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Edson Report

by

Meneley

1961

RESEARCH COUNCIL

Municipal Water Supply

TOWN OF EDSON

(Aug., 1961)

by
W. A. Meneley .

Introduction

During the past two years the Town of Edson has undertaken a groundwater exploration program, to assess the probable amount of water obtainable from wells in the vicinity of Edson. The existing well field derives water from sandstone lenses in the Paskapoo formation. Although definitive evidence is lacking, the individual production performance of some of these wells strongly suggests that they are currently being pumped at rates exceeding their safe production rates, and further, the well field as a whole is being over-pumped. It is suggested that in a few years at most the daily production of this well field will decline, slowly at first but at a rate increasing with time. Drilling additional wells into the Paskapoo formation may be expected to yield only a temporary increase in the total well field production, a temporary modification of the overall decline in production.

This overall decline with time is characteristic of many of the older municipal well fields throughout the province. It is not indicative of failure of a given well or wells, or failure of the aquifer to yield water after a given time; instead it is the logical and predicatble outcome of the failure of the well field design, in that individual wells and groups of wells have been designed to produce water at a rate greater than the maximum safe pumping rate of a well or group of wells in such an aquifer.

The basic problem at Edson is that a properly designed well field would have to be much more extensive than the present one, to safely produce the present amount of water. Further, the demand for water is increasing rapidly, more rapidly, in fact, than the well field could economically be extended to meet the increased demand. In short, the town's demand has exceeded the limit of economic utilization of this aquifer.

Consequently, exploration carried out during 1960 was directed toward locating potential aquifers which would be capable of supplying much more water than the Paskapoo formation. The direction and scope of exploration is limited by obvious fact that any aquifer recharged solely by precipitation in Alberta, regardless of its permeability, will have a definitely assignable maximum safe capacity, proportionate to its size and the amount of natural recharge. In Alberta this figure is low for almost all aquifers; therefore the second condition for exploration is that it must be directed toward locating an aquifer which may be recharged naturally or artificially, from a perennial stream, or one which can, at some later date, be integrated with a surface water supply source with a minimum capital loss.

At Edson exploration was limited to the area between McLeod River and the town. Within this area, existing well logs indicated that a buried channel should be present immediately south of the town. A total of eight test holes were drilled by the town, to fix the margins of the channel. Test holes 1960-6 and 1960-7 encountered about 13 feet of gravel; about 8 feet of coarse gravel was encountered in 1960-5, while in the remaining test holes, lesser thicknesses of gravel were encountered, or the gravel was interbedded with silt.

A pump test of 60-6 was attempted, but was unsuccessful, and it was decided that a production well would have to be completed before the productivity of this aquifer could be adequately determined. Automatic water level recorders were installed on Well #1 and on test hole 1960-7, to obtain continuous records of the water level fluctuations both in the Paskapoo formation and in the Edson channel.

During 1960 the possibility of an artificial recharge project, utilizing a high level meander of the McLeod River in Sec. 12, Tp. 53, R. 17, W. 5th Mer. as a storage site was also investigated. A reconnaissance geophysical survey indicated the possible presence of gravel around the meander; however this was not substantiated by the one test hole drilled and no further work has been done on this prospect. Although the initial results are not encouraging, further exploration would have to be carried out before any valid conclusion can be drawn, regarding the possibility of an artificial recharge project at this location.

This completed the exploration during the 1960 field season.

Edson Well 61-1

In July, 1961 an 8-inch production well was completed in Lot 13, Block 131, Edson. The pilot hole encountered 13 feet of medium to coarse gravel, overlying the Paskapoo formation; the well was completed with 13 feet of No. 80 Everdur screen, set across the interval from 118 to 131 feet. During development a large volume of sand was removed, and considerably more time was required to completely develop the well than had been anticipated. This was due principally to the presence of structurally weak coal and sandstone pebbles and boulders, which broke down during the development process and were removed by gradual attrition. This process had to be continued until only a stable, natural filter pack remained around the screen. The final result is, however, an extremely efficient well. The maximum well loss is estimated to be less than 0.5 feet at 225 gpm, and the well as a structure is capable of intercepting all of the water that can be transmitted through the aquifer. In all further calculations it has been assumed that the well efficiency is 100 per cent.

A pump test was run, as the final development phase of this well, for a period of 3,675 minutes at a rate of 225 gpm. During the test and the subsequent recovery, water level measurements were obtained in the pumping well, and in test holes 60-5, 60-6, and 60-7. Test hole 1960-8 responded very sluggishly to the pumping effects, and no useable information was obtained from this hole.

There was considerable variation in the pumping rate during the test, as the drive belt splice broke twice. Variations during the last day of the test were smaller and the average discharge rate is considered to be about 220 gpm.

Because of previous pumping, during the course of development, the water level in all of the wells was rising at a measurable rate prior to the start of the final pumping test. A static water level correction curve was therefore established from the rate of recovery from earlier pumping, and extrapolated to include the period of the pump test and the subsequent recovery test. This correction curve is at best only an approximation, and its effect is to considerably reduce the precision of the final analysis of the data from this test.

The transmissibility and storage coefficients, determined from data obtained during the first 250 minutes of the test, are transmissibility = 10,000 gpd/ft, and storage coefficient = 2.1×10^{-4}. If the aquifer may be considered as an infinite artesian aquifer, from which all water will be produced from storage, then the maximum continuous production rate of a single well is about 200 to 225 gpm.

