

ENGINEERS REPORT

to

NATIONAL PETRO-CHEMICALS CORPORATION

on

WATER WELLS NO. 1 AND NO. 2

WILSON & ANDERSON - - - - -CONSULTING ENGINEERS

CHAMPAIGN, ILLINOIS

January 12, 1953

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to
NATIONAL PETRO-CHEMICALS CORPORATION

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ENGINEER'S REPORT ON GROUNDWATER SUPPLY
from
NATIONAL PETRO-CHEMICALS CORPORATION WELLS NO. 1 & 2

Historical

Sites for Petro Wells no. 1 and 2 were selected upon the completion of a careful investigation of the water bearing sands and gravels in extensive unconsolidated drift deposits, lying geographically within the drainage pattern of the Kaskaskia River in Champaign County, Illinois, and readily accessible to the open channels thereof. See WATER WELL LOCATION MAP, Plate A.

The investigation consisted of an extensive but not exhaustive electrical earth resistivity survey and test drilling program, guided in part by all available and pertinent geological and hydrological data concerning the region under study. The aquifer utilized for the groundwater supply is the "Kansan" drift deposits of a pre-glacial valley, known locally as the "Sahonet" buried valley.

Sites for Petro Wells no. 1 and 2 were chosen and correspond respectively to test holes P-17 and P-18, drilled in January, 1951, by Hayes and Sias, Water Well Contractors, Champaign, Illinois. Petro Water Wells no. 1 and 2 were drilled by the reverse hydraulic method in the fall of 1952 by the Layne-Western Co., Aurora, Illinois. The wells are located in Section 18, T.19N, R.3E of the Third P.M. Well depths and general construction features are shown on an enclosed drawing identified as Plate B.

In addition, two observation wells were drilled in the vicinity by the Layne-Western Co. These wells will be permanently equipped with automatic water level recorders, to be furnished and maintained by the Illinois State Water Survey Division. The locations and characteristics of each of the observation wells are as tabulated on page 2.

T. 20N.
T. 19N.

CLINTON 32 MI.

CHAMPAIGN 2 MI.

NORTHERN ILLINOIS
WATER CORP. WELLS
#51 • #50
#49 •

PETRO OBS.
WELL #2 •

6

5

12

PETRO OBS.
WELL #1 •

7

8

ILL. RTE NO 10

ILL. CENTRAL RR.

STALEY STA.

ILL. TERMINAL R.R.

BONDVILLE

13

PETRO WATER WELLS

18
#2
#1
1270'

17

1. 2" FARM WELL

R. 7E.

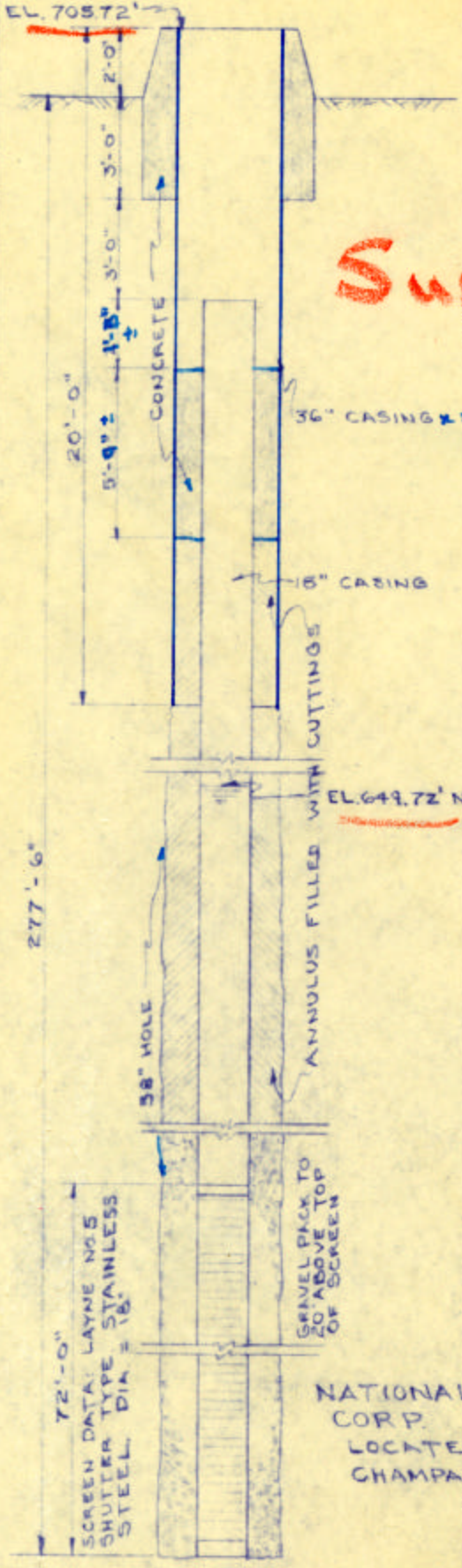
R. 8E.



