# GEO Field Procedure for Groundwater Gauging and Sampling

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| Field procedure title | Groundwater Gauging and Sampling | | |
| Document reference | FP001 | | |
| Author | Simon Cole | | |
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## 1. Purpose and Scope

This document describes the standard field procedure used by Hydrock for gauging and sampling groundwater.

All work must be undertaken in accordance with the requirements of the project-specific health and safety documents, including the Method Statement and Risk Assessment, and the Construction Phase Plan. .

The key objectives of groundwater sampling are:

- to obtain samples of groundwater that are representative of in-situ groundwater conditions; and
- to minimise changes in groundwater chemistry during sample collection and handling.

Additional requirements apply relating to equipment, clothing and procedures to avoid cross-contamination when samples are to be tested for per and poly-fluoroalkyl substances (PFAS). Hydrock provides specific training and more detailed procedures that apply when sampling for PFAS. Please refer to the Project Director or Manager for more information.

## 2. Selecting Sampling Method

Several different methods are available for groundwater sampling. The method should be selected in consultation with the Project Manager and with input from the Client, where appropriate, taking into account the following considerations:

- Sampling objectives;
- Well geometry, screened interval and depth to groundwater;
- Well yield (known or anticipated, based on geology);
- Methods previously used for sampling the well in question;
- Wastewater collection and disposal requirements; and
- Client requirements.

Wells that contain NAPL (LNAPL and/or DNAPL) should not generally be sampled for groundwater, unless this is specifically instructed. NAPL thickness should be measured at Step 6 if present.

The most common methods and the circumstances in which these methods may be appropriate are as follows:

## 2.1 Low flow purging and sampling (0.5l/min or less).

This is the generally preferred method for sampling to obtain representative groundwater samples (contrary to the guidance in BS ISO 5667-11:2009). Do not use if aquifer transmissivity is too low for a stable water level to be maintained during purging.

The sampling tube inlet must be at the correct depth to ensure that water is sampled from the correct point within the screened zone of the well.

## 2.2 'Traditional' purging and sampling.

This is the purging and sampling method preferred by BS ISO 5667-11:2009. It can be used in most wells unless the aquifer transmissivity is too low, in which case the well may purge 'dry' and a 'grab' sample may have to be collected, or the well sampled later following recovery.

## 2.3 'No purge' sampling using low/micro-flow or passive sampling methods

Use no purge sampling where the well screen is fully saturated and is relatively short (≤2m) or where the sample does not need to be representative of the entire saturated screen (e.g., if a series of samples are being collected at different depths). The method is not suitable for collection of field parameter information (dissolved oxygen, etc) unless a down-hole probe is utilised and is unlikely to be suitable for wells that are screened across the water table (due to potential biogeochemical changes and/or thermal stratification). Sampling should be achieved using very low flow or passive sampling methods (e.g., hydrasleeve).

It should be checked that the method is suitable for the potential contaminants as anything not uniformly distributed in the water column or surrounding groundwater will be targeted or missed depending on the sampling depth chosen.

## 2.4 'Grab' sampling

This method is, by default, often necessary in low aquifer transmissivity conditions where a well becomes 'dry' during traditional or low flow purging. Unlike the "no purge" options above, this can be a partially purged sample when the fully purged sample cannot be taken. It tends to be more associated with unplanned sampling and can simply be taken with a bailer if necessary.

# 3. Standard Procedure

## 3.1 Planning

**Step 1:** Wait for the groundwater monitoring well to equilibrate after installation before sampling. A rule of thumb quoted by EA (2006) and BS5930 is to wait 14 days, however, there is no little scientific basis for this. Actual stabilisation period should be assessed based on the hydrogeological conditions and the installation method and materials used. The well should be developed before the first sampling event (see separate Hydrock procedure for well development).

**Step 2:** Obtain and review available information relating to the construction of the well (in particular its depth and the depth to the top of the screened interval), as well as data from previous gauging or sampling events. This will help guide equipment selection (e.g., length of dip meter tape) and provide an indication of what results might be expected.

