RABA KISTNER

McKINNEY TEXAS
Unique by nature.

LOCAL ROADWAYS: SOIL CONDITIONS – PAVEMENT PERFORMANCE – MANAGING PVR

PUBLIC WORKS ROUNDUP| SEPTEMBER 13, 2022

Presentation Team Introductions

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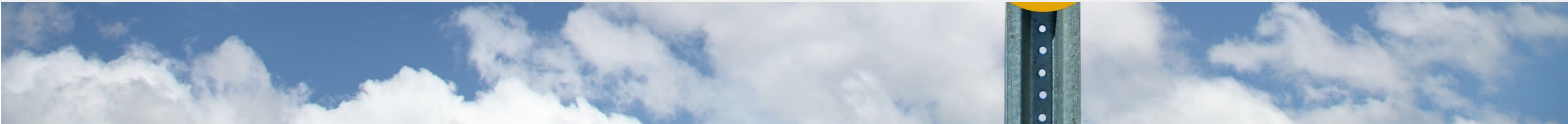
RABA KISTNER

SAFETY MOMENT



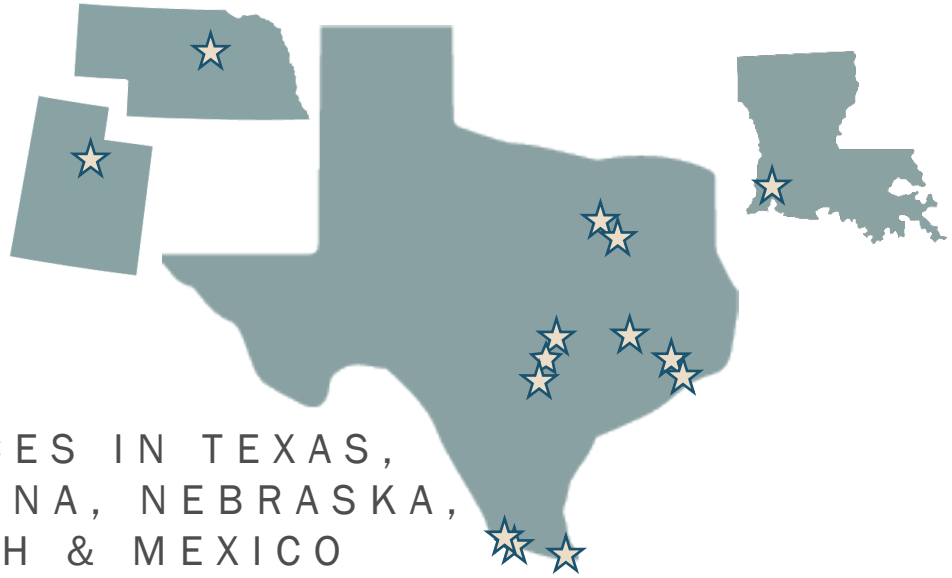
City of McKinney Objectives

1. Greater understanding of McKinney Soil Conditions
2. Moisture conditioning techniques
3. City moisture conditioning standards and other agencies
4. Impacts of existing standards
   a. Quality of products – over/under designing
   b. Initial and life cycle costs
   c. Economic development
   d. City financial resources

