Maximizing the Use of 3-D Site Visualizations

Presented by:

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Objectives

At the end of this presentation participants will:

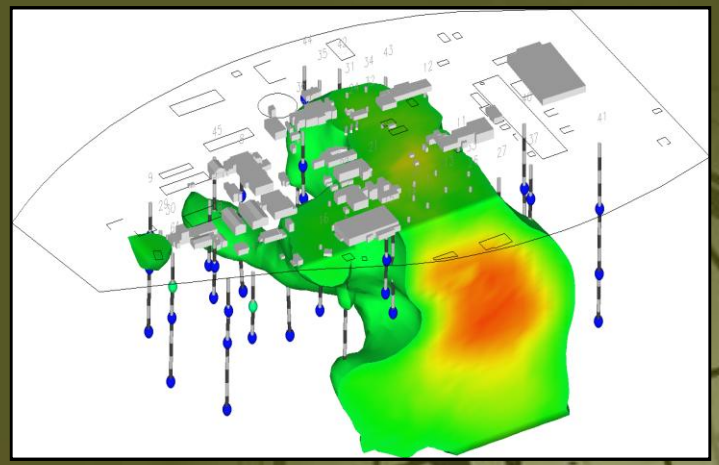
- Understand the 3-D site visualization tools that can be used
- Recognize opportunities to use these tools on your projects
- Understand the effectiveness of the tools through review of case studies

Agenda

1. Introduction
2. Overview
3. Geologic Interpolation Methodology
4. Case Studies

1. Introduction

3-D Data Visualization has become a more common method of analyzing, presenting & communicating site information



1. Introduction

Typical Questions:

- Is the conceptual site model (CSM) correct?
- Is the Site properly characterized?
- Are the constituents of concern (COC's) delineated?
- Are the remedial options appropriate and will they work?

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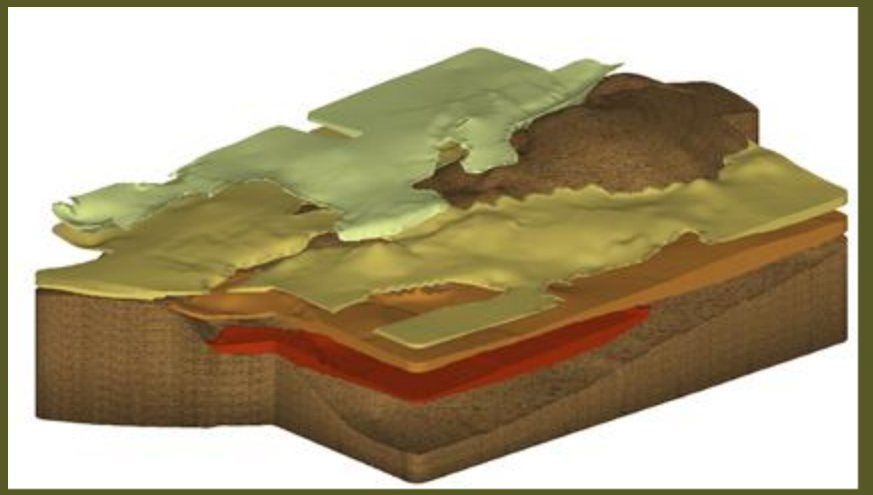
4. Case Studies

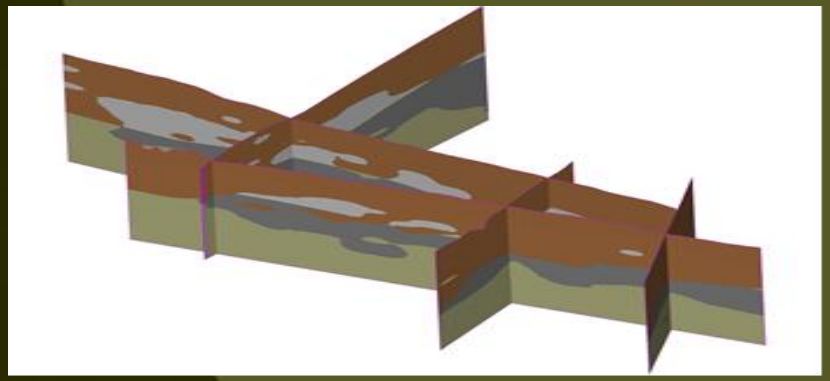
2. Overview

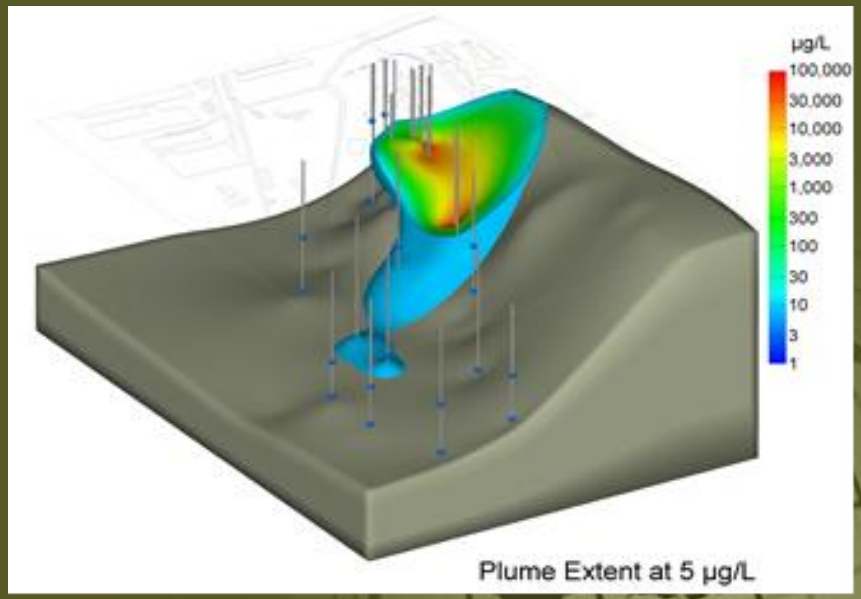
- 3-D Data Visualizations are not conceptual cartoons, they are defensible geostatistical models based on your site data
- Integrates geologic modeling, geostatistical analysis and visualization tools
- CRA has used EVS/MVS developed by C Tech Corporation

