1806.95
22-10	.67	10	.27	15-11	1810.05
24-11	.84	11	.49	06-12	1811.74
22-12	.88	26	.40	24-01-68	.90
20-01-65	1747.02	07-10	.93	14-03	.49
25-02	.67	10-11	.73	09-04	1813.00
01-04	.85	09-12	.61	09-05	1814.82
13	.78	08-01-66	1758.18	13	1815.18
21	1749.43	28-02	1759.76	07-06	1817.35
23	1753.29	13-04	1760.83	15-07	1823.95
07-05	.34	21-05	1761.36	08-08	1826.99
14	1754.16	23	.28	03-09	1828.05
26	.94	25	.23	03-10	1830.29
09-06	1755.50	27	.24	18	1831.10
23	1756.05	31	.02	07-11	1830.48
24	.17	02-06	.26	21	.88
25	.35	05	.30	05-12	1831.82
26	.48	08	.39	20	.32
28	.60	13	.59	10-01-69	1827.09
29	.60	21	.78	07-02	1826.57
01-07	.73	28	.76	17-04	1820.94
03	.65	06-07	.84	02-05	1829.52
05	.71	11	1762.01	23	1831.08
07	.80	19	.06	30	.72
09	.88	01-08	.32	12-06	1832.65
13	1757.05	05	.40	27	1834.20
14	.15	08	.65	11-07	1836.27
15	.26	11	1762.96	25	.12
16	.34	14	1763.17	08-08	1837.90
17	.50	16	.44	15	.98
18	.67	22	1764.06	28	.89
19	.77	03-09	1765.58	11-09	1838.05
20	.87	08	1766.22	25	1837.90
21	.92	12	.74	10-10	1838.24
22	.97	17	1767.45	23	.00
23	.99	03-11	1771.05	05-11	1837.85
24	1758.01	20-12	1774.39	20	.80
25	.04	01-03-67	1773.27	18-12	1836.80
26	.06	25-04	1774.25	21-01-70	.96
27	.06	04-05	1775.14	20-02	1833.26
28	.04	16-06	1787.73	24-03	1831.50
29	.02	19	1789.27	16-04	1830.99
30	1757.97	21	1790.09	13-05	1831.16
31	.92	05-07	1796.21	18-06	1834.26
01-08	.89	18	1798.51	15-07	1838.19
02	.86	01-08	1800.51	10-08	1841.38
03	.81	09	.83	27	.29
04	.75	15	1801.92	18-09	.72
05	.64	19	1802.26	16-10	1840.96
06	.54	22	.55	18-11	.03
07	.47	19-09	1804.18	08-12-70	1839.50
08-08-65	1757.39	10-10-67	1805.42		

PIEZOMETER 4C

Elevations: Collar - 1852.36; Ground - 1852.30; Screen - 1172.70

Installed: July 1963

Date	Level	Date	Level	Date	Level
24-09-64	1823.74	05-07-65	1832.22	19-09-67	1863.36
22-10	.68	06	.12	10-10	.36
24-11	.57	07	.02	24	1866.36
22-12	.65	08	1831.93	15-11	1868.36
20-01-65	.80	09	.84	06-12	.36
25-02	1824.03	10	.77	24-01-68	*
01-04	.02	11	.71	14-03	*
13	.13	26	.66	09-04	*
21	1827.20	07-10	.88	09-05	1871.56
28	1829.66	02-11	.83	13	1872.20
07-05	1830.55	09-12	.76	07-06	1873.86
14	.74	18-01-66	1832.25	15-07	1875.36
26	.86	28-02	1833.45	08-08	1876.36
09-05	1831.05	13-04	1834.45	03-09	1877.36
23	.33	21-05	.66	03-10	.36
24	.37	23	.68	18	1876.36
25	.49	25	.66	07-11	.36
26	.63	27	.66	21	.36
28	.80	31	.62	05-12	*
29	.91	02-06	.63	20	*
01-07	.95	05	.68	10-01-69	*
03	.78	08	.77	07-02	*
05	.95	13	.97	18-04	*
07	.85	21	.89	02-05	1878.36
08	.86	28	1835.10	23	1875.36
09	.87	06-07	.20	30	.36
10	.89	11	.34	12-06	1874.36
11	.92	19	.36	27	1875.36
12	.93	01-08	.47	11-07	.36
13	.92	03	.49	25	1880.36
14	.95	05	.53	08-08	.36
15	1832.03	08	.79	15	1885.00
16	.16	11	1836.13	28	1884.36
17	.33	14	.46	11-09	.36
18	.53	16	.70	25	1883.36
19	.71	22	1837.38	10-10	.36
20	.86	03-09	1838.78	23	.36
21	.95	08	1839.28	05-11	.36
22	1833.00	12	.70	20	.36
23	.02	17	1840.15	18-12	1882.36
24	.02	03-11	1843.01	21-01-70	*
25	1832.99	20-12	1845.33	20-02	*
26	.95	01-03-67	1843.23	24-03	*
27	.89	25-04	1845.35	16-04	1879.36
28	.80	04-05	.72	13-05	.36
29	.91	08-06	1852.80	18-06	1883.36
30	.80	21	1859.52	15-07	1887.36
31	.70	18-07	1861.36	10-08	.36
01-08	.60	01-08	.36	27	1886.53
02	.50	09	1862.29	18-09	.36
03	.40	19	1863.66	16-10	.36
04-08-65	1832.30	22-08-67	1863.68	18-11	1885.36
				08-12-70	*

