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Challenges and Innovations in Tunnelling

Microtunnelling Advancements in North America

John Grennan
Ward and Burke Microtunnelling

Marc Gelinas
Hatch Mott MacDonald

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Tunnelling Association of Canada
Association Canadienne Des Tunnels

Presentation Goals

- Provide an overview of the North American microtunnelling industry
- Highlight industry-advancing microtunnel projects recently completed/currently underway in Ontario

Presentation Outline

- Definition of Microtunnelling
- History of Microtunnelling
  - Worldwide → Ontario
- Current state of the industry
  - North America → Ontario
- Industry Advancing Projects in Ontario
  - Long-distance drives
  - Curved drives
  - Drives in rock
  - Large diameter installations

Microtunnelling

DEFINITION

- A trenchless method of pipeline installation which includes all of the following features:
  - Remote-controlled
  - Guided
  - Pipe jacking
  - Continuously supported

Microtunnelling History

- Developed in Asia in the late 1960's (Komatsu, Iseki, Mitsubishi, etc.)
  - Offshoot of slurry shield tunnelling
- Gained popularity in Europe in the 1980s (Iseki, Herrenknecht, Soltau, Wirth, etc.)

Microtunnelling History

- North American industry developed in the late 1980's/1990s (Akkerman, Herrenknecht, Iseki, etc.)
- First project in Ontario = Welland, 1987 (Iseki)
  - Subsequent projects in 1990, 1994, 1995, 1998 (approx. 2500m total)
  - Mixed success, issues in tills and cobble/boulder-laden soils
  - OCPA design manual for microtunnel pipe
  - 12 year hiatus (1999-2011)

Microtunnelling History

- Gore Road Project (2011)
  - Project tendered as a "traditional" tunnel
  - Microtunnelling proposed as an alternative
    - Single-pass installation
    - Increased clearance below critical utilities
    - Jacking pipe (and just about everything else) imported from Ireland

State of the Industry

NORTH AMERICA

- Over 30 Microtunnel Contractors
- Multiple equipment manufacturers with North American presence
  - Others entering the market
- ASCE Guidelines (ASCE 36-15)
- Annual short course at the Colorado School of Mines (over 20 years running)

State of the Industry

ONTARIO

- 3 Ontario-based microtunnel contractors
  - Over 10 equipment spreads
  - 750 to 3300mm diameter (OD)
- 2 concrete jacking pipe manufacturers
- OPSS in development
  - Final draft completed on Sept. 30, 2015

Industry Advancements

- In the past 4 years, there have been an number of industry-advancing microtunnel projects
- Focus on Ontario-based projects
  - Long-Distance Drives
  - Curved Drives
  - Drives in Rock
  - Large Diameter Installations

Long Distance Drives

- Elgin Mills PD6 600mm CPP Feedermain Project
- North Don Sanitary Sewer
- 2nd Concession Reconstruction