2. Overview

- Transforms a room full of binders into an easy-to-use model
- Helps define data gaps
- Challenge and optimize CSM
- Leaves a lasting impression in viewers minds
- Allows you to communicate site information with all Stakeholders







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3. Geologic Interpolation Methodology

EVS/MVS has two principal methods for evaluation and modeling of geologic structures:

1. Hierarchical Layered Models (Layered)

- The Layered model approach extrapolates between borings to create a continuous geologic surface

3. Geologic Interpolation Methodology

2. Geologic Indicator Kriging (GIK)

- GIK assigns logical soil classifications (such as porosity, permeability, particle size) to cells over an interpolation grid
- Well suited to sites that have complex, heterogeneous geology (ex. fluvial environments, sand channels) or complex structures that do not lend themselves to layered models

3. Geologic Interpolation Methodology

- Selection of the most appropriate method is critical step in developing a reliable subsurface characterization
- The selection of the most appropriate method is based on the complexity of the geological conditions to be modeled
- GIK can be used to test a CSM that includes a layered system

3. Geologic Interpolation Methodology

Summary of GIK

- Materials are numbered based on logical classification (such as porosity, permeability, particle size)
- Consecutive integer values are used to describe each material observed in the entire site
- The probability for each material is computed for every cell within the model grid

3. Geologic Interpolation Methodology

- Materials having the highest probability (for an individual cell) are assigned to the cell
- The finer the grid spacing the more accurate the model representation
- When geologic interpretation and chemistry interpretation (which are generated independently) are superimposed there should be a good correlation if the site is properly characterized

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Case Study 1

Its All in the Geology!

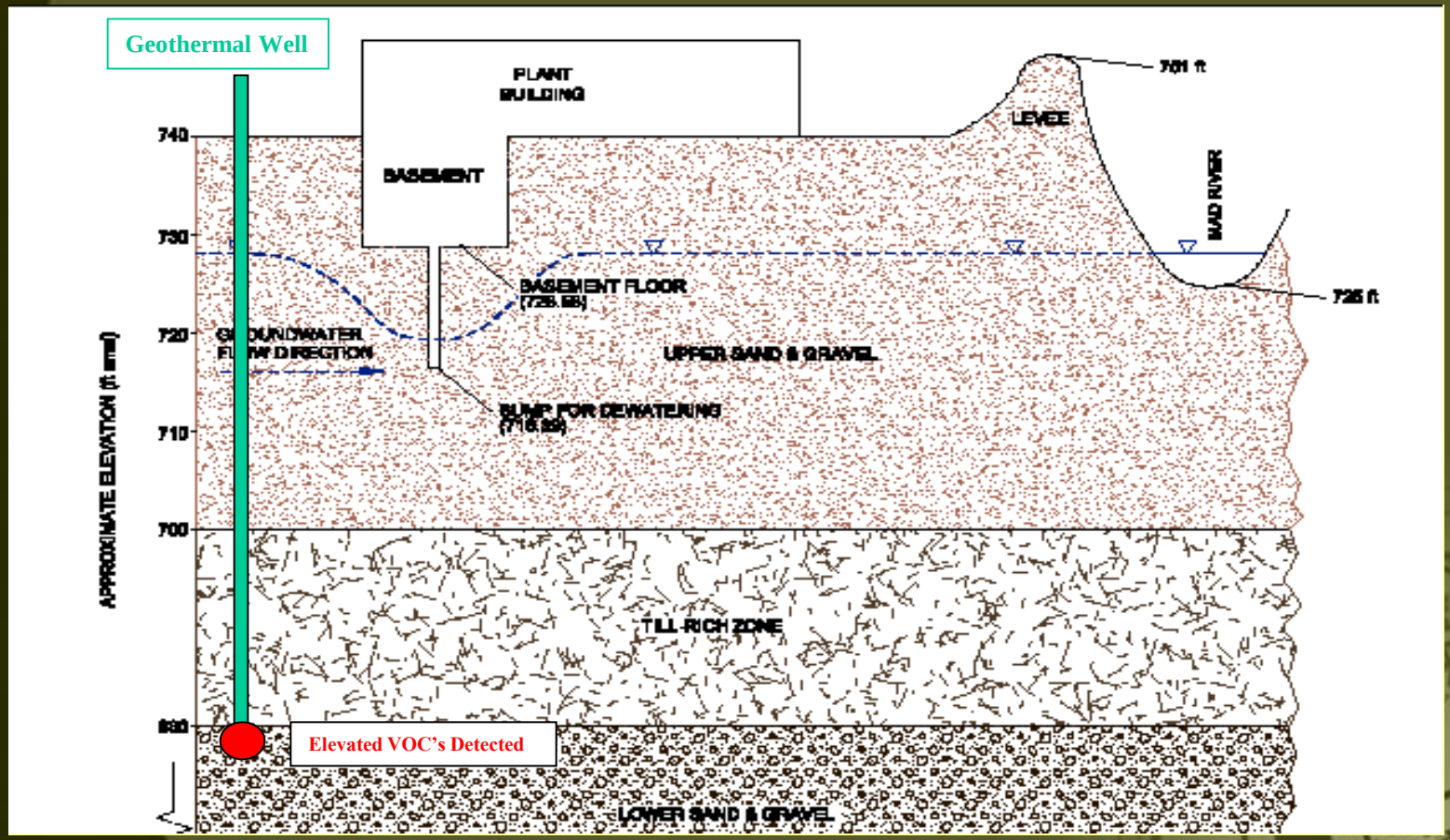
Case Study 1

Site Background

- Site in Ohio
- Facility impacted with VOCs
- Previous consultant believed the geology at the Site consisted of an Upper Aquifer, Clay Aquitard, and a Lower Aquifer
- Given that impacts were observed in the Lower Aquifer, the well casing of the Lower Aquifer Geo Thermal well was suspected of causing a short circuit

