Guide to Conducting Pumping Tests

THIS GUIDE PROVIDES GENERAL INFORMATION AND GUIDANCE ON BEST PRACTICES FOR PUMPING TESTS for well drillers and well pump installers. In addition, the guide offers information to developers and local governments on the requirements for water supplies (e.g., to determine if sufficient groundwater is available for residential developments) and an explanation of the benefits of a properly conducted pumping test. This guide is not meant to offer professional guidance nor be a substitute for appropriate standards of care.

WHAT IS THE DIFFERENCE BETWEEN A WELL YIELD TEST AND A PUMPING TEST?

A **WELL YIELD TEST** is a short (approximately one hour) flow test, usually done by a registered well driller once the well is completed to provide an approximate estimate of the capacity of the well to produce groundwater. It is generally recorded in the well construction report by the well driller. Well yield tests are done using bailing[1], air lifting or similar methods. Well yield tests are not as reliable as a pumping test in the following situations:

- when well capacity is low (*e.g., typical bedrock well*);
- when the maximum yield from the well is required;
- when reliable estimates of aquifer properties are needed; and
- when assessing impacts of proposed pumping on neighbouring wells.

A **PUMPING TEST** is a practical method of estimating well performance, well capacity, the zone of influence of the well and aquifer characteristics (e.g., the aquifer's ability to store and transmit water, anisotropy, aquifer extent, presence of boundary conditions and possible hydraulic connection to surface water). A pumping test consists of pumping groundwater from a well, usually at a constant rate, and measuring the change in water level (drawdown) in the pumping well and any nearby wells (observation wells) or surface water bodies during and after pumping (see Figure 1). Pumping tests can last from hours to days or even weeks, depending on the purpose of the pumping test, but traditional pumping tests typically last for 24 to 72 hours.

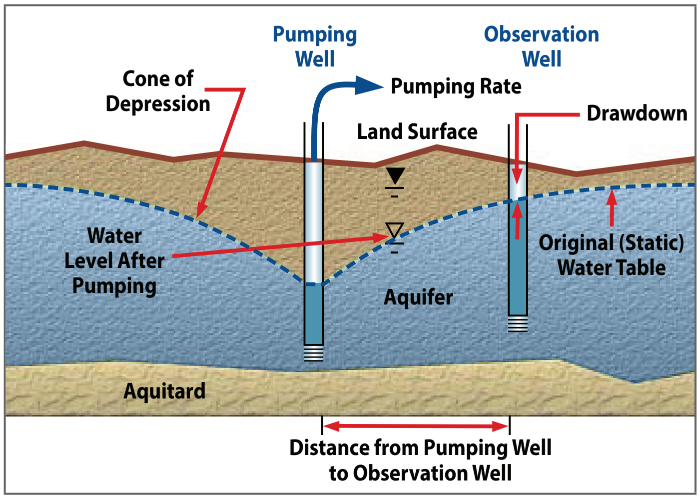

FIGURE 1 *This figure shows the impact of a pumping well on the water table and a neighbouring well (observation well) in an unconfined aquifer As the water is pumped from the well, the original or static water level lowers, ie., drawdown occurs in the well. A cone of depression is formed in the aquifer around the pumping well as the water level declines due to pumping. Note that drawdown in the observation well is much less than in the pumping well.*

A pumping test should also measure the changes in water level after the pump stops (see Figure 2). The information collected during this recovery period will verify the results of the pumping test.

1 *Water is removed from the well using a cylindrical pipe with a check valve at the bottom that is lowered on a sand line*

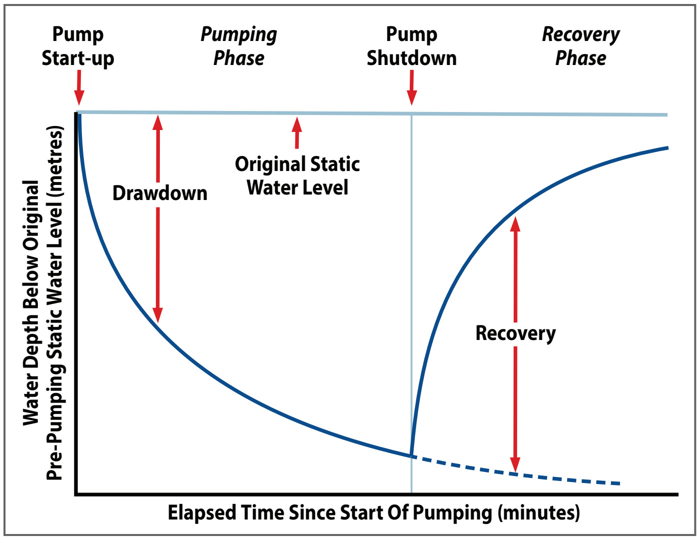

FIGURE 2 *Graph showing the different phases of a constant rate pumping test – the pumping phase and the recovery phase.*

WHEN ARE PUMPING TESTS NEEDED?

