THE HONG KONG INSTITUTION OF ENGINEERS

RESEARCH ON AUGMENTING ENGINEER MANPOWER TO COPE WITH THE FORESEEABLE SURGE IN DEMAND

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EXECUTIVE SUMMARY

A new development blueprint for Hong Kong has been rolled out with some major announcements made recently in the National 14th Five-Year Plan, 2021 Policy Address and Hong Kong 2030+ final report. In the foreseeable future, it is expected that large scale developments such as the Lantau Tomorrow Vision and Northern Metropolis would be under active planning and construction to meet the land and housing demand as well as to develop Hong Kong into a Technology & Innovation hub. As a result, the construction volume will surge and there would be a concern on whether there will be sufficient engineers (amongst other players) in the engineering industry to deliver the vision and commitments made in the development blueprint.

In view of this, the Hong Kong Institution of Engineers (the HKIE) has set up a Task Force to research the foreseeable workload and the local engineering manpower supply situation in the coming decades.

This report summarises the findings of the Task Force on the prevailing construction expenditures and the current engineer manpower situation in Hong Kong. An estimation on the future construction expenditures has been made from 2021/22 to 2040/41. With large-scale developments such as Lantau Tomorrow Vision and Northern Metropolis, the construction expenditure may increase by up to **28%** and **50%** in 2030/31 and 2040/41 respectively compared to 2021/22.

Together with data of the past and current manpower supply retrieved from different parties of engineering and tertiary education institutions, the report demonstrates a widening supply gap will occur in the years to come. There are currently around 14,000 engineering professionals engaging in the construction industry. To match the surge in construction volume, additional manpower in the corresponding magnitude may be required. Though some of the supply gaps shall be overcome by means such as increase in productivity through innovation within the industry itself, concerted effort among Government, the Academia and the industry on all fronts shall be called upon to look into the matter and implement more drastic revamps. These may include possibly reviewing and streamlining the submission and approval process, reforming school curriculums, etc.; and more importantly, curtailing the vicious circle as mentioned below thus attracting more talented successors.

As mentioned, it is observed that a vicious circle has apparently been repeating in the industry for the past decade. It is expected that this vicious circle will only be worsened with an expected increase in construction volume, resulting in a long-term augment of engineering manpower deficiency; unless actions are taken to reverse/ alter this.

This vicious circle could be briefly described as follows:

- “Alleged” or “reported” reduction in quality of the deliverables in the construction industry.
- As a result, more rigorous checking and supervision were imposed by the regulatory bodies.
- More professional staff are required by the checking authorities to exercise enforcement of the above enhanced rigorous measures. The professionals

transferred to these authorities are often from middle or entry-level of private sectors.

- With their departure, maintaining the quality of deliverables in the industry is becoming a bigger challenge;
- Remaining professionals in the middle or entry-level of private sector will need to struggle to survive through bigger challenges under poorer working environments; rendering the profession less attractive to future successors.

Without any improvement, young talents will be further deterred from joining the engineering industry.

Taking into account the present difficulties fronting the professionals together with the upcoming challenges, recommendations to possibly tackle the problems are identified and presented in this report. The major observation made is the public's adverse perception of the engineering industry and the possible worsening of the vicious circle above. Therefore, a suggestion for enhancement in promoting engineering to the general public is made. There are also other suggestions such as improving the engineer's working environment and condition; strengthening the engineering community base; cultivating interest and also enhancing the quality of youngsters. The suggestions presented aim to improve the perception of the public on engineers, attract young talents to become engineers; and most importantly, reduce the spinning of the vicious circle that is affecting the whole engineering profession. However, these measures will require concerted and sustained efforts among all stakeholders in the years to come.

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1. INTRODUCTION

The engineering and construction industry plays a vital role in enhancing people's living environment and contributing to the economic growth and long term competitiveness of Hong Kong.

In 2018, the Development Bureau envisaged that the annual construction output of the public and private sectors would be in the range of HK$250 billion to HK$300 billion over the following ten years[1]. The vision and strategy set out recently in the National 14th Five-Year Plan, 2021 Policy Address and Hong Kong 2030+ final report[2] have added new impetus to the development of Hong Kong. The key objectives include, maintaining Hong Kong's prosperity and stability, reinforcing and enhancing Hong Kong's competitiveness, and furthering the development of the Greater Bay Area (GBA) [3]. There are also supportive initiatives such as increasing housing and land supply[4], developing a new technology & innovation hub, building a liveable city and nurturing talents and youth development. In other words, there is likely large-scale development in the foreseeable future to support the proposed initiatives in these publications.

Let alone the new technology & innovation hub which will similarly increase the demand on other streams in the engineering professionals, with a growing portfolio of mega infrastructure projects in the pipeline, the construction volume will surge, and opportunities as well as challenges for engineers will also arise. There would be concerns on the capabilities and manpower resources for the profession in order to achieve the vision and commitments in the future.

To ensure the quality and timely delivery of these projects, the HKIE, being the professional body of engineering excellence and a guardian of the engineering professional standard and competence, has set up a Task Force consisting of members of the President's Protégés Club to undertake a study on the future construction expenditures and demand upon the engineering professionals. Arising from the study results, various recommendations on augmenting the supply of engineering professionals as well as enhancing the quality are suggested in this report.

[1] Project Strategy and Governance Office (2018), Construction 2.0 Time to Change.

[2] Planning Department (2021), Towards a Planning Vision and Strategy Transcending 2030.

[3] Brand Hong Kong (2021), Hong Kong's role in the National 14th Five-Year Plan.

[4] For instance the Lantau Tomorrow Vision and Northern Metropolis.

2. SUMMARY OF FUTURE CONSTRUCTION EXPENDITURES

2.1. Overview of the future construction expenditures

To provide a better picture on future surge in construction volume, a forecast on the construction expenditure from 2021/22 towards 2040/41 has been carried out. The baseline of this estimation is the annual construction expenditure forecast for both public and private sectors from 2021/22 to 2030/31 released by the Construction Industry Council (CIC) in June 2021[5] (further elaboration can be found in **Section 2.1.1** below). As there is no forecast onwards from 2031/2032, the baseline figures from 2031/32 to 2040/41 are estimated via linear regression analysis on CIC's predicted values from 2026/27 to 2030/31. The simplified but logical assumption that the annual construction expenditure in the market would continue to increase at a steady rate has been made.

On top of the baseline figures, the construction expenditure arising from the Lantau Tomorrow Vision (LTV) and the Northern Metropolis (NM), two of the largest developments proposed at the moment, are added. It is assumed that the construction expenditures of other public and private projects from 2031/32 to 2040/41 are already included in the linear regression baseline estimates.

It should be noted that the estimation from 2021/22 to 2030/31 by CIC is based on information up to May 2021; and Lantau Tomorrow Vision was unveiled in the 2018 Policy Address[6]. There is thus a question of whether LTV has been included in the baseline estimate. It is observed that the upper and lower bounds in the CIC's forecast have exhibited quite a significant change in 2026/2027 year. It is thus anticipated that the difference between the upper and lower bound may partly be taking account of two possible scenarios, i.e. the upper one representing expenditures with LTV included while the lower one does not. As the baseline curve in this study adopted the average of the two sets of figures in the CIC forecast, it could be taken that the baseline curve does not consider the effect of LTV. And even if it does, the amount would not be significant. On the other hand, the Northern Metropolis was announced in the 2021 Policy Address in October 2021[7]. Therefore, the expenditure from Northern Metropolis would unlikely be included in the CIC's forecast.

Therefore, in our estimation, the total construction expenditure forecast from 2021/22 to 2031/32 would be the sum of: -

1) the construction expenditure forecast from 2021/22 to 2030/31 released by the CIC (**Section 2.1.1**); and
2) the estimated construction expenditure for NM from 2021/22 to 2030/31 (**Section 2.1.4**).

[5] Construction Industry Council (2021), Construction expenditure forecast for public and private sectors.

[6] Hong Kong Special Administrative Region Government (2018), 2018 Policy Address.

[7] Hong Kong Special Administrative Region Government (2021), 2021Policy Address.

The total construction expenditure forecast from 2031/32 to 2040/41 would be the sum of: -

1) the construction expenditure forecast from 2031/32 to 2040/41 obtained from linear regression analysis (**Section 2.1.2**);
2) the estimated construction expenditure for LTV from 2031/32 to 2040/41 (**Section 2.1.3**); and
3) the estimated construction expenditure for NM from 2031/32 to 2040/41 (**Section 2.1.4**).

More detailed discussion on these estimations would be elaborated in the ensuing sections. In our analysis, September 2020 Price Level (Sept 2020 Price Level) is adopted to reflect the construction expenditure in the upcoming years. The money-of-the-day (MOD) prices are converted to the Sept 2020 Price Level for easy comparison. The conversion factors would be further discussed in **Section 2.1.5.**

2.1.1. Baseline construction expenditure forecast from 2021/22 to 2030/31 from the CIC

The construction expenditure forecast released by the CIC, as shown in **Figure 2.1**, is a 10-year forecast (from 2021/22 to 2030/31) of the construction expenditure in Hong Kong. The forecast included the Building Works, Civil Engineering Works, Electrical and Mechanical Works, and Repair, Maintenance, Alteration and Additional Works, in both the public and private domains[8]. An envelope approach is applied to project the future trend of the construction expenditure by showing the lower and upper bound levels.

In this study, the average of the lower and upper bound values is adopted to be the baseline expenditure from 2021/21 to 2030/31 as summarised in **Table 2.1**. The data extracted from the CIC's forecast are attached in **Appendix A.**

2.1.2. Baseline construction expenditure forecast from 2031/32 to 2040/41 by linear regression model

As the forecast released by the CIC covers only expenditures up to 2030/31, a linear regression analysis is adopted to project the construction expenditure from 2031/32 to 2040/41 in broad-brush manner. The projection of baseline expenditures is done by assuming the annual construction expenditure would increase at a steady rate as per the trendline shown in **Figure 2.2**. The estimated rate of increase is taken as HK$1.25 billion per year from 2031/32 to 2040/41.

From the linear regression analysis, the calculated baseline construction expenditure from 2031/32 to 2040/41 is summarised in **Table 2.2.** The relevant data and linear regression model are attached in **Appendix B**.

[8] Construction Industry Council (2021), Construction expenditure forecast for public and private sectors.

2.1.3. Total construction expenditure for Lantau Tomorrow Vision

To harness the strategic advantages and opportunities of Lantau, LTV was promulgated in 2018 Policy Address. It is the aspiration of the LTV to create land for meeting housing and economic needs and to enhance intra-connectivity within Hong Kong and connection to our neighbouring cities and the rest of the world[9].

With reference to LC Paper No. CB (1)729/18-19(03)[10] dated 26 March 2019, the key projects under the LTV Plan would include large-scale reclamation works, infrastructure works and construction of priority transport networks. The scope and the estimated expenditure are summarised in **Table 2.3** and **Table 2.4**.

The total construction cost of the key projects under the LTV would be in the order of **$624 billion** (in September 2018 prices). According to the Secretary for Development's Blog on 24 March 2019[11], the total expenditure is expected to be spent over a period of ten to fifteen years (i.e. an average of $40 to $50 billion per year).

As explained above, the baseline curve in this study adopted the average of the two sets of figures in the CIC forecast, and hence could be taken that it does not consider the effect of LTV. Therefore, in this study, as a conservative approach, the annual construction expenditure arising from the Lantau Tomorrow Vision (taken as $40 billion per year at September 2018 Price or **$39.4 billion per year** at Sept 2020 Price Level) is added after the 2031/32 period only.

However, as emphasised in LC Paper No. CB (1)729/18-19(03)[12], the above estimates were indicative in nature given the early stage and the relatively long time horizon of the Vision. In addition, it should be noted that the possible artificial islands at Hei Ling Chau and Cheung Chau South, and other possible transport networks in the longer term were not considered yet. As a result, the actual construction expenditure could be higher than the current estimation provided in this report.

2.1.4. Total construction expenditure for Northern Metropolis based on the developments mentioned in the Northern Metropolis Development Strategy of the Policy Address 2021

In order to address the growth of local population and meet the need of economic development in Hong Kong, the NM was announced in 2021 Policy Address.

[9] Hong Kong Special Administrative Region Government (2018), 2018 Policy Address – Housing and Land Supply.

[10] Legislative Council (2019), Paper for meeting of the Panel on Development: Administration's paper on studies related to artificial islands in the central waters, Lantau Conservation Fund and work progress of the Sustainable Lantau Office (LC Paper No. CB(1)729/18-19(03).

[11] see https://www.devb.gov.hk/en/home/my_blog/index_id_330.html

[12] Legislative Council (2019), Paper for meeting of the Panel on Development: Administration's paper on studies related to artificial islands in the central waters, Lantau Conservation Fund and work progress of the Sustainable Lantau Office (LC Paper No. CB(1)729/18-19(03).

The Northern Metropolis Development Strategy (NMDS) [13] was concurrently announced by the Government in October 2021. The publication outlined the ongoing and proposed developments at the Northern New Territories, which included mature new towns in Tin Shui Wai, Yuen Long and Fanling/Sheung Shui, the neighbouring rural areas, six New Development Areas (NDA) and Development Nodes, namely Kwu Tung North/Fanling North, Hung Shui Kiu/Ha Tsuen, Yuen Long South, San Tin/Lok Ma Chau, Man Kam To and the New Territories North New Town as shown in **Figure 2.3**.

Unlike the LTV, the estimated construction expenditure for NM Development is yet to be released by the Government. Therefore, a broad-brush construction expenditure forecast is conducted by studying the aforementioned publication and referencing the priced unit rates of the works in recent projects of similar nature. This would then be added to the baseline figures as shown in **Figure 2.2** to estimate the total construction expenditure.

To summarise, the development at the NM can be categorised as follows: -

1. Infrastructure and site formation development (**Section 2.1.4.1**)
2. Housing development (**Section 2.1.4.2**)
3. Railway development (**Section 2.1.4.3**)
4. Conservation facilities development (**Section 2.1.4.4**)

The estimation methodology for each category of the NM development and the calculated total construction expenditure arising from the initiatives in NM are presented in the ensuing sections.

2.1.4.1. Infrastructure and site formation

It should be noted that the six NDAs and Development Nodes at the NM are in different planning and development stages. Therefore, the construction expenditure of ongoing projects should not be counted in our additional estimation as it should have already been included in the CIC's forecast.

The status of respective development areas is summarised in **Table 2.5**.

Based on the status of various development areas, only the expenditures arising from the construction phase of the following areas are considered: -

1. San Tin/Lok Ma Chau Development Node,
2. Man Kam To Development Corridor and
3. New Territories North New Town.

They are coloured in purple in **Figure 2.4**. From this figure, there are three development areas that should be accounted for in our additional estimation. The respective approximate areas, in the order of a total 1460 ha, are listed in **Table 2.6**.

[13] Hong Kong Special Administrative Region Government (2021), Northern Metropolis Development Strategy Report.

The cost of infrastructure and site formation works in these three areas is estimated by referencing the priced unit rate of site formation and infrastructure works in Kwu Tung North (KTN) and Fanling North (FLN) NDA, which covers a total area of 612 hectares (ha)[14].

A summary of public works programme items in KTN and FLN NDA is indicated in **Table 2.7**[15]. The calculations are attached in **Annex I of Appendix C**.

The construction cost in KTN and FLN NDA would be around **$96.9 million/ha**. By applying this reference rate, the ballpark estimated construction expenditure on site formation and infrastructure works in the three newly proposed NDAs and New Towns would be in the order of **$141 billion** (Sept 2020 Price Level).

2.1.4.2. Housing development

To increase housing supply, the NMDS advocated the expansion of the planned development areas of various development stages, as shown in **Figure 2.4** and summarised in **Table 2.5**, to neighbouring areas. The four land formation projects would be: -

1. Inclusion of Pak Nei, Lau Fau Shan and Tsim Bei Tsui into the Hung Shui Kiu/Ha Tsuen NDA,
2. Development of the San Tin Technopole to the north of the San Tin/Lok Ma Chau Development Node,
3. Inclusion of Ma Tso Lung into the Kwu Tung North NDA
4. Development of Lo Wu/ Man Kam To Comprehensive Development Node near Man Kam To Development Corridor.

As suggested in the NMDS, the new developments in the aforementioned areas would provide an additional 165,000 to 186,000 residential units[16] on top of the planning and development projects which were under development. It is assumed that 175,500 residential units, an average of the lower bound and upper bound levels would be provided.

With reference to the Government Press Release issued in April 2017, the estimated average construction cost of the public rental housing and Home Ownership Scheme flats produced by the Hong Kong Housing Authority in 2020/21 was $1,063,100 per flat and $1,163,300[17] per flat respectively. By assuming that the construction cost for each residential unit (both private and public, which is thus on the conservative side) in the NM would be the average of the aforementioned rates, i.e. $1,113,200 per flat,

[14] Legislative Council (2019), Paper for meeting of the Panel on Development: Administration's paper on Kwu Tung North and Fanling North New Development Areas - Funding Applications for Main Works, Detailed Design and Special Ex-gratia Cash Allowance (Powerpoint presentation materials) (LC Paper No. CB(1)499/18-19(01)).

[15] Legislative Council (2019), Item for Public Works Subcommittee of Finance Committee (LC Paper No. PWSC (2018-19)41).
Legislative Council (2020), Item for Public Works Subcommittee of Finance Committee (LC Paper No. PWSC (2020-21)25).

[16] Hong Kong Special Administrative Region Government (2021), Northern Metropolis Development Strategy Report.

[17] Legislative Council (2018), Press Release: LCQ2: Construction costs of subsidised housing flats.

the total construction expenditure of the proposed housing development would be around **$195 billion** (Sept 2020 Price Level). The calculations are attached in **Annex II of Appendix C**.

