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Underground Stations Excavation of up to 45m Deep for MRT in Limestone Formation, Malaysia

(MYS-03)

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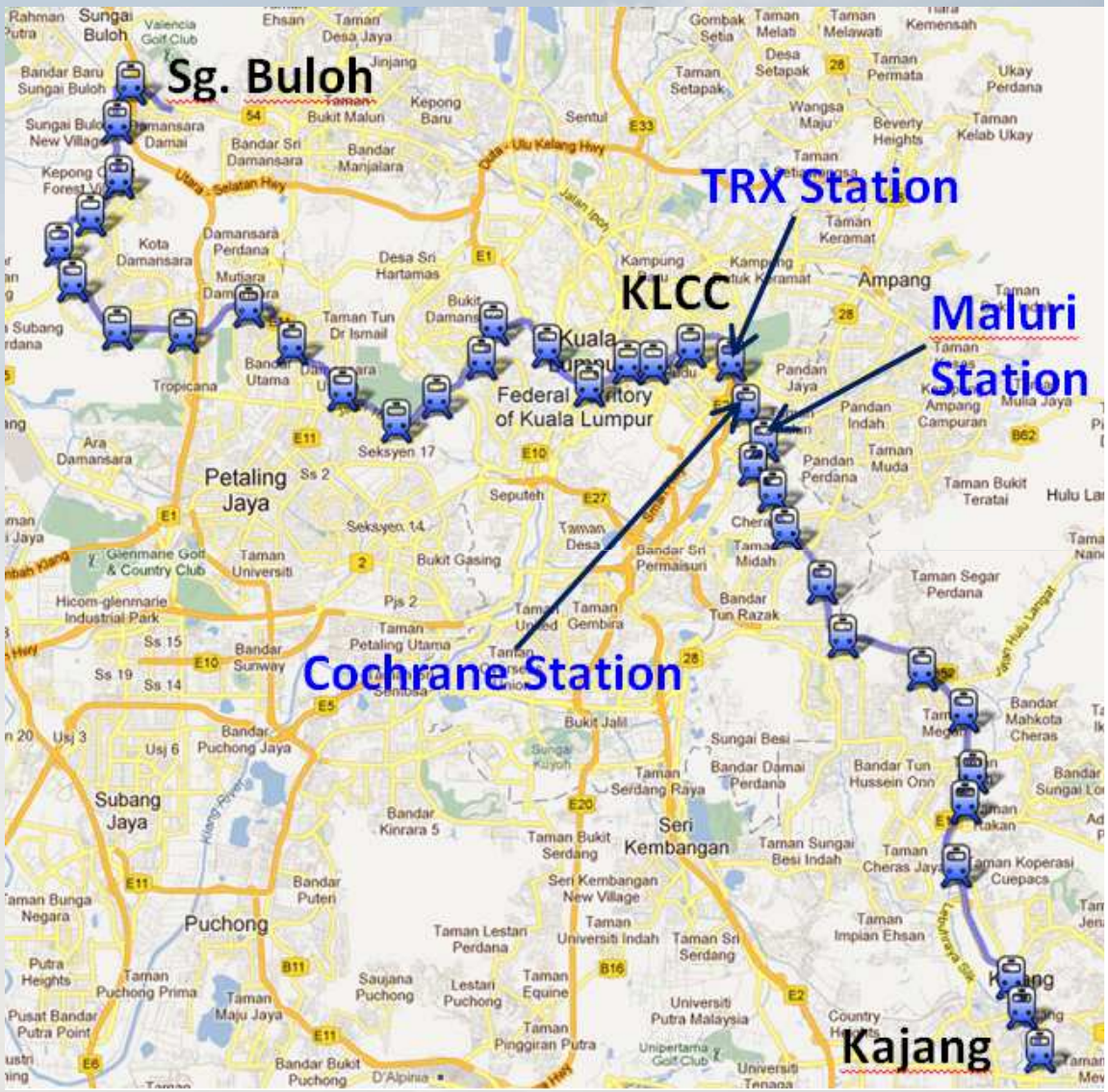
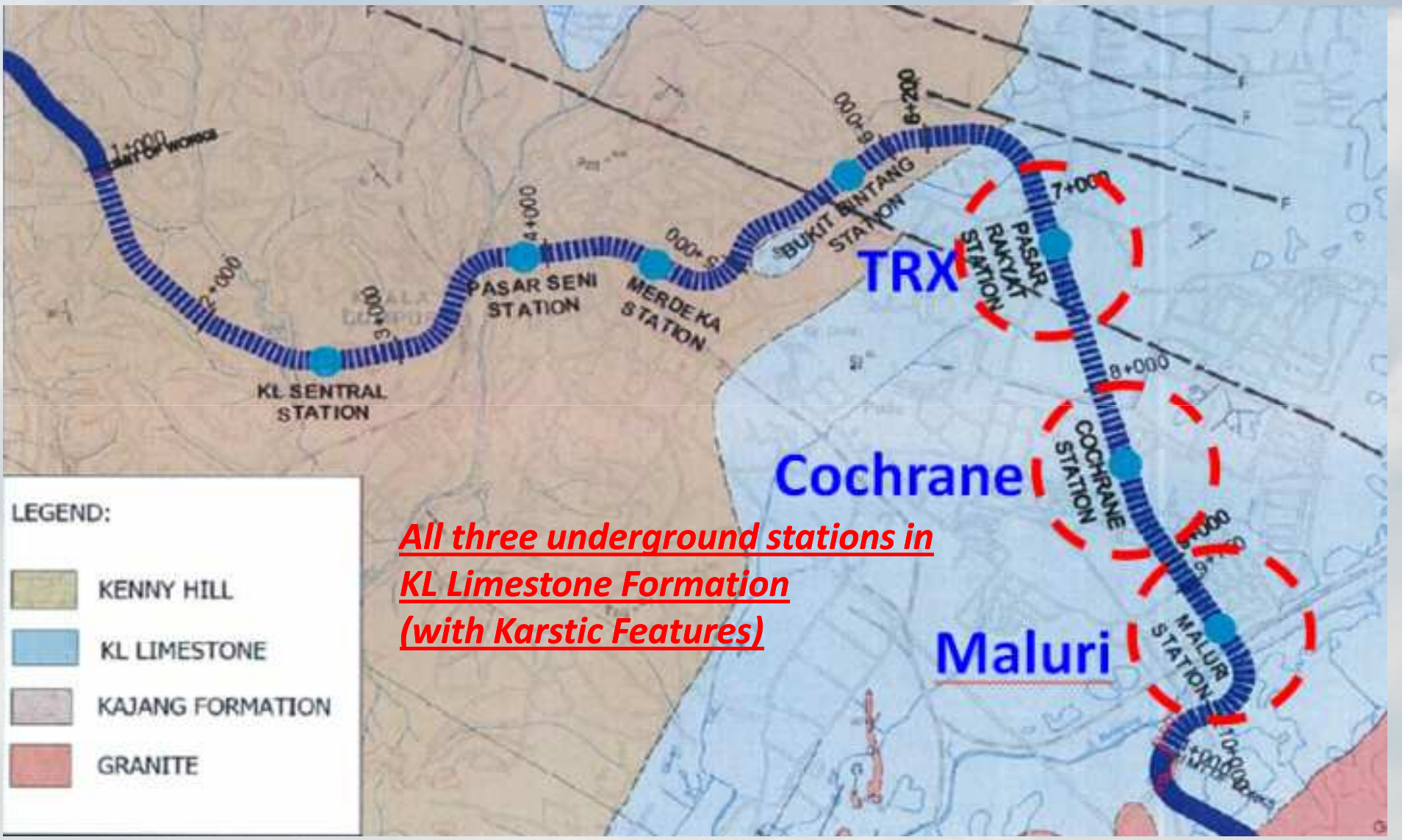
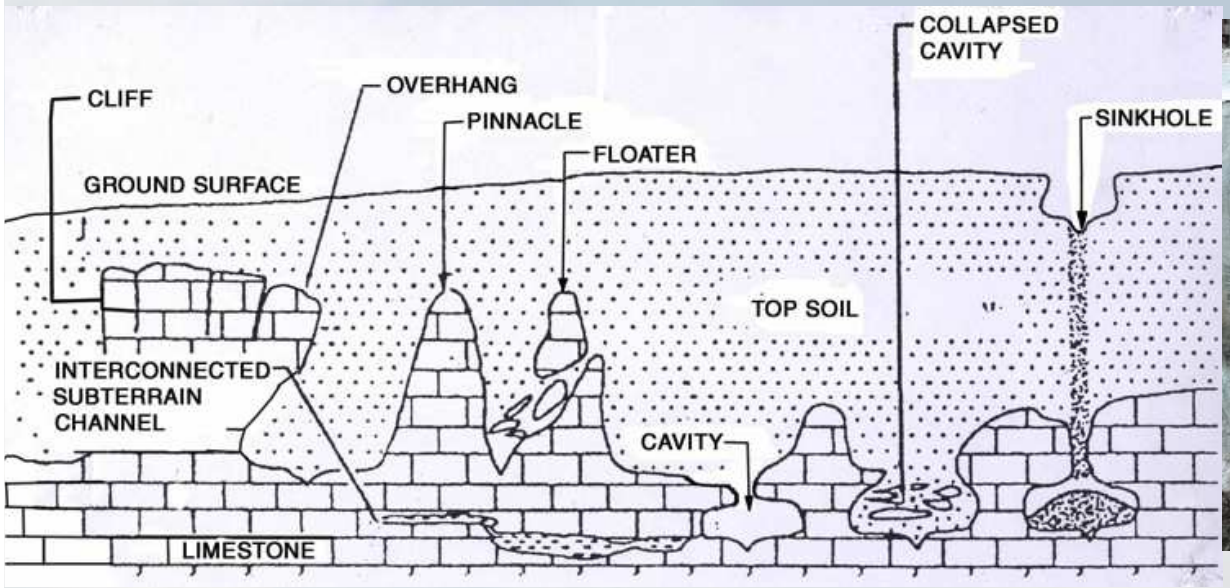
Locations of the MRT Underground Stations

