Hydraulic Testing, Wellfield Design and Installation

Duke Engineering and Services

Duke Engineering & Services℠
A Duke Energy Company

SEAR Workshop

Overview

- Hydraulic Testing
- Wellfield Design
- Well Installation

Hydraulic Testing

Hydraulic Testing

- Slug Tests
  - Reconnaissance
- Extraction Tests
  - Well array design
- Conservative Interwell Tracer Test (CITT)
  - PITT/SEAR optimization

Hydraulic Testing Objectives

- Conduct slug tests
- Estimate hydraulic conductivity
- Conduct extraction tests
- Provide hydrogeological data to characterize the DNAPL zone
- Provide empirical data for SEAR design
- Test sustainable injection and extraction rates

Slug Tests

Slug Tests

- A reconnaissance tool
- Yields:
  - Hydraulic conductivity in the near-well zone only
  - Accuracy only order of magnitude
- Results are strongly impacted by well construction and degree of well development
- Results are not suitable for remedial design

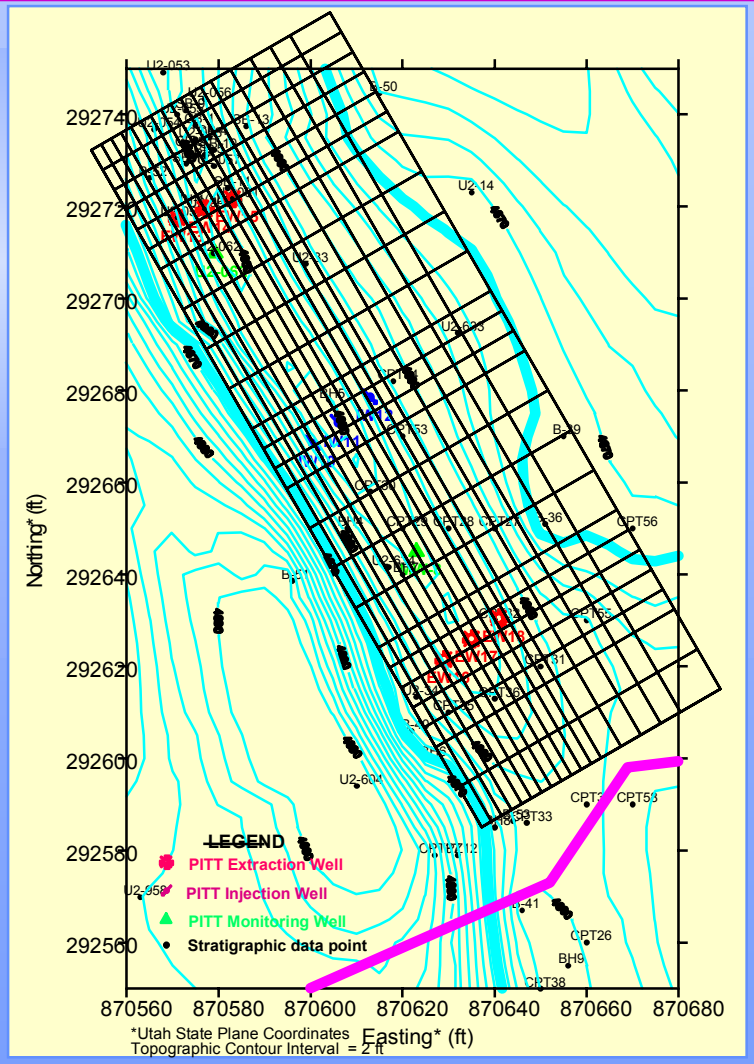
Extraction Tests

- Constant rate
- Yields:
  - Hydraulic conductivity
  - Storativity, specific yield
  - Aquifer yield
  - Leakance
- Identifies hydraulic boundaries
- Provides model calibration data

Extraction Tests

- Results provide average parameter values over interwell aquifer volume
- In comparison to slug tests, results are much less affected by well construction and degree of development
- Results are suitable for remedial design

