Construction and Maintenance Challenges with Sudbury’s Sewage Rock Tunnel

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Outline

• Introduction
• Early Wastewater Conveyance in Sudbury
• Sudbury’s Sewer Tunnel System
• Monitoring/Maintenance
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• Future of the Tunnel
Introduction

- R.V. Anderson Associates Limited (RVA) is a multi-disciplinary civil engineering consultant based out of Toronto, ON.
- Sudbury Branch of RVA managed the South End Tunnel and Tunnel Survey projects.
- City of Greater Sudbury located in Northeastern Ontario.
- Encompasses more than 3,200 km², wide range of land uses.
- Focus on wastewater collection in Greater City’s “core” – former City of Sudbury.
Early Wastewater Collection in Sudbury

• From the very beginning, Junction Creek used as a sewage outlet.
• 1930s and 1940s – development flourished around City
• Need arose for proper sewers – costly.
• Rolling topography in Sudbury area, required many sewage lift stations.
Early Wastewater Collection in Sudbury

- Degradation of environment increased over time as City built up.
- How to service other areas (Minnow Lake, New Sudbury) – separate treatment plants, or major trunk sewer through City?
- Solution – sewer tunnel.
Early Wastewater Collection in Sudbury

• From 1960 to 1964, 92.3 km new sewers and 18 sewage lift stations in the works.
• Main Tunnel (Sudbury Sewer Tunnel) and Kelly Lake Lift Station built – no treatment.
• By 1966, 210 km sewers serving population of 82,000 people.
• Sudbury Waste Water Treatment Plant on Kelly Lake Road (complete 1972).
• Expand sewer Tunnel (Minnow Lake, Lockerby) in late 1960s and 1970s.
Sudbury’s Sewer Tunnel System

Sudbury’s geology ideal for trunk sewer in bedrock below City:

- Shallow layer of overburden soils (sand, silt, gravel).
- Very hard bedrock (UCS 100 to 250 MPa) – metasidements, quartzite.
Sudbury’s Sewer Tunnel System

- Excavated in bedrock by drill and blast methods.
- Approx. finished dimensions 1.5m by 2.1m.
- Broken rock base lined with concrete, sloped invert.
- No ‘liner’, only ground support as req’d.
- ‘Drop shafts’ convey sewage to tunnel.
Sudbury’s Sewer Tunnel System

Main Tunnel (Sudbury Sewer Tunnel)

• Started in 1961, completed in fall of 1962.
• Generally follows Junction Creek route.
• +/- 7.9km tunnel, including 6 shafts
• Cost $1,964,000 ($230/m)
Sudbury’s Sewer Tunnel System

Lockerby Tunnel
Connected Lockerby Sewage System to Main Tunnel.
Sudbury’s Sewer Tunnel System

Tunnel expanded to prevent bypassing of sewers into Lake Ramsey.
This branch eliminated 9 lift stations.
Sudbury’s Sewer Tunnel System

South End Tunnel

- Solution: **Expand Sewer Tunnel Again**
- +/- 6.5 km extension, 3 access shafts and 9 drop shafts.
- Project eliminated 6 lift stations.
Sudbury’s Sewer Tunnel System

• 2010 Ontario Public Works Association (OPWA) Public Works Project of the Year
Sudbury’s Sewer Tunnel System

• 2011 American Public Works Association (APWA) Project of the Year Award – Environment ($25M to $75M)
Sewer Tunnel Performance

Oldest portions of tunnel in operation for 50+ years.
  • Sustainable infrastructure – has worked well over the years.

South End Tunnel in operation for +/- 4 years (brought online in three phases).
  • Allowed for growth in City’s South End.
  • O&M cost reduction (eliminated 6 stations).
  • Reduction in basement flooding, backups.
Sewer Tunnel Performance

• 2 level monitors and 3 flow monitors tied to the City’s wastewater SCADA system.
• Provide early warning to Operations staff to increase pumping at plant.
• Confirms depth of storage occurring in tunnel.
Monitoring and Maintenance

Past Inspections of Tunnel System
• 1972 – Inspection of Main Tunnel
• 1980 (February 26/27) – Follow-up Inspection:
  • MOL, Mine Rescue & Region of Sudbury
  • Main Tunnel, part of Minnow Lake Tunnel
  • Assess conditions, blockages, rockfalls.
  • Tunnel in good conditions.
  • Provided recommendations.
Monitoring and Maintenance

- 1997-1998 Region of Sudbury Underground Sewer Tunnel Inspection
- Ontario Mines Rescue in cooperation with Northern Centre for Advanced Technology, Inc. (NORCAT)
- Manned entry – visual inspection only (video, photos, notes)
Monitoring and Maintenance

Two distinct phases:
- August 25-29, 1997 (Minnow Lake, Main)
- August 24-28, 1998 (remainder of Main)

Objectives of Inspection:
- Stability of rock, note any areas of failure or potential failure;
- Ground water infiltration;
- Condition of sewer pipes and drop shafts; and
- Sewage flow, solids buildup.
Monitoring and Maintenance

Findings:
• General stability of underground openings very good (minor debris only).
• Rock walls generally wet, very little ground water intrusion observed.
• Drop shafts stable (some solids buildup).
• Some sludge in tunnel sections with reduced flow.
Tunnel Survey Project

**Present day** – what does the City need?

- Understanding of condition of tunnel (rock falls, solids buildup, groundwater inflow, etc.)
- More precise calculation on hydraulic capacity of sewer tunnel.
  - Insufficient information on original as-built drawings of older sections.
  - Detailed survey of walls, invert, features.
  - Not obtained in previous inspections.
- Confined Space Regulations – significant change in requirements (permits, rescue, communications).
Tunnel Survey Project

- **Project**: Survey of ‘lower’ 2,000m of Main Sewer Tunnel (video, photos, 3-D survey)
- Pre-Qualification – June, 2011
- Tender – November, 2011
- Successful Tenderer: D.M. Robichaud Associates Ltd. (Oshawa, ON).
  - Sub-contractor – Penguin Automated Systems Inc. (Naughton, ON).
Tunnel Survey Project

Progress To Date:

• Two survey deployment attempts so far:
  • October, 2012 – no entry completed
  • June, 2013 – partial entry
    ▪ Survey of vertical shaft and +/- 10m of tunnel;
    ▪ Visual inspection of 245m tunnel downstream of Shaft #2.
• Delays related to addressing challenges with Confined Space requirements.
• Planned re-deployment for spring, 2014
The Future of the Sewer Tunnel?

• The City of Greater Sudbury is always looking for more efficient means to convey wastewater.
• As the City’s infrastructure is aging, lift station and trunk sewer challenges becoming evident.
• Sewer Tunnel extensions are being considered if applicable to long term solutions to City’s challenges.
• Scope of work for ongoing Water/Wastewater Master Plan includes review of expansion to tunnel system.
Thank-you!