New River Crossing Feasibility Review

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*my findings and opinions do not reflect those of the university.

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Summary of my findings

1. Further consideration should be given to the larger single bore tunnel to house two rail lines and the Fort Lauderdale station. The use of the larger bore tunnel as a significant component of the Fort Lauderdale station has not been considered in the reports.

2. I believe that the schedule and therefore cost benefits of the larger single bore have not been properly considered, nor has the considerable reduction in surface impact that a larger single bore tunnel would have over a cut-and-cover station or elevated structure.

3. I find that the 5:1 capital cost ratio of the tunnel option to high level bridge option is inflated as is the operating cost ratios reported.

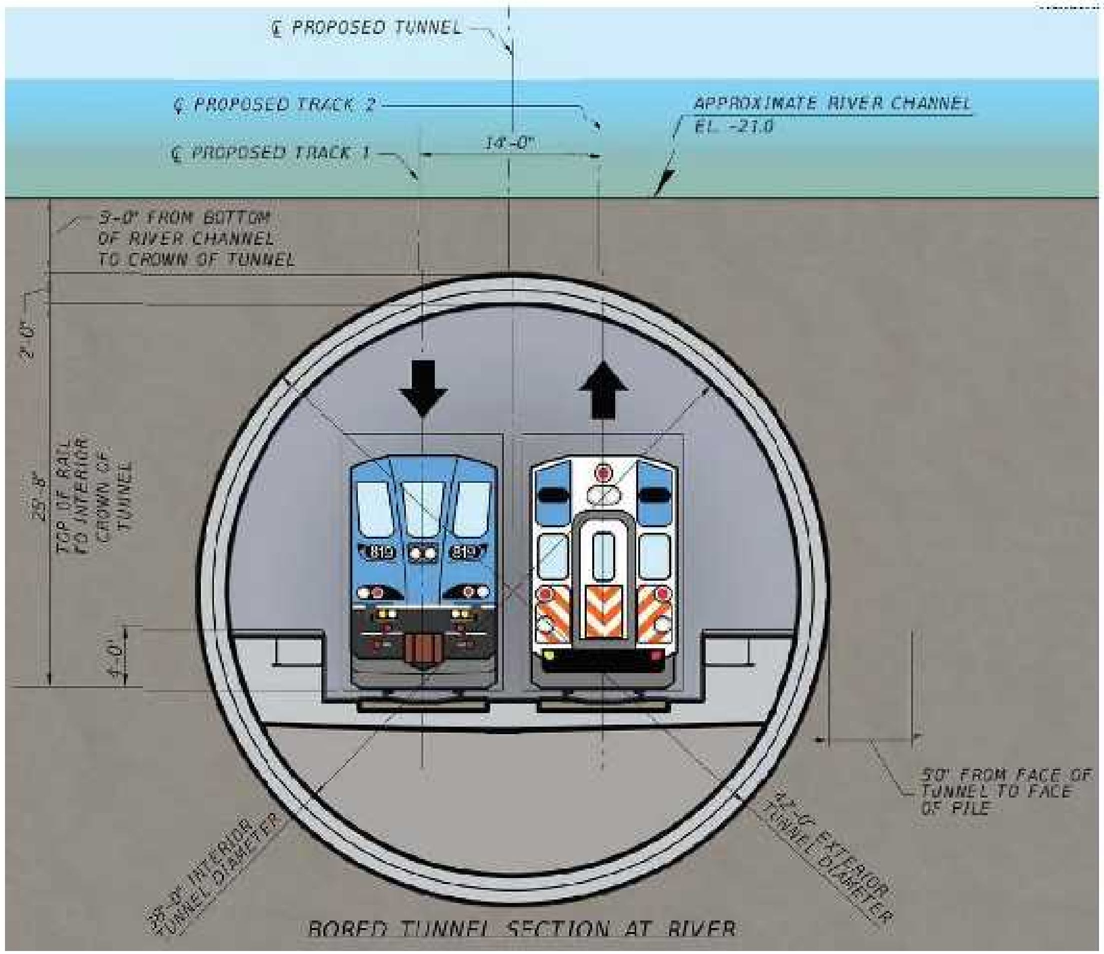
4. The $3.3B estimated operating cost of the tunnel over 50 years (2023 Whitehouse Group report) appears overestimated in my view.

5. The difference in bridge design service life (75 yrs) and tunnel design service life (125-150 years) has not been factored into the cost model, nor has the economic, aesthetic, quality of life and public health benefits of undergrounding rail service (compared with elevated structure).

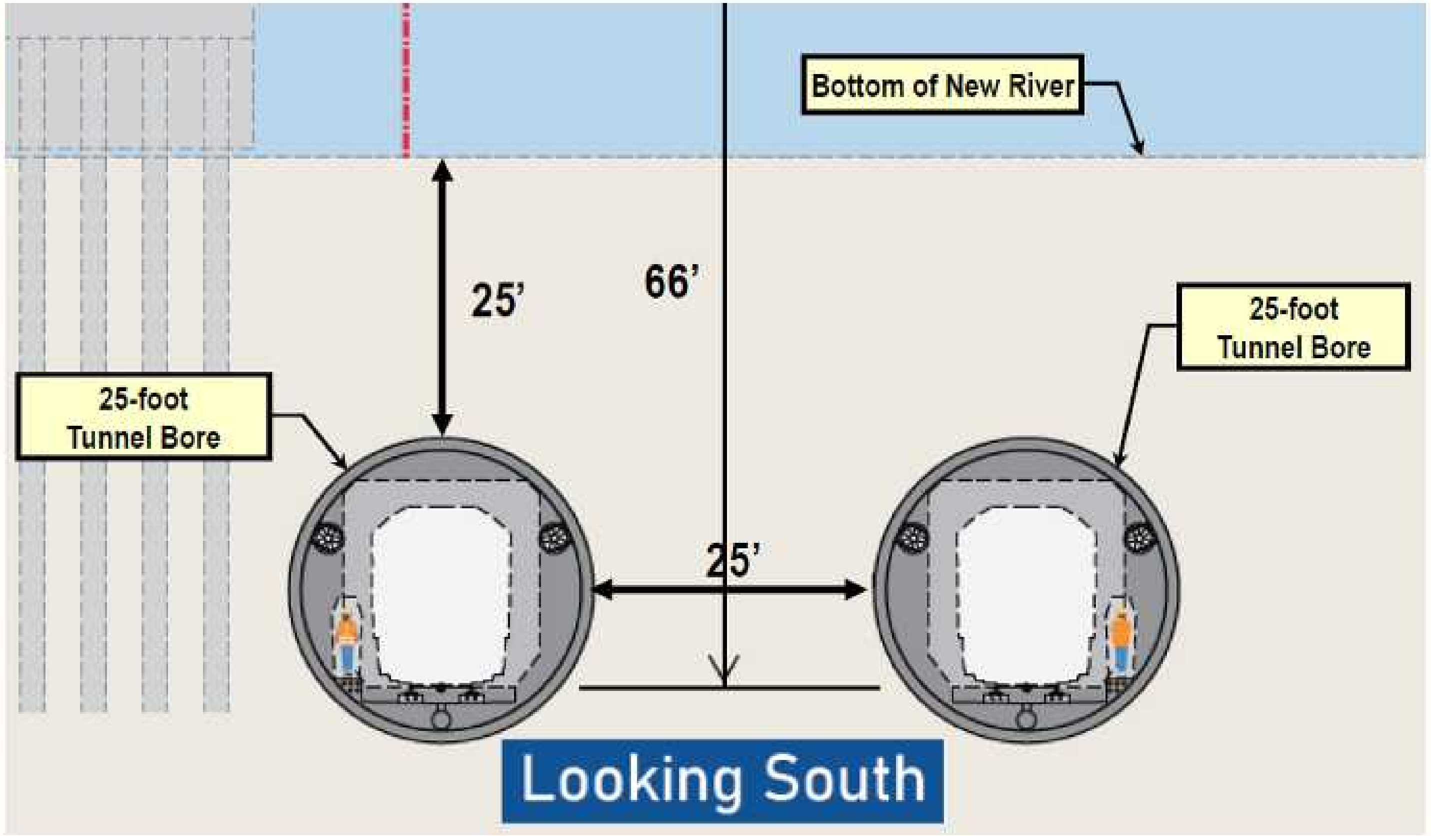
6. Given the changing dynamics and future priorities of urban life, I find the up front capital cost-only framework for comparing alternatives as incomplete and biased against underground options.