Pumping tests may be conducted solely to provide a greater confidence in the well driller's estimated well capacity. These pumping tests are typically shorter in duration (4 to 12 hours) and are commonly done on domestic or single-residence wells.

Longer duration pumping tests are commonly required to:

- provide proof of water availability under local government bylaws for new residential developments or regulatory requirements, *e.g., Certificate of Public Convenience and Necessity* (CPCN);
- determine the maximum yield from a well;
- assess impacts on neighbouring wells or water bodies, such as streams, from the proposed use of the well; and/or
- obtain aquifer properties such as permeability and boundary conditions.

WHO CAN CONDUCT A PUMPING TEST?

Under Section 50 of the Water Sustainability Act, the following persons can conduct a flow test[2]:

- a well driller;
- a well pump installer; or
- a person working under the direct supervision of the well driller, pump installer or professional with competency in hydrogeology.

A professional with competency in hydrogeology must **DESIGN, PERFORM OR DIRECTLY SUPERVISE, AND INTERPRET THE PUMPING TEST RESULTS** when a pumping test is conducted:

- as part of an application for a water use authorization; or
- as directed in an order of the comptroller, water manager or an engineer.

It is also recommended for a professional[3] to design, perform or directly supervise, and interpret pumping tests in the following situations:

- where a pumping test for a well is required by an approving agency; or
- where the yield of the well needs to be maximized; or
- when data needs to be interpreted, for example:
  - when there is a need to assess the impact of the pumping well on nearby surface and ground-water resources; and
  - when estimates of an aquifer's properties are required.

WHAT ARE THE KEY THINGS TO CONSIDER WHEN DESIGNING AND PLANNING A PUMPING TEST?

Designing and planning a pumping test is critical and should be done first, before any field work is done or equipment set up on the site. Lack of planning can result in delays, increased costs, technical difficulties and poor or unusable data.

Some things to consider in the pre-planning stage are:

- time of year the pumping test will be done
- natural variations in the groundwater levels
- informing others who may be affected
- depth of pump setting and type of pump
- pumping duration
- pumping rate
- control and measurement of the pumping rate
- frequency of changes in the water levels
- measuring water levels in neighbouring wells and/or streams
- disposal of pumped water
- collection of water samples for analysis
- special circumstances to be aware of
- accessibility of the well e.g., clearance from power lines, confined spaces, small pump houses, or nearby traffic

2 *As defined in the Groundwater Protection Regulation, flow tests include pumping tests and well yield tests.*

3 *Professionals who are registered with the Engineers and Geoscientists of British Columbia*

Refer to the document Guidance for Technical Assessment Requirements in Support of an Application for Groundwater Use in British Columbia for additional information: ***https://a100.gov.bc.ca/pub/acat/documents/r50847/GW_TAG_Aug2020_1605220217068_5216198940.pdf***

WHAT TIME OF YEAR SHOULD A PUMPING TEST BE DONE?

An approving agency may require a pumping test to be conducted during a low recharge period (*e.g., dry period*) or other time of the year. In the absence of this requirement, a pumping test may be done at any time of the year. However, it is recommended to avoid large volume tests during periods of severe drought. For fractured bedrock and other low-yielding wells, a pumping test should be done during a dry period when water tables are least likely to be affected by temporary rainfall events. Optimal times for testing in B.C. are summer and fall in coastal areas and fall and winter in the Interior.

ARE THERE NATURAL VARIATIONS IN THE GROUNDWATER LEVELS?

Natural variations in water levels caused by tidal, river and barometric changes can influence water levels during pumping and recovery. Even diurnal variation can occur in aquifers with shallow water tables due to the difference between nighttime and daytime evapotranspiration. Pre-pumping and post-pumping water levels of the pumping well and any observation well(s) can be used by the professional hydrogeologist to correct for natural fluctuations.

