2. CONSIDERATION OF ALTERNATIVES

Introduction

2.1 In the course of design development of the Shatin to Central Link - Mong Kok East to Hung Hom section [SCL (MKK-HUH)], engineering feasibility and site investigation works have been undertaken to determine all technical parameters for the construction of the scheme. Alternative schemes were also studied to enhance the overall rail network for the benefit of the travelling public and the local community, taking into account of all interfacing projects and constraints. This section of the report provides details of the project options considered and the constraints and considerations assessed in adopting the preferred scheme.

2.2 Various construction methodology options and locations of works areas have been reviewed in order to determine the most cost effective means of building the Project. Alternative rail alignment and alternative locations for Hung Hom Station (HUH) as well as ventilation shafts have been reviewed to identify the optimum option. The review has taken into account engineering feasibility, site constraints, construction programme and environmental considerations as well as feedback from the public consultation, Value Engineering workshops and technical review.

Background Information

Purpose and Objective of the Project

2.3 The Shatin to Central Link (SCL) is strategically important for connecting the existing railway lines into an integrated rail network. The east-west connection will allow the creation of an east-west rail corridor across the city connecting Wu Kai Sha with Tuen Mun via Kowloon. The north-south connection will extend the existing East Rail Line (EAL) to Hong Kong Island, facilitating a direct link between Mainland China and Hong Kong Island.

2.4 As part of the SCL, the objective of this Project is to realign the existing EAL from Portal 1A to the HUH, enabling the extension from HUH to ADM across Victoria Harbour.

Brief Description of the Project

2.5 This Project refers to the 1.2 km railway section from tunnel portal near Oi Man Estate (Portal 1A) to the revamped HUH. The alignment will be both underground and at grade. **Figure No. NEX2213/C/361/ENS/M50/502** illustrates an overview of the Project alignment.

Project Scope

2.6 The Project comprises the following key elements:

- Realignment and modification of the railway section from MKK to HUH; and
- Ventilation shaft and other associated station-related works at Hung Hom with new platforms.

2.7 Apart from the above key elements, barging facilities, supporting works areas and access roads will be required to support the construction of the Project. It should be noted that the works at the HUH would be within the scope of this Project.

Benefit of the Project

2.8 The SCL is an important strategic rail corridor. It consists of a new section of railway allowing a through-running line between Mong Kok and the Central District of Hong Kong Island. This new strategic railway corridor will provide a through service between Lo Wu/Lok Ma Chau and Hong Kong Island supporting cross-boundary integration. Coupled with the proposed Shatin to Central Link – Tai Wai to Hung Hom section [SCL (TAW-HUH)] with two-way interchange at HUH. It will bring various benefits to the community, including:

- Providing a fast, reliable and convenient mode of transport running through the northern New Territories, Kowloon and Hong Kong Island;

- Redistribution of railway passenger flows to relieve the existing railway lines in urban Kowloon and on Hong Kong Island;
- Relieving road-based public transport in the existing developed areas, and alleviation of the traffic congestion and environmental nuisance on existing road networks, including the demand on the Hung Hom Cross Harbour Tunnel;
- Stimulation of the redevelopment of Hung Hom and Waterfront areas; and
- Providing more environmentally friendly public transport in terms of energy conservation and gas emissions.

2.9 The Project improves the accessibility to the harbour by providing a direct link between Hung Hom and Hong Kong Island. With this link, there will be increased opportunities for the public to access the areas and enjoy the harbour and the promenade area of Tsim Sha Tsui East. This would produce more possibilities for the planning and development of leisure and tourism.

2.10 More importantly, the expansion in railway network can gradually conduce a significant modal shift in passengers' travel behaviours from road-based transport to railway system, and thereby alleviating environmental nuisance from existing road networks.

2.11 From the environmental perspective, the railway will be powered electrically. Railways are widely recognized as a more sustainable form of transport than road transport in terms of carrying capacity and energy effectiveness and adverse environmental implications such as roadside air pollution associated with electrically-powered rail are far less in comparing to road-based transport. Having anticipated that the Project will increase public transport patronage and reduce the overall road traffic volumes through providing a more convenient and easily accessible transport option, the Project will bring improvements in air quality, noise pollution, on-road safety and the overall quality of the ambient environment.

2.12 In addition, new types of train services, i.e. 9-car SP1900 or equivalent, will be adopted. The SP1900 type of train is a modern electrically powered train that is considered to be more environmentally friendly. With the shorter train length, length of platforms and stations can be reduced accordingly. In general, this will reduce the potential environmental impact (in terms of extent and/or duration) that would be generated from the Project during both the construction and operational phases.

2.13 The construction and operation of the SCL will also create numerous new employment opportunities within Hong Kong. Construction of new stations and redevelopment of current stations will also create commercial opportunities within the stations and enhanced economic development of the areas they serve.

Considerations for Alternative Project Design and Alignment Options

2.14 The following sections present the consideration of the alternatives for the following key elements of the Project:

- Alignment;
- Station/platforms;
- Ventilation shafts;
- Train system and
- Locomotive sidings.

Alignment

Criteria for Options Development

2.15 In order to assess the suitability of alternative alignments, a range of environmental, engineering, safety and general community disruption considerations has been developed to help the decision making process. They were based on considerations commonly adopted for large infrastructure projects in Hong Kong and are presented in **Table 2.1**.

