



City Rail Link – A pioneer underground metro project in New Zealand

AFTES
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May 2022

Karakia

Haumaru ki te rangi
Haumaru ki te papa
Haumaru ki te tangata
Haumi e, hui e, tāiki e

Safety working at heights
Safety on and below ground
Safety to all people
Haumi e, hui e, tāiki e



City Rail Link – A railway project

- Le système de transport ferroviaire de CRL respecte les plus hauts standards mondiaux et permettra de mieux relier l'ensemble du réseau ferroviaire d'Auckland - plus de trains et les trajets seront plus faciles et plus rapides
- Le CRL permettra de doubler le nombre de personnes situées à moins de 30 minutes du centre d'Auckland, plus grand pôle d'emploi de Nouvelle-Zélande
- Lorsqu'il sera pleinement opérationnel, 54 000 passagers par heure utiliseront les stations du CRL aux heures de pointe.
- Il s'agit du plus grand projet d'infrastructure de transport jamais réalisé par la Nouvelle-Zélande
- Plus de 2000 personnes travaillent sur le chantier du CRL - l'innovation et la complexité du projet contribuent à l'amélioration des compétences de la main d'œuvre au bénéfice des générations futures



City Rail Link – Some Key Figures

Civil key figures

- Concrete: 237,800 m3
- Reinforcement: 31,300 tons
- Excavation: 1,735,000 tons

Systems (Rail & Stations) key figures

- Rail track & OHLE: 11 km
- Cable: 1,500 km
- I/O: appr. 100,000
- Installed capacity: 6 MW x 2

People:

- 2,000 workers
- 18mi worked hours (up to 12/2023)

=> Turnkey project



Maungawhau Station (250ml)
Elevated station + caverns



TBM tunnel
2 x 1.8 km twin tube
6.24m int. diameter



Te Wai horotiu Station (435ml)



Karanga-a-Hape Station (215ml)
2 shafts



NAL Line
2 x 1.3 km

Waitemata Station

Tunnel
contract C2

Delivery model: an Alliance

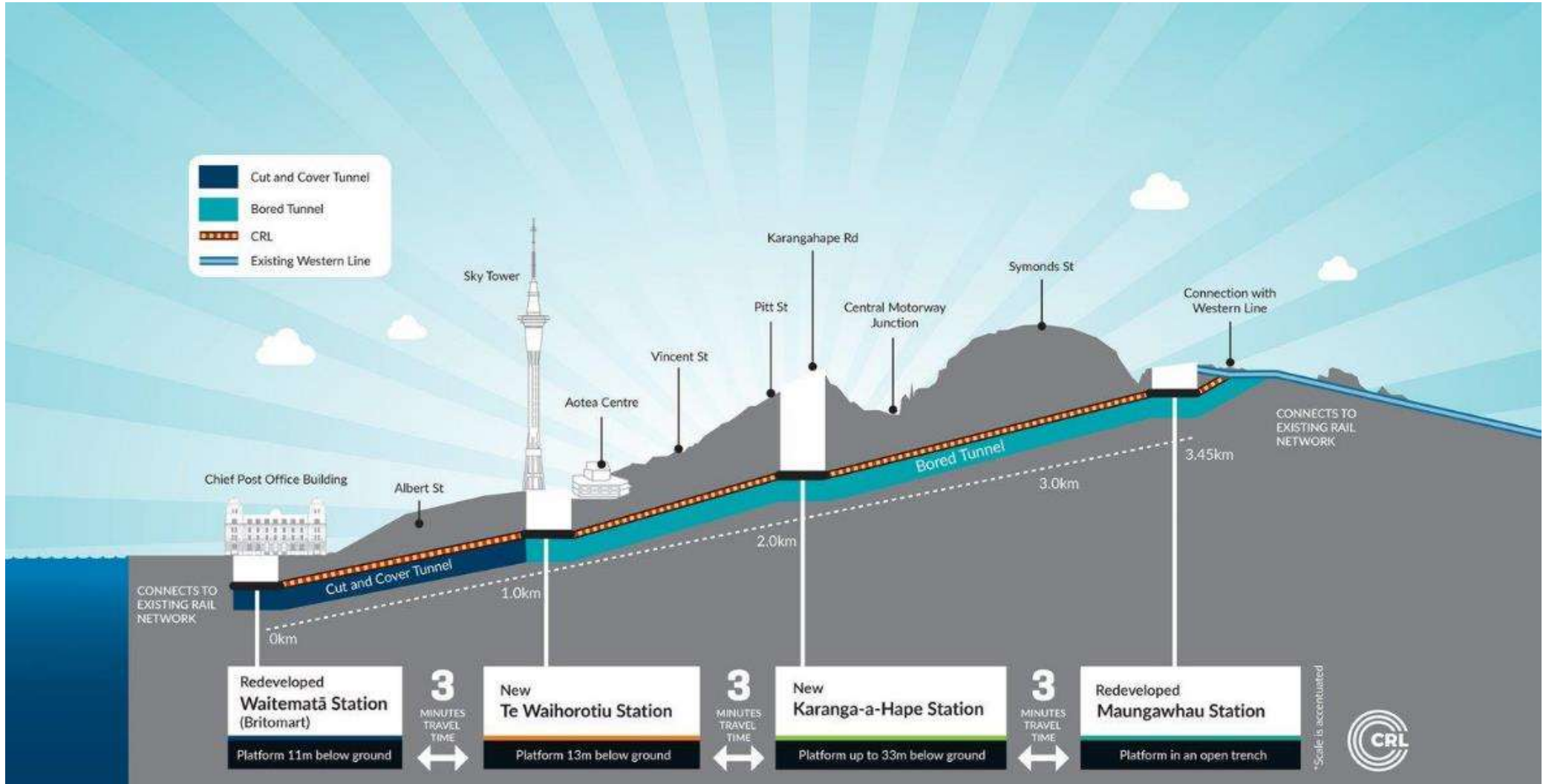
- Why select an Alliance model ?
- Alliance objectives, performance requirements and risk sharing
- Link Alliance Participants

- The biggest project of the NZ history
- 2b€
- The first underground railway project in NZ

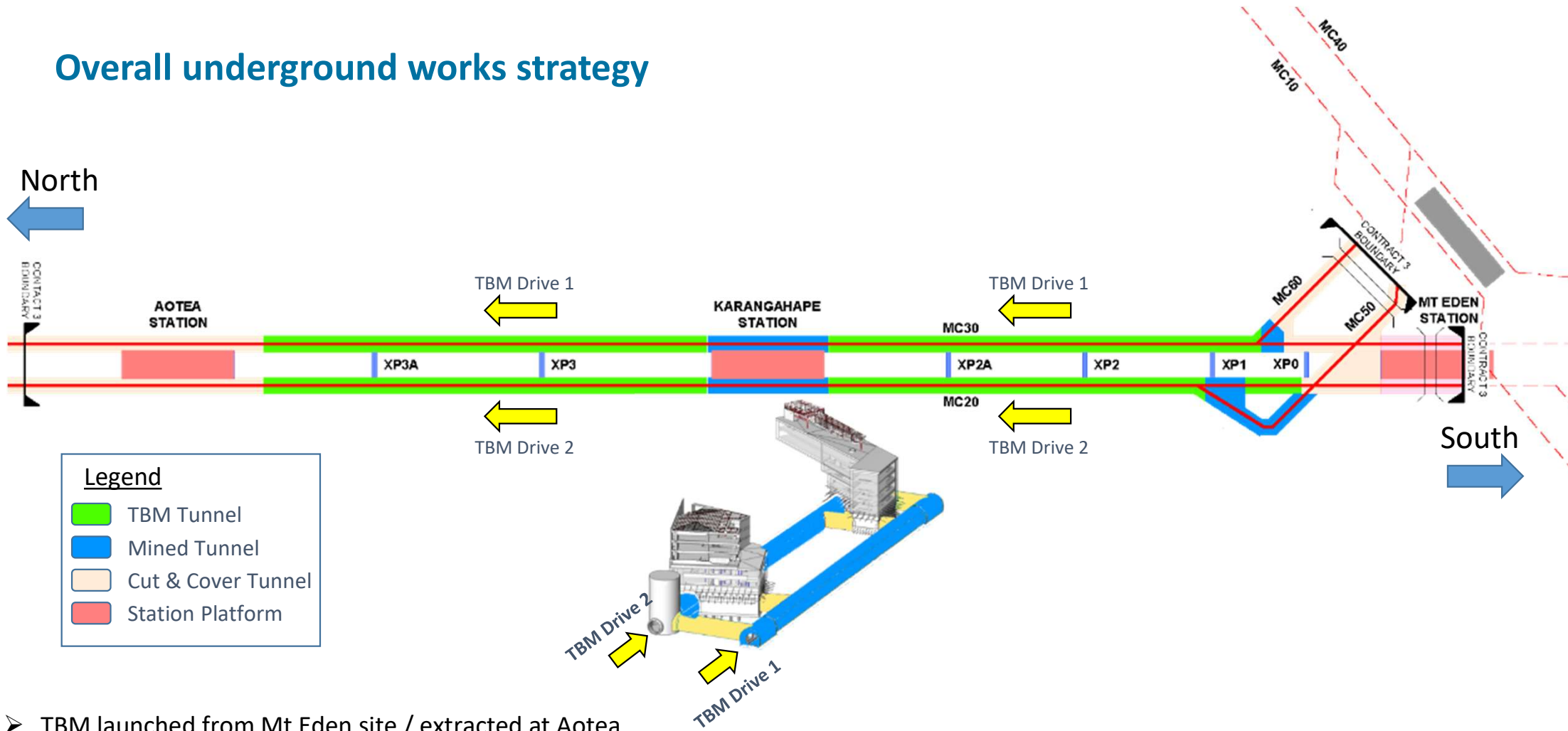


- Other parties involved in the Alliance: Auckland Transport, KiwiRail, the Maintainer & Mana Whenua

Mana Whenua Partnership – Station naming

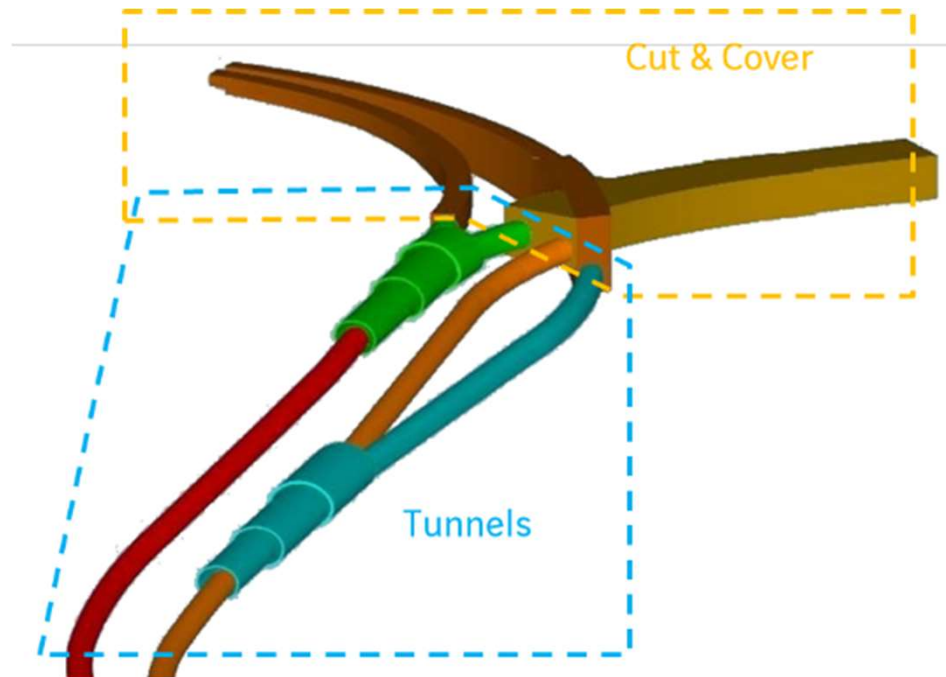
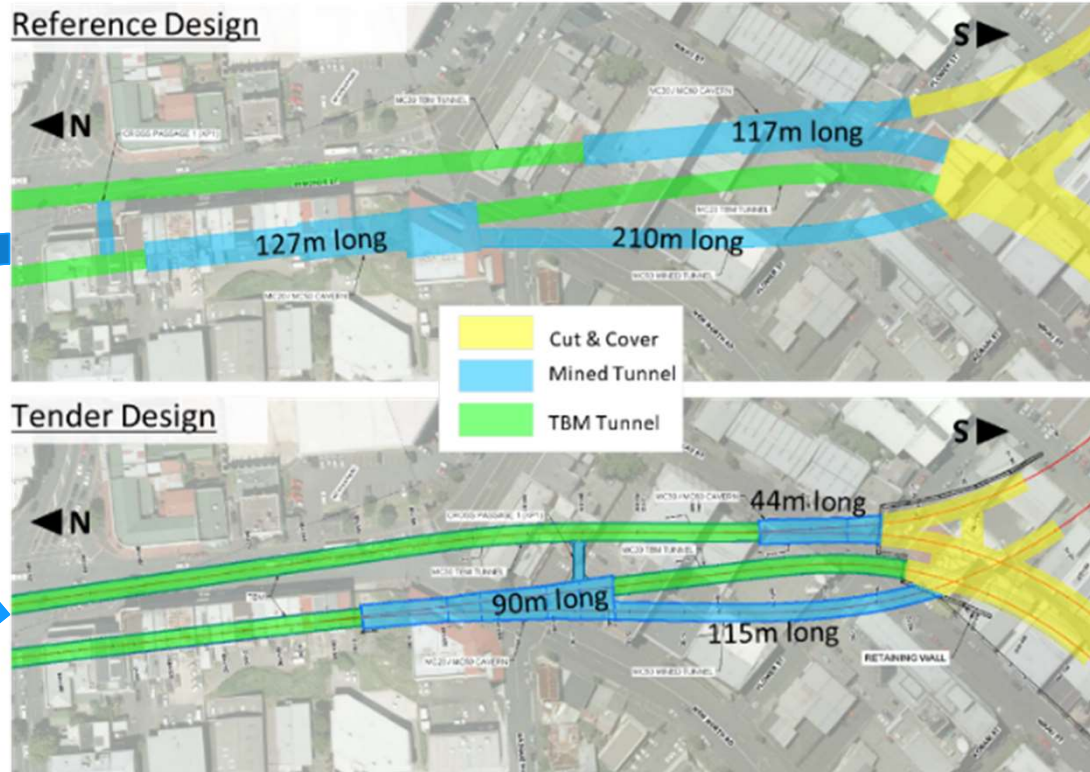


Overall underground works strategy



- TBM launched from Mt Eden site / extracted at Aotea
- First TBM launched from MC30-MC60 bifurcation mined cavern → crossing Karangahape MC30 mined platform → extracted at Aotea
- Second TBM launched from Mt Eden Portal → crossing MC20/MC50 cavern → crossing Karangahape MC20 mined platform → extracted at Aotea

