GAINESVILLE REGIONAL UTILITIES

Strategic Planning Department

June 18, 2008

Mr. Scott Miller
Remedial Project Manager
United States Environmental Protection Agency
Region IV, Superfund North Florida Section
61 Forsyth Street, SW
Atlanta, GA 30303

RE: GRU Comments to Sentinel Monitoring Well Installation Work Plan (May 20, 2008)

Dear Mr. Miller:

This letter provides GRU's comments to the Sentinel Monitoring Well Installation Work Plan provided by GeoTrans (dated May 20, 2008). GRU appreciates Beazer and EPA's efforts toward developing a robust long-term Floridan Aquifer sentinel monitoring program at the Koppers site, which will be a critical component in ensuring the long-term protection of the City's water supply. Our comments are below. Also attached are additional more detailed comments provided by our consultant team.

1. Monitoring Well Locations
The proposed off-site sentinel monitoring well clusters will be beneficial in conjunction with on-site Floridan wells. GeoTrans' proposed locations for these off-site wells, down-gradient of the Koppers site, are reasonable to us.

The inherent limitation of the off-site wells is that they might not detect a plume which is not moving directly down-gradient due to anisotropic conditions. For this reason, a closely-spaced network of wells along the perimeter of the Koppers site is critical. Based on our consultants' review of the information to date, we would propose two additional on-site monitoring well locations (with multi-level UTZ and LTZ wells) along the perimeter of the site: between FW-22B and FW23B, and between FW-23B and FW-4C.

Additional locations (beyond the two off-site and 2 on-site locations discussed above) may or may not be necessary pending the results from the additional wells which are proposed to be installed in the vicinity of FW-12B; these wells were originally identified as FW-25C and FW-26B&C in the Geotrans March 12 Meeting Agenda. We strongly recommend that these 3 wells plus an additional UTZ well (FW-25B) adjacent to FW-25C be completed prior to finalizing the locations of the additional perimeter wells. Given description of 'strong creosote odors' as deep as 233 ft bgs in the boring log of FW-12B, it will be critical for GeoTrans and Beazer to install sampling and pumping ports in the Westbay systems to at least that depth.

2. Drilling Method
During the course of the construction of the existing on-site multi-level Floridan wells, there was much discussion about the drilling method. We are concerned that the rotosonic drilling method may have caused the formation of mud caking on the sides of the boreholes, which

P.O. Box 147117, Station A136, Gainesville, Florida 32614-7117, Phone: (352) 334-3400 ext. 1218 Fax: (352) 334-3151

would lead to artificially low aquifer conductivity at the wells and may affect the communication with the aquifer.. In addition, we are concerned that the "unconsolidated" Floridan cores were the result of the drilling method and not representative of the aquifer condition. We strongly recommend that Beazer and GeoTrans consider how more complete hydraulic communication between the well and the Floridan Aquifer can be accomplished. Ideally, well development would continue until the section under development has a hydraulic conductivity of the order of 10 ft/day for the UTZ and 100 ft/day for the LTZ. This step will ensure that the monitoring well is fully connected to the adjacent limestone.

3. Well Construction
Because of concerns expressed by the Beazer Independent Panel about the failure of grout to seal the annular spaces surrounding the monitoring wells, it is recommended that the grout be allowed to cure for 24 hours following emplacement. Furthermore, the integrity of the grout seal should then be checked by the completion of a wireline sonic log to detect zones of incomplete grouting.

4. Well Completion
It is not clear to us whether GeoTrans intends to install Westbay type multi-level wells or not. Regardless of the brand or type of sampler unit, we request that the wells meet the following performance criteria:

a) sample minimum of four discrete UTZ and three discrete LTZ intervals
b) prohibit vertical flow between intervals (both during sampling and on a continuous basis)
c) yield sufficient sample to conduct the required analyses

As indicated earlier, more detailed comments from our team are attached.

Thank you very much for your on-going effort in addressing the Cabot/Koppers Superfund site. If you need additional information, please contact me at 352-393-1218.

Sincerely,

Richard A Hutton

Rick Hutton, P.E.
Supervising Utility Engineer

xc: John Mousa (ACEPD)
Kelsey Helton (FDEP)
Mitchell Brourman (Beazer East, Inc.)
John Herbert, Brett Goodman (Jones Edmunds)
David Richardson, Ron Herget (GRU)
Correspondence

GRU DNAPL TEAM COMMENTS TO THE
UPPER FLORIDAN AQUIFER
SENTINEL MONITORING WELL INSTALLATION
WORK PLAN
KOPPERS INC. SITE
GAINESVILLE, FLORIDA
(Report Dated MAY 20, 2008)
(Revised Report (Figures 4, 5, and 6) Dated JUNE 10, 2008)

The GRU DNAPL Team has reviewed the Upper Floridan Aquifer Sentinel Monitoring Well Installation Work Plan for the Koppers Inc. Site dated May 20, 2008 (Work Plan). This Work Plan was prepared by GeoTrans, Inc. for Beazer East, Inc. and addresses upcoming installation of Upper Floridan Aquifer sentinel monitoring wells north of the Koppers Inc. Site. We have several comments relative to the proposed scope of work.

1. During a telephone conversation with Jim Erickson to resolve minor discrepancies between text and figures, Jim stated that GeoTrans is having difficulty sampling the Westbay Wells and that wells proposed in this plan will not include multi-port sampling equipment. Instead, all four Upper Transmissive Zone (UTZ) and three Lower Transmissive Zone (LTZ) screens will be open to the formation simultaneously. We believe that Westbay (or equivalent) multi-port systems must be installed in both the UTZ and LTZ sentinel monitoring wells. Reasons for requiring Westbay (or equivalent) multi-port system completions include the following:
    a. Vertical flow is likely in a well that has open screen intervals spanning 70 feet of Ocala Limestone. Vertical flow within the monitoring wells will result in the groundwater analytical data being biased toward groundwater quality at the screened interval that contributes the greatest volume of groundwater to the monitoring wells – to the possible exclusion of all other screened intervals. Please see the attached document titled Ambient Flow in Monitoring Wells: Causes, Measurement Simulation and Evaluation by Fred J. Molz, III and Alper Elci. This document explains why we believe it is ill-advised to complete the sentinel monitoring wells in a manner that will allow vertical flow within the well.
    b. Differences in vertical distribution of contaminants were identified at Koppers because we have multiple, discrete sample points from which groundwater is recovered. We believe that that level of detail is required at the sentinel wells. Examples of vertical changes in groundwater quality are illustrated by FW-12B and by FW-16B, FW-20B, and FW-21B.

    Multi-level monitoring system performance criteria should include the following:
        1. Sample minimum of four discrete UTZ and three discrete LTZ intervals
        2. Prohibit vertical flow between intervals (both during sampling and on a continuing basis)
        3. Yield sufficient sample to conduct the required analyses

2. Regarding Figures 5 and 6 of the Work Plan, we understand that GeoTrans intends to construct a 5-foot sump for both the UTZ and LTZ sentinel monitoring wells because the lack of an intended Westbay multi-port system makes it unnecessary to have a 15-foot

sump to accommodate the long sampling train. We disagree with GeoTrans' decision to not install a multi-port system for the reasons enumerated above and therefore believe that 15-foot sumps are necessary for both the UTZ and LTZ sentinel monitoring wells.

3. Gainesville Regional Utilities (GRU) views these offsite sentinel monitoring wells as one part of the final Floridan Aquifer Monitoring Program. Representatives from GRU have expressed previously that approximately two or three additional monitoring locations will likely be necessary along the northern and eastern site perimeter for the final Floridan Aquifer Monitoring Program, particularly between existing locations FW-22B and FW-23B, and between FW-23B and FW-4C.

4. In prior telephone discussions, Beazer indicated that additional Westbay multi-port system monitoring wells would be installed onsite at two locations to the north of FW-12B where elevated concentrations of creosote compounds have been observed. UTZ wells and LTZ wells should be installed at both of these locations. GRU would prefer to have the two onsite installations completed, sampled, and analytical data evaluated before finalizing the locations for the additional perimeter wells.