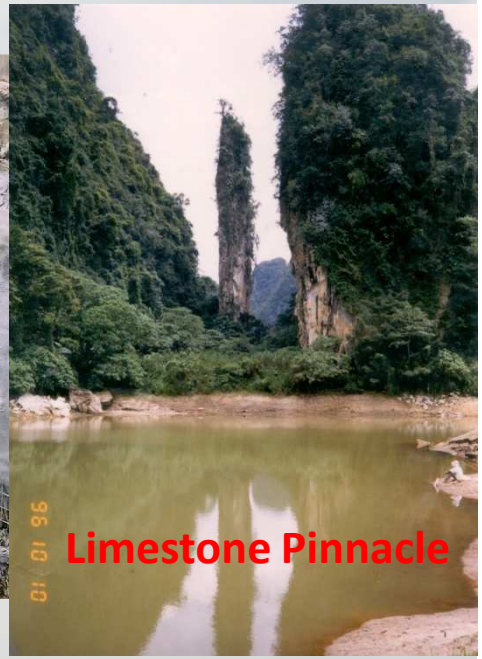


Geology of Kuala Lumpur

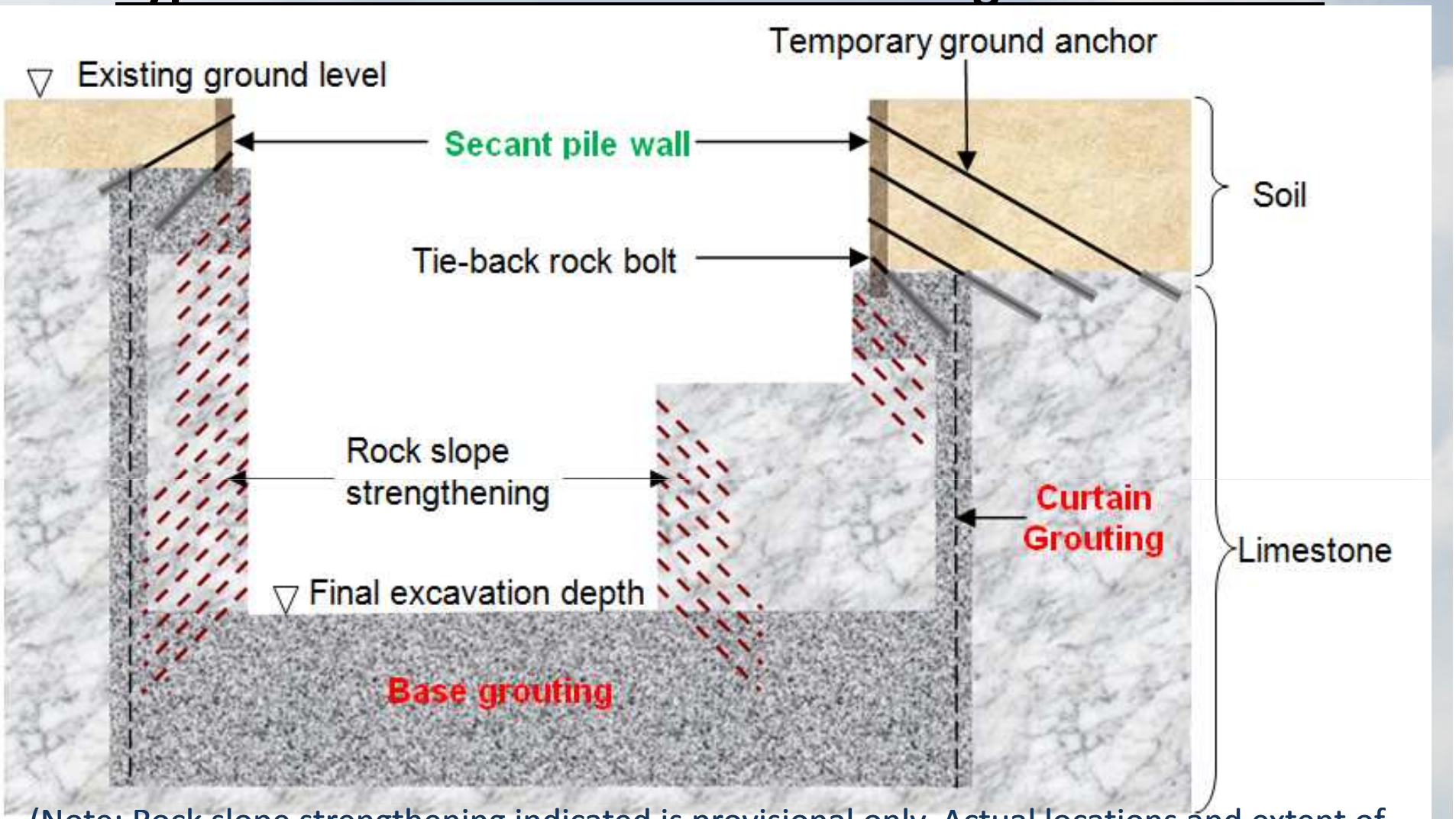


Karstic Features of Kuala Lumpur Limestone Formation



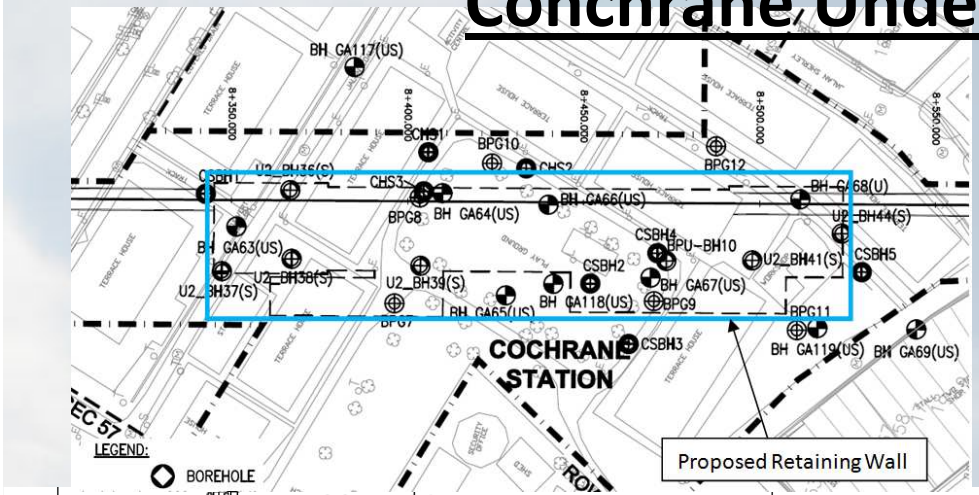


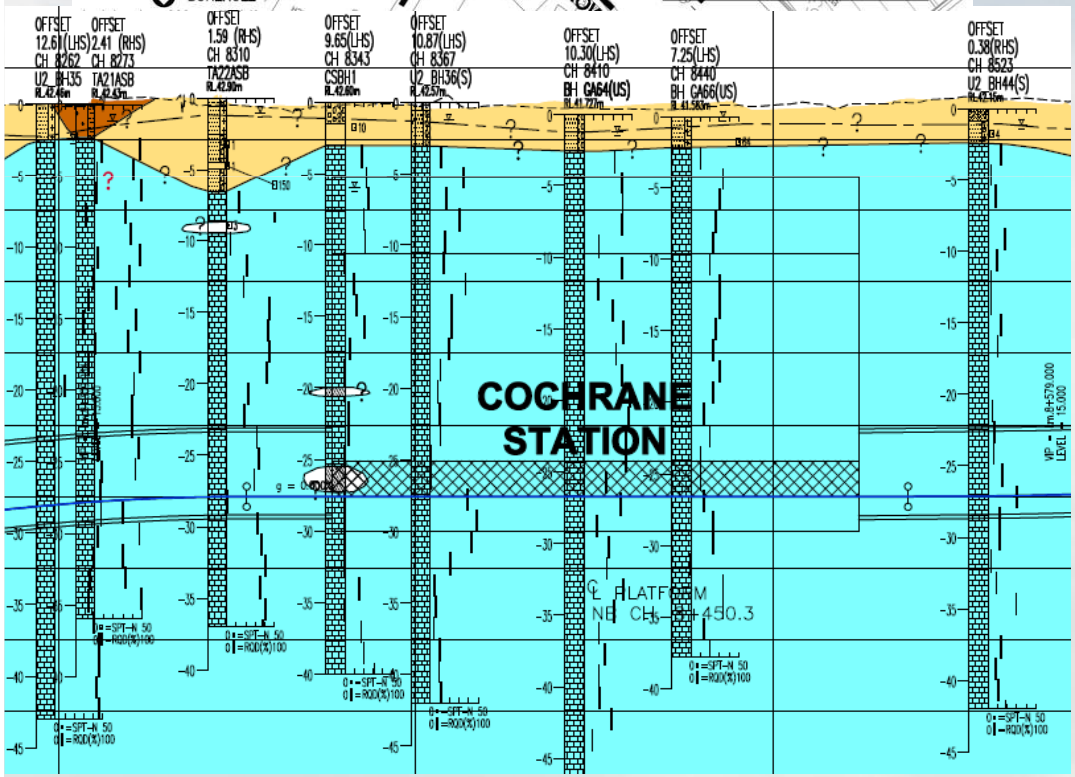
Typical Excavation Section for Underground Station



(Note: Rock slope strengthening indicated is provisional only. Actual locations and extent of rock slope strengthening are determined after geological mapping works and kinematic analysis).

