



ITA TUNNELLING  
AWARDS 2017



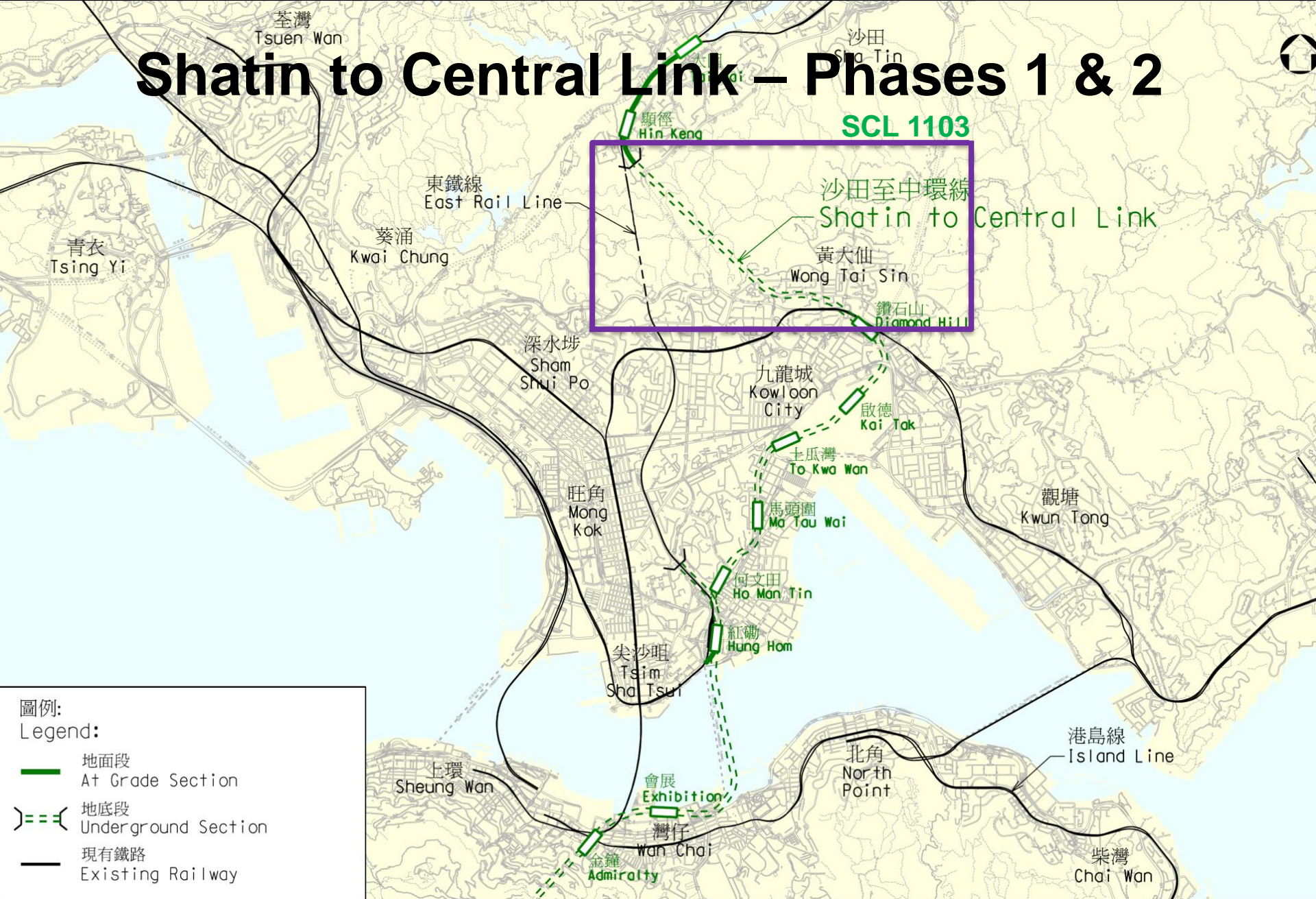
# MTR Shatin to Central Link Contract 1103 Hin Keng to Diamond Hill Tunnels Hong Kong, China

Francois Dudouit

Project Director, VINCI Construction Grands Projets



# Shatin to Central Link – Phases 1 & 2







ITA TUNNELLING  
AWARDS 2017



# Shatin to Central Link – SCL 1103

- **Scope** : The contract comprises inter alia the construction of 2,433 m of drill and blast/mined tunnel, 1,400 m twin TBM tunnels, 3 shafts and one 99m long cut & cover section
- **Client and Engineer**: MTR Corporation Limited (Project entrusted to MTR by the Railway Development Office - RDO - of Highway Department)
- **Contract amount** : 2,750 MHK\$
- **Dates of execution** : 10/2012 - 04/2018 / 68 Months
- **VCGP's role** : General Contractor (100 %)
- **VCGP Main Designer** : ARUP



# Major high-risk tunneling works underneath Hong Kong's densely populated areas

Hin Keng Cut & Cover Tunnel

Fung Tak Shaft

Ma Chai Hang Shaft

Diamond Hill Station





ITA TUNNELLING  
AWARDS 2017



# Stakeholders

Client



Government departments & utility companies



路政署  
HIGHWAYS  
DEPARTMENT



運輸署  
Transport Department



屋宇署  
BUILDINGS  
DEPARTMENT



土木工程拓展署  
Civil Engineering and  
Development Department



消防處  
Fire Services  
Department



水務署  
Water Supplies Department

District Councils



Wong Tai Sin  
District Council



Sha Tin  
District Council



渠務署  
Drainage Services Department



煤氣  
Towngas



Community groups and nearby residents

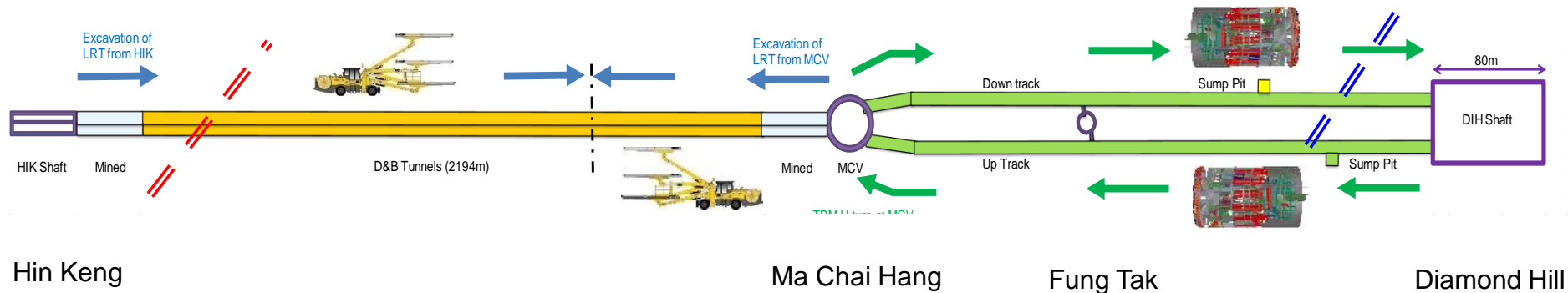
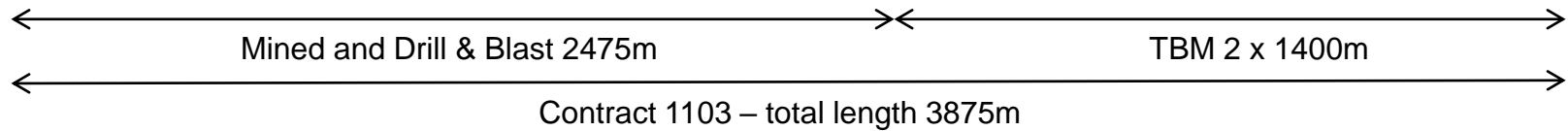
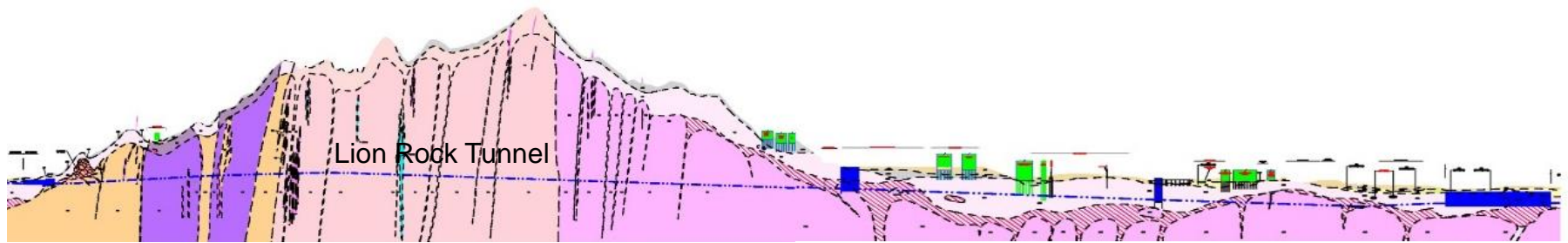


