DISCUSSING DIRT
-AN OVERVIEW

Presented by Christopher R Kehl, PE
Vice President – Principal Engineer
Braun Intertec Corporation

Discussing Dirt

What we will cover:

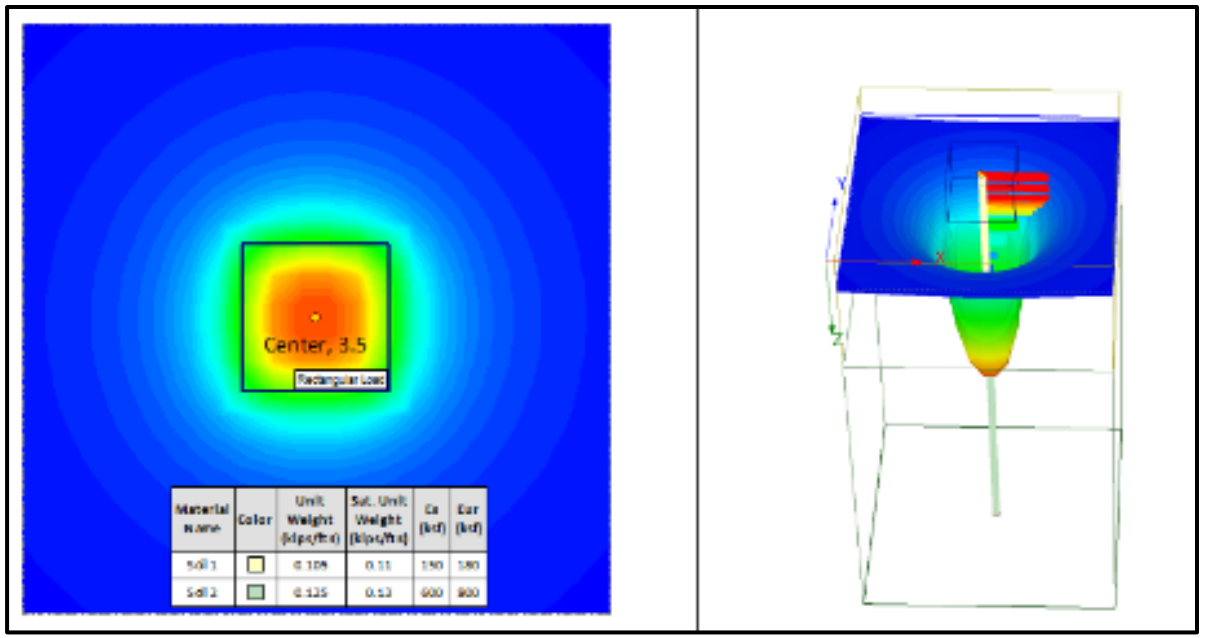
- Basics on terminology and concepts of geotechnical engineering
- What is a geotechnical evaluation?
- How to understand the earthwork cost / avoid litigation

BRAUN INTERTEC
The Science You Build On.

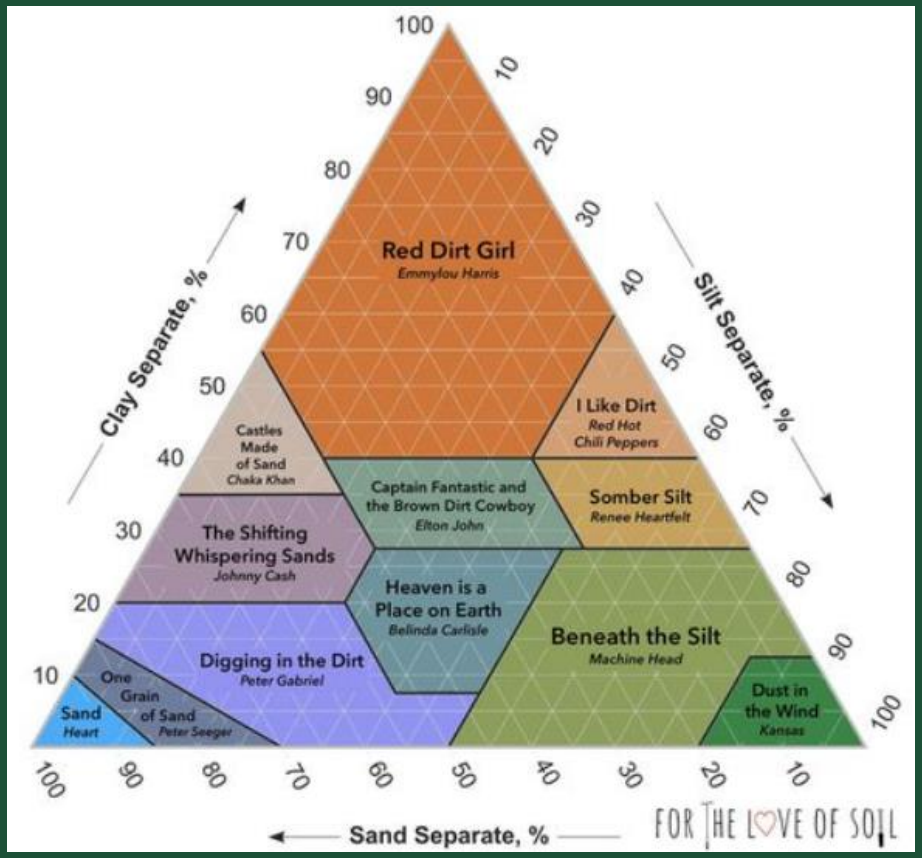
Discussing Dirt

But first a disclaimer

- Every site is different and nearly everything we discuss, will have an exception to it.