NATIONAL PETRO-CHEMICALS CORP.
~ WATER WELL LOCATION MAP ~

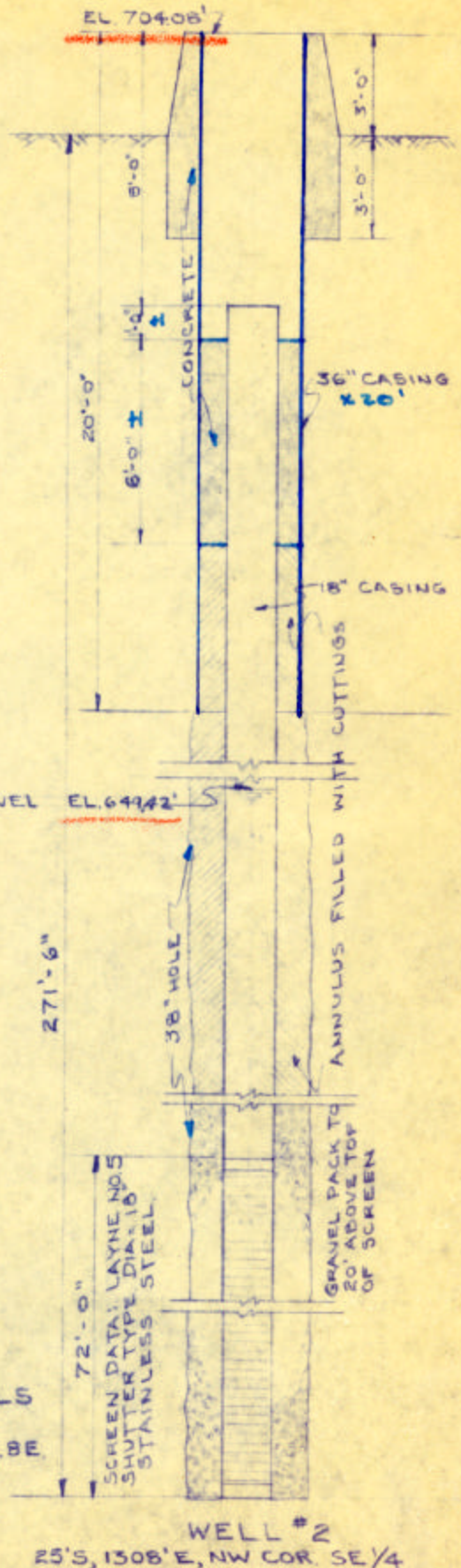
SCALE: 2" = 1 MILE

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WELL #1
70'S, 25'E, NW. COR. SE 1/4

Superseded
5-23-53
RTB



WELL #2
25'S, 1308'E, NW COR. SE 1/4
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NATIONAL PETRO-CHEMICALS
CORP. WATER WELLS
LOCATED IN SEC. 18, T.19N, R.8E
CHAMPAIGN COUNTY, ILL.
SCALE: 1" = 5'-0"

	<u>Observation Well No. 1</u>	<u>Observation Well No. 2</u>
<u>Location</u>	15°S, 27°W of NE corner of the NE 1/4 Sec. 7, T.19N, R.8E	955°N, 34°W of SE corner of the NE 1/4 Sec. 6, T.19N, R.8E
<u>Geological Formation</u>	"Kansen" Drift	"Kansen" Drift
<u>Drilled Depth</u>	213 Ft.	255 Ft.
<u>Bottom of Well Screen</u>	204 Ft.	235 Ft.
<u>Casing</u>	*6-inch, black steel in each well.	
<u>Screen</u>	6-inch, 3 ft. length, galvanized W.I. in each well.	

*In both wells the upper 25 ft. ± of casing is increased to 8-inch to accommodate recorder mechanism.

Well Production Tests

Production tests were conducted on Petro Water Wells no. 1 and 2 in October, 1952. Present were representatives of the owner, National Petro-Chemicals Corporation; the Well Contractor, Layne-Western Co.; the owner's Engineers, Wilson & Anderson, Consulting Engineers; and the Illinois State Water Survey.

For test purposes Wells no. 1 and 2 were equipped with a deep-well turbine-pump assembly, driven by a gasoline engine. Measurements of production were made with a Layne 8" x 10" orifice tube. Water levels in the pumped wells were determined by the water-air displacement method, using a calibrated pressure gage supplied by the State Water Survey.

During the production test of Well no. 1 changes in water levels were observed and measured in Well no. 2. With Well no. 2 pumping, similar observations were made in Well no. 1, in Observation Well no. 1, and also in a small diameter farm well, 119 feet in depth and situated approximately 2110 feet south of Well no. 2.

A resume' of the recorded production test data and the observations of water levels in non-pumping wells is tabulated below.

It should be noted that the production of Wells no. 1 and 2 during the test periods was limited to the maximum capacity of the test pump assembly.

WELL NO. 1 PRODUCTION TEST DATA, OCTOBER, 1952

<u>Date</u>	<u>Well No. 1 (Pumped)</u>			<u>Remarks</u>	<u>Well No. 2 (Observed)</u>	
	<u>Time</u>	<u>GPM</u>	<u>Feet to Water.*</u>		<u>Time</u>	<u>Feet to Water</u>
Oct. 23	8:03 A.M.	1683	57.9	Started pumping	8:03 A.M.	53.63
	10:25	1683	71.7	Sample #1	10:23	55.54
	1:30 P.M.	1683	71.9	Sample #2	1:41 P.M.	55.98
	4:00	1683	72.1	Stopped pumping	4:00	56.11
	4:30		59.3	Recovery	4:26	55.21
Oct. 24	9:30 A.M.		58.0			53.75

*Feet to Water, Below Top - 36" Casing, Elev. 705.72' A.S.L.

1
25
60
57
14
2

Z 110'5 #2
119 days

BELL NO. 2 PRODUCTION TEST DATA, OCTOBER, 1952

<u>Bell No. 2 (Pumped)</u>				<u>Bell No. 1 (Observed)</u>			<u>Farm Well (Observed)</u>	
<u>Date</u>	<u>Time</u>	<u>GPM</u>	<u>Feet to Water * Remarks</u>	<u>Time</u>	<u>Feet to Water **</u>	<u>Time</u>	<u>Feet to Water ***</u>	
Oct. 29	8:00 A.M.		54.8 Non-pumping level	8:00 A.M.	57.85	8:05 A.M.	52.55	
	8:17		Started pumping					
	10:00	1780	70.0 43	10:00	59.62	10:00	52.55	
	12:00 (Noon)	1775	70.7	11:30	60.01	11:30	52.55	
	4:20 P.M.	1767	70.8 Sample #1	4:30 P.M.	60.43	4:15 P.M.	52.54	
	8:00	1767	71.3					
	(Mid-12:00)	1767	70.8					
					59.62			
					57.82			
					1.80			
Oct. 30	8:00 A.M.	1753	70.9	8:13 A.M.	61.00	8:20 A.M.	52.62	
	3:00 P.M.	1739	71.1 Sample #2	2:00 P.M.	61.29	3:25 P.M.	52.61	
	4:17	1711	71.1 Stopped pumping					
	4:40		57.2 Recovery	4:45	59.34	4:50	52.60	
Oct. 31	8:00 A.M.		55.3	8:20 A.M.	58.59	8:40 A.M.	52.57	

* Feet to Water, Below Top of 36" Casing, Elev. 702.31' A.S.L.
 Note: 36" casing raised 1'-9" after test.
 ** Feet to Water, Below Top of 36" Casing, Elev. 705.72' A.S.L.
 *** Feet to Water, Below Top of 2" Casing, Elev. 701.24' A.S.L.