About Raba Kistner

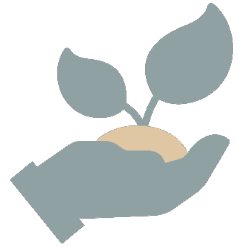
50+ YEARS
IN BUSINESS

600+
EMPLOYEES

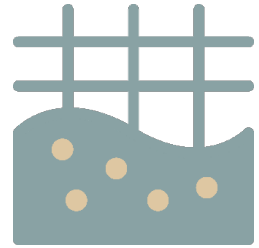


OFFICES IN TEXAS,
LOUISIANA, NEBRASKA,
UTAH & MEXICO

SERVICES

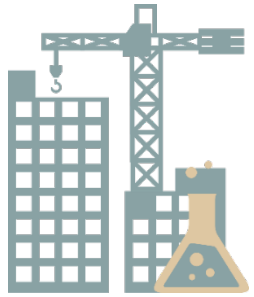


Environmental

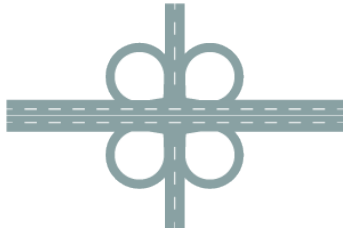


Construction Materials
Engineering & Testing

Geotechnical
Engineering



Building Sciences