Wellfield Design Using the Geosystem Model



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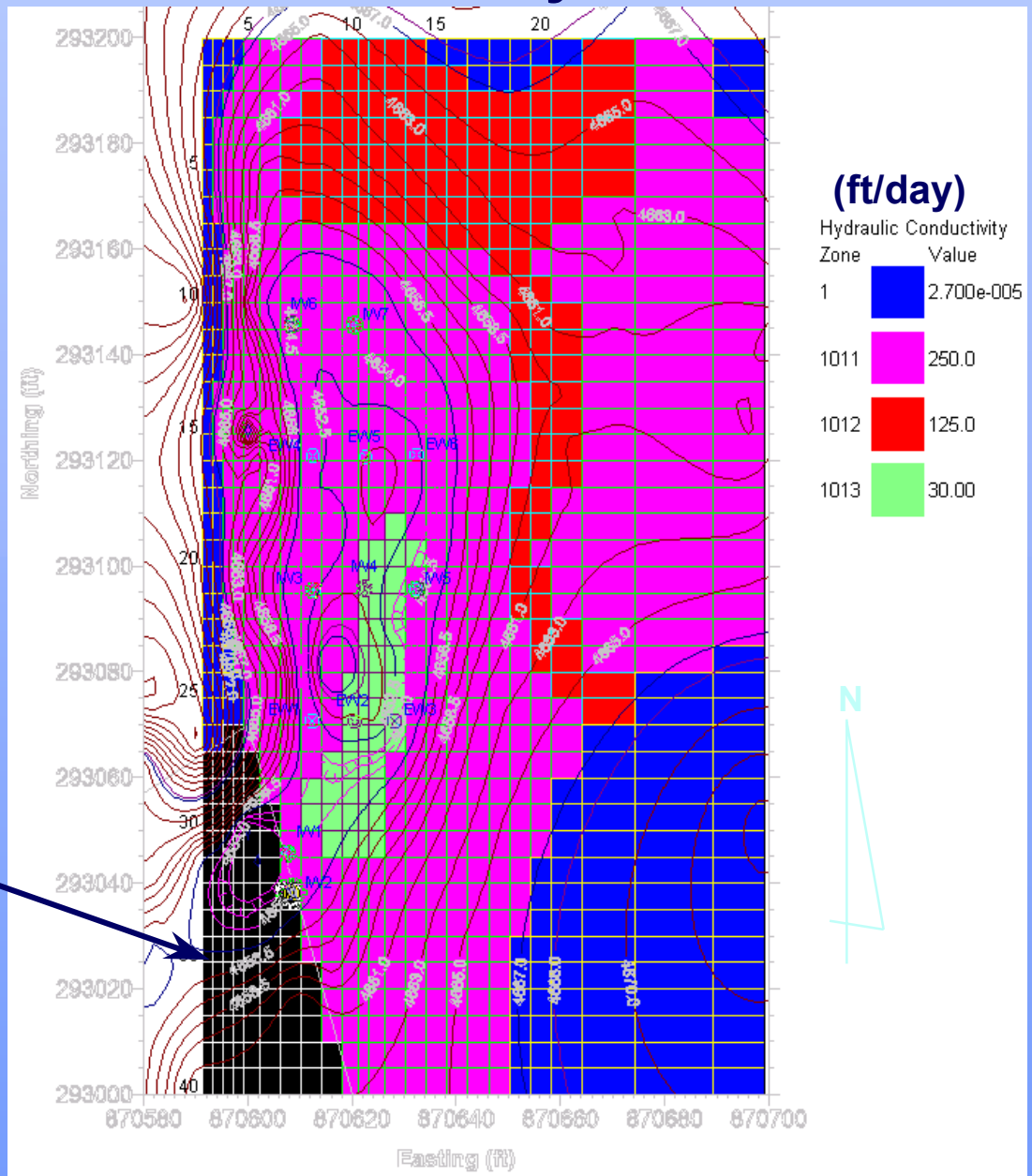
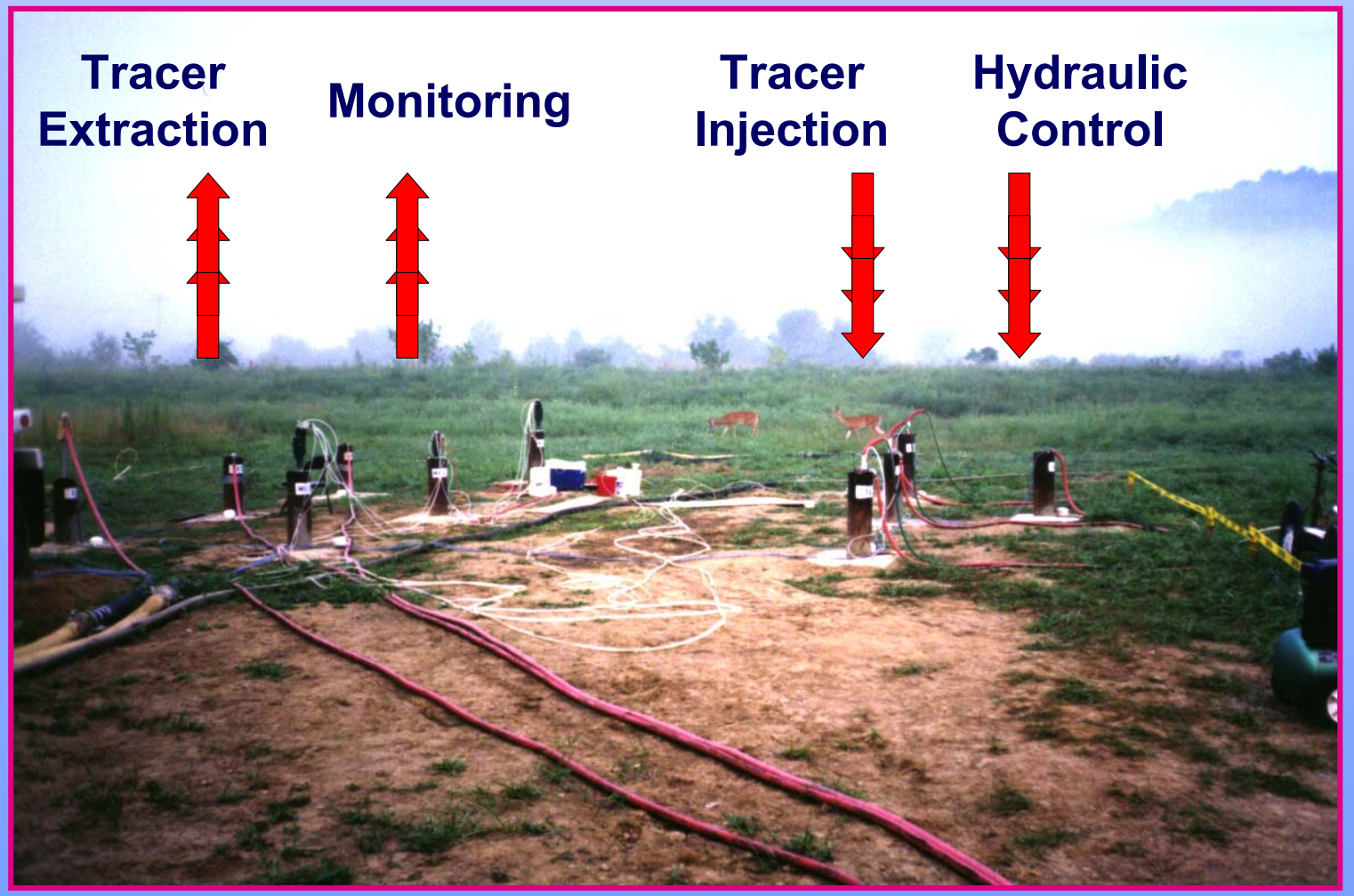
Plan View of Model Grid Layer 1

