Drilling Technologies in Today's Environmental & Geotechnical Market

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National Key Account Manger

CASCADE

DRILLING | TECHNICAL SERVICES

Many Types of Drilling Technologies are Available Today

- GeoProbe® / Direct Push Technology (DPT)
- Auger Drill (Solid and Hollow-Stem)
- Bucket Augers
- Rotary Drills:
  i. Direct Air
  ii. Direct Conventional Mud
  iii. Reverse Circulation
  iv. Dual Rotary (w/various casing advancing systems)
  v. Down Hole Hammer (DTH)
  vi. Water Hammer
  vii. Air Rotary Casing Hammer
- Sonic Drills

What to Consider When Deciding on the Right Drill for your Project

- Geology and the Local Subsurface Site Conditions
- Site Access
- Cost of the Waste Disposal As a Result of Drilling (IDW)
- Diameter and Depth Considerations
- Economics Based on the Project as a Whole (Office/Field/Subs)
- Is the Drill Compatible with Collecting the Samples Required
- Flexibility to Accommodate Changes During Exploration

To Outline a Few……..

Many of these Styles are Relatively Well Know

Therefore:

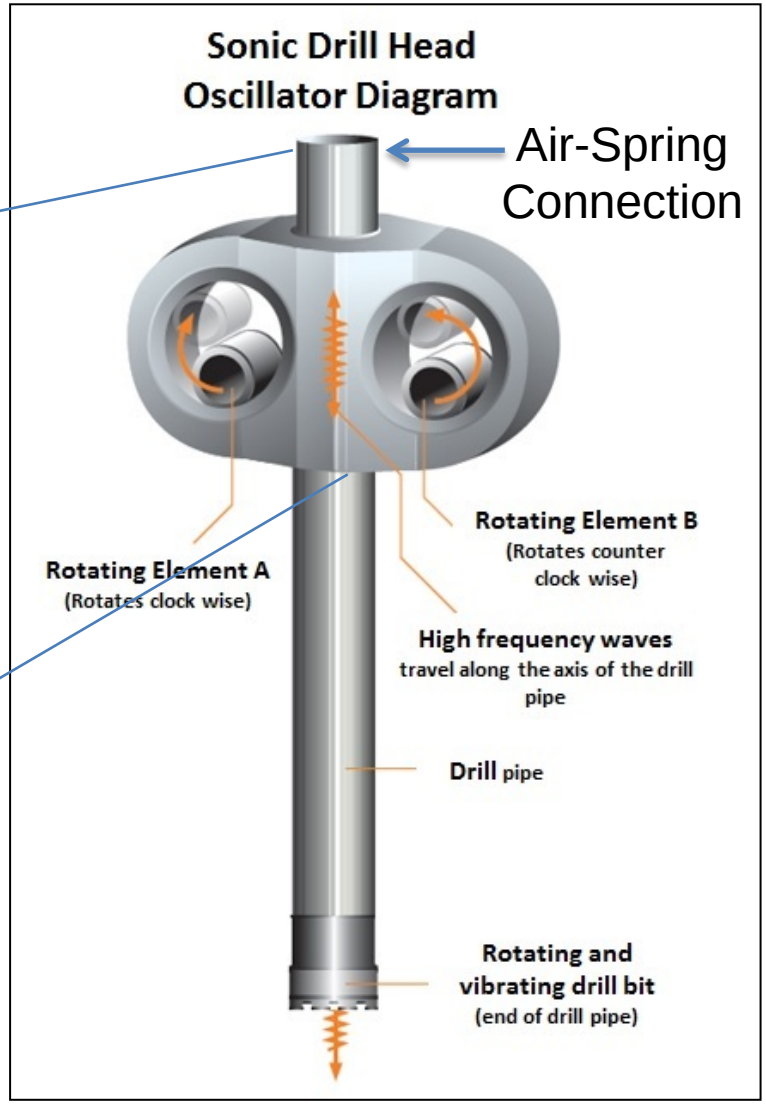
Let's Focus on **Sonic Drilling**

What Is Sonic Drilling?