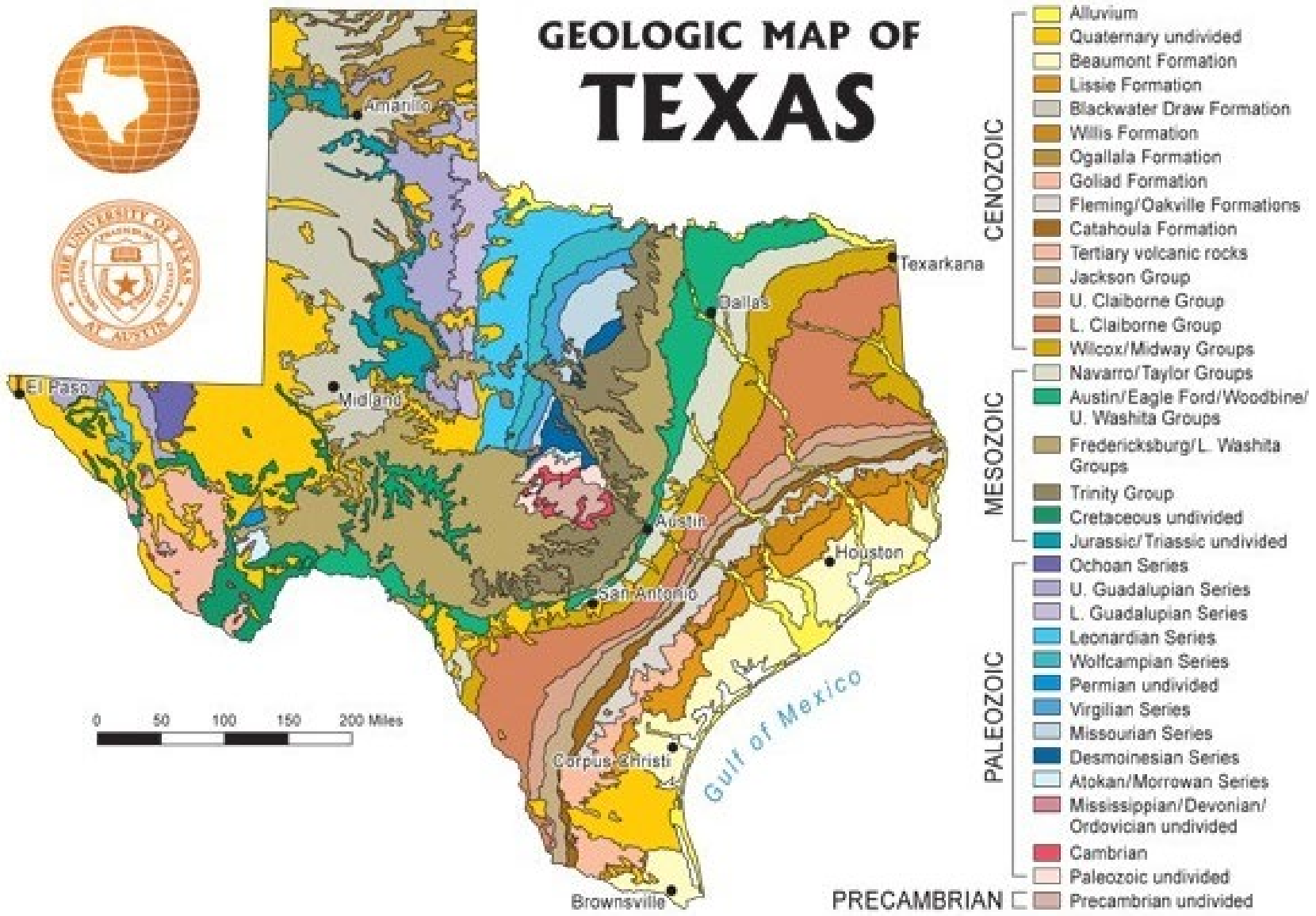
Construction
Management

Program/Project
Management

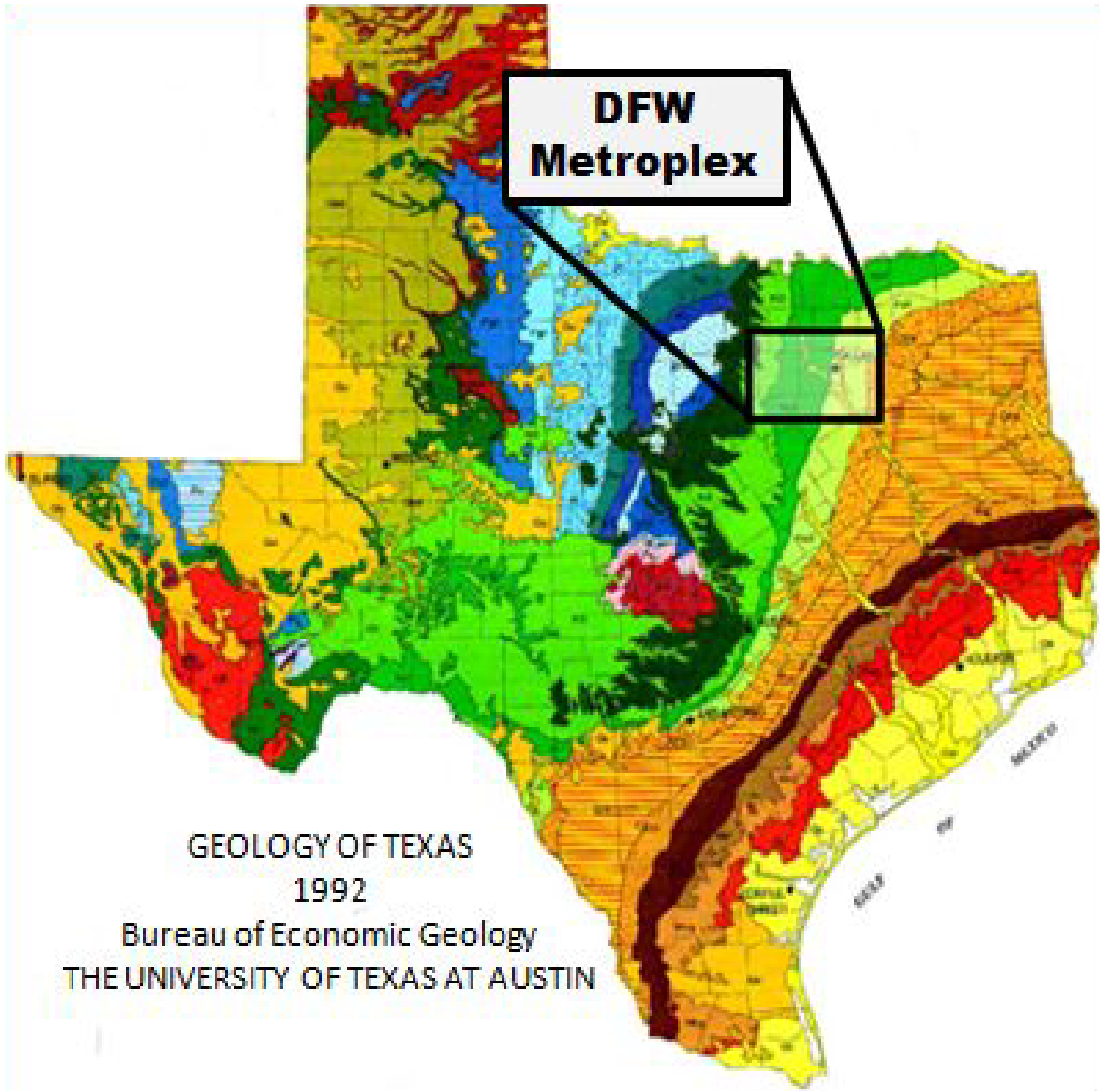
Discussion Overview

1. Geology of Texas and DFW Area
2. Characteristics of expansive soils and risk of movements
3. Methodologies to quantify expansive soils
4. Expansive clay movement mitigation methods
5. Standard practices by DFW Cities and TxDOT