Tunnel options considered

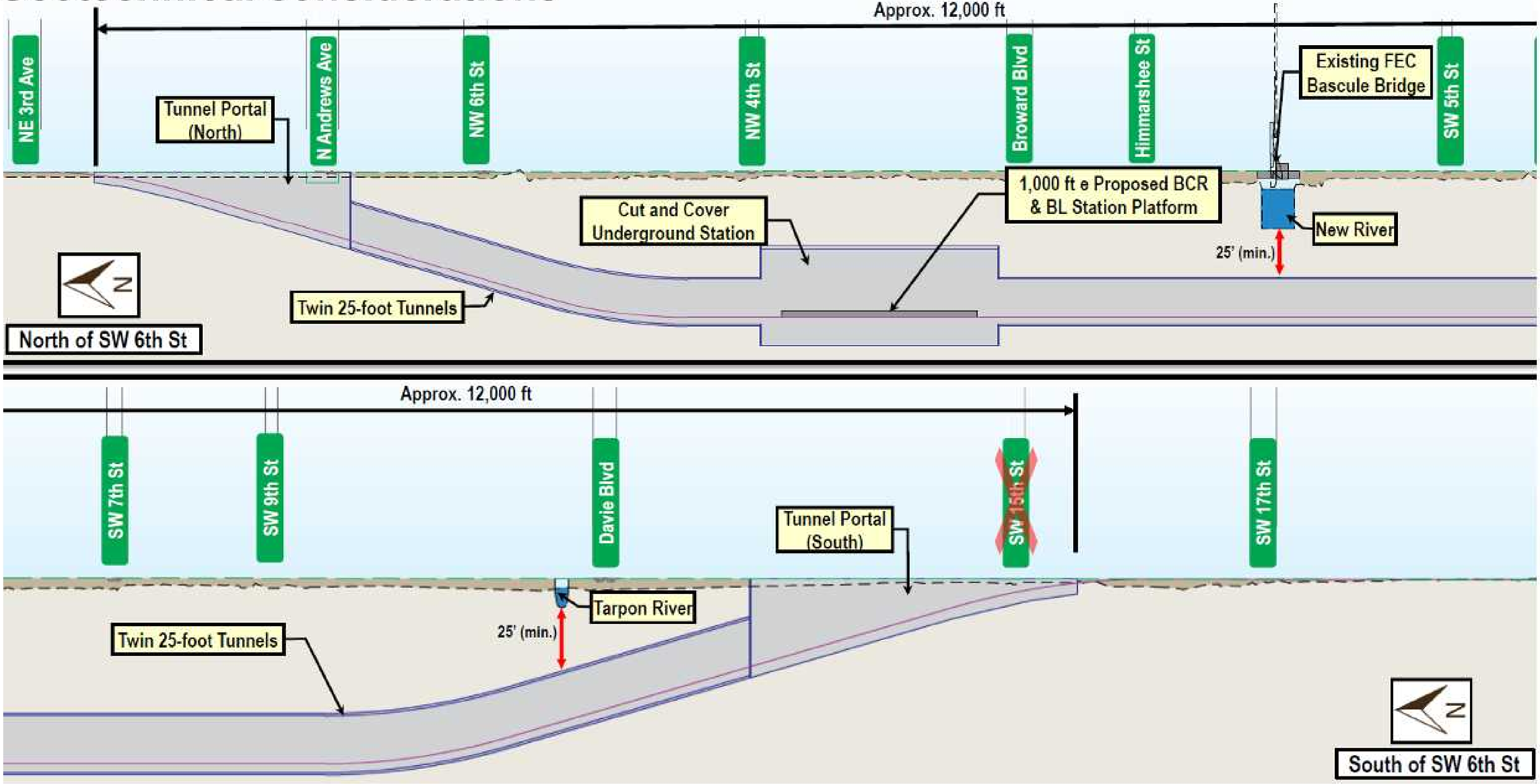
Proposed 42 ft bored diameter, 38 ft inside diameter tunnel in 2020 Corradino Group feasibility report. Cross-section shown at the New River crossing.



Proposed 25 ft ft bored diameter, 23 ft inside diameter tunnel in 2022 PD&E public workshop presentation. Cross section shown at the New River crossing.



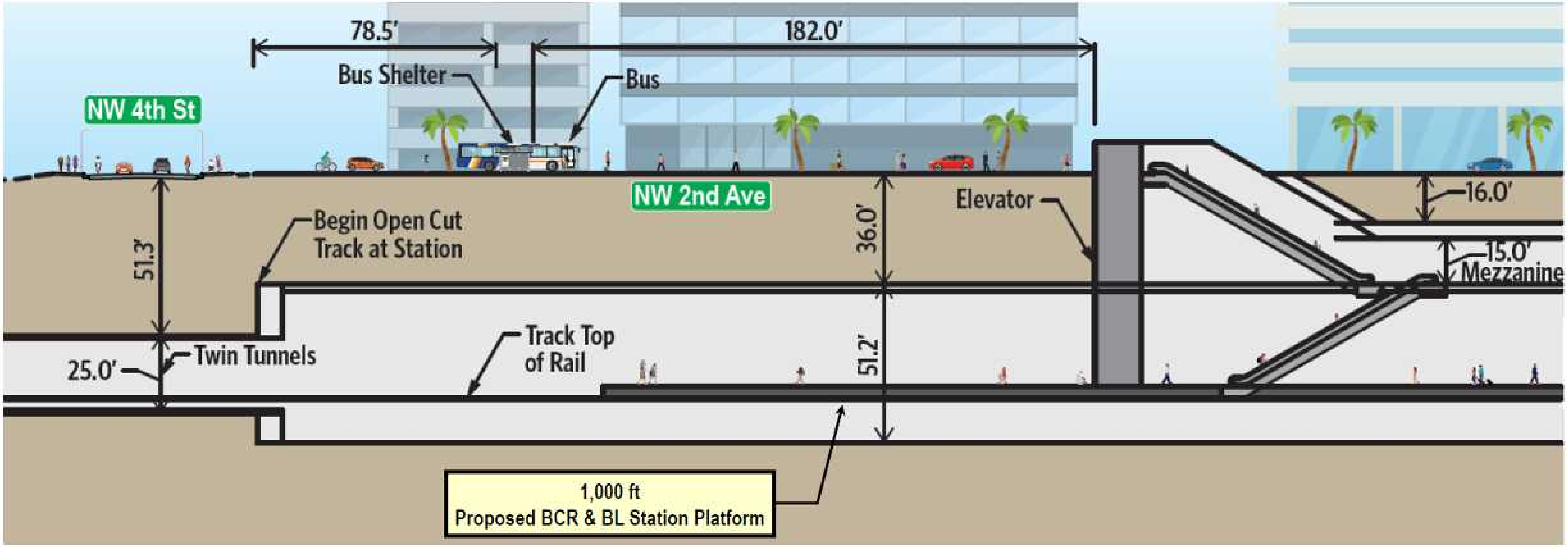
Geotechnical considerations



Underlying image from jan 27, 2022 FDOT public workshop presentation.

