Enhanced Hydrostratigraphic Modeling Approach Using Direct Push Electrical Conductivity Logging (DP e-logging)

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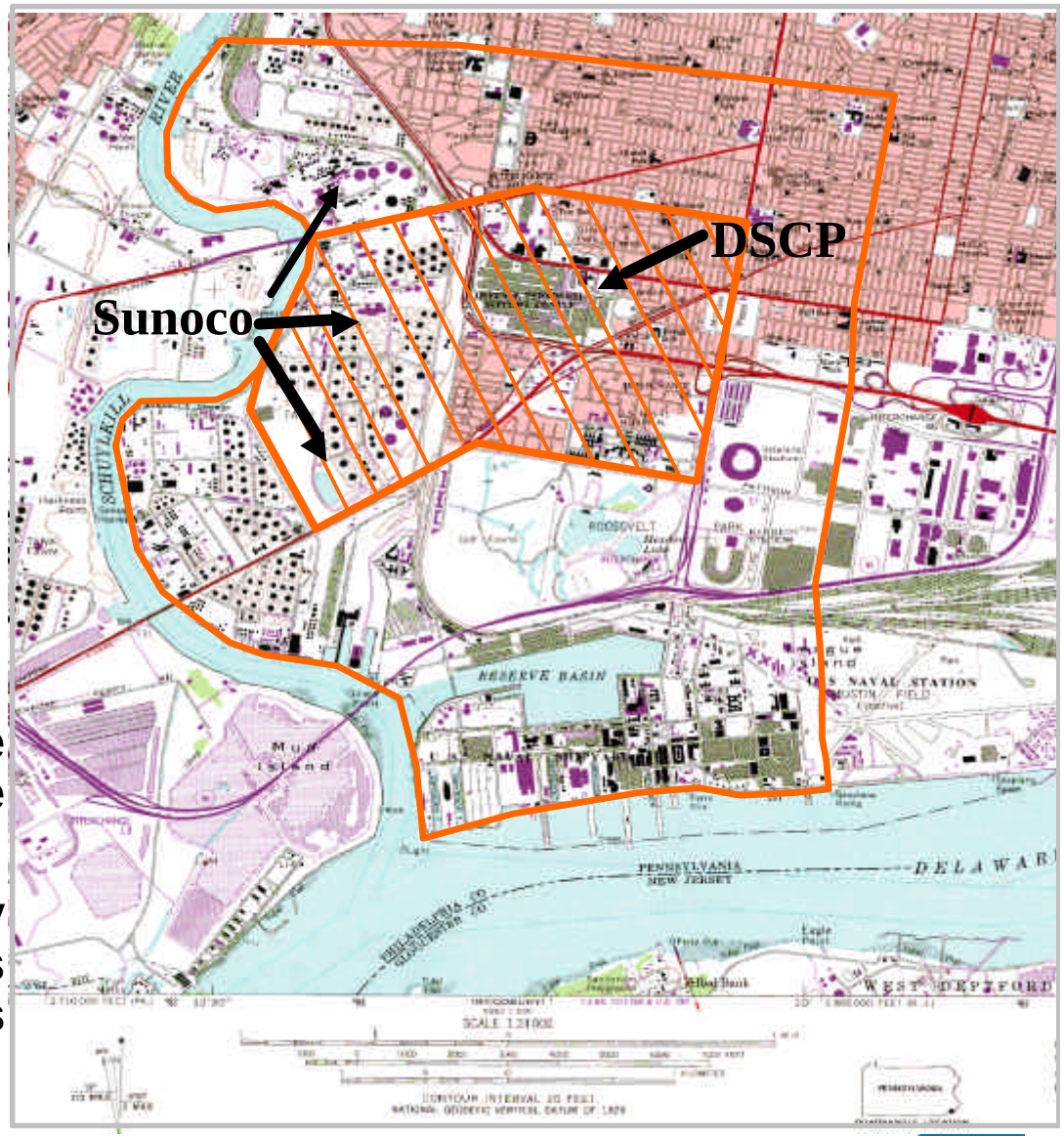
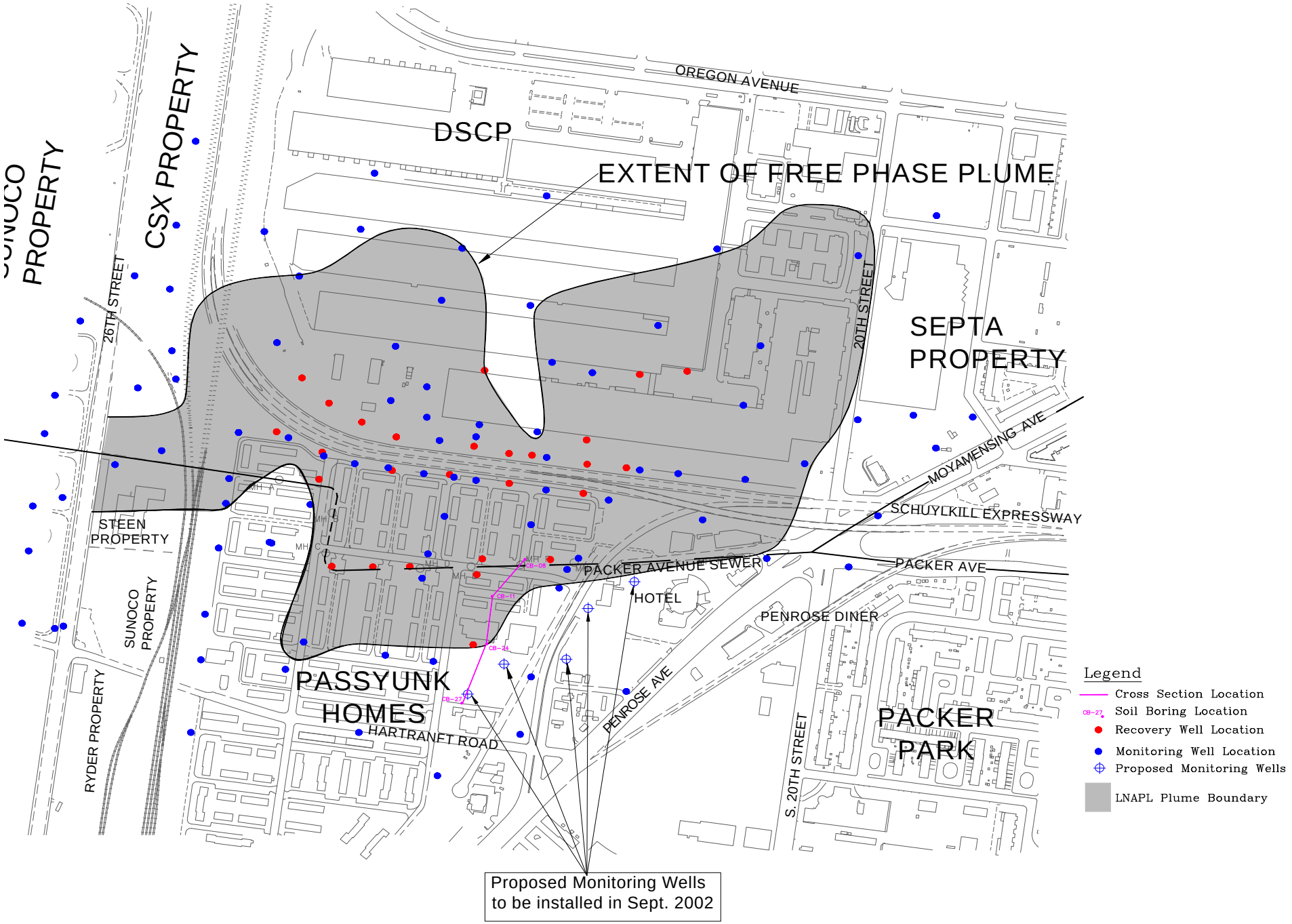
Problem Overview