The configuration of the drawdown curves, however, indicate that there is an impermeable hydrologic boundary located about 2500 feet northwest of the pumping w ell. The aquifer therefore cannot be considered to be of infinite areal extent. Geologically, the valley walls north and south of the pumping well should both behave as hydrologic boundaries, in that the permeability of the Paskapoo formation is much lower than the deposits in the channel. A theoretical model was developed to determine what drawdown should have been observed in the pumping well, and in the observation wells, in a channel aquifer of the same dimensions as theEdson channel. The theoretical analysis conclusively indicates that if the hydrologic boundaries of the aquifer conform to the geologic boundaries, then the drawdown observed in the various wells should have been considerably greater than the drawdown actually observed. It is considered that the reason that the observed hydrologic behavior of the aquifer does not conform to that predicted from the theoretical model is that there is recharge to the aquifer. If there is recharge to the aquifer, then in time equilibrium will be restored in the aquifer, at some drawdown so that the recharge to the aquifer is equal to the discharge from the well. Unfortunately the magnitude of recharge to this aquifer cannot be reliably predicted from this pump test, consequently the maximum safe production rate of this well cannot be stated with any certainty. On the basis of the present pump test, however, it appears that the minimum safe production rate should be in excess of 120 gpm.

I would suggest that a long-duration production test be carried out on this well to obtain a better estimate of the maximum production rate, and to provide better information regarding the optimum well spacing in this aquifer. I am of the opinion that the pump owned by the town will be adequate for the test which should be run at a rate between 75 - 125 gpm. The test should be run at a constant rate for a period of 75 to 90 days. Short interruptions due to power failures may unavoidably occur; however if the pump is shut down for as long as 8 hours, it would be advisable to terminate the test at that point, rather than to re-start the pump. Because the long-term behavior of this aquifer is of considerable interest to us, the Groundwater Division is prepared to assist in running the initial phase of this production test. The recorders presently installed will be left there until the test is completed, after which one or both of them will be converted to a permanent installation.

Future Exploration

The probability that a large municipal or industrial groundwater supply can be located within six miles of Edson is very good. The gravel deposits of the Edson channel occur below the water level in McLeod River by an unknown amount, both upstream and downstream from Edson. Thus there are two areas in which groundwater supplies may be obtained by induced infiltration from McLeod River.

The Edson channel originates somewhere west of Edson and trends northeastward from Big Eddy parallel the CNR tracks to Edson; from there it continues northeastward for an unknown distance. The McLeod River cuts into the gravel deposits believed to have been deposited in the Edson channel, for about two miles downstream from Big Eddy. Thereafter the McLeod River follows a younger sharply incised channel, which is cut into the bedrock, downstream to a point about a mile north of the highway bridge over McLeod River. Downstream from this point the McLeod River again follows the course of the Edson channel for many miles. Reconnaissance along the reach of river downstream from the highway bridge to the Rosevear ferry revealed that the river is flowing over gravel deposits for almost the entire distance. It is reported that there is about 30 feet of gravel below river level in a large gravel pit along this stretch of river.

If further exploration substantiates the presently available information, then it appears certain that the geologic environment is such that it will be possible to develop a large-scale water supply from McLeod River by induced infiltration.

The advantages of induced infiltration are principally:

(a) no intake structure is required

(b) no treatment is required to remove turbidity, or bacteriological contamination

(c) the temperature of the product water varies much less than the river water temperature

(d) the water quality is less variable than quality of the river water.

The principal disadvantage of induced infiltration at Edson is the higher capital outlay for a pipeline to the town from either of the previously mentioned sites, and the cost of exploration to prove up the induced infiltration potential at either or both of these sites.

It is suggested therefore that an exploration program should be carried out to determine whether the best induced infiltration site is upstream or downstream from

