2018 NORTHEAST ANNUAL UTILITY CONFERENCE

Trenchless Technology – Horizontal Directional Drilling (HDD)

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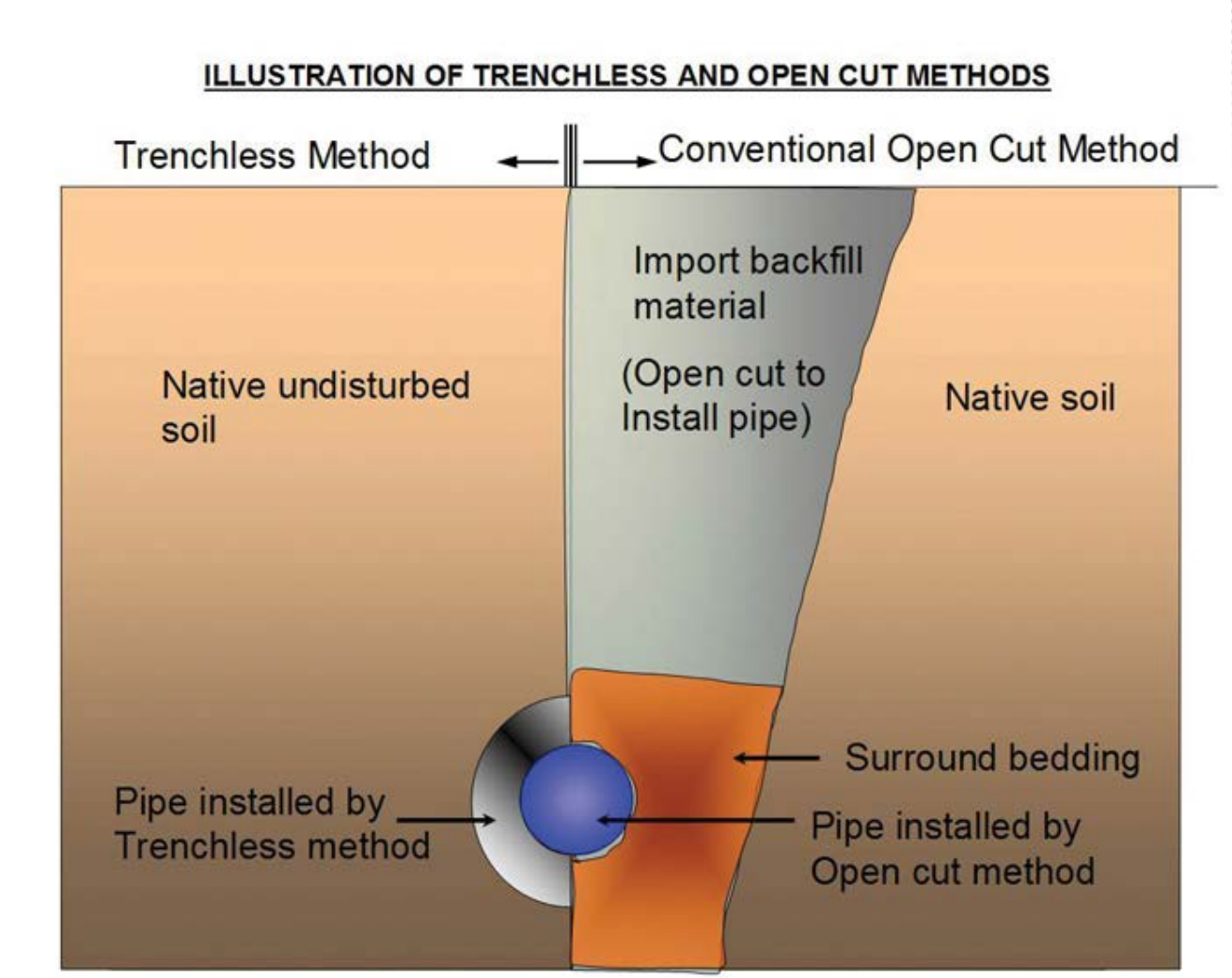
Topics

- Open cut vs. trenchless (definition of terms)
- Pros/Cons, limitations and applications of different trenchless methods, advances in technology, industry capabilities.
- HDD basics and equipment (above ground, below ground)

Topics

- HDD steering, tracking
- Drilling mud
- HDD case study example
- Questions (as time allows)

Open Cut vs Trenchless



Open Cut vs Trenchless Methods

Typical Underground Utility Installation Methods

1. Direct Installation
    a) Trenched or Open-cut
    b) Cable Plow

2. Trenchless
    a) Jack & Bore/Auger Bore
    b) HDD (Horizontal Directional Drilling)
    c) Microtunneling
    d) Direct Pipe
    e) Pipe Bursting, CIPP, etc. (less common)