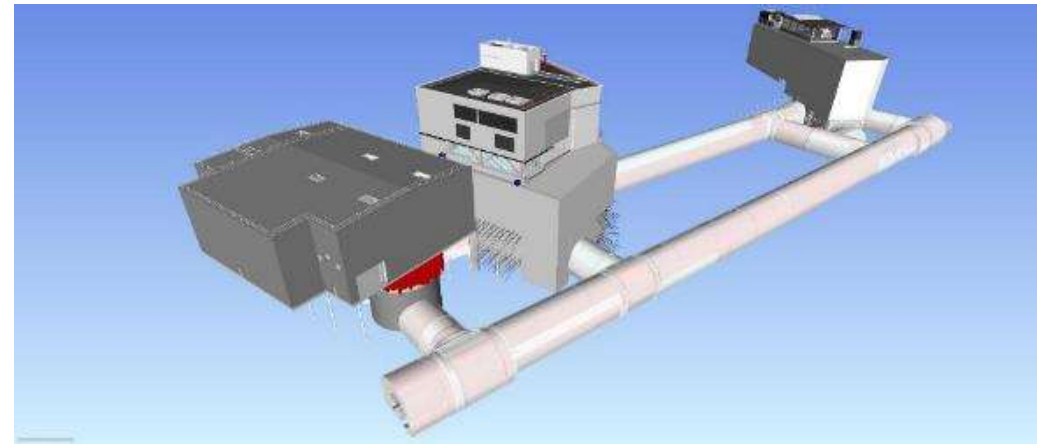
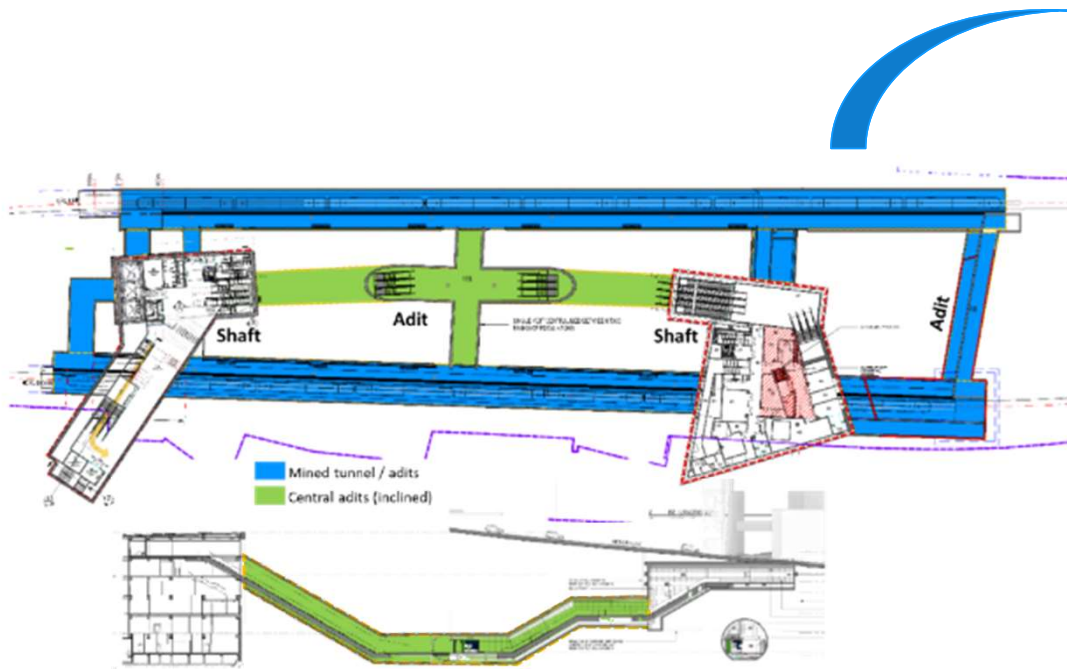
Maungawhau – Newton Junction optimization



Maungawhau – Newton Junction construction



Karanga-a-Hape - Station layout optimization

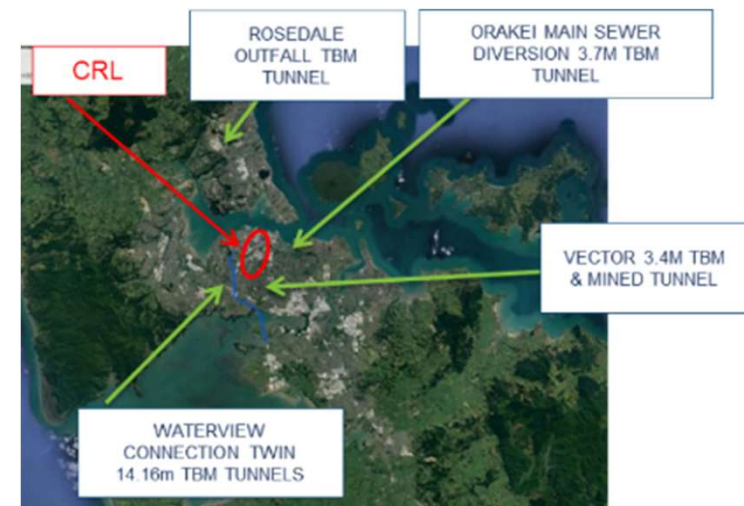


Reference Design: vertical access to the train platforms by inclined adits

Tender Design: vertical access to the train platforms within shafts

Geological conditions & geotechnical information

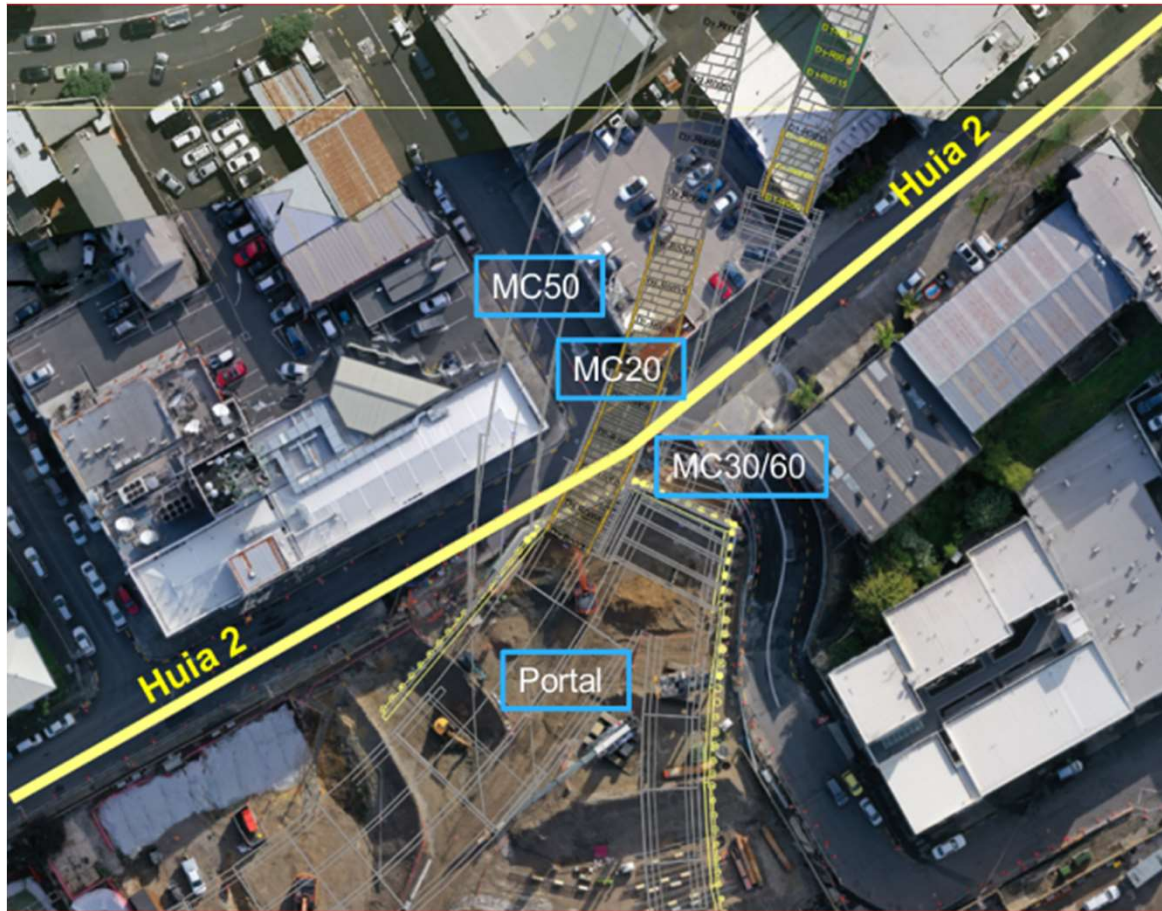
- East Coast Bays Formation (ECBF)
 - > interbedded sandstones and mudstones
 - > associated generally to a good tunnelling environment: weak rocks (2 to 5 MPa) which stand up well and are easily excavated
 - > presence of lenses or layers of uncemented materials at Mt Eden
 - > presence of harder lenses such as the 'Parnell Grit' at Karangahape
 - > low permeability
 - > sticky when excavated
- Low ground water pressure
- Site investigation: more than 750 boreholes (historical and site specific)
- Local tunneling know how



Mined tunnels



Watercare's Auckland Watermain Huia 2



Watercare's Huia 2 watermain is 1.3m diameter and 15km long pipe, running from the initiation point at the Huia Treatment Plant in Titirangi to the Khyber Pass reservoirs.

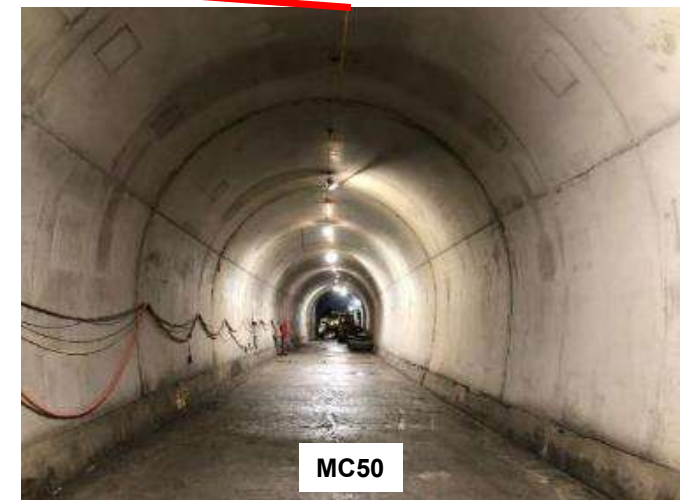
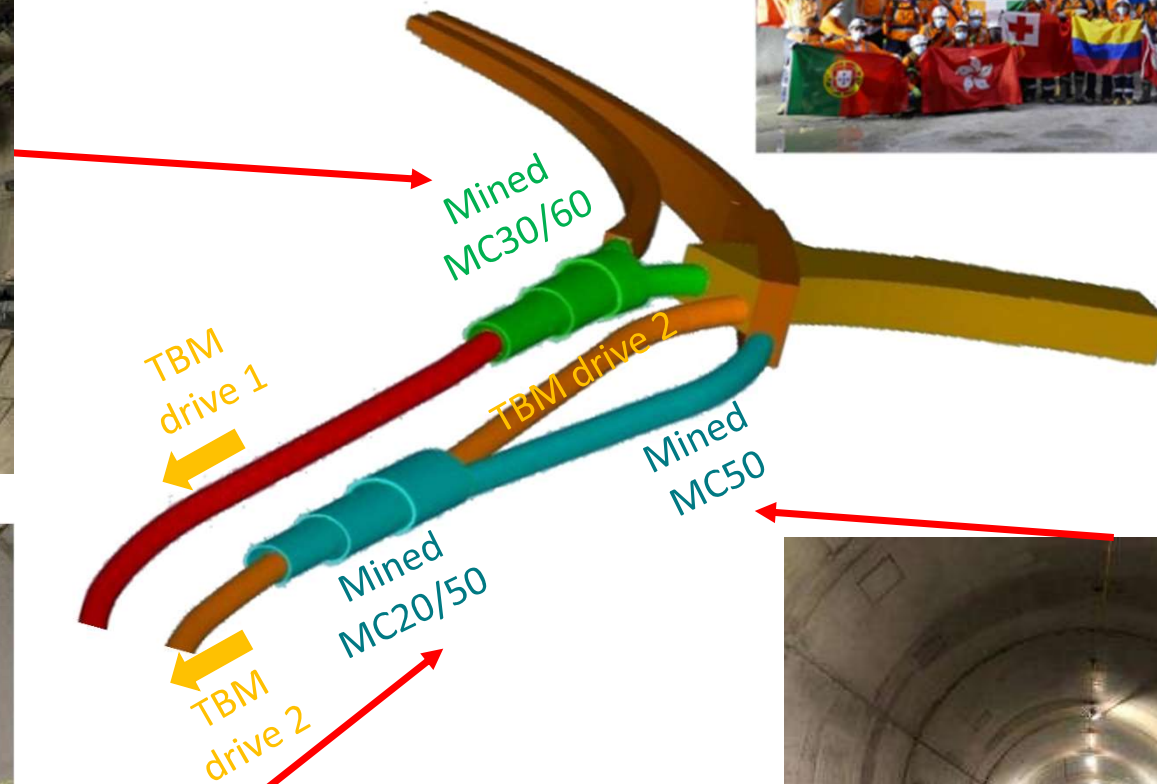


Huia 2 watermain

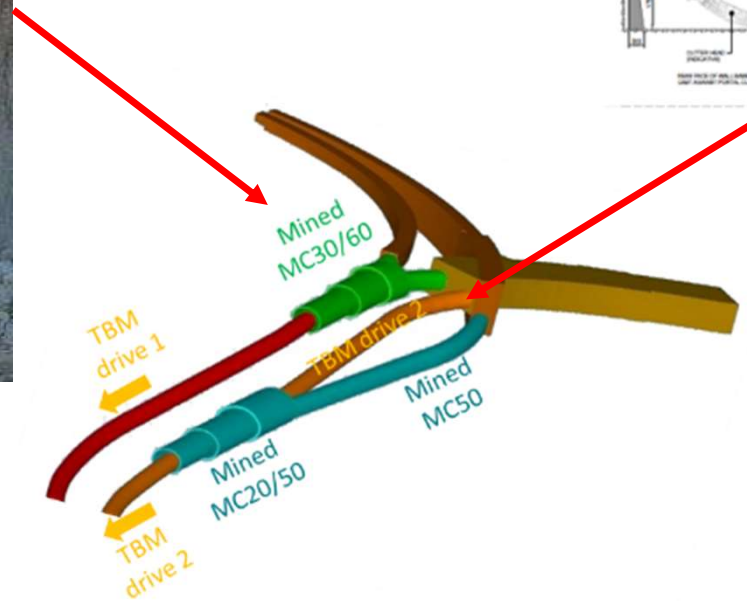
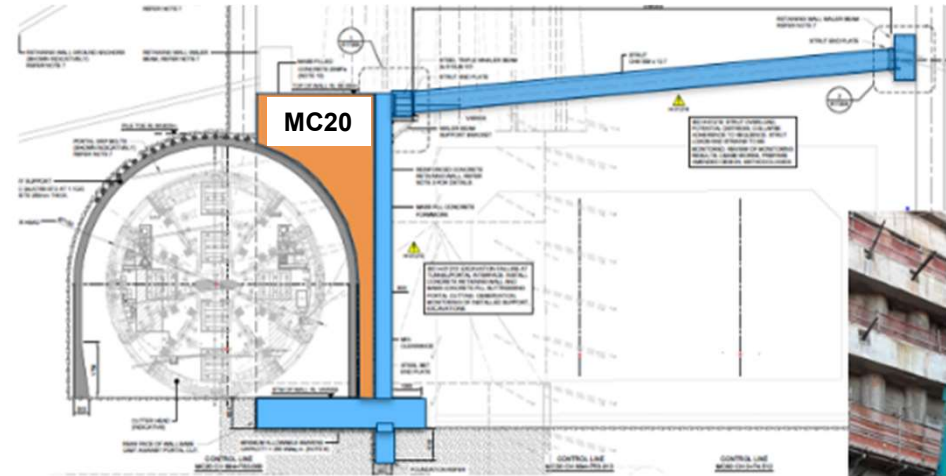


No significant settlement effects due to construction activities, maximum settlement of ~9mm.

