

Missouri Department of

**Natural Resources**

# Geotechnical Parameter Documentation

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# Objective

To highlight the importance of accurately determining and documenting site-specific geotechnical parameters during risk assessment

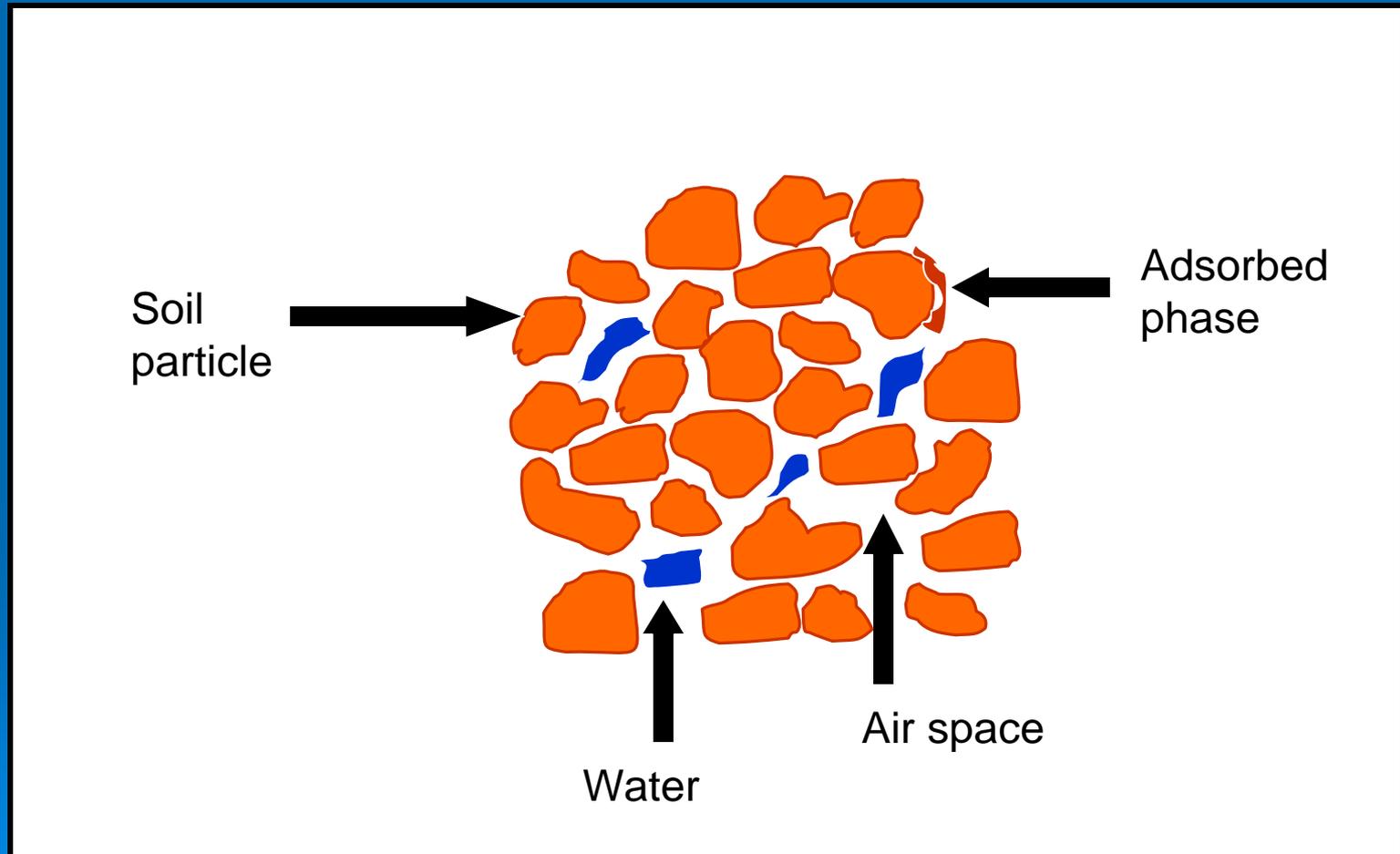
# Introduction: MRBCA risk assessment process