BRAUN INTERTEC
The Science You Build On.



SOME VOCABULARY

Let’s speak the same language

Discussing Dirt

Basic Soil Terms

- Sand
- Silt
- Clays
- Mixed
- Organics
- Existing Fill

BRAUN INTERTEC
The Science You Build On.

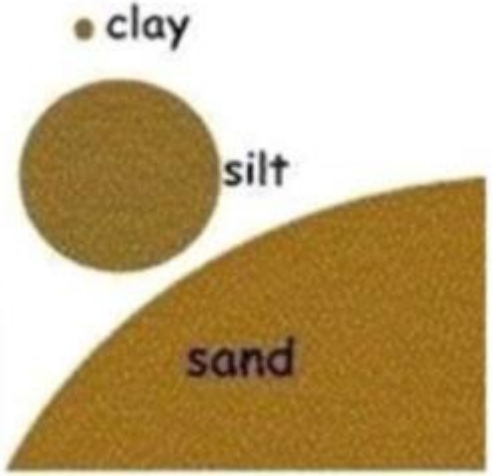
Discussing Dirt
Sand

- Field identification
  - Non plastic -Will not ribbon
  - Can see & feel grains
- Low moisture sensitive
- Low frost susceptibility
- High permeability
- Settles quickly
- Strength medium to high
- Densified by vibration

BRAUN INTERTEC
The Science You Build On.

Discussing Dirt

Silt



- Field identification
  - Talcum powder texture
  - When you jiggle, and it is wet it liquefies
  - Non plastic -Will not roll out into a ribbon
- Moisture sensitive - Construction challenges
- Frost susceptibility high
- Low to moderate permeability
- Strength low to medium

BRAUN INTERTEC
The Science You Build On.

Discussing Dirt

Clay

- Field identification
  - Will ribbon out when moist
- Particle size microscopic
- Moisture sensitive properties
- Frost susceptibility low to medium
- Impermeable
- Settles slowly
- Strength low to medium
- Compacted by kneading

BRAUN INTERTEC
The Science You Build On.

Discussing Dirt

Mixed Soils - Silty Sand or Clayey Sand, Loam

- Field identification
  - Can see grains but leaves your “hands dirty”
  - Can mold but will not ribbon
- Variable performance based on composition and plasticity
- High moisture sensitive
- Frost susceptibility very high
- Low to medium permeability
- Strength medium to high

BRAUN INTERTEC
The Science You Build On.

Discussing Dirt

Organics

- Identification
  - low density, organic smell, brown to black color

Peat

- Strength low
- Susceptibility to settlement - medium to extreme

Topsoil

- What is the definition of topsoil?

BRAUN INTERTEC
The Science You Build On.

Discussing Dirt

Existing Fill

Unknown and variable qualities add risk

- Environmental
- Composition?
- Was it compacted with moisture control?
- Did they remove unsuitable soils below fill?

BRAUN INTERTEC
The Science You Build On.

Discussing Dirt

OSHA Guidelines

Type A (¾:1)

- Stiff Clays

Type B (1:1)

- Medium Clays
- Clay and Silty Fill
- Silts and Silty Sands (SM, ML)
- Type A fissured or subject to vibration
- Dry Rock, unstable

Type C (1.5:1)

- Soft Clays
- Sand Fill
- Saturated soils & rock
- Sands with less than 20 percent fines (SP, SP-SM, SM)
- Soils layered with [illegible]4H:1V

BRAUN INTERTEC
The Science You Build On.

Discussing Dirt

Groundwater

- Best to stay away
- Permits
- Clays - sumps
- Sands - wellpoints
- Environmental considerations

BRAUN INTERTEC
The Science You Build On.

Discussing Dirt

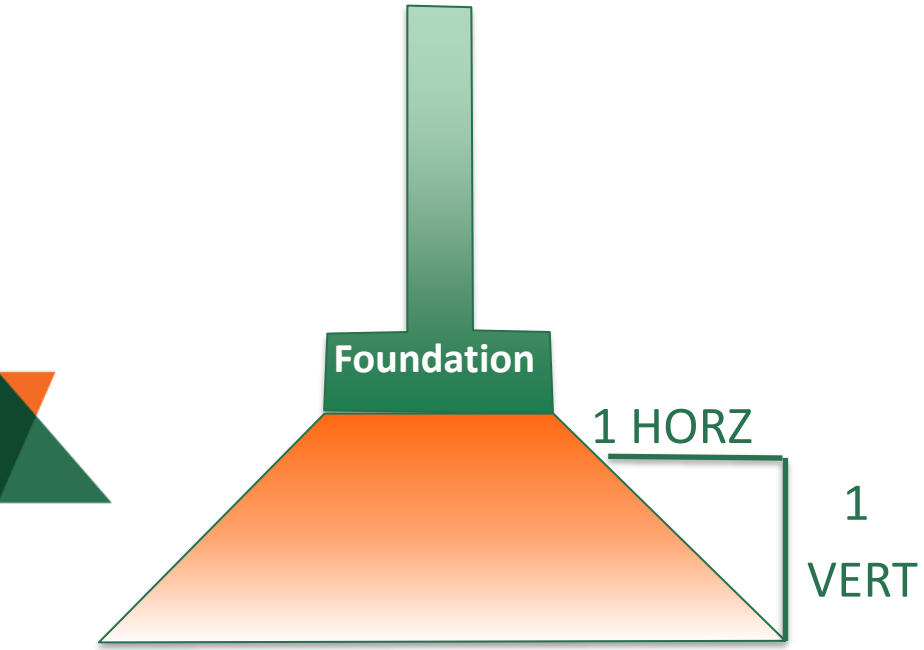
Bedrock

- How do we define?

