DEVELOPMENT OF AQUIFER TESTING PLANS & WAIVER REQUESTS

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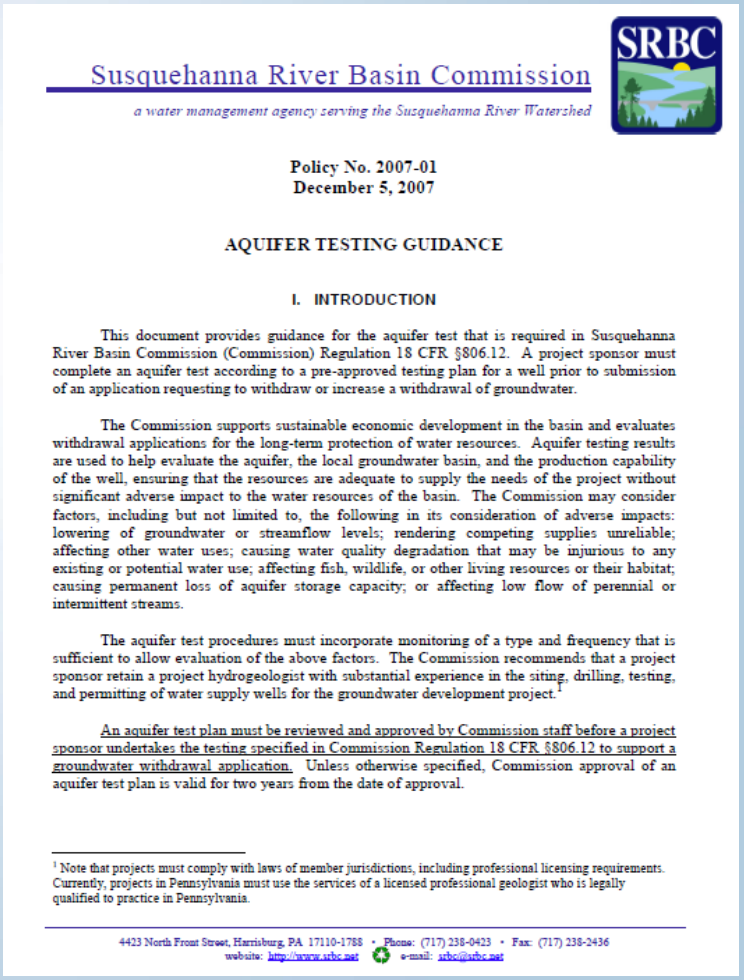
DEVELOPMENT OF AQUIFER TESTING PLANS

- Goals of Aquifer Testing
- What questions are we trying to answer
- Staff review and approval of Aquifer Test Plans
- Commission Aquifer Testing Guidance
- Components of a successful plan



Susquehanna River Basin Commission

a water management agency serving the Susquehanna River Watershed

Policy No. 2007-01
December 5, 2007

AQUIFER TESTING GUIDANCE

I. INTRODUCTION

This document provides guidance for the aquifer test that is required in Susquehanna River Basin Commission (Commission) Regulation 18 CFR §806.12. A project sponsor must complete an aquifer test according to a pre-approved testing plan for a well prior to submission of an application requesting to withdraw or increase a withdrawal of groundwater.

The Commission supports sustainable economic development in the basin and evaluates withdrawal applications for the long-term protection of water resources. Aquifer testing results are used to help evaluate the aquifer, the local groundwater basin, and the production capability of the well, ensuring that the resources are adequate to supply the needs of the project without significant adverse impact to the water resources of the basin. The Commission may consider factors, including but not limited to, the following in its consideration of adverse impacts: lowering of groundwater or streamflow levels; rendering competing supplies unreliable; affecting other water uses; causing water quality degradation that may be injurious to any existing or potential water use; affecting fish, wildlife, or other living resources or their habitat; causing permanent loss of aquifer storage capacity; or affecting low flow of perennial or intermittent streams.

The aquifer test procedures must incorporate monitoring of a type and frequency that is sufficient to allow evaluation of the above factors. The Commission recommends that a project sponsor retain a project hydrogeologist with substantial experience in the siting, drilling, testing, and permitting of water supply wells for the groundwater development project.[1]

An aquifer test plan must be reviewed and approved by Commission staff before a project sponsor undertakes the testing specified in Commission Regulation 18 CFR §806.12 to support a groundwater withdrawal application. Unless otherwise specified, Commission approval of an aquifer test plan is valid for two years from the date of approval.

[1] Note that projects must comply with laws of member jurisdictions, including professional licensing requirements. Currently, projects in Pennsylvania must use the services of a licensed professional geologist who is legally qualified to practice in Pennsylvania.

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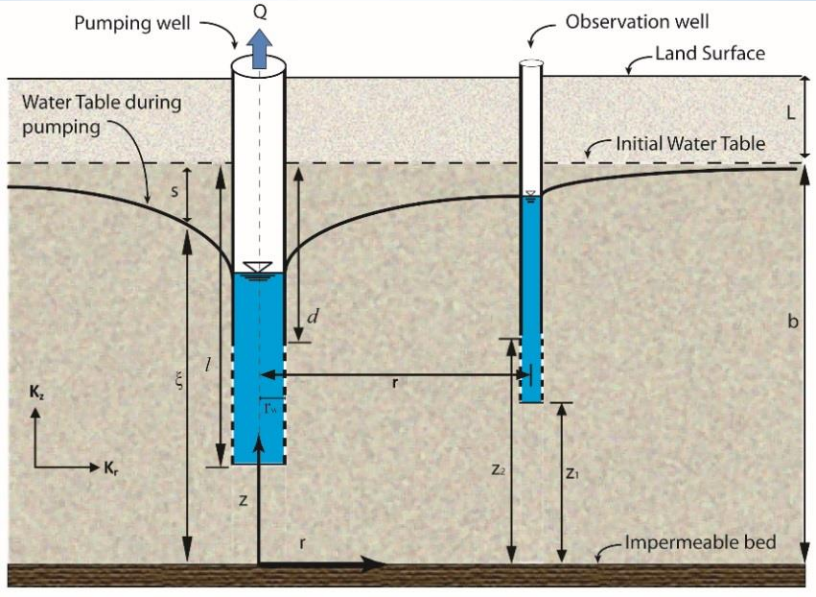
CONSTANT-RATE AQUIFER TESTING

Pumping a production well at a rate greater than or equal to the desired rate of withdrawal and observing the induced changes in groundwater levels, surface water bodies, and wetlands.

The constant-rate test allows the evaluation of the aquifer, the local groundwater basin, and the proposed production well to supply the requested quantity of water and the potential impact of the proposed withdrawal on existing water supplies and environmental resources.



AQUIFER TESTING PLANS

- **Required under 18 CFR 806.12**

  "The project sponsor shall prepare a constant-rate aquifer test plan for prior review and approval by Commission staff before testing is undertaken."