- Extensive light non-aqueous phase liquid (LNAPL) in shallow unconfined aquifer
- Approximately 778,000 gallons of LNAPL have been removed to date.
- There is approximately 1 to 1.5 million gallons of LNAPL remaining on the water table.
- The site near the confluence of the Schulykill and Delaware Rivers.
- This area is underlain by unconsolidated sediments including sands and gravels and well as silt and clays




SUNOCO PROPERTY
CSX PROPERTY
DSCP
OREGON AVENUE
EXTENT OF FREE PHASE PLUME
26TH STREET
20TH STREET
SEPTA PROPERTY
MOYAMENSING AVE
SCHUYLKILL EXPRESSWAY
STEEN PROPERTY
PACKER AVENUE SEWER
PACKER AVE
HOTEL
PENROSE DINER
SUNOCO PROPERTY
RYDER PROPERTY
PASSYUNK HOMES
HARTRANFT ROAD
PENROSE AVE
S. 20TH STREET
PACKER PARK
Legend
Cross Section Location
Soil Boring Location
Recovery Well Location
Monitoring Well Location
Proposed Monitoring Wells
LNAPL Plume Boundary
Proposed Monitoring Wells to be installed in Sept. 2002

Investigation Background

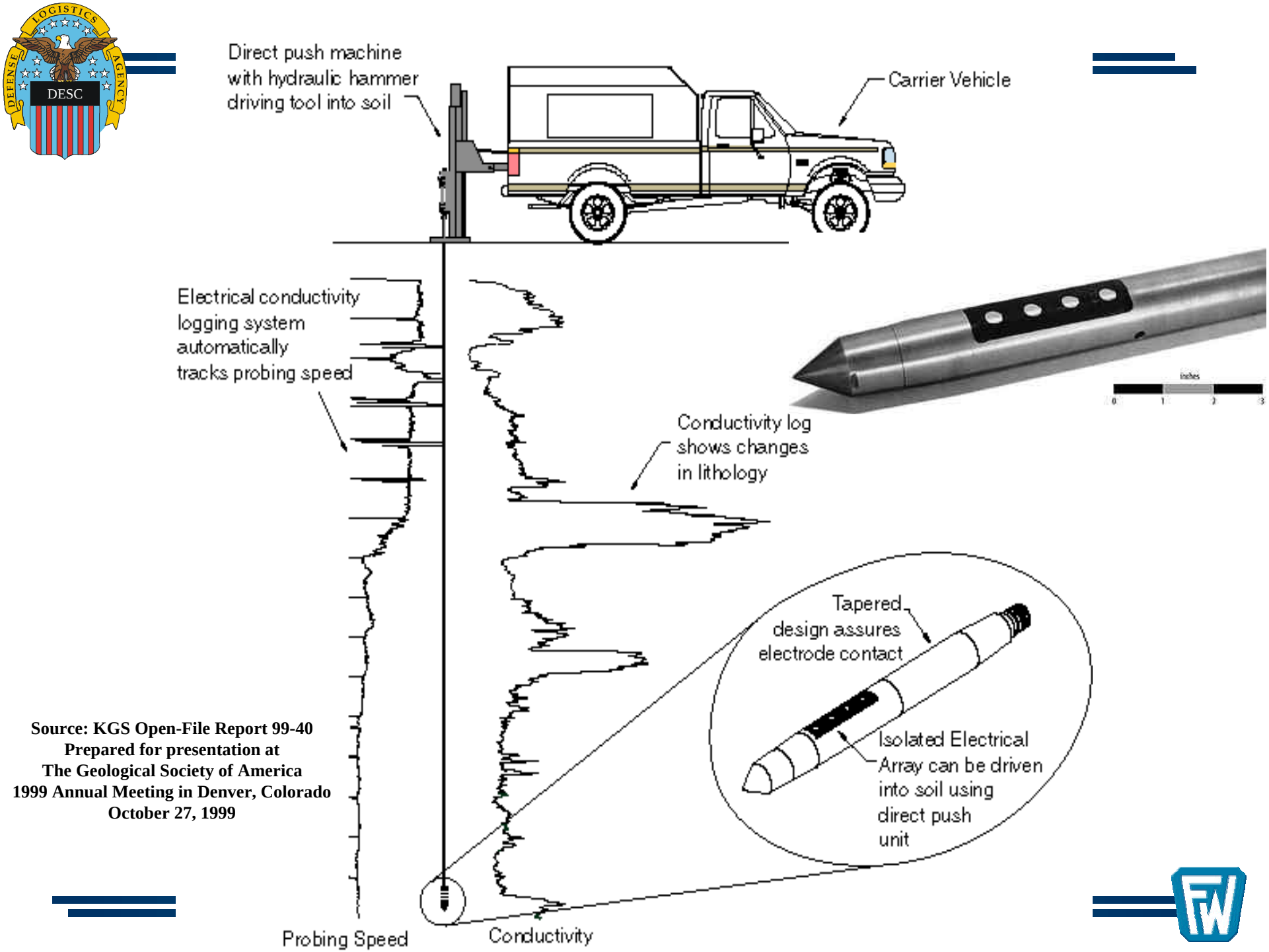
- LNAPL removal operations at the former Defense Supply Center Philadelphia (DSCP) facility involve current skimming systems and future vacuum-enhanced skimming systems.
- Delineation of low hydraulic conductivity zones, namely clays and or silts, at the site is critical in determining past and future LNAPL migration and accumulation.

Electrical Conductivity Soil Boring Program

- A soil-boring program was completed using direct-push electrical conductivity logging (DP e-logging) to:
  - Investigate the vertical and horizontal orientation of low hydraulic conductivity zones (i.e. clays and silts) to determine the potential effects these zones have on current and future LNAPL migration scenarios;
  - and to log soils ahead of drill rigs installing recovery wells and monitoring wells.

DIRECT-PUSH ELECTRICAL CONDUCTIVITY

- Direct push equipment provides the method for pushing a probe mounted Wenner Array of electrodes.
- A current is applied across a pair of electrodes and the voltage drop is measured across another pair of electrodes.
- Electrical conductivity data indicating silts and clays are easily correlated to actual lithology.