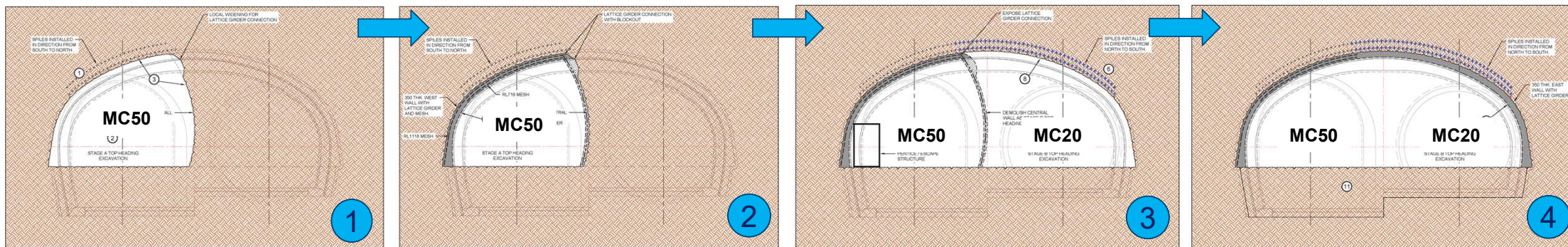
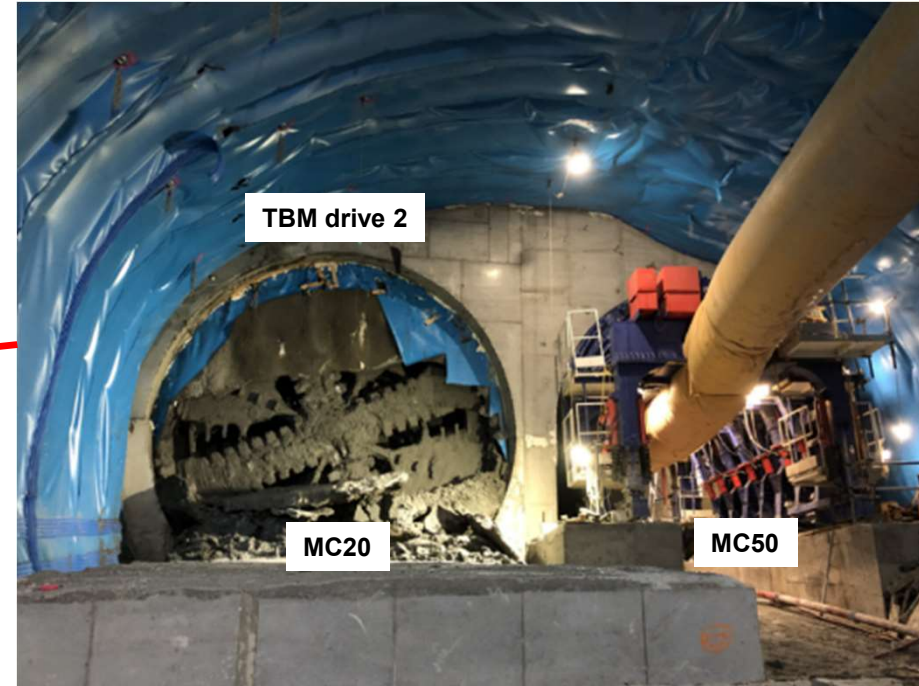
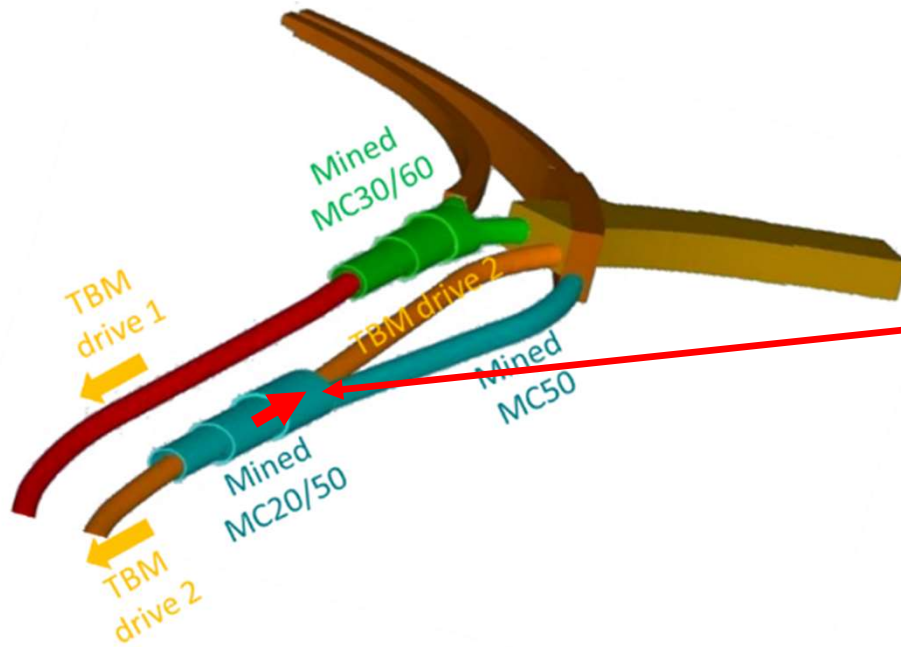
Mining works at Maungawhau



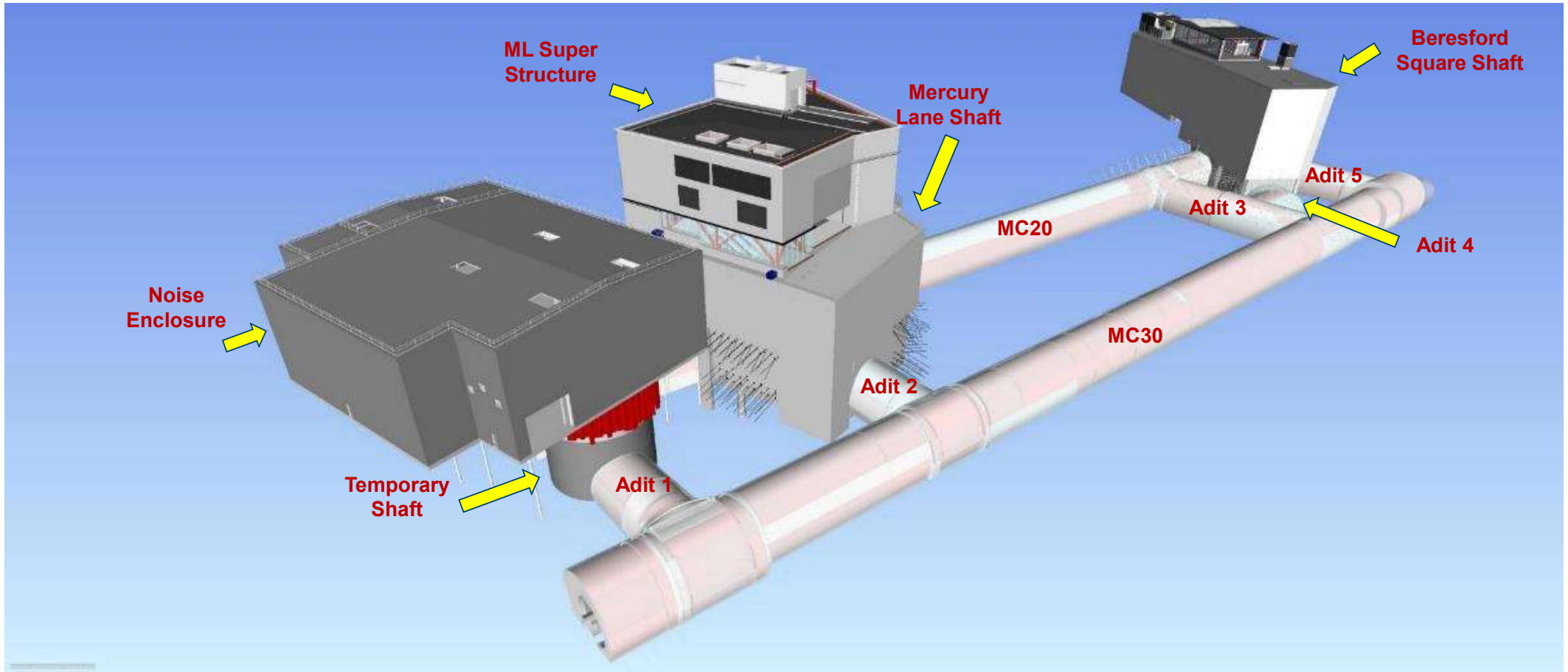
Mining works at Maungawhau – MC20 & MC30/60



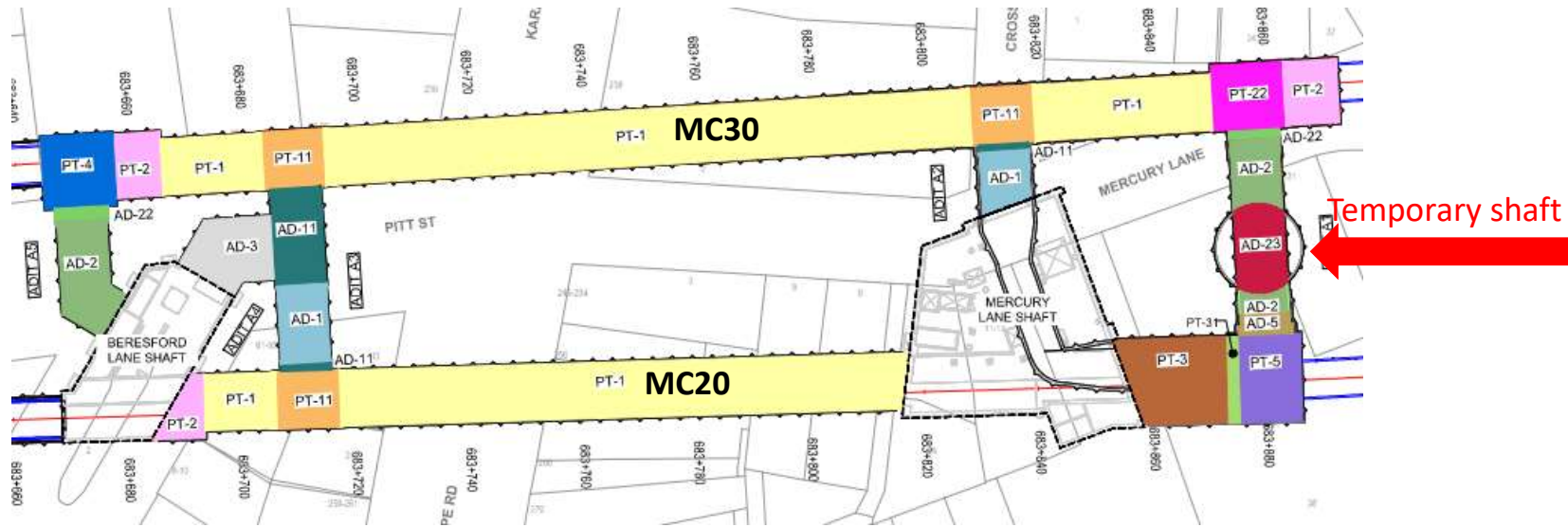
Mining works at Maungawahau – MC50 & MC20/50



Mining works at Karanga-a-Hape



Mining works at Karanga-a-Hape



Mining works at Karanga-a-Hape – Ground conditions

MC30 CH841 – Massive EUs3



MC30 CH821 – EUs3

Increase in the number of joints and iron staining as approaching the broken zone



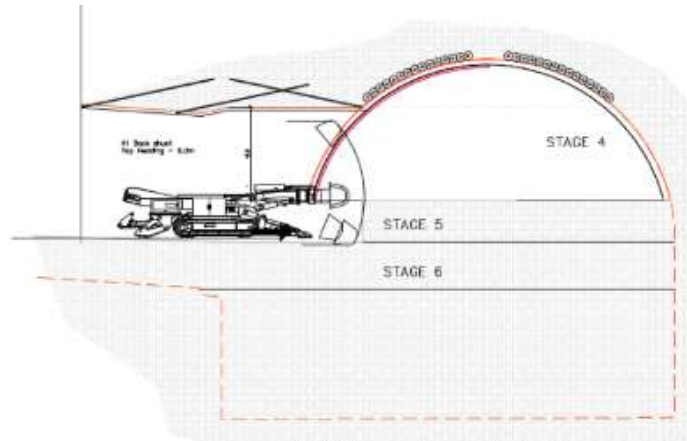
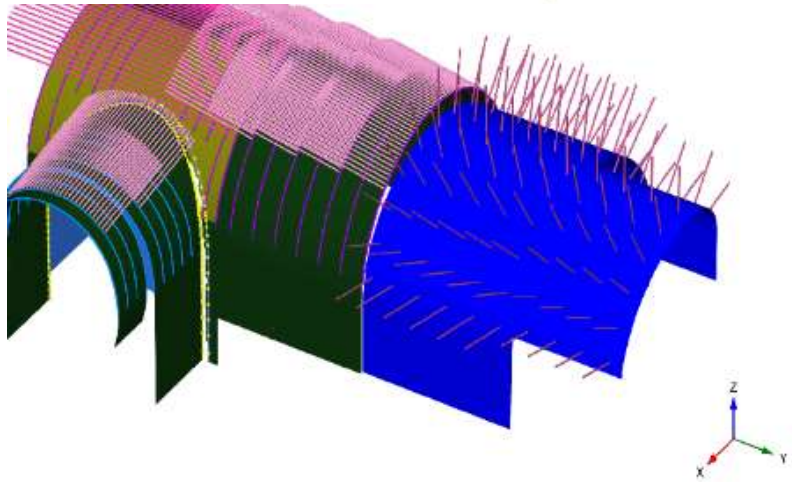
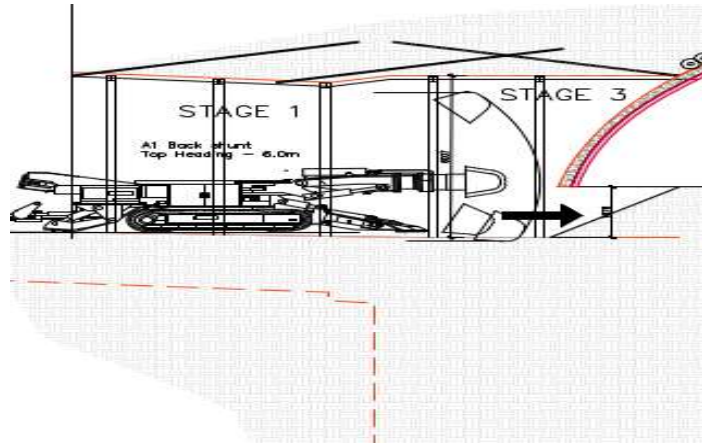
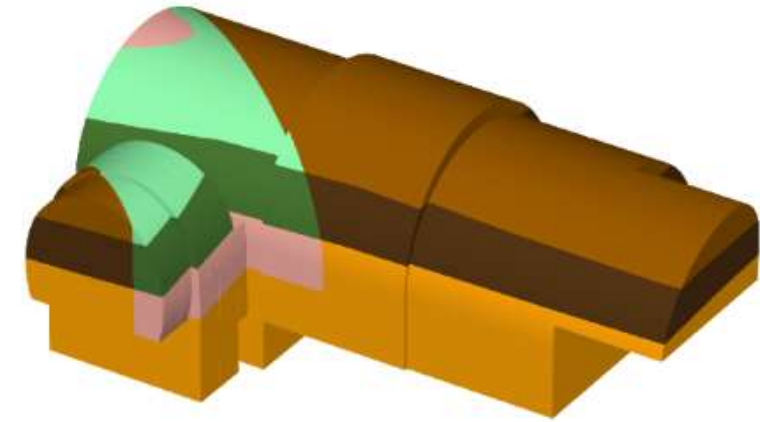
MC30 CH808 – Half Face Brecciated Rock
Part way through the broken zone