2.1.4.3. Railway development

Other than the infrastructure and housing development, an efficient transportation system at the NM would be essential to enhance the development potential and attraction of the area. Therefore, major railway development would be required for a better network between NM and other parts of Hong Kong and Shenzhen.

There are five proposed major railway developments[18] and they are summarised as shown in **Table 2.8**. For the estimation of these railway developments, past and current developments such as Northern Link (NOL) Phase 1 and 2, Shatin Central Link (SCL)[19] and the Taipa line[20] at Macau are referenced. The total construction expenditure, number of stations and length of the railway tracks of these developments are considered in order to determine a reference rate ($/ station/ km). These reference rates are then used to multiply the number of stations and length of the railway tracks for the above five major railway developments.

As shown in **Figure 2.5**, the Hong Kong Shenzhen Western Rail Link (HKSWRL) (denoted in blue), being a heavy railway development, could be separated into two portions which are the undersea portion connecting Hong Kong to Shenzhen and the land portion located at the Northern New Territories. The reference rate adopted is the average between the ongoing NOL Phase 1 and 2 and SCL[21]. The HKSWRL and the ongoing NOL Phase 1 and 2 and SCL shared similar characteristics including the close proximity and similar terrain encountered for the developments.

As shown in **Figure 2.6**, the Northern Link Eastern Extension (denoted in blue), Northern Link Spur Link (denoted in green) and Eastern Rail Link (ERL) extension to Luohu and relocation of Lo Wu Station to Luohu in Shenzhen[22], these proposed heavy railway developments would be on land only. Hence, the rate of the ongoing NOL Phase 1 and 2 is adopted considering their close proximities and similar terrains encountered.

The Automated People Mover System (APMS) (denoted in orange in **Figure 2.5**), would create a transportation network which spans from Ha Pak Nai to Tsim Bei Tsui as part of the Hung Shui Kiu expansion. Light railway development would be adopted for the APMS. However, as there is no light railway construction recently in Hong Kong, the rate of Taipa Line Light rail located in Macau is adopted due to their similar scale of development.

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[18] Hong Kong Special Administrative Region Government (2021), Northern Metropolis Development Strategy Report.

[19] MTR Corporation (2021), Company Overview July 2021.

[20] The Standard (2019), Macau's $10b light rail makes tracks at last.

[21] The SCL consists of undersea portion, from Admiralty to Hung Hom, and land portion in both the Hong Kong Island and Kowloon.

[22] Hong Kong Special Administrative Region Government (2021), Northern Metropolis Development Strategy Report.

By the above assumptions, the estimated construction expenditure for the proposed railway development at the NM would be around **$272 Billion** (Sept 2020 Price level). The total construction expenditure calculation for the proposed railway development is shown in **Annex III of Appendix C** for reference.

Strategic highway linking the NM to the rest of Hong Kong would be required for major development as NM. However, this report did not make specific assessments on the construction cost on this part since it is envisaged that the NM should aim at a more self-contained development model and put more reliance on using railway as the backbone or other green mode(s) for transportation.

2.1.4.4. Conservation facilities development

With China's development goals, "Construction of Ecological Civilisation" and "Construction of Beautiful Villages" in mind, ecological conservation in the NM would play a major role in achieving these goals. The Northern New Territories has diverse habitats such as freshwater/ brackish wetlands, fish ponds, marshes, reedbeds. To improve the major ecosystem conservation and restoration, conservation facilities would be developed as mentioned in the NMDS Report. There are five major proposed developments in terms of conservation facilities taken into account in our estimation: -

1) Nam Sang Wai Wetland Park
2) Sam Po Shue Wetland Park
3) Hoo Hok Wai Wetland Park
4) Expansion of Hong Kong Wetland Park
5) Tsim Bei Tsui/ Lau Fau Shan/ Pak Nai Conservation Park

In these conservation facilities, the government plans to preserve the diverse habitats and restore the vast amount of deserted and degraded habitats in the Northern New Territories. In order to minimise the damages to the ecosystem caused by unregulated outdoor recreational activities, there would also be planning for provision of eco-recreation/ tourism facilities to cater for the substantial growth of residential and working population in the Northern Metropolis[23].

The development of the Long Valley Nature Park (LVNP) is referenced in the estimation. There would be 37 ha of land with facilities such as visitor centre, boardwalks, bird hide and different landscape features at the LVNP. In addition, there would also be a footbridge which provides connection between the nature park and the visitor centre.

Considering that the 5 proposed conservation facilities would be of a similar nature, a reference rate from the development of the LVNP is calculated and adopted for estimation.

[23] Hong Kong Special Administrative Region Government (2021), Northern Metropolis Development Strategy Report.

The reference rate ($/ha) is calculated using the capital cost ($) extracted from LC Paper No. PWSC (2018-19)41[24] and dividing it by the area (ha) of the development. The reference rate is then used to multiply by the area of the five proposed conservation facilities as mentioned in the NMDS. With such calculation, the estimation of the total construction expenditure for these developments could be obtained.

By adopting this methodology, the estimated construction expenditure for conservation facilities at the NM would be around **$12.7 billion** (Sept 2020 Price Level). The detailed calculations are attached in **Annex IV of Appendix C** for reference.

2.1.4.5. Total construction expenditure for Northern Metropolis

Table 2.9 summarised the expenditure of each category of the NM development as calculated in **Sections 2.1.4.1** to **2.1.4.4**. Therefore, the total construction cost of the key projects under the NMDS would be in the order of **$620 billion** (Sept 2020 Price Level). As envisaged by the Chief Executive in the NMDS, the making of the NM would be completed in the coming twenty years. Therefore, the average annual construction expenditure generated by the NM would be **$31.0 billion per year** (Sept 2020 Price Level). This would be on the low side as we have not included Strategic highway improvements normally required as mentioned in **Section 2.1.4.3**.

Similarly, given the early stage and crude assumptions made in the forecast, the above estimates are all ballpark and indicative in nature and subject to the findings of subsequent studies and design changes. And by no means they should be taken as any formal estimation in comparison with the future budgeting provided by the Government.

2.1.5. Conversion of MOD prices to the Sept 2020 Price Level

The conversion factors of 2013/14 to 2020/21 are referenced from the Civil Engineering Works Index published by the Civil Engineering and Development Department whereas those of 2021/22 to 2030/31 is based on the latest price adjustment factors advised by the Office of the Government Economist (OGE) by assuming the price deflators to be 1% for 2021/22, 4.5% per annum from 2022/23 to 2029/30 and 4% for 2030/31[25]. For the conversion factors from 2031/32 onwards, it is assumed that the price deflator would be 4% per annum following OGE's assumption for 2030/31. The adopted conversion factors from 2013/14 to 2038/39 are listed in **Table 2.10.** The derivation of the factors is attached in **Appendix D.**

[24] Legislative Council (2019), LC Paper No. PWSC(2018-19)41

[25] Secretary for Financial Services and the Treasury (2021), Capital Works Programme Price Adjustment Factors for Conversion of Constant Prices into MOD Prices.

2.2. Total construction expenditure forecast

Summing up the above assessments, the ballpark estimated annual construction expenditure from 2021/22 to 2030/31 and from 2031/32 to 2040/41 are summarised in **Table 2.11** and **2.12**. The total construction expenditure forecast is indicated in **Appendix E.** The construction expenditure forecast graph which has taken account of the LTV and NM developments is also attached in **Figure 2.7** for reference.

From the estimation, with the large-scale developments planned in the Northern Metropolis and Lantau Tomorrow Vision, the annual construction volume would exceed **$300 Billion,** reaching **$313.5 billion** and **$366 billion** (Sept 2020 Price level) in 2030/31 and 2040/41 respectively. In other words, **the construction expenditure would increase by 28% and 50% in 2030/31 and 2040/41 respectively.** With the surge in construction volume, the HKIE would need to assess whether the current supply of engineers in the market could cope with these large-scale developments. The trend and engineer manpower supply studies would be discussed in the ensuing sections.

3. MANPOWER SUPPLY TREND

3.1. Current manpower supply of the engineering profession

In order to understand the current manpower supply situation of the engineering profession, surveys are conducted with tertiary education institutions and major engineering organisations and associations.

Manpower supply data collected through surveys from these organisations focused on the construction related – building, civil engineering and built environment industry. The total number of civil engineering students and number of final year civil engineer students are obtained from tertiary education institutions, as detailed in **Table 3.1**.

For practising engineers in the profession, there are five major sectors, namely, the government sector, consulting sector, construction sector, crown corporations and utility undertakers. Adding on top of the figures in the Government Directory and through the surveys, the current number of engineers (categorised into chartered and non-chartered engineer) are obtained from major organisations and institutions including the Association of Consulting Engineers (ACEHK), Resident Site Staff Association (RSSA), Mass Transit Railway Corporation (MTRC), Hong Kong Airport Authority (HKAA) and a number of utility companies. The current number of engineers obtained via the surveys is summarised in **Table 3.2**.

Despite having successfully obtained numbers of practising engineers in the profession, it is understood that this result might not truly reflects the actual manpower contributing to the building/infrastructure construction due to the diverse nature of engineering work in the industry. For instance, software, computer and electrical engineers at crown corporations would not be heavily involved in the construction aspects. As a result, considering this research focuses mainly on the manpower for construction-related works, it is decided that the analysis of this research would be based on the results obtained separately from the Manpower Surveys of the Building, Civil Engineering and Built Environment Industry conducted by Vocational Training Council (VTC)[26]. Details of the VTC Manpower survey findings can be found in the following sections while results obtained from the HKIE surveys would be used to gain a better understanding of the full picture and calibrate the VTC Manpower survey findings where necessary.

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Vocational Training Council (2011), Building, Civil Engineering and Built Environment Industry - 2011 Manpower Survey Report
Vocational Training Council (2013), Building, Civil Engineering and Built Environment Industry - 2013 Manpower Survey Report
Vocational Training Council (2015), Building, Civil Engineering and Built Environment Industry - 2015 Manpower Survey Report
Vocational Training Council (2017), Building, Civil Engineering and Built Environment Industry - 2017 Manpower Survey Report
Vocational Training Council (2020), Building, Civil Engineering and Built Environment Industry - 2020 Manpower Update Report

Data were collected from the Manpower Surveys of the Building, Civil Engineering and Built Environment Industry in 2011, 2013, 2015 and 2017 conducted by VTC. The number of engineers extracted from these manpower surveys are summarised in **Table 3.3**.

Since the latest manpower survey conducted by VTC was in the year of 2017 and there were no further survey findings released afterwards, numerical modelling is applied to the dataset collected from the aforementioned manpower surveys in order to obtain an estimation on the current number of engineers in the industry. It is observed that the number of engineers from 2011 to 2017 was apparently increasing linearly. Therefore, a linear regression model is applied to this dataset to project the current number of engineers in the industry. The projection on the current number of engineers in the industry based on a linear regression model is summarised in **Table 3.4**. The linear regression model is shown in **Figure 3.1.** A comparison with the results obtained from the HKIE Manpower surveys reveals that the projection by the model is reasonable.

3.2. Summary of findings for manpower supply of the engineering profession

The above findings indicate that there has been a steady and moderate increase in the number of engineers engaged in the industry over the last decade. For the vacancy percentage of engineers, it is observed from the Manpower Surveys conducted by VTC that it had temporarily risen from 2013 to 2015 and then dropped from 2015 to 2017[27] as shown in **Figure 3.2**. All these observations tally generally with the construction volume displaying a gradual rising trend except for a decline over the last several years. Despite the Administration's commitment made to boost public projects expenditure, the decline was essentially related to the filibuster actions adopted at the Legislative Council when approval for these projects was sought. From the recent development of improving the electoral system in Hong Kong, it is anticipated that such disruptive activities will not recur.

Whether the increase in the engineer supply will sustain would be difficult to predict. This will depend on a host of factors including fertility rate, interest in joining the profession by the young generation, measures adopted to prolong the engagement/retention of engineers already in the industry etc. However, it is rather obvious to note from the total construction expenditure forecast (**Figure 2.7**) and the trend of manpower supply (**Figure 3.1**) that there will be a major gap in the coming years when the various large-scale developments are in full steam.

A further area of concern is that a vicious circle has apparently been repeating in the industry for the past decade. It is expected that this vicious circle will only worsen with an increase in construction volume, resulting in a long-term augment of engineering manpower deficiency; unless actions are taken to reverse/alter this.

[27] Vocational Training Council (2015), Building, Civil Engineering and Built Environment Industry - 2015 Manpower Survey Report
Vocational Training Council (2017), Building, Civil Engineering and Built Environment Industry - 2017 Manpower Survey Report

This vicious circle could briefly be described as follow:

- "Alleged" or "reported" reduction in quality of the deliverables in the construction industry.
- As a result, more rigorous checking and supervision were imposed by the regulatory bodies.
- More professional staff are required by the checking authorities to exercise enforcement of the above enhanced rigorous measures. The professionals transferred to these authorities are often from the middle or entry-level of private sectors.
- With their departure, maintaining the quality of deliverables in the industry is becoming a bigger challenge;
- Remaining professionals in the middle or entry-level of private sector will need to struggle to survive through bigger challenges under poorer working environments; rendering the profession less attractive to future successors.

This vicious circle has probably led to the apparent drop in the productivity of the engineering professionals over the years. Apart from general observation by stakeholders engaged in the industry, this phenomenon was also noted in the VTC Manpower Update Report 2020[28]. There are comments that stringent regulations have been introduced relentlessly in the past decades and these have led to disproportionate checks and over supervision. Moreover, the resources deployed to manage general surveillance and quality assurance are ever increasing. It is not uncommon to find submissions made to the authorities experiencing excessively long period of scrutiny and/or rejection.

As a useful means to alleviate the upcoming supply gap with the implementation of the large-scale developments, a more detailed study should be undertaken by the Government to investigate the extent of the productivity decline and the real reasons behind it. Appropriate measures can then be devised which will not only address the productivity issue and hence narrow the supply gap, but also boost the morale of the profession.

Since 2018, the Government advocates adoption of digitised approaches by the industry in both design and construction. These include implementation of Building Information Modelling (BIM) and off-site construction methods such as Design Manufacture and Assembly (DfMA) and Modular Integrated Construction (MIC). This helps enhancing the productivity. While digitising the construction is most welcome, it would be helpful if the authorities will also adapt to the corresponding changes like acceptance of electronic submission of building plans. Furthermore, while the industry is prepared to take onboard more innovative design and construction methods so as to enhancing the productivity to meet the surge in construction volume, red tapes and overly scrutiny/caution during the submission and approval process would deter such motivation since the time benefit would thus be forfeited. Though, it is observed that the Government has been advocating streamlining and business facilitation in the past

[28] Vocational Training Council (2020), Building, Civil Engineering and Built Environment Industry - 2020 Manpower Update Report

few years, more effort on this front would apparently be needed in order to help enhance the productivity.

To summarise, there are currently around 14,000 engineering professionals engaging in the construction industry. Without any adjustments to the current practice, to match the surge in construction volume as identified in Section 2 above (28% to 50% increase), additional manpower in the corresponding magnitude may be required. Though some of the gaps shall be overcome by means such as increase in productivity through innovation within the industry itself, concerted effort among Government, the Academia and the industry on all fronts shall be called upon to look into the matter and implement more drastic revamps; including possibly reviewing and streamlining the submission and approval process; school curriculums and more importantly, curtailing the vicious circle thus attracting more talent successors. More discussion on this subject is depicted in Section 4 below.

4. RECOMMENDATIONS

Without any improvement in the current practice, young talents will be further deterred from joining the engineering industry. To tackle the upcoming challenges and vicious circle fronting the engineering industry, both short term and long term recommendations have been devised from various perspectives. Different stakeholders will have to work together in order to increase the supply of engineers. Not only will this attract more bright talent to become engineers, but also enhances the productivity of the entire industry.

4.1. Improving engineer's working environment and condition

Like other professions, engineers face unique industry challenges in their working environment. Engineers are facing predicaments such as mounting workload, delivering on time, encountering more stringent regulations and newly adopted design methods and approaches in Hong Kong. These issues have imposed a great deal of pressure on them. The stressful environment faced by engineers has impeded and influenced them to change careers and discouraged potential engineering students from joining the industry. Therefore, to retain engineers in the industry, the engineers' working environment and conditions must be improved.

Today, the cost of engineering projects is often criticised by the public for overvaluation. However, the consultancy services sector has expressed its concern with significantly low tender prices in the current market. This causes an incentive for companies to curtail resources which subsequently hampered the quality of these engineering projects. With significantly low tender prices, engineers especially at the entry-level often suffer from working overtime as they are trying to meet the milestones requirements and tight deadlines. In fact, their hard work is often not rewarded with overtime pay or bonuses due to low tender prices.

The *Research on Procurement Policy Review for Works Contracts and Consultancy Contracts*[29] released by the HKIE in March 2022 has discussed the trend for some accepted tender prices of Public Works Contracts and Consultancy Agreements being significantly lower than that allowed in the original Pre-Tender Estimates. The Report illustrates the views and suggestions of the HKIE on the Procurement Policy, with a view to enhancing healthier competitions among tenderers which is conducive for upholding programme adherence, quality and safety, etc. for the projects; and ultimately offering more reasonable remuneration package to engineers.

Another recommendation is to allocate more resources to training and nurturing the younger generation of the engineering industry. It is a common trend nowadays that engineering design work is mostly done by graduate and assistant engineers. These entry-level engineers possess less experience in handling engineering projects while the number of experienced engineers in these projects is often not sufficient due to the significant low tender price. More importantly, without the supervision of more experienced engineers, the design work done by the less experienced engineers may not fully meet the requisite criteria and client's requirements; thereby creating a vicious

[29] https://www.hkie.org.hk/docs/research_procurement_policy.pdf

circle of requiring more supervision and checking efforts on the Client side. This is not a productive cycle.

