

**WAT-G-076**

**EASR Guidance: Pumping test information to support a permit application for a groundwater abstraction**

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# Purpose

This document provides information and guidance for anyone undertaking a pumping test in order to gain information to support an abstraction permit application authorised under The Environmental Authorisations (Scotland) Regulations.

For example, a pumping test may be required to gather evidence that there will not be an impact on a nearby water supply.

Before you carry out any testing you will need to have:

* Undertaken a water features survey to identify any sensitive water features.
* Checked with SEPA what information that they need from you to support your abstraction application.
* Obtained any necessary EASR Authorisation, GBR, registration or permit, to conduct the test pumping.

# What is a pumping test?

To determine the impact on other water feature you will normally conduct a constant rate pumping test at the proposed maximum abstraction rate. The data from the test pumping allows an estimation of aquifer characteristics to be made. These characteristics can then be used to predict the impact of the abstraction on water features through calculation or modelling. The pumping test may also provide direct evidence of short term impact through monitoring of these water features.

On completion of the pumping test, a further period of monitoring will be required, during which time groundwater levels should recover towards their original pre-test levels. Monitoring of the abstraction borehole and other features should continue over the recovery period. The data from the recovery period can also be analysed to determine aquifer characteristics. This data can be of better quality than that obtained during the pumping test as the pumping rate, which can vary slightly, will not affect the results. Furthermore, it provides a second data set to supplement the pumping phase data, should this be inadequate.

# When to monitor

Monitoring may be required for three stages in the test pumping process:

* Pre-pumping test (or baseline).
* During the pumping test and following the test as water levels recover.
* Long-term monitoring may also be required in a few cases.

## 3.1 Before the test starts

Baseline monitoring is necessary to establish the conditions that exist prior to the pumping test so that any effects caused by the abstraction can be assessed. A number of factors can cause fluctuations in groundwater levels in addition to an abstraction and the baseline monitoring should aim to characterise these effects where possible. These effects may be caused by changes in the hydrological, hydrogeological and climatological regimes. These fluctuations may be periodic or singular.

Borehole construction and development should be completed before monitoring for the pumping test begins and sufficient time must be allowed for equilibrium conditions to be established. This may be 3 -7 days for boreholes without development but may require significantly longer for boreholes where there has been development to increase yield. Monitoring of level and/or quality should be used to establish when equilibrium conditions have been achieved.

The pumping test should begin immediately after completion of the baseline monitoring period to provide a continuous and comparable data record. In situations where a baseline monitoring period has been chosen to ensure other impacts on the aquifer are minimised (e.g. when other abstractions are not operational), and these cannot be achieved immediately before the pumping test, baseline monitoring should continue from the preferred period to the start of the test.

## 3.2 During and following the test

This will require monitoring of the same features as the baseline monitoring but the frequency will be increased for some parameters. It should continue for the full period of the pumping and recovery test.

## 3.3 Timing of Pumping Tests

Ideally, pumping tests should take place only under conditions that will maximise the quality of the data collected. For example rapidly changing conditions, such as when groundwater levels respond rapidly to significant rainfall events (e.g. in fissured or very shallow aquifers), may be an inappropriate time for testing. However, we know that weather and other conditions can change rapidly and this is not always possible.

# What should be monitored

You should always monitor:

* **Pumping rate**

The constant rate test should be pumped at a discharge equal to the maximum abstraction rate applied for. The rate that water is pumped from the abstraction borehole must be measured accurately. Ideally, two forms of independent measurement should be used to ensure the accuracy of the readings. Typical measurement devices include inline meters, weir tanks and containers of known volume.

* **Groundwater Level**

Groundwater level (depth below a fixed datum) will always need to be monitored in the pumping well and in all observation wells if available.