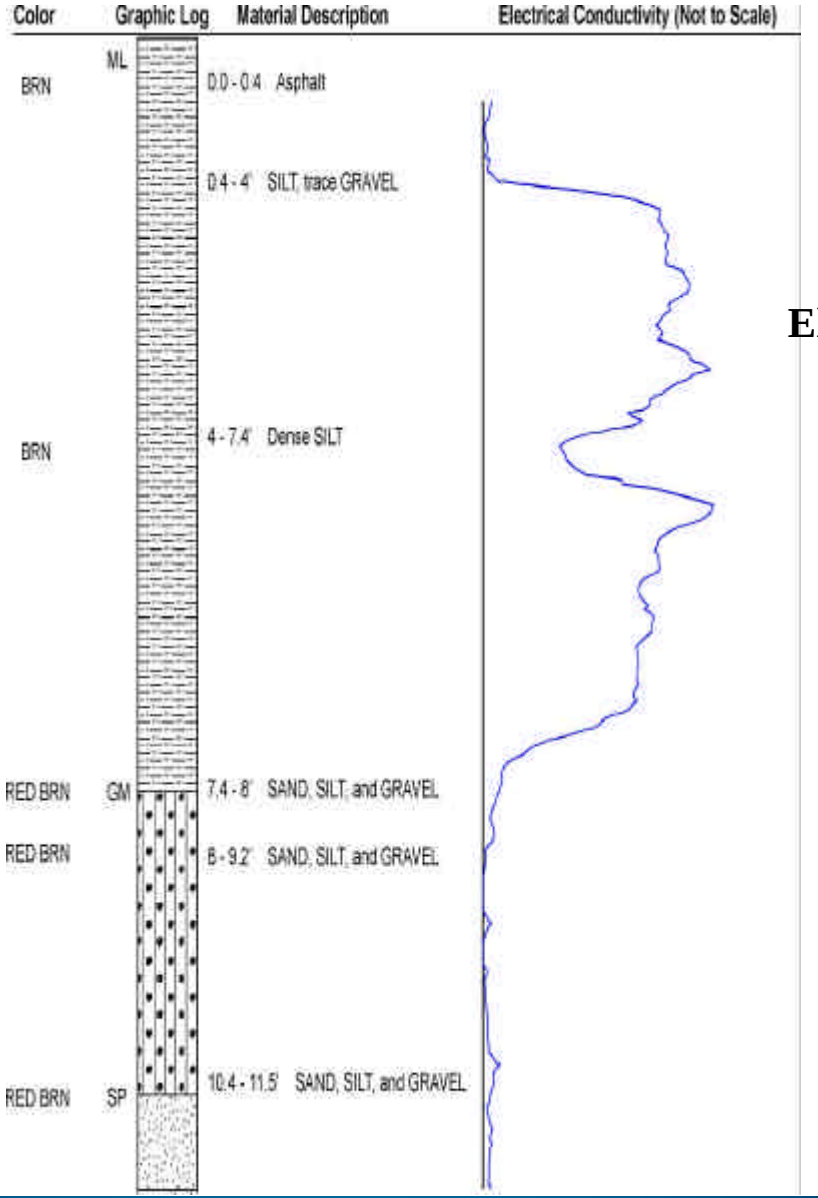
Source: KGS Open-File Report 99-40
Prepared for presentation at
The Geological Society of America
1999 Annual Meeting in Denver, Colorado
October 27, 1999

A Direct-Push Rig Advancing the Electrical Conductivity Probe

SOIL BORING PROGRAM AT DSCP

- **The soil-boring program involved the advancement of 35 conductivity borings and 12 visual borings to a depth of 40 to 50 feet.**
- **Visual borings were used to:**
  - **calibrate the conductivity log;**
  - **confirm the presence of low hydraulic conductivity layers of silt and or clay;**
  - **visually identify staining, sheens, and the presence of free product;**
  - **and allow for screening of samples using a Photoionization Device (PID).**