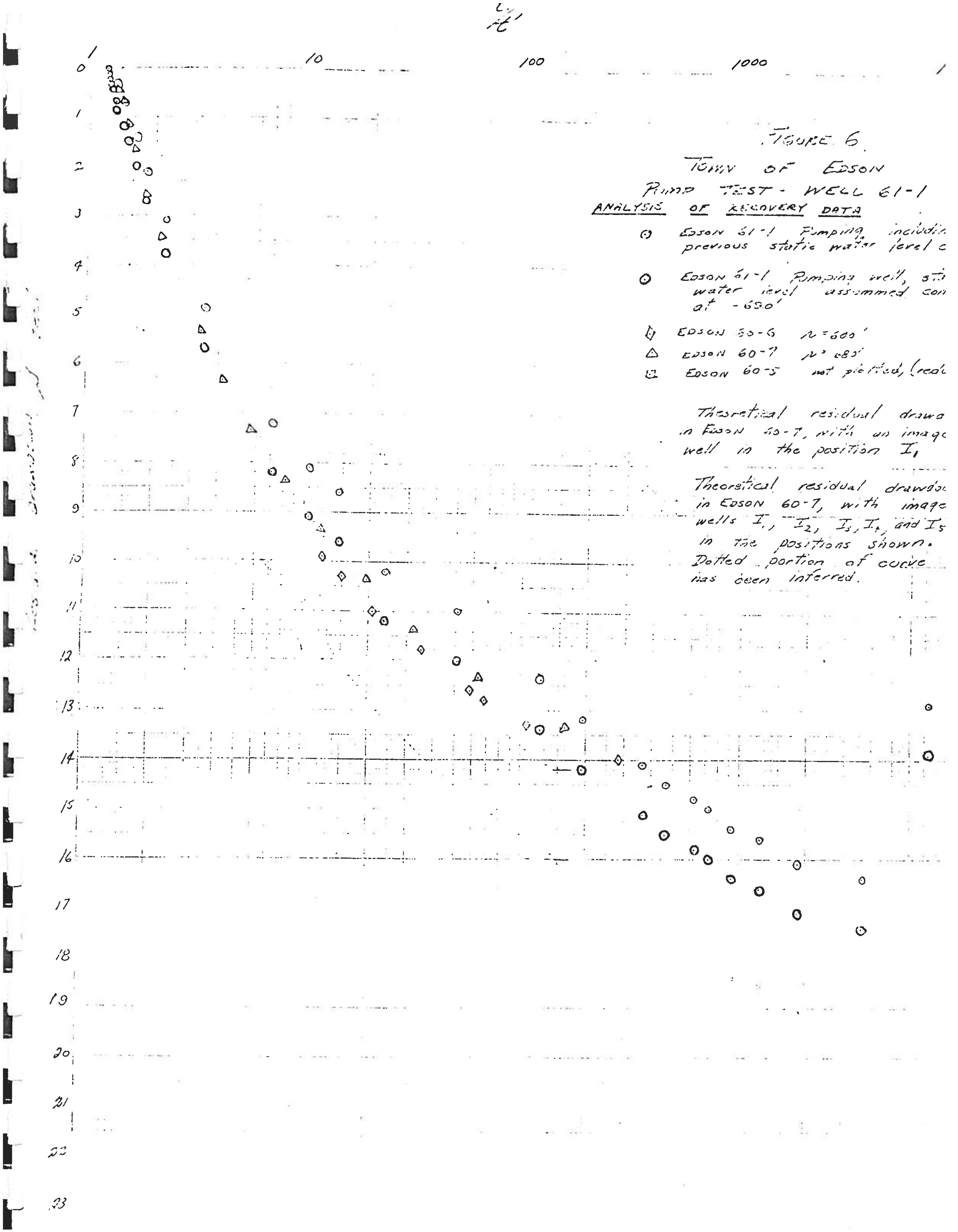
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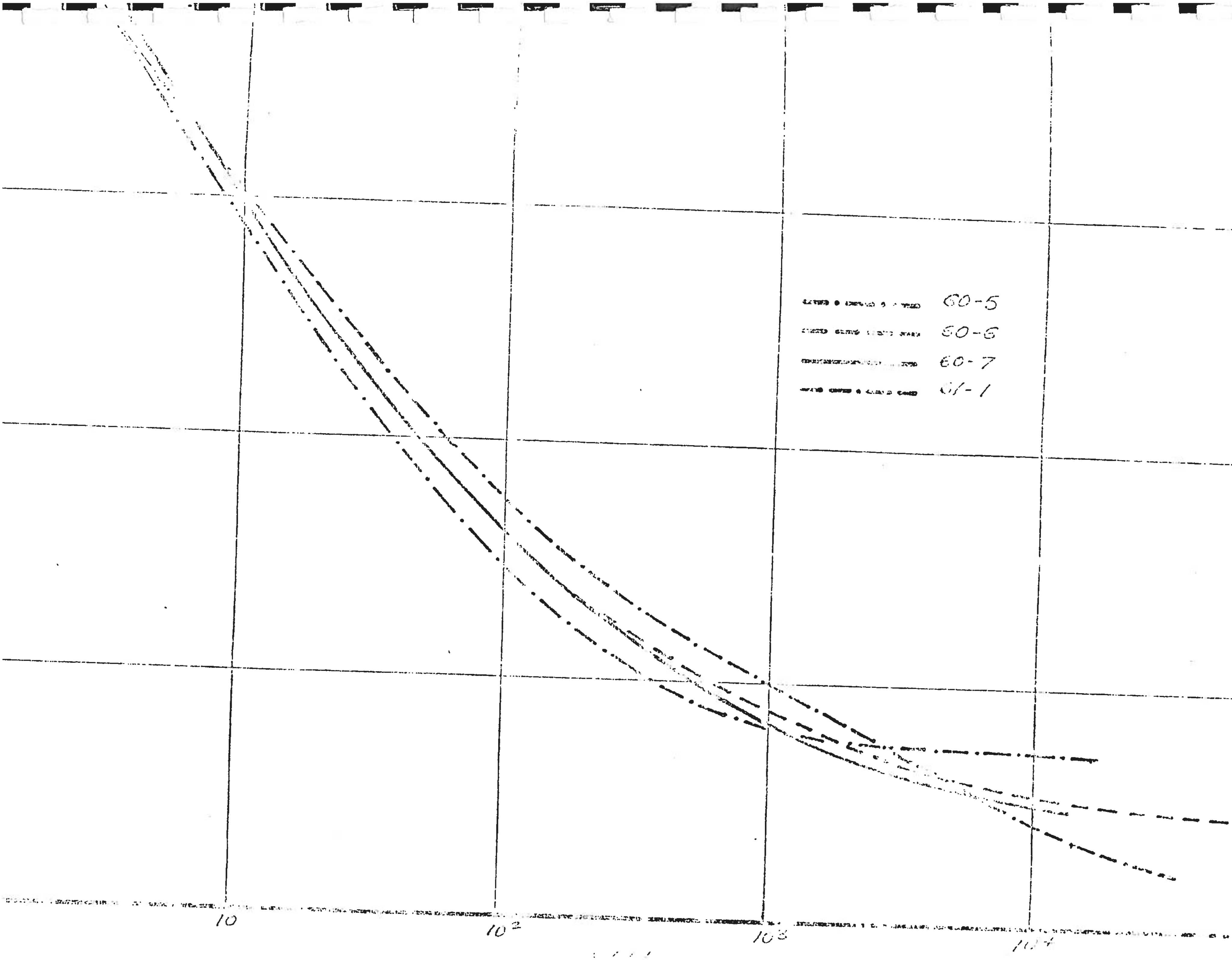
FIGURE 6.
TOWN OF EDSON
PUMP TEST - WELL 61-1
ANALYSIS OF RECOVERY DATA
Edson 61-1 Pumping includin
previous static water level c
Edson 61-1 Pumping well, st
water level assummed con
at -650'
EDSON 55-6 r=600'
EDSON 60-7 r=685'
EDSON 60-5 not plotted, (redu
Theoretical residual drawd
in Edson 60-7, with an image
well in the position I1
Theoretical residual drawdo
in Edson 60-7, with image
wells I1, I2, I3, I4, and I5
in the positions shown.
Dotted portion of curve
has been inferred.



