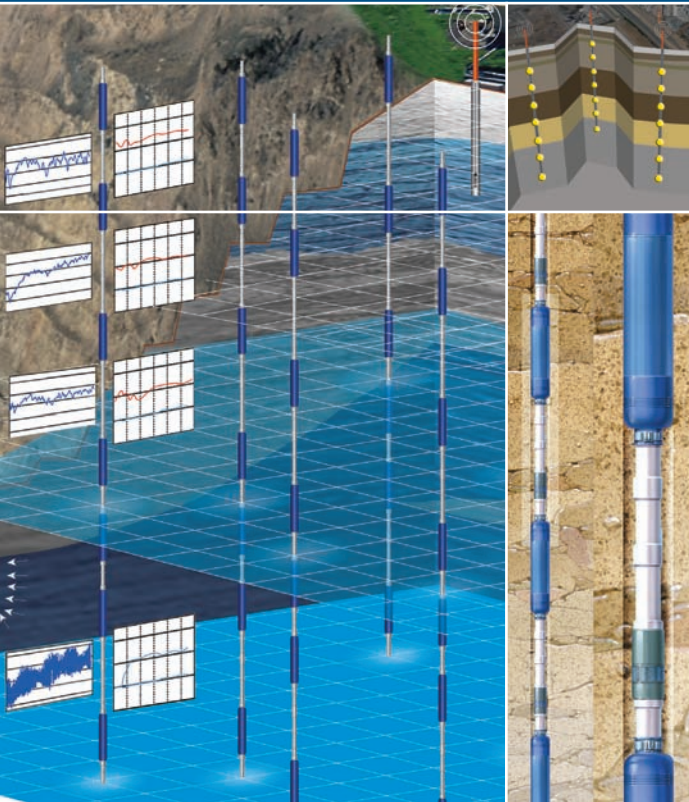


Westbay System

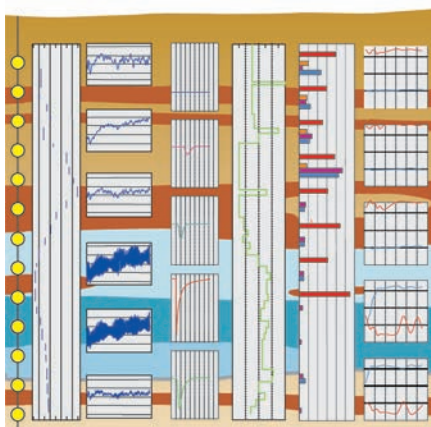


*Multi-level, Multi-parameter
Subsurface Monitoring*

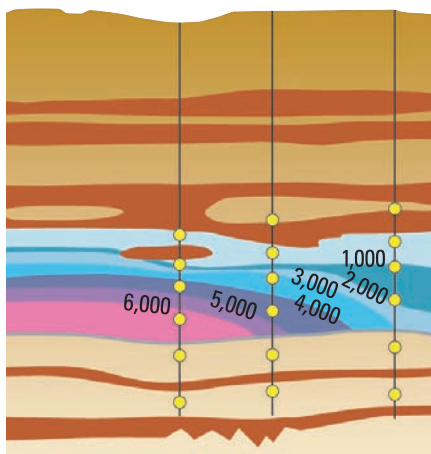
Is Groundwater Monitoring Important?



Monitoring impacts from industry



Subsurface characterization using Westbay Systems



Westbay Systems offer a detailed view of the vertical distribution of contaminants in the subsurface

Why groundwater monitoring networks?

Groundwater is an essential resource of great social, environmental and economic importance. With continuous population growth and industrial expansion impacting the state of groundwater around the world, implementing comprehensive groundwater management strategies is critical.

As an essential component of water management, groundwater monitoring networks are designed to optimize the collection of vast amounts of field data during the life of a project. Collection, analysis, and management of water levels and water quality parameters provide fundamental baseline information necessary for identifying potential risks and managing groundwater as a sustainable resource.

