

West Rail: A Project Profile

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Abstract

Hong Kong's rapidly growing population, especially in the North West New Territories, requires a new, high-capacity rail system to cater for the estimated level of public transport demand. To this end, the Kowloon-Canton Railway Corporation (KCRC) is undertaking the implementation of a new rail line, West Rail, which will extend Hong Kong's railway network into the NWNT and provide a convenient, high-speed and environmentally responsible means of transport between the business district and this fast-growing suburban area. This paper provides a general background of the project, a description of the complex alignment, a vision for the operating environment and some of the unique challenges faced in bringing the project to a successful completion.

1. Background

West Rail was conceived as a result of the 1994 Hong Kong Government Railway Development Strategy. The report found that a new railway was required to meet the transport demands of Hong Kong's rapidly developing western corridor portion of the New Territories. This railway was envisaged to provide:

- a) A domestic passenger service between the North West New Territories (NWNT) and urban Kowloon
- b) A cross-boundary passenger service for passengers travelling between Hong Kong and China
- c) Container freight transport between ports in China and Hong Kong.

In January 1995, the Government invited the Kowloon-Canton Railway Corporation (KCRC) to submit a proposal for the design, construction and operation of the proposed Western Corridor Railway, later renamed West Rail. KCRC submitted its Full Proposal in November 1995, and in December 1996 the Government announced that KCRC's proposal should be adopted and endorsed as the way forward for West Rail. Planning for West Rail would proceed on the basis of a phased implementation, namely:

Phase I: A domestic passenger line from urban Kowloon to Tuen Mun. The line would originate in the south in the Sham Shui Po District of West Kowloon and terminate in Tuen Mun in the NWNT via Mei Foo, Tsuen Wan, Kam Tin, Yuen Long, Long Ping and Tin Shui Wai.

Phase II: Cross-boundary passenger and freight services extending to the north via Lok Ma Chau and Lo Wu.

The Government concluded that Phase I should be implemented and brought into operation as soon as possible and should include provisions to accommodate the future cross-boundary passenger and freight services. Phase II would be implemented at a date to be decided later.

2. West Rail Phase I

West Rail Phase I is a fast-track project to improve domestic transport for residents in the NWNT by providing a swift, convenient rail link with urban Kowloon. Likewise, it will provide easy access for urban residents to the rapidly growing NWNT. According to the Government's updated projections in 1998, Hong Kong's population is forecast to grow from 6.2 million in 1996 to 8.1 million by the year 2011. The population of the NWNT alone is projected to grow by about 70% during this period, from approximately 800,000 to some 1.4 million.

West Rail will cut in half the existing bus journey time from the NWNT to the urban district. Of major importance will be efficient and high-capacity passenger interchanges with the KCRC's existing Light Rail Transit (LRT) system in the NWNT and with the Mass Transit Railway Corporation's underground railway system in urban Kowloon. With four LRT interchanges and two Mass Transit Railway (MTR) interchanges, West Rail will introduce an integrated railway network that will enhance travel convenience for residents throughout Hong Kong.

To integrate West Rail with other modes of transport, public transport interchanges (PTIs) will be provided at eight of the nine West Rail stations to enable passengers to travel to and from the stations by various feeder services, including buses, mini-buses and taxis. (Mei Foo station is excluded as it will serve primarily as an interchange with the MTR.) Parking facilities for cars and bicycles will also be available at selected stations in the rural areas. Construction of the PTIs is being carried out by the KCRC for and on behalf of the Government, with Government funds, and these facilities will be handed over to the Government's Highways Department for management and maintenance upon completion.

Using high-capacity train cars, frequent and reliable service, and convenient passenger interchange facilities, West Rail will serve 340,000 passengers a day when it opens in 2003, increasing to more than 500,000 passengers a day by the year 2011.

3. The Route

West Rail Phase I will comprise 30.5 km of alignment, nine stations, a depot, and a headquarters building housing a central operations control centre. It will include Hong Kong's longest transport tunnel, a 5.5 km bored rock tunnel beneath the mountainous Tai Lam Country Park, built without disturbance to the country park or existing water services installations.