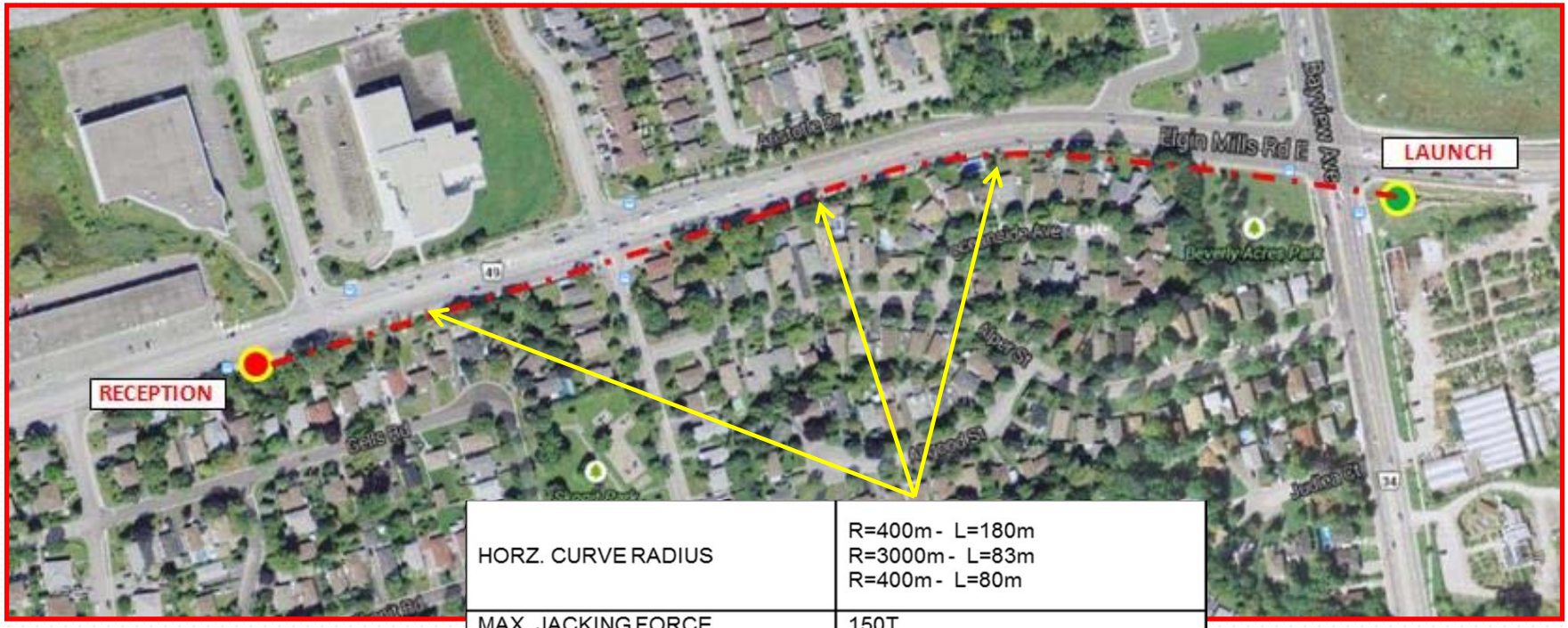
Long Distance Drives

Elgin Mills PD6 600mm CPP Feedermain Project

- 740m Drive Length
- 1500mm ID Reinforced Concrete MT Pipe
- 3 Horizontal Curves
  - R=400m L=180m
  - R=3000m L=83m
  - R=400m L=80m
- Glacial Tills, Sands, Silts
- Longest Microtunnel in Canada
- Longest Curved Microtunnel in North America

Long Distance Drives

Elgin Mills PD6 600mm CPP Feedermain Project



HORZ. CURVE RADIUS	R=400m - L=180m R=3000m - L=83m R=400m - L=80m
MAX. JACKING FORCE	150T
NO. OF INTERJACKS	4
DRIVE DURATION	51 Days
SOIL TYPE	Glacial Till, Sands. Silts.
MTBM TYPE	HERRENKNECHT AVN1500

Long Distance Drives

Elgin Mills PD6 600mm CPP Feedermain Project

Long Distance Drives

North Don Sanitary Sewer

- Max Drive Length 635m
- 600m and 467m Drive also on the project
- 1200mm ID Reinforced Concrete Microtunnel Pipe
- Glacial Till, Sand, Silt