Groundwater monitoring networks:

- provide baseline data to map the spatial and temporal distribution of water quality
- identify short-term changes to groundwater flow from pumping, natural recharge and discharge, agricultural and industry use
- isolate impacts to groundwater from contaminant spills and releases
- present early warning of potential risks and the need for mitigation measures
- offer real-time accounting of water use and compliance with regulatory guidelines
- support calibration efforts when conducting computer modeling

Our solution

For over 30 years, Schlumberger Water Services' (SWS) **Westbay System**[®] has provided its clients with a cost-effective, multilevel monitoring technology designed for long-term groundwater monitoring and data acquisition. The Westbay System is designed for collecting subsurface data at any number of discrete positions within a single well. Under even the most complex hydrogeologic conditions, this completely customizable system is a cost-effective, reliable solution that surpasses traditional monitoring methods.

SWS - Monitoring Services

SWS' Monitoring Services offers technology and services to support virtually all stages of groundwater monitoring networks. From Westbay System completions to data acquisition and analysis, our tools and expertise will minimize risk and reduce uncertainty for your projects.

Site Assessment

Initial site assessments offer baseline data necessary for characterizing the site. Westbay Systems are designed with tools to characterize the hydrogeologic conditions of the site, and optimize well placement.

Design & Deployment

Westbay Systems are completely customizable for each unique hydrogeologic condition. The versatility in design minimizes overall construction and deployment costs.

Data acquisition

Westbay Systems are engineered to record and collect pressure measurements and samples from any number of monitoring zones within a single borehole.

Interpretation

Accurate data interpretation is critical to supporting decisions. Westbay Systems provide reliable and highly accurate data for understanding the groundwater flow regime.

Reporting & Decision Making

HydroManager, a data management system, provides the ideal platform for management of Westbay System data for decision support and web-based information distribution.



Westbay System

Flexible, industry-tested design offers
Superior Performance

Overview

The Westbay System is a completely versatile, multilevel monitoring technology that allows testing of hydraulic conductivity, monitoring of fluid pressure and collection of fluid samples from multiple zones within a single borehole. Designed for reliability and defensibility, the Westbay System can accommodate a wide variety of borehole conditions including diameter, depth, temperature and chemistry considerations.

Westbay System advantages:

- obtain measurements and samples at any number of discrete locations along a single borehole
- collect samples without purging
- designed for long-term monitoring
- engineered to operate at great depths
- reduced drilling and installation costs, with minimal site disturbance
- removable probes allow for convenient calibration and servicing
- built-in defensible QA/QC procedures

Well completions

Westbay Systems are engineered with a unique, customizable casing system. The casing system is available in two sizes to accommodate various borehole dimensions and operational requirements.

Hydraulically-inflated packers and/or select backfill provide engineered seals between monitoring zones, preventing unnatural flow and cross-contamination. Valved ports in the zones provide access for monitoring, sampling and hydraulic testing.

Westbay Systems can be installed in a number of different ways to suit varying geologic conditions, drilling methods, and project objectives.

Completion methods include:

- packers in open borehole
- packers through temporary casing
- packers in a cased well
- direct backfill

Westbay System probes

A variety of probes are available for use with the Westbay System. Reliable, accurate, and portable wireline-operated probes can be lowered into the casing system and used to:

- measure groundwater pressure
- test hydraulic parameters
- collect samples in-situ
- perform system specific tests

Sampling Probes

Westbay Systems offer the unique ability to collect discrete fluid samples at formation pressure. For sample collection the probe and sample container are lowered to the desired depth, where the sample is collected into the container. The probe and container are then retrieved to the surface for further analysis.

Westbay System sampling allows you to:

- collect samples with minimal disturbance and without repeated purging
- maintain samples at formation pressure
- monitor pressure during sampling
- document quality assurance

❶ Packer

- Engineered seal in a range of borehole sizes
- No dedicated inflation lines
- Controlled hydraulic inflation with record of pressure and volume
- Quality control tests to confirm performance at any time after installation

❷ Measurement Port

- For fluid pressure measurements, fluid sampling and low-k testing

❸ Pumping Port

- For purging, hydraulic conductivity testing, and quality control testing



Accurate, reliable long-term monitoring delivers *Definitive Results*

Measuring groundwater pressure

Westbay System pressure probes can be used to take periodic, manual measurements of in-situ fluid pressures or to automatically monitor pressures more frequently.