- **What questions are we trying to answer**
  - Sustainability of the withdrawal
  - Impacts to competing groundwater or surface water users
  - Impacts to the Environment

COMPONENTS OF AN AQUIFER TESTING PLAN

A. Hydrogeologic Description
B. Groundwater Availability
C. Aquifer Testing Procedures
D. Step Testing
E. Background Monitoring
F. Constant-Rate Aquifer Test
G. Recovery Testing
H. General Performance Requirements

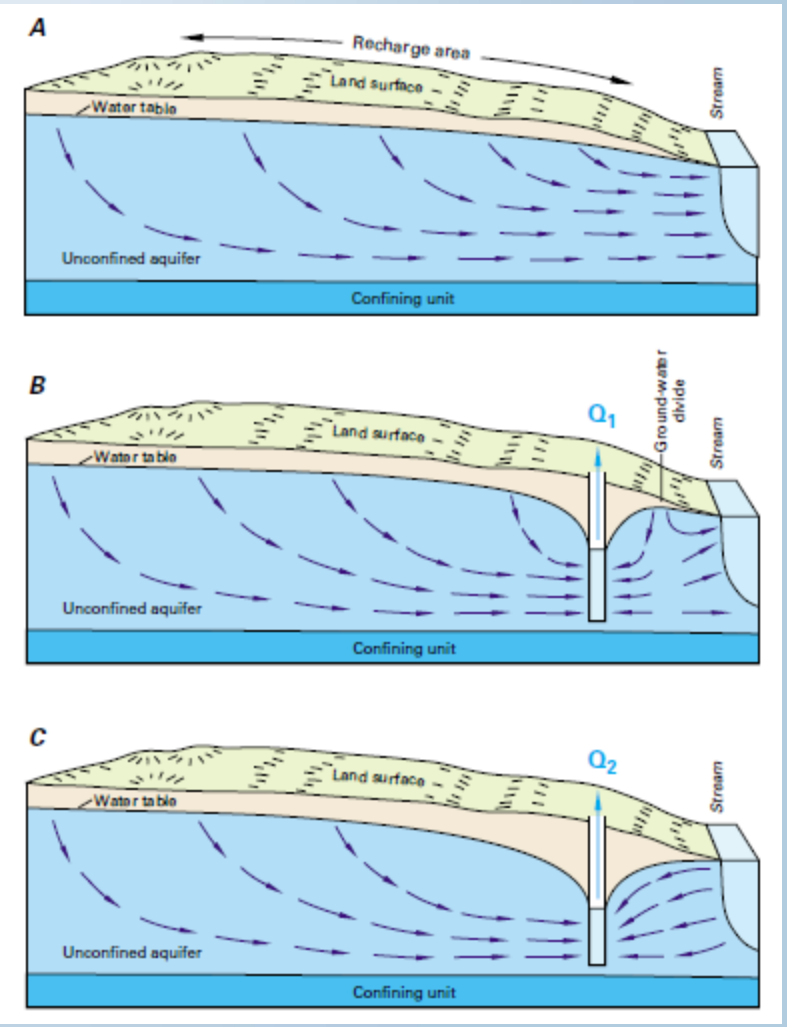
**SRBC Aquifer Testing Guidance*

http://www.srbc.net/policies/docs/2007-01AquiferTestingGuidance.PDF

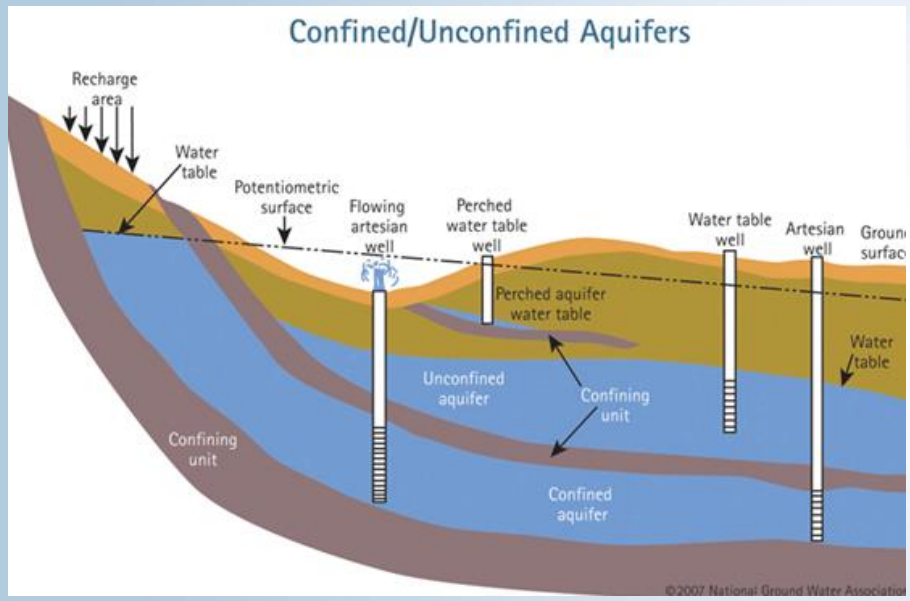
HYDROGEOLOGIC DESCRIPTION

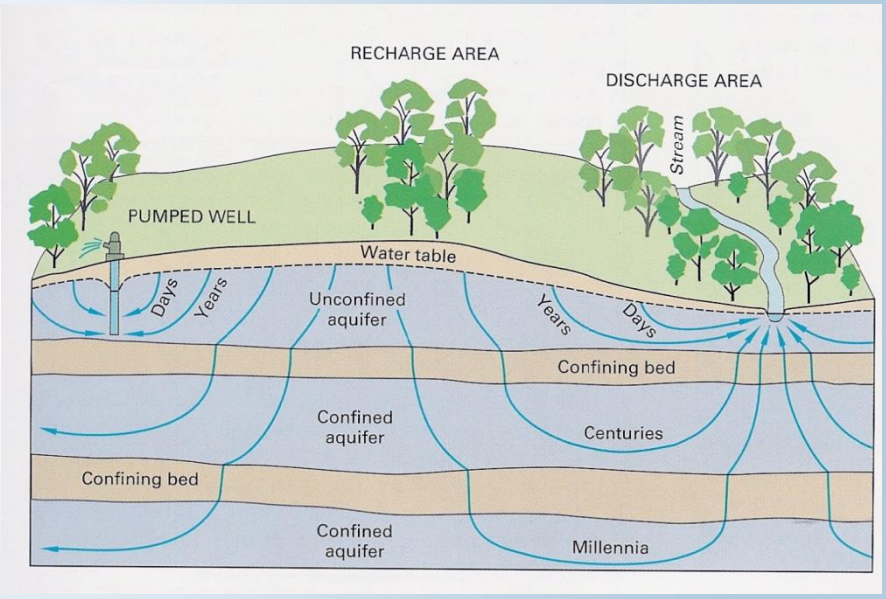
- Geologic setting
  - Site Conceptual model
  - Local vs. Regional Flow Systems
  - Formation(s), field measurements, boundary conditions