Table 2.1 Considerations Used to Determine Preferred Alignment and Construction Method

Considerations	Description
Engineering Factors	
Implementation Programme	Minimisation of construction period. Shorter construction period is preferable in order to minimise the disturbance to the community.
Interface with Existing Facilities	The alignment should be a direct connection with minimal distance to reduce construction costs, maintain operational efficiency and to minimise passenger travelling time between stations and interfacing with existing facilities. Specific issues investigated at HUH included: • having minimum impact on the operation of the existing station; and • ensuring an efficient interchange between the east-west corridor and the north-south corridor. Other specific interfacing issues that were taken into account during selection of alignment options include the need for the associated Shatin to Central Link - Hung Hom to Admiralty Section [SCL (HUH-ADM)) to have a depth of up to -20mPD when crossing under the Hung Hom Bypass piers and the fender piles, the need to minimise impacts to the existing freight pier and to avoid impacting on the Cross Harbour Tunnel and tension anchors.
Construction/ Operational Safety, Flexibility and Maintenance Requirements	A number of safety, flexibility and maintenance requirements in the design and construction of railway lines can constrain certain alignment options. Constraints identified within this Project included: • the desired horizontal curve radius for a rail track is 300 m minimum; • a maximum vertical gradient of 3% should be achieved, with minimum gradients for long lengths of track to improve energy efficiency; and • additional tunnel ventilation and emergency access points are required for a long tunnel.
Constructability	Constructability is primarily related to concerns surrounding destabilising structures already present or to be built. Specific concerns identified in the SCL include: • allowing for practical construction under the Hong Kong Coliseum (HKC); • avoidance/minimisation of constructing soft ground tunnel due to safety and building settlement issues; and • avoidance/minimisation on construction risks due to uncertain ground condition and long tunnel.
Land acquisition	Land acquisition is considered in order to minimise area of land that may need to be acquired so as to minimise disruption to the local community.
Environmental Factors	
Air Quality	Dust generated during the construction of the Project and its impact on human health and the environment is considered.
Noise	Both airborne and ground-borne noise impact associated with the train pass-bys, together with impact on nearby residential premises and schools during the construction phase of the Project is considered.
Other Environmental considerations	Other environmental factors that are considered include: • the avoidance or minimisation of landscape and visual impacts associated with the above-ground structures; • avoiding the felling or disturbance of mature trees; • minimisation of C&D material / waste generation (e.g. contaminated soil/sediment); and • minimisation of fuel usage.
Other Factors	
Avoidance/Minimisation of issues/constraints	This includes the minimisation of Project areas encroaching into developed area and minimising interface issues with other projects currently being planned or constructed.
Disruption to the community	This minimisation of disruption to the community takes into account residential households, business operations and potential structural impacts along the alignment.

2.16 During the preliminary and detailed design stages for the Project, comprehensive studies have been carried out to investigate various alignment options.

Alignment Options

2.17 There are many constraints which dictate the alignment selection of the Project. These include the existing Cross Harbour Tunnel, existing buildings, location of HUH and existing rail service. Given the relatively short length of this section, the potential area available when considering alternative alignments is largely confined by the existing buildings adjacent to the existing East Rail alignment.

2.18 Besides, one of the key factors in determining the alignment options is the location of the HUH. A review of the locations for HUH has concluded that the HUH must be located to the east of the existing platforms and to the west of the Metropolis. This is because the location of the HUH is constrained by the existing platforms and plant rooms on one side and Metropolis and its structure on the other side. Alternative station locations were proved to be unfeasible due to constraints caused by existing infrastructure and the impacts on the existing operating railway (detail in sections 2.48 – 2.57 of this Chapter). Moreover, the alignment option selection will also be affected by the construction methods which will be described in sections 2.73 – 2.83.

2.19 Possibilities were explored extensively during the preliminary and detailed design of the Project. Three basic alignment options were consolidated for further development. Details of these three options are illustrated in **Appendix 2.1** and summarised below.

Option A

2.20 Option A is required in conjunction with the bored tunnel construction method across Victoria Harbour for SCL (HUH - ADM), and the tunnel depth has to be deep enough to achieve sufficient ground cover under the seabed.

Option B

2.21 Option B has been developed in the previous feasibility study. This option, running on the west side of the existing EAL, includes a 1.2km long realignment from the Portal 1A to the HUH. The at-grade section of this alignment will run very close to Wylie Court and go underground underneath the Chatham Road Interchange and pass under the HUH.

Option C

2.22 Option C is similar to Option B except the alignment being closer to Oi Man Estate that it will be running on the east side of the existing EAL. It assumes that freight will no longer operate at HUH in order to utilise the corridor currently occupied by the freight sidings.

Evaluation of Option

Option A

2.23 Option A provides a tunnel option from HUH to EXH. A number of “no-reclamation” options in terms of tunnel options have been investigated. The tunnel options include Shallow/Deep Tunnel Options.

(1) Shallow Tunnel Boring Machine (TBM) Option

2.24 The tunnel option would require the tunnel to be deep enough to achieve sufficient ground cover to enable ground control and steering and for safety requirements. The minimum ground cover required for safe bored tunnelling is generally an absolute minimum of one and preferably two TBM diameters above the tunnel. An internal diameter of 9m would be required for the TBM which would equate to the external diameter of about 10.35m for each tunnel. Accordingly, to allow for sufficient ground cover, the top of the tunnel would require an absolute minimum depth of 10.35m and preferably more than 20m below the ground.

