


Research equipment for Soil and Groundwater Remediation

from Eijkelkamp Agrisearch Equipment



All it takes for
environmental research





In this brochure you can find research equipment from Eijkelkamp Agrisearch Equipment that you can use for environmental research prior to or during soil and groundwater remediation projects. Eijkelkamp is continually extending its range of products with equipment intended for remediation projects. To this aim, we maintain close contact with experts in the field of remediation, such as the Wageningen University.



Dr. Ir. Grotenhuis, university lecturer at the Department of Environmental Technology at the Wageningen University explains: "In the 'eighties, the standard method of decontaminating groundwater was to simply pump it up and treat it. Contaminated ground was excavated and transported to a soil-washing plant or a thermal decontamination unit, or was biologically decontaminated by landfarming. Furthermore, soil that could not be decontaminated was dispatched to a controlled landfill. However, in the 'nineties, the range of soil remediation techniques expanded considerably. In addition in the mid 'nineties, the policy in the area of soil remediation changed. As the method of decontamination used then was very expensive, the focus started to move to alleviating the risks instead of completely excavating the contamination. It goes without saying that it is very important to ensure that water or soil contamination is not allowed to spread and become a hazard to man and the environment."

During remediation activities, measurements are taken to determine the degree to which the contamination has diminished in the groundwater or soil. As these measurements are often carried out at just one moment, the results only give limited information about the contamination at the contaminated locations. Dr. Ir. Grotenhuis indicates that there are new developments in the use of passive samplers and on-line monitoring, which can be used to gain a more reliable impression over a longer period. After all the Dutch saying 'to measure is to know' applies, according to Grotenhuis. The situation should preferably be monitored for between three months and a year. On the one hand, this should give better insight into the average concentrations and on the other, using on-line monitoring, a better impression can be gained of the extremes in these concentrations. In short: this will make the measurement results more reliable and more consideration can be given to the actions that must be taken by the soil remediation team. Grotenhuis: "Incidentally, the authority to decide about soil remediation projects is nowadays increasingly being delegated to the more local authorities. However, at the local level, very little knowledge is available in this area. For this reason, the Wageningen University is developing courses to train, for instance, municipal employees in the area of groundwater and soil research and in the development of new and better soil remediation techniques."

With respect to legislation and standards in the area of soil remediation, Grotenhuis says the following: "In the 'eighties, the Netherlands was number one with respect to legislation and standards. In the 'nineties, Germany, Canada and the US caught up. In the last decade, within the Netherlands the environmental theme was 'out of fashion', and it attracted less money. At the end of 2006, the European Parliament started to develop the European Soil Strategy. Seven countries in the EU already have a soil policy, the remaining countries so far have not. A 'framework directive for water' exists, which of course also applies to the groundwater. As contaminated groundwater also affects the soil, the framework directive is certainly important when dealing with soil remediation."

Soil remediation techniques

When carrying out environmental research, it becomes clear whether the soil is contaminated. Dependent among other things on the seriousness of the contamination and the use that will be made of the land, it is decided whether the soil needs remediation and which technique will be used.

Techniques for soil remediation can globally be applied in three ways:

- 1. In situ:** contaminating substances are removed on site, without excavating the soil;
- 2. On site:** contaminated soil is excavated, decontaminated on site and returned to the original location;
- 3. Ex situ:** contaminated soil is excavated and transported for treatment / processing elsewhere;

A number of techniques for soil and or groundwater remediation are explained in brief below:

Bio screens

Screens some tens of centimetres thick are created perpendicular to the groundwater flow in which the biological circumstances for micro-organisms are optimised. Contamination in the groundwater flowing through the screens is in this way removed.

Venting (soil vapour extraction)

Vapour is extracted from the soil and as a result volatile substances are removed. Both the soil and the (upper layer of) groundwater can be decontaminated in this way by continually replenishing the air in the soil. The extracted vapour is decontaminated above ground.

Bio venting

This technique is a variant of soil vapour extraction, with the contamination in the unsaturated zone being biologically broken down into innocuous products.

In situ chemical oxidation

An oxidation agent (e.g. hydrogen peroxide, potassium permanganate or ozone) is injected into the soil. This reacts with the contamination, causing it to decompose into natural, innocuous substances.

