Topics of Discussion

- Projects Geologic Setting
- Geotechnical Program
- Foundation and Anchor Types
- Testing Program
OVERVIEW

» **Description:** 225 miles of new 500 kV single-circuit towers from Canadian border to near Grand Rapids. Divided into 4 Segments.

» **Structure Types:** Guyed delta, self-supported lattice and 3-poles

» **Project Challenges:** Access, Access, Access, lack of geotechnical data prior to construction

» **Foundations Timeline:** 799 structures in winter 2017-2018 & 2018-2019

» **Solutions:** Grouped design zones with variable designs.
ALLUVIAL

» **Description:** 31 miles (14%)

» **Typical Soil:** Sand, silt and gravels.

» **Challenges:** Highly variable soil conditions with occasional large cobbles and boulders

» **Solutions:** Grouped design zones with variable designs. POWER provided field engineers and extra borings when required
OVER CONSOLIDATED

CLAY

» **Description:** 87 miles (39%) of predominantly glacially consolidated cohesive soils.

» **Typical Soils:** 1.5 to 4 ksf cohesive soils with occasional glacial erratic's

» **Challenges:** Glacial erratic's required

» **Solutions:** Grouped design zones with variable designs. POWER provided field engineers. Dug out erratics when taking advantage of tolerances did not allow piles to miss.
WETLANDS

» **Description:** 105 miles (47%)

» **Typical Soils:** Peat and organics underlain by highly variable soils

» **Challenges:** Extremely soft and hard to define strength parameters

» **Solutions:** Peat probes and pre-construction testing.
» **Composition**: occurs in areas with low-oxygen and poor drainage that’s prevent normal decomposition.

» **Strength**: Triaxial, shear vane, CPTs and SPTs

» **Challenges**: Peat’s strength is not consistent with conventional soil properties.
TESTING
PROGRAM
PEAT PROBE

Depth: Peat Probes every 100 ft along alignment

Peat Sampling: Peat sampling to determine type and correlate to matting requirements

Challenges: Peat too variable.
» **Drilling:** 7 borings and historical data.

» **Locations:** 3 initial locations chosen to represent average soil conditions.

» **Peat:**
  - 4 to 6 feet of Peat

» **Capacity:**
  - Tested to 1-D deflection in Shear
» Locations: Every Structure following clearing.

» Depth:
  – 30 feet for tangents
  – 50 feet for PIs
  – With minimum strength requirements
  – 10 feet into bedrock
GROUNDWATER

» Description
– Groundwater under pressure that may or may not rise above the ground surface when punctured with a piezometer

» Encountered During Geotechnical Drilling
– Primarily associated with seepage from the Minnesota Hill
Locations: Primarily utilized in areas with artesian concerns

Depth:
- 30 feet for tangents
- 50 feet for PIs
- With minimum strength requirements
FINAL DESIGN

» Timeline
- Borings within 1 week of clearing using limited access drill rigs
- Design parameters from Braun 3 days from completion of boring
- Final design within 1 week of receiving design parameters

» Just-In-time design challenges:
- Material management
FOUNDATION TYPES
» **Description:** Helical bearings plates welded to square or round steel pipe

» **Soil Types:**
  - Sands
  - Soft/Stiff Clays

» **Advantages:**
  - Quick install
  - Immediate loading
  - Torque – capacity correlation
  - Common equipment
  - Low headroom
  - No vibration

» **Disadvantages:**
  - Corrosion
  - Precision
  - Rock/Cobbles/Boulders
**Description:** Grout bonds soil or bedrock to central tendon

**Soil Types:**
- All soils, clays can be difficult
- Rock & weathered bedrock
- Cobbles and boulders

**Advantages:**
- Quick install
- Versatility in variable soil conditions
- Limited vibration

**Disadvantages:**
- Must wait for grout to cure
- Corrosion
- Moment capacity
**DEADMAN**

» **Description:** Pre-cast concrete, steel plates, cast-in-place concrete or buried logs

» **Soil Types:**
  – All Soils, no bedrock, no GW

» **Advantages:**
  – Simple construction
  – Standard equipment
  – Cheap

» **Disadvantages:**
  – Large disturbance
  – Ground water makes construction difficult to impossible
  – Slow
CONSTRUCTION TESTING

» Anchors: 100% of anchors tested

» Test requirements: Varied based on type of anchor

» Each Segment: To prove out final product