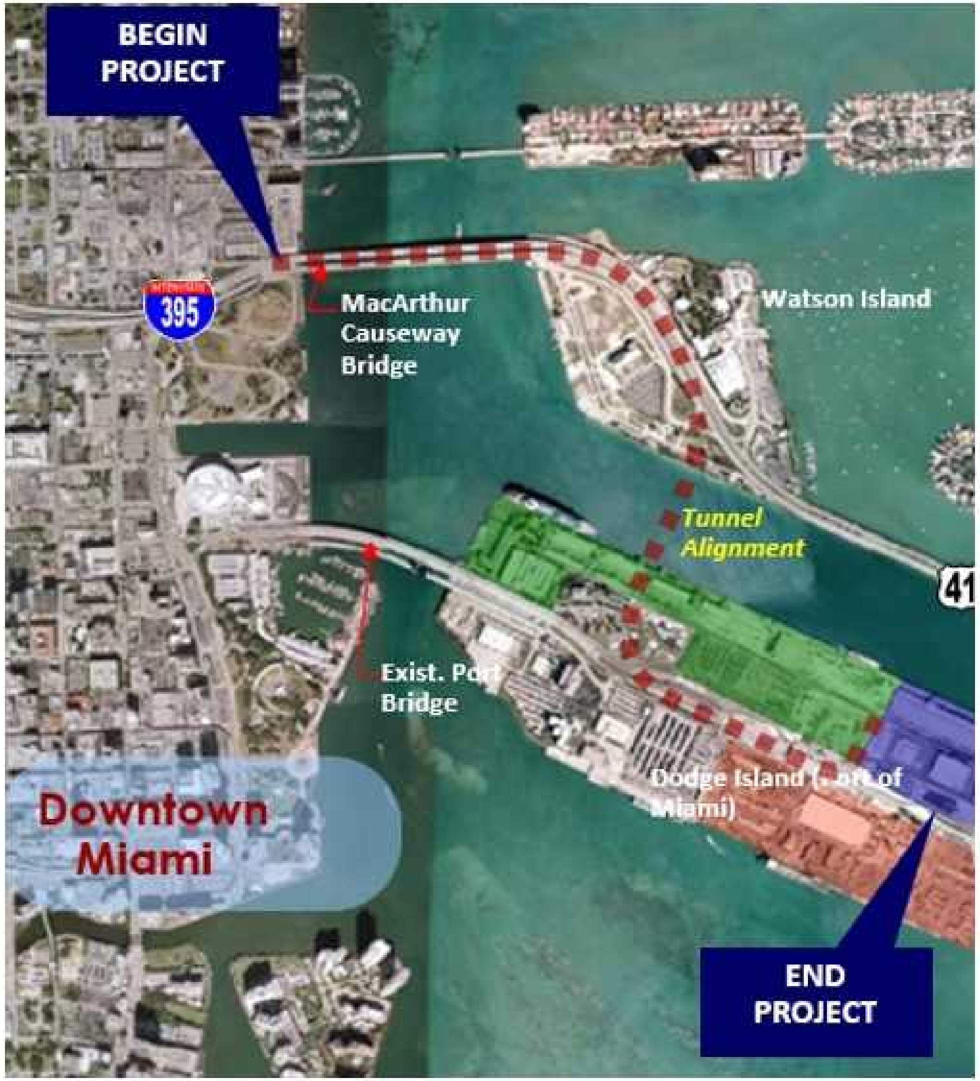
Geotechnical considerations

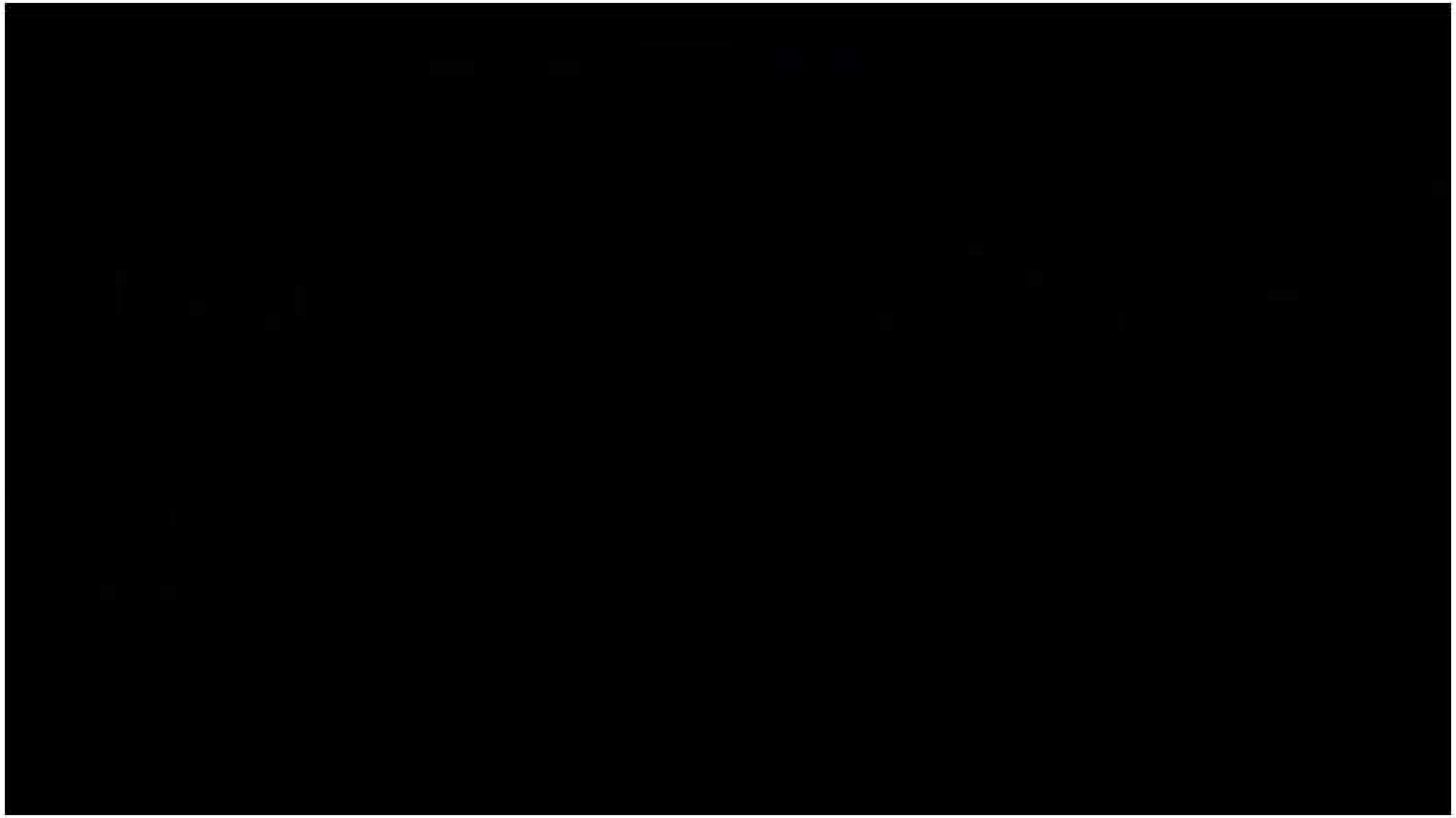
A 2021 geotech investigation in the vicinity showed interbedded layers of sand, limestone and sand with limestone fragments to 100 ft depth.



Underlying image from jan 27, 2022 FDOT public workshop presentation.