60-5
60-6
60-7
61-1
10
10²
10³
10⁴

Appendix

PRELIMINARY REPORT - TOWN OF EDSON, MARCH, 1961

During 1960 the Town of Edson carried out an extensive test-drilling program to evaluate the possibility of increasing the amount of groundwater that could be obtained from several aquifers in the vicinity of Edson. This included:

1. An attempt to increase the productive capacity of the existing well field by deepening wells #1 and #4.

2. An examination of the feasibility of an artificial recharge project adjacent to the McLeod River in section 12.

3. The location and evaluation of the potential productivity of the gravel deposits of the Edson channel.

The program of deepening two of the existing wells was partially successful. Well #4 was deepened to 355' and placed back on production. Well #1 could not be deepened as a metallic object in the bottom of the well prevented any drilling and the object could not be fished. This well was then converted to an observation well and is providing useful information regarding the hydrologic behavior of this aquifer.

A resistivity survey, comprising 5 stations, was carried out in section 12 (Fig. 1). The operating conditions were poor because of the heavy rain preceding the survey and little conclusive information was gained. One test hole was drilled in Lsd. 8 (of section 12?), and it encountered 15 feet of gravel and some clay above bedrock. Although these results were disappointing, they should not be regarded as conclusive. The area in the vicinity of the oxbow lakes offers an ideal natural environment for artificial recharge, if a sufficiently large gravel deposit is present that can be used as a natural filtration medium. The groundwater division is prepared to carry out additional geophysical surveys in this area if you will obtain permission to enter onto the land. The work that we propose to carry out is a hammer seismic survey to locate the depth to bedrock. This instrument differs from the usual seismic equipment in that no explosives are used and the entire instrument is portable. We have just obtained this instrument and the results that may be obtained cannot be predicted; however, we would like to evaluate its performance under the widest possible range of conditions.

POTENTIAL GROUNDWATER RESOURCES OF THE EDSON CHANNEL

The results obtained from test drilling in the Edson channel indicate that it offers the best prospect for immediate development.

The Edson channel was located by a series of test holes drilled by the Town of Edson during 1960, after preliminary study by Farvolden indicated the possible presence of a channel at this location. A cross-section of this channel (Fig. 2) shows that it is sharply incised into the bedrock. About 10 feet of alluvial gravel is found immediately overlying the bedrock in this channel. Of the eight test holes drilled, six encountered well-sorted gravel, one encountered interbedded sand and gravel (#2), and one encountered predominantly fine-grained sand (#3). A log of one of the town wells (Well #5) shows that about 20 feet of gravel was penetrated and cased off in this hole. The water level in all wells stands about 50 feet above the top of the aquifer.

Short period pumping tests were carried out on T.H.#5 (transmissibility = 7200 gpd/ft) and on T.H. #6 (transmissibility = 4000^{+} gpd/ft). Neither test was intended to determine the complete hydrologic behavior of the aquifer. Later in the summer a full-scale pumping test was attempted; however, the test was terminated almost immediately when the pump became plugged with fine sand. It was concluded that it would be impossible to conduct a pumping test at the desired rate until a screened well was completed in this aquifer.

Two water samples were taken during the pumping test of test hole 60-5. The following analyses were obtained:

	Sample #1	Sample #2
Total solids	563 ppm	550 ppm
Ignition loss	33	58
Hardness	140	150
Sulphates	71	78
Chlorides	nil	nil
Alkalinity	400	405
Nature of alkalinity	Bicarbonate of lime and magnesium	
Nitrites	nil	nil
Nitrates	nil	nil
Iron	1.0	1.0
Soda	19.29 gr/gal.	18.92 gr/gal.

