



ITA TUNNELLING  
AWARDS 2017

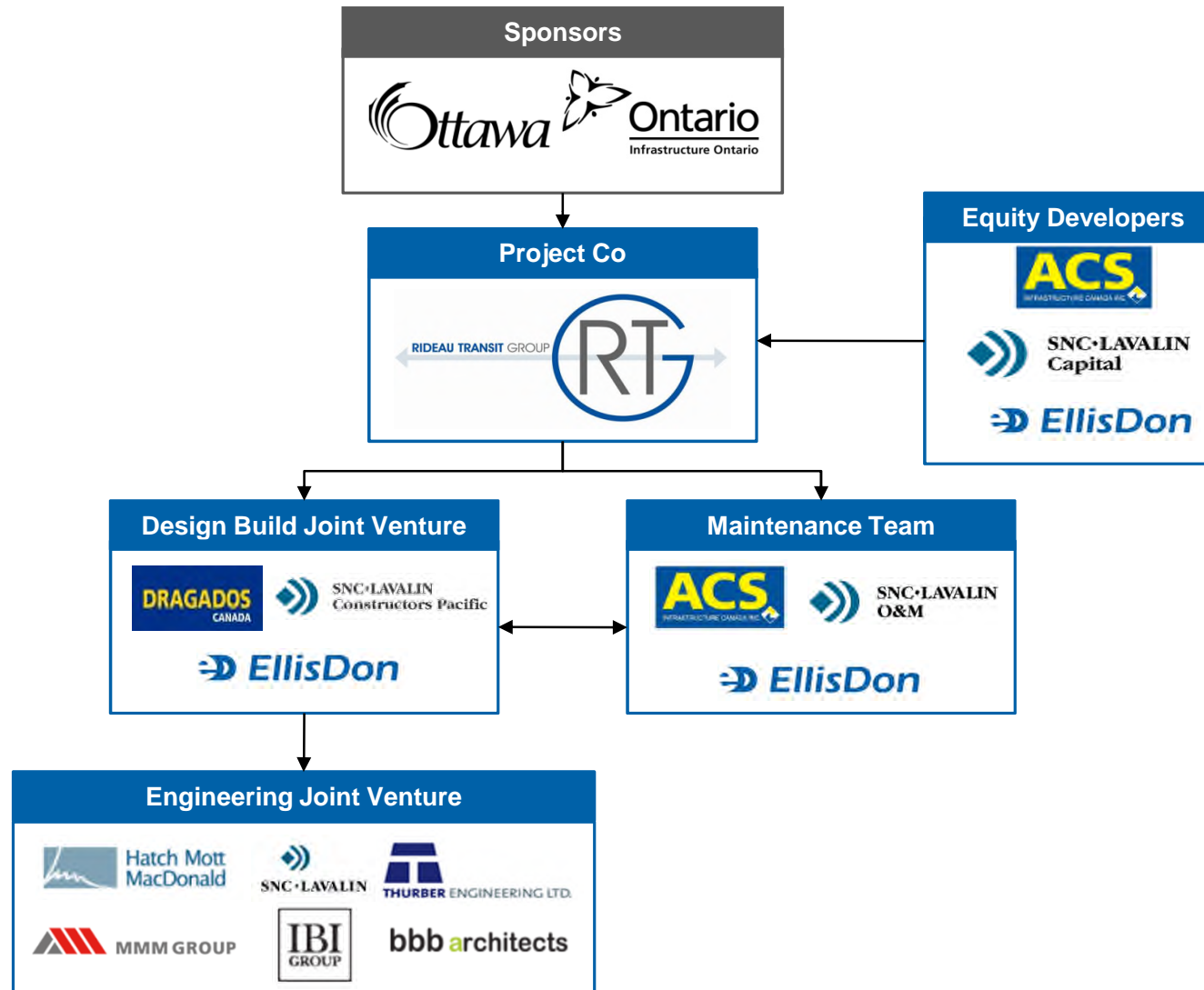


# The Confederation Line Ottawa LRT Project

Tom Middlebrook, P.Eng  
Senior Vice President, Business Development – Canada  
Dragados Canada