Sonic Drilling ***['sän·ik 'dril·iŋ]:***
Sonic drilling is method of advancing into material (subsurface) by the mechanics of resonating a series of connected steel drill pipes using a highly specialized sonic drilling head as the energy source. The resonating drill pipe fluidizes the adjacent formation to overcome the borehole friction.

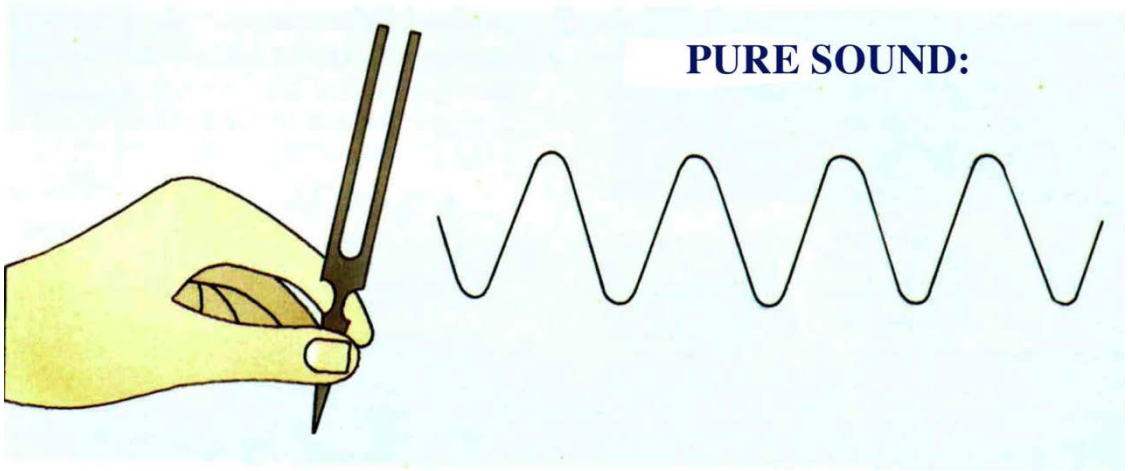
***Compared to conventional drilling – Sonic is Low Force and Low Torque

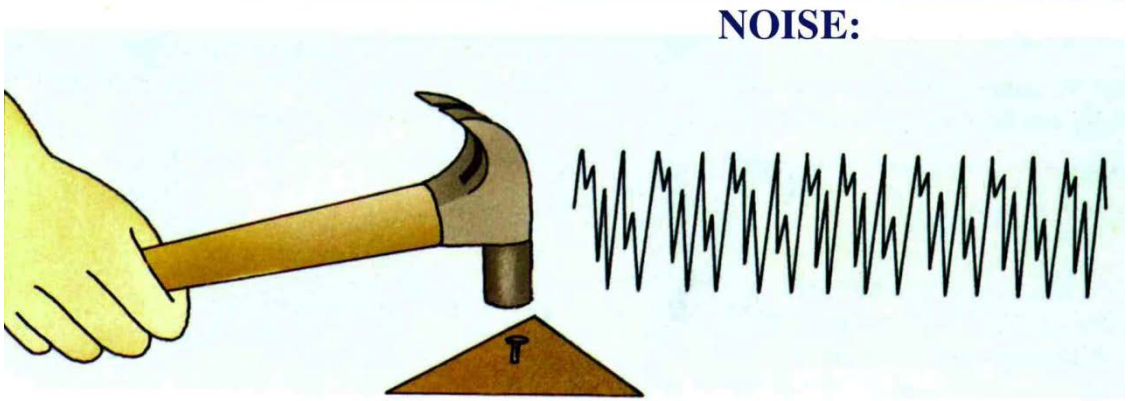
Mechanics of the Sonic Drilling Head



Typically Resonates at **50-150 Hz** (Cycles per Second)

Why is it called SONIC?





