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HSWA LANL 6/m/1996

August 21, 1996

Beth Oms, POC/KAO
U.S. Department of Energy
Kirtland Area Office
P.O. Box 5400
Albuquerque, New Mexico 87185-5400

RE: Discussion of Low-Flow (Micro-Purge) Sampling Technology

Dear Ms. Oms:

As we have discussed previously, I am attaching a DOE Oversight Bureau (DOE OB) memorandum which basically summarizes the currently available information in the literature regarding low-flow sampling. Sandia National Laboratories (SNL) is currently using low-flow (Micro-Purge) technology locally for sampling of ground water and is proposing to expand its use on a site-wide basis. The DOE OB recognizes that this may be a cost-effective technology and is striving to determine the capability of Micro-Purge pumping to yield a representative ground-water sample. For this purpose, the memorandum contains DOE OB's proposed means to resolve the issues of Micro-Purge sampling.

I have also provided this memorandum previously in draft form to pertinent personnel at SNL. DOE OB is interested in discussing with DOE and SNL personnel an approach to validating Micro-Purge technology.

If there are any questions, please contact me at 845-5933 or William Stone of my staff at 845-4103.

Sincerely,

Ronald A. Kern, Manager/POC
SNL/ITRI Oversight Program

Attachment

cc: Ed Kelley, NMED, Director, WWMD
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M E M O R A N D U M

To: R. Kern
From: W. Stone
Date: 14 Aug 1996

Subject: Low-flow (Micro-Purge) Sampling

CONCLUSIONS

If micropurging (from "Micro Purge", a trademark of QED Environmental Systems, Inc.) could be shown to yield representative ground-water samples, it would indeed be an improvement over traditional methods. However, there are three specific concerns.

1. The main concern is the validity of the basic assumption that:

> **Ground-water flow is horizontal in the screened interval, so samples taken there are representative of the adjacent saturated formation, without purging the entire well bore.**

Evidence offered does not rule out the possibility of vertical movement within the filter pack or aquifer. Thus, the source of the water sampled by micropurging still needs to be demonstrated. This could be done by comparing the chemistry of low-flow water samples with that of the formation water (as shown by induction logging) or a tracer test designed to show flow is either from the aquifer or not from the filter pack.

2. Also of concern is the validity of the assumption about mixing:

> **Stagnant bore water need not be purged as it will not mix with the "fresh water" developed by micropurging at the screen.**

Published tests, where the "stagnant bore water" was represented by a tracer solution with a density similar to that of ground water, suggest there is no such mixing. However, when a tracer solution of greater density was used, there was mixing. The density of contaminated stagnant water may make mixing inevitable.

3. Even studies favoring micropurging note that **the method is suitable only for fully characterized sites and properly constructed wells.** This may not be the case at all sites.

INTRODUCTION

This briefly summarizes my investigation of the suitability of micropurge sampling of monitor wells. Although a comprehensive review would be much longer, this raises the main issues. As the origin of the water sampled is the major concern, my findings are presented in three parts: a summary of evidence generally offered for and against the assumption of horizontal flow and that the sample is representative of the aquifer (Table 1), a brief discussion of each line of evidence and finally some possible ways to resolve concerns.

In view of the natural variation in both aquifer and analyte properties (Huntzinger and Stullken, 1988), together with "well trauma" or all the things that happen to the aquifer during the drilling, construction, development, purging and sampling of a well (Pennino, 1988), obtaining a truly representative ground-water sample by any method may be an impossibility. The question remaining, therefore, is whether the water obtained by micropurge sampling is from the well bore, the filter pack or the aquifer.

Table 1. Summary of evidence offered for and against low-flow or micropurge sampling of monitor wells (numbers in parentheses indicate references in the list below).

EVIDENCE OFFERED FOR	EVIDENCE OFFERED AGAINST
parameter stabilization (6, 7)	well-bore flow (1, 8)
tracer tests (5, 9)	site conditions (3, 6, 10)
comparison w/ traditional (3, 10)	well construction (6)
colloidal borescope (2)	need for further tests (2, 4)
minimal water-level drawdown (6)	

1 Church and Granato (1996)
2 Kearl and others (1992)
3 Kearl and others (1994)
4 Parker (1994)
5 Powell and Puls (1993)
6 Puls and Barcelona (1995)
7 Puls and Paul (1995)
8 Reilly and others (1989)
9 Robin and Gillham (1987)
10 Shanklin and others (1995)

EVIDENCE OFFERED FOR MICROPURGING (see Table 1)

Parameter stabilization -- The leveling off of values for selected indicator parameters has long been used to determine when a well has been sufficiently purged (Anonymous, 1980). Equilibration of such parameters has also been cited as evidence that stagnant water has been removed from the screened interval in micropurging (Puls and Barcelona, 1995; Puls and Paul, 1995).