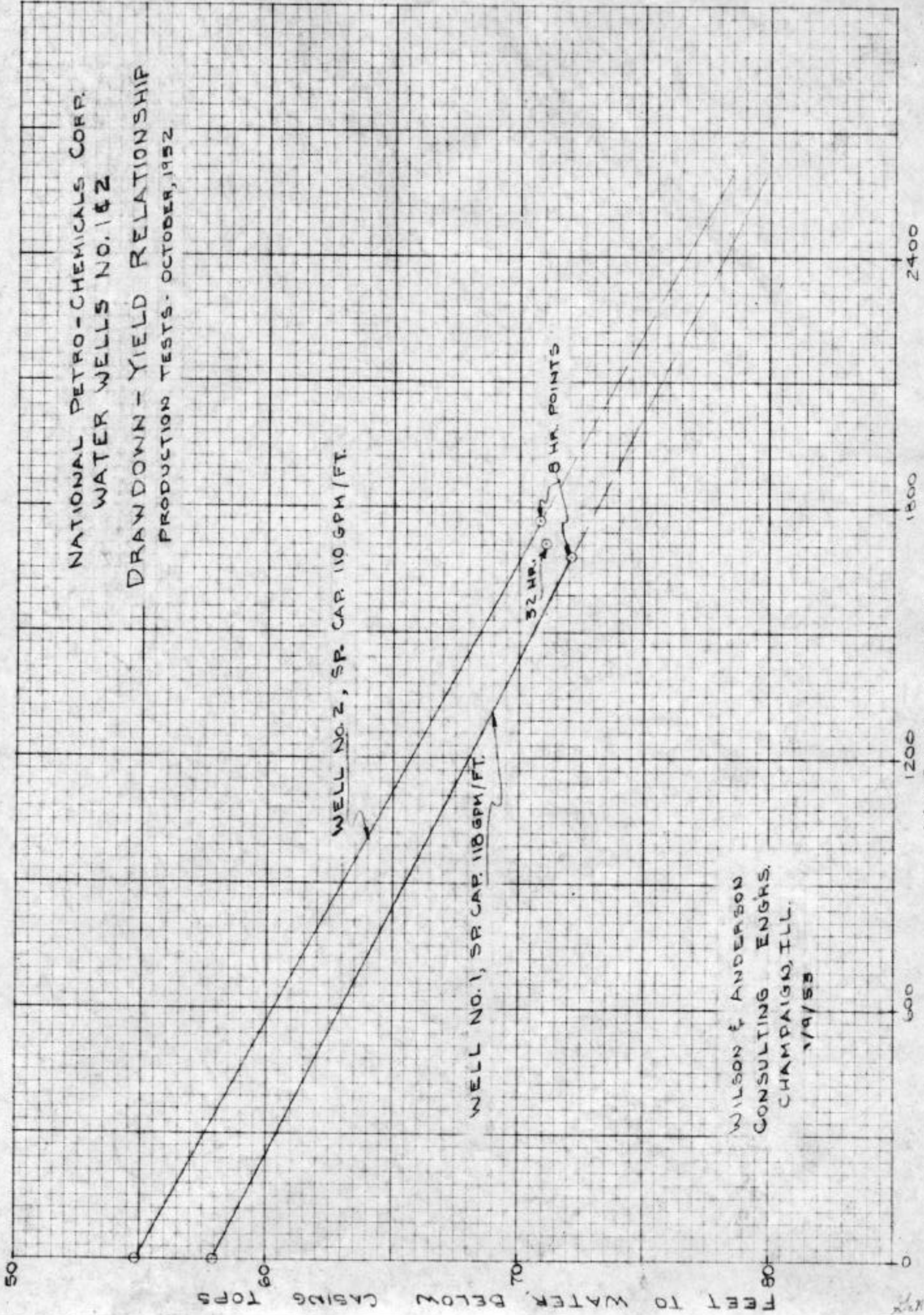
Production test results of Wells no. 1 and 2 are shown diagrammatically on enclosed Plate C, on which the drawdown-yield relationship of Wells no. 1 and 2 are plotted. It will be noted that for comparable periods of pumpage, Well no. 1 has a slightly greater Specific Capacity (GPM, per foot of drawdown) than Well no. 2. These curves may be of value in future years in helping to diagnose and remedy any deterioration of the wells or pumps.

Petra Observation Wells No. 1 and 2

Observation Well no. 2 was not built at the time the production tests were conducted so it will be excluded from further consideration in this report. Observation Well no. 1 was equipped with an automatic water level recorder at that time and continuous observation throughout the test period was available. The water level fluctuations have been plotted against time on Plate D in conjunction with water level changes in the two-inch farm well. These changes in water levels are compared to the barometric pressure changes for like periods of time.

A glance at Plate D gives the impression that the water surface in Observation Well no. 1 is influenced more by the effect of the barometric pressure variations (typical for artesian wells) than by the effect of the extraction of groundwater from a point in the aquifer. Since the time of pumpage was short and the distance between the center of pumpage and the point of observation rather long for an aquifer of such characteristics, this had been anticipated. Furthermore, the small increments of measurement involved and the various inconsistencies and inaccuracies in these measurements would give only inconclusive results should an attempt be made to analyze the data from Observation Well no. 1 more completely.