書色園  
SIK SIK YUEN  
Wong Tai Sin Temple



Hin Keng Estate  
Tin Ma Court  
Tsui Chuk Garden

# SCL 1103 - Original Sequence of Works





# Complex ground conditions

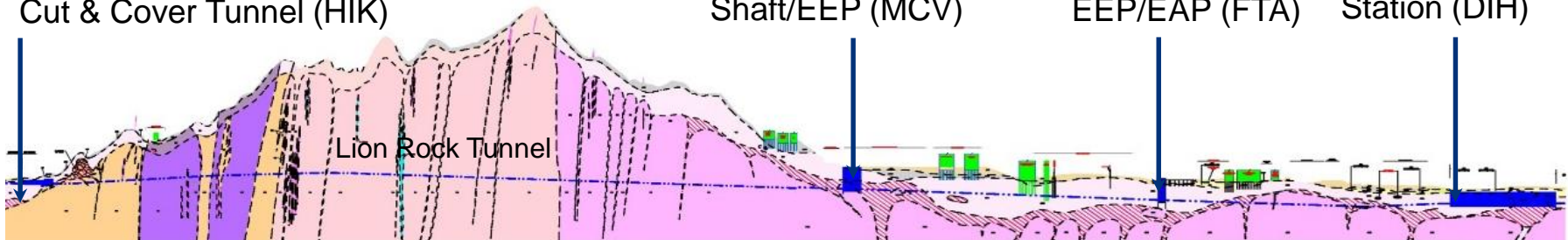


Hin Keng  
Cut & Cover Tunnel (HIK)

Ma Chai Hang Vent  
Shaft/EEP (MCV)

Fung Tak  
EEP/EAP (FTA)

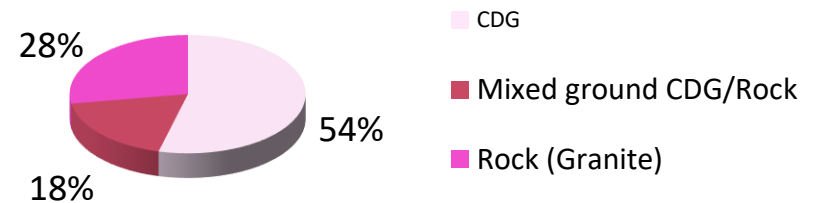
Diamond Hill  
Station (DIH)



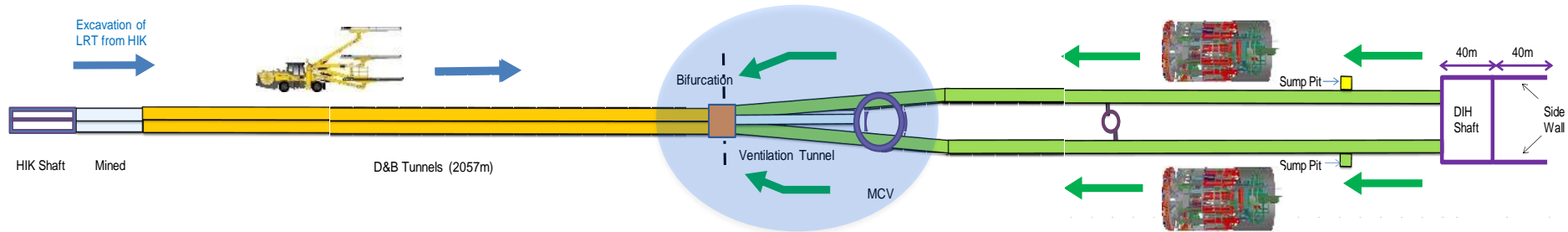
Contract 1103 – total length **3,875m**

Mined + Drill & Blast 2,475m

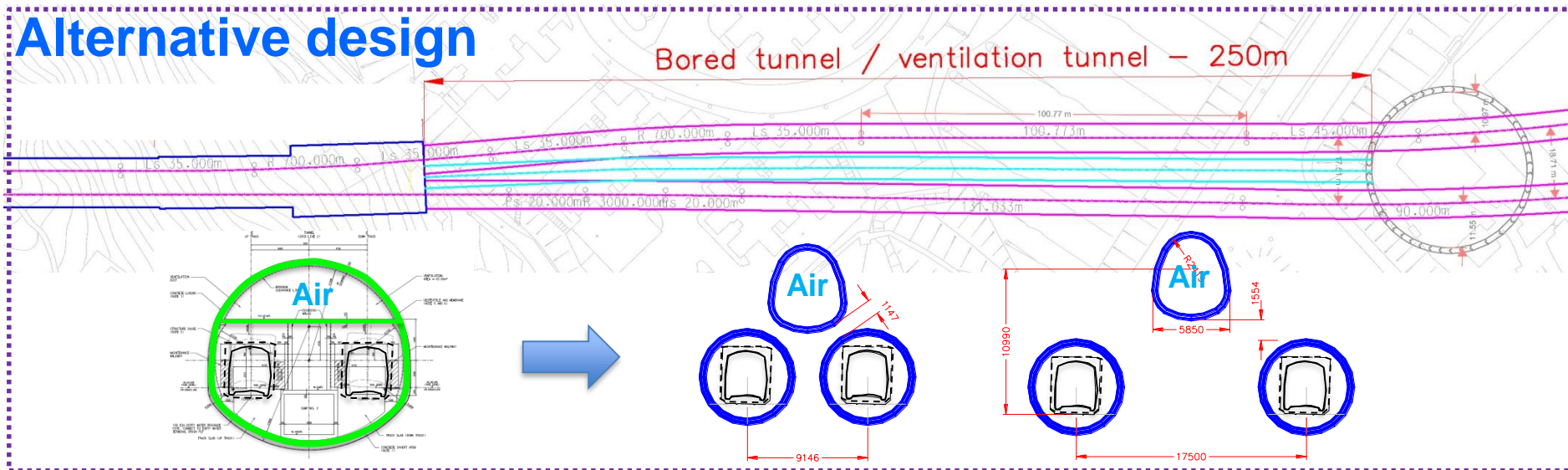
TBM 2 x 1,400m



# Alternative Sequence of Works – De-risking



## Alternative design



### Conforming design

a 250m-long, 16m-span mined tunnel in mixed ground condition (up to 8 bars water pressure)