1. Characterization of contamination
2. Geotechnical parameters

# Determination of MRBCA geotechnical parameters (Sections 5.6 and 8.0)

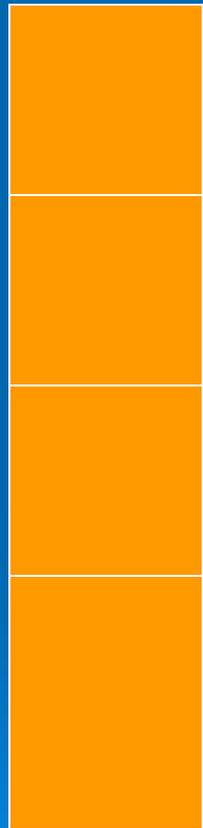
- A. Site-specific values
- B. Default values (soil type dependant)
- C. Literature values (USGS)
- D. Adjacent site values

# The soil subsurface



# Vadose zone lithology

Homogeneous soil



Silty clay

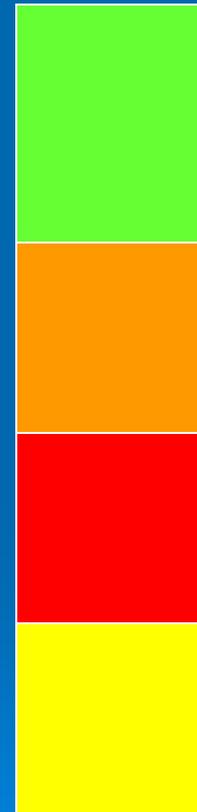
Silty clay

Silty clay

Silty clay

One sample

Heterogeneous soil



Stiff clay

Silty clay

Fine sand

Coarse sand

Many subsamples

# MRBCA geotechnical parameters

- 1 - Dry bulk density
- 2 - Soil porosity
- 3 - Volumetric water content (VWC)
- 4 - Fractional organic carbon content (FOC)

# Dry bulk density (g/cc)

The dry weight (110 degrees C) of an undisturbed soil sample divided by its field volume (ASTM Method D2937-94)

Dry bulk density is inversely related to porosity (high porosity/more friable soil/less compacted/low bulk density)

# How to obtain dry bulk density?

## 1. Soil sampling:

- Collect soil samples using Shelby tube or thin-walled sampler or equivalent method
- Homogeneous soil: one sample
- Heterogeneous soil: one soil sample from each soil type (horizon) - consider the % of each soil type in the vadose zone

# Dry bulk density (continued)

2. Literature values:

- USGS-CARES value (depth)

3. MRBCA default value (1.5)

Generally reasonable values are reported  
(range of 1.0 to 2.0)\*

\*California Department of Pesticide Regulation

# Soil porosity (cc/cc-soil)

The ratio of volume of voids in a soil sample to the volume of the sample  
(ASTM Method D854)

# How to determine soil porosity?

We need to determine:

- dry bulk density
- specific gravity

Porosity =  $1 - \frac{\text{dry bulk density}}{\text{specific gravity or particle density}}$

At MRBCA Tier 2 porosity for the vadose zone, capillary fringe, & foundation or wall cracks are assumed identical

# Specific gravity (ASTM D854)

The mass of solid matter in a given soil sample as compared to an equal volume of water

# Specific gravity values\*

<u>Soil</u>	<u>Specific gravity</u>
Sand	2.63 – 2.67
Silt	2.65 – 2.7
Clay & silty clay	2.67 – 2.9
Organic soils (Histosols-peat (OMC 0.12 - 0.18))	<2.0

\*University of Akron, OH

# Verification of soil porosity value

- Boring logs information/ soil type/MRBCA default values (0.38, 0.44)
- Literature value of comparable lithology
- Adjacent site value of comparable lithology

# Soil porosity values

Material	USGS	Argonne Nat. Lab.	Tanks MRBCA
Sand	0.25	0.25 - 0.50	0.38
Silt	NA	0.35 - 0.50	0.44
Clay	0.50	0.40 - 0.70	0.44

# Volumetric water content (cc/cc)

The ratio of volume of water to the volume of soil (ASTM Method D2216-92)

- VWC is used in models
- Convert gravimetric value to volumetric value

$$\text{VWC} = \text{GWC} \times \text{dry bulk density} / \text{density of water}$$

# How to determine volumetric water content?

- 1- Collect multiple soil samples across the site at varying depths and determine the water content from each of the vadose zone lithologic units
- 2- Calculate average water content in lab reports for soil samples collected from the vadose zone
- 3- USGS value- CARES (check depth)
- 4- MRBCA default value (determine soil type)

# General volumetric water content issues

1. Volumetric water content higher than porosity?
2. High volumetric water content for sites with shallow depth to groundwater (3 to 5 feet – SSTLs > effective saturated concentration for soil and groundwater)