- Figures / Maps
  - Well Logs
  - Geologic Maps
  - Contour Maps
  - X-Sections



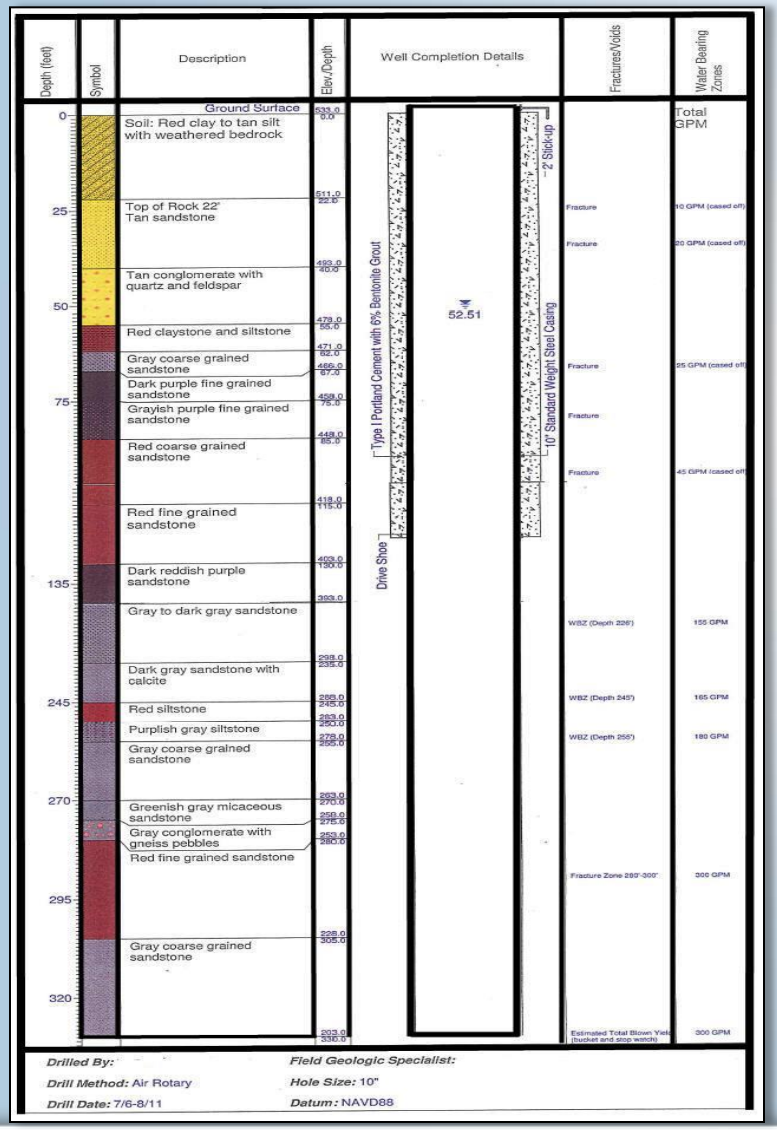
SITE CONCEPTUAL MODEL
LOCAL V. REGIONAL FLOW SYSTEMS





Groundwater flow path vary greatly in length, depth, and travel-time from the points of recharge to the points of discharge in the groundwater flow system

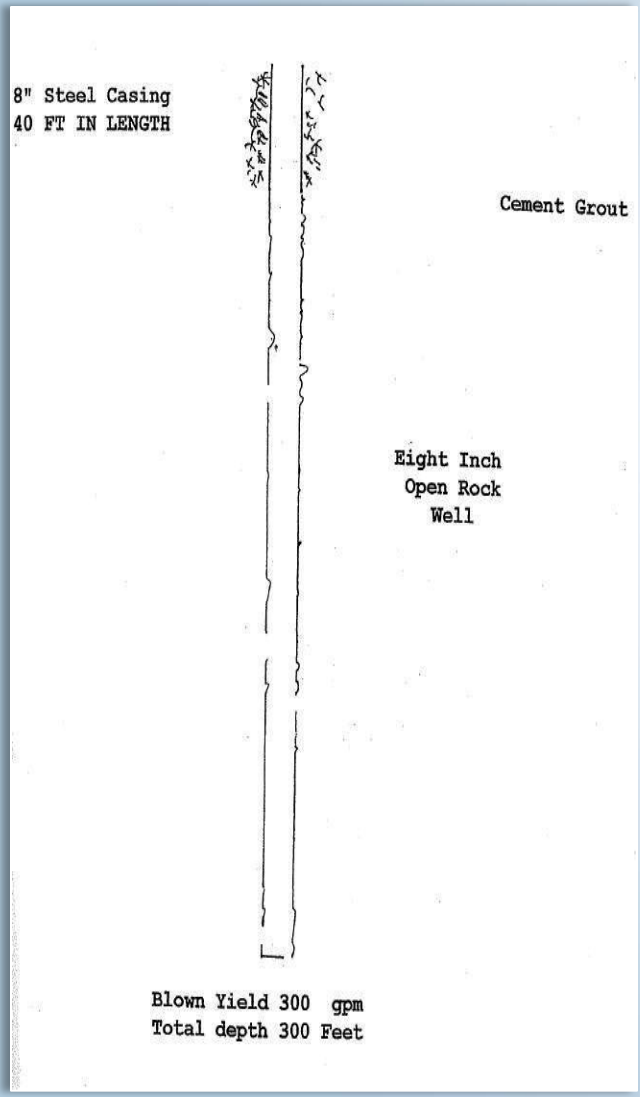
WELL LOGS



Commission Guidance requests:

- *A scaled diagram showing well construction and geology.*
- *The geologic description should include lithology, lithologic contacts, and the depth, yield, and lithologic characterization of water-bearing zones (fractures, conduits, clay seams, gravel beds, etc.).*
- *A textural and mineralogic description of the unconsolidated and weathered materials.*