5. Given the recent speculation by the Independent Panel about the failure of grout to seal the annular spaces surrounding other monitoring wells onsite, we recommend that the grout be allowed to cure for 24 hours, not "a minimum of 12 hours." Furthermore, we recommend that after 24 hours of curing, the monitoring wells be tested by a wireline sonic log (Cement Bond Log) to evaluate the degree to which grout does or does not completely fill the annular space between the casing and the formation.

6. We are concerned about the possibility that a "skin" or "mud cake" of sorts may form on the borehole wall during rotosonic drilling through the Ocala Limestone. The formation of "skins" or "mud cakes" would explain the very low flow rates observed during development of Floridan wells installed at Koppers. We believe that more aggressive development is required. GeoTrans should specify well development procedures and performance criteria that will be attained before well development ceases. These criteria should include not only turbidity and NaBr concentration, but also a K (~10ft/day) or T (~3,000 ft^2/day over the whole of the Ocala fm) that is reasonably similar to values at the Murphree well field.

7. Section 2.3, 1st paragraph states that "Samples from select cores may be taken for chemical analyses." We understand that Beazer has no specific sample locations or analyses in mind per Jim Erickson (GeoTrans) in a telephone conversation with John Herbert (Jones Edmunds) on Tuesday, June 3, 2008.

Ambient Flow in Monitoring Wells: Causes, Measurement Simulation and Evaluation

By

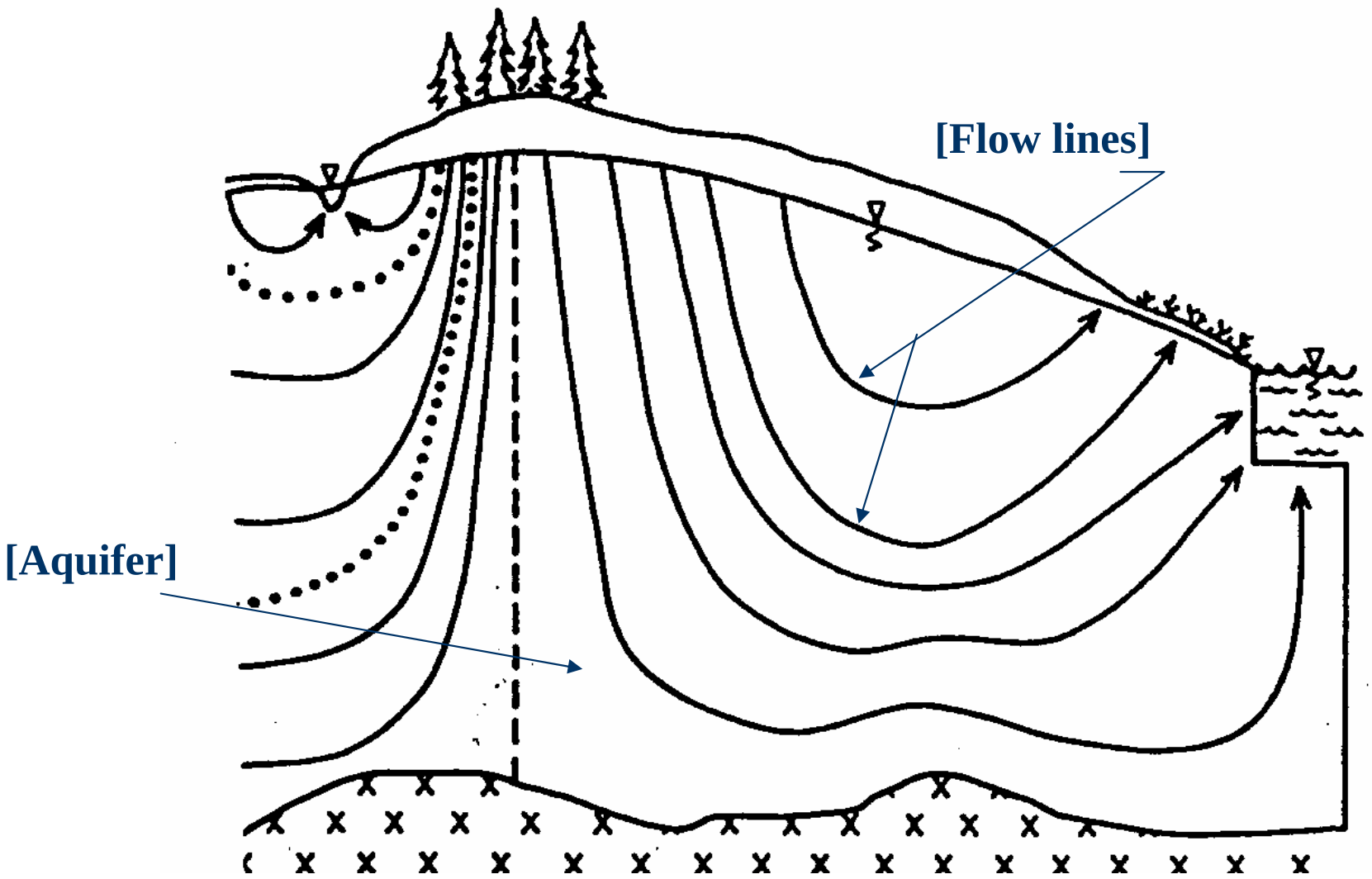
Fred J. Molz, III[1] and **Alper Elci**[2]

[1]Professor & SCUREF Distinguished Scientist, Environmental Engrg. & Geology
Clemson University, Clemson, South Carolina 29632 (fredi@clemson.edu)

[2]Senior Staff Hydrologist, S.S. Papadopulos & Associates, 7944 Wisconsin Avenue, Bethesda, MD 20906 (aelci@sspa.com)

AMBIENT FLOW AND FLOW-METERS

Hydraulic head differences drive flow in the subsurface. Whenever a well connects two regions having different heads, local ambient flow occurs.
(Ambient flow is downward in recharge areas and upward in discharge areas.)



High sensitivity flow-meters, such as the electromagnetic borehole flow-meter, increased awareness of ambient flow, because it could now be measured.