Direct Installation

Trenched/Open-Cut

Plow

Direct Installation

Trenched/Open-Cut

- Typically cheapest cost per foot overall
- Can install any pipe size or material - versatile
- Large number of contractors able to perform work
- Potential for environmental concerns
- High surface impact, high public impact in urban areas

Direct Installation

Plow

- Highly efficient
- Only can install small diameter conduit, pipes or cable
- Large number of contractors can perform work
- Less environmental concerns than trenching
- High surface impact, high public impact in urban areas

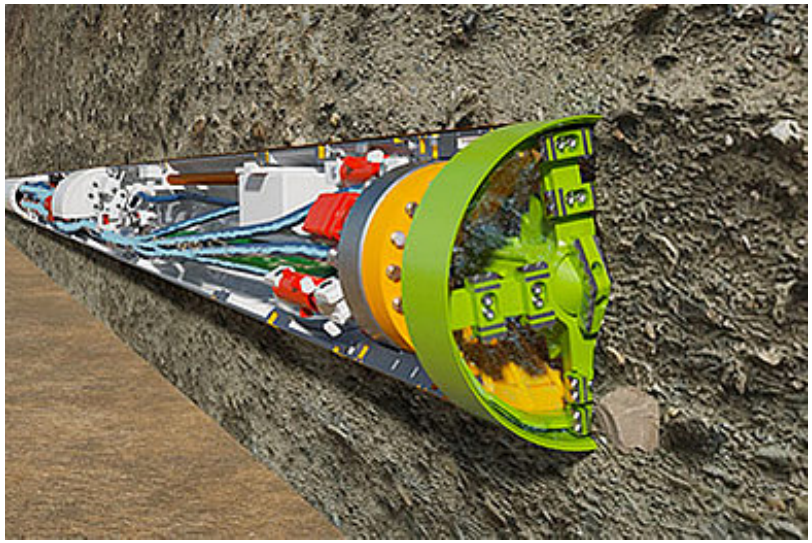
Trenchless – Jack & Bore Auger Bore

- Typically larger diameter installations
- Short distance capabilities (~250’ max)
- Not often used for waterbody crossings (water table requires dewatering)
- High per foot cost
- Not all contractors can perform
- Low surface impact

Trenchless – HDD

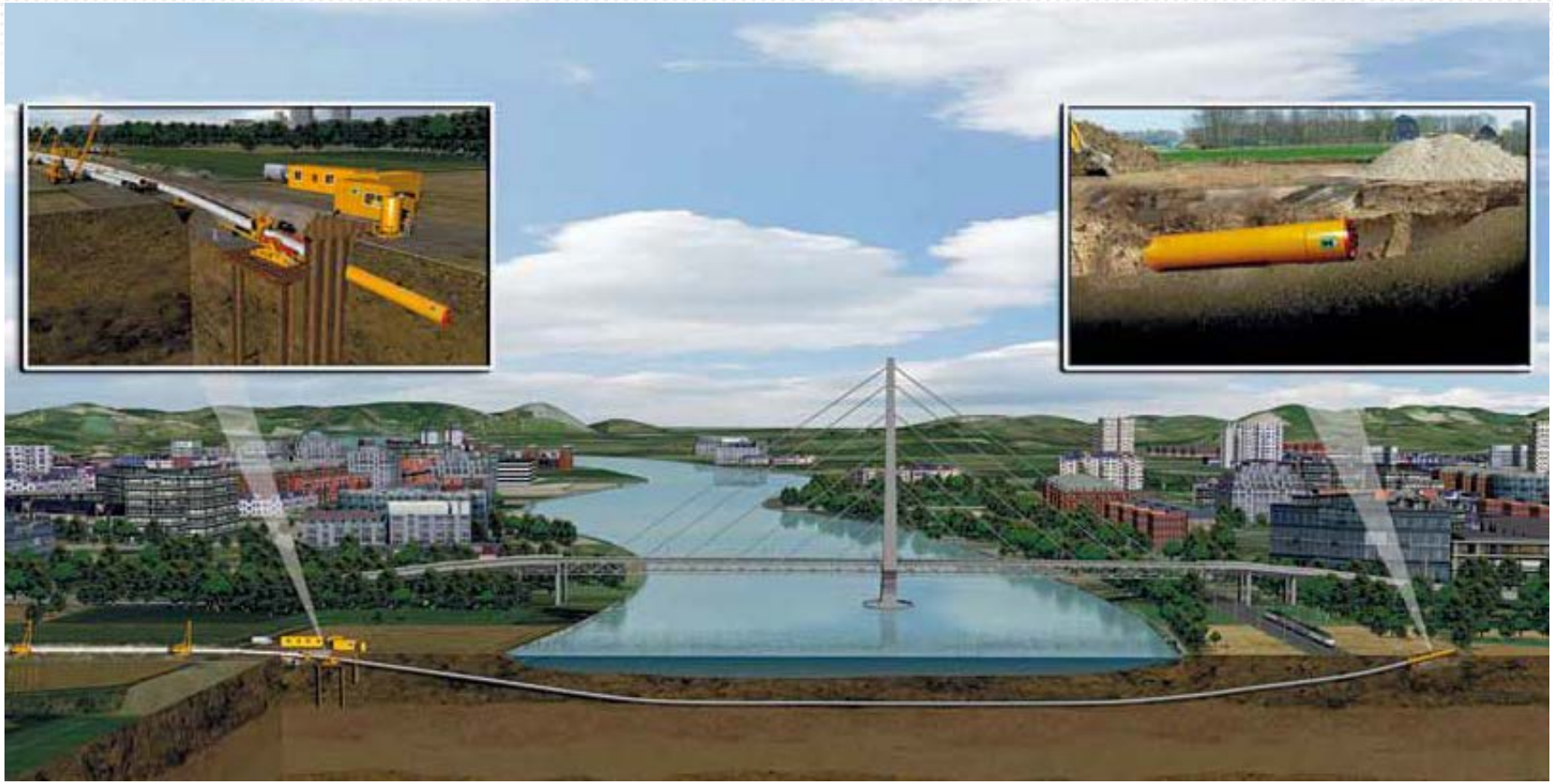
- Pipe up to 60” in diameter.
- Installations up to 13,000’ +
- Need specialized and competent contractor
- Poor soils can present risks and environmental concerns
- Higher per foot cost
- Very low surface impact
- Inadvertent Return risk