Geology of Texas



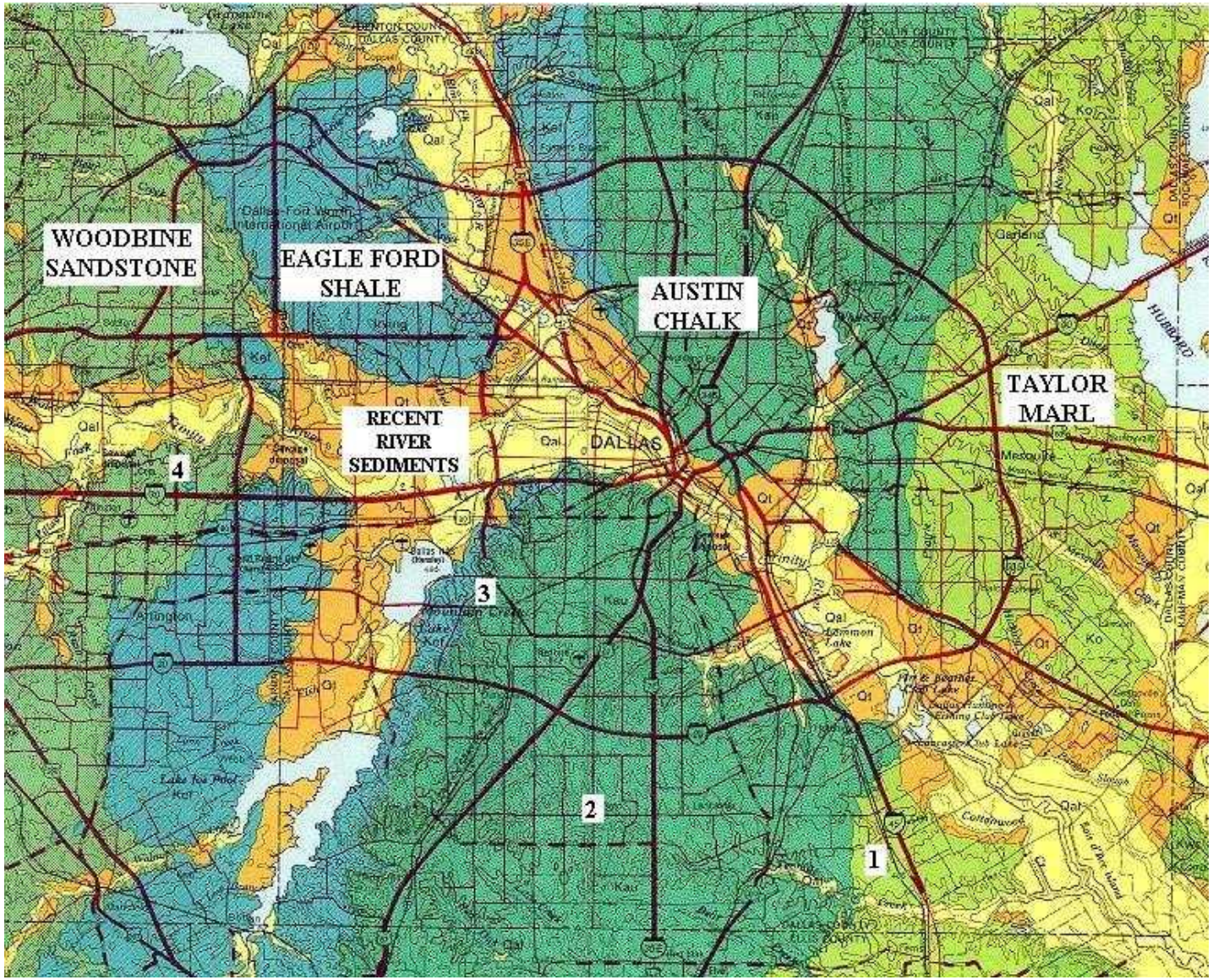
Geology of Texas and DFW Area



Geology of DFW Area

CRETACEOUS FORMATIONS OF THE DFW METROPLEX

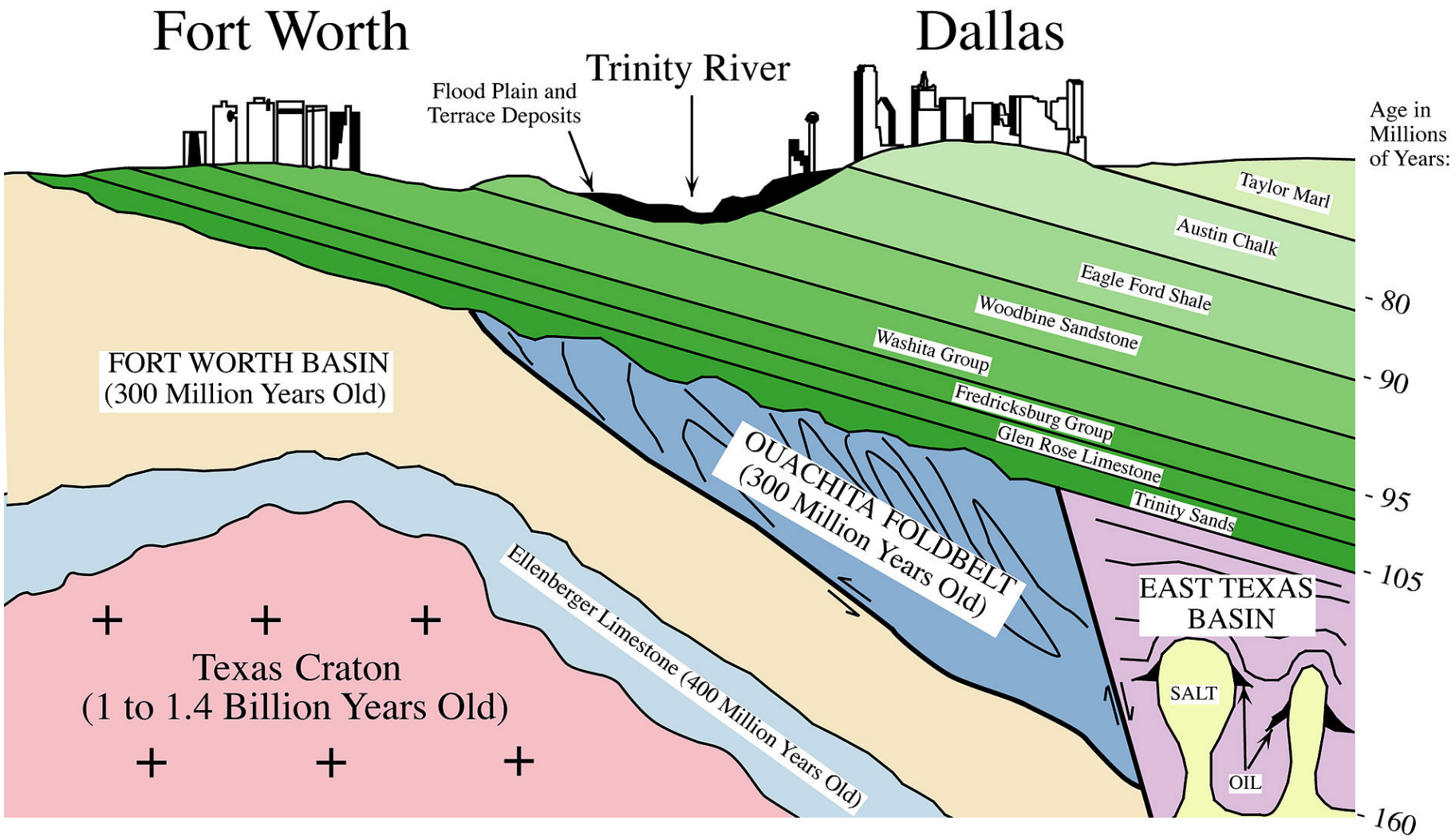
Geology of DFW Area



Geology of DFW Area

- Taylor Marl
  - Marl - can be sandy, chalky or glauconitic
  - Generally a calcareous, micaceous clay that coarsens upward
  - Contains montmorillonite - expands when wet
- Austin Chalk
  - Very hard limestone - seams of chalky marl and clay