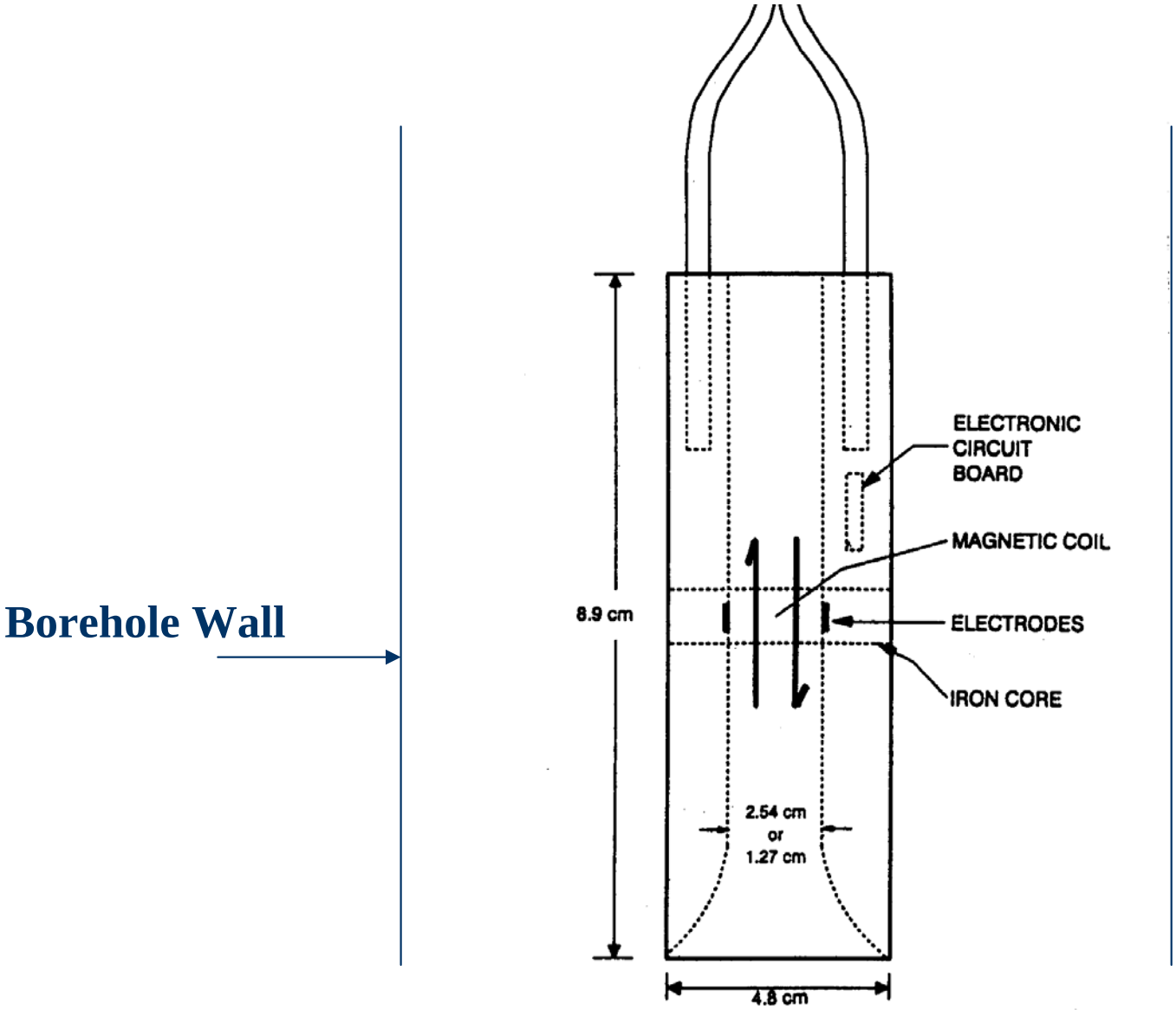
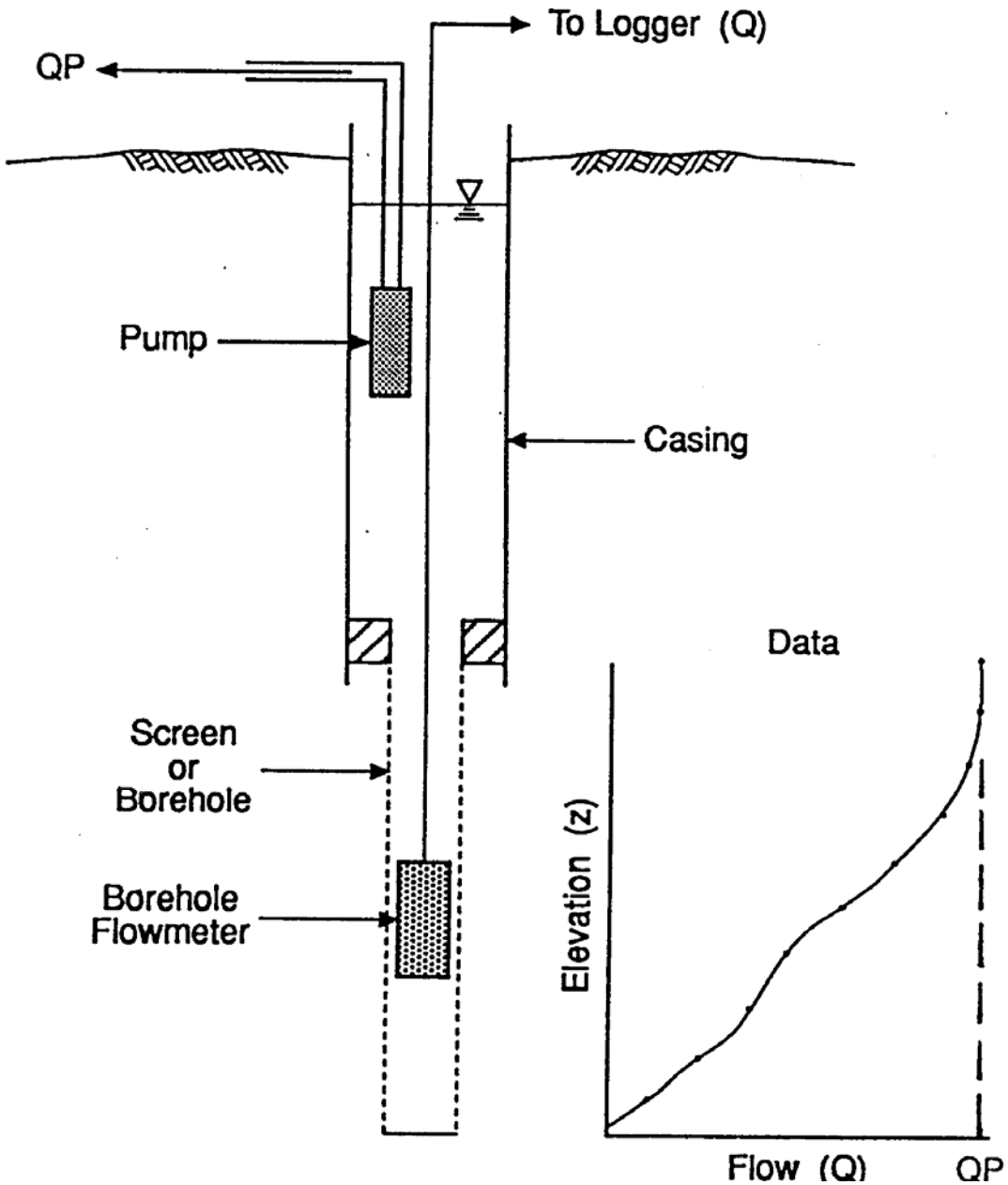


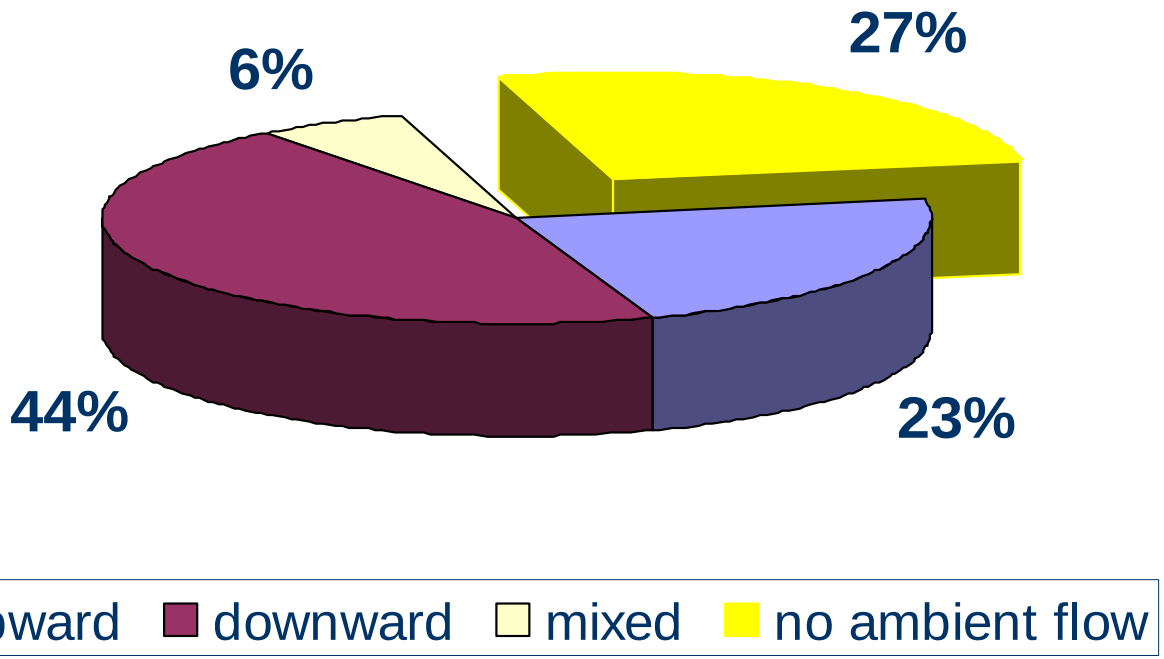
Illustration of how a flow-meter is applied.
(Pump is turned off for ambient flow measurement)



How Common Is Measurable Ambient Flow?