Lithological Description

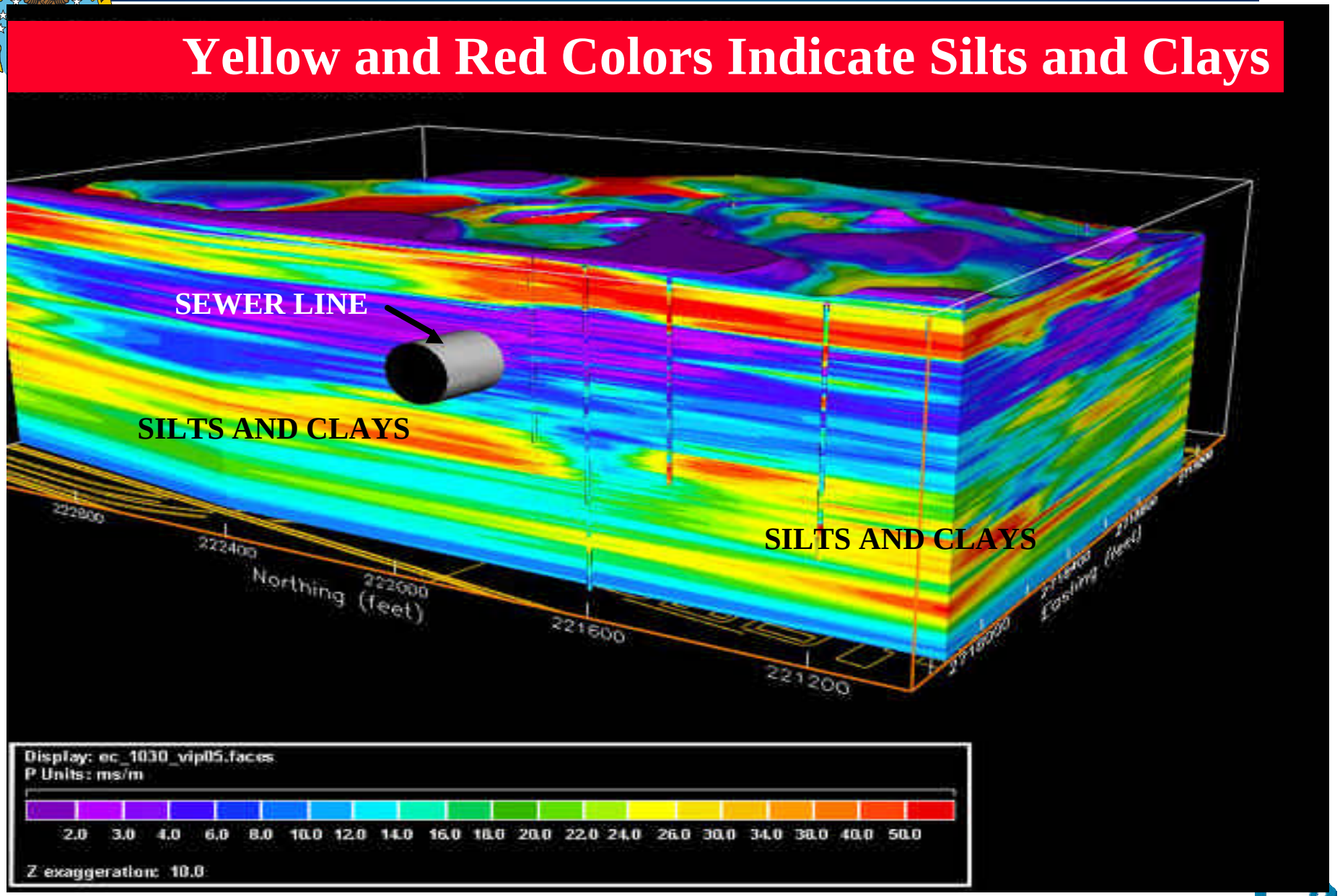


Electrical Conductivity Log

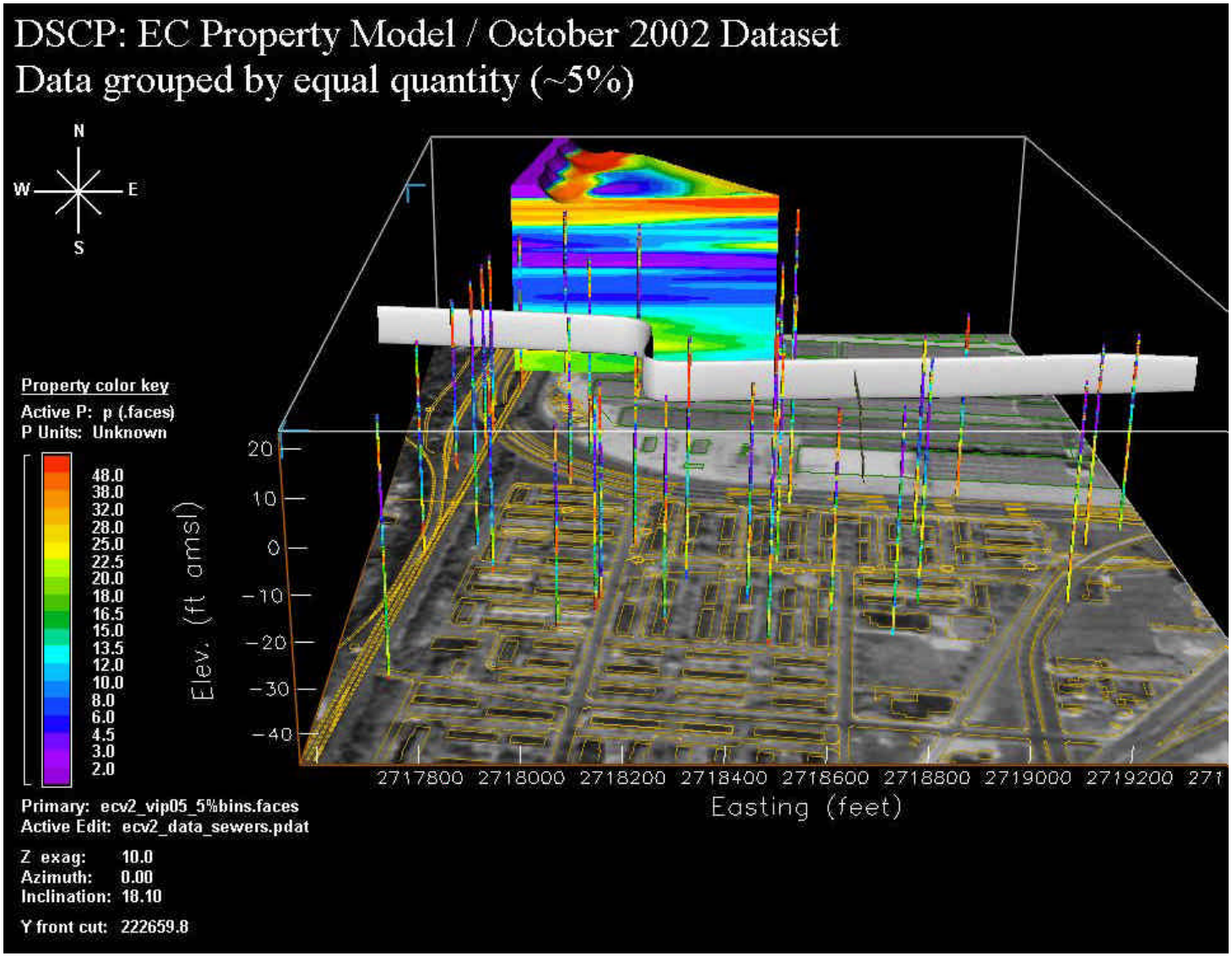
TRANSFORMING RAW DATA INTO VISUALIZATIONS

- The raw data from the conductivity logs was imported into the EarthVision® Model.