- Fluviatile Terrace Deposits
  - Stream bed deposits - clays, sands, silts and gravels
- Eagle Ford Shale
  - Shale weathered to unweathered - thin beds of sandstone and sandy limestone
  - High potential for expansive, soil-related movements and high sulfate contents
- Woodbine Formation
  - Sandstone with some clay and shale

Geology of DFW Area



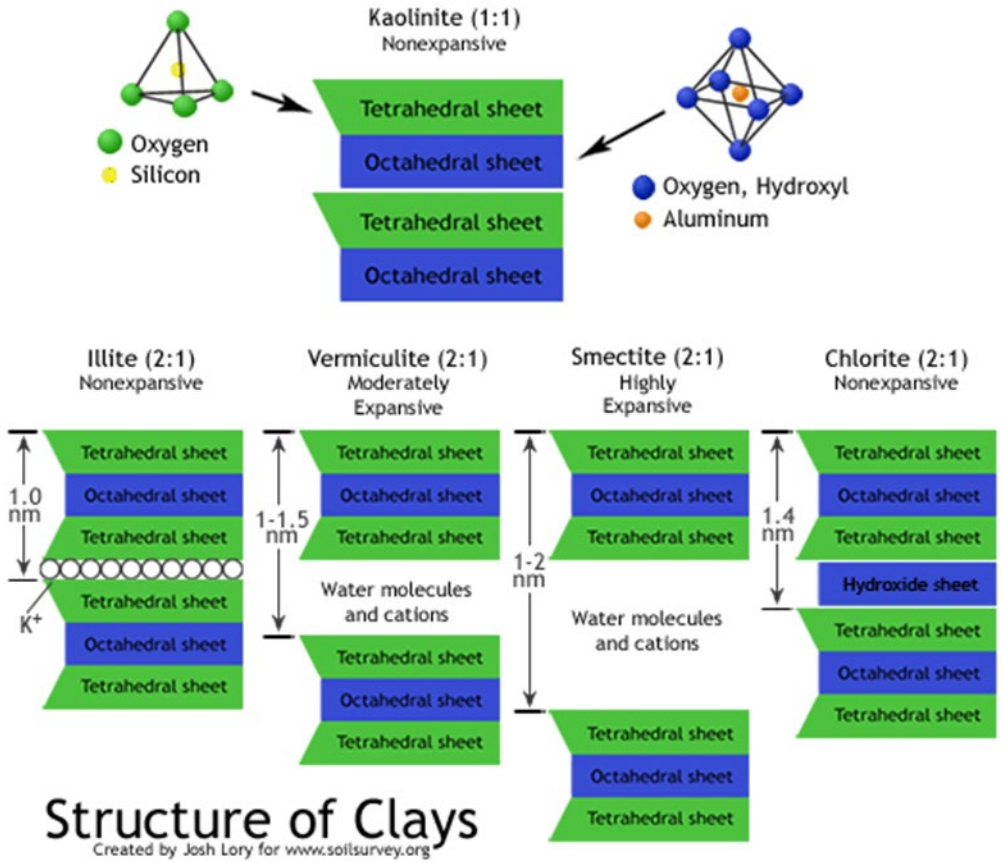
Characteristics of Expansive Soils & Risk of Movements