BRAUN INTERTEC
The Science You Build On.

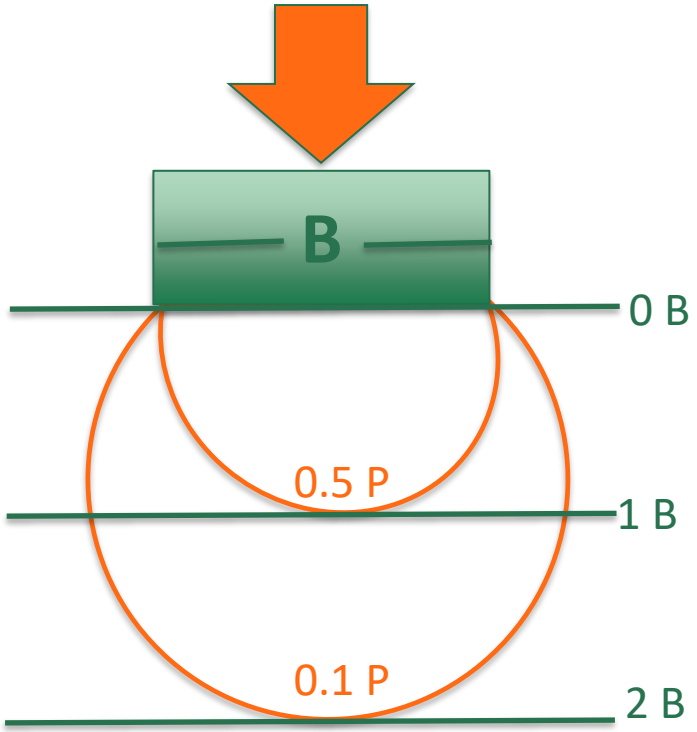
Discussing Dirt

Oversize



B is width of the footing

P is the Load



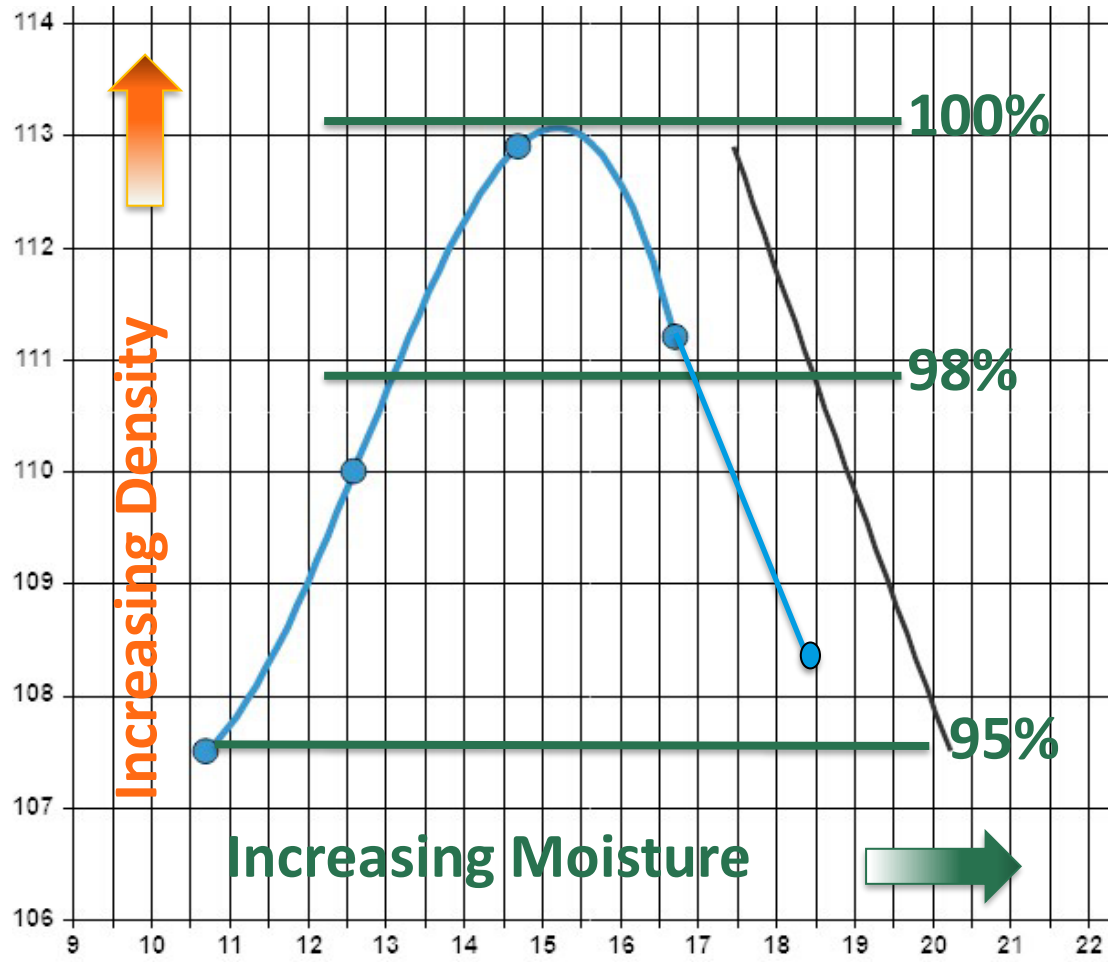
BRAUN INTERTEC

The Science You Build On.

