DEPARTMENT OF THE ARMY
BUFFALO DISTRICT, CORPS OF ENGINEERS
1776 NIAGARA STREET
BUFFALO, NEW YORK 14207-3199

REPLY TO:

JUL 9 2010

Environmental Engineering

SUBJECT: NFSS Interim Waste Containment Structure

Ms. Ann Roberts
[redacted]

Dear Ms. Roberts:

The information below is provided in response to your letter dated June 23, 2010. We have itemized your concerns so that they could be addressed individually.

a. IWCS has a minimum life expectancy of 25 years

Corps Response: According to Table 3-2 of the *Design Report for the Interim Waste Containment Structure* (IWCS) at Niagara Falls Storage Site (NFSS) (Bechtel National for USDOE, 1986), the United States Department of Energy (DOE) design life of the clay dike and cutoff walls surrounding the IWCS and natural glaciolucustrine clay under the IWCS have a design service life between 200 to 1,000 years, which is comparable to the Corps modeled life of 160 years. A sensitivity analysis from a DOE numerical model of the three (3)-foot thick compact clay cap atop the IWCS is sufficient to control infiltration for the 25 to 50 year design life of the cap, according to the same design report. Since the IWCS was originally constructed in 1986 (and later added to in 1991), the IWCS cap is designed to last at least through 2011 and possibly as long as 2036, and the clay dike and cutoff walls designed to last to at least 2186 (200 years), according to this study. Based upon visual inspection, radon flux, and perimeter external gamma and radon monitoring results, there is no reason to believe that the integrity of the IWCS cap is compromised in any way at this time. A topographic survey was conducted in 2009 and compared to the final configuration of the IWCS (1991 after the addition) and there was negligible settling of the IWCS cap, further demonstrating the effectiveness of the design of the IWCS.

b. RI and ESP data (contamination in LWBZ west of IWCS in 1993; increased uranium to the south, west, and east of the IWCS) demonstrate that the cell is leaking.

Corps response: The Corps' evaluations indicate that the IWCS is functioning and performing as designed and continues to remain protective of human health and the environment. The EPA also has the same opinion of the IWCS, as indicated by statements that were made at the June 23, 2010, public workshop by [redacted], Chief of the Radiation & Indoor Air Branch, U.S. Environmental Protection Agency (EPA) Region 2.

The most likely source of groundwater contamination north and west of the IWCS is historic leaching from the R-10 pile prior to the construction of the IWCS. The R-10 pile was left open to the elements from 1946 through 1982 (for 36 years). The R-10 spoil pile is now located inside the IWCS, along with other residues and wastes. However, current groundwater contamination near the IWCS closely mimics the documented location of contamination in 1981, prior to the construction of the IWCS.

The Corps has detected similarly high contamination in wells away from the IWCS where past radioactive material storage occurred (e.g., uranium plume in southeast corner of Exposure Unit 8). The possibility that current groundwater contamination in the vicinity of the IWCS may be due to ongoing releases rather than historic releases that occurred prior to completion of the IWCS has been further evaluated. Groundwater plumes in the vicinity of the IWCS were likely established prior to IWCS construction, and were truncated by construction of the cut-off wall. Long-term trends in the environmental surveillance groundwater data show steady-state to declining contaminant concentration levels suggesting that the IWCS is performing as designed. The uranium groundwater plumes south of the IWCS are believed to be associated with former Building 409 and nearby residue storage activities.

Historical documentation and analysis of aerial photos indicates that in the late 1940s, contaminated metal, concrete, lumber and reduction slag from other wartime plants were shipped to the NFSS and stored adjacent to Building 409, which was located just south of the current location of the IWCS, prior to and during IWCS construction. As with other documented storage areas on-site, there is localized groundwater contamination in this area, which may be due to leaching from contaminated soil associated with this temporary storage, as well as historic use of Building 409 prior to IWCS construction. The R-10 pile and the material storage piles evident in the 1956 aerial photograph that correspond to elevated concentrations of dissolved total uranium observed in area groundwater are now contained within the IWCS. The most recent aerial photograph analysis performed for the NFSS is found at http://www.lrb.Corps.army.mil/fusrap/nfss/nfss-hpa-2009-09.pdf. An example of this analysis was presented in the June 23, 2010 workshop. This presentation is at http://www.lrb.Corps.army.mil/fusrap/nfss/nfss-ws-presentation-2010-06.pdf

Figure 2-3 in the Chemical Characterization Report prepared by Bechtel National in December 1991 (attached) highlights "areas of known contamination" in 1981, prior to the construction of the cell, which closely resemble total uranium contamination in groundwater measured over 25 years later.

The Final Report on a Comprehensive Characterization and Hazard Assessment of the DOE (Battelle, June 1981) states "The area (referring to the R-10 area) has been fairly unstable, eroding east to the Central Drainage Ditch and eroding west onto the area west of the site and into the West Ditch. Also, this area is underlain by one or more saturated zones, creating the potential for subsurface migration to off-site areas."

The Corps did install a new permanent well south of the IWCS as part of the Remedial Investigation (RI) Report addendum sampling in order to further enhance the distribution of groundwater wells surrounding the IWCS. However, we focused most of our resources where we had more uncertainties with the providence of the groundwater contamination, with an eye toward bounding groundwater contamination that had the potential to exist or move off-site. We interpret the contamination south of the IWCS to be from legacy waste storage on the surface around former Building 409. This is apparent to us from viewing the aerial orthophotographs http://www.lrb.Corps.army.mil/fusrap/nfss/nfss-hpa-2009-09.pdf.

c. Performance Monitoring Program data show increased and seasonal variation in water levels inside the IWCS during the first year after closure.

Corps Response: Please provide the data trends you refer to for further Corps evaluation. The Corps will need time to assemble the references from the historical records (likely located in microfiche) and evaluate the data. We will also attempt to verify what the actual equipment in question was. The Corps team evaluations of the long- and short-term effectiveness will continue as the feasibility study for the IWCS is being conducted. As noted in the work plan for the Feasibility Study (located at http://www.lrb.Corps.army.mil/fusrap/nfss/nfss-feasstudy-workplan-2009-12.pdf), seven different alternatives are currently being evaluated for the IWCS. The first of these alternatives is removal of the entire contents of the IWCS with off-site disposal, along with partial removal options, in-place management, and a no action alternative, which is required under the Comprehensive Environmental Reponse Compensation and Liability Act (CERCLA).

d. Leakage of the IWCS may be the source of cesium-137 contamination in groundwater east of the IWCS.