**DRAGADOS**

# Project Stakeholders

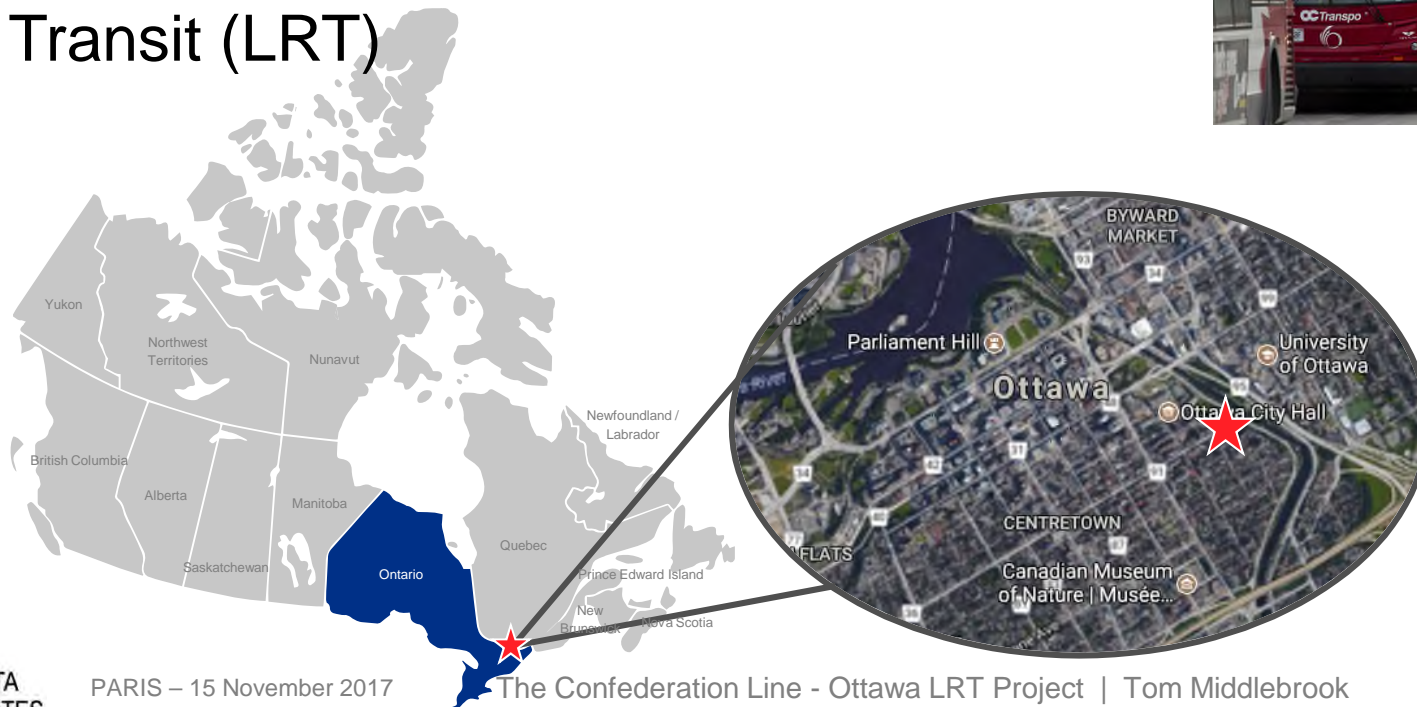




# City of Ottawa



- Canada's Capital City with population of 950,000
- Problem: saturated with buses (BRT)
- Solution: replace BRT with Light Rail Transit (LRT)



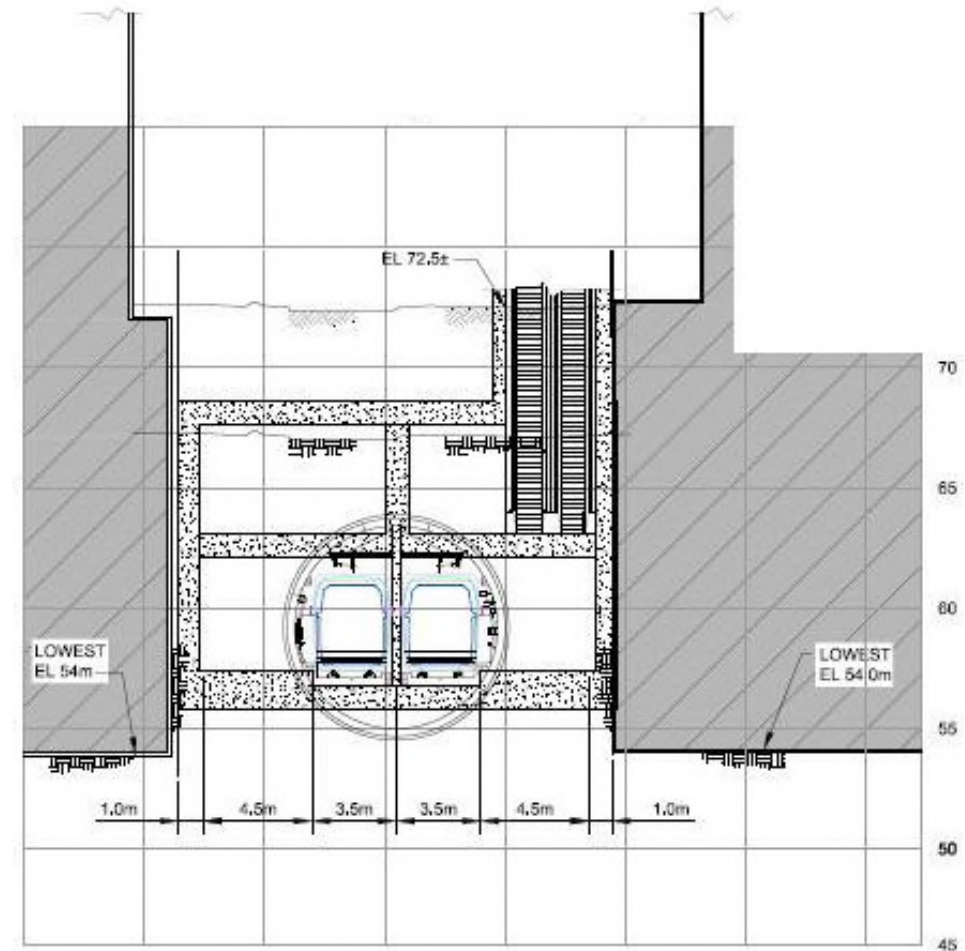
# Confederation Line

- 12.5 km LRT line with 13 stations
- 10 km at grade in existing BRT Right-of-Way
- 2.5 km tunnel between Ottawa University (uOttawa) and Pimisi
- 3 underground stations: Lyon, Parliament and Rideau



# Initial Design Approach

- Running tunnel: TBM tunnel (mono tube or twin-tube)
- Underground stations: cut-and-cover