Port of Miami Tunnel

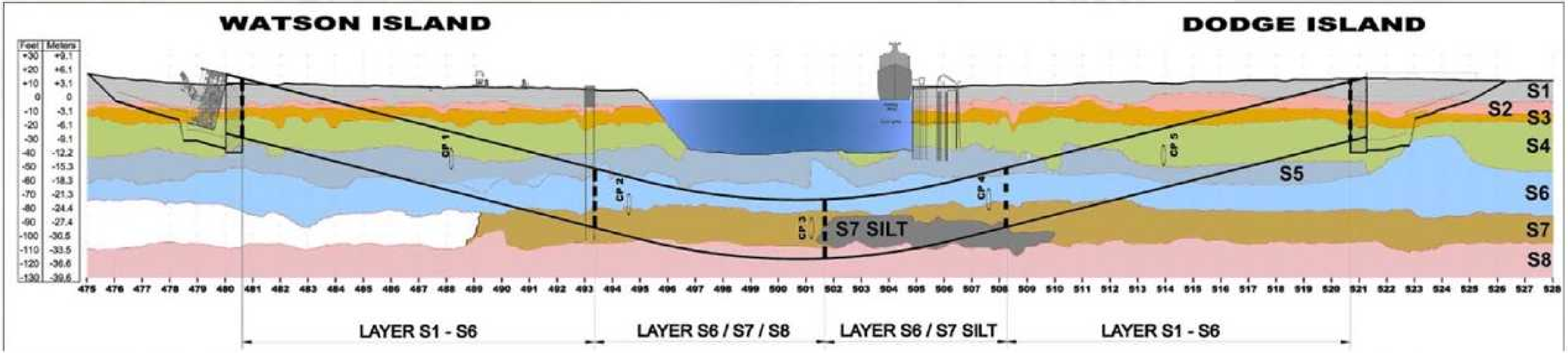




- Twin tunnels, 1.5 miles total
- 42.5 ft (12.9 m) exc. diameter, 37.3 ft (11.3 m) inside diameter.
- May 2010 - May 2014 (subst. completion).
- Tunnel construction over 15 mo. (500 ft/mo).

Port of Miami Tunnel

Vertical alignment and geotechnical profile

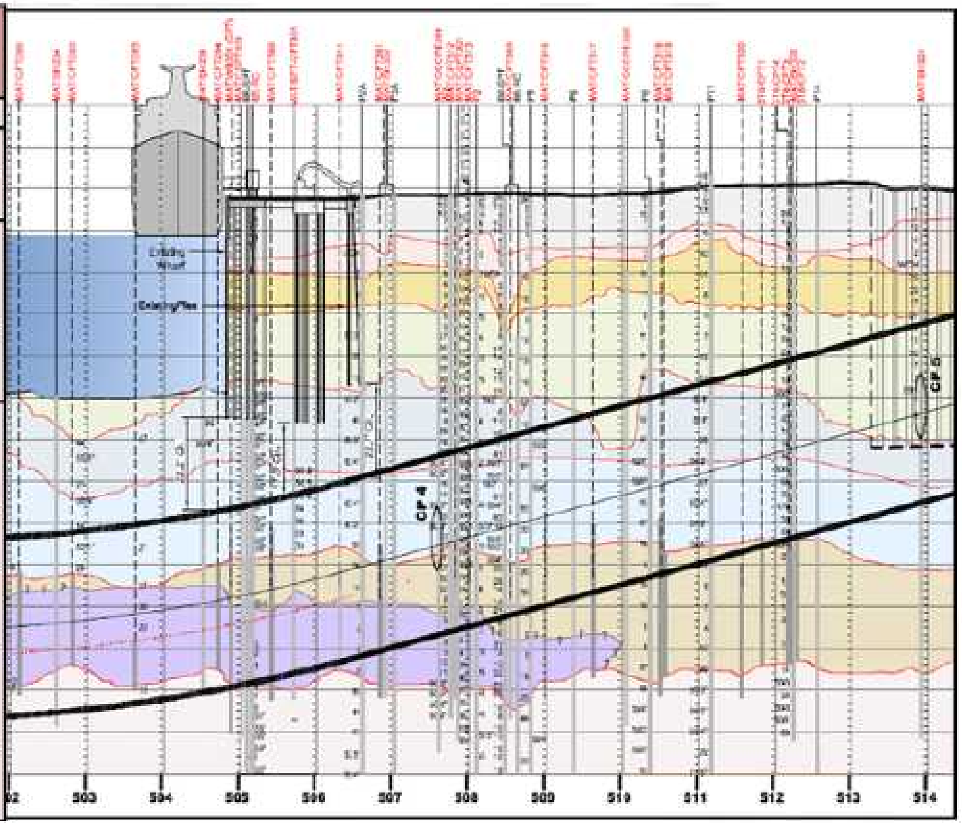


Soil Layer	Geological Description	Strata Description
Layer S1	Man-Made Deposits	Reclamation/Dredged Limestone Fill
Layer S2	Coastal Sediments	Sand, Silty Sand and Silt
Layer S3	Miami Limestone	Weakly cemented limestone with fine sand
Layer S4	Transition Zone	Siliceous sand, limestone / cemented sand layers
Layer S5	Fort Thompson Formation	Moderately to strongly cemented, fine to medium-grained sandy Limestone (UCS 1.5-35.5MPa)
Layer S6	Anastasia Formation	Cemented Shell / Cemented Sand (Coquina) (UCS 2.4-24.2MPa)
Layer S7	Key Largo Formation	Coralline limestone, heavily dissolved and highly porous (coral and limestone fragments weakly to very weakly cemented with calcarenite with zones of uncemented fragments and sand lenses)
Layer S7 SILT		Lime Silt with varying amounts of limestone fragments
Layer S8	Tamiami Formation	Limestone and Sandstone with interbedded lenses of cemented sand, cemented shell and sand (UCS 0.9-35.9MPa)

Port of Miami Tunnel

Challenging ~30 ft thick Key Largo Formation (S7) layer required injection grouting before tunneling

Designation	Description
S1	Fill
S2	Silty Bay Sediments
S3	Miami Limestone
S4	Transition Zone - Sand, Shells, Limestone and Cemented Sands
S5	Fort Thompson Formation - Limestone
S6	Anastasia Formation - Cemented Shell (Coquina)
S7	Key Largo Formation - Highly porous, coralline limestone consisting of coral and limestone fragments bound or partially bound with calcarenite, with zones of unstable and potentially unstable material
S8	Tamiami Formation - Limestone



Figure/table courtesy of Bouygues-CBNA

Port of Miami Tunnel

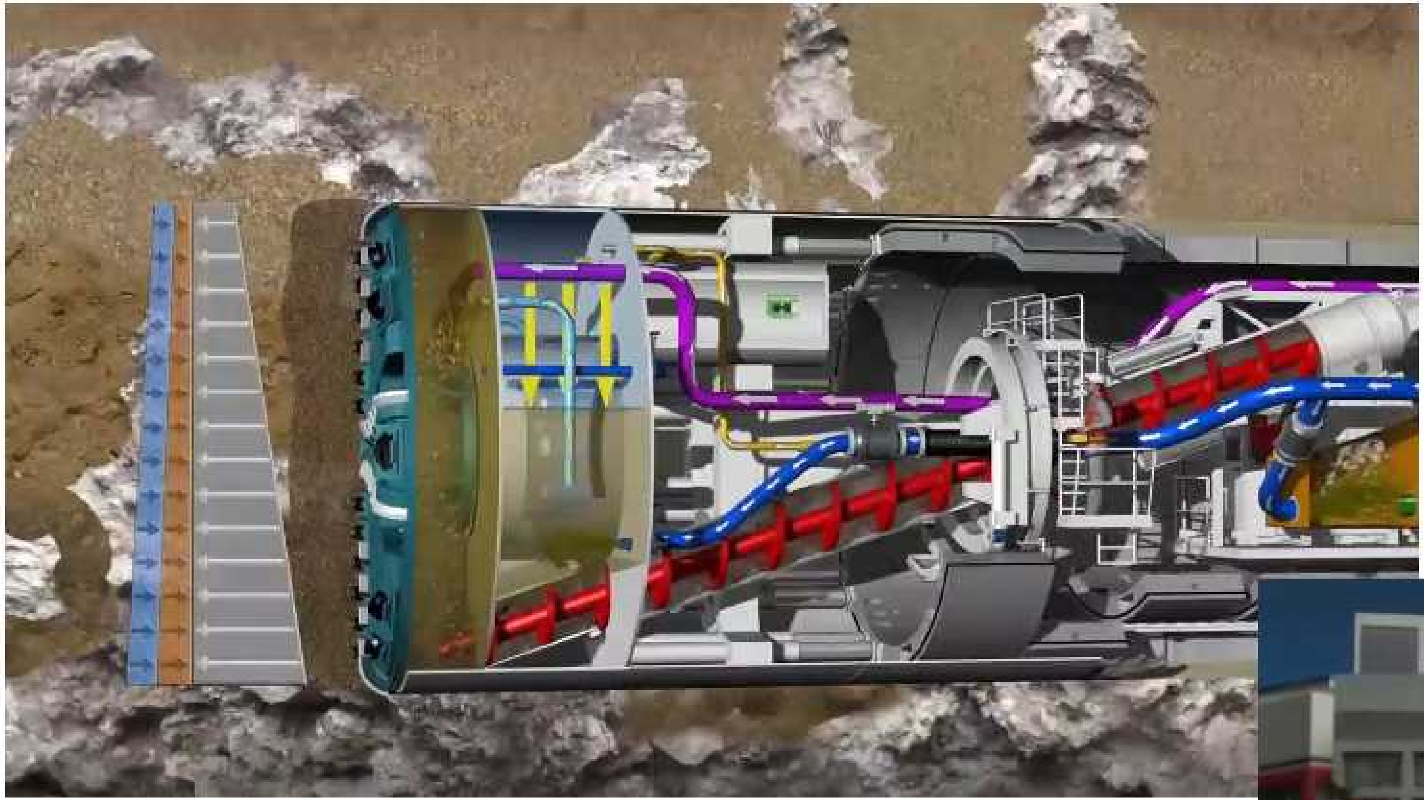
Formation grouting: 1000 holes, 100,000 ft, 50,000 m^3