Corps Response: Cesium-137 is not very mobile in the environment and therefore, not the best indicator of a potential cell breach. Uranium is much more mobile in groundwater and would be a better indicator of IWCS leakage if it were occurring. Like the radium-226 in Observation Well (OW)-15A in 1993, the cesium-137 detection in the upper water-bearing zone (UWBZ) was likely due to soil artifacts from turbid groundwater samples taken from wells. The presence of cesium-137 identified during the RI has not been replicated in the noted wells on site, even after four rounds of sampling. The better sample quality (non-turbid samples) accurately represents groundwater versus interferences from soil floating in the groundwater sample, where even small amounts of cesium-137 from past fall out (from 1950-60s nuclear weapons testing) can impact the sensitive groundwater analysis. The results of additional groundwater sampling for cesium-137 (and other radiological constituents) is currently available at http://www.lrb.Corps.army.mil/fusrap/nfss/nfss-riaddendum-raddata-2010-05.pdf and will be discussed in the addendum to the RI Report.

e. Poor mapping/delineation of contamination of the LWBZ

Corps Response: During our RI, 39 of 42 (or 93%) groundwater wells in the lower water-bearing zone [(i.e. lower water-bearing zone (LWBZ) and bedrock wells)] across the site were sampled. The results of this well sampling are summarized in the RI Report in Figures 4-18 and 4-19, Section 4.9 and associated tables, as well as in several sub-sections of Section 5, with overall conclusions of impacts to LWBZ wells discussed in Section 5.10.14. During the RI, no groundwater plumes were identified in the LWBZ.

In addition, groundwater from OW-15A was sampled on June 24th per your request to verify whether or not the radium detect in 1993 was a result of turbidity of the sample or actually representative of groundwater contamination. Once data is received and validated to ensure quality, it will be distributed.

Turbidity is a measure of the degree to which the water loses its transparency due to the presence of suspended particulates. The more total suspended solids in the water, the murkier it seems and the higher the turbidity. Low turbidity is considered as a good measure of the quality of water.

A report that discusses the relationship between Nephelometric Turbidity Units (NTU) measurements (or unit of measure for turbidity) and Total Suspended Solids (TSS) is located at: http://el.erdc.Corps.army.mil/elpubs/pdf/doere8.pdf

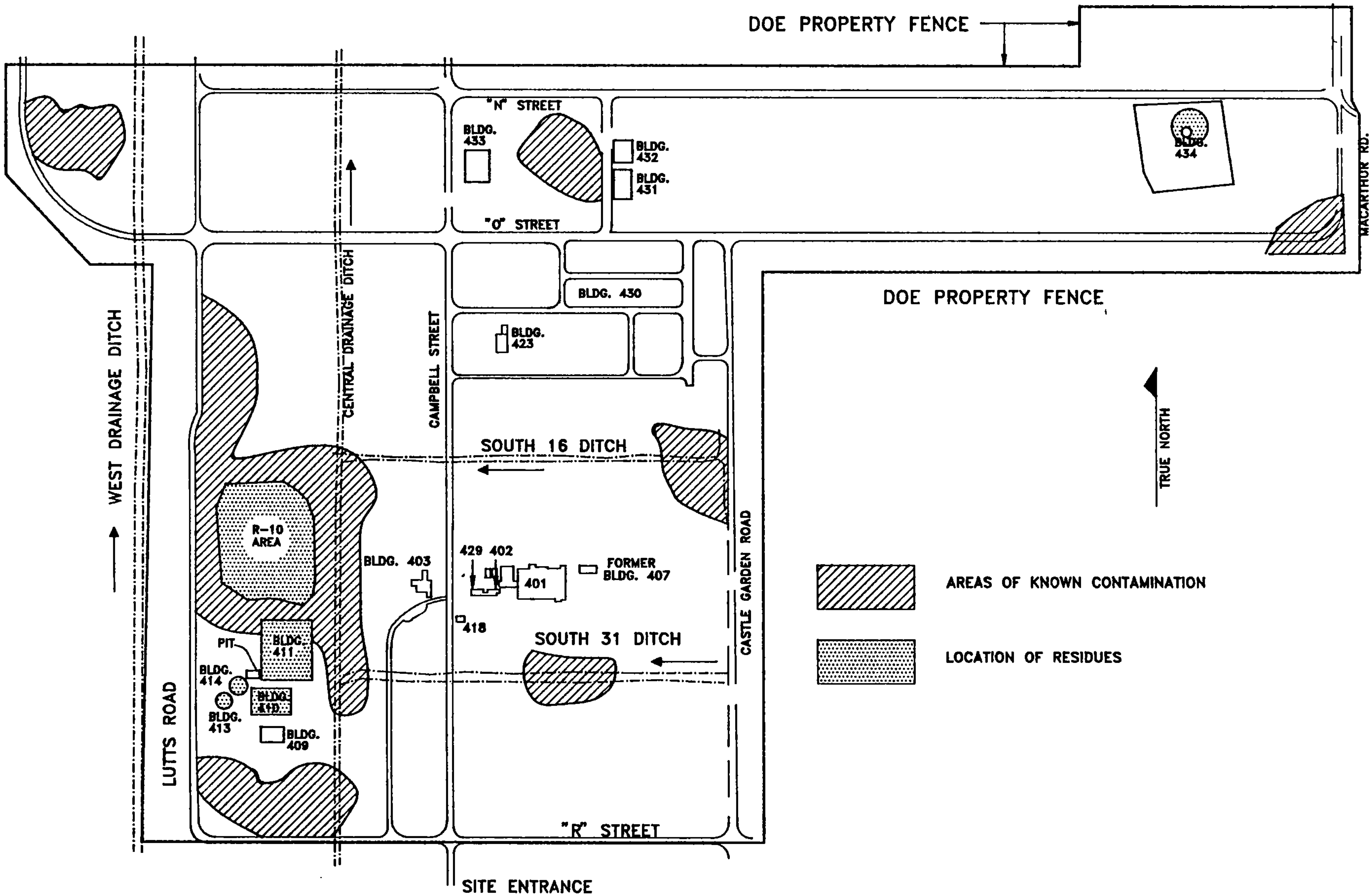
It is not clear why well OW-15A was omitted from further sampling after 1993 by the US Department of Energy. The dataset you presented at the June 23rd public workshop showed that the sample with one radium detection was not filtered prior to analysis; therefore, contaminants adsorbed to solid particles may have been included in the analysis. Several other data points listed in the table you reference showed both unfiltered and filtered data. The differences in results between the unfiltered and filtered samples indicated that the unfiltered results may have been impacted by solids present in the sample. In other words, if there were solids (such as soils or sediments) in the water sample, the results would not be reflective of what is actually dissolved and available for transport in the water. This is the fraction of interest for examining movement of constituents from the IWCS via the groundwater pathway. The radium-226 result from the unfiltered sample from OW-15A appeared to have natural soil interferences that elevated the water result (to 5.28 pCi/L versus the maximum contaminant level of 5 pCi/L for radium) and had a turbidity in excess of the instrument detection limit (200 NTU) meaning it exceeded the meter's upper range of measurement. Recommended turbidity for sampling is 50 NTU or lower for low flow sampling. At a minimum this sample was very murky containing a large amount of suspended solids due to bailing. Once the sample is collected it is placed into a container which typically contains nitric acid as a sample preservative. This nitric acid would have caused most if not all of the suspended solids to enter into solution, thereby artificially increasing the dissolved contaminant concentration. Another indication that the radium-226 result from the OW-15A sample was not a reflection of IWCS leakage is that no uranium was collocated with the radium-226. Uranium is a more mobile constituent than radium, so the absence of uranium in the sample is a further indication that the radium detection was due to soil interferences in the water sample. Enclosed is a presentation that discusses how sampling methodology can affect the turbidity of groundwater samples. The Corps uses low flow groundwater sampling protocols, whereas the elevated sample collected by DOE in 1993 was likely collected via hand bailing.