- 142 wells at 16 sites in 12 states
- 73% of the cases had measurable amounts of ambient flow
- Range of measured ambient flow at all sites:

  0.01 L/min - 6.2 L/min



COLLECTION OF HYDRAULIC DATA FOR AMBIENT FLOW SIMULATIONS

Flow measurements in a monitoring well.

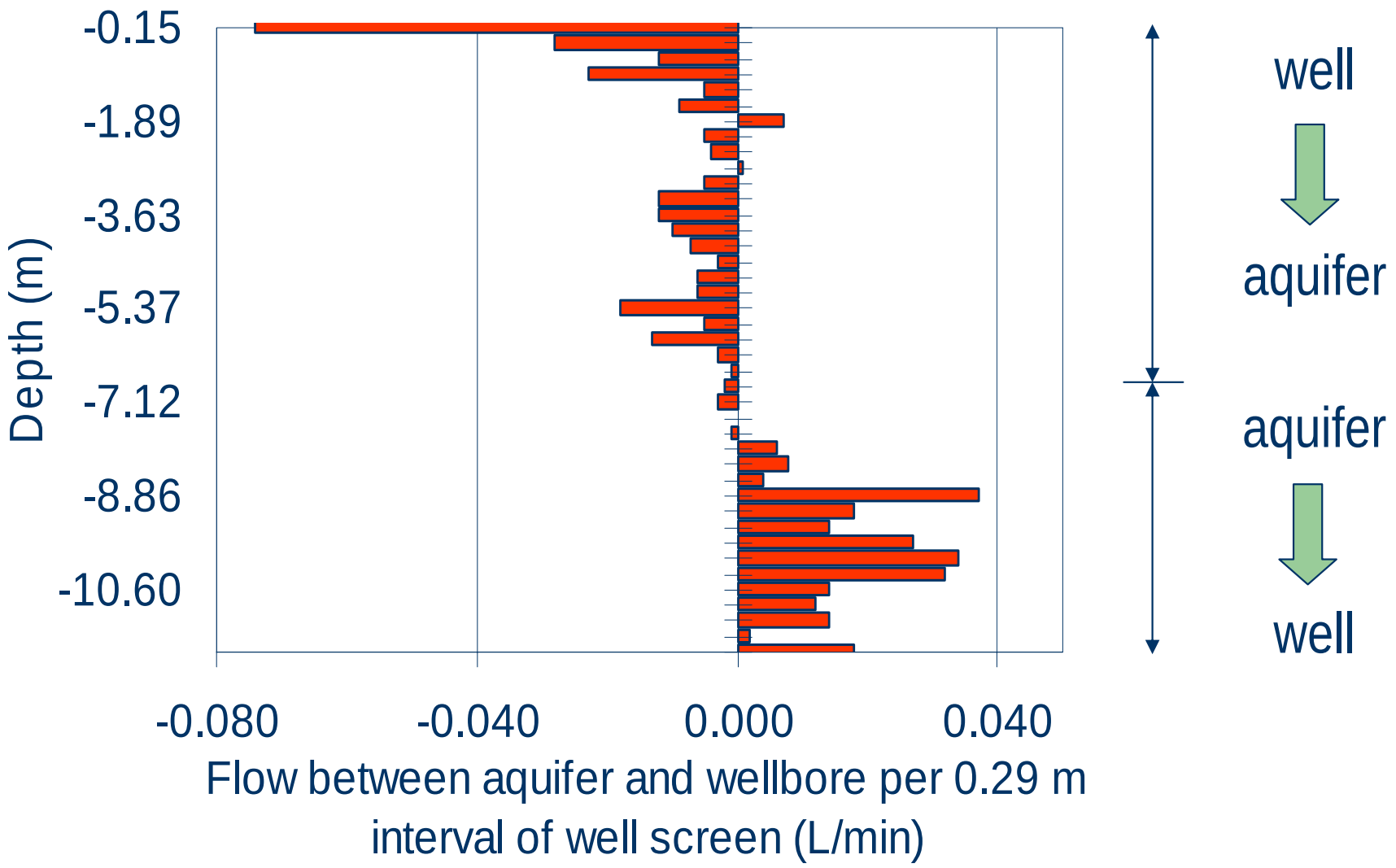
- The monitoring well is located at the Savannah River Site (SRS) in a confined aquifer (Gordon aquifer)
- Fully penetrating [15.25 cm I.D. (6 inch)] monitoring well in a 12.2 m thick aquifer

Flow measurements: (Boman et al, 1997; *Ground Water*)

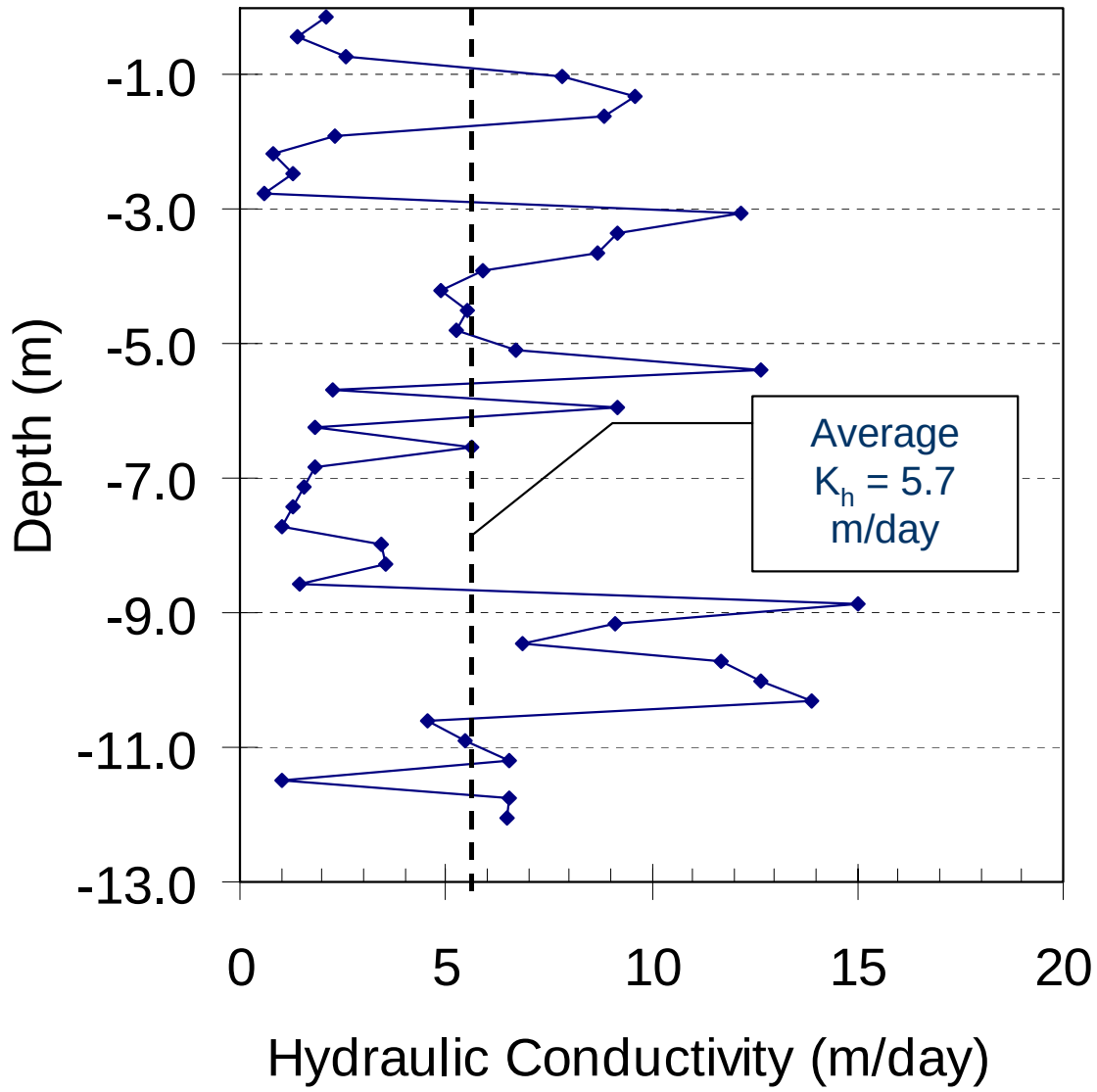
- Ambient flow distribution
- Hydraulic conductivity distribution (K)

Ambient flow enters the well through the bottom third of the screen and exits through the top half.