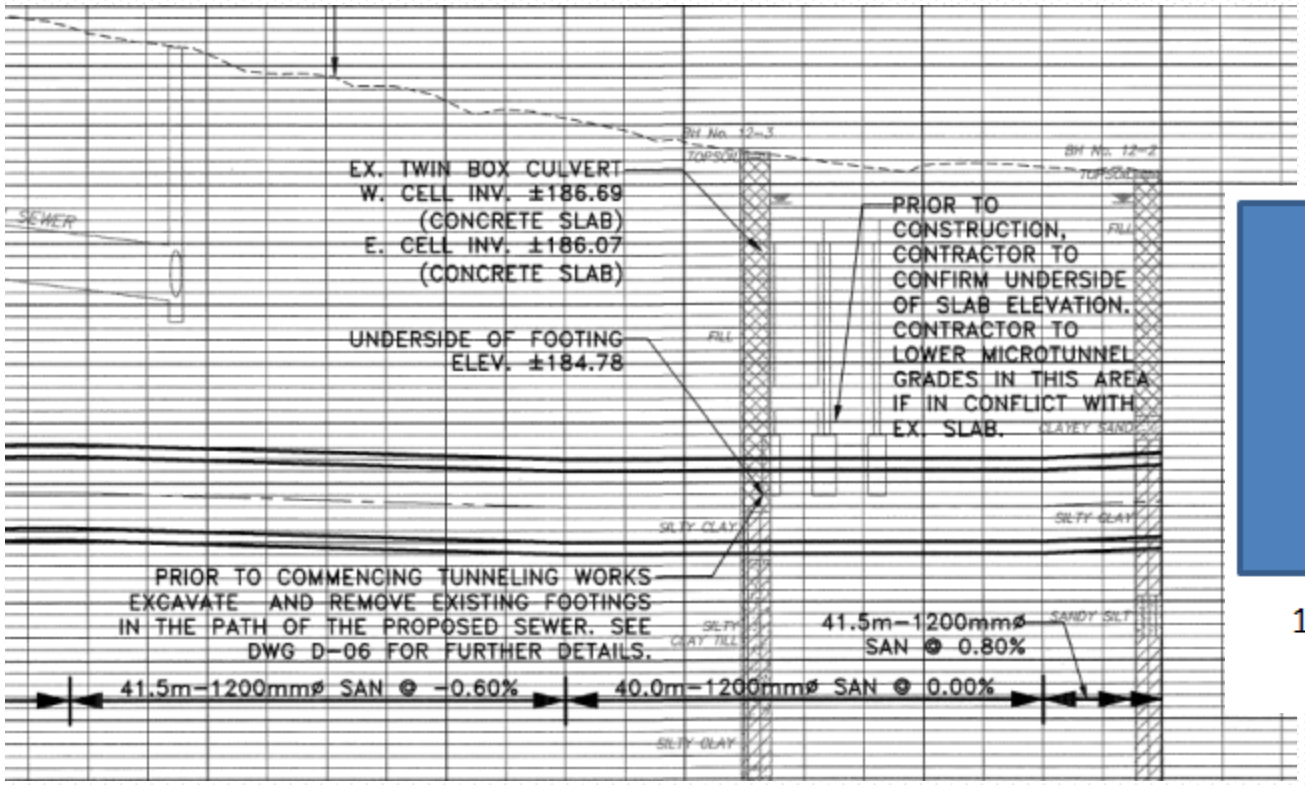
Long Distance Drives

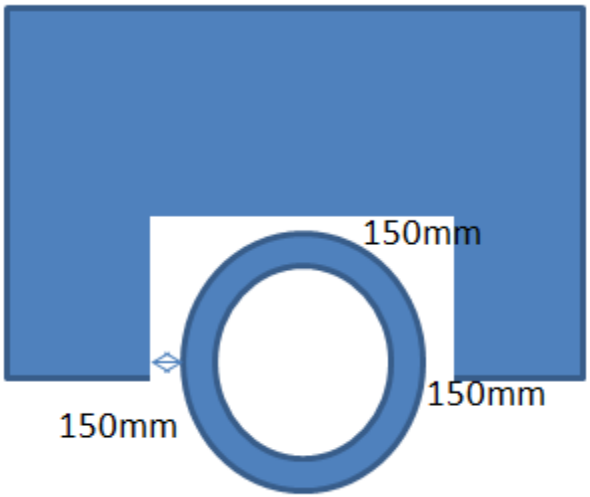
North Don Sanitary Sewer

CURVED DRIVE No. 3	NORTH DON SAN. SEWER
DRIVE LENGTH	635m
INTERNAL DIAMETER	1.2m
VERT. CURVE RADIUS – Double S	-3567m and 4338m
VERT CURVE LENGTH	80m
HORZ. CURVE RADIUS	400m
HORZ CURVE LENGTH	129m
MAX. JACKING FORCE	350T
NO. OF INTERJACKS	2
DRIVE DURATION	42 Days
SOIL TYPE	Saturated, Low Shear Strength Sand, Silts.
MTBM TYPE	HERRENKNECHT AVN1200