Thank you for providing us with your analysis. We hope our response addresses your concern. The Corps maintains that the IWCS at NFSS is functioning and performing as designed and continues to be protective of human health and the environment.

Sincerely [redacted]

Environmental Engineering Section
Team Leader

Enclosure



B5:NFSS7:V1

Figure 2-3
Site Configuration and Location of Radioactive Contamination at NFSS in 1981

Low-Flow Ground-Water Sampling: *An Update on Proper Application and Use*

[redacted]

QED Environmental Systems Inc.

Ann Arbor, MI - San Leandro, CA

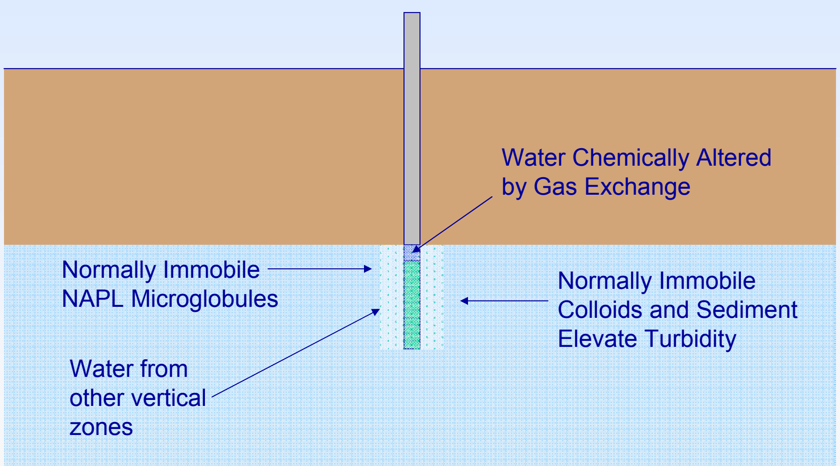
Today's Webinar Topics

- Early well purging research and guidelines
- Sample bias and error from traditional purging
- What is low-flow purging and sampling?
- Advantages of low-flow purging and sampling
- Low-flow application guidelines
- Other low-flow application issues
  - What do low-flow samples represent?
  - Where should the pump intake be placed?
  - Is there a screen length limit for low-flow sampling?
- Questions and Answers

Early purging research resulted in guidelines to remove "stagnant" water from the well

- The "rule of thumb" was 3 to 5 well volumes prior to sampling to get formation water.
- "Low-yield" wells were evacuated and sampled upon recovery, typically within 24 hours.
- Little concern was given to how purging protocols and devices (e.g., bailers) affected the chemistry of ground water samples.

What does the sample represent with traditional purging methods?

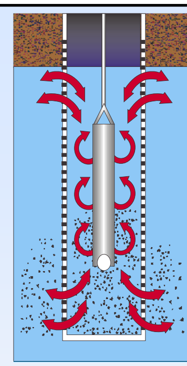


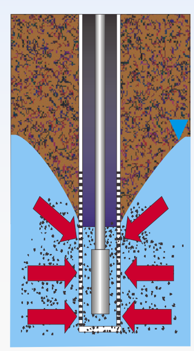
Traditional Well Purging Effects on Sample Chemistry and Quality

- High purge volume can cause underestimation of maximum contaminant concentrations due to dilution.
- High purging rates can cause overestimation due to contaminant mobilization and increased sample turbidity.
- Dewatering lower-yield wells causes losses of VOCs, affects DO and CO_2 levels, and increases sample turbidity.
- Excessive drawdown can cause overestimation or “false positives” from soil gas or from mobilization of soil-bound contaminants in the overlying formation or “smear zone.”

Hand bailing and high-rate pumping can elevate sample turbidity

- Sample filtration adds cost and time in field or laboratory
- Turbidity can elevate metals and some organics (e.g., PAHs) bound to soils
- Filtration affects sample chemistry
  - Turbid samples that are filtered to remove solids are not the same as low turbidity samples
- Gibbons & Sara, 1993 found no statistical difference between filtered and unfiltered samples for metal when turbidity is <10 NTU.
  - Various guidance documents suggest 5-20 NTU is acceptable for sampling (e.g., Florida DEP FS2200, 2006; US EPA Region 1 SOP, 2010)





Limitations in traditional purging methods led to the evolution of low-flow purging

- Low-flow purging and sampling is a methodology that reduces disturbance to the well and aquifer typically caused by bailing or high-rate/high-volume purging.
- Contrary to popular belief, the development of the low-flow purging approach was based on a need to control artifactual turbidity, not to reduce purge water volumes.