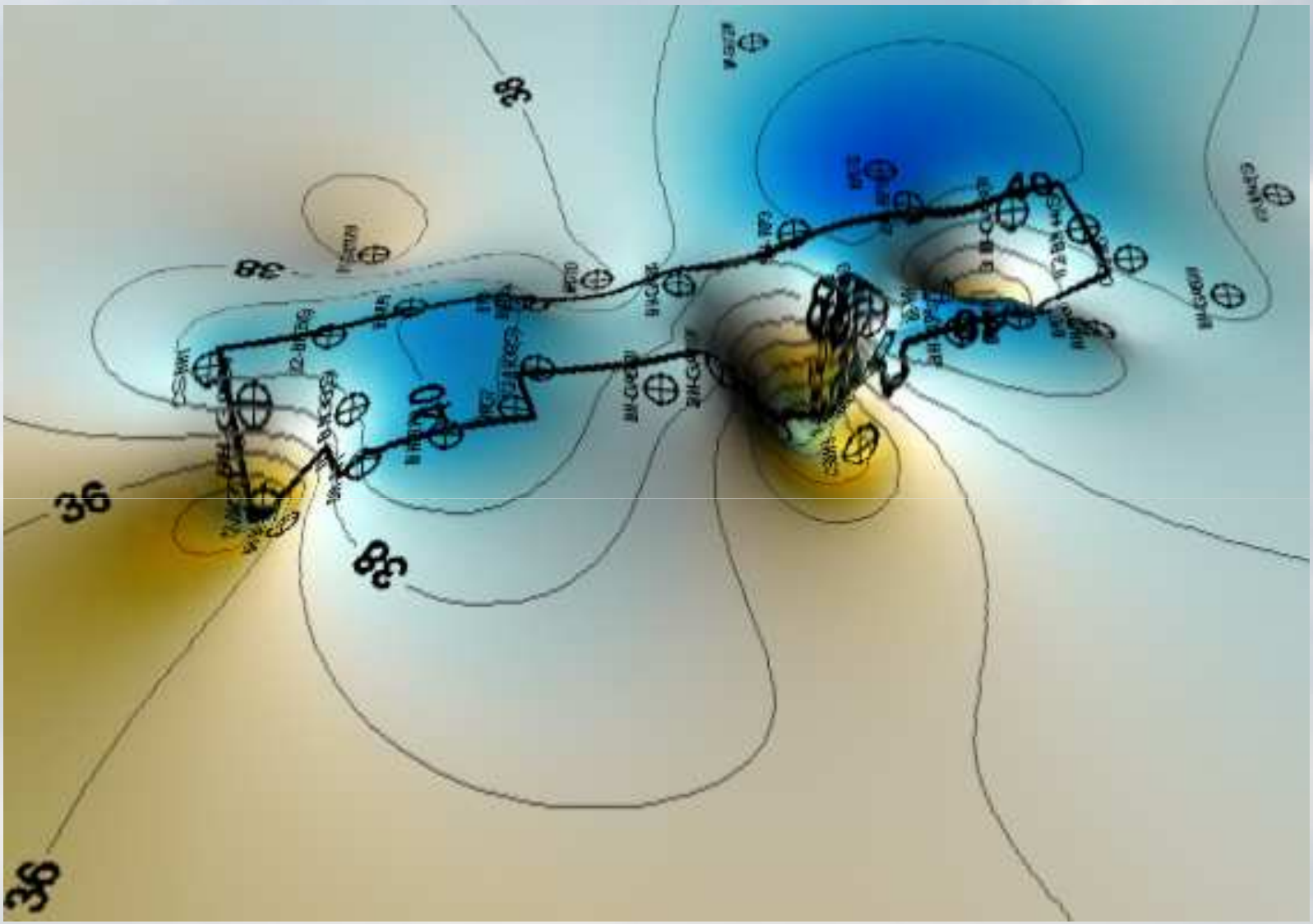
Conchrane Underground Station



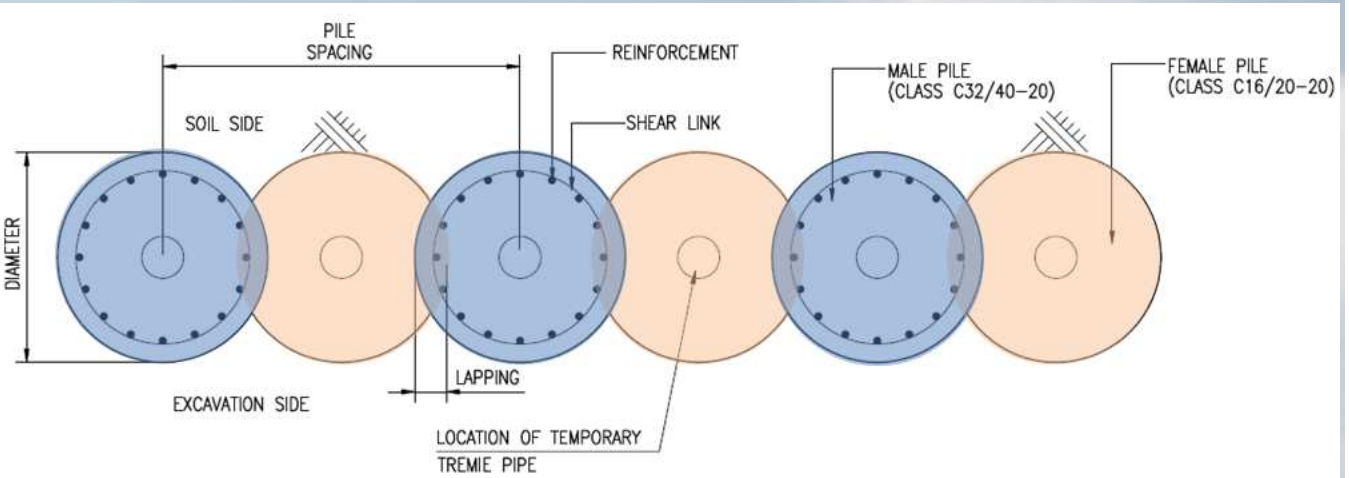


	Subsoil	Bedrock
Material type	Silty Sand	Limestone
Average depth	5m	5m below
Unit weight	18 kN/m^3	24 kN/m^3
SPT N	2 - 4	-
RQD	-	0 – 100%
Average UCS	-	50 MPa
Effective shear strength	c'= 1 kPa ϕ'= 29º	c'= 400 kPa ϕ'= 32º
Elastic Modulus, E' (kPa)	4000 - 12000	1.0E6 – 1.0E7