Establish the required datum to which well dip measurements should be taken to. This should be a pre-determined datum that has (or will be) surveyed in, is consistent across the wells, will not change over the monitoring period, and is easily identified in the field (this can be top of casing, ground level, or another pre-determined datum).

Determine the required pump/sample tube/bailer inlet depth required to sample water at the required depth within the well. This is specifically important when using low/very low/micro flow sampling methods and when sampling from wells with long screen sections (see here for further information on this latter issue News Story - Sampling in Long-Screened and Open Boreholes ( Parts 1 & 2 ) (in-situ.com)).

To the extent practical, sampling should be planned so that the wells are sampled in order of increasing contaminant concentrations (if prior knowledge is available) to reduce the potential for cross-contamination.

Set out and agree the sampling plan for the works such that all team members are clear on the objectives of the sampling and that the wider project objectives will be met.

Establish required method for collection, handling, storage and disposal of purged water. (See section 3.7).

**Step 3**: Make sure all required field equipment is available and in good working order before arriving at site and that it is calibrated as applicable (refer to equipment manual) prior to use. Where purging and sampling equipment is not dedicated or single use, it must be decontaminated before use at each well using a clean cloth or brush, clean water, and an approved detergent such as Decon-90, or a household plant-based detergent such as Ecover. Refer to Hydrock's Technical Note on PFAS for specific decontamination requirements when sampling for PFAS.

## 3.2 Gauging of fluid levels

**Step 4:** Note well condition (particularly any factors that may compromise or affect the quality of the groundwater sample to be collected e.g., missing cap, cracked seal, surface spill). Record observations in the Groundwater Gauging Record Sheet. ). Where possible a fixed datum is preferable, e.g., for a monitoring well in a grassy field the top of casing datum will be more accurate than referring back to ground level.

**Step 5:** Note the datum used for measuring depths (e.g., ground level, top of casing etc,). (See Step 2).

**Step 6:** Measure the depth to water using an electronic water level indicator ('dip meter') or other suitable device. Fluid depths in any wells in which NAPL has previously been detected or is suspected should be gauged using an electronic interface probe.

If LNAPL is present at the water surface, record the thickness of the LNAPL using the change in the interface meter sound. Note not all dip meters have an interface probe capable of detecting NAPL.

**Step 7** – Measure the depth to the base of the well using the same instrument used for Step 5 above. If DNAPL is present at the base of the well, record the thickness of the DNAPL using the change in the interface meter sound.

TIP: Correct measurement for "dead length" (if any) at tip of probe. This can be measured by comparing the first length value printed on the meter tape with the measurement from the probe tip to that printed value on the tape using a standard tape measure. Note: Not all probes will have a dead length and the dead length does not apply to the water or NAPL interface readings.

Take care to prevent contact of purging and sampling equipment with the ground or with other potential sources of sample contamination.

Step 7 can be undertaken after sampling (particularly for low flow and no-purge methods) if there is specific concern over potential disturbance of fines at the base of the well or mixing of the water column.

If the groundwater at the site is susceptible to short-term fluctuations (e.g., tidally influenced) it is preferable to dip all the wells at the start of the day rather than at the start of sampling at each well.

Make sure measurements are taken to the agreed datum set out in Step 2.

Make sure dip/interface meter is cleaned between boreholes. The importance of this can be lessened by progressing in order from most contaminated to least contaminated boreholes, and is specifically important when meter is contaminated with NAPL or sediment.

Manual fluid gauging can be replaced by automated data loggers if better understanding of temporal change in water levels is required, and/or if required frequency and number of manual measurements is high and use of data loggers would be more cost/time efficient (and with lower carbon footprint).

## 3.3 Purging

### *3.3.1 General*

The chosen purge rate should be less than that used to develop the well and greater than that intended for sampling the groundwater within the well.

### *3.3.2 Low Flow Purging (0.5l/min or less)*

**Step 7:** Select a pump that will minimize disturbance of the water in the borehole column (e.g., peristaltic pump for water levels shallower than 6m or pneumatic bladder pumps for water levels deeper than 6m). The same pump should subsequently be used for sampling without removal to reduce the chance of mixing in the borehole. Do not use peristaltic pumps for water depths greater than 6m due to the risk of significant volatile contaminant degassing even though the operational design depth of the pumps is up to 9m.