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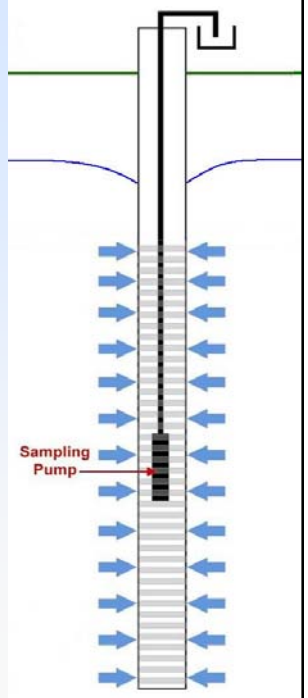
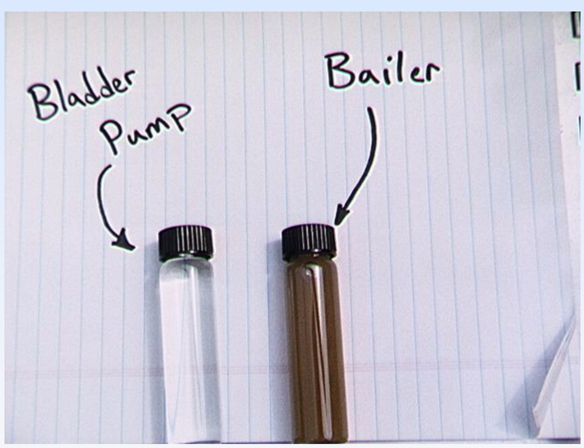
Low-Flow Purging & Sampling

- Low pumping rate minimizes drawdown, mixing and formation stress, isolates stagnant water above well screen.
- Low stress = low turbidity, improved sample accuracy, reduced purge volumes.
- Samples represent naturally mobile contaminants, not stagnant water in the well or mobilized contaminants.
- Purge volume is based on stabilization of indicator parameters measured during purging.



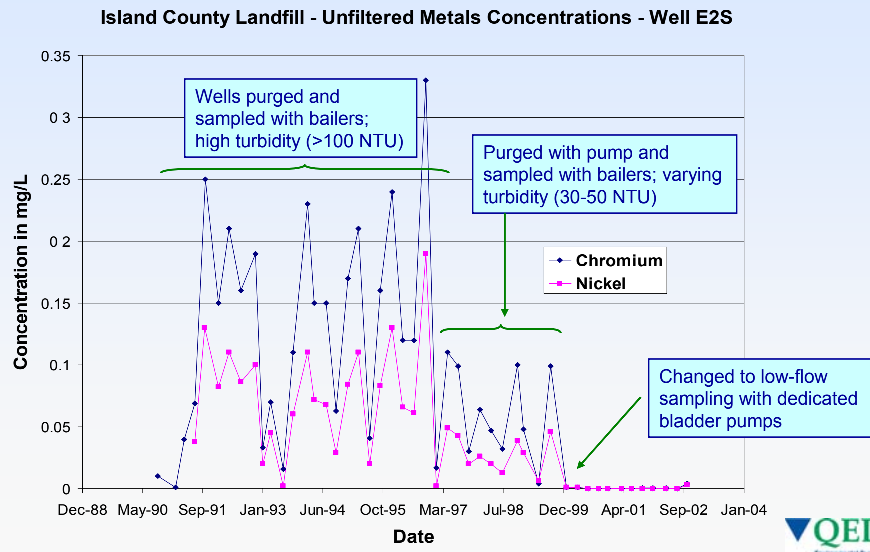
Lower flow improves sample quality



Low-flow purging and sampling controls turbidity and delivers higher quality samples - *a clear advantage*.

QED

Effect of low-flow sampling on data accuracy and precision



Reduced Purge Water Handling/Disposal

Traditional Well Volume Purging

Low-Flow Purging

Cost Savings with Low-Flow Sampling

(From Schilling, 1995)

	Low-flow Purging	Three Well Volumes
Purging Analysis:		
Total Purge Volume (15 wells)	61 gallons	743 gallons
Average Volume Purged	3.3 gallons	50 gallons
Average Pumping Rate	0.3 GPM	2-5 GPM
Average Purging Time per Well	13 minutes	50 minutes
Total Purging Time (15 wells)	3.25 hours	12.5 hours
Economic Analysis (in US Dollars):		
Time for Purging Wells (a)	$500	$1,875
Disposal costs (b)	$1,300	$3,750
Cost per Sampling Event	$1,800	$5,625
Annual Sampling Costs (quarterly sampling)	$7,200	$22,500
Sampling costs for 30 years	$216,000	$675,000

(a) Two-person crew at $150/hr.USD

(b) First drum = $1,000; additional drums = $300 (drum = 55 US gallons/208 liters).

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Advantages of Low-Flow Sampling

- Low-flow is a consistent, performance based standard for purging, rather than an arbitrary rule of thumb.
- It documents purging process for every sample, overcoming factors that can affect required purge volume.
- Low-flow sampling can reduce sampling costs:
  - Direct cost savings - reduced purge water handling & disposal, reduced purging time (in some wells).
  - Sample Quality - reduced turbidity, more accurate dissolved concentrations, and a better estimate of the true mobile contaminant load
  - Indirect cost savings - improved data accuracy and precision (fewer false statistical “hits”); better data = better decisions.

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Low-Flow Sampling Application Guidelines – The Basics

- Flow rates must be controlled to pump without continuous drawdown (water level must stabilize) and not increase turbidity. Rates of 200 to 1,000 mL/minute are typical.
- Drawdown is based on well performance, not arbitrary guidance.
- Indicator parameters are monitored for stabilization to indicate formation water and purging completeness.
- Dedicated sampling equipment is preferred. Portable pumps require larger purge volumes, can increase turbidity and require decontamination between wells, but are still better than bailing or high-rate pumping.

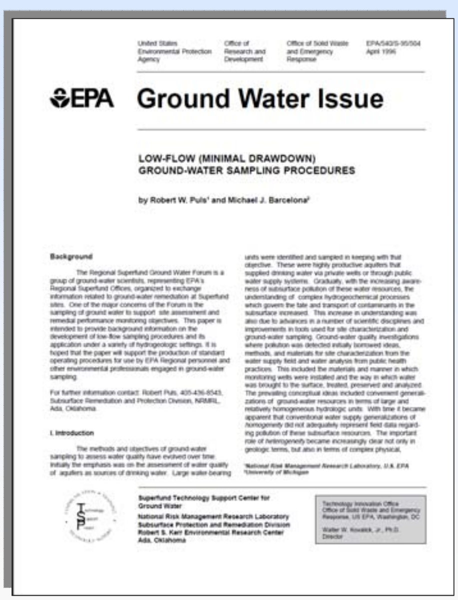
Purging Flow Rates

- From US EPA, 1996: "Typically, flow rates on the order of 0.1 - 0.5 L/min are used, however this is dependent on site-specific hydrogeology. Some extremely coarse-textured formations have been successfully sampled in this manner at flow rates to 1 L/min."
- The goal is to achieve a stabilized pumping water level as quickly as possible. This reduces mixing within the borehole, drawing water from the sampling zone.
- Flow rates are established for each well based on drawdown values measured during purging, not an arbitrary value or upper limit.

