TECHNICAL GUIDANCE DOCUMENT

INDIANA DEPARTMENT OF ENVIRONMENTAL MANAGEMENT

The Micro-Purge Sampling Option

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Notice

The Technology Evaluation Group (TEG) completed this evaluation of *The Micro-Purge Sampling Option* based on professional expertise and review of items listed in the "References" section of this document. The criteria for performing the evaluation are generally described in the IDEM OLQ technical memorandum, *Submittal Guidance for Evaluation of Remediation Technologies*.

This evaluation does not verify the effectiveness of the sampling technique in conditions not identified here. Mention of trade names or commercial products does not constitute endorsement or recommendation by the IDEM for use.

Background

Most of today's well purging methods were developed during studies of water supply wells in the 1960's and early 1970's (Powell and Puls, 1997). The studied wells were usually steel-cased with screens set below the top of the water table, and they were analyzed for inorganic water quality parameters.

The procedures used for sampling the water supply wells called for removing about three well volumes of water before sampling, because all the water in a well was thought to be "stagnant", and not representative of water in the aquifer. This purging or removal of the "stagnant" water was deemed necessary before taking "fresh" samples. These procedures have since been carried over into the sampling of groundwater monitoring wells.

Problems Encountered

Traditional purging methods do present problems such as:

- Excessive agitation resulting in volitalization and degassing, which gives erroneous results;

- If the well is purged dry (common in Indiana's low permeable areas) the recharge water cascading through the sand filter pack can lose up to 70% of volatile organic compounds (McAlary and Barker, 1987), and bias metals analyses (Puls and Powell, 1992);

- Preferential recharge from more porous layers, biasing the sample;

- Increased turbidity from the disruption of the sand pack and surrounding soils;

- The large amount of time and effort, resulting in increased labor expense; and

- Disposal of large volumes of contaminated purge water at considerable handling expense, and some risk of additional spills.

Studies to determine actual well flow patterns, including direct observation of colloidal suspensions and dyes in wells, have changed previously held dogma (Kearl, Korte and Cronk, 1992; Powell and Puls, 1993). Multiple studies have shown that while the water above and below a well screen may be stagnant, the water actually in the screened section flows across the well with no significant mixing of water in the screened interval with the stagnant water above or below. This holds true even for wells completed in low permeable materials (Robin and Gillham, 1987).

Therefore, a sample taken from the screened area only (excluding stagnant layers above and sediments below the screen) should be of "fresh" water, representative of the aquifer. Purging, with its attendant problems, may not be necessary. Sediments below the screen can be avoided by restricting the depth of the sampling device. Stagnant water in the casing above the well screen is much more difficult to avoid, but dedicated pumps or careful, slow pump insertion will minimize mixing.

Research and testing of sampling procedures have focused on improving quality and the ease of sampling. Micro-purge, or Low-Flow, sampling has been the most successful new approach. It involves using an in-well pump, not to remove a set volume of water, but to purge water at very low pumping rates (0.1 - 1.0 L/min) just until measured water characteristics exhibit steady-state conditions, showing that the water is being drawn from the aquifer. The most useful parameters are turbidity, dissolved oxygen, and oxidation-reduction potential. Parameters of less value, but often measured, are temperature, pH, and specific conductance (EPA/540/S-95/504).

Advantages

Micro-Purging has numerous advantages over conventional bailing or high speed pumping:

- Samples are much more consistent,
- Sample artifacts are minimized,
- Less operator variability,
- Less time sampling overall,
- Less expensive,

- Less purge water to dispose of (95% less - Serlin & Kaplan, 1996),
- Much less stress on the formation, and
- Filtration eliminated due to marked decrease in turbidity.

Limitations

The disadvantages are:

- Higher capital cost,
- More set-up time,
- Additional equipment, and
- Additional training needed.

Conclusion

The improvements in sample quality, particularly for metals analyses, are well documented (Powell & Puls 1997, EPA/540/S-95/504) and micro-purge sampling is allowed in most states. The EPA has approved its use (EPA/540/S-95/504) and several Regions (I, VIII, and IX) have drafted standard operating procedures for micro-purge sampling. These sampling procedures have been approved and used successfully at many Indiana sites.

The use of micro-purge sampling continues to have immense benefits to Indiana. Much of this state is covered with low permeable soils, in which purging is difficult or impossible without running the wells dry. This costs more time waiting for recharge and yields biased samples. Besides the money and time saved, the improvement in data consistency, accuracy and repeatability is also a bonus, particularly when the public's health is involved.

In one Indiana case study, IDEM approved micro-purge sampling on a site specific basis for a RCRA landfill in Indiana. The sample results for this site, plagued by extreme turbidity, have significantly improved over previous sampling, with turbidity dropping from over 40,000 nephelometric turbidity units (NTUs) to 6 or less. (Weaver, 1997) Additional case study information can be found in the Reference documents, and in Remediation files.