SHOULD OTHER WELL OWNERS BE NOTIFIED ABOUT THE PUMPING TEST?

If the pumping test involves pumping a large volume of water for a long duration (*e.g., 24 to 72 hours*), owners of neighbouring wells (*e.g., any well within 100 meters or 300 feet of the pumping well*) should be notified. Use of these neighbouring wells during the pumping test could affect the results of the test, especially if the neighbouring wells are used as observation wells.

WHAT TYPE OF PUMP SHOULD BE USED AND AT WHAT DEPTH SHOULD IT BE PLACED?

The pump intake is normally placed above the well screen to maximize the amount of available drawdown for the pumping test. The intake of the pump should not be placed within the well screen as this may cause increased velocities resulting in sanding and potential casing deteriorization, along with screen plugging.

For bedrock wells the pump is set at or just above the uppermost major water-bearing fracture (refer to the driller's well construction report).

There are several factors to consider when determining the type of pump to use and where it should be set, including:

- well diameter;
- desired pumping rate;
- total dynamic head including the pumping water level, the above ground head (if applicable) and all friction losses in the casing, pipes, fittings, etc.;
- power source; and
- horsepower requirements.

Also, consider whether the pump is submersible and can be operated at variable speeds.

HOW MUCH TIME WILL THE PUMPING TEST TAKE?

The duration of the pumping test depends on the purpose of the well, the type of aquifer and any potential boundary conditions. This information can be obtained from:

- well construction reports for the pumping well and any neighbouring well(s);
- information on the aquifer and surface water bodies, such as lakes or rivers in the vicinity of the well; and
- well drillers and professional hydrogeologists.

Minimum durations of typical pumping tests are 24 to 72 hours unless stabilization of the pumping water level occurs. Local by-laws, regulatory requirements (e.g., an Order issued by a Water Manager) or a professional can stipulate minimum pumping durations. Duration is generally longer for bedrock wells (due to uncertainties associated with bedrock aquifers), and for wells completed in unconfined aquifers (due to the delayed release of water as the water level goes down or "delayed yield" effect).

HOW IS PUMPING RATE SELECTED?

The well should be pumped at or above the intended pumping rate of the well and the well should not be rated above the pumping rate used during the test.

Other considerations for setting the pumping rate are:

- wells should not be pumped at a rate higher than the manufacturer's recommended capacity for the well screen to avoid damage to the well or a sand/gravel pack developed around the well (Check the well screen details in the driller's construction report and refer to the screen manufacturer's specifications or the book *Groundwater and Wells* to calculate the expected screen entrance velocity);
- wells completed in unconsolidated materials (e.g., sands and gravels) with an open bottom (e.g., no well screen) should not be pumped at a rate which could cause the heaving of aquifer materials and locking up of the pump; and
- bedrock wells should not be overpumped, resulting in the water level being drawn down past the uppermost water bearing fracture, because turbulence at the borehole/well interface could damage the aquifer formation and result in excessive turbidity in the water and also decreased capacity.

A professional involved in the design of a pumping test may determine if a step drawdown test is needed before the constant rate pumping test is conducted (e.g., in situations where the aquifer conditions are not sufficiently understood). If a step drawdown test is done, the well should be "rested" between the step test and the constant-rate pumping test to allow for the water level to fully recover. A professional should determine the optimum pumping rate for the constant rate pumping test and the step drawdown test.

Another consideration when selecting the pumping rate is borehole storage (water stored in the well casing). In most cases, for a short period after pumping begins, all the pumped water comes from borehole storage. However, in some cases, where the well is deep and the rate of intended use is low, the borehole storage may never be pumped out. In these instances, the pumping rate can be initially set higher than the rate of intended use to remove the borehole storage and then the pumping rate is cut back to match the rate of intended use.

HOW IS THE PUMPING RATE CONTROLLED AND MEASURED?

During a constant rate pumping test, variations in the pumping rate should be avoided, as they can lead to uncertainties in the calculation of well capacity and aquifer properties. Control of the rate requires an accurate device for measuring the discharge (e.g., flow meter or orifice weir) and a means of adjusting the rate to keep it constant, such as a gate valve. The discharge pipe and the valve should be sized so that the valve will be from ½ to ¾ open when pumping at the desired rate. The valve should be installed at a sufficient distance from the measurement device to avoid any impacts from turbulence.