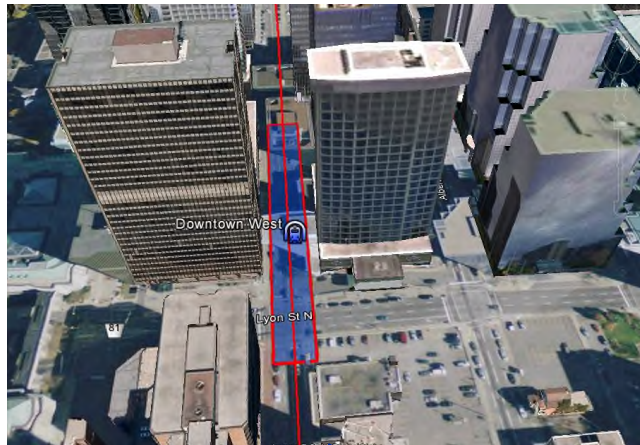
# Design Options

	Option	Pros	Cons
<b>Design Scheme</b>	Single Tunnel	<ul style="list-style-type: none"> <li>• Lower cost</li> <li>• Flexibility in operation</li> </ul>	<ul style="list-style-type: none"> <li>• Higher risk of settlement minimized by rock quality</li> </ul>
	Twin Tunnel	<ul style="list-style-type: none"> <li>• Multiple faces</li> <li>• Overlapping of construction activities</li> </ul>	<ul style="list-style-type: none"> <li>• Higher cost and longer schedule</li> <li>• Potential impact on building basements</li> </ul>
<b>Excavation Procedures</b>	TBM	<ul style="list-style-type: none"> <li>• Speed</li> <li>• Open mode</li> <li>• One pass lining</li> </ul>	<ul style="list-style-type: none"> <li>• Paleovalley (soft soil)</li> <li>• Possible damage to building basements</li> <li>• Coordination required with stations</li> <li>• 1.5-2 years TBM procurement</li> </ul>
	Drill & Blast	<ul style="list-style-type: none"> <li>• Speed</li> <li>• Economy</li> <li>• Multi face</li> </ul>	<ul style="list-style-type: none"> <li>• Urban restrictions</li> <li>• Noise</li> <li>• Vibrations</li> </ul>
	Mechanical	<ul style="list-style-type: none"> <li>• Flexibility, Geometry</li> <li>• Multiple faces</li> <li>• Mobilize quickly</li> </ul>	<ul style="list-style-type: none"> <li>• Lower speed</li> </ul>

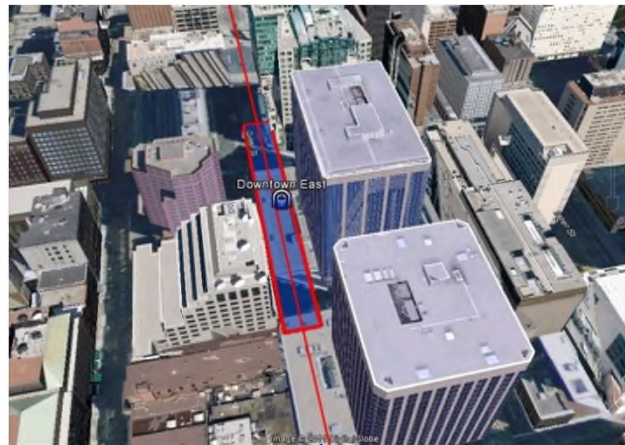
# Tunnel and Underground Stations



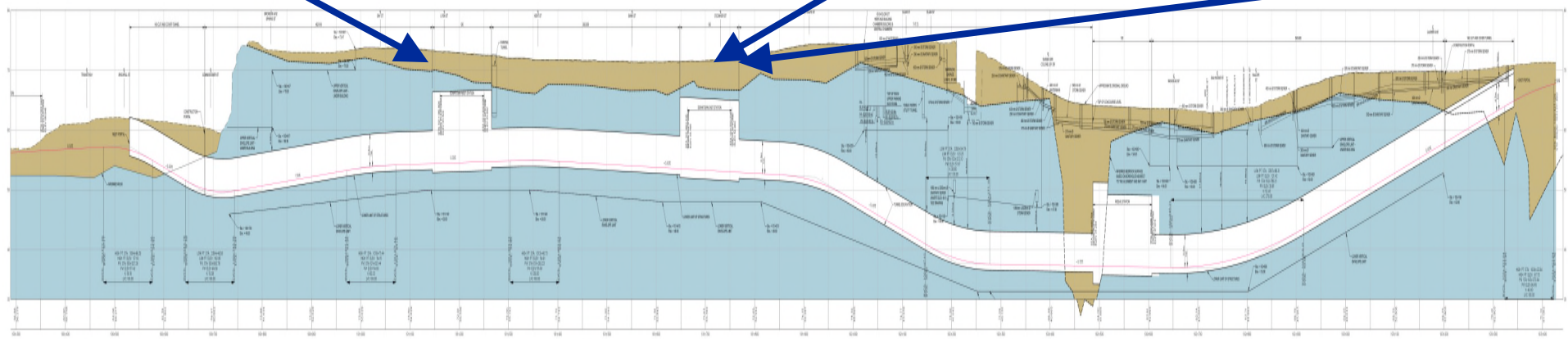
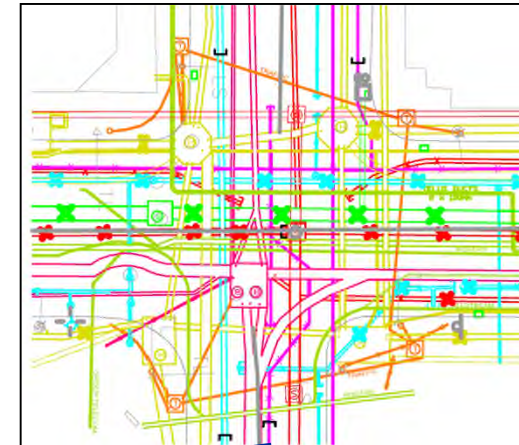
## LYON Station