Electro reclamation

Using electrodes an ion flow is started in the soil with which heavy metals can be removed. At the same time the heating stimulates accelerated decay or vaporisation of organic substances.

Flotation

Excavated soil can be physically decontaminated by blowing a jet of gas through a contaminated slurry. The contamination binds to additives and forms a foam layer. The contaminated foam layer that contains the highly-concentrated contamination is subsequently removed.





Landfarming

Soil is being excavated and treated aboveground in such a way that circumstances for decontamination are optimized.

Natural decay

Natural processes ensure the decay of the contamination, while monitoring ensures that the contamination is not spreading. Here it is important that the risks associated with the contamination are thoroughly assessed, taking into account the local circumstances and the possible external influences (such as changing weather conditions).

Pump and treat

The groundwater is pumped up and treated in a treatment plant. The purified water is then discharged to the sewer system or to surface water.

Thermal decontamination

Excavated soil is heated so that contamination evaporates. The contamination is subsequently incinerated in a separate unit.



Equipment from Eijkelkamp Agrisearch Equipment

Eijkelkamp Agrisearch Equipment offers a wide range of equipment that can be used for environmental research and for monitoring soil remediation projects. Eijkelkamp continually works on the development of equipment for the actual execution of soil and groundwater remediation projects. New in our product range are two specific soil remediation pumps and two types of skimmer. You can read more about this in Chapter 4: Remediation pumps.

This brochure contains a selection of our equipment related to soil remediation projects, divided into the following categories:

- 1. Measuring**
- 2. Sampling**
- 3. Monitoring and telemetry**
- 4. Remediation pumps**

1. MEASURING (in soil and groundwater)

1.1 Physical measurements

Oil detection pan

Oil on water gives an oil slick, often displaying beautiful colours. The oil detection pan uses this effect. By placing soil in water in one pan and then by separating the water from the soil by pouring it into the other pan, it can be determined very effectively to which contamination class the oil-bearing soil belongs. The consequence is a more economic and accurate decontamination process.



Digital thermometer with long probes

Eijkelkamp's digital thermometer can read out probes with lengths of 50, 100 or 150 cm. In soft soils it can directly be pushed in, otherwise a gouge must first be used to make a hole.



Particle size analysis set

Using our equipment for determining particle sizes and particle size distribution (sand rulers, mini hand sieves sets, laboratory sieve shaker, lutum content determination equipment), the particle size distribution can be determined, allowing the physical chemical properties to be determined that will have an influence on the soil remediation technique selected.



Sounding apparatus for water and floating layer thickness meter with acoustic and light signal

Water level sensors for manual measurements are available with a cable length of 10 to several hundreds of metres. Acoustic and light signals indicate the water level. The probe of the much smarter floating layer thickness meter can, based on an infrared light signal and the electrical conductivity, make a distinction between water, air and sunk or floating (chlorinated) hydrocarbons. Read-out in mm, standard length of the measuring tape is 30 m.



1.2 Chemical analyses

Reflectometer RQ-flex

The portable reflectometer RQ-flex can be used to measure various water-borne anions and cations. Simple-to-use test strips are accurately read photometrically.

Multimeter for pH/redox/EC/salt/T/O₂

A Multimeter belongs to the basic set of instruments if you want to determine the preconditions for the soil remediation techniques to be used. When carrying out groundwater measurements, the Multimeter can most effectively be used via our flow-through cell, to prevent erroneous measurements of dissolved oxygen or redox. When taking soil measurements (electrical conductivity; redox; pH), for redox an in situ measurement (probes of up to 70-cm long are available) is preferably chosen or otherwise a sample is taken using a core sampler.

Flow-through cell

The flow-through cell considerably simplifies taking electrochemical measurements of, for instance, pH, redox, electrical conductivity, temperature and O₂. But in particular it ensures that the O₂ and redox measurements are reliable. This is because the electrodes take measurements in water that has not yet come in contact with the air. The cell can be simply disassembled and cleaned.

Oxygen availability in the soil

A pricking probe (1 m long) and a special air oxygen meter can be used to determine the oxygen available for soil life.

Oxygen diffusion meter

The oxygen diffusion meter is a scientific instrument that can give an indication of the speed at which O₂ moves through the soil. In addition, the instrument contains a redox measurement probe that can be used to determine redox up to a soil depth of 70 cm.