MC30 CH798 – Half face brecciated rock
face exiting the broken zone



Mining works at Karanga-a-Hape – Junctions



DESIGN

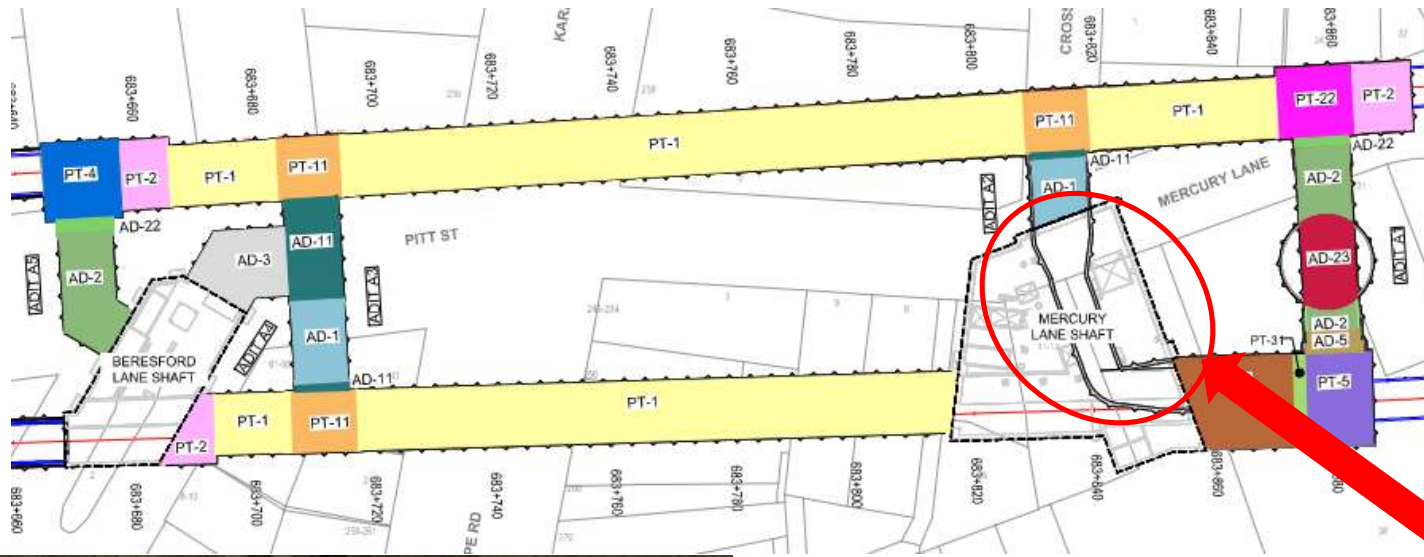


EXCAVATION



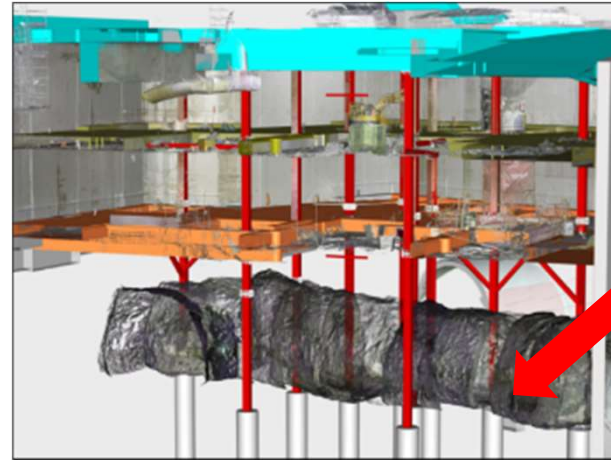
LINING

Mining works at Karanga-a-Hape – Pilot tunnel through Mercury shaft



Upmain / MC30

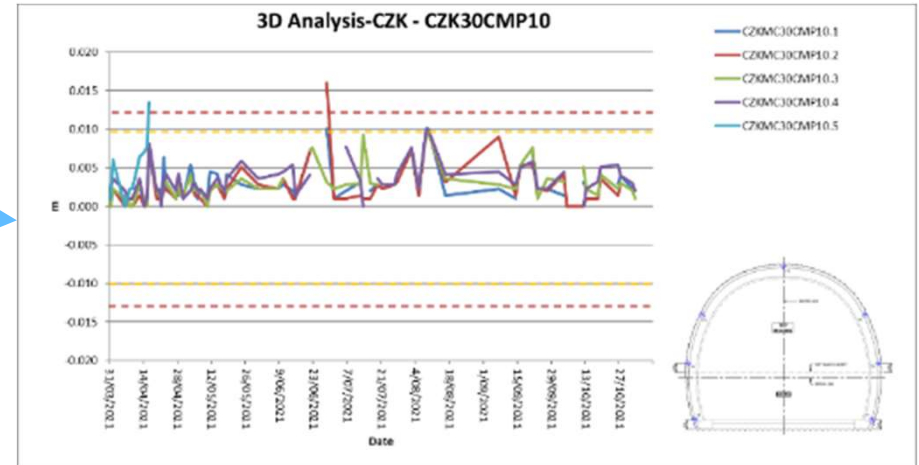
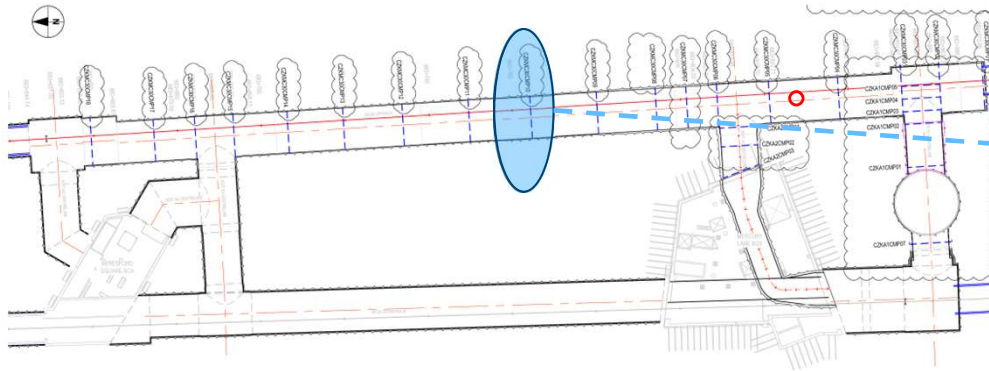
Downmain / MC20



Pilot tunnel

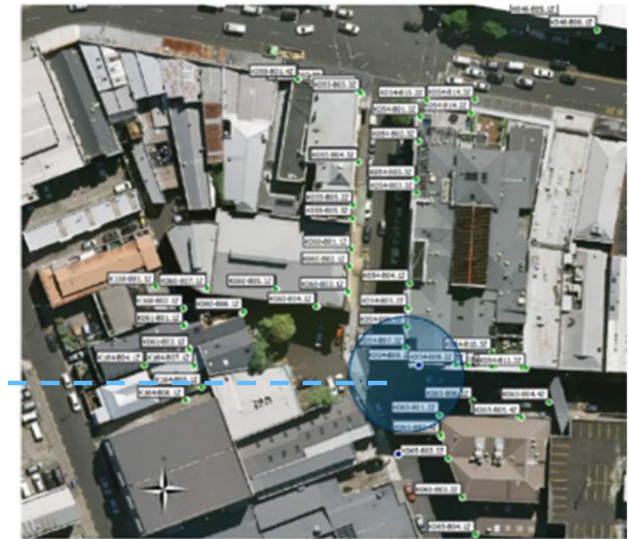
Mining works at Karangahape – Convergence Monitoring

Tunnel Convergence: $C_{max} \sim 5mm$



Groundwater Monitoring: $\sim 5m$ of groundwater drawdown overall, limited to ECFB

