Railway Developments and Highlights of the Construction Features of Recent Railway Projects
### Statistics on Rail Transport – KCR rail lengths & stations

<table>
<thead>
<tr>
<th>Existing (KCR)</th>
<th>Rail Length</th>
<th>Total Rail Length</th>
<th>No. of Stations</th>
<th>Total No. of Station/stop</th>
</tr>
</thead>
<tbody>
<tr>
<td>East Rail</td>
<td>33.2 km</td>
<td>98.1 km</td>
<td>13</td>
<td>22 stations</td>
</tr>
<tr>
<td>Light Rail</td>
<td>35.4 km</td>
<td></td>
<td>68 stops</td>
<td>68 stops</td>
</tr>
<tr>
<td>West Rail</td>
<td>29.5 km</td>
<td></td>
<td>9</td>
<td></td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Project being Constructed</th>
<th>Rail Length</th>
<th>Total Rail Length</th>
<th>No. of Stations</th>
<th>Total No. of Station/stop</th>
</tr>
</thead>
<tbody>
<tr>
<td>MOSR (Ma On Shan)</td>
<td>10.1 km</td>
<td>18.6 km</td>
<td>9</td>
<td>13</td>
</tr>
<tr>
<td>TSTE (TST Extn)</td>
<td>1.1 km</td>
<td></td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>LMC Spur Line</td>
<td>7.4 km</td>
<td></td>
<td>2</td>
<td></td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Project Approved for implementation</th>
<th>Rail Length</th>
<th>Total Rail Length</th>
<th>No. of Stations</th>
<th>Total No. of Station/stop</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCL (Shatin Central)</td>
<td>15.9 km</td>
<td>20.4 km</td>
<td>9</td>
<td>12</td>
</tr>
<tr>
<td>KSL (Kwoloon Southern Link)</td>
<td>4.5 km</td>
<td></td>
<td>3</td>
<td></td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Project under planning</th>
<th>Rail Length</th>
<th>Total Rail Length</th>
<th>No. of Stations</th>
<th>Total No. of Station/stop</th>
</tr>
</thead>
<tbody>
<tr>
<td>NOL (Northern Link)</td>
<td>14.8 km</td>
<td>15.6 km</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>PRL (Port Rail Line)</td>
<td>8 km</td>
<td></td>
<td>Nil</td>
<td></td>
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</tbody>
</table>
### Statistics on Rail Transport – MTR rail lengths & stations

<table>
<thead>
<tr>
<th>Existing (MTR)</th>
<th>Rail Length</th>
<th>Total Rail Length</th>
<th>No. of Stations</th>
<th>Total No. of Station</th>
</tr>
</thead>
<tbody>
<tr>
<td>TWL (Tsuen Wan)</td>
<td>15.6 km</td>
<td></td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>KTL (Kwun Tong)</td>
<td>14.0 km</td>
<td></td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>ISL (Island Line)</td>
<td>12.5 km</td>
<td></td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>TKE (Tseung KwanO)</td>
<td>9.1 km</td>
<td>86 km</td>
<td>7</td>
<td>50</td>
</tr>
<tr>
<td>TCL (Tung Chung)</td>
<td>30.8 km</td>
<td></td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>AEL (Airport Express)</td>
<td>34.8 km</td>
<td></td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>

**Project being Constructed**

- Penny Bay
  - Rail Length: 3.4 km
  - Total Rail Length: 3.4 km
  - No. of Stations: 2
  - Total No. of Station: 2

**Project Approved for implementation**

- Cablecar (Tung Chung)
  - Rail Length: 5.7 km
  - Total Rail Length: 5.7 km
  - No. of Stations: 2
  - Total No. of Station: 2

**Project under planning**

- SIL (South Island)
  - Rail Length: 13 km
  - Total Rail Length: 20.5 km
  - No. of Stations: 9
  - Total No. of Station: 18
- WIL (West Island)
  - Rail Length: 3.5 km
  - Total Rail Length: 5
  - No. of Stations: 4
  - Total No. of Station: 18
- NIL (North Island)
  - Rail Length: 4 km
  - Total Rail Length: 4
  - No. of Stations: 4
  - Total No. of Station: 18
### Statistics on Rail Transport patronage