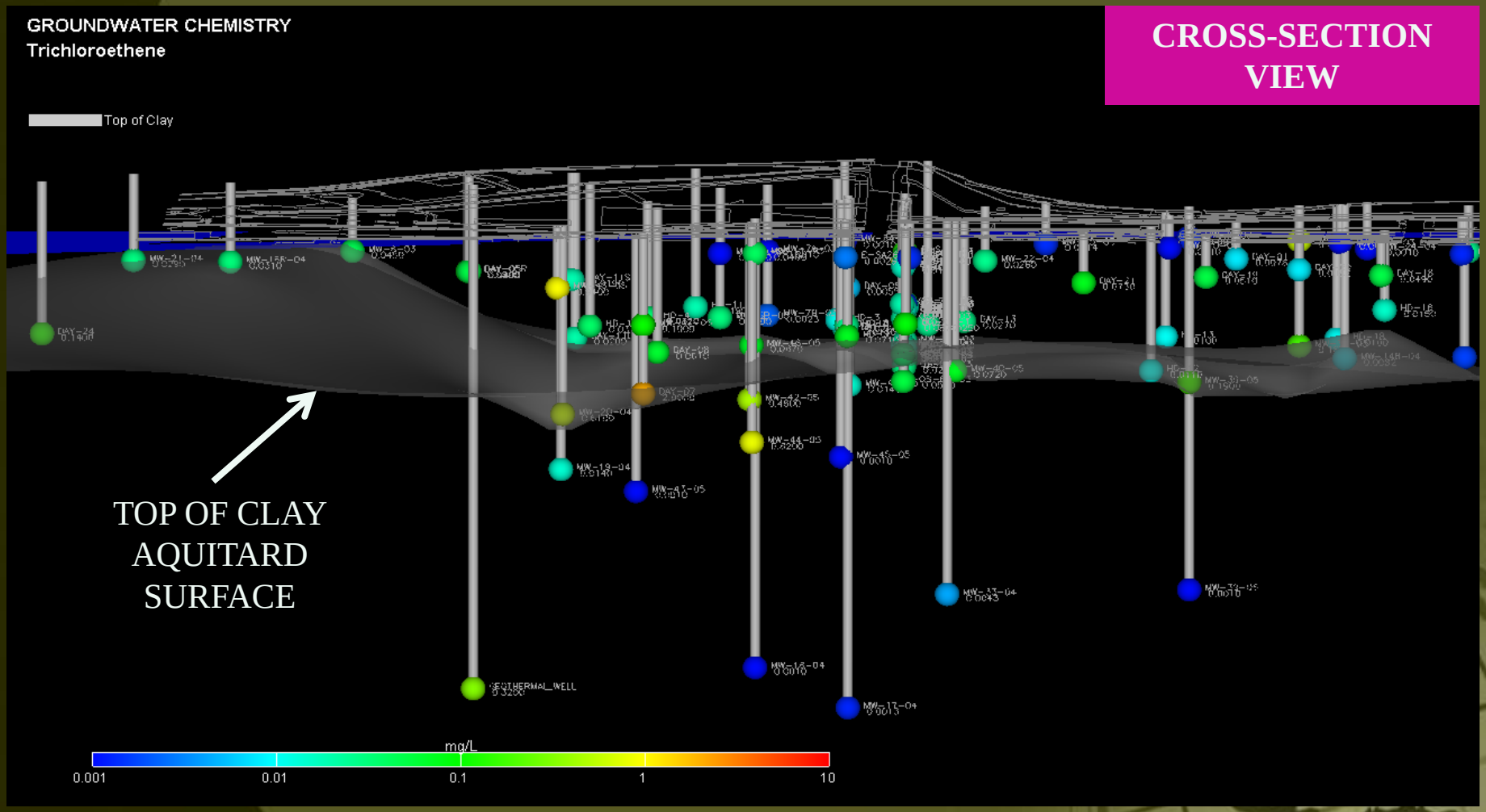
Case Study 1

Initial Depiction of Geology



Case Study 1

Initial Depiction of Geology - model



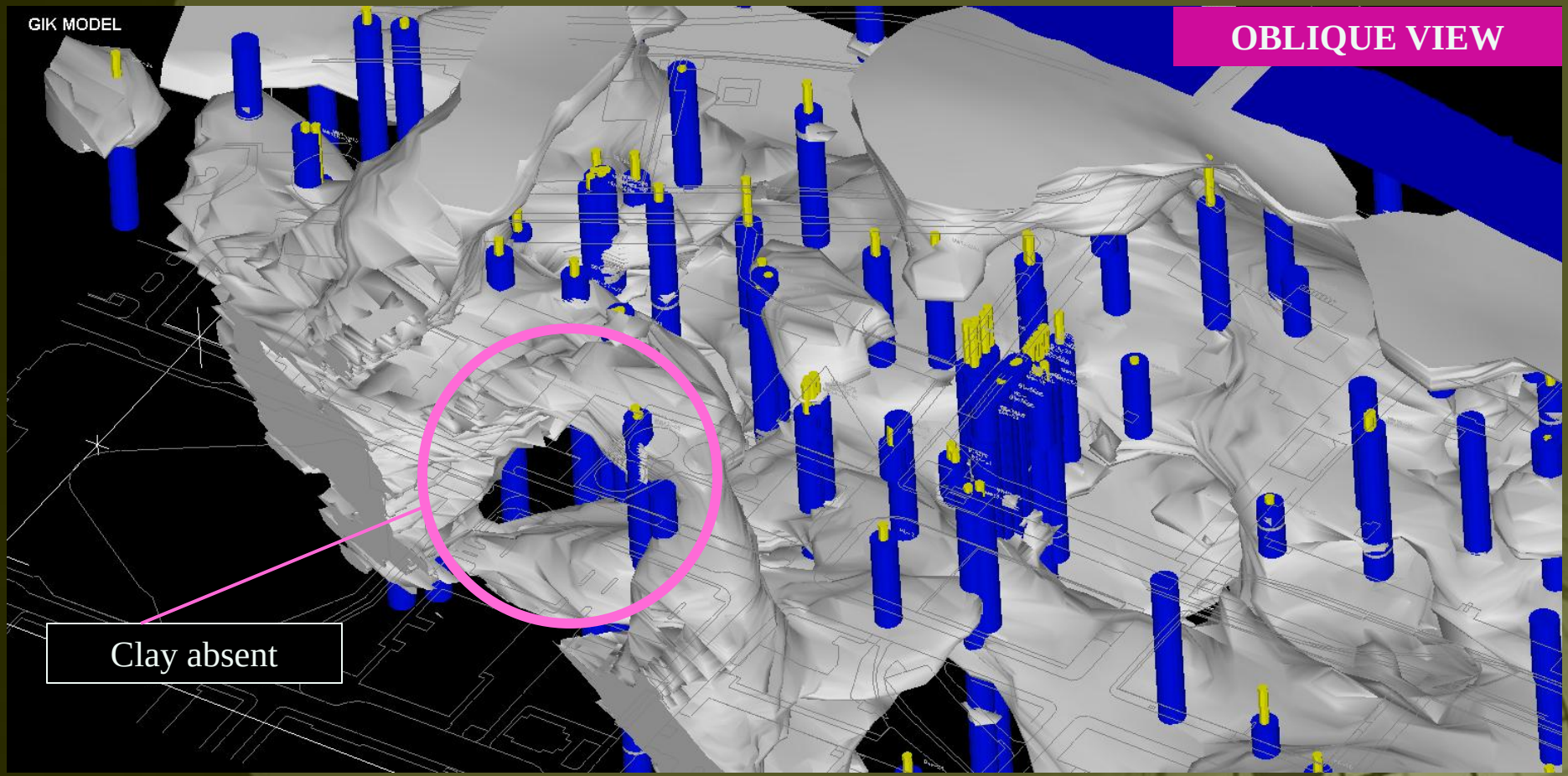
Case Study 1

CRA's Review of Geology

- In 2006, CRA used 3-D visualization to better understand the potential movement of contaminants and to identify areas where the clay was likely to be absent based on the geological and chemical interpretation of the existing data
- GIK methodology was applied
- Model results confirmed the aquitard was not continuous and showed the VOCs migrating through these 'gaps' in the Lower Aquifer