## PARLIAMENT Station



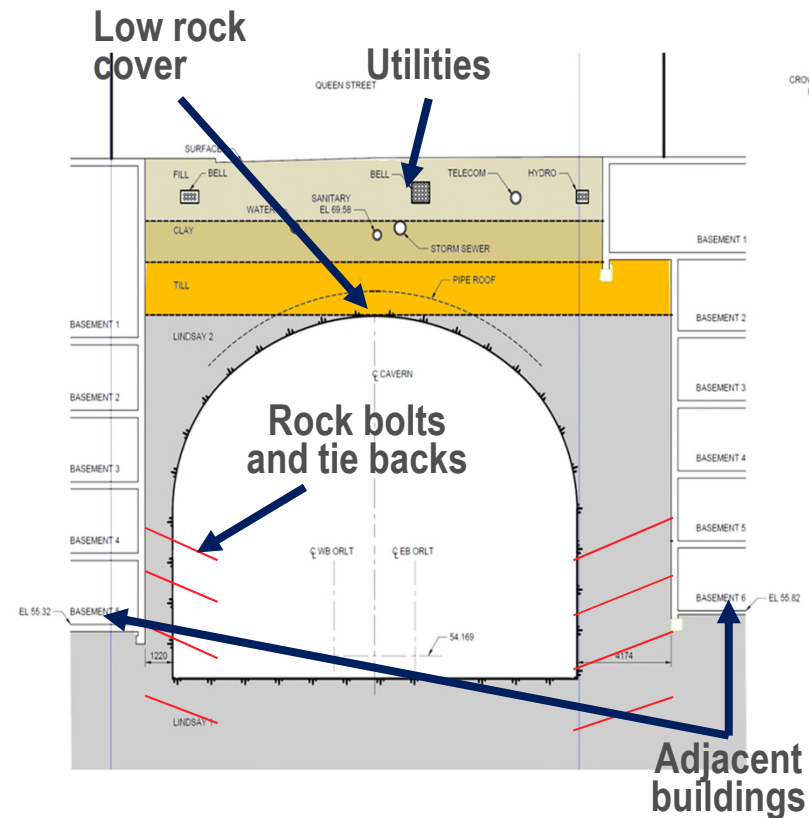
## Existing Utilities in Parliament Station



# Construction Challenges



- Congested downtown core
- Mixed ground conditions
- Significant potential for impacts on buildings
- Wide span ~ 18m
- Potential obstructions: rock dowels & tie backs
- Complex utilities





# Implications

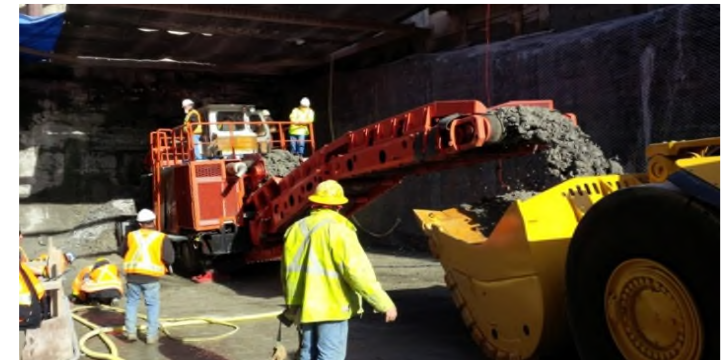
- Cut-and-cover or top down excavation not feasible
- Twin-tube tunnel not feasible
- High risk for TBM operation from complex and unknown utilities, and presence of tiebacks and bolts from existing structures
- Flexible and adaptable tunneling method required



