TRENCHLESS TECHNOLOGY IN PIPELINE CONSTRUCTION

2009 AMERICAN WATERWORKS ASSOCIATION
PACIFIC NORTHWEST SPRING CONFERENCE
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Presented by:
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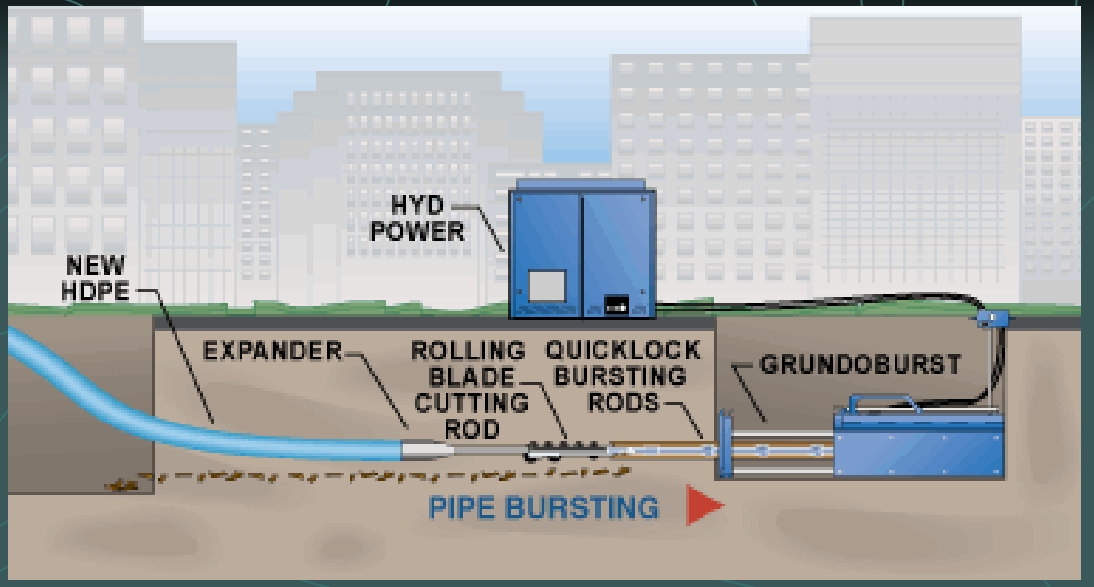
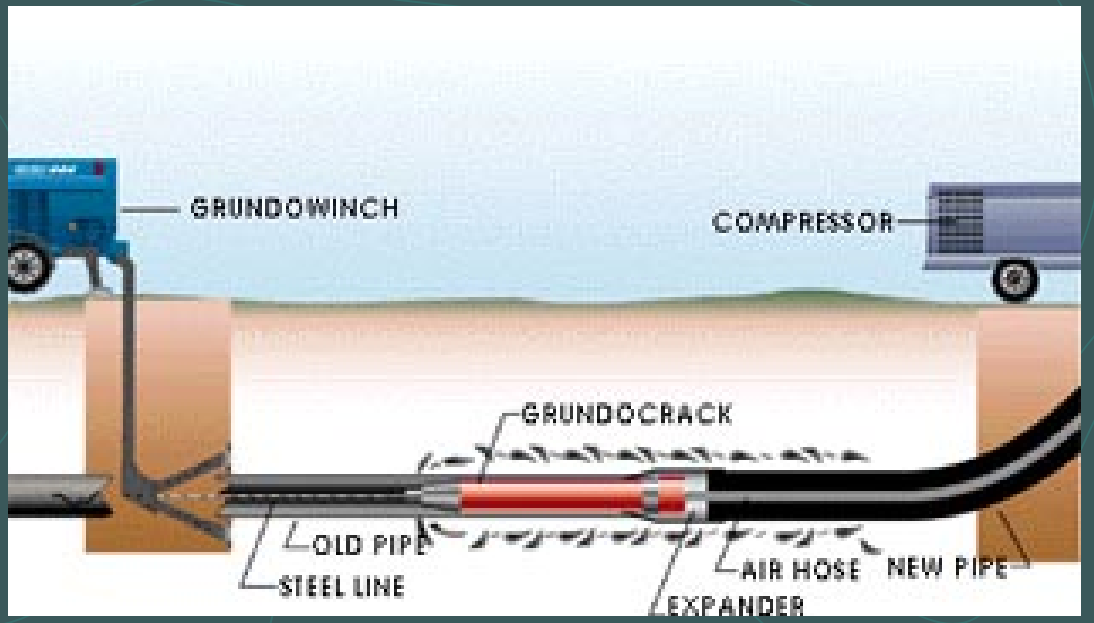
Trenchless Construction Methods

- Pipe Bursting
- Auger Boring
- Pipe Ramming
- Microtunneling/Pipe Jacking
- Pilot Tube Microtunneling
- Horizontal Directional Drilling (HDD)

Pipe Bursting

- Two General Methods
  - Static
  - Pneumatic
- Applicable Pipe Types
  - Concrete
  - Clay
  - Some Plastics
  - Cast Iron





Pipe Bursting

- Advantages
  - Replace existing pipe with minimal disturbance
  - Increase pipe diameter
  - New pipe follows invert of old pipe
  - No need to abandon existing pipe
- Disadvantages
  - Potential for surface heave and deformation of nearby utilities
  - Temporary bypass necessary
  - Bends and restrained joints problematic