Case Study 1

CRA's Review of Geology

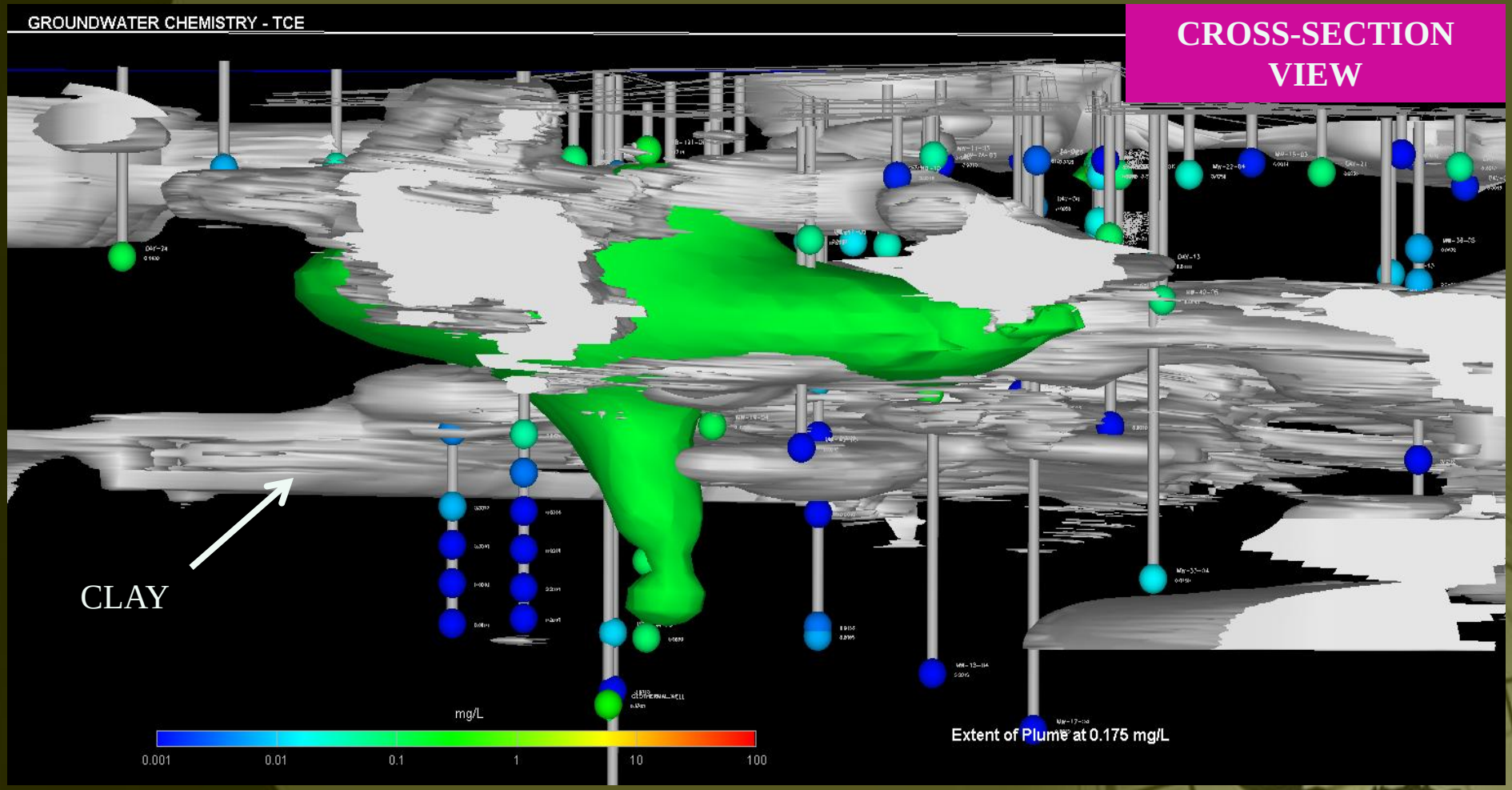


Case Study 1

- In 2007, CRA installed monitoring wells in the areas that the model predicted the clay to be absent and where VOCs were predicted to be migrating, to confirm that the clay was not continuous
- The field investigation confirmed the predictions of the model
- Subsequent groundwater investigations confirmed CRA's initial suspicion that discontinuities in the aquitard were allowing elevated levels of VOCs to migrate into the Lower Aquifer