# Selected Construction Method



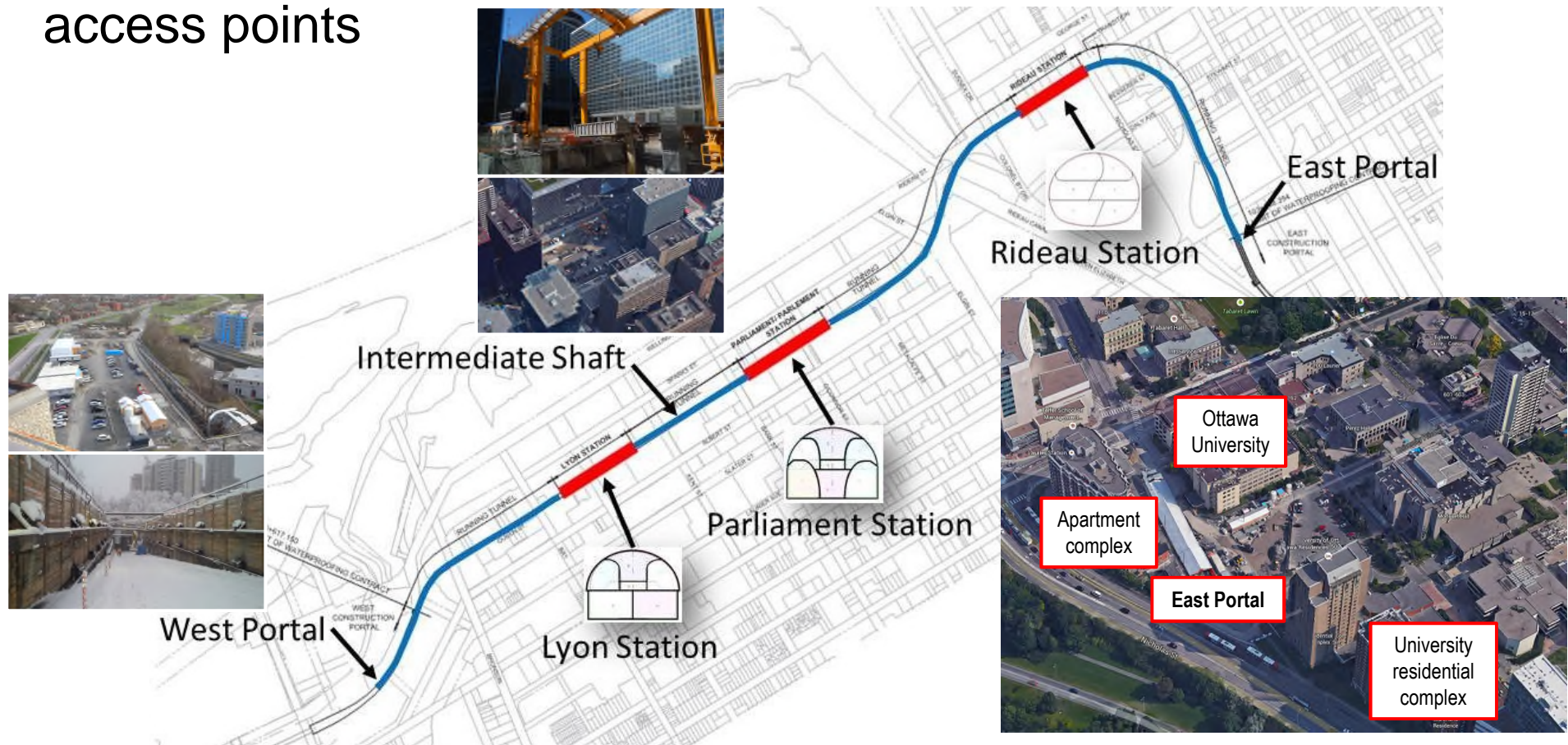
- Sequential Excavation Method (**SEM**)
- Equipment used:
  - **Excavation:** 3 roadheaders (SANDVIK MT-720)
  - **Mucking:** LHD loaders





# Work Planning

Three independent tunneling teams were deployed at separate access points





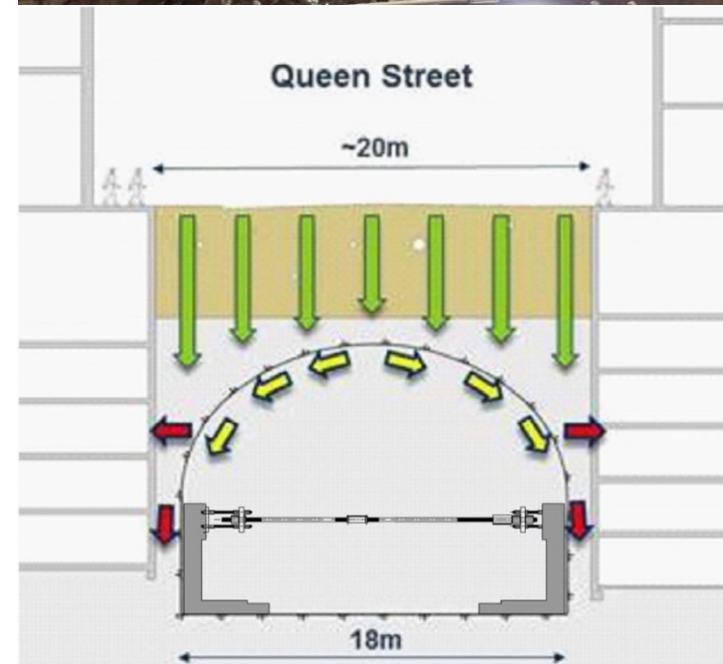
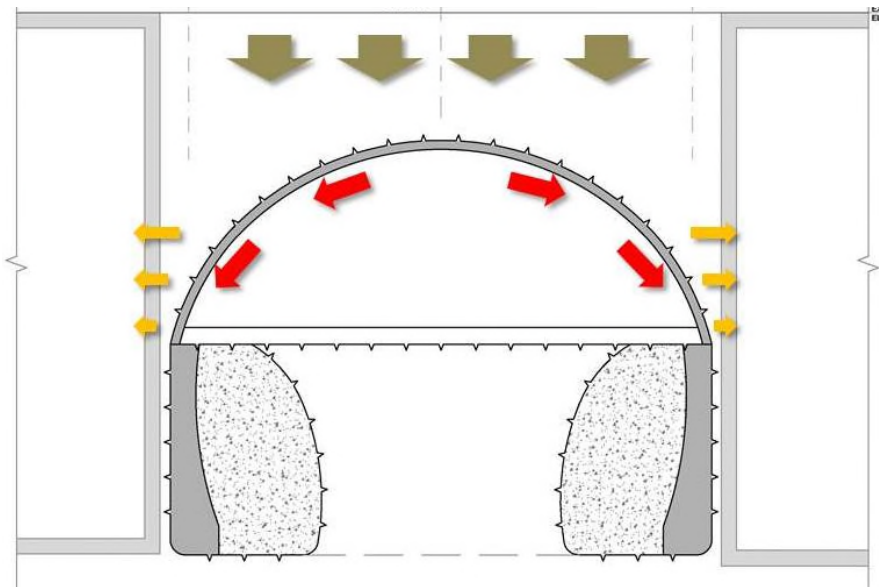
# Construction Challenges