With a single probe, pressures are measured one port at a time. The output from the probes is digitized and transmitted through a rugged but lightweight wireline to a control unit at the surface. By attaching a standard laptop to the interface, data can easily be downloaded and stored for interpretation and analysis.

For automated multilevel measurements of fluid pressures, a string of pressure probes can be distributed down the well with each probe located at a selected measurement port. Each probe has a unique identity, allowing them to be polled individually or simultaneously by the datalogger.

Westbay Systems allow you to :

- measure pressure and temperature at multiple locations in a single well
- measure manually or automatically
- redeploy probes in alternate locations
- select from a variety of logging modes
- perform in-situ calibration checks
- document quality assurance

Engineered for versatility, long-term monitoring and high-resolution results

Testing hydraulic parameters

The Westbay System provides many effective methods for evaluating and testing the hydraulic characteristics of a site. Vertically distributed monitoring ports offer the unique ability to observe and record details within a single well.

Westbay Systems allow you to:

- observe detailed vertical distributions of groundwater pressures
- observe the effects of pumping tests or changes in barometric pressures
- gain insight into permeability variations
- generate a stress in a monitoring zone and observe responses of neighbouring zones and wells

A number of qualitative and quantitative tests can be performed to determine the hydraulic conductivity of formation materials or to verify the operation of the system.

Hydraulic tests include:

- single-zone tests
- slug tests
- pulse-interference tests
- constant-head tests
- vertical interference tests
- cross-hole tests
- tracer tests

As part of a complete groundwater monitoring project, Westbay Systems are engineered to meet the rigorous demands of a wide range of projects. Westbay Systems provide the highest level data quality necessary to support critical decisions.

4 Sampler Probe

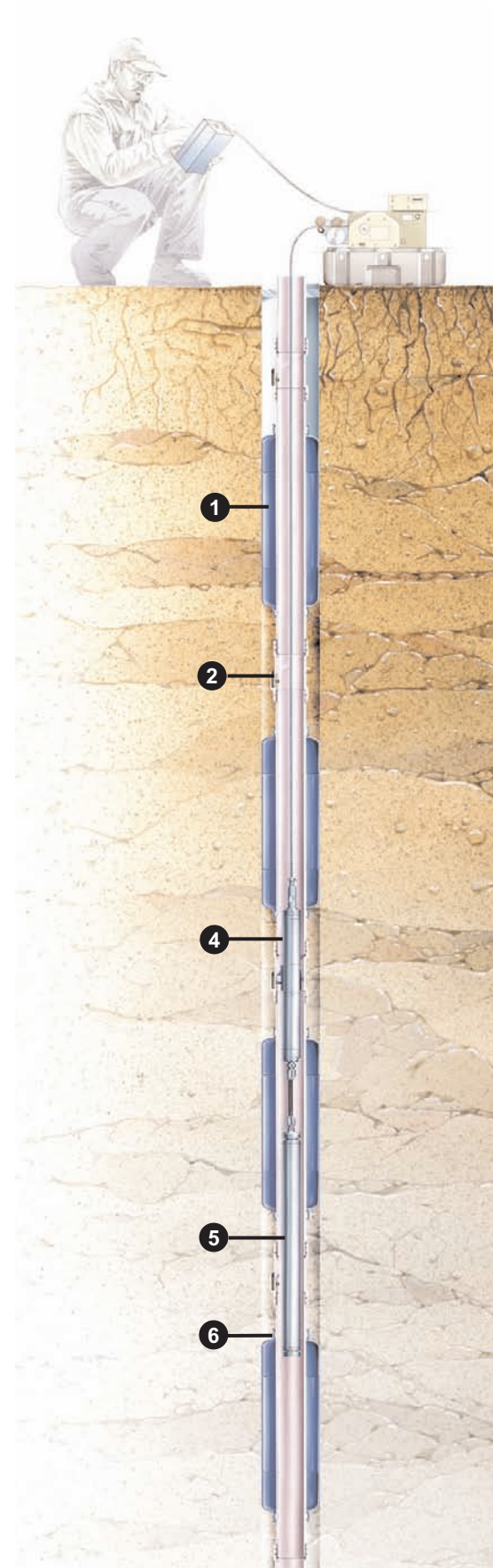
- Independently controlled sampling valve
- Silicon strain-gauge pressure transducer
- Location/activation mechanism compatible with Westbay System