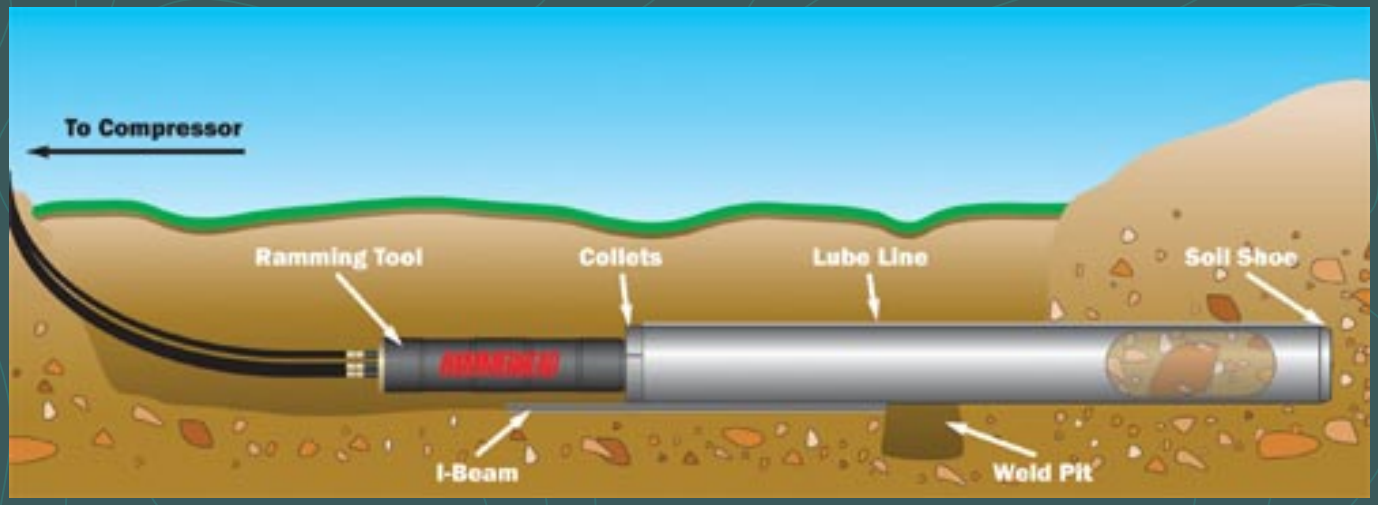
Auger Boring

- Most common trenchless construction method
- Use auger to bore while advancing a steel casing
- Generally limited to lengths of 200 – 400 feet
- Casing pipe diameters of 24 to 72 inches

Auger Boring

- Advantages
  - Wide variety of ground conditions, including rock
  - Common construction method
  - Face access to remove obstructions
  - Usually minimal surface disruption
- Disadvantages
  - Difficult to maintain line & grade in certain ground conditions
  - Difficult to steer
  - Relatively large area required for jacking pit
  - Dewatering usually required in granular soil

Pipe Ramming



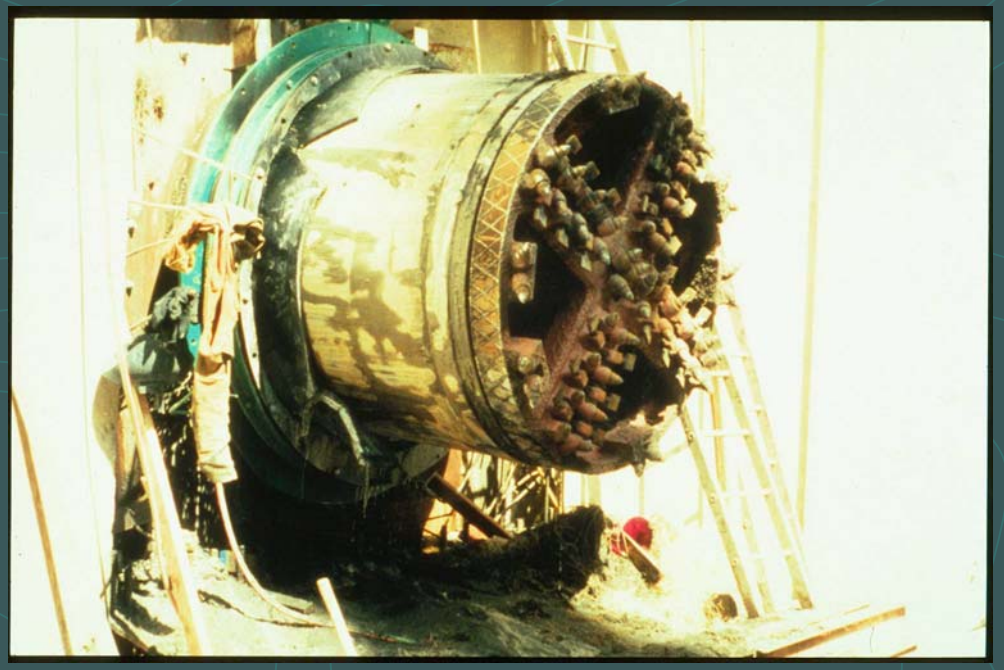
- Pneumatic hammer used to drive welded steel or Permalok casing
- Typical casing pipe diameters of 4 to 72 inches (147-inch Permalok casing recently driven under a railway in Iowa)
- Applicable for short crossings of 200 – 300 feet
- Pipe ramming can be used in conjunction with HDD to drive casing and to assist in pullback

Pipe Ramming

Pipe Ramming

- Advantages
  - Suitable for a wide variety of soil conditions
  - Can be driven at almost any angle
  - Accommodates obstructions well
- Disadvantages
  - Pipe difficult to steer. “Goes where it’s pointed”
  - VERY noisy!
  - Dewatering generally required below groundwater table

