

Report  
PUMPING TEST RESULTS FOR AN AQUIFER UNDER WATER TABLE  
CONDITIONS AT ANDREW, ALBERTA

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By

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INTRODUCTION

A survey to determine the groundwater resources of the Andrew area was conducted by the Research Council of Alberta in 1958 (Farvolden et al, 1963). In conjunction with this program a pumping test was carried out during July 1960 on the Canadian Pacific Railway well located in the Village of Andrew. An analysis of the pumping test data was completed in November, 1960, but improved methods of analysis prompted a second analysis of the data during 1962. The results of the second analysis are included in this report.

A group of five wells were used in the pumping test conducted in 1958 (Fig. \_\_\_). Water was discharged through the towns sewage system to a point about one-half mile from the test site. The effects of the pumping well (C.P.R. well) were measured in observation wells 1, 2, 3 and 4. Pumping commenced at 1:00 p.m. on July 5th at a constant rate of 27 imperial gallons per minute and continued until 11:40 a.m. July 12th.

GEOLOGY OF THE AQUIFER

The aquifer consists mainly of sand and gravel deposits which were laid down in glacial melt-water channels or stream trenches. The aquifer varies in thickness from 1 to 31 feet and lies directly on bedrock of low permeability. The aquifer material commonly extends to the surface but less permeable materials ranging up to 12 feet in thickness overlie a portion of the aquifer.

Evidence indicates the sand and gravel deposits have a westerly lineation (Fig. \_\_\_). The width of the deposits most suitable for the development of groundwater at Andrew is approximately 2/3 of a mile.

#### ANALYSIS OF PUMPING TEST DATA

The analytical methods used to evaluate the aquifer have been outlined by Walton (1962).

The drawdown data was adjusted for decrease in the saturated thickness and therefore the coefficient of transmissibility of the aquifer by an equation devised by Jacob (1944). The adjusted values represent the drawdown that would occur in an equivalent artesian aquifer. Calculated future drawdowns in the aquifer were also adjusted with Jacob's equation.

Values of the aquifer constants, maximum safe pumping rate, and future drawdowns in the aquifer for given pumping rates at various distances from the center of the pumping well were calculated with the nonequilibrium formula developed by Theis (1935). (See Fig. \_\_\_ & \_\_\_.) Values for the storage coefficient were also computed using an equation described by Ramsahoye and Lang (1961).

The natural percolation of water through a given cross-section of the aquifer has been derived from a useful form of Darcy's equation (Ferris and others, 1962).

RESULTS OF PUMPING TEST ANALYSIS

TABLE \_\_\_\_ . AQUIFER CONSTANTS CALCULATED FROM  
TIME-DRAWDOWN DATA

<u>Well</u>	<u>Transmissibility</u> gpd/ft	<u>Storage</u> <u>This Curve</u>	<u>Coefficient</u> <u>Ramshoye &amp; Lang</u>
Pumping	20,628	-	-
1	20,357	0.075	0.036
2	22,100	0.114	0.109
3	22,920	0.096	0.111
4	14,065	0.111	0.087

TABLE \_\_\_\_ . AQUIFER CONSTANTS CALCULATED FROM  
DISTANCE-DRAWDOWN DATA

<u>Transmissibility</u> gpd/ft	<u>Storage Coefficient</u>
21,488	0.054

MAXIMUM SAFE PUMPING RATE

The maximum safe pumping rate in imperial gallons permissible for the well can be calculated from the Theis nonequilibrium equation

$$Q_{max.} = \frac{T s'}{114.6 W(u)}$$

where

$$u = \frac{1.56 r^2 S}{T t}$$

r = nominal radius of well in feet

S = storage coefficient (dimensionless)

T = coefficient of transmissibility in gallons per day per foot

t = time in years

s' = adjusted drawdown in feet

W(u) = from standard tables

The Canadian Pacific Railway well at Andrew has a nominal radius of 8 feet. The average value of transmissibility for the aquifer in the vicinity of the well is 21,500 gpd/ft. A value of 0.11 is considered a characteristic storage coefficient <sup>for the</sup> aquifer. The total equivalent artesian drawdown available (s') is 2.5 feet.

Based on a 20 year period the maximum safe pumping rate for the well is:

$$Q_{max.} = \frac{21,500 \times 2.5}{114.6 \times 20.5}$$

= 22.9 imperial gallons per minute

FUTURE DRAWDOWN IN THE AQUIFER

TABLE \_\_\_\_ . PREDICTED FUTURE DRAWDOWN IN THE  
AQUIFER AFTER ONE DAY OF PUMPING

<u>Distance from Center of Pumping Well in Feet</u>	<u>Pumping Rate in Imperial Gallons Per Minute</u>		
	<u>10</u>	<u>20</u>	<u>30</u>
10	0.37	0.76	1.68
100	0.23	0.23	0.45
200	0.00	0.00	0.18
500	0.00	0.00	0.01
1000	0.00	0.00	0.01