### Alternative design

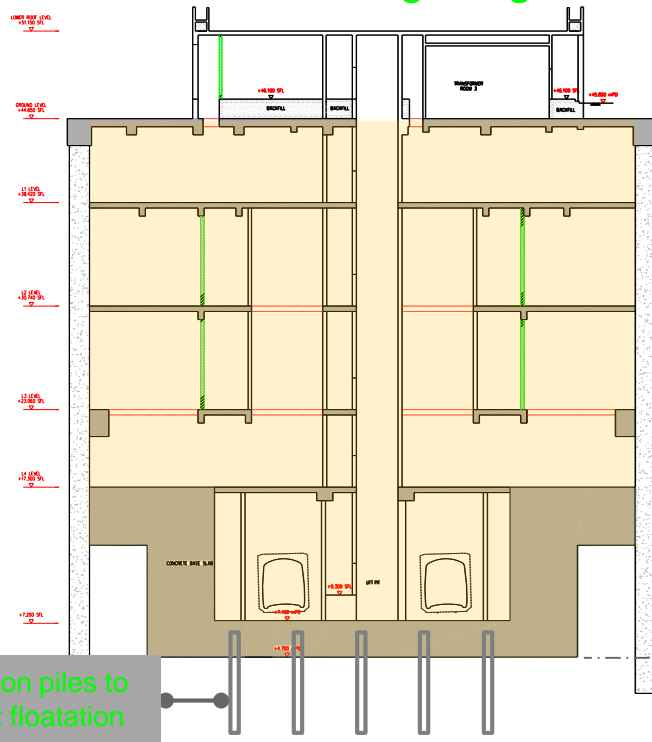
3 small tunnels: 2 TBM tunnels and a 6m-span ventilation tunnel

- ✓ Reduce construction risks
- ✓ Saved huge amount of temporary support



# Innovative design MCH Shaft Underslab drainage system

Conforming design

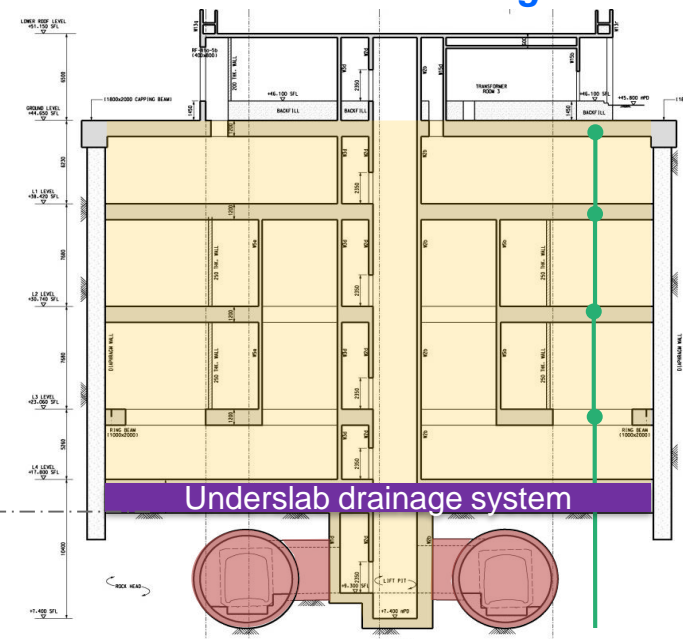


Presence of deep weathering associated to a fault zone



Formation level raised by 10m

Alternative design

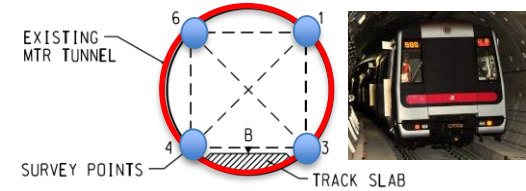
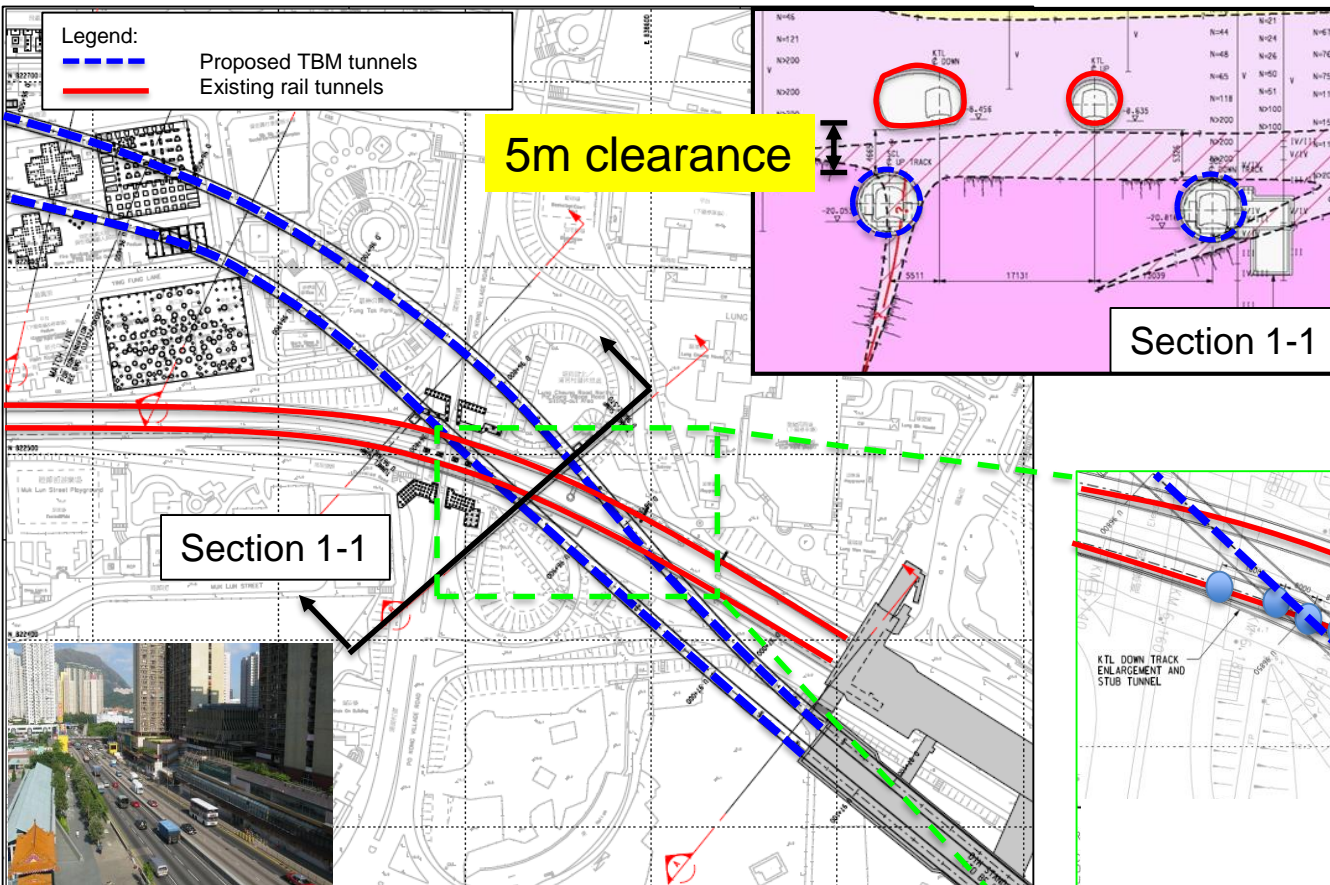