## Lyon and Parliament Stations

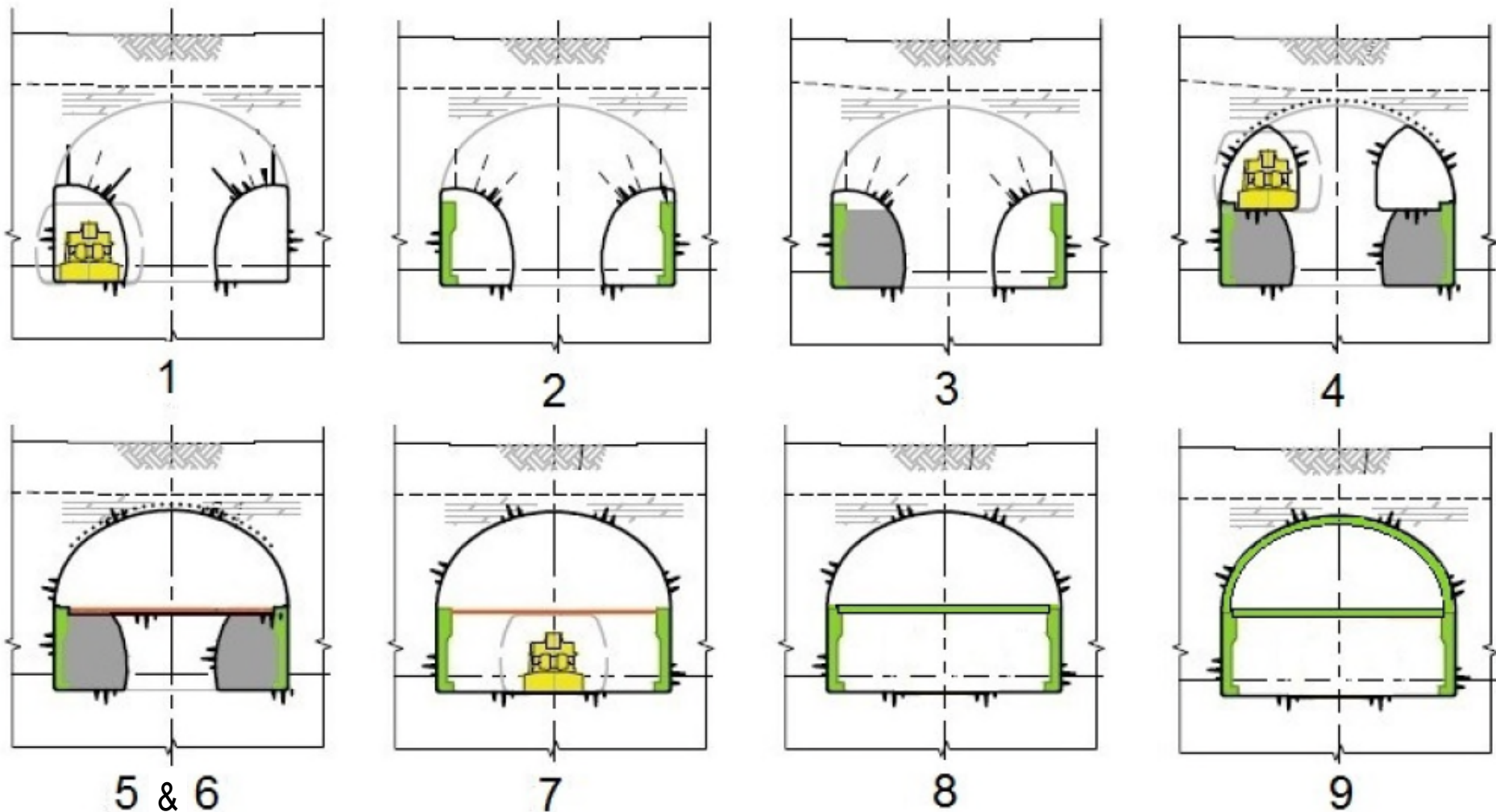


- **Challenge:** Build 18m wide stations in between buildings 20m apart.
- **Design issue:** Potential horizontal load transfer onto the adjacent buildings