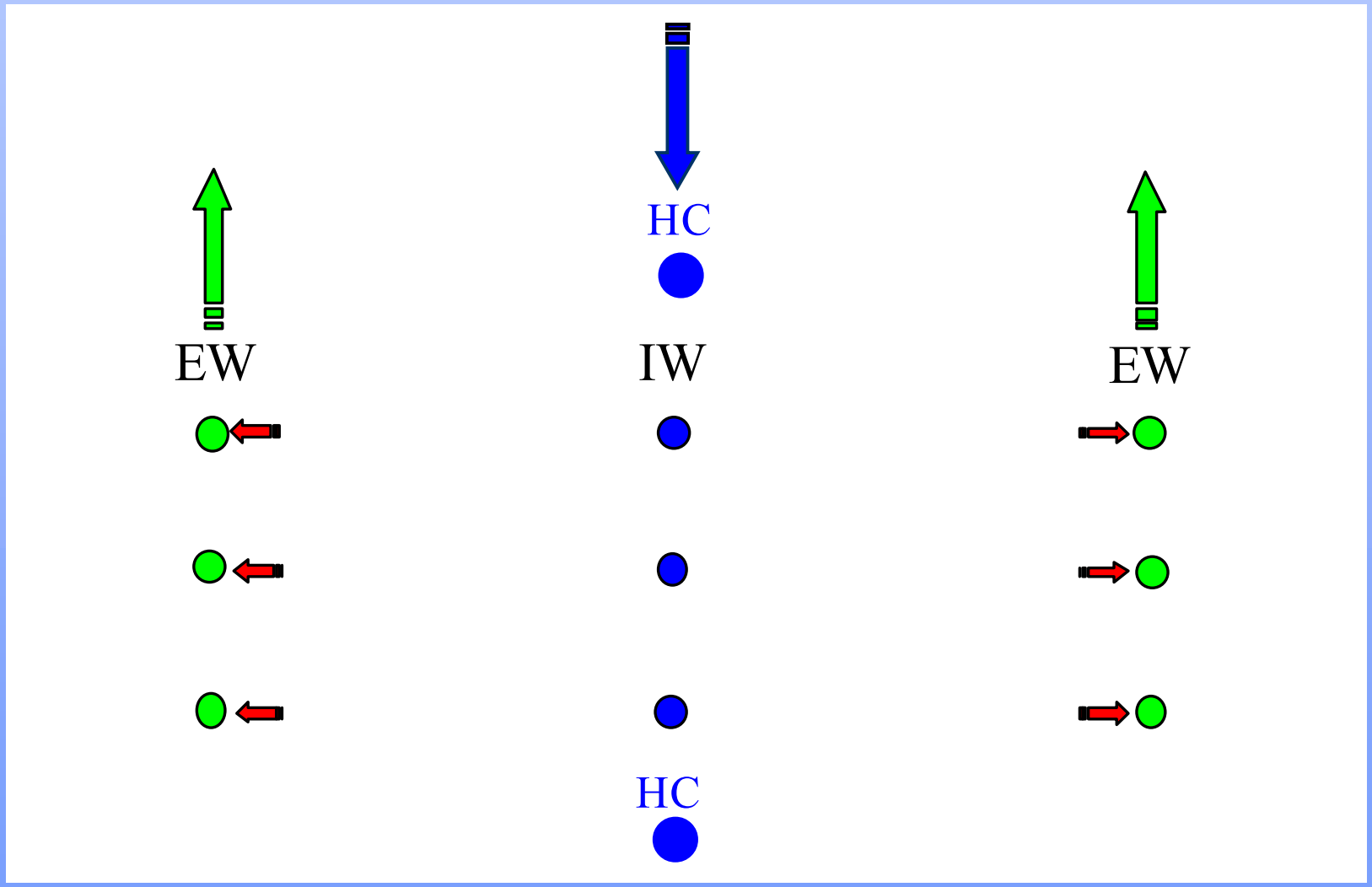


No-Flow Barrier Wall