To recruit and retain talents, companies should therefore better allocate more resources in training and nurturing engineers. The HKIE provides structured training schemes for graduated members since the 1980s and developed different entry-level opportunities and practising standards for its membership. For graduate engineer training, which is considered an important period and breeding ground in becoming a professional engineer, the acclaimed Scheme “A” training is designed as a fast-track preparation from an academic environment to real-life industry practice for obtaining professional status. Trainees under Scheme “A” will be following approved training programmes arranged by the companies, attending Continuous Professional Development (CPD) activities and keeping appropriate records under the guidance and monitoring of their Engineering Supervisor throughout the training period. Upon completion of the formal training and gaining sufficient responsible experience, trainees can apply for the full HKIE professional membership. Opportunities should also be offered to encourage engineers to participate in CPD activities and upkeep their competencies throughout their careers so that they can properly carry out their responsibilities.

On the other hand, it is essential to ensure experienced and qualified professionals are assigned to take charge of engineering projects such that more senior engineers will be leading and held accountable for critical tasks throughout the project cycle. With more experienced and knowledgeable engineers leading, the quality of engineering projects will improve and the juniors can also learn during the process.

A further suggestion on this front is streamlining the administrative and checking process by the various authorities. A number of construction incidents that happened in public housing development during the late 1990s had triggered some major reforms in the engineering industry. This had set the ground for a series of policies and procedures review for ensuring quality and rebuilding public confidence in the construction industry. However, over the years, this has somehow generated a mountainous volume of guidelines/practice notes, repetitive checks and quality assurance processes to an extent that may have encouraged over supervision and wastage of valuable manpower. The Government is suggested to conduct urgent reassessment and consider measures to streamlining the submission, checking, supervision and approval processes with a view to cut down the red tape and hence reduce the workload of engineers and also other stakeholders concerned so that they can spare more efforts on other more important professional duties and tasks. Consideration can be given to adopt more self-regulation/certification systems which have been successfully implemented in some countries.

It must be emphasised that streamlining the checking and approval process does not imply lowering the quality and safety of the work/works. The liability and responsibility shall always be vested on the designer and constructing parties who should be reasonably renumerated and supported with adequate top/middle/lower tier of professional staff.

4.2. Strengthening the engineering community base

Engineering has long been a mobile industry where its knowledge or skill sets can be applied in different parts of the world. With this advantage, it is important to strengthen the engineering community base within Hong Kong and other regions. It can be an effective method in addressing the manpower shortage issue.

In the short term, the government and engineering community should continue to strengthen the relationship between Hong Kong and other regions. By maintaining or even expanding the mutual recognition arrangements among professional qualifications organisations in the international arena, the engineering talent pool in Hong Kong can further expand which would allow more manpower to contribute to the future developments of Hong Kong. However, the criteria upfront are to enable reasonable tender bids which could support and attract quality professional staff around the world.

Under co-operative liaison between the Development Bureau of Hong Kong and the Ministry of Housing and Urban-Rural Development (MOHURD) of Mainland China, six types of professionals including structural engineers, architects, general practice surveyors, planners, quantity surveyors and building surveyors are currently mutually recognised between the Mainland China and Hong Kong[30]. Moreover, according to the "Agreement on Economic and Technical Cooperation" signed under the Closer Economic Partnership Arrangement (CEPA) framework, Mainland China and Hong Kong are committed to expanding mutual recognition of professional qualifications for other professionals.

With the co-operative liaison concept in mind, the government should continue to pursue extending the scope of mutual recognition agreements to other engineering professions including building services engineering, civil engineering, electrical engineering and geotechnical engineering to cope with future large-scale developments in Hong Kong. Moreover, the government should support the HKIE in exploring mutual recognition agreement with professional bodies in strategic regions like Guangdong[31] or the Greater Bay Area. As a result, diversity will be enhanced and new vigour will be injected into our engineering community.

Secondly, the government should consider establishing appropriate and efficient immigration policies to attract engineering talents from other regions to work in Hong Kong. Currently, under the Technology Talent Admission Scheme (TechTAS), a fast-track arrangement will be provided for talents from other regions to undertake research and development work in Hong Kong within 12 months. Moreover, professionals from Mainland China may apply to work in Hong Kong under the Admission Scheme for Mainland Talents and Professionals (ASMTP). To meet the upcoming demand of engineering professionals in Hong Kong, the government may wish to explore the feasibility of implementing fast-track admission schemes specifically for qualified engineering talents to work in Hong Kong as a stopgap measure to address the imminent need.

[30] see "DEVB - Mainland / Hong Kong Mutual Recognition of Professional Qualifications (166)"

[31] The HKIE signed a MRA with the Guangdong Society for Electrical Engineering in September 2021.

4.3. Cultivating engineering interest among the younger generation

It is worth particular attention that the engineering professionals apparently do not earn the proportionate status and image in the public eyes as they should be when considering their contribution to the society. Engineering professionals basically build, maintain and further enhance the daily living and development of Hong Kong that accommodate more than 7 million people. It is observed that during the Joint University Programmes Admissions System (JUPAS) choice in recent years, students generally prefer other non-professional careers rather than engineering studies as their first choice. While career choice is certainly in the free hands of the students, we must look into the problem and try to correct any misconception that may have so as to promote the interest and attract more young talents to the field of engineering and boost the spirit of current practitioners. Therefore, it is crucial to educate the youngsters and arouse their interest in engineering from the age of primary and secondary education. It requires a combined effort from the HKIE, the Government, the Academia as well as the engineering industry comprising different engineering organisations and private companies.

Although the government has implemented STEM education to promote science to students, the effort in promoting engineering through STEM education is not sufficient. After reviewing the material published by the Education Bureau, the engineering component in STEM education can be reinforced. The current sample teaching materials contain interesting science and technology-related topics from the software and science perspective. However, the current teaching sample materials lack engineering concepts such as design and construction. As a result, primary and secondary school students do not have enough exposure to the field of engineering.

To attract youngsters and arouse their interest in engineering, providing more experiential learning opportunities to the students should be better means to cultivate their interest. For instance, some cross-discipline competitions can be held, like Robotics competitions (University Robocon) and case competitions (City I&T Grand Challenge). Similar competitions could be held with the participation of primary school and secondary school students in the future.

When it comes to arousing the interest of our teenagers, it is essential to allocate resources adequately and properly. In this regard, institutional collaboration among the HKIE, different government departments like the Education Bureau and the Innovation and Technology Bureau, local universities, Hong Kong Science & Technology Parks (HKSTP), Cyberport, Hong Kong Productivity Council (HKPC), and private partners can be reinforced. Currently, there are some ongoing promotions held by the HKIE. For example, The HKIE Engineer Day STEM Product Proposal and Design Competition was held in 2019 for promoting engineering. The Yan Chai Hospital No. 2 Secondary School, the champion of this competition, also organised an exhibition to advertise engineering to other students. If more institutions can collaborate in organising inspiring events for our teenagers, young talents and potential prospects can be identified early and the culture of becoming an engineer among the students can be established at their knowledge enlightening age.

To maintain their interest during their study, career planning opportunities in engineering must be promoted to the students. One of the feasible methods is to

further enhance the current programmes held by the HKIE and to encourage more participation in the education sector through collaboration with the Education Bureau. To promote the engineering profession to the younger generation, HKIE has organised different extra-curricular activities for the students. The HKIE School Ambassadors Programme and HKIE Engineer Cadet Club are two examples that are currently adopted. These two programmes provide the younger generation with practical experiences and career advice from practising engineers. Opportunities can be explored to amalgamate the efforts of the two programmes so that these can be extended to more schools in a more structural and effective manner. However, funding support and assistance from the Government would be required in order to subsidise more physical visits, promotional or experiential activities as well as establish the linkage between HKIE and the various school managing bodies, for instance, consideration may be given to establishing a One- School-One-Engineer scheme.

To conclude, education is unquestionably one of the most effective ways to attract more youngsters to enter the engineering industry. It is also necessary to improve the public's perception on engineering in the mind of the next generation and their parents.

4.4. Enhancing the quality of school students

Apart from retaining existing talents and nurturing the younger generation's interest in engineering, keeping a steady supply of quality new blood is also important.

To cultivate engineering talents, efforts need to be made at every education stage. Changes to the secondary school curriculum, university admission policy and university curriculum are suggested in this section.

As a start, the secondary school curriculum should be reviewed. Science is not only the basis for engineering, but also for developing a knowledge-based economy and stimulating high-value-added industries. In recent years, the performance of Hong Kong students in science subjects has presented a worrying trend. The Programme for International Student Assessment (PISA) is a worldwide study to evaluate educational systems. It is done by measuring a 15-year-old student's scholastic performance in mathematics (maths), science, and reading. Hong Kong's performance on maths and science which used to rank top of the world have dropped to No. 4 and No. 9 respectively in the latest PISA, lower than other Asian regions/countries, including Mainland China, Singapore and Macau. In Singapore and Mainland China, calculus is a mandatory subject in junior high school. However, in Hong Kong, they are placed in the curriculum as an extended modulus and an optional elective. Therefore, to improve students' maths and science ability, basic contents in extended maths modulus should be included in the core Maths courses instead.

Next, the difficulty level of the science subjects should be increased gradually from Form 1 to Form 3. Secondary education should help the students to set up a good foundation on science subjects, especially Physics and Maths, which will help and prepare them to become engineers in the future.

Although some elements of engineering have already been included in the current syllabus, such as geological knowledge in the syllabus of General Studies, it is apparent that the current syllabus does not contain sufficient elements of engineering.

For primary school students, the overall understanding of engineering should be further promoted to the future generation. Incorporating engineering concepts into the syllabus is another possible means to provide some engineering insights to the students. Engineering examples and related concepts can be included in the existing subjects. For instance, engineering problems can be introduced into the Science syllabus. Simple electrical, drainage or geotechnical engineering knowledge can be introduced into the current General Studies (GS) for primary schools' and Geography/ Science for secondary schools' syllabus. In this way, students not only can gain a clearer picture of what engineers do but also have a better understanding of engineering concepts in real life.

Apart from secondary school curriculum reformation, university admission policy also affects the motivation of secondary school students to study engineering. Many programs count scores for four core and two electives (4+2). This drives students to put more effort into studying the core subjects. Currently, among the four core courses for HKDSE, three of them are liberal arts subjects, which emphasise reading and writing abilities. With Maths being the only science subject, there is a tendency for students to put less effort into science subjects under the current admission requirement. Thus, more university programs should be encouraged to count the best five subjects (best 5) when calculating admission scores.

Considering engineering programs, among the eight UGC-funded universities in Hong Kong, five of them are offering a total of 55 engineering-related bachelor's degree programs as shown in **Table 4.1**. Most of them are using weighted average scores for the best five subjects (best 5) or 4 core and 2 electives (4+2). English, Mathematics (Compulsory Part) and Physics are normally the most heavily weighted subjects, with a weighting of 2 times. M1(Calculus and Statistics) /M2 (Algebra and Calculus) and other science subjects are generally weighted 1.5 times only. In the past, Physics and M2 used to be compulsory requirements for many engineering programs. However, after interviewing different universities, it is observed that there are currently insufficient students taking M2. This leads to the requirement being relaxed from "required" to "preferred".

Considering that calculus is an essential part of many entry-level university engineering and science courses, it is difficult for students who did not take extended Maths Modulus M2 to catch up with those who did. A similar issue applies to Physics too. Therefore, the HKIE strongly suggests that during subject selection for secondary school students, the importance of Physics and the extended Maths Modulus should be highlighted to students who want to apply for engineering programmes in the future.

Another observation made from the JUPAS, admission data is the wide range between highest and lowest admission scores in school/faculty-based programs. The approximate non-factored best five subjects (best 5) admission scores in 2022 range from the lowest of 17 to the highest of 34. This reflects the quality of the engineering students under the same batch also varies substantially.

In order to raise engineers' social status for attracting more quality students, universities could consider holding interviews or one-day workshops to observe the students and provide conditional offers to those who truly have a passion for engineering.

It is however worth noting that in other non-school based programs, engineering management, data science, and artificial intelligence programs have a higher admission score, which reflects the market trend. While for those more 'traditional' engineering majors, like civil and mechanical engineering, the lowest admission score is slightly lower than a few years ago. This is really alarming. In fact, some practitioners in the engineering sector have already expressed their concern that it will affect the quality of future engineering recruits.

There may be various reasons for the general decline in admission scores. One is related to the reduction in the number of DSE students. The number of students has gradually decreased by 40% from the first DSE in 2012, resulting in a less competitive admission. Another reason can be the concern on the career prospect by students and their parents. With the completion of mega projects in the coming years, eg. Third Runway Project, Sha Tin-Central Line, students and parents may be worried about future employment opportunities. However, such worries are unwarranted with the government's commitment on future developments such as the Lantau Tomorrow Vision and Northern Metropolis together with other initiatives. It is suggested that not only the HKIE, but also the government can highlight and help promote the future opportunities to not only engineers but future talents as well.

Having said the above, the decline in admission scores does not necessarily mean degradation of the quality of engineering school graduates. College education still plays an important role in the performance of graduates. Nevertheless, the voices from the industry have reflected the following concerns:

1. One of the major skills current engineers lack is risk management.
2. Some engineers lack the technical capabilities to review and administer large-scale design and build projects.
3. The skills learned in university are still far from the requirements needed to practise engineering in the industry.
4. The university curriculum becomes wide but not in-depth. Practical teaching is lacking in the curriculum.

To address the above issues, it is suggested that **more resources should be allocated to better equip university students and improve the quality of new blood in the engineering industry**. The universities can offer more opportunities and courses like capstone projects to allow students to collaborate and play different roles in a mimic design or construction project. Such knowledge and management skills are difficult to pick up from the current theoretical academic courses. Currently, channels, such as working as interns, for students to learn those practical skills are relatively limited. Through the capstone projects, students can gain more hands-on experiences and learn more practical skills, including project and risk management[32], which will be useful in the engineering industry. More collaboration between the university and employers should also be held. For example, during the mimic design and mini construction project, students can be taught in a collaborative manner how to use common design engineering software. To link theoretical knowledge and practical use

[32] UGC-funded universities in Hong Kong currently offer risk management courses and degree majors in science and business schools. Still, there is no in-depth risk management courses customed for engineering students. Universities shall consider developing some interdisciplinary courses for this purpose.

will be the key to improving engineering graduates' quality and preparing them to join the engineering community.

4.5. More effort in promoting engineering to the general public

When it comes to engineers, the general public always has a poor impression and perceives them as front-line construction technicians. This is due to a lack of understanding and awareness of the role engineers play in our daily life. In essence, the general public does not understand what engineers do.

There are many different medical and courtroom TV dramas such as Healing Hands and Will Power. The general public has thus gained a concept that these occupations have a higher social status compared to other occupations. Furthermore, the general public in their daily lives often makes contact with doctors or lawyers for personal consultation and treatment. However, the general public, though they are enjoying the engineers' work (water, electricity, roads and sewers, etc.) in their daily living, do not have an understanding of what engineers do. Therefore, it will be less likely for them to fully understand and realise the contribution of engineers to society.

However, producing a TV drama in Hong Kong can be very costly. To overcome this, it is suggested that the government can help promote the engineering profession to the general public, in particular to the non-engineering population; thereby attracting more talented students to become future engineers and hence supporting the prosperity and development of our city. For example, the Development Bureau and Commerce and Economic Development Bureau can subsidise broadcast through Radio Television Hong Kong (RTHK). The "Buildings Department Special", filmed by RTHK, through which audiences have gained a better understanding of structural engineers and the Buildings Department, is a good example. Similar programmes introducing the local engineering projects such as railway network extensions and upgrading/ relocation of sewage treatment works can also be considered in promoting engineering to the general public. These can educate the general public not only on the contributions made by engineers towards our city but also the role of engineers from different disciplines and sectors. Meanwhile, the government can also advertise the achievements in completing large scale infrastructure and development.

On the other hand, collaboration among the HKIE, local universities, engineering companies, social media Key Opinion Leaders (KOLs) and popular Youtube Channels can also be considered to promote engineering. To let the general public understand what engineers do, representatives from universities and engineering companies can collaborate with KOLs and Youtubers by inviting them to film engineers' daily works. Furthermore, the HKIE can continue to make short videos on interesting engineering knowledge/fun facts that may appeal to and relate to the public, including how water/gas/electricity is transmitted and distributed to their home, how the railway system works, how to combat climate change and sea level rise etc.

Another reason for a negative engineering image among the public is that negative publicity could easily be arisen from incidents when they occurred, though these incidents could amount to less than 1% of the daily engineering activities ongoing in

Hong Kong[33]. These incidents and negative publicity could easily overshadow the 99% good work that engineers provided to the public; and these good work or contributions are often taken for granted. Reports from the media can be easily misinterpreted. For example, media reports that settlement in the New Acute Hospital at Kai Tak Development Area exceeding the empirical pre-set trigger level for works suspension[34] (25mm) could often be easily misinterpreted by the media as the building might face a risk of collapse at any minute. Negative perceptions caused by these incomprehensive analyses or rumours would often discredit the public's confidence in engineers.

To resolve this, more collaborations and communications between the government, local universities and HKIE with the media can help alleviate the problems. Academics from local universities, representatives of the Institution or government officials are always welcome as interviewees in city news. It is suggested that the government can invite university professors, and acclaimed engineers of the HKIE to answer enquiries on engineering incidents that attract the public's concerns. The media is always welcome to approach the HKIE on any sort of engineering queries or opinion from a professional, scientific objective and impartial perspective. Not only can this provide an additional platform for professional engineers to deliver correct messages and build public confidence in the infrastructural development projects in Hong Kong, but also promote engineers' professionalism, status and image. This practice is also applicable when major announcements on upcoming infrastructure or development plans are to be released by the government. The suggestion benefits not only the engineering industry but also Hong Kong. Enhancing engineers' image can attract talents and youngsters to the field, which tackles manpower shortage and improves the quality of engineering projects delivery in turn sustaining the long term development of Hong Kong.