Trenchless – Microtunneling



- Large diameter pipes (typically 36” and above)
- As pipe size increases so does potential max length.
- Maximum installation length shorter than HDD
- Can handle poor soils without risk or environmental concerns
- Very high per foot cost
- Very low surface impact
- Very specialized contractor
- Virtually no risk of inadvertent return

Direct Pipe Installation



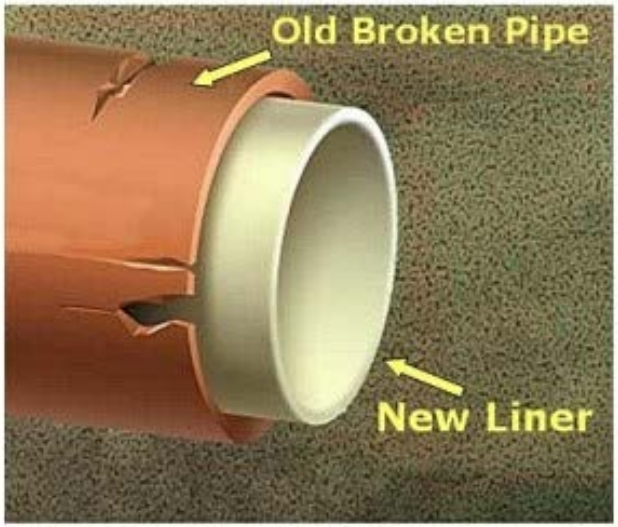
Trenchless – Direct Pipe

- New Technology
- Typically only 36”-48” pipe sizes
- As pipe size increases so does potential max length.
- Maximum installation length shorter than HDD
- Can handle poor soils without risk or environmental concerns
- Very high per foot cost
- Very low surface impact
- Very specialized contractor
- Virtually no risk of inadvertent return