Long Distance Drives

North Don Sanitary Sewer





Long Distance Drives

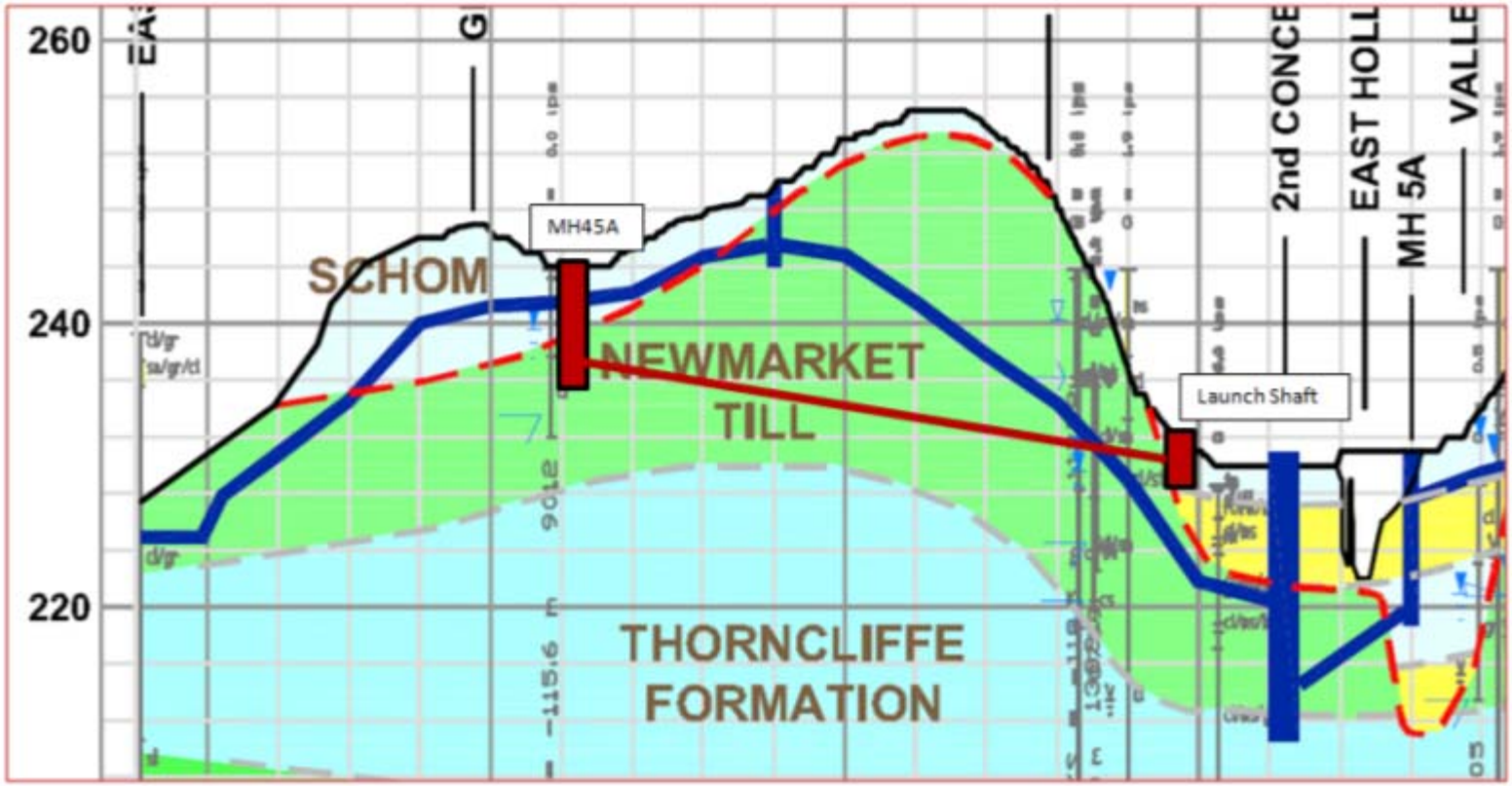
2nd Concession Reconstruction – Trunk Sewer

- Max Drive Length 668m
- 1200mm ID Reinforced Concrete Pipe
- Glacial Till, Sand, Silt
- Longest 1200mm ID Drive in North America

Long Distance Drives

2nd Concession Reconstruction – Trunk Sewer

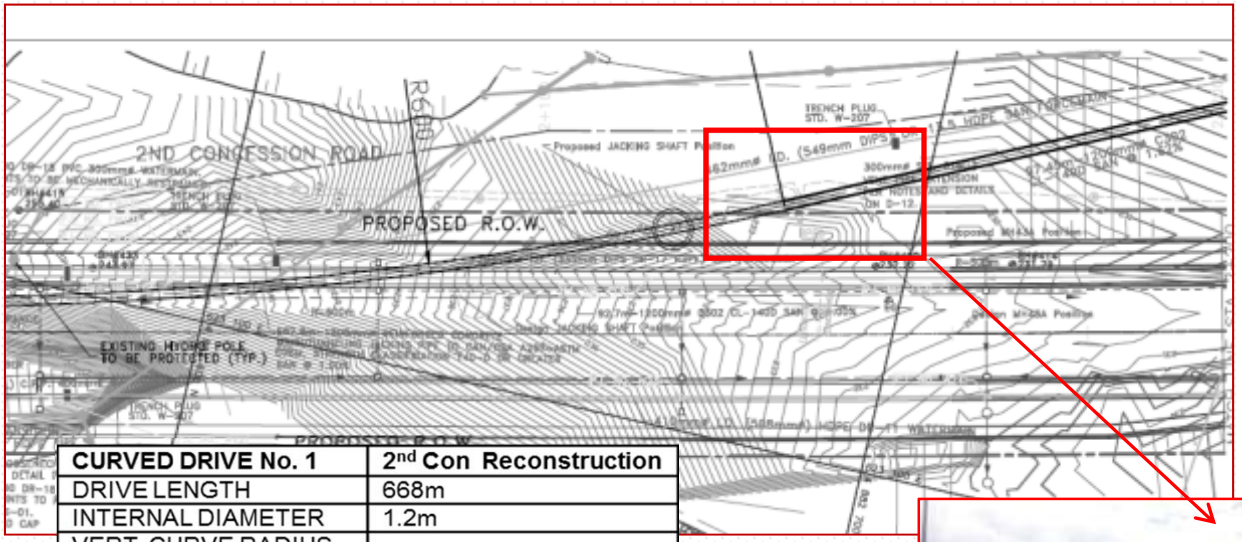
- Vertical Profile



Long Distance Drives

2nd Concession Reconstruction – Trunk Sewer

- Horizontal Profile



CURVED DRIVE No. 1	2nd Con Reconstruction
DRIVE LENGTH	668m
INTERNAL DIAMETER	1.2m
VERT. CURVE RADIUS	-
HORZ. CURVE RADIUS	600m
CURVE LENGTH	97.7m
MAX. JACKING FORCE	1600T
NO. OF INTERJACKS	3
DRIVE DURATION	5 Days
SOIL TYPE	Till, Cobbles, Boulders
MTBM TYPE	HERRENKNECHT AVN1200