Tracer Tests -- Two tracer studies are cited by Kearl and others (1994) as supporting the concept that stagnant water in the well bore does not mix with ground water flowing through the screen. In one (Robin and Gillham, 1987), fresh water developed in the screened interval by micropurging did not mix with stagnant water, in this case represented by tracer solution placed in the well bore above the screen. In the other, Powell and Puls (1993) reported that dual tracer studies (using fluorescent colloidal particles in NaBr solution) showed that water from the screened interval in three of four wells tested did not mix with that in the casing, but noted that the method should be further studied at sites characterized by other conditions, such as low permeability, alternating strata and the presence of organic species.

Comparison With Results From Traditional Methods -- In two studies where analyses of samples obtained by low-flow and traditional purging were statistically compared, there was reportedly no significant difference in the results for selected analytes (Kearl and others, 1994; Shanklin and others, 1995).

Colloidal Borescope Observations -- Use of an in-situ device to observe colloid size, density and movement in well-bore water revealed horizontal laminar flow in the screened intervals after micropurging (Kearl and others, 1992).

Minimal Water-Level Drawdown -- Water level is another parameter usually monitored during micropurging (Puls and Barcelona, 1995). If water level is not allowed to drop significantly below its static position, the vertical movement that leads to mixing of stagnant water in the bore with fresh water opposite the screen presumably does not occur.

EVIDENCE OFFERED AGAINST MICROPURGING (see Table 1)

Well-Bore Flow -- Vertical flow in wells is inevitable. It has been well documented, even in unstressed wells (Reilly and others, 1989). "The well screen acts as a conduit for vertical flow because it connects zones of different head and transmissivity", even in seemingly homogeneous aquifers (Church and Granato, 1996, p. 262). Although this is more of a problem in long well screens, any screen connecting materials of different properties should be considered as "long".

Site Conditions -- Even papers in favor of micropurging caution that the method is suitable only in "selected circumstances" (Kearl and others, 1994) or at "sites that have been fully characterized" (Shanklin and others, 1995). Puls and Barcelona (1995) noted that use of the method may be impractical for low-permeability materials. Both geologic and hydrochemical heterogeneity of the material penetrated by the well must be known.

Well Construction -- As noted by Puls and Barcelona (1995), the effectiveness of micropurging depends on proper screen location, screen length, well construction and development methods.

Need For Further Tests -- Although clearly favoring micropurging, Kearl and others, 1992) recommended additional tracer studies, like that of Robin and Gillham (1987). Parker (1994, p. 130) concluded from a comparison of various sampling devices that "bladder pumps [like used in micropurging] gave the best recovery of sensitive constituents". However, she noted that further study was needed, especially of sample quality vs flow rate.

POSSIBLE SOLUTIONS

Tracer test(s) -- The best way to validate the basic assumption would be to conduct a different kind of tracer test than has been done to date. This might involve either one that shows the water sampled **does** come from the formation (tracer placed in the aquifer adjacent to the monitor well) or one that shows it **doesn't** come from the filter pack (tracers placed in the filter pack above and below the screen when the well is constructed). This could be done in a well that is being installed anyway or in one drilled for the purpose (an auger hole where water table is shallow may suffice).

Site Characterization -- Regarding the caution that the method only be used at "fully characterized sites", I'm not certain that this is assured where the method is being used or is planned to be used. Local hydrogeology and hydrochemistry must be well known. An understanding of the heterogeneity of the material in the saturated zone is essential, but geologic logging of holes can be inconclusive if samples are poor or the logger is inexperienced. Geophysical logging for aquifer lithology is a useful supplement, but budgets seldom permit it. Although, the hydrochemical heterogeneity of the saturated zone must also be understood, the vertical distribution of contaminants in the portion penetrated by the well may be unknown. Church and Granato (1996) noted that induction logging can provide a profile of solutes in the aquifer. This measures electrical conductivity and is possible through PVC casing or screen. A comparison of specific conductance of micropurged samples and induction-log profiles should clarify the portion of the saturated interval from which the water was drawn.

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