2.25 The requirement for the ground cover results in a deeper HUH. Given that the maximum vertical gradient cannot be greater than 3%, the Project cannot connect to the existing EAL south of Tunnel 1A (about 800 m north of HUH). Instead, it must be extended almost 2km to the north. This additional rail section would require the following items to be constructed, which would significantly increase the environmental impacts, as well as the difficulties and cost for the Project construction:

- 350m of cut-and-cover tunnel in the HUH north fan track area;

- 980m of twin bored tunnel to a reception shaft in Wylie Road;
- 350m of cut-and-cover and trough along Wylie Road immediately adjacent to the existing operating railway;
- new bridge over Waterloo Road & new track on embankment to the north of Waterloo Road; and
- an increase in the overall length of the Project alignment by 1.2km.

2.26 The impact to the environment and the community of the Shallow TBM Tunnel Option is significant in the area surrounding Waterloo Road and Wylie Road, due to the increased ground cover required for the extension north of Waterloo Road. This extension would require the construction of a new bridge, additional track and a permanent retaining wall on the embankment north of Waterloo Road. In addition, temporary acquisition of land and significant traffic impacts would be resulted near the Wylie Road area while a number of trees along the existing EAL tracks would be felled. Additional private land would be resumed due to the limited space at the existing EAL boundary. Diversion of major utilities would also be required with a significant increase in safety risks for workers.

2.27 In addition, a main constraint associated with the Shallow TBM Tunnel Option is the proximity of the alignment to the Hong Kong Coliseum (HKC) foundations. The SCL tunnels must be constructed through or below the limited space between the existing HKC foundations, which significantly increases construction difficulty, and ensuring construction tolerances becomes more critical. Therefore an alignment under the HKC but above the rockhead is preferred in order to avoid undermining the existing foundations and limit the volume of rock to be excavated.

2.28 Moreover, the tunnel options would require working in high pressure exceeding the statutory limit of 3.45 bar as currently set in the Factories and Industrial Undertakings Ordinance (Cap 59). It is considered that the health and safety risks associated with these options cannot be justified when there are options available which avoid this problem.

2.29 The Shallow TBM Tunnel Option also has significant constraints and difficulties for connecting the stations and achieving operational requirements on both sides of the harbour. At the proposed Exhibition Station (EXH), a cross platform interchange could not be provided since the SCL platform at HUH would need to be at least 15m lower than the Cut & Cover (C&C) Option. This would result in the following implications:

- Approximately 2km of the existing EAL north of HUH would have to be lowered to tie into the deeper platforms at the station;
- Impacts on the HKC may occur due to increased volumes of rock excavation adjacent to and under it;
- Increased construction risks and costs associated with construction adjacent to the existing HUH foundations and under the HKC;
- Increased interchange times, as commuters would need to travel to a higher platform level to change trains;
- Extremely difficult, risky and challenging construction immediately adjacent to long lengths of the existing EAL. The modification of the existing semi noise enclosure along Wylie Road while still keeping EAL operating will be particularly difficult and would require non-operational hours construction in an environmentally sensitive area;
- Resumption and temporary occupation of private land adjacent to the alignment;
- Significant loss of trees and amenity area at Wylie Road;
- Significant disruption and impacts to the public including schools;
- Disruption to traffic at Yim Po Fong Street, Wylie Road and Waterloo Road;
- Major utility diversions including 400kV power cables;

- Tunnel 1A is an old design tunnel with a simple portal structure on pad footings. In terms of the structure of the tunnel, it is very risky to apply bored tunnel construction under Tunnel 1A since it is a critical element of the EAL network;
- Undercutting of the steep retained slopes opposite Wylie Road may be required, which may affect the overall stability of these sensitive slopes;
- It is considered that the risks to health, life and the Project associated with the TBM Tunnel Option cannot be justified. There are alternative ways of constructing the project which avoid these risks.
- Two ventilation facilities are required due to the long tunnel length between HUH and MKK (1.8km approximately). Ventilation buildings are proposed at Chi Man Street (mid-point), and at Wylie Road (north portal). Owing to the closer setback distances with the nearby sensitive receivers, potential environmental impacts, such as construction dust during construction phase and fixed source noise during operation phase are anticipated.

2.30 In summary, with the shallow tunnel option there will be several major impacts on the community. The section of the EAL to be lowered even deeper would extend to the north of Waterloo Road, where a new bridge and new track would be required on the embankment to the north of Waterloo Road. Resumption of land would be required and traffic impact would need to be resolved in the Wylie Road area. However, the most significant impacts would be the increased construction risks arising from works required immediately adjacent to the existing EAL tracks. Thus shallow tunnel option is not viable.

(2) Deep Tunnel Option

2.31 As mentioned in section 2.27, an alignment under the HKC foundations but above the rockhead is preferred. However, the Deep Tunnel Option is expected to have cost and programme implications and cause disruption to the community and environment in the area surrounding the HKC.

2.32 For the connection to the SCL (HUH – ADM), the tunnels would have to be lowered to approximately 80m below ground to be in rock to avoid the need for pressurized face interventions. The stations at both sides of the harbour would also have to be deepened significantly. The HUH and EXH would be approximately 50m and 43m in depth respectively and cross platform interchange would not be possible at these stations. This would provide an unacceptable level of service for passengers entering or leaving these stations and an inconvenient interchange due to the level difference.

2.33 There would be a knock on effect along the EAL. A significant length of EAL would have to be lowered to suit this new level including MKK. Tunnelling at depths with intervention pressures greater than 3.45 bars would also be required along the Project. Health protection for workers under compressed air will be strictly regulated by the Factories and Industrial Undertakings Ordinance, and strong justification on the safety concerns shall be fully addressed.