- **Solution:** Tension ties



# Excavation Sequencing Lyon and Parliament Stations

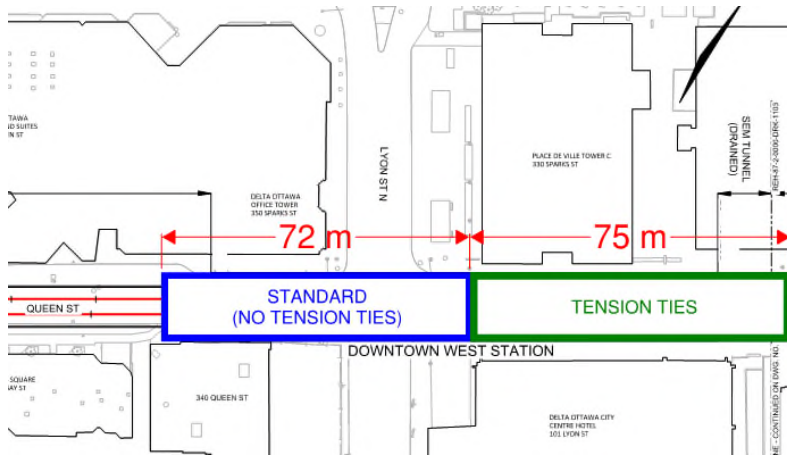


# Excavation Sequencing

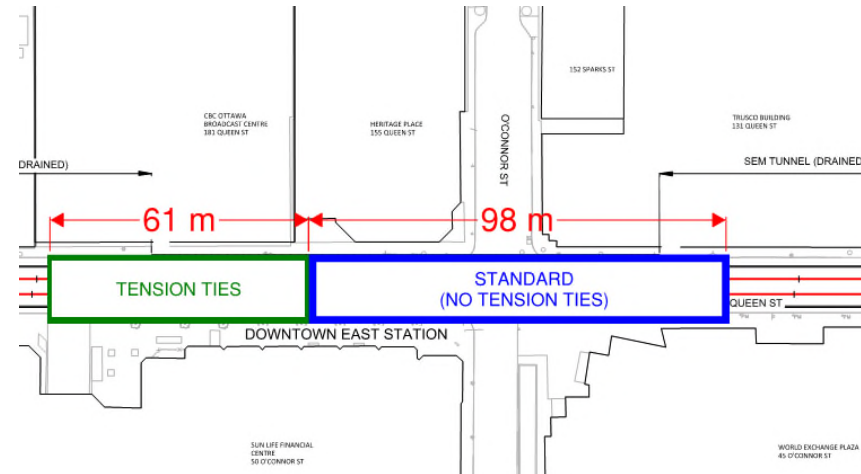
## Lyon and Parliament Stations



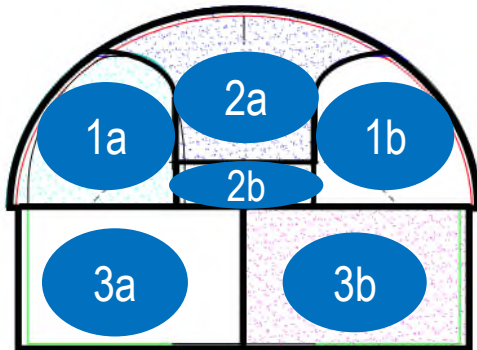
### LYON Station



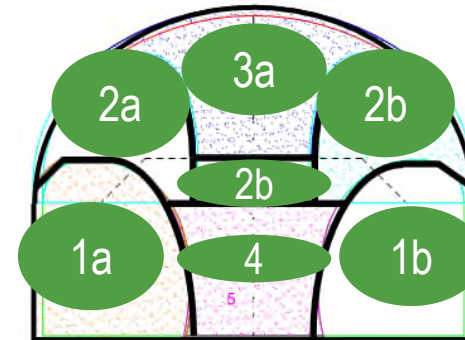
### PARLIAMENT Station



### Without Ties



### With Ties



## Excavation Stages





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# Construction Challenges

## Rideau Station



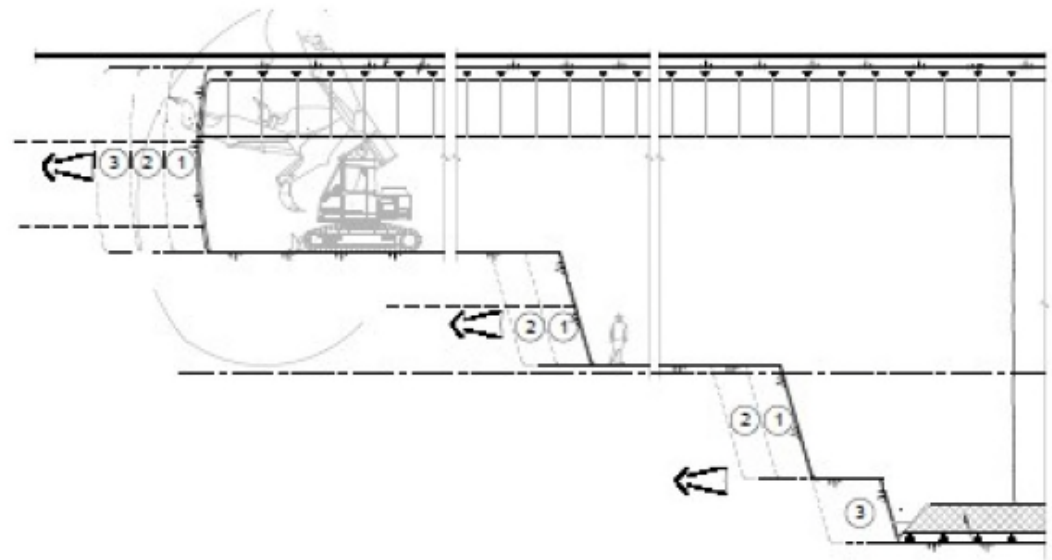
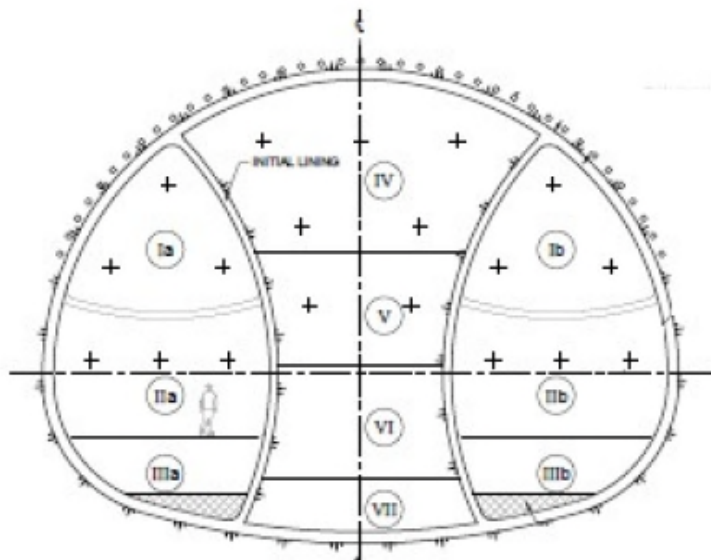
Proximity to existing sewer tunnels and Rideau Canal