It is desirable to establish the theoretical performance of this aquifer in order to assess the economic feasibility of proceeding with additional development in this channel. This was done by setting up a series of mathematical models of a theoretical aquifer having characteristics similar to the Edson channel. Because of the complexity of the hydrologic environment only an approximate solution was attempted.

Initially, the aquifer was considered to be an ideal artesian aquifer bounded by two parallel boundaries 3,600 feet apart. It was considered that the average thickness of gravel is 10 feet and that all water would be obtained from storage in the gravel. The effect of the impermeable boundaries can be mathematically replicated by a series of imaginary pumping wells which are located at increasing distances away from each boundary, and which are pumping at the same rate as the real pumping well. Analysis of this model indicates that the safe production rate for a production well deriving all of its water from storage would approach zero as the volume of water in storage in this aquifer is very small. This is an unreasonable conclusion, and it is considered that this model is too restrictive in its assumptions to represent the hydrologic environment adequately.

The regional direction of groundwater movement in the vicinity of Edson is southward from the upland area to the north of town toward the McLeod River. The easterly-trending Edson channel acts as an interceptor drain diverting water eastward which eventually discharges to the tributary of Edson Creek shown on Figure 1. It is known definitely that the channel walls are not impermeable, as the present town wells are completed in the same formation. Further, the glacial deposits overlying the channel gravels are not impremeable, and would transmit water to the gravel if the hydraulic gradient were favorable.

A new model was then developed, which assumes that the potential distribution in the channel is similar to that in a linear segment of an infinite artesian aquifer. In this model the volume of water derived from storage in the aquifer is ignored and it is considered that all water is obtained from lateral infiltration through the north channel wall and from vertical infiltration through the overlying glacial deposits.

The lateral infiltration was calculated from the average permeability of the Paskapoo formation determined from the production performance of the existing production wells and the average gradient of the piezometric surface. It is considered that infiltration will occur only into the gravel over a lateral distance of 10,000 feet on either side of the production well. The approximate infiltration would be about 200,000 gpd. or about 120 gpm.

The vertical infiltration is more difficult to estimate, as we have no data regarding the permeability of the glacial deposits overlying the aquifer. The barometric efficiency, which is the response of the water level in a well to changes in barometric pressure, was calculated from the hydrograph of test hole 60-7. The barometric efficiency is about 10 per cent, which is rather low for an artesian aquifer and which suggests that the aquifer may be only partially confined. It appears, therefore, that it is reasonable to consider that the overlying strata have a permeability of at least 0.015 gpd/ft^2 (1 millidarcy). If this is so, then the leakage induced by pumping a well in this aquifer would be in the order of 110,000 gpd or 75 gpm.

It is interesting to note that if the vertical permeability is in the order of magnitude considered in the above calculation, then the maximum rate of vertical infiltration will be in the order of 0.02 ft/day. Thus it would require about 17 years for a particle of water to move from the ground surface to the aquifer.

On the basis of this model it appears that it is reasonable to anticipate that a well or wells completed in this aquifer should be capable of yielding in the order of 220 gpm. Any more precise estimate of the sustained yield of this aquifer, or of the quality of water that will be obtained, can be determined only from a long-term production test of a well completed in this aquifer.

In conclusion, I would recommend on the basis of available information that the town proceed with the construction and testing of a well completed in the vicinity of test hole 60-6.

Well Construction Details

I would suggest that the well should have an 8-inch screen across the entire thickness of the gravel. Surface casing should be set either by driving or cementing to avoid any possibility of direct contamination of the well. The screen opening size should be determined from a mechanical analysis of a good sample of the gravel obtained in a pilot hole drilled at the desired site. Analysis of the gravel sample obtained from test hole 60-6 indicates that an 0.08" to a 0.1" slot screen could be used.