Discussing Dirt

Proctor curve is a graph of the density of a soil for a fixed amount of compactive effort at various moisture contents

BRAUN INTERTEC
The Science You Build On.



WHAT IS A GEOTECHNICAL EVALUATION

It is more than a boring report

Discussing Dirt - Geotechnical Evaluation

- Evaluates how the site's geology (soils/bedrock) and groundwater conditions can affect the project.
- Provides design and construction recommendations.
- Helps construction team to estimate soil conditions and soil related costs.

BRAUN INTERTEC
The Science You Build On.

Discussing Dirt - Geotechnical Evaluation

- Not representative of the entire site
- Not a structural design
- Not an environmental investigation
- Not a “blessing” for the site as testing & inspections are needed
- Not universal in application –
  - Site and soil conditions vary
  - Variations in the design impact recommendations

BRAUN INTERTEC
The Science You Build On.

Discussing Dirt - Geotechnical Evaluation

Geotechnical Evaluation Vs Geotechnical Report

1. Site Review / History/ Reconnaissance/ Preliminary Eng.
2. Exploration
3. Testing - Lab or Field
4. Analysis / Engineering
5. Reporting
6. Plans and Specs Review
7. Construction Observations, Testing and Adjustments

A. Project Description

B. Results

C. Recommendations

D. Procedures

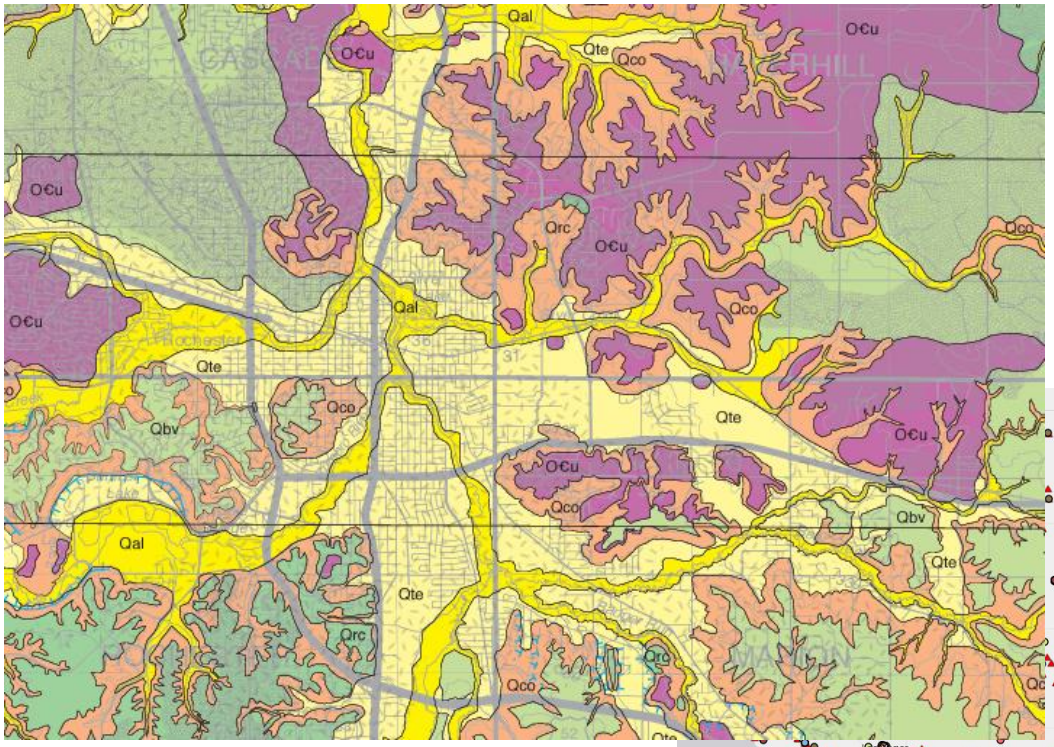
E. Terms of use

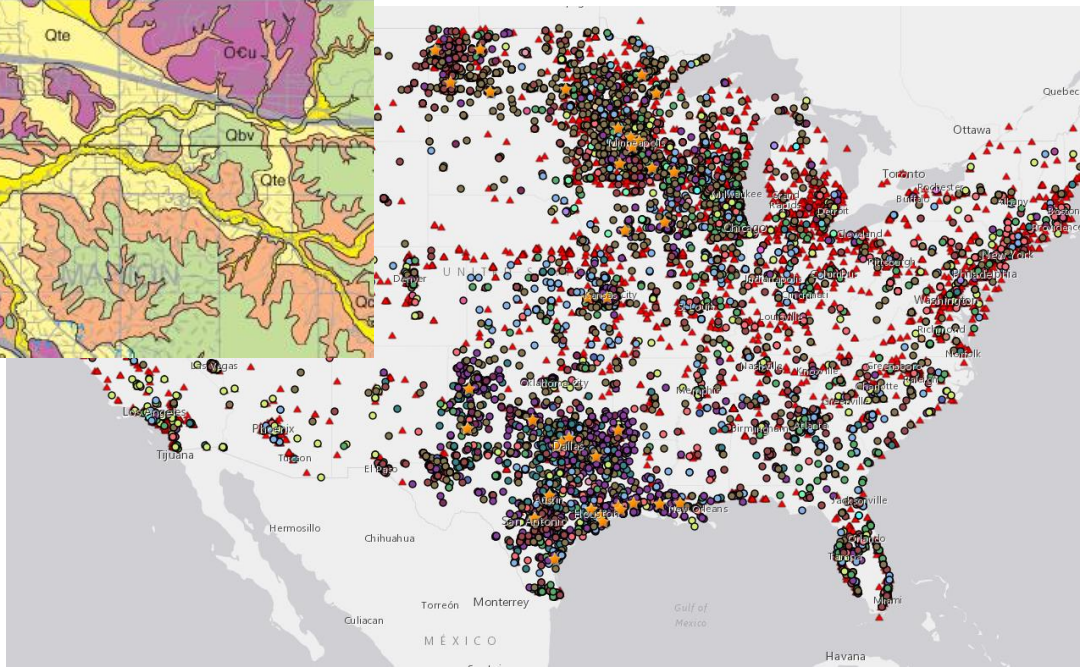
Appendix - Sketch / Logs

BRAUN INTERTEC
The Science You Build On.