Underslab drainage system

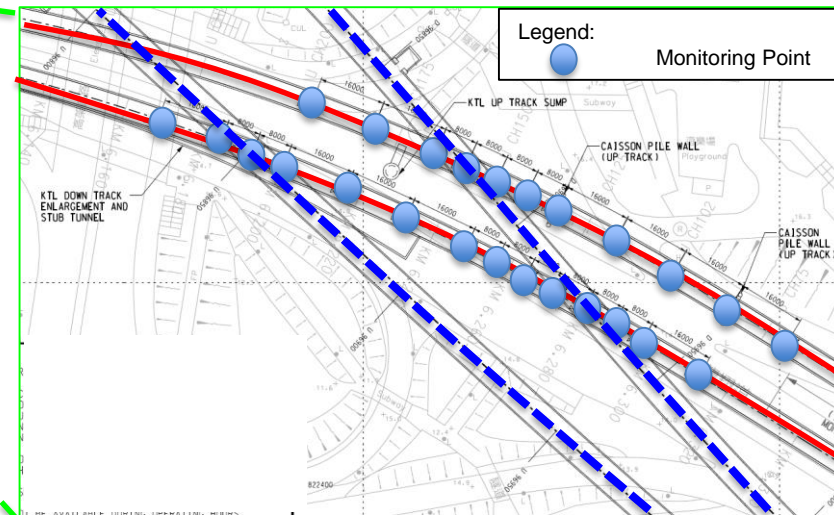
- ✓ D-walls not toed into rock
- ✓ Shaft construction programme not linked to TBM drive – off critical path
- ✓ No tension piles
- ✓ Substantial reduction in excavated volume
- ✓ With active-drainage system - 5,000m<sup>3</sup> less concrete (or carbon emission reduction of 1,000 tonnes)
- ✓ Better functional planning!



# TBM Tunnelling below operating rail tunnels



Typical Details for Monitoring of Rail Tunnels by ADMS



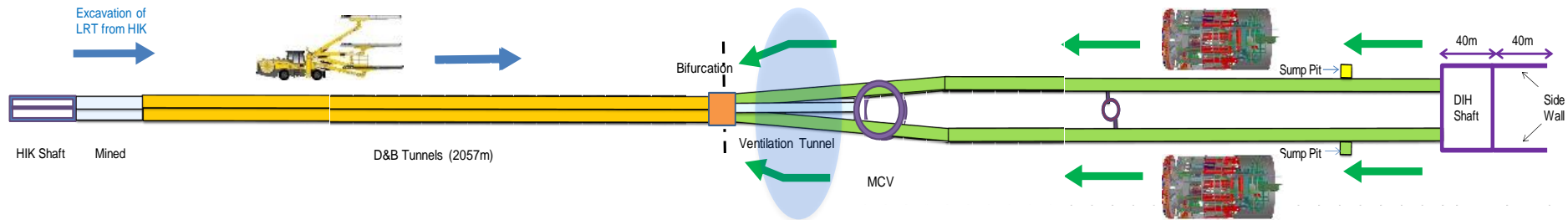
Blow-up Instrumentation and Monitoring Plan of Rail Tunnels

Features of Automatic Deformation Monitoring System (ADMS):

1. Continuous, real-time monitoring
2. Deformation and movement measurement



# TBM Tunnelling at 6.25 bars in mixed ground

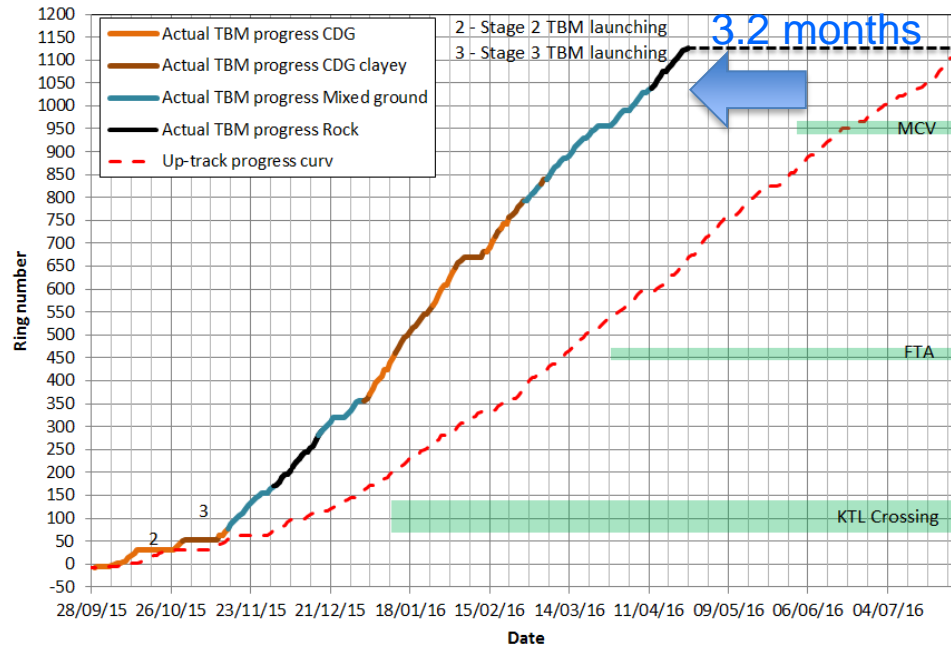


Ground conditions after Ma Chai Hang shaft:

- Complex mixture of CDG, boulders and coreslabs of grade III or better rock before entering into the rock
- High water ground water pressure (up to 8 bars)

# TBM Tunnelling - Improvements

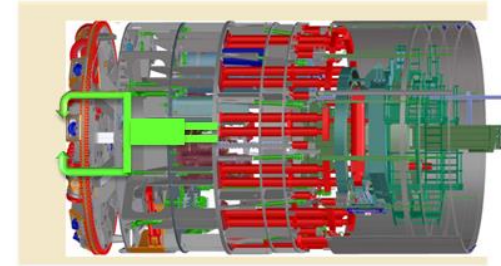
TBM drive Down-Track versus Up-track



- Clogging controlled to an acceptable level
- Higher excavation speed (+21%)
- Lower consumption of cutting tools (-26%)
- Lower number of hyperbaric interventions for cleaning the cutterhead & replacing cutting tools (-58%)
- Lower consumption of energy for excavation (-18%)



Cutterhead central flushing system  
(2 x120 m<sup>3</sup>/hr of bentonite fluid)