[33] For instance, the faulty incidents in MTR operation account to less than 1% of the total trips. However public attention would easily be drawn through media coverage of the inconvenience that caused.

[34] AAA levels is a purposely in-built mechanism used worldwide to safeguard the relevant structures from any real damages and provide warning to the professional engineers and call for actions at a very early stage.

5. CONCLUSION

In conclusion, with the recently published National 14th Five-Year Plan, 2021 Policy Address and Hong Kong 2030+ final report, there will be ongoing large-scale developments in the coming decades in Hong Kong. With mega projects like Lantau Tomorrow Vision and the Northern Metropolis in the pipeline, we have estimated that the annual construction output would soon exceed HK$300 billion, reaching $366 billion (September 2020 price level) by 2040/41. Such construction expenditure would far exceed that during the period of the Airport Construction Project (ACP) back in the early 1990s. Whilst these developments would improve the livelihood locally and also enhance the global competitiveness of Hong Kong with a stronger connection to Mainland China, there will also be a challenge in terms of manpower sustainability for delivering the commitment made in these blueprints.

The HKIE has made plausible short term and long term recommendations that will be conducive to overcoming the manpower shortage problem and also enhancing the quality of the engineering profession and most importantly resolving the vicious circle that is affecting the whole engineering profession. However, these measures will require concerted and sustained efforts among all stakeholders in the years to come. They include: -

5.1 Improving engineer's working environment and condition

With thin profit margin in the industry, engineers especially at entry-level often work in poorer working environments and wage packages. The HKIE published a report "The Research on Procurement Policy Review for Works Contracts and Consultancy Contracts" in March 2022 with a view to enhancing healthier competitions and ultimately offering a more reasonable remuneration package to engineers. With this improvement, more experienced engineers could be retained in the private sector to lead projects; thus ensuring quality. This could help curtail the vicious circle of requiring more checking efforts on the Client side; which is not conducive to productivity. Companies should also allocate more resources in training and nurturing engineers. To further curtail the vicious circle, the Government is suggested to study means to streamline the submission and approval processes involved to facilitate the work while not losing quality and safety.

5.2 Strengthening the engineering community base

The mutual recognition arrangements among professional qualifications organisations in the international arena shall be maintained or even expanded to promote mobility in the engineering industry. With these, diversity will be enhanced, and new vigour could be injected into the engineering community. To meet the upcoming demand of engineering professionals in Hong Kong, the government may implement fast-track admission schemes specifically for qualified engineering talents to work in Hong Kong as a stopgap measure to address the imminent need.

5.3 Cultivating engineering interest among the younger generation

It is crucial to educate the youngsters and arouse their interest in engineering from the age of primary and secondary education. This calls for a combined effort from the HKIE, the Government, the Academia as well as the engineering industry. The current STEM education would need to be revamped to increase students' exposure to the field of engineering. More experiential learning opportunities should be given to cultivating their interest. Government should provide funding support and assistance in order to subsidise more physical visits, and promotional or experiential activities as well as establish the linkage between HKIE and the various school managing bodies.

5.4 Enhancing the quality of school students

The current secondary school syllabus does not contain sufficient elements of engineering. Curriculums of secondary school and university and university admission policy should be reviewed and revamped. More effort is required to improve secondary school students' maths and science ability (especially Maths Modulus M2 and Physics), and consideration should be given to placing these as core subjects; since science is not only the basis for engineering but also for developing a knowledge-based economy and stimulating high-value-added industries. Primary school students should be given a better understanding of engineering concepts via real-life examples. The HKIE and the government should also promote future opportunities to not only engineers but future talents as well.

5.5 More effort in promoting engineering to the general public

To clear any misconception among the general public, the government should help promote the engineering profession to the general public, in particular to the non-engineering population; thereby attracting more talented students to become future engineers. Collaboration among Government, HKIE, local universities, engineering companies, social media Key Opinion Leaders (KOLs) and popular Youtube Channels should be considered to promote the profession.

While this report focuses on the manpower supply and demand for the Engineer profession, it is suggested that the Government or other relevant institution should conduct similar assessment on the situation for workers, technicians and inspectorate or other associated professionals level so that a more comprehensive manpower planning can be conducted.

~End~

LIST OF TABLES

Year	Adopted baseline value (HK$ Billion) at Sept 2020 Price Level
2021/22	245
2022/23	247.5
2023/24	262.5
2024/25	267.5
2025/26	272.5
2026/27	275
2027/28	282.5
2028/29	282.5
2029/30	280
2030/31	282.5

Table 2.1 – Baseline annual construction expenditure forecast from 2021/22 to 2030/31 based on CIC's data (Not including HKIE's construction expenditure estimation on Northern Metropolis and Lantau Tomorrow Vision)

Year	Adopted baseline value (HK$ Billion) at Sept 2020 Price Level
2031/32	284.3
2032/33	285.5
2033/34	286.8
2034/35	288
2035/36	289.3
2036/37	290.5
2037/38	291.8
2038/39	293
2039/40	294.3
2040/41	295.5

Table 2.2 – Projected baseline annual construction expenditure forecast from 2031/32 to 2040/41 based on CIC's data (Not including HKIE's construction expenditure estimation on Northern Metropolis and Lantau Tomorrow Vision)

Development areas	Construction cost estimate at Sept 2018 Price Level (HK$ Billion)		
	Reclamation	**Infrastructure**	**Total**
Kau Yi Chau Artificial Islands	140	116	256
Sunny Bay Reclamation, Lung Kwu Tan Reclamation and Tuen Mun coastal area development (including River Trade Terminal)	34	61	95
Total	**174**	**177**	**351**

Table 2.3 – Construction cost estimate for Development Areas under Lantau Tomorrow Vision

Priority transport network	Construction cost estimate at Sept 2018 Price Level (HK$ Billion)
Kau Yi Chau – Hong Kong Island Corridor (Road)	55
Kau Yi Chau– Hong Kong Island Corridor (Rail)	38
Kau Yi Chau – Lantau Road Link	19
Kau Yi Chau – Sunny Bay Rail Link	52
Western Coastal Rail Link	82
Road P1 + Upgrading of Lung Mun Road	27
Total	**273**

Table 2.4 – Construction cost estimate for Priority Transport Network under Lantau Tomorrow Vision

Development areas	Status		
	Planning and engineering study	**Investigation and detailed design**	**Construction**
Kwu Tung North/Fanling North NDA	Completed	• Advance works: Substantially completed • First stage works: Substantially completed • Remaining phase: Ongoing	• Advance works: Ongoing • First stage works: Ongoing • Remaining phase: #
Hung Shui Kiu/Ha Tsuen NDA	Completed	• Advance works Phase 1 and 2: Substantially completed • Advance works Phase 3: Ongoing • Stage 1 works: Substantially completed • Stage 2 works: Ongoing	• Advance works Phase 1 and 2: Ongoing • Advance works Phase 3: # • Stage 1 works: Ongoing • Stage 2 works: #
Remark: # indicates funding applications of project items have not been submitted to the Finance Committee at the time of study.			

Table 2.5 (To be continued on the next page) – Status of ongoing developments at the Northern Metropolis

Development areas	Status		
	Planning and engineering study	**Investigation and detailed design**	**Construction**
Yuen Long South Development Area	Completed	• Stage 1 and 2 (first phase) works: Substantially completed • Stage 2 (second phase) and 3 works: Under part of 7827CL to be upgraded to Category A	• Stage 1 works: Under 7817CL to be upgraded to Category A • Stage 2 (first phase) works: Under part of 7827CL to be upgraded to Category A • Remaining Stages: #
San Tin/Lok Ma Chau Development Node	Substantially completed	Ongoing	#
Man Kam To Development Corridor and New Territories North New Town	Ongoing	#	#
Remark: # indicates funding applications of project items have not been submitted to the Finance Committee at the time of study.			

Table 2.5 (Cont'd) – Status of ongoing developments at the Northern Metropolis

Development areas	Approximate area (hectares)
San Tin/Lok Man Chau Development Node	320
Man Kam To Development Corridor	1140
New Territories North New Town	
Total	**1460**

Table 2.6 – Approximate areas of the proposed NDAs/ New Towns

Phase	Public works programme Item	Project title	Approved project estimates in Sept 2020 Price Level ($ million)
Construction	747CL	Advance Site Formation and Engineering Infrastructure works at Kwu Tung North New Development Area and Fanling North New Development Area	15,914.1
	759CL	First Stage of Site Formation and Engineering Infrastructure at Kwu Tung North New Development Area and Fanling North New Development Area	849.9
	828CL	Remaining Infrastructure and Development at KTN & FLN NDAs	29,327.1
	388DS	Shek Wu Hui Effluent Polishing Plant	8,980.8
	51CG	District Cooling System at the Kwu Tung North New Development Area	4,213.0
		Total	**59,284.9**

Table 2.7 – Referenced approved public works project in KTN and FLN NDA

No.	Proposed railway development	Number of new stations (No.)	Length of railway track (km)
1	Hong Kong Shenzhen Western Rail Link	3	7.8
2	Northern Link Eastern Extension	8	15.4
3	Northern Link Spur Line	3	5.6
4	Automated People Mover System	6	7.6
5	ERL extension to Luohu and relocation of Lo Wu Station to Luohu in Shenzhen	1	1.5

Table 2.8 – Proposed Railway Development as per the NMDS

Category	Total construction cost estimate for Northern Metropolis at Sept 2020 Price Level (HK$ Billion)
Infrastructure and Site Formation Development	141
Housing Development	195
Railway Development	272
Conservation Facilities Development	12.7
Total	**620.7**

Table 2.9 – Total construction cost estimate for Northern Metropolis at September 2020 Price Level

Year	Adopted Conversion Factor	Year	Adopted Conversion Factor
2013/14	0.81589	2026/27	1.25181
2014/15	0.85591	2027/28	1.30814
2015/16	0.87095	2028/29	1.36701
2016/17	0.92058	2029/30	1.42853
2017/18	0.98607	2030/31	1.48745
2018/19	1.01606	2031/32	1.54695
2019/20	1.00021	2032/33	1.60883
2020/21	1.00000	2033/34	1.67318
2021/22	1.01300	2034/35	1.74011
2022/23	1.04972	2035/36	1.80971
2023/24	1.09696	2036/37	1.88210
2024/25	1.14632	2037/38	1.95738
2025/26	1.19791	2038/39	2.03568

Table 2.10 – Adopted conversion factor for MOD prices to the September 2020 price level

Year	Adopted Baseline Value (HK$ Billion) *(vide Table 2.1)*	Estimated Annual Construction Expenditure for Northern Metropolis (HK$ Billion)	Total
2021/22	245	0	245
2022/23	247.5	0	247.5
2023/24	262.5	0	262.5
2024/25	267.5	31.0	298.5
2025/26	272.5	31.0	303.5
2026/27	275	31.0	306.0
2027/28	282.5	31.0	313.5
2028/29	282.5	31.0	313.5
2029/30	280	31.0	311.0
2030/31	282.5	31.0	313.5

Table 2.11 – Total construction expenditure forecast from 2021/22 to 2030/31 (including the HKIE's construction expenditure estimation on Northern Metropolis)

Year	Adopted Baseline Value (HK$ Billion) *(vide Table 2.2)*	Estimated Annual Construction Expenditure for Northern Metropolis (HK$ Billion)	Estimated Annual Construction Expenditure for Tomorrow Lantau Vision (HK$ Billion)	Total (HK$ Billion)
2031/32	284.3	31.0	39.4	354.7
2032/33	285.5	31.0	39.4	355.9
2033/34	286.8	31.0	39.4	357.2
2034/35	288	31.0	39.4	358.4
2035/36	289.3	31.0	39.4	359.7
2036/37	290.5	31.0	39.4	360.9
2037/38	291.8	31.0	39.4	362.2
2038/39	293	31.0	39.4	363.4
2039/40	294.3	31.0	39.4	364.7
2040/41	295.5	31.0	39.4	365.9

Table 2.12 – Total construction expenditure forecast from 2031/32 to 2040/41 (including the HKIE's construction expenditure estimation on Northern Metropolis and Lantau Tomorrow Vision)

Tertiary Education Institutions	No. of civil engineering students	No. of final year civil engineering students
The University of Hong Kong	417	159
The Hong Kong University of Science and Technology	499	166
City University of Hong Kong	142	62
The Hong Kong Polytechnic University	495	155
Chu Hai College of Higher Education	36	12
Total	**1589**	**554**

Table 3.1 – Number of civil engineering students collected through surveys

Industry	No. of chartered engineers	No. of non-chartered engineers
Government Sector	4270	No information
Consulting Sector (including ACEHK, RSSA)	3179	2182
Construction Sector	670	689
Crown Corporations (including MTRC, HKAA)	949	3470
Utility Companies (including CLP, HKE, Towngas)	692	1469
Total	**17,570**	

Table 3.2 – Number of engineers in different sectors collected through surveys

Year	Total no. of engineers
2011	9,775
2013	10,420
2015	11,123
2017	12,096

Table 3.3 – Number of engineers extracted from the VTC Manpower Surveys

Year	Total no. of engineers by linear regression
2022	13,920

Table 3.4 – Number of engineers projected from the VTC Manpower Surveys

Name of University	Name of BEng/BSc Degree Programs	No. of Programs
City University of Hong Kong	• BEng Energy Science and Engineering, • BEng Environmental Science and Engineering, • BEng Architectural Engineering, • BEng Civil Engineering, • BEng Computer and Data Engineering, • BEng Electronic and Electrical Engineering, • BEng Information Engineering, • BEng Microelectronics Engineering, • BEng Aerospace Engineering, • BEng Mechanical Engineering, • BEng Nuclear and Risk Engineering, • BEng Materials Science and Engineering, • BEng Biomedical Engineering, • BEng Intelligent Manufacturing Engineering	14
The Chinese University of Hong Kong	• BEng in Financial Technology, • BEng in Electronic Engineering, • Information Engineering, • Systems Engineering and Engineering Management, • BEng in Biomedical Engineering, • BEng in Energy and Environmental Engineering, • BEng in Artificial Intelligence: Systems and Technologies, • Mathematics and Information Engineering	8

Table 4.1 (To be continued on the next page) – Summary of Engineering Related bachelor degrees Offered in UGC-funded Universities

Name of University	Name of BEng/BSc Degree Programs	No. of Programs
The Hong Kong Polytechnic University	• BEng (Hons) Scheme in Building Sciences and Engineering, • BEng (Hons) Scheme in Civil Engineering and Sustainable Development, • BEng (Hons) Scheme in Aviation Engineering, • BEng (Hons) Scheme in Electrical Engineering, • BEng (Hons)/BSc (Hons) Scheme in Information and Artificial Intelligence Engineering, • BEng (Hons) Scheme in Product and Industrial Engineering, • BEng (Hons) Scheme in Mechanical Engineering, • BSc (Hons) Scheme in Biomedical Engineering, • BSc (Hons) Scheme in Logistics and Enterprise Engineering	9
The University of Hong Kong	• BEng in Data Science and Engineering, • BEng in Engineering Science, • BEng in Biomedical Engineering, • BEng in Civil Engineering • BEng in Computer Engineering • BEng in Computer Science • BEng in Electrical Engineering • BEng in Electronic Engineering • BEng in Industrial Engineering and Logistics Management • BEng in Mechanical Engineering	10

Table 4.1 (To be continued on the next page) – Summary of Engineering Related bachelor degrees Offered in UGC-funded Universities

Name of University	Name of BEng/BSc Degree Programs	No. of Programs
The Hong Kong University of Science and Technology	• BEng in Aerospace Engineering • BEng in Bioengineering • BEng in Chemical Engineering • BEng in Chemical and Environmental Engineering • BEng in Civil Engineering • BEng in Civil and Environmental Engineering • BEng in Computer Engineering • BSc in Computer Science • BEng in Decision Analytics • BEng in Electronic Engineering • BEng in Industrial Engineering and Engineering Management • BSc in Integrative Systems and Design • BEng in Mechanical Engineering • BEng in Sustainable Energy Engineering	14

Table 4.1 (Cont'd) – Summary of Engineering Related bachelor degrees Offered in UGC-funded Universities