Discussing Dirt - Site Review/ Reconnaissance

External data and maps & Internal experience

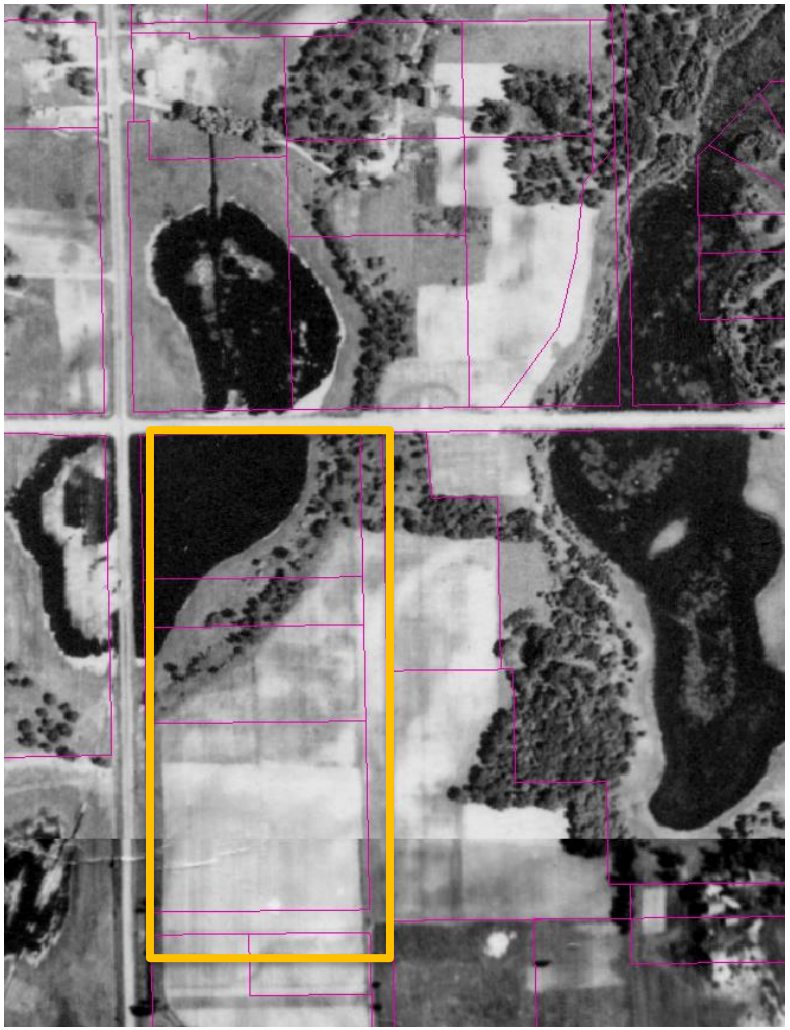


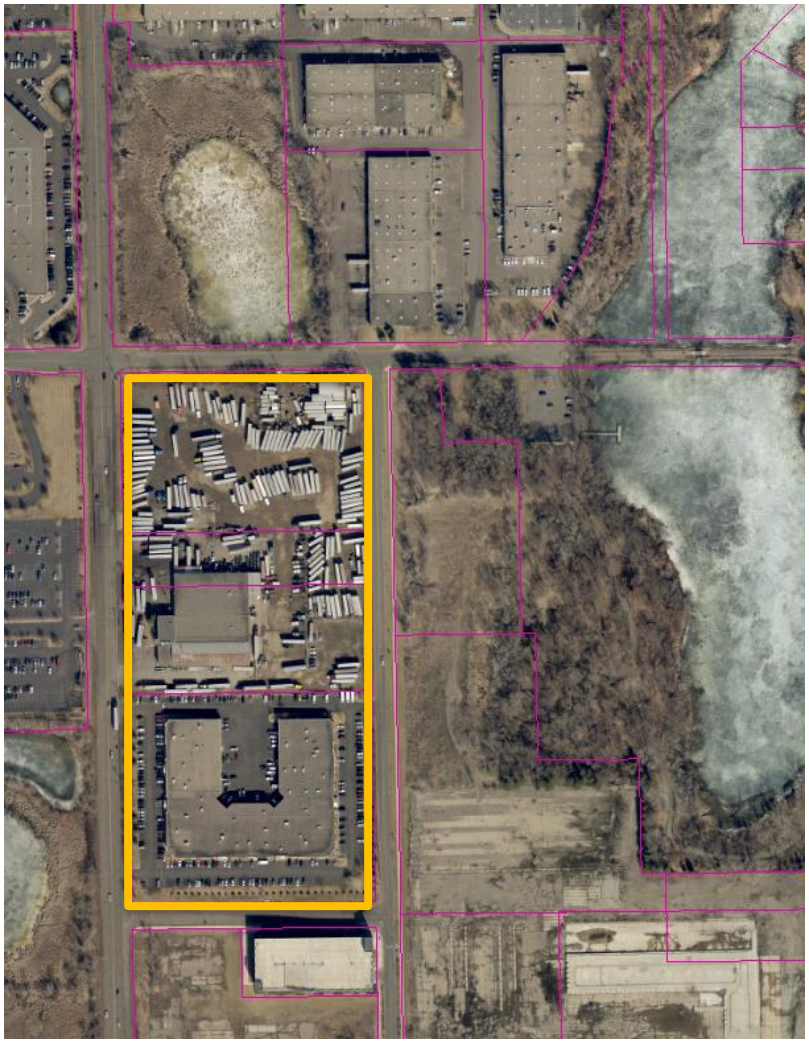


BRAUN INTERTEC

The Science You Build On.

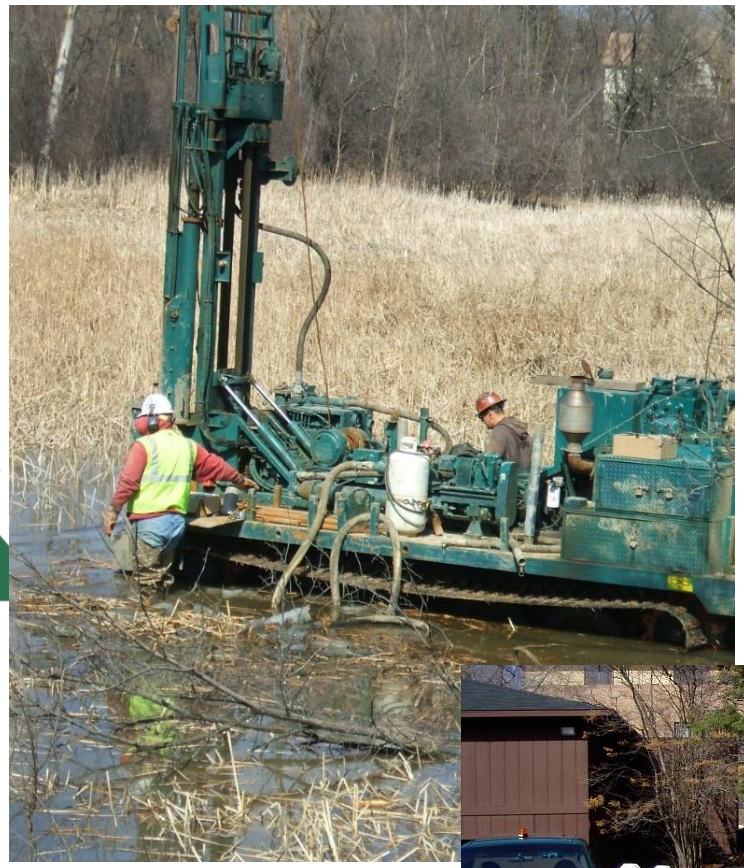
Discussing Dirt – Site Review/ Reconnaissance





BRAUN INTERTEC
The Science You Build On.

Discussing Dirt - Exploration



What can you access?

BRAUN INTERTEC
The Science You Build On.

Discussing Dirt - Exploration

Most Common – Standard penetration test (SPT)

BRAUN INTERTEC
The Science You Build On.

Discussing Dirt - Exploration

Most Common –

Standard penetration testing borings (SPT)

- Auger and Drive split tube
- Typically sample every 2 ½ to 5 feet
- Measure groundwater
- Core into bedrock
- Production – 100 to 150 ft per day?
- Sampling only (0.0001%) of the site!