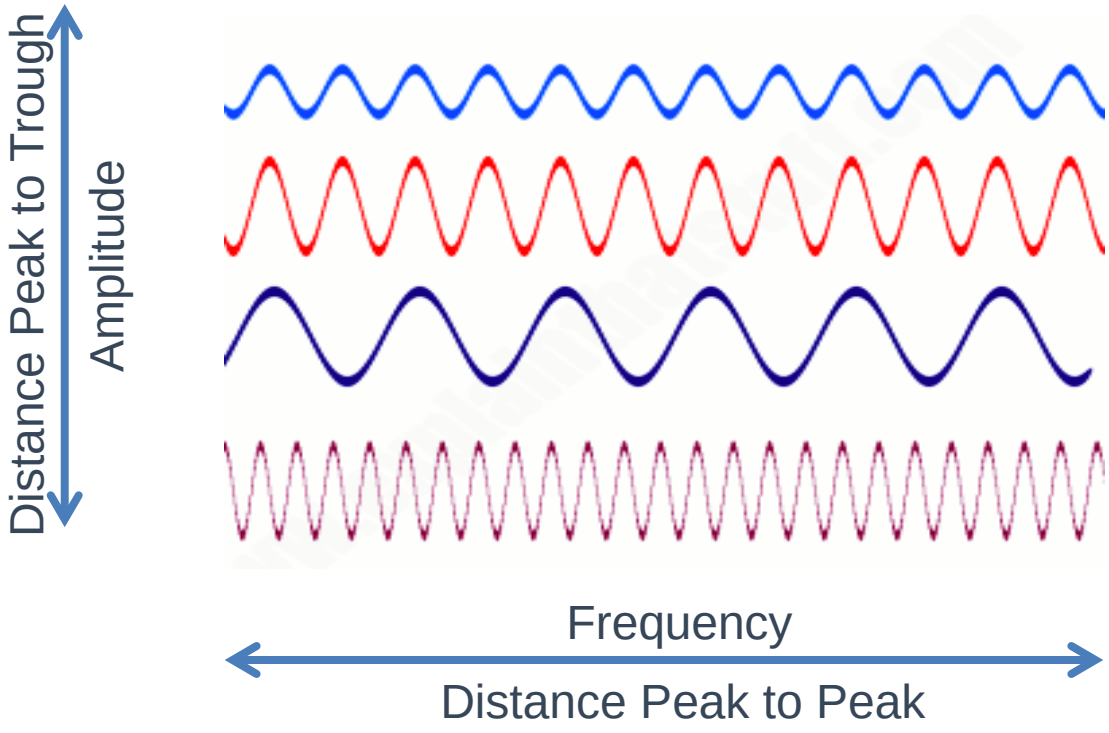
Sonic Drilling

VS.