<table>
<thead>
<tr>
<th>Rail based</th>
<th>1999 (Daily)</th>
<th>2003 (Daily)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MTR/AR</td>
<td>2.16</td>
<td>2.13</td>
</tr>
<tr>
<td>KCR/XB/LRT</td>
<td>1.07</td>
<td>1.06</td>
</tr>
<tr>
<td>Tram</td>
<td>0.24</td>
<td>0.22</td>
</tr>
<tr>
<td><strong>Total Rail Based</strong></td>
<td><strong>3.47M</strong></td>
<td><strong>3.41M (-1.7%)</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Non Rail Based</th>
<th>1999 (Daily)</th>
<th>2003 (Daily)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buses (public/private)</td>
<td>4.14</td>
<td>4.29</td>
</tr>
<tr>
<td>PLB/GMB</td>
<td>1.59</td>
<td>1.62</td>
</tr>
<tr>
<td>Taxi</td>
<td>1.31</td>
<td>1.31</td>
</tr>
<tr>
<td>Ferry</td>
<td>0.16</td>
<td>0.15</td>
</tr>
<tr>
<td><strong>Total Non Rail Based</strong></td>
<td><strong>7.20M</strong></td>
<td><strong>7.34M (+2.4%)</strong></td>
</tr>
</tbody>
</table>

From the above figure, non-rail based passengers are gaining on the rail based passengers, i.e. rail share diminishes.
Rail Studies by Government

The government has undertaken 2 intensive studies to formulate a framework serving as a guideline both for the government and general public in the long-term commitment in railway development

Railway Development Study–1 (Report released in May 1993)
The Report recommended the construction of WR, TKE, MOSR, TSTE and EKL

Railway Development Study–2 (Report released in May 2000)
The Report recommended the construction of SCL, KSL, NOL, NIL and WIL, REL and PRL

Based on the key findings of RDS-2, government has formulated the Railway Development Strategy 2000. It maps out the preferred railway network expansion plan for the HKSAR up to 2016. (included the addition of the Penny’s Bay Rail Link)
Railway Network according to Railway Development Strategy 2000

Five major Lines are proposed as a strategic development to enhance the existing railway systems

1. Shatin to Central Link – linking Tai Wai Diamond Hill, Kowloon City, Hung Hom, Wanchai to Central

2. Kowloon Southern Link – linking East Rail and West Rail at south between TST Station & Nam Chong Station (West Rail)

3. Northern Link – linking the East Rail and West Rail of KCR at the north between Sheung Shui to Pat Sheung

4. Regional Express Link – provide a non-stop railway link between the city and the border at Lo Wu

5. Island Line Extension – an extension at the north shore of the existing Island Line to relief the existing line traffic

6. Port Rail Line – an extension from the East Rail to enhance cross boundary freight services
Major Railway Lines/Projects

2. MTR Island Line (1978 – 1985/9)
3. MTR Tung Chung Line and Airport Express Line (1994-98)
4. MTR Quarry Bay Congestion Relief project (1997 - 2001)
9. KCR Lok Ma Chau Spur Line (2002 - 2006)
10. KCR Shatin to Central Link (2007 – 2011….)
How a Railway Project is implemented?

1. Initial planning/decision to build a railway line by Govt.

2. Govt. instruction to proceed

3. Submission of engineering proposals with financial analysis etc. from potential railway operators to government (1 year)

4. Tender proposal to govt. – vet by Transport and Finance Bureau, Railway Development Office of Highways Dept. to coordinate, submit detail technical and financial proposals, including capital and operating costs, patronage, fare structures, return on investment. Result to be approved by ExCO. (1 to 2 years)
How a Railway Project is implemented?