Pictures courtesy of Bouygues-CBNA

BOUYGUES CONSTRUCTION CBNA JACOBS

Coraline limestone not present in existing boreholes in New River tunnel area. Further geotech site investigation required.

Variable Density TBM – inspired by Port of Miami Tunnel

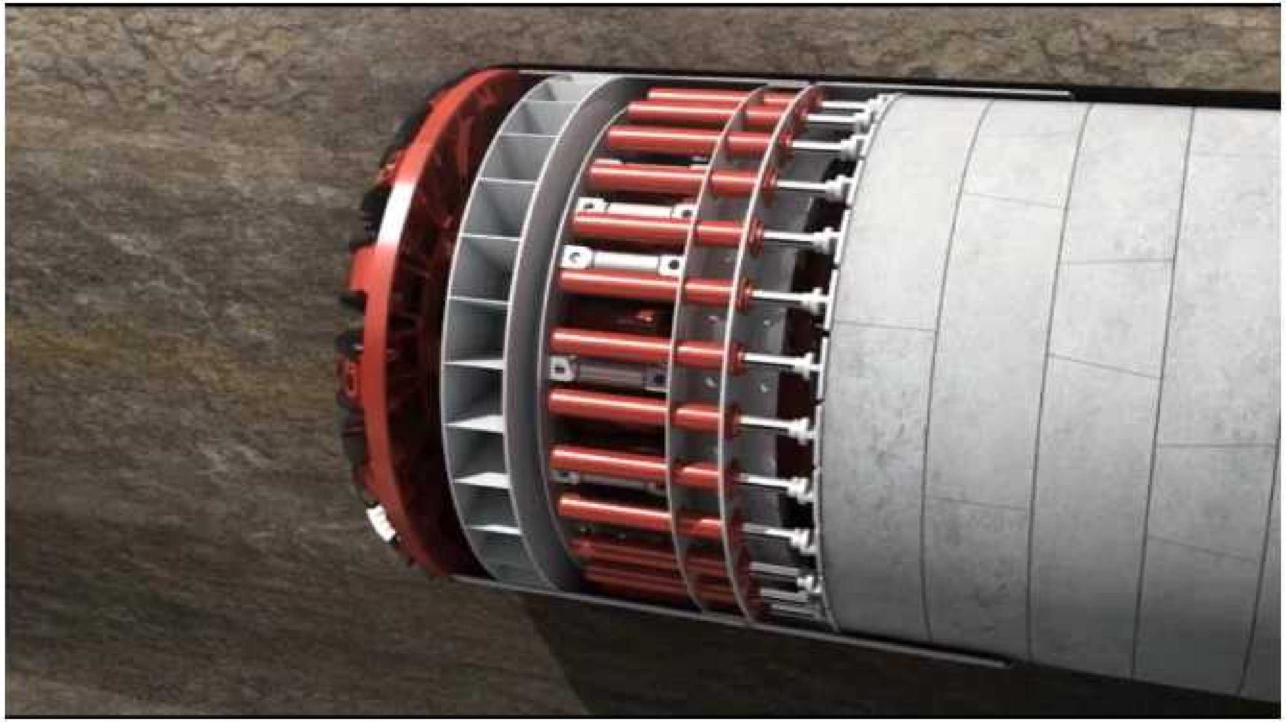


Video source: Herrenknecht

Slurry pressure balance TBM

Video source: Herrenknecht

TBM tunnel construction



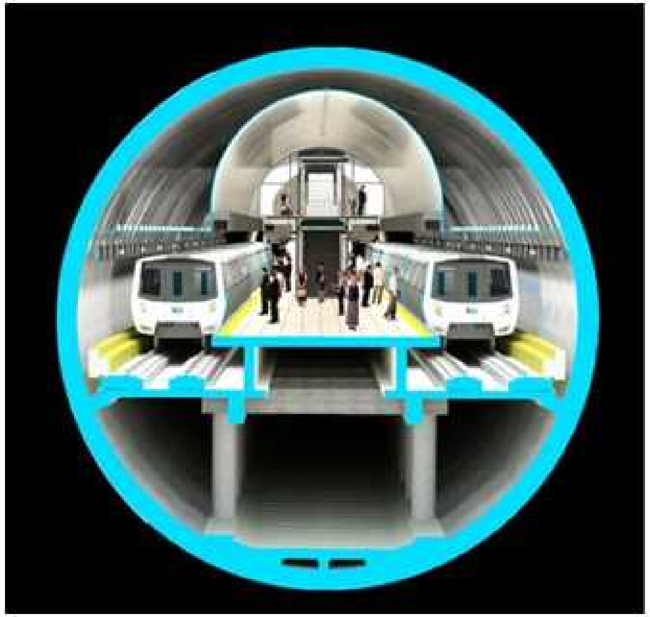
Source: Terratec (extracted from https://www.youtube.com/watch?v=1XVkmbeB958 to show ring building. Note that type of TBM and cutterhead layout not representative of GLTP TBM type)

(double gasketed concrete segments; from regional connector tunnel project, LA)

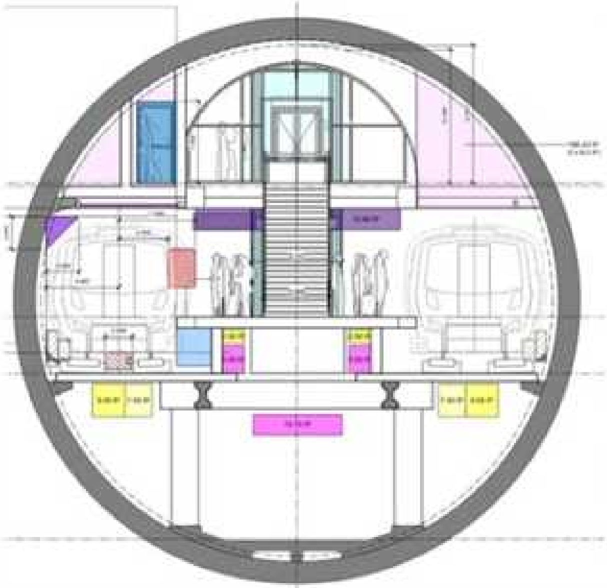
(completed segmental lining tunnel)

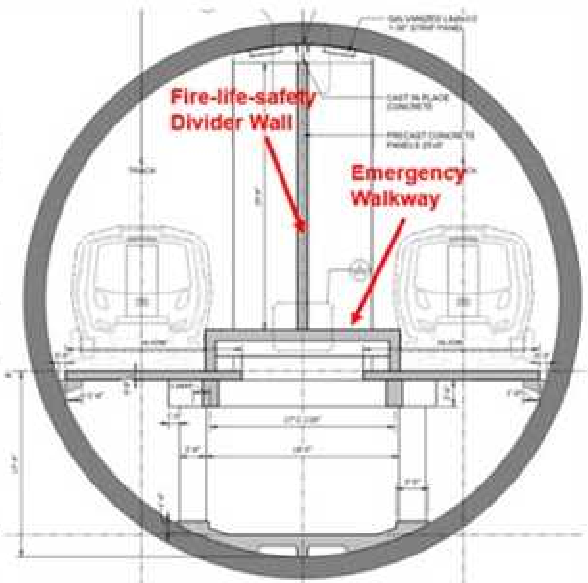
Single bore tunnel approach

From left to right: Barcelona, San Jose, Toronto.