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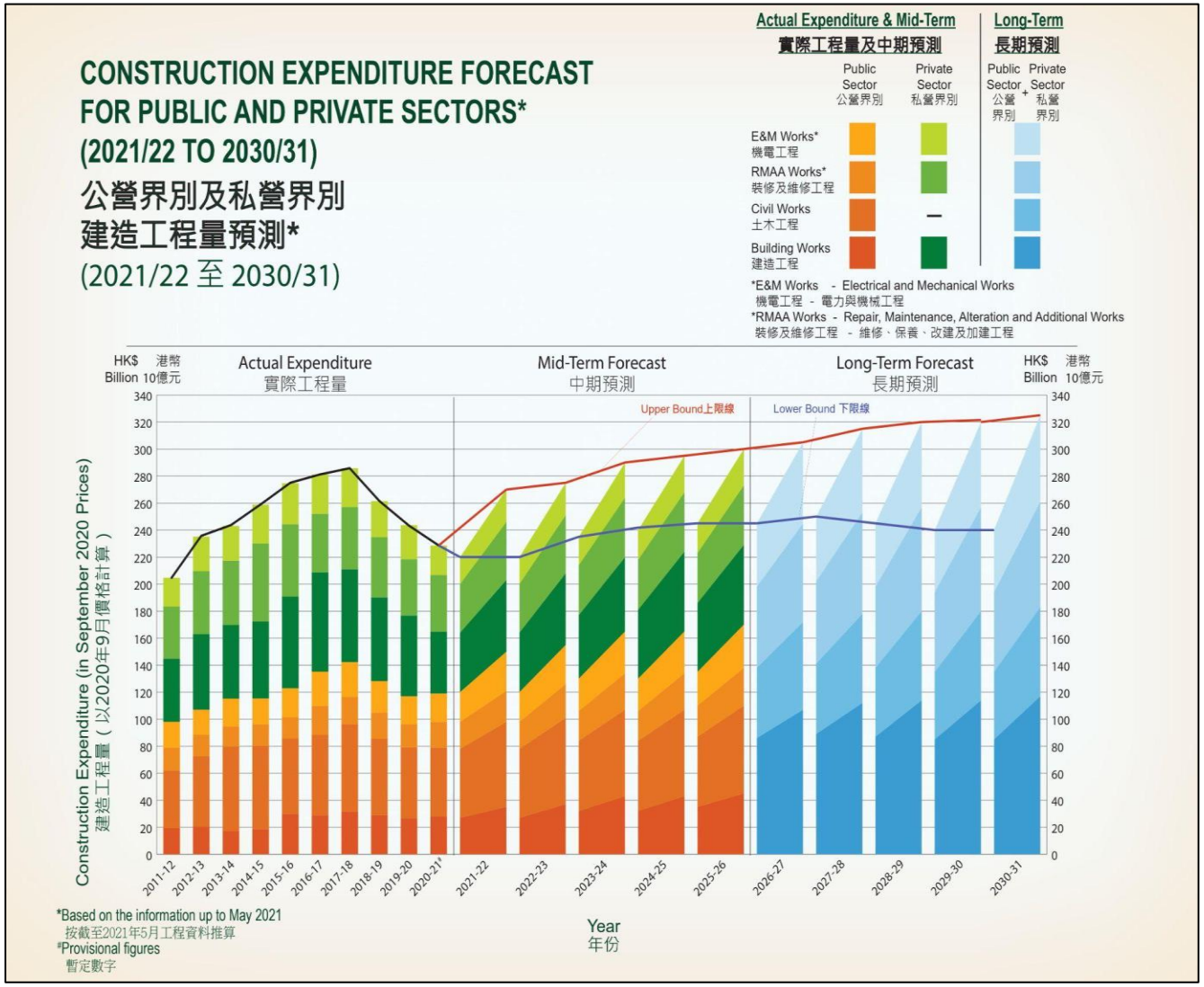


Figure 2.1 – CIC's Construction Expenditure Forecast for Public and Private Sectors (2021/22 to 2030/31)

(Not including HKIE's construction expenditure estimation on Northern Metropolis and Lantau Tomorrow Vision)

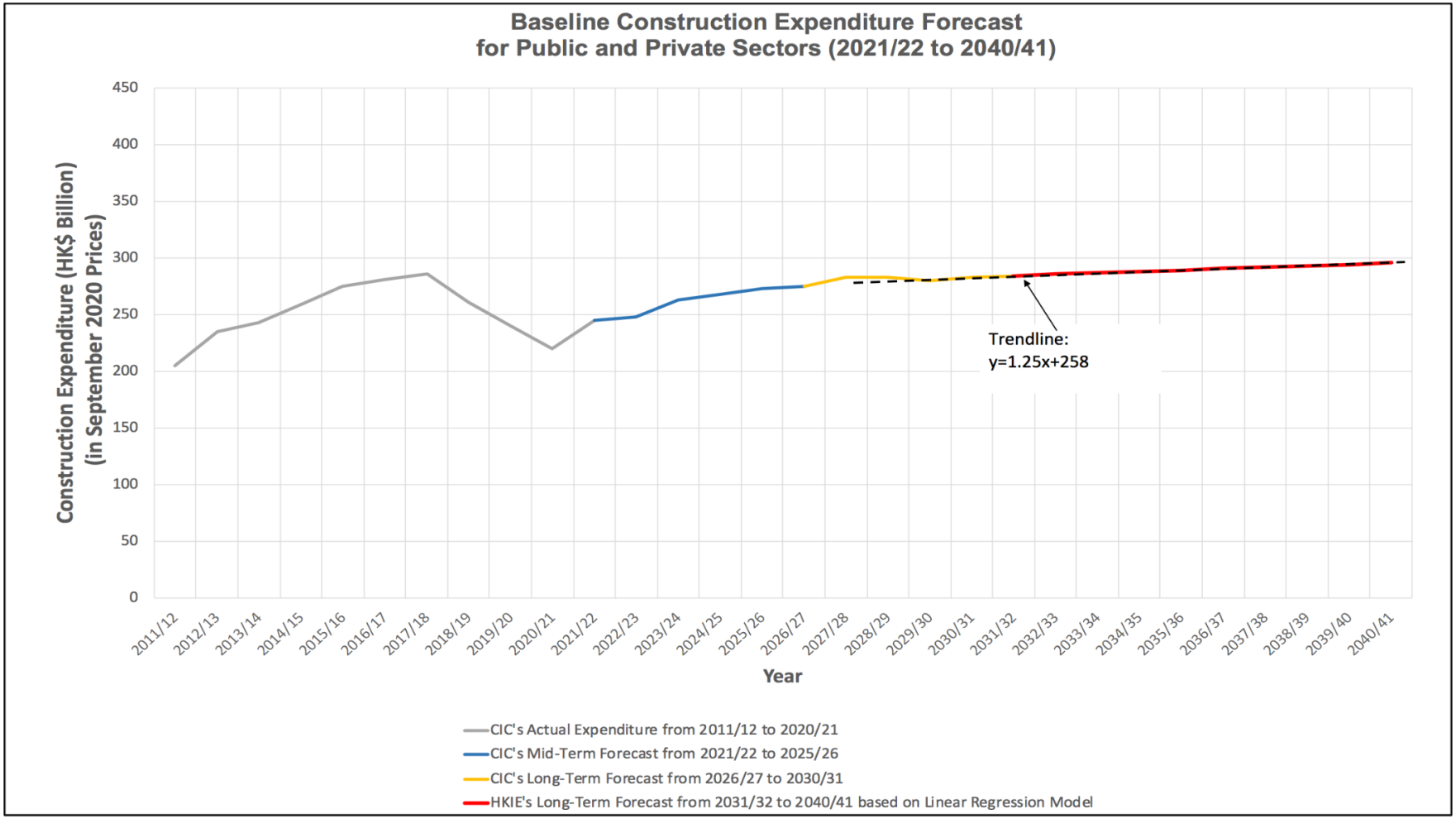


Figure 2.2 – Baseline construction expenditure forecast for public and private sectors (2021/22 to 2040/41)

(Not including HKIE's construction expenditure estimation on Northern Metropolis and Lantau Tomorrow Vision)

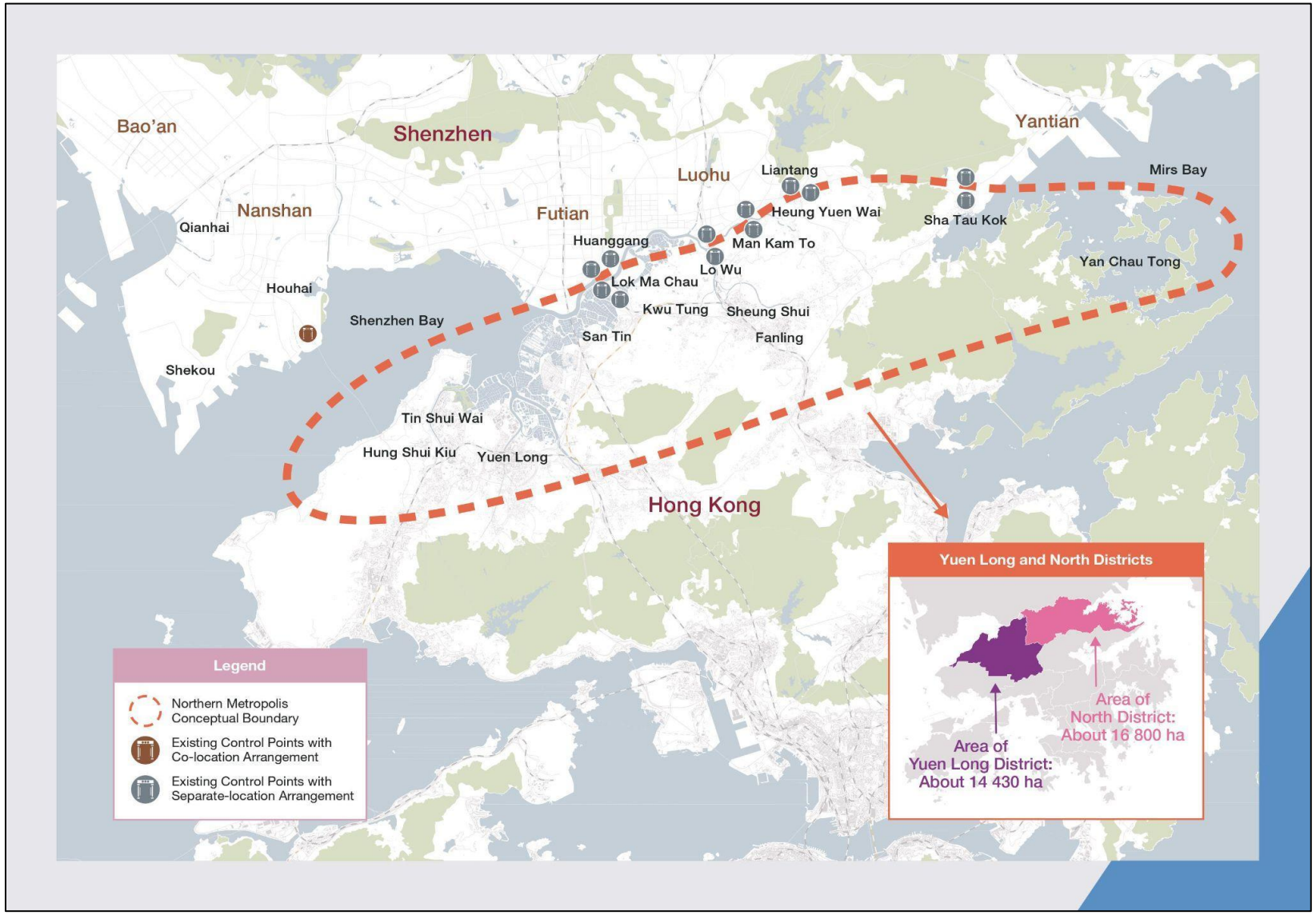


Figure 2.3 – NDA and Development Nodes as mentioned in the NMDS

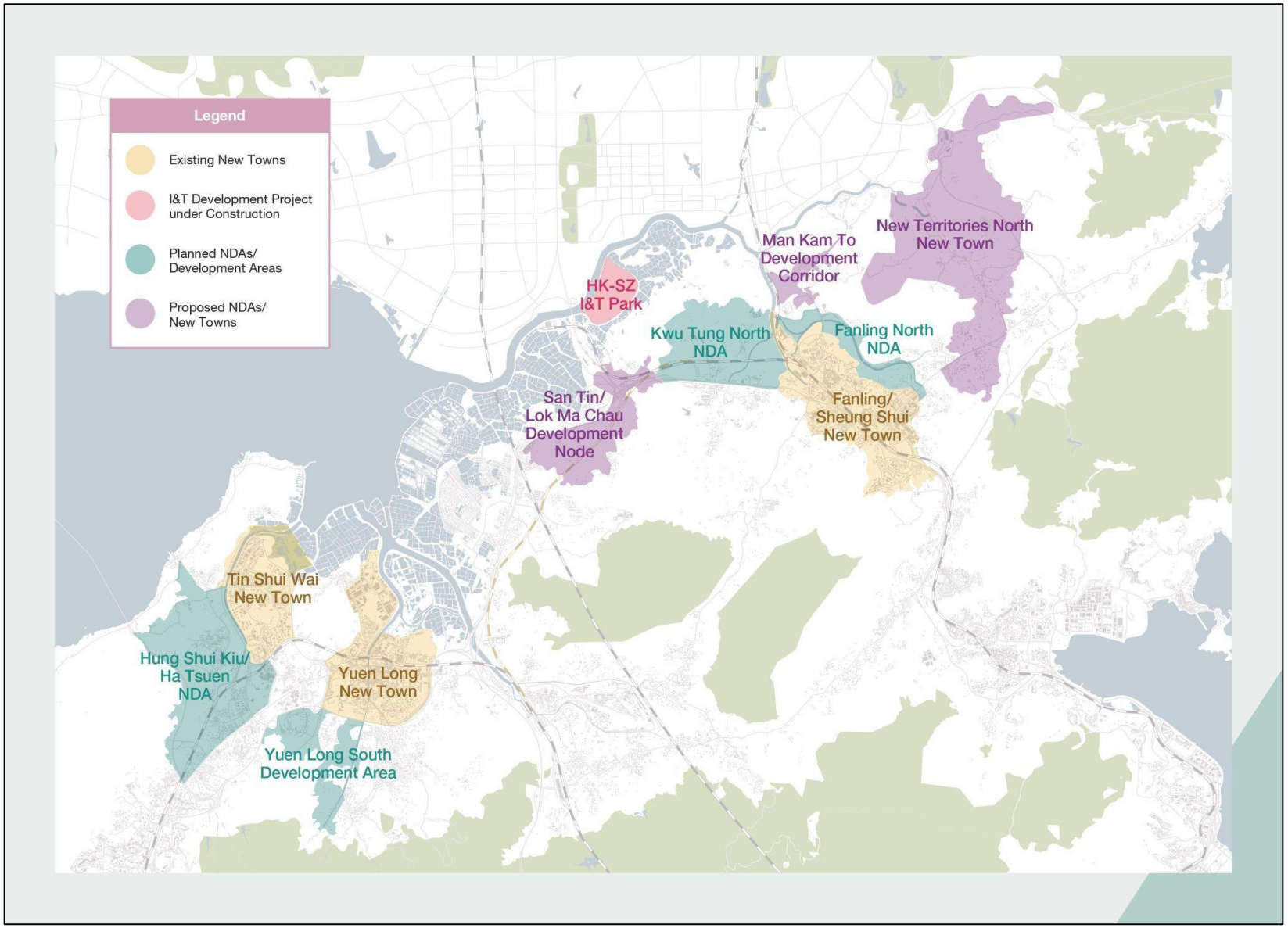


Figure 2.4 – Proposed NDAs/ New Towns/ Development nodes as mentioned in the NMDS

