TRENCHLESS TECHNOLOGY

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Trenchless Technology

- Overview
- Operation

0 – The Soil

1 - Description

2 - Services

3 - Design Considerations

4 – Engineering Considerations

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The Soils Report / Geotechnical Report

- Critical to the success of trenchless projects
- Key to the selection of the trenchless method
- Planning here – saves money later on
- Ground conditions can limit any construction work
- Take time with your Trenchless contractor to understand the implications
- Know your water table!

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The Soils Report cont'd

Ground	Soil Type	Cohesive Soils (Clay)			Cohesion-less Soils (Sand/Silt)				Boulders	Full-Face Rock~	Split-Face~2
	N Value (Standard Penetration Value as per ASTMD 1452)	N<5 (soft)	N=5-15 (firm)	N>15 (stiff-hard)	N<10-30 (loose)	N=10-30 (medium)	N>30 (dense)	High Ground Water*			
Applications	Earth Boring Rating	A	B		C		D	De-watering	Low Frequency	Detailed Analysis	Detailed Anlysis
	Auger Boring (AB)	P	R	R	P	R	R	Requires de-watering	≤33%Ø[1] low frequency	≤ 30k psi	X SBU
	Pipe Ramming	R	R	R	R	R	R	R	≤90%Ø	X	X
	Pipe Jacking (PJ) W/ TBM	P	R	R	P	R	R	P	P	≤18k psi	Full Path Analysis
	Pipe Jacking (PJ) W/ Hand Mining (HM)	X	R	R	P	R	R	X	≤95%Ø	P	P
	Maxi/Midi-Horizontal Directional Drilling (HDD)	R	R	R	R	R	R	R	P	≤ 20k psi	X
	Mini-Horizontal Directional Drilling (Mini-HDD)	R	R	R	R	R	R	R	X	X	X

R: Recommended
P: Possible
X: Unsuitable

* High ground water required shaft and bore path de-watering for all applications **EXCEPT** pipe ramming & horizontal directional drilling which only requires start/receipt pit de-watering. These costs are not included in this proposal

~ Warrant pricing based on detailed information of job – reasonable estimate not available

[1] Size of largest boulder versus minimum casing diameter (D)

[2] Split face – bore face is comprised of two different types ground condition – an example is a seam of hard matter adjacent to a seam of soft material

Low Frequency assumes that the ground is **not** continuous with boulder or cobble material. Means occasional boulders i.e. 1 in 25 feet of size close to or equal 1/3 of bore diameter but no larger

Utilized as a guide and is used in conjunction with field experience and understanding of the complete geo-technical report

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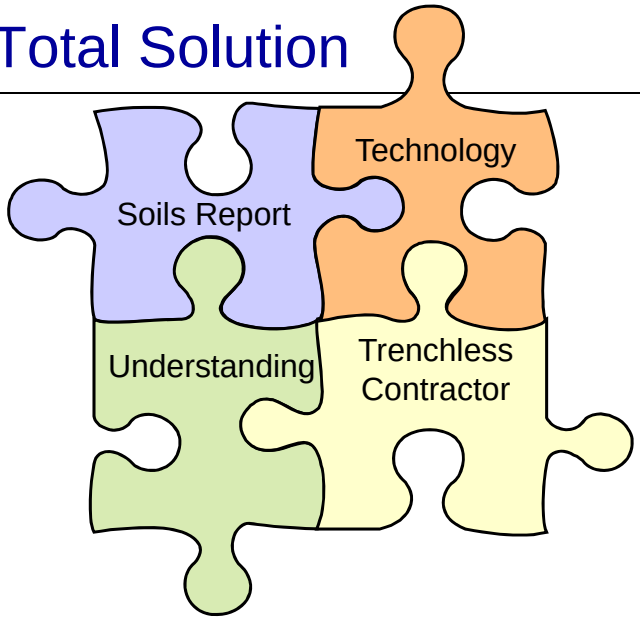
The Total Solution



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Trenchless Methodologies

- New Pipe Placement
  - Replacement / Rehab
- Main types of Trenchless Technologies (Ontario)
  - Augering (Jack & Bore)
  - Tunneling / Pipe Jacking
  - Pipe Ramming
  - Directional Drilling
  - HDD Assist

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Augering - Jack & Bore

- Mechanical removal of soil via cutting head/augers to create a horizontal hole
- Soil (Spoil) is removed via augers
- Simultaneously jack steel casing as soil is removed
- Specific grades can be achieved for required applications

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Augering - Jack & Bore

- Casing augered in 3m to 6m lengths (250mm – 1500mm diameter)
- Completion -- augers removed, product pipe is braced, inserted (threading)
- Grouting, typically occurs once rest of pipeline has been installed
- Proven method of pipe installation with well defined standards