\* Frozen

PIEZOMETER 5-1

Elevations: Collar - 1958.09; Ground - 1956.56; Screen - 1751.62

Installed: July 1963

Date	Level	Date	Level	Date	Level
24-09-64	1791.55	25-05-66	1791.09	15-07-68	1792.18
22-10	.24	27	.61	08-08	.25
24-11	1792.00	31	.31	03-09	.40
22-12	1791.57	02-06	.05	03-10	.67
20-01-65	.72	08	.31	18	1793.14
25-02	.52	13	1790.97	07-11	.19
01-04	.44	21	1791.20	21	.28
13	.42	28	.23	05-12	.50
21	.40	06-07	.36	20	.62
28	.59	11	.05	10-01-69	.63
07-05	.11	19	.22	07-02	.93
14	.10	01-08	.31	18-04	.86
26	.10	05	.34	02-05	1794.07
09-06	.18	08	.38	23	.94
23	.09	14	.40	30	.92
24	.27	16	.46	12-06	.58
25	.60	22	.32	27	.98
26	.55	03-09	.14	11-07	1795.38
28	1790.85	08	.30	25	.56
29	.99	12	.01	08-08	.42
01-07	1791.37	17	.32	15	.69
03	.41	03-11	.27	28	.66
05	.27	20-12	.18	11-09	.89
07	.13	01-03-67	.17	25	.84
09	.13	25-04	.05	10-10	.67
13	.09	04-05	.22	23	1796.15
15	.51	16-06	.12	05-11	.57
19	.31	19	.21	20	.60
21	.23	21	1790.93	18-12	.09
23	.22	05-07	1791.14	21-01-70	1797.14
25	.34	18	.25	20-02	1796.89
27	.24	01-08	.14	24-03	.98
29	.26	09	.28	16-04	.76
31	.30	15	.37	13-05	.79
02-08	.45	19	.54	18-06	1797.01
05	.23	22	.32	15-07	.79
07	.33	19-09	.72	10-08	1798.09
09	.24	10-10	.77	27	1797.65
26	.17	24	.11	18-09	1798.25
07-10	.18	15-11	.96	16-10	.55
02-11	.50	06-12	.84	18-11	.62
09-12	.21	24-01-68	1792.19**	08-12-70	1798.54
18-01-66	.43	14-03	1791.96		
28-02	.09	09-04	1792.07		
13-04	.00	09-05	.25		
21-05	.56	13	.35		
23-05-66	1791.01	07-06-68	1792.12		

\*\* Doubtful measurement

PIEZOMETER 5A

Elevations: Collar - 1969.04; Ground - 1967.58; Screen - 1577.04

Installed: July 1963

Date	Level	Date	Level	Date	Level
24-09-64	1915.45	21-05-66	1915.77	14-03-68	1919.24
22-10	.36	23	.71	09-04	.34
24-11	.49	25	.67	09-05	.54
22-12	.46	27	.71	13	.70
20-01-65	.54	31	.69	07-06	.73
25-02	.66	02-06	.67	15-07	1920.26
01-04	.62	05	.67	08-08	.37
13	.59	08	.64	03-09	.73
21	.75	13	.66	03-10	1921.20
28	.76	21	.62	18	.19
07-05	.75	28	.78	07-11	.54
14	.61	06-07	1916.00	21	.55
26	.71	11	1915.72	05-12	.71
11-06	.66	19	.63	20	.71
23	.56	01-08	.73	10-01-69	.82
24	.60	05	.75	07-02	.96
25	.67	08	.83	18-04	1919.95**
26	.84	11	.86	02-05	1922.21
28	.55	14	.92	23	.30
29	.59	16	.86	30	.62
01-07	.65	22	.75	12-06	.54
03	.55	03-09	.88	27	.94
05	.61	08	.85	11-07	1923.23
07	.51	12	.86	25	.30
09	.56	17	.92	08-08	.29
13	.54	03-11	.94	15	.43
15	.71	20-12	1916.31	28	.43
17	.71	01-03-67	.36	11-09	.38
19	.74	25-04	.46	25	.58
21	.73	04-05	.52	10-10	.73
23	.65	08-06	1917.04	23	.70
25	.60	16	.08	05-11	.86
27	.61	19	.19	20	.82
29	.55	21	.19	18-12	.65
31	.52	05-07	.49	21-01-70	.82
02-08	.60	18	.59	20-02	.73
05	.58	01-08	.71	24-03	.79
07	.56	09	.75	16-04	1924.02
09	.52	15	.85	13-05	1923.94
11	.56	19	.86	18-06	1924.19
26	.52	22	.93	15-07	.52
07-10	.67	19-09	1918.25	10-08	.54
02-11	.52	10-10	.45	27	.60
09-12	.50	24	.48	18-09	.77
18-01-66	.67	15-11	.86	16-10	.79
28-02	.62	06-12	.97	18-11	.79
13-04-66	1915.64	24-01-68	1919.04	08-12-70	1924.93