5. Prepare Preliminary Project Feasibility Study (PPFS), including rail alignment, station location and layouts, engineering feasibility, environmental impact, traffic impact, interfacing problems, land requirements, programme, cost estimates etc. (1 year)

6. Environmental Impact Assessment procedure – go through publication consultation including the public and Advisory Council on Environment (1 year)

7. Pre-construction activities including getting the Environmental Permit, gazette, land resumption, public consultation, resolve objections, tender arrangement etc. (2 to 3 years)

8. Construction processes, including testing and commissioning before the handing over (5 years)
Recently completed KRC Railway projects
Alignment of the
1. Island Line
2. Shatin to Central Link
3. Kowloon Southern Link
Alignment of the Northern Link and Regional Express Line
Detail understand of some recent Railway Projects
MTR Tseung Kwai O Line (TKE)
Layout of the MTR
Tseung Kwan O Line
Tseung Kwan O Line –
Formation of the Yau Tong Station
Aerial view showing the overall layout of the Yau Tong Station and its vicinity
Yau Tong Station as seen in the construction stage
Approach tunnel merging into the slip section of the Eastern Harbour Crossing.
Cutting through a rock slope to form the approach tunnel between the Yau Tong Station and Eastern Harbour Crossing
Tseung Kwai O Line –
Formation of the Tiu Keng Leng Station
Formation of Tiu Keng Leng Village to provide land for the Development of the Tiu Keng Leng Station Complex
Cutting a 450m x 60m x 30m deep trough into solid rock to form the buried structure of Tiu Keng Leng Station
The Station and its vicinity as seen in early 2002
Tseung Kwai O Line –
Formation of the Tseung Kwai O Station
Tseung Kwan O Station located on new land formed by reclamation
Construction of the Tseung Kwan O Station
Tseung Kwai O Line –
Formation of the Hang Hau Station
Layout of the Hang Hau Station as seen in early 1999
The buried station structure was formed using a top-down and bottom-up mixed construction approach.
Tseung Kwai O Line –
Formation of the Po Lam Station
Po Lam Station is the only station that built at-grade. The photo shown the early stage of station work.
Gradual completion of the station’s superstructure
Tseung Kwai O Line – Maintenance Depot of the TKE Line
MTR Tseung Kwan O Depot – residential development will be provided on top of the depot podium at a later stage.

Rail track for MTR train entering the depot.
Close up of the depot podium and the train maintenance depot underneath
Tunnels in the Tseung Kwai O Line

There are 2 forms of tunnels being built:

1. Drill-and-blast tunnel
   - tunnel between Lam Tin and Yau Tong Station (1.2 km)
   - Black Hill Tunnel between Yau Tong and Tiu Keng Leng Station (2.2 km)
   - Pak Shing Kok Tunnel between Tseung Kwan O Station and the Depot (2.0 km)

2. Cut-and-cover tunnel
Tseung Kwai O Line –
Cut-and-Cover Tunnels
Cut-and-cover tunnel between Tseung Kwan O and Hang Hau Station
Typical formwork arrangement (tunnel form) for the construction of the tunnel tubes
Some difficult situations in constructing the cut-and-cover tunnel – working in the reclaimed land very close to culvert and seawall
Some difficult situations in constructing the cut-and-cover tunnel – double decked tunnel and tunnel junctions
Some difficult situations in constructing the cut-and-cover tunnel – tunnel crossing servicing roadway
Tseung Kwai O Line –
Drill-and-Blast Tunnels
Tunnel portal provision at the Yau Tong Tunnel
Traveling formwork for the forming of the tunnel lining
Laying of membrane sheeting to waterproofing the tunnel interior before placing the lining
KCR West Rail
Alignment of West Rail – Nam Cheong to Tuen Mun
West Rail – Fast Fact

- West Rail Phase I is a 30.5-km domestic passenger railway linking Sham Shui Po in West Kowloon with Tuen Mun.

- It has nine stations, namely:
  Nam Cheong, Mei Foo, Tsuen Wan west, Kam Sheung Road, Yuen Long, Long Ping, Tin Shui Wai, Siu Hong and Tuen Mun Station.

- Alignment type
  - enclosed structure at grade 3.1km
  - cut-and-cover tunnel 2.3km
  - surface alignment 2.3km
  - rock tunnel 9.1
  - viaduct 13.5

- Capacity of serving 500,000 passengers per day.