2.34 The overall design implication of the above would be significant and the poor vertical interchange arrangement for the east-west corridor and the north-south corridor at HUH would not meet the project objectives of providing a direct and convenient interchange for passengers. Furthermore, most of the construction works would be difficult and risky and the overall construction duration would be greatly increased.

2.35 It is estimated that immersed tube tunnel option (IMT)/cut-and-cover option across the Harbour would cost approximately HK$3.3 Billion less than the bored tunnel TBM “No Reclamation” option. The programme implications are that the SCL cross harbour tunnels constructed using IMT/cut-and-cover option would be completed up to around 2 years earlier than the TBM options.

2.36 Due to engineering difficulties, additional risks, relatively long construction programme, costs and impacts on the community, Shadow or Deep TBM option is deemed not to be a viable option.

Option B

2.37 Option B bifurcates to the west of the existing EAL Tracks. This alignment passes through the existing Ho Man Tin traction feeder station and descends below the Chatham Road Interchange before passing underneath the operating EAL tracks and going into the HUH. The EAL crossing was recognized as a particularly difficult piece of work to construct due to the limited clearance, confined

working space and stringent movement criteria imposed on the existing tracks. This Option also has risk associated with tunnel construction beneath the live EAL tracks in the north of HUH.

2.38 In addition, the Chatham Road Ventilation Building required for this Option will have significant visual and landscape impact to the surrounding. Thus, Option B is considered not a feasible option.

Option C

2.39 In order to avoid the risk associated with tunnel construction beneath the live EAL tracks in the north of HUH, Option C has been established taking into account the criteria namely safety, constructability, convenient transportation system, cost, local and urban constraint, environmental and statutory constraints as well as visually coherent station planning. The alignment has been changed both vertically and horizontally. This has positive effects on the station design in terms of passenger connectivity and reduced vertical travel distances. The changes are as follows:

Horizontal change

2.40 The rail freight business would be ceased thereby freeing up land to the east of the operating East Rail tracks. The alignment could therefore adopt an easterly route avoiding the difficult and complex EAL crossing. In addition, the western track of the project has been moved slightly eastwards in order to maximize the distance of the station diaphragm wall from existing piles that are shallow and not founded on rock, and therefore potentially sensitive to ground movements induced by the construction. This also has the benefit of reducing the station width and thus the excavation volume.

2.41 The distance between the Project tracks is increased at the location close to the NOV. Such change is a consequence of the relocation of the ventilation building adjacent to the floodgate and immediately above the Project tunnel. The wider track spacing will allow sufficient space between them to house a ventilation duct that carries the air from the fans towards the station.

2.42 Another change is to reduce the spacing between the SCL (TAW-HUH) tracks through the station area and thus to allow SCL (TAW-HUH) on the western perimeter to be completely accommodated within the structural envelope of the project station box. This would simplify construction by allowing one vertical perimeter wall to house both railways.

Vertical change

2.43 The change involves the raise of the Project alignment by 3m, thus reducing excavation depth and volume. The Project will bifurcate from south of portal 1A, descending in a ramp structure at maximum grade. SCL (TAW-HUH) will adopt a rising gradient into the HUH. Its alignment has been developed to maximize the clearance to the existing Winslow Street underpass to avoid the known piled foundations and low ground cover associated with the descending road tunnel ramp. Where the two tunnels converge, a joint box structure will be constructed with SCL (MKK-HUH) sitting below the SCL (TAW-HUH) which rises in a ramp on approach to the ground level platforms in the HUH.

Other Modification

2.44 The Chatham Road Ventilation Building as required in Option B has also been deleted. The Back of House (BOH) and plant spaces have also been optimized and the Project related ventilation shafts and ancillary requirements have been relocated south of the podium. The station intake and exhaust ventilation shafts are located at the north and south end of the podium and linked to the tunnel ventilation fan rooms and plant rooms for air intake and discharge. As a result, the potential visual impact associated with ventilation structures size and their location within the podium level has been reduced.

Preferred Alignment Option

2.45 The comparison of potential environmental benefits and disbenefits is shown in **Table 2.2**.

Table 2.2 Potential Environmental Benefits/Disbenefits of Alignment Option

Criteria	Alignment Option		
	Option A	**Option B**	**Option C**
Construction Dust	A much longer tunnel and more works are required; and therefore, more Air Sensitive Receivers are likely to be affected. The construction period and therefore the period of dust generation will be longer (both construction truck movement and operation at above ground works area). The potential for dust impact is likely to be the highest since more above ground works areas/works items would be involved. HUH would be deeper and require more excavation, generating more dust.	A relatively shorter tunnel and fewer works sites are required; and therefore fewer air sensitive receivers are likely to be affected. The construction period and therefore the period of dust generation will be shorter (both construction truck movement and operation at above ground works area). The potential for dust impact is likely to be smaller since fewer above ground works areas/works items are required. HUH would be shallower and require less excavation, generating less dust.	A relatively shorter tunnel and fewer works sites are required; and therefore fewer air sensitive receivers are likely to be affected. The construction period and therefore the period of dust generation will be shorter than Option A (both construction truck movement and operation at above ground works area). The potential for dust impact is likely to be lower than Option A since fewer above ground works areas/slope works items would be involved. HUH would be shallower and require less excavation, generating less dust.
Construction noise	More noise sensitive receivers are likely to be affected since the extent of construction works is larger. The construction period will be longer and the potential affecting period will be longer (both construction truck movement and operation at above ground works area). Since more construction works within rock would be required, a higher and longer ground-borne construction noise impact would be anticipated.	Fewer noise sensitive receivers are likely to be affected since the extent of construction works is smaller. The construction period will be shorter and the potential affecting period will be shorter (both construction truck movement and operation at above ground works area). Since minimal construction works in rock layer need to be conducted underneath sensitive buildings (e.g. residential premises and schools), a lesser and	Fewer noise sensitive receivers are likely to be affected since the extent of construction works is smaller. But slope cutting is much closer to Ho Man Tin Estate. The construction period will be shorter than Option A and the potential affecting period will be shorter (both construction truck movement and operation at above ground works area). Temporary traffic management scheme