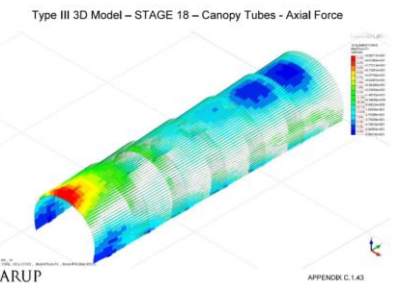
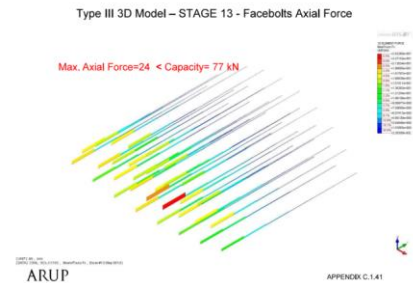
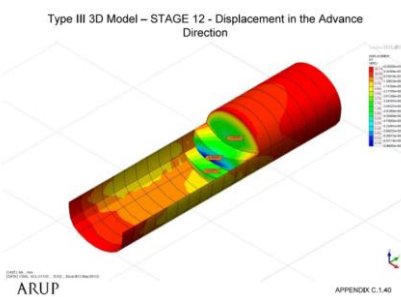
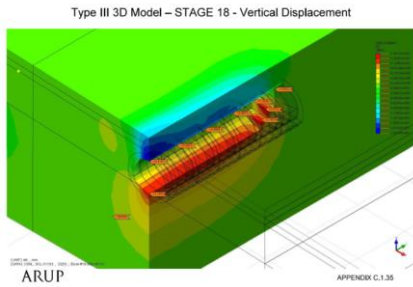
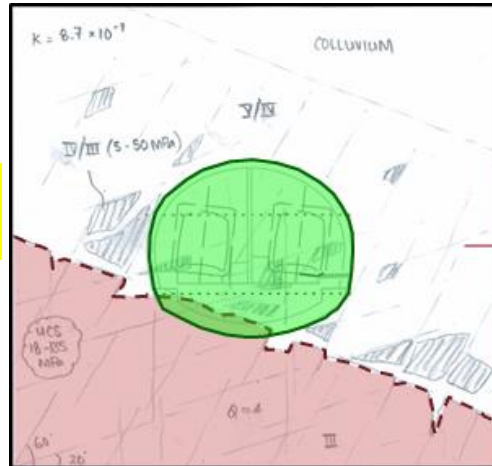
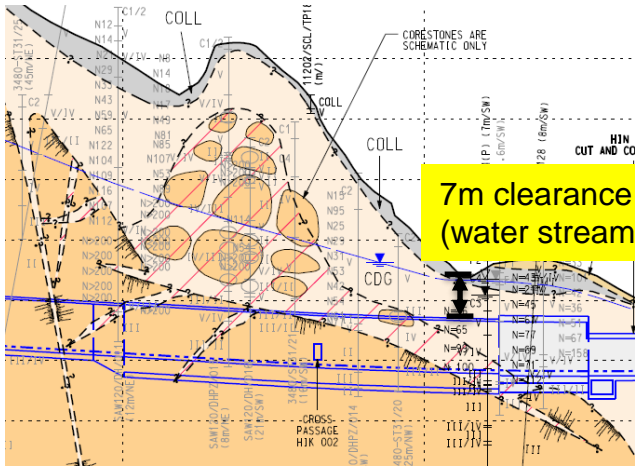


TCBI cutters (in CDG)





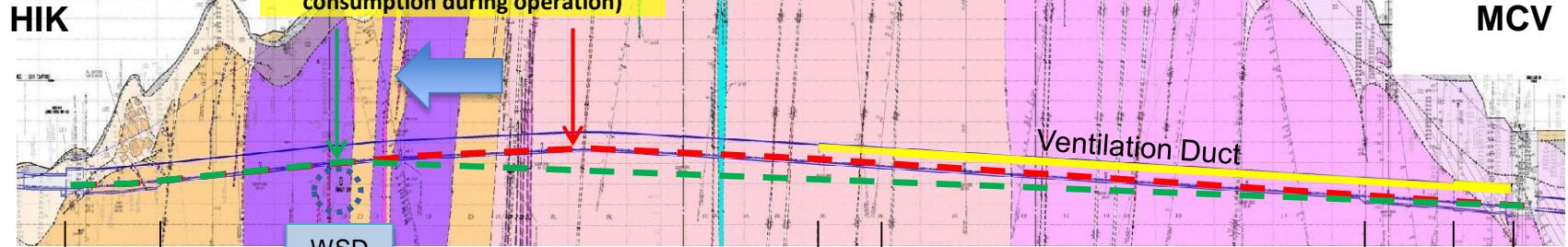
# Mined Tunnel at HIK



Checking 3D model: Individual components  
(face bolts, canopy tubes, overall stability)

# Lion Rock Tunnel Optimisation

High point moved by 368m → profile lowered by 5.2m (reduction of energy consumption during operation)



Mined  
125m

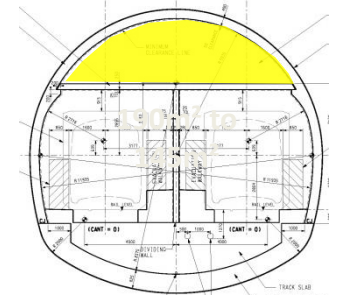
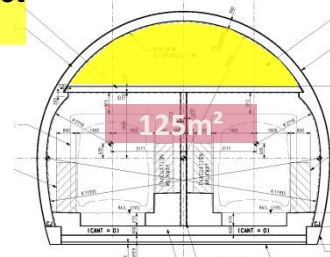
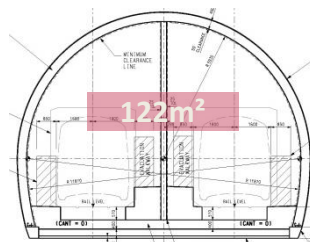
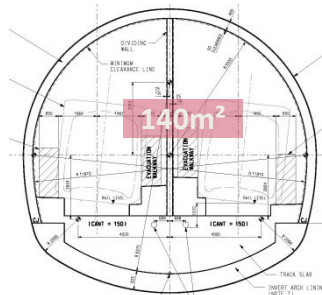
D&B  
1200m

D&B  
857m

D&B  
137m

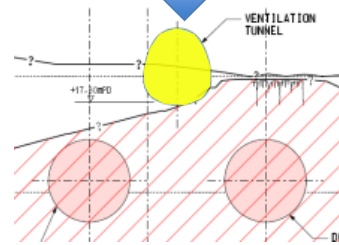
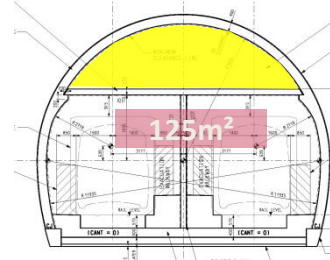
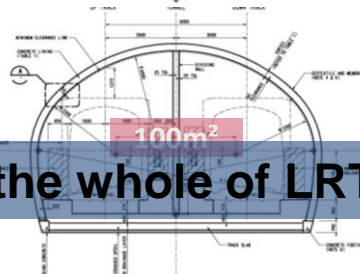
Mined  
114m