- Estimated project cost is $46.4 billion (Original $64 billion as in 1996 estimate)
West Rail – Nam Cheong Station

Construction Features
- Enclosed structure, measure about 350 x 80m
- Partially constructed underground
- Part of the station concourse have to pass under the Airport Railway track
- Interchanging station with Tung Chung Line
- Public transport interchanging facility provided
Nam Cheong Station
West Rail – Nam Cheong Station

Western and Eastern Concourse of Nam Cheong Station
West Rail – Nam Cheong Station

Top-down construction inside the buried portion of the station
West Rail – Cut-and-cover Tunnel between Nam Chong and Mei Foo Station

Tunnel backfilled to provide integrated landscape

Traveling type tunnel formwork to construct the tunnel section
West Rail – Mei Foo Station

Construction Features

- Enclosed structure, measure about 260m x 35m
- Partially constructed underground
- Station bisected by the Kwai Chung Road
- Station integrated into future Lai Chi Kok Park
- Interchanging station with MTR Tsuen Wan Line
- Connecting to on-grade cut-and-cover tunnel on south and entering the Tsing Kwai Tunnel on the north end of station
- Complicated connecting pedestrian tunnels into MTR Mei Foo Station
West Rail – Mei Foo Station
West Rail – Mei Foo Station

Temporary footbridge erected to maintain pedestrian traffic to Princess Margaret Hospital

Early stage of station construction in early 2000
West Rail – Mei Foo Station

Kwai Chung Road

Station structure passing through Kwai Chung Road
West Rail – MeiFoo Station

Ching Cheung Road

Overall layout of the station structure with the nearby facilities
Traffic Diversion at Ching Cheung Road – alignment crossing into the Tsing Kwai Tunnel
West Rail – Tsing Kwai Tunnel

Kwai Tsing Tunnels – 3.6 km

- Ha Kwai Chung Tunnel (1.7 km)
- Tsing Tsuen Tunnel (1.78 km)
- Tsing Tsuen Cut-and-Cover Section (0.12 km)

Location of major Tunnel Portal

Cross-Section of Ha Kwai Chung Tunnel

Cross-Section of Tsing Tsuen Tunnel
West Rail – Tsing Kwai Tunnel

Construction Features
- Total length about 3.6 km
- The 1st section from Mei Foo to Lai King, about 1.7 km long, constructed using drill-and-blast method
- The 2nd section from Lai King to Tsuen is Wan about 1.8 km long, constructed using a 8.4m dia. mix-mould tunnel boring machine (TBM)
- A 50m dia. access shaft is provided at Lai King to facilitate the dismantling of the TBM upon its completion of the drilling from Tsuen Wan direction.
- The TBM has been used twice, forming the east and south bound tube in two separated journeys from Tsuen Wan direction to Lai King
West Rail – Tsing Kwai Tunnel Service Shaft at Lai King

Lai King Hill Road

Kwai Chung Road
The Breaking Through of the TBM at Lai King Shaft – the machine would then be dismantled and transported back to Tsuen Wan Portal for re-assembly and prepare for the drilling of the second tube.
West Rail – Tsing Kwai Tunnel Portal at Tsuen Wan

- Waterside Plaza
- Wing Shun Street Diversion
- Alignment of cut-and-cover tunnel
Tsing Kwai Tunnel
Portal at Tsuen Wan

Early stage of portal formation before excavation

The Paul Y Industrial Bldg. being demolished to give way for the Tsing Kwai Tunnel

A shaft measured about 220 x 35 x 25m deep was formed as portal to support the tunnel drilling process.
West Rail – Tsuen Wan Reclamation

Reclamation layout as in Nov 1999
West Rail – Tsuen Wan Reclamation

Reclamation layout as in Oct 2001
West Rail – Tsuen Wan Reclamation

Stage I Reclamation work in mid 1999

Previous Tsuen Wan Public Pier

Ma Tau Pa Culvert

Wing Shun Street diversion
West Rail — Tsuen Wan Reclamation

Tsuen Wan before reclamation

Tsing Kwai Tunnel TW Portal

Reclamation in late 1999
Tsuen Wan Reclamation

Construction of a new public pier before the closing down of the old pier

Old Tsuen Wan Pier to be demolished in later phase of reclamation
Formation of Box Culvert

Touching up of the precast culvert and connect the structure into existing system
Formation & Diversion of Box Culvert

Construction the Tai Ho culvert using in-situ casting. Note that the cut-and-cover tunnel approaching TW Station will be constructed afterware underneath the culvert structure.