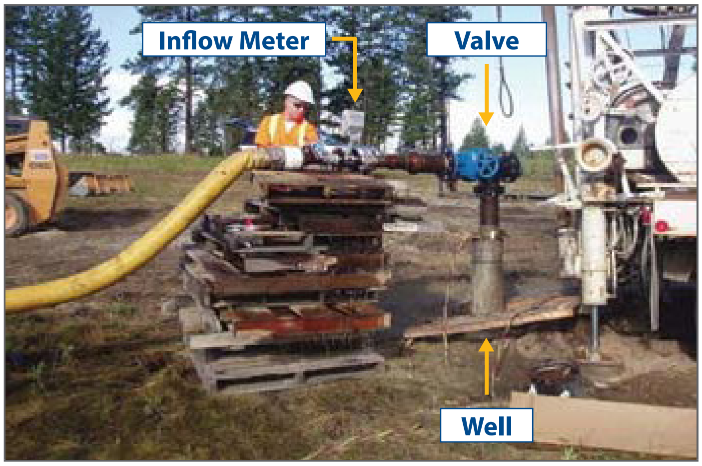

FIGURE 3 *In-line flow meter on discharge line*

The flow measurement device should be compatible with the expected pumping rate. Calibrated in-line flow meters and orifice weirs are used to measure pumping rates for high production wells. If an orifice weir is used, the discharge pipe should be straight and level for a distance of at least 1.8 meters (6 feet) before the water reaches the orifice plate. For relatively low pumping rates (e.g., <10 USgpm or <0.6 L/s), a 19 L (5 gallon) bucket or graduated cylinder and a stop watch is practical for measuring flow (see Figure 4).

During a constant-rate pumping test, the pumping rate must be measured correctly and recorded regularly. In general, the lower the pumping rate, the more accurate and careful the flow measurement must be. An unrecorded change of as little as two per cent in the pumping rate can affect the interpretation of the data, for example, indicating a false stabilization or a boundary condition. At the beginning of the pumping test the pumping rate should be set as quickly and accurately as possible and should remain constant for the duration of the test. For example, the pumping rate should not vary by more than five per cent and should generally be within two to three per cent for higher pumping rates. It is good practice to measure and record pumping rates frequently at the beginning of the test (every 15 minutes for the first hour) and hourly thereafter for tests of one to three days. Checking the pumping rate allows for adjustments to be made if the rate has drifted, and confirms that the selected pumping rate has been maintained. Adjustments to the pumping rate should be recorded along with the measured rate and water levels during the pumping test. Good record keeping is key to interpreting the pumping test results.

FIGURE 4 *A five gallon bucket and a stop watch can be used to estimate low pumping rates.*

HOW AND AT WHAT INTERVALS WILL CHANGES IN WATER LEVELS BE MEASURED?

Prior to the pumping test, all monitoring instruments should be checked to be sure they are working properly. Fresh replacement batteries should be available for all manual sounding probes. Before the pumping test begins, synchronize the watches of all observers and data logger's "time-of-day" settings.

Establish initial conditions by measuring static water levels in the well and any observation well(s) for a period of time before starting the pumping test. If static water levels in the aquifer are changing due to recharge or other factors, a professional should be consulted on establishing the static water level.

A sounding tube or access tube, typically a 19 to 25 mm (¾" to 1") diameter PVC pipe that extends from the top of the casing down to 0.9 to 1.2 m (3 to 4 ft) above the well pump, can be used to take water level measurements without the probe getting tangled in the well pump wiring (see Figure 5). Water levels can be measured using water level probes or pressure transducers lowered into the sounding tube. If pressure transducers are used, make sure that it is positioned so that the water level does not draw down below it, or recover to a level that would exceed its maximum measurement range. Take manual readings of the water level prior to and following the test pumping and periodically throughout the pumping test to confirm the water level measurements by the transducer. Measurements should be taken to the nearest 0.3 to 0.6 cm (1/8" or 1/4").