# Fractional organic carbon content (g-C/g-soil)

The weight of organic carbon in the soil  
divided by the weight of the soil

# How to determine fractional organic carbon content?

1. Collect soil samples from area of no petroleum impact (PID-log)

Consideration of lithology: composite samples from two or more borings

2. USGS-CARES- organic matter content-correction factor

# Fractional organic carbon content (continued)

## ✓ Vadose zone:

Three subsamples from 3 feet depth to the top of the water table (from 0 to 3 feet/soil zone/high OMC)

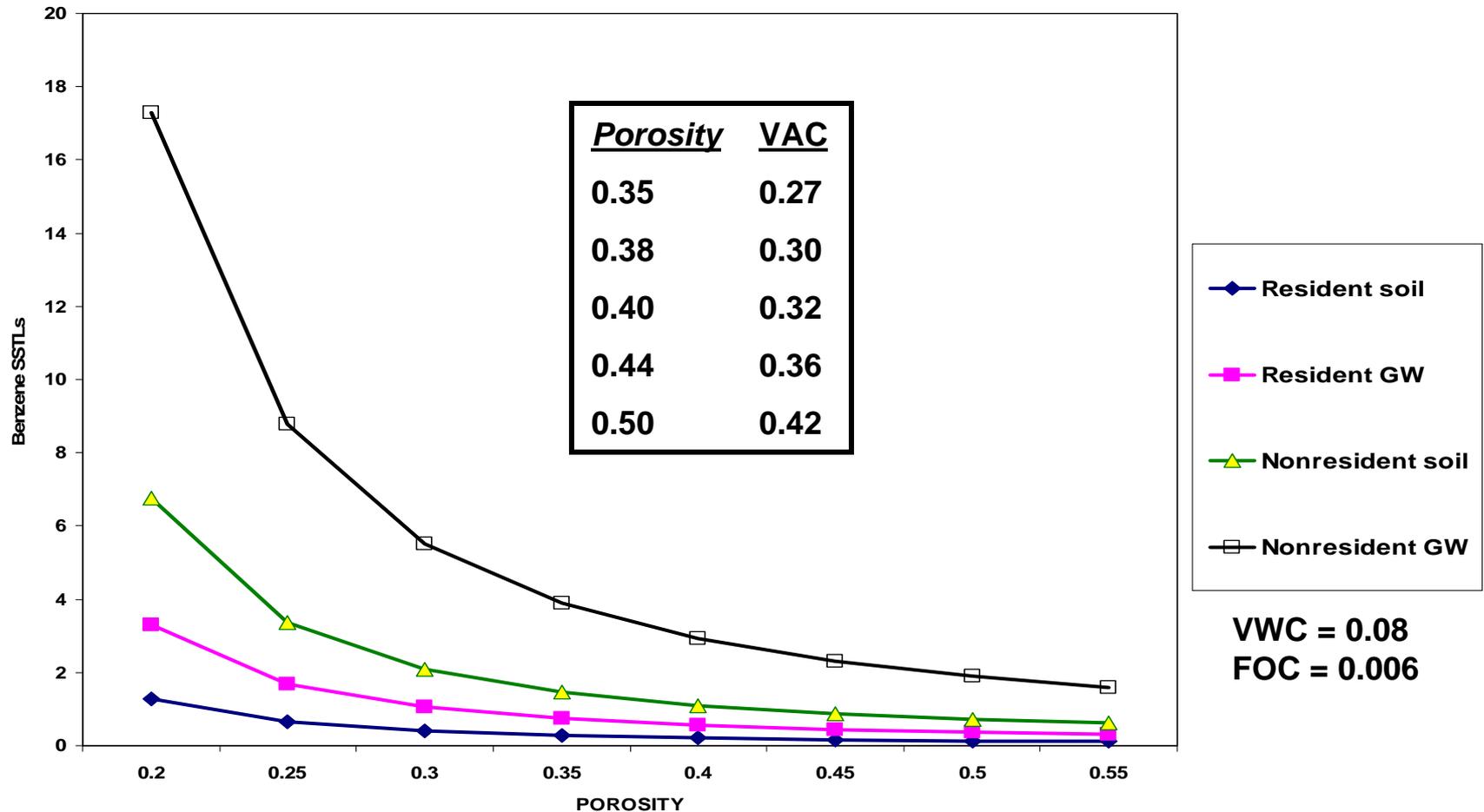
## ✓ Saturated zone:

two subsamples, one immediately below the top of the saturated zone and one 3 feet below the top of the groundwater table