- Expansive Soil
  - Clay - a fine-grained soil
  - Prone to large volume changes
    - → Changes in water content
  - Deep cracks in drier seasons
  - Smectite clay minerals have the most dramatic shrink-swell capacity

Characteristics of Expansive Soils & Risk of Movements

CLAY MINERALOGY

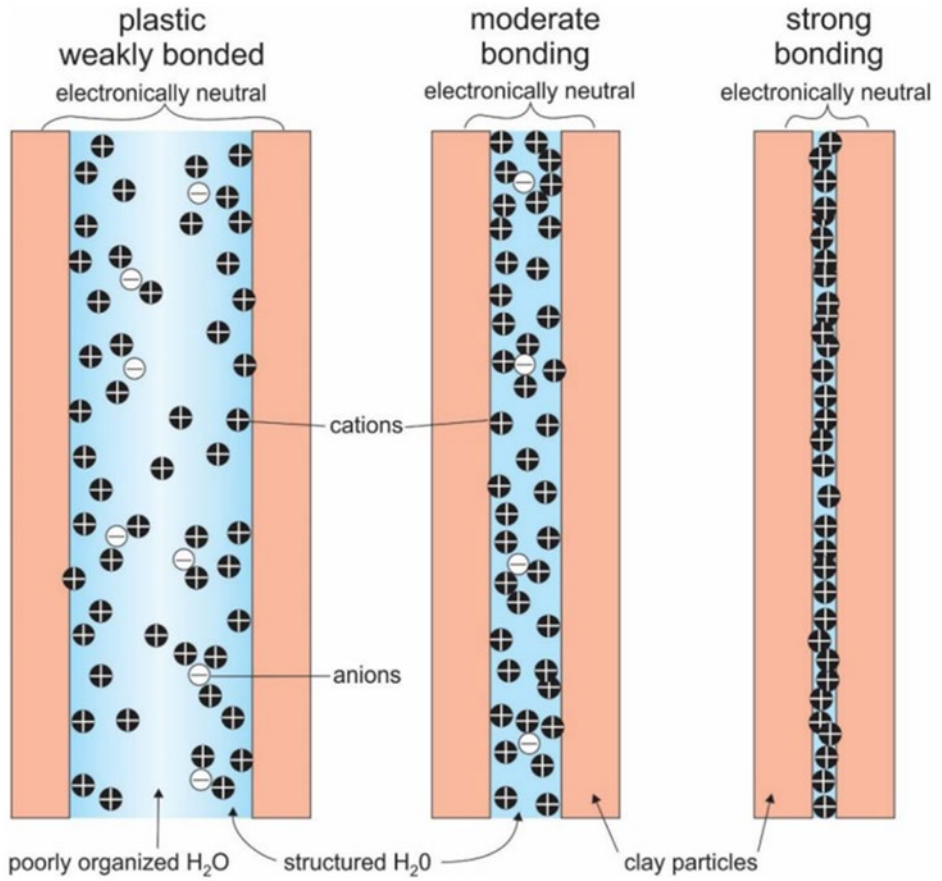
- Two basic building blocks of clay minerals:
  - Silica Tetrahedron
  - Aluminum Octahedron
  - 1:1 or 2:1 : Ratio of Silica Tetrahedron Sheets to Aluminum Hectahedron Sheets
- The larger interlayer spaces between 2:1 sheets result in increased capacity to hold water molecules