Settlement and buildings monitoring: $S_{max} \sim 10mm$



Building Monitoring Prisms – Mercury Lane

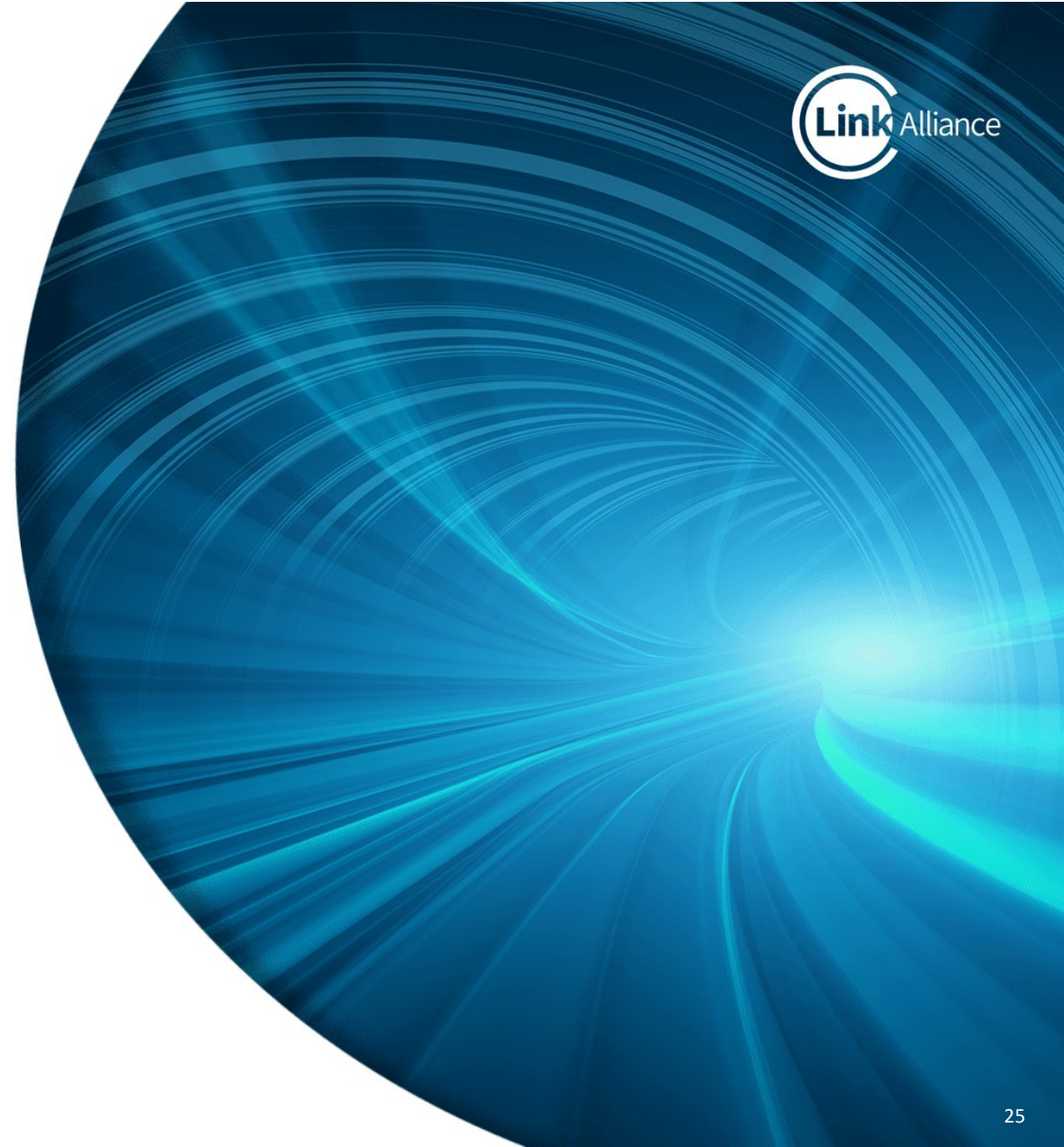
Mining works at Karanga-a-Hape – Lining



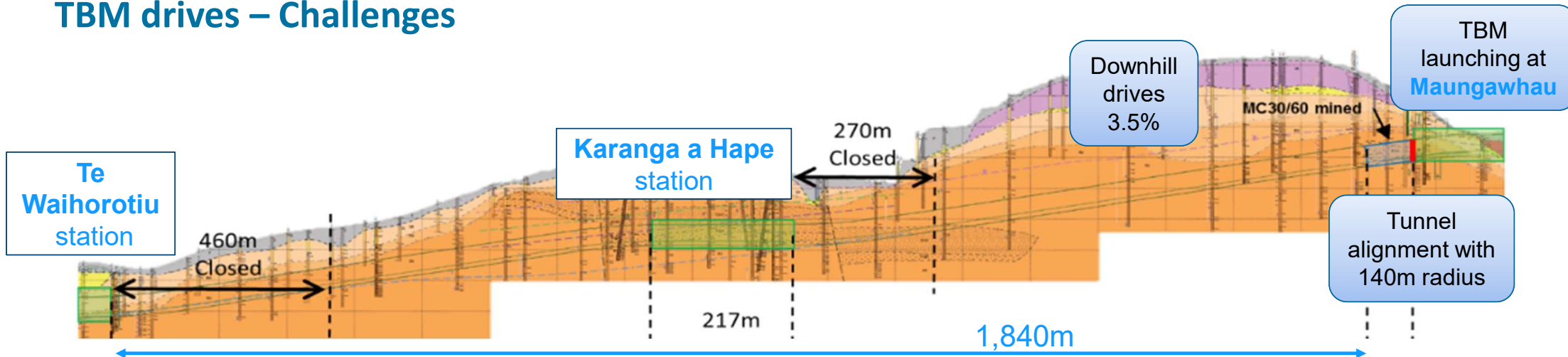
Karanga a Hape – Tunnel fit-out



TBM tunnels



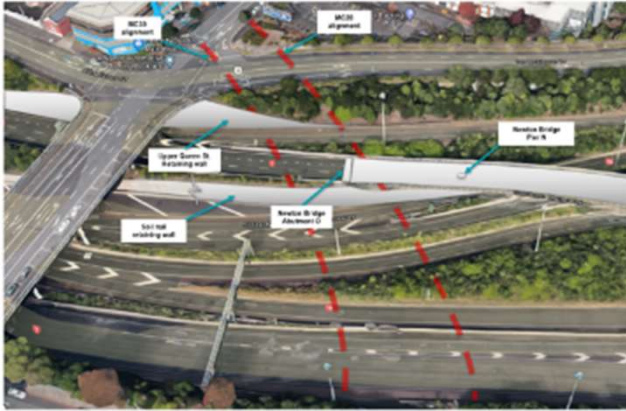
TBM drives – Challenges



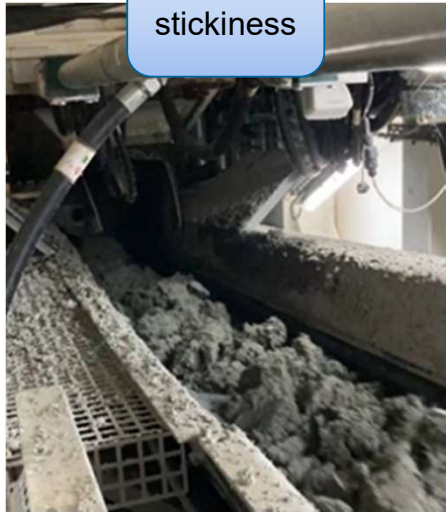
Aotea Centre temporary anchors



Crossing Auckland Motorway Junction



ECBF stickiness



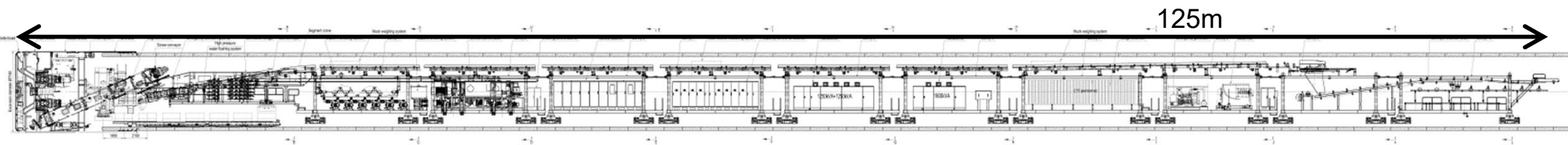
TBM tunnels

1 EPB shield (Herrenknecht)

- Boring Diameter: 7.15m
- Cutterhead: 44% opening ratio / Cutters & rippers
- Max operating pressure: 4bars (manlock, material lock)
- Designed for 110m tunnel radius

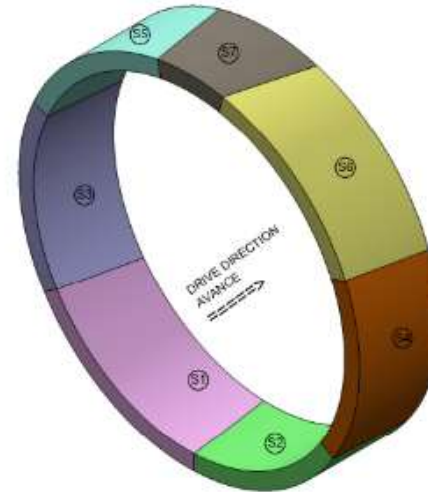
Mucking out by conveyor 600t/h

Tunnel logistic by electrical MSVs



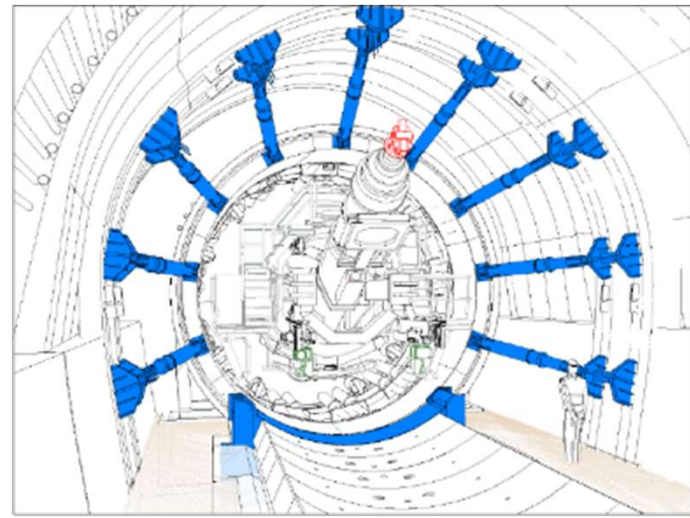
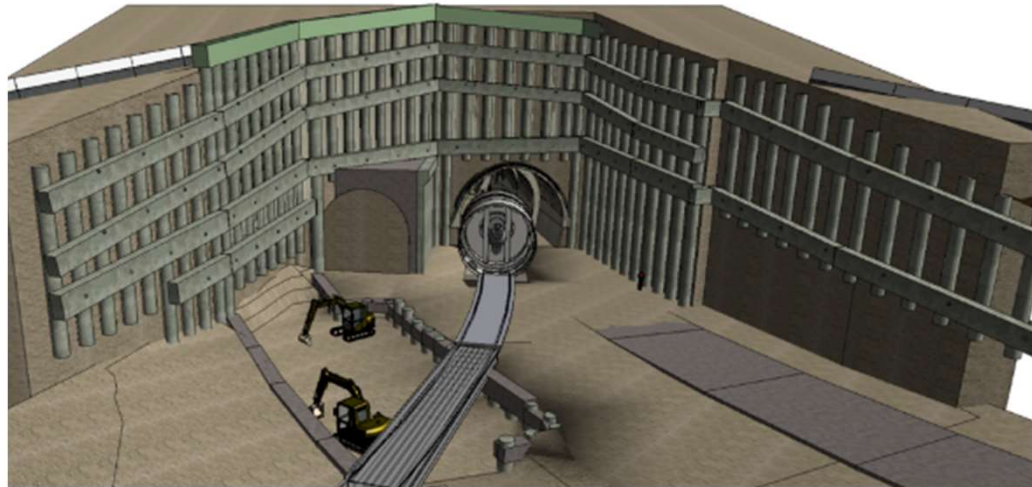
Segmental lining

- Universal rhomboidal ring
- 6 + 1 ring with small key segment
- Internal diameter = 6.24 m
- Thickness = 300 mm
- Minimum alignment radius = 141 m



Ring type	Length	Reinforcements	Usage
A1	1.6 m	SFRC around 35 kg/m ³	85 % of the alignment
A2	1.6 m	Light	Break in/out and shallow covers
A3	1.6 m	Heavy	Cross passages
B	1.1 m	Light	Tight curves

TBM launching – Up main tunnel (MC30)

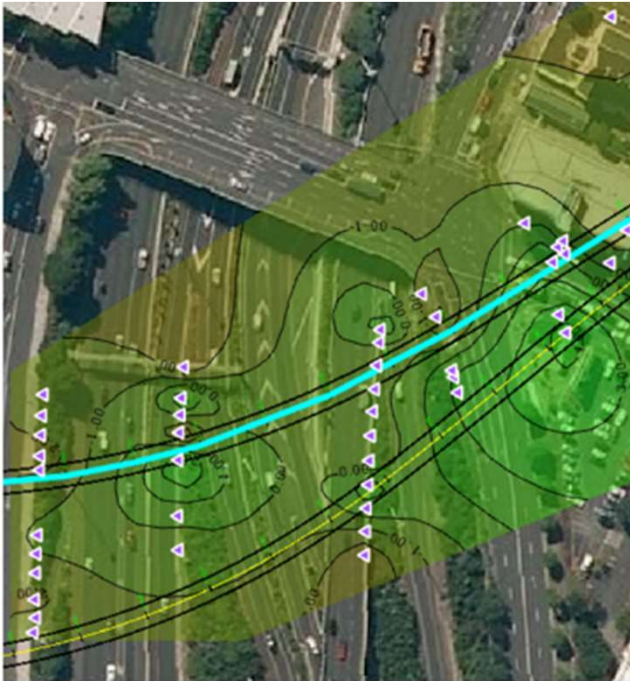


Thrust frame

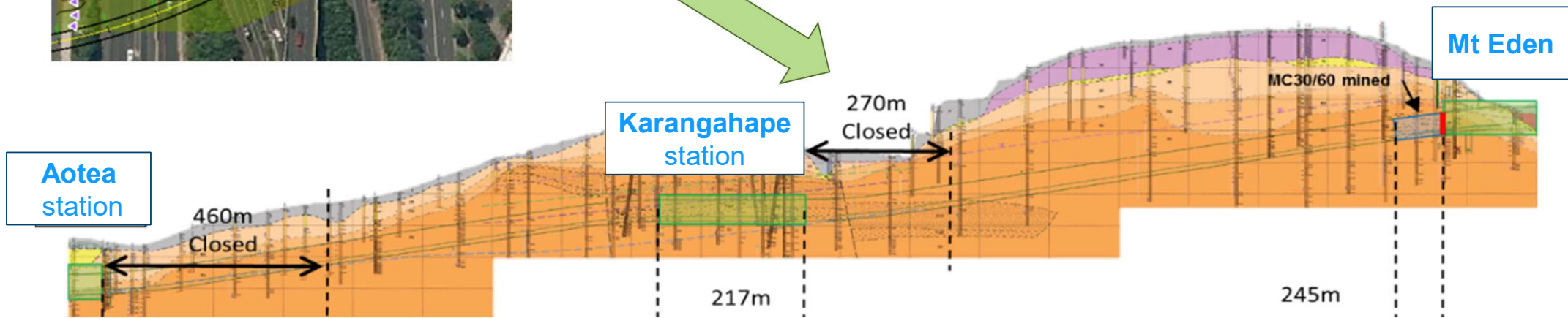
TBM launching – Down main tunnel (MC20)



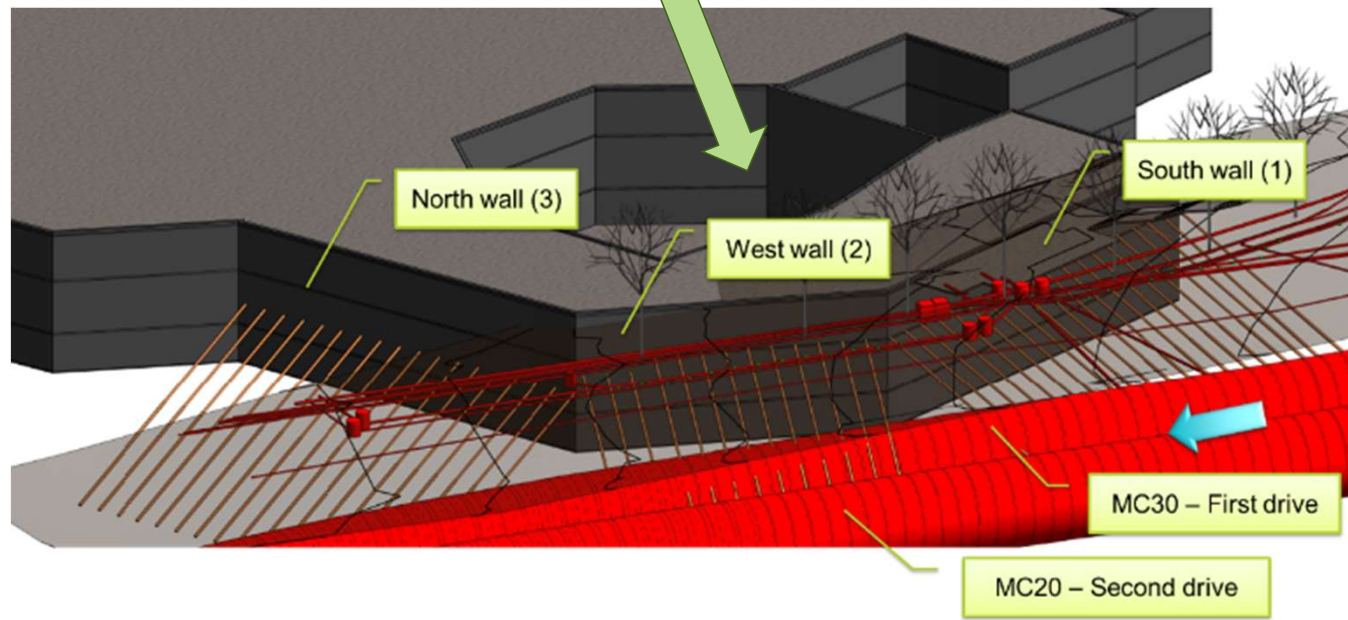
TBM drives – Crossing Auckland Motorway Junction – MC30



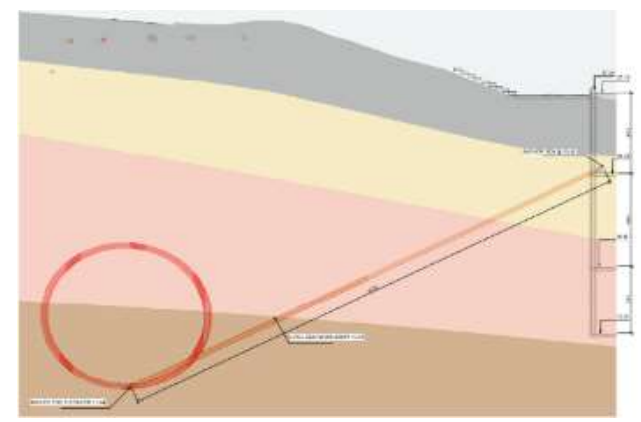
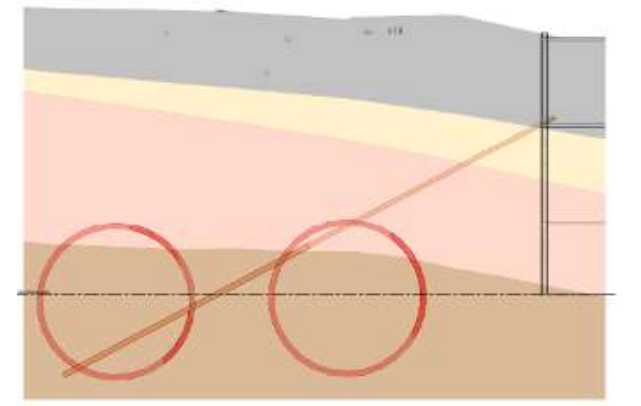
- Groundwater Monitoring: ~5m of temporary groundwater drawdown due to tunneling works, limited to ECBF.
- Settlement and buildings monitoring: $S_{max} \sim 2\text{mm}$
- Tunnel Convergence: Nothing significant