Case Study 1

Post Well Installation



Case Study 1

3-D Visualization Model Result:

- Aided in both location and type of remedial design
- helped our client save time and money in Site characterization

CASE STUDY 1 MODEL

Case Study 2

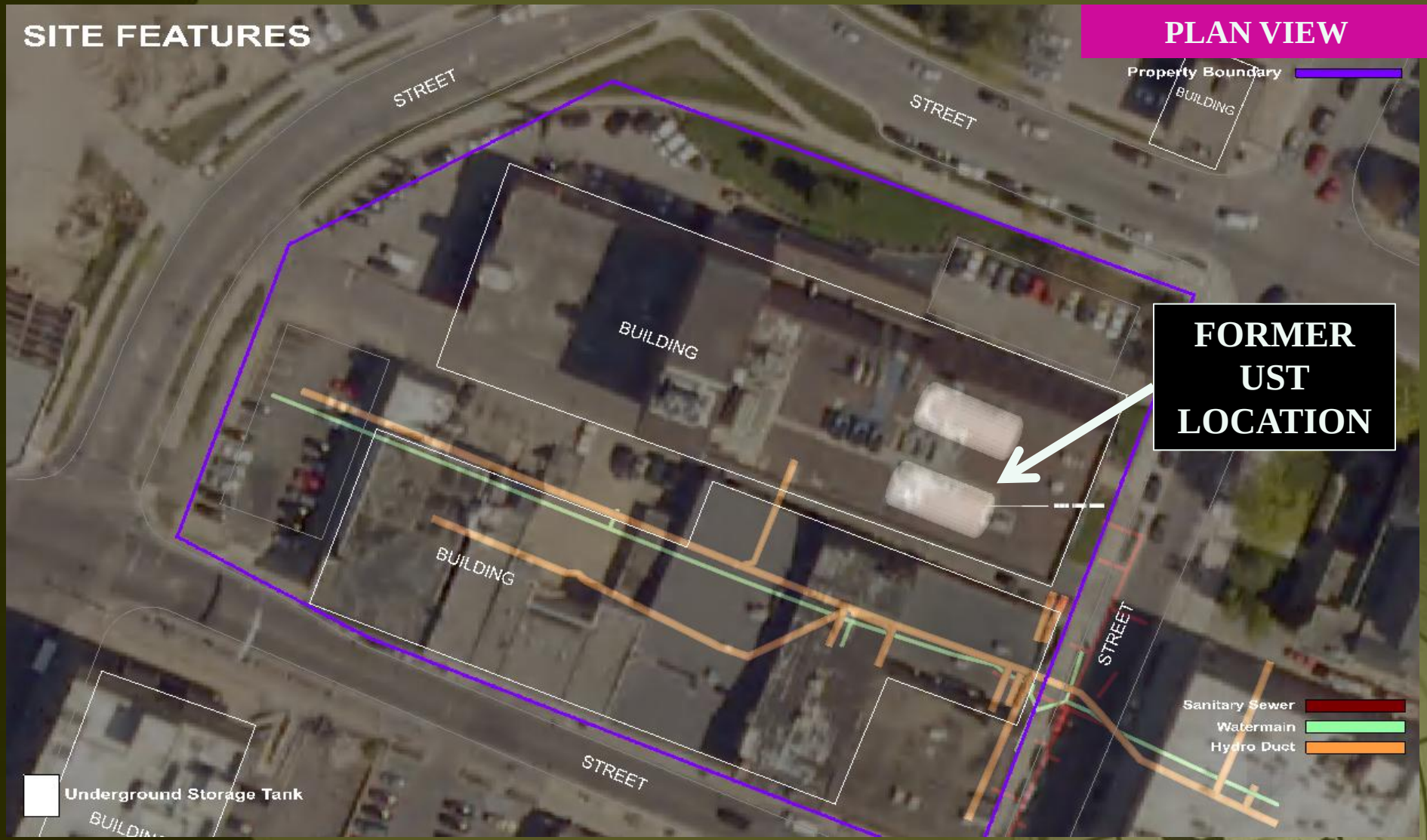
The Tip of the Iceberg!

Case Study 2

Site Background

- Industrial site in Ontario
- Historical UST release of heating oil from 10,000 gal UST
    - In service from 1963 to 1981
    - UST and 400 tons of impacted soil removed in 1998

Case Study 2


SITE FEATURES
PLAN VIEW
Property Boundary
STREET
STREET
BUILDING
BUILDING
FORMER UST LOCATION
BUILDING
STREET
STREET
Sanitary Sewer
Watermain
Hydro Duct
Underground Storage Tank

Case Study 2

Site Background

- 2010 CRA retained to conduct a peer review of an ongoing remedial project to address Agency comments on previous consultant's work that the extent of LNAPL had not been adequately delineated
- CRA subsequently assumed control of this project from the previous consultant

Case Study 2

- CRA implemented a very sophisticated investigation program involving:
  - Laser-induced fluorescence (LIF) survey
  - Soil core petro-physical testing
  - LNAPL baildown testing
  - Groundwater sampling
  - Soil gas sampling
  - 3-D LNAPL body visualization
- To evaluate the current conditions of the LNAPL body after 10 years of active remediation