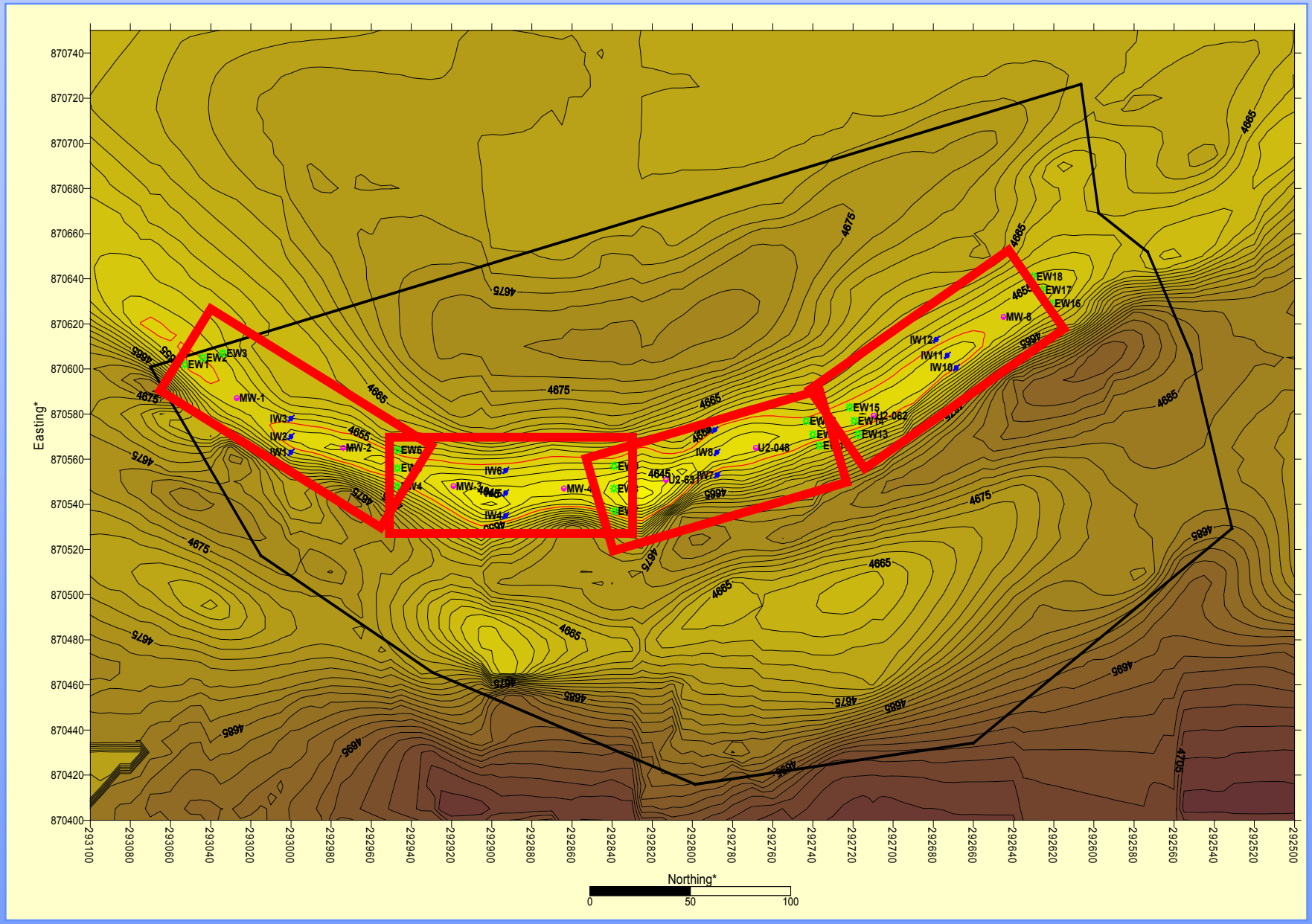
Single-Line Drive Wellfield: 3x3 Line Drive