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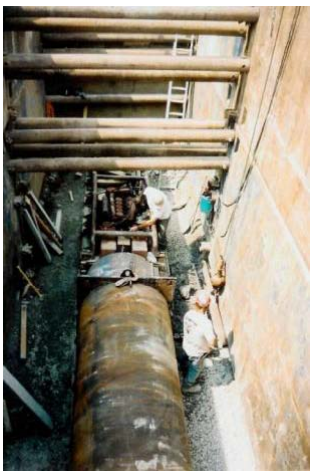
Augering - Jack & Bore (Design Consideration)

- Project
  - Sewer, Water main, Grade sensitivity
- Ground
  - Soils report (test bore/hole)
    - Wide range of soil conditions, varying cutting heads to address needs.
    - Distances of 3m - 100m
- Area – Location
  - Ideal location, adaptability
  - Space to set up shaft and store material
- City, Region Acceptance
  - Well known & accepted technology
- Environmental Consideration
  - Great for preserving environment, streams, trees, Railways and of course roads



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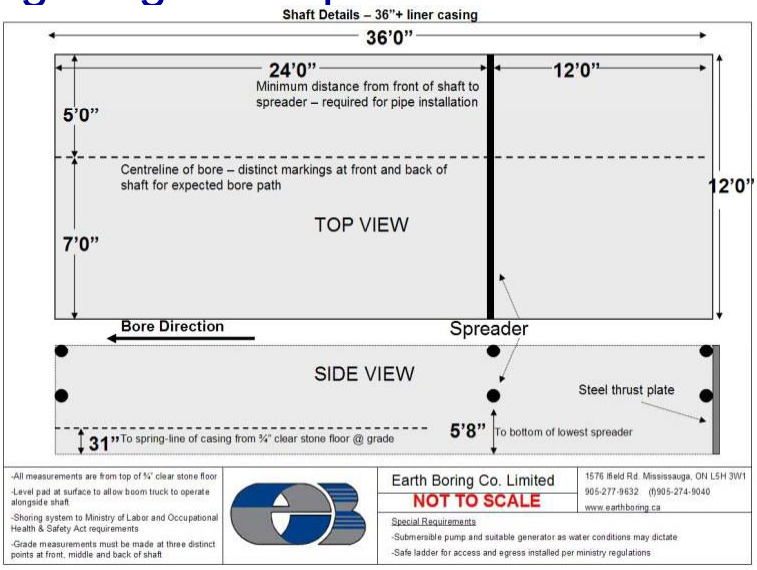
Augering - Footprint



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Augering – Grade Management

Steering Head Assembly

For long distance bores that require specific grade – a steering head can be utilized to effectively maintain or correct grade variances.

Electronics utilized to verify and assist in grade correction

Keeping grade and line on long distance ‘shots’

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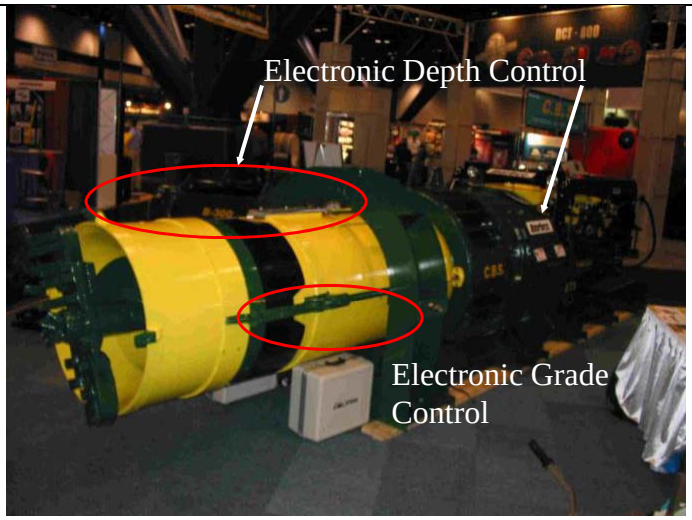
Augering – Grade Management



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Augering - Jack & Bore (Design Cont'd)

Application Requires

- Tried and True
- Defined Stds.
- Grade Sensitivity
- Environmental preservation
- Acceptance

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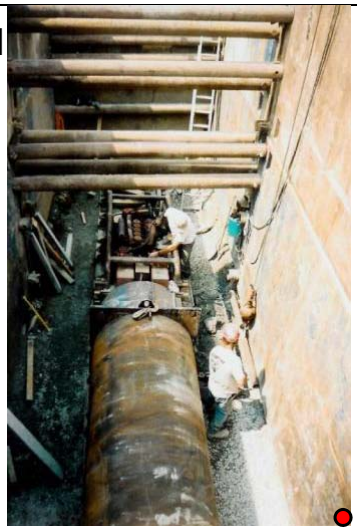
Augering - Jack & Bore (Engineering Consideration)

