Designation: D 5786 – 95 (Reapproved 2000)

Standard Practice for (Field Procedure) for Constant Drawdown Tests in Flowing Wells for Determining Hydraulic Properties of Aquifer Systems[1]

This standard is issued under the fixed designation D 5786; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This practice covers the methods for controlling drawdown and measuring discharge rates and head to analyze the hydraulic properties of an aquifer or aquifers.

1.2 This practice is used in conjunction with analytical procedures such as those of Jacob and Lohman **(1)/(2)**, and Hantush **(3)/(4)**.

1.3 The appropriate field and analytical procedures for determining hydraulic properties of aquifer systems are selected as described in Guide D 4043.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

1.5 *This practice offers a set of instructions for performing one or more specific operations. This document cannot replace education or experience and should be used in conjunction with professional judgment. Not all aspects of this practice may be applicable in all circumstances. This ASTM standard is not intended to represent or replace the standard of care by which the adequacy of a given professional service must be judged, nor should this document be applied without consideration of a project's many unique aspects. The word "Standard" in the title of this document means only that the document has been approved through the ASTM consensus process.*

2. Referenced Documents

2.1 *ASTM Standards:*

D 653 Terminology Relating to Soil, Rock, and Contained Fluids[2]

D 4043 Guide for Selection of Aquifer-Test Method in Determining of Hydraulic Properties by Well Techniques[2]

D 4750 Test Method for Determining Subsurface Liquid Levels in a Borehole or Monitoring Well (Observation Well)[2]

3. Terminology

3.1 *Definitions*—For definitions of terms used in this practice, see Terminology D 653.

4. Summary of Practice

4.1 This practice describes the field procedures for conducting an aquifer test on a well that is flowing, that is, the head in the well remains above the top of the well casing. This method involves inducing a constant drawdown and measuring the varying discharge rate from the control well.

5. Significance and Use

5.1 Constant drawdown test procedures are used with appropriate analytical procedures to determine transmissivity, hydraulic conductivity, and storage coefficient of aquifers.

6. Apparatus

6.1 Various types of equipment can be used to measure the flow rate of the well. The equipment shall be sized so that it does not constrict the flow rate from the well.

6.2 An apparatus shall be placed on the control well discharge line such that the well can be shut in to prevent flow prior to conducting this field procedure and so that the apparatus will not constrict flow from the well when it is allowed to flow.

6.3 Head measurements can be made using one of the following apparatuses:

6.3.1 *Standpipe*—A pipe or piece of well casing may be installed to extend above the elevation of the discharge. This standpipe will also extend above the elevation of the head in the control well. This standpipe will allow for direct measurement of the water level following methods described in Test Method D 4750.

6.3.2 *Pressure Measurement*—A pressure gage (mechanical gage, manometer, or pressure transducer) may be installed below the shut-in mechanism in the control well. Determine the head elevation by adding the pressure reading (expressed in the height of the water) to the elevation of the sensor of the pressure gage.

6.4 *Control Well*—This practice requires that water flow from a single well. This well, known as the control well, shall

[1] This practice is under the jurisdiction of ASTM Committee D18 on Soil and Rock and is the direct responsibility of Subcommittee D18.21 on Ground Water and Vadose Zone Investigations.

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[2] *Annual Book of ASTM Standards,* Vol 04.08.

be drilled and completed such that it transmits water from the aquifer (usually the entire thickness of the aquifer) as efficiently as possible to reduce head loss between the aquifer and the well. Well development should be as complete as possible to eliminate additional production of sediments (aquifer particles or drill cuttings) and consequent changes in well efficiency during the test.

7. Procedure

7.1 *Pretest Procedures*:

7.1.1 *Select Aquifer Test Method*—Develop a conceptual model of the site hydrogeology and select the appropriate aquifer test method according to Guide D 4043. Observe the requirements of the selected test method with regard to specifications for the control well and observation wells.

7.1.2 *Field Reconnaissance*—Make a field reconnaissance of the site before conducting the test to collect as much detail as possible on the depth, continuity, extent, and preliminary estimates of the hydrologic properties of the aquifers and confining beds. Note the location of existing wells and water-holding or conveying structures that might interfere with the test. Turn off nearby wells well before the test, and disable automatic pump controls throughout the anticipated test period. Alternately, it may be necessary to pump some nearby wells or allow them to flow throughout the test. If so, the discharge shall be at a constant rate, and shall not be started or stopped during the test and prior to the test for a duration at least equal to that of the test. The control well should be equipped with a pipeline or conveyance structure adequate to transmit water away from the test site, such that the structure does not impede the flow of water from the control well.

7.1.3 *Construction of Control Well*—Screen the control well throughout the full extent of the aquifer to be tested.