Beginning in the south, the alignment commences below grade at the Nam Cheong over-run tunnel, immediately south of the West Kowloon Prince Edward Road interchange. The over-run tunnel rises to Nam Cheong station, a side-platform station at grade. Nam Cheong is unique in that it is a jointly owned station with the MTR Corporation and contains facilities for both West Rail and the MTR's

The route follows the West Kowloon Expressway northwards, running generally at grade, with a short underground section at the West Kowloon Lai Wan Interchange before curving

right across the Lai Chi Kok Park to Mei Foo station. Although the running line in this section is generally at grade, it is contained within a landscaped box structure for environmental purposes. Mei Foo is a side platform station constructed at grade partially below the elevated Lai Chi Kok Bridge. This station will also be contained within a landscaped box and will feature an innovative rooftop parkland to integrate with the park environment.

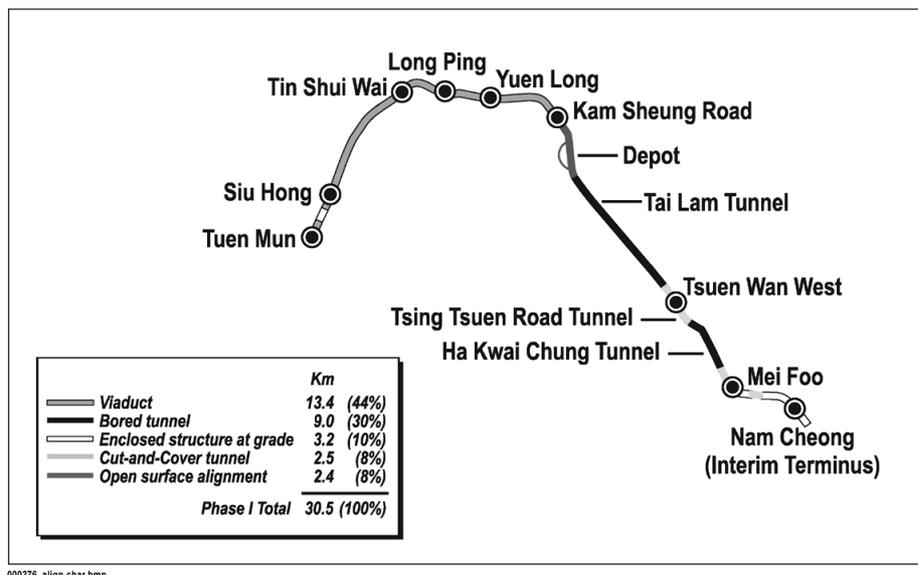


Figure 1 West Rail Phase I Alignment

From Mei Foo, the alignment heads northwards on a left hand curve, through the Ha Kwai Chung bored rock tunnel. Ha Kwai Chung Junction is a point where the passenger tracks merge, in a tunnelled, grade-separated junction, with the future freight tracks to the Port Rail Terminal.

The alignment continues northwards in the Tsing Tsuen Tunnel, through soft ground, under a portion of Kwai Fuk Road before transitioning back to bored rock tunnel at Tsing Tsuen Road Tunnel. This tunnel is being bored with a state-of-the-art Tunnel Boring Machine (TBM), the largest ever used in Hong Kong and the first TBM to be employed in mixed ground conditions in Hong Kong. The TBM weighs 1,500 tonnes, has a diameter of 8.5 metres and length of 100 metres, and is capable of boring at an average rate of 11 metres per day.

The Tsing Tsuen Road Tunnel extends northwards towards the sites of the Wah Kai and Paul Y Industrial Buildings, which will be and has been demolished, respectively, to make way for construction. The alignment then transitions to cut-and-cover tunnel northwards to Tsuen Wan West station (TWW).

The location of TWW requires that new reclamation of approximately five hectares be developed in Tsuen Wan Bay and necessitates the demolition and re-provisioning of the Tsuen Wan Ferry Pier. These works are currently well advanced.

From TWW, the alignment continues in cut-and-cover tunnel north to the former site of Shun Kei Factory Estate (already demolished to make way for construction), where it enters

the Tai Lam (bored rock) Tunnel. The tunnel passes below the Water Services Department (WSD) Water Tunnel No. 3. The alignment then continues to climb to the north portal where it exits the tunnel on a broad right-hand curve.