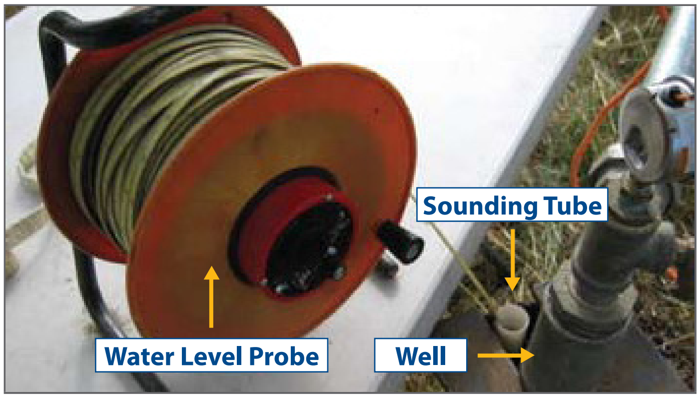

FIGURE 5 *Water level measurement using water level probe and sounding tube.*

FIGURE 6 *A pressure transducer can be used for automatic measurement and recording of water level and temperature, specific conductance or other parameters during the pumping test.*

The Province of British Columbia has developed a Pumping Test Report form to record information and data collected from the pumping and recovery test – *https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/water-wells/pumping_test_form.pdf.* An Excel spreadsheet has also been developed to record the test drawdown and recovery data. The recommended minimum frequency for water level measurements in both the pumping and observation well(s) during the pumping and recovery phases is shown in Table 1 as well as on the back of the Pumping Test Report form. Data collection at the minimum specified intervals will establish conditions that affect groundwater flow to the well. It may not always be possible to take the drawdown measurements at the specified intervals. In these cases, each reading should reference the time elapsed since the pumping test started.

TABLE 1
Recommended minimum frequency for water level measurements for pumping tests.

WELL BEING PUMPED
DURING PUMPING:
» Every minute for the first 10 minutes**
» Every 2 minutes from 10 minutes to 20 minutes**
» Every 5 minutes from 20 minutes to 50 minutes**
» Every 10 minutes from 50 minutes to 100 minutes**
» Every 20 minutes from 100 minutes to 200 minutes**
» Every 50 minutes from 200 minutes to 500 minutes**
» Every 100 minutes from 500 minutes to 1000 minutes**
» Every 200 minutes from 1000 minutes to 2000**
» Every 500 minutes from 2000 minutes to 5000 minutes**
» Every 24 hours from 5000 minutes onward**
» Final water level measurement just prior to end of pumping
DURING RECOVERY:
» Every minute for the first 10 minutes after end of pumping***
» Every 2 minutes from 10 minutes to 20 minutes after end of pumping***
» Every 5 minutes from 20 minutes to 50 minutes after end of pumping***
» Every 10 minutes from 50 minutes to 100 minutes after end of pumping***
» Every 20 minutes from 100 minutes to 200 minutes after end of pumping***
» Every 50 minutes from 200 minutes to 500 minutes after end of pumping***
» Every 100 minutes from 500 minutes to 1000 minutes after end of pumping***
» Every 200 minutes from 1000 minutes to 2000 minutes after end of pumping***
» Every 500 minutes from 2000 minutes to 5000 minutes after end of pumping***
» Every 24 hours from 5000 minutes onward***

OBSERVATION WELL*
DURING PUMPING:
» Every 10 minutes for the first 100 minutes**
» Every 50 minutes from 100 minutes to 500 minutes**
» Every 100 minutes from 500 minutes to 1000 minutes**
» Every 500 minutes from 1000 minutes to 5000 minutes**
» Every 24 hours from 5000 minutes onward**
» Final water level measurement just prior to end of pumping
DURING RECOVERY:
» Every 10 minutes for the first 100 minutes after end of pumping***
» Every 50 minutes from 100 minutes to 500 minutes after end of pumping***
» Every 100 minutes from 500 minutes to 1000 minutes after end of pumping***
» Every 500 minutes from 1000 minutes to 5000 minutes after end of pumping***
» Every 24 hours from 5000 minutes onward***

**If the observation well is located in close proximity to the pumping well it may be desirable to take more frequent measurements*

***Time since the start of pumping or time immediately after a step change in pumping*

**** Not required if time is beyond the specified duration of recovery measurements*

Monitoring recovery after the well pump has been stopped is important because it aids the interpretation of the pumping test. Recovery data also tend to smooth out variations in the pumping rate, should variations occur. To obtain accurate recovery data, a check valve, or other back-flow prevention device, should be installed at the bottom of the well pump discharge pipe, during the initial pump setup to eliminate backflow of water into the well.