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WATER WELLS NO. 1 & 2
DRAWDOWN - YIELD RELATIONSHIP
PRODUCTION TESTS - OCTOBER, 1952

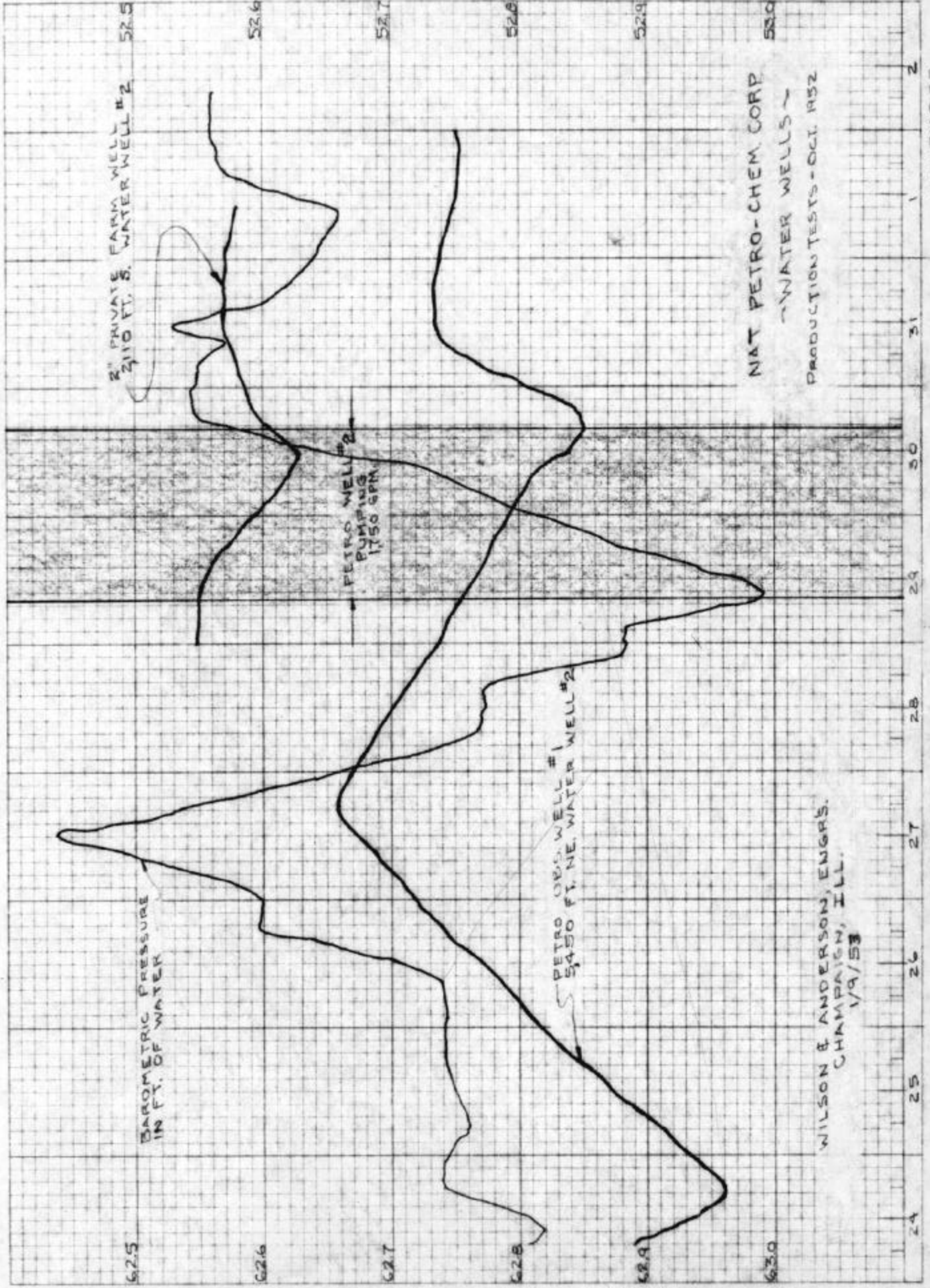


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NAT PETRO-CHEM. CORP.
 WATER WELLS -
 PRODUCTION TESTS - OCT. 1952

WILSON & ANDERSON, ENGRS.
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 1/9/53

N" FARM WELL, FEET TO WATER BELOW TOP OF CASING

D PLATE

24

However, after many months of sustained pumpage from Wells no. 1 and 2, the continuous gaging of water levels in Observation Wells no. 1 and 2 will be of great value in further determining the various characteristics of the producing aquifer. In future years with the potential possibilities of the aquifer better known any supplemental groundwater development can be planned properly, insuring safe and economical utilization of the resource.

The data plotted from gaging the water level in the two-inch farm well would indicate as expected that the depth (119') is not sufficient to encounter the top of the "Kansan" deposit. Hence any consistent lowering of the water surface in that well due to pumping Petro Wells no. 1 and 2 would be occasioned by slow leakage of water into the lower water bearing horizons as the artesian pressure in the lower deposit became less due to pumping from it. After the new farm well of 211 ft. depth is completed near the 119 ft. well, and static water levels compared in them, some forecast of effect on shallower wells due to pumping Petro Wells may be made, but more than likely such effect will only be known from actual pumping experience.

Mineral quality of Water

The water samples collected during the pumping tests were analyzed in the laboratories of the Chemistry Sub-Division of the Illinois State Water Survey. The mineral analyses are included herein as Tables I and II. The analyses show that the quality of water from the two wells is practically identical; that it is the same as water from Northern Illinois Water Co. Wells no. 49, 50 and 51 as anticipated in the Engineers first report on this water supply system (August 16, 1951); and that it is typical for Kansan drift waters in this area except that the iron content is lower than average.

Accordingly, the Engineers forecast of and comments regarding quality of well water and mixed water contained in the first report (August, 1951) may still be used in the anticipation of average treatment requirements for a one-year cycle.

STATE OF ILLINOIS
DEPARTMENT OF
REGISTRATION AND EDUCATION

STATE OF ILLINOIS
STATE WATER SURVEY DIVISION
ARTHUR M. BUSWELL, CHIEF
URBANA, ILL.

TABLE I

November 7, 1952

MINERAL ANALYSIS (PETRO-CHEM. WELL NO. 1)

18.4d

Sample No. 2 of water collected at 4:00 p.m. on October 23, 1952 from Well #1 owned by the Petro Chemical Company in Champaign, Illinois in Champaign County. Location of well: 70' S. and 25' E. of NW Corner, SE 1/4, of Section 18, T. 19 N. R. SE. Depth 275 feet. Sample collected after pumping 1680 gpm. for 8 hours.