\*\* Doubtful measurement

PIEZOMETER 5B

Elevations: Collar - 1968.65; Ground - 1967.07; Screen - 1414.15

Installed: July 1963

Date	Level	Date	Level	Date	Level
24-09-64	1762.05	23-05-66	1766.18	14-03-68	1802.97
22-10	1761.53	25	.20	09-04	1803.22**
24-11	1760.79	27	.20	09-05	1805.07
22-12	1759.98	31	.25	13	.40
20-01-65	.25	02-06	.26	07-06	1806.54
25-02	1758.39	05	.18	15-07	1810.40
01-04	1757.70	08	.26	08-08	1812.35
13	.73	13	.40	03-09	1814.20**
21	.95	21	.61	03-10	1816.56
28	1758.13	28	.48	18	1817.55
07-05	.92	06-07	.63	07-11	.85
14	1759.47	11	.73	21	1819.02
26	1760.30	19	.71	05-12	.63
11-06	1761.10	02-08	.09	20	.87
23	.69	03	.21	10-01-69	.83
24	.71	07	.17	07-02	.70
25	.61	08	.23	18-04	1801.33**
26	.67	09	.26	02-05	1812.15
28	.73	11	.35	23	1813.22
29	.89	14	.45	30	.63
01-07	.78	16	.50	12-06	1821.18
03	.85	22	.48	27	1822.41
05	1762.06	03-09	1767.29	11-07	1823.65
07	1761.96	08	.63	25	1824.48
09	1762.04	12	.84	08-08	1825.12
13	.17	17	1768.18	15	.49
15	.41	03-11	1770.85	28	.90
17	.44	20-12	1773.62	11-09	1826.28
19	.56	01-03-67	1774.95	25	.61
21	.64	25-04	.77	10-10	.81
23	.70	04-05	1775.30	23	.97
25	.72	08-06	1779.15	05-11	1827.20
27	.77	16	.94	20	.23
29	.81	19	1780.65	18-12	.75
31	.84	21	1781.04	21-01-70	1829.20
02-08	.90	05-07	1784.50	20-02	1824.43
05	.98	18	1787.30	24-03	1823.26
07	1763.06	01-08	1789.43	16-04	1821.74
09	.01	09	1790.59	13-05	1823.45
11	.10	15	1791.36	18-06	1825.23
26	.09	19	.83	15-07	1827.95
07-10	.57	22	1792.15	10-08	1829.34
02-11	.62	19-09	1794.84	27	.94
09-12	.87	10-10	1796.37	18-09	1830.63
18-01-66	1764.06	24	1797.27	16-10	.82
28-02	.81	15-11	1799.26	18-11	.69
13-04	1765.40	06-12	1801.43	08-12-70	1830.63
21-05-66	1766.15	24-01-68	1801.47**		

\*\* Doubtful measurement



PIEZOMETER 5C

Elevations: Collar - 1968.46; Ground - 1966.91; Screen - 1176.96

Installed: July 1963

Date	Level	Date	Level	Date	Level
24-09-64	1835.92	23-05-66	1844.88	24-01-68	1872.62**
22-10	.83	25	.75	14-03	1875.04
24-11	1836.03	27	.84	09-04	.80
22-12	.19	31	.78	09-05	1876.82
20-01-65	.14	02-06	.81	13	1877.14
25-02	.05	05	.88	07-06	1878.21
01-04	.22	08	.94	15-07	1881.80
13	.19	13	1845.03	08-08	.34**
21	1838.15	21	.04	03-09	1883.74
28	1839.96	28	.17	03-10	1885.09
07-05	1840.65	06-07	.26	18	.54
14	.91	11	.34	07-11	.01
26	1841.10	19	.32	21	1886.01
11-06	.48	02-08	1844.81	05-12	1885.91
23	.74	03	1845.04	20	.65
24	.86	05	.19	10-01-69	1884.85
25	1842.06	07	1844.98	07-02	.00
26	.17	08	1845.12	18-04	1876.76**
28	.01	09	.17	02-05	1884.76
29	1841.99	11	.41	23	1885.56
01-07	1842.25	14	.63	30	.71
03	.29	16	.84	12-06	1886.22
05	.27	22	1846.18	27	1887.25
07	.19	03-09	1847.31	11-07	1888.46
09	.20	08	.79	25	.89
13	.32	12	1848.07	08-08	1889.15
15	.50	17	.50	15	.28
17	.73	03-11	1851.24	28	.31
19	1843.00	20-12	1853.33	11-09	.16
21	.24	01-03-67	1852.12	25	.20
23	.23	25-04	1853.36	10-10	.08
25	.23	04-05	.84	23	1888.99
27	.16	08-06	1860.38	05-11	1889.07
29	.09	16	1861.53	20	1888.86
31	1842.94	19	1862.47	18-12	1887.57
02-08	.88	21	.92	21-01-70	1886.49
05	.64	05-07	1866.45	20-02	1884.96
07	.48	18	1868.01	24-03	.46
09	.29	01-08	.61	16-04	.88
11	.34	09	.96	13-05	1885.76
26	.42	15	1869.27	18-06	1888.05
07-10	.79	19	.44	15-07	1890.81
02-11	.79	22	.54	10-08	1891.21
09-12	.65	19-09	1870.26	27	.07
18-01-66	.90	10-10	.80	18-09	.20
28-02	1843.86	24	1872.14	16-10	1890.69
13-04	1844.96**	15-11	1874.36	18-11	.30
21-05-66	1844.98	06-12-67	1875.28	08-12-70	1889.74

\*\* Doubtful measurement

PIEZOMETER 6-1

Elevations: Collar - 1699.94; Ground - 1699.40; Screen - 1592.94  
 Installed: June 1964

Date	Level	Date	Level	Date	Level
27-06-64	1694.79	28-08-64	1689.09	22-07-65	1727.31
01-07	.00	29	.03	27	1723.39
03	1693.77	10-09	1688.74	04-08	1717.38
04	.61	24	.50	08	1716.00
11	1692.40	22-10	.36	15-07-66	1725.50
13	.55	24-11	.79	18	.50
17	.19	22-12	1689.04	03-08	1728.20
20	.11	20-01-65	.89	09	.70
27	1691.23	25-02	1690.39	12	1730.50
01-08	1690.67	01-04	1691.54	15	1731.50
03	1689.77	13	1693.19	04-09	1736.46
18	.31	21	Flooded <sup>1)</sup>	11	1737.27
21	.15	29-06	1723.85	18	1739.58
24	.07	06-07	1724.77	14-08-67	1806.46
25	.03	14	.77	22-08-67	1806.66
26-08-64	1689.18	19-07-65	1728.47		