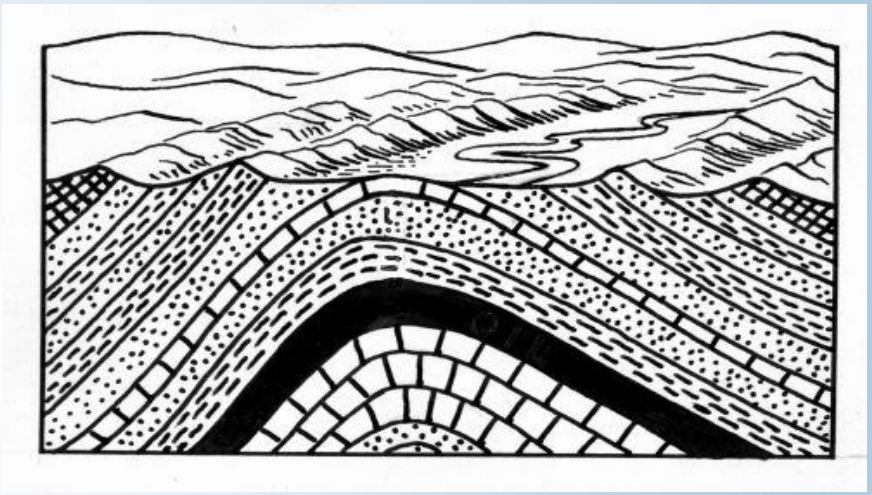
WELL LOGS

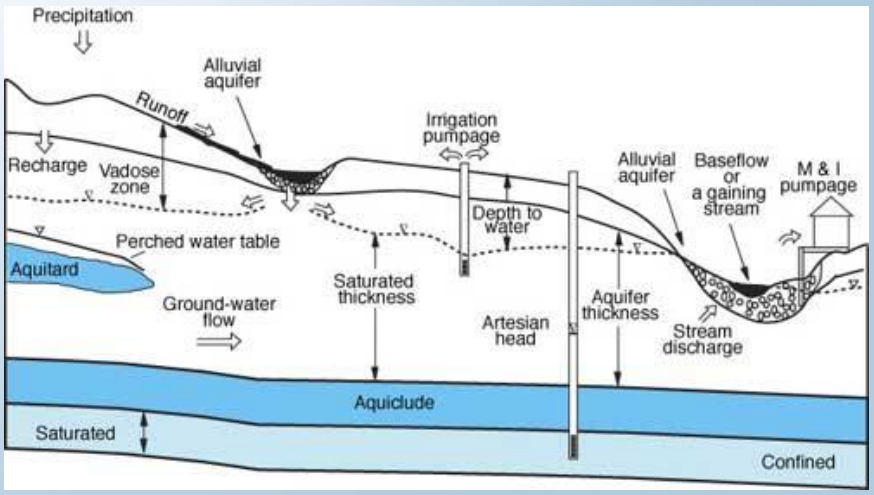


- For existing wells, detailed well logs may not be available. Acceptable well log varies depending on what is being requested:
  - For existing well with no requested increase, historic use demonstrating the requested rate, and/or historic water level data, less information may be required.
  - For existing well with a requested increase, the project sponsor should provide as many details as possible.

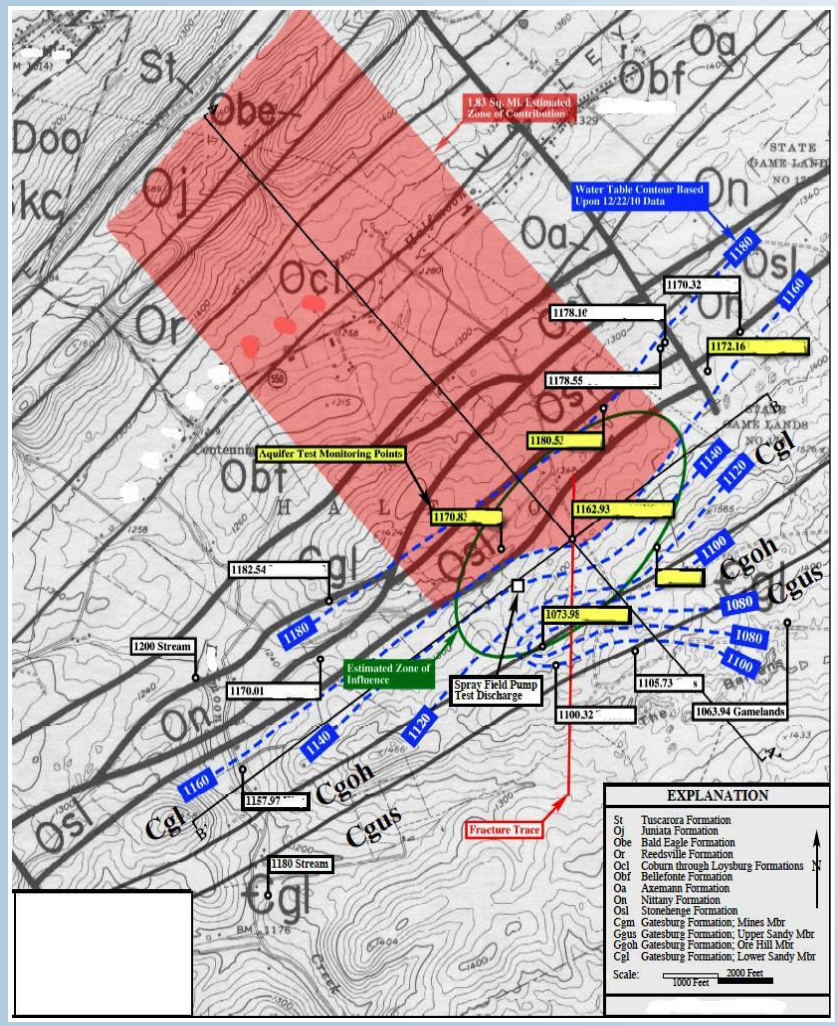
HYDROGEOLOGIC CROSS SECTION

- Geologic structure
- Potentiometric surface
- Surface water features and wetlands
- Aquifers, aquitards, and hydrogeologic boundaries
- Top of rock; Unconsolidated deposits – thickness and extent
- Well bore, casing, pump intake, and water-bearing zones, or screened intervals;
- Monitoring Locations (GW, SW, Wetlands)





PLAN-SPECIFIC MAPS



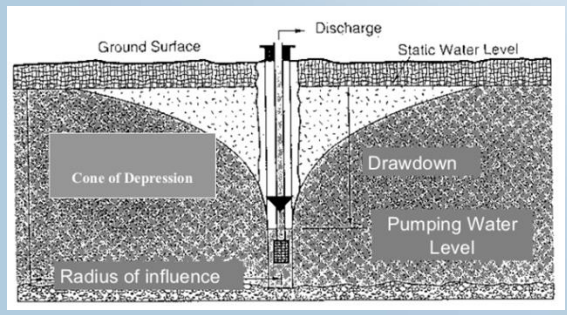
- Contributing geology within the area of contribution of the proposed well.
- Location(s) of recorded field measurements.
- Locations of surface water features.
- Fracture traces.
- Boundary conditions.
- Hydrogeologic cross section transects.
- Groundwater Contours
- Estimated Zone of Influence
- Proposed Discharge Location

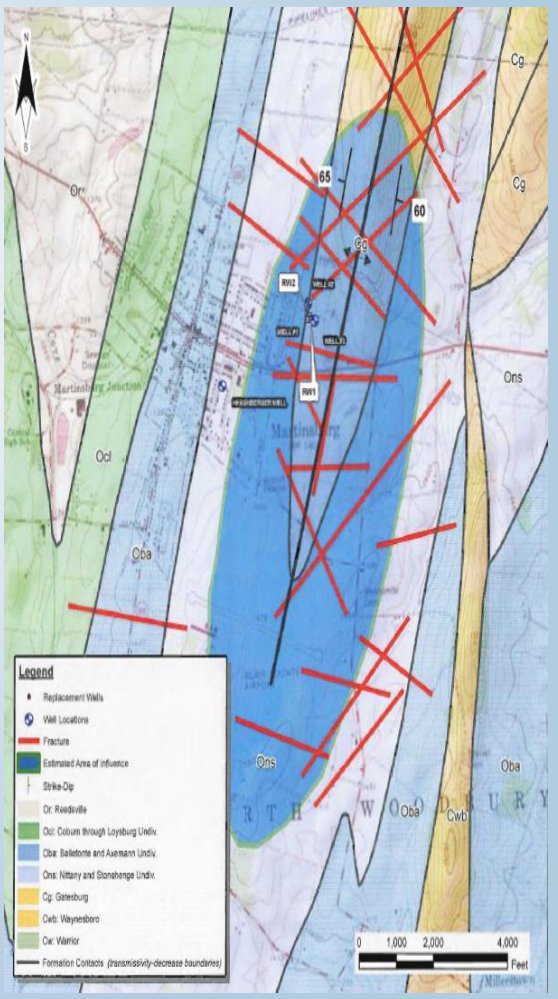
ESTIMATED AREA OF INFLUENCE

AOI should be based upon aquifer properties including:

- dominant types of permeability and their spatial characteristics such as bedding and fracture orientations, anisotropy, etc.
- topography, hydraulic gradient, groundwater flow directions, recharge boundaries, confining boundaries, etc.