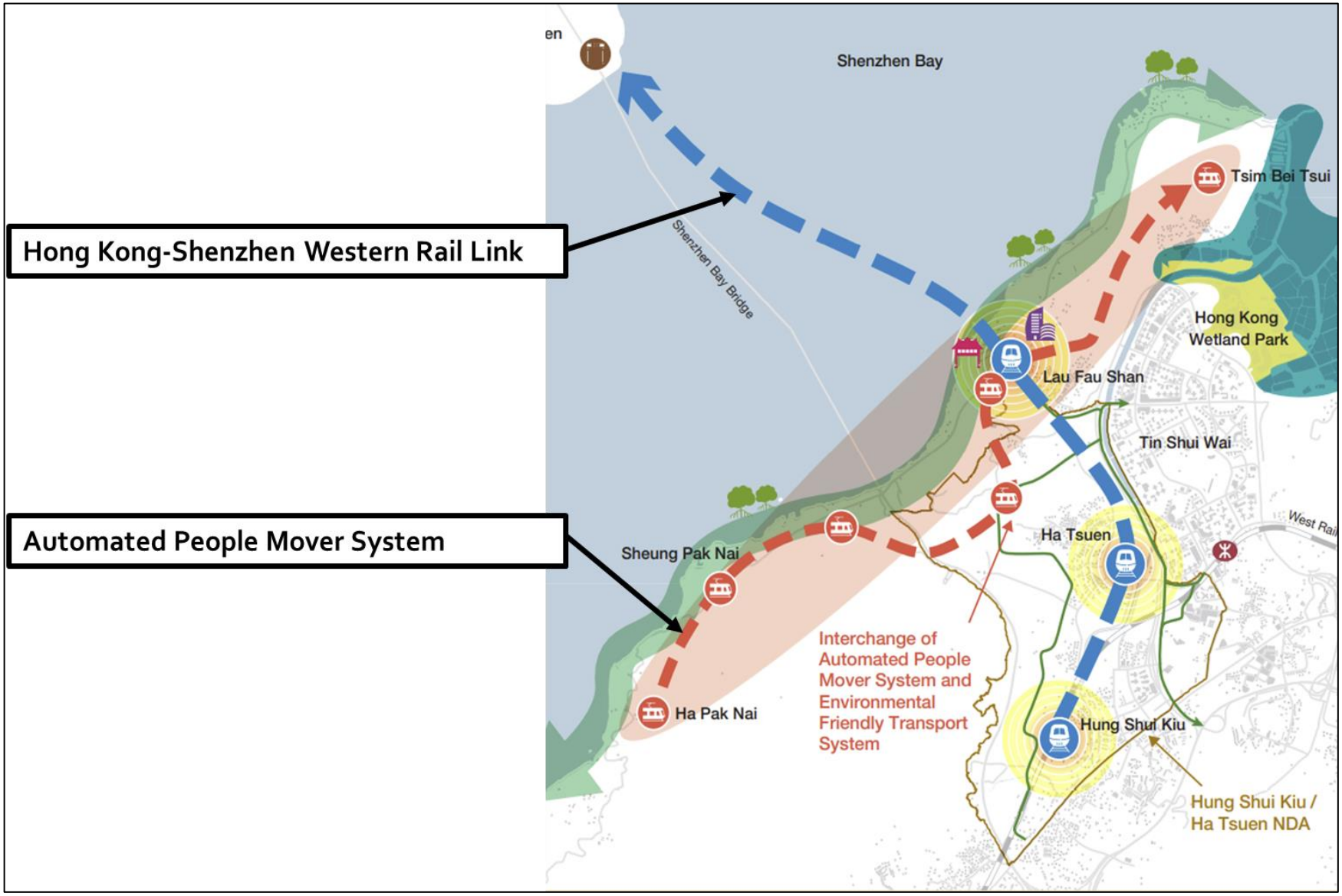


Figure 2.5 – Railway Development at the Northern Metropolis – 1

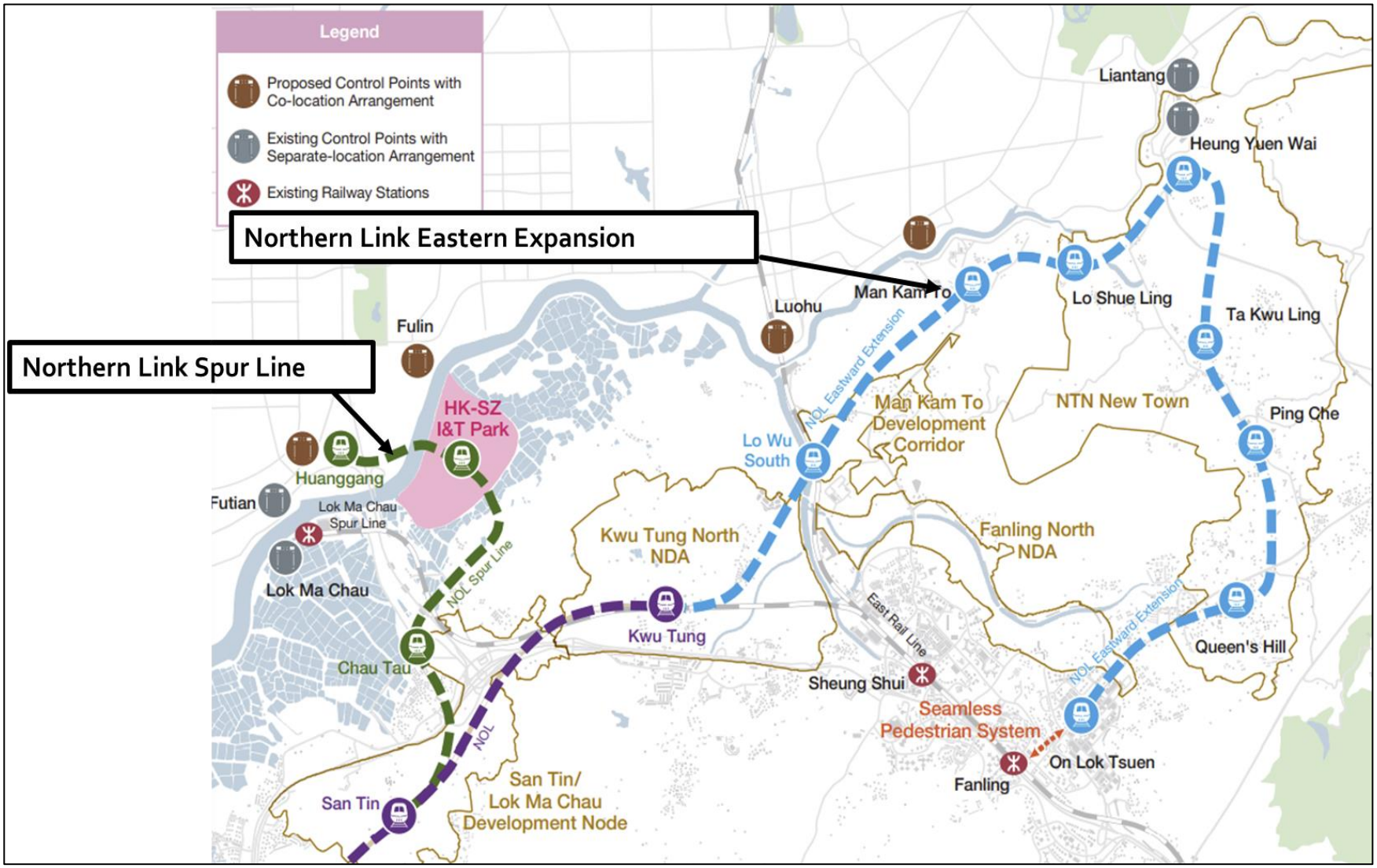


Figure 2.6 – Railway Development at the Northern Metropolis – 2

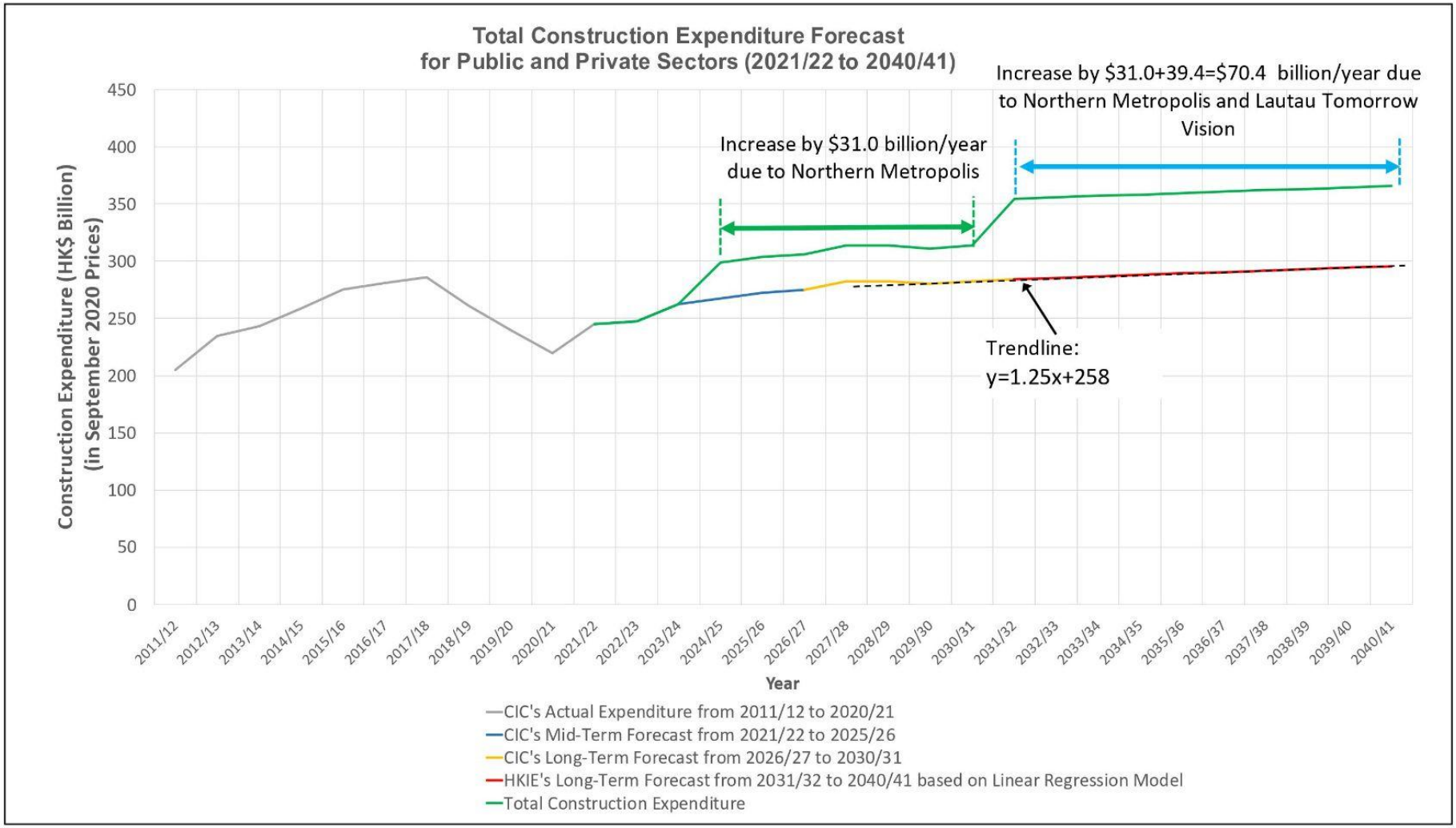


Figure 2.7 – Total construction expenditure forecast from 2021/22 to 2040/41

(including the HKIE's construction expenditure estimation on Northern Metropolis and Lantau Tomorrow Vision)

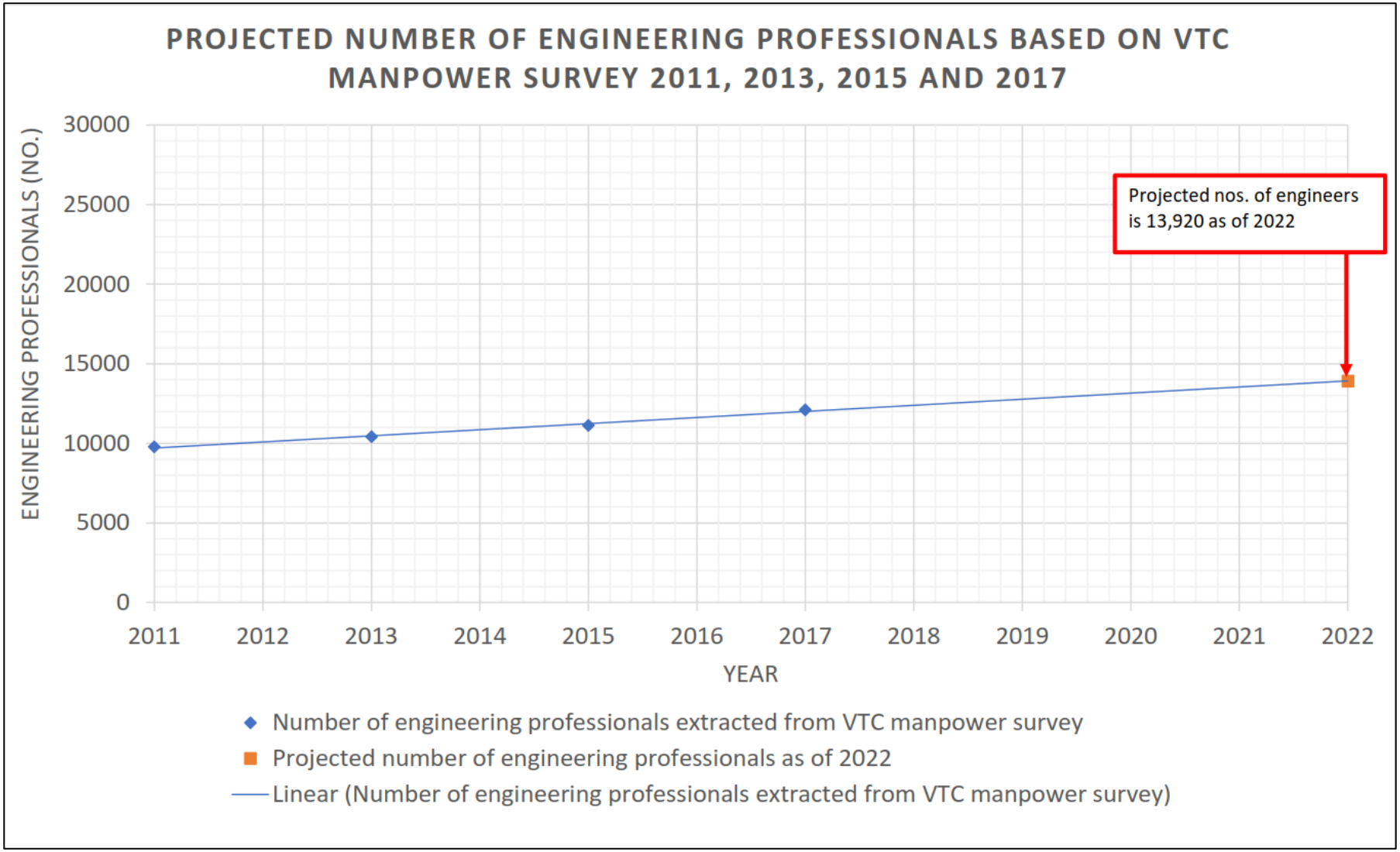


Figure 3.1 – Projected number of engineering professionals based on VTC Manpower Survey

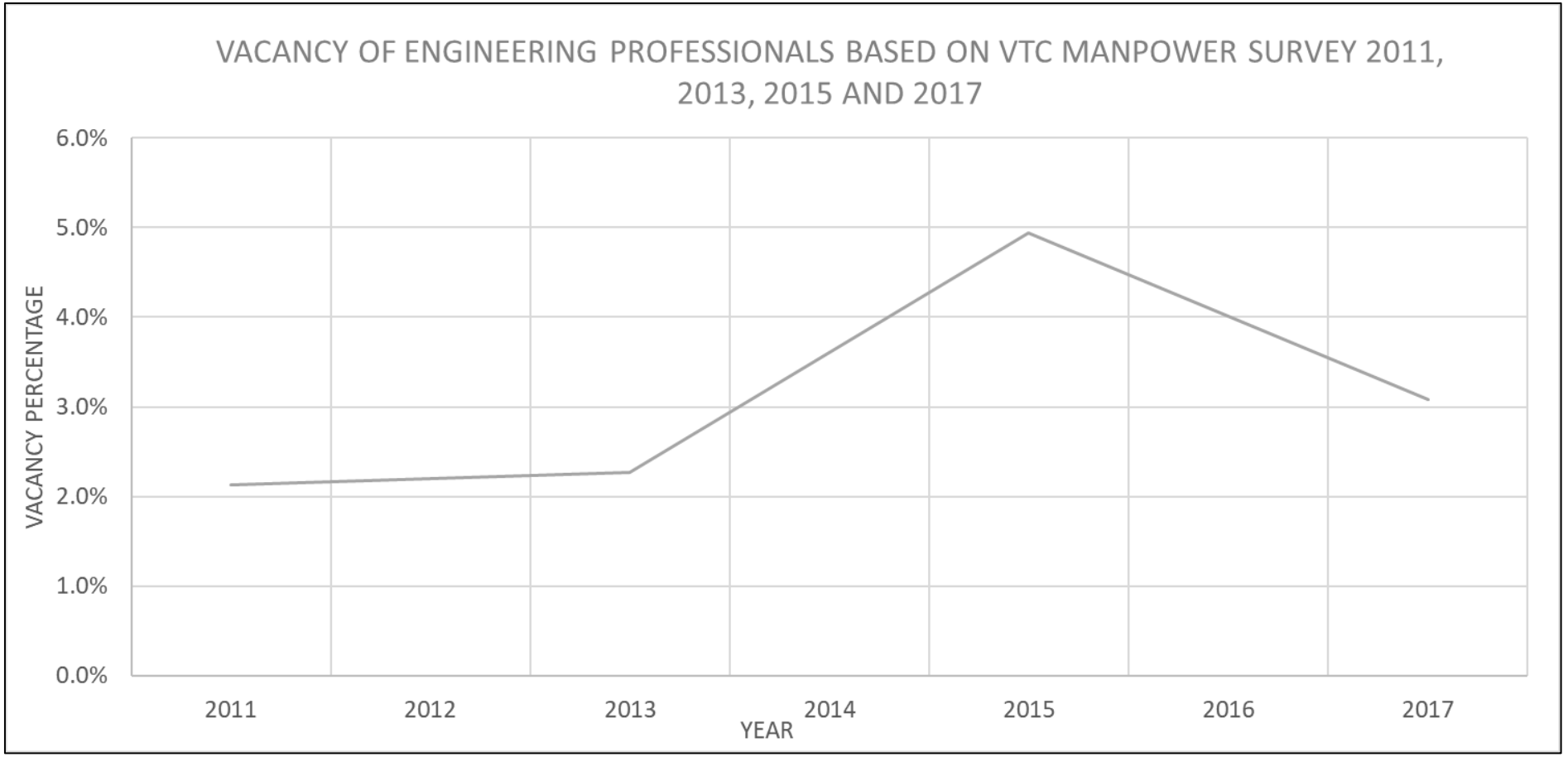


Figure 3.2 – Vacancy percentage of engineering professionals based on VTC Manpower Survey

Appendix A

Construction Industry Council (CIC)
Construction Expenditure Forecast
from 2021/22 to 2030/31 (as at June 2021)
(Not including HKIE's construction expenditure estimation on Northern Metropolis and Lantau Tomorrow Vision)

CONSTRUCTION EXPENDITURE FORECAST FOR PUBLIC AND PRIVATE SECTORS* (2021/22 TO 2030/31)

