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Leveraging Environmental Sequence Stratigraphy To Refine Contaminant Mass Calculations: Middlesex County, NJ

AECOM

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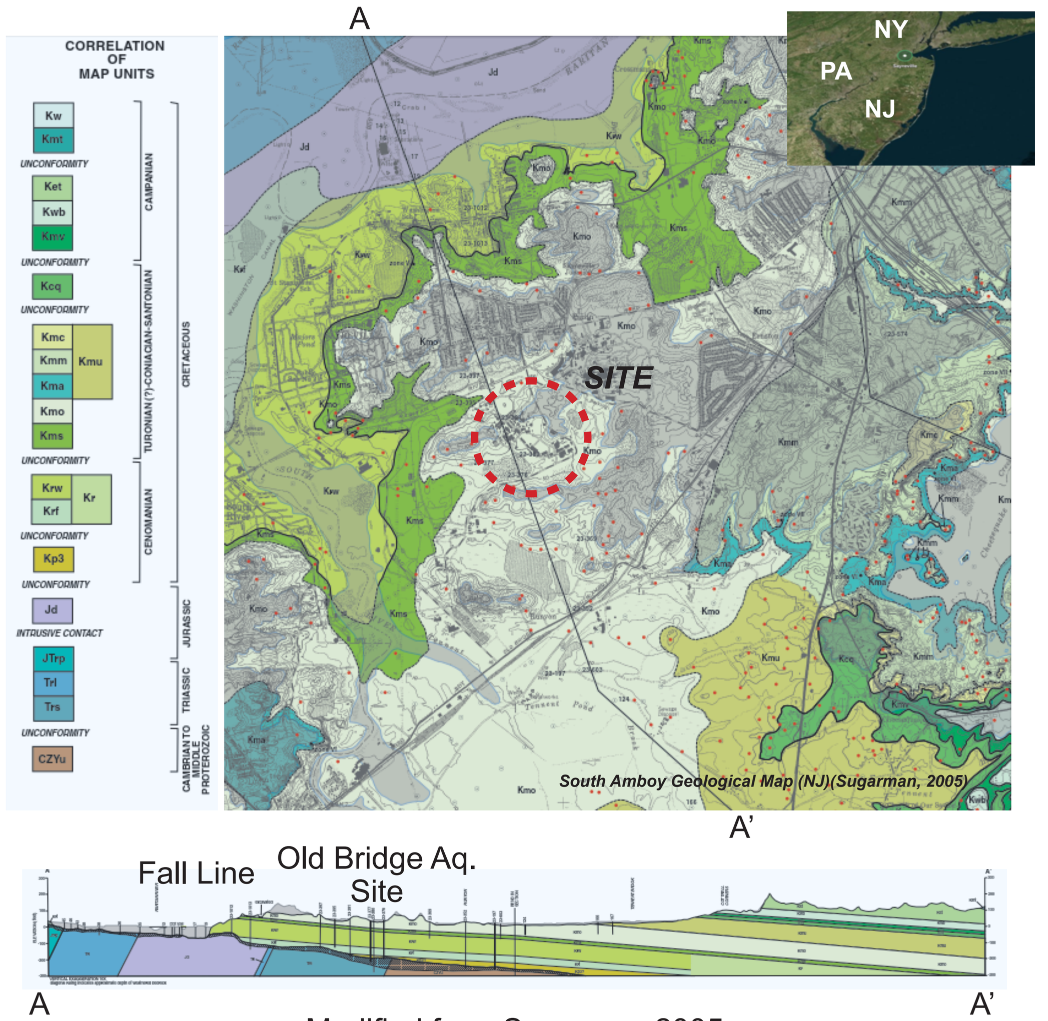
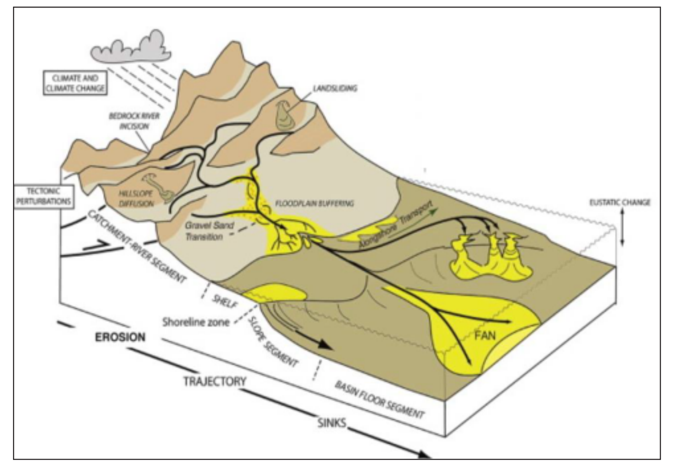
Introduction

