Susquehanna River Basin Commission

a water management agency serving the Susquehanna River Watershed

Policy No. 2002-01
June 12, 2002

PUMPING TEST GUIDANCE

INTRODUCTION

This document provides guidance for the development of pumping test plans for the constant-rate pumping test, which is required as part of the ground-water withdrawal application for the Susquehanna River Basin Commission (the Commission) under 18 CFR §803.43(b). **The pumping test plan, a Project Information Module, and Checklist For Pumping Test Plan (SRBC forms No. 72 and 73) must be submitted and approved by the Commission staff prior to performance of any testing in support of a ground-water withdrawal application.** The pumping test plan submittal must be a discrete document, conforming to the general outline provided in the Commission's pumping test guidance.

The Commission recommends that project sponsors retain a professional geologist with substantial experience in the siting, drilling, testing, and permitting of high-capacity water supply wells.

The Commission uses pumping test results to help evaluate the production capability of the well, the aquifer, and the local ground-water basin. These must be adequate to supply the needs of the project, and do so without significant adverse impact to neighboring water supplies, surface water bodies, and wetlands. The pumping test procedures must incorporate monitoring of a type and frequency that is sufficient to allow evaluation of the above factors.

Further, a complete submittal will describe the plan for evaluating the aquifer and include discrete sections for: (1) ground-water availability analysis; (2) a hydrogeologic description; and (3) a monitoring plan. Nearly all of this information is needed and developed by consulting geologists and engineering staff during the early phases of a ground-water development project. Therefore, it should be available to support Commission's staff review of the pumping test procedures. Much of this information was incorporated previously into the hydrogeologic report on the project that is required by the Commission for submission with a ground-water withdrawal application.

A request for a waiver of any requirement in this document must be made in writing at the time that the pumping test procedures are submitted. The request must include a justification for the waiver, and propose an alternative action or procedure.

PRETEST INFORMATION

Ground-Water Availability Analysis

New ground-water sources should be located in ground-water basins that have sufficient recharge to support the desired withdrawal. A ground-water availability analysis must be included in the pumping test procedure in order to demonstrate that there is enough ground water in the basin to support the applicant's proposed withdrawal. Typically, the ground-water availability analysis will have been performed prior to any well siting and drilling. The analysis must demonstrate that there is sufficient water available during a severe drought, based on a recharge rate derived from the $Q_{7\text{-}10}$ flow (the average consecutive 7-day low flow having a 10-year recurrence period) of the receiving stream, or on 60 percent of the average annual recharge rate (approximate one-in-ten-year average annual drought). Calculations should be based on the best available recharge rate information. The ground-water availability analysis must include a topographic map showing:

a. the local ground-water basin (from which the water will be withdrawn);
b. hydrogeologic boundaries (divides, discharge areas or points [springs], dikes, sharp permeability changes);
c. production wells (residential, municipal, industrial, irrigation, etc.);
d. stream intakes;
e. scale;
f. north arrow; and
g. topographic map names.

Hydrogeologic Description

A fundamental understanding of the hydrogeology of an area is required in order to competently select a well site and design a test of the aquifer and well. The pumping test procedures, therefore, require a hydrogeologic description of the test site that includes the following:

a. lithologic units within 2,500 feet of the well being tested;
b. dominant types of permeability (fractures, joints, faults, etc.) and their spatial characteristics (spacing and orientation);
c. fracture traces (location and grade);
d. potential boundary conditions (streams, diabase dikes, etc.); and
e. approximate hydraulic gradient and direction(s) of ground-water flow.

Note that for items b and e, site-specific information (obtained/measured in the field) will be required in most cases.

The hydrogeologic description must include a contour map of adequate scale (minimum: 1 inch = 1,000 feet) to portray the above information and also should include the following:

a. wells—include all nearby domestic wells (residential, municipal, industrial, irrigation, etc.);

b. wetlands and surface water bodies monitoring points;
c. fracture traces;
d. geologic structure;
e. aquifers;
f. boundary conditions;
g. ground-water contours (The approximate hydraulic gradient and ground-water flow directions in the test area should be established through water levels from wells and surface-water bodies. Show the wells and ground-water elevations on the contour map.); and
h. An estimated area of influence for the well under test, at the proposed pumping rate, must be plotted on the map. The area of influence should be based on the best available information on the aquifer properties (dominant types of permeability and their spatial characteristics such as bedding and fracture orientations, anisotropy, etc., and their approximate values), topography, hydraulic gradient, and ground-water flow directions.