Compare Direct Pipe to HDD

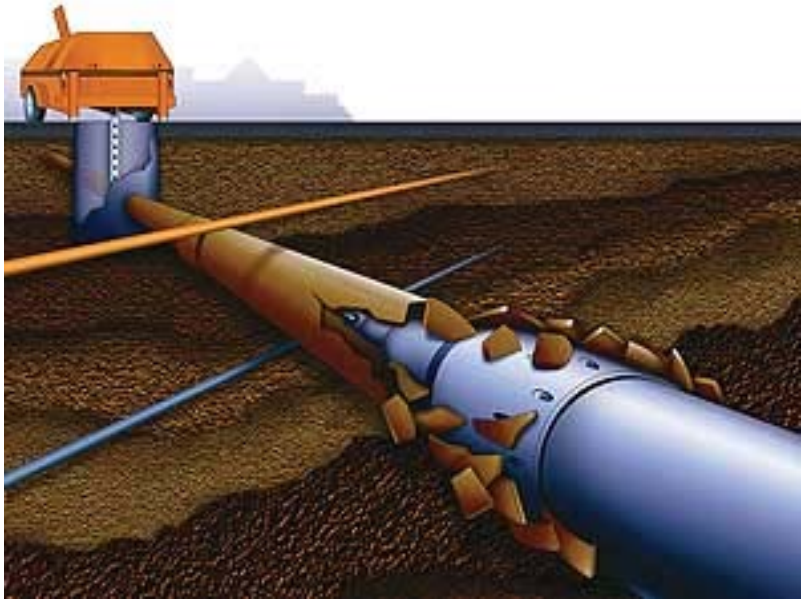
DIRECT PIPE	HORIZONTAL DIRECTIONAL DRILLING
One-pass pipe installation	Multiple Passes – Pilot, Ream, Swab, Pull
Smaller borehole diameter – 3” larger than product pipe	Borehole Diameter - 1.5 times or 12 inches larger than product pipe
Permanent borehole support.	Hole support from drilling fluid.
Entry Side Workspace and Exit Side shaft only	Working room on entry and exit required
Surface Launch or only shallow shafts at entry and exit	Surface to Surface
Lower mud pressure and mud volume.	Geology needs to be able to support annular pressure and high fluid volumes
Less overburden needed typically 2-3 times product OD	Deeper cover to support annular pressure
Minimal disposal of cuttings	Disposal cuttings typically 1.75 to 2 times hole volume.

Trenchless – Cured in Place Pipe (CIPP)



- Rehabilitates old pipes
- Water and sewer only
- No surface impact
- Option to only line damaged area if desired
- Typically lower overall replacement cost
- Easy to obtain permits

Trenchless – Pipe Bursting



- Rehabilitates old pipes
- Can increase finished pipe size diameter
- No surface impact
- Typically lower overall replacement cost
- Easy to obtain permits