Typically, the duration of the recovery test is directed by the professional supervising the test. At a minimum, recovery water levels should be monitored for the same duration of the pumping test or until at least 90 per cent recovery has been achieved (see Table 1). The well pump should not be removed from the well until the water level has returned to 85-90 per cent of the static water level or until the supervising professional indicates the well pump can be removed. However, generally for a 24-hour pumping test, 90 per cent recovery occurs within two to three hours after the well pump is stopped and the well pump can then be removed (this event should be recorded on the data sheet). If the water level does not recover within the same time duration of the pumping test (e.g., 24 hours) the water level should be monitored daily for an additional week.

If the water level does not return to 90-95 per cent of the static water level after a week, the well may be inadequate (e.g., the pumping rate was too high for the well's capacity) or further testing (e.g., longer pumping time and lower pumping rate) may be required. If this happens, a professional should interpret the pumping test and recovery data and recommend a course of action.

Good record keeping is key to interpreting the data collected from a pumping test. Occasionally, fluctuations in the water level will occur, due to nearby pumping of another well, sudden rainfall events, or changes in surface loading of the aquifer due to heavy equipment (trains, for example). It is important not to "make up" data and to record events that occur during the pumping test. Key points to note are as follows:

- staff changes during the pumping and recovery tests;
- if and when equipment was changed during the test;
- if the pumping test was conducted in a well field, or when other wells were pumping;
- when the pump was pulled out;
- times and pumping rates of any neighbouring wells used as observation wells;
- precipitation that occurred during the test;
- visual changes in water quality, including presence of sediments, turbidity, colour, air bubbles or other gases;
- any periodic cycling on and off of well pumps in the area; and
- changes in the pumping rate.

WHEN SHOULD NEIGHBOURING WELLS AND/OR STREAM LEVELS BE MEASURED?

Monitoring of water levels in neighbouring wells (observation wells) and/or streams to assess the impact of the pumping well should be specified by the professional, especially where:

- the pumping rate is high;
- there are regulatory requirements; and/or
- neighbouring wells or stream levels could be impacted by pumping.

Existing wells may be used if they are within the same aquifer formation[4] and the well owner has provided consent. It is important to take care not to contaminate a water supply well if using it as an observation well during a pumping test. Proper disinfection procedures should be followed for any equipment lowered down their well. Ideally, at least one observation well should be monitored to estimate the aquifer's storativity. The observation well should not be pumped during the pumping test. If this is unavoidable, the times and pumping rates should be recorded. Often, water levels may not vary as much in observation wells as they will in the pumping well, therefore it is important to establish reliable background conditions prior to the pumping test.

HOW IS THE PUMPED WATER DISPOSED OF?

Proper disposal of the pumped water is important to ensure there is no damage due to erosion, flooding or sediment deposition in streams (see Figure 7). For land disposal, direct the water from the pumping well in a down-hill direction at a sufficient distance from the pumping well. This will prevent recirculation of the pumped water into the well or aquifer and will preserve both the pumping water level and the integrity of the pumping test. Several hundred feet or more of discharge line may be needed. If the aquifer is confined (refer to the lithology section of the driller's well construction report), the water can generally be conveyed a shorter distance away from the pumping well without affecting the pumping water level.

In an urban setting, the pumped water may be discharged to a storm sewer but local government approval may be required.

For large production wells, where disposal will be to an adjacent water body or wetland, the local Provincial Government and Department of Fisheries and Oceans (DFO) offices must be advised. Even if the well water is potable, it may contain sediment or be low in dissolved oxygen and have the potential to impact fish habitat. To eliminate or minimize this, a proper conveyance channel should be used. Ensure the channel is either rock-lined or vegetated to prevent erosion and that the outlet to the receiving water body does not harm fish habitat by destabilizing stream banks or eroding instream habitat such as riparian vegetation, river banks or beds.

4 *In locations with multiple layered aquifers, monitoring of a second aquifer above or below the one in which the test well is located is recommended to interpret connection between the aquifers.*

FIGURE 7 *Water discharge during a pumping test*

IS A WATER SAMPLE REQUIRED FOR ANALYSIS?