Criteria	Alignment Option		
	Option A	**Option B**	**Option C**
		shorter ground-borne construction noise impact would be anticipated.	utilizing diverted traffic lanes north of Chatham Road North, thereby reduce construction noise impacts in the Winslow Street area.
Waste Management	An increase in C&D material would be expected to be generated due to much longer tunnel construction. HUH would be deeper and require more excavation, generating more spoil.	Much less C&D material will be generated due to a fairly short tunnel construction. HUH would be shallower and require less excavation, generating less spoil.	Much less C&D material will be generated due to a fairly short tunnel construction. HUH would be shallower and require less excavation, generating less spoil. Reduced excavation volume due to raising of SCL (MKK-HUH) and SCL (TAW-HUH) levels, reduced platform's width by 800mm and reduced spacing to the SCL (TAW-HUH) track in the eastern part of the alignment.
Water Quality	Longer tunnel route length (about 2km) so more tunnel wastewater generated.	Shorter tunnel route length (about 1km) so less tunnel wastewater generated.	Shorter tunnel route length (about 0.8km) so less tunnel wastewater generated.
Land Contamination	Potential interface with contaminated land at Chatham Road Interchange.	Potential interface with contaminated land at Chatham Road Interchange.	Potential interface with contaminated land at Chatham Road Interchange.
Landscape and Visual	It is likely that more trees are likely to be required to be felled or transplanted. Significant visual impact from ventilation buildings.	Tree impact reduced. Significant visual impact from tunnel ventilation building.	Tree impact reduced. Tunnel ventilation building is not required.
Construction Duration	Longer construction programme (two more years than Option C) involves longer duration of disturbance, longer presence of	Shorter construction programme involves shorter duration of disturbance, shorter presence of works areas with associated	Shorter construction programme involves shorter duration of disturbance, shorter presence of works areas with associated

Criteria	Alignment Option		
	Option A	**Option B**	**Option C**
	works areas with associated air quality, noise and landscape & visual impacts and later commencement of operations.	air quality, noise and landscape & visual impacts and earlier commencement of operations.	air quality, noise and landscape & visual impacts and earlier commencement of operations.
Disruption to the Community	Due to longer time span and more works areas, a greater disruption to the community would be expected.	Due to shorter time span and fewer works areas, a less disruption to the community would be expected.	Due to shorter time span and fewer works areas, a less disruption to the community would be expected.

2.46 According to the comparison in Table 2.2, Option A has less of identified environmental benefits for the selected criteria than Options B and C. There are major risk, costs and impacts on community for the Option A such that it is not considered as a viable option.

2.47 As compared to Option C, Option B is also considered less favourable in the construction and environmental perspective. Option C significantly reduces complexity of construction for the Project tunnel box and shortens the length of the vertical circulation elements. The Project platform's width was also reduced by 800mm. This alignment presents the following environmental benefits:

- reduced excavation volume due to raising of SCL (MKK-HUH) and SCL (TAW-HUH) levels, and reduced spacing to the SCL (TAW-HUH) track in the eastern part of the alignment;
- deletion of the tunnel ventilation building so that the visual impact could be reduced;
- shorter tunnel route length resulting in less tunnel waste water generated; and
- temporary traffic management scheme utilizing diverted traffic lanes north of Chatham Road North, thereby reduce construction noise impacts in the Winslow Street area.

2.48 Option C has been determined to have minimized environmental effects and provides overall environmental benefits over the other two options and presents the optimum scheme from an operational and environmental perspective. **As such, Option C was selected as the preferred alignment.**

Station/Platforms

2.49 In addition to the different alignment options, alternative options for HUH location have been considered in order to maximise station functionality and minimise constraints on other sections of the Project.

2.50 The existing HUH, located in a heavily developed area, currently provides an interchange between the West Rail Line, EAL, Intercity and the existing Cross Harbour Tunnel bus routes. This critical function will be required to be maintained throughout the construction stage of the Project. On completion of the SCL, the station will need to provide an additional cross platform between east-west corridor and north-south corridor, whilst also continuing to provide interchanges with intercity services and the cross harbour tunnel bus routes.

2.51 Key factors in the development of an enhanced scheme for Hung Hom are:

- Provision of freight – freight operation will be ceased
- Intercity – Provision is made in the design of HUH for Intercity continuing operation

2.52 On the abovementioned basis, station options were developed within the existing Freight Terminal. The differences between them mainly relate to the configuration of entrances and concourse, and how they relate to the surrounding facilities and connections. Subsequent to the review, options in terms of podium level concourse have been adopted due to the least expensive to build and the least impact to the existing station operation.