**Step 8:** Set the pump intake depth by lowering it slowly into the well to a position midway within the saturated part of the screened interval and record the pump intake depth. Note that different depths may be required depending on the sampling objectives (for example, you may want to have the pump intake 0.5m below the top of water if we are wanting to ascertain the dissolved phase concentration beneath an LNAPL layer). Alternative sampling objectives must be set out in the project/task plan (refer to Step 2). Set the pump rate to between 100ml/min and 300ml/min depending on the expected permeability of aquifer stratum being sampled. Pump rate can be ascertained by measuring water flow in a graduated container as part of Step 9 below.

**Step 9(a):** Monitor wellhead parameters including electrical conductivity, pH, temperature, turbidity, dissolved oxygen and redox potential during purging at fixed intervals (suggested approach is once every three minutes) using a flow-through cell. Attach a short piece of tubing to the outlet of the flow-through cell so that it empties into a bucket. Make sure the flow-through cell is stable and will not easily tip over while purging. Purging should be continued until at least one borehole volume of water has been removed and the wellhead parameter values are stable over three readings[1]. Record wellhead parameter readings on a Groundwater Sampling Record sheet.

TIP: Tilt flow-through cell at 45 degrees to avoid creation of air bubbles which will skew dissolved oxygen readings.

If wellhead parameters do not stabilise, check the borehole volume and pump rate to confirm that sufficient time has elapsed to remove at least one borehole volume of groundwater from the well. Check well design (targeted stratum and well screen interval) and that depth to pump inlet corresponds to this. Adjust if necessary and continue to purge until wellhead parameters stabilise or three borehole volumes are removed (whichever is sooner).

**Step 9(b):** Monitor the groundwater level during purging to confirm that it remains stable. If the groundwater level continues to fall during purging, the purge rate should be reduced. If it is not possible to maintain a stable groundwater level the well is not suitable for low flow purging and the sample that is obtained should be considered a 'grab' sample, or the well left to recover before sampling.

### *3.3.3 'Traditional' Purging*

**Step 7:** Purge the borehole by pumping or bailing using dedicated or decontaminated equipment. Acceptable pumps for purging include pneumatic pumps, inertial, electric submersible, peristaltic, diaphragm and centrifugal pumps.

[1] Note that BS ISO 5667-11:2009 requires a purge volume of 3 well-volumes in most instances unless alternative strategies can be justified by comparative trials. 1 x borehole volume and time purge based on hydraulic properties are two alternatives in BS ISO 5667. Combining the two is a pragmatic approach in most instances in the absence of site-specific comparative trials. This may be impractical for deep wells with large well volumes, in which case an alternative method should be justified.

**Step 8(a):** Monitor wellhead parameters including electrical conductivity, pH, temperature and turbidity, dissolved oxygen and redox potential at fixed time intervals (suggested approach is once every three minutes) using grab samples of purged water to record changes in water quality with time and to check the degree to which they have stabilised prior to collection of the groundwater sample. This cannot be done using a flow-through cell and is best achieved by carefully pouring a purged sample of water into a 500,ml clean plastic container held at 45 degrees to minimise water aeration and then testing the water sample using the multi-parameter water quality meter.

Continue purging until at least three borehole volumes of water have been removed and wellhead parameters are stable. Record wellhead parameter readings on a Groundwater Sampling Record sheet.

If wellhead parameters do not stabilise, check the borehole volume and pump rate calculations to confirm that at least three borehole volumes have been purged. Record the final wellhead parameter readings after three borehole volumes have been purged and make a note that readings had not stabilised and whether they were increasing or decreasing.

If using bailers, measure water parameters only at the beginning and end of purging as level of water disturbance created by bailing makes intermediate water quality testing unhelpful.

**Step 8(b):** Monitor drawdown during purging. Where drawdown does not stabilise, dewater the well and, where the well-screen was initially fully saturated, allow water level to recover above the screened interval before sampling; otherwise allow water level to recover to 50% of static level before sampling.