- Soil – Geo-Technical Report
- Timing
- Access & ROW
- Staging
- Inspection



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Augering - SBU

SBU

- Control Line and Grade
- Big Tunnel Tech

Small Tunnel Project

- Grade Sensitivity
- Highly Successful
- Rapid

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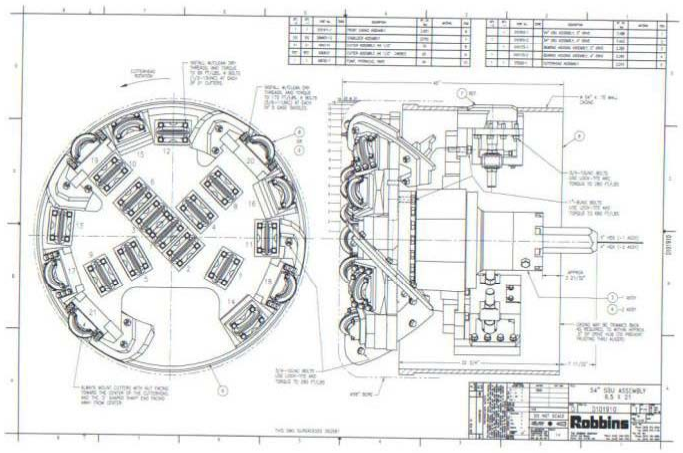
Augering - SBU



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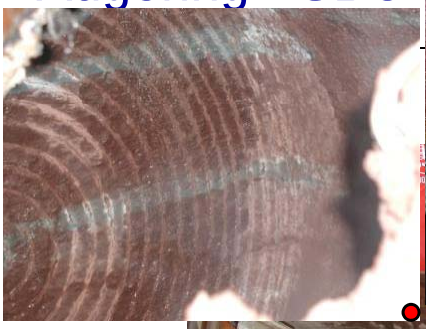
Augering - SBU



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Tunneling / Pipe Jacking

- Directly installing pipes behind a Shield Machine by hydraulic jacking
- Excavation can be performed manually or mechanically

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Tunneling / Pipe Jacking

- Usually crew req'd inside pipe to perform excavation/spoil removal process - manual
- Mechanical units may require crews inside to monitor soil cutting and grade variances

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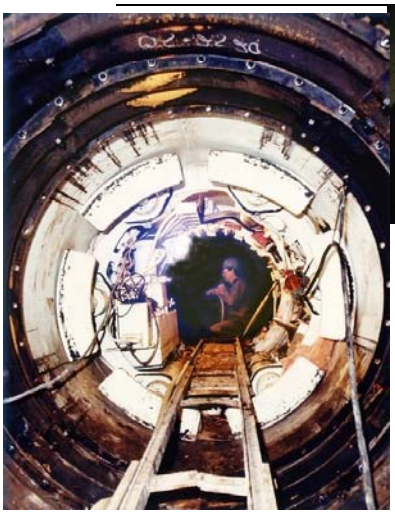
Tunneling / Pipe Jacking



Manual

Hand Mine

Shield Assisted

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Tunneling / Pipe Jacking

Mechanical

TBM / MTBA

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Tunneling / Pipe Jacking (Design Consideration)

- Project
  - Trunk Sewer, Trunk Water, Extreme Grade Sensitivity, constrained work area, Drainage, Walkway, Distance 60m+
- Ground
  - Wide range of soil conditions, typically utilized in challenging soil conditions

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Tunneling / Pipe Jacking (Design Cont'd)

- Area – Location
  - Shield method requires comparable less space
  - Require space for jacking equipment
- City, Region Acceptance
  - Well known, widely accepted
- Environmental Consideration
  - Great for preserving environment, rivers, streams, trees, railways, roads

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Tunneling / Pipe Jacking (Design Cont'd)

Application Requires

- Quick Set up (Manual)
- Accuracy - grade is critical
- Versatility due to various ground conditions
- Cost efficiency with large diameter pipe
- Well known solution - oldest technology

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Tunneling / Pipe Jacking (Mechanical)

Typical Set Up for a Tunnel Boring Machine' (TBM)

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Tunneling / Pipe Jacking (Mechanical)

The 'Inner Works' of a Tunnel Boring Machine' (TBM)

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Tunneling / Pipe Jacking (Mechanical)

The ‘Inner Works’ of a Tunnel Boring Machine’ (TBM)

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Tunneling / Pipe Jacking

(Engineering Consideration)