Characteristics of Expansive Soils and Risk of Movements

BONDING OF CLAY PARTICLES WITH EXCESS NEGATIVE CHARGE DISTRIBUTED ALONG SURFACES

- Bonding of clay particles with excess negative charge distributed along surfaces
- An overall neutral state occurs when naturally occurring 3 introduced cations dominate the inter-particle bonding
- Without significant water, clay particles are held together by strong electrostatic forces



Characteristics of Expansive Soils and Risk of Movements

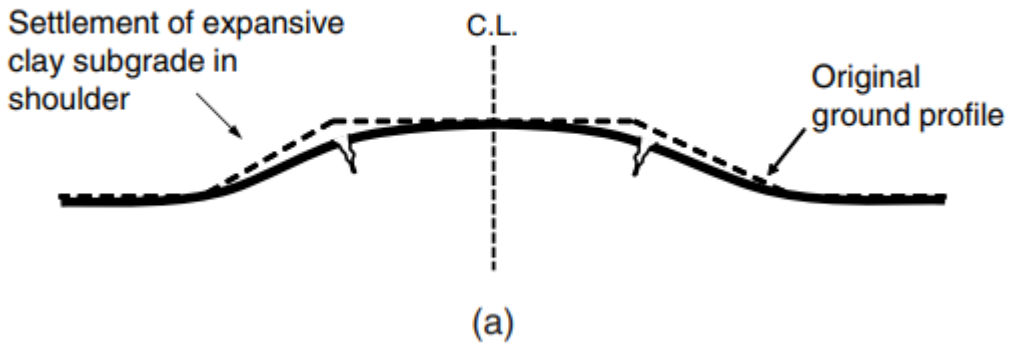
- Magnitude of expansive, soil-related movements varies based on geologic and climatic conditions
- Varies with depth of seasonal moisture change
- Deep-seated failure can occur in some formations
- Site drainage
- Moisture control during and after construction

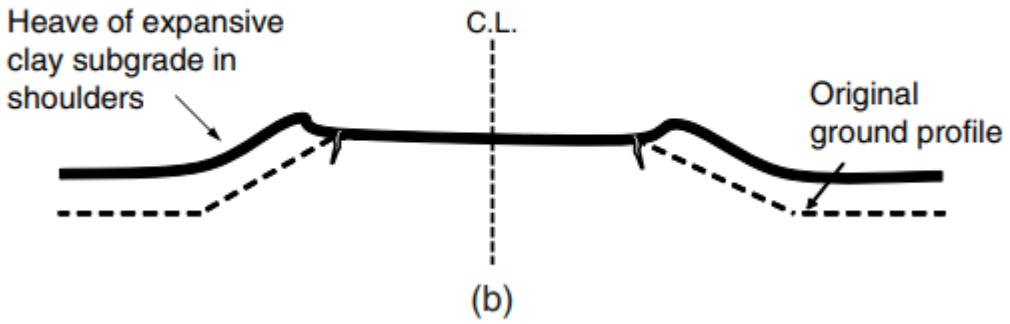
Characteristics of Expansive Soils and Risk of Movements

- Sources of water cause changes in moisture content of expansive clays:
  - Poor drainage
  - Leaks within utilities
  - Changes in the groundwater level
  - Pre-existing vegetation

Characteristics of Expansive Soils and Risk of Movements

- Swelling and shrinkage contribute to increases in roughness and degradation of pavements
- Pavement edges can reflect cyclic movement (shrink-swell) associated with seasonal variation in moisture content





Methodologies to Quantify Expansive Soils

PREDICTIVE RELATIONSHIPS

- Atterberg Limits (ASTM D4318)
  - Liquid Limit (LL)
  - Plastic Limit (PL)
  - Plasticity Index (PI)
  - (PI = LL-PL)