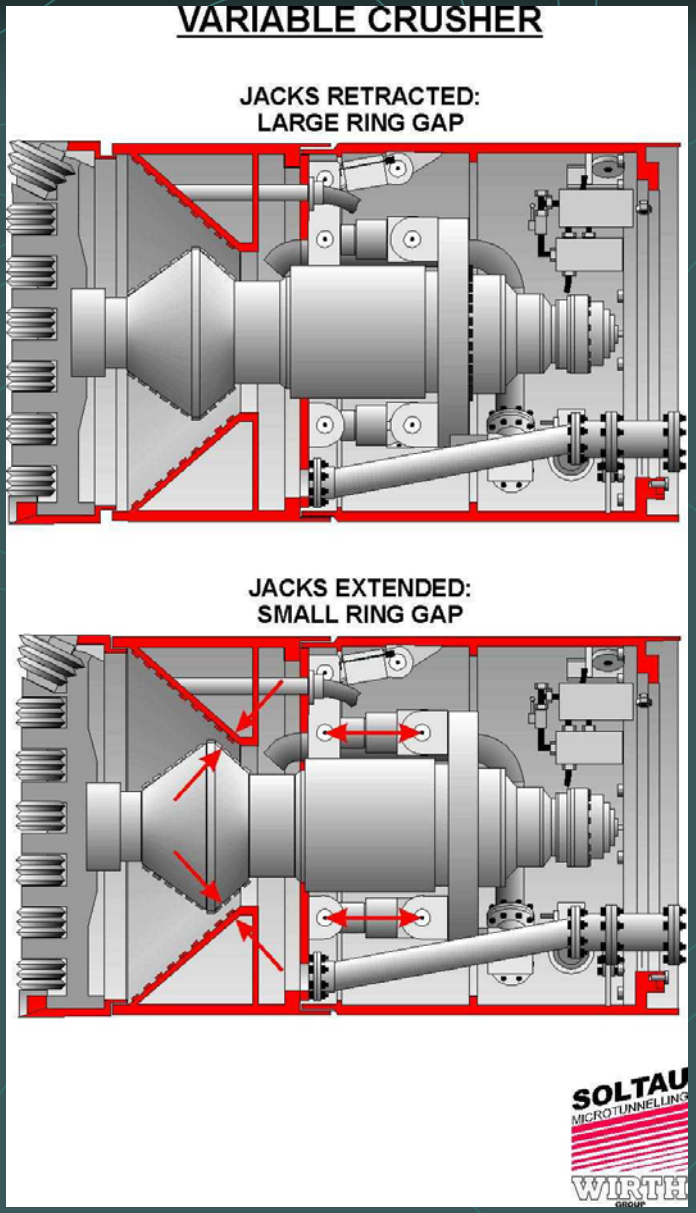
Microtunneling/Pipe Jacking



- Microtunneling: small diameter tunneling using a remote controlled tunneling machine
- Pipe jacking: small diameter tunneling using a guided tunneling machine (i.e., operator located inside the boring machine and/or on the haul cart)

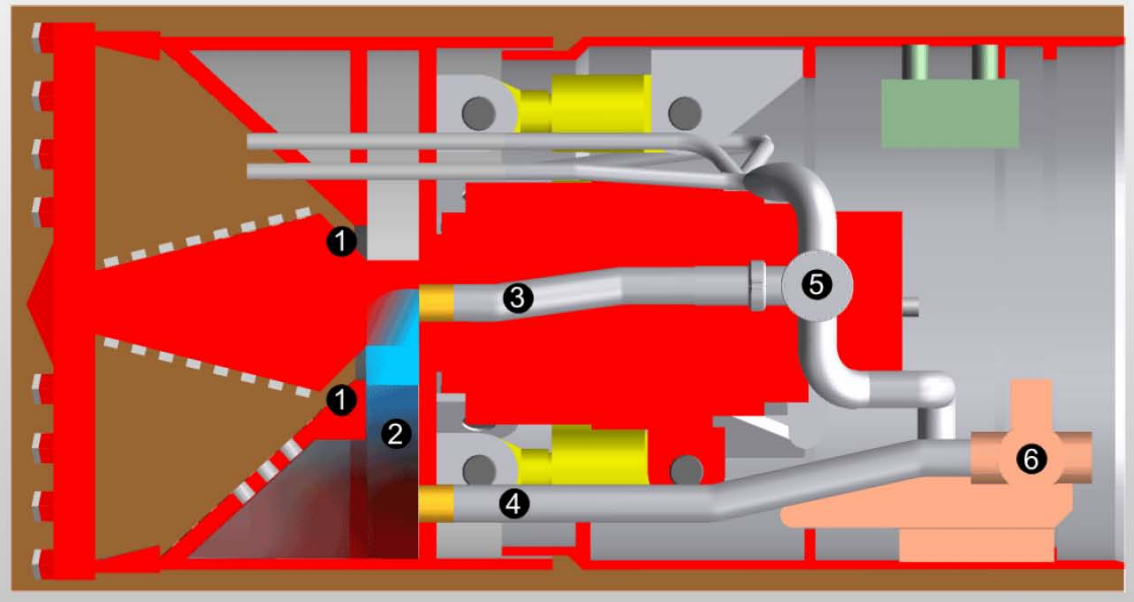
Microtunneling

- Two basic modes:
  - Slurry Shield
  - Earth Pressure Balance
- Machine advances off the end of the pipe string
- Hydraulic jacks advance the pipe string