A pumping test is a good time to collect water quality samples to assess the chemical, physical and bacterial properties of the water. Water samples should be collected when conditions have stabilized (usually near the end of the pumping test). Sanitize the sampling port or bib with isopropyl alcohol or a dilute chlorine solution before collecting a sample, taking care not to introduce the disinfection fluid to the water sample. Consult with the professional responsible for the test or the approving authority (regional health authority or local government) to determine what water quality parameters to analyze. Consult a professional if field measurements are required (e.g., pH, temperature, electrical conductivity, alkalinity, dissolved oxygen and turbidity). Consult with an accredited laboratory for sampling procedures, sampling bottles, coolers and holding times for delivery of water quality samples to the laboratory.

ARE THERE SPECIAL CONDITIONS TO BE AWARE OF WHEN CONDUCTING OR INTERPRETING THE PUMPING TEST?

If **HYDROFRACTURING** (fracking) has been used to increase the productivity of the well, it may advisable to wait up to a week before conducting the pumping test. Hydrofracturing uses large volumes of water (up to 2,000 U.S. gallons or 7.6 m3/ min) that either need to be pumped out or dissipate into the surrounding rock before the pumping test is done. Dissipation effects of hydrofracturing can be checked by measuring the water level immediately after the hydrofracturing has occurred and over subsequent hours or days.

In **FRACTURED BEDROCK AQUIFERS** it is important to know the depth of any major water-bearing fracture(s) (usually found in the driller's well construction report) to:

- ensure the water level is not drawn down below the fracture during the pumping test; and
- enable meaningful interpretation of the pumping test and the well's capacity.

A professional hydrogeologist should be consulted if the major water-bearing fracture(s) are not known.

SMALL UNCONSOLIDATED (SAND AND GRAVEL) AQUIFERS (e.g., covering up to a few km^2 in area) have a limited storage and recharge capacity and are often bounded by low permeability deposits such as silt, clay, till or bedrock (see Figure 8). The drawdown behaviour in the early part of the pumping test may give a falsely optimistic impression of the long-term capacity of the well. The aquifer's limits are reached when the drawdown rate increases noticeably (e.g., an impermeable geologic boundary or barrier may have been reached).

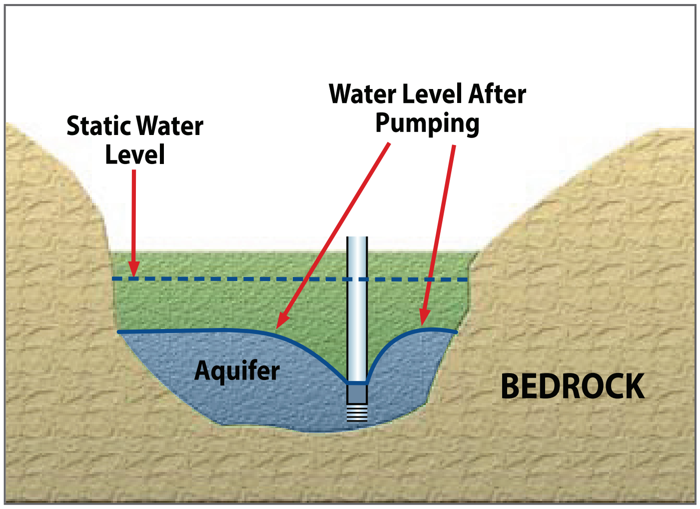

FIGURE 8 *Drawdown behaviour in small unconsolidated unconfined aquifer bounded by bedrock.*

Wells pumped in **COASTAL AQUIFERS** have the potential to be affected by salt water intrusion, particularly where pumping occurs adjacent to the ocean (see Figure 9). In this case, a professional hydrogeologist should be involved. Monitoring a parameter like electrical conductivity, using a field probe or meter, throughout the pumping test will indicate whether salt water intrusion is occurring. For example, when specific conductance has risen to greater than 1,000 micro Siemens per centimetre (µS/cm) or total dissolved solids is greater than 700 mg/L, it is likely salt water intrusion is being initiated. The professional will design the pumping test and determine whether wells (monitoring wells located between the foreshore and faults or fracture zones adjacent to sea water and the pumping well) should be installed, and determine the parameters to monitor where there is a reasonable concern about salt water intrusion. On the advice of a professional hydrogeologist, pumping should be stopped if intruding salt water could affect the water quality in the coastal aquifer.