Case Study 2

Primary Goal of 3-D Visualization Model & Investigation:

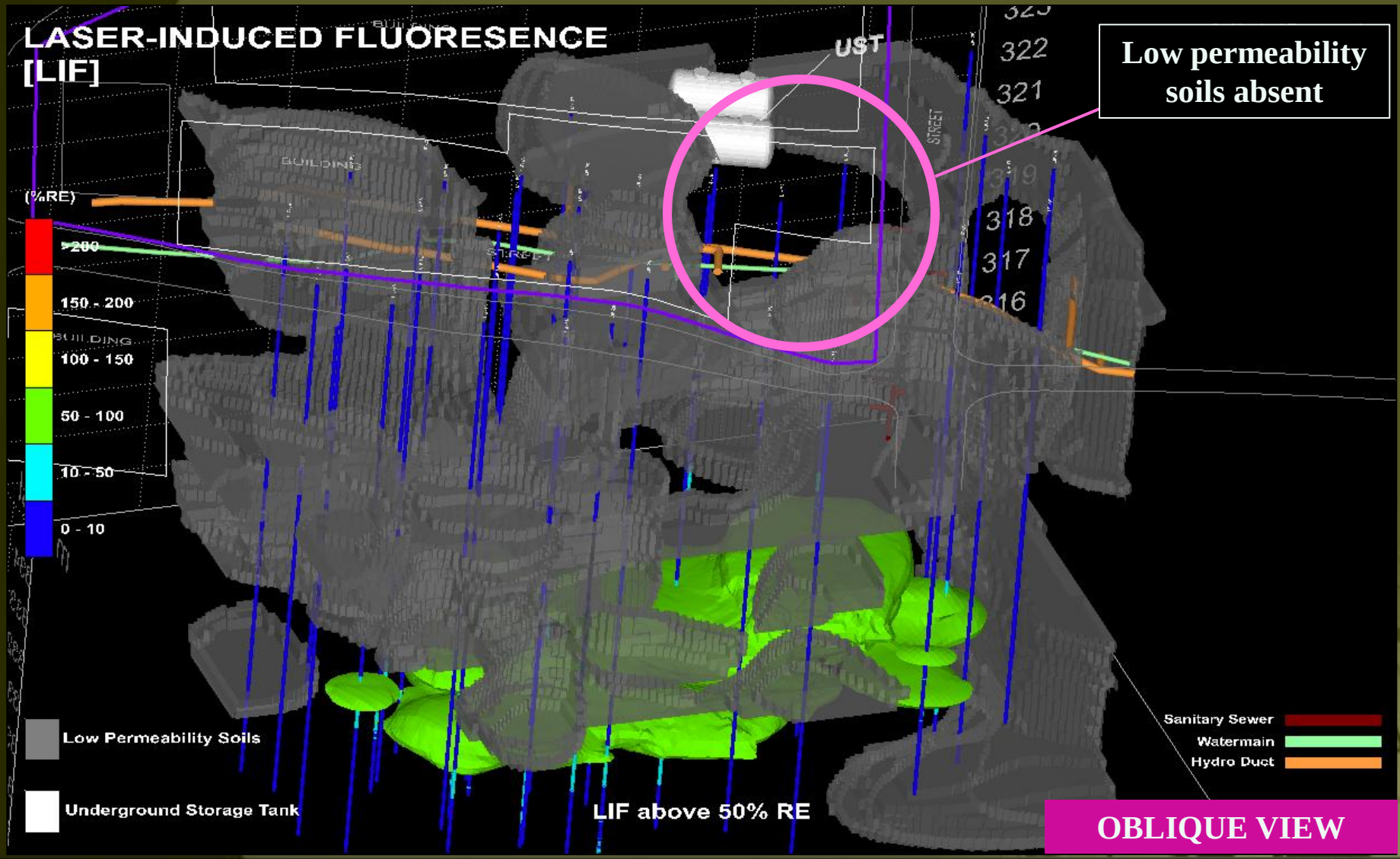
- Capture & visualize current conditions
- Determine applicable remedial drivers
- Develop remedial strategy/goals based on drivers
- Target implementation