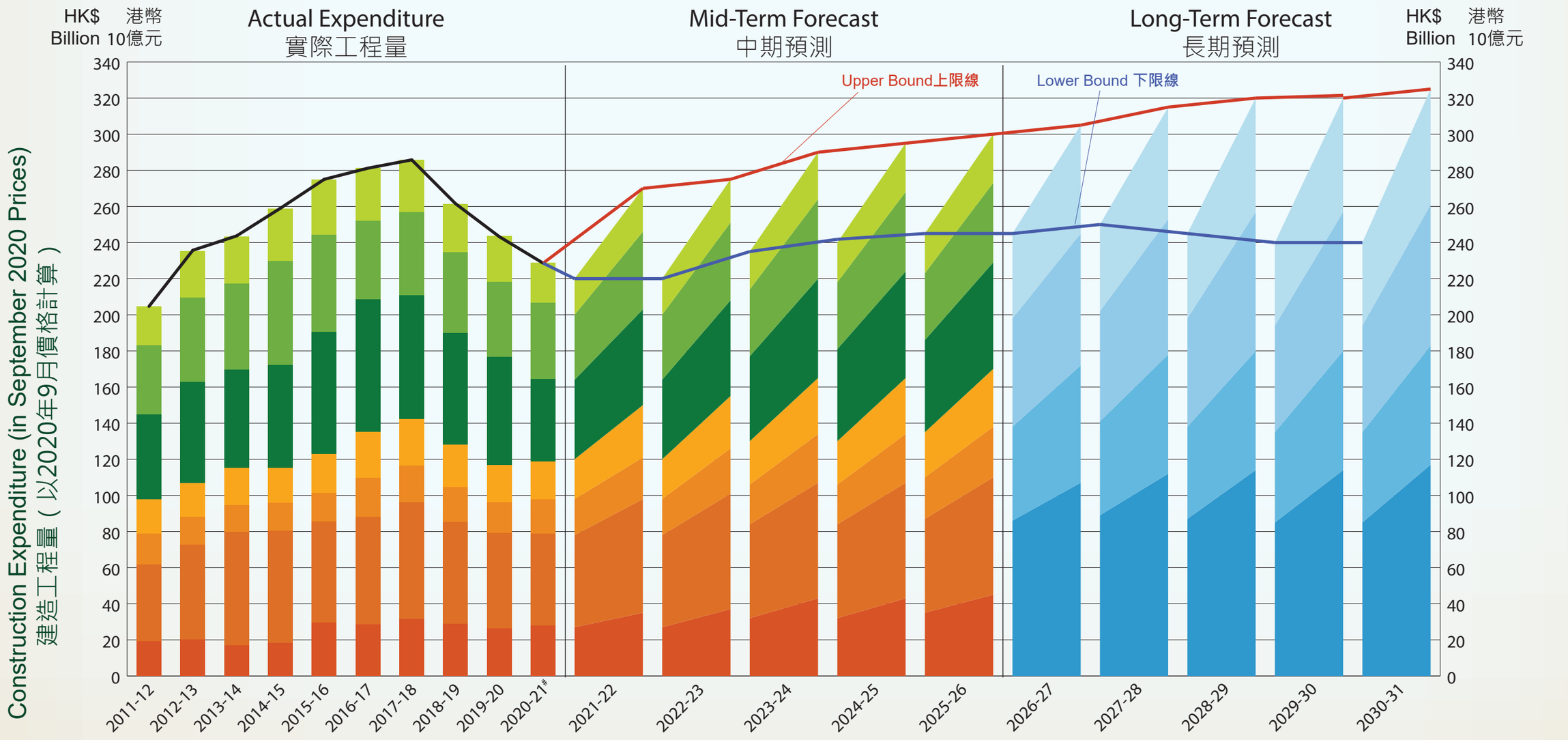
公營界別及私營界別建造工程量預測*
(2021/22 至 2030/31)

Actual Expenditure & Mid-Term
實際工程量及中期預測

Long-Term
長期預測

	Public Sector 公營界別	Private Sector 私營界別	Public Sector 公營界別 + Private Sector 私營界別
E&M Works* 機電工程			
RMAA Works* 裝修及維修工程			
Civil Works 土木工程		–	
Building Works 建造工程			

*E&M Works - Electrical and Mechanical Works
機電工程 - 電力與機械工程
*RMAA Works - Repair, Maintenance, Alteration and Additional Works
裝修及維修工程 - 維修、保養、改建及加建工程



*Based on the information up to May 2021
按截至2021年5月工程資料推算
#Provisional figures
暫定數字

(in September 2020 prices) (以2020年9月價格計算)	Past 10 Years Data (2011/12 - 2020/21) - in HK$ Billion 過去10年建造工程量 (2011/12 - 2020/21) - 港幣十億元									
	2011-12	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2020-21***
Public Sector : 公營界別 :										
Civil Works 土木工程	42.6	52.3	62.7	61.9	56.0	59.6	64.7	56.6	52.6	51.0
Building Works 樓宇建造工程	19.5	20.4	17.1	18.6	29.7	28.8	31.6	28.9	26.6	28.0
RMAA Works 維修、保養、改建及加建工程	16.8	15.7	14.9	15.7	15.7	21.4	20.3	19.2	17.2	19.0
E&M Works 機電工程	19.2	18.6	20.5	19.1	21.5	25.4	25.7	23.5	20.6	21.0
Sub-Total 小計	**98.1**	**107.0**	**115.2**	**115.3**	**122.9**	**135.2**	**142.3**	**128.2**	**117.0**	**119.0**
Private Sector : 私營界別 :										
Building Works 樓宇建造工程	46.7	56.0	54.6	57.0	67.9	73.5	68.6	61.8	59.7	45.8
RMAA Works 維修、保養、改建及加建工程	38.7	46.7	47.6	57.9	53.7	43.4	46.3	44.0	41.7	41.9
E&M Works 機電工程	21.3	25.7	25.8	28.7	30.4	29.2	28.7	26.5	25.3	21.9
Sub-Total 小計	**106.7**	**128.4**	**128.0**	**143.6**	**152.0**	**146.1**	**143.6**	**132.3**	**126.7**	**109.6**
Total 總計	**204.8**	**235.4**	**243.2**	**258.9**	**274.9**	**281.3**	**285.9**	**260.5**	**243.7**	**228.6**

Last Publication in Sep 2020 **2020年9月發布的建造工程量** (In September 2020 prices) (以2020年9月價格計算)	**204.7**	**235.2**	**243.1**	**258.8**	**274.7**	**281.2**	**285.8**	**261.4**	**240.0**	**225-275**

***Provisional Figures**
***暫定數字**

(in September 2020 prices) (以2020年9月價格計算)	Mid-Term Forecast (2021/22 - 2025/26) - in HK$ Billion 中期預測 (2021/22 - 2025/26) - 港幣十億元									
	2021-22		2022-23		2023-24		2024-25		2025-26	
	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper
Public Sector : 公營界別：										
Civil Works 土木工程	51.0	63.0	51.0	64.0	52.0	64.0	52.0	64.0	52.0	65.0
Building Works 樓宇建造工程	27.0	35.0	27.0	37.0	32.0	43.0	32.0	43.0	35.0	45.0
RMAA Works 維修、保養、改建及加建工程	20.0	23.0	20.0	25.0	22.0	27.0	22.0	27.0	23.0	28.0
E&M Works 機電工程	22.0	29.0	22.0	29.0	24.0	31.0	24.0	31.0	25.0	32.0
Sub-Total 小計	**120.0**	**150.0**	**120.0**	**155.0**	**130.0**	**165.0**	**130.0**	**165.0**	**135.0**	**170.0**
Private Sector : 私營界別：										
Building Works 樓宇建造工程	44.0	53.0	44.0	53.0	47.0	55.0	51.0	59.0	51.0	59.0
RMAA Works 維修、保養、改建及加建工程	36.0	43.0	36.0	43.0	37.0	44.0	37.0	44.0	37.0	44.0
E&M Works 機電工程	20.0	24.0	20.0	24.0	21.0	26.0	22.0	27.0	22.0	27.0
Sub-Total 小計	**100.0**	**120.0**	**100.0**	**120.0**	**105.0**	**125.0**	**110.0**	**130.0**	**110.0**	**130.0**
Total 總計	**220.0**	**270.0**	**220.0**	**275.0**	**235.0**	**290.0**	**240.0**	**295.0**	**245.0**	**300.0**

Last Publication in Sep 2020 **2020年9月發布的建造工程量** **(In September 2020 prices)** **(以2020年9月價格計算)**	**230.0**	**280.0**	**225.0**	**280.0**	**230.0**	**285.0**	**240.0**	**290.0**	**245.0**	**300.0**

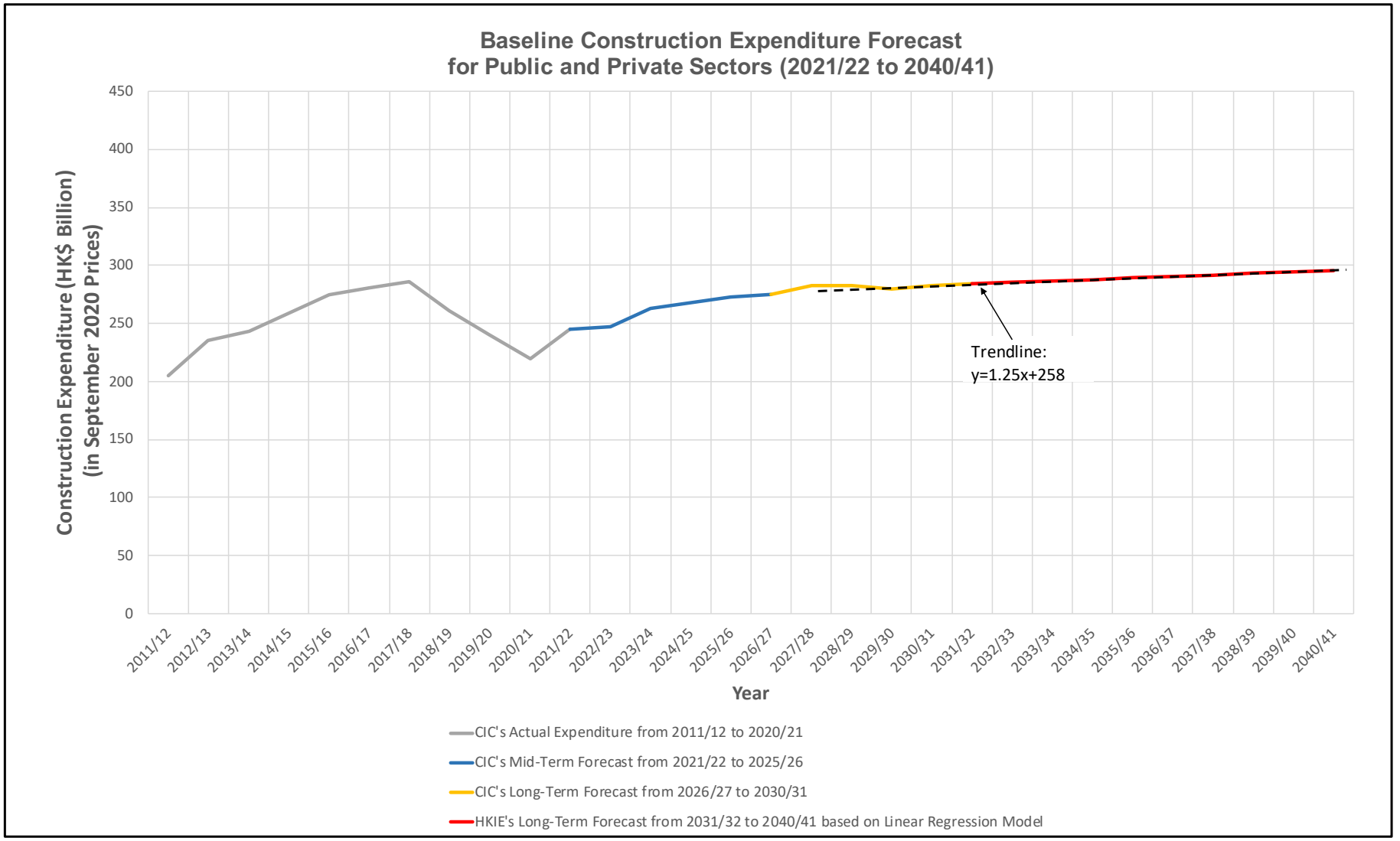
(in September 2020 prices) (以2020年9月價格計算)	Long-Term Forecast (2026/27 - 2030/31) - in HK$ Billion 長期預測 (2026/27 - 2030/31) - 港幣十億元									
	2026-27		2027-28		2028-29		2029-30		2030-31	
	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Lower
Public Sector + Private Sector 公營界別 + 私營界別										
Civil Works 土木工程	52.0	65.0	52.0	66.0	51.0	66.0	50.0	66.0	50.0	66.0
Building Works 樓宇建造工程	86.0	107.0	89.0	112.0	87.0	114.0	85.0	114.0	85.0	117.0
RMAA Works 維修、保養、改建及加建工程	60.0	73.0	61.0	75.0	60.0	77.0	59.0	77.0	59.0	78.0
E&M Works 機電工程	47.0	60.0	48.0	62.0	47.0	63.0	46.0	63.0	46.0	64.0
Total 總計	**245.0**	**305.0**	**250.0**	**315.0**	**245.0**	**320.0**	**240.0**	**320.0**	**240.0**	**325.0**
Last Publication in Sep 2020 **2020年9月發布的建造工程量** **(In September 2020 prices)** **(以2020年9月價格計算)**	**250.0**	**305.0**	**245.0**	**310.0**	**250.0**	**315.0**	**245.0**	**315.0**		

Appendix B

Baseline Construction Expenditure Forecast to 2040/41 (Not including HKIE's construction expenditure estimation on Northern Metropolis and Lantau Tomorrow Vision)

Baseline Construction Expenditure Forecast for Public and Private Sectors (2021/22 to 2040/41)

	CIC's Forecast as at June 2021							HKIE's Forecast	
Year	Actual Expenditure (2011/12 - 2020/21) (in September 2020 Prices) (HK$ Bilion)	Lower Level for Mid-Term Forecast (2021/22 - 2025/26) (in September 2020 Prices) (HK$ Bilion)	Upper Level for Mid-Term Forecast (2021/22 - 2025/26) (in September 2020 Prices) (HK$ Bilion)	Average Value for Mid-Term Forecast (2021/22 - 2025/26) (in September 2020 Prices) (HK$ Bilion)	Lower Level for Long-Term Forecast (2026/27 - 2030/31) (in September 2020 Prices) (HK$ Bilion)	Upper Level for Long-Term Forecast (2026/27 - 2030/31) (in September 2020 Prices) (HK$ Bilion)	Average Value for Long-Term Forecast (2026/27 - 2030/31) (in September 2020 Prices) (HK$ Bilion)	Long-Term Forecast based on Linear Regression Model (2031/32 - 2040/41) (in September 2020 Prices) (HK$ Bilion)	Adopted Baseline Values (2021/22 - 2040/41) (in September 2020 Prices) (HK$ Bilion)
2011/12	205								
2012/13	235								
2013/14	243								
2014/15	259								
2015/16	275								
2016/17	281								
2017/18	286								
2018/19	261								
2019/20	240								
2020/21	220								
2021/22		220	270	245					245
2022/23		220	275	247.5					247.5
2023/24		235	290	262.5					262.5
2024/25		240	295	267.5					267.5
2025/26		245	300	272.5					272.5
2026/27					245	305	275		275
2027/28					250	315	282.5		282.5
2028/29					245	320	282.5		282.5
2029/30					240	320	280		280
2030/31					240	325	282.5		282.5
2031/32								284.3	284.3
2032/33								285.5	285.5
2033/34								286.8	286.8
2034/35								288.0	288.0
2035/36								289.3	289.3
2036/37								290.5	290.5
2037/38								291.8	291.8
2038/39								293.0	293.0
2039/40								294.3	294.3
2040/41								295.5	295.5


Baseline Construction Expenditure Forecast
for Public and Private Sectors (2021/22 to 2040/41)
Construction Expenditure (HK$ Billion)
(in September 2020 Prices)
450
400
350
300
250
200
150
100
50
0
2011/12
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2031/32
2032/33
2033/34
2034/35
2035/36
2036/37
2037/38
2038/39
2039/40
2040/41
Year
Trendline:
y=1.25x+258
CIC's Actual Expenditure from 2011/12 to 2020/21
CIC's Mid-Term Forecast from 2021/22 to 2025/26
CIC's Long-Term Forecast from 2026/27 to 2030/31
HKIE's Long-Term Forecast from 2031/32 to 2040/41 based on Linear Regression Model

Appendix C

Estimation of Construction Expenditure at the Northern Metropolis

Annex I

Estimation of Construction Expenditure for Infrastructure and Site Formation

Estimation of construction expenditure on the infrastructure and site formation in the Northern District as per the Northern Metropolis Development Strategy

The construction expenditure of Kwu Tung North/Fanling North New Development Area (KTN/FLN NDA) was taken as reference for the estimates.

1. The new development areas as mentioned in the Northern Metropolis Development Strategy are summarised below:

Development Area	Approximate Area (hectare)
San Tin/Lok Man Chau Development Node	320
Man Kam To Development Corridor	1140
New Territories North New Town	
Total	1460

2. The following table summarised the list of public works programme items in KTN/KLN DNA considered for the estimation:-

		Estimated Annual Expenditure (MOD) ($ million)*						Annual Expenditure (at September 2020 Prices) ($ million)					
		Design and Site Investigation		Construction				Design and Site Investigation		Construction			
Year	Adopted Conversion Factor	Advance detailed design (747CL)	Detail design for remaining phase (part of 828CL)	Advance construction (747CL)	First phase construction (759CL)	District Cooling System (51CG)	STW upgrade (388DS)	Advance detailed design (747CL)	Detail design for remaining phase (part of 828CL)	Advance construction (747CL)	First phase construction (759CL)	District Cooling System (51CG)	STW upgrade (388DS)
2013/14	0.81589	29.5						36.2					
2014/15	0.85591	67.4						78.7					
2015/16	0.87095	143.6						164.9					
2016/17	0.92058	75.7						82.2					
2017/18	0.98607	11.8						12.0					
2018/19	1.01606	7.4						7.3					
2019/20	1.00021	5.0	26.5	125.9	16.5		50.0	5.0	26.5	125.9	16.5		50.0
2020/21	1.00000		84.8	1574.5	152.9		416.2		84.8	1574.5	152.9		416.2
2021/22	1.01300		115.7	3338.6	274.0	127.1	539.9		114.2	3295.8	270.5	125.5	533.0
2022/23	1.04972		150.9	4082.3	148.9	186.9	700.0		143.8	3888.9	141.8	178.0	666.8
2023/24	1.09696		205.4	3042.2	166.0	224.2	760.1		187.2	2773.3	151.3	204.4	692.9
2024/25	1.14632		124.3	1833.3	73.3	637.8	992.3		108.4	1599.3	63.9	556.4	865.6
2025/26	1.19791		39.5	1225.6	39.6	620.1	1310.6		33.0	1023.1	33.1	517.7	1094.1
2026/27	1.25181		17.4	1025.3	19.0	226.3	686.0		13.9	819.1	15.2	180.8	548.0
2027/28	1.30814			903.8	4.4	221.9	430.6			690.9	3.4	169.6	329.2
2028/29	1.36701			168.6	1.8	547.1	483.3			123.3	1.3	400.2	353.5
2029/30	1.42853					865.5	999.2					605.9	699.5
2030/31	1.48745					825.9	429.0					555.2	288.4
2031/32	1.54695					274.9	344.8					177.7	222.9
2032/33	1.60883					265.2	647.0					164.8	402.2
2033/34	1.67318					236.4	998.2					141.3	596.6
2034/35	1.74011					266.3	1394.3					153.0	801.3
2035/36	1.80971					21.3	260.8					11.8	144.1
2036/37	1.88210					22.1	272.9					11.7	145.0
2037/38	1.95738					23.1	257.6					11.8	131.6
2038/39	2.03568					95.9						47.1	
							Total	386.3	711.8	15914.1	849.9	4213.0	8980.8

There would also be construction expenditure arising from the remaining phase construction (remainder of 828CL). As no funding application has been submitted to the Finance Committee at the time of study, it is estimated using the ratio between the construction and design expenditure of the Advance Phase.