LABORATORY NO. 130,293

	PPM.	PPM.		PPM.	PPM.
Iron (total) Fe	0.1		Silica SiO ₂	16.3	
Manganese Mn	0.0		Fluoride F	0.3	
Calcium Ca	53.0	2.65	Chloride Cl	3.	.08
Magnesium Mg	28.7	2.36	Nitrate NO ₃	3.3	0.05
Ammonium NH ₄	0.8	0.04	Sulfate SO ₄	0.0	0.00
Sodium Na	34.0	1.48	Alkalinity (as CaCO ₃)	320.	6.40
Turbidity	tr.		Hardness (as CaCO ₃)	251.	5.01
Color	0		Residue	324.	
Odor	0				
Temp. (reported)	= 54.0°F.				

ppm. = parts per million
 eqm. = equivalents per million
 ppm. x .0583 = grains per gallon

STATE WATER SURVEY DIVISION

R. M. King, Asst. Chemist

RMK:it

STATE OF ILLINOIS
DEPARTMENT OF
REGISTRATION AND EDUCATION

STATE OF ILLINOIS
STATE WATER SURVEY DIVISION
ARTHUR M. BOSWELL, CHIEF
URBANA, ILL.

TABLE II

November 7, 1952

18.3d

MINERAL ANALYSIS (PETRO-CHEM. WELL NO. 2)

Sample No. 2 of water collected at 3:00 p.m. on October 30, 1952 from Well No. 2 owned by the Petro Chemical company in Champaign, Illinois in Champaign County. Location of Well: 25' S. and 1308' E. of SW Corner, SE 1/4, of Section 18 T. 19 N. R. 8 E. Depth: 271 feet. Sample collected after pumping 1760 gpm. for 30 3/4 hours.

LABORATORY NO. 130,295

		PPM.	EQV.			PPM.	EQV.
Iron (total)	Fe	0.4		Silica	SiO ₂	17.4	
Manganese	Mn	tr.		Fluoride	F	0.3	
Calcium	Ca	50.6	2.53	Chloride	Cl	4.	.11
Magnesium	Mg	26.6	2.19	Nitrate	NO ₃	0.4	0.01
Ammonium	NH ₄	1.0	0.06	Sulfate	SO ₄	0.0	0.00
Sodium	Na	41.9	1.82	Alkalinity (as CaCO ₃)		324.	6.48
Turbidity		5.		Hardness (as CaCO ₃)		236.	4.72
Color		0		Residue		334.	
Oder		0					
Temp. (reported) = 54.6°F.							

ppm. = parts per million
eqv. = equivalents per million
ppm. x .0583 = grains per gallon

STATE WATER SURVEY DIVISION

R. M. King, Asst. Chemist

RGK:lt

Analysis of Data

Theoretically drawdowns observed at points in an aquifer as water is extracted can be used to determine the formation constants of the aquifer. These formation constants are essential in evaluating the amounts of groundwater that will be available for long term pumping operations.

The formation constants are the coefficients of transmissibility and storage. The coefficient of transmissibility is the product of the average permeability of the deposit and the average thickness. Closely defined, it is the number of gallons per day that will flow through a vertical strip of the aquifer one foot wide under a unit hydraulic gradient at a stated temperature. The coefficient of storage is an indication of the rate at which the formation will yield water from storage as the piezometric surface declines.

The piezometric surface is that surface which would be established by interconnection of water levels in a group of wells penetrating the same aquifer. In the case of artesian conditions, such as displayed in the aquifer under discussion, the piezometric surface represents the groundwater pressure at points in the formation. In an area where there is no water discharged from or flowing through the deposit, the pressure surface would be a plane. When a well is pumped this surface would represent roughly an inverted flared cone with the apex at the pumped well. With continued pumping the periphery of the cone expands, but at a decreasing rate of expansion. The formation constants can be calculated either from (1) the shape of the cone of depression at any given time; that is, from the drawdown in two or more observation wells or (2) the rate of change of drawdown (or recovery) at any point on the cone, such as in the case of any observation well penetrating the same formation.

A thorough technical treatment of the determination of the aquifer coefficients is given in the United States Department of Interior, Water Supply Paper #887, prepared by L. K. Wenzel. It is not the intention of this report to elaborate more fully on the various assumptions and mathematical devices prerequisite for the complete presentation of the various theories, but rather to use what solutions are applicable for the assembled field data.

The coefficient of transmissibility was determined by two methods:

- (1) the change in rate of drawdown of a point on the cone of depression. (The best data available for this study were the observations in Well no. 1 during the thirty-two hour pumping test on Well no. 2 conducted on October 29 and 30, 1952) and (2) the recovery of Wells no. 1 and 2, both during employment as observation and pumped wells.

1. Change in Rate of Drawdown, Well No. 1

The method used in this case for determining the coefficients was the Straight-Line Modification* of the Theis, type-curve, non-equilibrium solution, which is explained fully in Water Supply Paper #887. The plot of the Straight-Line Modification is shown on Plate E. On this sheet the drawdown in feet in Well no. 1 is plotted against accumulative time in minutes since the beginning of groundwater discharge from Well no. 2. The solutions for T (transmissibility coefficient) and S (storage coefficient) are also given on the sheet.

*Note: The Straight-Line Modification may be found in C. O. Walter & E. F. Brater's "Hydrology" Chapter 7 written by John G. Ferris.

NATIONAL PETRO-CHEMICALS CORP.
- WATER WELLS -
TRANSMISSIBILITY BY STRAIGHT-LINE
MODIFICATION
PRODUCTION TESTS, OCTOBER, 1952

PLAT OF OBSERVATION DATA IN WELL #1
WELL #2 PUMPING 1760 GPM.

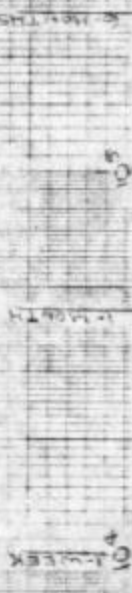
$t_0 = 5 \text{ min.}$

$$T = 264 \frac{Q}{\Delta S} = 264 \times \frac{1760}{1.26} = 360,000$$

$$S = \frac{0.3 T C_0}{r^2 \times 1440} = \frac{0.3 \times 360000 \times 5}{(1760)^2 \times 1440} = 0.00026$$

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ACCUMULATIVE TIME SINCE PUMPING BEGAN - MINUTES



The equations to be solved are:

$$T = 264 Q / \Delta s$$

where Δs = drawdown in one logarithmic cycle of time
(i.e. from 10 to 100 or 100 to 1000 etc., units of time)
and Q = rate of pumping in gallons per minute

$$S = \frac{0.3 T t_0}{r^2}$$

where t_0 = time intercept at zero drawdown of the extension of
the straight line drawn through the plot of the
observed data.