5 Sample Container

- Maintains sample pressure during recovery
- Easy to clean

6 Sealed Connections

- All casing connections sealed by o-rings



Applications

A valuable tool for any groundwater project

Groundwater Resource Management

Regulatory agencies and private water companies continually strive to support sustainable groundwater supplies. Westbay Systems provide water managers the means for accessing, characterizing, and monitoring the groundwater flow regime. They offer a three-dimensional network of monitoring zones providing the data necessary to observe groundwater behavior on a "macroscopic" scale. This detailed data allows water supply managers to optimize the use of groundwater.

Contaminant Site Investigations

Characterization of contaminated groundwater requires detailed monitoring to eliminate data gaps and provide sufficient information to support predictive numeric models. The Westbay System is a reliable, cost-effective technology for obtaining detailed vertical information, enabling groundwater professionals to carry out contaminant site investigations.

Geologic Repositories

Construction of deep geologic repositories for long-term storage of radioactive waste requires a concerted scientific program, and deployment of proven monitoring well technologies. Westbay Systems are the experts' choice for characterization and monitoring related to the establishment and construction of deep geologic repositories.

Geotechnical Projects

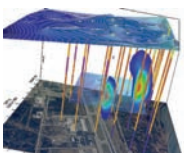
Landslides, large dams, underground tunnels and various civil engineering projects at risk of structural failure require constant monitoring of groundwater pressures. The Westbay System has been deployed at large-scale geotechnical projects for more than 20 years and provides detailed fluid pressure data required for monitoring slope stability, subsidence, and drainage.

Mining

The ability to measure pore pressures, collect fluid samples and test hydraulic conductivity make Westbay Systems the ideal technology for mining projects. Applications include site characterization for environmental impact assessment, tailings and waste ponds, process water ponds, waste piles, monitoring of leach operations, closure analyses; geotechnical needs such as mine dewatering, pit slope stability, construction of tunnels and shafts, etc.

Data Analysis Software

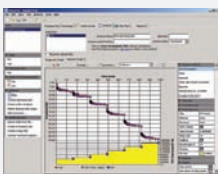
Making sense of your Westbay System data



Hydro GeoAnalyst* is an all-in-one environmental information management system designed with built-in tools for analyzing, mapping, visualizing and reporting vast amount of data collected during typical groundwater monitoring and remediation projects.

Features:

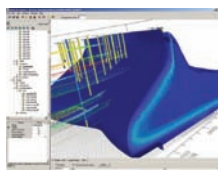
- manage and report groundwater levels and chemistry
- map the spatial distribution of water quality parameters
- develop geologic models directly from borehole data
- design borehole logs and well construction details
- prepare field data for use in numeric flow models



AquiferTest Pro* is specifically designed for graphical analysis and reporting of pumping test and slug test data. Import a vast range of data types including Westbay Probes, Diver dataloggers, etc. AquiferTest Pro includes features and tools for calculating hydraulic properties of the aquifer.

Features:

- calculate hydraulic conductivity, storativity, or transmissivity directly from pumping test data
- diagnostic graphs provide a quick assessment of the aquifer type and presence of boundary influences
- trends correction compensates for barometric changes



Visual MODFLOW Premium* is an industry-leading 3D groundwater flow and contaminant transport modeling package based on the USGS MODFLOW. Visual MODFLOW Premium incorporates various tools for determining groundwater flow and contaminant migration.

Features:

- determine groundwater flow direction and magnitude
- conduct single or multi-species transport simulations
- calibrate simulations with data collected in the field
- design and optimize remediation techniques (pump-and-treat, funnel-and-gate, natural attenuation, etc.)



About Schlumberger Water Services

Managing the world's water resources is no small task. We tackle global water challenges with our worldwide network of hydrologists, geologists, and environmental experts. Combined with powerful and cost-effective technologies, we are successfully managing the world's water resources, for now and the future.

Our people deliver your success.