The ratio between the construction and design expenditure of the Advance Phase = 15,914.07 / 386.3

= 41.20

The estimated cost of remaining phase construction at September 2020 Prices ($ million) = 711.8 x 41.2

= 29,327.1

Therefore, the total construction expenditure on infrastructure and site formation in KTN/FLN NDA at September Prices ($ million) = 15,914.1 + 849.9 + 4,213.0 + 8,980.8 + 29,327.1

= **59,284.93**

Total Area of KTN/FLN NDA (ha) = **612**

Construction expenditure per hectare ($million/ha) = 59,284.9 / 612

= **96.9**

3. Therefore, the total construction expenditure for the infrastructure and site formation is estimated as follow:

Development Area	Approximate Area (hectare)	$ million/ha	Price at September 2020 ($million)
San Tin/Lok Man Chau Development Node	320	96.9	31008
Man Kam To Development Corridor	1140	96.9	110466
New Territories North New Town			
		Total =	**141474**

4. In conclusion, the total construction expenditure for proposed infrastructure and site formation at the Northern Metropolis is $ 141 Billion at Sept 2020 price level.

* The information on the expenditure of various public works programme items are based on Public Works Subcommittee Endorsed Papers PWSC(2013-14)38, PWSC(2018-19)41 and PWSC(2020-21)25.

Annex II

Estimation of Construction Expenditure for Housing Development

Estimation of construction expenditure on the housing development in the Northern District as per the Northern Metropolis Development Strategy

1. Proposed additional no. of residential unit to be provided in the Northern District:

Lower Bound Value =	165000	units
Upper Bound Value =	185000	units
Average Value =	**175000**	units

2. Average construction cost of residential unit at 2020/21*:

public rental housing ($/unit) =	1063100
Home Ownership Scheme ($/unit) =	1163300
Average Unit Price ($/unit) =	1113200

2. Therefore the estimated construction expenditure of housing development in the Northern District for Sept 2020 Price Level

Total =	175000 x 1113200	
Total =	194.81	Billion (Sept 2020 Price Level)

4. In conclusion, the total construction expenditure on housing development at the Northern Metropolis is $ 195 Billion at Sept 2020 price level.

* The reference rate adopted are extracted from the Government Press Release issued in April 2017.

Annex III

Estimation of Construction Expenditure for Railway Development

Estimation of construction expenditure on the railway development in the Northern District as per the Northern Metropolis Development Strategy

1. The major railway developments as mentioned in the Northern Metropolis Development Strategy are summarized below:

Proposed Railway Development	Length (km)	No. of new station
Hong Kong Shenzhen Western Rail Link	7.8	3
Northern Link Eastern Extension	15.4	8
Northern Link Spur Line	5.6	3
Automated People Mover System	7.6	6
ERL extention to Luohu and relocation to Lo Wu Station to Shenzhen	1.5	1

Table D1: Proposed railway development as per the Northern Metropolis Development Strategy

2. The following table summarised the list of past railway developments considered for the estimation:-

Referred Railway Development	Length (km)	Price (million)	No. of new station	$/station/km (million)	Note	Factor convert to Sept 2020 price level	$/station/km (million) Sept 2020 price level
Northern Link (NOL) Phase 1 & 2	10.7	62000	4	1449	December 2015 price	0.87095	1664
Shatin to Central Link (SCL)	17	90700	5	1067	July 2021 price	1.01300	1053
Taipa Line - Macau	9.3	9900	11	97	December 2019 price	1.00000	97

Table D2: Reference rate adopted for the estimation of the proposed railway developments

The references of these rate are from MTR Corporation Company Overview Report of 2021 and key information identified in the MTR website.
These publications are attached behind for references.

3. Therefore, the total construction expenditure for railway development is estimated as follow:

Proposed Railway Development	Referenced Railway Development	$/station/km	Length (km)	No. of new station	Price (million)
Hong Kong Shenzhen Western Rail Link	Average of NOL Phase 1 and 2 and SCL	1359	7.8	3	31789
Northern Link Eastern Extension	NOL Phase 1 and 2	1664	15.4	8	205005
Northern Link Spur Line	NOL Phase 1 and 2	1664	5.6	3	27955
Automated People Mover System	Taipa Line - Macau	97	7.6	6	4423
ERL extention and relocation to Luohu	NOL Phase 1 and 2	1664	1.5	1	2496
				Total =	272 Billion (Sept 2020 Price)

Table D3: Estimation of total construction expenditure for the propsed railway development

4. In conclusion, the total construction expenditure for proposed railway development at the Northern Metropolis is $ 272 Billion at Sept 2020 price level.

Annex IV

Estimation of Construction Expenditure for Conservation Facilities

Estimation of construction expenditure on the conservation facilities in the Northern District as per the Northern Metropolis Development Strategy

1. The existing area of conservation facilities (ha) in the Northern District (Total (a)) is as follow:

Hong Kong Wetland Park =	62	ha
Mai Po Natrual Reserve =	370	ha
Total (a) =	432	ha

2. Proposed total area to be developed (ha) for conservation facilities in the Northern District (Total (b)) is as follow:

Nam Sang Wai Wetland Park =	400	ha
Sam Po Shue Wetland Park =	520	ha
Hoo Hok Wai Wetland Park =	300	ha
Expansion of Hong Kong Wetland Park =	240	ha
Tsim Bei Tsui/ Lau Fau Shan/ Pak Nai Conservation Park =	145	ha
Total (b) =	1605	ha

3. With the total area of proposed conservation facilities calculated, the rate below is taken as reference:

Development of Long Valley Nature Park (LVNP)* =	330	Million (Feb 2022 Price Level)
Area of LVNP =	40	ha
Rate of development of Nature Park per hectre (d) =	8.25	Million/ha

4. Therefore the estimated construction expenditure of conservation facilities in the Northern District for Feb 2020 Price Level (Total (e))

Total (e) = Total (c) x d =	13300	Million (Feb 2022 Price Level)
Total (e) =	13.3	Billion (Feb 2022 Price Level)

Adopted PAF for conversion from Feb 2022 to Sept 2020 (e) = 1.05

5. In conclusion, the estimated construction expenditure of conservation facilities in the Northern District for Sept 2020 Price Level (Total (z)):

Total (z) = Total (e) / e =	**12.7**	**Billion (Sept 2020 Price Level)**

* The reference rate adopted are extracted from P. 40 of Item 759CL of LC paper no. PWSC(2018-19)41.

Appendix D

Conversion calculation of Money of the day (MOD) to the September 2020 Price Level

Conversion Factor for Converting money-of-the-day Prices to Price Level at September 2020

Year	Civil Engineering Works Index (CEWI)* (1980 Value=100)	Normalised CEWI by CEWI of 2020/21	Price Adjustment Factor (PAF) **	Adopted Conversion Factor***
2013/14	590.2	0.81589		0.81589
2014/15	619.15	0.85591		0.85591
2015/16	630.03	0.87095		0.87095
2016/17	665.93	0.92058		0.92058
2017/18	713.3	0.98607		0.98607
2018/19	735	1.01606		1.01606
2019/20	723.53	1.00021		1.00021
2020/21	723.38	1.00000	1.00000	1.00000
2021/22			1.01300	1.01300
2022/23			1.04972	1.04972
2023/24			1.09696	1.09696
2024/25			1.14632	1.14632
2025/26			1.19791	1.19791
2026/27			1.25181	1.25181
2027/28			1.30814	1.30814
2028/29			1.36701	1.36701
2029/30			1.42853	1.42853
2030/31			1.48745	1.48745
2031/32			1.54695	1.54695
2032/33			1.60883	1.60883
2033/34			1.67318	1.67318
2034/35			1.74011	1.74011
2035/36			1.80971	1.80971
2036/37			1.88210	1.88210
2037/38			1.95738	1.95738
2038/39			2.03568	2.03568

Remarks

* The CEWI of a financial year is taken as the average monthly CEWI from April of the first year to March of the second year. For example, CEWI of 2013/14 is taken as the average monthly CEWI from from April 2013 to March 2014.

** The PAF from 2020/21 to 2030/31 is based on the latest PAF released by the Office of the Government Economist in Memo from SFST ref. ( ) in TsyB W 00/645-1-13/49/0 dated 30 December 2021.
The PAF from 2031/32 to 2038/39 is obtained by assuming the price deflator to be 4% per annum.

*** The MOD price (X) is then adjusted back to Price level (Y) at September 2020 by the following formula: -

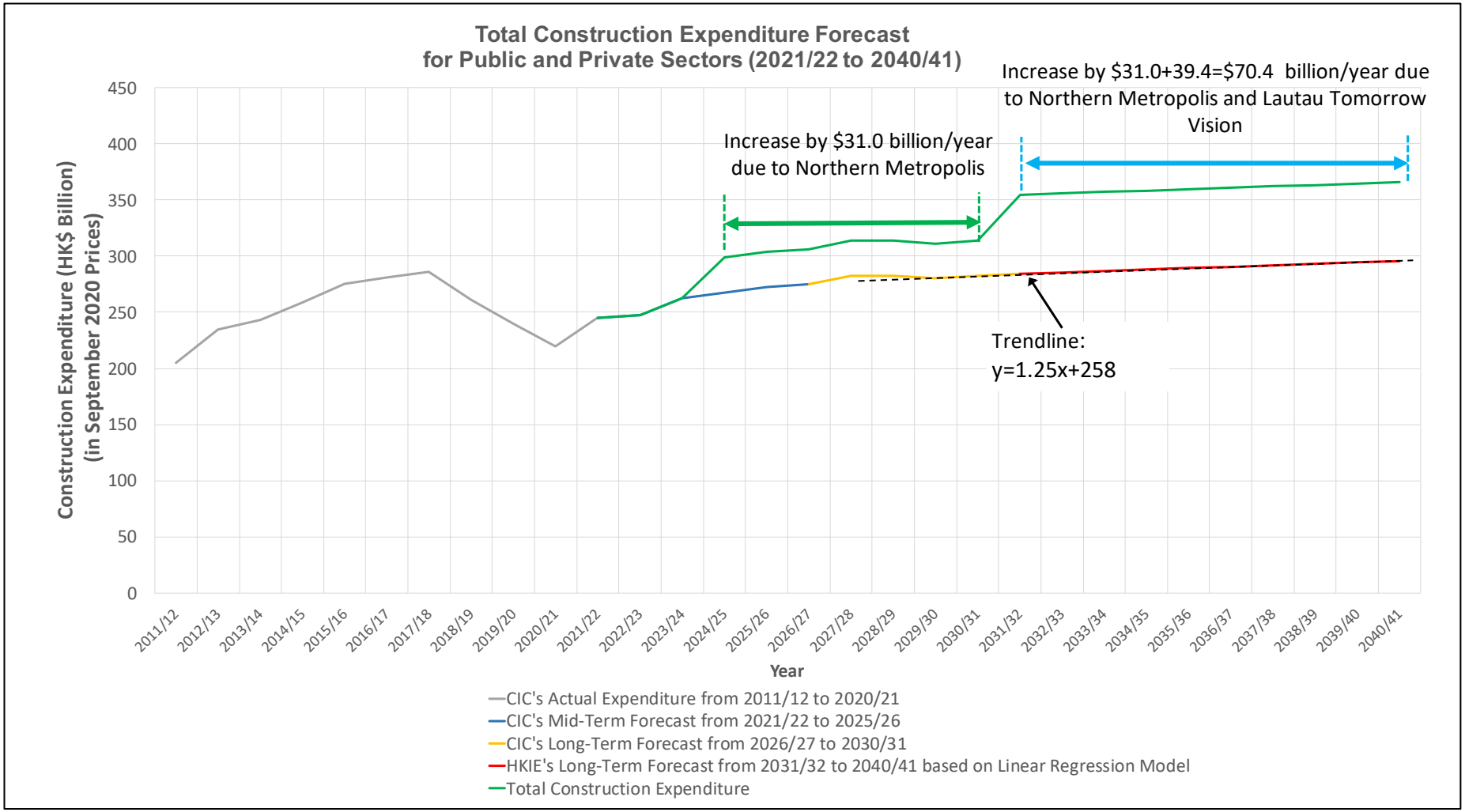
$$Y = \frac{X}{ADOPTED\ CONVERSION\ FACTOR}$$

Appendix E

Total Construction Expenditure Forecast from 2021/22 to 2040/41 (including the HKIE's construction expenditure estimation on Northern Metropolis and Lantau Tomorrow Vision)

Total Construction Expenditure Forecast for Public and Private Sectors (2021/22 to 2040/41)

	CIC's Forecast as at June 2021							HKIE's Forecast				
Year	Actual Expenditure (2011/12 - 2020/21) (in September 2020 Prices) (HK$ Bilion)	Lower Level for Mid-Term Forecast (2021/22 - 2025/26) (in September 2020 Prices) (HK$ Bilion)	Upper Level for Mid-Term Forecast (2021/22 - 2025/26) (in September 2020 Prices) (HK$ Bilion)	Average Value for Mid-Term Forecast (2021/22 - 2025/26) (in September 2020 Prices) (HK$ Bilion)	Lower Level for Long-Term Forecast (2026/27 - 2030/31) (in September 2020 Prices) (HK$ Bilion)	Upper Level for Long-Term Forecast (2026/27 - 2030/31) (in September 2020 Prices) (HK$ Bilion)	Average Value for Long-Term Forecast (2026/27 - 2030/31) (in September 2020 Prices) (HK$ Bilion)	Long-Term Forecast based on Linear Regression Model (2031/32 - 2040/41) (in September 2020 Prices) (HK$ Bilion)	Adopted Baseline Values (2021/22 - 2040/41) (in September 2020 Prices) (HK$ Bilion) (A)	Construction Expenditure from Lantau Tomorrow Vision (2031/32 - 2040/41) (in September 2020 Prices) (HK$ Bilion) (B)	Construction Expenditure from Northern Metropolis (2021/22 - 2040/41) (in September 2020 Prices) (HK$ Bilion) (C)	Total Construction Expenditure (2021/22 - 2040/41) (in September 2020 Prices) (HK$ Bilion) (A)+(B)+(C)
2011/12	205											
2012/13	235											
2013/14	243											
2014/15	259											
2015/16	275											
2016/17	281											
2017/18	286											
2018/19	261											
2019/20	240											
2020/21	220											
2021/22		220	270	245					245			245.0
2022/23		220	275	247.5					247.5			247.5
2023/24		235	290	262.5					262.5			262.5
2024/25		240	295	267.5					267.5		31.0	298.5
2025/26		245	300	272.5					272.5		31.0	303.5
2026/27					245	305	275		275		31.0	306.0
2027/28					250	315	282.5		282.5		31.0	313.5
2028/29					245	320	282.5		282.5		31.0	313.5
2029/30					240	320	280		280		31.0	311.0
2030/31					240	325	282.5		282.5		31.0	313.5
2031/32								284.3	284.3	39.4	31.0	354.7
2032/33								285.5	285.5	39.4	31.0	355.9
2033/34								286.8	286.8	39.4	31.0	357.2
2034/35								288.0	288.0	39.4	31.0	358.4
2035/36								289.3	289.3	39.4	31.0	359.7
2036/37								290.5	290.5	39.4	31.0	360.9
2037/38								291.8	291.8	39.4	31.0	362.2
2038/39								293.0	293.0	39.4	31.0	363.4
2039/40								294.3	294.3	39.4	31.0	364.7
2040/41								295.5	295.5	39.4	31.0	365.9


Total Construction Expenditure Forecast
for Public and Private Sectors (2021/22 to 2040/41)
Increase by $31.0+39.4=$70.4 billion/year due to Northern Metropolis and Lautau Tomorrow Vision
Increase by $31.0 billion/year due to Northern Metropolis
Trendline:
y=1.25x+258
Construction Expenditure (HK$ Billion)
(in September 2020 Prices)
450
400
350
300
250
200
150
100
50
0
2011/12
2012/13
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Year
CIC's Actual Expenditure from 2011/12 to 2020/21
CIC's Mid-Term Forecast from 2021/22 to 2025/26
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HKIE's Long-Term Forecast from 2031/32 to 2040/41 based on Linear Regression Model
Total Construction Expenditure