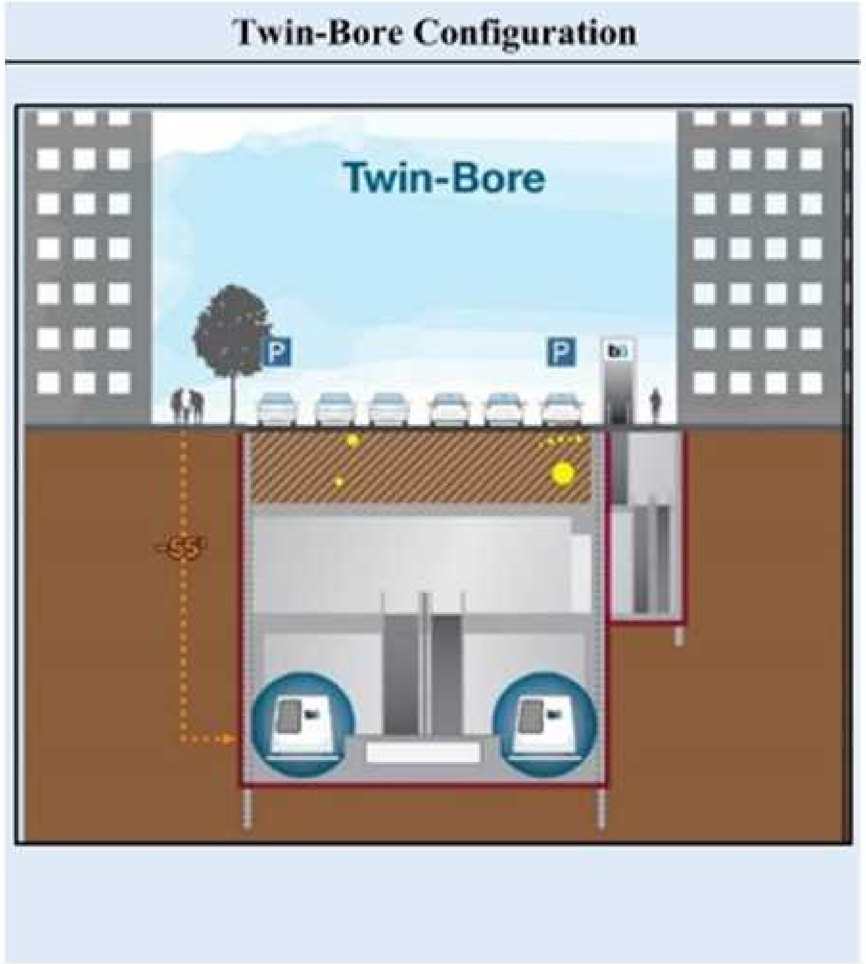
Station configuration within the large bore tunnel (here San Jose)

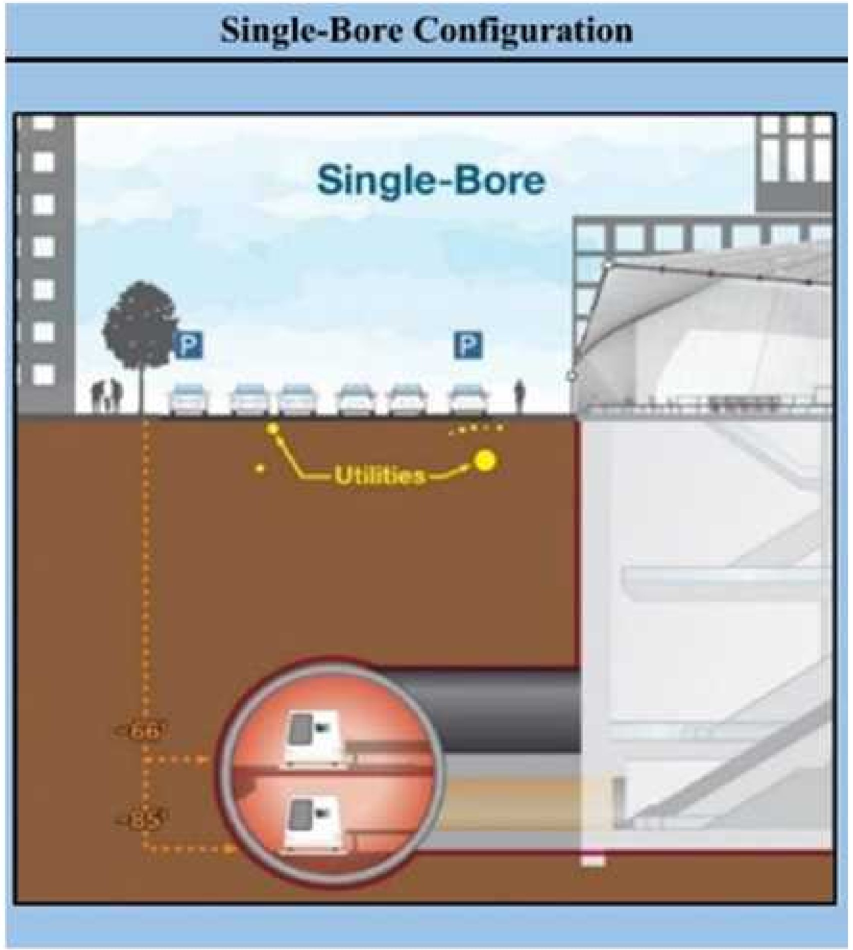




Running trains with separation wall in running tunnel and emergency egress doors every 500-800 ft.