Sampling Flow Rates

- Sampling flow rates "less than 0.5 L/min are appropriate." (US EPA 1996).
- Use rates at or below the purging flow rate for metals and other inorganic parameters, lower rates (100 ml/min.) for VOCs and filtered samples.
- Fill larger sample bottles first, then reduce the flow rate (if needed) for VOCs and any filtered parameters.
- Sampling at 100 ml/minute for all parameters can extend sampling times unnecessarily.

Water Level Drawdown



United States Environmental Protection Agency | Office of Research and Development | Office of Solid Waste and Emergency Response | EPA/540/S-95/504 April 1996

EPA **Ground Water Issue**

LOW-FLOW (MINIMAL DRAWDOWN) GROUND-WATER SAMPLING PROCEDURES

by Robert W. Puls[1] and Michael J. Barcelona[2]

Background

I. Introduction

[1]National Risk Management Research Laboratory, U.S. EPA
[2]University of Michigan

Superfund Technology Support Center for Ground Water

National Risk Management Research Laboratory
Subsurface Protection and Remediation Division
Robert S. Kerr Environmental Research Center
Ada, Oklahoma

Technology Innovation Office
Office of Solid Waste and Emergency Response, US EPA, Washington, DC

Walter W. Kovalick, Jr., Ph.D.
Director

From USEPA 1996, Puls and Barcelona:

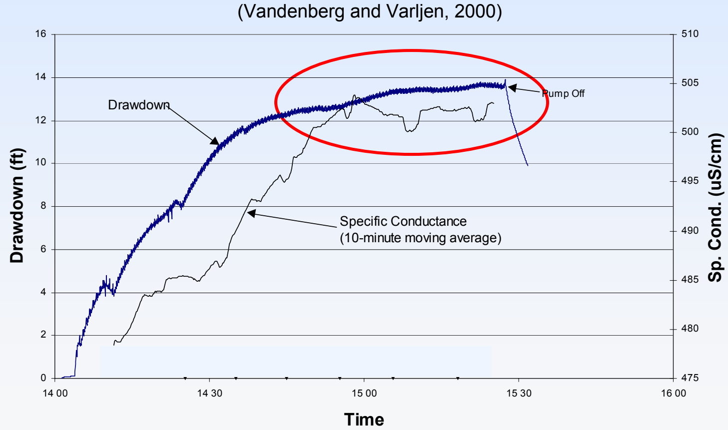
"The goal is minimal drawdown (0.1m) during purging. This goal may be difficult to achieve under some circumstances… and __may require adjustment based on site-specific conditions and personal experience__."

Water Level Drawdown

- The recommendation from Puls and Barcelona (1996) has been interpreted as a maximum drawdown limit in some regulatory guidance documents. There is no data to support this or any other arbitrary drawdown limit.
- A study by Vandenberg and Varljen (2000) shows that the goal is to establish a stable pumping water level during purging, with indicator parameter stabilization following water level stabilization.

Correlation of Drawdown and Indicator Parameter Stabilization

Drawdown and Specific Conductance During Purging
St. John's Landfill Well D-2A
(Vandenberg and Varljen, 2000)



At the point where the water level stabilized, the indicator parameters (conductivity shown above) and target analytes were also stabilized.

Indicator Parameters for Purging

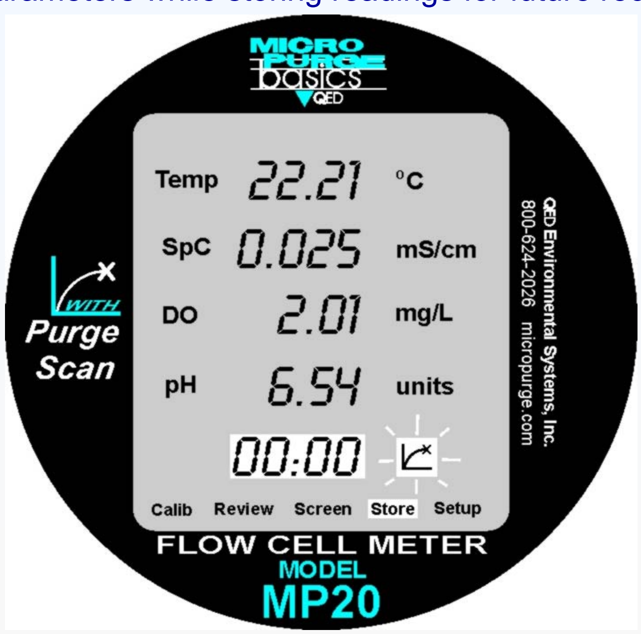
- Indicator parameters often include pH, temperature, conductivity, DO, ORP (redox) and turbidity.
- DO and C are the most reliable indicators, based on published research and field experience.
  - pH stabilizes readily, often shows little change.
  - Temperature measured at the well head is affected by sunlight, ambient temperature, and some electric pumps
  - Turbidity cannot indicate when purging is completed. It should be measured primarily to support sample data and prevent excessive pumping/formation stress.
- Stabilization criteria are typically ± 3-10% of readings or a range of units (e.g., ± 0.2 mg/L DO, ± 0.2 pH units) where percentages are not appropriate. Stabilization occurs when three consecutive readings fall within the criteria.