Shorten  
ventilation duct  
by 170m



125m<sup>2</sup>

Redesign the whole of LRT tunnel



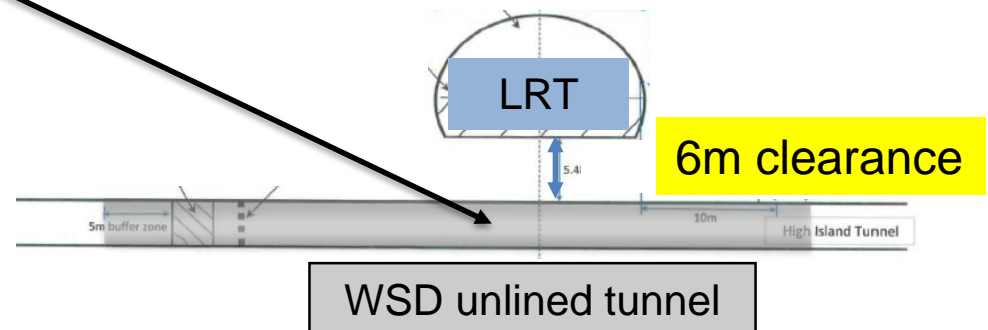
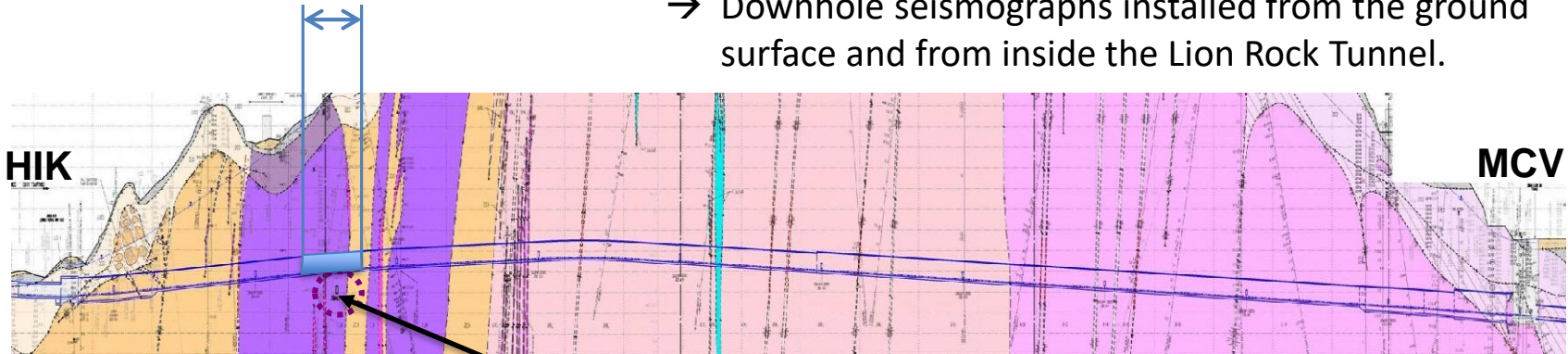


# Drill & Blast below water supply tunnel

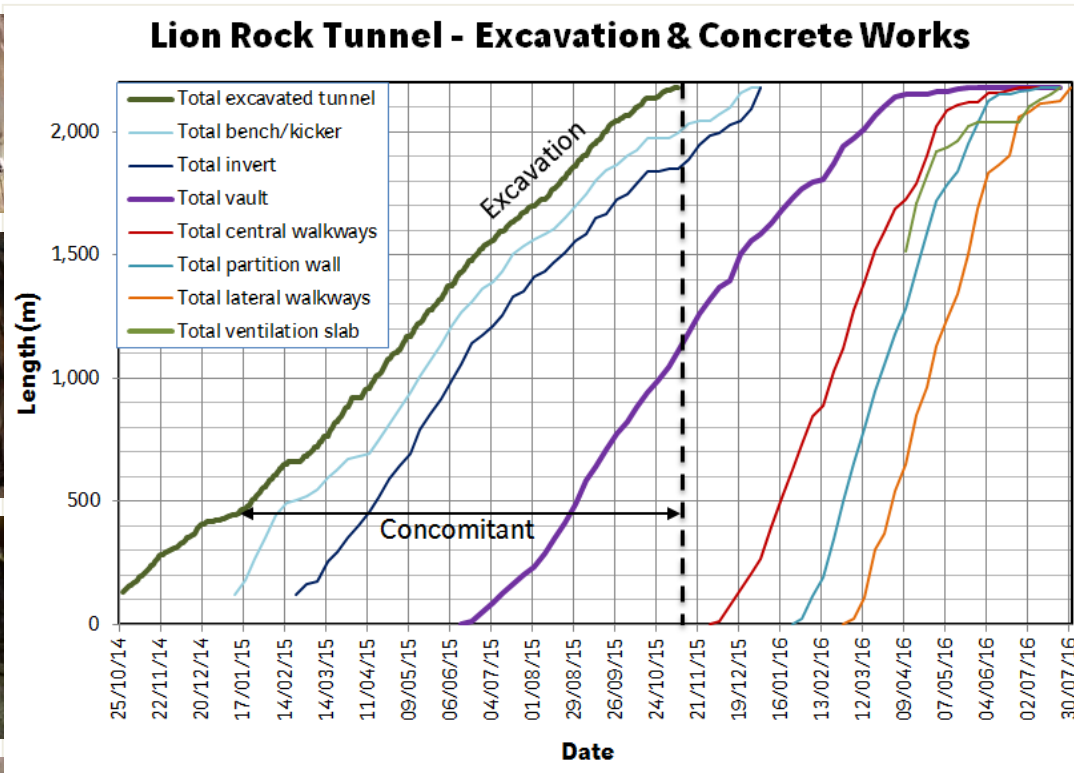
Contract  
Non Blast Zone 40m



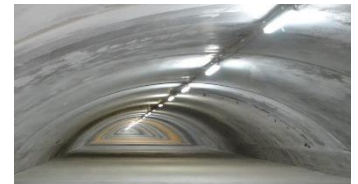
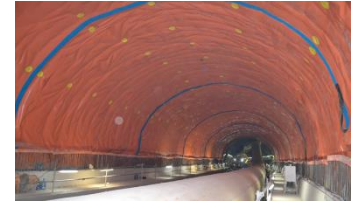
- Controlled blasting allowed (reduced MIC & electronic detonators)
- 52m steel lining installed in WSD tunnel
- Downhole seismographs installed from the ground surface and from inside the Lion Rock Tunnel.