Future cut-and-cover tunnel below
West Rail – Cut-and-Cover Tunnel and Traffic Diversion at Chai Wan Kok, Tsuen Wan

Cut-and-cover tunnel linking TW Station with the Tai Lai Tunnel at the south portal

Traffic diversion at Chai Wan Kok interchange
Traffic Diversion

Diversion at Wing Shun Street

Temporary pedestrian diversion providing access to the public.
Tsuen Wan West Station

Construction Features

- Mainly underground structure, measure about 380 x 40m
- Constructed on newly reclaimed land
- Public transport interchanging facility provided
- Complicated diversion works are incorporated in the construction process
West Rail – Tsuen Wan West Station
Station structure constructed using bottom-up method as seen in June 2001
Construction of the station structure as seen in December 2001
Tai Lam Tunnel
South Portal at Chai Wan Kok

Access ramp complete allowing vehicle entering into the tunnel for spoil removal

Tunnel alignment
West Rail – Tai Lam Tunnel North Portal at Pat Sheung
West Rail – Tai Lam Tunnel
Construction using Blast & Drill

Forming the tunnel lining using in-situ method

Crusher & Conveyor system for spoil removal
Tai Lam Tunnel - Construction using Blast & Drill

Forming the inner wall separating the rail tracks inside the tunnel

Laying the waterproofing membrane before casting the in-situ concrete lining
West Rail – Depot at Pat Sheung
West Rail – Depot at Pat Sheung

Construction of the Depot structure as in early 2000
Depot at Pat Sheung

Construction of the Depot structure as in August 2001
West Rail – Kam Sheung Road Station

Construction Features

- Elevated structure, measure about 280 x 30m
- Connected to both ends by viaduct
- with trunk tracks leading to maintenance depot at Pat Sheung
- Parking and public transport interchanging facility provided to convenient passenger to use the rail instead of using private vehicle
West Rail – Kam Sheung Road Station
West Rail – Kam Sheung Station

Outlook of the station as in May 2001
Viaduct section between Kam Sheung & Yuen Long Station

Viaduct section outside Kam Sheung Station with tracks leading to the Maintenance Depot
Viaduct section between Kam Sheung & Yuen Long Station

Viaduct section at Au Tau Interchange
West Rail – Yuen Long Station

Construction Features

- Elevated structure, measure about 420 x 40m
- Part of the station structure constructed over wetland of Yuen Long Plain
- Connected to both ends by viaduct
- Interchanging provision to Light Rail
- Public transport facilities also provided
West Rail – Yuen Long Station
West Rail – Yuen Long Station

The station structure as seen in August 2001
West Rail – Viaduct Section between Yuen Long and Long Ping Station

Construction of the portal frame to support the viaduct
West Rail – Long Ping Station

Construction Features

- Elevated structure over Yuen Long Nullah, measure about 380 x 30m
- Large area of glazed panel for wall & roof are used to provide natural lighting and to improve orientation
- Connected to both ends by viaduct
- Public transport interchanging facility provided
West Rail – Long Ping Station
West Rail – Long Ping Station

The station structure as in September 2001
West Rail – Viaduct Section between Long Ping and Tin Shui Wai Station

Viaduct passing through a section of rural villages known as the Wing Ning Tsuen
West Rail – Tin Shui Wai Station

Construction Features

- Elevated structure at junction of Ping Ha Road & Tin Fuk Road
- Station structure measured about 460 x 30m
- New Light Rail stop is to be built at ground level under station concourse
- Structure cast in 2 main sections to minimize interruption to existing busy traffic junction at Tin Yiu Estate