1.3 Water and air permeability of the soil

The permeability of the soil determines for a large part the distribution speed of mobile contamination or the speed at which the soil remediation activities are having a result. Eijkelkamp supplies field methods and a method that measures permeability based on samples.



K-Sat in situ permeameter

The K-sat in situ permeameter is a device that can be used to collect data directly in the field that can be used to determine the water permeability of separate soil layers in the unsaturated zone. The device exerts a constant pressure on water in a borehole and measures the subsequent water consumption.



Permeameters for water permeability measurements in the laboratory

Soil samples can be collected in rings (for instance using set 07.53.SC). The rings are fitted to holders in the laboratory and water is flown through them. The volume of water/24 hours is measured and gives the K-value for that soil layer. The K-value can be used in calculations to determine the density of an extraction or injection network to filters.



Borehole method

Using the borehole method (also called the 'Hooghoudt' method), the water permeability of the soil can be determined in the field for a maximum of two layers under the groundwater level (to a depth of approximately 4.5 m).



Air permeameter

The water permeability can be derived from the determined air permeability. The air permeability can be used to determine the density of an air injection or air extraction network. Using the built-in moisture content meter, the percentage of pores that does not contribute to the air permeability can be determined.



1.4 Soil moisture and salinity

Salt concentrations can directly result in a degree of contamination (cyanides, minerals). Soil moisture percentages are an indicator for the survival rate of micro-organisms such as bacteria or fungi. To measure this we have hand-held meters as well as automatic loggers.

e+ SOIL MCT

The e+ SOIL MCT is a sensor that can (semi-)permanently be installed in the soil and that measures the moisture content, electrical conductivity and temperature, stores the data and forwards it to an end user anywhere in the world via the e-SENSE telemetry system. The MCT logger/sensors are available in various lengths and can work unattended for months. Of course it must be determined in advance whether the contamination affects the MCT sensors (high-quality stainless steel 316), also in the long term.

EC-probe for soil salinity measurements, standard set for measurements to a depth of 1 m

Just like the MCT, the EC-probe measures the "bulk soil conductivity": the total effect of conductivity of any contaminated soil particles and the contaminated water in the pores. The value is measured at the tip of a robust probe. The temperature is of major importance when calculating the conductivity, it is measured simultaneously with the conductivity at the tip of the probe.

Soil moisture meter with Thetaprobe

Pricking and measuring directly, that is the motto for the Thetaprobe soil moisture measurement. The read-out gives a volumetric moisture percentage. An extension rod can be mounted to the sensor to be able to take measurements at the bottom of boreholes. The soil moisture content determines whether micro-organisms or fungi can optimally clear up the organic contamination in the soil.

2. SAMPLING (of soil, water and beds of lakes and water courses)

2.1 Sampling of soil-like material

Auger set for heterogeneous soils

The diversity of our auger sets ensures that you can almost always reach the required depth and therefore that you can bore effectively, describe the soil profile and take samples. Available with bayonet (rapid) or conical threaded connection (more rigid, hammering possible). Using this equipment, borehole depths of 8-10 metres are actually achievable. Using the piston sampler it is even possible to take a 75-cm sample (optional 200 cm) in water-saturated sand.

Single gouge auger set for hard soil

This set contains a gouge that can be used problem free in hard or stony soil layers. The gouge is worked into the soil using an impact absorbing hammer. The set, supplied in a carrying bag, can be used for a rapid exploration of soil profiles or for searching for residual contamination.

Soil coring kit for chemical soil research

Taking soil samples to determine the possible presence of very volatile components such as benzene, toluene, xylene and chlorinated hydrocarbons must be done using a coring device that prevents the sample being exposed to air, as occurs when using an auger or gouge (also when the sample is put directly into methanol). When stored, the empty room in the core sampler ("head-space") is filled with a filling block and the sampler is cooled (for a period of up to 48 hours) or frozen to -7°C (for a period of up to 2 weeks).

Akkerman core sampler, standard set

Using the Akkerman core sampler, much larger samples can be taken, also in stainless steel sample tubes. Can be used in boreholes or casings up to a maximum depth of 50 m.