(upward flow ⇒ discharge area).



After the ambient flow measurement, the small pump was turned on, and data were collected for measuring the hydraulic conductivity (K) distribution.



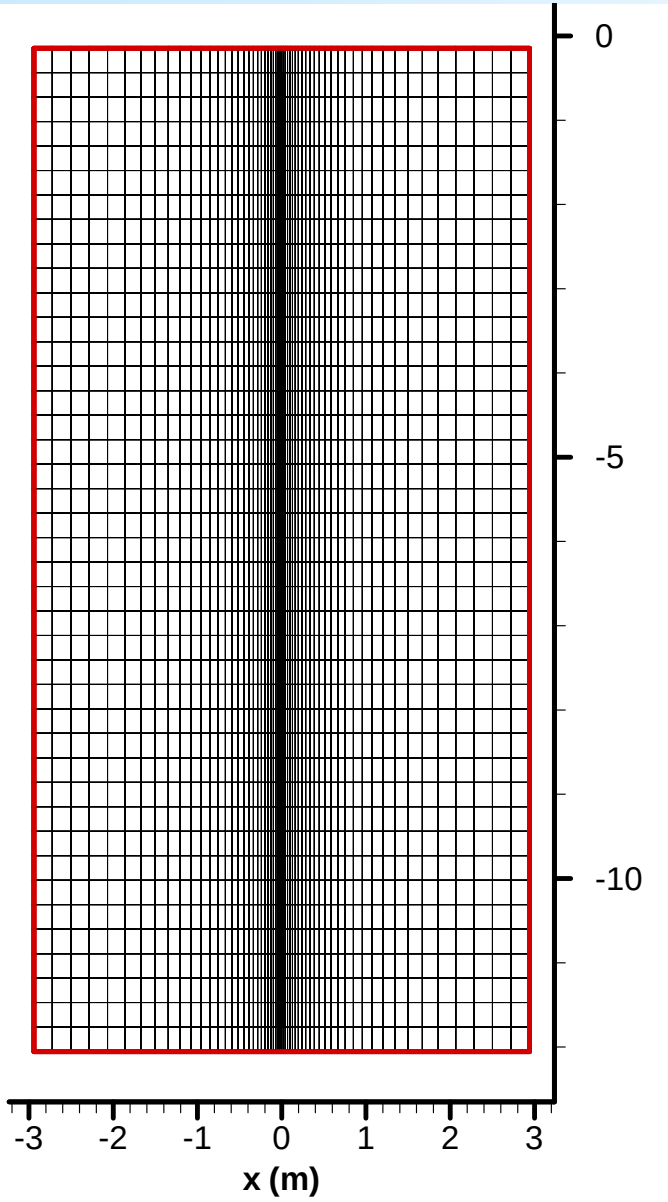
Ref: Boman et al., 1997

Additional data needed to perform an ambient flow simulation are hydraulic head gradients.

- Horizontal gradient:
  - Data source: potentiometric surface map of the Gordon aquifer at SRS
  - $\partial h / \partial x = 4.6 \times 10^{-3}$
- Vertical gradient:
  - calculated from vertical head measurements
  - $\partial h / \partial z = 5.0 \times 10^{-3}$

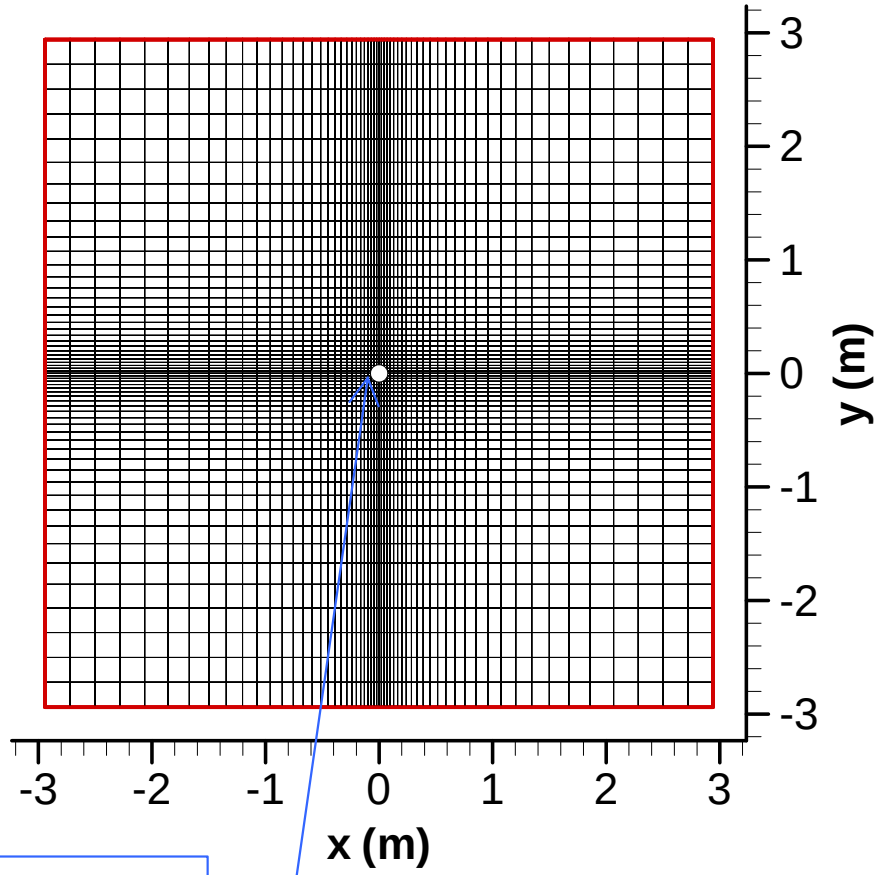
SIMULATION OF AMBIENT FLOW AND COMPARISON TO MEASUREMENTS

First a finite-difference or finite-element grid is set up for a numerical solution of the applicable flow equation.