TBM drives – Anchors at Aotea Centre



26 passive anchors on the first TBM drive



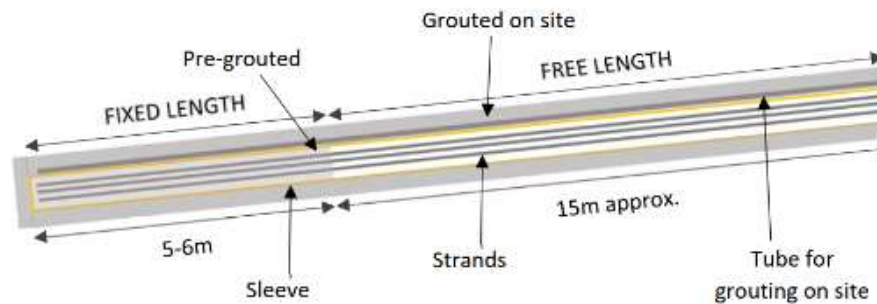
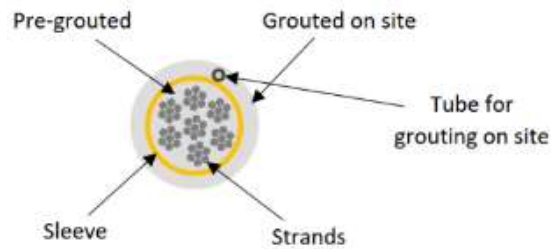
TBM drives – Anchors at Aotea Centre - Investigation



Samples from S28



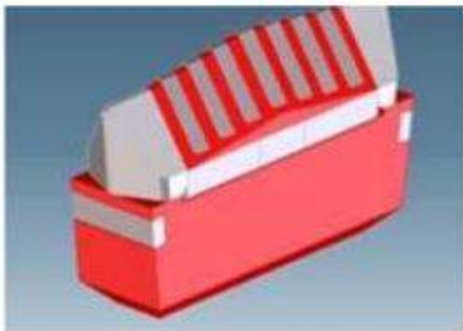
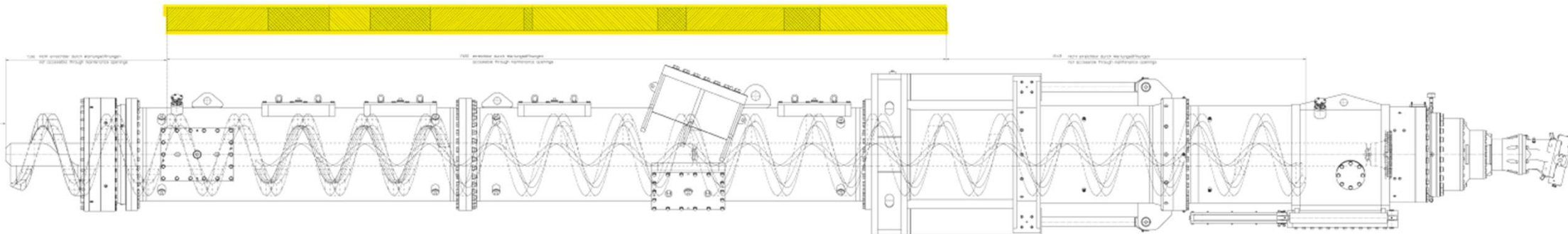
Samples from S27



Anchors characteristics:

- 7 strands each
- 7 wires/strand
- Strand \varnothing : 15mm
- Anchor \varnothing : 60mm

TBM drives – Anchors at Aotea Centre – TBM design



TBM specifically designed to deal with the anchors:

- TBM screw designed with several openings allowing access to almost 90% of the length. Screw conveyor equipped with a 1000 mm telescopic function to make the areas between these maintenance openings accessible as well.
- Cutterhead equipped with special heavy duty knives (16 units) (to be installed during Karangahape station crossing => 800 m of excavation)

TBM drives – Anchors at Aotea Centre – TBM design



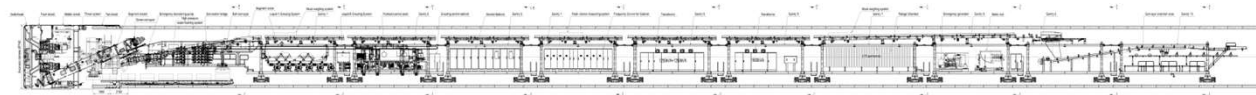
Heavy duty knives

TBM drives – Anchors at Aotea Centre – TBM performance – MC30

- Daily cutterhead inspection & removal of anchors accessible through the cutterhead opening
- Average TBM progress in the area obstructed by anchors: 10m/day



TBM tunnels



MC30 TBM Tunnel

MC20 TBM Tunnel

Karanga-a-Hape

Te Waihorotiu

Maungawhau

Karanga-a-Hape

Te Waihorotiu



17/10/2021

22/12/2021

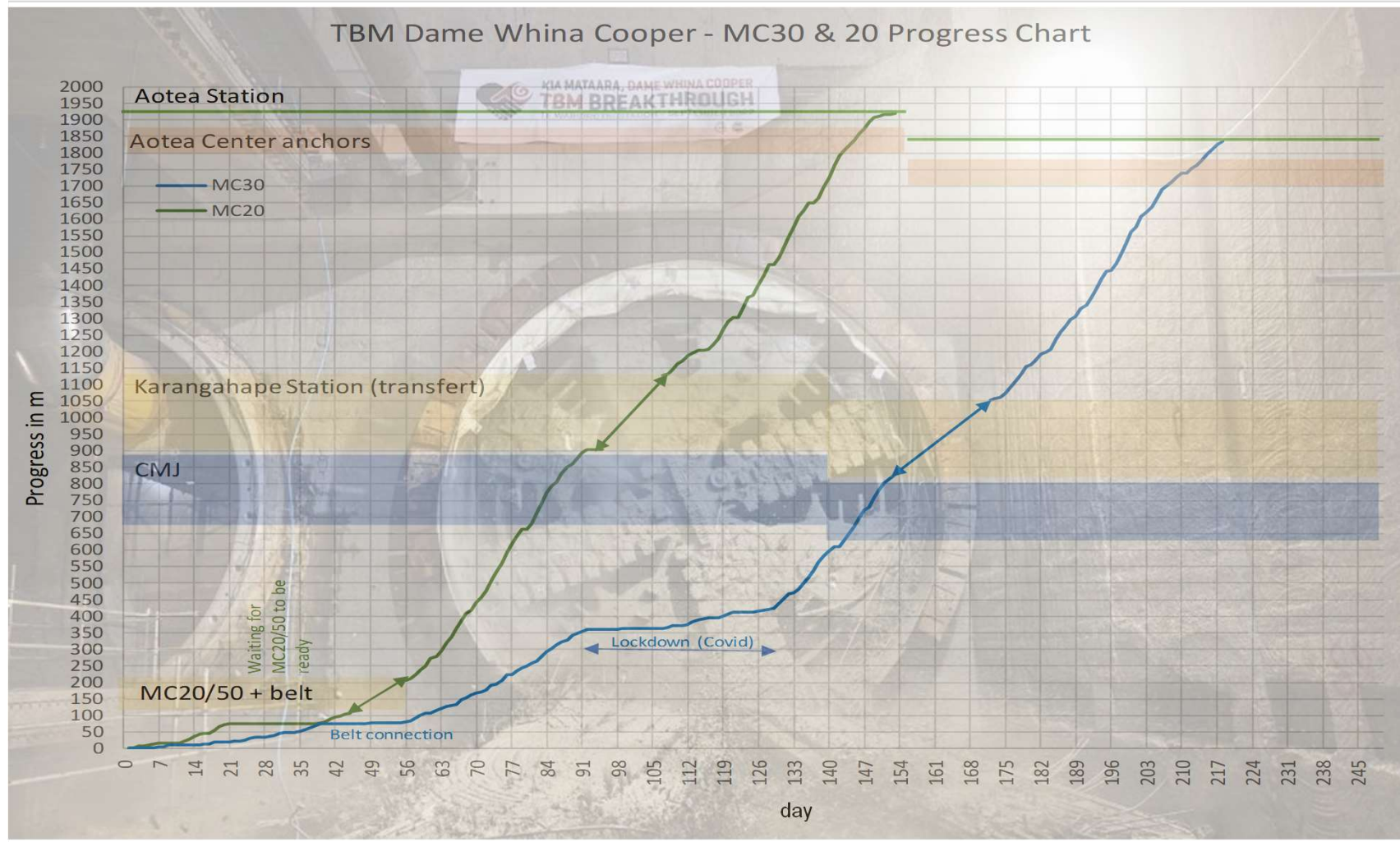
28/05/2022

15/07/2022

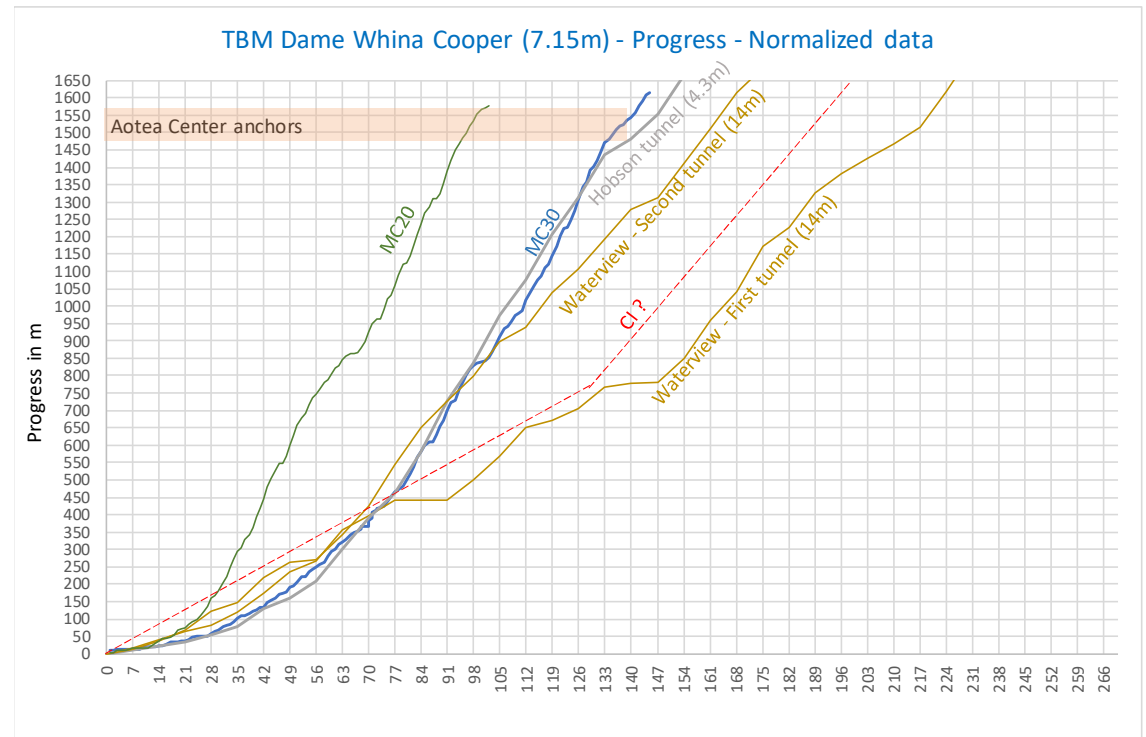
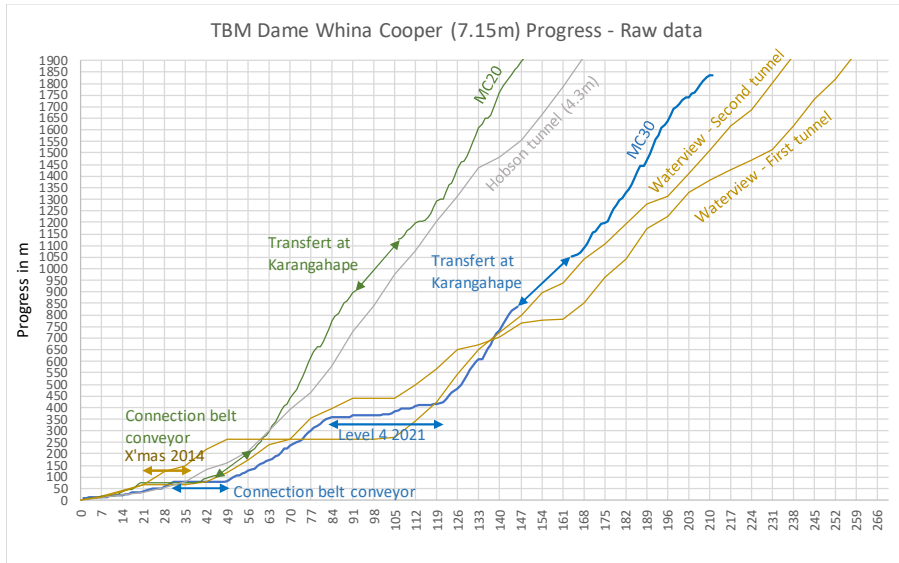
14/09/2022



TBM Performance



TBM Performance



TBM tunnels – Invert works - Cable tray / Water line / Walkway / Rail & Catenary installation



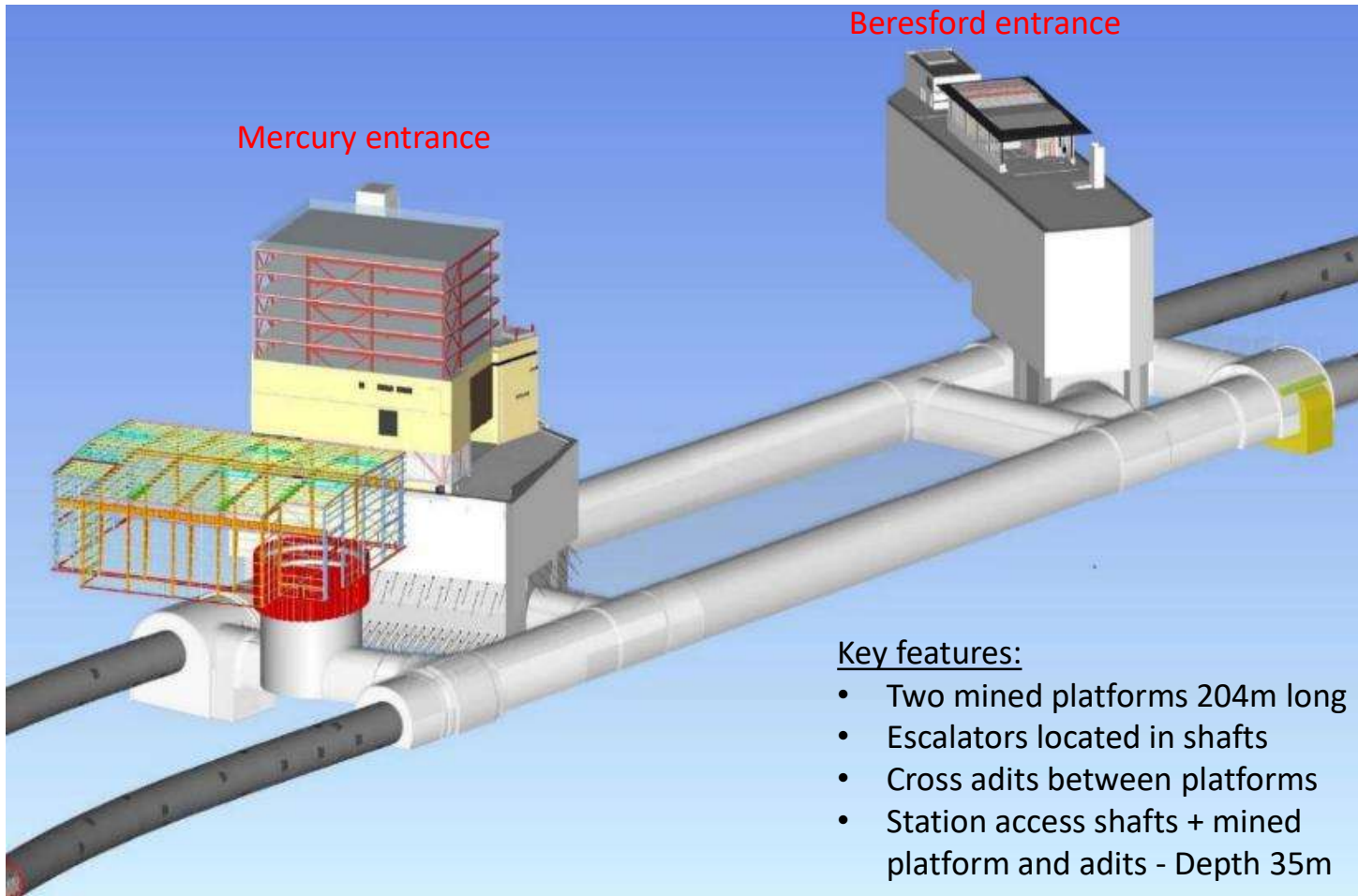
TBM tunnels – Cross Passages (4 units)