Hammering / Pile Driving

Frequency vs Amplitude

The Two Key Elements of the Sonic Casing Advancement System

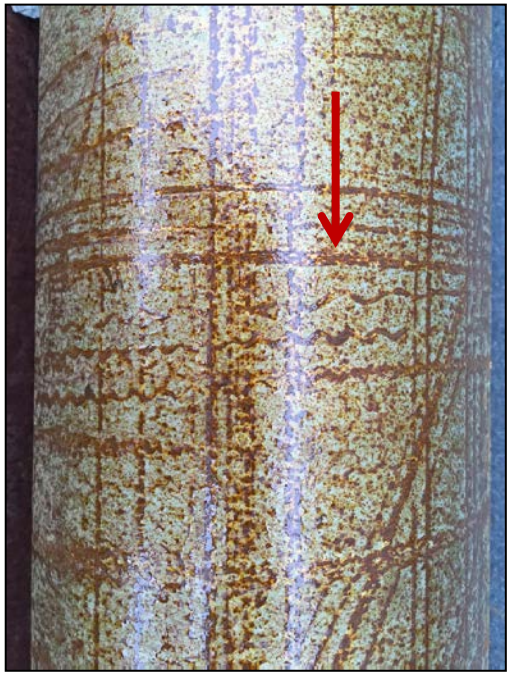


Frequency Scribed on Pipe

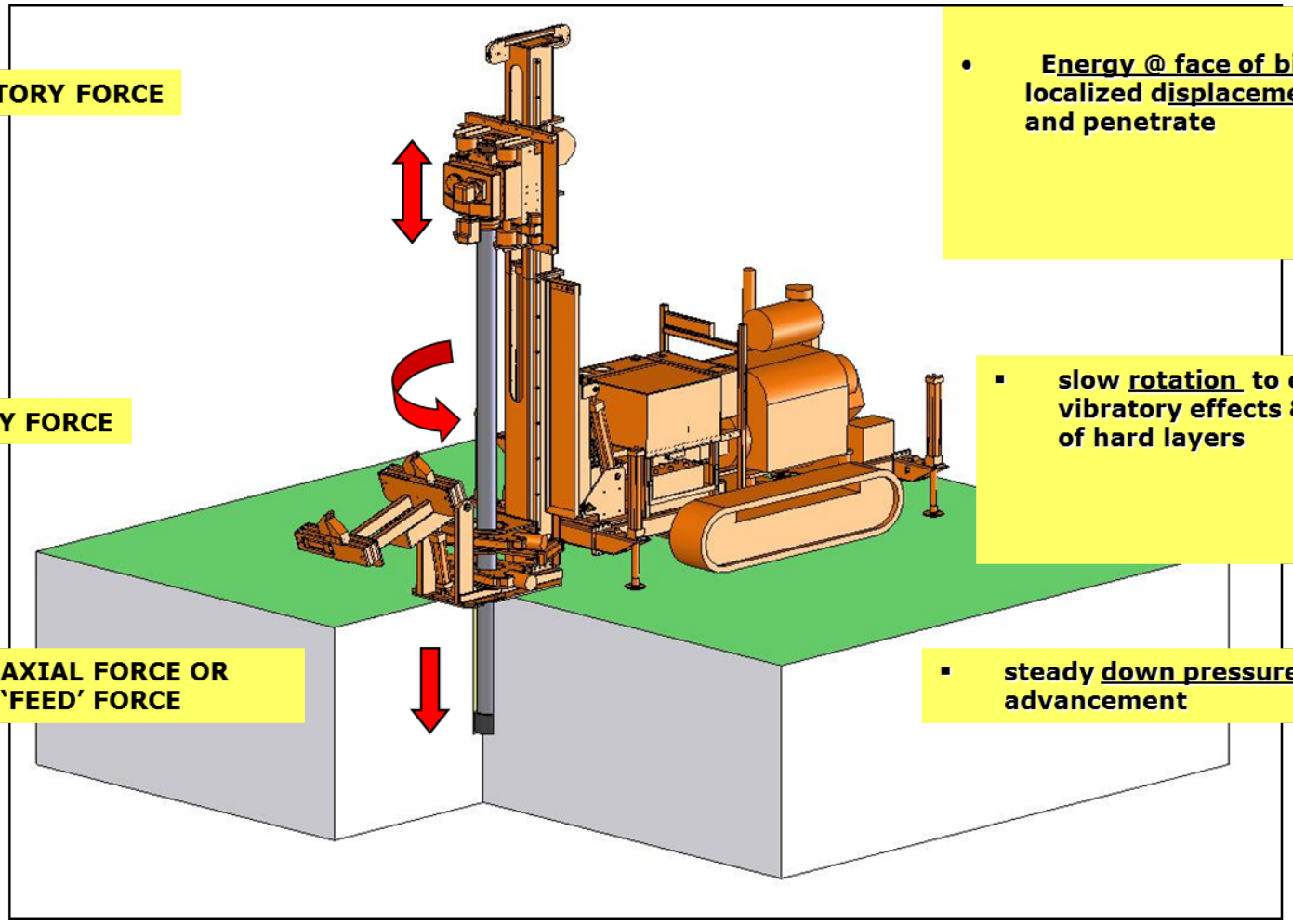
Why does this matter?