# Drill & Blast – Rapid excavation with concurrent lining works

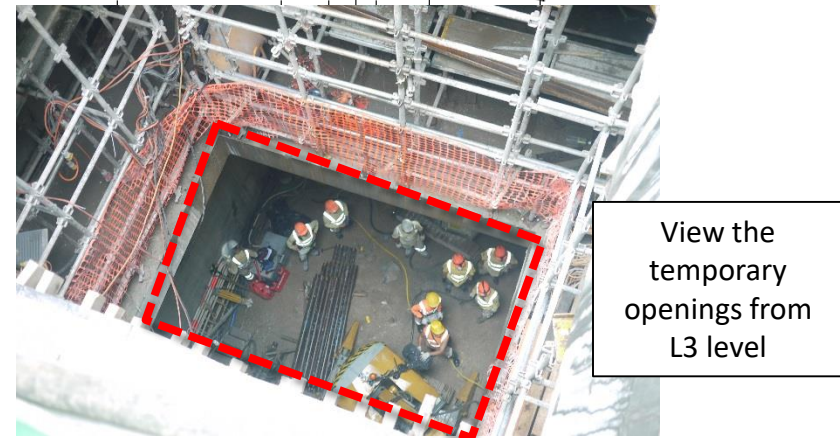
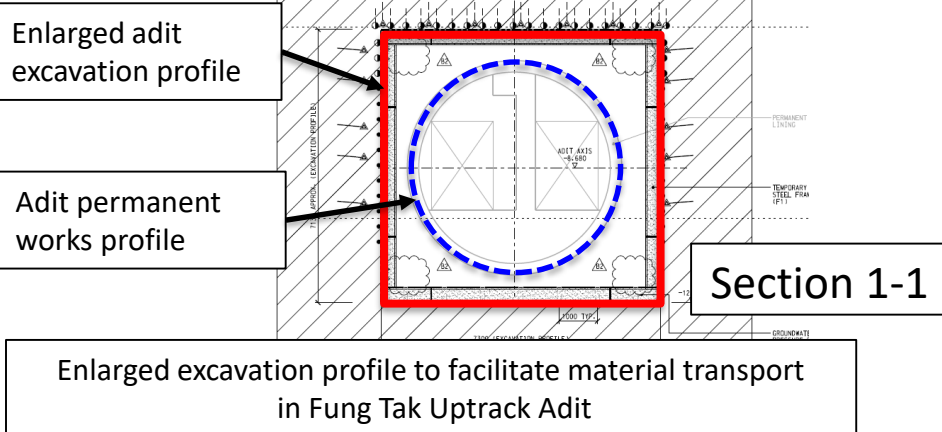
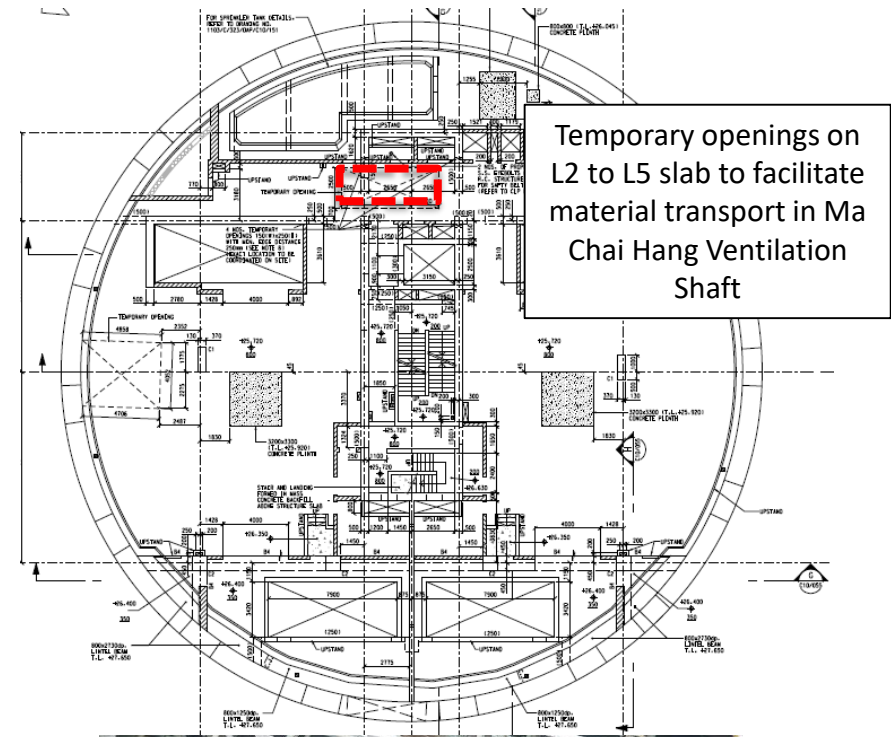
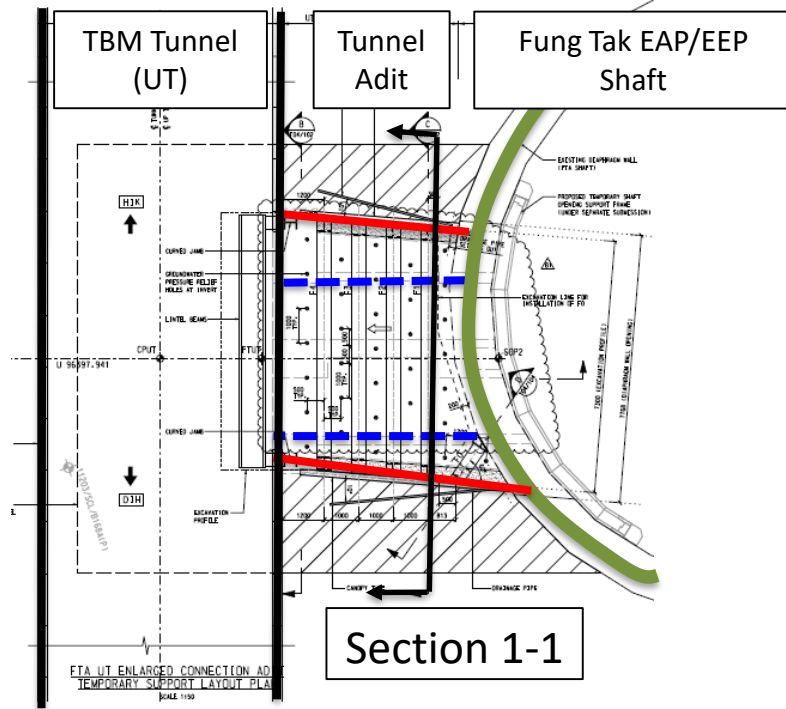


- Up to 12 blasts per week (from one single face)
- Standard advance in good rock 5.60m
- Best week: 67m excavated
- 2.1 km in 12.5 months (mucking out only day time)





# Engineering solutions to improve efficiency



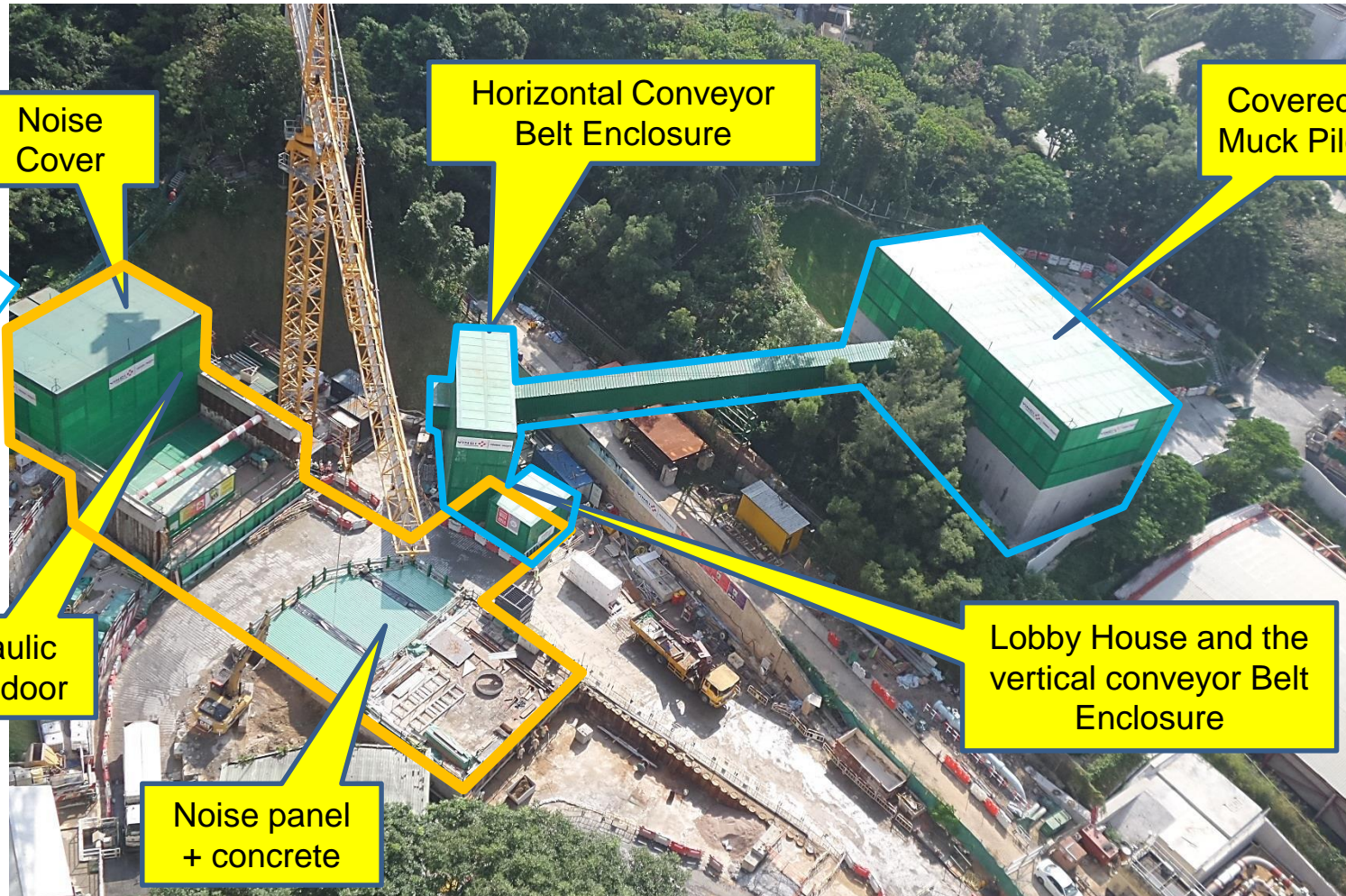
*“On top of the difficult geological conditions at Lion Rock, tunneling underneath the existing railway tunnels of the Kwun Tong Line and various busy traffic arteries such as Prince Edward Road East and Choi Hung Road required great precision engineering.”*