From the north portal, the alignment continues into the Kam Tin Valley, with Pat Heung Depot maintenance and stabling facilities on the west side and additional stabling on the east side. Covering 32.5 hectares, this will be the largest railway depot in Hong Kong.

Leaving the depot, trains will curve slightly to the west at a maximum speed of 130 kilometres per hour before the tracks separate to enter the double-island platform of Kam Sheung Road station (KSD). The depot and alignment to KSR are on embankment until the tracks rise onto viaduct as they enter KSR platform level.

The alignment from KSR northwards is primarily on viaduct. The two tracks cross Kam Tin Road and converge and rise to a grade-separated crossing over the future main lines to Lok Ma Chau, Lo Wu and Sheung Shui, planned as part of Phase II construction. The Phase I alignment turns to the west, traverses a short cut section along Au Tau Hill, then crosses the Drainage Services Department (DSD) drainage channel, Route 3 and Castle Peak Road and proceeds at a high level into Yuen Long.

Yuen Long station (YUL) is an elevated island platform station which links with the Light Rail Transit terminus. To the west of YUL, the alignment is on viaduct following a highly constrained corridor formed by Long Yip Street, Yuen Long On Lok Road and a principal drainage nullah straddled by Long Ping station (LOP), another elevated island platform station.

Table 1 West Rail Key Features

Total Length	30.5 kilometres
Alignment Profile	11.5 km underground (38%) 5.4 km surface (18%) 13.4 km elevated (44%)
Number of Stations	9
2 Interchanges with MTR	Tsuen Wan Line at Mei Foo Tung Chung Line at Nam Cheong
4 Interchanges with Light Rail	Yuen Long, Tin Shui Wai, Siu Hong, Tuen Mun
Operating Hours	5:30 a.m. – 1:00 a.m.
Peak Hours	7:00 - 10:00 a.m., 5:00 - 8:00 p.m.
Train Speed	Maximum: 130 km/hr Average: 60 km/hr (including station dwell time)
Journey Time NAC to TUM	30 minutes
Train Car Requirements/ Frequency	Initial: 20 7-car trains per hour per direction Ultimate: 34 9-car trains per hour per direction
Passengers per Car	335

To the west of LOP, the alignment remains elevated before reaching Tin Shui Wai station (TIS). This elevated island platform station will be a key West Rail/Light Rail/bus interchange facility serving the rapidly expanding Tin Shui Wai community. Future Light Rail Phase 4 operations will be served from this integrated station.

From the elevated TIS, the alignment continues on viaduct where trains will again reach maximum speeds of 130 kilometres per hour en route to Siu Hong station (SIH) in the northern area of Tuen Mun New Town. SIH is an island platform station built over the Tuen Mun drainage nullah adjacent to the Light Rail Siu Hong stop. From SIH, the alignment follows alongside the nullah in a 700 metre enclosed amenity structure with public park facilities provided on the rooftop. The alignment returns to viaduct before entering the Tuen Mun station (TUM), also elevated above the nullah. As the terminus of the Tuen Mun branch, TUM will be a three-track, two-island platform station with public transport interchange. Track over-runs will be provided just south of the station.

4. Customer Convenience

To gain an overview of the systems that will be used to operate West Rail, consider a typical passenger living in the suburban North West New Territories commuting to work in the business districts in Kowloon. The customer might live in one of the 40,000 residential property development units created as a result of West Rail or in a more remote area connected by the Light Rail.

The first system which the passenger will encounter will be the automatic revenue collection (ARC) system. This system will accept single-journey magnetic tickets and Octopus, a contactless smart card supported by all the major transport operators including railways, buses and ferries. Passenger flow around the entry/exit gates will be facilitated by normally-open flap gates, large overhead signs above the gates, and wide gates for the disabled and those in need.

The major systems for passenger movement and circulation are lifts and escalators, both designed with signs and annunciators showing operation status. The walk-through glass lifts are equipped with help phones and hand-rails for the disabled. Use of glass balustrades for escalators gives a more cosy impression at a lower cost.