Not all sonic drills are the same:

Some are Full Range High Frequency / Low Amplitude -- Some are High Amplitude / Low Frequency -- Some are Fixed Frequency



Mechanics of the Full Sonic Drill Rig



VIBRATORY FORCE

- **Energy @ face of bit achieves localized displacement to shear and penetrate**

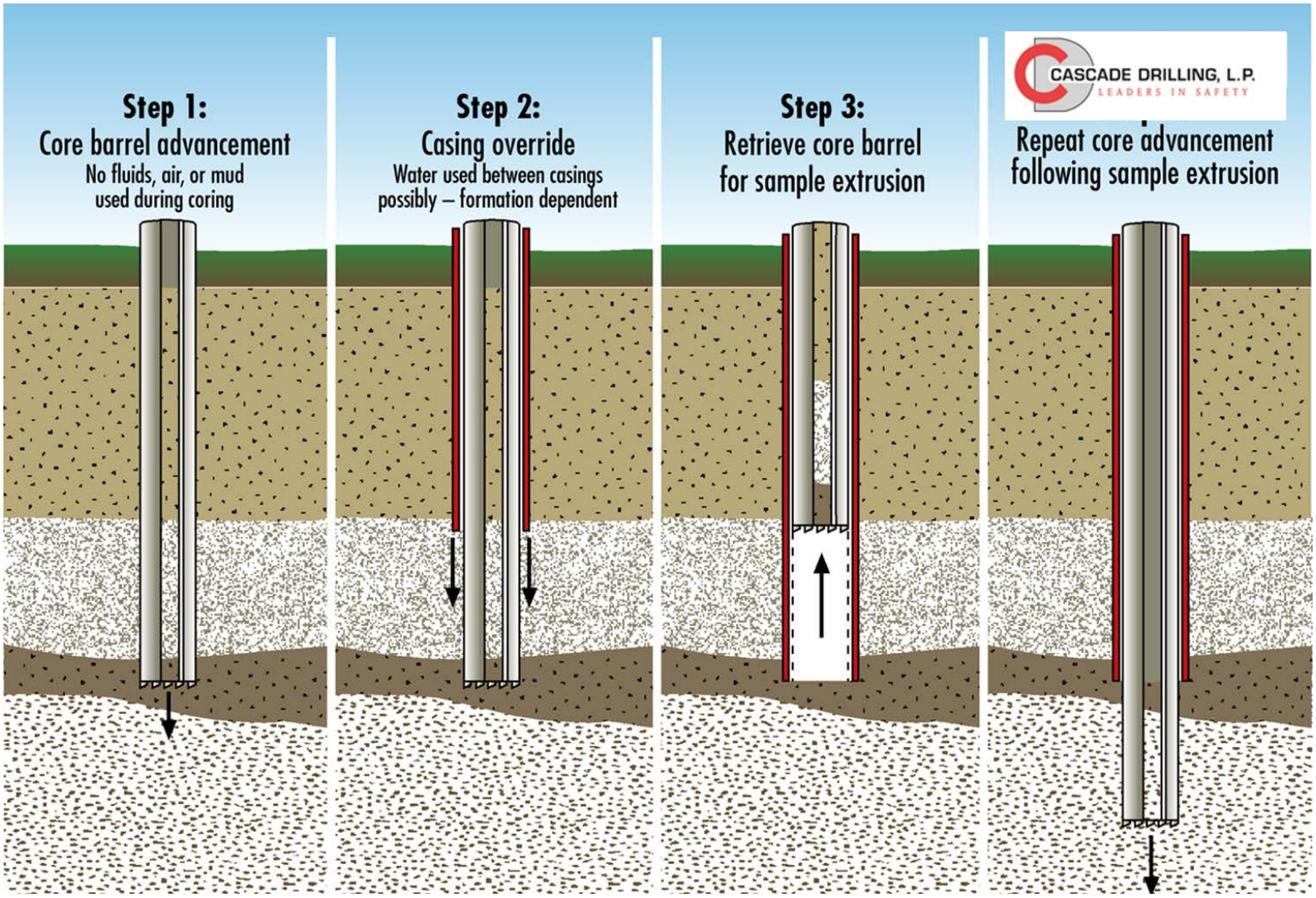
ROTARY FORCE

- **slow rotation to enhance vibratory effects & penetration of hard layers**

AXIAL FORCE OR 'FEED' FORCE

- **steady down pressure to aid advancement**

How is the Hole Advanced?



Sonic Tooling Sizes

- **Casing Sizes - 5,6,7,8,9,10, and 12 inch**
- **Sample Sizes – 3,4,5,6,7 and 8 inch**

Depths are dependent upon casing size and formations.

Some of the Benefits…

- **Speed**
  - ✓ 2-4 times faster than conventional drilling
- **Superior Information (continuous core sample)**