Curved Drives

- Keswick WPCP Effluent Outfall Expansion Project
  - First curve in Canada
  - First spatial curved microtunnel in North America
  - First Wet Reception of MTBM in Canada
- West Don Sanitary Trunk Sewer
  - Tight Radius microtunnelling – R=250m

Curved Drives

Keswick WPCP Effluent Outfall Expansion Project

- Increase diameter to 1200mm ID RCP
- Introduction of curves to eliminate shafts

Curved Drives

Keswick WPCP Effluent Outfall Expansion Project

- Longest Drive = 335m
- Spatial Drive = 208m
- Vertical R = 6600m; Horizontal R = 875m

CURVED DRIVE No. 1	KESWICK WPCP
DRIVE LENGTH	335
INTERNAL DIAMETER	1.2m
VERT. CURVE RADIUS	-
HORZ. CURVE RADIUS	6850m
CURVE LENGTH	295m

CURVED DRIVE No.2	KESWICK WPCP
DRIVE LENGTH	207.969m
INTERNAL DIAMETER	1.2m
VERT. CURVE RADIUS	6600m
HORZ. CURVE RADIUS	875m
CURVE LENGTH	182.984m

Curved Drives

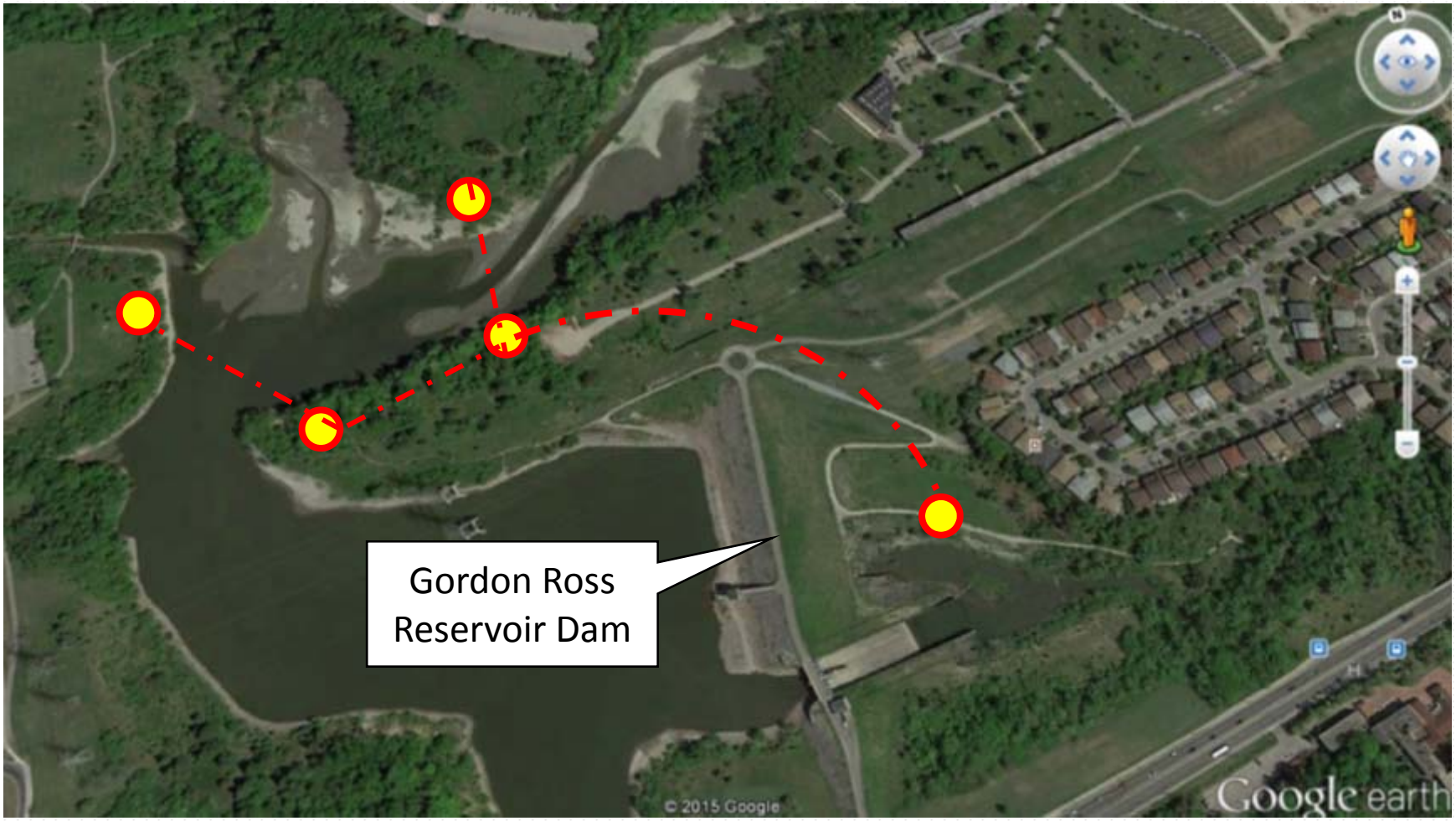
West Don Sanitary Trunk Sewer

- 350m long tunnel
- 250m continuous radius
- 1200mm ID RCP
- 20m deep launch shaft
- 15m water head
- Glacial till with boulders
- First use of Jack Control System in Canada

Curved Drives

West Don Sanitary Trunk Sewer

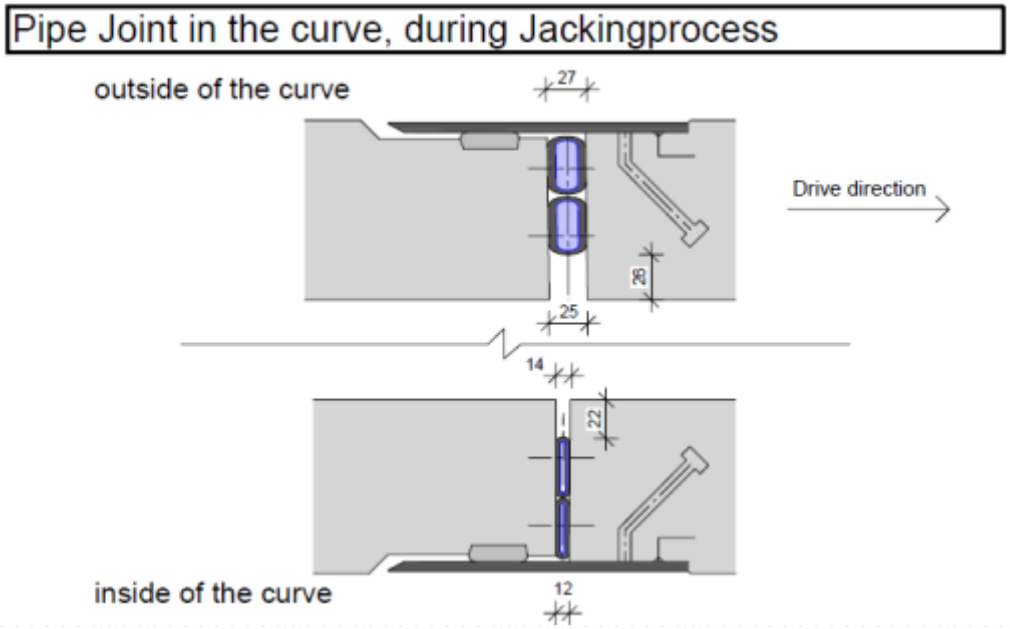