The hydrogeologic description must include a well log of the well to be tested, showing well construction and geology. The geologic description must include lithology, lithologic contacts, and the depth and yield of water-bearing zones (fractures, conduits, clay seams, gravel beds, etc.). The lithologic description must be sufficiently detailed to allow a determination of the stratigraphy. The well log must be a scaled diagram. A driller's log is not acceptable. The driller and the geologist should work together closely in the field so that the information in the well log is a synthesis of the data collected by each.

The hydrogeologic description must include a hydrogeologic cross section of no greater than 10:1 vertical exaggeration. Indicate the location of the cross section on the contour map. The cross section must pass through the well to be tested and cover at least 1,000 feet of length. It should show the following:

a. water table or piezometric surface;
b. surface-water bodies and wetlands;
c. geologic structure;
d. aquifers, aquitards, and hydrogeologic boundaries;
e. top-of-rock;
f. overburden thickness and extent (Overburden should be classified and described as alluvium, colluvium, flood plain fines, glacial outwash, stratified drift, till, residuum, saprolite, etc. Much of this information can be obtained from the examination of shallow road cuts, stream channel banks, drainage ditches, well logs, and geotechnical boring logs.); and
g. well bore, casing, pump intake, and water-bearing zones, etc.

PUMPING TEST PROCEDURES

Test Components

The well/aquifer testing consists of three (3) components:

a. background monitoring (minimum 48 hours);
b. constant-rate pumping test (minimum 48 hours—to be determined in the pumping test procedure approval—the duration may need to be increased during the test in response to ongoing test results), and
c. recovery monitoring (24 hours or 90 percent recovery, whichever is longer).

Monitoring Plan

The monitoring plan will include a description of all the features monitored (wells, springs, streams, wetlands, etc.), the type of monitoring (digital, manual [electric, sonic or paste/chalk water tape], staff gage, weir, etc.), and the monitoring schedule. The monitoring plan must include a topographic base map illustrating all of the monitored features and specific monitoring points (wells, wetlands, ponds, streams, piezometers, weirs, etc.).

Late additions to the monitoring network must be included in all the remaining testing.

Monitoring guidelines for a variety of features are provided below.

A. Ground-water wells

A representative sample of the wells within 2,500 feet of the well under test must be monitored. Their selection should be based on the expected area of impact, and on the distribution of existing wells and concerned well owners. Include as much of the following information as possible on each well: owner name and address, well construction (diameter, depth, casing depth, open interval construction), yield, static water level, and geology.

The well being tested must be monitored with an automatic monitoring device such as a digital data-logger or a Bristol-type recorder. Provision should be made to monitor the water level to the top of the pump assembly.

Observation wells that are pumped during the period of testing must be monitored with an automatic monitoring device such as a digital data-logger or a Bristol-type recorder.

Observation wells that are not pumped during the period of testing must be monitored with an electronic water tape on a scheduled basis (see below) or by an automatic monitoring device such as a digital data-logger or a Bristol-type recorder.

B. Surface water

Surface water bodies, springs, and wetlands located between 1,000 feet (isotropic aquifers) and 2,500 feet (anisotropic aquifers: k max directions) of the well under test, or within 300 feet of the discharge area (spring) of a karst aquifer being pumped, must be monitored. Surface water bodies and wetlands may be monitored by either electronic water tape on a scheduled basis (see below), or by automatic monitoring device such as a digital data-logger or a Stevens-type recorder, depending upon the sensitivity of the resource to impact, the quality of the resource, and the likelihood of impact. Levels from surface water bodies should be taken from inside a stilling well.

1. Ponds and wetlands

Ponds, and wetlands with standing water, must be monitored with a staff gage (or a stilling well) and a piezometer (screened approximately 2 feet below the bottom of the water body), which must have a common reference (i.e., the zero level must be at the same elevation in both). The piezometer may be installed adjacent to the surface water body being monitored, provided that the screened interval is in close hydraulic continuity with the material underlying the surface water body.

Ponds, springs, and wetlands with outflow must be monitored with a weir or flume, as appropriate, that allows the reliable measure of 10 percent of the test pumping rate. If measurements are to be made manually, 10 percent of the test pumping rate must correspond to a change of at least 0.01 feet (approximately 1/8 inch).

Wetlands without standing water must be monitored with two separate piezometers, screened at approximately 2 and 7 feet below ground surface. The piezometers must have a common reference (i.e., the zero level must be at the same elevation in both piezometers).

2. Streams and springs (flowing surface water)

Streams and springs must be monitored when the proposed rate of withdrawal is greater than 10 percent of the $Q_{7\text{-}10}$ flow.