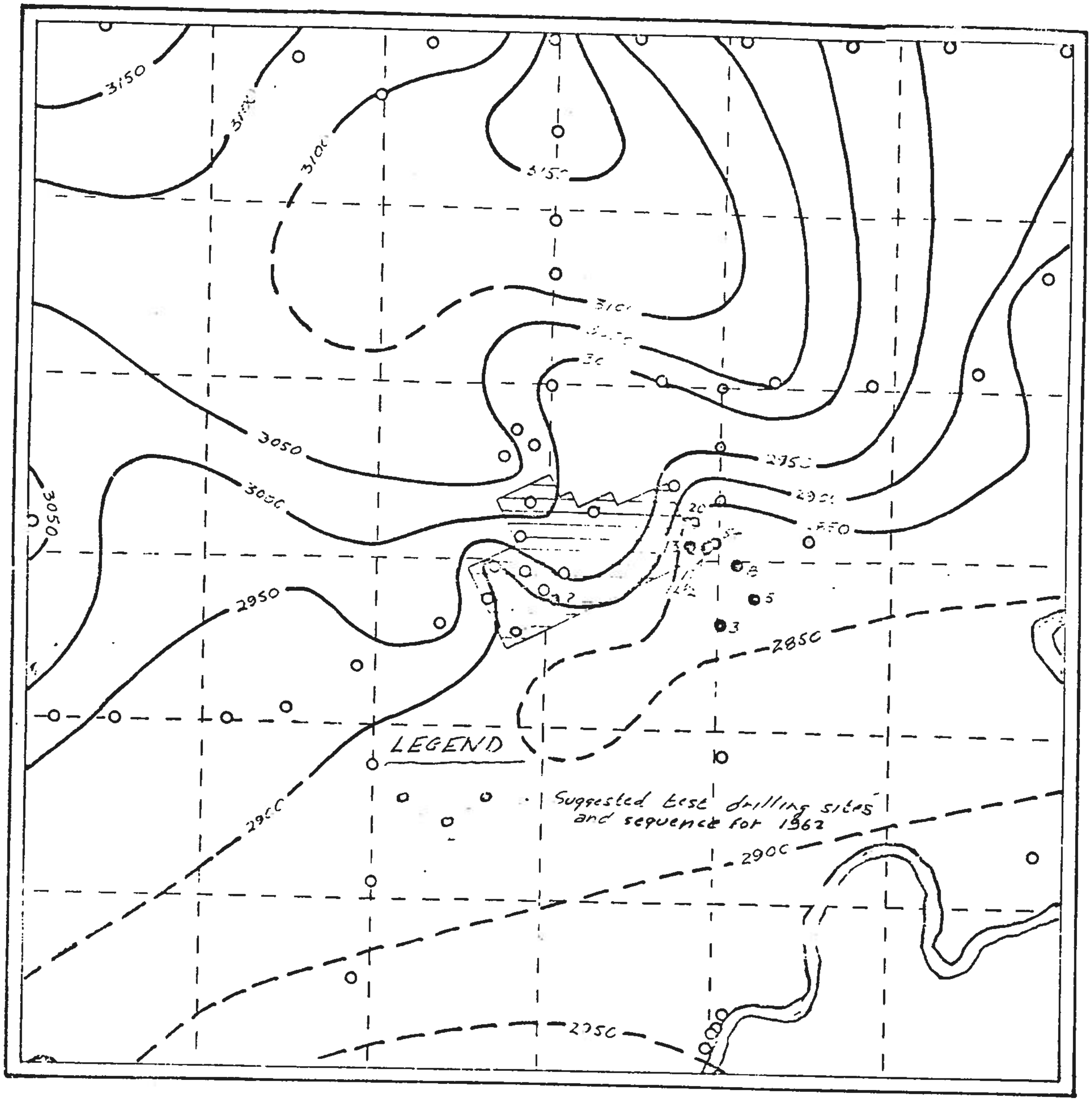
As the probable yield of this well is not yet known, it would be advisable to see if a pump capable of yielding about 100 to 150 gpm could be rented for testing purposes. For a production test to run for say one or two months it would be necessary to run a power line to the proposed well-site.

Recently two water samples were obtained from private wells completed in the Edson channel. Although the samples were too small to permit complete analyses to be carried out, the following constituents were determined:

	E. Bossert well	E. Taylor well
Total solids	950 ppm	1026 ppm
Ignition loss	36	50
Iron	0.3	0.1

BEDROCK TOPOGRAPHY

Tp53-R17-W5



1962 describing test drilling in detail.

LEGEND

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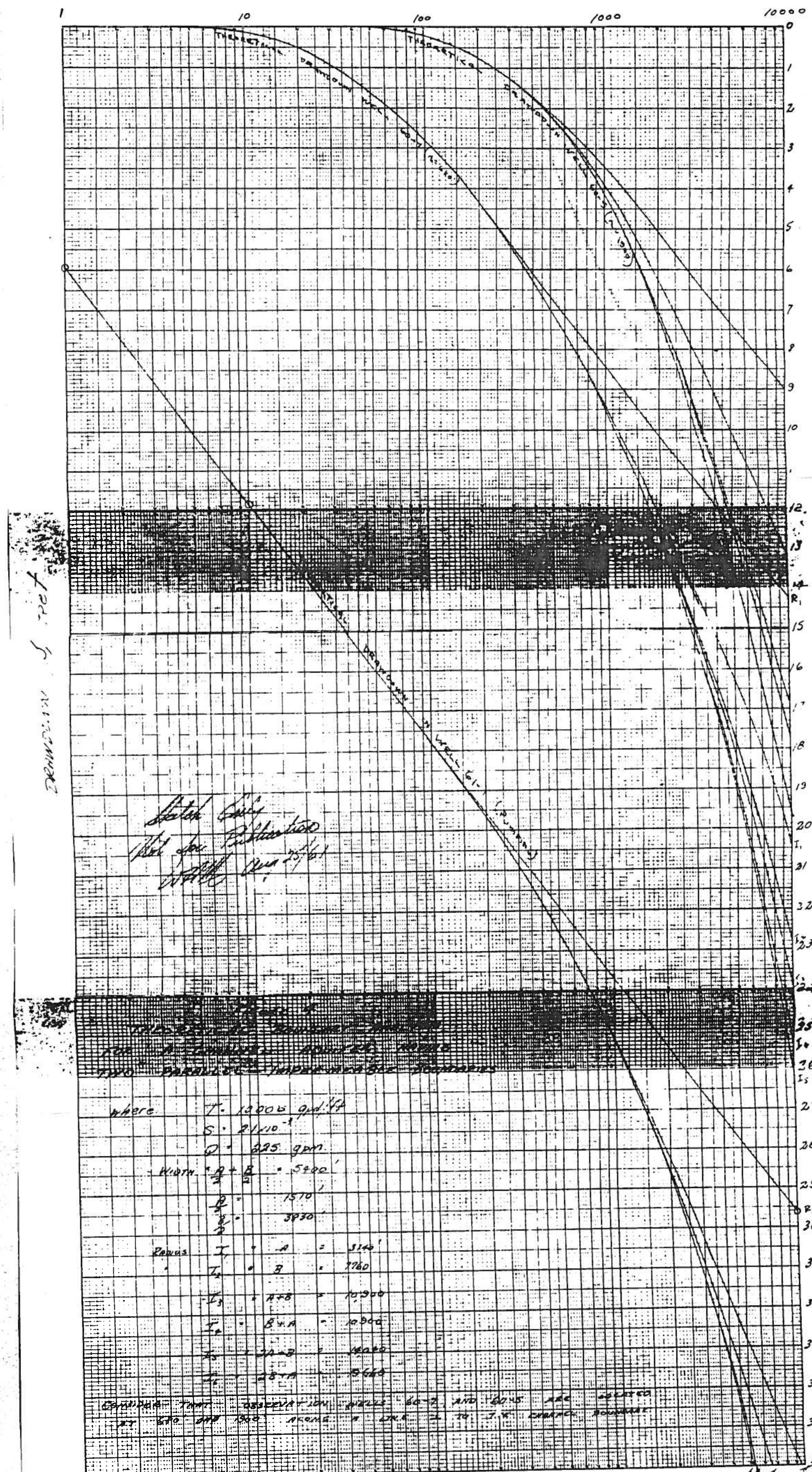
Fig. 4