Groundwater levels fluctuate as a response to natural or anthropogenic influences. It is important to identify and measure these fluctuations to be able to make compensation for them in the pumping test data. The depth to groundwater from a common datum, preferably Ordnance Datum, should be measured as accurately as possible but at least to the nearest centimetre. Groundwater Level can be measured using manual or automatic measurement devices. Water level dippers are a common form of manual measuring device. These consist of a probe attached to a measuring tape. The probe is sensitive to water so that when the water table is intercepted a light (and/or buzzer) is activated. Automatic water level devices take a number of forms. Amongst the most common are pressure transducers with data loggers. These measure changes in water pressure, due to differences in the water table elevation, to measure water level. The rating of the device should ensure the greatest accuracy in water level measurement possible. Pressure transducer water level measurements should be validated with manual measurements periodically.

You may also need to monitor:

* **The flow/level in ponds, springs or wetland with an outflow or watercourses if there is a risk of reducing such flow.**

Flow monitoring should be undertaken using a weir or flume, as appropriate, that allows the reliable measure of at least 10% of the test pumping rate e.g. if the pumping rate is 100 m3 /day, the equipment should be capable of measuring flows in the surface water of 10 m3 /day. If measurement is to be made manually, 10% should represent a change in water level in the weir or flume of at least 0.5cm.

It may be difficult or impossible to measure the impacts of an abstraction upon a river or stream where the flow is large compared to the abstraction volume during a pumping test. In many cases the impact may not become apparent for a period much longer than the duration of the pumping test. Generally, we rely on other forms of information to determine the impact on a river rather than a reduction in river flow.

* **The height above/below a fixed datum of any nearby ponds or wetlands with no outflow.**

Water level monitoring should be undertaken using a gauge board or a stilling well / piezometer (screened over a minimum of one metre beginning approximately 50cm above the base of the water body), with a common datum, preferably Ordnance Datum. The piezometer may be installed within or close to the surface water body to be monitored, provided that the screened interval is in close hydraulic continuity with the pond or wetland.

For wetlands water level monitoring should be undertaken using two piezometers, screened between approximately 0.75 and 2.0 metres below ground surface. The piezometers must have a common datum, preferably Ordnance Datum.

* **The height above/below a datum of any tides. This may be needed for abstractions near to the coastline.**

You can obtain this information from the internet.

* **The pumping regime of other local abstractions (volume, times and duration).**

If there are local abstractions that are not continuously pumped at a constant rate, fluctuations in groundwater levels will occur. These may render the monitoring and pumping test measurements difficult or impossible to interpret. The abstraction regime of all local abstractions should be examined to determine those that are intermittent. It may be possible to arrange for a stable pumping regime from these during the period covered by the baseline monitoring, pumping test and recovery period. Alternatively, the baseline monitoring period or frequency should be chosen so as to eliminate these fluctuations by taking measurements when the full effect of the local regime is apparent so that the monitoring measurements include any effects of the other abstraction(s). Details of the pumping regime(s) (volume and duration) should be collected if possible and submitted with the pumping test and monitoring results. The use of data loggers may overcome difficulties in timing readings.

* **Rainfall amount, usually mm/day and barometric Pressure (Pascals or mbars)**

Local and regional effects of rainfall may cause changes in groundwater levels. Barometric pressure is normally only required for confined or partially confined aquifers.

Changes in barometric pressure are invariably regional although localised low pressure events are not unknown (tornados). Rainfall and barometric pressure data is collected by the Meteorological Office and data from their nearest station can be used, providing climatic conditions at the weather station are similar to those at the abstraction site. It should be remembered that topography and latitude are important causes of rainfall and barometric pressure variations. These aspects should be considered when comparing the weather station and abstraction sites. A custom weather station that will measure rainfall and barometric pressure may need to be used where local conditions vary greatly from the nearest Met Office station.