Effective conceptual site models (CSMs) and estimates of mass discharge (mass/time) are essential for developing a better understanding of natural attenuation processes and preferential groundwater flow pathways at contaminated sites. However, because groundwater remediation projects are commonly challenged by inherent geologic complexity in the subsurface, CSMs, and a quantification of associated uncertainties, are often inaccurate. In this study, we use Environmental Sequence Stratigraphy (ESS) to better understand the subsurface geology and define preferential flow pathways within a complex contaminated site. This information is then used to refine site contaminant mass discharge estimates.



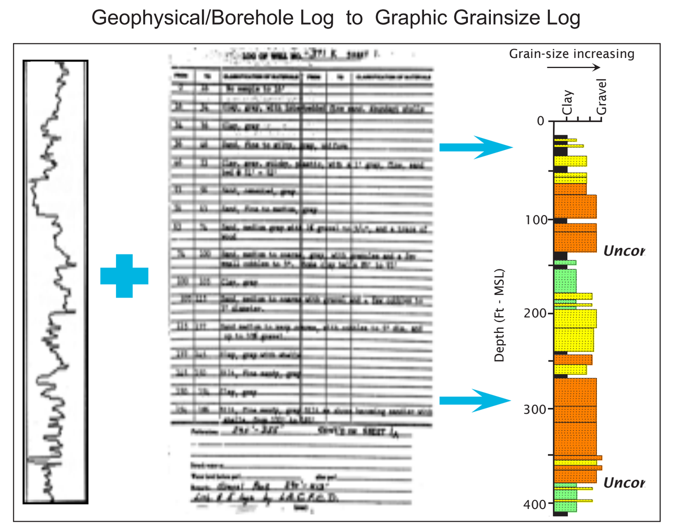
Modified from Sugarman 2005

What is Environmental Sequence Stratigraphy?



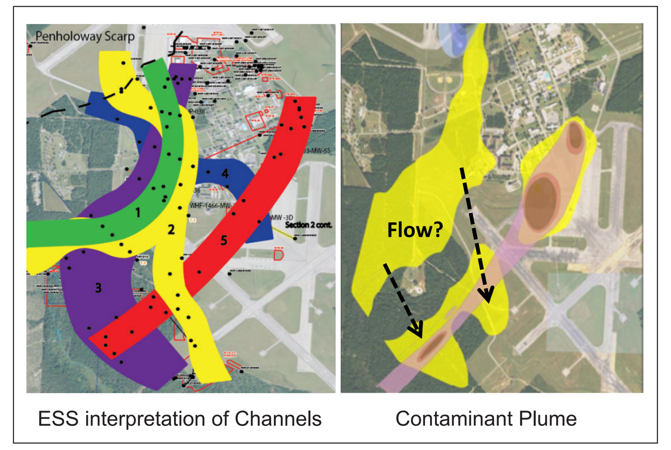
1

Determine depositional environment which is the foundation to the ESS evaluation



2

Leverage existing lithology data to identify vertical grain size trends and correlate between boreholes