Measuring indicator parameters

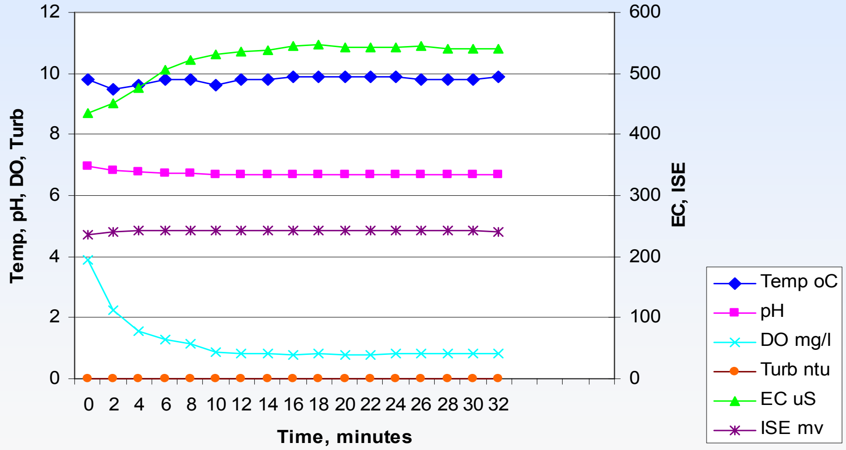
- Traditional approaches use hand-held or bench-top instruments that expose samples to air and make precise measurement intervals difficult.
- Readings may not appear stable even though water chemistry has stabilized.

An in-line flow cell isolates water from air, maintaining water chemistry and allowing automated measurement. Open-top “flow containers” can’t achieve accurate values for dissolved oxygen or redox due to rapid gas exchange.

Typical flow-cell output provides simultaneous display of parameters while storing readings for future recall



Typical Indicator Parameter Stabilization Curves



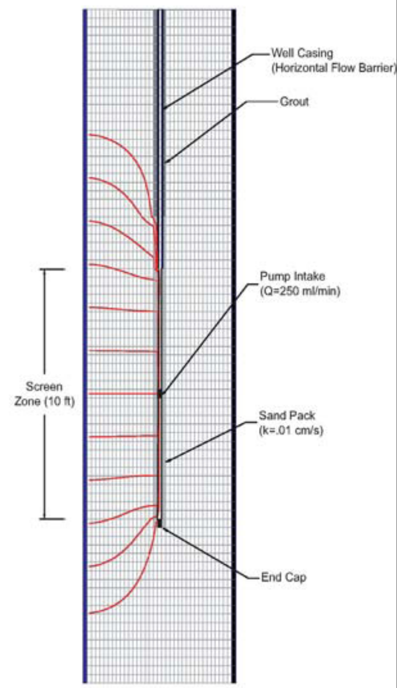
Other issues surrounding proper use of low-flow purging and sampling and regulatory acceptance

- Do low-flow samples represent the entire well screen zone, or just a discrete interval?
- Does the pump inlet location affect sample results?
- Does low-flow sampling work in longer well screens, or is there a practical screen length limit?

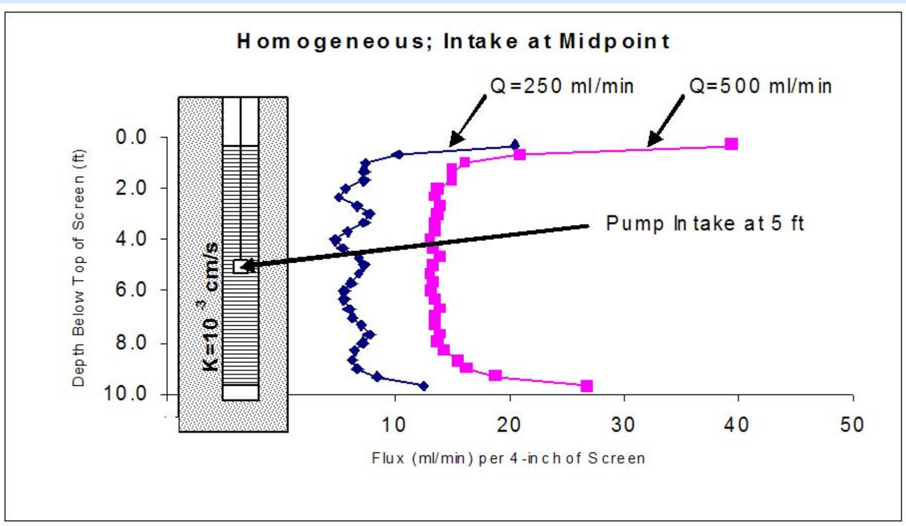
What Does a Low-Flow Sample Represent?

Empirical studies and modeling simulations show that the entire well screen contributes to the sample

- Flow into screen is controlled by the geology near the well, regardless of pump position; high K zones contribute more water
- The actual zone monitored is longer than the length of the screen
- Same for 5, 10, and 20 foot screens
- Applies to both fully submerged screens and screens intersecting the water table

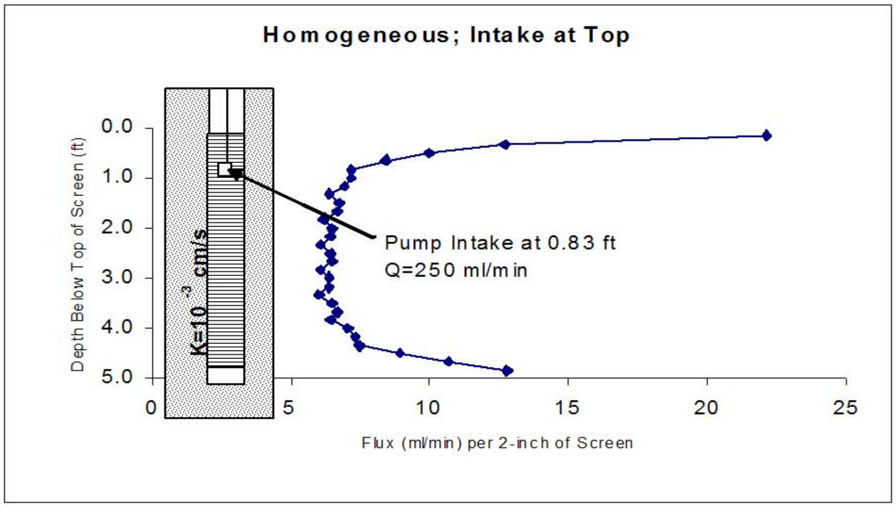


Vertical Distribution of Flux into a 10-foot Well Screen and Effect of Changes in Pumping Rate