Hydraulic conductivity, k	1.0E-5 m/s	0 – 31 Lugeon

Conchrane Station Bedrock Contour

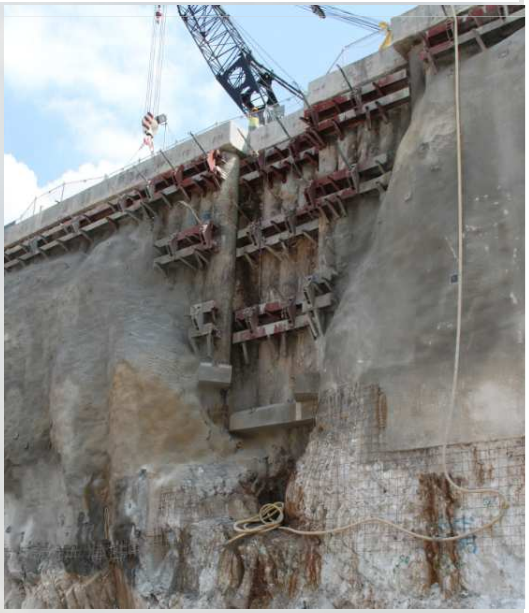


Secant Pile Wall



TYPICAL CROSS SECTION OF TEMPORARY HARD/SOFT SECANT PILE WALL (PLAN VIEW)

NOT TO SCALE



Typical Secant Pile Wall Elevation View

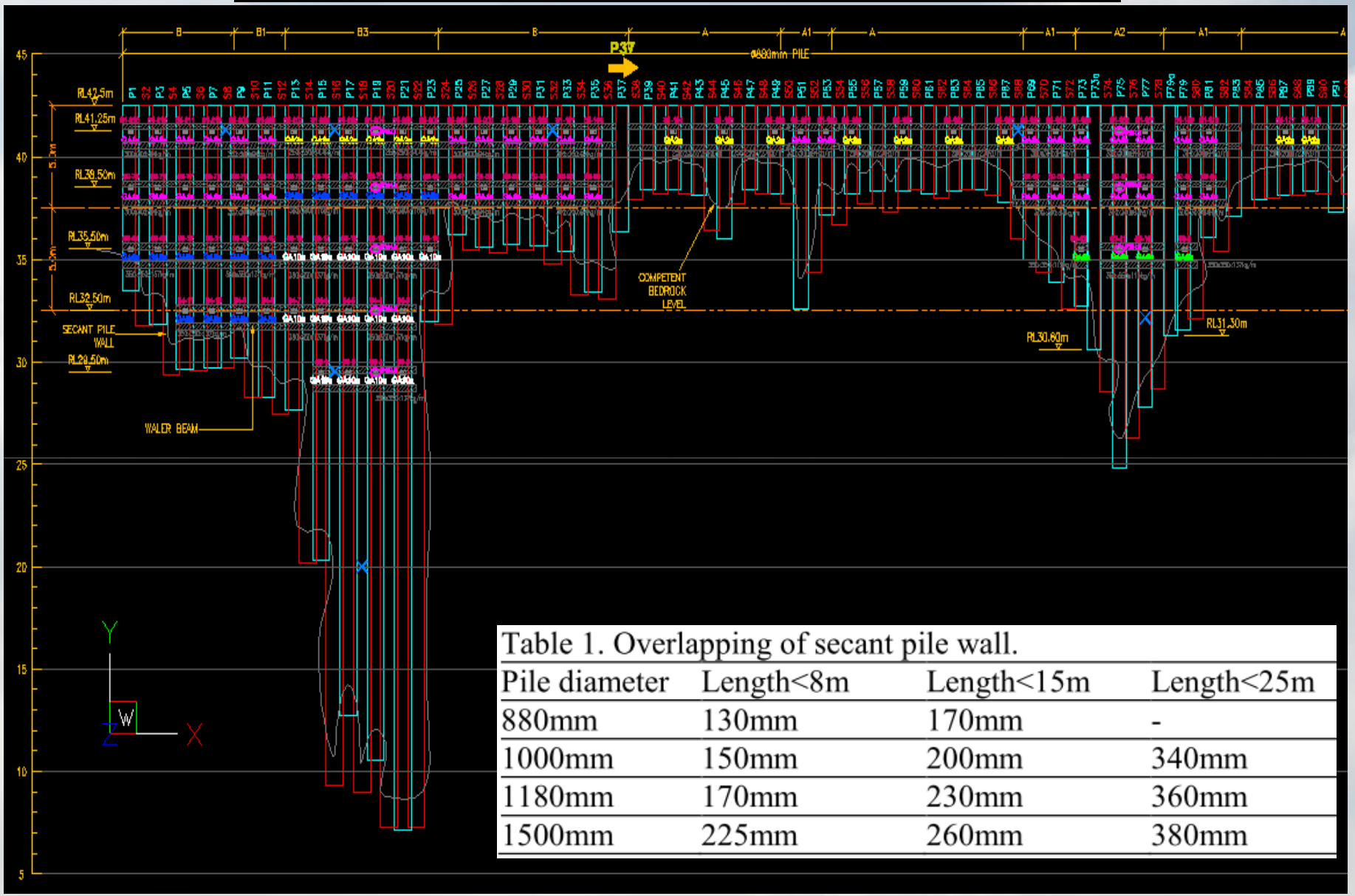
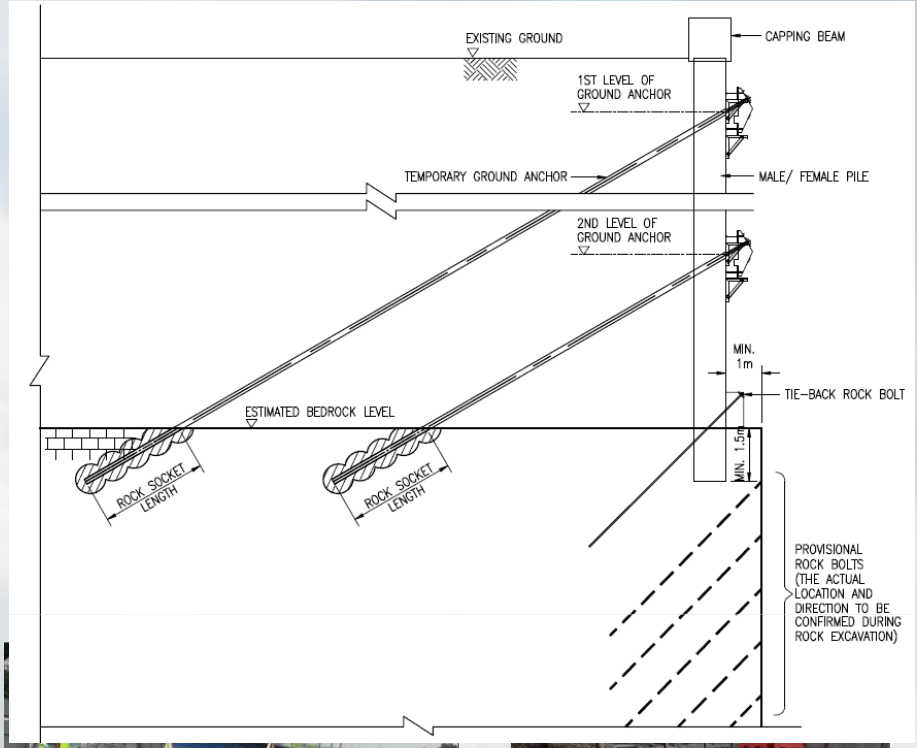