Case Study 2

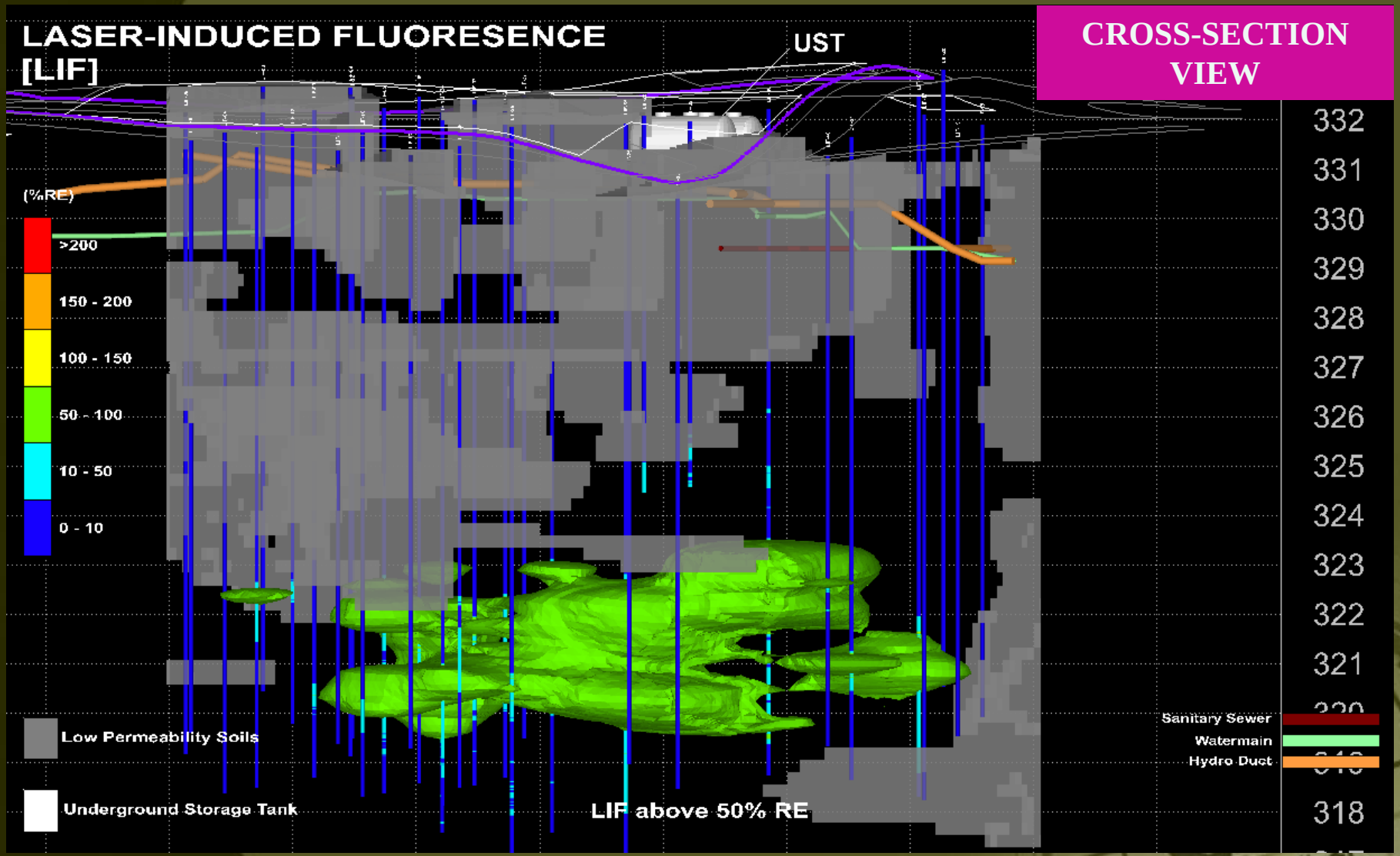
3-D Visualization Model & Investigation Results :

- GIK was applied
- Model identified areas where lower permeability soils were absent based on the geological observation data
- LNAPL body stable (i.e. not migrating or expanding) and predominately trapped in the saturated zone at low saturation levels
- Mobile/recoverable LNAPL is estimated to be a small fraction of the overall LNAPL body

Case Study 2


LASER-INDUCED FLUORESCENCE [LIF]
UST
322
321
318
317
STREET
BUILDING
(%RE)
>200
150 - 200
100 - 150
50 - 100
10 - 50
0 - 10
Low permeability soils absent
Low Permeability Soils
Underground Storage Tank
LIF above 50% RE
Sanitary Sewer
Watermain
Hydro Duct
OBLIQUE VIEW

Case Study 2


LASER-INDUCED FLUORESENCE [LIF]
UST
CROSS-SECTION VIEW
(%RE)
>200
150 - 200
100 - 150
50 - 100
10 - 50
0 - 10
Low Permeability Soils
Underground Storage Tank
LIF above 50% RE
Sanitary Sewer
Watermain
Hydro Duct
332
331
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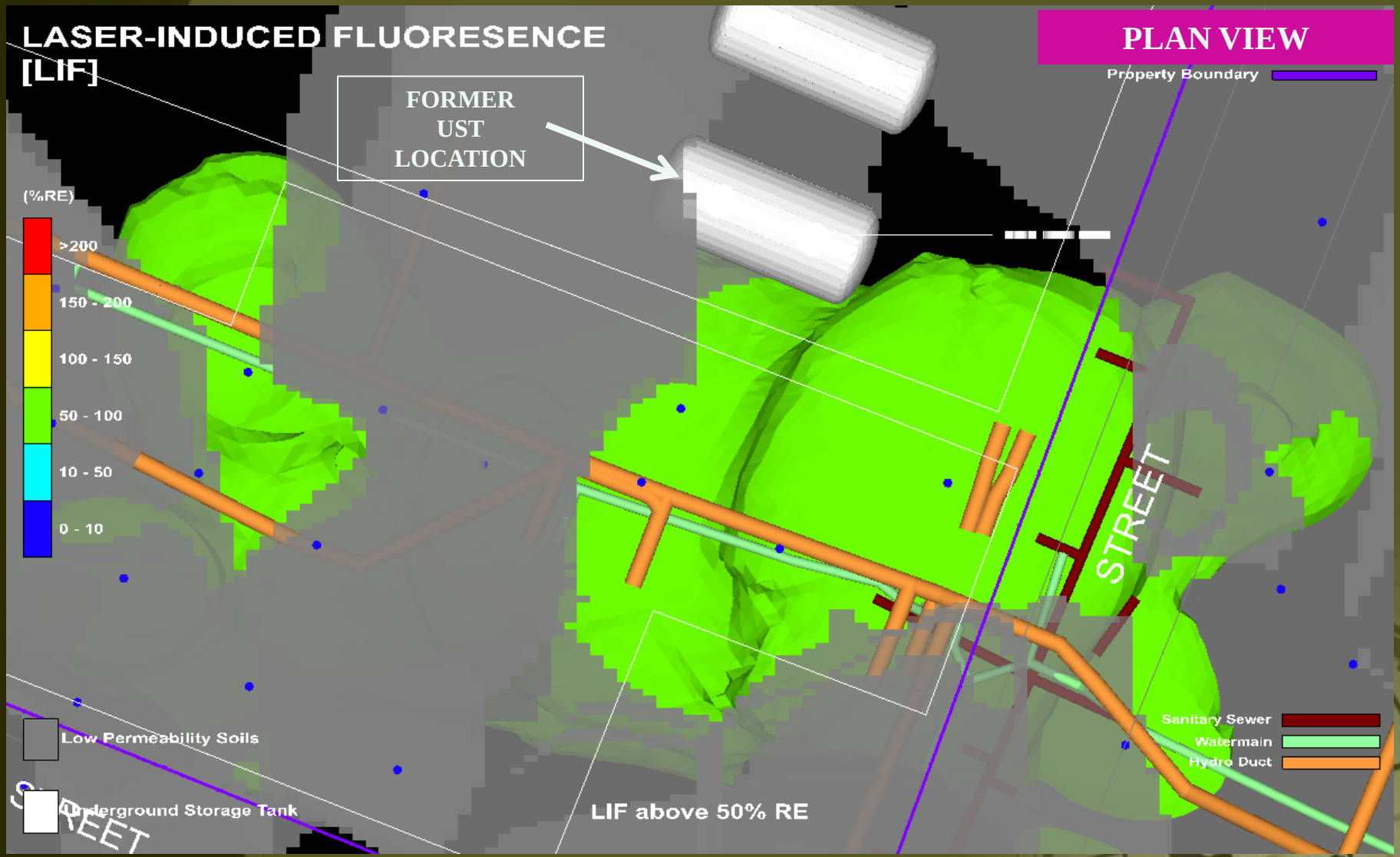
Case Study 2


