New Pipeline Installations – Which Trenchless Method is Best?

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Overview

- Examples of pipelines that will be discussed
- Example trenchless installations
- Overview of Trenchless methods
  - Description of methods
  - Applicable installations
  - Applicable ground conditions
  - Risks & issues
- Other considerations
Examples of Water Pipelines

• Water mains (Raw water, treated water)
• Sanitary Sewers
  - Gravity sewers
  - Force mains
• Storm drains, culverts
• From a trenchless standpoint:
  - Gravity pipe – line and grade are critical
  - Pressurized pipe – line and grade not critical
  - Casing pipe
• Size – generally ~12” – 96”
  - Utility size installations
  - Not larger tunnels
  - Not local connections
Examples of Trenchless Installations

• Isolated crossings
  - Major roadways
  - Railroads
  - Rivers/Creeks, Wetlands

• Long drives
  - Urban settings – open cut too disruptive
  - Deeper installations (too deep for open cut)
Overview of Trenchless Methods

• Horizontal Directional Drilling (HDD)
• Auger Boring
• Pilot Tube Method
• Pipe Ramming
• Hand Mining
• Microtunneling
Horizontal Directional Drilling (HDD)

Typical Process

• Set up at ground surface
• Drill pilot hole
• Pullback ream
• Hole supported with bentonite slurry
• Pullback product pipeline

From Canadian Association of Petroleum Producers
Horizontal Directional Drilling (HDD)

**Typical applications / properties**

- River/creek/roadway crossings
- Longer installations possible
- Variety of soil conditions
- Full face rock
- Smaller dia. pipes (<48”)
- Flexible pipes (plastic, steel)
- Not grade critical
  - Pressurized pipe
    - water mains, force mains
    - Gas mains, electrical conduits
Issues / Risks / Considerations

- Set-up / staging areas
- Required set-back
  - Entry/exit angles
  - Bend radius (drill steel & pipe)
- Mixed face and boulders problematic
- Bentonite slurry
  - E&S controls
  - Potential for “frac-out”
- No casing
  - third party requirements
  - RR crossings
Auger Boring

Typical Process

- Jacked pipe installation
- Excavate launch/jacking & receiving pits
- Auger excavates soil as pipe is jacked into place
- Spoils return to jacking pit through auger

From Nickol Boring, Inc.
Auger Boring (cont.)

Typical applications / properties

- Roadway / RR crossings, <~300’
- Cohesive or stable soils
- Above groundwater
- Generally steel casing, sometimes product pipe
- Up to 72” dia.
- Can be adapted to full face rock
- Relatively simple, crude, low cost
Auger Boring (cont.)

Issues / Risks / Considerations

• Need space for pits and SOE
• Potential settlements due to over-excavation
• No face support, unstable soils will flow, create voids
• Crude steering, limited line & grade control
• Boulders and obstructions are problematic, no face access
• Mixed face (soil & rock) problematic
Pipe Ramming

Typical Process

- “Jacked” pipe installation
- Excavate launch/jacking & receiving pits
- Drive pipe into ground
- Excavate soils from within pipe
  - Maintain a soil “plug” during installation
Typical applications / properties

- RR crossings / roadway crossings, <~300’-500’
- Soils only, generally stable soils
- Can “ingest” boulders within pipe
- Range of diameters, up to ~120”
- Excavation within pipe – continuously supported, minimum settlements
- Steel casing only
- Relatively simple, crude, low cost
Pipe Ramming (cont.)

Issues / Risks / Considerations

• Need space for hammer & pipe
• No steering capability
• Large boulders or obstructions problematic, no face access
• No rock
• Wet sandy soils may flow
• Loose sands may settle due to vibrations
Pilot Tube Method

Typical Process

• Jacked pipe installation
• Excavate launch/jacking & receiving pits / shafts
• Push pilot tube through ground
• Enlarge hole with auger
• Installation of product pipe
Typical applications / properties

- Compact equipment, shafts
  - economical if applicable
- Smaller dia. pipes, < 48”
- Relatively short drives, < 300’
- Soils must be displaceable (loose, soft)
- Steerable, good line and grade control possible
Pilot tube method (cont.)

Issues / Risks / Considerations

- No face support or access
- Limited drive lengths and dia.
- Limited ground conditions (displaceable soils)
- Obstructions problematic
- No rock
- Limited application below groundwater
Hand mining

Typical Process

• Jacked pipe installation, or
• Conventional tunneling (initial liner – segments, rings & lagging, etc.)
• Excavate launch/jacking & receiving pits
• Excavate tunnel heading
  - hand tools or small excavator
  - Tunneling shield or hood
• Installation of product pipe
Hand mining (cont.)

Typical applications / properties

• Min. 48” dia.
• Adaptable to variable ground conditions
  - Rock (can blast)
  - Mixed face
  - Boulders
• Applicable in stable ground
• Jacked installations generally < 300-400’
• Conventional tunneling can be > 1000’s
• Widely accepted
• Steerable with a tunneling shield
• Can be economical
Hand mining (cont.)

Issues / Risks / Considerations

• Unstable ground can flow into heading
  - Risks to personnel
  - Sinkholes

• Possible settlements
  - Over-excavation at heading
  - Annular void space

• Can be slow, time consuming
Microtunneling

Typical Process

- Jacked pipe installation
- Excavate launch/jacking & receiving pits
- MTBM excavates ground (remote controlled)
- Slurry transports spoils to pit for separation
- Slurry provides support of face and annular space
- Grout annular space following installation
Typical applications / properties

• Longer crossings and installations
  - 300’ -> 3000’ possible

• Dia. = 24” - 108”

• Steerable - excellent line and grade control possible

• Various pipes (steel, concrete, VCP, FRP)

• Challenging conditions possible
  - Unstable soils, below GW
  - Rock (>60” dia.)
  - Mixed face possible (>60” dia)
  - Boulders possible depending on size

• Pressurized support, minimize settlements
Issues / Risks / Considerations

- Need space for pits, SOE, slurry separation, control box, and generator
- Specialized work, fewer contractors
- Longer set-up time
- More expensive (equipment, set-up, skill)
- Slurry handling
- Slurry loss / frac out
- Face clogging or blockage
Other Considerations for Trenchless Installations

- Third party requirements
  - Approvals / Permits
  - Casing
  - Pressurized Support

- Dewatering
  - Can make some methods viable
  - Can cause settlements

- Ground improvements / Grouting
  - Pre- installation (improve prior to excavation, make methods viable)
  - Post-installation (remediate settlements – fix issues that occurred)

- Recommendations
  - Get borings & testing
  - Do an evaluation, hire a specialist if needed
  - Consult with contractors
Example project

Steel pipe under roadway and RR

- 90” dia., 175’ length
  - Too big for HDD, Pilot tube
  - Too short for microtunnel
- Mixed face: Stiff clay, rock at invert
  - No Auger bore, pipe ram
- Line and grade critical

- Design: “Hand mine”
  - Stable soil
  - No groundwater
  - Require tunneling shield w/ breasting capabilities (face support for RR)
  - Require a proactive settlement mitigation plan & measures on site
Summary

- Trenchless applications
  - Grade critical vs. pressurized pipes
- Typically for:
  - Crossings – RR, roadway, water
  - Longer installations
  - Deeper installations
- Methods include
  - HDD
  - Auger Bore
  - Pilot Tube
  - Pipe Ramming
  - Hand mining
  - Microtunneling
- Other considerations
  - Third party
  - Ground improvements / dewatering
Thank you! Questions?