- Site Layout



Curved Drives

West Don Sanitary Trunk Sewer

- Jack Control Technology
  - Use of hydraulic joint packer at pipe joints instead of a wood based packer to evenly distribute the jacking force through the pipe wall



Drives in Rock

- North Trunk Trenchless Scugog River Crossing – Kawartha
  - 220m – 1500mm ID – 120 to 150 MPa Limestone
- Kenilworth Ave. Combined Sewer Overflow Project
  - 319m – 1500mm ID – Queenston Shale and Limestone Layers – Curved Alignment
- Etobicoke Creek – Under Construction
  - 575m – 1800mm ID - Alluvium and Georgian Bay Shale

Drives in Rock

North Trunk Trenchless Scugog River Crossing – Kawartha

Drives in Rock

Kenilworth Ave. Combined Sewer Overflow Project

	KENILWORTH AVE. N. CSO
DRIVE LENGTH	319m
INTERNAL DIAMETER	1.5m
VERT. CURVE RADIUS	-
HORZ. CURVE RADIUS	952m
CURVE LENGTH	142m
MAX. JACKING FORCE	90
NO. OF INTERJACKS	1
DRIVE DURATION	35 Days
SOIL TYPE	Queenston Shale
MTBM TYPE	HERRENKNECHT AVN1500
PRIMARY LINING	Reinforced Concrete Pipe

Drives in Rock

Etobicoke Creek Trunk Sanitary Sewer

- 575m long drive
- 1800mm ID RC jacking pipe
- Crossing beneath the busiest runway at Canada's busiest airport
- Georgian Bay formation bedrock