The Office of Land Quality (OLQ), Science Services Branch has evaluated research and USEPA guidance on micro-purge (or low-flow) sampling; and concluded that this methodology can provide more consistent and reliable data than traditional methods, with a significant savings in time, money, and waste. Accordingly, micro-purge sampling can be used as an optional sampling method, if the requirements below are met.

This document is not a complete outline of sampling procedures; for that refer to USEPA EPA/540/5-95/504 or EPA groundwater sampling guidance at http://www.epa.gov/tio/tsp/download/gw_sampling_guide.pdf. This memorandum lists the various requirements or specifications requested by OLQ.

Equipment

- Down-hole bladder or centrifugal pumps must be used. Peristaltic pumps may be used only if volatile organic compounds are not on the list of contaminants of concern. Inertial pumps may not be used.

- It is impossible to perform low-flow sampling with a bailer. Inertial lift devices and high flow rate pumps may not be used. Down-hole, low-flow rate pumps must be used.

- A multi-probe, in-line flow cell, preferably transparent (to detect particulate build-up) must be used. The design of the flow cell must prevent air bubble entrapment during use. The types of flow cells and multi-probes used must be specified in the report, as well as information on how often the multi-probes were calibrated.

- Tubing used should be small diameter (1/4 or 3/8 inch) Teflon or Teflon-lined polyethylene. PVC, polypropylene, or polyethylene tubing should only be used for samples restricted to inorganic analyses. Stainless steel tubing may be used for organics, but not metals.

Sampling

- The monitoring well must be permanent, properly constructed, and developed (Indiana Water Well Drilling Rules 312 IAC 13).

- The water table must be below the top of the well screen.

- A dedicated, submersible pump is recommended. If a dedicated pump is not feasible, then the tubing used for each well should be dedicated and cut to length for that well. The use of a portable pump will require a longer purge time for stabilization. It must be lowered into place as slowly as possible to prevent mixing or surging of the well.

- The midpoint of the saturated screen is usually the optimum depth for the pump intake, but other depths may be used to target specific zones, such as maximum flow layers or zones of high chemical concentrations. Pump intakes must not be so close to the surface that the water level may be pulled below the intake. The pump intake should also be at least two feet above the bottom of the well to preclude excess turbidity from the well bottom. The site sampling and analysis plan must provide detailed information outlining why, how and where each pump intake depth was selected.

- The pump should not be raised or lowered while taking samples.

- A depth gauge must be used during purging to take continual water level readings. Drawdown must be held to less than 0.3 foot during purging. During initial pump start-up, drawdown may temporarily exceed this, before recovery. The water level readings must be recorded and submitted in the sampling report.

- If the water level is pulled down to the pump intake, all concurrent attempts at sampling cease for the well and alternative procedures should be prepared to prevent this from happening during the next sampling period.

- The pump should be started at the lowest flow volume, and adjusted higher as long as the maximum drawdown is not exceeded. Typical extraction volumes are 100 ml/min to 300 ml/min. Volumes may approach 1.0 L/min in very highly permeable soils, but should not exceed this.

- The parameters normally measured for stability (listed in increasing order of sensitivity) are pH, temperature, specific conductivity, oxygen-reduction (redox) potential, dissolved oxygen (DO) and turbidity. Not all parameters may be used for each site, but at least one of the last three listed must be used. All measurements except turbidity must be made using a multi-probe, in-line flow cell.

- The frequency of measurements will depend on the rate of sampling, but should generally be on the order of three to five minutes. Stability will be achieved when three consecutive readings do not vary more than ± 10% for turbidity and DO, ± 3% for conductivity and temperature, ± 10 microvolts for redox, and ± 0.1 for pH. The stability data must be provided to OLQ in the sampling report.

- If, during purging, the turbidity readings increase, this indicates that the well is being re-developed, and the pumping rate should be lowered. Turbidity may be naturally high in some formations, but should stabilize at or below 5 NTU. If this does not happen, the well should be re-developed. If the problem persists, other forms of sampling should be used.

- If the well yield (recharge rate) is lower than the lowest extraction rate and the 0.3-foot maximum drawdown cannot be met, no-flow (or passive) sampling can be used. Permission must be obtained from the IDEM program manager before this option is used, and it must be noted in the sampling plan.

- The sampling methodology and procedures must be detailed in the sampling section of each corrective action plan and progress report. The procedures must be approved by the IDEM program manager before sampling commences.

Further Information

If you have any additional information regarding this technology or any questions about the evaluation, please contact Bob Sonnefield, Senior Geologist, at (317) 234-4688 or by e-mail at rsonnefi@idem.IN.gov. This technical guidance document will be updated periodically, or if new information is acquired.

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