PIEZOMETER 6A

Elevations: Collar - 1701.05; Ground - 1699.49; Screen - 1525.56  
 Installed: June 1964

Date	Level	Date	Level	Date	Level
19-06-64	1703.55	27-07-65	1726.96	12-08-66	1739.73
05-03-65	.47	04-08	1720.26	15	1740.33
29-06	1724.65 <sup>1)</sup>	08	1719.57	04-09	1742.19
06-07	1727.89	15-07-66	1726.48	11	.88
14-07	1729.04	18	.48	18-09-66	1746.11
19	1731.58	03-08	1731.33		
22-07-65	1732.28	09-08-66	1737.33		

1) Piezometers flooded on April 21, 1965. Later measurements by means of pressure transducers.

PIEZOMETER 6B

Elevations: Collar - 1700.63; Ground - 1699.36; Screen - 1436.67

Installed: June 1964

Date	Level	Date	Level	Date	Level
19-06-64	1727.06	08-08-65	1749.41	15-08-66	1759.58
05-03-65	1734.05	15-07-66	1754.38	04-09	1761.88
19-07	1756.11 <sup>1)</sup>	18	.08	11	1762.35
22	.57	03-08	.38	18-09-66	1762.81
27	1754.49	09	1756.78		
04-08-65	1750.34	12-08-66	1758.98		

PIEZOMETER 6C

Elevations: Collar - 1701.46; Ground - 1698.98; Screen - 1196.85

Installed: June 1964

Date	Level	Date	Level	Date	Level
22-08-64	1785.27	27-07-65	1831.60	12-08-66	1831.90
05-03-65	1815.88	04-08	1829.00	15	1833.00
29-06	1826.90 <sup>1)</sup>	08	1826.90	04-09	1838.88
06-07	1827.00	15-07-66	1828.00	11	1840.28
14	1828.80	18	.10	18	1841.18
19	1831.80	03-08	.80	14-08-67	1871.93
22-07-65	1832.90	09-08-66	1831.00	22-08-67	1872.25

1) Piezometers flooded on April 21, 1965. Later measurements by means of pressure transducers.

PIEZOMETER 7-1

Elevations: Collar - 1705.70; Ground - 1704.43; Screen - 1609.30  
Installed: June 1964

Date	Level	Date	Level
24-09-64	1690.17	25-02-65	1693.46
22-10	1691.47	01-04	.70
24-11	1692.42	13	1693.81
22-12	.85	21-04-65	Flooded
20-01-65	1693.10		

PIEZOMETER 7A

Elevations: Collar - 1705.98; Ground - 1704.70; Screen - 1528.98  
Installed: June 1964

Date	Level	Date	Level
11-08-64	1706.42	05-03-65	1706.42
		21-04-65	Flooded

PIEZOMETER 7B

Elevations: Collar - 1706.03; Ground - 1704.63; Screen - 1437.83  
Installed: June 1964

Date	Level	Date	Level
28-08-64	1729.11	05-03-65	1729.03
		21-04-65	Flooded

PIEZOMETER 7C

Elevations: Collar - 1706.27; Ground - 1704.43; Screen - 1210.97  
Installed: June 1964

Date	Level	Date	Level
17-08-64	1779.48	05-03-65	1780.27
		21-04-65	Flooded

PIEZOMETER 8-1

Elevations: Collar - 1946.32; Ground - 1946.22; Screen - 1939.32

Installed: July 1966

Date	Level	Date	Level
01-08-66	1938.26	03-09-68	1937.32
06	.15	03-10	.65
08	.11	18	.87
11	.13	07-11	.82
14	.13	21	.52
16	.12	05-12	.92
22	1937.93	20	.86
03-09	.84	07-02-69	.80
08	.87	18-04	1939.26
12	.80	02-05	.97
17	.78	23	.65
03-11	.52	30	.33
20-12	.30	12-06	1938.90
01-03-67	1936.98	27	.76
25-04	1944.34	11-07	.56
04-05	1943.22	25	.61
16-06	1939.98	08-08	.49
19	.89	15	.43
21	.76	28	.13
05-07	.18	11-09	1937.93
18	1938.82	25	1938.31
01-08	.40	10-10	1937.77
09	.25	23	.88
15	.18	05-11	1938.07
19	.14	20	.32
22	.05	18-12	.02
19-09	1937.66	21-01-70	.01
10-10	.69	20-02	.01
24	.62	24-03	1937.52
15-11	.69	16-04	1941.03
06-12	.62	18-06	.32
24-01-68	.22	15-07	1940.05
14-03	.14	10-08	1939.61
09-04	.24	27	1938.97
09-05	.77	18-09	.73
13	.86	16-10	.57
07-06	.79	18-11	.48
15-07	.32	08-12-70	1938.37
08-08-68	1937.22		