Methodologies to Quantify Expansive Soils

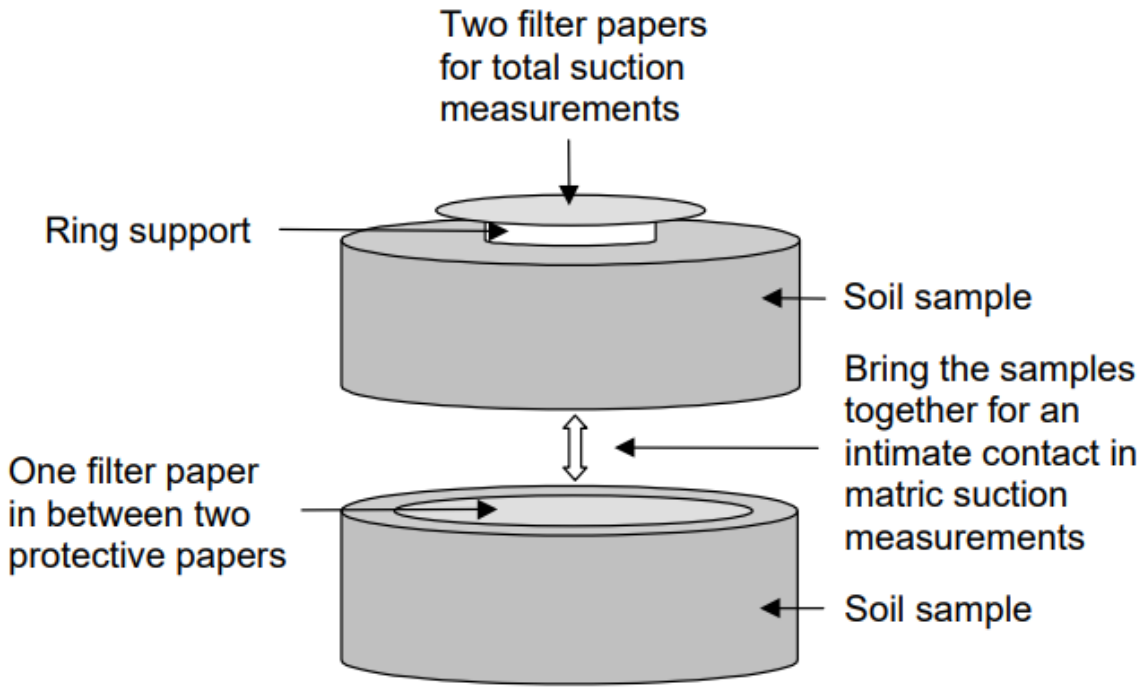
PREDICTIVE RELATIONSHIPS

- PRV “Method for Determining the Potential Vertical Rise” (TEX-124-E)
  - Empirical method based on correlations with the soil properties (Atterberg Limits)
  - Requires an initial moisture condition
  - Evaluated for active zone (zone of seasonal moisture variation)
  - Magnitude of potential movement based on:
    - → seasonal wetting
    - → drying of soil

Methodologies to Quantify Expansive Soils

PREDICTIVE RELATIONSHIPS

- Measurement of Soil Potential (Suction) Using Filter Paper (ASTM D5298)
  - Soil suction (or negative pore water pressure) - affects soils above the natural water table
  - Combination of forces, including molecular and physical-chemical acting at the boundary between the soil particles and the water, and evaporation and transpiration acting at and close to the surface
  - Forces give soil an attraction (or potential) for water



Methodologies to Quantify Expansive Soils

DIRECT MEASUREMENTS

- Swell Tests (ASTM D4546) - Standard Test Method for One-Dimensional Swell or Collapse of Soils”
  - Undisturbed or reconstituted specimens
  - Free swell or pressure swell
  - Method based on the swell index and void volume considerations

Expansive Clay Movement Mitigation Methods

- Partial over-excavation and select fill replacement
- Chemical injection
- Moisture conditioning/water injection
- Lime-slurry injection
- Cement/lime/fly ash stabilization
- Surcharging
- Moisture barriers (horizontal and/or vertical)
- Hybrid systems

Standard Practices by DFW Cities and TxDOT

- Common municipal practice:
  - Lime subgrade treatment
  - Cement subgrade treatment
- City of Arlington Special Provision – Paving Specification Section No. 13-05
  - Lime treatment to reduce PI to 15% or less
  - Followed by cement treatment for strength gain
- TxDOT Pavement Design Manual
  - PVR analysis based on 15’ recommended soil column
  - PVR tolerance: 1.5” for main lanes, 2” for frontage roads or less conservative SOP
- TxDOT Dallas District Standard Operating Procedure
  - Pavement boring depth: 10’
  - PVR analysis based on 10’ soil column

Standard Practices by DFW Cities and TxDOT

- Three Municipalities Require Moisture Conditioning:
  - **Frisco**
  - **McKinney**
  - **Midlothian**
  - PVR analysis based on 20’ recommended soil column
  - Generally required for projects located within the Eagle Ford Shale
  - Specified criteria: limit post-construction PVR to a magnitude on the order of 4” to 4.5”
  - Depth of overexcavation and moisture conditioning can range from 48” to 96”

QUESTIONS?

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