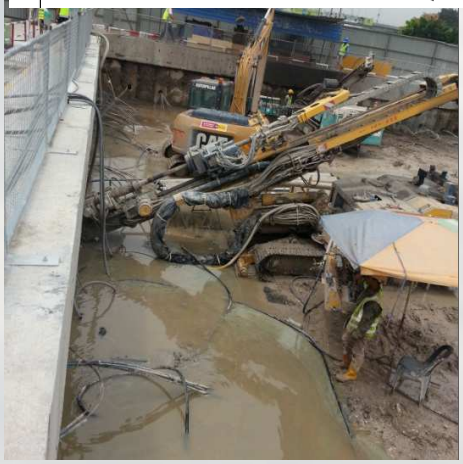
Table 1. Overlapping of secant pile wall.

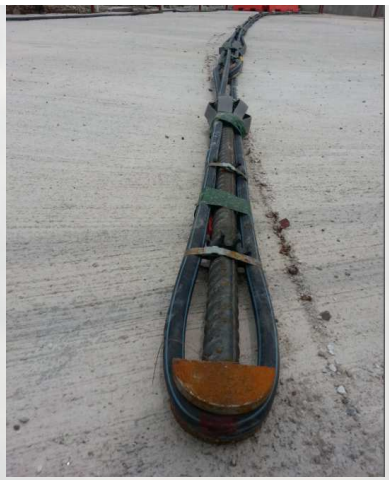
Pile diameter	Length<8m	Length<15m	Length<25m
880mm	130mm	170mm	-
1000mm	150mm	200mm	340mm
1180mm	170mm	230mm	360mm
1500mm	225mm	260mm	380mm

Temporary Ground Anchor Support System



Description	Properties
Working loads (kN)	212; 424; 636; 848
No. of strand	2; 4; 6; 8
Strand diameter	15.24mm
Breaking load	260.7 kN
Factor of safety	1.6
Strand U-turn radius	47.5mm
Reduction factor	0.65
Drill hole diameter	175mm
Allowable bond stress	400 kPa (limestone)
Free length	Varies (until bedrock)
Bond length (m)	3; 3; 4.5; 6