* **Water quality. For example, where there is a risk of saline intrusion.**

Where the groundwater abstraction has been predicted to intercept a zone of potential saline intrusion, or the boundary of formations containing water of different chemical composition, you may need to test the abstracted water for applicable parameters depending on the nature of the different quality groundwater. The chemical testing entails the measurement of electrical conductivity (EC) or other suitable parameters (chloride, pH, Dissolved Oxygen, etc.) in springs, observation or abstraction wells, and groundwater supported features. Some parameters, such as EC, pH and Dissolved Oxygen, require on-site measurement; others (e.g. chloride) may be tested on-site or in a laboratory. Where possible, continuous on-site measurement is preferred. The applicant should ensure that any water sampled or tested is representative of the local groundwater conditions. This is particularly important when sampling observation boreholes or abstraction boreholes that are not operational during the monitoring period. Purging of between three and five borehole volumes is usually considered sufficient to remove stagnant water, although this may not always be the case. However, when considering saline intrusion, downhole logging may be more useful than taking purged samples.

# Monitoring frequency

## 5.1 Accuracy

### 5.1.1 Manual Measurement

Time measurements should be made as accurately as possible but, during the first 10 minutes of pumping an error greater than 5 seconds should be avoided. Borehole level measurements should be accurate to at least 1 cm, stilling well measurements to 0.5mm. Weir flow measurement should be in line with the BS ISO 14686:2003.

### 5.1.2 Automatic Measurement

Where automatic water level measurements are made then the accuracy should be at least as good as for manual measurements.

## 5.2 Monitoring Duration and Frequency

The duration and frequency of monitoring will depend upon the variability of the parameter being measured, some parameters may require a small number of measurements, others may need frequent or continuous measurement for an extended period. The data gathered during the early stages of the monitoring should be reviewed and carefully analysed for periodic fluctuations and the monitoring regime increased, if appropriate, so that it appropriately records changes in levels. The adjustments may require a shorter interval between measurements e.g. from twice daily to 6 hourly, or a change in the time of measurement, e.g. from morning/evening to midday/midnight. The typical frequency and duration of monitoring is indicated in Tables 1 and 2 below. These periods should be regarded as the minimum and may be extended depending on the risk to identified nearby receptors (e.g. other abstractions).

**Table 1: Testing periods**

| **Abstraction rate (m3/d)** | **Pump test duration (days)** | **Recovery period (days)** |
| --- | --- | --- |
|  (days)<500 | 1 | 1 |
| 500-1000 | 2 | 2 |
| 1001-3000 | 4 | 4 |
| 3001-5000 | 7 | 7 |
| >5000 | 10 | 10 |

**Table 2: Monitoring frequency**

| **Parameter for measurement** | **Monitoring frequency pre-test** | **Monitoring frequency during test pumping and recovery**  |
| --- | --- | --- |
| Rainfall | Daily | Daily  |
| Barometric pressure | Twice per day | Twice per day |
| Tides | Each max/min | Each max/min |
| Surface waters | Twice per day | Twice per day |
| Salinity testing | Every 4 hours to see tidal variation | * Hourly for the first 5 hours
* Twice per hour from 6 to 24 hours
* Every 4 hours from 24 hours to 4 days
* Every 6 hours after 4 days
 |
| Groundwater levels in abstraction and observation wells\* | Every 4 hours, including immediately before the pumping starts | * Every 30 seconds for the first 10 minutes
* Every 2 minutes from 10 to 20 minutes
* Every 5 minutes from 20 to 60 minutes
* Every 10 minutes from 60 to 100 minutes
* Every 20 minutes from 100 to 300 minutes
* Every 50 minutes from 300 to 1000 minutes
* Every 100 minutes from 1000 to 3000 minutes
* Every 200 minutes thereafter until completion of the test, unless circumstances require more frequent measurements.
 |
| Level in other observation points Surface waters, wells, and wetlands) | Every 4 hours, including immediately before the pumping starts | * 1 hour prior to startup
* Every 2 hours thereafter.

In the event that drawdown/impact is probable or detected, the period between measurements should be decreased to: * Once every 10 minutes during the first hour.
* Hourly or less thereafter, as appropriate.
 |

\* Time measurements should be made as accurately as possible but, during the first 10 minutes of pumping an error greater than 5 seconds should be avoided.

# 6. Discharge of water

You must consider how best to disposal of the water to avoid polluting the water environment and interfering with the results of the test pumping. For example, the discharge point must be sufficiently distant to prevent recirculation of the water to the aquifer being tested and/or abstraction point.

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