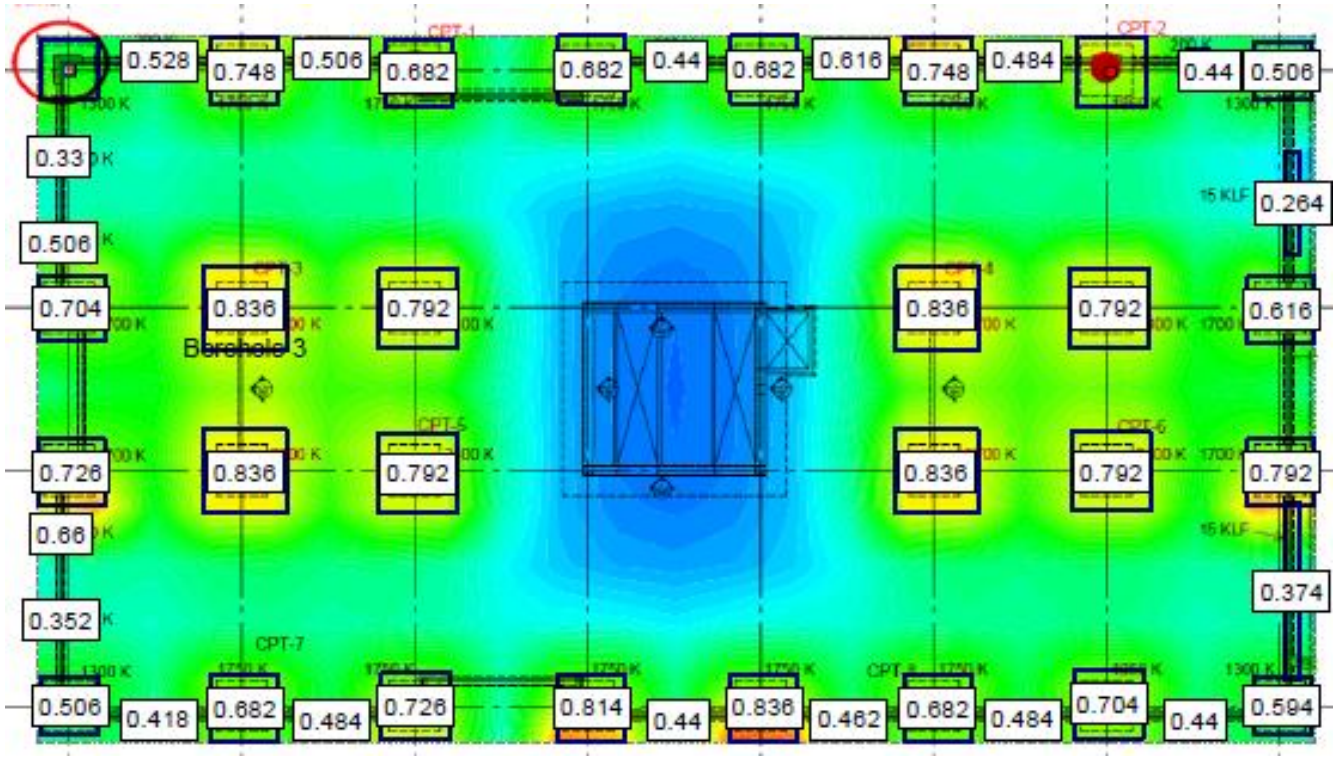
BRAUN INTERTEC
The Science You Build On.

DRILLER:	B. Kammermeier	LOGGED BY:	A. Schulzetenberg	START DATE:	02/02/22	END DATE:	02/02/22
SURFACE ELEVATION:	798.8 ft	RIG:	7506	METHOD:	3 1/4" HSA	SURFACING:	Soil
WEATHER:	Clear						

Elev./ Depth ft	Water Level	Description of Materials (Soil-ASTM D2488 or 2487; Rock-USACE EM 1110-1-2908)	Sample	Blows (N-Value) Recovery	q_p tsf	MC %	Tests or Remarks
796.8		SILTY SAND (SM), fine-grained, trace Gravel, and roots, dark brown, moist (TOPSOIL)					Fill 9 feet to slab on grade at 807.5
2.0		SANDY SILT (ML), dark brown to brown, moist, loose to medium dense (SLOPEWASH)		2-4-5 (9) 13"			
			5	4-5-6 (11) 14"		7	P200=17%
791.8							
7.0		LEAN CLAY (CL), brown, moist, soft (ALLUVIUM)		2-2-2 (4) 16"		26	LL=29, PL=21, PI=8
789.8							
9.0		LEAN CLAY (CL), trace Gravel, brownish gray, moist, medium (ALLUVIUM)	10	1-1-4 (5) 7"			
786.8							
12.0		SILTY SAND (SM), fine to coarse-grained, with Gravel, brown, moist, medium dense (GLACIAL OUTWASH)		8-7-8 (15) 14"			
784.8							
14.0		CLAYEY SAND (SC), with Gravel, brown, moist, stiff (GLACIAL TILL)	15	3-6-9 (15) 15"			
		Limestone fragments at 19 feet *Auger met refusal at 19 feet*					
779.7							
19.1		END OF BORING	20	50/1" (REF*) 1"			*Little to no recovery Water not observed while drilling.
		Boring then grouted					

Discussing Dirt – Calculations and Reporting

- You should engineer each site.
- What will control recommendations: performance, cost, risk or constructability?



BRAUN INTERTEC
The Science You Build On.

Discussing Dirt – Reading the report

After reading report, you should understand:

- What must be removed (bedrock, fill, topsoil)
- What can be used for fill.
- Will soil moisture or groundwater impact construction
- The limits on what the soils are capable of (expansive, frost susceptible, deep fills)
- Outside constraints (weather, adjacent sites)

BRAUN INTERTEC
The Science You Build On.

HOW TO STAY OUT OF TROUBLE

Or at least reduce the cost when you get there

Ten Commandments of staying out of trouble

1. Understand the geotechnical profession
   - Don’t low bid professional services, build long term relationships
   - We expose such a small part during exploration, understand the risks
   - Provide continuity through construction and design or understand differences during Geotechnical consultation in design vs Construction

BRAUN INTERTEC
The Science You Build On.