Large Diameter Installations

- 2nd Concession Reconstruction – Forcemain Casing
  - 330m – 2000mm ID – 2400mm OD - RCP
- 37th St. Storm Sewer Construction - Calgary
  - 2500mm ID Installation
- Burbrook TSS London
  - 2500mm ID Installation

Large Diameter Installations

2nd Concession Reconstruction – Forcemain Casing

- 330m Long Tunnel
- 2000mm ID RCP
- 11m Deep Launch Shaft
- 7m Water Head
- Saturated Sands and Silts

Large Diameter Installations

2nd Concession Reconstruction – Forcemain Casing





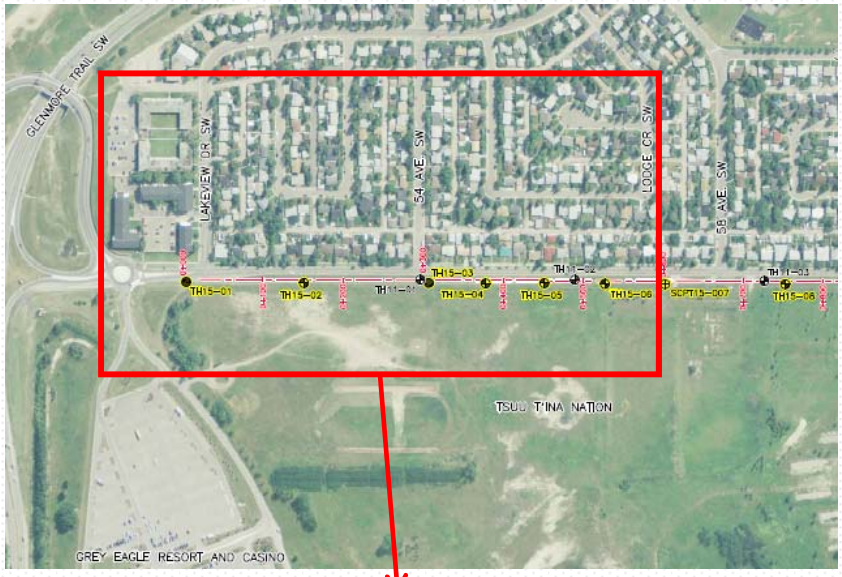
Large Diameter Installations

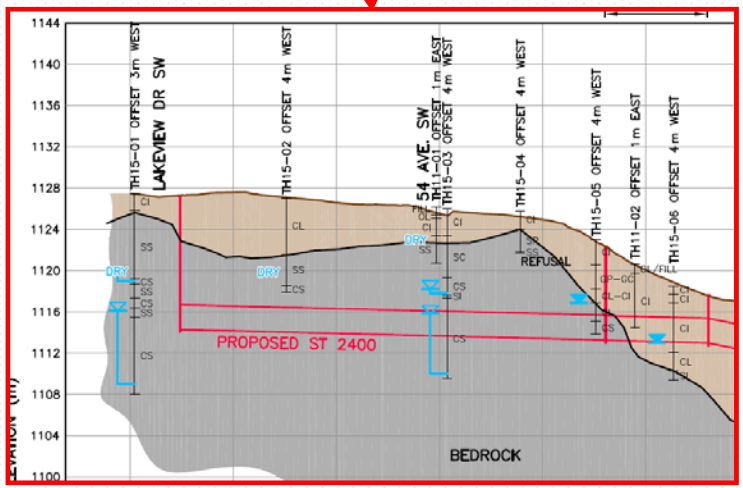
2nd Concession Reconstruction – Forcemain Casing

Large Diameter Installations

37th St. Storm Sewer Construction - Calgary

- 415m Drive Length
- Tunnelling parallel to existing street
- 2500mm ID RCP
- 15 - 10m deep shafts
- Bedrock with transition into till conditions