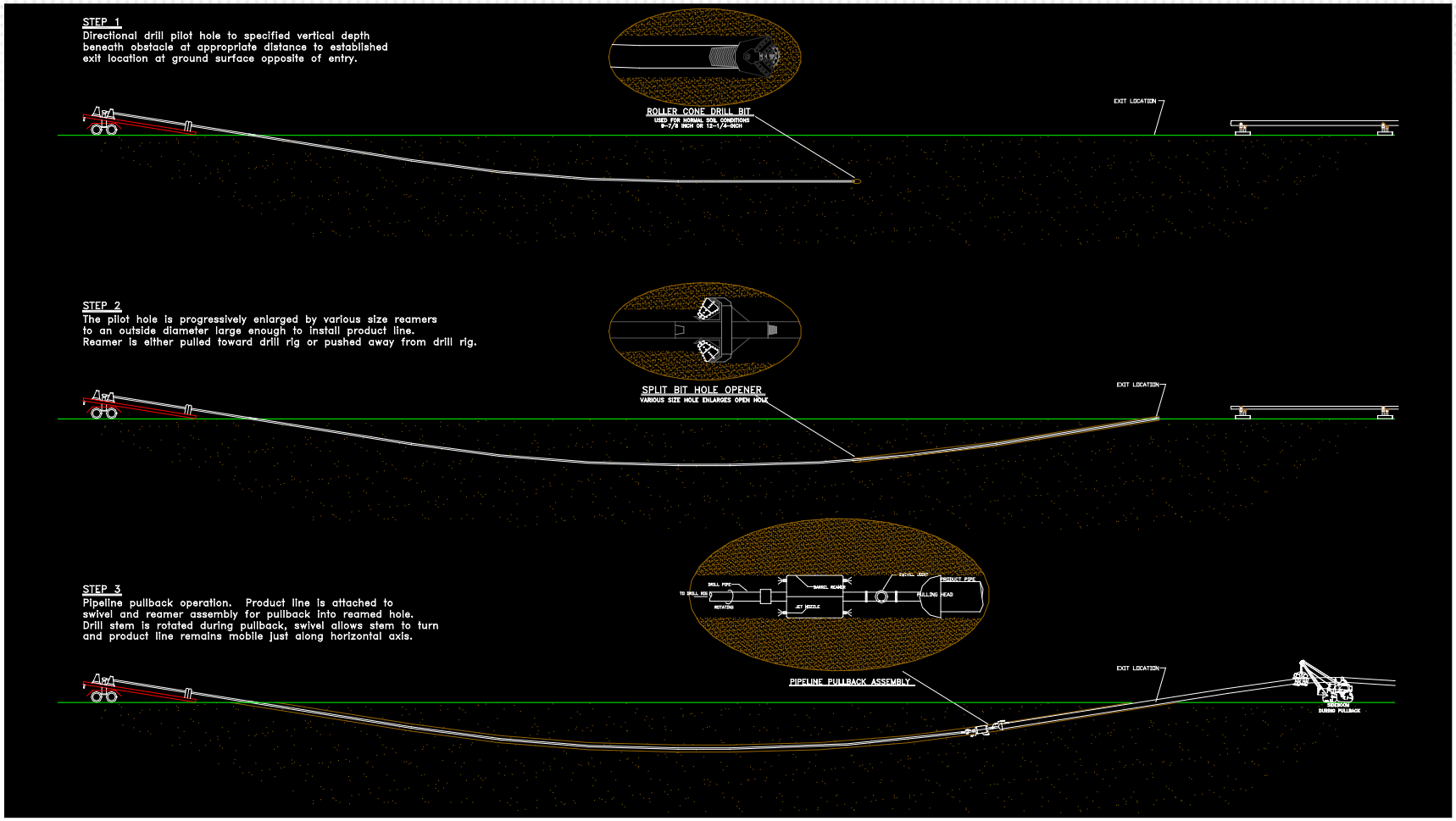
HDD – In depth

SUPPORT EQUIPMENT

HDD Rig Size Classification

- Mini (Typical less than 50,000 pounds of thrust/pullback capacity)
- Mid Size (Typical 50,000 pounds to 150,000 pounds of thrust/pullback capacity)
- Large (Typical 150,000 to 550,000 pounds of thrust/pullback capacity)
- Maxi (Typically greater than 550,000 pounds)

Phases of HDD Construction



HDD Tracking Systems

- Primary
  - Walkover (no secondary)
  - MGS –Magnetic Guidance System
- Secondary
  - Tru-Tracker – requires surface coil
  - Para-Tracker – surface coil or solenoid
- Gyroscopic
  - Both primary and secondary in one
  - No surface coil required
  - Not affected by interference
  - Hard rock limitations

HDD Tracking Systems

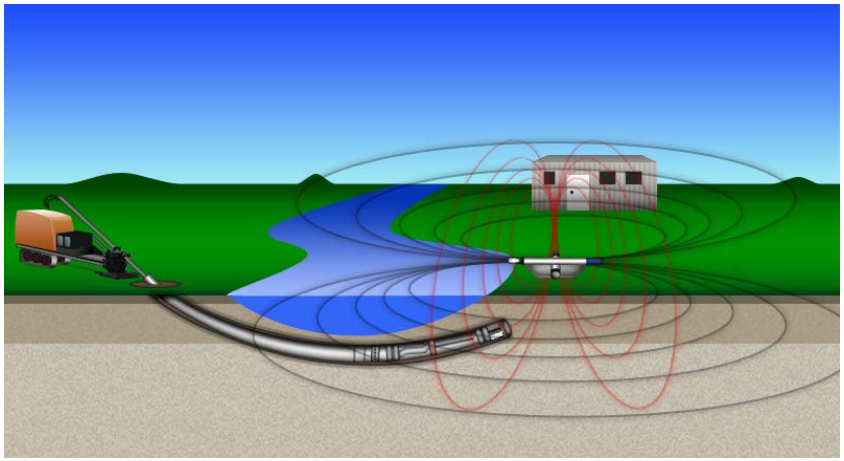
Walkover

- Typically for small drill rigs
- Limited precision
- Limited depth
- Can only track where there is foot access

HDD Tracking Systems

Wireline

- Tru-tracker, Para-track or Tensteer
- Virtually unlimited depth and length capabilities
- Requires surface cable

