

## Differentiation Through Technology and Services

Schlumberger Water Services (SWS) provides a complete range of cost-effective water exploration, utilization and optimization solutions for public, and private sectors.

Working as an integral part of your team, or as technology providers, we offer several scalable solutions to meet your business needs.

With over two decades of environmental experience, our teams of professionals are ready to assist you in all aspects of your water and groundwater resource projects.

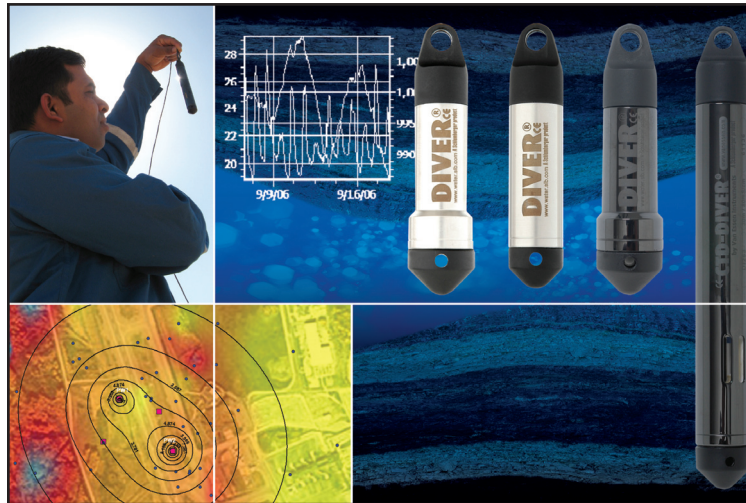
## Applied Technologies:

- Micro-Diver\*
- Cera-Diver\*
- CTD-Diver\*
- Baro-Diver\*
- Diver-Pocket\*
- Diver-Office\*
- AquiferTest Pro\*
- Visual MODFLOW Premium\*

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## Test Pumping Water Wells

Efficient Groundwater Development and Management



Diver\* dataloggers help you gain a better understanding of your groundwater systems

- ▣ Obtain information on aquifer properties and borehole performance
- ▣ Meet the requirements of regulatory agencies for environmentally sustainable groundwater use
- ▣ Benefit from our expertise in planning, implementing, monitoring, analysing, and interpreting pumping tests
- ▣ Apply the most up-to-date technologies: instrumentation, software, test analysis, and data management

## Integrated service from Schlumberger Water Services

Schlumberger Water Services offers an integrated service for the test pumping of water wells, from the beginning to the end of your project, covering:

- Planning and design of test pumping programs
- Installation and maintenance of complete monitoring networks for pumping tests
- Data collection, quality control, and management
- Analysis and interpretation of pumping test data
- Recommendations for water well operation or rehabilitation
- Integration of pumping test results into wider water resources or water quality studies

## Why do we do pumping tests?

Conducting pumping tests on boreholes and wells is a standard technique for investigating aquifers. The concept is simple: water is pumped at a known rate from a well, and water levels are monitored in the pumped well and in un-pumped observation wells in the surrounding area. The way in which water levels (or piezometric heads) change with time can be used to derive borehole performance characteristics and aquifer hydraulic properties. Pumping tests are undertaken for many different reasons:

- to test the operation of the pumping and monitoring equipment
- to assess the performance of a well and determine the most effective pumping rates and durations
- to derive the hydraulic properties of an aquifer
- to determine the effects of the abstraction on neighbouring wells or water systems
- to provide information on water quality
- to optimise operational pumping regimes

## Benefits

The information gained from test pumping water wells is essential for the efficient development and management of groundwater resources, and for the protection of sensitive groundwater-dependent ecosystems. When tests are repeated at suitable intervals, problems such as well clogging can be identified early by comparing test performance. Significant savings can be achieved by optimising pumping regimes, because pumping costs are directly related to drawdown.

## Types of pumping test

The most common types of pumping test are:

- Constant-rate test: the well is pumped at a constant rate, for several days or weeks, at the intended long-term operational pumping rate. This is the best type of test for deriving aquifer properties or investigating environmental impacts, and in general, the longer the test the more valuable the results.
- Step test: the well is pumped for short periods at different pumping rates in a

series of 'steps'. A typical step test consists of four or five steps of a couple hours each, starting at a low pumping rate and increasing the pumping rate with each successive step. This gives very useful information about the performance of the well, and changes in performance over time

- Recovery test: can be described as the inverse of a pumping test, because water recovery, after the pump is switched off, is monitored and analysed. It is particularly useful for heavily-used wells.
- Slug test: not strictly a pumping test, but nevertheless a quick and cheap way of testing a well, by instantaneously adding or removing a 'slug' of water. If this is done by displacement, then no water needs to be removed from the well (important if the groundwater is contaminated).

## Designing pumping tests

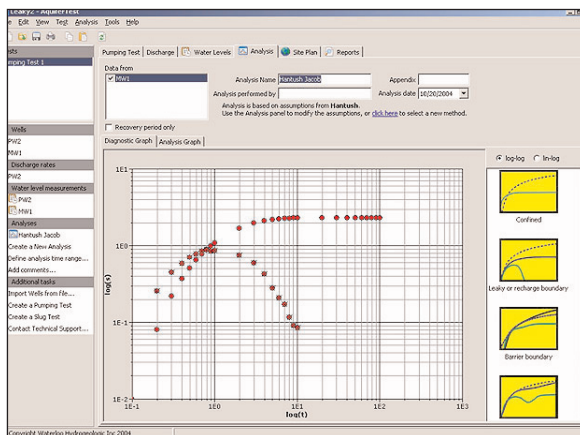
To gain the maximum benefit from pumping tests, it is important to spend time designing and planning each test. The test design will depend on the objectives of the test, and on the conceptual understanding of the aquifer system. Seasonal variations must also be accounted for.

## Monitoring pumping tests

Along with pumping rate, water levels in the pumped well and observation wells are the most common parameters monitored when test pumping water wells. Diver\* dataloggers are ideal for monitoring water levels during pumping tests, because they enable accurate data to be collected automatically, at high frequencies, in many different locations simultaneously. It is important to know the behavior of the water levels before and after the pumping test, and Divers can be left in place unattended for long periods of pre-test background (or baseline) monitoring and post-test recovery monitoring.

## Analysing pumping tests

There are many methods for analysing and interpreting pumping test data, including analytical equations, graphical curve-fitting, spreadsheets, and numerical models. AquiferTest Pro\* is a specialist software package that enables test pumping data to be displayed, analysed, and interpreted quickly and conveniently, with a wide choice of analytical methods. The chosen analytical method should be appropriate for the type of test and the aquifer conditions.



Pumping test analysis with AquiferTest Pro\*



Diver\* datalogger installed in a monitoring well