r = radial distance from pumped well.

the values for T and S computed by this method are

$T = 360,000$ gal. per foot/day and $S = 0.00025$ (considered dimensionless)

2. Recovery of Wells No. 1 and 2

The rate of recovery of the water level in the wells when pumping
is discontinued can be used to determine the coefficient of transmissibility
as explained in Water Supply Paper #887 by the following equation.

$$T = 264 Q \log \frac{t/t'}{s}$$

where t = time since pumping began

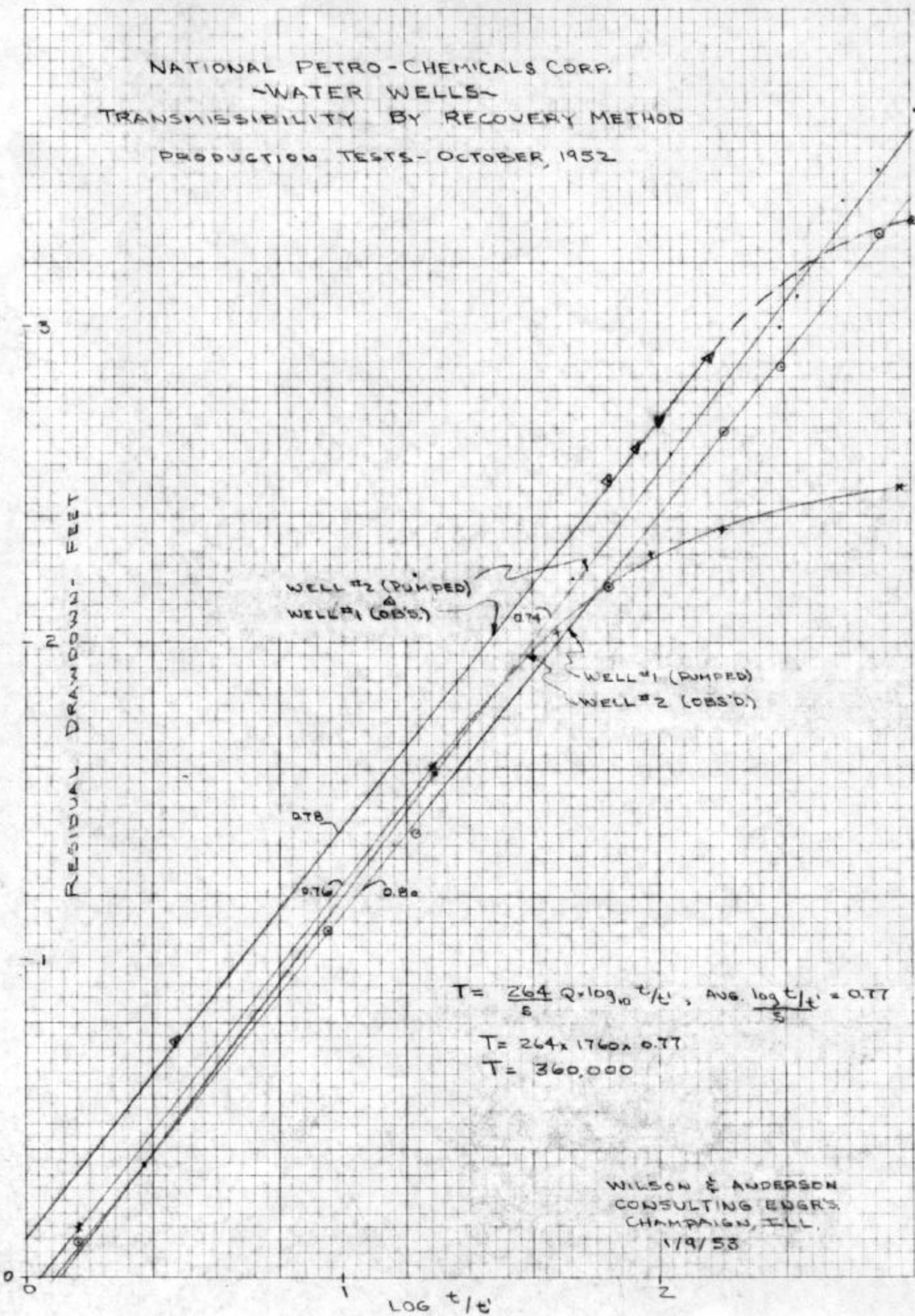
t' = time since pumping stopped

s = residual drawdown in feet, i.e. the difference between
the original non-pumping level and the observed water
level

A plot of the residual drawdown in feet and $\log t/t'$ of observations in both wells after each pumping period is given on Plate F in conjunction with the solution for T. If an average $\log t/t'$ of 0.77 for the four curves is used the resultant value for T is 360,000 which is in complete agreement with the T calculated from data obtained during the discharge cycle.

The formation constants of $T = 360,000$ and $S = 0.00025$ are in close accord with the constants derived from calculations made by the State Water Survey Division in the analysis of field data derived from tests conducted on the Northern Illinois Water Corporation Wells no. 49, 50 and 51, drilled in the same type formation and located approximately 2.8 to 3 miles northeast of Petro Wells no. 1 and 2.

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 -WATER WELLS-
 TRANSMISSIBILITY BY RECOVERY METHOD
 PRODUCTION TESTS - OCTOBER, 1952