- Soil – Geo-Technical Report
- Timing
- Access & ROW
- Staging
- Inspection

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Pipe Ramming

- Pneumatic hammer used to ‘ram’ steel casing into ground - sizes from 500mm to 2100mm diameter
- Casing is ‘rammed’ in 6m to 12m (<) segments

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Pipe Ramming

- After each casing is rammed, another segment is welded or mechanically fitted together
- Once ramming is complete the soil inside is removed by augers
- Product pipe is inserted / ‘threaded’
- Grouting, typically occurs once rest of pipeline has been installed

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Pipe Ramming (Design Considerations)

- Project
  - Drainage, Sewer, Watermain,
- Ground
  - Typically utilized in more challenging soil conditions, hard ground, cobble
- Area – Location
  - Require space for set up
  - Loud percussion hammer
- City, Region Acceptance
  - Making In-roads
  - CNR and CPR 'encourage' methodology
- Environmental Consideration
  - Great for preserving environment, streams, trees, roads, railways

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Pipe Ramming (Design Cont'd)

Application Requires

- Compatibility w/ cobbled soil, hard ground, wet raveling ground
- Consideration of high water table conditions, no bore path de-watering
- Handle rocks to the size of the ID of the casing
- No void creation caused by removal of bore path boulders
- 'burst' boulders in path

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Pipe Ramming (Engineering Consideration)

- Soil – Geo-Technical Report
- Timing
- Access & ROW
- Staging
- Inspection

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Directional Drilling

- Surface launched, electronically guided, steerable (depth-roll-pitch), bore

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Directional Drilling

- 20mm water services to 1200mm water transmission pipeline, tremendous success with gravity sewers and other grade specific projects
- Pilot bore created along predetermined bore path with 1.5m to 6m drill rods (drill string)
- A reamer is used to enlarge the bore path
- Once the hole is enlarged (25% to 50% larger than product pipe) the product pipe is pulled into the bore hole

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Directional Drilling (Design Considerations)

- Project
  - Drainage, Sewer, Water main, Horizontal Wells, Electrical, anything short of large diameter steel casing
- Ground
  - Variable, not suited for cobble
- Area – Location
  - Require minimal space for set up and limited excavation
- City, Region Acceptance
  - Popular solution
- Environmental Consideration
  - Great for preserving environment, streams, trees, roads, small setup footprint

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Directional Drilling (Design Cont'd)

Application Requires

- **Quick Installation**
- Water crossing
- Minimal Start and receipt pits (depends on application)
- Long distances - 10m to over 400m
- Very little disruption to surrounding area, environmentally sound
- Cost effective pipe laying technique

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Directional Drilling

Locating - Pilot Bore Survey

Walk-over System

- Most cost effective
- Updates quickly
- May experience surface interference

Wire-line Systems

- Slower to bore - Insertion of wire-line and survey plot
- More expensive to operate
- Used for extreme depths or areas where walkover survey is restricted (water body, steep grade, building)

Directional Drilling

Locating - Pilot Bore Survey

Directional Drilling

Mud Mixing - Back Reaming

- Reaming of hole to proper size
  - Mud enables the hole to stabilize and remain open
- Amount needed
  - (Hole Diameter)^2 / 25 = Volume of Mud (GPF)
  - Multiple depending on soil type
- "Inadvertent Returns" or "Frac-out's"
- Plan required for mud clean up and disposal

Directional Drilling

Mud Mixing

- Essential component of a successful bore
- Bentonite used in sand
- Polymer used in clay
- Combination of bentonite and polymer used in glacial till

Directional Drilling

Simplified

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Directional Drilling (Engineering Consideration)

- Soil – Geo-Technical Report
- Timing
- Access & ROW
- Staging
- Inspection

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HDD Assist

- Pneumatic hammer used to ‘re-start’ stalled installations
- Hammer / transition piece attached to end/top of carrier/product pipe
- Hammer assists in pullback

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HDD Assist (Considerations)

- Projects that can benefit -
  - Drainage, Sewer, Water main, Gas Main, Rigid Installation
- Ground
  - Assist application – ground is less of a consideration
- Area – Location
  - Require space for set up
  - Loud percussion hammer
- City, Region Acceptance
  - Solution to stalled installation
- Environmental Consideration
  - Continue to preserve environment by assisting initial trenchless method

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HDD Assist (Considerations Cont'd)

Job Requires

- Compatibility w/ cobbled soil, hard ground, wet raveling ground
- Consideration of high water table conditions, no bore path de-watering

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HDD Assist (Engineering Consideration)

- Soil – Geo-Technical Report
- Timing
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EARTH BORING COMPANY LIMITED

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AUGER BORING
DIRECTIONAL DRILLING
PIPE RAMMING

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