Underground stations

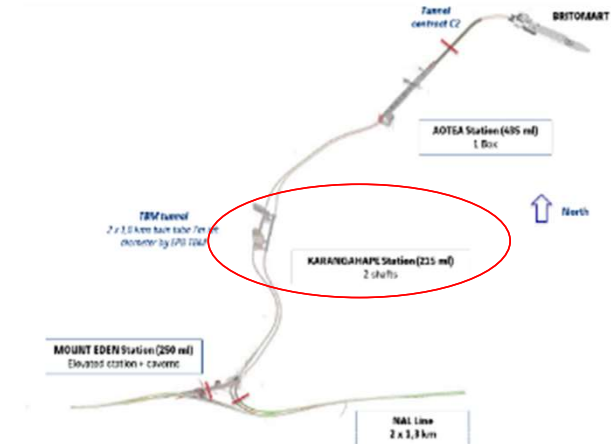


Karanga-a-Hape Station

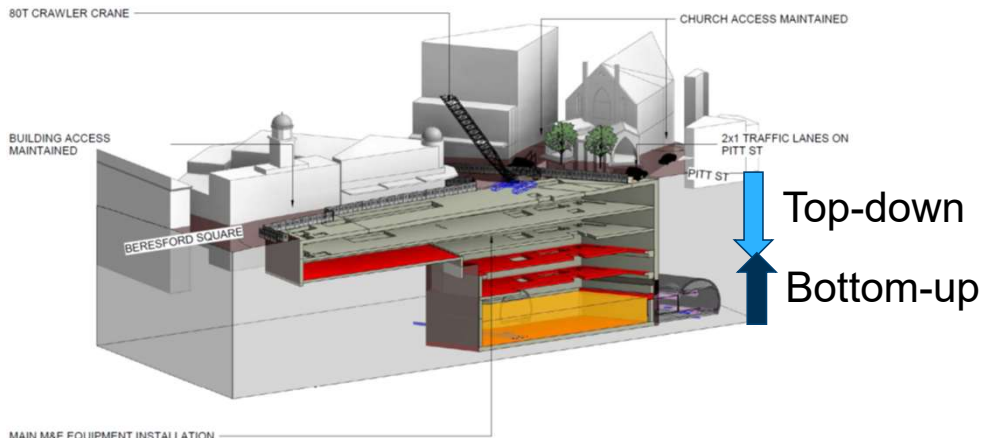


Key features:

- Two mined platforms 204m long
- Escalators located in shafts
- Cross adits between platforms
- Station access shafts + mined platform and adits - Depth 35m



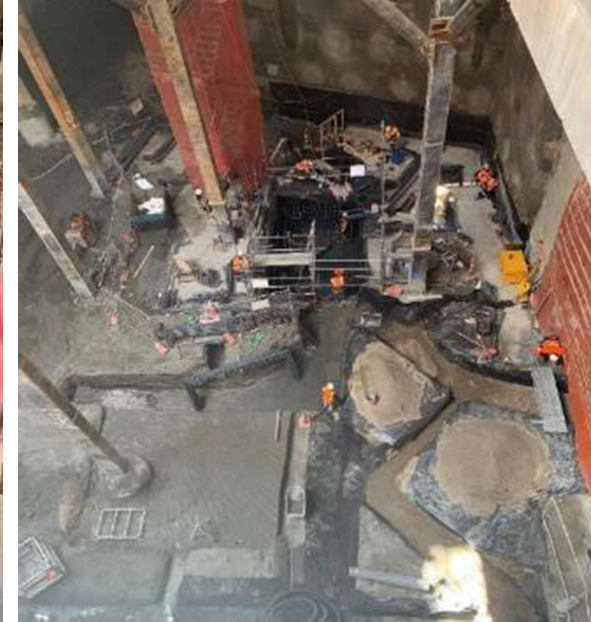
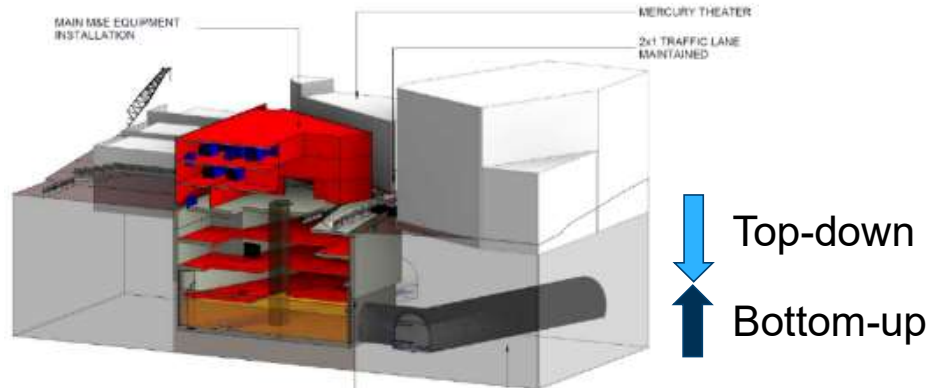
Karanga-a-Hape - Beresford Entrance – Top down & bottom up methods of works



Karanga-a-Hape – Beresford Entrance



Karanga-a-Hape - Mercury Entrance – Top down & bottom up methods of works



Karanga a Hape Station – Mercury Lane entrance



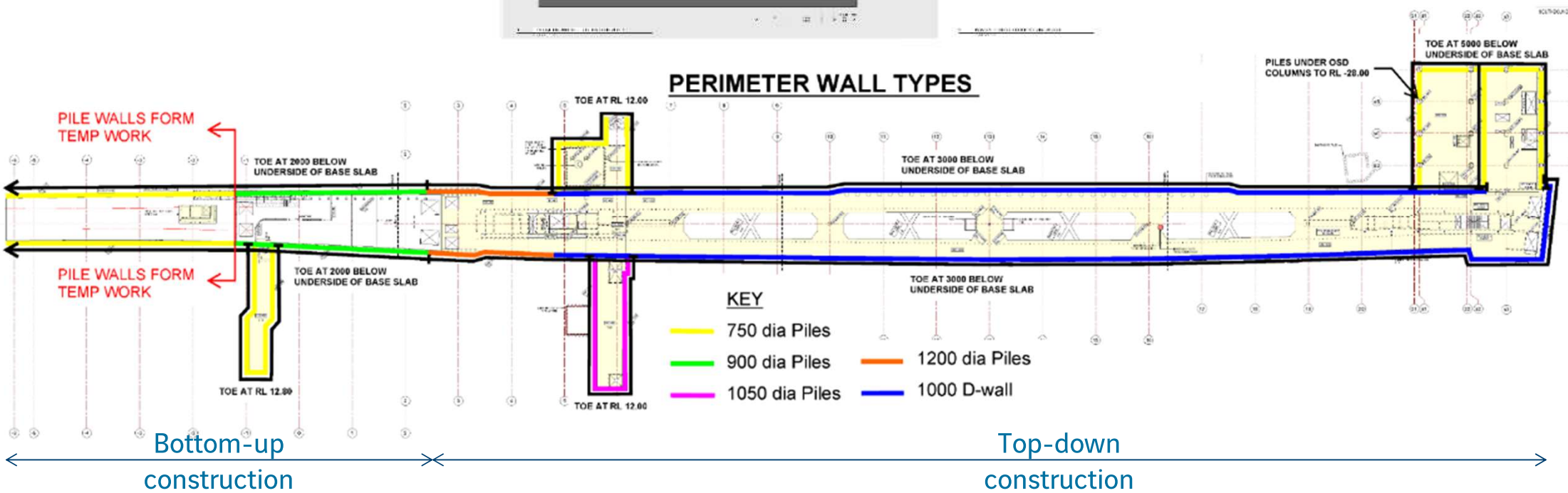
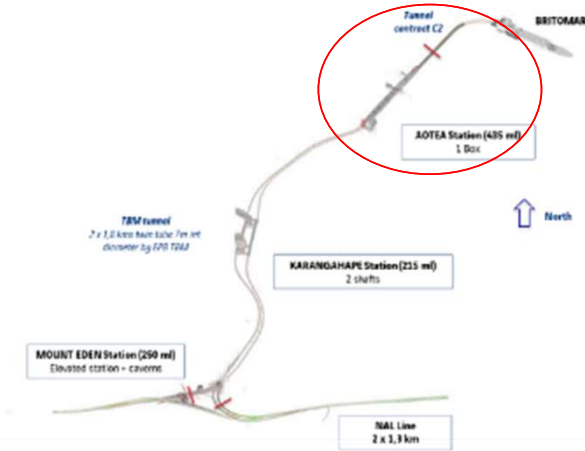
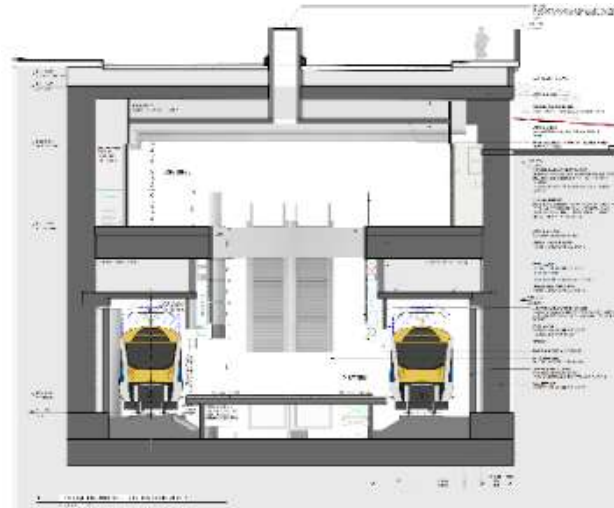
Te Waihorotiu Station

Key features:

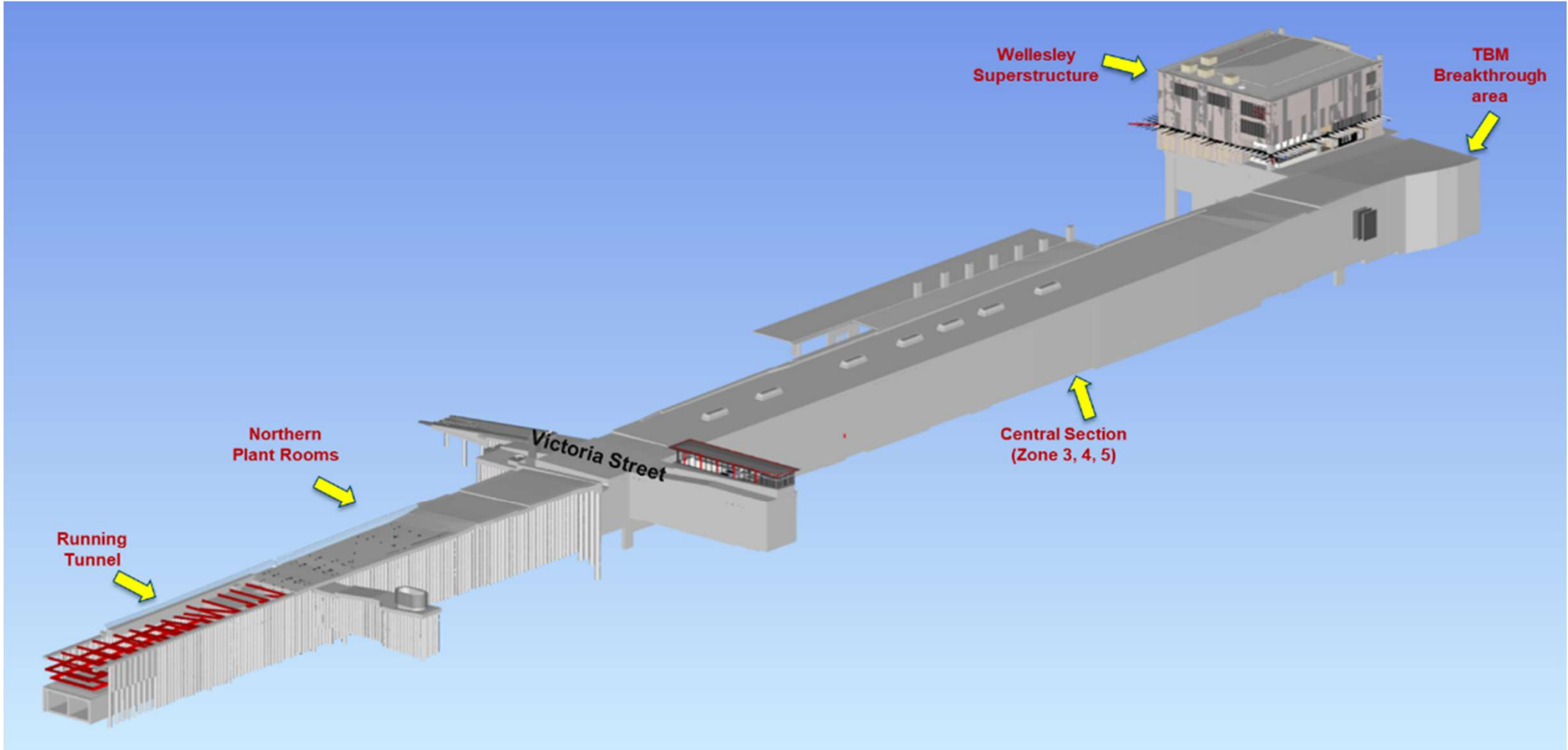
- Island platform 204m long
- Open concourse above platform