- The data was used to create a three-dimensional, color-contoured visualization of the data.
- The visualizations allow for rapid evaluation of subsurface conditions at the site.

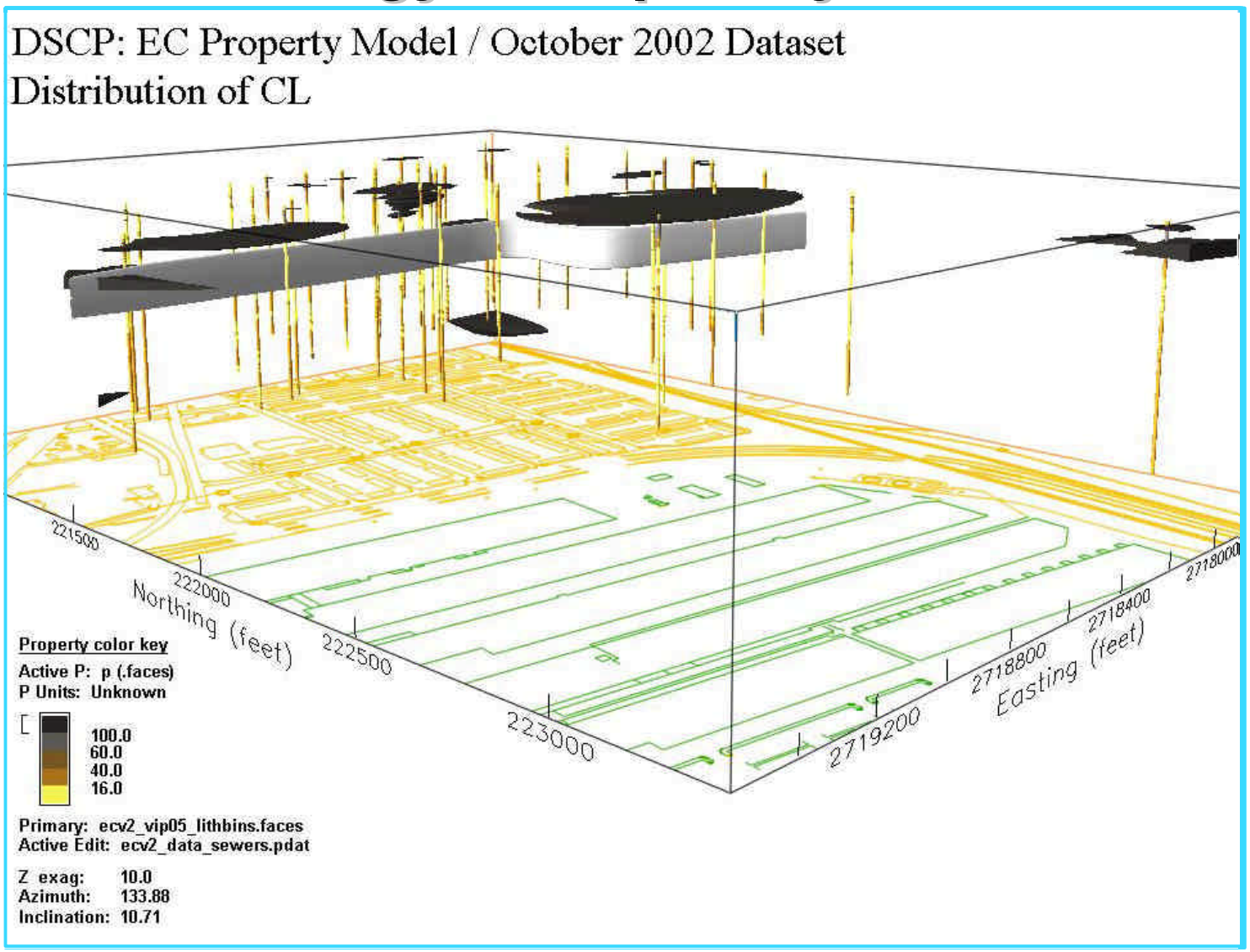
Yellow and Red Colors Indicate Silts and Clays