Cutter Head mts 1000 / mts 2000

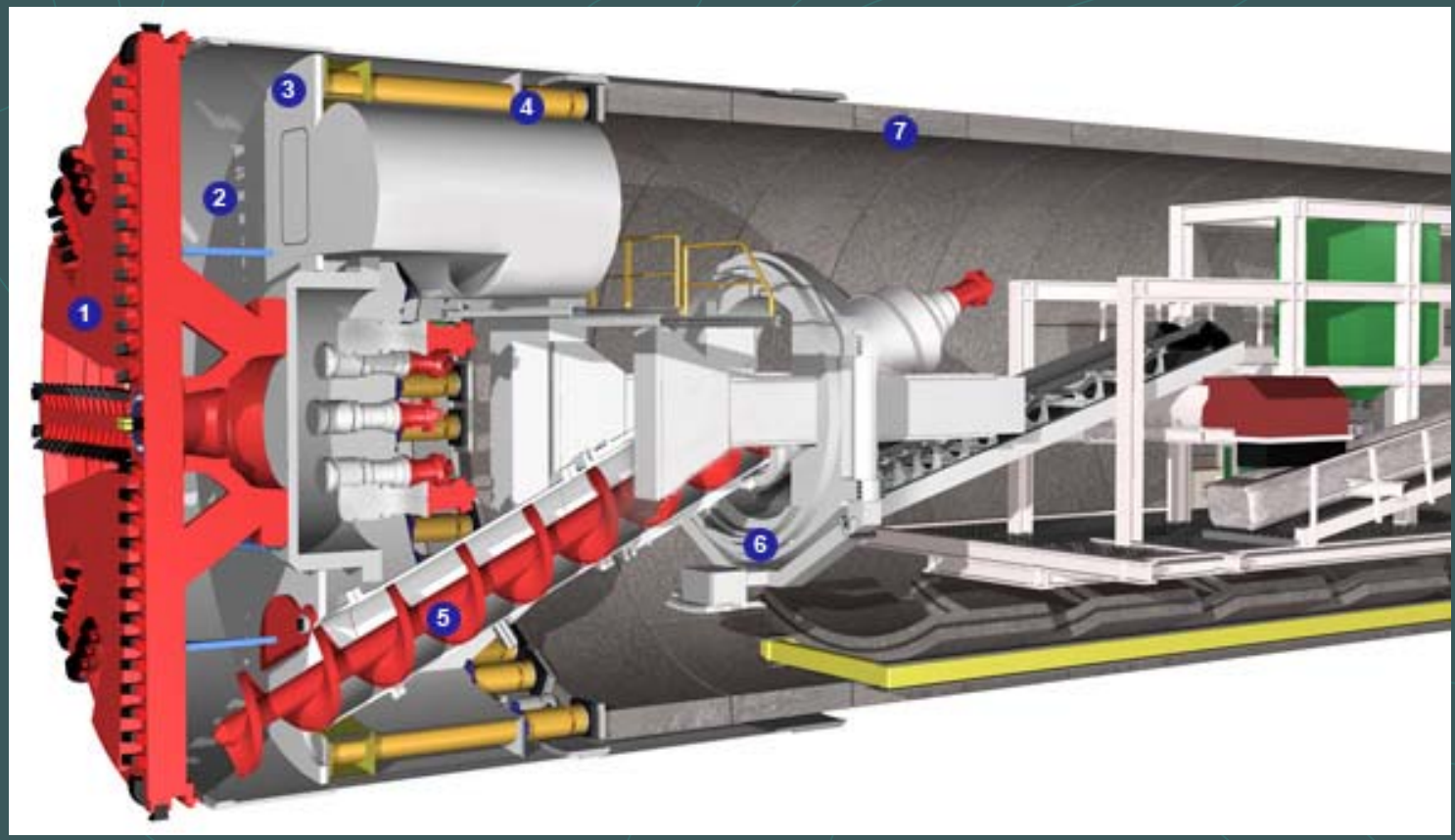
EPB Mode



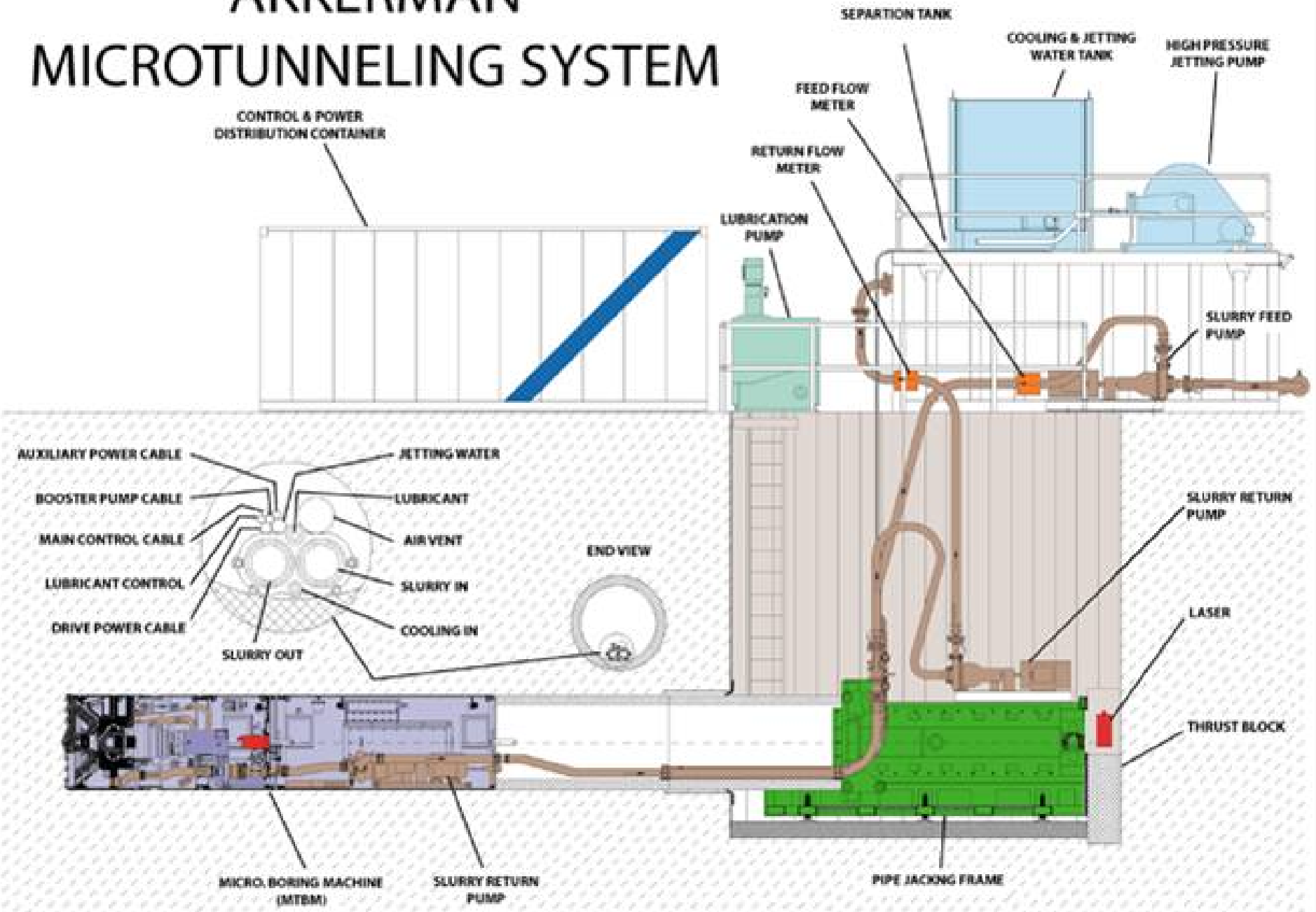
1 Crusher gap
2 Slurry chamber
3 Slurry chamber charge line
4 Slurry chamber discharge line
5 Jet valve
6 Bypass valve

