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PUMPING TEST AT LEVITTOWN, NASSAU COUNTY, NEW YORK

SEPTEMBER 16-18, 1949

By

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ABSTRACT

This report presents and discusses the quantitative and qualitative data obtained during a pumping test at the Levittown housing development in Nassau County, N. Y. One of the ten principal supply wells, screened in the sands of the Magothy (?) formation which is overlain unconformably by the sand and gravel of the upper Pleistocene deposits, was pumped for more than 24 hours at a rate of 790 gallons per minute. During this time the development of the cone of depression extended a distance of more than 1,000 feet from the pumping well. A coefficient of transmissibility of 245,000 gallons per day per foot was computed and a coefficient of storage of 0.13 was determined at the site of the pumping test.

The qualitative results show that the two aquifers at the pumping-test site, that is, the sand and gravel of the upper Pleistocene deposits and the underlying sands of the Magothy (?) formation, function essentially as one hydrologic unit. Such information, together with other data of this kind, assumes importance when it is realized that the New York Water Power and Control Commission by regulation considers every aquifer as a separate and distinct hydrologic unit. It thus requires the return of water pumped for cooling and other similar uses to the same aquifer from which the water was taken, unless sufficient evidence is obtained to show that two adjacent aquifers function as a single hydrologic unit.

Sufficient data were obtained during the test to suggest that perhaps about 14 feet of the 19.7 feet measured as drawdown in the pumped well is attributable to well and screen losses.

INTRODUCTION

A pumping test was run September 16-18, 1949, at one of the ten wells (see pl. 1) constructed for public water supply and industrial uses at Levittown, a popular low-cost housing development in Nassau County on Long Island, N. Y. Water-level measurements were made at the discharging well and four observation wells before, during, and after pumping. Two of the observation wells were equipped with automatic water-level-recording instruments. Discharge rates and other pertinent geologic and hydrologic information were obtained. As shown on plate 2, the pumped well N 2791 (2B) and one observation well N 3313 (7) were screened in the Magothy (?) formation of Upper Cretaceous age; all the other wells used for the test were screened in the upper Pleistocene (glacial) deposits. Although this pumping test was arranged primarily to furnish qualitative information, sufficient data were obtained for quantitative studies by means of which the hydraulic characteristics of the water-bearing formations were determined.

Permission to use the Levittown pumping facilities and equipment for this pumping test was granted through the kindness and cooperation of Levitt & Sons, Inc., at the suggestion of R. M. Leggette, their ground-water geologist consultant, and C. W. Lauman & Co., Inc., well drillers.

Pumping tests of this kind and other hydrologic-research studies are part of a regular program of investigation of the ground-water resources on Long Island. The work in Nassau County is done in cooperation with the New York Water Power and Control Commission and the Nassau County Department of Public Works.

QUANTITATIVE RESULTS

Water-level data collected at only two wells were utilized for quantitative analyses; those taken manually at observation well O-2, located 252 feet from the pumped well, and those recorded by an automatic instrument at well N 3313 (7), 705 feet from the pumped well. Records obtained by recorder at well O-3 were practically identical to those obtained at well N 3313 (7) located 2 feet away. As depicted on plate 2, wells O-2 and O-3 are screened in the glacial deposits and well N 3313 (7) in the sands of the Magothy (?) formation.

Readings taken with an air line in the pumped well were not accurate enough for analytical studies; also, observed data indicate that some degree of development - that is, a change in the arrangement of sand and gravel particles involving removal of the smaller particles - occurred outside the well screen during the test. The manual readings obtained in observation well O-1, 3 feet from the pumped well, were not used for quantitative analysis because of the effect of the convergence of flow lines due to the fact that the pumped well is a partially penetrating well - a well that is not screened through the full thickness of the water-bearing material.

The results of quantitative studies based on two types of log-log plottings - drawdown (and recovery) vs. time, and drawdown (and recovery) vs. distance squared - are listed in table 1. In the computation of drawdown and recovery, due consideration was given to the trend of the water levels prior to the start of the test. A straight-line recession of the water levels amounting to 0.03 foot in 24 hours was indicated in wells at the site of the pumping test and in the general vicinity. Inasmuch as the rate of discharge varied appreciably during the first 4 hours of the test, studies were made not only of the drawdowns as observed but also of those adjusted to a constant discharge of 790 gallons per minute. However, very little difference in results was obtained by adjusting the drawdowns for variations in discharge rate.

The coefficient of transmissibility as computed averaged 245,000 gallons per day per foot. As can be noted from table 1, the several computed coefficients of transmissibility and storage are close to the average, except for those determined from the drawdown-vs.-time curve for well N 3313 (7). For an assumed saturated thickness of 100 feet, the coefficient of permeability would be about 2,450 gallons per day per square foot. The saturated thickness is assumed, inasmuch as the available logs of wells fail to provide sufficient data to define it. As the average coefficient of storage, 0.13, is somewhat smaller than anticipated, general conclusions concerning the storage coefficient are being withheld until more data for the upper beds of the Magothy (?) formation are available.

The departure, during the last 12 hours of the pumping test, of the observed readings, as plotted on sheets 1, 2, and 5 from the type curve for W (u) vs. u, reveals that some form of geologic boundary (or boundaries) began to show an influence on water levels in wells 0-2 and N 3313 (7). Data plotted on plate 5 for well N 3313 (7) and plate 8 for well 0-2 fail to show boundary effects. A brief study suggest that the thinning out of the aquifer as indicated by the log of well N 3312 (8) (see pl. 2) may cause the boundary effect indicated by the data. The effective distance to this "boundary" was calculated to be approximately 700 feet from well N 3313 (7).