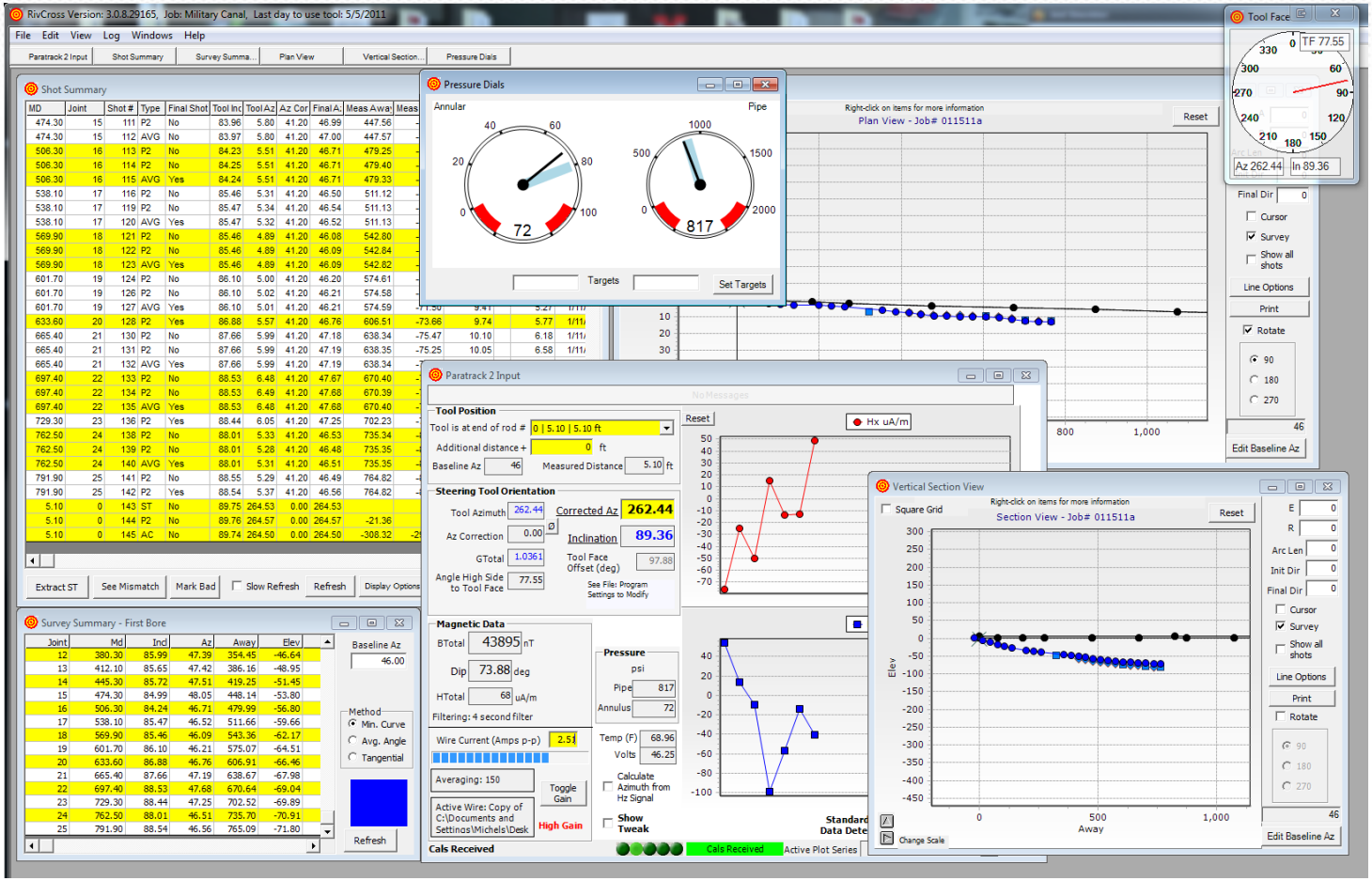


HDD Tracking Systems

Gyroscope

- Latest Technology
- More expensive
- Can have availability concerns
- No surface cable required
- Requires exacting preliminary design and coordinates to be determined as a target.

Computer Wireline Tracking



Tracking Form and Calculations

MICHELS DIRECTIONAL CROSSINGS

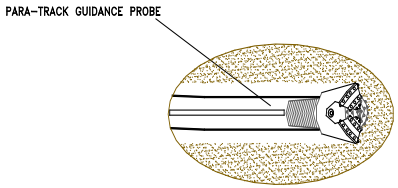
PROJECT:
LOCATION:
JOB #:
SHEET #:

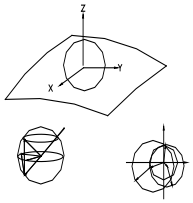
CASING DEPTH:
CASING DEPTH:
BIT MANUF:
MOTOR MAKE:
MD IN:
MD OUT:
BIT CODE:
MOTOR SN:
JETS:
CASING SIZE:
CASING SIZE:
BIT SIZE:
SETTING:
GPM:

DATE	SURVEY #	MD	INC	FINAL AZI	HTOTAL	DIP	P2 ELEV	P2 RT	CALC STATION	CALC ELEV	CALC RIGHT	3 JOINT INC RADIUS	3 JOINT AZI RADIUS

MICHELS CORPORATION

Pilot Hole Intersect



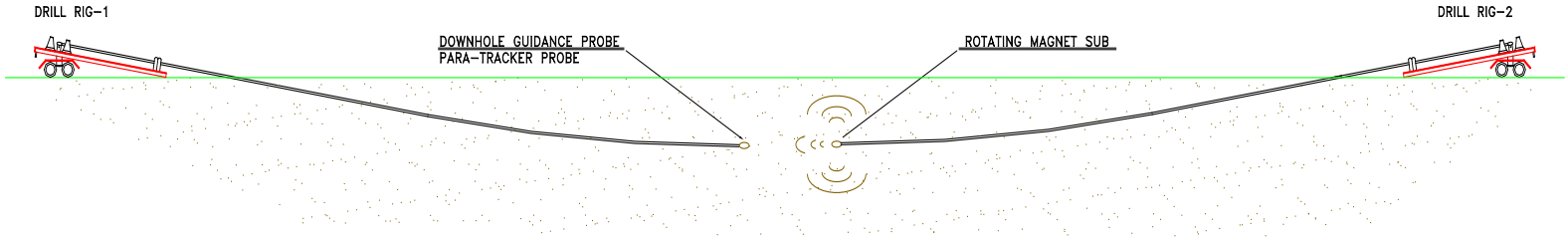


DRILL RIG–1

Directional drill pilot hole to specified vertical depth utilizing Par–Track downhole guidance system