PIEZOMETER 8A

Elevations: Collar - 1948.74; Ground - 1946.57; Screen - 1605.23

Installed: June 1966

Date	Level	Date	Level
11-06-66	1944.06	09-05-68	1945.95
13	.66	13	.98
15	.71	07-06	1946.11
21	.61	15-07	.03
28	.90	08-08	.12
06-07	.84	03-09	.02
11	1945.02	03-10	.45
19	1944.98	18	.63
26	.95	07-11	.68
01-08	.96	21	.66
06	.98	05-12	*
08	1945.02	20	*
11	.00	07-02-69	*
14	.02	18-04	1948.43
16	.06	02-05	.44
22	1944.85	23	.30
03-09	1945.06	30	.31
08	.13	12-06	.34
12	.09	27	.34
17	.08	11-07	.37
03-11	.03	25	.39
20-12	.24	08-08	.43
01-03-67	.23	15	.42
25-04	.17	28	.40
04-05	.39	11-09	.38
08-06	.46	25	.45
16	.31	10-10	.56
19	.52	23	.48
21	.51	05-11	.28
05-07	.53	20	*
18	.56	18-12	*
01-08	.50	21-01-70	*
09	.53	20-02	*
15	.51	24-03	*
19	.50	16-04	*
22	.54	18-06	.05
19-09	.51	15-07	.23
10-10	.61	10-08	.33
24	.60	27	.39
15-11	.70	18-09	.46
06-12	.83	16-10	.41
24-01-68	*	18-11	1948.33
14-03	*	08-12-70	*
09-04-68	*		

\* Frozen

PIEZOMETER 8B

Elevations: Collar - 1948.66; Ground - 1946.06; Screen - 1432.16

Installed: June 1966

Date	Level	Date	Level
19-07-66	1792.08	08-08-68	1798.00
23	.10	03-09	.37
06-08	.17	03-10	.96
08	.22	18	1799.31
11	.26	07-11	.51
14	.27	21	.80
16	.31	05-12	1800.03
22	.12	20	.18
03-09	.19	07-02-69	.99
08	.26	18-04	1801.66**
12	.20	02-05	1803.55
17	.26	23	.41**
03-11	.36	30	.85**
20-12	.86	12-06	.45
01-03-67	1793.28	27	.90
25-04	1794.18	11-07	1804.21
04-05	.25	25	.28
08-06	.10	08-08	.26
16	1793.86	15	.37
19	1794.11	28	.36
21	.08	11-09	.36
05-07	.09	25	.64
18	.04	10-10	.79
01-08	1793.96	23	1805.59
09	.97	05-11	.28
15	1794.03	20	.51
19	.00	18-12	1806.66
22	.09	21-01-70	1807.53**
19-09	.25	20-02	.53**
10-10	.44	24-03	.44
24	.46	16-04	1808.64
15-11	.92	18-06	.51
06-12	1795.16	15-07	.70
24-01-68	.46**	10-08	.74
14-03	1796.80	27	.73
09-04	.98	18-09	1809.16
09-05	1797.25	16-10	.28
13	.45	18-11	.64
07-06	.53	08-12-70	1809.93
15-07-68	1797.88		

\*\* Doubtful measurement

PIEZOMETER 8C

Elevations: Collar - 1947.81; Ground - 1945.45; Screen - 1175.81

Installed: June 1966

Date	Level	Date	Level
08-06-66	1868.57	09-04-68	1885.60
09	.83	09-05	.72
11	.86	13	.99
13	.69	07-06	1886.25
15	.67	15-07	1887.54
21	.67	08-08	1888.31
28	.85	03-09	1889.34
06-07	.77	03-10	1890.15
11	.87	18	1889.96
19	.81	07-11	1891.06
26	.97	21	.51
01-08	.88	05-12	.79
06	.99	20	.86
08	1869.00	07-02-69	1892.03
11	.06	18-04	1891.68
14	.11	02-05	.73
16	.17	23	1892.13
22	1868.98	30	.28
03-09	1869.27	12-06	.38
08	.42	27	.94
12	.50	11-07	1893.43
17	.64	25	.84
03-11	1870.85	08-08	.98
20-12	1872.25	15	1894.22
01-03	1873.25	28	.40
25-04	1872.95	11-09	.71
04-05	1873.17	25	.86
08-06	1874.31	10-10	1895.02
16	.52	23	1894.97
19	.76	05-11	1895.34
21	.83	20	.32
05-07	1876.06	18-12	1894.90
18	1877.25	21-01-70	1895.03
01-08	1878.34	20-02	.03
09	.79	24-03	.30
15	1879.09	16-04	1893.78
19	.39	18-06	1894.72
22	.59	15-07	1895.69
19-09	1880.91	10-08	.93
10-10	1881.56	27	1896.23
24	.90	18-09	.76
15-11	1882.95	16-10	.88
06-12	1883.64	18-11	.94
24-01-68	.94	08-12-70	1896.93
14-03-68	1884.96		



PIEZOMETER 9-1

Elevations: Collar - 1953.11; Ground - 1951.80; Screen - 1941.03

Installed: July 1966

Date	Level	Date	Level
22-07-66	1935.56	13-05-68	1941.37
23	1936.36	07-06	.53
24	1938.87	15-07	.56
25	1940.68	08-08	.31
26	.78	03-09	.23
30	.83	03-10	.20
02-08	.88	18	.31
04	.90	07-11	.26
05	.87	21	.35
08	.86	05-12	.31
11	.86	15-01-69	.18
14	.87	17-04	1940.31
16	.83	02-05	.14
22	.81	23	.72
03-09	.72	30	1941.30
08	.72	12-06	1940.96
13	.66	27	1941.64
17	.68	11-07	.61
03-11	.47	25	.76
20-12	.27	15-08	.79
25-04-67	1941.43	28	.71
03-05	.77	11-09	.61
08-06	1943.11	25	.45
16	1942.46	10-10	.40
19	.45	23	.49
21	.41	05-11	.65
05-07	.46	20	.65
18	.39	18-12	.69
01-08	.23	21-01-70	.87
09	.17	20-02	.58
15	.16	24-03	.36
19	.16	14-04	.31
22	.11	13-05	.95
19-09	1941.83	18-06	1943.07
10-10	.72	15-07	.43
24	.61	10-08	1942.94
15-11	.66	27	.65
06-12	.62	18-09	.41
24-01-68	.54	16-10	.16
14-03	1940.96	18-11	.01
09-04	.97	07-12-70	1941.92
09-05-68	1941.22		