Percussion gouge set for heterogeneous soils with gasoline-powered Cobra TT percussion hammer

Where hand augers and flighted augers are difficult or impossible to use (lots of rubble, stone), the percussion gouge comes into its own. Gouges with diameters between 40 and 100 mm allow holes to be made in steps, which contributes considerably to the speed of working. In addition, uncontaminated samples are obtained from less deep layers that were previously bored.

Entirely hydraulic percussion gouge installation on caterpillar tracks for all terrains

If you need to make many boreholes per location, even percussion gouging is heavy going. A small manoeuvrable caterpillar-tracked vehicle with a hydraulic percussion hammer and extraction jack mounted to it can then be ideal to meet the requirements of greater impact power, extraction power and ergonomics.

AquaLock sampler

The AquaLock sampler is a heavy-duty soil sampler for special use using a sonic vibrating drilling machine or machine ram hammer. The sampler can be supplied in lengths of 1 to 4 metres and supplies cores of 50 or 70 mm diameter. The piston in the head can be vibrated straight through the soil layers and be opened at depth, often several tens of metres deep. Once retrieved, the sample is pressed out using water pressure.





2.2 Monitoring wells, extraction and injection filters

Quality monitoring well pipe

The quality monitoring well pipe is easy to install and supplies water for years without problem, as long as the soil itself is somewhat permeable to water. The monitoring well pipe works with a ready-to-use filter section that is suitable for sampling all types of contamination. We apply bentonite in advance to plain pipes. Therefore the bentonite is always in the right place and does not come up with the pipe. Usable for pipes and boreholes up to 100 mm in diameter.



HDPE monitoring well pipes

Our PVC monitoring well pipes contain no heavy metals or softeners, but are less suitable for soils strongly contaminated with hydrocarbons. HDPE monitoring well pipes are resistant, do not become brittle in cold weather and are more environmentally friendly than PVC or Teflon. All of our monitoring well pipes have leak tight threaded or socket connections. HDPE monitoring well pipes are used on a large scale for monitoring wells or injection filters.



Direct-Well

The Direct-Well is a smart monitoring well system and is usable in up to 70-mm diameter boreholes or pipes with an internal diameter from 40 mm. The ready-to-use filter is 1 m long and can be used to sample all micro contamination. Very special is that the plain part consists of hose. This means that leaks at pipe connections are a thing of the past and in addition, there is room to string hollow bentonite rods on the hose. After 48 hours, the entire hole is sealed with swollen bentonite. This guarantees that later samples are taken at exactly the right depths. Combined with the Sonic lost cone drilling technique, these filters can be installed at great depths in a very short time. Sampling is possible, also in greater water depths, using a 9 mm ball valve and hose.



Multi Channel Well – MCW

The perfect solution for 3D research. A hose with 3 or 7 parallel channels is fitted at the desired depths with a prefabricated filter and sand bentonite catchers. The catchers isolate the filters in the soil from the bentonite seals, soil layers and filler soil. The pre-mounted hose is slid into the piping (88 mm internal, optionally 100 mm). At the same time, pre-shaped bentonite blocks are stacked between the (maximum 7) filters. When the bentonite has swollen completely (72 hours), sampling can start. You then have 7 monitoring positions in a single borehole, suitable for all analyses and with absolute certainty about the positioning of the filters and in particular the bentonite! Using a number of MCWs in and next to the contaminated area, particularly effective 3D monitoring can occur for many years.

2.3 Water sampling

Bailer sampler

The bailer sampler is a basic tool for everyone who needs to take a water sample from, for instance, a tank, ditch or monitoring well. This can be done to a great depth. The bailer sampler is available in stainless steel, Teflon and disposable PE.



Submersible pump set for priming and sampling monitoring wells up to a depth of 90 m

This submersible pump specially made of Teflon and stainless steel is very powerful. The speed can be reduced to a sampling flow rate (200 ml/min). Sets are available with hose and cable lengths ranging from 20 to 90 m. Suitable for monitoring wells from 51 mm internal diameter.



Motorised foot valve pump

If your monitoring well has a diameter less than 51 mm or the water in it contains a lot of silt, a motorised foot valve pump is preferred. Ball valves (and associated hoses) are available in 9, 12, 18 and 22 mm. With the foot valve pump that is driven by a four-stroke engine, you have an all-in-one priming and sampling pump, suitable for all monitoring wells and for all parameters (also volatile substances).