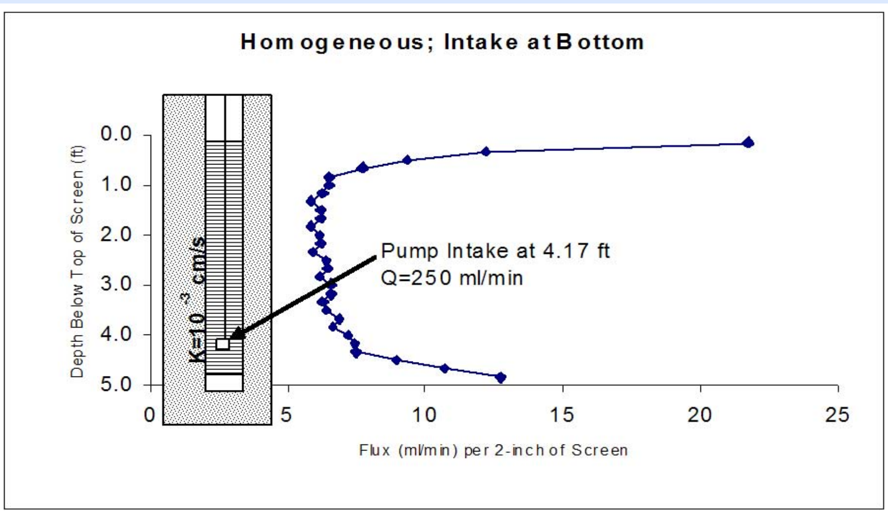
Varljen, et al. 2006

Effect of Pump Placement on Vertical Flux Distribution



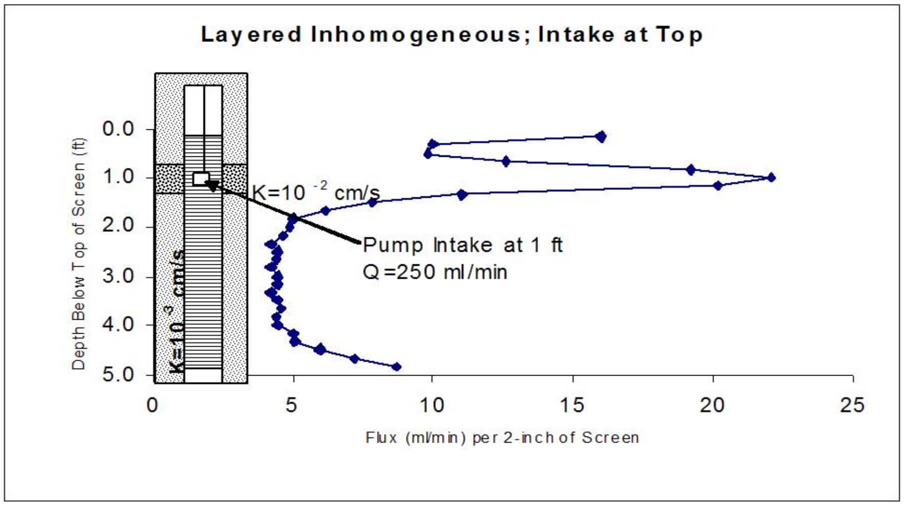
Varljen, et al. 2006

Effect of Pump Placement on Vertical Flux Distribution



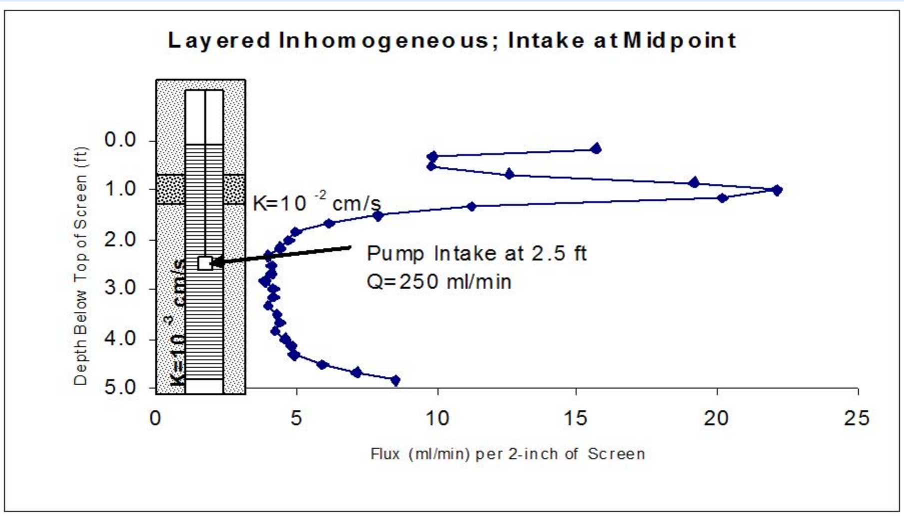
Varljen, et al. 2006

Effect of Heterogeneities on Flux Distribution Pattern



Varljen, et al. 2006

Effect of Heterogeneities on Flux Distribution Pattern



Varljen, et al. 2006

Vertical Concentration Profiles (Puls and Paul, 1998)

- Low-flow sample concentrations were averaged throughout the well screen; analyte concentrations were known to be measurably stratified within the surrounding formation.
- Low-flow samples were virtually identical to the mean concentration of the multi-level and direct-push samples taken.
- Bailed sample concentrations were biased lower than the low-flow pumped sample results.

Device	DMLS	Geoprobe	Low-Flow	Bailer
Cr (mg/l)	1.69	1.86	1.76	1.05

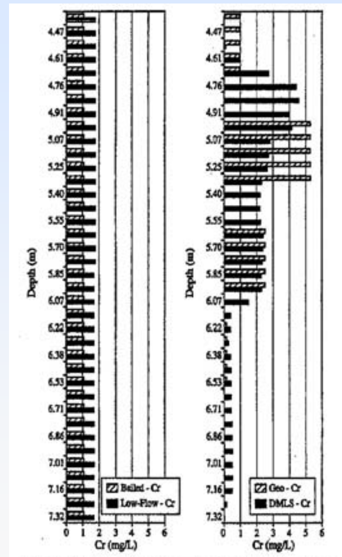
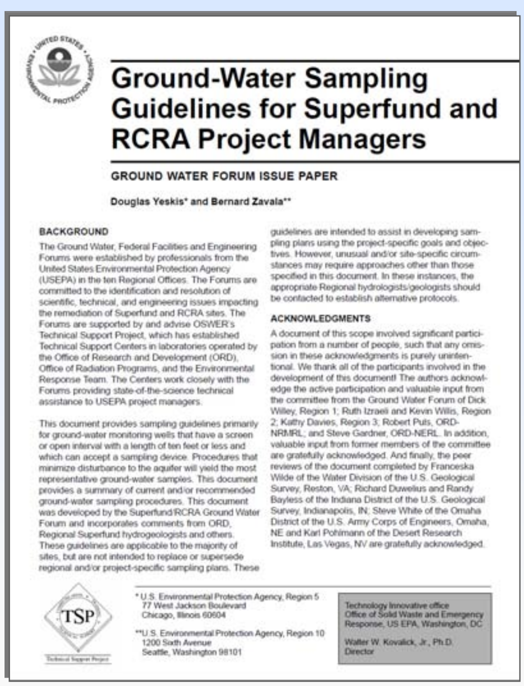