Passenger flow and other operation aspects will be monitored primarily from the Station Control Room, with an ergonomically designed console housing devices to broadcast audio and video passenger information, CCTV cameras and the like. Communication with the central Operations Control Centre (OCC), located in the 8-storey West Rail Headquarters building adjacent to KSR, will be through the dedicated radio, telephone and fibre-optic transmission systems.

Once in the "paid area" the passenger will be able to view the arrival time of the next train, shown in the passenger information display units, which interface with the train control and signalling system. Special attention has been paid to station layouts, platform and concourse spacing, and the ticketing system. Concourses and platforms will be bright and spacious to create a pleasing environment. Station layouts will ensure that a large number of passengers will be able to enter the system, find their way to the right platform and train, and exit the system conveniently and safely.

The train control and signalling system will provide automatic train protection, automatic train operation and central train control, with the tracks signalled for bi-directional operations. With a service headway of 30 trains per hour and an operational headway of 90 seconds, the system will ensure short waiting time for passengers. The platform screen doors separating the air-conditioned station from the tracks will reduce energy consumption and improve passenger safety and security.

The trains, electric multiple units (EMUs), will be equipped with safety features, emergency communication facilities, panels for passenger information, handrails, space for wheelchairs, and skirting for noise mitigation. While travelling between stations, passengers will notice the comfort of the ride on the permanent way, which will employ Sonneville low-vibration track and floating-slab track to mitigate noise and vibration, as well as mono-block concrete sleepers with ballast in the 'at-grade' sections.

The OCC is the central control hub for the entire railway system, with a large rear-plane projection display, which shows the line overview and real-time movement of trains, CCTV images, and status of the traction power system and the tunnel ventilation system, providing ventilation and temperature controls inside the tunnels. Workstations and other devices installed on the consoles allow operators to efficiently monitor and control all railway operations.

The southbound journey terminates at Nam Cheong station for Phase I. This is an interchange with the MTR's Tung Chung Line, where passengers might continue on to Hong Kong Island or to Lantau Island to the new town at Tung Chung, adjacent to the new airport at Chek Lap Kok. The transfer gates allow seamless transfer from one railway to the other with only one ARC transaction.

5. Safety First

KCRC has the enviable reputation of being one of the safest railway operators in the world, with an accident rate as low as 0.05 accidents per million passengers carried on its East Rail line. The same performance is expected of West Rail. Since the early planning stages, high safety achievement has been a mandatory requirement. To this end, a dual approach is being adopted for West Rail planning: (1) setting design standards to build in safe operations, and (2) using a risk-based approach to ensure that the overall level of risk posed to passengers, staff and the public is managed and reduced to a level as low as reasonably practicable.

The size and complexity of West Rail present particular challenges, considering the long underground and elevated sections combined with high speed, high frequency operations. A technical study completed on systems safety and reliability identified more than 1,000 potential hazards and defined specific requirements to be accounted for in the design of the railway. Among the hazards identified, fire, collision and derailment are the most common and the most severe categories of events. To prevent these incidents, special safety requirements are designed into the railway systems, and contractors are held accountable for compliance with these requirements.

For example, detailed emergency infrastructure and evacuation plans have been developed for the Tai Lam Tunnel. A fundamental requirement is the ability to evacuate passengers on a fully loaded train to a place of safety within 20 minutes. Tunnel ventilation, telecommunications systems and other facilities relating to train operations have been fully considered in terms of the role they will play in providing the safest railway operation possible.

To meet KCRC's goal of placing West Rail among the safest railways in the world, the provision of safety in every aspect of operations will be a process of continual challenge and refinement.

6. Environmentally Responsible

KCRC is committed to protecting and improving Hong Kong's environment and has sought to address environmental concerns from the initial planning stage. A comprehensive Environmental Impact Assessment (EIA) was completed to identify potential environmental issues arising from construction and operation of West Rail and to recommend appropriate mitigation measures. The EIA covers the full range of environmental concerns including noise, air and water quality, land use and landscape, visual impact, archaeology and culture, resources, ecology, waste management, and man-made hazards.