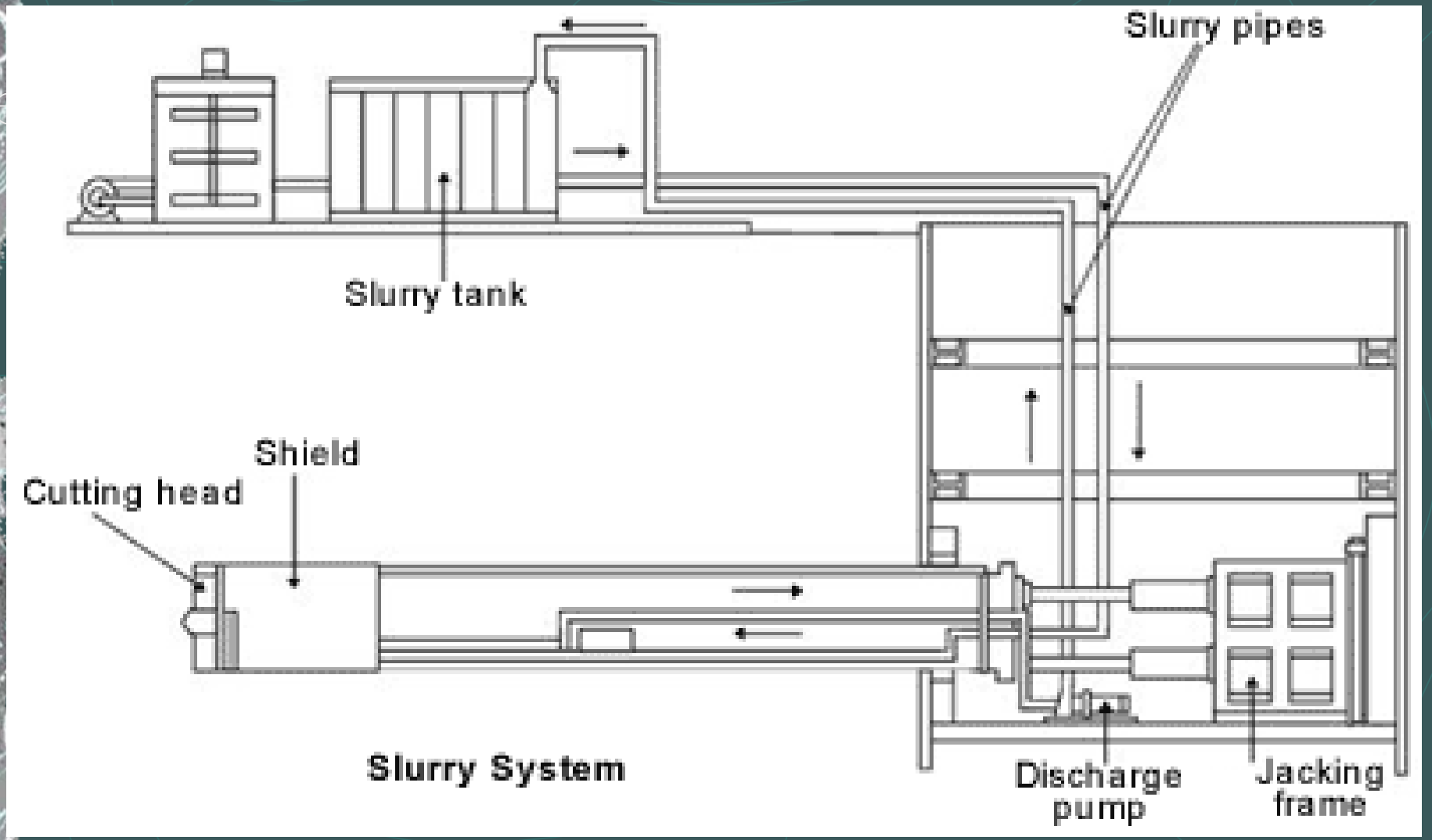
September 2006

Microtunneling



AKKERMAN MICROTUNNELING SYSTEM



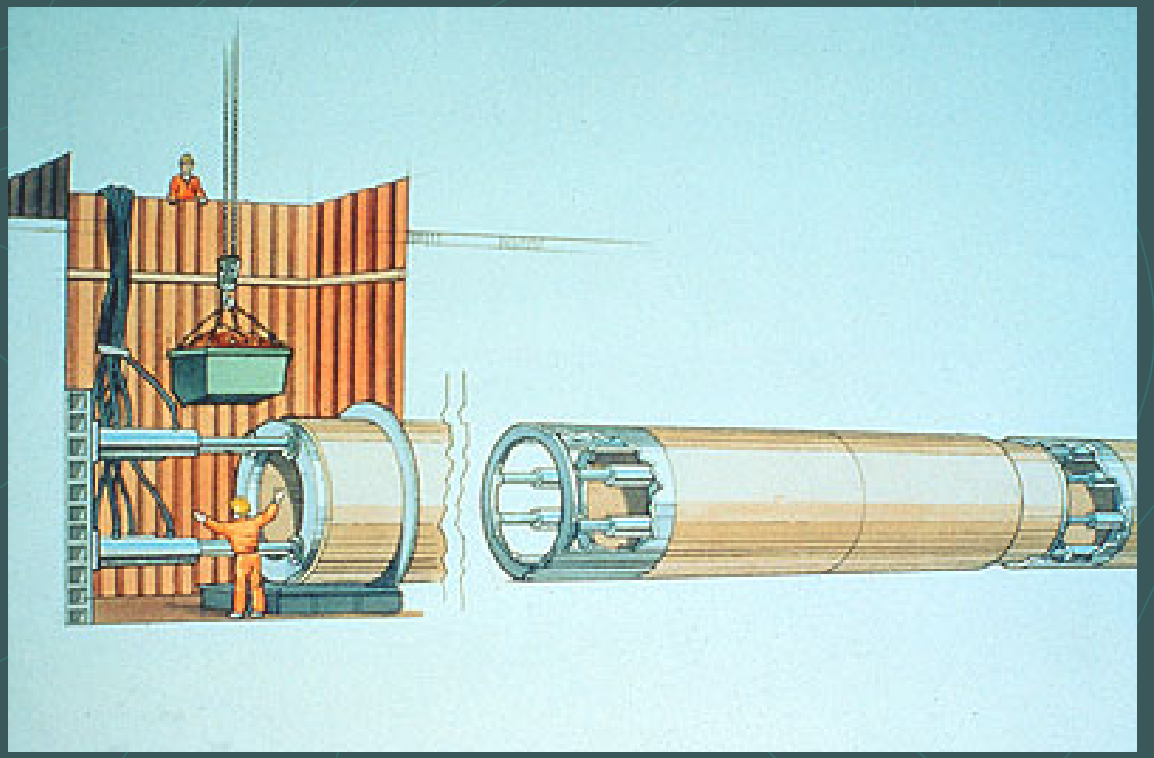

Slurry pipes
Slurry tank
Shield
Cutting head
Slurry System
Discharge pump
Jacking frame

Microtunneling

- Jacking pipe:
  - One-pass
    - Concrete
    - Clay
    - Fiberglass (Hobas)
    - Polycrete
  - Two-pass
    - Steel Casing (welded & Permalok)
    - Ribs and lagging
- Typical Diameters of 24 inches up to 130+ inches
- Lengths up to 2,000 feet with intermediate jacking stations

Microtunneling/Jacking Pipe

Intermediate Jacking Stations (IJS)