West of existing HUH

2.53 The heavily trafficked approach roads to the Cross Harbour Tunnel (CHT) at the west of the existing HUH restrict the use of cut and cover construction techniques that would likely create unacceptable impacts on traffic flow. To move HUH to the west would also bring the Mong Kok East – Hung Hom alignment too close to the existing CHT, which would likely produce unacceptable interfacing impacts due to potential settlement / movements of that structure.

2.54 The area to the west of the CHT approach road is currently occupied by the Hong Kong Polytechnic University, which may require large portions of the existing facility to be demolished in order to allow the HUH to be moved there. In order to access the harbour, this alignment would also have to use a similar alignment occupied by the EAL between Hung Hom and East Tsim Sha Tsui Stations. Thus there is insufficient space to allow station to be located west of HUH.

East of Existing HUH

2.55 The area to the east of the station is constrained due to the major Metropolis development and its foundations, which would likely restrict possible EAL alignment in this area. Due to horizontal alignment constraints it is also infeasible to realign the SCL (TAW-HUH) from East Tsim Sha Tsui Station to the east of the existing HUH. However, with the termination of the freight service, this area for freight operation can be used for future development.

North of Existing HUH

2.56 The area to the north of the station is constrained due to the daily rail operation at the railway fan area and the associated underground utilities. There would be major operational constraint to re-route or divert rail tracks at the fan area to other places in order to make room for the construction of new platforms.

South of Existing HUH

2.57 The HKC constrains how far the station could be located to the south as it occupies all of the podium level where the station concourse would be located. Together with this, there is insufficient space to allow station platforms to be located under the central core of the HKC.

Summary

2.58 In order to provide a convenient interchange between the SCL east-west corridor and north-south corridor, minimal distance to reduce construction costs, maintenance of operational efficiency and to minimise passenger travelling time between HUH and Exhibition Station (EXH), it is proposed that the new HUH platforms will be constructed in-situ at the eastern side of the existing EAL platforms. In other words, instead of constructing a new station elsewhere, new platforms will be constructed within the existing HUH. Platforms for the SCL (MKK-HUH) are proposed to be built underneath the existing HUH/podium and interchange with SCL (TAW-HUH) will be through the existing podium level concourse. The existing Platforms will be connected with future SCL (MKK-HUH) and SCL (TAW-HUH) platforms via escalators for effective cross-platform interchange. **Appendix 2.2** shows the cross-section of the new HUH platforms. Based on the constraints caused by existing infrastructure and the impacts on the existing operating railway, alternative station locations were considered and proved to be unfeasible.

Ventilation Shaft

2.59 Ventilation shafts will serve several purposes. In normal operation, they will be the air exchange route for the railway system. In emergency mode, they will be essential components of the tunnel smoke control system. One major environmental consideration of the Project is to design and locate the ventilation shafts such that environmental impacts including fixed plant noise (fan noise), air quality and visual impacts associated with their operations could be minimized.

2.60 The ventilation shafts would be designed to comply with the specified noise limits with no adverse noise impacts.

2.61 Tunnel ventilation exhausts and smoke extraction facilities will also be carefully positioned to avoid adverse air quality impacts.

2.62 Careful consideration has been given to the locations and design of required ventilation shafts to minimize the visual impact. The number of ventilation shafts has been significantly reduced from the original 22 in the preliminary design stage to 13 in the detailed design stage. The ventilation shafts for the reconfigured station have been grouped along the northern and southern podium edges. The vent disposition has been coordinated with the requirement of 5m separation from the podium level, from the other smoke ventilation shafts and 3m above the grade where required. They form a series of geometrically shaped boxes whose facades are articulated with trapezoidal vent louvers. These structures appear as a natural extension of the podium.

2.63 The north and south side ventilation shafts are physically minimised with the top level generally at the podium level. They have been provided with the physical statutory separation requirements and the vent openings of up to 80% efficiencies. The top of these vent structures will be covered with planter boxes and green roof. Details will be discussed in Chapter 4 (Landscape and Visual Impact Assessment).

2.64 All the ventilation shafts of the HUH would be situated within the station footprints where disturbance to nearby sensitive receivers can be reduced to the greatest extent with the implementation of suitable mitigation measures.

Train System

2.65 Two types of train services will be provided at different stages of the project:

- As per the current situation, a mixed fleet of MLR train and SP1900 will be used before SCL (HUH – ADM) is commissioned; and
- 9-car SP1900 or equivalent will be adopted when the entire SCL (HUH–ADM) is commissioned. The train will be less noisy as compared to the existing fleets.

2.66 The SP1900 type of train is a modern electrically powered train that is considered to be more environmentally friendly. With the shorter train length, length of platform and stations can be reduced accordingly. In general, this will reduce the potential environmental impact (in terms of extent and/or duration) that would be generated from the project during both the construction and operational phases.

Locomotive Sidings

2.67 Due to the long haulage to existing depots at Lo Wu or Ho Tung Lau, backup engineering locomotive will be required for maintenance of infrastructures and buildings, as well as handling of emergency situation such as emergency inspection.

2.68 In order to provide supporting service to the main line, locomotive sidings are required to meet the operational requirements. These requirements are listed below:

- Locomotive travelled along the existing rail siding is not operated regularly as the main line service; and
- Major maintenance works will only be conducted in depot.

Layout of Stabling Siding

2.69 In order to achieve the operational requirements, the area will comprise:

- Maximum of three sidings; and
- Associated stores.

Preferable Location

2.70 Due to the long haulage distance, it is not recommended to stable all maintenance locomotives at the existing depots despite that emergency maintenance activities will still be carried out at the depot.

