INDIANA DEPARTMENT OF ENVIRONMENTAL MANAGEMENT

Micro-Purge Sampling Option

Eric J. Holcomb
Governor

Bruno L. Pigott
Commissioner

(317) 232-8603 • (800) 451-6027 www.idem.IN.gov 100 N. Senate Ave., Indianapolis, IN 46204

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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 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.

Recent studies show the water within the screened section actually flows across the well with no significant mixing of water in the screened interval with the stagnant water above or below the screened interval. Development of the Micro-purge option is an attempt to prevents the mixing the stagnant water above the well screen with the "fresh" water within the screen interval. The TEG evaluation of the *Micro-Purge Sampling Option* is based upon analysis of parameters not associated with petroleum products (BTEX) in water collected from monitoring well screen intervals having stagnant water above the well screen.

Problems Encountered

Traditional purging methods of removing a prescribe amount of water from the monitoring well may present problems such as:

- Excessive agitation resulting in volatilization and degassing, which can underestimate contaminant concentrations;
- 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 resulting in biased low VOC analyses (McAlary and Barker, 1987);
- Aeration can cause metals to precipitate out of solution resulting in biased low metals analyses (Puls and Powell, 1992);
- Preferential recharge from more porous layers, biasing the sample low;
- Increased turbidity from the disruption of the sand pack and surrounding soils which can bias the sample high;
- Increased amount of time and effort, resulting in increased labor expenses; and
- Disposal of large volumes of contaminated purge water at considerable handling expense and potential 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 doctrine (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 within the screened section actually 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) provides "fresh" water, representative of the aquifer. By removing the water as it comes into the well places less stress on the formation, and filtration may be eliminated due to marked decrease in turbidity (IDEM, 2005). 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. Groundwater monitoring wells having a screen or open interval with a length of ten feet or less, which can accept a sampling device that minimizes the disturbance to the aquifer or the water column in the well casing, usually can use the micro-purge option. Procedures that minimize disturbance to the aquifer will yield consistently the most representative ground-water samples (EPA 542-S-02-001). The screen or open interval should have been optimally located to intercept an existing contaminant plume(s) or along flow paths of potential contaminant releases.

Micro-purge involves using an in-well pump, not to remove a set volume of water, but purging water at very low pumping rates (0.1 - 1.0 L/min) until showing that the water is being drawn from the aquifer. This is typically done by measured water quality characteristics until they exhibit steady-state conditions, which allows for less operator variability. This commonly creates less purge water to dispose of (95% less - Serlin & Kaplan, 1996). U.S.EPA recommends 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).

Conclusions

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 continue to be used successfully at many Indiana sites.

The use of micro-purge sampling at non-ELTF eligible sites has immense benefits in Indiana. In low producing confined aquifers, traditional purging is difficult or impossible without running the wells dry. This results in increased costs waiting for recharge and yields biased samples. Besides the money and time saved, the improvement in data consistency, accuracy and repeatability is particularly beneficial, especially when the public's health is involved. Case study information can be found in the Reference documents and in the IDEM Virtual File Cabinet (VFC).

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 at non-ELTF eligible sites. The use of Micro-purge/Low flow sampling techniques is a viable option when sampling for chlorinated volatile organic compounds in groundwater, especially when delineating final extent of contamination or requesting unrestricted closure where lower concentrations are expected.

Conditions for Utilizing the Micro-Purge Sampling Option

- Consider the following when selecting equipment for the *Micro-Purge Sampling Option*:

  1. Commonly use down-hole bladder or centrifugal pumps.

2. Bailer moving up and down through the water column will mix the stagnant water with the fresh water making it difficult to collect a representative sample.

3. Inertial lift devices and high flow rate pumps may inadvertently mix the water in the well casing.

4. Using a multi-probe, in-line flow cell, preferably transparent (to detect particulate build-up) is beneficial to use. The design of the flow cell will prevent air bubble entrapment during use. Listing the types of flow cells and multi-probes used, as well as information on how often the multi-probes were calibrated is beneficial in evaluating the sampling procedure.

5. Tubing typically used is small diameter (1/4 or 3/8 inch) Teflon or Teflon-lined polyethylene. Select tubing material based on the sample analyses

- Consider the following when using the *Micro-Purge Sampling Option*:

1. Indiana Water Well Drilling Rules 312 IAC 13, requires monitoring well to be permanent, properly constructed, and developed.

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

3. 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 intake close to the surface water level may pull the water level below the intake. Pump intake close to the bottom of the well create excess turbidity from the well bottom. Provide detailed information outlining why, how and where each pump intake depth was selected.

4. Keep pump stationary while taking samples.

5. Take continual water level readings during purging.

6. Establish a drawdown target/action point during purging. During initial pump start-up, drawdown may temporarily exceed this, before recovery. The water level readings should be recorded and any drawdown exceeding drawdown target level is noted in the field record, along with any corrective actions taken.

7. Prepare alternative procedures to prevent the water level being pulled down to the pump intake during the next sampling period.

8. Start the pump 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.

9. 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. 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 millivolts for redox, and ± 0.1 for pH.

10. Lower the pumping rate if, during purging, the turbidity readings increase, this indicates that the well is being re-developed. Consider re-developing the monitoring well if turbidity does not stabilize at or below 5 NTU.

11. Possible options for the sampler if the well yield (recharge rate) is lower than the lowest extraction rate and the target drawdown cannot be met may include:
    - Continue to purge to stabilization with note of variation from the plan or allowing a larger drawdown;
    - Based on the excessive screen length allow 25% of distance between the pump intake and the top of screen (Nielsen 2010, and ASTM 6771-18 suggest this standard).
    - If low hydraulic conductivity is a problem (such as in drought conditions), switch to no-flow or passive sampling (i.e., Diffusion Bag samplers, GORE® Modules can be used).

12. The sampling team review the methodology and procedures to be used and how sample variations will be handled in the field.

13. Sampling field data may be recorded via hand-written sheets/forms or automated electronic data storage and reporting.

Further Information

This document is not a complete outline of sampling procedures; for that refer to USEPA EPA/540/S-95/504 or EPA groundwater sampling guidance at http://www.epa.gov/sites/production/files/2015-06/documents/gw_sampling_guide.pdf

If you have any additional information regarding this technology or any questions about the evaluation, please contact the Office of Land Quality (OLQ), Science Services Branch (SSB) at (317) 232-3215. This technical guidance document will be updated periodically or when new information is acquired.

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