Curtain & Base Grouting to seal the Limestone Karstic Features

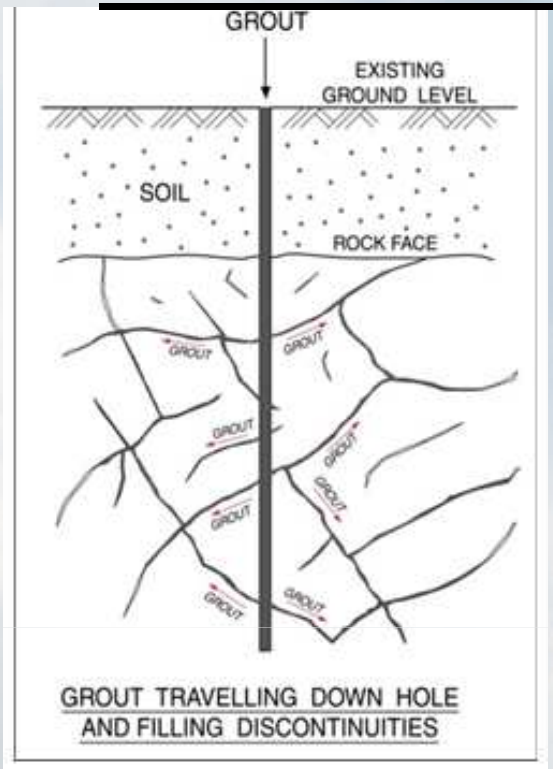
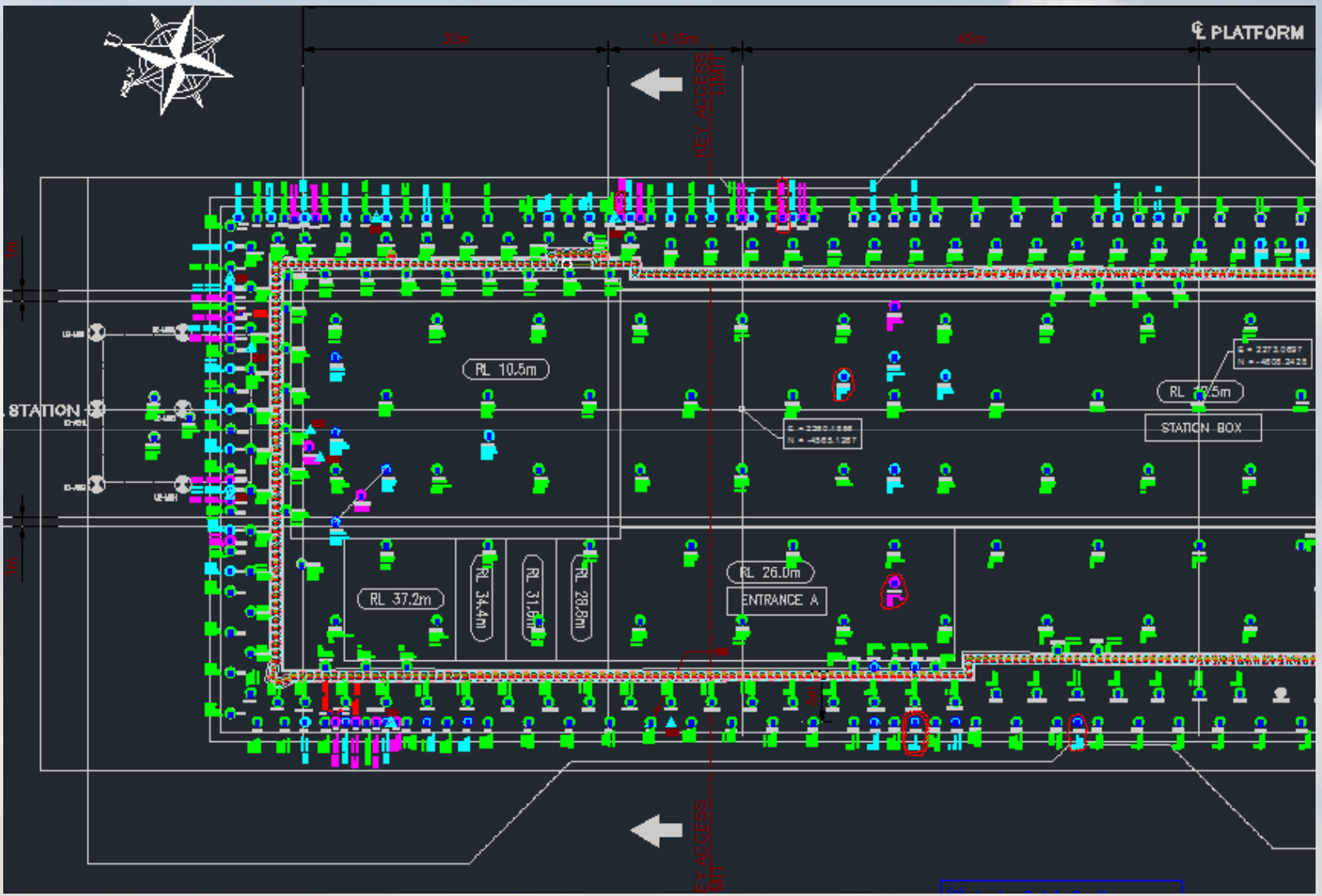


Table 3. Holding pressure for fissure grouting.

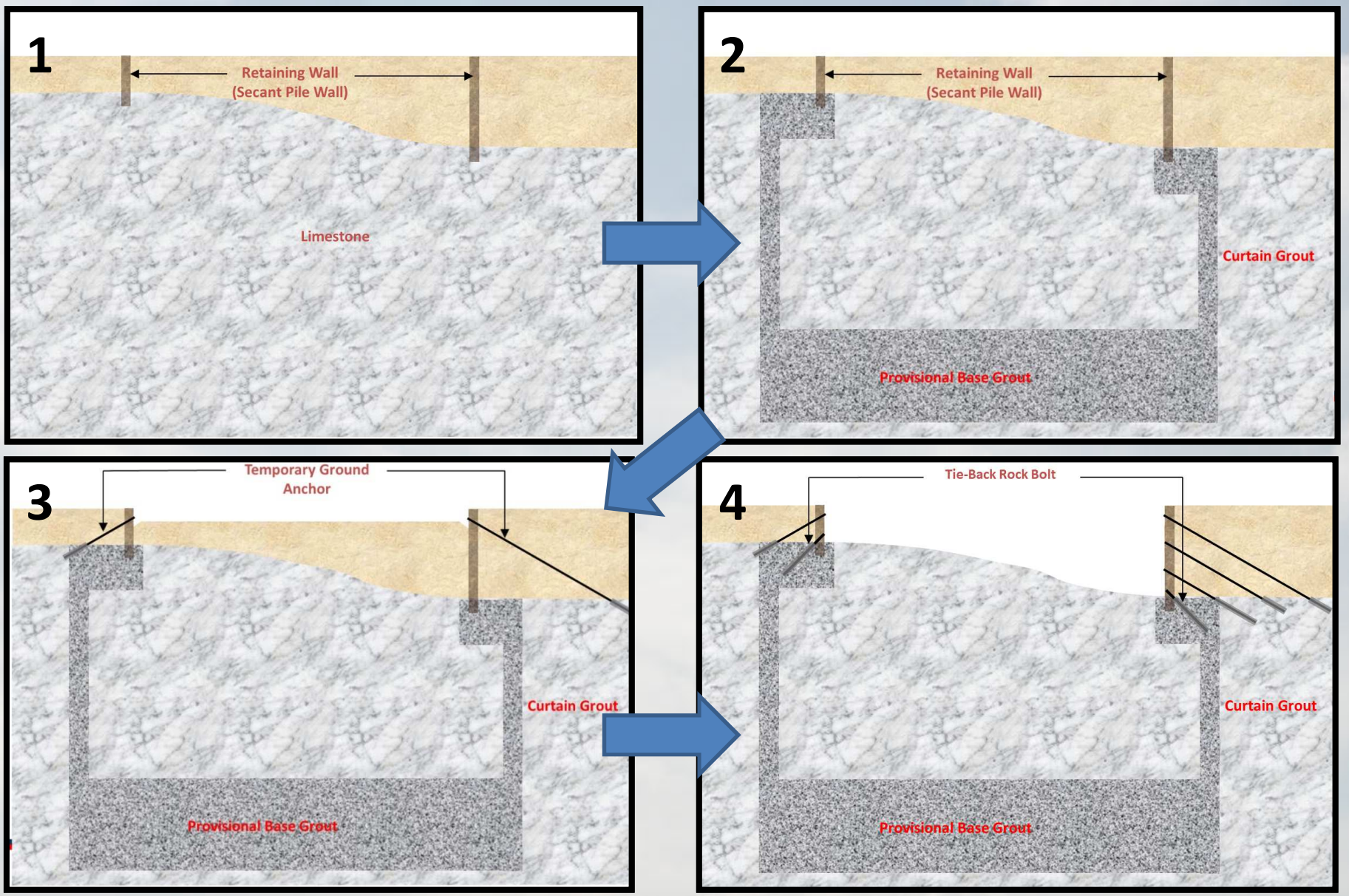
Depth (m)	Holding pressure (Bar)
0 to 10	2 to 4
10 to 20	6 to 8
20 to 30	10 to 12
30 to 40	14 to 16
40 to 50	18 to 20
>50	>22