Dr Philco Wong, Projects Director of MTR Corporation



# Minimising construction impacts

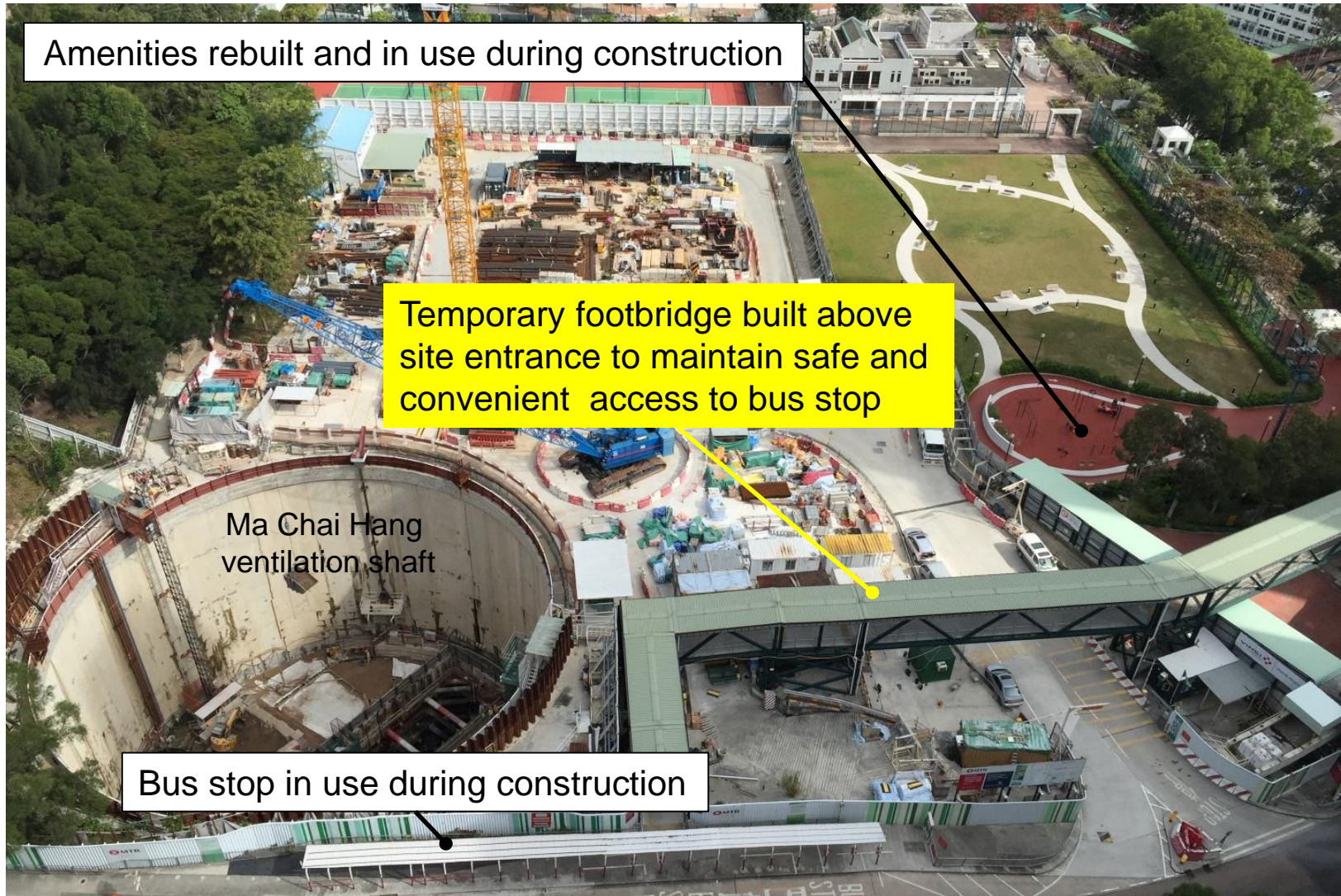
## Noise and dust mitigations



At HIK (Drill & Blast excavation): 51 dB(A) reduction noise cover



# Minimising construction impacts







ITA TUNNELLING  
AWARDS 2017

# Engaging the community



Donation to Red Cross for Nepal Earthquake







ITA TUNNELLING  
AWARDS 2017

# Safety

- Awards received
  - MTR Gold Safety Award in 2013
  - MTR Silver Safety Award in 2014
  - MTR DNV Independent Audit (Safety) Award in 2014 and 2015
  - MTR Safe Subcontractor Award in 2013, 2014 and 2015
  - Special MTR Safety Award: TBM safely crossed underneath KTL with only 5m clearance
  - Development Bureau's Considerate Contractors Site Award Scheme 2015 – Merit Award (Non-public new works group)
- More than 2,600 man exposures to hyperbaric works without any accident (up to 4.2 bars).







ITA TUNNELLING  
AWARDS 2017

# Client satisfaction



A total of 13 awards from MTR

- 5 Safety awards
- 2 Best Site Condition awards
- 3 Safe Subcontractors awards
- 1 Stakeholders Engagement award
- 2 Environmental awards







ITA TUNNELLING  
AWARDS 2017



## Multi-fold values

- Innovative alternative design for a large-span mined soft ground tunnel to **reduce construction and safety risks**
- Redesigning a ventilation shaft to **improve programme surety**
- Overcoming complex and difficult geological challenges:
  - Drill-and-blast at only **6m above a live water supply tunnel**;
  - Rapid drill-and-blast works;
  - **TBM crossing twice at 6m below** an operating railway line;
  - Mixshield operations at 6.25 bar **and cut-and-cover**
- **10 safety-related awards**
- **3,039 tons CO<sub>2</sub> reduction** (equivalent to 8,000 flights between Hong Kong and Beijing)