All construction and operation activities must comply with relevant environmental requirements including Hong Kong's stringent Noise Control Ordinance. West Rail is among the first railways in the world to be faced with such strict noise level requirements. A modern railway operating at high speeds would normally generate wayside noise of around 88 dB(A). The NCO, however, limits the average noise over a 30 minute period to a maximum of 55 dB(A) during the hours from 11:00 p.m. to 7:00 a.m. and requires noise to be mitigated at the source.

To make West Rail one of the quietest railways in the world, a combination of engineering measures has been adopted, including –

- a) A multi-plenum noise attenuation system comprising three major components: (1) under-car sound absorbing materials, (2) sound absorbing body panels on both sides of the train to trap the noise, and (3) 1.2m to 4.2m high noise barriers along the viaducts
- b) Noise enclosures at points and crossings
- c) "Floating" track slabs supported by rubber pads
- d) Vibration-absorbing rail fasteners

In addition to the low noise aspect, West Rail will contribute to reducing Hong Kong's air pollution from vehicle exhaust emissions, one of Hong Kong's most serious environmental problems, by reducing the need for road travel and eliminating more than 1,000 tonnes of vehicle exhaust emissions per year.

In keeping with the environmentally-friendly principle, a regenerative braking system will be used on the trains to enable a significant amount of the power required to drive the trains to be recovered and fed back into the power transmission system, thus keeping energy demands to a minimum.

West Rail's EIA represents the first time that archaeological impact has been included in an assessment. Of special interest is Tsui Shing Lau Pagoda at Ping Shan, one of the oldest buildings in Hong Kong and in close proximity to the Tin Shui Wai station. KCRC has carried out surveys at this site and continues monitoring during construction to ensure this important landmark will not be affected by West Rail.

Another special environmental feature of the West Rail project will be the re-creation of more than 12 hectares of wetlands in the Kam Tin Valley for rare species of birds, frogs and other organisms. KCRC will ensure that provisions are made for the long-term management and maintenance of this habitat as a feeding and breeding ground for these birds and frogs.

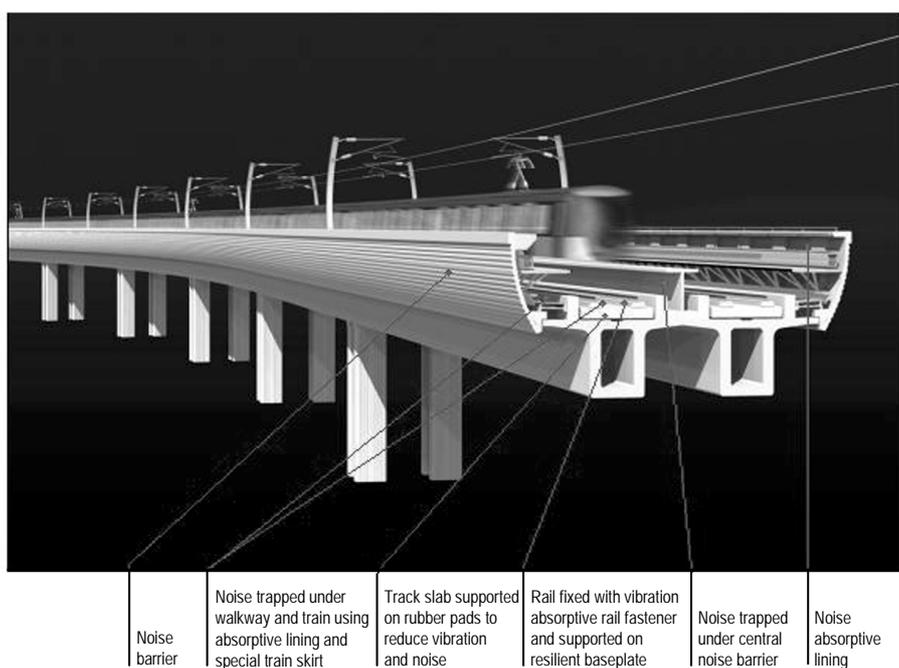


Figure 2 Viaduct design -- noise control measures

7. Project Management Approach

At an estimated cost of HK\$51.7 billion (money of the day), West Rail Phase I is the largest stand-alone infrastructure project ever undertaken in Hong Kong and is the first major capital expansion project for KCRC. To control costs and to ensure the aggressive programme is achieved, the Corporation has assembled an in-house team of experienced professionals to undertake the project management of West Rail. A baseline programme and cost estimate have been established against which all progress and potential changes are monitored throughout design and construction. As soon as potential deviations are identified, corrective action is taken to keep the programme and costs on track.