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# Excavation Sequencing Rideau Station

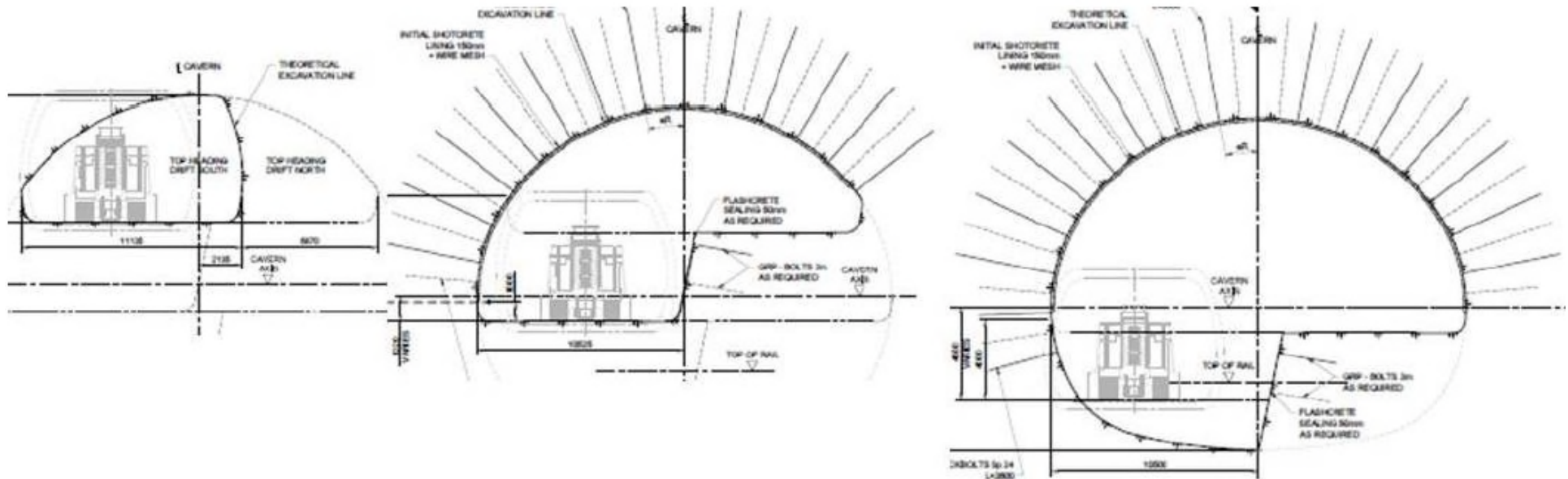


In Soil



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# Excavation Sequencing Rideau Station



In Rock





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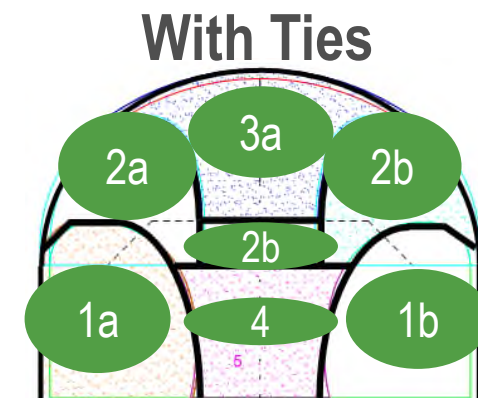
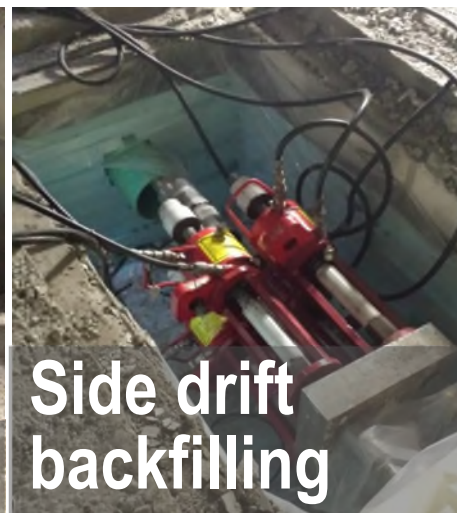
# Gallery

# Running Tunnel





# Excavation with Tension Ties





# Lyon Station



## Cavern Excavation at Lyon Station



# Parliament Station



# Rideau Station



## Rideau Station – Hard and Soft Ground



# Rideau Station



Rideau Station Cavern Arch Concrete Work



Photo Credit: Giuseppe Gaspari

# Confederation Line LRT Multi-Dimensional Underground Space

## Photo of the Year, Tunnel Association of Canada





[TAC 2017 Canadian Infrastructure Project of the Year](#)

<https://youtu.be/P0h0qk36mqk>