Microtunneling

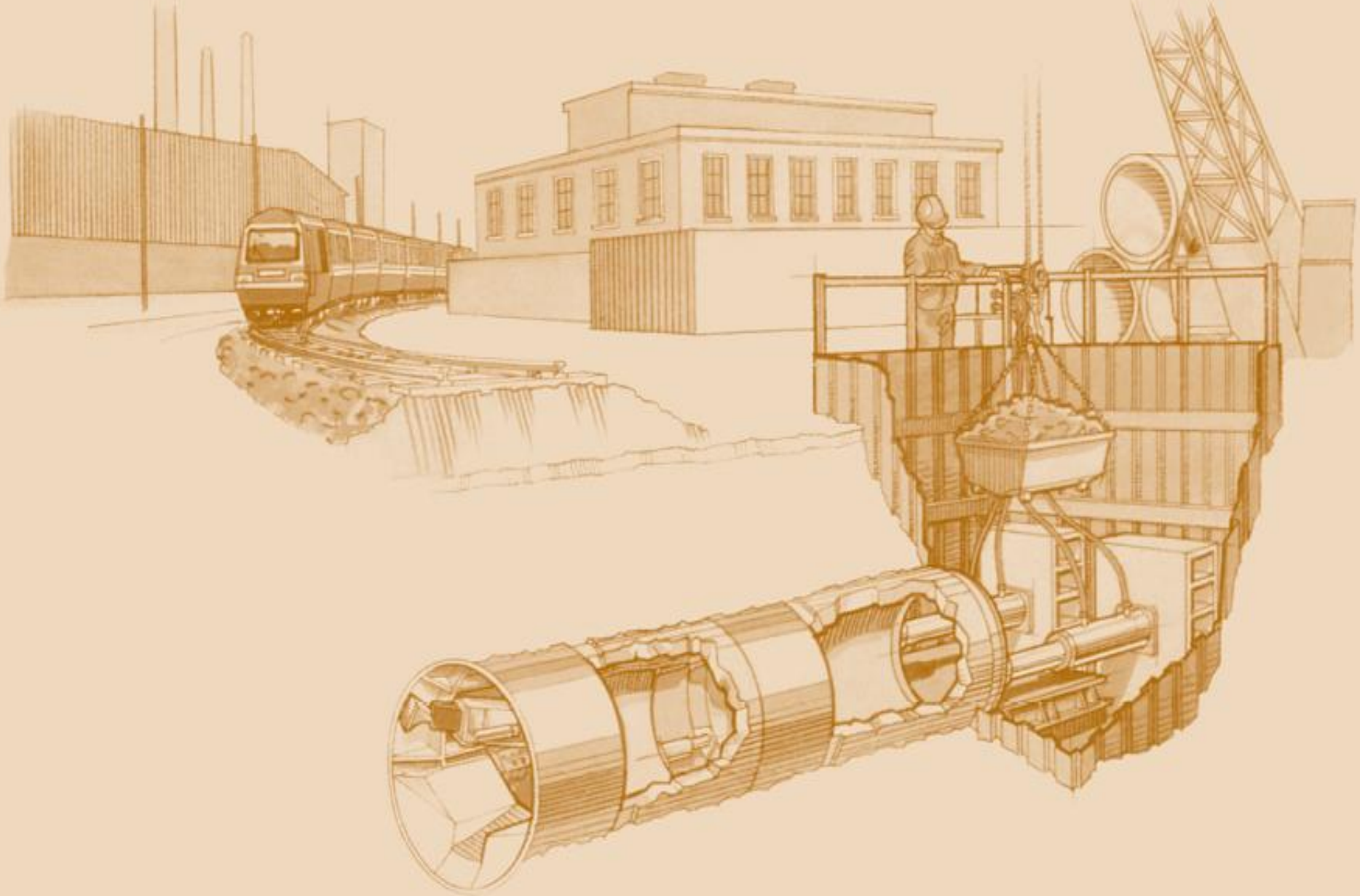
Microtunneling

- Advantages
  - Handles wide variety of ground conditions
  - No dewatering
  - Minimal surface disruption
  - Very accurate (slopes of 0.2% easily achieved)
- Disadvantages
  - Requires large area for jacking shaft and support equipment
  - Relatively high cost
  - Obstructions problematic

Pipe Jacking

- Two machine types:
  - Wheel machine
  - Excavator machine
- Machine diameters of 44 to 100+ inches
- Wheel machines can be fitted with a closed face cutter head to control unstable ground conditions

Pipe Jacking



Pipe Jacking

- Advantages
  - Handles wide variety of ground conditions
  - Minimal surface disruption
  - Very accurate
  - Less costly then microtunneling
  - Face access to deal with obstructions
- Disadvantages
  - Requires large area for jacking shaft and support equipment
  - Dewatering below groundwater table in running/flowing soil

Pipe Jacking

Other things can also be jacked!

14’ x 14’ x 84’ tunnel in Connecticut

Pilot Tube Microtunneling

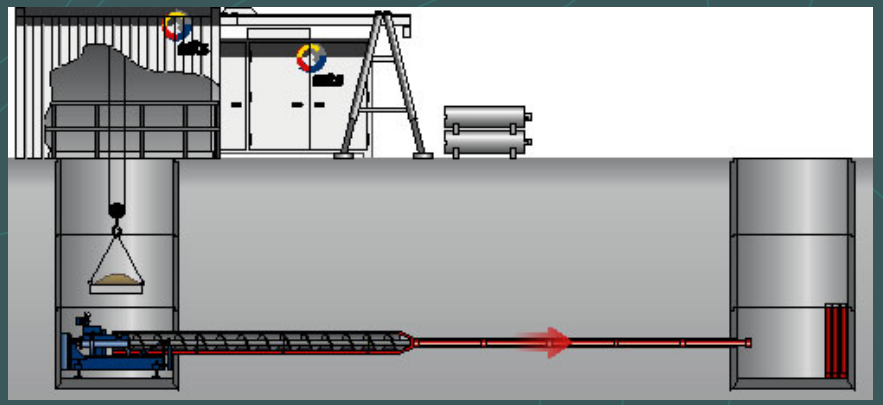
- Hybrid of microtunneling, HDD, auger boring
- For small diameter pipes 4 to 24 inches
- Lengths of up to 250 ft
- Clay pipe most common
- Power cutting head allows pipes up to 44”