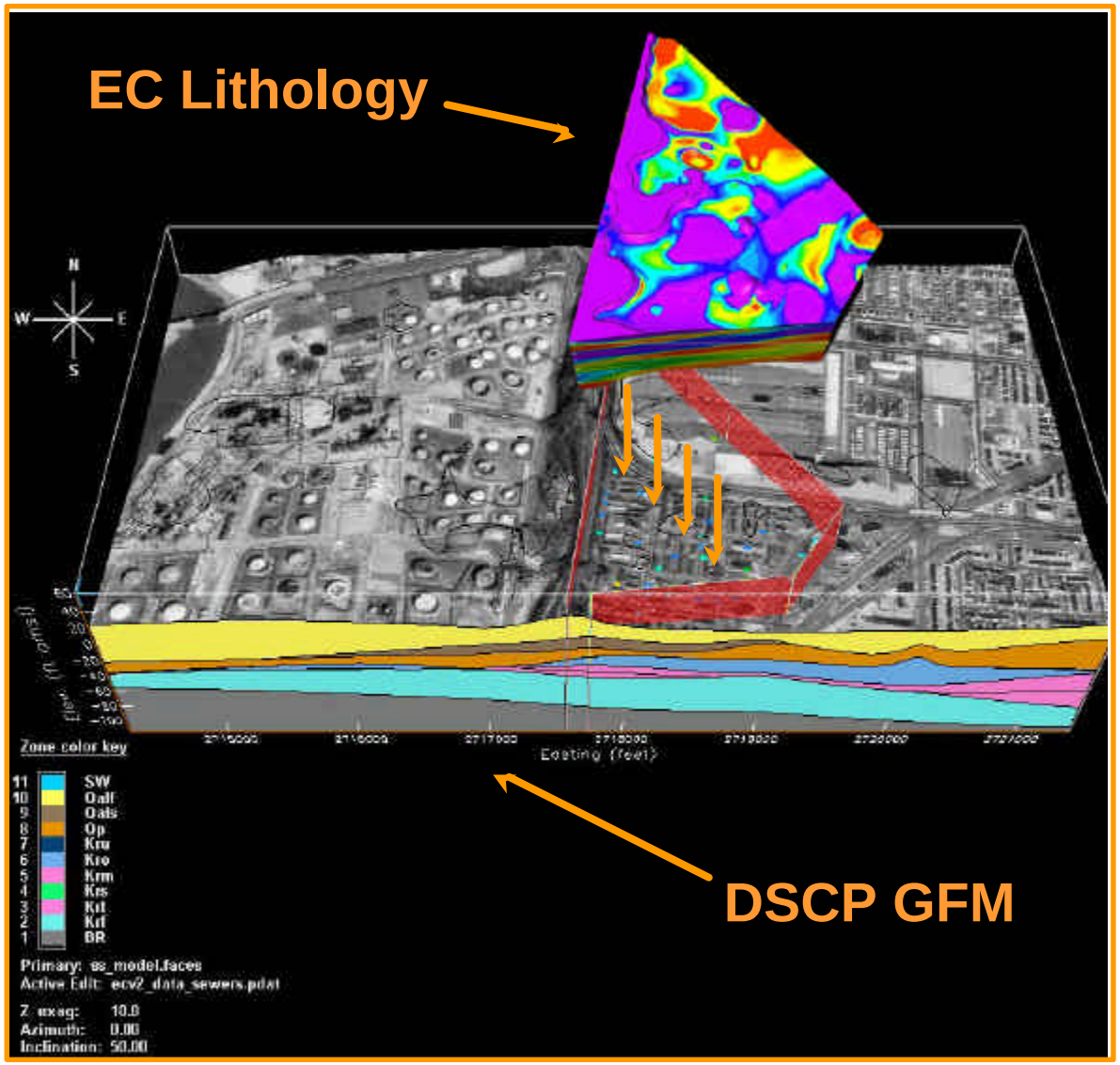
EC Defined Lithology



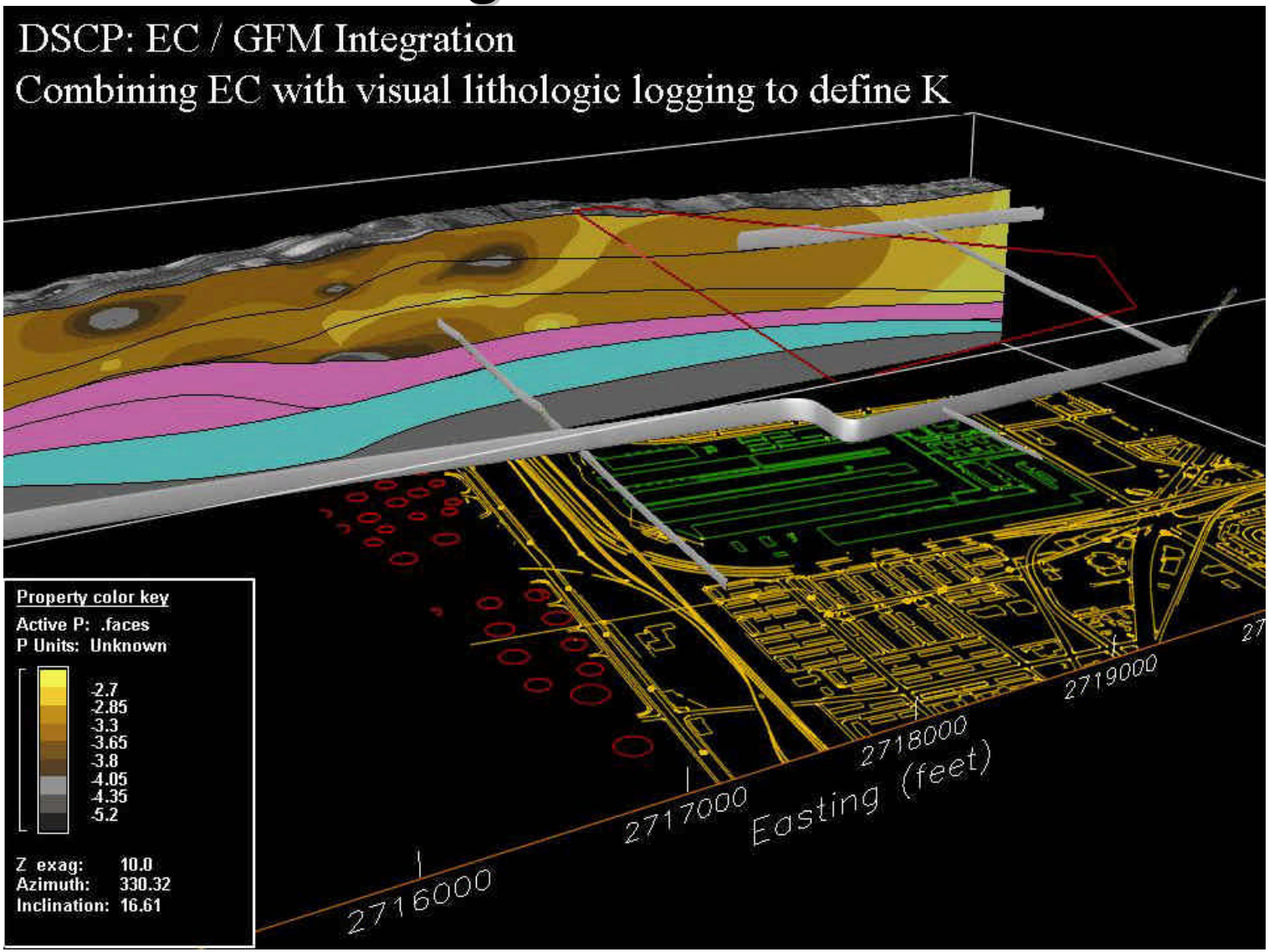
EC Lithology Grouped by USCS Code



Including EC Delineations in the GFM



EC / GFM Integration



CONCLUSIONS

- **The Geoprobe® mounted electrical conductivity probe proved to be a cost-effective way to investigate the unconsolidated sediments at the DSCP Site.**
- **Twice as many electrical conductivity borings could be advanced per day versus visual borings.**
- **The method allowed for quick installation of wells and limited the need for the collection of split spoons for the purpose of visual logging.**
- **Very minimal drill cutting generated.**

CONCLUSIONS

- The EC data along with survey data and visual boring data proved to be easily incorporated into the pre–existing EarthVision® framework model.
- The 3-D visualization of the EC data was also utilized to determine areas in which silts and clays impeded the migration of LNAPL.
- This rapid investigation and visualization allowed for optimal placement of LNAPL recovery systems to prevent further migration.