2.71 The sidings could be developed within the existing Homantin sidings and Mong Kok Freight Terminal without major modifications to the existing EAL tracks. In particular for Mong Kok Freight Terminal, three existing freight tracks decked under podium structure can be deployed for the use of siding. This site has historically been used for loading and unloading activities and locomotives/freight movements, and is already screened from the surrounding community, with minimal visual or noise or social impact on sensitive receptors expected.

2.72 The existing Homantin siding will be slightly modified. Three existing tracks will be reduced to one track with spur track approaching the Hong Kong Polytechnic University Phase 8 (HKPU Phase 8) area and the number of crossing will be reduced. The alignment of the reprovisioned track will also be slightly further away from the nearby residential blocks (Wylie Court). In addition, the operation mode and function of the siding remain the same and the siding will only be used for maintenance and emergency operation, no significant environmental impact would be expected.

2.73 As such, the proposed locations detailed above are deemed the best practical way to accommodate all operation requirements of the Project with minimal impact to the surrounding community.

Considerations for Construction Method

Tunnelling

2.74 The preferred alignment results in the major length of the railway being within tunnel with remaining sections at grade. Construction of the Project will potentially lead to certain levels of environmental impacts. Thus alternative tunnel construction methods have been considered to pre-empt the potential construction impact to the nearby sensitive receivers.

2.75 There are several tunnel construction methodologies that have been undertaken in Hong Kong, with the main three including:

- cut-and-cover construction;
- drill and blast construction; and
- bored tunneling construction.

Cut-and-Cover (C&C) Construction Method

2.76 Cut-and-cover construction is a proven and common method of excavation and construction for tunnels, stations and shafts. This construction method can accommodate different shapes of works areas. It typically requires several overlapping stages of work to be conducted in sequence, including removal of obstruction and diversion of existing utilities, installation of pipe pile or sheet pile wall/diaphragm wall, grouting, installation of decking, soil excavation, construction, backfilling and reinstatement.

2.77 In urban areas, the trench can be covered with a temporary deck following excavation to maintain traffic management, if required.

Drill and Blast

2.78 For this project, drill and blast construction has been ruled out predominantly due to the majority of the tunneling works requiring soft ground excavation.

Bored Tunneling Construction Method

2.79 Tunnel boring machines (TBM) can be utilized for the soft and mixed ground tunnels with adequate ground cover. The construction methodology eliminates the need for surface access except at launching and retrieval shafts thus minimising surface disruption. Availability of suitable sites for these shafts is a major consideration. The machine can be utilized for short lengths of rock sections of the tunnels but is not as efficient or flexible as traditional drill and blast techniques.

2.80 The selection of the appropriate tunneling machine will depend on many issues, including the ground conditions and available ground cover above the tunnel, contractor's experience, and tunnel size and tunnel alignment. Given the ground conditions anticipated, a shielded TBM erecting an un-drained (i.e. sealed) segmental lining would be required to ensure the stability of the tunnel face and safety of the workers, minimize the impact to the groundwater regime and limit surface settlement. Dealing with buried obstructions would also be more difficult than with the C&C method.

2.81 In order to adopt the TBM Tunnel Option, sufficient ground cover is required over the TBM to enable ground control and steering and for safety requirements. The minimum ground cover required for safe bored tunneling is generally an absolute minimum of one TBM diameter and preferably two diameters above the tunnel. This criterion cannot be met for the proposed tunnels. In addition, the alignment conflicts with many existing foundations (e.g. the foundations of the east abutments of Overbridge OB2 and OB2A) which could not be handled with a TBM method within acceptable level of risk. Finally since the project tunnels connect the existing EAL at Portal 1A, there is no suitable site for launching or retrieval of the TBM south of Portal 1A.

Environmental Considerations of Construction Methods

2.82 Potential environmental issues associated with the two possible tunneling methods have been reviewed and a summary of the benefits and disbenefits of construction methods is presented in **Table 2.3**.

Table 2.3 Environmental Benefits and Disbenefits of Tunnel Construction Methods

Tunnel Construction Method	Cut-and-cover construction (C & C) method	Bored tunnelling Construction method
Benefits	● Accommodation of different sizes of works areas. ● Can undertake both shallow and relatively deep tunnelling. ● C&D material can be sorted and reused easily. ● Since the extent of the tunnel can be limited, less sensitive receivers will be affected over a short works extent within the existing EAL boundary (further setback to sensitive receivers).	● Noise impact could be minimized by provision of temporary decks over the portal. ● Less impact on groundwater level with the installation of water tight concrete tunnel lining in pre-cast segments.
Disbenefits	● More construction plants will be involved such that this is likely to generate relatively more airborne noise and dust impacts.	● Only applicable for a fairly long tunnel section. ● Require recycling of bentonite/slurry ● Spoil usually well mixed with slurry and not easily to separate out for reuse. ● Requires additional land for the handling of slurry that requires processing before disposal. ● Tunnelling in congested area next to existing EAL is likely to be a critical concern. ● Extremely difficult, risky and challenging construction immediately adjacent to long lengths of the existing EAL and roads from the Chatham Road Interchange area.

Selection of Preferred Construction Methods

2.83 Based on the considerations presented above, an evaluation of the two main construction options was conducted. It is concluded that the C&C Option is the most appropriate option that can achieve the Project requirements and benefits to the public and be constructed safely with proven technology, lower costs, less environmental impacts and less risk to programme. As such, the C&C Option using Option C is selected as the preferred construction method.