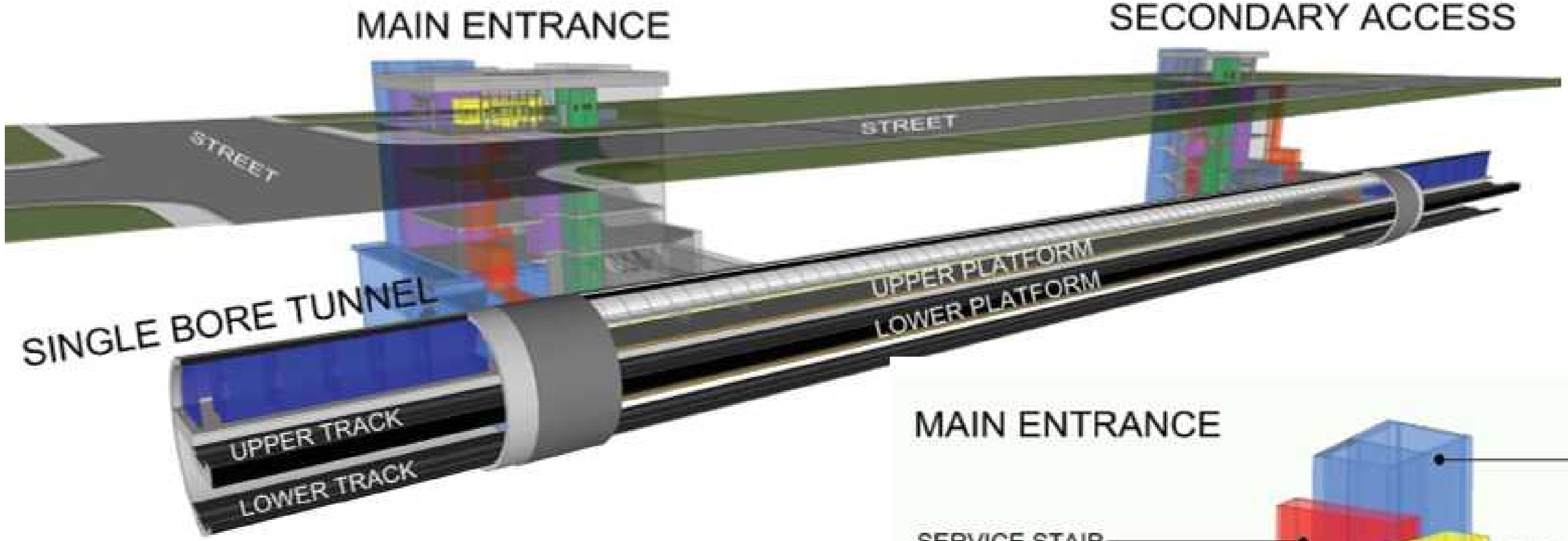
Station construction: twin bore vs. large bore



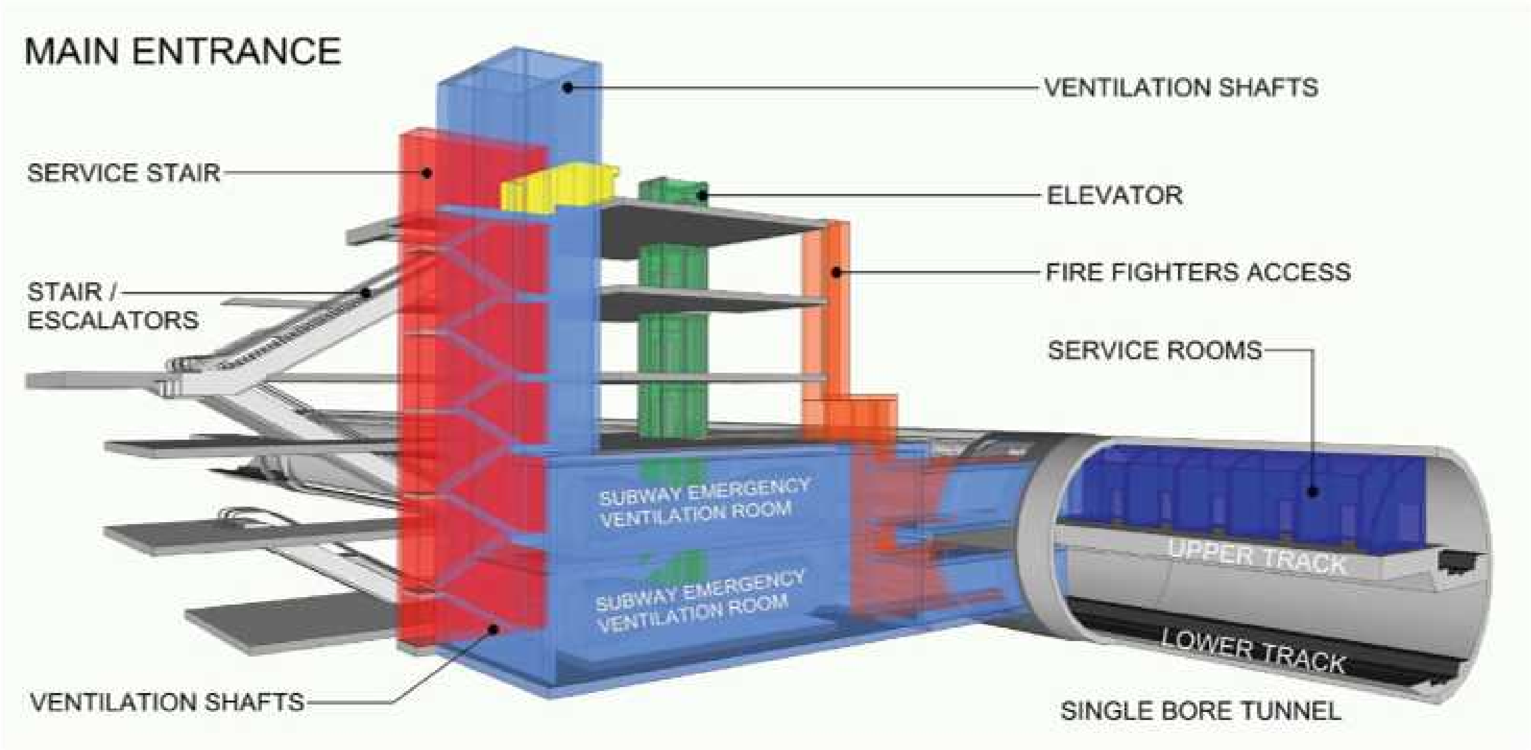


Images from the San Jose tunnel project currently undergoing final design.

Large bore station configurations



Stations within the large bore; side access to stations off of the main road and out of the way of major utilities and road disruption. Here, pictures from Toronto Scarborough line.



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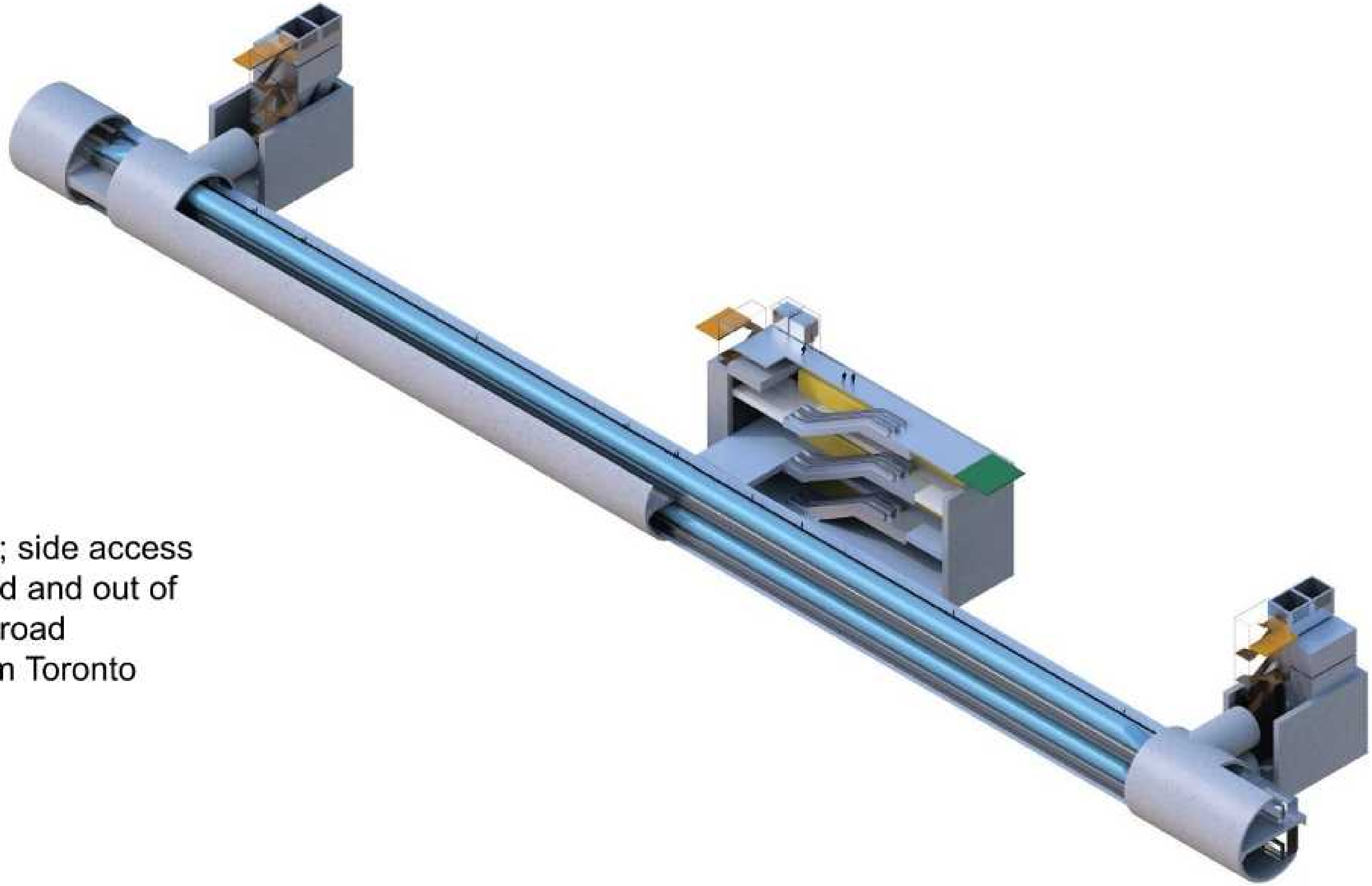