LASER-INDUCED FLUORESENCE [LIF]
PLAN VIEW
Property Boundary
FORMER UST LOCATION
(%RE)
>200
150 - 200
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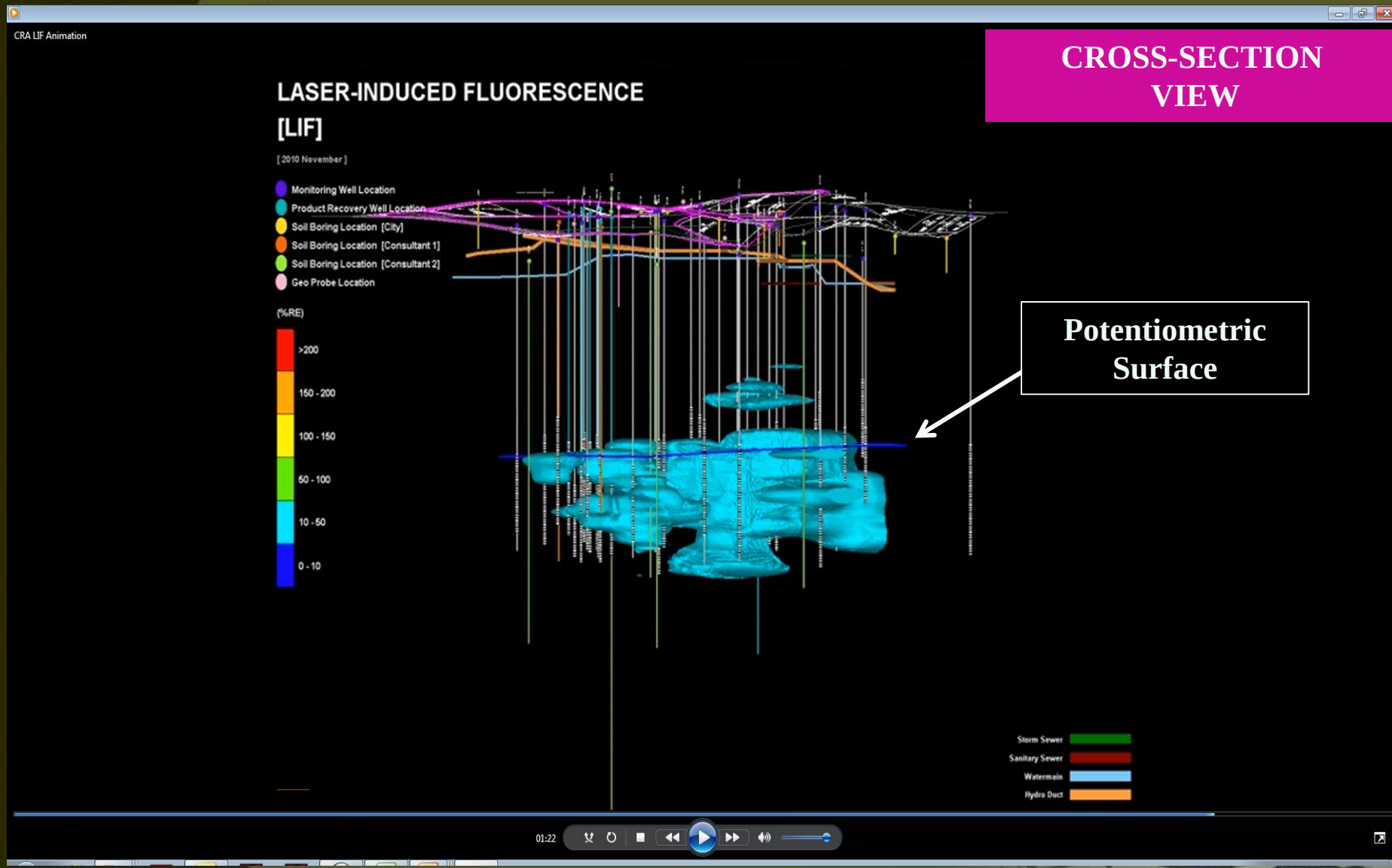
STREET
Low Permeability Soils
Underground Storage Tank
LIF above 50% RE
Sanitary Sewer
Watermain
Hydro Duct

Case Study 2


CRA LIF Animation
LASER-INDUCED FLUORESCENCE
[LIF]
[2010 November]
Monitoring Well Location
Product Recovery Well Location
Soil Boring Location [City]
Soil Boring Location [Consultant 1]
Soil Boring Location [Consultant 2]
Geo Probe Location
(%RE)
>200
150 - 200
100 - 150
50 - 100
10 - 50
0 - 10
CROSS-SECTION VIEW
Potentiometric Surface
Storm Sewer
Sanitary Sewer
Watermain
Hydro Duct
01:22

Case Study 2

- Model was presented to Agency, Client and various off-site property owners
- Agency agreed that Client could stop pumping LNAPL even though there is still LNAPL present

CASE STUDY 2 MODEL

Thank You