time t, minutes



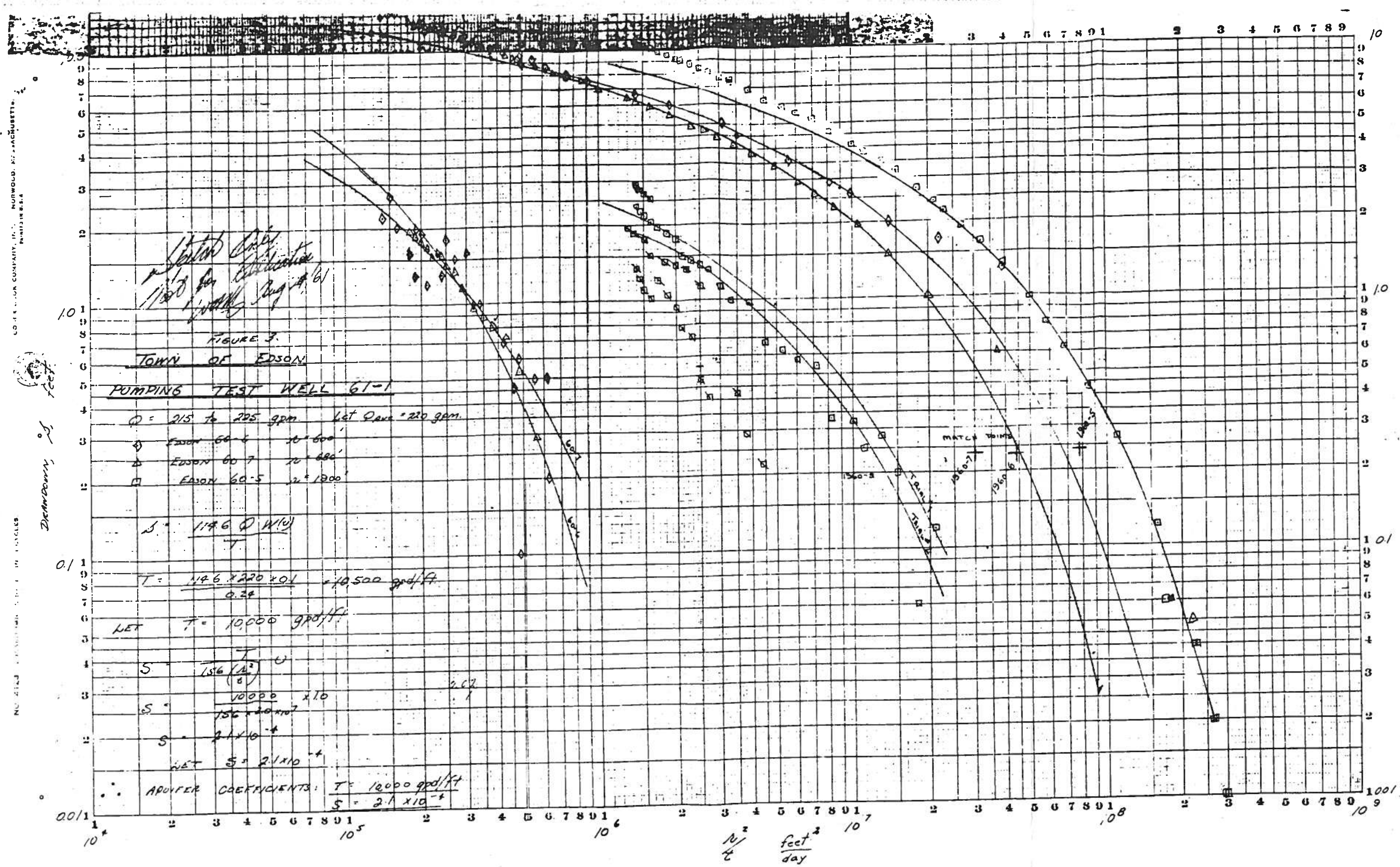


FIGURE 3.
TOWN OF EDSON
PUMPING TEST WELL 61-1
Q = 215 to 225 gpm. Let Qave = 220 gpm.
EDSON 60-6 r = 600'
EDSON 60-7 r = 680'
EDSON 60-5 r = 1900'
S = 114.6 Q W(u) / T
T = 114.6 x 220 x 0.1 / 0.24 = 10,500 gpd/ft.
LET T = 10,000 gpd/ft.
LET S = 2.1 x 10^-4
AQUIFER COEFFICIENTS: T = 10,000 gpd/ft S = 2.1 x 10^-4