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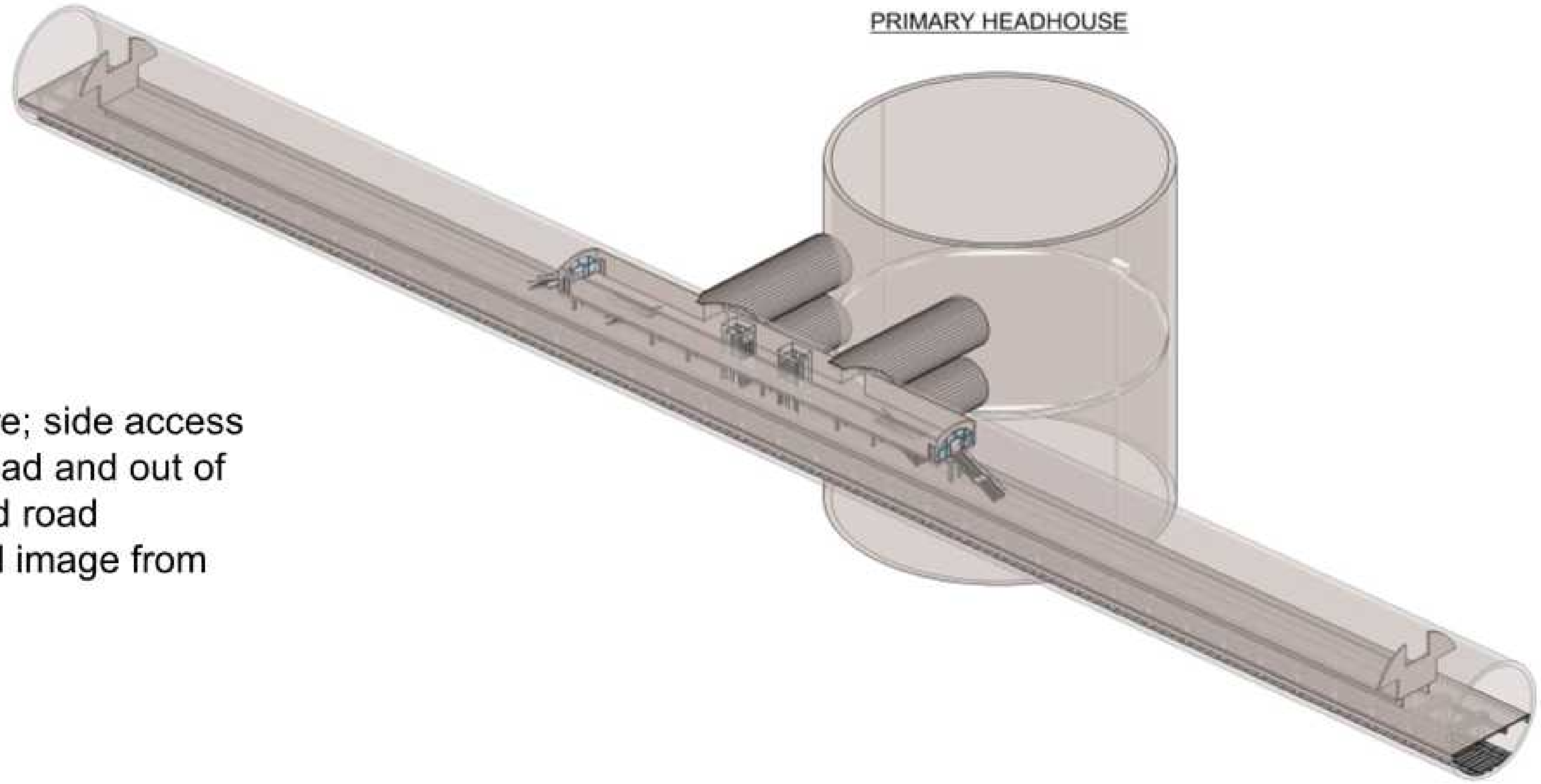

Stations within the large bore; side access to stations off of the main road and out of the way of major utilities and road disruption. Here, conceptual image from San Jose tunnel.

Cost

1. 2020 Corradino report on single bore 38 ft inside diameter.
   - $3.3B, including 30% overall contingency.
   - $1.6B for 5400 ft long tunnel; $1.4B for cut and cover station.
   - This is on the high end of tunneling costs that are $600M-$900M/mile (with exception of NYC).
   - Port of Miami tunnels spanned 1.5 miles and cost $350M to construction ($230M/mile in 2014 dollars).
   - In my view, the $1.4B station cost could be reduced considerably by integration into large bore tunnel.

2. 2021 HDR cost estimate for the twin tunnels and cut-and-cover station.
   - $1.8B, including 25% contingency.
   - $650M for cut and cover station; compared to $1.4B for single bore cut and cover station.
   - $365M professional services compared to $865M for single bore option.

3. Maintenance & operations cost estimates were $8.2M/year in the 2020 Corradino vs. $3.3B over 50 years in the 2023 Whitehouse report. The latter appears highly overestimated.

Important Miscellaneous Points

1. Underground construction is designed to be significantly less disruptive during construction than surface or elevated construction.

2. Transport of excavated ground is a challenge with tunnels. Consider using freight rail lines.

3. Cut and cover station would interact with extensive utilities within right of way. Large bore avoids this.

4. Tunnels are routinely designed to 150 year service life. The design life of a bridge is 75 years. Life cycle cost analysis should be employed.

5. Maintenance cost for underground are less than elevated structures because they are protected from the elements. Underground infrastructure requires mechanical and electrical equipment for fire-life safety and ventilation. 20-30 year lifespan and does require maintenance.

6. The concrete quantity and thus embodied carbon footprint of elevated structure options is greater than underground.

7. Flood risk must be considered for tunnel option but can be designed for.

8. Quality of life aspects (noise, aesthetics, emissions, safety) is better with tunnel than elevated structure.

Closing

Urban areas are undergoing significant change prompted by:

- the increase in urban population density
- the increase in elderly population
- a greater desire for improved quality of urban life including lower noise, more green/natural space, social/environmental justice
- a greater need for multi-modal transportation including autonomous vehicles, micro-mobility, etc.

All points to undergrounding of the transport of people and goods.

Whether a 5:1 up front capital cost differential as suggested in the reports or a 2:1 to 3:1 ratio that is more typical, the cost differential decreases further when considering sustainability, lifecycle cost analysis, noise, aesthetics, quality of life, that all favor underground.

Finally, benefits would be amplified by moving existing FEC freight rail underground adjacent to planned commuter rail lines.