KCRC has established a contract strategy for West Rail following fair, open and competitive tendering practices in accordance with the World Trade Organisation procurement rules. West Rail adopts two contracting approaches: one is to combine the design and the construction works into a single design-build contract, and the second is to separate the design activities from the works, resulting in design-only contracts plus separate construct-only contracts. These two different approaches are used for improved flexibility and cost-effectiveness, the choice depending upon the nature of permanent works and the temporary works for construction purposes. All major civil and systems contracts for West Rail construction were awarded by the first quarter of 2000.

Civil construction contracts, with a total value of around HK\$21 billion, account for the bulk of the works of the project. These works are packaged into two design-build contracts for the tunnels and 15 construct-only contracts for the stations and running lines. The works have been organised into manageably sized contract packages, based upon size, geographic location and type of work, thus allowing maximum opportunity for participation by local contractors. These contracts are overseen by a team of construction managers on KCRC's

project management team. A resident site staff has been hired by the the detailed design consultants to supervise construction activities on site. These representatives of the 'Employer' and the 'Engineer' work in close co-ordination with the contractors' management staff to monitor progress and proactively identify problems in their early stages, such that solutions can be developed and mitigation measures put in place to minimise risk to the project programme and budget.

System-wide contracts, such as rolling stock, overhead traction power, signalling, and communications, are generally being let on a design, supply and installation basis at a total value of approximately HK\$8 billion. These contracts are overseen by a team of experienced railway systems professionals in KCRC's project management office. The systems used to operate West Rail are being designed and built using successfully proven technologies available on the worldwide market. Some 13 countries are currently involved in supplying these systems, making West Rail a project of international importance.

Throughout the project planning process, KCRC has maintained a close dialogue with members of the community that West Rail will serve. Public consultations have been held with the municipal councils, relevant District Boards and their subcommittees, rural committees and other statutory bodies to ensure that planners and engineers fully understand and address community issues. Public views on the alignment, interface issues and results of the environmental, traffic and drainage impact assessments have been considered in the implementation plan for the railway.

As part of the KCRC's commitment to the community and environment in which it serves, the Corporation will continue to adopt a proactive approach to understanding and resolving public concerns until and beyond the commissioning of West Rail.

8. Concluding remarks

The implementation of West Rail presents interesting and unique challenges for KCRC and its major stakeholder, the Hong Kong Government. First, the project spans a vast length of distance through the Hong Kong SAR including both urban and rural areas and utilises a variety of construction methods such as underground tunnelling in urban districts and viaduct construction through flood-prone rural areas. Second, the aggressive programme for project completion provides little scope for error; thus, a multi-tiered approach to project management has been adopted with all tiers working together in a spirit of partnership to ensure success of the project. Third, West Rail is being built under the strictest environmental statutory requirements ever seen in Hong Kong and, in deed, in many parts of the world. This has required a new approach by contractors to minimising impact during construction and has necessitated innovative designs by the engineers to ensure West Rail will be built to operate as one of the quietest railways in the world.

The approach to West Rail implementation has been successful thus far, as KCRC has just completed the first year of a five-year construction programme. Earthworks, tunnelling and foundation construction are all well advanced. By the end of the first quarter of 2000, the project was 12 percent complete overall, with civil construction work approximately 15 percent complete. By the end of 2000, Hong Kong will see West Rail structures taking shape along the entire alignment, and interfaces and co-ordination between civil and systems contractors will be in full swing. By the end of 2003, the project will become a reality, and Hong Kong will have expanded its railway network into the North West New Territories with a safe, efficient and environmentally responsible mode of transport between the NWNT and urban Kowloon.