Mapping should depict the aquifer properties (bedding strike, fracture traces, joints, etc.) used to determine the area of influence.





GROUNDWATER AVAILABILITY

- Project Hydro should evaluate prior to well siting
- 18 CFR 806.12(b) – Requires completion of a groundwater availability analysis using 1-in-10 year recurrence interval (drought conditions).
- The Commission considers the cumulative effects of existing and proposed withdrawals within a watershed, and can limit approvals to ensure the sustainability of the stream/aquifer system based on this standard.

GW Availability Analysis Steps

- Select applicable recharge rate;
- Delineate GW recharge basin;
- Calculate Unit Area Recharge
- Complete Phase I Analysis; and
- Phase II Analysis, if necessary.

"Finding scientific and technical solutions to problems of water availability and quality will require extensive cooperation and collaboration among Federal, State, and local agencies, private sector water experts, stakeholders, and the public..."

From "A Strategy for Federal Science and Technology to Support Water Availability and Quality in the United States," National Science and Technology Council (2007)

GROUNDWATER BASIN MAP

- Topographic map with contributing geology
- Potential hydrogeologic boundaries (divides, discharge areas or points [springs], dikes, sharp permeability changes).
- Production wells within the contributing recharge area of the proposed pumping well (residential, municipal, industrial, irrigation, etc.).
- Surface water withdrawals.

Geologic Formation	Map Symbol	Age	Rock Type	Recharge Area (mi^2)	1-in-2 Recharge Rate (mgd/mi^2)	1-in-10 Recharge Rate (mgd/mi^2)	1-in-10 Recharge (mgd)
Annville Fm	Oan	Ordovician	High-calcium limestone	0.18	0.76	0.46	0.08
Cocalico Fm	Oco	Ordovician	Shale, Siltstone, Argillaceous Sandstone	0.78	0.64	0.39	0.30
Epler Fm	Oe	Ordovician	Limestone, Dolomite	3.0	0.76	0.46	1.38
Hershey and Myerstown Fm, undivided	Ohm	Ordovician	Argillaceous limestone, Limestone	0.15	0.76	0.46	0.07
New Oxford conglomerate	Trnc	Triassic	Quartz conglomerate	0.28	0.46	0.28	0.08
New Oxford Fm	Trn	Triassic	Arkosic sandstone, Shale, Mudstone, Sandstone	1.47	0.46	0.28	0.41
Stonehenge Fm	Os	Ordovician	Limestone, Conglomeratic siliceous limestone	0.31	1.01	0.61	0.19
			Total Recharge Area =	6.17		Total 1-in-10 Recharge =	2.51

mgd = million gallons per day
mi^2 = square mile
mgd/mi^2 = million gallons per day per square mile

PHASE I GROUNDWATER AVAILABILITY

Table 4.4 Utilization Summary	
	Volume
Available 1-in-10-year Drought Recharge	.662
Existing Groundwater Withdrawal(s)	.272
Remaining 1-in-10-year Recharge Available (minus existing withdrawal)	.39
Proposed Withdrawal (anticipated withdrawal rate)	.187
Remaining Groundwater Availability	.203
Percent Utilization 1	69.325

Note:

1. A Phase II Groundwater Availability Analysis will be required if the Phase I Groundwater Availability Analysis indicates that the anticipated withdrawal rate will be greater than 50 percent of the available resources (i.e. Percent Utilization > 50%) during a 1-in-10-year drought.

PHASE II GROUNDWATER AVAILABILITY ANALYSIS

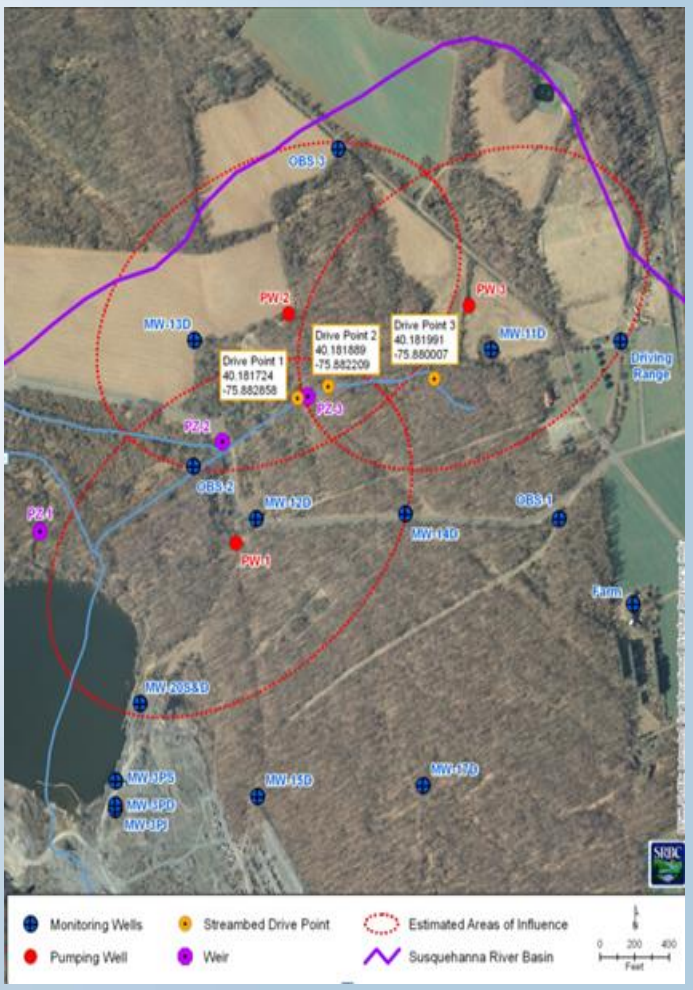
- Required where utilization exceeds 50%

- Considers:
  - Impervious cover (land development)
  - NPDES discharges
  - Surface water withdrawals
  - Contributions to aquifer from surface water (setting dependent)

AQUIFER TEST MONITORING LOCATIONS

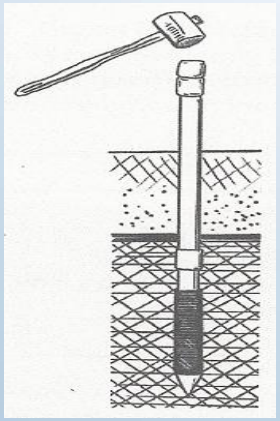
Monitoring should be:

- Focused on the AOI, especially along high permeability trends, generally in the up-dip or k-max direction, where impacts are most likely to occur.
- Selected to adequately characterize impacts in the k-max and k-min directions.
- Coordinated with member jurisdiction agencies to ensure monitoring meets all requirements



GROUNDWATER MONITORING

- Observation well selection should be based on the expected area of influence, and the distribution and construction of existing wells.
- It may be necessary to monitor wells outside the anticipated area of influence due to impact sensitivity or uncertainty in the estimated area of influence or area of contribution.
- All observation points should be monitored with digital data loggers. Staff recommend the collection of back up manual water levels.