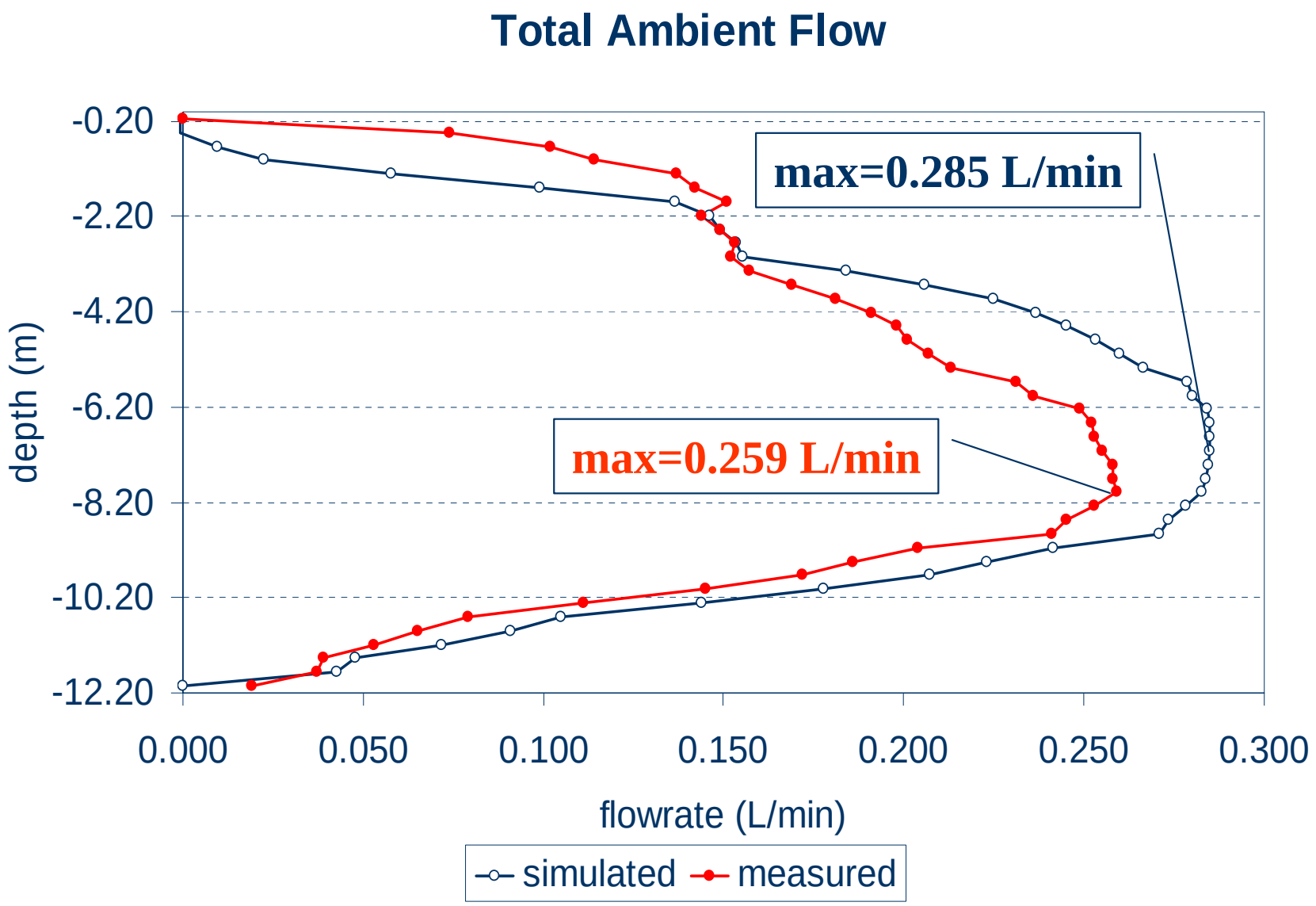


$\delta x = \delta y = 0.02 \leftrightarrow 0.22$ m

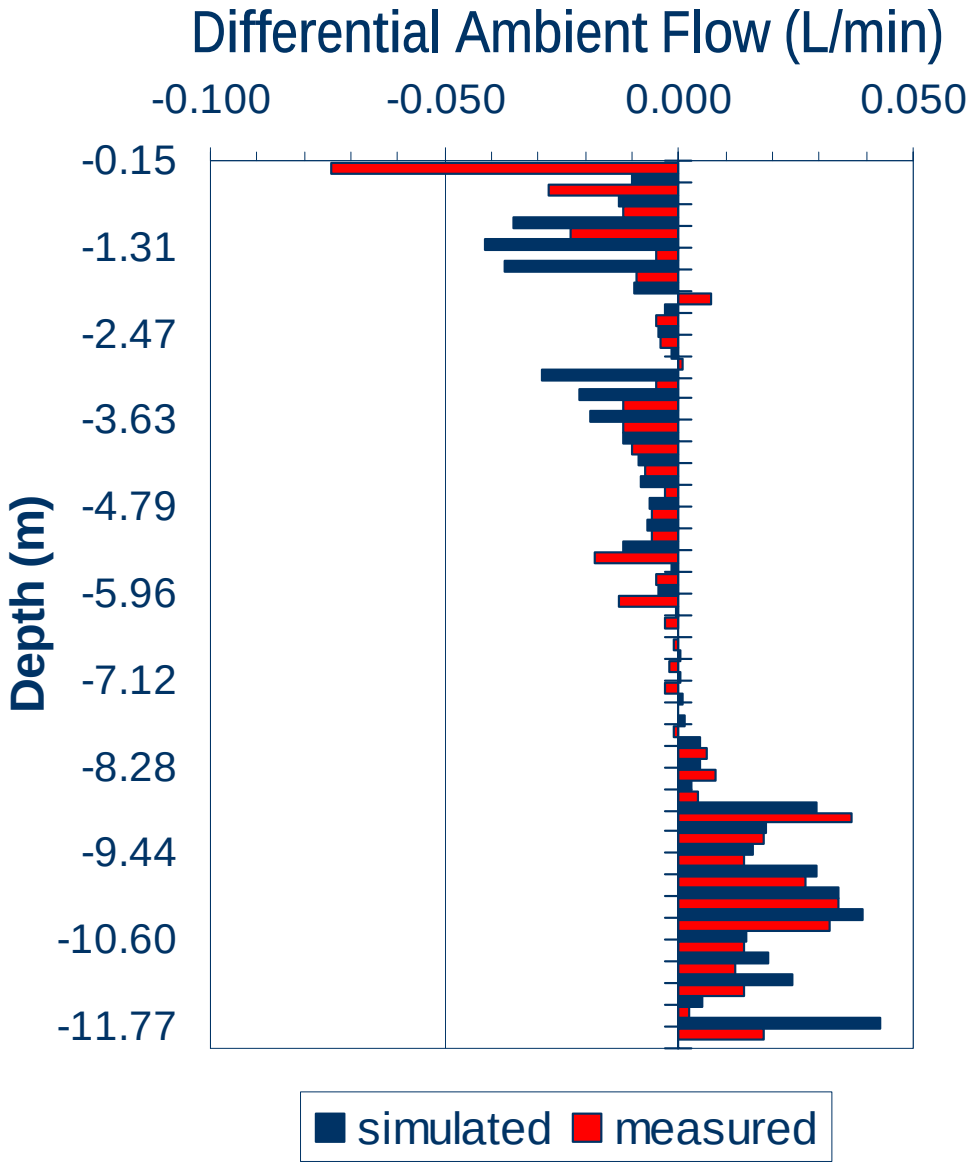
$\delta z = 0.29$ m



Using the measured K distribution and gradients, the simulation is checked by comparing measured ambient flow inside the well to simulated flow.



An even more stringent test is to compare the simulated and measured ambient flow distribution entering and leaving the well.



Evaluation of the simulated flow field.

- The magnitude and pattern of simulated ambient flow agreed fairly well with field data.
- Flow entered the screen mainly through high K layers in the lower half of aquifer, and exited through high K layers in the upper half.
- The conceptual model was realistic and able to simulate ambient flow.