If the proposed rate of withdrawal is greater than 10 percent of $Q_{7\text{-}10}$, the approximate base flow of the stream, for the period of testing, must be measured with an appropriate flow meter, and in a relatively uniform reach with predominantly laminar flow.

If the proposed rate of withdrawal is greater than 25 percent of the flow at the time of testing, a weir or flume, and a piezometer (screened at least 2 feet below the channel bottom) will be used to monitor streams. If

measurements in the weir or flume are to be made manually, 10 percent of the test pumping rate must correspond to a change of at least 0.01 feet.

If the proposed rate of withdrawal is less than 25 percent of the flow at the time of testing, piezometers and a stilling well will be utilized for monitoring. The piezometers must be in close hydraulic continuity with the material underlying the channel bottom. Two piezometers will be required, with their screened intervals separated vertically by 5 feet.

C. Water chemistry

During the period of pumping, measurements must be made for pH, temperature, and conductivity every 2 hours for the well under test and every 12 hours from all surface water bodies (streams, ponds, springs, and wetlands) being monitored.

D. Precipitation

On-site precipitation must be monitored on a 12-hour interval through the background, pumping, and recovery phases of testing. Record precipitation to a 0.1 of an inch.

E. Measurement frequency

During the pumping test, water level measurements should be taken on the pumped well, springs, and streams a minimum of once every minute for the first 10 minutes, once every 5 minutes from 10 to 30 minutes, once every 10 minutes from 30 to 60 minutes, once every 30 minutes from 1 to 6 hours, once every hour from 6 to 24 hours, and once every 2 hours thereafter. If an automatic recorder is used, it should be programmed to start at a small measurement interval (for example, 100 milliseconds) and ramp upward logarithmically to a 10-minute measurement interval.

During the pumping test, measurements should be taken on all observation points (wells, ponds, and wetlands) at least an hour prior to startup, and every 2 hours thereafter. In the event that drawdown/impact is detected, the period between measurements should be decreased to hourly or less, as appropriate, during the constant-rate test, and once every 10 minutes during the first hour of recovery.

During the background and recovery phases, digital automatic recorders should record measurements every 10 minutes. Manual measurements should be recorded every 4 hours during background monitoring. During recovery, manual measurements should be recorded every 15 minutes during the first 2 hours and every hour thereafter.

TEST PERFORMANCE REQUIREMENTS

The pumping rate of the well under test must be monitored with an appropriate flow measurement device that is accurate to within 5 percent. The flow rate must be held to within 5 percent of the target flow rate for the duration of the test. Valving must allow adjustment of the pumping rate to within those tolerances. The flow rate (gallons per minute) and cumulative flow (total gallons pumped) must be recorded a minimum of once per hour. All flow-rate adjustments must be documented with a measurement of flow before and after adjustment, and the time at which the adjustments were made. This information will be included in the required hydrogeologic report.

The length of the pumping test will be a minimum of 48 hours. A greater length of testing may be required to evaluate aquifer and well capabilities, as well as potential impacts to existing water supplies and the environment. The hydrogeologist retained by the project sponsor will recommend an adequate pumping test length, and provide a rationale for that recommendation.

The test must be performed during a period of ground-water and/or surface-water recession (i.e., base flow). The test should not be performed during or shortly after a precipitation/recharge event, which could result in a rapid change of water level or flow.

The background monitoring must immediately precede the constant-rate test. A step test cannot be performed during the 48 hours immediately preceding the constant-rate test.

A step test performed prior to the constant-rate test is highly recommended, but is not required. Such a test should be performed at pumping rates that start at approximately 25 percent of the blown/bailed yield or the desired yield, whichever is less, and progress to higher rates in discrete steps until the water level fails to equilibrate during the step period (usually one hour). Such a test can provide information on the efficiency of the well over a wide range of pumping rates and the short-term maximum yield, allow identification of water-bearing zones, and allow selection of an appropriate rate for the constant-rate test.

The well under test may be pumped at any rate desired, but must be pumped at a constant rate for at least 48 hours. Note that the well will not be approved by the Commission for operation at a rate that is higher than the tested rate. A test with a declining pumping rate due to excessive drawdown or inadequate pump capacity will be considered a failed test. A well that exhibits excessive drawdown due to limited yield must be tested at a rate that can be held for a minimum of 48 hours. If this becomes apparent early in the test (generally during the first 8 hours), the pumping rate may be adjusted to a lower, sustainable rate and run at the adjusted rate for the full length of the test (minimum of 48 hours). If this becomes apparent late in the test, full recovery and retesting will be required.