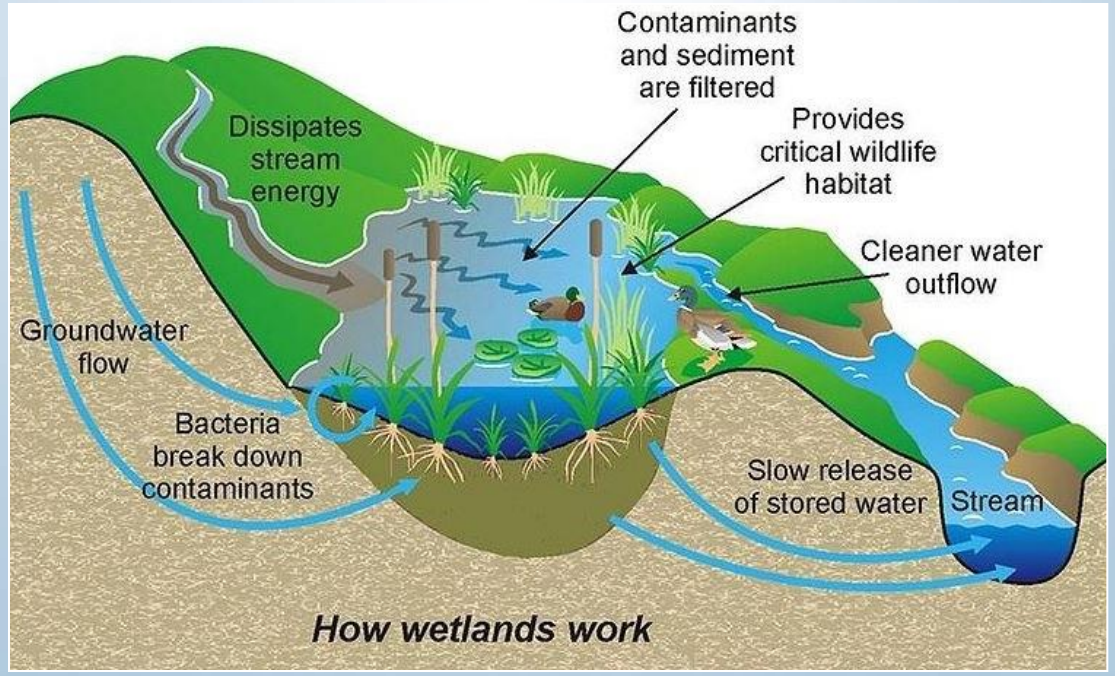
SURFACE WATER MONITORING

- Surface water monitoring locations should be selected to adequately characterize surface water impacts. These will generally be in the k-max or up-dip direction(s) and in the proximity of the well being tested.
- The location of high permeability features should be taken into consideration (fracture trends, gravel beds, etc.) that likely have an efficient hydraulic connection to the well being tested.

WETLAND MONITORING

- Monitoring important for assessing water level drawdown. Wetlands have specific hydrology that support vegetation and ecosystem functions. Impacts to that hydrology, especially during the growing season, could result in significant adverse impacts to wetland plant diversity, quality, and eventual ecosystem functions.

- Nested piezometers should be designed so that the shallow PZ targets wetland roots zone (0-18”) bgs; deep PZ targets are project specific.



POND/LAKE MONITORING

Monitoring is important for assessing potential water level drawdown and reduction in outflow (if present). Water level drawdown could result in adverse impacts to connected wetlands, reduction in quality of in-pond aquatic communities, diminution of flow to downstream surface waters/wetlands, or limitations to a user's ability to recreate in the system.

- Ponds and wetlands without flow – monitor using nested piezometers
- Ponds and wetlands with flow – monitor flow using an instrumented weir or flume, as appropriate

PRECIPITATION MONITORING

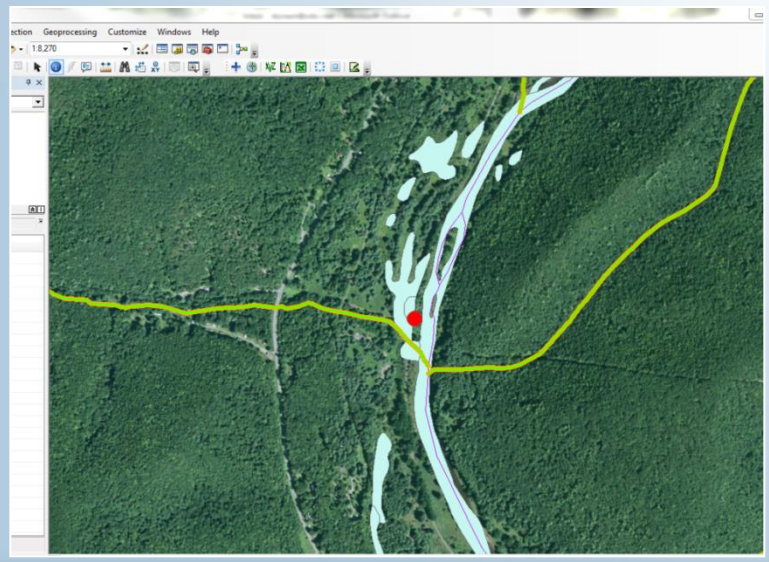
- Precipitation should be monitored (on-site) on a 12-hour interval through the background, pumping, and recovery phases of testing.
- Liquid precipitation should be recorded to the nearest 0.1 inch.
- Precipitation as snow should be reported in a liquid equivalent.
- An attempt should be made to note the duration (i.e., the start and stop times) of any precipitation events that occur during the aquifer testing.

ENVIRONMENTAL REVIEW – AQUIFER TESTING PLAN

1. Desktop environmental screening to assess mapped natural resources & review proposed monitoring network.

2. Site visit to assess on-the-ground natural resources & proposed monitoring network, as needed.

3. Both efforts inform final monitoring network for the aquifer test so that sensitive natural resources, that could potentially be impacted by the withdrawal, are properly monitored. This may include coordination with partner resource agencies.



SITE VISIT

SRBC biologist may attend field visit to meet project sponsor and go over proposed monitoring locations based on results from desktop environmental screening. This effort works to ensure streams, wetlands, and/or sensitive natural features are included in the aquifer testing plan monitoring network.

Results from these monitoring points can be used to inform docket conditions during the Groundwater Withdrawal Application phase.