Main Dimensions:

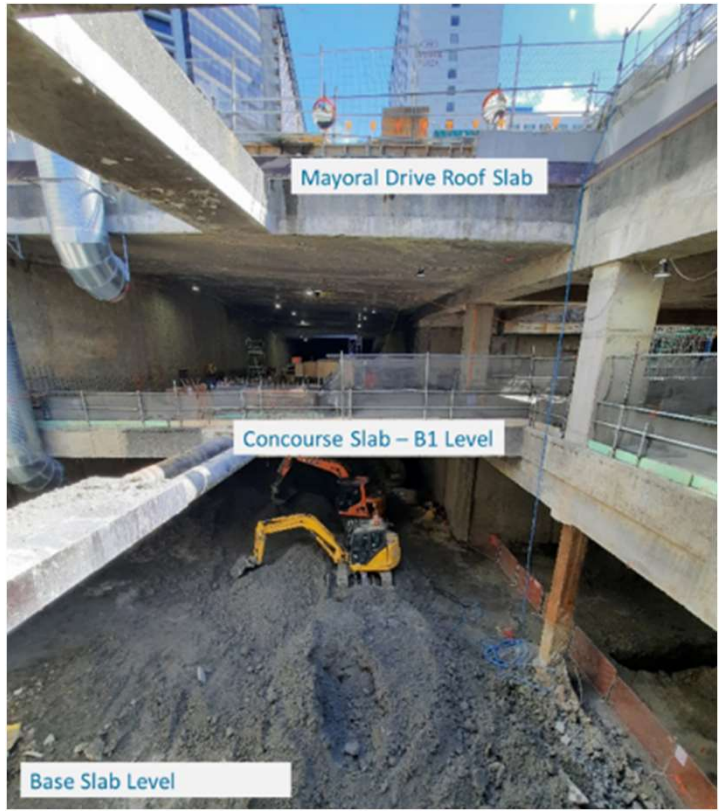
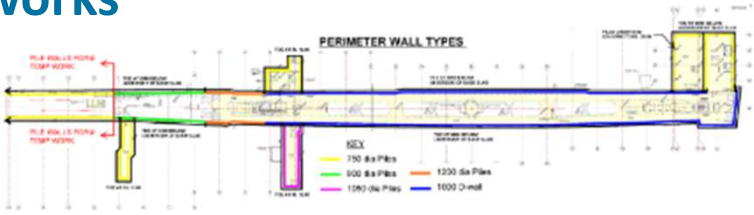
- Station + C&C 435m long
- Depth 15m
- Width approximately 20m



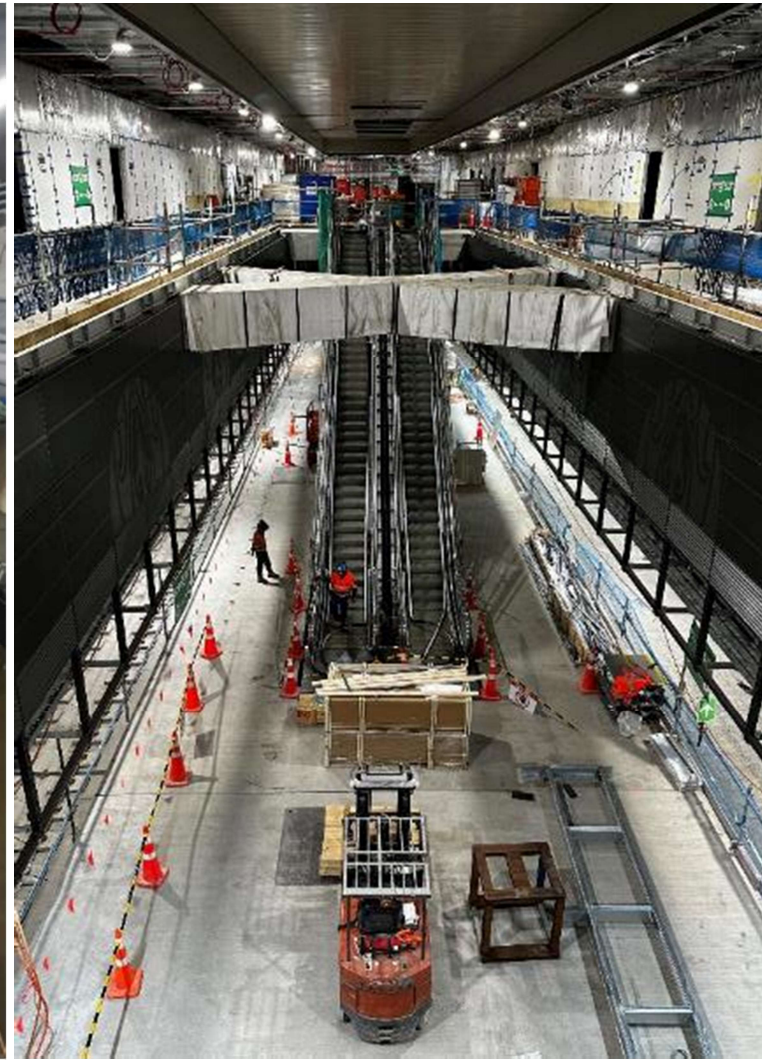
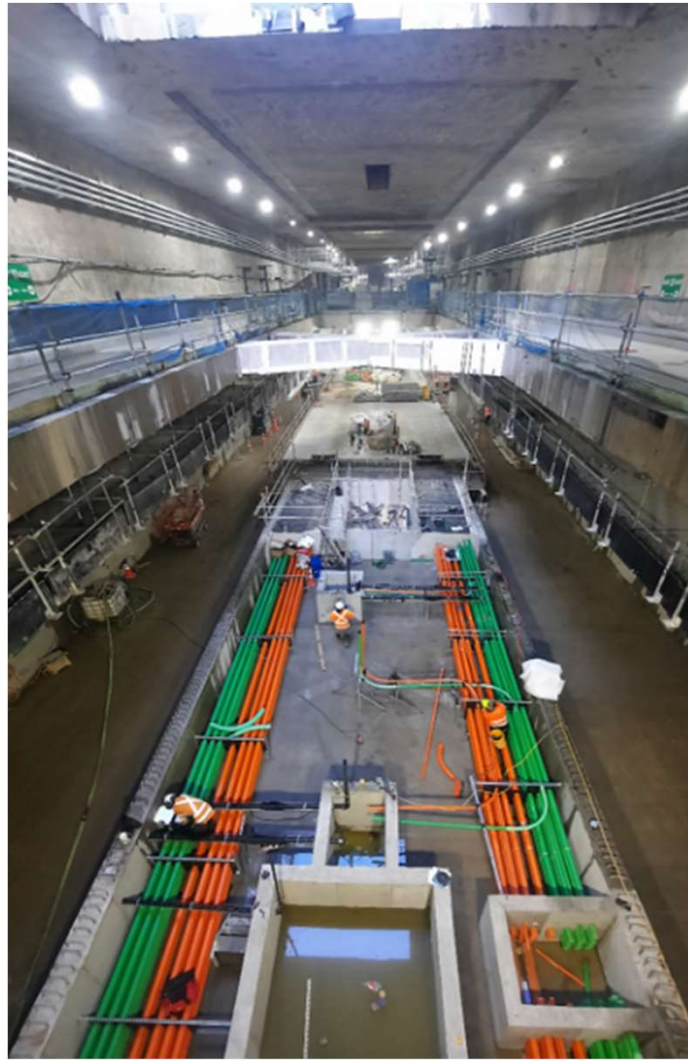
Te Waihorotiu Station



Te Waihorotiu – Top down & bottom up methods of works



Te Waihorotiu Station – Concourse & platform



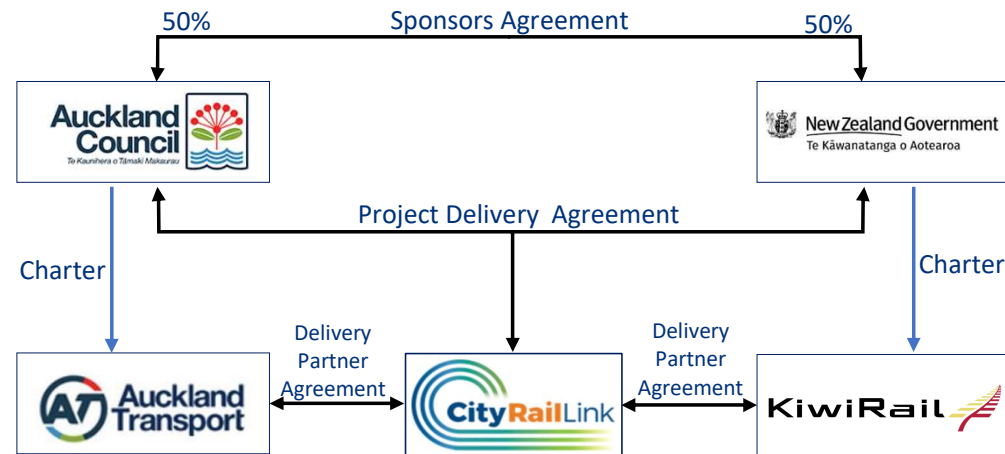


He tangata, he tangata,
he tangata



The Client

- Client: CRL Limited (Crown Entity) set up for the delivery of the CRL infrastructure
- CRL funded by 2 sponsors (NZ Central Gvt 50% - Auckland Council 50%)
- **Auckland Transport** and **Kiwi Rail** will own and operate the infrastructure [AT for stations and trains, KiwiRail the tunnels] Transdev operate the trains.
- Timing:
 - C3 Procurement process started in March 2017 [EOI for a D&B]
 - C3 preferred bidder in April 2019 [1619mNZ\$ for an Alliance]
 - C5 Variation Agreement “in principle” in December 2019
 - C5/C7 Variation in October 2020 [825mNZ\$]



The Alliance Charter



Our Charter

Our Mission: Transform Auckland with a rail network people love to use



The Alliance Principles



Alliance Principles

The Alliance Participants, including Stakeholder Alliance Participants, are committed to the following principles:

1

All decisions are made on a 'best for project' basis

2

All Alliance Participants win, or all Alliance Participants lose, depending on outcomes actually achieved

3

Risks and performance are managed collectively and there is equitable sharing of risk and reward

4

All transactions are undertaken on a fully 'open book' basis

5

Each Alliance Participant provides unconditional support to the Alliance including resources

6

Responsibilities are clearly defined in the context of a 'no blame' culture that allows all Alliance Participants to have a say

7

The Alliance Participants are committed to developing a culture that promotes, drives and maintains innovation and outstanding performance

8

Communication between Alliance Participants is open, straight, honest and timely



LINKA_26_06/27

The Alliance principles

- Les obligations de performance sont **collectives** [entre Client, Constructeurs et Concepteurs]
- Le projet est dirigé par un « Project Alliance Board » [**PAB**] composé de représentants de toutes les parties, y compris AT et Kiwi Rail.
- Le PAB se réunit au moins **une fois par mois**.
- Toutes les décisions sont prises **à l'unanimité** [aucun mécanisme de blocage]
- Engagement explicite **de non-recours** à l'arbitrage ou aux litiges [pas de Dommages et intérêts]
- Résiliation pour convenance avec rémunération équitable
- **Paiements mensuels** selon les coûts (Limb1) + frais (Limb2) + prime/pénalité (Limb3)
- Prime ou Pénalité équitablement partagé [50/50] entre le client et les autres participants de l'Alliance [OAP - Other Alliance Participants]
- La responsabilité entre les parties est limitée à Limb2 + Limb3 [sauf en cas de défaut volontaire - **Limb1 jamais à risque**]
- Participants à l'Alliance partagent **tous** les risques [sauf risques identifiés dans le contrat] indépendamment du fait qu'ils soient maîtrisables par les Participants ou qu'ils auraient pu être prévus
- Gestion quotidienne du projet est assurée par une équipe de projet intégrée où les membres sont affectés strictement sur la base du « **meilleur profil pour le projet** », indépendamment de l'entreprise dans laquelle ils sont employés
- Directeur de projet de l'Alliance (VCGP) avec une large délégation de pouvoir [5mioNZ\$]
- PCG (Parents Company Garanty) et deux garanties de bonne exécution [60 + 40mioNZ\$]
 - Modèle de contrat d'alliance **bien connu** en NZ

The Alliance Objectives



Project Objectives

- ## 1 Achieve industry leading standards for health, safety and wellbeing

 - Total commitment to safety in everything we do
 - Deliver a safe rail system
 - Protect the health, safety and wellbeing of the public
 - Invest in the competence and capability of our people
 - Collaborate within the industry to achieve safer outcomes
 - Demonstrate visible leadership at all levels
 - Promote the wellbeing, mental and physical health of our people
 - Learn from incidents and adapt to continuously improve
 - Implement best practice to limit the effects of Covid
- ## 2 Develop exceptional interfaces and collaborative relationships

 - Manage interface risks
 - Develop and maintain collaborative and supportive relationships within the alliance team, between alliance participant organisations and with sponsors, partners and stakeholders
 - Demonstrate an unwavering commitment to be a good neighbour by partnering effectively with our communities
- ## 3 Complete the project on time

 - Handover all infrastructure to achieve practical completion in 2024
 - Integrate all KiwiRail and Auckland Transport actions and interfaces into the programme for timely completion
 - Deliver a fit for purpose, fully integrated system
 - Demonstrate performance of the infrastructure and achieve an asset with no defects
- ## 4 Build a team committed to delivering high performance


 - Work together as a united delivery team to lift performance
 - Commit to the Alliance Charter
 - Embrace cultural differences and diversity
 - Achieve high levels of accountability and role clarity
 - Promote opportunities for people to learn and develop
 - Appreciate and recognise genuine high performance
- ## 5 Achieve best value

 - Deliver the project within budget
 - Use innovative design and construction methods
 - Integrate seamlessly into the transport system
 - Drive whole-of-life value so project assets are economic and efficient to operate and maintain
 - Integrate all relevant project initiatives to achieve efficient use of resources
- ## 6 Set new benchmarks in sustainable and environmental performance

 - Minimise disruption to surrounding communities and transport users
 - Contribute to innovative approaches to reducing carbon in construction
 - Integrate sustainability in design, construction, operation and maintenance
 - Minimise waste and limit visual, air quality, water quality and noise effects
- ## 7 Social outcomes that make a positive difference to the lives of others

 - Maximise opportunities for training, skills development and employment for our focus group: Mana Whenua, Māori, Pasifika and Youth
 - Engage Māori and Pasifika businesses where possible across the project
 - Promote a range of career and development opportunities in schools, universities and training institutes
 - Support Māori, Pasifika and local business affected by our construction sites
 - Promote a broader understanding of Māori culture and values through the alliance
- ## 8 Leave a great legacy

 - Build a reliable and safe rail system people love to use
 - Set new benchmarks for safety, health, environmental and sustainability performance for the New Zealand construction industry
 - Deliver memorable architecture, buildings and finishes
 - Shape and grow a competent, confident and diverse workforce for the future
 - Grow support and confidence in New Zealand's ability to deliver mega-projects
 - Enhance the reputation of all sponsors, partners, stakeholders and participants



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