PIEZOMETER 9-2

Elevations: Collar - 1953.52; Ground - 1952.08; Screen - 1835.52

Installed: July 1966

Date	Level	Date	Level
01-08-66	1937.94	07-06-68	1939.80
02	1938.52	15-07	.69
04	.90	08-08	.62
05	1939.02	03-09	.75
06	.08	03-10	.83
07	.11	18	.84
08	.18	07-11	.79
11	.28	21	.82
14	.31	05-12	.86
16	.32	15-01-69	.91
22	.38	17-04	1940.02
03-09	.37	02-05	1939.94
08	.38	23	.85
13	.35	30	.91
17	.41	12-06	.81
03-11	.48	27	.98
20-12	.74	11-07	1940.10
25-04-67	1940.23	25	.02
03-05	.02	15-08	1939.96
08-06	1939.94	28	.91
16	.93	11-09	1940.10
19	.89	25	1939.86
21	.87	10-10	1940.19
05-07	.80	23	.03
18	.76	05-11	.20
01-08	.67	20	.55
09	.73	18-12	1939.94
15	.72	20-01-70	1940.37
19	.75	20-02	.24
22	.72	24-03	.43
19-09	.81	14-04	.15
10-10	.79	13-05	.22
24	.76	18-06	.35
15-11	.85	15-07	.24
06-12	.87	10-08	.10
24-01-68	.87	27	.06
14-03	.92	18-09	.11
09-04	.89	16-10	.07
09-05	.87	18-11	.11
13-05-68	1939.90	07-12-70	1940.14

PIEZOMETER 9A

Elevations: Collar - 1954.71; Ground - 1951.96; Screen - 1546.21

Installed: June 1966

Date	Level	Date	Level
06-07-66	1712.00	07-06-68	1714.58
09	.21	15-07	.63
11	.23	08-08	.50
18	.29	03-09	.71
06-08	.71	18-10	1715.01
07	1713.02	07-11	1714.91
08	.15	21	1715.11
11	.23	05-12	.06
14	.27	15-01-69	.25
16	.28	17-04	1716.52
22	.25	02-05	.11
03-09	.31	23	1715.81
08	.35	30	.95
13	.34	12-06	1716.96
17	.34	27	.35
03-11	.36	11-07	.51
20-12	.68	25	.46
25-04-67	.48	15-08	.56
03-05	.87	28	.58
08-06	1714.00	11-09	.33
16	.01	25	.71
19	.05	10-10	.92
21	.02	23	.65
05-07	.05	05-11	.81
18	.04	20	.97
01-08	.01	18-12	1717.06
09	1713.98	21-01-70	1718.73
15	.98	20-02	.24
19	.97	24-03	.00
22	1714.03	14-04	.06
19-09	.03	13-05	.21
10-10	.01	18-06	.47
24	.16	15-07	.60
15-11	.16	10-08	.63
06-12	.23	27	.74
24-01-68	.69	18-09	.92
14-03	.39	16-10	.97
09-04	.41	18-11	1719.31
09-05	.46	07-12-70	1719.55
13-05-68	1714.57		

PIEZOMETER 9B

Elevations: Collar - 1954.10; Ground - 1951.78; Screen - 1386.60

Installed: June 1966

Date	Level	Date	Level
21-06-66	1770.13	07-06-68	1777.05
28	.12	15-07	.18
06-07	.01	08-08	.07
09	.13	03-09	.30
11	.04	03-10	.47
18	.41	18	.70
04-08	.64	07-11	.47
08	.70	21	.58
11	.83	05-12	.55
14	.90	15-01-69	.75
16	.90	17-04	.90
22	.92	02-05	1778.10
03-09	1771.32	23	.12
08	.50	30	.31
13	.52	12-06	.05
17	.74	27	.85
03-11	1772.63	11-07	.63
20-12	1773.40	25	.51
25-04-67	1774.02	15-08	.47
03-05	.58	28	.48
08-06	.93	11-09	.67
16	.98	25	.70
19	1775.02	10-10	.78
21	1774.96	23	.62
05-07	1775.11	05-11	.74
18	.17	20	.54
01-08	.13	18-12	1777.85
09	.24	21-01-70	1778.80
15	.31	20-02	.78
19	.36	24-03	1779.03
22	.41	14-04	1778.71
19-09	.67	13-05	1779.46
10-10	.79	18-06	.83
24	.76	15-07	.71
15-11	1776.13	10-08	.93
06-12	.19	27	.38
24-01-68	.60	18-09	.50
14-03	.85	16-10	.45
09-04	.83	18-11	.52
09-05	.91	07-12	1779.69
13-05-68	1777.10		