Purging should continue until the differences between successive sets of field parameters, taken at intervals of at least 3 minutes are within the following criteria (based on CL:AIRE, 2008):

pH: ± 0.2

EC: ± 3%

Redox: ± 20 mV

DO: ± 10% or ±0.2mg/l whichever is greater

Temperature: 0.2°C

Turbidity: ± 10%

### *3.3.4 'No Purge' Sampling*

No purging of the well is required. For this technique a volume of water equal to the volume of the sample tubing should be drawn out prior to taking a sample of water for subsequent laboratory testing.

## 3.4 Groundwater Sampling

A fresh pair of nitrile gloves should be used at each borehole to prevent cross-contamination.

**Step 10:** Sampling should be conducted as soon as practicable following purging, and at a lower flow rate than used in purging. Prior to collecting the sample, the flow-through cell should be disconnected, and the sample collected directly from the purge tubing.

If the sample is being collected using a 'no purge' sampling method, the manufacturer's recommended methodology should be used for deploying the equipment and collecting the sample. The basis of low flow no purge sampling is that water is sampled so slowly that recharge from the surrounding ground occurs instead of from the water column in the well. To use this technique, the sample must be taken at the correct depth to ensure it is within the desired point in the screened zone of the well.

Samples should be collected with minimal turbulence and aeration into appropriately prepared bottles or vials supplied by the laboratory and should be free of air bubbles. Bottles containing samples for analysis

of volatile compounds should be filled to the top including a meniscus before the cap is put on, to avoid the presence of air bubbles in the sample bottle.

Samples that need to be filtered on site (e.g., samples for analysis of metals, sulphide or cyanide) should be filtered using a filtration unit fitted with a dedicated sample-specific high capacity 0.45-micron filter and then transferred to a plastic sample bottle, as supplied by the laboratory with appropriate preservative). On-site filtration is essential when the sample bottles contain preservatives, otherwise the preservatives may dissolve sediment from the sample and produce unrepresentative results.

TIP: check specific laboratory sampling requirements before sampling as these vary between laboratories. i2 does not require preservation or filtering as standard.

Sample bottles should be labelled using a unique identifier and stored in insulated cool boxes containing bags of ice (water ice is much more effective than frozen blue ice packs). The ice should be present prior to sample collection and should be double bagged to reduce the chance of water leakage into the cool box. A chain-of-custody form must be kept with the samples, recording the sample type, sampling time, date and required analysis. This form should also be used to record the handover of the samples. All samples should be transferred by same-day or overnight courier to the laboratory (generally within 24 hours of sampling if volatile chemicals are being tested for) in the sealed insulated cool boxes.

## 3.5 QA/QC Samples

QA/QC samples must be kept with the primary samples while on site and during transport to the laboratory. Various types and numbers of QA/QC samples may be required depending on the project scope and objectives. These include:

- Field duplicate and triplicate samples. These should be collected in the same manner and at the same time as the primary samples.
- Field blank (also referred to as equipment blank) samples.
- Trip blank samples. Where required (e.g., when volatile contaminants are being tested for), trip blanks will be supplied by the laboratory. Transport them to site in the cool box, keep them with the samples and then transport them back to the laboratory with the samples.

Refer to the separate Hydrock Technical Note on sample and laboratory QA/QC.

## 3.6 Post-Sampling

**Step 11**: If using no purge or low flow sampling, dip base of well if not done at Step 7. (See Step 7 tip re: tape dead length correction)

**Step 12**: Replace well cap and lock and leave the area around the well in a tidy condition. Ensure all relevant information has been recorded on the gauging or sampling record sheet.

**Step 13:** Dispose of all sampling wastes in accordance with the project waste management plan.

**Step 14:** Decontaminate all re-usable sampling equipment between sampling locations in accordance with the project-agreed method.

## 3.7 Disposal of Purge Water

All purge water should be collected in suitable containers (such as sealable drums or IBC) where required (see below) and disposed of in accordance with the project waste management plan. You will likely require a laboratory test certificate for chemical testing of the water prior to disposal being accepted. Therefore ensure a representative sample of the extracted water is taken and submitted for relevant chemical analysis to support disposal arrangements.