Peristaltic pumps STANDARD and COMPACT

The peristaltic pump is, like the bailer sampler, standard equipment for everyone who must prepare or monitor a soil remediation project. It can be used to prime (not too large) monitoring wells, to sample all monitoring wells with shallow groundwater levels and it is extremely suitable for filtering water in-line under pressure (obligatory for heavy metals). The two hoses must be replaced for every sampling period, making an entirely 'new' pump available. It is even possible to sample gases from a crawl space or chimney.

Both versions of our peristaltic pump have a built-in battery (for more than four hours of pumping) and continuously adjustable speed. The 'STANDARD' peristaltic pump has additional memory for speeds, can feed external submersible pumps and can be powered by an external 12 V battery.



2.4 Beds of lakes and watercourses

For hundreds of years, water has proven to be an attractive place to dump waste. This applies both to individuals and to industry and agriculture. As a result, beds of lakes or watercourses are contaminated more than average when compared to sites on land. Mapping out the contamination of the beds of harbours, lakes and rivers is therefore essential. Samples must be taken during and after remediation projects to determine the result of the actions.

Sediment sampler, type Beeker

In addition to the extensive set, we also have a simple basic set (04.23.SA). Using the basic set and a hammer, a sample can be taken from a bed. A small electric battery pump closes the cutting head, keeping the often watery sample in the head. A piston rod now makes it possible to transfer the sample into pots or a bucket above ground, therefore the device does not need to be taken apart. The essential piston, a substantial sample diameter and the transparent tube guarantee the sample quality with perfect layers every time. Can be used in still water to a depth of 10 m (2 people).

Multisampler

The more economic Multisampler is available for exploratory research. This device also has a piston and a transparent 1-m long sample tube. This provides good control over the sample obtained. The piston holds the sample in the tube. If the material is loose or very watery, another cutting head (including a ball) can be installed, so that the sample does not drain out of the tube.

Van Veen grab

The stainless steel Van Veen grab is used primarily for taking mixed samples from the top layer of the bed. The top layer must not be too liquid, otherwise the device will descend into a deeper layer before it closes. Various sizes are available. The smaller versions can be used without a winch.

Free-fall corer

Just like the Van Veen grab, the free-fall corer is suspended on a cable. With a free vertical fall under water, the more than 1 m long tube takes a core from the bed and retains it during lifting by a ball valve in the top of the tube. The content is discharged into a bucket by opening the ball valve.

Peat sampler, standard set for sampling to a depth of 10 m

The stainless steel peat sampler is in essence a gouge auger with a closed point and a cover. Therefore the peat sampler is only suitable for weak and very soft soil types. Using the peat sampler and the flap gouge auger (smaller version), in addition to beds of lakes and watercourses, all sorts of other (soft) materials can be sampled, such as sand in a sand collector or from a hydrocyclone and powders.

Water clarity; sludge depth

During remediation of beds of lakes and watercourses, large amounts of sludge are often disturbed. This can be checked using a visibility disc according to the Secchi method (to a maximum depth of 3 m). Using a sediment level stave it is possible to sound the depth of the old and new position of the bed.



3. MONITORING AND TELEMETRY

In-situ remediation projects in particular can take tens of years. During this period the process must be monitored. It is normally desirable to remotely control the process, for instance because the groundwater level changes. Travelling time is expensive and often represents lost time. Therefore, by investing in remote measuring, considerable money can be saved. For this purpose, Eijkelpamp supplies in its e-SENSE range a number of intelligent e+ dataloggers and an associated telemetry system.



Monitoring water levels in monitoring wells, reservoirs and influent and effluent channels

When extracting water from or injecting water into the soil, the groundwater level in the vicinity changes. This can pose a danger to foundations and to various other aspects of ground use and environmental safety. Water levels can be monitored (if required with the read-out being made available using telemetry) using various types of Diver by Schlumberger Water Services, such as the MiniDiver, MicroDiver, CeraDiver and BaroDiver. The CeraDiver is made of zirconium oxide and is extremely resistant to many forms of organic and inorganic contamination. Eijkelpamp also supplies other water level loggers using telemetry, for instance for use in open water (e+ WATER L).