  - ✓ Lithology/geochemistry/hydrogeology
- **Waste Minimization**
  - ✓ ~ 70% less IDW than conventional drilling methods due to cased hole
  - ✓ Ability to ”dry ” drill
- **Better Well Construction**
  - ✓ Less development time/better yield
- **Safer and Cleaner**
  - ✓ No flights – just smooth drill tooling
  - ✓ Elevated platform
- **No refusal**
  - ✓ Drills through cobbles, boulders, & hard layers/lenses
  - ✓ Great for heaving sands
- **Reduced Risk for Mistakes**
  - ✓ Better info to make decisions
  - ✓ Angle wells/multi-cased wells w/o leaving casing in ground

Samples and Rig Platforms

Sample Quality Is Important

Disturbance Rind on Outside

Sample Quality Is Important

More Soil Cores…

More Soil Cores

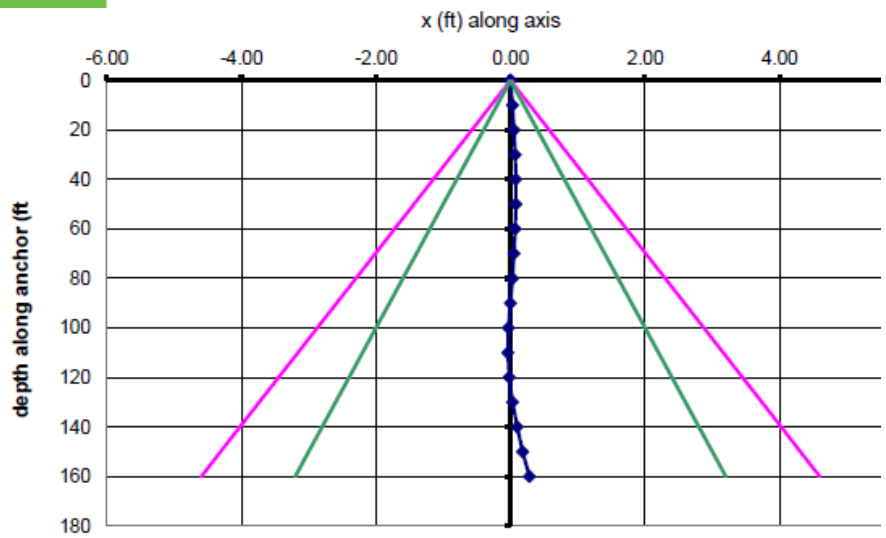
Not Just Quality Samples, But Very Straight Samples