7.1.4 *Test of Control Well*—Test the control well by allowing the well to flow and then stopping the flow. Based on the recovery response, make a preliminary estimate of the hydraulic properties of the aquifer and estimate the initial flow rate from the control well expected during the aquifer test.

7.1.5 *Testing Observation Wells*—Test observation wells or piezometers prior to the aquifer test to ensure that they are hydraulically connected to the aquifer. Accomplish this by adding or withdrawing a known volume of water (slug) and measure the water-level response in the well. The resultant response should be rapid enough to ensure that the water level in the observation well or piezometer will reflect the water level in the aquifer during the test. Alternatively, if observation wells are flowing, measure their response in a manner similar to that described for the control well. Redevelop wells or piezometers with unusually sluggish response.

7.1.6 Measure the pressure head in the shut-in control well and observation wells (if any) to determine the trend of water levels before the commencement of the test. This period should be at least equal to the length of the flowing portion of the test.

7.2 *Test Procedure*:

7.2.1 Based on pretesting results and the conceptual model of the site (see Guide D 4043), select the duration of the test.

7.2.2 *Shut in the Control Well*—Completely stop flow from the control well prior to conducting the test for a period at least as long as the anticipated duration of the flowing portion of the test.

7.2.3 *Discharge from Control Well*—Allow the control well to flow at a variable rate. The flow rate will vary naturally to maintain a constant drawdown at the control well.

7.2.4 *Measure Discharge Rate*—Measure and record the discharge rate frequently during the early phase of discharge; increase the interval between measurements in a logarithmic manner as pumping continues.

NOTE 1—Table 1 presents a suggested frequency of discharge measurements.

7.2.5 *Measure Water Level*—Measure and record the water levels in nearby wells at a frequency similar as presented in Table 1.

7.3 *Post-Testing Procedures*:

7.3.1 Tabulate water levels, including pre-flowing (shut-in), flowing, and post-flowing levels. For each well or piezometer record the date, clock time, time since flowing started or stopped, and the measurement point.

7.3.2 Tabulate the rate of discharge of the control well, the date, clock time, time since flowing started or stopped, and the method of measurement.

7.3.3 Prepare a written description of each well, describing the measuring point, giving its elevation and the method of obtaining the elevation, and the distance of the measuring point above the mean land surface.

7.3.4 *Plot the Rate of Discharge Versus Time*—Prepare a plot of the rate of discharge versus the time since discharge began.

8. Report

8.1 Prepare a report containing field data including a description of the field site, plots of water level and discharge with time, and preliminary analysis of data:

8.1.1 An introduction stating the purpose of the test, dates and times water-level measurements commenced, dates and times the control well was shut in, dates and times the control well began to flow, and the stabilized head in the control well prior to the test.

8.1.2 The “as built” description and diagrams of all control wells, observation wells, and piezometers.

8.1.3 A map of the site showing all well locations, the distances between wells, and locations of all geologic boundaries or surface-water bodies which might affect the test.

8.1.3.1 The locations of wells and boundaries that affect the aquifer tests need to be known with sufficient accuracy to provide a valid analysis. For most analyses, this means the locations must provide data points within the plotting accuracy

TABLE 1 Example of Measurement Frequency

Frequency	Elapsed Time
1 measurement every:	
30 s	3 min
1 min	3 to 15 min
5 min	15 to 60 min
10 min	60 to 120 min
20 min	2 to 3 h
1 h	3 to 15 h
5 h	15 to 60 h

on the semilog or log-log graph paper used in the analysis. Radial distances from the control well to the observation wells usually need to be known with ±0.5 %. For prolonged large-scale testing, it may be sufficient to locate wells from maps or aerial photographs. However, for small-scale tests, well locations should be surveyed using land surveying methods. When test wells are deep relative to their spacing it may be necessary to conduct well-deviation surveys to determine the true horizontal distance between well screens in the aquifer.

8.1.4 Include tabulated field data collected during the test.

9. Keywords

9.1 aquifers; aquifer tests; control wells; ground water; hydraulic conductivity; observation wells; storage coefficient; transmissivity

REFERENCES

(**1**) Jacob, C. E., and Lohman, S. W., "Nonsteady Flow to a Well of Constant Drawdown in an Extensive Aquifer," *American Geophysical Union Transactions*, Vol 33, No. 4, 1952, pp. 552–569.

(**2**) Lohman, S. W., "Ground-Water Hydraulics," *Professional Paper 708*, U.S. Geological Survey, 1972.

(**3**) Hantush, M. S., "Nonsteady Flow to Flowing Wells in Leaky Aquifer," *Journal of Geophysical Research*, Vol 64, No. 8, 1959, pp. 1043–1052.

(**4**) This document is presently under development in D18.21.04 and may be obtained by contacting the Committee D-18 Staff Manager.