CTD-Diver

In addition to the water level, this Diver also measures the electrical conductivity and temperature of the water. Because of its ceramic housing that is made of zirconium oxide, the CTD-Diver is extremely durable. This Diver is, for instance, suitable for monitoring landfills from where inorganic contamination leaks or can start to leak. In combination with the e-SENSE system, the CTD-Diver can be monitored telemetrically from your PC.



Multiparameter probe

This instrument that measures water quality has been specially developed for the in-situ determination of parameters such as pH, redox, electrical conductivity, temperature, O₂, turbidity and water depth. All sensors are fitted together into a single probe attached to a cable that is from 30 m to 100 m long, and can be read on the cable drum above ground (logging is optional).





Intelligent e+ dataloggers

During remediation projects it is often very important to monitor the progress of the process. The e-SENSE concept allows you to take measurements and monitor the measurement results, if required at a great distance from the decontamination installation.

The intelligent e+ dataloggers can autonomously and individually measure and record. They can also generate alarms if adjustable high and low levels are passed. The sensors that are used for this include:



- MicroDiver** Water level and temperature logging in monitoring wells > 20 mm
- MiniDiver** Water level and temperature logging in monitoring wells > 25 mm
- CeraDiver** Water level and temperature logging
- CTD-Diver** Water level, electrical conductivity and temperature logging in monitoring wells > 25 mm
- e+ RAIN** Rain gauge with datalogging
- e+ SOIL mct** Logging of moisture percentage, bulk soil-conductivity and -temperature
- e+ WATER L** Logging of levels and temperatures of surface water

Eijkelkamp is continually developing new e+ loggers. Let us know if your application is not included in the above list!

Telemetry

Remote monitoring using the e+ dataloggers mentioned above is simple if the e-SENSE telemetry system is used. From 1 to 8 intelligent sensors are easily interconnected via e-SENSE field modems. The set ups in the field are robust, resistant to vandalism and, if required, can be installed underground (out of sight). The data are sent automatically to the office, where they are received by a modem connected to a PC, stored and examined as desired. The e-SENSE direct software gives you complete control of the system and also offers an interface to other automation systems. If required, an alarm can be immediately forwarded to a manager using a text message.

4. REMEDIATION PUMPS

Soil contamination is often caused by oil products or solvents that have leaked into the soil. Even in the smallest concentrations, these products pose a threat to the quality of groundwater used for drinking water. The removal of these products is often achieved using pumps installed in wells that extract the fluid from under the soil (chlorinated hydrocarbons; also called Dense Non-Aqueous Phase Liquids (DNAPL)) or pump it away as it floats on the groundwater (Light Non-Aqueous Phase Liquids (LNAPL)). A skimmer can ensure that only the oil is pumped away and no undesired water. We supply pumps and skimmers for monitoring wells with an internal diameter of 50 or 100 mm.

Remediation double-action pump 48 mm

Fully pneumatic piston pump for installation in a monitoring well. For general remediation projects or for connection on top of a skimmer. The pump housing contains an integrated automatic but adjustable controller. Diameter 48 mm, length 800 mm, capacity up to 320 l/hour, maximum pressure 75 m. Air consumption 32 l/min.

Remediation pressure pump 89 mm

Fully pneumatic 89 mm high capacity submersible pump (up to 3300 l/hour). A built-in adjustable float monitors the desired reduction of the fluid level. Standard version with suction opening below (for pumping away DNAPL or contaminated groundwater). The pump must be installed below the fluid level, it is not suitable for installing on a monitoring well skimmer.

Monitoring well skimmers

These skimmers are installed under a pump and separate the oil from the water below. The skimmer can be used with the remediation double-action pump 48 mm or an above-ground extraction system. The range of 500 mm (standard) ensures that also in areas with varying groundwater levels no maintenance is required. A skimmer can be fitted with a float or a filter, as desired. The float reacts purely on the difference in densities between water and oil (0.7-0.96 gr/ml). The float system (RD) has the largest feed capacity, but only extracts oil to a thickness of 25 mm. After fitting a hydrophobic filter (HP), the oil is removed to a final thickness of just 0.25 mm. Skimmers are available in diameters suitable for 50- and 100-mm diameter wells.



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