Clean, uncontaminated water can often be discharged at surface near to the well (think typical greenfield site) or via existing surface water drainage systems if permitted. Contaminated water that will contaminate surface ground should be collected and suitably disposed of off-site.

## 3.8 Terms and Definitions

Well yield: the amount of water that can be pumped from a given well per unit of time.

Well screen: slotted pipe which enables infiltration of groundwater.

Purging: the process of removing stagnant water from a well, immediately prior to sampling, causing its replacement by groundwater from the adjacent formation that is representative of actual aquifer conditions.

Dip meter: equipment used to determine the water level within a borehole, piezometer or pipe.

Digital interface probe: equipment used to determine the presence and thickness of LNAPL or DNAPL present in the water column within the monitoring well.

Trip blank: a set of sample containers filled with analyte-free water that originates in the environmental laboratory, travels to the field site and remains unopened. This blank checks for potential contamination sources in sample container preparation, method blank water, and sample transport.

Field duplicate: A field duplicate is a duplicate sample collected at the same place, at the same time. It is used to estimate sampling and laboratory analysis precision.

Field blank: a set of sample containers filled with analyte-free water supplied separately by the laboratory. This water is sampled using the field equipment used to sample groundwater. Field blanks assess potential contamination from field equipment that comes into contact with samples.

Well volume: Calculation of well (purge) volume (based on BS ISO 5667-11 Figure 1)

$$V = 3000\left(\frac{\pi}{4}\right) {d_B}^2 L$$

dB = diameter of the borehole (m)

L = length of zone from which sample is drawn (i.e. screen interval/length of filter pack) (m)

V = well volume (litres)

## 4. References

BS ISO 5667-11:2009. Water quality – Sampling. Part 11: Guidance on sampling of groundwaters.

BS5930:2015+A1:2020 Code of Practice for Ground Investigations.

Environment Agency, 2006. Guidance on the design and installation of groundwater quality monitoring points. Science Report SC020093.

Environment Agency, 2003. Guidance on monitoring of landfill leachate, groundwater and surface water. LFTGN02.

CL:AIRE, 2008. Principles and Practice for the collection of representative groundwater samples. Technical Bulletin TB3

Nuclear Industry Group for Land Quality, 2015. Nuclear Industry Code of Practice for Routine Water Quality Monitoring Version 1, February 2015.

## 5. Records

Groundwater Gauging Record Sheet; and

Groundwater Sampling Record Sheet

## 6. Attachments

Attachment 1 - Decision Support Flowchart for Groundwater Sampling Method Selection