3x3x3 Divergent Line Drive



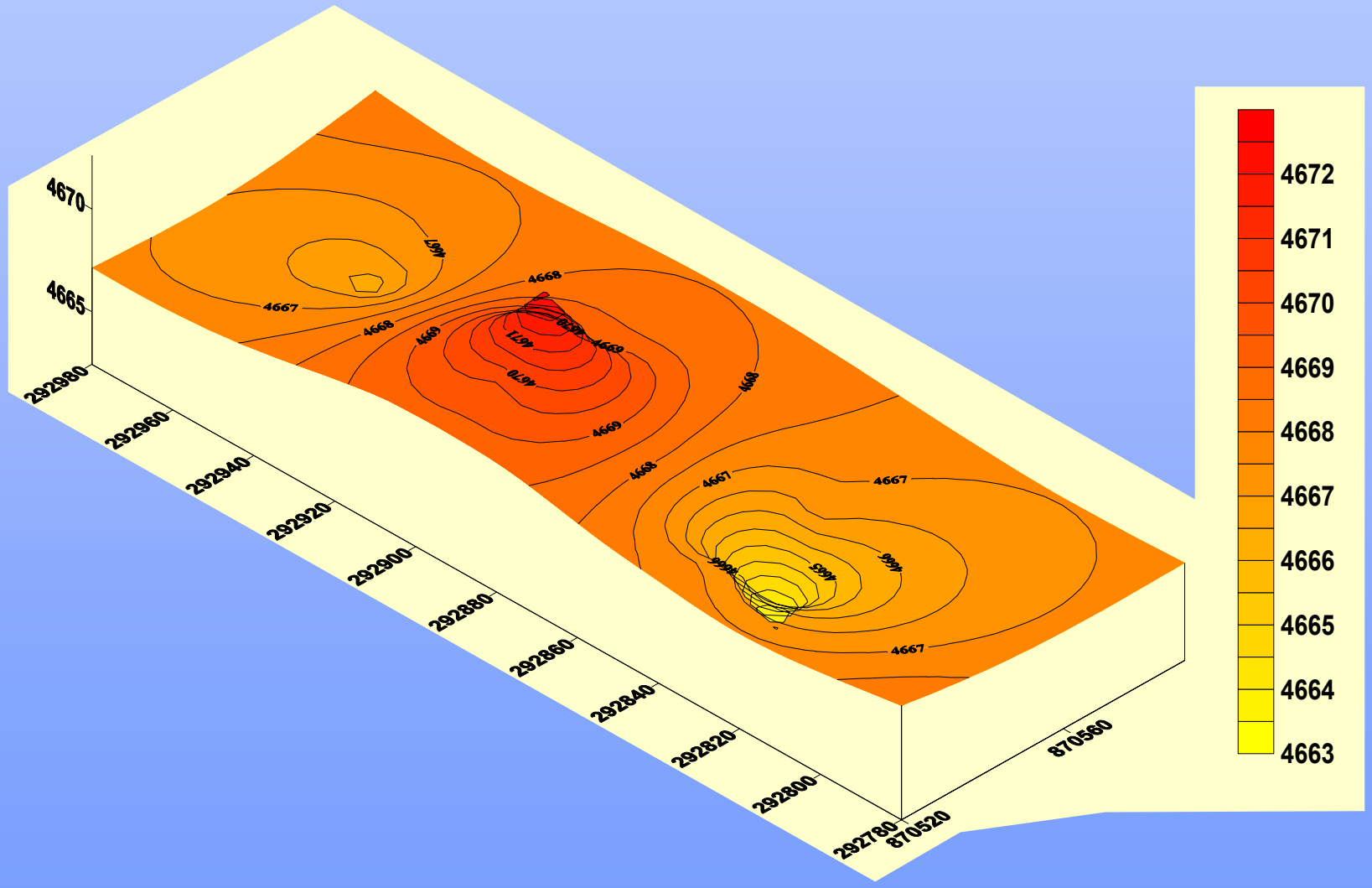
SEAR Wellfield Design



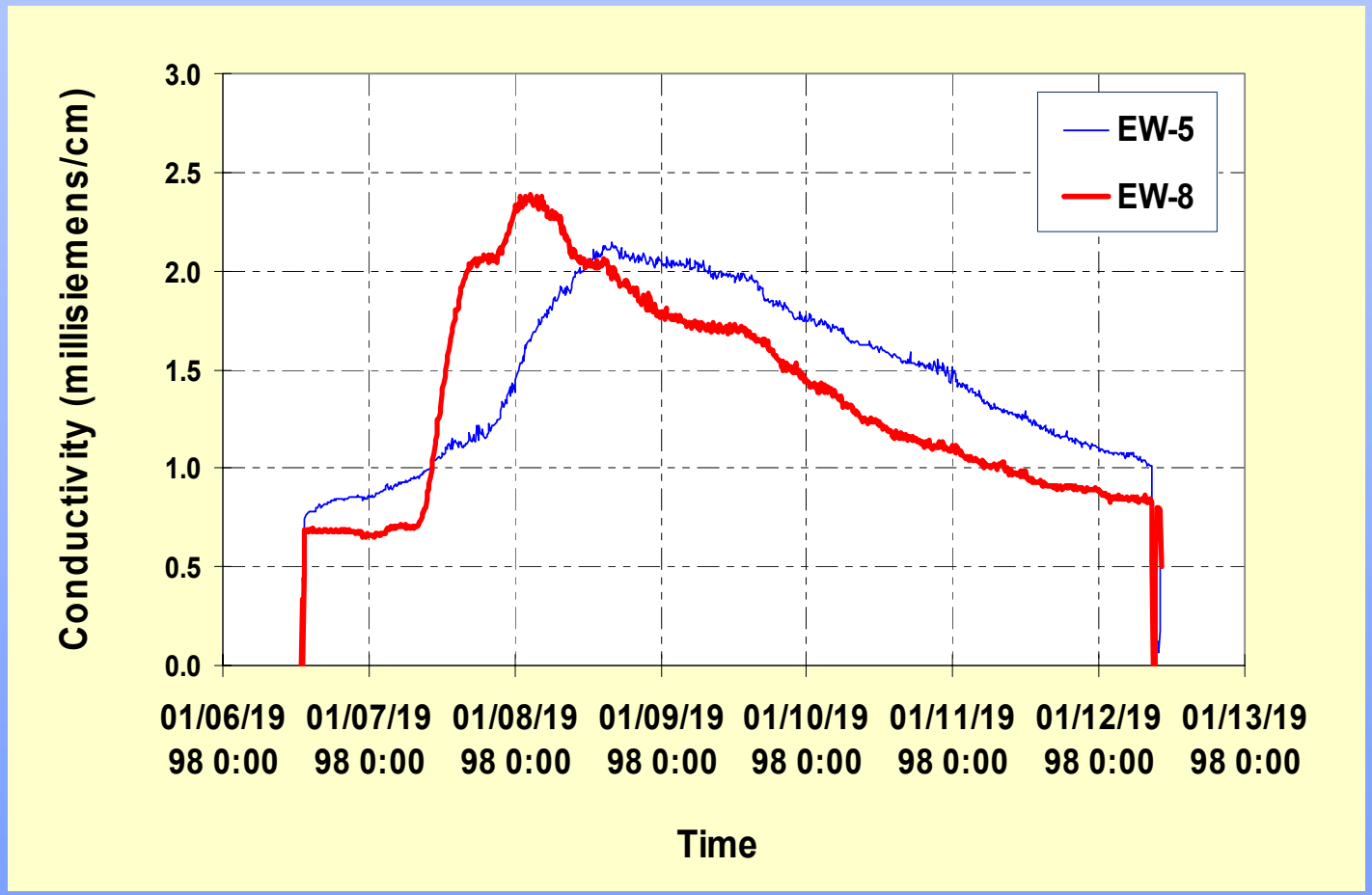
Hydraulic Testing Objectives

- Conduct Conservative Interwell Tracer Test
- Provide a "shake-down" for the SEAR process system
- Provide detailed PITT/SEAR optimization data
- Demonstrate hydraulic control