ESS interpretation of Channels | Contaminant Plume

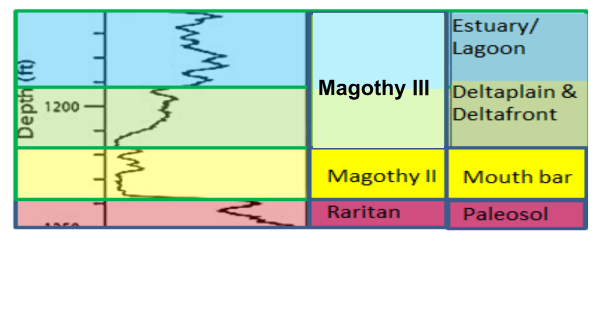
3

Map the facies architecture to predict contaminant migration

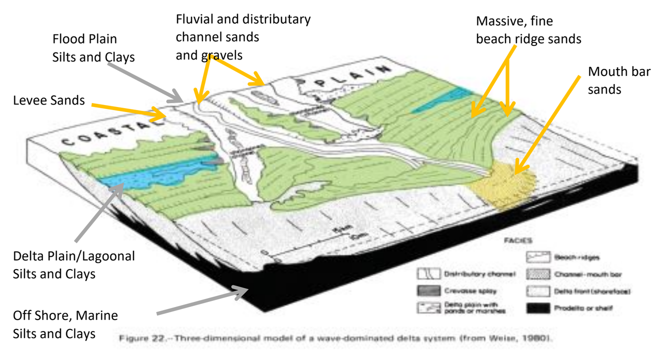
- EPA-endorsed remediation best practice
- Transforms pre-existing 2D lithology data into a 3D understanding of the subsurface
- Constructs a geologically defensible framework of the subsurface that better defines subsurface heterogeneity, accurately predicts preferential pathways in sediments and sedimentary rocks, and reduces data gaps.

ESS in Action!

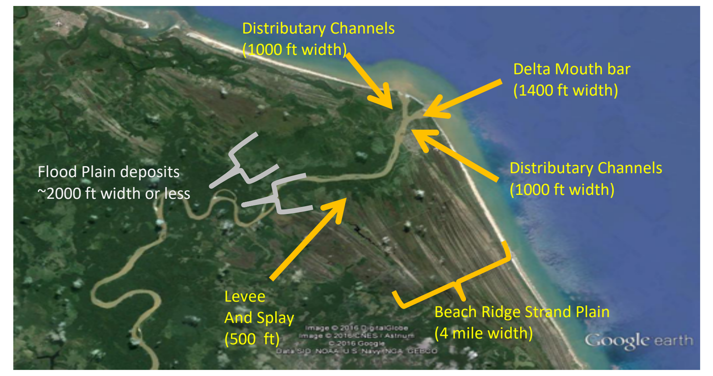
1 Determine Depositional Environment



Vertical profile
(Modified from Sugarman 2005)