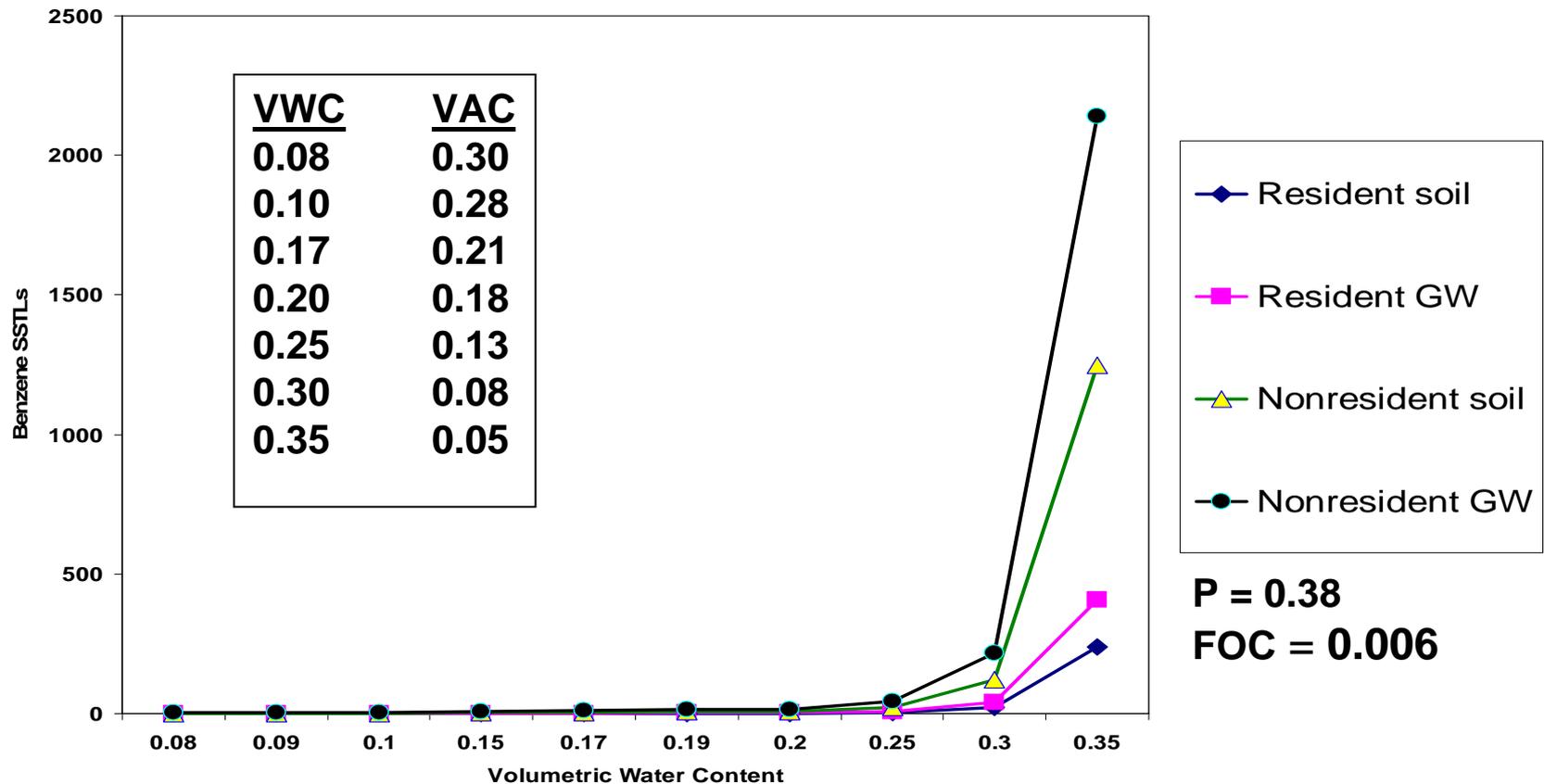
# Sensitivity illustrations

- Assess Indoor inhalation of vapor exposure pathway
- Use MRBCA software version 2.1 of 2005
- Use soil type 1 default parameters
- Determine tier 2 site-specific target levels for benzene for soil and groundwater for a resident and nonresident