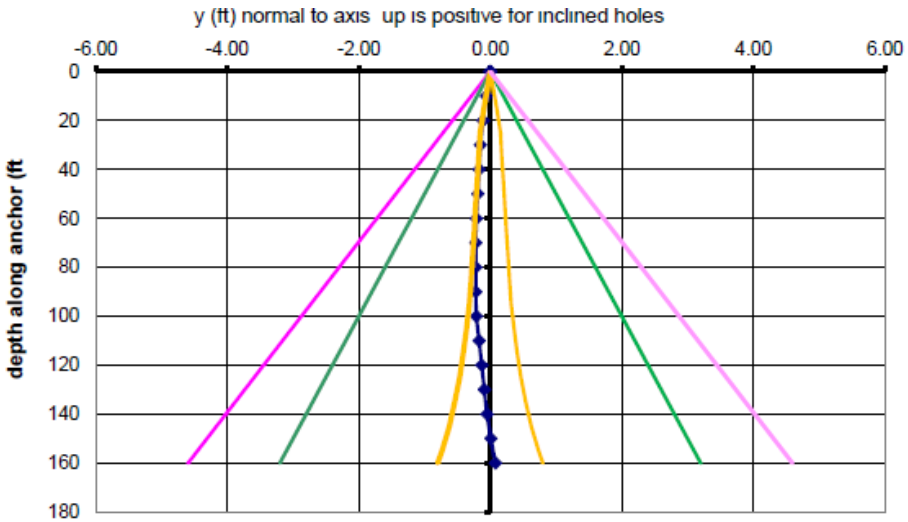
Concrete Cutoff Wall Core

Ability to core and stay within 1-2% borehole deviation or less.

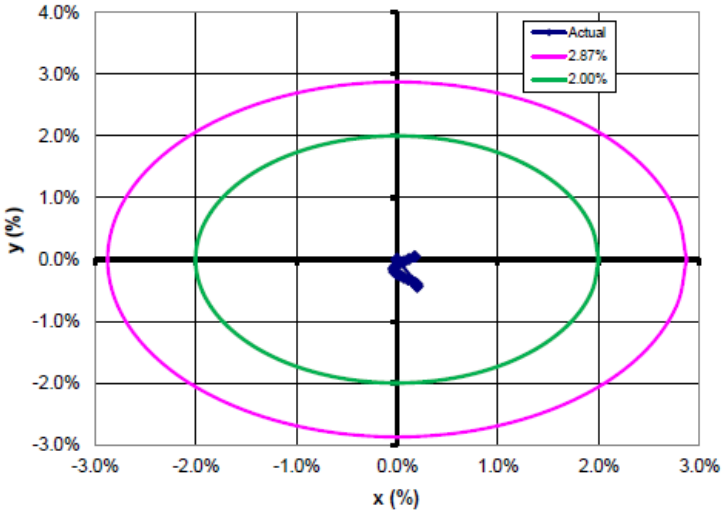
Seam between cut-off wall panels maintained over 200’ BGS