TABLE \_\_\_\_ . PREDICTED FUTURE DRAWDOWN IN THE  
AQUIFER AFTER ONE WEEK OF PUMPING

<u>Distance from Center of Pumping Well in Feet</u>	<u>Pumping Rate in Imperial Gallons Per Minute</u>		
	<u>10</u>	<u>20</u>	<u>30</u>
10	0.47	1.01	2.40
100	0.21	0.44	0.91
200	0.14	0.29	0.60
500	0.05	0.10	0.20
1000	0.01	0.02	0.04

TABLE \_\_\_\_ . PREDICTED FUTURE DRAWDOWN IN THE  
AQUIFER AFTER ONE YEAR OF PUMPING

Distance from Center of Pumping Well in Feet	Pumping Rate in Imperial Gallons Per Minute		
	<u>10</u>	<u>20</u>	<u>30</u>
10	0.71	1.58	75.00
100	0.44	0.91	1.95
200	0.35	0.72	1.65
500	0.26	0.52	1.12
1000	0.17	0.36	0.76

TABLE \_\_\_\_ . PREDICTED DRAWDOWNS COMPARED WITH ACTUAL DRAWDOWNS  
FOR A WEEK LONG PUMPING PERIOD AT A RATE OF 27 IMPERIAL GALLONS PER

MINUTE

Well	Predicted Drawdowns in Feet	Actual Drawdowns in Feet
<u>Pumping</u>	1.52	2.11
i	0.90	1.07
2	0.74	0.76
3	0.57	0.62
4	0.38	0.48

### NATURAL MOVEMENT OF WATER THROUGH THE AQUIFER

The natural movement of water in imperial gallons per minute can be calculated from a form of Darcy's equation:

$$Q = \frac{TIL}{1440}$$

where

T = coefficient of transmissibility in gallons per day per foot

I = hydrolic gradient in feet per mile

L = width of cross-section in miles through which flow takes place

A cross-section of the aquifer  $2/3$  of a mile in width was considered at Andrew. A hydrolic gradient of 4 feet per mile was established from water level elevations at the Canadian Pacific Railway well and a point approximately two miles north-west of the Canadian Pacific Railway station. Using an average value of 21,500 gallons per day per foot for the coefficient of transmissibility of the aquifer, the natural movement of water through the cross-section of the aquifer is:

$$Q = \frac{21,500 \times 4 \times 2/3}{1,440}$$

= 40 imperial gallons per minute (rounded)

### RECHARGE OF THE AQUIFER

Groundwater replenishment of the aquifer is thought to be derived primarily from local precipitation.

### OTHER PUMPING TESTS

A 33  $3/4$  hour long pumping test was conducted by the Research Council of Alberta during January, 1963, on one of two new wells completed west of the Canadian Pacific Railway well at Andrew to establish a safe pumping rate for the wells.

The pumping test results indicate that each of the two new wells should be pumped at a rate not exceeding 10 gallons per minute.

CONCLUSION

A week long pumping test was necessary before a reliable evaluation could be made of the shallow, water table aquifer at Andrew, Alberta.

The aquifer is of limited areal extent and is thought to be recharged by local precipitation. The future availability of water cannot be <sup>assured</sup> ~~assumed~~ if a groundwater supply exceeding 40 imperial gallons per minute is developed in the aquifer.



## REFERENCES CITED

- Farvolden, R.N., Meneley, W.A., LeBreton, E. G., Lennox, D.H., and Meyboom, P. (1963): Early contributions to the groundwater hydrology of Alberta; Res. Coun. Alberta Bull. 12, 123 pages.
- Ferris, J. G., Knowles, D. B., Brown, R. H., and Stalman, R. W. (1962): Theory of aquifer tests; U.S. Geol. Surv. Water-Supply Paper 1536-E, 174 pages.
- Jacob, C.E. (1944): Notes on determining permeability by pumping tests under water table conditions; U.S. Geol. Surv. mimeo rept.
- Ramsahoye, L.E., and Lang, S.M. (1961): A simple method for determining specific yield from pumping tests; U.S. Geol. Surv. Water-Supply Paper 1536-C, 46 pages.
- Theis, C. V. (1935): The relation between the lowering of the piezometric surface and the rate and duration of discharge of a well using ground-water storage; Trans. Am. Geophys. Union, Vol. 16, Pt. 2, p. 519-524.
- Walton, W.C. (1962): Selected analytical methods for well and aquifer evaluation; Illinois State Water Surv. Bull. 49, 81 pages.

# C.P.R. Well.

t = 10,000 MIN.

11 = E  
211 = 10

Well #	I	D.D. = 2	$\frac{1}{s}$	$\frac{1}{s^2}$
1	49' E.	1.07	.46	$1600 \times 10^3$
2	67' SW	0.76	.70	$400 \times 10^3$
3	108' NW	0.62	.58	$1100 \times 10^4$
4	302' NW	0.48	.42	$408 \times 10^6$

Thin Coal  
S

Removal of  
HSP = 1536  
S

Dist.  $\frac{1}{T}$

T  $\frac{1}{10^4} \frac{1}{T}$

Pressure

20,628

1

20,357

0.075

0.036 (P)

2

22,100

0.114

0.109

3

22,920

0.096

0.111

4

14,065

0.111

0.057

Pressure

21,255

0.054

Pressure

Pressure

21,500

0.054

Use minimum  
value as  
fact.

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value as  
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