2.84 Based on the engineering information, the works areas requiring for the C&C method will be minimal and mostly confined to the existing EAL boundary. As such, minimal land resumption and temporary traffic diversion will be necessary. Since the tunnel length can be kept fairly short (about 0.8km), the C&C method is more cost-effective. Owing to the large setback distances with the nearby sensitive receivers, environmental impacts such as construction noise/dust and fixed source noise impact would be minimized.

Hung Hom Station

2.85 The construction methodology employed for the new platform at the existing HUH will also determine the impact on the surrounding environment. Two construction methods were considered appropriate for further investigation for the areas next to HKC:

- Temporary Open Deck Scheme; or
- Underpinning Scheme.

Temporary Open Deck Scheme

2.86 The defining construction methodology of the Temporary Open Deck Scheme is to "remove" the constraints imposed by the existing podium deck arrangements. The affected part of the existing podium deck would need to be demolished prior to the construction of the SCL (MKK-HUH) tunnel.

2.87 In order to minimize any potential implication to existing infrastructure (e.g. HKC), a staged construction scheme must be developed to minimize the duration and extent of podium deck to be removed at any one time. The main tunnel works would be deferred until after each stage of podium deck reconstruction is completed, with only the temporary cofferdam walls being installed at each stage of the deck removal. Temporary reprovisioning of the affected HKC facilities would also be required.

2.88 Since part of the deck must be demolished and major construction activities would be exposed, construction noise and dust should be managed properly. HKC operator, LCSD raised objections to this scheme. Thus alternative scheme such as underpinning is considered.

Underpinning Scheme

2.89 The defining construction methodology of the Underpinning Scheme is to construct new foundations and columns to underpin the existing podium deck structure. Once the loading is successfully transferred to the new supporting structure, those columns and foundations which are obstructing the SCL (MKK-HUH) tunnel are able to be demolished.

2.90 The underpinning works are more complex. The mid-level walkway and plant room locations must be maintained throughout construction and the headroom under these structures must be limited to 5m. The CLP substation and chiller plant room which serve the existing HUH will also be required to be maintained during all construction stages. In addition, no cofferdam wall could be undertaken within this area as maintenance access will be required. However in order to avoid impact with existing foundation locations, the alignment of the cofferdam wall and temporary retaining wall will require precision engineering.

2.91 After the underpinning works, the connection between the column base and the pile cap can be cut. An excavation with layers of strut and waling can then commence in stages and a bottom up method could be used. Underpinning schemes have been modified to minimize the engineering difficulties as this is the scheme favoured by stakeholders such as HKC due to minimal interference with their activities.

Summary

2.92 The benefits and disbenefits of the two HUH construction methods are compared in **Table 2.4**. In summary the Underpinning Scheme would have less environmental impact through reductions in construction noise, dust and waste.

Table 2.4 Benefits and Disbenefits of the Proposed HUH Construction Methods

Station Works Construction Method	Benefits	Disbenefits
Underpinning Scheme	• This method in general is favoured by stakeholders, such as HKC due to minimal interference with their activities; • Less environmental impacts, through reduction in construction noise, dust and waste; • Less impacts on community through reduction in construction noise and dust; • Existing evacuation route and emergency vehicular access for the HKC would not be affected; and • This method can be modified to minimize the engineering difficulties.	• More difficult construction method and very complex in design; • Continuous inspection and maintenance of permanent left in place bearing in future are required; and • Longer programme is expected for underpinning due to the complexity of works.
Temporary Open Deck Scheme	• Easier construction method and simple form of design; • No need for long term continuous inspection and maintenance of permanent bearings; and • Shorter construction programme.	• A staged construction scheme has to be developed to minimise as much as possible the duration and extent of podium deck to be removed at any one time; • Temporary reprovisioning of the affected HKC facilities would also be required which will have concern from HKC due to the potential interference on activities; and • Since part of the deck needs to be demolished and some of the construction activities will be exposed. Relatively higher construction noise and dust will be anticipated. Additional mitigation measures would be required to minimize the impact.

2.93 In view of the HKC's constraint and the latest designs to simplify the underpinning works of existing columns supporting the podium being developed in the detailed design of the Project underpinning construction methods for the HUH has been selected as the preferred construction method for the station works.

Works Area/Site Requirements

2.94 Given the scale of the Project, works areas/sites would be required for supporting the construction and have been identified for site office, storage of materials, utility, barging facilities and traffic diversion. For construction of a new railway system within a built-up urban environment, identification of available works areas/sites represents a significant challenge. Details of the works areas/sites are discussed in Chapter 3.

2.95 The location of works areas/sites have been selected with consideration to their accessibility and suitability for construction works and future permanent facilities. The above-ground works areas/sites have been minimised to reduce the land taken as far as possible and avoid the potential environmental sensitive areas. In this regards, the works area/site are mostly planned within the EAL boundary. Other minor works areas/sites for storage can utilise works sites from other concurrent projects. In other words, new works area/site has been minimised as much as possible such that potential impact to additional sensitive receivers can be avoided.

2.96 To support the construction of the Project, additional temporary works areas/sites would be required for the provision of site office, storage of materials, utility, traffic diversion and barging points for efficient removal of spoil. With a view to minimizing road-based traffic and stress on existing road networks, barging points have to be set up at waterfront sites to remove the excavated materials generated from tunnelling and earth works by sea. This will significantly reduce the impact on road traffic in particular the burden on routes in Hung Hom and Tsim Sha Tsui and hence the impact on nearby environment.