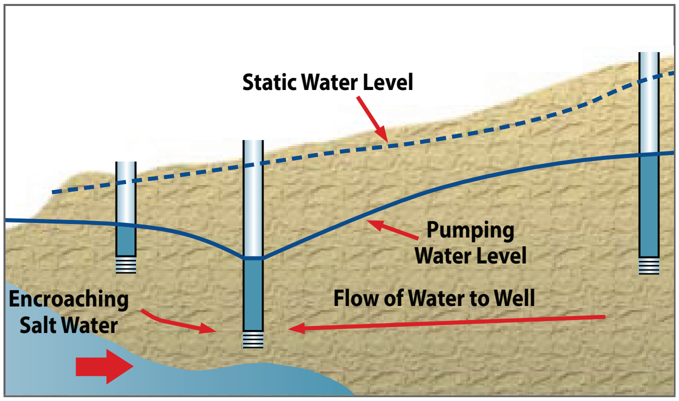

FIGURE 9 *Pumping test of a well adjacent to the ocean.*

WHO CAN INTERPRET PUMPING TEST DATA?

Interpretation of pumping test data must be done by a professional with expertise in hydrogeology when required by an approving agency or when directed in an order of the comptroller, water manager or an engineer. A professional is also recommended for interpreting data in the following situations:

- where the maximum well capacity is needed;
- to assess impacts of the pumping well; or
- when estimates of aquifer properties are needed.

Where pumping tests are conducted solely to provide greater confidence in the driller's estimated well yield, a well driller or well pump installer with competency in pumping test interpretation may be able to interpret the pumping test data.

WHAT SHOULD BE IN THE PUMPING TEST REPORT?

The formal report for a pumping test should contain the following:

- information on the wells (the construction report, type of well and, and a diagram showing the locations of the well and any observation wells, etc.);
- information on field procedures and personnel involved in the test (e.g., person responsible for the pumping test, such as a registered well pump installer)
- information on the hydrogeologic setting, including references to mapped aquifers, when available;
- pumping test information, including the date of the pumping test, all data on the pump (type, depth of pump setting, pumping rates, method of flow measurement), observations made during the pumping test, duration of the pumping test, available drawdown, specific capacity, method of water level measurements and water levels/times recorded during the pumping test and recovery period with all measurement units specified;
- analysis and assessment of the pumping test data, including an assessment of the long-term sustainable yield and potential impacts to neighbouring wells and/or streams;
- the professional hydrogeologist's opinion on the short and long-term capacity of the well and its ability to meet the applicable production criteria (e.g., subdivision by-law for private sources, projected demand for water systems);
- assessment of the water quality results, including copies of laboratory results; and
- signature and professional seal of the individual responsible for the report.

FURTHER INFORMATION AND RESOURCES ON PUMPING TESTS

BOOKS

Sterrett, R. J. 2007. Groundwater and Wells, 3rd edition. New Brighton: Johnson Screens

INTERNET RESOURCES

Listing of Groundwater Consultants in BC *https://www.egbc.ca/Member-Directories/Membership-Directory*

Province of British Columbia Pumping Test Report form: *www.env.gov.bc.ca/wsd/plan_protect_sustain/groundwater/ brochures_forms.html*

Guidance document on conducting pumping tests for wells requiring a Certificate of Public Convenience and Necessity (CPCN): *http://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/water-rights/water-utilities/cpcn_appen5_guidelines_for_groundwater_reports_and__well_testing.pdf*

Guidance for Technical Assessment Requirements in Support of an Application for Groundwater Use in British Columbia: *https://a100.gov.bc.ca/pub/acat/documents/r50847/GW_TAG_Aug2020_1605220217068_5216198940.pdf*

Registers of well drillers and pump installers: *https://www2.gov.bc.ca/gov/content/environment/air-land-water/water/groundwater-wells-aquifers/groundwater-wells/information-for-well-drillers-well-pump-installers*

IMapBC: *http://www2.gov.bc.ca/gov/content/data/geographic-data-services/web-based-mapping/imapbc*

Provincial Acts and Regulations for water: *https://www2.gov.bc.ca/gov/content/environment/air-land-water/water/laws-rules*

British Columbia

The British Columbia Ground Water Association

Agriculture and Agri-Food Canada Agriculture et Agroalimentaire Canada