DRILL RIG–2

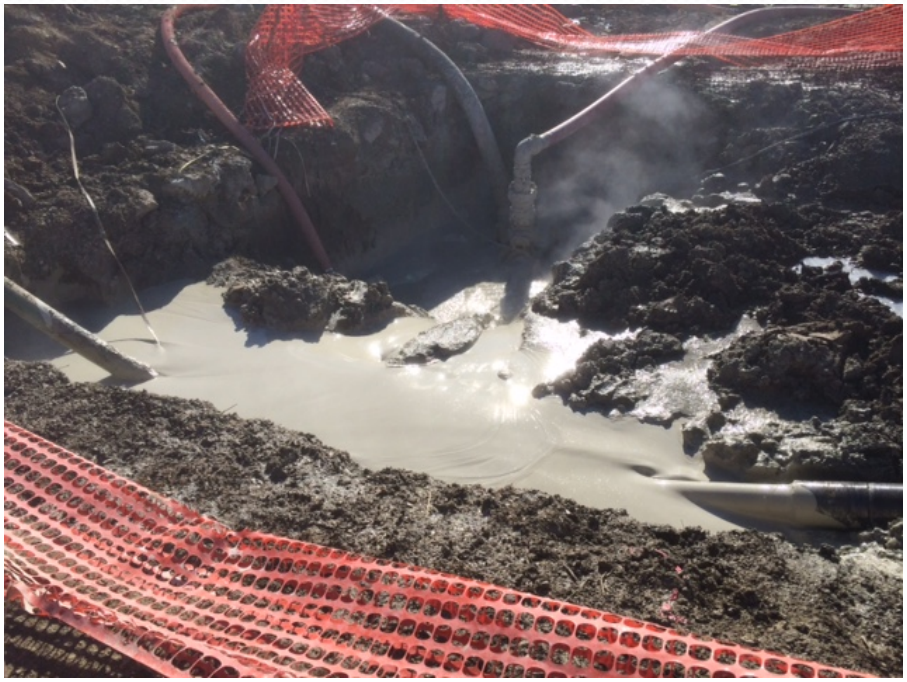
Directional drill pilot hole to specified vertical depth utilizing rotating magnet sub. Drill rig one will advance drill bit & probe toward signal emitted by rotating magnet.



Pilot Hole Intersect Advantages

- Reduced downhole pressures
- Less time to complete the crossing
- Increased pipe side tolerance
- Surface casing on both sides of the crossing
- Increases potential length limits of HDD

Drilling Fluid



QUIK-GEL®

Viscosifier

Description

QUIK-GEL is an easy-to-mix, finely ground (200-mesh), premium-grade, high-yielding Wyoming sodium bentonite. QUIK-GEL imparts viscosity, fluid loss control and gelling characteristics to freshwater-based drilling fluids.

Applications/Functions

- Mix with fresh water to form a low-solids drilling fluid for general drilling applications
- Viscosify water-based drilling fluids
- Reduce filtration by forming a thin filter cake with low permeability
- Improve hole-cleaning capability of drilling fluids
- Mix with foaming agents to make "gel/foam" drilling fluids for air/foam drilling applications

Advantages

- ANSI/NSF Standard 60 certified
- Single-sack product and cost effective
- Provides lubricity for drilling fluids
- Mixes easily and quickly reaches maximum viscosity
- Yields more than twice as much mud of the same viscosity as an equal weight of API oilfield grades of bentonite

Typical Properties

Appearance	Grey to tan powder
Bulk density, lb/ft^3	68 to 72 (compacted)
pH (3% solution)	8.9

Recommended Treatment

Mix slowly through a jet mixer or sift slowly into the vortex of a high-speed stirrer.