FIG. 6. Chromium Data for Samples Collected Using DMLS, Low-Flo, and Bailed Sampling Approaches for Well 45 in September 1995



Ground-Water Sampling Guidelines for Superfund and RCRA Project Managers

GROUND WATER FORUM ISSUE PAPER

Douglas Yeskis* and Bernard Zavala**

BACKGROUND

The Ground Water, Federal Facilities and Engineering Forums were established by professionals from the United States Environmental Protection Agency (USEPA) in the ten Regional Offices. The Forums are committed to the identification and resolution of scientific, technical, and engineering issues impacting the remediation of Superfund and RCRA sites. The Forums are supported by and advise OSWER's Technical Support Project, which has established Technical Support Centers in laboratories operated by the Office of Research and Development (ORD), Office of Radiation Programs, and the Environmental Response Team. The Centers work closely with the Forums providing state-of-the-science technical assistance to USEPA project managers.

This document provides sampling guidelines primarily for ground-water monitoring wells that have a screen or open interval with a length of ten feet or less and which can accept a sampling device. Procedures that minimize disturbance to the aquifer will yield the most representative ground-water samples. This document provides a summary of current and/or recommended ground-water sampling procedures. This document was developed by the Superfund/RCRA Ground Water Forum and incorporates comments from ORD, Regional Superfund hydrogeologists and others. These guidelines are applicable to the majority of sites, but are not intended to replace or supersede regional and/or project-specific sampling plans. These guidelines are intended to assist in developing sampling plans using the project-specific goals and objectives. However, unusual and/or site-specific circumstances may require approaches other than those specified in this document. In these instances, the appropriate Regional hydrologists/geologists should be contacted to establish alternative protocols.

ACKNOWLEDGMENTS

A document of this scope involved significant participation from a number of people, such that any omission in these acknowledgments is purely unintentional. We thank all of the participants involved in the development of this document! The authors acknowledge the active participation and valuable input from the committee from the Ground Water Forum of Dick Willey, Region 1; Ruth Izraeli and Kevin Willis, Region 2; Kathy Davies, Region 3; Robert Puls, ORD-NRMRL; and Steve Gardner, ORD-NERL. In addition, valuable input from former members of the committee are gratefully acknowledged. And finally, the peer reviews of the document completed by Franceska Wilde of the Water Division of the U.S. Geological Survey, Reston, VA; Richard Duwelius and Randy Bayless of the Indiana District of the U.S. Geological Survey, Indianapolis, IN; Steve White of the Omaha District of the U.S. Army Corps of Engineers, Omaha, NE and Karl Pohlmann of the Desert Research Institute, Las Vegas, NV are gratefully acknowledged.

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Screen Length Limits Using Low-Flow

- USEPA, 2002 guidelines limit low-flow purging to wells with screens 10’ or less.
- Their reference for this limit (USEPA, 1996, Puls and Barcelona) DOES NOT support it.
- No other independent data or any other published study is cited to support the limit.
- Some state regulatory agencies have used the USEPA 2002 guidelines to limit use of low-flow purging to well screens no longer than 5-10 feet.

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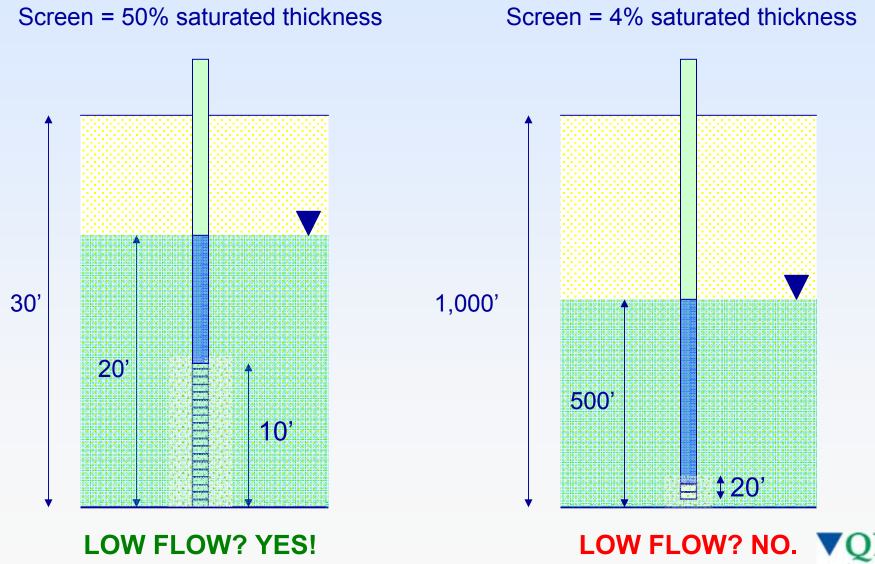
Well screen length controversy



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Screen Length Issues and Objectives

- The issue of well screen length is one of <u>monitoring program objectives</u> and **<u>not</u>** a sampling method issue.
- The length of the screen (i.e., the target monitoring zone) should relate to the saturated thickness and identifiable preferential flow paths and should not be based on an arbitrary design or guideline.
- Previously mentioned studies support using low-flow purging and sampling in well screens to 20 feet.

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Summary

- Traditional well purging methods can cause significant bias and error in groundwater sample data.
- Low-flow purging and sampling can overcome many of the problems associated with traditional well-volume purging, hand bailing and high-rate pumping.
- Proper application of low-flow sampling requires attention to pumping rate, drawdown and indicator parameter stabilization.
- Low-flow purging and sampling will provide a flow-weighted average sample from most monitoring wells when used correctly.
- Pumping rate, drawdown and screen length should not be based on arbitrary limits.

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Questions?

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