Tin Yiu Estate
Tin Shing Estate
West Rail – Tin Shui Wai Station

A new Light Rail stop will be built at ground level to interchange with the elevated West Rail Tin Shui Wai Station.
West Rail – Tin Shui Wai Station

Early stages of station construction as in mid-2000
West Rail – Tin Shui Wai Station
West Rail – Viaduct Section between Tin Shui Wai and Shiu Hong Station

Viaduct construction at a traffic junction near Lam Tei
West Rail – Siu Hong Station

Construction Features

- Elevated structure over Tuen Mun Nullah
- Structure measured about 440 x 55m
- Construction using a suspended gantry form in repeated sections
- Major interchange station with the Light Rail.
- Elevated public transport interchanges will be provided at either end of the station concourse.

Siu Hong Court
West Rail – Siu Hong Station
Piers are constructed at the early stage in January 2000 to support the station structure over the Tuen Mun Nullah
West Rail – Siu Hong Station

Construction of the station structure as in early 2001
West Rail – Siu Hong Station

Close up of the gantry form to construct the station deck
West Rail – Viaduct Section between Siu Hong and Tuen Mun Station

Viaduct being constructed over the Tuen Mun Nullah
West Rail – Tuen Mun Station

Construction Features

- Elevated structure over Tuen Mun Nullah
- Structure measured about 370 x 50m
- A public transport interchange will be provided at the site of the existing San Fat Estate at ground level
- serve as an interchange station between West Rail and the Light Rail

San Fat Estate – to be demolished to provide public transport interchange facilities
West Rail – Tuen Mun Station
Tuen Mun Station under construction as in 2002
Tuen Mun Station with the new Light Rail connection as in 2003

Night Light Rail Stop connecting into the Station
Common construction features of the stations

Though the 9 stations located within the alignment of the West Rail differ from each other somewhat in design, functions or method of construction, they bear quite a lot of commonality in terms of construction feature, such as:

- All the stations are very large structure in term of building volume (av. 400000–500000 m$^3$), therefore very complicated phasing and sectioning arrangements are required during construction in particular when the usual unfavourable physical site conditions (e.g. complicated diversion, stages of handing over etc) are taken into account.

- Highly non-repeated nature in the station layout thus makes the construction arrangement such as the use of formwork and other resources scheduling consideration become very difficult.
Common construction features of the stations

- Most of the station structures are with large area of in-situ RC walls and therefore large-size panel shutter is a common formwork being used.

- Usual high headroom in the station design require the provision of very expensive and complicated falsework.

- Station generally in long span design with very deep beams and other transfer or suspending members, resulted again to the requirement of complicated falsework provision or the introduction of large number of tensioned members.
KCR East Rail Extensions – Tsim Sha Tsui Extension
Tsim Sha Tsui Extension alignment running basically alongside the Salisbury Road at the coast of TST East
Track within covered tunnel coming from the KCR Kowloon Station at Hung Hom
Tunnel work outside Mail Centre of the Post Office – just on top of the approach tunnel section of CHT
Cut-and-cover tunnel between Kowloon and Tsim Sha Tsui Station
Tsim Sha Tsui Station
Tsim Sha Tsui Station and the nearby road condition as in mid 2002
Tsim Sha Tsui Station and the Salisbury Road Underpass working at the same time as in mid 2003
KCR East Rail Extensions – Ma On Shan Line
Alignment of the KCR Ma On Shan Line
Alignment of the KCR Ma On Shan Line
Ma On Shan Line
joining East Rail
at Tai Wai Station
Service Depot of the MOS Line located in Tai Wai
The first section of viaduct running from Tai Wai northbound along Shing Mun River
Construction of viaduct at Tai Shui Hang crossing a busy highway
Installing the box-girder viaduct using a gantry type launching machine
Forming the piers and portal beams for the supporting of the viaduct
Construction of other Stations along the Line

Sha Tin Wai Station

Hang On Station
Laying of track
Noise Barrier and Noise Covering Hood
Ma On Shan (above) and Tai Shui Hang Stations
Tai Wai Depot (above) and Cha Kung Mui Station
End of Presentation