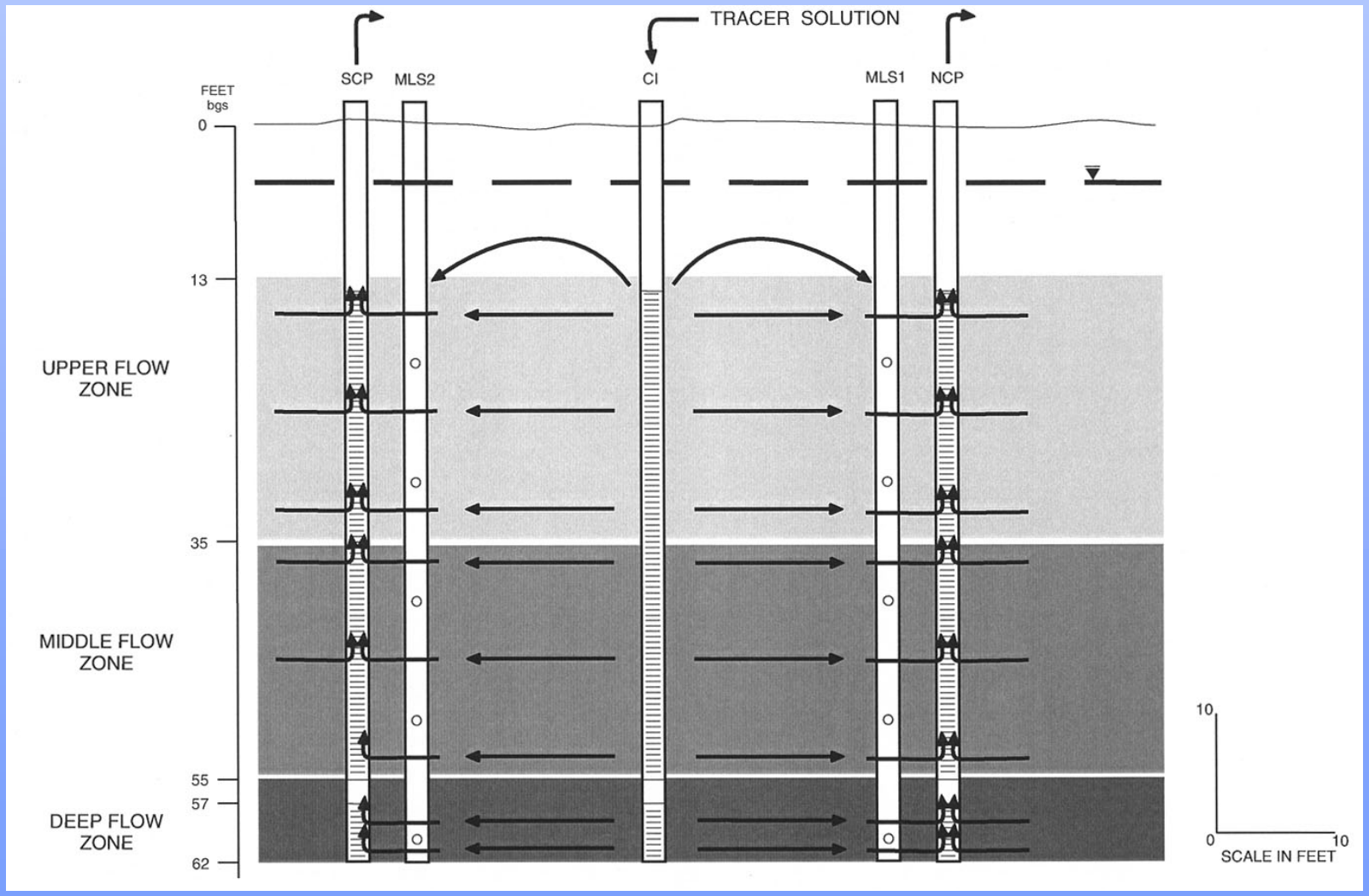
CITT2 Water Level Surface (01/09/98)



CITT2 Extraction Well Tracer Response



Cross Section of a CITT Wellfield Screened Over a Significant Aquifer Thickness



Well Installation

Well Installation

- Wellfield used for characterization and remediation
- Well installation is most underrated component
- Poor wells will doom your efforts!
  - No matter how good the design or execution is, poor wells severely limit ability to control fluids, thereby putting the success of a given characterization/remediation in serious jeopardy!

A Well Is a Well Is a Well???

"...it makes water, doesn't it?"

What are your objectives for a given well?

- Monitoring:
  - Water levels and samples

  OR
- Hydraulic Performance:
  - Aquifer testing
  - Recovery well
  - SEAR injection and extraction

Where Do I Put the Screen?

For DNAPL sites:

- Typically 5 ft long, with the bottom of the screen placed across the capillary barrier, which allows:
  - Free-phase liquid to be detected and sampled
  - Effective sweep of tracers and surfactant across zone of interest
- Don't compromise the aquitard!

What Is a Poor Well?