Approximate Amounts of QUIK-GEL Added to Freshwater

Application/Desired Result	lb/100 gal	lb/bbl	kg/m^3
Normal Drilling Conditions	15-25	6-10	18-30
Unconsolidated Formations	35-50	15-21	42-60
Make-Up For Gel/Foam Systems	12-15	5-7	14-18

- 1 bbl = 42 U.S. gallons

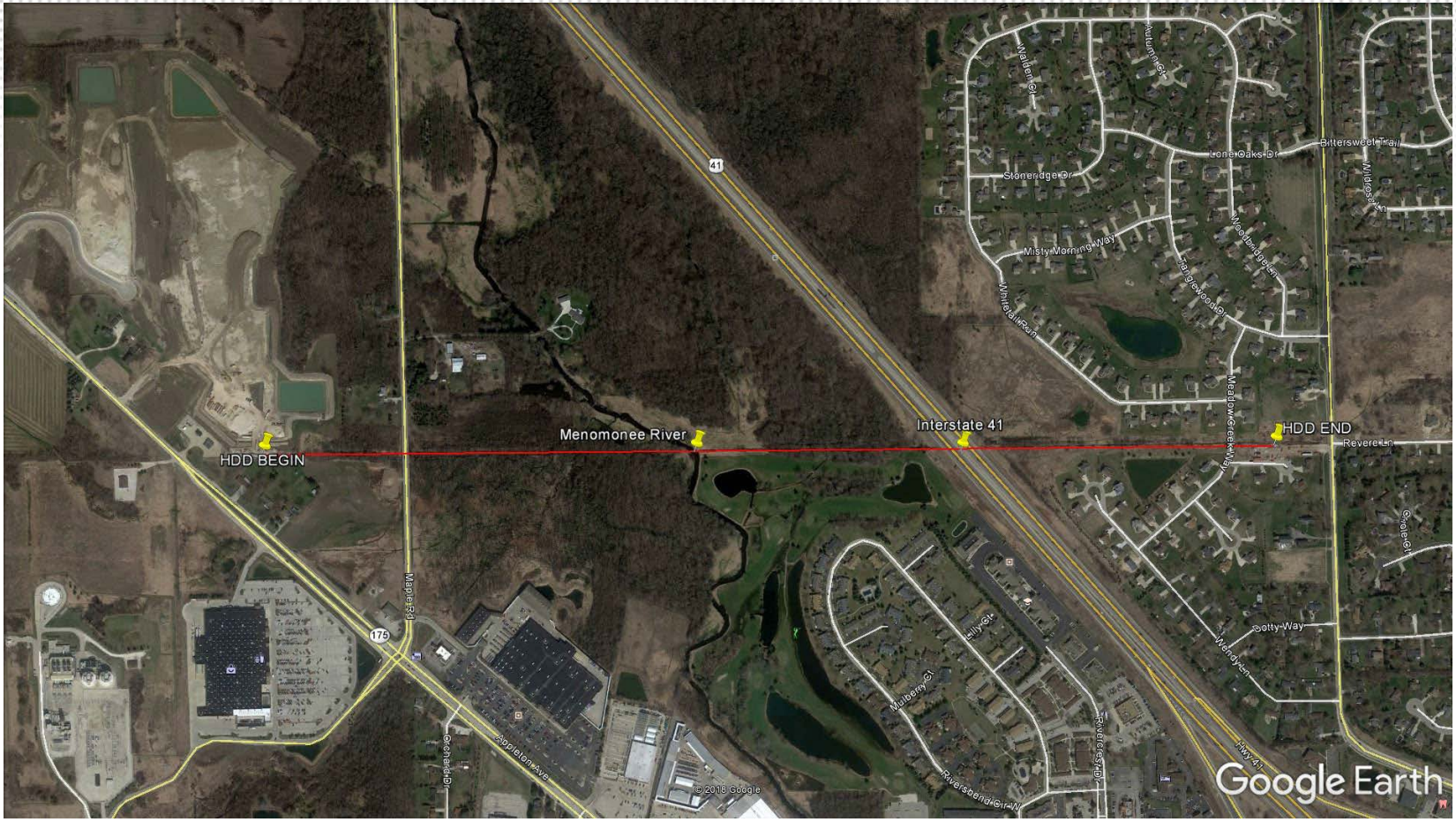
Additional Information

Note:

- For optimum yield, pre-treat make-up water with 1-2 pounds of soda ash per 100 gallons of water (1.2-2.4 kg/m^3).

HDD case study example

- WE Energies 24” diameter gas line installed in 2017
- 5,762’ long under Interstate 41 near Germantown, WI
- Limestone rock at 50-70’ deep
- Pipe Installed ~140’ below Interstate
- Pilot Hole Intersect Method was used


HDD BEGIN
Menomonee River
Interstate 41
HDD END
41
175
Google Earth
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Residential Setting

Residential Setting

Second rig over a mile away

Second Rig

Pipe laydown 5,700’ of 24” steel pipe

Pipe staged in sections

Thank you and questions