Depositional model

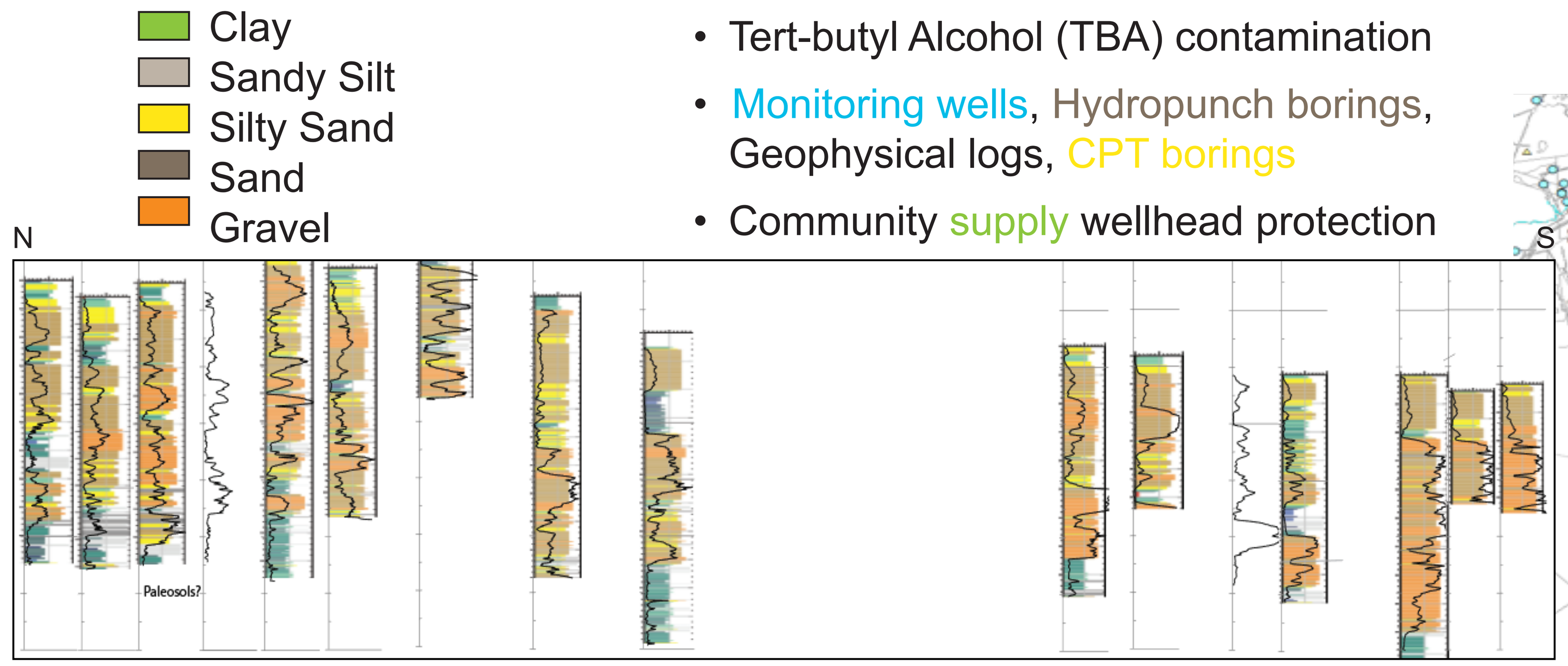


Modern analog

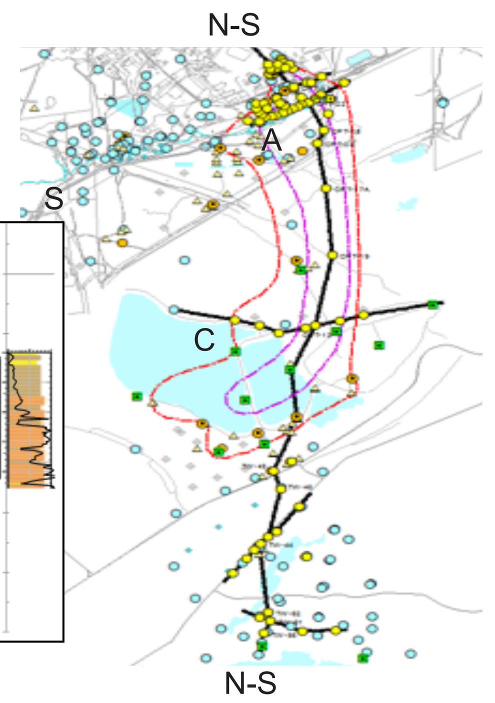
"The present is the key to the past"

(C. Lyell, 1830-33, Principles of Geology - Uniformitarianism)