Ten Commandments of staying out of trouble

2. Follow the geotechnical report
   - Read it, then follow it

     (assuming it aligns with specifications!)
   - Is the Geotechnical Report still applicable?
     - Additional grading of the site has occurred
     - Building has moved or changed
     - Have the geotechnical engineer help review
   - Most important part is phone number

BRAUN INTERTEC
The Science You Build On.

Ten Commandments of staying out of trouble

3. Actively mitigate risks

- Have Geotech Eng. perform plan and spec review
- Additional exploration - test pits
- Get Geotechnical Engineer involved in the bidding process
  - RFPs, bid tabulations, interviews, soils reuse definition
- Contractual risk allocation

BRAUN INTERTEC
The Science You Build On.

Ten Commandments of staying out of trouble

4. Have a plan for soils reuse
   - Additional test pits or Proctors
   - Place to stockpile on site?
   - Weather, time and space to dry soils ?
   - Environmental considerations
     - What can be used and where?
     - Where can it go offsite?
     - Groundwater Impacted?
     - Vapors
     - HAZMAT
     - COSTS!

BRAUN INTERTEC
The Science You Build On.

Ten Commandments of staying out of trouble

5. Look “outside the box”
   - Consider impact on or from adjacent sites, structures, water bodies
   - Consider construction phasing
   - Consider new technologies and approaches with cautious optimism
     - Exploration
     - Soil improvement/foundation systems
     - Construction monitoring

BRAUN INTERTEC
The Science You Build On.

Ten Commandments of staying out of trouble

6. Consider impact of water in soil and water table
   - Silty and clayey soil need to be near optimum
   - Understand water table and how and when we estimated
   - Stay away from water /Stay away from problems basements, paving, site grading.

BRAUN INTERTEC
The Science You Build On.

Ten Commandments of staying out of trouble

7. Accommodate freezing conditions in construction and long term
   - Frozen soil compaction issues, frost under footings, weakening during the thaw
   - Long term frost heave damage, seasonal weaking of pavement subgrades, grade changes in slabs resulting in drainage issues

BRAUN INTERTEC
The Science You Build On.

Ten Commandments of staying out of trouble

8. Consider constructability / Soil Retention systems
   - Vibrations
   - Movements
   - Space
   - Get the owner involved in the decision

BRAUN INTERTEC
The Science You Build On.

Ten Commandments of staying out of trouble

9. Accommodate deep fills
   - 8 to 10 feet it starts to be an issue
   - 20 feet is almost certainly an issue
   - 1%+ of fill height can easily occur that is 1 ¼ inches in 10 feet
   - Biggest concern next to a fixed point
   - Sand = easy & Clay = challenging
   - Challenges for placing and compacting fill in onfined areas
   - Understand the impact of time

BRAUN INTERTEC
The Science You Build On.

Ten Commandments of staying out of trouble

10. Construction testing and documentation

- Review and through document base of excavation
- Scheduling and coordination of testing firm
- Review of reports and tests

BRAUN INTERTEC
The Science You Build On.

Questions ? Complaints? Compliments?

Christopher R Kehl, PE
612.282.6513
ckehl@braunintertec.com

BRAUN INTERTEC
The Science You Build On.

BRAUN INTERTEC
The Science You Build On.

COMPACTING SOIL

You get what you pay for

Discussing Dirt – Building with out Geotechnical Reports

Basics of compaction

- Soils are suitable
  - Sand vibration
  - Clay kneading
- Moisture is near optimum
  - Sands broader range
  - Clays -about 2 to 3 point of optimum

BRAUN INTERTEC
The Science You Build On.

Discussing Dirt – Building with out Geotechnical Reports

Basics of compaction

- Sufficient compaction effort
- Space to work
- Flat smooth level surface
- Can’t compact a slope
- Lift thickness
  - Few inches to a foot

BRAUN INTERTEC
The Science You Build On.

Basics of Compaction- What to be cautious of

BRAUN INTERTEC
The Science You Build On.

Discussing Dirt – Building with out Geotechnical Reports

Basics of Compaction- What you should look for

BRAUN INTERTEC
The Science You Build On.

Discussing Dirt – Building with out Geotechnical Reports

Basics of evaluating soil compaction

- Moisture/Density tests
  - Nuclear
  - Sand cone
- Stiffness –
  - Pocket penetrometer
  - Dynamic cone penetrometer

BRAUN INTERTEC
The Science You Build On.

Discussing Dirt – Building without Geotechnical Reports

Issues when there is no geotechnical evaluation

- Who is taking on the liability
- Using presumptive values

BRAUN INTERTEC
The Science You Build On.

Discussing Dirt – Building without Geotechnical Reports

When it is possibly OK

- Native, non organic soils
  - Dense sand
  - Clays/silts that is moist and stiff/hard
- Minor structures prescriptive values
- Cutting soils
  - Unload
  - No Filling

BRAUN INTERTEC
The Science You Build On.

Discussing Dirt – Building without Geotechnical Reports

When you should ask more questions

- Soils are
  - Fill (existing/recently placed)
  - Very loose or Soft
  - DRY!
  - Organic
- Filling soils
  - Was compaction sufficient and at correct moisture
  - Weight of soil can add tremendous load

BRAUN INTERTEC
The Science You Build On.