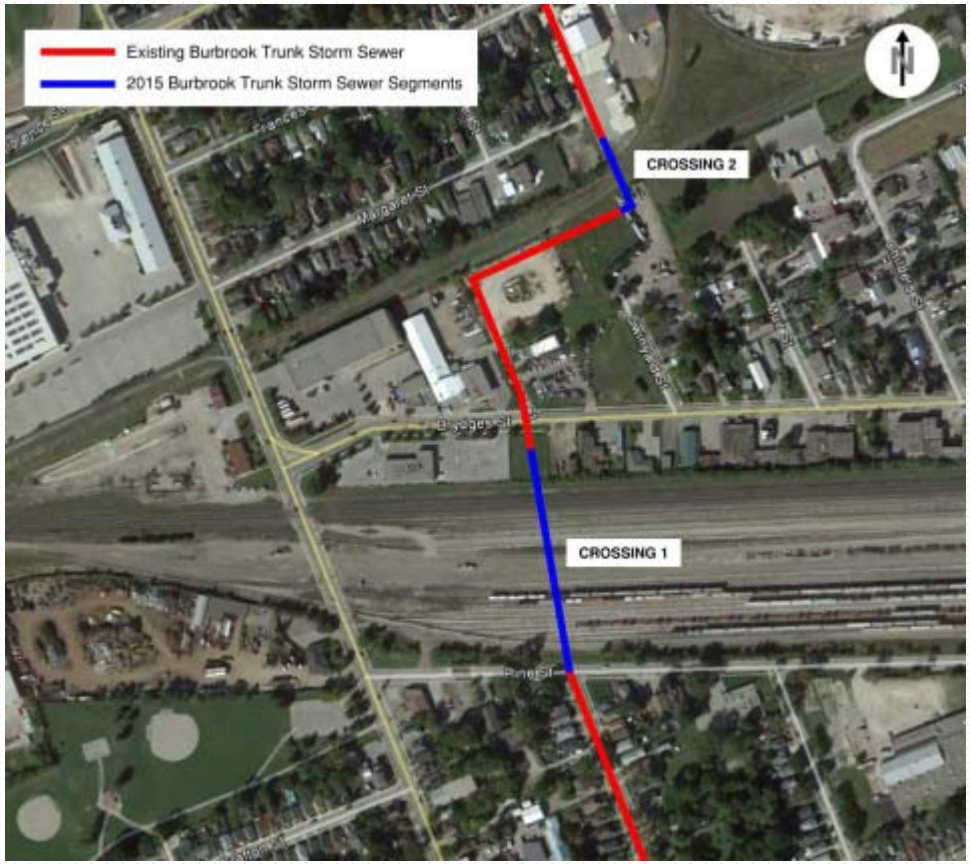




Large Diameter Installations

London Burbrook TSS

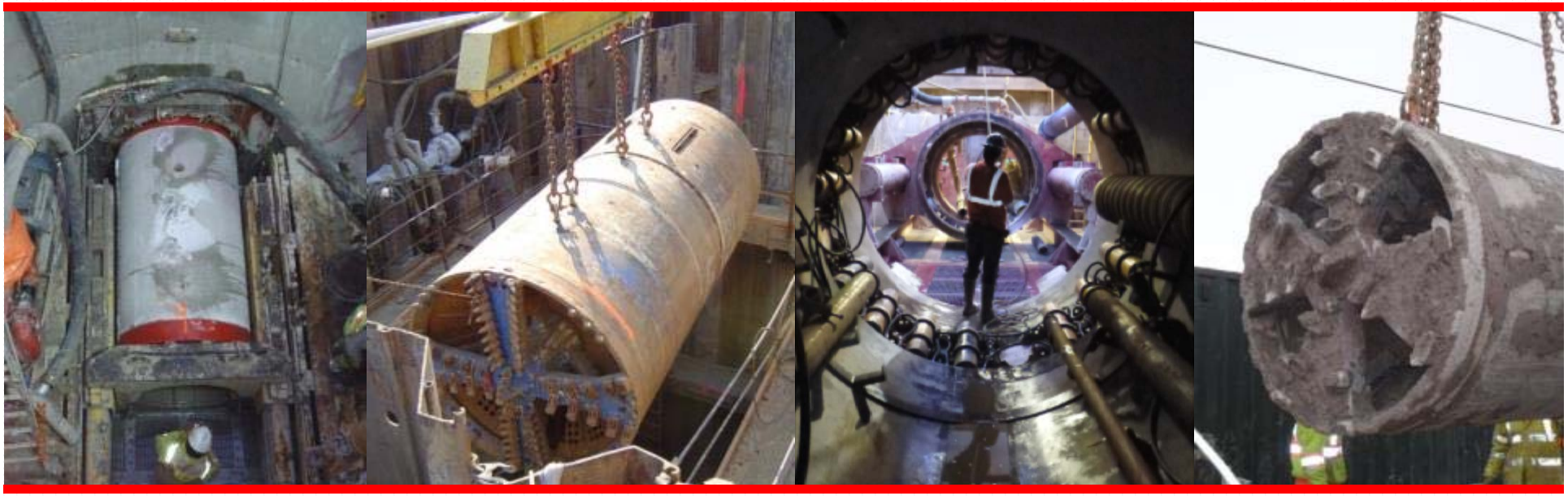
- 2 crossings (50m & 175m)
- Crossings beneath live rail lines
  - 22 track shunting yard
  - 2 track line
- 2500mm ID RCP
- 8 - 11m deep shafts
- Saturated sands, gravels, and till



Closing

- The microtunnelling industry in North America is strong
- Growth of the microtunnelling industry in Ontario has been remarkable
- Ontario-based projects are setting new benchmarks, particularly as regards:
  - Curve drives
  - Long-distance drives

Questions



John Grennan
john.grennan@wardandburke.com

Marc Gelinas
marc.gelinas@hatchmott.com