AQUIFER TESTING PROCEDURES

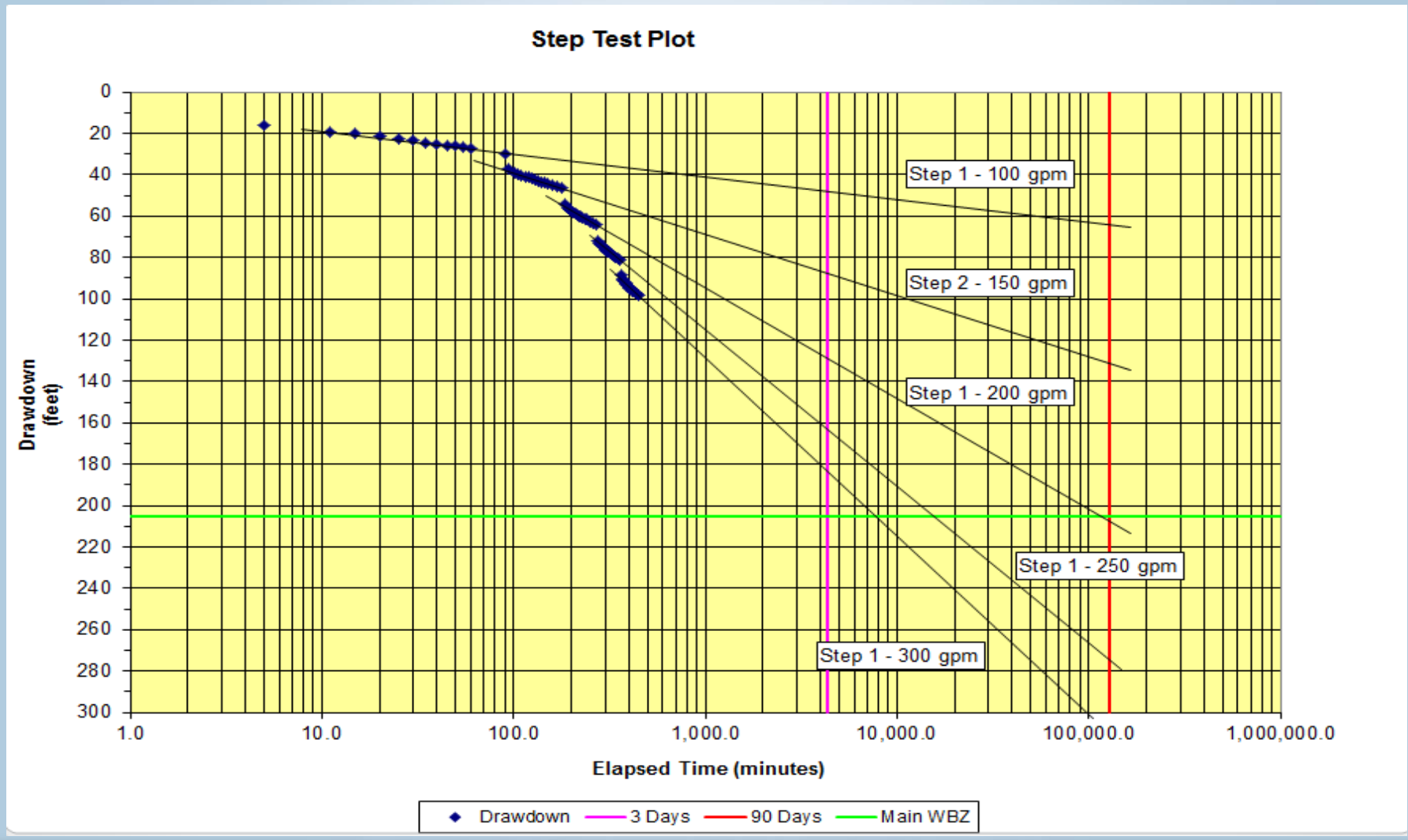
The Aquifer Test is comprised of four parts:

- Step test;
- Background monitoring (48 hours);
- Constant-rate test (72 hours); and
- Recovery monitoring (24 hours or 90 percent recovery).

STEP TESTING AND SELECTING A FLOW RATE

- Usually not required, but a good idea
  - If the proposed production well is to be used as one of the two monitoring points in a distance-drawdown analysis, then a step test is necessary to provide information on the efficiency of the well.
- Used to select appropriate rate for constant-rate test
- Steps of equal duration
  - First step 25% of blown yield; increase by 25% blown yield
  - Target 5 steps (until water level in well does not equilibrate during test period)

STEP TESTING AND SELECTING A FLOW RATE

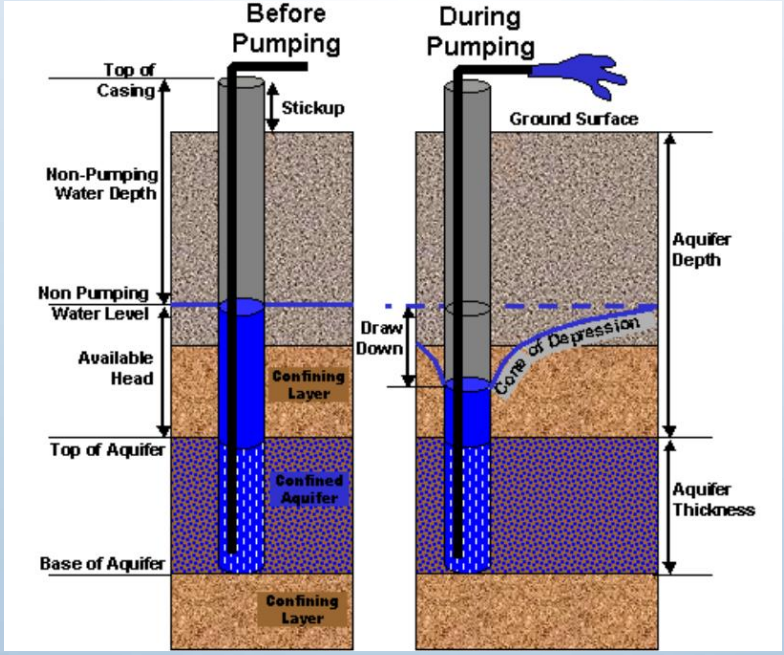


BACKGROUND MONITORING

- Begins after 90% recovery from step test
- At least 48 hours (72-hours in PADEP guidance)
- Demonstrate asymptotic recessional trends in surface water and ground water monitoring network prior to starting test
- Additional background monitoring may be required for some projects (e.g. projects with other pumping wells)
- No pumping of test well during background period.