PIEZOMETER 9C

Elevations: Collar - 1954.11; Ground - 1951.74; Screen - 1160.61

Installed: June 1966

Date	Level	Date	Level
15-06-66	1882.23	13-05-68	1890.43
17	.49	07-06	.49
21	.49	15-07	1891.13
28	.53	08-08	.48
06-07	.46	03-09	1892.17
09	.61	03-10	.56
11	.52	18	1893.01
18	.40	07-11	.11
04-08	.52	21	.47
08	.50	05-12	.66
11	.60	15-01-69	.97
14	.61	17-04	1894.09
16	.60	02-05	.11
22	.58	23	.29
03-09	.61	30	.48
08	.74	12-06	.48
13	.63	27	.95
17	.84	11-07	1895.33
03-11	1883.31	25	.46
20-12	1884.06	15-08	.76
25-04-67	.47	28	.88
03-05	.38	11-09	.79
08-06	1885.02	25	1896.21
16	.16	10-10	.38
19	.28	23	.37
21	.26	05-11	.73
05-07	.86	20	.55
18	1886.33	18-12	.86
01-08	.77	21-01-70	.84
09	1887.03	20-02	.46
15	.31	24-03	.60
19	.39	14-04	.29
22	.46	13-05	.39
19-09	1888.11	18-06	.83
10-10	.39	15-07	1897.22
24	.47	10-08	.53
15-11	.96	27	.78
06-12	1889.21	18-09	1898.16
24-01-68	.54	16-10	.23
14-03	.83	18-11	.38
09-04	.99	07-12-70	1898.52
09-05-68	1890.19		

Figure 3. Cross sections of the Riverhurst area.  
 a. Piezometric levels for bedrock aquifers in 1964.  
 b. Distribution of total head in 1964.

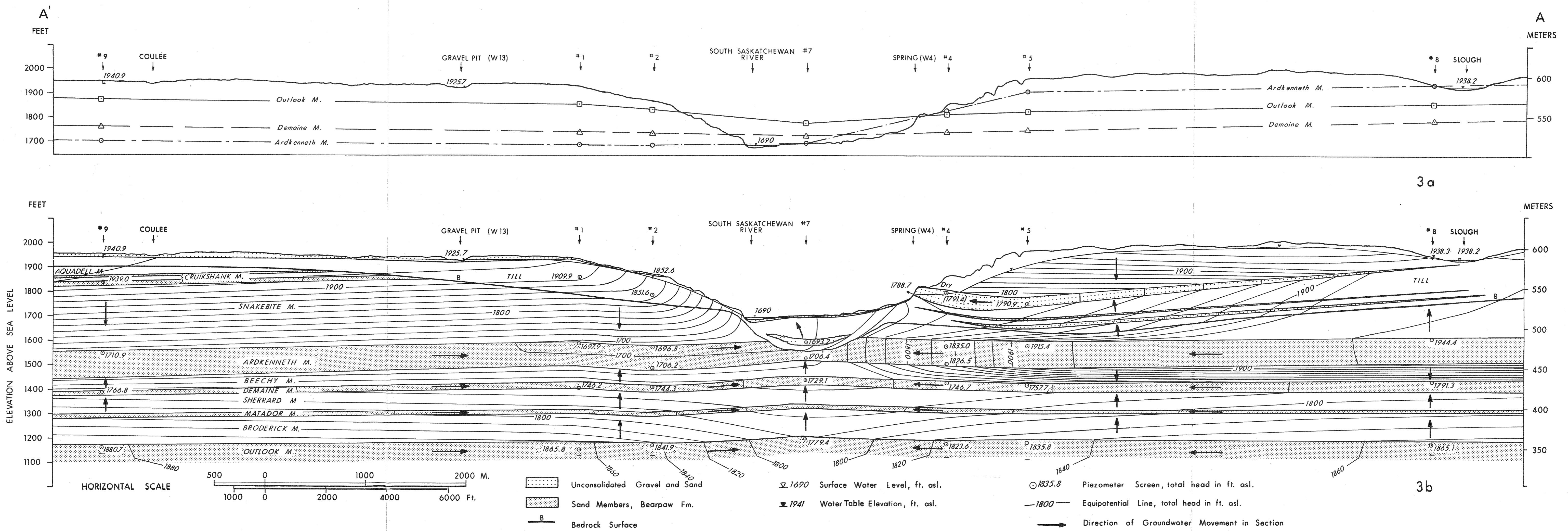
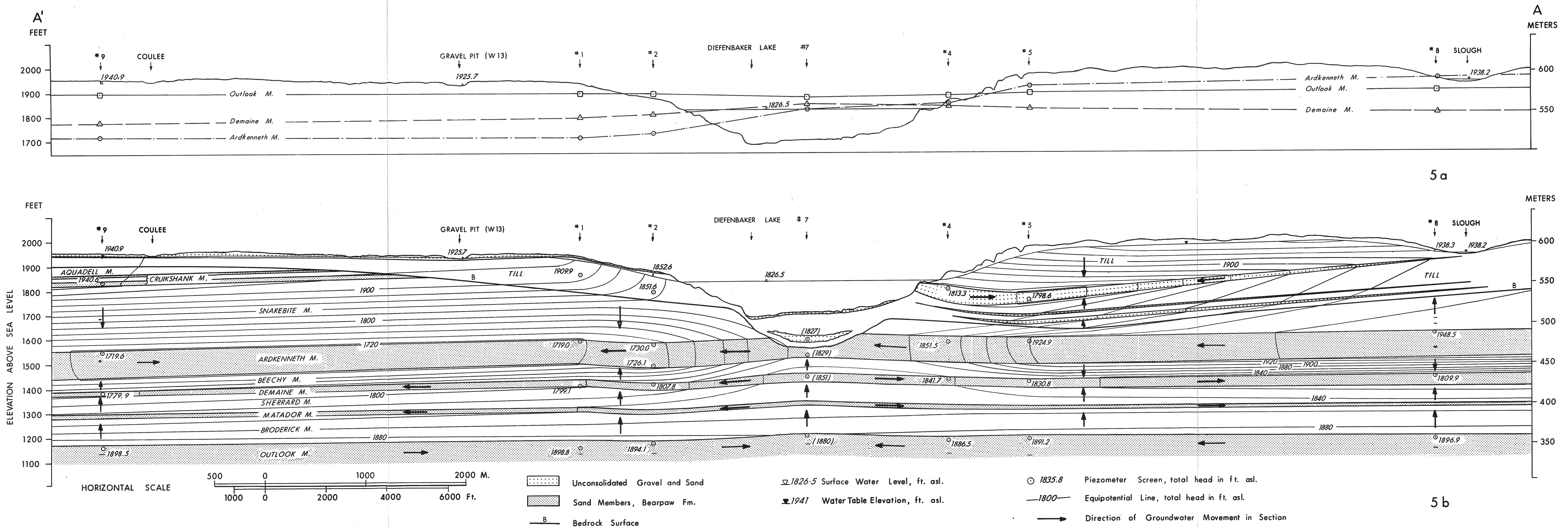