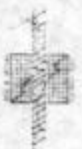
$$T = \frac{264 Q}{S} \log_{10} \frac{t}{t'}, \text{ AVG. } \log \frac{t}{t'} = 0.77$$

$$T = 264 \times 1760 \times 0.77$$

$$T = 360,000$$

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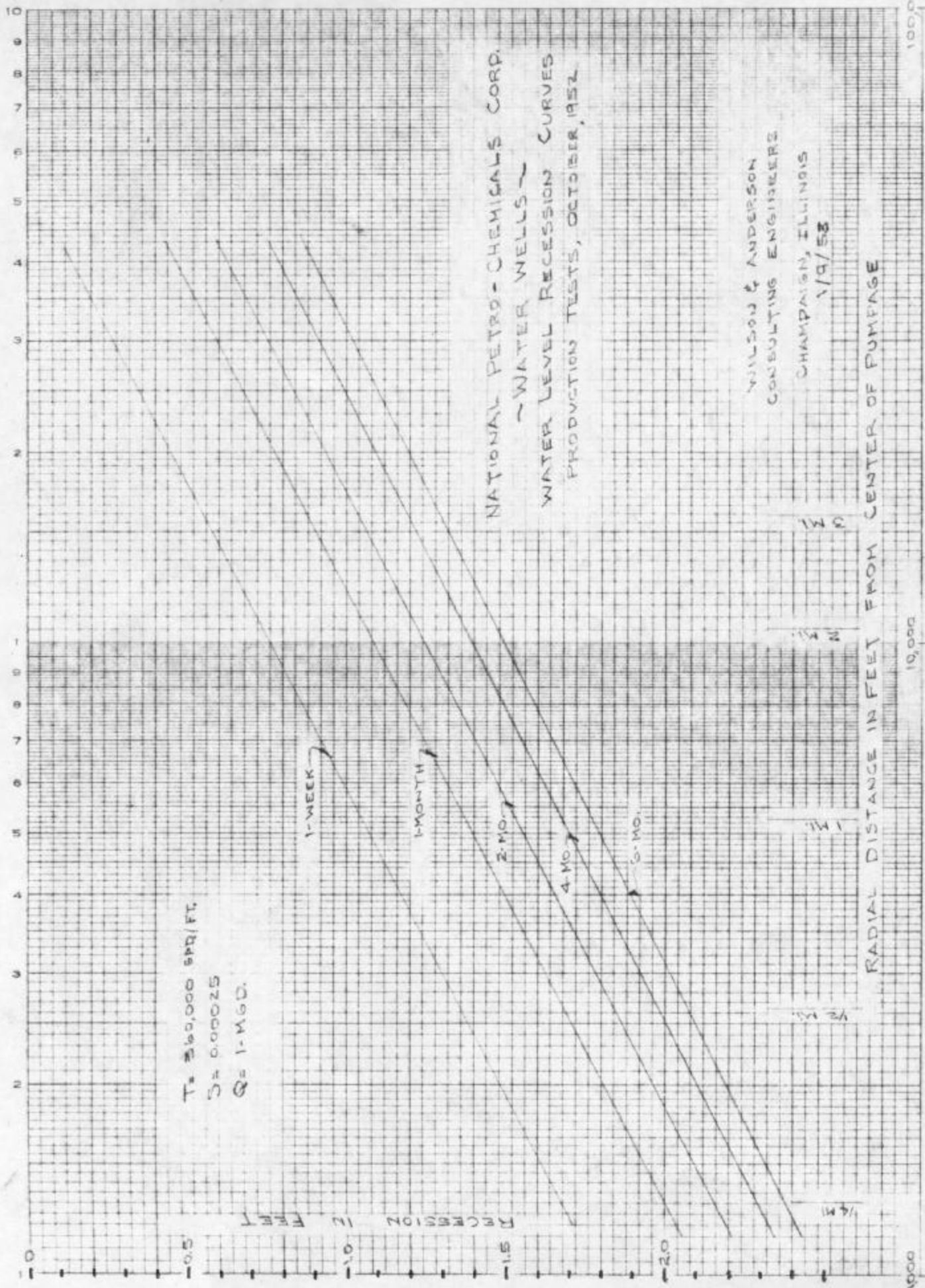
Application of Analyses and Plotted Field Data

Once the formation constants are calculated, they may be used to compute drawdowns at selected points in the formation under presumed conditions of groundwater discharge and elapsed time. Such computations have been made for 1.0-MGD continuous pumping rate and the results are shown graphically on Plate G, entitled, Water Level Recession Curves. The 1-MGD rate of production was chosen since the recession is directly proportional to the rate of production, and consequently the recession at other rates may be easily determined by reading values on the graph (plate G) and multiplying by the actual pumping rate in MGD.

For example, the recession of static level in the Kansan aquifer at a point one mile from both of the wells, due to pumping six months at 4 MGD (from Well no. 1) and four months at 3 MGD (from Well no. 2), would be estimated from Plate G as follows:

$$\begin{aligned} \text{Recession @ 1 mile due to 6 no. pumping @ 1 MGD} &= 1.76' \\ \text{Recession @ 1 mile due to 4 no. pumping @ 1 MGD} &= 1.68' \\ 4 \times 1.76 &= 7.0 \text{ ft.} \\ 3 \times 1.68 &= 5.0 \text{ ft.} \\ \text{Total Recession} &= 12.0 \text{ ft.} \end{aligned}$$

This estimated recession at one mile distance from Wells no. 1 and 2 should approximate the maximum effect in a drought of at least ten-year average frequency, in the Engineer's opinion. It would be lessened by recharge (which we are unable to calculate), and it will probably be less for Illinoian and certainly for Wisconsin drift wells at the same distance (one mile) from Petro Wells no. 1 and 2.



NATIONAL PETRO-CHEMICALS CORP.
~ WATER WELLS ~
WATER LEVEL RECESSON CURVES
PRODUCTION TESTS, OCTOBER, 1952

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CHAMPAIGN, ILLINOIS
1/9/53

Selection of Well Pumps

The preceding groundwater analyses coupled with the various recordings of field data assembled in this report were used in the selection of well pump capacities and settings. This application is given in the following tabulation, to suit expected maximum operating conditions during a very dry year.

PREDICTED PUMPING LEVELS IN PETRO WELLS NO. 1 AND 2
Anticipated Maximum Conditions

Assuming 6 month continuous, simultaneous operation at 7-MGD combined, total discharge. 4-MGD from Well no. 1 (approximately 2800 GPM)
3-MGD from Well no. 2 (approximately 2100 GPM)

<u>Description</u>	<u>Head on Pumps</u>		<u>Remarks</u>
	<u>Well no. 1</u>	<u>Well no. 2</u>	
Elev. top of 36" casing	705.7	704.1	Permanent datum
Dist. to centerline 12" diach.	- 6.8	- 6.8	
Elev. centerline 12" diach.	698.9	697.3	
Elev. static water level	-649.7	-649.4	See Sheet B
(1) Static lift	49.2 ft.	47.9 ft.	
(2) Drawdown at assumed rates (1-day)	$\frac{2800}{118} = 23.8$	$\frac{2100}{110} = 19.0$	See Sheet C
(3) Recession in pumping level due to own pumping* (1-Day to 6-Mo.)	$(6.0-3.2)\frac{2800}{1760} = 4.4$	$(6.0-3.2)\frac{2100}{1760} = 3.4$	See Sheet E, use proportional Q's
(4) Recession due to interference at 1/4 mi., distance between wells	$2.4 \times 3 = 7.2$	$2.4 \times 4 = 9.6$	See Sheet G, 6 mo. curve, @ 1/4 mi., use proportional Q's
(5) Theoretical total Max. Lift	84.6 ft.	79.9 ft.	