Discharge from the pumped well must be routed such that recirculation does not occur. In bedded formations, this typically results in a discharge point 300 to 500 feet down dip and across strike from the pumping well. In carbonate formations, the required distance is more typically in the range of 1,000 to 2,000 feet. Recirculation will invalidate the test.

Prior to discharging any wastewater, drilling wastes, or raw water from any well testing to any stream, intermittent stream, wetlands, lake, or waterway, the project sponsor must first obtain written approval from the state's appropriate water management program. The written approval(s) must be forwarded to the Commission prior to the start of testing.

Any positive/recharge boundary or negative/barrier boundary encountered during the test must have a record of at least 24 hours. Therefore, any boundary condition encountered after 24 hours into the constant-rate test will require that the test be extended beyond 48 hours.

At the conclusion of the pumping phase of testing, a sample of water should be collected. The water sample should be sent to a U.S. Environmental Protection Agency or state-certified laboratory for the Commission required chemical analysis.

The Commission must be notified at least two working days prior to the start of testing.

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Chemical Analysis of Ground Water

The analysis must be performed by a laboratory certified by either the U.S. Environmental Protection Agency or the state in which the project is located. Report dissolved metals in micrograms per liter; all other data in milligrams per liter, except as noted.

STORET No.	Parameter
00410	Alkalinity, Total (as $CaCO_3$)
01106	Aluminum
01005	Barium
00915	Calcium
01025	Cadmium
00940	Chloride, Total
01030	Chromium
00900	Hardness, Total (as $CaCO_3$)
01046	Iron
01049	Lead
00925	Magnesium
01056	Manganese
00620	Nitrate-Nitrogen, Total (as N)
00403	pH (standard units)
00671	Phosphorus (Orthophosphate)
00515	Residue, Total Filterable Solids (TDS)
00930	Sodium
00095	Specific Conductance (µmhos/cm at 25°C)
00946	Sulfate
00680	Total Organic Carbon
01090	Zinc

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06/12/02

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PROJECT INFORMATION

1. Applicant Information:

Applicant Name or Registered Fictitious Name _____

Parent Corporation Name, if different _____

Mailing Address _____

_____

City _____ State _____ Zip _____

Contact Person _____ Title _____

Telephone (____) _____ Fax (____) _____ E-Mail _____

2. Preparer (Hydrogeologist/Engineer):

Name _____

Title _____

Company _____

Address _____

_____

_____

Phone (____) _____ Fax (____) _____

Signature _____

Date _____ E-Mail Address _____

3. Project Engineer:

Name _____

Title _____

Company _____

Address _____

_____

_____

Phone (____) _____ Fax (____) _____

Signature _____

Date _____ E-Mail Address _____

4. Location of proposed source(s), if applicable:

State _____ County _____

Municipality _____

Latitude _____ Longitude _____

5. State, county, or other regulatory/permitting contacts:

Agency _____ Department _____

Name _____ Position _____

Permit/Area of Concern: _____

Address _____

_____

_____

Phone _____ E-Mail _____

Agency _____ Department _____

Name _____ Position _____

Permit/Area of Concern: _____

Address _____

_____

_____

Phone _____ E-Mail _____

Agency _____ Department _____

Name _____ Position _____

Permit/Area of Concern: _____

Address _____

_____

_____

Phone _____ E-Mail _____

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PUMPING TEST PLAN CHECKLIST

Please take the time to review this checklist prior to mailing your pumping test procedures submission. **The following items and this Check List must be included in an acceptable Pumping Test Plans Submission.** Please be sure that all of these items are included in your submission in order to ensure timely review and approval. **For details on the listed items, see the Pumping Test Plan Guidance.**

A request for a waiver of any requirement in the Pumping Test Procedure Guidance must be included with the pumping test protocol submission. All such requests must be accompanied by a justification for the waiver. Those seeking a waiver of one or more requirements are encouraged to discuss the request with Commission staff prior to submission.

PRETEST INFORMATION

Ground-Water Availability Analysis

- ☐ Ground-Water Availability Map.
- ☐ Supporting Text, Calculations, and Recharge Rates.

Hydrogeologic Description

- ☐ Project Area Hydrogeology Map.
- ☐ Hydrogeologic Description (text).
- ☐ Well Log(s).
- ☐ Hydrogeologic Cross Section.

PUMPING TEST PROCEDURE

Monitoring Plan

- ☐ Pumping Test Map illustrating all of the monitored features (wells, ponds, etc.).
- ☐ Monitoring Plan Description documenting all of the monitored features (wells, ponds, etc.) and the proposed monitoring (monitoring devices and schedule) for each location.
- ☐ Description of the Flow-control Valving and Metering.