Pilot Tube Microtunneling

Pilot Tube Microtunneling

Pilot Tube Microtunneling

- Advantages
  - Relatively small shafts
  - Minimal surface disruption
  - Very accurate
  - Less costly than microtunneling
- Disadvantages
  - Short drive lengths
  - Dewatering below groundwater table (> 10 ft)
  - Doesn't handle cobbles and boulders well
  - Pipe size limited

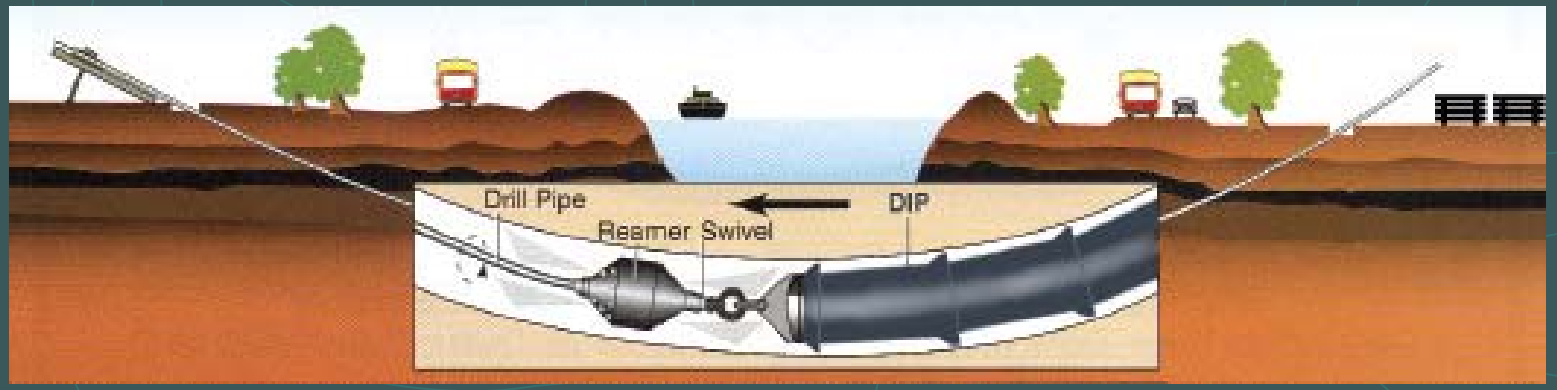


Horizontal Directional Drilling

- Generally used when line & grade not critical
- Lengths of hundreds to thousands of feet
- Steel and HDPE most common pipe materials
- Diameters of a few inches up to 60+ inches

Horizontal Directional Drilling

- Three stage process
  - Drill pilot hole
  - Expand to accommodate pipe
  - Pull back pipe



Horizontal Directional Drilling

Horizontal Directional Drilling

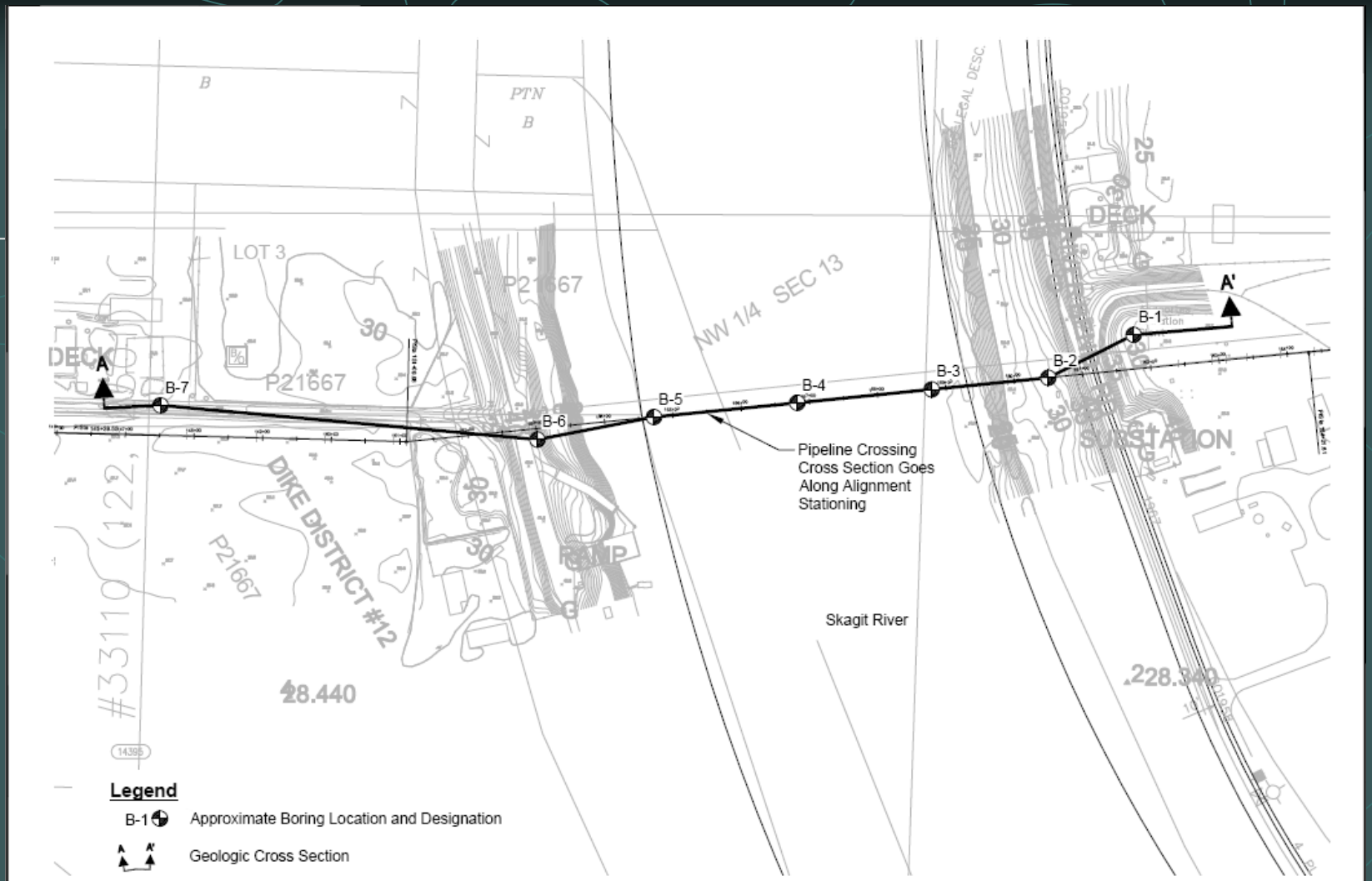
- Advantages
  - Handles wide variety of ground conditions
  - Steerable both horizontally and vertically
  - Handles obstructions
  - Doesn't require shafts
- Disadvantages
  - Not well suited for gravity systems
  - Open gravels problematic