Note: Termination criteria shall be satisfied with flow rate less than 2 liters per minute or grout volume reaches $10m^3$ for every grouting zone in 5m depth.

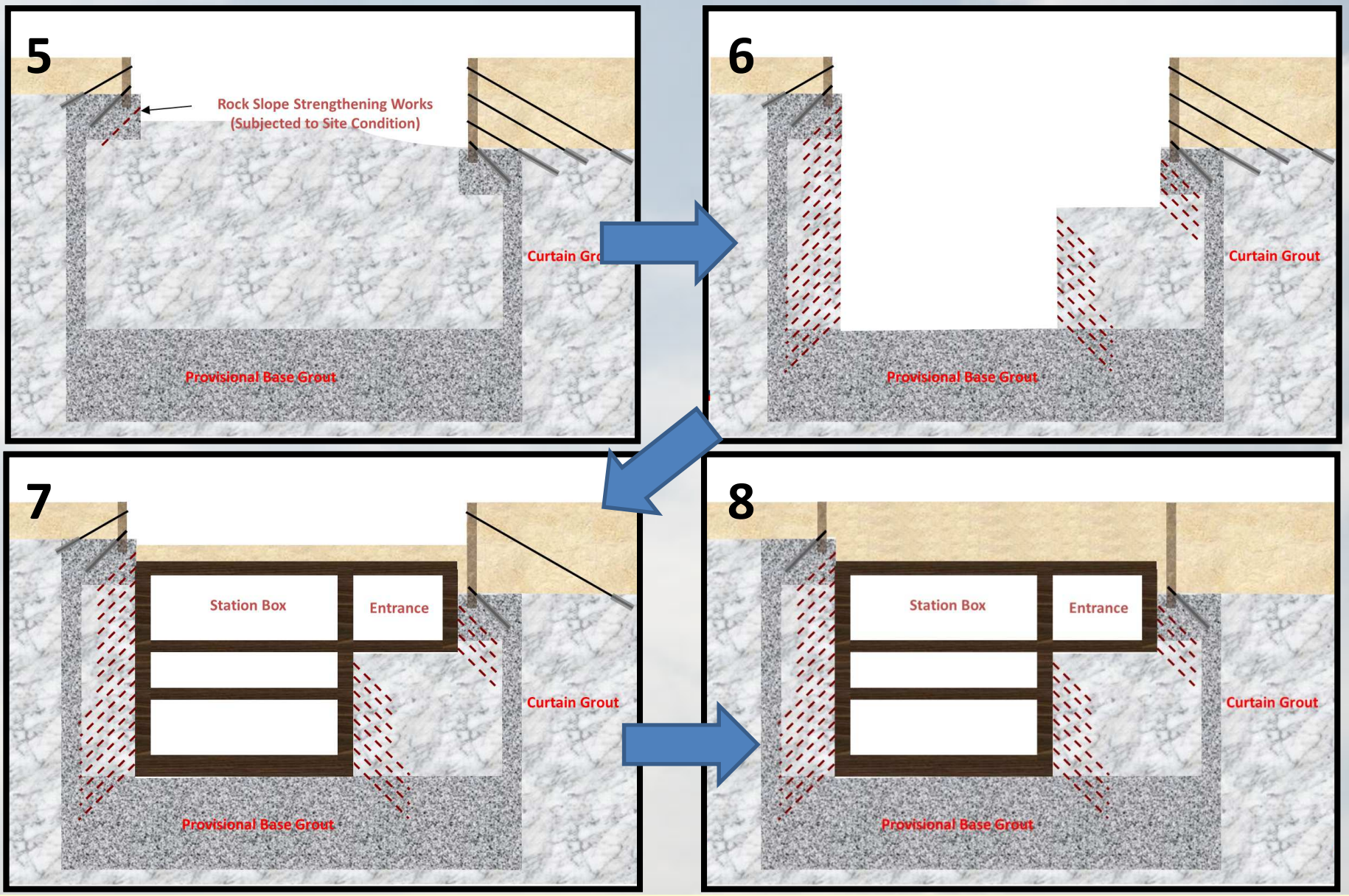
Typical Curtain & Base Grouting Holes Layout



Construction Sequence



Constrution Sequence (con't)



Exposed Vertical Rock Face of the Excavation

Maluri Portal (excavation in progress)

Table 2. Partial load factors.

Load case	EL	DL	LL	TL	IL
Working condition	1.4	1.4	1.6	1.2	NA
Accidental impact	1.05	1.05	0.5	NA	1.05
One-strut failure	1.05	1.05	0.5	NA	NA

Note:
EL – Earth pressure and groundwater
DL – Dead load
LL – Live load
TL – Tempreture effect
IL – Accidental impact load
NA – Not applicable

Steel Decking for the Traffic diversion above @ Maluri

Maximum 25m deep

TRX Station (Excavation in Progres)

Conchrane Station (Launching of 2nd TBM)

Conclusions

1) *Proper geotechnical input and continuous support from the design engineers* during construction ensure success.

2) This design scheme has resulted in considerable **time and cost saving** compared to non-vertical excavation which will incur additional cost and also present challenges in terms of additional land acquisition.

3) Prevented costly failure and delay associated with underground works in limestone formation such as excessive groundwater lowering, occurrences of sinkholes, excessive ground settlement, etc. can be prevented

Thank You

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