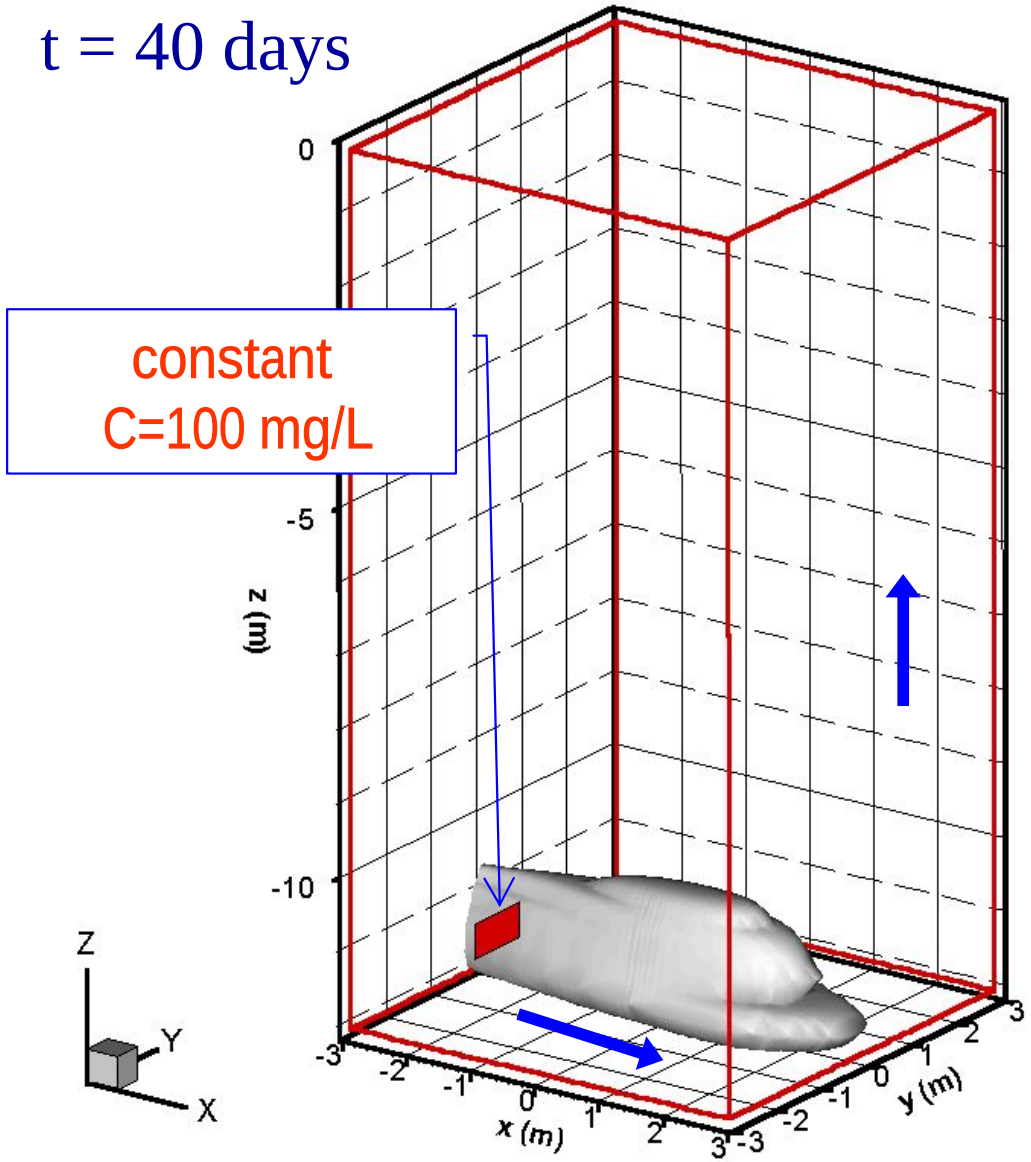
SIMULATION OF TRACER TRANSPORT IN THE AMBIENT FLOW-FIELD

3-D tracer transport simulations in the calculated ambient flow-field.

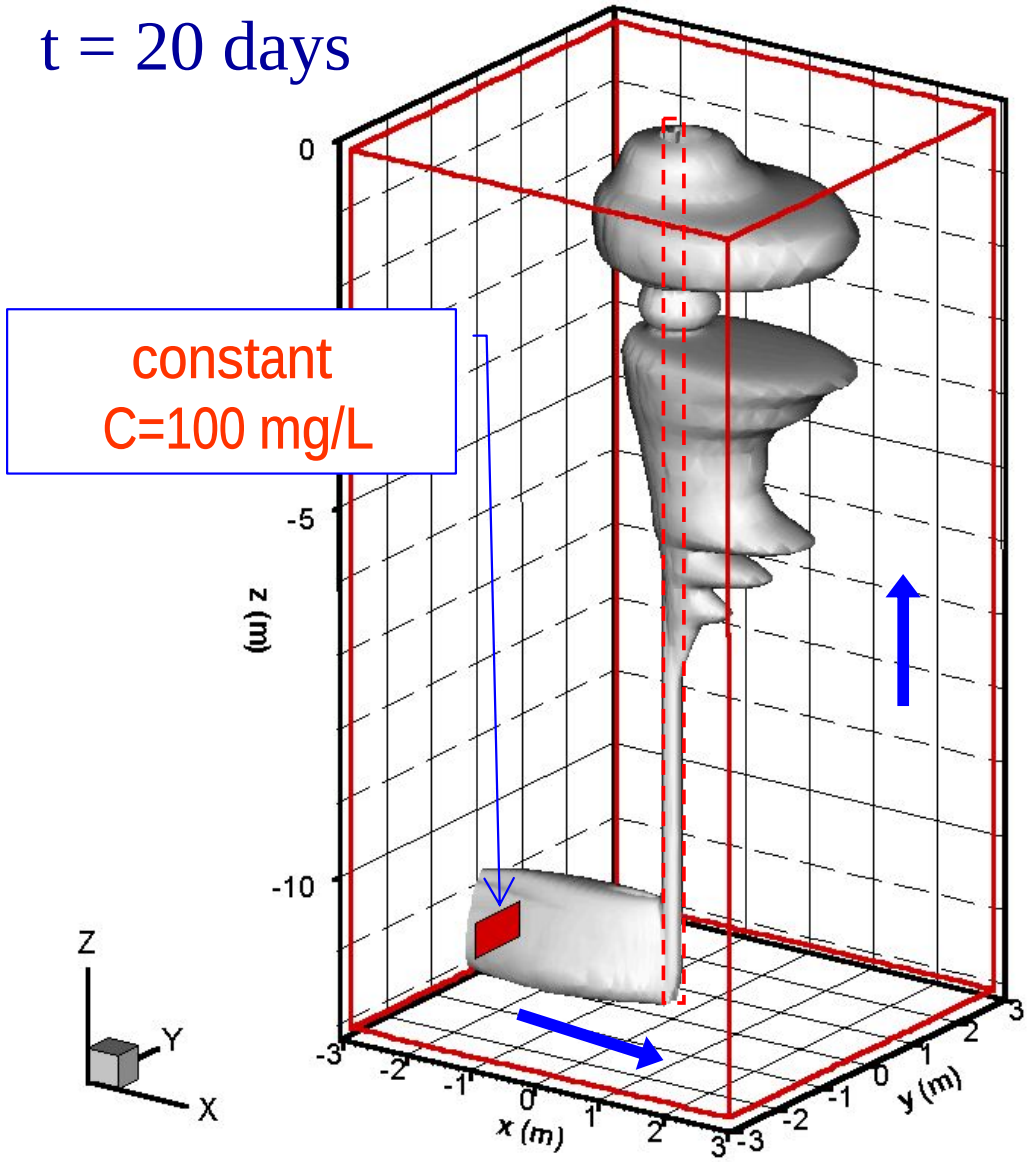
How does the presence of ambient flow affect the size and location of a tracer plume that is initially located upstream of the wellbore?

- The ambient flow simulation outlined previously was used.
- MT3DMS was selected as the transport model.
- A small local dispersivity was selected as α = 10 cm.