*After the initial drawdown (assumed 1-day in this case) the added rate of recession in the pumped well would have the same slope as shown on Sheet F for an observation well.

To the "maximum lift" for each well was added about 4.0 feet in each case, as friction head in pump column and discharge pipe, meter, etc., to determine total dynamic head for each pump. Pumps actually selected are of about 2700 GPM (for Well no. 1) and 2200 GPM (for Well no. 2) capacities, in order to use 75 HP and 60 HP motors, respectively, with manufacturer's equipment of maximum efficiency at capacity rates approximating the desired rates of 4 MGD and 3 MGD, respectively.

Pump column lengths of 100 feet were chosen for each pump, in order to allow about ten feet or more of submergence of bowls after six months of pumping of both wells. Necessary column length is item 5 (max. lift) plus 6.8 feet (motor base down to centerline of below-ground discharge), being (theoretically) 91.4 and 86.7 feet, respectively, for Wells no. 1 and no. 2. Actually, the net requirement of pump column would be about one foot less for Well no. 1, and one foot more for Well no. 2, due to pumping rates being about 100 GPM less for Well no. 1 and 100 GPM more for Well no. 2 than the rates assumed in the preceding calculations.

Evaluation of Data

Though the increments of head and the total lift are given as correct to tenths of feet, it is not intended to leave the impression that the application is that accurate. However, two important factors will operate to keep actual recessions within those estimated: Recharge, and decreased production from the well pumps as total lift increases. On the other hand, with elapsed time drawdowns may become somewhat greater due to loss of specific capacity induced by slight increases in entrance head losses resulting from deposition of minerals on the well screen, iron bacteriological growths, etc.

It seems likely that complete recovery will take place in the formation during the non-pumping cycle of the wells each year. Throughout the discussion any effect of recharge to the formation from the main buried channel of the "Mahomet" Valley (it is thought that the Petro wells are not in the main channel but in a finger of the valley) as the cone of influence expands has not been considered. Such an occurrence is expected to arise, in which case a condition of equilibrium will be reached between the groundwater inflow into the area and the amount of groundwater extracted. Under such circumstances the actual recessions due to prolonged pumping will be somewhat less than those estimated herein, depending upon the hydraulic gradient necessary to maintain an inflow of recharge equal to the total discharge at the wells.

Summary and Conclusions

It seems in order at this point to make some comparisons with anticipated water yield, recessions and production costs in the area between Bondville and Champaign, in a summary of the data included herewith.

1. The specific capacity of Well no. 1 was 118 GPM, and of Well no. 2 was 110 GPM, per foot of drawdown at pumping rates of about 1700 GPM. It may be slightly less at the proposed pumping rates of 2100 to 2800 GPM, but not materially less. This compares with specific capacities (at time of test) of 42 to 87 GPM per foot for NIRC Wells no. 49, 50 and 51; and with an assumed minimum specific capacity of 40 GPM in our evaluation of test holes no. 17 and no. 18 contained in our letter of March 10, 1952, to National Petro (marked for attention of Dr. Hulse or E. J. Tampest).

2. Wells no. 1 and no. 2 may be safely depended upon to produce 3 to 4 MGD each for a long period of time, as now planned and as forecast in the fifth paragraph of our letter of March 10, above referred to.

3. Due to the more favorable specific capacity of each well, and to a somewhat higher static water elevation than anticipated, pumping cost for supplementary water should be about 10% less than estimated in the Engineers original Report to Petro on Water Supply, dated August 18, 1951. (See pages 29 and 30, section I.B. of "Operating Cost Estimates".)

4. Well construction and equipment cost will be only about one-half of that assumed at the time of the original Engineers Report (August 18, 1951), since only two wells are required to produce the same amount of water expected to be available from four or five wells on the basis of evaluation made by Layne-Western after drilling of first thirteen test holes.

5. Characteristics of the aquifer are not significantly different from those on which earlier calculations of water level recessions were based. The assumptions and present calculations compare as follows:

	<u>T=Coeff.</u> <u>of Trans-</u> <u>missibility</u>	<u>S=Coeff.</u> <u>of</u> <u>Storage</u>
Values based on test data from NIRC wells 49, 50 & 51	482,000	.000168
Values calculated from tests on Petro wells no. 1 and no. 2	360,000	.00025

The variations in these characteristics are such that water level recessions should be reasonably close to estimates in a study made by the State Water Survey dated October 8, 1951, transmitted to Petro (Attention Mr. Teapest) by our letter and comments of October 9, 1951. The same statement applies to testimony on recession offered in the Champaign County Court by witness Harmon F. Smith of the State Water Survey during the hearing on agreement with the Drainage Districts.

6. When and if it is required to meet ultimate water requirements of Petro, in an extreme drouth, the Corporation may construct another well in the SE 1/4 of Sec. 13, under existing agreement with the landowners. The presently indicated location of such future well would be near test hole no. 15, about 1/4 mile south of Well no. 1. We would not expect production from a well at that location to be quite as good as from Wells no. 1 or 2, but it should nevertheless be capable of producing 3 MGD at economical pumping cost and without serious interference with Wells no. 1 or 2.

Such construction and equipment of a third well would make possible total maximum daily pumpage in the area of about 10 MGD, beyond which limit the agreement with Northern Illinois Water Corporation requires (Article 10) that advance notice be given to NIWC and that a joint study of the effect of pumping 10 MGD (or more) be made.

WILSON & ANDERSON, CONSULTING ENGINEERS
Champaign, Illinois, January 12, 1953

Data compiled by G. E. Neher
GEM & RDW:w