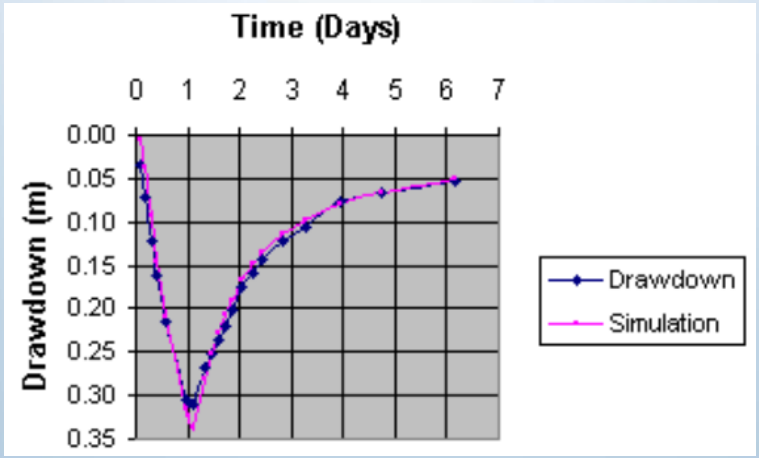
CONSTANT-RATE AQUIFER TESTING

- Immediately follows Background Monitoring Period
- The duration of pumping should be sufficiently long to establish the hydrologic changes and trend characteristics of the proposed production well operation, aquifer, and groundwater basin (recommended 72 hours).
- The consultant should be the expert on the site



RECOVERY TESTING

- The recovery test immediately follows the constant-rate test and consists of monitoring the recovery of water levels and flow rates at all of the monitoring locations, following pump shutoff.
- Duration is a minimum of 24-hours or until aquifer has recovered to at least 90% of pretest levels, minus groundwater recession
- The measurement interval for the first 15 minutes of recovery should be 1 minute or less.



GENERAL PERFORMANCE REQUIREMENTS

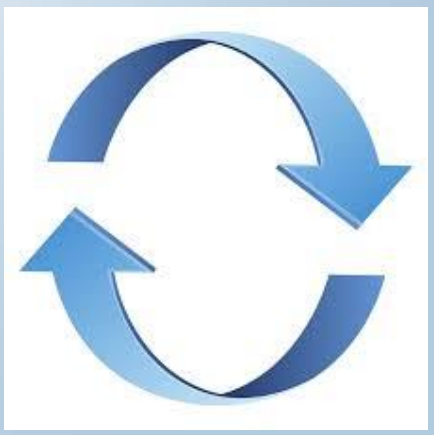
- **Appropriate Testing Conditions:** The background, pumping, and recovery phases of aquifer testing must be conducted during a period of asymptotic groundwater and surface water recession (base flow). The test should not be conducted during or shortly after a precipitation event that could result in a rapid change of water level or flow.

GENERAL PERFORMANCE REQUIREMENTS

- **Tested Rate:** The test well may be pumped at any rate desired, but must be pumped at a constant rate for the test duration. The Commission will not approve the well for operation at a rate higher than the average tested rate.
- **Maintaining a Constant Rate:** The tested rate must be monitored and maintained to within 5 percent of the target flow rate for the duration of the test or the test will likely not qualify as a constant-rate test and may have to be rerun.
- **Flow Rate Adjustments:** All flow rate adjustments must be documented with a measurement of flow before and after adjustment, the time at which the adjustments were made, and a rationale for the adjustment. This information must be included in the hydrogeologic report.

GENERAL PERFORMANCE REQUIREMENTS

- **Test Discharge:** Discharge from the test well must be routed such that recirculation does not occur. This typically results in a discharge point 300 to 500 feet down dip (bedding, schistosity, etc.) from the proposed pumping well, but may be 2,000 feet or more in karst or unconsolidated aquifers.
- **Discharge Approval:** Contact member jurisdiction agencies to determine if a temporary discharge approval is required.



WATER CHEMISTRY

- During the constant-rate testing, temperature, conductivity, turbidity, and any other agreed-upon chemistry measurements should be collected from the well being tested at a minimum of every 2 hours.
- Temperature and conductivity must be collected from all surface water features (streams, ponds, springs, and wetlands) being monitored at the start and end of the constant-rate test.
- Commission does not require laboratory analysis of water samples to evaluate water quality in relation to drinking water standards
- Coordinate with member jurisdiction agencies
- PADEP - New source sampling requirements and field measurements

SYSTEM OPERATION DURING TESTING

- Operations of systems during testing can be challenging
- Goal is to isolate impacts as a result of pumping the test well
- Extended background periods may be needed to establish steady-state or near steady-state conditions (especially for existing production wells)
- In some cases, it may be necessary to provide operational plans during the testing periods
  - Discuss how other on-site or system wells will operate to meet system/ facility demands during testing
  - Minimize interference during testing
- Use of test Discharge – In certain cases, test discharge water can be used by the project sponsor (renewal of approved source, or new source with member jurisdiction agency approval).

AQUIFER TESTING WAIVER REQUESTS

A project sponsor may request a waiver of any requirement, provided the request and explanation is made in writing at the time that the aquifer test plan is submitted (18 CFR § 806.8).

- Under Commission Resolution 2015-06 (Administration Authorizations) the Executive Director of the Commission has the authority to waive aquifer testing requirements.

- What Questions do we need to answer?
  - Sustainability of the withdrawal
  - Impacts to competing groundwater or surface water users
  - Impacts to the Environment

AQUIFER TESTING WAIVER REQUESTS

Waiver Requests should include:

- Historic operational data demonstrating reliable production at the requested rate with minimal impacts to existing users and the environment
- Historic Water Level Data
- Hydrogeologic description
- Groundwater availability analysis
- Background information

Waiver requests must be able to satisfy 18 CFR § 806.23 *(standards for withdrawals)*

§ 806.23 Standards for water withdrawals.

(a) The project sponsors of all withdrawals subject to review and approval under § 806.4, § 806.5 or § 806.6 of this part shall comply with the following standards, in addition to those required pursuant to § 806.21.

(b) *Limitations on withdrawals.* (1) The Commission may limit withdrawals to the amount (quantity and rate) of water that is needed to meet the reasonably foreseeable needs of the project sponsor.

(2) The Commission may deny an application, limit or condition an approval to ensure that the withdrawal will not cause significant adverse impacts to the water resources of the basin. The Commission may consider, without limitation, the following in its consideration of adverse impacts: Lowering of groundwater or stream flow levels; rendering competing supplies unreliable; affecting other water uses; causing water quality degradation that may be injurious to any existing or potential water use; affecting fish, wildlife or other living resources or their habitat; causing permanent loss of aquifer storage capacity; or affecting low flow of perennial or intermittent streams.

STAFF REVIEW OF WAIVER REQUESTS

- Request for waivers from aquifer testing must provide similar evaluation as testing.
  - Waivers are not waivers from evaluating impacts or sustainability and are not “rubber stamps”
  - Waivers can be complicated, as sufficient data does not always exist.
  - When in doubt, test.

WAIVER REQUEST SCENARIOS

Potential waiver request scenarios

- 72-hour testing won't satisfy 18 CFR § 806.23 (ex. dewatering projects, mine pools, etc.)
- Docket renewal at previous approved quantity, demonstrated use at requested rate with lack of impacts, stable historic water levels, drought conditions, etc.
- Docket renewal below previous approved quantity, requested rate coincides with demonstrated use, etc.
  - (historic approval based on unsustainable quantity - blown yield or MIWR)
  - Current infrastructure won't support historic approval
  - Regulatory concerns

WAIVER REQUEST SCENARIOS

Questionable waiver request scenarios

- Docket renewal at previous approved quantity without historic use or valid testing at requested rate that demonstrates :
  - lack of impacts to other users (new development, etc.)
  - lack of impacts to the environment (new species of concern)
  - Sustainable drawdown at the requested rate (historic water levels)
- Request to increase over previously approved/ demonstrated rates
- New or replacement Well

QUESTIONS…