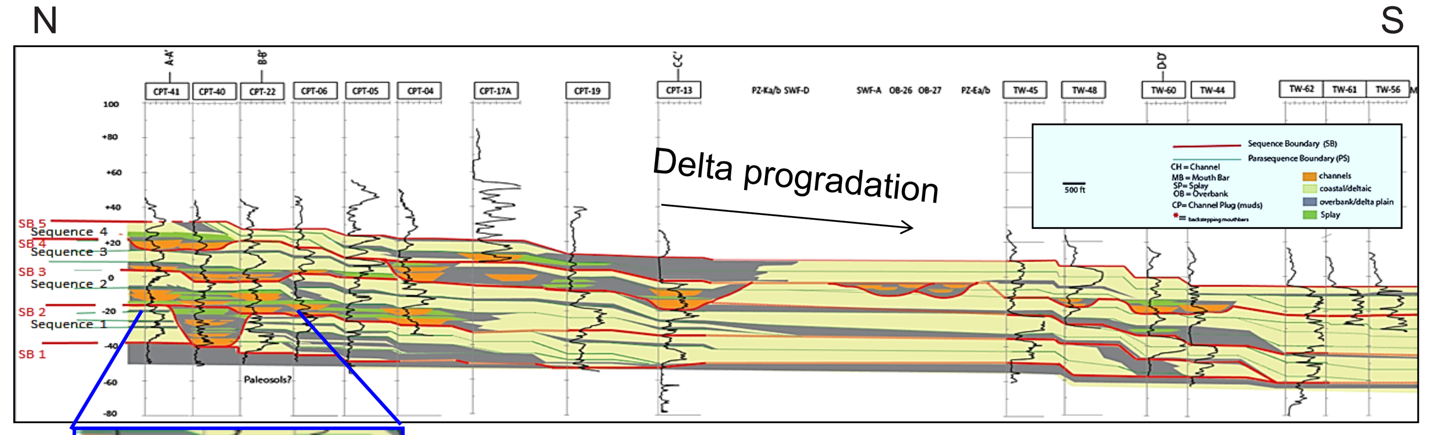
2 Leverage Existing Lithology Data

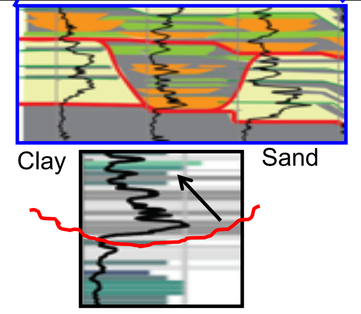


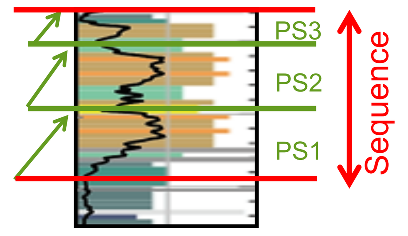
- Tert-butyl Alcohol (TBA) contamination
- Monitoring wells, Hydropunch borings, Geophysical logs, CPT borings
- Community supply wellhead protection