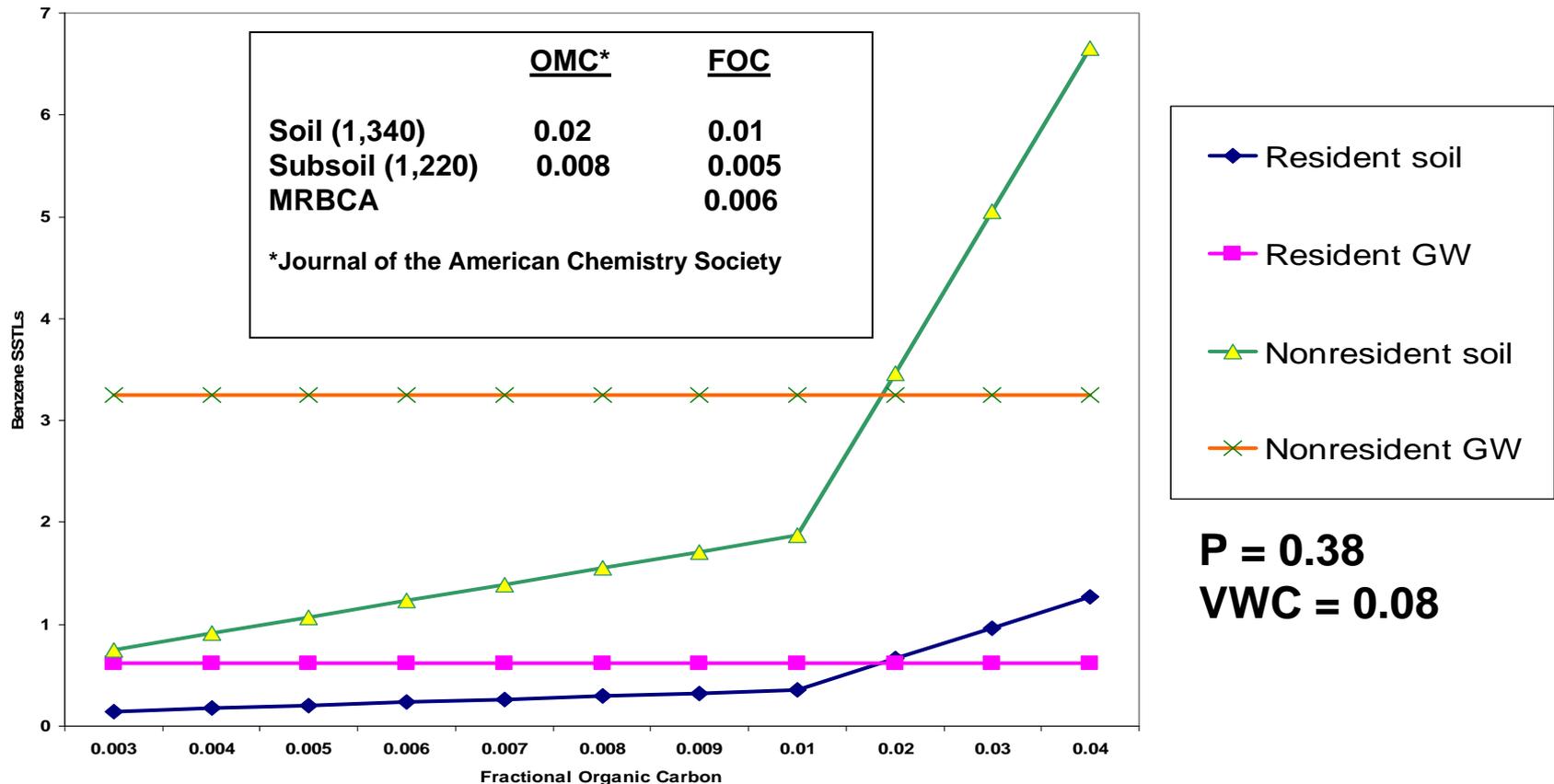
# Effect of porosity on Benzene SSTLs



# Effect of VWC on Benzene SSTLS



# Effect of FOC on Benzene SSTLs



# Summary

- ❖ Collect soil samples for geotechnical parameters according to the guidance procedures
- ❖ Collect soil samples from all soil horizons at sites where the soil profile is heterogeneous
- ❖ Submit laboratory reports and calculations
- ❖ Submit boring logs with PID results
- ❖ Support results with literature or comparable site values

# Geotechnical parameters

QUESTIONS?

COMMENTS?