DRAWDOWN, S, feet
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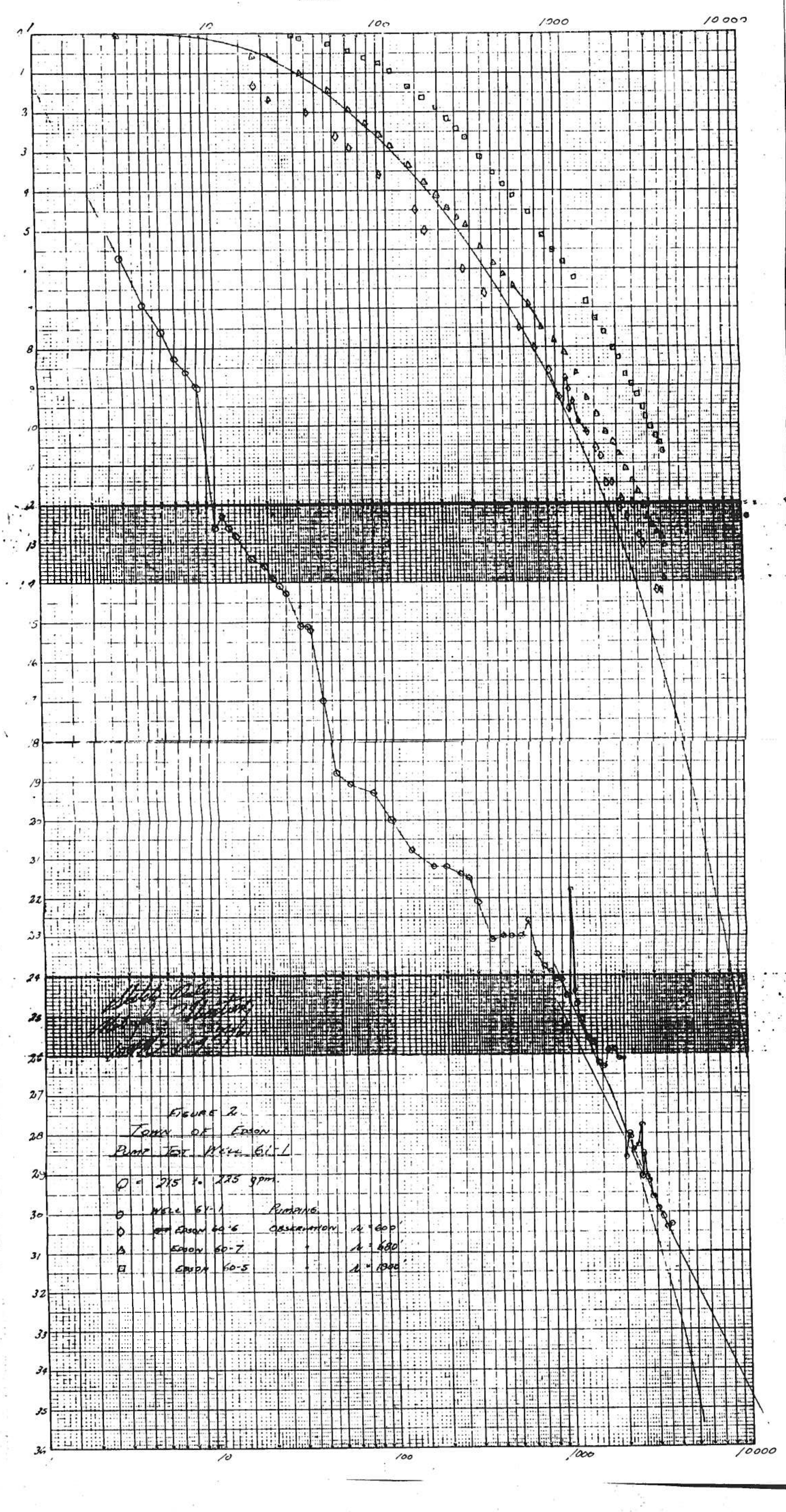
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Figure 2
Town of Edson
Pump Test Well 61-1
Q = 215 to 225 gpm.
○ Well 61-1 Pumping
◇ Edson 60-6 Observation r = 600'
△ Edson 60-7 r = 680'
□ Edson 60-5 r = 1900'