- Improperly designed
  - Screen length, slot size, continuous vs. machine slots, screen placement
- Poorly installed well screen
  - Clay fouling by drilling process
  - Poor sand pack selection or installation
- Poor or insufficient well development

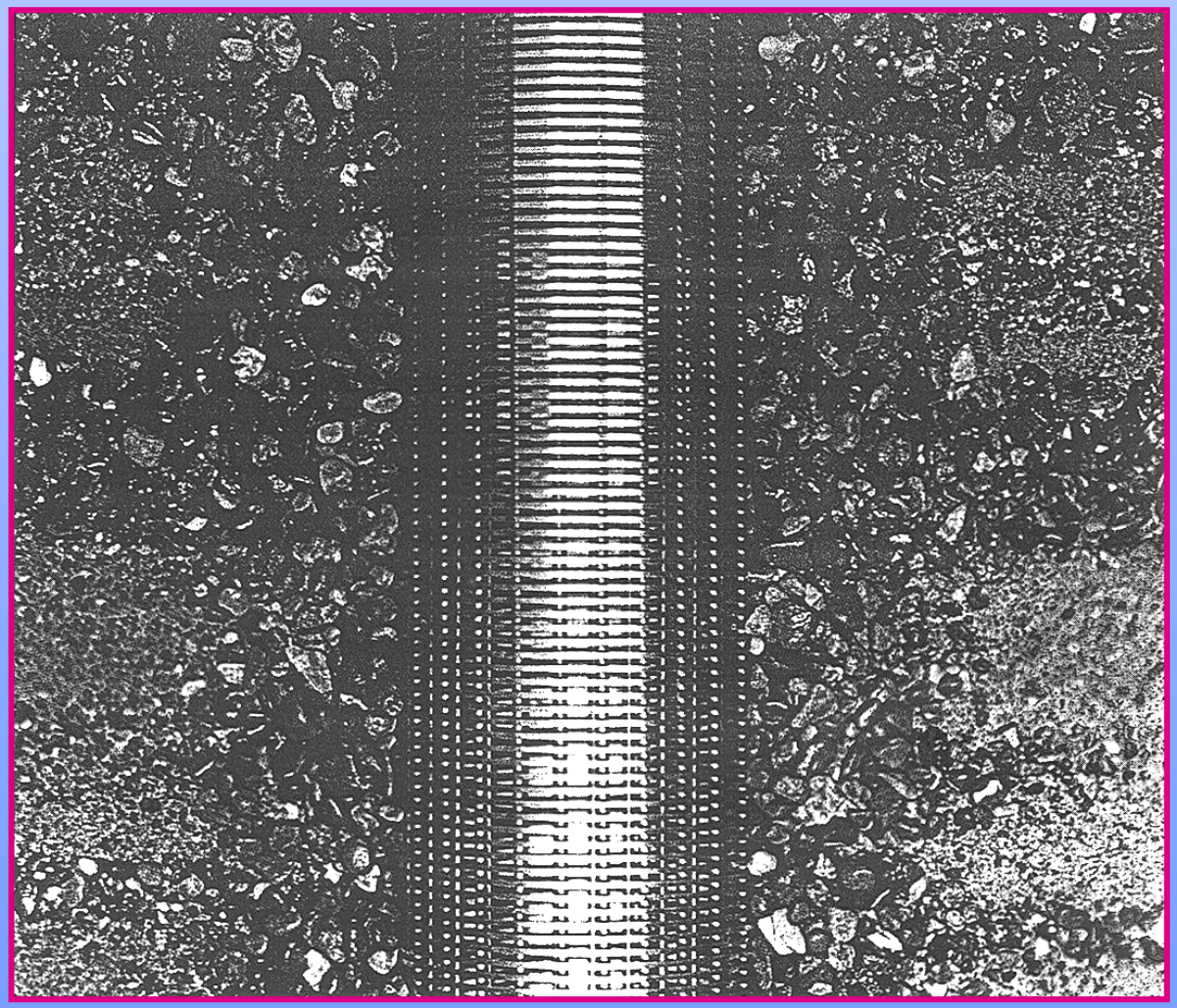
Reason for Development

- Drilling methods have altered aquifer
  - Introduction of fluids
  - Smearing of borehole walls
  - Compaction of formation materials in the near well environment

Objective of Development

- Reverse the damage done by drilling
  - Remove drilling fluids
  - Break down smearing on borehole walls
  - Remove fines from filter pack

Well Screen Installed Without Filter Pack and Developed



Benefits of Well Development

- Render the well capable of providing silt- and sand-free groundwater samples representative of the formation waters
- Increase pump life by removing sand and silt
- Improve the specific capacity of the well

Note: U.S. EPA guidance sets a goal for the turbidity of the samples collected. Wells yielding samples with a turbidity of 5 nephelometric turbidity units (NTU) or greater may be considered to have been improperly completed.

Modified Drilling Methods

To minimize clay fouling of the screened permeable zones:

- Hollow-stem auger with short-tripping
- Polymer-"mud" rotary (e.g., Super Mud)
- Minimizing "sand heave"

Bottom Line

- With poorly completed wells:
  - Hydraulic testing can provide inaccurate data (particularly with slug tests)
  - Geosystem model may contain errors
  - Design simulations may contain errors
  - May not be able to establish appropriate hydraulic control
  - May not be able to achieve project objectives

Any Questions?