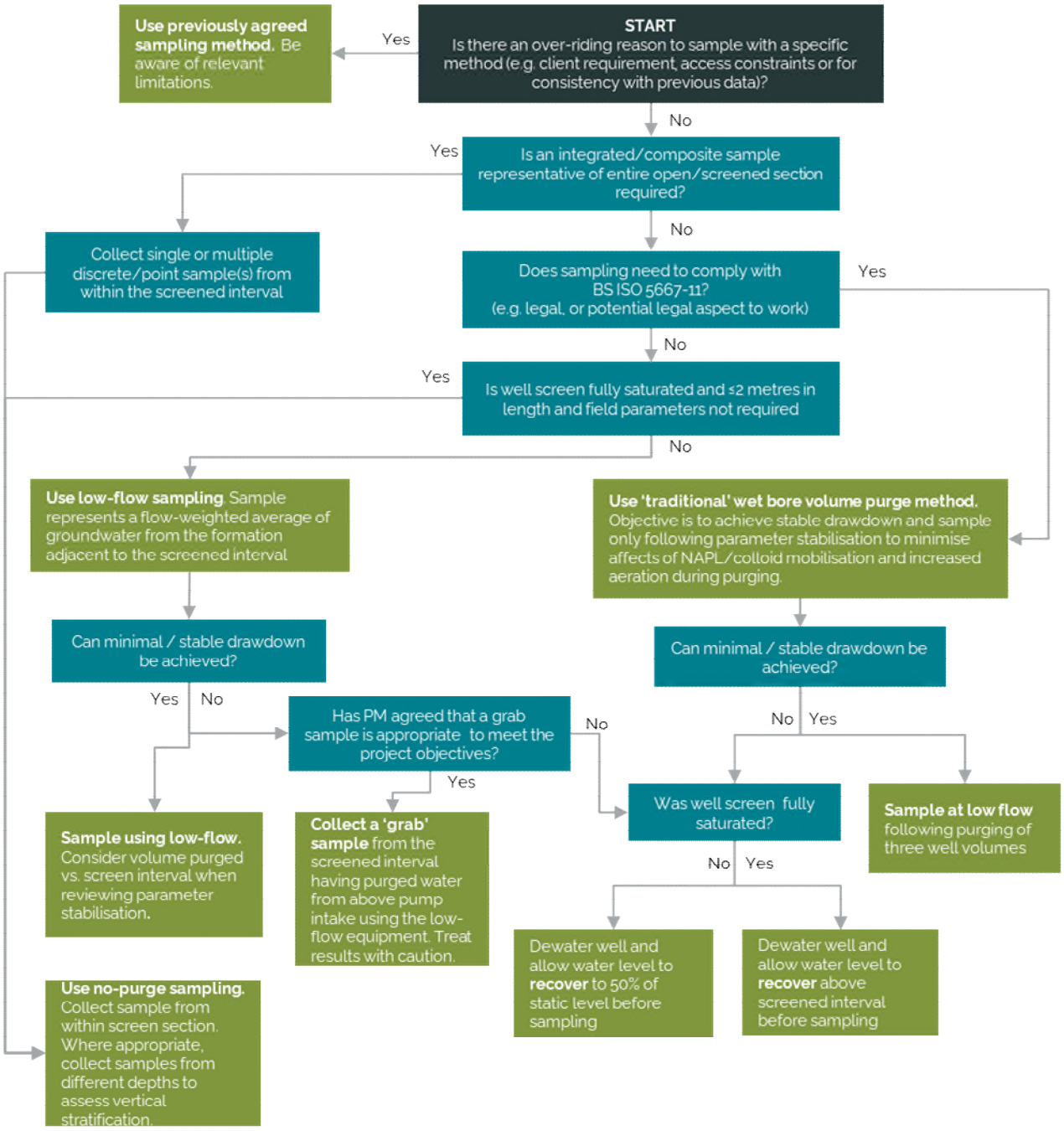
Attachment 2 - recommended equipment

## 7. Revision No.

| Rev # | Change Date | Description of Change | Location of Change |
|---|---|---|---|
| 01 | 15/02/2013 | Additional note on importance of vertical flow in wells with long screen sections and depth positioning of sampler inlet | s.3.1 Step 2 |
| | | | |
| | | | |

ATTACHMENT 1

## Decision Support Flowchart for Groundwater Sampling Method Selection



ATTACHMENT 2 – Recommended equipment

| Manufacturer | UK hire/purchase | Other info |
|---|---|---|
| Peristaltic pumps \| Royal Eijkelkamp | Peristaltic Pump (Advanced) \| My VanWalt | Eijkelkamp Peristaltic pump 12 VDC Advanced Manual (geotechenv.com)<br><br>Eijkelkamp-12.25-Peristaltic-Pump.pdf (ashtead-technology.com) |
| Waterra Groundwater Sampling Pump - Waterra Pumps Limited | Inertial Pump (in-situ.com) | Inertial Pumps new.pub (in-situ.com) |
| 12V Submersible Pump (solinst.com) | | 12V Submersible Pump Operating Instructions (solinst.com) |
| ProDSS Multiparameter Digital Water Quality Meter \| ysi.com | Water Level Meter & Data Logger Rental for Groundwater & Rivers (rshydro.co.uk)<br><br>YSI ProQuatro handheld multiparameter water quality field instrument (vanwalt.com) | |
| Aqua TROLL 500 Multiparameter Sonde - In-Situ | Water Quality Multiparameter Sondes \| Multiprobes (in-situ.com) | |