Case History – Skagit River Crossing

- Owner: City of Anacortes
- Project Team:
  - MWH – Civil Design & Construction Management
  - Landau Associates – Geotechnical
  - Bennett & Staheli – Trenchless Consultant

Project Details

- Construction: 2007
- 1,600 ft of 36” Steel Pipe
- Maximum depth of 50 ft below the river bottom



Base map source: MWH 2004

0 200 400
Scale in Feet

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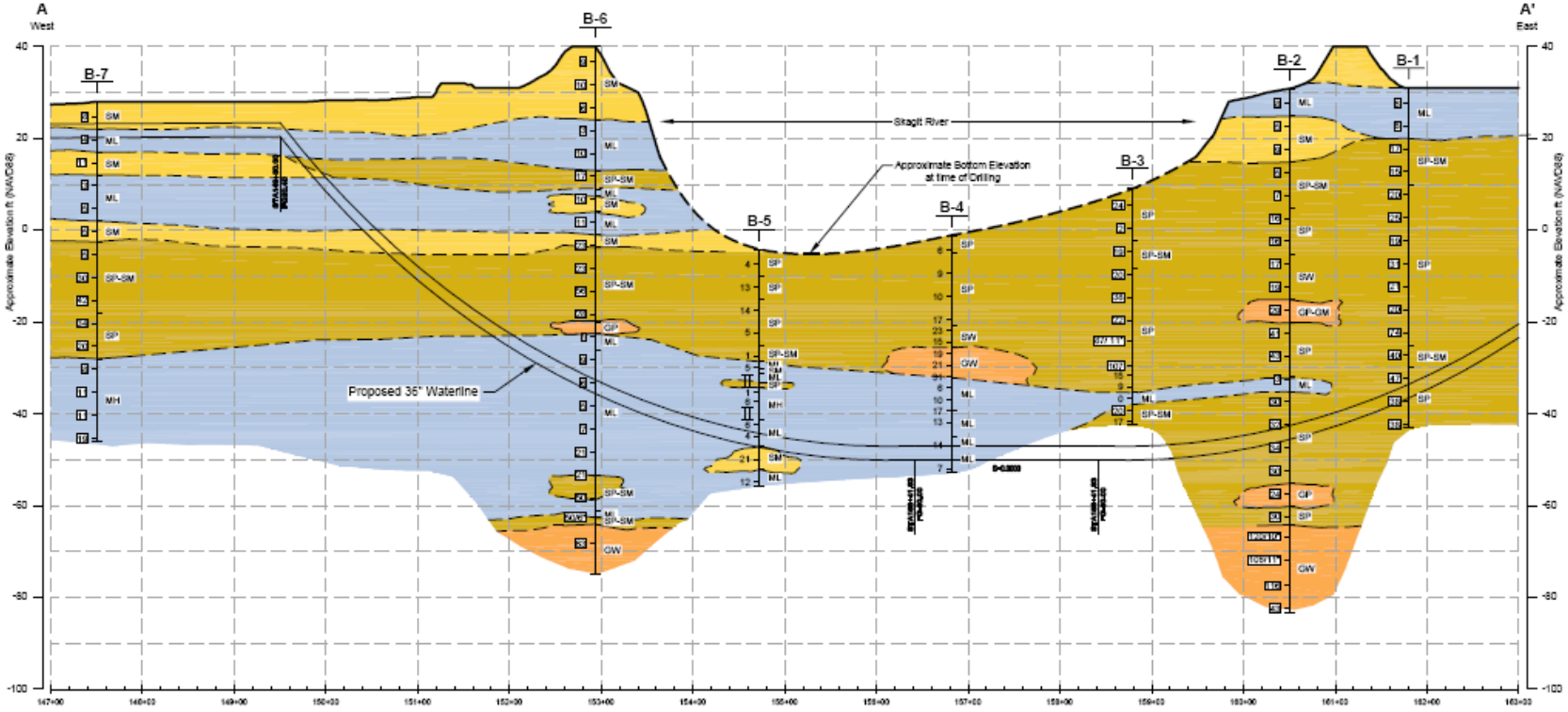
Anacortes Waterline Segment 5 & 6 Skagit County, Washington	**Site and Exploration Plan** **Skagit River Crossing**	Figure **3**

Geotechnical Explorations



Legend

- B-1 — Boring Number
- Groundwater Elevation at Time of Drilling
- 50 — Dames & Moore Blow Count (140 lb Hammer, 30" Drop)
- 30 — Standard Penetration Test Sampler (140 lb Hammer, 30" Drop)
- II — Shelby Tube Sample (Pushed 30" with Rig Hydraulics)
- Approximate Geologic Contact (Dashed where Inferred)
- SM — USCS Designation

- Very Loose to Loose, Silty to Very Silty Sand(SM)
- Very Loose to Medium Dense Sand (SP, SW) Sand with SILT (SP-SM)
- Loose to Medium Dense, Sandy Gravel (GP, GW) and Sandy Gravel with Silt (GP-GM)
- Very Soft to Stiff Silt (ML, MH) and Sandy Silt (ML)

0 120 240
Scale in Feet
Vertical Exaggeration 5X

Notes:

1. This cross section has been interpreted and generalized from project field data. Variations between this cross section and actual conditions may exist. The project boring logs and written report must be referenced for a proper understanding of the nature of the subsurface conditions.
2. Site Bathymetric Information was interpreted from elevation readings from the City of Anacortes pump house staff gauge. Staff gauge reading elevation readings differs from NAVD88 elevation by approximately -3.4 ft (MWH, 2005). Because of bottom scour, variations between the bathymetry shown on this cross section and actual bathymetry likely exist.

Base map source: MWH, 2005

Anacortes Waterline Segment 5 & 6 Skagit County, Washington	**Geologic Cross Section A-A' Skagit River Crossing**	Figure **4**

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Drilling the Borehole

Reaming the Hole

Assembling the Pipe

The Pull Back

The Pull Back

The Pull Back

Questions?