QUALITATIVE RESULTS

Extent of Cone of Depression

The extent of the cone of depression developed around a pumped well withdrawing ground water at a known discharge rate for a definite time was to be ascertained for the test location in Levittown. Information of this type is valuable in well-interference studies, which are particularly significant to water districts and companies with adjacent franchise areas, such as the Hicksville and Levittown Water Districts, when wells near the limits of the franchise areas are being considered. Pumping well N 2791 (2B) at an average rate of 790 gallons per minute for 24 hours created a drawdown of 0.14 foot (from recorder chart) at observation well N 3313 (7) located 705 feet from the pumped well. At the nearer observation wells the drawdowns were much larger, as shown in tables 2 and 3. A graphical extrapolation of the profile of the cone of depression, based on drawdowns observed at several wells, shows the practical extent of the cone to be at a radius of approximately 1,000 feet for that period of pumping. However, the approximate "measurable" limit, or the point of 0.01-foot drawdown, was computed to be about 1,500 feet from the pumped well.

How large a drawdown would be measured if a 7-day test were run? Assuming an extensive aquifer, no recharge from precipitation, and no appreciable variation in the geologic and hydrologic characteristics of the aquifer with distance from the pumped well, a drawdown of more than half a foot would be measured in well N 3313 (7). At the end of 7 days of continuous pumping the "measurable" cone of depression would extend to a radius greater than 4,000 feet. If, however, a radical change in geology, from the hydrologic standpoint, occurs within this distance, then the drawdown may be even larger (if the aquifer is limited) or smaller (if the cone expands into recharge areas).

Hydrologic Interconnection

In an attempt to conserve as much as possible of the available ground-water storage in each of the several aquifers on Long Island, the New York Water Power and Control Commission considers every aquifer as a more or less separate and distinct unit. The Commission thus requires that water pumped for air-conditioning and similar uses be returned to the same formation from which it was withdrawn. At times it seems desirable to show, however, that at some locations on Long Island two aquifers such as the sand and gravel of the upper Pleistocene deposits and the underlying sands of the Magothy (?) formation can and do function as one rather than two separate hydrologic units. The Commission gives due consideration to evidence of this kind. Geologic data first suggested that the pumping test at this site in Levittown might be utilized to demonstrate the hydraulic unity of two aquifers, as no clay or other relatively impermeable strata separates the two formations. For the purpose of the test a 4-inch observation well, 0-3, located 2 feet from well N 3313 (7), was driven into the glacial sand and gravel to a depth of 28 feet above the top of the screen of well N 3313 (7), which itself was screened in the sands of the Magothy (?) formation (see pl. 2).

If the upper sands of the Magothy (?) formation were not in direct hydraulic communication with the glacial sands and gravels, then the water levels in these two wells probably would not have been at practically the same elevations before, during, and after the pumping test. The excellence of the hydraulic connection is indicated by water-level data for wells N 3313 (7) and 0-3 listed in tables 2 and 3. Note that the water levels in these two wells did not differ by more than 0.02 foot at any time during the test.

Well, Screen, and Other Losses

Advantage was taken of the opportunity to obtain some interesting and unusual data that reveal that well and screen losses - losses in head due to friction in the well and screen - in partially penetrating wells, together with formational losses in the material immediately adjacent to the well or in the gravel pack surrounding the screen, usually are not as small as is generally believed but, to the contrary, are sometimes very large. The sum total of all such losses is determined easily by computing the difference between actual drawdowns in a pumped well and that measured in an observation well driven a short distance from the pumped well. To afford such information, observation well O-1 was driven 3 feet from the pumped well N 2791 (2B).

The bottom of observation well O-1 is about 22 feet above the level of the screen of the pumped well. Therefore the results cannot be expected to be as conclusive as those which would have been obtained had the screens of the pumped and observation wells been placed at the same altitude.

According to the driller, a 30-slot Johnson screen (slots 0.030 inch wide), 31 feet long, was chosen for the well. The slot size was selected as permitting passage of the finer-grained 77 percent of the aquifer sand, which has an effective size of 0.012 inch and a uniformity coefficient of 1.9. The effective size of sand is the size of grain such that 10 percent by weight of the sand grains are smaller than itself. The uniformity coefficient of sand is a measure of variations in the size of the sand grains and is expressed as the ratio of the size such that 60 percent by weight is smaller, to the effective size. The screen is set approximately in the vertical center of the aquifer which, as previously mentioned is assumed to be about 100 feet thick; therefore, the screen penetration is about 30 percent of the saturated thickness of the aquifer. With such conditions and arrangements, a drawdown of 19.7 feet was measured in the pumped well after it had discharged 792 gallons per minute for 24 hours, as shown in table 3. The drawdown in the observation well 3 feet away was only 2.9 feet. The difference of 16.8 feet between the two drawdowns admittedly is appreciable.

Had observation well O-1 been driven to a depth opposite the screen of the pumped well, the difference in drawdown certainly would have been less but by not more than 1 foot, when allowance is made for the slope of the cone of depression between the observation well and the pumped well. In any event, the resulting difference between the drawdowns observed in the pumped and observation wells - which represents, as mentioned above, well, screen, and formational losses in the vicinity of the well - would still be very large. Calculations also indicate that the difference in water levels outside and inside the pumped well, including only well losses and excluding formational losses, would probably be not much less than 14 feet. Even a 10-foot difference would be considered appreciable.

Such large head losses in discharging wells, as observed at N 2791 (2B) and many other wells, deserve more widespread recognition and investigation through special detailed studies based on actual field and laboratory tests.