Figure 5. Cross sections of the Riverhurst area.  
 a. Piezometric levels for bedrock aquifers in 1970.  
 b. Distribution of total head in 1970.



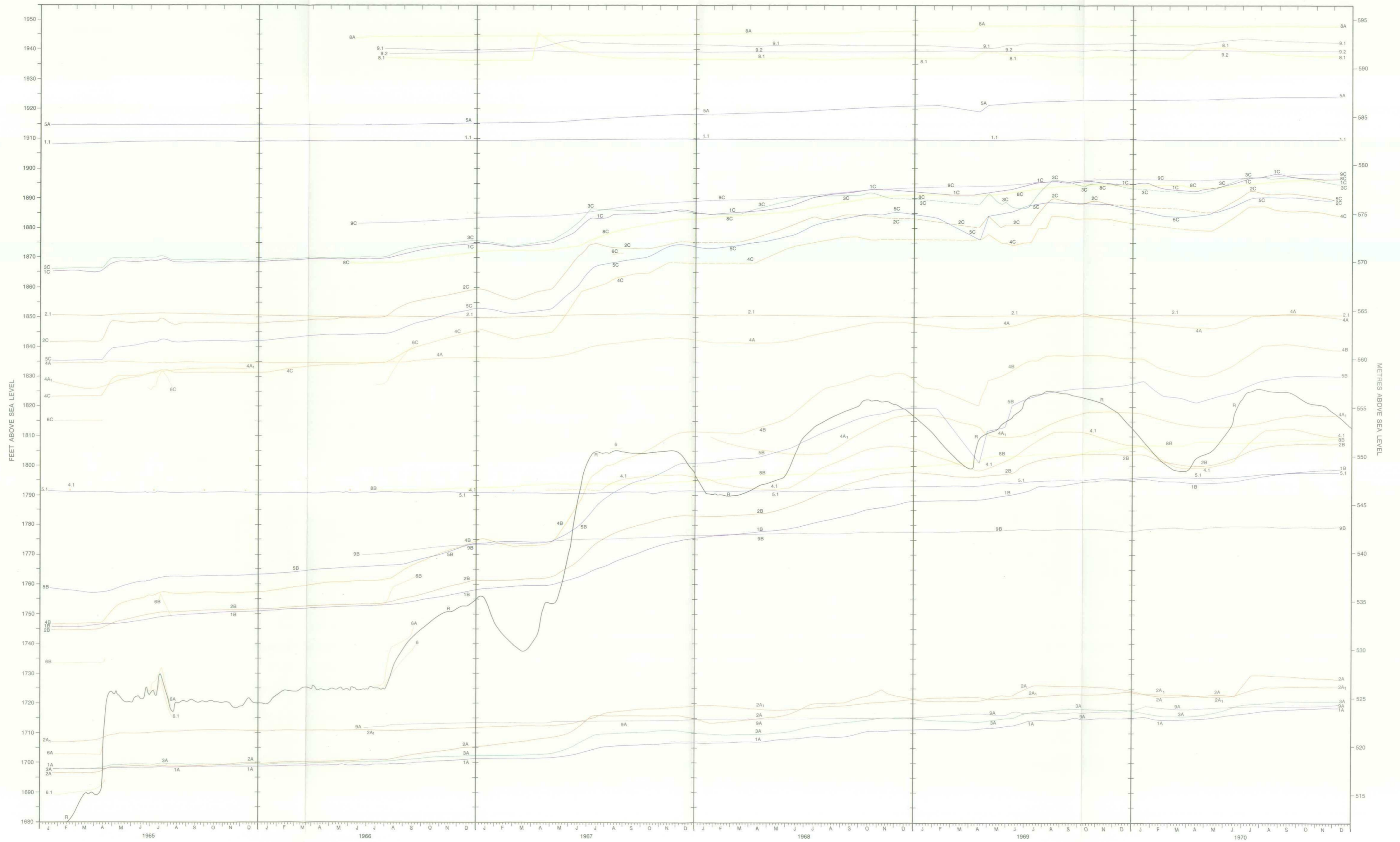


Figure 7. Graphs of piezometric head vs. time for the Riverhurst area, and water levels in Lake Diefenbaker. Broken lines for 2C, 3C and 4C indicate piezometer frozen. Circled dots for 4-1 indicate piezometer dry.