Borehole Deviation





TOR = ~100’ BGS
Rock Dip =~45-Degrees



X= 0.20%
Y = 0.44%
Result = 0.48%

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Truck Sonic Drills

ATV Rubber Tracked Sonic

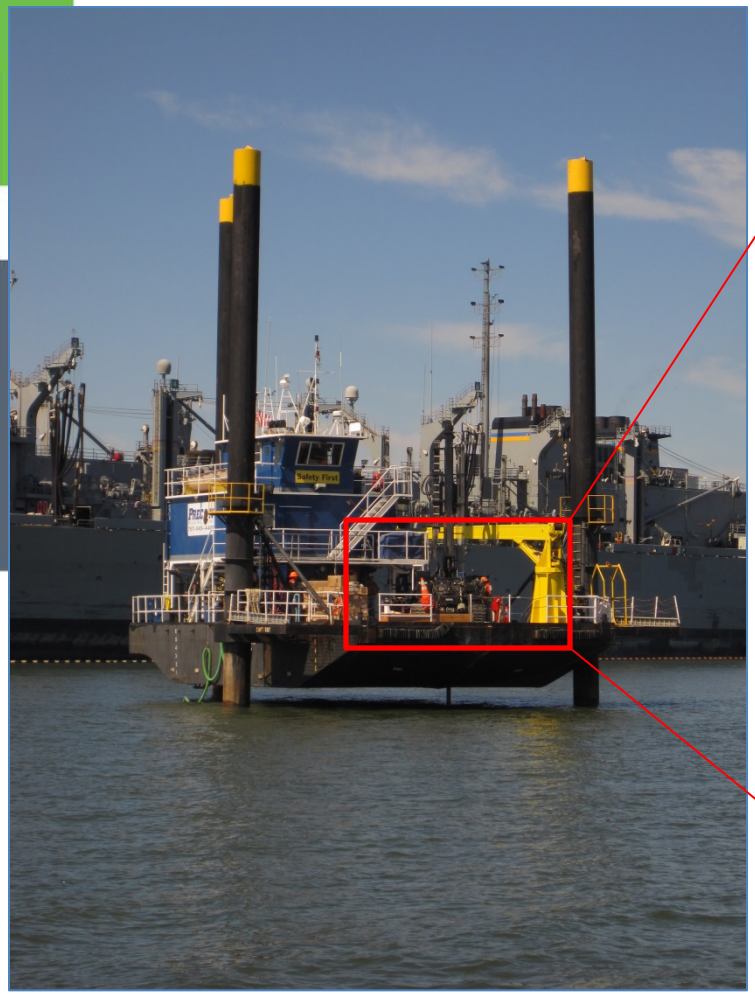
Spider Sonic – Limited Access

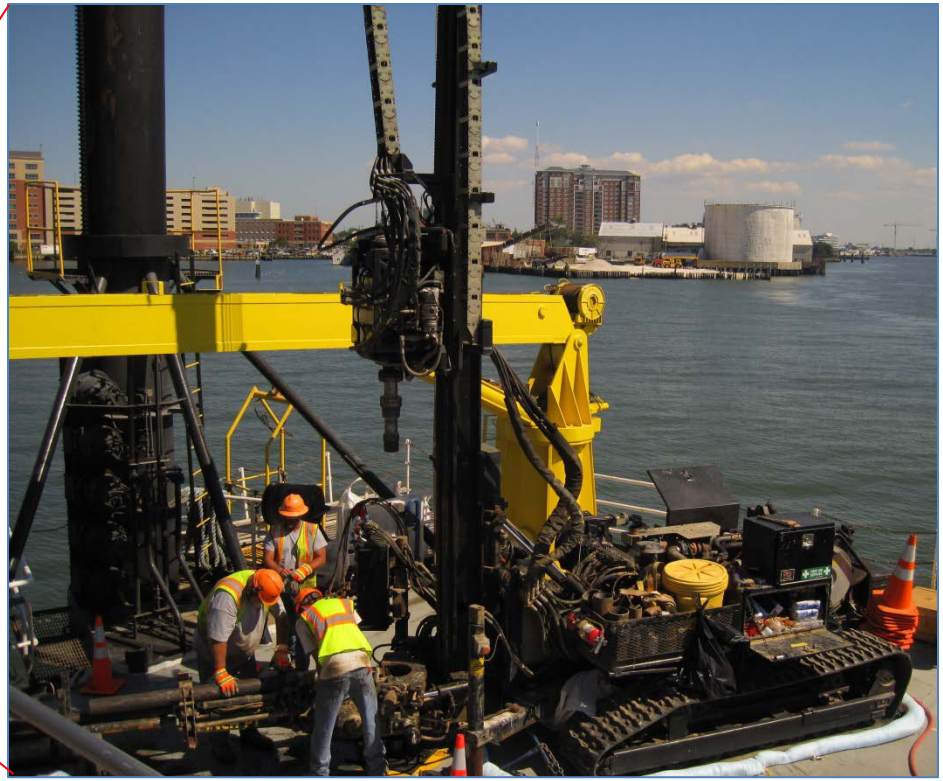
Mini Sonic – Limited Access

Barge Platform Access

Archival Sediment Tubes for Dredge Material Characterization

Barge Platform





Barge Platform

Questions?

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