3 Map the Facies Architecture

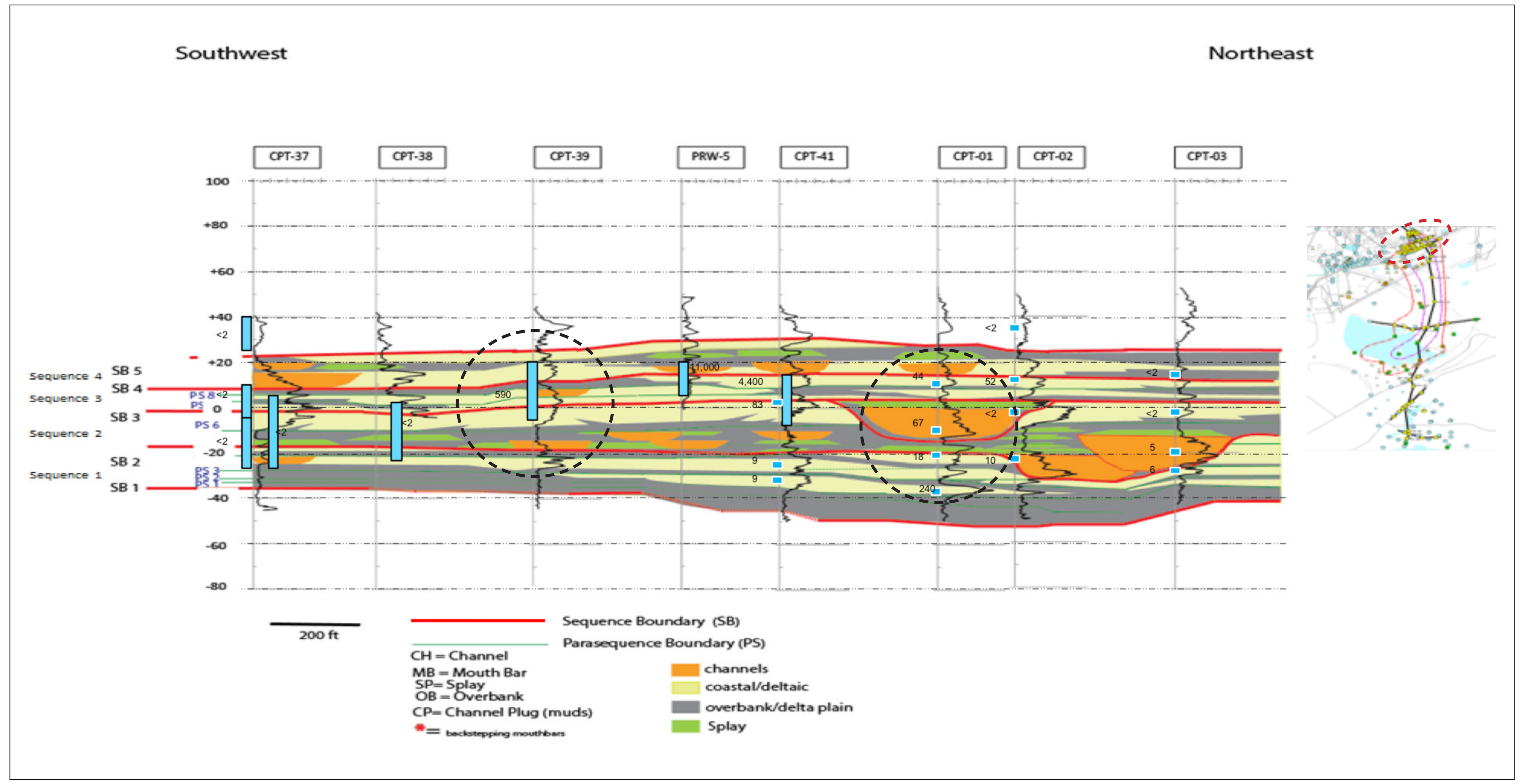






Delta mouthbars

Impacts on Mass Discharge Estimates



- Well screen on left is not only too long… it also cuts across 3 sequences!
  - Which sequence is impacted?
  - Risk of cross contamination
- Well screens on right are more discrete...
  - Channels and deltaic units are both conduits for contaminant flow, but behave differently
  - Deltaic units are more homogenous than channel units
  - Mass in a channel unit becomes more attenuated compared to mass in a more homogenous sand unit, over the same horizontal distance

Conclusions

Greater understanding of the geological framework improves input resolution for flow geometry and for specific discharge estimates.

- **Utilizing CPT data, a depositional sequence model of the Magothy aquifer at the Site was generated.**
- **The presence/juxtaposition of channel deposits, mouth bar/ deltaic deposits and overbank deposits exerts control over contaminant distribution and dispersion.**
- **Contaminant mass models are important in assessing the efficiency/success of remedial measures.**

Sugarman, P.J., Miller, K.G., Browning, J.V., Kulpecz, A.A., McLaughlin, Jr, P.P., and Monteverde, D.H., 2005, Hydrostratigraphy of the New Jersey Coastal Plain: Sequences and facies predict continuity of aquifers and confining units, Stratigraphy, v. 2, no. 3, pp. 259-275