Transport Simulation Results - without a well



Transport Simulation Results - with a well

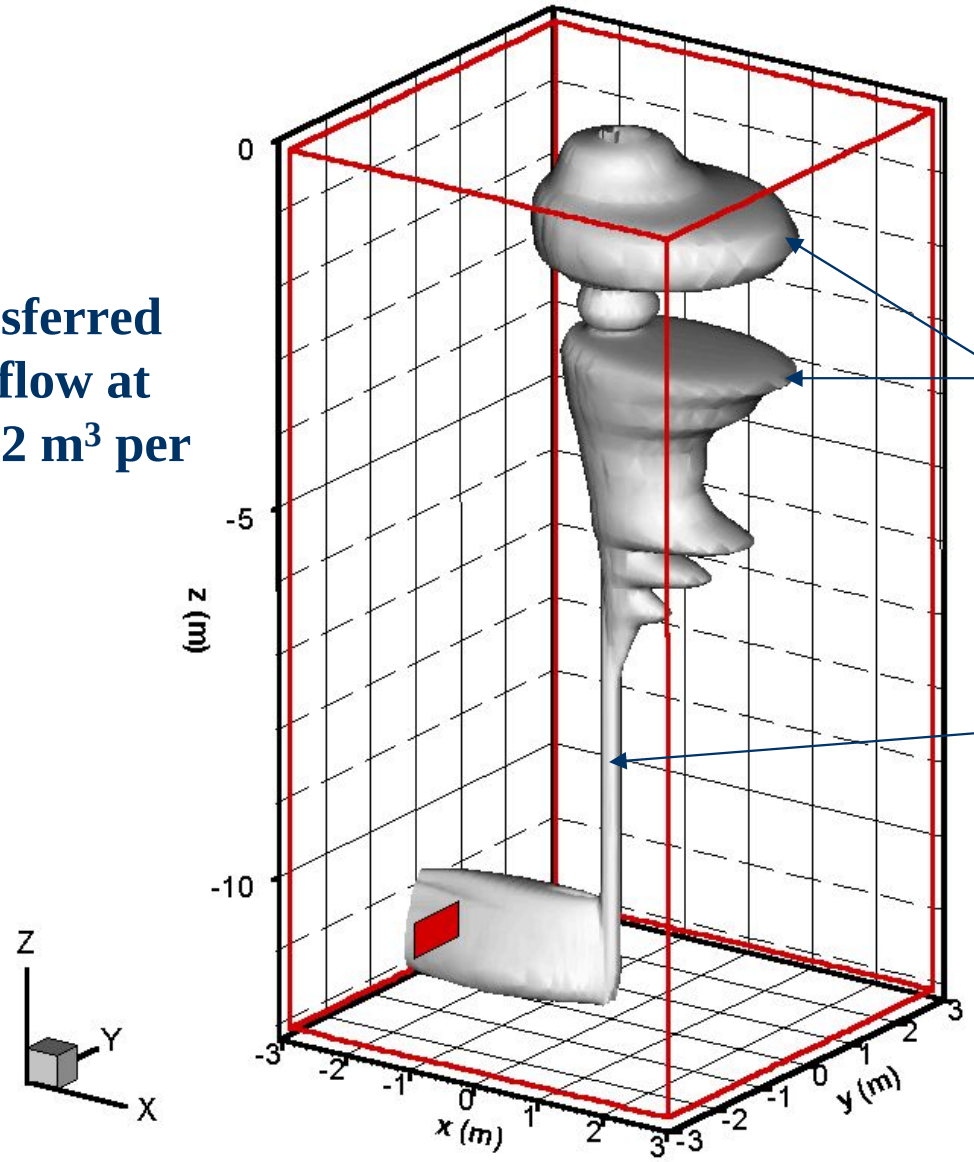


Summary of the Transport Simulation Results:

- The monitoring well functioned as a preferential flow channel, which caused tracer to disperse over the entire well length.
  - The dilution of GW samples from a long-screened well can lead to misinterpretation of ground water remediation efforts.
  - A massive displacement of the tracer plume can cause a redistribution of contaminants.
  - In ambient outflow zones, contaminants can bypass the monitoring well entirely.
  - A large volume of non-local groundwater (tens of m^3) can build up around the ambient outflow zones of a monitoring well.

More simulated Ambient flow details:

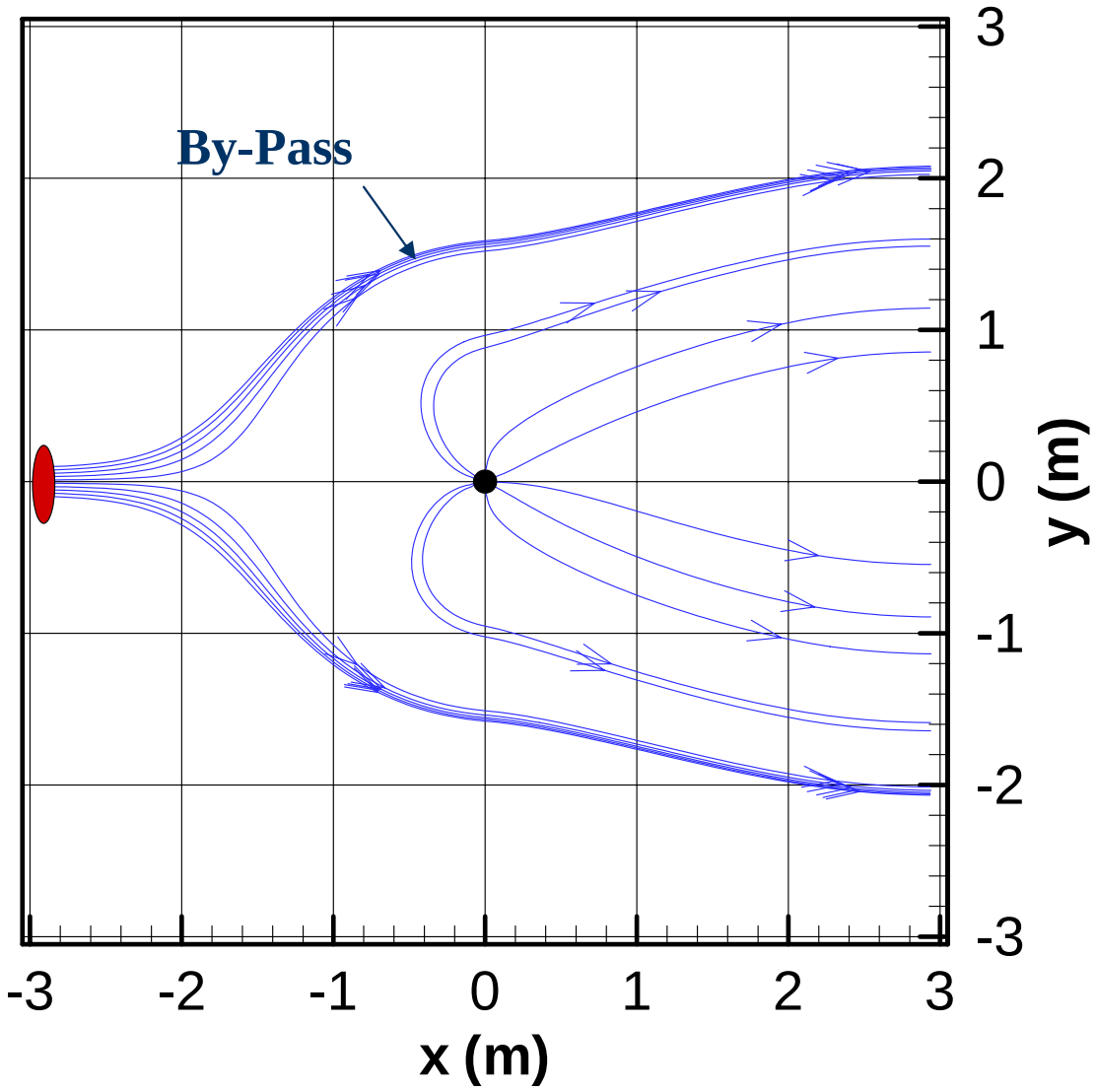
(Water transferred by ambient flow at the rate of 12 m^3 per month.)



Ambient outflow zones

Plume diluted here

Source Flow Divergence and By-Pass of Monitoring Well



Horizontal Cross-section at a depth of 1.3m where ambient outflow from the well occurs.

Conclusions & Recommendations

- Ambient flow is a common occurrence.
- Modern borehole flow-meters can measure such flow.
- Sampling from long-screened monitoring wells can be highly misleading, yielding an ambiguous relationship between sample concentration and plume characteristics (concentrations and geometry).
- Exchange of ground water happens continuously involving large flow volumes. Therefore, purging does not solve the problem.
- The problem can be solved through the use of multilevel sampling.

References

- Crisman, S.A., F.J. Molz, D.L. Dunn and F.C. Sappington, Application procedures for the electromagnetic borehole flowmeter in shallow unconfined aquifers, *Ground Water Monitoring & Remediation, 21*, 96, 2001.
- Church, P.E. and G.E. Granato, Bias in ground water data caused by well-bore flow in long-screen wells, *Ground Water, 34, 262, 1996.*
- Dinwiddie, C.L., N.A. Foley and F.J. Molz, In-Well hydraulics of the electromagnetic borehole flowmeter, *Ground Water, 37,* 305, 1999.
- Elci, A., F.J. Molz and W.R. Waldrop, Implications of observed and simulated ambient flow in monitoring wells, *Ground Water, 39*, 853, 2001.
- Elci, A., G.P. Flach and F.J. Molz, Detrimental effects of natural vertical head gradients on chemical and water level measurements in observation wells : Identification and control, *Journal of Hydrology, 281*, 70, 2003.
- Hutchins, S.R. and S.D. Acree, Ground water sampling bias observed in shallow, conventional wells, *Ground Water Monitoring & Remediation, 20*, 86, 2000.
- Molz, F.J. and S.C. Young, Development and application of borehole flow-meters for environmental assessment, *The Log Analyst, 3,* 13, 1993.
- Morin, R.H., A.E. Hess and F.L. Paillet, Determining the distribution of hydraulic conductivity in a fractured limestone aquifer by simultaneous injection and geophysical logging, *Ground Water, 26*, 587, 1988.
- Reilly, T.E., O.L. Franke and G.D. Bennett, Bias in groundwater samples caused by wellbore flow, *ASCE Journal of Hydraulic Engineering, 115,* 270, 1989.